Water Availability Grand Challenge

A concise overview 2015

Version: April 7, 2015)

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AND OTHERS.

Preview: Short term deliverables

- Global water/energy isnt 'balanced" (WG on E fluxes/water to deliver joint energy/water balance with full error characterization– 3yrs)
- Provide the basis for understanding global hydological 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 regions3-5 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

Co –leads
Graeme Stephens
Peter van Oevelen

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

Each degree of warming is projected to decrease renewable water resources by at least 20% for an additional 7% of the global population.

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?

Extremes GC

Water availability GC
Actionable questions and activities organized into themes

Evaluate | **Understand** | **Predict**

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

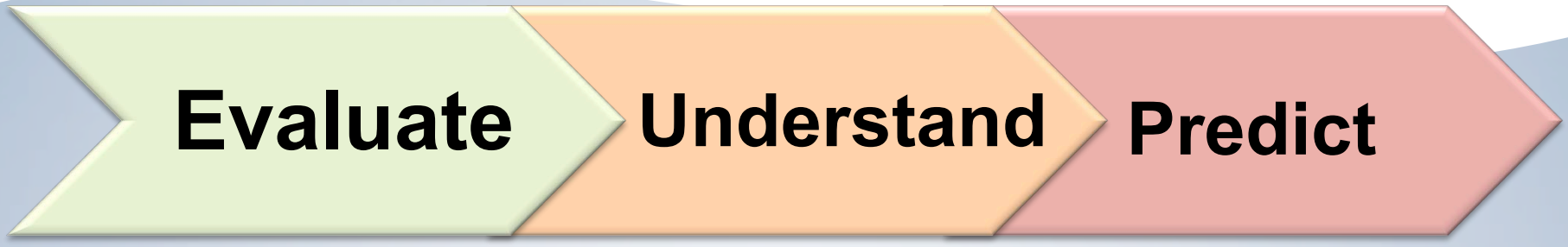
- ***Hydrological sensitivity?***
- ***Spatial pattern of precip change? ('wet wetter, dry drier'?)***
- ***Regional changes to precipitation intensity (Convection?)***
- ***Interactions between land water dynamics and atmospheric processes?***

