Coupled Ocean-Atmosphere Processes and European Climate

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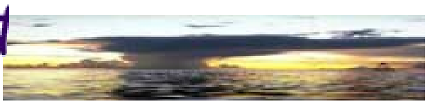

Newsletter No 4: March 2004

The fourth of an irregular series of Newsletters with brief reports on meetings and projects associated with the NERC's COAPEC directed programme

Programme News

COAPEC has just passed another major milestone with the formal completion if its first three projects, although in at least one case this is far from the actual end of the project: climate*prediction*.net goes (and grows) from strength to strength, but the COAPEC funding has now ended. There is a report in this newsletter from one of the many climate*prediction*.net projects (see page 3) as well as reports from the other two completed projects (Shaffrey & Sutton and Grist & Josey).

Another milestone last October was the appointment of a new core team member. Emily Black, based at CGAM, Reading, is now fully occupied with COAPEC matters and there are two short reports on her activities later in the newsletter. While we were sad to see Mat Collins leave us in August, he is still closely involved with COAPEC in his new role as Ensemble Climate Change Prediction Scientist in the QUMP project (Quantifying Uncertainty in Model Predictions) at the Met Office, Exeter.

Meetings Diary

This year's annual meeting will be held at New Hall, Cambridge, on **7-8 July 2004**. The annual meeting is your opportunity to present and discuss COAPEC science with other members of the COAPEC community. This year we hope to have two keynote speakers to provide us with a focus for discussions: Richard Greatbatch (Dalhousie University) has already agreed to speak.

In advance of the annual meeting, on **6 July**, also at New Hall, we will have the **first COAPEC students' workshop**. As the first (and only) year in which we will have our full complement of COAPEC students, this is an opportunity to present work in a totally non-threatening environment (no PIs allowed), discuss your work and experiences with other students and hopefully make links that will help in further studies.. This workshop is open to COAPEC funded students and also to students working on related projects.

Student Opportunities

As well as the student workshop, there are several opportunities for students within COAPEC. The new Beowulf cluster (see the article on page 11) is open for use by students for any COAPEC related research, whether on COAPEC funded projects or not. To apply to use the cluster, simply contact Alan Iwi (A.M.Iwi@rl.ac.uk) with details of the project.

For students funded by COAPEC, there are some funds allocated to help with unforeseen travel or training costs. These have been used in previous years to fund students on the Cambridge GEFD course and are also funding a student to travel to the US to follow up a research opportunity. If you have a proposal to use these funds, simply contact the Science Co-ordinator (h.snaith@soc.soton.ac.uk) with details.

Bjerknes Compensation and the Decadal Variability of Energy Transports in a Coupled Climate Model

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The climate system can be thought of as a heat engine. Radiative energy coming in at the top of the tropical atmosphere is transported towards the poles by the

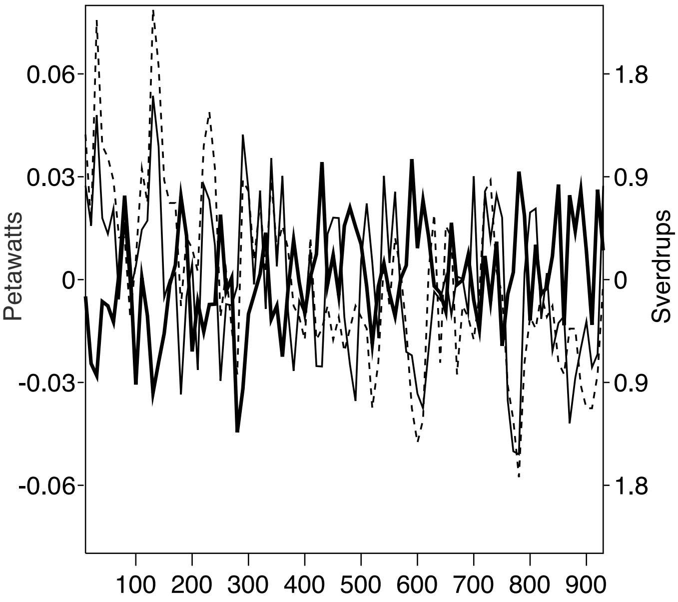

Figure 1. Time series of decadal anomalies in extratropical (20˚N to 70˚N) atmospheric energy transport (bold), Atlantic Ocean energy transport (solid) and Atlantic Meridional Overturning Circulation Index (dashed).

atmosphere and the oceans, where the climate system cools by longwave radiation. Bjerknes (1964) argued that if the top of the atmosphere radiative fluxes did not vary greatly and the heat storage was nearly constant, then the total energy transport would not vary greatly either. It follows that if either the atmospheric or oceanic energy transport were to change significantly, for example due to internal variability, then the other component would have to compensate, so a weaker atmospheric energy transport would be compensated for by a stronger oceanic energy transport. This simple mechanism has become known as Bjerknes compensation and might provide an insight into the processes by which the atmosphere and the oceans couple.

The relatively small number of observations in the oceans means that the variability of the oceanic energy transport is not as well known as it is in the atmosphere, making it difficult to use observational evidence to determine whether Bjerknes compensation is a relevant model of the climate system. However, long integrations of coupled climate models that can be run without flux adjustment provide an excellent test-bed to appraise the ideas of Bjerknes. This study makes use of the long control integration of HadCM3, the UK Met Office's climate model (Gordon *et al.*, 2000), to investigate the potential for compensation between the oceanic and atmospheric energy transports.

Figure 1 shows the timeseries of the decadal anomalies of the atmospheric and oceanic energy transport in the northern extratropics. The decadal variability of the atmospheric energy transport has approximately the same magnitude as that of the oceanic energy transport, and furthermore, the timeseries are significantly anti-correlated (-0.57). In HadCM3 the partially compensating energy transports in the atmosphere and oceans are, to some extent, consistent with the behaviour predicted by Bjerknes. The question that is now raised is what are the processes that lead to the partially compensating energy transports?

Figure 1 also shows the decadal timeseries of the maximum meridional overturning in the North Atlantic, which is a measure of the strength of the thermohaline circulation. It is clear from figure 1 that the decadal variability in the oceanic energy transport and the partially compensating atmospheric energy transport are associated with fluctuations in the meridional overturning in the North Atlantic. Changes in the strength of the meridional overturning will be directly related to changes in the oceanic energy transport, but how do changes in the meridional overturning influence the atmosphere and its energy transport?

