The World Climate Research Programme: Grand Challenges for the Decade Ahead

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Director, Earth System Science Interdisciplinary Center

Mission & Objectives

World Climate Research Programme supports **climate-related decision making** and planning **adaptation to climate change** by developing science required to improve

(1) climate predictions and

(2) our understanding of human influence on climate

"for use in an increasing range of practical applications of direct relevance, benefit and value to society" (WCRP Strategic Framework 2005-2015).

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Future Directions: Actionable Science

Defined as: data, analysis, and forecasts that are sufficiently predictive, accepted and understandable to support decision-making, including capital investment decision-making.

- World Climate Conference-3, OceanObs '09, ICSU Review and Visioning, acknowledge WCRP past contributions and identify future challenges and opportunities.

- Need for more flexibility/agility to respond to expanding users needs, that includes information:

  - At regional scale
  - For key sectors of global economy
  - For adaptation, mitigation and risk management

WCRP Open Science Conference

24-28 October 2011

Denver, Colorado, USA

http://conference2011.wcrp-climate.org

Climate Research in Service to Society

Registered Participants:

- **1907 from 86 countries**
- **541 Early Career Scientists & Students**
- **332 from Developing Countries**

WCRP Open Science Conference

Daily Conference Themes:

Emphasizing the integrative aspects of WCRP

Monday: Climate Research in Service to Society

Monday: The Climate System Components and their Interactions

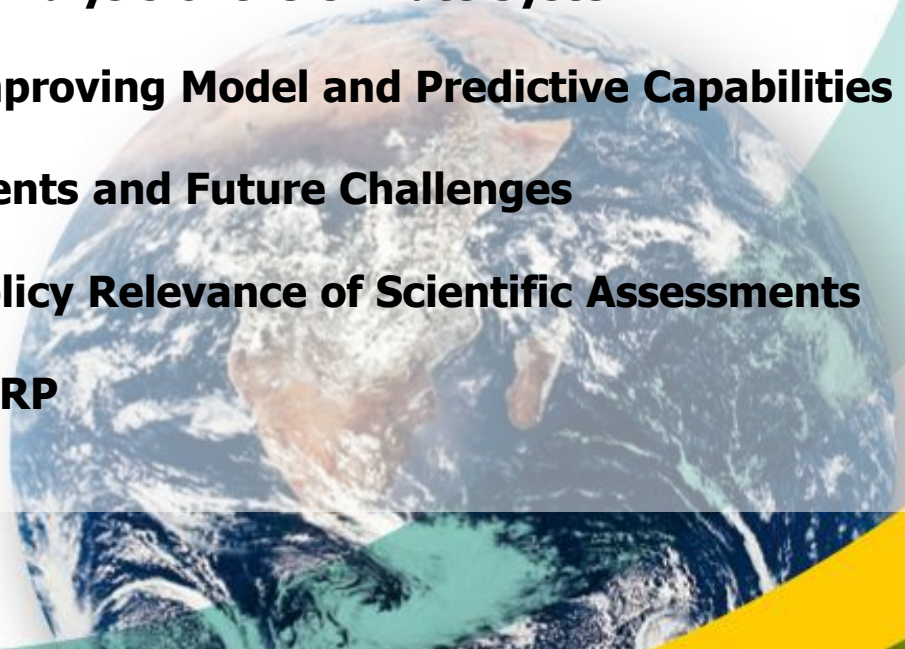
Tuesday: Observation and Analysis of the Climate System

