

ABOUT
*WATER, ENERGY,
& CLIMATE*



The GEWEX Core Project Report to JSC-37

Co-chairs

Graeme Stephens, Sonia Seneviratne

Peter van Oevelen, Director IGPO

Outline

1. (4) Panel reviews with one highlight
2. Panel outlook
3. Selection of new initiatives and activities
4. Data and modeling issues/thoughts

The GEWEX Mission

To measure and predict global and regional energy and water variations, trends, and extremes (such as heat waves, floods and droughts), through improved observations and modeling of land, atmosphere and their interactions; thereby providing the scientific underpinnings of climate services.

Water is a local 'challenge' driven by global processes. GEWEX focuses on improved understanding of the relevant geophysical processes of water and energy and the human interaction therein to better model and predict changes

Pursuit of the four GEWEX Science Questions underpin the 2 GEWEX-related GCs

Grand Challenges

Changes in Water Availability

Climate Extremes

1

Observations and Predictions of Precipitation

How can we better understand and predict precipitation variability and changes?

2

Global Water Resource Systems

How do changes in the land surface and hydrology influence past and future changes in water availability and security?

3

Changes in Extremes

How does a warming world affect climate extremes, and especially droughts, floods and heat waves, and how do land processes, in particular, contribute?

4

Water and Energy Cycles and Processes

How can understanding of the effects and uncertainties of water and energy exchanges in the current and changing climate be improved?

GEWEX Structure



GASS

The Global Atmospheric System Studies Panel coordinates scientific projects that bring together experts to contribute to the development of atmospheric models.



GHP

The GEWEX Hydroclimatology Panel aims to understand and predict continental to local-scale hydroclimates for hydrologic applications.

Cross cuts

- Extremes
- Human
- Land-climate
- aerosol/precip
- PROES
- HiRes
- Soils & Water
- Intense
- DICE



GLASS

The Global Land/Atmosphere System Study focuses on model development and evaluation, concentrating on the new generation of land surface models.



GDAP

The GEWEX Data and Assessments Panel guides the production and evaluation of long term, global atmospheric, surface water, and energy budget products.

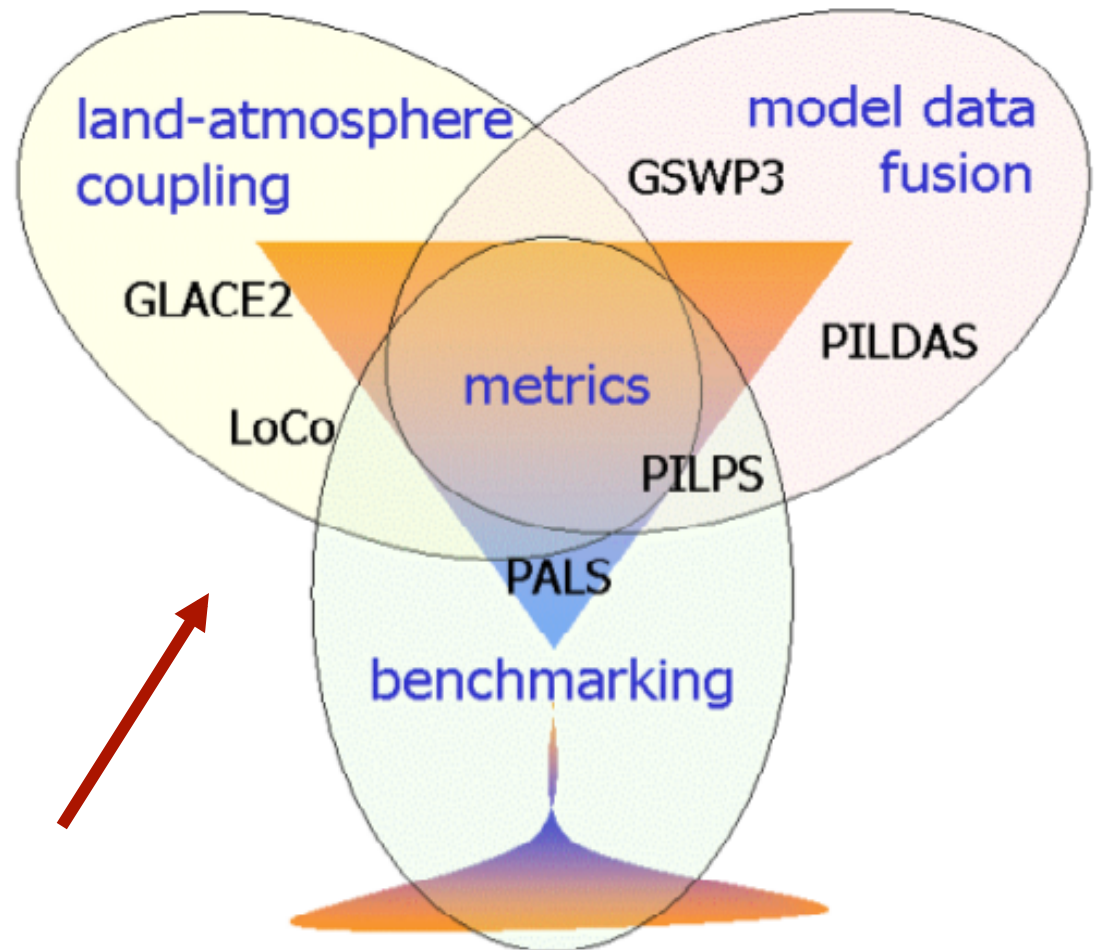
Plus, cross project activities with other core projects, e.g. extremes, monsoons , ocean heat content (CLIVAR), L3SMIP WITH CLIC & others developing with SPARC,CLIC

Global Land/Atmosphere System Study (GLASS)

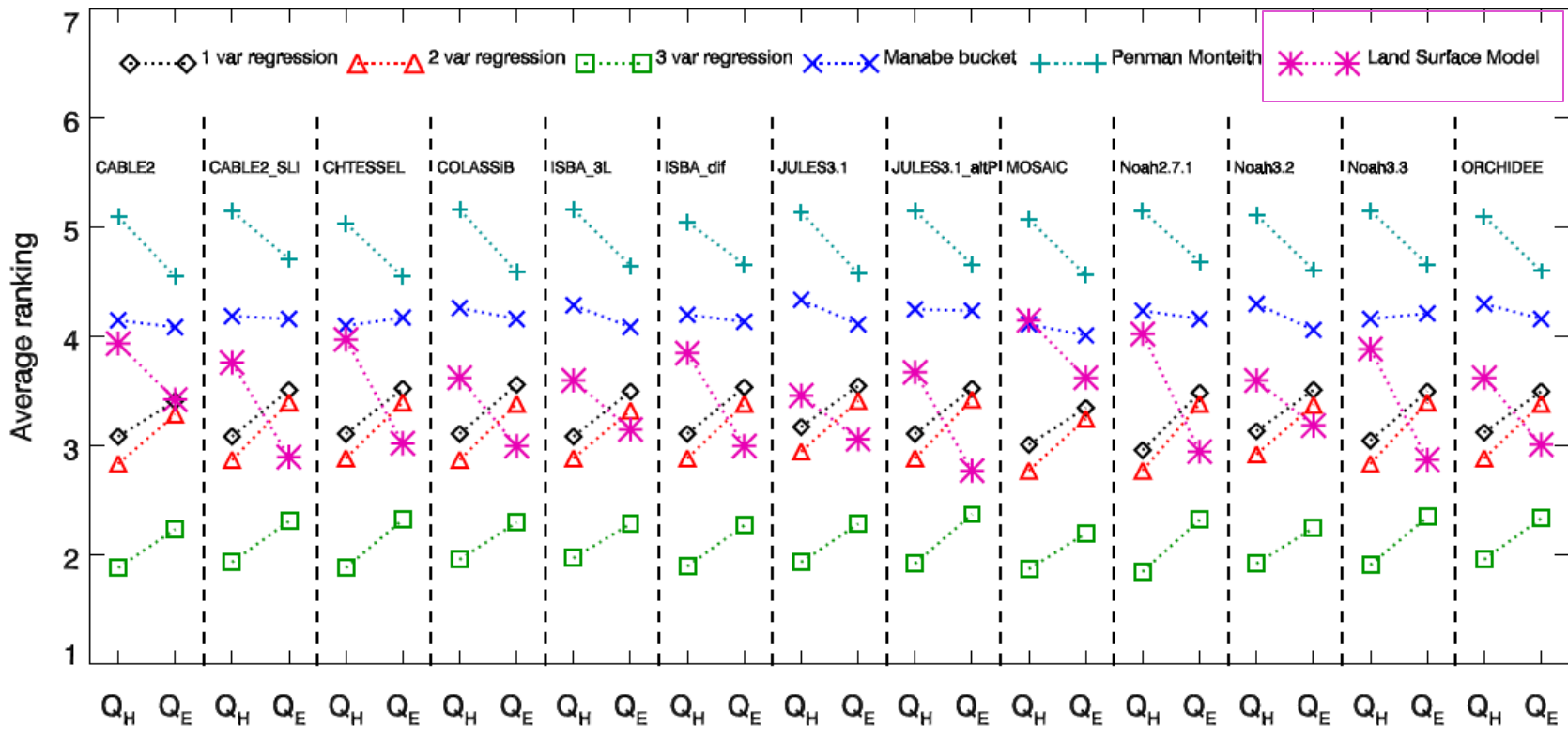
The aim of GLASS is to promote community activities that improve:

1. our best estimate and the model representation of state variables
2. our understanding of land/atmosphere feedbacks
3. our understanding of the role of land surface in predictability

To best achieve these aims, GLASS has been re-structured into three elements:



GLASS PLUMBER HIGHLIGHT



For sensible heat flux, the land surface models are outperformed by a simple regression against downward shortwave radiation

3-var (downward SW, atm. humidity, temperature) non-linear regression outperforms the LSMs for latent heat flux

(Best et al. 2015, JHM)

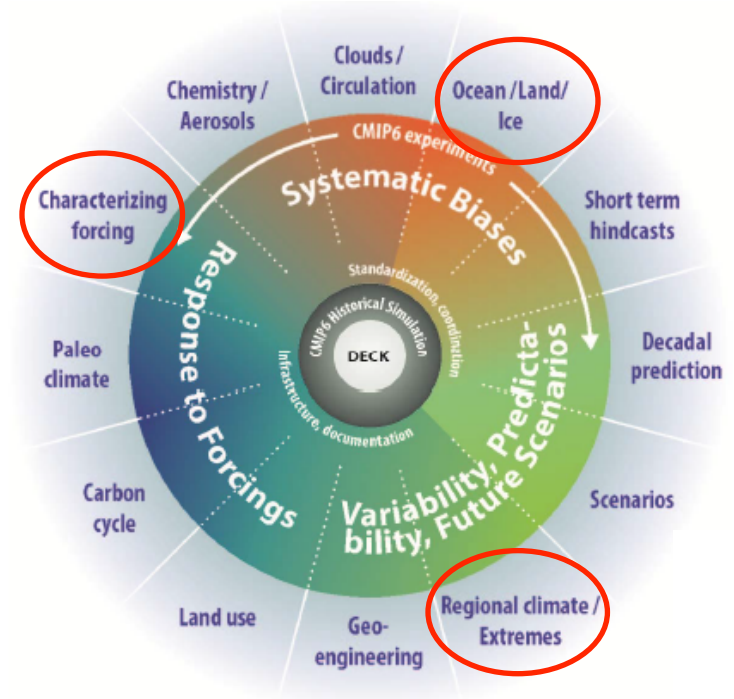
GLASS: CMIP6 / LS3MIP



Land Surface, Snow, and Soil Moisture MIP (LS3MIP)
New CMIP6-endorsed modeling activity (co-sponsored by CliC and GEWEX)

Land-only (“LMIP”) and coupled (“LFMIP”) simulations:

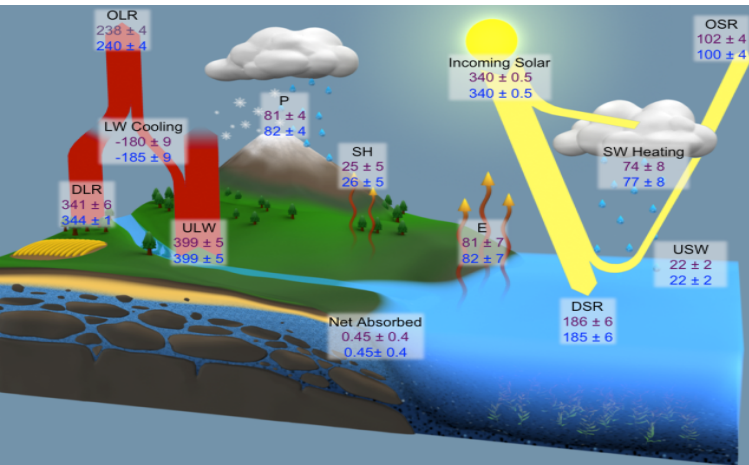
- Benchmarking of land surface models used in CMIP6 climate models (historical offline simulations for evaluation)
- Investigation of impacts of snow- and soil moisture-climate feedbacks
- Impacts on water cycle and climate extremes (Water availability GC and Extremes GC)



16 Participating Models: ACCESS, BCC-CSM2-MR, CanESM, CESM, CMCC, CNRM-CM, EC-Earth, FGOALS, GFDL, GISS, IPSL-CM6, MIROC6-CGCM, MPI-ESM, MRI-ESM1.x, NorESM, UKESM

Co-chairs: B. van den Hurk, G. Krinner, H. Kim, S. Seneviratne, C. Derksen, T. Oki (submitted CMIP6 paper)

GEWEX Data Assessment Panel



Goals

1) **Data records** - Guide production and analysis of global data sets with respect to GEWEX questions, e.g., energy and water budget closure;

- **Seaflux, Landflux, Surface Radiation Budget, ISCCP, GPCP, Gvap**

- **New data initiatives**

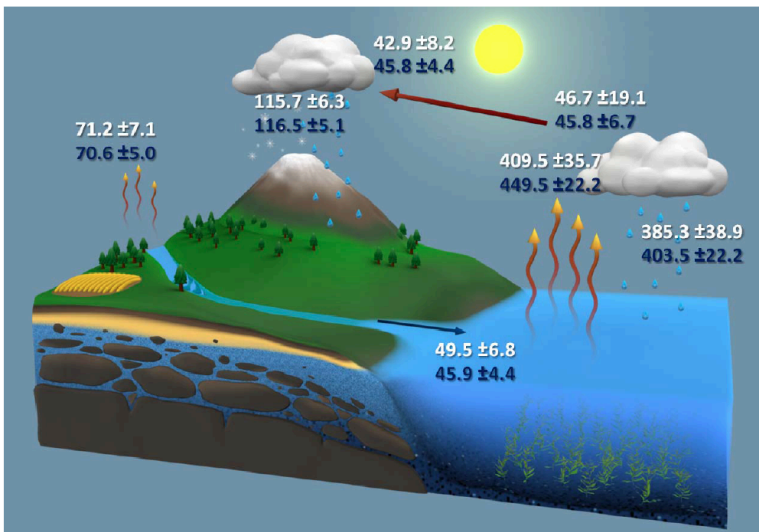
- **Evaluation of climate models – obs4mips, PROES**

2) **In situ networks** – guidance/oversight of surface networks

- **BSRN, GPCC, International soil moisture network**

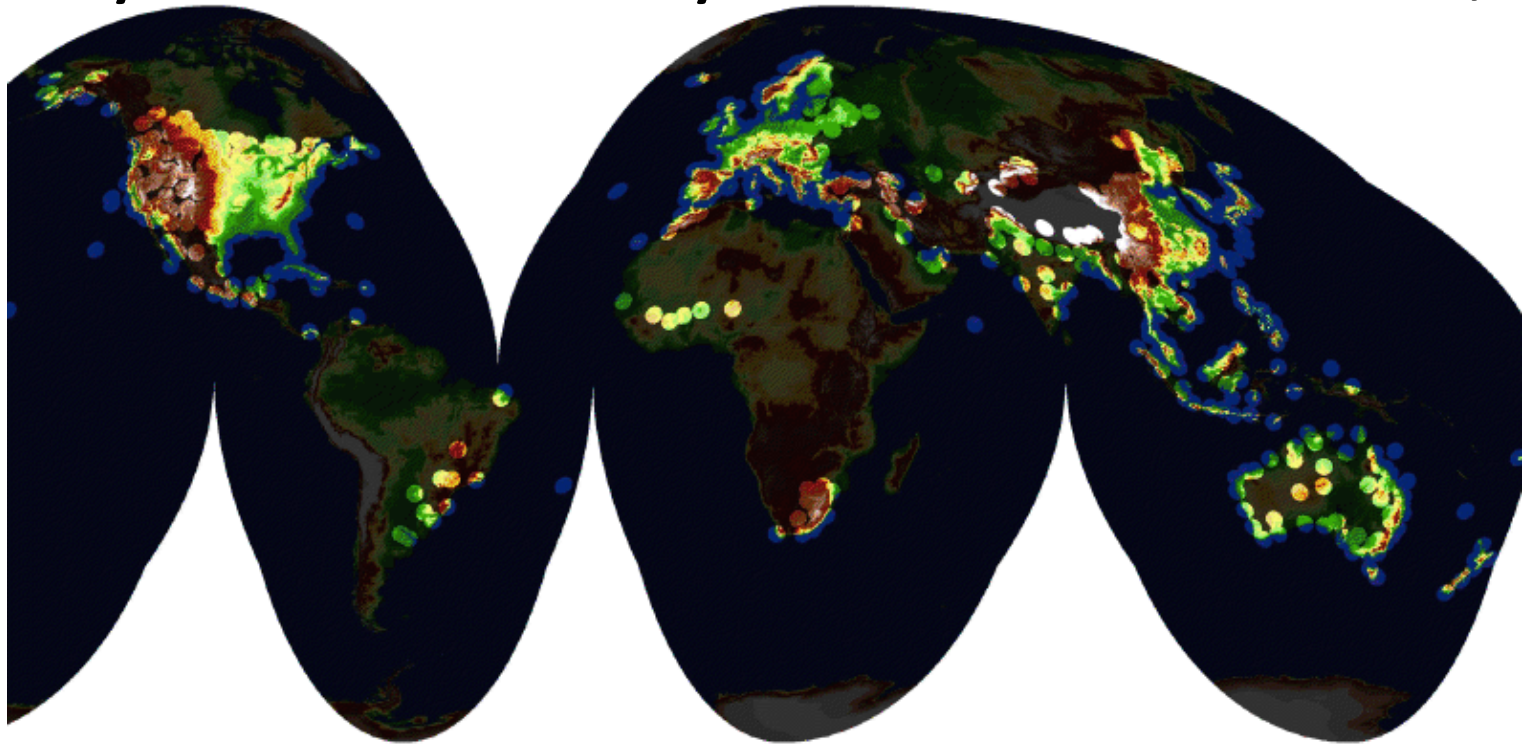
3) **Data quality assessments** - assure quality and knowledge about data sets including suitability for applications; improve uncertainty estimation for data records - Interact with CEOS/CGMS WG Climate

