WCRP
World Climate Research Programme

The Role of Observations & Research in Climate Services

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WMO IOC ICSU

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Mission

The World Climate Research Programme (WCRP), was established at the first World Climate Conference in 1979, and it is sponsored jointly by the World Meteorological Organization (WMO), the International Council for Science (ICSU), and the Intergovernmental Oceanographic Commission (IOC) of UNESCO

The major objectives of the WCRP are to:

- **Determine the predictability of climate,** and
- **Determine the effect of human activities on climate**

"…foruse in an increasing range of practical applications of direct relevance, benefit and value to society."

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WCRP Core Projects

Climate Variability and Predictability Mission: To identify the physical processes involved in the Climate dynamics, including anthropogenic effects, and develop models and predictive capabilities	**Climate and Cryosphere** Mission: To assess and quantify the impacts that climatic variability and change have on components of the cryosphere and its overall stability
Stratospheric Processes and their Role in Climate Mission: To focus on climate-chemistry interactions; detection, attribution and prediction of stratospheric change; stratospheric-tropospheric dynamical coupling	**Global Energy and Water Cycle Experiment** Mission: To observe, analyze, understand and predict the variations of the global energy cycle and hydrological regime and their impact on atmospheric and surface dynamics

Earth System Science Partnership

The Earth System Science Partnership 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.

International Earth Observing Systems

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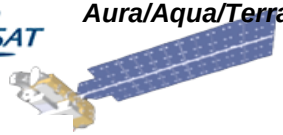
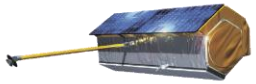
SMOS


