

World Climate Research Programme: Future Plan and Priorities

25th Anniversary of Nansen Center


November 2011

Bergen, Norway

Ghassem R Asrar, Director, WCRP

- **WCRP Mission and Objectives**
- **WCRP Current Plan and Priorities**
- **WCRP Open Science Conference, Highlights**
- **Future Challenges and Opportunities**
- **Summary and Concluding Remarks**

Mission & Objectives

 **World Climate Research Programme** supports **climate-related decision making** and **adaptation planning** by coordinating research required to improve

- (1) climate predictions and
- (2) 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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The Interdisciplinary Nature of Climate Science

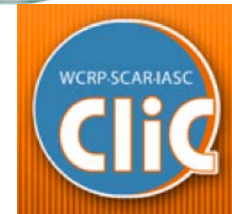
- Atmosphere, Oceans and Climate
- Cryosphere and Climate
- Atmospheric Chemistry and Dynamics
- Water, Energy and Climate



Meeting the Information Needs of Society

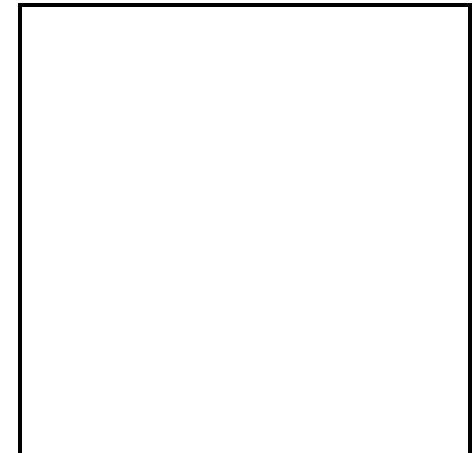
Activities in Support of Key Deliverables

- Decadal Variability, Predictability and Prediction
- Sea-Level Variability and Change
- Climate Extremes
- Atmospheric Chemistry and Dynamics
- Centennial Climate Change Projections
- Seasonal Climate Prediction

