

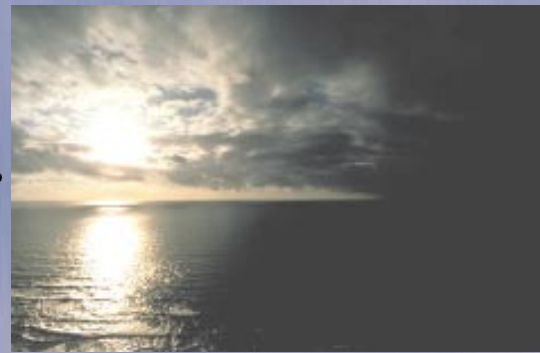
Climate Variability and Predictability

Climate Research

- The Challenge for the 21st Century -



A project of the World Climate Research Programme



What is **CLIVAR** ?

Understanding how the earth's climate system "works", documenting its variability, detecting and attributing human influences, determining the extent to which climate is predictable and developing predictive capabilities are scientific challenges that have enormous socio-economic relevance. **CLIVAR** is the WCRP project that addresses the physical aspects of these issues and focusses particularly on the role of the ocean in climate.



CLIVAR uses research observations of the atmosphere and oceans, operational data sets and analysis products, paleo data reconstructions of past climate and climate models, with the world's most powerful computers, to achieve these objectives.



Typical questions **CLIVAR** will help to answer

- Will there be an El Niño next year?
- Will the next monsoon cause droughts or floods?
- 'Warm and wet', 'cold and dry': What will next winter be like in northern Europe?
- How is the planet warming from human influences?
- How much will sea level rise in the 21st century?
- Will there be more extreme weather events because of global warming?
- Could climate make a sudden switch?

CLIVAR Observations and Data Sets

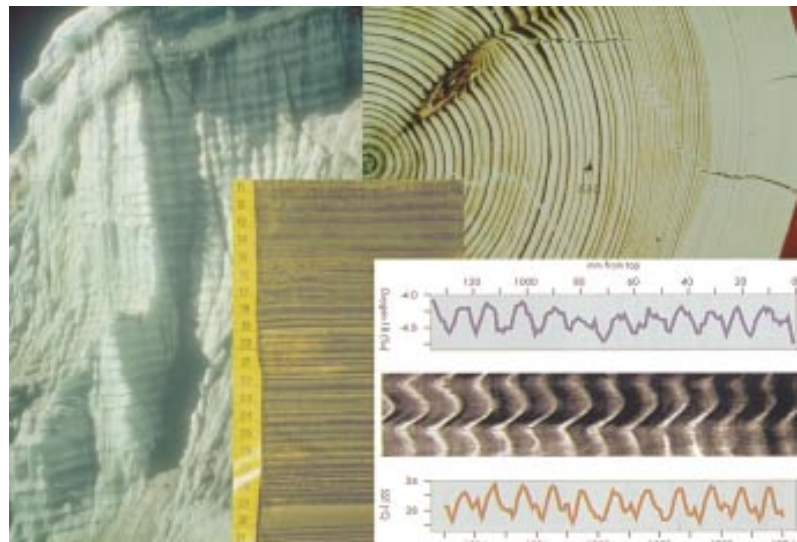
Since **CLIVAR** deals with variability a major challenge is to extend the climate record and to develop and implement an ocean observation system to meet the project's needs.



The oceans cover more than 70% of the earth's surface and contain 97% of its water. Ocean observations at present are sparse but are vital for our understanding of both short and long period climate variability. The WCRP's earlier World Ocean Experiment (WOCE) and Tropical Oceans Global Atmosphere (TOGA) projects have

impressively documented the value of an ocean observing system for climate research and climate predictions.

CLIVAR requires observations of the atmosphere, and analysis products derived from them. Indices such as number of days with frost or length of growing season also provide measures of climate variability and change.



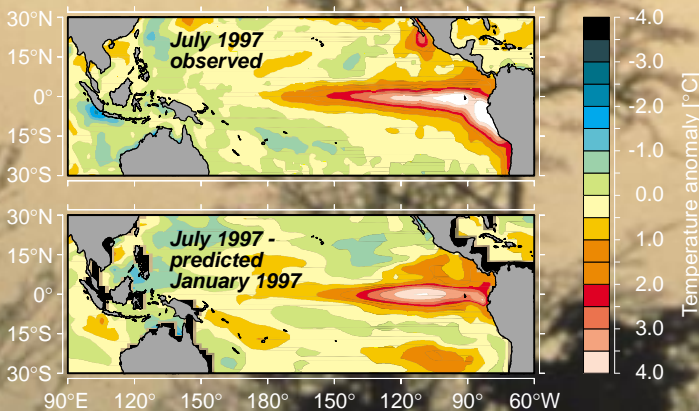
Proxy indicators (tree rings, sediments, ice cores, etc.) are the sole means of documenting climate prior to the instrumental record. **CLIVAR** cooperates closely with the International Geosphere-Biosphere Programme PAGES (Past Global Changes) to learn more about the past climate and its natural variability.