SORCE

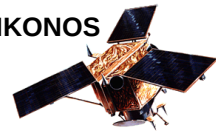

GOCE

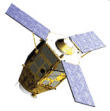

CRYOSAT


Aura/Aqua/Terra


TerraSAR-X


Envisat

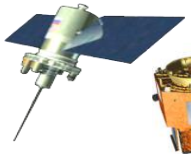

IKONOS


Pleiades

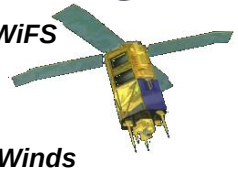

QuikScat


SPOT 4, 5


SPIN-2

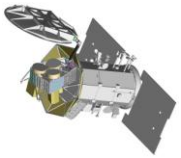

Sage

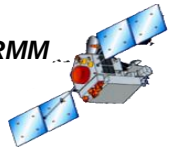

CBERS


SeaWiFS


Orbview 2, 3

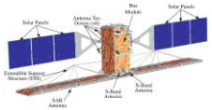

DMC


SAC-D/Aquarius


TRMM

SeaWinds

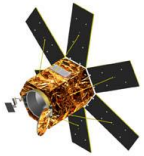

ERBS

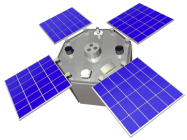

Radarsat


Grace

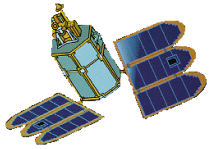