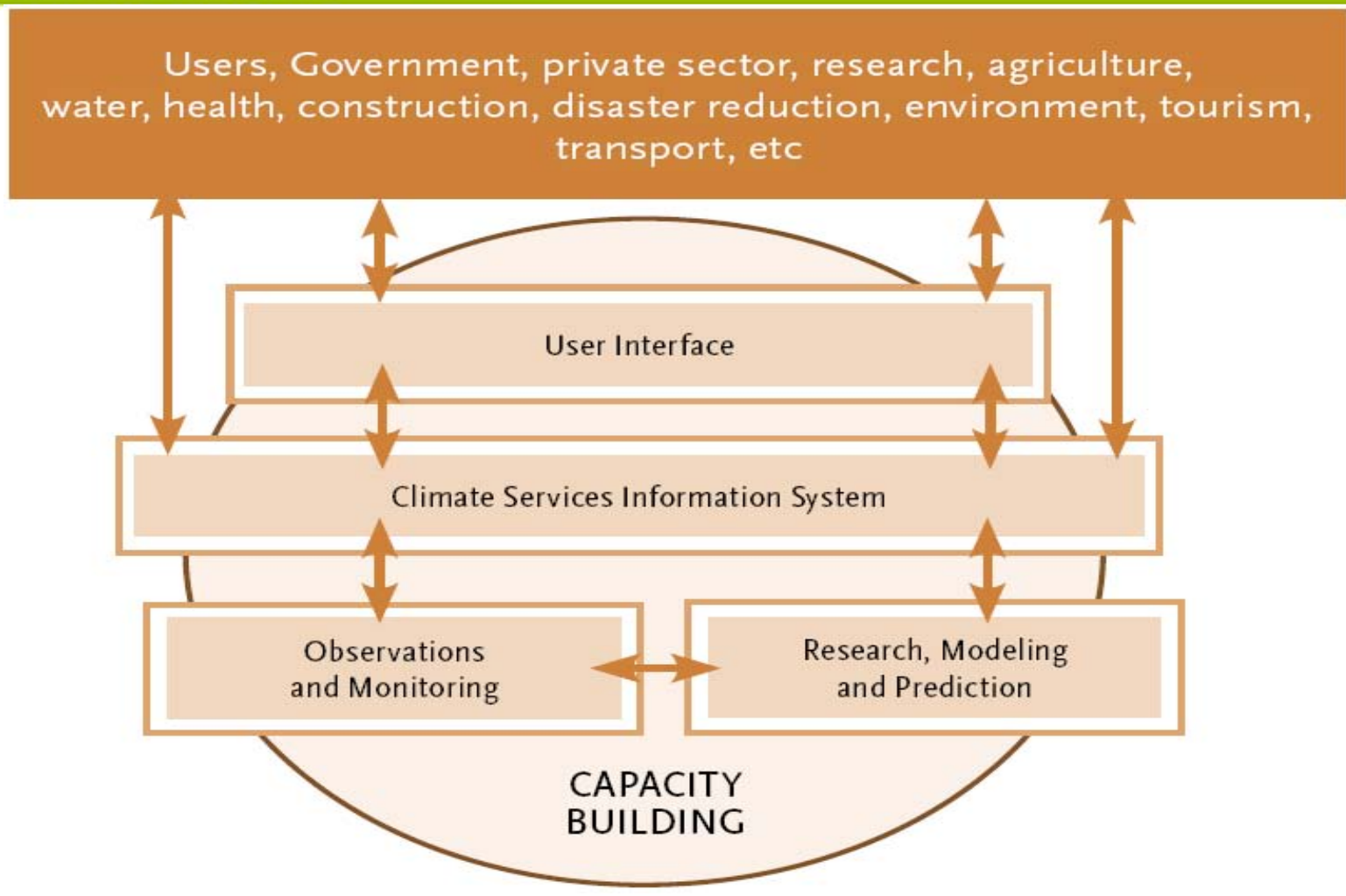


Activities in Support of WCRP Integrating Themes

- Climate-Quality Data Sets and Analyses
- A New Generation of Climate/Earth System Models
- Next Generation of Climate Experts: Developing Capacity Regionally and Globally



The Components of GFCS



WCRP Open Science Conference

24-28 October 2011

Denver, Colorado, USA

<http://conference2011.wcrp-climate.org>

**Promoting, Facilitating and
Coordinating**

Climate Research in Service to Society



Daily Conference Themes – Integrative aspect of WCRP

Monday (early AM): Climate Research in Service to Society

Monday (late AM): 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 Synthesis and Assessments

Friday (early AM): Translating Scientific Understanding of Climate System into Climate Information for Decision Makers

Friday (late AM): The Future of WCRP

<http://conference2011.wcrp-climate.org>



Participants:

1904 registered from 84 countries

213 Early Career Scientists & 300
Scientists from Developing Nations
284 Students

Plenary Sessions:

- 7 Sessions
- 30 Speakers

Parallel Sessions:

- 12 Sessions
- 58 Conveners
- 182 Speakers

Poster Sessions:

- A major feature of the conference
- 45 Sessions
- about 200 Conveners
- about 1750 Posters

- **Urgent need for “actionable” climate information based on sound science.**
- **Environment/climate related issues and concerns of the public and decision makers are complex and require trans-disciplinary approach to addressing them.**

- **The need for “symbiotic” relationship between providers and users of climate information to ensure ‘actionable’ climate information is developed and used effectively: timeliness, access, and easy to understand information is key to success.**
- **Urgent need for training and development of next generation of scientists and decision makers who pursue and promote trans-disciplinary research and use of actionable climate/environmental information in decisions.**

To what extent should WCRP become holistic in its scientific perspective?

There are still order one research problems in our observation, modelling & understanding of the global climate system (cold tongue & double ITCZ, clouds, aerosols, monsoons, blocking,)

Focus of WCRP: wider climate system

Prediction: all aspects of Earth System that affect climate

Impacts: aspects of Earth System that are affected by climate

In the development of the WCRP programme and in the communication of the information produced by it, the context of wider environmental change is important.

**WCRP science must be organised to contribute to global challenges:
food, water, health & energy**

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Climate Research in Service to Society



International Council for Science

#1 service to society by WCRP: encourage and enable climate-related research that will likely be needed over the next decades

WCRP contribution to IPCC is a superb example of a climate service to society

Climate services:

interface between climate information & information on a particular application.

Giving a *service* should not mean being *servile*!

