World Climate Research Programme's Grand Challenges: Elements for the NTGC

Presented by Gianpaolo Balsamo with slides from

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WCRP Organization

Joint Scientific Committee

Joint Planning Staff

Modeling Advisory Council

Data Advisory Council

Working Groups on: Couple Modeling (WGCM), Region Climate (WGRC), Seasonal to Interannual Prediction (WGSIP), Numerical Experimentation (WGNE)

CliC	CLIVAR	Grand Challenges	GEWEX	SPARC
Cryosphere-Climate Interactions	Ocean-Atmosphere Interactions	Sea-Level Rise	Land-Atmosphere Interactions	Troposphere-Stratosphere Interactions
		Cryosphere in a Changing Climate		
		Changes in Water Availability		
		Climate sensitivity and Clouds		
		Climate Extremes		

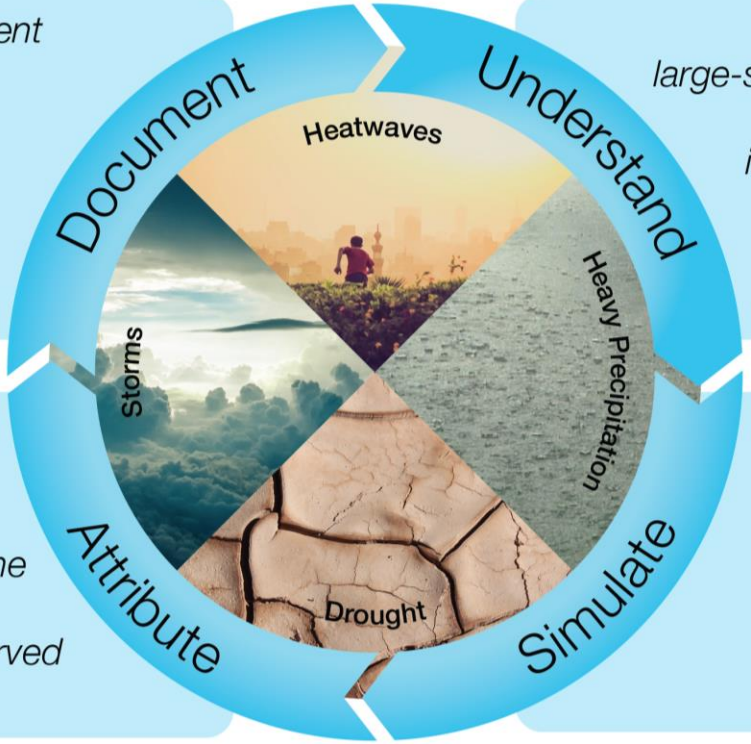
Lesson we could learno from WCRP GC on climate extremes

- ***service perspective***: What are frequency and magnitudes of various impact-causing extremes in the near and long term?
- ***science perspective***: causes and mechanisms of variability and change in extremes, how to improve the prediction of change
- Implementation needs to be focused: areas with opportunity for rapid progress

4 main extremes, 4 over arching themes

Are existing observations sufficient to underpin the assessment of extremes?

What are the relative roles of large-scale and regional or local-scale processes, as well as their interactions, for the formation of extremes?

