Max-Planck-Institut für Meteorologie
Max Planck Institute for Meteorology

EARTH EXPLORERS AND SCIENTIFIC CHALLENGES

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There will be no sustainable development without a co-ordinated Global Change research

Examples:

- depletion of the stratospheric ozone layer;
  detected by in situ and satellite observations,
  political solution available through the Montreal Protocol

- Global warming by the enhanced greenhouse effect of the atmosphere, detected in 1995 by combining time series of forcings, climate observations, coupled models, and new statistical methods;
  Kyoto Protocol only a first small step

Key Challenges

- Understanding the Earth System
- Finding the Predictability Window
- Exploiting the Predictability Window
- Binding International Law to Approach Sustainability

For the first three items Earth Observation from space and Coupled Modelling have played and will play a key role.

Envisat misst die Stickstoffdioxid (NO_2)- Konzentration in der Atmosphäre

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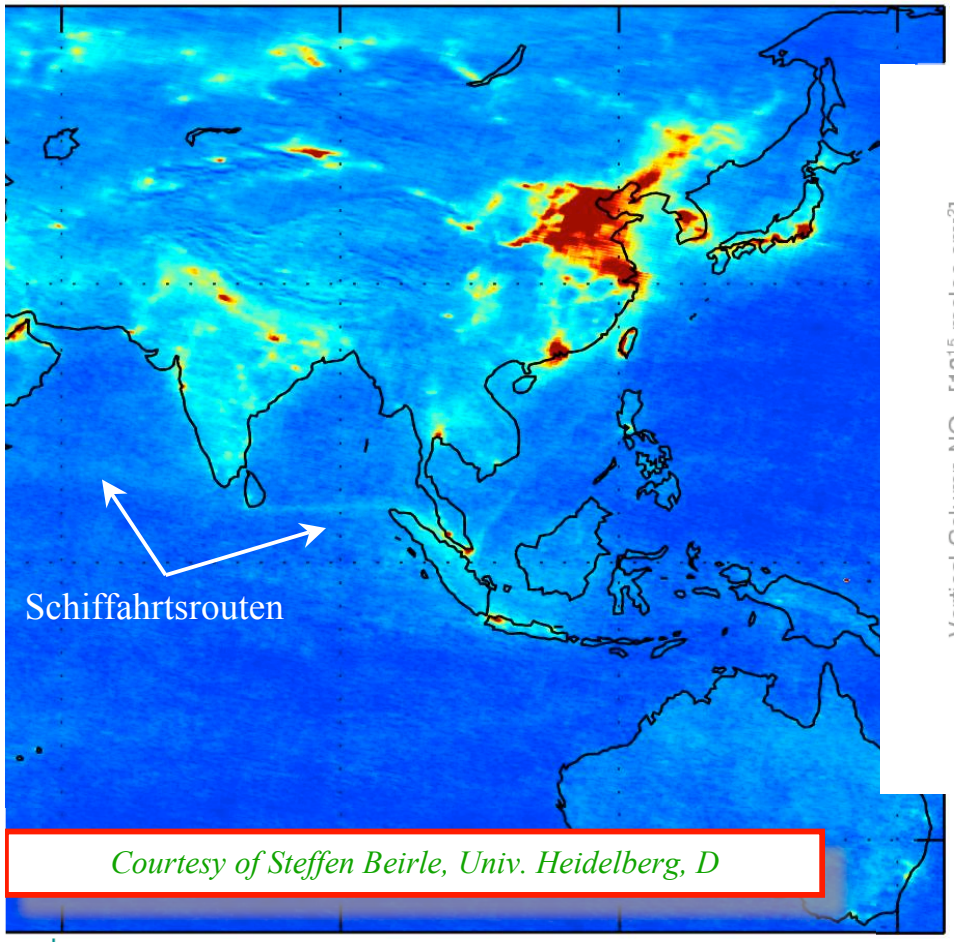
Understanding the Earth System