QuickBird

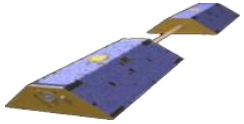

ALOS


EROS A1


ACRIMSAT

Toms-EP



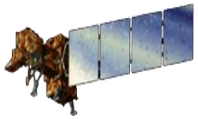


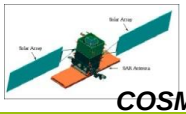

Jason

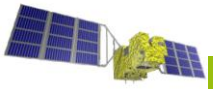

UARS


SAC-C

Landsat 7




COSMO-SkyMed


GOSAT

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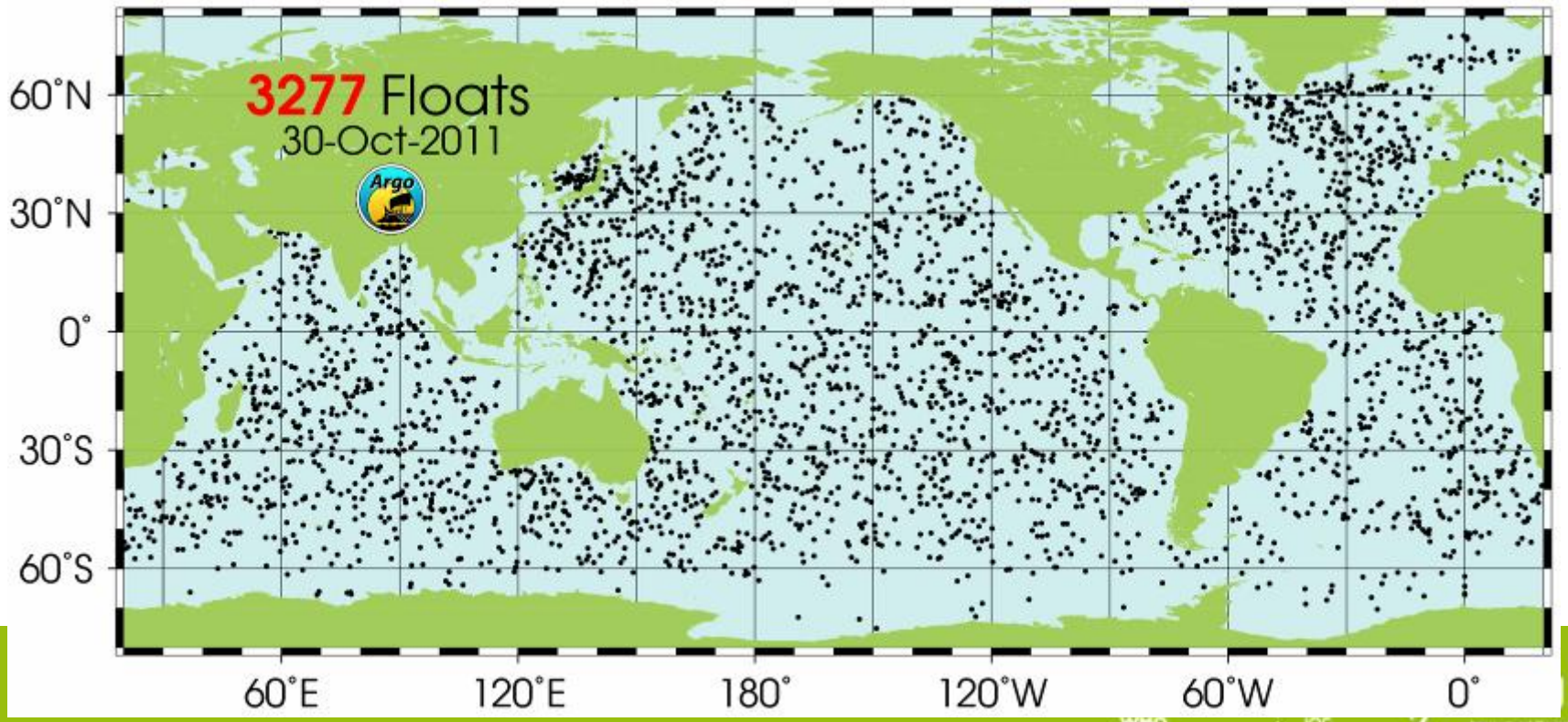
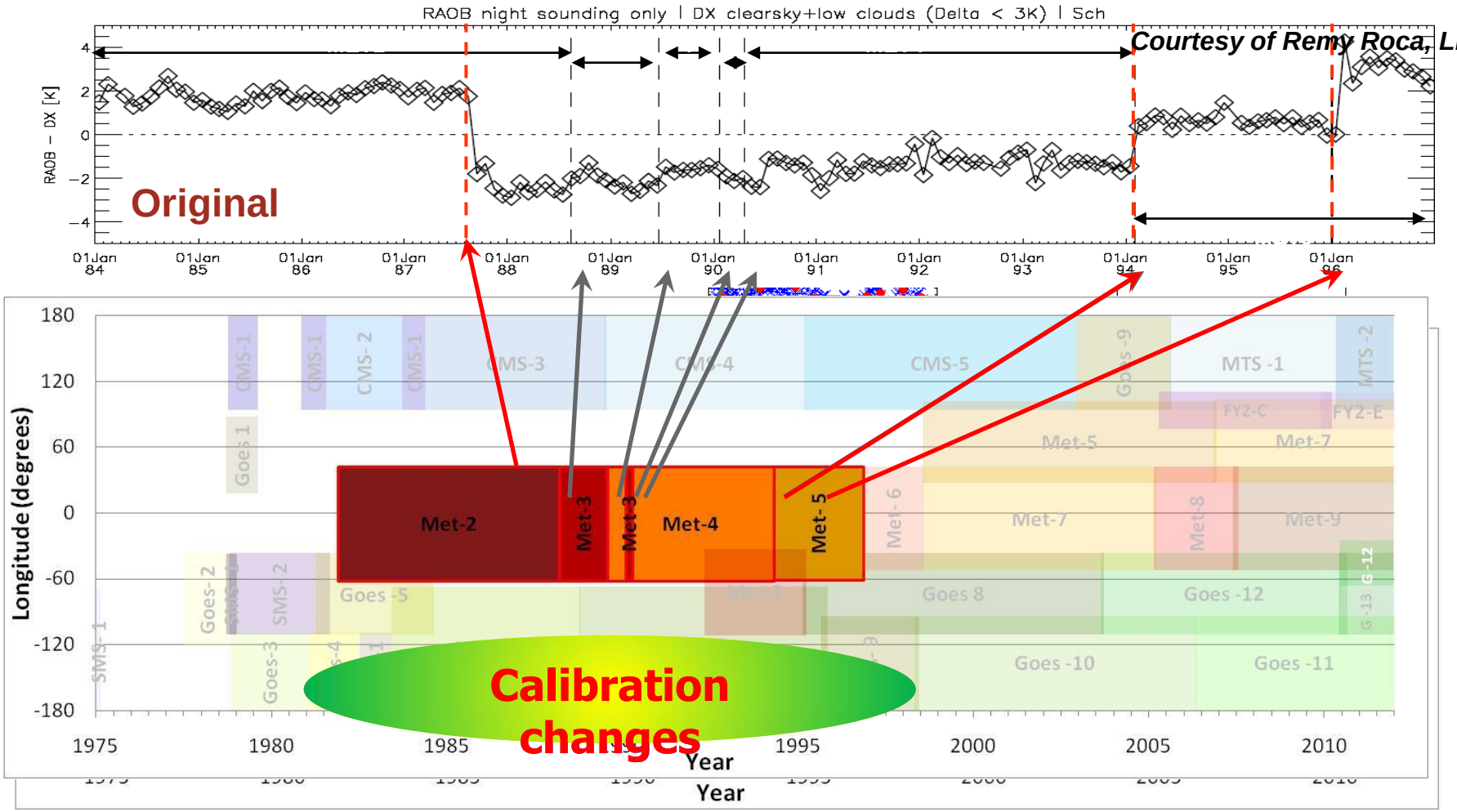
Example: Ocean Observing Systems

Temperature profiles from merchant ships

ARGO installation



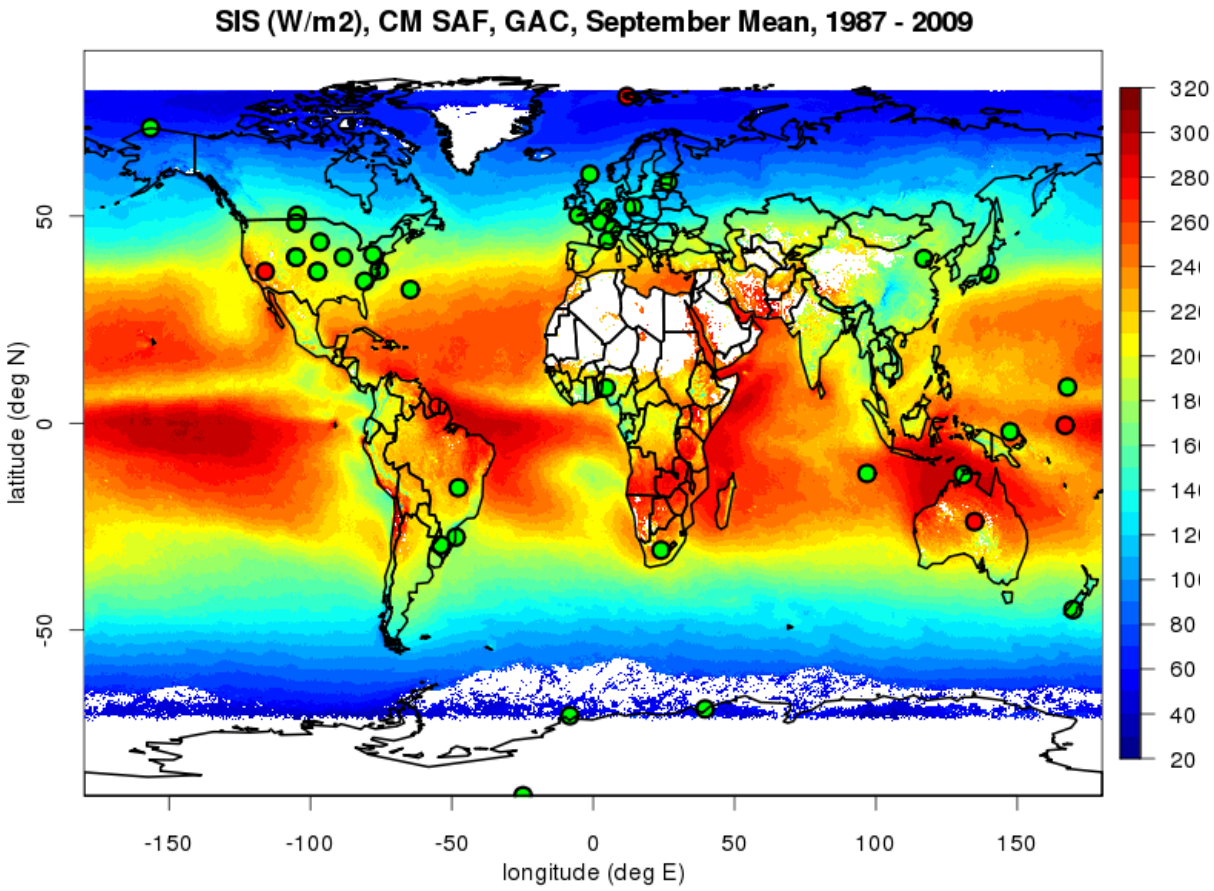
The challenge of Inter-calibration & Reprocessing