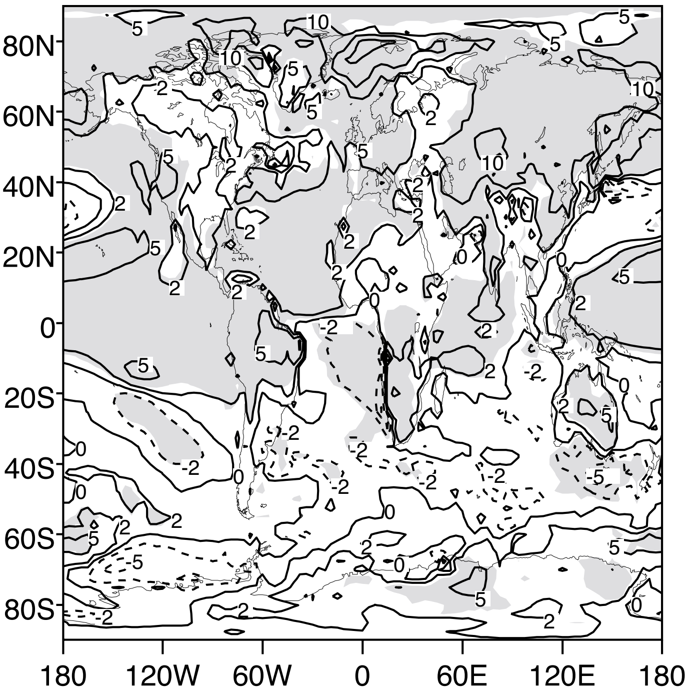

Figure 2. The regression of surface temperature against the decadal Atlantic Ocean energy transport averaged between 30°S and 70°N. The contour intervals are at -40, -20, -10, -5, -2, 0, 2, 5, 10, 20, and 40 $K\,PW^{-1}$. Negative contours are dashed and shading denotes regions that are 95% significant.

A stronger North Atlantic energy transport leads to a warming of North Atlantic ocean, with a strong warming at high latitudes in the Greenland Sea and a weaker warming at lower latitudes (figure 2). The changes in the Sea Surface Temperature associated with stronger oceanic energy transport lead to a reduction in the equator to pole gradient in the surface temperature, which reduces the baroclinicity in the atmosphere. The lower baroclinicity leads to a weaker transient heat transport in the North Atlantic storm track, and so to a weaker total atmospheric energy transport.

In summary, it appears in HadCM3 that the decadal variability in the North Atlantic meridional overturning has a direct impact on the oceanic energy transport and has an indirect affect on the baroclinicity of the North Atlantic storm track. The result is partially compensating decadal anomalies in the oceanic and atmospheric energy transports, a result which is consistent with the predictions of Bjerknes compensation. Whether similar processes can be found in other coupled climate models or in observations is an issue that warrants further study.

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Probabilistic Attribution of the UK Autumn 2000 Floods using a Forecast Resolution Global Atmospheric Climate Model and Distributed Computing

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The UK floods of October 2000 occurred during the wettest autumn in England & Wales on record (Alexander and Jones, 2001), causing widespread damage and an estimated insured loss of £35-50 million. In this article we outline our plans to use the 'probabilistic attribution' process to answer the question:

> *"What fraction of risk have past anthropogenic emissions of greenhouse gases contributed to the risk of a flooding event as serious as that of October 2000".*

We use a forecast resolution atmospheric climate model (as illustrated in figure 1) to make our assessment and give some details of the proposed distributed computing set-up and current model performance.

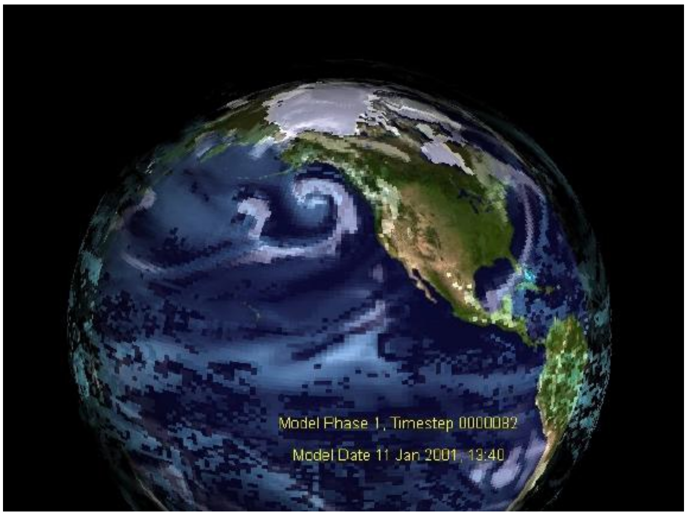

Figure 1. A visualisation (showing cell-based cloud) from our current high-resolution atmospheric climate model running on a Windows desktop PC.

Theory:

Probabilistic attribution is the process of quantifying the contribution of a specific driver (in this case greenhouse gases) towards the probability of occurrence of an inherently unpredictable event (such as a flood). The concept is illustrated schematically in figure 2.

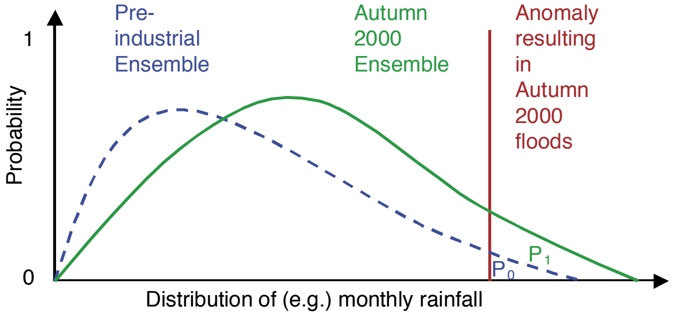

Figure 2. Schematic of probabilistic attribution.

i) The 'Autumn 2000' distribution is estimated from an ensemble of model simulations of the UK climate for the 4-6 months leading up to and during the autumn 2000 floods, under the greenhouse gas levels, sea surface temperatures and sea-ice at that time.

ii) The 'Pre-industrial' distribution is a similar ensemble, but now with greenhouse gas levels, sea surface temperatures and sea-ice adjusted to represent pre-industrial conditions.

iii) We then analyse available observations to identify the rainfall anomaly that caused the Autumn 2000 floods and derive the analogous "event" in the model, shown by the vertical line. P1 and P0 (figure 2) are the risk of such an event occurring in the autumn 2000 and pre-industrial climate respectively. It then follows that the fraction of risk attributable to anthropogenic greenhouse gases is given by (Allen, 2003):

$$R = 1 - P0/P1.$$

Values of R close to '1' or '0' would suggest that all or no risk of the autumn 2000 floods occurring during that time was attributable to anthropogenic greenhouse gas emissions.