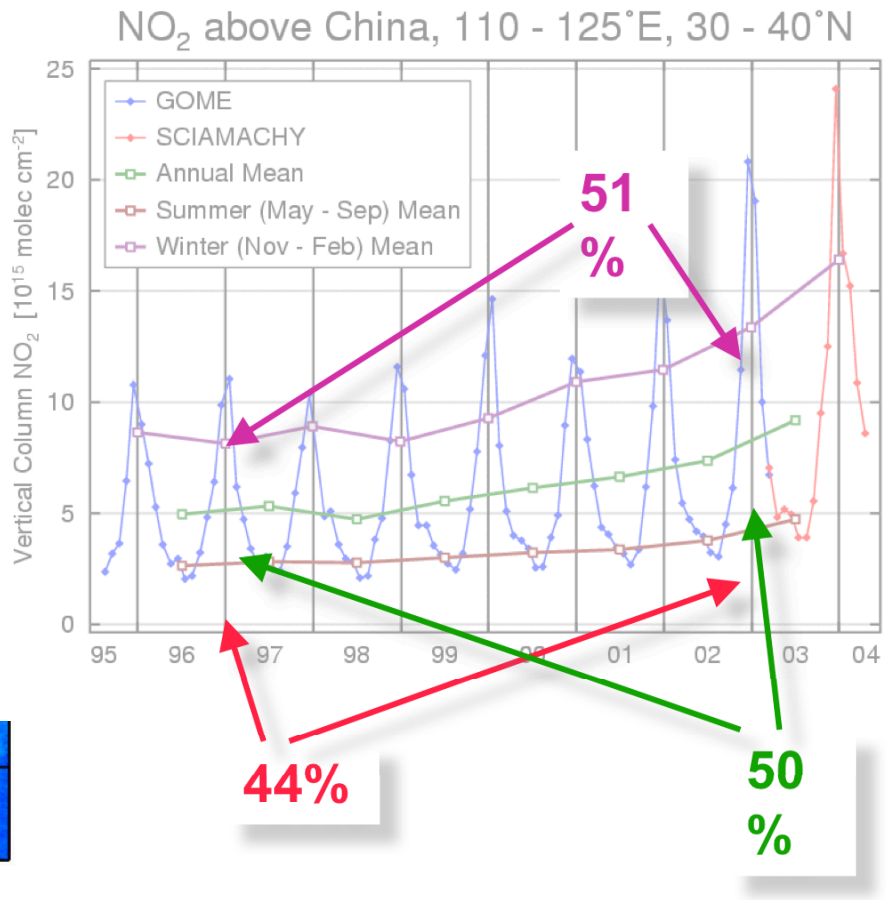


Courtesy of Steffen Beirle, Univ. Heidelberg, D

NO_2- Säulengehalt von SCIAMACHY beobachtet

-1 0 1 2 3 4 5 6

10^{15} Moleküle/cm²



NO_2 Konzentrationszunahme um 50%

Courtesy of John Burrows, Univ. Bremen, D