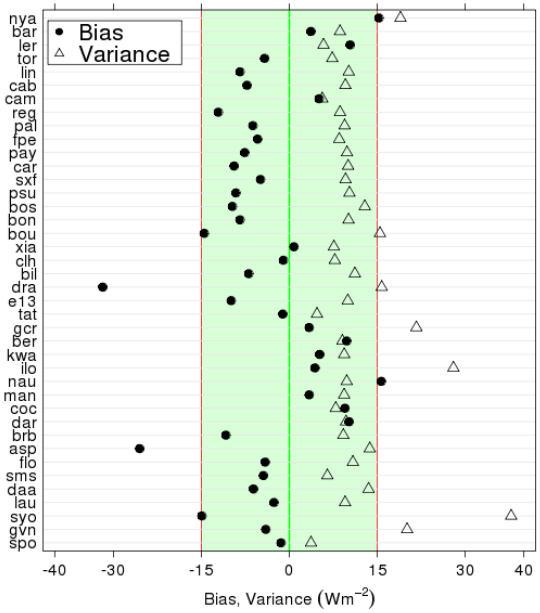
Satellites used for the ISCCP climate data record. (Courtesy of Ken Knapp, NOAA-NCDC)

AVHRR Climate Data Set

20 years Surface Incoming Shortwave Radiation



Validation using measurements from 40 BSRN stations



EUMETSAT

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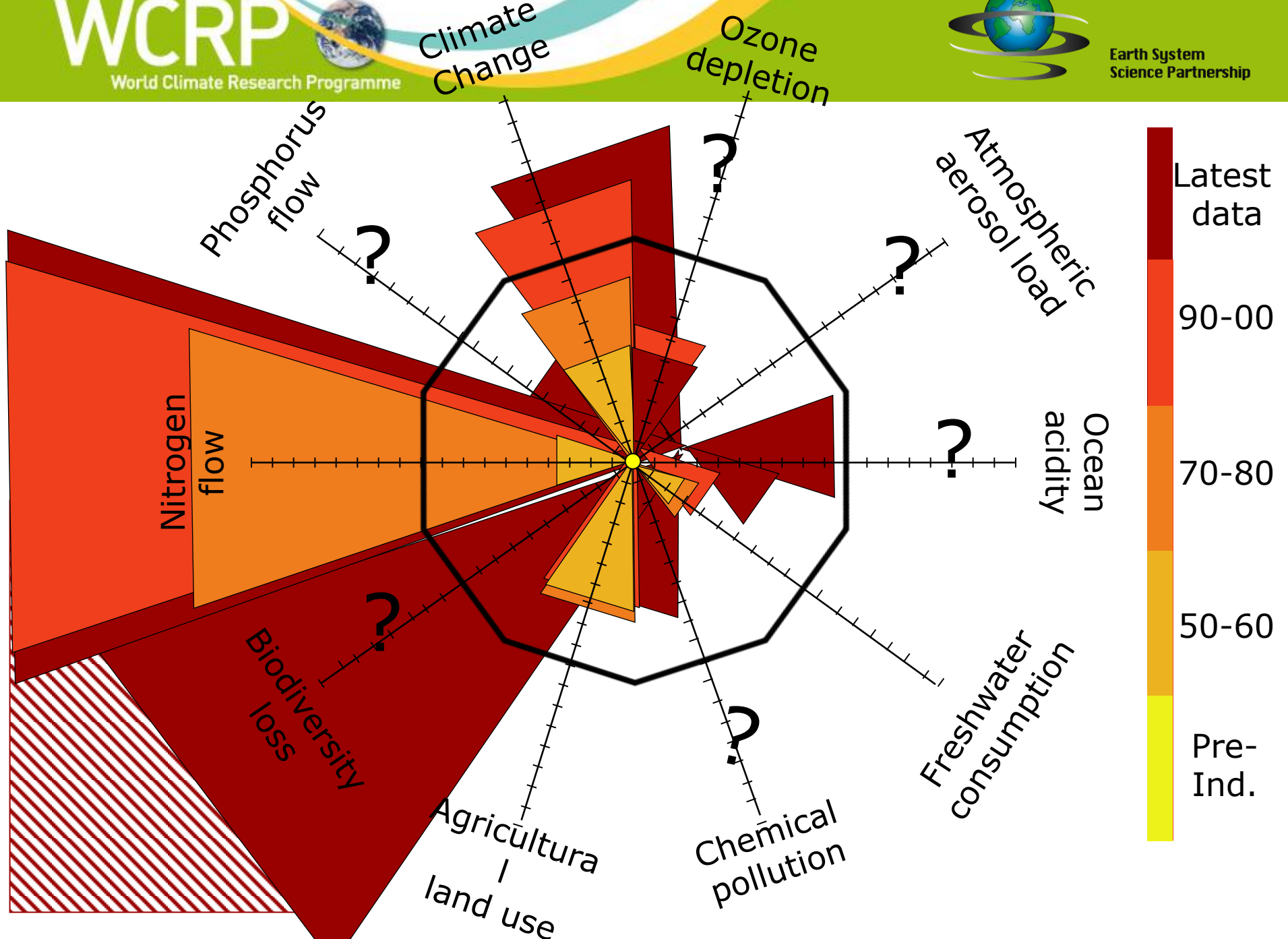
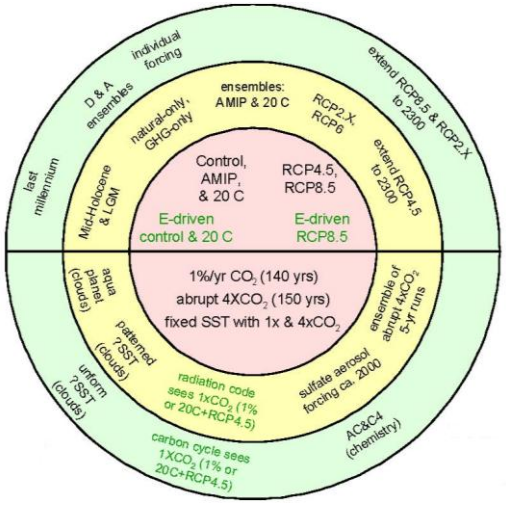
Earth System
Science Partnership

