Advancing Climate Prediction Science – Decadal Prediction

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Jan-Dec Global Mean Temperature over Land & Ocean

Anomaly (°C) relative to 1901-2000

1880 1900 1920 1940 1960 1980 2000

NCDC/NESDIS/NOAA
Outline

• Why decadal prediction
• Mechanisms of decadal variability
• What is the decadal predictability potential
• Challenges
“Climate surprises”

1900 1950 2000 2050 2100

cooling
Decadal variations in Sahel rainfall

Note that the Cape Verde islands, although not included in the map, are also defined as Sahel.

Source: Millennium Ecosystem Assessment

JJASO–mean Sahel precipitation anomalies 1900–2008

Averages over 20–10N, 20W–10E; 1900–2008 climatology
NOAA NCDC Global Historical Climatology Network data
Decadal variations in Atlantic hurricane activity
Decadal variability in sea level

Linear trend 1993-2003

Kwajalein (8°44’N, 167°44’E)
Global change prediction is a joint initial/boundary value problem

Projections were not initialized in IPCC-AR4
The uncertainty in climate projections for the 21st century

- Internal variability
- Unpredictable external influences
- Model bias

Hawkins and Sutton 2009

WCC-3, Geneva, 31 Aug-4 Sep 2009
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Internal vs. external influences

How much did internal decadal variability contribute to the warming during the recent decades?
Decadal variations in the North Atlantic Oscillation

How much of the decadal NAO variability is forced by changes in the boundary conditions?
Decadal North Atlantic sea surface temperature variations

Changes in hurricane activity and Sahel rain, for instance, can be traced back to variations in Atlantic sea surface temperature (SST)

WCC-3, Geneva, 31 Aug-4 Sep 2009
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Potential predictability of surface air temperature (SAT)

The North Atlantic Sector appears to be one of the promising regions.

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Predictability of the Meridional Overturning Circulation (MOC)

The MOC is predictable at a lead of one to two decades in perfect model studies
Strong volcanic eruptions, for instance, can cause global cooling of about 0.2°C for a few years and persist even longer in the ocean heat content. If they happen, we can exploit their long-lasting climatic effects.
Large spread for the next decade

3 climate model hind/forecasts

(A) Global average surface temperature

(B) Atlantic SST dipole index

Hurrell et al. 2009
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Climate observing system

Example: ocean observing system

We need climate observations to initialize the models to forecast variations up to decadal time scales
Model biases are large

Typical bias in surface air temperature (SAT)

Errors of several degrees C in some regions
Gulfstream SST front

Representation of small-scale processes
Resolution matters

The AGCM has T239 horizontal resolution (~50 km) and 48 levels

Compared to the smoothed SST run, rain-bearing low pressure systems tend to develop along the Gulf Stream front in the control simulation

Minobe et al. 2008

WCC-3, Geneva, 31 Aug-4 Sep 2009
Where are we today?

• A decadal predictability potential for a number of societal relevant quantities is well established.

• We need a better understanding of the mechanisms of decadal variability

• We need a suitable climate observing system (ocean, land surface, sea ice...)

• We need „good“ models! We know from NWP that reduction of systematic bias helps. Biases in climate models are still large
To realize the full decadal predictability potential we need a coordinated scientific programme under the auspices of the World Climate Research Programme (WCRP)

Thank you for your attention
Decadal variability in sea level
Topex/Poseidon 1993-2005