Wednesday: Assessing and Improving Model and Predictive Capabilities

Thursday: Climate Assessments and Future Challenges

Friday: Strengthening Policy Relevance of Scientific Assessments

Friday: The Future of WCRP



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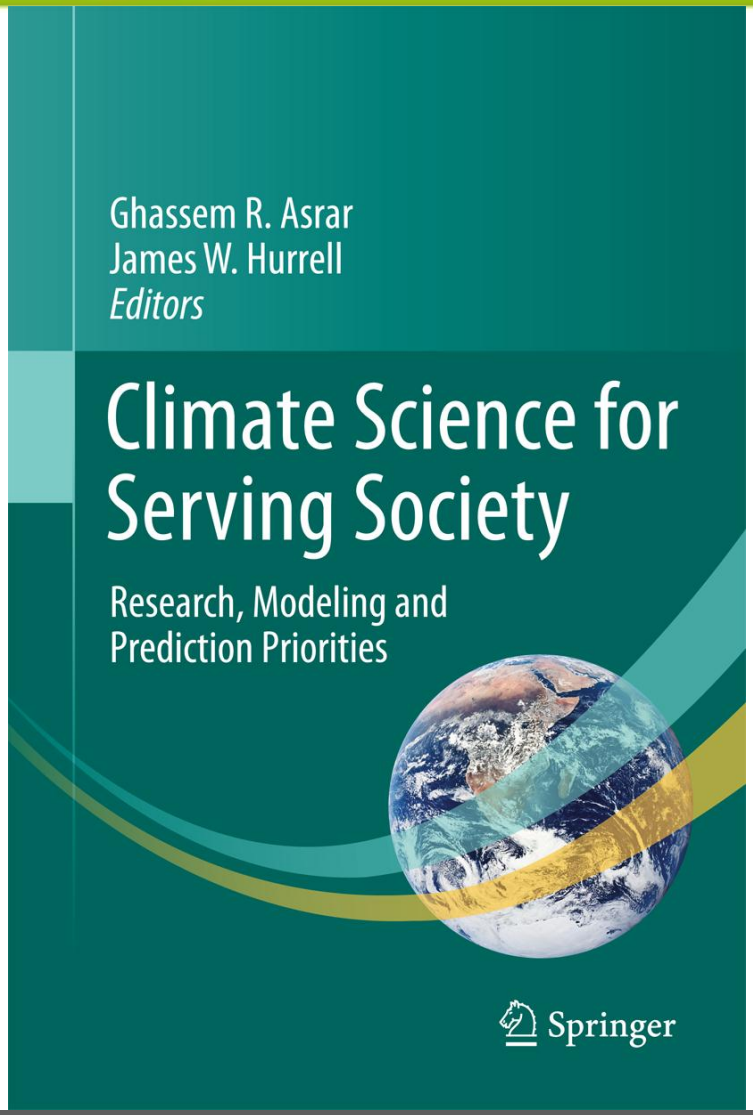
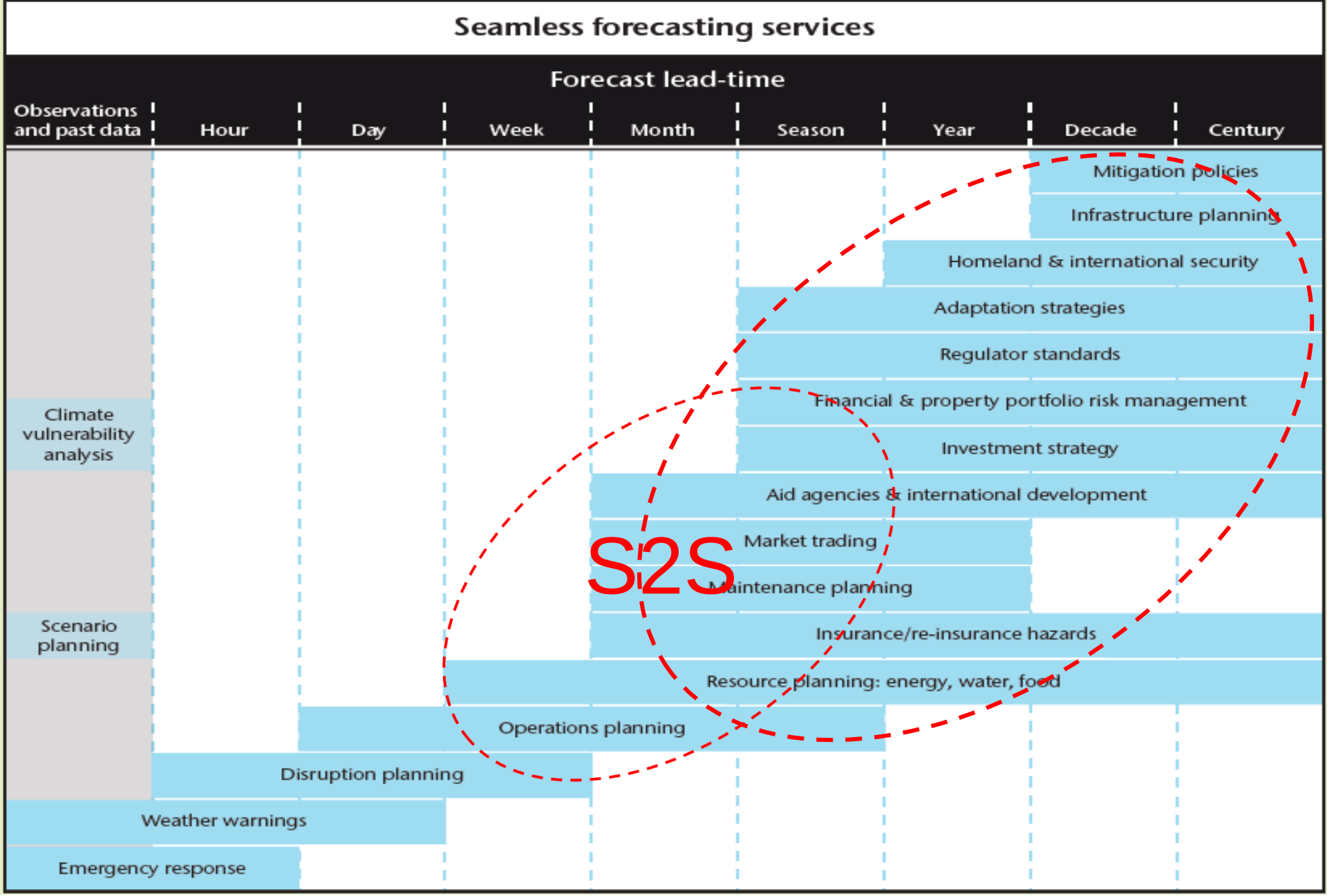


Stakeholders and User Perspective

- 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



Courtesy of UK MetOffice

WCRP Grand Challenges

- A Grand Challenge is both **highly specific and highly focused** identifying a specific barrier preventing progress in a critical area of climate science.

- This focus enables the development of **targeted research efforts** with the likelihood of significant progress over 5-10 years, even if its ultimate success is uncertain.

- It should thus enable the implementation of effective and **measurable performance metrics**.

- By being transformative, a Grand Challenge should bring the **best minds** to the table (voluntarily), **building and strengthening communities of innovators that are collaborative**, perhaps also extending beyond “in-house expertise”.

- It can **capture the public’s imagination**: teams of world-leading scientists working to solve pressing challenges can offer compelling storylines to capture the interest of media and the public.

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WCRP Grand Challenges

- **Regional Climate Information**
- **Regional Sea-Level Rise**
- **Cryosphere in a Changing Climate**
- **Clouds, Circulation, and Climate Sensitivity**
- **Changes in Water Availability**
- **Science Underpinning the Prediction and Attribution of Extreme Events**

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WCRP Organization

Joint Scientific Committee

Joint Planning Staff

Modelling Advisory Council

Data Advisory Council

Working Groups on: Coupled Modelling (WGCM), Regional Climate (WGRC), Seasonal to Interannual Prediction (WGSIP), Numerical Experimentation (WGNE)

CliC

CLIVAR

GEWEX

SPARC

Regional Climate Information

Sea-Level Rise and Regional Impacts

Cryosphere in a Changing Climate

Changes in Water Availability

Clouds, Circulation and Climate Sensitivity

Science Underpinning the Prediction and Attribution of Extreme Events

Cryosphere-Climate Interactions

Ocean-Atmosphere Interactions

Land –Atmosphere Interactions

Troposphere-Stratosphere Interactions

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WCRP Working Group on Regional Climate (2-way Communication: Science-User)

- coordination of WCRP research on regional climate information & services
- communication between WCRP, GFCS and Future Earth, point of contact to regional climate information/service entities
- prioritization of WCRP regional climate research and prediction
- advice for impact assessment, decision making and climate services, especially on water, health, food and disaster risk reduction
- oversee regional climate research initiatives such as CORDEX
- visibility of WCRP regional science and communication of advances to climate service institutions (through web, reports, workshops, etc.)
- liaison with other programmes, communication of science priorities to funding agencies, NGOs and development agencies

