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The Role of Research in Climate Services

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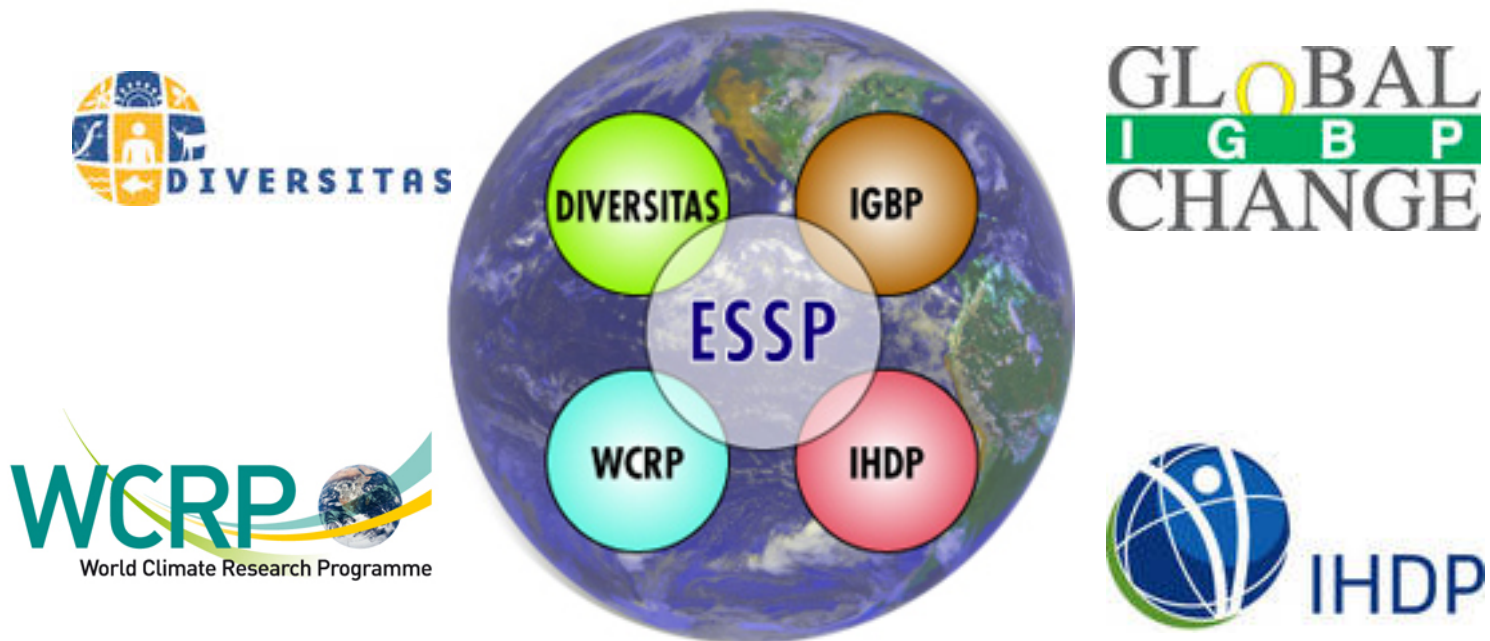
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Earth System Science Partnership



The Earth System Science Partnership (ESSP) consists of four international global environmental change (GEC) research programs for the integrated study of the Earth system, the changes that are occurring to the system and the implications of these changes for global and regional sustainability.



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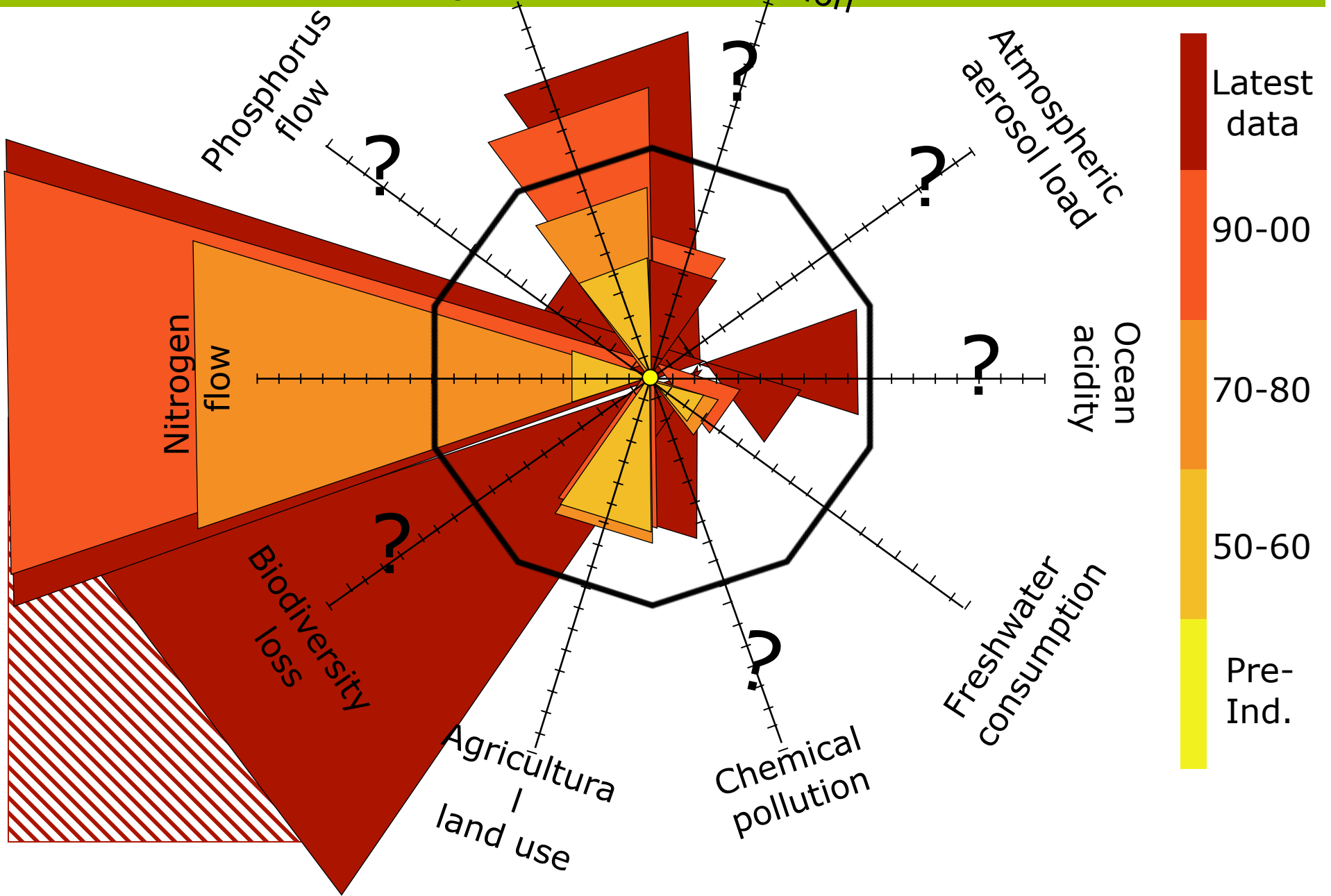


Climate Change

Ozone depletion



Earth System Science Partnership





- Promote **international cooperation** for obtaining, processing, analyzing and sharing observations and resulting information.
- Coordinate field and modeling experiments to **understand climate variability and change**.
- Develop **models** and future climate change **projections and scenarios**.
- Support **science-based assessments** of impacts, risks and vulnerability of natural and human systems to climate variability and change.
- Support **training and development of next generation of scientists, and research networks** at the regional and global level.



