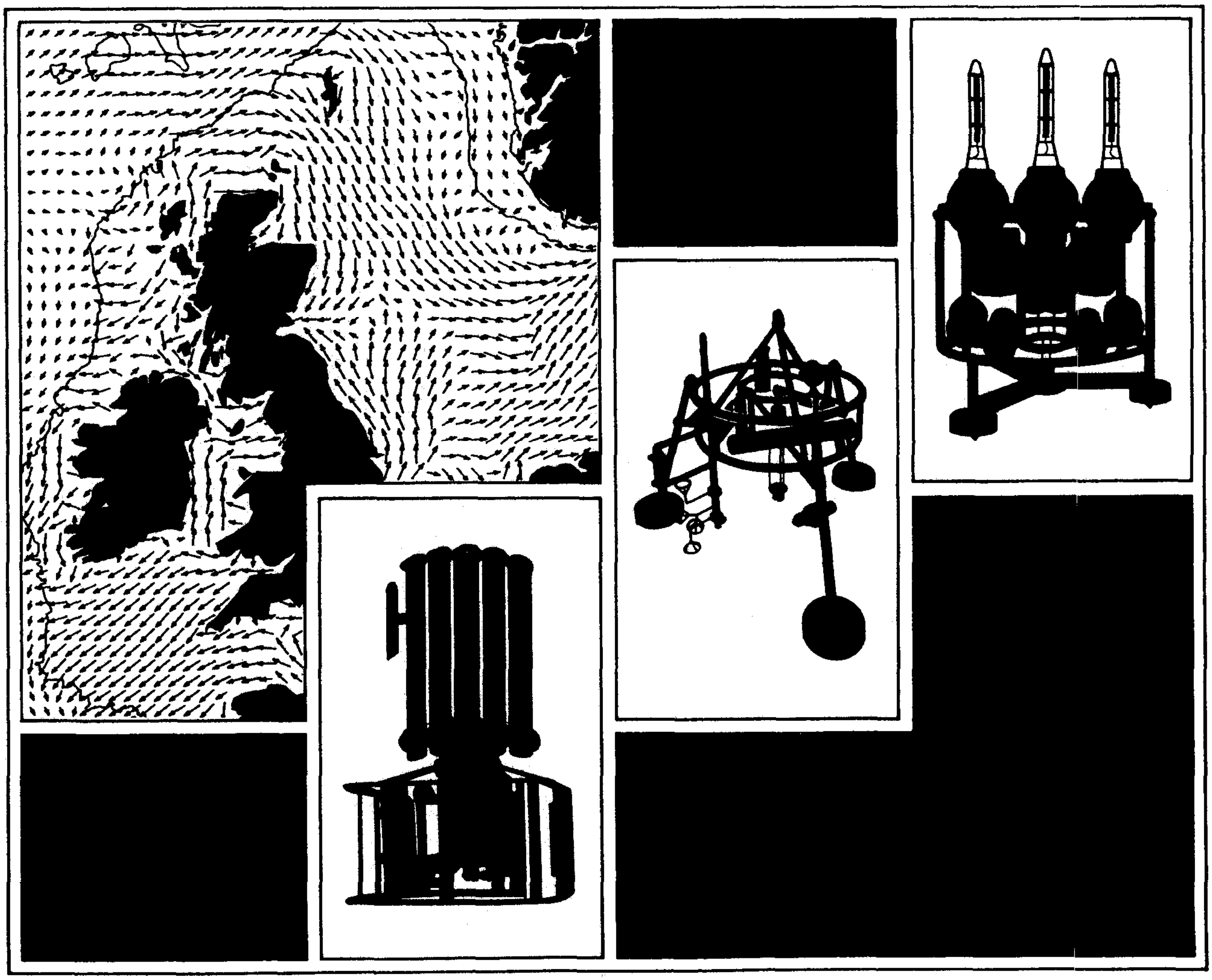
Proudman Oceanographic Laboratory

The depth – averaged residual circulation on the North West European Shelf

August 1988 – October 1989

R Proctor and JA Smith

Report No 20 1991



Natural Environment Research Council

PROUDMAN OCEANOGRAPHIC LABORATORY

Bidston Observatory,
Birkenhead, Merseyside, L43 7RA, U.K.

Telephone: 051 653 8633
Telex 628591 OCEANB G
Telefax 051 653 6269

Director: Dr. B.S. McCartney

Natural Environment Research Council

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AUTHOR PROCTOR, R. & SMITH, J.A.	*PUBLICATION DATE* 1991
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ISSUING ORGANISATION Proudman Oceanographic Laboratory Bidston Observatory Birkenhead, Merseyside L43 7RA UK Director: Dr B S McCartney	*TELEPHONE* 051 653 8633 *TELEX* 628591 OCEAN BG *TELEFAX* 051 653 6269
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REPORT No. 20

The Depth-Averaged Residual Circulation on the North-West European Shelf, August 1988 to October 1989.

R. Proctor and J.A. Smith

1991

1. INTRODUCTION

The North Sea Project evolved from a NERC review of shelf sea research in which the need for a multidisciplinary study of the North Sea was identified. Subsequent working groups of interested scientists developed the project, resulting in its adoption by NERC as a Marine Sciences Community Research Project running from 1987 to 1992.

Particular emphasis has been placed on circulation, transport and production - the former being of particular importance in relation to man's activities. By acquiring a more detailed knowledge of the seasonal movement of water, the fate and impact of anthropogenic input can be determined under different scenarios and can be distinguished from natural variability.

The North Sea Project Survey covered the period from August 1988 to October 1989. A 15 month period was chosen to enable any interannual variations that may occur to be observed and studied, in addition to seasonal variations. Cruises were undertaken every month, over a pre-defined survey track (Figure 1), during which extensive quantities of data were collected. Many parameters were measured including temperature, salinity, currents, suspended sediments and oxygen. Such data have enabled the calibration of models and, in addition, have proved invaluable in verifying model results.

A model of circulation is required primarily as a basis for predicting seasonal variations. This model is, by necessity, complex, needing to resolve fine structure including horizontal and vertical stratification; fronts and eddies; tides and meteorological effects. The model is currently under development. However, a first order insight into the circulation is obtained from a much simpler model - a 2D homogeneous depth integrated model. A 'user-friendly' version of this 2D model is available (Jones, 1991) for use by other participants who are, in turn, able to adapt it to a variety of applications such as the dispersion of contaminants, and the distribution of temperature, sediments and oxygen.

The data presented herein represents the first results of a model study relating to the depth-averaged circulation of the north-west European shelf during the North Sea Survey period. The results of this study fall into three categories:

i. Verification of model results by comparison with observational data in the form of:

a. Residual elevations at two standard ports, namely Heysham (west coast and Sheerness (east coast).

b. u (east) and v (north) components of current - obtained from long-term current meter records at sites located within the North Sea.

ii. An investigation into the seasonal variability of volumetric flow through selected transects of the model grid.

iii. Digital atlas of the North Sea - containing u and v components of daily (25 hour) mean residual (tide + surge) flow and corresponding variances. This data set covers the North Sea Project Survey period.

The model data originate from two separate, but identical models. Most of the meteorologically induced currents and elevations (surge data) were obtained from the operational storm surge model which runs operationally at the U.K. Meteorological Office (Flather et al., 1991). These data are archived at POL. From time to time problems in operational running result in gaps occurring in the archived data. These gaps have been filled by running an identical model at POL using meteorological data obtained from the Meteorological Office. The same model has been used to reproduce the tides over the 15 month period.

In August 1991 the operational surge model was revised and a new, higher resolution model ($1/9^{\circ}$ latitude x $1/6^{\circ}$ longitude) implemented. This is part of the ongoing development which will lead to a combined wave-tide-surge model (Wolf et al., 1988) in which all interaction effects are considered.

2. THE MODEL

Tide and surge motion can be represented in terms of the following equations:

$$\frac{\partial\zeta}{\partial t}+\frac{1}{R\cos\phi}\left\{\frac{\partial}{\partial\psi}(D\bar{u})+\frac{\partial}{\partial\phi}(D\bar{v}\cos\phi)\right\}=0 \tag{1}$$

$$\frac{\partial\bar{u}}{\partial t}+\frac{\bar{u}}{R\cos\phi}\frac{\partial\bar{u}}{\partial\psi}+\frac{\bar{v}}{R\cos\phi}\frac{\partial}{\partial\phi}(\bar{u}\cos\phi)-2\omega\sin\phi.\bar{v}=\frac{-g}{R\cos\phi}\frac{\partial\zeta}{\partial\psi}-\frac{1}{\rho R\cos\phi}\frac{\partial p_a}{\partial\psi}+\frac{1}{\rho D}(F_S-F_B) \tag{2}$$

$$\frac{\partial\bar{v}}{\partial t}+\frac{\bar{u}}{R\cos\phi}\frac{\partial\bar{v}}{\partial\psi}+\frac{\bar{v}}{R}\frac{\partial\bar{v}}{\partial\phi}+\bar{u}^2\tan\phi+2\omega\sin\phi.\bar{u}=\frac{-g}{R}\frac{\partial\zeta}{\partial\phi}-\frac{1}{\rho R}\frac{\partial p_a}{\partial\phi}+\frac{1}{\rho D}(G_S-G_B) \tag{3}$$

Equation 1 is the equation of continuity which represents a conservation of volume, i.e. inflow or outflow resulting in a change of surface elevation. Equations 2 and 3 show that force is equal to acceleration, per unit mass, where the forces involved are those experienced due to meteorological effects, i.e. wind and atmospheric pressure, and tides. The effect of atmospheric pressure is to raise or lower the sea surface (approximately +1cm for every 1mb below normal atmospheric pressure, and -1cm for every 1mb above). Wind stress is calculated from the mean value of wind speed (nominally 10m above the sea surface) by applying the quadratic stress law:

$$\underline{\tau}_S=C_D\,\rho_a\,\underline{W}\,|\underline{W}|$$

where C_D is the coefficient of drag - a function of sea surface roughness - which is empirically related to the wind speed as follows (Smith and Banke, 1975):

$$C_D \times 10^3 = 0.63 + 0.066\ \mathrm{W}$$

Similarly, a quadratic stress law relating the depth mean current will yield the bottom stress:

$$\underline{\tau}_B = \rho K \underline{q}\, |\underline{q}|$$

At a coastline, the boundary condition is:

$$q_n = 0$$

where q_n is the component of depth mean current along the outward directed normal to the boundary.

For an open sea boundary, a 'radiation' condition is used:

$$q_n = q_n^{\mathrm{M}} + q_n^{\mathrm{T}} + \frac{c}{h}(\zeta - \zeta^{\mathrm{M}} - \zeta^{\mathrm{T}}) \qquad c = \sqrt{gh}$$

This condition allows disturbances generated within the model to propagate outwards across the boundary as free progressive waves.

Equations 1 to 3 are solved using finite difference approximations on an Arakawa 'C' grid. The model grid covers the north-west European continental shelf and can be seen in Figure 2. Each grid box measures 20' latitude and 30' longitude. The first (top left-hand corner) grid box has its centre located at 62.5°N, 15.75°W. The model grid comprises 57 columns and 52 rows.

In order to determine variation due to meteorological effects, meteorological data from the Meteorological Office's 15 level fine grid weather forecasting model is used. The grid points of this model can be seen in Figure 2, superimposed on the surge model grid. Hourly values of atmospheric pressure at sea level and wind velocity components for the lowest level of this model (σ=0.997, approximately 25m) are used. These values are converted into sea surface elevations equivalent to hydrostatic pressure and wind stress at 10m above sea level, respectively, and then linearly interpolated onto the surge model grid points.

Storm surge residuals are obtained using data output from two model runs. Firstly the model is run for tide only without meteorological data. The second run includes the input of meteorological data. The storm surge residuals are obtained by subtracting the results of the first run from the second. This procedure enables tide-surge interaction - an important process for the propagation of surges in shallow water - to be accounted for. At the Meteorological Office, the model runs twice a day every day throughout the winter months (August to May) and produces a forecast up to 36 hours ahead, preceded by a 12 hour hindcast which makes use of assimilated meteorological observations. The hindcast provides the best possible initial conditions for each forecast. Initial conditions are set to zero at the beginning of the storm surge season (usually some date in August). Initial data for subsequent forecasts are taken from a previous forecast. Data are saved every 12 hours of the 36 hour forecast allowing some continuity should operations be disrupted. A restart with zero initial conditions is only performed if more than three successive forecasts are missing. Model arrays at hourly intervals of the hindcast are routinely saved for subsequent use. This data is archived to tapes which are subsequently transferred to POL. Approximately 73% of the surge data were retrieved from the archive. Additional model data, to complete the 15 month period were derived at POL.

3. DATA PROCESSING

Hourly values of tide and surge (ζ , u and v) were combined to produce the residual circulation of the North Sea and the seasonal flow around the north-west European continental shelf. The data for the 15 month survey period were sorted and stored as separate monthly files of tide and surge, giving 30 files in all, 15 files containing hourly values of tide and 15 files containing the hourly values of meteorologically induced surge. From these data three sets of results are presented:

(i) A comparison of model and observed data. Long-term current meter records were available from meters located as shown in Figure 3 and Table 1. As meters were situated at various depths throughout the water column, the meter closest to the depth mean value (0.4 x total depth) was chosen for comparison. The data from these meters were filtered using a low pass filter with a cutoff of 72 hours. This eliminated the tidal signal, leaving the slowly varying, mainly meteorological, component. An example of a record filtered in this way is shown in Figure 4 along with the filter response curve. For comparison, model surge data were extracted at the measurement sites by linearly interpolating the values of current at the model grid points to the current meter location. Theese data were filtered in the same way as the observed series.

Observed residual elevations are available for the ports in the Tide Gauge Network. Two ports have been chosen, Heysham (H) on the west coast of England, and Sheerness (S) on the east coast, on the basis of their continuous data sets extending over the period of interest. These locations are shown on Figure 3.

(ii) Several transects at strategic locations of the model grid were chosen (Figure 3), and the volumetric flow calculated. These calculations used only the surge component. The flux due to the tidal residual was not included, although an estimate of its magnitude is given, for each section, in Table 2. This table gives the mean value of one month's data (April 1989), which is representative of the 15 month period. The tidal residual does vary with the spring-neap cycle but that is not discussed here.

Flow at hourly intervals across u and v sections was calculated as follows:

For flow across a u element:

$$FLUX=(h+\zeta).u.R.\Delta\phi$$

For flow across a v element:

$$FLUX=(h+\zeta).v.R.\cos\phi.\Delta\psi$$

Individual u or v element flow were summed to give the total flux through a section. Daily mean flows and monthly mean flows are presented for all sections.

(iii) A sub-grid of the model area was chosen to encompass the southern North Sea, from 51°N to 57°N and from 3°W to 9°E (Figure 5). In this area daily (25 hour) means and variances of u and v components of total (tide plus surge) current were calculated and subsequently stored as a digital atlas.

4. RESULTS

4.1. Elevation Comparisons.

By virtue of the physical simplifications involved, a depth-averaged model is ideally suited to compute sea level variations. Comparisons of elevations produced by the model and those obtained from observational data can be seen in Figure 6. Both an east coast (Sheerness) and a west coast (Heysham) port were selected for this purpose. These comparisons are presented as an indication of the agreement between observed and computed surge levels. More detailed comparisons are done routinely as part of the monitoring of the operational surge model performance.

4.2. Current Component Comparisons.

Current meters were moored at six sites within the North Sea area. These are shown in Figure 3 and described in Table 1. Three of these sites, namely A, C and F, were chosen as a compromise between being spatially representative of this area and having the most complete data sets available for analysis. Monthly time series of filtered model surge currents at locations A, C and F are shown for the full 15 month period in Figure 7. Also plotted in this figure are the similarly filtered observed currents for all periods when measurements were made. Data are plotted at 3 hour intervals. Agreement can be assessed visually and by simple correlations of the components of current, given in Table 3. Residual currents of more than $0.2ms^{-1}$ are computed in the storm periods and visual inspection of the time series reveals generally good agreement in the winter months, with some discrepancies in the summer, particularly in the northern stratified region (Station A), where density differences will influence the vertical current structure. The correlation coefficients quantify the comparisons, with high correlations in the winter months and lower correlations in the summer, although the differences are less in the well mixed southern North Sea. Data obtained from the Acoustic Doppler Current Profilers (ADCP) located at stations A and C are subject to arbitrary datum shifts, the cause of which is presently under investigation. Further information relating to the six current meters deployed in the North Sea and the data retrieved from them can be found in Knight et al., 1990 (b), (e), (f), and Knight et al., 1991 (a), (c), (d).

4.3. Volumetric Flows.

Fluxes have been calculated across the sections shown in Figure 3. For each section, time series of daily mean flows are given in Figure 8 and time series of monthly mean flows are given in Figure 9. Section numbers refer to the locations shown in Figure 3. A number of these sections have been the subject of flux investigations by other authors and are discussed below.

Data represented in Figure 8 show large variability on a daily time scale for the majority of sections. Seasonal patterns are apparent in Figure 9 for most locations. These are typified by an increased flux during the months November to March, reaching a peak during January and February. In the case of the Irish Sea sections (4 to 7), the fluxes during these months were negative - indicating southerly flow. This contradicts circulation patterns derived for this region from previous studies (e.g. Prandle, 1984; Proctor, 1981) and, as such, demonstrates that the period November 1988 to March 1989 is anomalous. In general, fluxes correlate well with wind stress, and the passage of weather systems. The data reveal the generally accepted circulation pattern for the north-west European shelf; a clockwise circulation around the north of Scotland and an anticlockwise circulation in the southern North Sea.

A brief description follows of the flow through some of the sections, and their comparison with previous estimates and observations.

4.3.1. Faeroe-Shetland Channel (Section 9).

This is a deep water channel of depths in excess of 1000m in some parts. Flow through this channel is a consequence of the complicated movement of four water masses moving in different directions at different levels (Dooley et al., 1981). During the Overflow '73 experiment, the net flux of water was found to be 2.0Sv (1 Sverdrup = $10^6 m^3 s^{-1}$) towards the Atlantic (Dooley et al., 1981). However, the movement of Atlantic water within the surface layers results in a flux of 1.7Sv (van Aken and Eisma, 1987) into the North Sea. The water movement in this area is not generally related to wind (Dooley et al., 1981) and it is not therefore sensible to compare observed flows directly with those obtained during this study as it is apparent that other forces govern the circulation of this region. A 12 month mean value (November 1988 to October 1989) obtained from the model data presented within this report shows a comparatively weak inflow to the North Sea of 0.05Sv, with a marked monthly increase during periods of severe weather conditions (e.g. January, 0.42Sv). In general, the residual flow values obtained here are significantly less than previous estimates. Meteorologically induced flow is only one component of water movement in a region in which the density driven movement of water masses predominates.

4.3.2. Fair Isle Passage (Section 11).

A study of the residual flow within the Fair Isle current was recently made during the Autumn Circulation Experiment (Turrell and Henderson, 1990). This showed the flow to vary seasonally, with the effect of the wind on the flow related to the degree of stratification in the water column. To this end, Turrell and Henderson (1990) proposed two distinct seasonal circulation regimes based on the degree of stratification within the water column. These were further sub-divided to take into account a variation due to wind direction. During the stratified summer months it was deduced that a large non-wind driven component was present. This was no longer evident during winter months when enhanced vertical mixing resulted in a largely homogeneous water column, and the wind became the primary driving mechanism of flow.

Monthly mean values of flux from the model data show flow nearly always into the North Sea with the maximum inflow occurring during January (0.9Sv). Reversal of flow was only seen on one occasion over this period, during April for which the flux was calculated as -0.04Sv.

Turrell and Henderson (1990) selected several diverse meteorological events occurring between September and November 1987 for which the response of the flow was investigated. A maximum outflow was found to be 0.15Sv during the passage of a secondary depression, and a maximum inflow of 1.02Sv occurred during the passage of a severe storm. During the present study, February was found to be the most extreme month in terms of meteorological events. The passage of a storm on the 22nd and 23rd yielded a flux of approximately 2Sv and a secondary depression passing on the 26th and 27th resulted in a maximum daily outflow of approximately 0.3Sv. These results compare well with those of Turrell and Henderson, and demonstrate the highly variable nature of the flow and the large variation that can occur in response to the passage of weather systems.

4.3.3. Pentland Firth (Section 10).

The 15 month time series shown in Figure 9 for the Pentland Firth shows inflow into the North Sea almost entirely throughout this period, increasing during winter months. A twelve month mean value for this flux (November 1988 to October 1989) is 0.039Sv. This value is in reasonable agreement with previous studies; a value of 0.02Sv was obtained from the Autumn Circulation Experiment (W.R. Turrell, personal communication), and 0.03Sv was obtained from ICES (1983). Results of a recent modelling study using a depth-averaged, 8km grid model of the north-west European continental shelf, show that a westerly wind stress of $0.1Nm^{-2}$ generated a flux of 0.04Sv (J.E. Jones, personal communication). However, Prandle (1980), from voltage recordings induced by flow across submarine telephone cables, deduced that there was little evidence of wind-driven flow through the Pentland Firth, and that the residual flow was possibly attributable to the propagation of external surges.

4.3.4. Scottish Coastal Current (Section 8).

In this study, a section of the Scottish coastal current was chosen between Scotland and the Hebrides (The Minch, section 8). Model results show positive flow (northwards) for all months with the exception of April, where a small reverse flow of 0.01Sv was evident (Figure 9). Maximum flow occurred during January (0.2Sv) with generally large fluxes (greater than 0.08Sv) during the winter months. A 12 month mean (November 1988 to October 1989) yields the value 0.07Sv. This is slightly lower than values obtained during other studies. Observed values from two sources are a) 0.17Sv Turrell (personal communication) from the Autumn Circulation Experiment and b) 0.11Sv obtained from the distribution of radiocaesium by McKay et al. (1986). Recent studies using an 8km grid model (see above) have resulted in flux values for conditions of uniform wind stress ($0.1Nm^{-2}$). For a westerly wind stress, flux was found to be $0.7x10^{-4}$Sv and for northerly wind stress this value was -0.12Sv (J.E. Jones, personal communication). The mean track of depressions across the British Isles results in wind stress from the south-west. Assuming linearity (Pingree and Griffiths, 1980), the above values can be adjusted for the annual mean wind stress components given by Prandle (1984), to give a value of 0.05Sv based on a south-westerly wind stress.

4.3.5. Irish Sea (Sections 4 to 7).

Four sections of the Irish Sea were selected: St. George's Channel (section 4), west and east of the Isle of Man (sections 5 and 6, respectively) and the North Channel (section 7). The 15 monthly fluxes shown in Figure 9 show an atypical southward flow occurring through three sections for the majority of this period. Previous studies have shown the presence of a weak but well defined northward flow through the North Channel (total annual mean, 0.06Sv), determined from the movement of low level caesium 137 discharged into the Irish Sea from the Sellafield nuclear reprocessing plant (Prandle, 1984). Howarth (1982) determined that wind stress is the major driving force of flow through the North Channel, and, under conditions in which wind stress is directed into the Irish Sea, inflow is enhanced. The twelve month mean value from the present study (November to October) is -0.04Sv.

Southward flow occurs west of the Isle of Man (-0.05Sv), while a comparatively smaller, northward flow occurs to the east (0.01Sv) - indicating an anticlockwise circulation around the Isle of Man during this period. These values appear atypical, and are contrary to results from other studies. For example, fluxes obtained for these sections during a modelling study by Proctor (1981) using mean annual wind stress values were 0.007Sv (west) and 0.0028Sv (east).

4.3.6. North Sea (Sections 12 to 17).

The North Sea sections (12 to 17), with the exception of section 13d, show large seasonal variability, with flow being significantly enhanced during the winter months. Section 12a shows inflow into the North Sea throughout the 15 month period (12 month mean, -0.16Sv). Section 12b, the Norwegian Coastal Current, shows a corresponding outflow, of greater magnitude (0.44Sv, 12 month mean). This flow is highly variable in nature, the variability being related primarily to the changing wind fields over this area (de Ruijter et al., 1987). The maximum outflow through the Norwegian Trench during this period occurred in January 1989, where a mean flux of 1.12Sv was calculated. A small reversal of flow occurred during April, the mean flux for this month being -0.04Sv. A range of values for Norwegian Channel outflux has been obtained from studies by Hainbucher et al. (1986) and ICES (1983) (reviewed by Otto et al., 1990), in which flux through this area was found to be 1.34-1.80Sv (long-term mean values). Another estimate of this outflux is given in a review of North Sea circulation by de Ruijter et al. (1987) as being 1Sv (mean).

A new hypothesis concerning the circulation of the northern North Sea has recently been formulated by Turrell (in press) based on observational data collected during the Autumn Circulation Experiment. The major contradiction of Dooley's (1974) earlier hypothesis, is the presence of an inflow of Atlantic water east of Shetland. This is a warm, saline current 20-30km wide, and, according to Turrell, is associated with a total inflow of 0.26Sv, of which 0.1-0.2Sv is wind-driven. In order to investigate whether such an inflow was discernable from the model data, a subsection of section 12a (section 17) was chosen. Inflow through this section can be seen throughout the 15 month period, with the exception of September 1989. However, the 12 month mean value of flux was calculated to be -0.028Sv (negative value denoting inflow), which is one order of magnitude less than Turrell's value.

4.3.7. Dover Strait (Section 1).

Data from this study show neither persistent inflow (to the North Sea) or outflow, however outflow is apparent during winter months. A 12 month mean (November 1988 to October 1989) results in a value of -0.006Sv (i.e. out of the North Sea). Maximum inflow occurs during October 1988 (0.041Sv) and maximum outflow during September 1989 (-0.029Sv). Flow through the Dover Strait has been the subject of much study. Prandle (1978, 1980) constructed monthly tables of flux values for the period 1949-1980 based on model results using observational wind data. A value of 0.123Sv was added to these data to account for the tidally induced residual flow and the flow due to a long term gradient in mean sea level. A mean value obtained for the entire period of Prandle's study was 0.155Sv. Deducting the tidal residual from this value would provide a more valid basis for comparison with the model data described here, which is the meteorologically-driven component of the flow. This adjusted value is 0.032Sv. Table 3 shows Prandle's mean annual values for flow through the Dover Strait adjusted in this way. It can be seen from this table that the mean annual value obtained during this study is considerably lower than those obtained by Prandle and is directed out of the North Sea. Another value for flow through the Dover Strait was obtained by Prandle (1984) during a study into the mixing of caesium 137 on the continental shelf. This component of this flux, associated with a wind stress of $0.1Nm^{-2}$ applied from 196°, results in an inflow of 0.08Sv.

4.4. Daily Mean Distributions.

Daily mean distributions of elevations and currents can be found in the Appendix. The distributions are based on the 25 hour mean of the ζ, u and v components of tide + surge. The u and v components of current are represented in vector form and elevations (ζ) are contoured over the model area. Significant variability in circulation can be seen, both spatially and through time. For example, during August 1988, circulation is not well defined for most of the month as this is a relatively quiescent period. In contrast, circulation is well defined during February 1989, a month noted for the occurrence of storms. General circulation patterns are apparent; for much of the time flow occurs in a northerly direction along the west coast of Ireland and clockwise around the north-western coast of Scotland. There is inflow through the Fair Isle passage and the Pentland Firth which splits into two main flows; one is in a southerly direction along the east coast of Britain and the other follows the 100m isobath in a south-easterly direction - often described as the Dooley current. Anticlockwise circulation is evident in the southern North Sea. These current patterns reflect the typical movement of weather systems affecting the European continental shelf, i.e. depressions forming in the Atlantic north-west of Scotland and moving steadily eastward over a 2-3 day period. However the circulation can be markedly altered and even reversed by less typical weather situations, e.g. 25th May 1989, when a high pressure system was centred on the U.K. A more detailed analysis of the circulation variability during this period will appear elsewhere.

4.5. Digital Atlas.

Daily mean u and v components of current, as shown in the Appendix have been stored for each model grid box within the area of the North Sea extending from 51°N to 57°N, and from 3°W to 9°E. This sub-grid comprises of 18 rows and 24 columns - a total of 432 grid boxes (Figure 5). A grid box measures 1/2° longitude by 1/3° latitude. Each data value is associated with the centre of the grid box it represents. Daily mean residual current data covering the period 01/08/88 to 31/10/89 fit on two 1.44mb floppy disks. These data are available from the British Oceanographic Data Centre (BODC) as part of the North Sea Project data base.

5. CONCLUSIONS

Numerical model calculations of the depth-averaged circulation on the north-west European continental shelf have been presented for the 15 month period of the North Sea Project Survey, August 1988 to October 1989.

Comparison of computed and observed meteorologically-induced elevations show good agreement throughout the period. Comparison of depth-averaged currents with the mid-depth currents observed at the North Sea Project long-term moorings show a) good agreement in the shallow, well-mixed Southern North Sea throughout the year, and b) variable agreement in the deeper northern North Sea especially during summer when stratification takes place, although some of this variability can be attributed to calibration problems with the ADCP.

Calculations of volume fluxes across selected sections of the shelf show marked day-to-day and month-to-month variability in the meteorologically driven flow. Where possible, calculations of these flows are compared with similar estimates available in the literature. The comparisons suggest that the flows were atypical, especially on the west coast of Britain, during the period October 1988 to March 1989. The daily mean circulations demonstrate the variability of current experienced by the shelf waters. Although the accepted features of circulation on the shelf are more or less persistent - north-eastward flow along the north-west Scottish shelf, anticlockwise flow around the southern North Sea, eastward flow along the 100m isobath in the northern North Sea - these are frequently altered, and sometimes reversed, by variations in atmospheric circulation.

A subset of the model data, the daily mean currents in the southern North Sea, is available as part of the North Sea Project data base held at POL.

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GLOSSARY

ψ,ϕ	longitude and latitude
t	time
ζ	elevation of the sea surface
u,v	components of depth mean current, q
D	total depth of water $(h+\zeta)$
h	still water depth
R	radius of the Earth
ω	angular speed of rotation of the Earth
g	acceleration due to gravity
ρ	density of sea water (1025 kgm^{-3})
p_a	surface atmospheric pressure
F_S,G_S	components of wind stress, τ_S, on the sea surface
F_B,G_B	components of bottom stress, τ_B
ρ_a	density of air (1.25 kgm^{-3})
W	wind speed (ms^{-1})
K	friction parameter (0.0025)
M	input of meteorological origin
T	input of tidal origin

SITE NAME	POSITION	WATER DEPTH (m)	METER HEIGHT (m)
A	55°29.97'N 00°54.00'E	85	31
B	55°29.90'N 05°30.40'E	52	27
C	54°20.43'N 00°23.93'E	60	23
D	53°30.00'N 03°00.00'E	31	12
E	52°41.23'N 02°25.43'E	49	20
F	52°37.70'N 03°45.20'E	30	12

TABLE 1. Current meter sites

SECTION NUMBER	TIDAL FLUX (Sv)
1	0.0398
2	-0.1835
3	-0.1147
4	0.0005
5	0.0314
6	-0.0187
7	-0.0062
8	0.0034
9	0.2561
10	0.0604
11	0.0758
12a	-0.6738
12b	0.2214
13a	-0.8484
13b	0.4797
13c	0.2307
13d	-0.0110
14a	-1.7088
14b	0.9041
15a	-1.9779
15b	1.3272
16a	-0.3606
16b	0.6255

TABLE 2. Flux due to tidal residual (April 1989)

SITE A	u	v
10/88	0.11	0.34
11/88	0.82	0.95
03/89	0.84	0.67
04/89	0.71	0.55
05/89	0.73	0.33
06/89	0.82	0.39
07/89	0.23	0.35
09/89	0.16	-0.02
SITE C		
10/88	0.28	0.84
11/88	0.43	0.51
12/88	0.84	0.79
01/89	0.61	0.86
02/89	0.84	0.85
03/89	0.65	0.90
04/89	0.76	0.40
05/89	0.39	0.70
07/89	0.57	0.79
08/89	0.66	0.41
09/89	0.35	0.60
SITE F		
08/88	0.36	0.71
09/88	0.80	0.86
10/88	0.61	0.76
11/88	0.79	0.93
01/89	0.89	0.87
06/89	0.26	0.62
07/89	0.99	0.59
08/89	0.73	0.93
09/89	0.89	0.84

TABLE 3. Correlation statistics for current comparisons

YEAR	METEOROLOGICALLY INDUCED FLUX (Sv)
1949	0.034
1950	0.042
1951	0.056
1952	0.006
1953	0.029
1954	0.057
1955	0.005
1956	0.023
1957	0.027
1958	0.030
1959	0.043
1960	0.054
1961	0.041
1962	0.030
1963	0.030
1964	0.016
1965	0.039
1966	0.038
1967	0.059
1968	0.022
1969	0.012
1970	0.031
1971	0.015
1972	0.038
1973	0.049
1974	0.053
1975	0.018
1976	0.022
1977	0.040
1978	0.036
1979	0.054
1980	0.038

TABLE 4. Mean annual flux values for the Dover Strait (after Prandle, 1980)

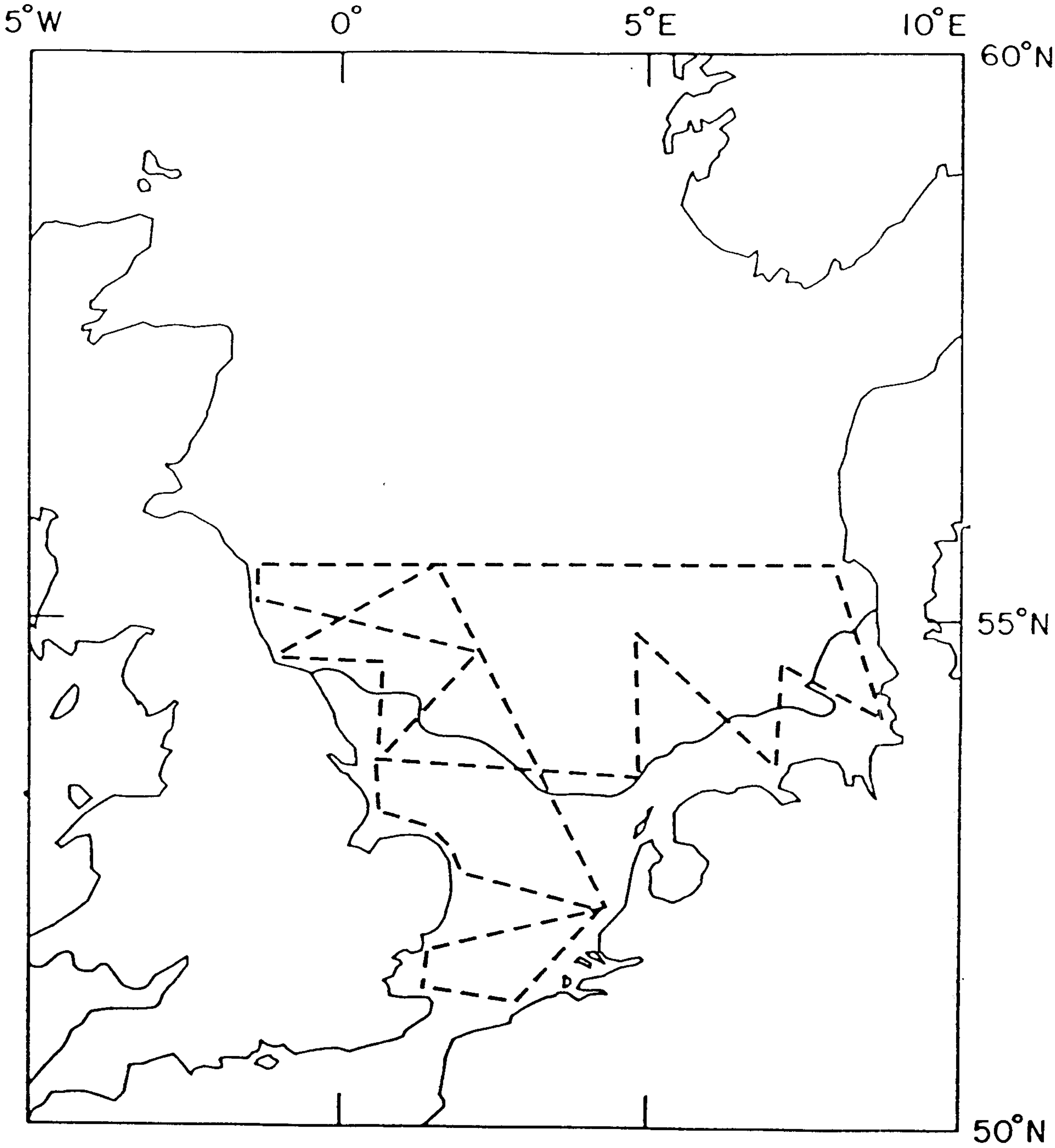


FIGURE 1. North Sea Project Survey track

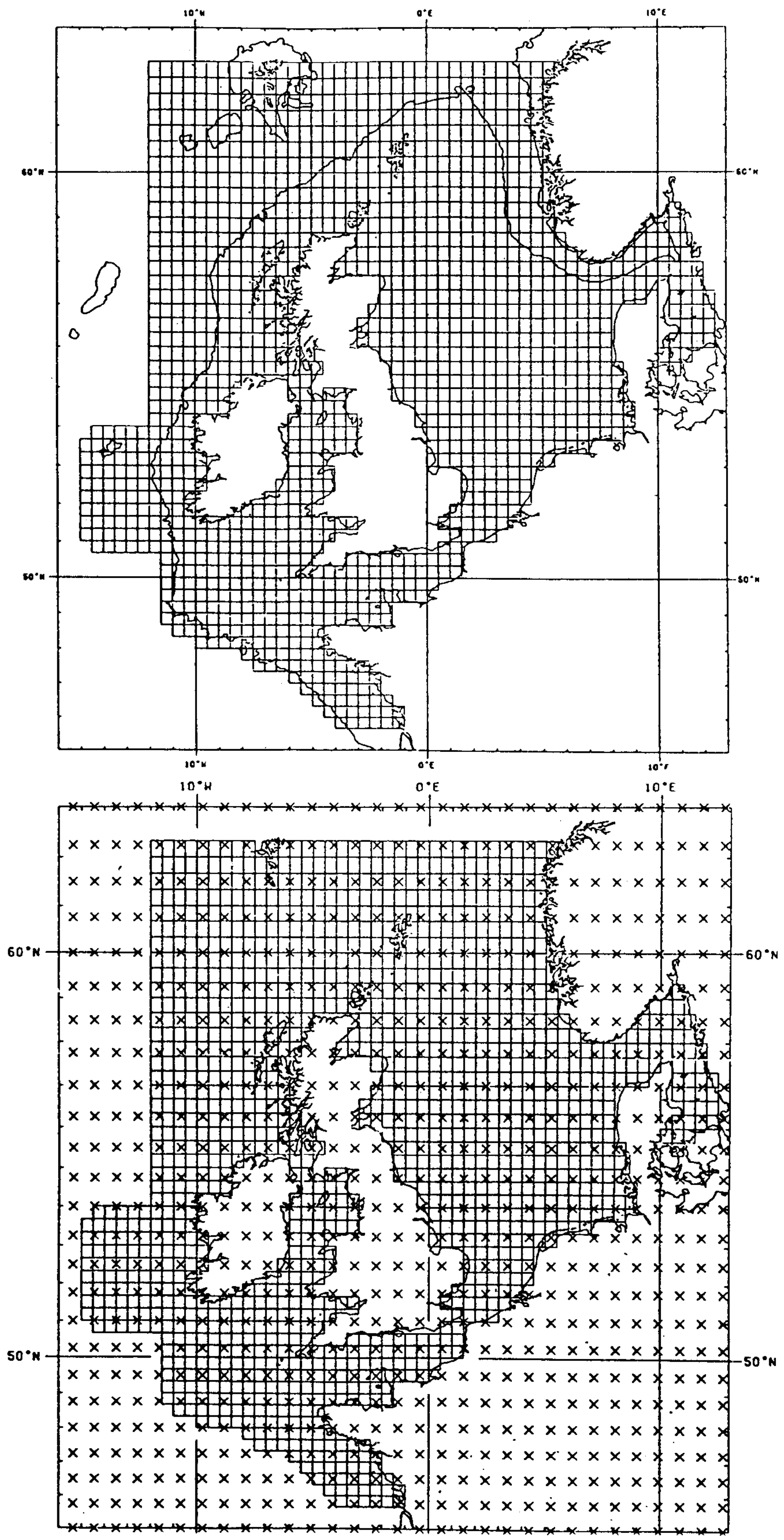


FIGURE 2. Model grid (above) and Met. Office atmospheric model grid points (below)

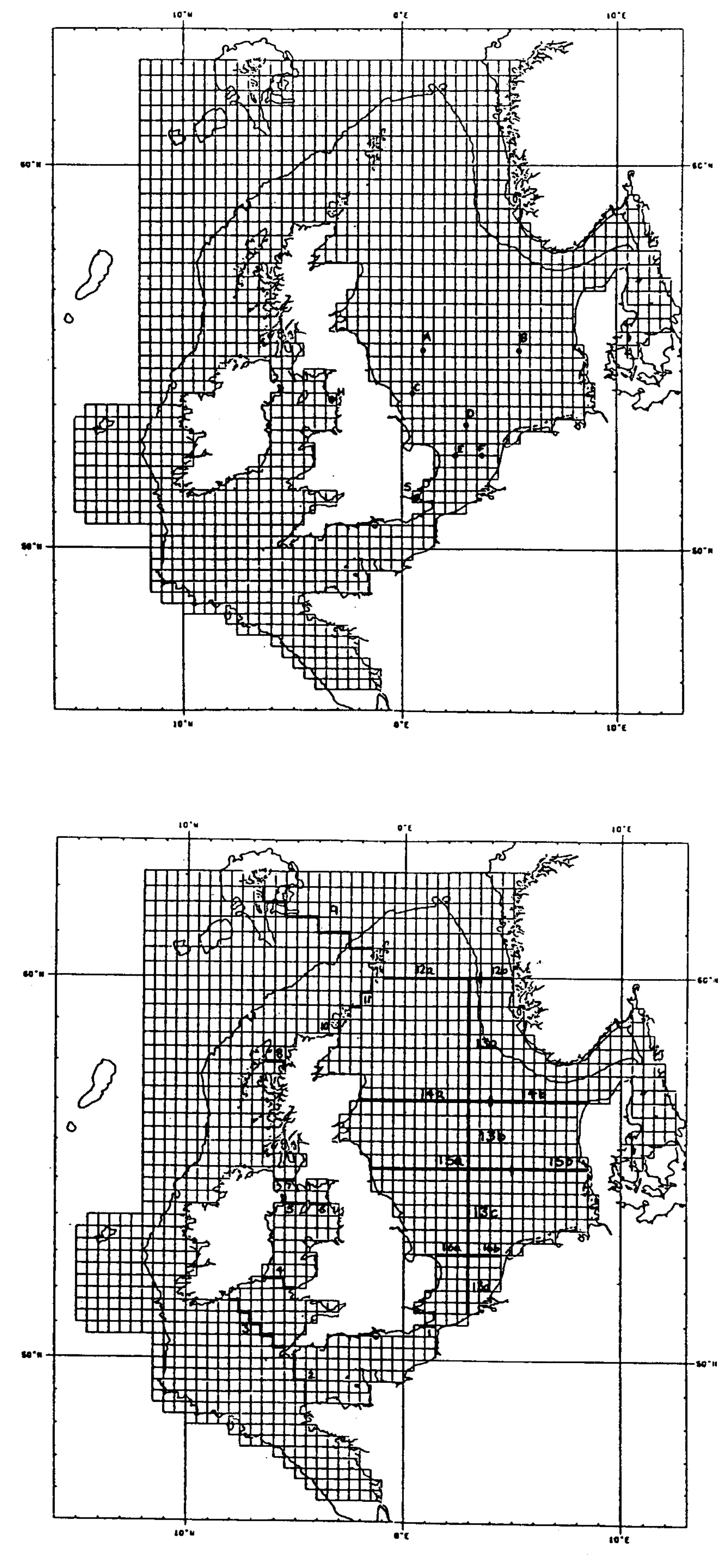
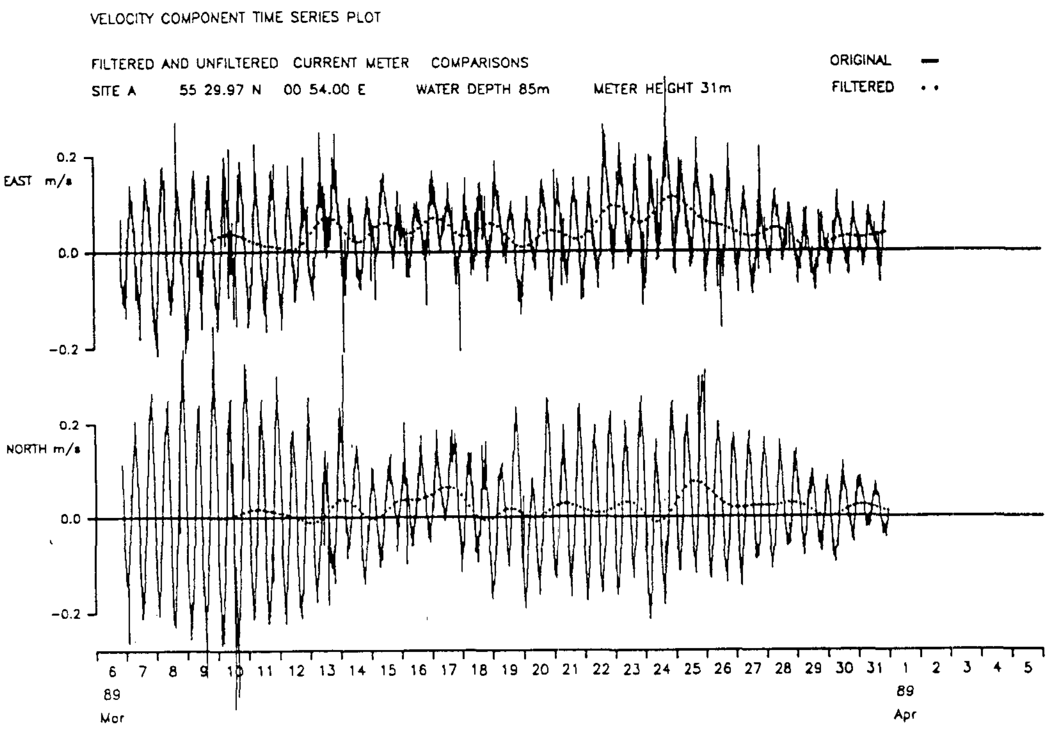


FIGURE 3. Locations of long-term current meters and flux sections



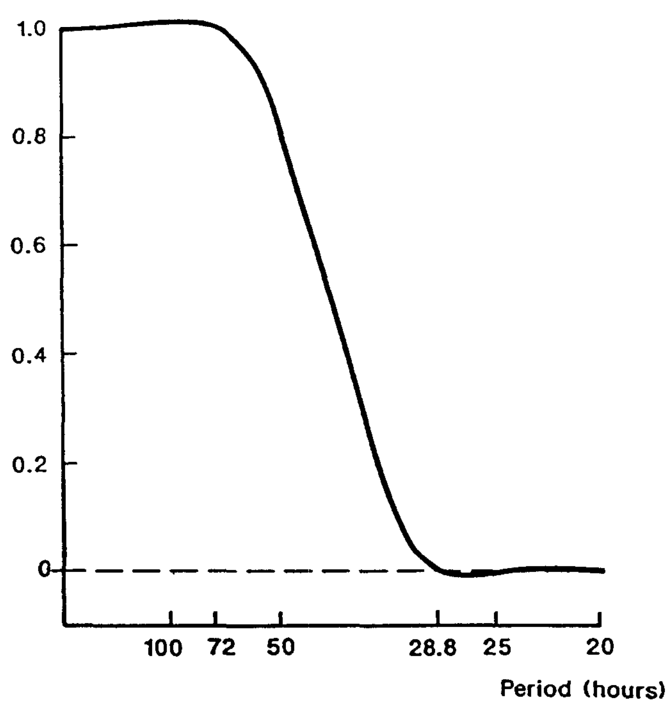


FIGURE 4. Filtered current meter record and filter response curve

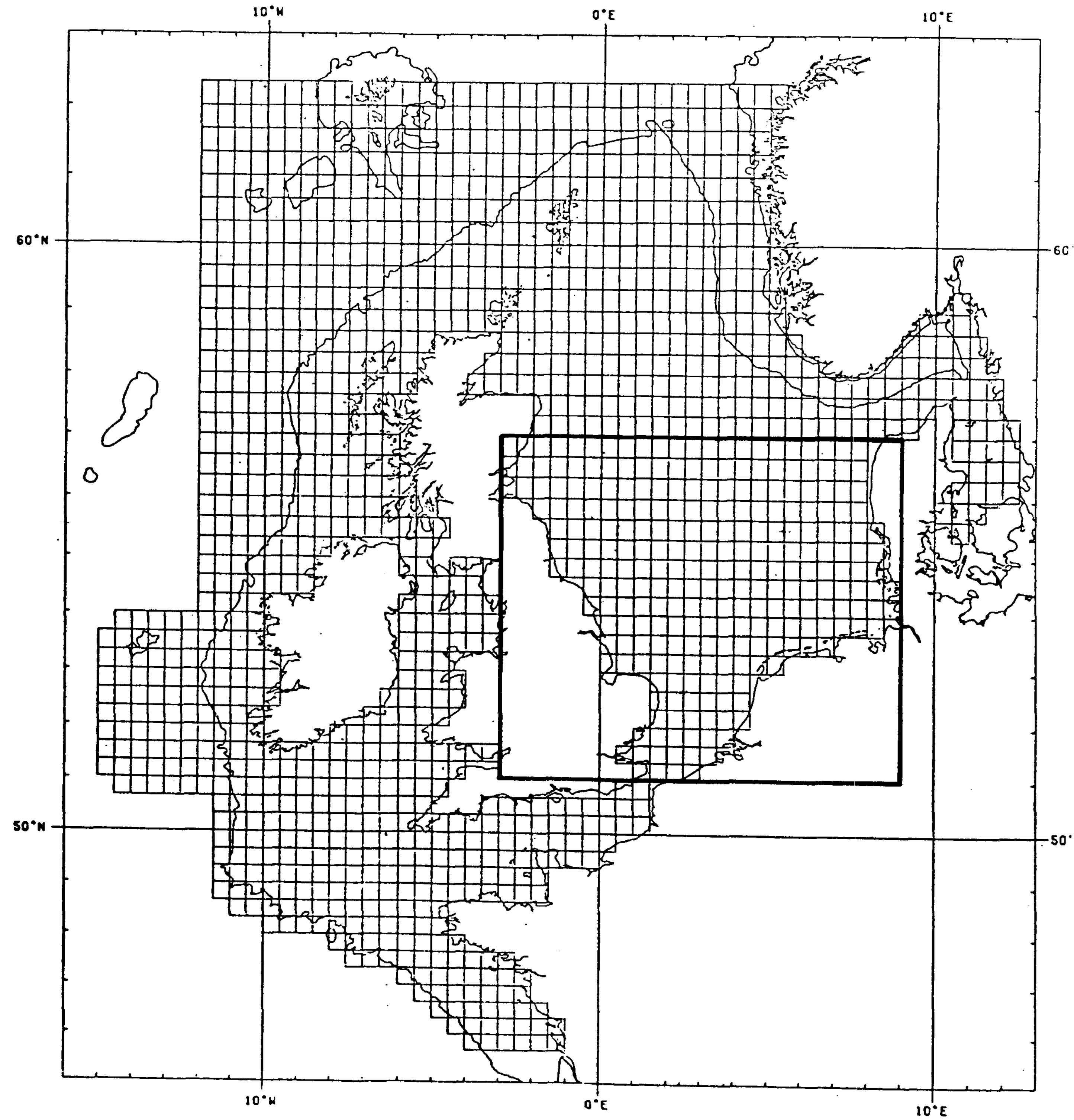


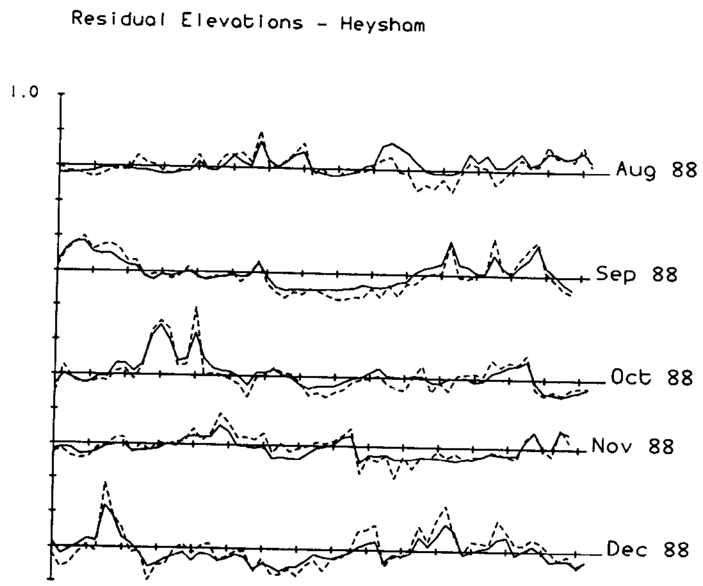
FIGURE 5. Sub-grid selected to represent the southern North Sea area

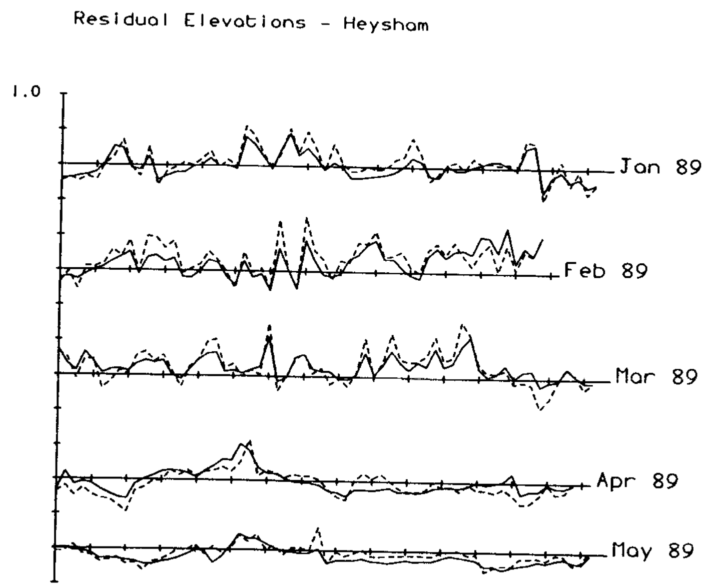
FIGURE 6

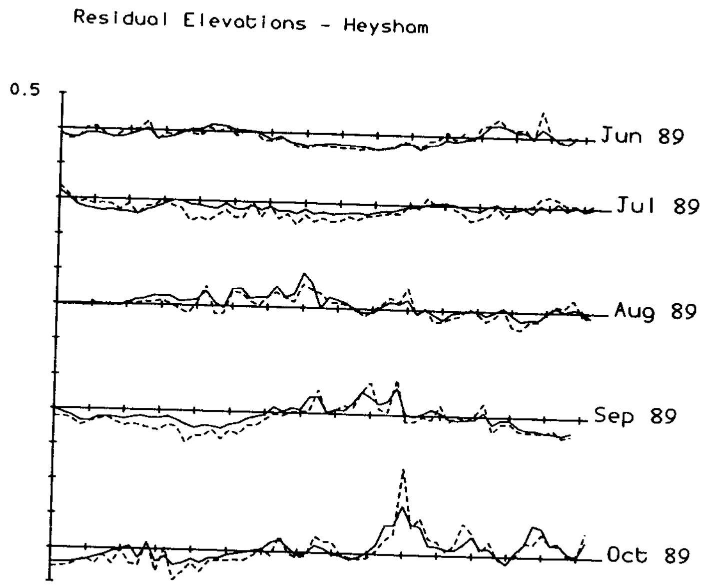
Residual elevation comparisons at two locations for the 15 month period

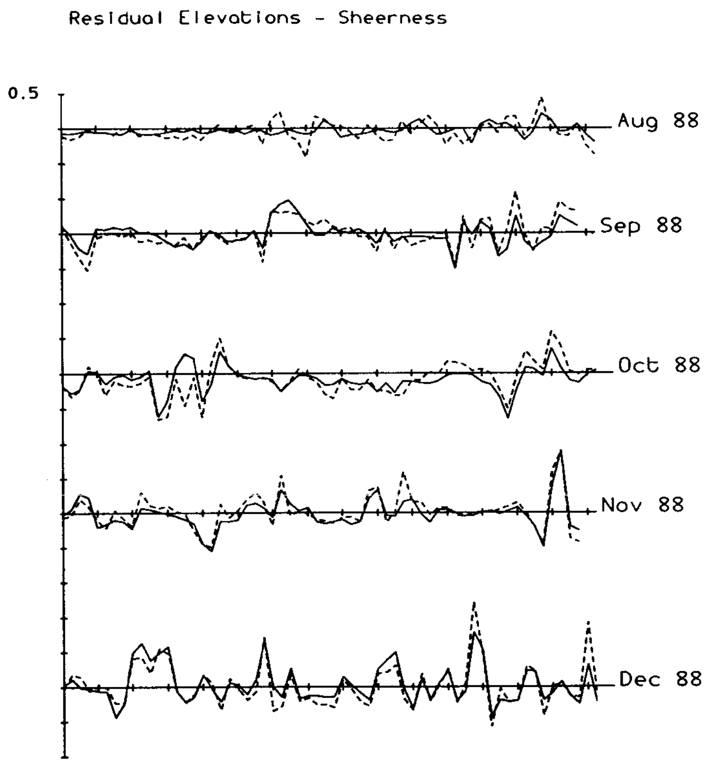
1. Heysham (west coast)
2. Sheerness (east coast)

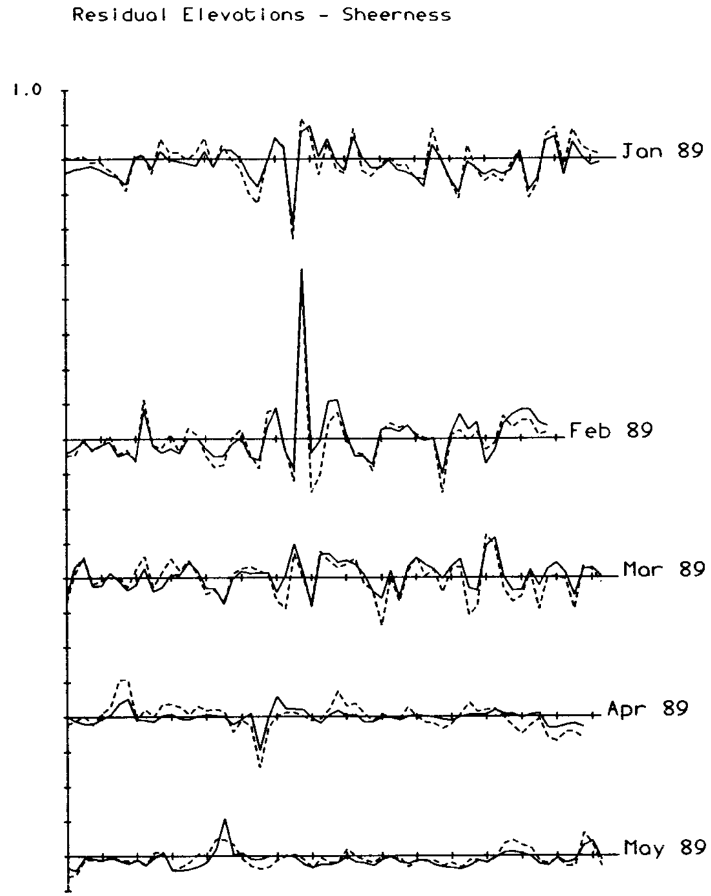
model (—) observed (----)


Residual Elevations - Heysham
1.0
Aug 88
Sep 88
Oct 88
Nov 88
Dec 88


Residual Elevations - Heysham
1.0
Jan 89
Feb 89
Mar 89
Apr 89
May 89


Residual Elevations - Heysham
0.5
Jun 89
Jul 89
Aug 89
Sep 89
Oct 89


Residual Elevations - Sheerness
0.5
Aug 88
Sep 88
Oct 88
Nov 88
Dec 88


Residual Elevations - Sheerness
1.0
Jan 89
Feb 89
Mar 89
Apr 89
May 89

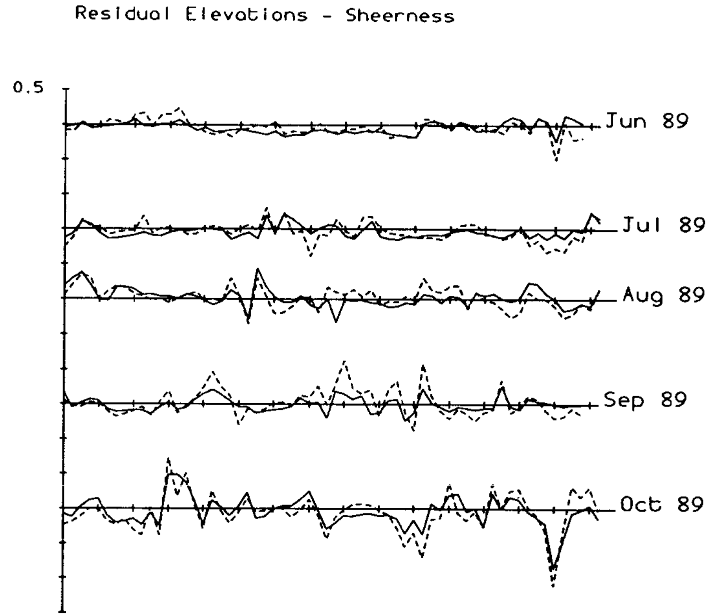

Residual Elevations - Sheerness
0.5
Jun 89
Jul 89
Aug 89
Sep 89
Oct 89

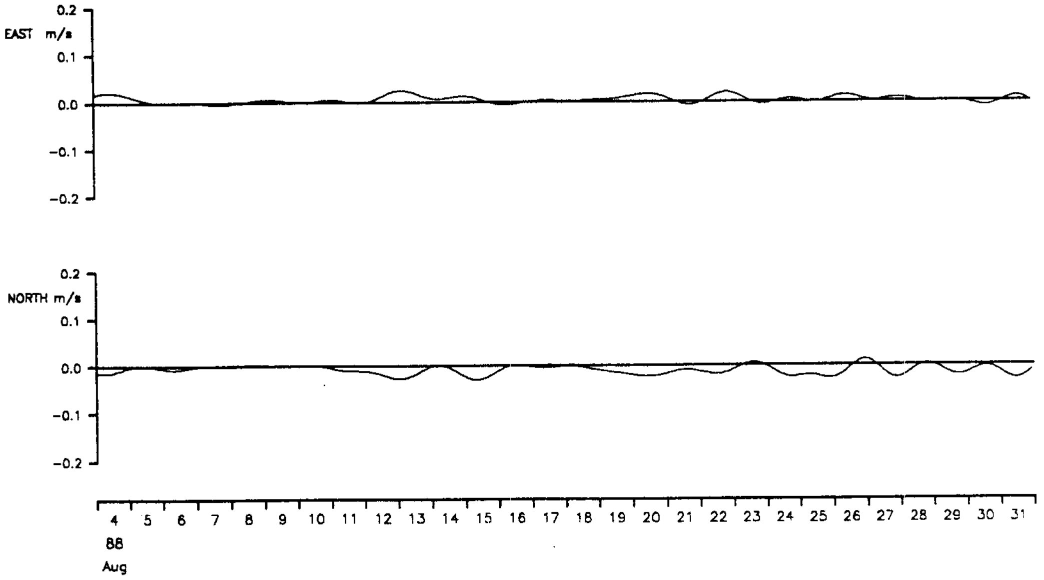
FIGURE 7

Comparison of low pass filtered model currents
with similarly filtered mid-depth observed currents

model (—) observed (----)

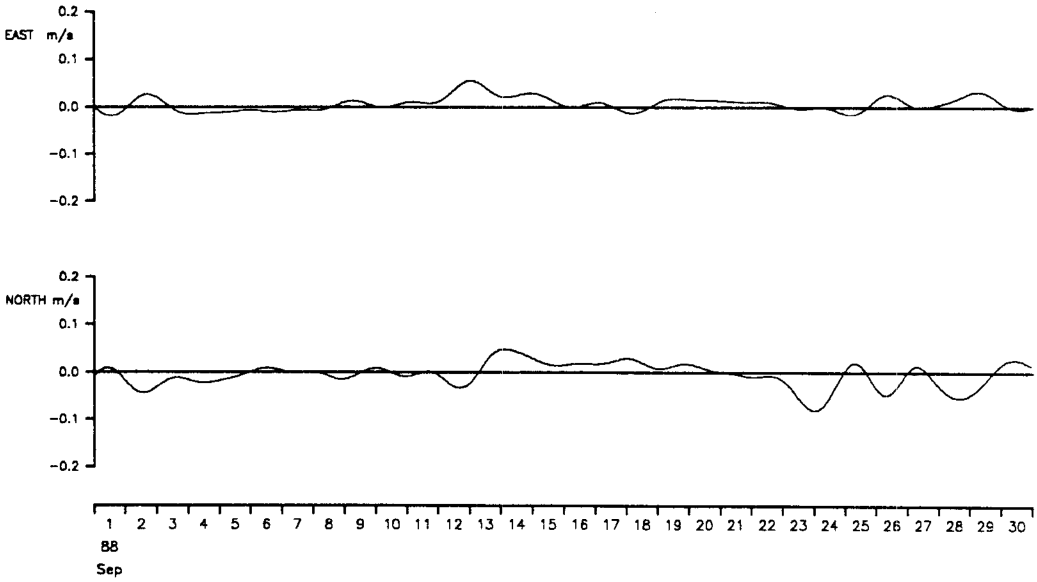
VELOCITY COMPONENT TIME SERIES PLOT

MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —
SITE A 55 29.97 N 00 54.00 E WATER DEPTH 85m METER HEIGHT 31m CURRENT METER • •



VELOCITY COMPONENT TIME SERIES PLOT

MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —
SITE A 55 29.97 N 00 54.00 E WATER DEPTH 85m METER HEIGHT 31m CURRENT METER • •



VELOCITY COMPONENT TIME SERIES PLOT

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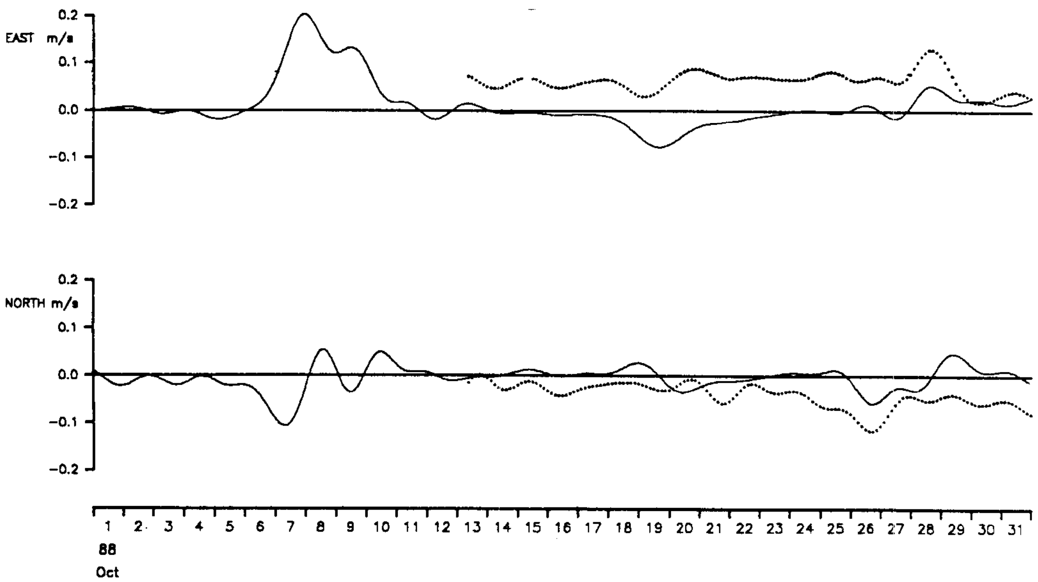
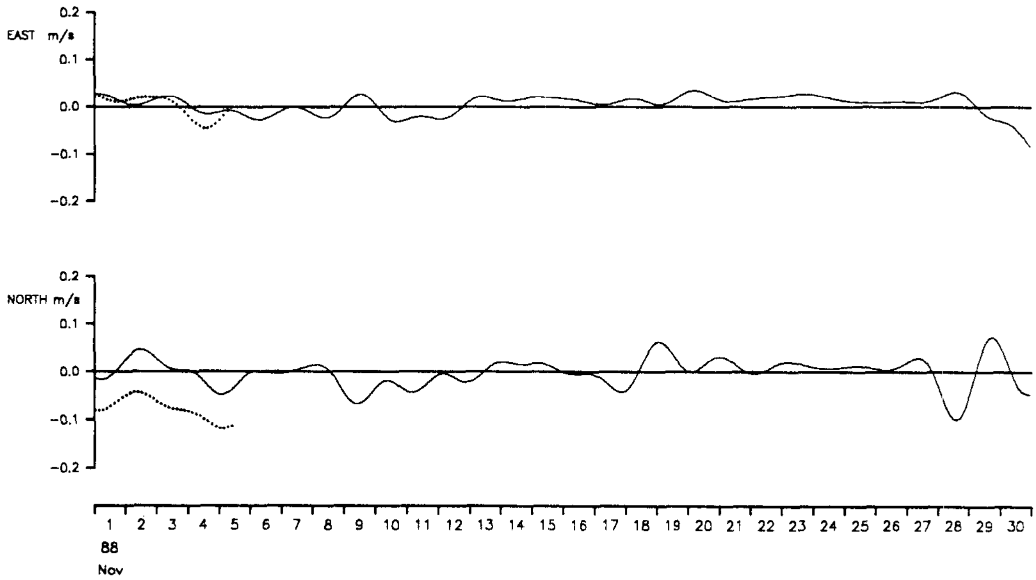


VELOCITY COMPONENT TIME SERIES PLOT

MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —
SITE A 55 29.97 N 00 54.00 E WATER DEPTH 85m METER HEIGHT 31m CURRENT METER ..



VELOCITY COMPONENT TIME SERIES PLOT

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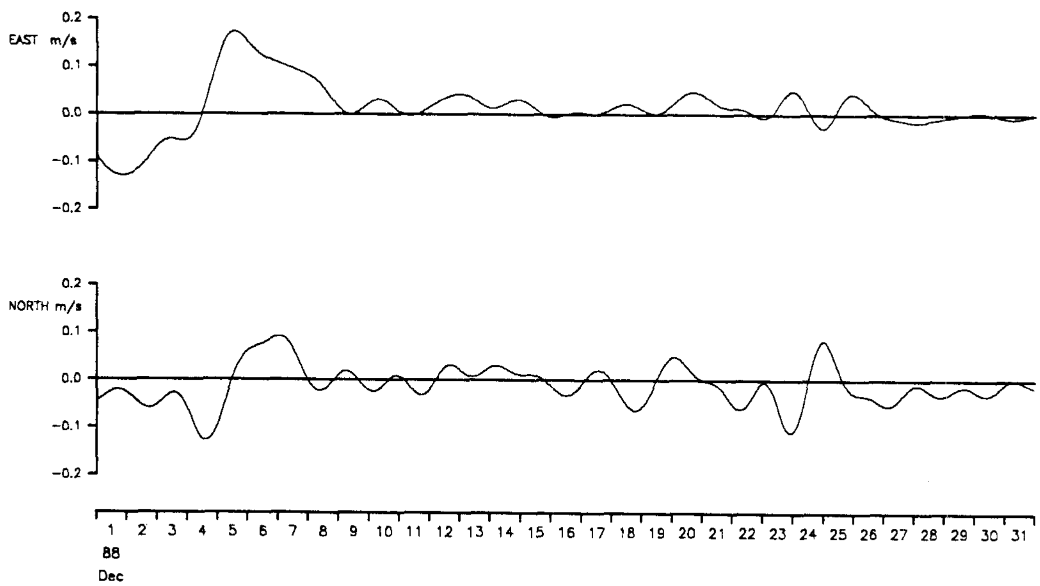

VELOCITY COMPONENT TIME SERIES PLOT

MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —
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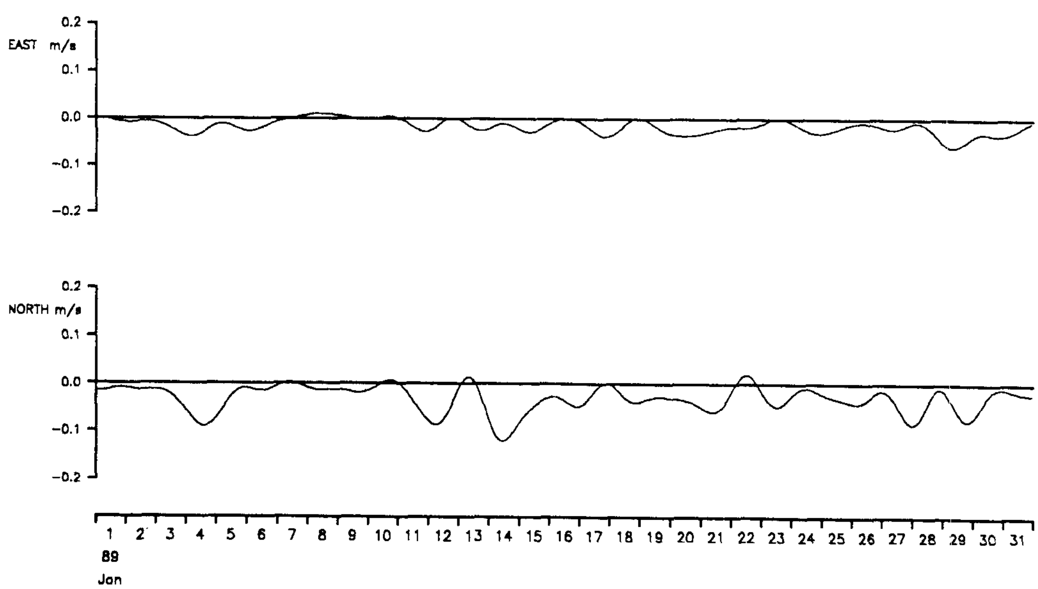
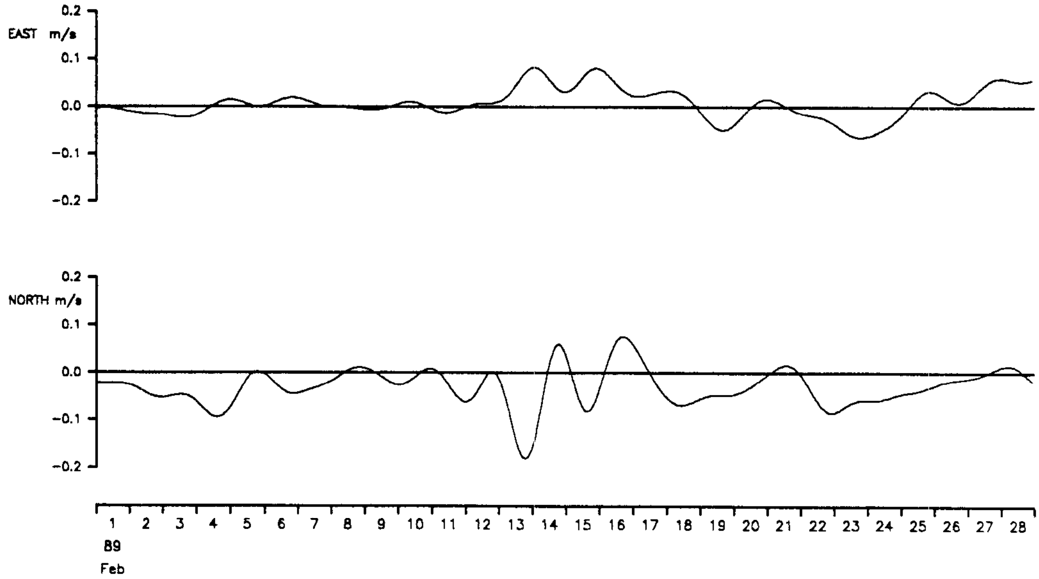


VELOCITY COMPONENT TIME SERIES PLOT

MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL ▬

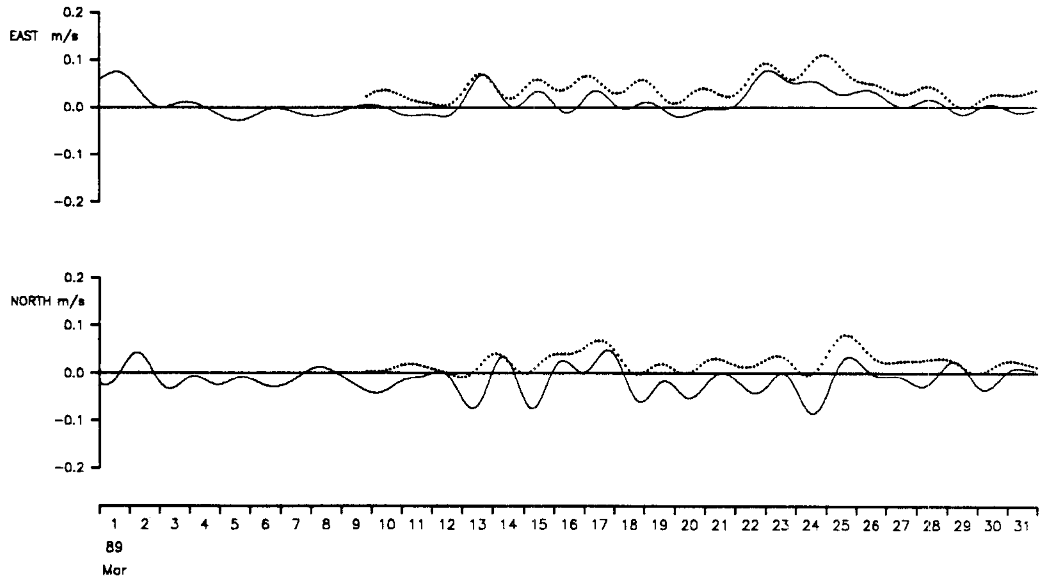
SITE A 55 29.97 N 00 54.00 E WATER DEPTH 85m METER HEIGHT 31m CURRENT METER • •



VELOCITY COMPONENT TIME SERIES PLOT

MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL ▬

SITE A 55 29.97 N 00 54.00 E WATER DEPTH 85m METER HEIGHT 31m CURRENT METER • •



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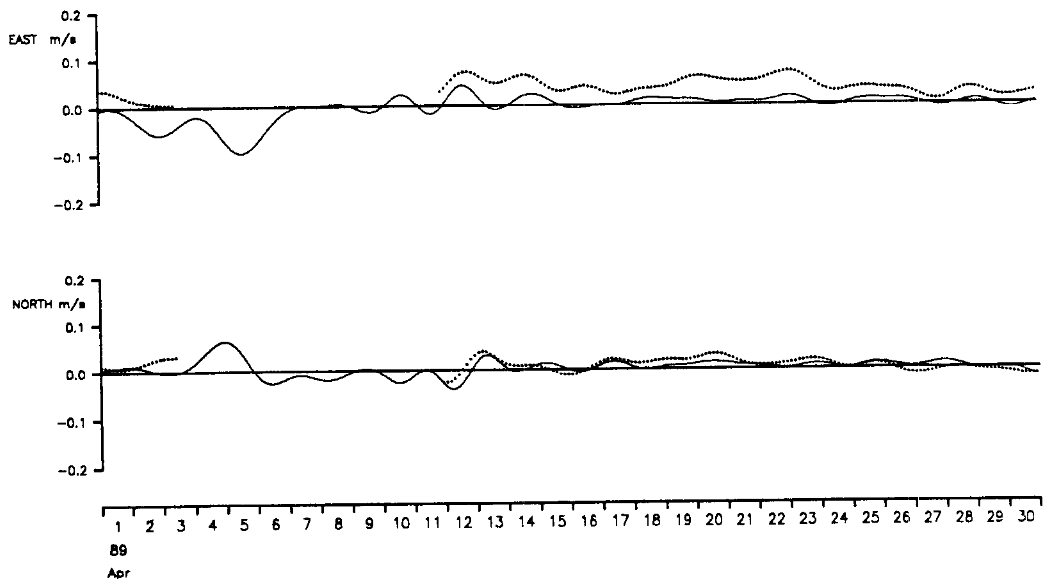

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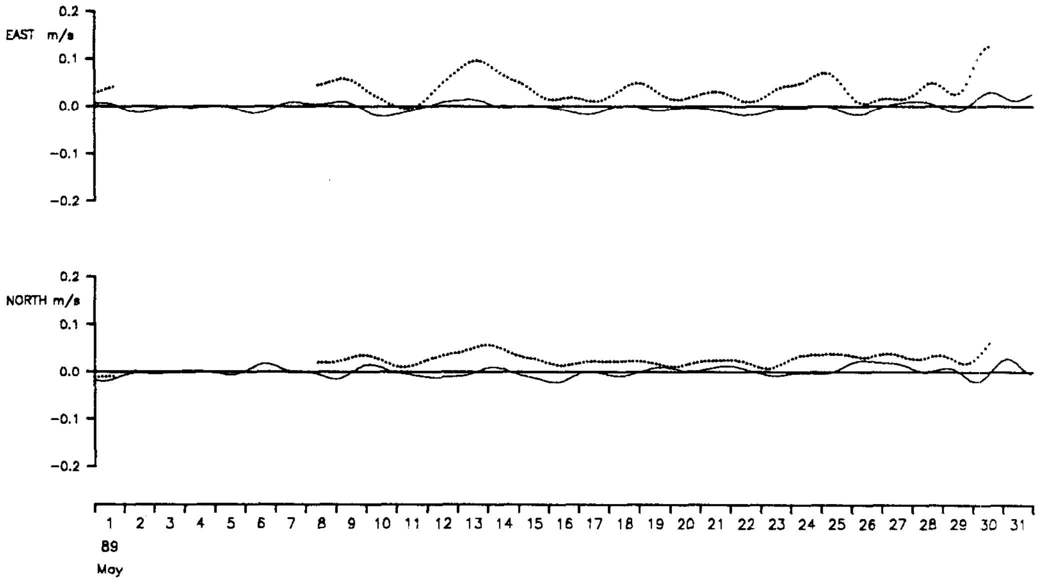

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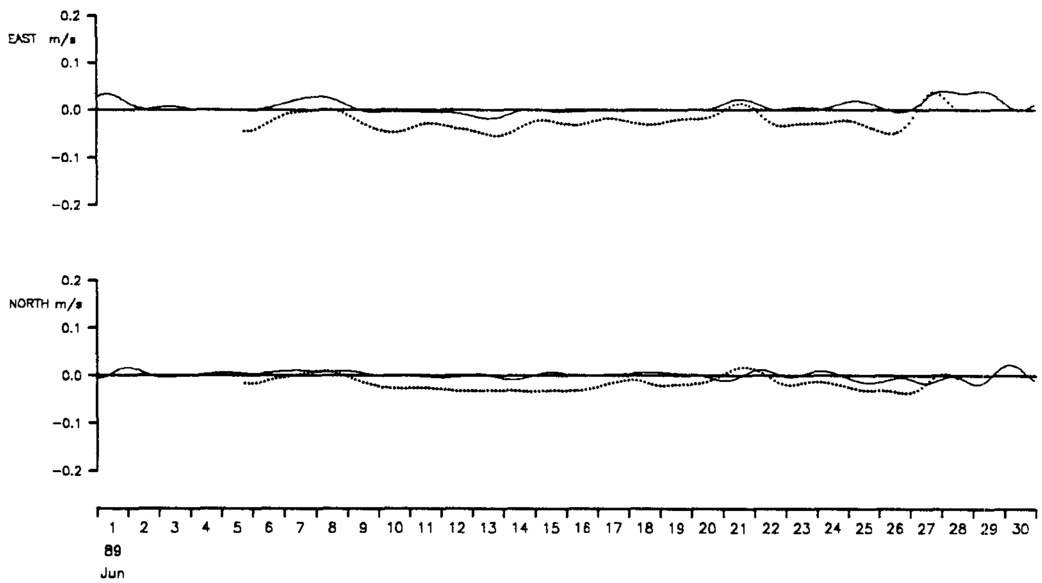

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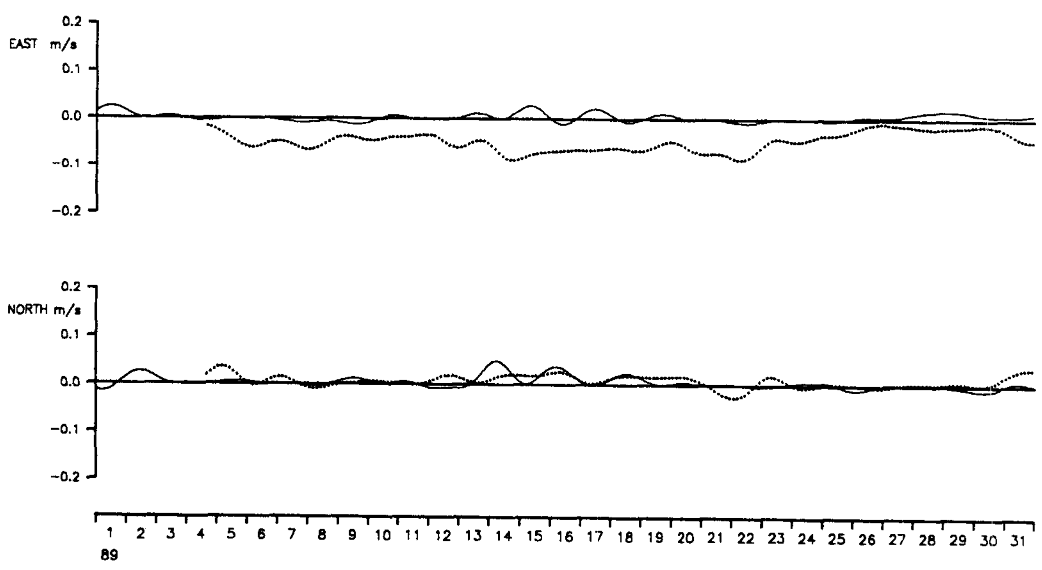

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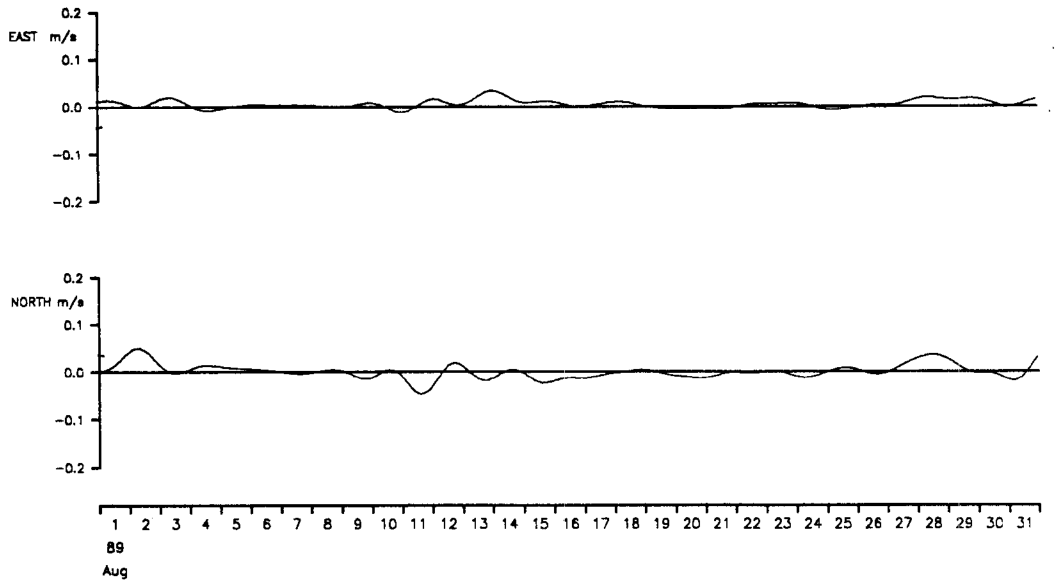

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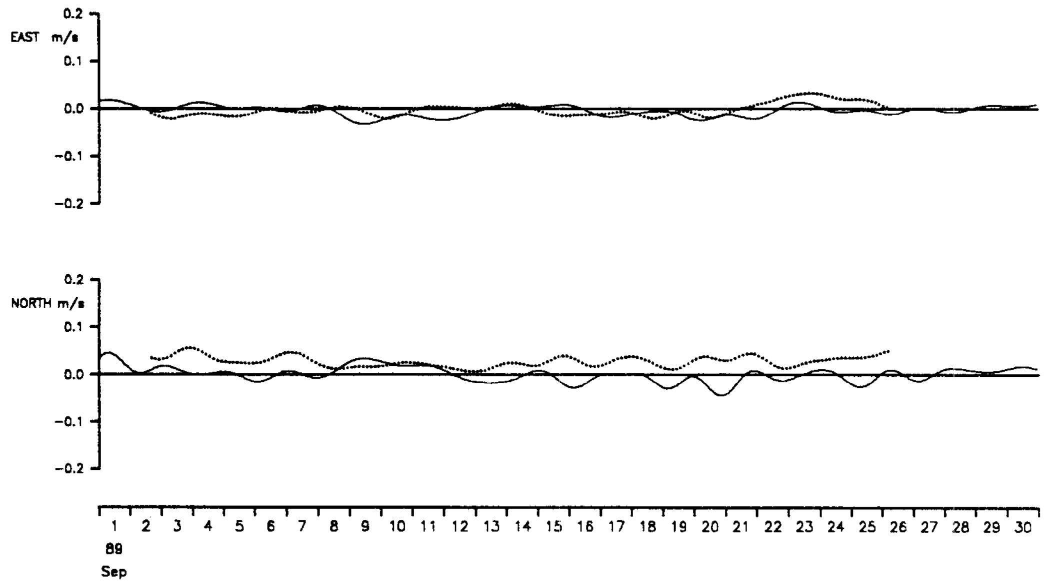

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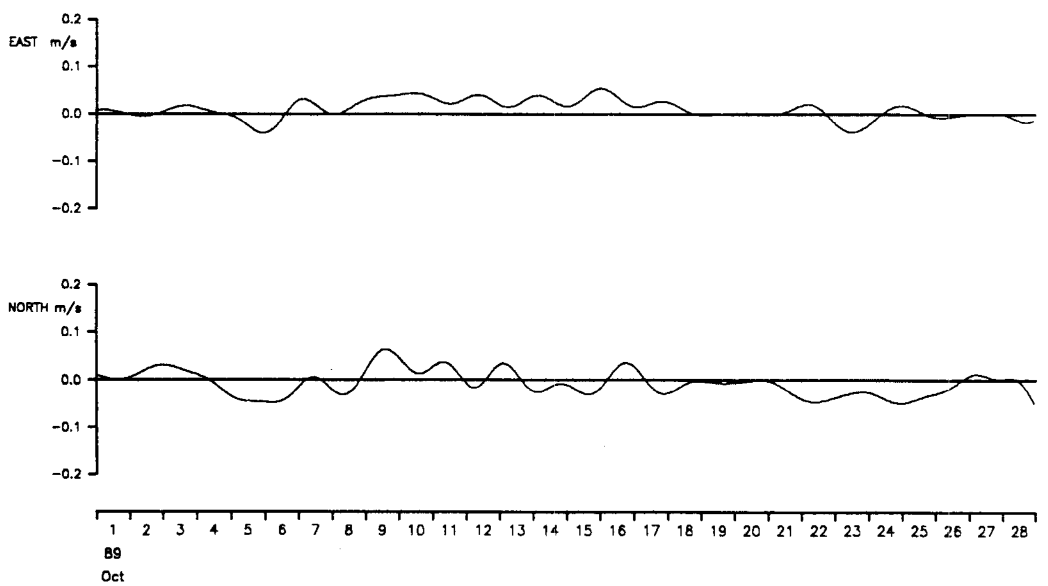

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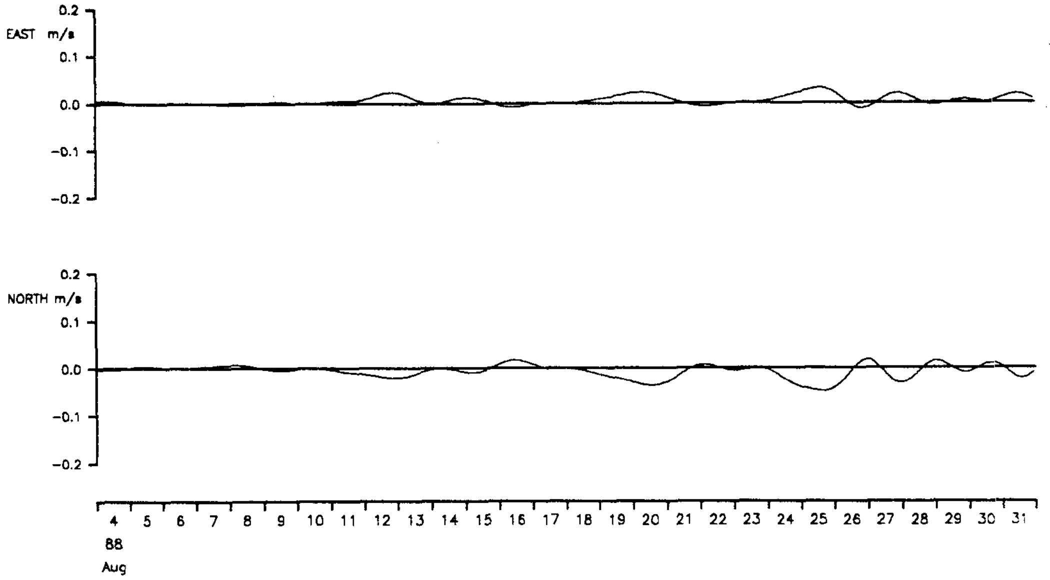
MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —
SITE C 54 20.43 N 00 23.93 E WATER DEPTH 60m METER HEIGHT 23m CURRENT METER • •



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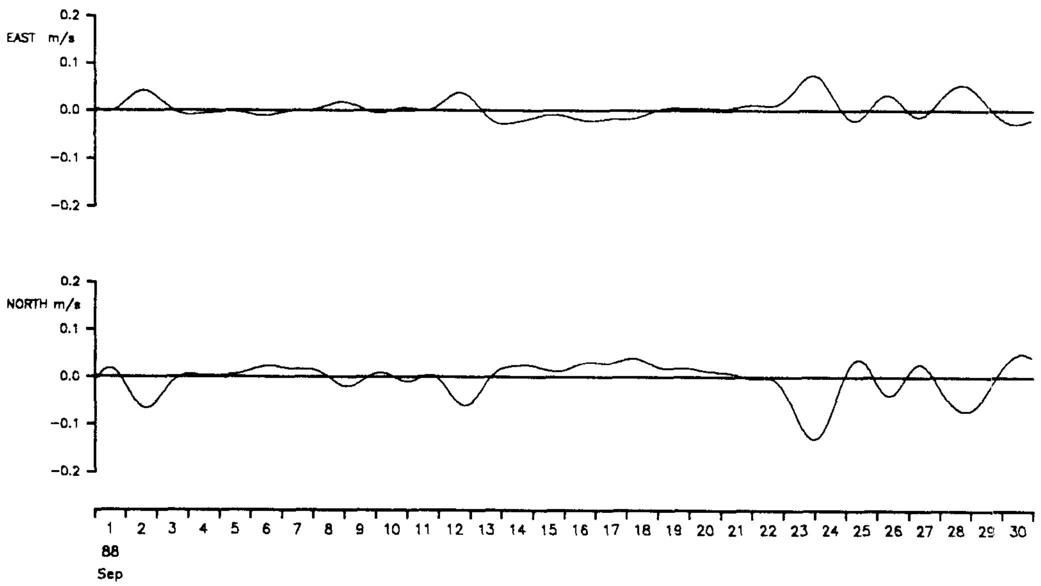

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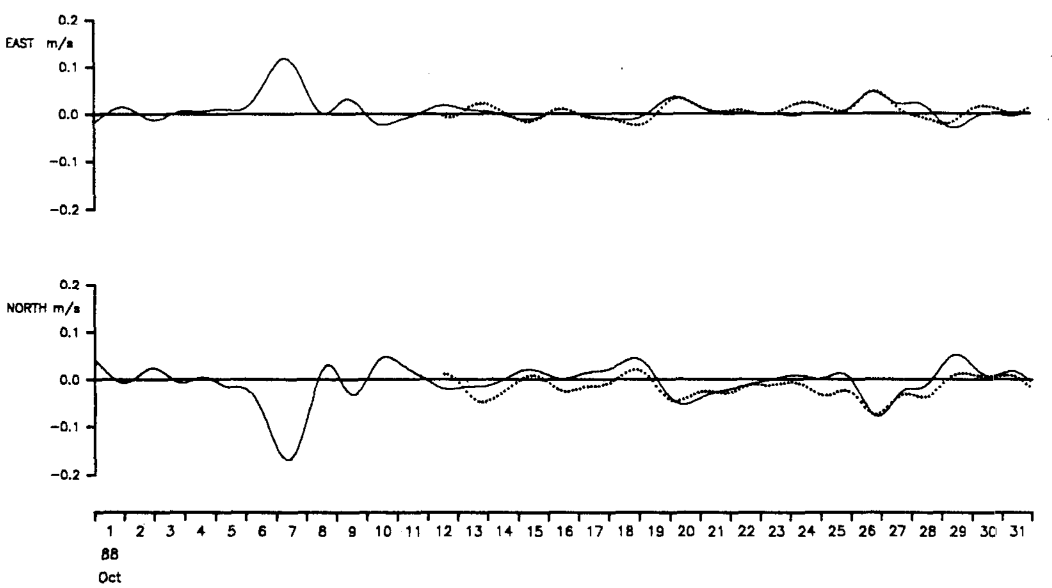

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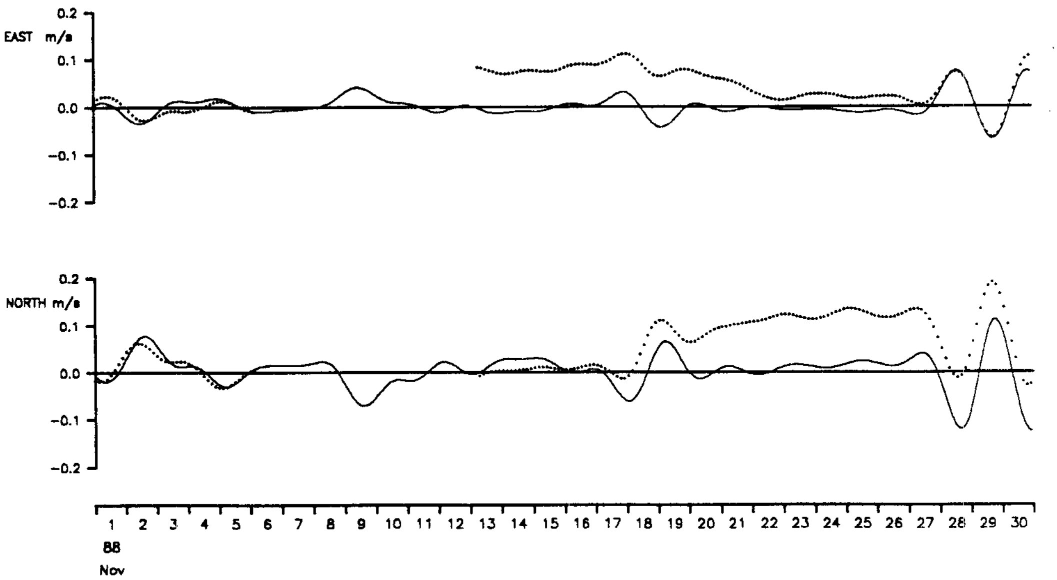

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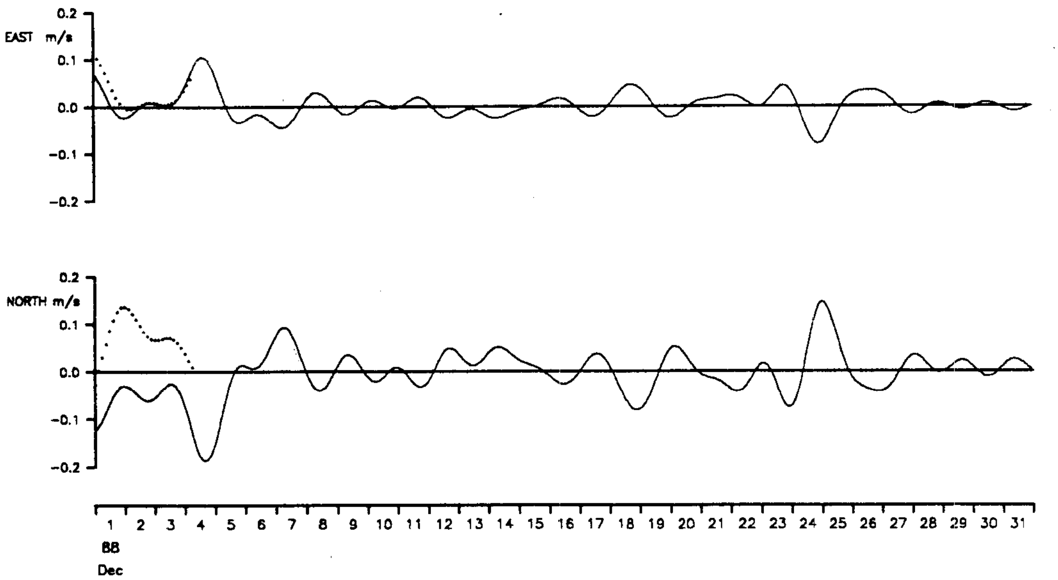

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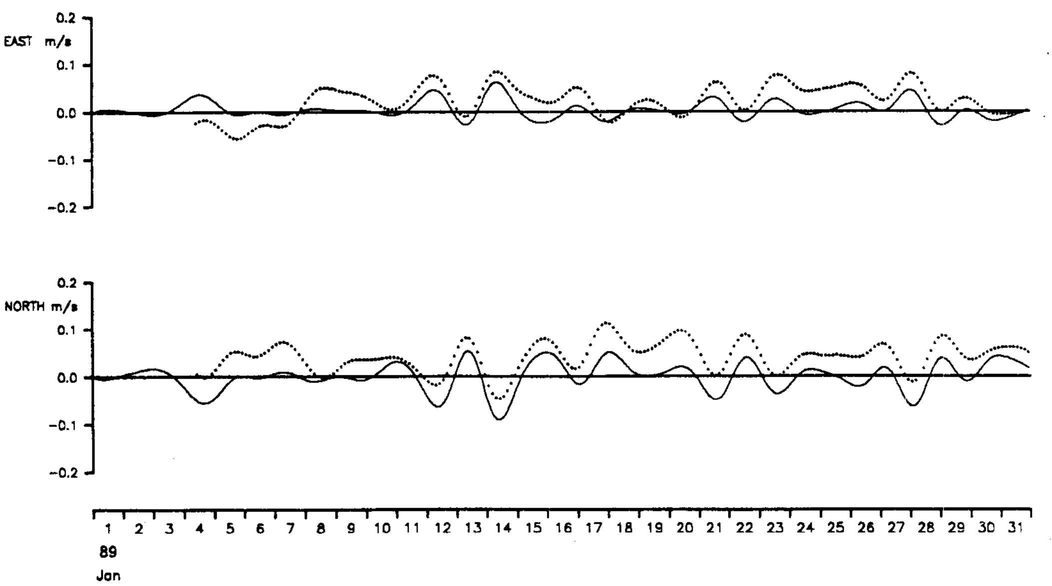

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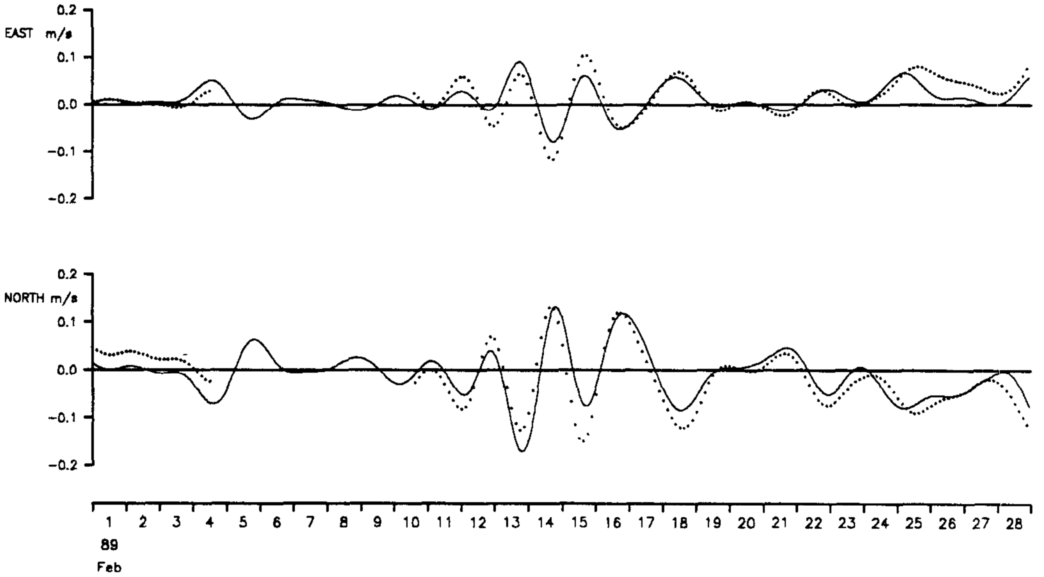
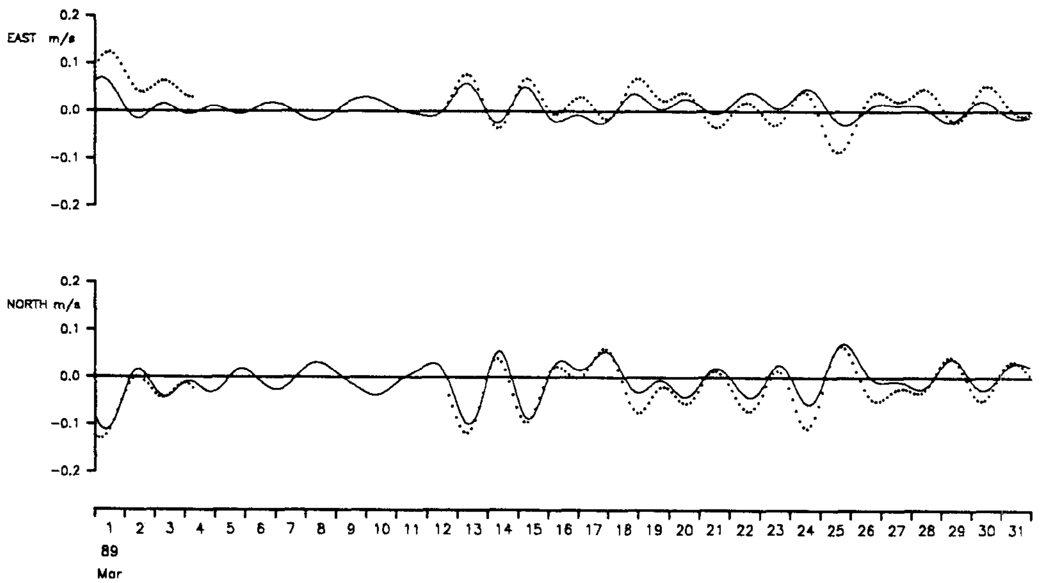
MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —
SITE C 54 20.43 N 00 23.93 E WATER DEPTH 60m METER HEIGHT 23m CURRENT METER • •



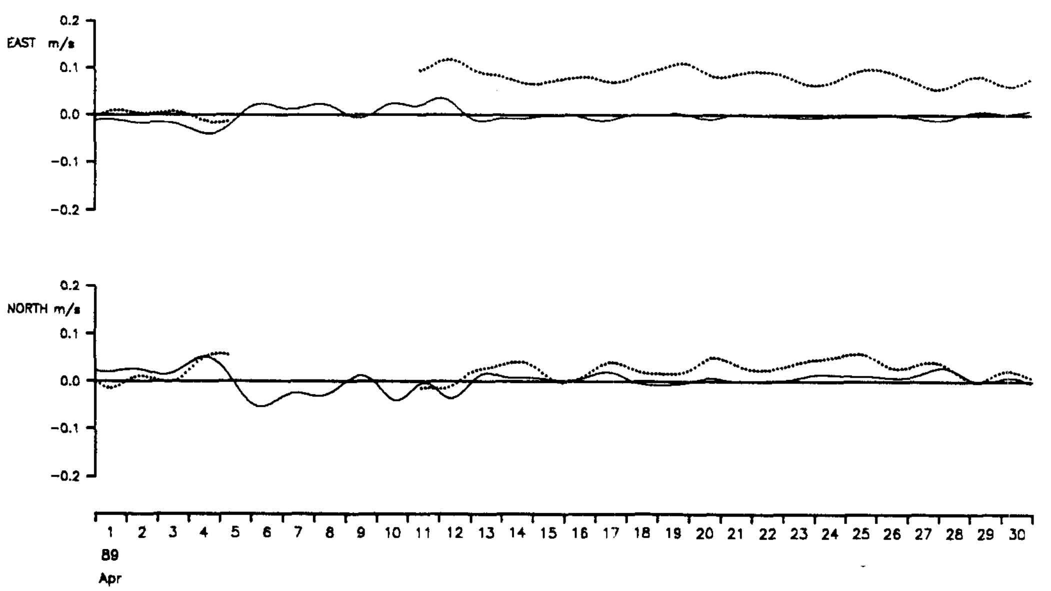
VELOCITY COMPONENT TIME SERIES PLOT

MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —
SITE C 54 20.43 N 00 23.93 E WATER DEPTH 60m METER HEIGHT 23m CURRENT METER • •



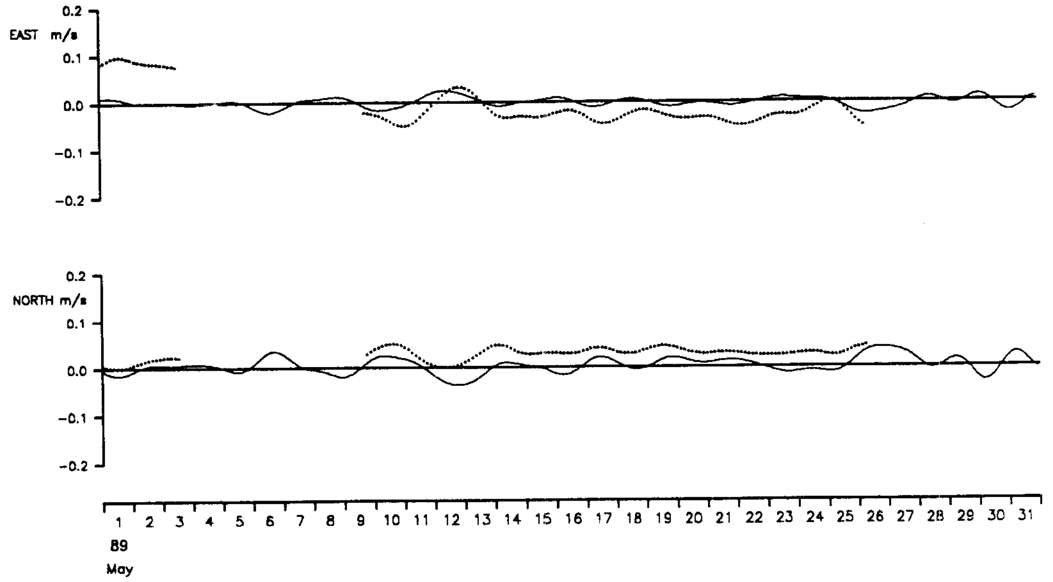
VELOCITY COMPONENT TIME SERIES PLOT

MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —
SITE C 54 20.43 N 00 23.93 E WATER DEPTH 60m METER HEIGHT 23m CURRENT METER • •



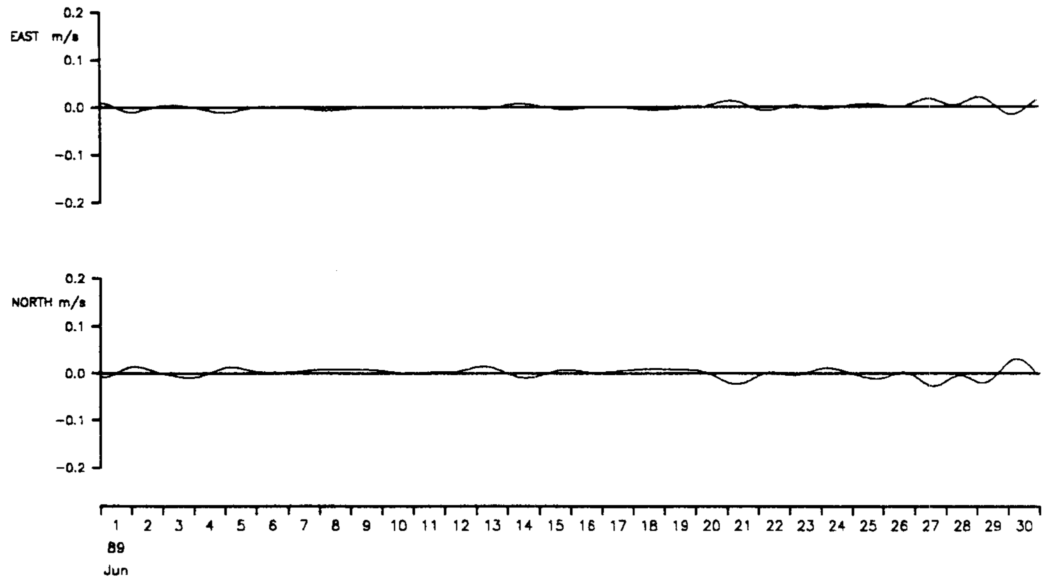
VELOCITY COMPONENT TIME SERIES PLOT

MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —
SITE C 54 20.43 N 00 23.93 E WATER DEPTH 60m METER HEIGHT 23m CURRENT METER • •



VELOCITY COMPONENT TIME SERIES PLOT

MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —
SITE C 54 20.43 N 00 23.93 E WATER DEPTH 60m METER HEIGHT 23m CURRENT METER • •



VELOCITY COMPONENT TIME SERIES PLOT

MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —
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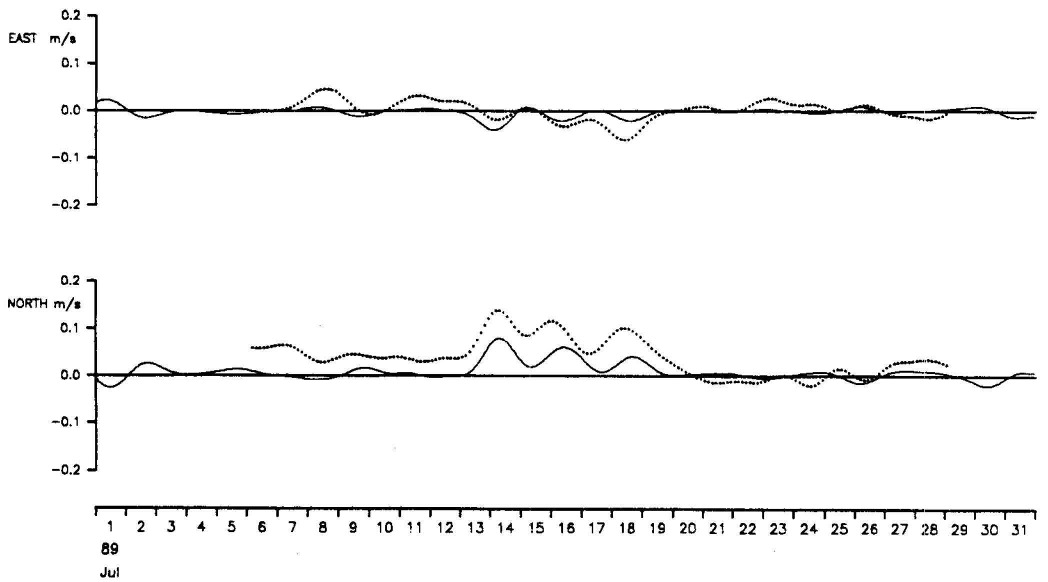
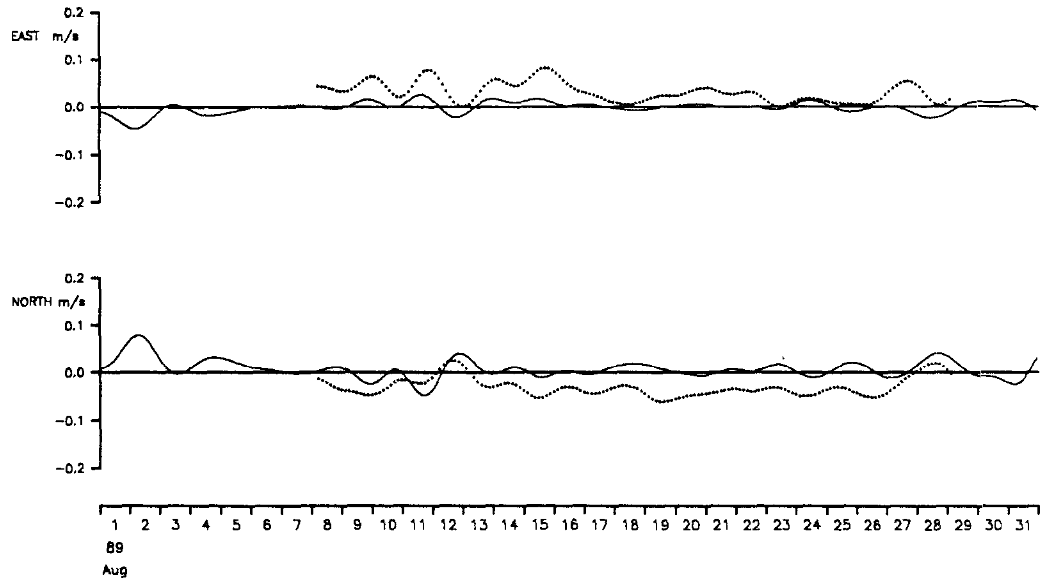


VELOCITY COMPONENT TIME SERIES PLOT

MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —

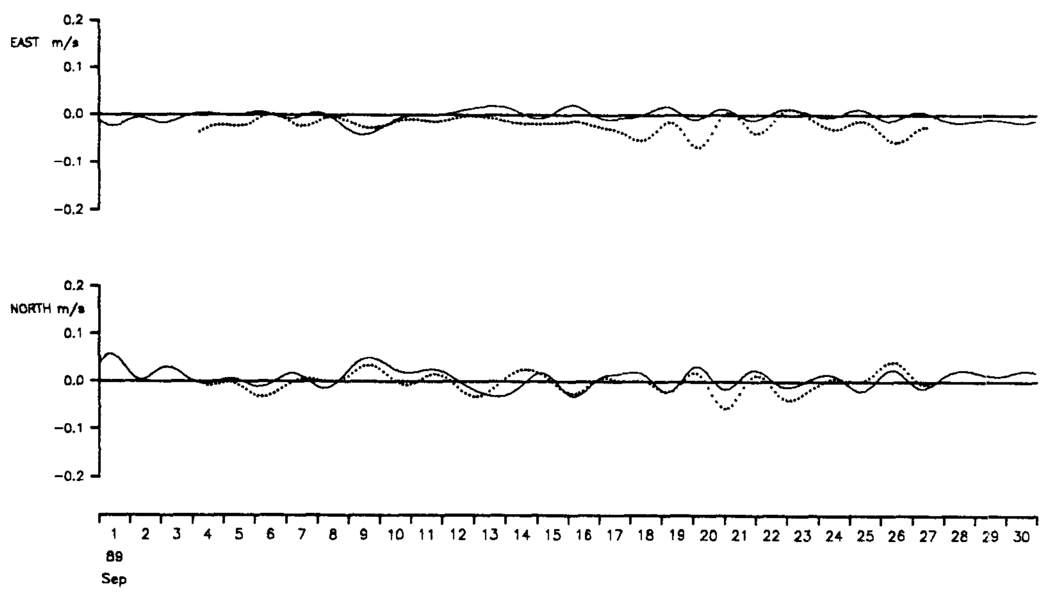
SITE C 54 20.43 N 00 23.93 E WATER DEPTH 60m METER HEIGHT 23m CURRENT METER • •



VELOCITY COMPONENT TIME SERIES PLOT

MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —

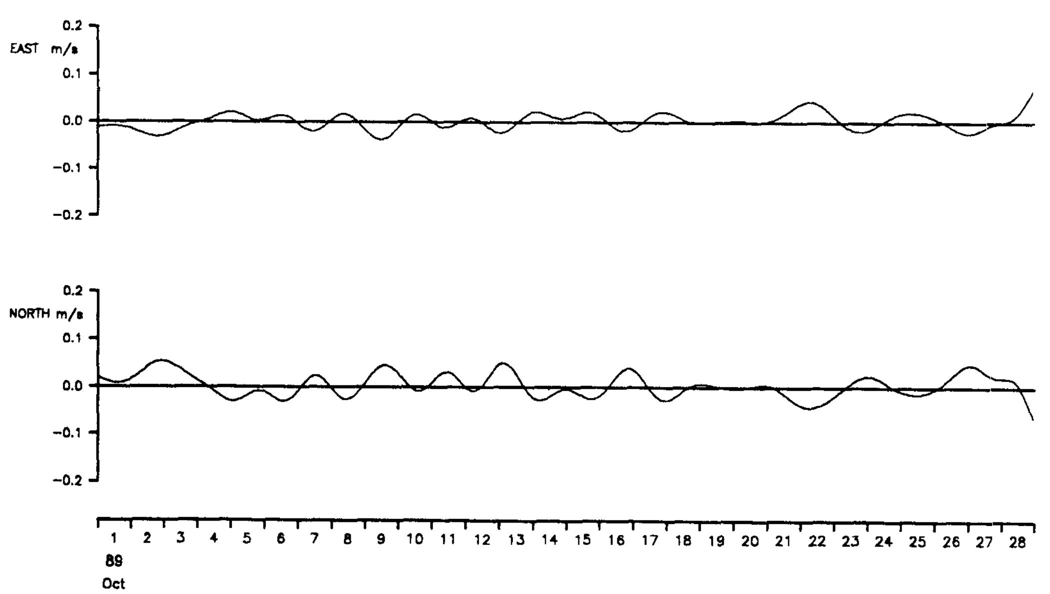
SITE C 54 20.43 N 00 23.93 E WATER DEPTH 60m METER HEIGHT 23m CURRENT METER • •



VELOCITY COMPONENT TIME SERIES PLOT

MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —

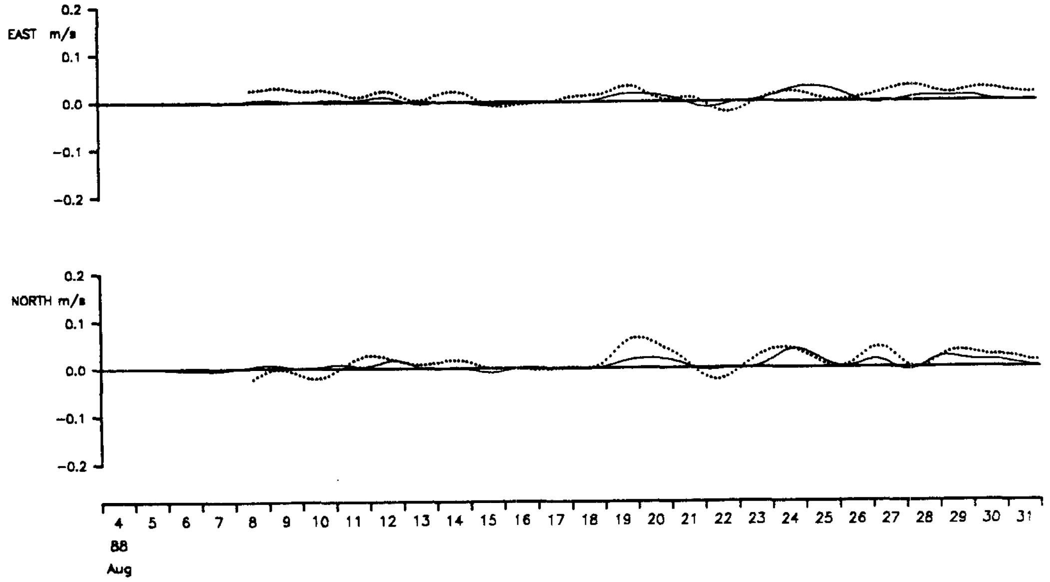
SITE C 54 20.43 N 00 23.93 E WATER DEPTH 60m METER HEIGHT 23m CURRENT METER • •



VELOCITY COMPONENT TIME SERIES PLOT

MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —

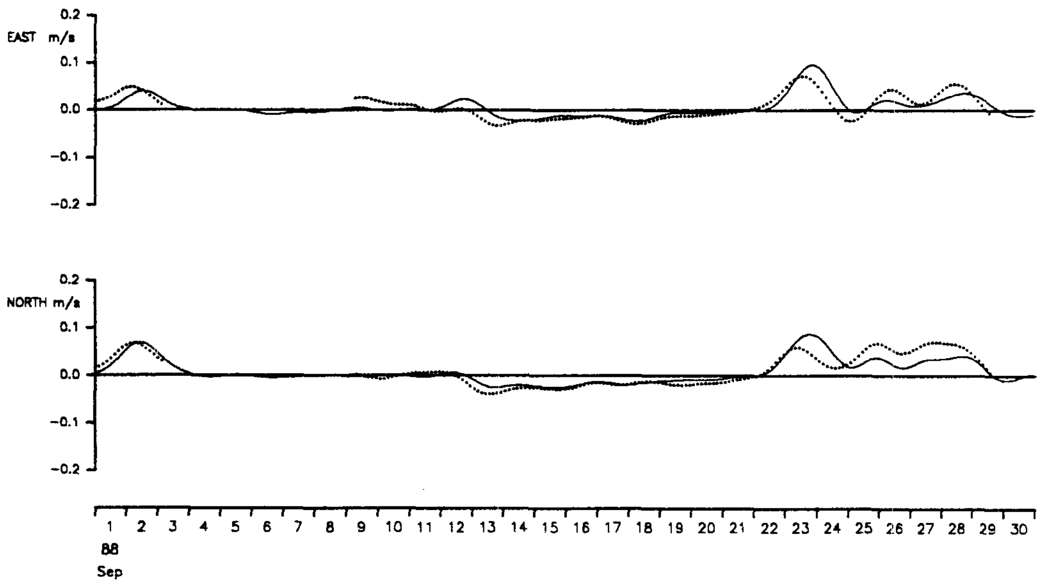
SITE F 52 37.70 N 03 45.20 E WATER DEPTH 30m METER HEIGHT 12m CURRENT METER • •



VELOCITY COMPONENT TIME SERIES PLOT

MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —

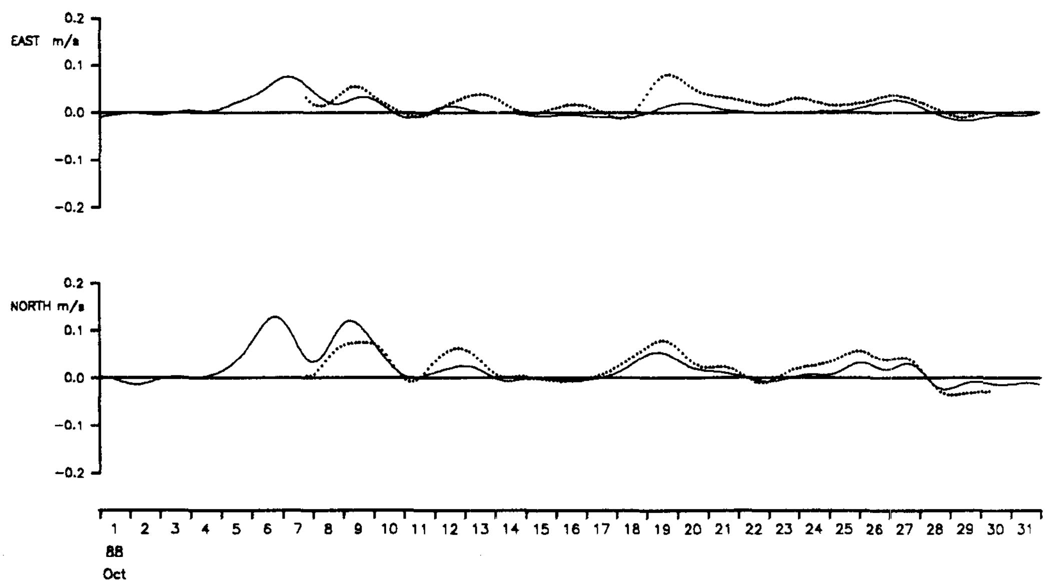
SITE F 52 37.70 N 03 45.20 E WATER DEPTH 30m METER HEIGHT 12m CURRENT METER • •



VELOCITY COMPONENT TIME SERIES PLOT

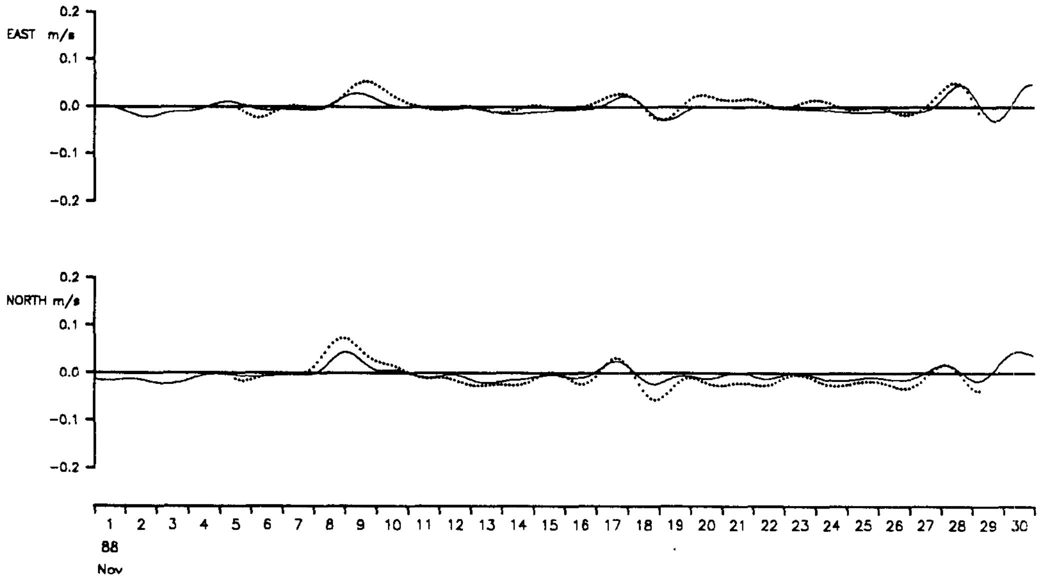
MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —

SITE F 52 37.70 N 03 45.20 E WATER DEPTH 30m METER HEIGHT 12m CURRENT METER • •



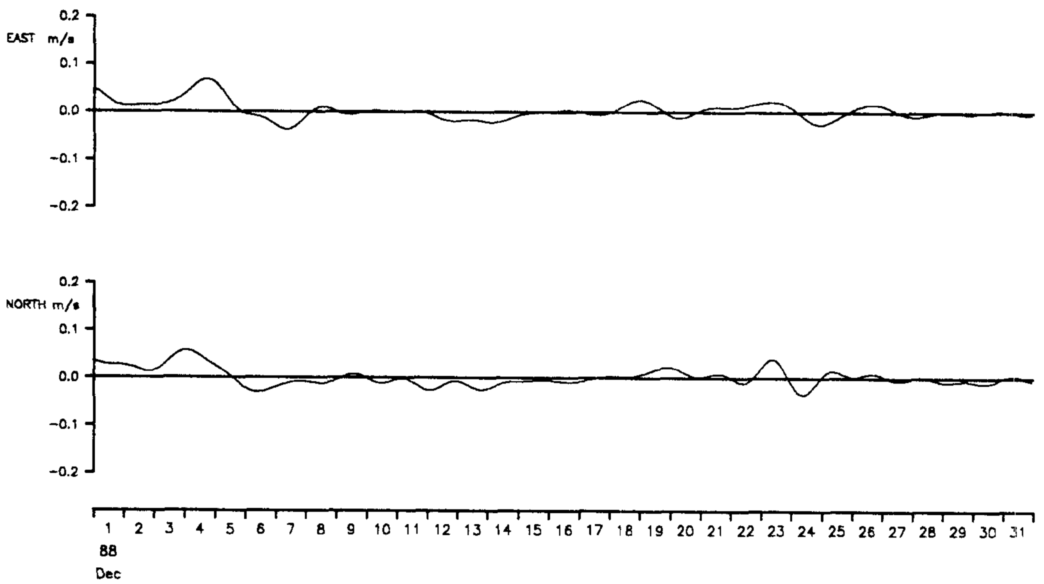
VELOCITY COMPONENT TIME SERIES PLOT

MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —
SITE F 52 37.70 N 03 45.20 E WATER DEPTH 30m METER HEIGHT 12m CURRENT METER • •



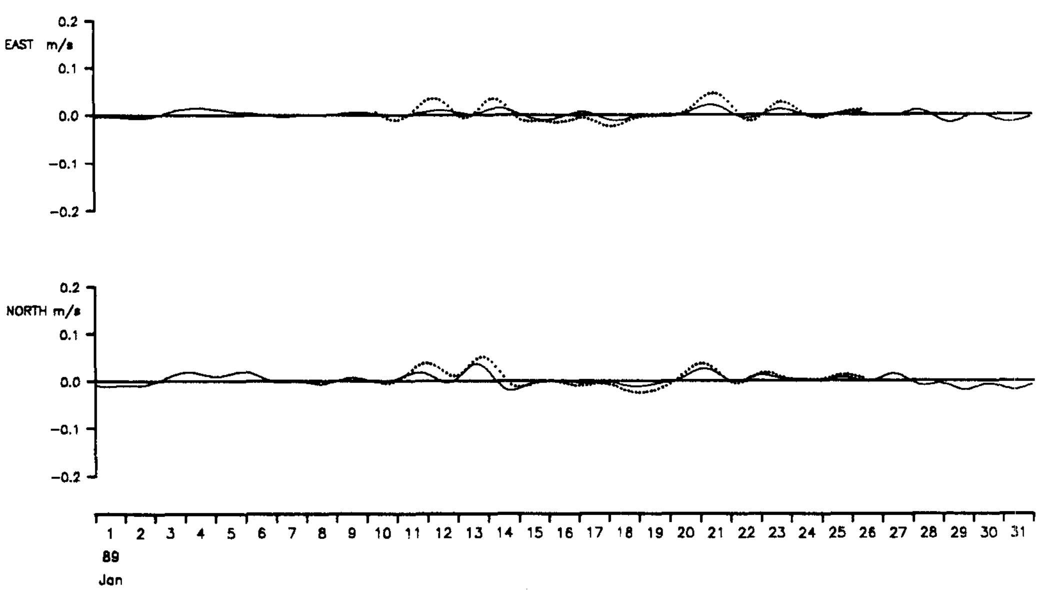
VELOCITY COMPONENT TIME SERIES PLOT

MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —
SITE F 52 37.70 N 03 45.20 E WATER DEPTH 30m METER HEIGHT 12m CURRENT METER • •



VELOCITY COMPONENT TIME SERIES PLOT

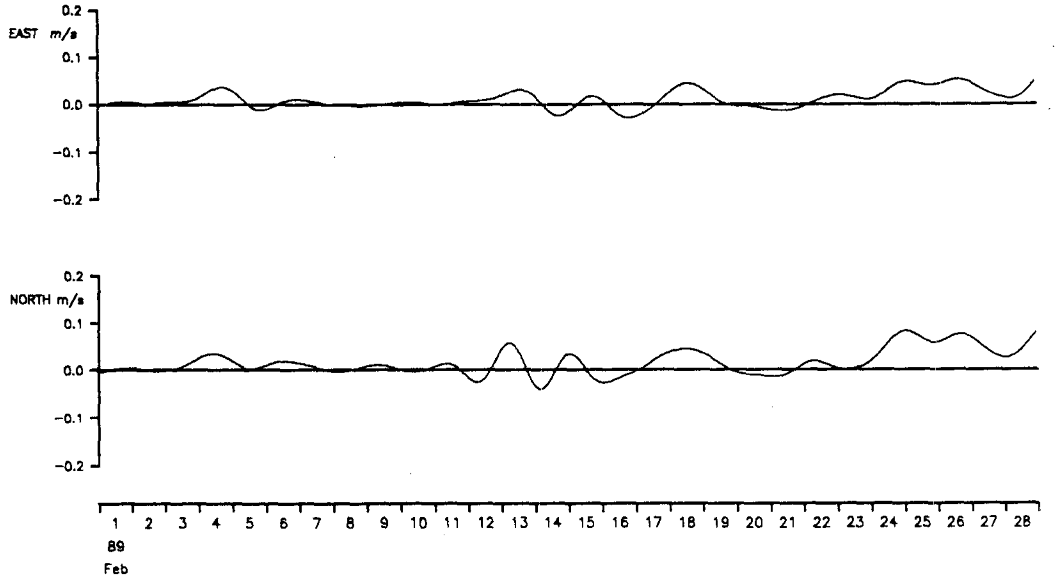
MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —
SITE F 52 37.70 N 03 45.20 E WATER DEPTH 30m METER HEIGHT 12m CURRENT METER • •



VELOCITY COMPONENT TIME SERIES PLOT

MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —

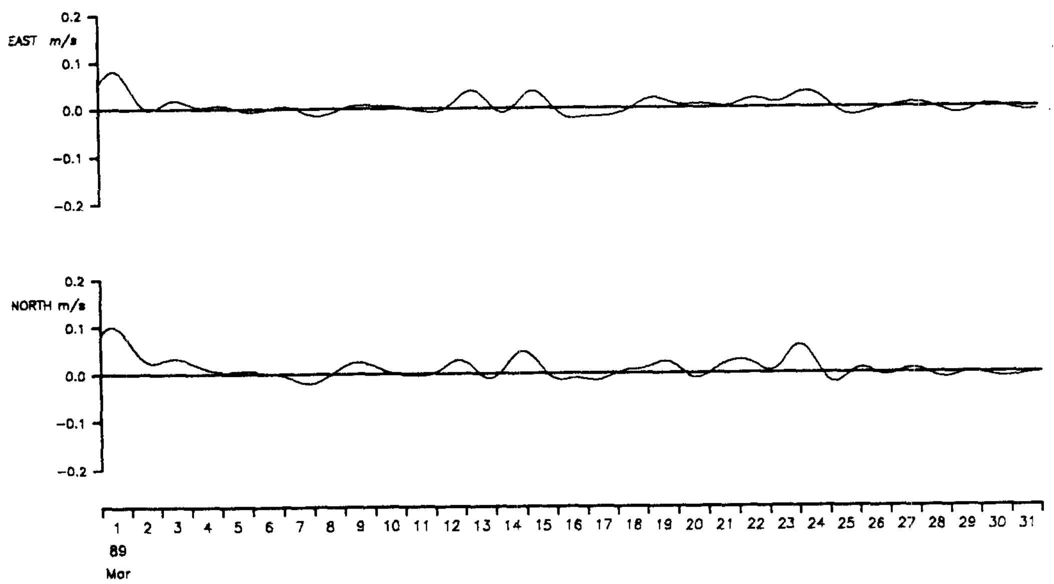
SITE F 52 37.70 N 03 45.20 E WATER DEPTH 30m METER HEIGHT 12m CURRENT METER • •



VELOCITY COMPONENT TIME SERIES PLOT

MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —

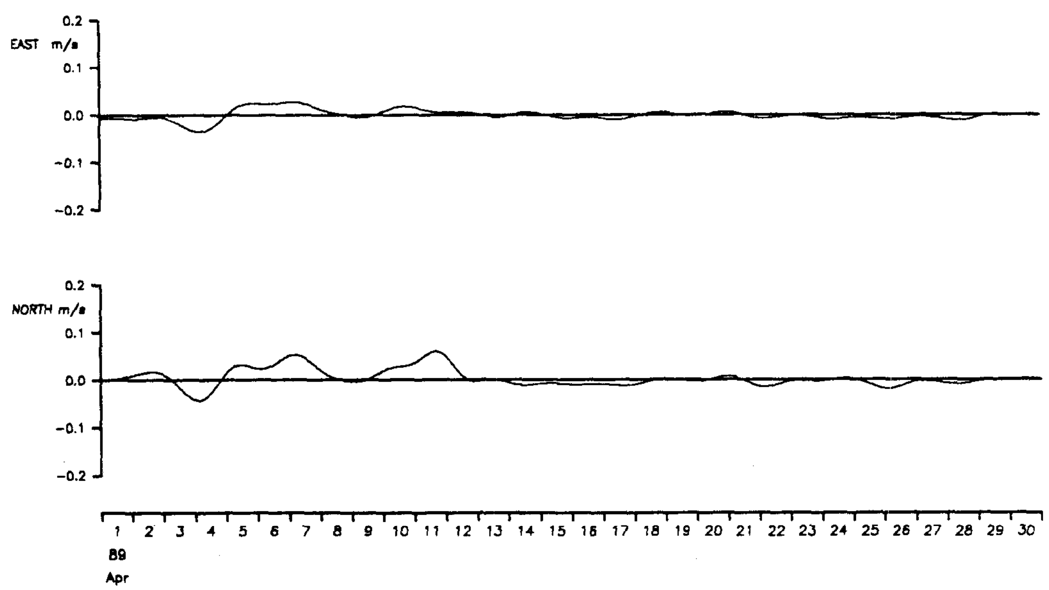
SITE F 52 37.70 N 03 45.20 E WATER DEPTH 30m METER HEIGHT 12m CURRENT METER • •



VELOCITY COMPONENT TIME SERIES PLOT

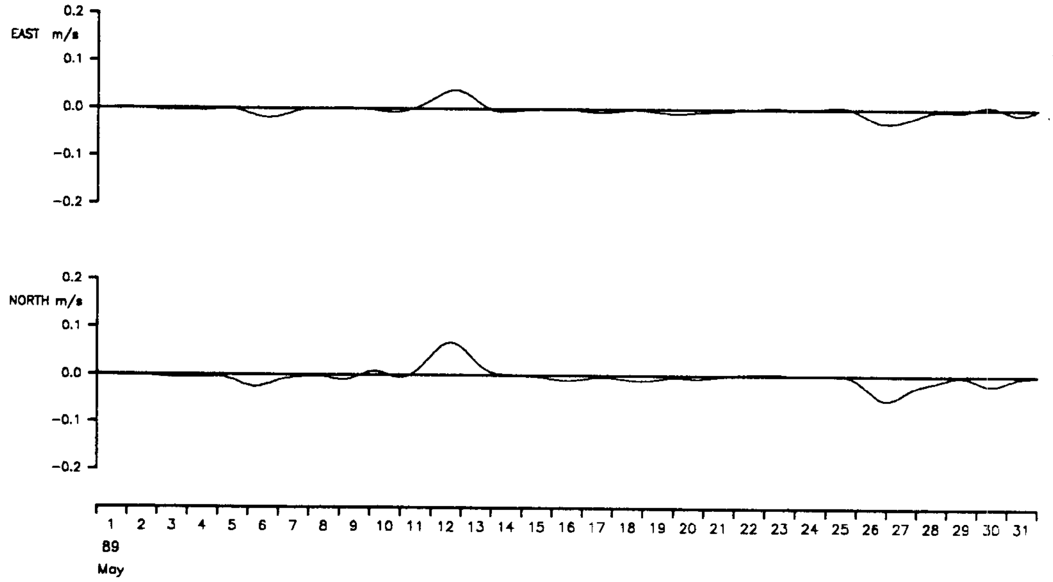
MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —

SITE F 52 37.70 N 03 45.20 E WATER DEPTH 30m METER HEIGHT 12m CURRENT METER • •



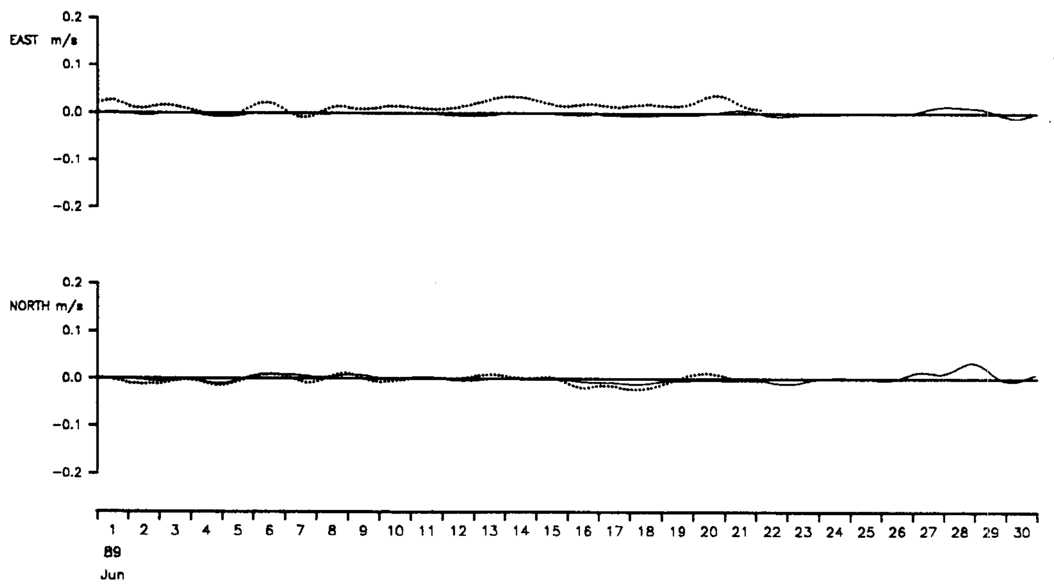
VELOCITY COMPONENT TIME SERIES PLOT

MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —
SITE F 52 37.70 N 03 45.20 E WATER DEPTH 30m METER HEIGHT 12m CURRENT METER ..



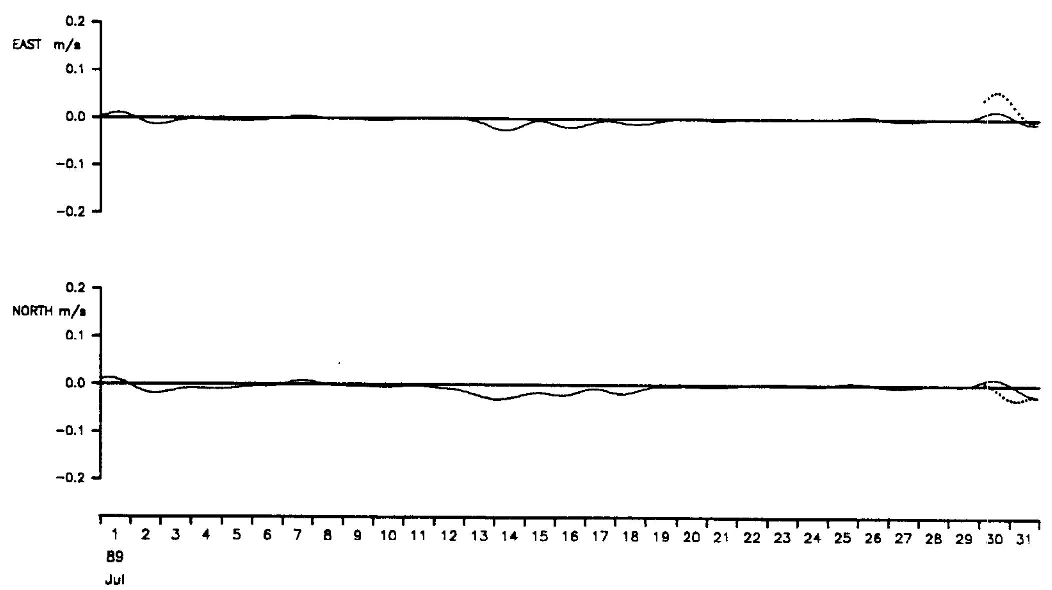
VELOCITY COMPONENT TIME SERIES PLOT

MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —
SITE F 52 37.70 N 03 45.20 E WATER DEPTH 30m METER HEIGHT 12m CURRENT METER ..



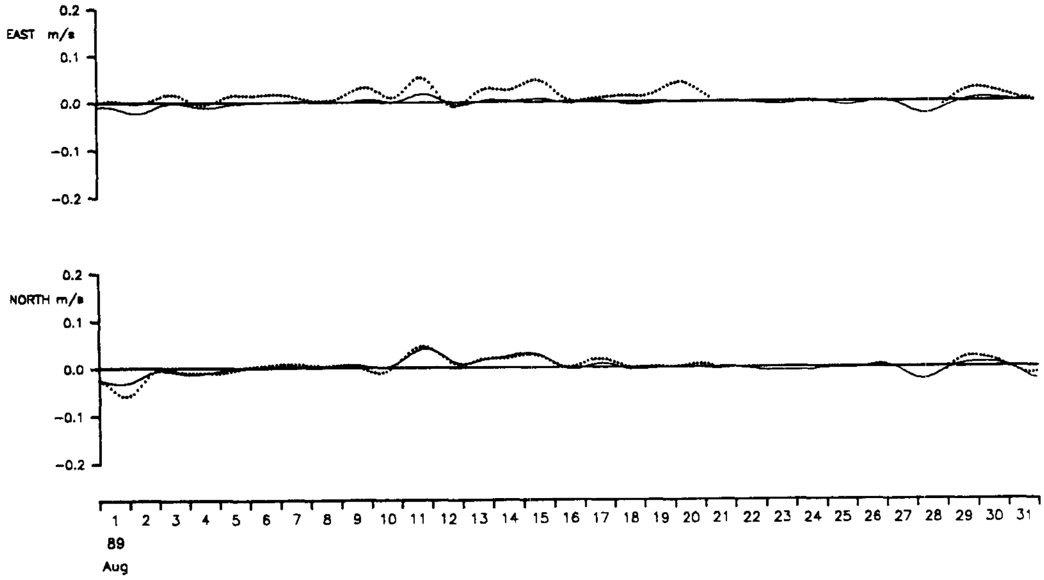
VELOCITY COMPONENT TIME SERIES PLOT

MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —
SITE F 52 37.70 N 03 45.20 E WATER DEPTH 30m METER HEIGHT 12m CURRENT METER ..



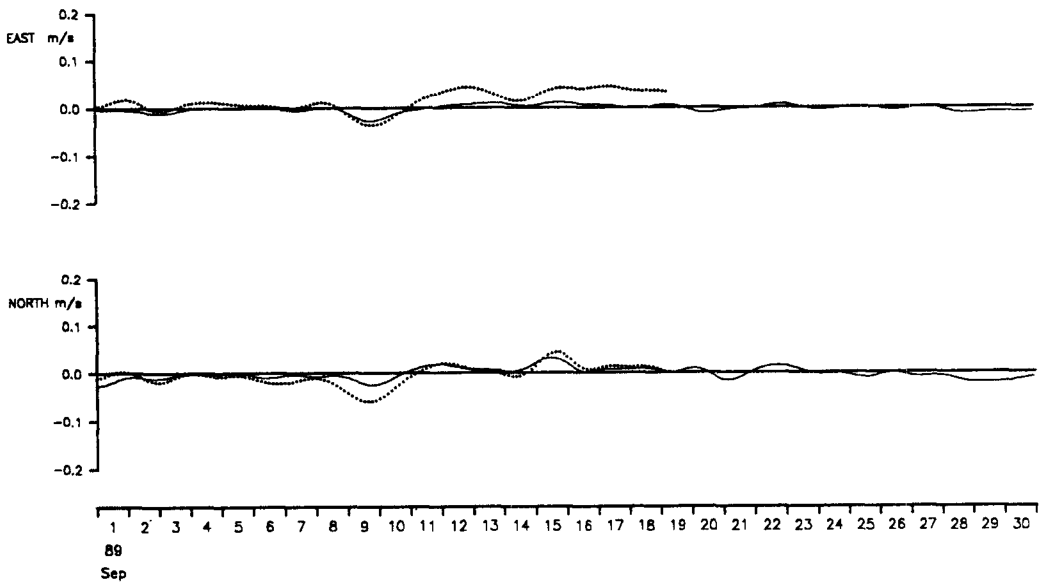
VELOCITY COMPONENT TIME SERIES PLOT

MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —
SITE F 52 37.70 N 03 45.20 E WATER DEPTH 30m METER HEIGHT 12m CURRENT METER • •



VELOCITY COMPONENT TIME SERIES PLOT

MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —
SITE F 52 37.70 N 03 45.20 E WATER DEPTH 30m METER HEIGHT 12m CURRENT METER • •



VELOCITY COMPONENT TIME SERIES PLOT

MODEL AND CURRENT METER RESIDUAL CURRENT COMPARISONS (LOW PASS FILTERED) MODEL —
SITE F 52 37.70 N 03 45.20 E WATER DEPTH 30m METER HEIGHT 12m CURRENT METER • •

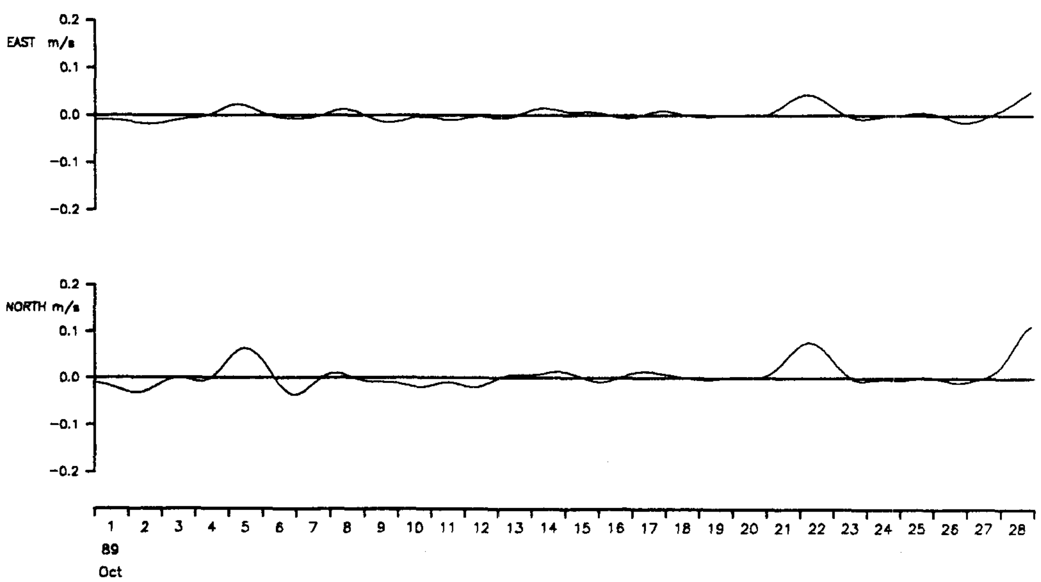
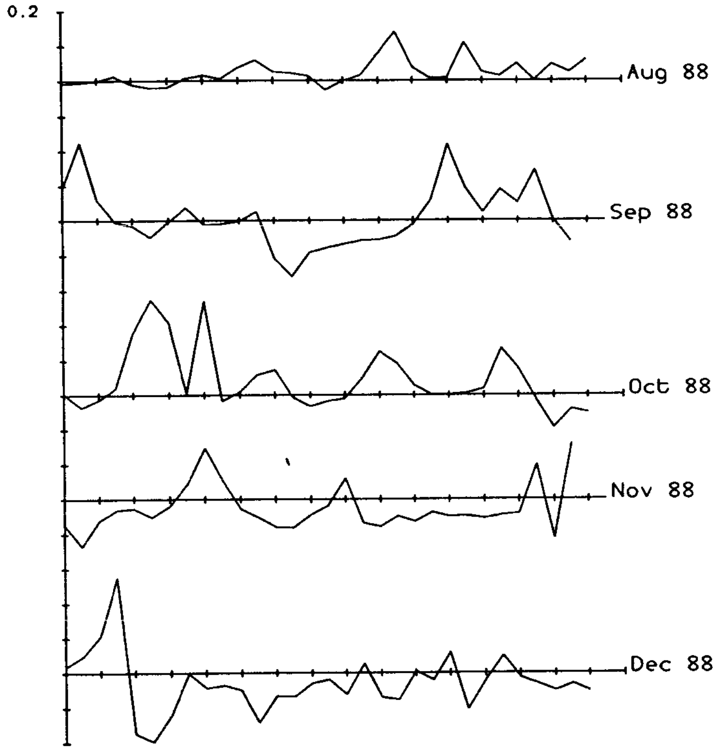


FIGURE 8

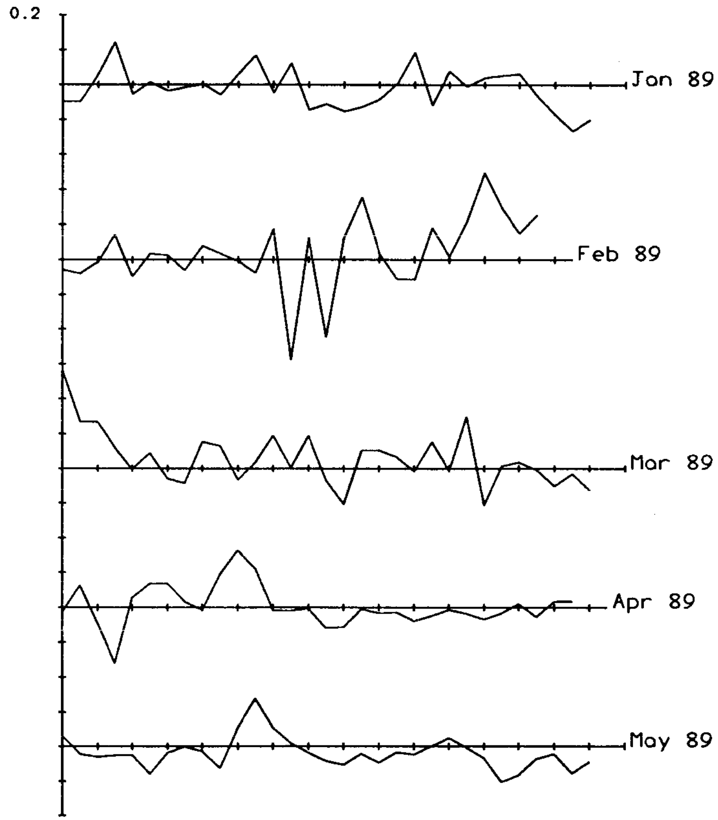
Time series of daily mean volume fluxes across sections of the north-west European continental shelf for the 15 month period

Section 1. Dover Strait	(positive flow into North Sea)
Section 2. Western Approaches	(positive flow into English Channel)
Section 3. Celtic Sea	
Section 4. St. George's Channel	
Section 5. Irish Sea (west of I.O.M.)	(positive flow northward)
Section 6. Irish Sea (east of I.O.M.)	
Section 7. North Channel	
Section 8. The Minch	
Section 9. Faeroe-Shetland Channel	
Section 10. Pentland Firth	(positive flow into North sea)
Section 11. Fair Isle Passage	
Sections 12 to 17. North Sea	(positive flow northward)
	(section 13: positive flow eastward)

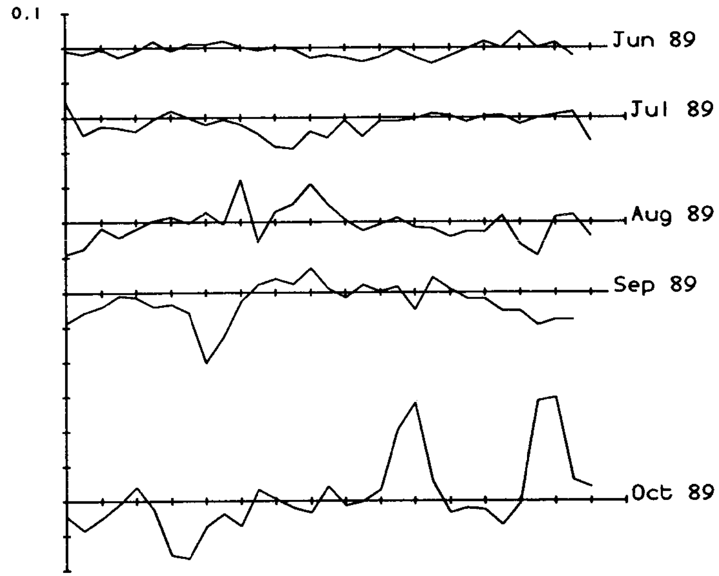
Calculated Flux (Sv) - Dover Strait (I)

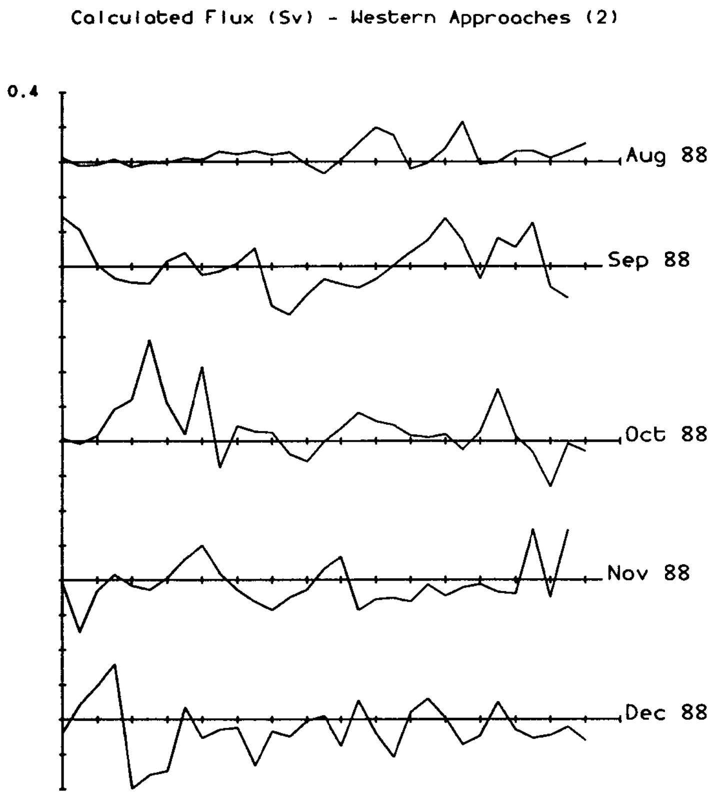


Calculated Flux (Sv) - Dover Strait (I)

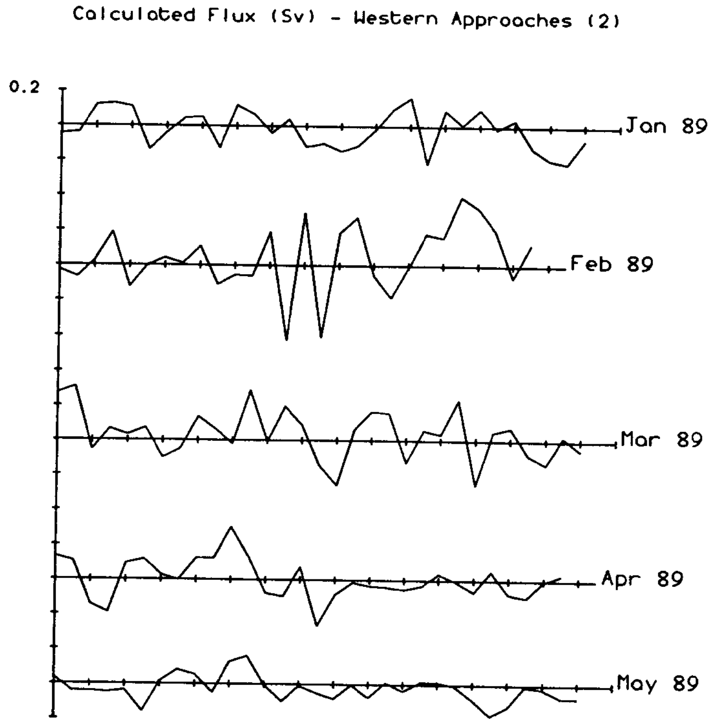


Calculated Flux (Sv) - Dover Strait (I)

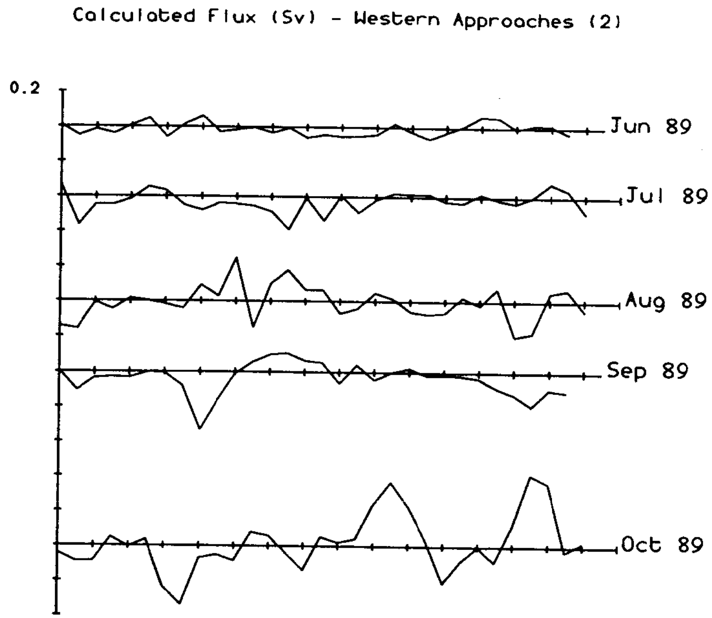




Calculated Flux (Sv) - Western Approaches (2)
0.4
Aug 88
Sep 88
Oct 88
Nov 88
Dec 88

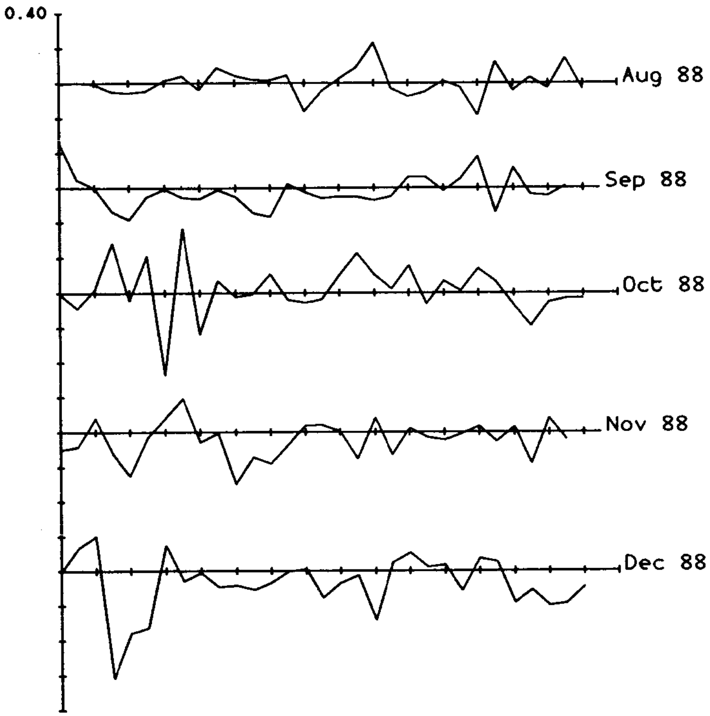


Calculated Flux (Sv) - Western Approaches (2)
0.2
Jan 89
Feb 89
Mar 89
Apr 89
May 89

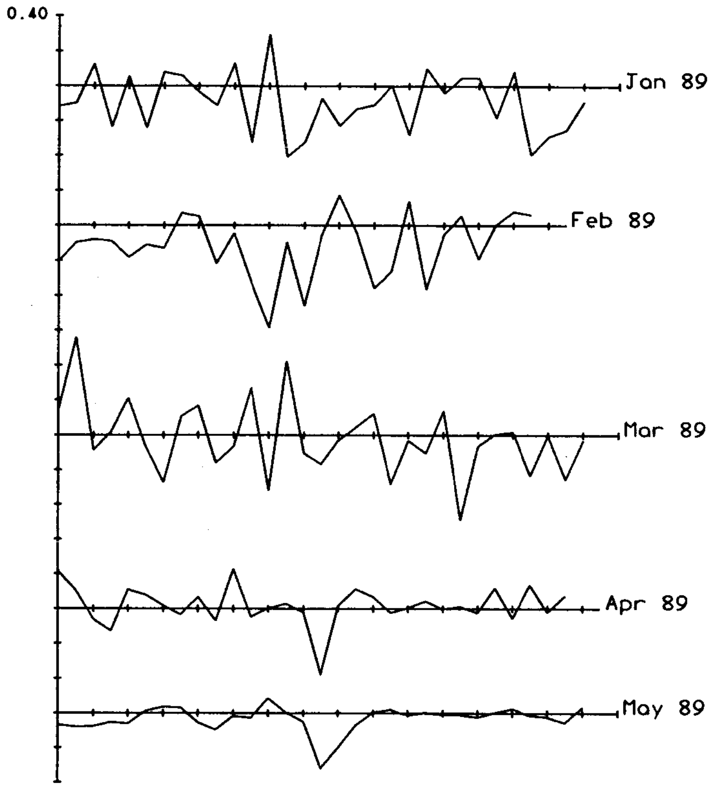


Calculated Flux (Sv) - Western Approaches (2)
0.2
Jun 89
Jul 89
Aug 89
Sep 89
Oct 89

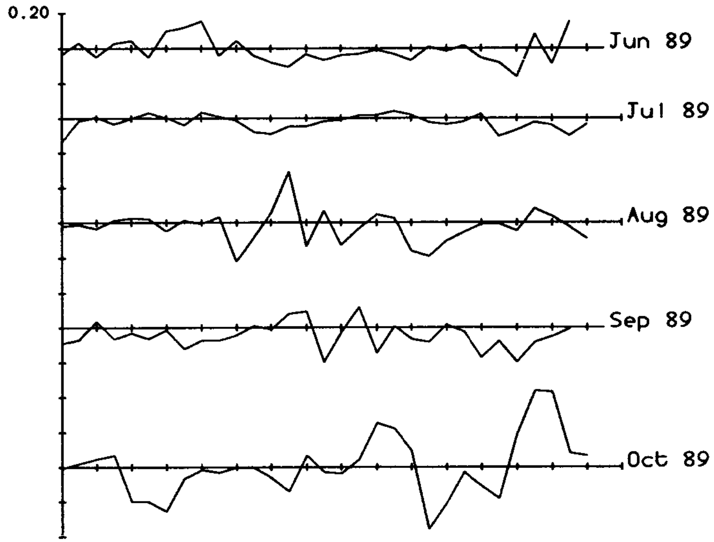
Calculated Flux (Sv) - Celtic Sea (3)



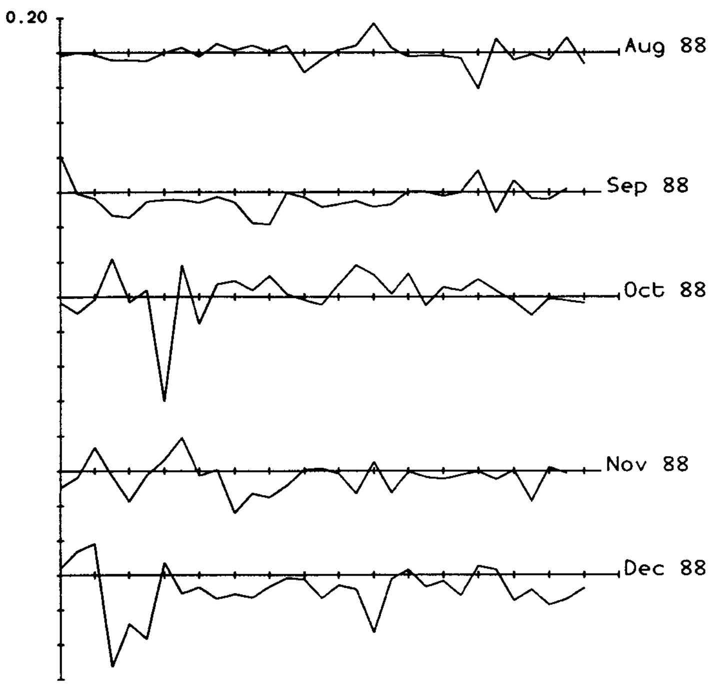
Calculated Flux (Sv) - Celtic Sea (3)



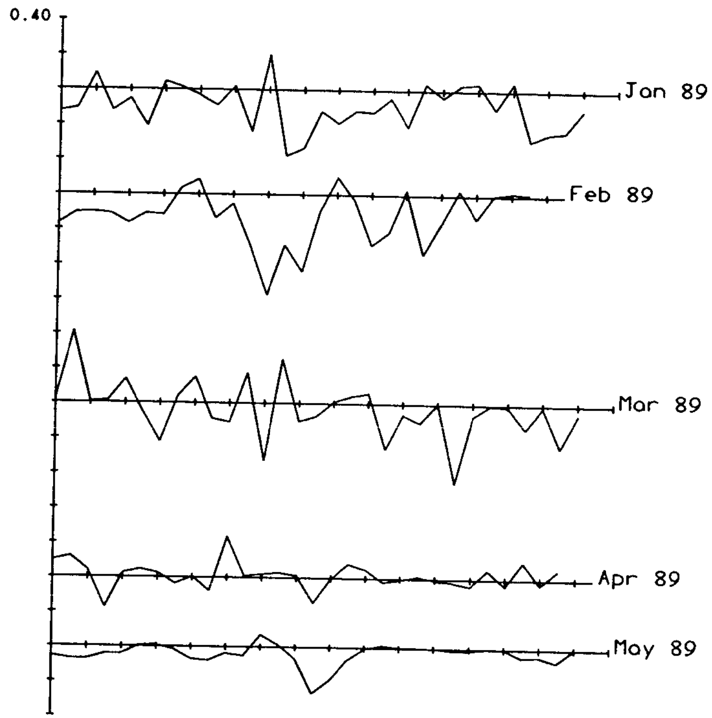
Calculated Flux (Sv) - Celtic Sea (3)



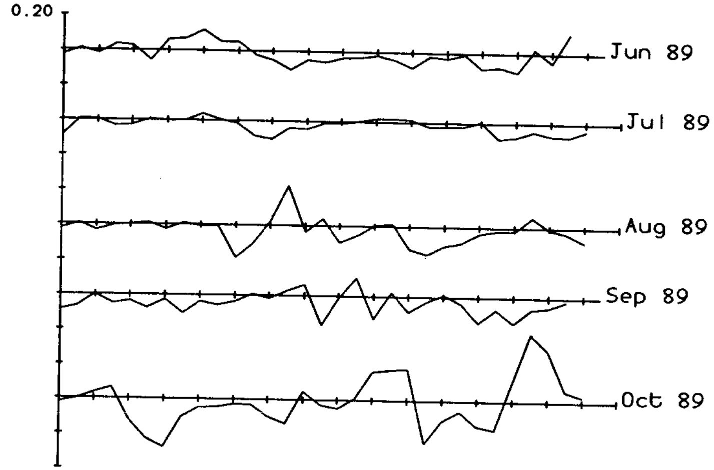
Calculated Flux (Sv) - St. George's Channel (4)



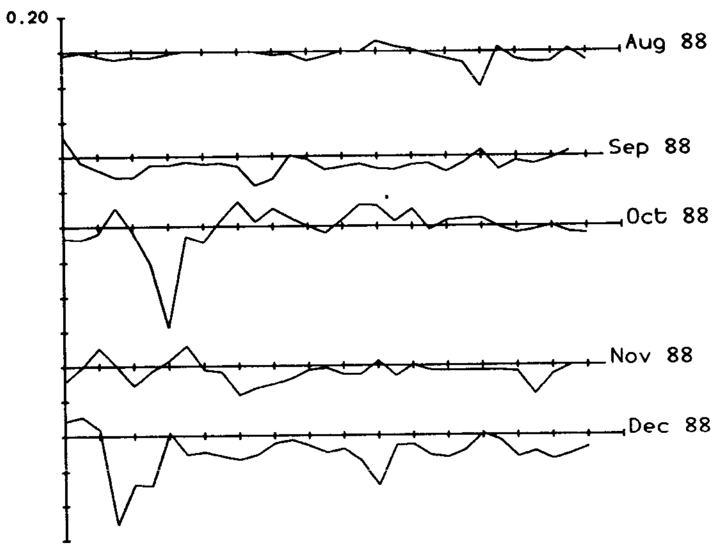
Calculated Flux (Sv) - St. George's Channel (4)



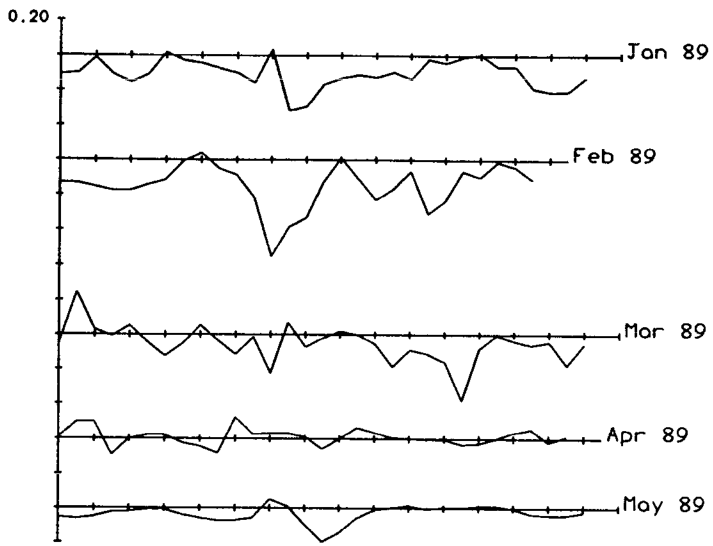
Calculated Flux (Sv) - St. George's Channel (4)



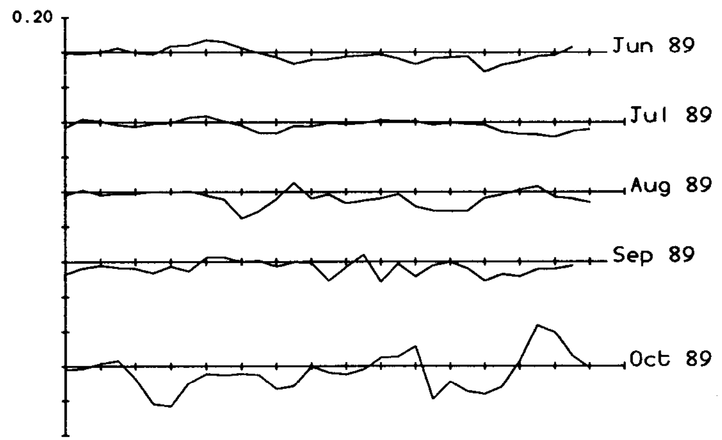
Calculated Flux (Sv) - Irish Sea (west of I.O.M.) (5)

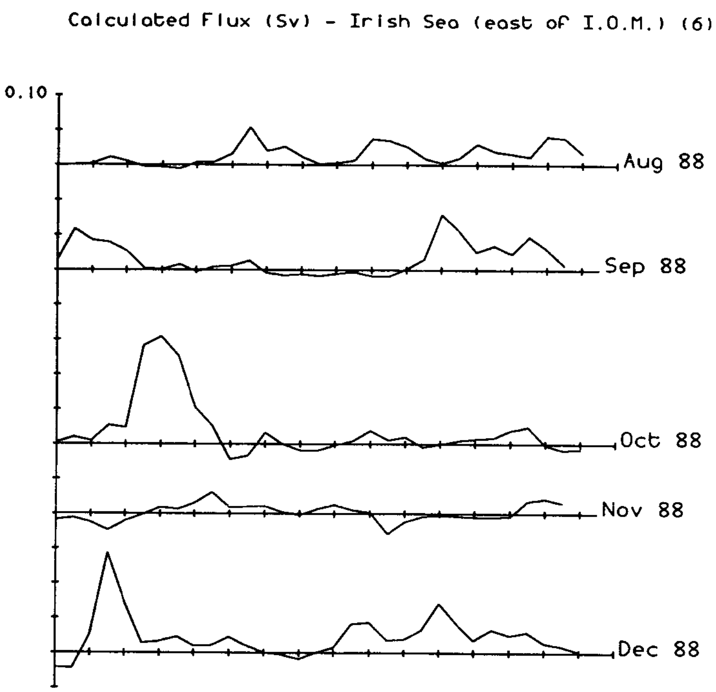


Calculated Flux (Sv) - Irish Sea (west of I.O.M.) (5)