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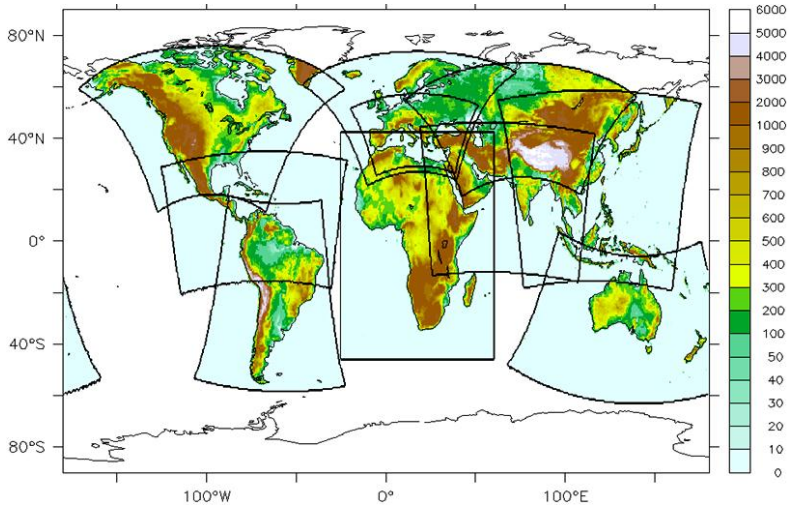
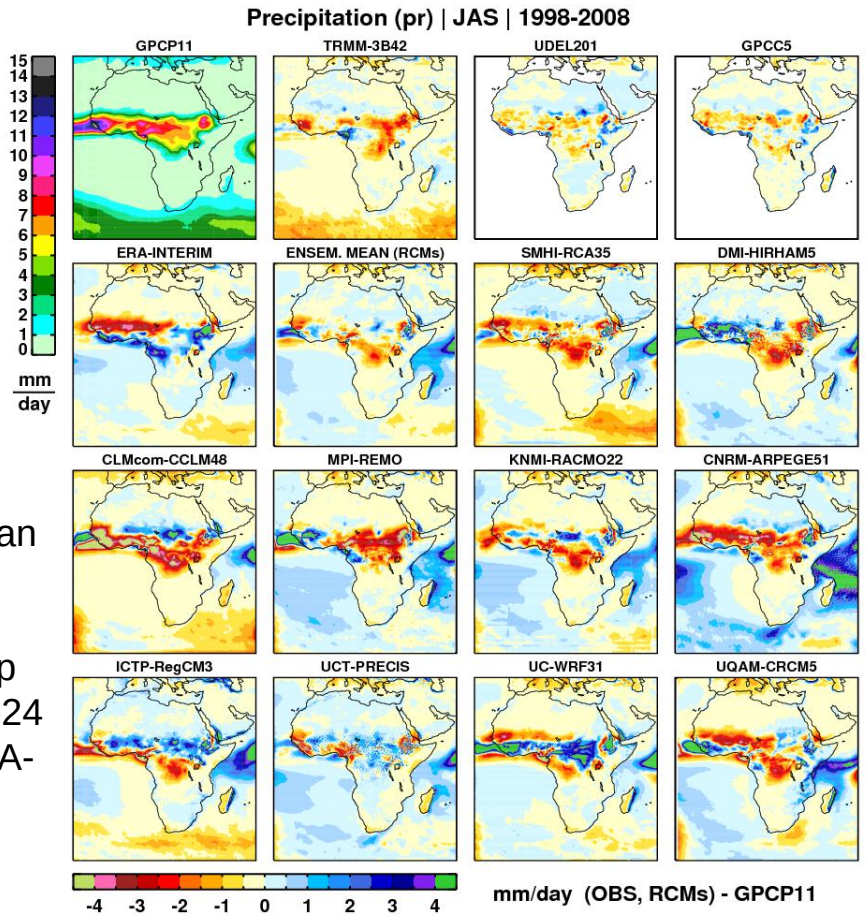
Skillful Regional Climate Information



CORDEX

- 12 domains with a resolution of 0.44˚ (approx. 50x50km²)
- Focus on Africa
- High resolution ~0.11˚ x0.11˚ 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



Courtesy of C. Jones

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World Cities Exceeding 5 Million Residents

2015

Source:
U.N.
Population
Division

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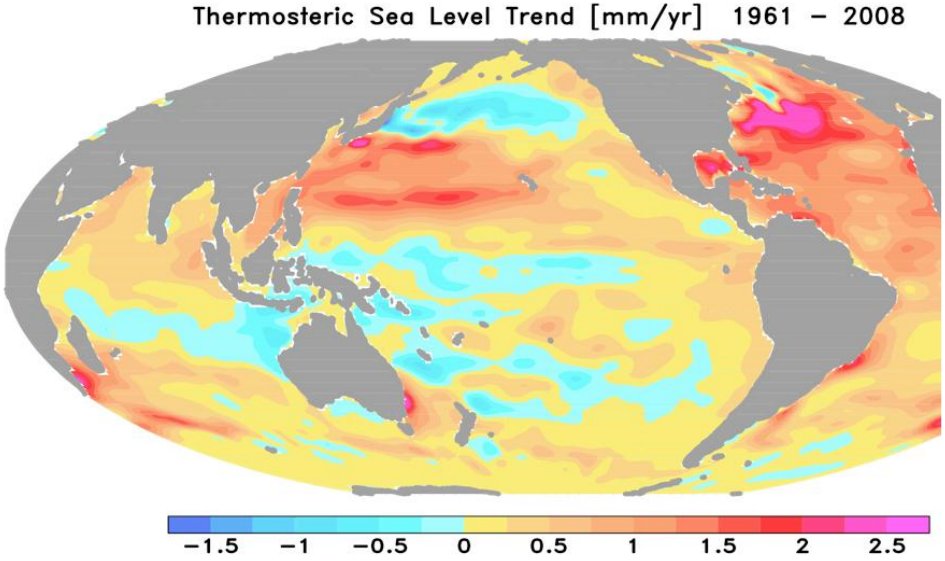
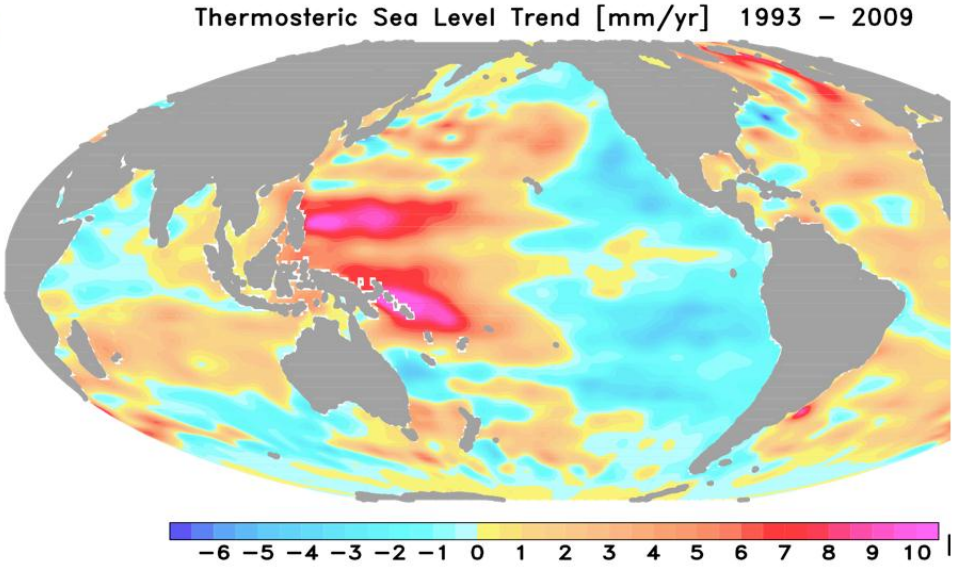
Regional Sea-Level Rise