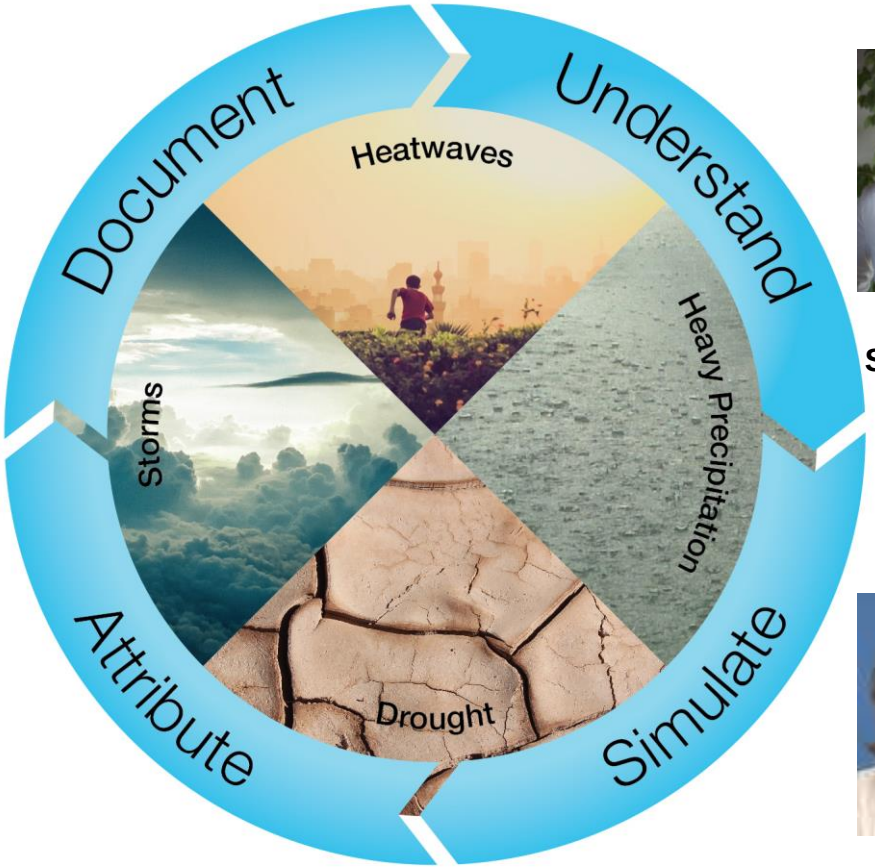


How can we determine the contributors to observed extreme events and to changes in the frequency and intnesity of observed extremes?

Are models able to reliably simulate extremes and their changes, and how can this be evaluated and improved?

Leads

Lisa Alexander | Ali Behrangi



Sonia Seneviratne | Olivia Martius | Robert Vautard

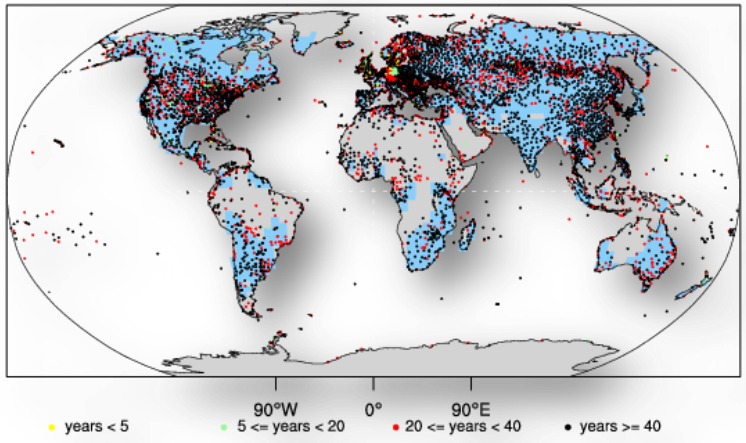
Xuebin Zhang | Fredi Otto

Gabi Hegerl | Jana Sillmann | Erich Fischer

Document

Observations crucial for understanding change and evaluating models, but critical gaps exist in the amount, quality, consistency and availability, especially for extremes

Sub-daily precip stations (HadISD) and SDII coverage (HadEX2)