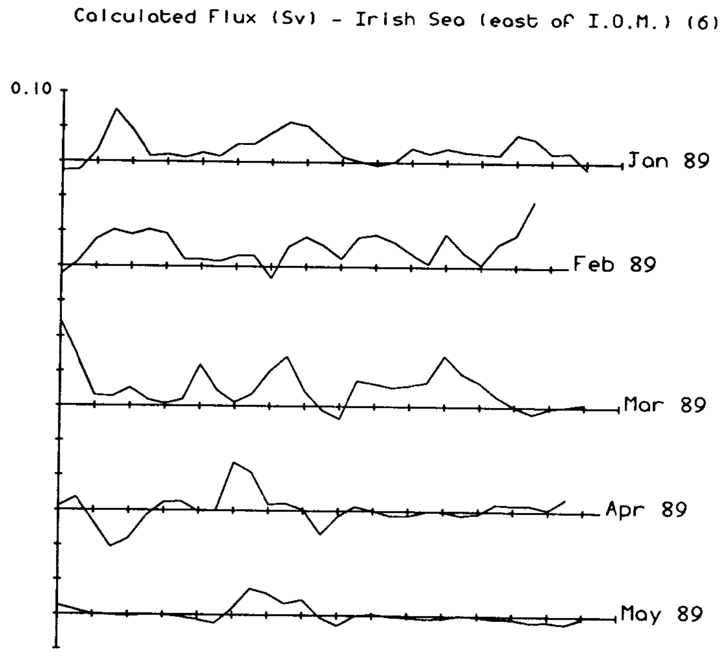


Calculated Flux (Sv) - Irish Sea (west of I.O.M.) (5)

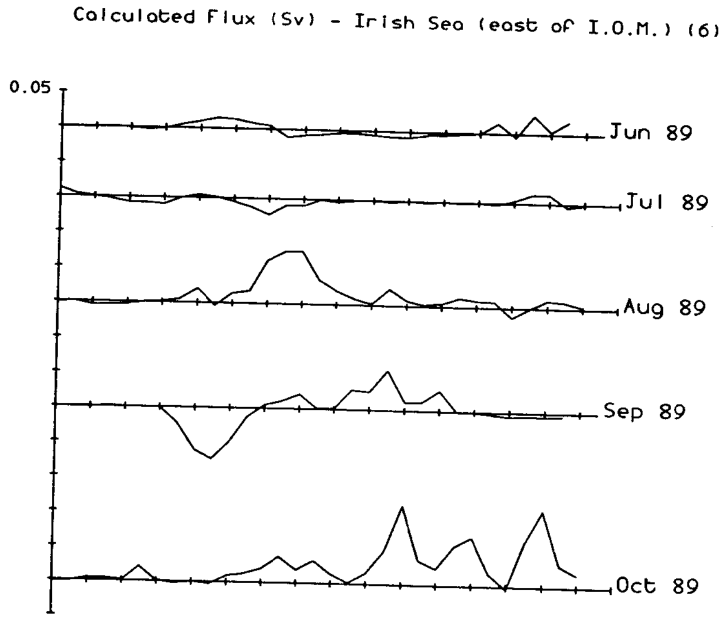




Calculated Flux (Sv) - Irish Sea (east of I.O.M.) (6)
0.10
Aug 88
Sep 88
Oct 88
Nov 88
Dec 88

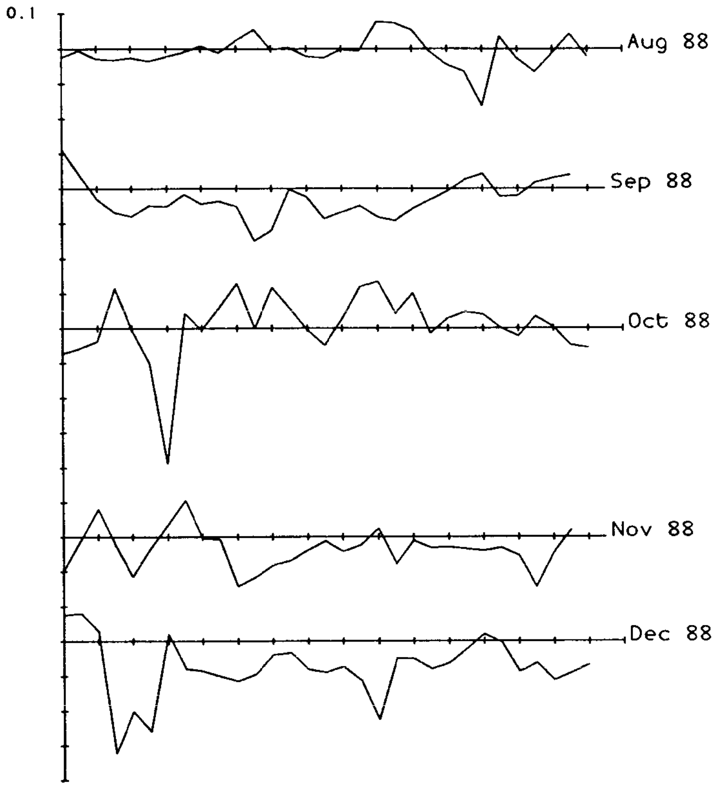


Calculated Flux (Sv) - Irish Sea (east of I.O.M.) (6)
0.10
Jan 89
Feb 89
Mar 89
Apr 89
May 89

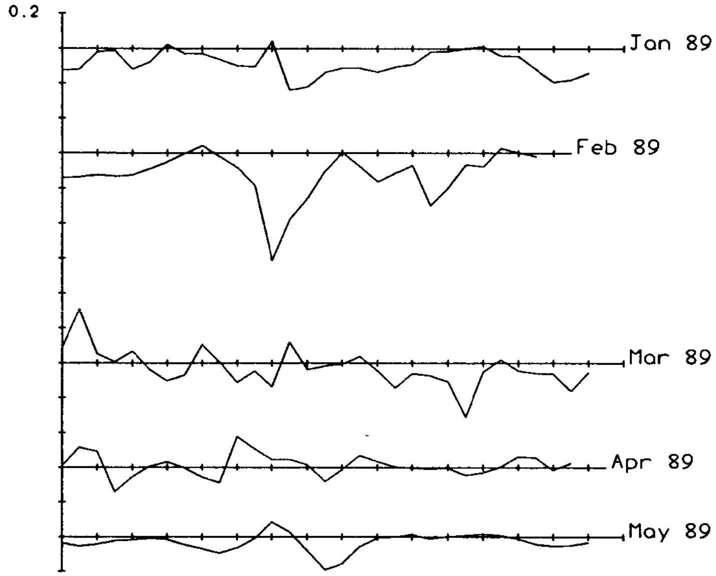


Calculated Flux (Sv) - Irish Sea (east of I.O.M.) (6)
0.05
Jun 89
Jul 89
Aug 89
Sep 89
Oct 89

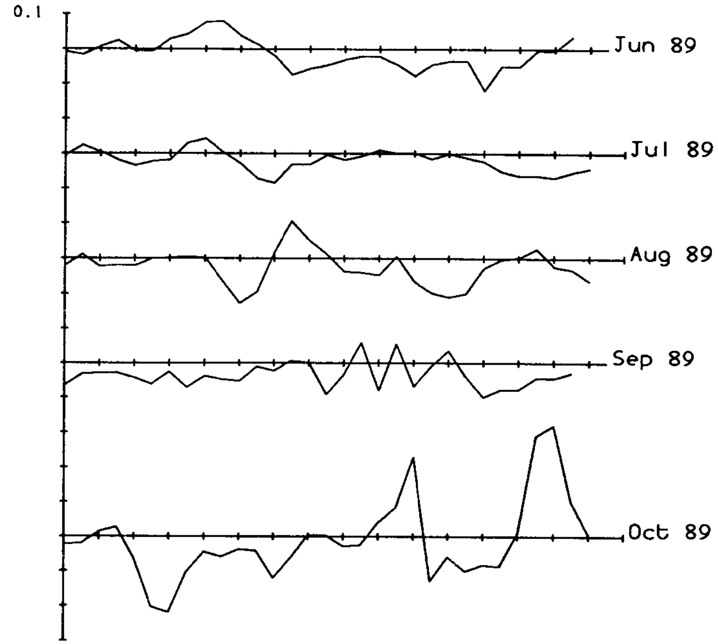
Calculated Flux (Sv) - North Channel (7)



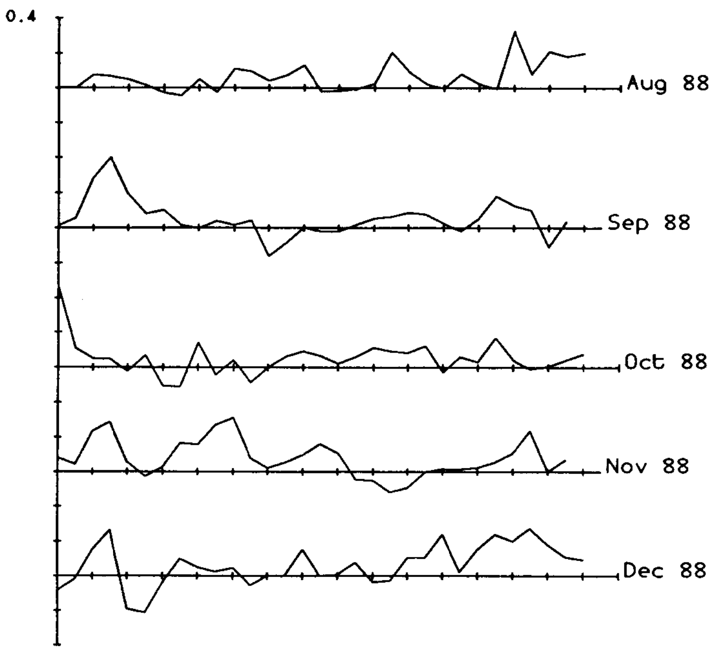
Calculated Flux (Sv) - North Channel (7)



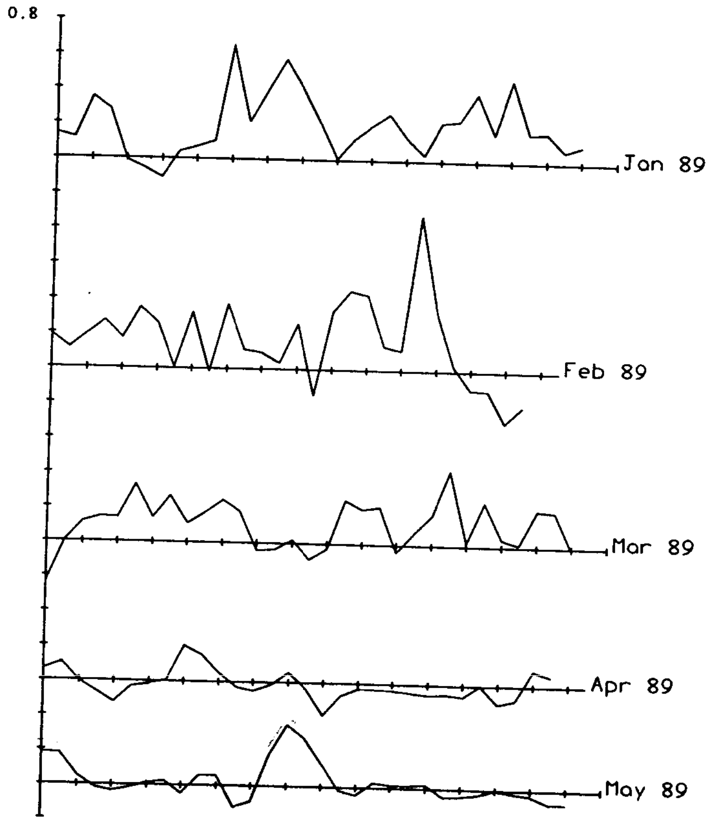
Calculated Flux (Sv) - North Channel (7)



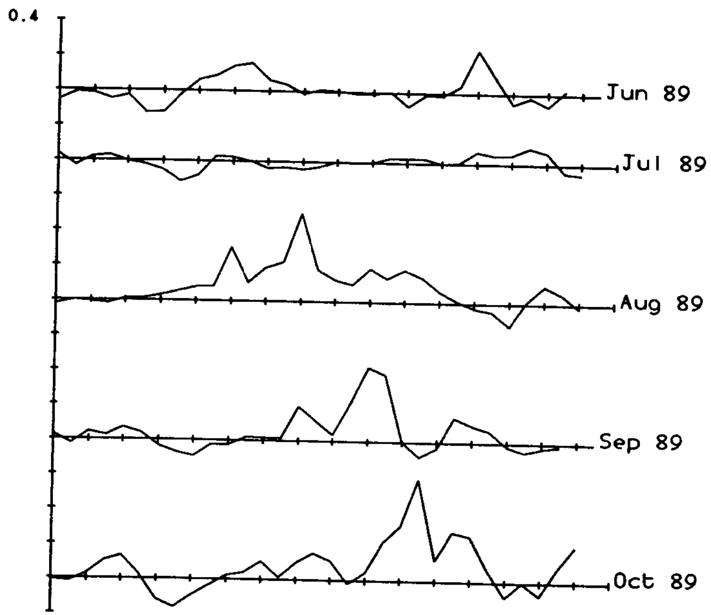
Calculated Flux (Sv) - The Minch (8)



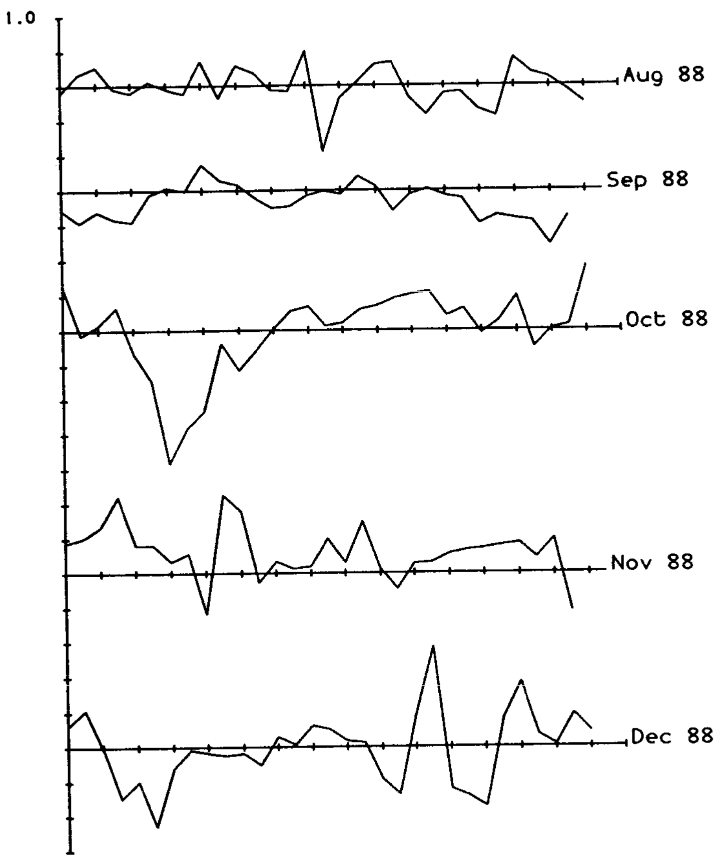
Calculated Flux (Sv) - The Minch (8)



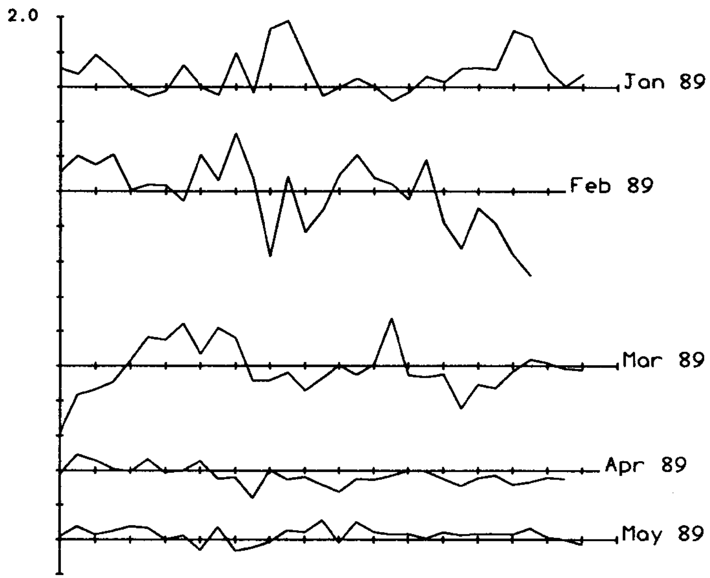
Calculated Flux (Sv) - The Minch (8)



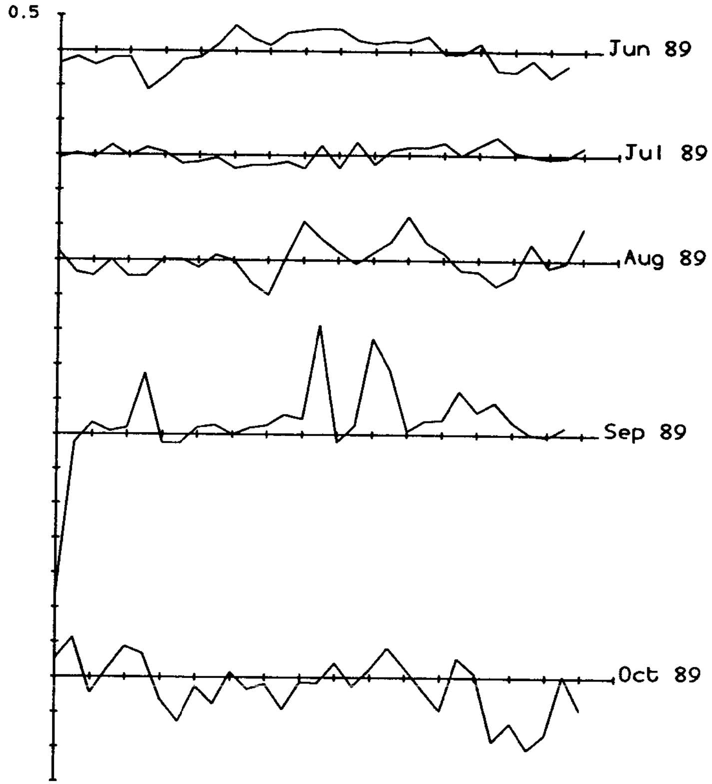
Calculated Flux (Sv) - Faeroes/Shetland Passage (9)

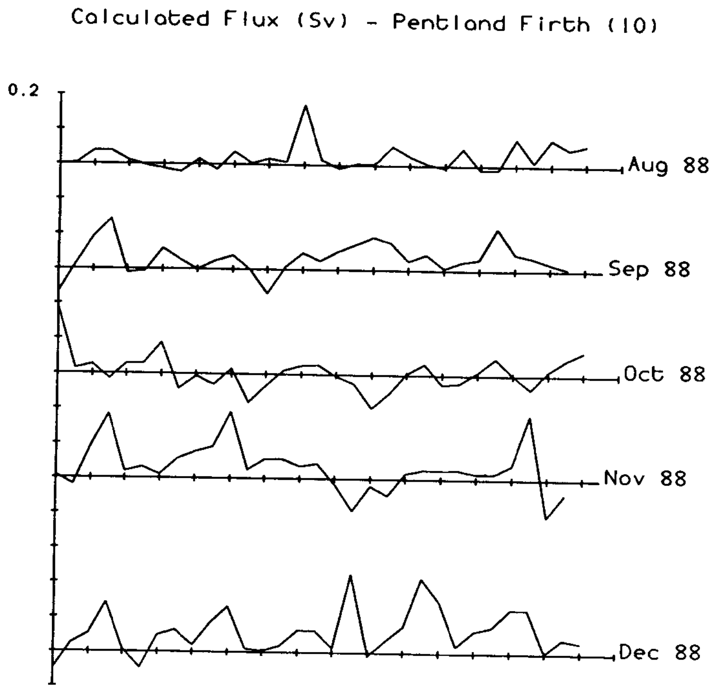


Calculated Flux (Sv) - Faeroes/Shetland Passage (9)

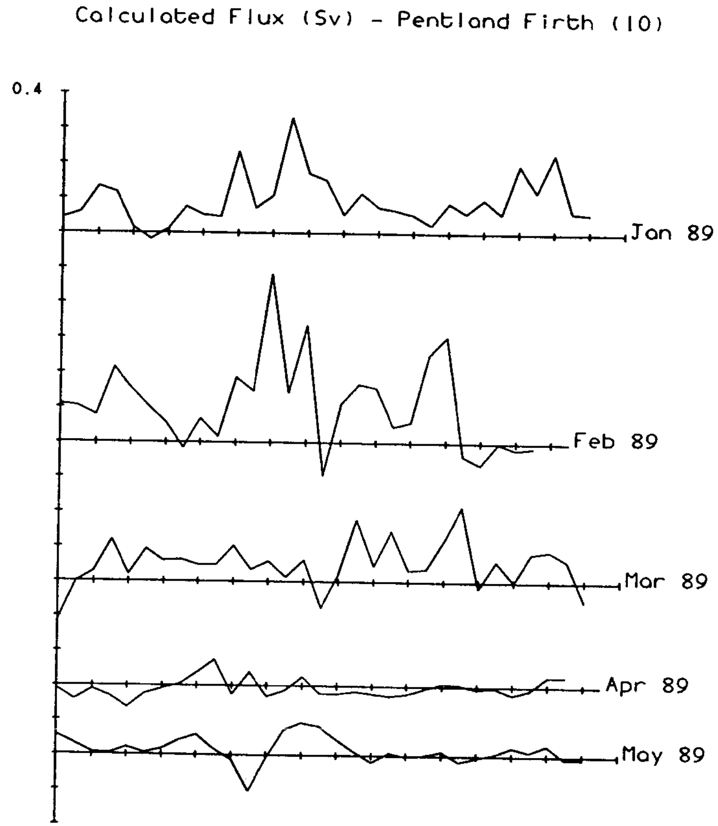


Calculated Flux (Sv) - Faeroes/Shetland Passage (9)

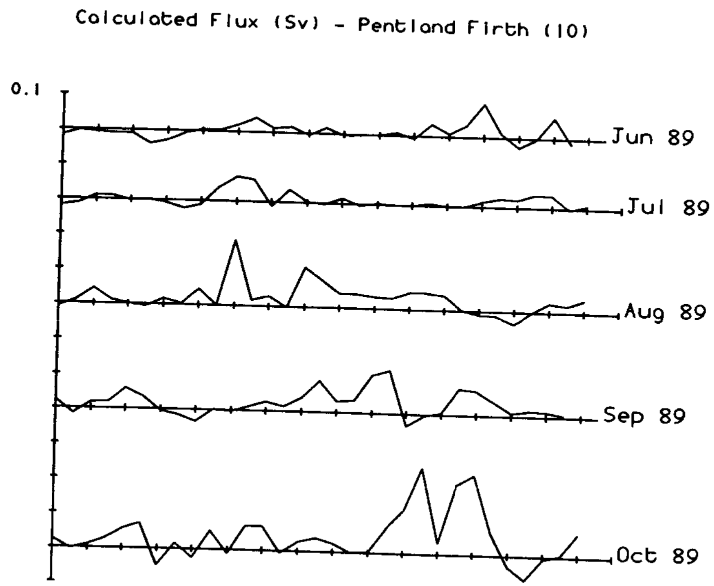




Calculated Flux (Sv) - Pentland Firth (10)
0.2
Aug 88
Sep 88
Oct 88
Nov 88
Dec 88

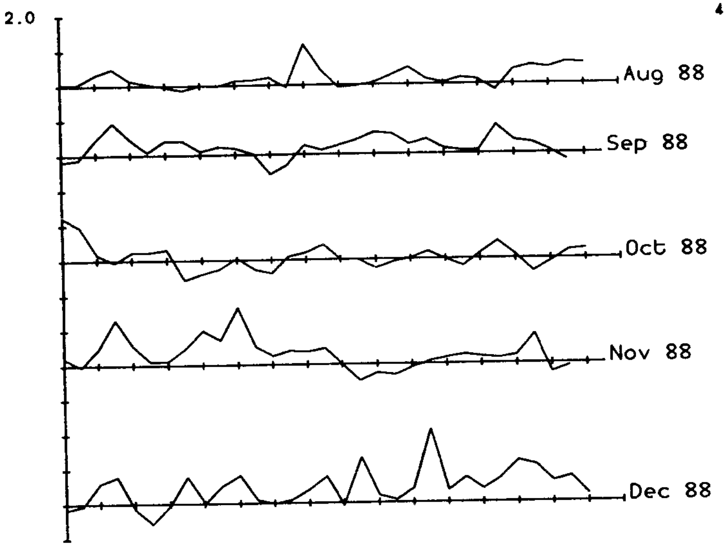


Calculated Flux (Sv) - Pentland Firth (10)
0.4
Jan 89
Feb 89
Mar 89
Apr 89
May 89

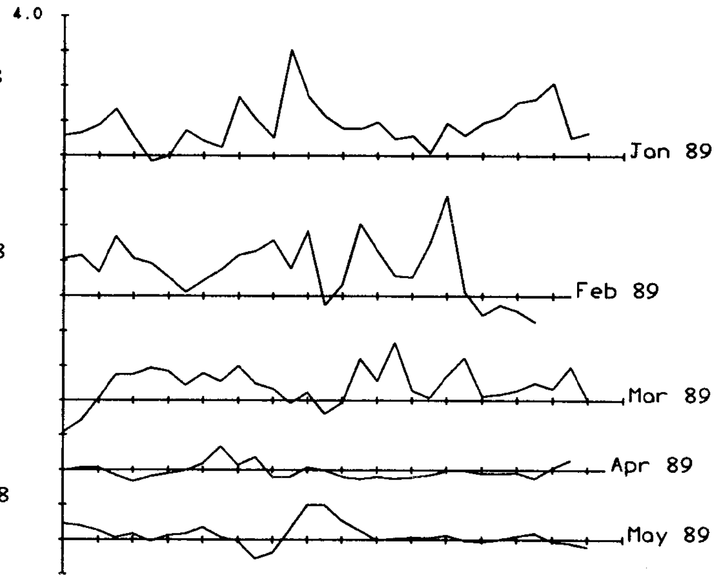


Calculated Flux (Sv) - Pentland Firth (10)
0.1
Jun 89
Jul 89
Aug 89
Sep 89
Oct 89

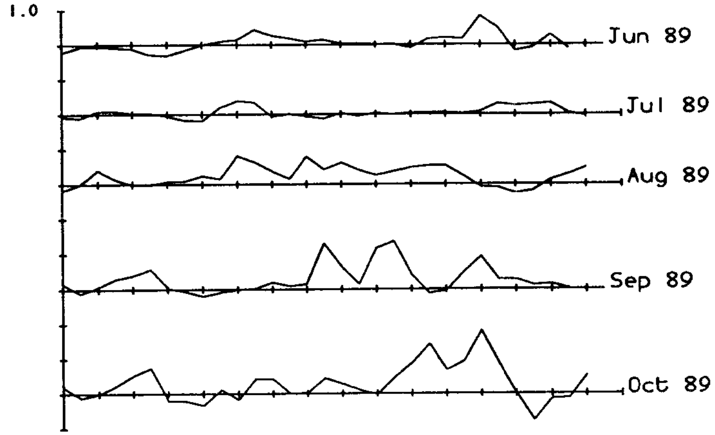
Calculated Flux (Sv) - Fair Isle Passage (II)



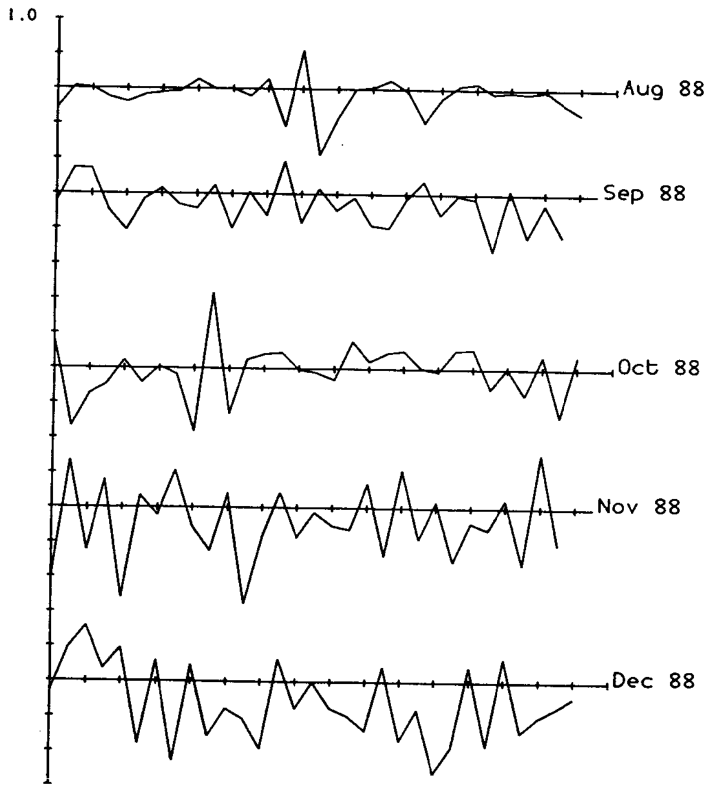
Calculated Flux (Sv) - Fair Isle Passage (II)



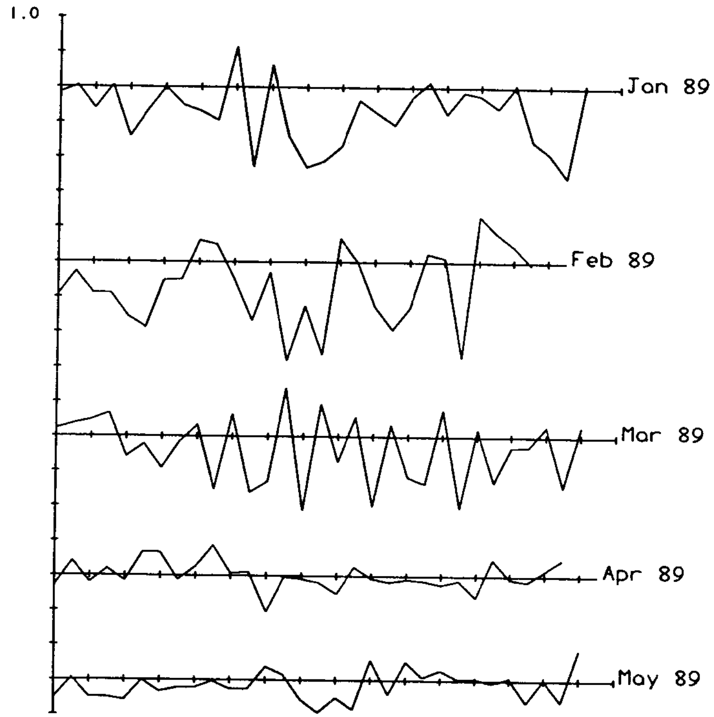
Calculated Flux (Sv) - Fair Isle Passage (II)



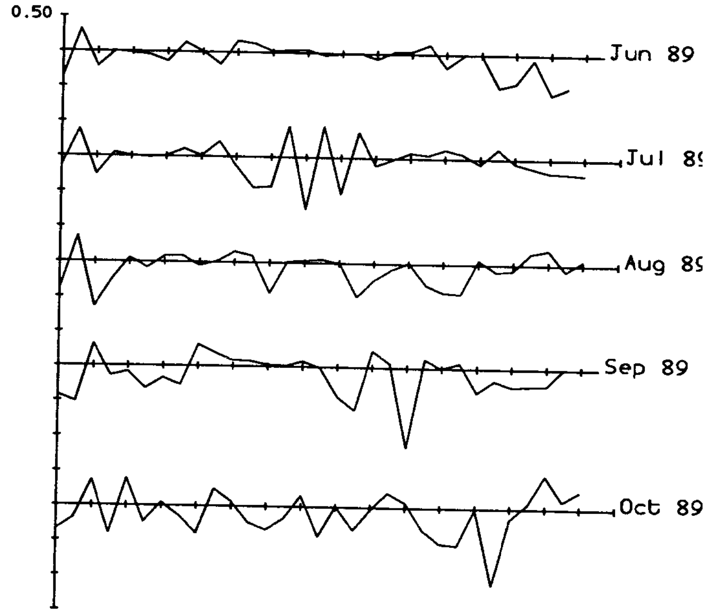
Calculated Flux (Sv) - North Sea (12a)

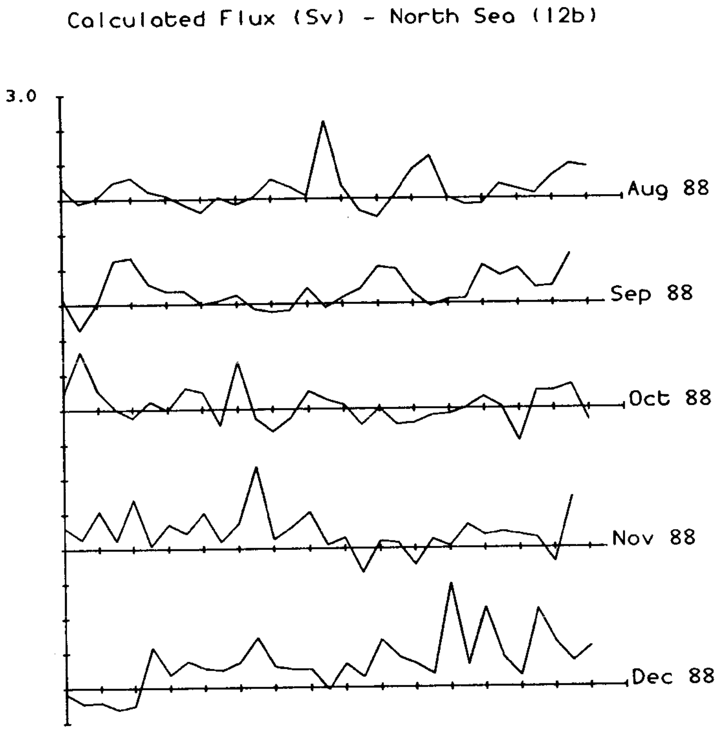


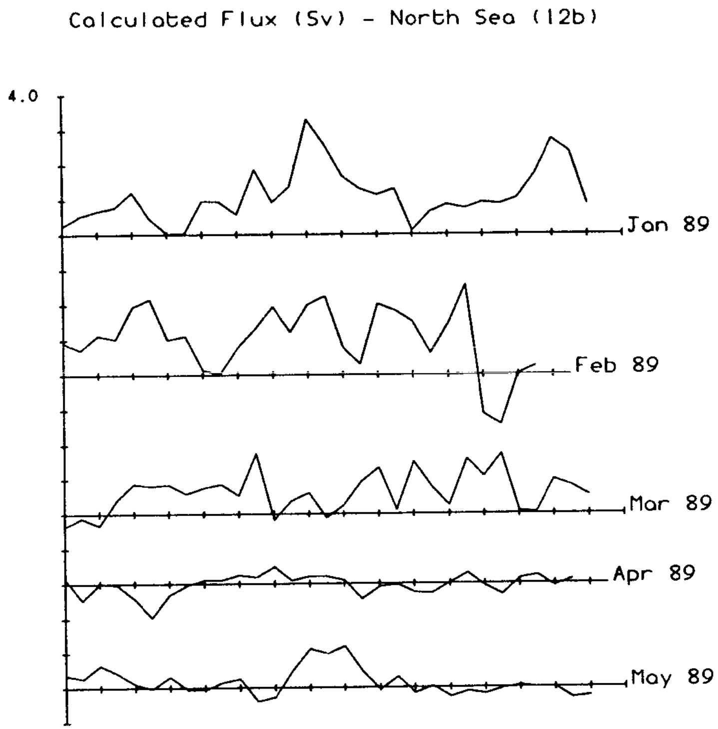
Calculated Flux (Sv) - North Sea (12a)

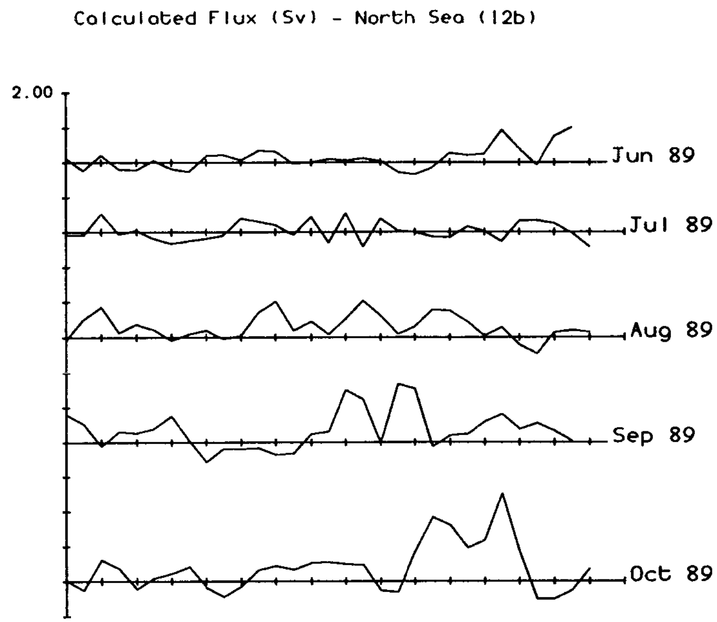


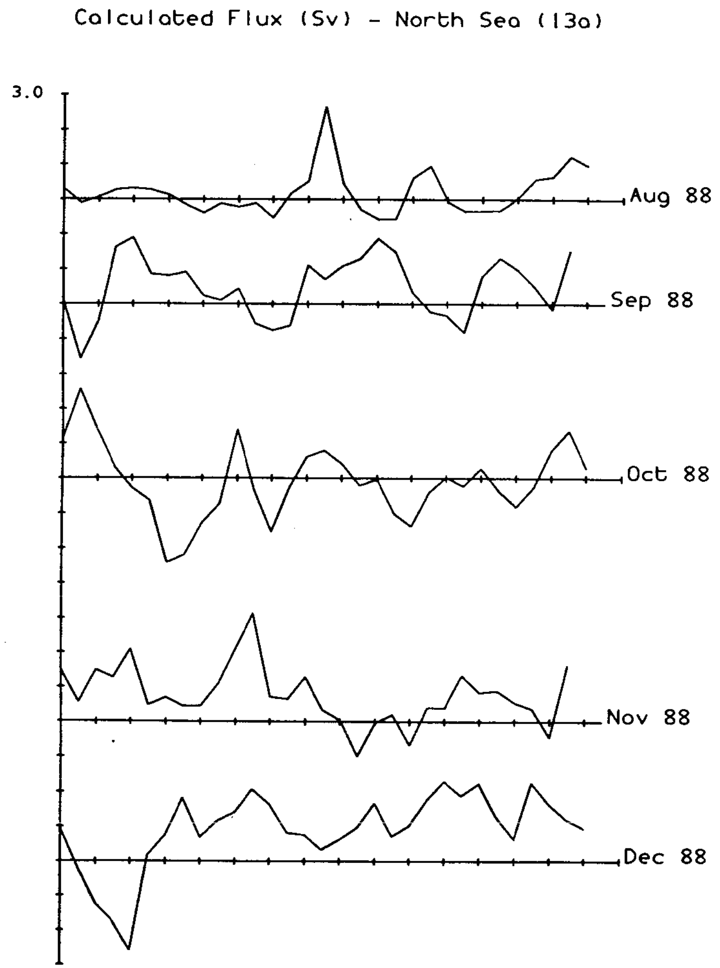
Calculated Flux (Sv) - North Sea (12a)

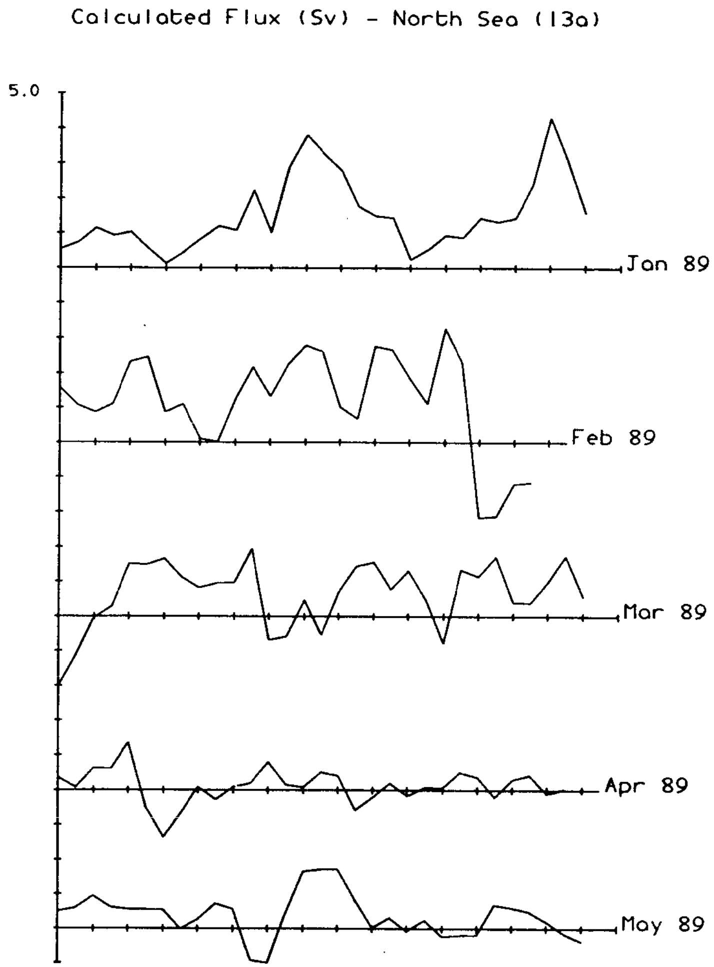


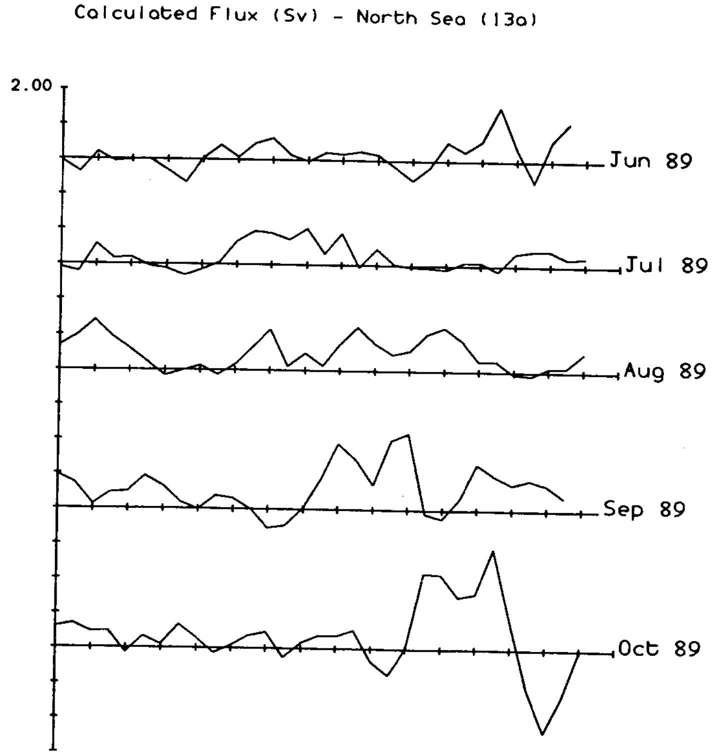

Calculated Flux (Sv) - North Sea (12b)
3.0
Aug 88
Sep 88
Oct 88
Nov 88
Dec 88


Calculated Flux (Sv) - North Sea (12b)
4.0
Jan 89
Feb 89
Mar 89
Apr 89
May 89

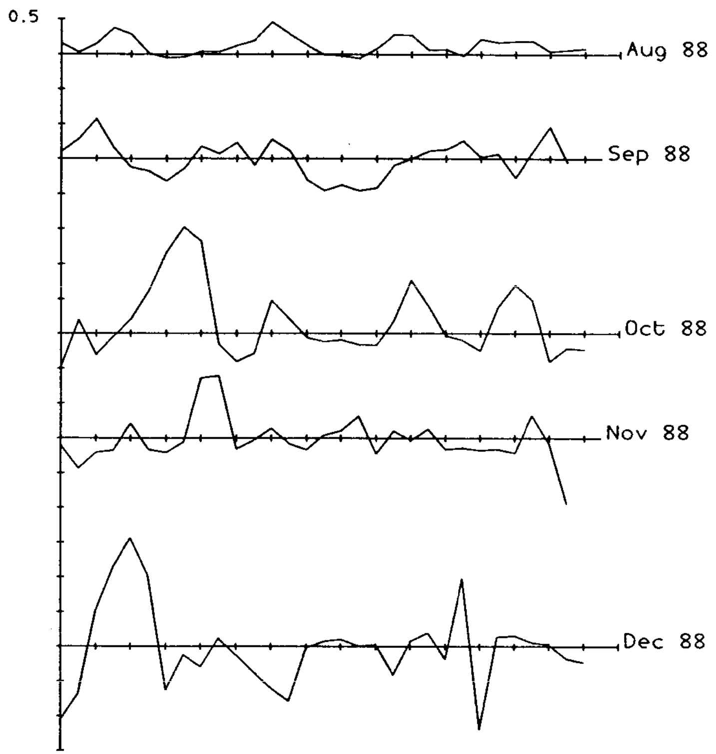

Calculated Flux (Sv) - North Sea (12b)
2.00
Jun 89
Jul 89
Aug 89
Sep 89
Oct 89


Calculated Flux (Sv) - North Sea (13a)
3.0
Aug 88
Sep 88
Oct 88
Nov 88
Dec 88

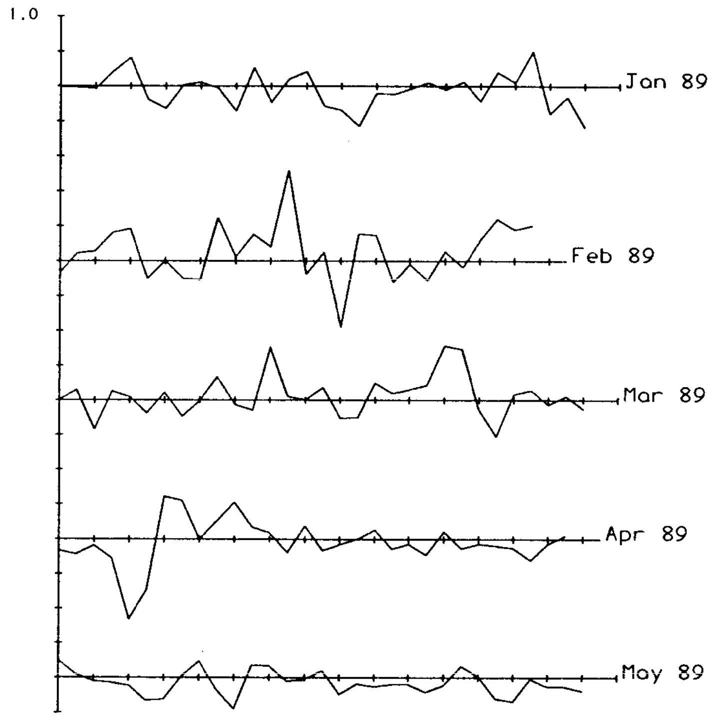

Calculated Flux (Sv) - North Sea (13a)
5.0
Jan 89
Feb 89
Mar 89
Apr 89
May 89


Calculated Flux (Sv) - North Sea (13a)
2.00
Jun 89
Jul 89
Aug 89
Sep 89
Oct 89

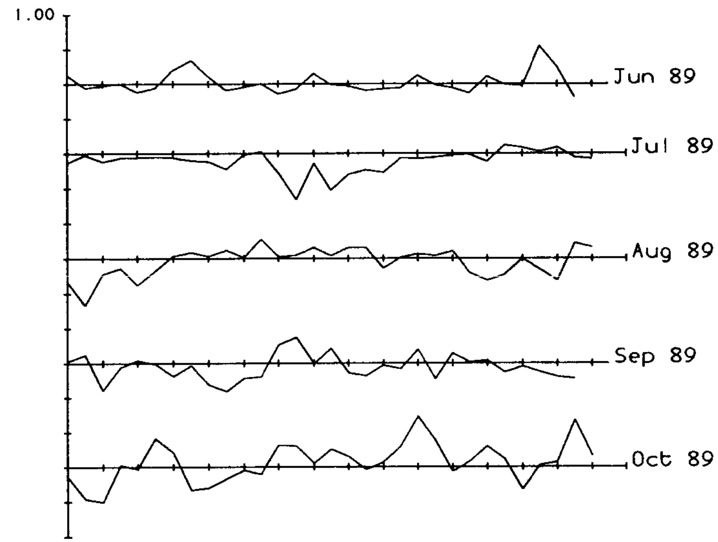
Calculated Flux (Sv) - North Sea (13b)



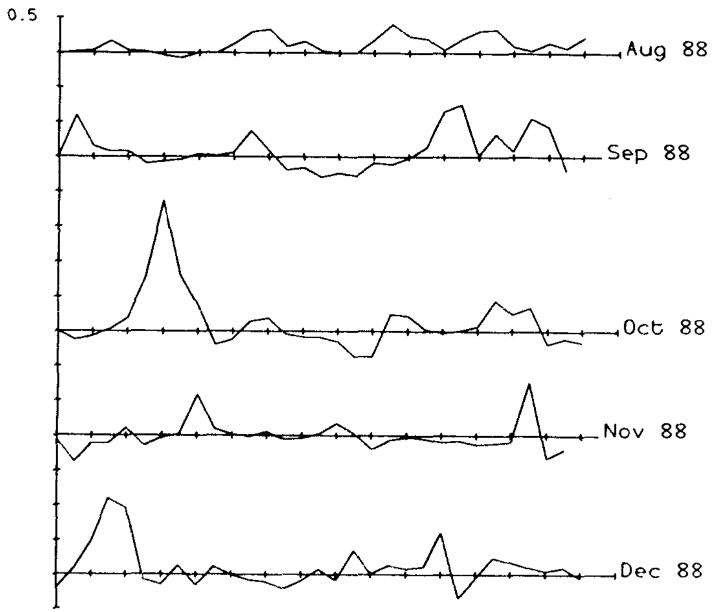
Calculated Flux (Sv) - North Sea (13b)



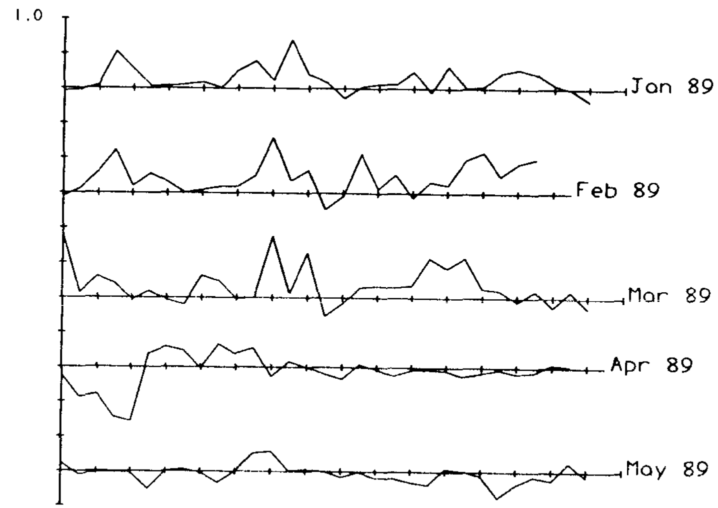
Calculated Flux (Sv) - North Sea (13b)



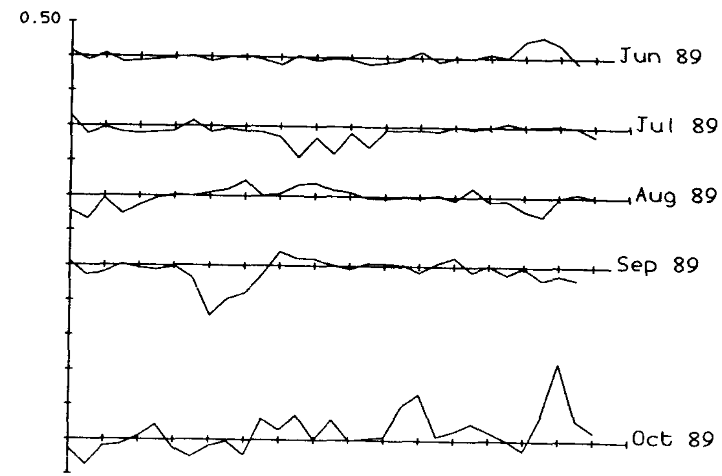
Calculated Flux (Sv) - North Sea (13c)

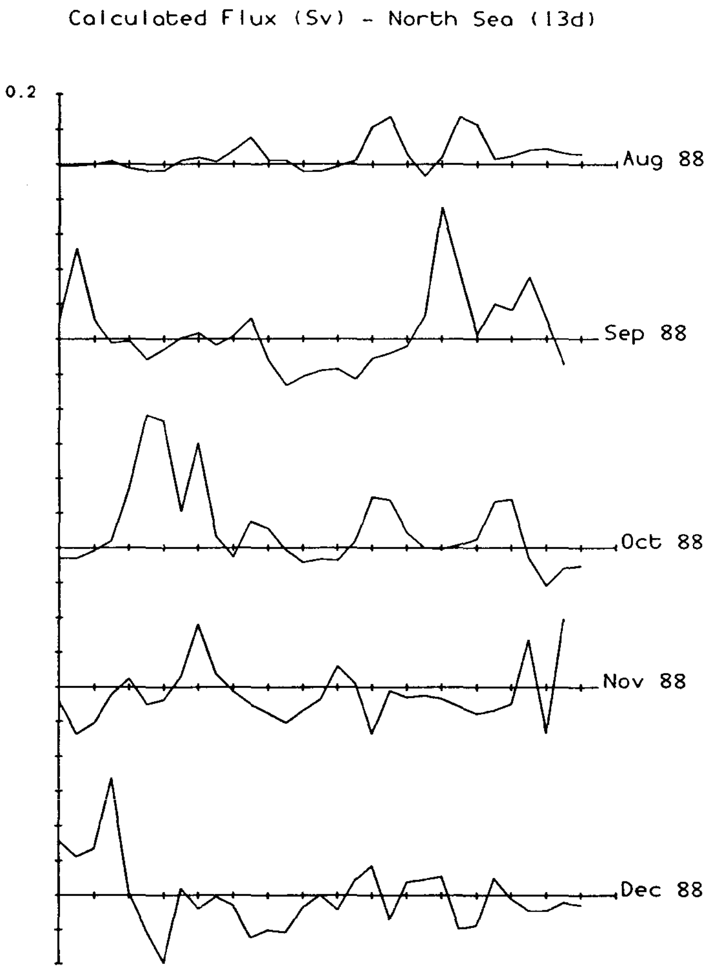


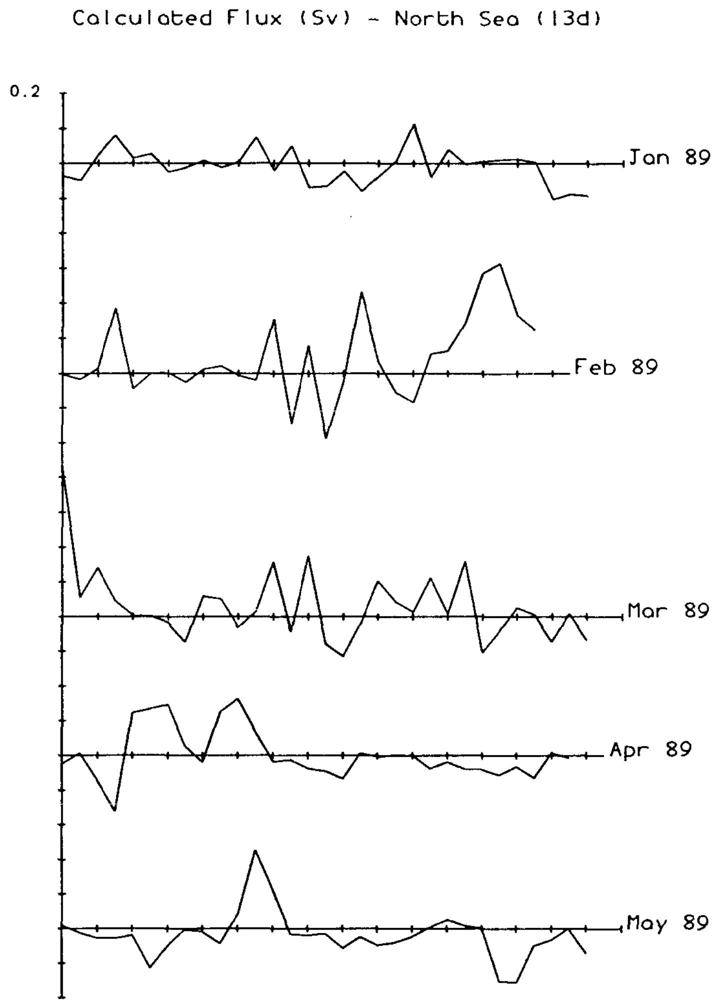
Calculated Flux (Sv) - North Sea (13c)

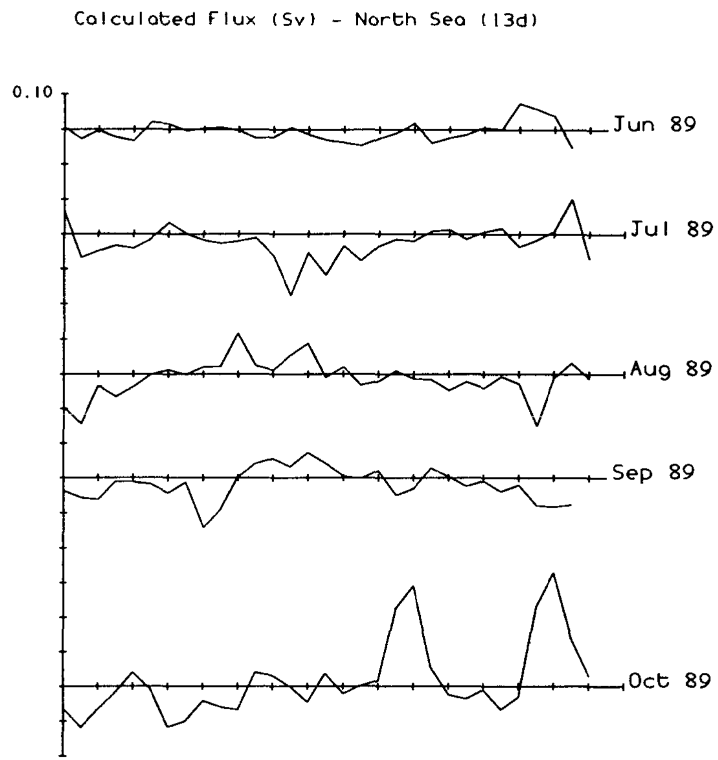


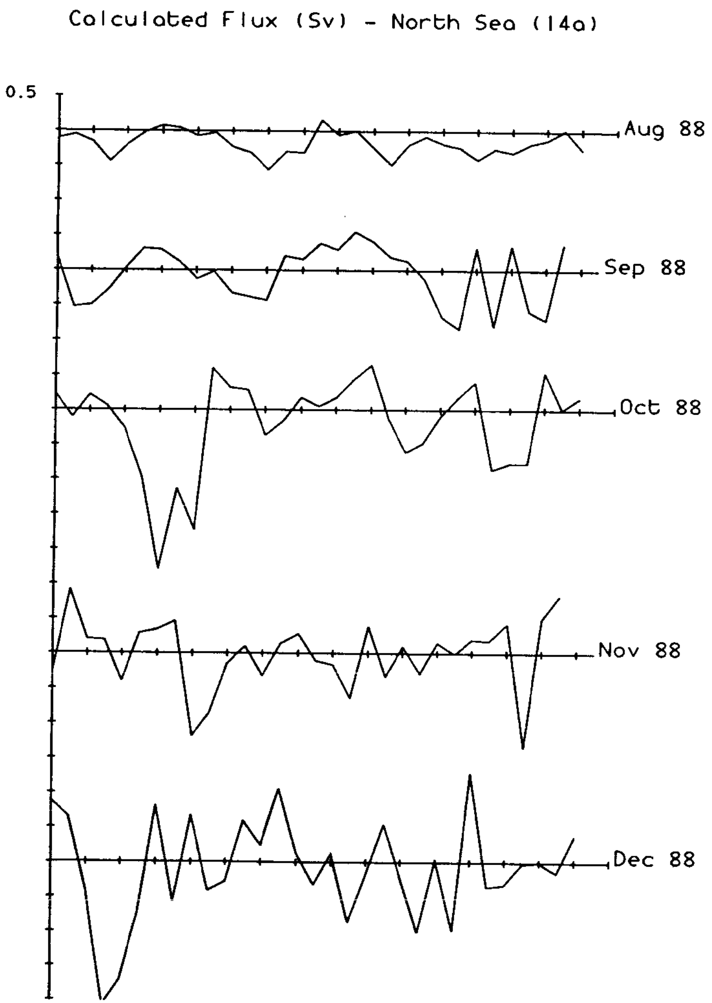
Calculated Flux (Sv) - North Sea (13c)



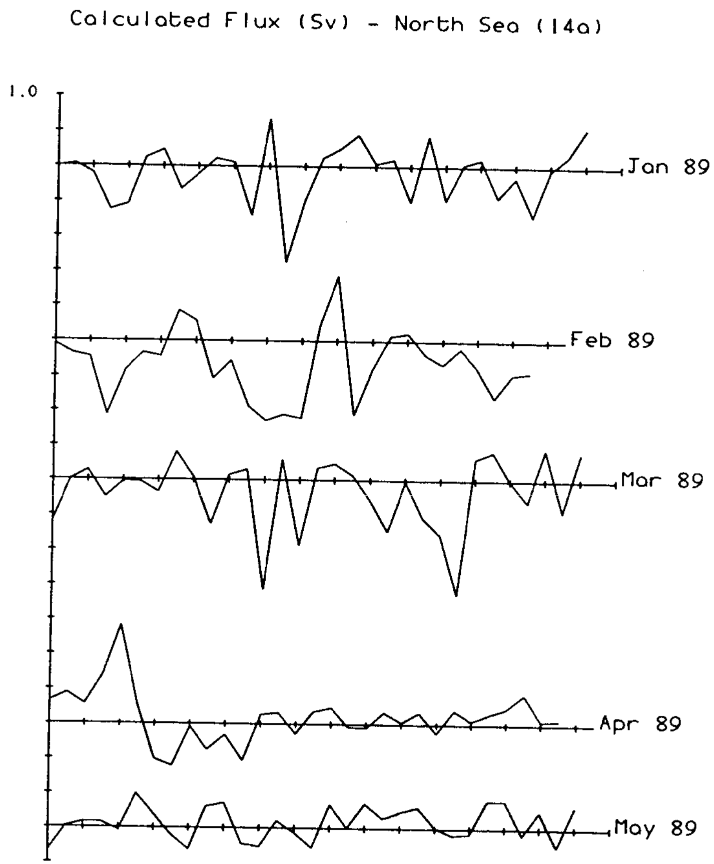

Calculated Flux (Sv) - North Sea (13d)
0.2
Aug 88
Sep 88
Oct 88
Nov 88
Dec 88


Calculated Flux (Sv) - North Sea (13d)
0.2
Jan 89
Feb 89
Mar 89
Apr 89
May 89

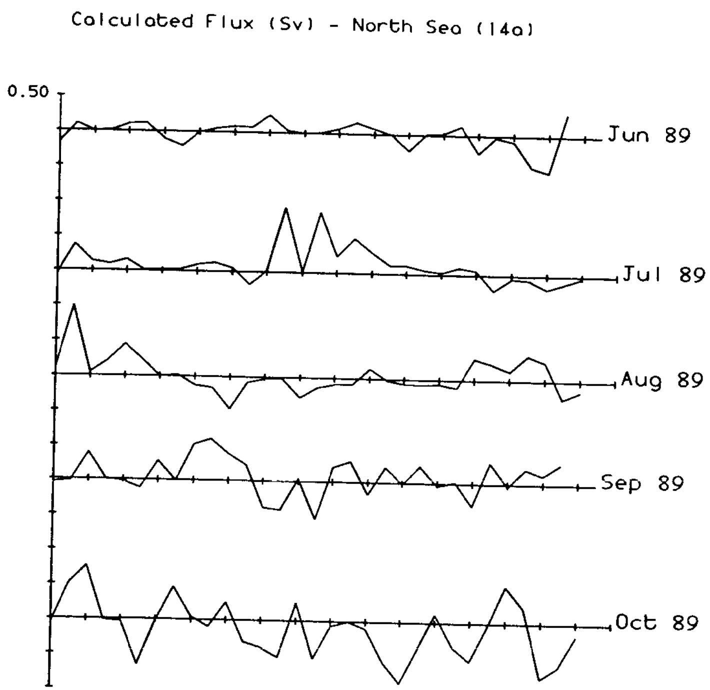

Calculated Flux (Sv) - North Sea (13d)
0.10
Jun 89
Jul 89
Aug 89
Sep 89
Oct 89



Calculated Flux (Sv) - North Sea (14a)
0.5
Aug 88
Sep 88
Oct 88
Nov 88
Dec 88

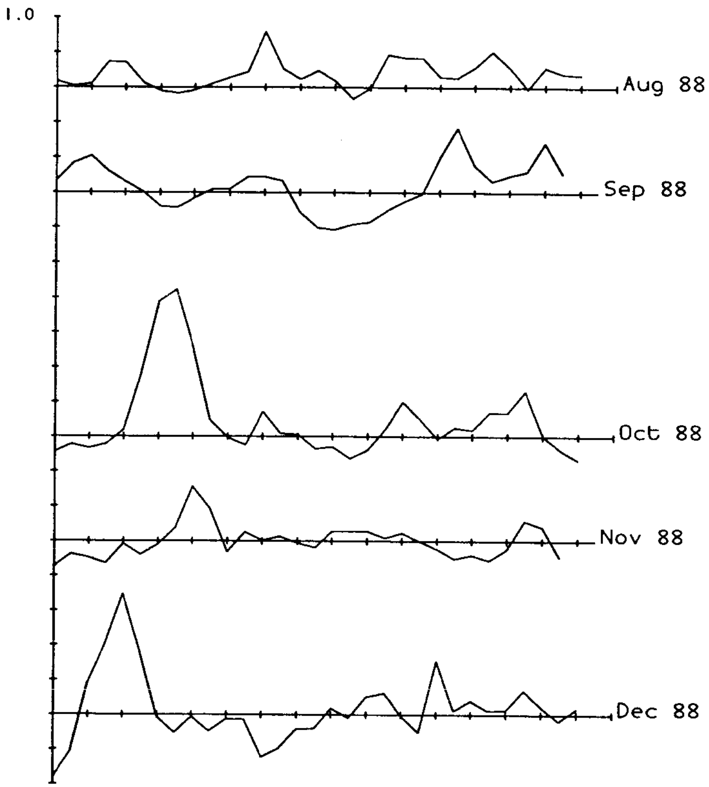


Calculated Flux (Sv) - North Sea (14a)
1.0
Jan 89
Feb 89
Mar 89
Apr 89
May 89

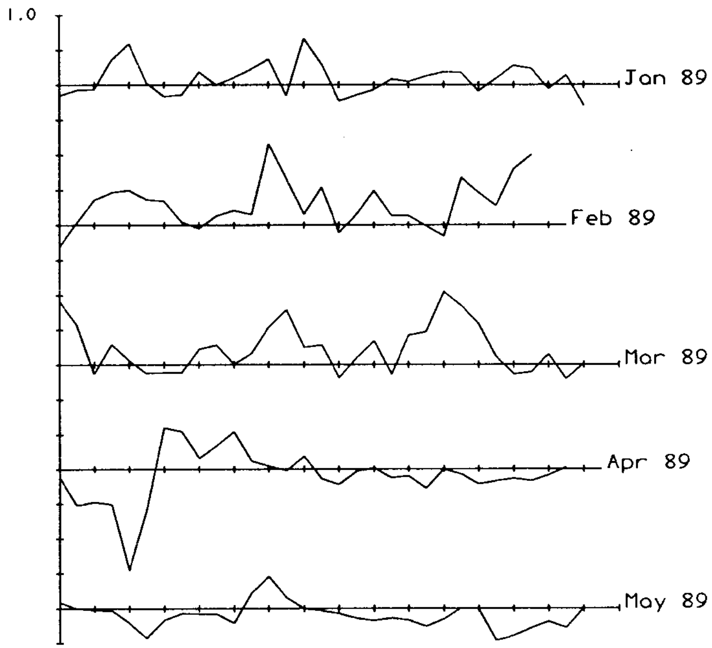


Calculated Flux (Sv) - North Sea (14a)
0.50
Jun 89
Jul 89
Aug 89
Sep 89
Oct 89

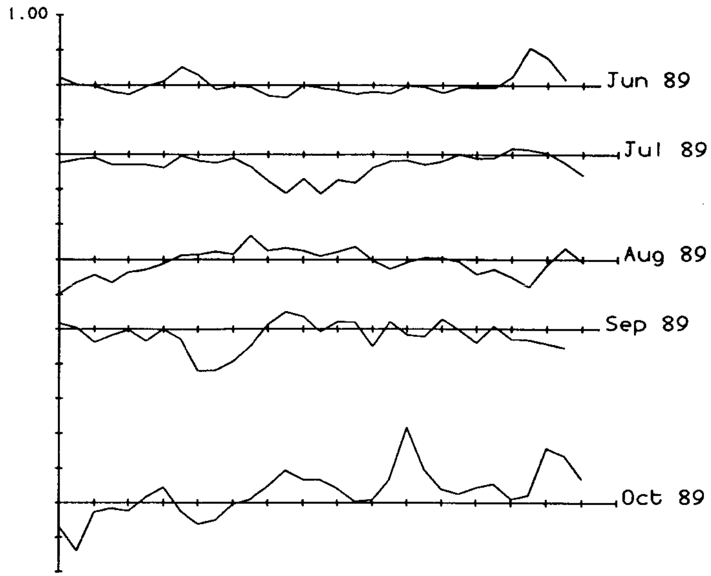
Calculated Flux (Sv) - North Sea (14b)



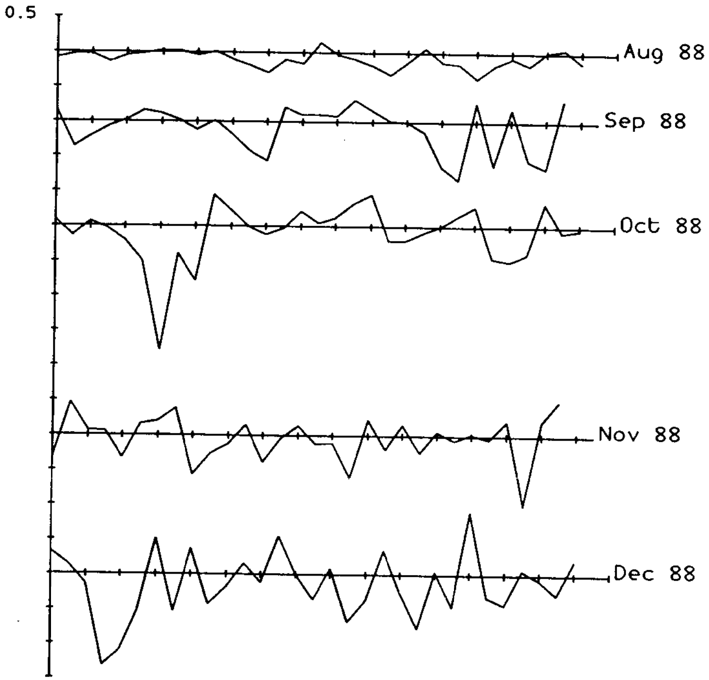
Calculated Flux (Sv) - North Sea (14b)



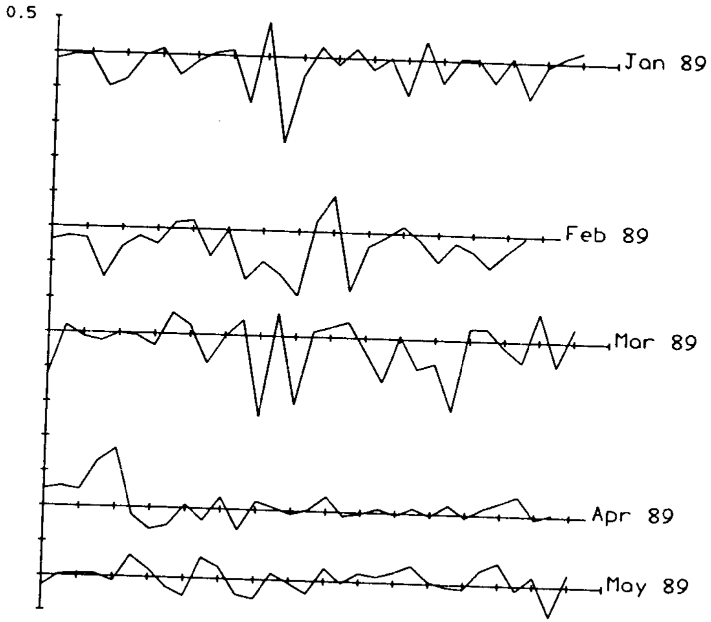
Calculated Flux (Sv) - North Sea (14b)



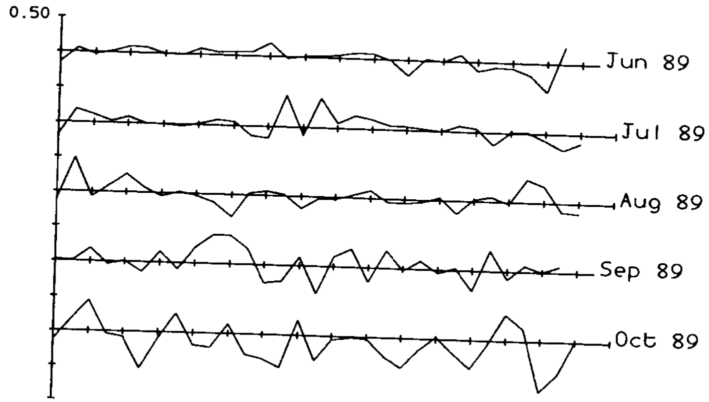
Calculated Flux (Sv) - North Sea (15a)

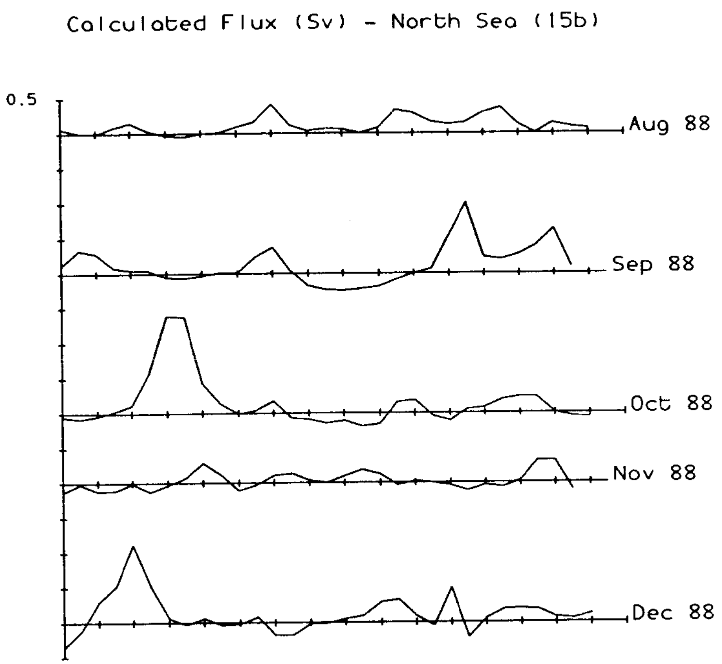


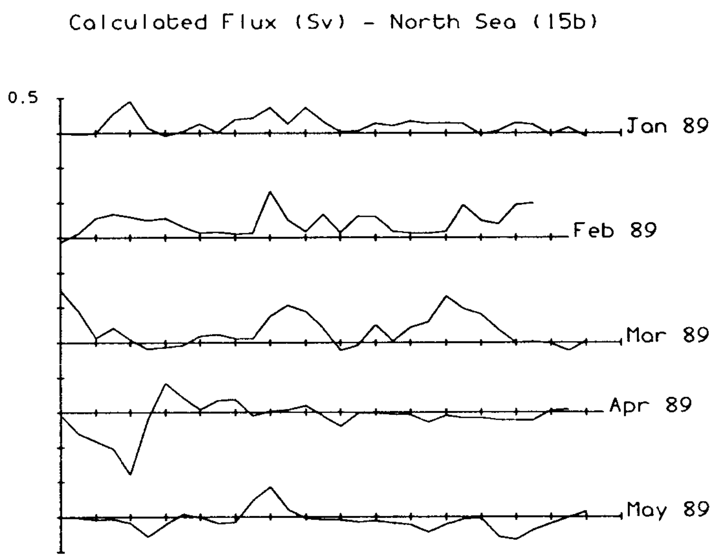
Calculated Flux (Sv) - North Sea (15a)

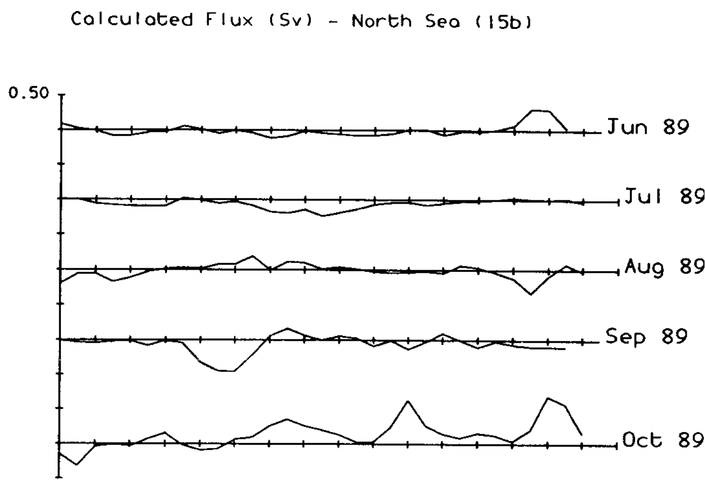


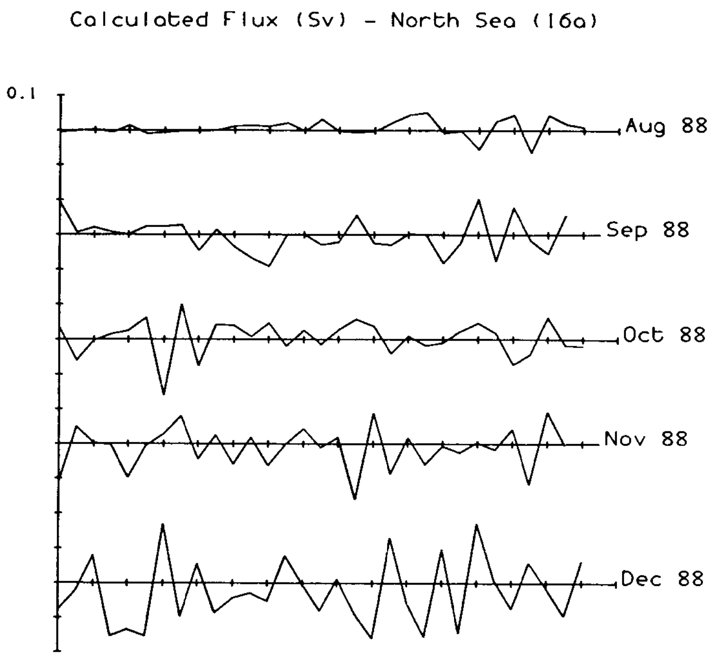
Calculated Flux (Sv) - North Sea (15a)

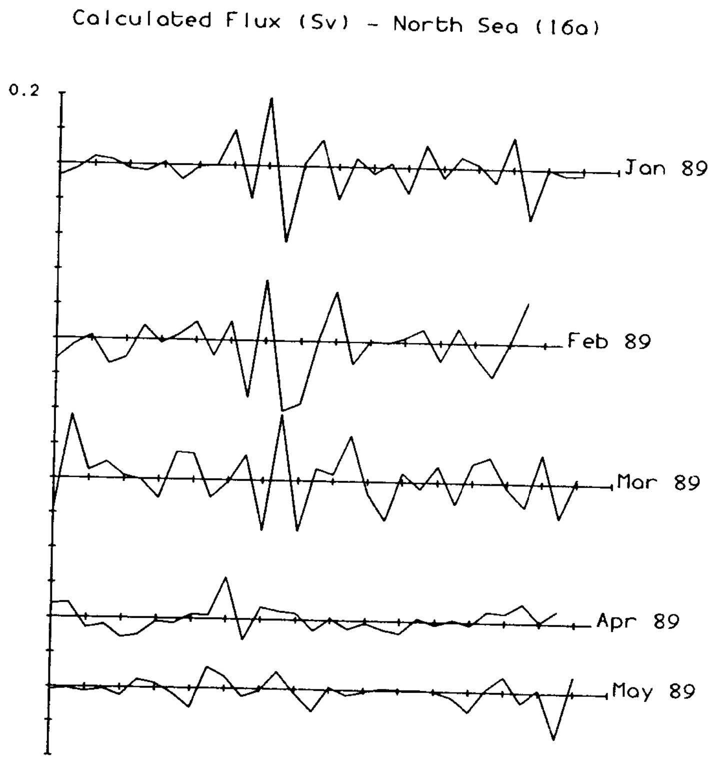


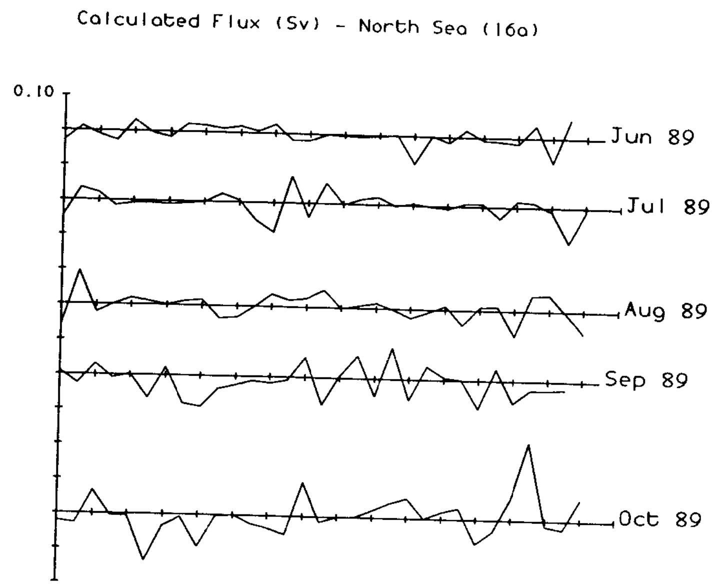

Calculated Flux (Sv) - North Sea (15b)
0.5
Aug 88
Sep 88
Oct 88
Nov 88
Dec 88


Calculated Flux (Sv) - North Sea (15b)
0.5
Jan 89
Feb 89
Mar 89
Apr 89
May 89

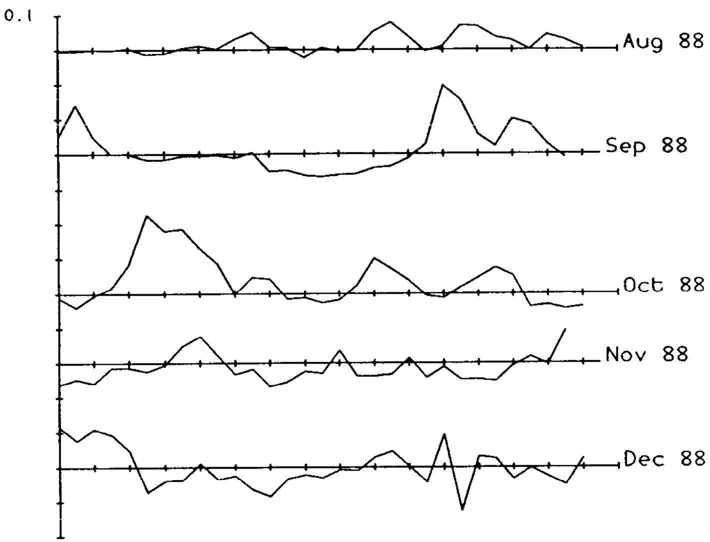

Calculated Flux (Sv) - North Sea (15b)
0.50
Jun 89
Jul 89
Aug 89
Sep 89
Oct 89


Calculated Flux (Sv) - North Sea (16a)
0.1
Aug 88
Sep 88
Oct 88
Nov 88
Dec 88

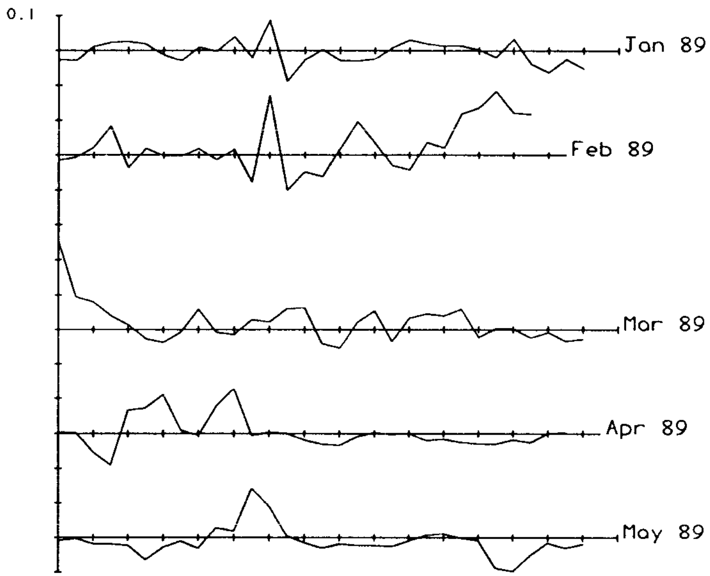

Calculated Flux (Sv) - North Sea (16a)
0.2
Jan 89
Feb 89
Mar 89
Apr 89
May 89


Calculated Flux (Sv) - North Sea (16a)
0.10
Jun 89
Jul 89
Aug 89
Sep 89
Oct 89

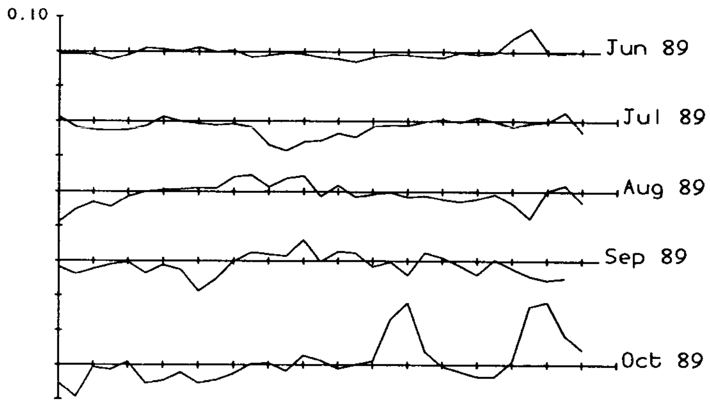
Calculated Flux (Sv) - North Sea (16b)

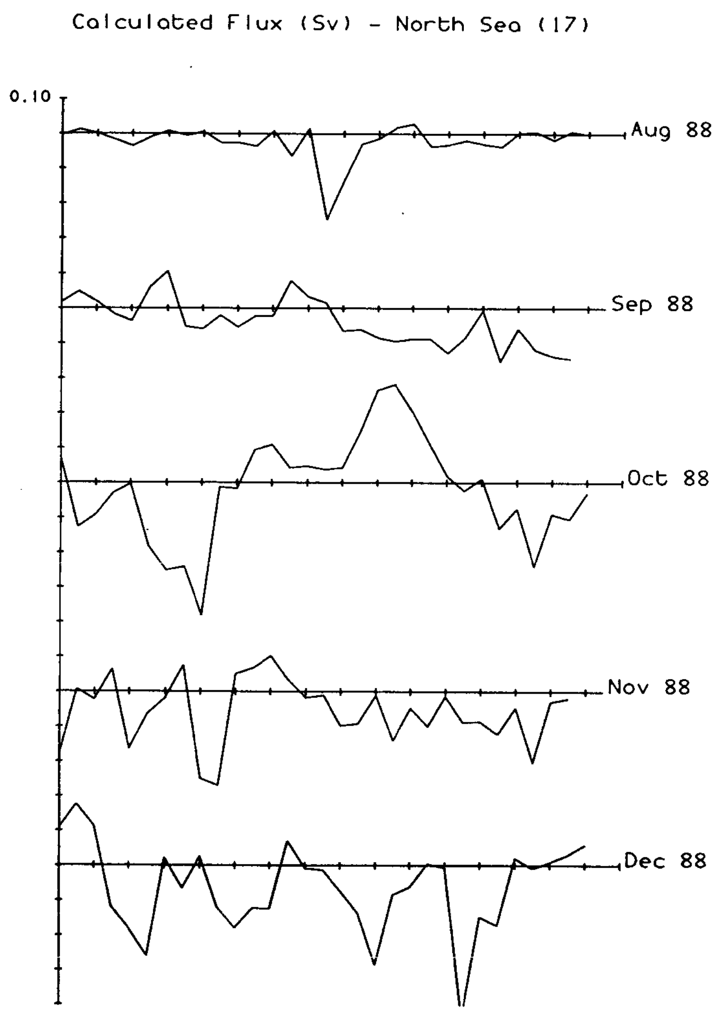


Calculated Flux (Sv) - North Sea (16b)

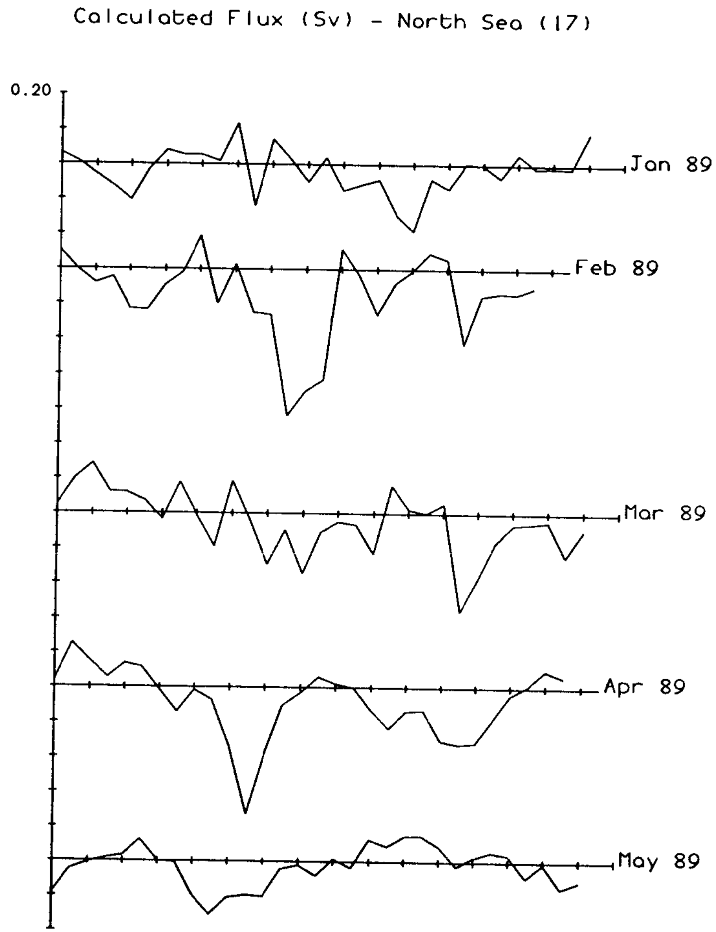


Calculated Flux (Sv) - North Sea (16b)

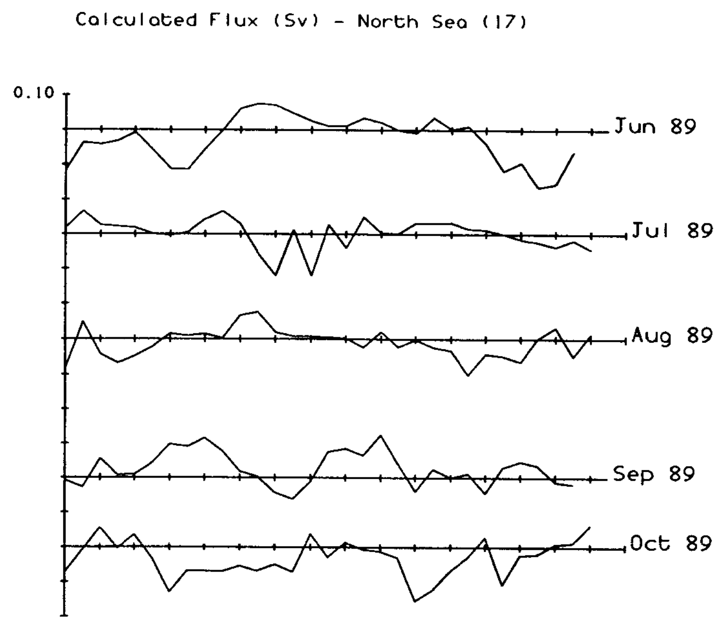




Calculated Flux (Sv) - North Sea (17)
0.10
Aug 88
Sep 88
Oct 88
Nov 88
Dec 88



Calculated Flux (Sv) - North Sea (17)
0.20
Jan 89
Feb 89
Mar 89
Apr 89
May 89

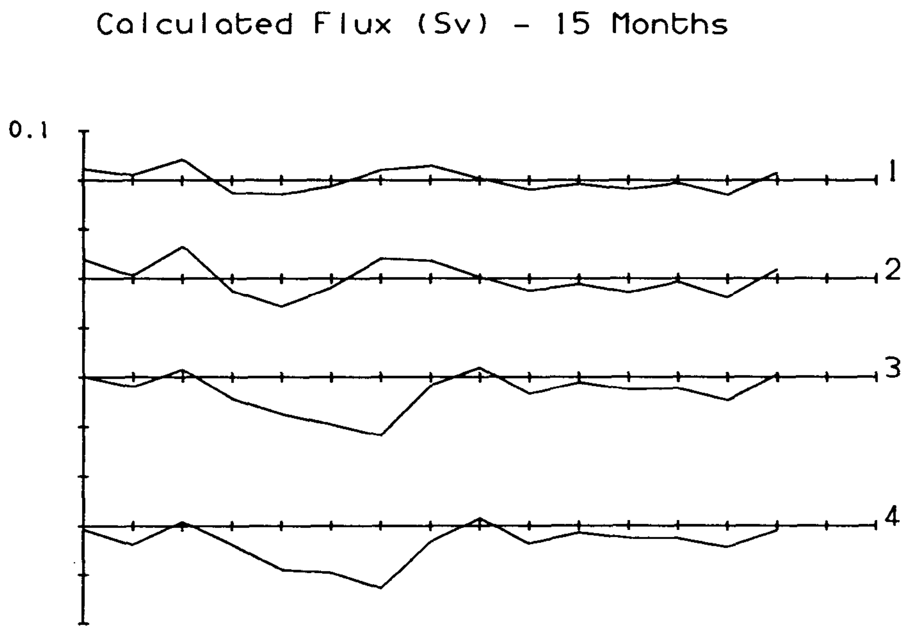


Calculated Flux (Sv) - North Sea (17)
0.10
Jun 89
Jul 89
Aug 89
Sep 89
Oct 89

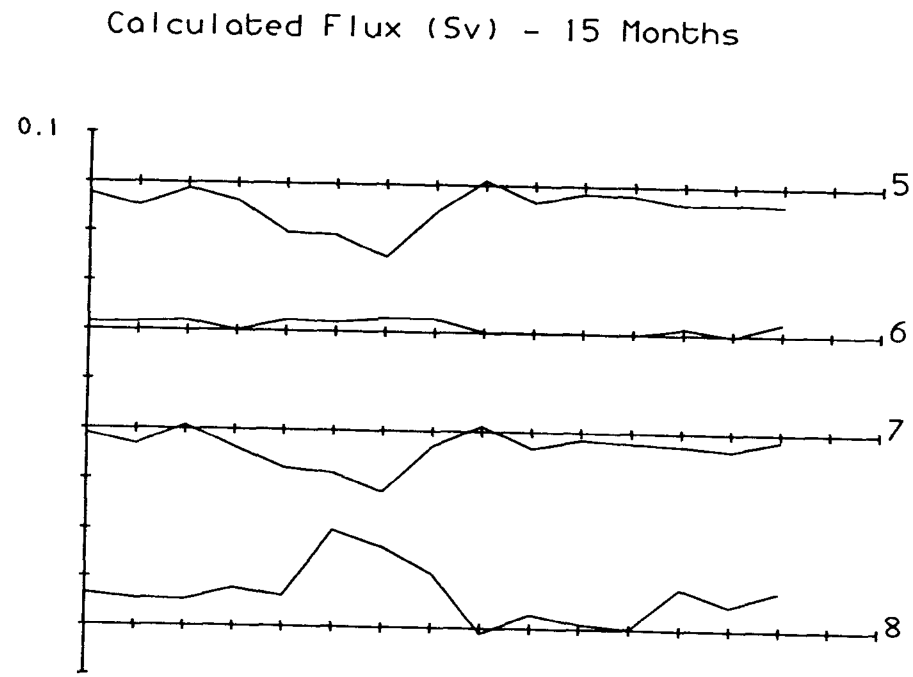
FIGURE 9

Monthly mean volume fluxes across the sections for the 15 month period

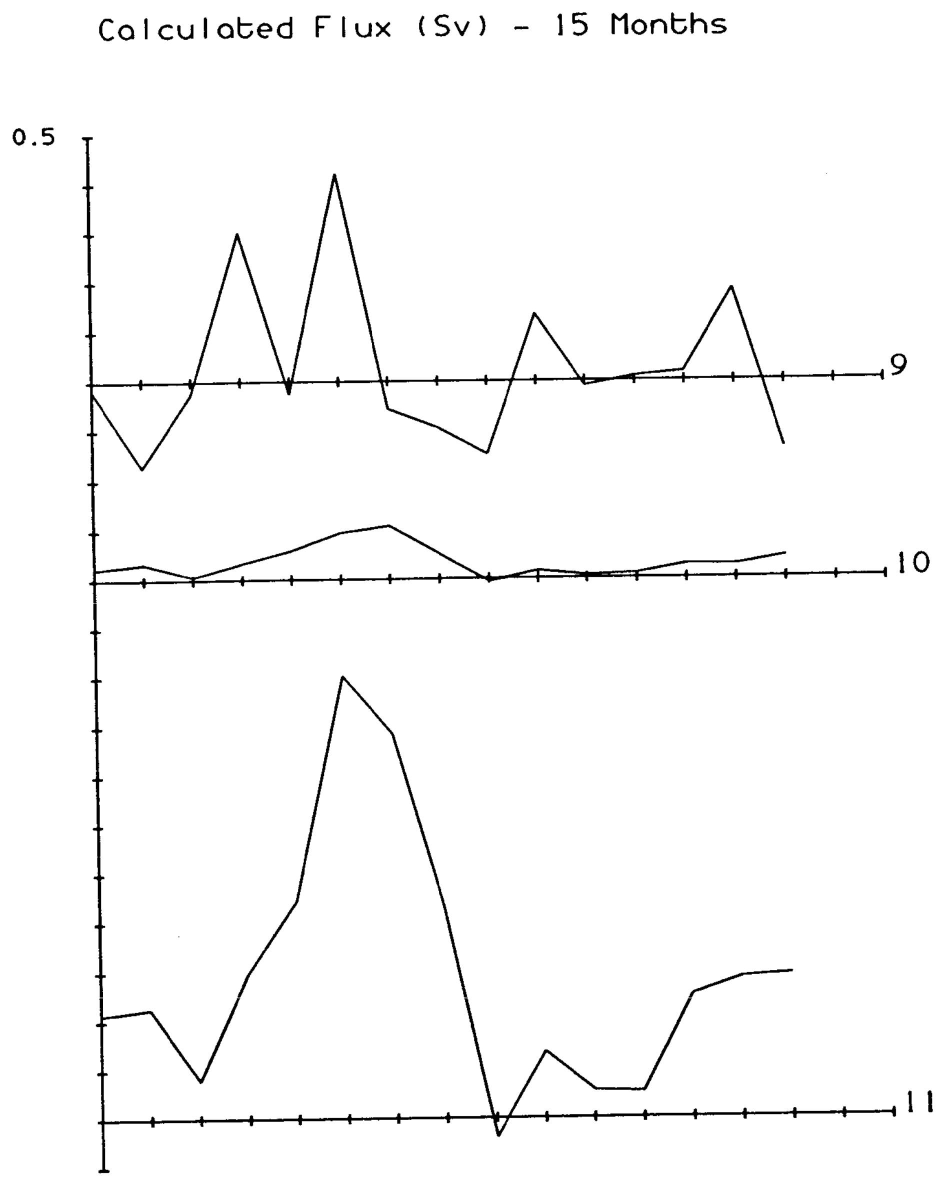
Section 1. Dover Strait	(positive flow into North Sea)
Section 2. Western Approaches	(positive flow into English Channel)
Section 3. Celtic Sea Section 4. St. George's Channel Section 5. Irish Sea (west of I.O.M.) Section 6. Irish Sea (east of I.O.M.) Section 7. North Channel Section 8. The Minch	(positive flow northward)
Section 9. Faeroe-Shetland Channel Section 10. Pentland Firth Section 11. Fair Isle Passage	(positive flow into North sea)
Sections 12 to 17. North Sea	(positive flow northward) (section 13: positive flow eastward)



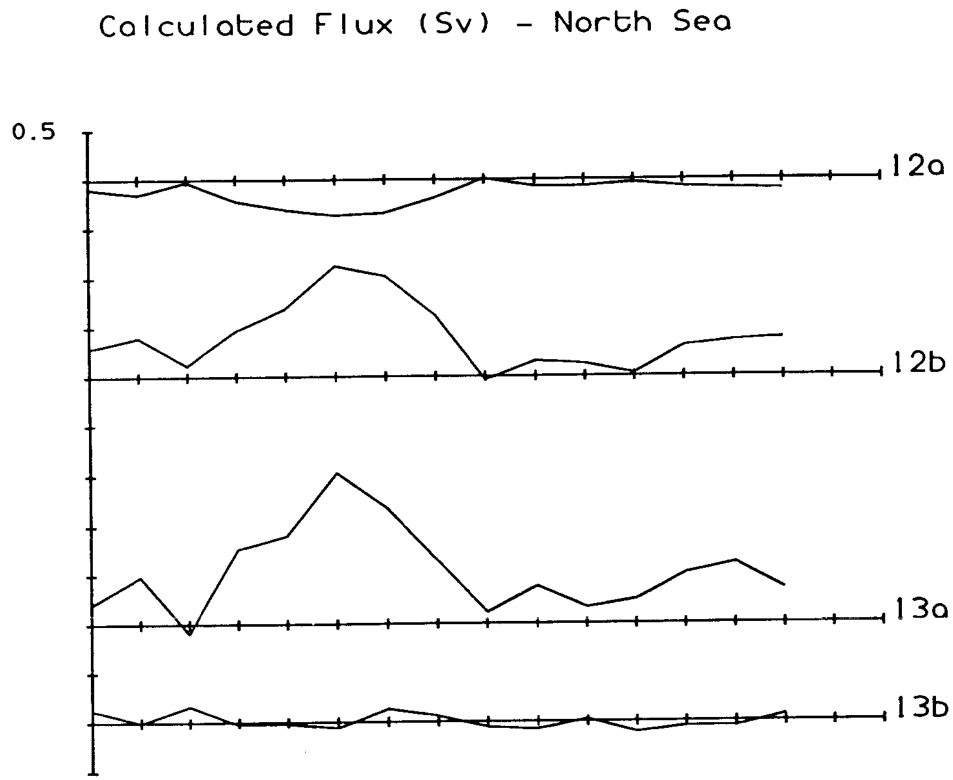
Calculated Flux (Sv) - 15 Months
0.1
1
2
3
4



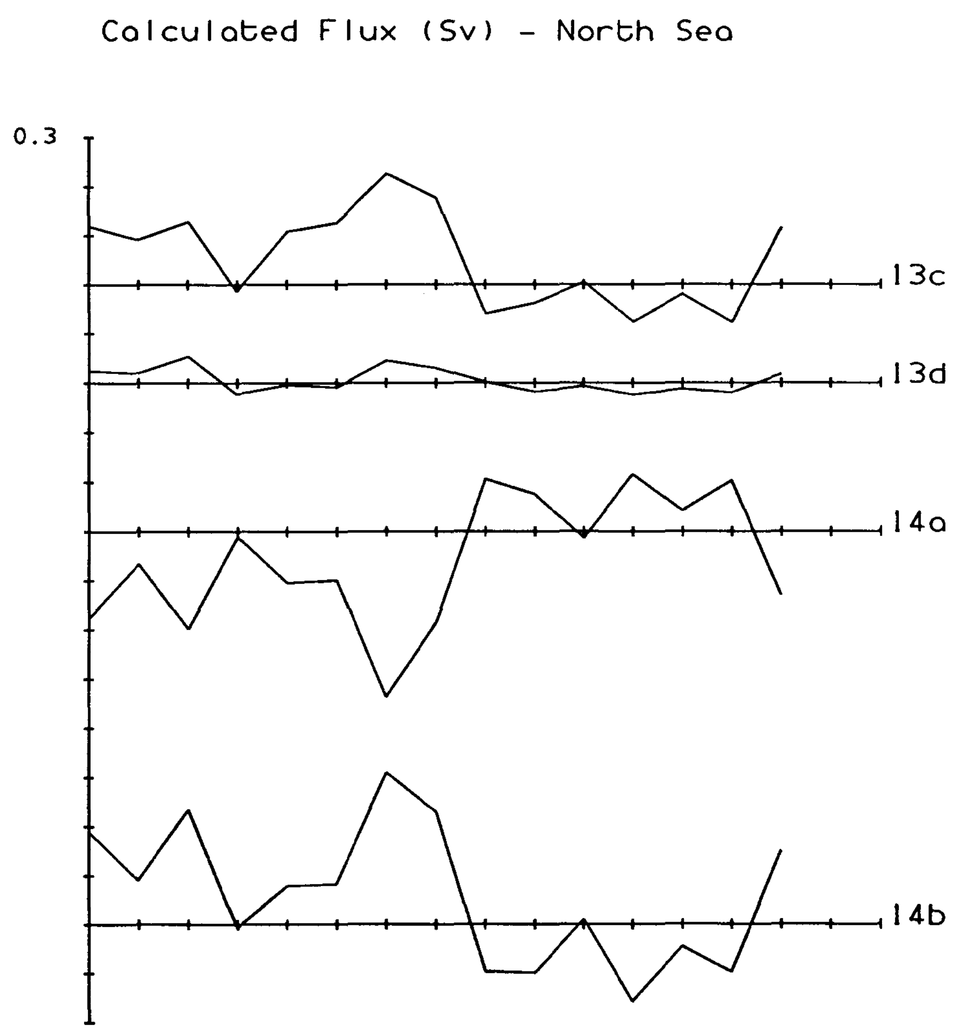
Calculated Flux (Sv) - 15 Months
0.1
5
6
7
8



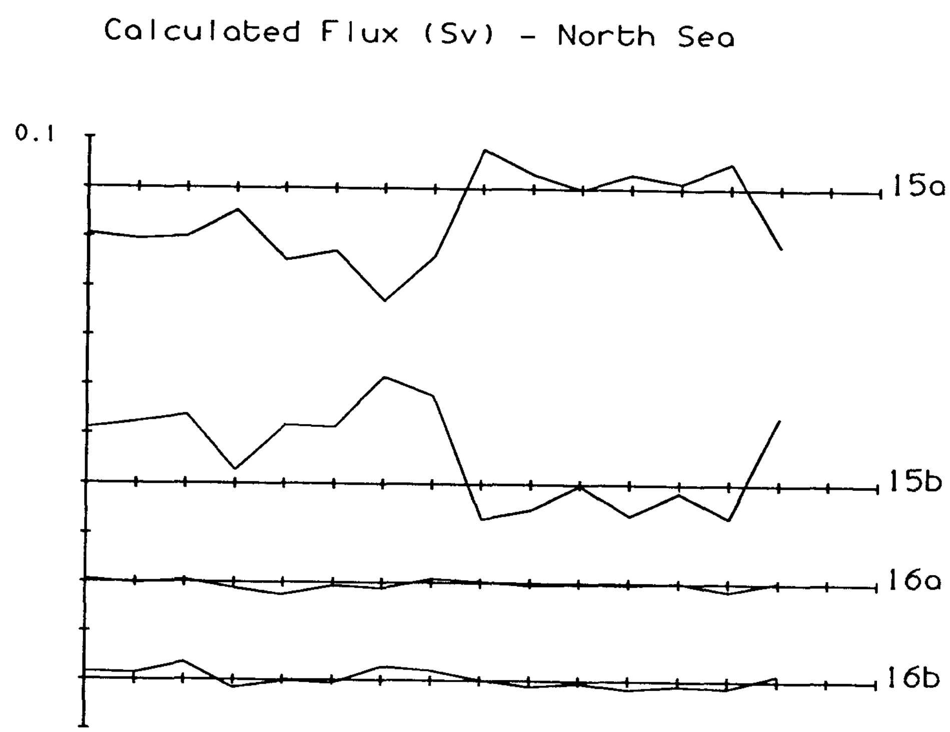
Calculated Flux (Sv) - 15 Months
0.5
9
10
11



Calculated Flux (Sv) - North Sea
0.5
12a
12b
13a
13b

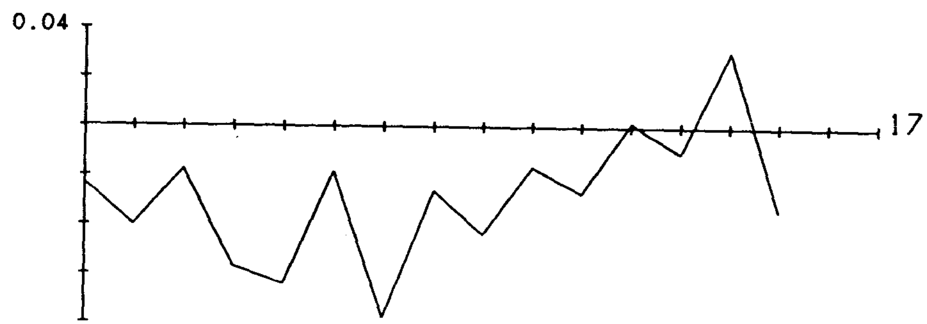


Calculated Flux (Sv) - North Sea
0.3
13c
13d
14a
14b



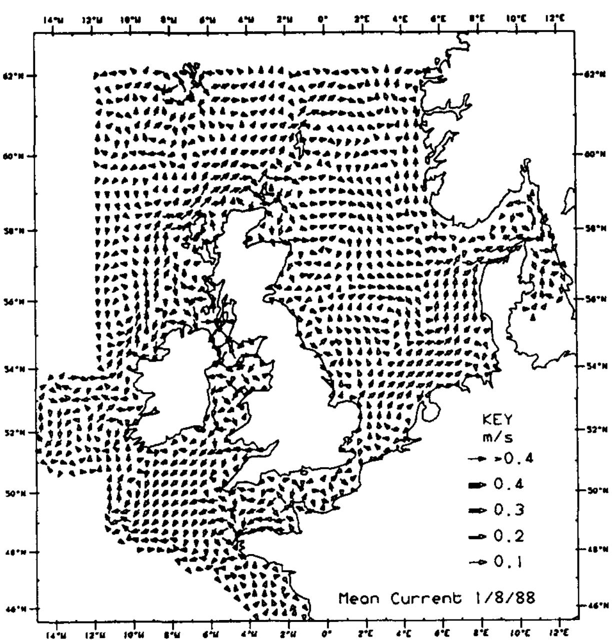
Calculated Flux (Sv) - North Sea
0.1
15a
15b
16a
16b

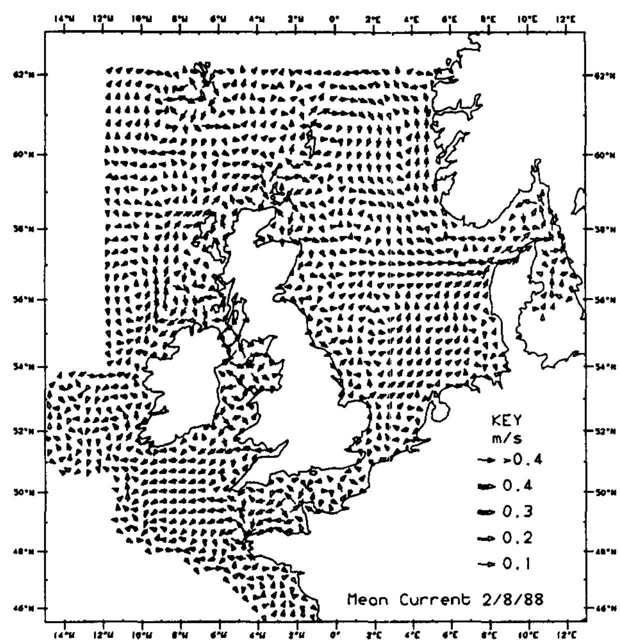
Calculated Flux (Sv) - 15 Months

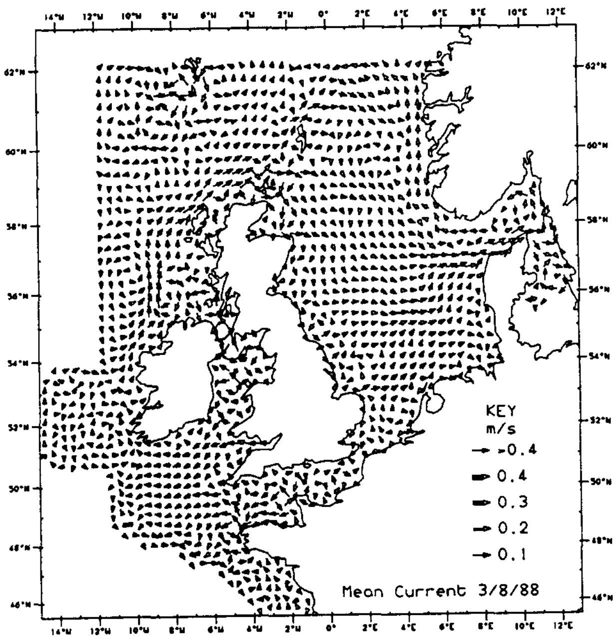


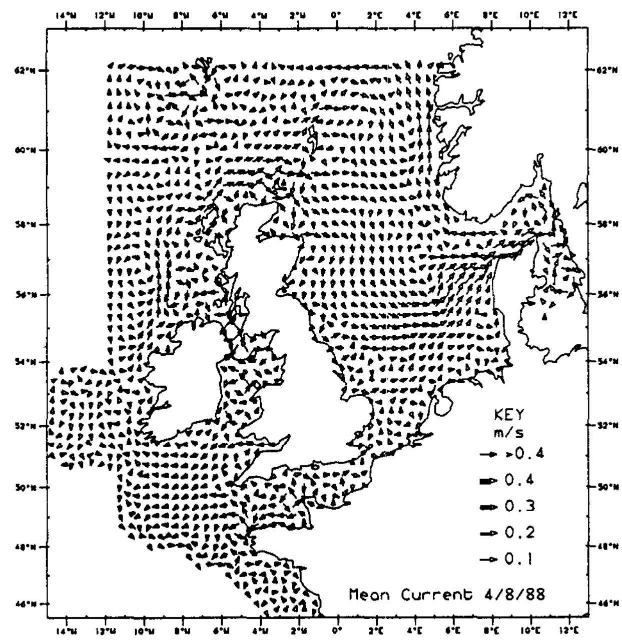
APPENDIX

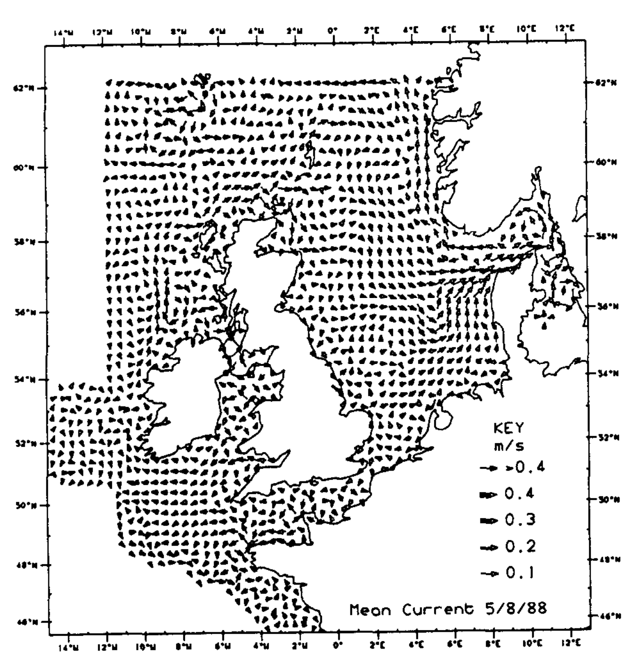
Daily Mean Distributions of Current and Elevation.