- **Cloud, Water Vapor, Aerosol, Precipitation, Soil Moisture**



World wide weather radar coverage

> 800 systems listed by Heistermann et al., 2013



Heistermann et al. (2013), HESS

Europe, UK: Nimrod, OPERA, EUMETNET 17 countries,

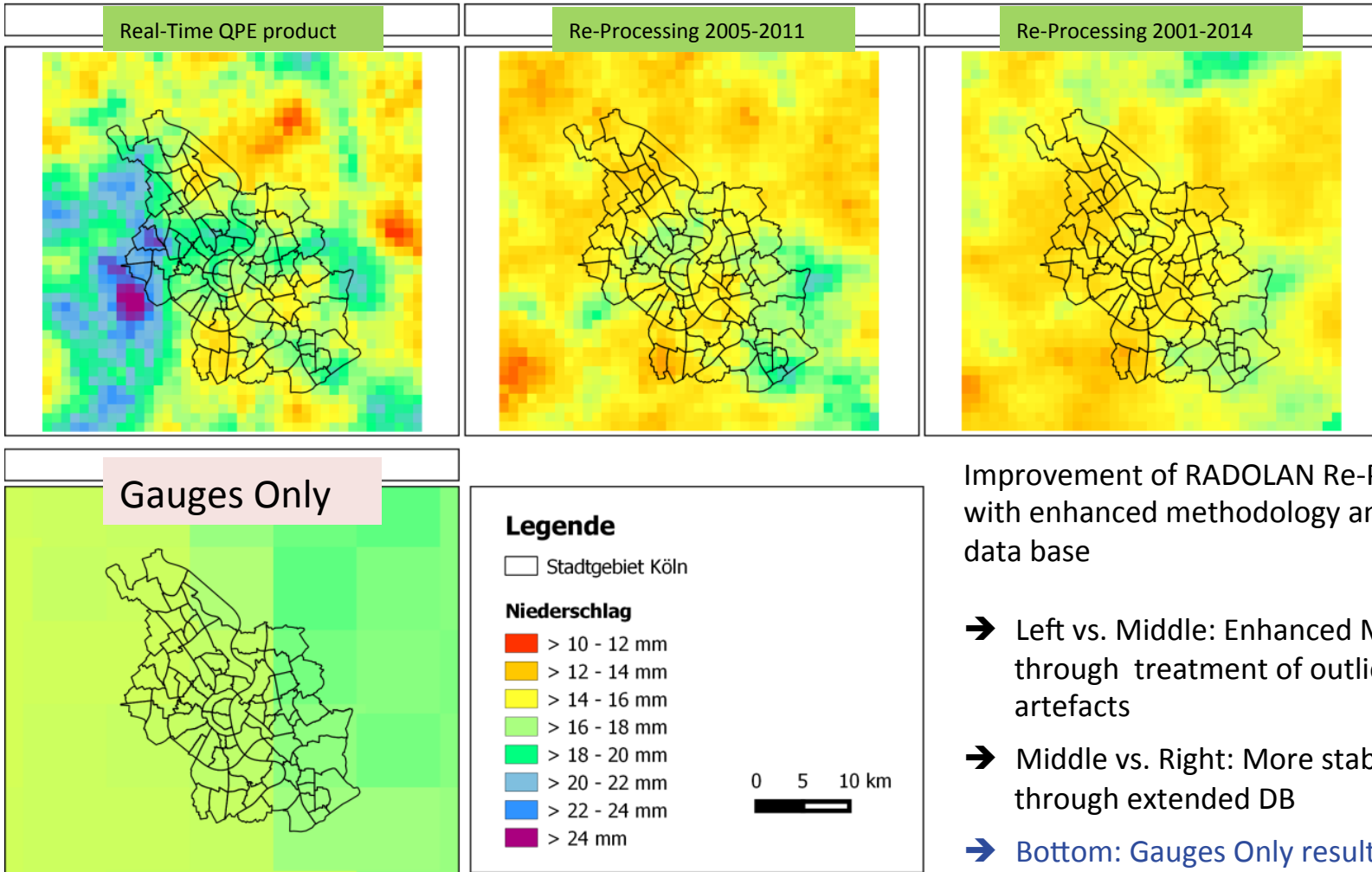
Northern Germany: Precipitation and Attenuation Estimates from a High Resolution Weather Radar Network (PATTERN)

US: NEXRAD (Next-Generation Radar), network of 160 high-resolution S-band Doppler weather radars

3 First Results and Future Perspectives

(14 year data record)

Extreme precipitation across Cologne for duration 1h and return period 1yr



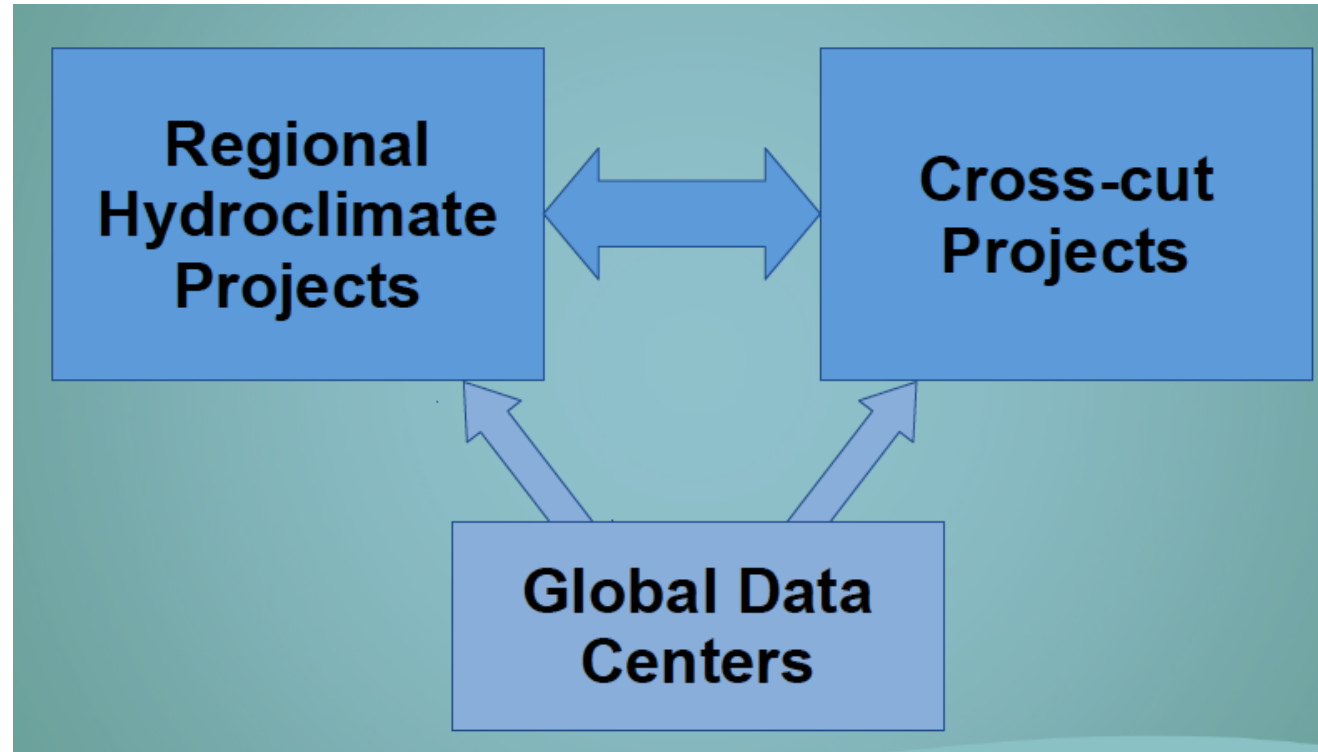
Improvement of RADOLAN Re-Processing with enhanced methodology and extended data base

- ➔ Left vs. Middle: Enhanced Methodology through treatment of outliers and radar artefacts
- ➔ Middle vs. Right: More stable statistics through extended DB
- ➔ Bottom: Gauges Only result (ways too coarse for target applications)