Example: Ocean Observing Systems

2002

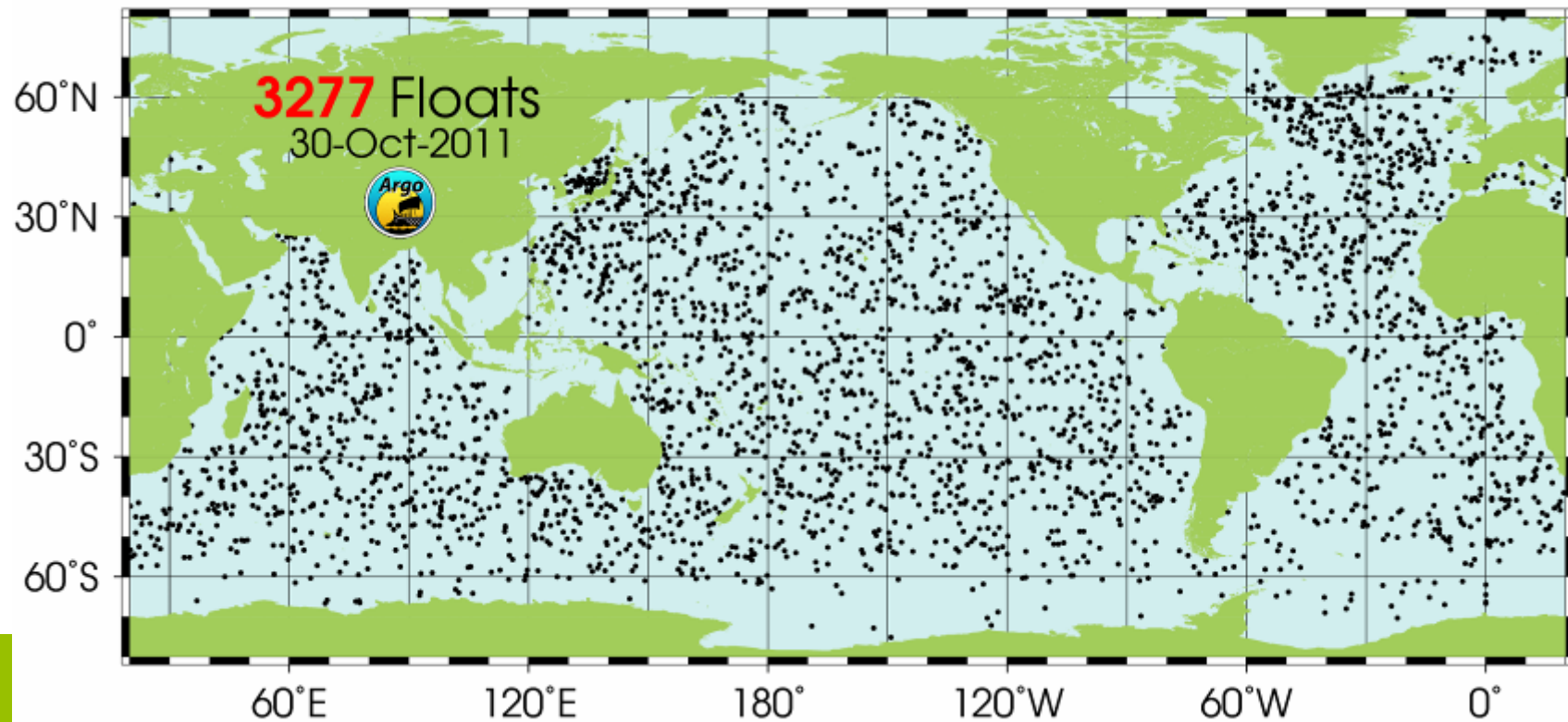


Temperature profiles from merchant ships

2003



ARGO installation



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International Earth Observing Systems

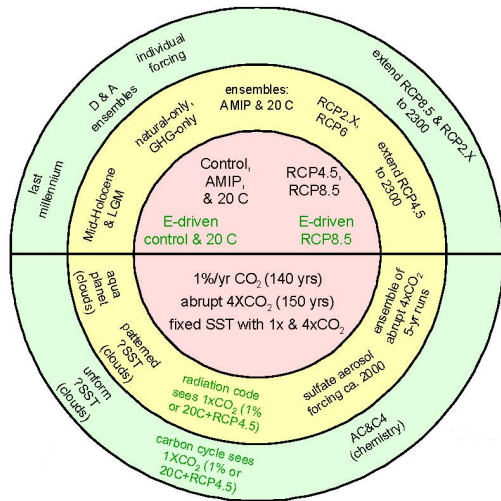


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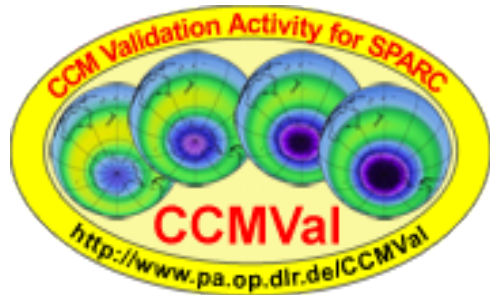
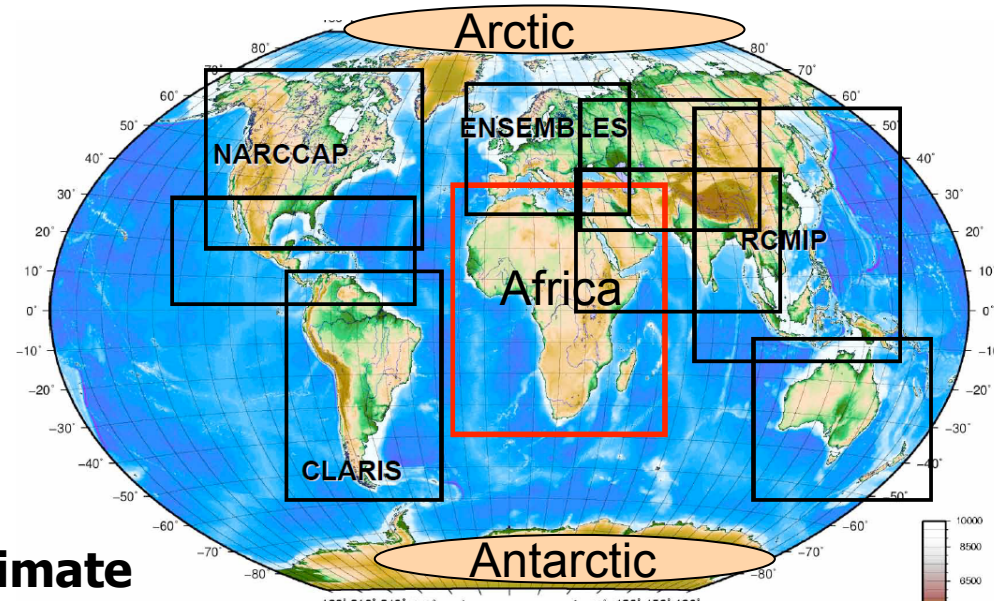
Example: Major Climate Prediction & Projection Experiments