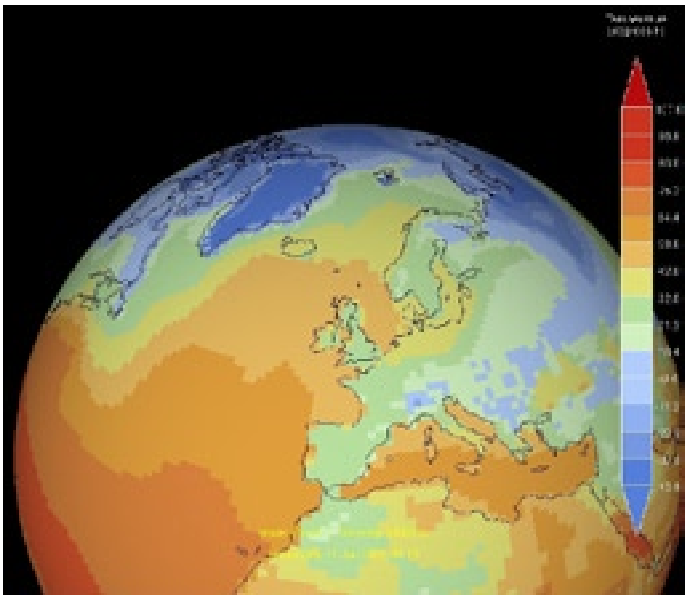

Figure 3. An anthropogenic climate change signal will be accounted for in the model via CO_2 levels, sea-ice and Sea Surface Temperatures.

This process is then repeated to allow for uncertainty in the sea surface temperature change attributable to past greenhouse gas increase estimated using conventional "detection and attribution" methods. Specifically, the 'Autumn 2000' ensemble will based on an atmosphere-only model driven with observed sea-surface temperatures for June-November 2000. We then generate a number (order 10) of possible 'pre-industrial' ensembles by subtracting possible versions of the greenhouse-gas-induced sea-surface temperature change to date that have been estimated by sampling the distribution of past attributable changes (*e.g.* from Stott and Kettleborough, 2002).

Model:

We use HadAM3 - the atmospheric component of Third Hadley Centre Coupled Model (Gordon *et al.*, 2000) in a high-resolution (HRES, N144) configuration, giving a horizontal resolution of approximately 100 km^2 at mid-latitudes. Results from seasonal forecasting experiments suggest a minimal role for coupled processes in the Autumn 2000 event (Massacand, 2003), justifying our use of an atmosphere-only model. The subsequent advantage is that integration times are shorter in real-time and more manageable (see set-up and model performance section below).

Previous studies (Pope and Stratton, 2002) have suggested that some model biases are reduced and features such as the jet stream – the anomalous southward displacement of which, leading to a persistence of rainfall over the UK, is what is believed to have been the cause of the flooding (Blackburn and Hoskins, 2001) - are improved at HRES compared to the standard climate resolution. However, from the same studies, we anticipate biases in the hydrological cycle due to the presence of unrealistic feedbacks such as those in soil moisture that will have to be guarded against.

Anticipating that the Autumn 2000 events were relatively unlikely, even given the sea-surface temperature and greenhouse gas levels prevailing at that time, each of these ensembles will need to be quite large (50-100 members), so the total number of model-years required would be in the region of 250-500 with a high-resolution global atmosphere model. This would represent a very significant resource requirement for conventional computing facilities: hence our proposal to use a distributed approach.

Distributed computing set-up and current model performance:

The implementation of the high resolution model is driven under the BOINC (Berkeley Open Infrastructure for Network Computing) framework which is engineered by the Seti@Home team and provides a robust framework for running distributed networked applications (see http://boinc.berkeley.edu/). Leveraging applications with BOINC enables a wide range of parallel applications to execute in a distributed environment. The architectural design is a typical client server mode with one or more scheduling and data servers for handling experiments' requests, which may or may not be one and the same machine. It is anticipated that future enhancement will permit peer-to-peer communication between participating clients.

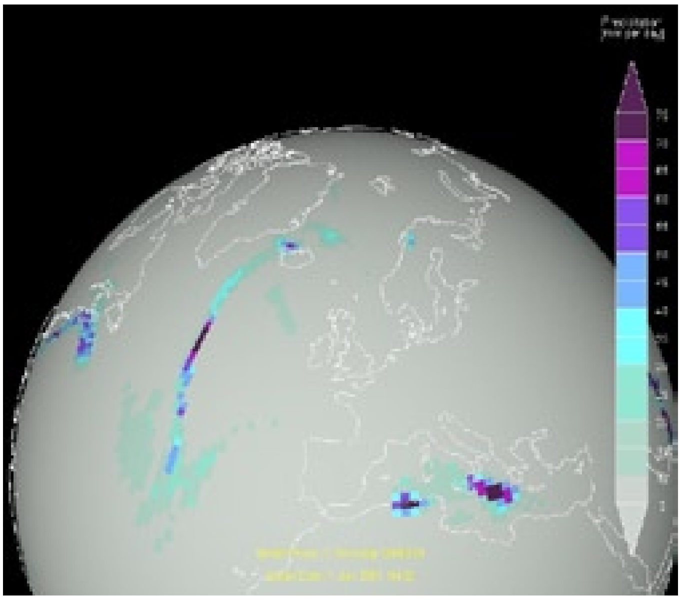

Figure 4. We aim to capture and attribute, in our high-resolution model, the precipitation events associated with the UK Autumn 2000 floods.

The BOINC framework supports large data transfer, storage and management to cater for the demands of running a full resolution climate model on a desktop machine. Additional features such as the 'trickle-back' mechanism and federated upload servers will make it possible for a wide range of distributed computing applications to be developed within a common application framework.

Several BOINC based projects are currently underway including CHARMM, climate*prediction*.net and Folding@Home. We aim to implement our BOINC project 'in-house' at Risk Management Solutions Ltd., a re-insurance firm who are becoming interested in attribution studies, using their desktop Windows PC's.

Currently the model performs approximately 17-20 minutes of model integration per real minute on a 3 GHz processor. The memory requirement is 600 MB. Thus, running continuously, we can simulate 6 model months in approximately 3 real weeks.

Concluding remarks:

The first set of model results are expected in late spring but preliminary results show that mesoscale type features as seen in the illustrations can be generated.

It remains to be seen whether the model can sufficiently reproduce the precipitation signal that was present during the time of the autumn 2000 floods. It may be the case that we have to relax our criterion of an 'event' in the model, appealing instead to the model's ability to capture the large scale meteorology, such as the 'Scandinavian pattern' which was present during the autumn 2000 period or some other large-scale measure of variability.

We intend to use the ECMWF ERA analyses (see http://www.ecmwf.int/products/data/archive/) for our model validation. We shall also appeal to extreme value theory making use of the fact that the September-October-November precipitation-pressure correlation pattern was an anomalously large occurrence of an otherwise annually recurring and similar pattern (Blackburn and Hoskins, 2001). One consequence of this is that one could fit a statistical model to observations of this pattern from which inferences could be made to aid extrapolation in the tails of the distributions of model output.