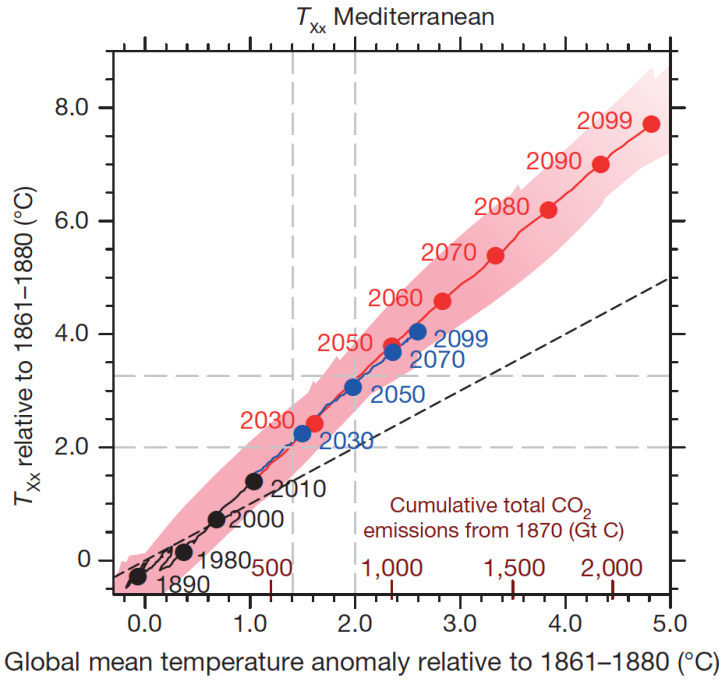
Source: Westra et al. 2014, Rev. Geophys.

- Permanent destruction of old records
- More data undigitised than digitised (especially pre WWII)
- Many institutions unwilling or unable to exchange data
- Data quality and homogeneity
- *Also considers runoff observations*

Understand

Interaction between large-scale phenomena (weather types, modes of variability) and regional-scale land-atmosphere feedbacks/forcing

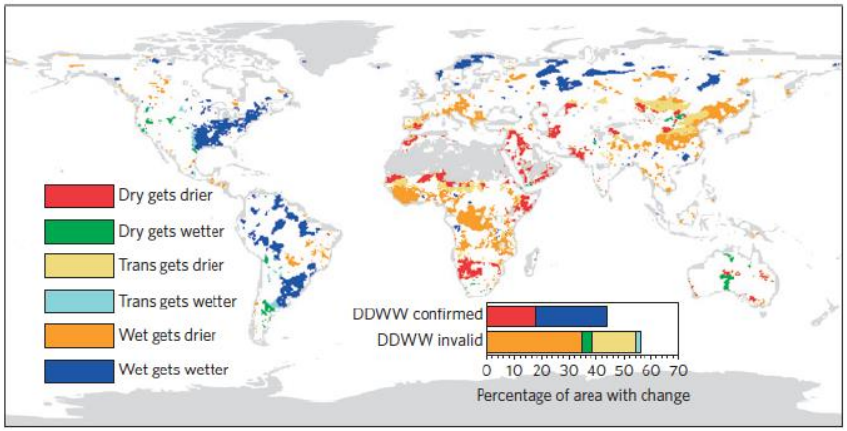
e.g. Response of regional temperature extremes to global CO_2 forcing



Source: Seneviratne et al. 2016, Nature

Understand: Water cycle aspects

Analysis of observed robust drying trends (from 1948-1968 to 1985-2005): No support for “dry gets drier, wet gets wetter” paradigm