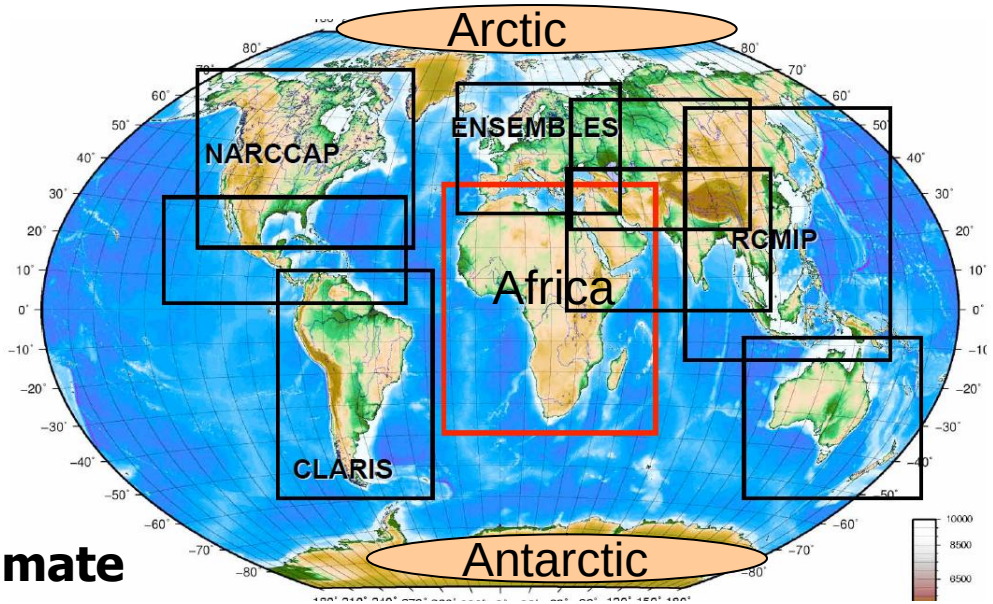


Example: Major Climate Prediction & Projection Experiments

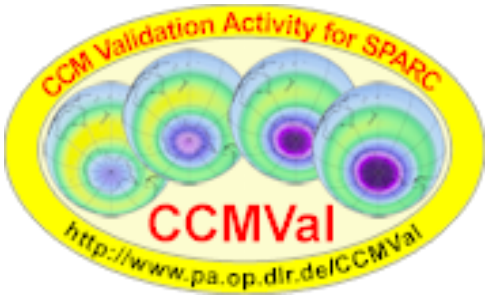


Climate-system Historical Forecast Project - CHFP

Coordinated Regional Downscaling Experiment – CORDEX ⇨ IPCC AR5



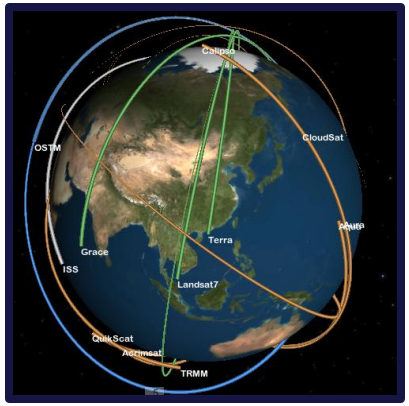
Coupled Model Intercomparison Phase 5 – CMIP5 ⇨ IPCC AR5



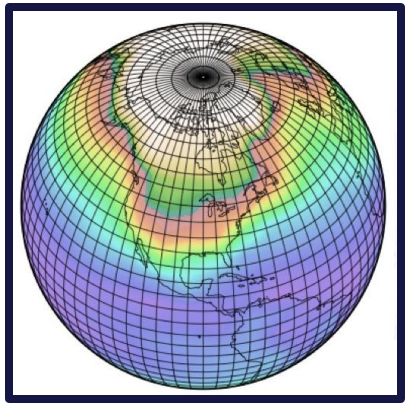
Chemistry-Climate Model Validation

Intercomparison of Models-Observations

Coordinated with CMIP5 are parallel efforts to collect and make available observationally-based products