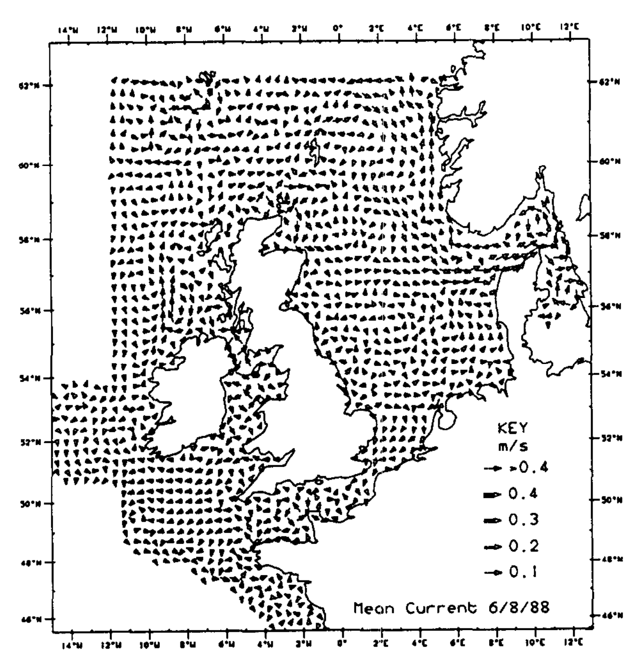

KEY
m/s
>0.4
0.4
0.3
0.2
0.1
Mean Current 1/8/88

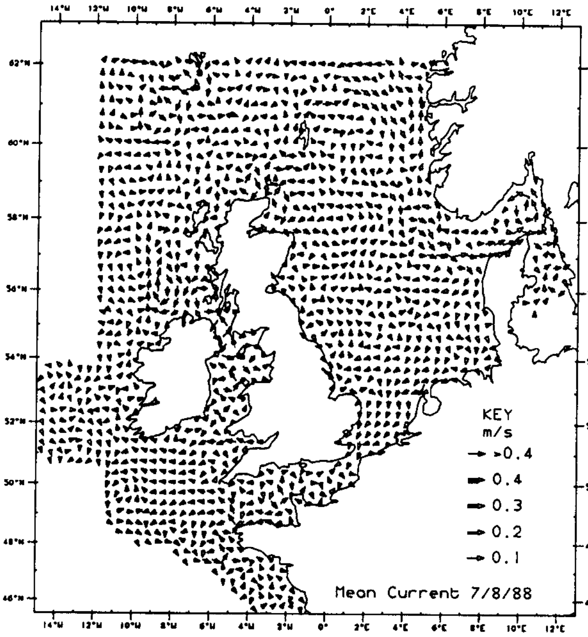

KEY
m/s
>0.4
0.4
0.3
0.2
0.1
Mean Current 2/8/88

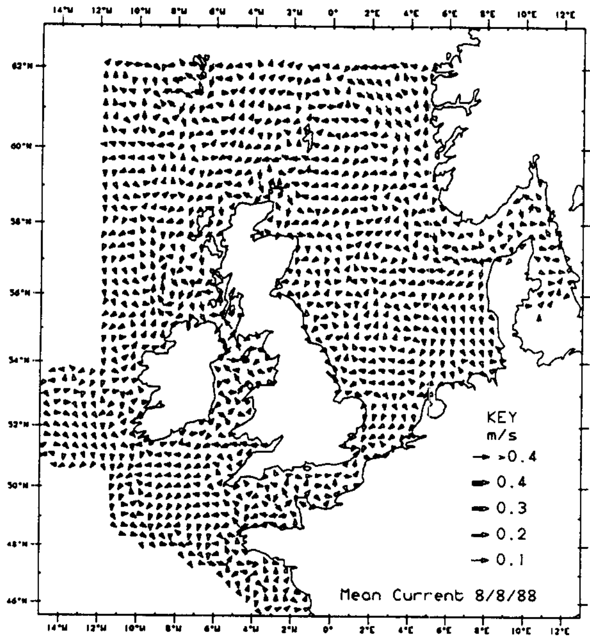

KEY
m/s
>0.4
0.4
0.3
0.2
0.1
Mean Current 3/8/88

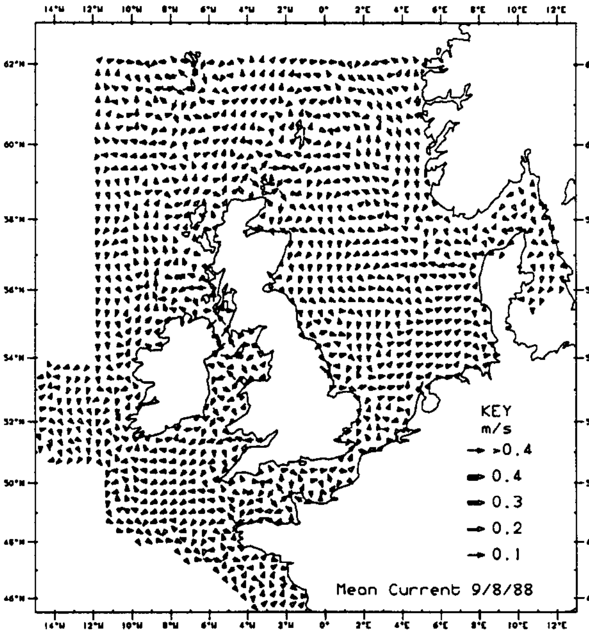

KEY
m/s
>0.4
0.4
0.3
0.2
0.1
Mean Current 4/8/88


KEY
m/s
>0.4
0.4
0.3
0.2
0.1
Mean Current 5/8/88


KEY
m/s
>0.4
0.4
0.3
0.2
0.1
Mean Current 6/8/88


KEY
m/s
>0.4
0.4
0.3
0.2
0.1
Mean Current 7/8/88


KEY
m/s
>0.4
0.4
0.3
0.2
0.1
Mean Current 8/8/88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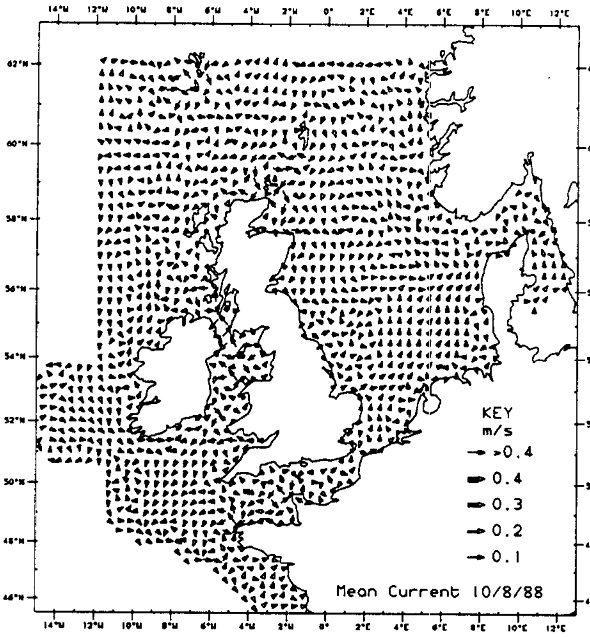
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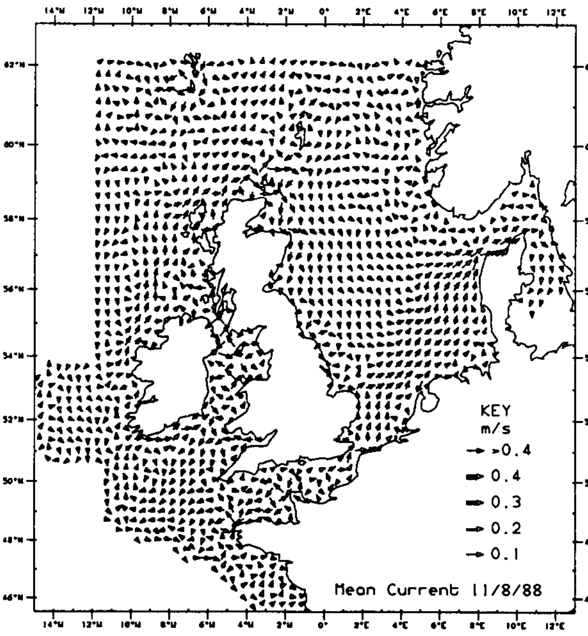
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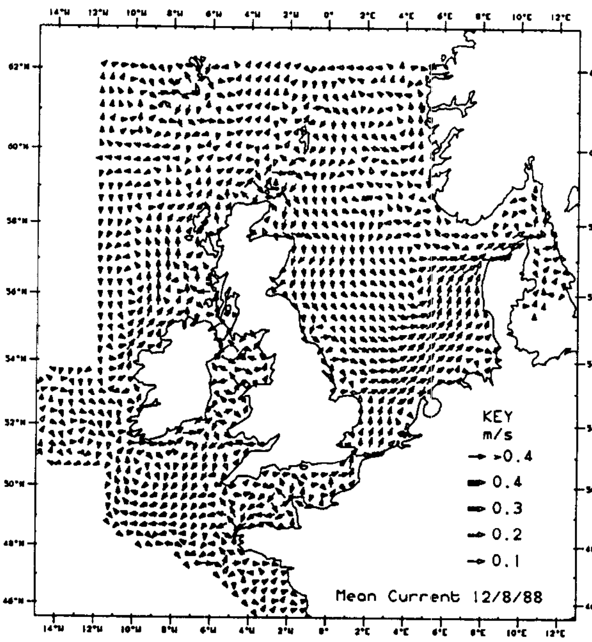
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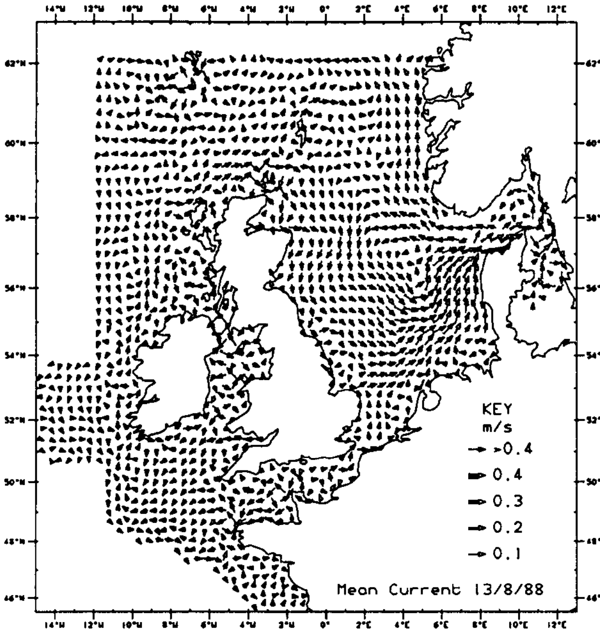
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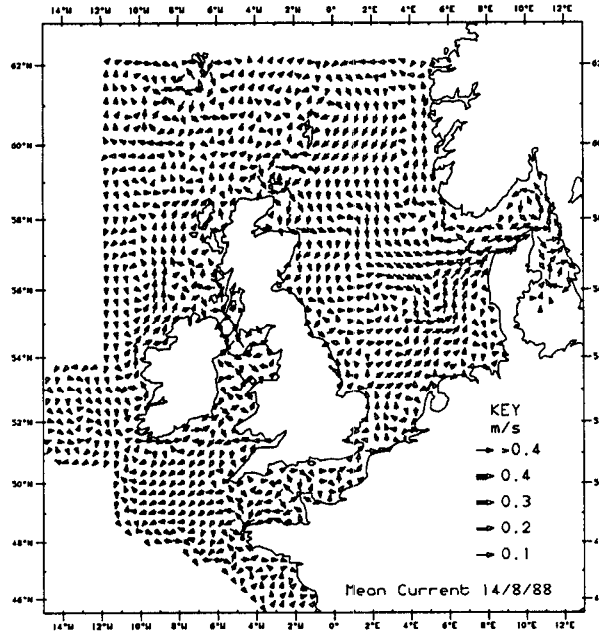
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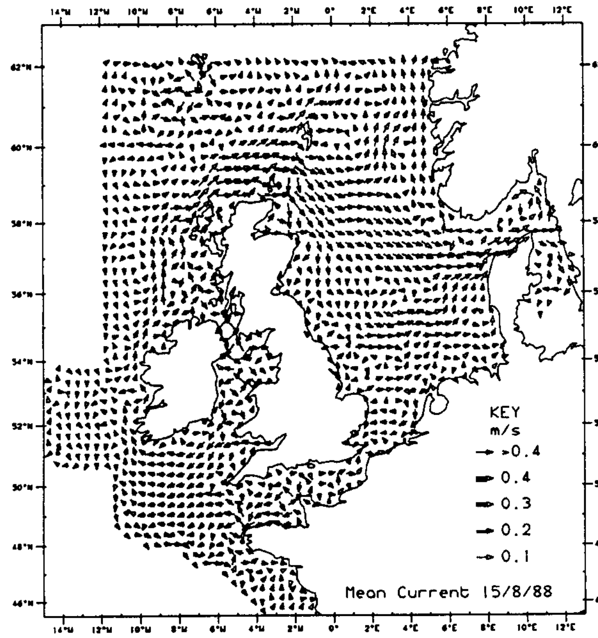
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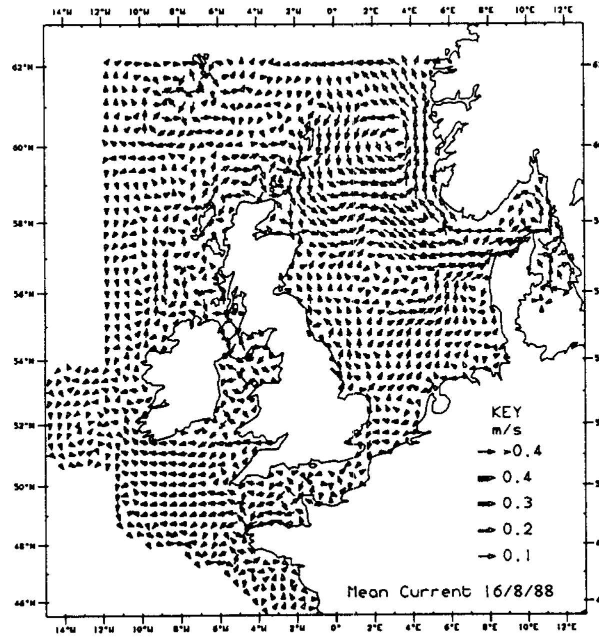
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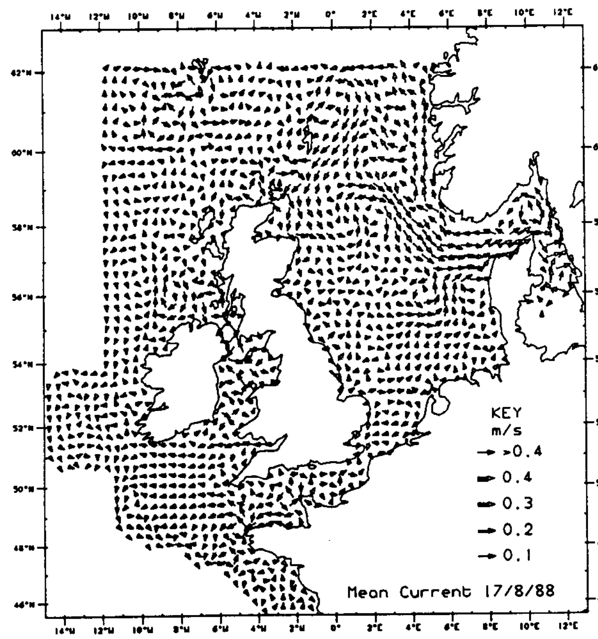
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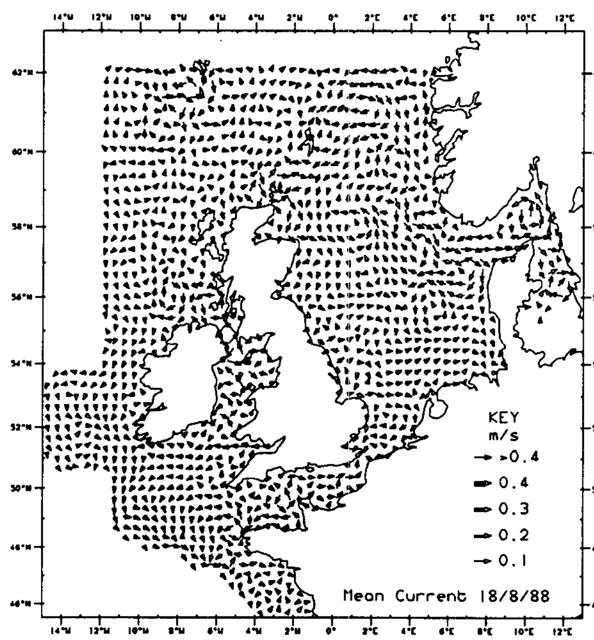
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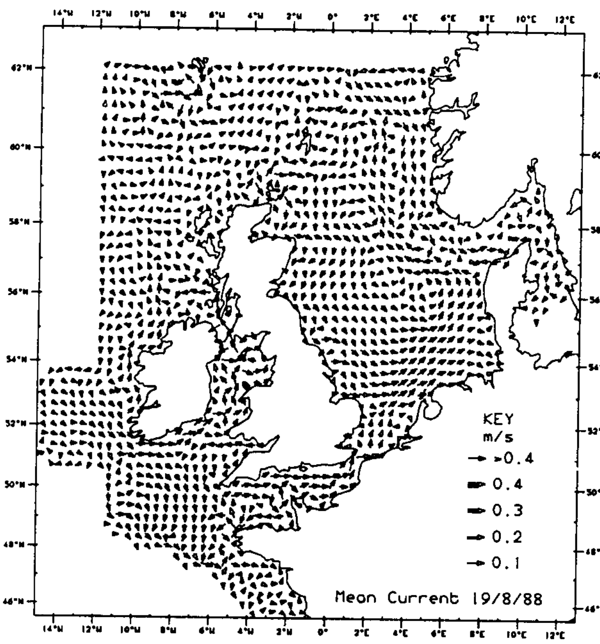
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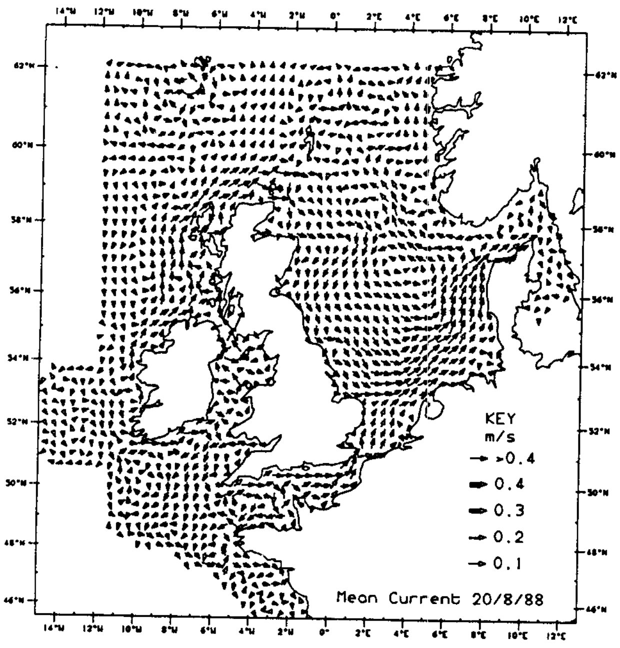
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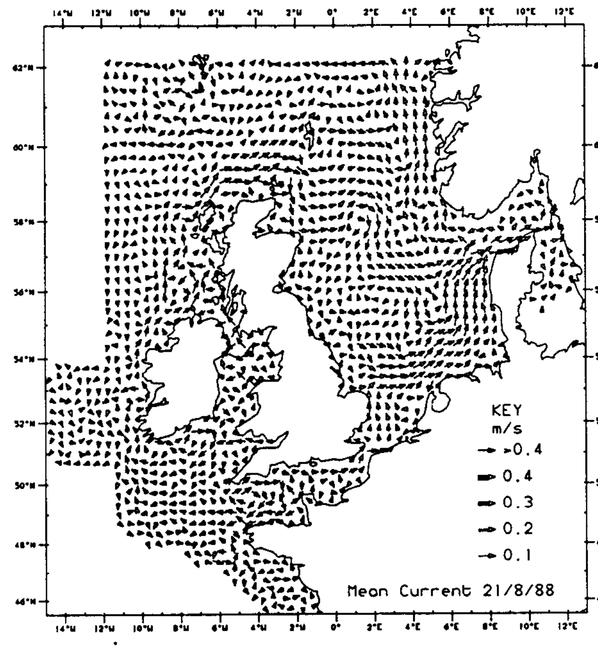
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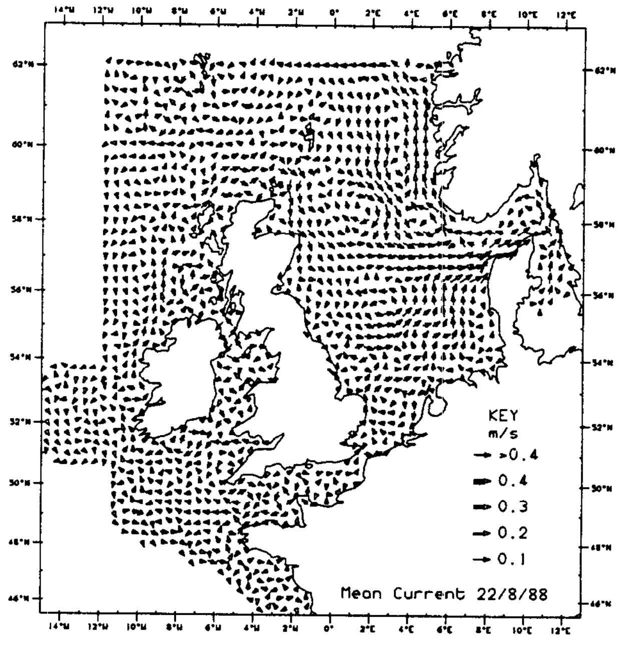
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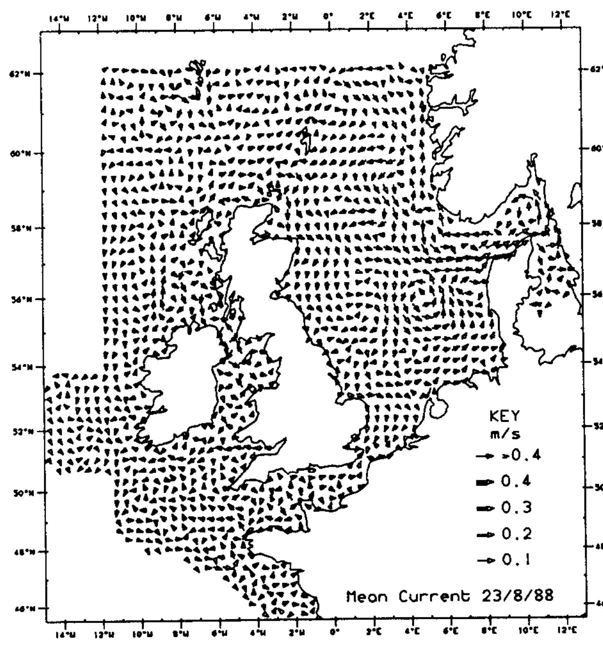
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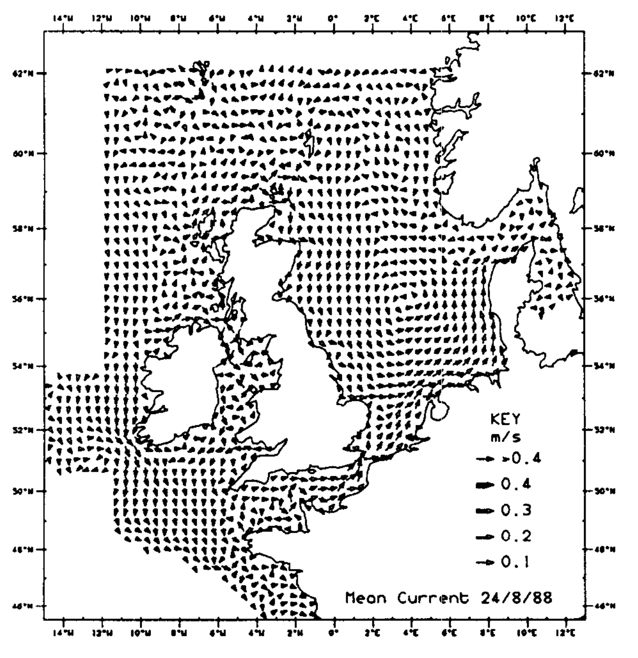
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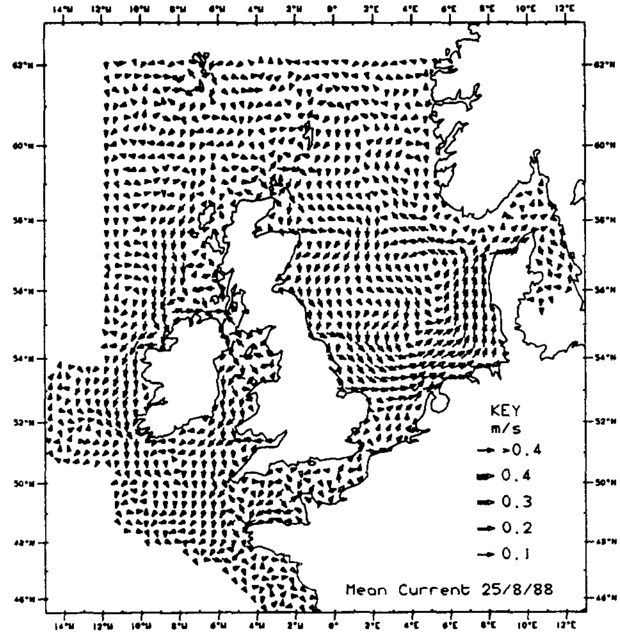
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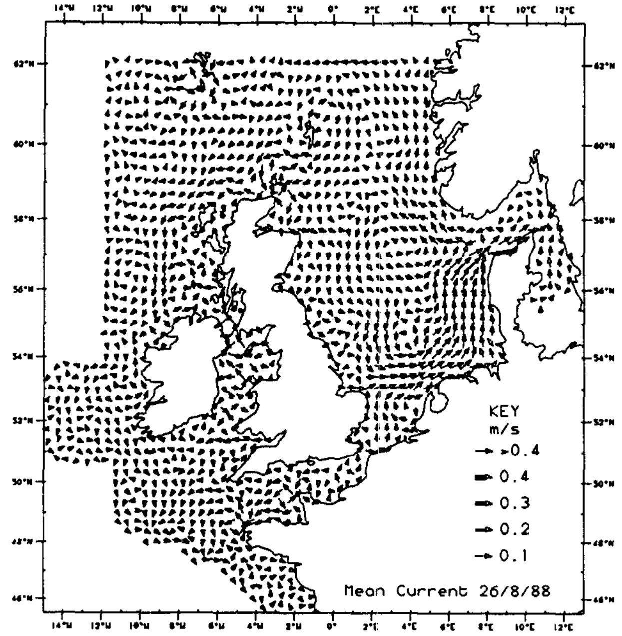
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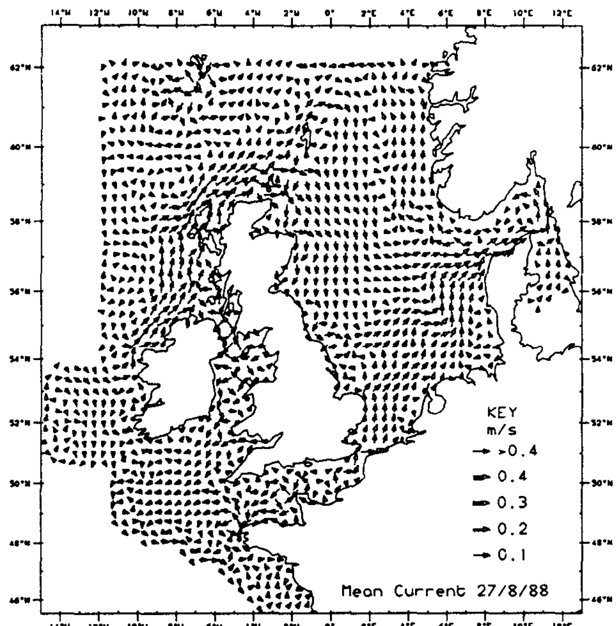
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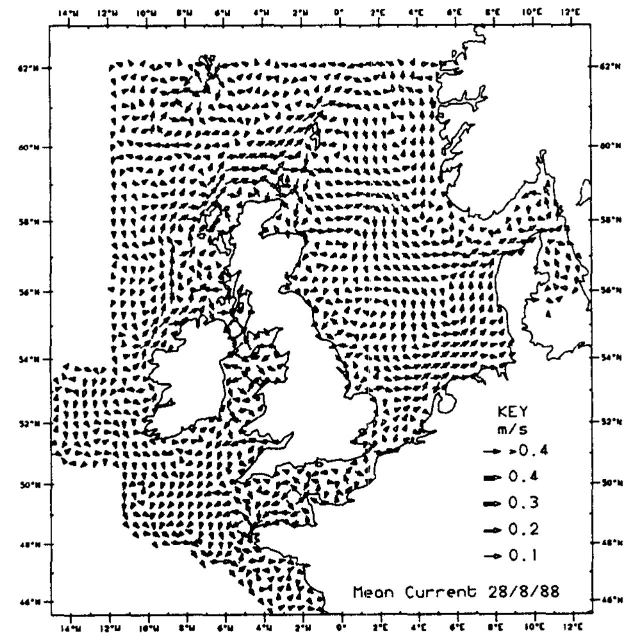
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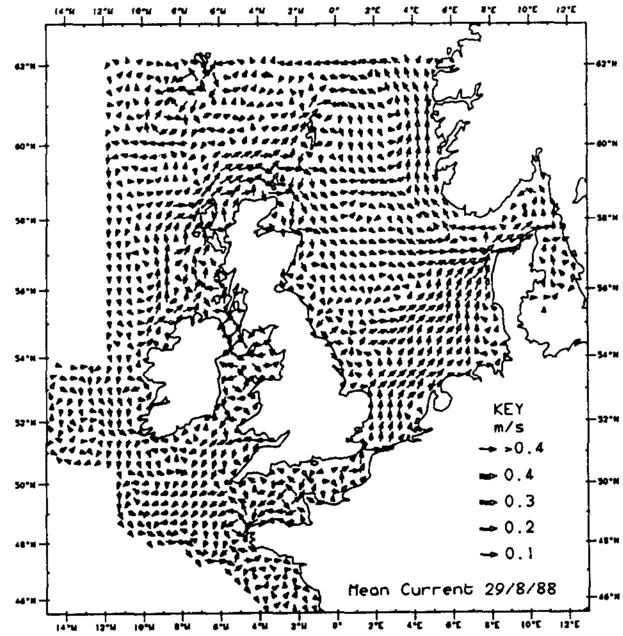
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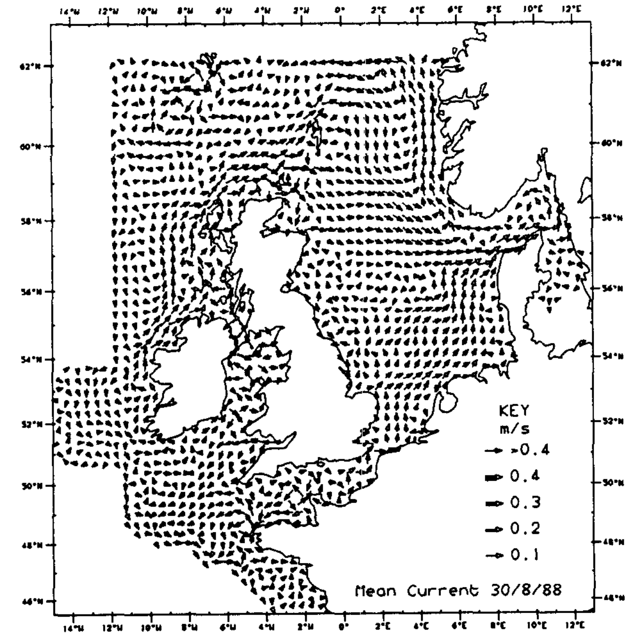
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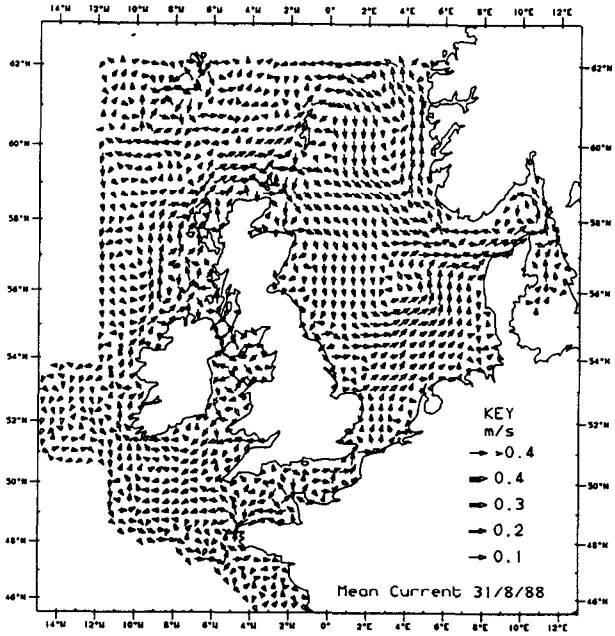
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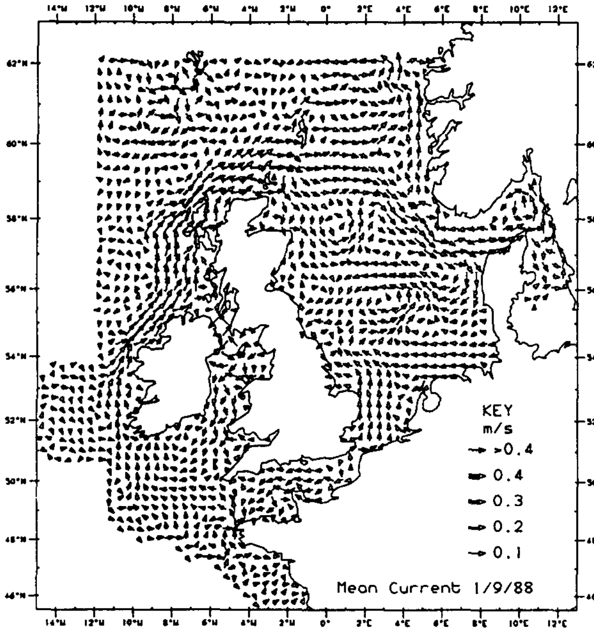
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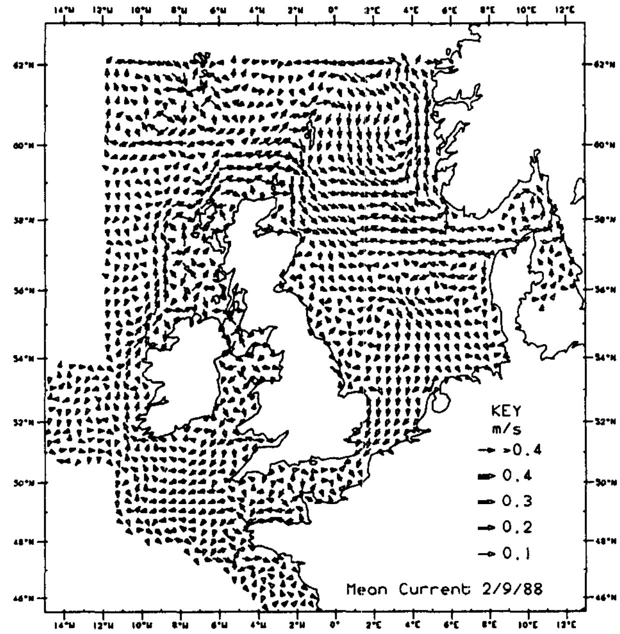
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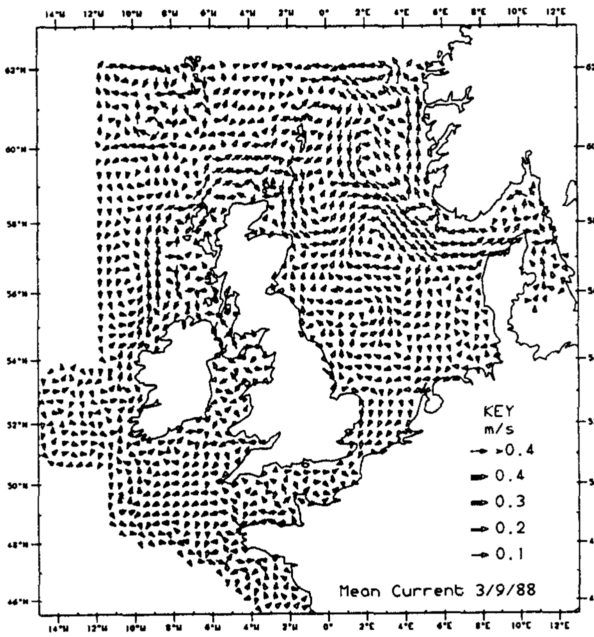
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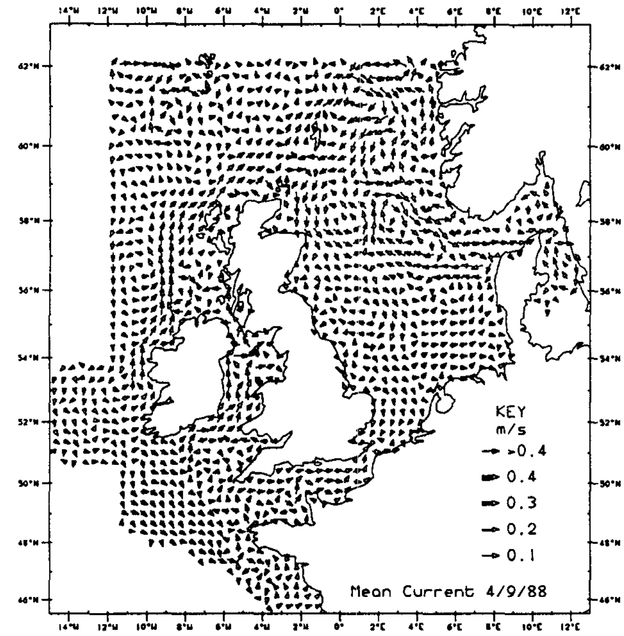
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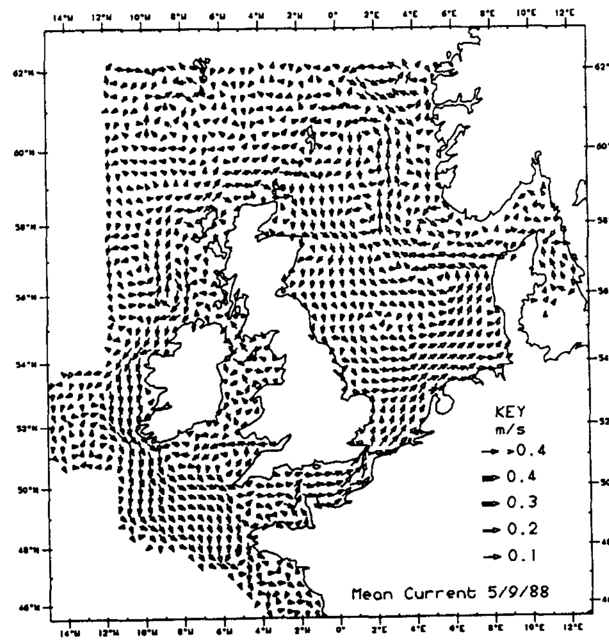
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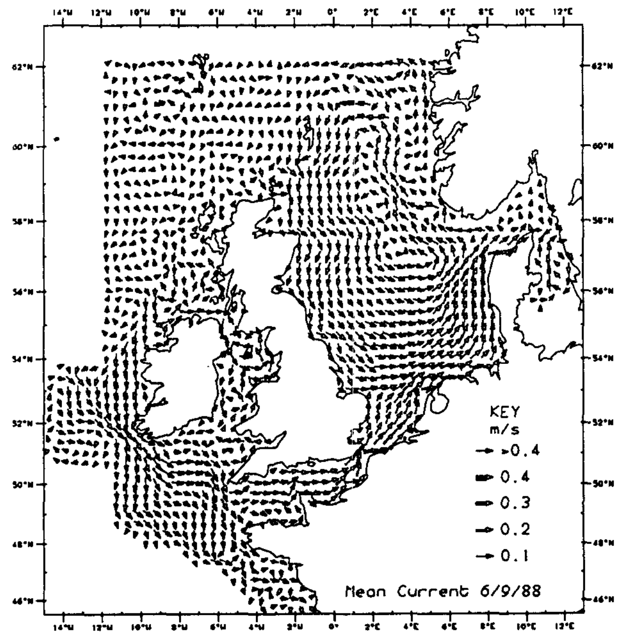
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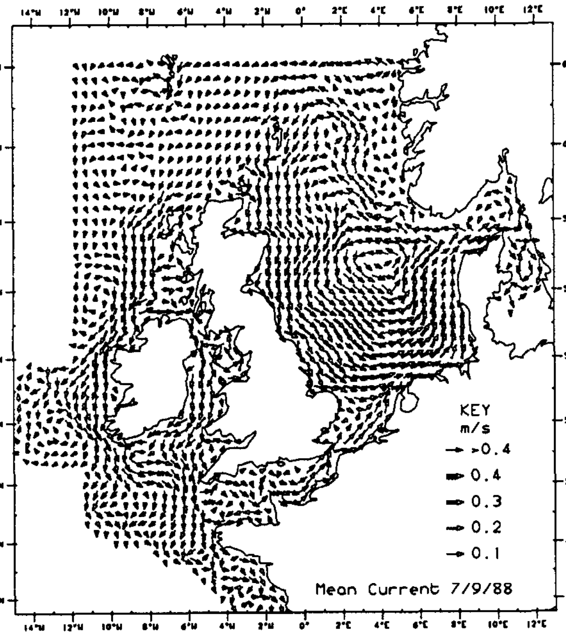
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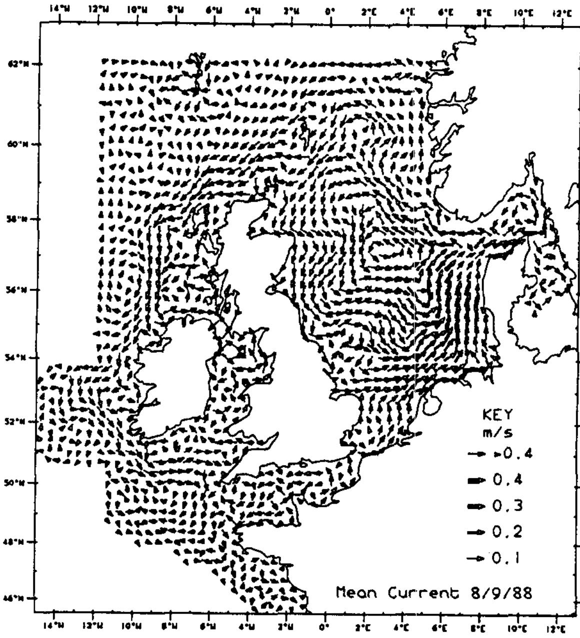
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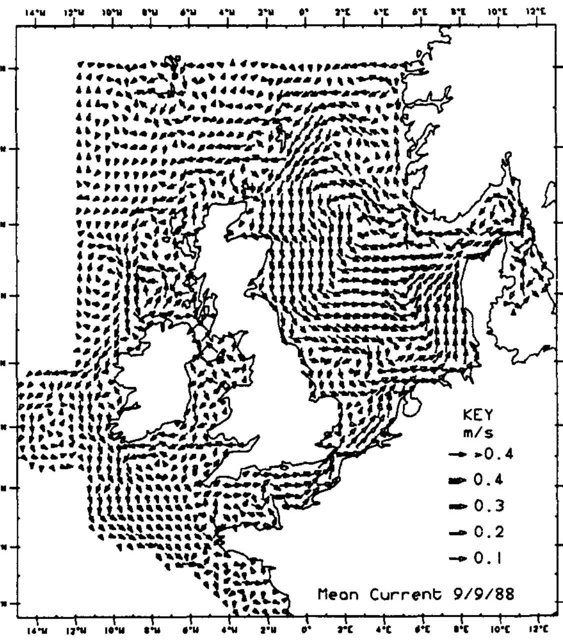
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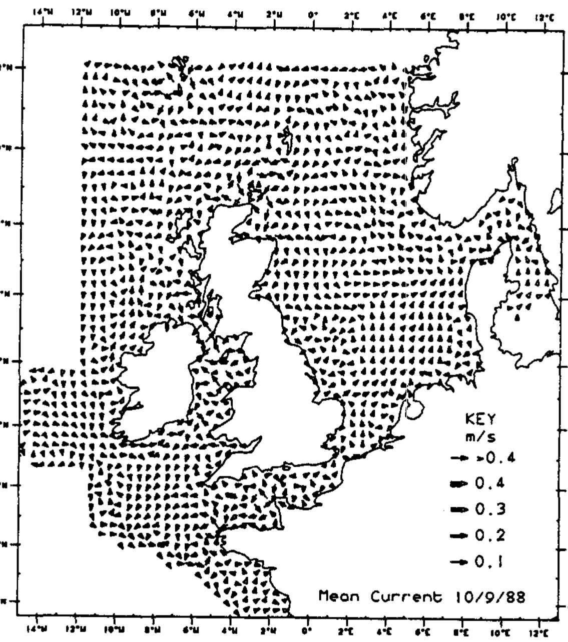
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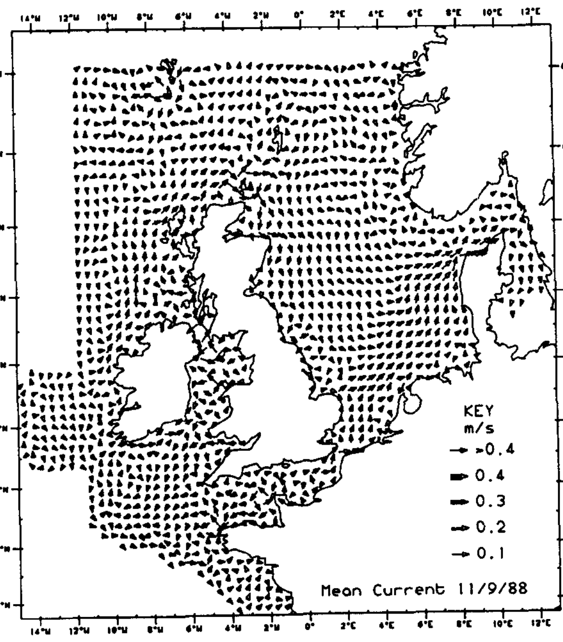
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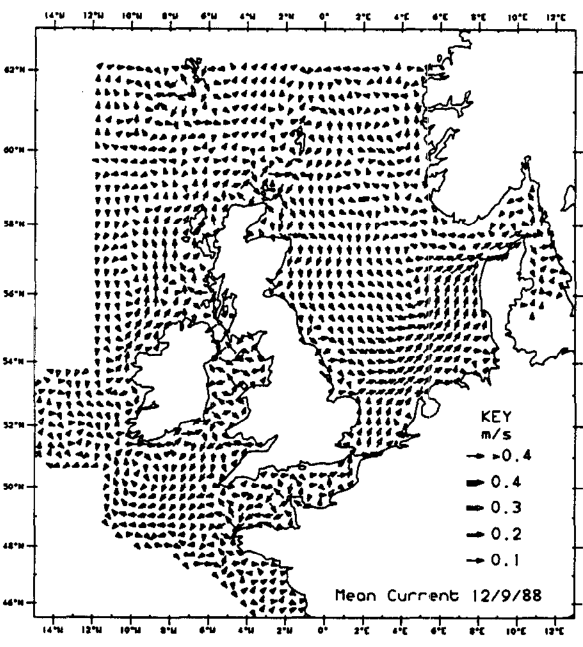
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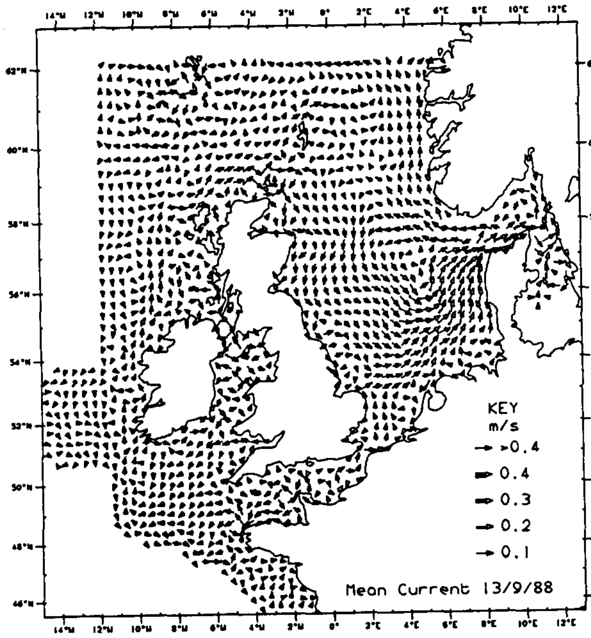
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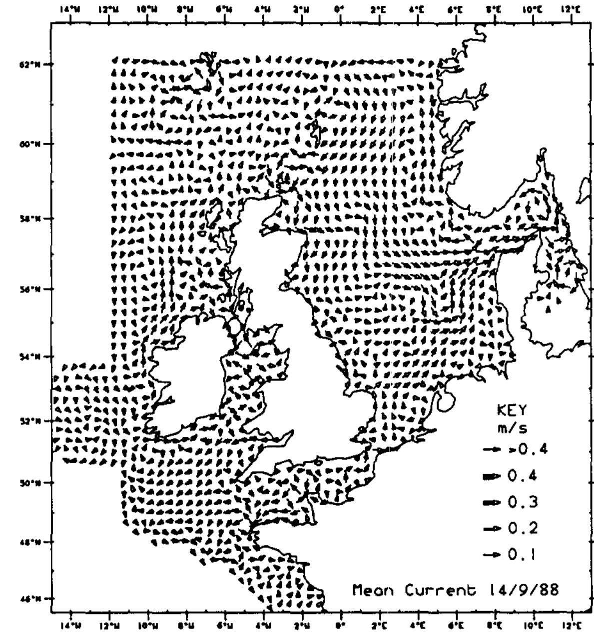
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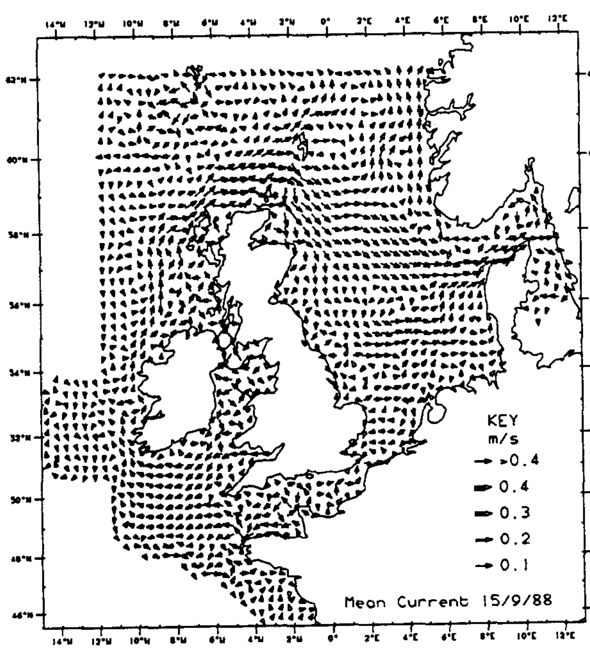
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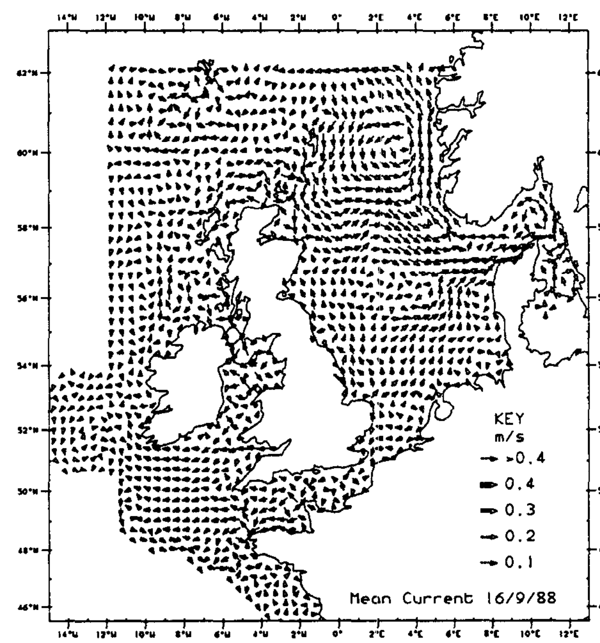
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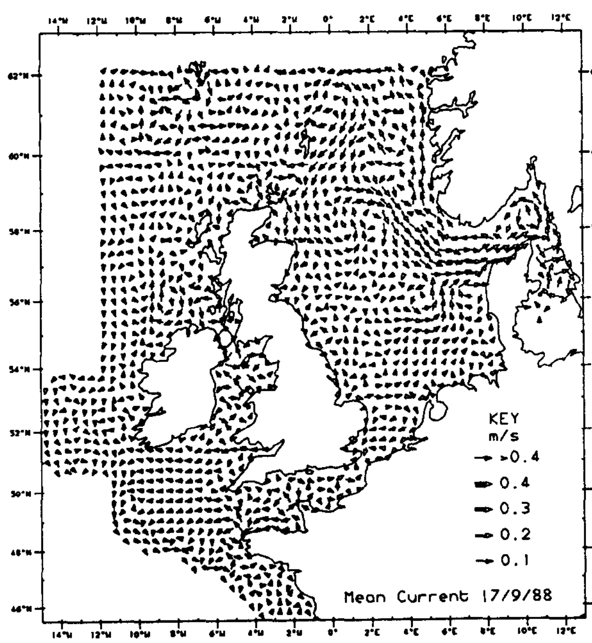
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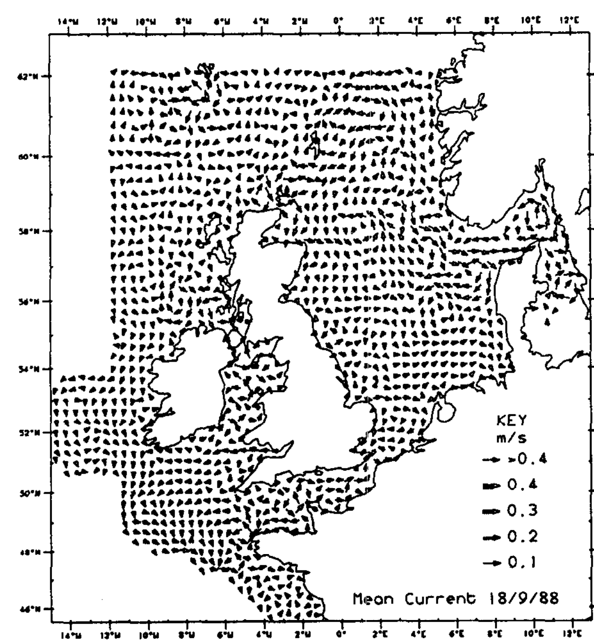
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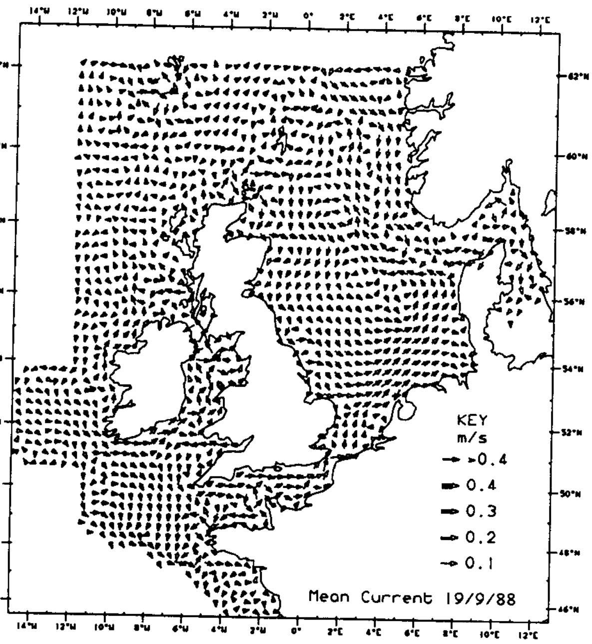
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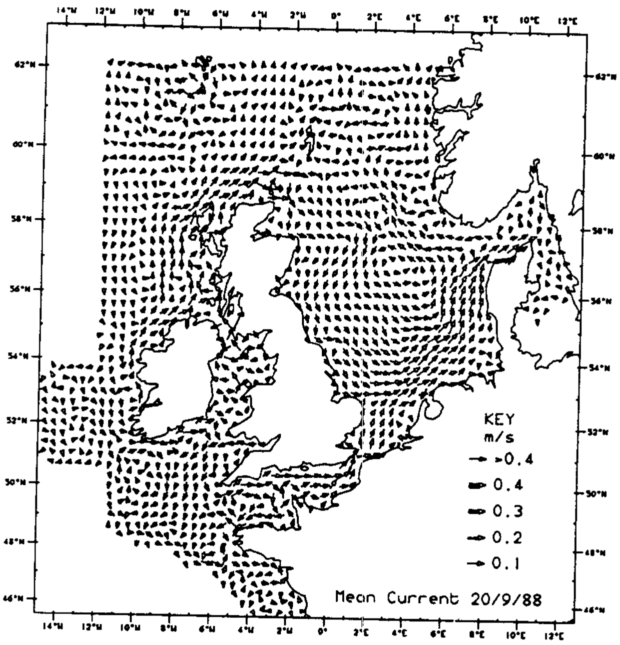
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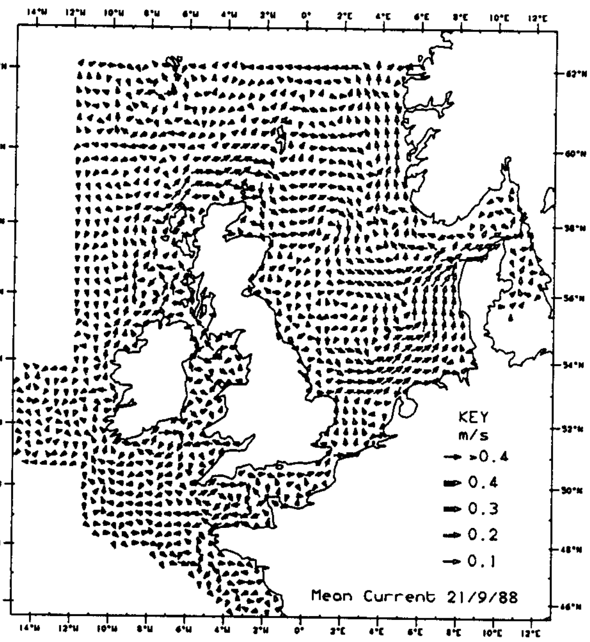
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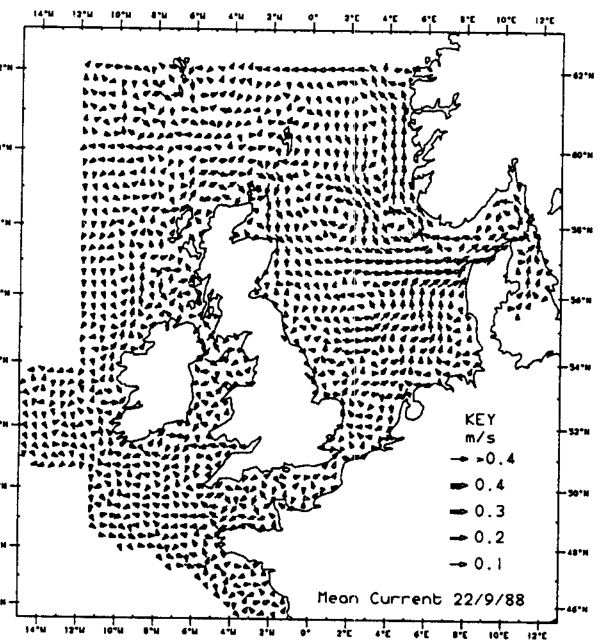
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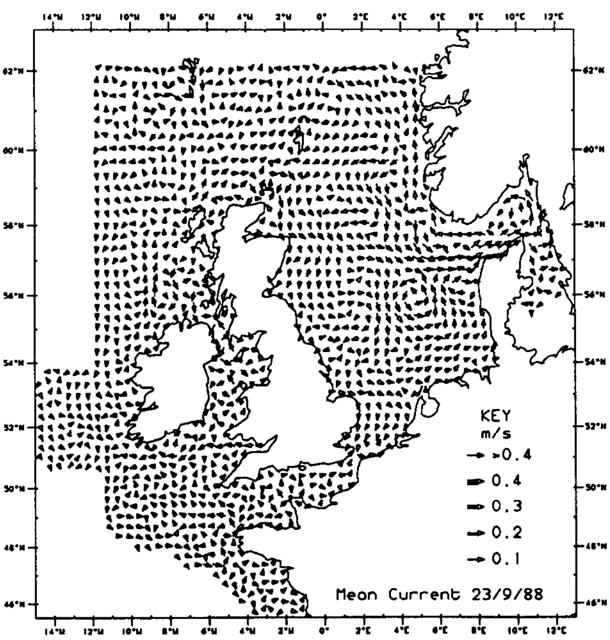
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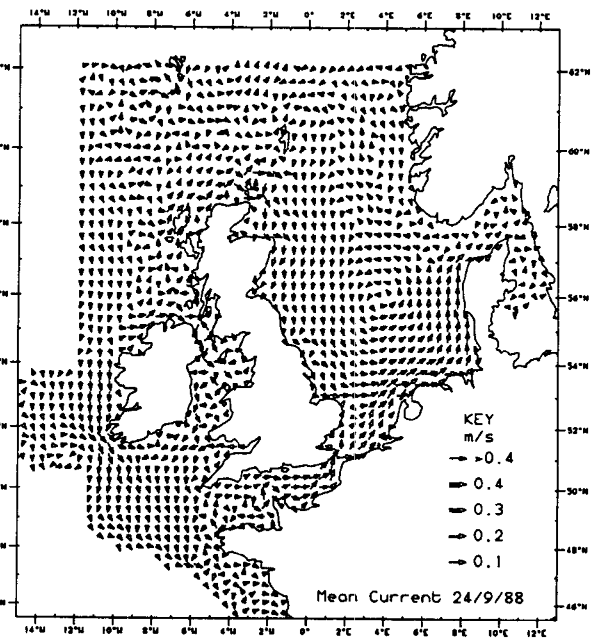
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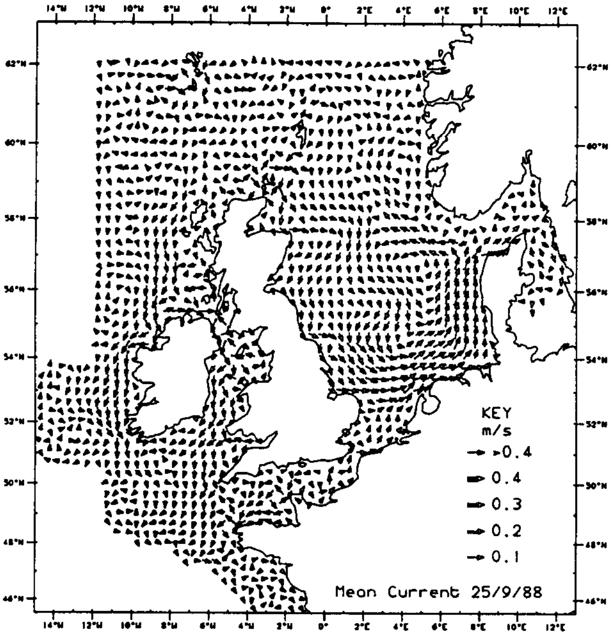
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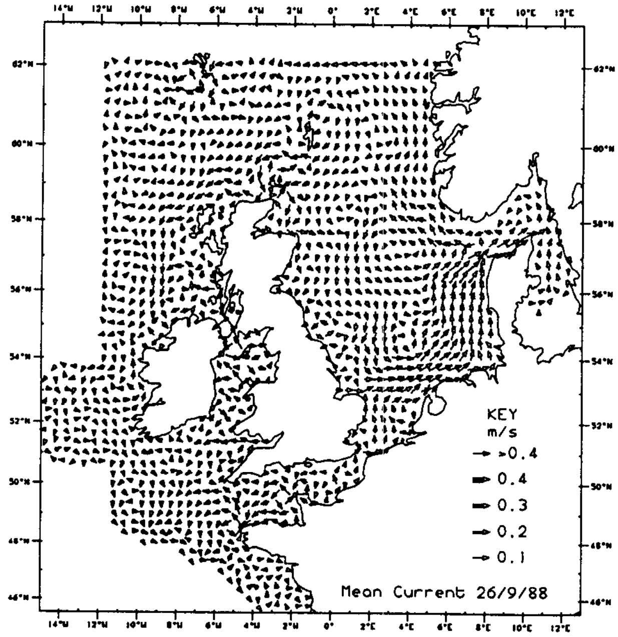
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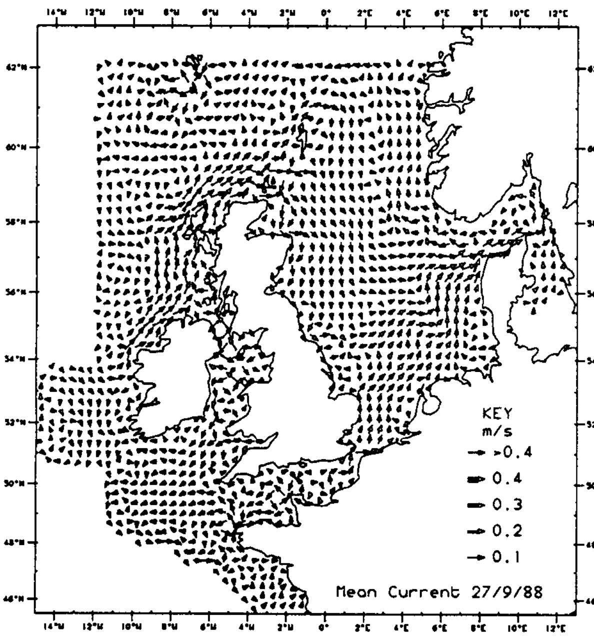
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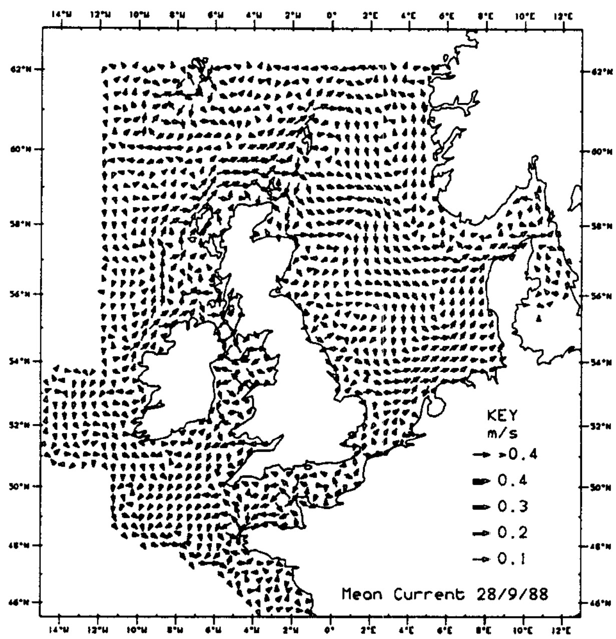
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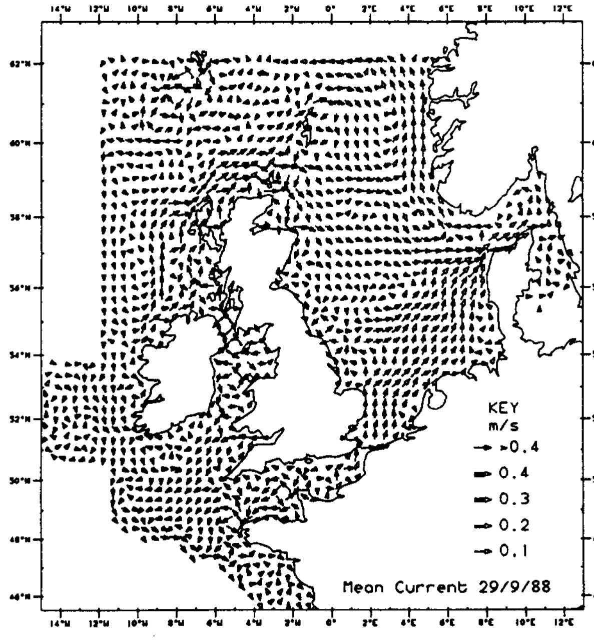
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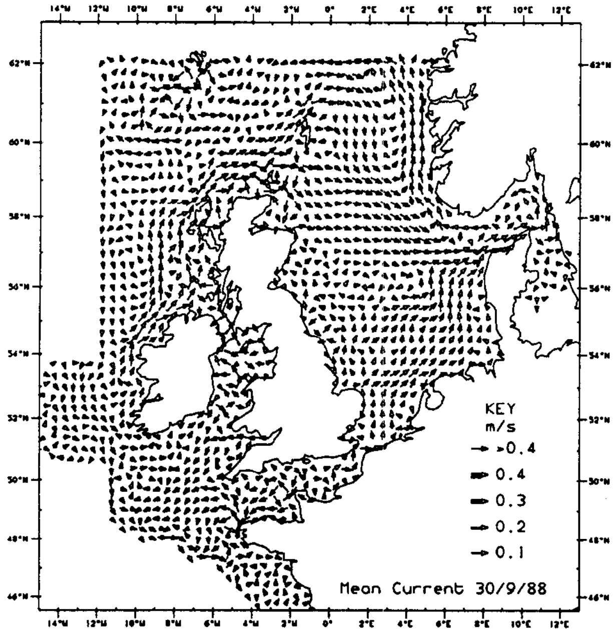
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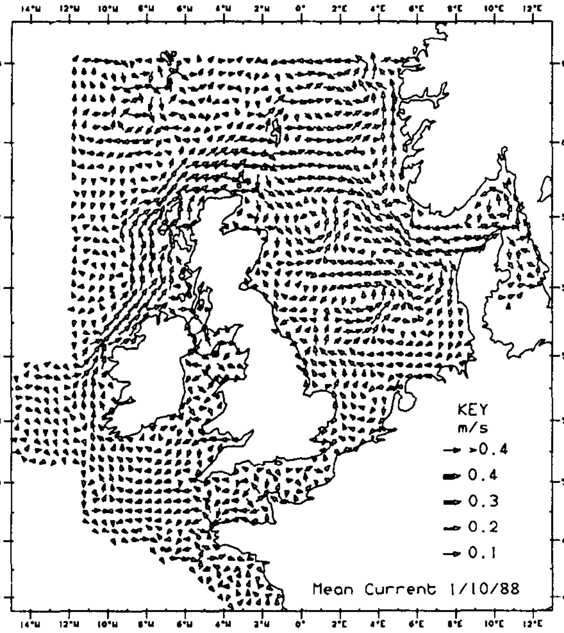
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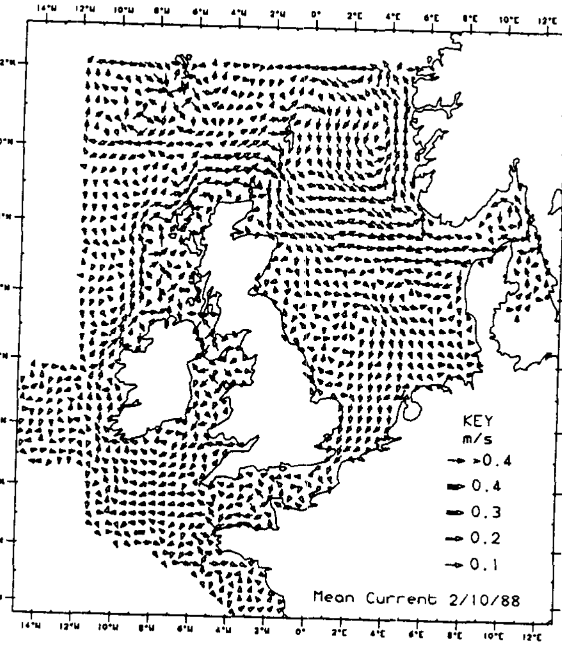
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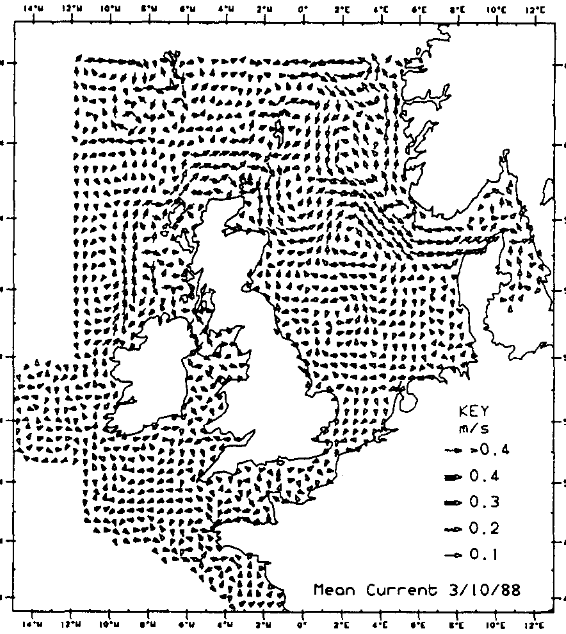
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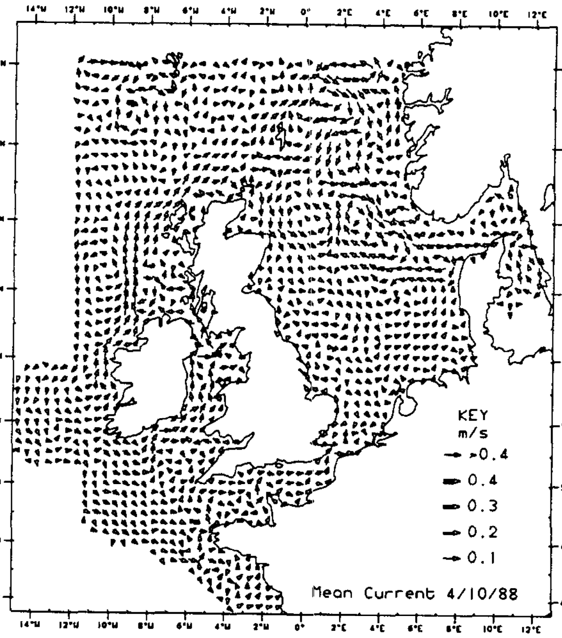
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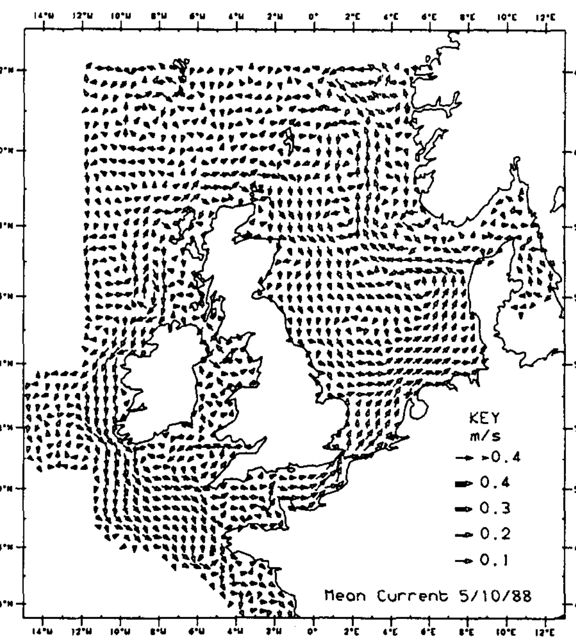
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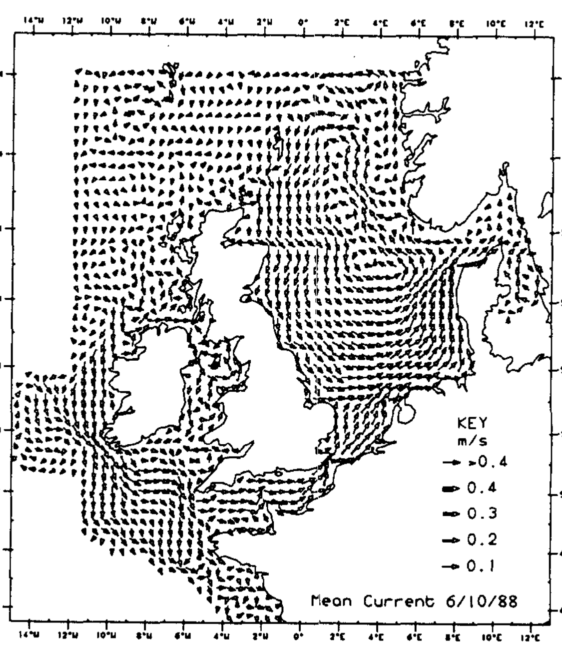
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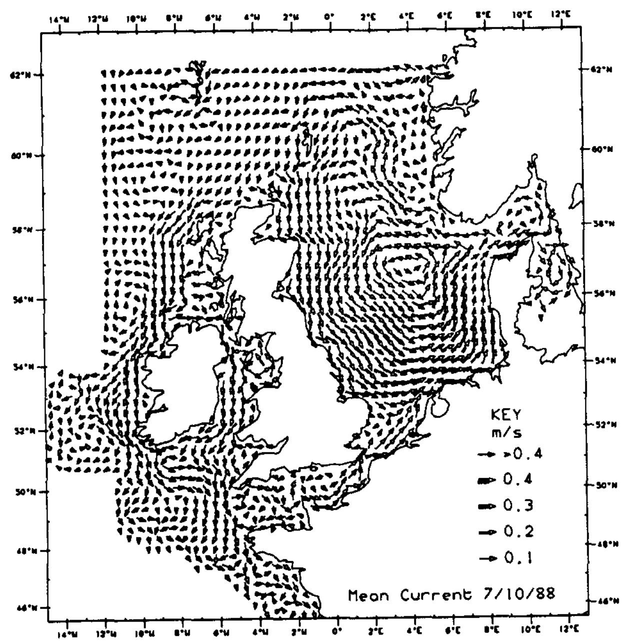
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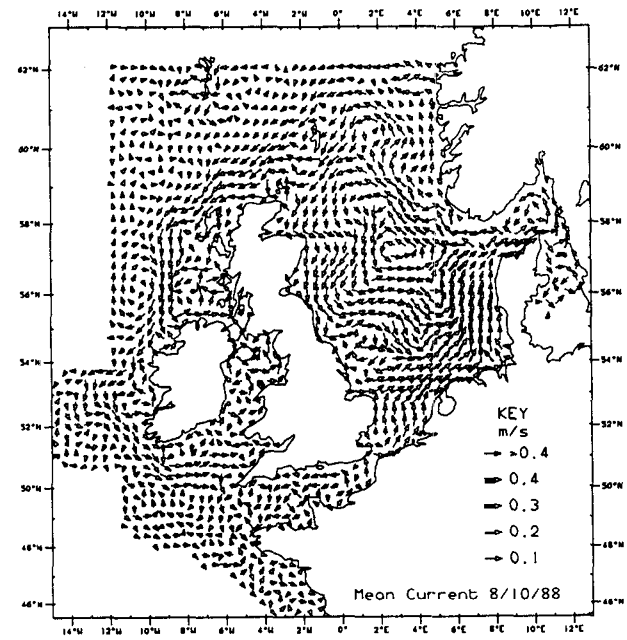
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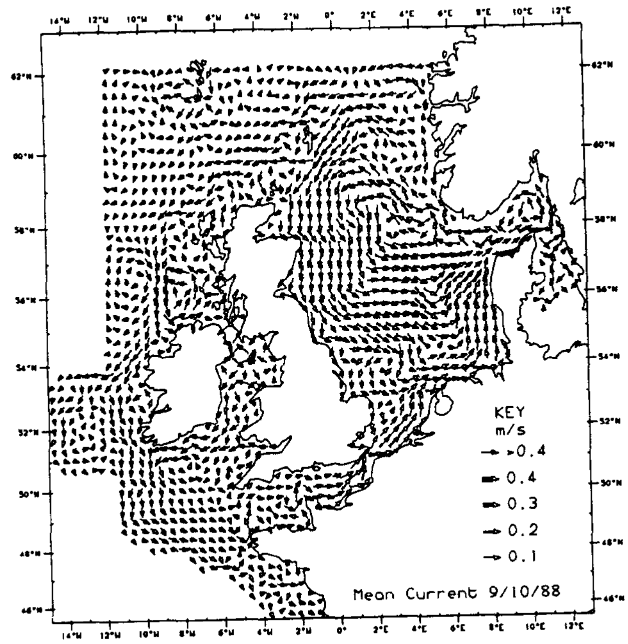
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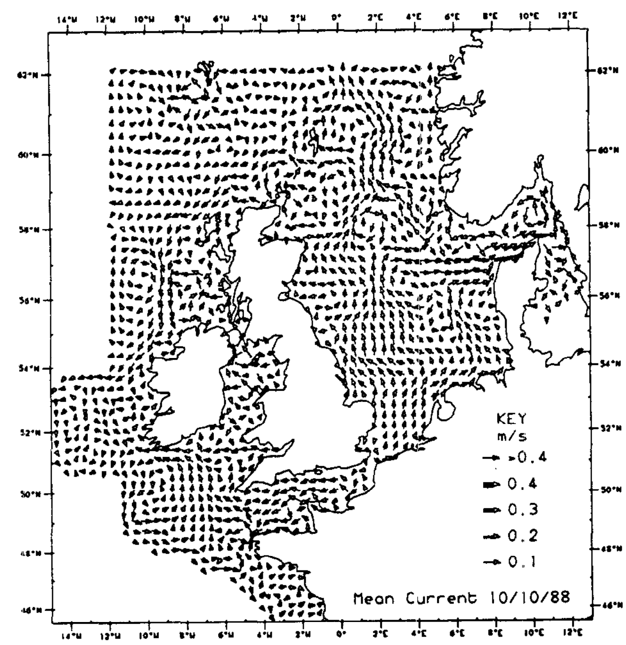
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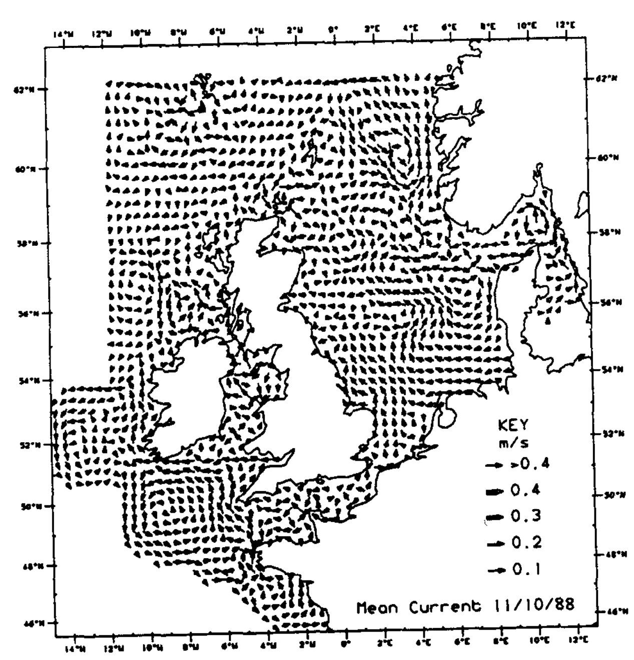
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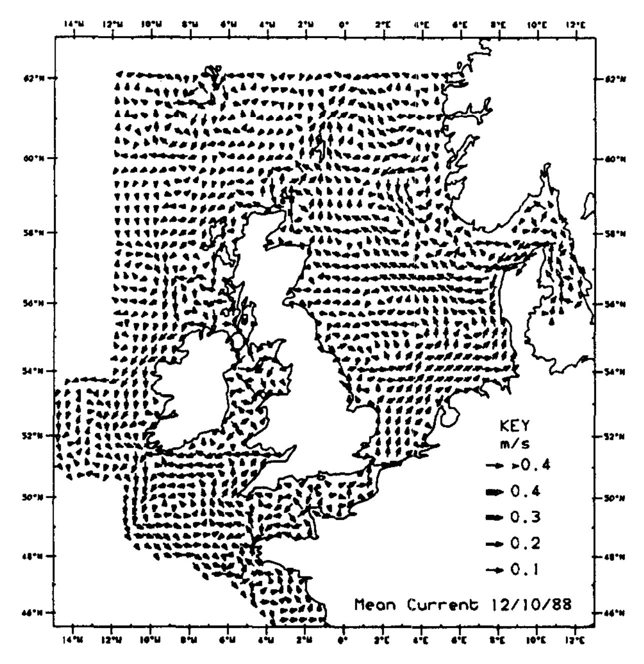
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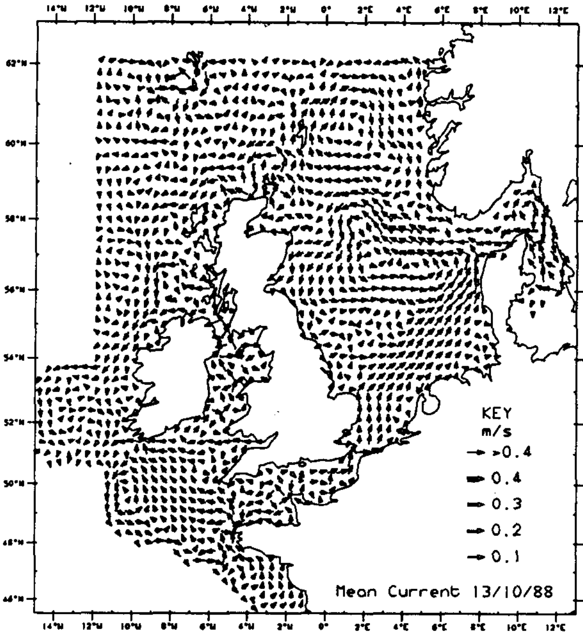
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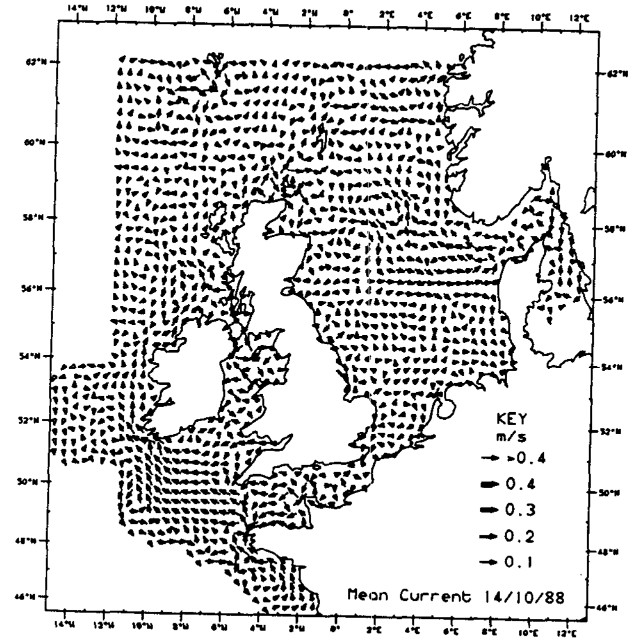
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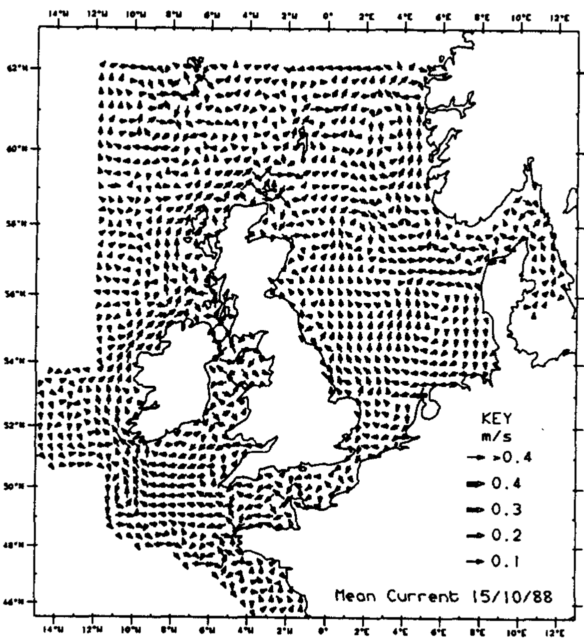
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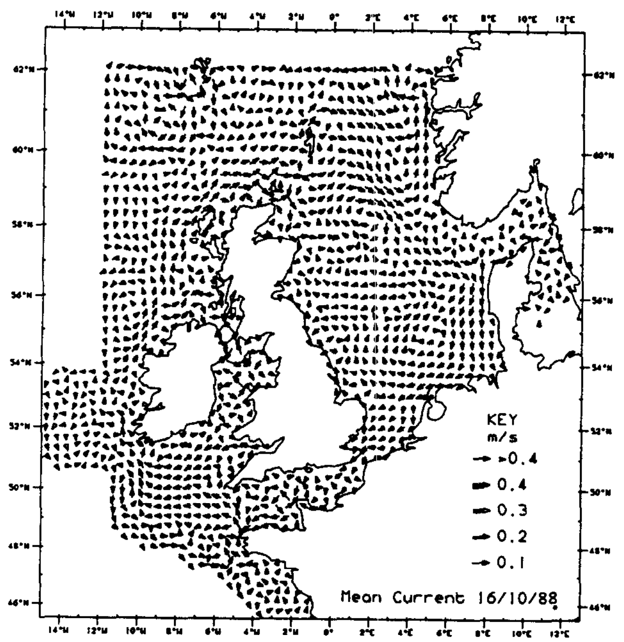
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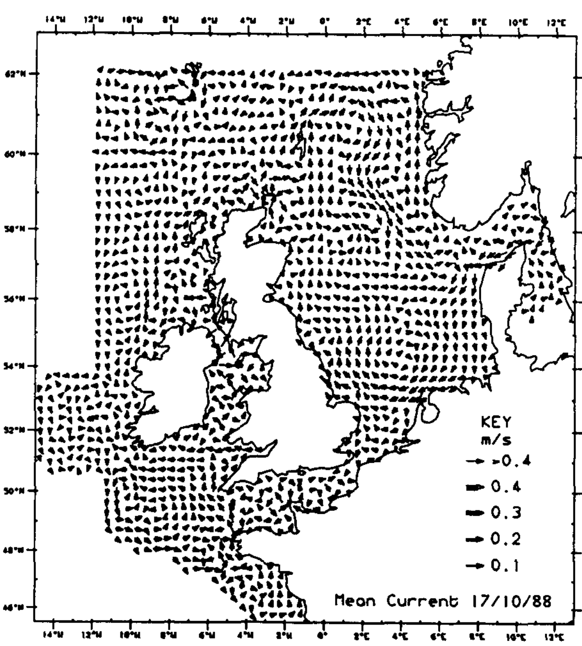
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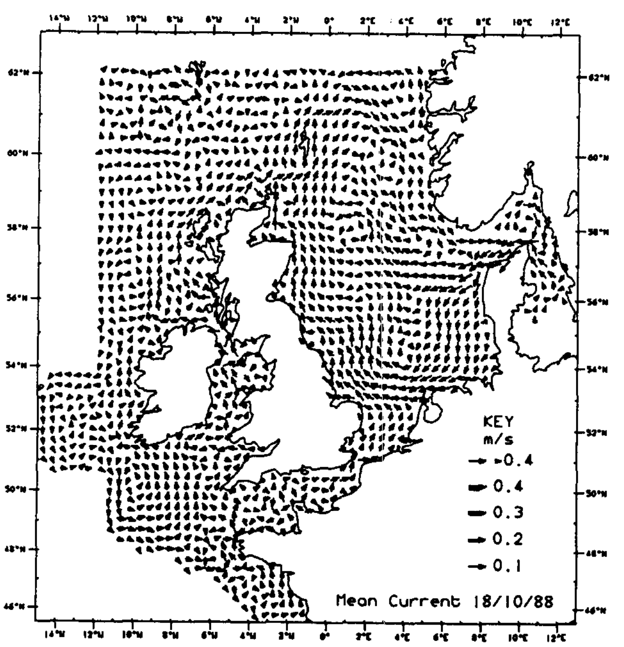
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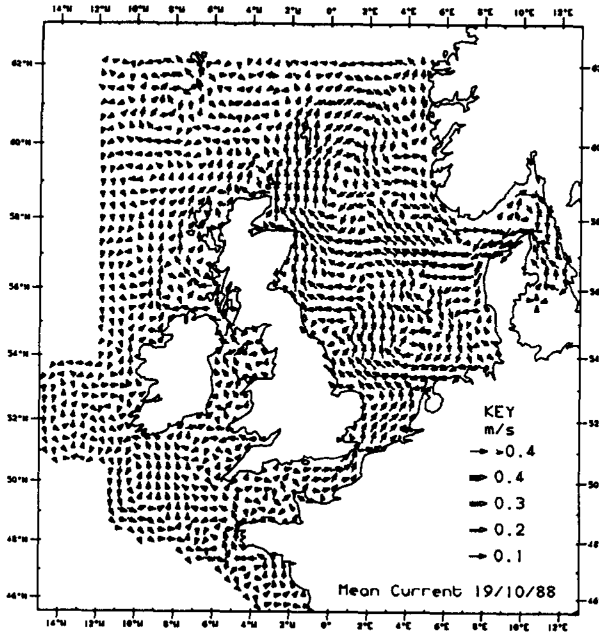
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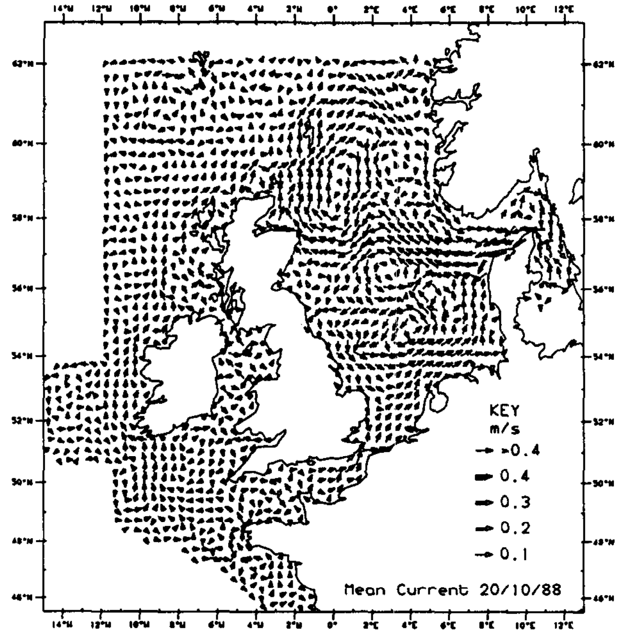
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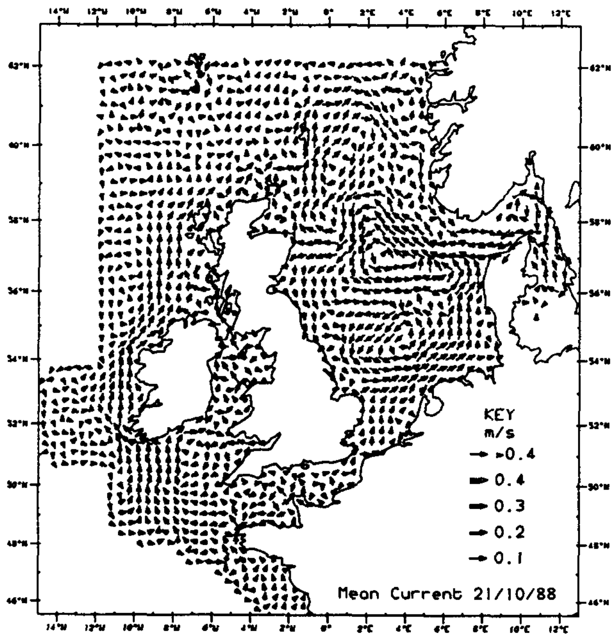
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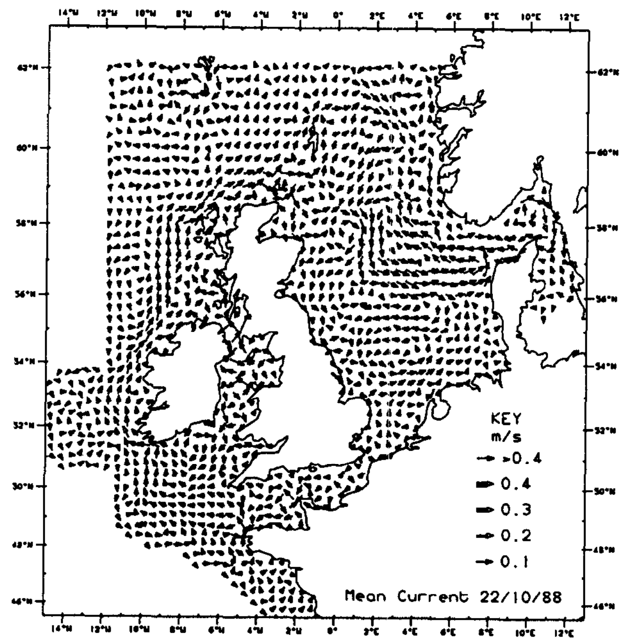
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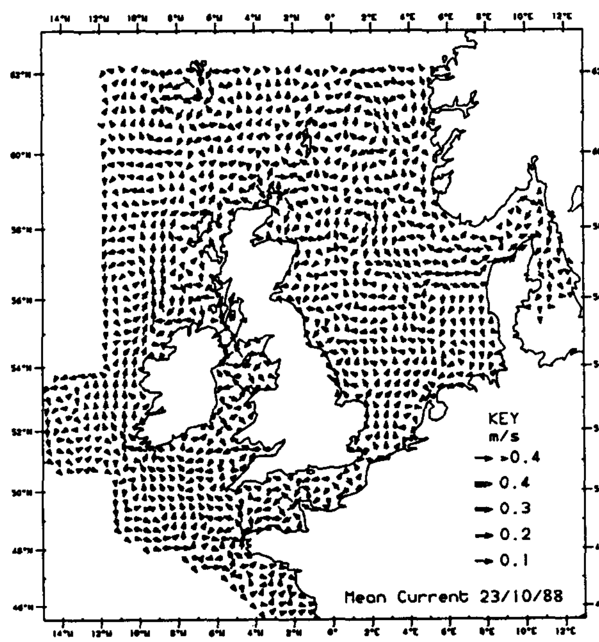
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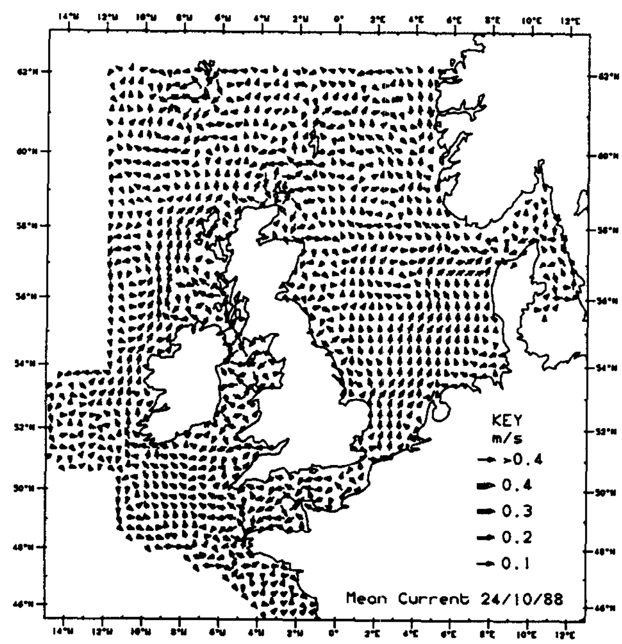
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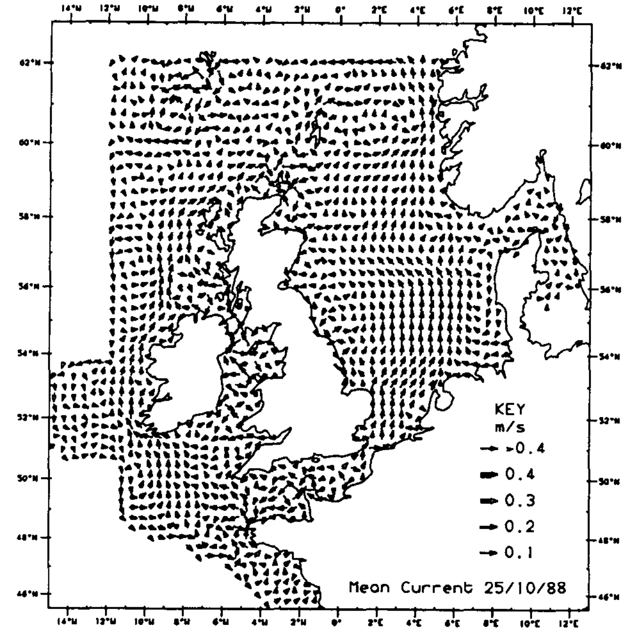
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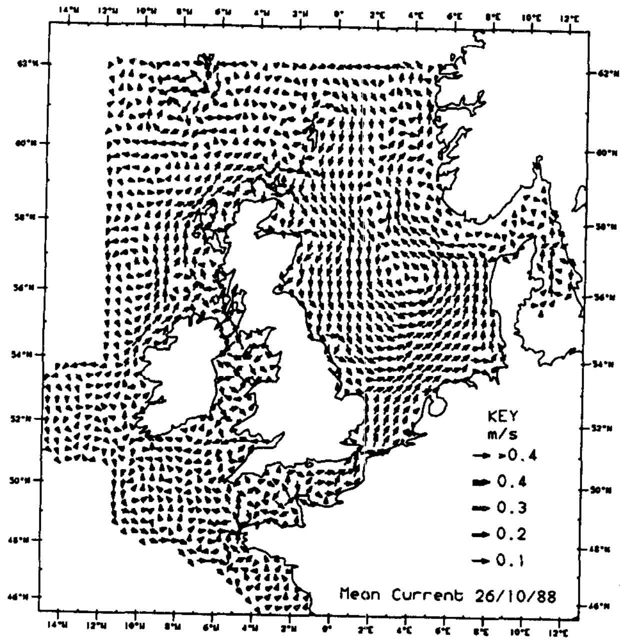
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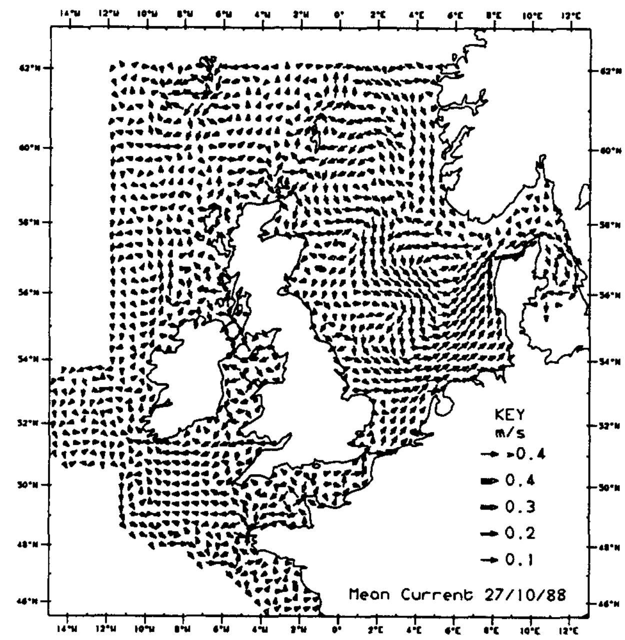
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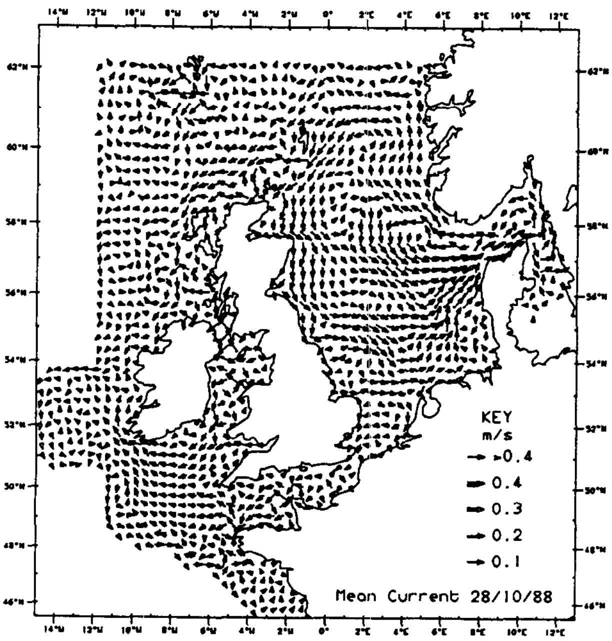
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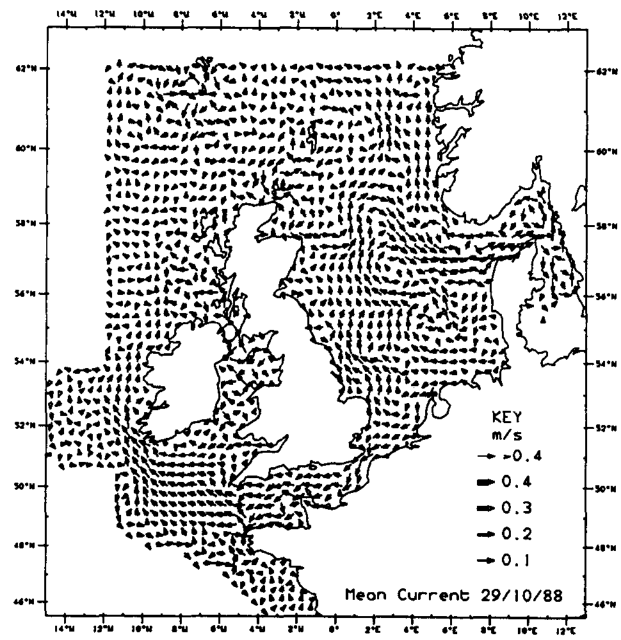
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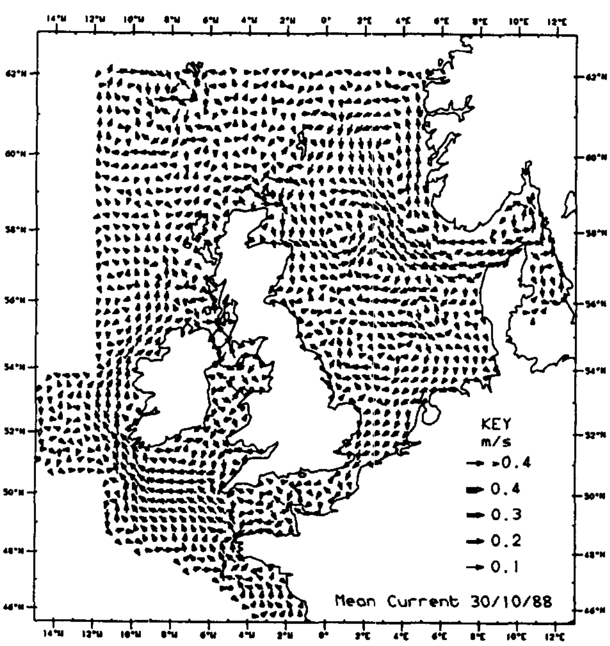
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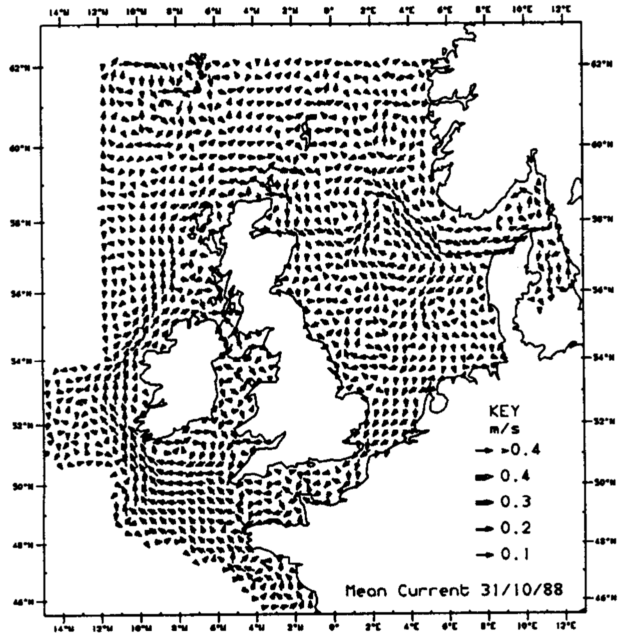
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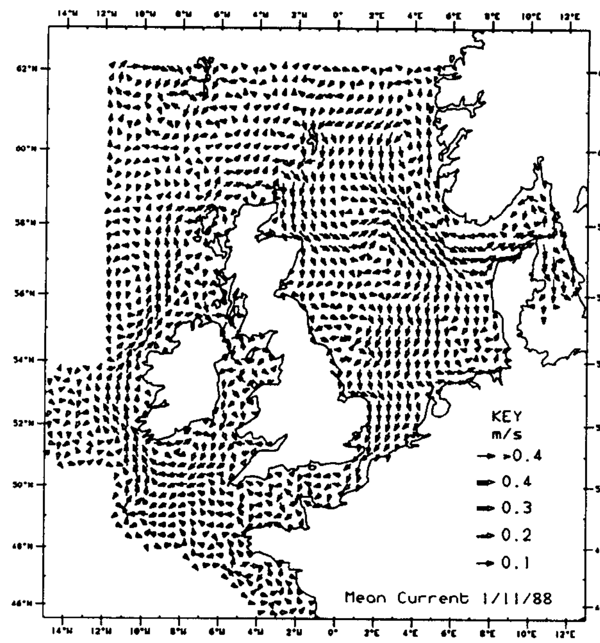
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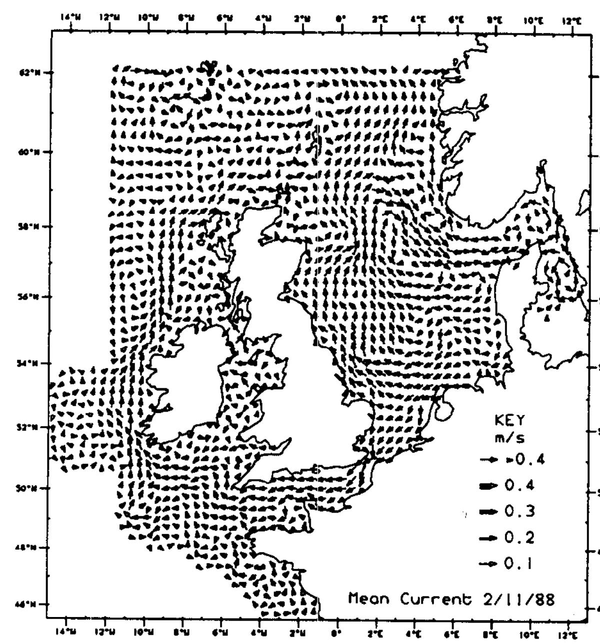
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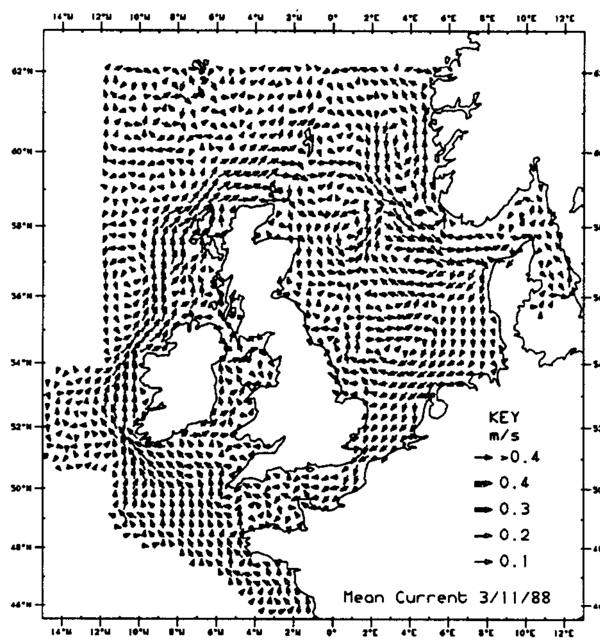
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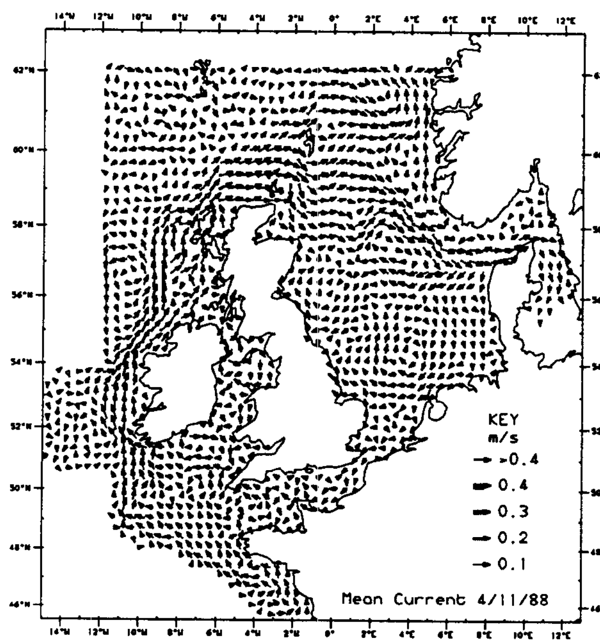
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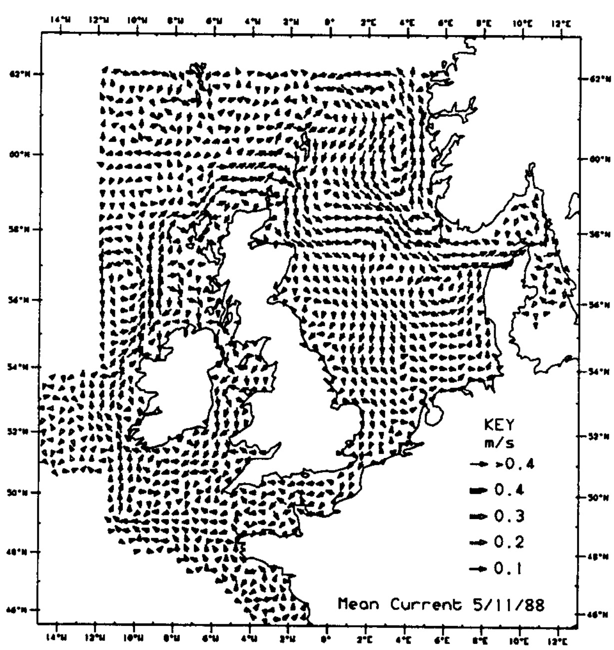
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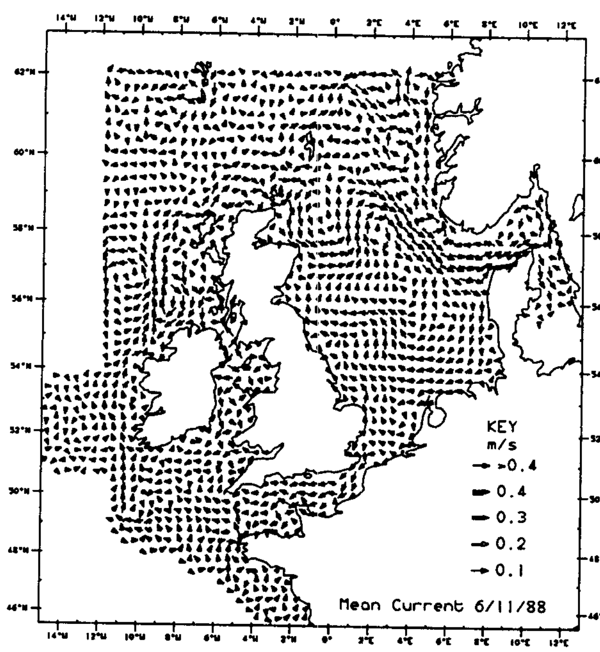
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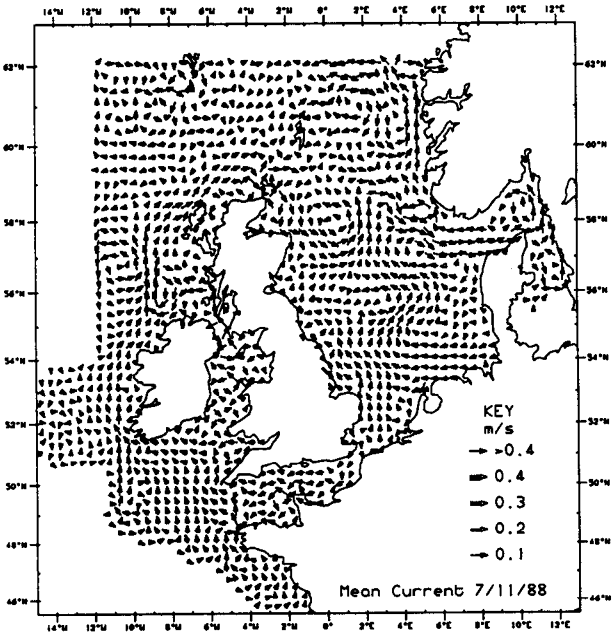
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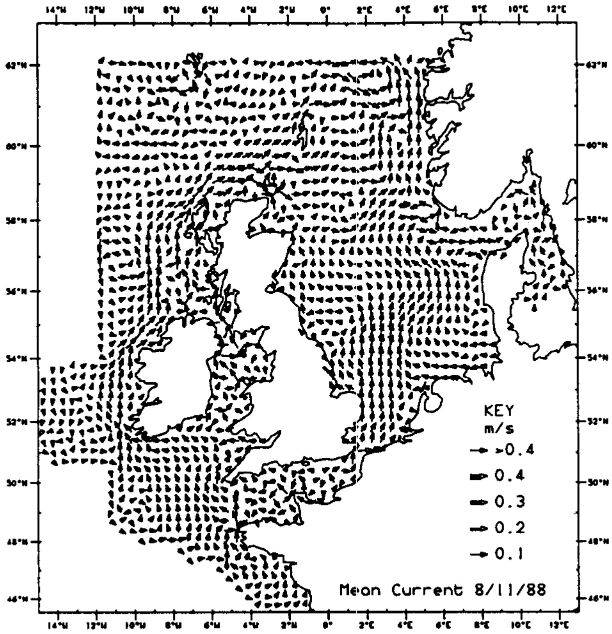
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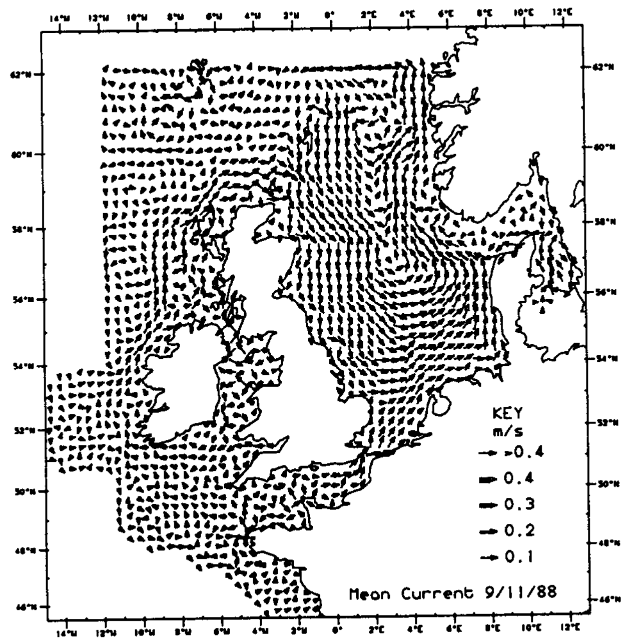
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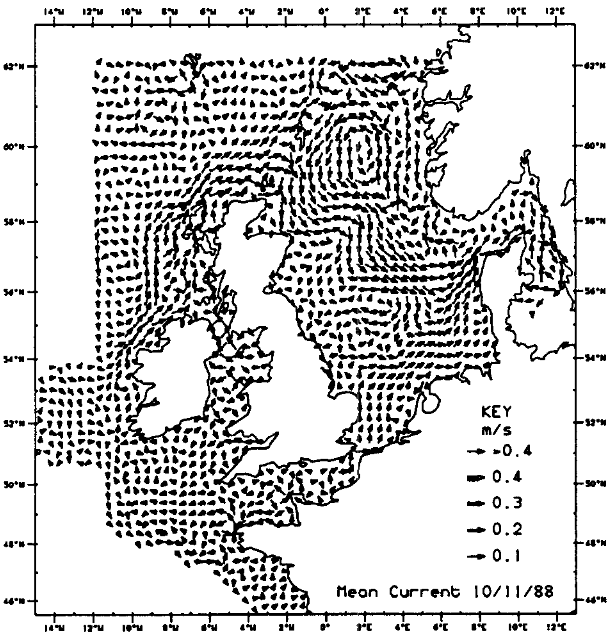
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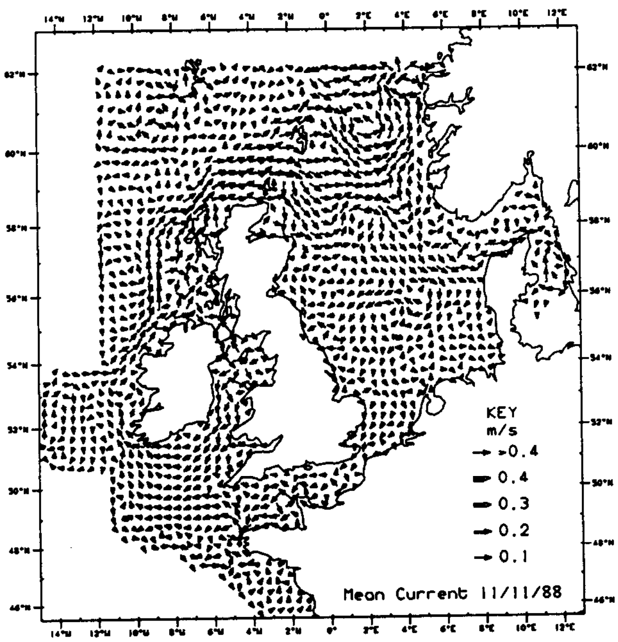
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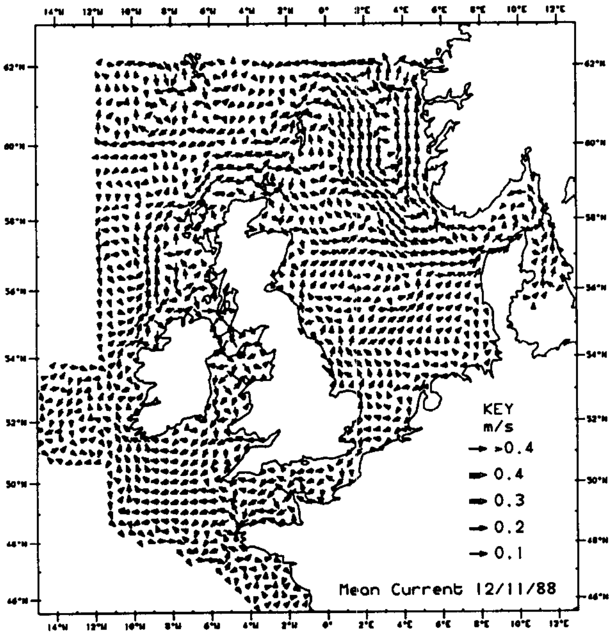
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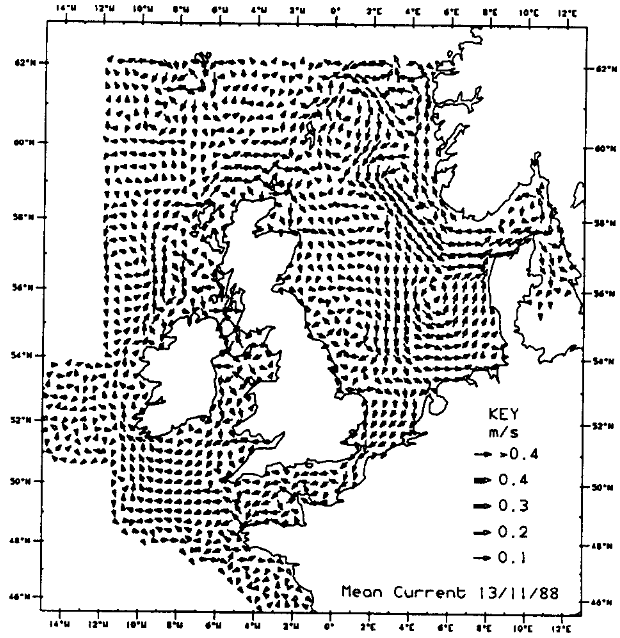
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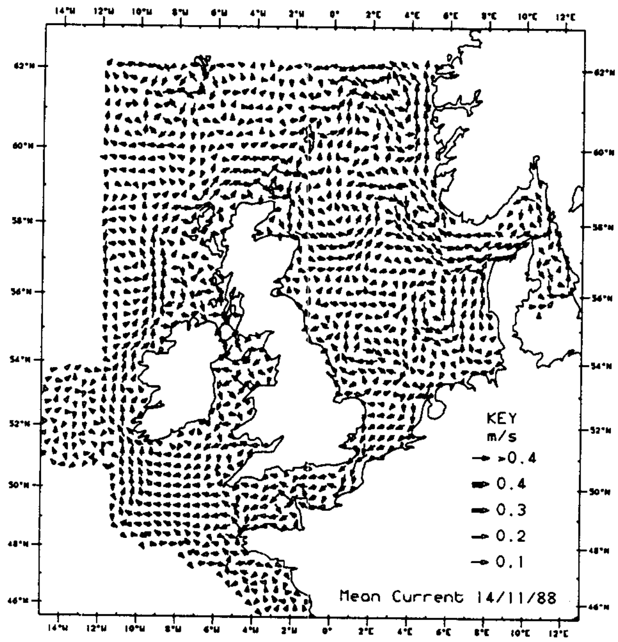
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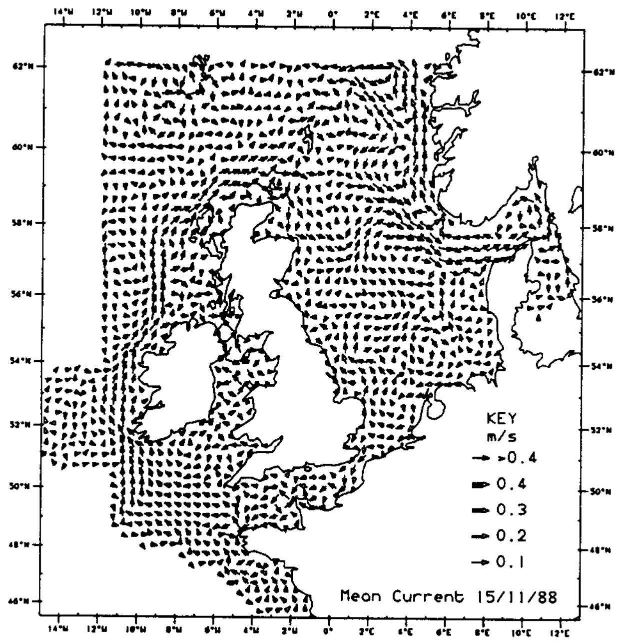
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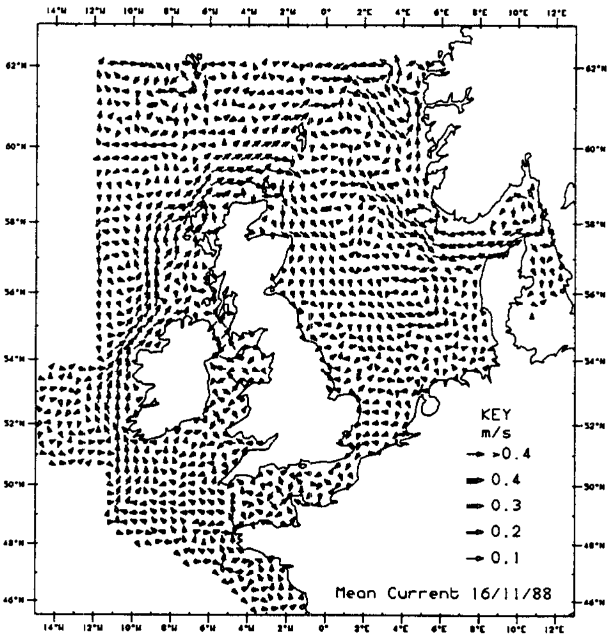
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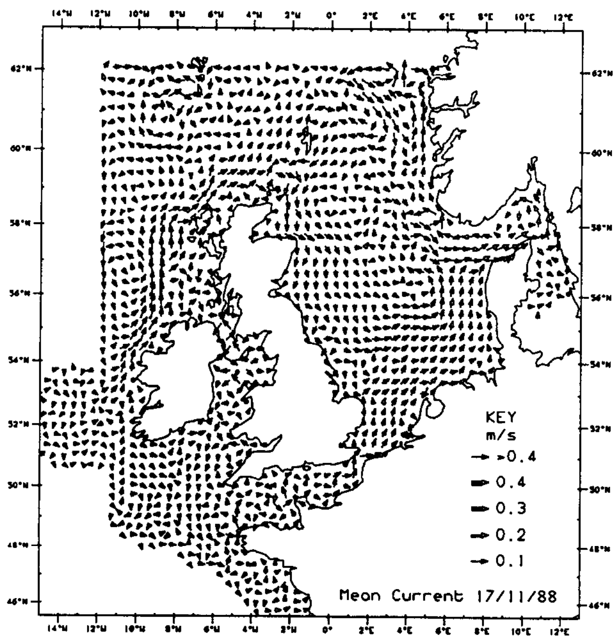
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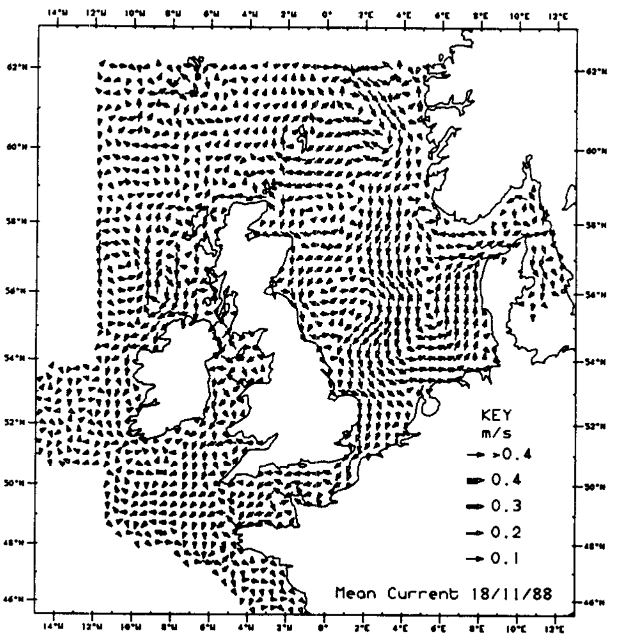
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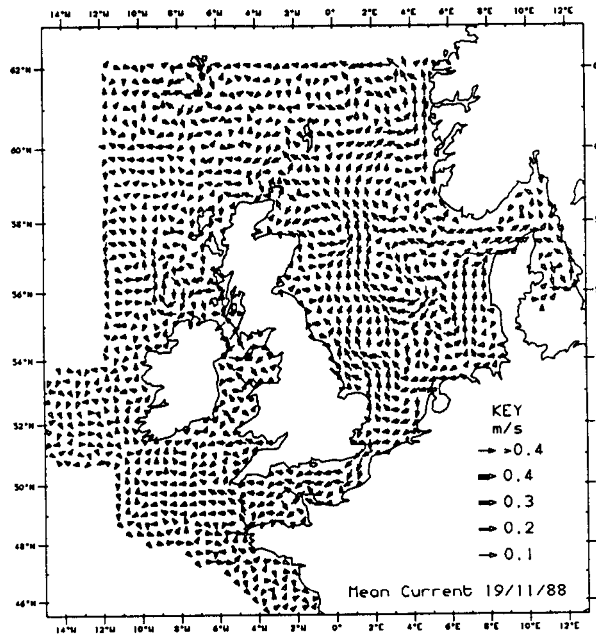
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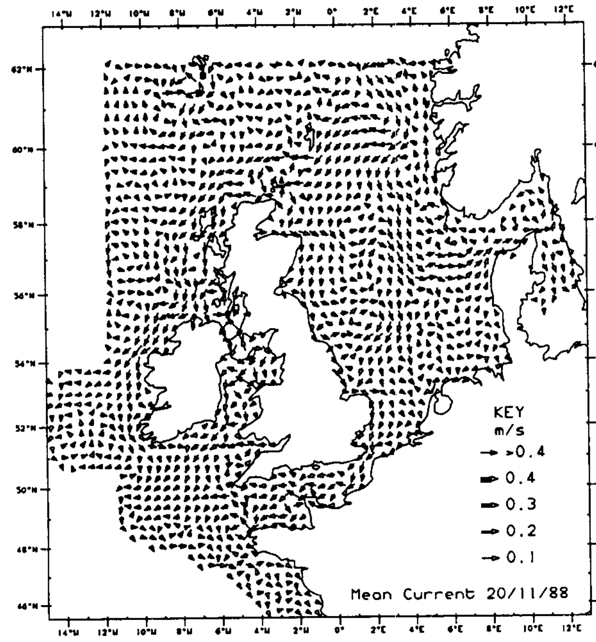
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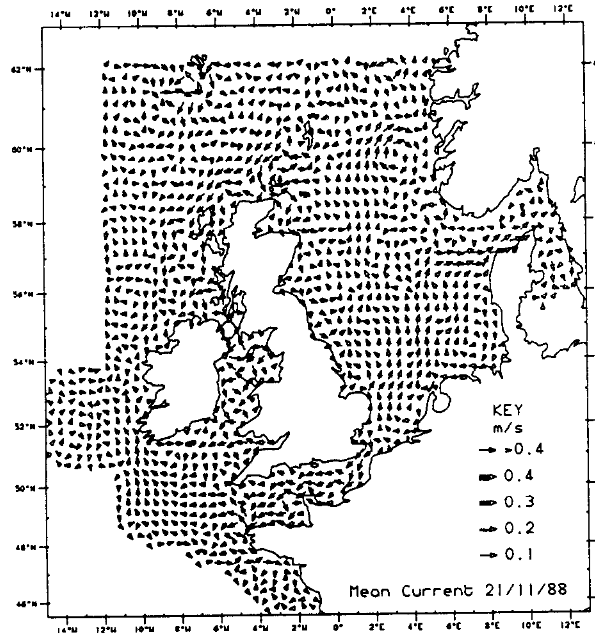
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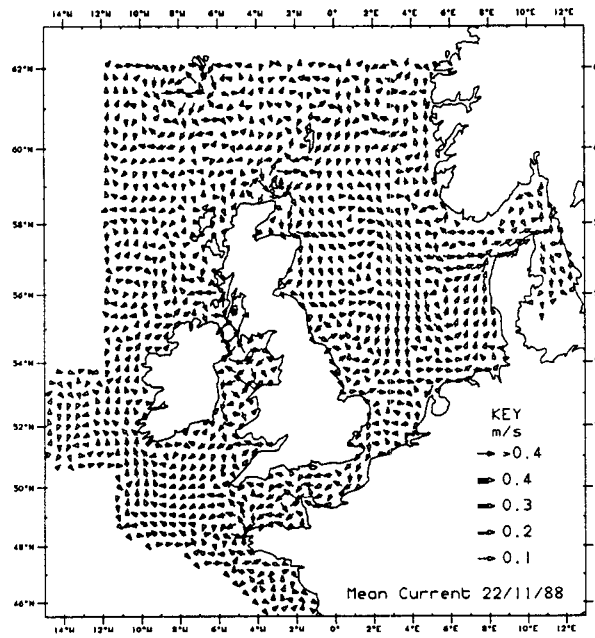
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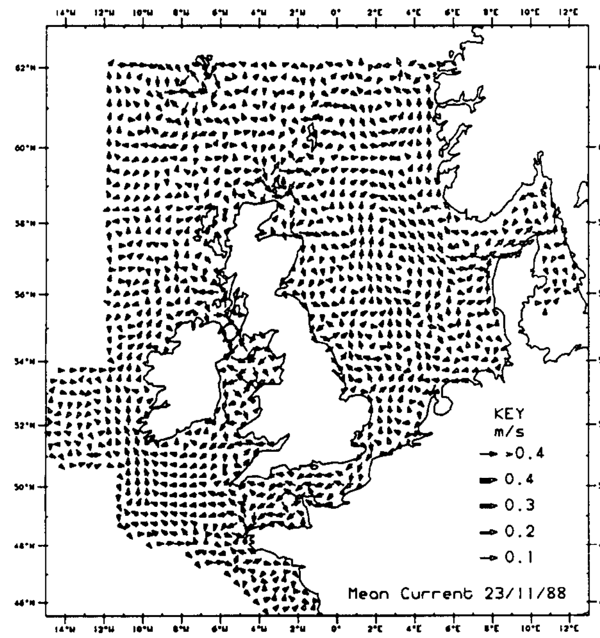
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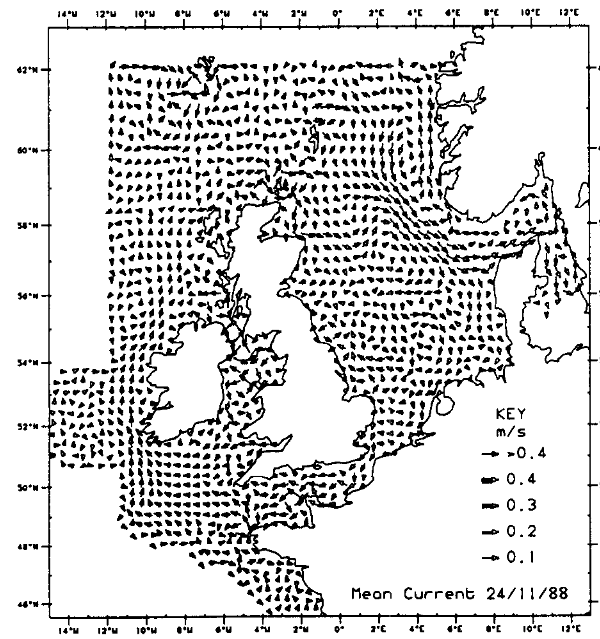
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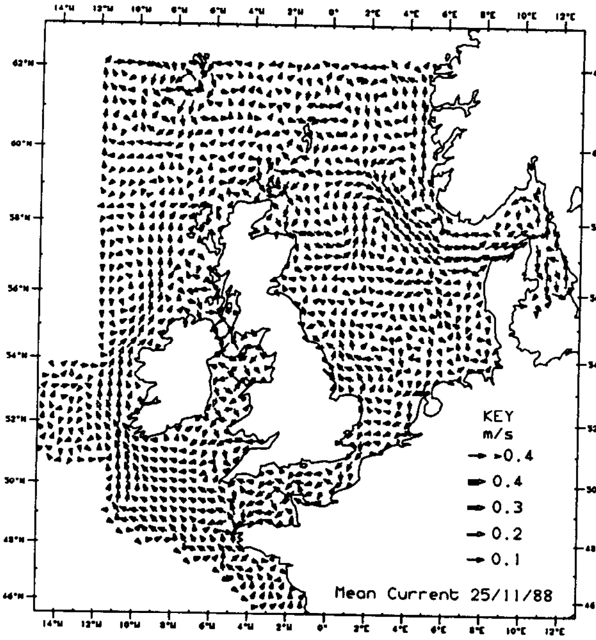
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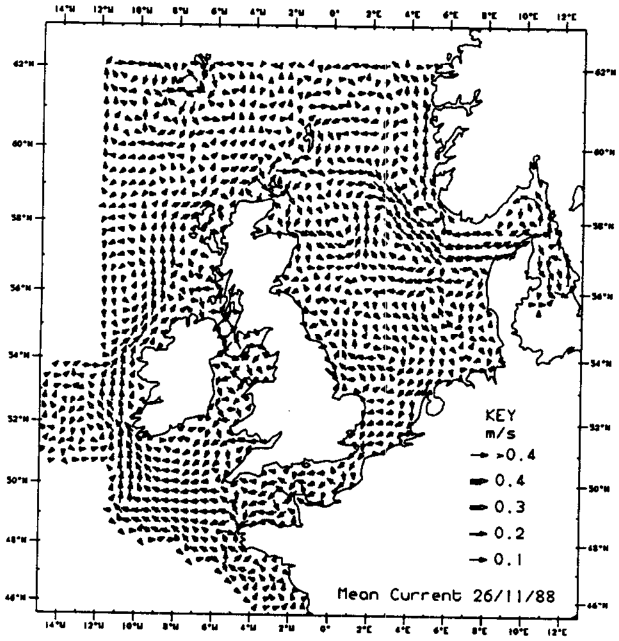
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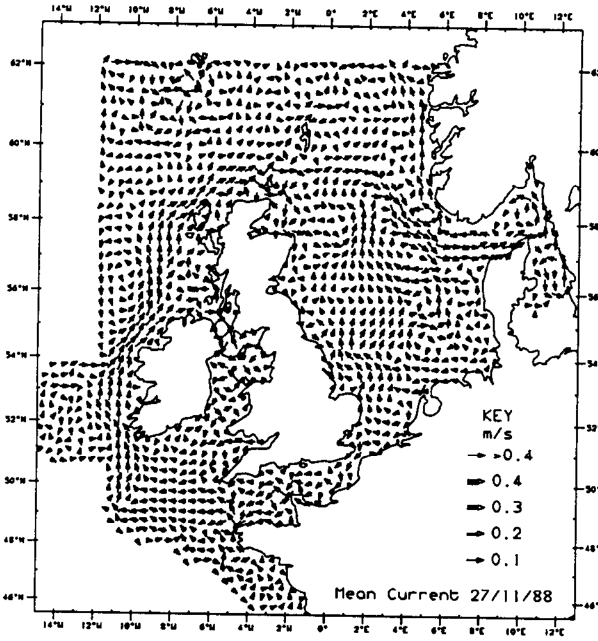
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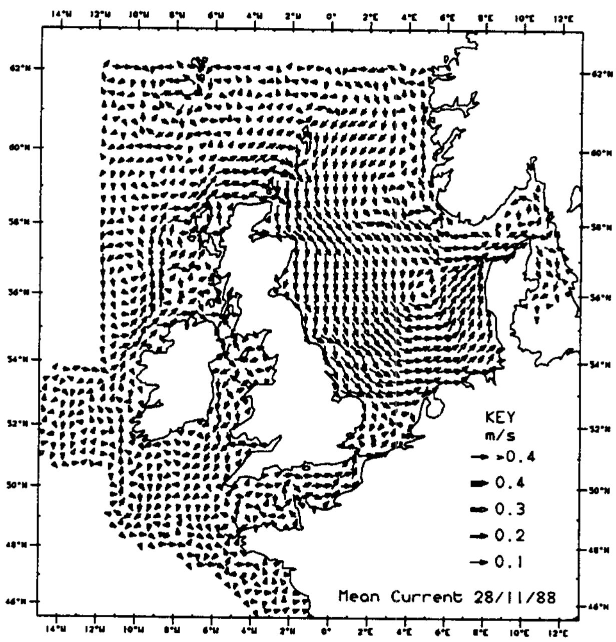
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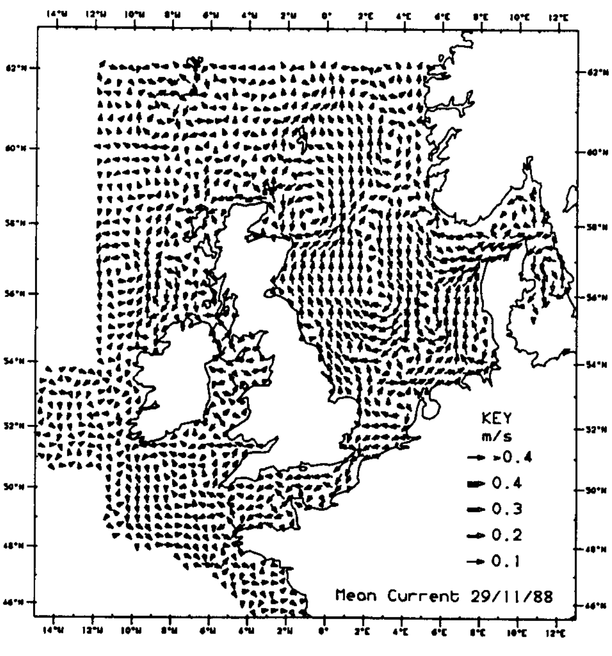
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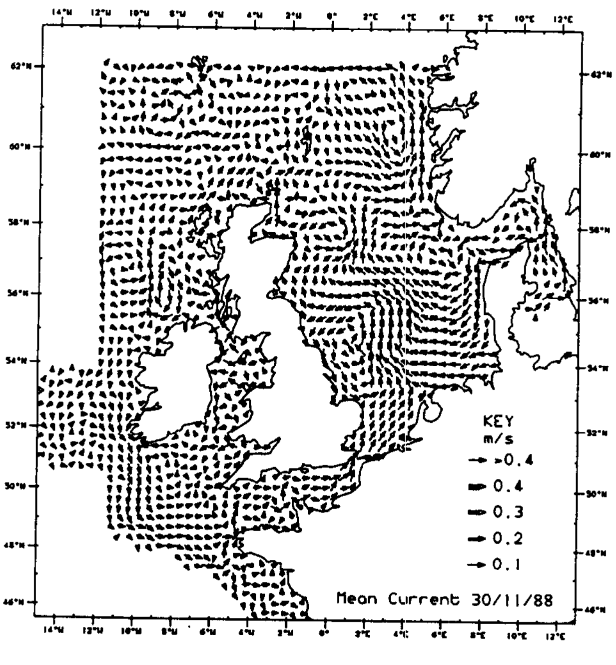
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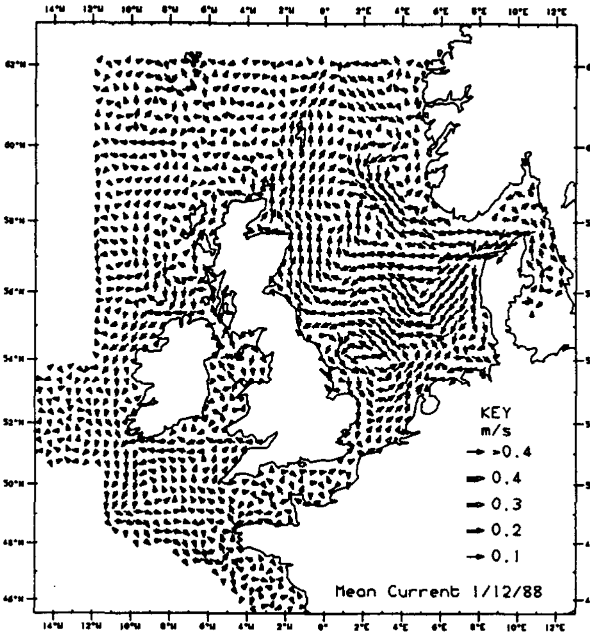
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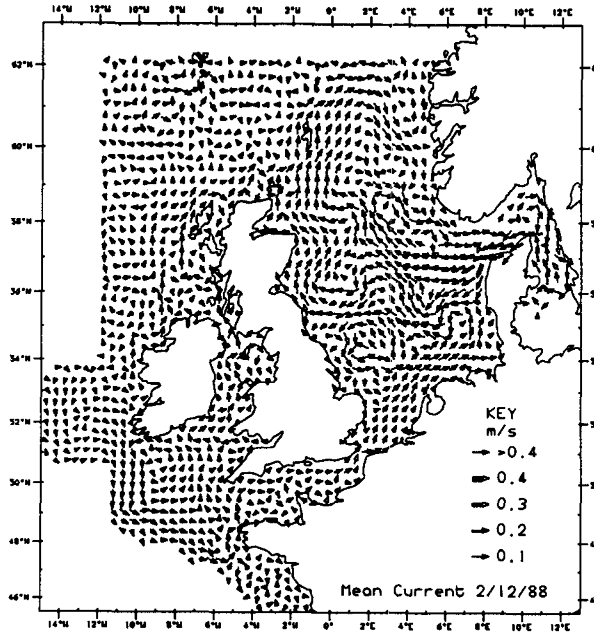
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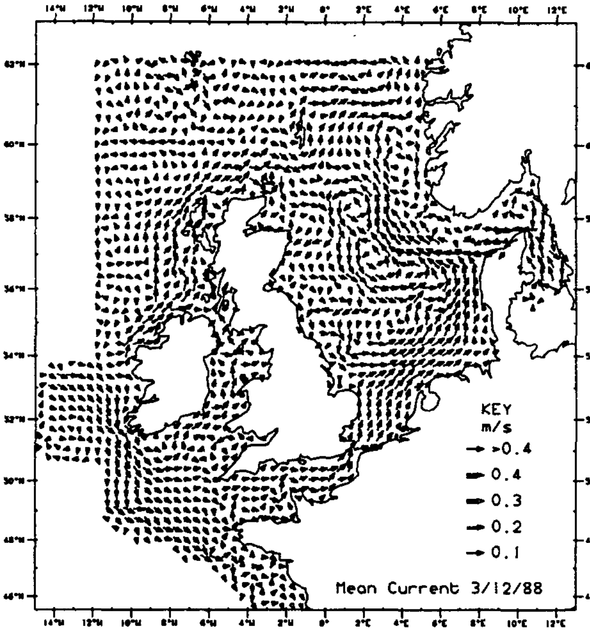
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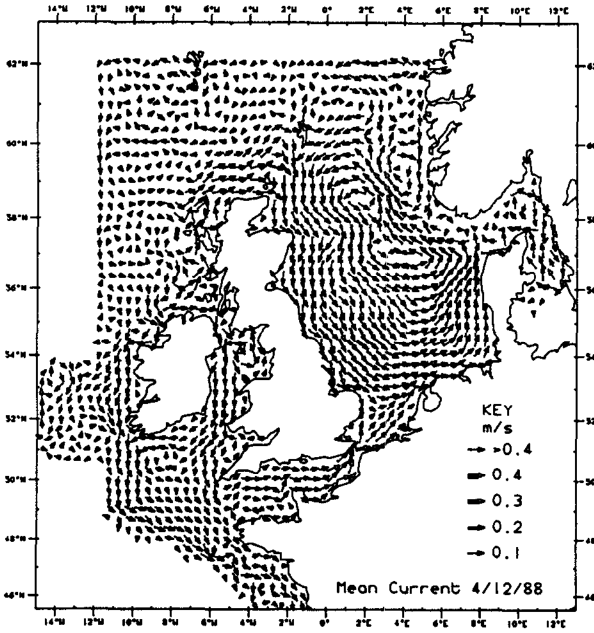
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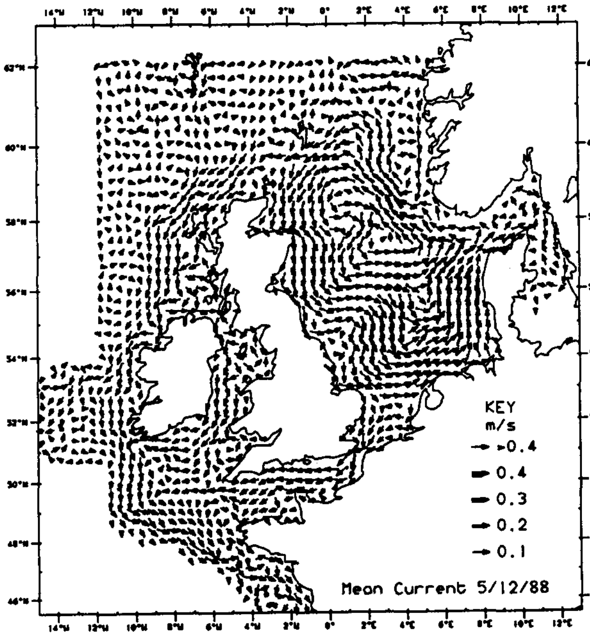
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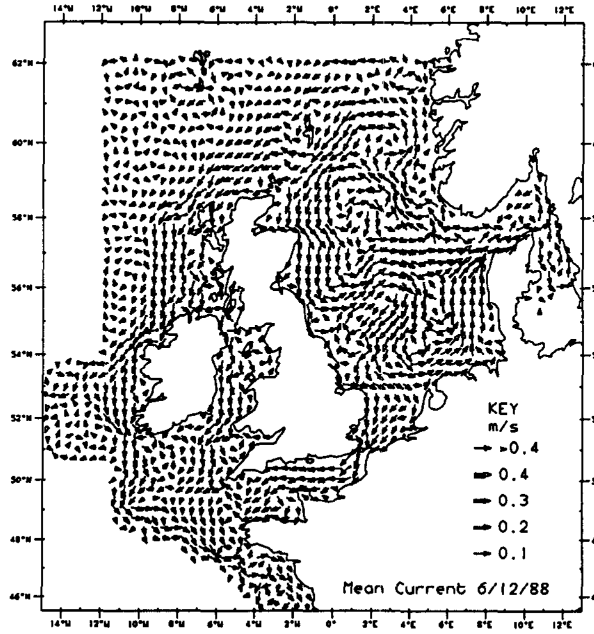
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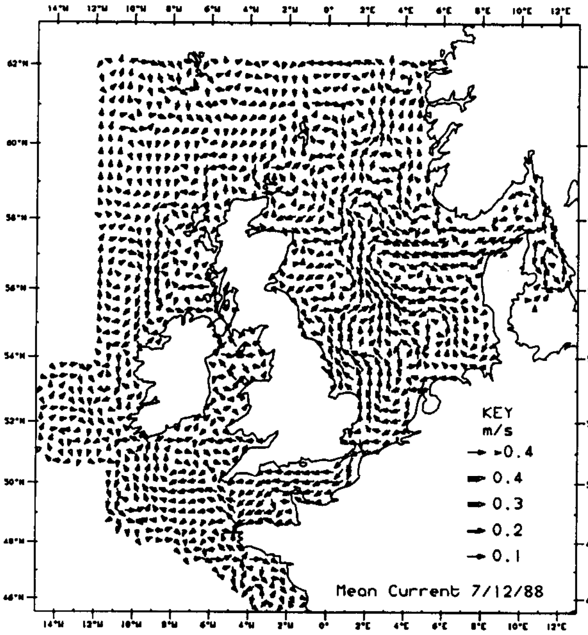
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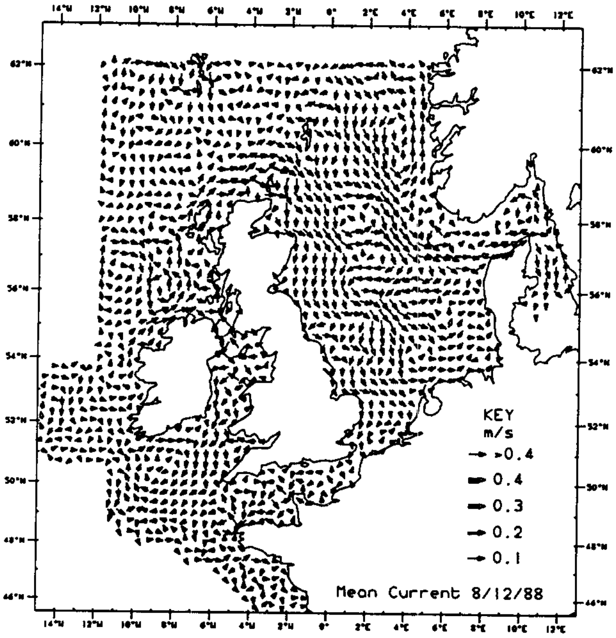
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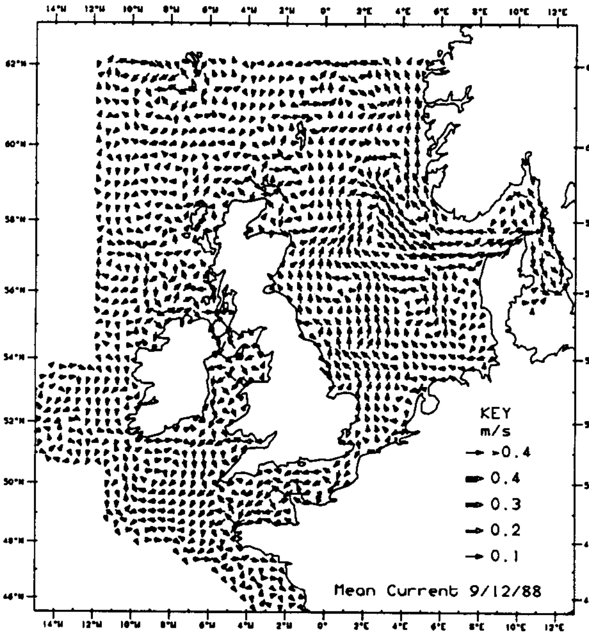
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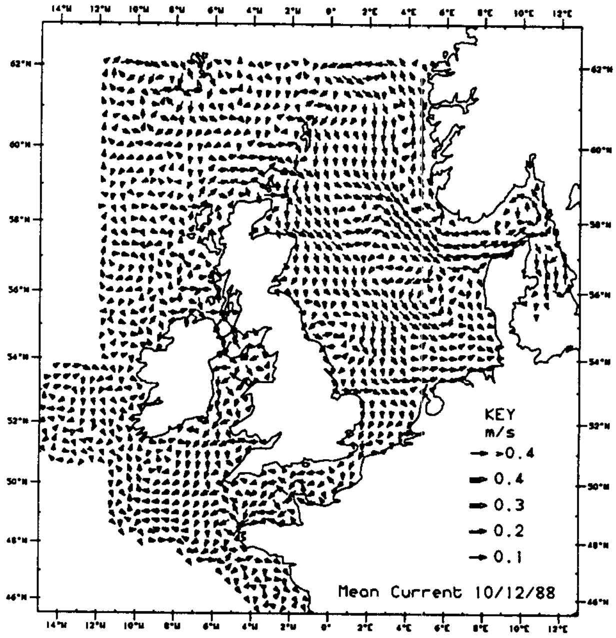
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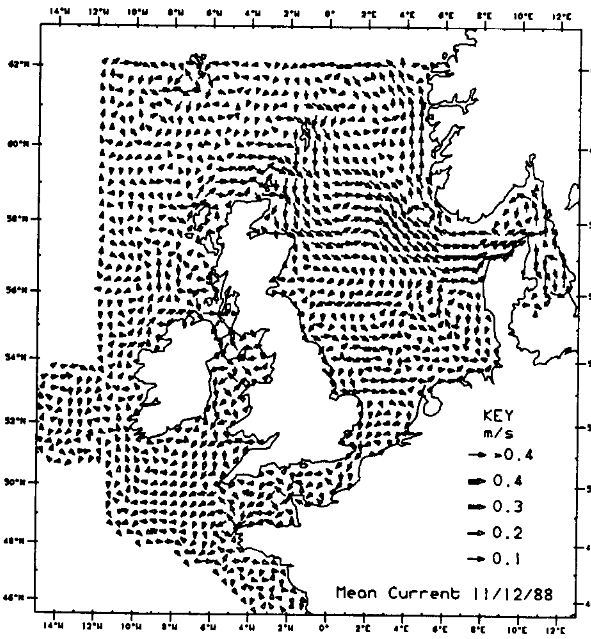
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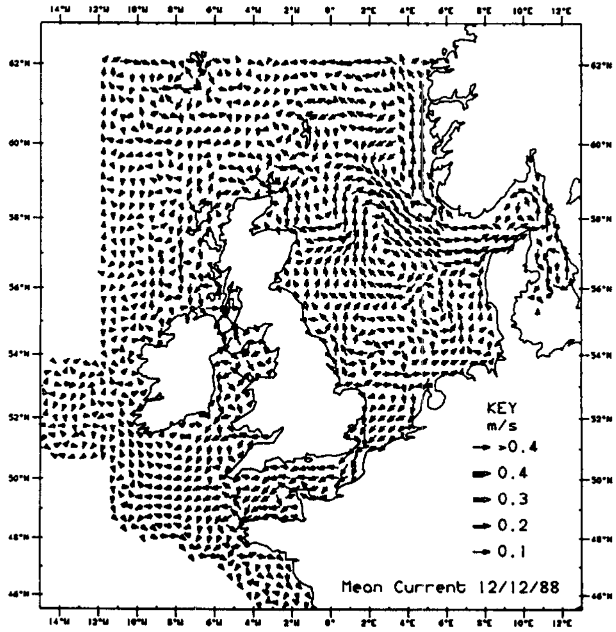
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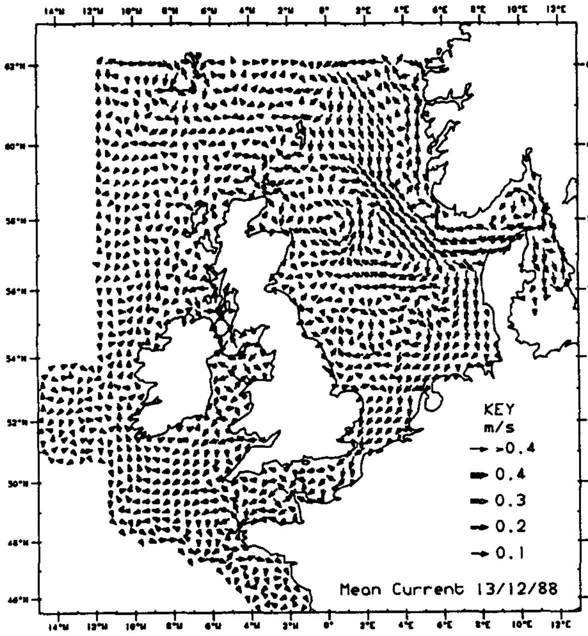
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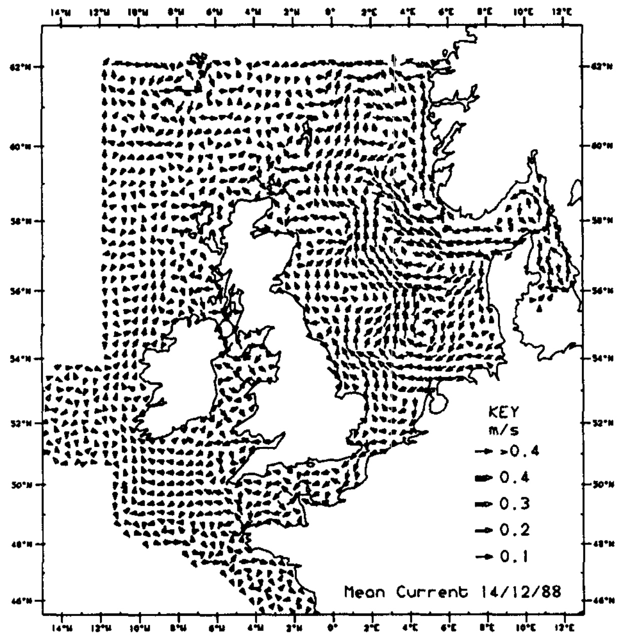
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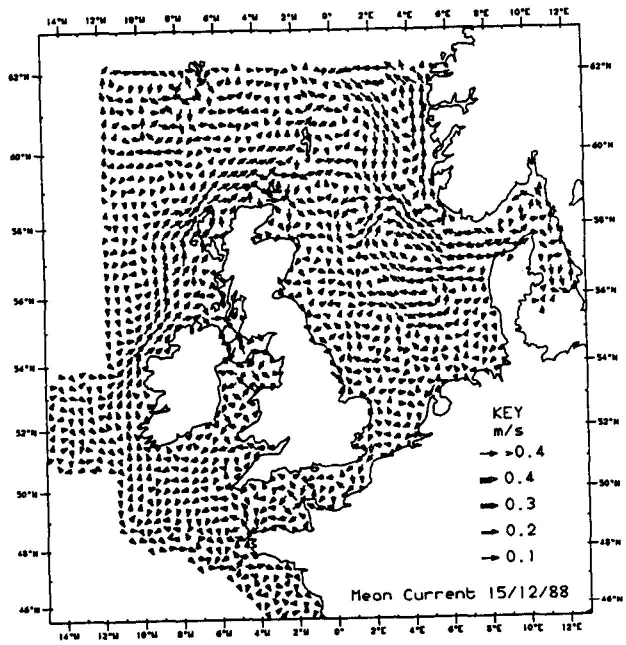
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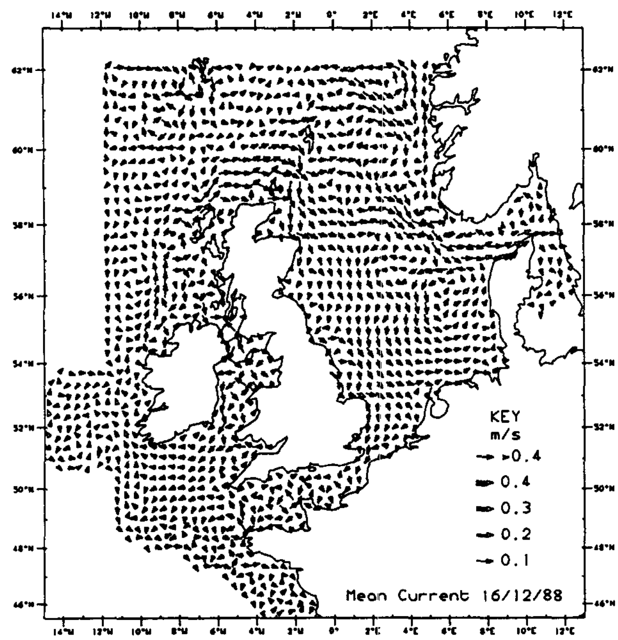
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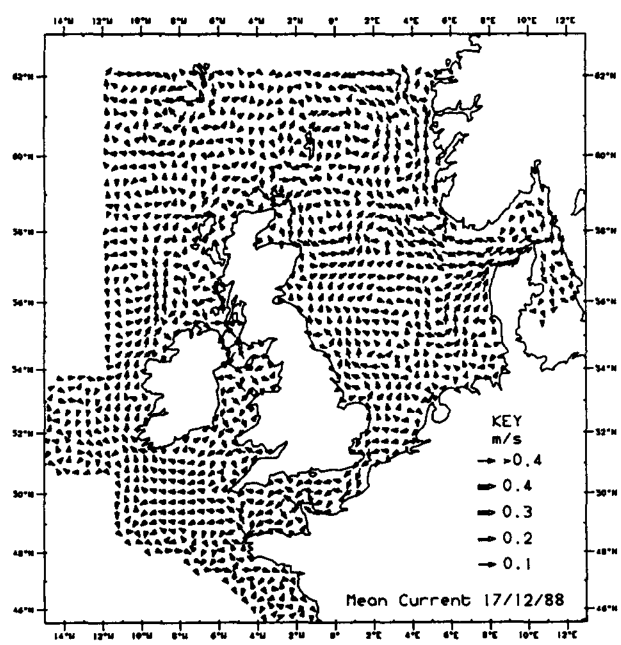
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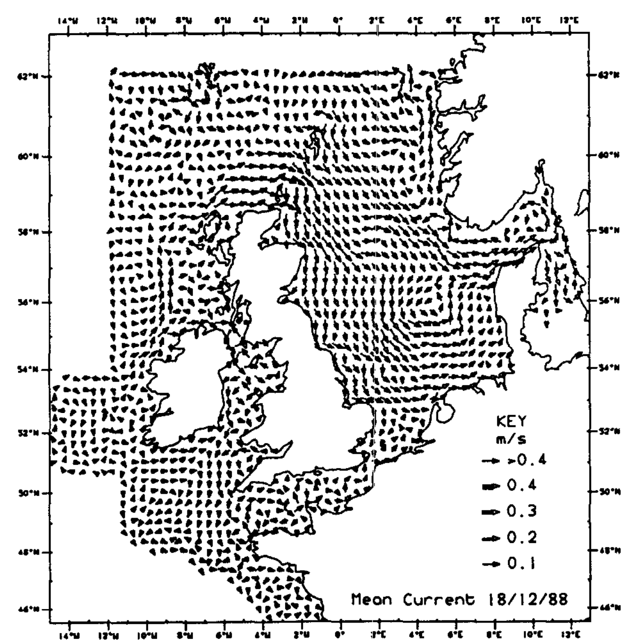
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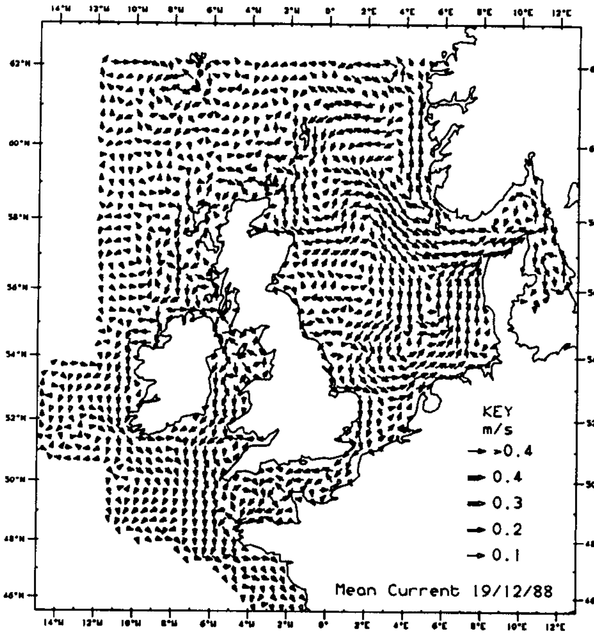
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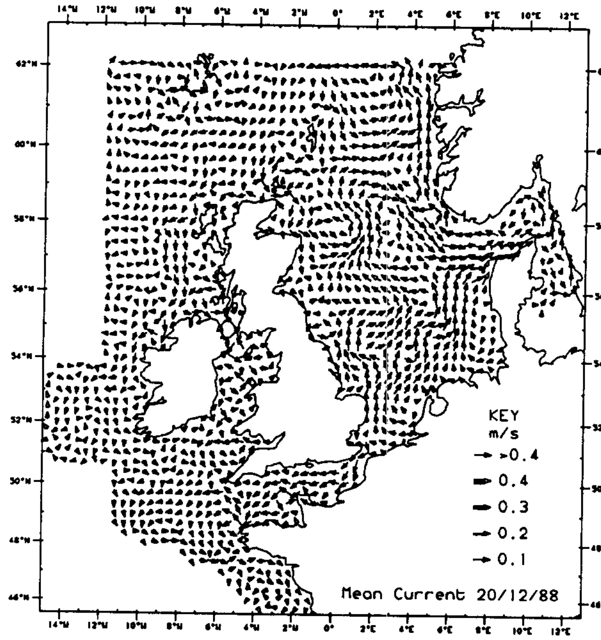
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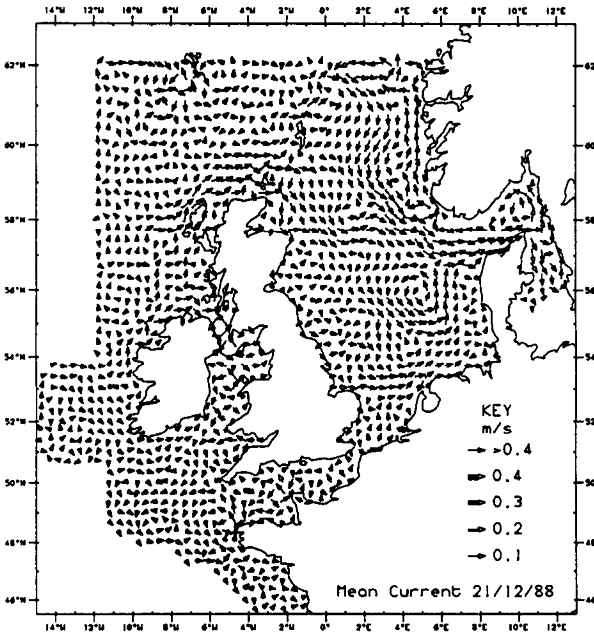
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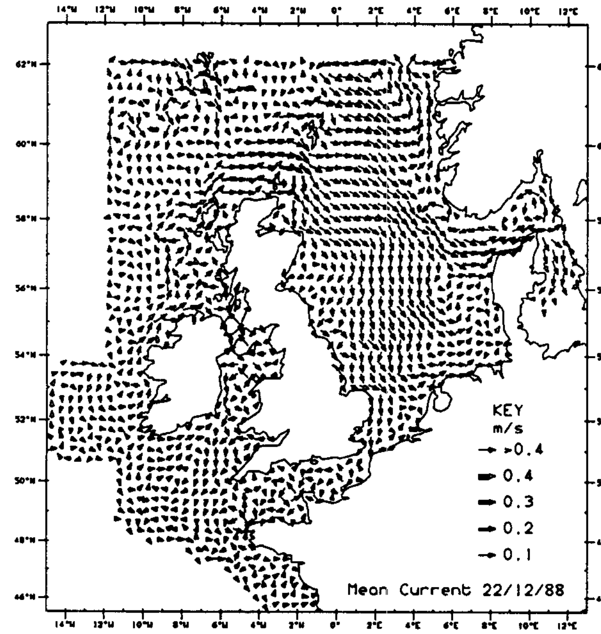
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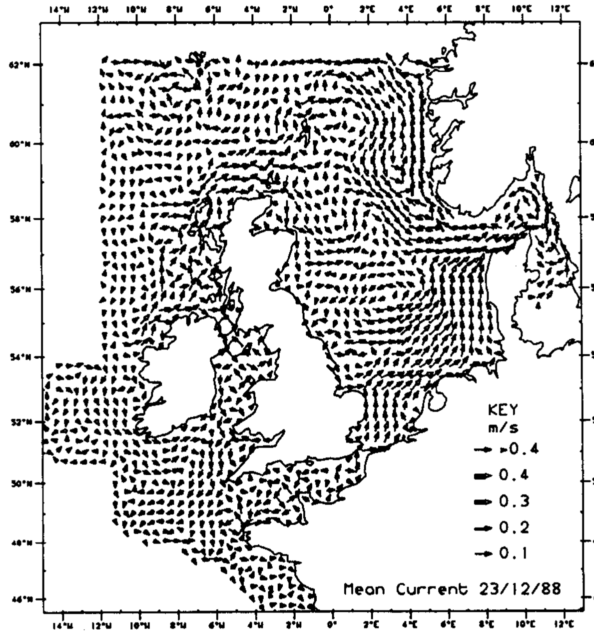
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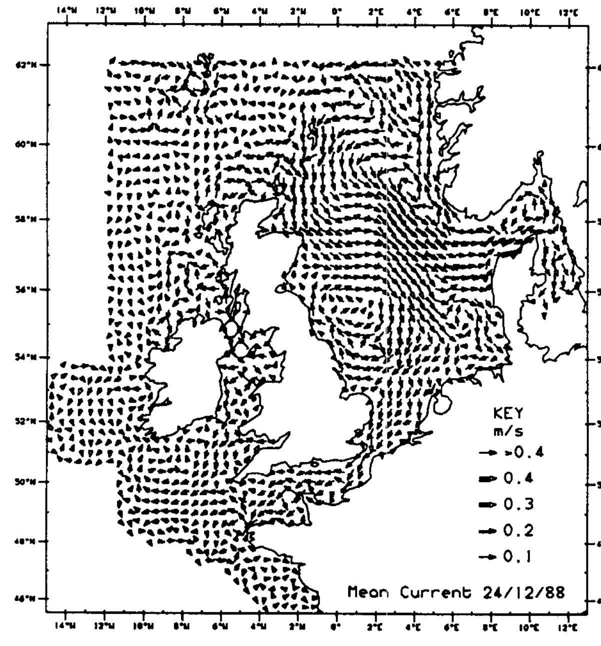
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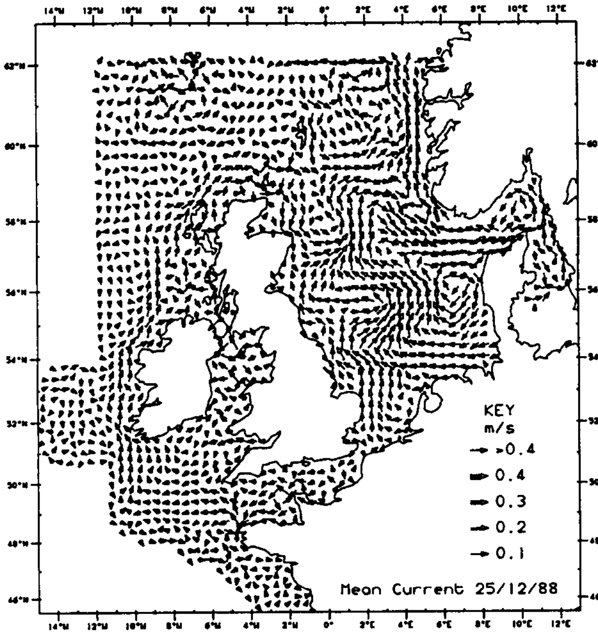
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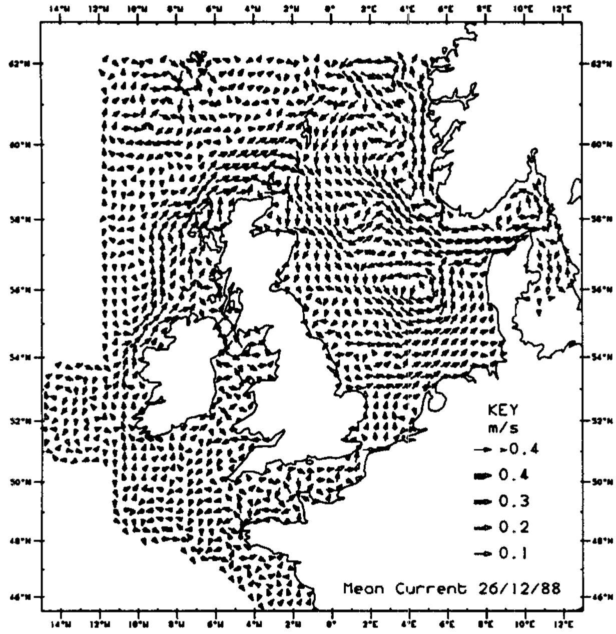
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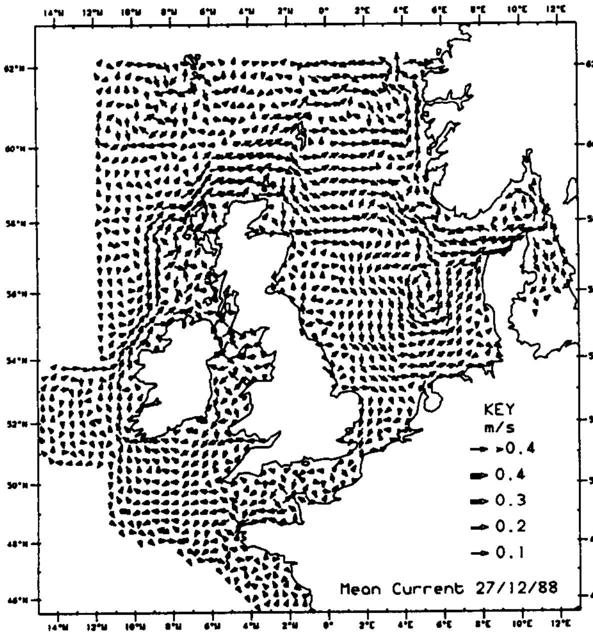
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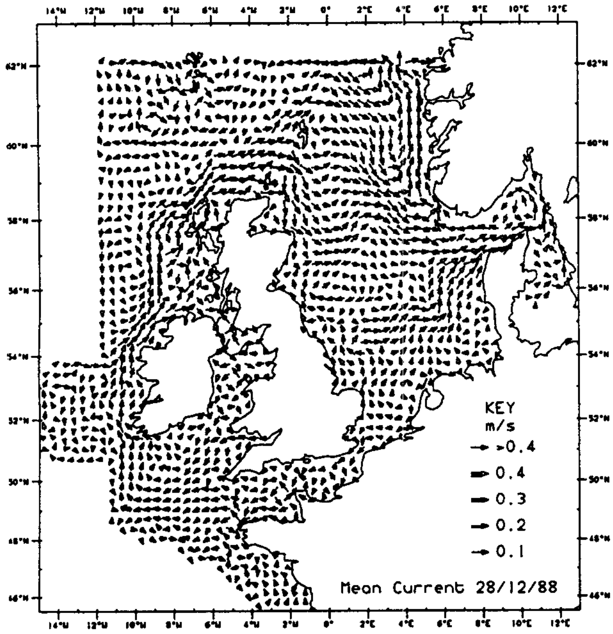
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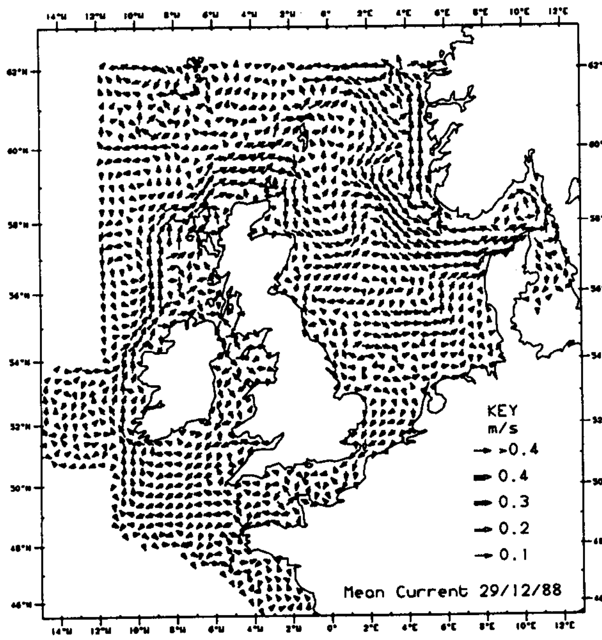
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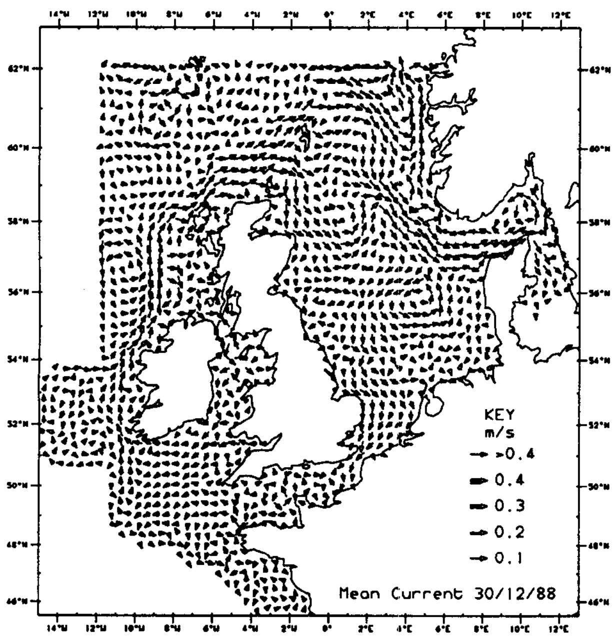
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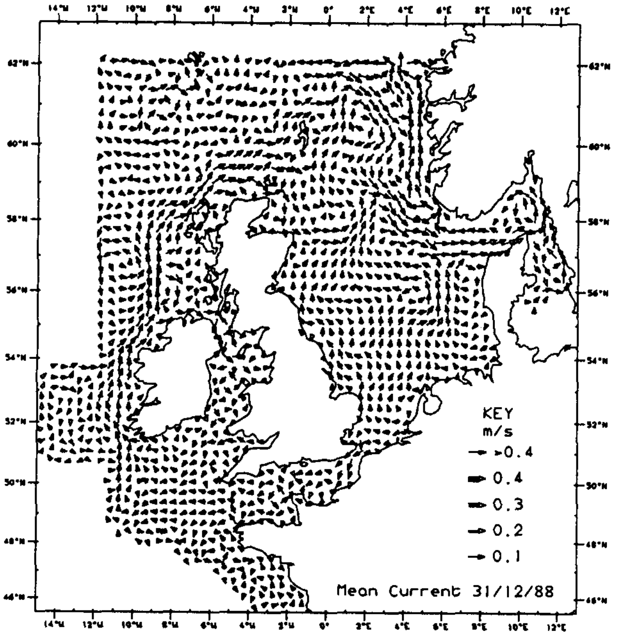
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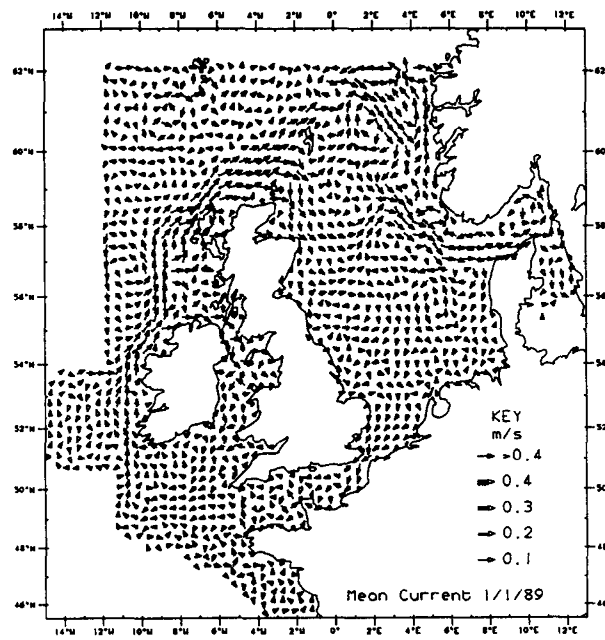
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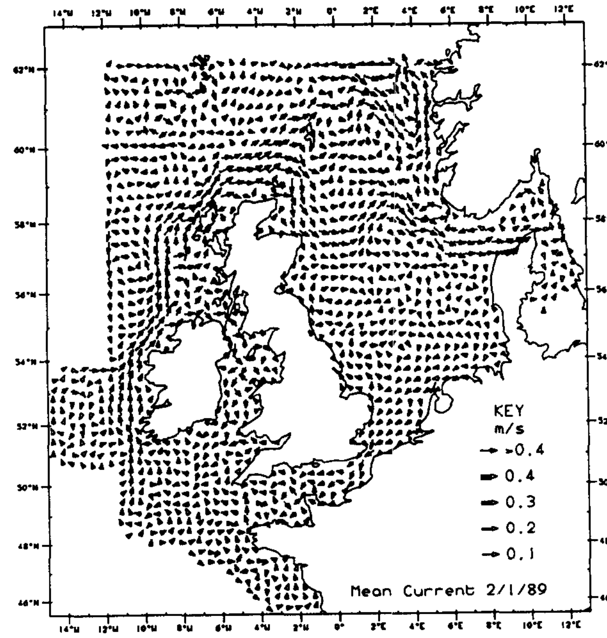
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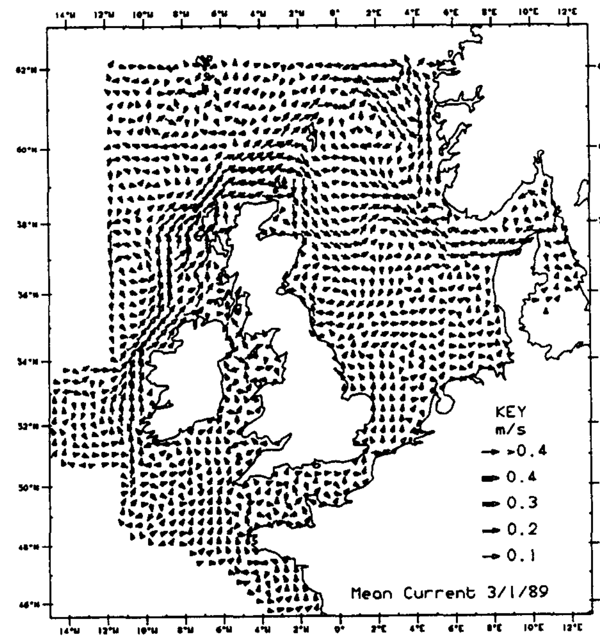
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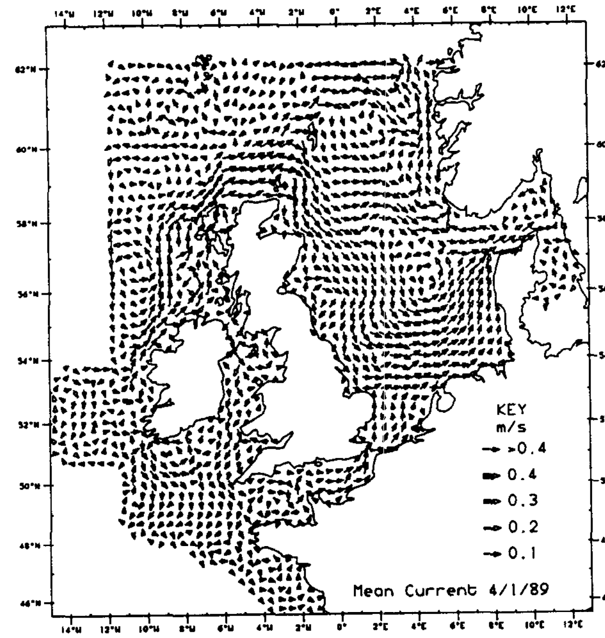
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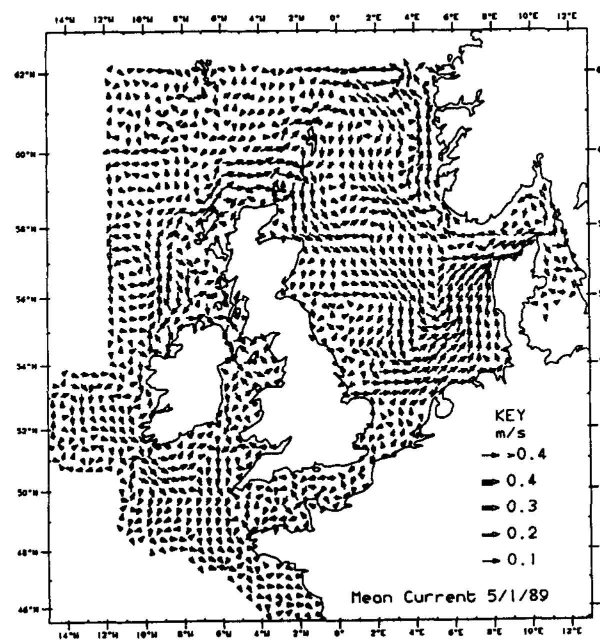
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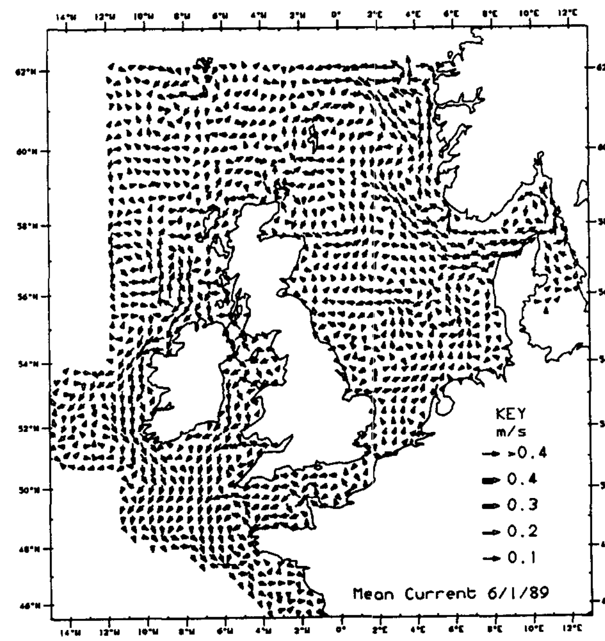
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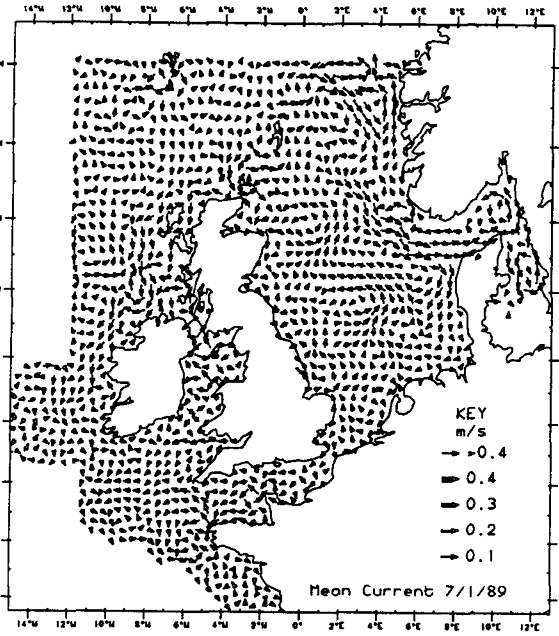
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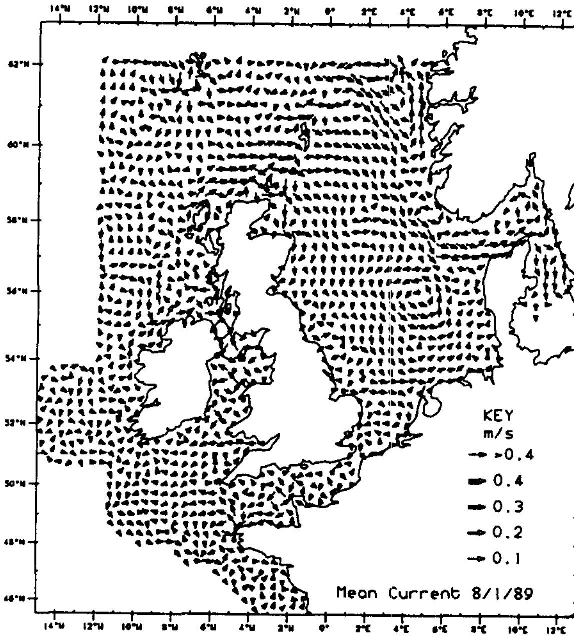
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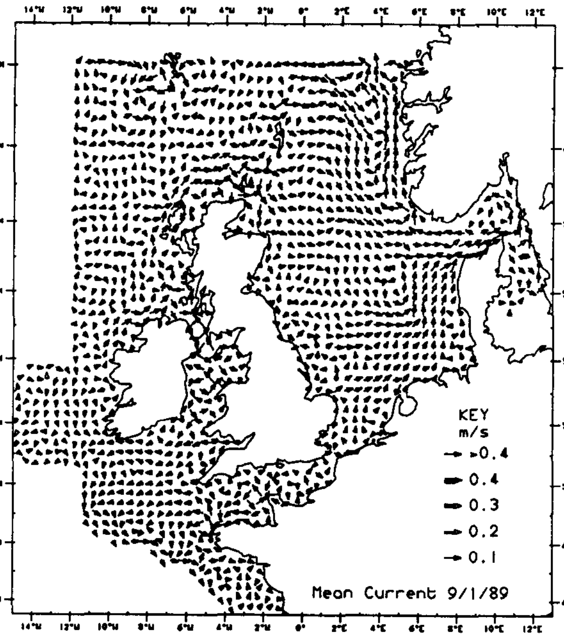
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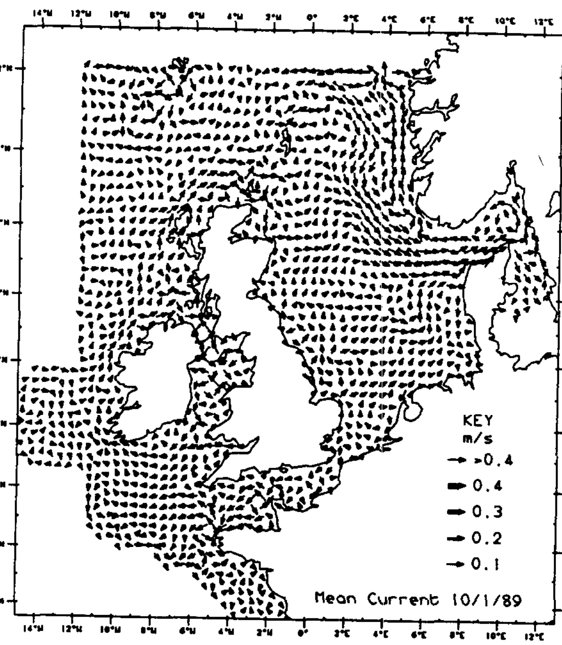
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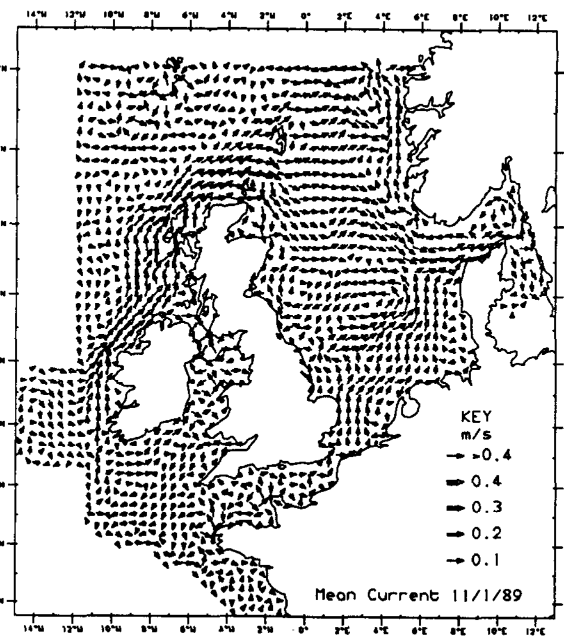
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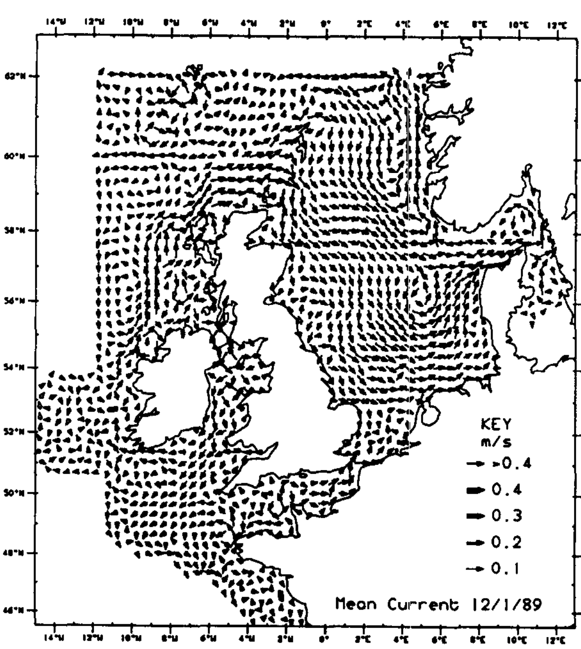
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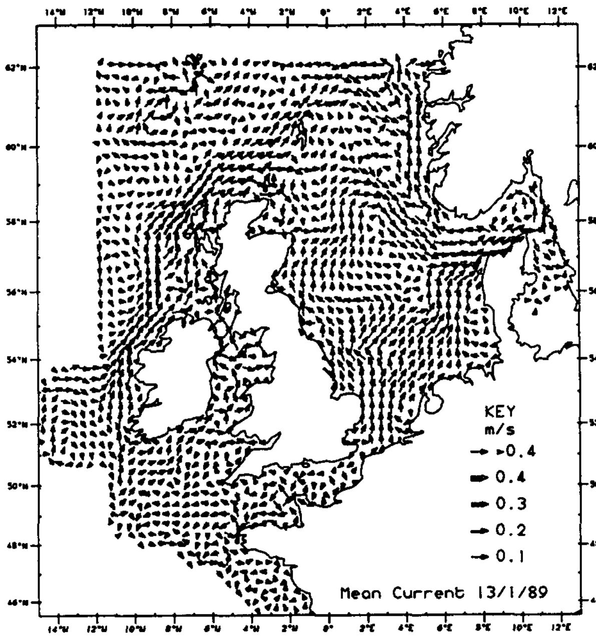
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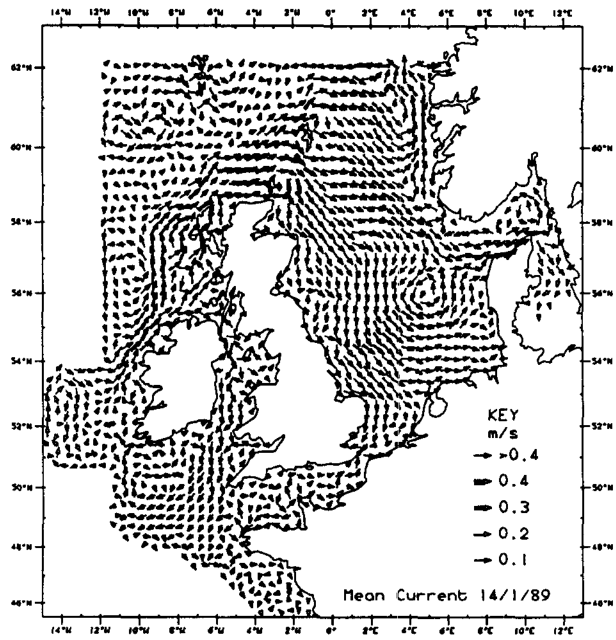
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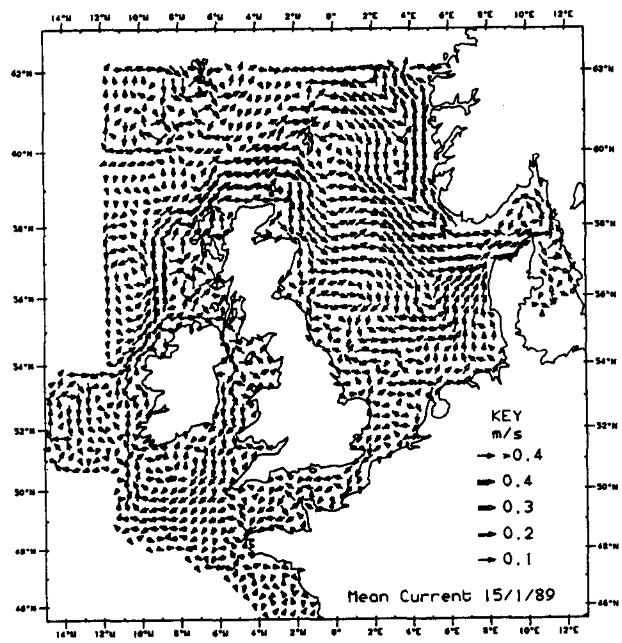
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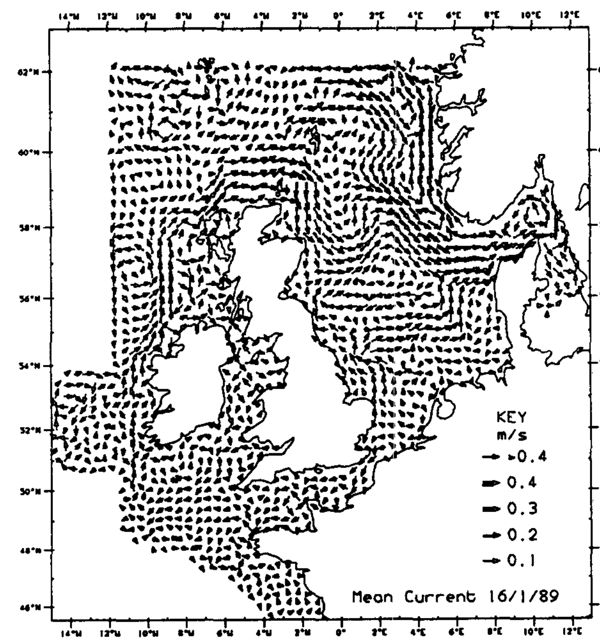
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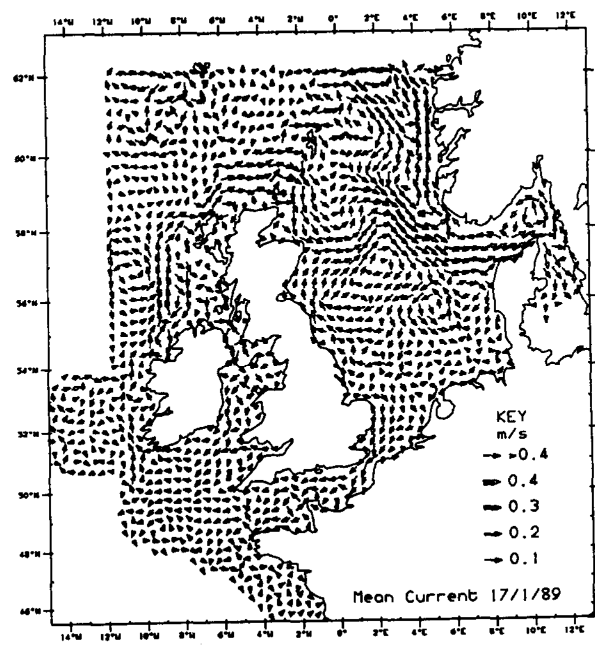
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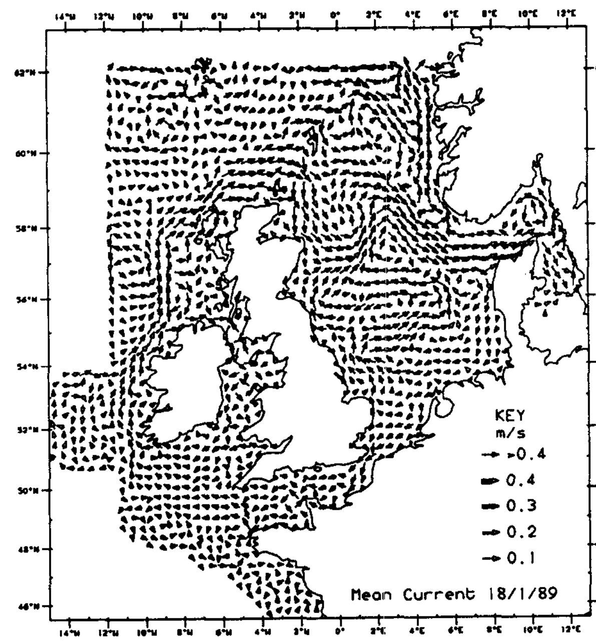
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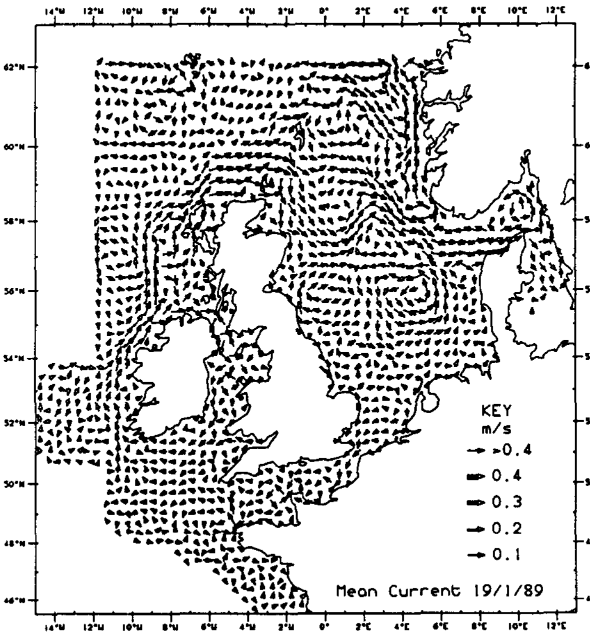
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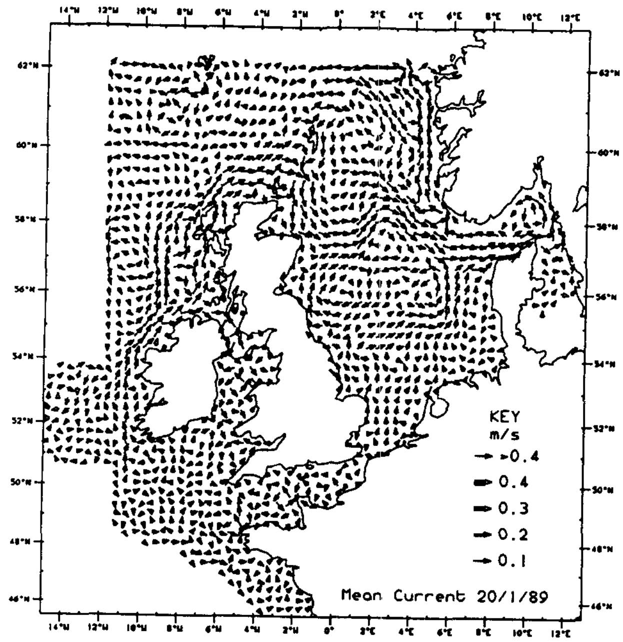
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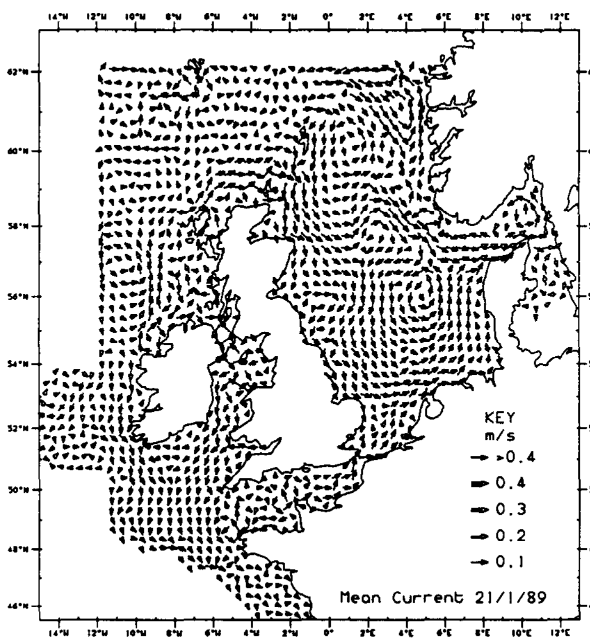
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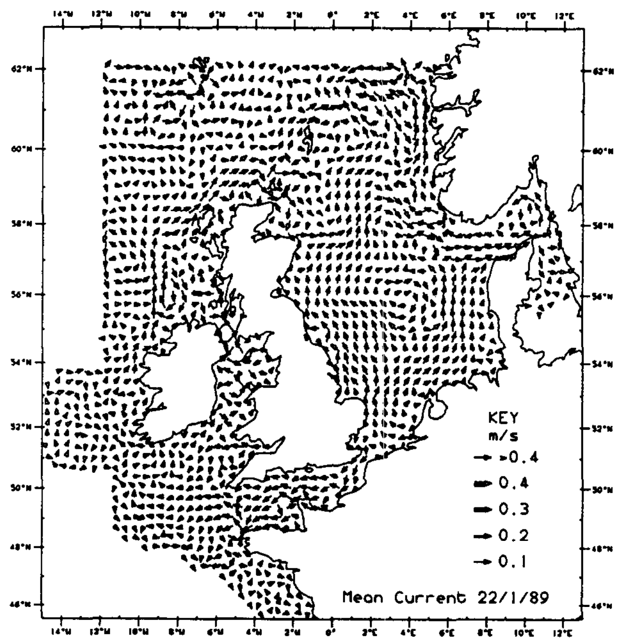
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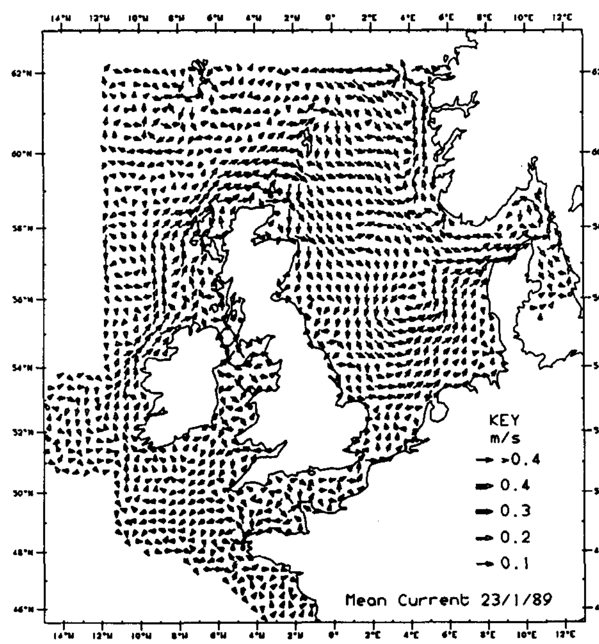
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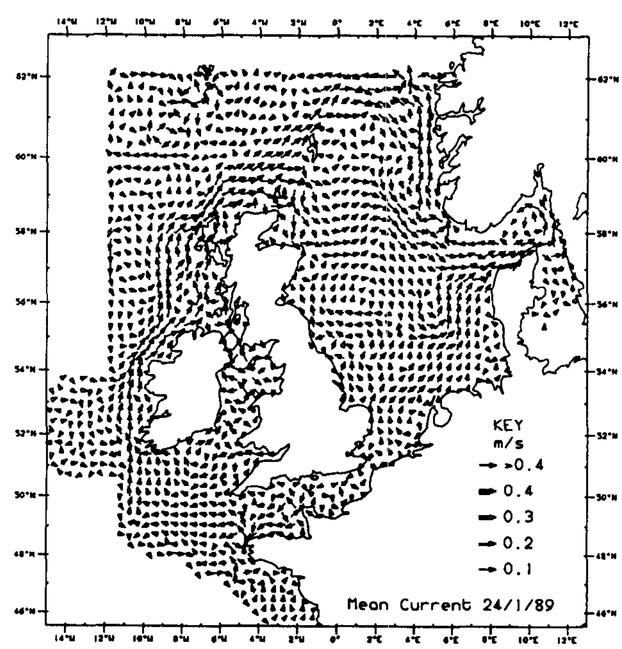
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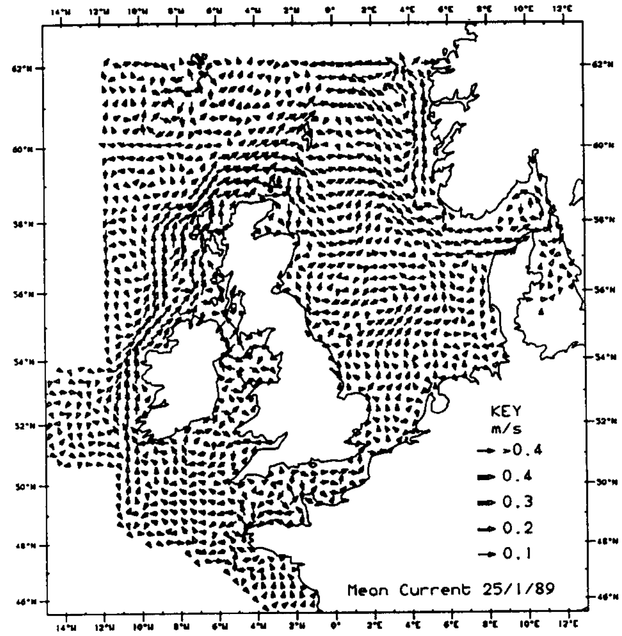
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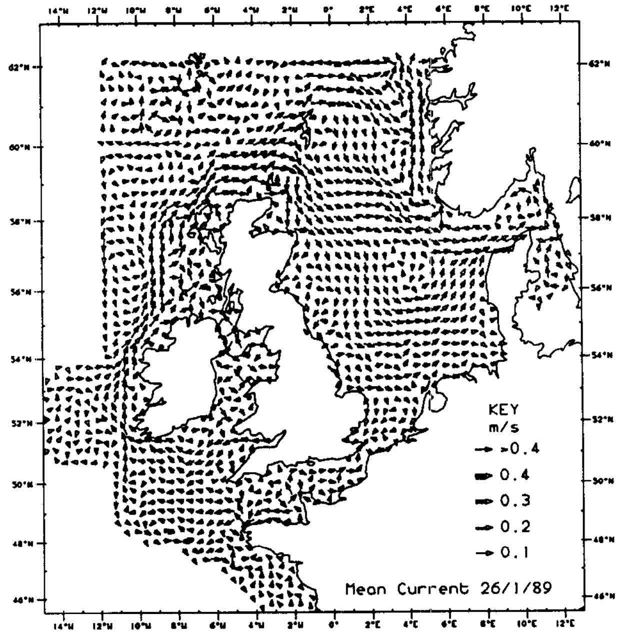
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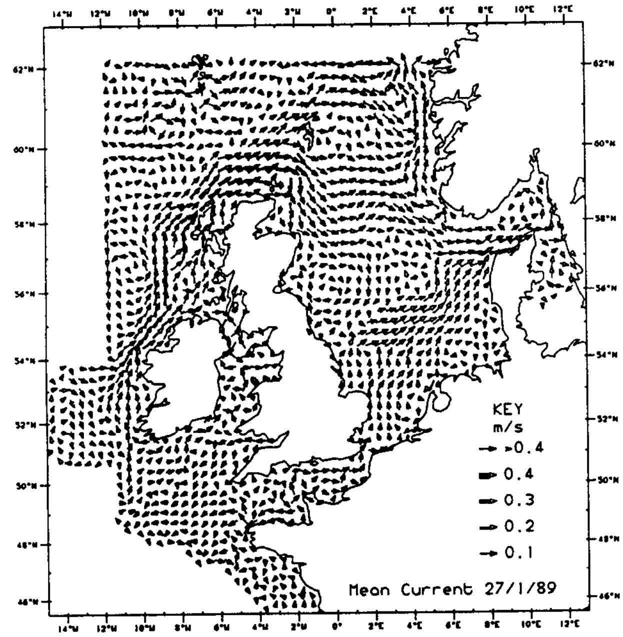
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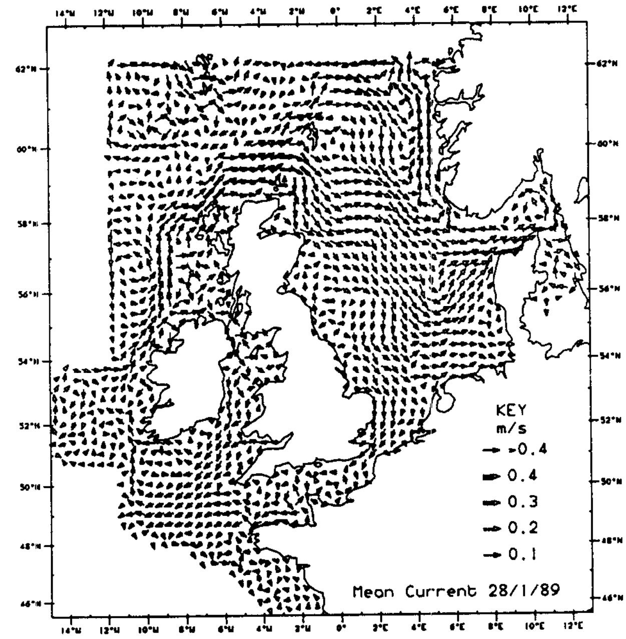
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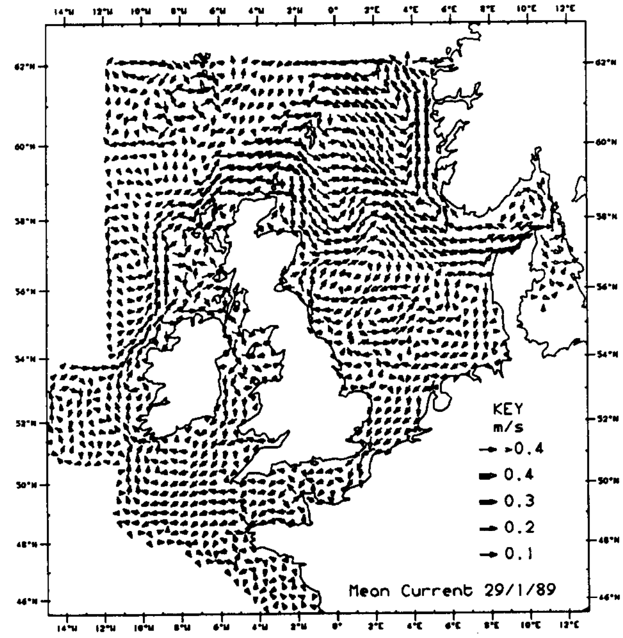
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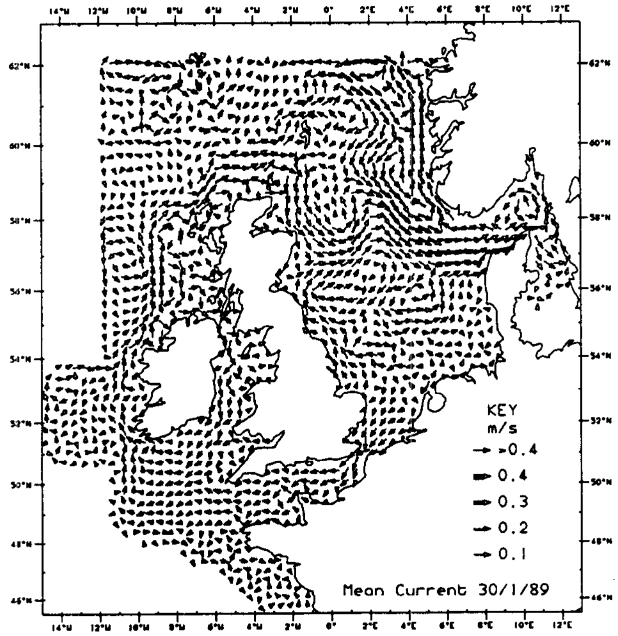
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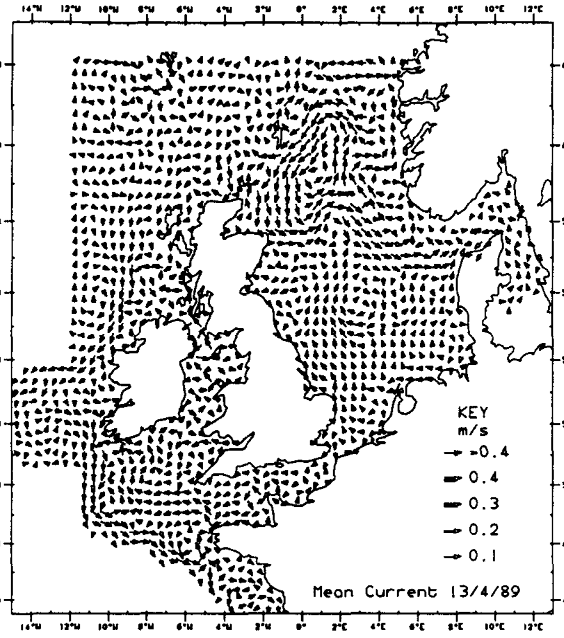
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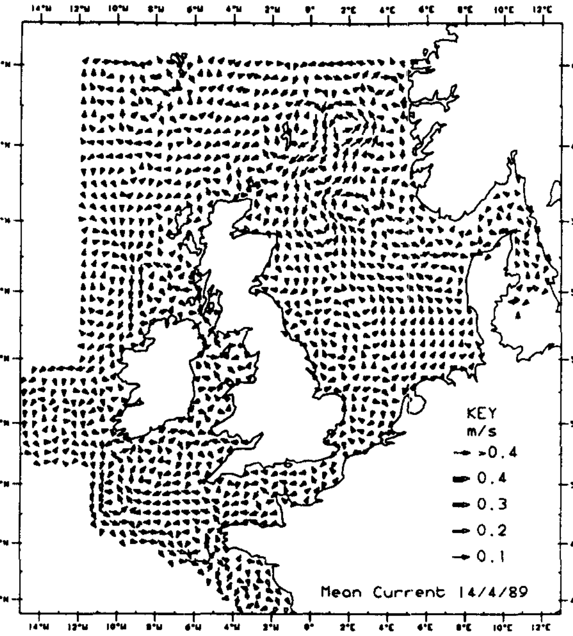
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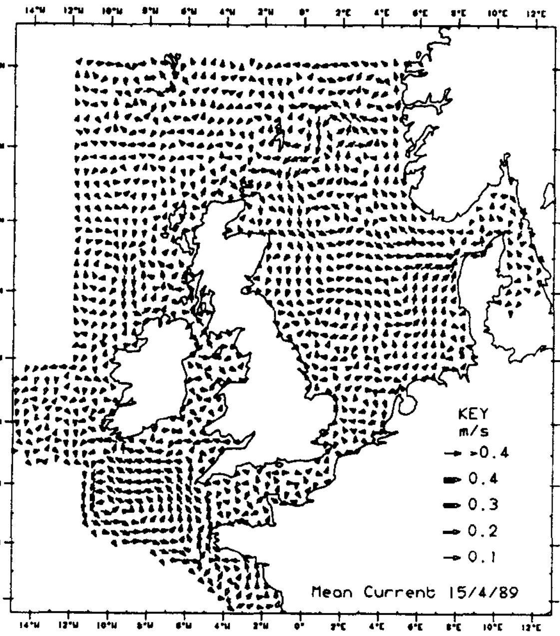
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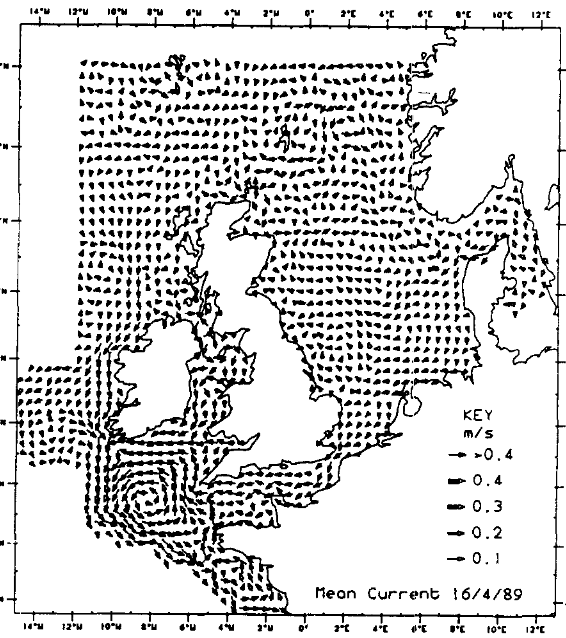
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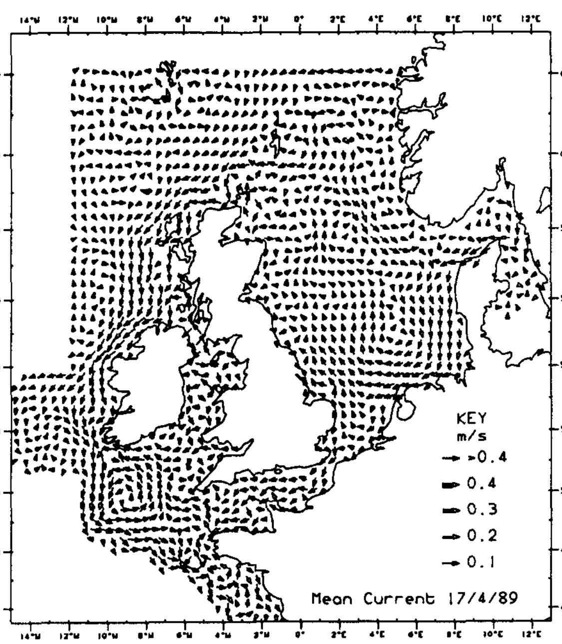
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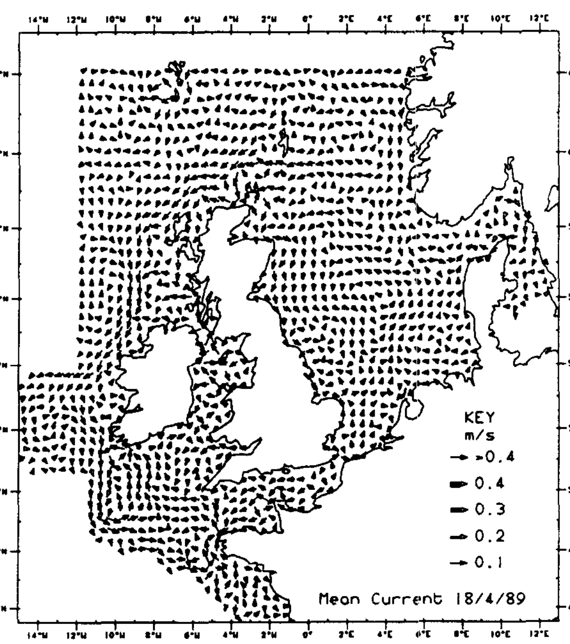
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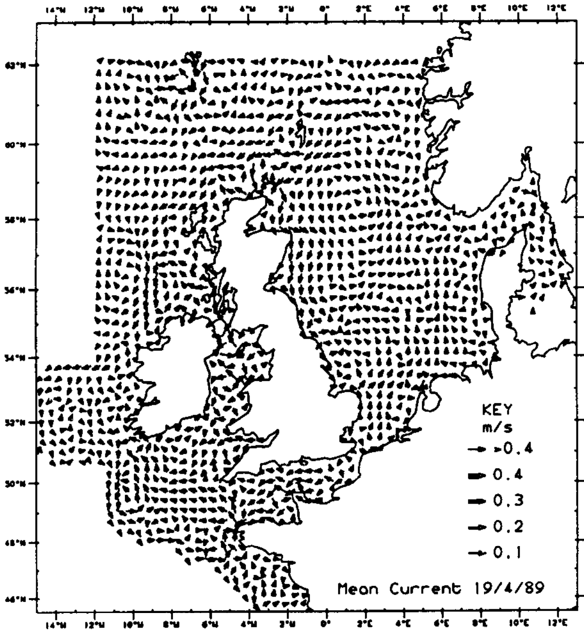
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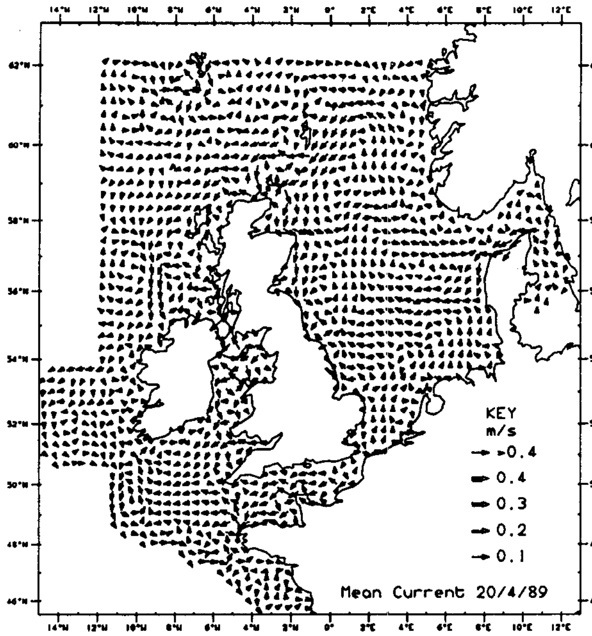
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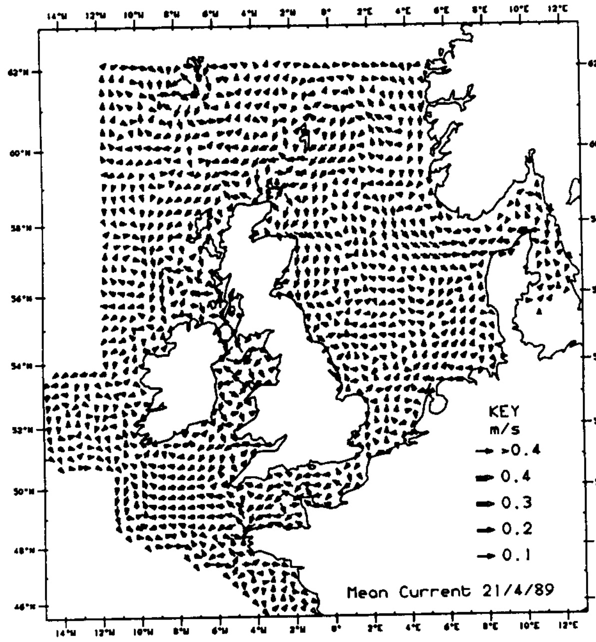
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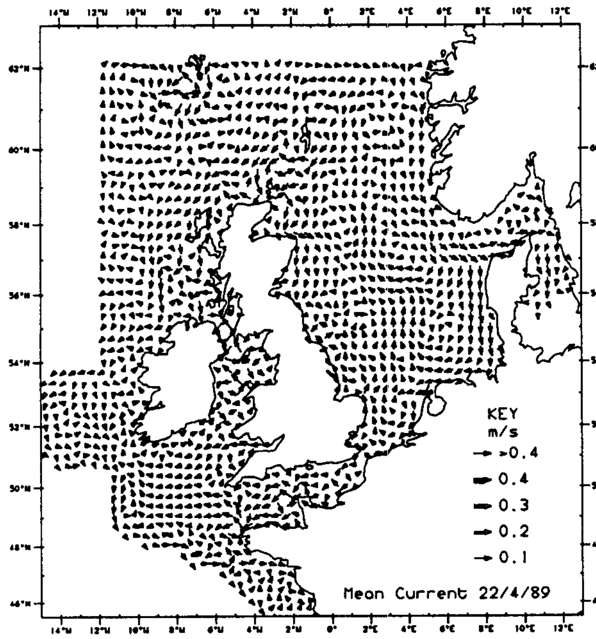
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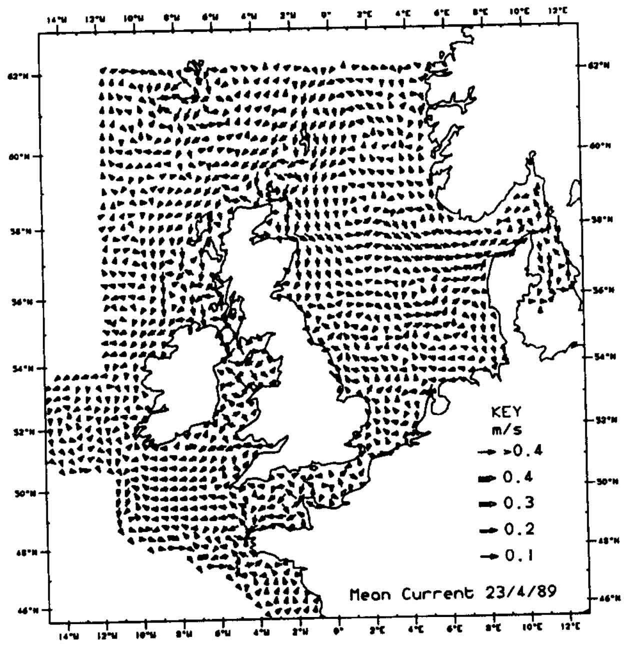
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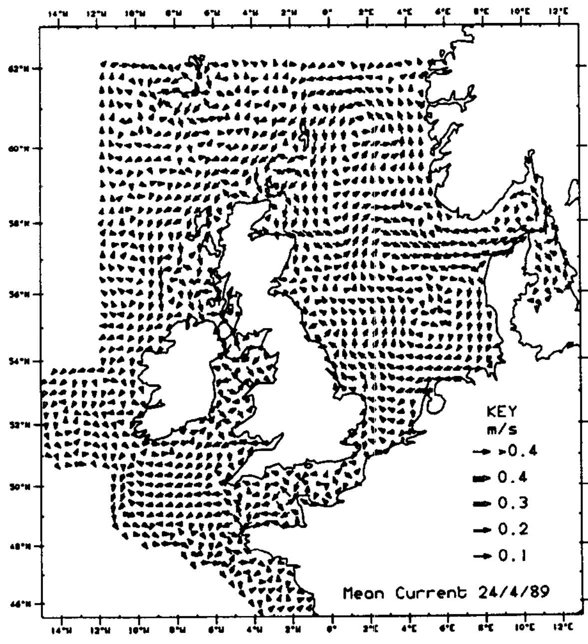
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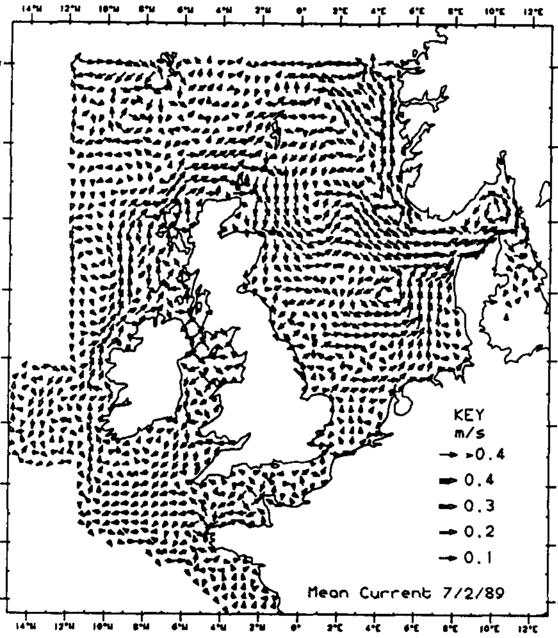
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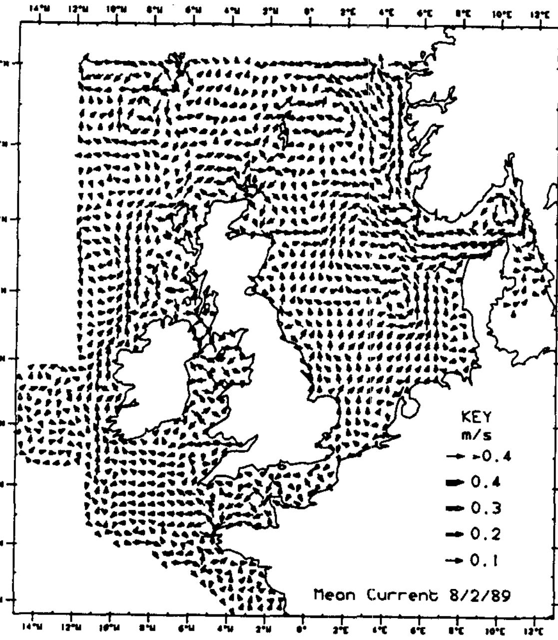
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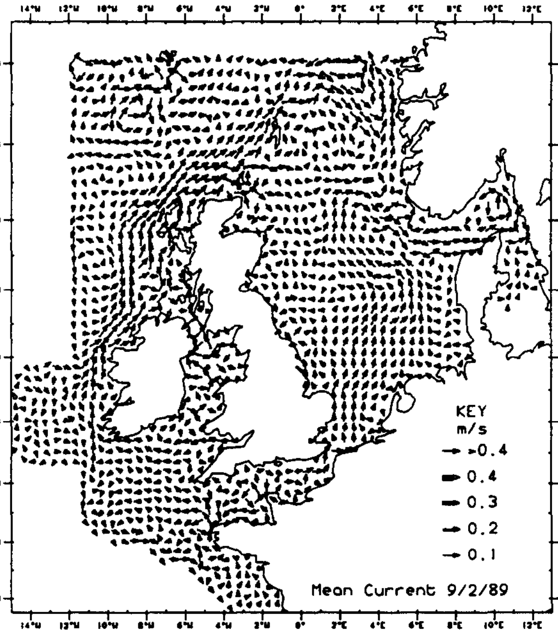
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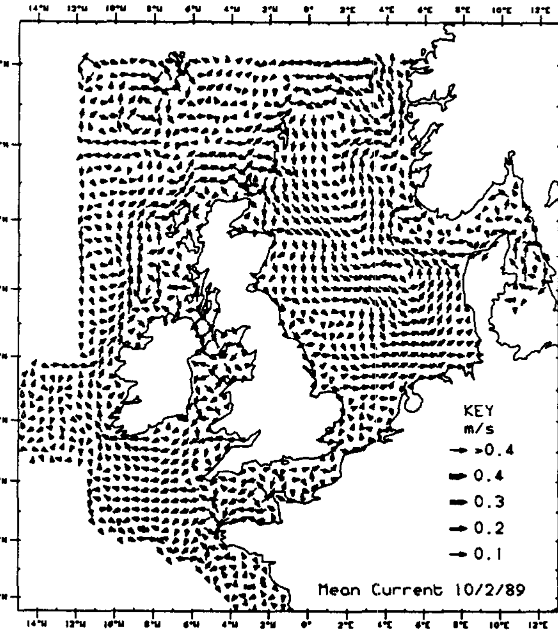
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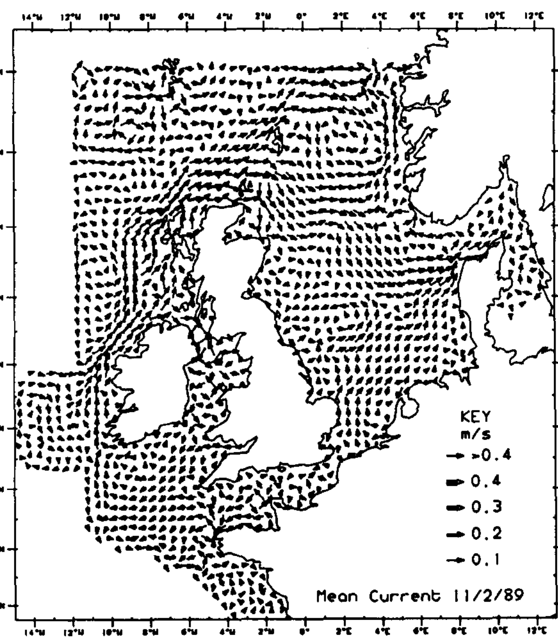
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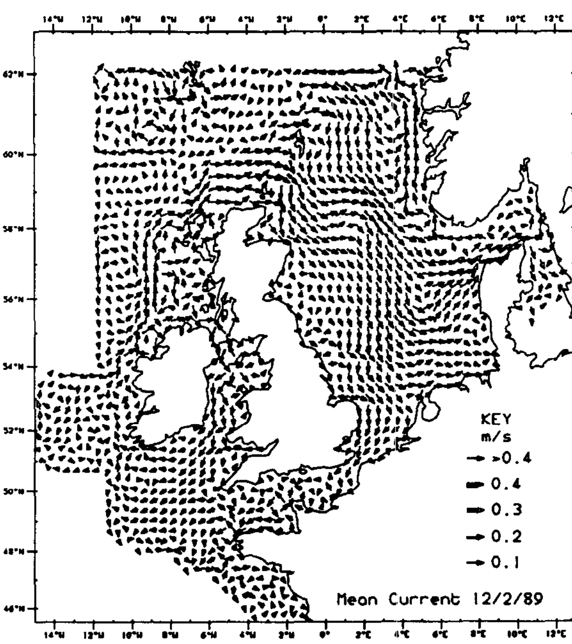
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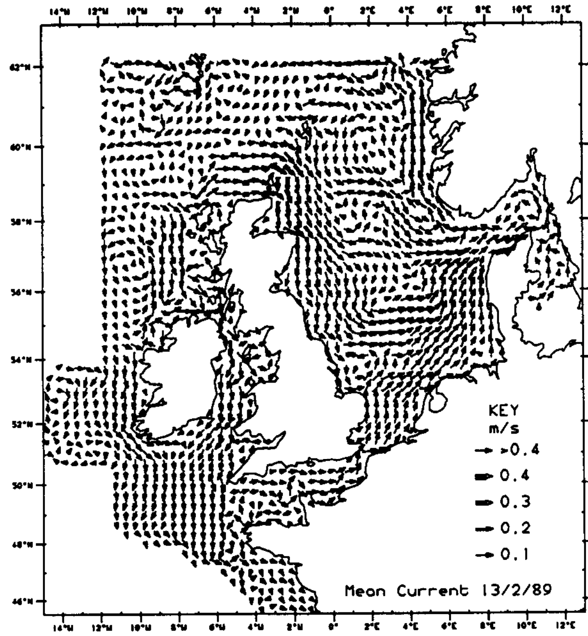
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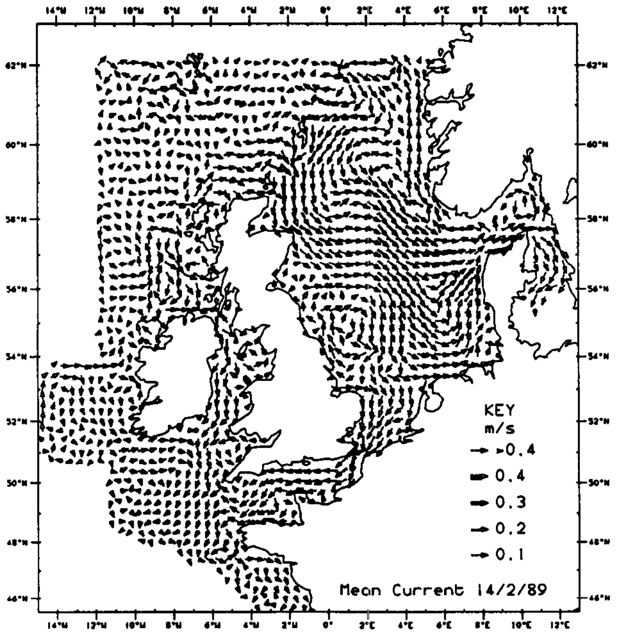
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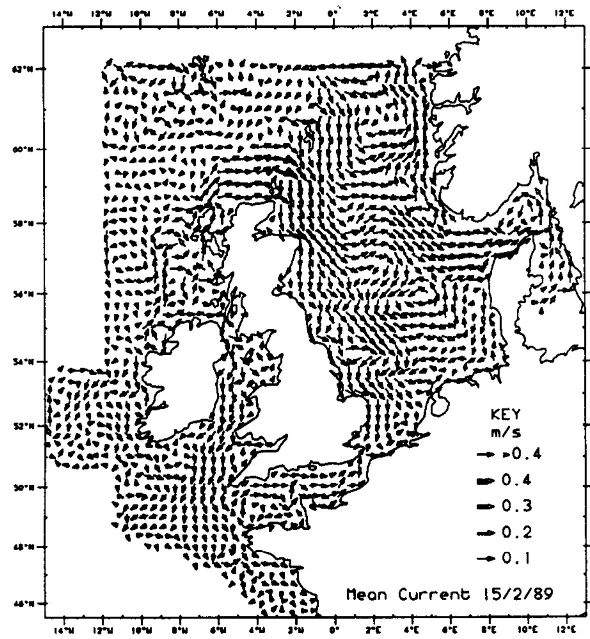
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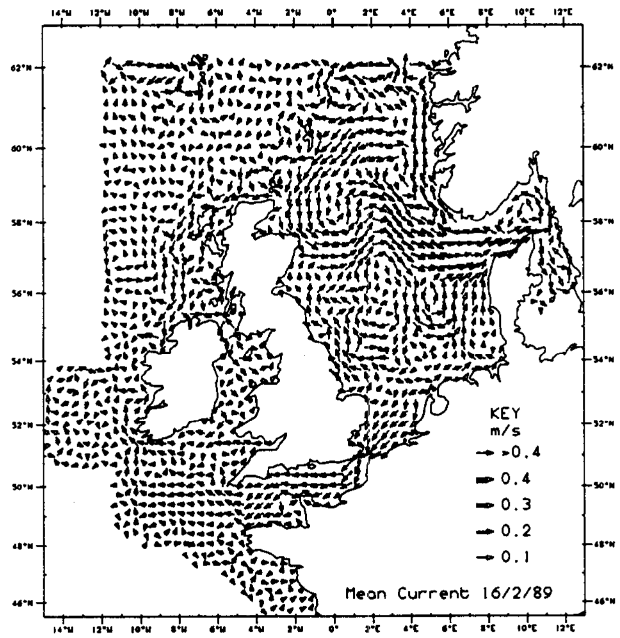
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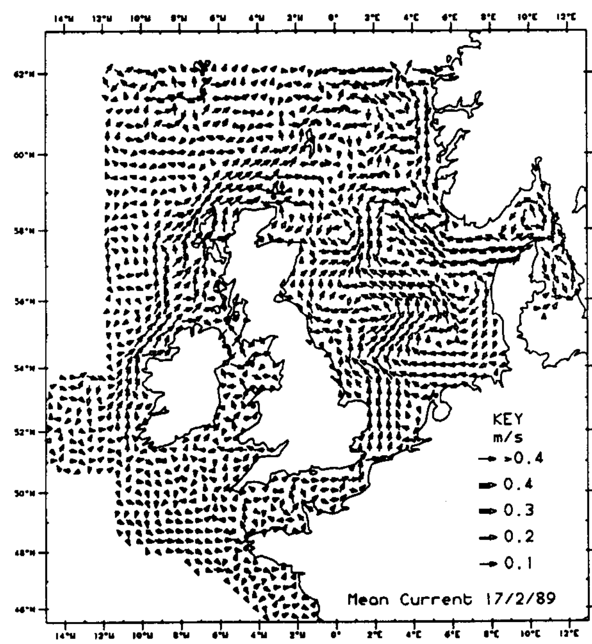
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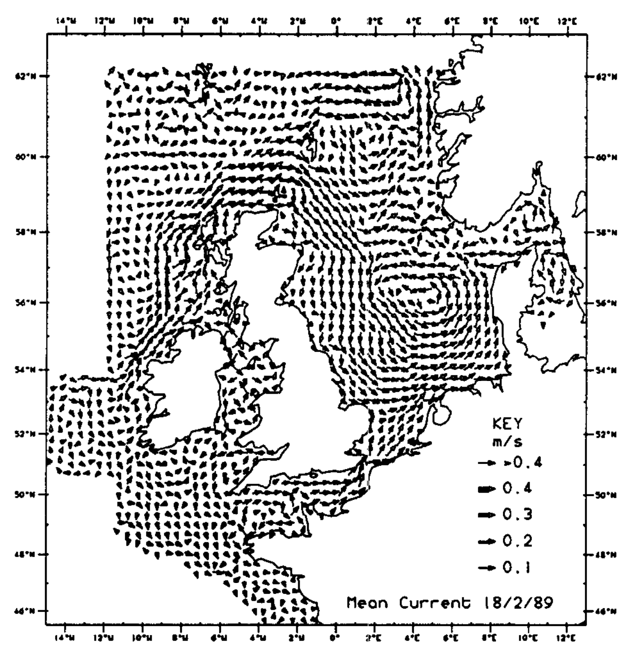
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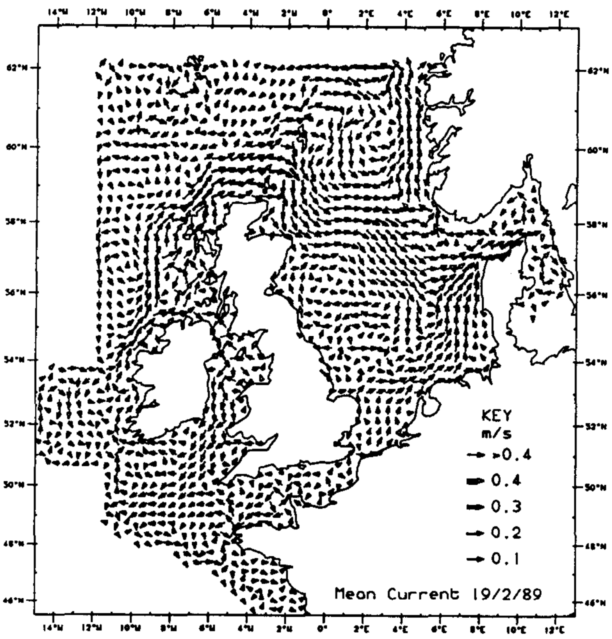
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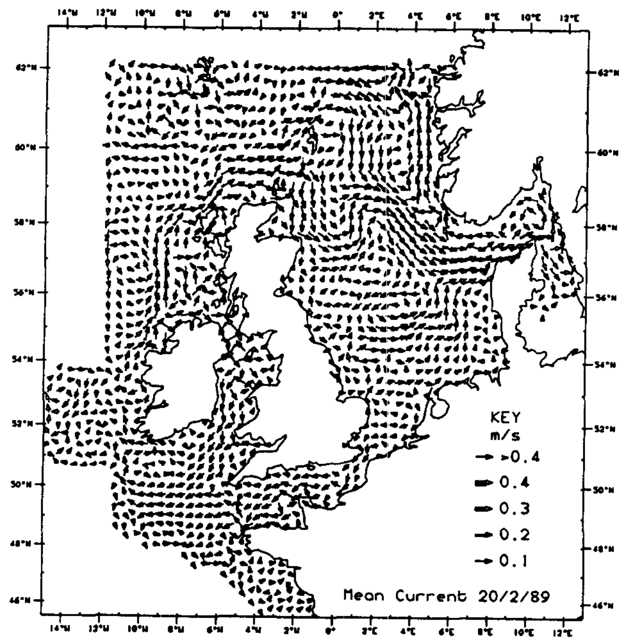
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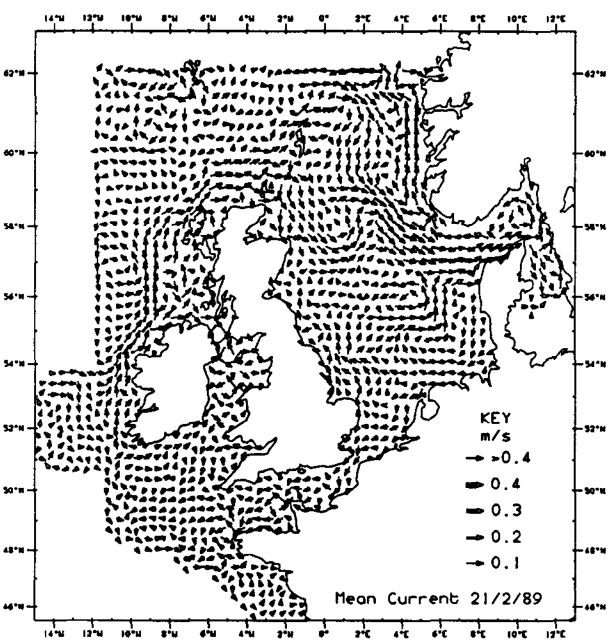
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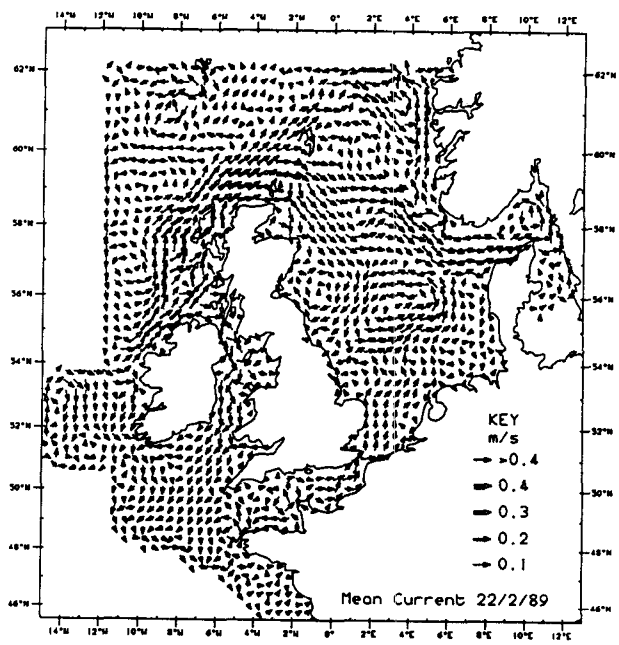
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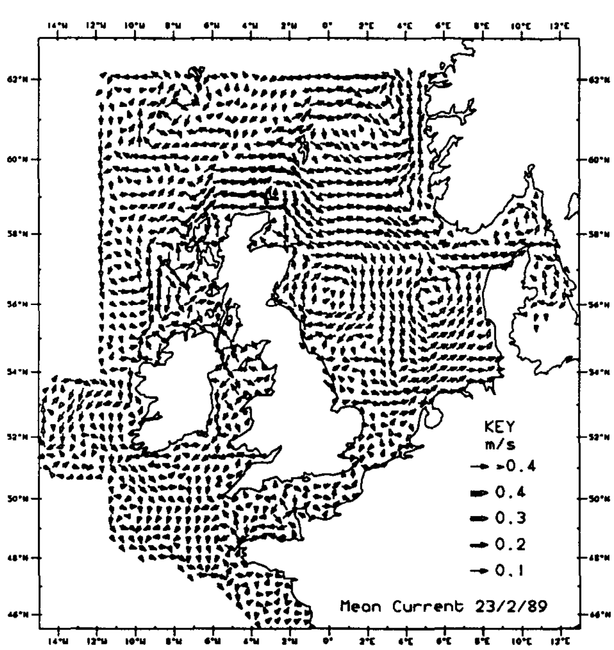
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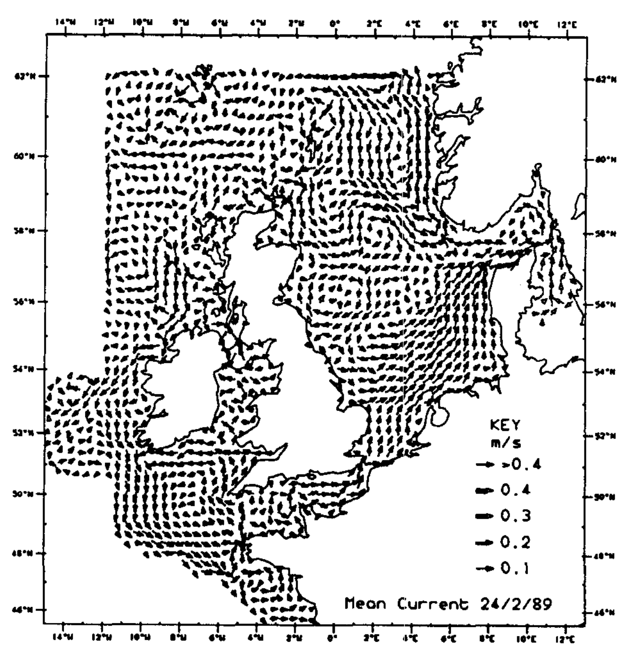
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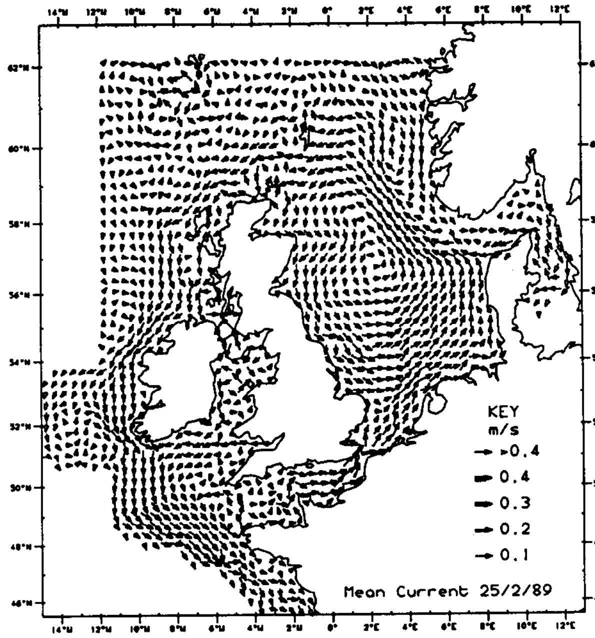
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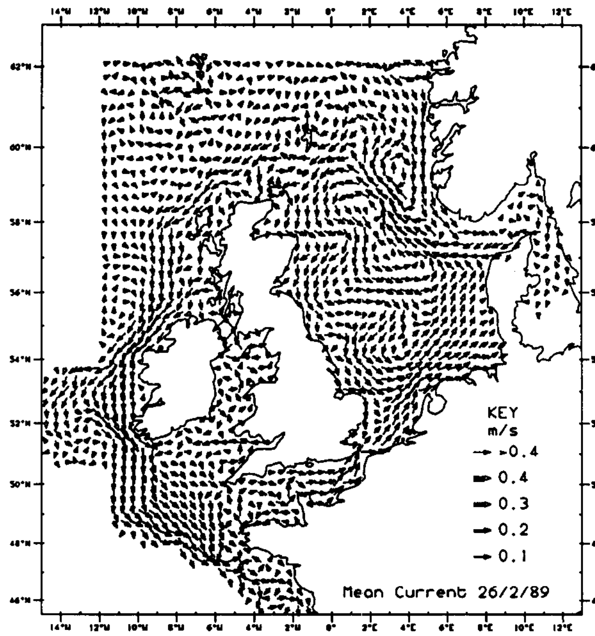
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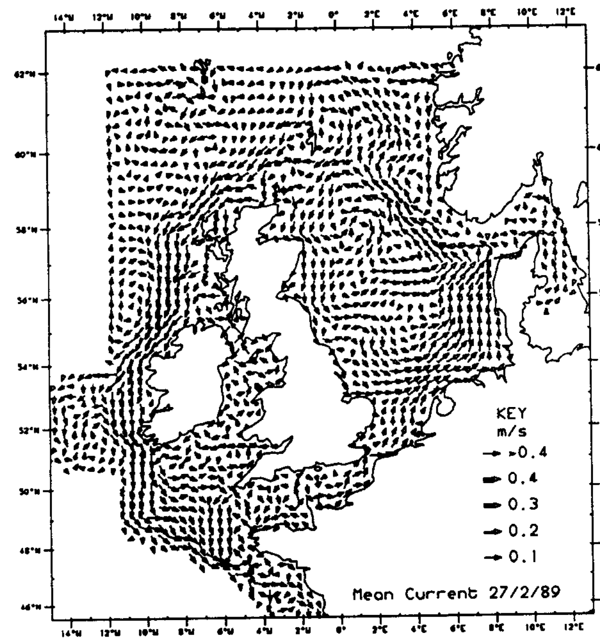
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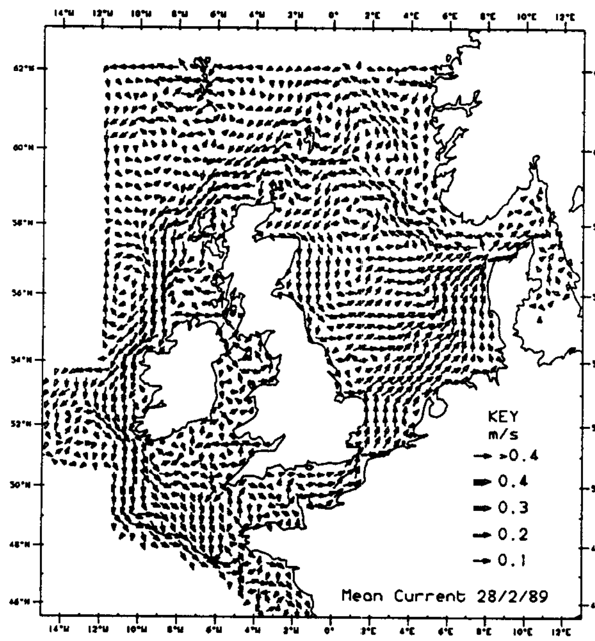
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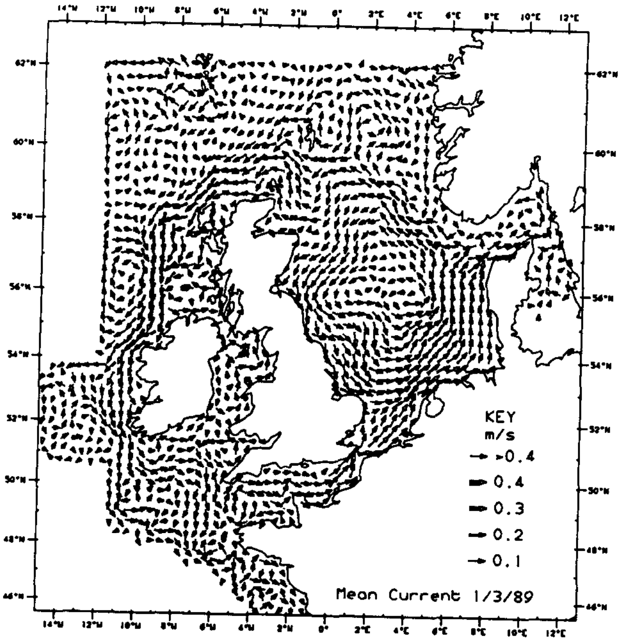
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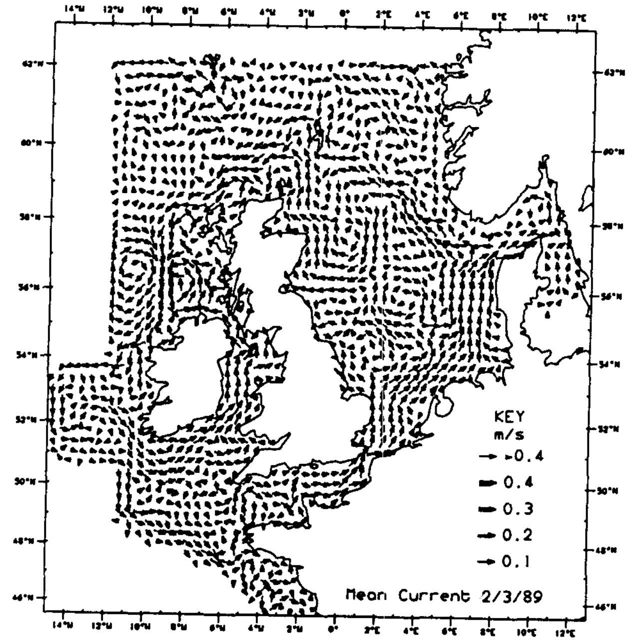
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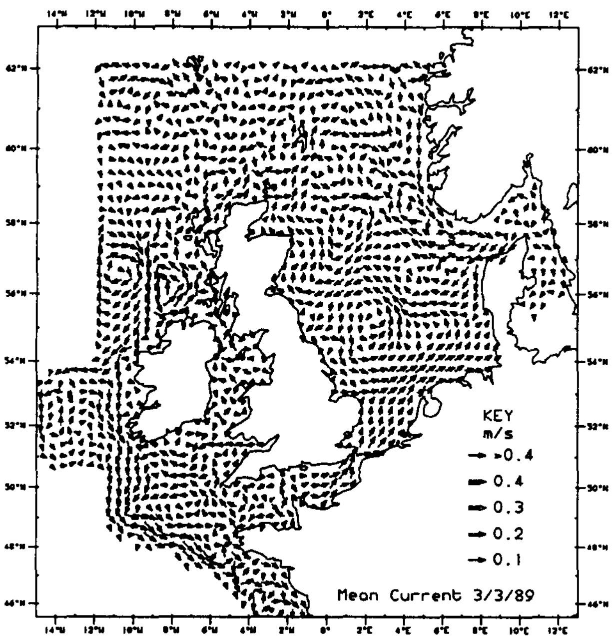
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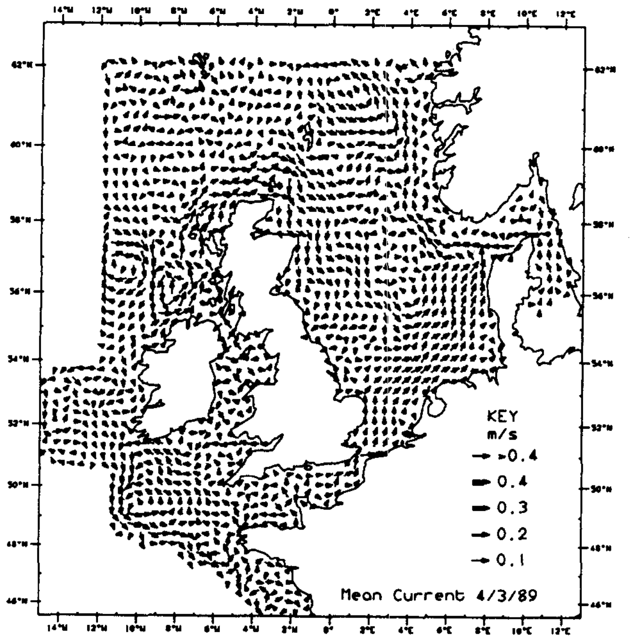
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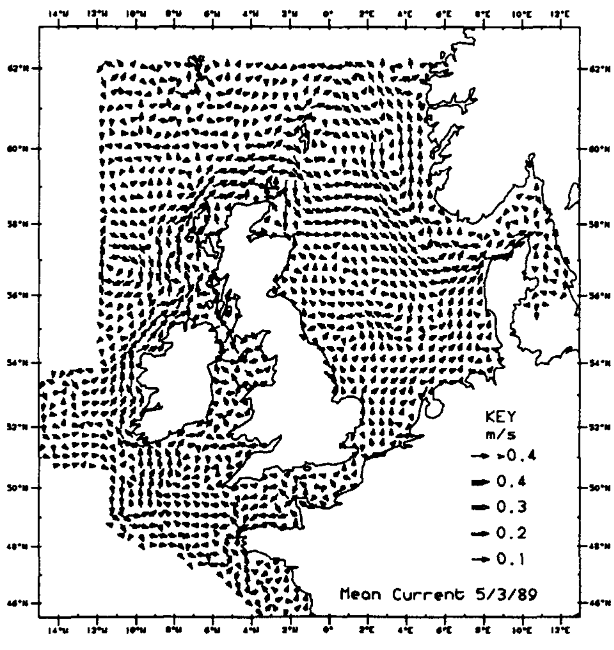
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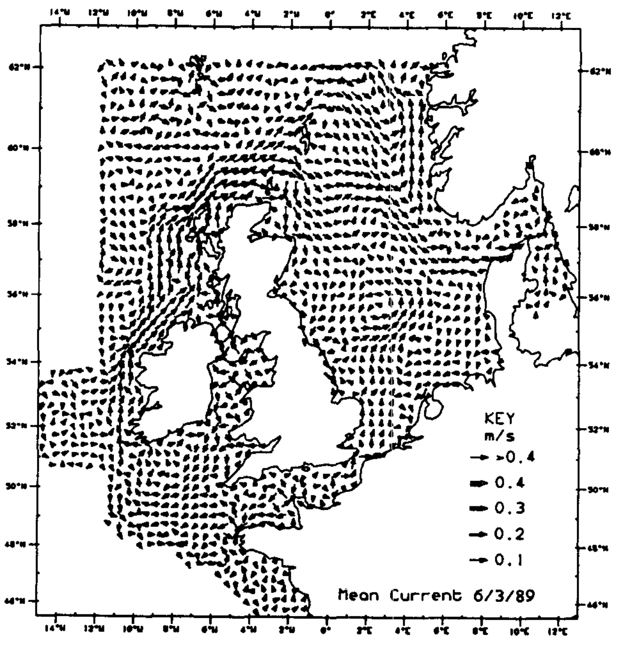
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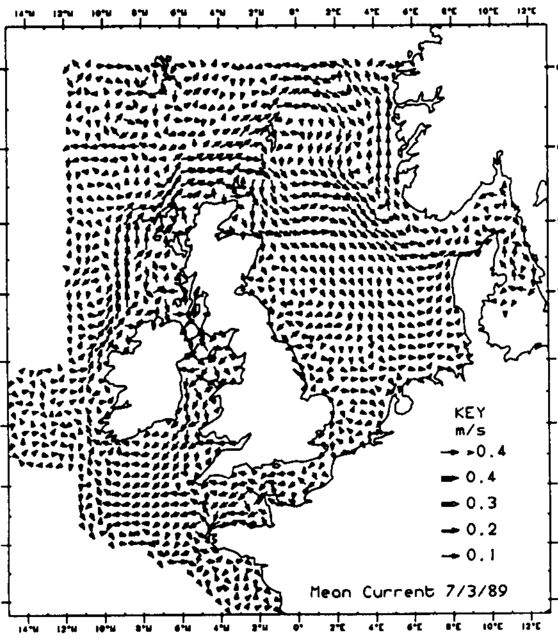
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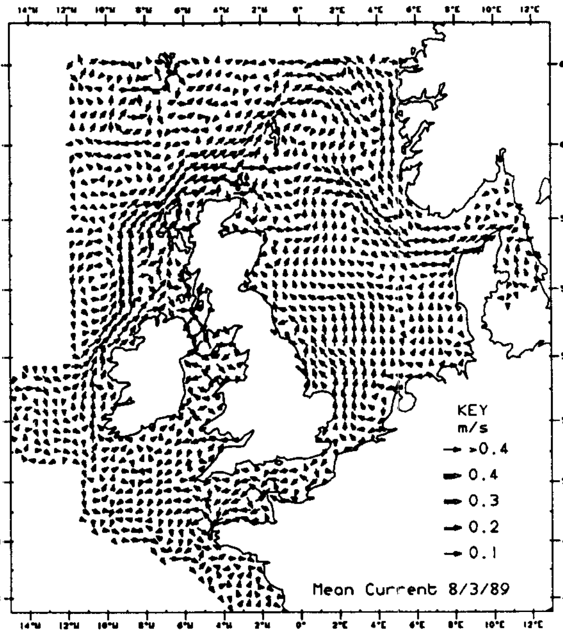
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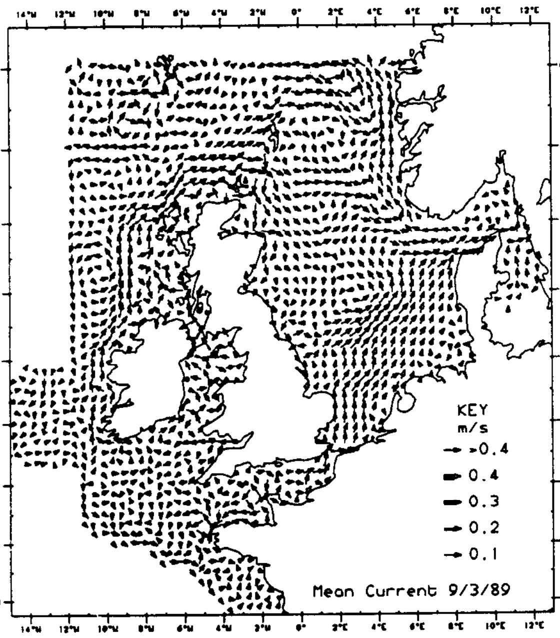
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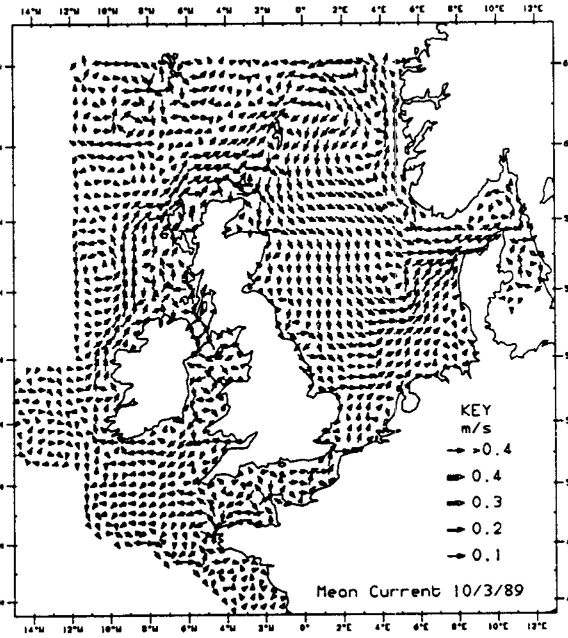
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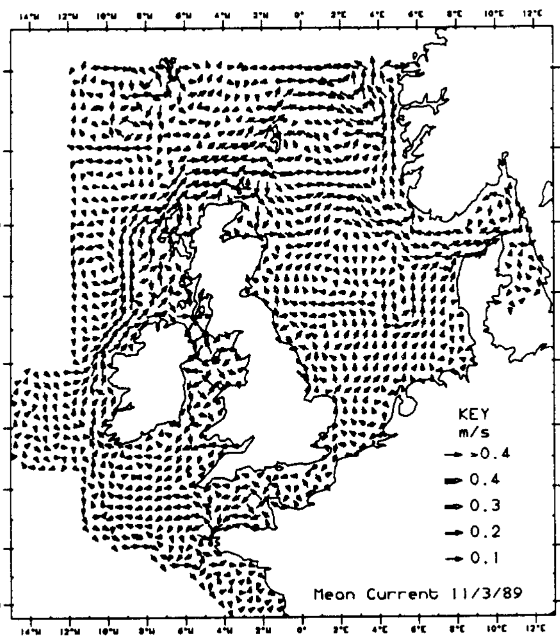
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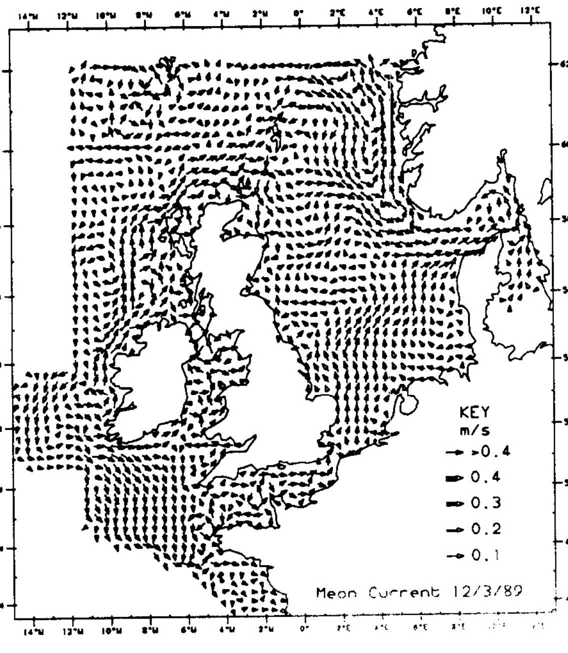
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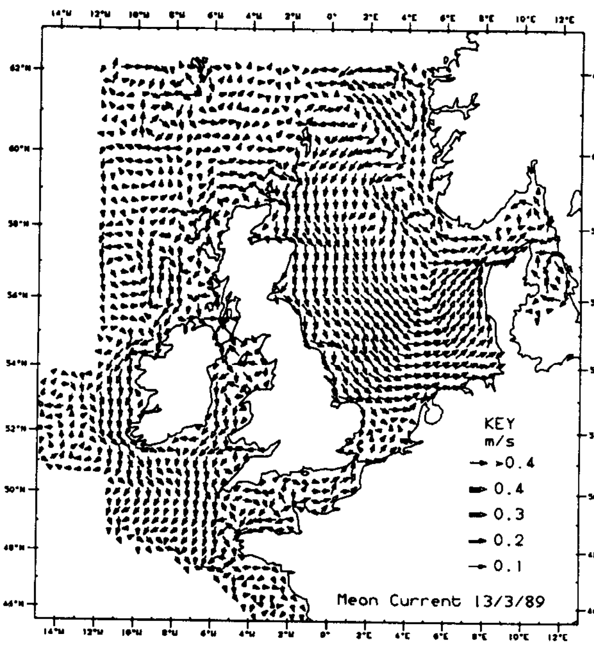
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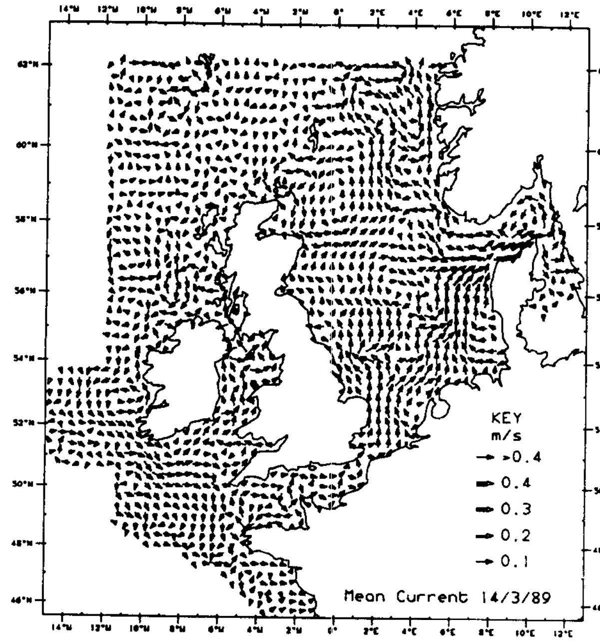
Mean Current 13/3/89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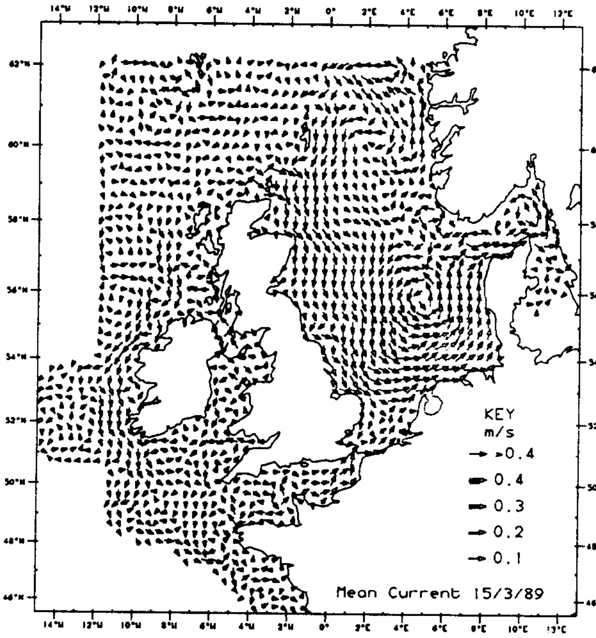
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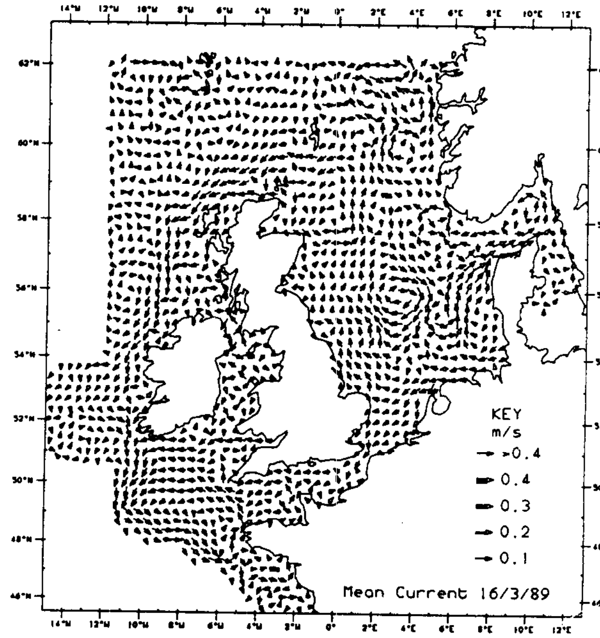
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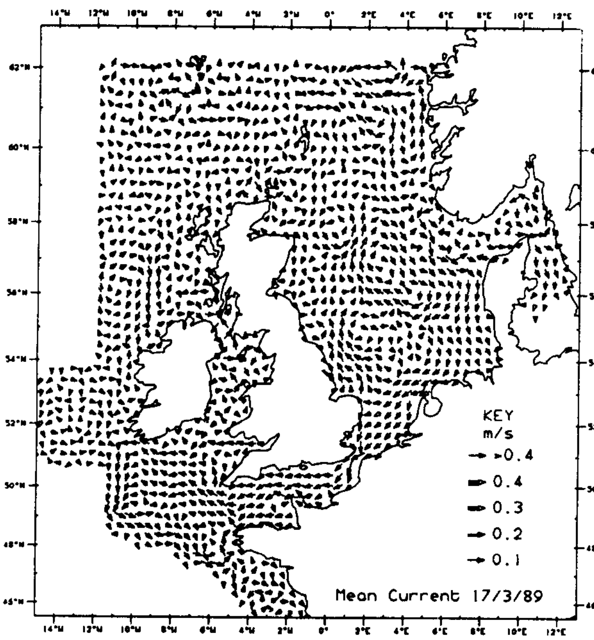
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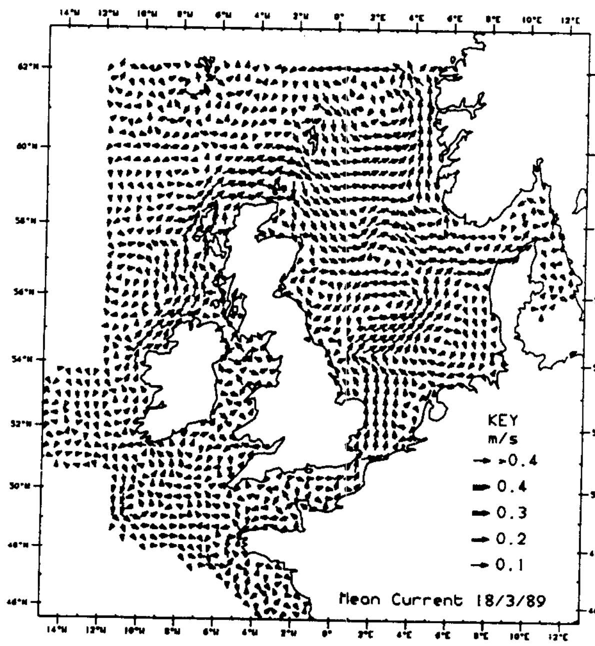
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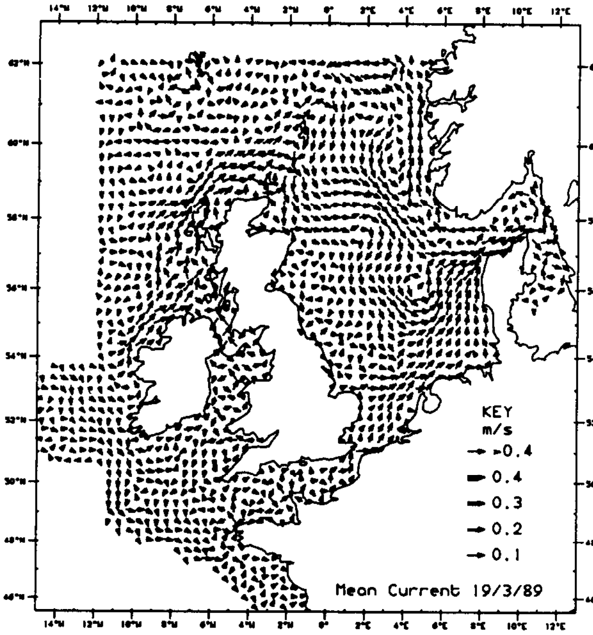
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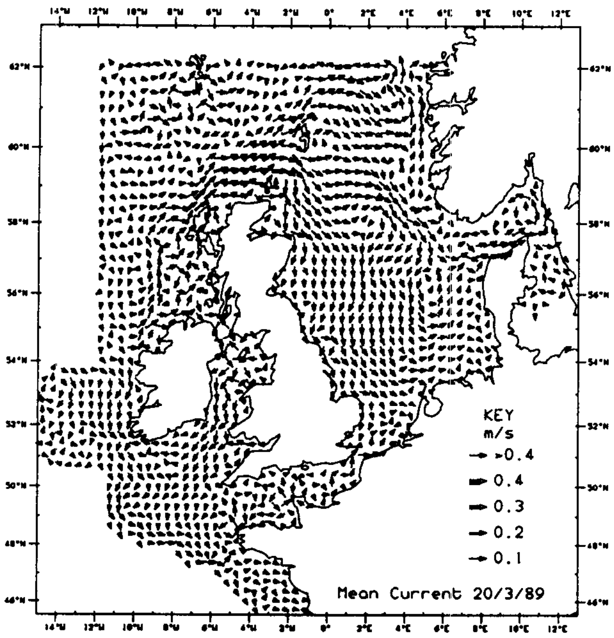
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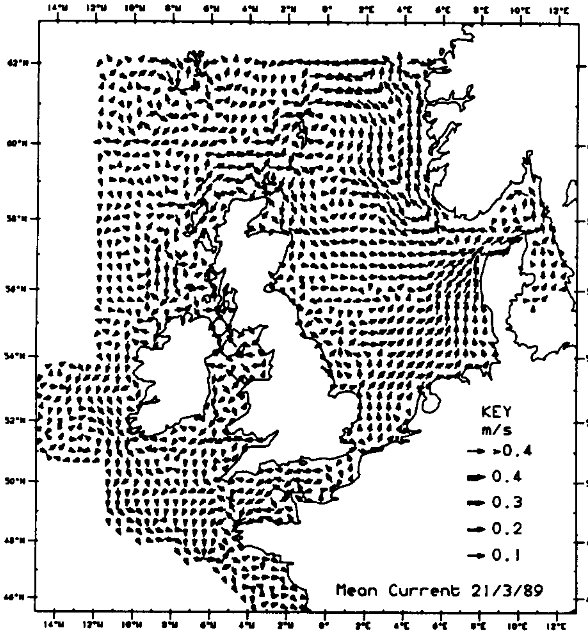
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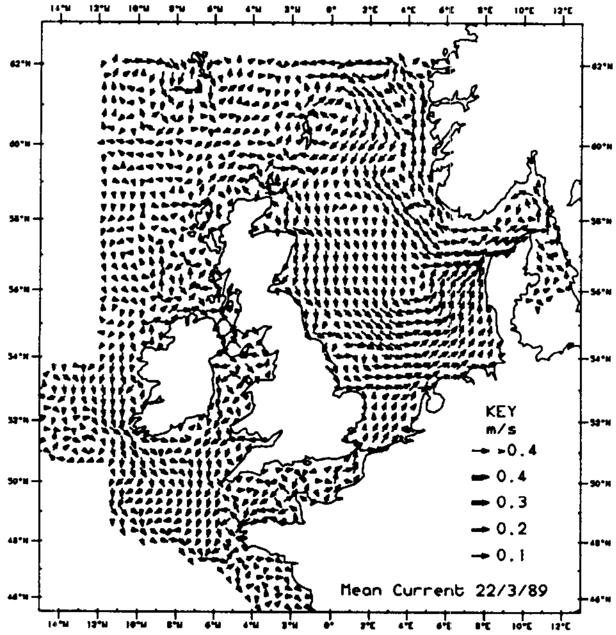
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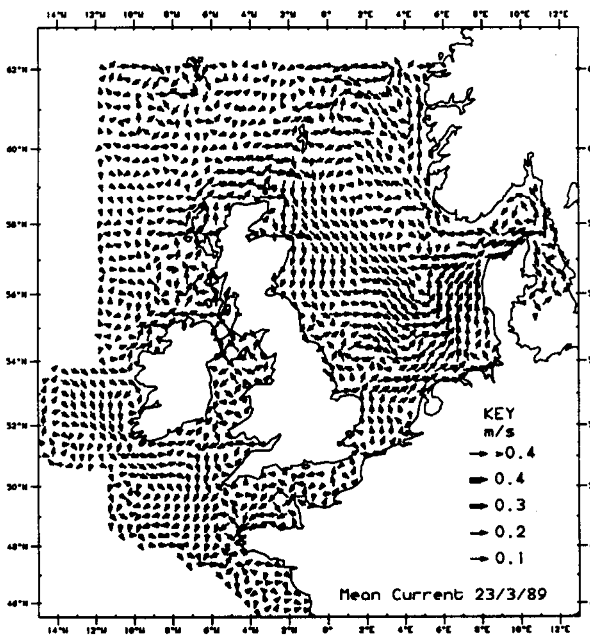
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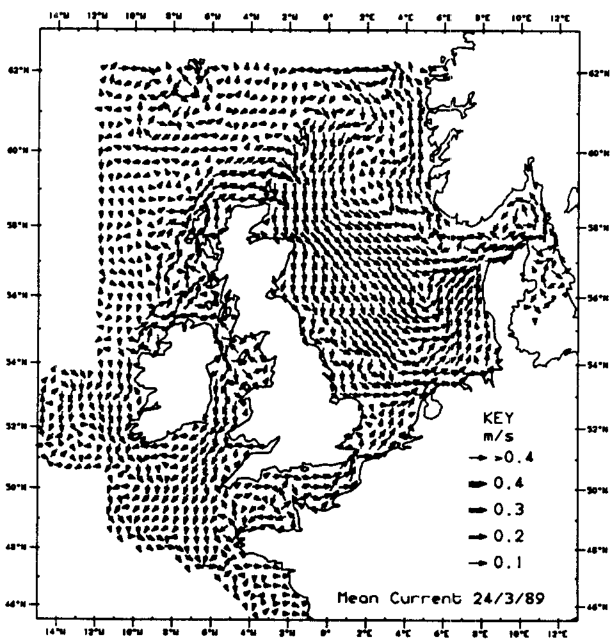
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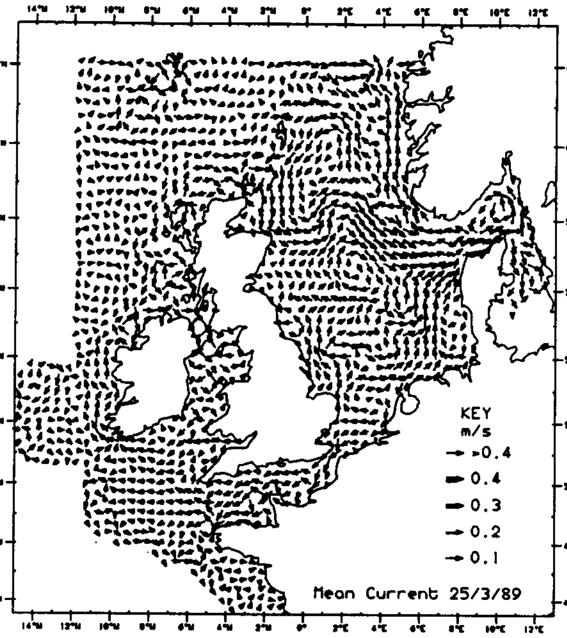
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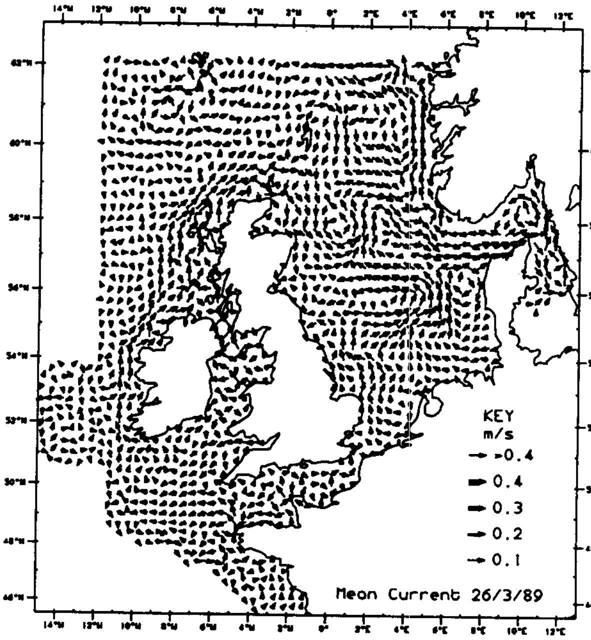
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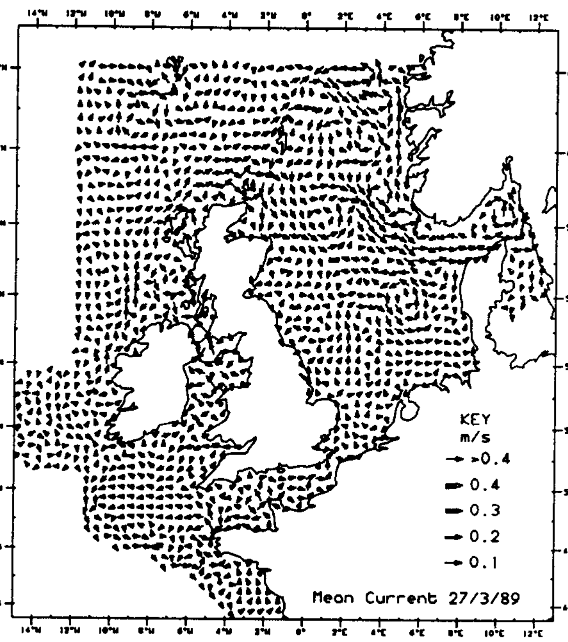
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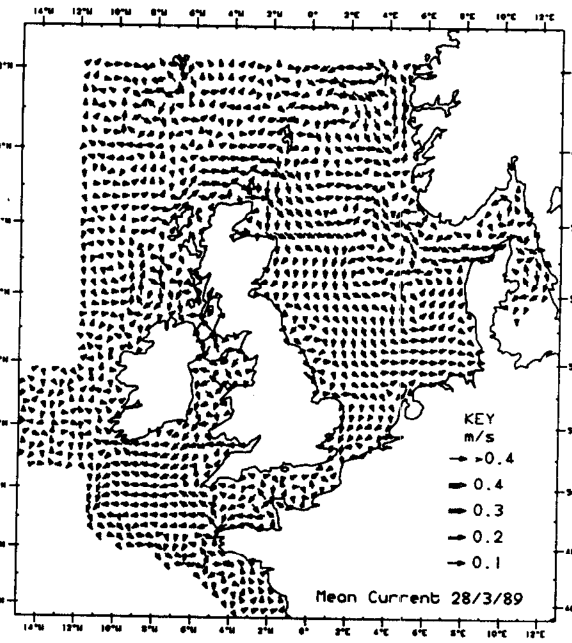
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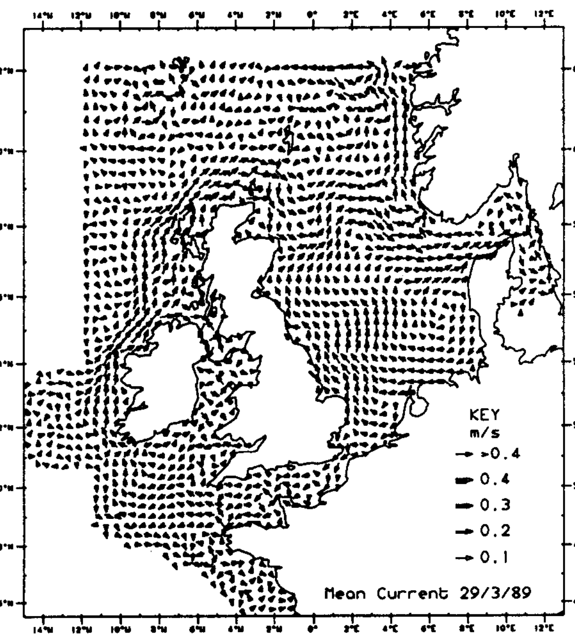
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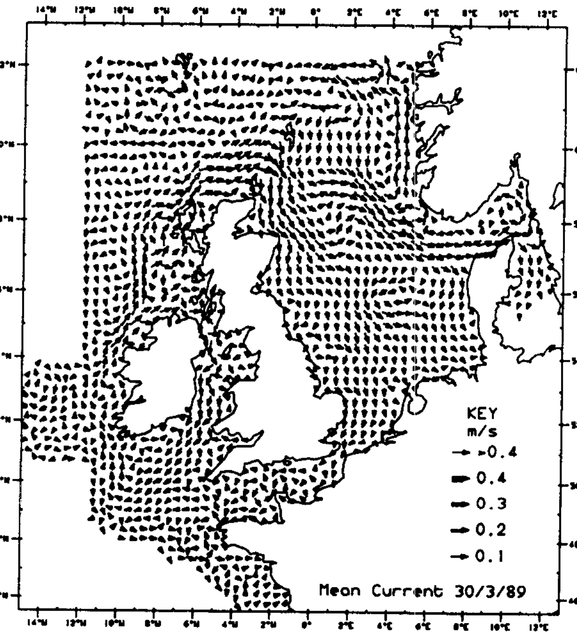
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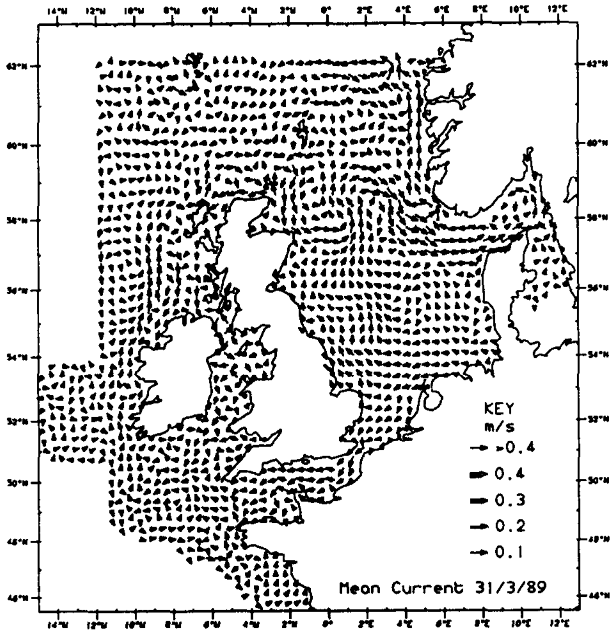