GEWEX HydroClimate Panel

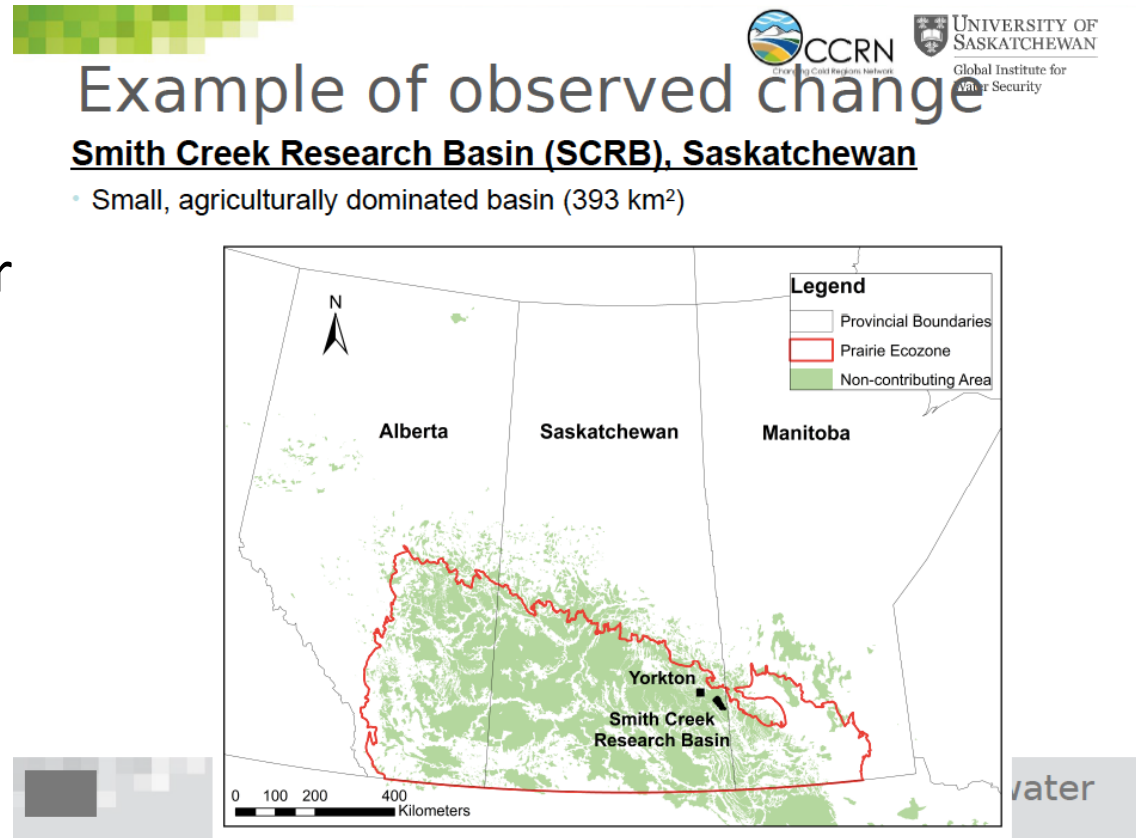
Intense – sub-daily precipitation
Inarch – mountain hydrology
Cold Sholder Precip
MountTerrain
Water management (w GLASS)

Two new RHPs
OzEWEX
HyVic
Prospective RHPs
BalticEarth
RELAMPAGO
Newly proposed RHPs
Pannex
USRHP



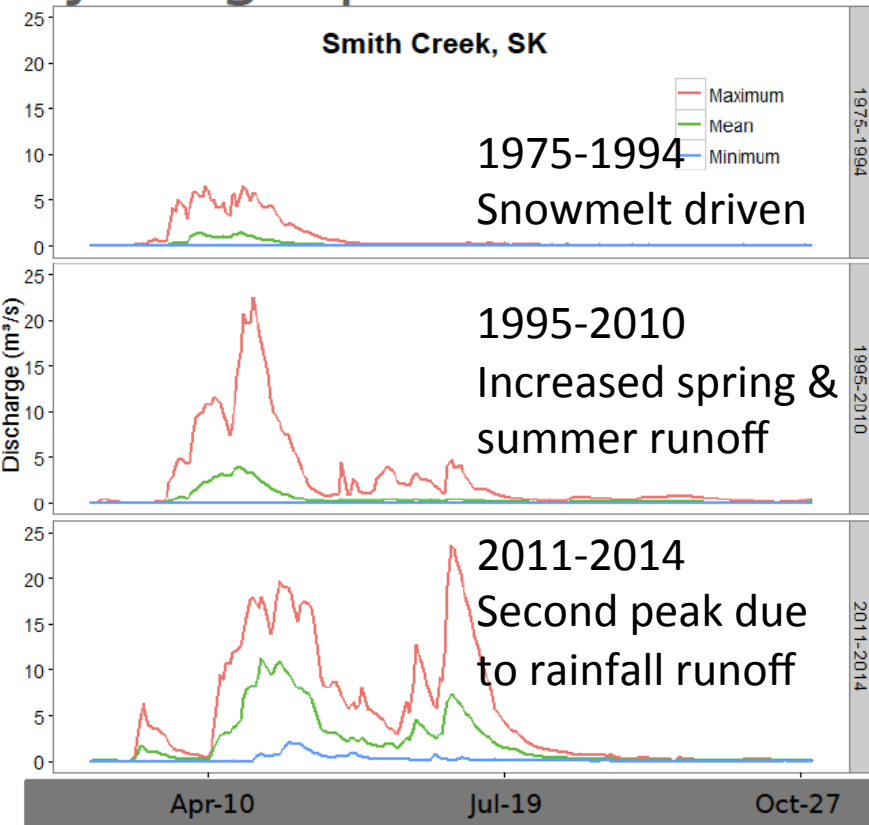
Highlight result from SaskRB RHP

An example of how human influences on the landscape together with changing climate conspire to increase flood risk (thus underscoring the goals of the human management cross cut activity)



Hydrographs

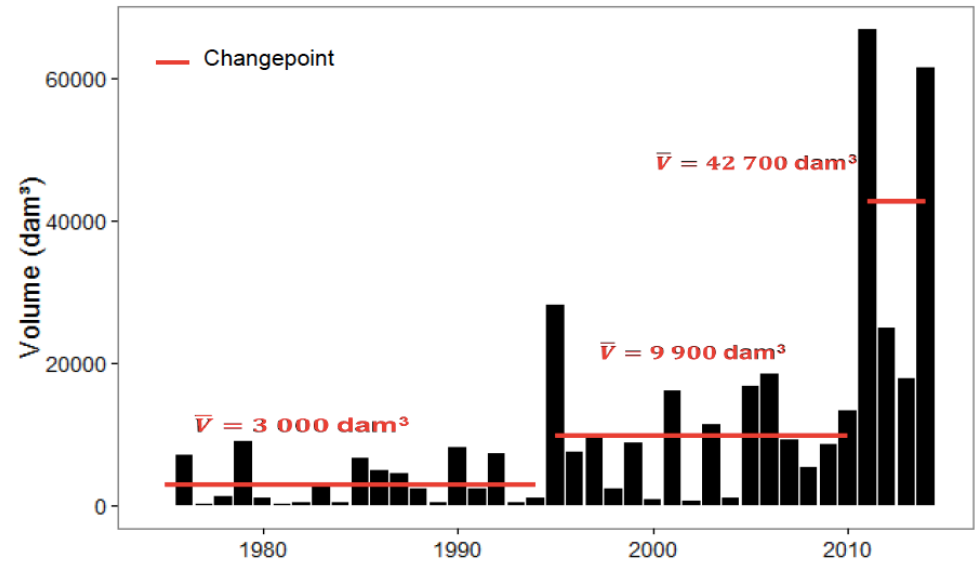
Change



Annual Streamflow Volume (1975 - 2014)



- 14-fold increase in streamflow volumes ($p < 0.001$)