- ***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



GDAP

GHP

GASS

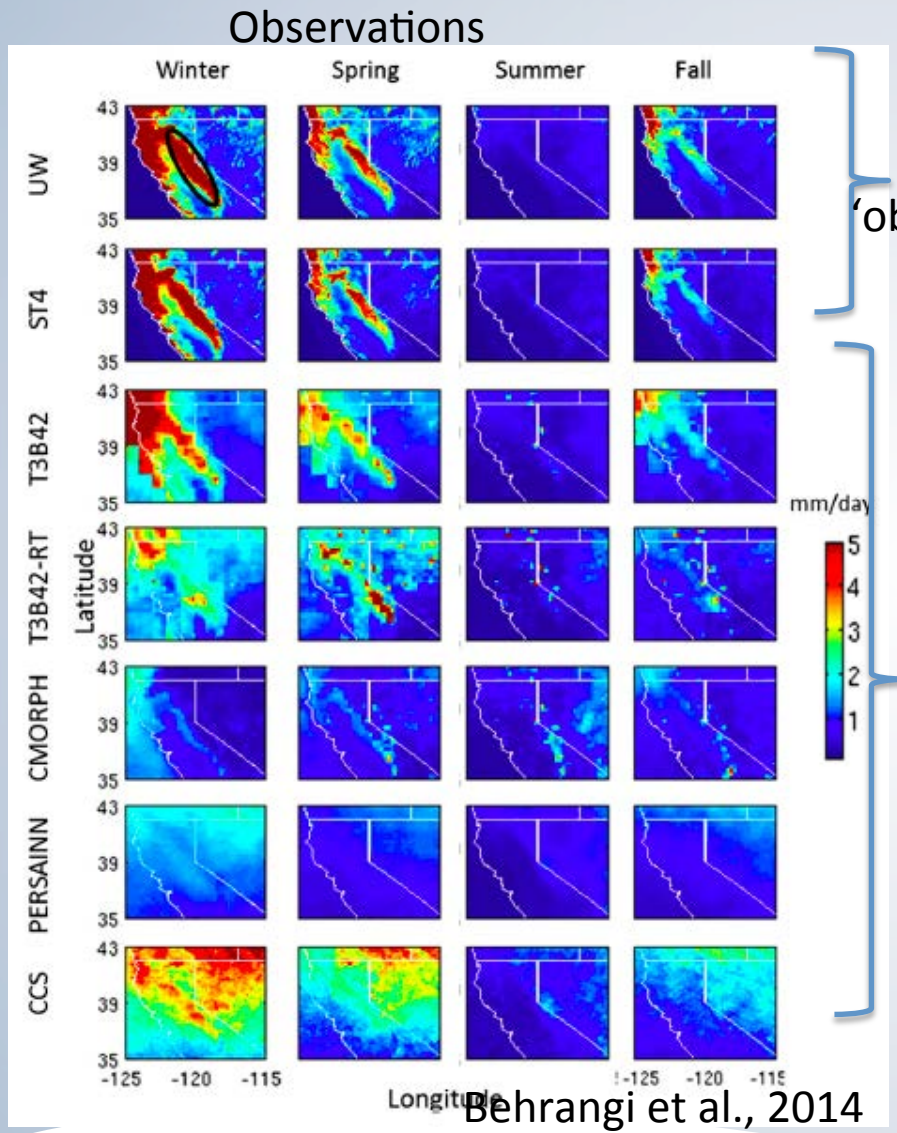
GLASS

- *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)*

- *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*

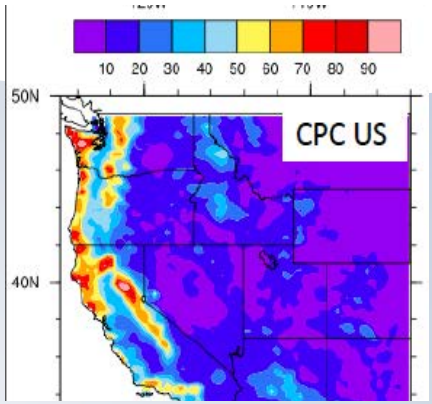
- *HiRES*
- *Soil processes w soils community;*
- *Subsurface hydrology;*
- *GDIS;*
- *Water management influences in large scale models;*
- *Workshops under planning*