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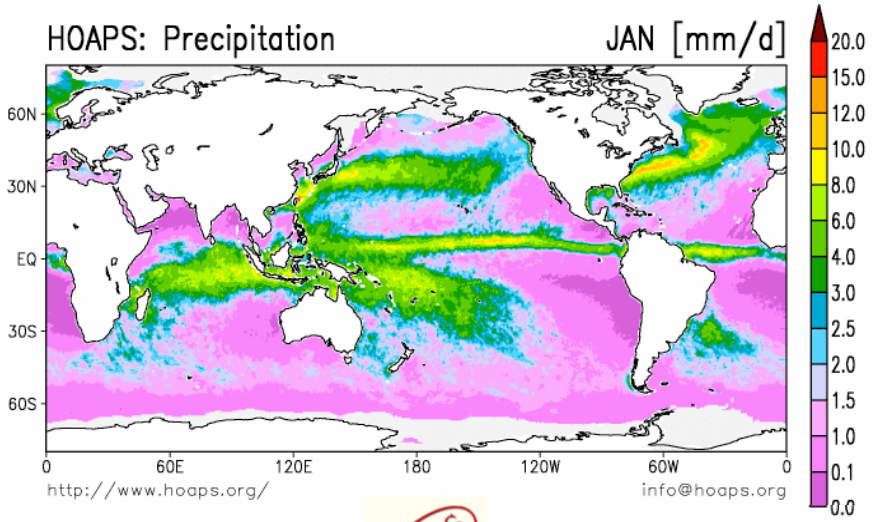
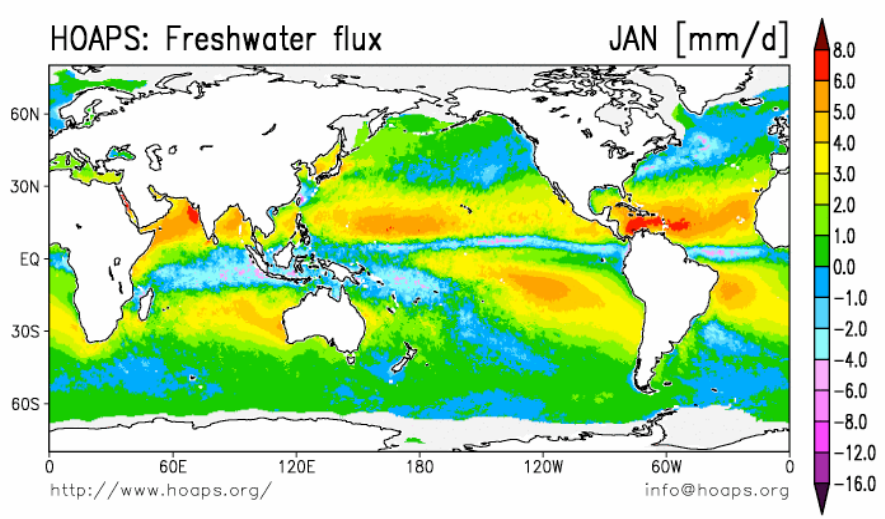
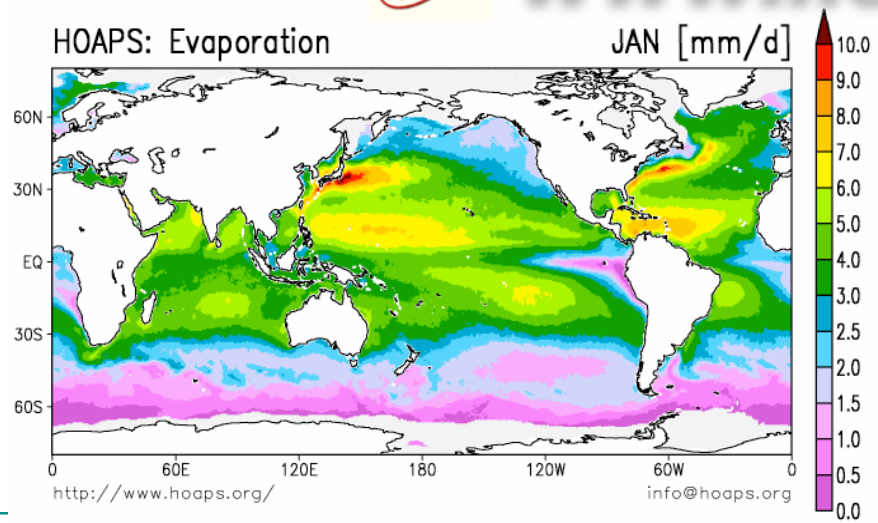
HOAPS II global mean fields (1988 –2002)