An important legacy of **CLIVAR** will be a better observing system and a much more comprehensive and extended climate record essential for understanding natural variability and human-induced change.

CLIVAR - Climate Variability - Seasons to Years

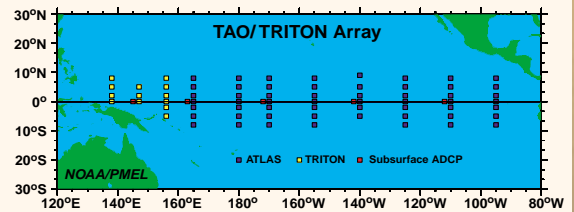
The best known phenomenon on these timescales is the El Niño - Southern Oscillation (ENSO). It affects millions of lives and has large economic impacts. Climate research has improved understanding and led to capabilities for making predictions.

Is El Niño predictable?



Observed and predicted SST anomaly in the equatorial Pacific for the last major El Niño event (courtesy M. Latif, MPI).

ENSO prediction is based on ocean-atmosphere models incorporating data from the Pacific Tropical Atmosphere Ocean (TAO) mooring array and the Japanese TRITON buoy system.



Many models have predicted individual ENSO events several months in advance. **CLIVAR** is working to give earlier warning of ENSO and to better predict its evolution.



agricultural production and society. **CLIVAR** with the Global Climate Observing System (GCOS) is developing and implementing the observing systems needed to describe these short-period climatic signals. This improved description is required before prediction of monsoons and of other regional climate variability can be further developed.

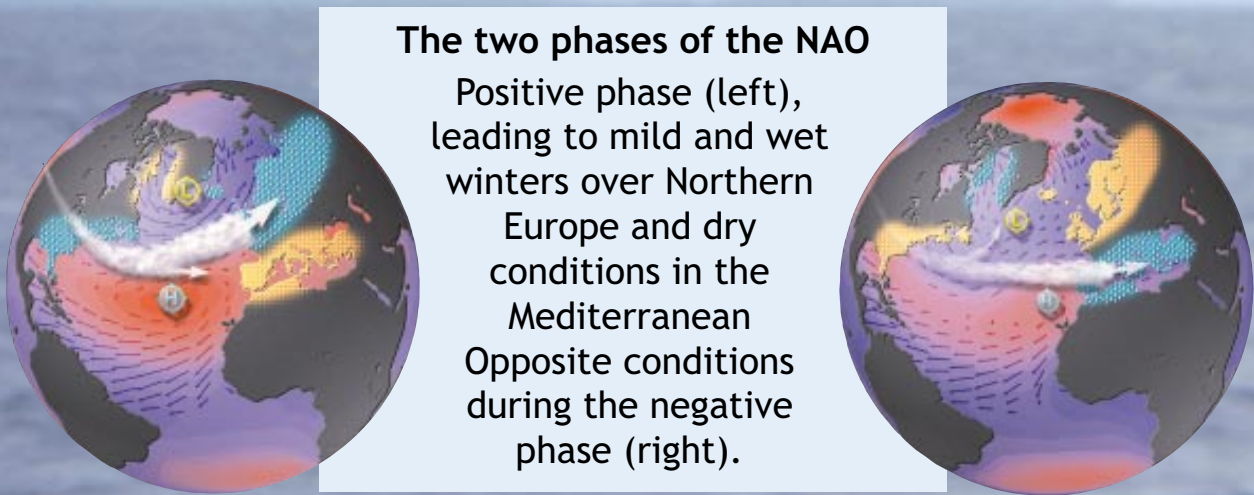
CLIVAR also has well-developed foci on the Asian-Australian and American Monsoon systems and on African Climate Variability all of which have impacts on water resources and thus