Source: Greve et al. 2014, Nature Geoscience

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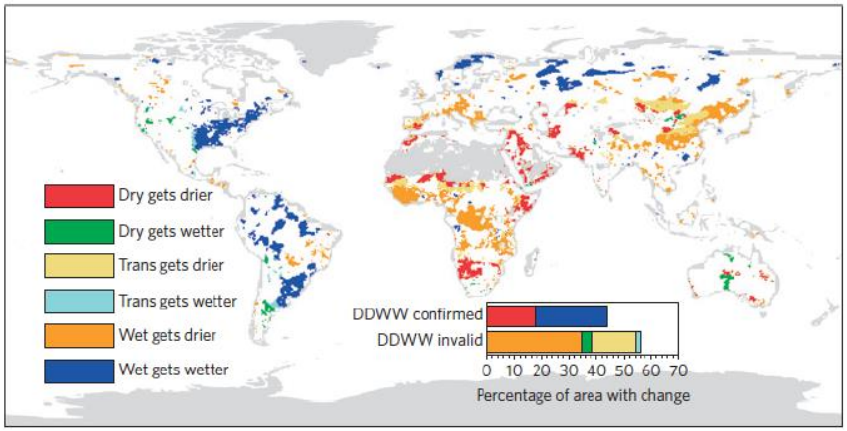
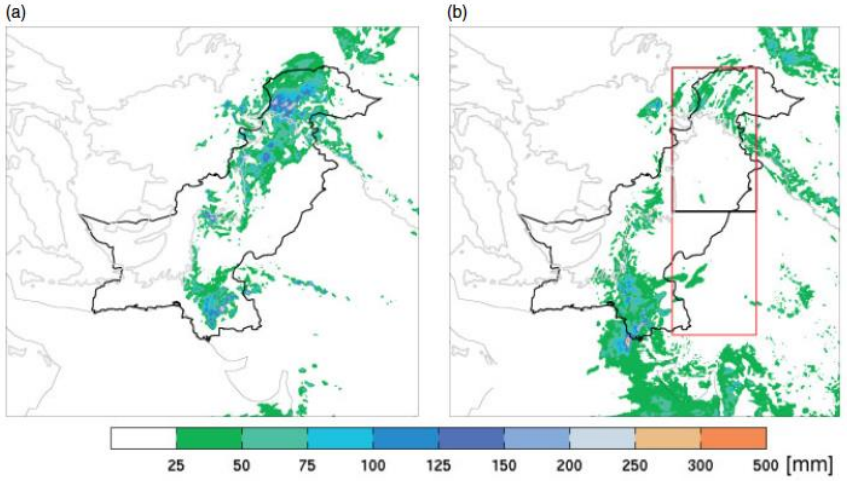


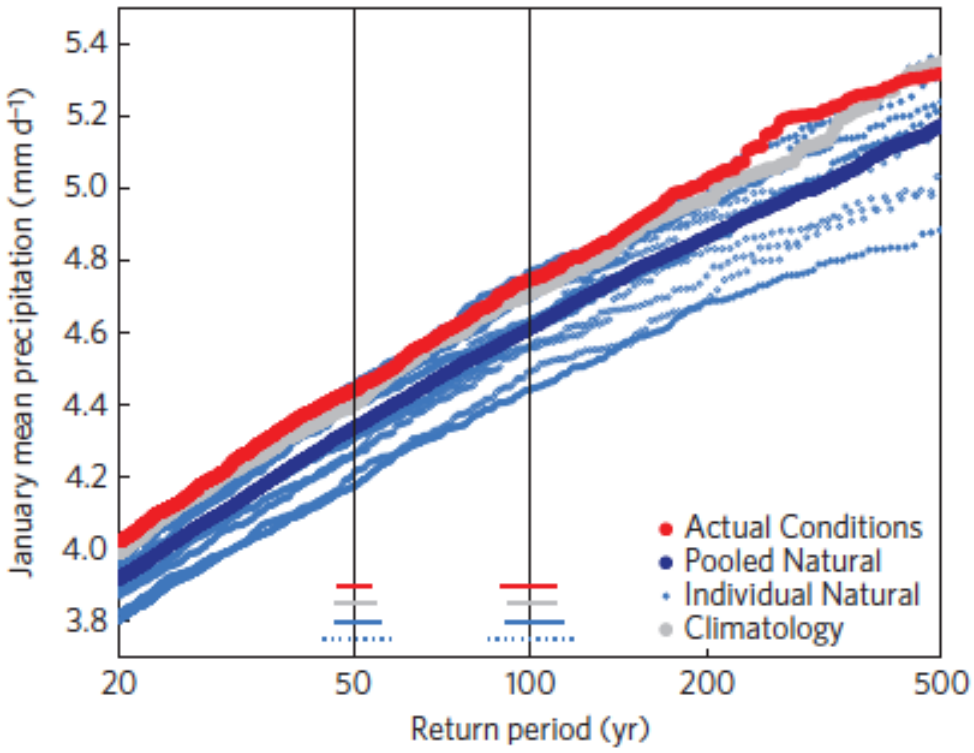
Source: Greve et al. 2014, Nature Geoscience