Sea level fall along the U.S. west coast and rise in the western tropical Pacific Ocean since early 1990s appears to result from the phase change of the Inter-basin Pacific Decadal & multi-decadal Variability
(Weiqing Han et al., University Colorado, 2011)



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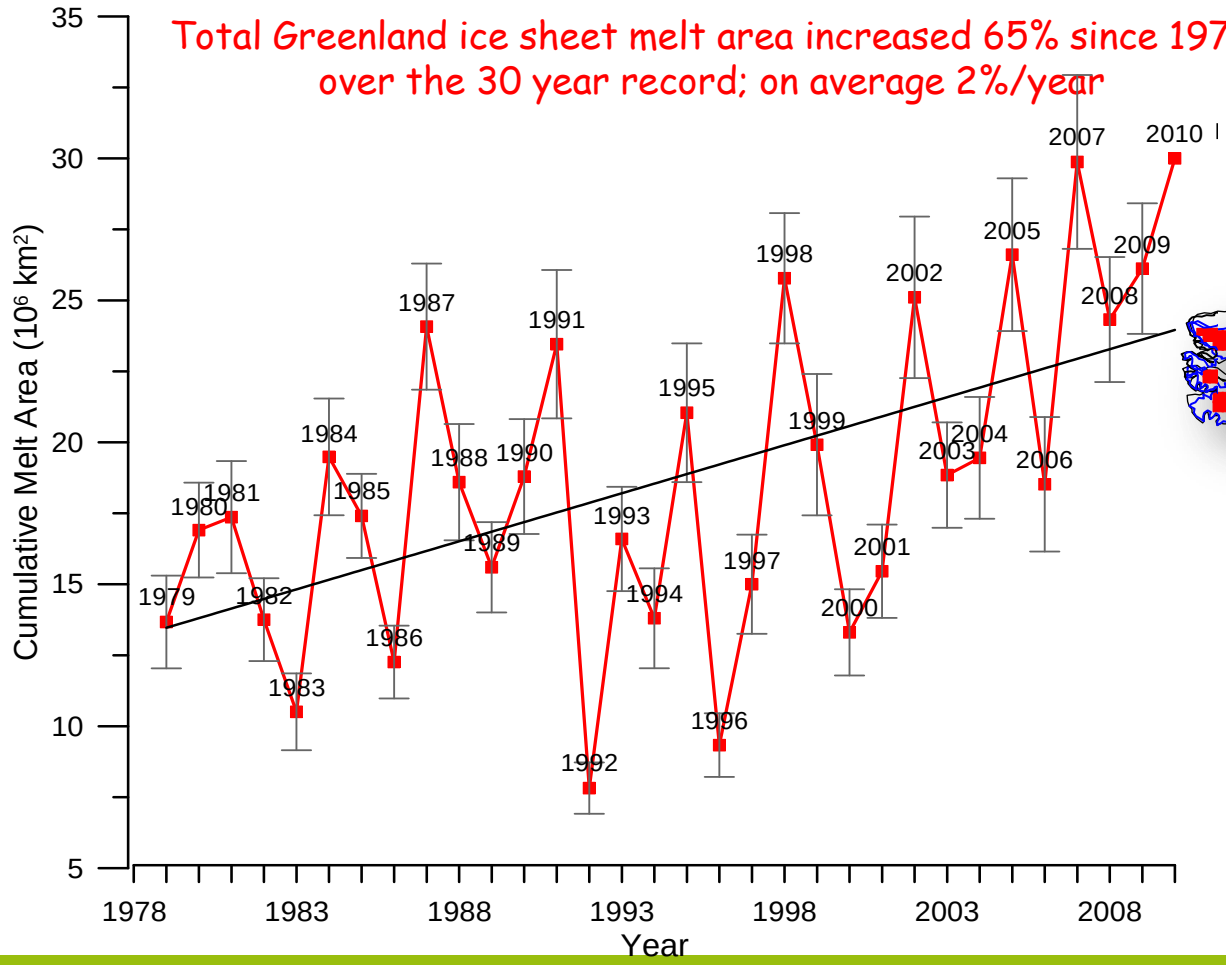
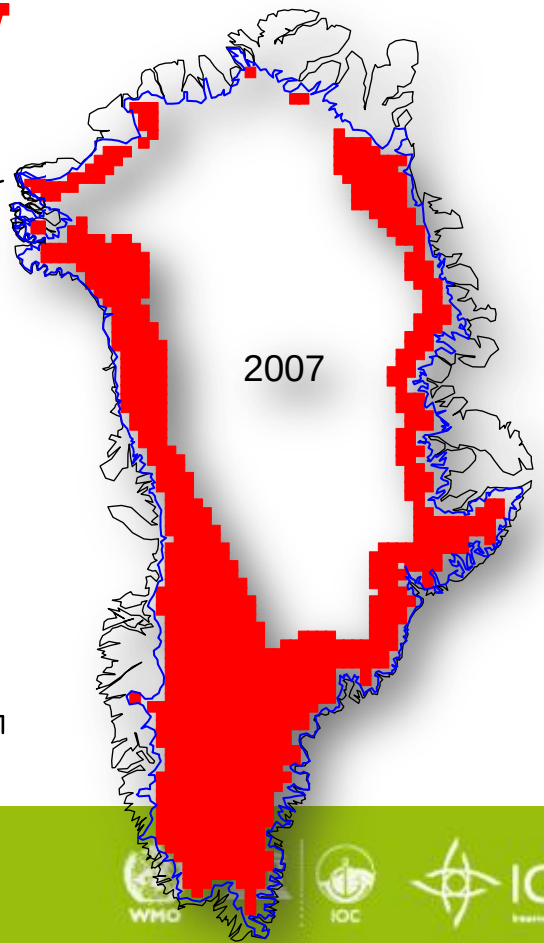
Cryosphere and Climate Change