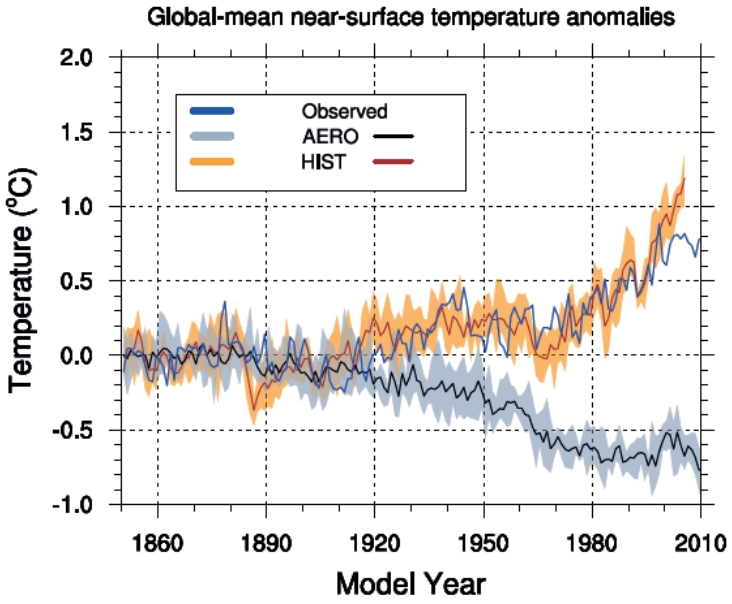


Obs4MIPs

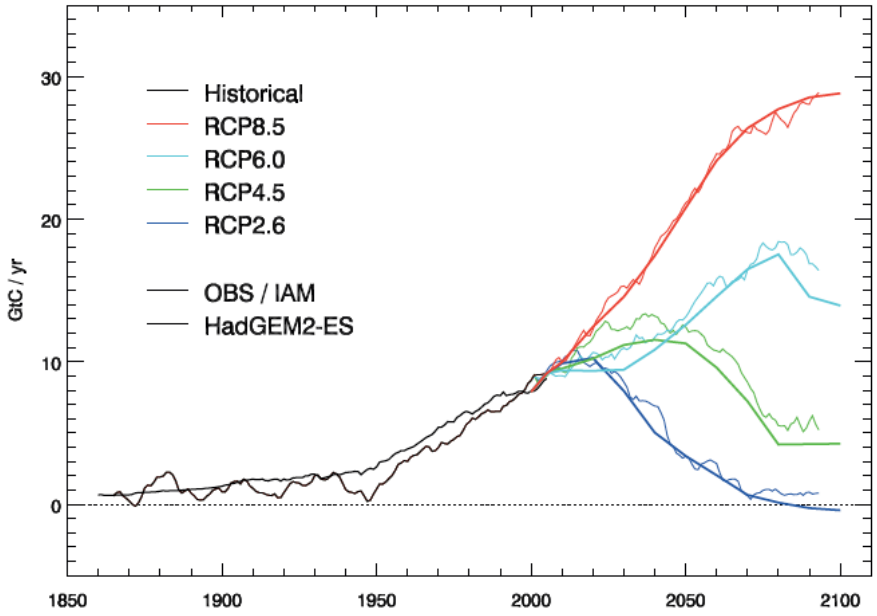


Obs4MIPs is a pilot effort to improve the connection between data experts and scientists involved in climate model evaluation. It is closely aligned with CMIP5, with encouragement from the WGCM and WGNE. NASA and the U.S. DOE have initiated the project with significant contributions of appropriate NASA products. An overarching goal is to enable other data communities to contribute data to Obs4MIPs.

Improving Climate Projections: CMIP-5



Global-mean near-surface temperature anomalies in simulations with all natural and anthropogenic forcings (red line), and with the anthropogenic aerosol forcing alone (black line), in one of the CMIP5 models. (from Boucher et al, 2011)



Permissible emissions as simulated by a CMIP5 model (HadGEM2-ES) compared with observed CO2 emissions for the historical period and those projected for the RCP scenarios (OBS/IAMs) (from Friedlingstein and Jones, 2011)

Earth System Grid: Unprecedented International Coordination

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

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

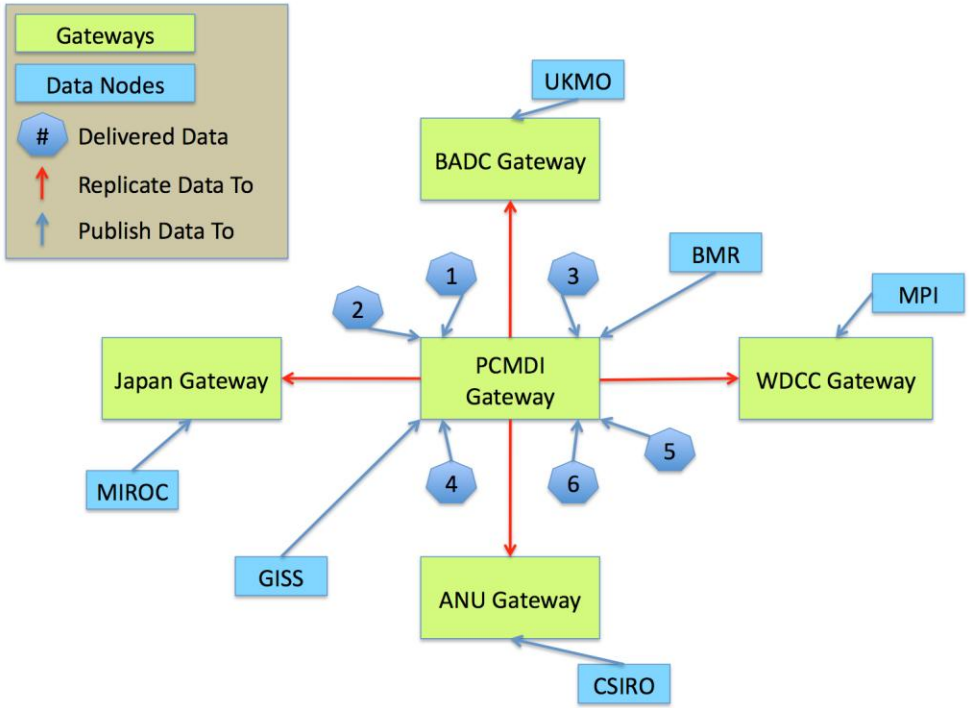
Model data will be accessed by the Earth System Grid - output will be served by federated centers around the world and will appear to be a single PCMDI archive.

CORDEX participating groups

Data sets from four major reanalysis

Obs4MIP data sets

The archive is available to all researchers and other users, but not for commercial purposes.



International Coordination-Key to Success

- International partnerships were the hallmark of this success(CEOS, CGMS, GCOS, GEOSS,..)
- Creating a strong and sustained network of scientists, engineers and technology experts around the world (Professional Societies, WMO, ICSU, WCRP,IGBP,..)
- National and international organizations and their investments.

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Challenges

- Urgent need to maintain the solid foundation we have built.
- Most missions are getting old, beyond their intended lifetime, but fortunately still producing remarkably stable observations.
- The focus/demand is shifting from observations to their information content for near-real-time applications and decisions.
- Access to space is getting more difficult and expensive, and risks remain relatively high.
- Remote sensing obs. are a part of the decision making space, thus justification of large investments is harder than the past.
- To realize/deliver societal benefits require to include increasingly the needs of non-science applications in mission requirements/definition.
- Scientific foci are shifting even more than the past towards interactions and feedbacks among the major components of the Earth system domains.

Opportunities

Are abound and they can be realized by,

- Continuing to fuel the innovation engine with training of next generation of scientists and investments in science and technology.
- Striving to demonstrate the value of past and present observing systems/networks (e.g. Assimilation, Re-analysis, Obs4MIP, etc.)
- Focusing our research on design, development and optimizing operation of the current and future observing systems/networks.
- Providing answers to the questions such as, why we need to maintain what exists and add new components to such systems? What is/are the absolute essential components for continuity?...
- Answering these questions, backed by solid analysis, will facilitate securing required resources for future systems.

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WCRP Grand Science Challenges

- **Provision of skillful future climate information on regional scales (includes decadal and polar predictability)**
- **Regional Sea-Level Variability and Change**
- **Cryosphere response to climate change (including ice sheets, water resources, permafrost and carbon)**
- **Interactions of clouds, aerosols, precipitation, and radiation and their contributions to climate sensitivity**
- **Past and future changes in water availability (with connections to water security and hydrological cycle)**
- **Prediction and attribution of extreme events**

WCRP Grand Science Challenges

Planned Activities by WCRP Project-GEWEX Examples:

- Using analysis/reanalysis outputs, which provide the information of intersensor calibration and model components, to help characterize uncertainties.
- Having consistently defined error estimation methodology applied to all products within the main target of 2013.
- Assessing long-term trends of GDAP products in order to study climate changes over several decades.
- Shortening the updated/repeat cycle of data assessment with no loss in the quality and comprehensiveness.
- Interacting with CliC involving the cryosphere in GDAP assessments, and participate in new polar prediction activities in both WCRP and WWRP which include sub-project activities on observations.
- Improving estimation of the global water and energy budgets and to identify the sources of the inconsistency currently found in GDAP products.
- Collaborating with GLASS and GHP to close terrestrial water and energy budgets regionally over land.
- Evaluating climate model prediction skill of extreme events will not be possible with datasets that contain only climatological means and Information on observed PDFs should be made available.