Climate-system Historical Forecast Project - CHFP

Coordinated Regional Downscaling Experiment – CORDEX → IPCC AR5

Coupled Model Intercomparison Phase 5 – CMIP5 → IPCC AR5



Chemistry-Climate Model Validation



World Meteorological Organisation

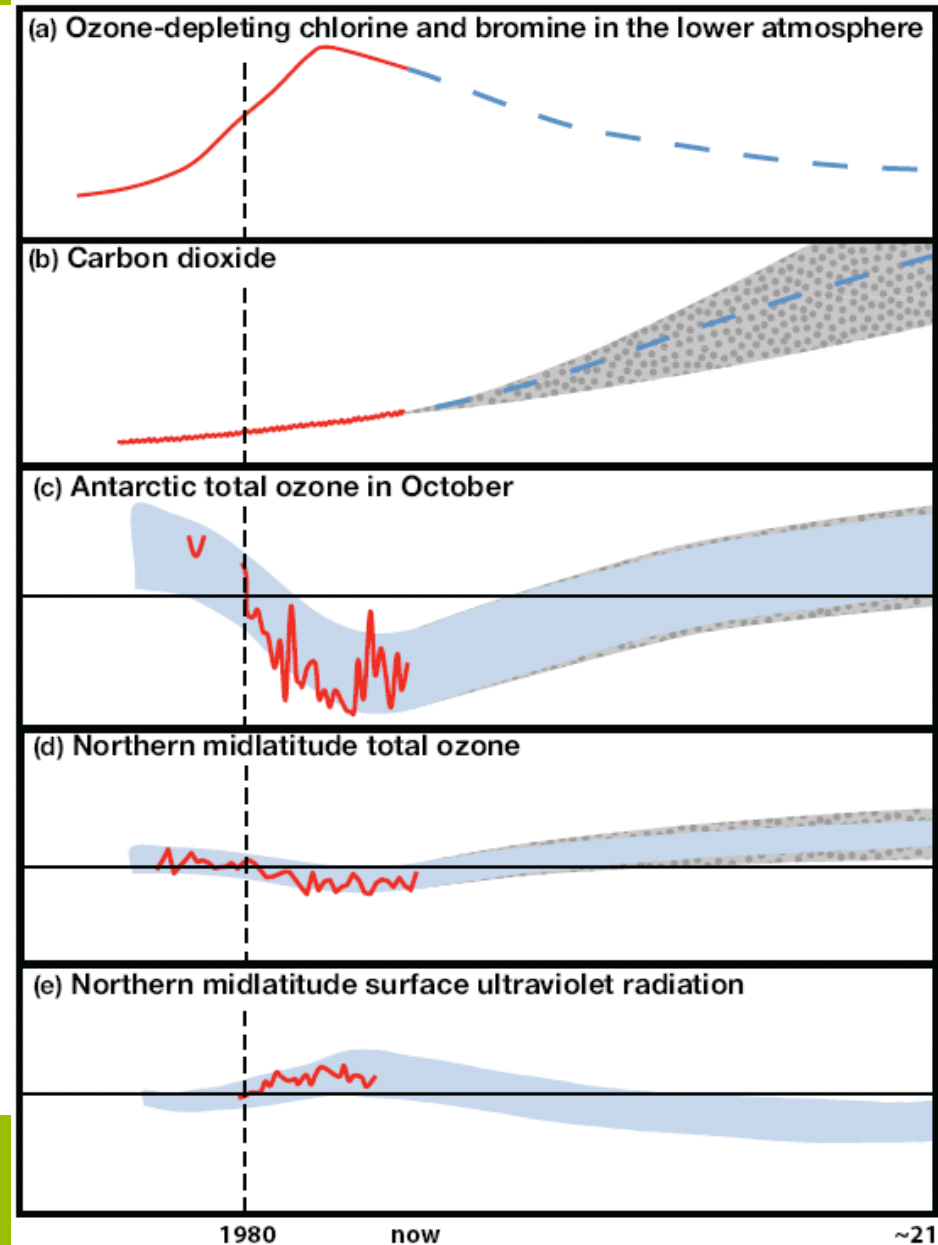


UNEP

Assessment of Ozone Depletion 2010

The shaded areas in panels (c)-(e) came from CCMVal based on sophisticated statistical analysis of model variability and trends

In past Assessments, estimates of model ranges had been pure guesswork





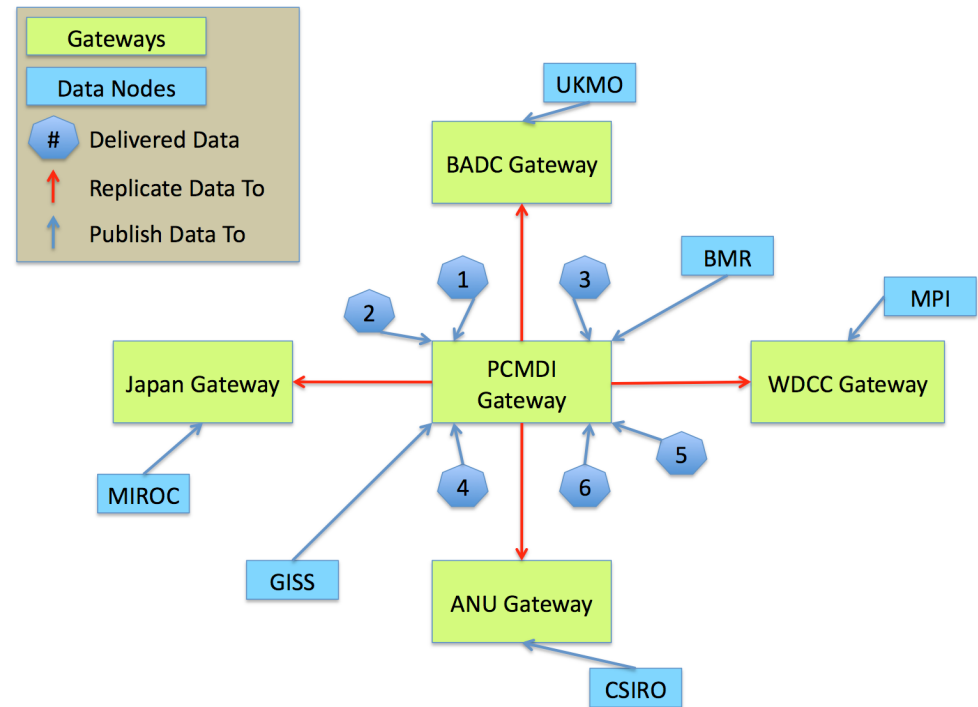
Earth System Grid: Unprecedented International Coordination

CMIP5 participating groups (20+ groups; ~40 models).

2.3Pbytes of model output expected - 100 times greater than CMIP3.

Model data will be accessed by the Earth System Grid - output will be served by federated centers around the world and will appear to be a single PCMDI archive.

The archive will become available to analysts from end 2010 to Spring 2011.





Research, Modeling and Prediction-Objectives

- Improve **understanding of the Earth's climate system** and **assess the impacts of climate variability and change** on people, ecosystems, and infrastructure;
- Enhance significantly the **two-way interactions** and cooperation between the **providers and users** of climate information;
- Focus proactively the research towards developing and improving **practical information products** required by decision makers, especially for GFCS near-term priorities; and
- Improve the **science readiness level** of climate projections, predictions, and **user-tailored climate information** products for decision making.



- Urgent need for **“actionable” climate information** based on sound science
- The need for **“symbiotic” relationship between providers and users of climate information** to ensure climate information is timely, accessible, easy to understand
- Urgent need for **training and development of “next generation” of scientists and decision makers** who pursue and promote the use of actionable climate/environmental information

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Research, Modeling and Prediction- Science Priorities

- Climate predictability and prediction on **subseasonal to seasonal time scales**;
- Climate predictability and prediction on **decadal to centennial time scales**;
- Scientific challenges such as monsoons, blockings, systematic biases, ...
- Characterizing and communicating **uncertainties in climate information** for **climate risk, adaptation, and mitigation decisions**; and
- Developing climate quality **observations and datasets** for research and other applications.