Total Greenland ice sheet melt area increased 65% since 1979 over the 30 year record; on average 2%/year



The increasing trend in the total area of melting bare ice is at 13% per year



Courtesy of K. Steffen

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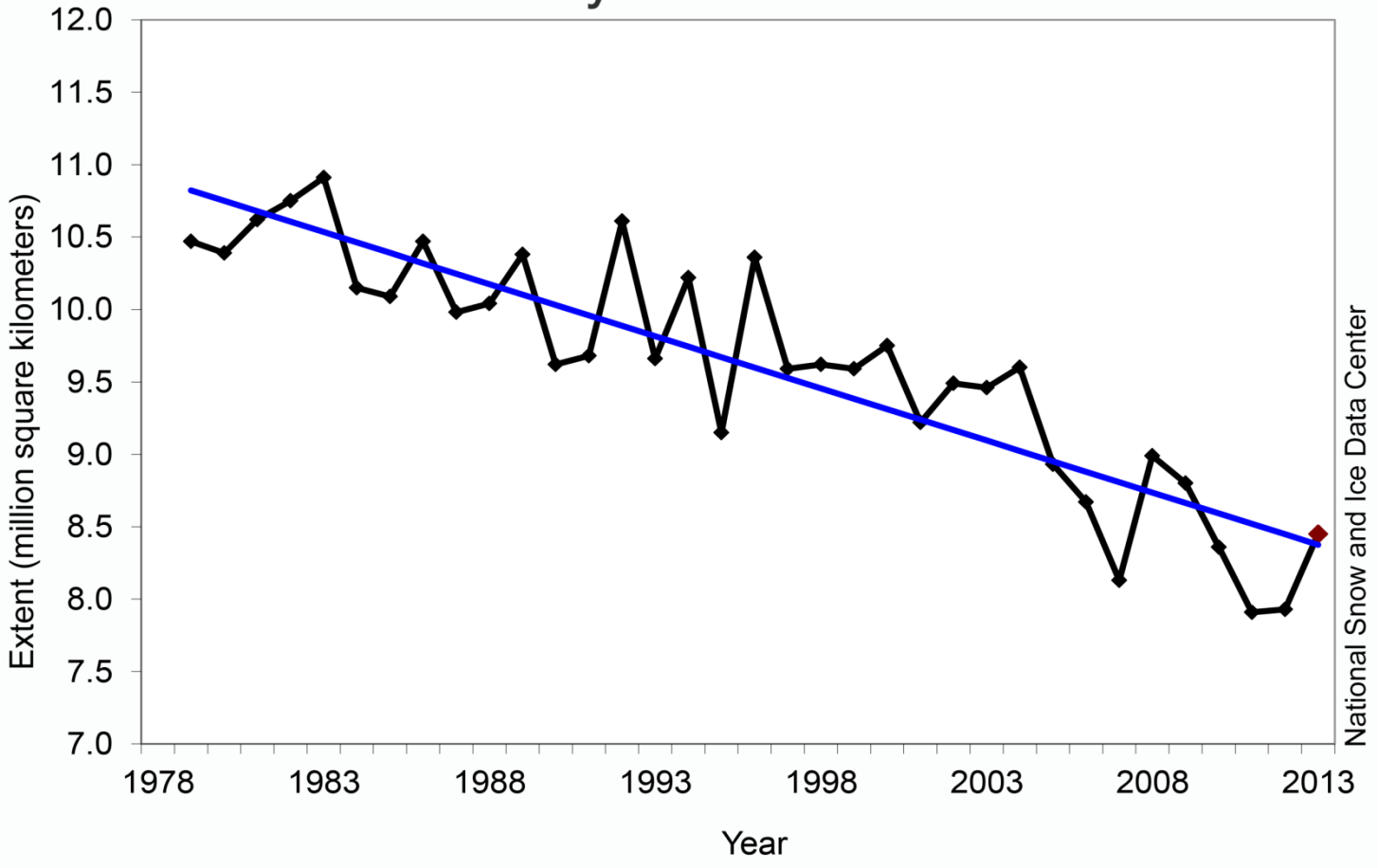
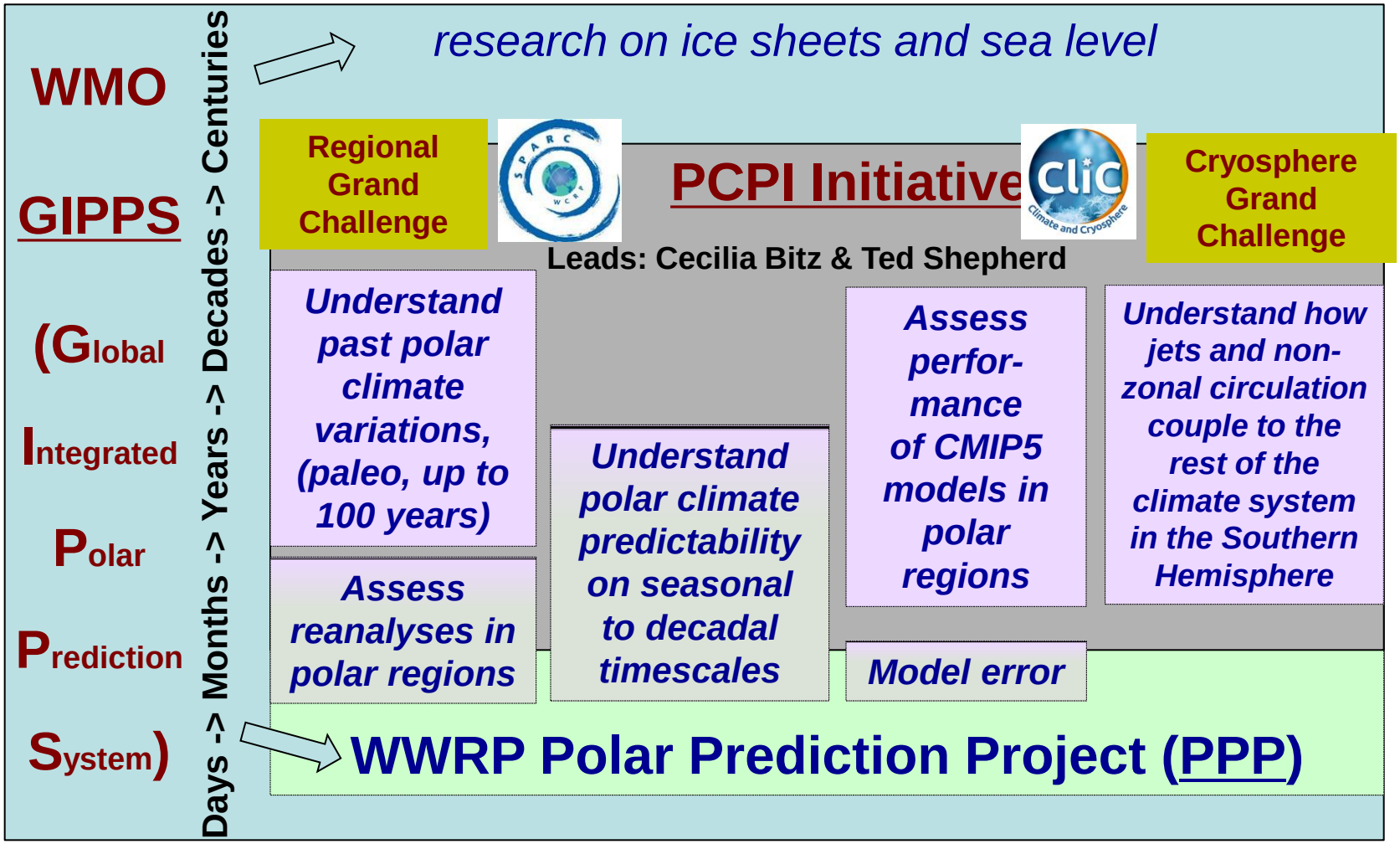
Average Monthly Arctic Sea Ice Extent
July 1979 - 2013