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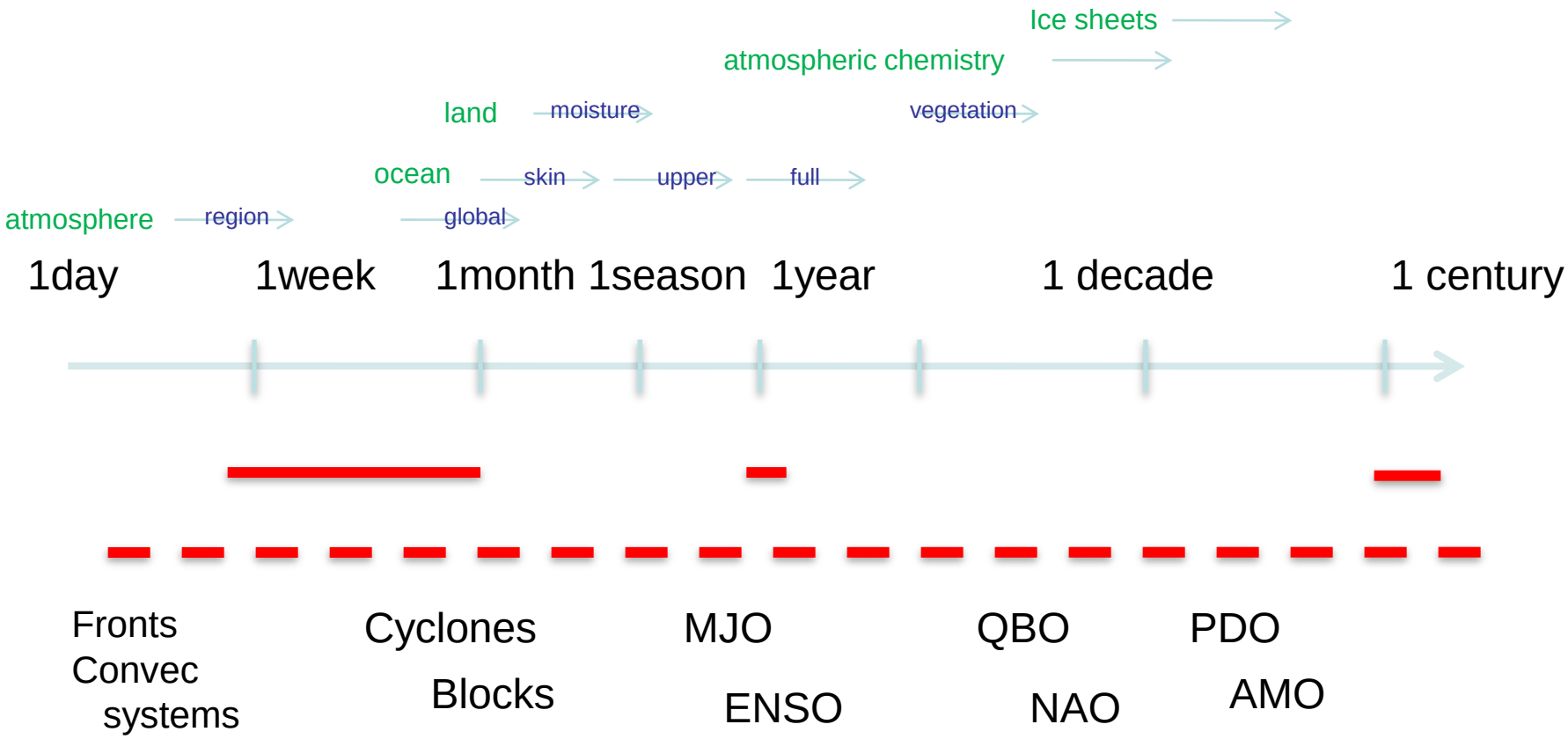
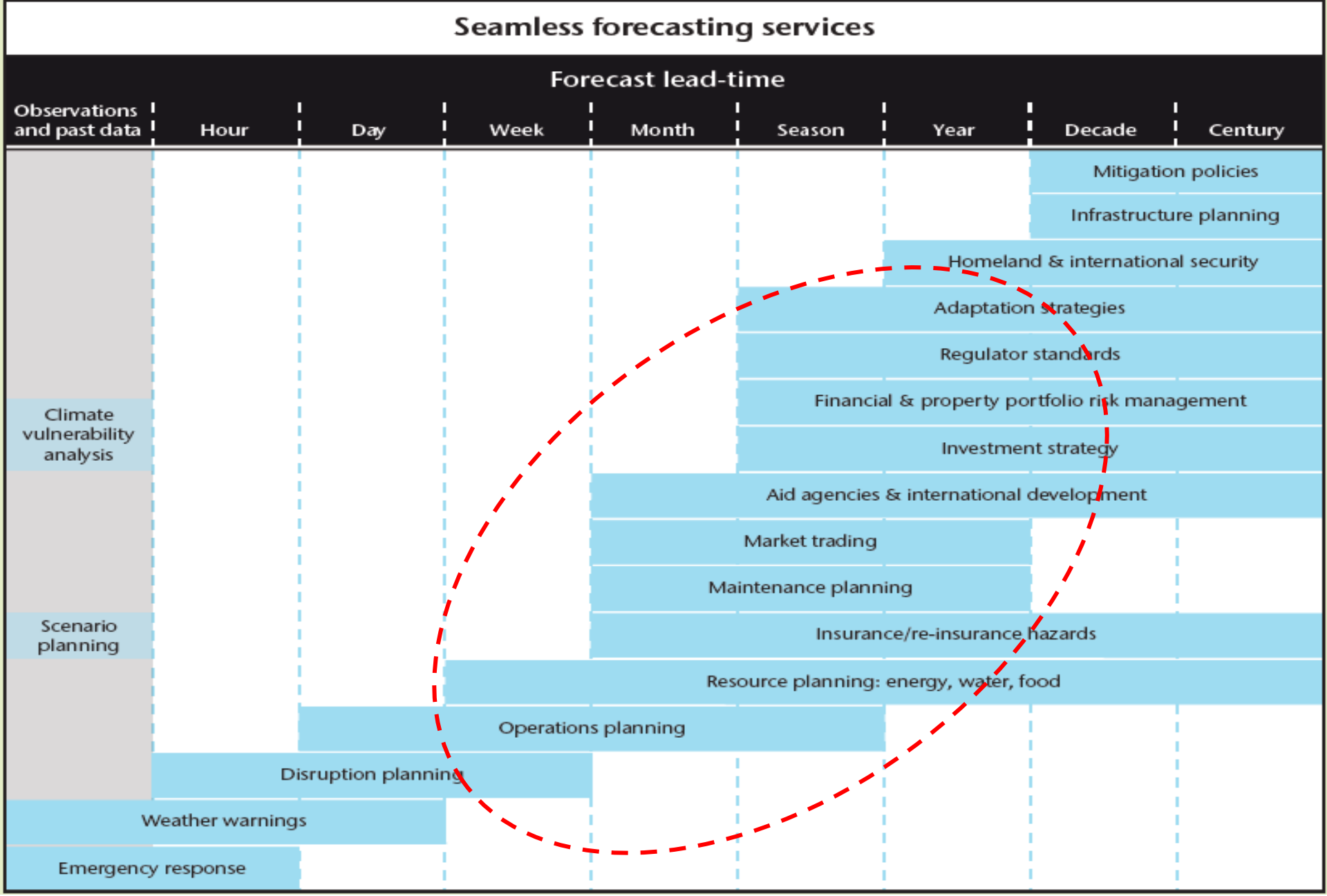
The Seamless Prediction of Earth System