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Research, Modeling and Prediction- Near-term Activities

- **Planning and coordination** of the ongoing and future research activities, and developing sectoral research strategies and virtual forums together with **sponsors, stakeholders and users of expected information/outcomes**;
- Bridging Earth system science communities by **co-developing** experimental and regular climate information and making them available to **climate service providers and users** for further analysis and decision making;
- Focusing on **research that enables core climate products/information for decision makers** including subseasonal to seasonal predictions, decadal to centennial projections, and regional and thematic climate information; and
- Promoting **research on climate observations and development of climate quality data records**, and their greater use by scientists and decision makers.



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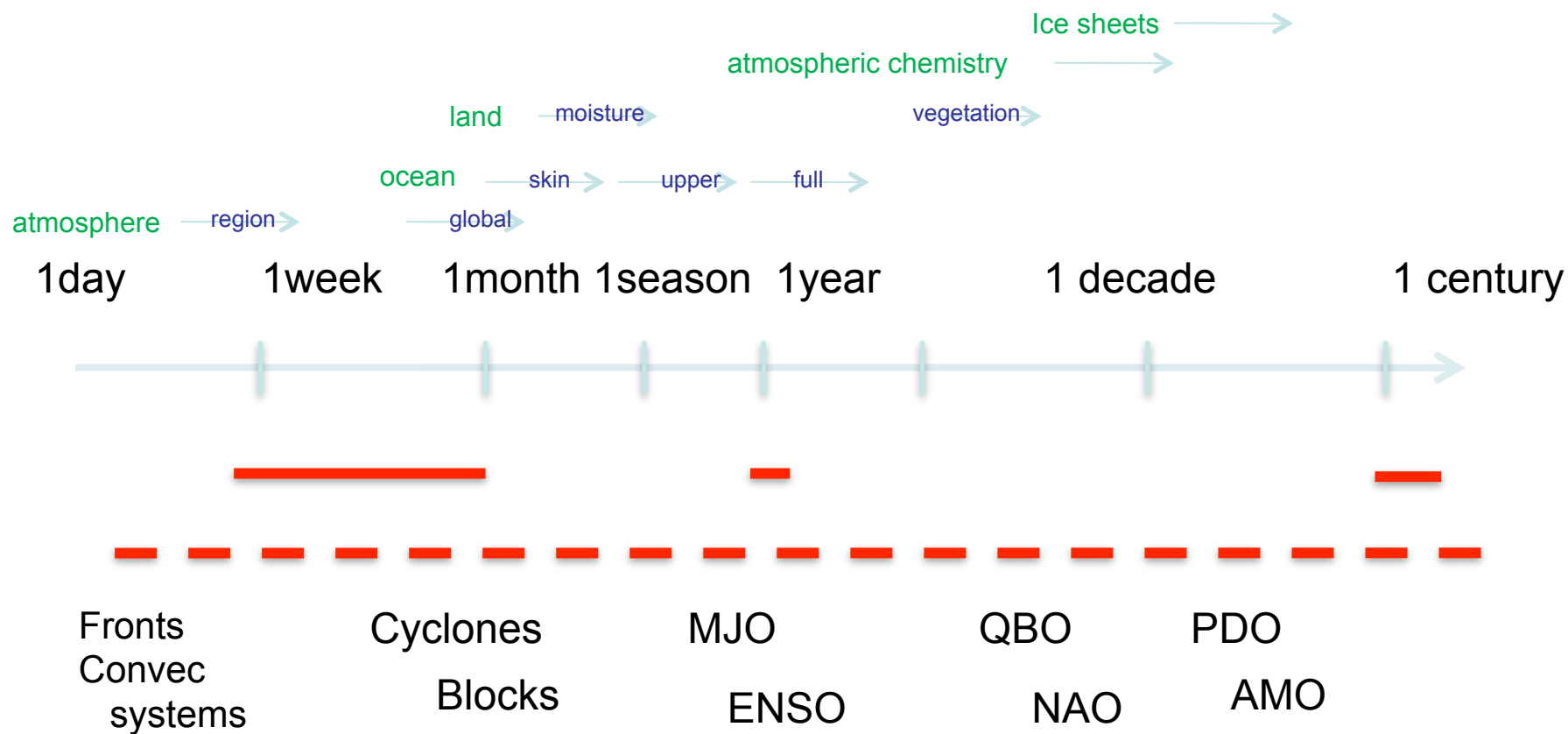
- Maintain **scientific objectivity and excellence** as a foundation for **science-based** climate information.
- Establish an **effective dialogue with users** of climate information to understand their needs and to obtain their feedback on use of available knowledge, and required new information.
- Facilitate the **holistic approach** to Earth climate system research to **include socioeconomic** aspects of the problems, and decision processes.
- Provide greater support to **research capacity development** with **special focus on regional** aspects of climate variability and change.
- Promote **solution-based approach** to addressing challenges and opportunities in developing, evaluating and disseminating climate information for risk management, adaptation planning and global sustainability and development.

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The Seamless Prediction of Earth System



The University of Reading



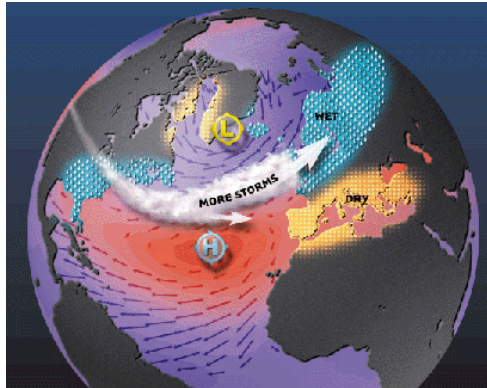
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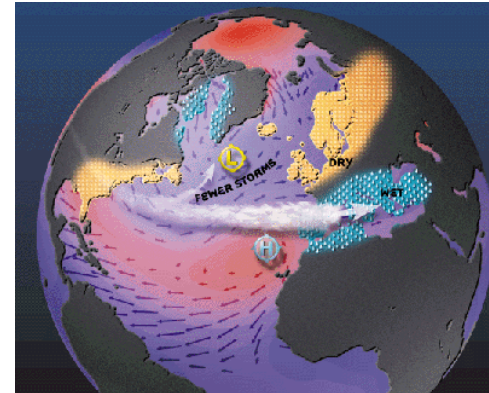