WCRP Polar Climate Predictability Initiative (PCPI, 2010 - …)



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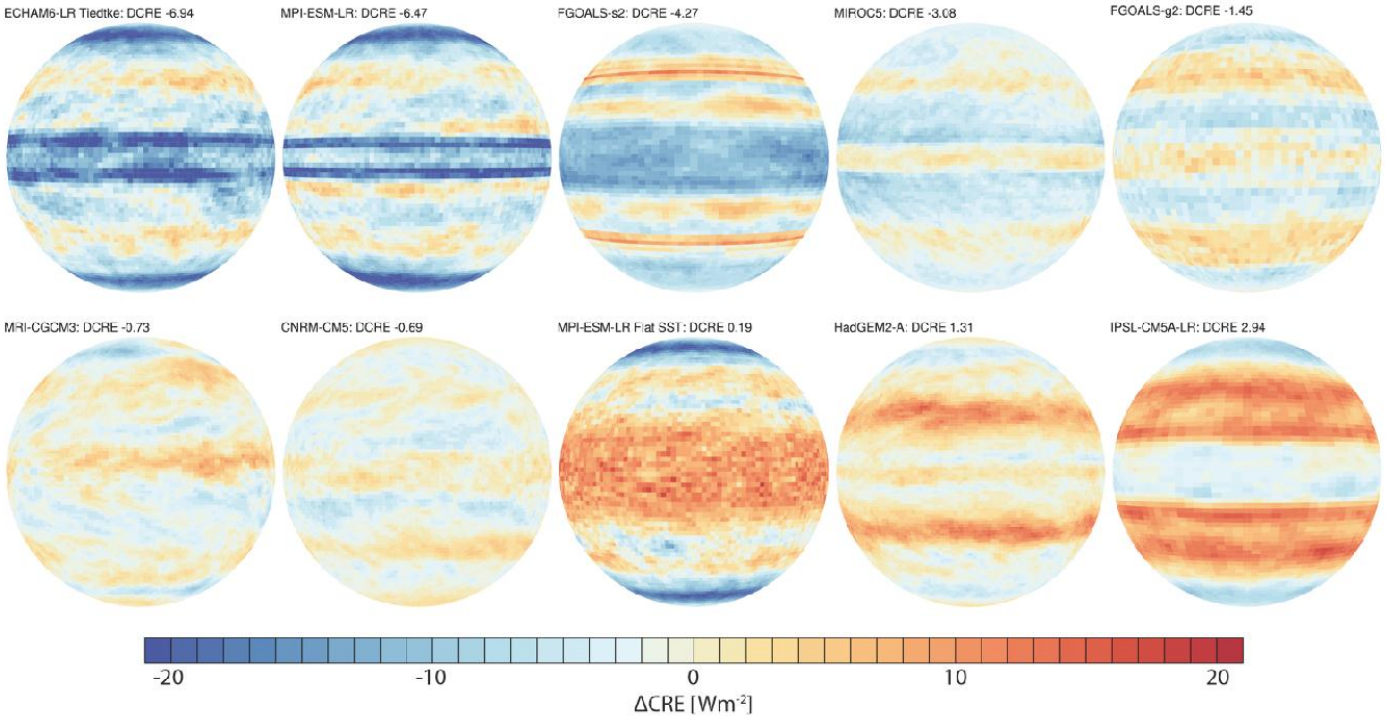
Something Aqua Planets Make Painfully Evident



Response of Cloud Radiative Effects to a uniform warming (+4K) in **CMIP5 aqua-planets**

- Uncertainties related to basic physical processes
- Critical limitation for mitigation and adaptation studies

(Stevens & Bony, Science 2013, inpress)