Land moisture sources strong contributor to 2010 Pakistan flood-inducing rainfall events



Source: Martius et al. 2013, QJRMS

Attribute



Estimate changing risk due to human influence, e.g:

Human influence on 2014 southern England winter floods

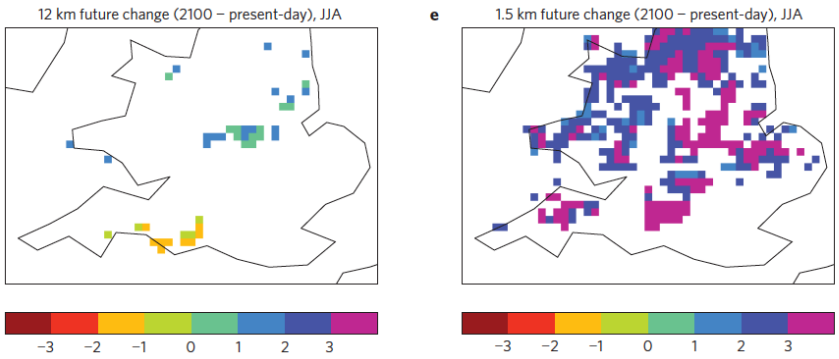
Source: Schaller et al. 2016, Nature Climate Change

Simulate

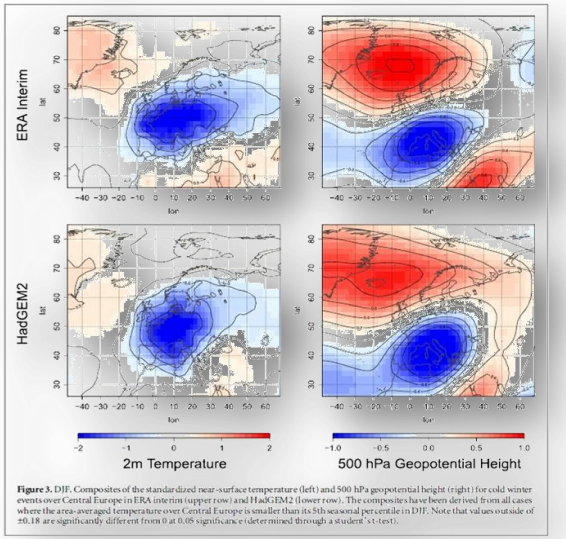
Do the models simulate extreme events for the right reason?

How to use both statistical methods for tails and knowledge about mechanisms/storylines?

What phenomena are GCM and RCM simulations credible for and how can simulations be improved?



Source: Kendon et al. 2014, Nature Climate Change

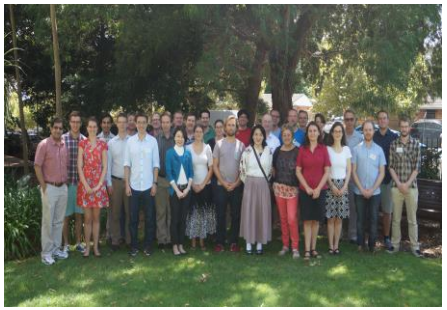


Source: Krueger et al. 2015, ERL

Activities

Early successes

2014 WCRP summer school (Trieste, Italy) & journal special issue



2015 Workshop on data requirements (Sydney, Australia)

2015 Workshop on understanding & simulating extremes (Oslo, Norway)

2016

- *Blocking workshop (UK, with SPARC)*
- *Data Rescue workshop, Ireland*
- *High-impact weather, USA (with WWRP)*
- *13th International Meeting on Statistical Climatology and Statistics and D&A meeting, Canada*
- Banff workshop (statistical aspects of extremes)
- Extremex workshop (late 2016 or early 2017)
- Perspective paper in progress by grand challenge team