Month – Seasons: The North Atlantic Oscillation Oscillation

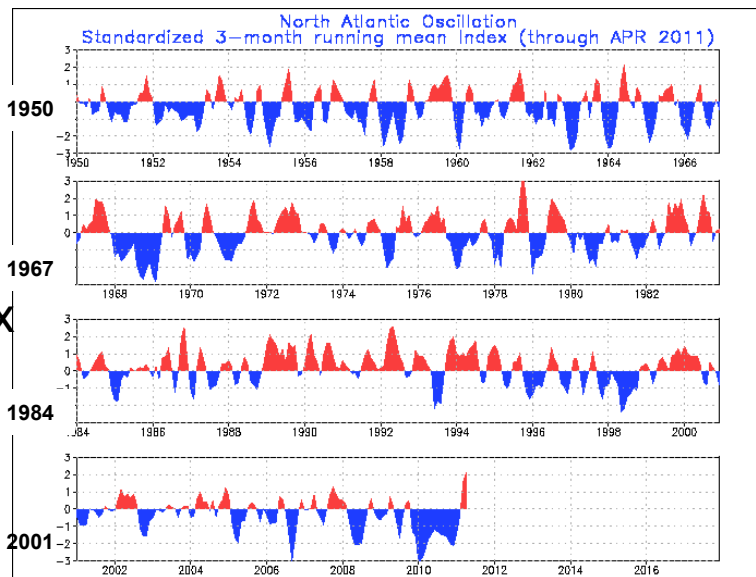
Positive NAO phase



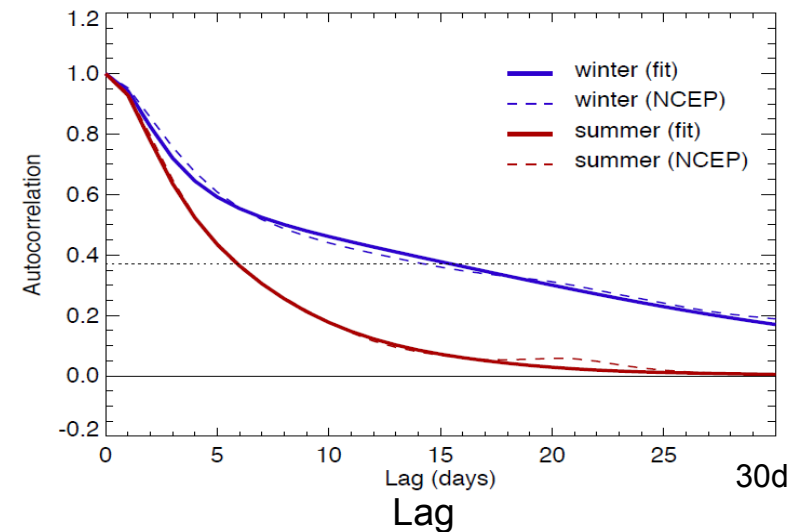
Negative NAO phase



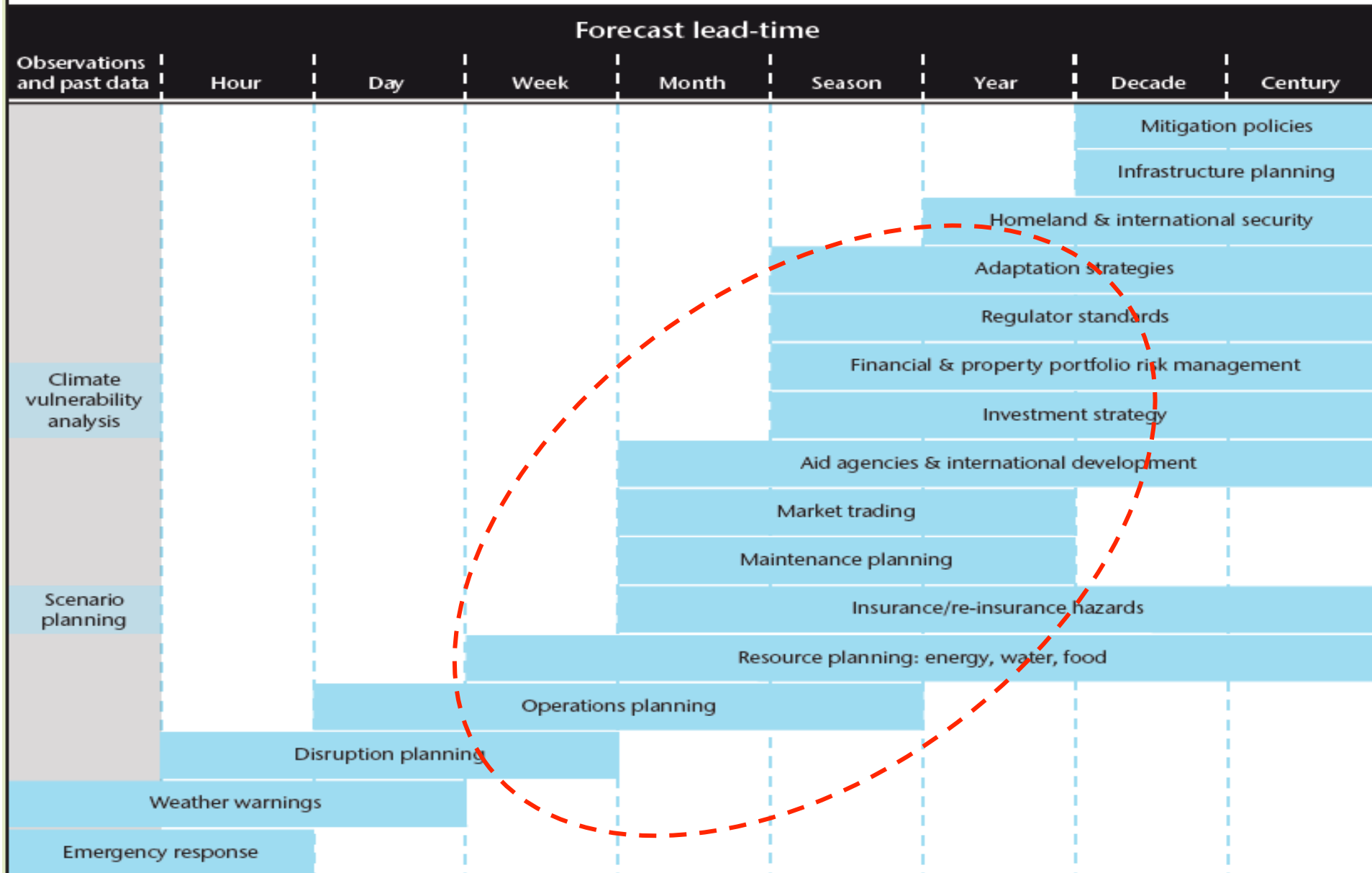
3-month running mean of NAO index 1950-date



Autocorrelation



Seamless forecasting services



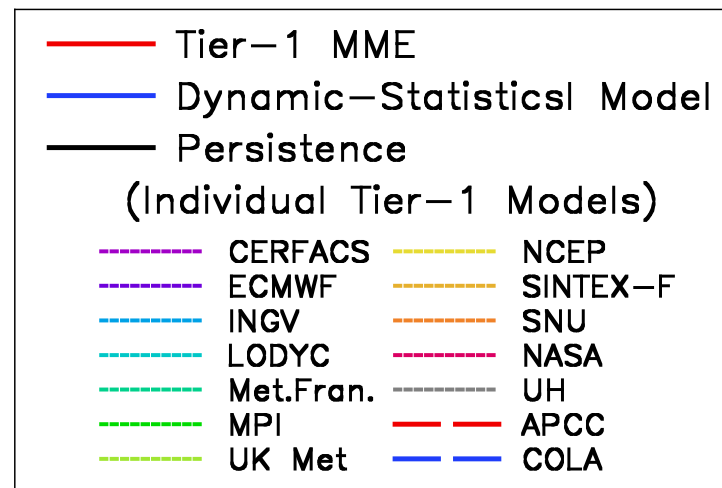
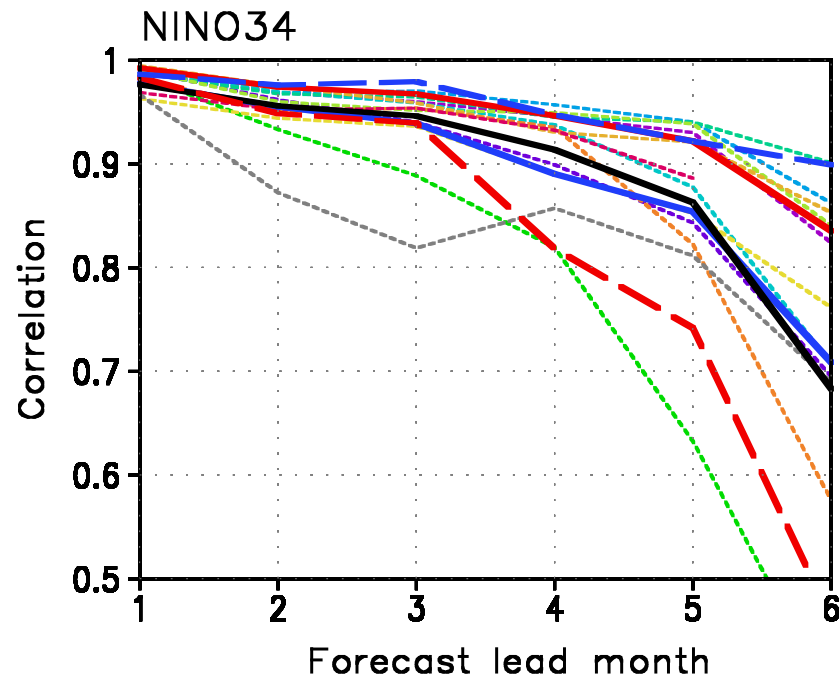
Courtesy of UK MetOffice