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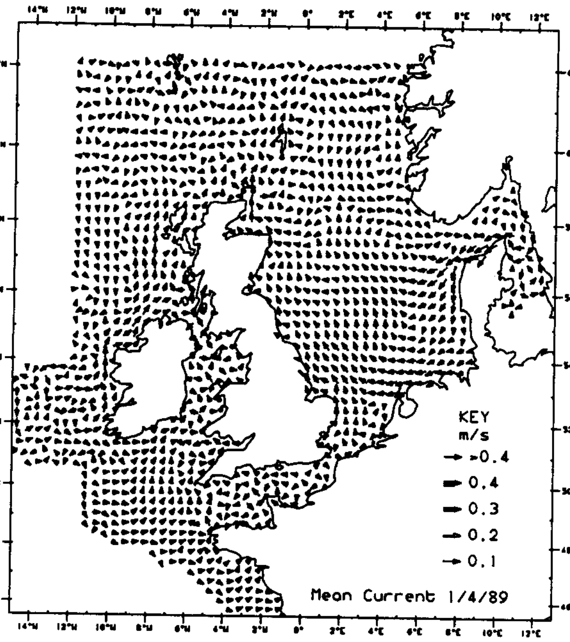
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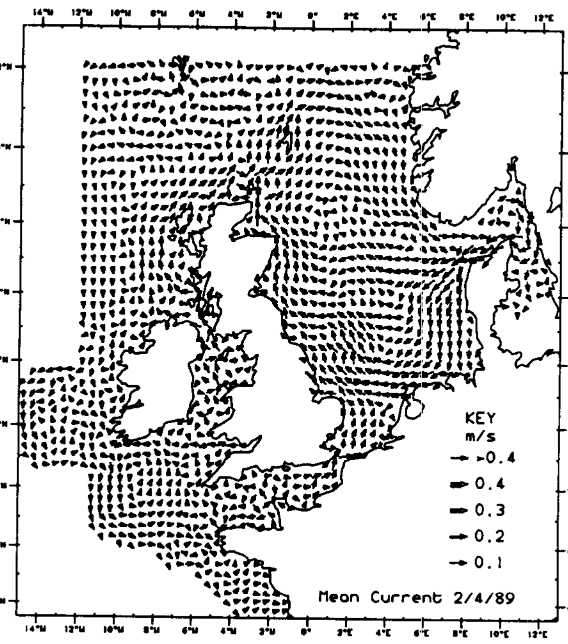
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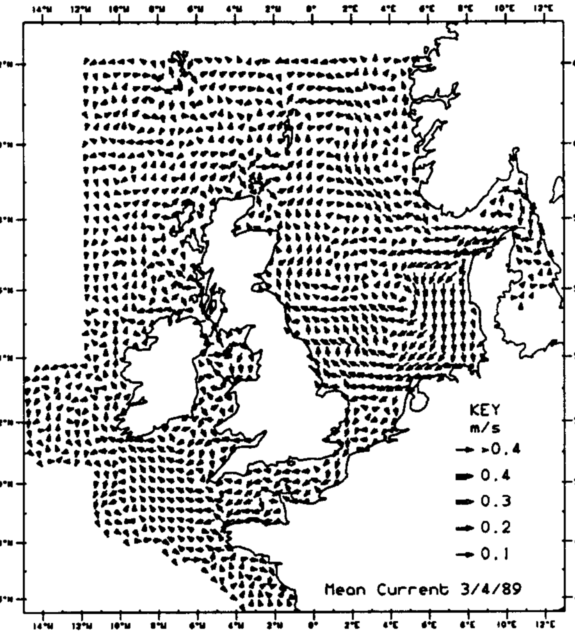
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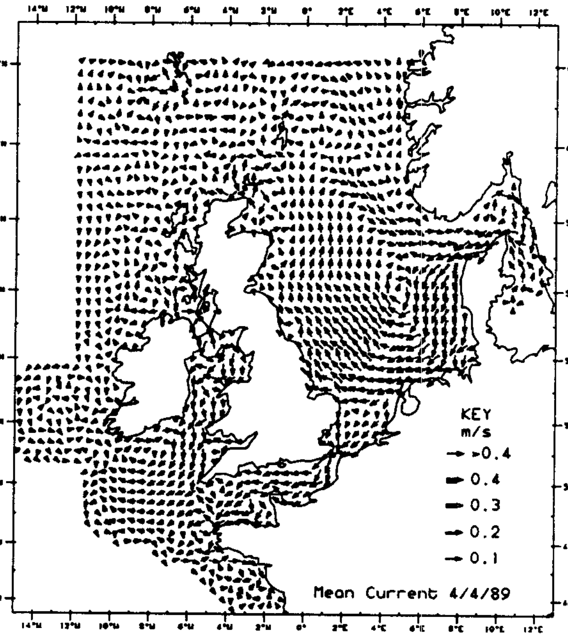
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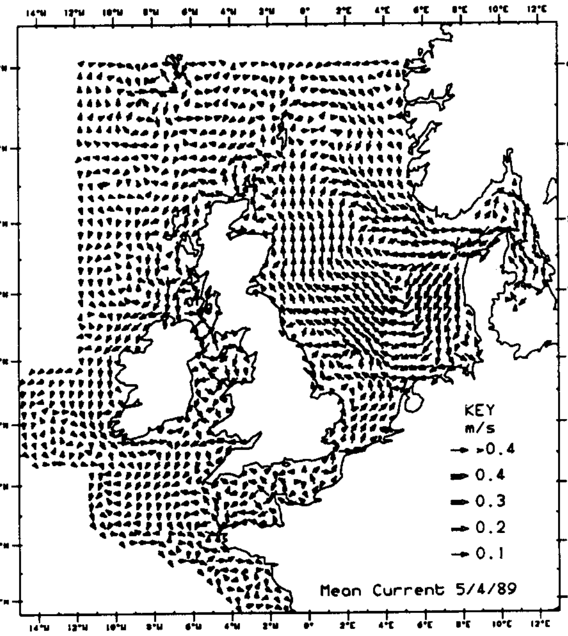
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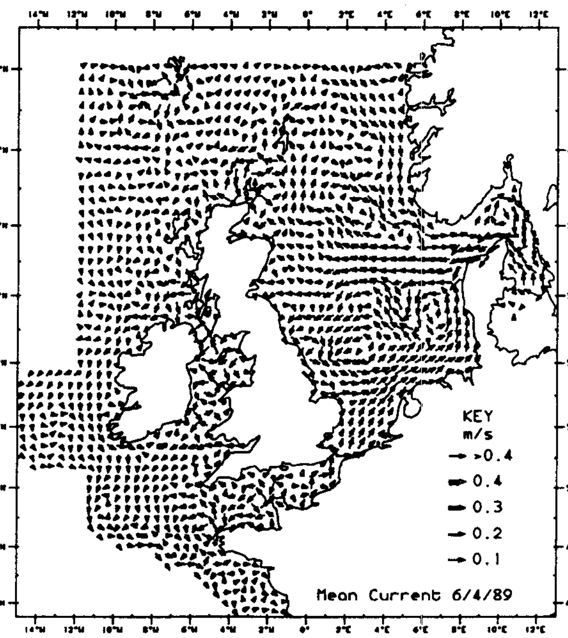
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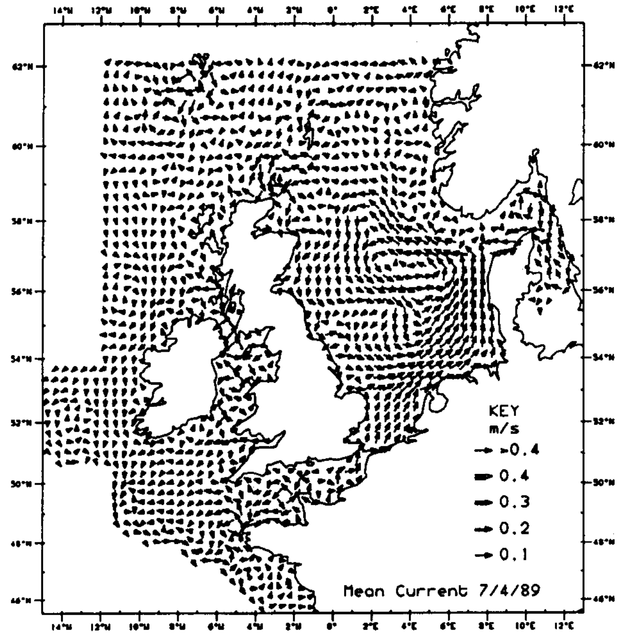
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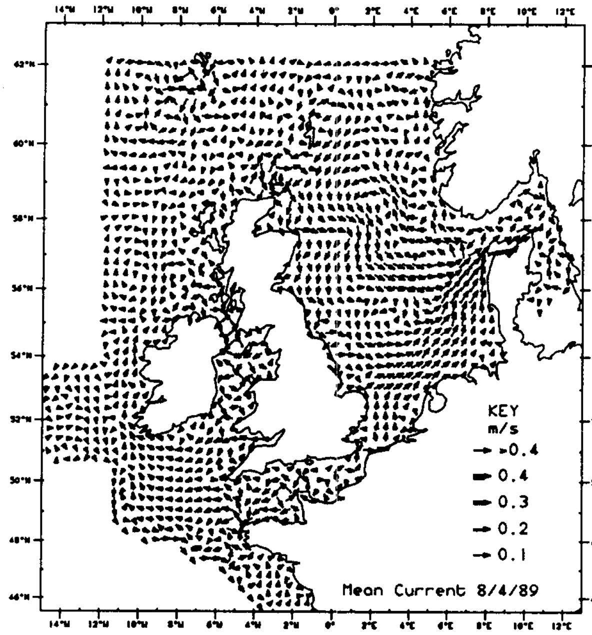
Mean Current 7/4/89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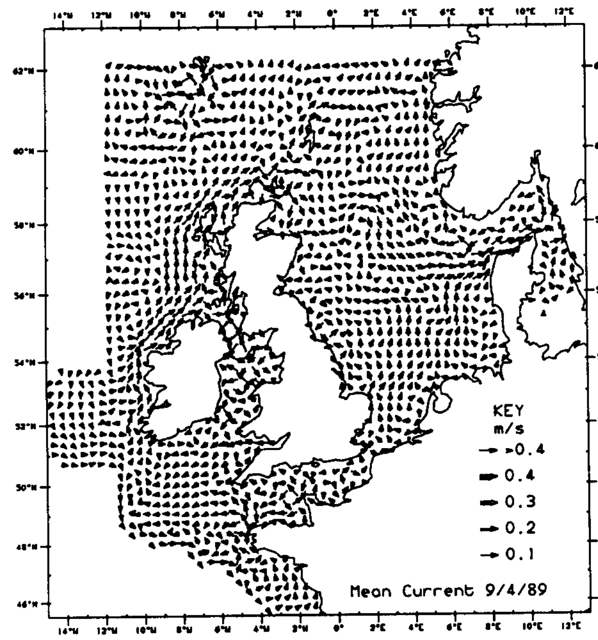
Mean Current 8/4/89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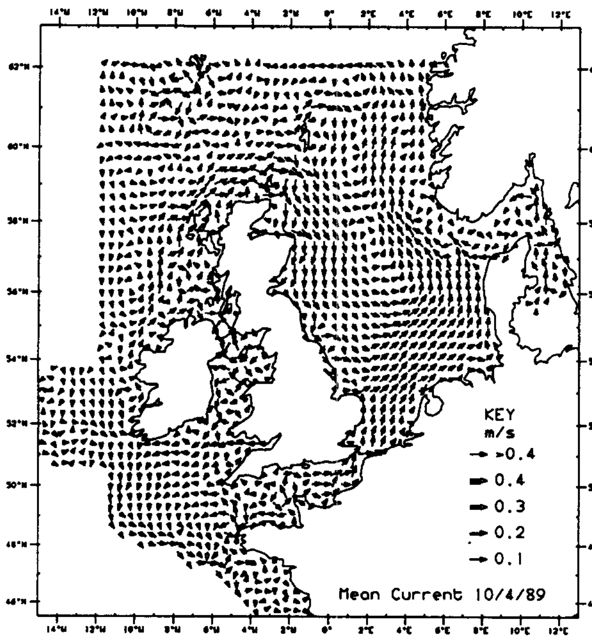
Mean Current 9/4/89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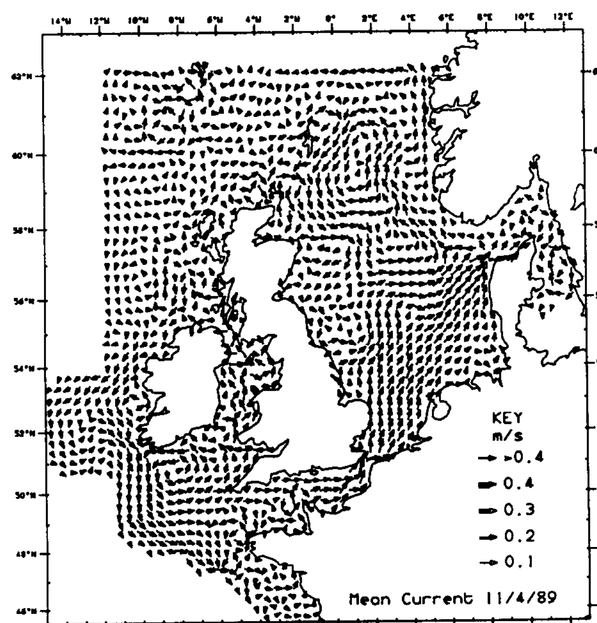
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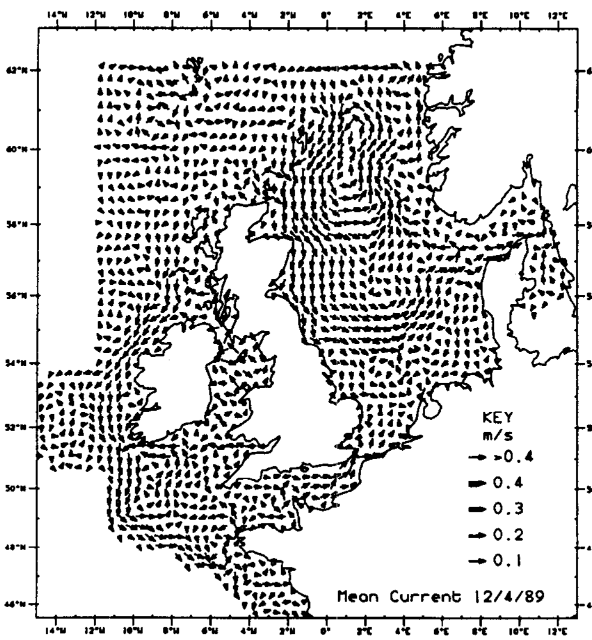
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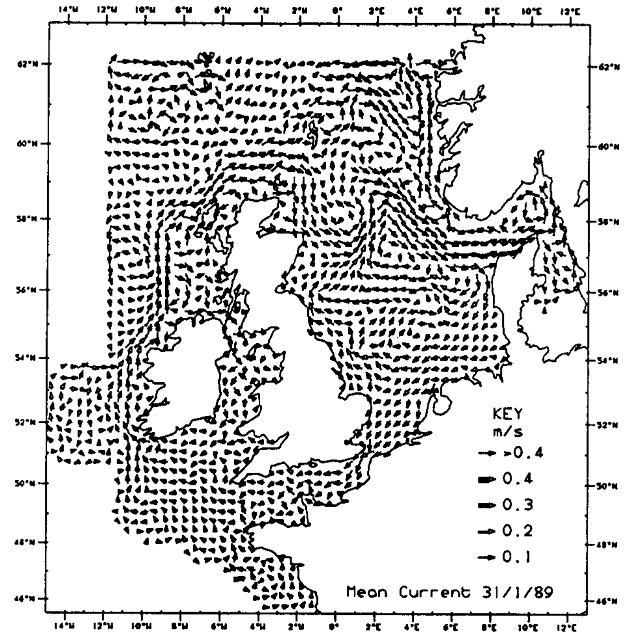
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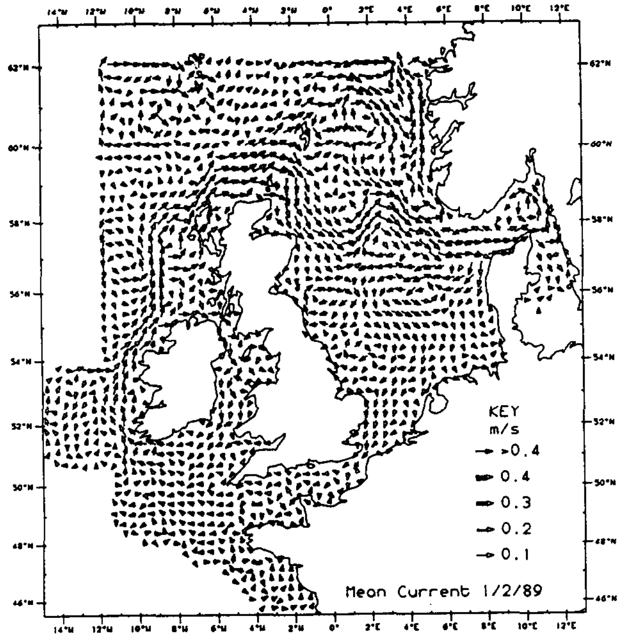
Mean Current 31/1/89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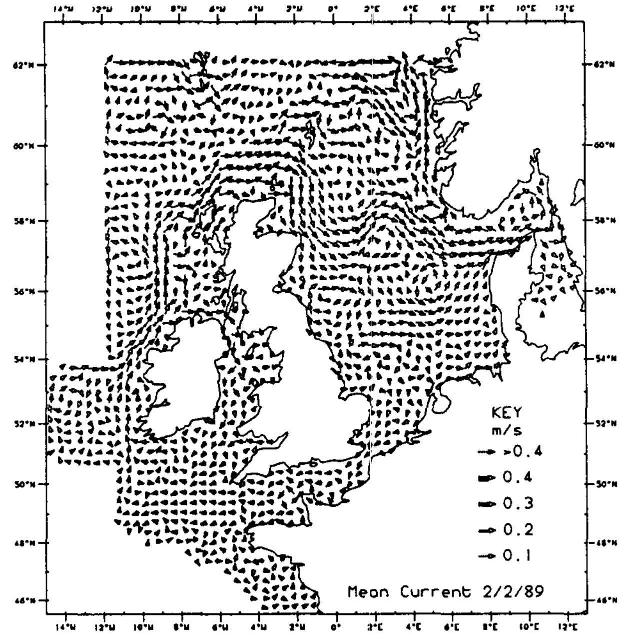
Mean Current 1/2/89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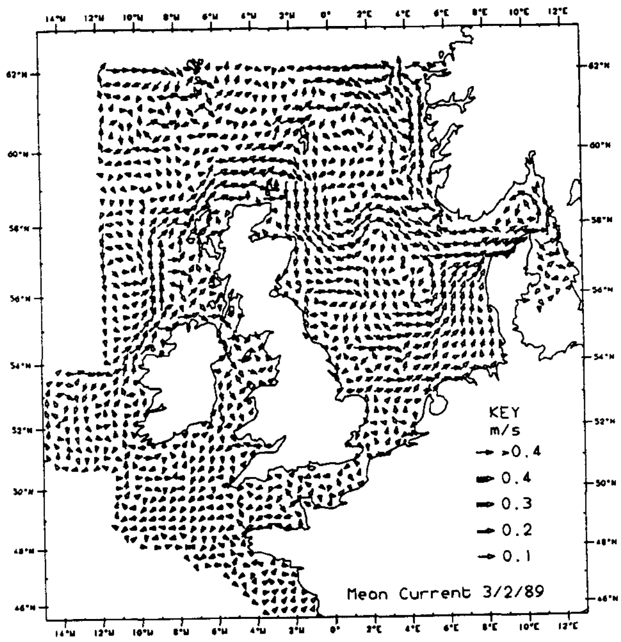
Mean Current 2/2/89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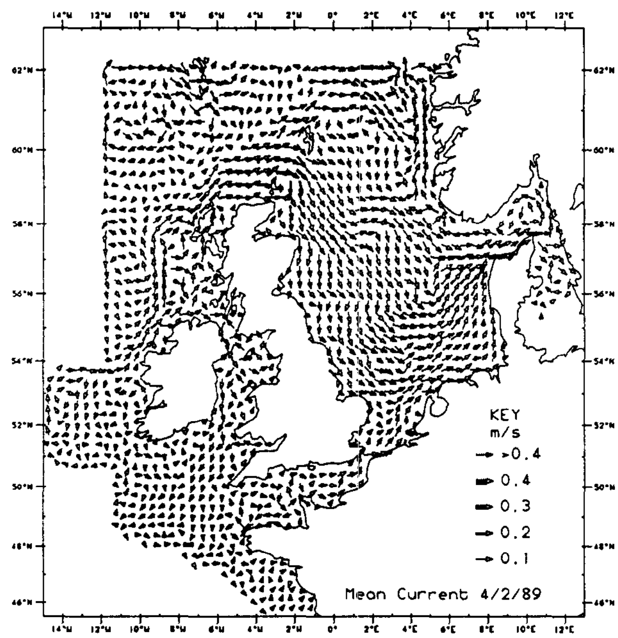
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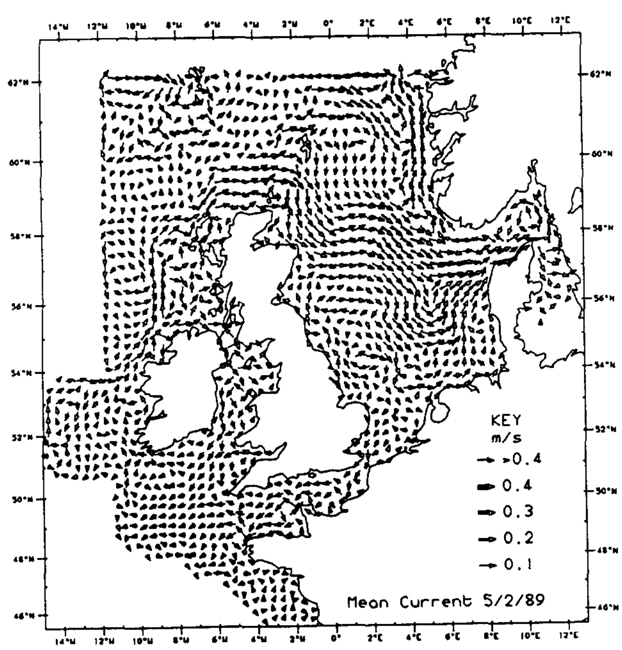
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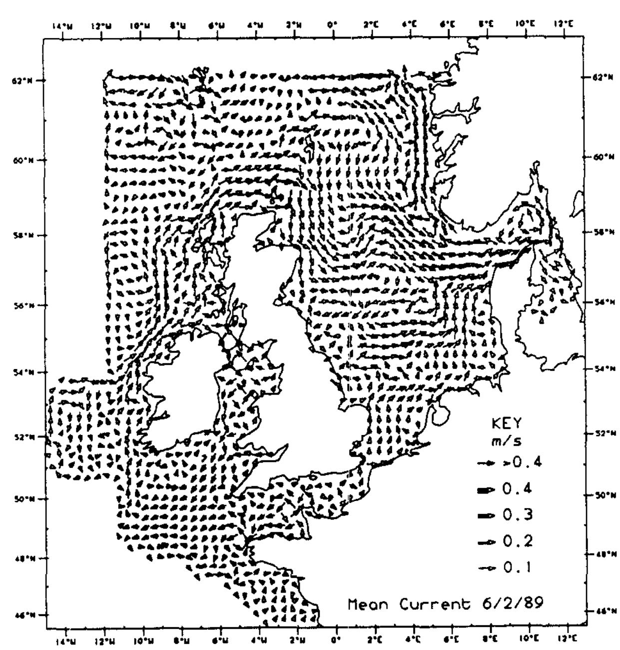
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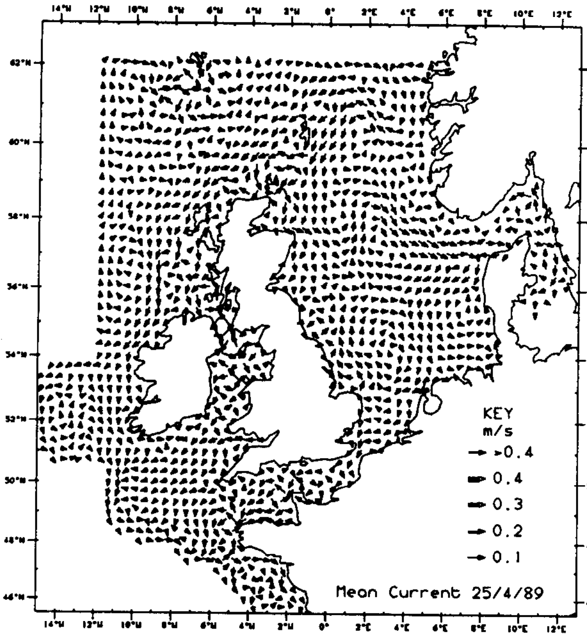
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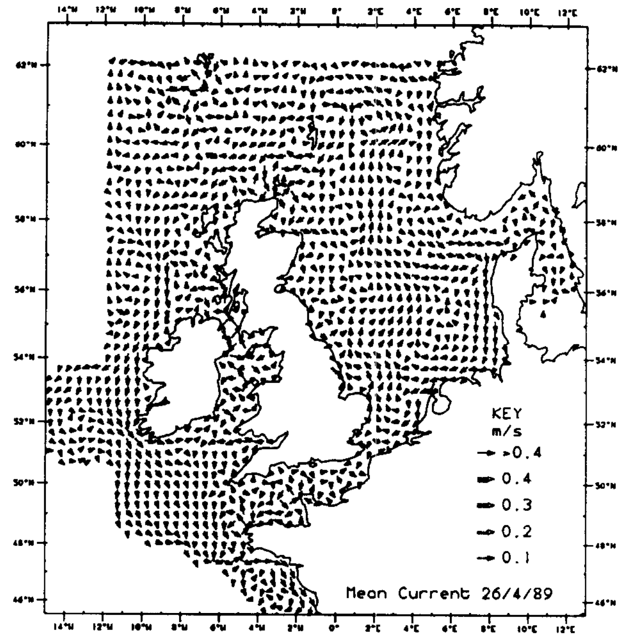
Mean Current 25/4/89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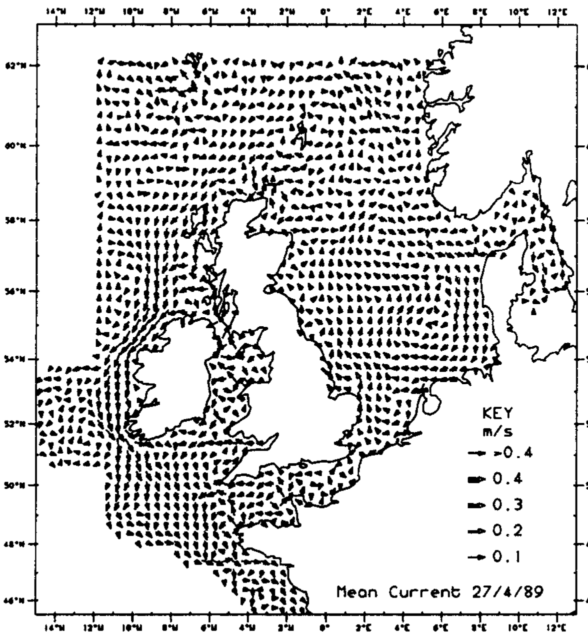
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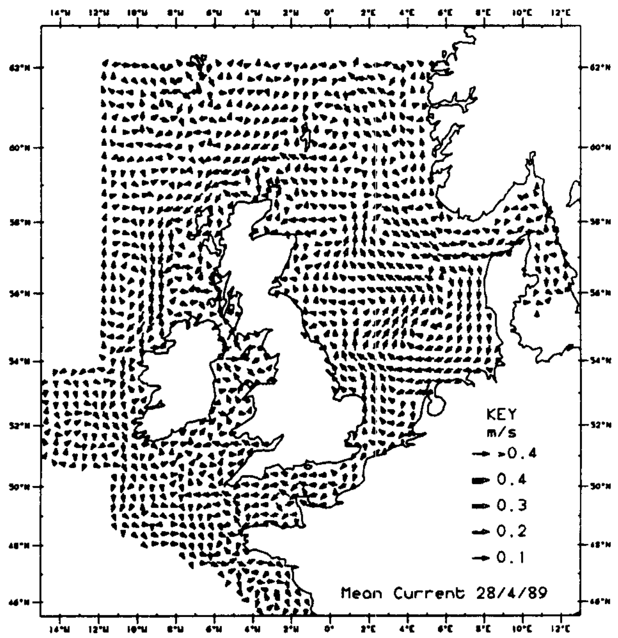
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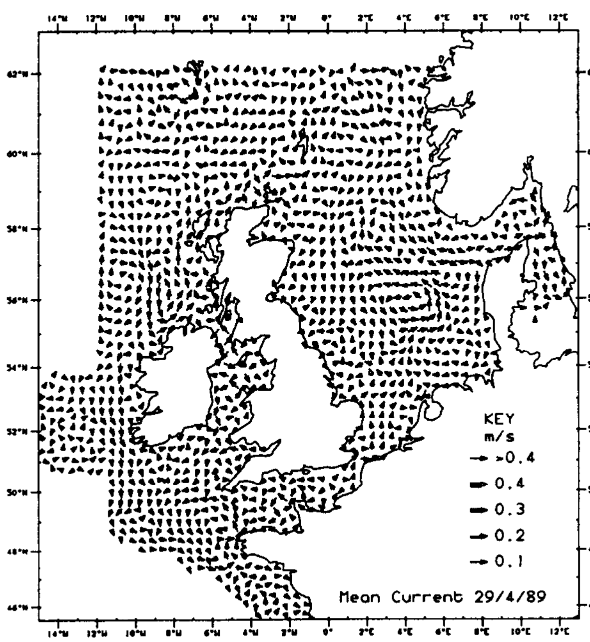
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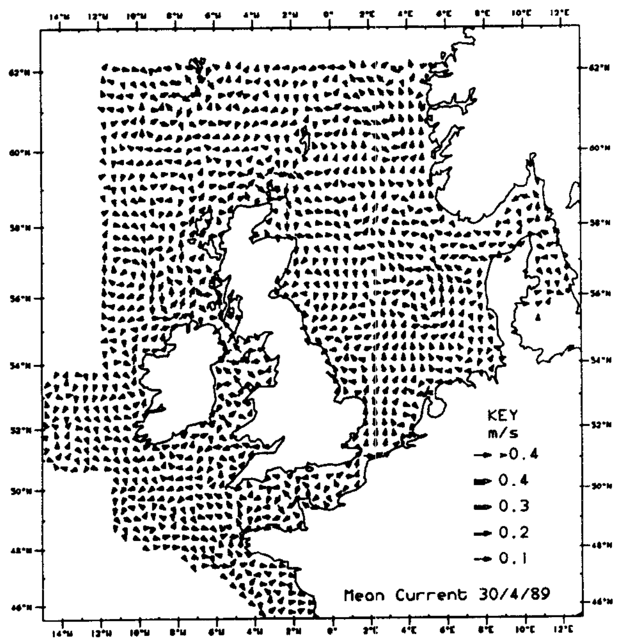
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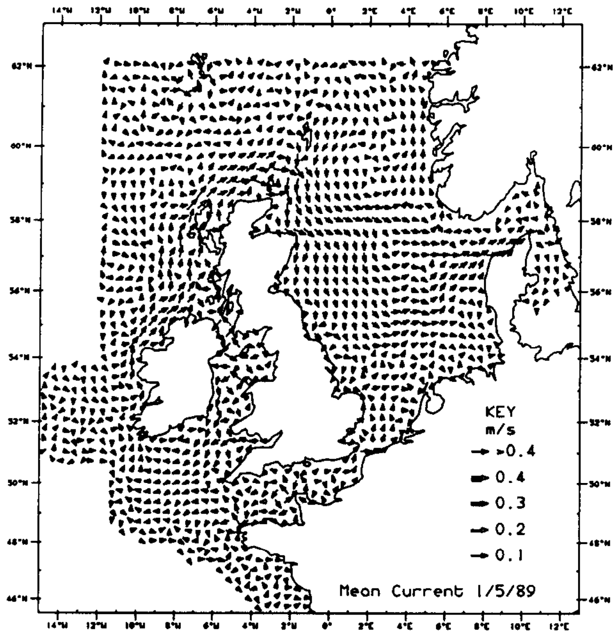
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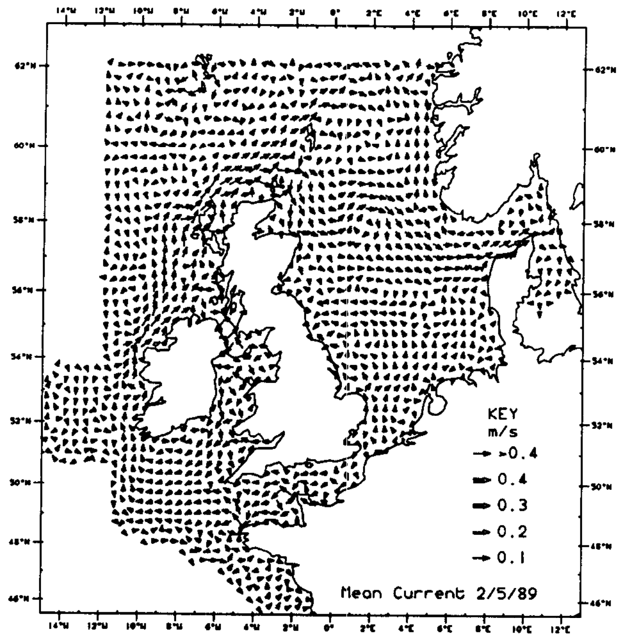
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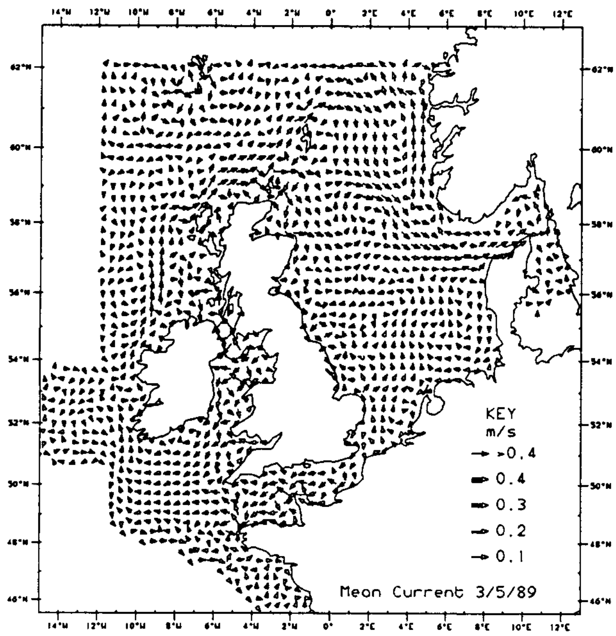
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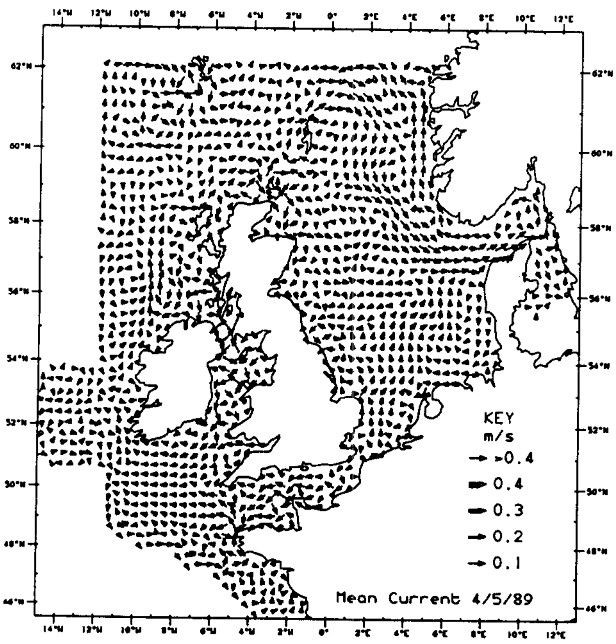
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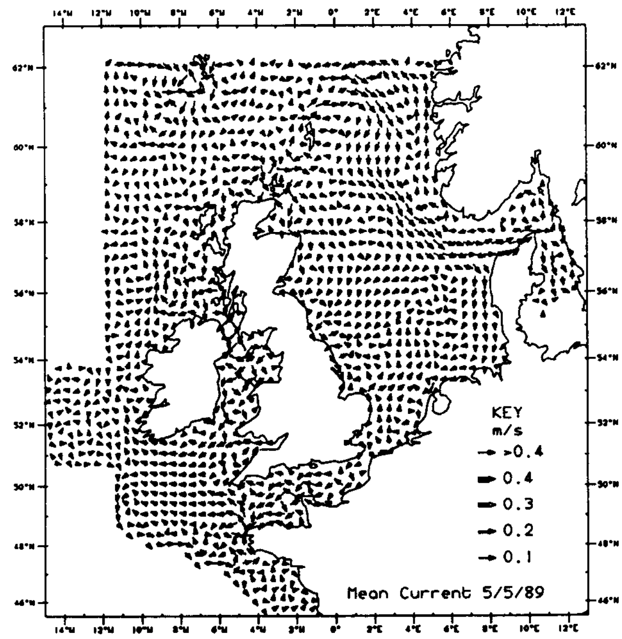
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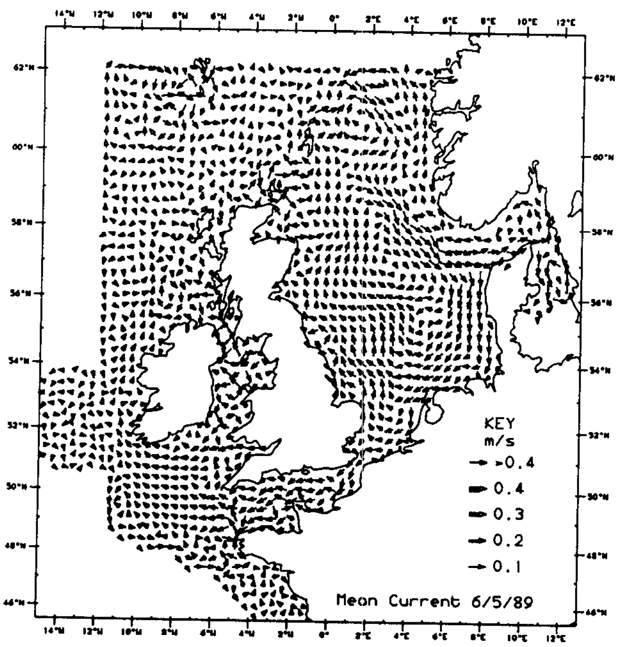
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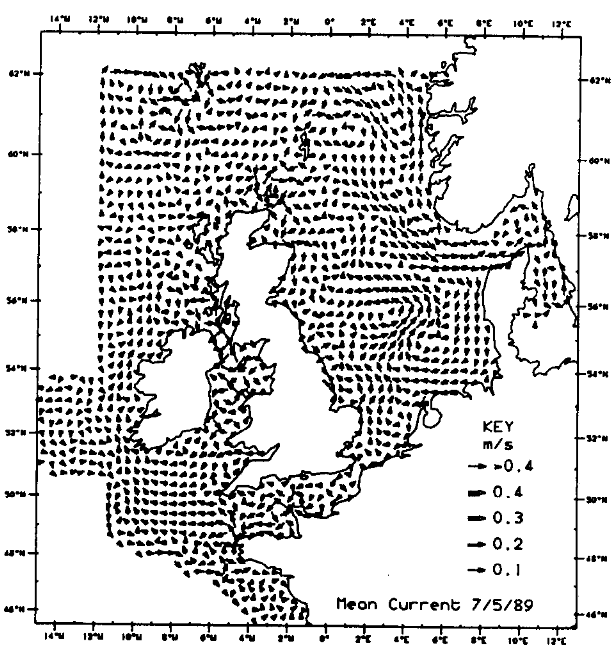
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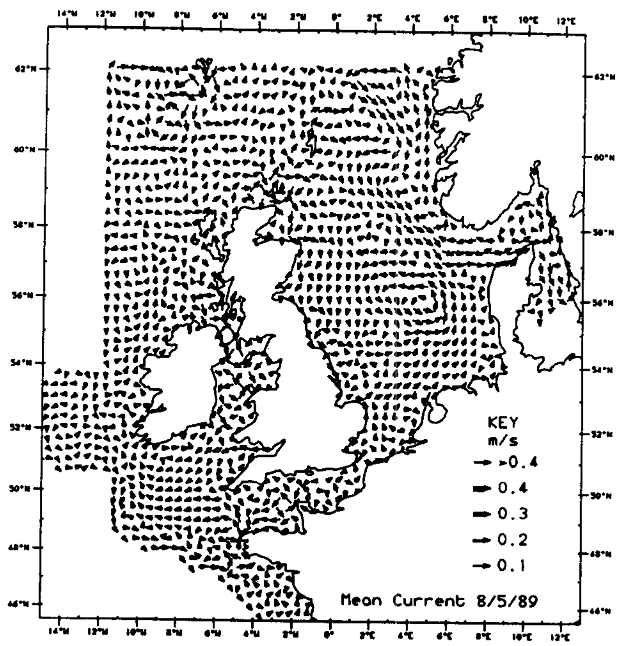
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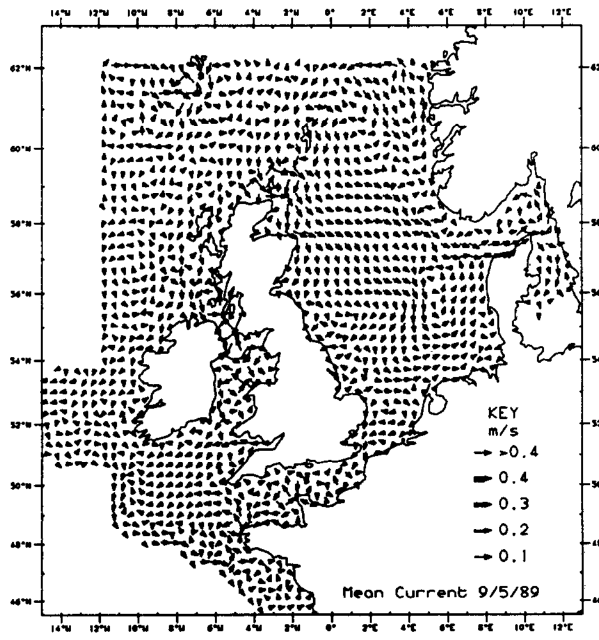
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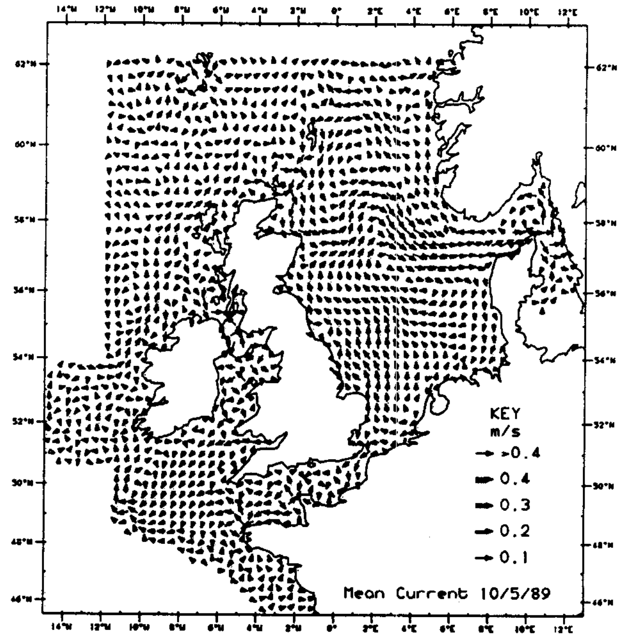
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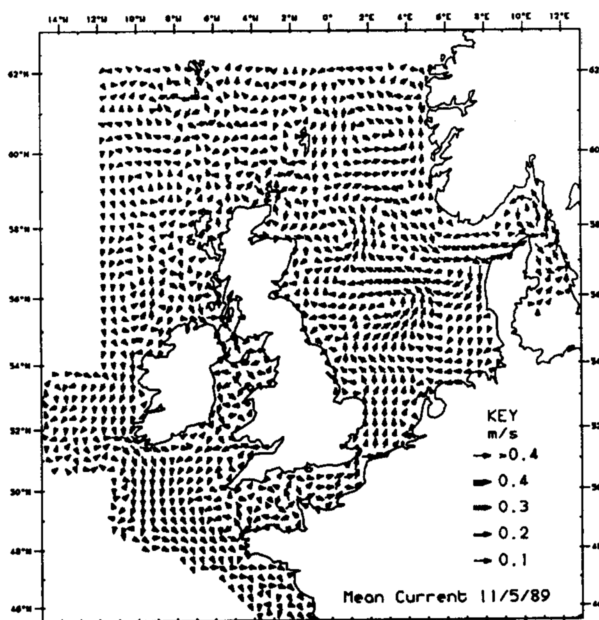
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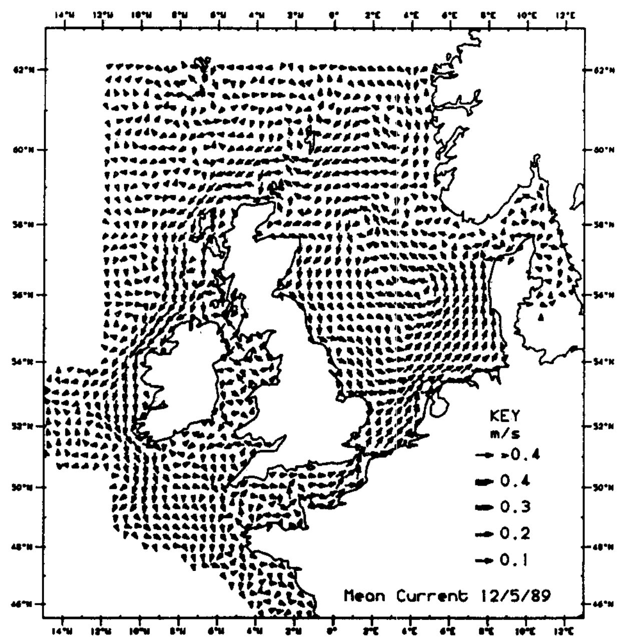
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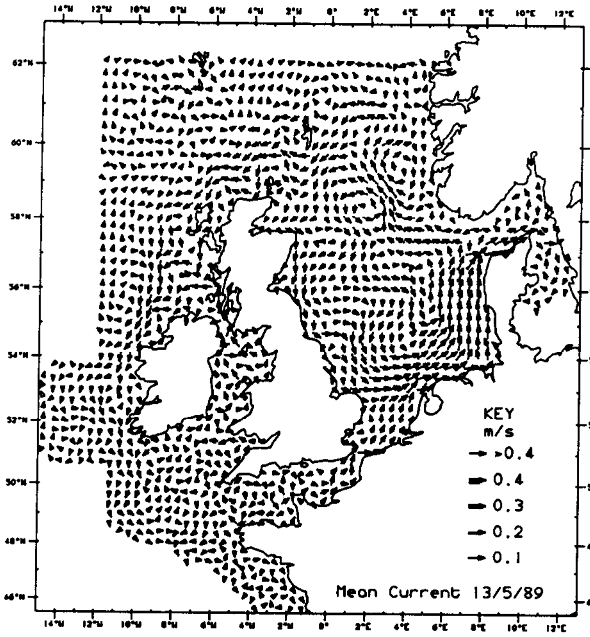
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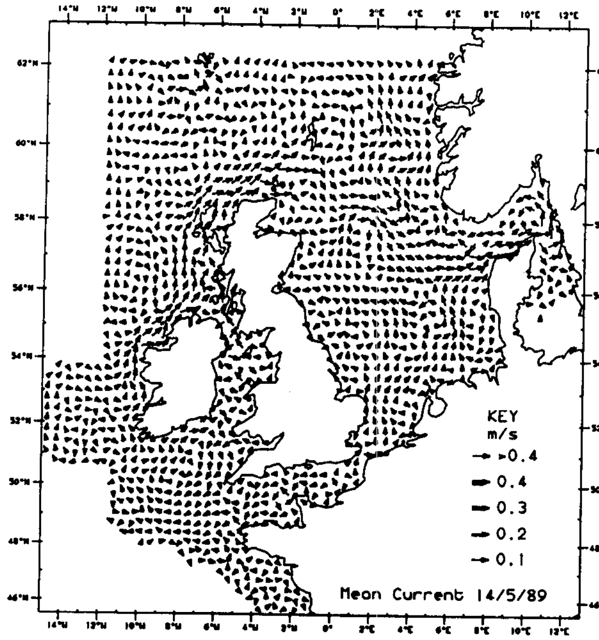
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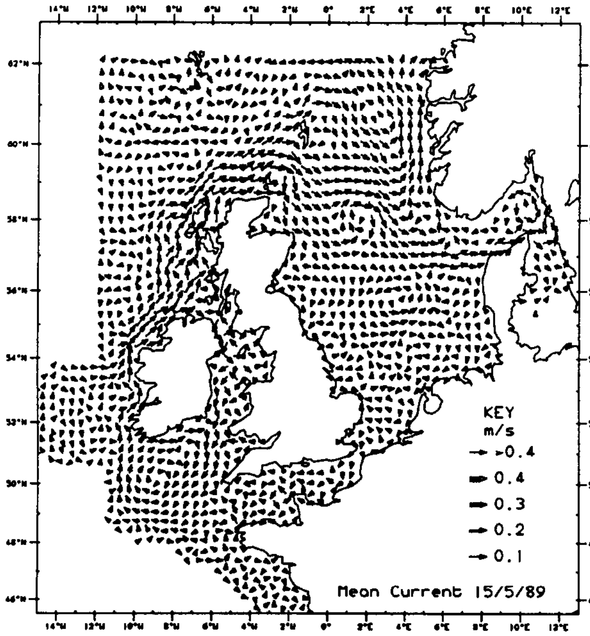
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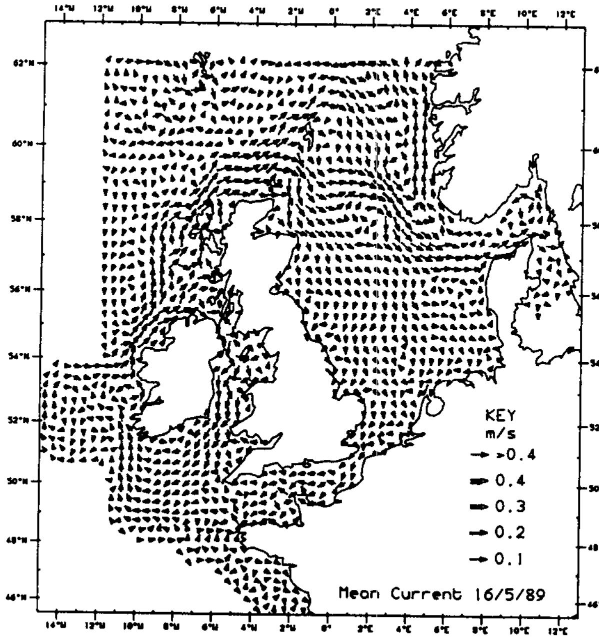
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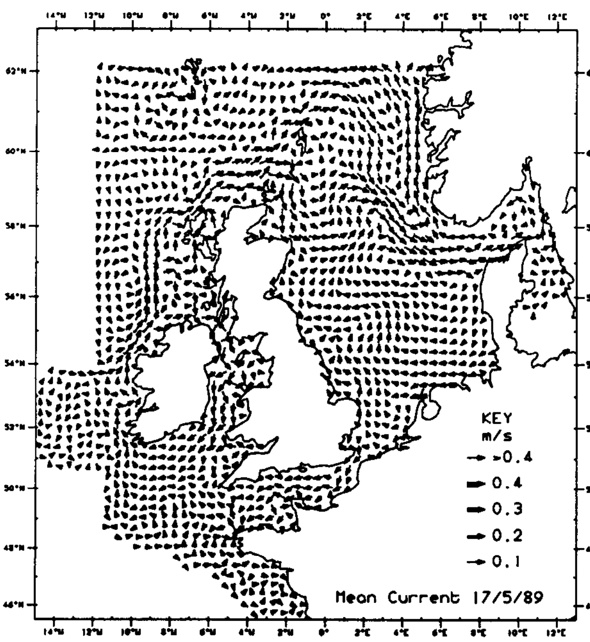
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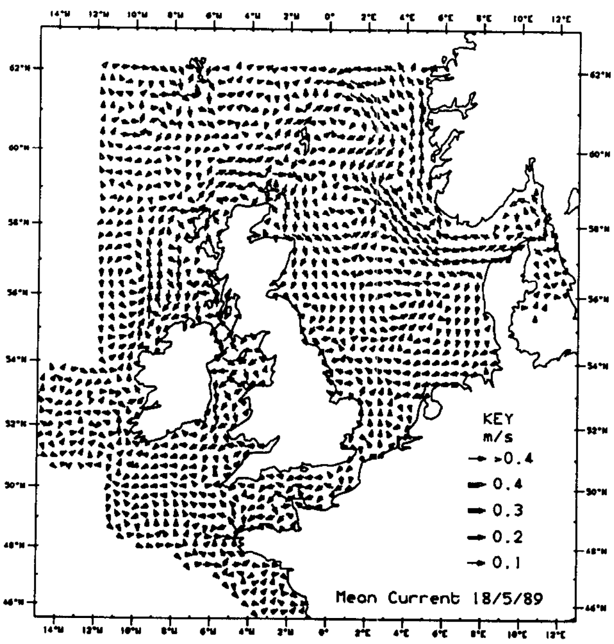
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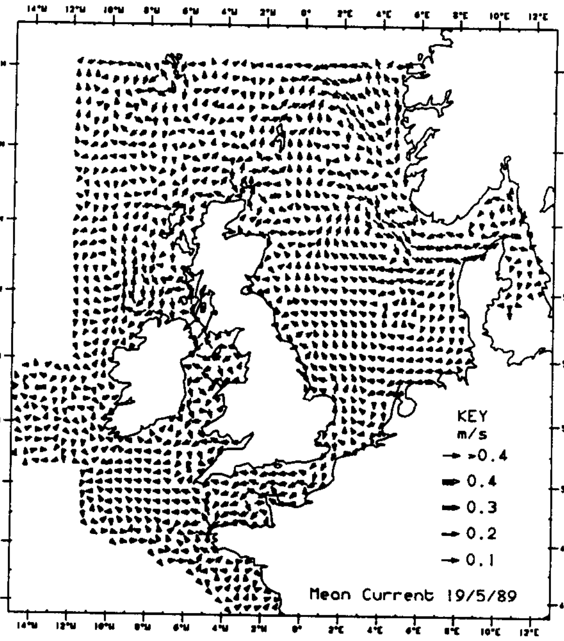
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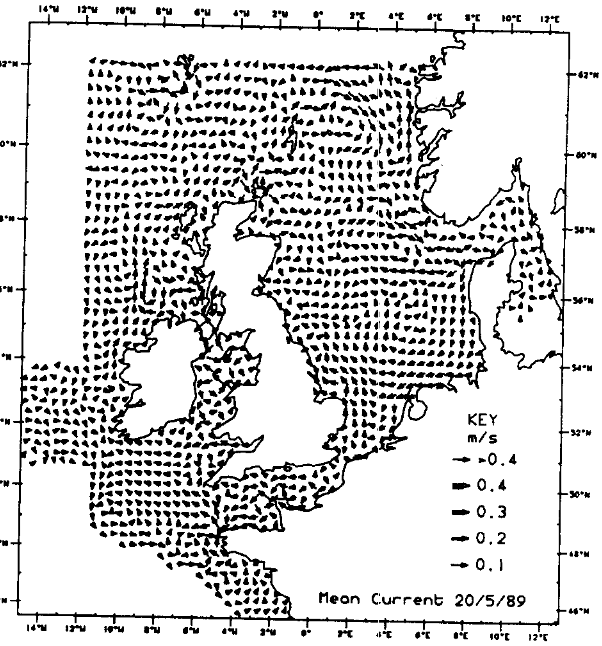
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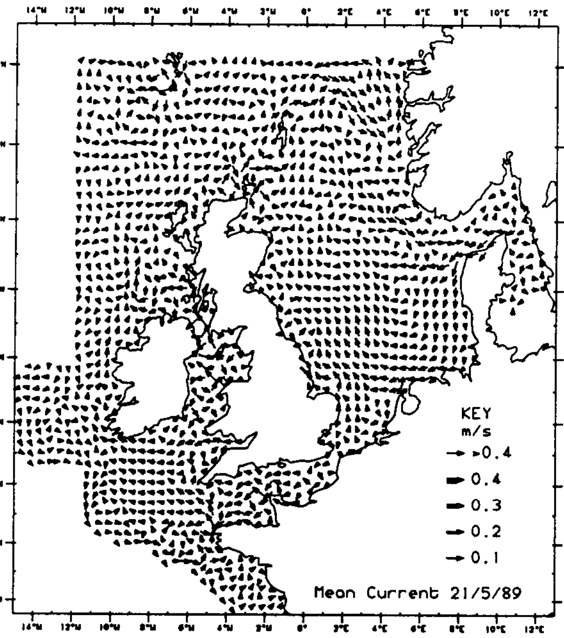
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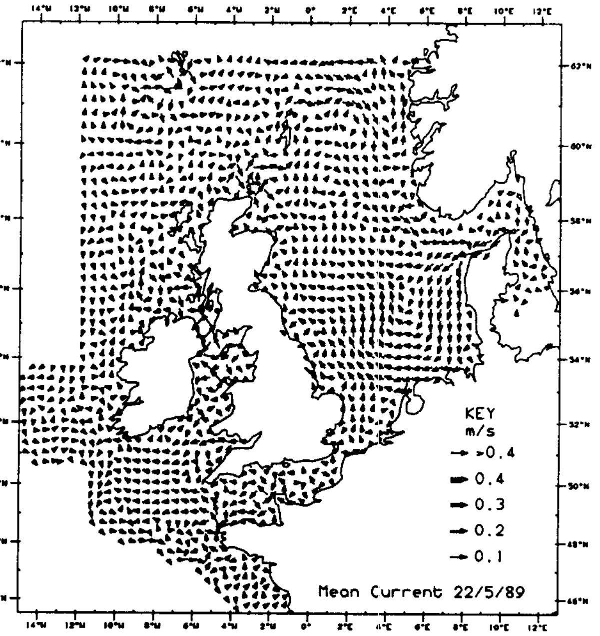
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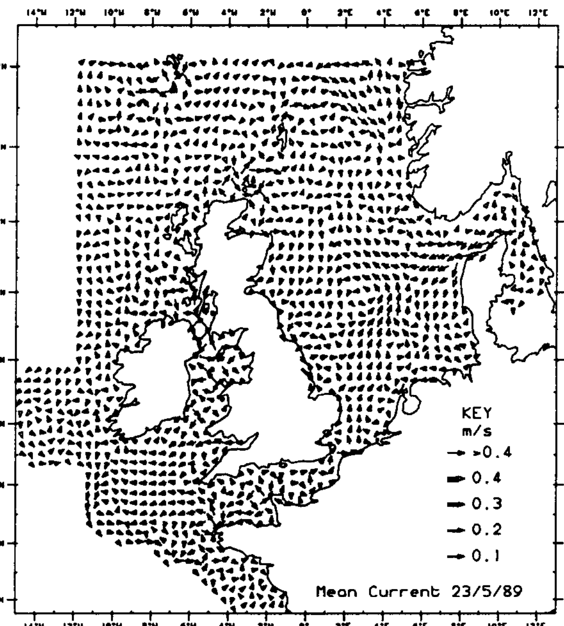
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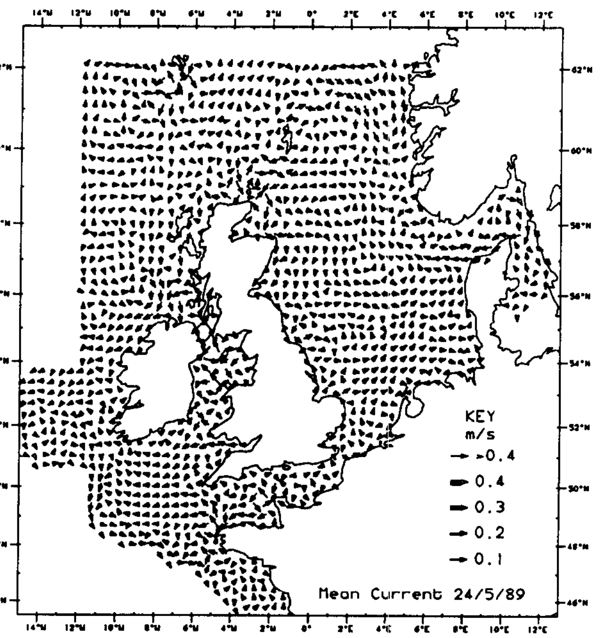
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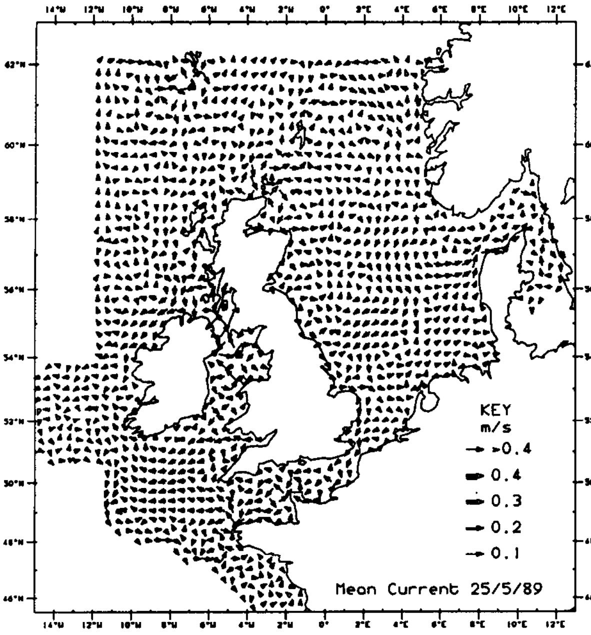
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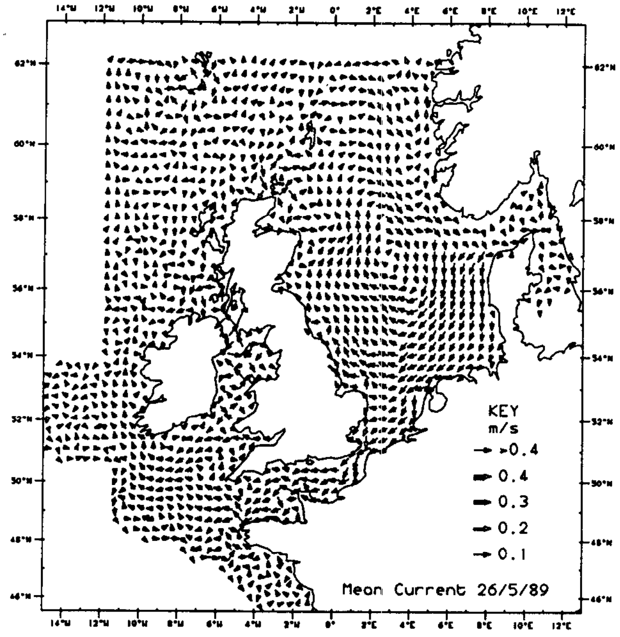
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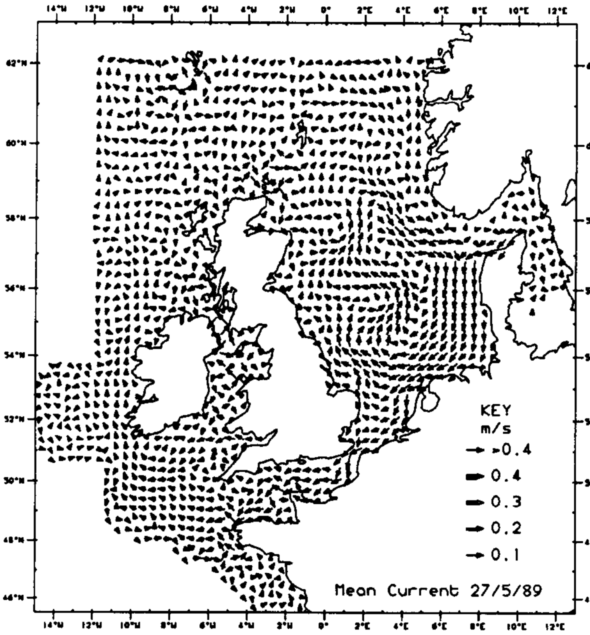
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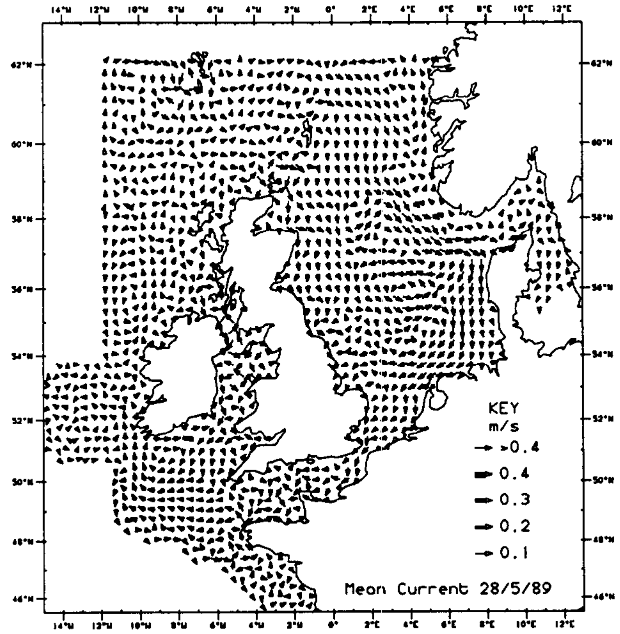
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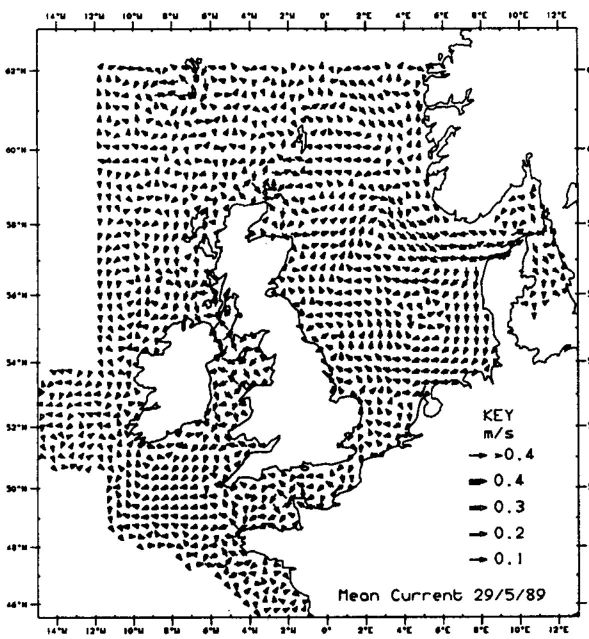
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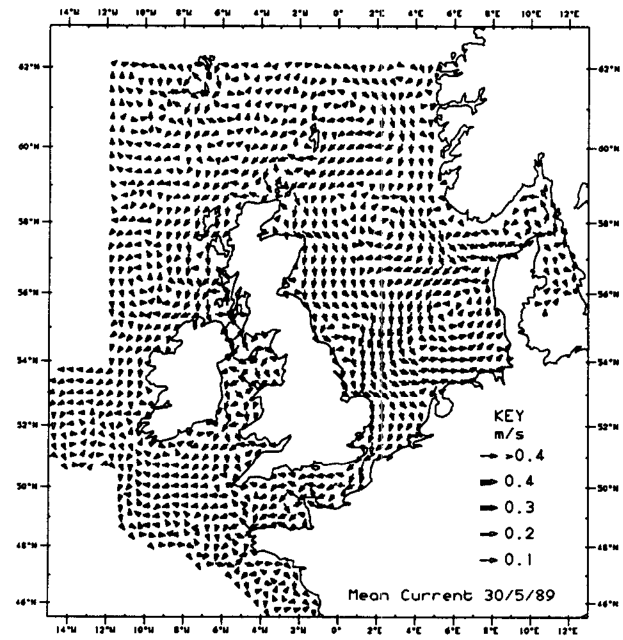
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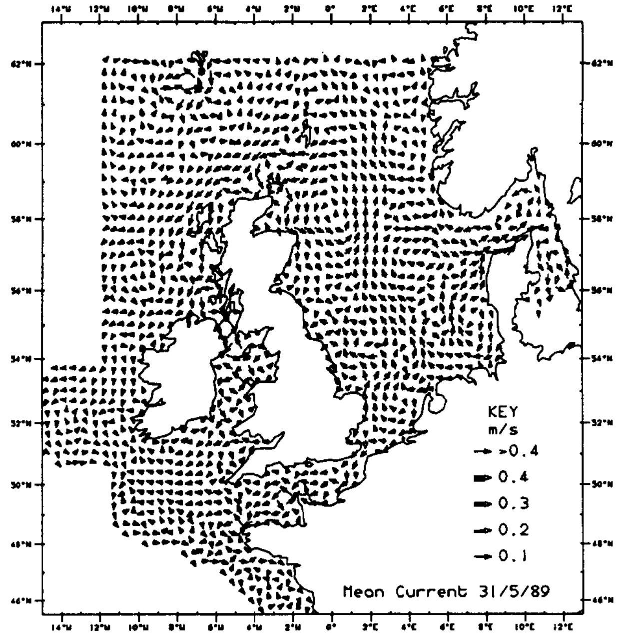
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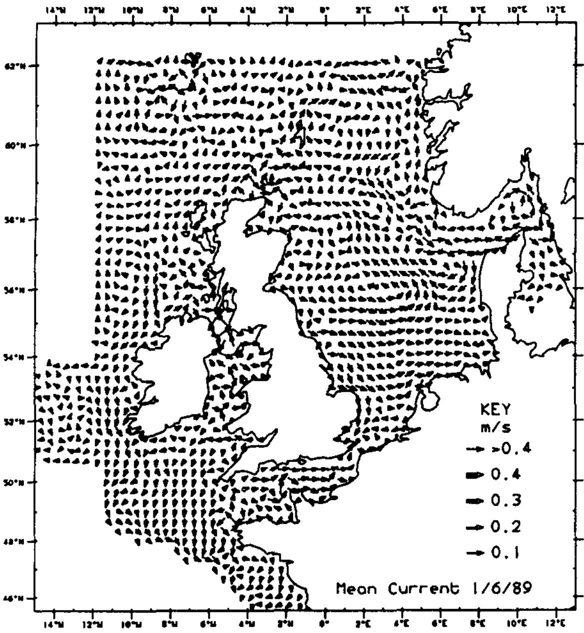
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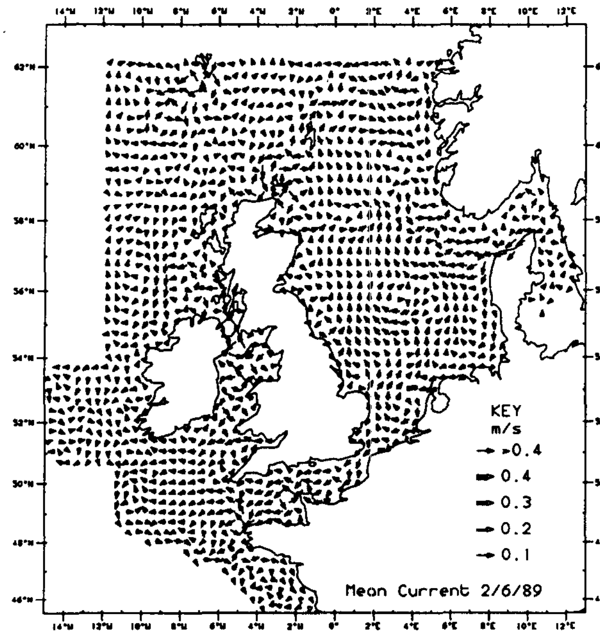
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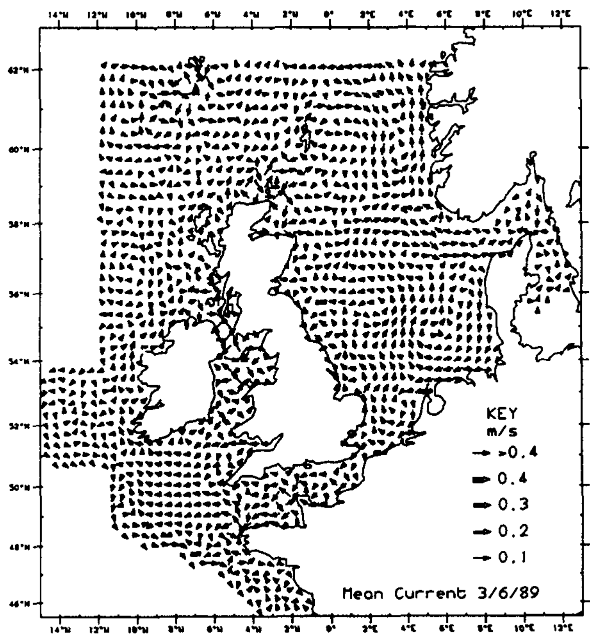
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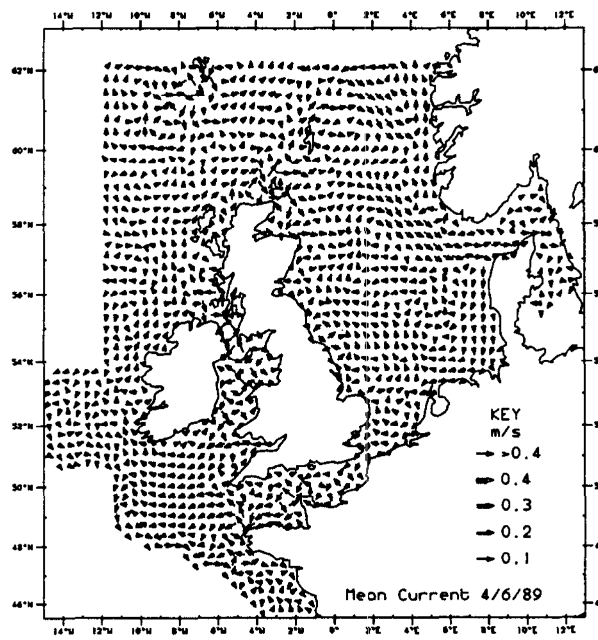
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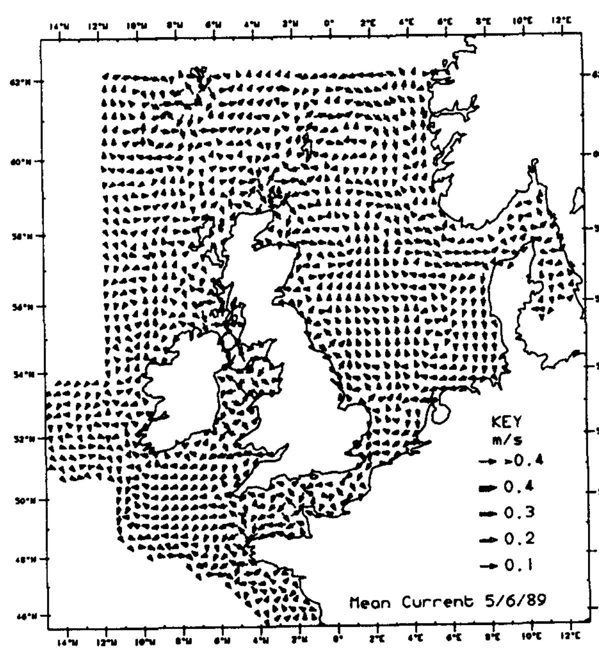
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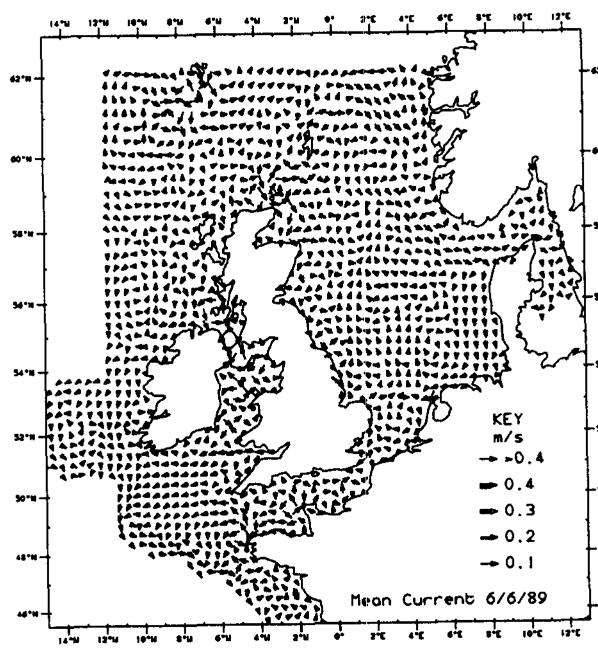
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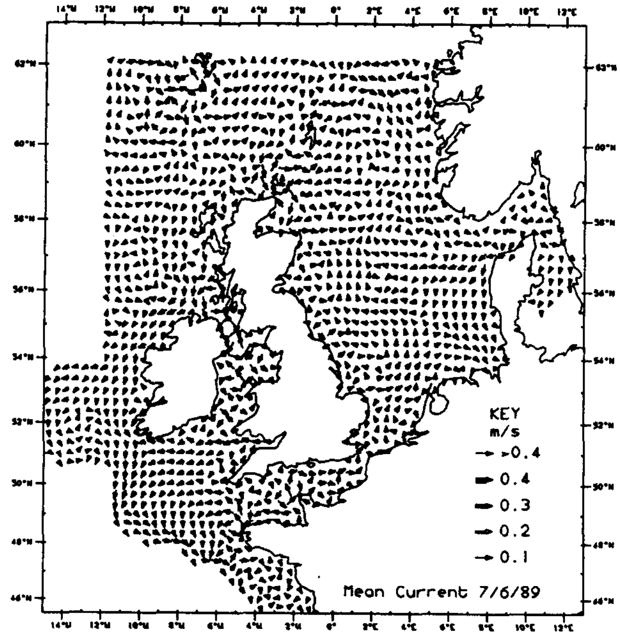
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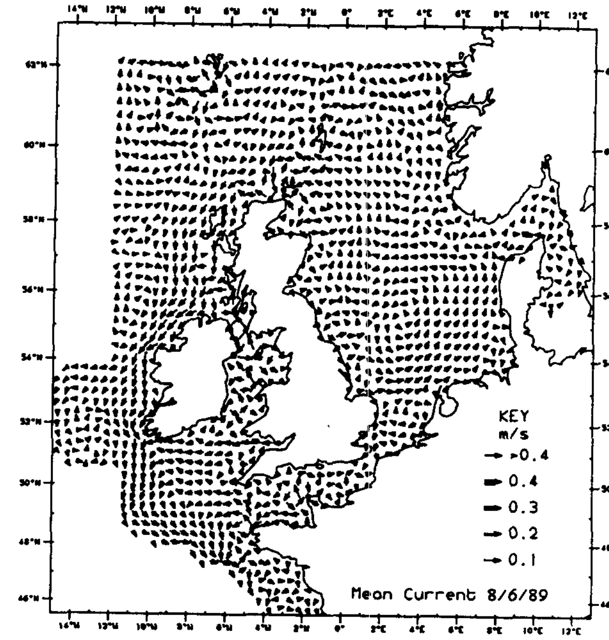
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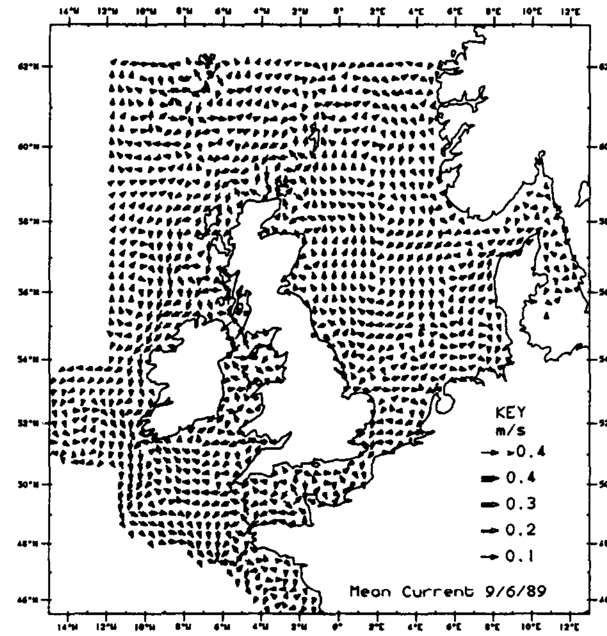
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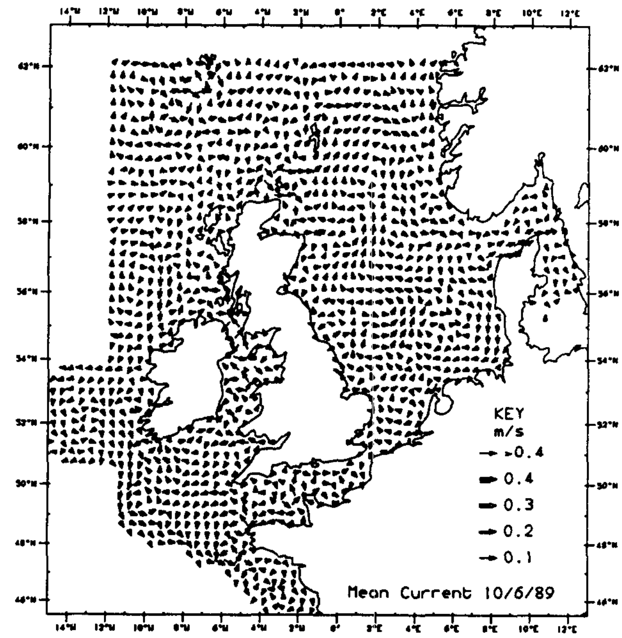
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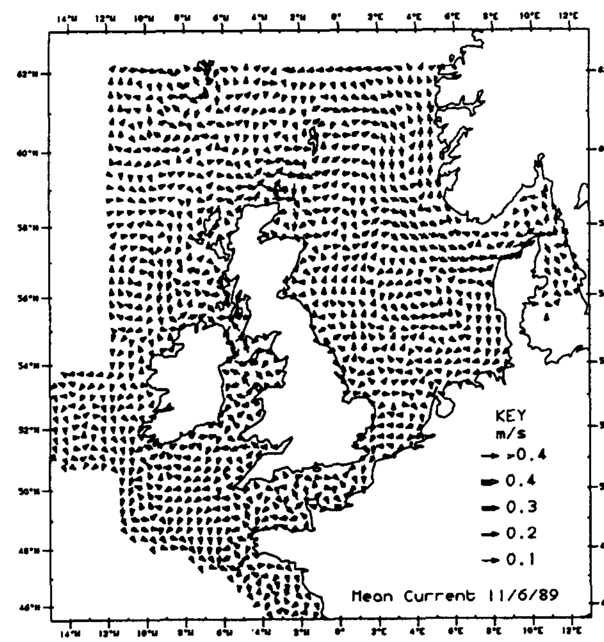
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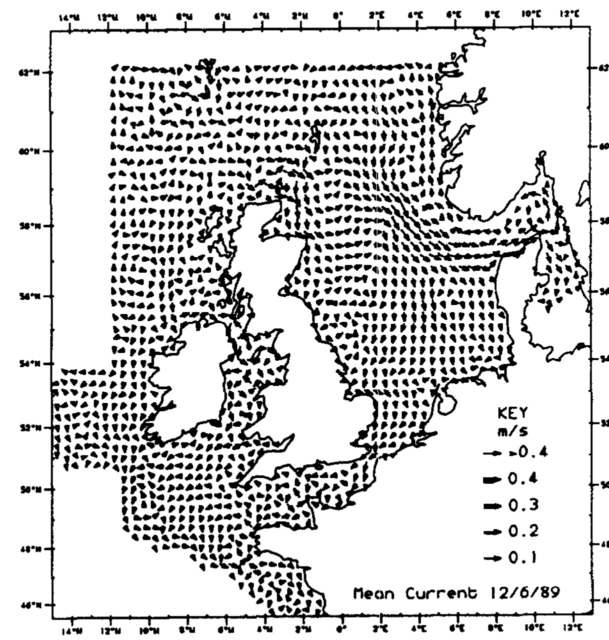
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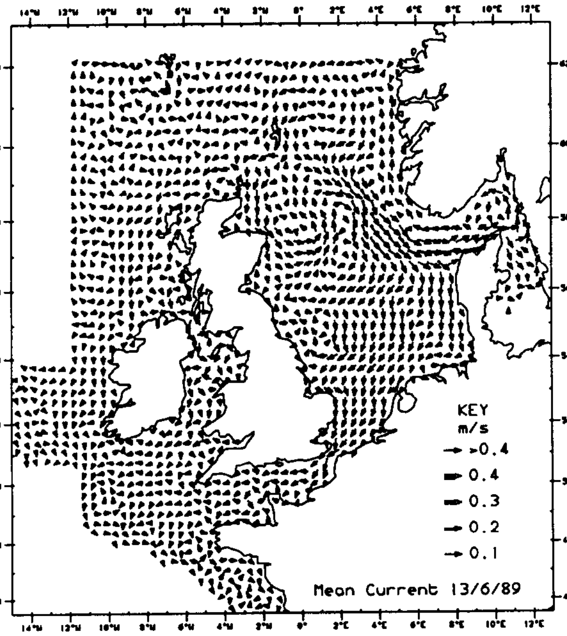
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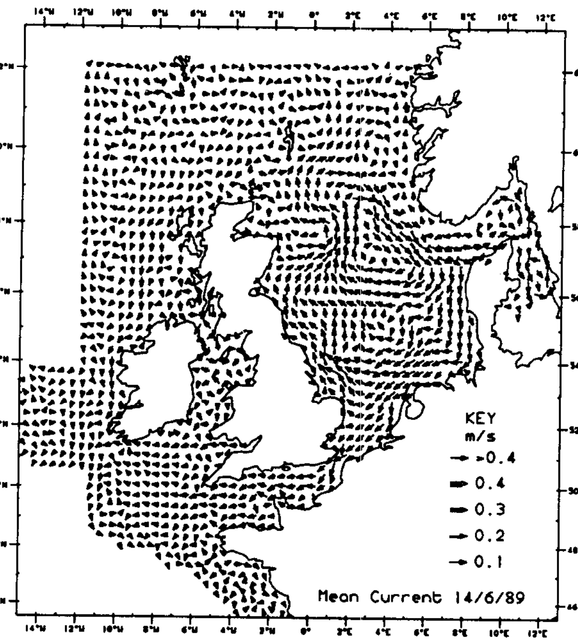
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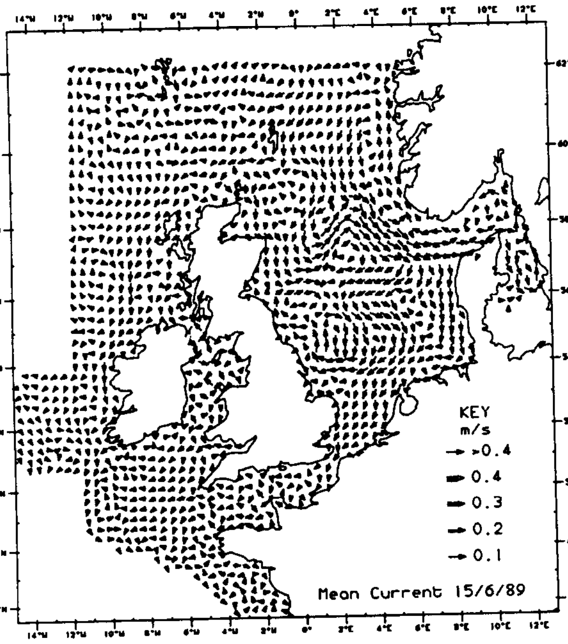
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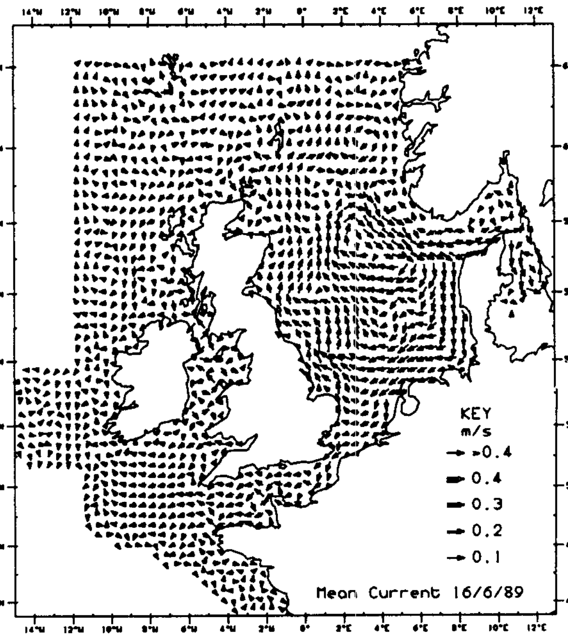
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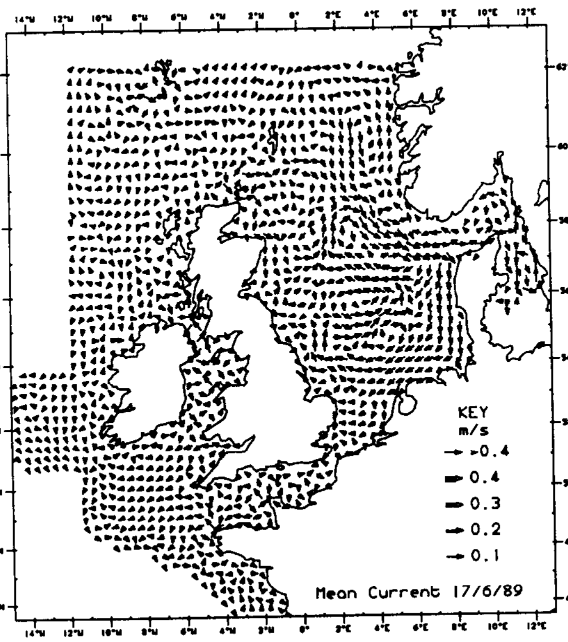
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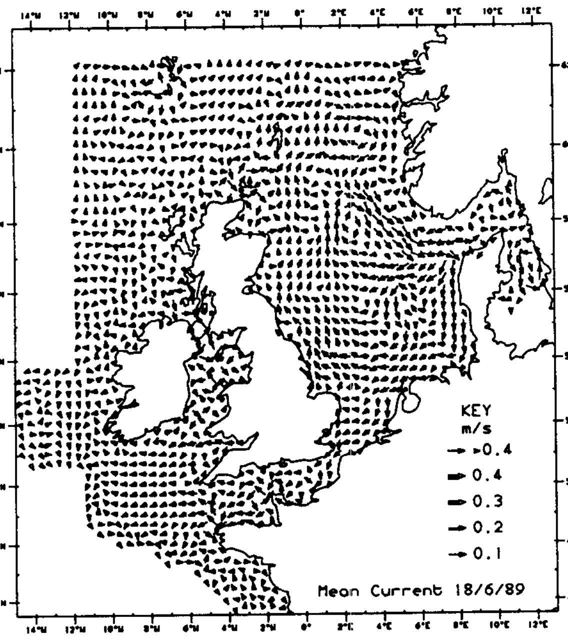
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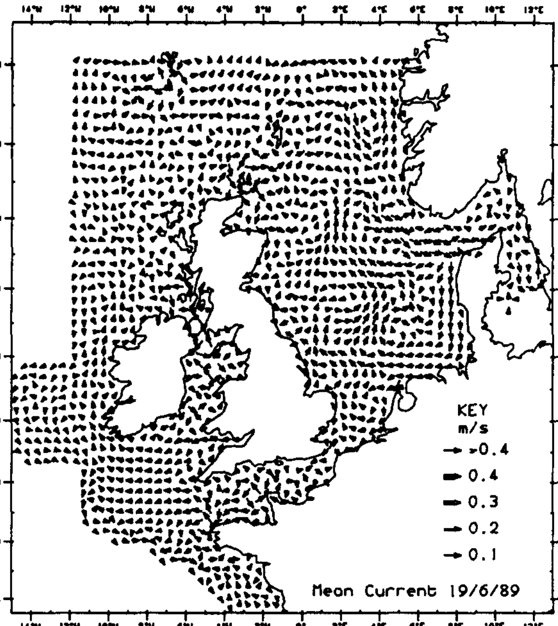
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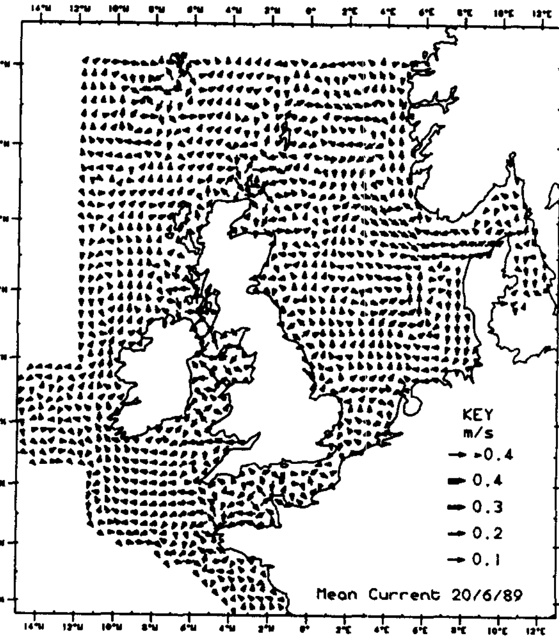
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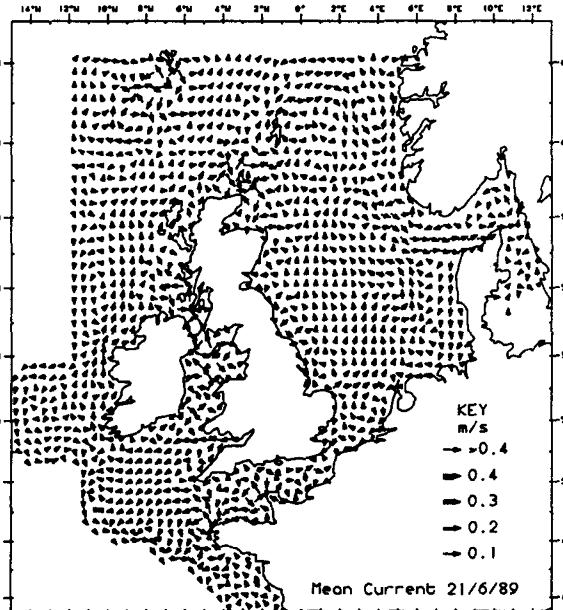
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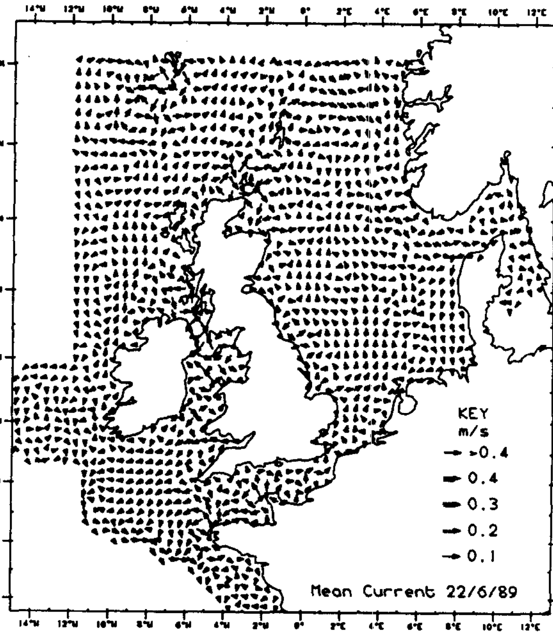
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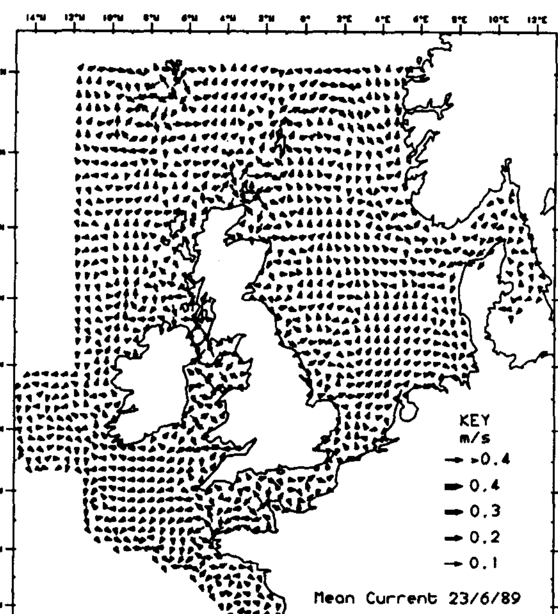
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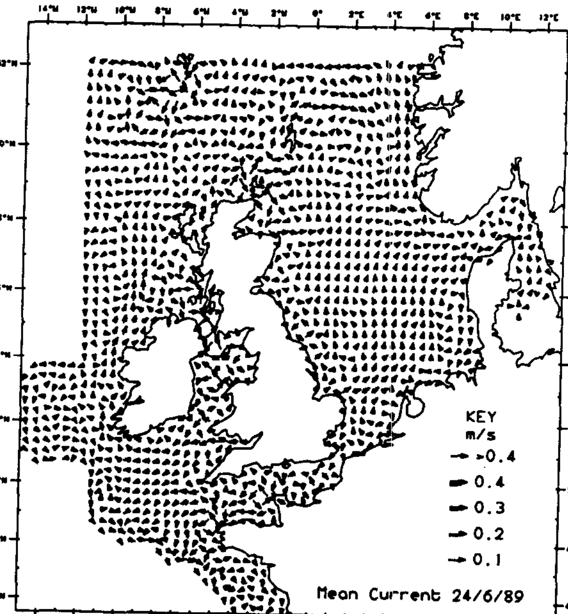
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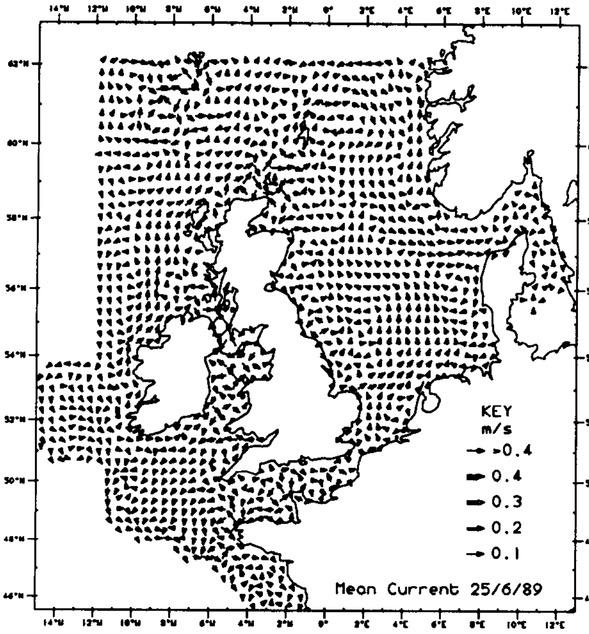
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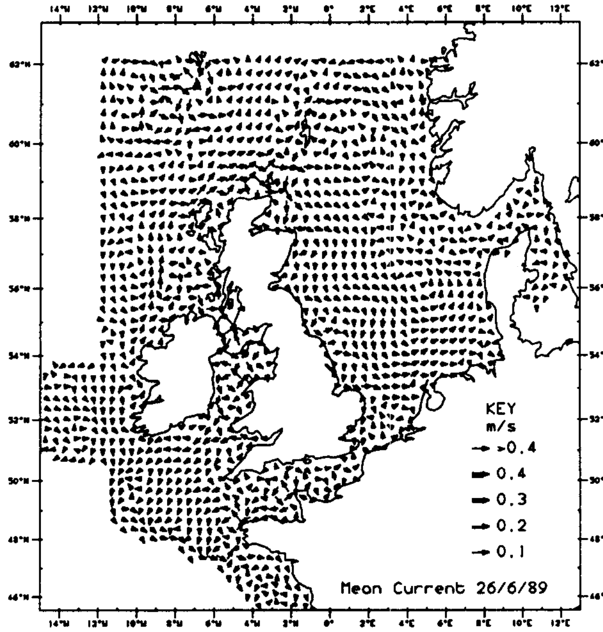
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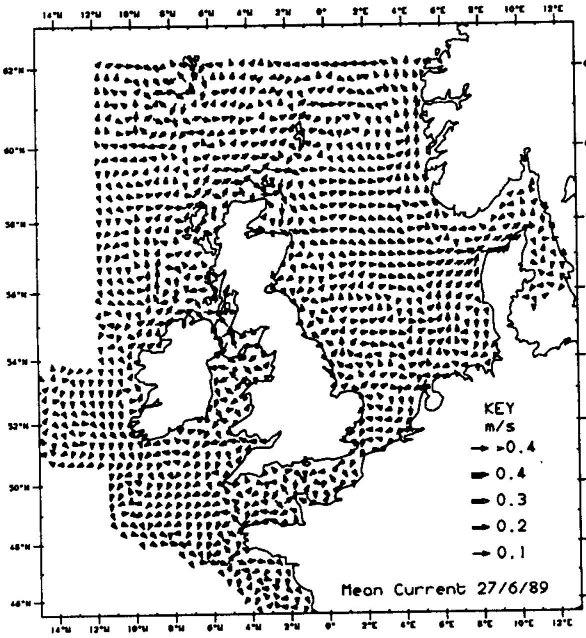
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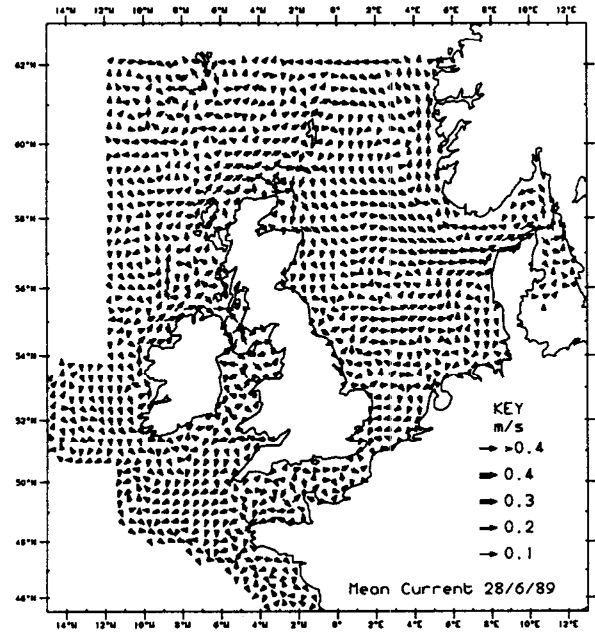
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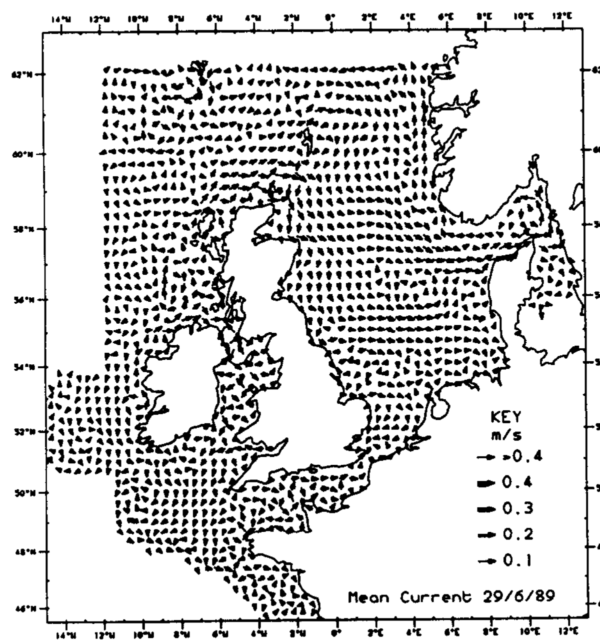
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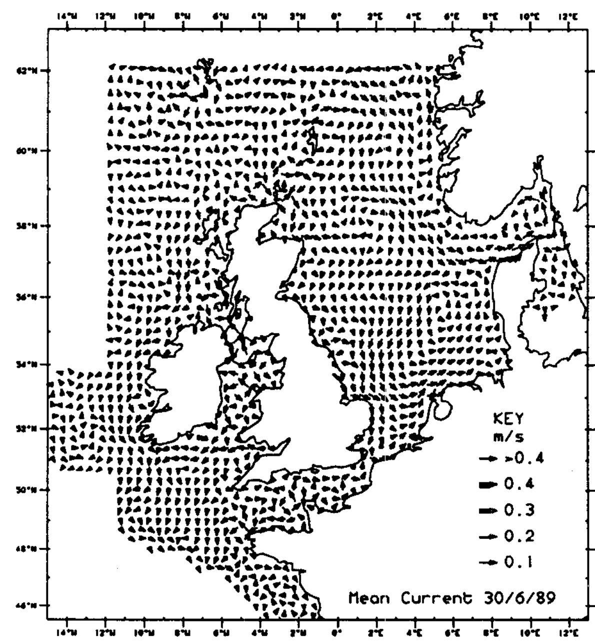
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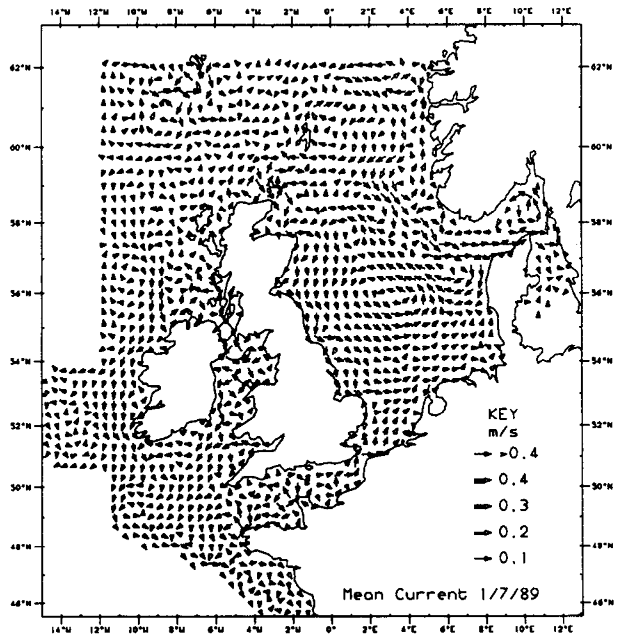
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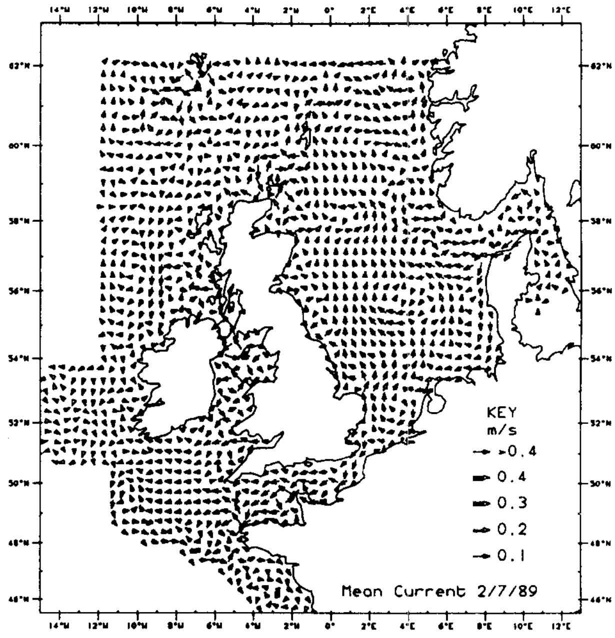
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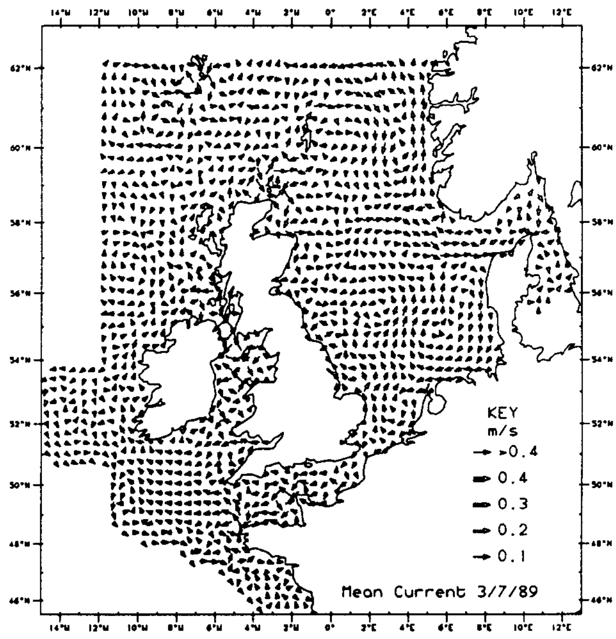
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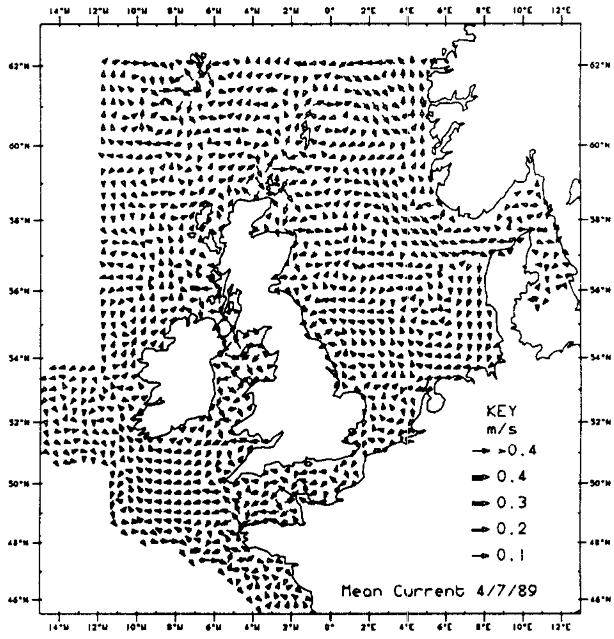
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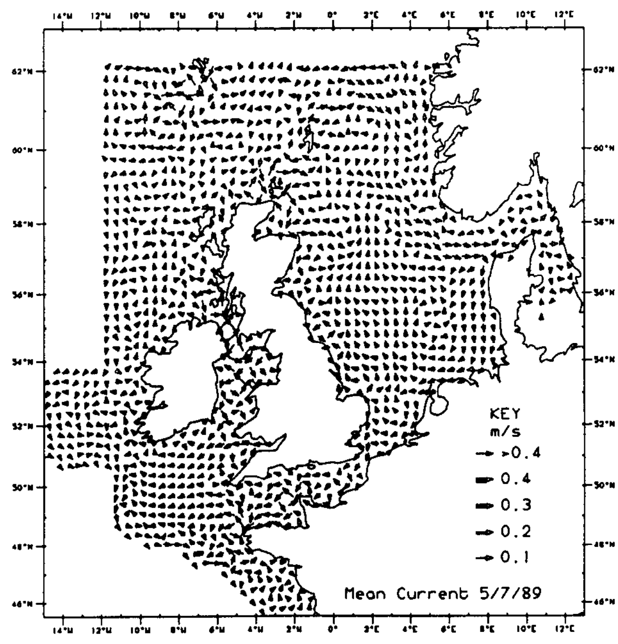
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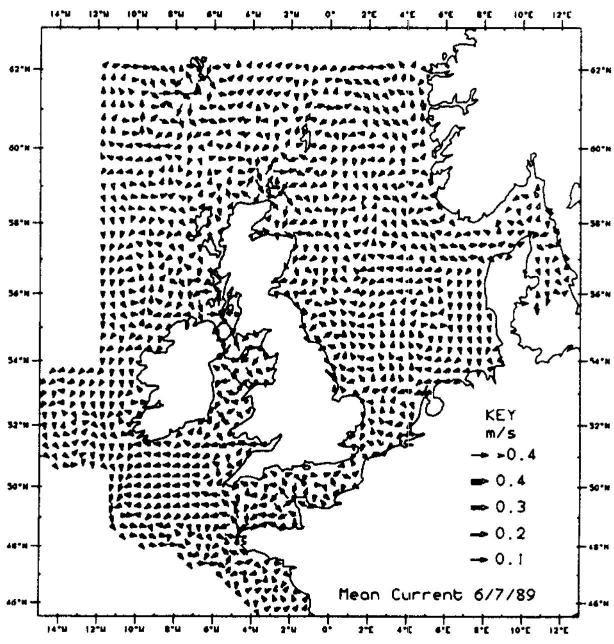
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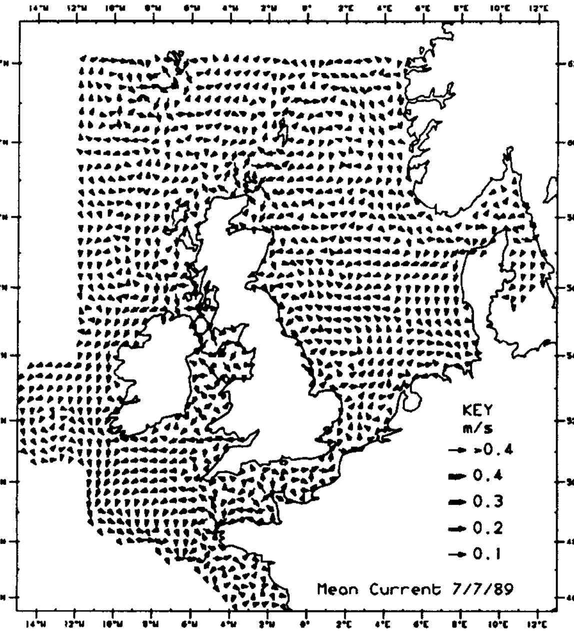
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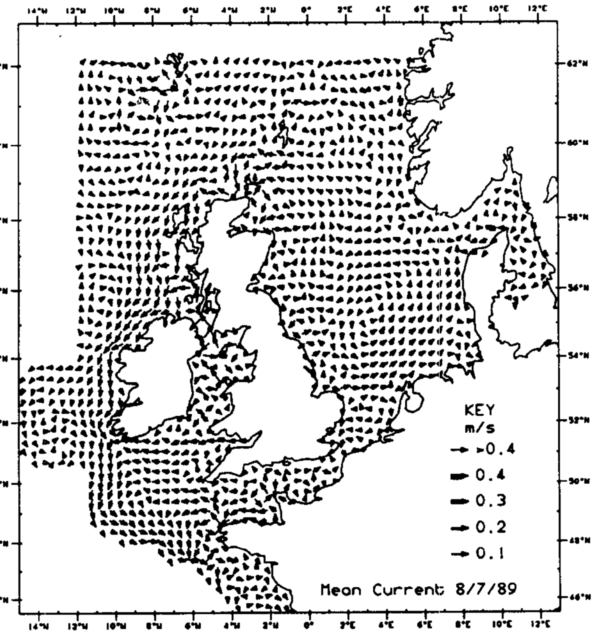
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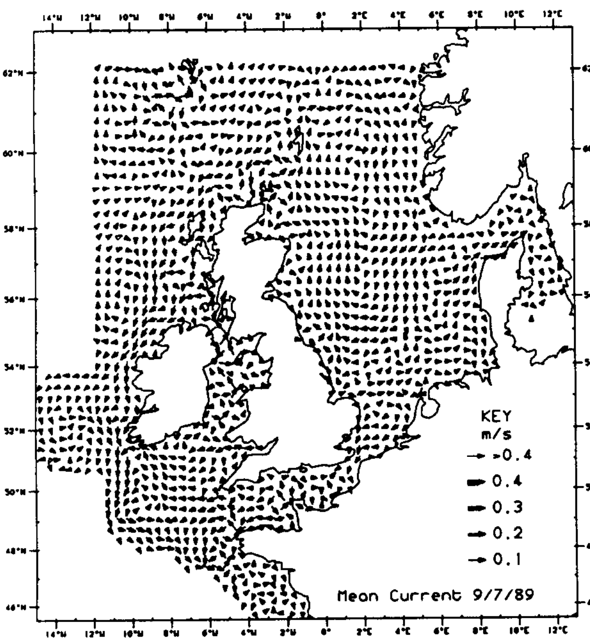
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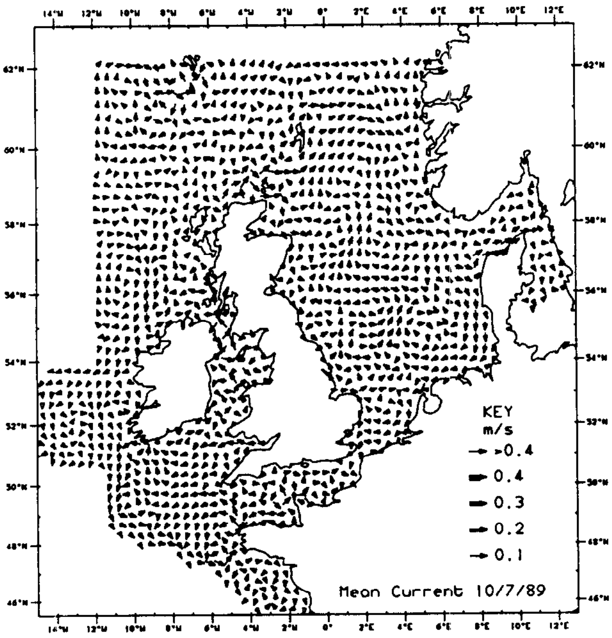
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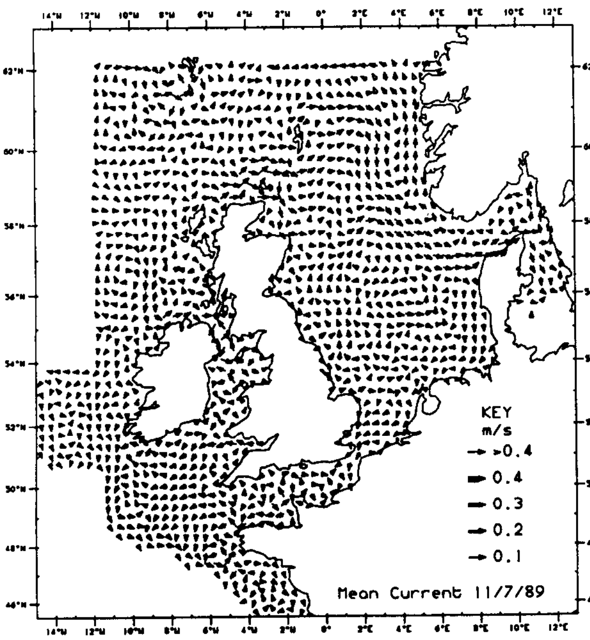
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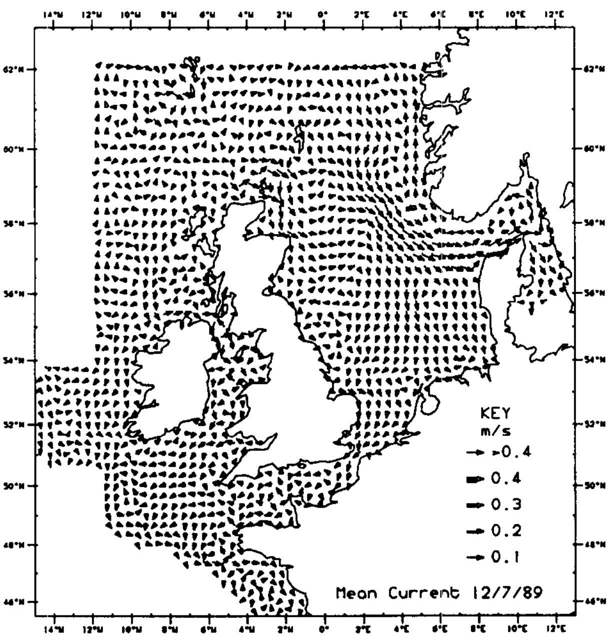
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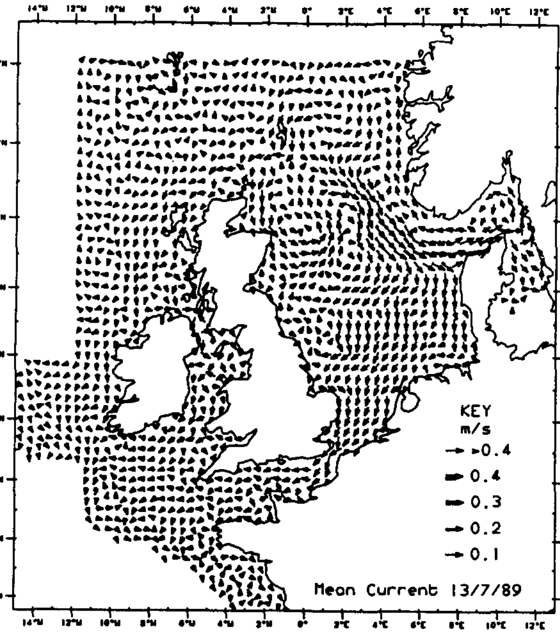
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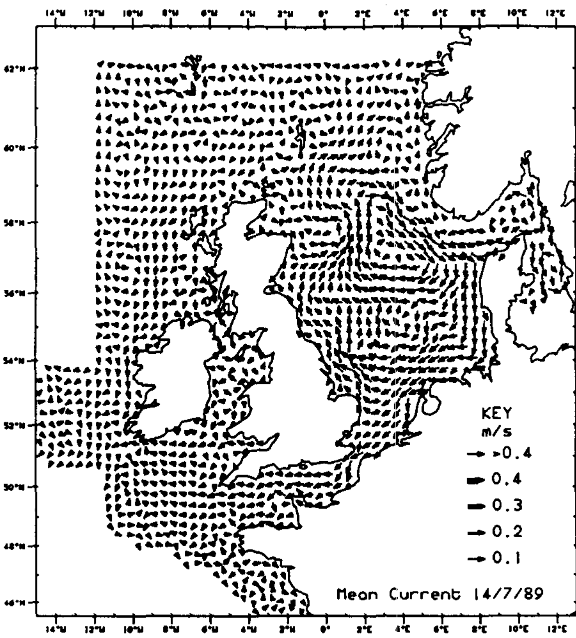
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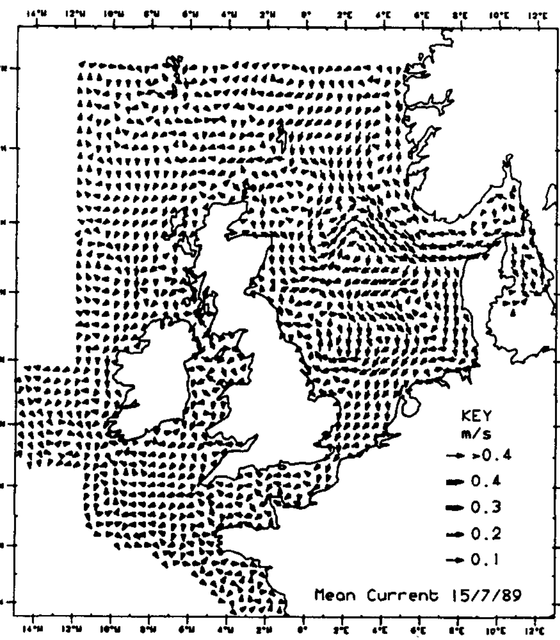
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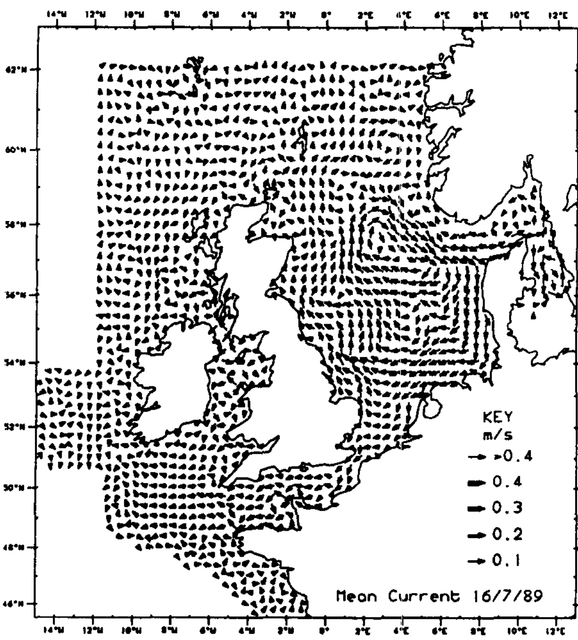
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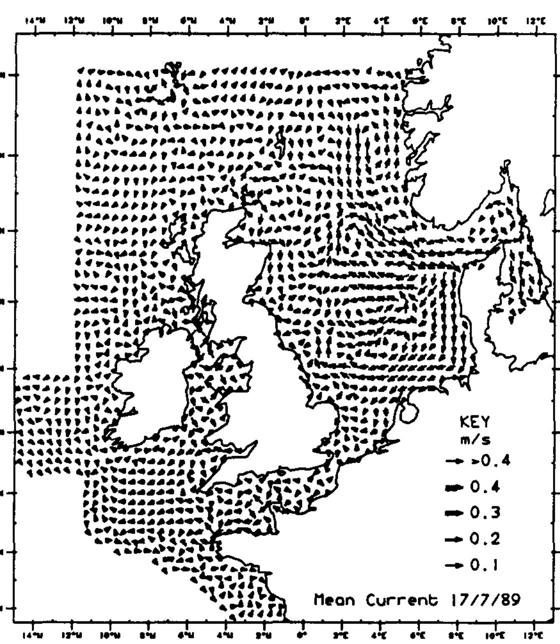
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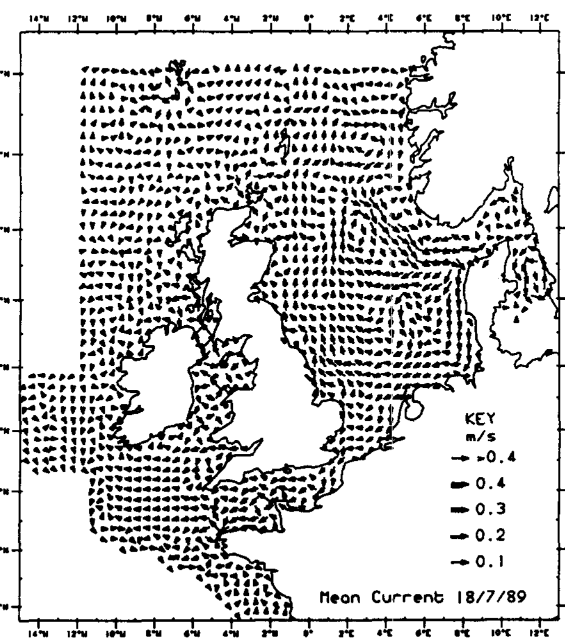
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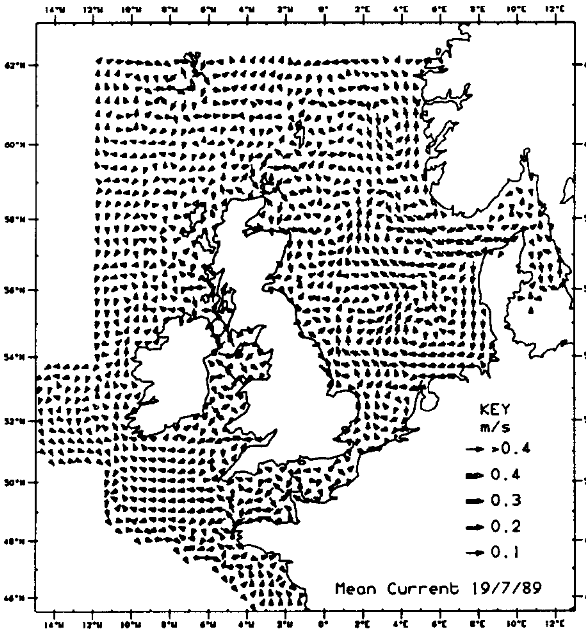
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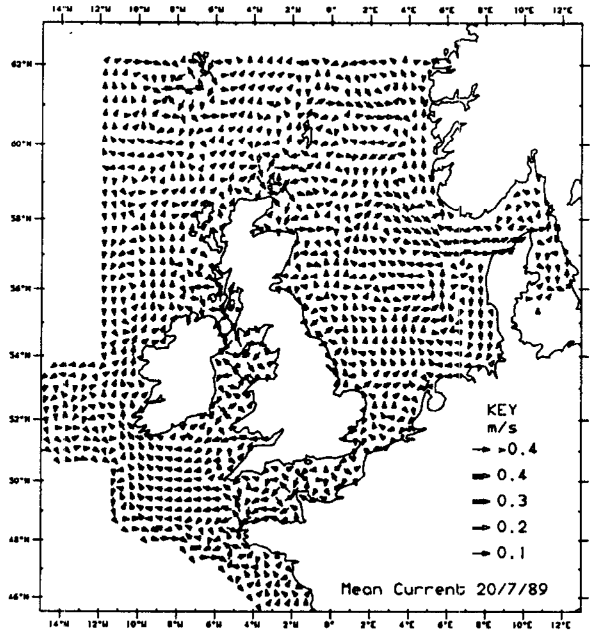
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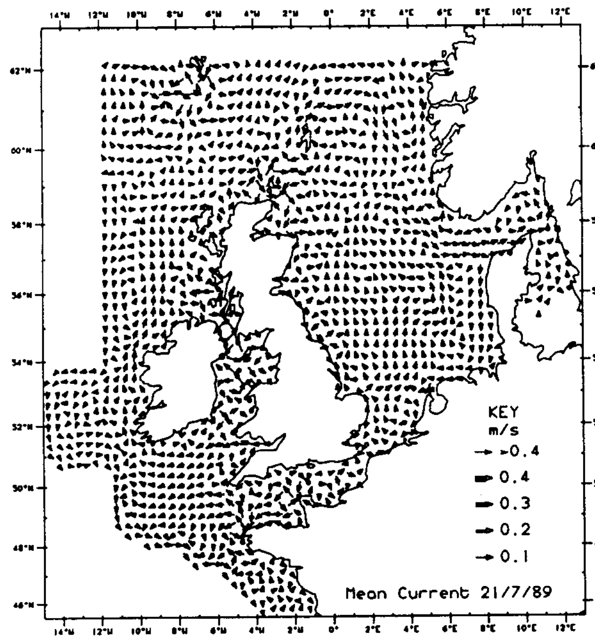
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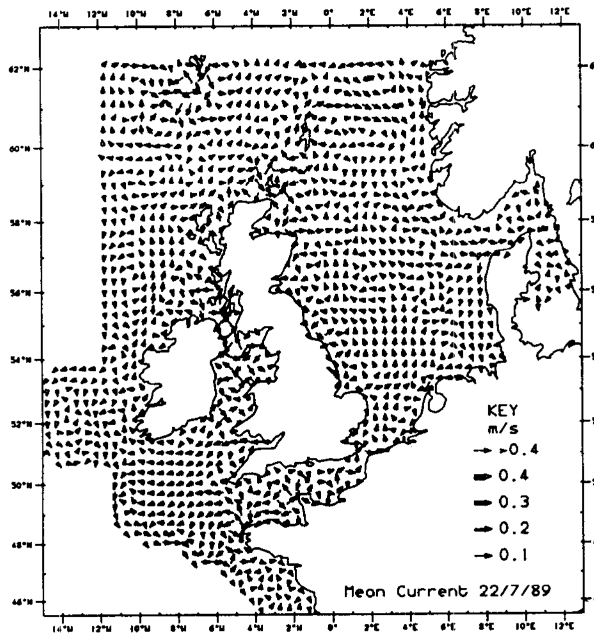
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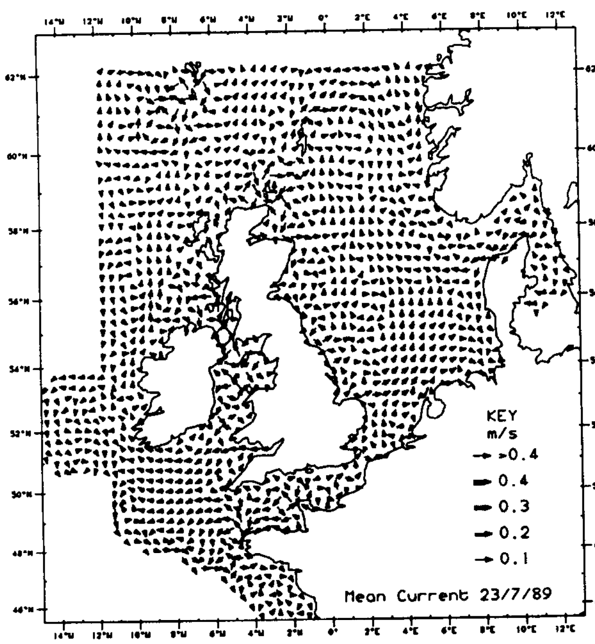
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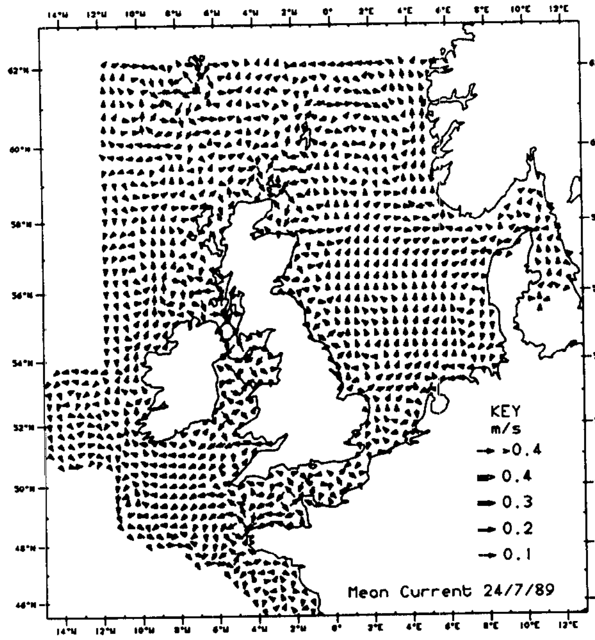
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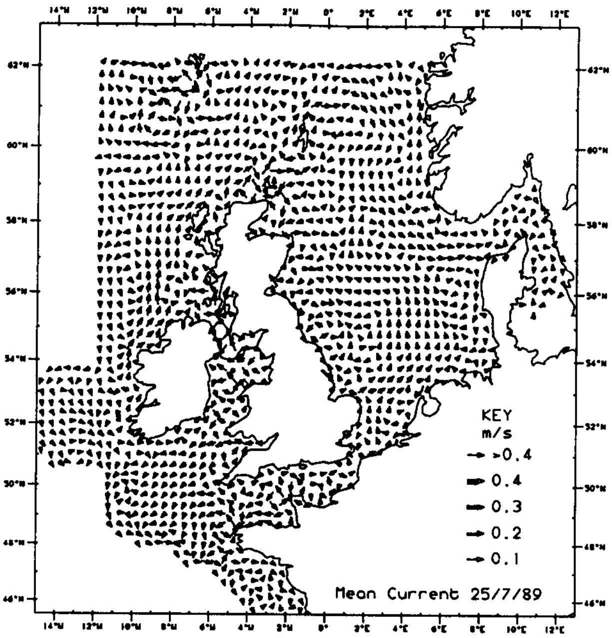
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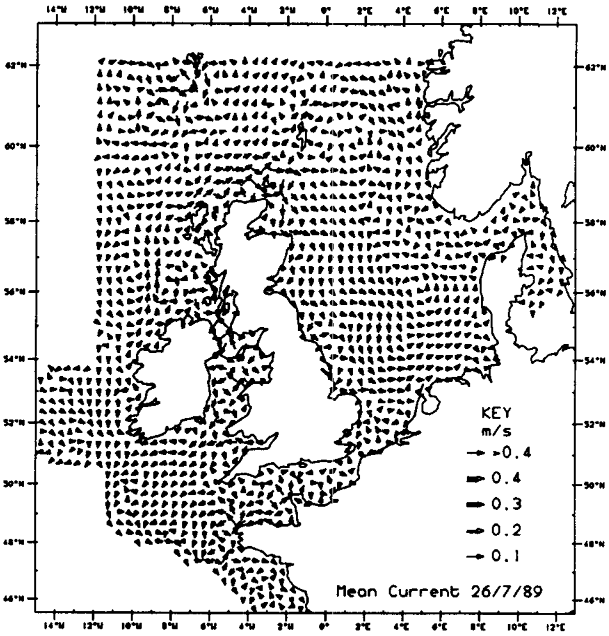
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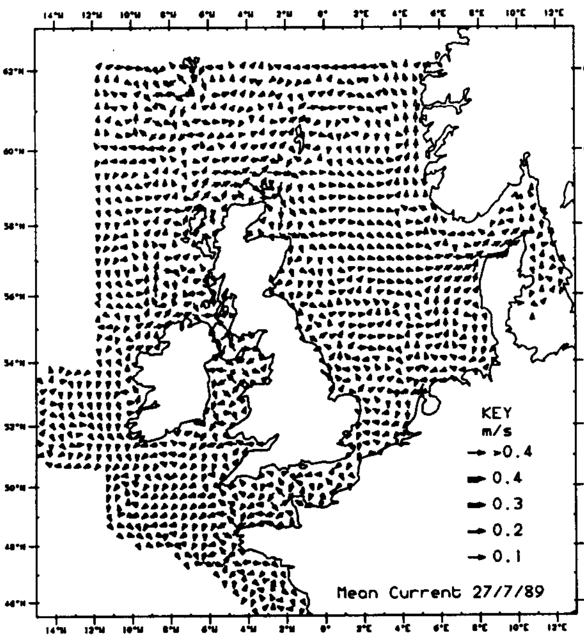
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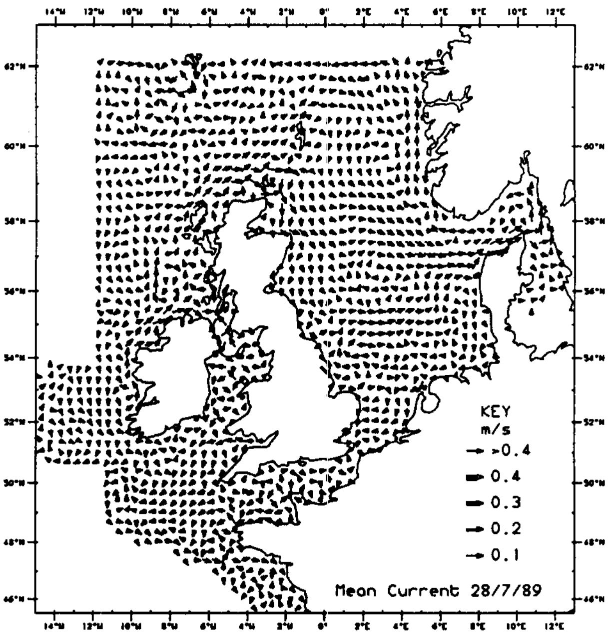
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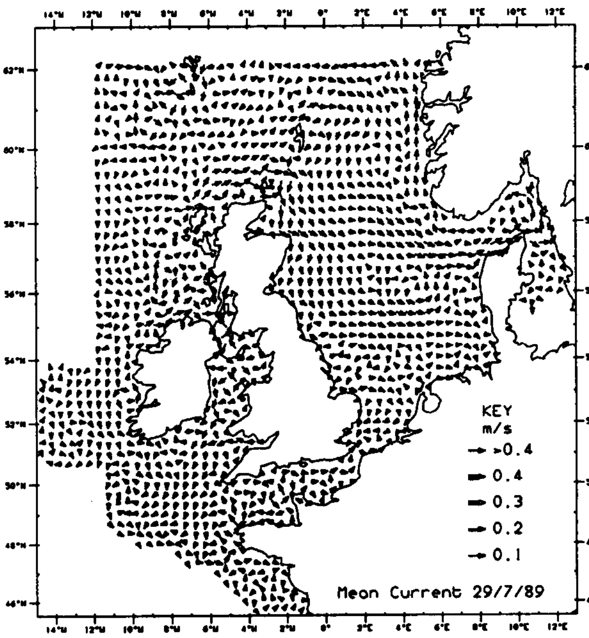
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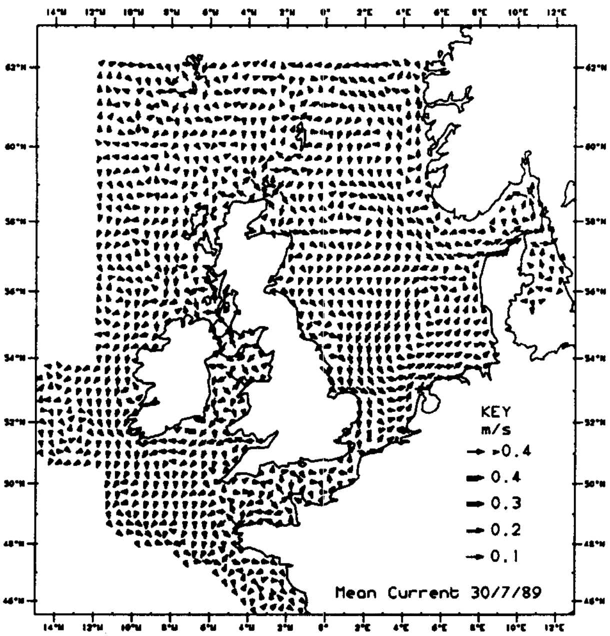
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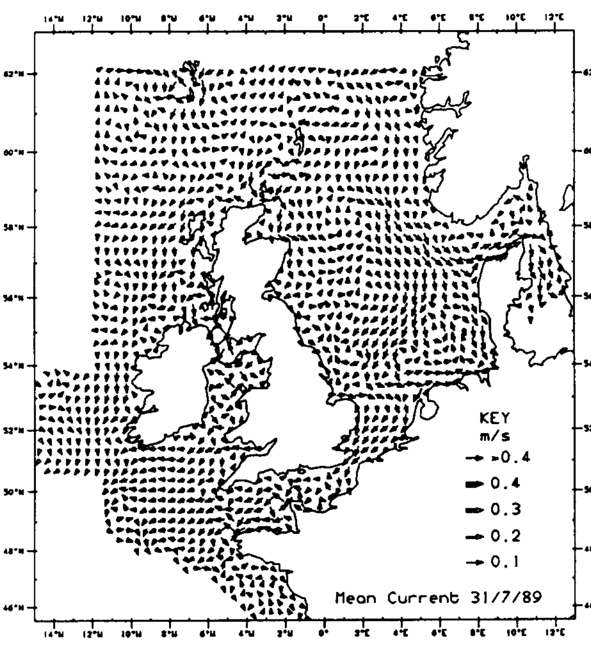
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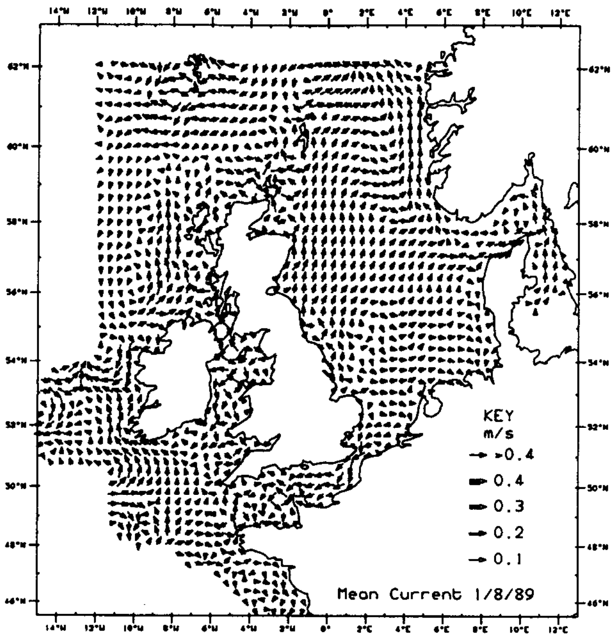
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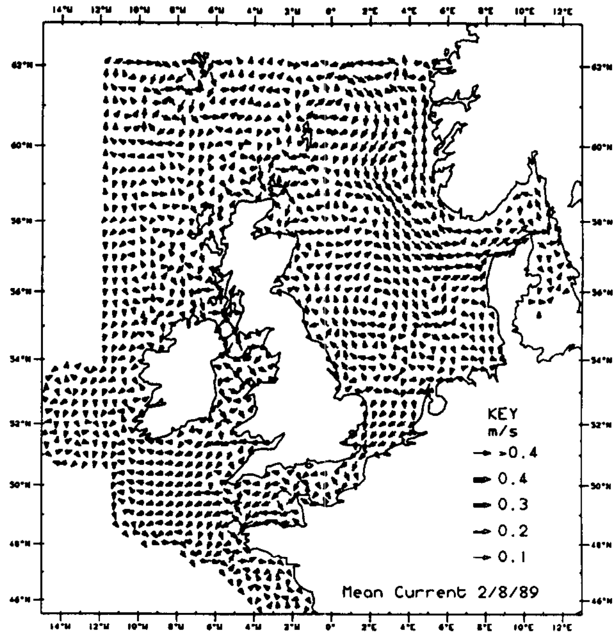
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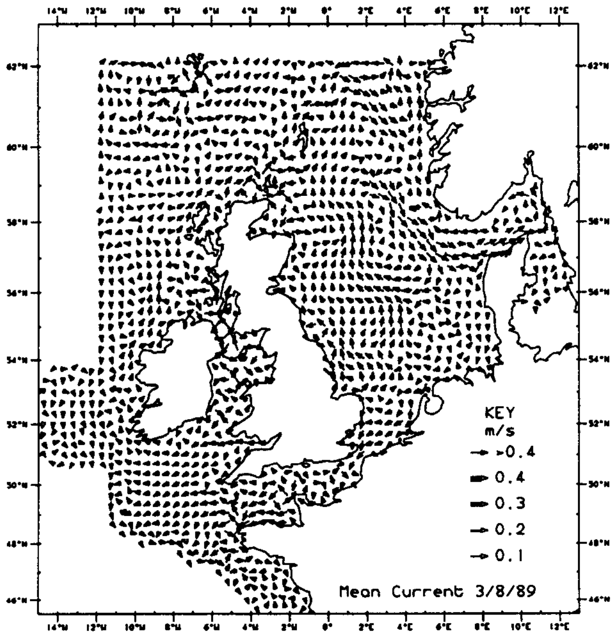
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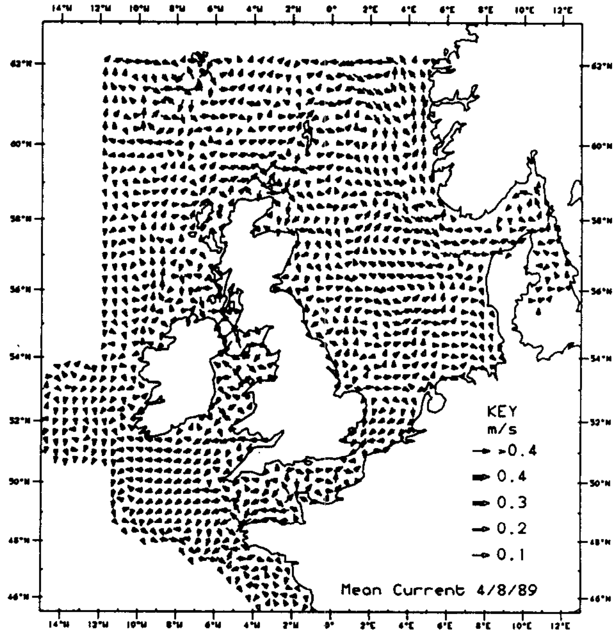
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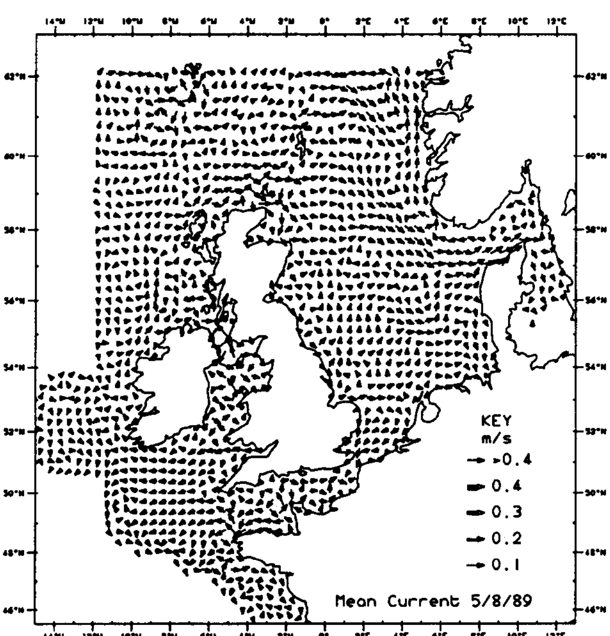
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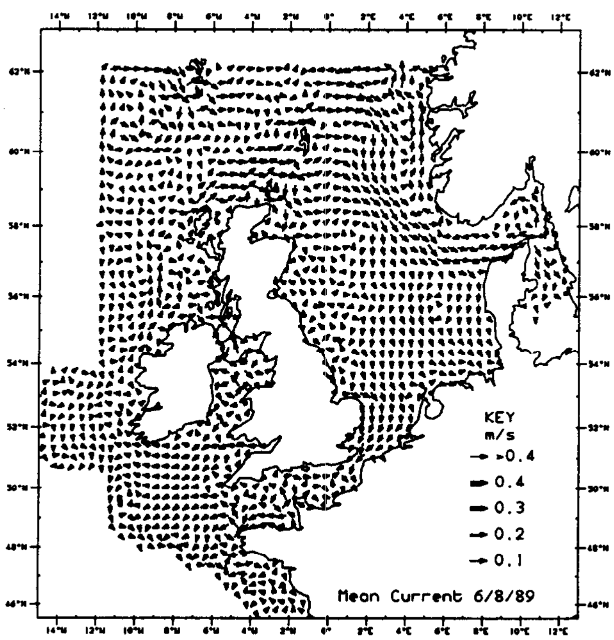
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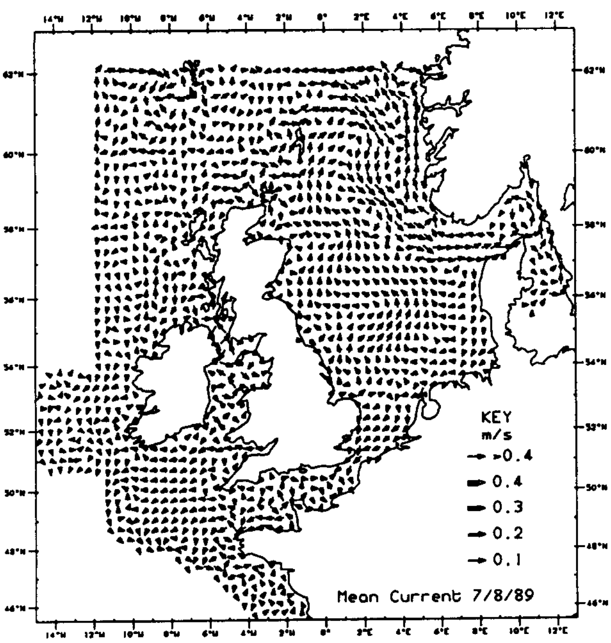
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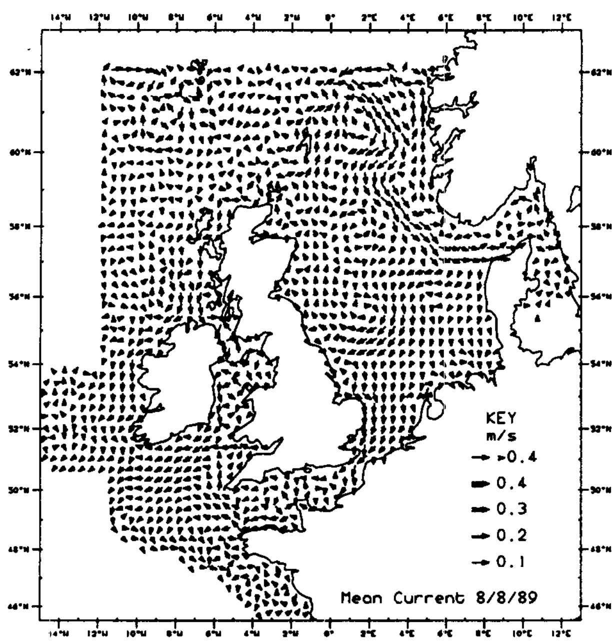
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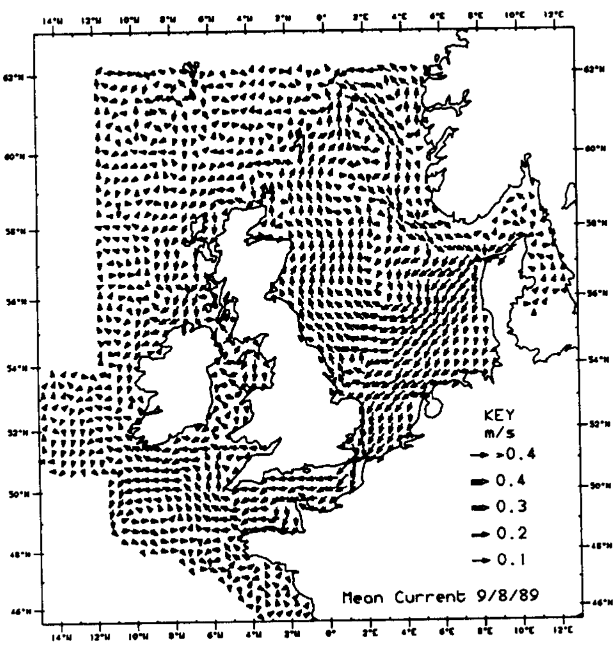
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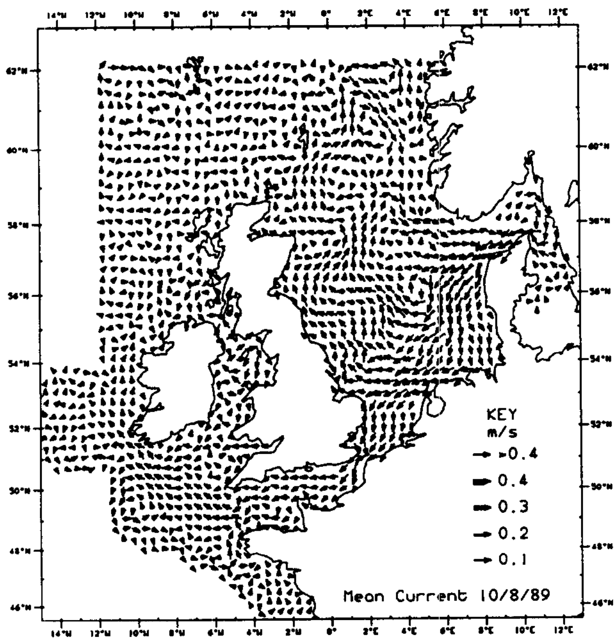
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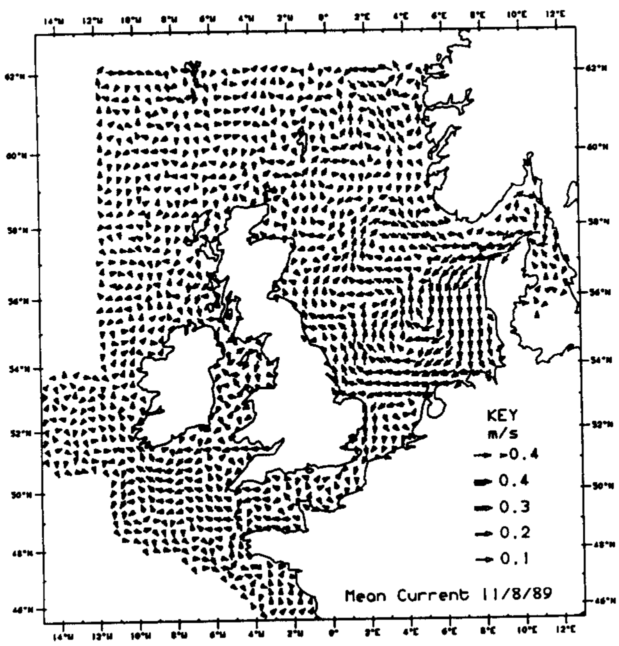
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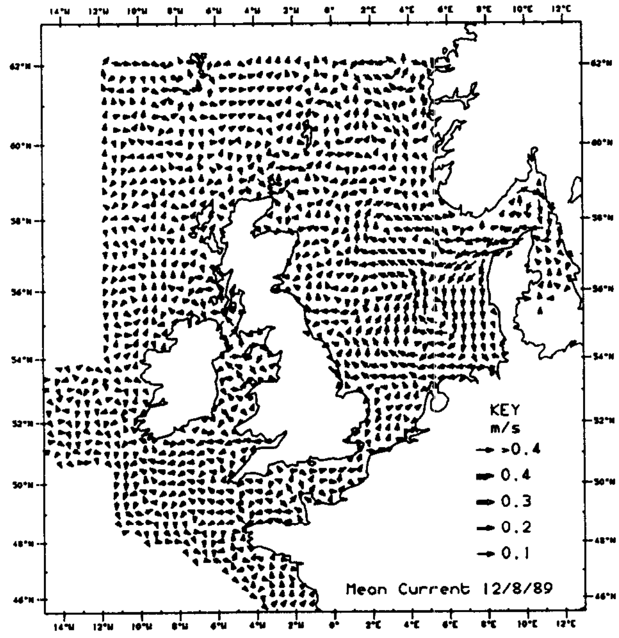
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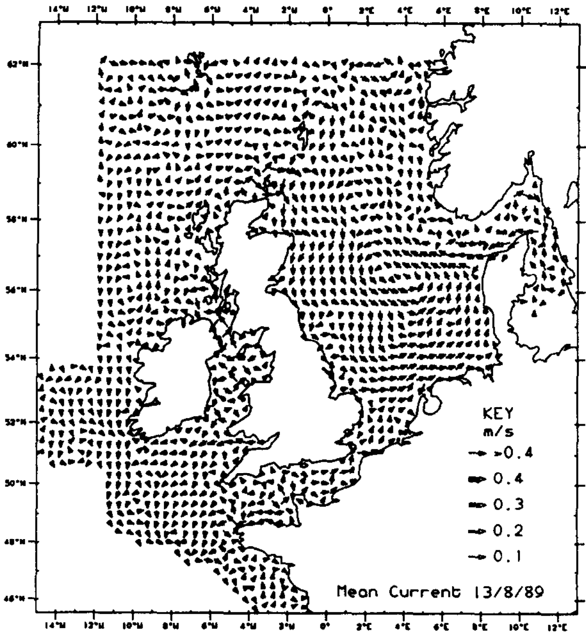
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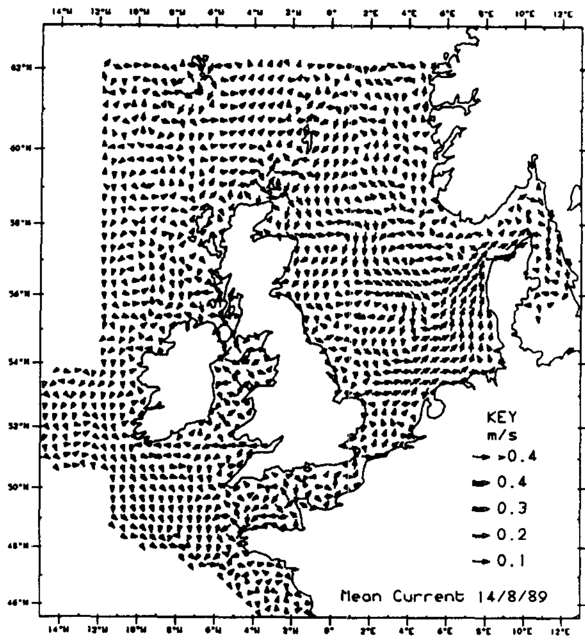
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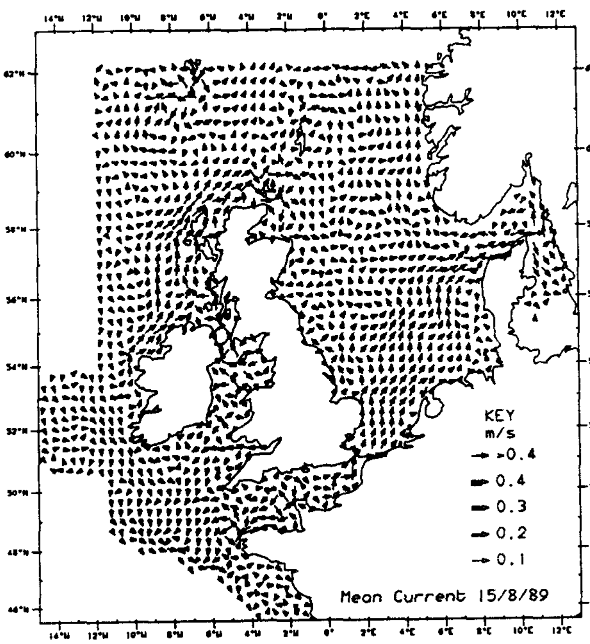
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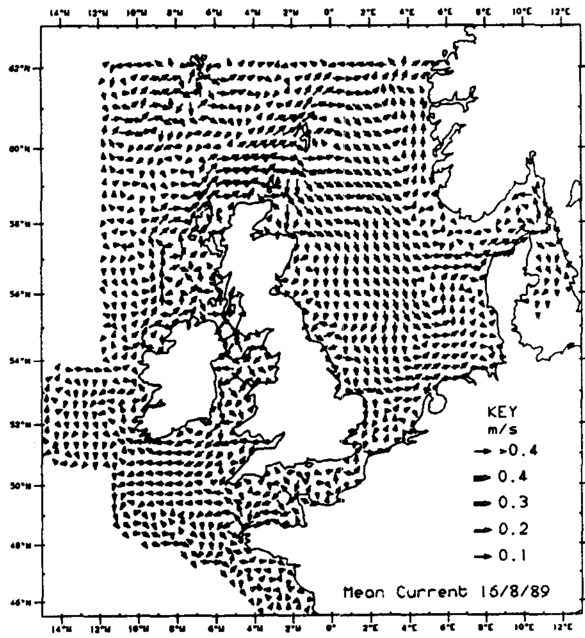
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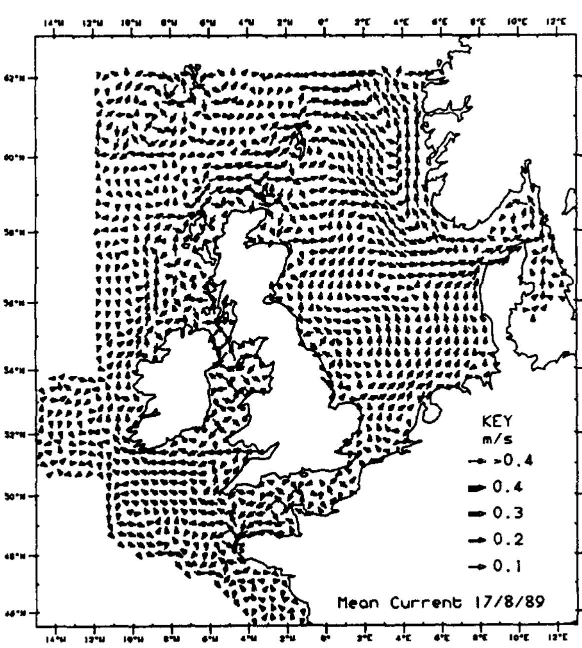
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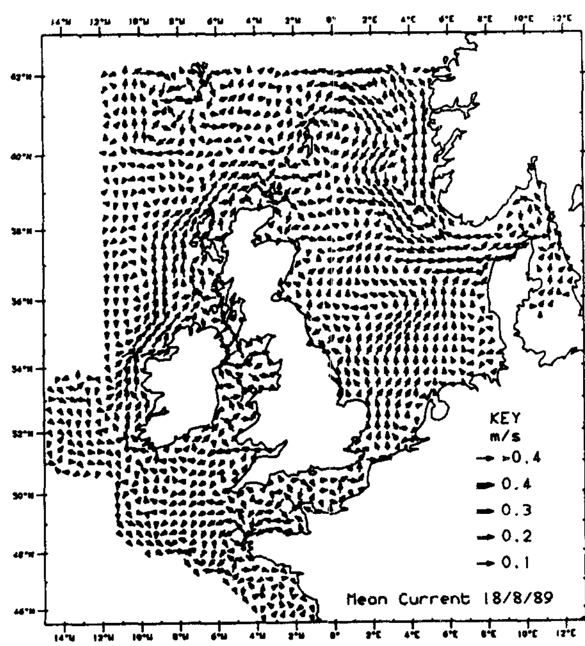
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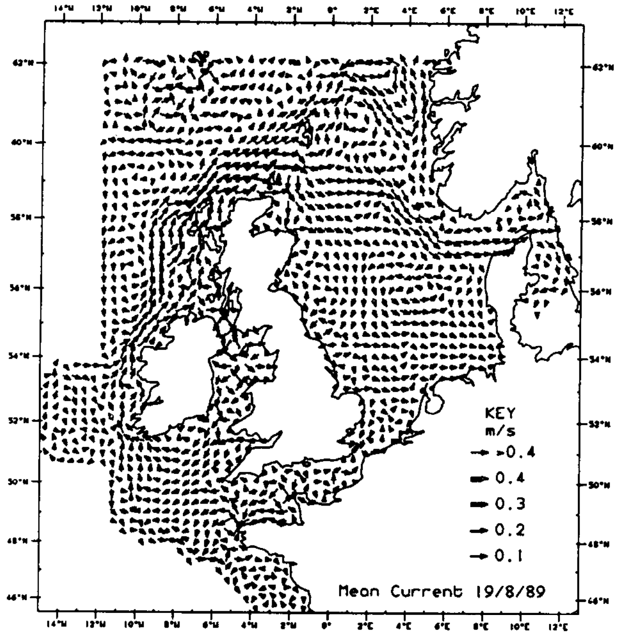
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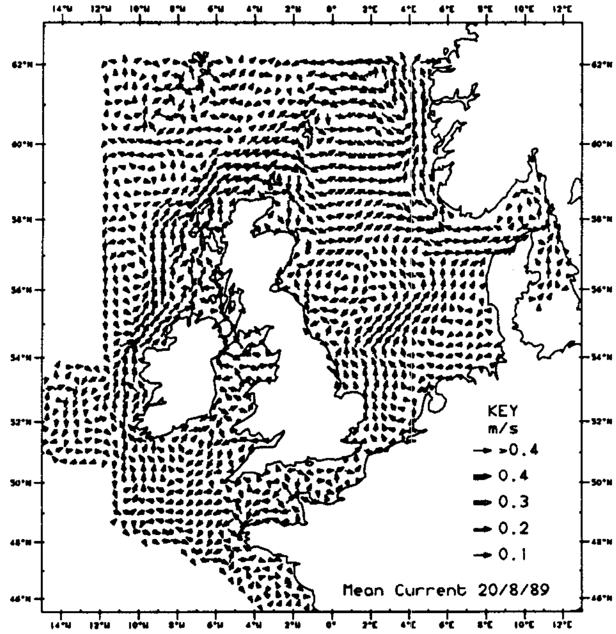
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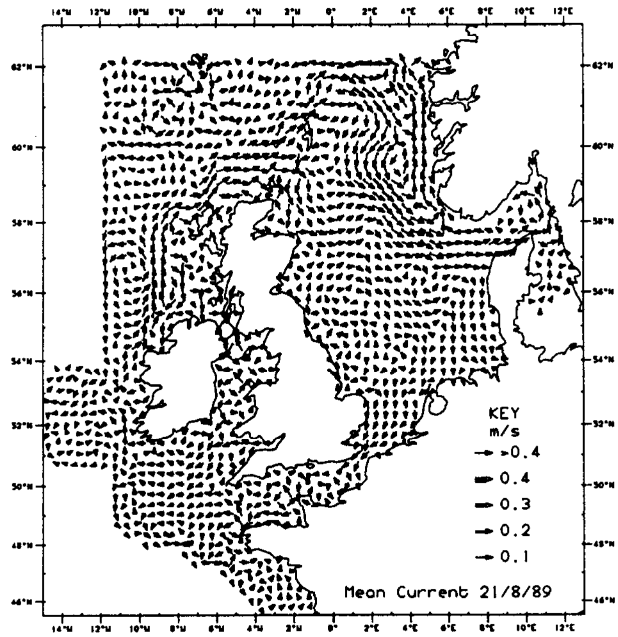
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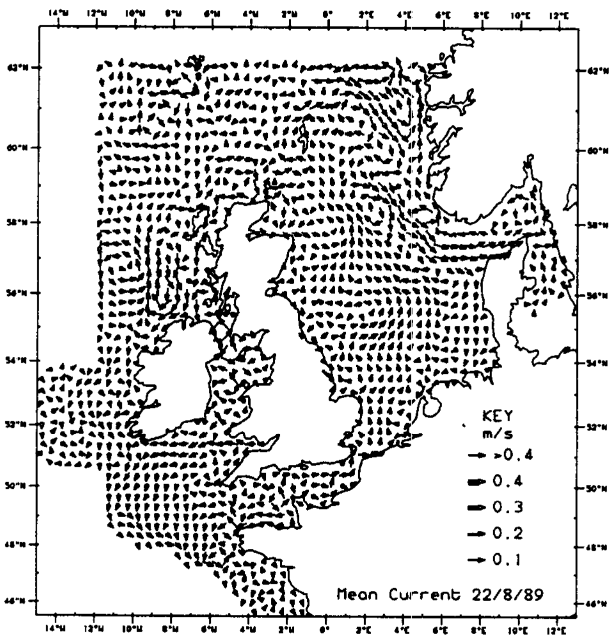
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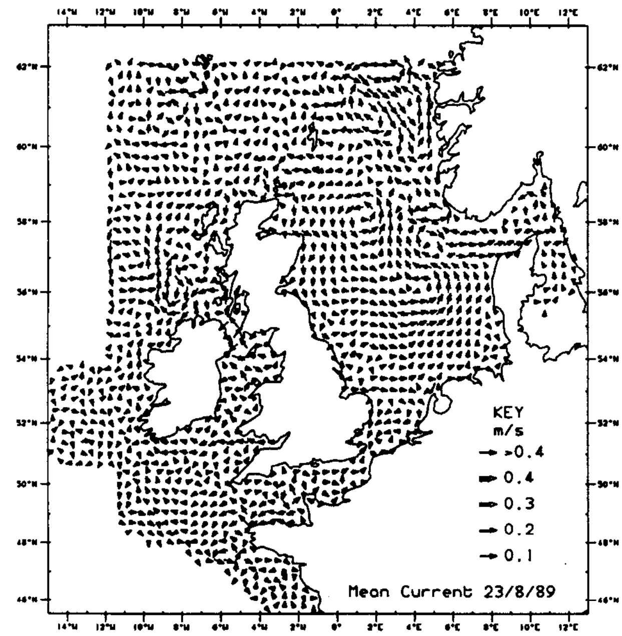
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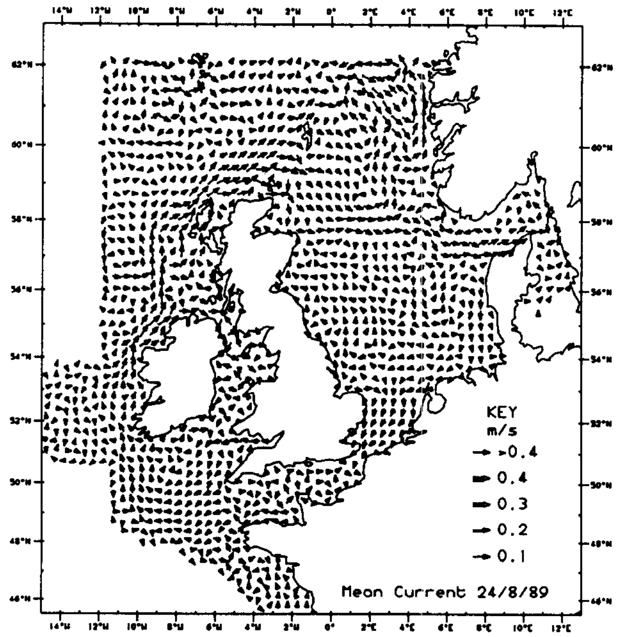
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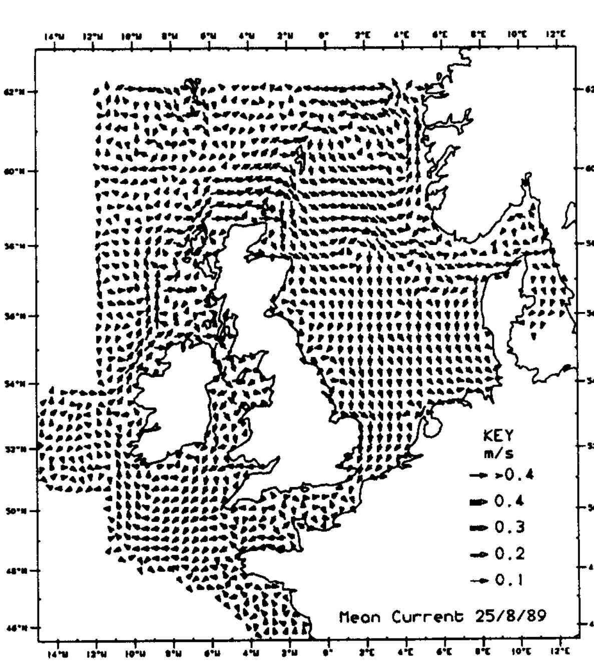
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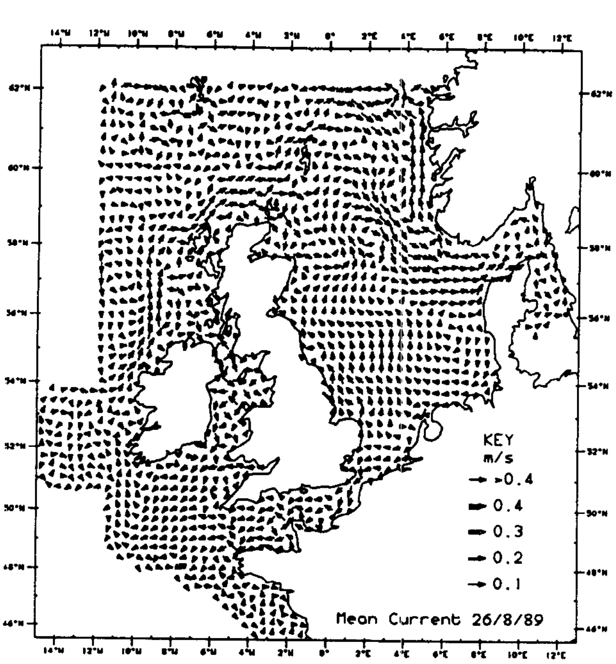
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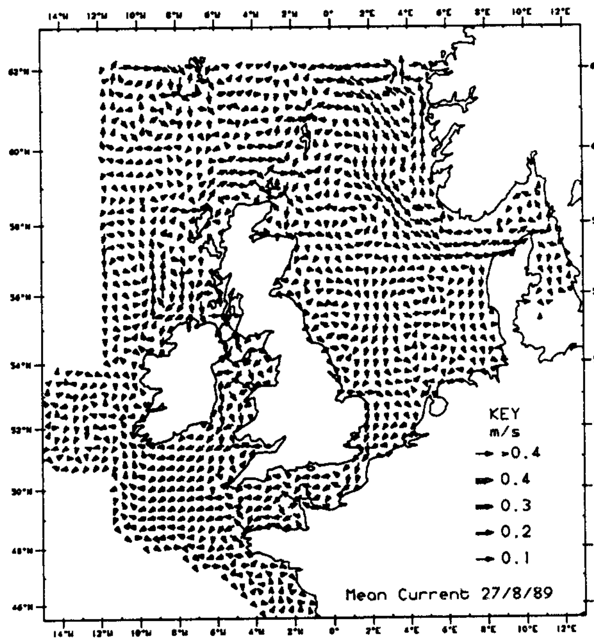
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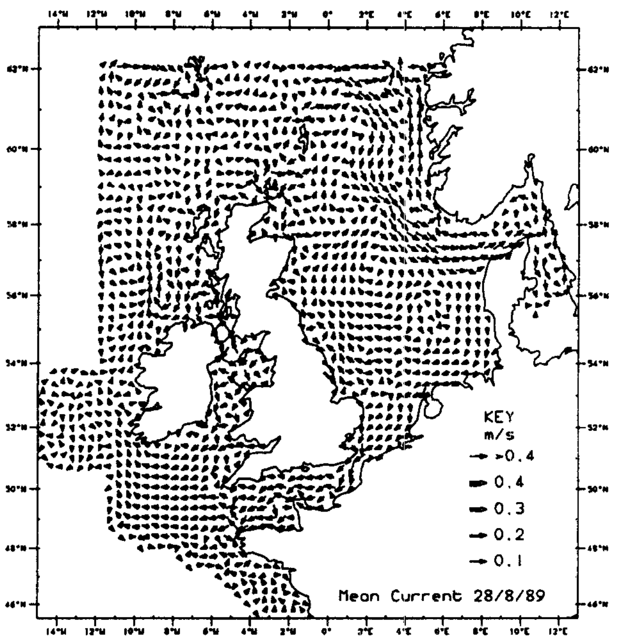
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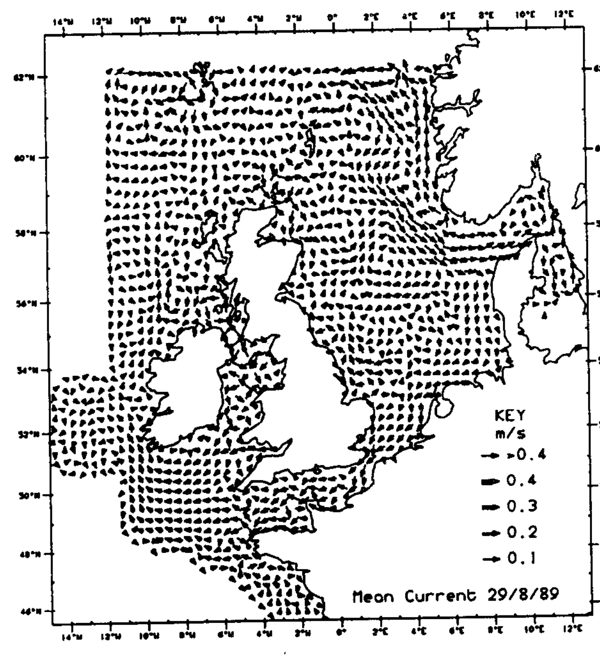
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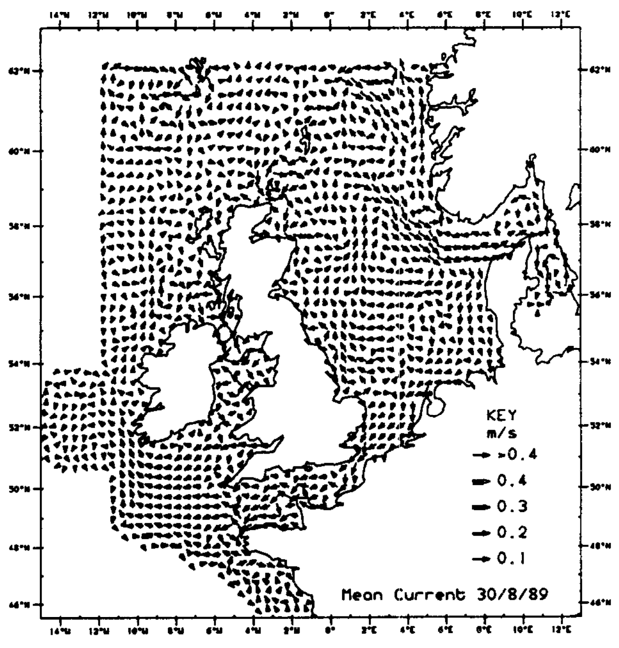
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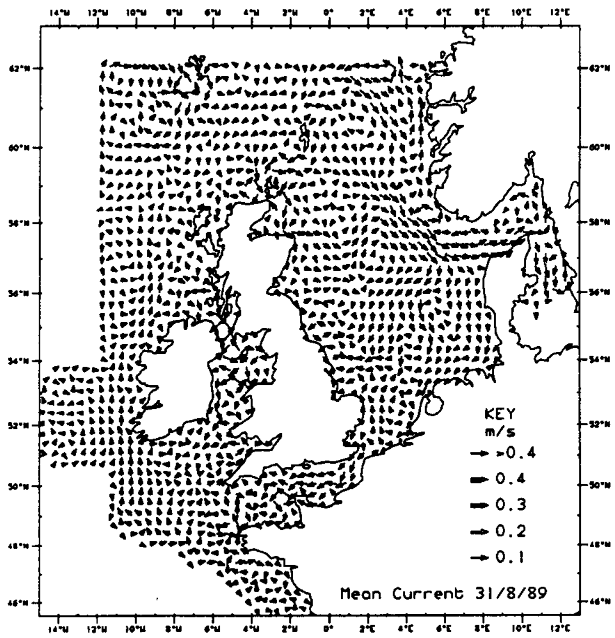
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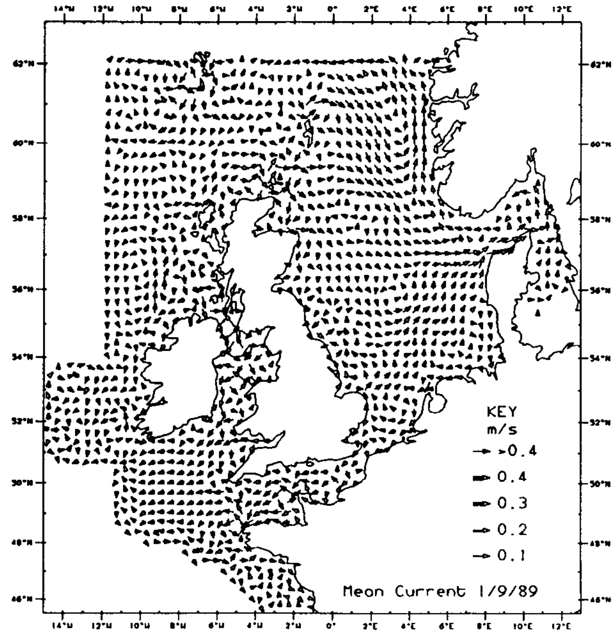
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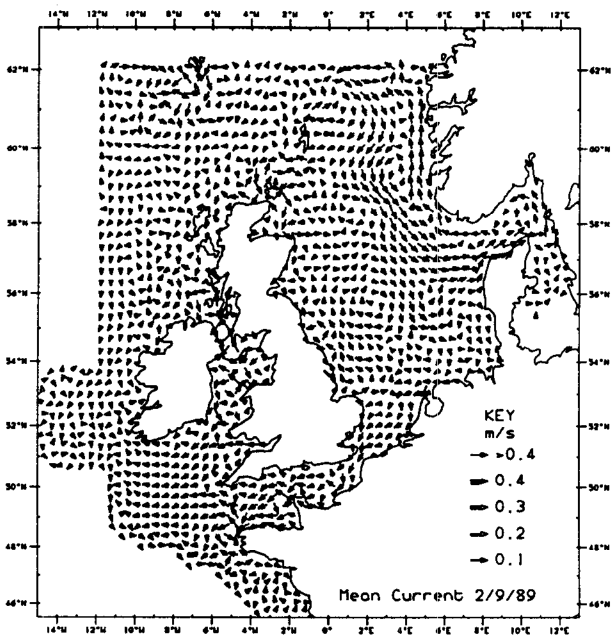
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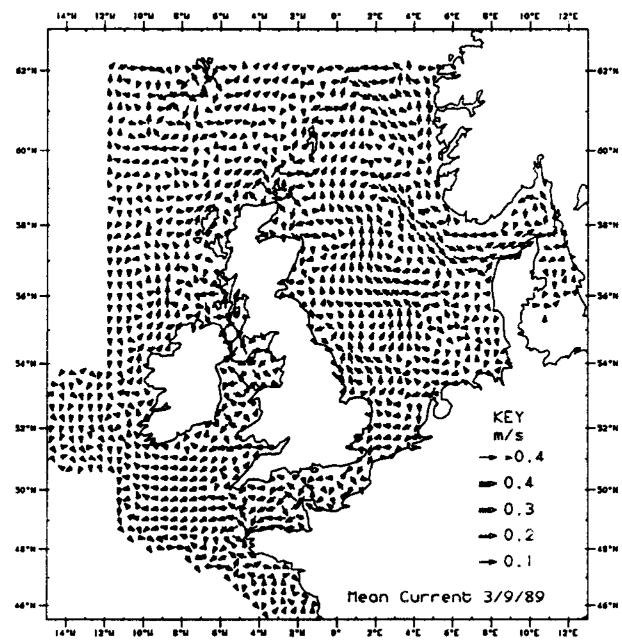
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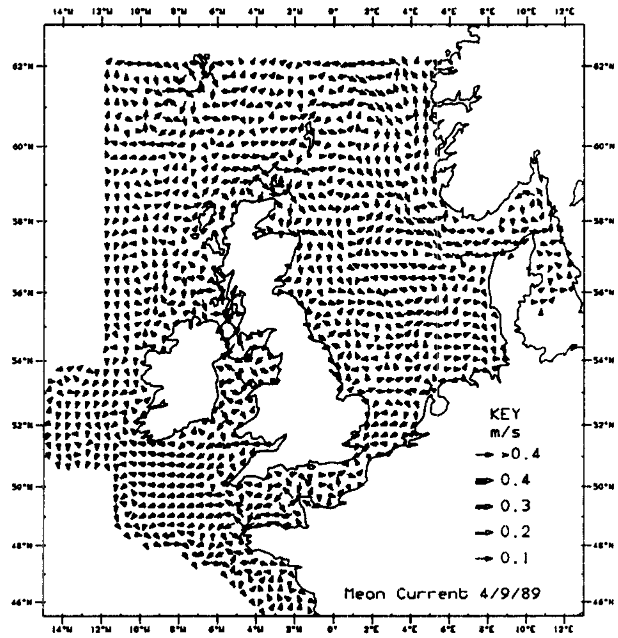
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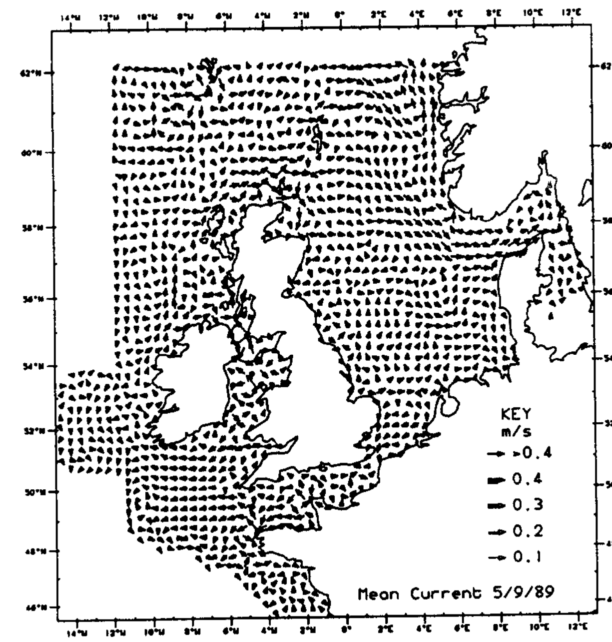
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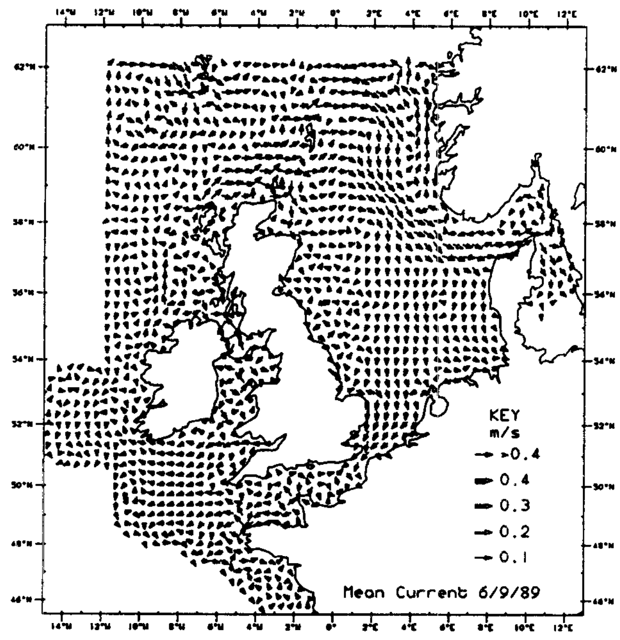
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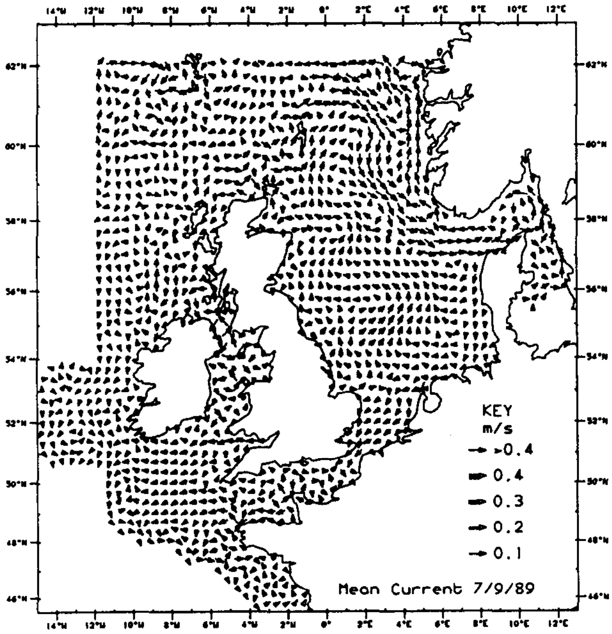
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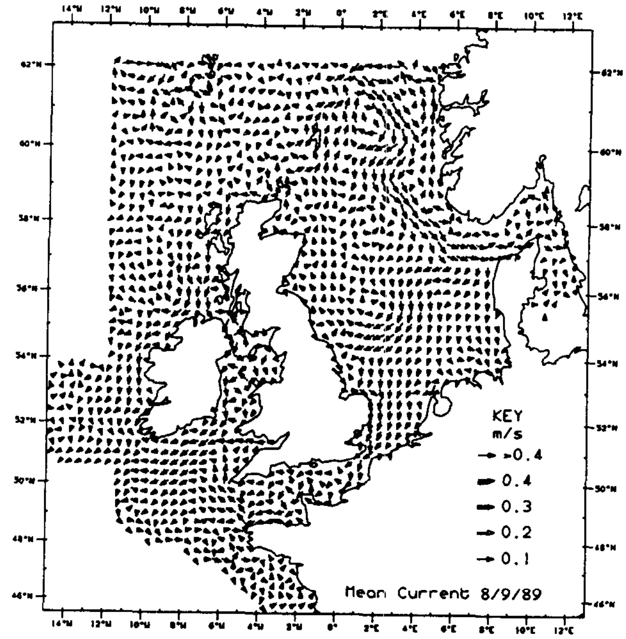
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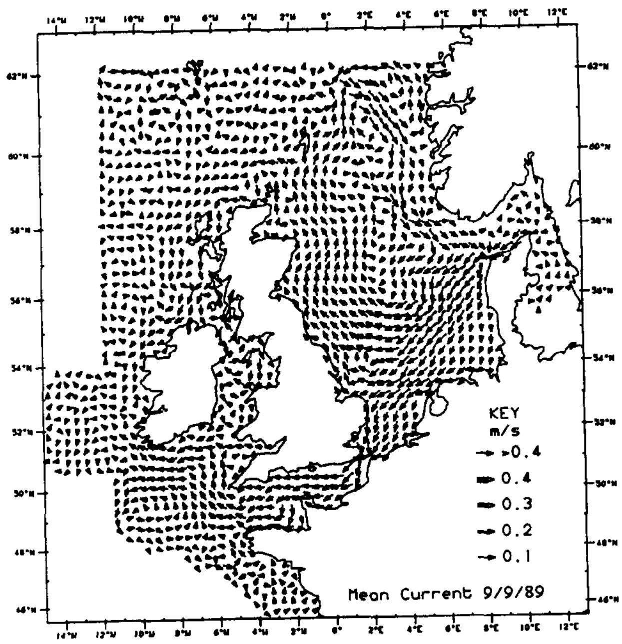
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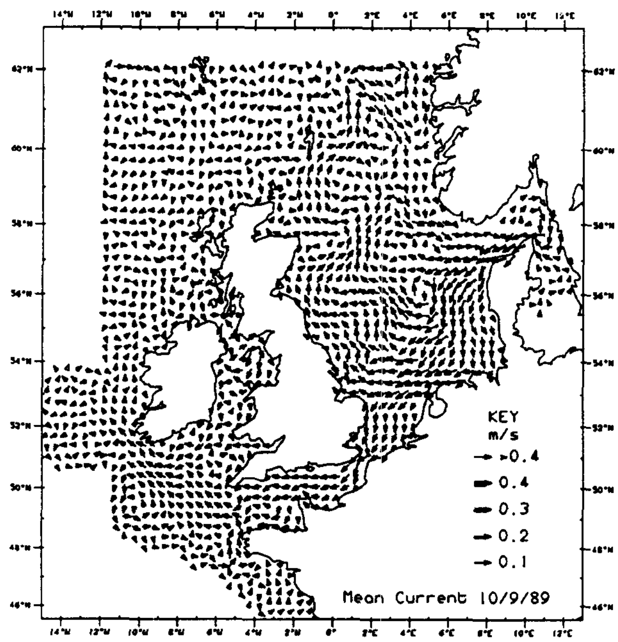
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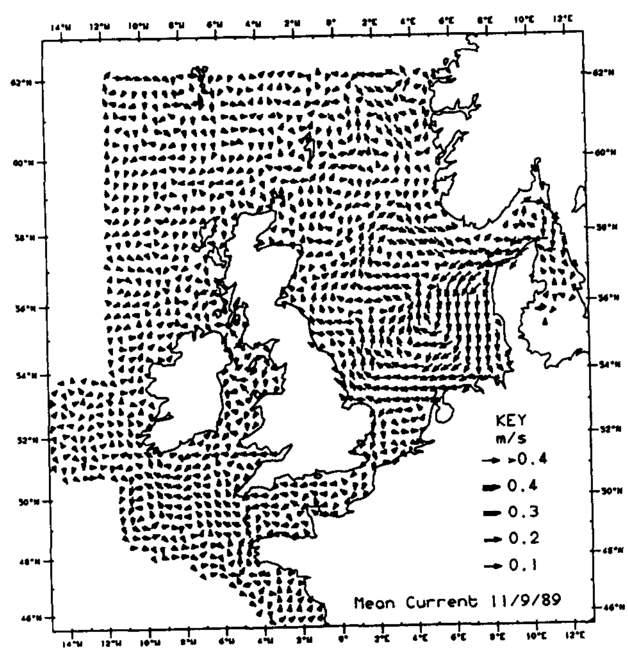
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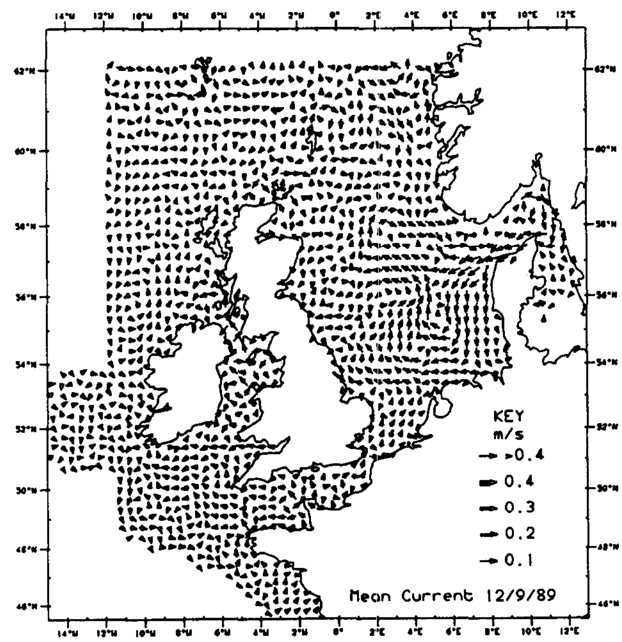
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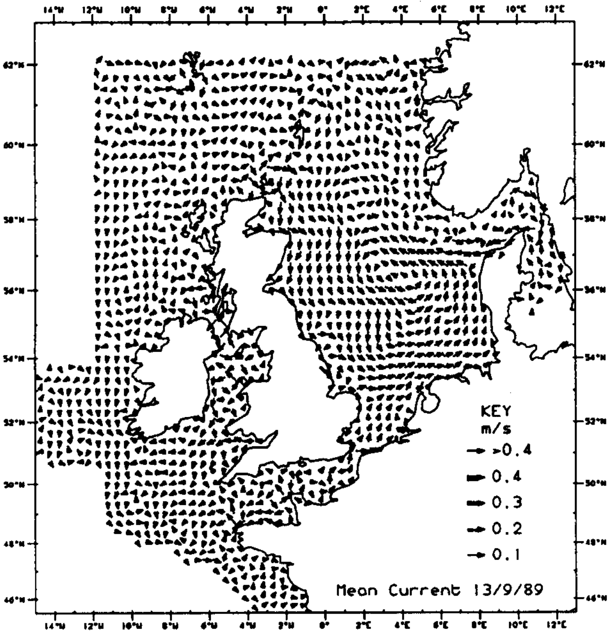
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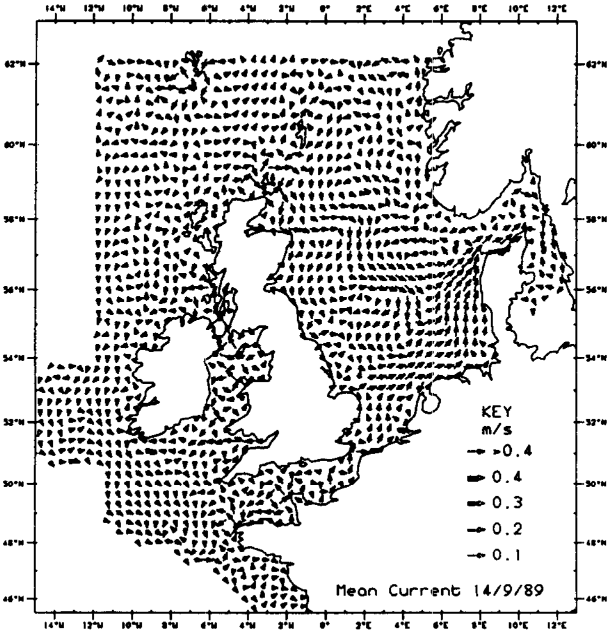
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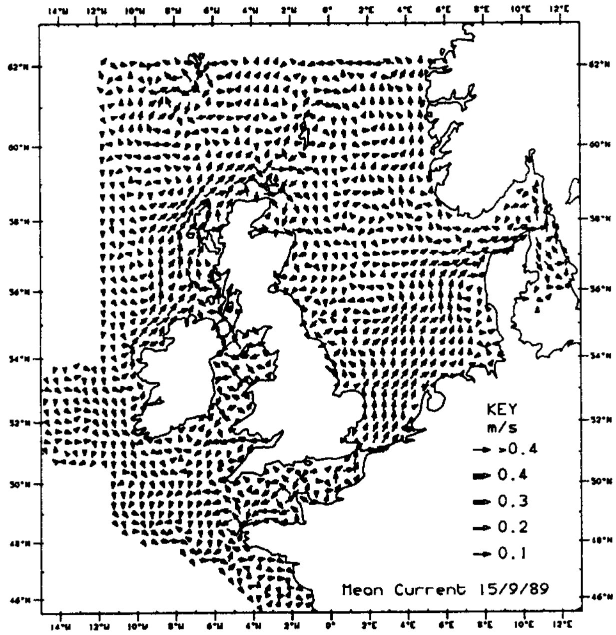
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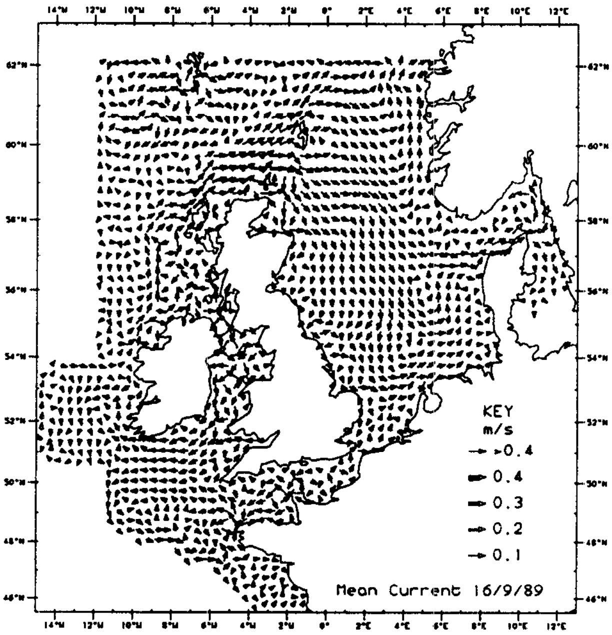
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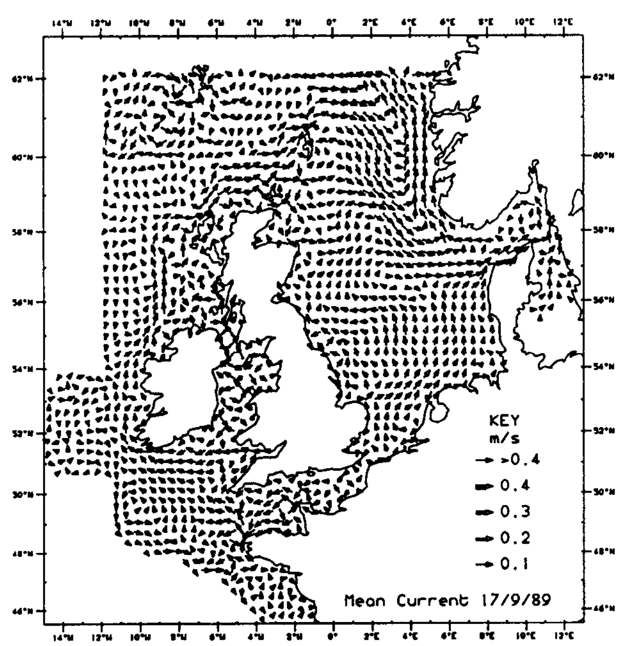
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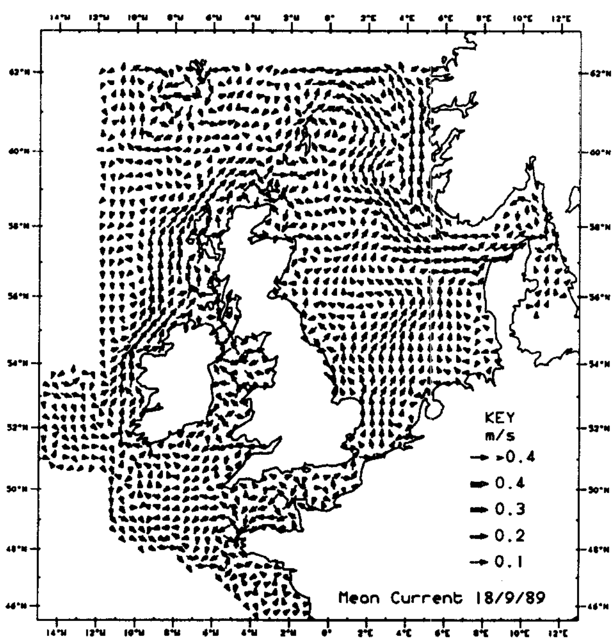
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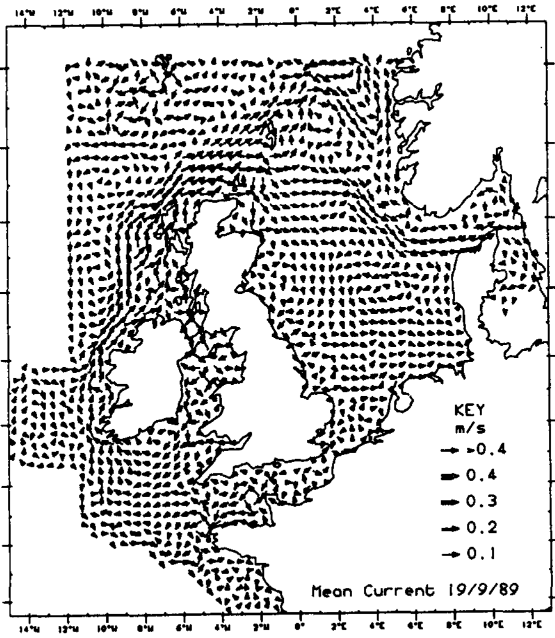
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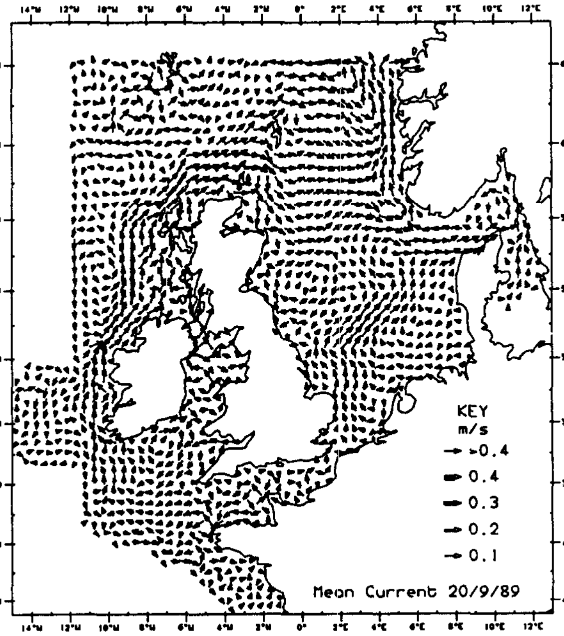
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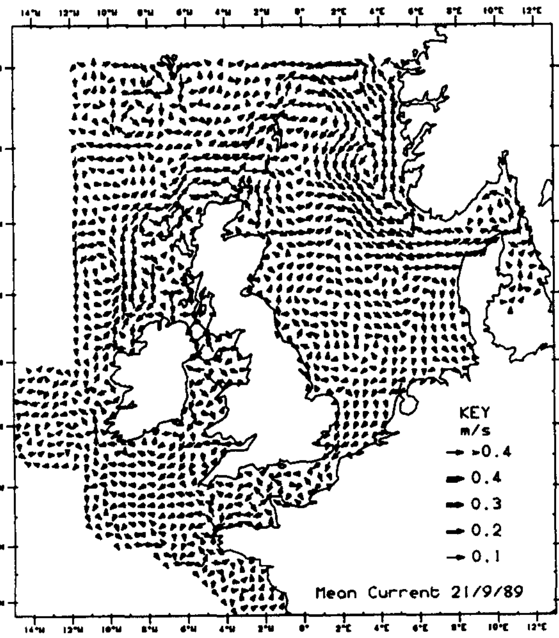
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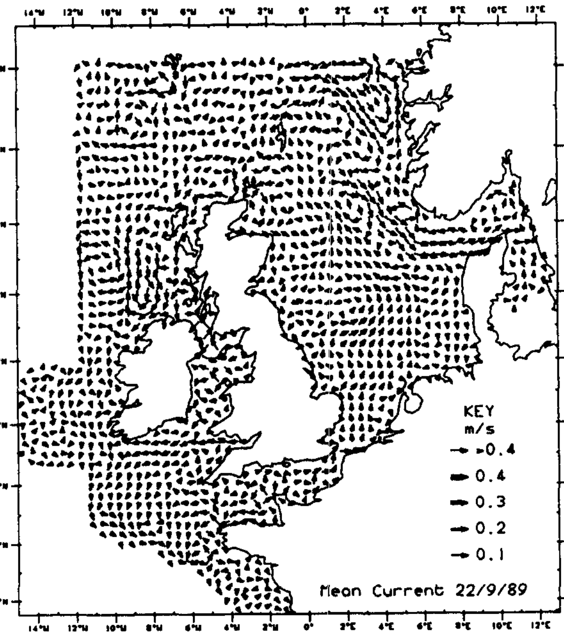
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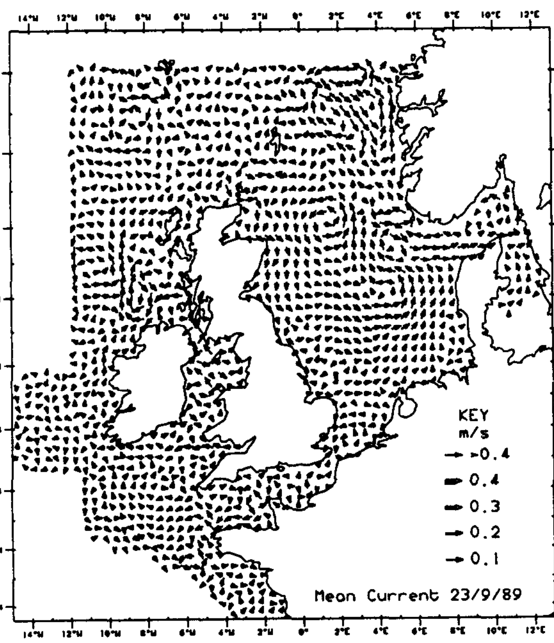
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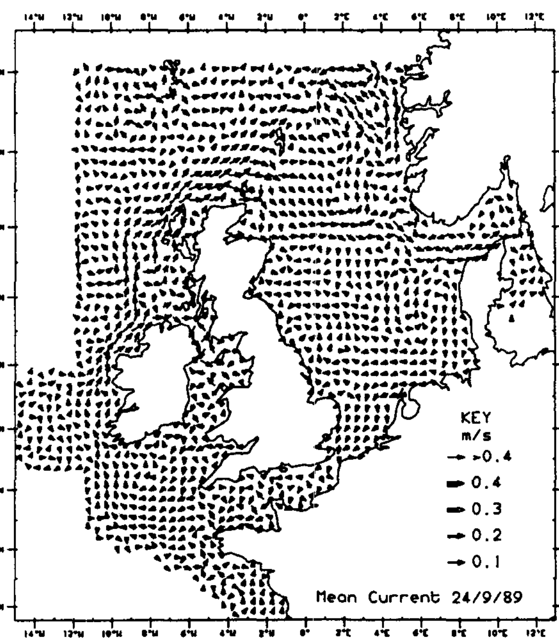
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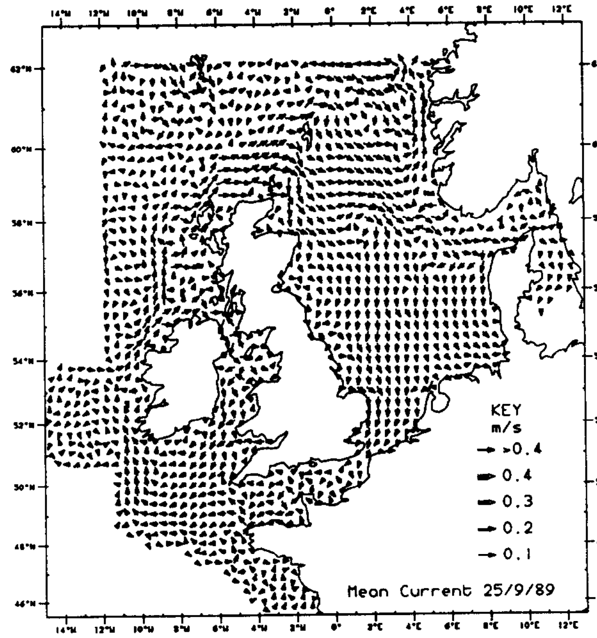
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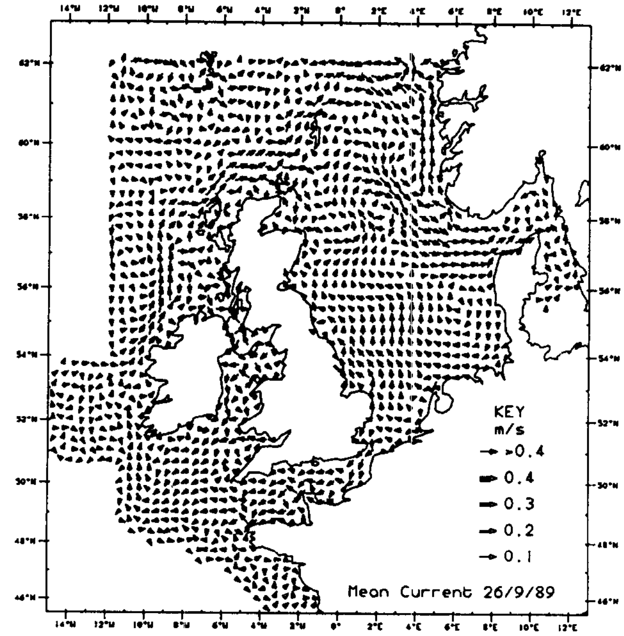
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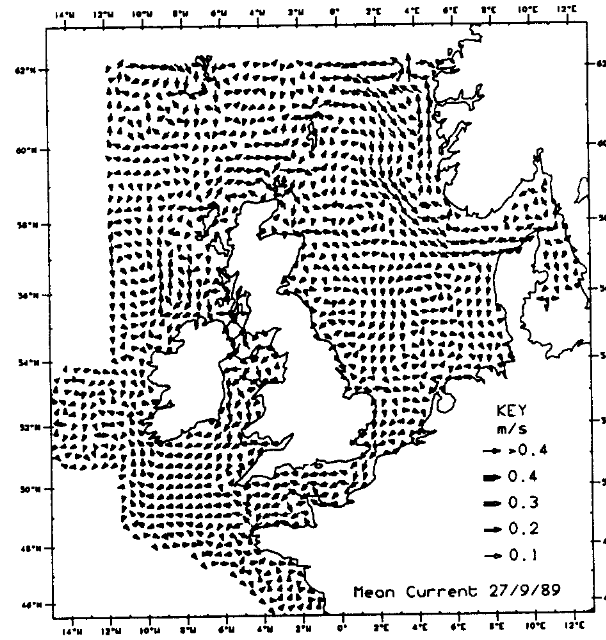
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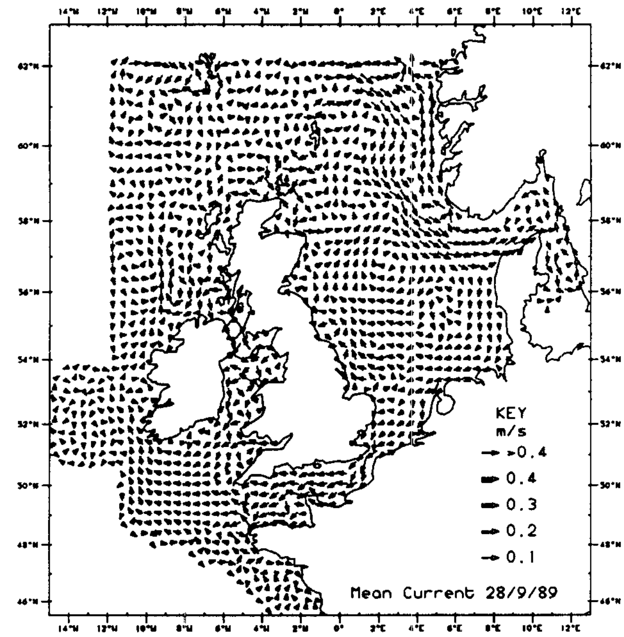
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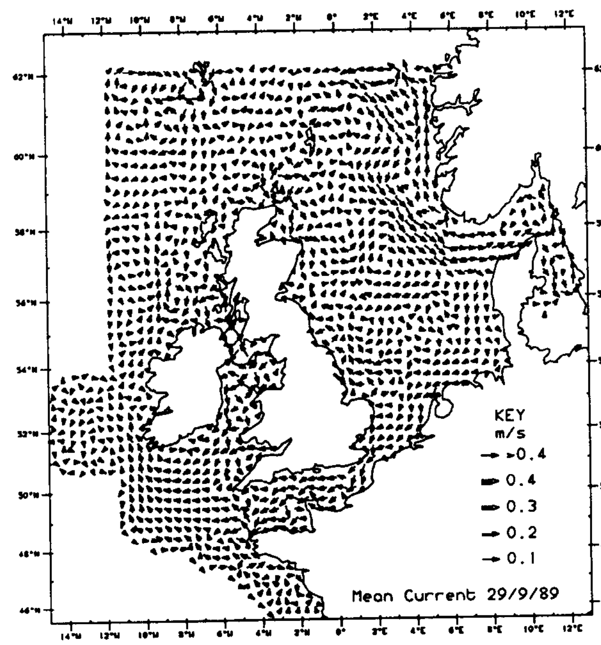
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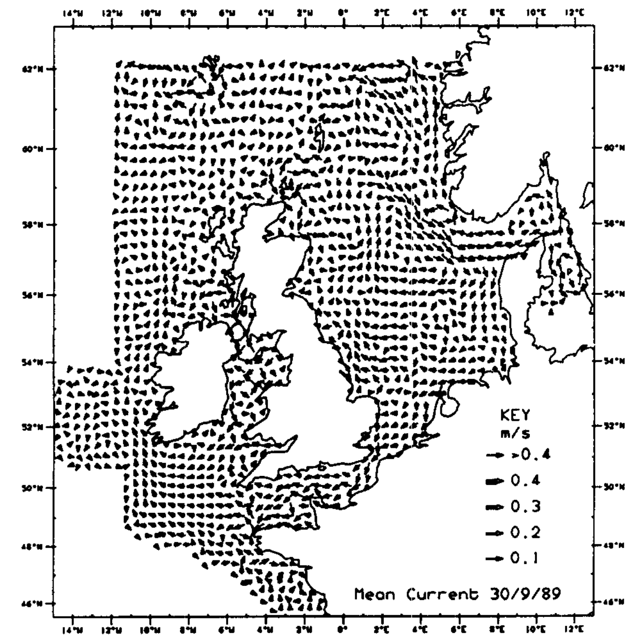
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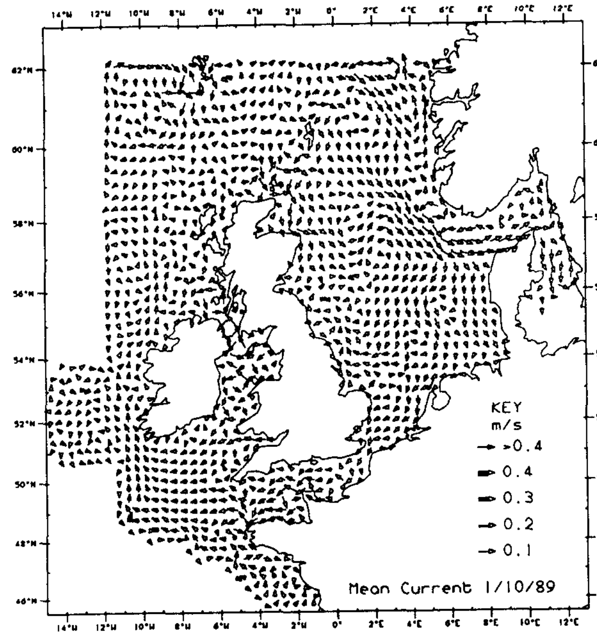
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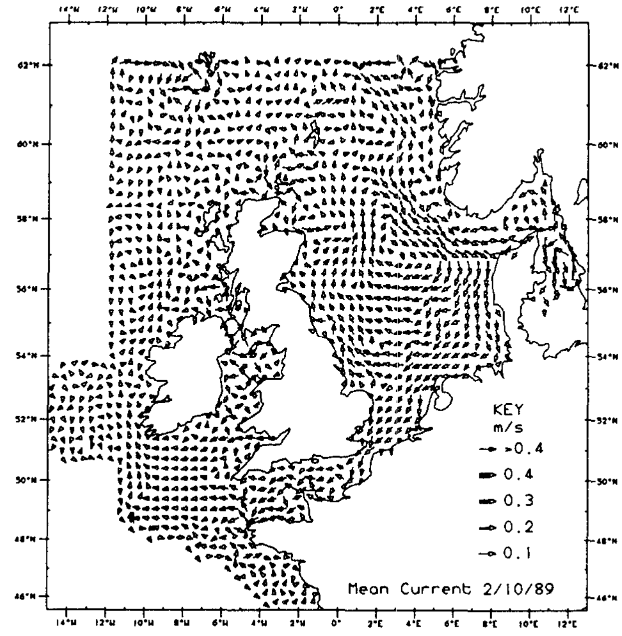
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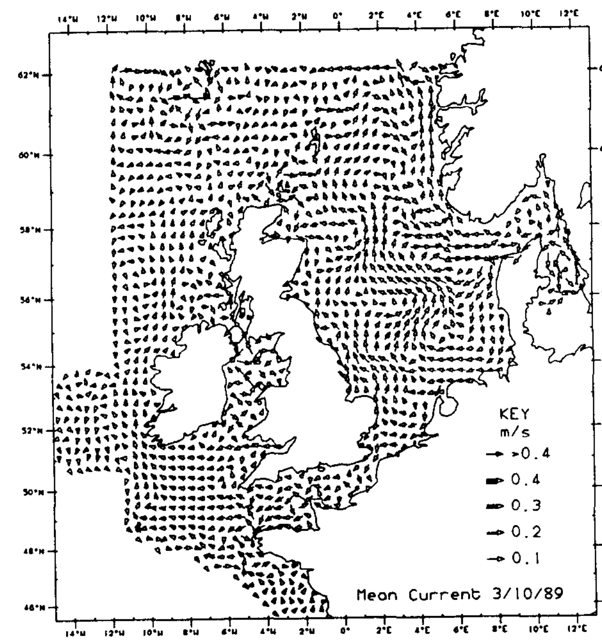
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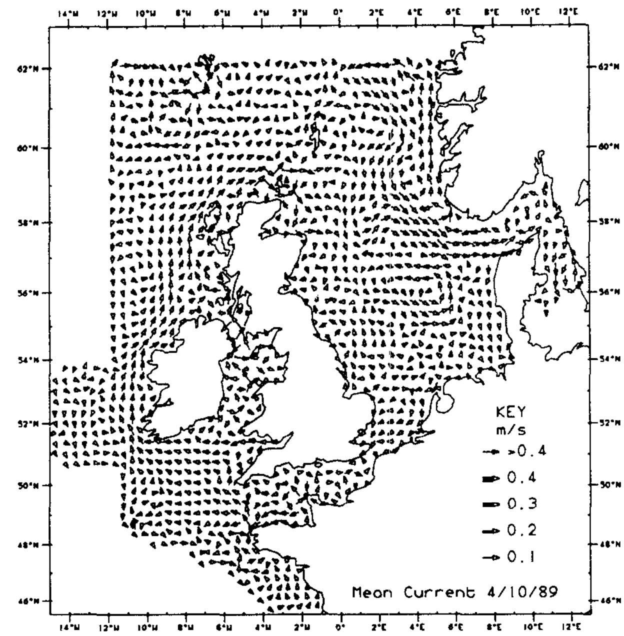
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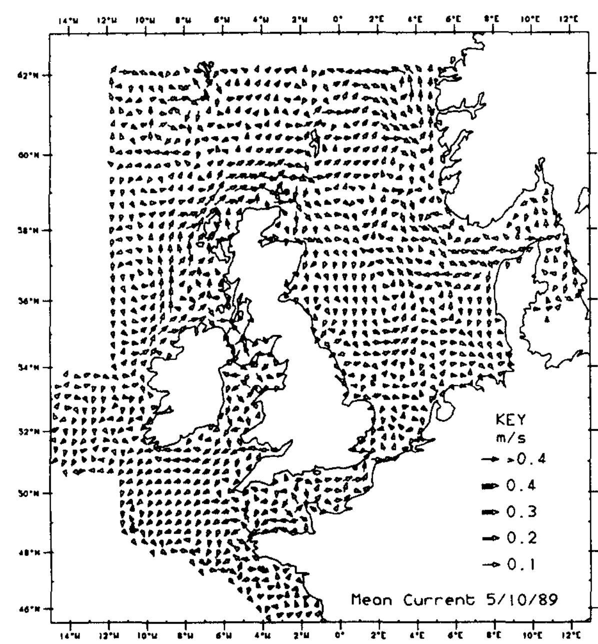
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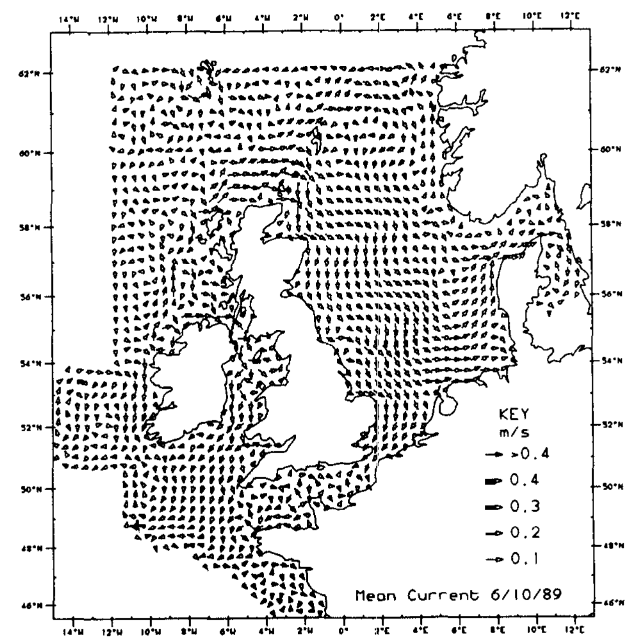
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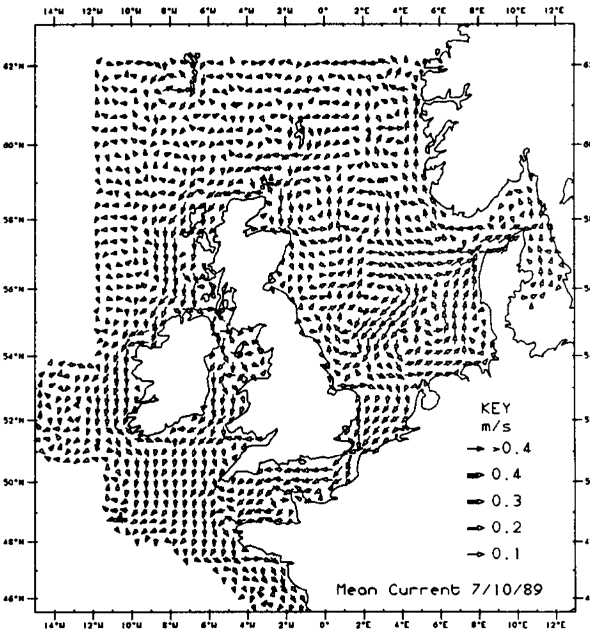
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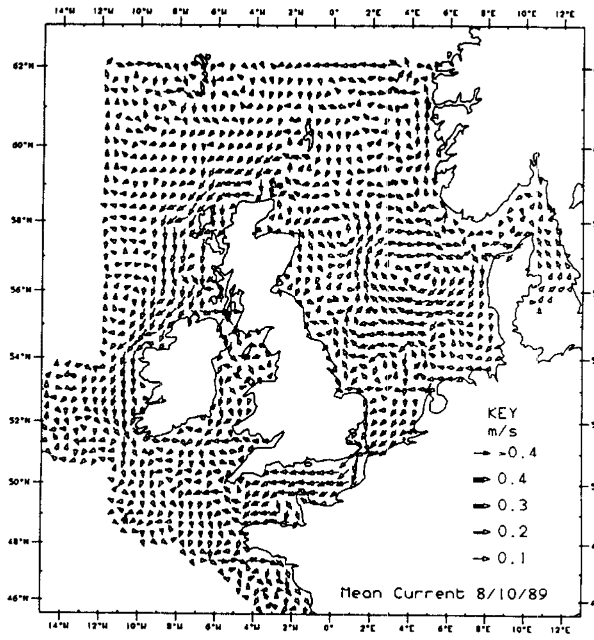
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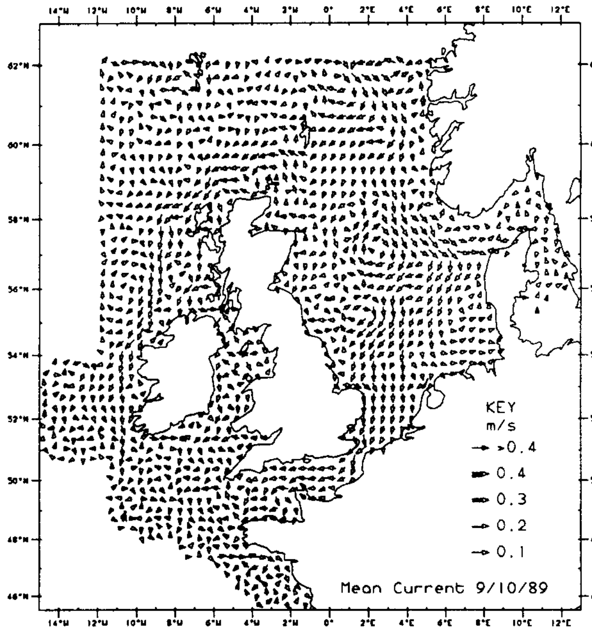
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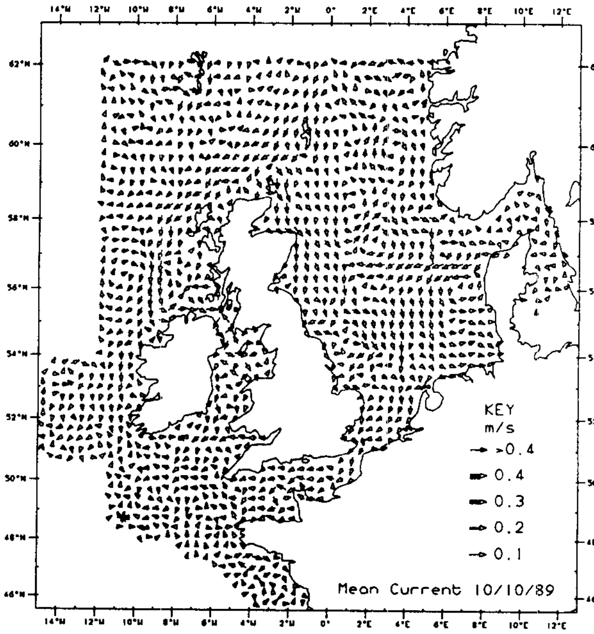
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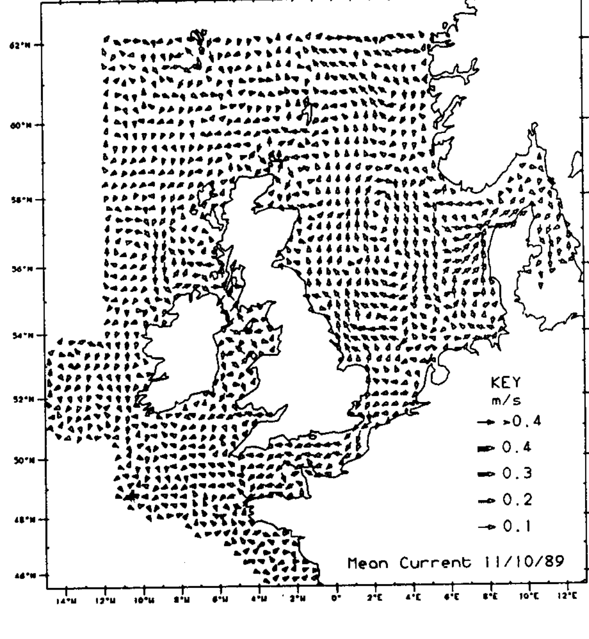
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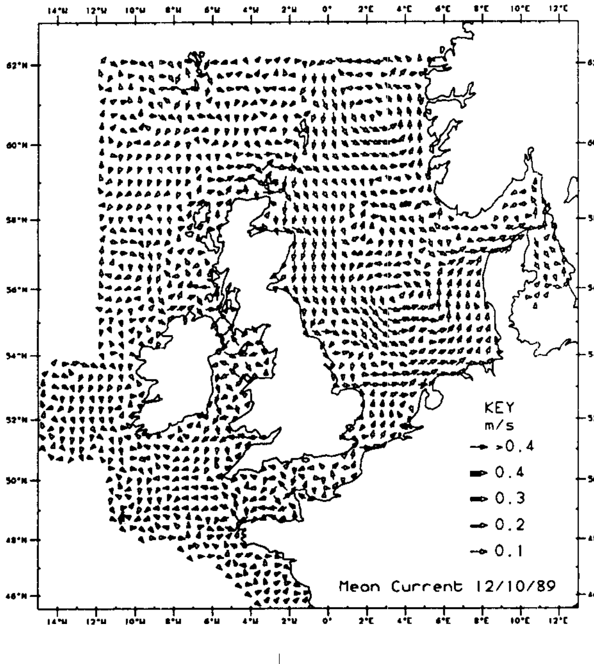
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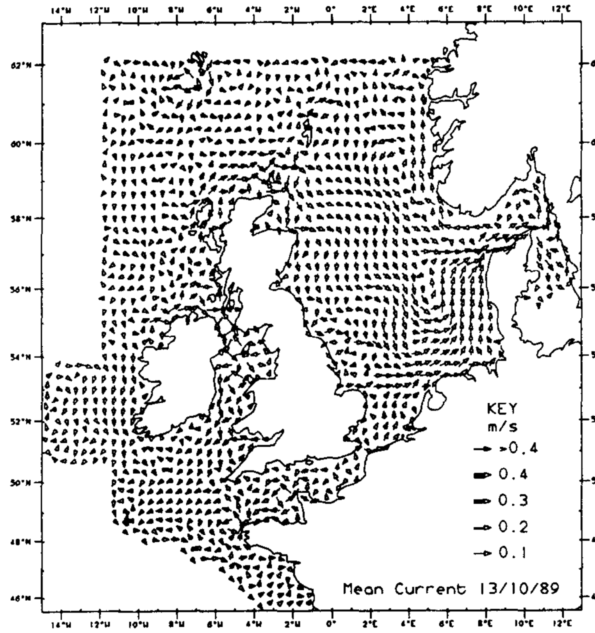
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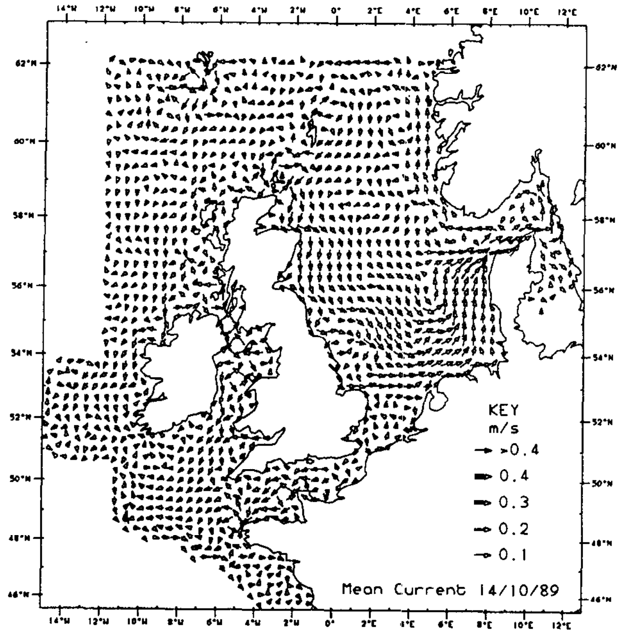
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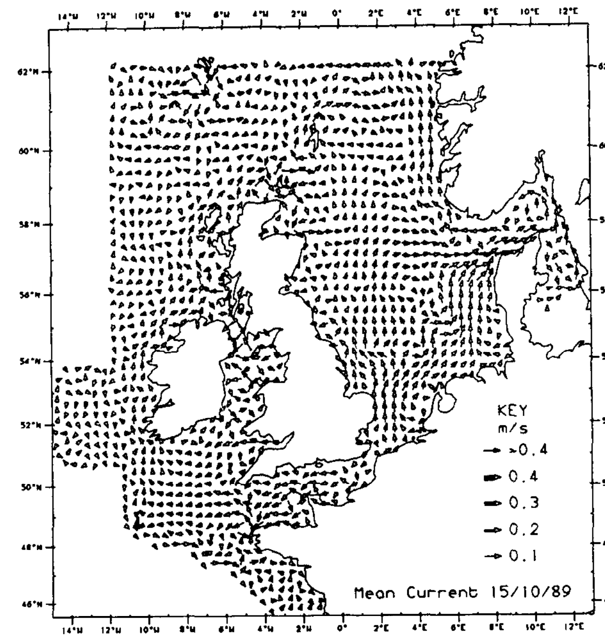
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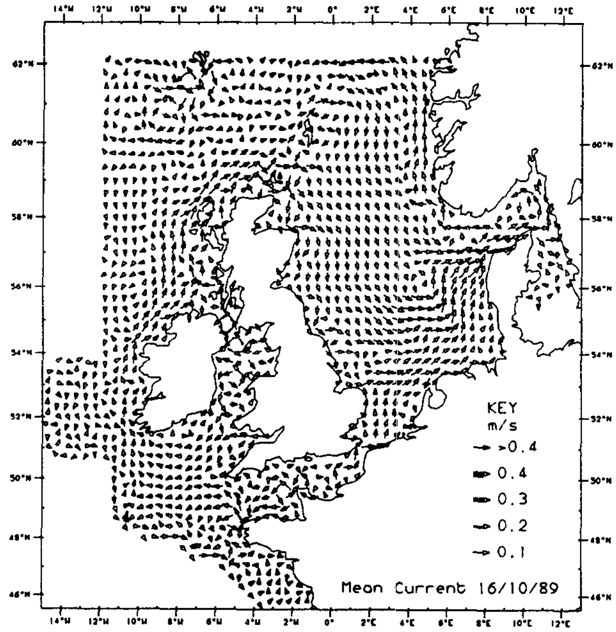
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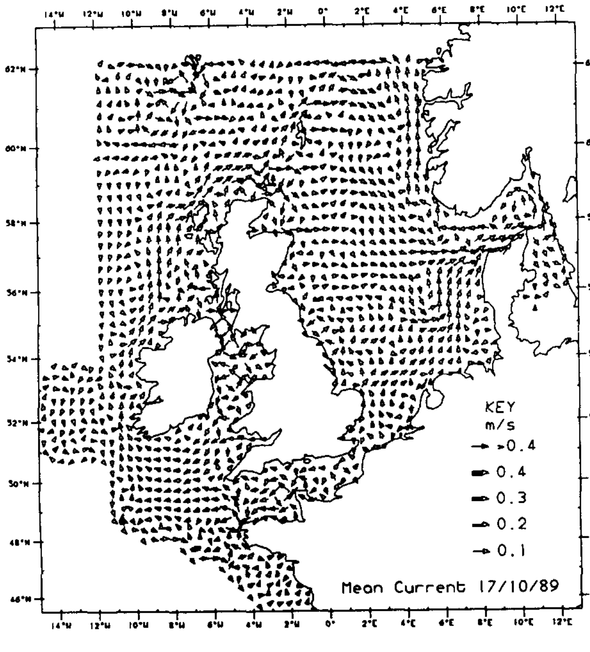
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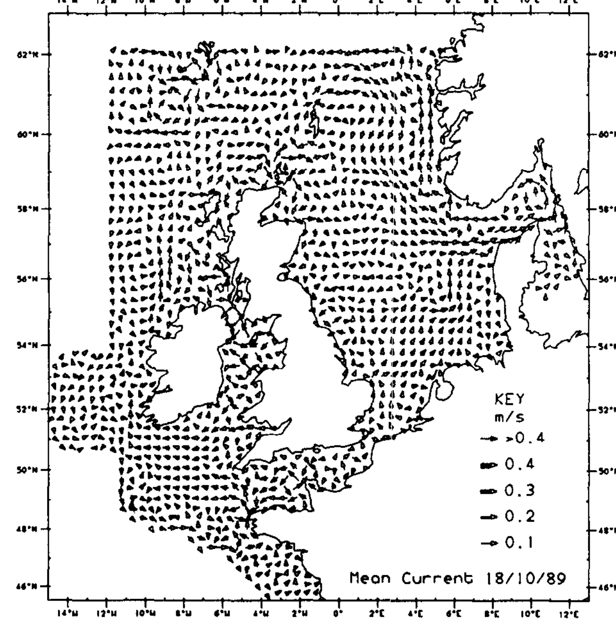
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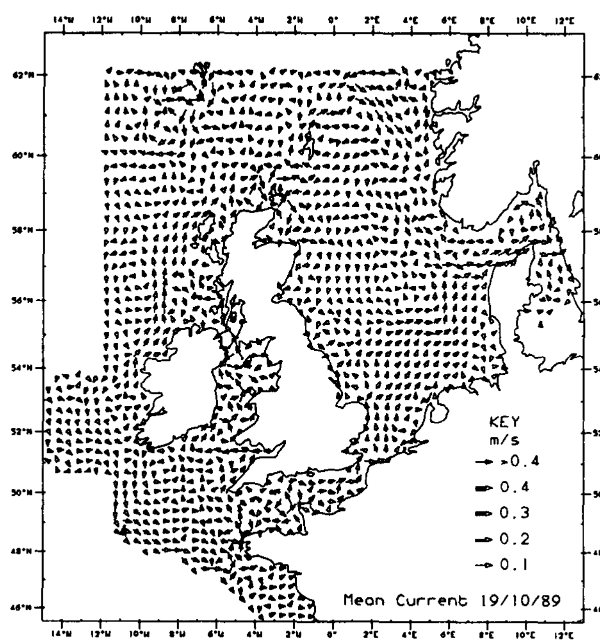
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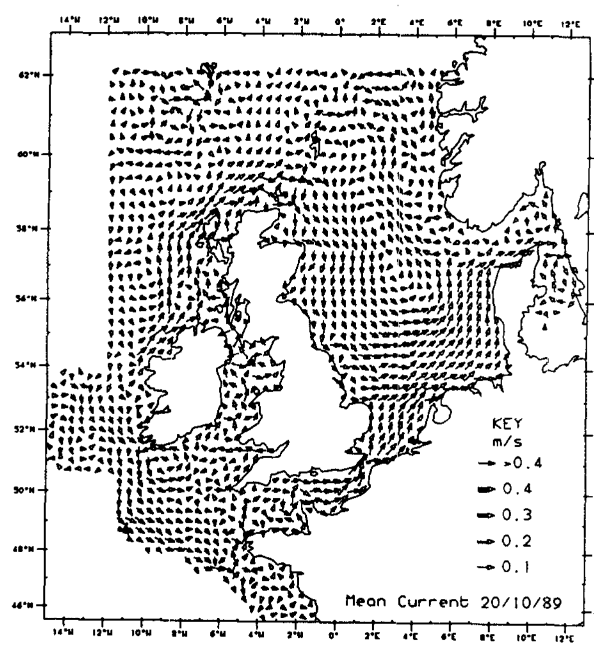
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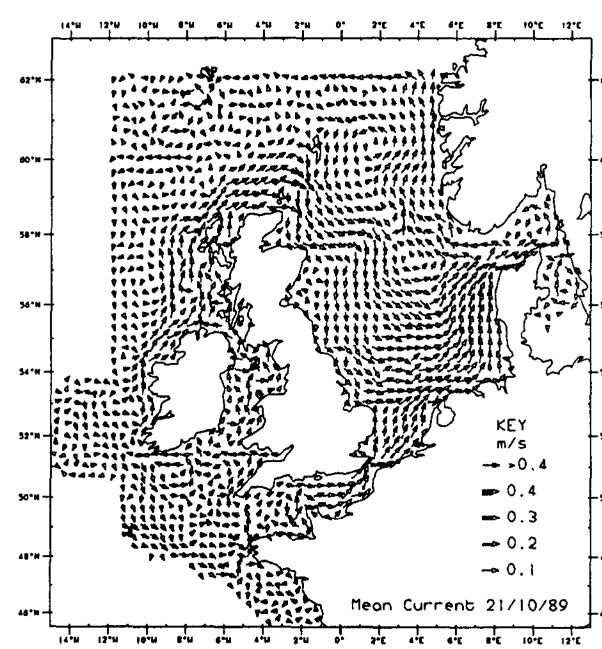
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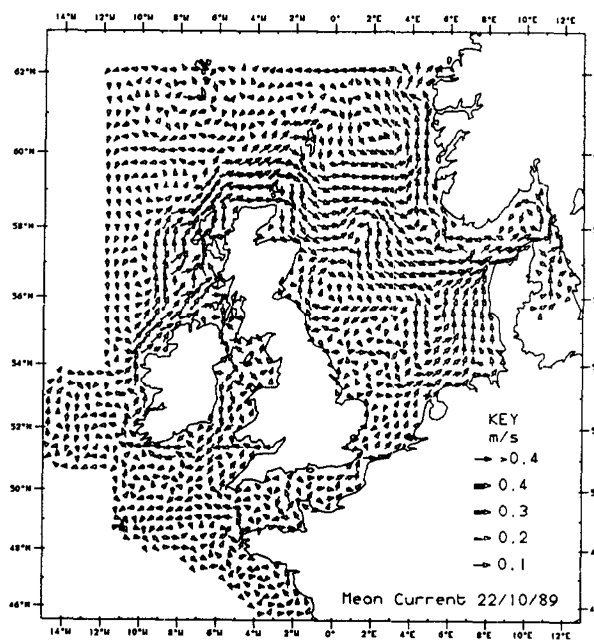
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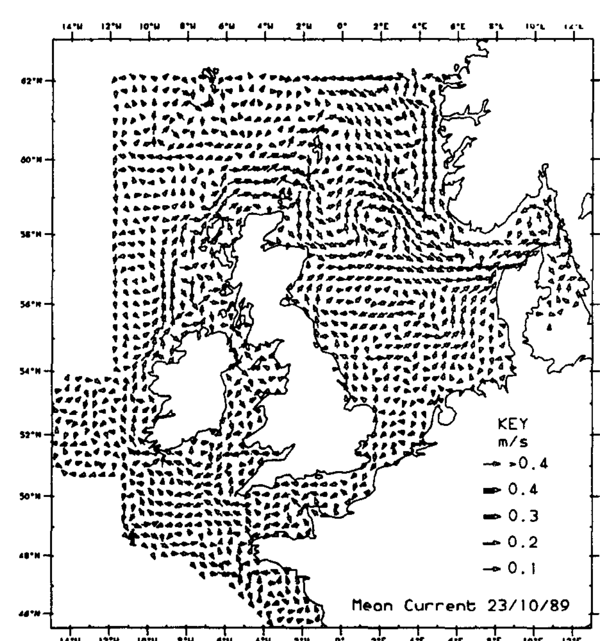
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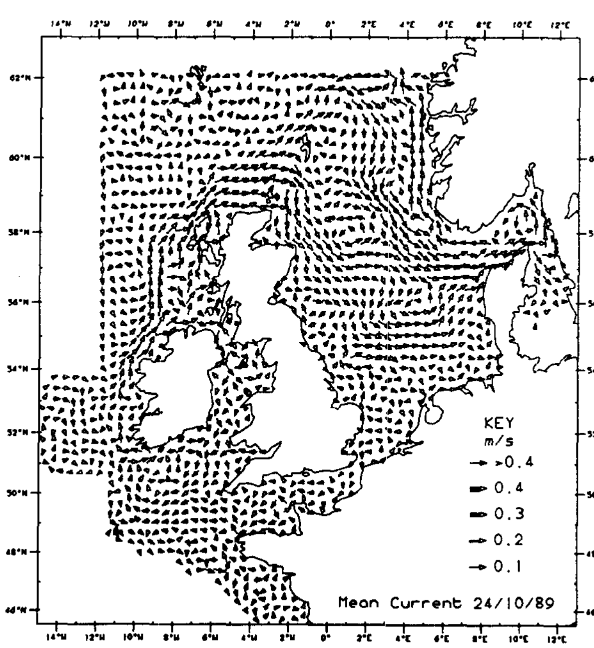
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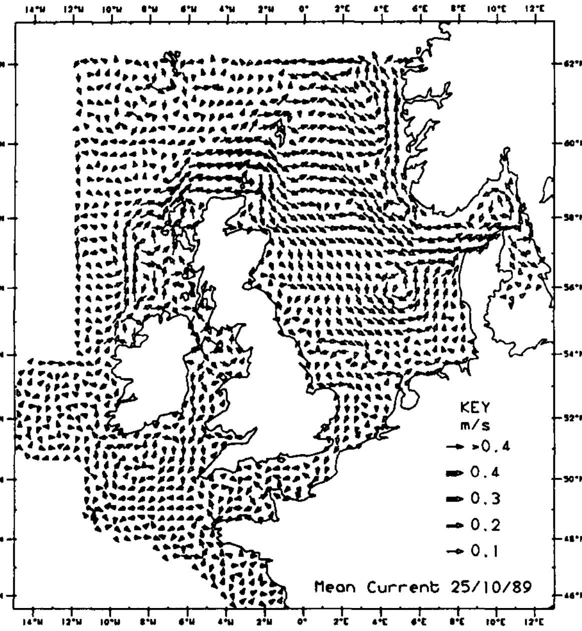
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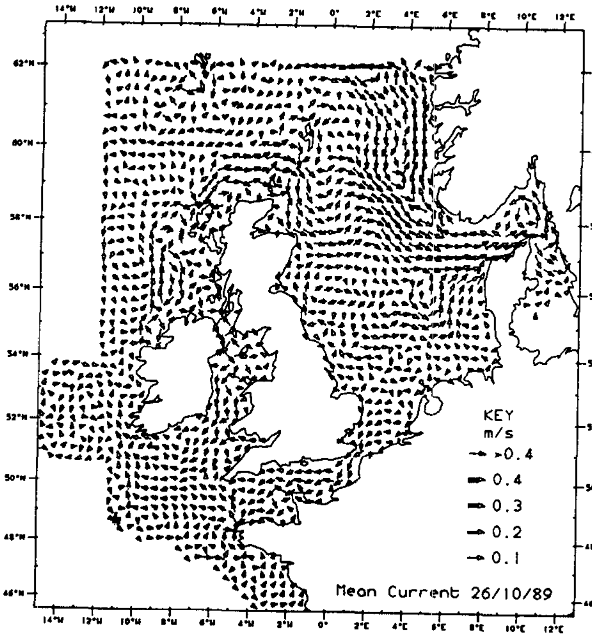
0.3
0.2
0.1
Mean Current 25/10/89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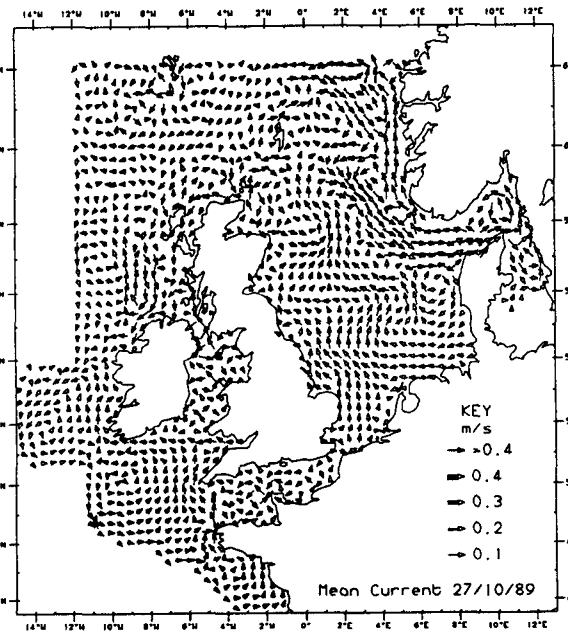
Mean Current 26/10/89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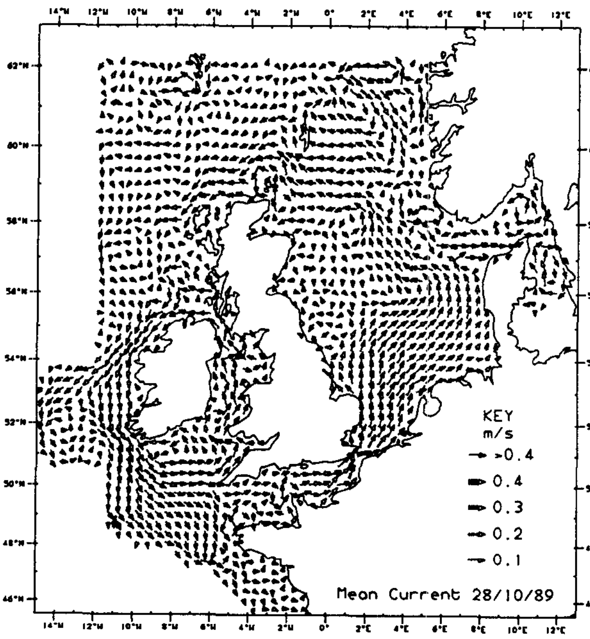
Mean Current 27/10/89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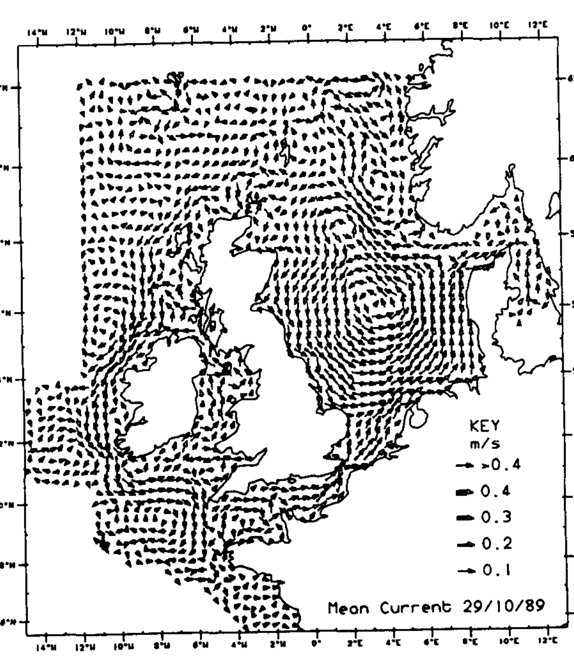
Mean Current 28/10/89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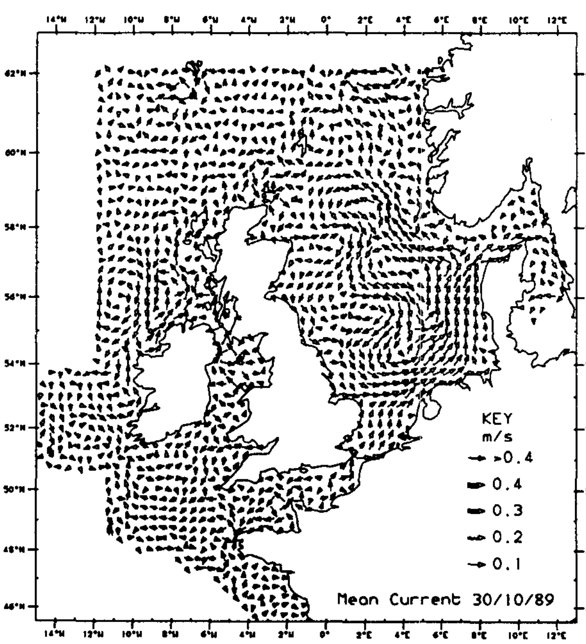
Mean Current 29/10/89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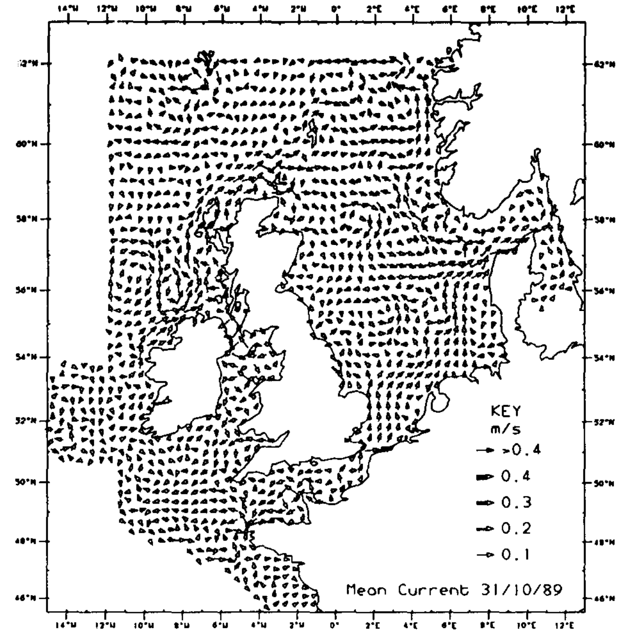
Mean Current 30/10/89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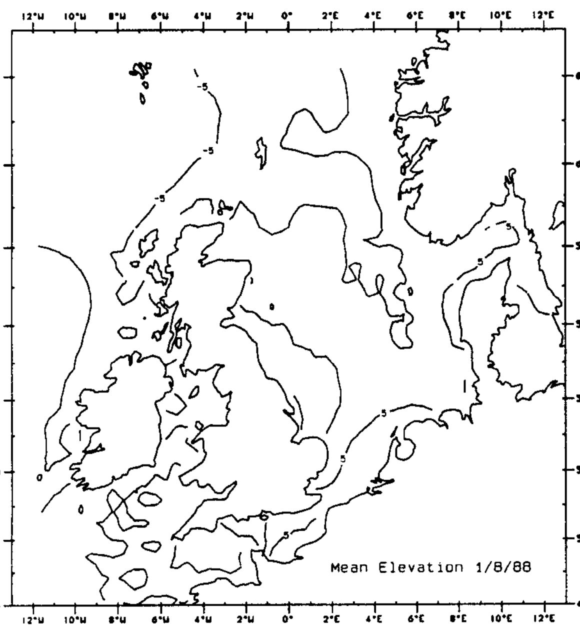
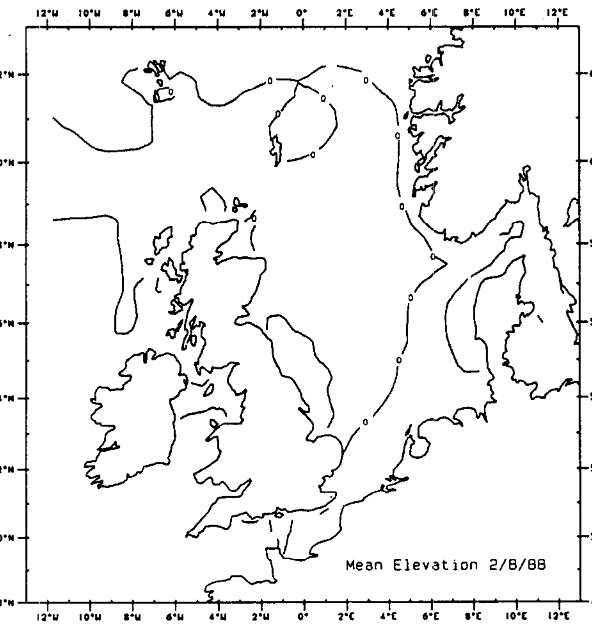
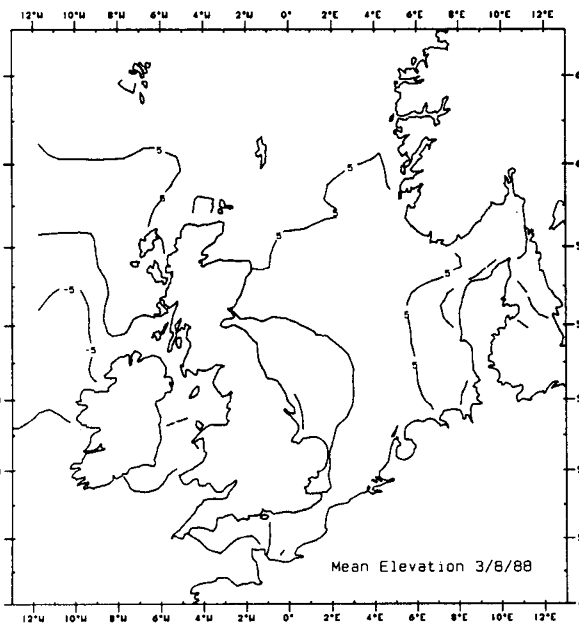
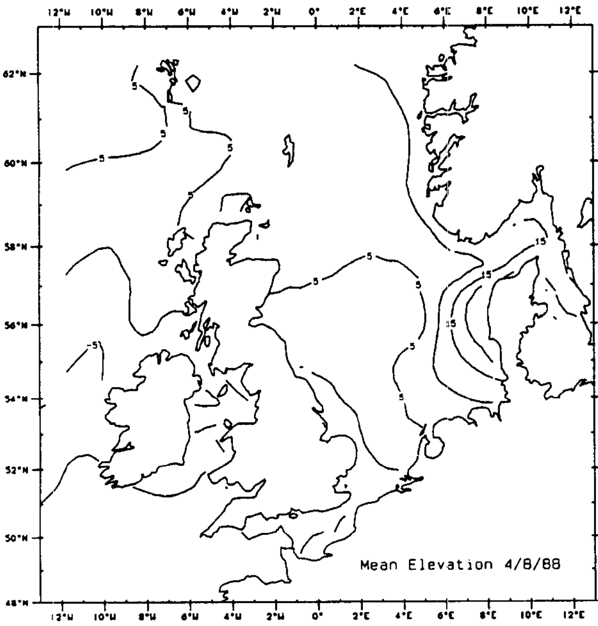
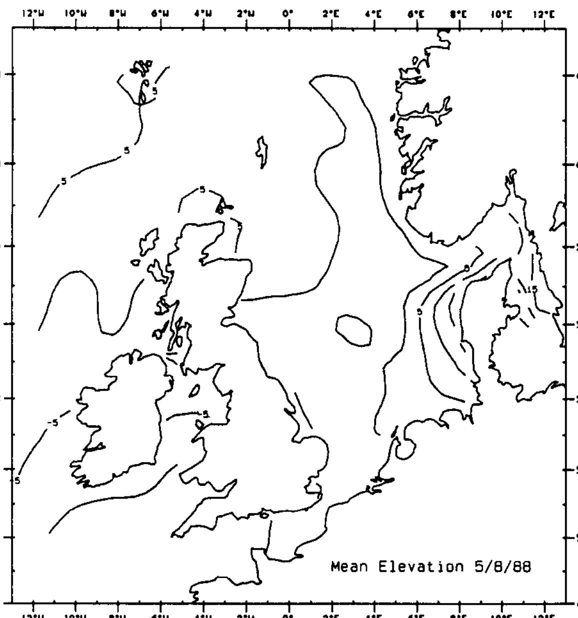
Mean Current 31/10/89