If successful, this model could be used to perform similar probabilistic attribution studies on past or future 'iconic' meteorological events which occur on the seasonal timescale. Furthermore, the distributed computing architecture of the project is favourable for its inclusion in future high resolution climate*prediction*.net projects involving coupled models.

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Accuracy of Sea-Ice Observations and Impact on GCM Simulations

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Sea-ice concentration and area are important variables in climate modelling due to their effect on surface albedo and because open-water areas within the ice pack are of major significance for ocean-atmosphere heat/ moisture exchanges. Consequently, accurate representations of these fields are essential both for driving atmospheric models and for evaluation of coupled GCMs (modelled sea-ice).

There are several observational datasets of sea-ice concentration available covering the period since the introduction of routine satellite imaging. Discrepancies arise between datasets due to the varying sources and processing methodologies used to derive them (Singarayer and Bamber, 2003) which may have a measurable effect on simulation results and thus requires investigation.

Four datasets of sea-ice concentration have been examined: the NASA team and Bootstrap datasets (1979-2001), both derived from passive microwave radiometry (PMR) using different algorithms (available from the National Snow and Ice Data Center - NSIDC), the National Ice Centre (NIC) records (1972-1994), which are compiled from several sources including AVHRR, OLS (Operational Linescan System) and PMR, and the standard HadAM3 UKMO (U.K. Met Office) sea-ice climatology.

The datasets show the largest differences in summer. For example, the NIC ice covered area is greater than the NASA team by 5-10% for most of the year, which rises up to 23% larger in summer (figure 1). The greater summer differences suggest that the effect of surface melt on PMR ice concentration retrievals is

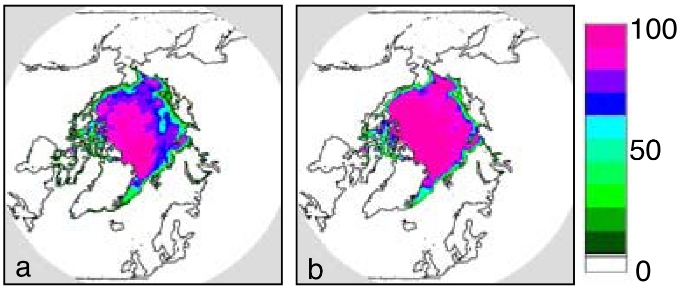

Figure 1. Sea ice concentrations from (a) NASA team (b) NIC records, for September 1994.

one of the main causes of the discrepancies. However, validation studies have found it difficult to demonstrate that one dataset is more reliable overall.

Four simulations of 41 years were performed to examine the impact of the sea-ice concentration variations on the climate, using four sea-ice climatologies based on NIC, NASA team, Bootstrap and UKMO sea-ice. The last 33 years were integrated (initial 8 year spin-up discarded).

The warmest climate was simulated with the NASA team ice (which has the lowest ice concentrations). The largest differences between simulations were in winter, despite the greater accuracy of sea-ice observations at this time of year (>12˚C in some Arctic regions, see figure 2; winter global difference, 0.11˚C). Climate was much less sensitive to summer sea-ice specification.

In areas of reduced sea-ice there was also a reduction of Sea Level Pressure over the Central Arctic and increases in outgoing sensible heat flux from the prescribed ocean up to 40-50 Wm^{-2} near the sea-ice edge in winter. However, changes in surface fields did not alter patterns of pressure and circulation higher in the troposphere. There was greatest increase in low cloud cover and precipitation near the ice edge, where sea-ice discrepancies are largest. Spatial patterns of internal variability (North Atlantic Oscillation) do not appear to be significantly affected.

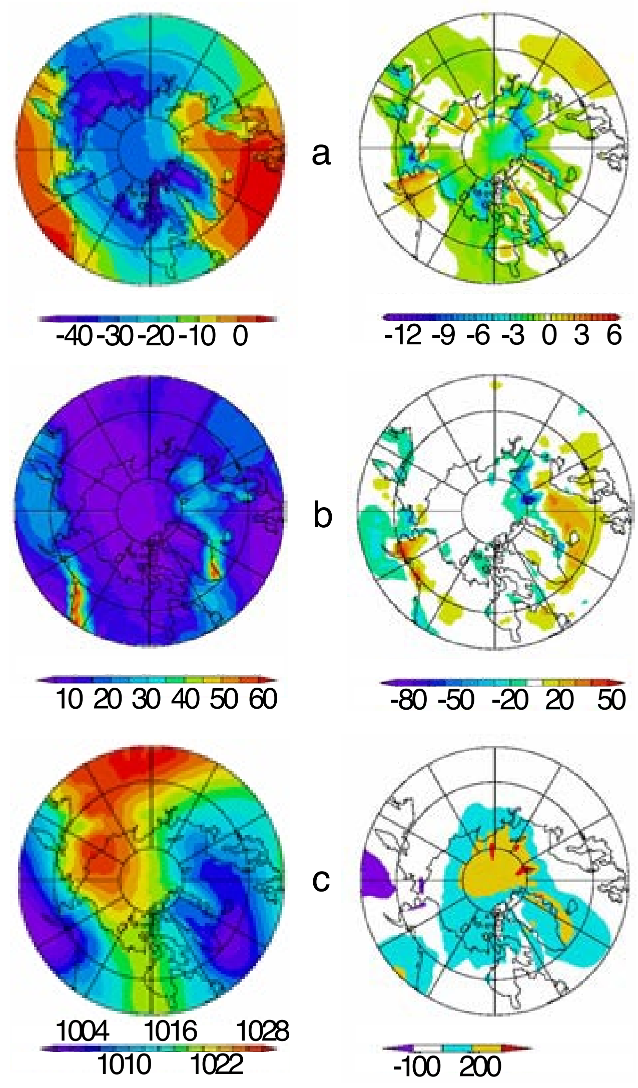

Figure 2. December-January-February means of (a) Surface Air Temperature, ˚C (b) snowfall rate kgm^{-2}s^{-1} (c) Sea Level Pressure, hPa, for NASA team (lhs) and NIC minus NASA team anomalies (rhs)

The results suggest that prescription of sea-ice concentrations requires greater accuracy in winter than in summer. Discrepancies of over 20% ice-covered area have little impact on the mean climate, while 5-10% differences in winter have Arctic-wide consequences for surface climate conditions.

Ongoing work is focused on coupled ocean-atmosphere simulations with a sophisticated sea-ice model to investigate the influence of sea-ice on climate variability.