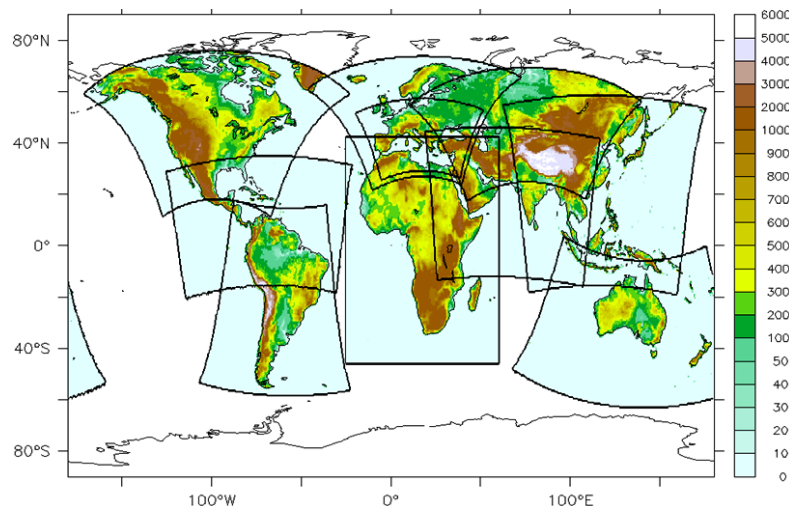
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- Assess seasonal prediction capabilities using the best available models and data for initialization;
- Experimental framework for focused research on how various components of the climate system interact and affect one another; and
- Test bed for evaluating IPCC class climate models in seasonal prediction mode.



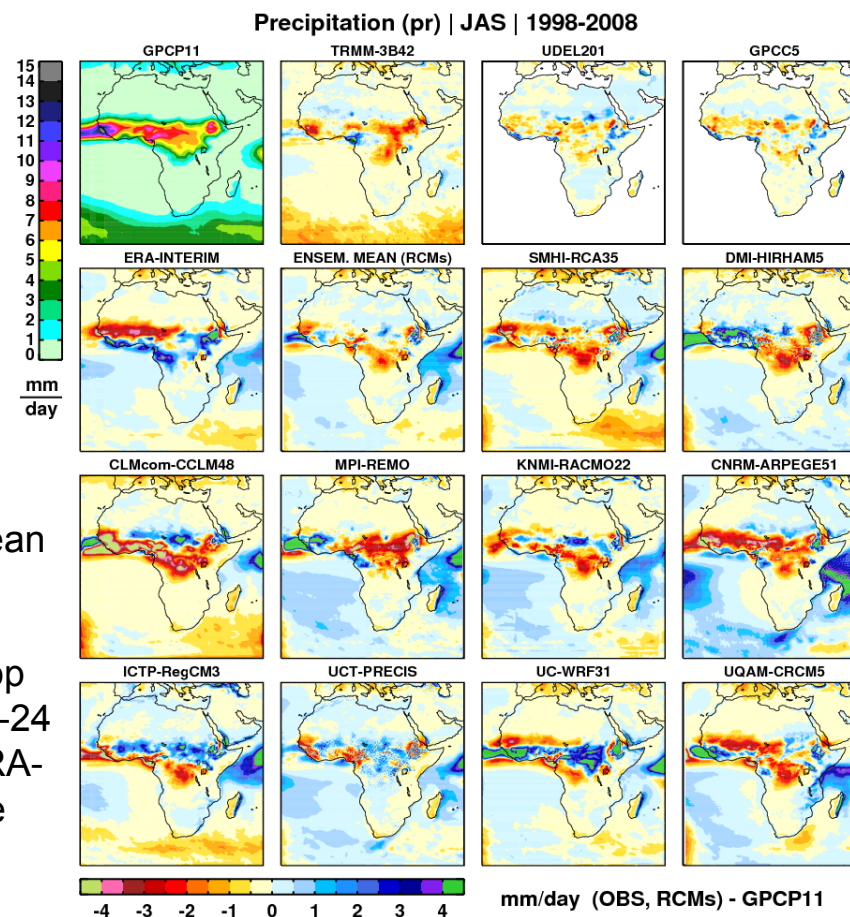
Nino3.4 skill scores from CHFP participating groups
 The multi-model ensemble (MME) generally give improved skill over longer lead times, compared to persistence and individual models



CORDEX

- 12 domains with a resolution of 0.44° (approx. $50 \times 50 \text{ km}^2$)
- Focus on Africa
- High resolution $\sim 0.11^\circ \times 0.11^\circ$ for Europe (by some institutions)

July to September mean precipitation for 1998-2008. Four observational (top row), accumulated 12-24 hour forecast from ERA-Interim reanalysis, the ensemble mean and individual Regional Climate Models

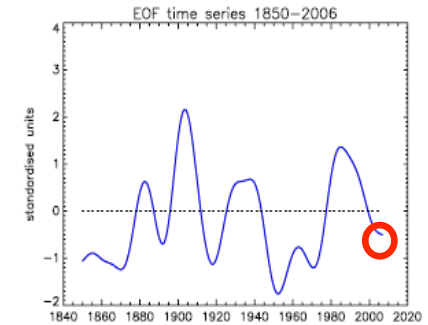
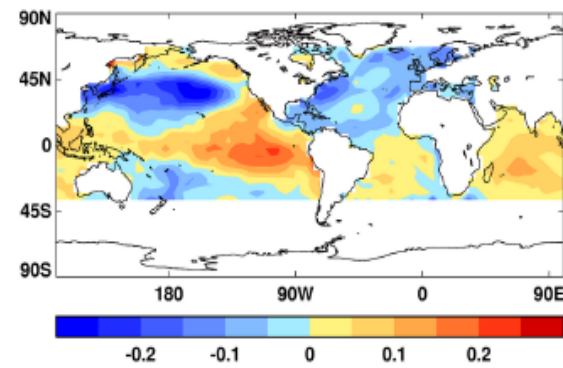
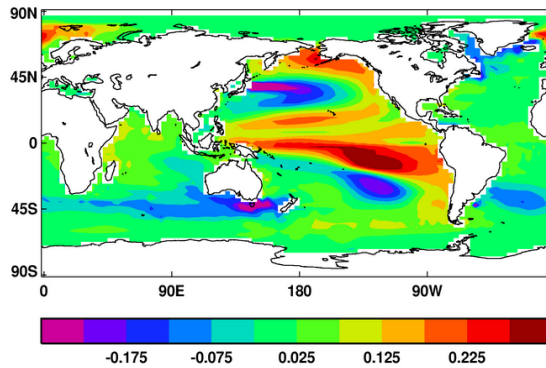