WCRP grand challenge on water availability

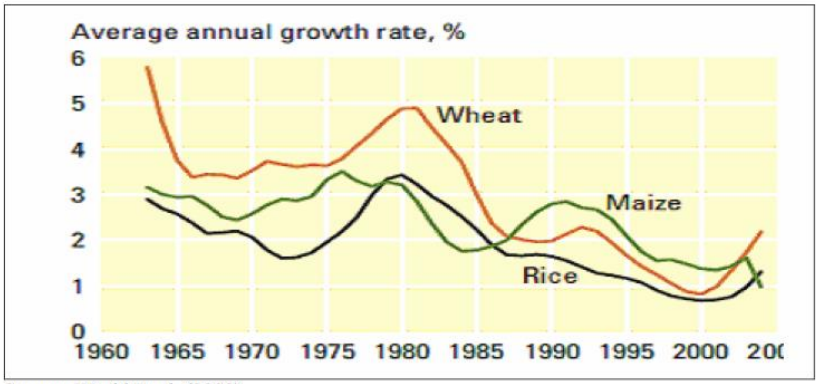
Water for the Food Baskets of the World

Based on Version: 1.0.0 (April 2016)

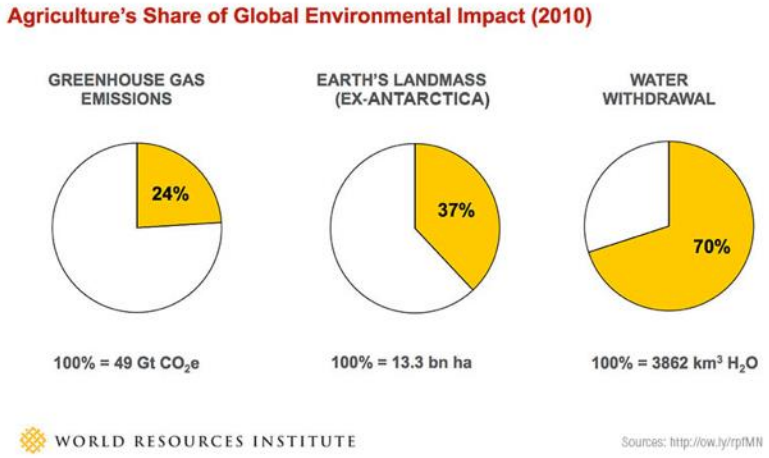
BASED UPON CONTRIBUTIONS FROM: JAN POLCHER, ROY RASMUSSEN, PETER VAN OEVELEN, YAHYA ABAWI, GRAEME STEPHENS, SONIA SENEVIRATNE, KEVIN TRENBERTH, YAOMING MA, MICHAEL EK, MATT RODELL, ERIC WOOD, JOERG SCHULZ, CHRIS KUMMEROW, ROBERT A. SCHIFFER, JUN MATSUMOTO, TOSHIO KOIKE, TAIKAN OKI, AND MANY MORE…

Current state: Challenges for Food Production

Growth rates of yields for major cereals, 1960 - 2000



Source: World Bank (2008)



- Population growth *(Asia and Africa primarily)*
- Globalization
- Urbanization
- **Water scarcity**
- Declining yield
- **Climate variability and Climate Change**
- Modernization of agriculture has lagged behind industrialization in developing countries
- Transfer of land from the production of food to production of fuel
- Transfer of land to livestock (high protein food)
- Biosecurity issues affecting Free Trade Agreements

Food Security

"Reliable access to sufficient quantities of affordable, nutritious food to maintain healthy, active lives." – 1996 World Food Summit

