Water Availability Grand Challenge
A concise overview 2015

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AND OTHERS.
Global water/energy isn’t ‘balanced’ (WG on E fluxes/water to deliver joint energy/water balance with full error characterization– 3yrs)

Provide the basis for understanding global hydrological sensitivity & regional hydrological change.

Precipitation assessment study – report documenting major gaps in observations/capabilities

One known gap concerns mountain precip. Develop new initiatives to target this gap and provide data in selected regions (e.g. MOUNTerrain, INARCH) : output Q/C mountain precip. data products in selected regions 3-5 yrs

Improve representation of land water fluxes, water management influences in climate models (LS3MIP, LUMIP, HUMAN) – 3 -5 years (CMIP6 cycle)

Improve modelling the terrestrial water cycle over complex terrain realized through high resolution modelling (HiRES, HiRESMIP) 3-5 yrs

Develop new data records from non traditional data sources (e.g. GPS), traditional sources data underutilized (e.g. surface radar network data), emerging space assets (GRACE, GPM, SMAP) 3-5 yrs.
Water Availability GC

‘How will the character of fresh water availability change in the coming decades?’

**GEWEX Questions**

**Q1:** How can we better understand and predict precipitation variability and changes?
- What determines the global, hydrological sensitivity and is the hydrological cycle intensifying beyond prediction?
- What sets the spatial pattern of precipitation change? (‘wet wetter, dry drier’ ?)
- What determines the regional changes to precipitation intensity (e.g WW @7%/K?)
- How well are the processes that control precipitation frequency, distribution and intensity represented in models?

**Q2:** How do changes in the land surface and hydrology influence past and future changes in water availability and security?
- How are management practices influencing water availability and water security?
- How can the effects of water management and related changes in land use be adequately represented in models?
- How do changes in climate affect terrestrial ecosystems, hydrological processes, water resources and water quality, including water temperature?
- How are land water dynamics and atmospheric processes interacting?

**Q3:** How does a warming world affect climate extremes, and especially droughts, floods and heat waves, and how do land processes, in particular, contribute?
- Each degree of warming is projected to decrease renewable water resources by at least 20% for an additional 7% of the global population.
Water availability GC
Actionable questions and activities organized into themes

Evaluate

- Precipitation observations?
- Model performance?
- Land-water processes models and observations?

Understand

- Hydrological sensitivity?
- Spatial pattern of precipitation change? (‘wet wetter, dry drier’?)
- Regional changes to precipitation intensity (Convection?)
- Interactions between land water dynamics and atmospheric processes?

Predict

- Models improvements?
- Modeling human impacts

Cross cutting activities
Monsoons, Energy balance closure, HiRes, PROES, data compilations

These activities also contribute directly to Extremes GC, climate sensitivity GC
Implementation activities

Evaluate
- Precip Assessment study
- New initiatives on mountain precip & frozen precip
- Development of new data sets (e.g. INTENSE),
- Model evaluation though focuses MIPS (LS3MIP,LMIP) Planned workshops a& contributions to obs4mip
- Model Process evaluations (PROES)

Understand
- Monsoons in a changing climate (joint with CLIVAR)
- Energy controls on global & regional water cycles
- Hydrological sensitivity
- New modeling initiatives under HiRes (e.g. HiREsMiP)
- Proposed Workshops: Fall 2015 ‘What sets the hydrological sensitivity?’ CalTech ; Fall/Spring 2015; HiRES, NCAR Boulder

Predict
- HiRES
- Soil processes w soils community;
- Subsurface hydrology;
- GDIS;
- Water management influences in large scale models;
- Workshops under planning
Theme I: Evaluation
Example of mountain hydrology

Observations

Surface 'observations'

Satellite Products

DJF 99% percentile

Obs

Model (135km)

Model (25km)

Simulation of spatial distribution of high-impact precipitation events improves with high resolution
Regional changes: The wet wetter and dry drier (WWDD) paradigm. How relevant is it?

Global Changes
Models predict a global hydrological sensitivity ~2%/K but a number of studies suggest a much higher sensitivity than that predicted by models.

Evaporation – minus precipitation

Salinity

LAND
No clear support for WWDD over land
(Greve et al. 2014, Nature Geoscience)

Durack et al. 2011
Change in Salinity over 50 years
Global water/energy isn’t ‘balanced’ (WG on E fluxes/water to deliver joint energy/water balance with full error characterization—3yrs)

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data products in selected regions3-5 yrs

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Closing the planets Energy balance

To achieve a balance we are forced to make ‘large’ adjustments to our best estimate fluxes (10-15 Wm\(^{-2}\)).

At the TOA this is done wrt the observed ocean heat uptake (e.g. Loeb et al., 2012)

At the surface, two philosophical pathways have been followed

1) Small adjustment to turbulent fluxes – Big decrease to radiation - what is the missing sink of radiant energy?
2) Big increase to turbulent fluxes – Small adjustment to radiation - where is the missing source of water?

Stephens et al., 2012

Trenberth et al., 2009
WG on energy fluxes—goal to develop a more objective, joint adjustment of energy and water -

e.g Rodell & L’Ecuyer, GEWEX The Hague NASA NEWS project
Thank You