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Use of Spatially Dependent Inverse Analysis Techniques to Close the SOC Flux Climatology Ocean Heat Budget

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Improving current estimates of the transfer of energy between the atmosphere and the ocean is important for COAPEC modelling studies both in order to provide boundary conditions for ocean models and for verification of the flux fields obtained from coupled ocean-atmosphere models. Previously (COAPEC Newsletter, No. 3) we reported on work to improve the SOC air-sea flux climatology. The original climatology was adjusted using the inverse analysis method of Isemer *et al*. (1989) with 10 hydrographic estimates of heat transport as constraints. The heat budget was balanced to within 2 Wm^{-2} by making globally fixed parameter adjustments. The most significant adjustments were an increase of 19% to the latent heat flux and a reduction of 6% to the shortwave flux (Grist and Josey 2003, hereafter GJ03). The adjusted fluxes agreed well with area averaged heat flux estimates obtained using a hydrographic section that was withheld from the analysis and also with the global ocean heat transport obtained using residual techniques. However comparisons of the adjusted fluxes with measurements made by various Woods Hole Oceanographic Institute research buoys yielded mixed results.

We have now extended the inverse analysis method to allow for spatially varying parameter adjustments. The solutions obtained with the spatially dependent adjustments are described in detail in Grist and Josey (2004a). In the new method, the global ocean is divided into various sub-regions in order to allow the parameter adjustments to vary spatially. With this approach a balanced version of the SOC climatology was obtained that required smaller adjustments, in the range 2-12%, to the latent heat flux than previously, but larger changes to the shortwave, up to 18%, depending on the region. Improvement was found in the level of agreement with the hydrographic measurements of heat transport. However, the buoy comparisons revealed similar problems to those obtained in GJ03. In addition to enabling direct spatial dependence of the parameter adjustments, we also explored the possibility of making the parameter error spatially dependent both by sub-region and through a dependency on observation density. The introduction of spatially dependent error had little influence on the results. This suggests that when applying the new method to the SOC climatology, variations in the prescribed parameter error are of secondary importance to the magnitude of the differences between the climatology and hydrography in determining the adjustments.

Although the spatially varying parameter adjustments provided improvements in some areas, the larger adjustment to the shortwave flux lead to significant differences with respect to satellite based estimates of this component of the flux (Grist and Josey, 2004b). In particular the global mean shortwave flux with the new fields based on spatially varying parameter adjustments is now 27 Wm^{-2} less than the corresponding satellite based value and it is difficult to see what processes could account for such a large discrepancy. We concluded that the earlier solution, in which the latent heat flux is increased by 19%, is in better agreement with independent estimates than the new spatially dependent solutions. Thus, although the new method is a useful development of the inverse analysis technique which will find greater application as additional constraints become available in the future, our preferred means of closing the SOC climatology heat budget imbalance remains that derived from spatially fixed parameter adjustments and presented in GJ03. This solution is available from the project website* to interested users.

*http://www.soc.soton.ac.uk/JRD/MET/coapec.php.

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The Hot Summer of 2003

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The anomalously hot summer of 2003 resulted in wide-spread wild fires and an estimated 14,000 extra deaths from heat-related illness in France alone (see for example Grazzini *et al.* (2003). The question of whether such climate anomalies are more likely in the current climate than they have been in the past is important from both humanitarian and scientific points of view. Both the causes of the event and its place in interannual variability are key to this issue. This article uses reanalysis data to compare the temperature anomalies that occurred during 2003 to those observed in the past, and describes the large-scale circulation and climate anomalies associated with them.

Comparison between the 2003 event and the previous warm events

Figure 1a shows a time series of June-August surface air temperature over Western Europe (10˚W-20˚E 35-60˚N) from 1948 - 2003. The data are taken from the NCEP reanalysis. The mean seasonal surface temperature in 2003 is 21.15˚C - an anomaly of 2.4˚C (5.1 standard deviations from the mean). It should be noted that the magnitude of the anomaly is explained in part by a warming trend. In order to assess this, the post-1976 linear warming trend was removed from the data. The resulting time series is shown in figure 1a as a dashed line. It can be seen that, even with the linear warming trend removed, 2003 has a greater anomaly than any previous summer since 1948, indicating that the anomalous warming was not due entirely to the warming trend. This is consistent with the conclusions of Schar *et al.* (2004), who showed that the summer

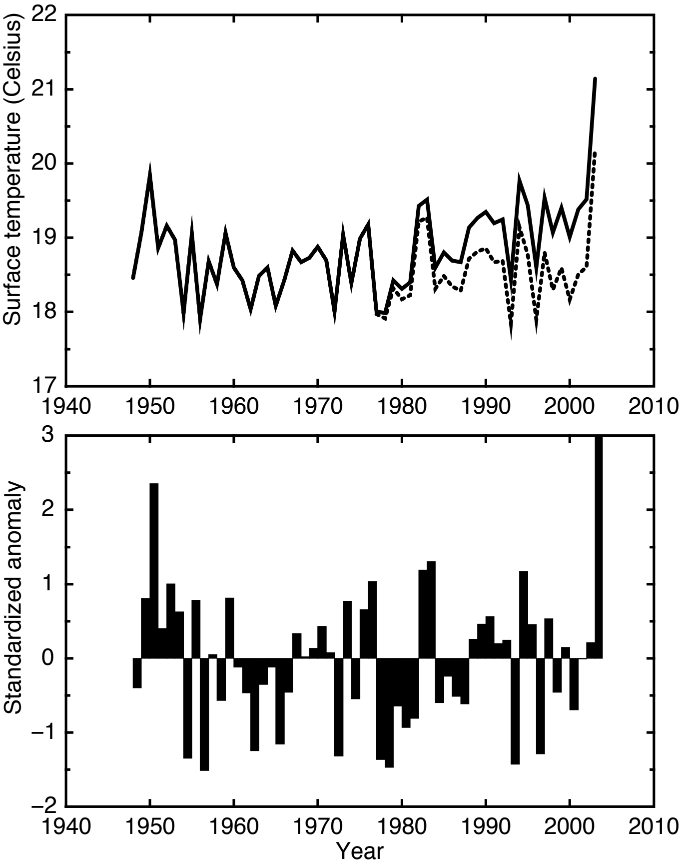

Figure 1. a) Time series of June-August 2 m air temperature for western Europe (10˚W-20˚E 35-60˚N). The dashed line is the data with the linear warming trend removed b) as for (a) with the standardized detrended anomaly

of 2003 was unusual, even when the warming trend is accounted for. However, figure 1b, which depicts the standardized and detrended anomalies, shows that when the warming trend is removed, the warm anomalies in 2003 are 3 rather 5 standard deviations from the mean. Moreover, there have been years within the reanalysis period, such as 1950, when temperature anomalies of well over 2 standard deviations from the mean were observed. Further analysis reveals that there have been extremely warm European summers in the instrumental record. Piervitali *et al.* (1997), for example, showed that there were anomalies of 3.5˚C relative to 1950 - 1980 climatology centred over Poland. For comparison, the maximum anomalies observed in the summer of 2003 were 4.5˚C relative to this climatology.