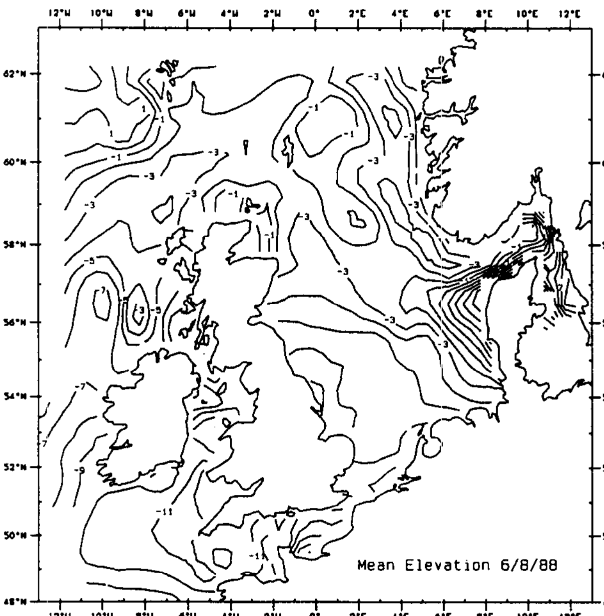

Mean Elevation 1/8/88

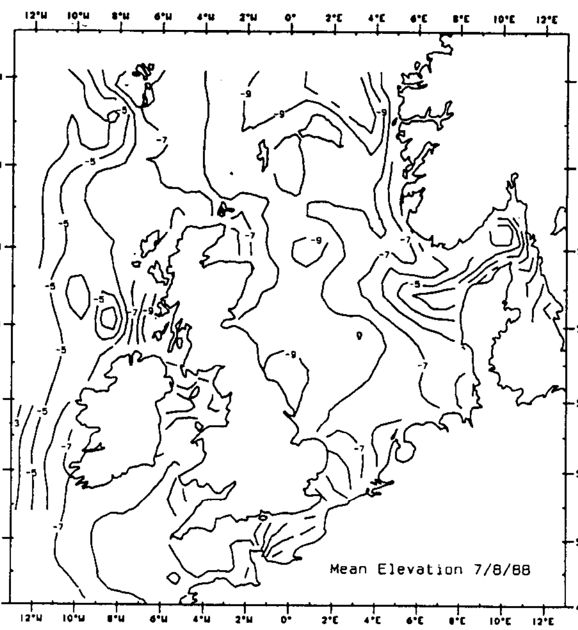

Mean Elevation 2/8/88

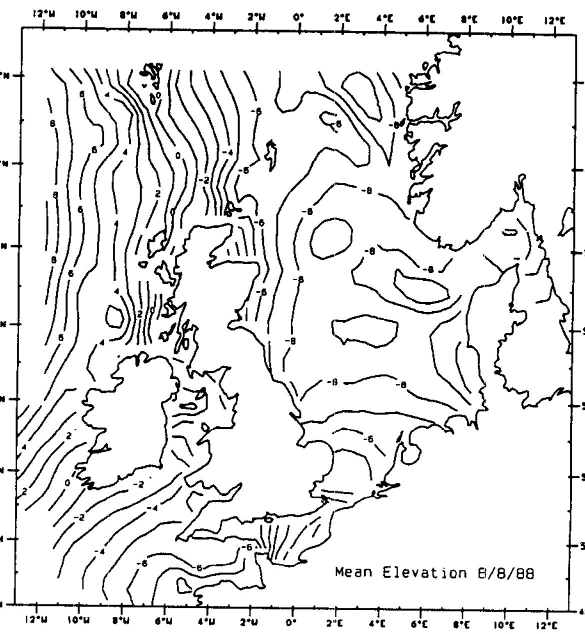

Mean Elevation 3/8/88

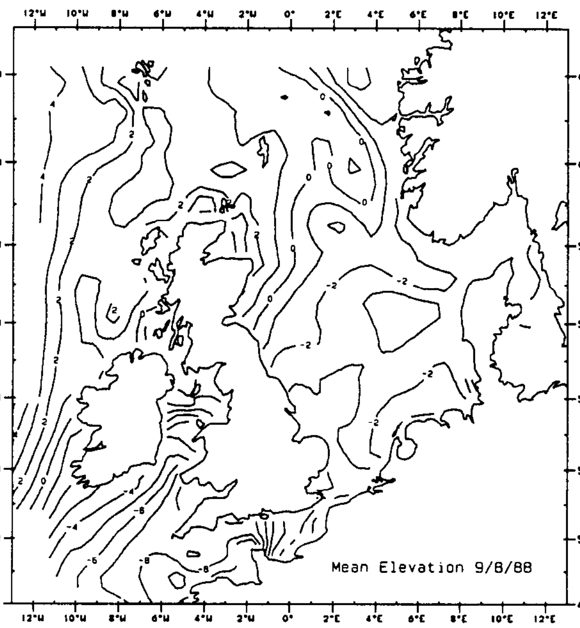

Mean Elevation 4/8/88

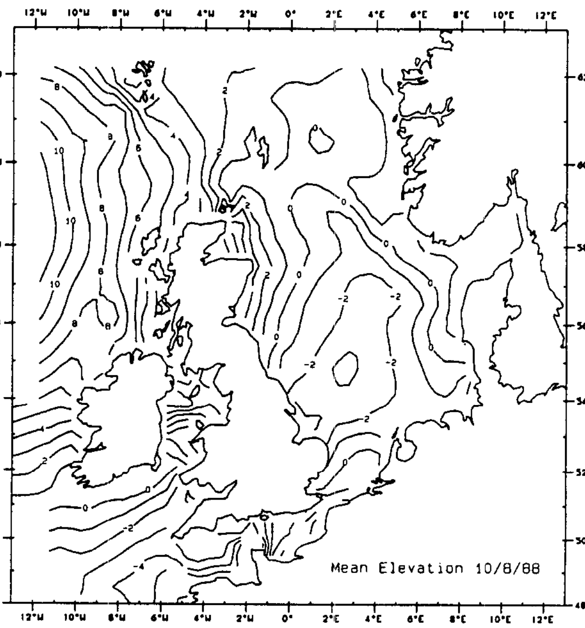

Mean Elevation 5/8/88

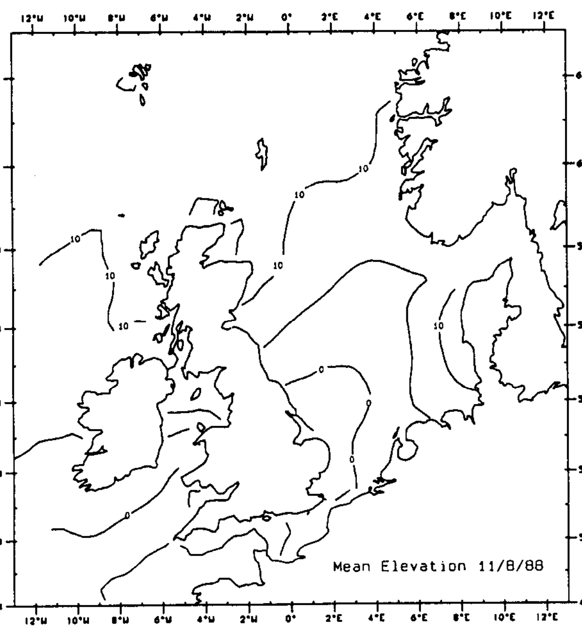

Mean Elevation 6/8/88

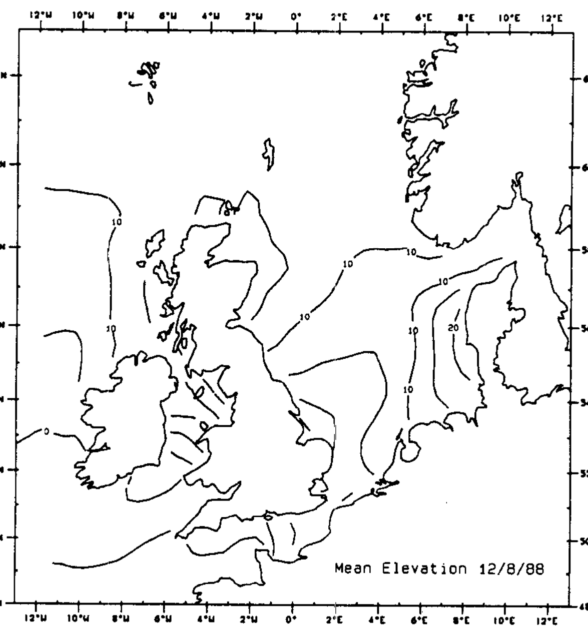

Mean Elevation 7/8/88

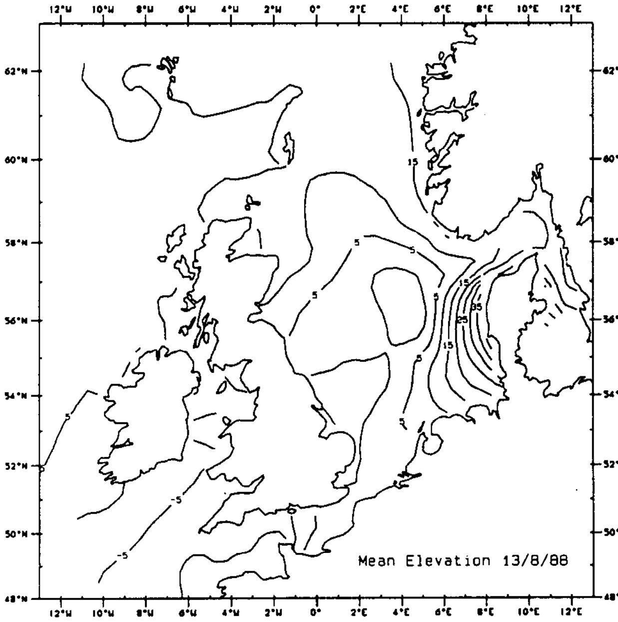

Mean Elevation 8/8/88

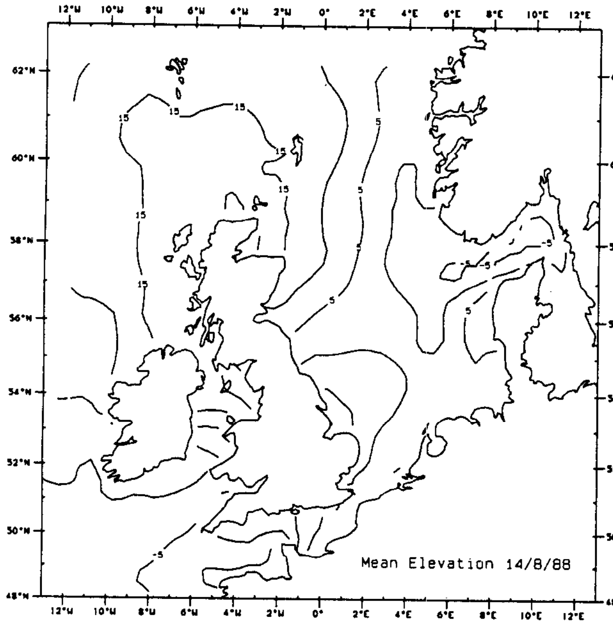

Mean Elevation 9/8/88

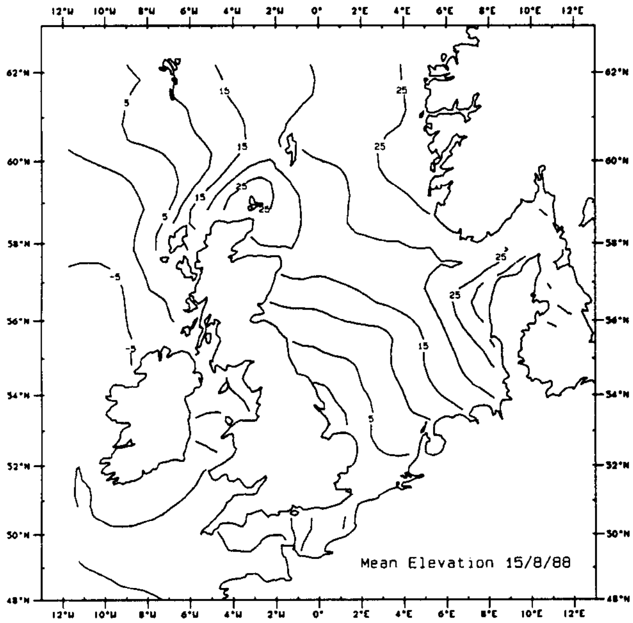

Mean Elevation 10/8/88

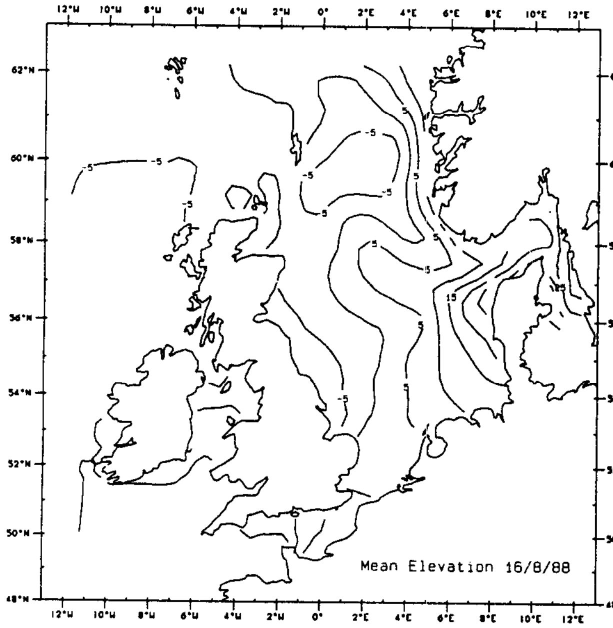

Mean Elevation 11/8/88

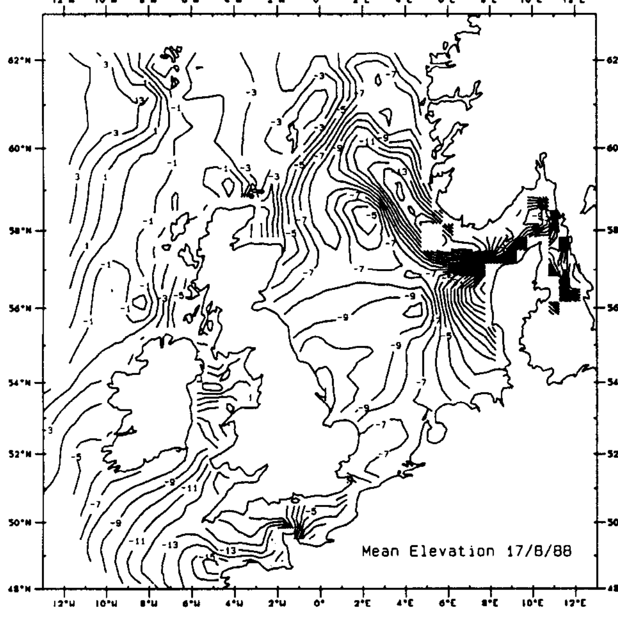

Mean Elevation 12/8/88

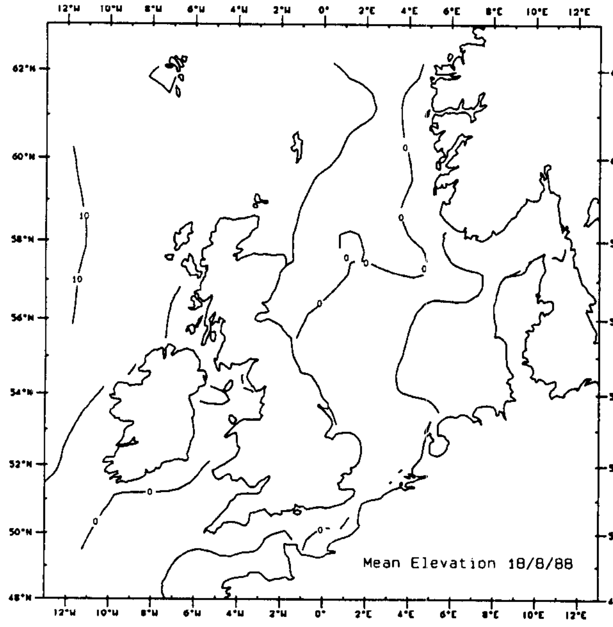

Mean Elevation 13/8/88

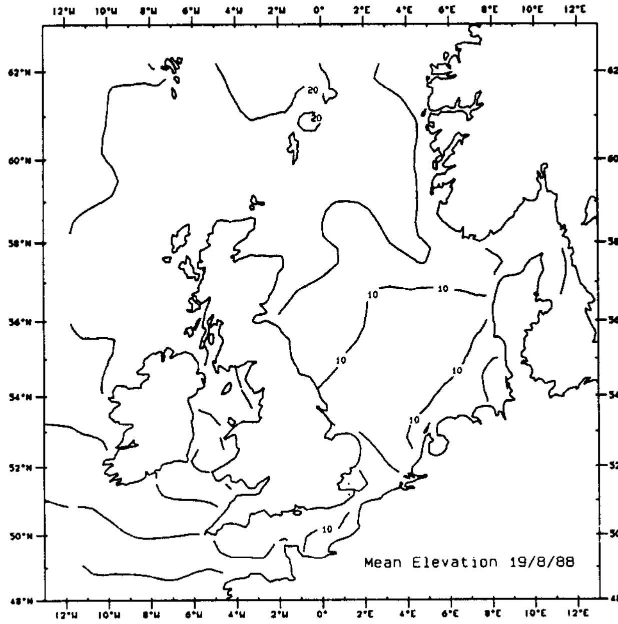

Mean Elevation 14/8/88

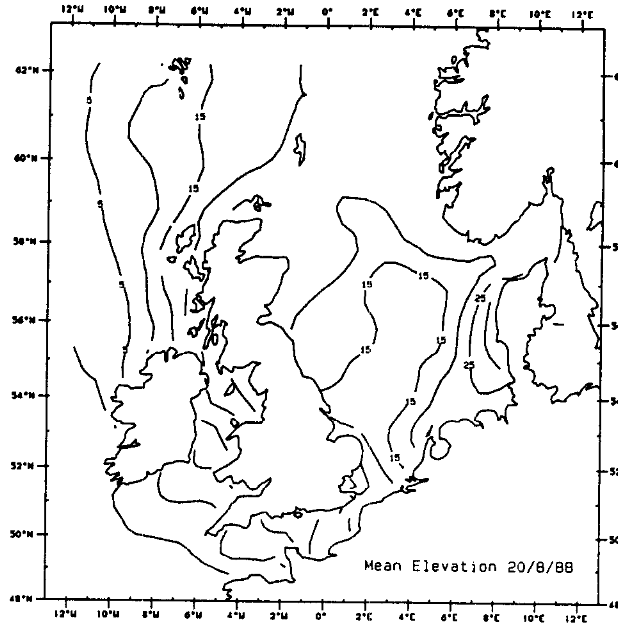

Mean Elevation 15/8/88

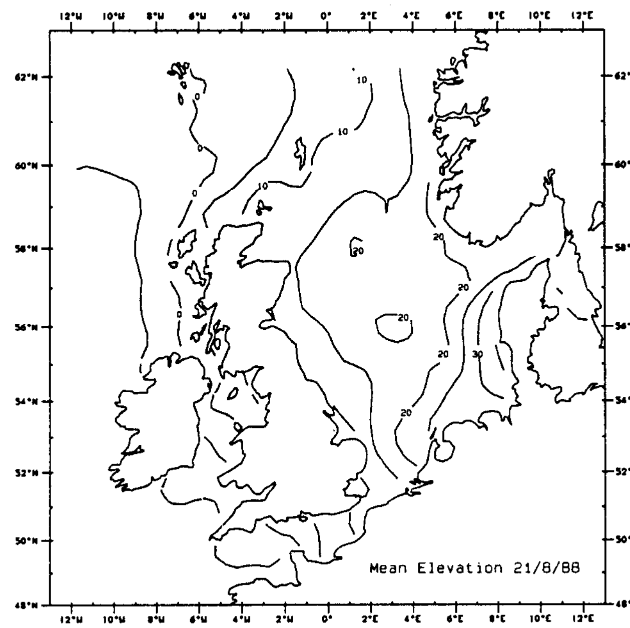

Mean Elevation 16/8/88

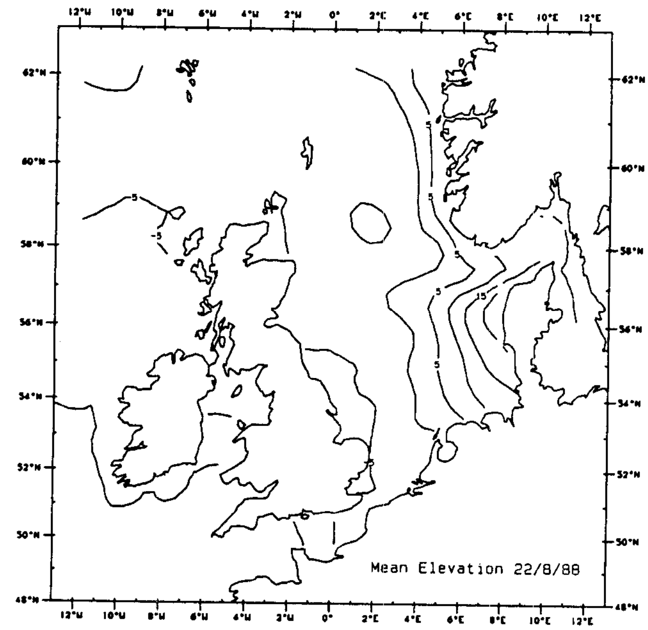

Mean Elevation 17/8/88

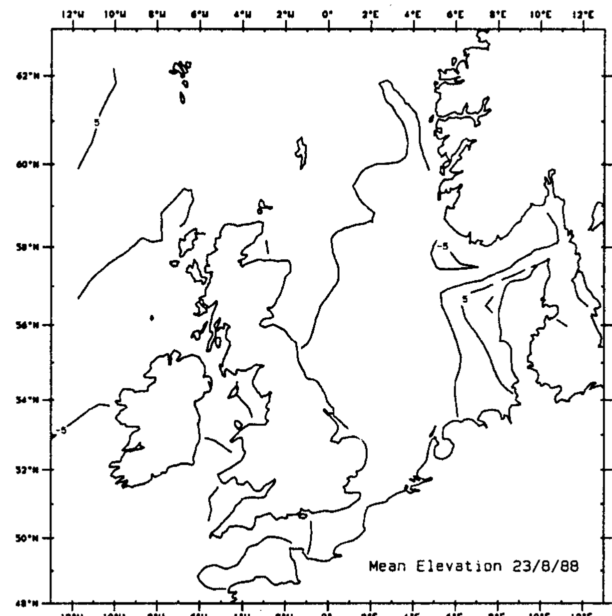

Mean Elevation 18/8/88

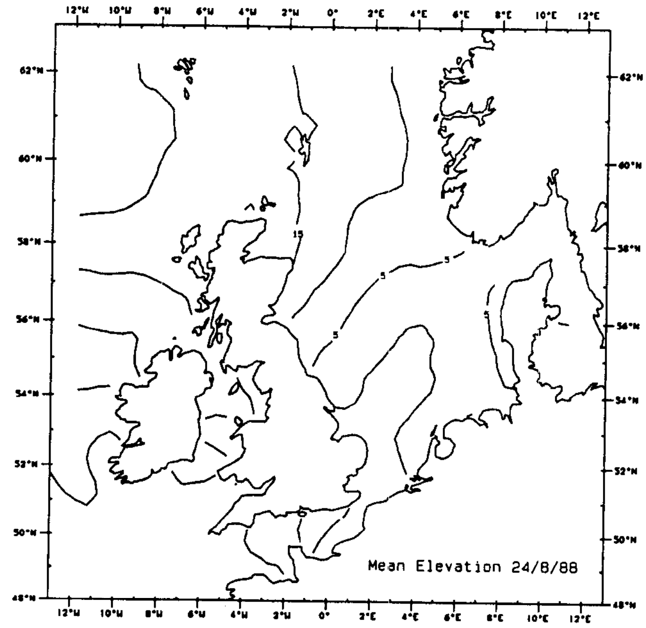

Mean Elevation 19/8/88

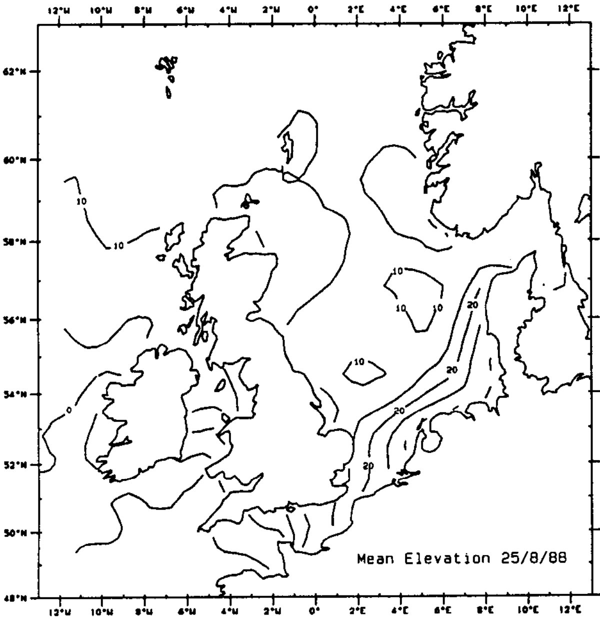

Mean Elevation 20/8/88

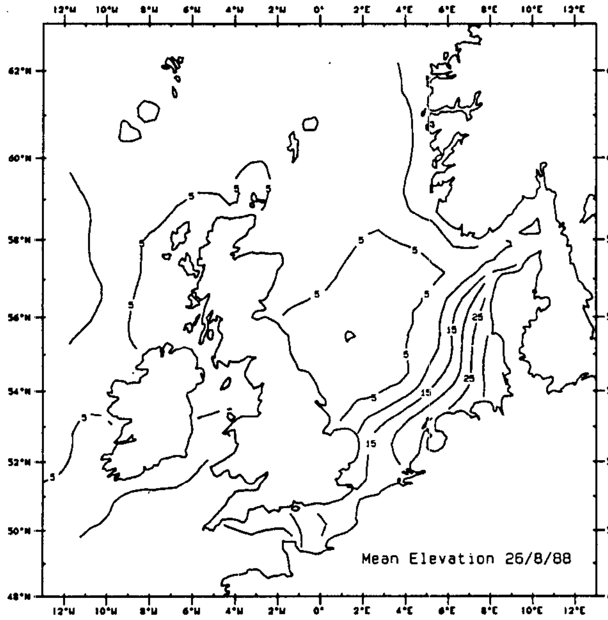

Mean Elevation 21/8/88

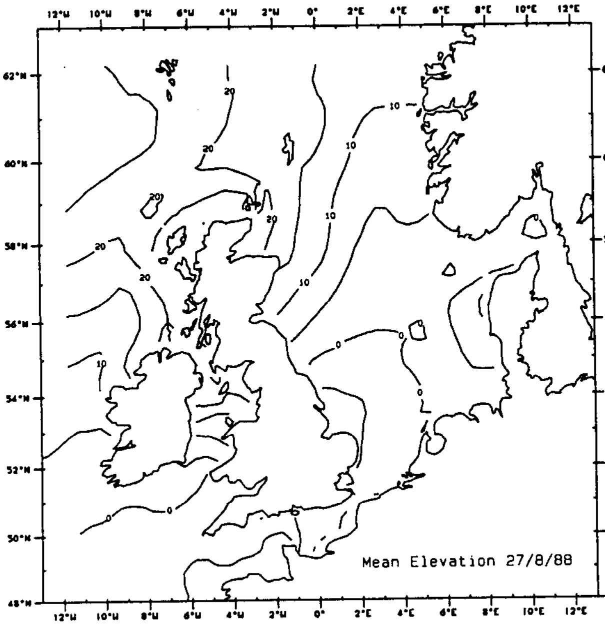

Mean Elevation 22/8/88

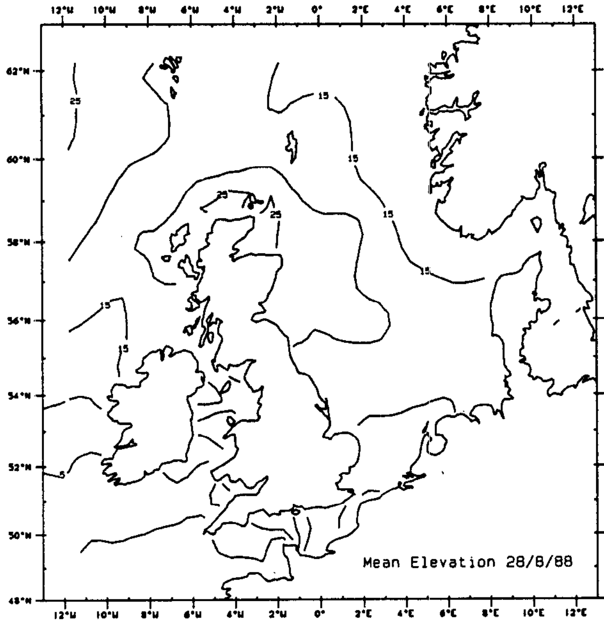

Mean Elevation 23/8/88

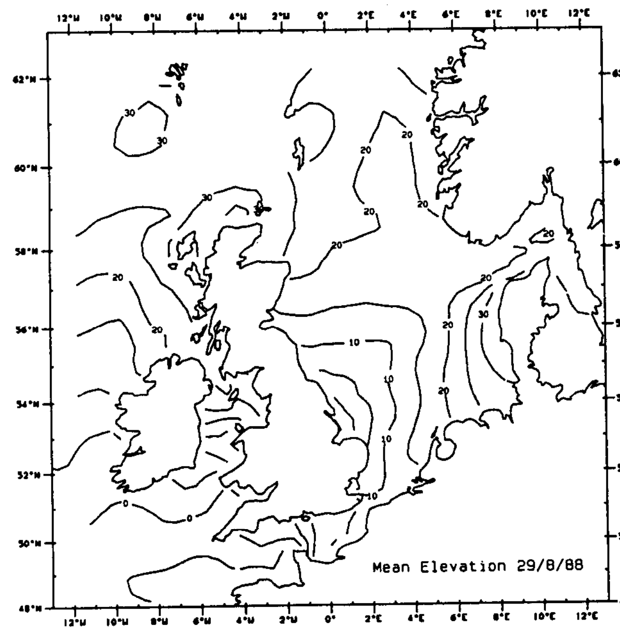

Mean Elevation 24/8/88

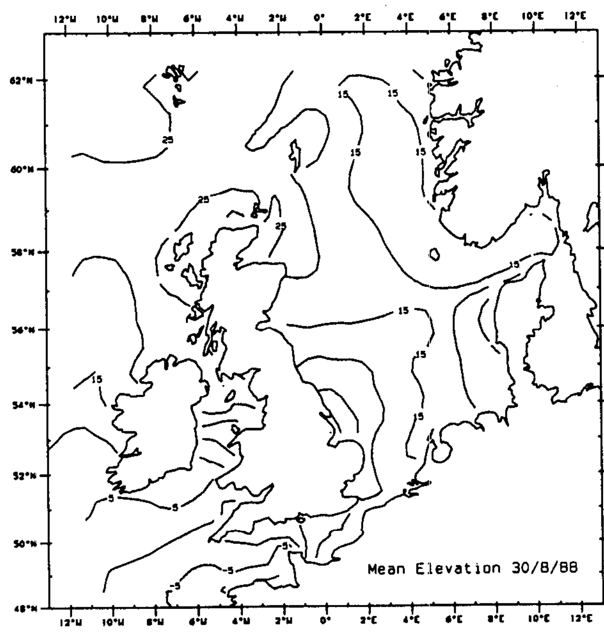

Mean Elevation 25/8/88

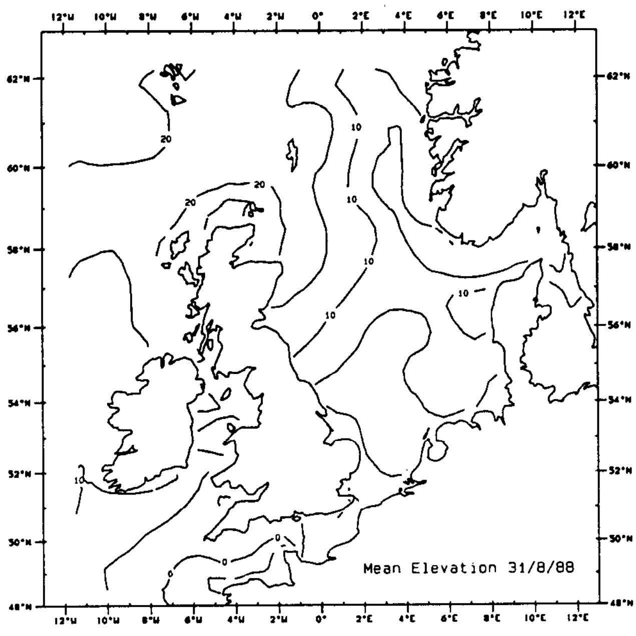

Mean Elevation 26/8/88


Mean Elevation 27/8/88


Mean Elevation 28/8/88


Mean Elevation 29/8/88


Mean Elevation 30/8/88


Mean Elevation 31/8/88
12°W
10°W
8°W
6°W
4°W
2°W
0°
2°E
4°E
6°E
8°E
10°E
12°E
62°N
60°N
58°N
56°N
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50°N
48°N
20
20
20
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10
10
10
10
10
0
0
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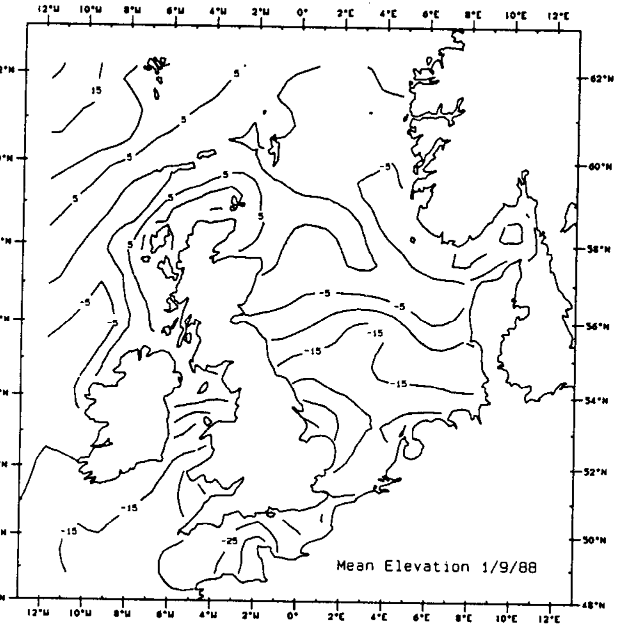
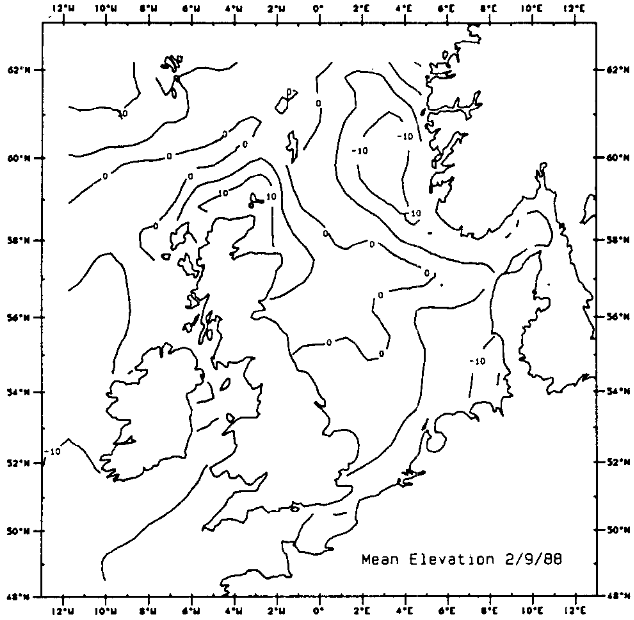
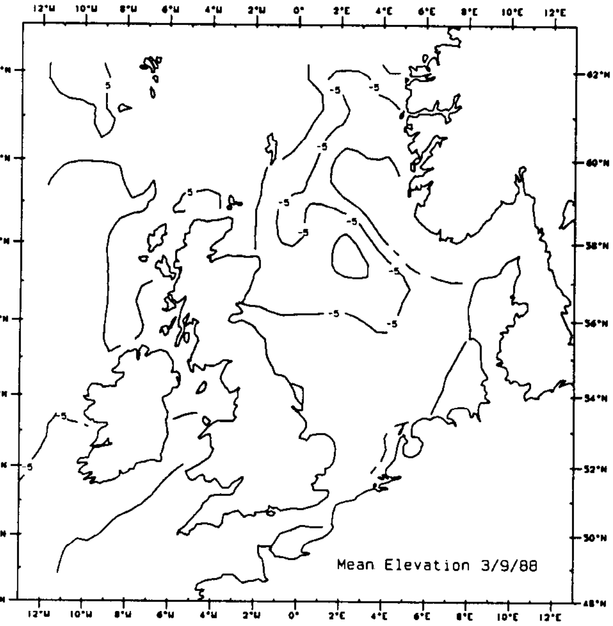