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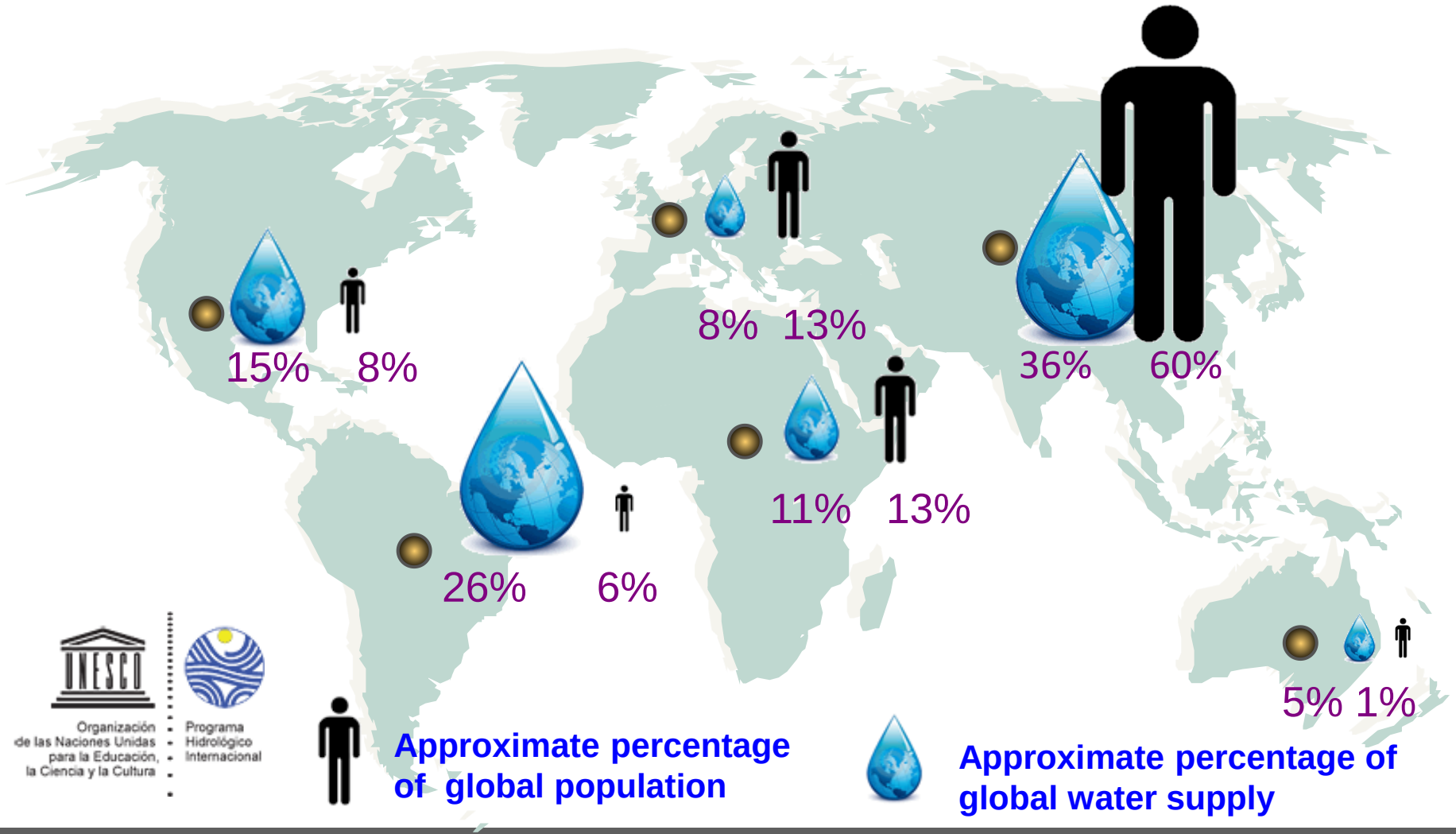
Water and Population

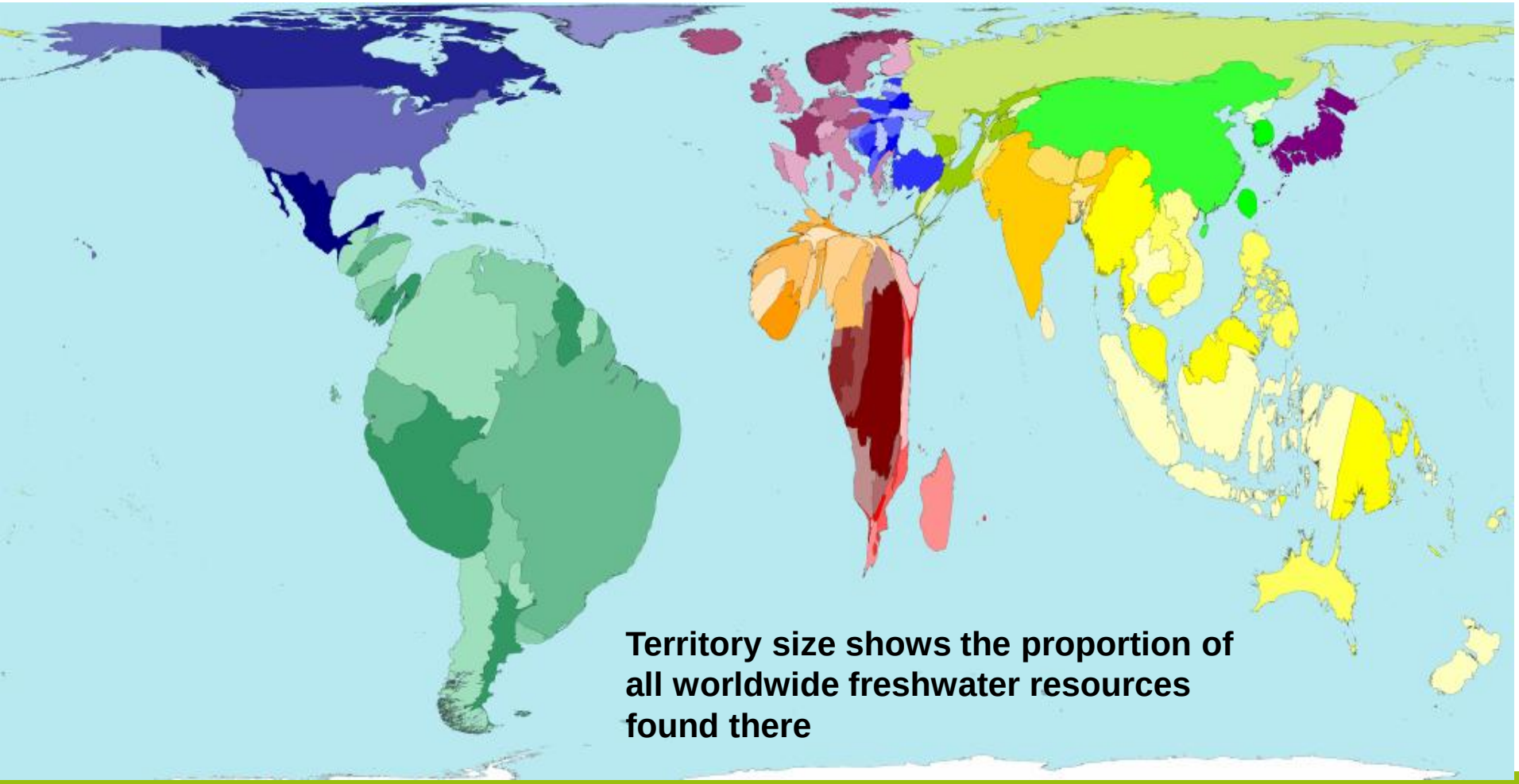
Water is not everywhere!



Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura

Programa Hidrológico Internacional

Water Availability



Territory size shows the proportion of all worldwide freshwater resources found there

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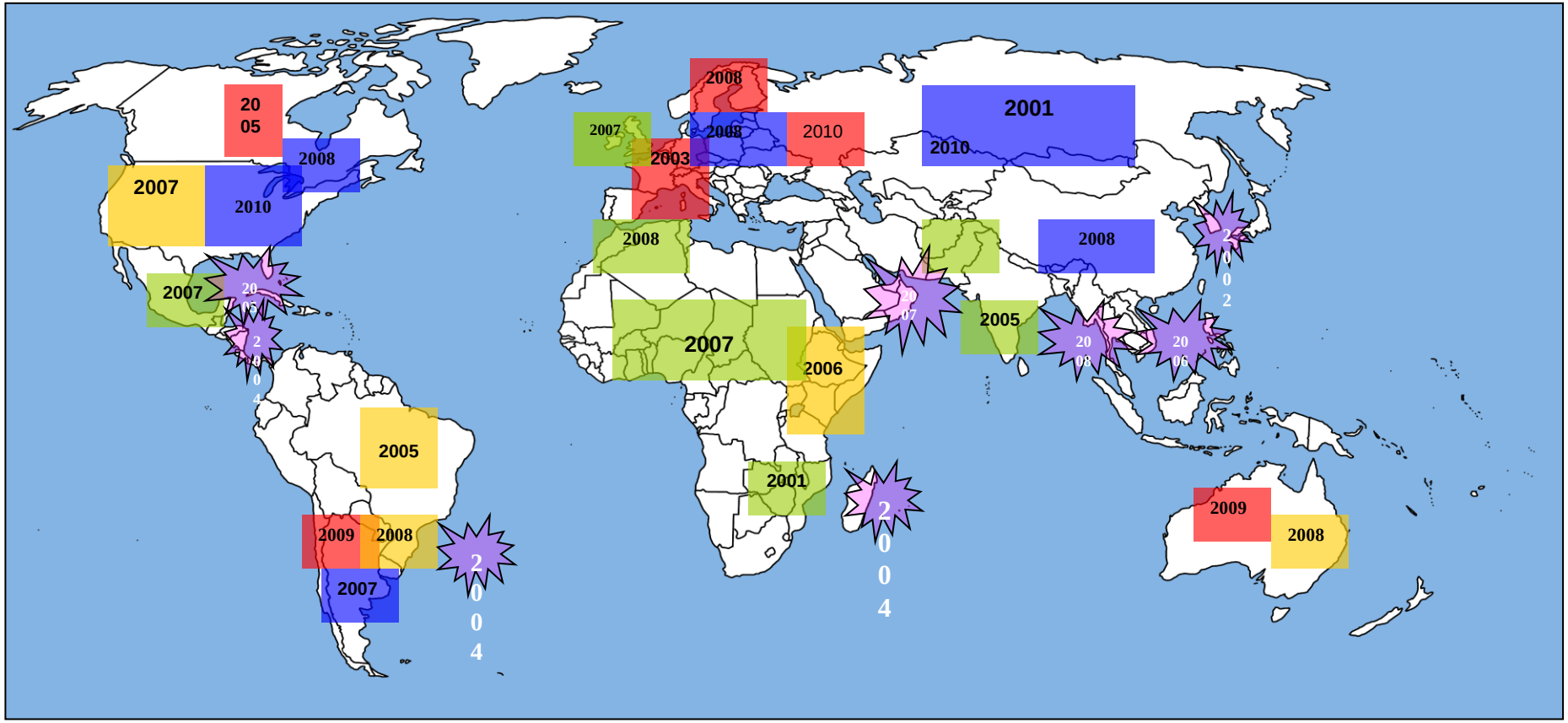
Extreme Events over the Past Decade



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

WCRP-ICTP Summer School on Extremes

Trieste, Italy - 2014

Advanced training on indices, extreme value theory, and event attribution, in each case with the objective of understanding the analysis of the past and the evolution of future (in terms of both prediction and projection) extremes events.

Francis Zwiers (co-Chair), Pacific Climate Impacts Consortium, Canada
Sonia Seneviratne (co-Chair), ETHZ, Switzerland
Albert Klein Tank, KNMI, Netherlands
Peter Stott, Hadley Center UK Met Office, UK
Judith Perlwitz, NOAA, USA
Philippe Naveau, CNRS-IPSL, France
Xuebin Zhang, Environment Canada, Canada
Lisa Alexander, University New South Wales, Australia
Eric Gilleland, NCAR, USA
Gabi Hegerl, University of Edinburgh, UK
David Stephenson, University of Exeter, UK

30 PhD or early post-doc students will be selected, at least half coming from developing world counties, to participate in the two week course

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Summary

Opportunities and Challenges;

- Support development of climate information for decision makers;
- Develop seamless regional and intraseasonal to interannual, and decadal climate prediction/projection;
- 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.
- International cooperation and coordination is key to success.

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