Importance of handling & communicating uncertainties

Understanding of relevant aspects of the climate system is central

Well-established science can often provide the basis for actionable information



- **WCRP must aim to get much more involvement of developing countries & their scientists**
- **Help in attending this conference was welcomed, but follow up and sustained efforts is essential to long-term success**
- **Capacity development & involvement in programmes: many great examples (e.g. AMMA) but much more needs to be done.**
- **Regional weather & climate variability information and its application provides a good focus.**

- **Observations are fundamental**

- The foundations for understanding, models and their evaluation

- **Many serve multiple purposes**

- Requirements (for “climate quality” data) are application dependent

- **Funded by nations**

- Made mostly by agencies of nations or sets of nations

- **Grouped into observing systems, systems of systems, under various auspices for operations, product generation, ...**

- WIGOS, GOOS, GTOS, ...; GCOS, GEOSS; CCI*, WCP, WCRP, ...

- **Not a fully managed system**

- WCRP (and GCOS, ...) can advocate, assess, cajole, guide, identify needs, persuade, propose, promote, provoke, recommend, review, ...

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Global Observing System



ICSU

International Council for Science

- **Better than ever for weather and many climate purposes**
 - Seen in medium-range forecast scores from ECMWF ops and ERA-Interim
 - Seen in coverage of Argo floats, surface drifting buoys, ...
 - Seen in data from GRACE, ...
- **But concerns over completeness and sustainability**
 - Gaps remain in network coverage, with threats to some existing stations
 - Decline in numbers for some data types (river discharge data in particular)
 - Concerns over continuity of satellite missions (limb sounding, scatt, NPP/JPSS , ...)
 - Concerns over establishing reference observation (CLARREO, GRUAN)
 - Emerging needs (deep ocean, under sea-ice, carbon, ecosystems, ..., OSSEs?)
- **Though some reasons for optimism**
 - Opportunities from new satellite missions (GCOM series, GMES providers (China, India, Korea ...))
 - Advances continue in our ability to extract information from observations (improvements in reanalysis)
 - Emerging capabilities (deep ocean Argo floats, ...)





- **Welcome advances in data products and related coordination**
 - Reanalyses (atmosphere and ocean)
 - GEWEX radiative flux and SPARC water vapour assessments, GPCP
 - MetServices Initiatives, CEOS Working Group on Climate, Architecture for Space-based Climate Monitoring, ESA Climate Change Initiative
- **But needs remain, despite progress**
 - Recovery of historical data
 - Bias correction (sea surface temperature, ship winds, radiosonde temperatures, ...)
 - Data management and ease of discovery/access
 - Policy development (data sharing, measurement in Exclusive Economic Zones)
 - Linkages with data from impacted societal sectors, for end-to-end systems
 - Continued improvement of data assimilation and products (including uncertainties)
 - Product intercomparison and documentation
- **Some of this is WCRP's core business, but all of this needs WCRP's advocacy and support.**



Accomplishments:

Models are increasingly becoming more sophisticated and comprehensive to deliver daily, seasonal, inter-annual, decadal predictions and climate projections to users.

- Dynamical prediction of ENSO now semi-operational
- Dynamical seasonal forecasting started with demonstrated skill
- Successful reproduction of 20th Century climate provided a scientific basis for anthropogenic climate change discussion
- Climate projections by GCMs and ESMs (CMIP) contributing to adaptation and mitigation planning and discussion
- Power of multi-model ensemble is being proven for seasonal to climate time scales,



Research Priorities to Meet Future Challenges

Models are far from perfect and considerable progress needs to be made, to aid decision making in various societal sectors.

- Many unknown about clouds physics/chemistry, convection, cloud-aerosol interaction, ...
- Stochastic parameterization?
- Systematic errors (=biases) are still large, especially hydrological aspects
- Insufficient performance/*understanding* of double ITCZ, MJO, teleconnections, ENSO, monsoon, AMOC, atmosphere/ocean/land/cryosphere interactions, stratosphere-troposphere coupling, sea ice, extreme events, bio-geochemical processes, ..., and climate sensitivity
- None of the model sub-components are *done*.
- Attempts at decadal prediction started, but whole lot of issues in initialization, realism of capturing decadal modes of variability, ...
- High-resolution climate simulations are beginning, including global cloud (system)-resolving models, but climatic biases still seem to be more physics-dependent
- Monitoring/prediction system for global climate *and* environment? (environmental data assimilation with coupled Earth System models)