In summary, although the summer of 2003 was unusually warm (even allowing for the warming trend), the standardised anomalies were comparable to those observed during exceptionally warm summers in the past. There is thus no reason to suppose that the event was a one-off occurrence.

Evolution of the event

Figure 2 shows the evolution of SST anomalies between April and August and the 2 m air temperature on land. All anomalies are standardised and detrended. It can be seen that Britain and France were quite warm during April, although further east there was cooling. At this time, a patch of cold Sea Surface Temperature (SST) in the North Atlantic developed. During May (not shown), warming started in the Mediterranean and warm air temperature anomalies were also observed in continental western Europe. In June, both the warming over western Europe and the Mediterranean, and the cool anomalies in the North Atlantic intensified. During July (not shown), the warm anomalies reduced slightly over western Europe, although the warming in the Mediterranean persisted. During August, the warm event re-invigorated over the whole of western Europe, resulting in the greatest anomalies of the summer. In contrast, some of the remote anomalies associated with the event such as the North Atlantic and Eastern European cooling and western Indian Ocean warming weakened.

The warm anomalies described above were accompanied by circulation and precipitation anomalies (not shown). The circulation anomalies peaked during June, with strong anti-cyclonic flow resulting in dry hot conditions. They then weakened during July, at which time the temperature in western Europe was only moderately above normal. It is interesting to note however, that the circulation anomalies remained relatively weak in August, when the strongest warming occurred. It is possible that these exceptional anomalies were related to the anomalously dry surface conditions that resulted from the persistent drought.

It is speculated that the first heat wave in May and June was triggered by the strong, hot anti-cyclonic circulation, and the second heat wave, in August, was exacerbated by the dry land-surface conditions. GCM experiments using idealised land-surface and SST conditions will be used to test these hypotheses.

Conclusions

- Even when the warming trend is accounted for, summer 2003 was exceptionally hot. However, when the trend is removed, the surface temperature anomalies are comparable with previous hot summers (such as 1950 and 1834).
- The event can be divided into two parts: May-June when the heat wave was associated with anomalous anti-cyclonic circulation and August, when the heat wave may have been exacerbated by the dry land-surface.

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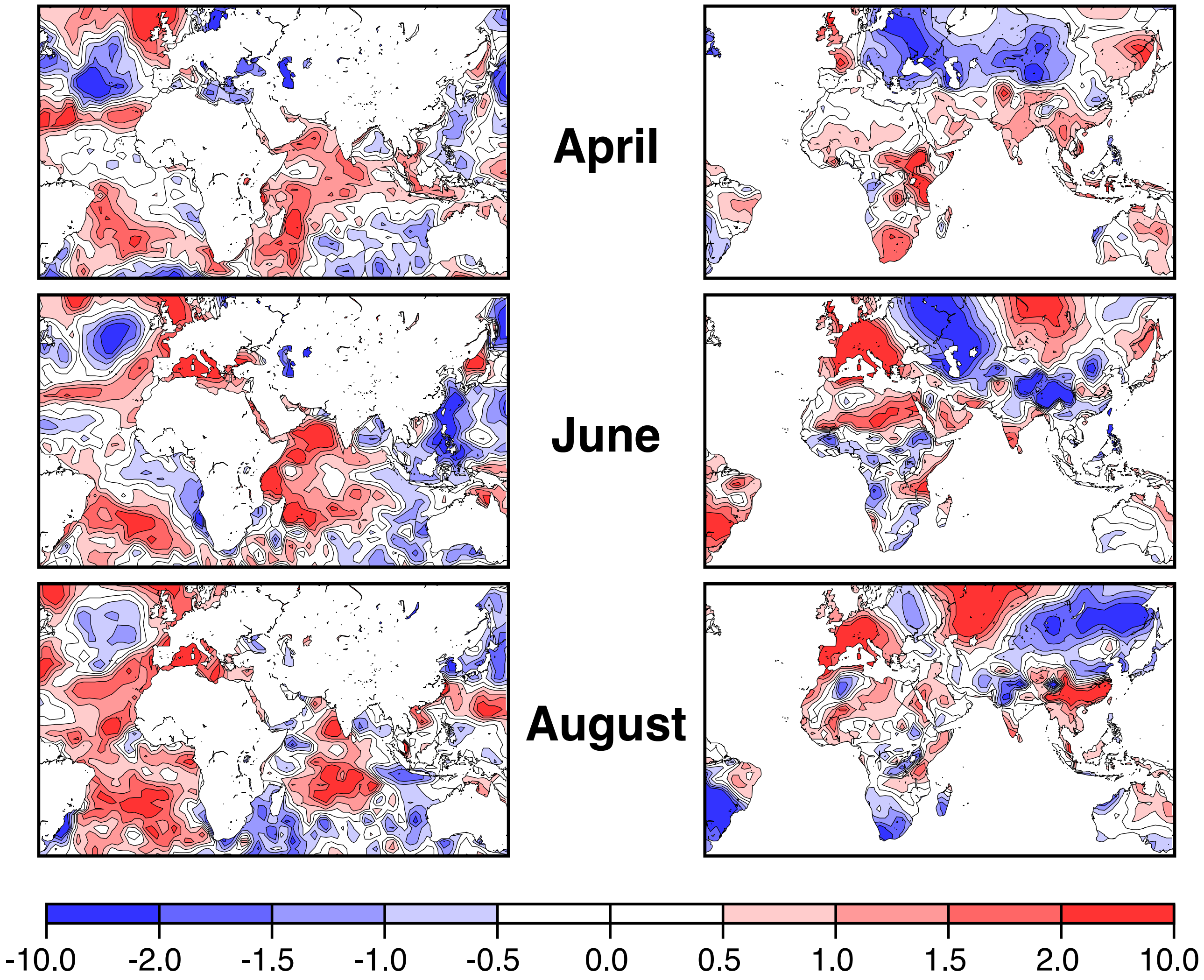

Figure 2 Left panel: Sea Surface Temperature detrended standardized anomalies for April, June and August 2003. Right panel: Surface Air Temperature detrended standardized anomalies for April, June and August 2003.

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Schar, C., P. Vldale, D. Luthl, C. Frel, C. Haberll, M. Llnlger and C. Appenzeller (2004). The role of increasing temperature variability in European summer heatwaves. ***Nature***, **427**, 332-336.