Theme I: Evaluation
Example of mountain hydrology

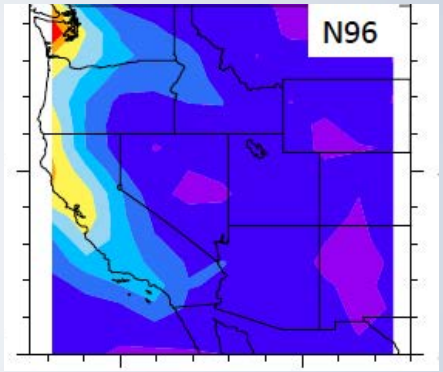


Behrangi et al., 2014

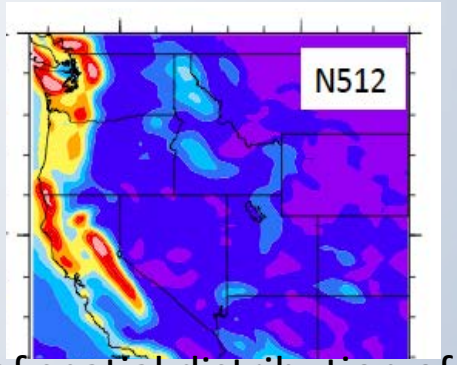
DJF 99% percentile



Obs

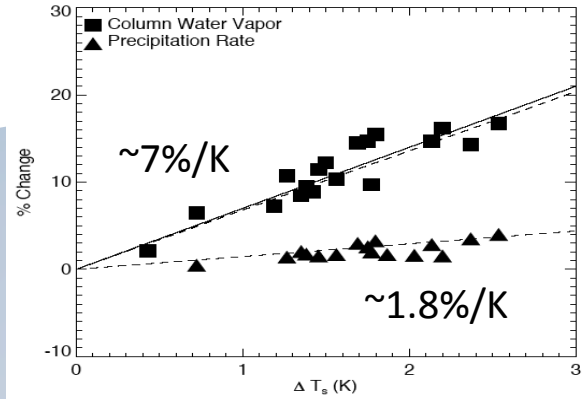


Model (135km)



Model (25km)

Simulation of spatial distribution of high-impact precipitation events improves with high resolution



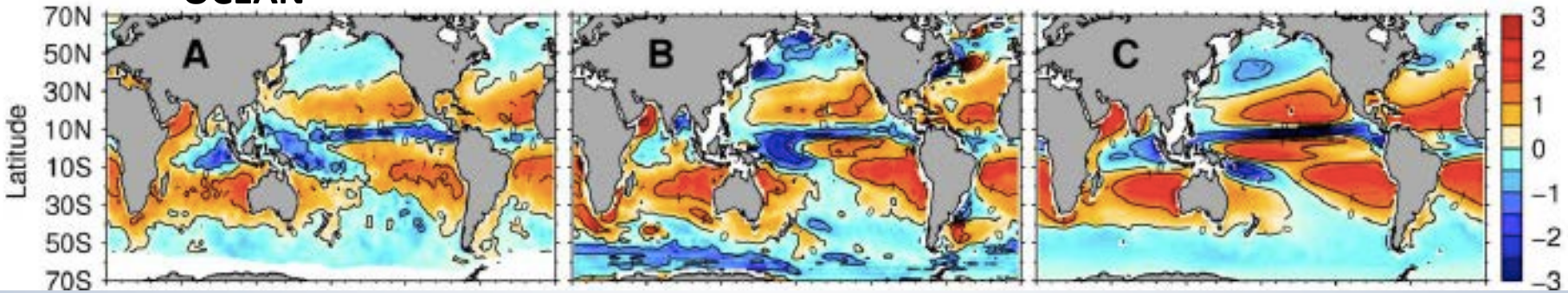
Theme II: Understanding

Global Changes

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

Regional changes: The wet wetter and dry drier (WWDD)paradigm. How relevant is it?

OCEAN



Evaporation –minus precipitation

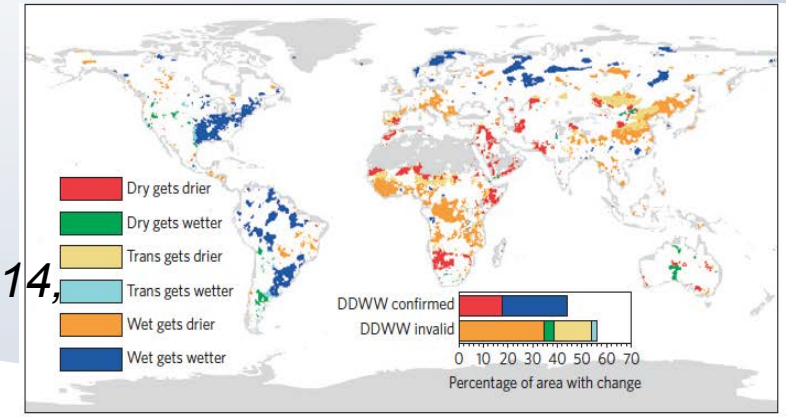
Salinity

Durack et al. 2011
Change in Salinity over 50 years

LAND

No clear support for WWDD over land

(Greve et al. 2014, Nature Geoscience)



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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?**