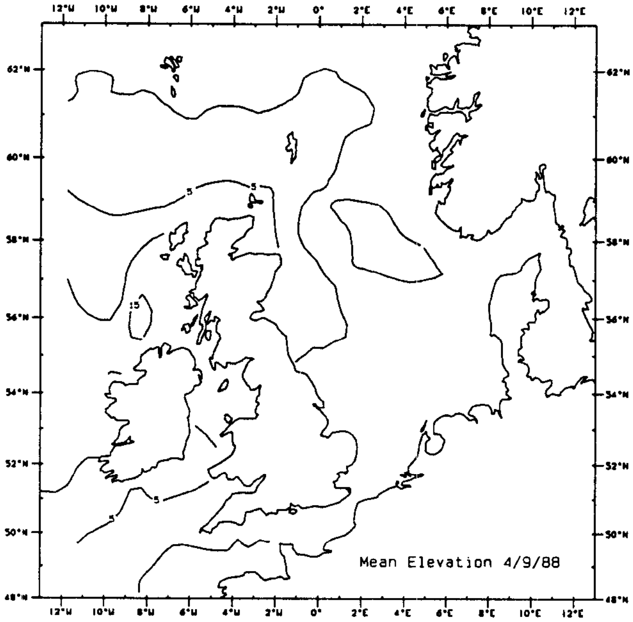
Mean Elevation 1/9/88



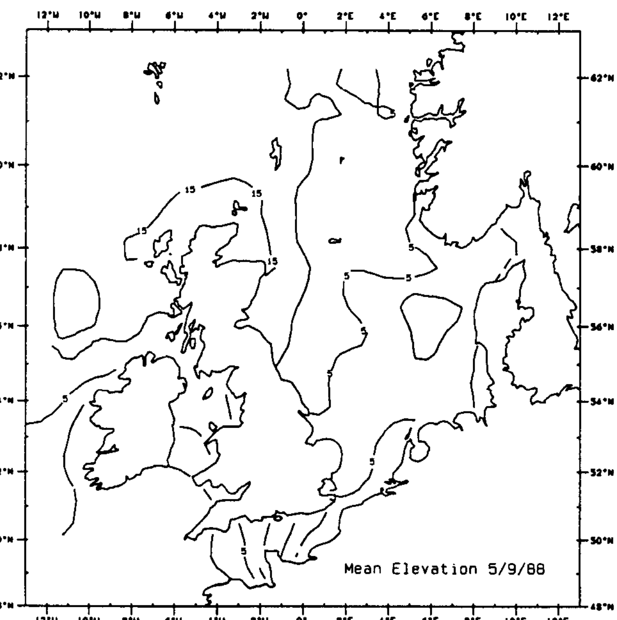
Mean Elevation 2/9/88



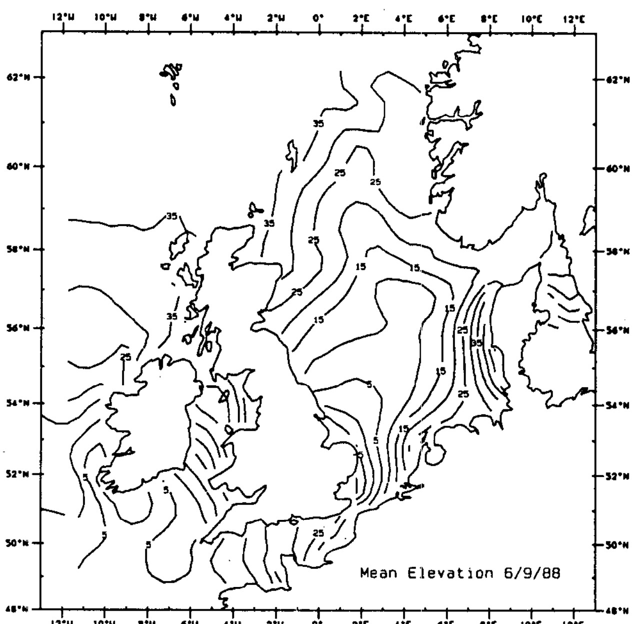
Mean Elevation 3/9/88



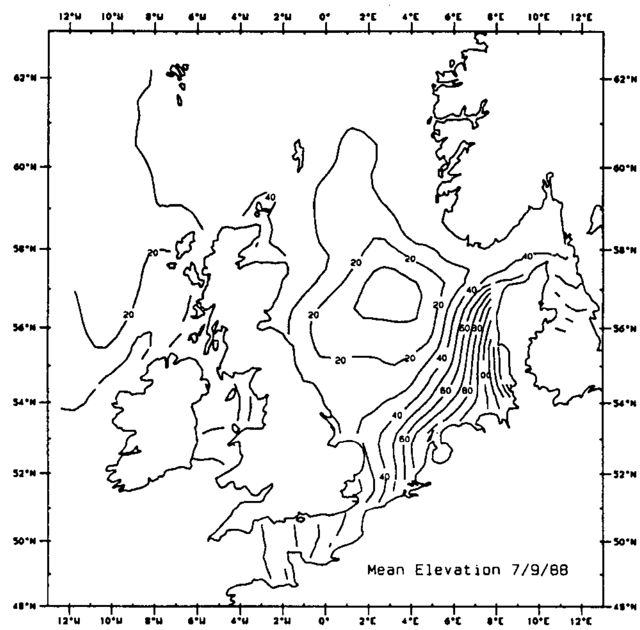
Mean Elevation 4/9/88

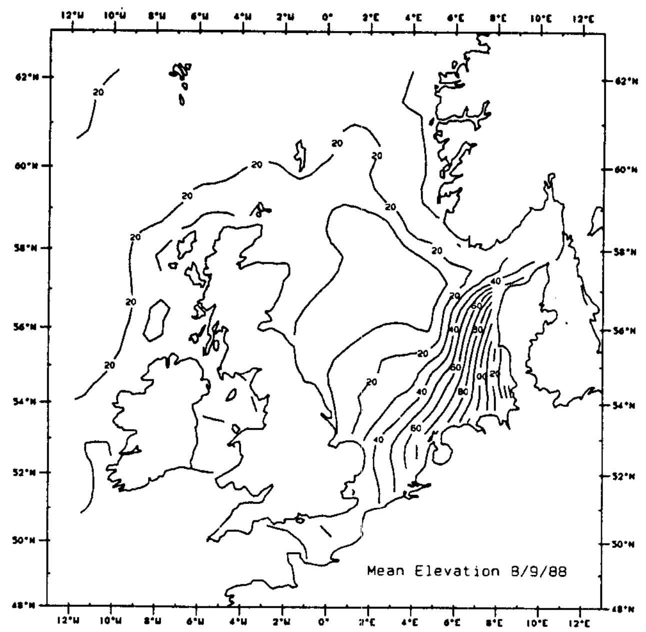


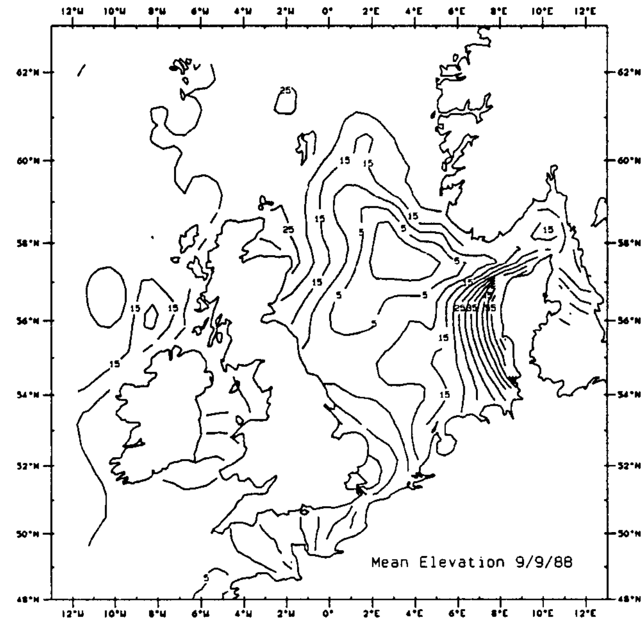
Mean Elevation 5/9/88

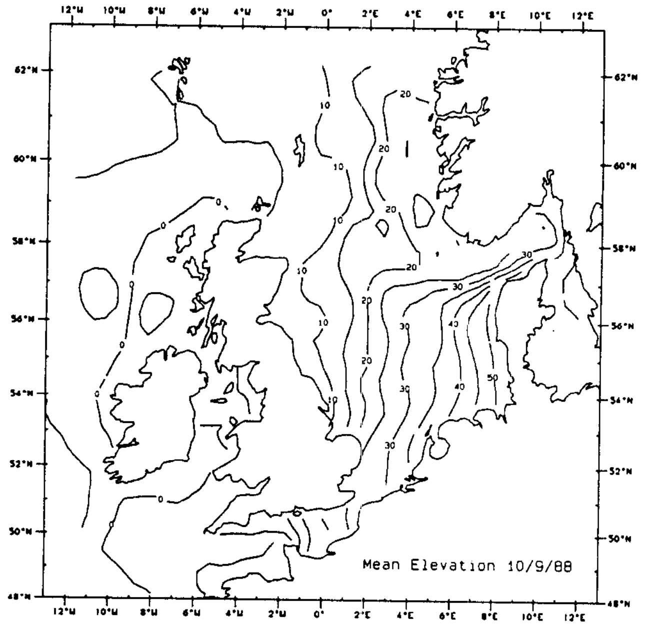


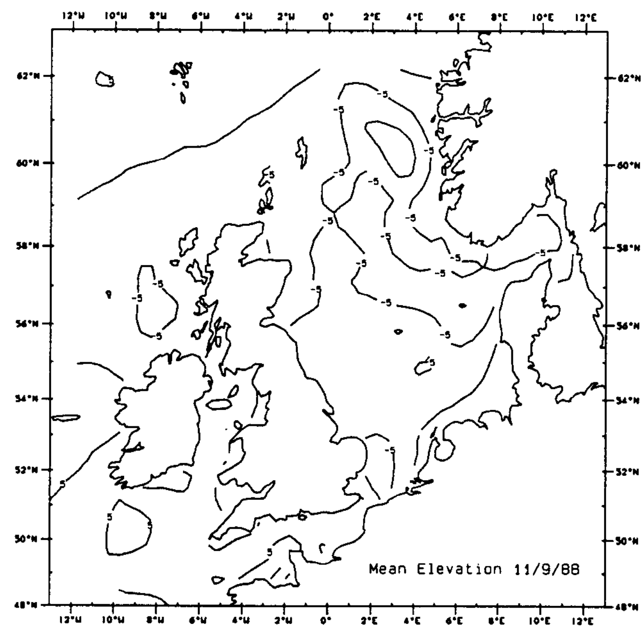
Mean Elevation 6/9/88

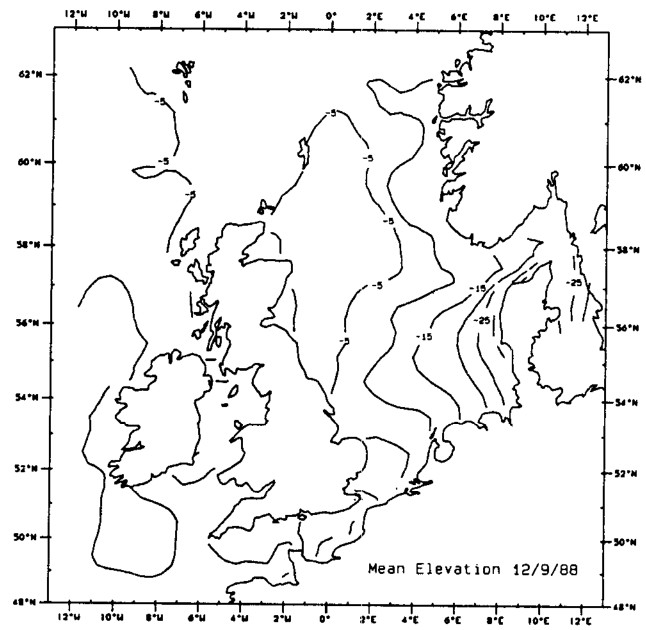

Mean Elevation 7/9/88

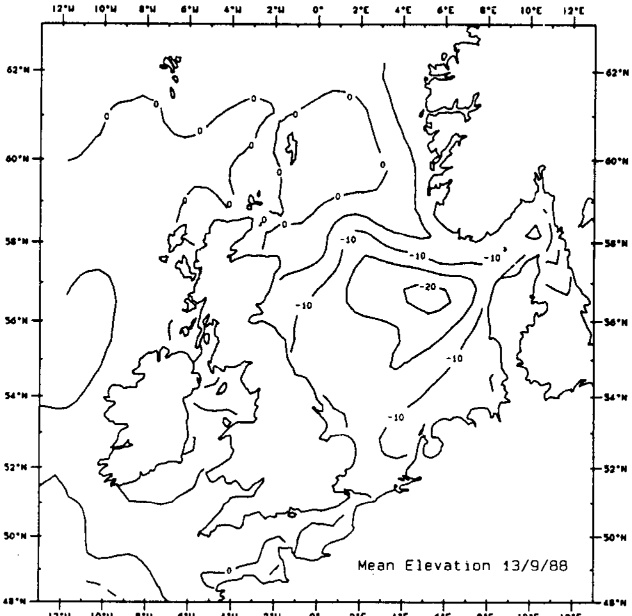

Mean Elevation 8/9/88

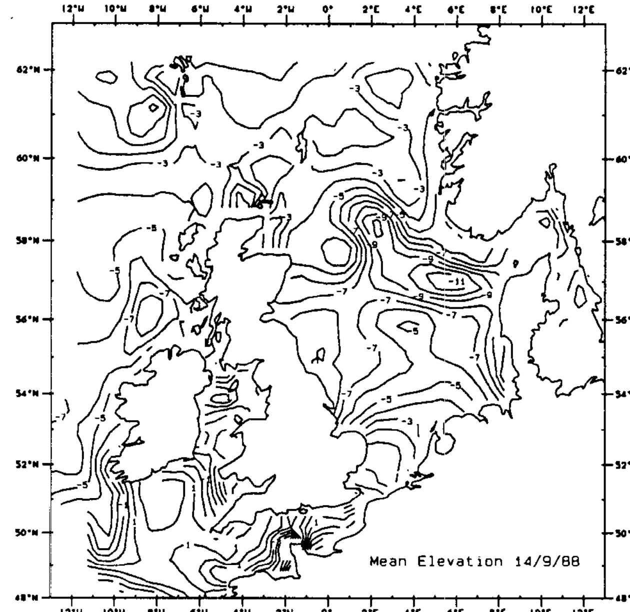

Mean Elevation 9/9/88

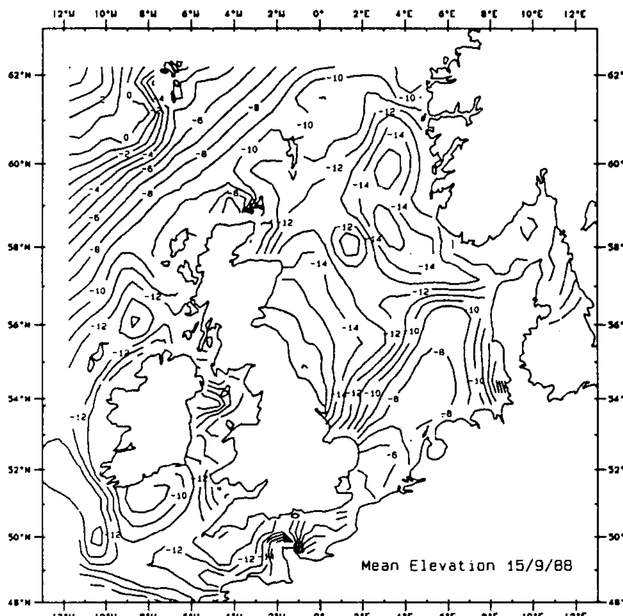

Mean Elevation 10/9/88

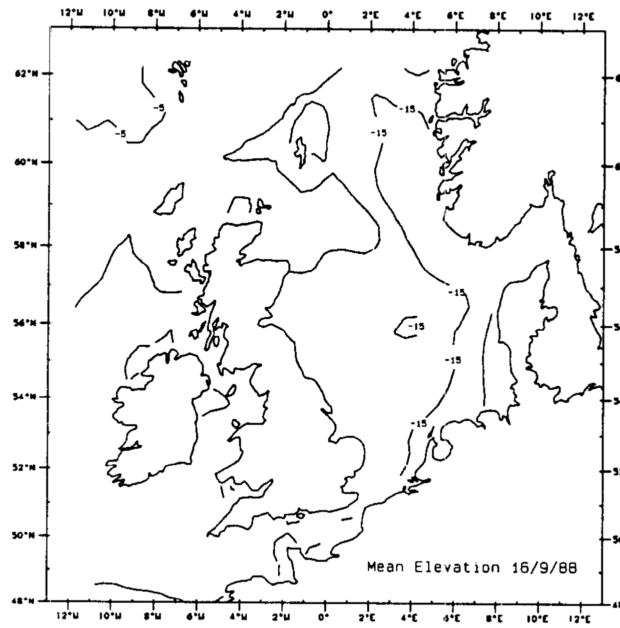

Mean Elevation 11/9/88

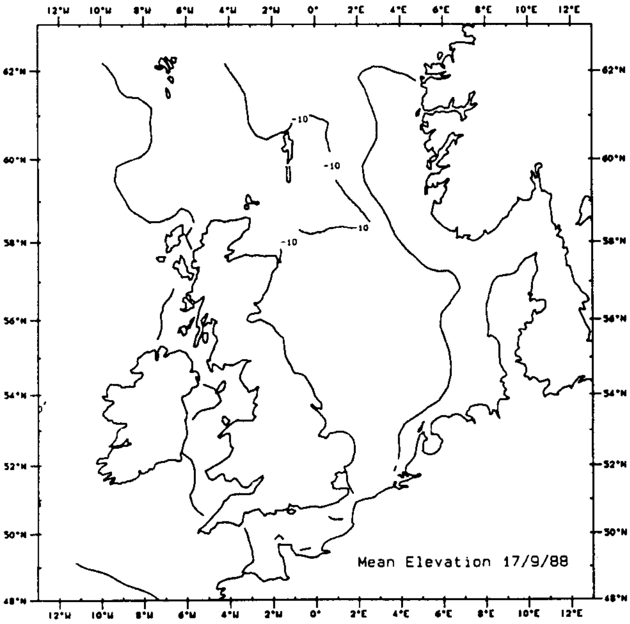

Mean Elevation 12/9/88

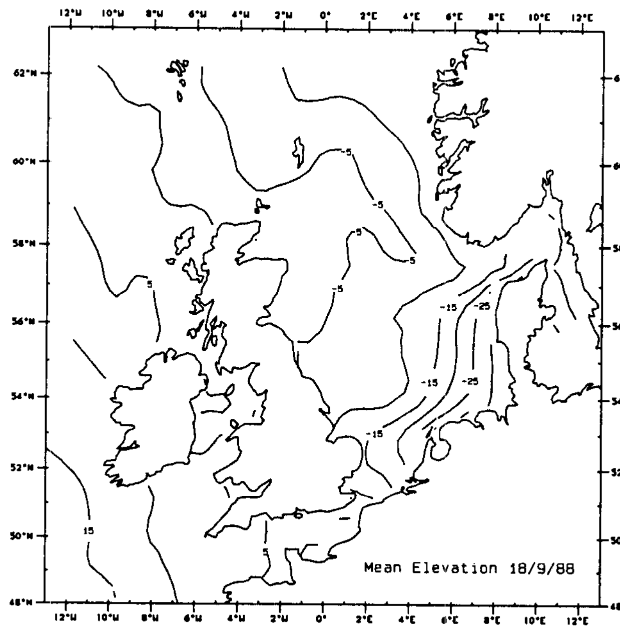

Mean Elevation 13/9/88

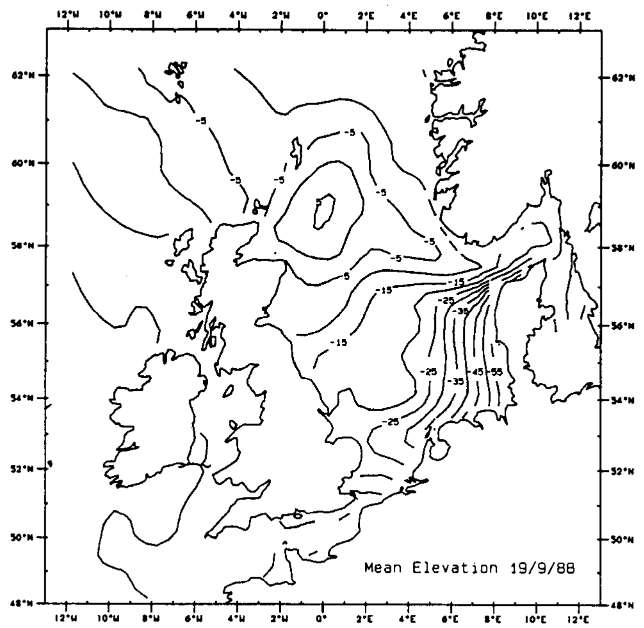

Mean Elevation 14/9/88

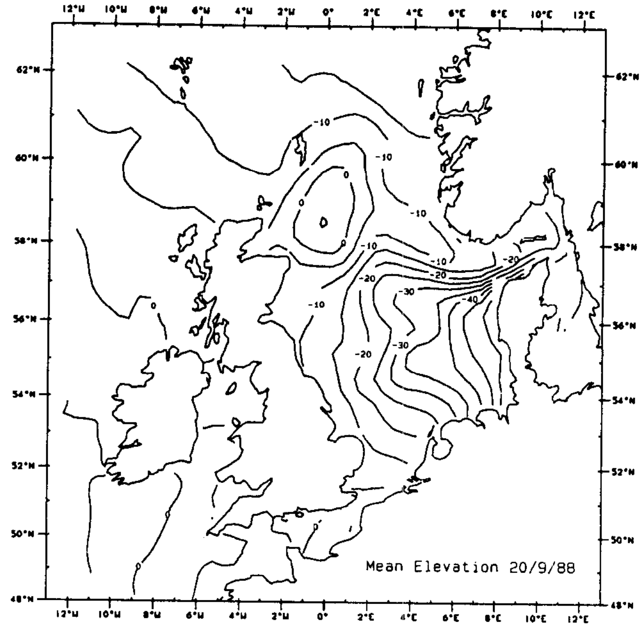

Mean Elevation 15/9/88

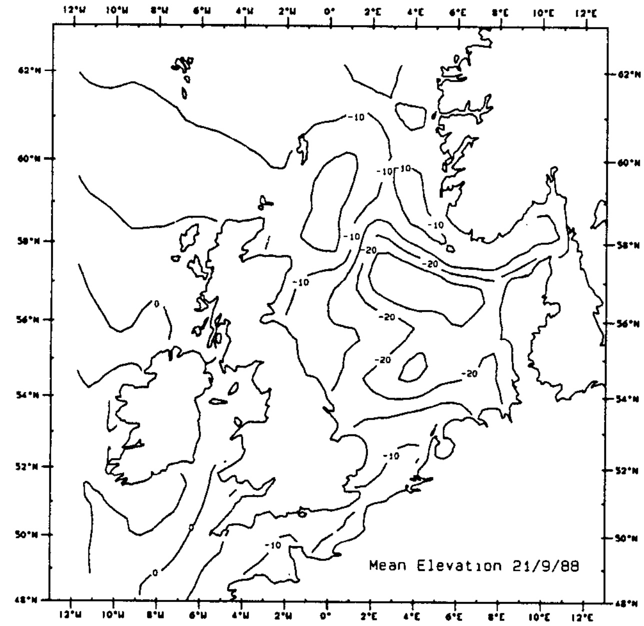

Mean Elevation 16/9/88

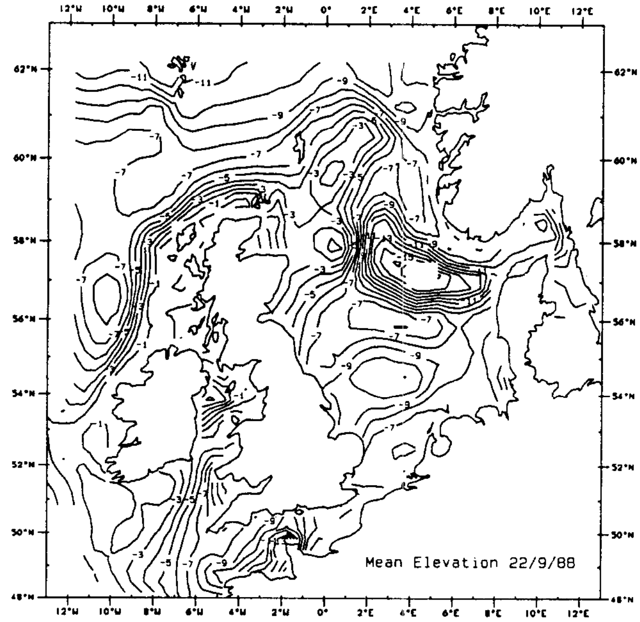

Mean Elevation 17/9/88

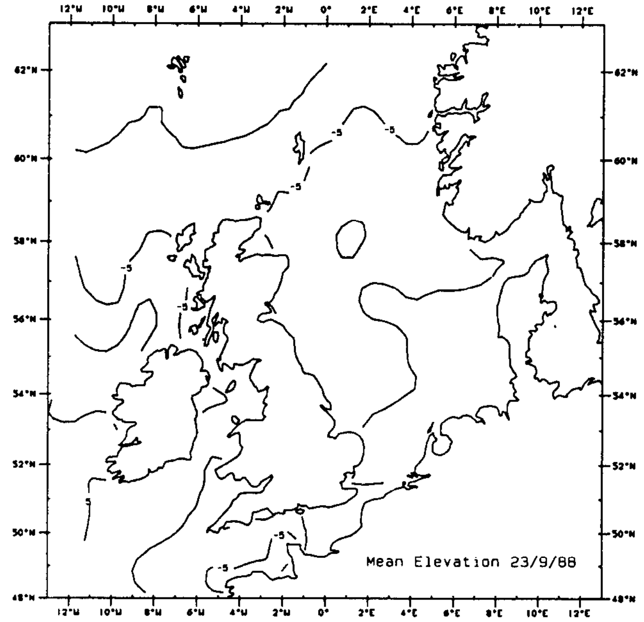

Mean Elevation 18/9/88

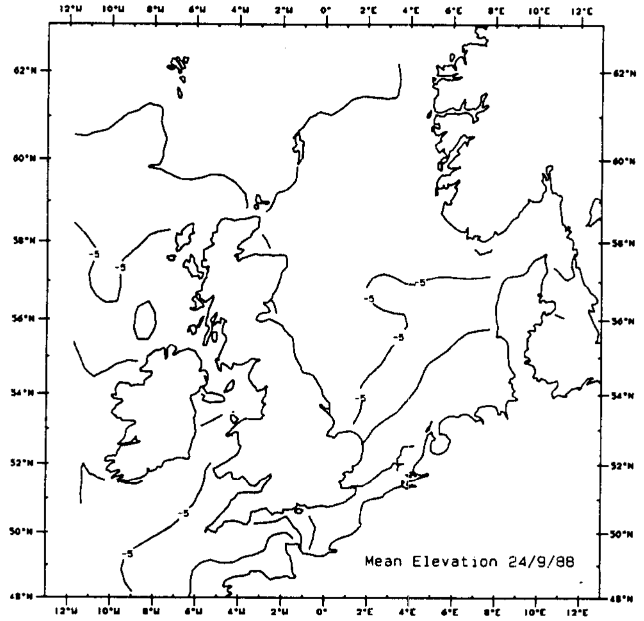

Mean Elevation 19/9/88

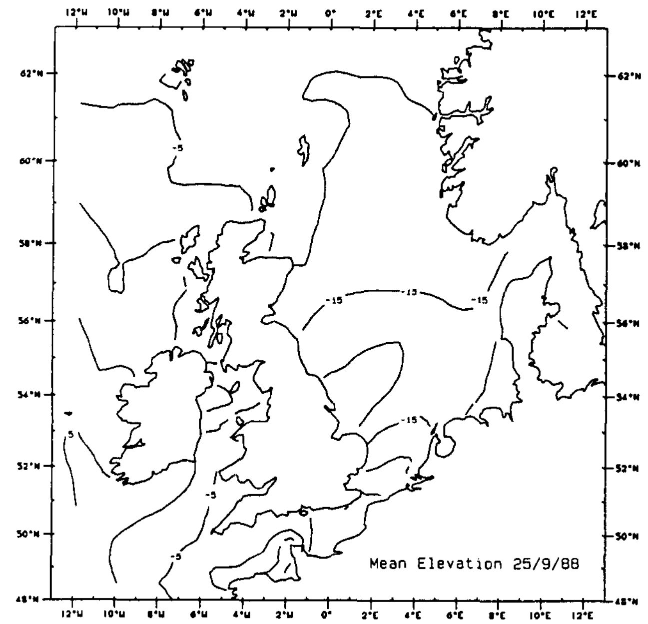

Mean Elevation 20/9/88

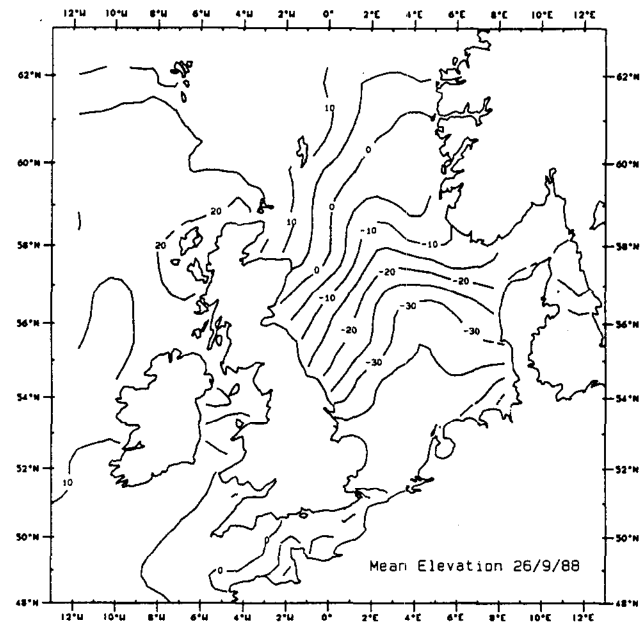

Mean Elevation 21/9/88

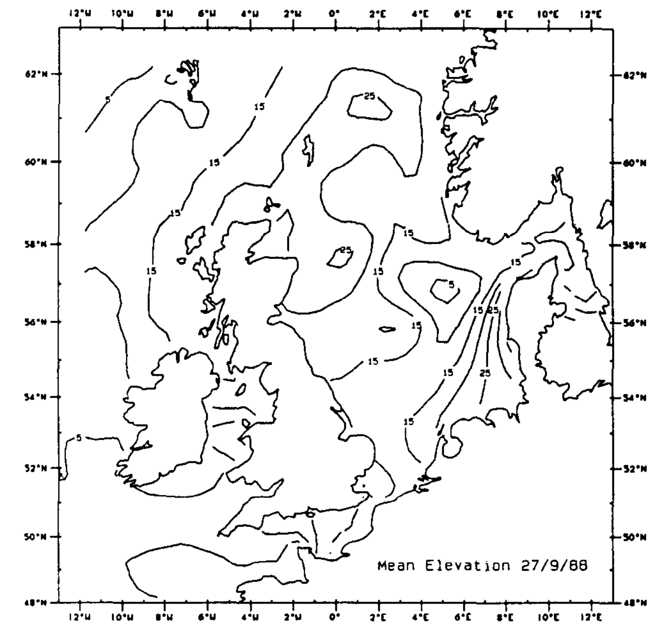

Mean Elevation 22/9/88


Mean Elevation 23/9/88


Mean Elevation 24/9/88


Mean Elevation 25/9/88


Mean Elevation 26/9/88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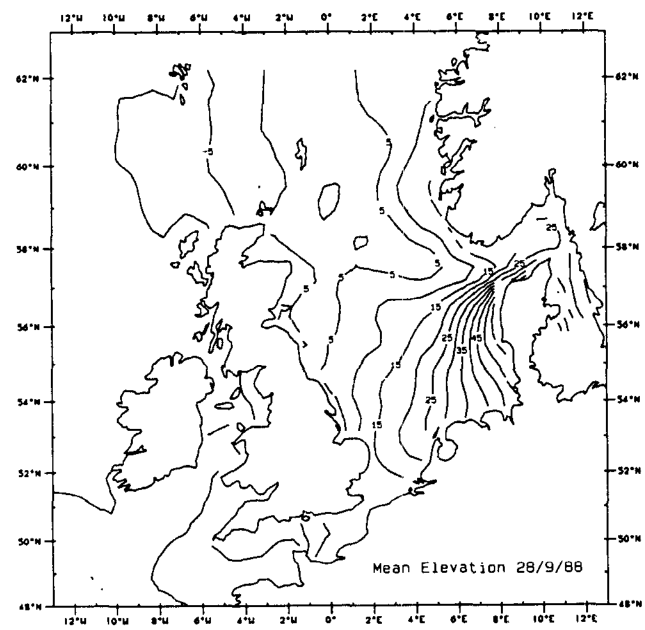
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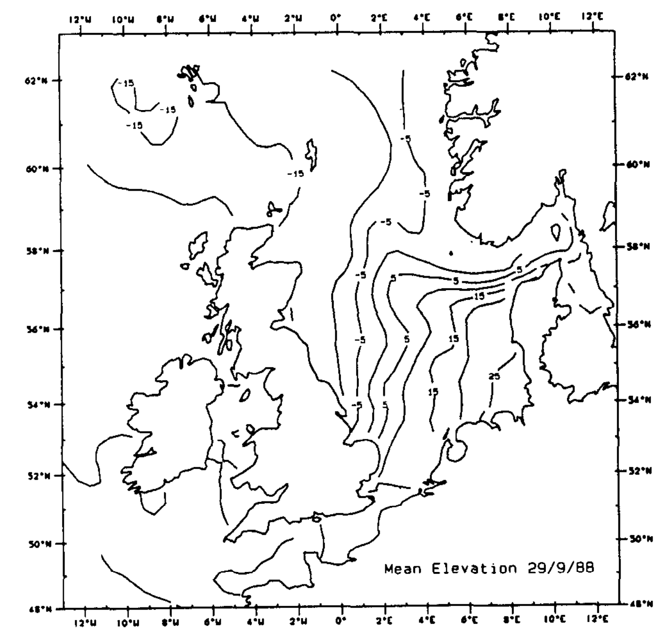
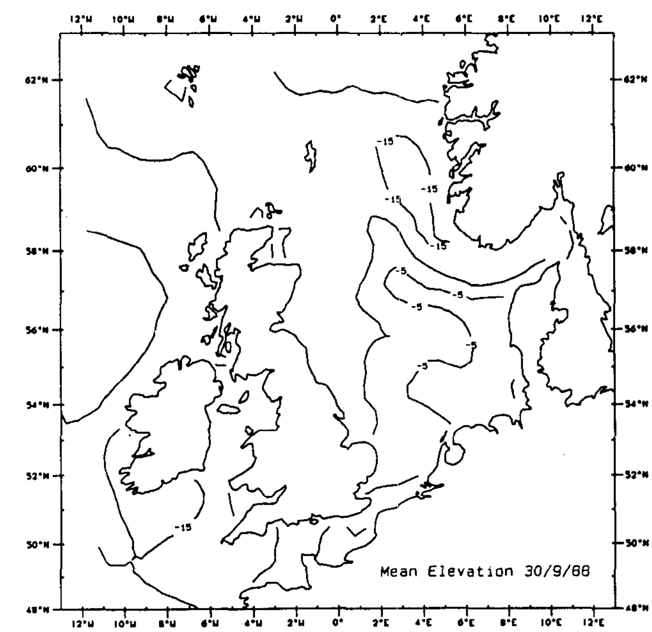
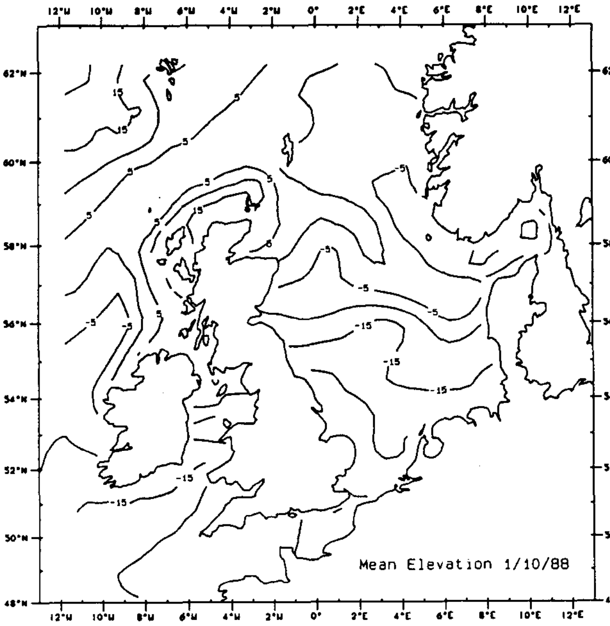
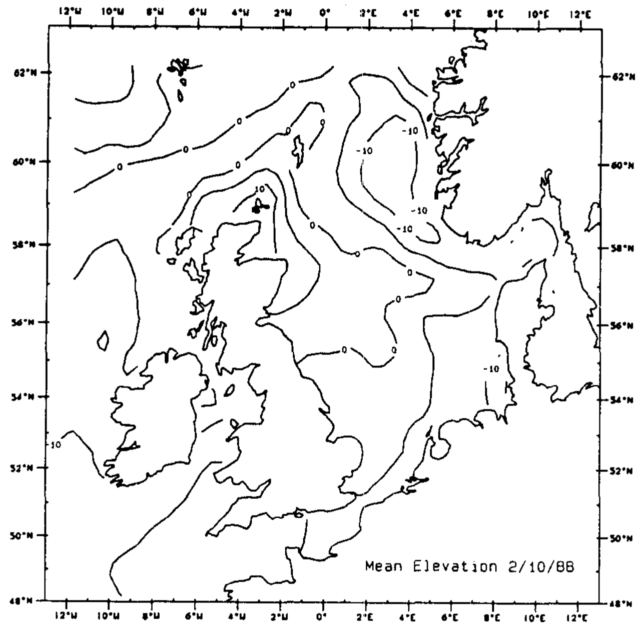

Mean Elevation 29/9/88


Mean Elevation 30/9/88


Mean Elevation 1/10/88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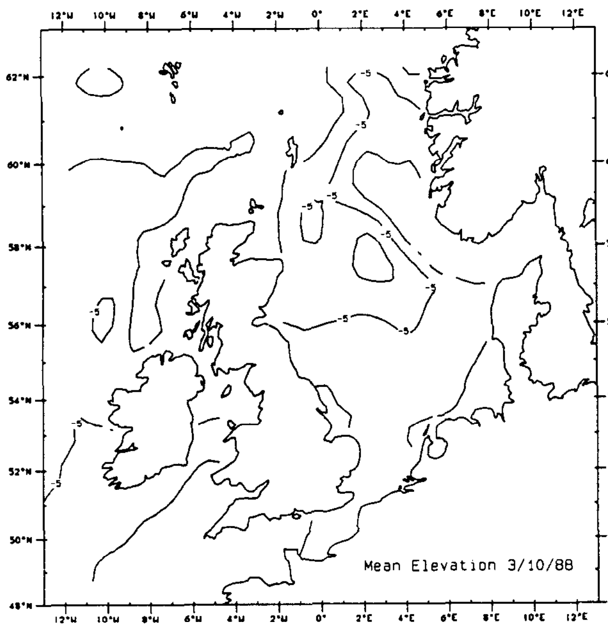
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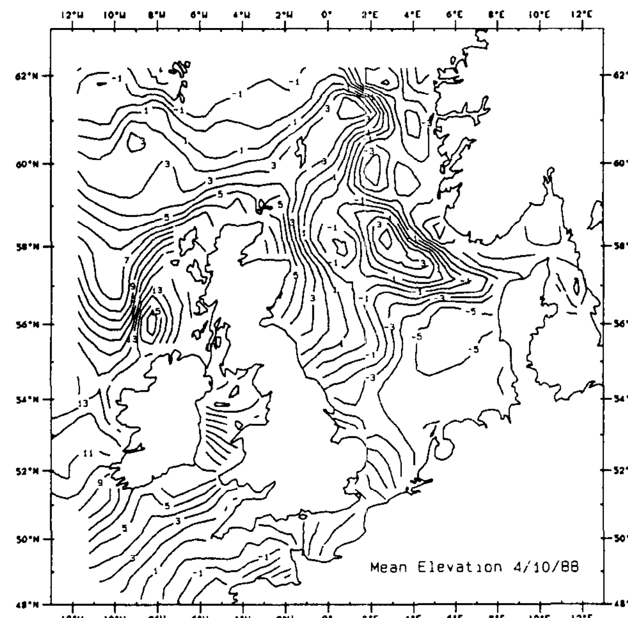
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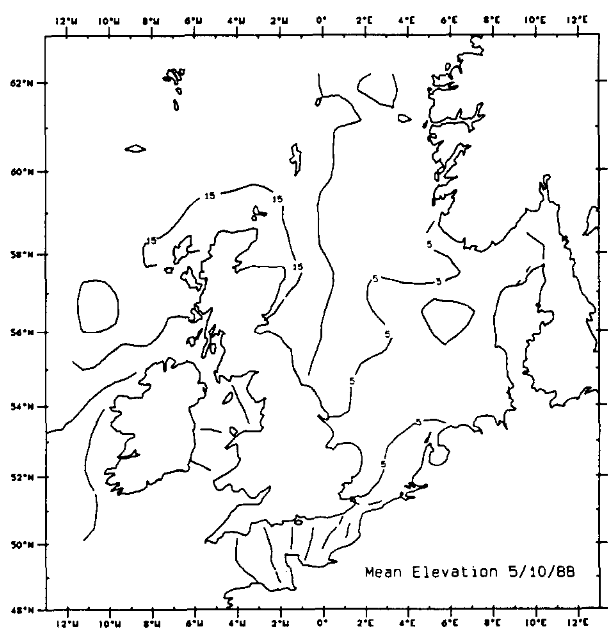
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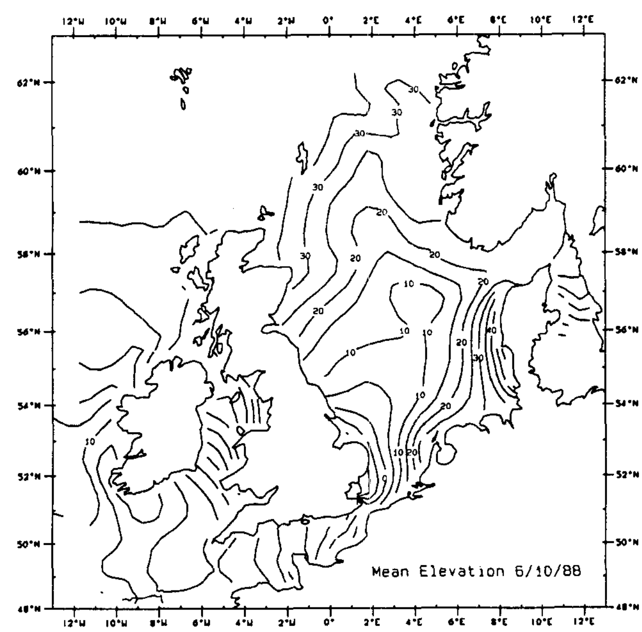
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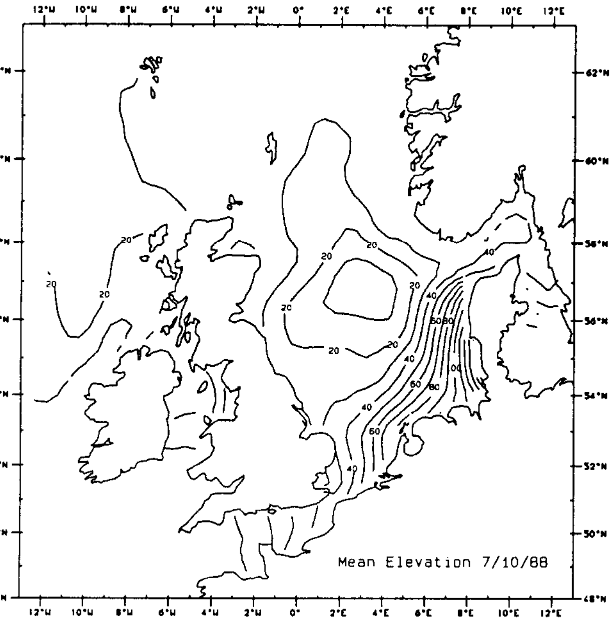
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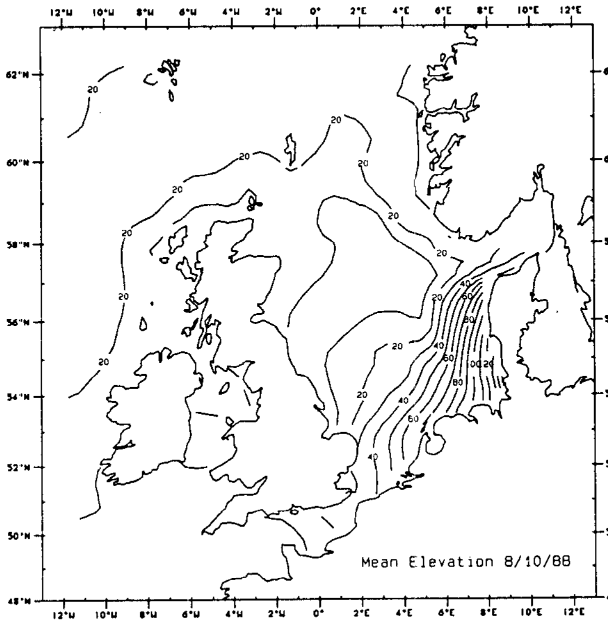
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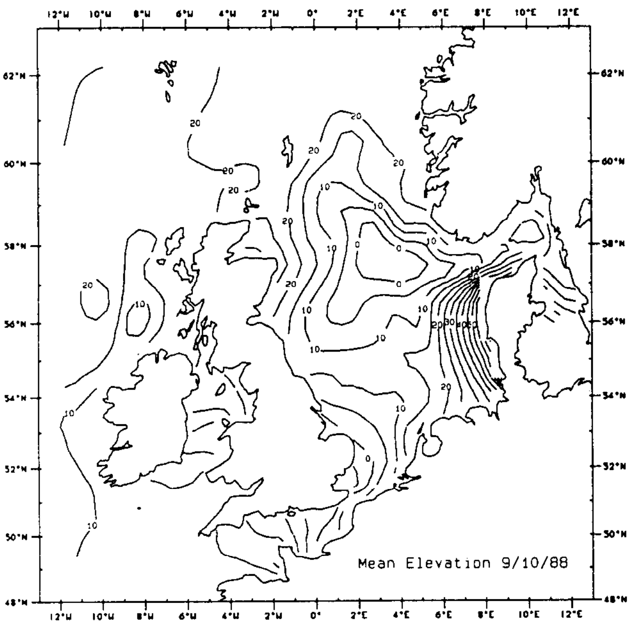
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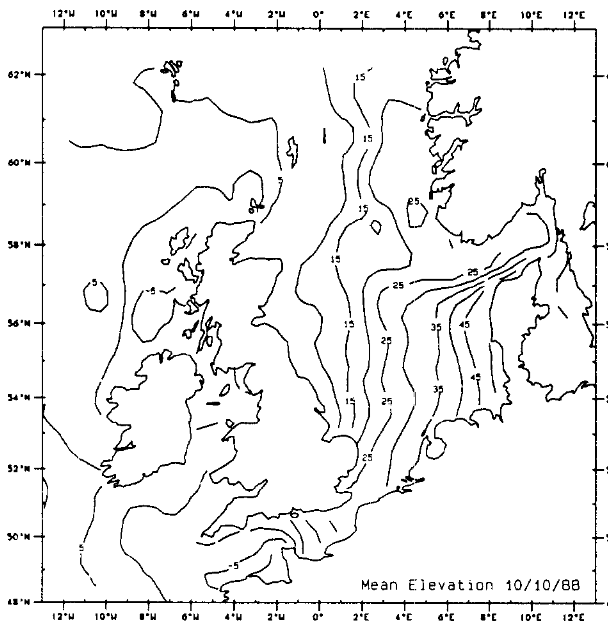
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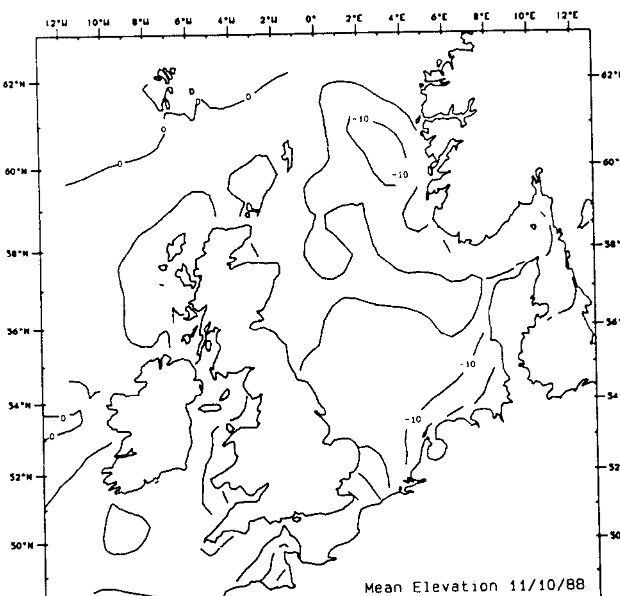
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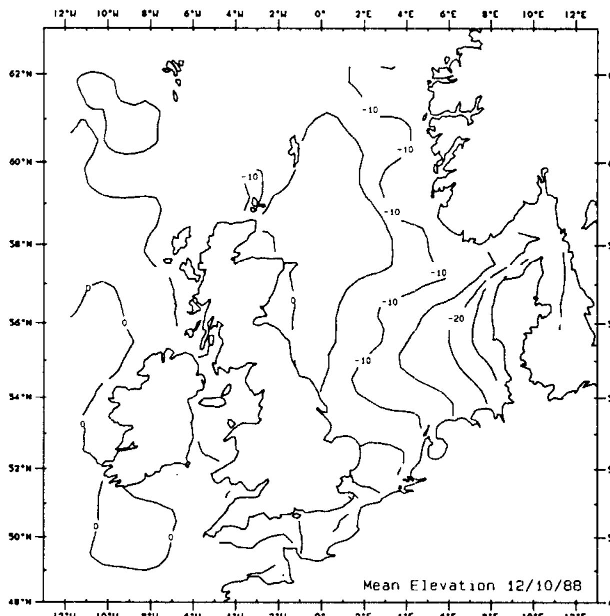
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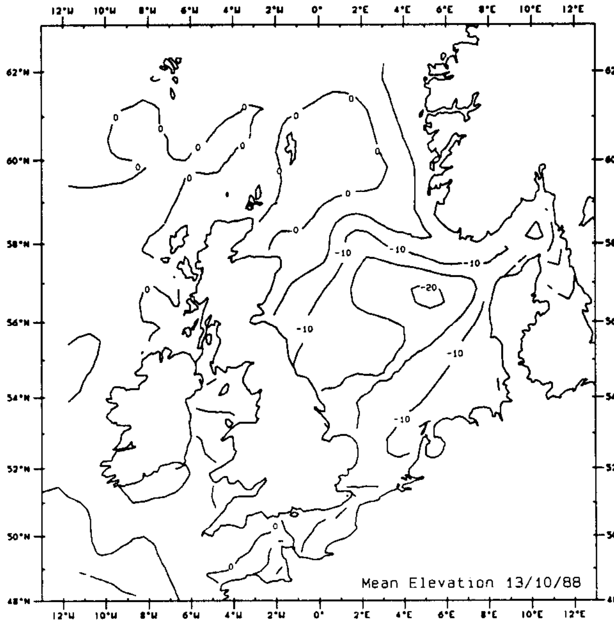
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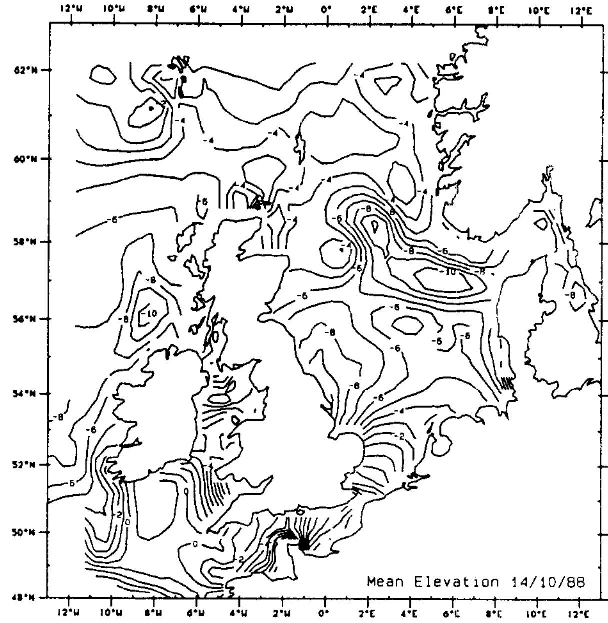
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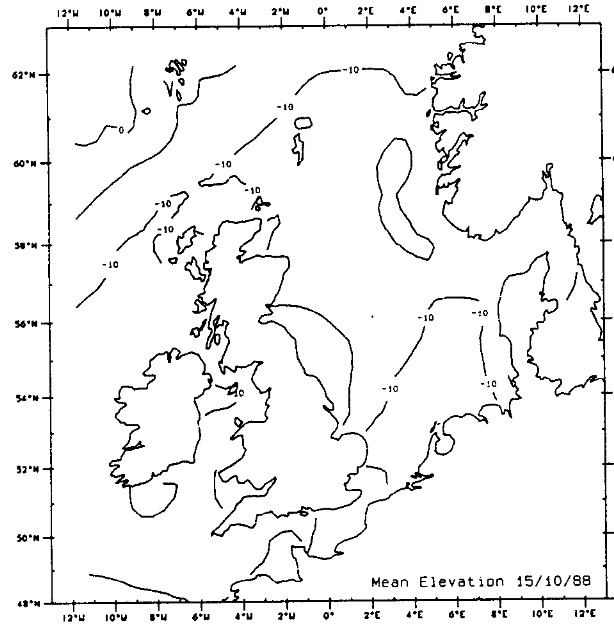
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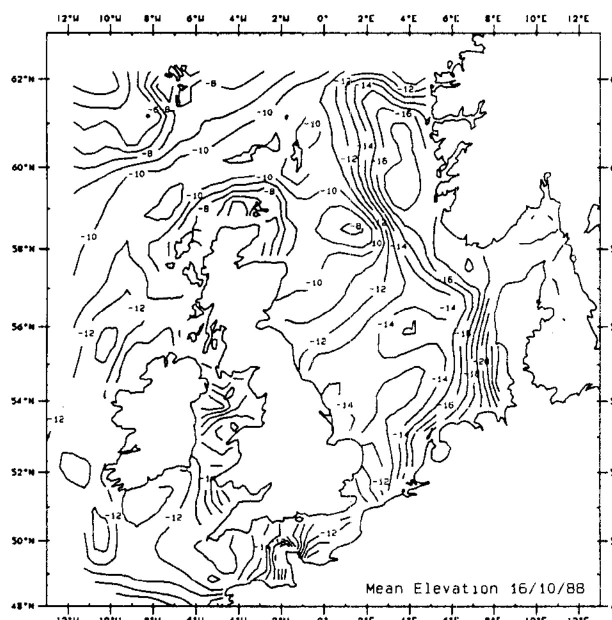
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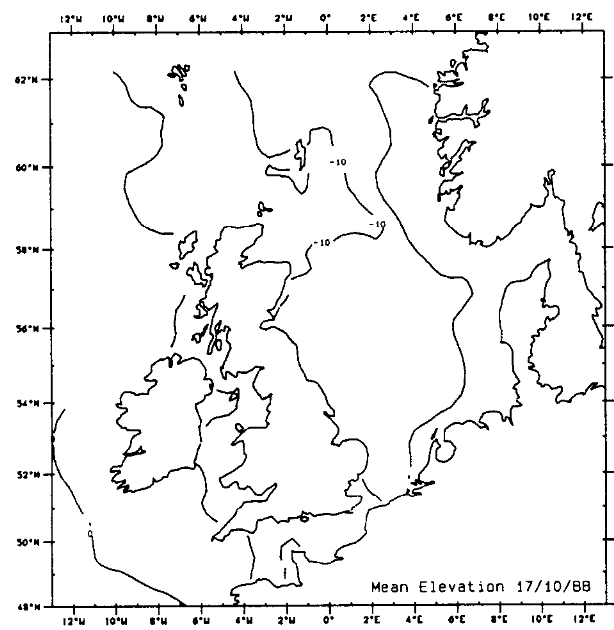
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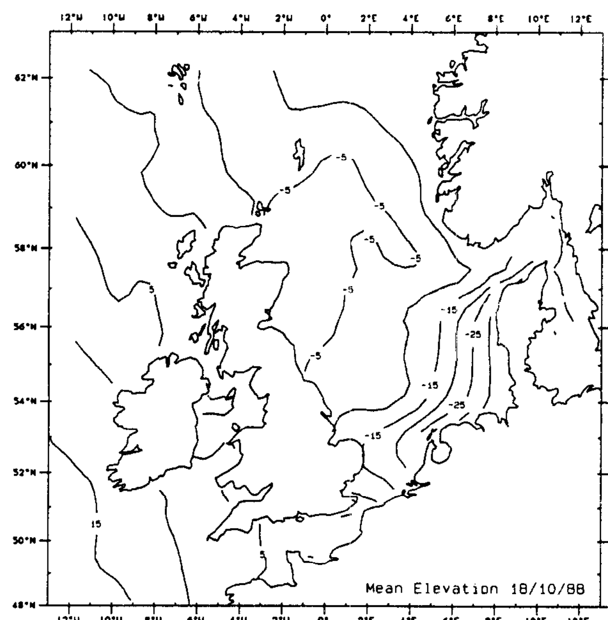
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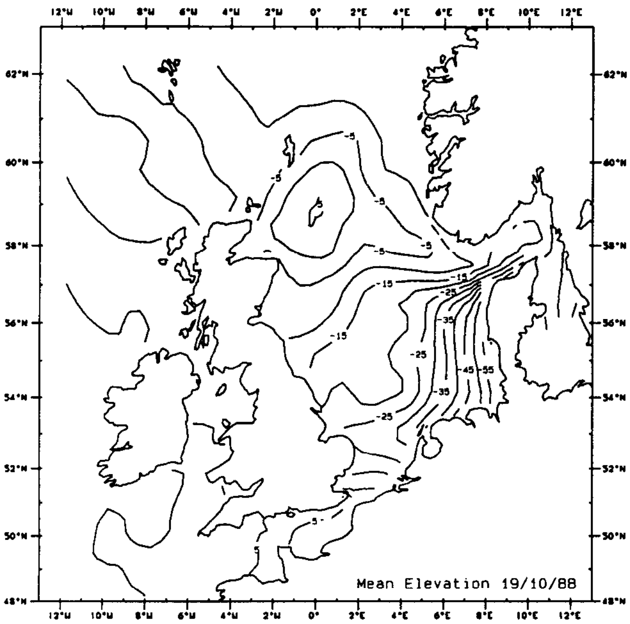
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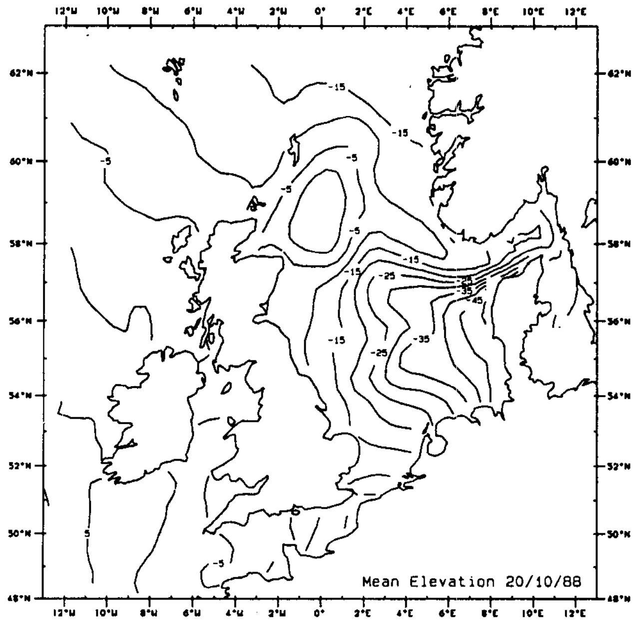
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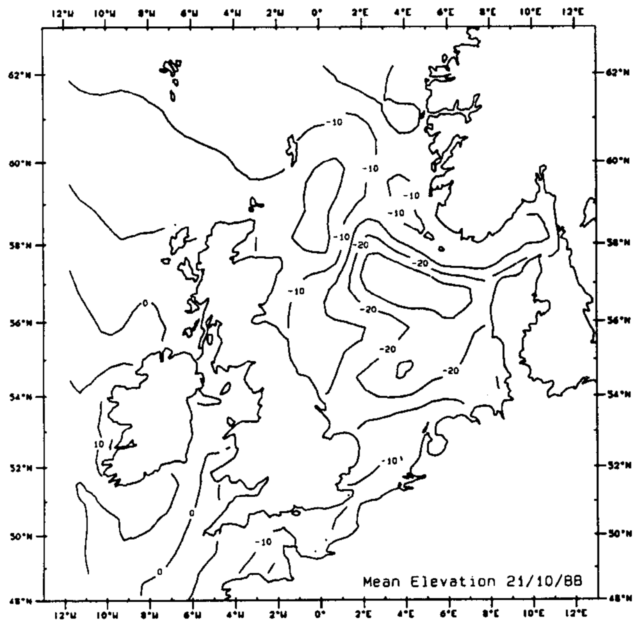
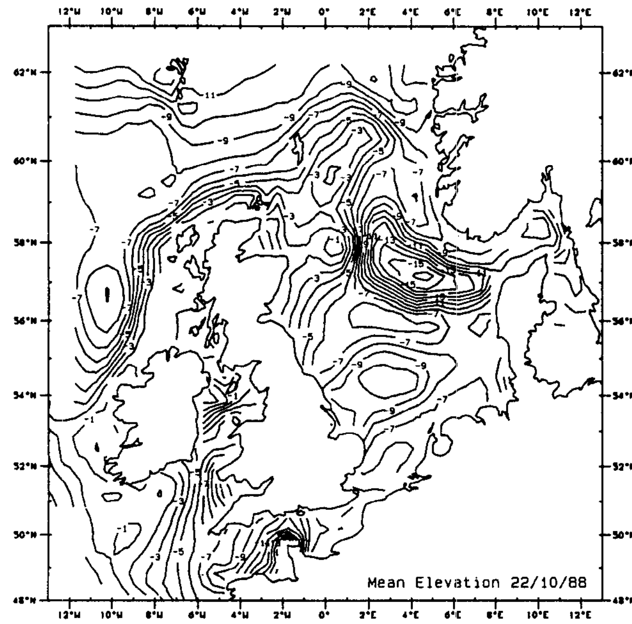

Mean Elevation 21/10/88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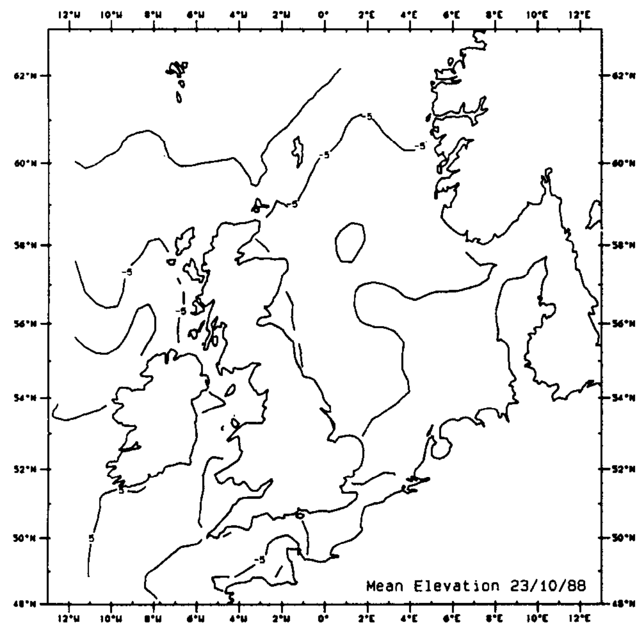
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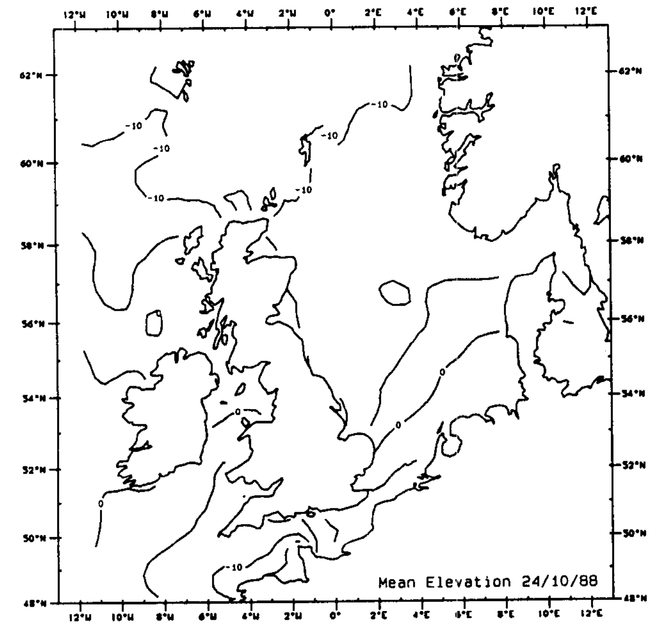
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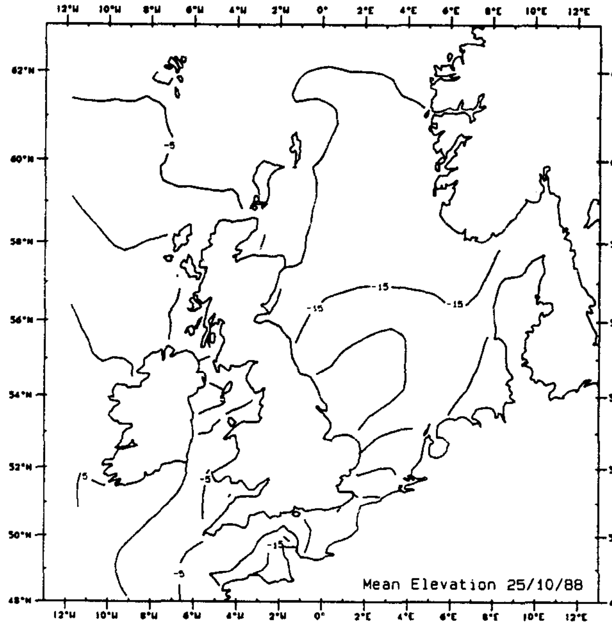
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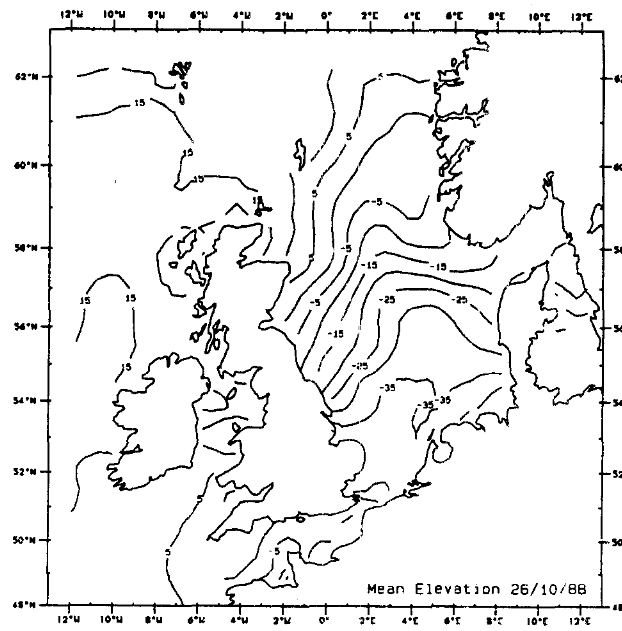
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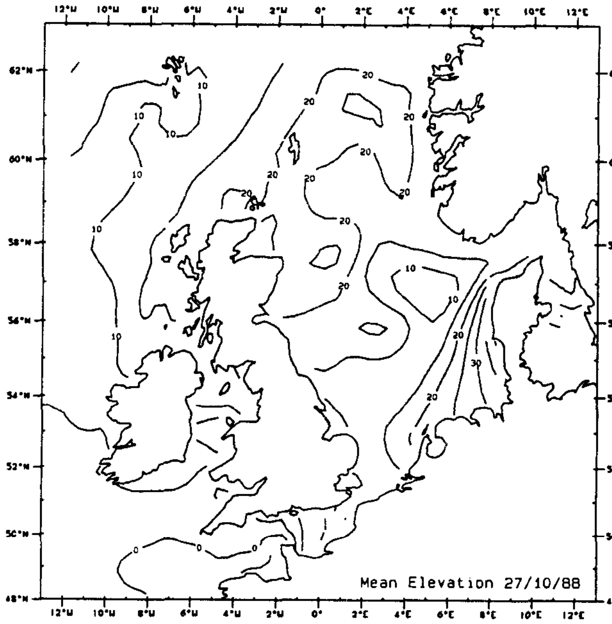
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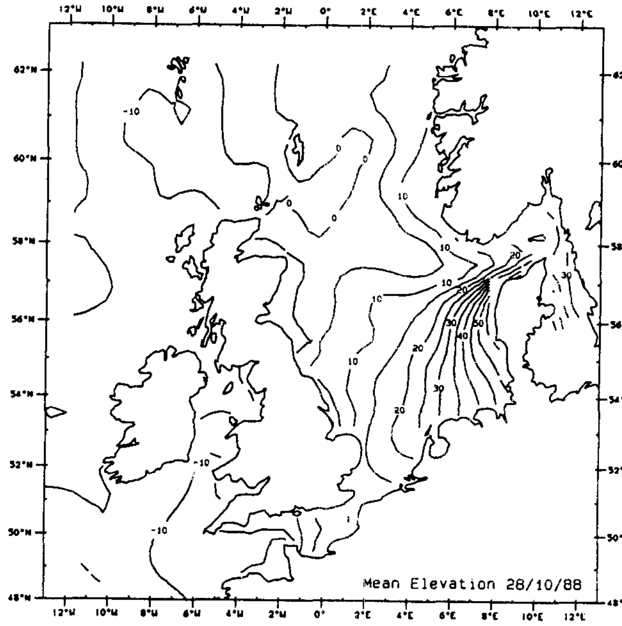
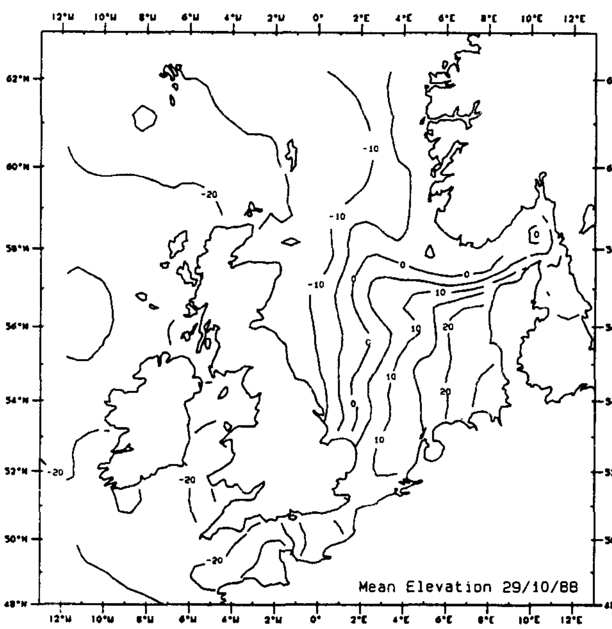

Mean Elevation 28/10/88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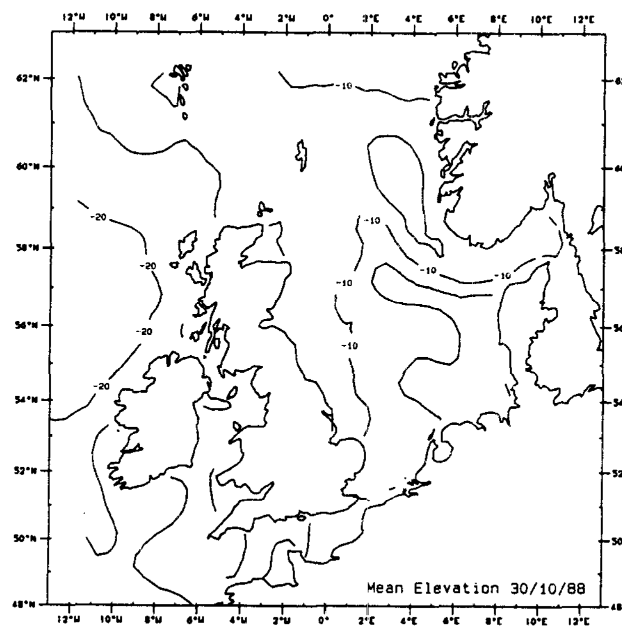
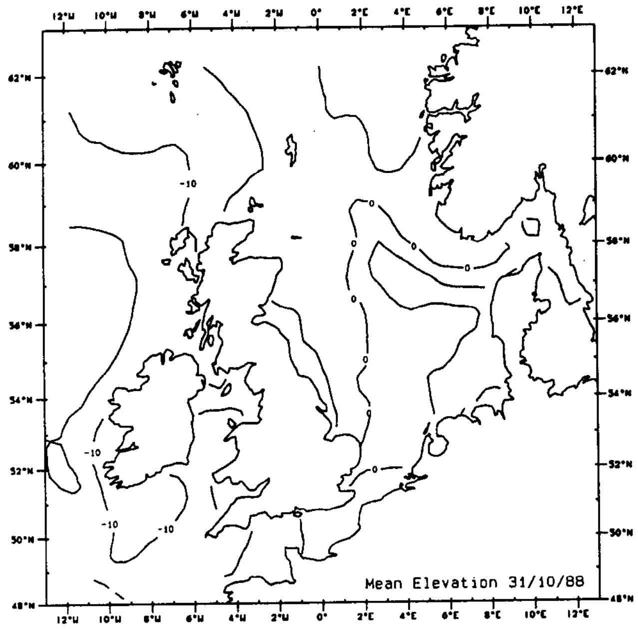

Mean Elevation 30/10/88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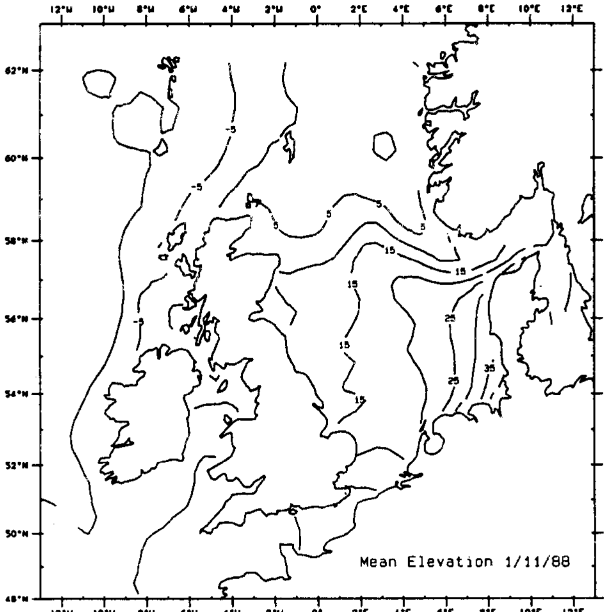
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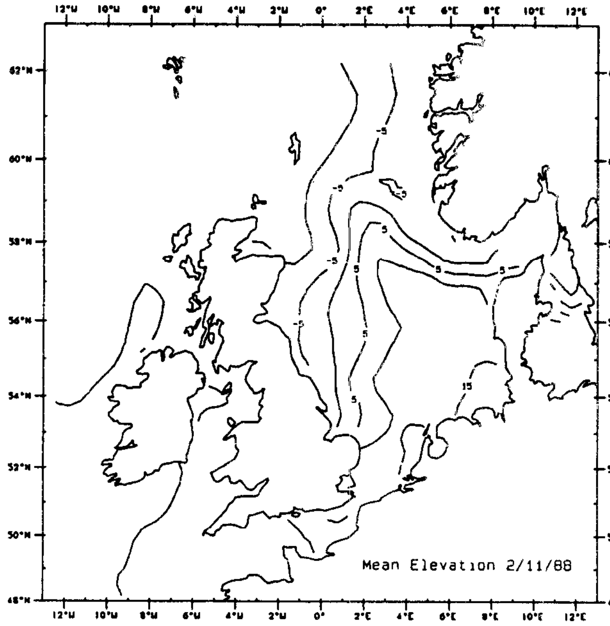
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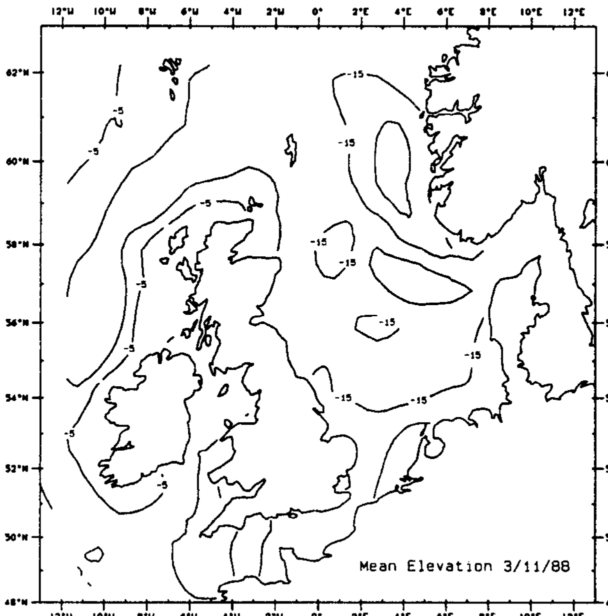
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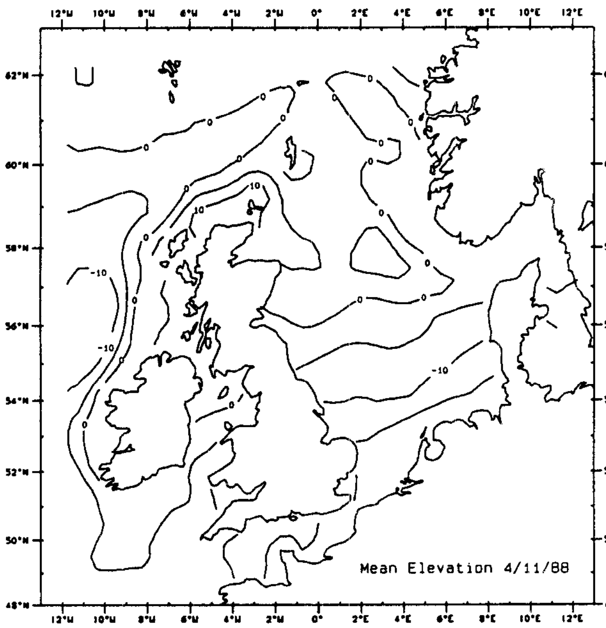
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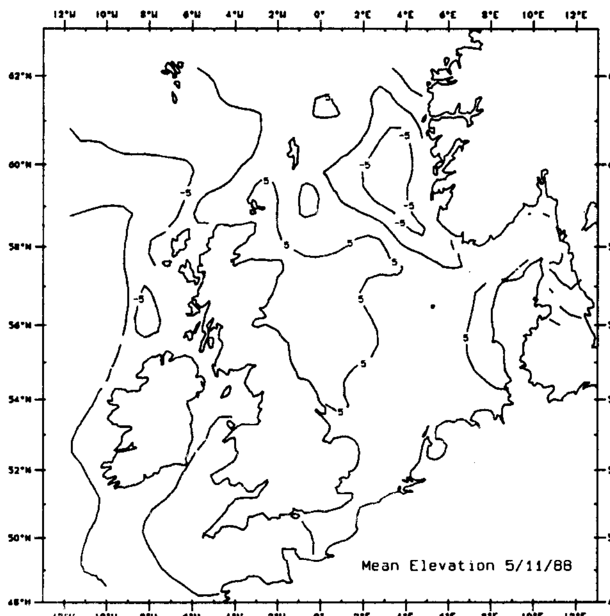
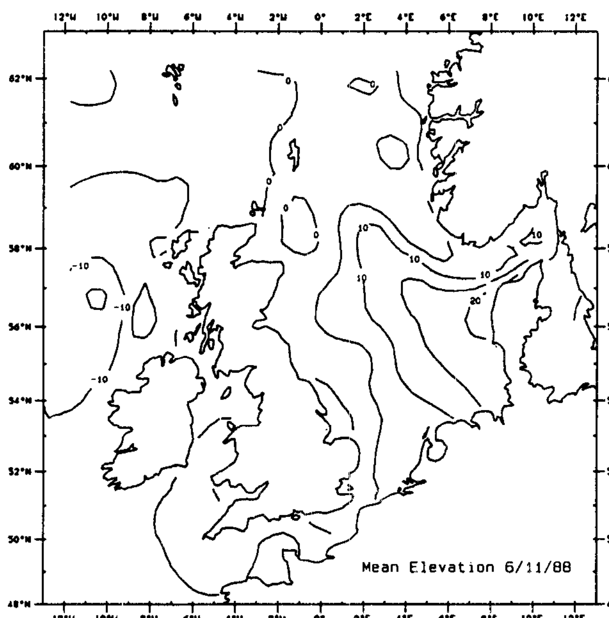
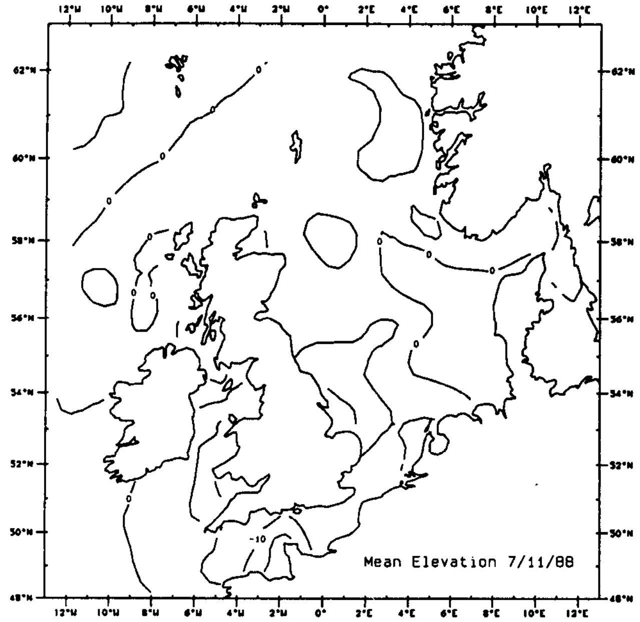
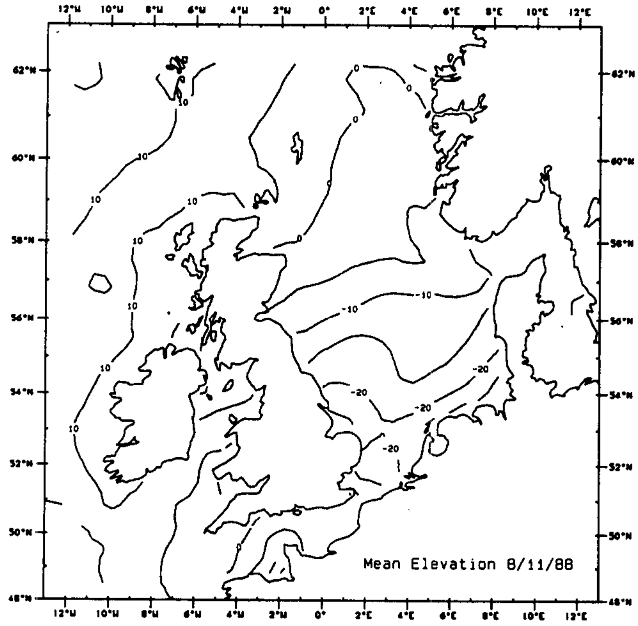

Mean Elevation 5/11/88

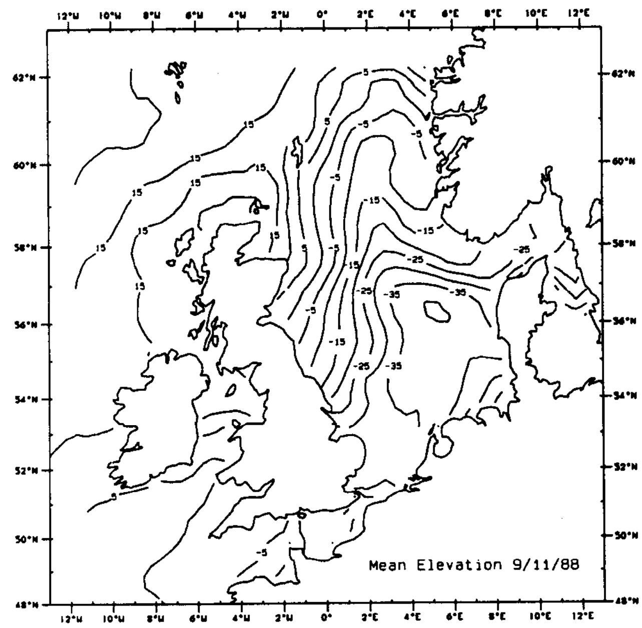

Mean Elevation 6/11/88



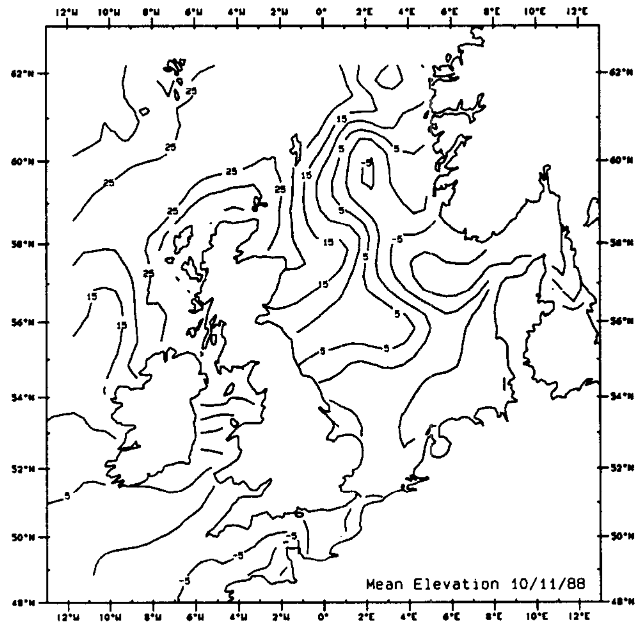
Mean Elevation 7/11/88



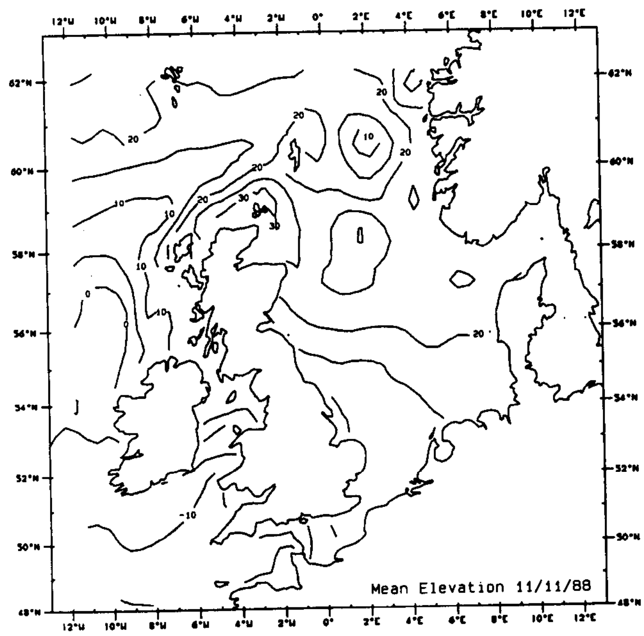
Mean Elevation 8/11/88



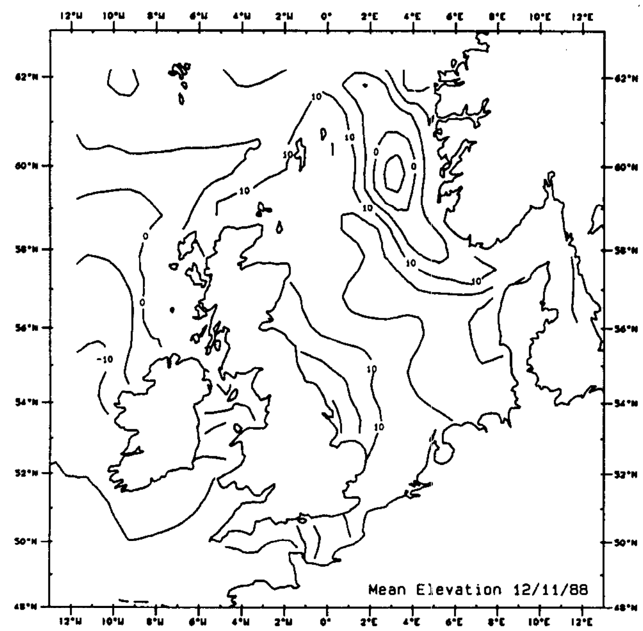
Mean Elevation 9/11/88



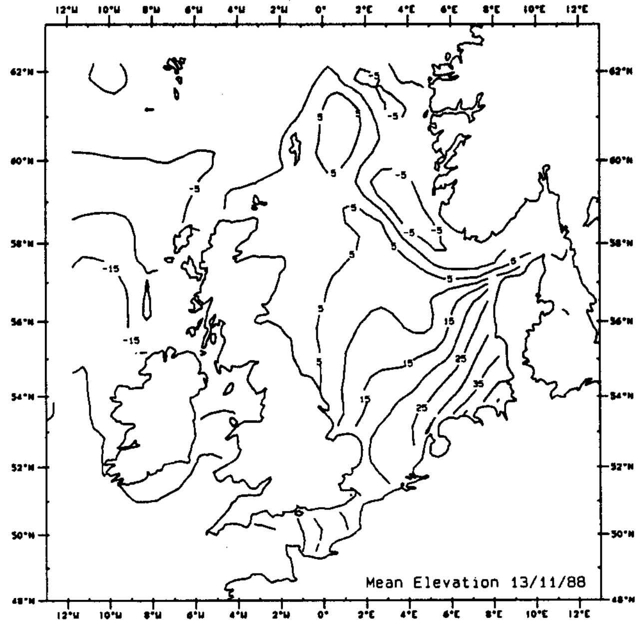
Mean Elevation 10/11/88

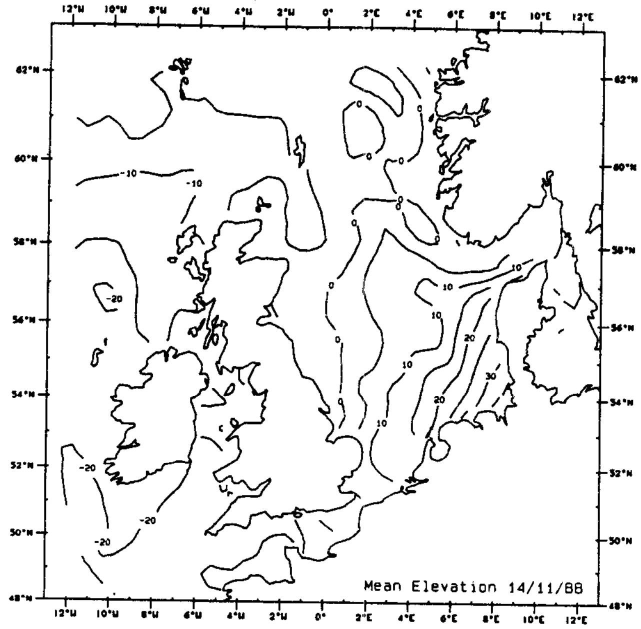


Mean Elevation 11/11/88



Mean Elevation 12/11/88


Mean Elevation 13/11/88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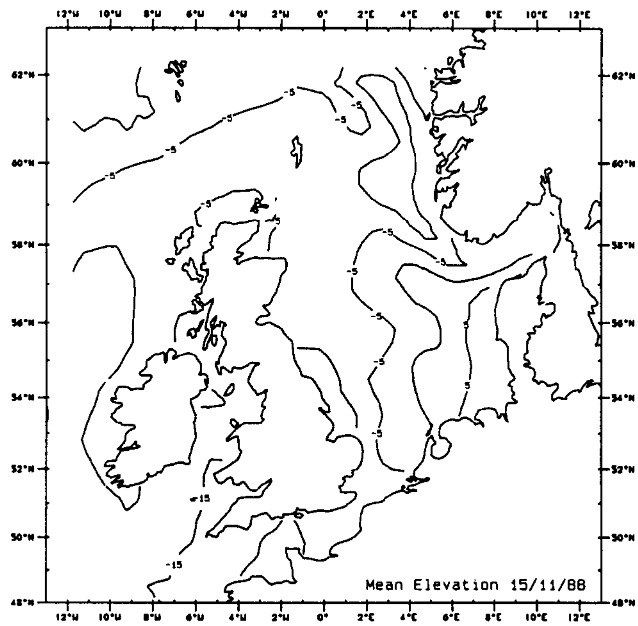
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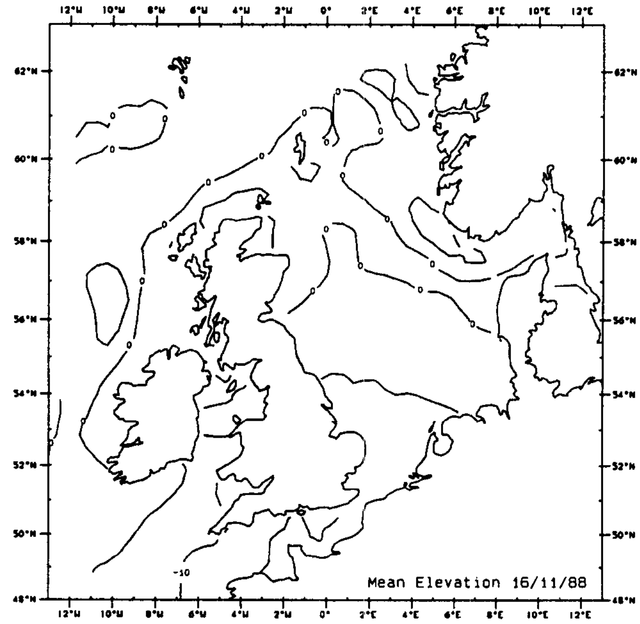
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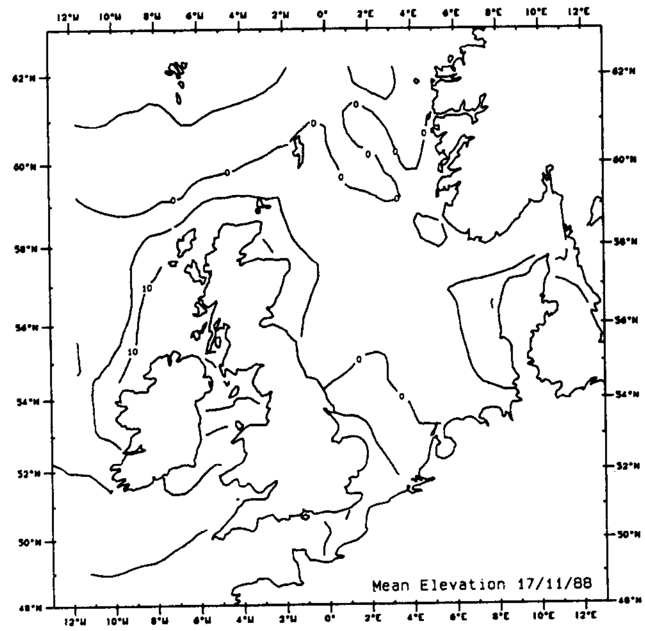
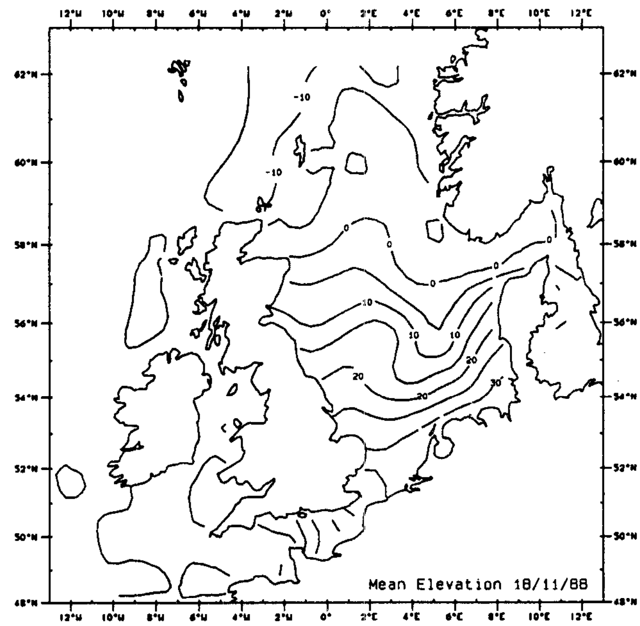
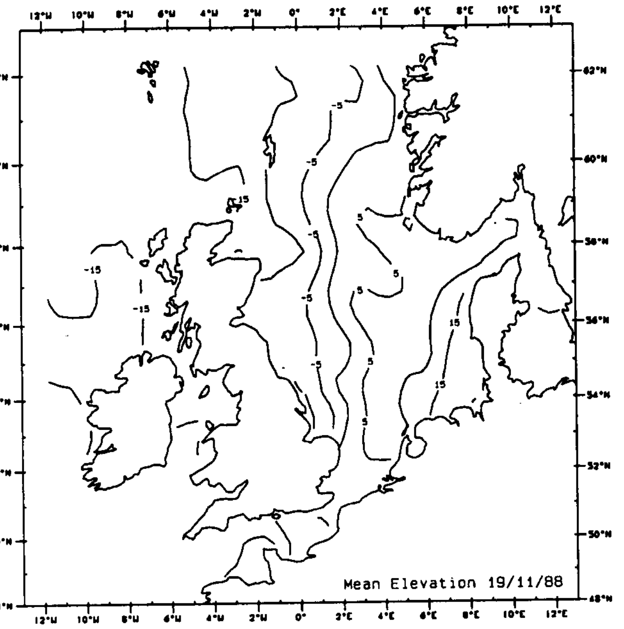

Mean Elevation 17/11/88


Mean Elevation 18/11/88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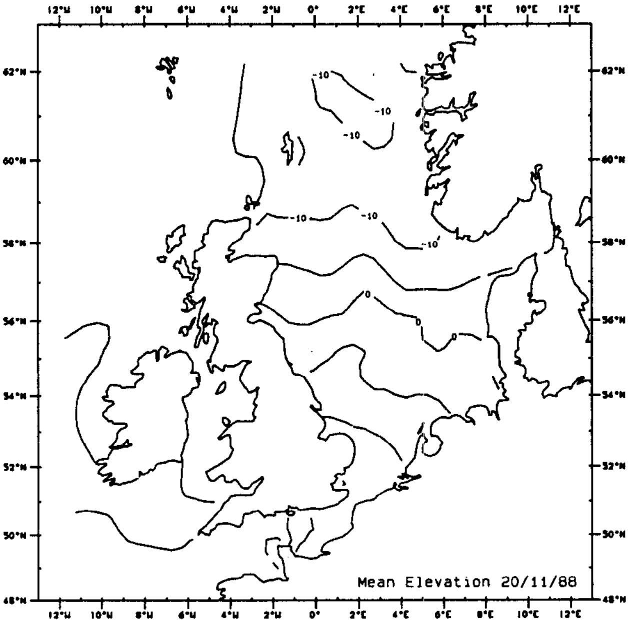
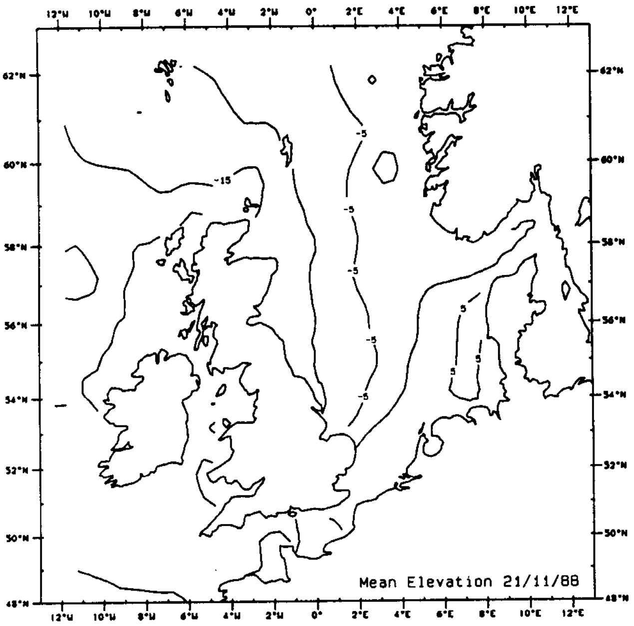
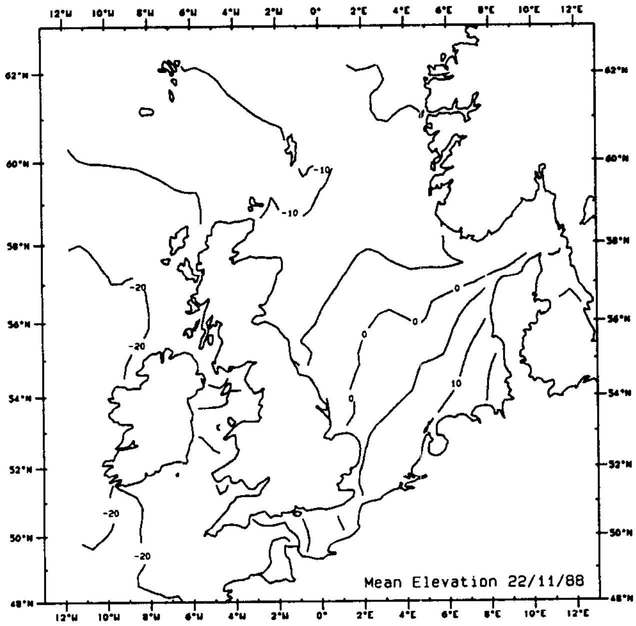
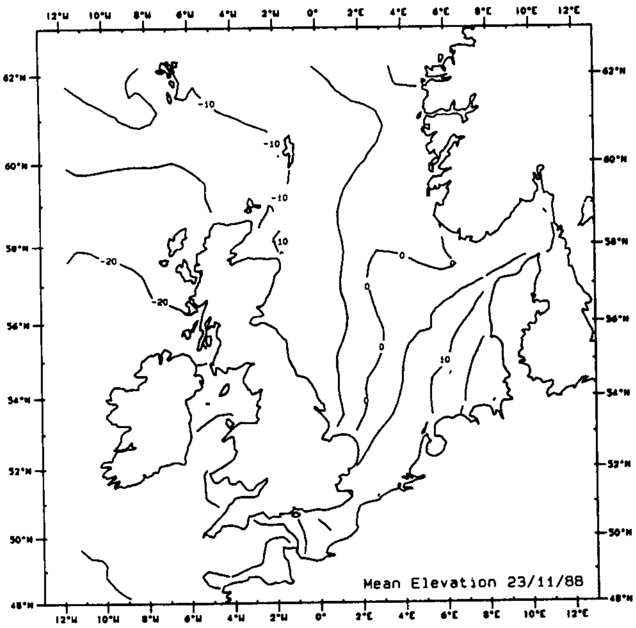

Mean Elevation 20/11/88


Mean Elevation 21/11/88


Mean Elevation 22/11/88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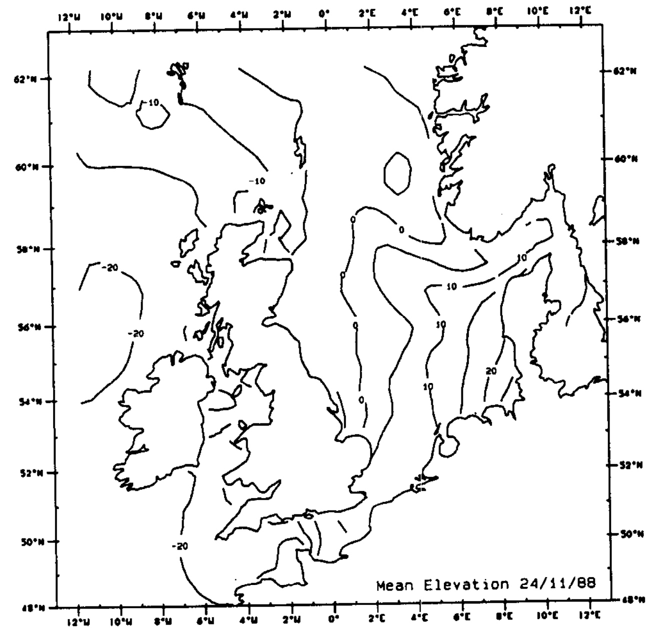
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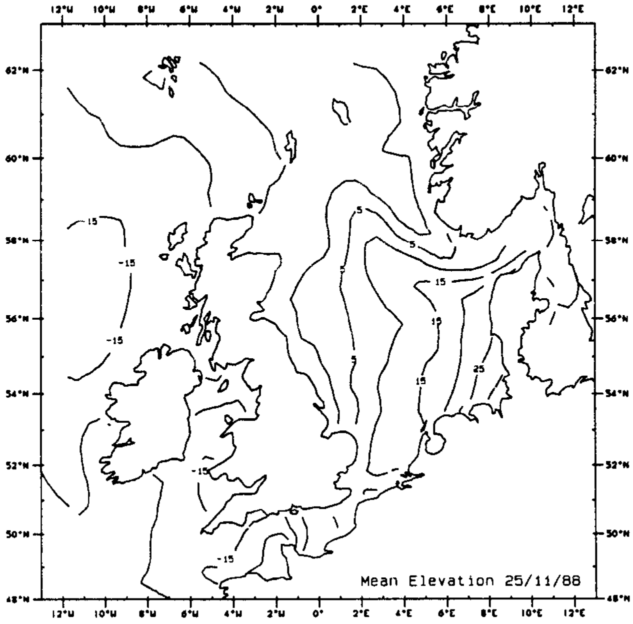
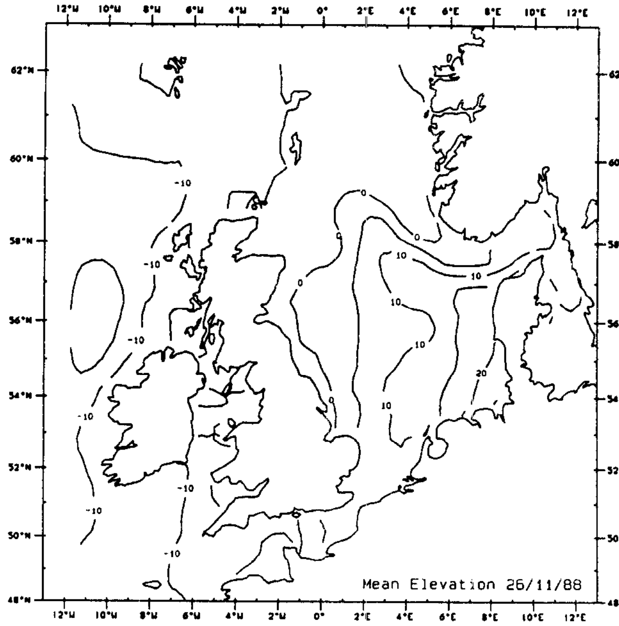

Mean Elevation 25/11/88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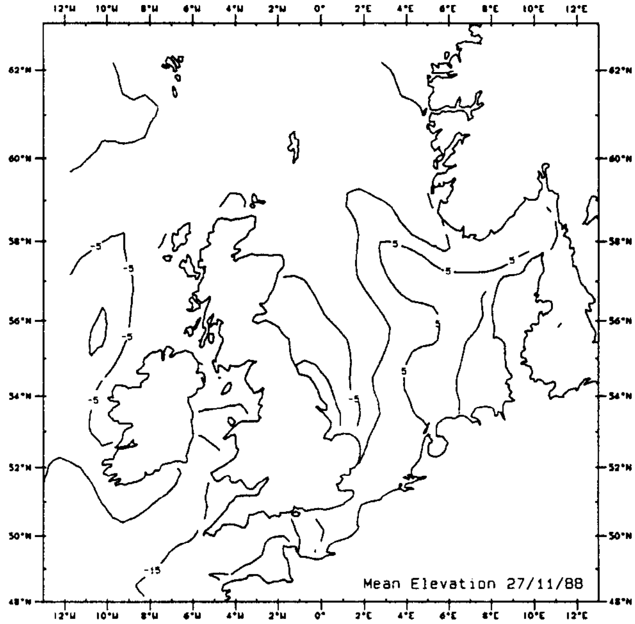
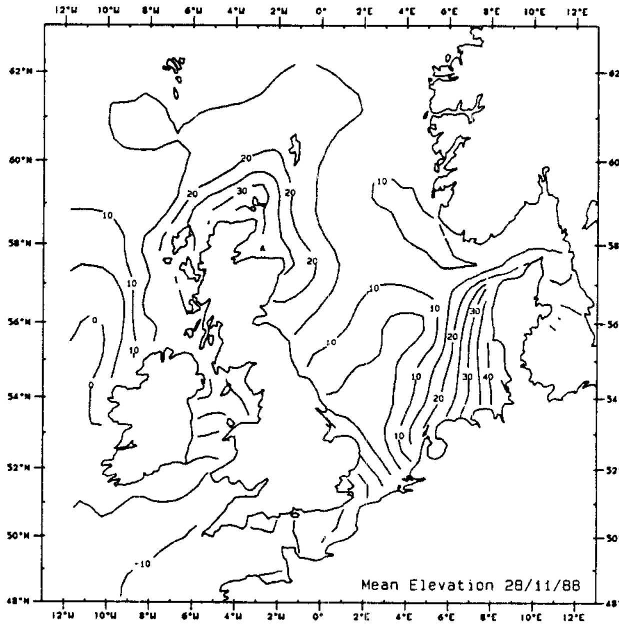

Mean Elevation 27/11/88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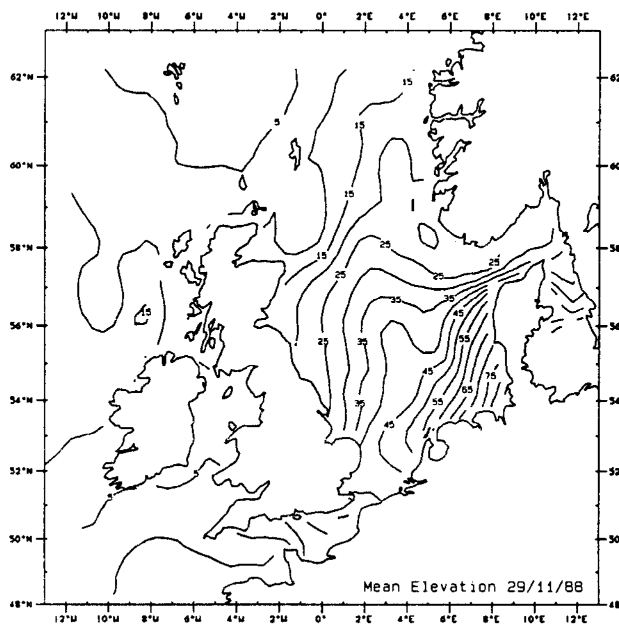
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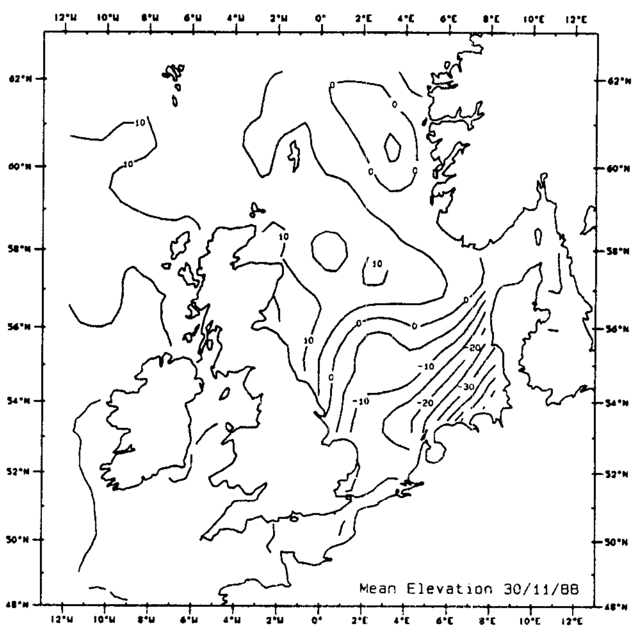
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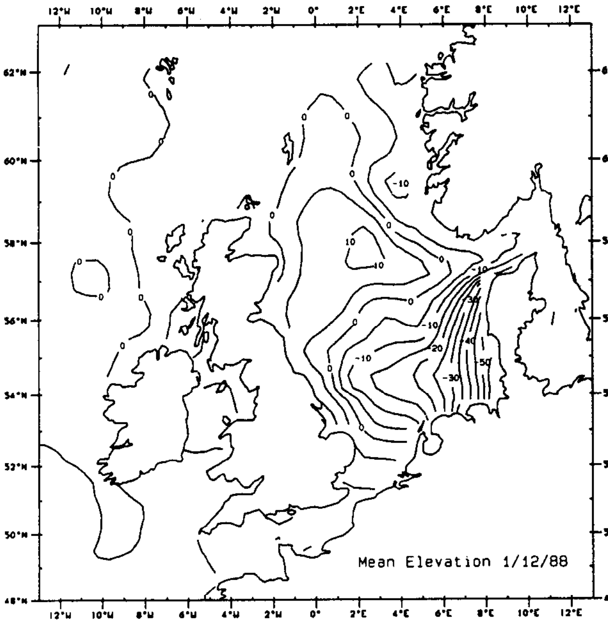
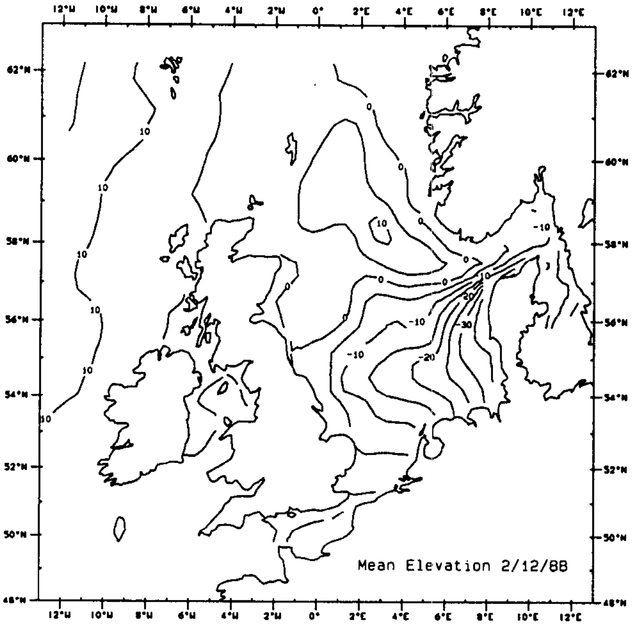

Mean Elevation 1/12/88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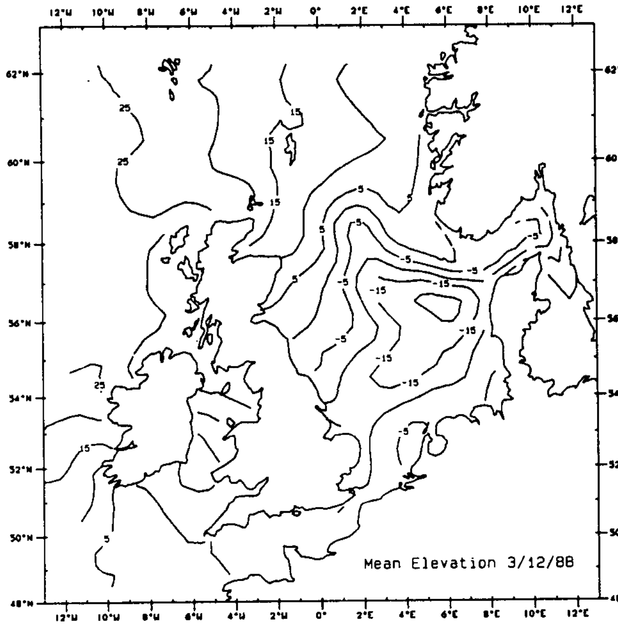
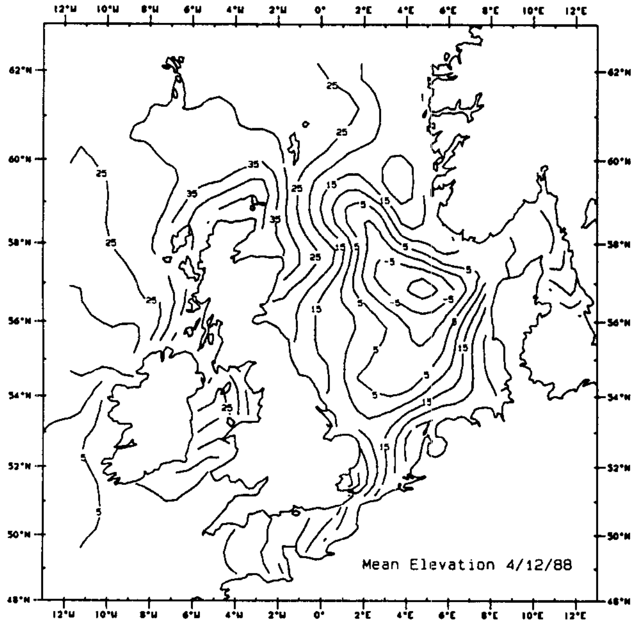

Mean Elevation 3/12/88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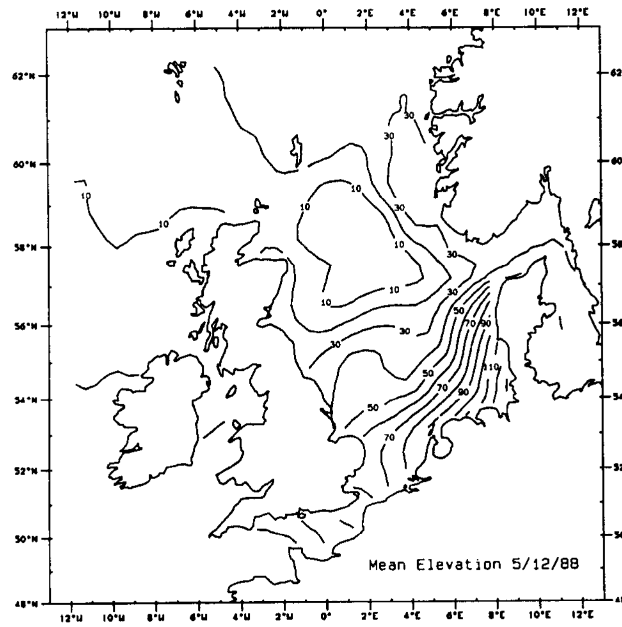
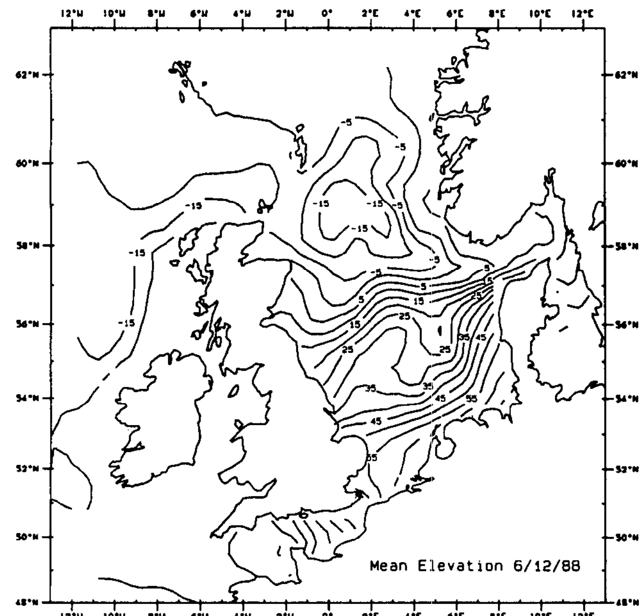
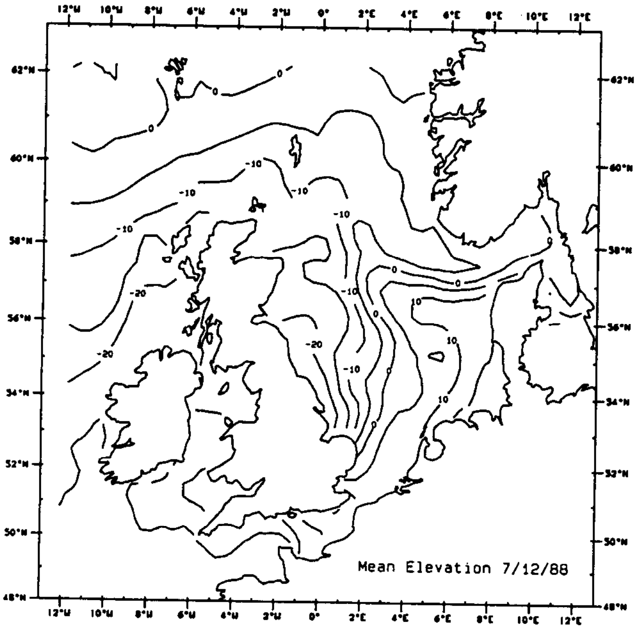

Mean Elevation 5/12/88


Mean Elevation 6/12/88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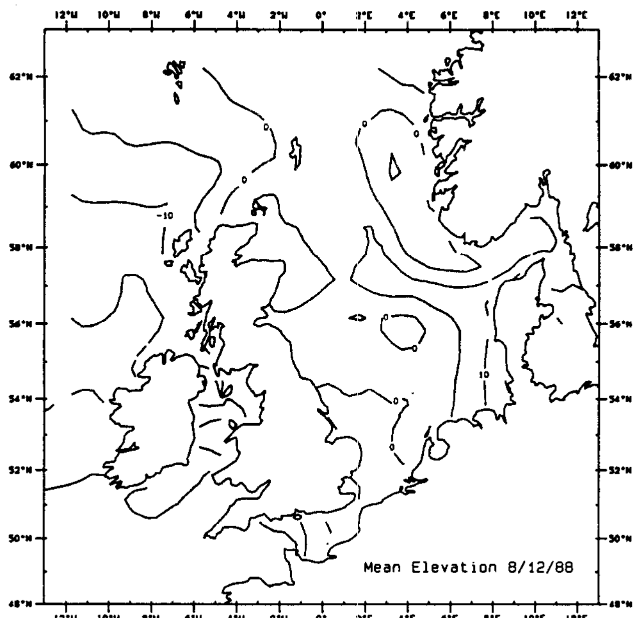
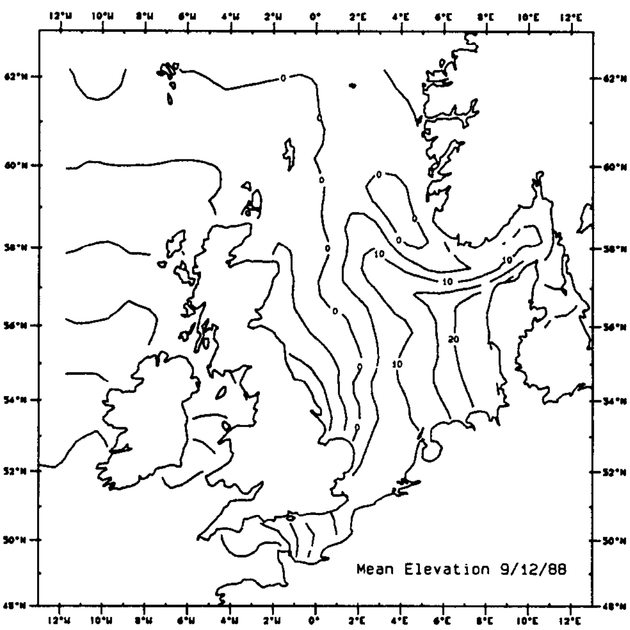
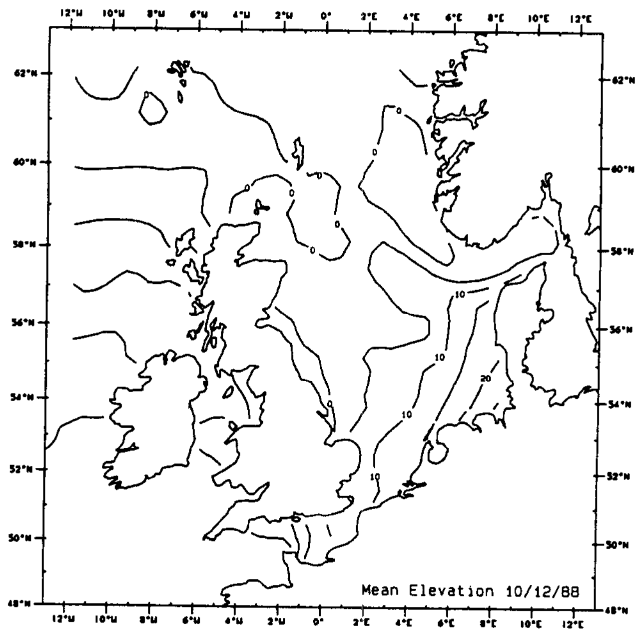

Mean Elevation 8/12/88


Mean Elevation 9/12/88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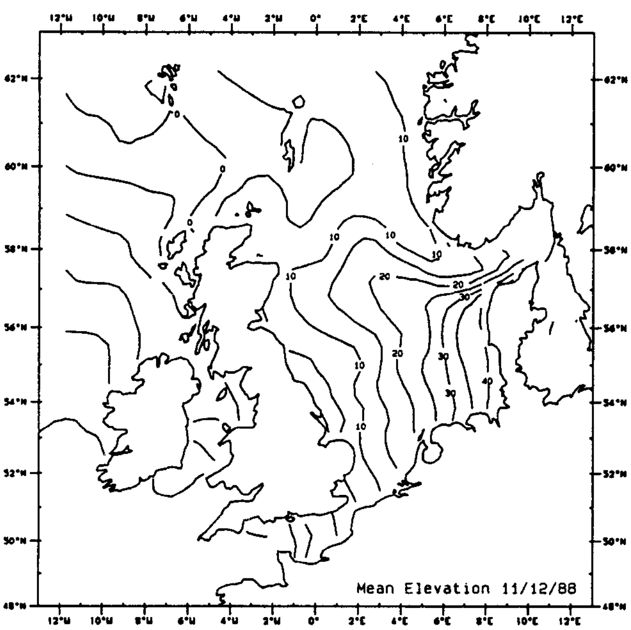
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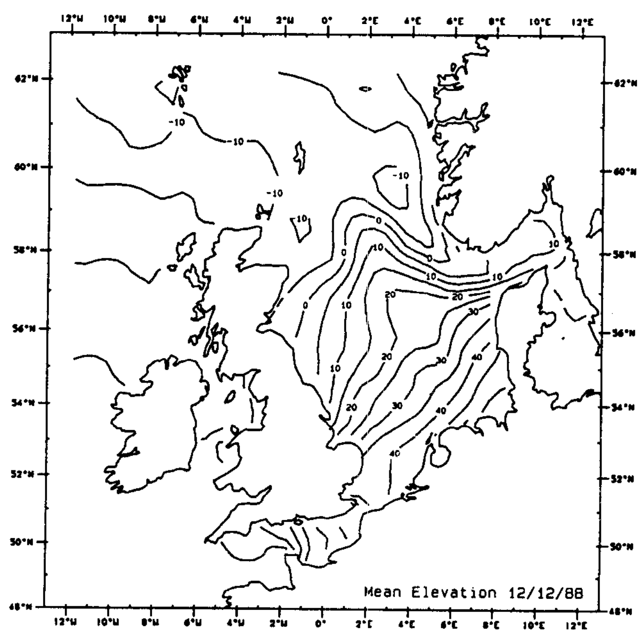
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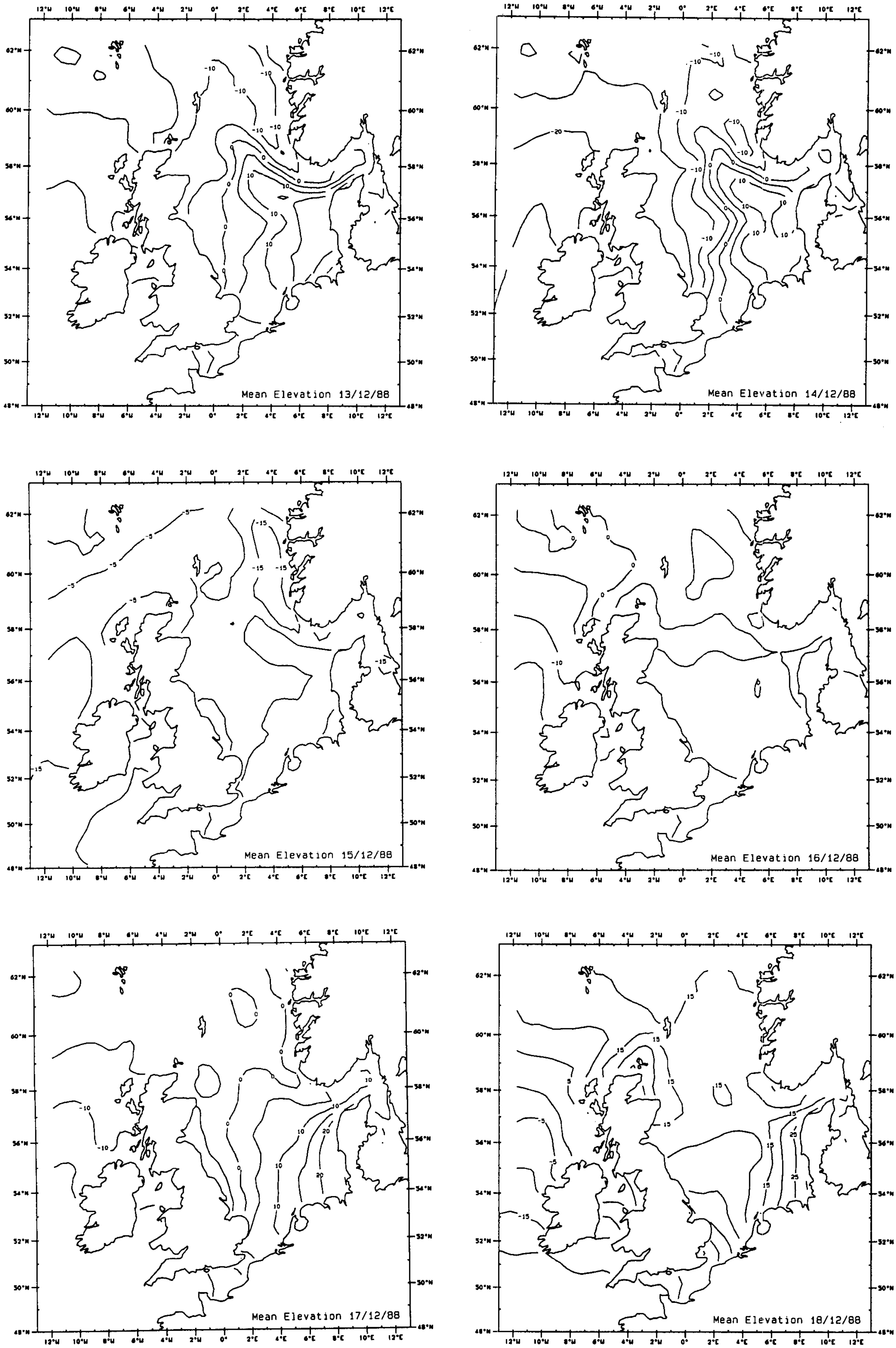
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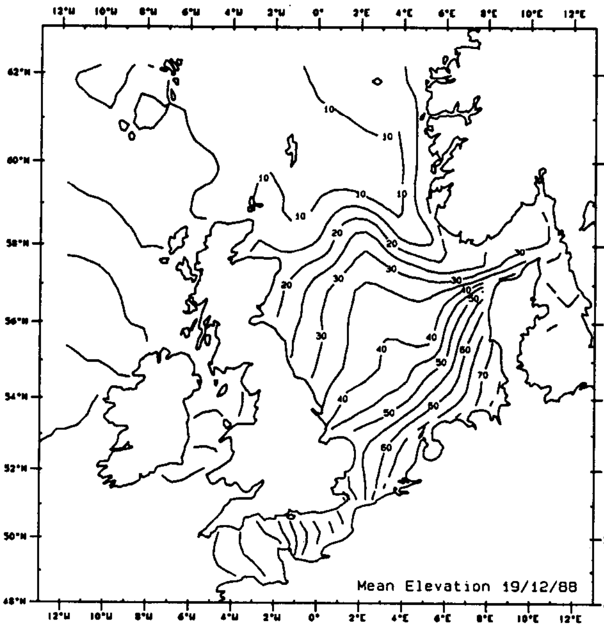
Mean Elevation 14/12/88
Mean Elevation 15/12/88
Mean Elevation 16/12/88
Mean Elevation 17/12/88
Mean Elevation 18/12/88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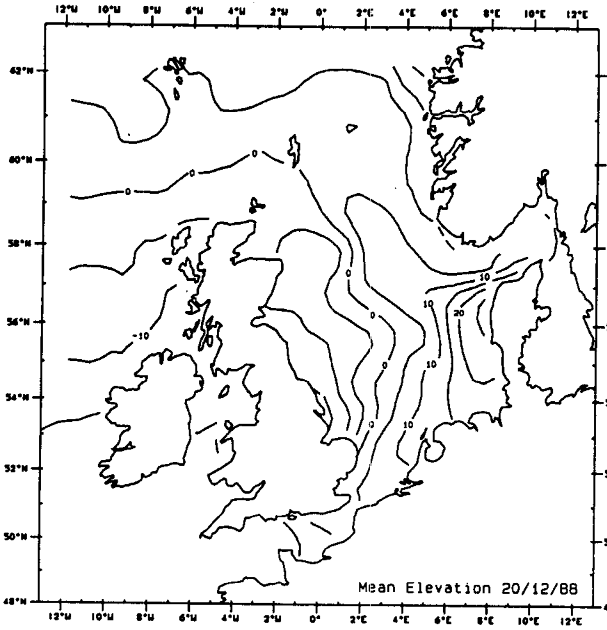
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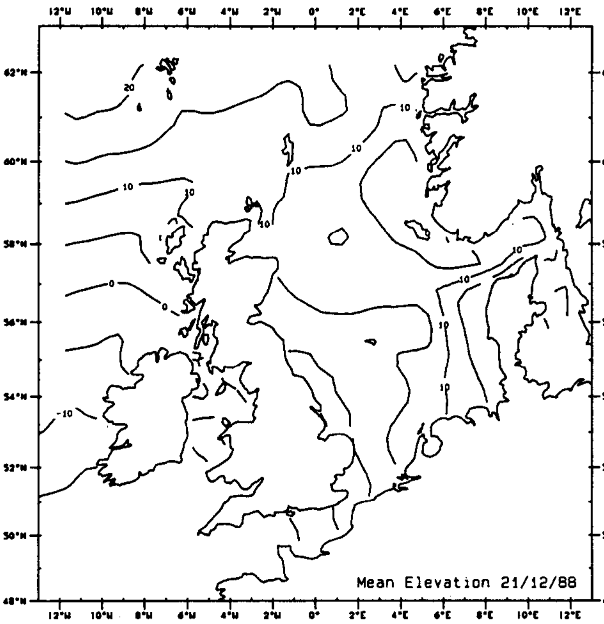
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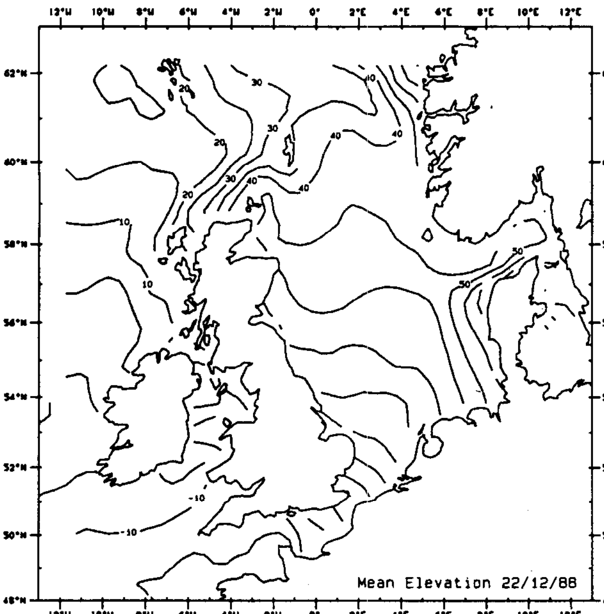
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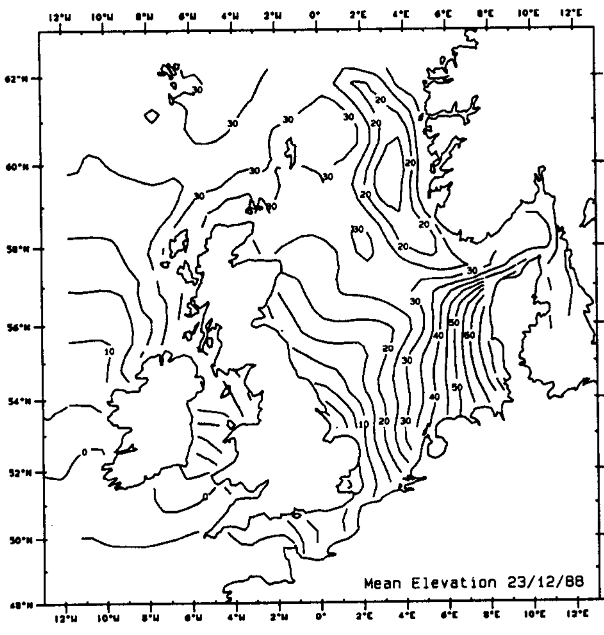
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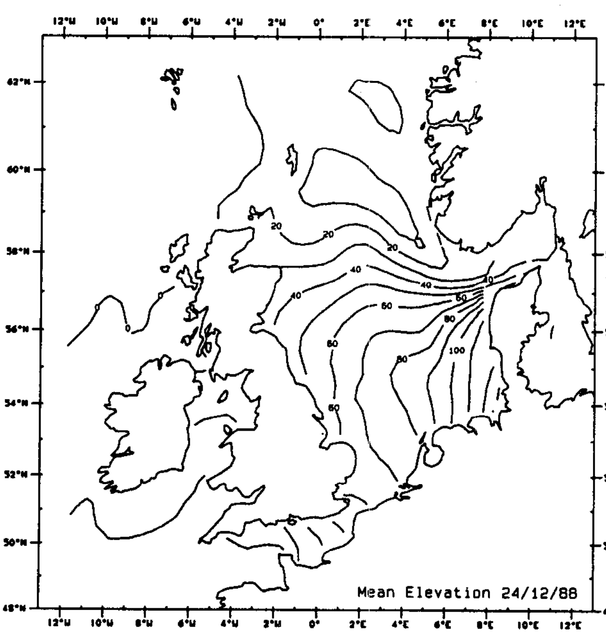
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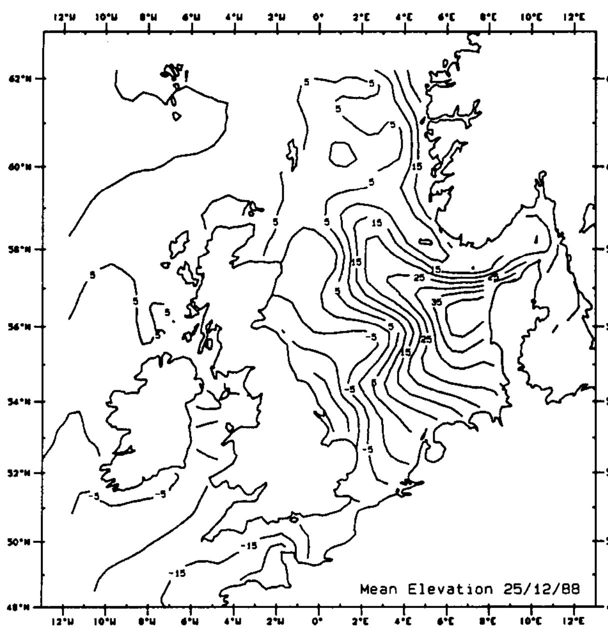
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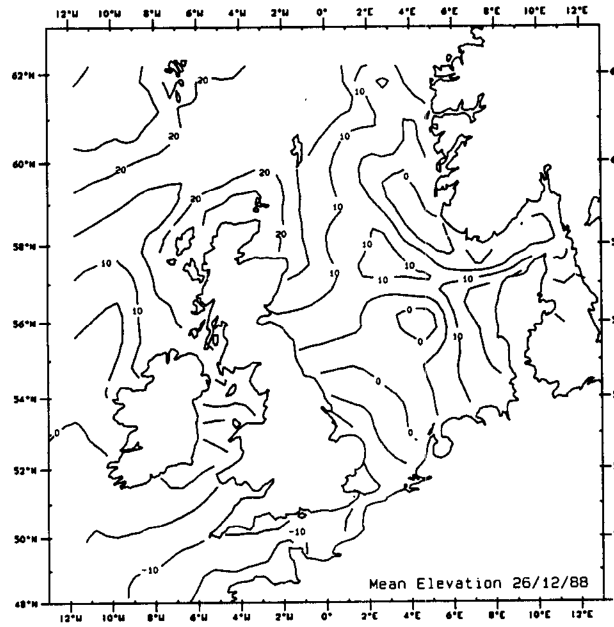
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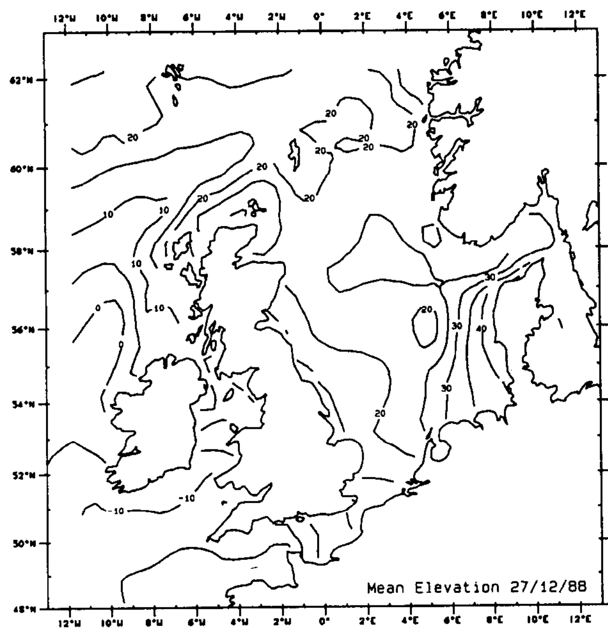
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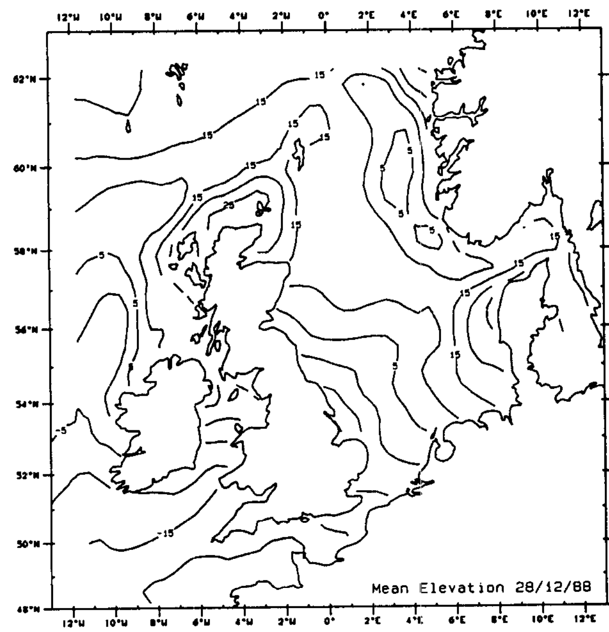
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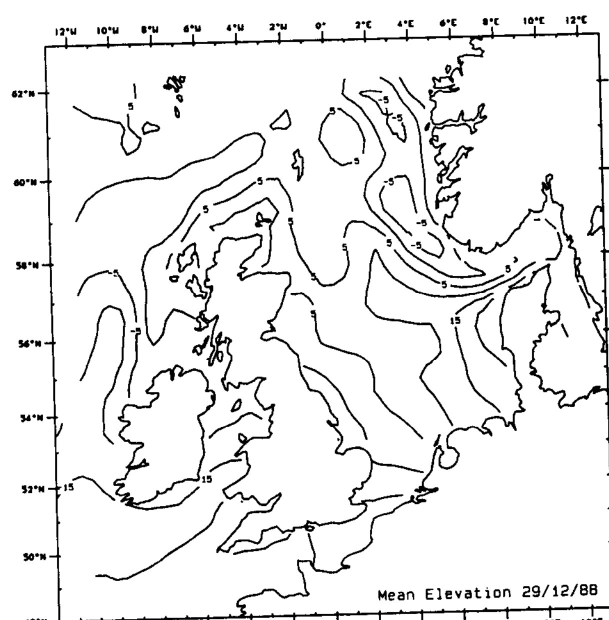
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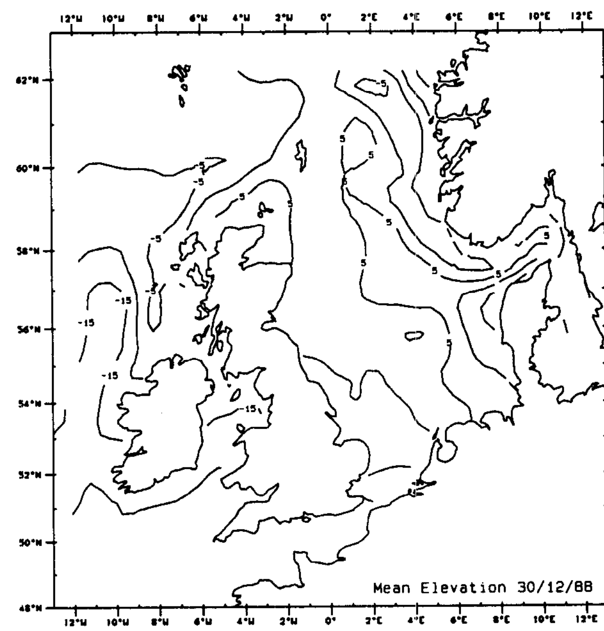
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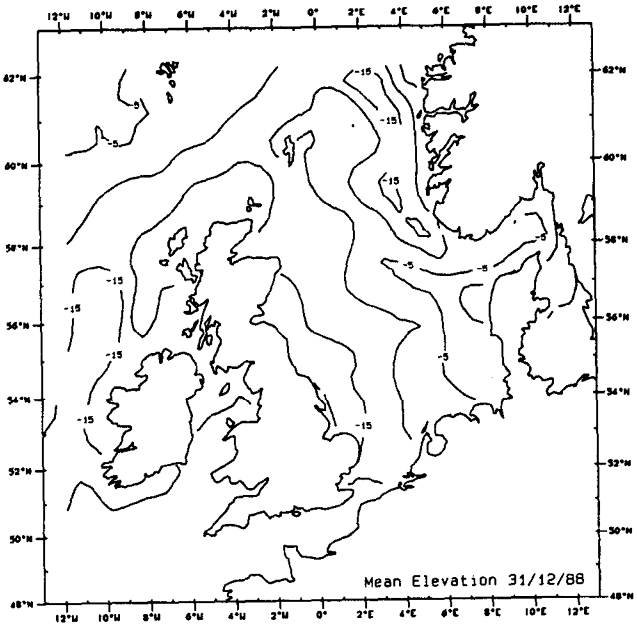
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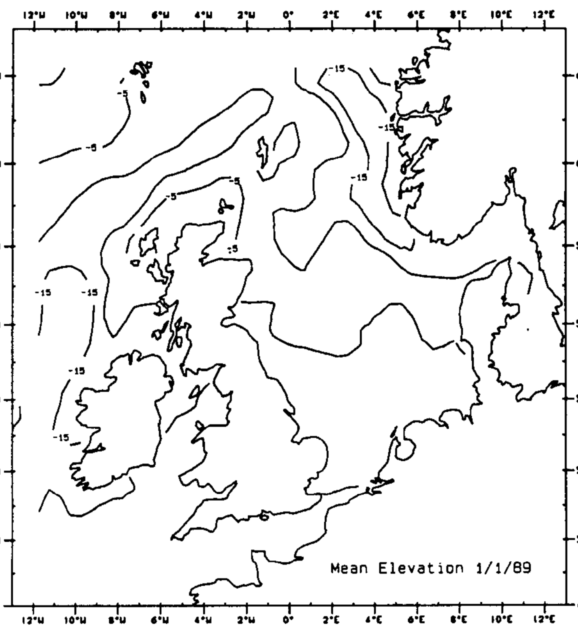
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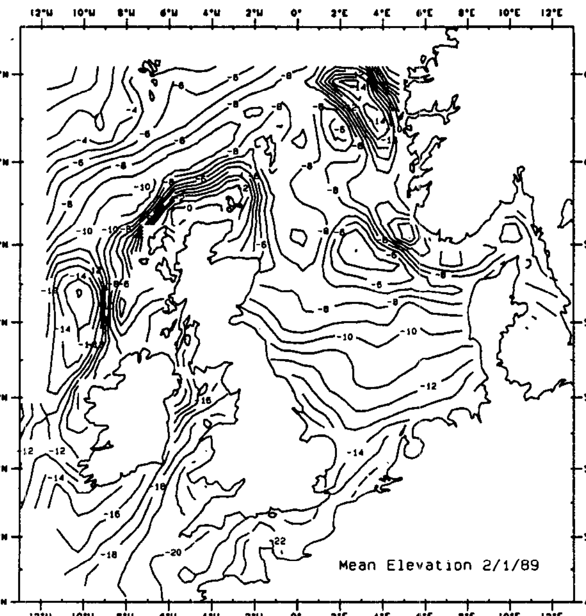
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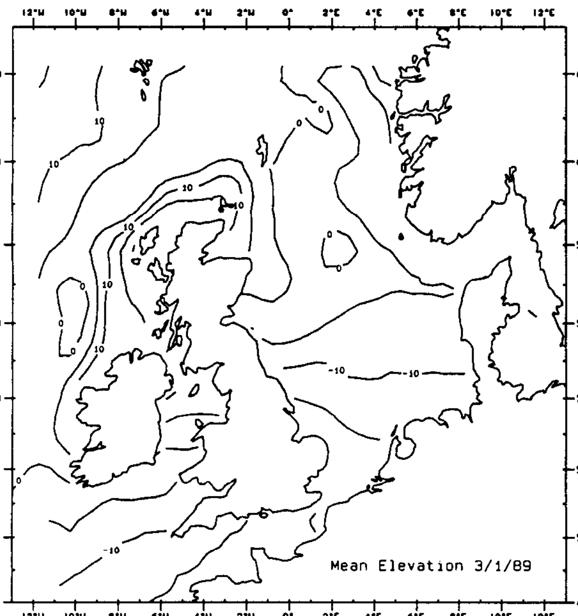
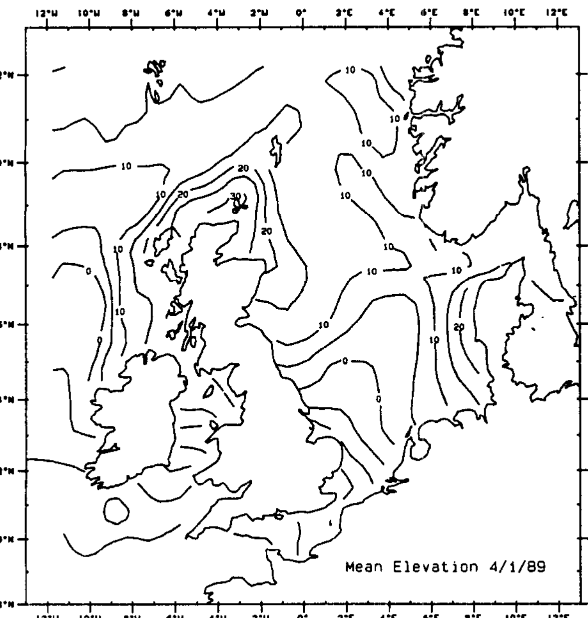

Mean Elevation 3/1/89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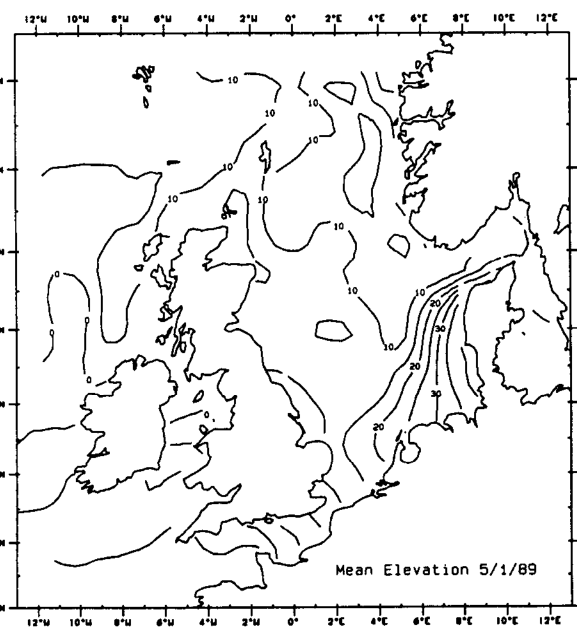
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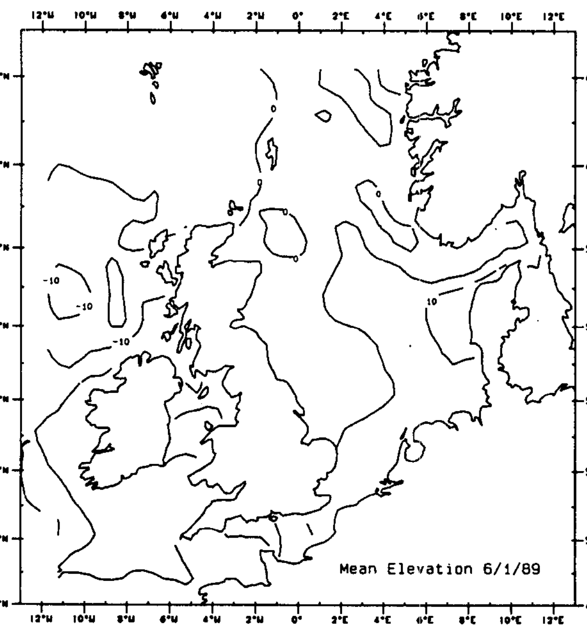
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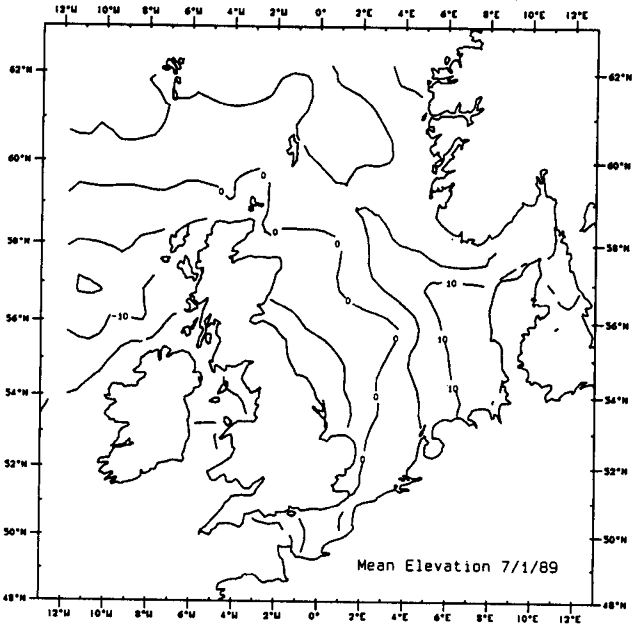
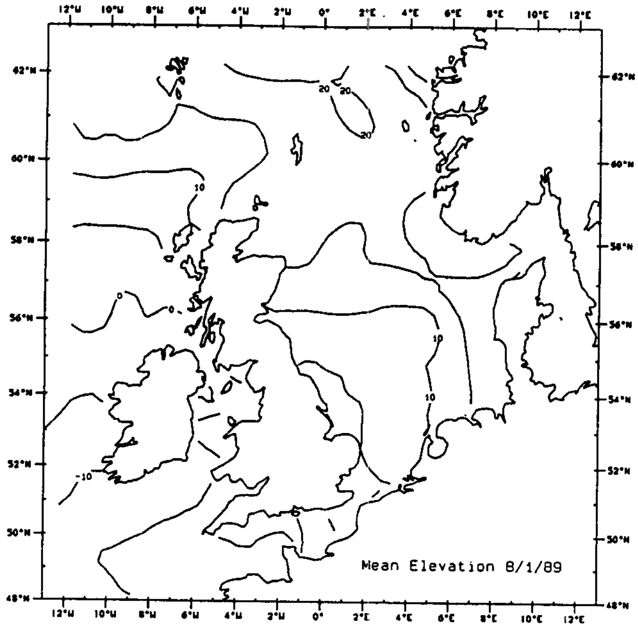
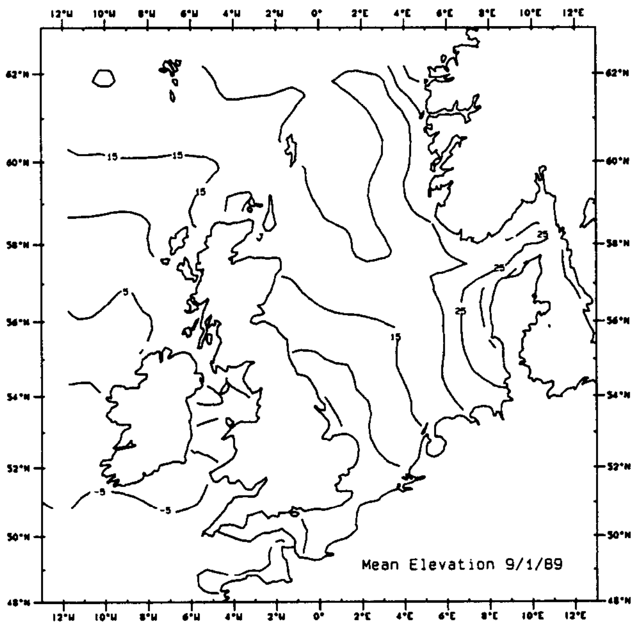


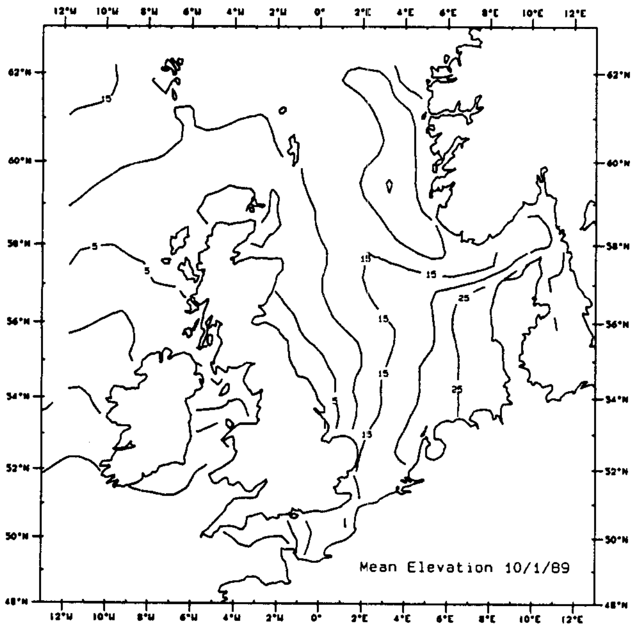
Mean Elevation 7/1/89



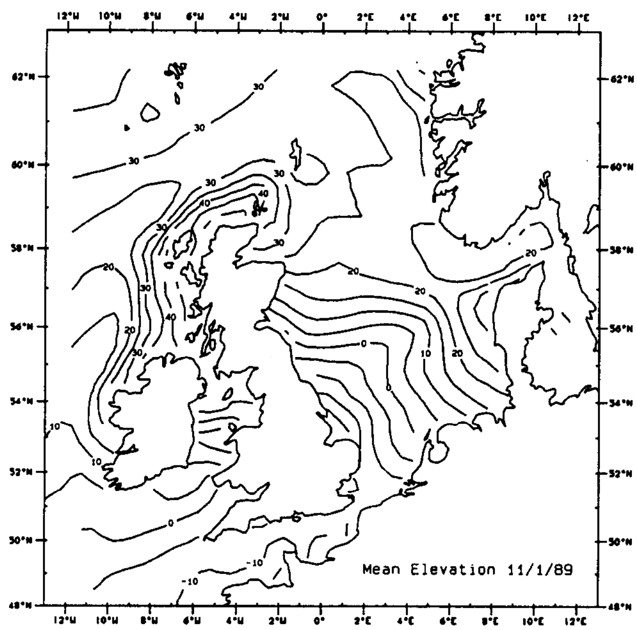
Mean Elevation 8/1/89



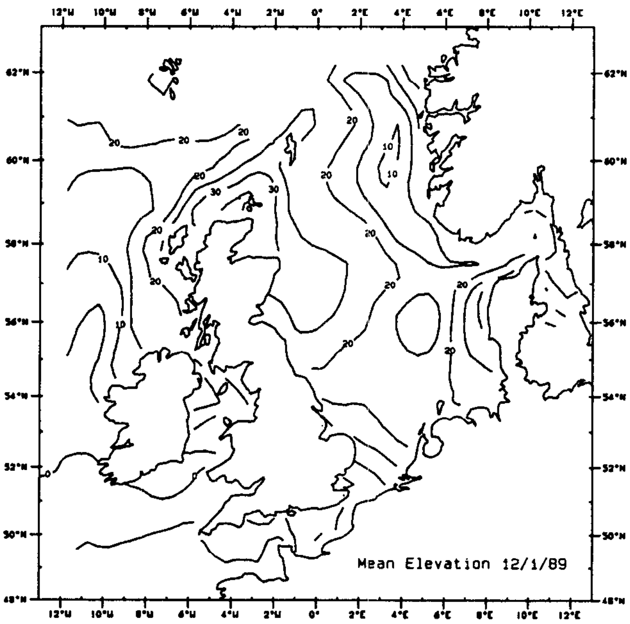
Mean Elevation 9/1/89



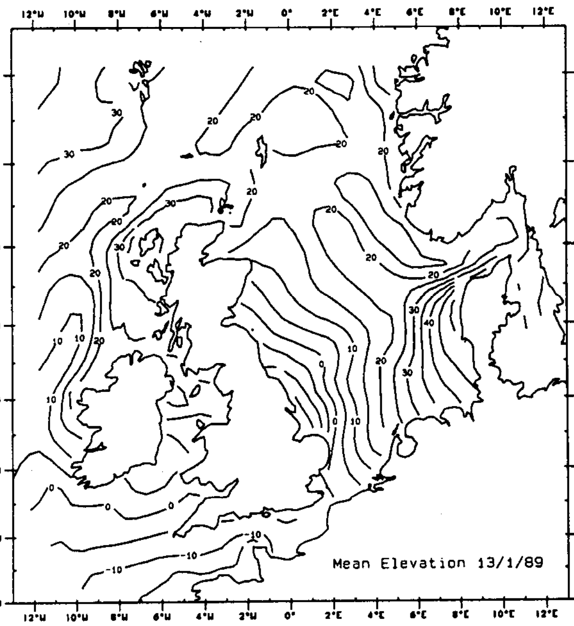
Mean Elevation 10/1/89



Mean Elevation 11/1/89



Mean Elevation 12/1/89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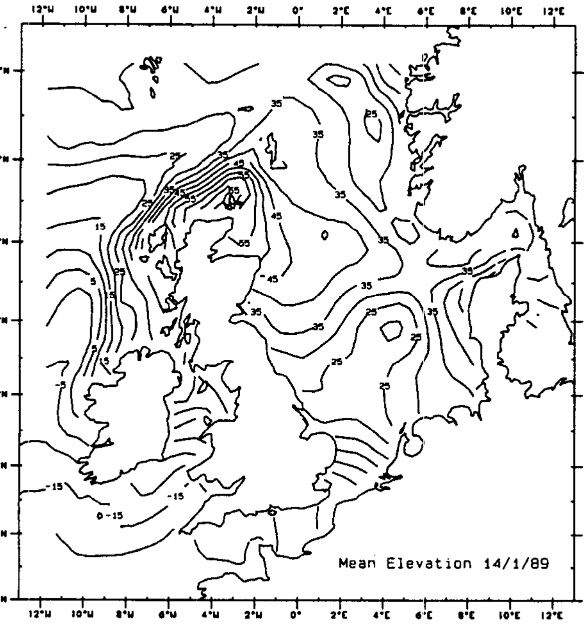
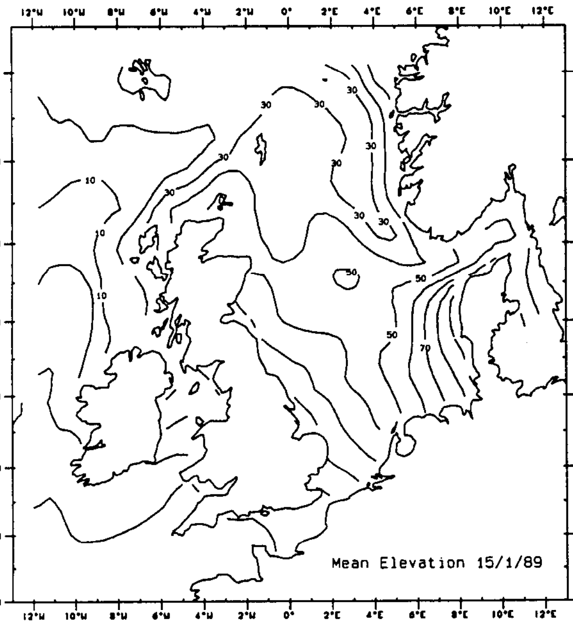

Mean Elevation 14/1/89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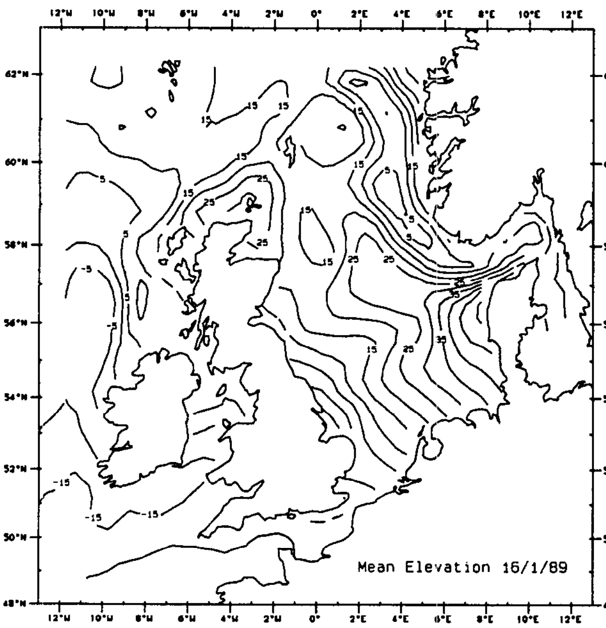
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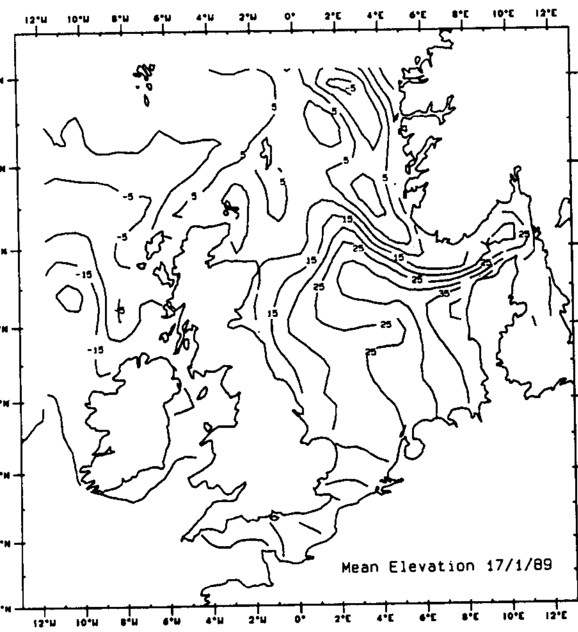
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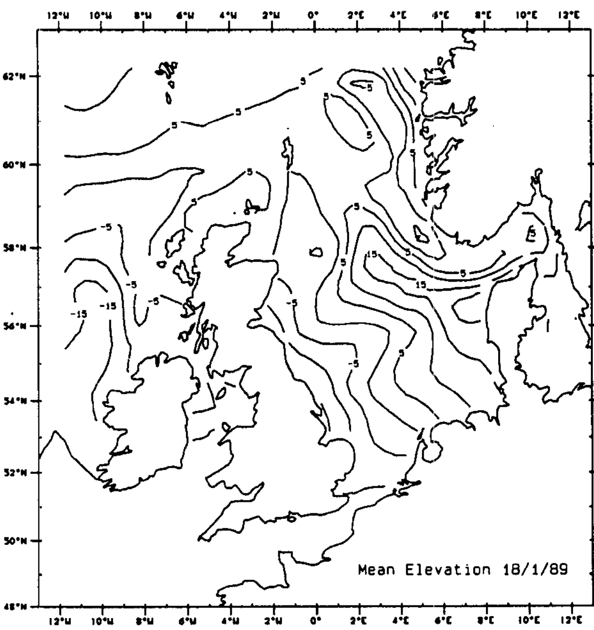
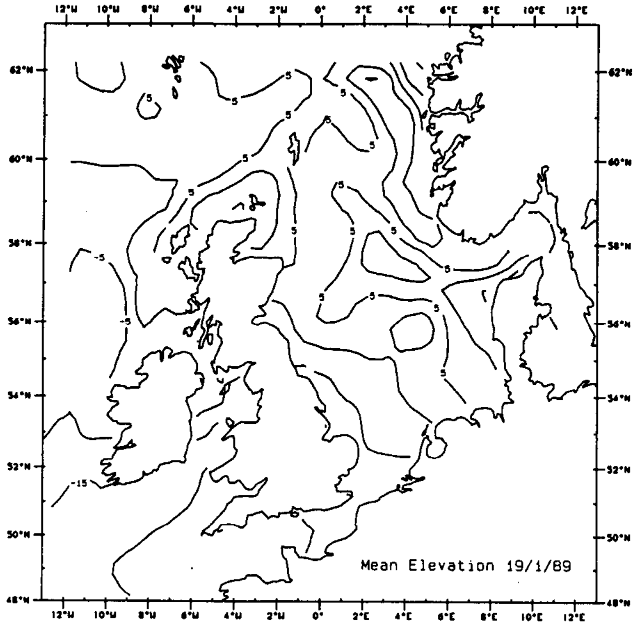

Mean Elevation 18/1/89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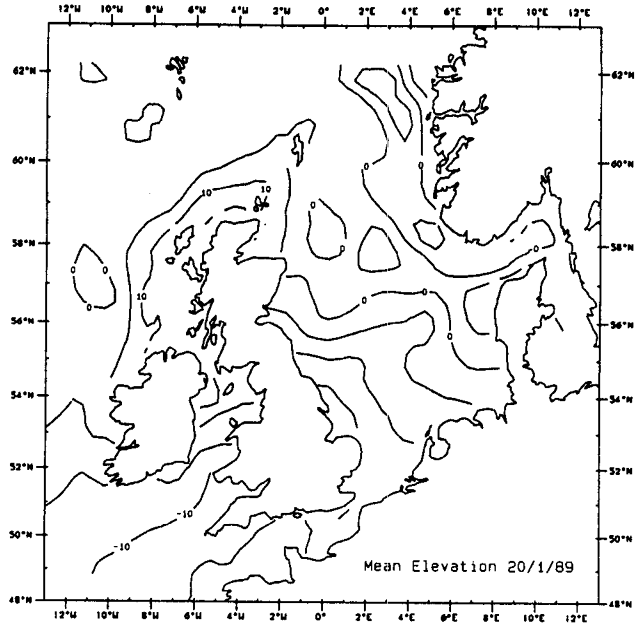
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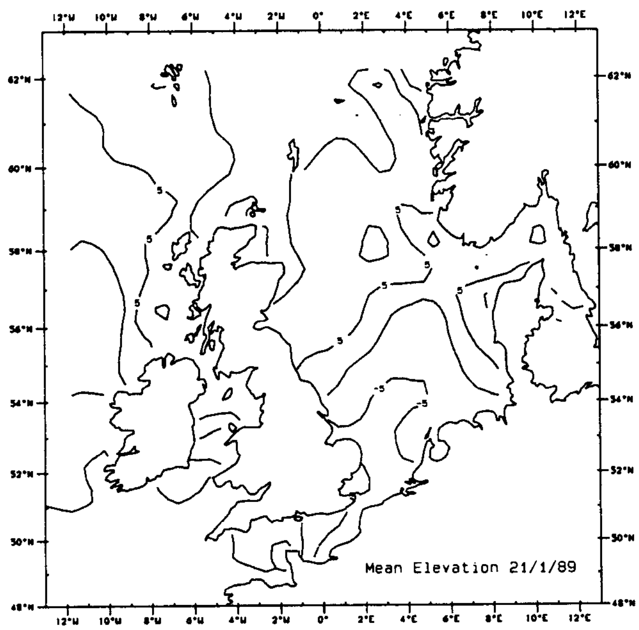
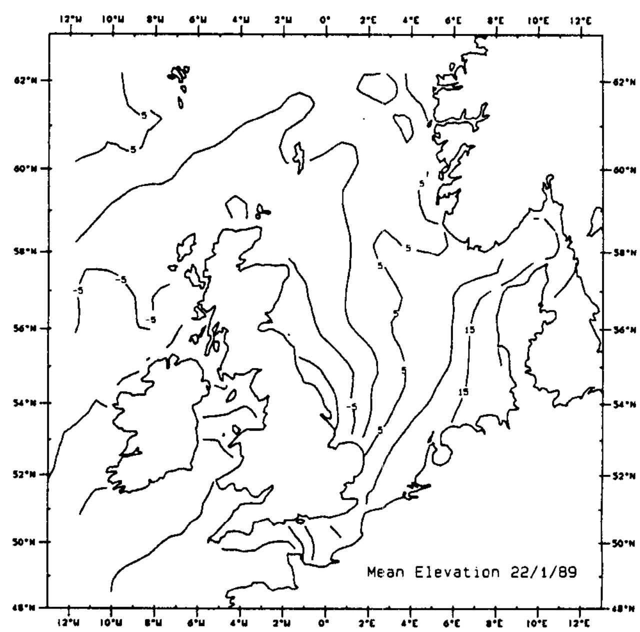
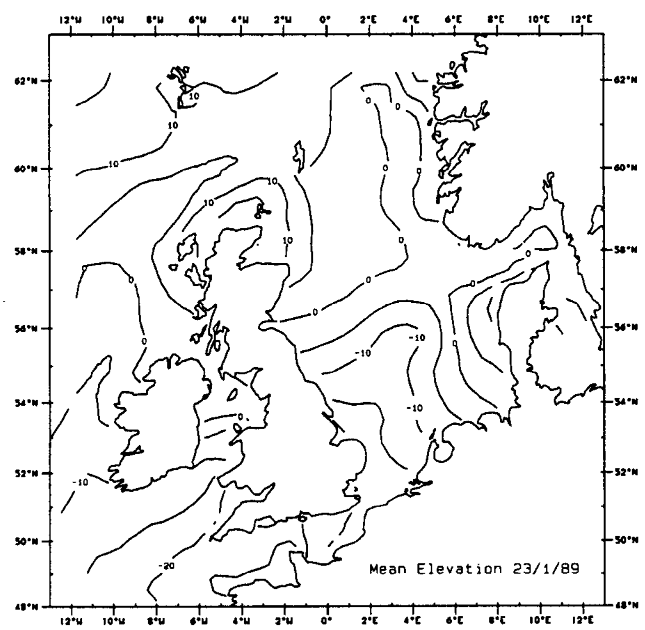
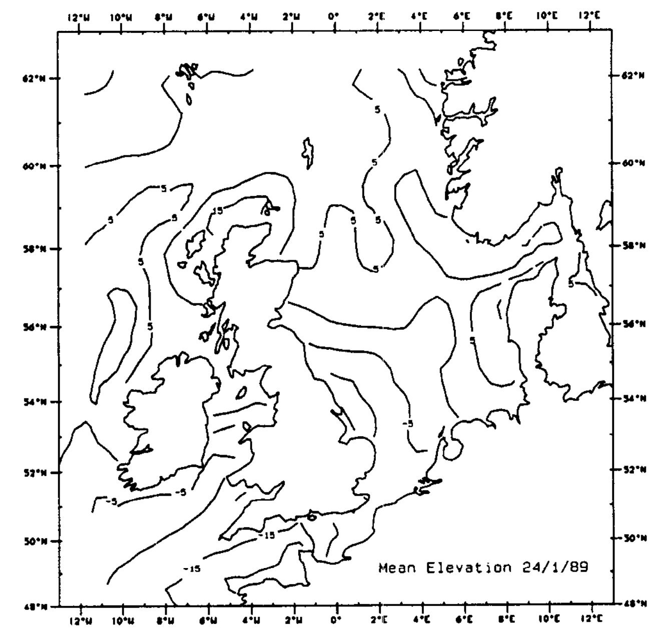
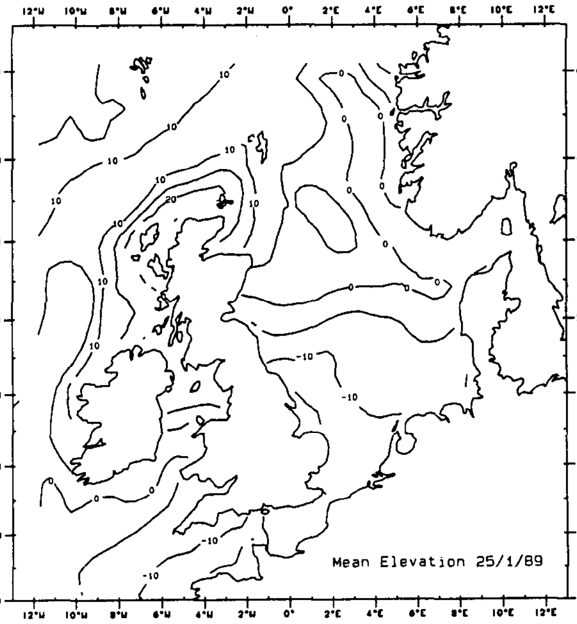