COAPEC Data

Whilst COAPEC is not primarily an observational data collection programme, data are being collected in the South Atlantic as part of the ARGO programme, funded by COAPEC. Fifteen floats were deployed at 30°S in November 2003, from the *RV Mirai*. Data from the 14 working COAPEC floats are held at BODC and can be most easily found from links on the Met Office ARGO UK float page at:

http://www.met-office.gov.uk/research/ocean/argo/ukfloats.html

The main data source for the COAPEC programme has been the output from climate models, made available through the BADC. These datasets are described in the following two articles from the BADC.

The COAPEC Data Archive at the BADC

British Atmospheric Data Centre

The British Atmospheric Data Centre (BADC) is the Natural Environment Research Council's (NERC) Designated Data Centre for the Atmospheric Sciences. The role of the BADC is to assist UK researchers to locate, access and interpret data. It also ensures the long-term integrity of data produced by a number of sources, including NERC projects and the Met Office. One such data collection is the BADC COAPEC archive.

Over the past 3 years, this collection has grown in size to almost 1 TB, and contains data from a number of sources.

- 100 years (2079 - 2178) of monthly means of 107 atmospheric and 54 oceanic parameters derived from the control run of the Hadley Centre HadCM3 model (binary PP format).
- 1000 years (1849-2849) of monthly means of 47 selected atmospheric and oceanic parameters from the HadCM3 control run (binary PP format).

- 50 years (1950-2000) of MOM (GFDL Modular Ocean Model) data (gzipped NetCDF format).
- Output from the 500 year HadCM3 control integration produced using UM4.5 on the COAPEC Beowulf Cluster (gzipped NetCDF format). (See the article later in the newsletter for more details on this model run).

In addition, data from the ECMWF Seasonal Hindcast project has recently been added to the archive. These are derived from seasonal forecast ensemble data, and consist of monthly means, maxima, minima and standard deviations for the available surface variables for the period 1987-2001. A number of atmospheric variables are also available as monthly means (see the following article for further details).

Access to COAPEC data at the BADC is restricted to academic researchers only, but all that is required is for the user to register with the BADC (if not already registered), and to complete and sign the Met Office Agreement form. This should then be returned to the BADC (see http://badc.nerc.ac.uk/data/coapec/ for details).

The data themselves can be accessed in a number of ways. The normal method is via the BADC web interface to the archive using the BADC data browser. This permits the user to browse and download either single or multiple files. Alternatively, users may use the ftp server (ftp://ftp.badc.rl.ac.uk) to download data directly. Both of these require the user to download the data to their local system for analysis.

Software utilities are also available from the BADC to allow these data to be subset, visualised and converted to other formats (see http://badc.nerc.ac.uk/help/software/xconv/). These utilities are particularly useful for dealing with data in binary PP format and example scripts are also available.

A new method to access these data is currently under development. A dedicated Live Access Server (LAS) for COAPEC users is being set up at the BADC. This will allow users to access, subset and visualise COAPEC data on BADC systems via their web browser, thereby greatly reducing the amount of data they need to download. This service should be available by the end of March.

Another resource available to the COAPEC community is via the CAST (Collaboratory for Atmospheric Science and Technology) site at the BADC (http://cast.rl.ac.uk/production/hosts/coapec/). This provides a workspace where information can be easily exchanged and COAPEC issues discussed. Information on the current status of the COAPEC data collection is included on the CAST site.

The BADC are always keen to improve and develop the service we provide. If you have any ideas for improvements, please contact us at badc@rl.ac.uk.

ECMWF Seasonal HindCast Data

Ag Stephens
British Atmospheric Data Centre

In support of the COAPEC Programme the BADC has extracted seasonal forecast ensemble data from the ECMWF MARS (Meteorological Archive and Retrieval System) archive. These data are also known as “Hindcasts” as they are forecasts run retrospectively.

The ECMWF produced two sets of runs, System 1 and System 2. The data archived at the BADC are the System 2 runs, which use the atmospheric component Cy23r4 of the IFS (Integrated Forecasting System) with a horizontal resolution of TL95 at 40 levels in the vertical. This is the same cycle of the IFS used for the ERA-40 re-analysis.

The BADC has extracted monthly means, maxima, minima and standard deviations for the available surface variables for the period 1987-2001 (with 2002 onwards currently being extracted). Atmospheric variables are only currently available as monthly means. The data are held as part of the main BADC Operational ECMWF archive and are also linked from the COAPEC data archive, although you must be registered to access the ECMWF operational dataset to traverse the link (see below).

For each month there are six forecast months archived, with 5 ensemble members for 10 months of the year, and 40 ensemble members in May and November of each year. There are 33 parameters held on surface or single levels including winds, temperatures, heat fluxes, radiation, precipitation and soil moisture. Geopotential, Temperature, Specific Humidity, Relative Vorticity and Divergence are available on pressure levels.

The data are held on a regular 1.875 x 1.875 degree grid in GRIB format.

This dataset is now available to BADC users registered for the ECMWF Operational dataset and with documentation located at:

http://badc.nerc.ac.uk/data/ecmwf-op/seasonal_forecasts.html

There is some further documentation on the seasonal forecasts available at the following ECMWF links:

http://www.ecmwf.int/products/forecasts/seasonal/documentation

http://www.ecmwf.int/publications/newsletters/pdf/98.pdf

The COAPEC Beowulf Cluster

Alan Iwi (A.M.Iwi@rl.ac.uk)
Rutherford Appleton Laboratories

COAPEC has a “Beowulf” cluster of PCs at RAL, which is available for modelling use by all members of COAPEC, plus other students of COAPEC PIs, or students working on closely related topics. It can be used for running the Met Office Unified Model in standard configurations (*e.g.* HadCM3) on a fully supported basis, or for running any other modelling code with “best-effort” support.

The cluster (called “Lewis”) has 32 processors for job execution (16 dual-processor 2.4 GHz 512 MB Pentium 4 Xeon PCs). A 4-processor job typically computes 1.3 to 1.7 years of HadCM3 per day, depending on the diagnostics written. There is an extra node for interactive login, which also has some output visualisation software.

A 500-year control integration of HadCM3 has been run on the cluster and sample fields from this run are shown in figure 1. Model output (monthly, seasonal and annual means) and restart dumps are available to users via the BADC as part of the COAPEC data archive (see the previous articles), whether or not you register to use the cluster.