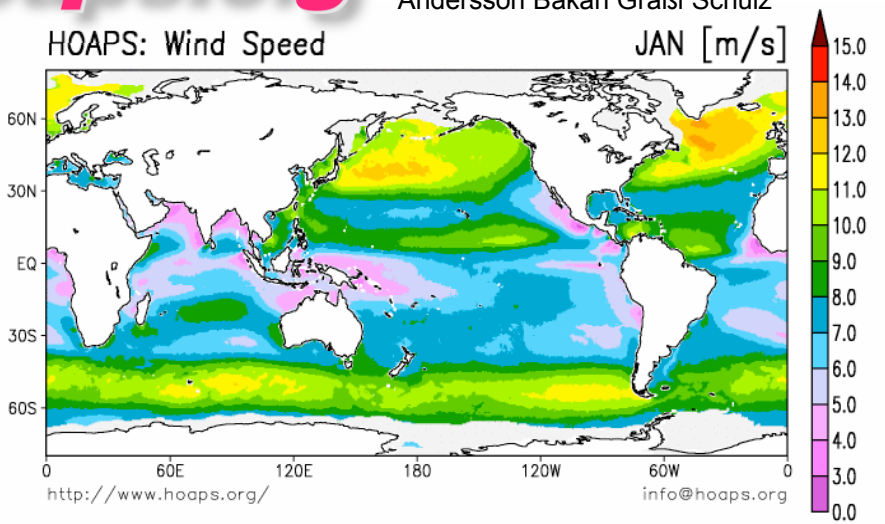




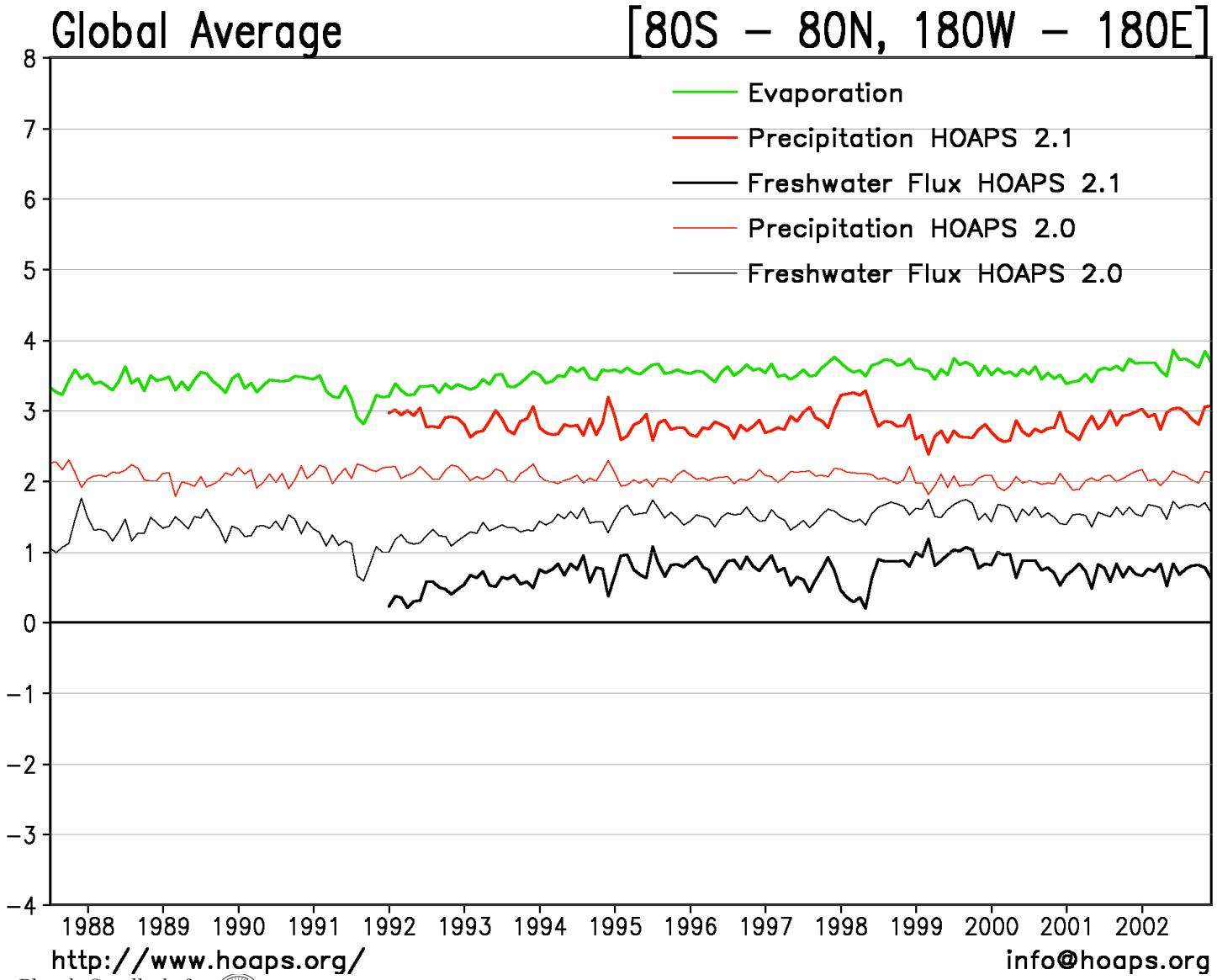
HOAPS **www.hoaps.org**