CLIVAR - Decades to Centuries

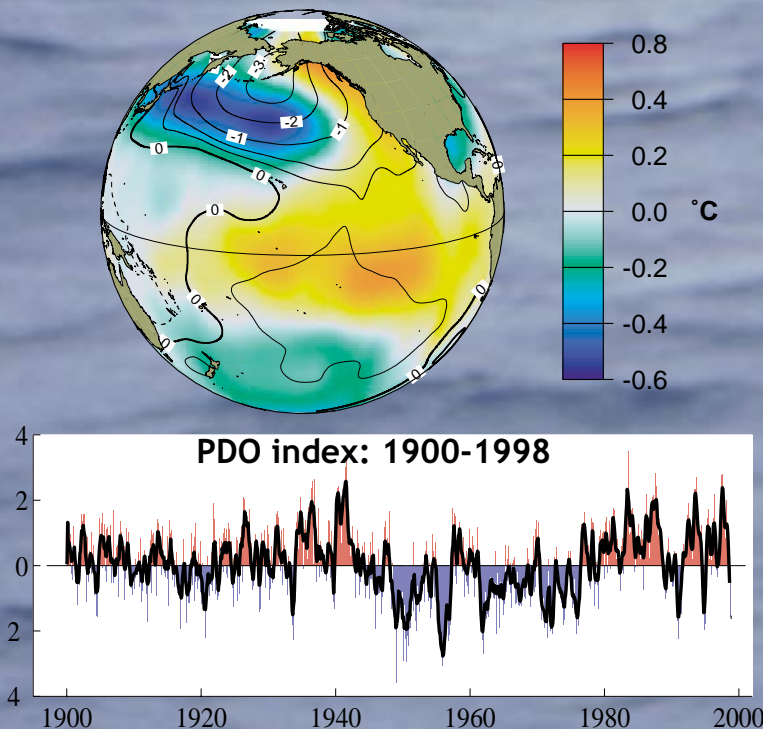
Climate varies on a range of timescales from seasons to millions of years. Many climate phenomena have timescales of decades. At these periods the oceans, because of their ability to store and distribute heat around the earth, play a vital role. Therefore **CLIVAR**'s focus on these phenomena (e.g. the North Atlantic Oscillation, the Pacific Decadal Oscillation and variability of the Southern Ocean) has a strong ocean emphasis.

The North Atlantic Oscillation

The main climate variability outside the tropics during wintertime over the North Atlantic region is due to the North Atlantic Oscillation (NAO).



Pacific Decadal Variability



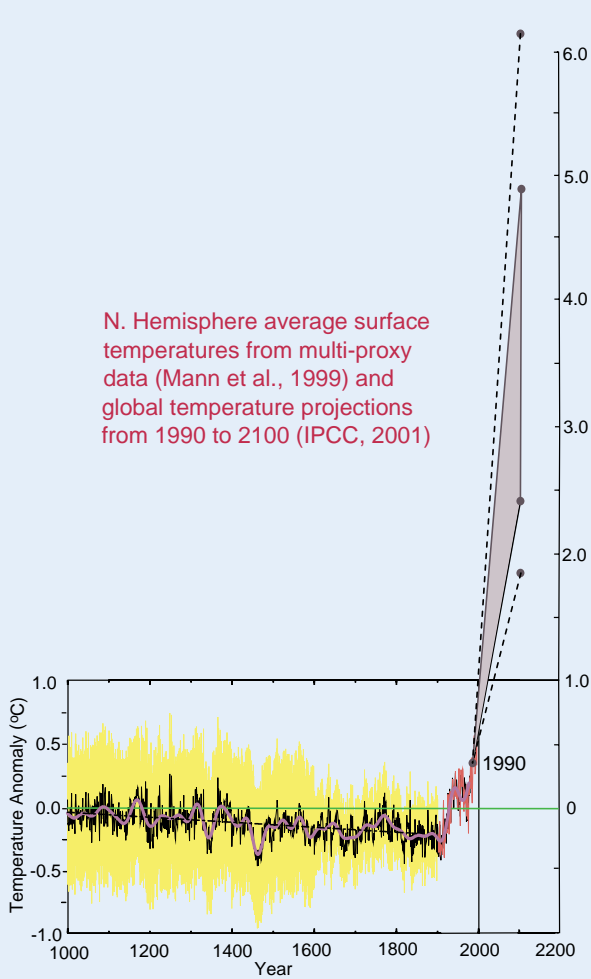
Upper left: Typical winter-time sea surface temperature (SST) (colors) and sea level pressure (contours) anomaly patterns during warm phase of the Pacific Decadal Oscillation (PDO).

Below: Time series of monthly PDO index.

The PDO is the main component of North Pacific monthly sea surface temperature variability poleward of 20°N (courtesy, N. Mantua, U. Washington).