WCRP Research Priorities

- **Emphasis on model development through better modelling frameworks, e.g using couplers to “modularise” models**
 - Need to “reinforce the foundations” – atmosphere, ocean, land
 - Need to “build a new house” – “Denver” project?
- **Importance of model validation cannot be overemphasized**
- **More interaction between observation/process studies and modeling should be promoted.**
 - Seamless approach should be of help. (e.g., use of DA-mode to identify model biases)
 - Climate Process teams?
 - Appeal of scientific excitement of model development (to students)
- **Better linkage between operational centers and universities**
- **Research on data assimilation of coupled systems**
- **Greater use of paleoclimate information to improve models**
- **Research and investment is needed to translate climate data into actionable information.**
 - Modelers-users interaction

- **Provision of Skillful Climate Information on Global to Regional Scales**
- **Cryosphere Response to and Influence on Climate**
- **Regional/Global Sea-Level Change**
- **The interactions of Clouds, Aerosols, Radiation and Precipitation, and their Contributions to Climate Sensitivity**
- **Past and Future Changes in Hydrological Cycle: Fresh Water Availability & Water Security**
- **Scientific Foundation for Detection, Attribution & Prediction of Extreme Events**

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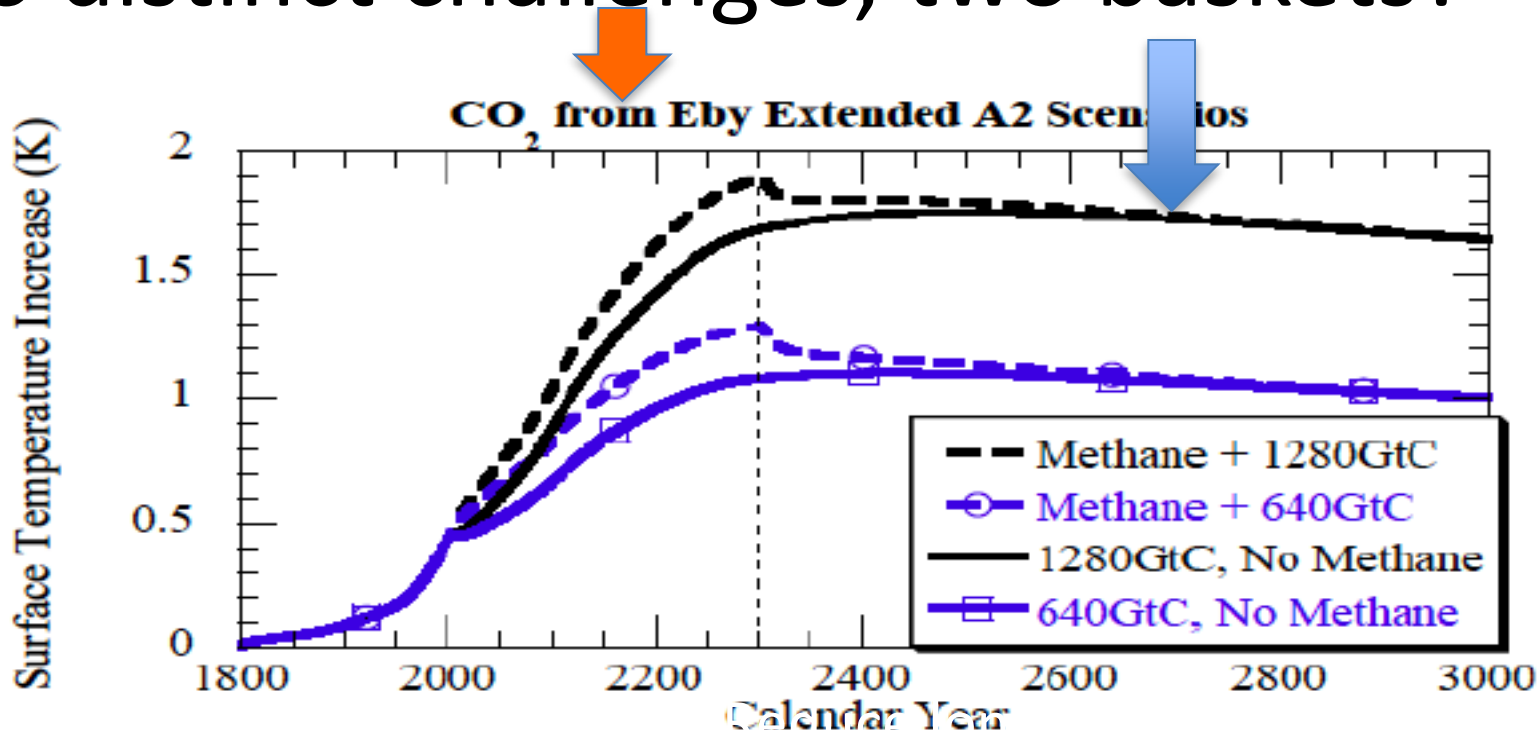
Anthropogenic Climate Change