Mean Elevation 21/1/89


Mean Elevation 22/1/89


Mean Elevation 23/1/89


Mean Elevation 24/1/89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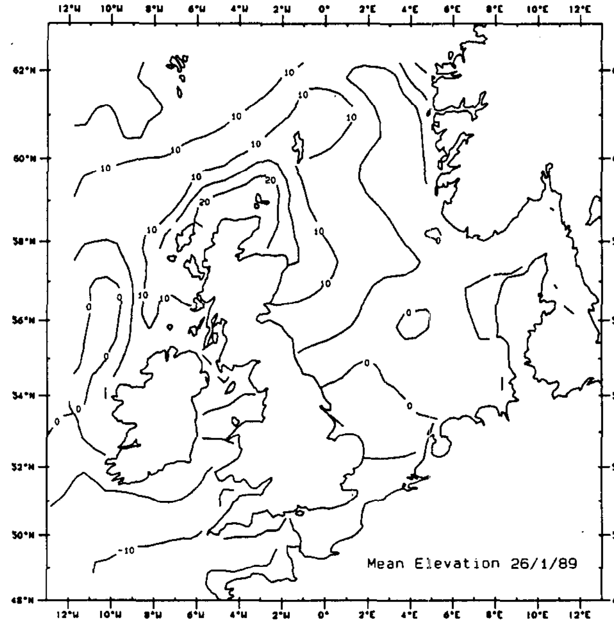
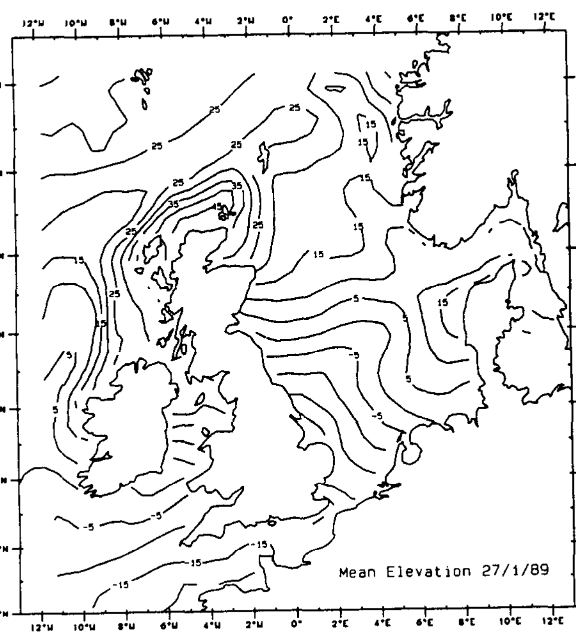
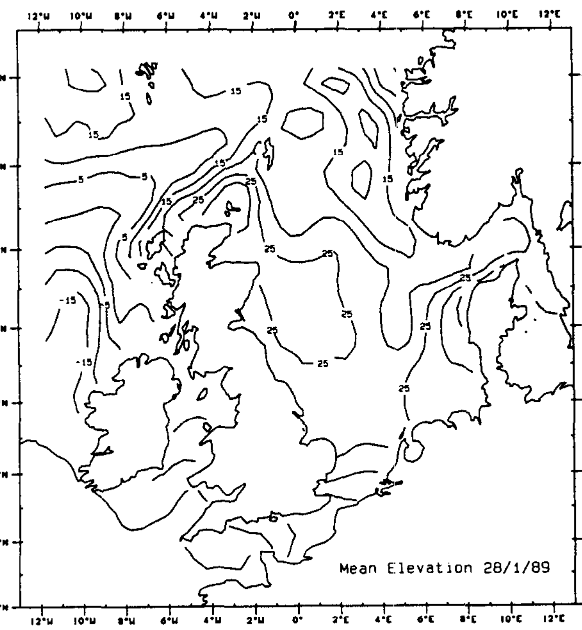
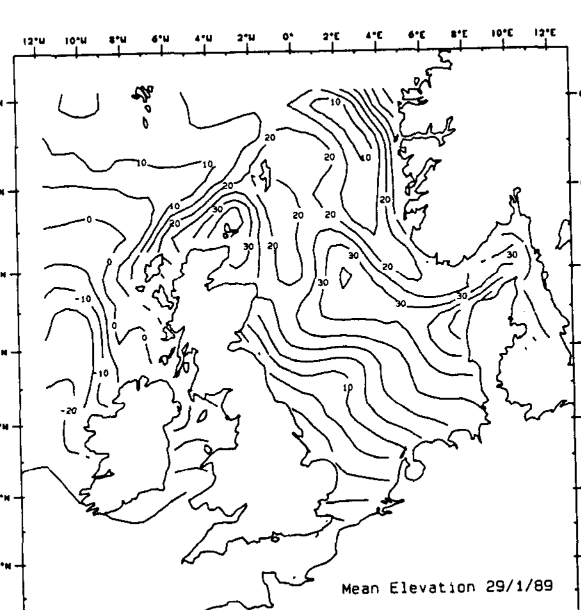

Mean Elevation 26/1/89


Mean Elevation 27/1/89


Mean Elevation 28/1/89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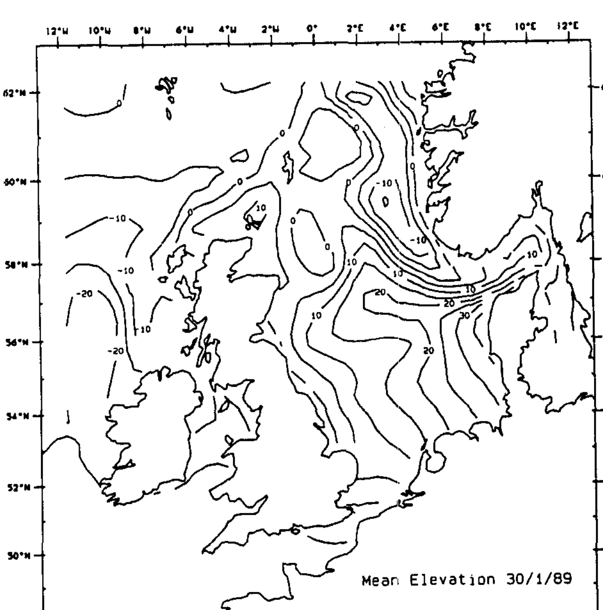
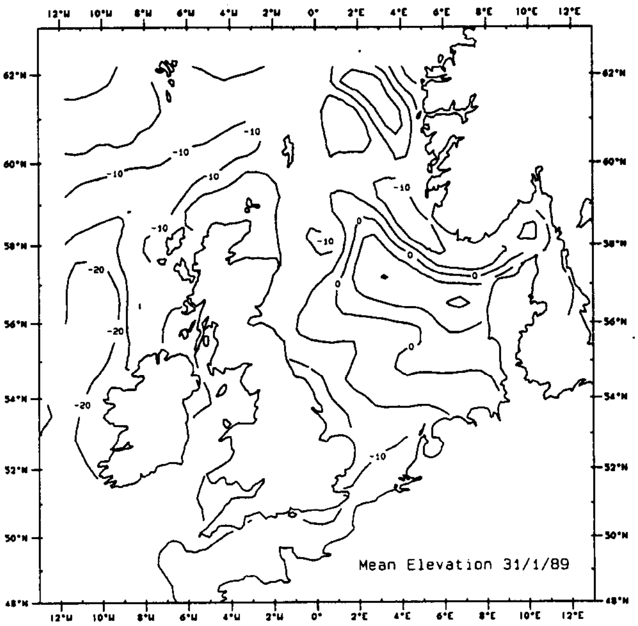
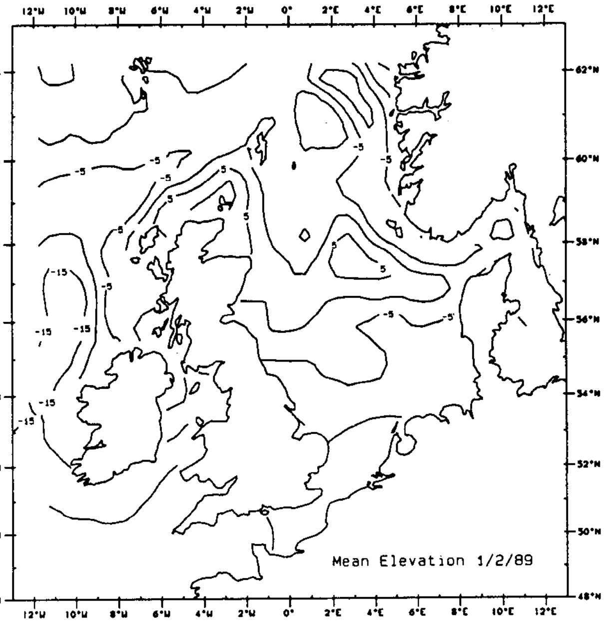
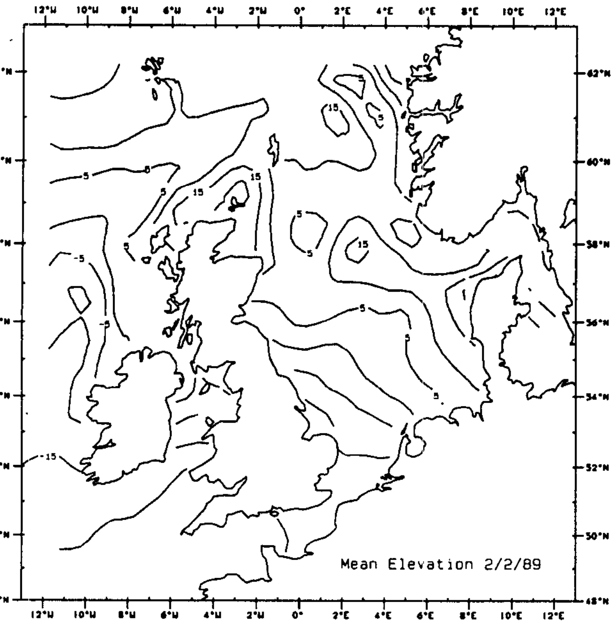
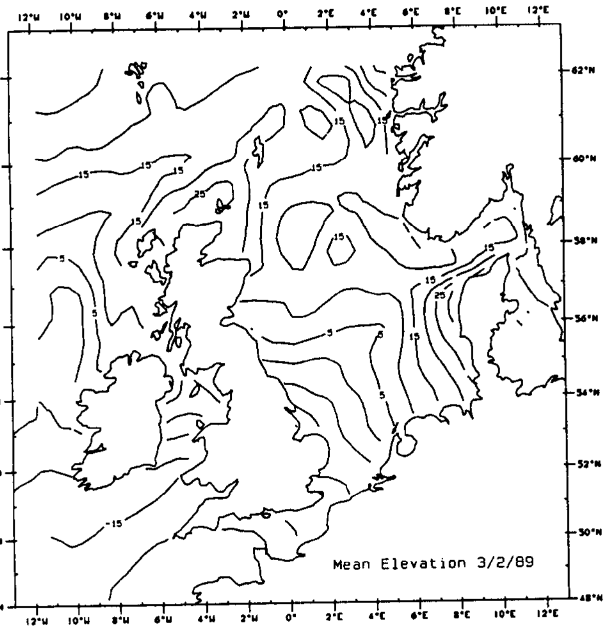

Mean Elevation 30/1/89

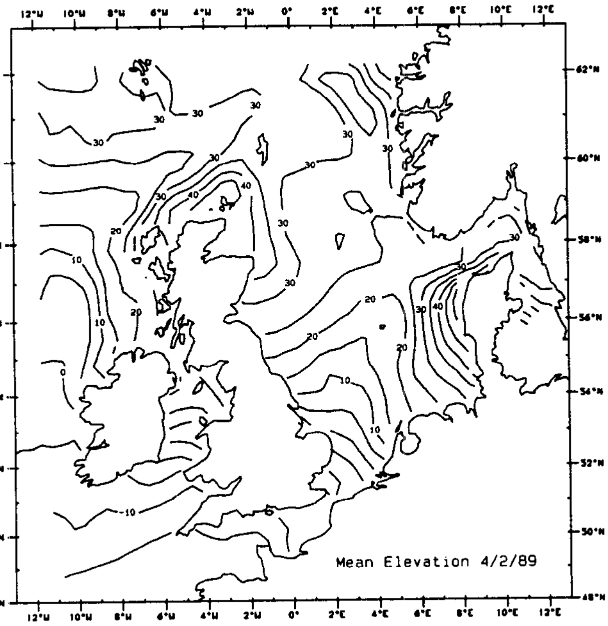


Mean Elevation 31/1/89


Mean Elevation 1/2/89


Mean Elevation 2/2/89


Mean Elevation 3/2/89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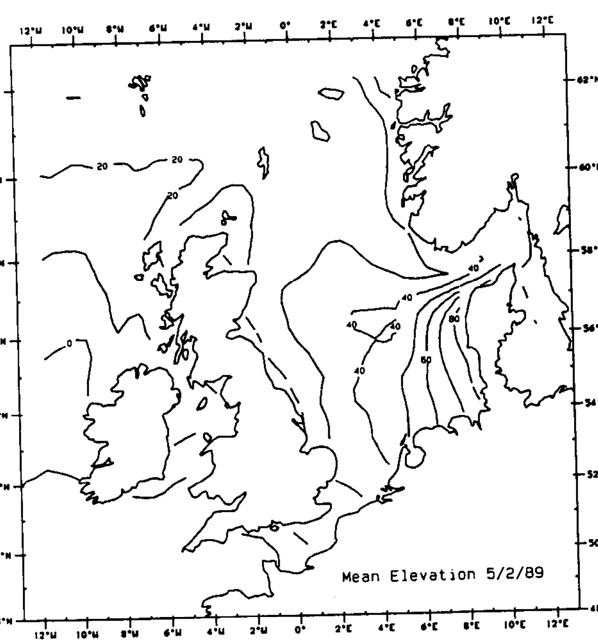
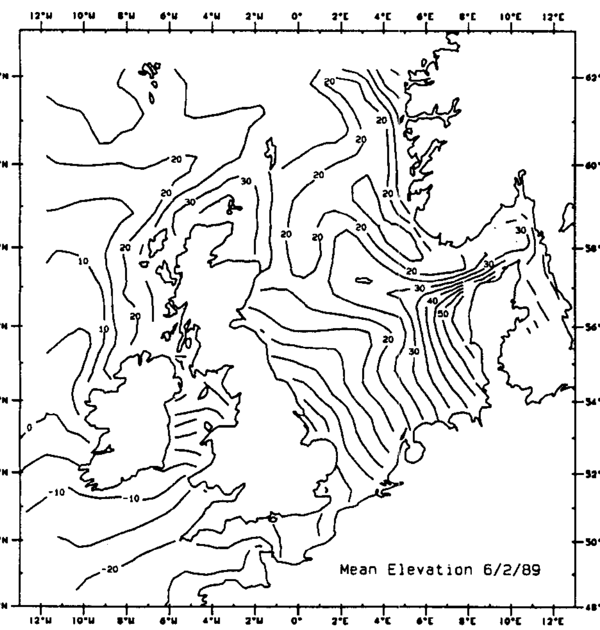

Mean Elevation 5/2/89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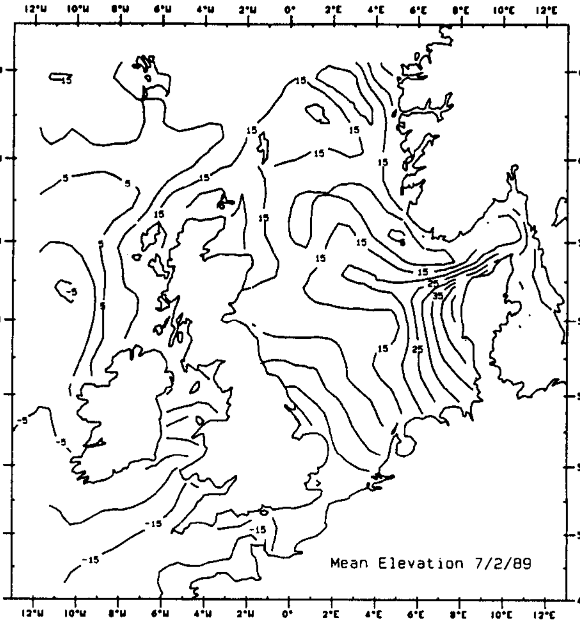
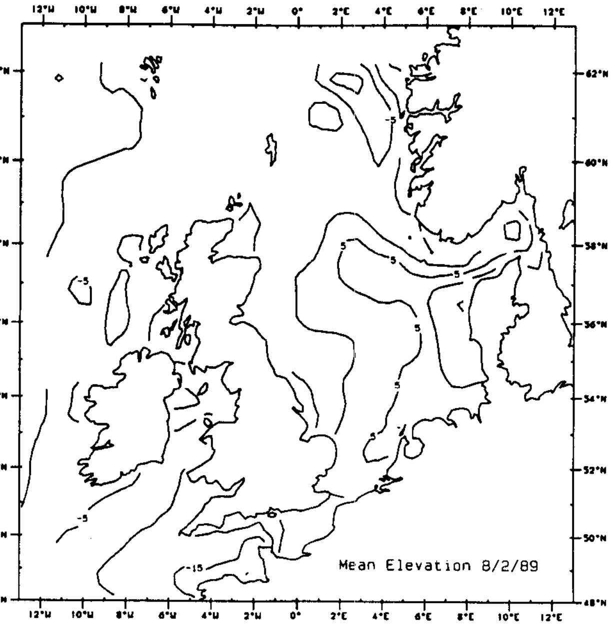
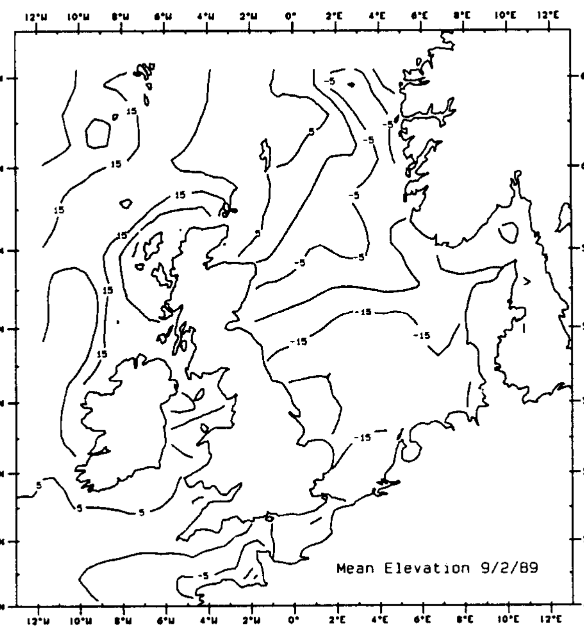


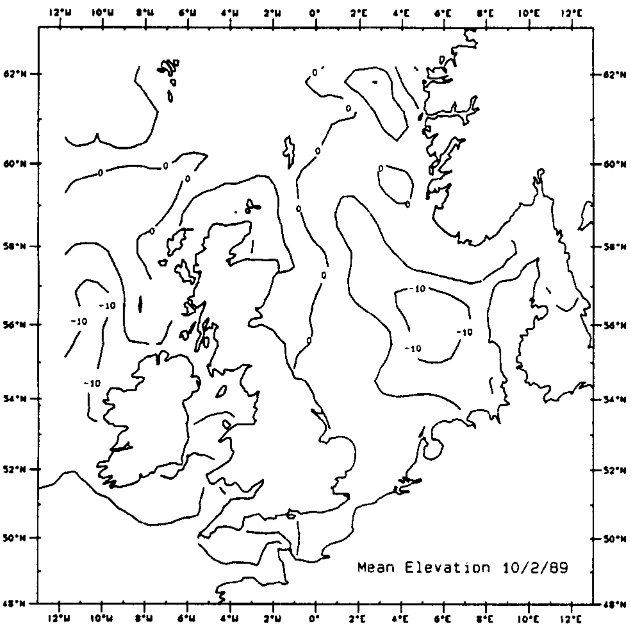
Mean Elevation 7/2/89



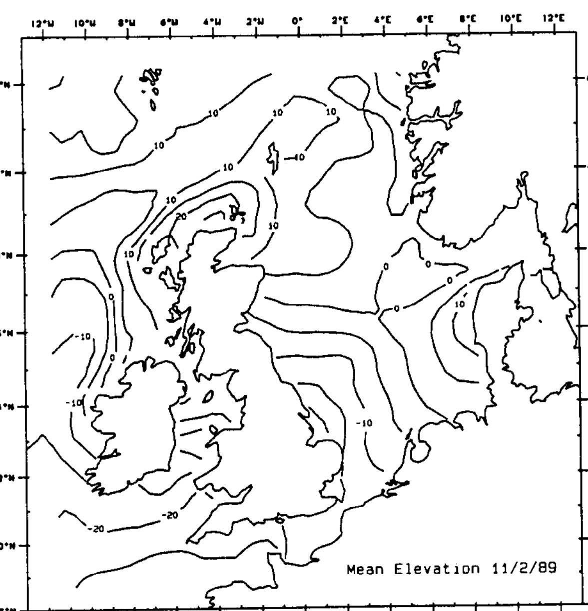
Mean Elevation 8/2/89



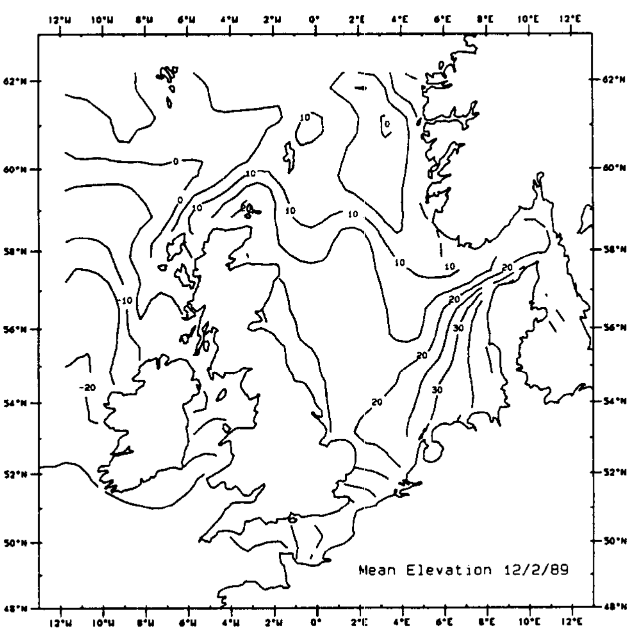
Mean Elevation 9/2/89



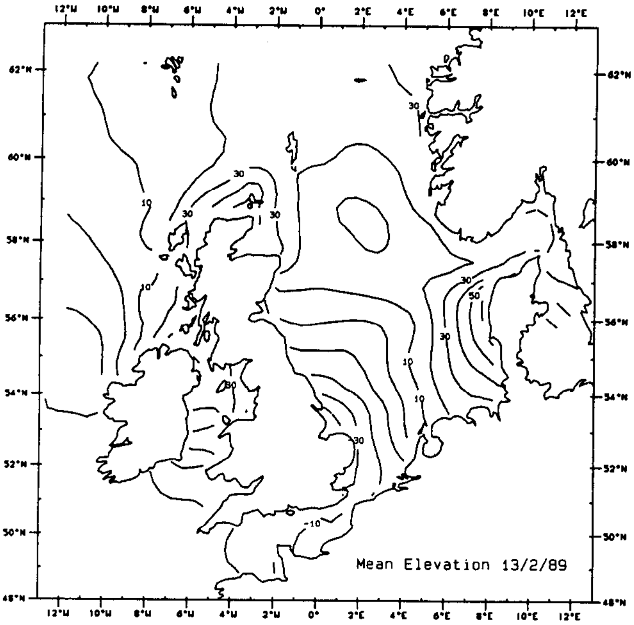
Mean Elevation 10/2/89

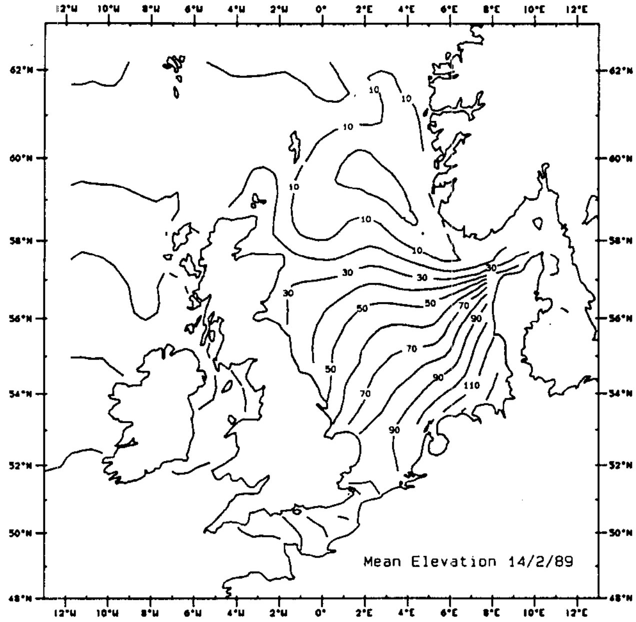


Mean Elevation 11/2/89



Mean Elevation 12/2/89


Mean Elevation 13/2/89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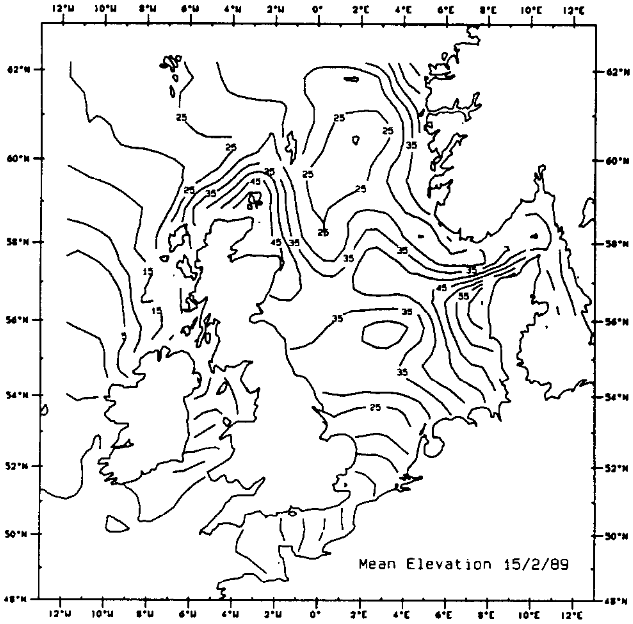
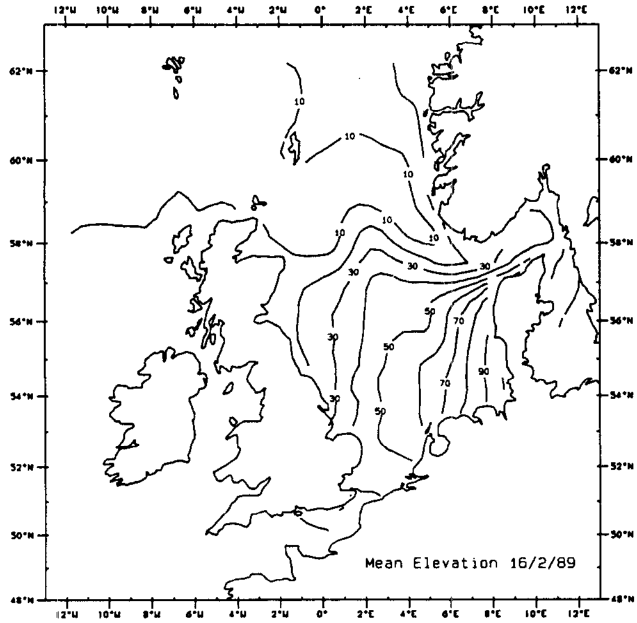
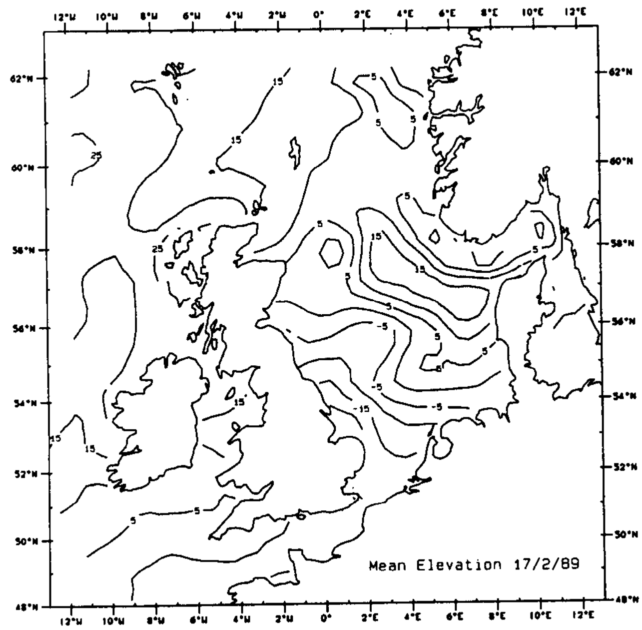
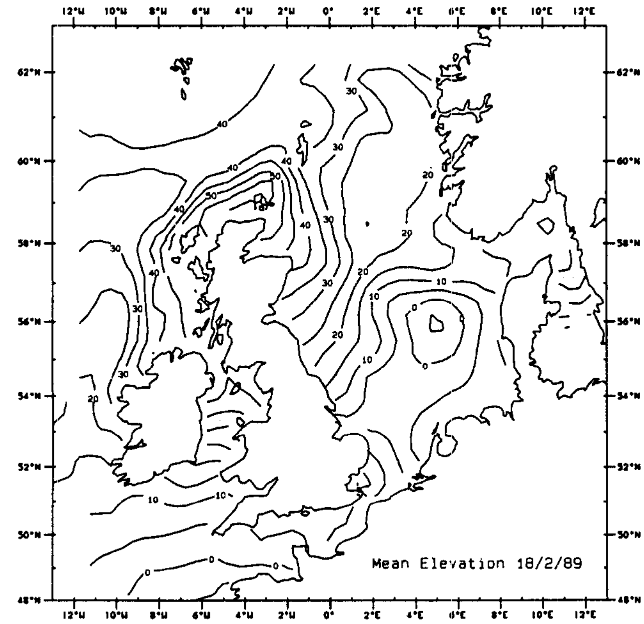
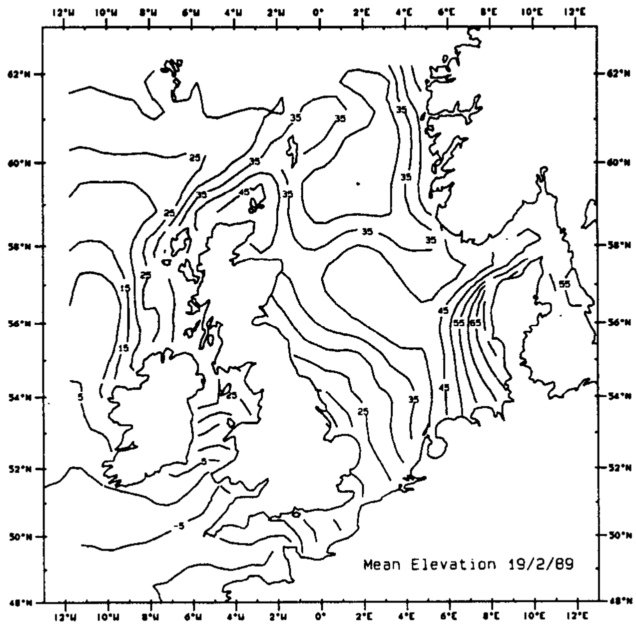
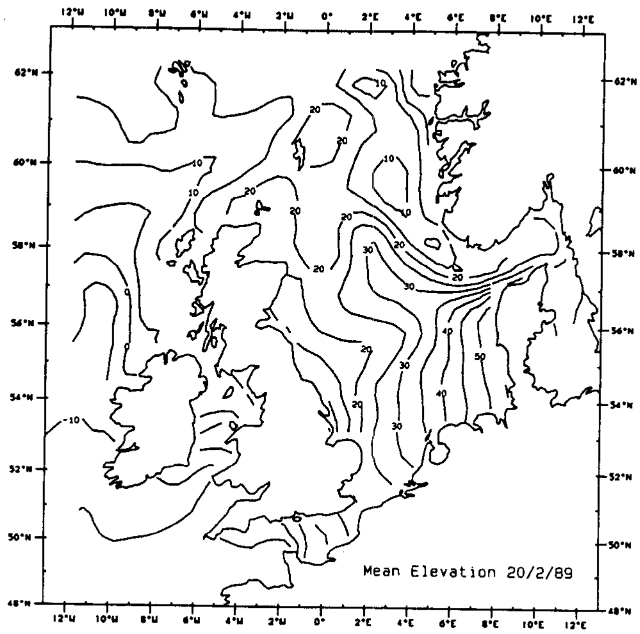

Mean Elevation 15/2/89

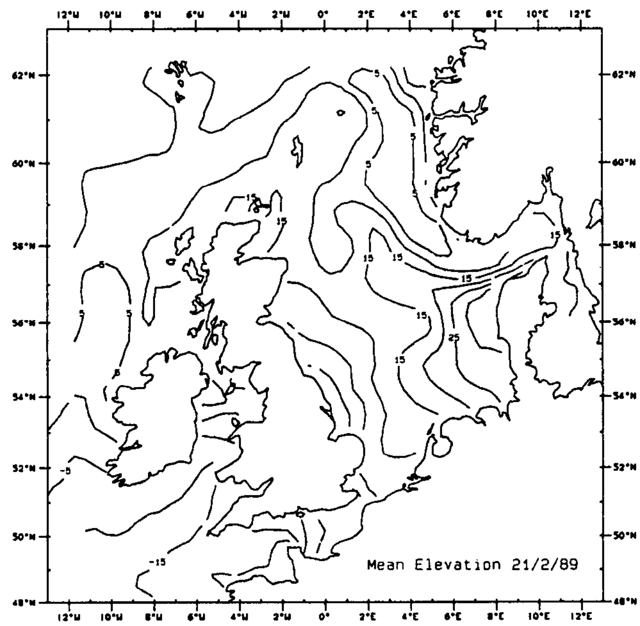

Mean Elevation 16/2/89

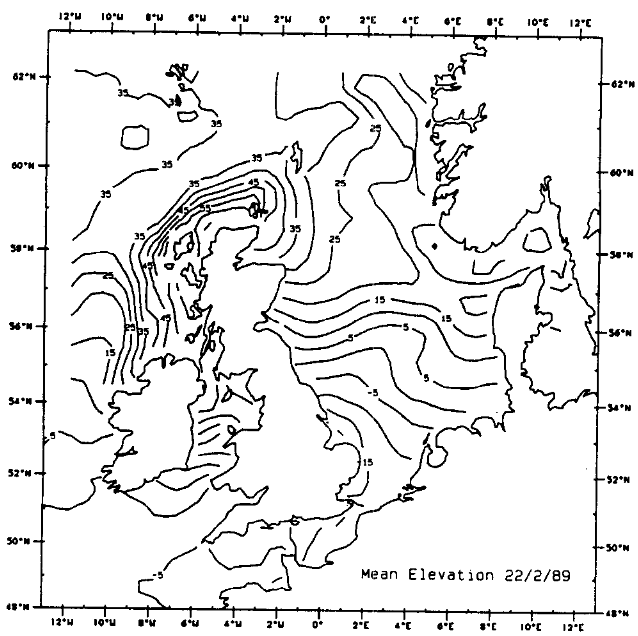

Mean Elevation 17/2/89

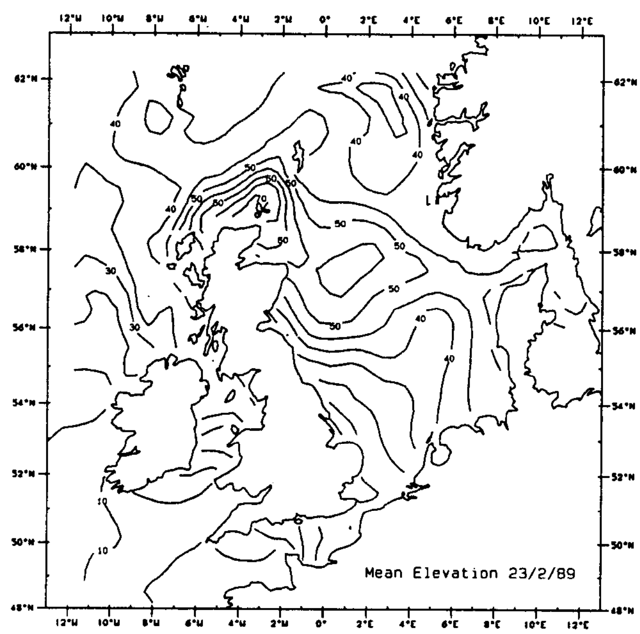

Mean Elevation 18/2/89

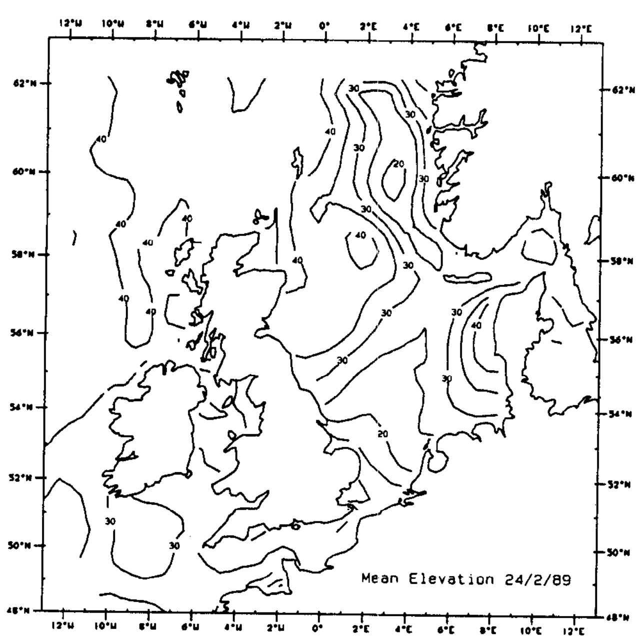

Mean Elevation 19/2/89

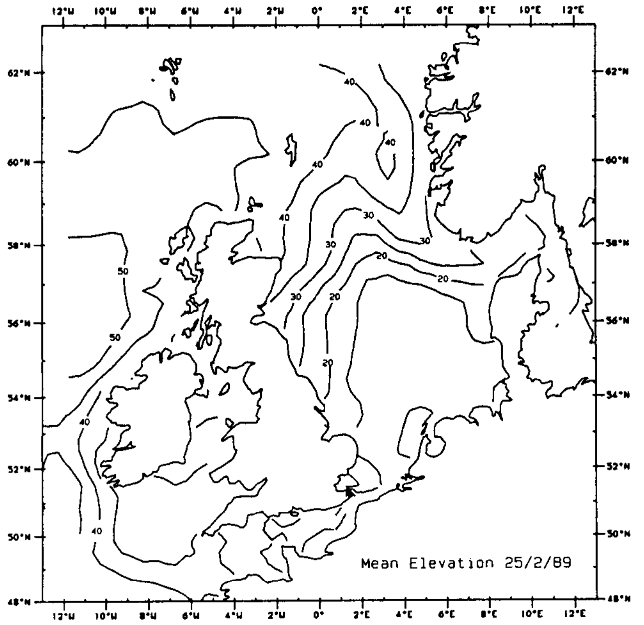

Mean Elevation 20/2/89


Mean Elevation 21/2/89


Mean Elevation 22/2/89


Mean Elevation 23/2/89


Mean Elevation 24/2/89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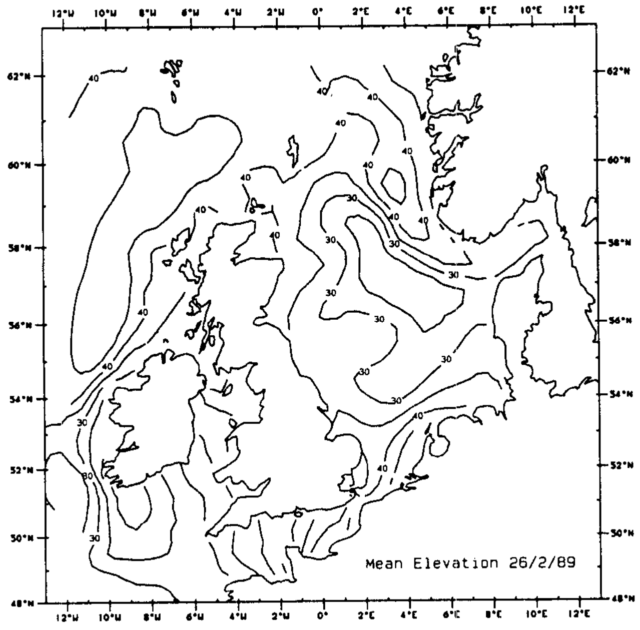
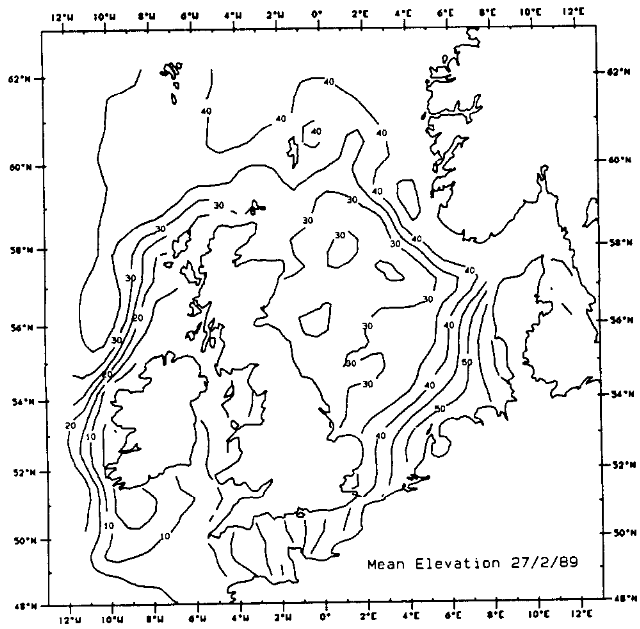
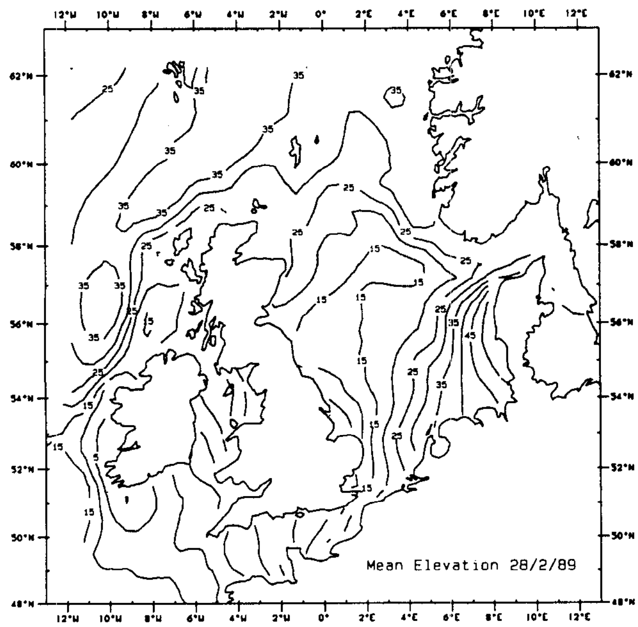
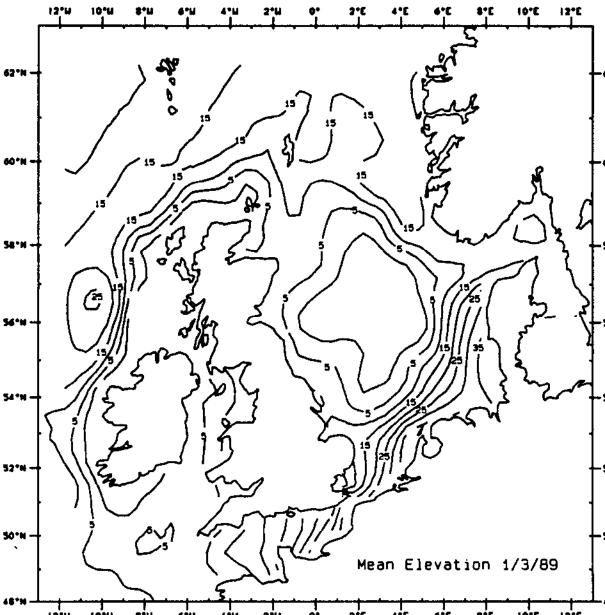
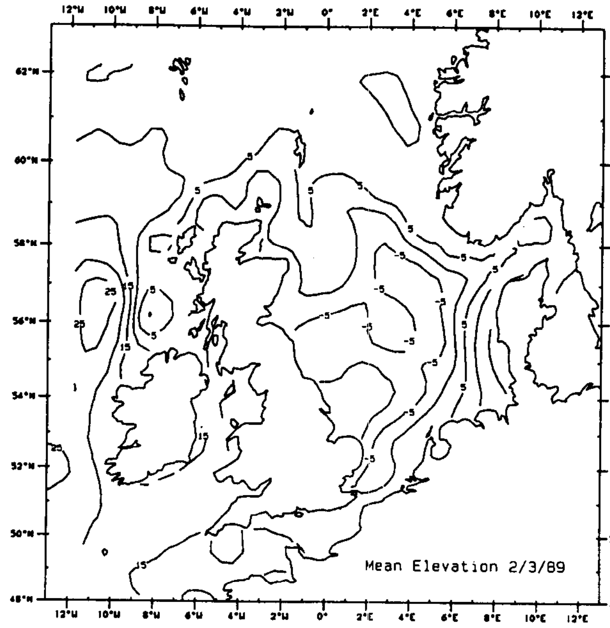

Mean Elevation 26/2/89


Mean Elevation 27/2/89


Mean Elevation 28/2/89


Mean Elevation 1/3/89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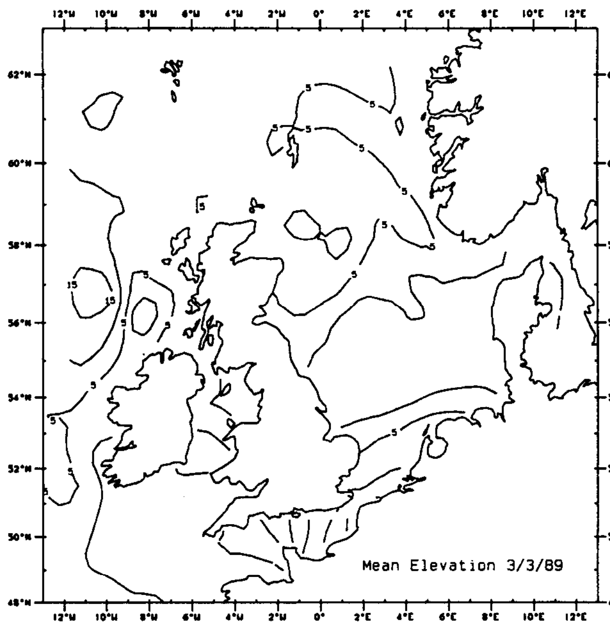
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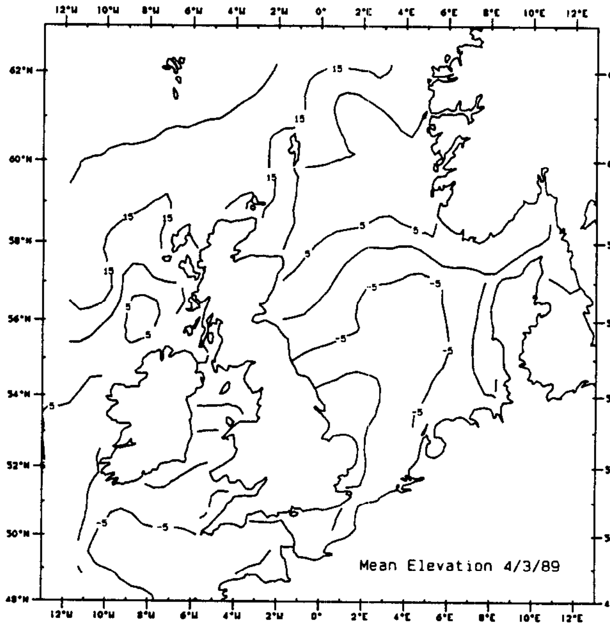
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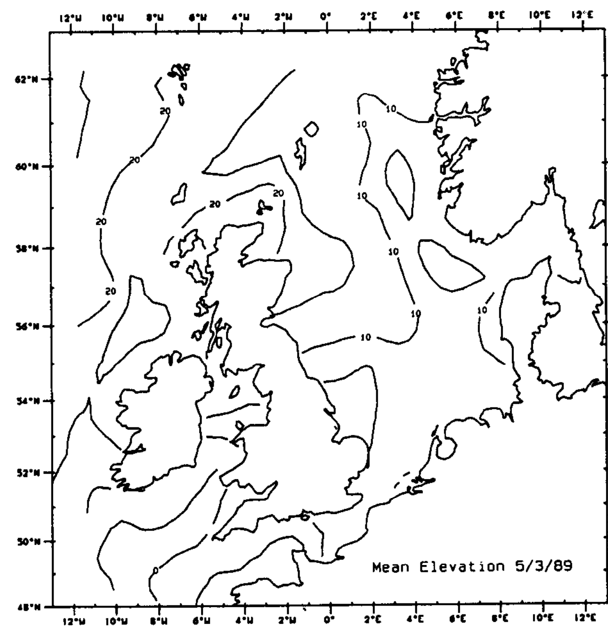
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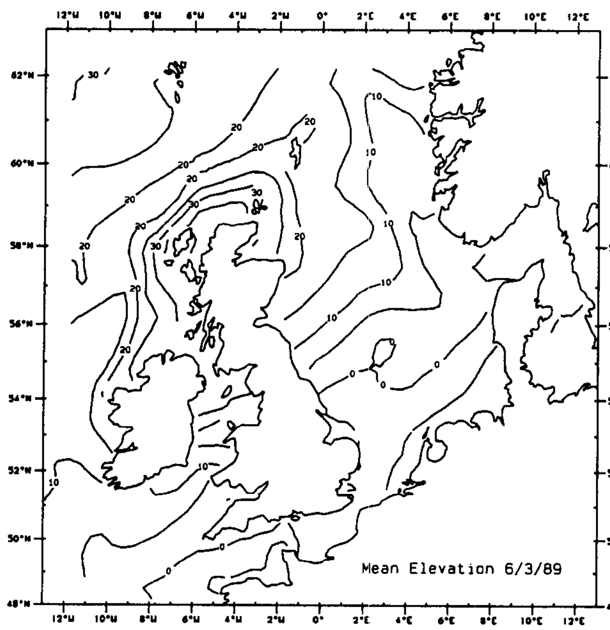
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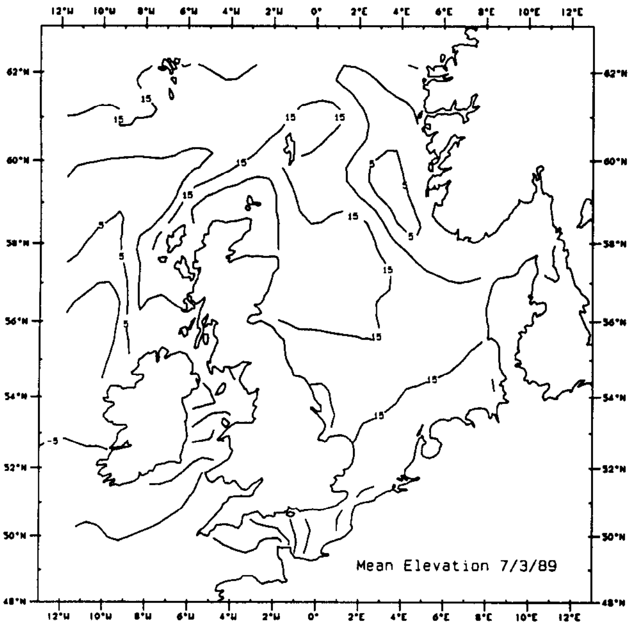
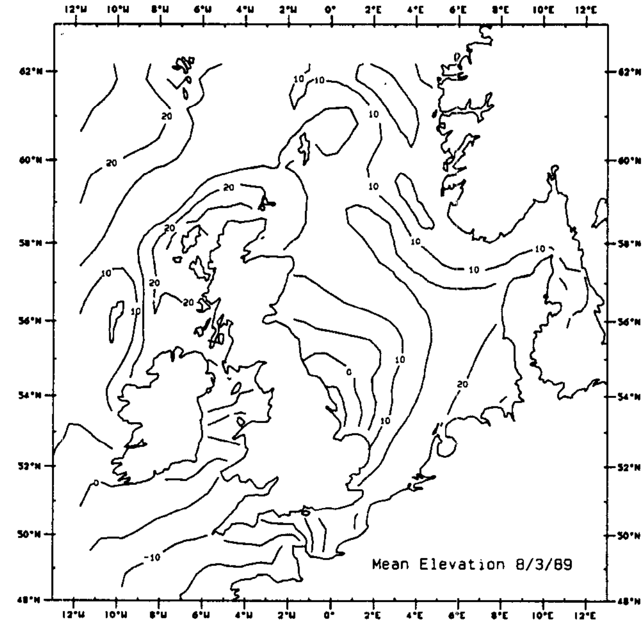
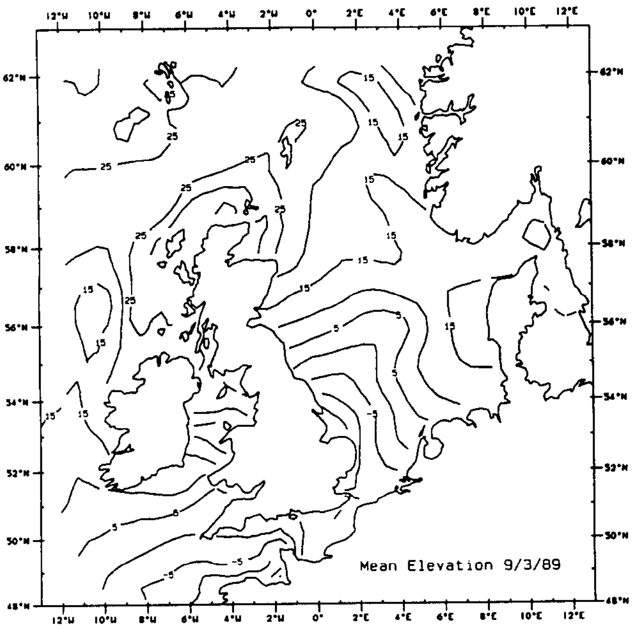
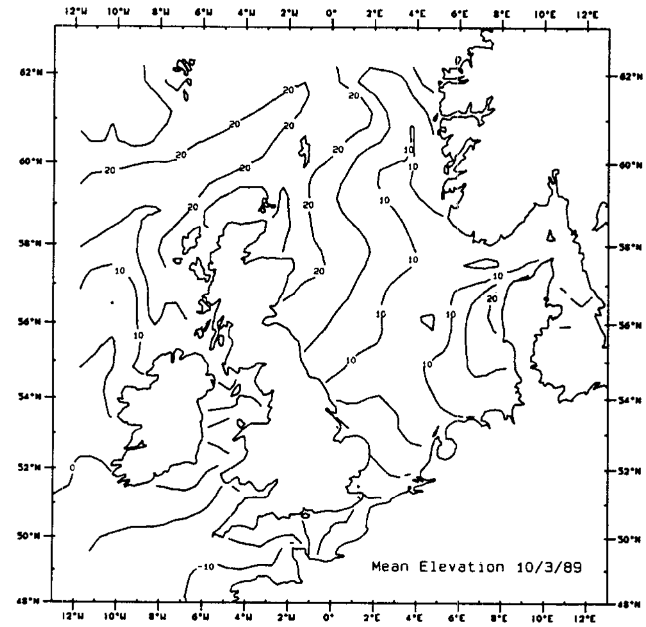
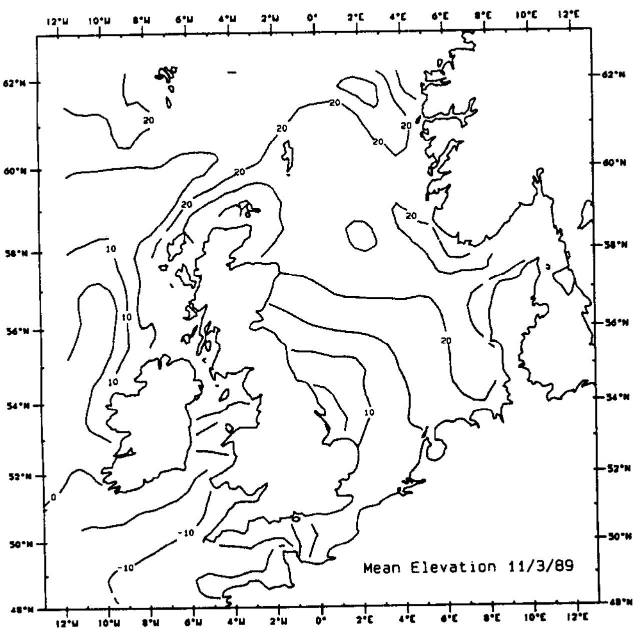
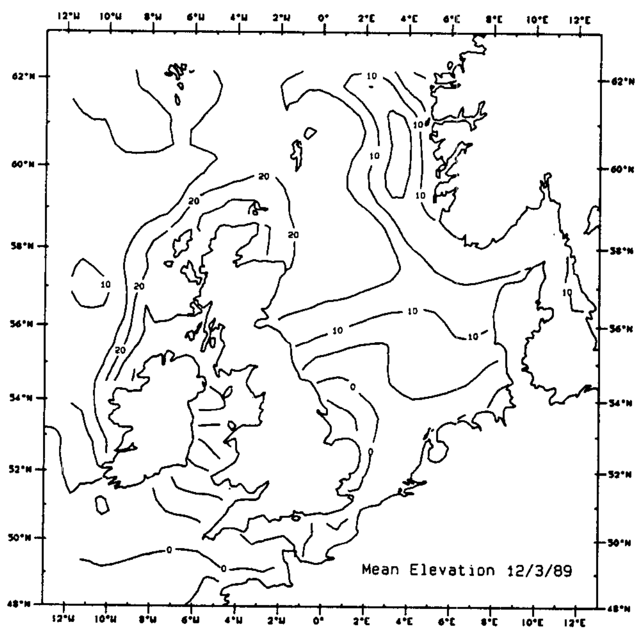

Mean Elevation 7/3/89

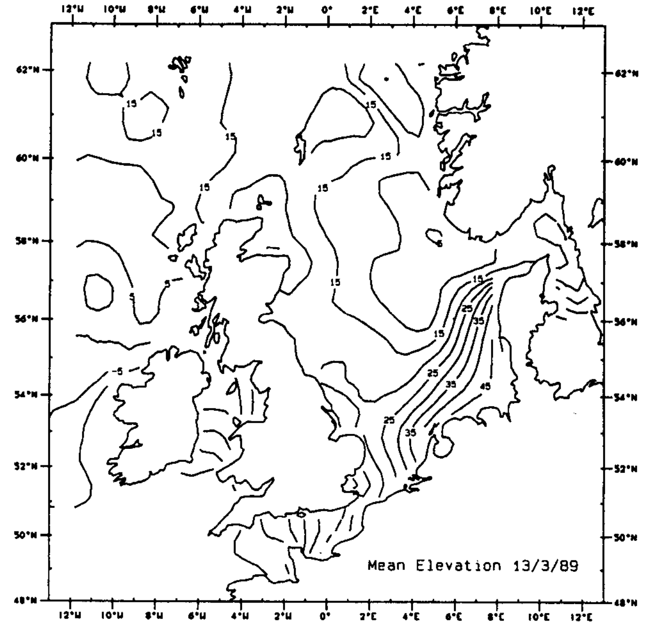

Mean Elevation 8/3/89


Mean Elevation 9/3/89


Mean Elevation 10/3/89


Mean Elevation 11/3/89


Mean Elevation 12/3/89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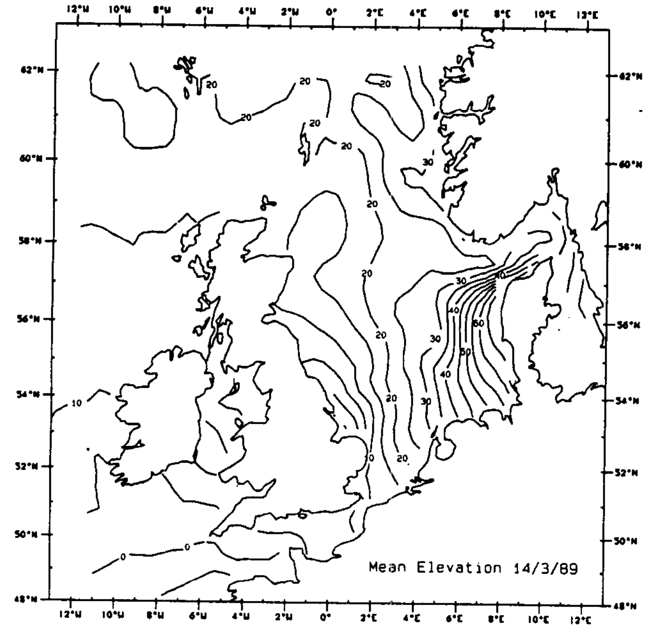
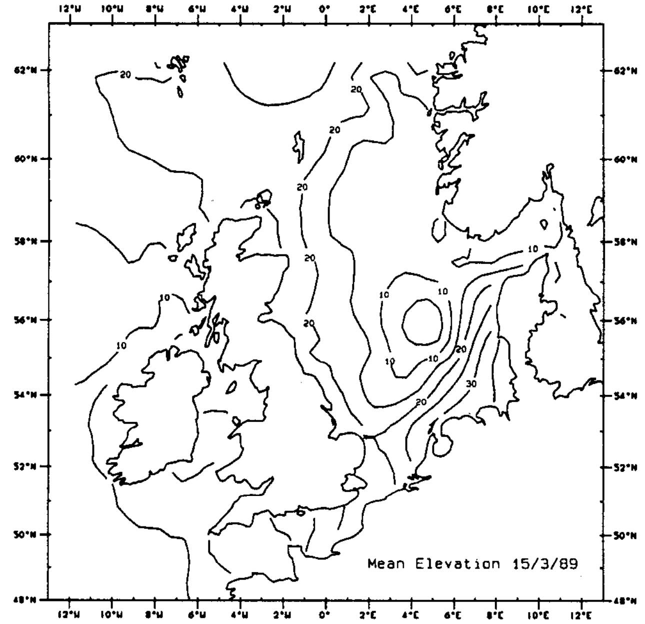
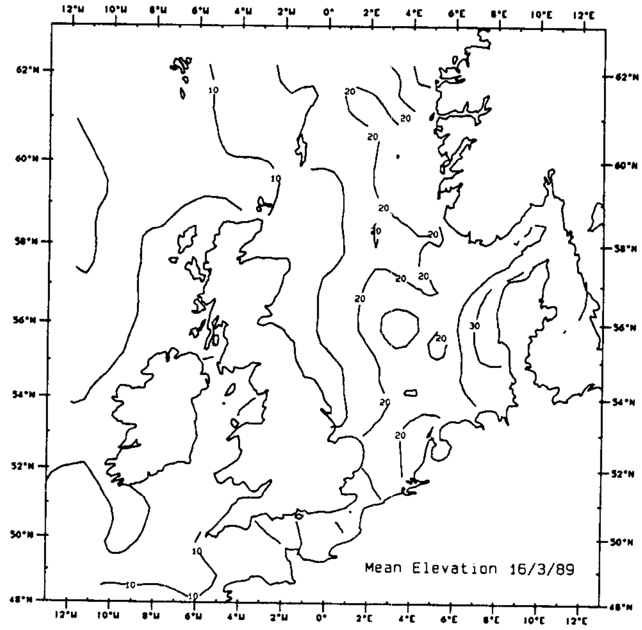
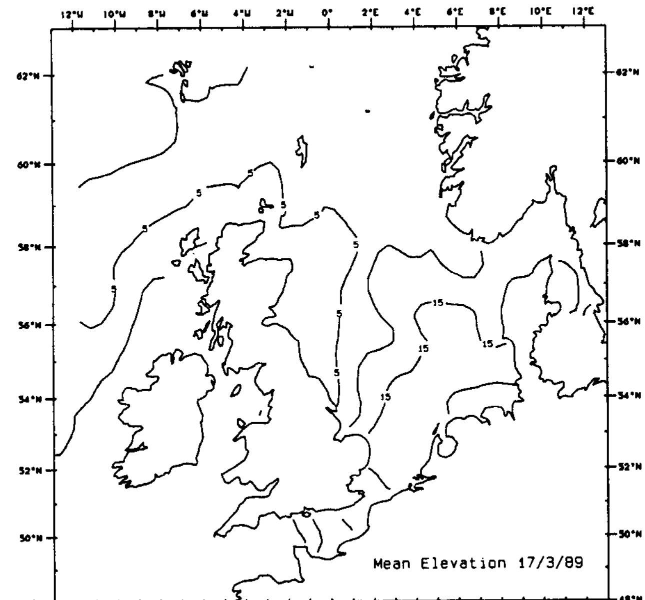
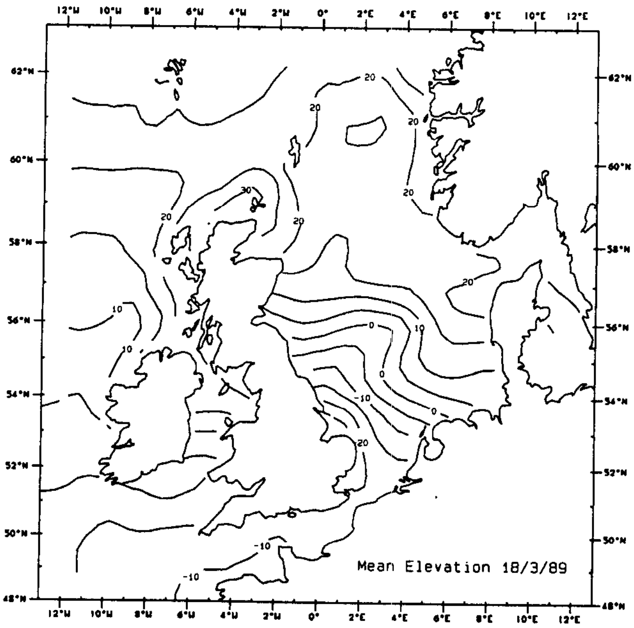
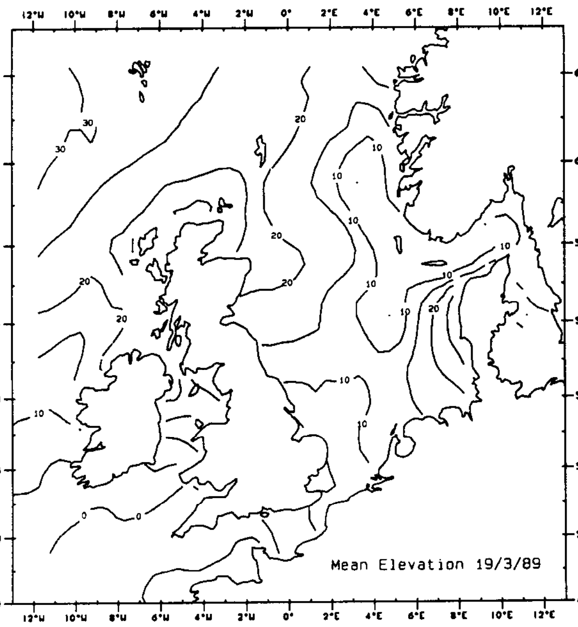

Mean Elevation 14/3/89


Mean Elevation 15/3/89

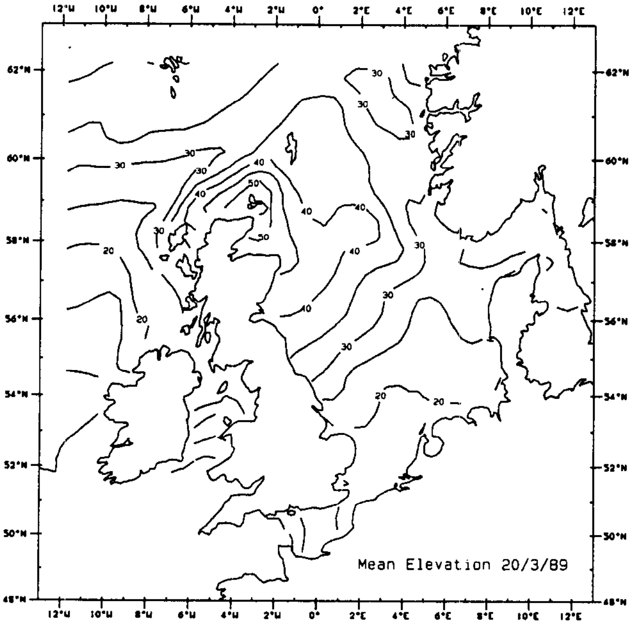

Mean Elevation 16/3/89


Mean Elevation 17/3/89

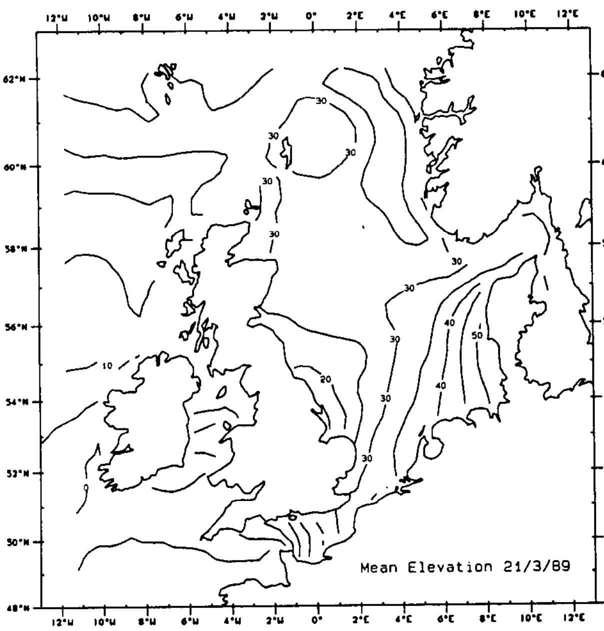

Mean Elevation 18/3/89



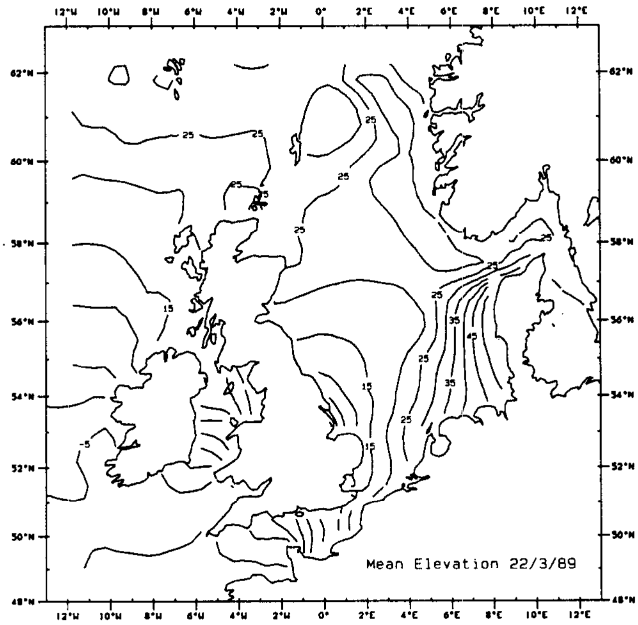
Mean Elevation 19/3/89



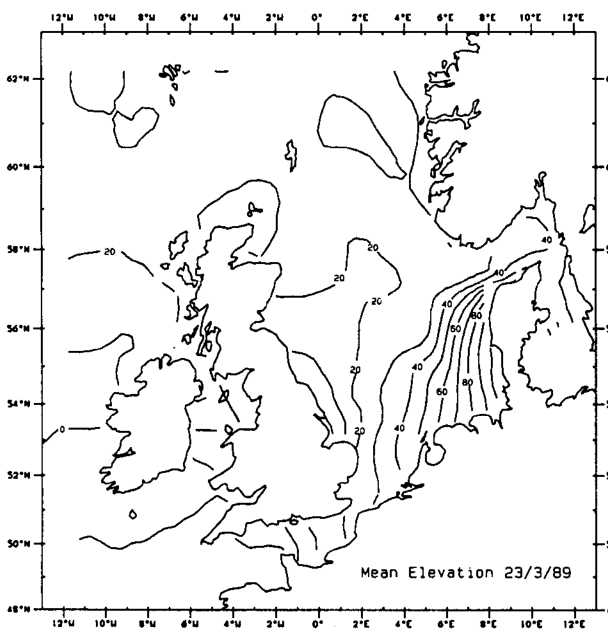
Mean Elevation 20/3/89



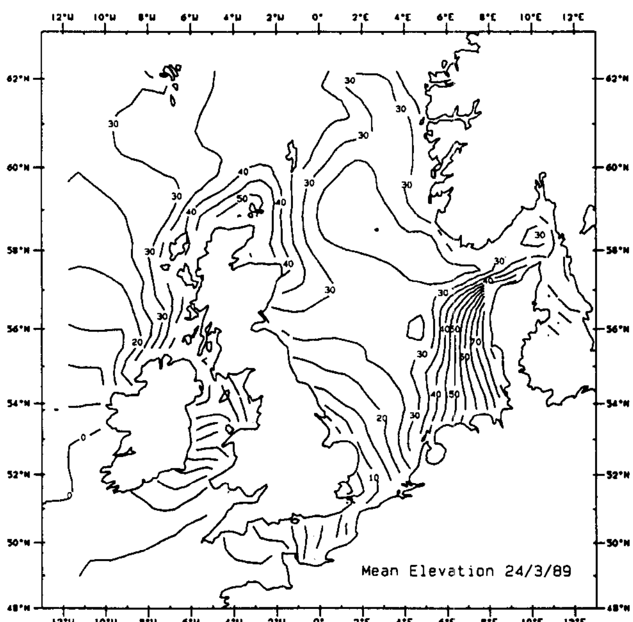
Mean Elevation 21/3/89



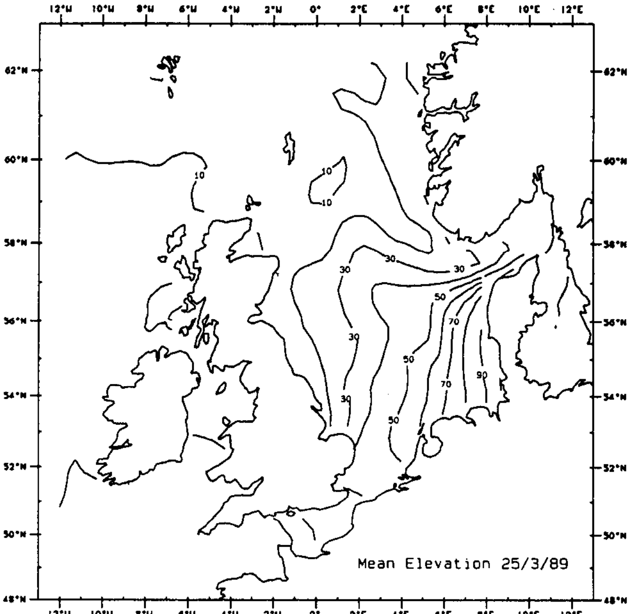
Mean Elevation 22/3/89

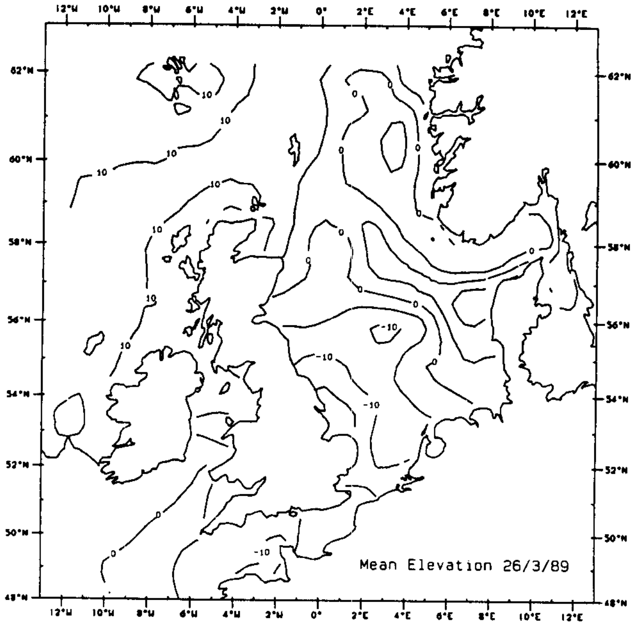


Mean Elevation 23/3/89



Mean Elevation 24/3/89


Mean Elevation 25/3/89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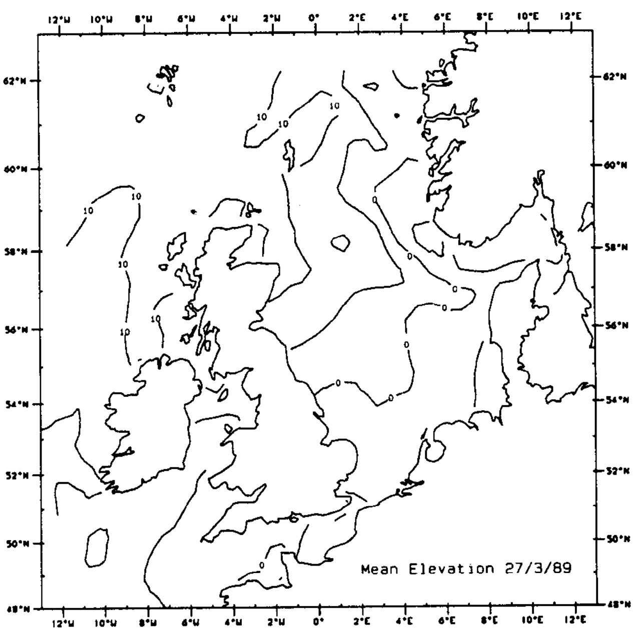
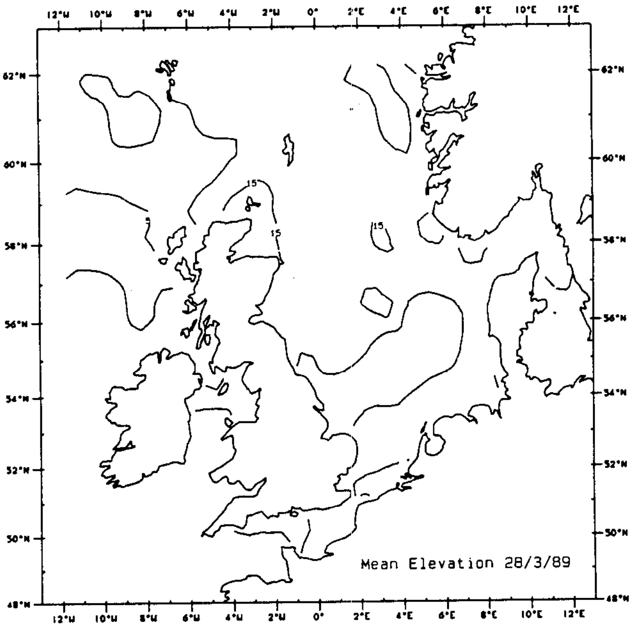
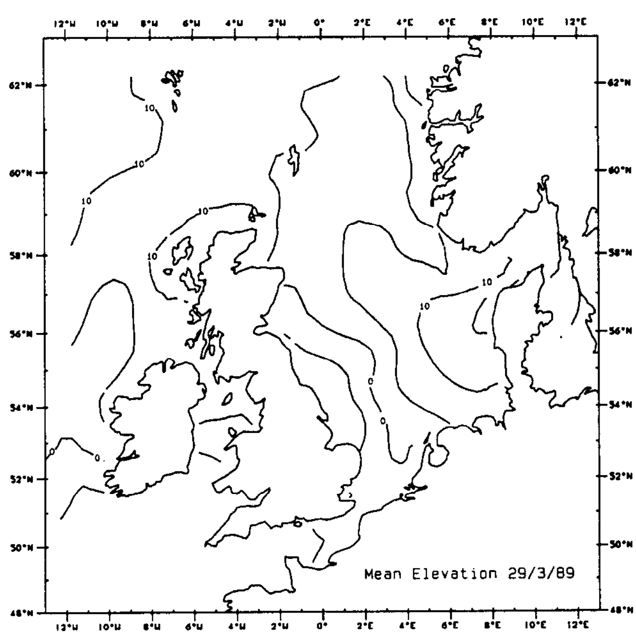
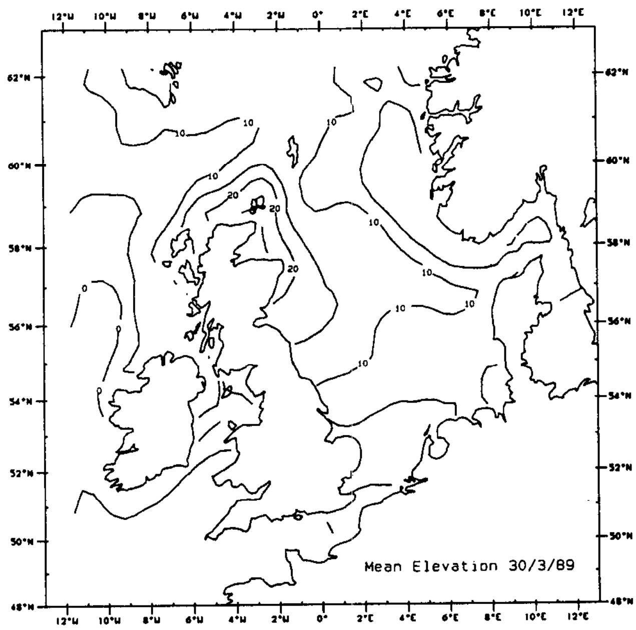
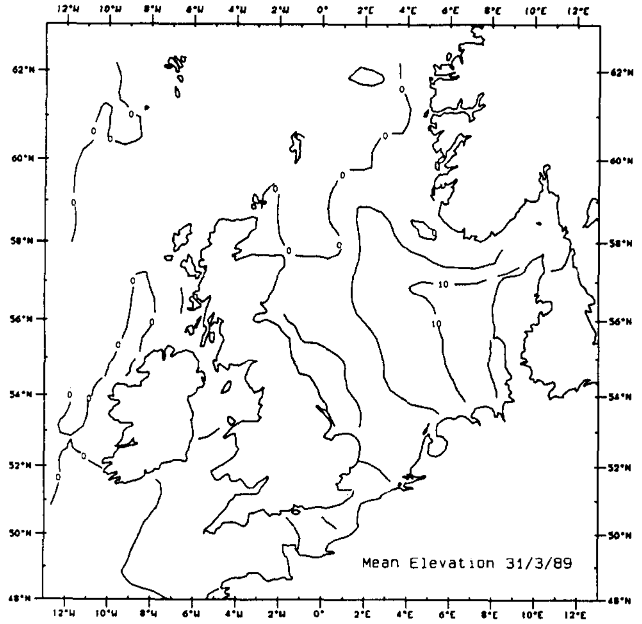

Mean Elevation 27/3/89


Mean Elevation 28/3/89


Mean Elevation 29/3/89


Mean Elevation 30/3/89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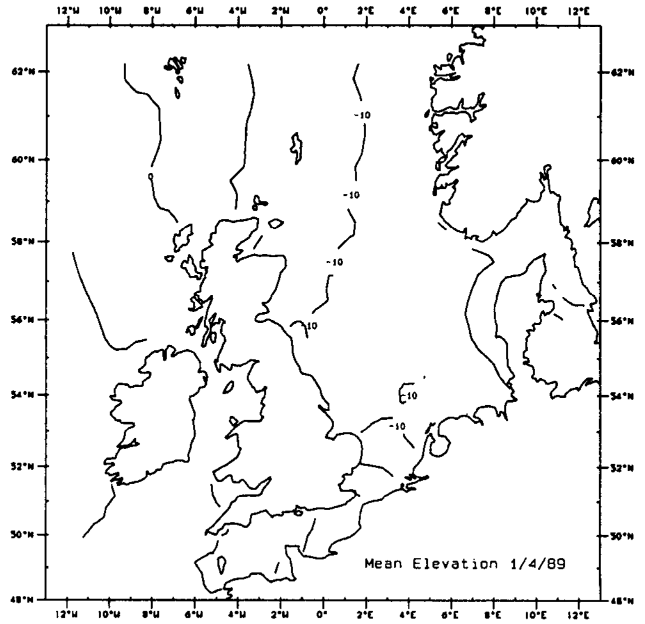
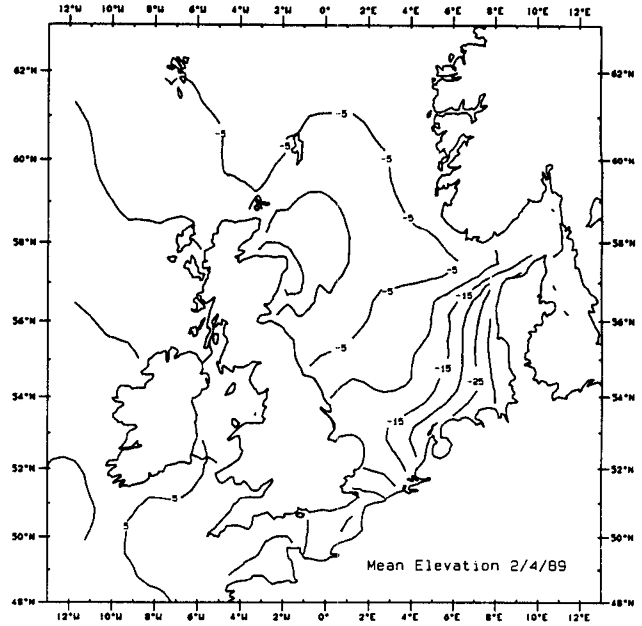
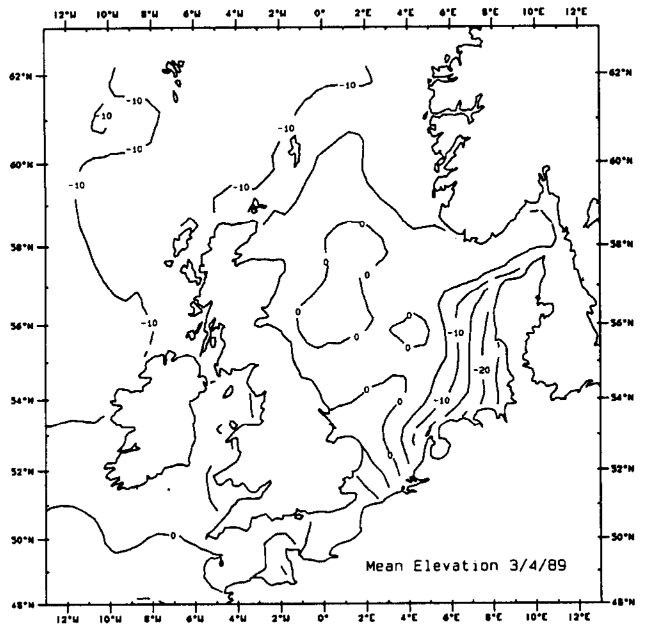
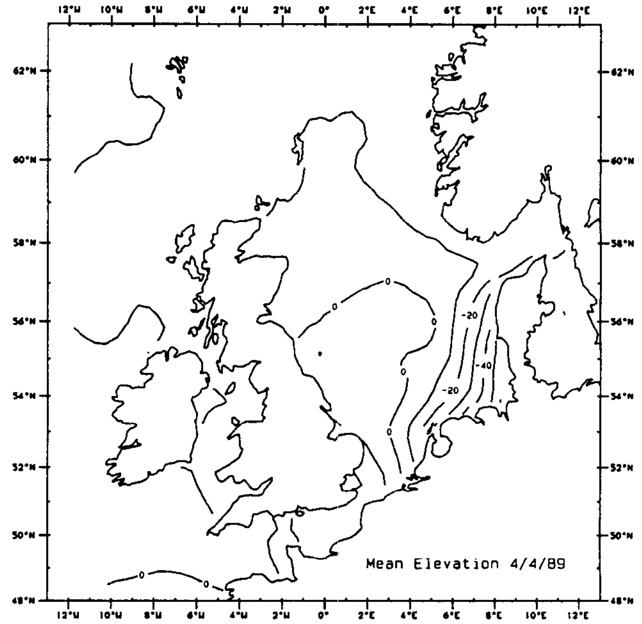
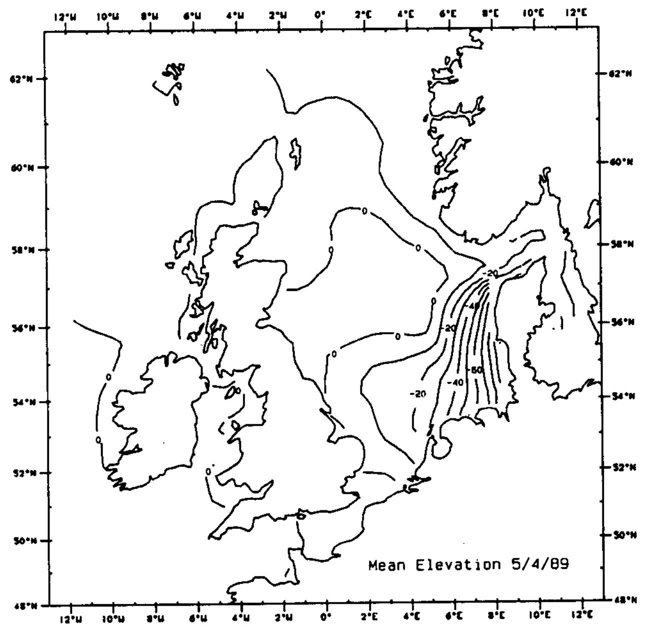
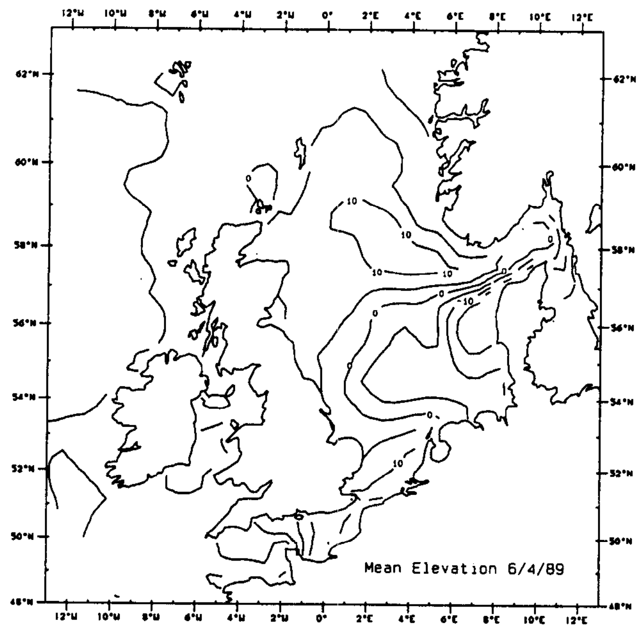

Mean Elevation 1/4/89

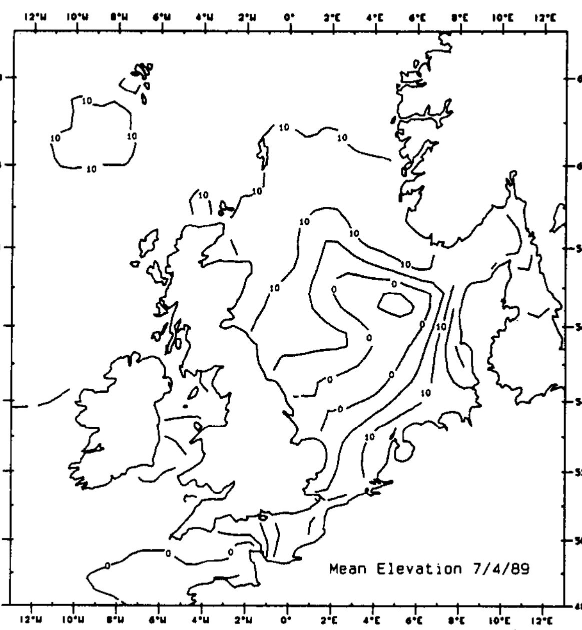

Mean Elevation 2/4/89


Mean Elevation 3/4/89

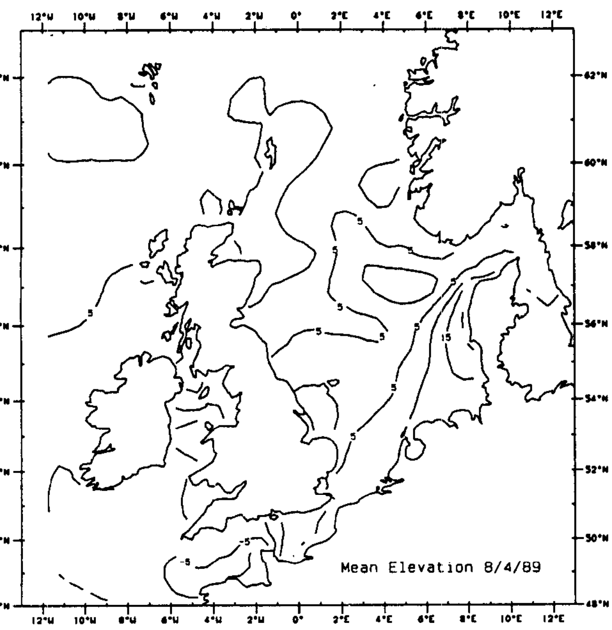

Mean Elevation 4/4/89


Mean Elevation 5/4/89

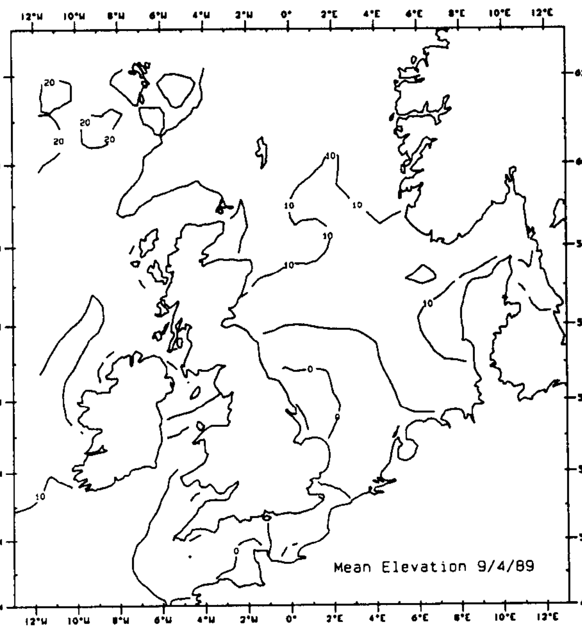

Mean Elevation 6/4/89



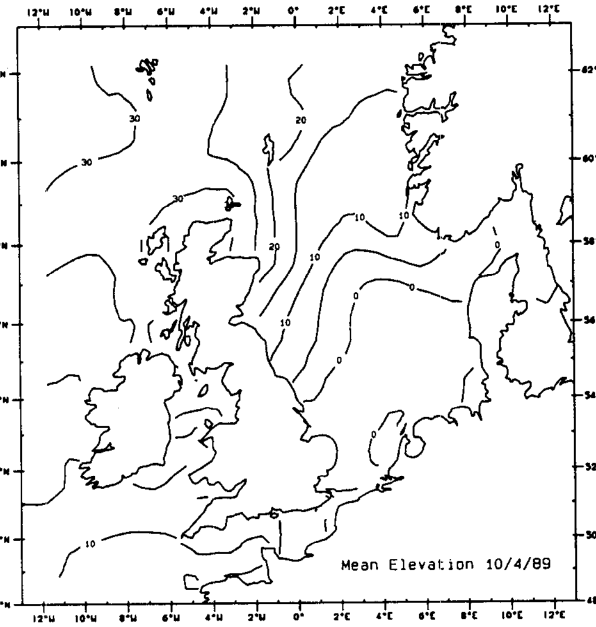
Mean Elevation 7/4/89



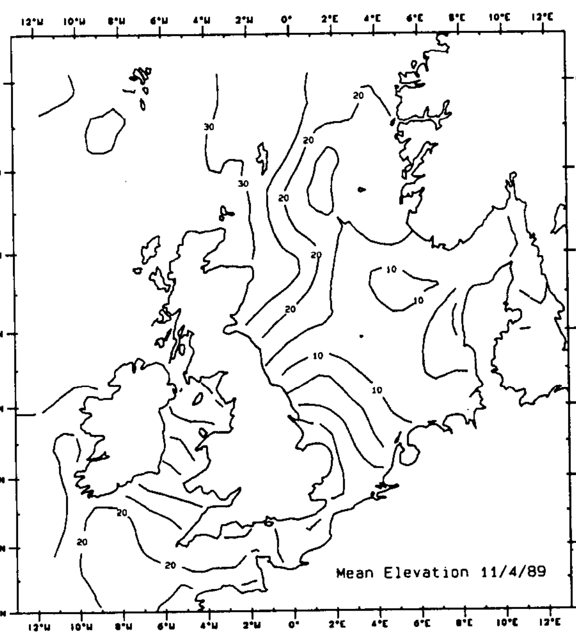
Mean Elevation 8/4/89



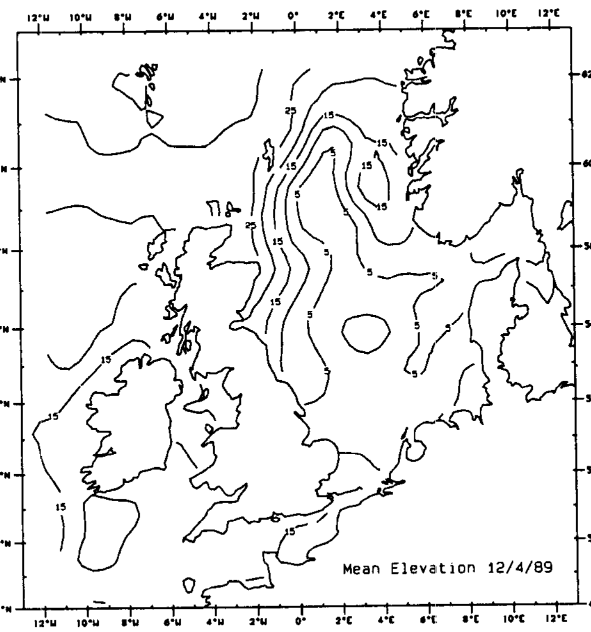
Mean Elevation 9/4/89



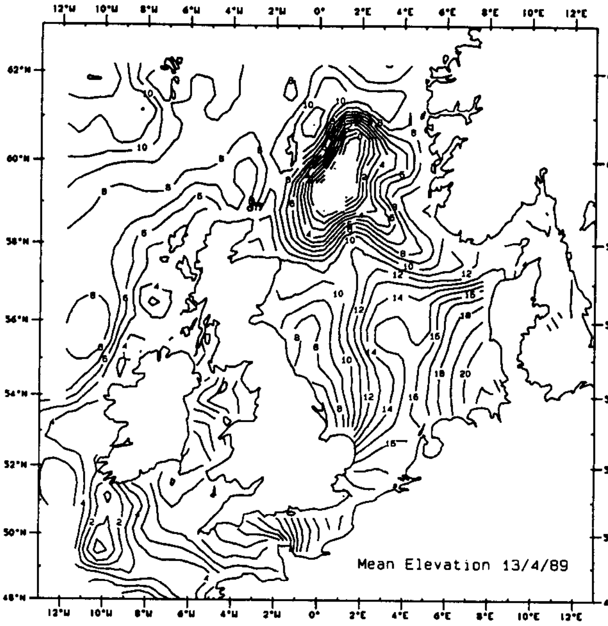
Mean Elevation 10/4/89

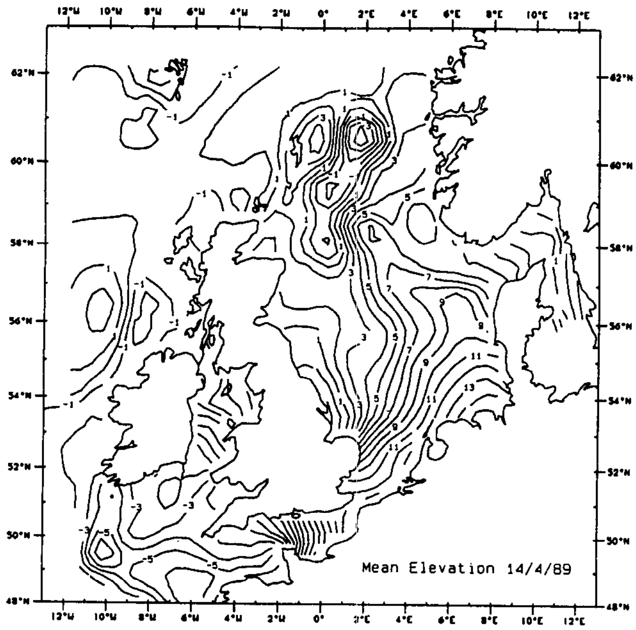


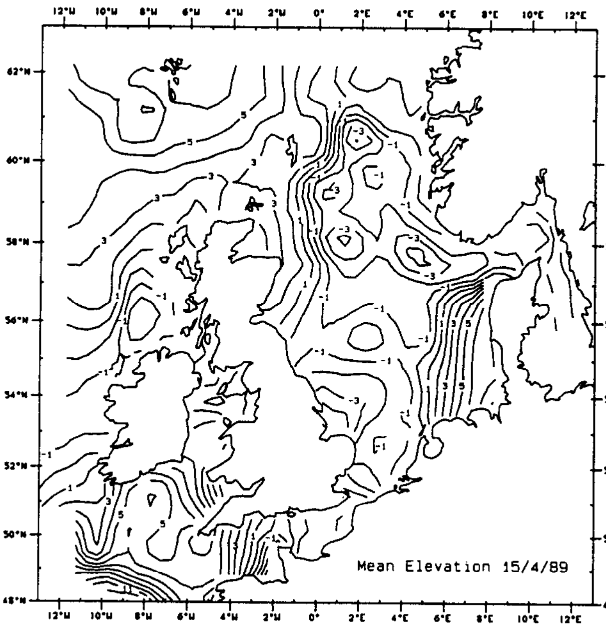
Mean Elevation 11/4/89

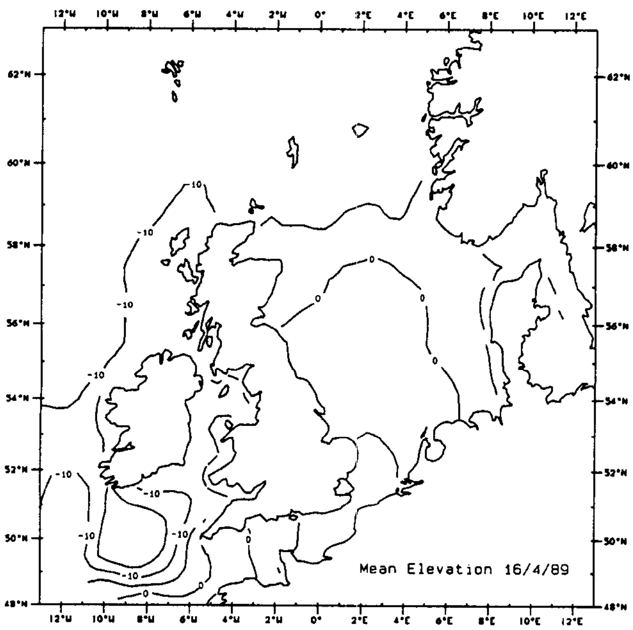


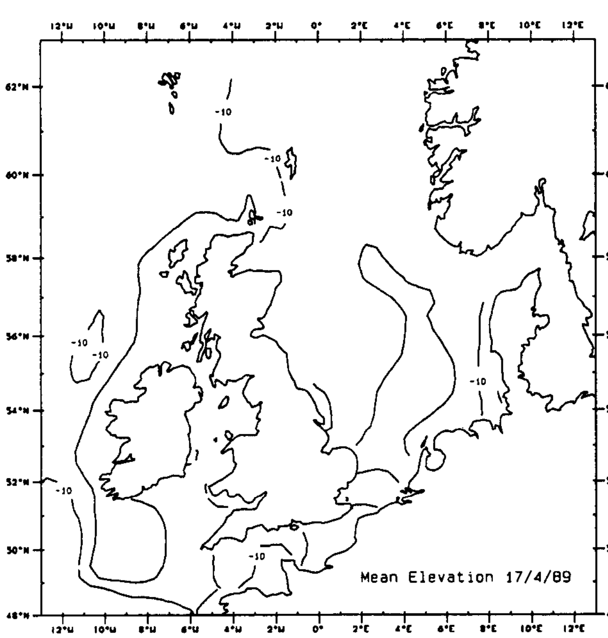
Mean Elevation 12/4/89

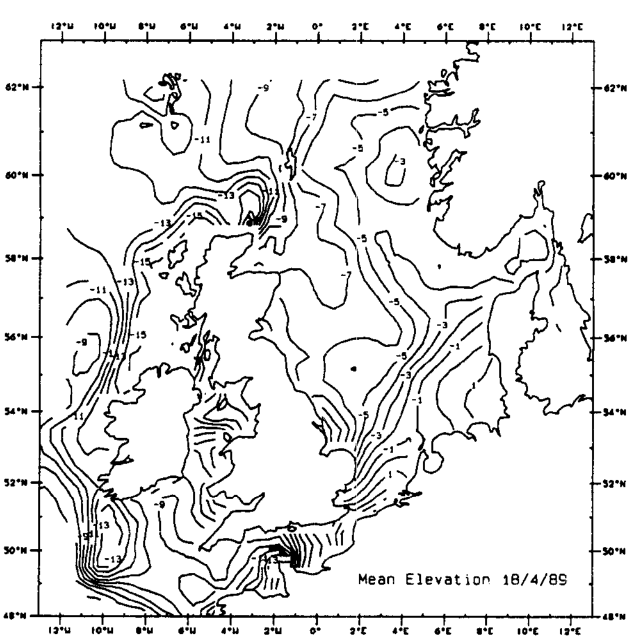

Mean Elevation 13/4/89

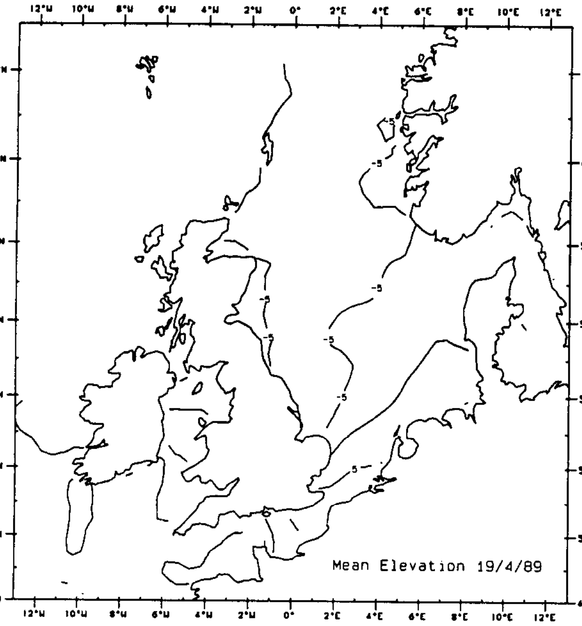

Mean Elevation 14/4/89

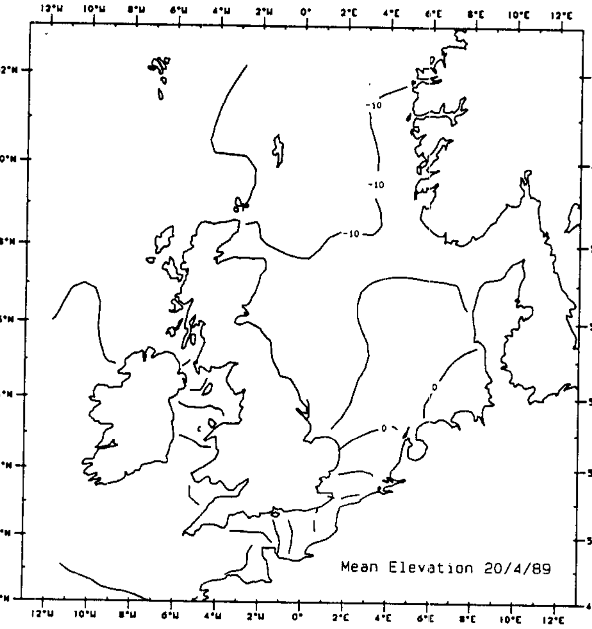

Mean Elevation 15/4/89

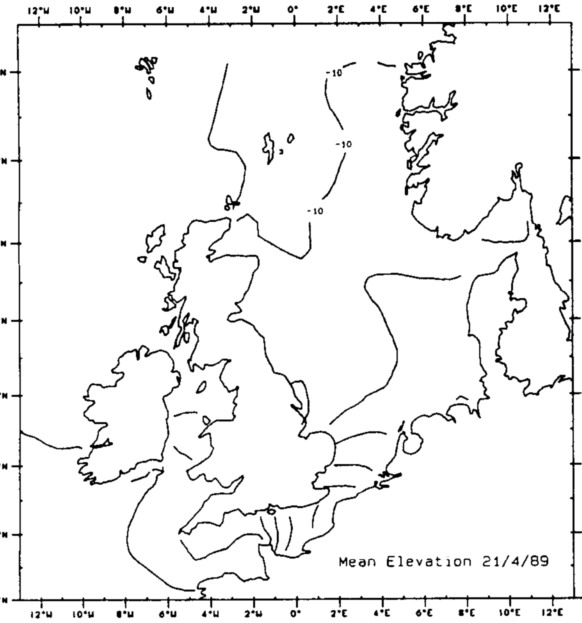

Mean Elevation 16/4/89

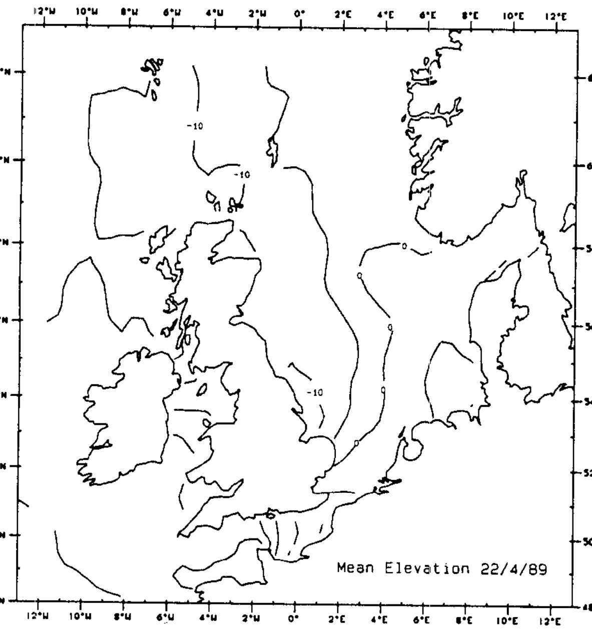

Mean Elevation 17/4/89

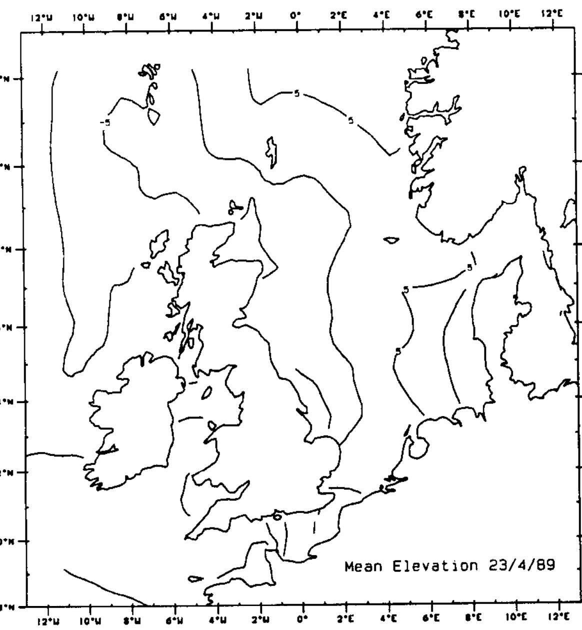

Mean Elevation 18/4/89

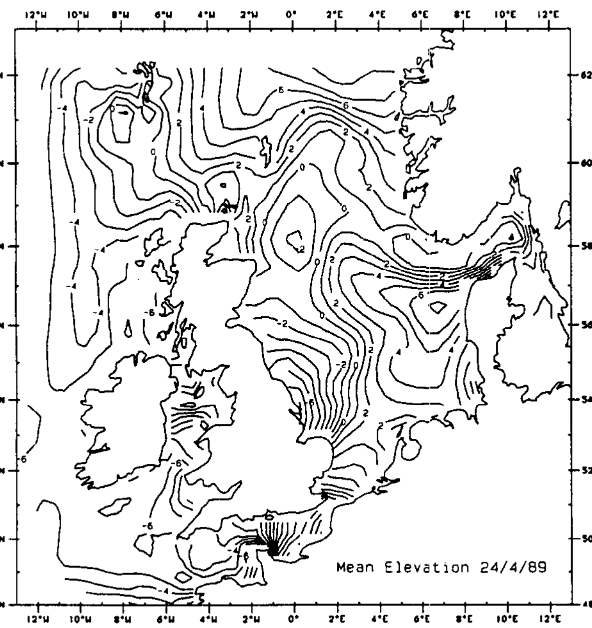

Mean Elevation 19/4/89

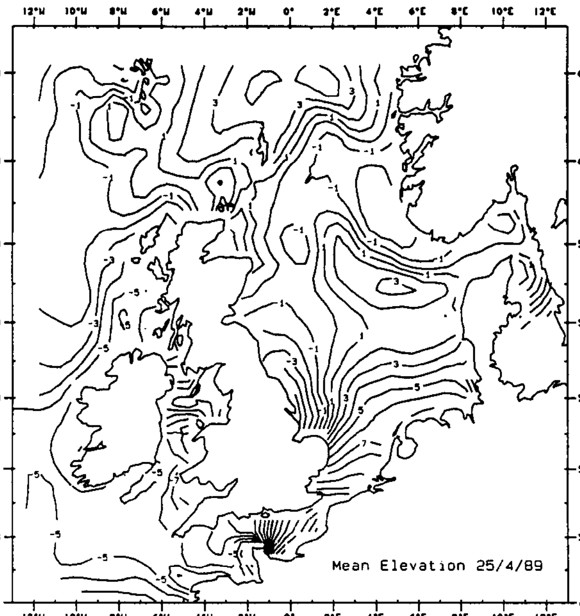

Mean Elevation 20/4/89

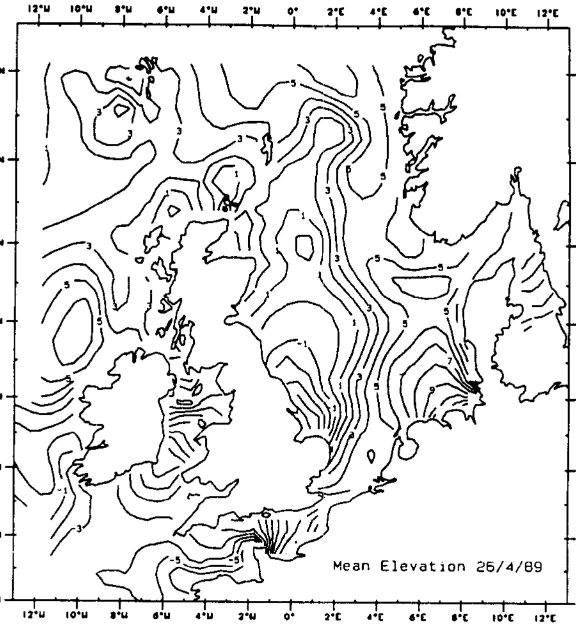

Mean Elevation 21/4/89

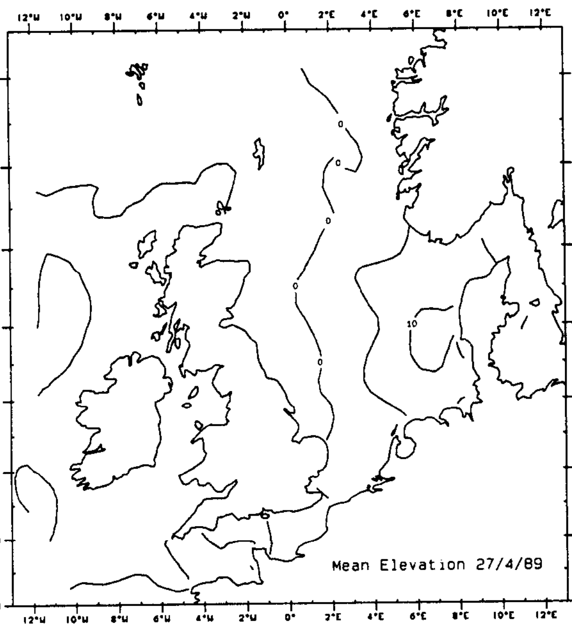

Mean Elevation 22/4/89

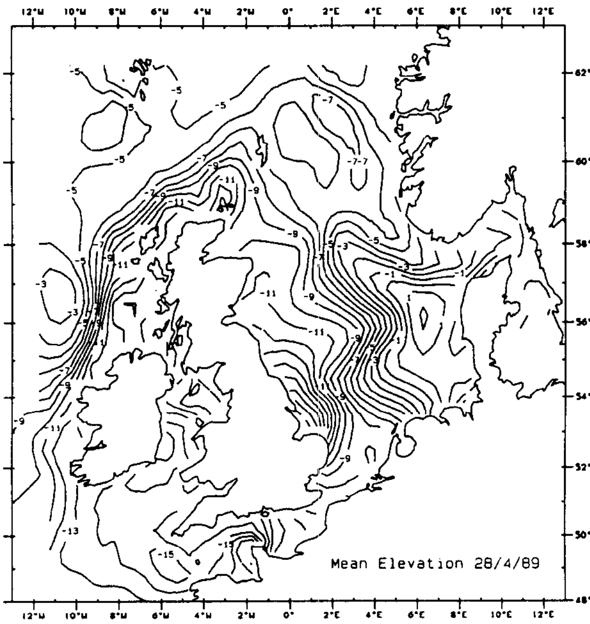

Mean Elevation 23/4/89

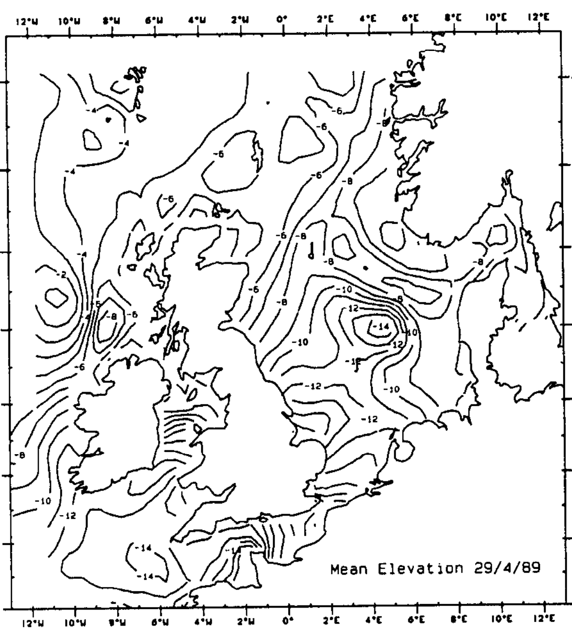

Mean Elevation 24/4/89

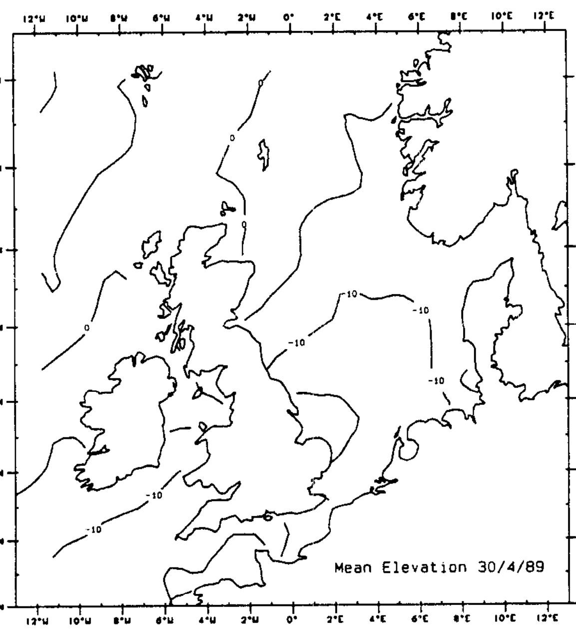

Mean Elevation 25/4/89

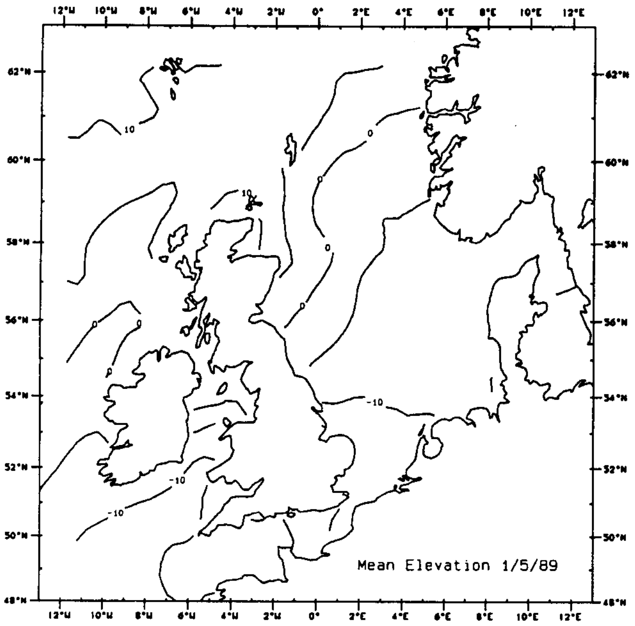

Mean Elevation 26/4/89

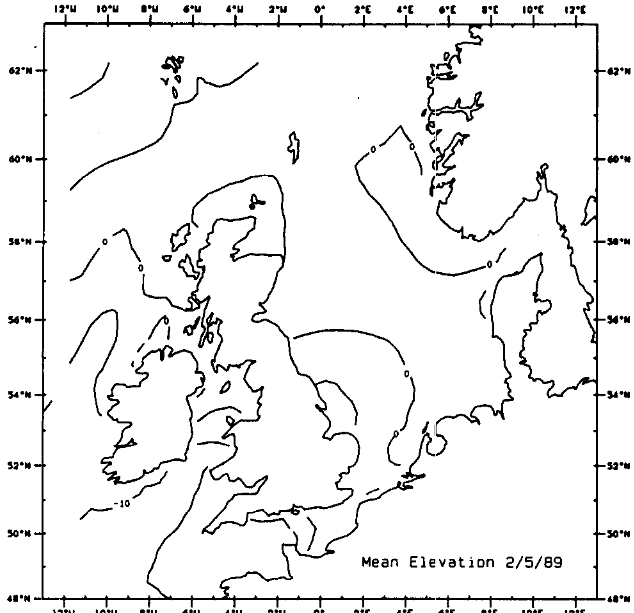

Mean Elevation 27/4/89


Mean Elevation 28/4/89


Mean Elevation 29/4/89


Mean Elevation 30/4/89


Mean Elevation 1/5/89
10
0
-10


Mean Elevation 2/5/89
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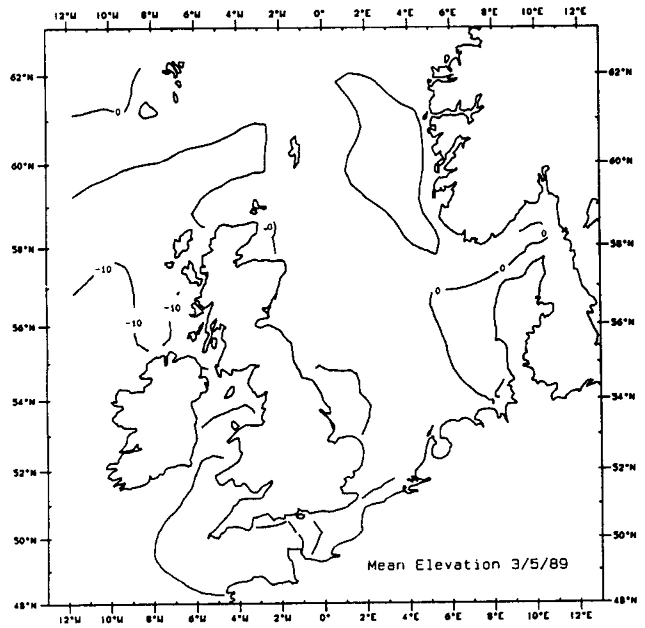
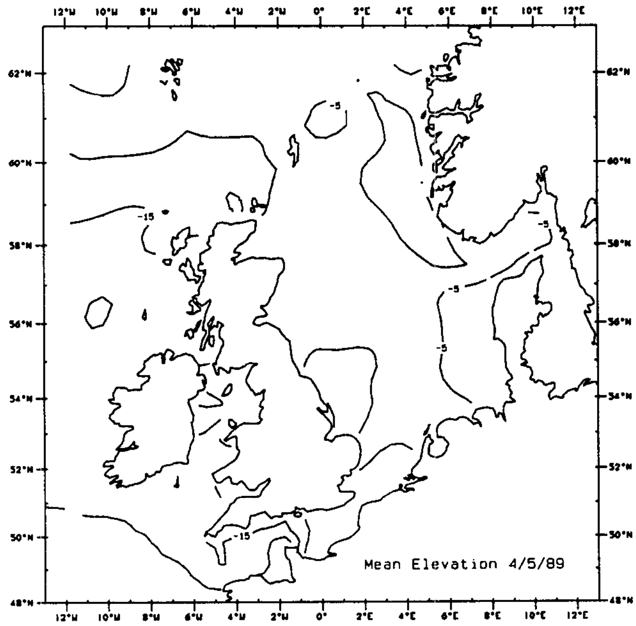
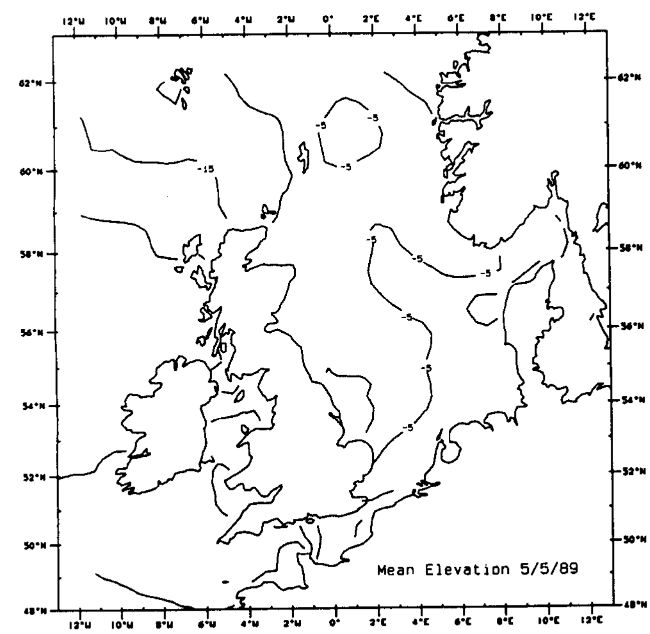
-10


Mean Elevation 3/5/89
0
-10


Mean Elevation 4/5/89
-5
-15


Mean Elevation 5/5/89
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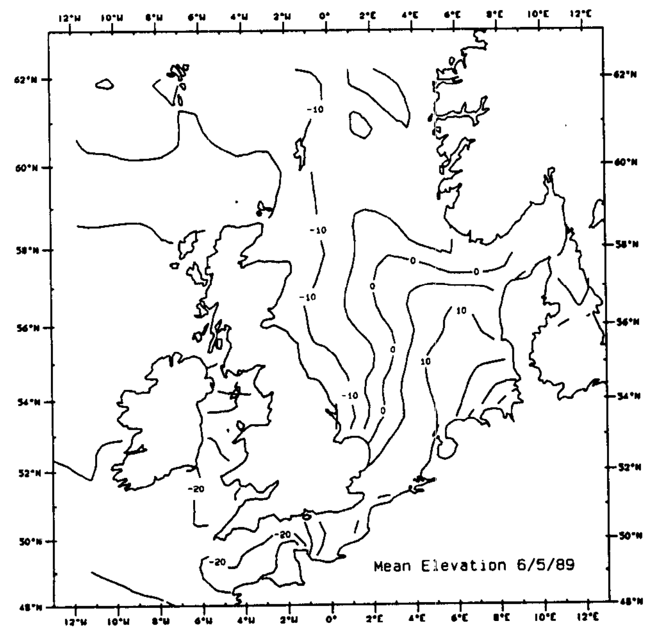
Mean Elevation 6/5/89
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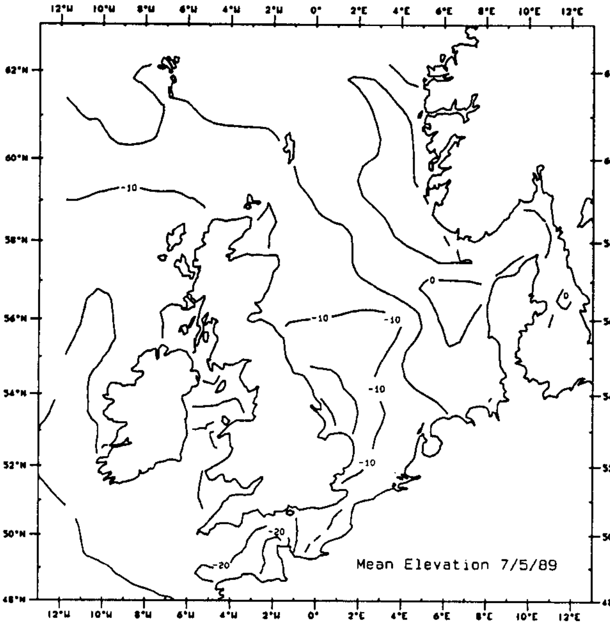
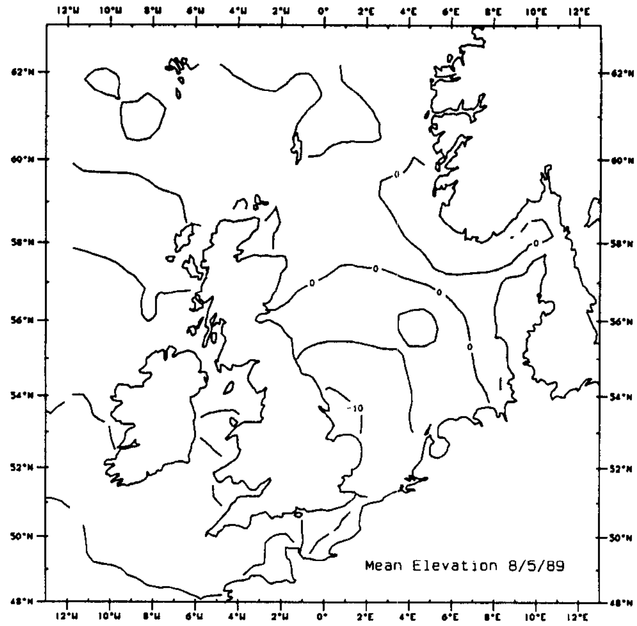
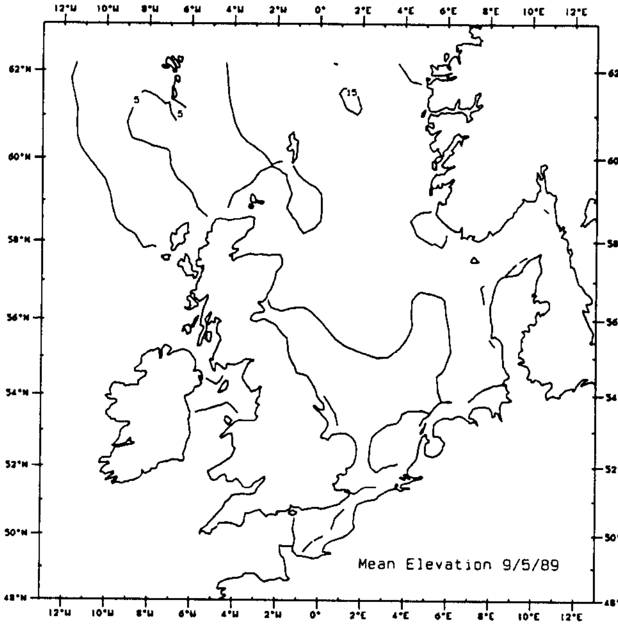
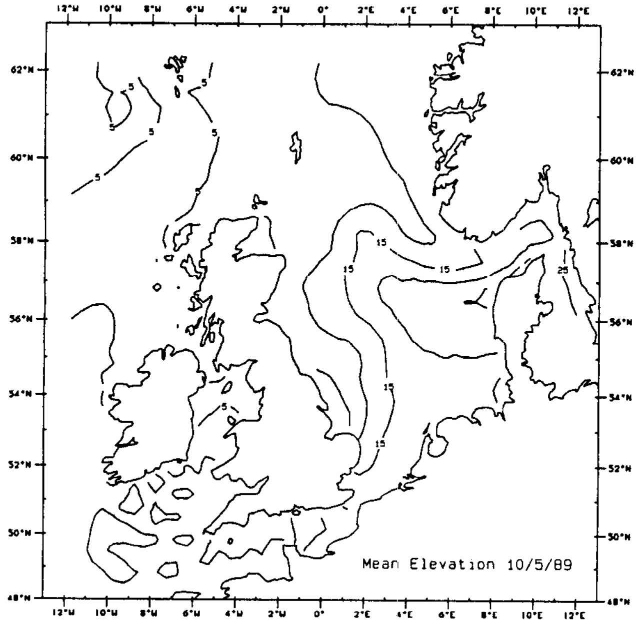
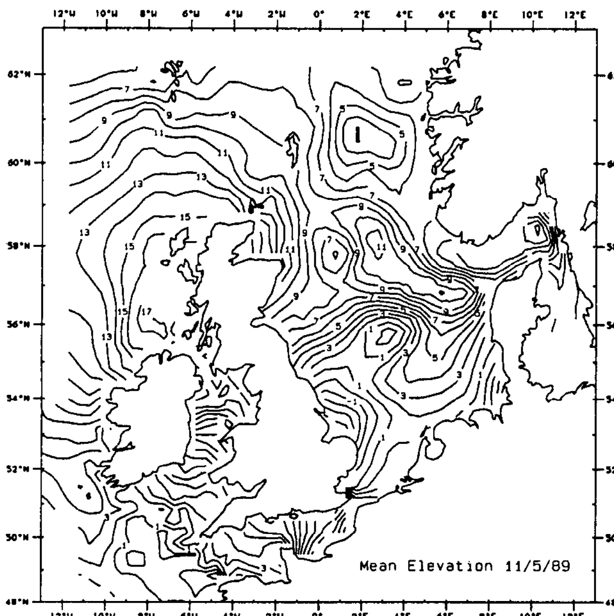
0
10
-20


Mean Elevation 7/5/89


Mean Elevation 8/5/89


Mean Elevation 9/5/89


Mean Elevation 10/5/89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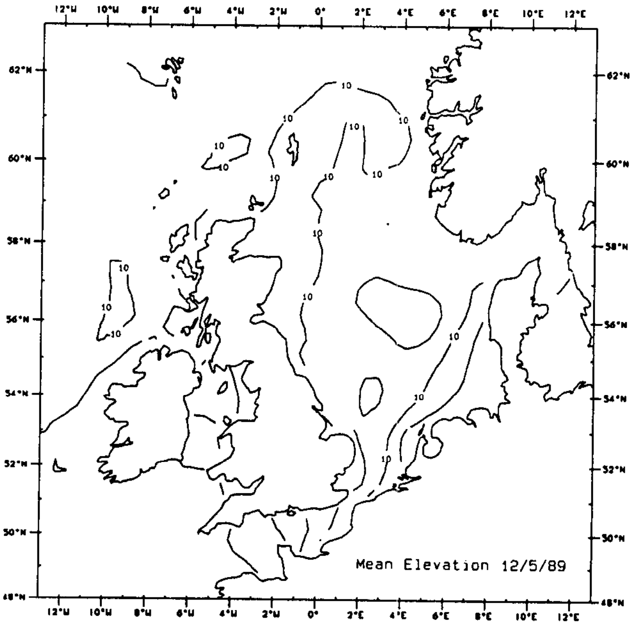
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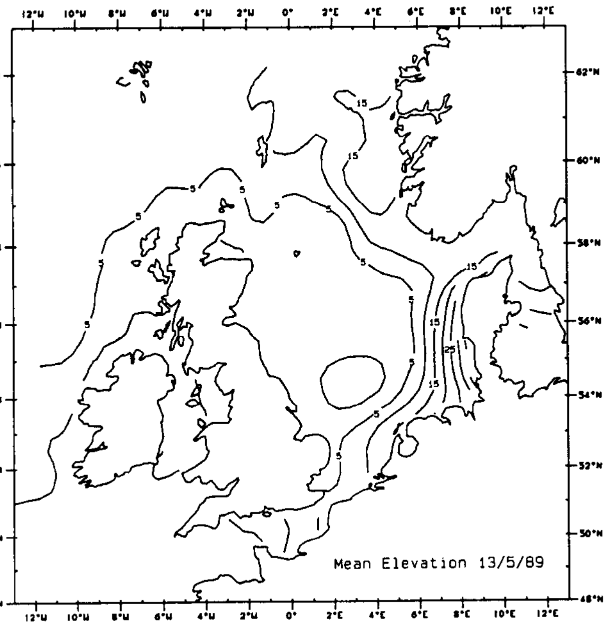
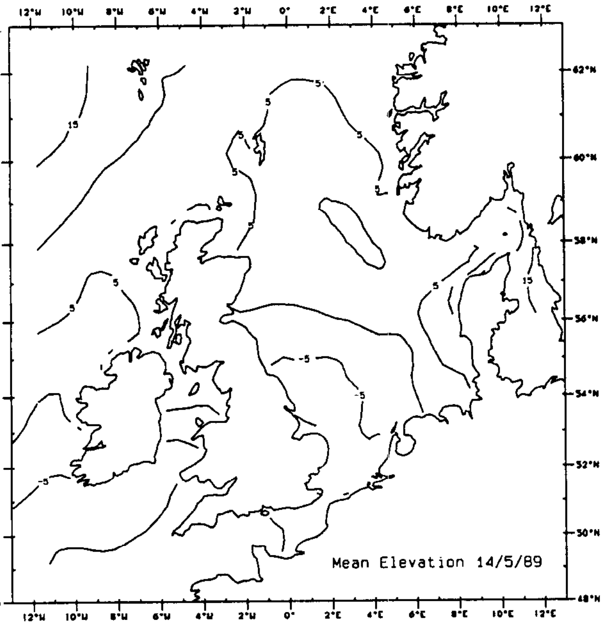
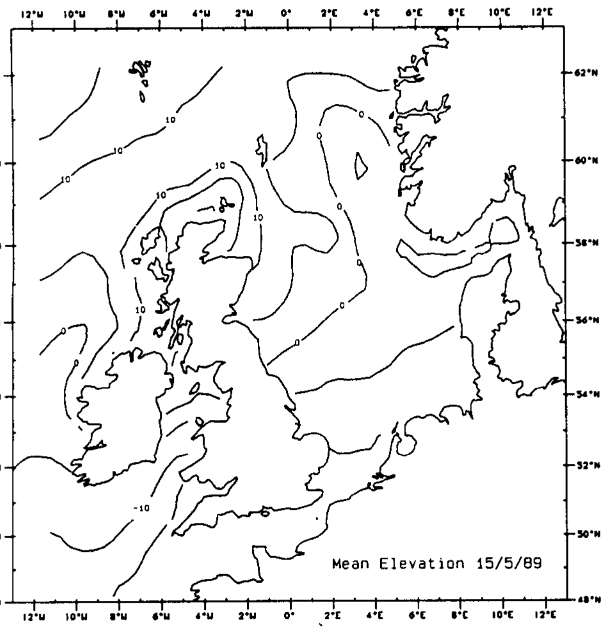

Mean Elevation 13/5/89


Mean Elevation 14/5/89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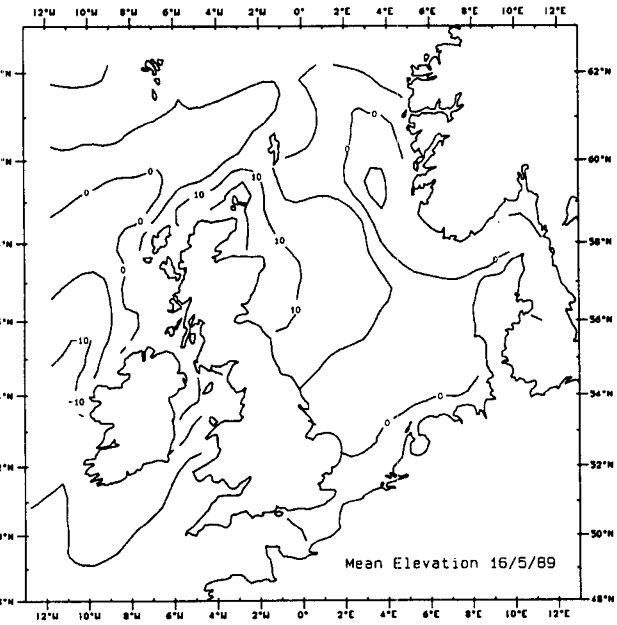
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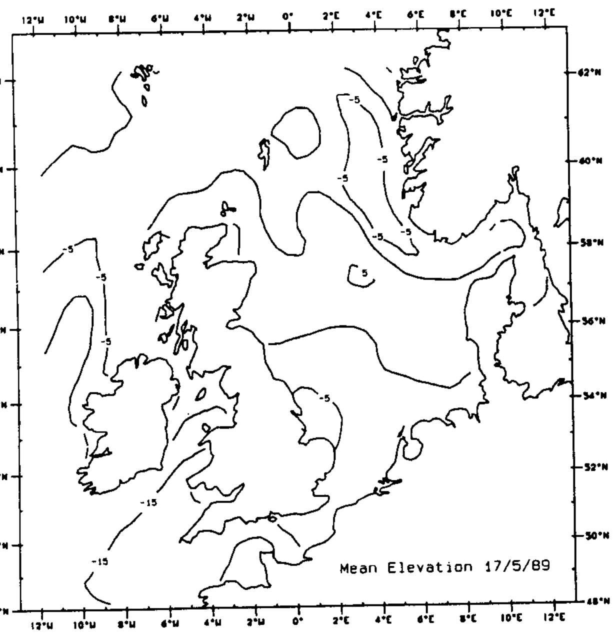
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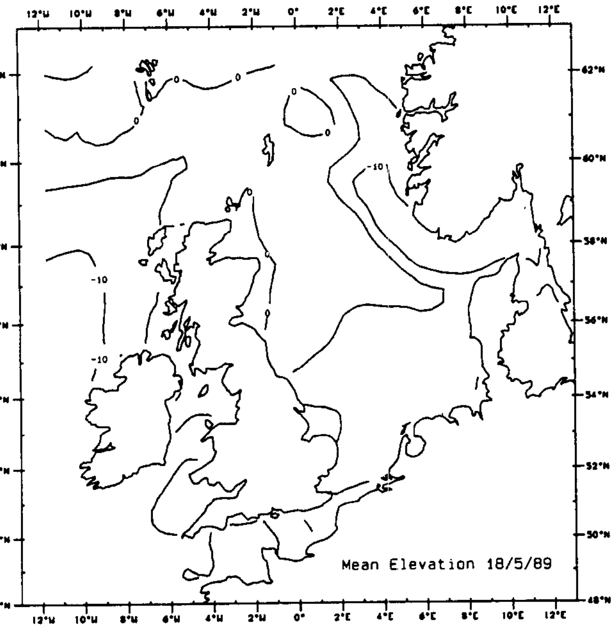
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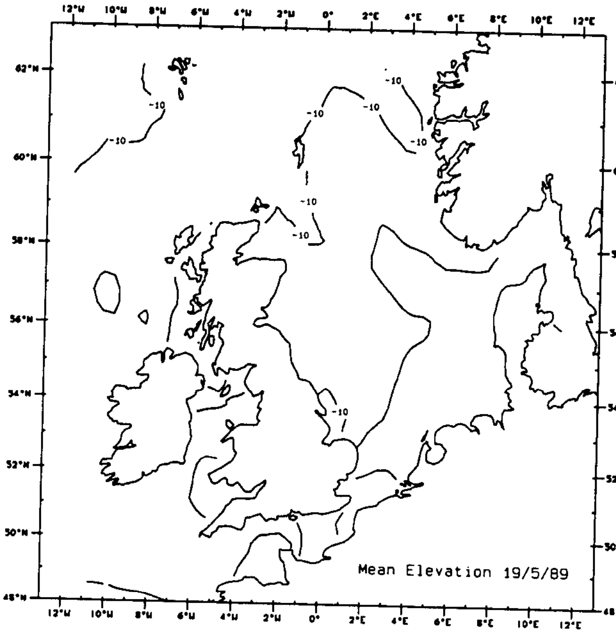
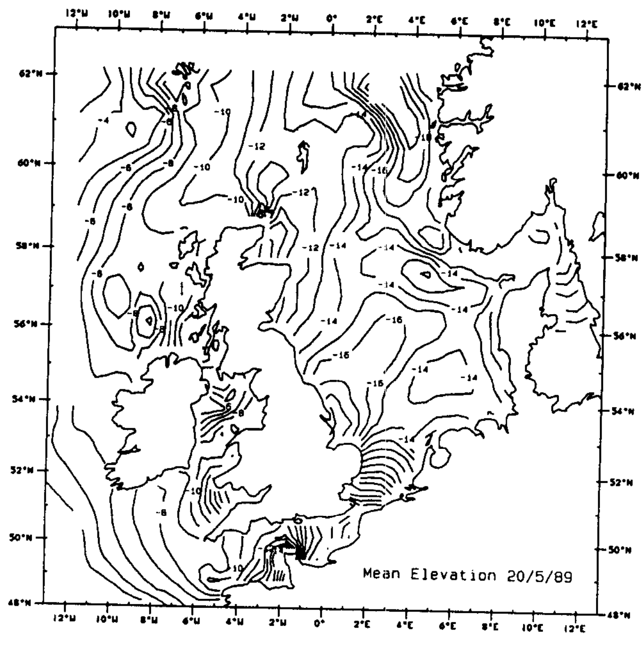

Mean Elevation 19/5/89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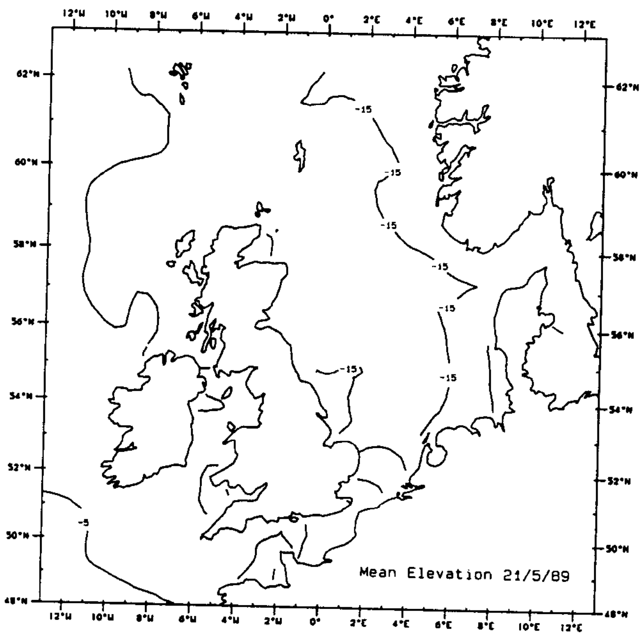
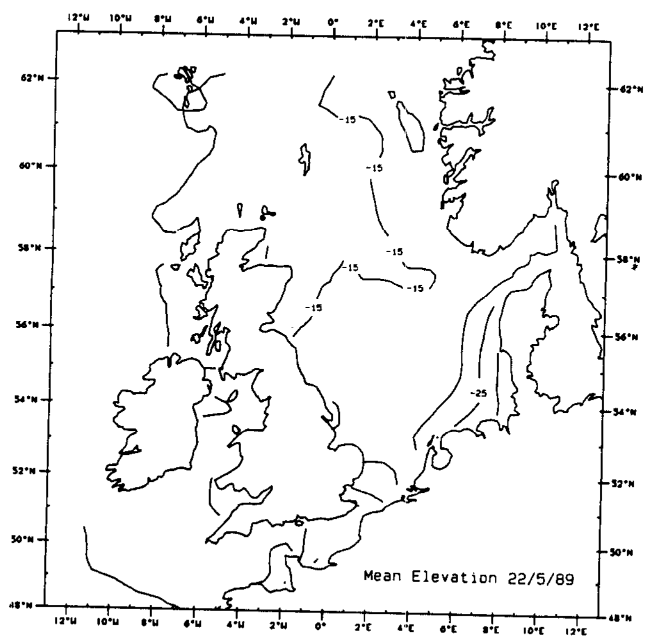
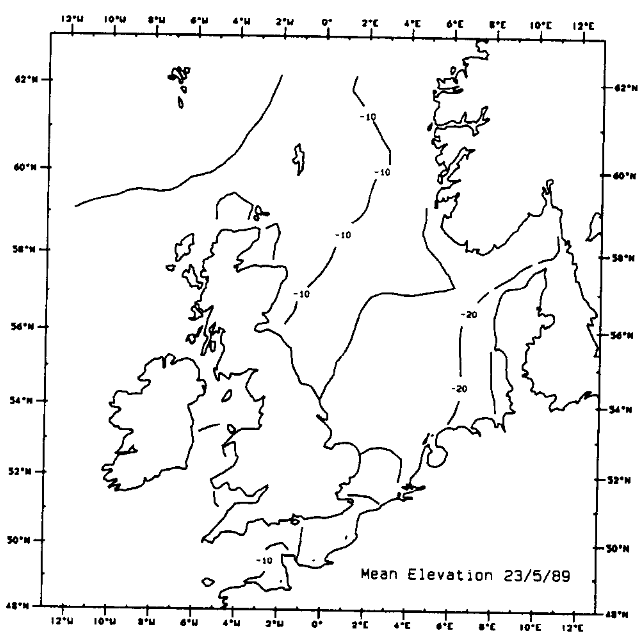
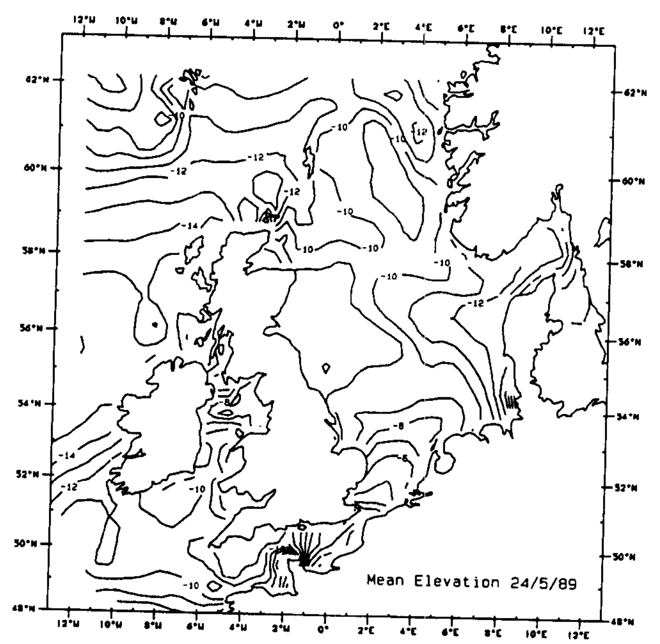
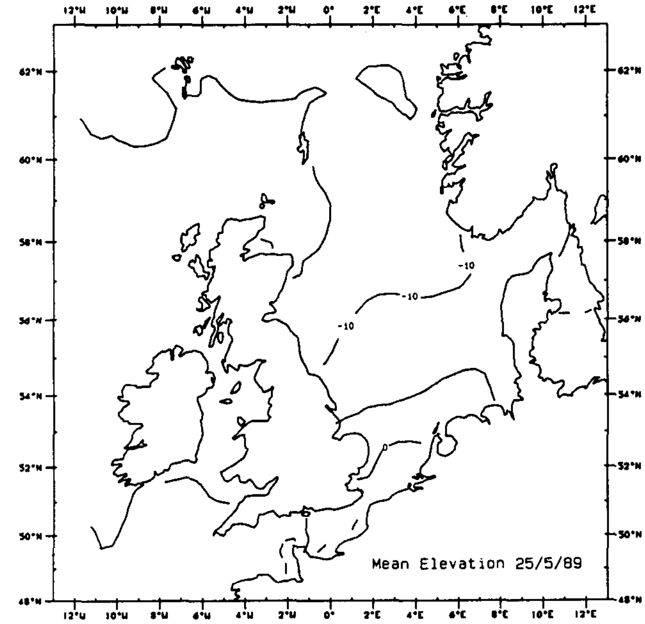
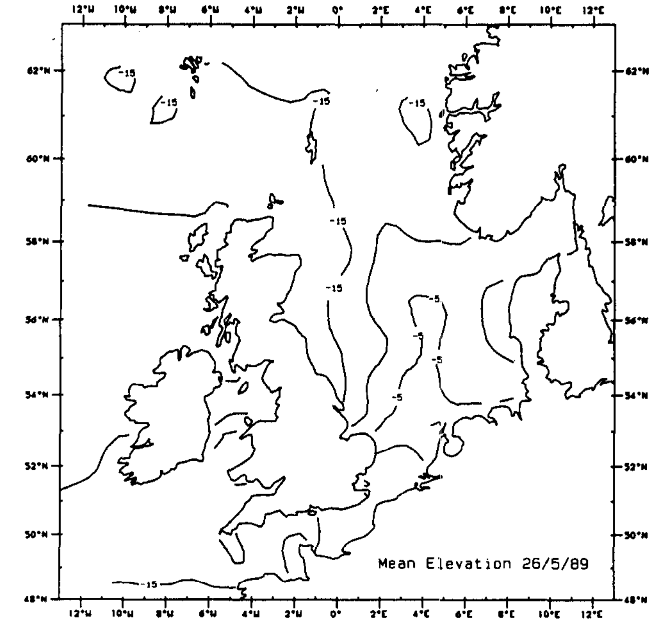

Mean Elevation 21/5/89

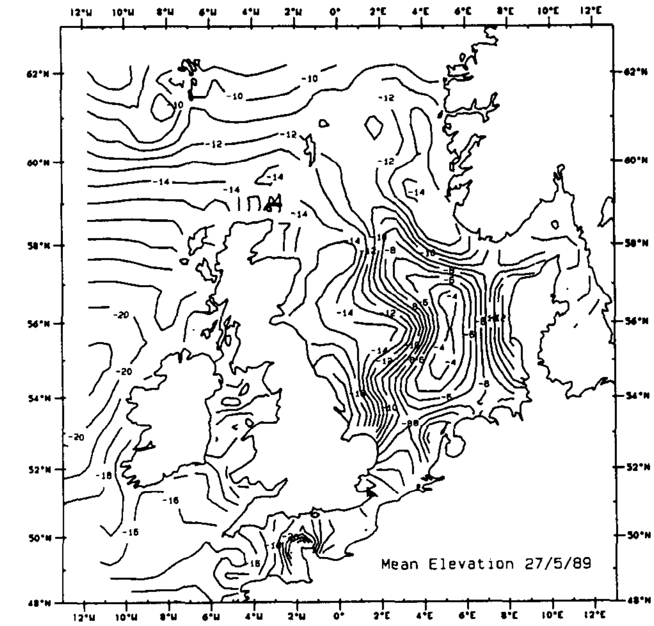

Mean Elevation 22/5/89

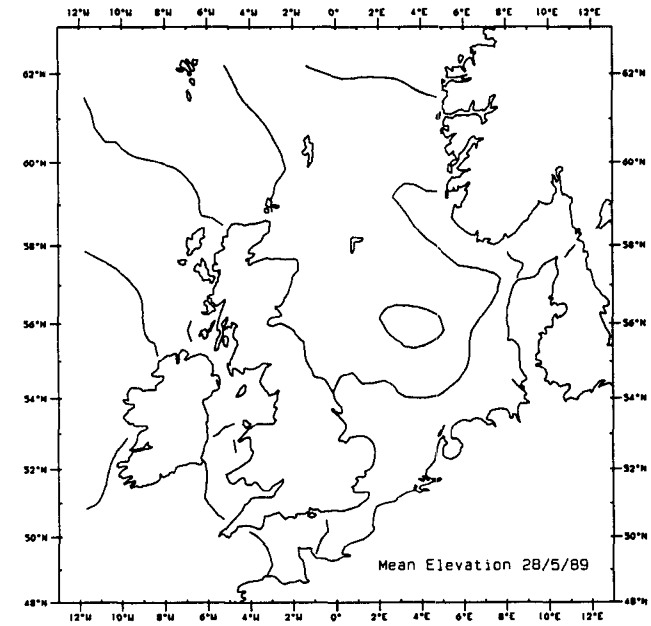

Mean Elevation 23/5/89

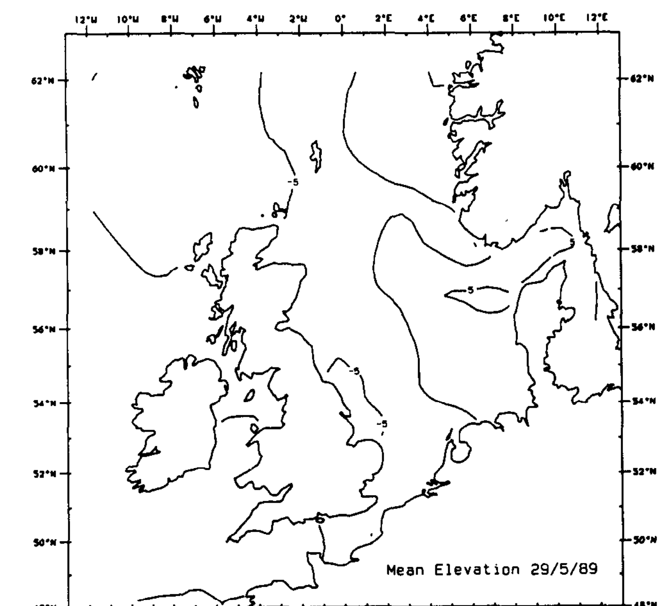

Mean Elevation 24/5/89


Mean Elevation 25/5/89


Mean Elevation 26/5/89


Mean Elevation 27/5/89


Mean Elevation 28/5/89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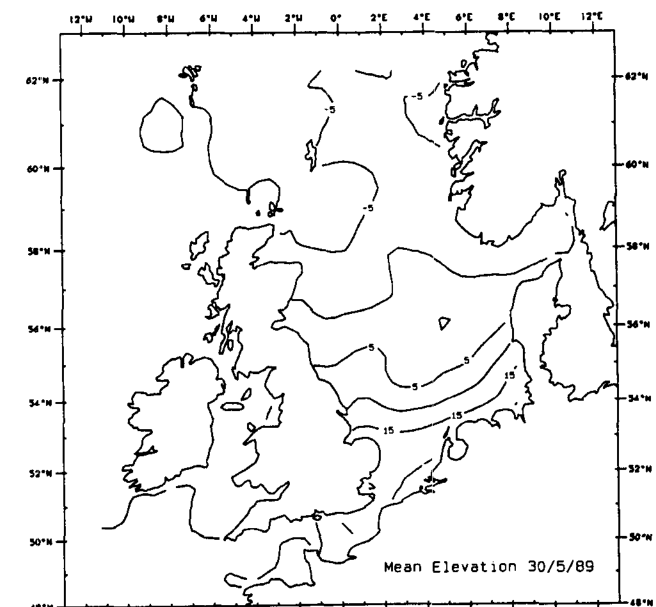
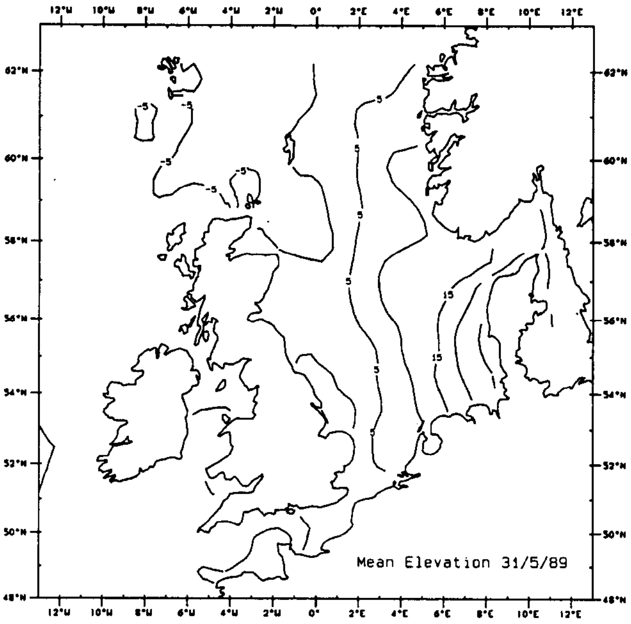

Mean Elevation 30/5/89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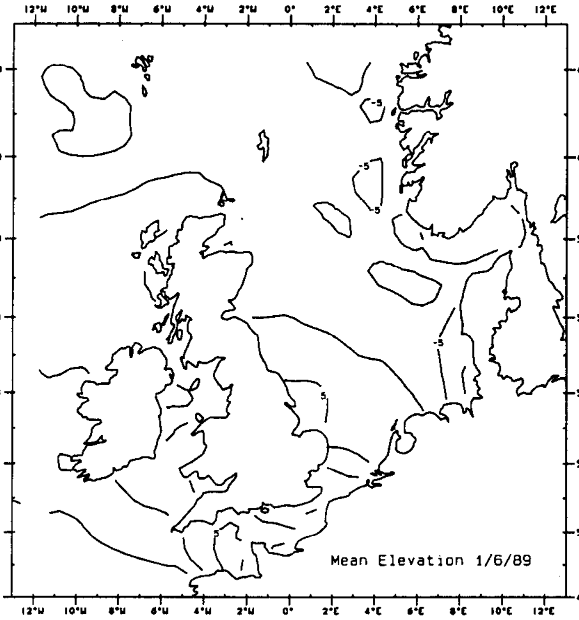
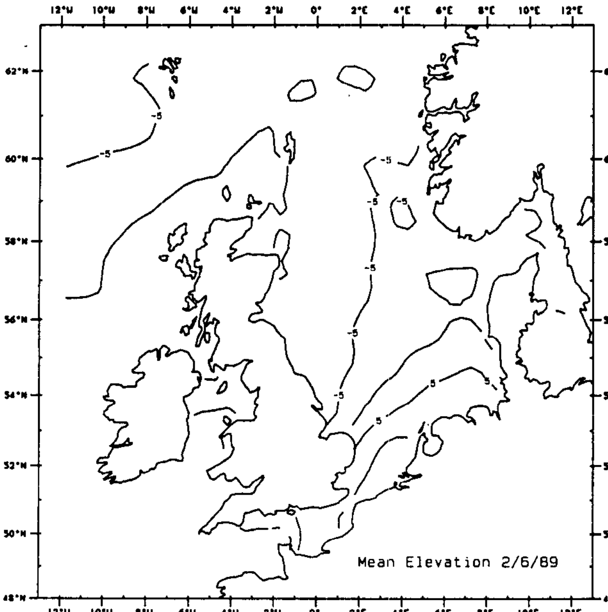
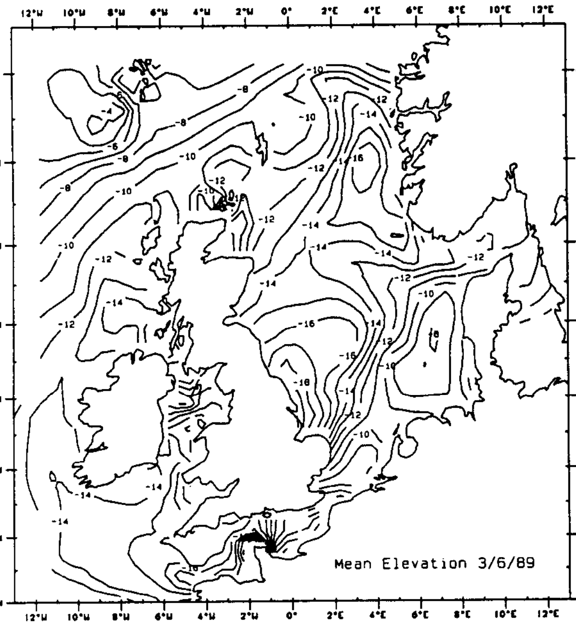
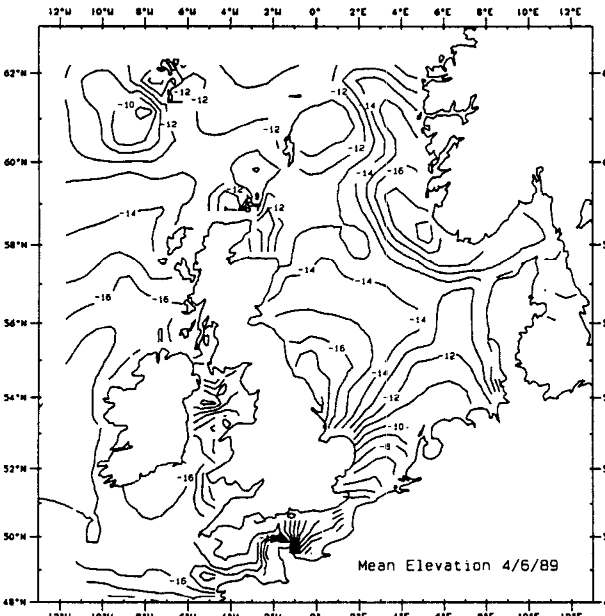
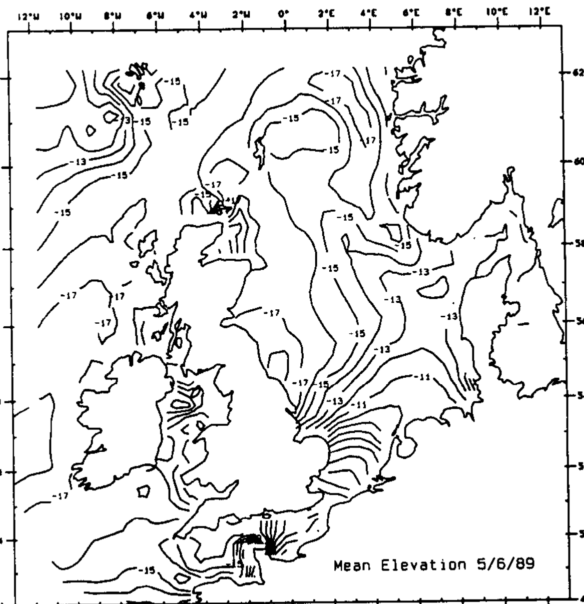
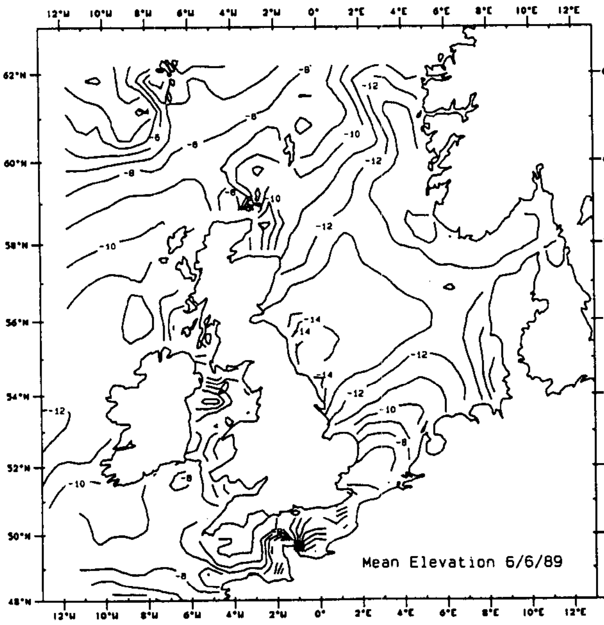