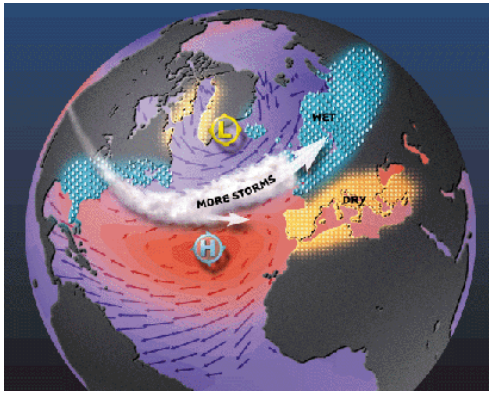




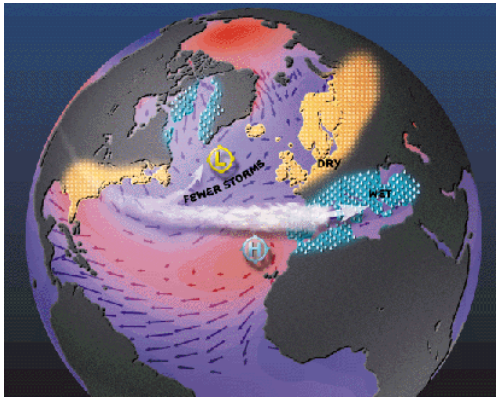
Courtesy of UK MetOffice

Month – Seasons: The North Atlantic Oscillation

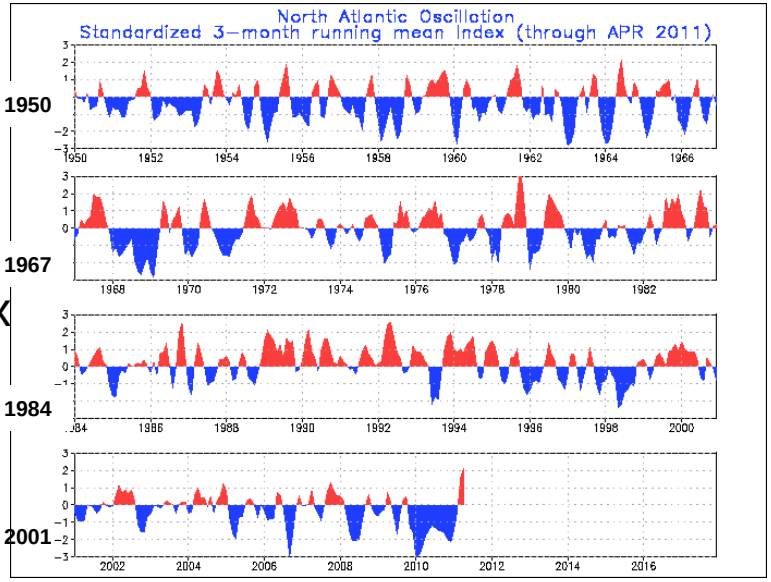
Positive NAO phase



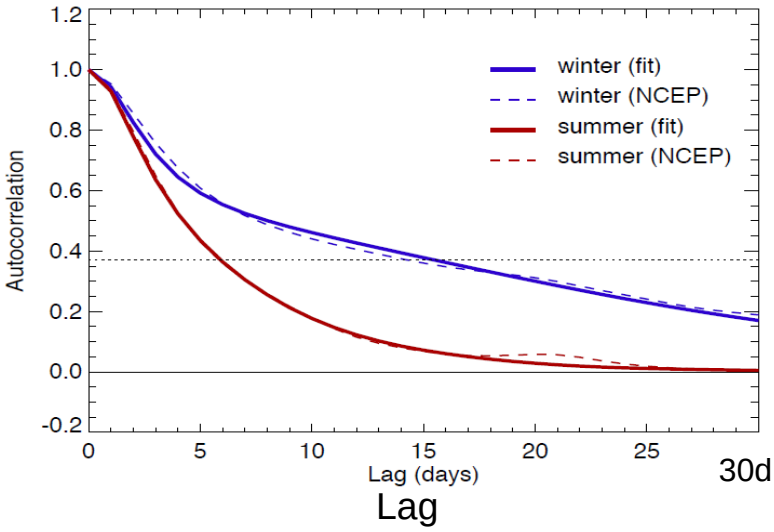
Negative NAO phase



3-month running mean of NAO index 1950-date



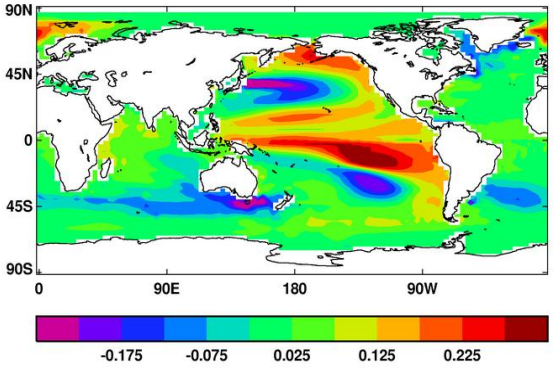
Autocorrelation

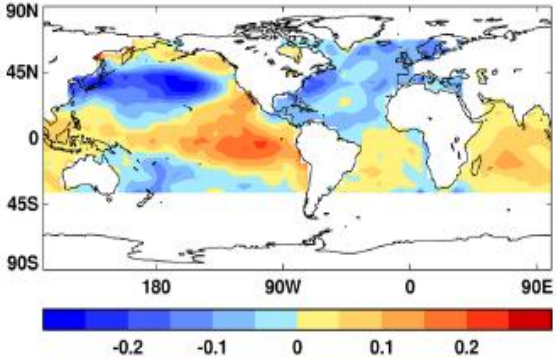


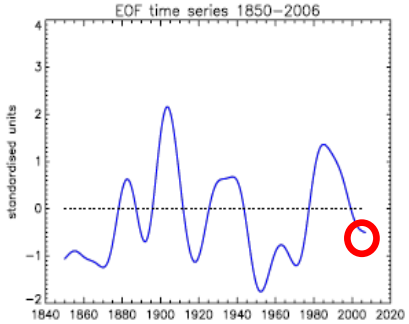
Natural Decadal Variability

Model | Observation

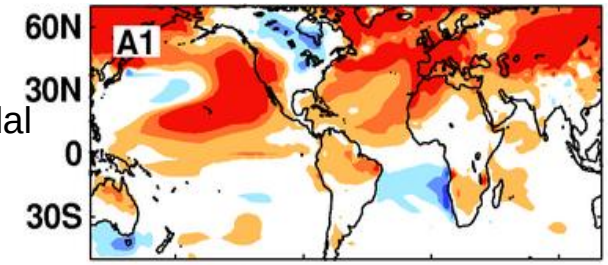
Pacific Decadal Oscillation

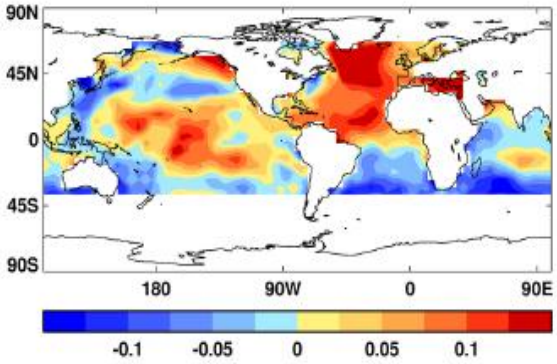


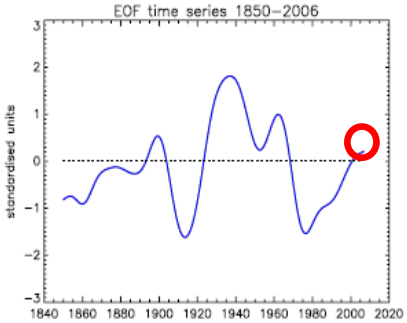




Atlantic Multidecadal Oscillation



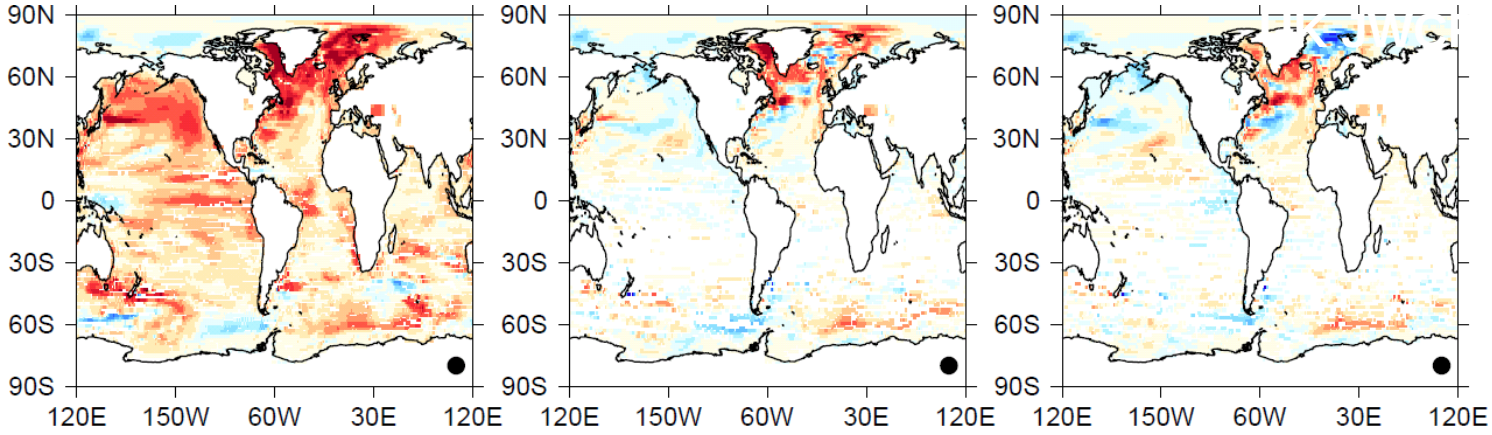




Knight et al 2005, Parker et al 2007

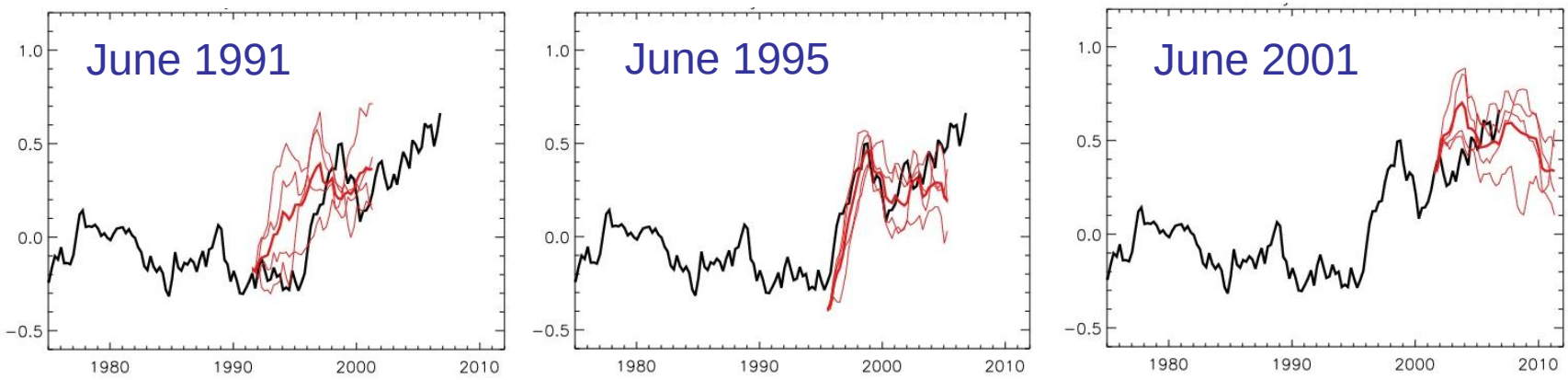
Prediction Skill on 1-10 Year Time-scale

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



1-2y 3-4y 5-6y

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



Courtesy of UK MetOffice

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Conclusions

- The Earth system complexity and uncertainties in observations, models and resulting information require our continued focus and attention.
- Information resulting from seasonal, inter-annual and decadal prediction of Earth/climate system will enable a wide range of new applications/services.
- Research on designing, developing, optimizing and maintaining observing systems/networks is urgently needed.
- International cooperation and continued investment in future generation of scientists and engineers are key to success.