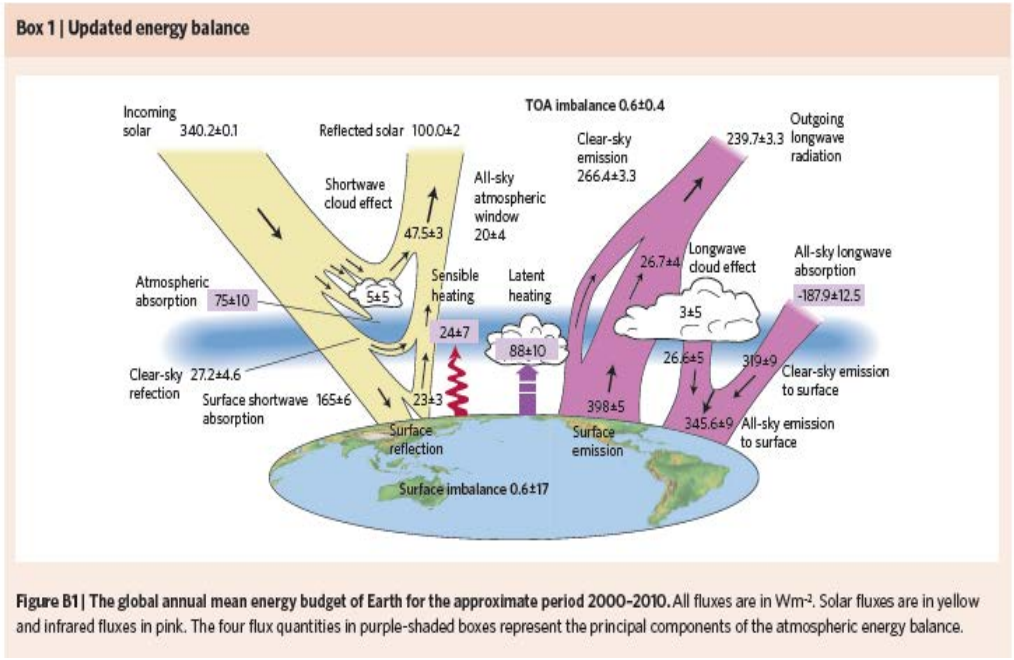
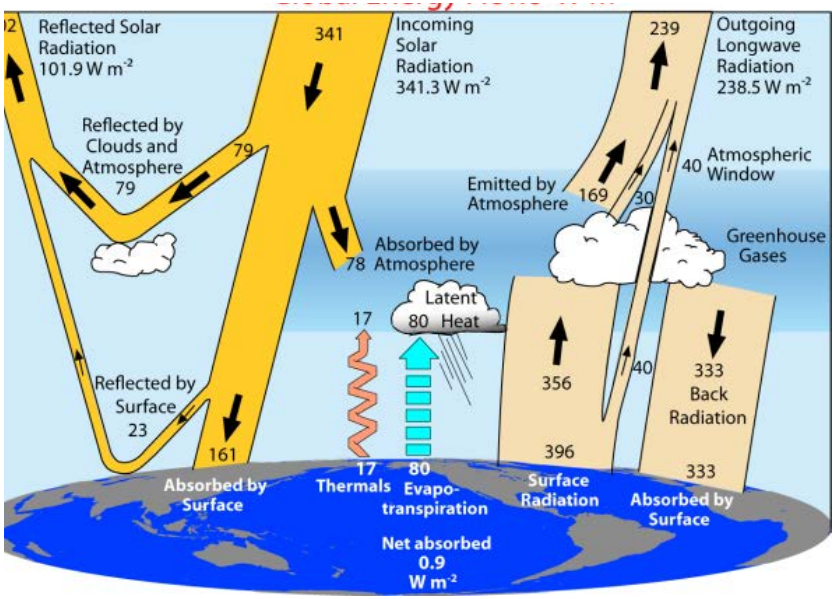