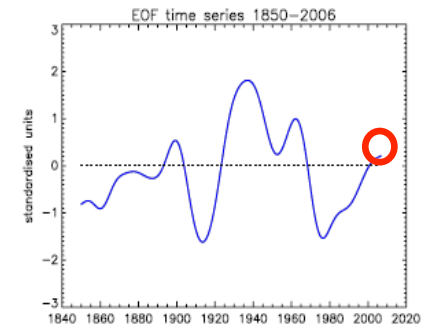
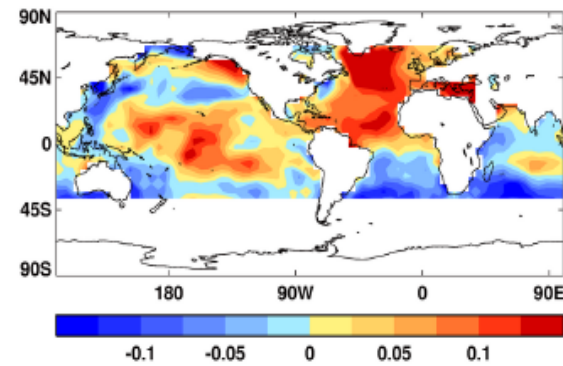
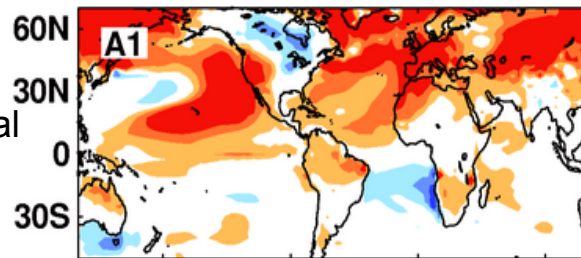
Model