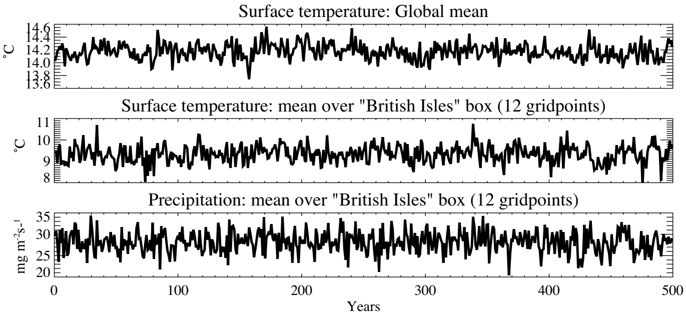


Figure 1 Sample plots from Beowulf HadCM3 control integration (annual means)

For further details of the cluster and the HadCM3 control run, including details on how to register to use the cluster, please see

http://home.badc.rl.ac.uk/iwi/lewis/lewis.html

or contact A.M.Iwi@rl.ac.uk.

The PRECIS Regional Modelling System

Emily Black (emily@met.rdg.ac.uk)
CGAM, Department of Meteorology, University of Reading

The resolution of standard coupled model data (approximately 3.750 x 2.50) is frequently insufficient for both impacts studies and detailed investigation of regional climate. For this reason, it is often necessary to downscale data. In some situations, regional modelling is preferable to statistical methods because no *a priori* assumptions about the statistics of the weather are necessary. On the other hand, regional models may be awkward to configure and relatively expensive computationally.

The Hadley Centre has attempted to address these issues through the development of a new regional modelling system - PRECIS (Providing Regional Climates for Impacts Studies). The system comprises a regional climate model (RCM) based on the Hadley Centre’s limited area model, a simple user interface and a system for displaying and manipulating RCM data. PRECIS runs on a high-specification PC.

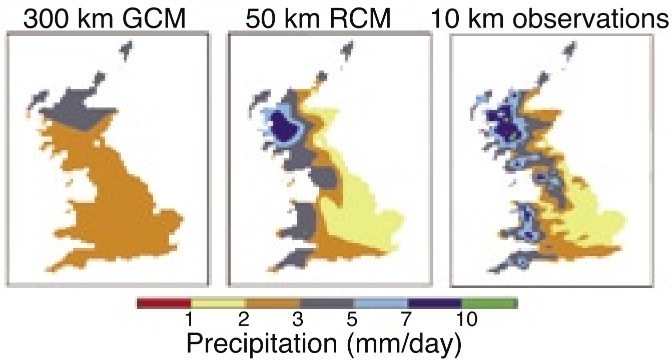
The Hadley Centre regional modelling group will provide lateral boundary condition data for any domain. The data available comprises reanalysis (ERA-15, and soon ERA-40), a control run of the Hadley Centre coupled model and various emission scenario runs. PRECIS will run at either 50 or 25 km resolution. An advantage of PRECIS is that it is easy to configure for different domains. The system has already been tested over Europe and found to perform well.

PRECIS is installed and running at CGAM in Reading. Over the next few months, I will be carrying out several integrations for Europe using both reanalysis and coupled model data. Subject to the appropriate permission from the Hadley Centre, I will be willing to make these data available to the COAPEC community. If COAPEC PI’s are interested in obtaining downscaled reanalysis and coupled model data, please contact me as soon as possible to ensure that I choose useful diagnostics.

For more about PRECIS see:

http://www.precis.org.uk

I can be contacted by email (emily@met.reading.ac.uk) or telephone (0118 3786608)



Patterns of present-day winter precipitation over Great Britain. Left, as simulated with a global model. Middle, as simulated with the 50 km regional model. Right, as observed. (courtesy of Richard Jones, Met Office Hadley Centre)

Meetings and Workshops

COAPEC Fluxes Workshop

The 3rd in a series of focused workshops on key COAPEC topics was held at the University of East Anglia (UEA) on Monday 23rd June 2003. The role of fluxes of heat, freshwater and momentum in coupled processes is a fundamental topic for COAPEC and is emphasized repeatedly in the COAPEC workplan.

The meeting was organized by the COAPEC core team, with help from David Stevens (UEA). There were about 30 attendees representing 7 Institutions. A full report of the workshop can be found on the COAPEC CAST site (see the link from the "Meetings" page of the COAPEC web site) but a brief outline is given here.

Keeping the key COAPEC workplan in mind, the objectives of the workshop were as follows:

1 Review the latest scientific results across the relevant COAPEC projects.

2 Describe and share analysis tools and methods.

3 Identify opportunities for interaction, collaboration and synthesis between the ongoing projects and external to COAPEC.

4 Note any gaps in coverage which could usefully be filled.

5 Summarize the direction and scope of further research.

These objectives were addressed by a series of five sessions, summarized in the following table. The presentations in each session were followed by short discussions.

Some of the attendees of the fluxes workshop, UEA

SESSION 1 Observed fluxes & transports	
Grant Bigg (UEA)	Changes in NCEP latent heat fluxes near the ice edge in the late 1990s?
Jeremy Grist (SOC)	Towards a Balanced Description of the Air-Sea Heat Exchange Through Inverse Analysis of the SOC Flux Climatology
Karen Heywood (UEA)	Towards heat and freshwater fluxes in HadCM3 and WOCE sections
SESSION 2 Freshwater / Salinity	
Martin Wadley (UEA)	Variability of salt fluxes through the Denmark Strait in the HADCM3 control integration
Bablu Sinha (SOC)	Surface fluxes, heat and freshwater budgets and watermass transformation in HadCM3
SESSION 3: Heat / SST	
Chris Old (ESSC)	Surface fluxes and water formation using T-Class diagnostics applied to HadCM3 data
Itsuki Handoh (UEA)	Surface heat fluxes in the "coupled" tropical Atlantic warm / cold event
Adam Blaker (SOC)	The impact of variations in the THC related cross-equator heat transport on the SST 'dipole'
SESSION 4: Related Programmes	
Rob Goddard (U. Newcastle)	SOLAS: the Surface Ocean-Lower Atmosphere Study
David Woolf (SOC)	What CASIX wants to do
SESSION 5: Fluxes and models	
Nick Faull (U. Oxford)	Flux adjusted coupled models for climate change experiments
Scott Osprey (RAL)	Stochastic forcing of the HOPE model – two steps forward, two Steps Back

Notes from the Editor

The Core team are always keen for your feedback on how they are doing. If you would like support from the core team, or would like to comment on how they are doing, then please email me. There is also an online form to request support from the core team - just click on the link from the COAPEC home page (if you don't have a note of the user id and password, just email me).

The Core Team are particularly interested in users interested in registering for the Beowulf cluster, and projects that may want access to data from the PRECIS regional modelling data.

If you have comments on the newsletter, or contributions for further editions, then please send them to me, the Science Coordinator :

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For any further information on the COAPEC programme, also contact me, or check the COAPEC web site:

http://coapec.nerc.ac.uk