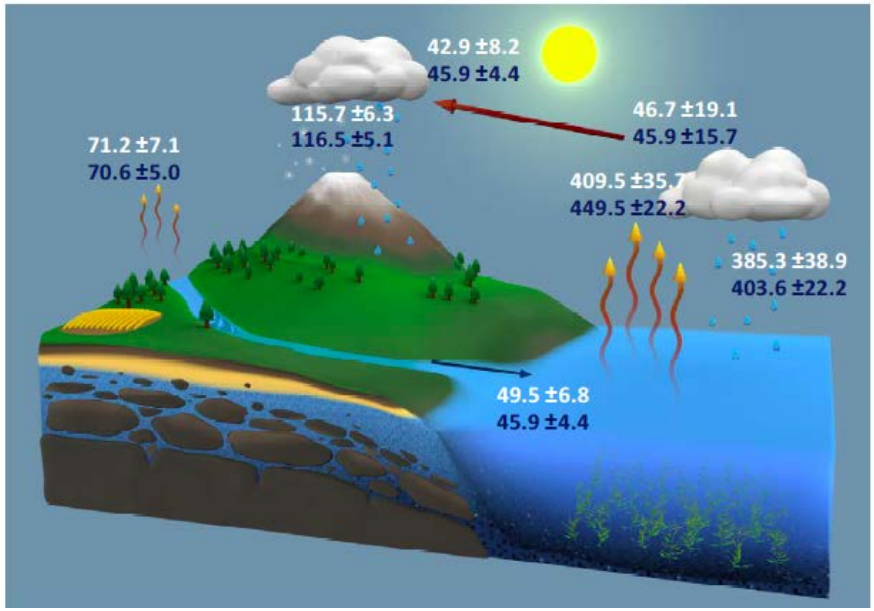
Figure B1 | The global annual mean energy budget of Earth for the approximate period 2000-2010. All fluxes are in Wm^{-2}. Solar fluxes are in yellow and infrared fluxes in pink. The four flux quantities in purple-shaded boxes represent the principal components of the atmospheric energy balance.

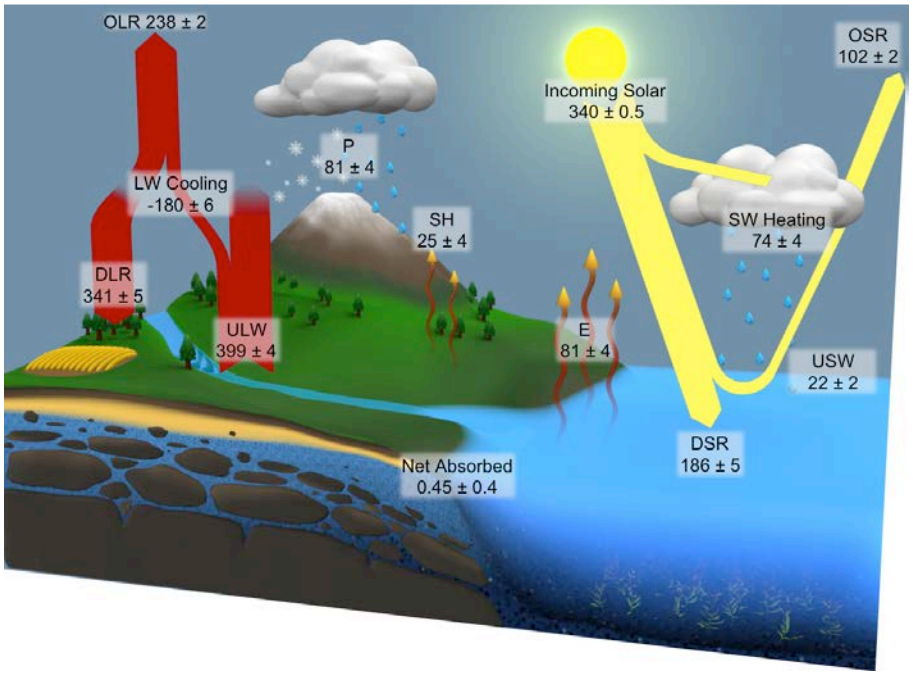
Stephens et al., 2012



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

WCRP
World Climate Research Programme

Thank You

GEWEX