No Drainage

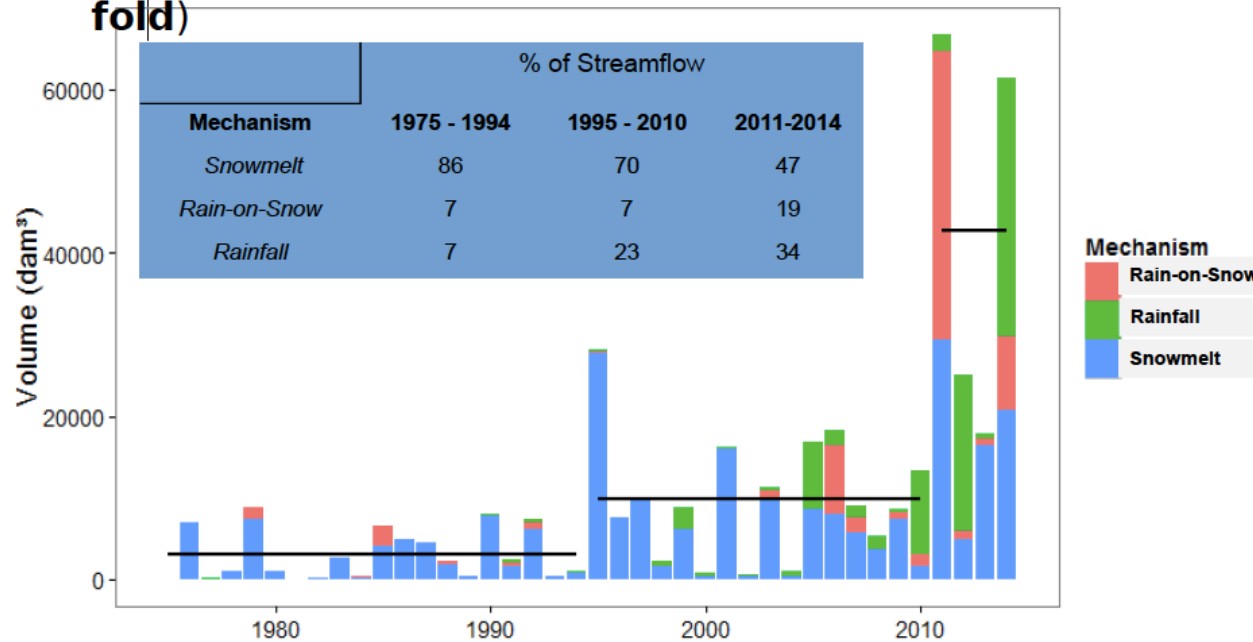


Artificial Drainage



Runoff Processes (1975 - 2014)

- Increased runoff contributions from:
 Snowmelt (**5-fold**), rain-on-snow (**34-fold**), rainfall (**150-fold**)

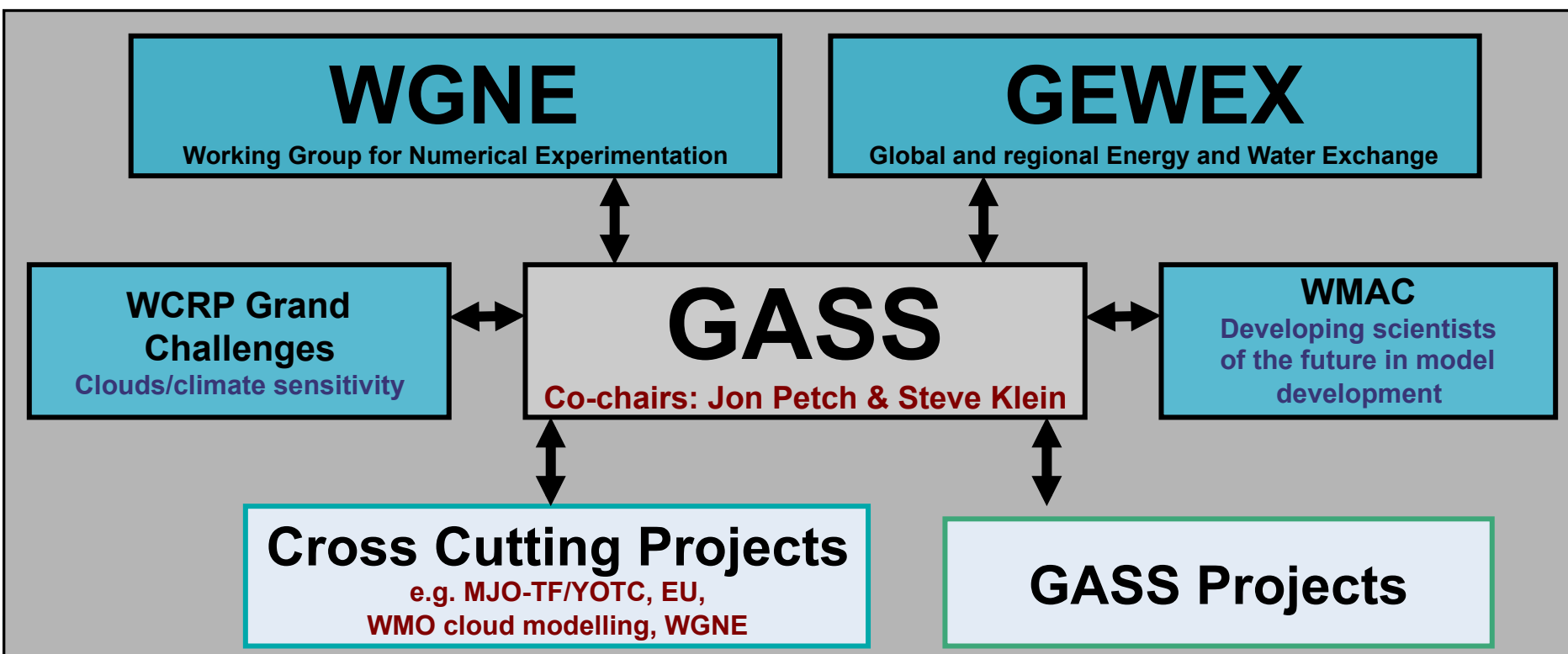


“atmospheric processes” includes the interaction with other components (e.g. land in DICE; ocean in MJO; aerosols in Kid-A)

GASS provides leadership for the scientific community involved in improving the representation of atmosphere processes in weather and climate models.

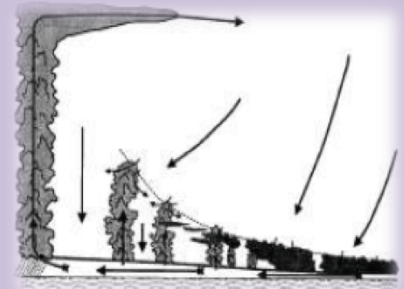
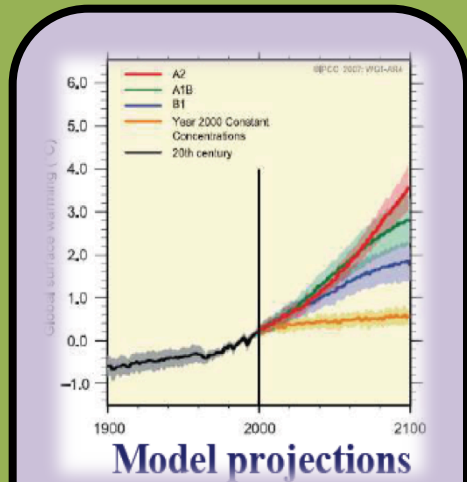
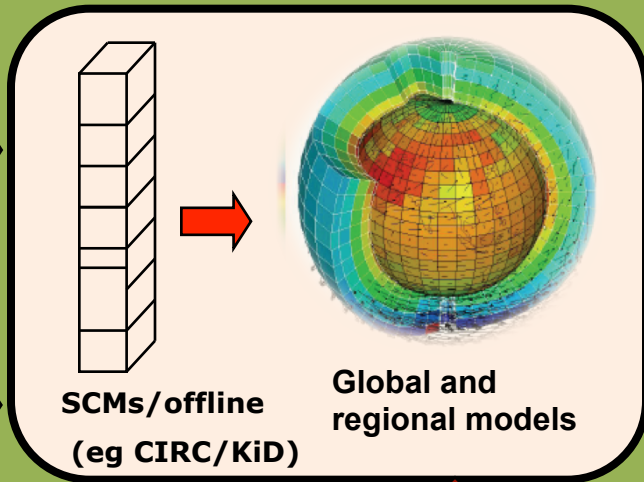
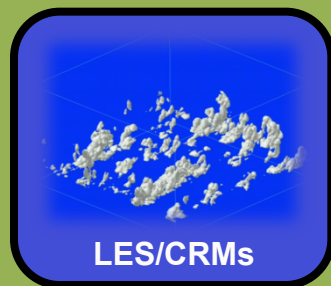
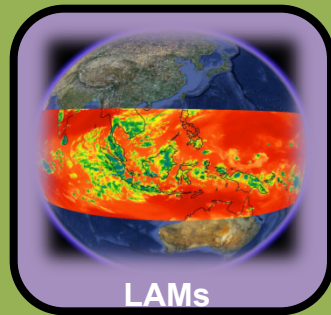
through the coordination of scientific projects that bring together experts in process-modelling, observations, and the development of atmospheric parameterizations.