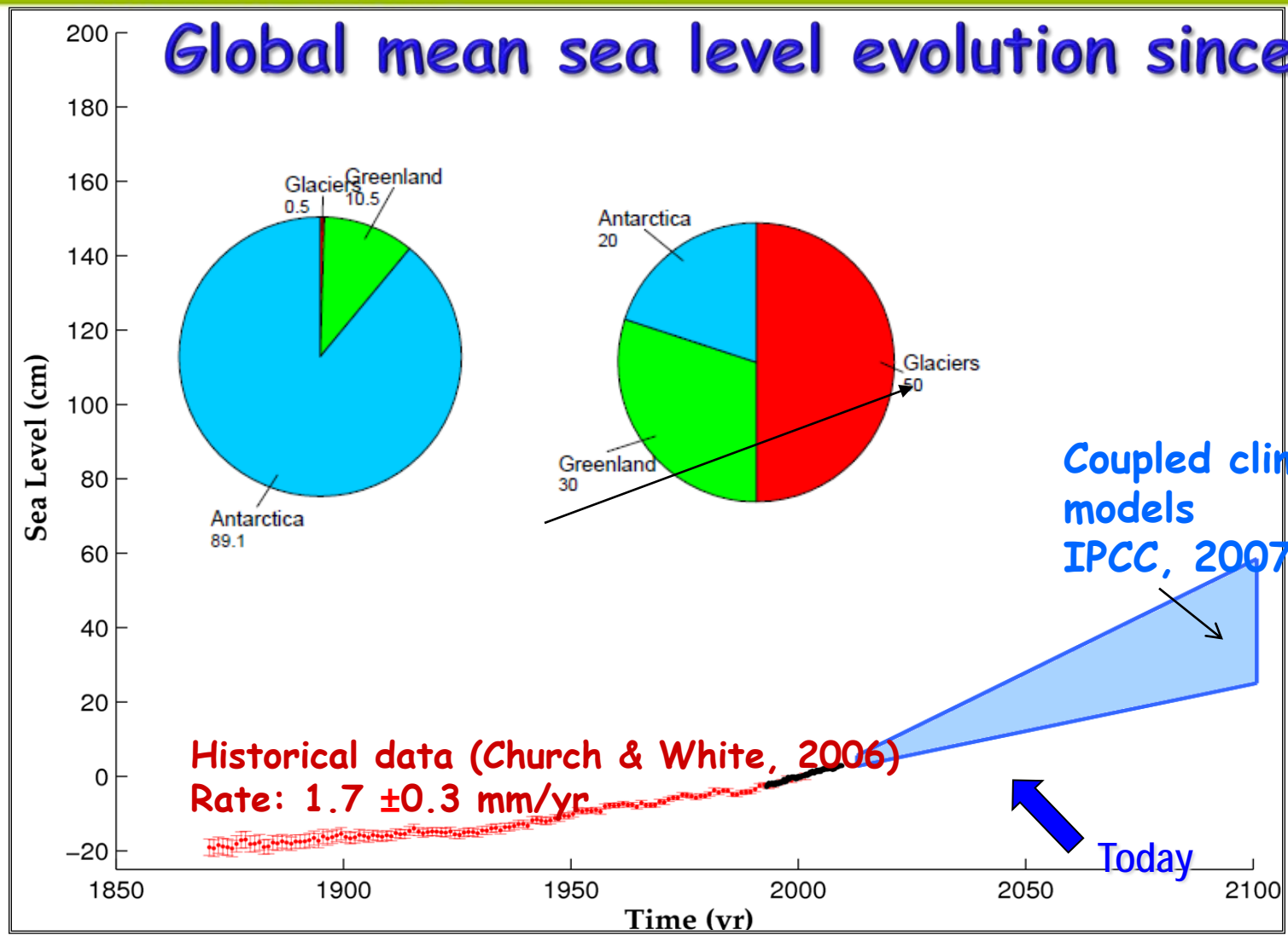
WCRP should focus on:

- **Assessments of feedbacks on short- and long- time scales (i.e. seasonal, decadal to centennial)**
- **Regional climate sensitivity**
- **Resolve issues related to cloud - radiation and albedo feedbacks for most cloud types**

Two distinct challenges, two baskets?