The HOAPS Team
Fennig Klepp
Andersson Bakan Graßl Schulz





New precipitation algorithm in HOAPS 2.1



100% (1961-1990) = 22 Sv

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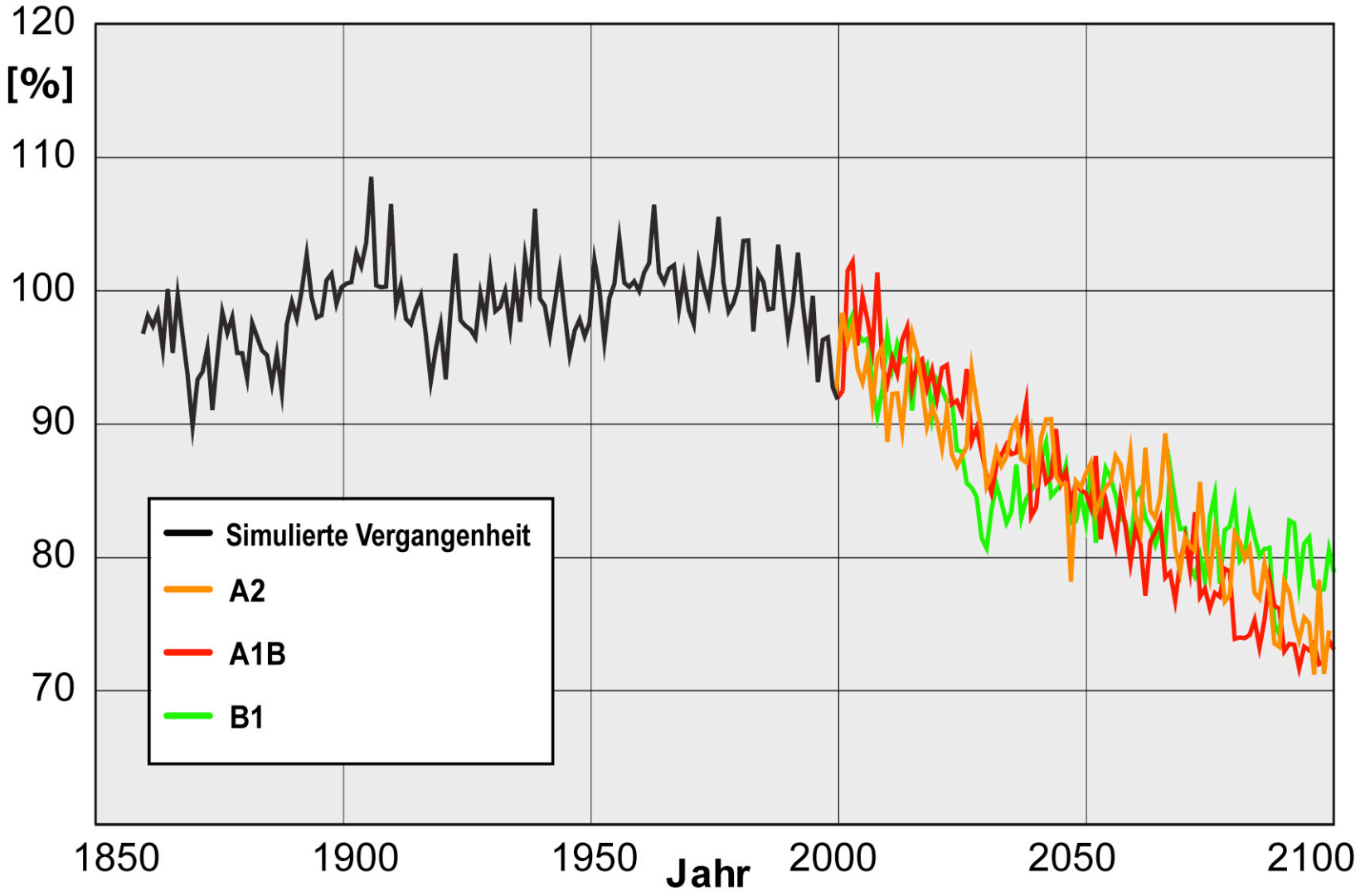