(All GASS projects to date involve model comparisons)



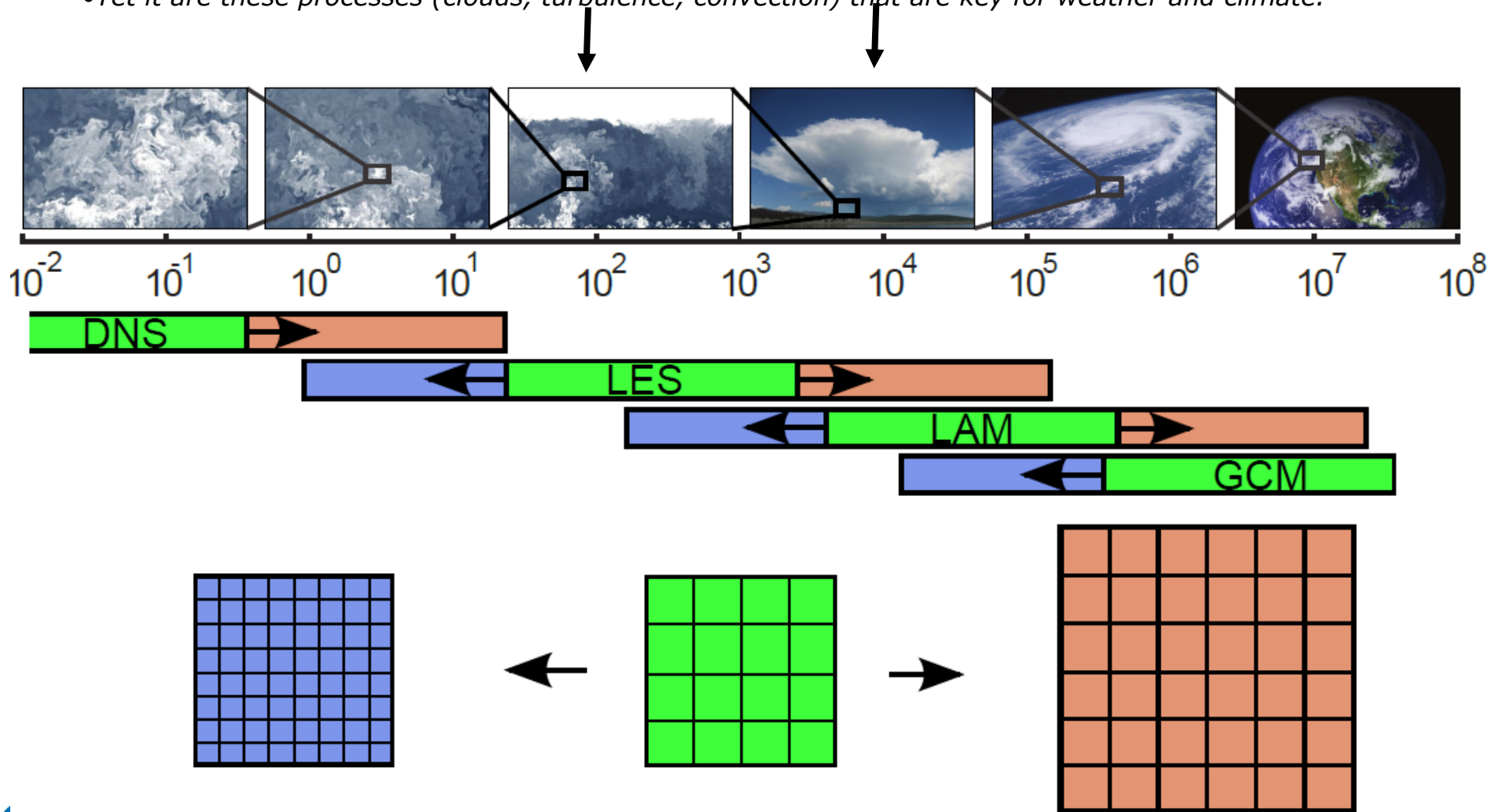
Working with many model types
 bringing together expertise in observations, modelling
 and understanding through intercomparison projects

GASS methodologies



The Grey Zone Project

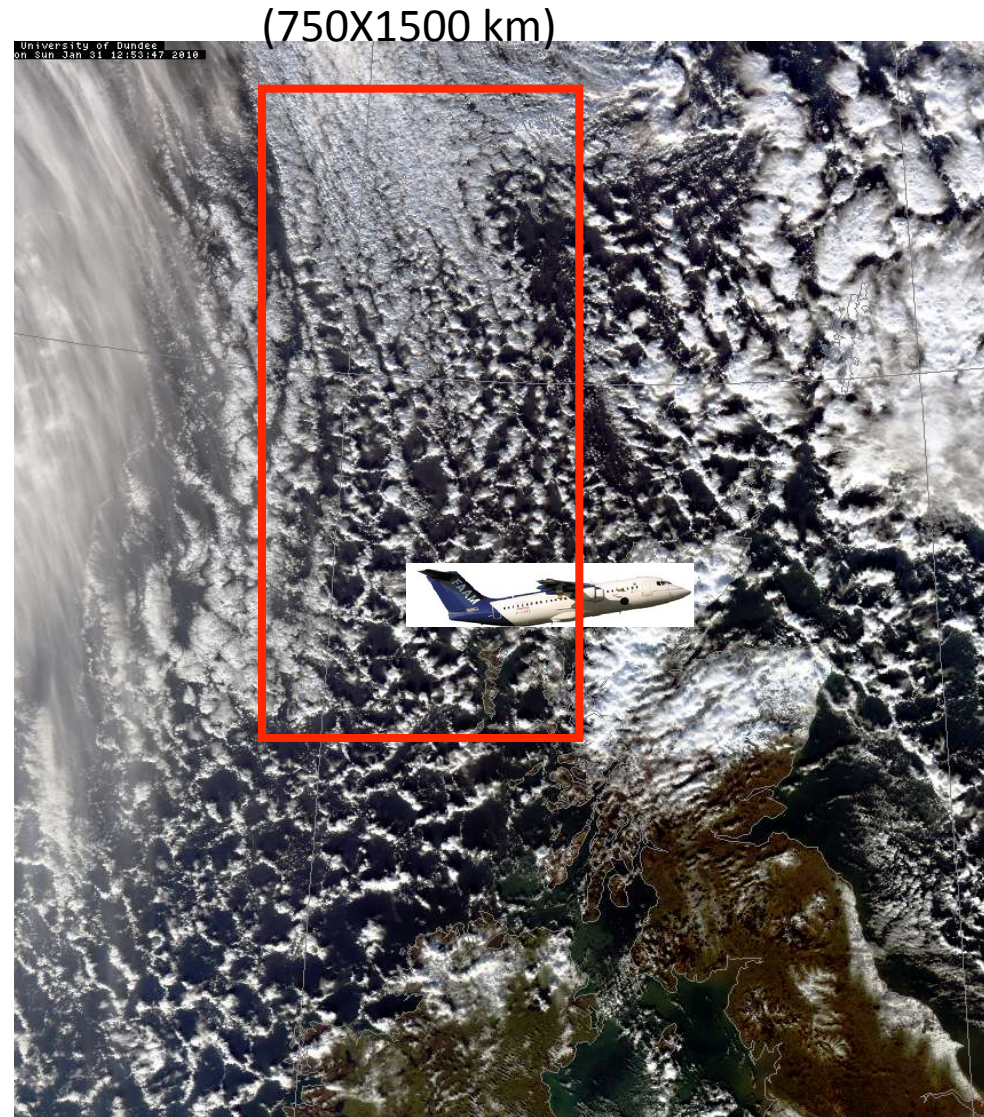
- Most operational models are in or approaching "the Grey Zone"
- We do not know how to parameterize overturning related processes in the "Grey Zone"
- Yet it are these processes (clouds, turbulence, convection) that are key for weather and climate.



Case study - extra-tropical case of cold-air outbreaks

see: www.knmi.nl/samenw/greyzone

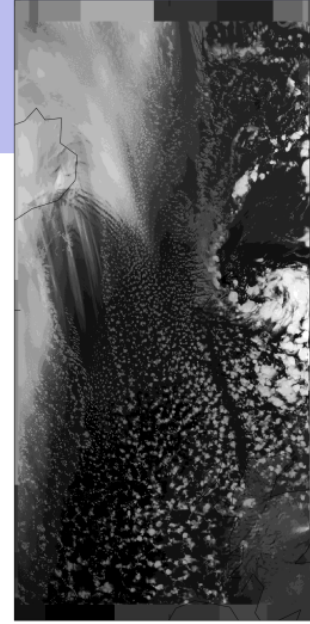
1. Global Simulations (at the highest possible resolution up to 5 km) *Coordinator: Lorenzo Tomassini*
 2. Mesoscale Models (Eulerian) At various resolutions (up to 1 km) LAM-set up *Coordinators: Paul Field & Adrian Hill*
 3. Mesoscale/LES Models (Lagrangian) highest resolution ($\sim 100\text{m}$), *Coordinator: Stephan de Roode*
- 7 Global Models
 - 7 Mesoscale Models
 - 7 LES Codes