CLIVAR - Detecting and Attributing Human Influences

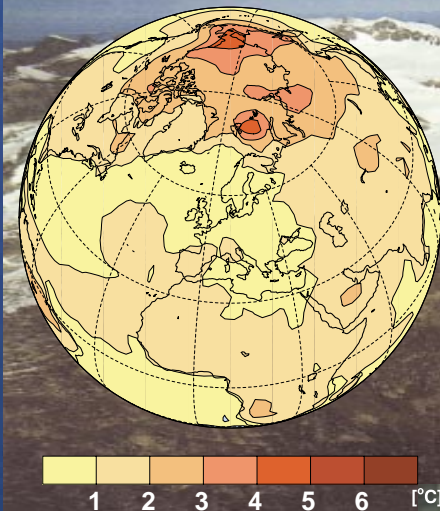
The end of 1000 years of stable climate ?



Our knowledge of climate change based on instrument measurements is very short (mostly restricted to the last 2 centuries). **CLIVAR** is involved in extending the instrumental record through "data archeology" and, jointly with the the IGBP's PAGES project, in reducing the uncertainties and increasing the resolution and spatial coverage of the paleo climate record.

The work of the Intergovernmental Panel on Climate Change (IPCC) is supported by **CLIVAR**'s research on the detection, attribution and prediction of human-induced climate change. The main focus is on modelling of the coupled climate system using scenarios of expected increases in atmospheric pollutants to predict regional and global climate through the 21st Century and beyond.

What will the climate of the 21st Century be like?



Although the response of climate models to human-induced activities depends on scenarios and model formulation, there is evidence for an accelerated warming of our planet in the 21st century.

Expected surface temperature anomalies in 2050 for a scenario that includes feedbacks to greenhouse gases and aerosols. (courtesy U. Cubasch, DKRZ).



How **CLIVAR** operates

CLIVAR has, through a period of international consultation, developed and published science and implementation plans that highlight the science issues and challenges that fall within **CLIVAR**'s remit and documented a consensus of what research activities need to be undertaken and which can benefit most from international coordination.



The International CLIVAR conference 1998 in Paris. A milestone for the implementation of CLIVAR.

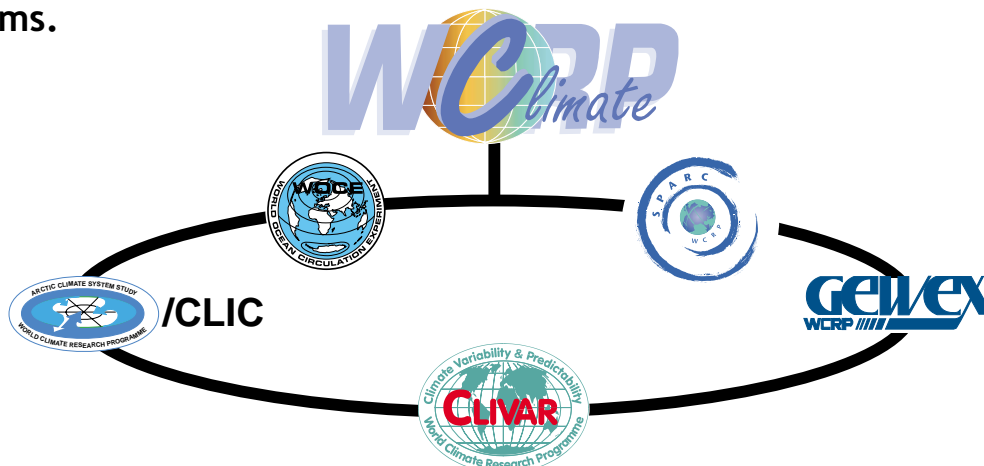
To provide clear foci for implementation, a number of Principal Research Areas (PRAs) have been identified.

CLIVAR has established international panels and working groups that have expertise in these PRAs, or that cover regional and global issues. The PRAs are embedded in a global modelling and observational strategy.