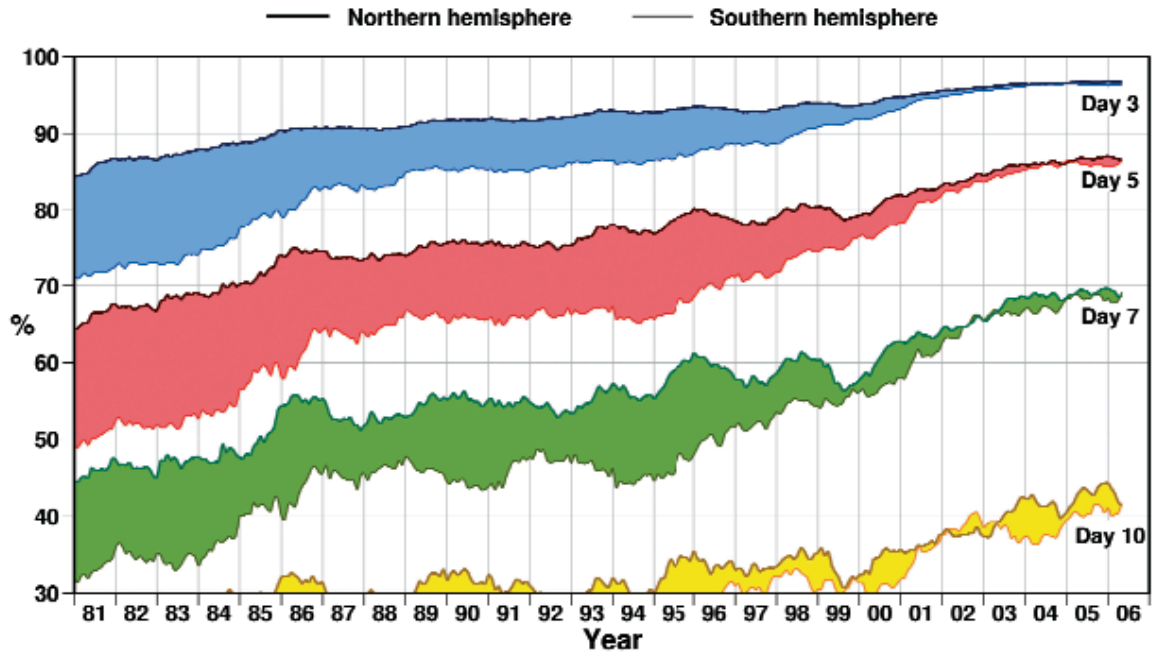
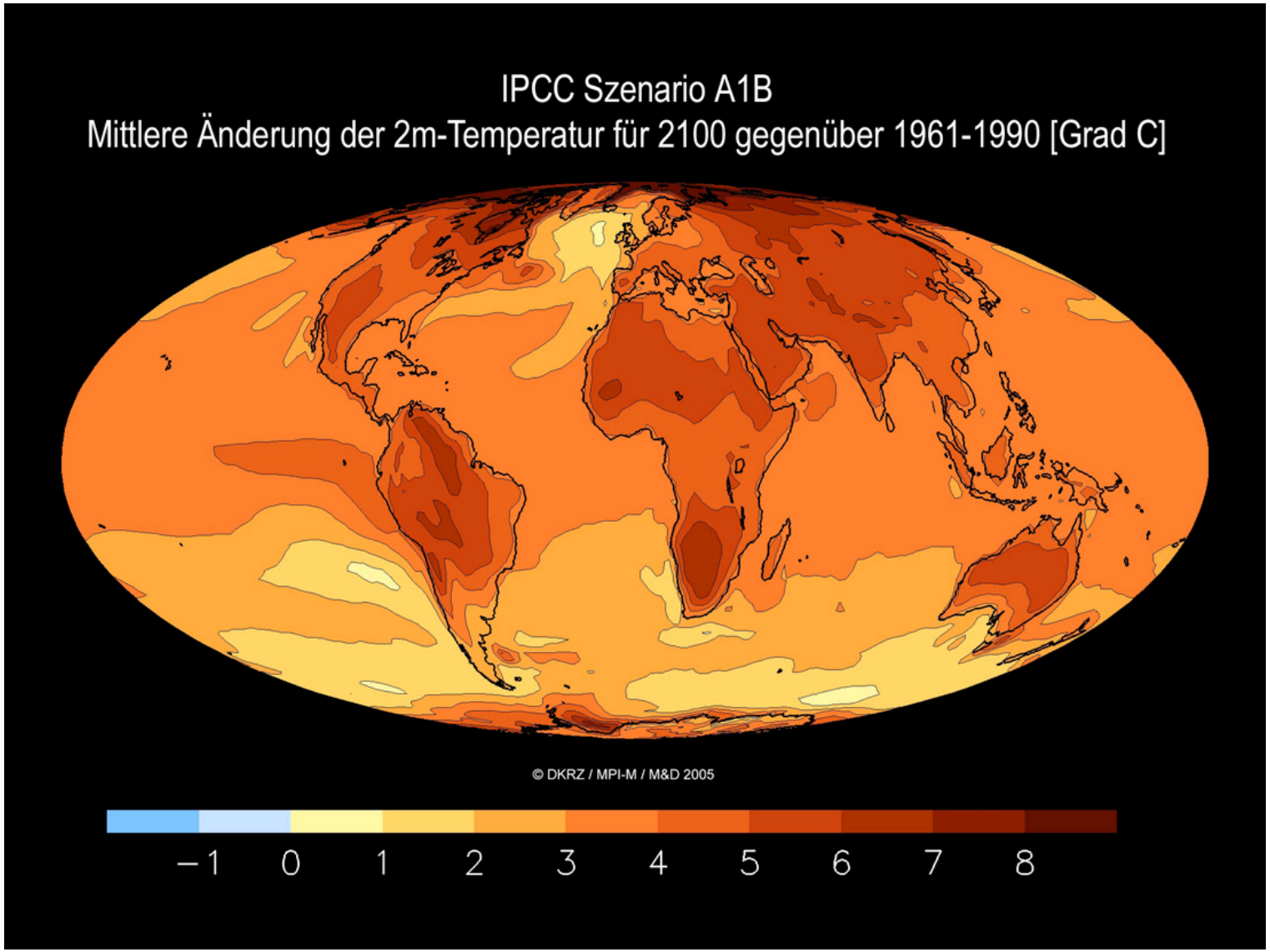
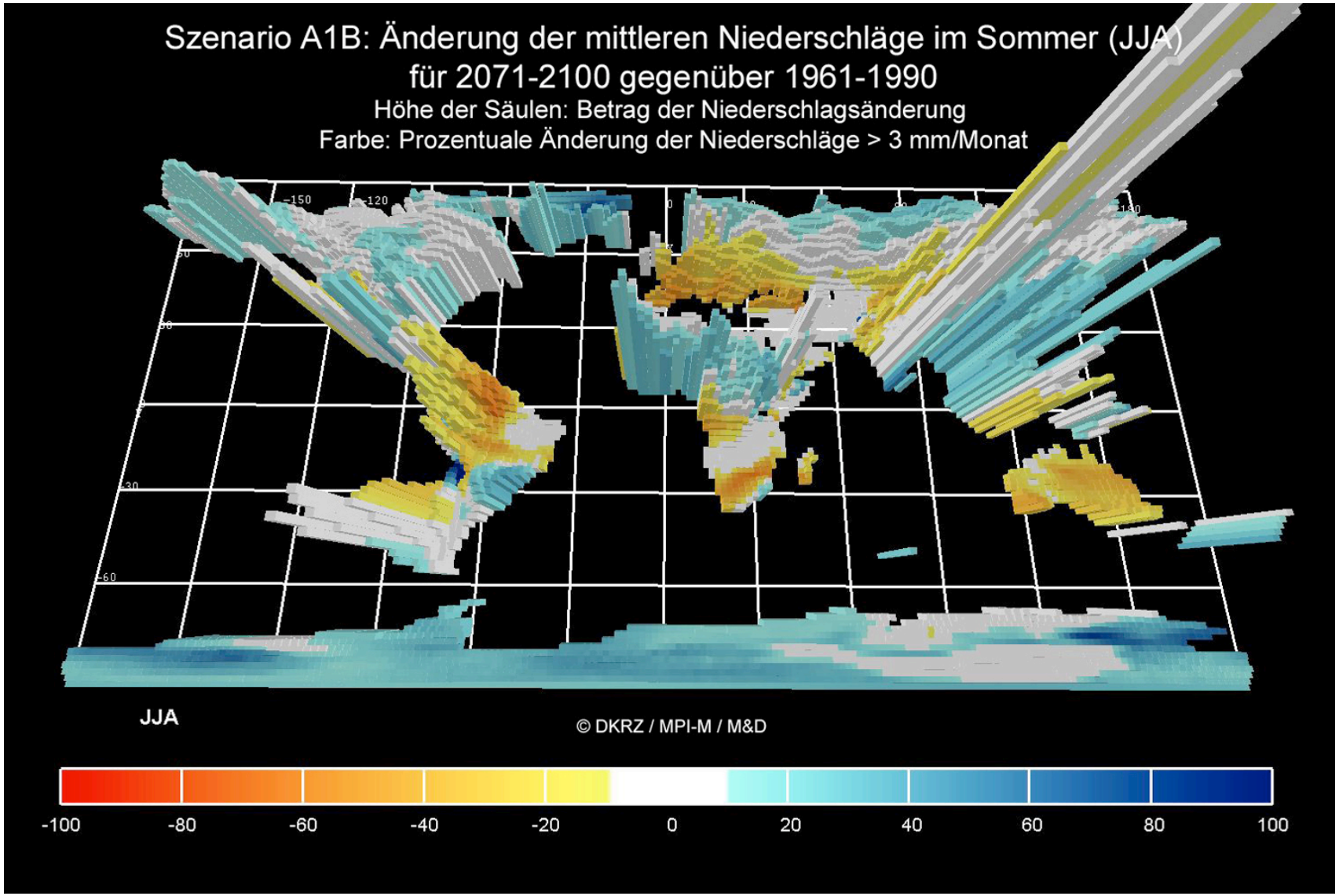