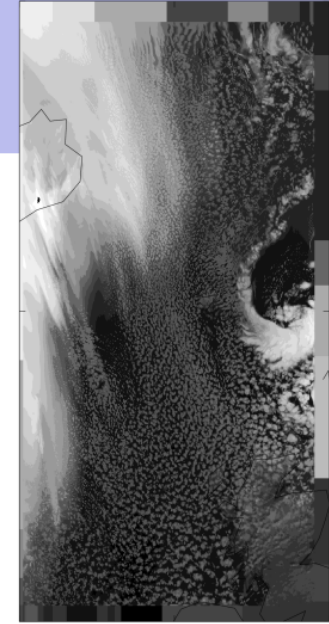
UKMO
UKMO Cuoff 1km meth1 0100c



WRF_NCAR
NCAR Cuoff 1km meth1



WRF_NOAA
NOAA Cuoff 1km meth1



Limited Area Models

TOA Long Wave Radiation Fields

12Z 31 Jan 2010

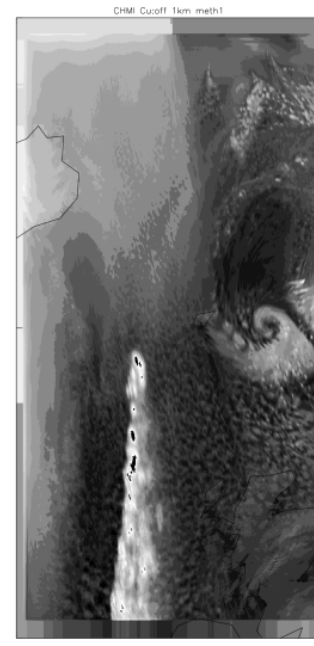
No convection

1km

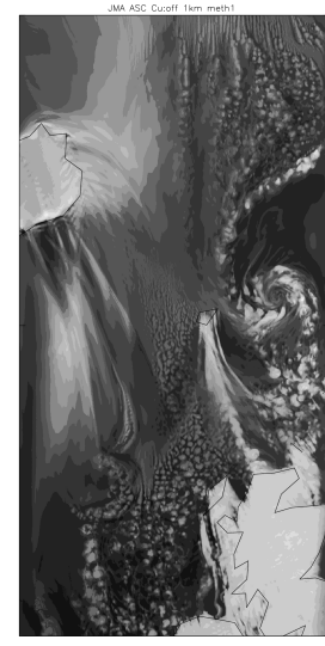
In general the LAM & LES reproduce qualitatively the the breakup of the Scu into the Cu open cells amazingly well but the GCM doesn't.



MODIS



ALADIN



JMA ASC April 2016

Panel issues and outlook

- All panels have transitioned or are about to transition to new leadership
- GASS transition has proven difficult
- Pan-GASS meeting in 2018 to review the panel efforts and reform as new panel with a much more integrated approach

June 20-22, 2016 'originally

Upcoming activities (selected)

- US RHP definition panel meeting, US GEWEX project office (Washington, DC, May)
- Soil & water workshop (June, 2016)
- Hydrological sensitivity workshop (June, Exeter)
- Hi Res modeling workshop (Sept, Boulder)
- 2nd Pannex workshop, Sept 2016 (Budapest)
- GEWEX & GC OSC: Climate extremes and Water availability, 2018 planning

INARCH Meeting (colocated with GHP Panel Meeting)	September 2016	Paris, France	GEWEX, GC Water
2nd PANNEX Workshop		Budapest	GEWEX/GHP
Monsoon Panel	Should meet at latest at CLIVAR OSC		

GEWEX Soils and Water Initiative

Current Land surface Models (e.g CLM)

- Model design assume uniform soil depth, soil layers
- Affect ability to resolve flood and drought

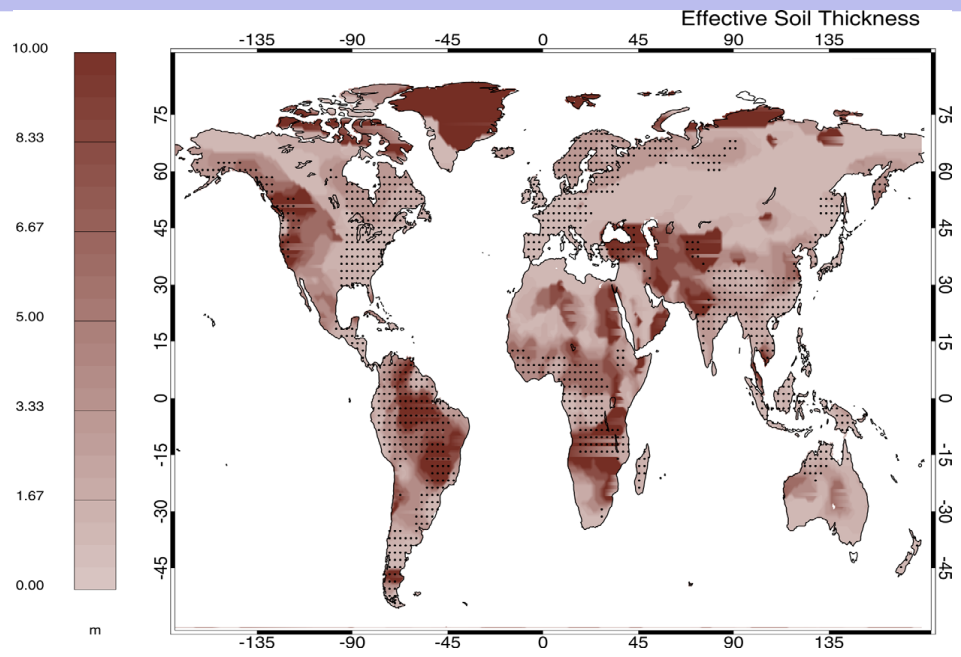
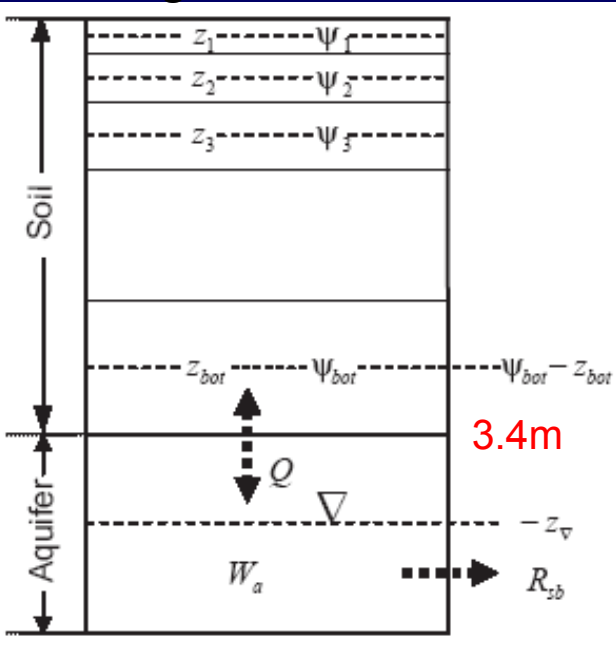


Figure 11. Optimal CLM soil thickness parameter (m). Value at each gridcell is taken from the ZBOT simulation giving the smallest bias between GRACE and CLM TWS.

Water Resources Research

RESEARCH ARTICLE
10.1002/2015WR017582

A GRACE-based assessment of interannual groundwater dynamics in the Community Land Model

Key Points:

S. C. Swenson¹ and D. M. Lawrence¹

• CLM shows water storage biases

SoilWat Workshop

June 28-30, 2016
Leipzig, Germany

GEWEX Soils and Water Initiative

The Soil and Critical Zone communities have been exploring ways to broaden disciplinary participation in addressing global challenges where soil and subsurface processes (groundwater) play important roles.

To establish a structure that develops a road map for better integrating soil research into climate research, and for interfacing research on soils, climate, and socio-economics. These objectives target six core:

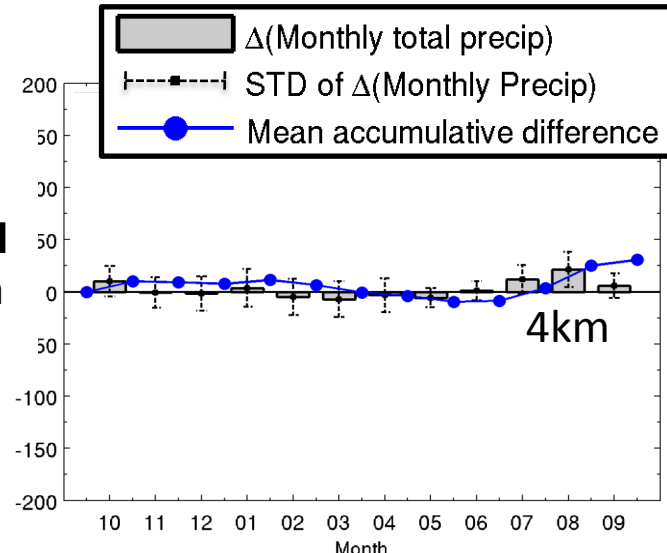
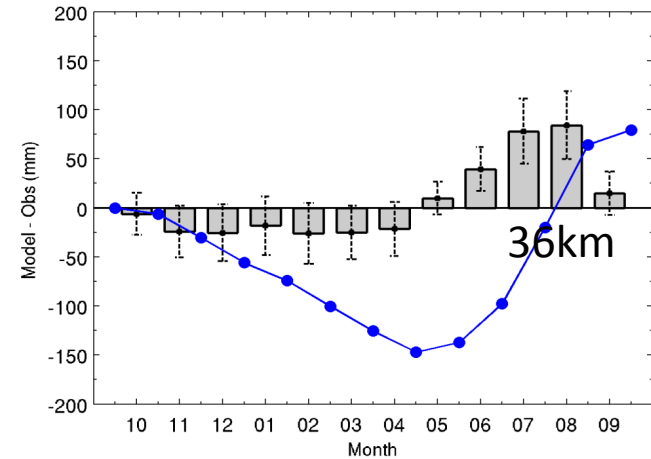
- *Integrating (sub-) surface modeling in hydrological and climate models – Eleanor Blyth and Dani Or (co-leads)*
- *Model complexity and utility (simple vs complex models) - Martin Best and Matthias Cuntz (co-leads)*
- *Groundwater-surface-atmosphere interactions - Marc Bierkens and Stefan Kollet (co-leads)*
- *Human interactions affecting soil-water processes - Taikan Oki and Shmuel Assouline (co-leads)*
- *Soil observations for hydro-climate research - Sonia Seneviratne and Harry Vereecken (co-leads)*
- *Structures and mechanisms for informing climate and soil communities - Gerrit de Rooij and Peter van Oevelen (co-leads)*