Observation

Pacific Decadal Oscillation

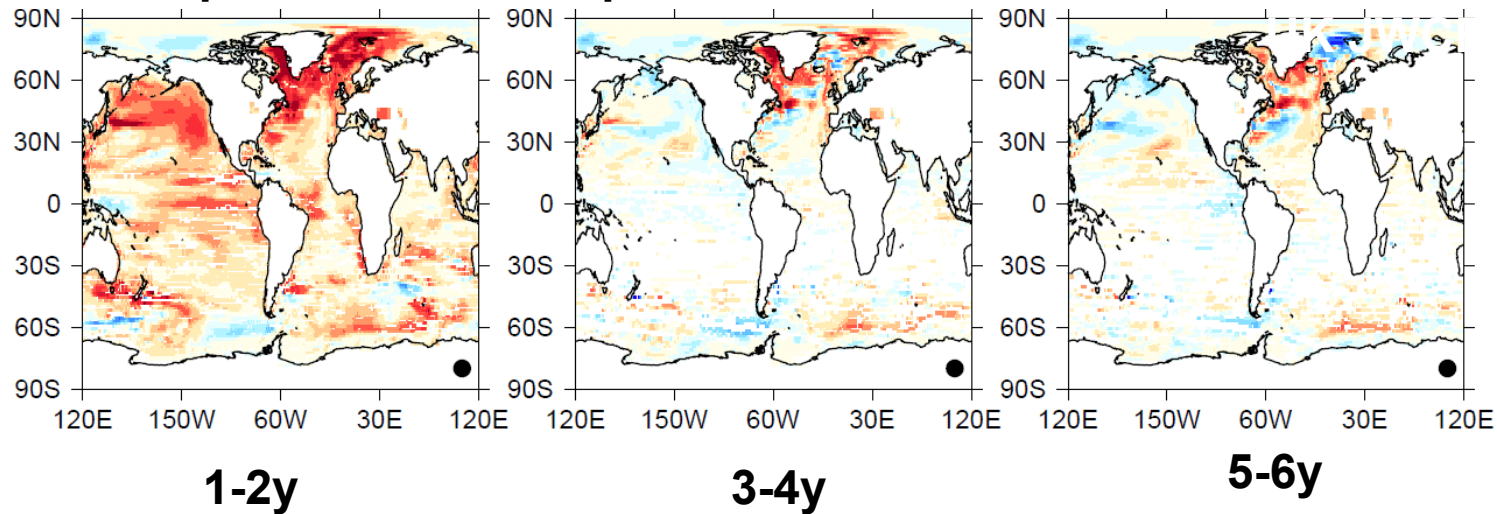


Atlantic Multidecadal Oscillation

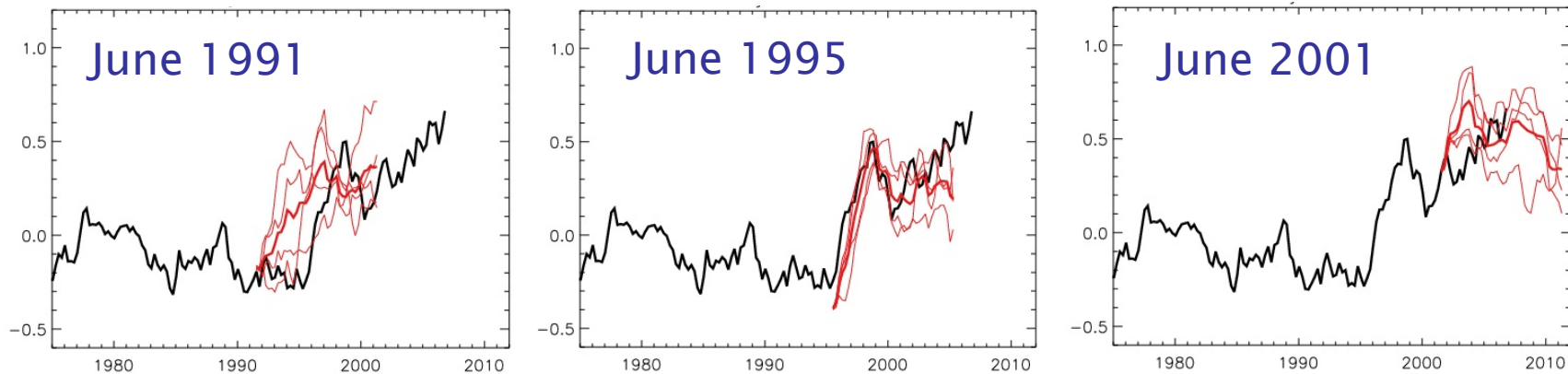




Heat in top 100m ocean: Improvement in Skill from initialisation

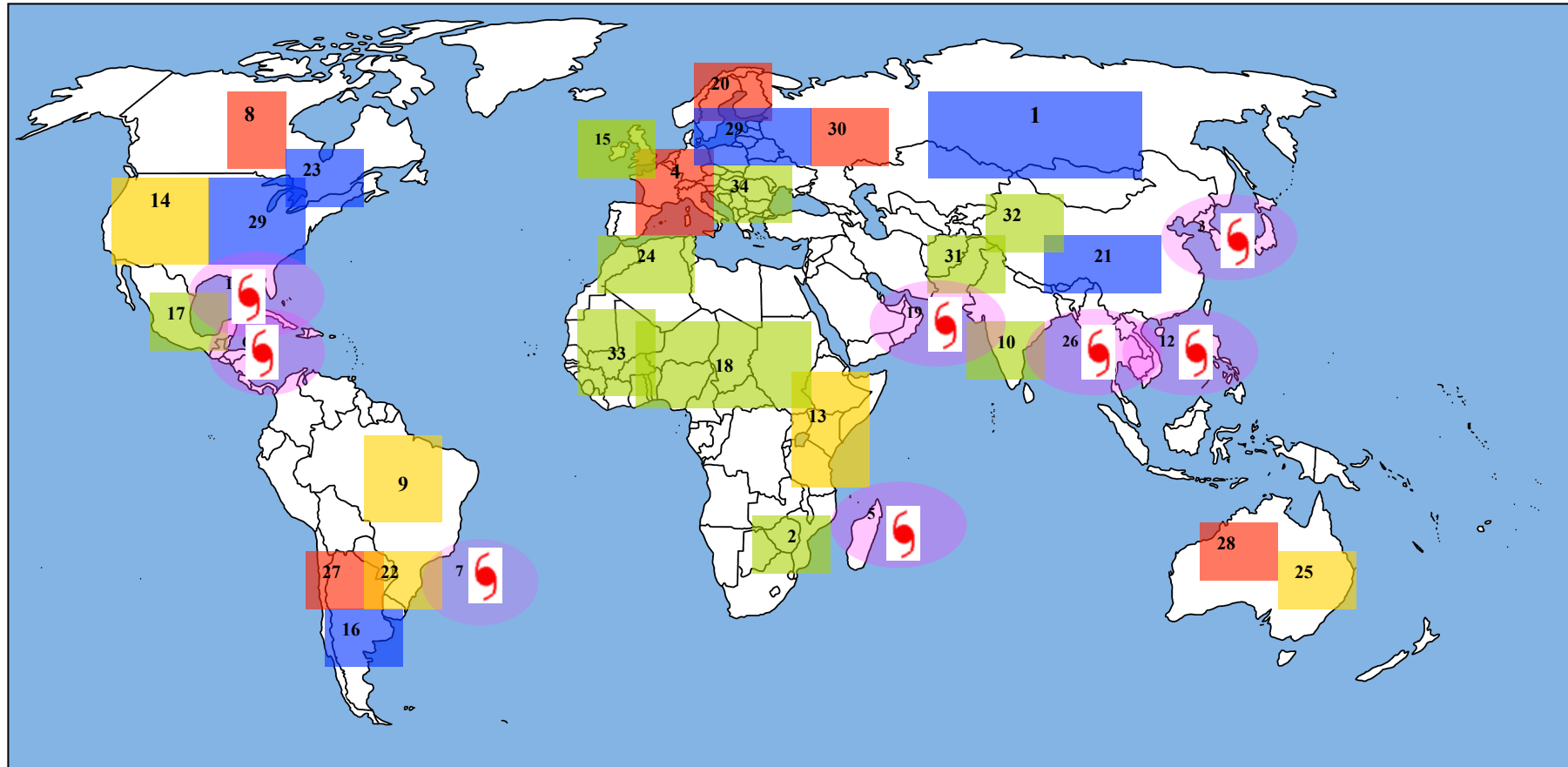


Hindcast predictions of 500m heat content in Atlantic sub-polar gyre



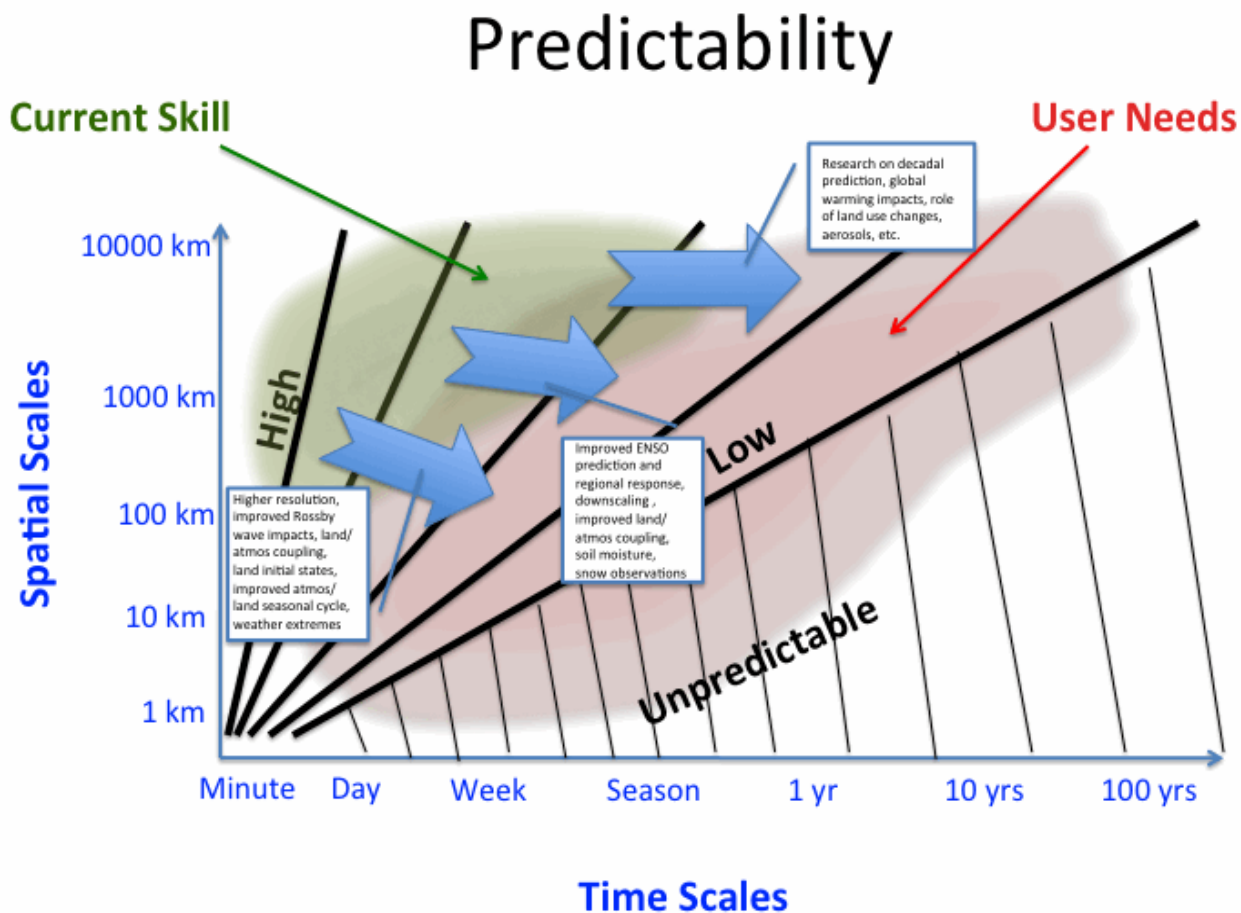


Snapshot of Extreme Events over the Past Decade



- Heat waves / Extreme high temperatures
- Severe or prolonged droughts
- Cold waves / Extreme low temperatures / Snow storms
- Tropical cyclones, hurricanes and typhoons
- Intense storms / Flooding / Heavy rainfall

Example: Global Drought Information System



**WCRP Drought
Workshop
11-13 April 2012
Frascati ITALY**



Research, Modeling and Prediction- Success Criteria

- Active **engagement of researchers** from the climate and applied sciences;
- Identifying and **engaging stakeholders in co-design, development and implementation** of RMP activities;
- Mobilizing required **resources** for implementing RMP activities through active engagement of **funding agencies, development aid organizations, non-governmental and inter-governmental organizations**;
- **Capacity development** to support training and education of **scientists** and establishing **research networks**;
- Continuity of key Earth system **observations for process understanding, modeling and analysis**; and
- Creating an environment to **engage scientists to work together on co-design, development and delivery of products and services**, in unison with the Climate Science Information System (CSIS) and Users Interface Platform (UIP) pillars of GFCS.



Research Foci;



Quantify and communicate uncertainties in climate change information/knowledge;



Develop seamless regional and intera-seasonal to inter-annual, and decadal climate prediction/projection;



Support development of climate information for adaptation planning, mitigation policies, and assessing risks of climate variability and change;



Promote and enable timely, reliable, and easy to access climate information and knowledge; and



Support education, training and development of next generation of climate experts and networks.