Four main dimensions of food security are;

- Availability – Supply of food as determined by production, stock level and net trade
- Access - affected by income, expenditure, markets and prices
- Utilisation – nutritional status of what we produce
- Stability – Inadequate access to food on periodic basis

Availability and *Stability* are threatened by the impact of climate variability, climate extremes and climate change

WCRP Grand Challenge on Water Availability: Water for the Food Baskets of the World

- Water Cycle Main Driver of Food Production
- A Warmer Climate Pushes the Water Cycle into Unknown Territory
- The Terrestrial Water Cycle is not Natural Anymore
- Urgency to Understand the New State of the Water Cycle in which Natural and Anthropogenic Processes Interact

WCRP Grand Challenge on Water Availability: Water for the Food Baskets of the World

How will a warming world affect the available fresh water resources globally, the human interactions with these water resources, as well as their value to society and how does this translate specifically to the food basket regions of the world?

***Within the context of the World Climate Research Programme the focus will be on the geophysical processes and the anthropogenic influences on these processes**

Products and Deliverables

H*ow will a warming world affect the available fresh water resources globally and how does that translate specifically to the bread basket regions of the world*?

- Expands on questions related to changes in water storages both temporally and spatially with respect to reservoirs, ground water, snowpack depth etc. and in order to answer that we need to address both the water supply and demand side
- Set of sub questions see next slide
- Answers to these questions are the main outcome of this grand challenge. To enable the research needed we set up this grand challenge in tiers both in the regional sense as well as in research sense