Improvements of Weather Forecasting

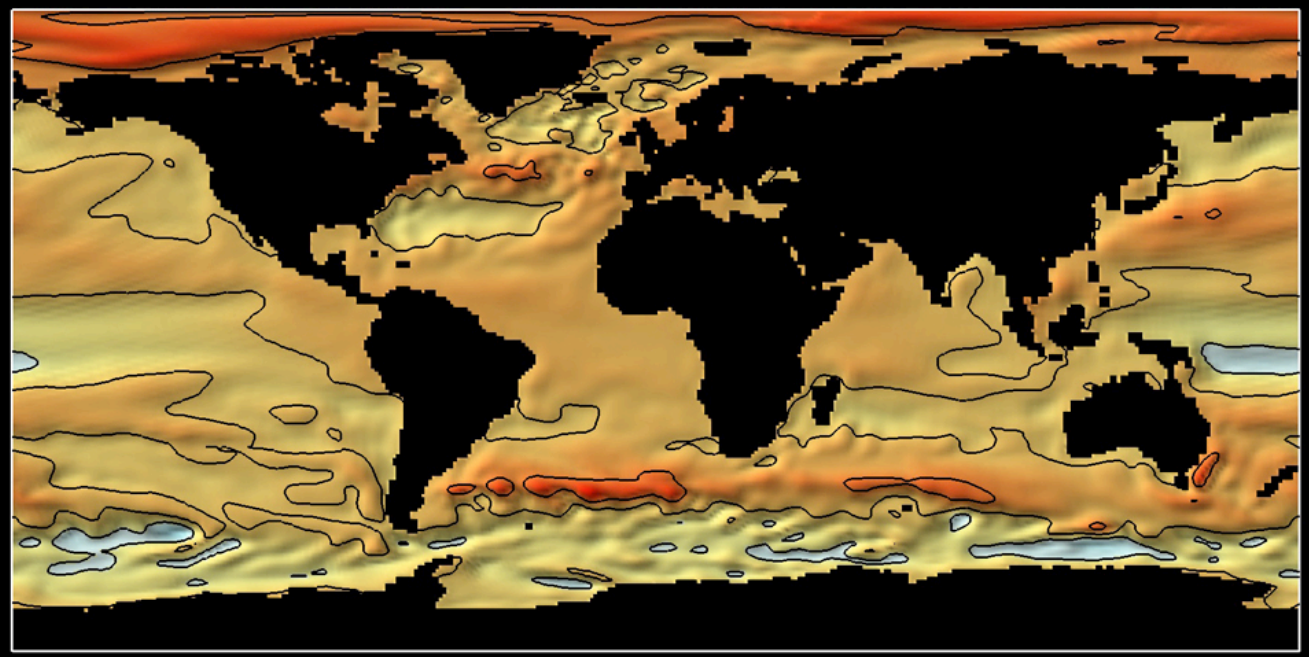



IPCC Szenario A1B
Mittlere Änderung der 2m-Temperatur für 2100 gegenüber 1961-1990 [Grad C]
© DKRZ / MPI-M / M&D 2005
−1 0 1 2 3 4 5 6 7 8


Szenario A1B: Änderung der mittleren Niederschläge im Sommer (JJA)
für 2071-2100 gegenüber 1961-1990
Höhe der Säulen: Betrag der Niederschlagsänderung
Farbe: Prozentuale Änderung der Niederschläge > 3 mm/Monat
JJA
© DKRZ / MPI-M / M&D
-100
-80
-60
-40
-20
0
20
40
60
80
100

Ausdehnung des Meerwassers

Szenario A1B



Interaction between Scientific Community and Space Agencies
Example: Climate Research

June 1996: D/WCRP wrote on behalf of WCRP's JSC to Space Agencies

His wish list:

- better geoid for oceanography
- 3-D aerosol, liquid water and ice in the atmosphere
- soil moisture
- ocean surface salinity
- tropospheric wind profiles
- sea ice thickness

The answer of space agencies:

- ESA: GOCE NASA: Grace already decided
- ESA: EarthCARE NASA: CNES Cloudsat + Calypso
- ESA: SMOS NASA: Aquarius
- ESA: SMOS
- ESA: ADM-Aeolus
- ESA: Cryosat

Scientific Challenges in more Detail

- How much anthropogenic carbon dioxide will be taken up by the terrestrial biosphere?
  - ESA: pre-phase A studies for A-SCOPE; NASA: OCO; JAXA: Carbosat

- Can we define seismic risks and start to 'dream' of earth-quake predictions?
  - ESA: InSAR with ERS-1/2, Envisat; ESA Alpbach Summer School 2006: new concept

- Prediction of volcanic eruptions?
  - ESA Alpbach Summer School 2006: global survey and prediction attempts

- Drought monitoring and yield forecasts on global scale?
  - feasible, but not yet done, improvements by SMOS; in parts done by private companies, which do not report

- How does terrestrial and marine biomass react to climate variability?
  -ESA: MERIS etc.; NASA: MODIS etc.

- Will the Atlantic Overturning Circulation weaken?
  - full implementation of the ARGO buoy system, data collection by satellites

Contributions of ESA Member States

- The national space agencies of Europe are mainly engaged in high spatial resolution sensors both active and passive and in the optical domain as well as for microwaves.
  Examples: Pleiades (F); Cosmo Skymed (I); Tandem X (D);
  EnMap (D)
  Consequence: The GMES sentinels do not serve this domain.

- Some European space agencies have developed add-on payloads for ESA and EUMETSAT missions.
  Examples:
  - ATSR-1 on ERS-1; ATSR-2 on ERS-2; AATSR on Envisat (all UK)
  - Sciamachy on Envisat (D, NL, B)
  - GERB (UK)

  Consequence: Missions are enriched, but data dissemination is more complex.

- Some space agencies contribute to ESA‘s Earth Explorer missions.
  Examples: CNES to SMOS and SWARM; JAXA to EarthCARE
  Consequence: financial ceiling can be kept

Infrastructure Needed to Overcome the Bottlenecks

Key Bottleneck: Dissemination of Information
- by Scientific Community
- by National Services
- by Policy-makers

Examples for the Failure:

- no full assessment of soil degradation on global scale, which would help the implementation process of UNCCD
- belated information about the recent tsunami on Java
- neglect of anthropogenic global warming by several governments, including the main polluter

Further Bottleneck: Inadequate Co-operation among National Services

Examples:

- no operational ‘ocean weather‘ forecasting for European Seas although feasible with satellite data and ARGO
- no international flood forecasting for major rivers
- no Europe-wide dissemination of streamflow data

Required Infrastructure

- scientific assessment bodies for all UN conventions
- enlargement of EUMETSAT‘s constitution to include natural hazard monitoring (fires, sandstorms, etc.)
- rapid implementation of GMES services building up on existing infrastructure
- GMES as a pillar of GEOSS
- Earth Explorers paving the way for tomorrow‘s services

Thank you