Mean Elevation 1/6/89

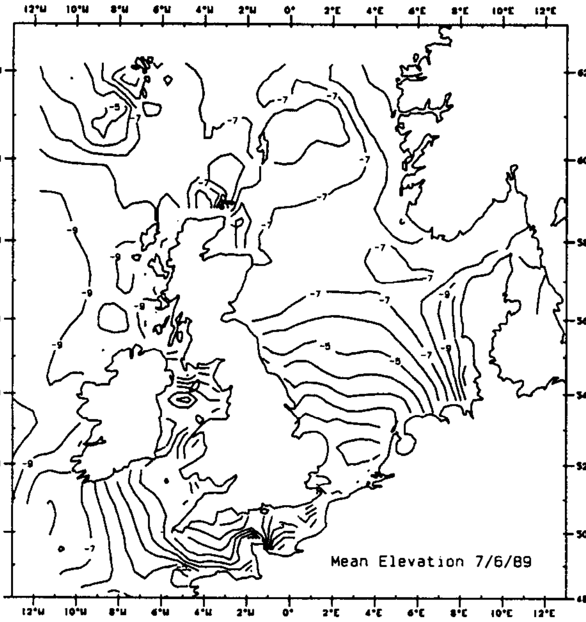

Mean Elevation 2/6/89


Mean Elevation 3/6/89

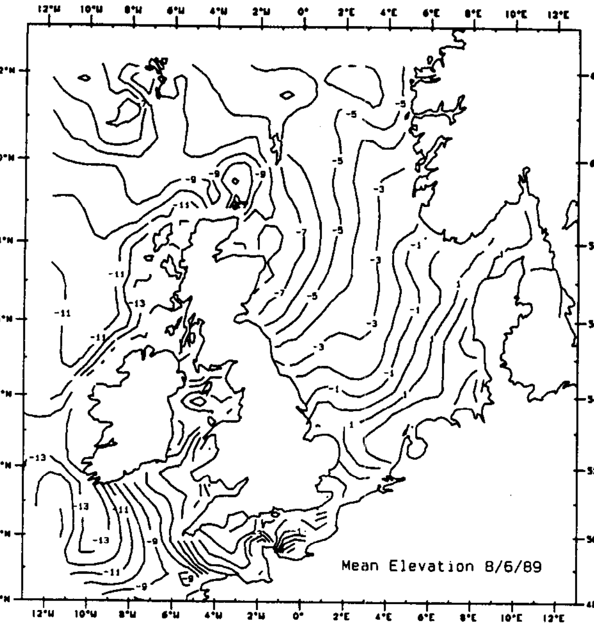

Mean Elevation 4/6/89


Mean Elevation 5/6/89

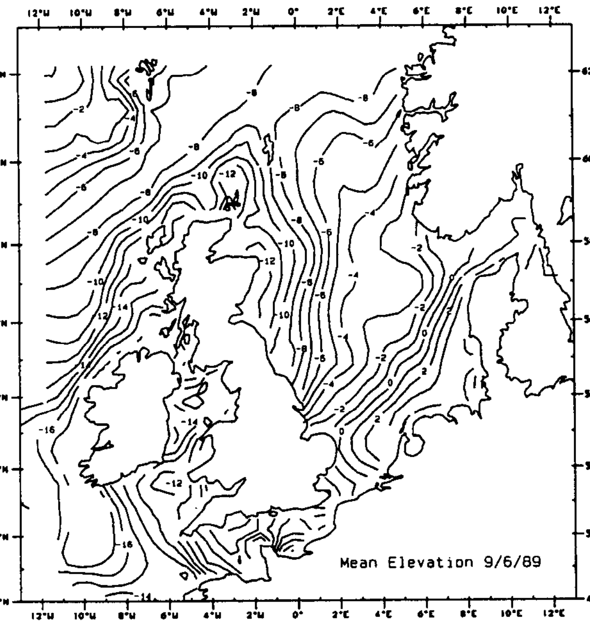

Mean Elevation 6/6/89



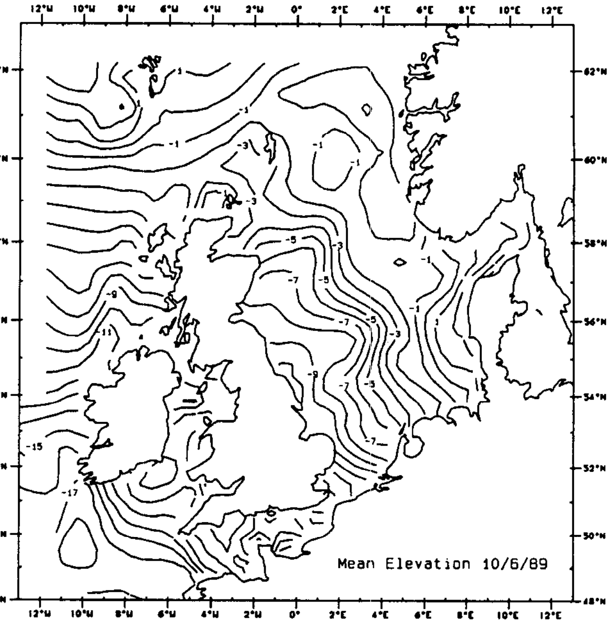
Mean Elevation 7/6/89



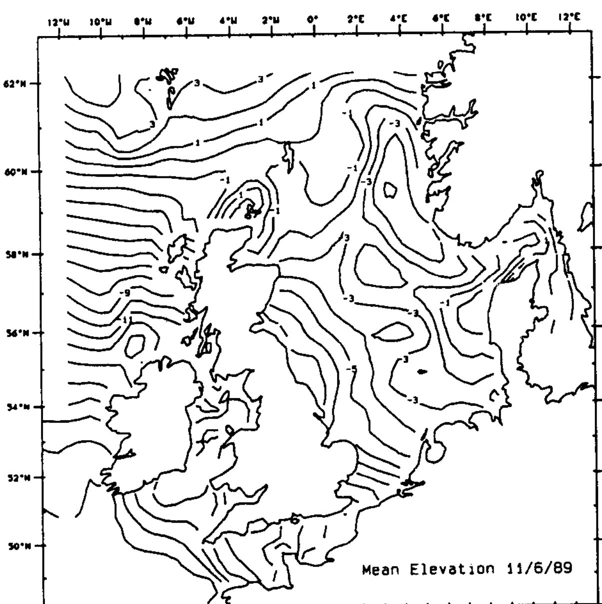
Mean Elevation 8/6/89



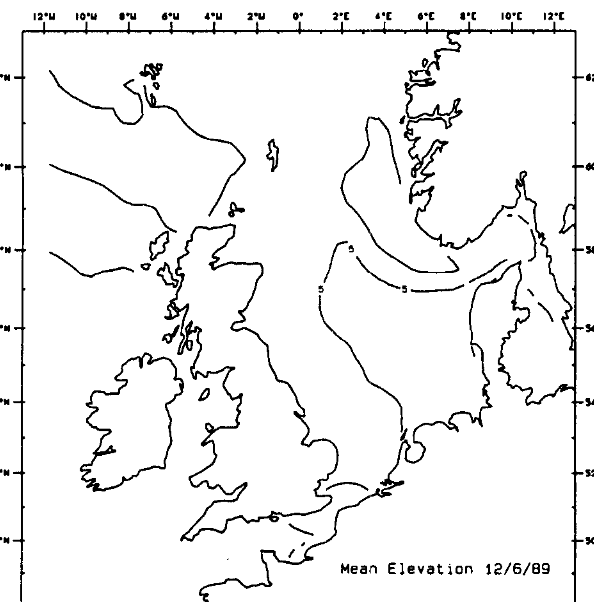
Mean Elevation 9/6/89



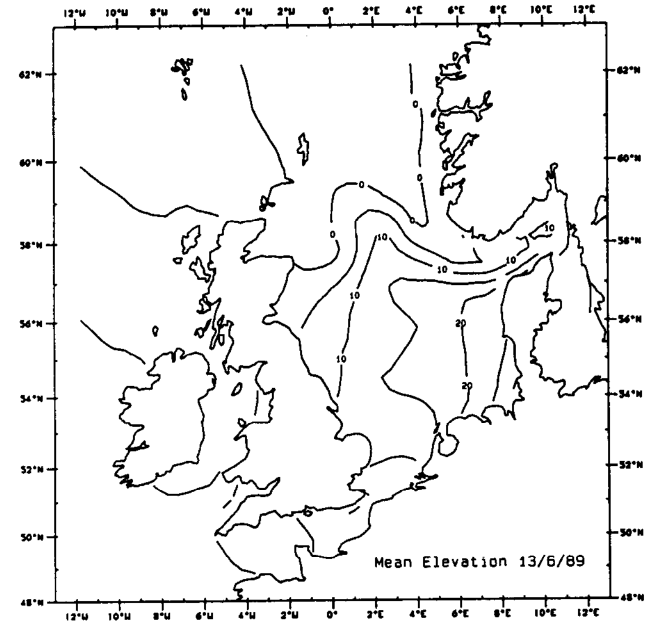
Mean Elevation 10/6/89

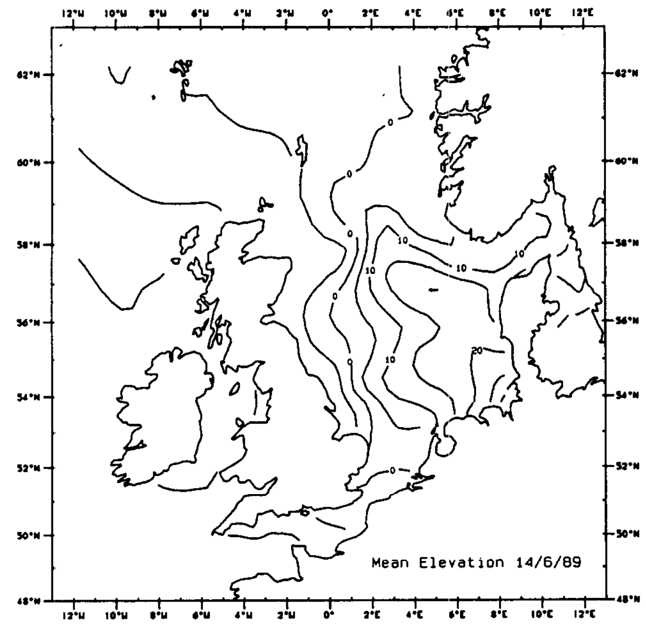


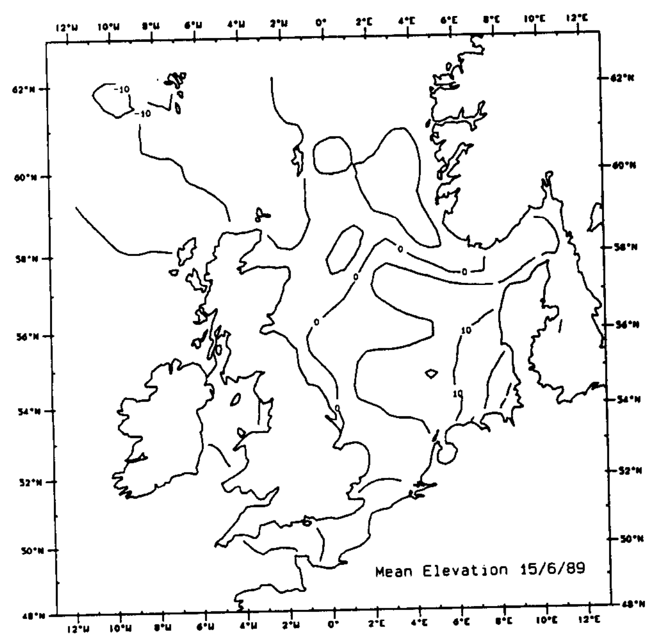
Mean Elevation 11/6/89

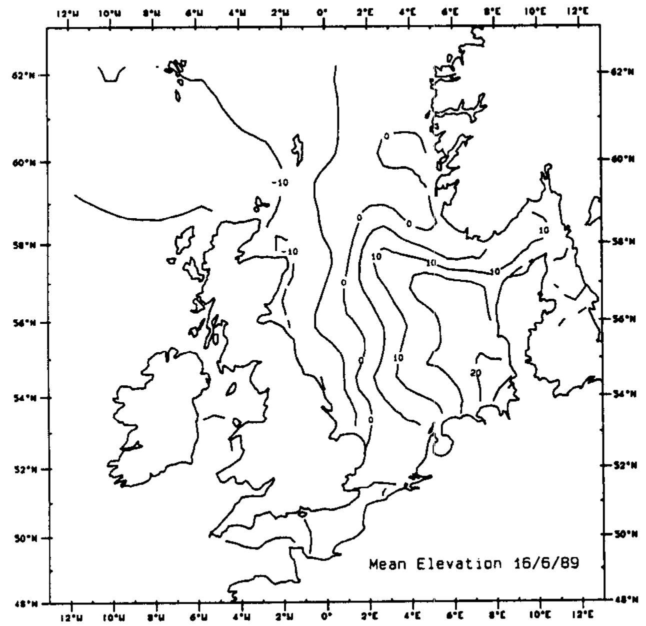


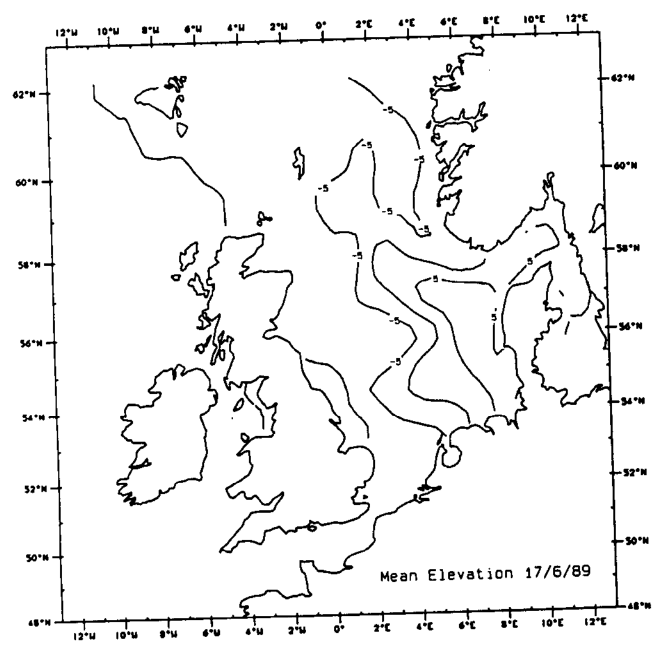
Mean Elevation 12/6/89

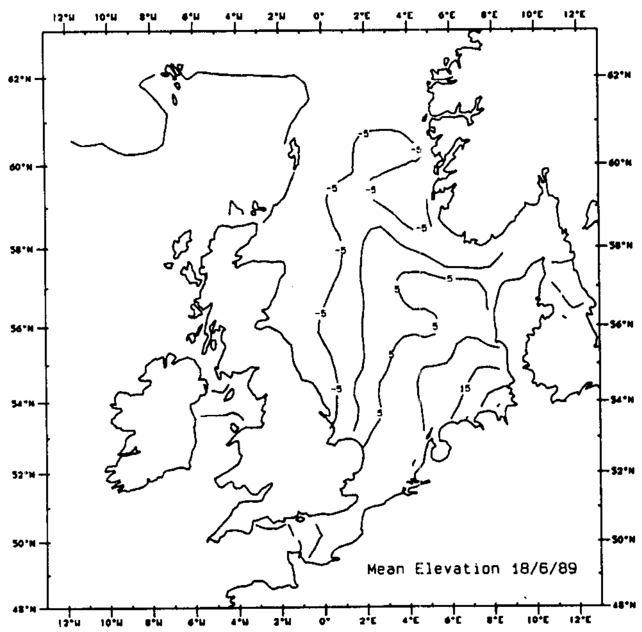

Mean Elevation 13/6/89

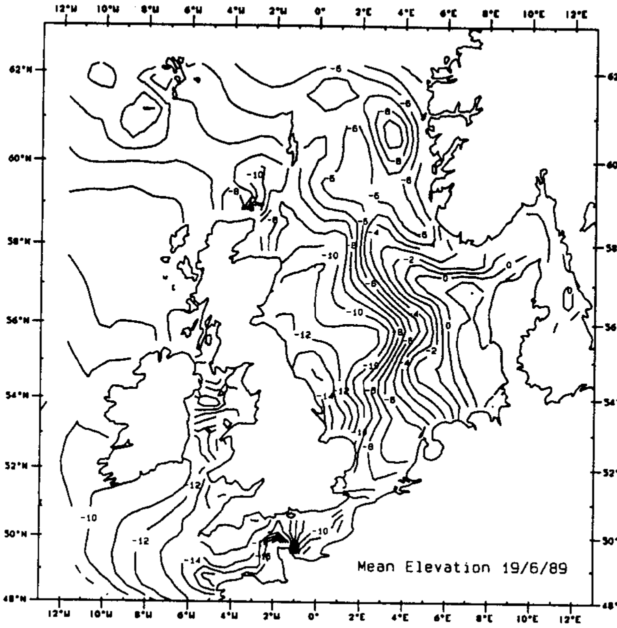

Mean Elevation 14/6/89

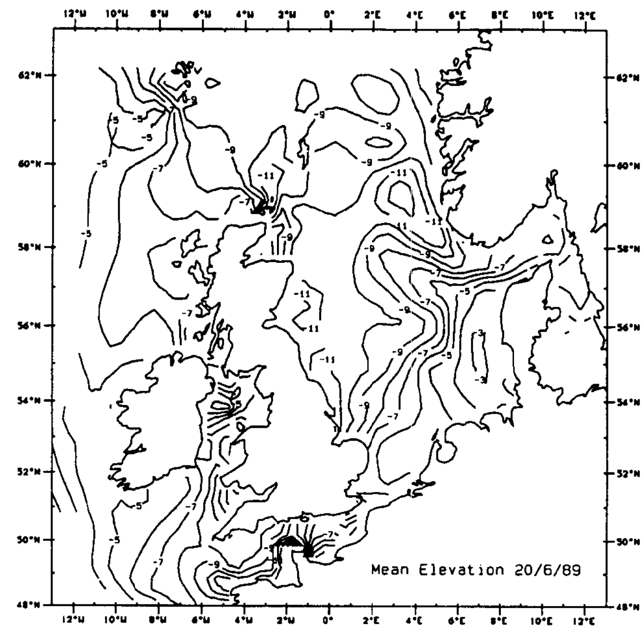

Mean Elevation 15/6/89

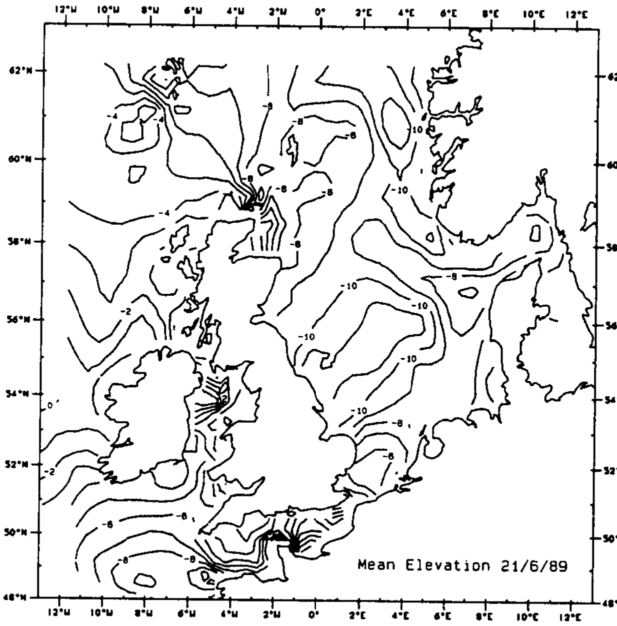

Mean Elevation 16/6/89

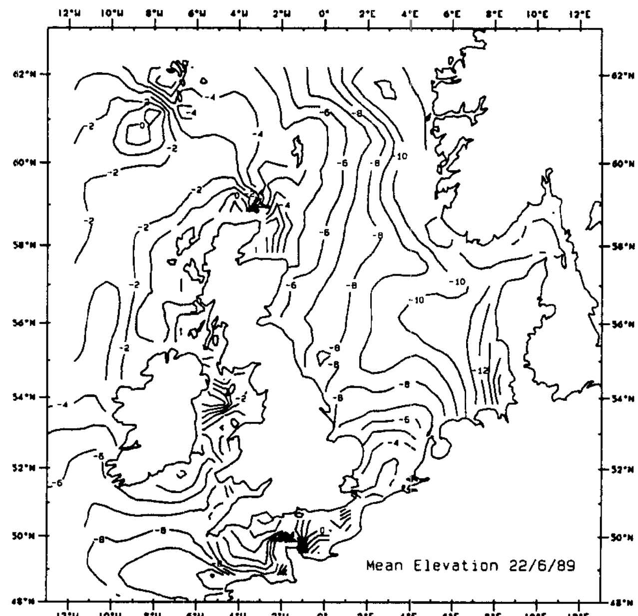

Mean Elevation 17/6/89

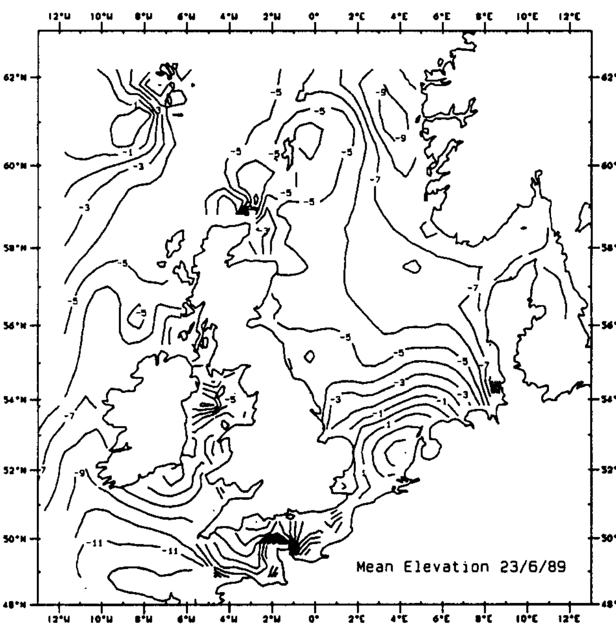

Mean Elevation 18/6/89

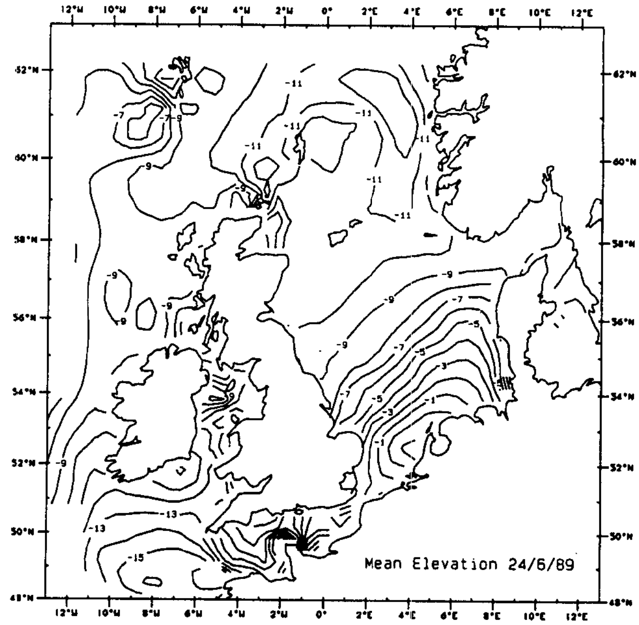

Mean Elevation 19/6/89

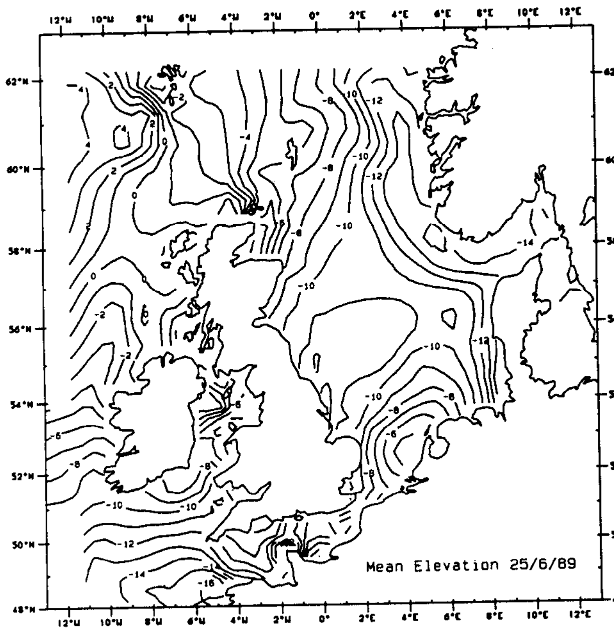

Mean Elevation 20/6/89

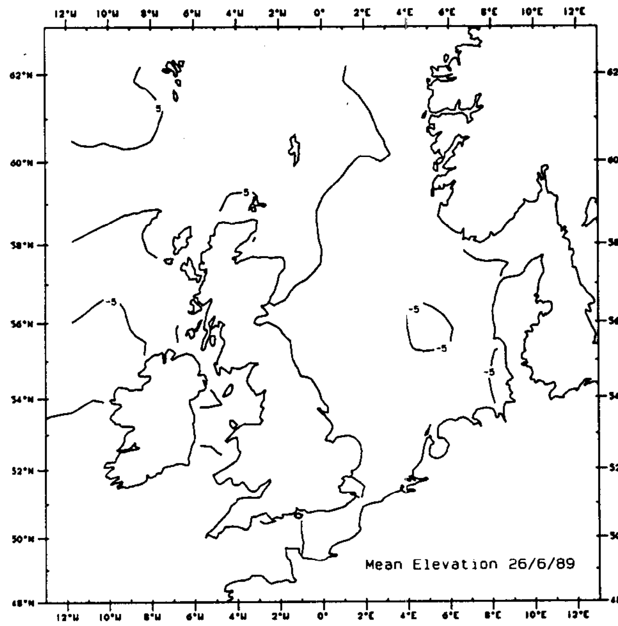

Mean Elevation 21/6/89

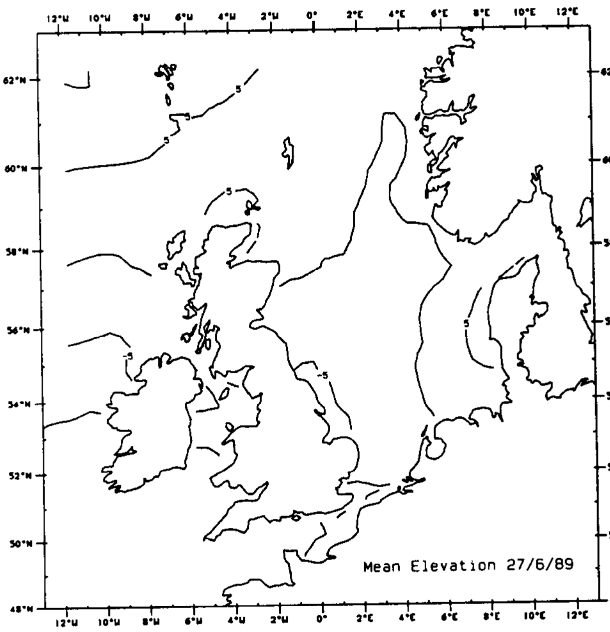

Mean Elevation 22/6/89

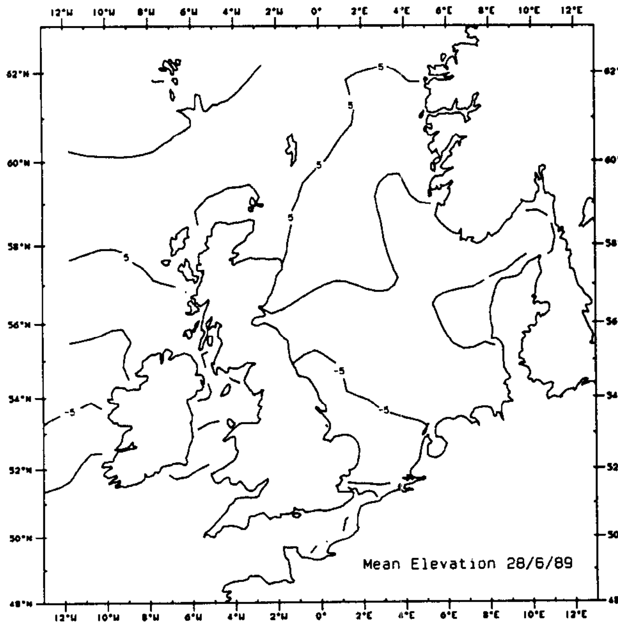

Mean Elevation 23/6/89

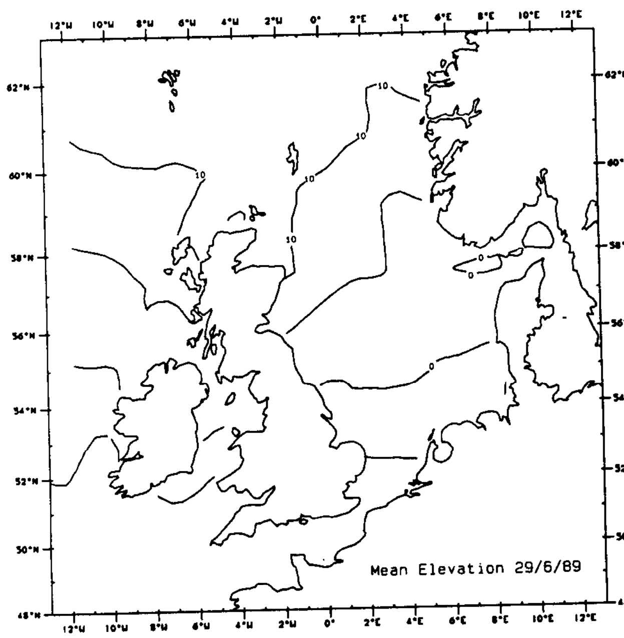

Mean Elevation 24/6/89


Mean Elevation 25/6/89


Mean Elevation 26/6/89


Mean Elevation 27/6/89


Mean Elevation 28/6/89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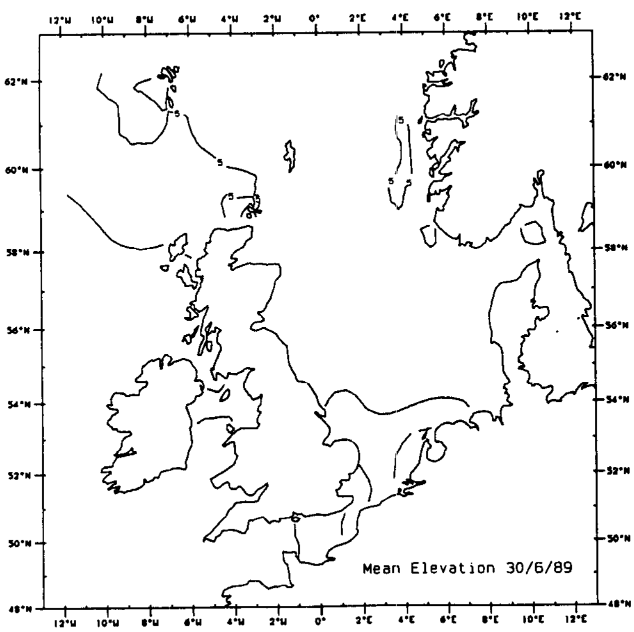
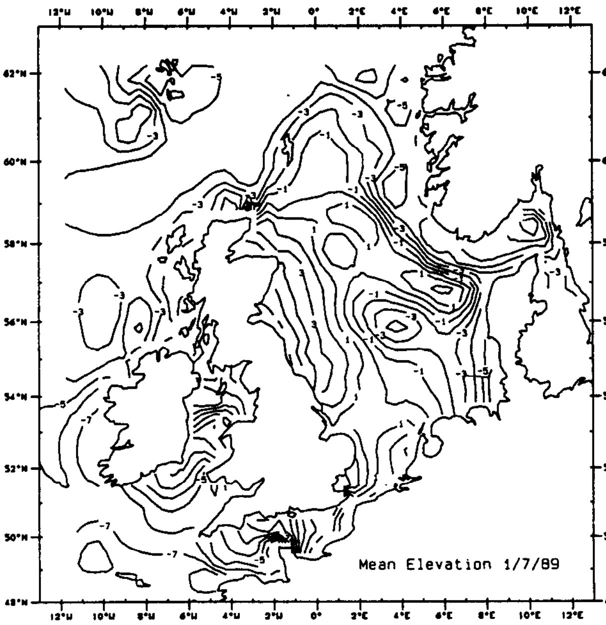
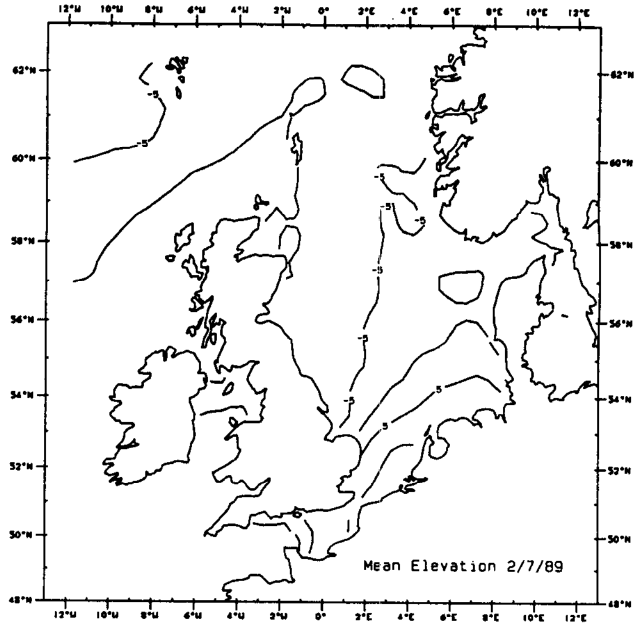
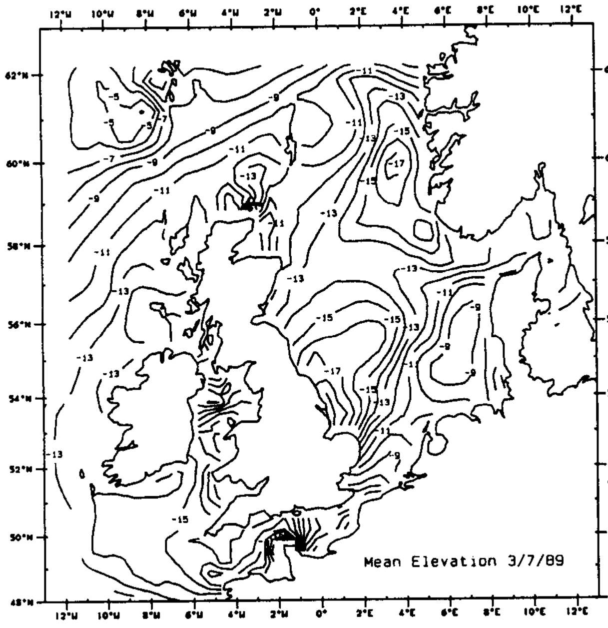
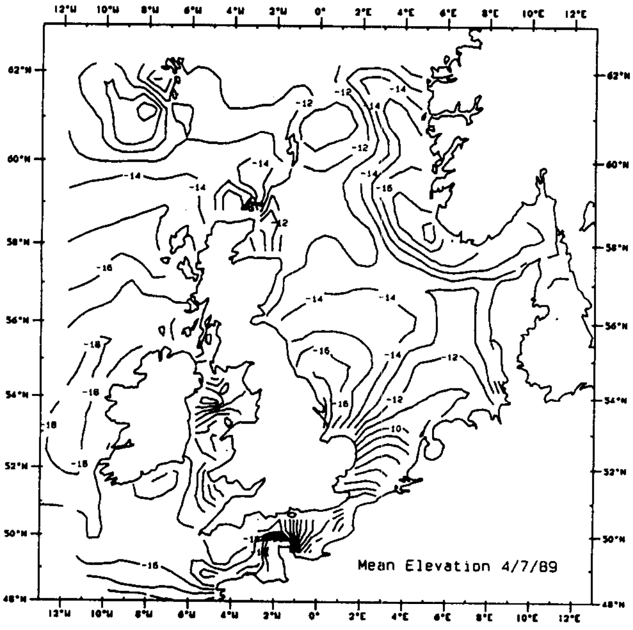
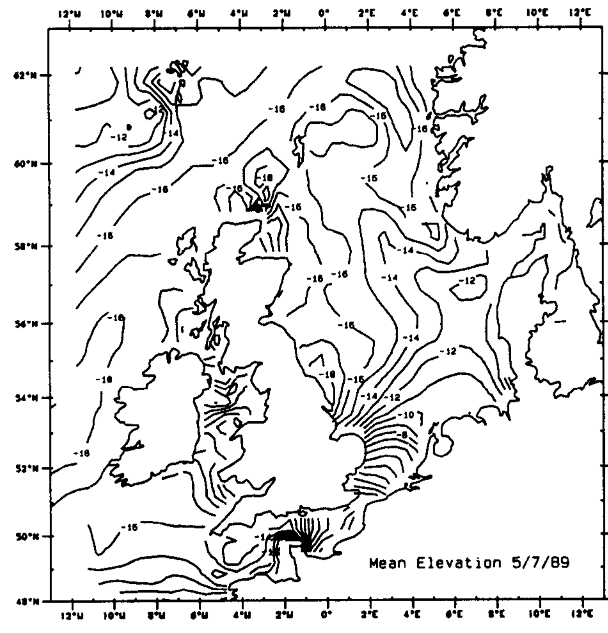

Mean Elevation 30/6/89

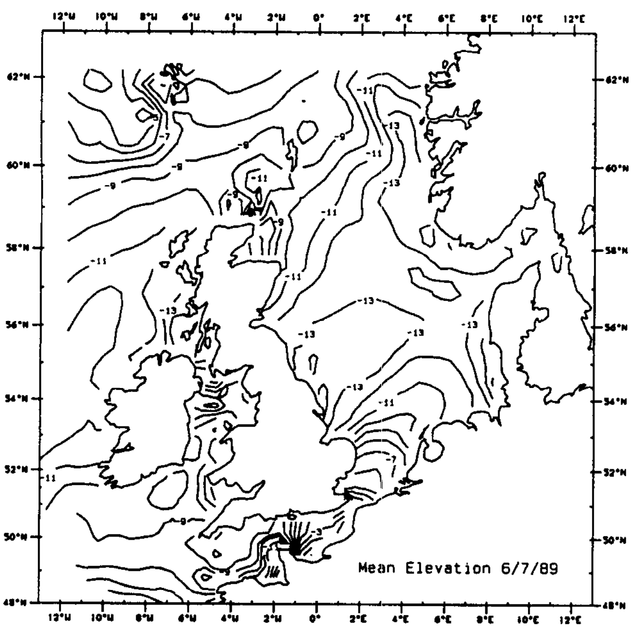

Mean Elevation 1/7/89

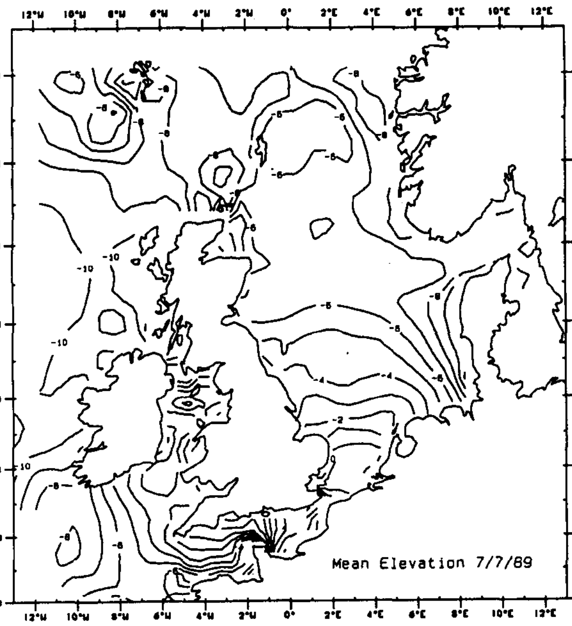

Mean Elevation 2/7/89

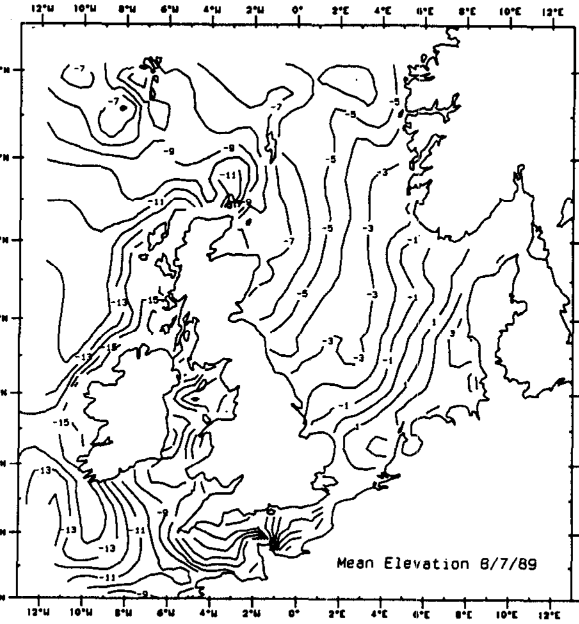

Mean Elevation 3/7/89

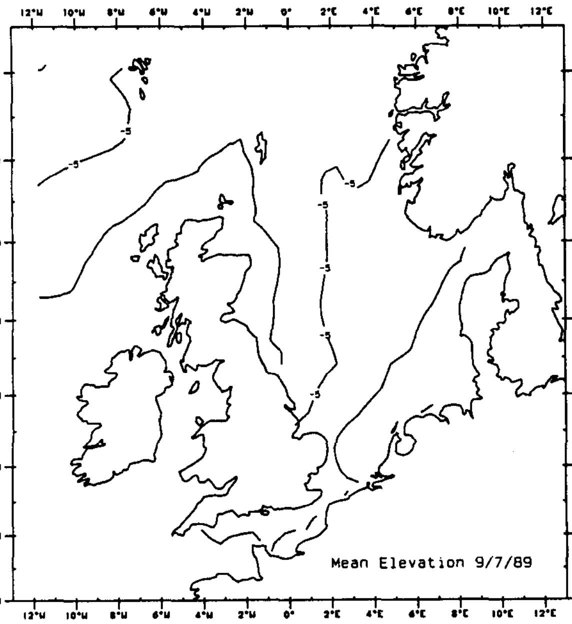

Mean Elevation 4/7/89

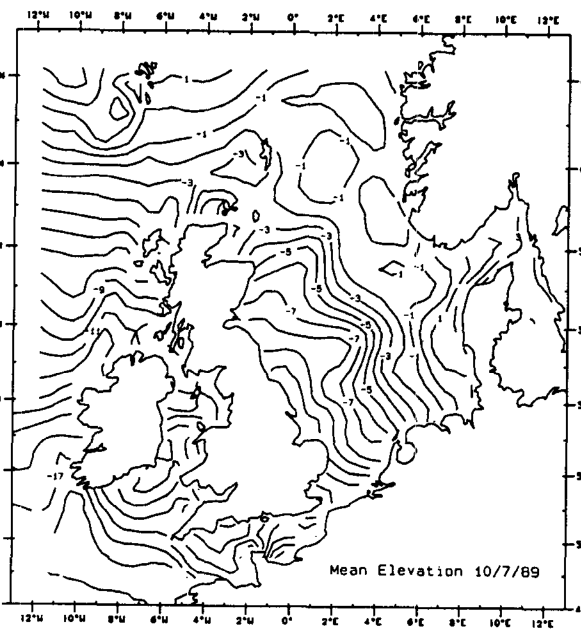

Mean Elevation 5/7/89

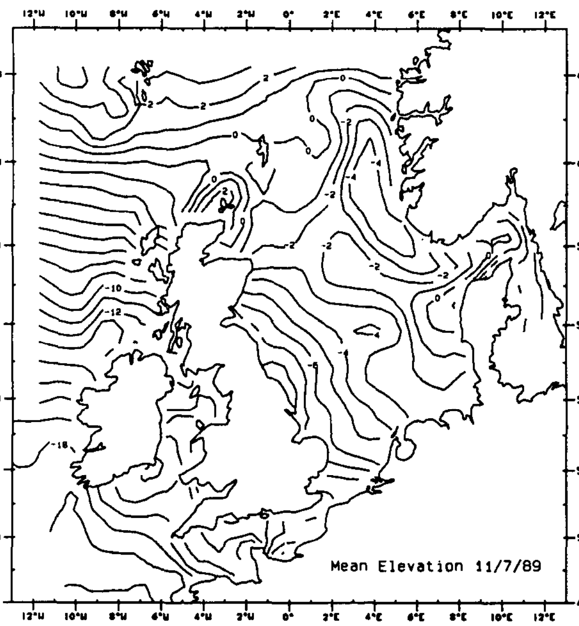

Mean Elevation 6/7/89

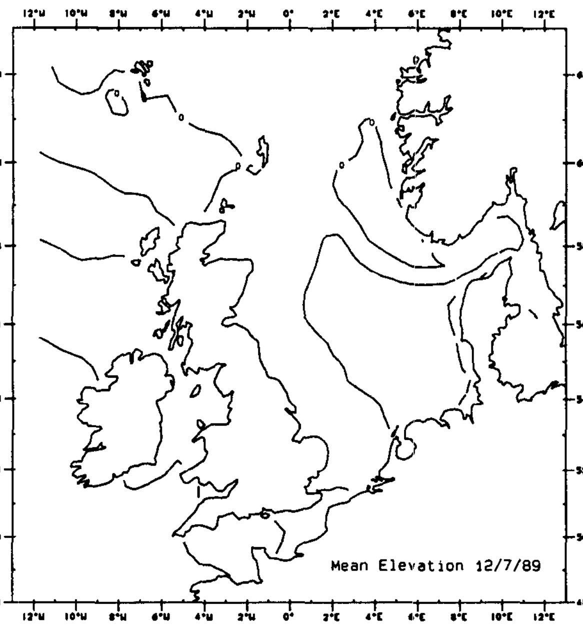

Mean Elevation 7/7/89

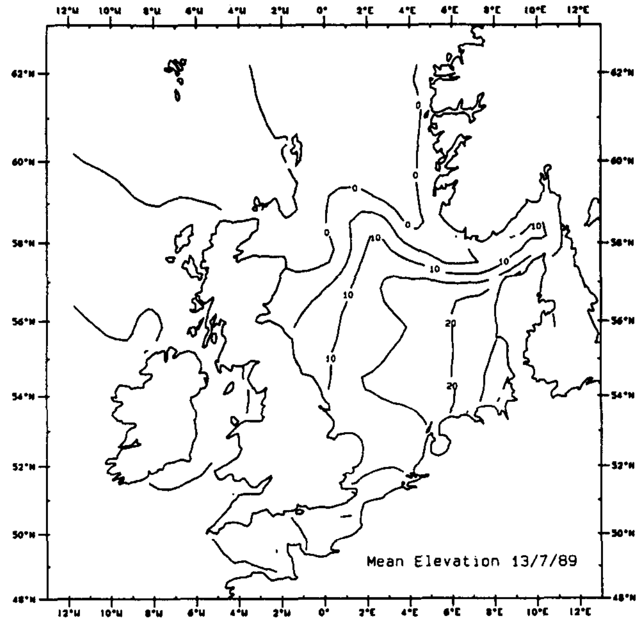

Mean Elevation 8/7/89

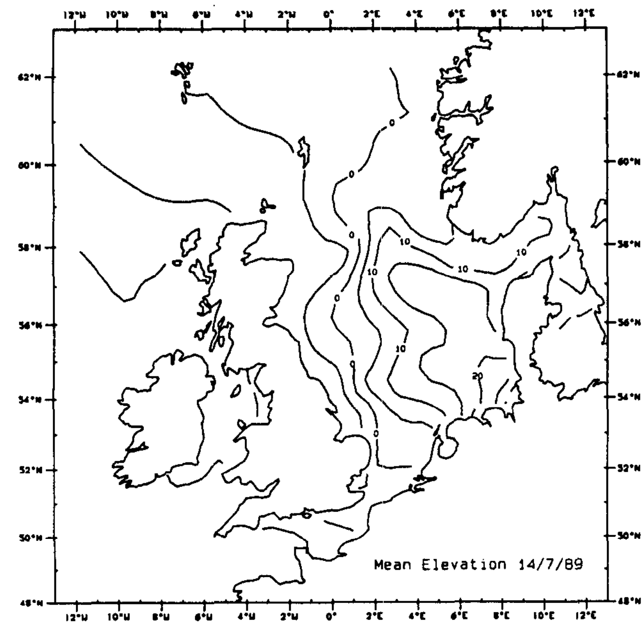

Mean Elevation 9/7/89

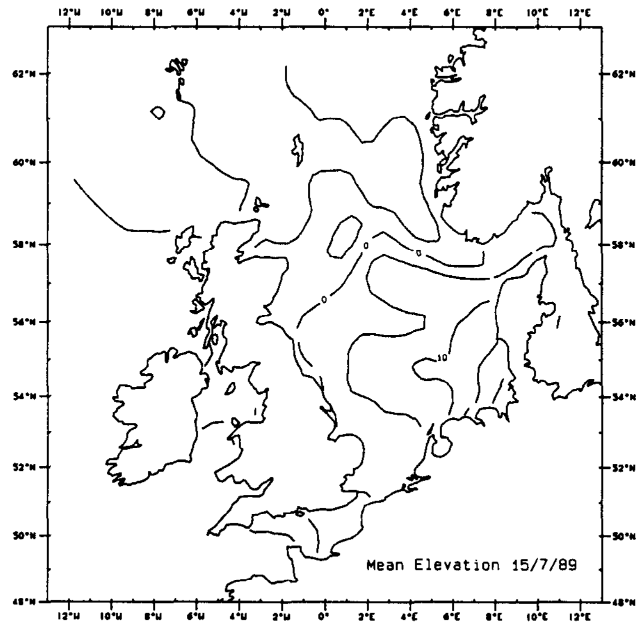

Mean Elevation 10/7/89

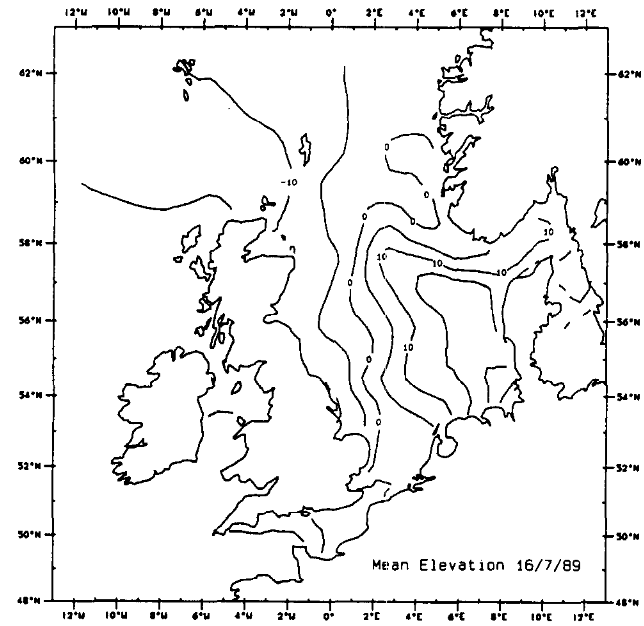

Mean Elevation 11/7/89

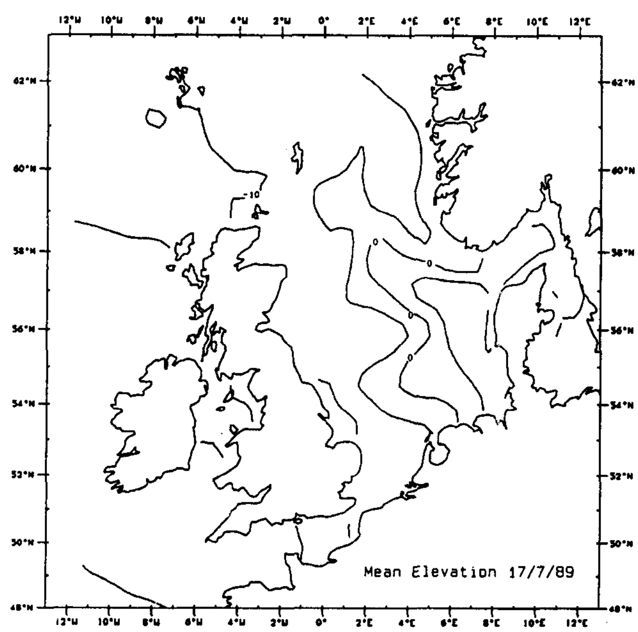

Mean Elevation 12/7/89

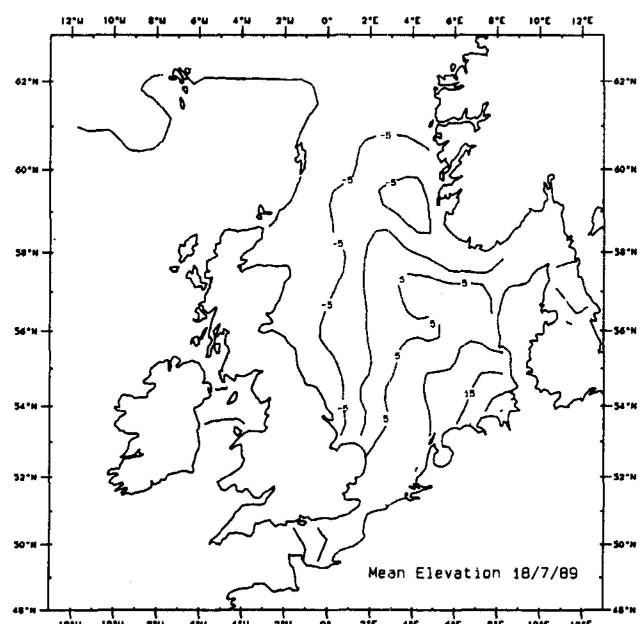

Mean Elevation 13/7/89

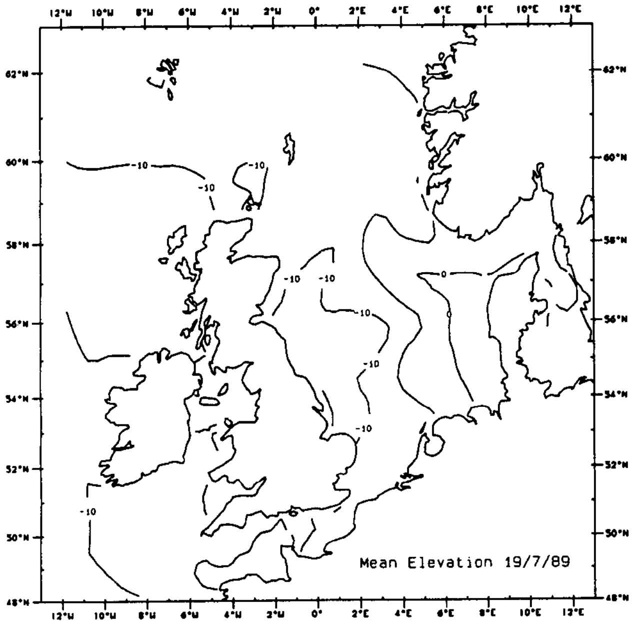

Mean Elevation 14/7/89

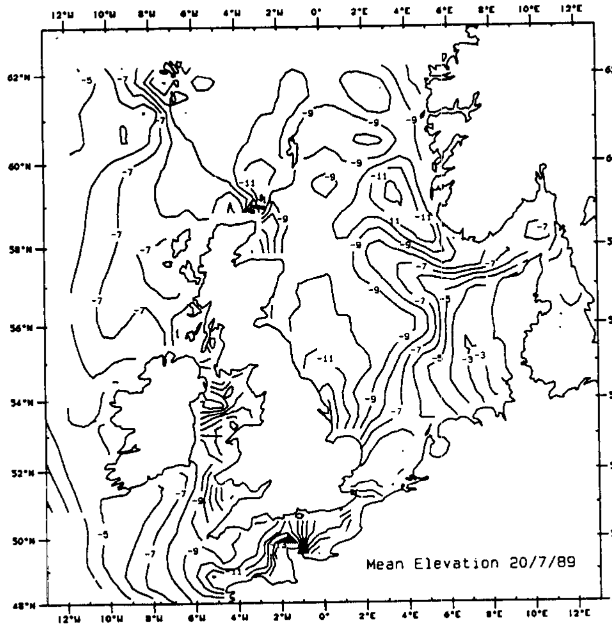

Mean Elevation 15/7/89

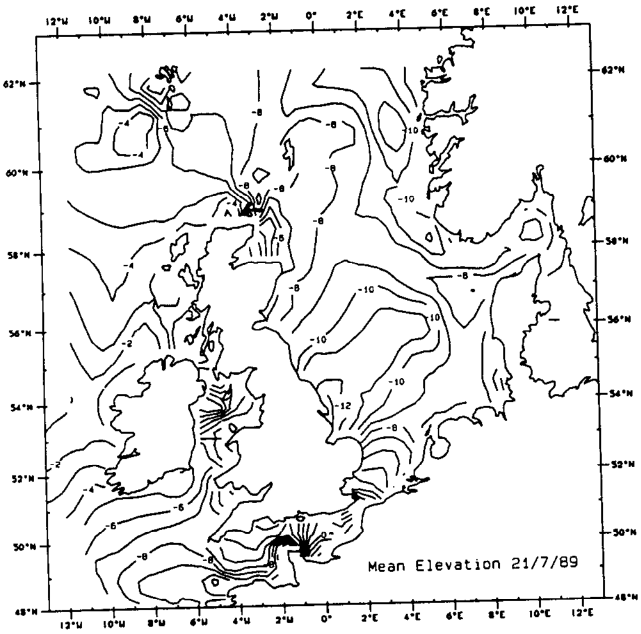

Mean Elevation 16/7/89

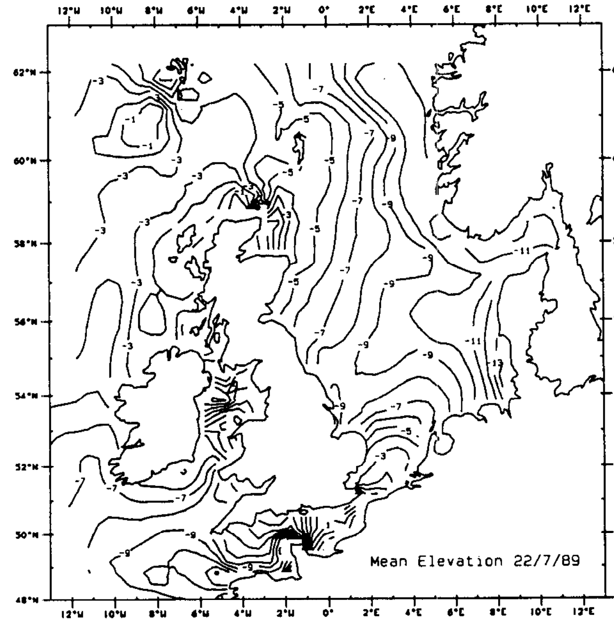

Mean Elevation 17/7/89

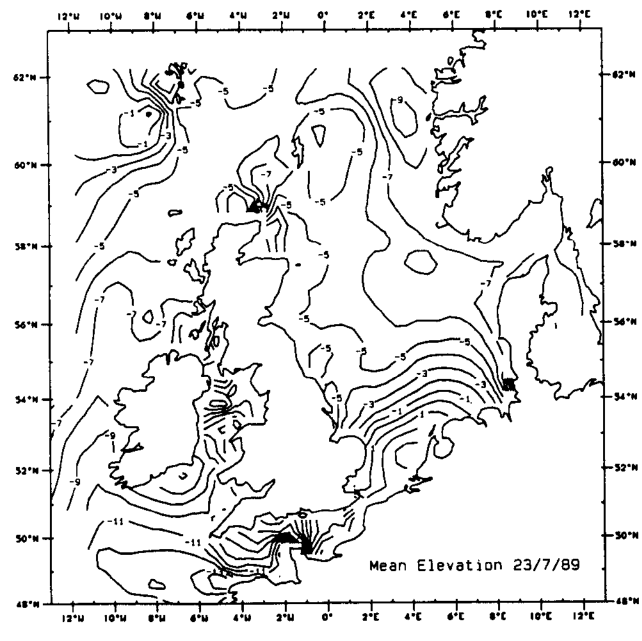

Mean Elevation 18/7/89

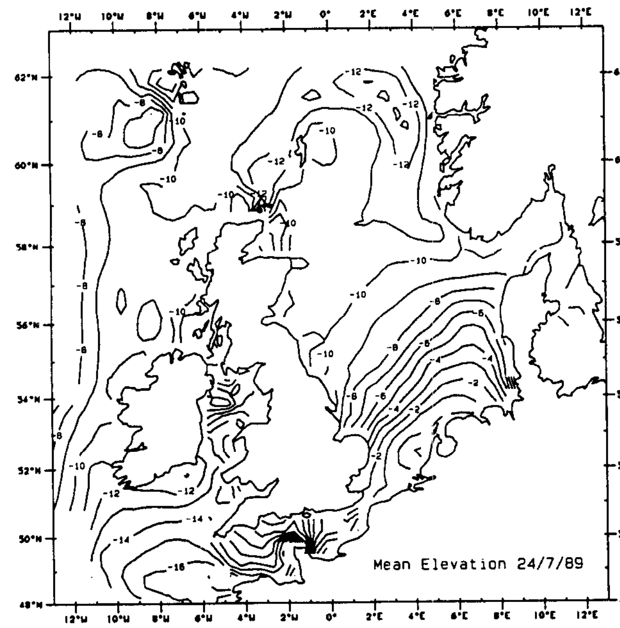

Mean Elevation 19/7/89

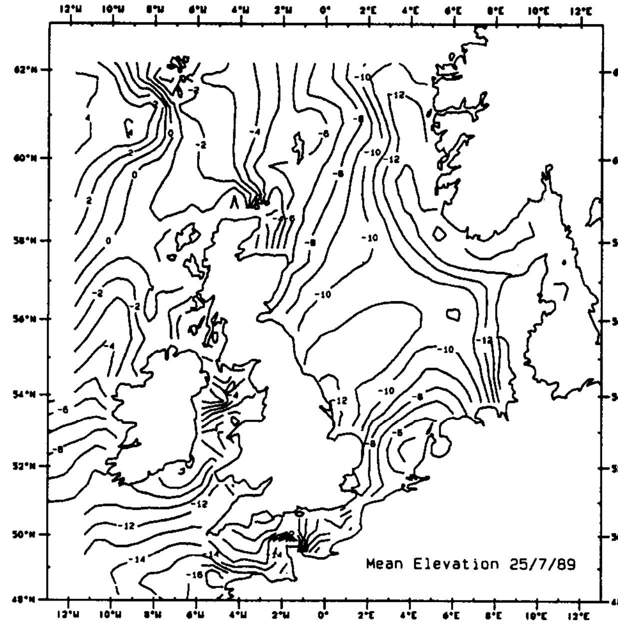

Mean Elevation 20/7/89

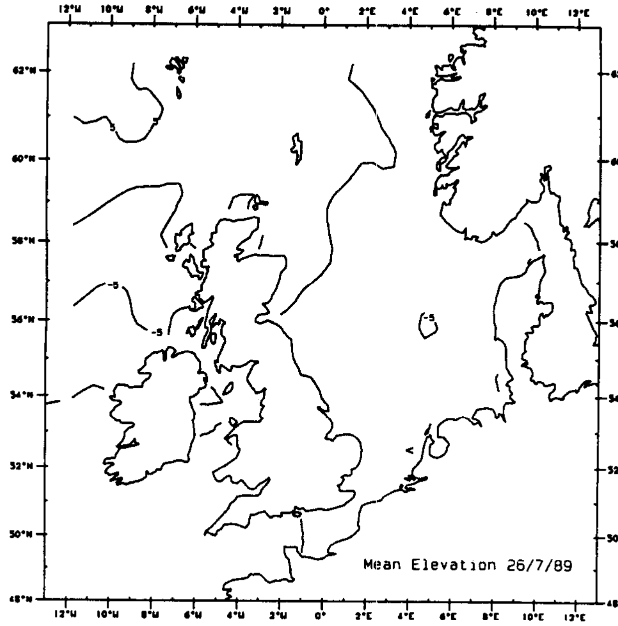

Mean Elevation 21/7/89

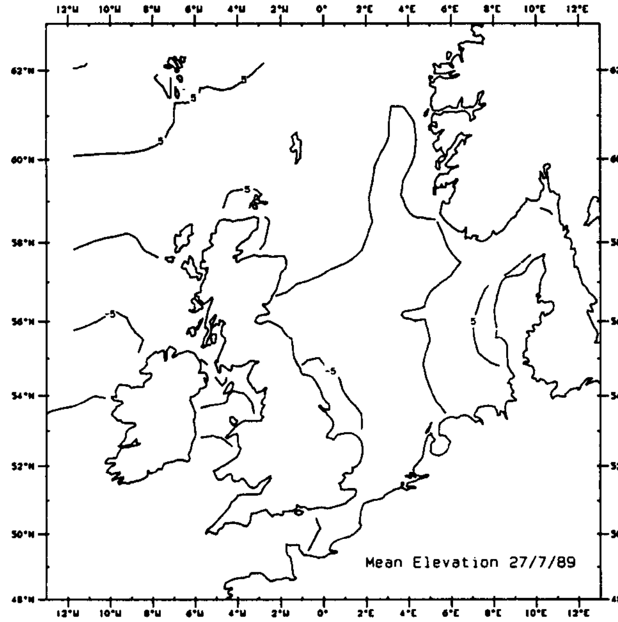

Mean Elevation 22/7/89

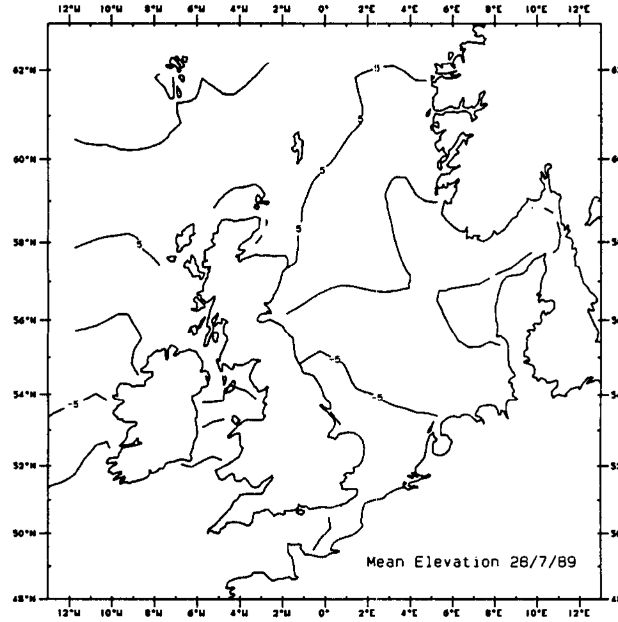

Mean Elevation 23/7/89

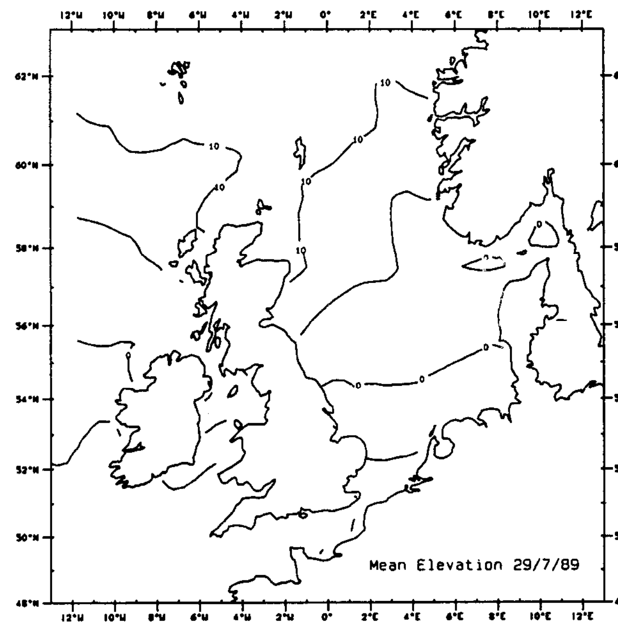

Mean Elevation 24/7/89

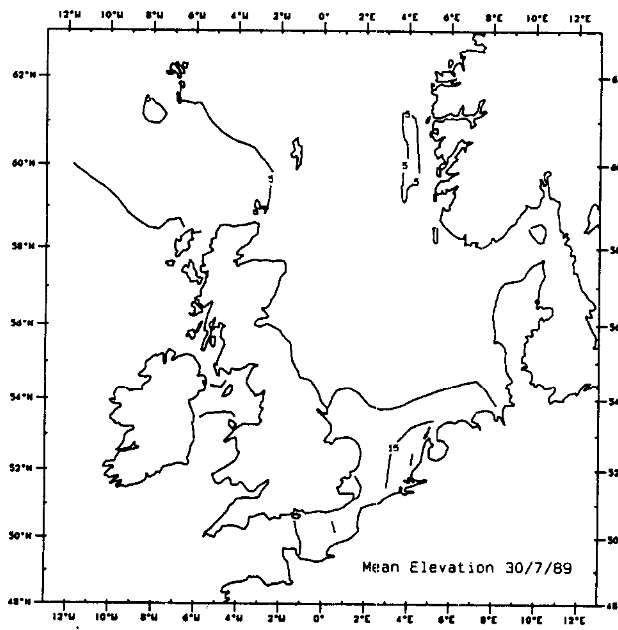

Mean Elevation 25/7/89

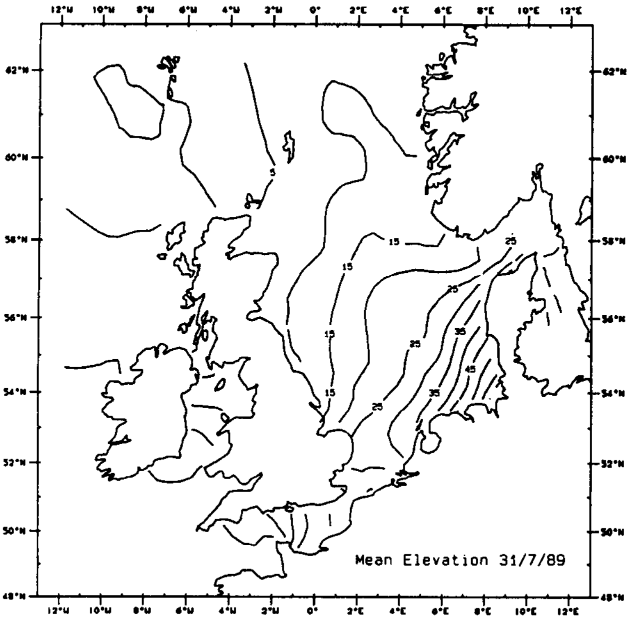

Mean Elevation 26/7/89


Mean Elevation 27/7/89


Mean Elevation 28/7/89


Mean Elevation 29/7/89


Mean Elevation 30/7/89


Mean Elevation 31/7/89
15
25
35
45
62°N
60°N
58°N
56°N
54°N
52°N
50°N
48°N
12°W
10°W
8°W
6°W
4°W
2°W
0°
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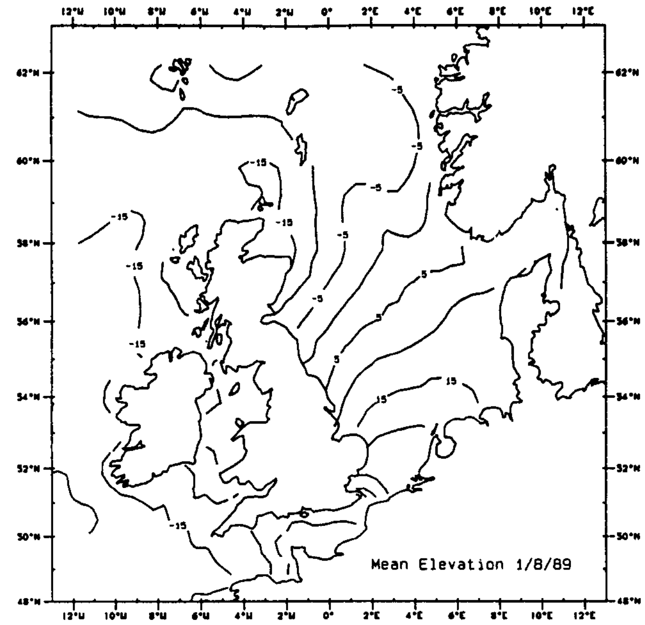
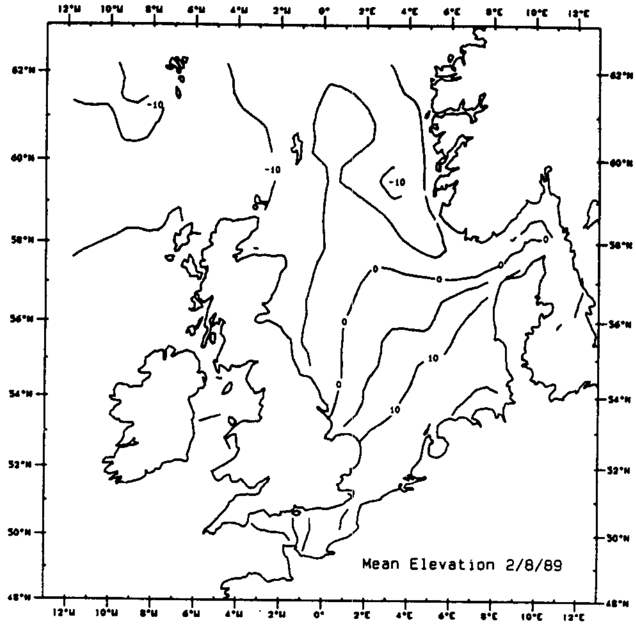
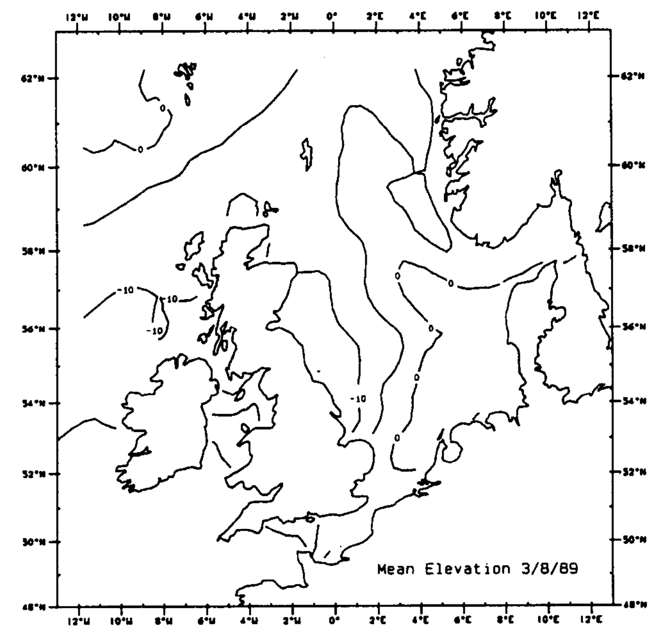
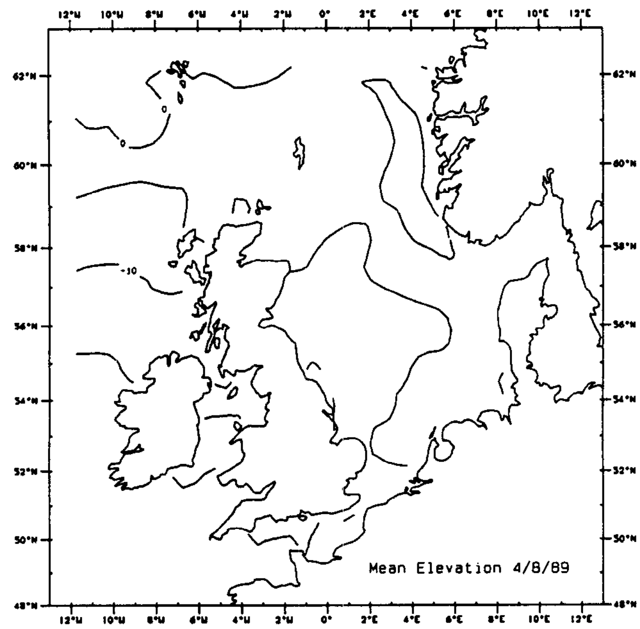
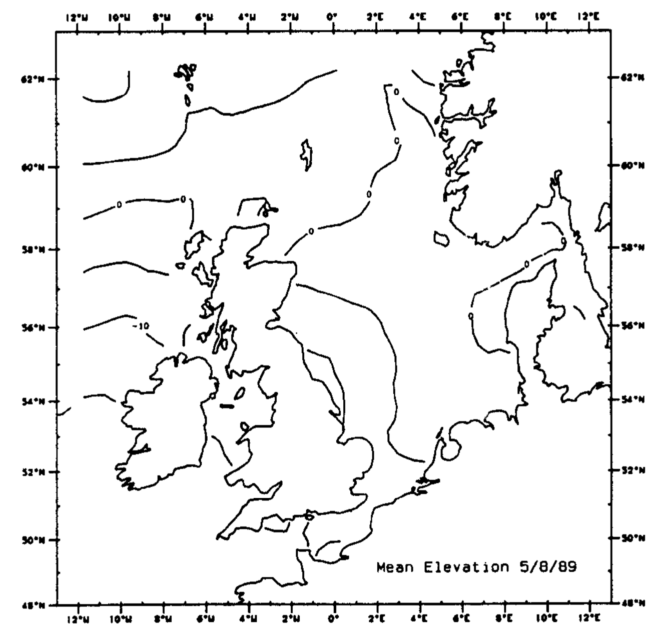
4°E
6°E
8°E
10°E
12°E

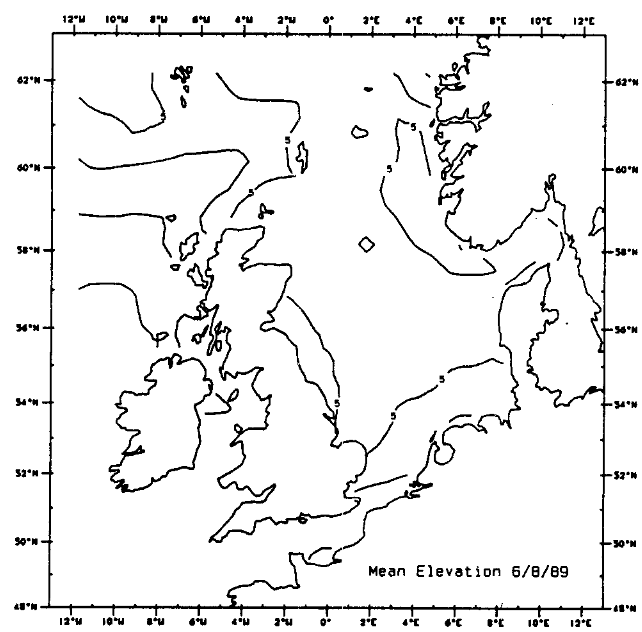

Mean Elevation 1/8/89

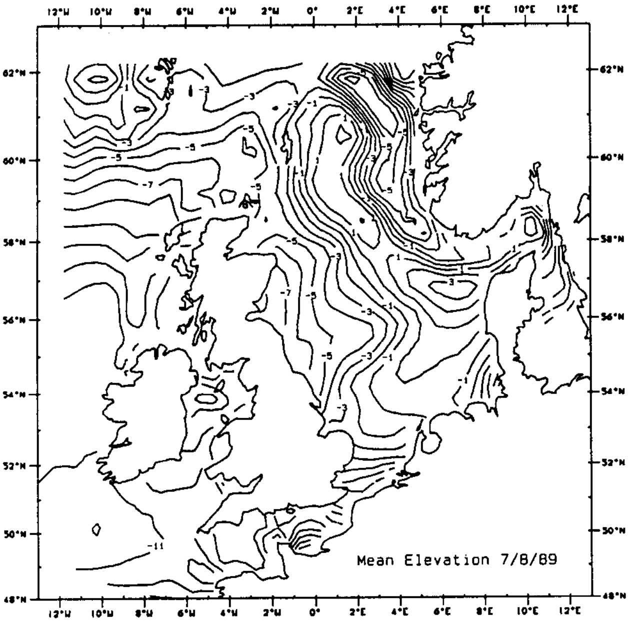

Mean Elevation 2/8/89

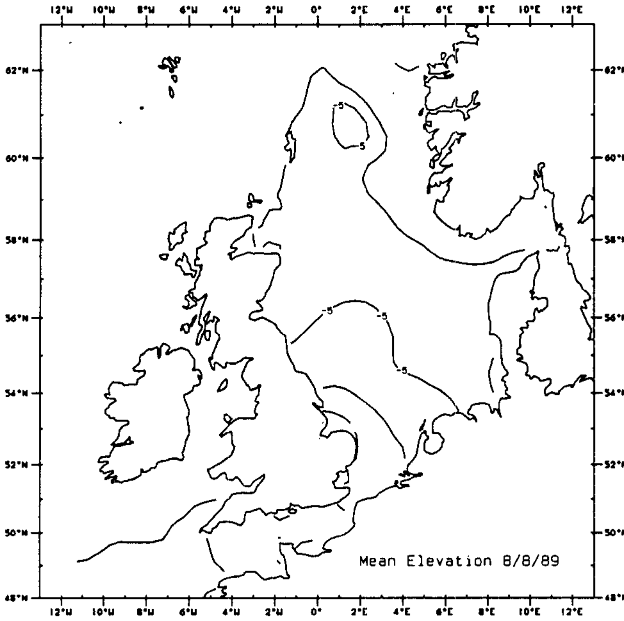

Mean Elevation 3/8/89

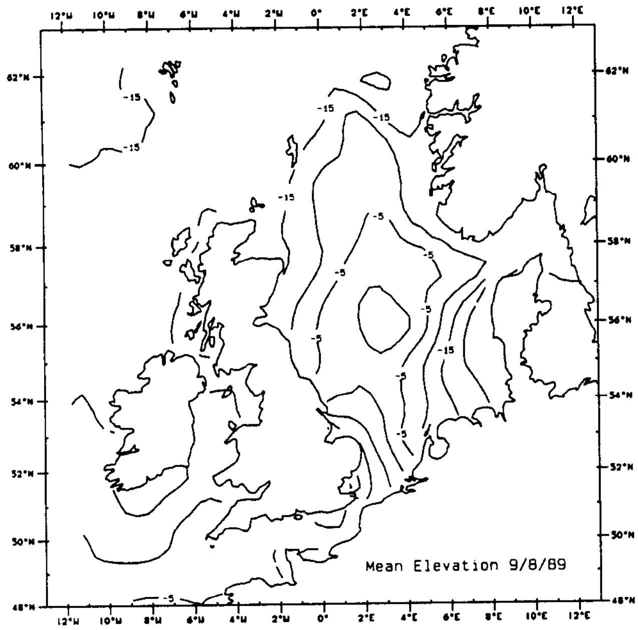

Mean Elevation 4/8/89

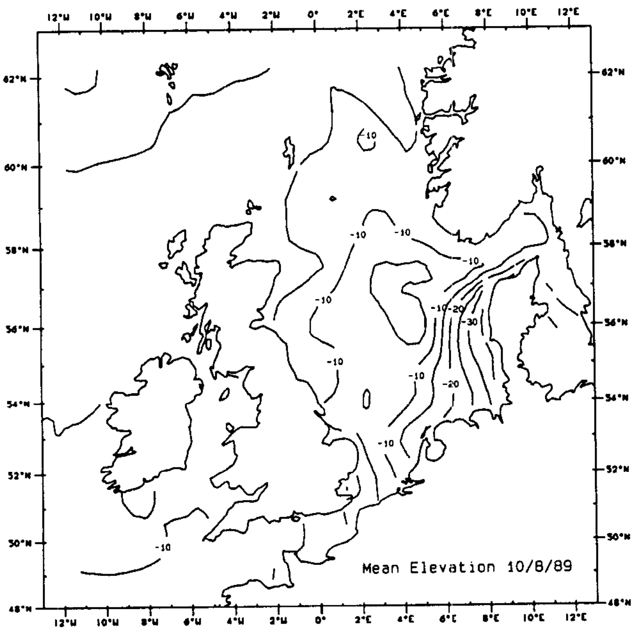

Mean Elevation 5/8/89

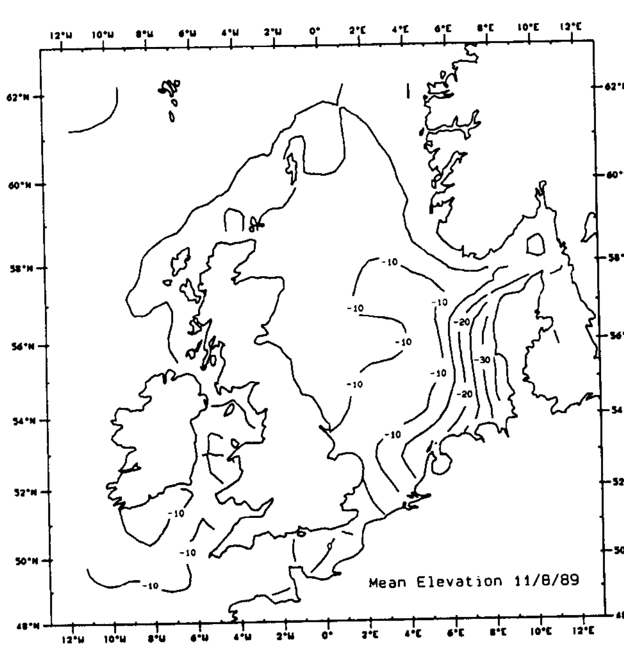

Mean Elevation 6/8/89

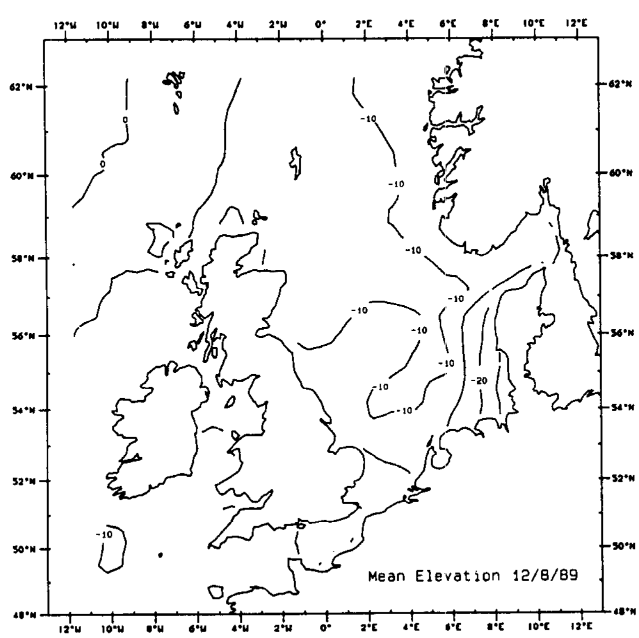

Mean Elevation 7/8/89

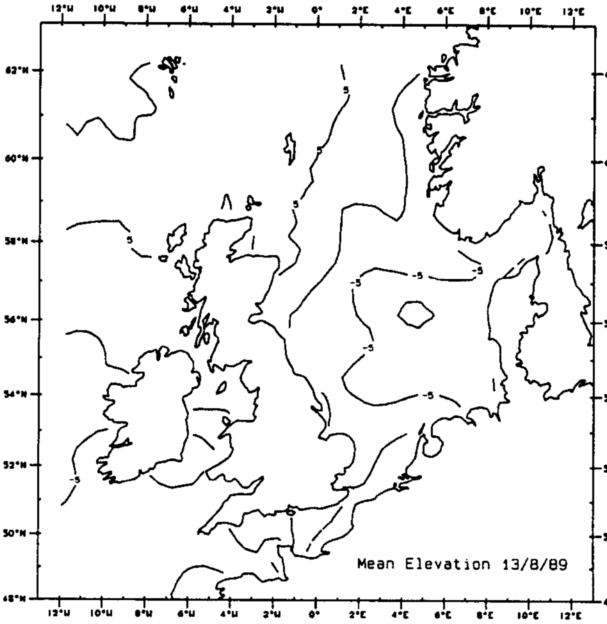

Mean Elevation 8/8/89

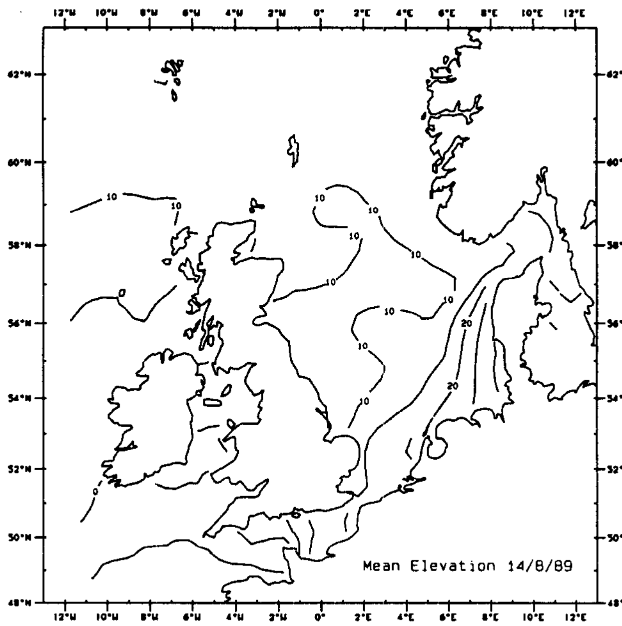

Mean Elevation 9/8/89

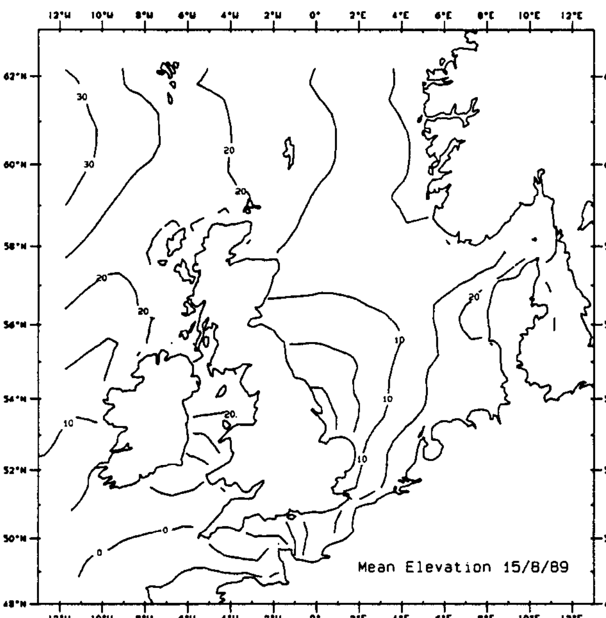

Mean Elevation 10/8/89

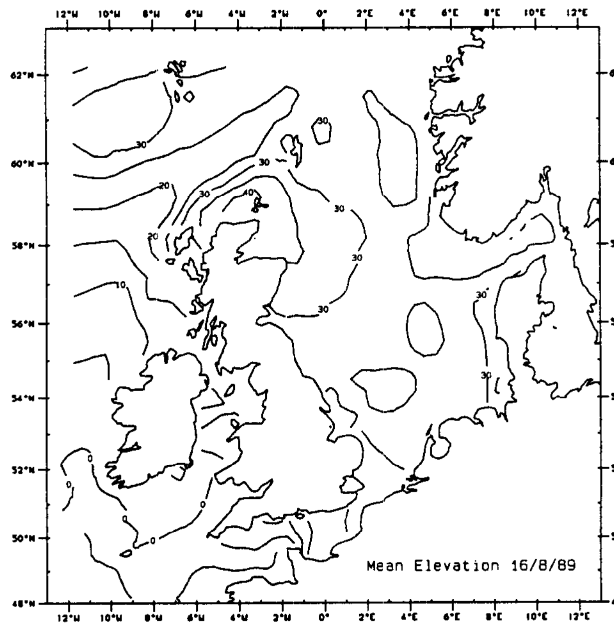

Mean Elevation 11/8/89

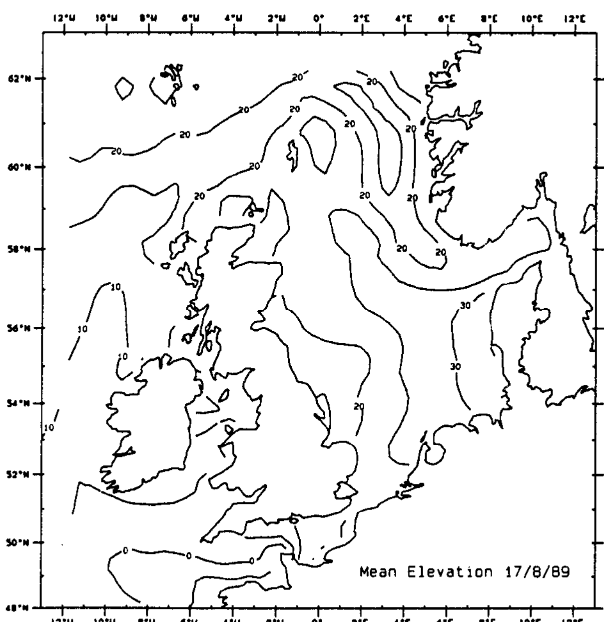

Mean Elevation 12/8/89

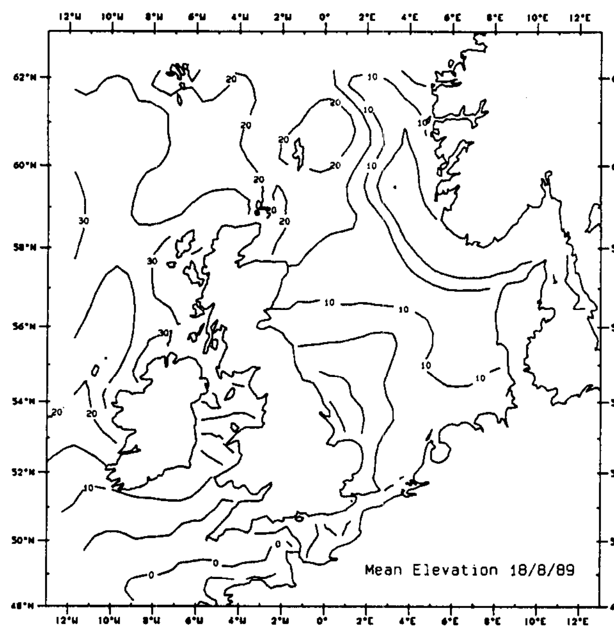

Mean Elevation 13/8/89

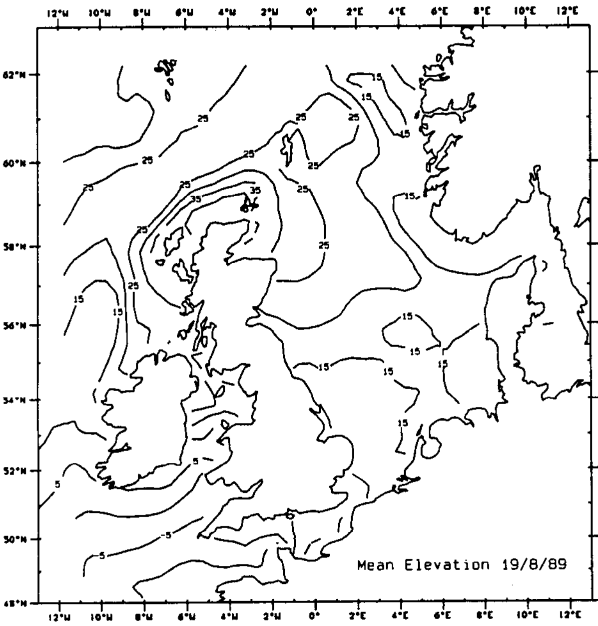

Mean Elevation 14/8/89


Mean Elevation 15/8/89

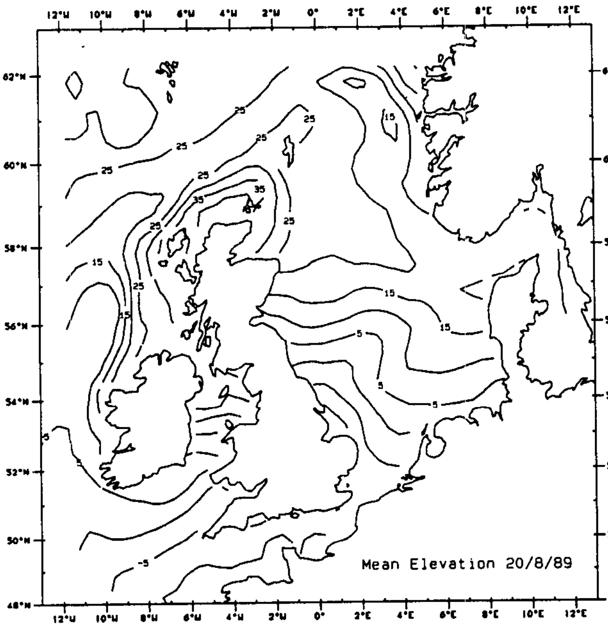

Mean Elevation 16/8/89


Mean Elevation 17/8/89

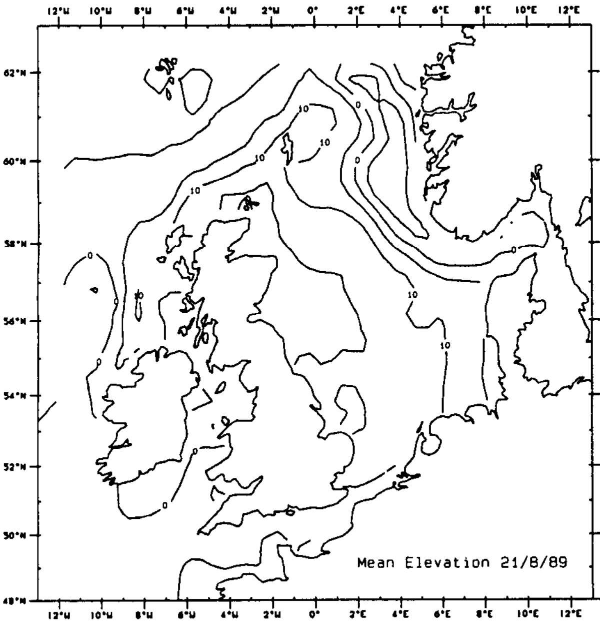

Mean Elevation 18/8/89



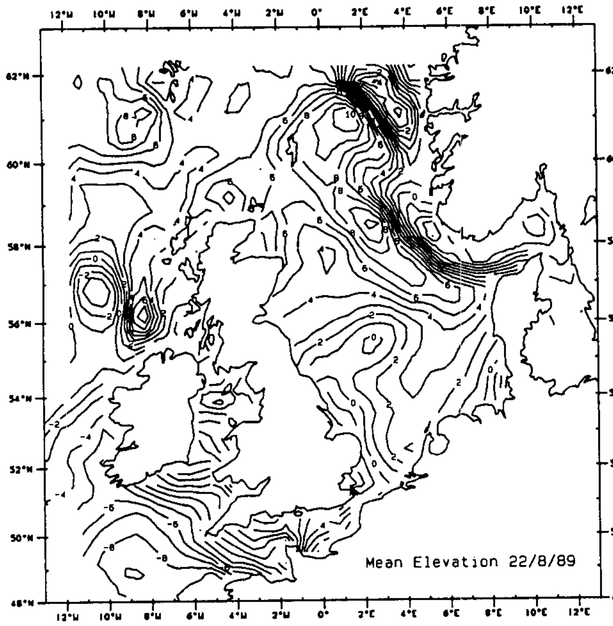
Mean Elevation 19/8/89



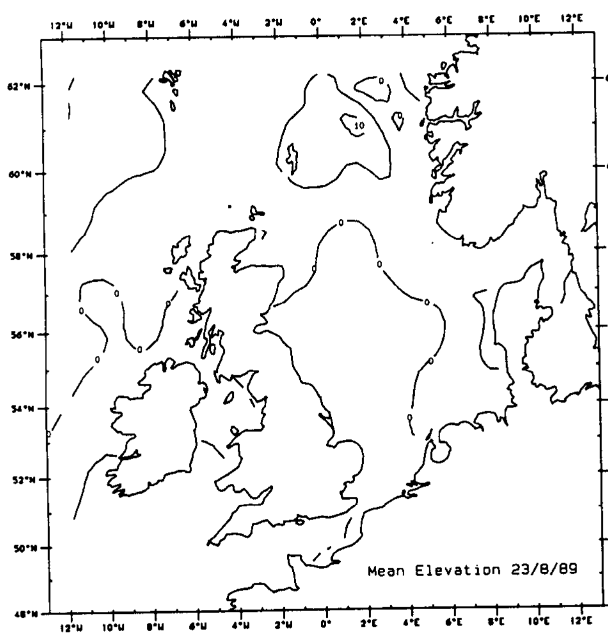
Mean Elevation 20/8/89



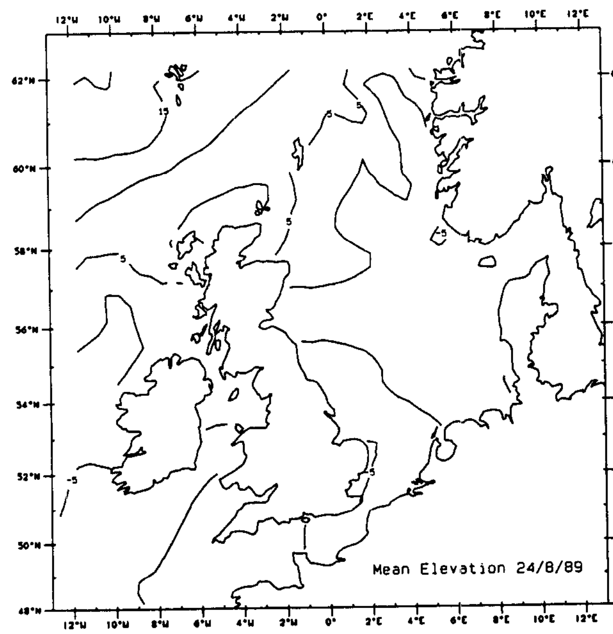
Mean Elevation 21/8/89



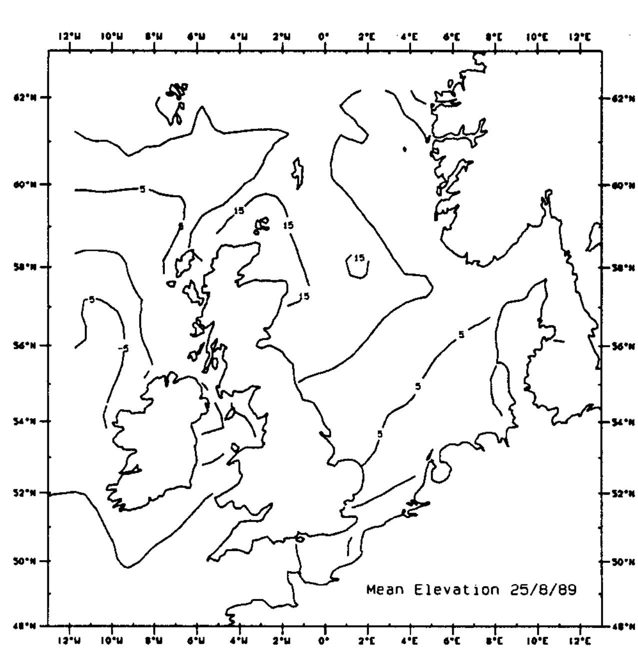
Mean Elevation 22/8/89



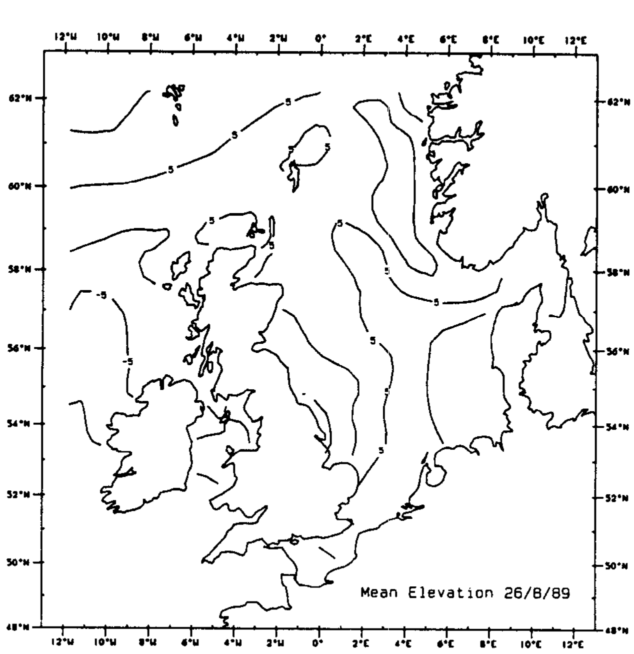
Mean Elevation 23/8/89



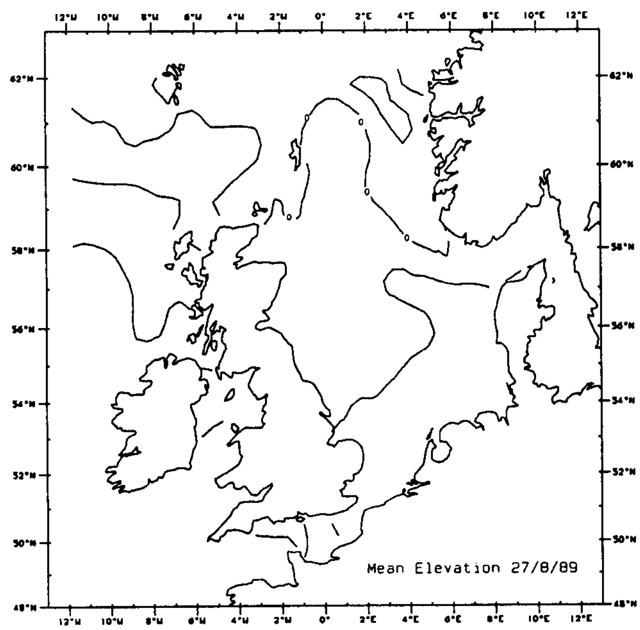
Mean Elevation 24/8/89



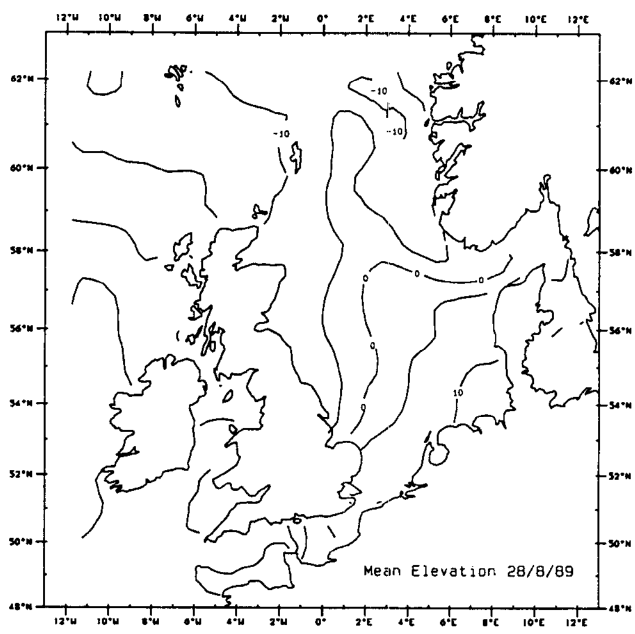
Mean Elevation 25/8/89



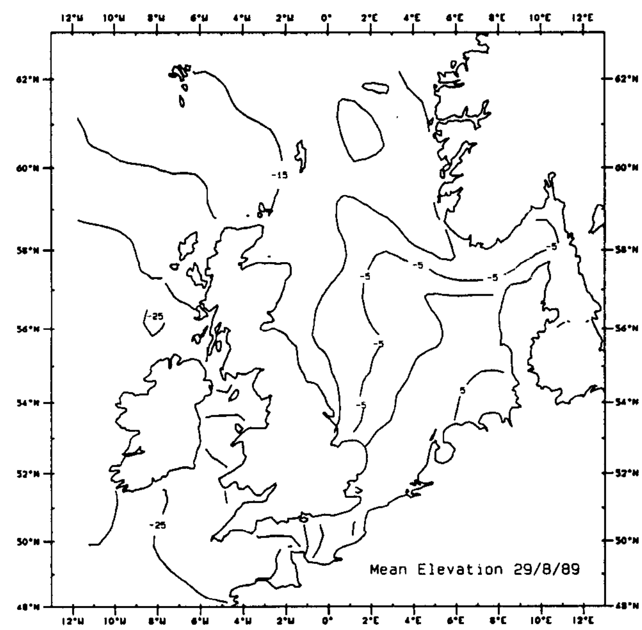
Mean Elevation 26/8/89



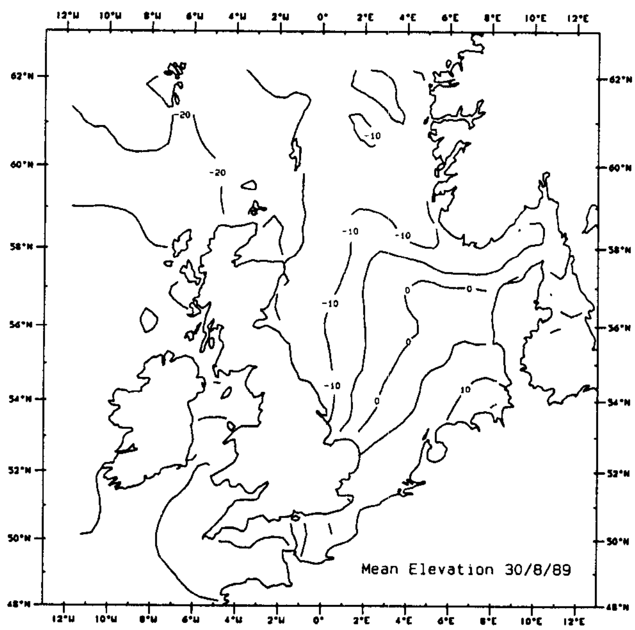
Mean Elevation 27/8/89



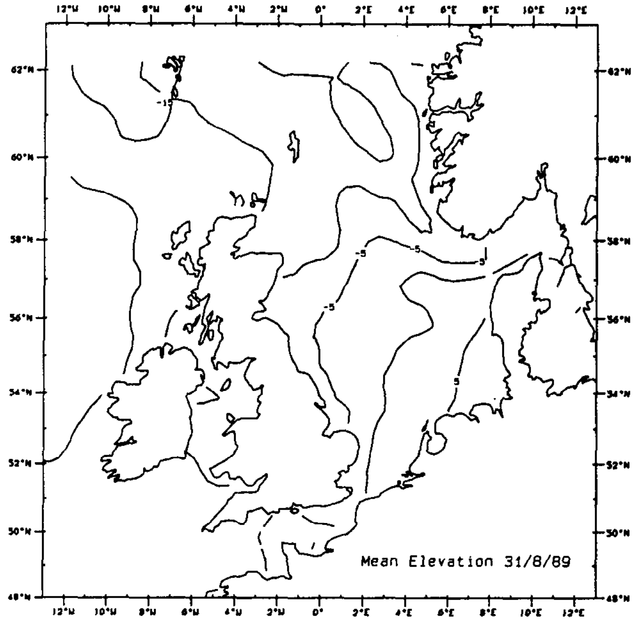
Mean Elevation 28/8/89

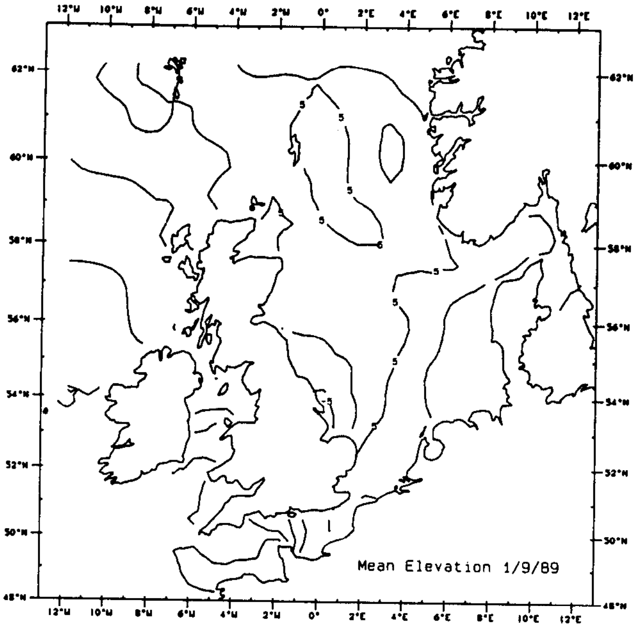


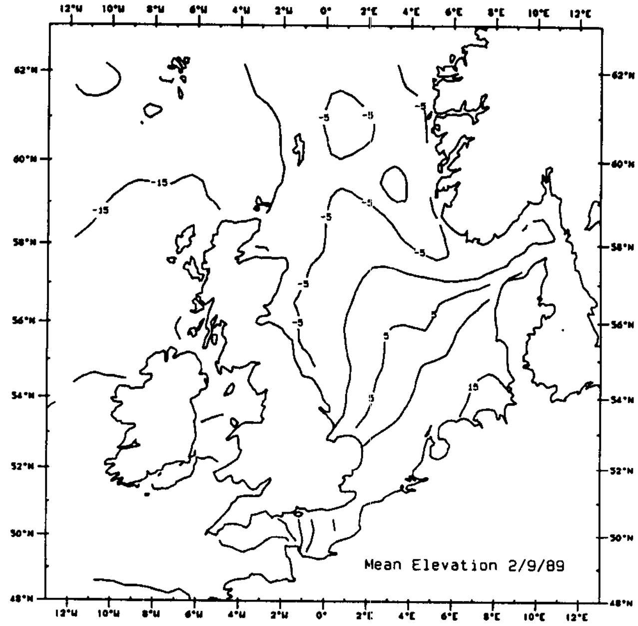
Mean Elevation 29/8/89

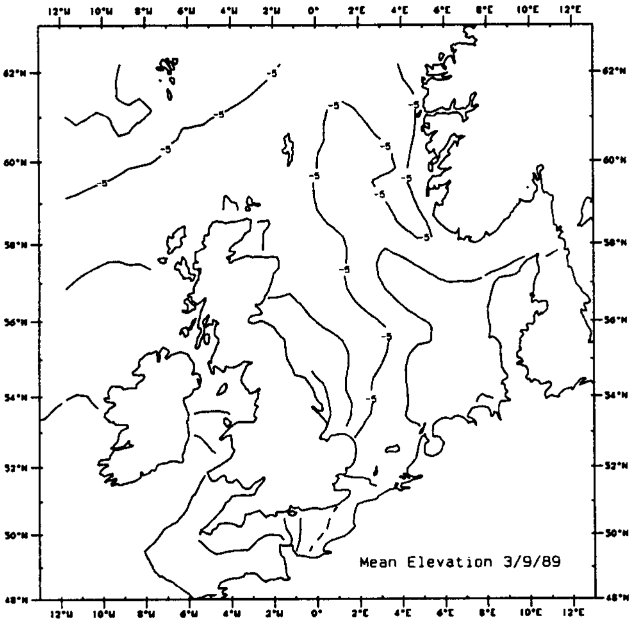


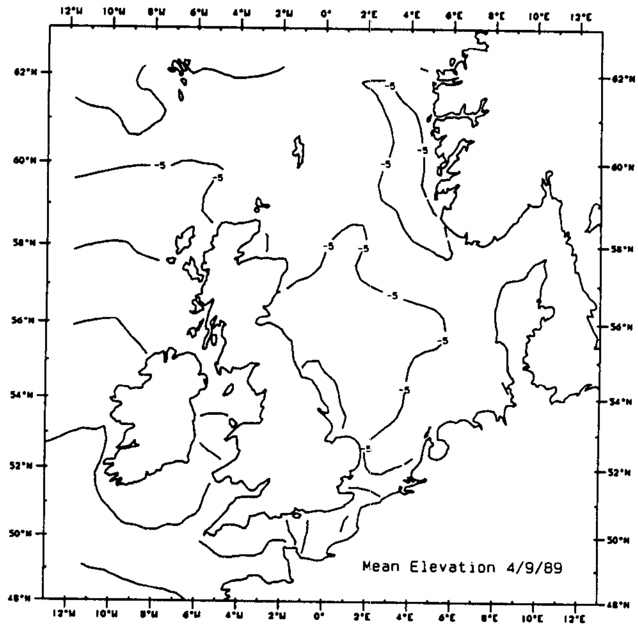
Mean Elevation 30/8/89

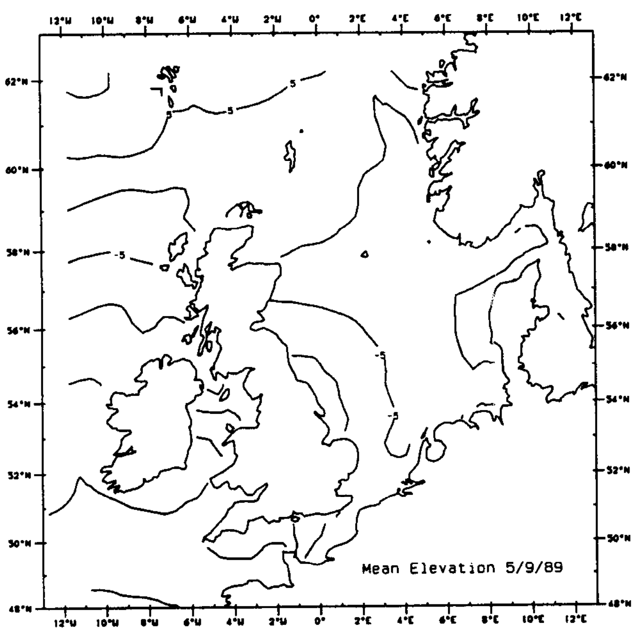

Mean Elevation 31/8/89
-15
-5
-5
-5
5
5
12°W
10°W
8°W
6°W
4°W
2°W
0°
2°E
4°E
6°E
8°E
10°E
12°E
62°N
60°N
58°N
56°N
54°N
52°N
50°N
48°N

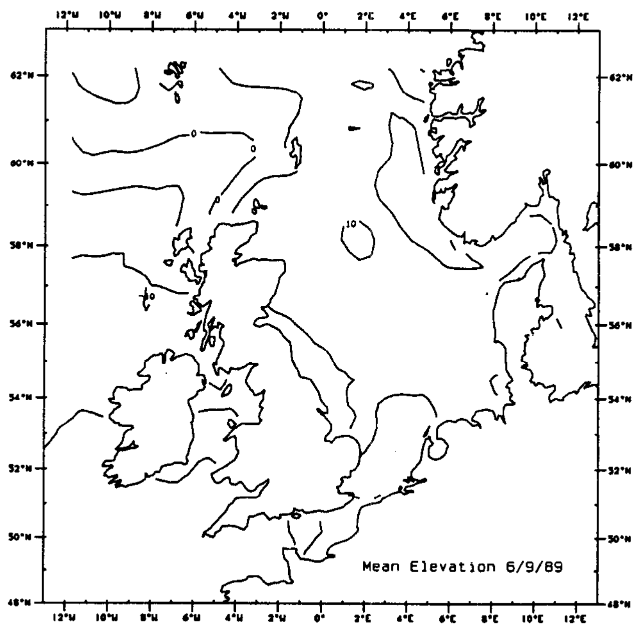

Mean Elevation 1/9/89

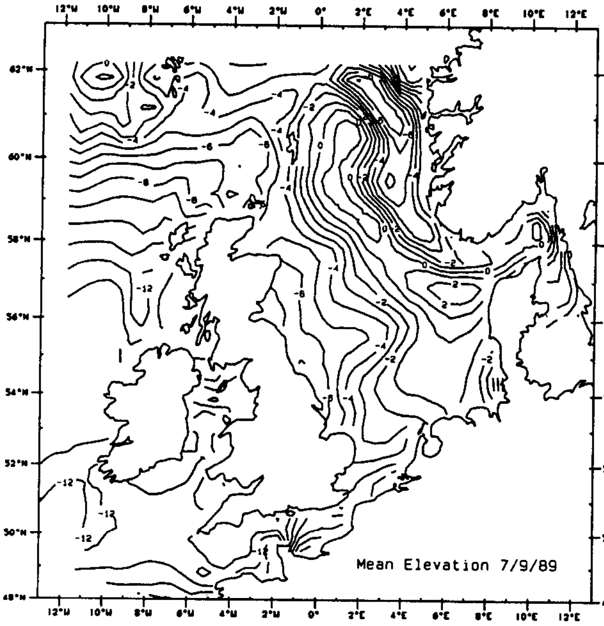

Mean Elevation 2/9/89

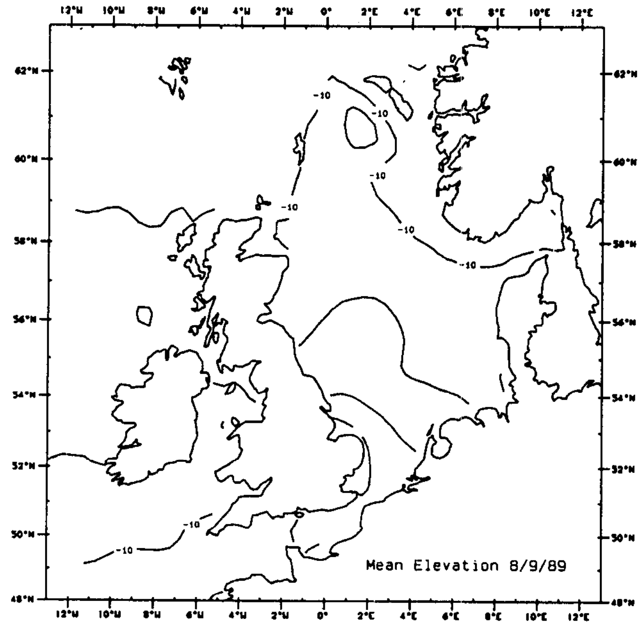

Mean Elevation 3/9/89

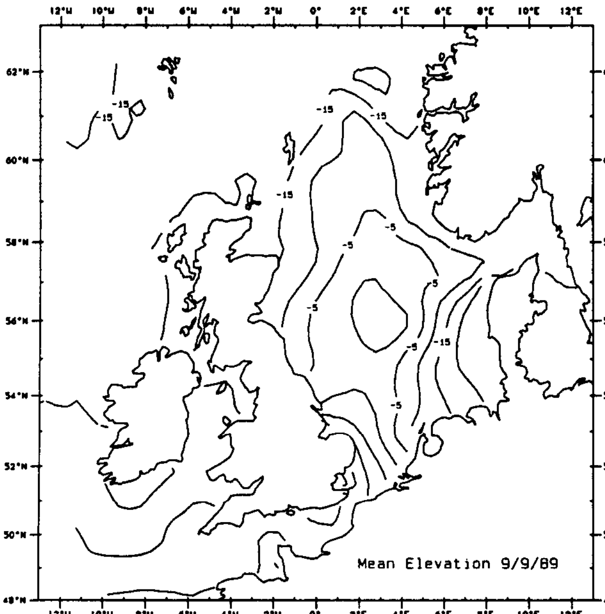

Mean Elevation 4/9/89

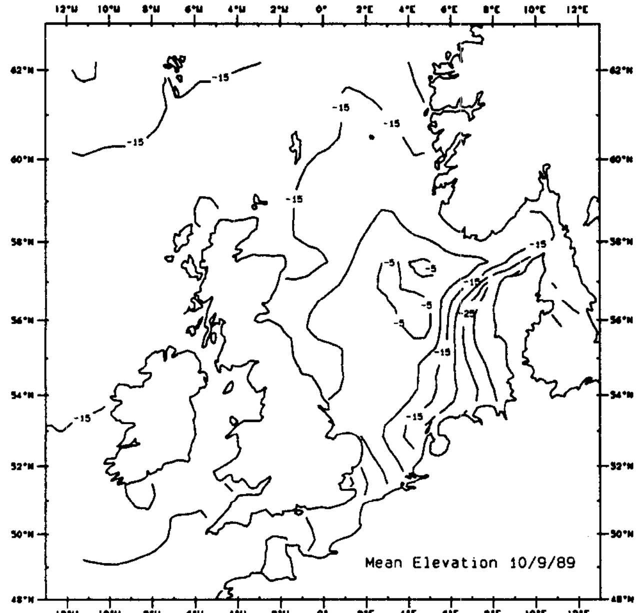

Mean Elevation 5/9/89

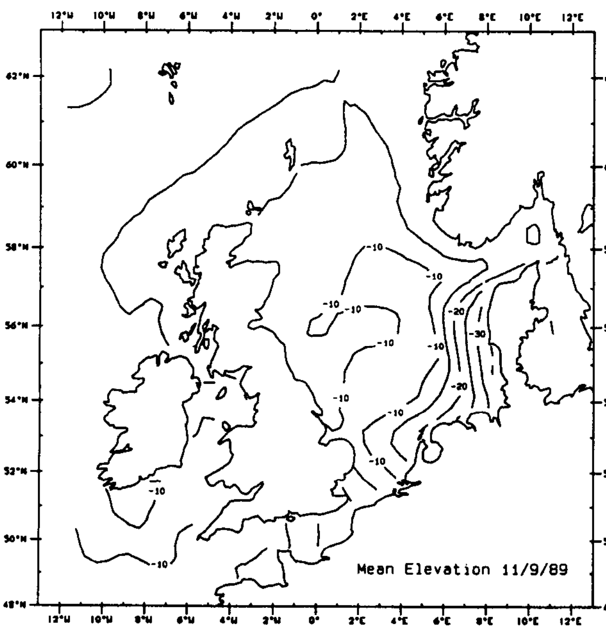

Mean Elevation 6/9/89

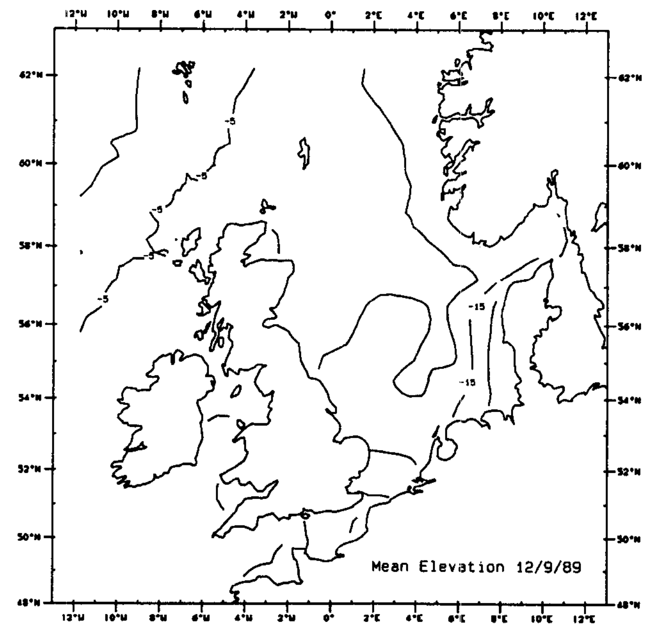

Mean Elevation 7/9/89

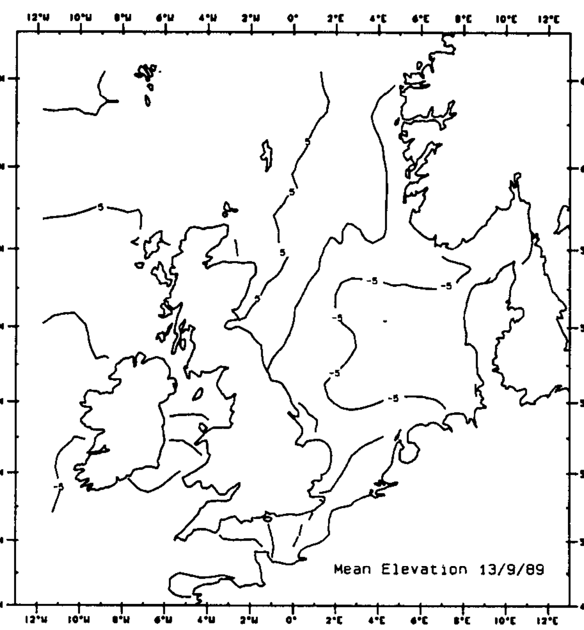

Mean Elevation 8/9/89

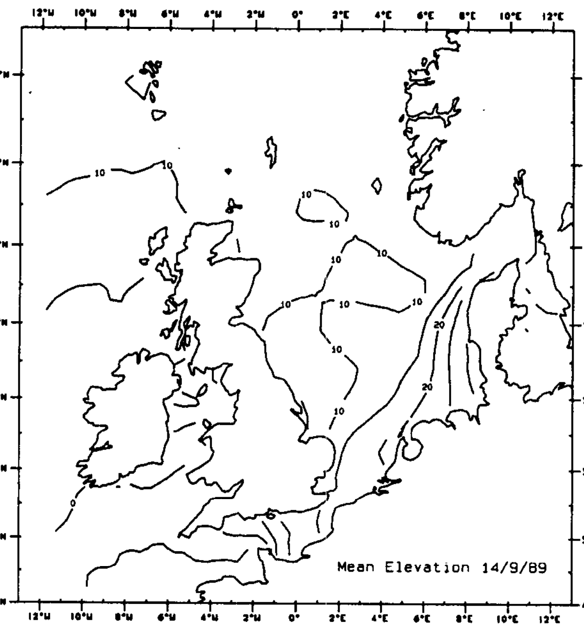

Mean Elevation 9/9/89

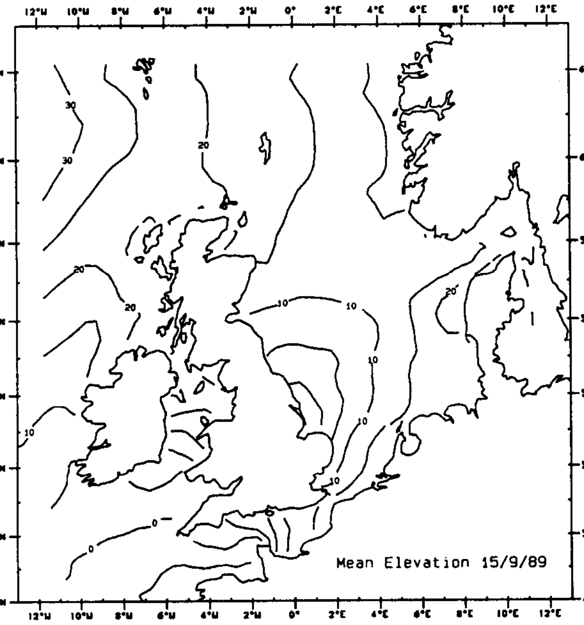

Mean Elevation 10/9/89

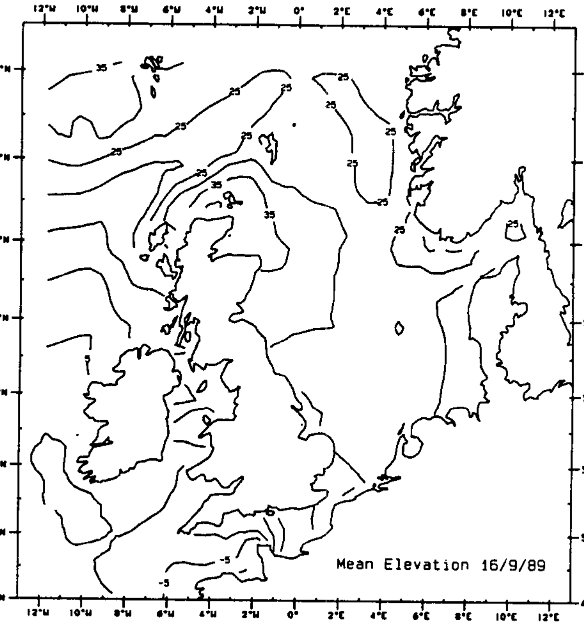

Mean Elevation 11/9/89

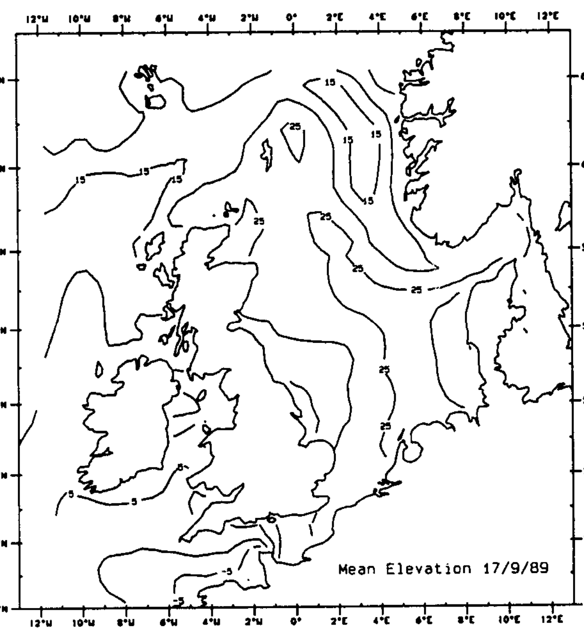

Mean Elevation 12/9/89

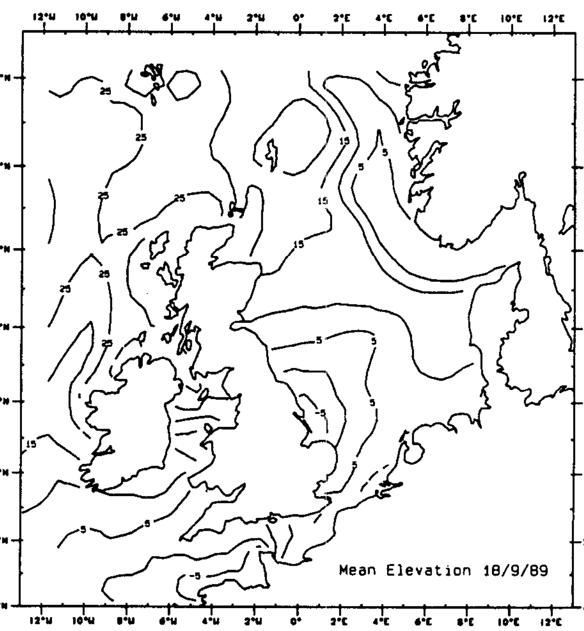

Mean Elevation 13/9/89

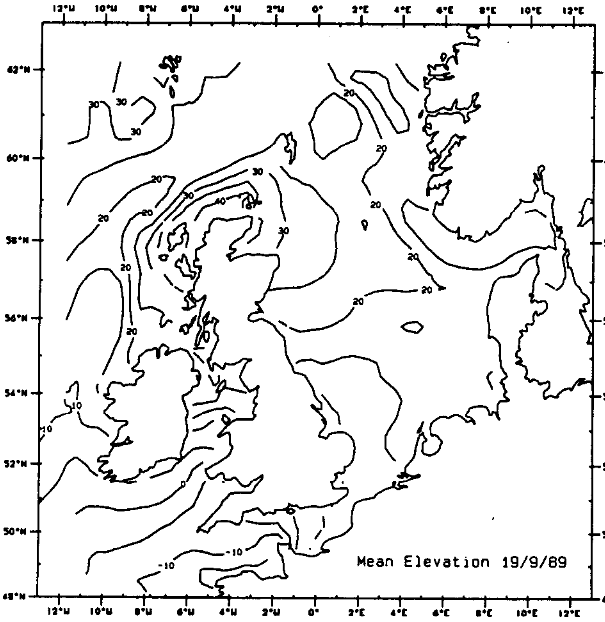

Mean Elevation 14/9/89

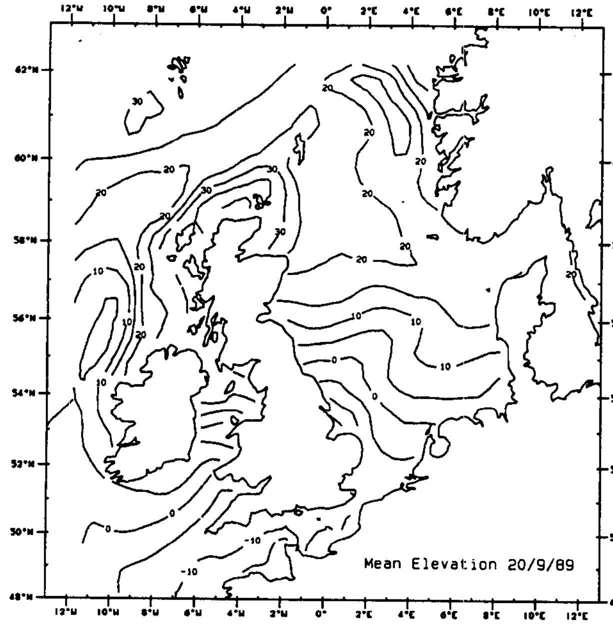

Mean Elevation 15/9/89

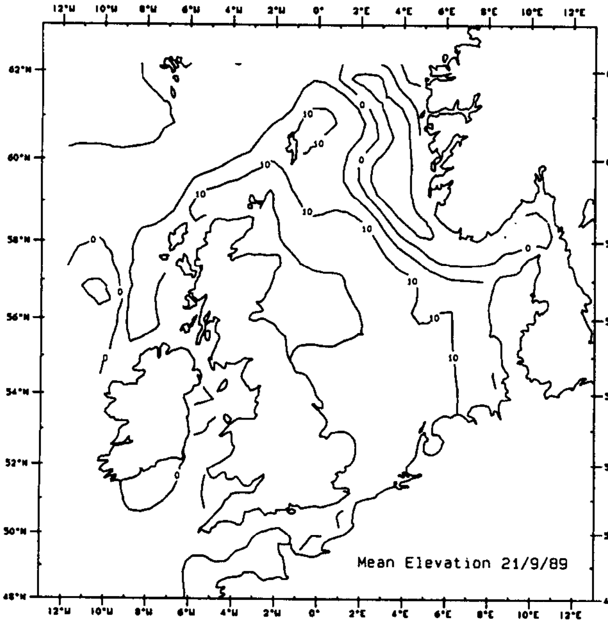

Mean Elevation 16/9/89

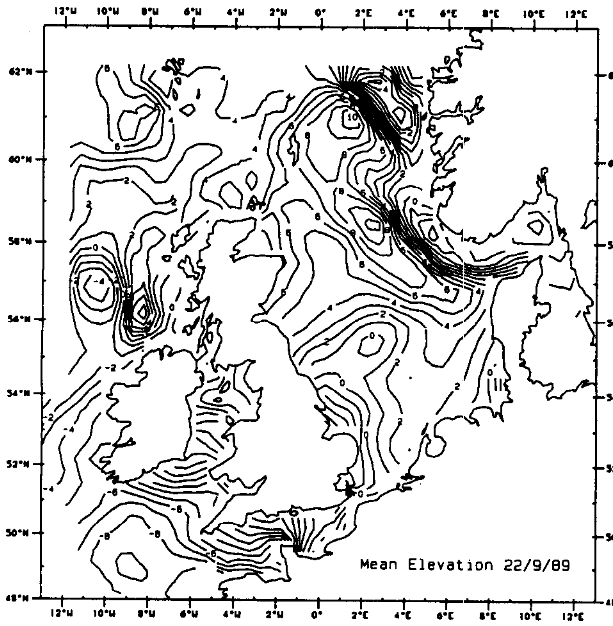

Mean Elevation 17/9/89

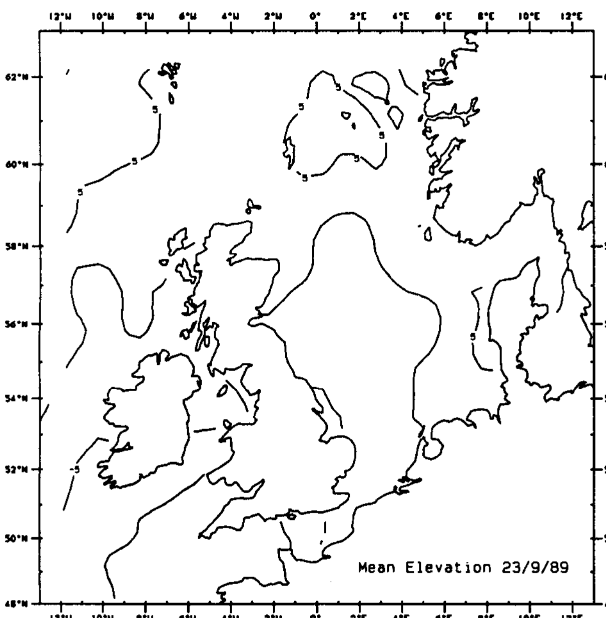

Mean Elevation 18/9/89

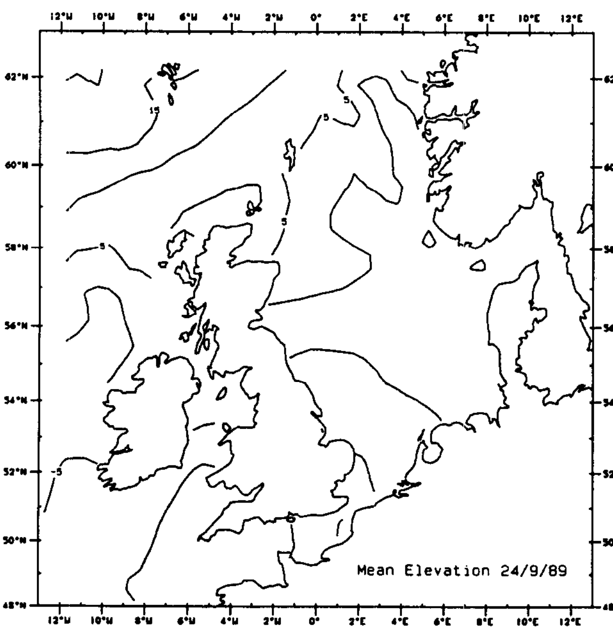

Mean Elevation 19/9/89

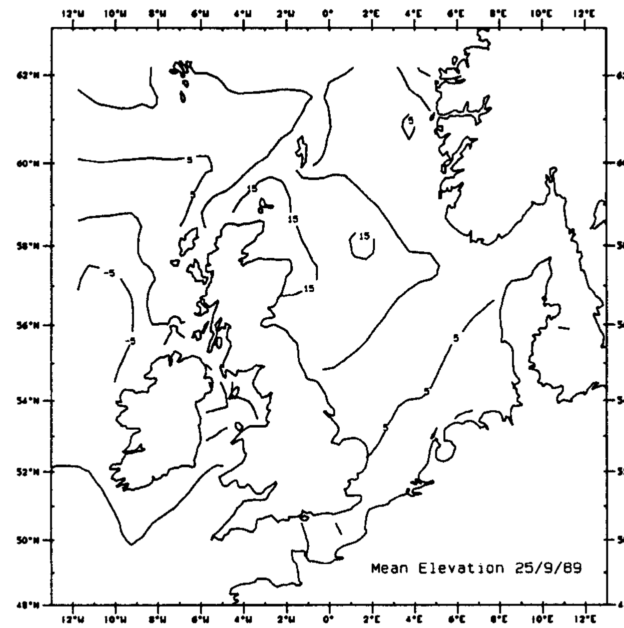

Mean Elevation 20/9/89

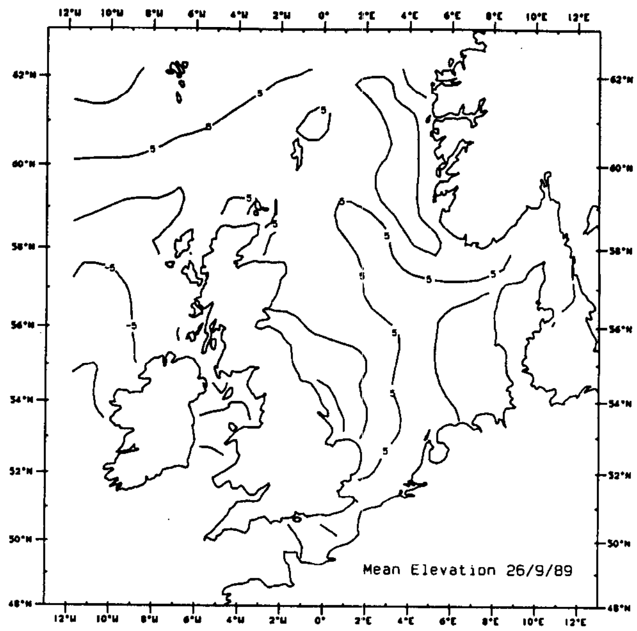

Mean Elevation 21/9/89

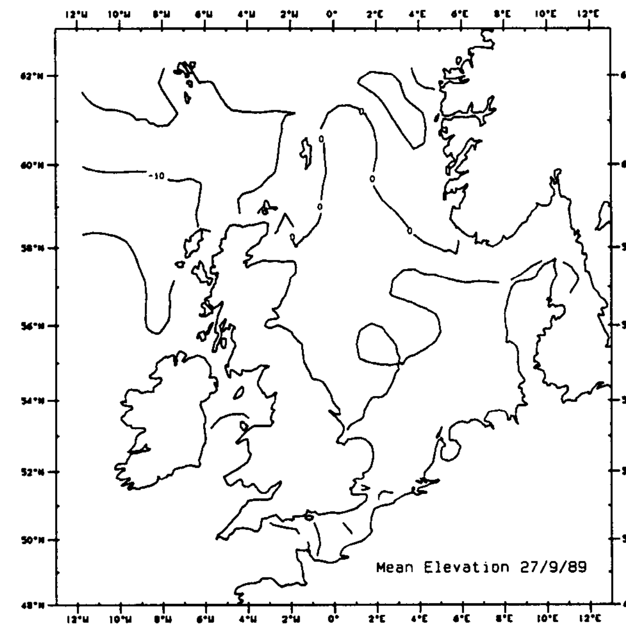

Mean Elevation 22/9/89

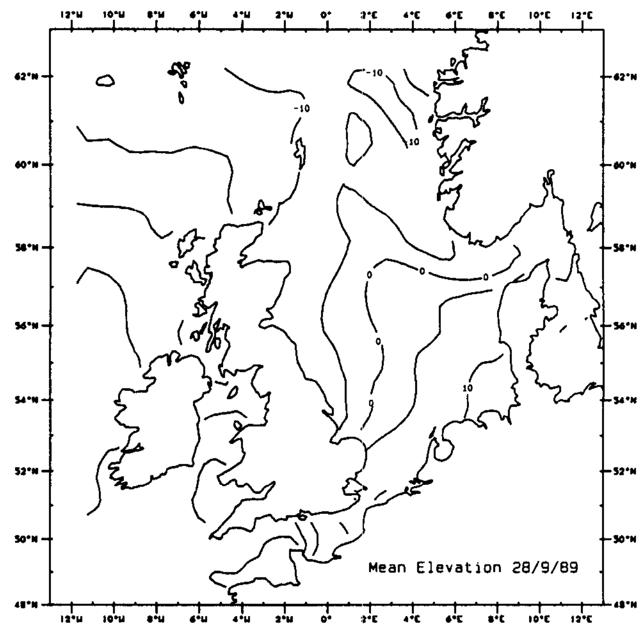

Mean Elevation 23/9/89

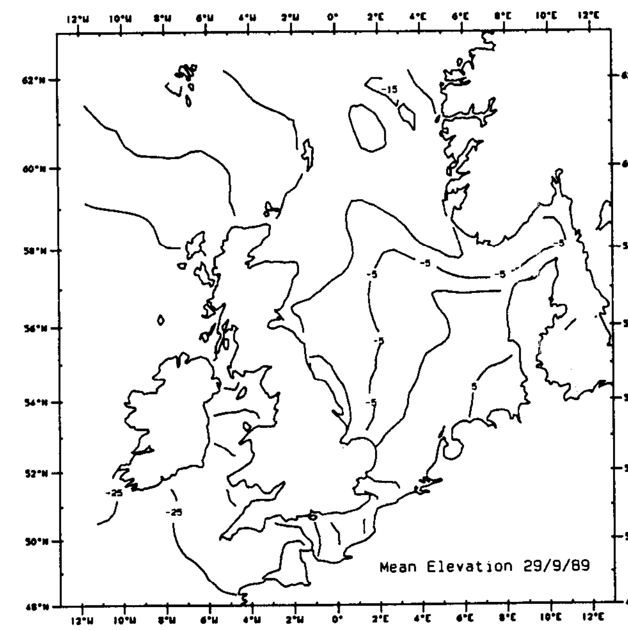

Mean Elevation 24/9/89

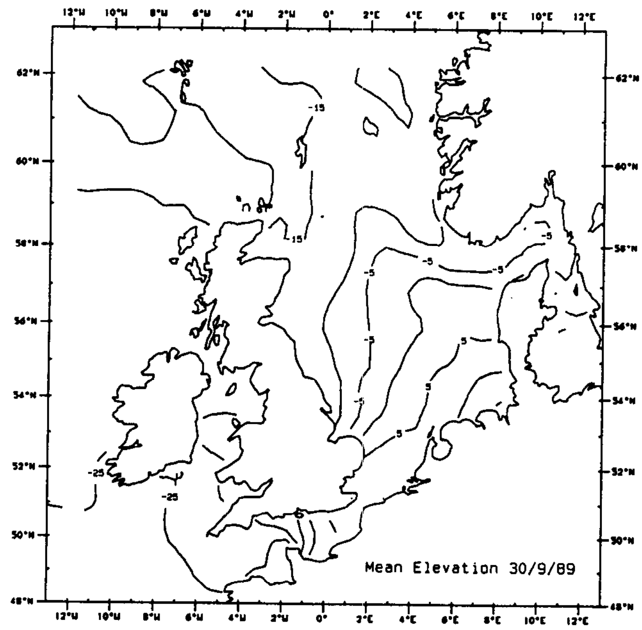

Mean Elevation 25/9/89

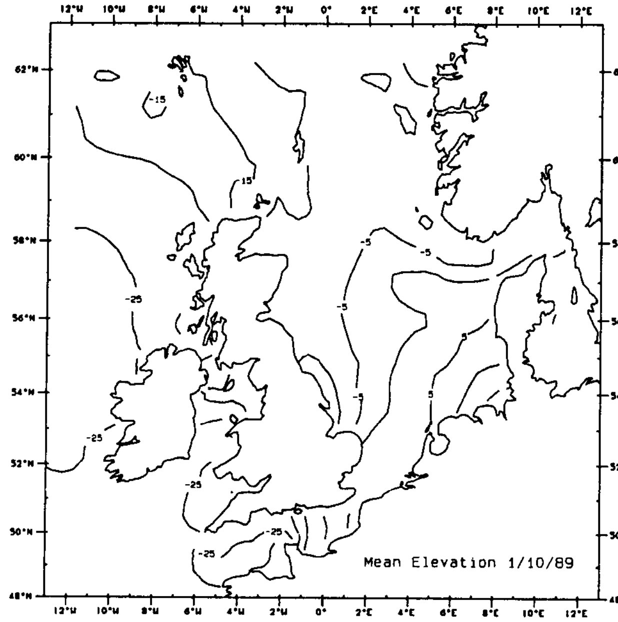

Mean Elevation 26/9/89

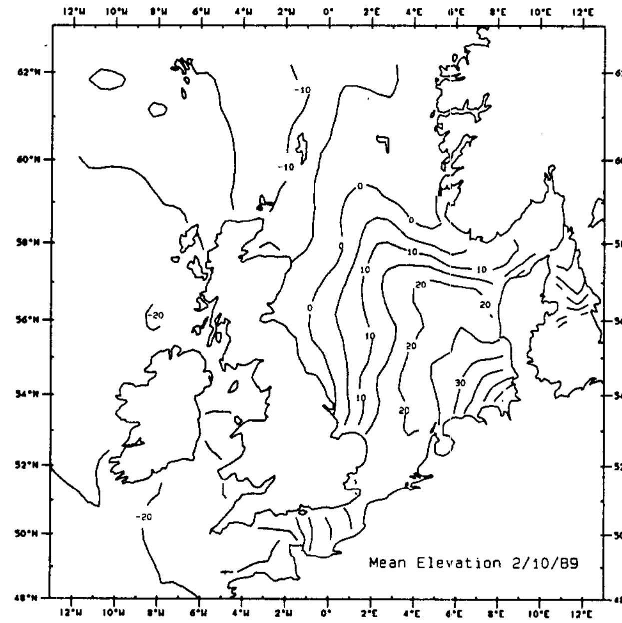

Mean Elevation 27/9/89

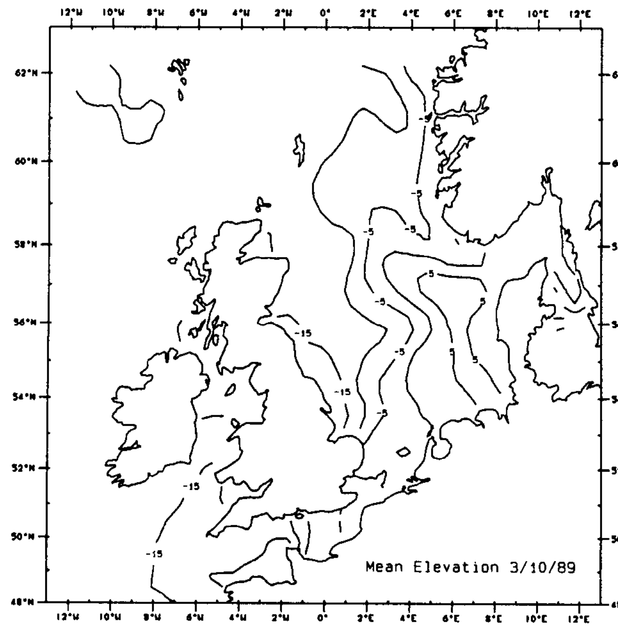

Mean Elevation 28/9/89

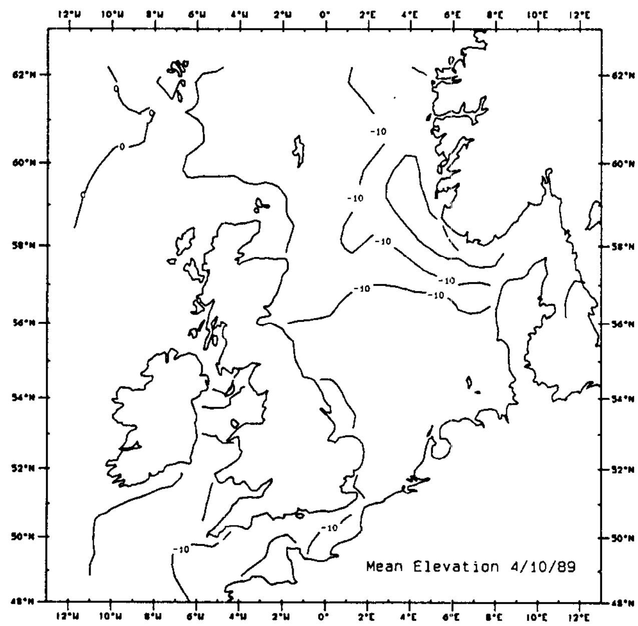

Mean Elevation 29/9/89

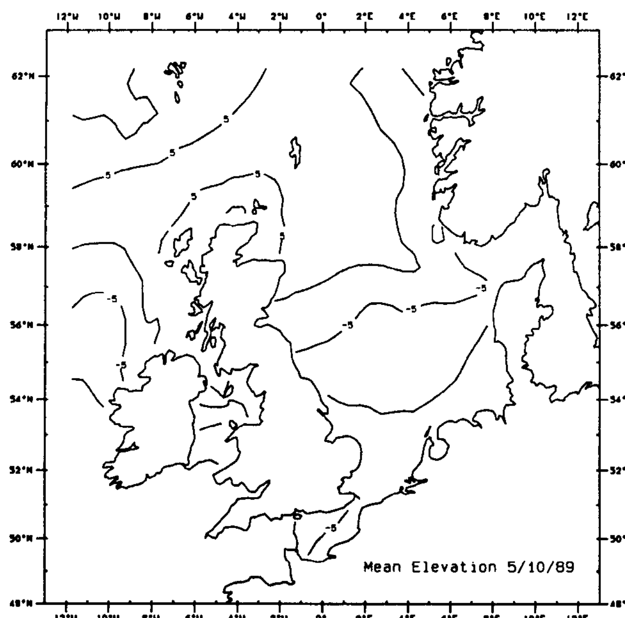

Mean Elevation 30/9/89

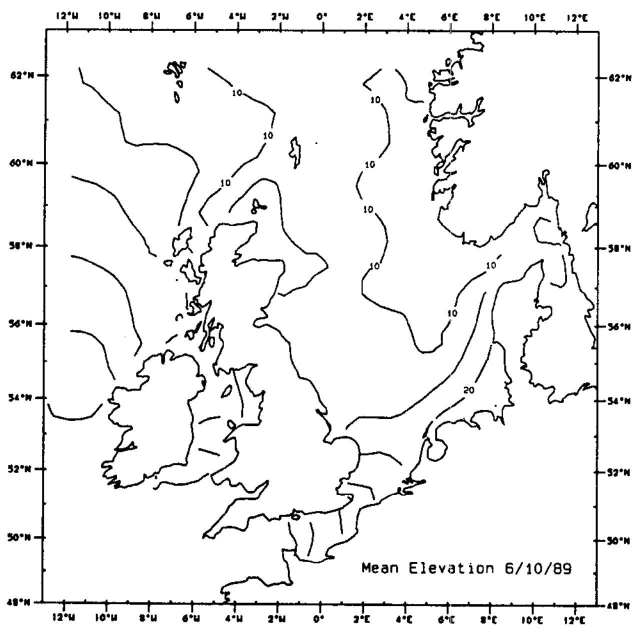

Mean Elevation 1/10/89
12°W 10°W 8°W 6°W 4°W 2°W 0° 2°E 4°E 6°E 8°E 10°E 12°E
48°N 50°N 52°N 54°N 56°N 58°N 60°N 62°N

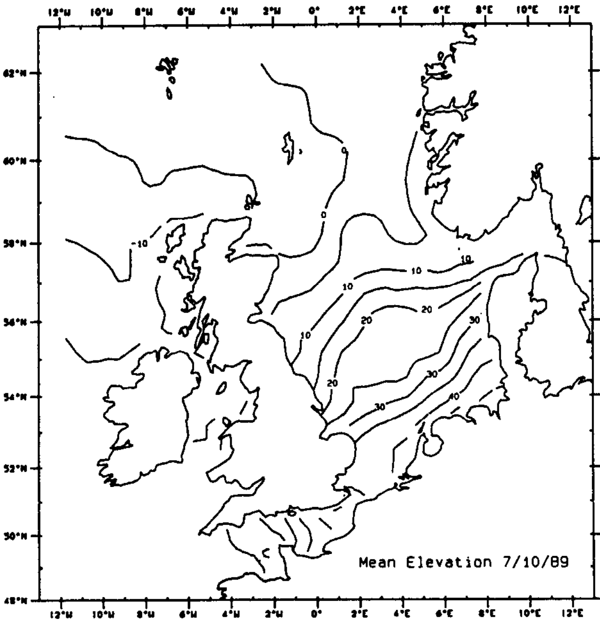

Mean Elevation 2/10/89
12°W 10°W 8°W 6°W 4°W 2°W 0° 2°E 4°E 6°E 8°E 10°E 12°E
48°N 50°N 52°N 54°N 56°N 58°N 60°N 62°N

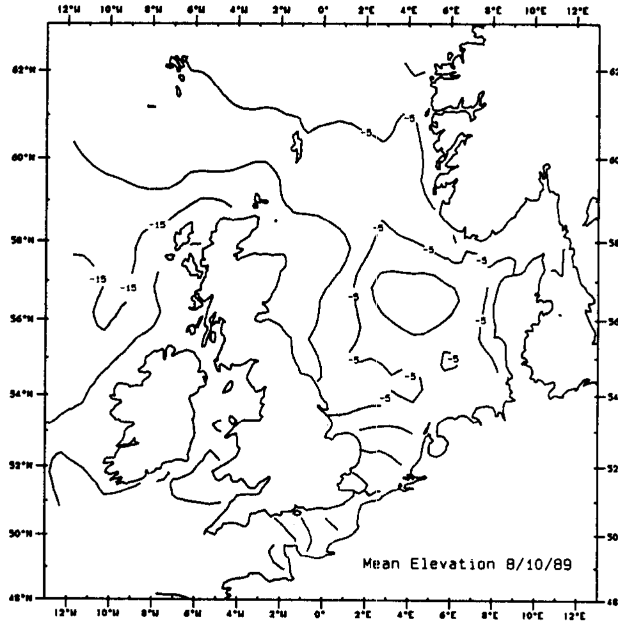

Mean Elevation 3/10/89
12°W 10°W 8°W 6°W 4°W 2°W 0° 2°E 4°E 6°E 8°E 10°E 12°E
48°N 50°N 52°N 54°N 56°N 58°N 60°N 62°N

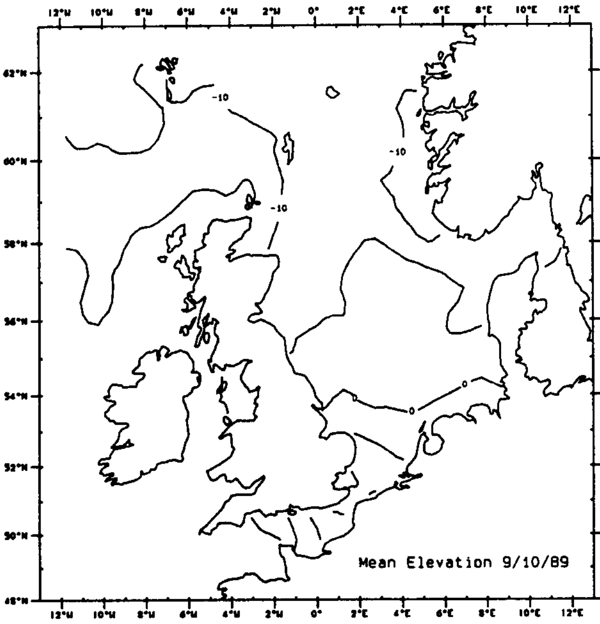

Mean Elevation 4/10/89
12°W 10°W 8°W 6°W 4°W 2°W 0° 2°E 4°E 6°E 8°E 10°E 12°E
48°N 50°N 52°N 54°N 56°N 58°N 60°N 62°N

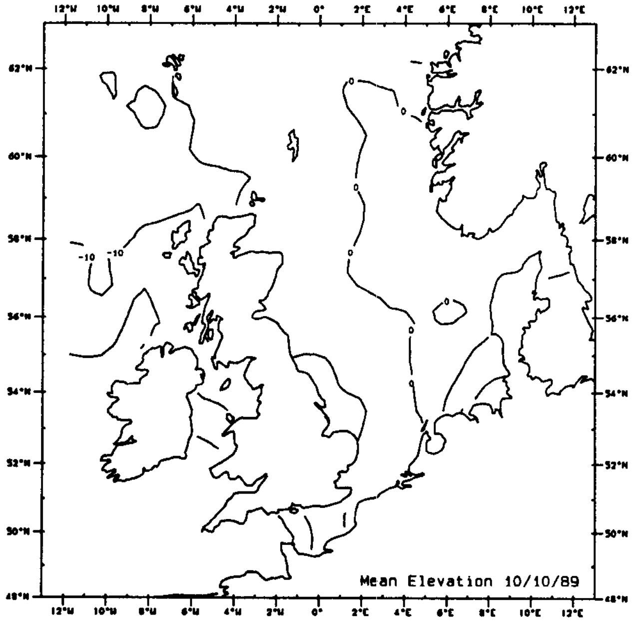

Mean Elevation 5/10/89
12°W 10°W 8°W 6°W 4°W 2°W 0° 2°E 4°E 6°E 8°E 10°E 12°E
48°N 50°N 52°N 54°N 56°N 58°N 60°N 62°N

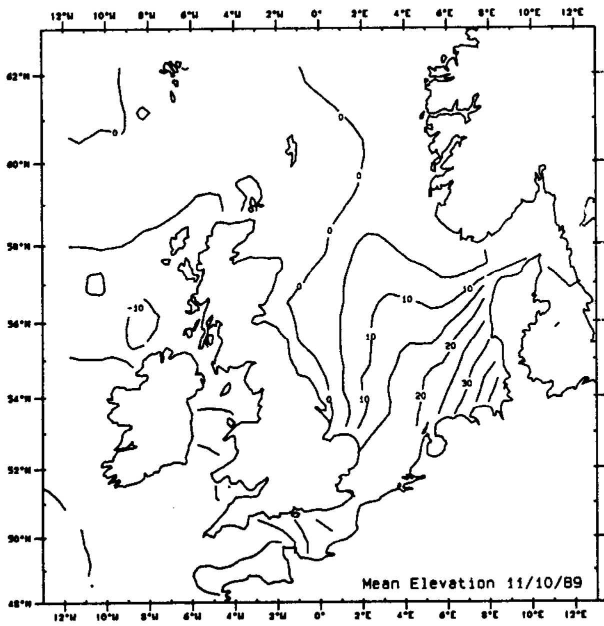

Mean Elevation 6/10/89
12°W 10°W 8°W 6°W 4°W 2°W 0° 2°E 4°E 6°E 8°E 10°E 12°E
48°N 50°N 52°N 54°N 56°N 58°N 60°N 62°N

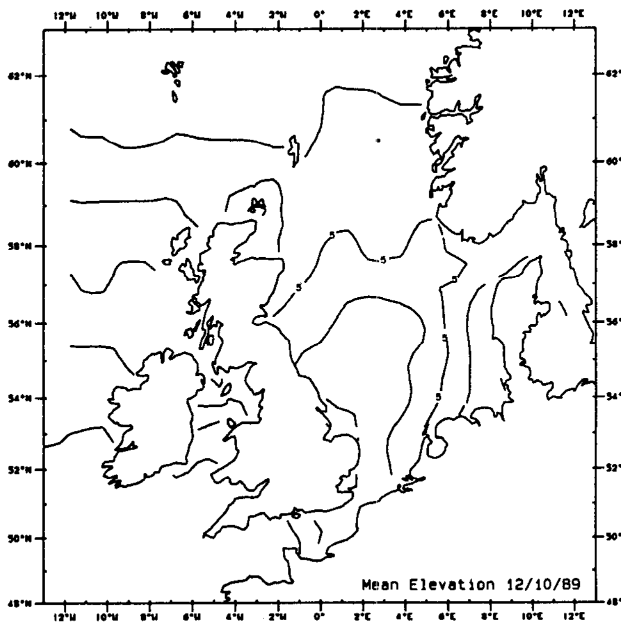

Mean Elevation 7/10/89

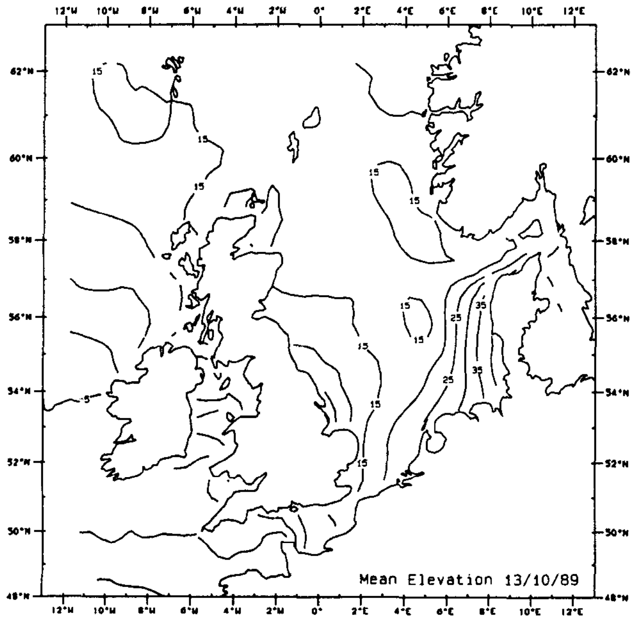

Mean Elevation 8/10/89

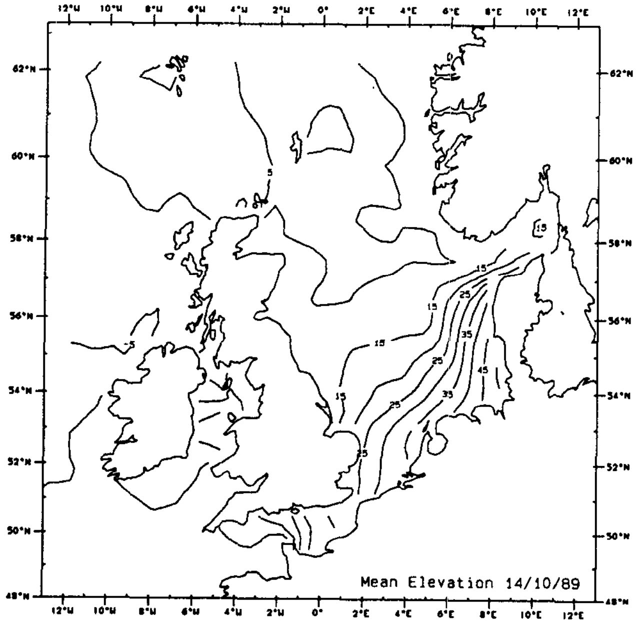

Mean Elevation 9/10/89

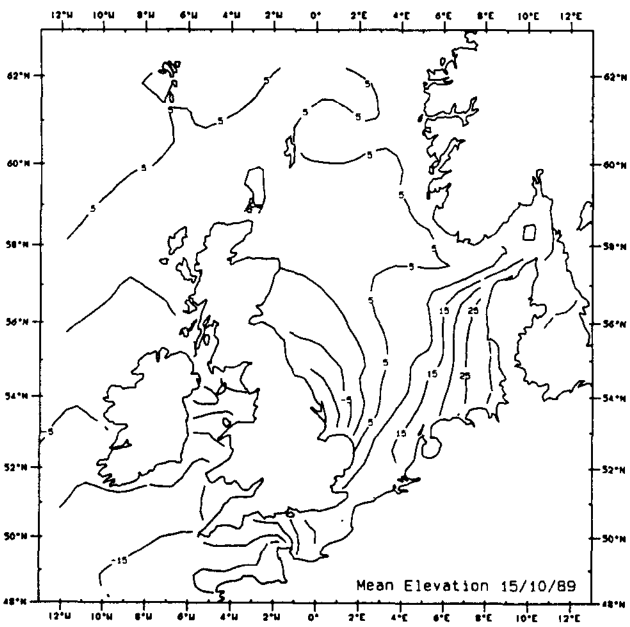

Mean Elevation 10/10/89

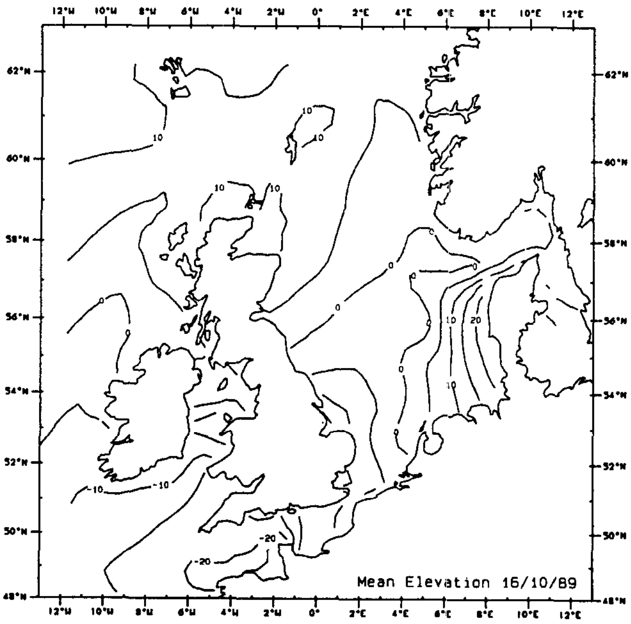

Mean Elevation 11/10/89

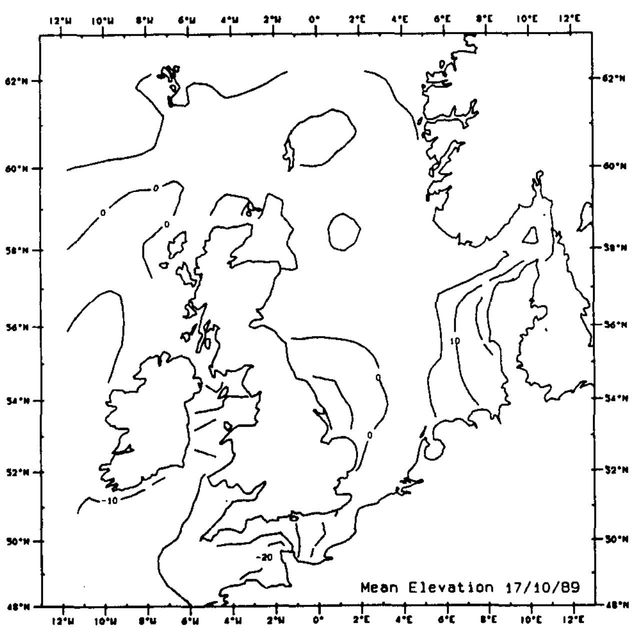

Mean Elevation 12/10/89


Mean Elevation 13/10/89


Mean Elevation 14/10/89


Mean Elevation 15/10/89


Mean Elevation 16/10/89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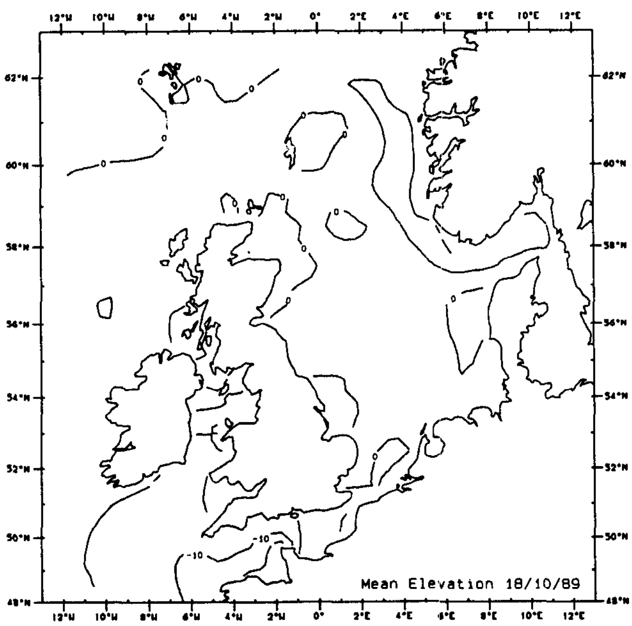
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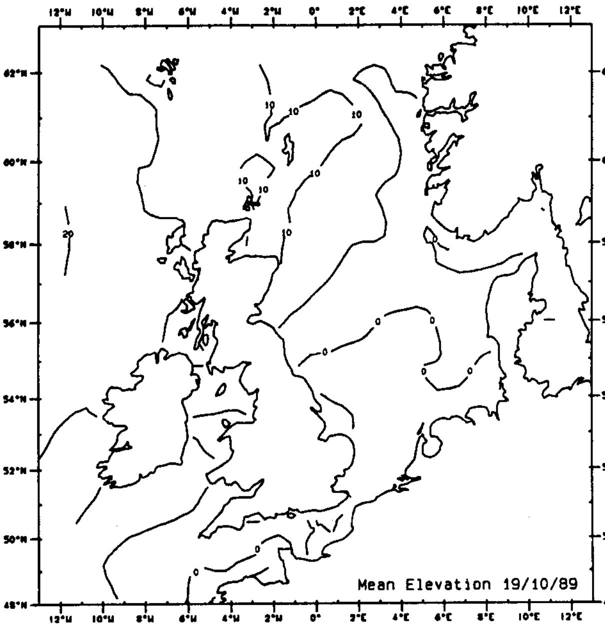
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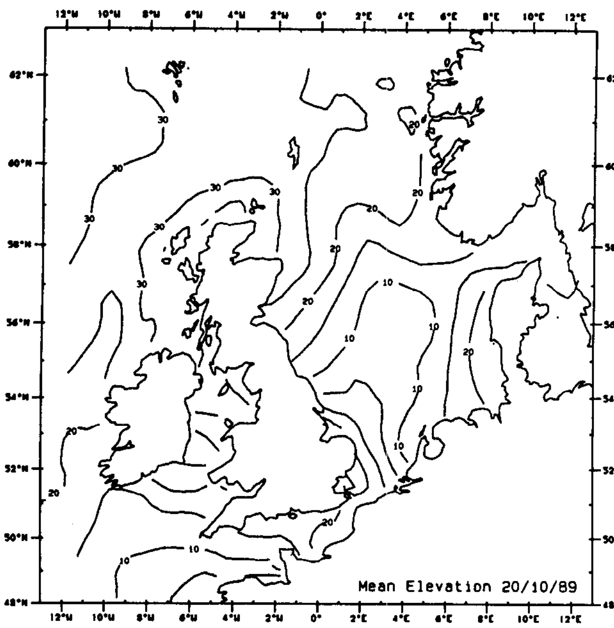
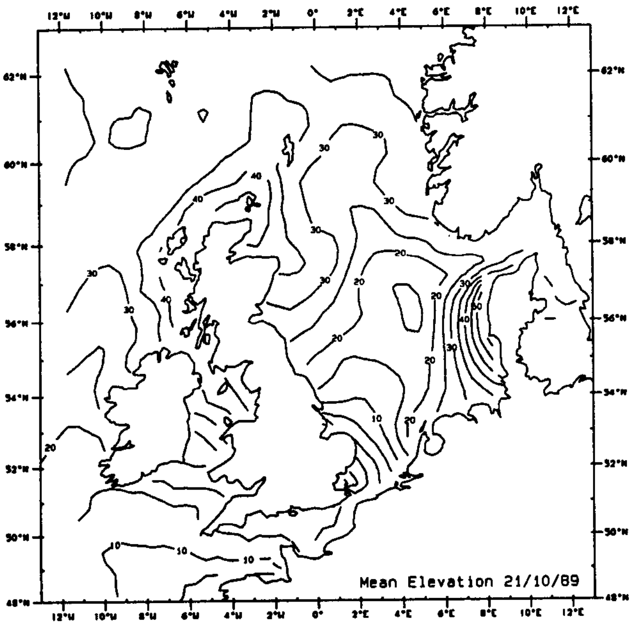
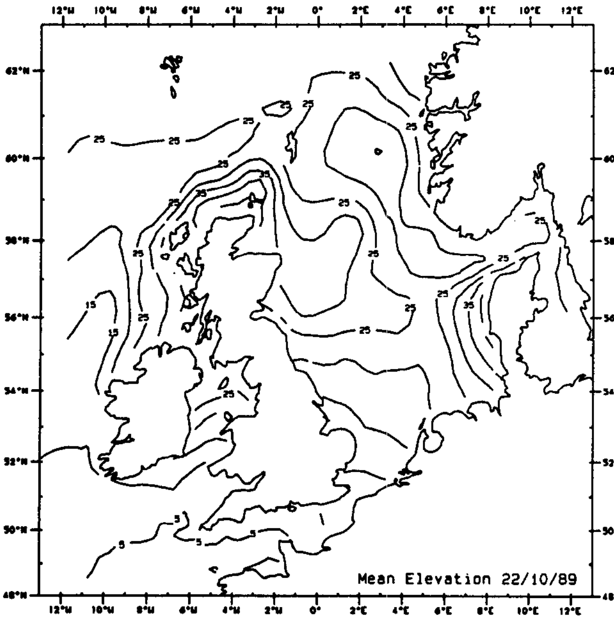
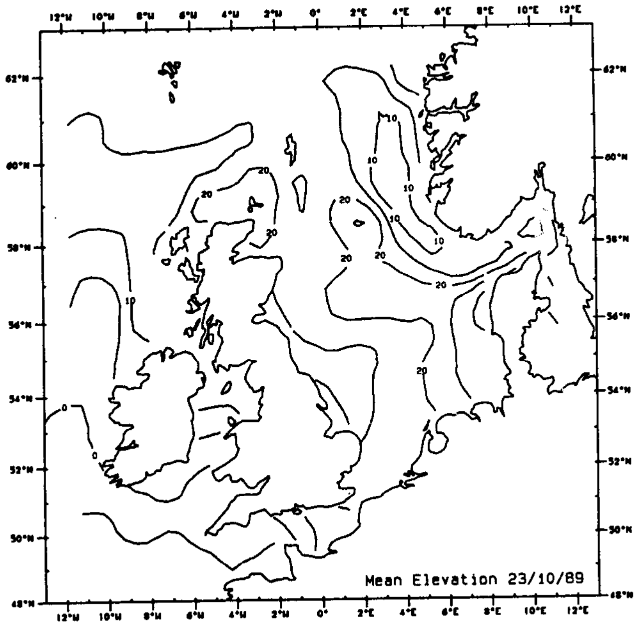
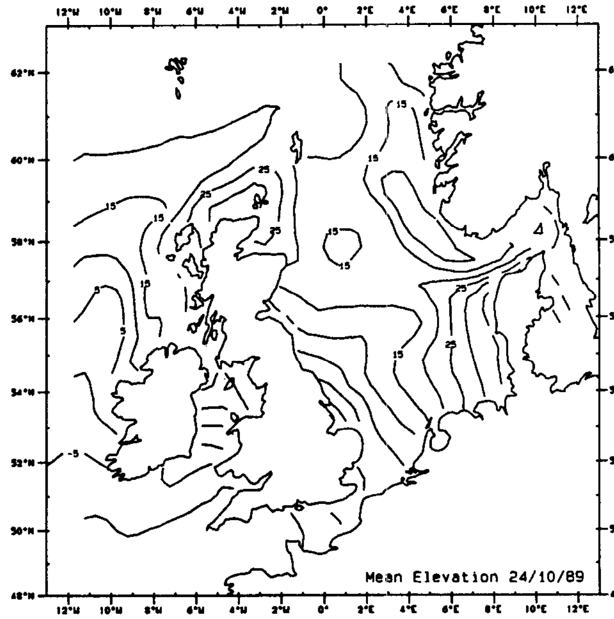
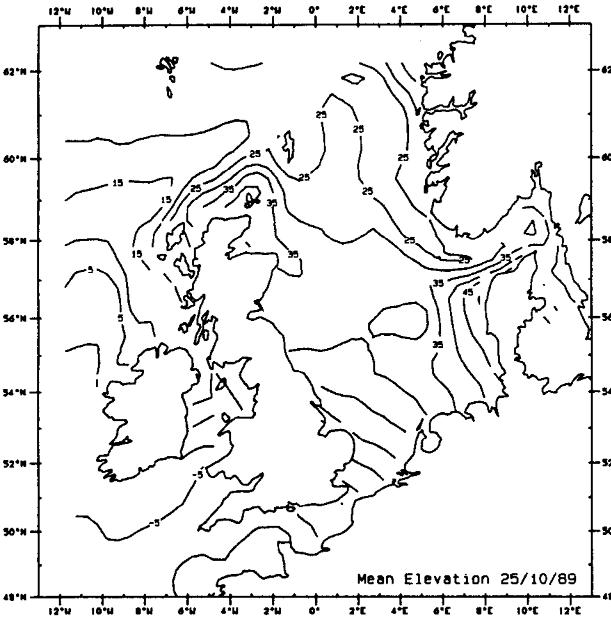

Mean Elevation 20/10/89

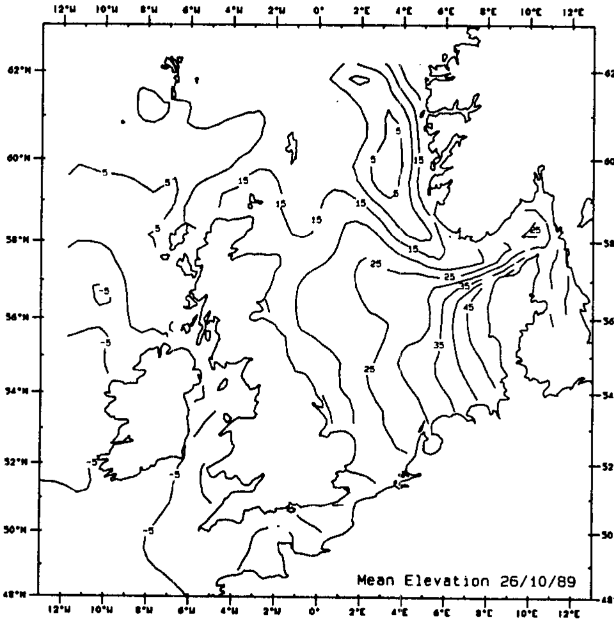

Mean Elevation 21/10/89

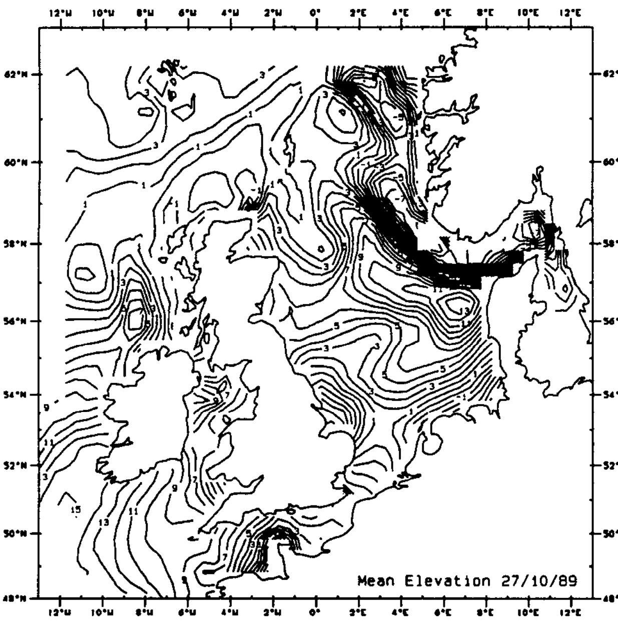

Mean Elevation 22/10/89

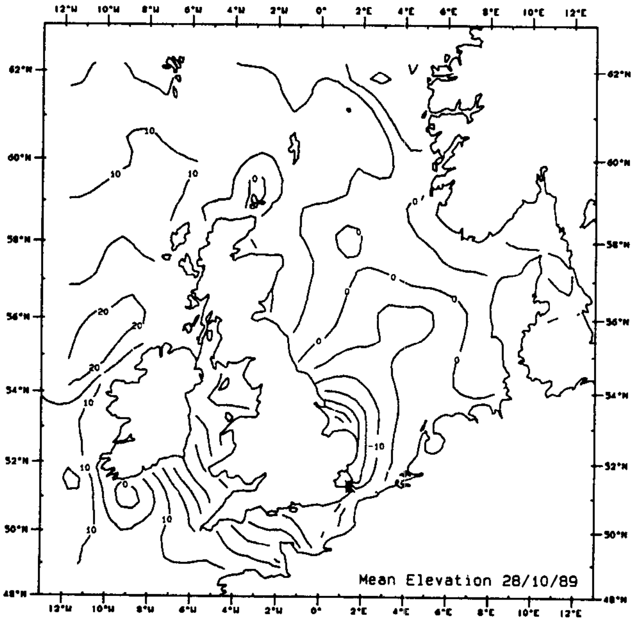

Mean Elevation 23/10/89

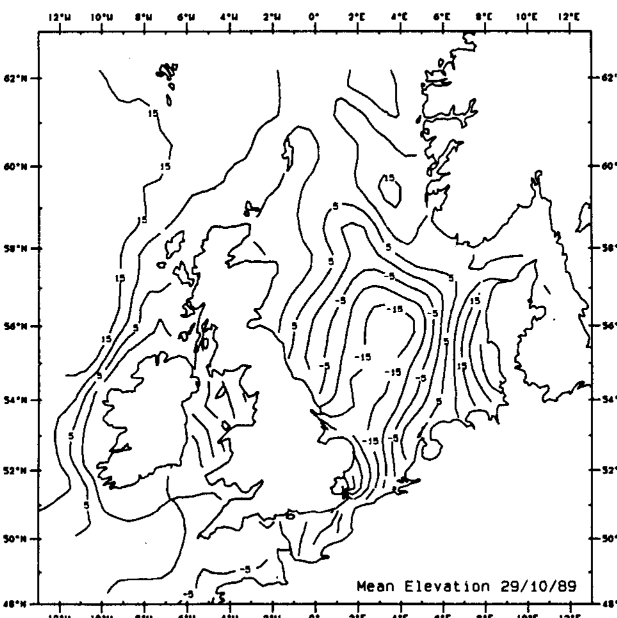

Mean Elevation 24/10/89

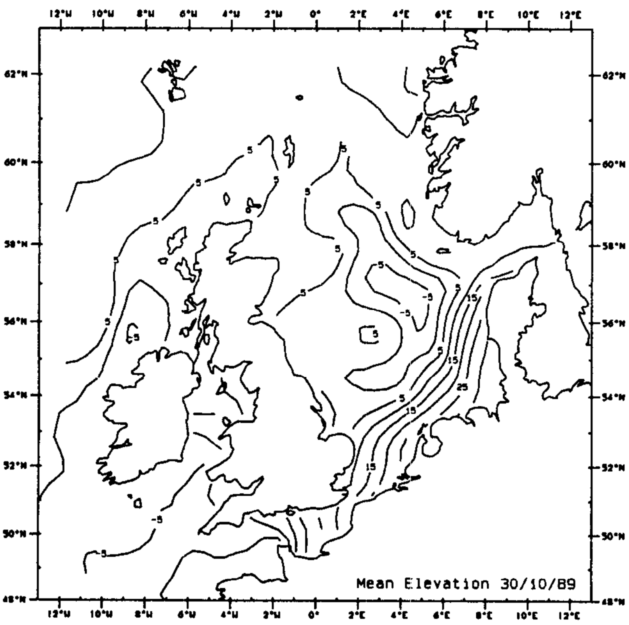

Mean Elevation 25/10/89

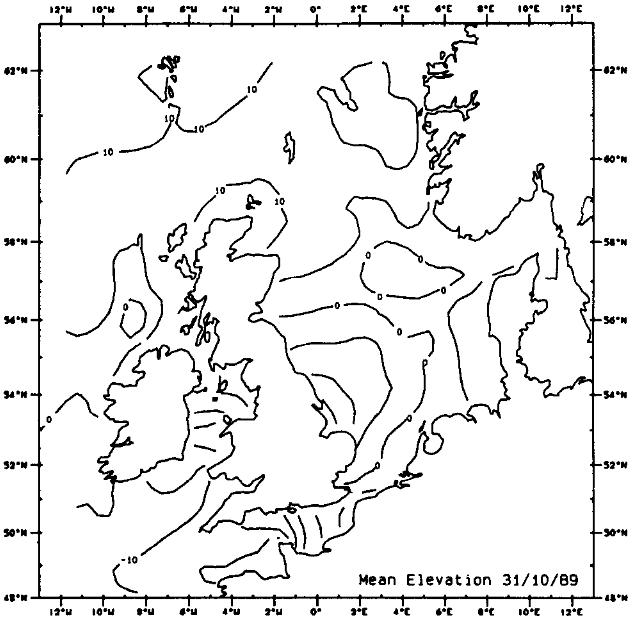

Mean Elevation 26/10/89


Mean Elevation 27/10/89


Mean Elevation 28/10/89


Mean Elevation 29/10/89


Mean Elevation 30/10/89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