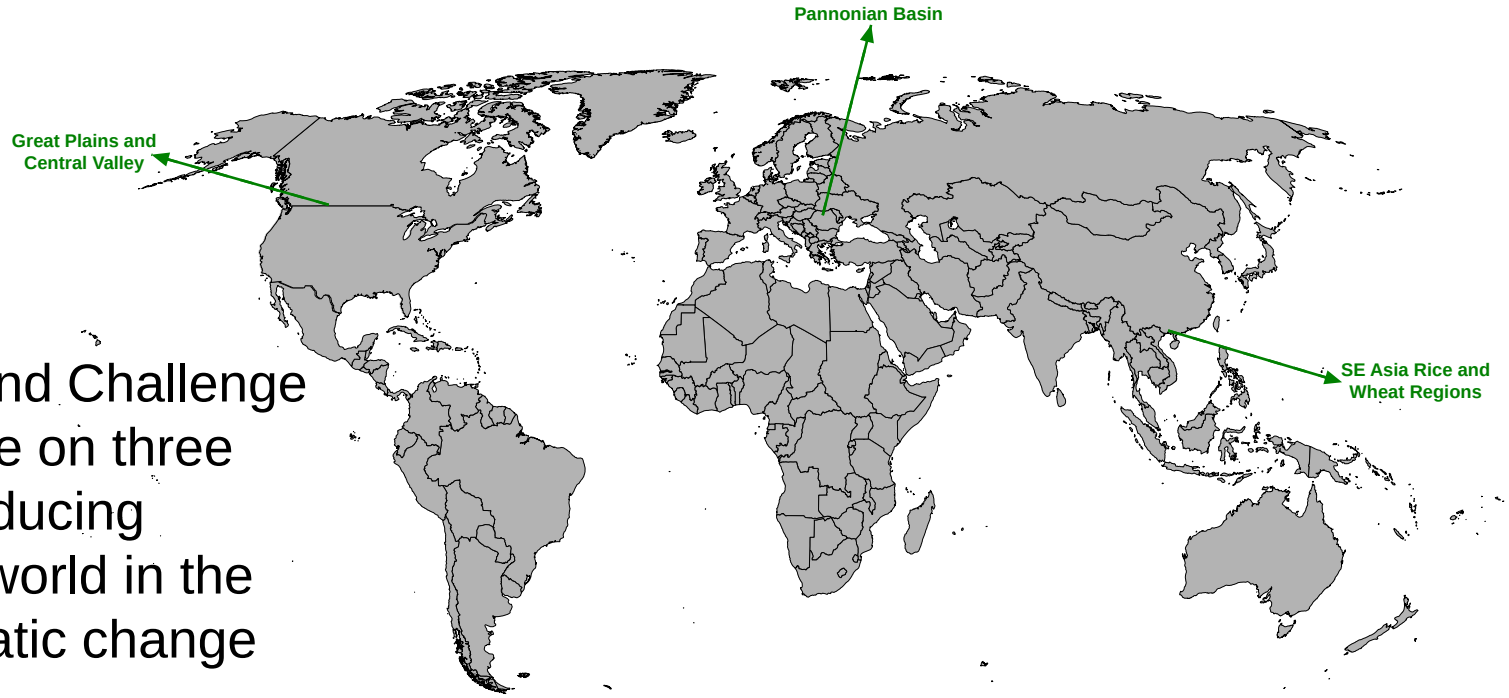
Set of Sub Questions

- What are the effects of changes in the character of precipitation (snow vs. rain, snow water equivalent etc.)?
- How do the temporal changes in precipitation regimes affect water availability?
- How will changes in the mean and variability of precipitation affect human infrastructures ?
- Which regions will see an increase vs. decrease in precipitation?
- Which regions will see an increase vs. decrease in actual and potential evapotranspiration?
- Which regions will see an increase vs. decrease in the climatically available water (P-E)
- How is groundwater recharge and availability affected?
- In which regions can groundwater pumping be sustained in a warmer climate?
- How is snow cover, depth and water equivalent affected?
- In which regions is food productions endangered by the expected changes in the water cycle?
- Which actions need to be undertaken to improve our water management and maintain a viable agriculture?
- How will climate change modify competing interests for water?
- How are land water exchanges affected by climate change, or affecting themselves regional climate responses (e.g. temperature and precipitation means and extremes)
- How are changes in land-use/land cover affected by the water availability or affecting the water availability?

Methodology

- A Regionally Tiered Approach
  - Focus on Three Main Regions
- A Research Topic Tiered Approach
  - NEW: Human Dimension
  - NEW: High Resolution Convection Permitting Modeling
  - NEW: Representation of land use effects on regional and global climate
  - Build upon Existing Efforts (Within and beyond WCRP)
    - UNESCO IHP, HYDROMET Services, iLEAPS, etc.

WCRP Grand Challenge on Water Availability: Water for the Food Baskets of the World



Within this Grand Challenge the focus will be on three major food producing regions of the world in the context of climatic change

Meetings 2016

Meeting	Date	Location	Lead
Water Availability Grand Challenge for North America	May 3-5	Columbia, MD	Van Oevelen , Schiffer
CORDEX Conference	May 17-20	Sweden	CORDEX IPO
GEWEX Hydro-Climate-Sensitivity Workshop	June 20-23,	Exeter, UK	Stephens, Lambert
GEWEX Soils and Water	June 28-30	Leipzig, Germany	Or, De Rooij, van Oevelen, Seneviratne
GEWEX Hi Res Modeling	Sept 6-8	Boulder, USA	Rasmussen
GDAP Meeting	September or October	Washington, DC	Schulz
GHP/GLASS Crosscut on Human Dimension (before GHP)	Sept 28-30	Paris, France	Harding
GHP Meeting	Oct 3-5	Paris, France	Polcher, Evans, Cuxart
GLASS Meeting (colocated with GHP)	Oct 3-5	Paris, France	Ek, Boone
INARCH Meeting (colocated with GHP Panel Meeting)	Oct 6-7	Paris, France	Pomeroy
2nd PANNEX Workshop	Jun 1-3	Budapest	Lakatos, Guettler

WCRP World Climate Research Programme

GEWEX

Links of WCRP Extremes and Water Availability Grand Challenges with SDGs

WMO IOC ICSU

Thank you!

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