Cryosphere: Rich on "Grand Challenges"



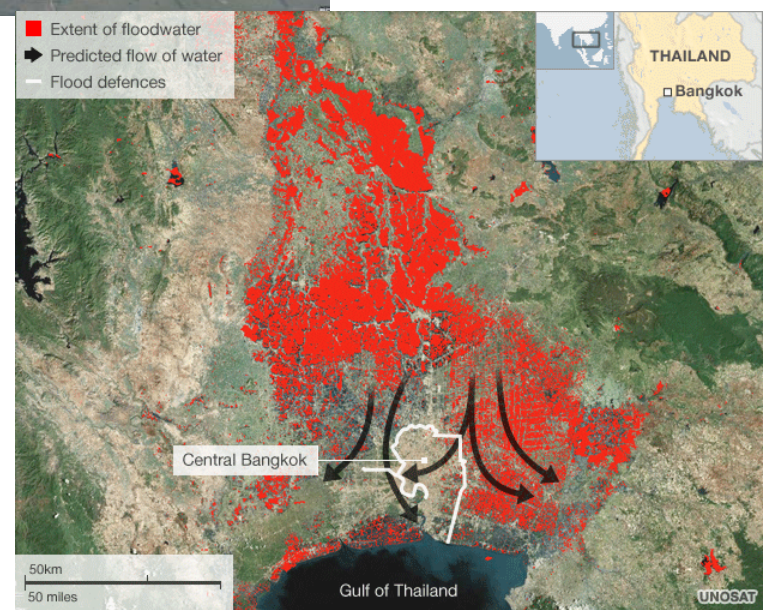
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WCRP should focus on:

- **Addressing large uncertainties of ice sheet mass balance**
- **Regional Sea-Level: ocean thermodynamics and ice sheet melt create non homogeneous patterns of sea-level variability and change**
- **Permafrost and carbon: Arctic is turning from carbon sink to source!**
- **Arctic sea-ice loss: focus on albedo feedbacks, boundary layer and ocean transport!**
- **Urgent Needs: long-term coordinated observations and modeling for polar regions and the cryosphere.**



- **Scientific frontiers, examples**
 - Understanding and predicting the rate of Arctic sea ice loss
 - Understanding the drivers of change in the Antarctic, including connections to ocean circulation, carbon uptake, and ice shelves
- **Imperatives**
 - Improve models (can identify needs to WGNE or GEWEX)
 - Identify measurement needs, both for initialization and for monitoring variability and long-term changes (feed to GCOS)
- **Focused science topics; can imagine several, e.g.**
 - Ocean/ice shelf interactions
 - Response of southern ocean circulation to surface winds
 - Seasonal predictability of Arctic summertime sea ice



UK flooding, July 2007

Cold winters, UK, 2009, 2010

Bangkok, now

- **Great progress in attribution of extreme events**
- **Considerable progress in research on heat waves, tornadoes, extreme precipitation (including their predictability)**
- **Progress in research on tropical cyclones**

What WCRP should do:

- **Aim research on extremes of maximal social value**
- **Promote availability of observational data**
- **Continue process-oriented research on extremes**
- **Improve understanding the impacts of large-scale climate variability (modes of atmosphere/oceans circulation) on extremes**
- **Involve the statistical and mathematics sciences community**

Still Many Challenges:

- Working with complex systems (humans, society, ecosystems, etc).
- Must build stronger links between climate research and ecosystems research, and health research, etc.
- Use of climate information requires clarity of message – especially when talking to public (technically rigorous, but understandable)
- Need to increase climate literacy and education

But, We have achieved much in past few decades:

- Realization and treatment of the complexity
- More consideration of the “decision space”
- Some messages on climate are getting through
 - Can affect some decisions, but many are still outstanding

Thank You!

<http://www.wcrp-climate.org>