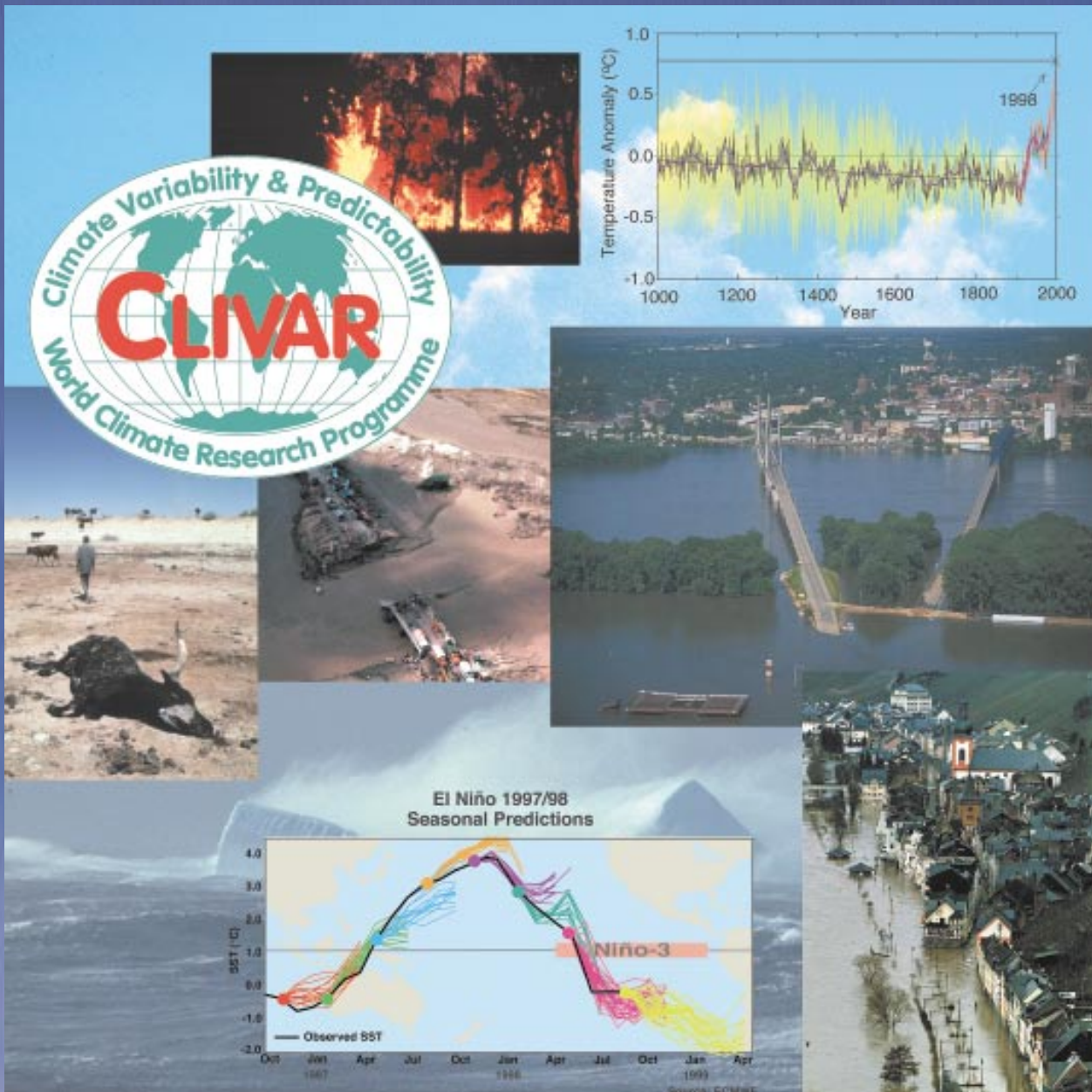
CLIVAR research is made up of activities funded by national research programmes and those funded through international organisations such as the European Union. Combining these national contributions in such a way that they will enable **CLIVAR** to attain its objectives is a main task for the science panels and working groups and for the International **CLIVAR** Project Office (ICPO).



CLIVAR's research, while it is very extensive, covers only part of an entire range of climate issues. **CLIVAR** therefore has close working links with other components of the World Climate Research Programme (WCRP) and has developed links with the International Geosphere Biosphere Programme (IGBP) and programmes concerned with the application of climate knowledge to socio-economic problems.



The World Climate Research Programme and its current projects



CLIVAR, a World Climate Research Programme (WCRP) project

The World Climate Research Programme (WCRP) was established in 1980 by the International Council for Science (ICSU) and the World Meteorological Organization (WMO) with the mandate to develop the fundamental scientific understanding of the physical climate system and climate processes needed to determine to what extent climate can be predicted and the extent of human influence on climate.

The WCRP established **CLIVAR** in 1995 as a research programme to focus on the variability of the “slow” climate system. It is the main WCRP project for the study of climate variability and predictability on time-scales from months to centuries.

Information about **CLIVAR**, its plans, its organisation, its publications and its research can be found on the **CLIVAR** web site (<http://www.clivar.org>)