SoilWat
Workshop

June 28-30, 2016
Leipzig, Germany

HiRes Modeling Initiative

Alpine precip over the Colorado head waters



30% too little precip in the winter and 65% too much in the summer using 36 km model compared to 4 km model (compensating errors)

Evapo-transpiration in the 36 km model 38% higher than the 4 km model

GEWEX CONVECTION-PERMITTING CLIMATE MODELING WORKSHOP

GEWEX Convection-Permitting Climate Modeling Workshop



About [Agenda](#) [Logistics](#) [Registration](#) [Contact](#)

September 6-8, 2016 | NCAR Foothills Laboratory, Boulder, Colorado

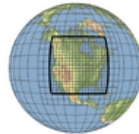
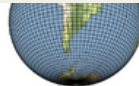
- Observations & Evaluation?
- Model experiments including nature runs?
- Model intercomparisons
- Relation to global models?

Applications Open through June 15.

Participants will be notified in early July.

Sponsored By:

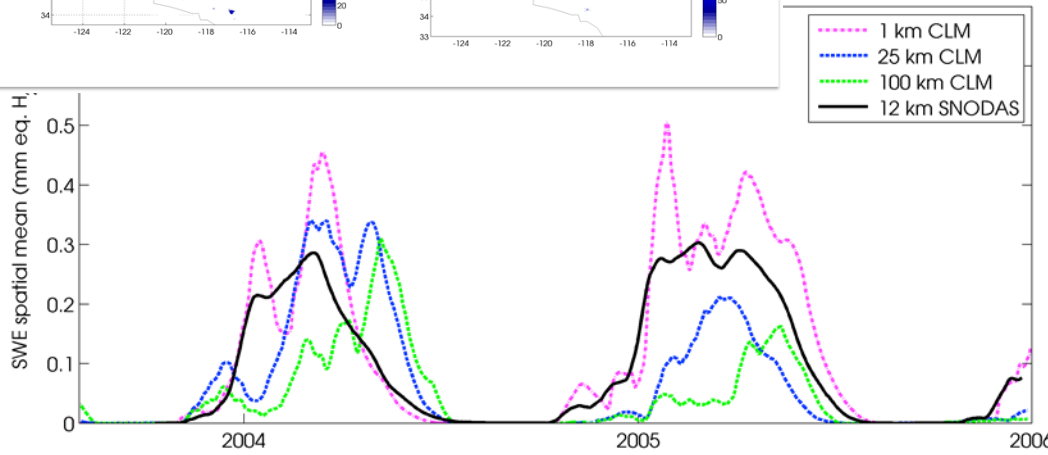
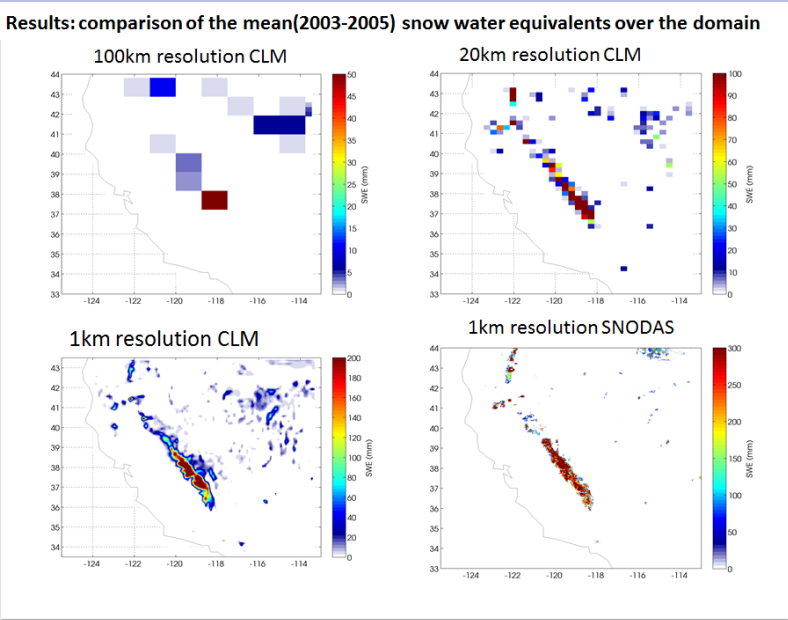
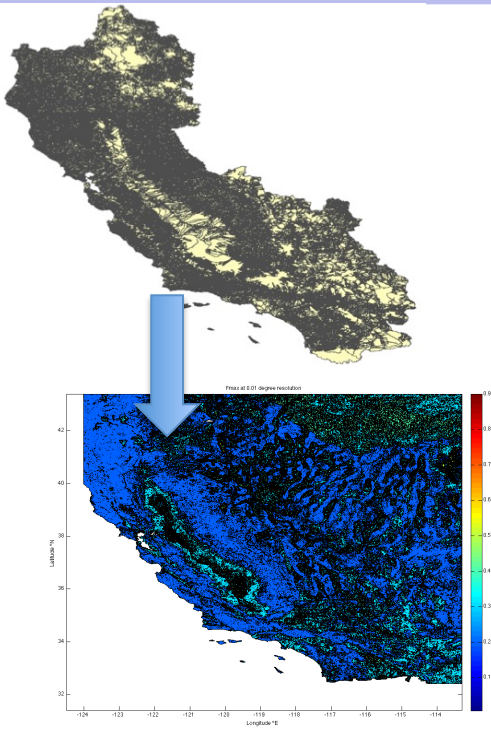
 <http://www.gewex.org/>



Sept, 2016



km-scale hydrological modeling



Singh et al., 2014: WRR:
1-km domain California
and Colorado River
basin

Correlation Coefficient (r)	Soil Moisture (v/v)	Δ TWS (mm)	Sensible Heat (W/m^2)	SWE (mm)
Obs- 1km CLM	0.807	0.735	0.914	0.880
Obs-25km CLM	0.651	0.525	0.830	0.650
Obs-100km CLM	0.640	0.454	0.830	0.360



A New Aerosol-Cloud-Precipitation Initiative *

Co-leads Susan C van den Heever Colorado State University
Philip Stier, Oxford University

GOALS

1. Enhance our understanding of aerosol – precipitation relationships on a global scale
ACPC focus is on the importance of processes on a LOCAL scale as opposed to the intended global scale envisioned here
2. Facilitate connections between all GEWEX cloud-aerosol-precipitation efforts (GASS and GDAP)
3. Address the WCRP Grand Science Challenges where possible (Clouds, Circulation and Climate sensitivity; Climate Extremes; Water Availability)

* Also reports to ACPC

Integrated data activities

- Arctic Observations and Reanalysis Integrated Systems (AORIS)
- PROES –(more ‘object based’)
- GDAP Integrated product

Multi-data sources are collected and integrated on common space/time scales that facilitates process related science

Christensen et al., 2016; *Bull Amer. Met Soc.*
cloudsat.cira.colostate.edu

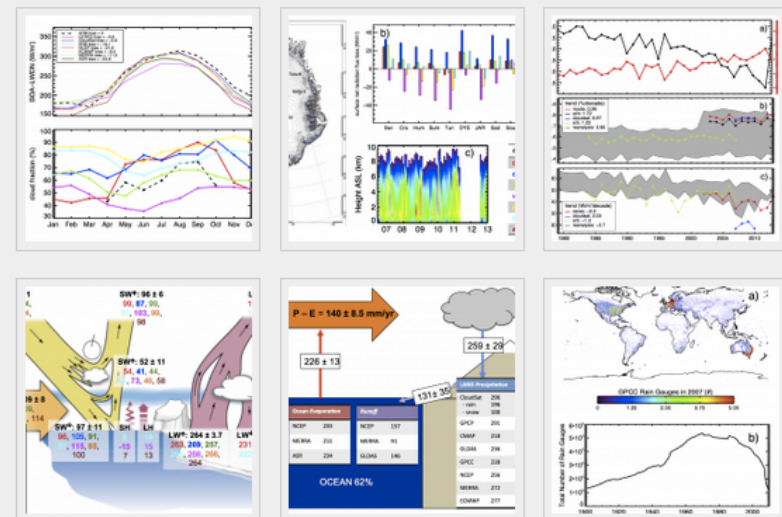
Satellites

AIRS	CERES	CloudSat	GEWEX-SRB
GRACE	NSIDC	CMAP	GPCP

Reanalysis

ASR	ECMWF-INTERIM	MERRA	NCEP
MACC			

Product Image Examples



GEWEX PROES - Process Evaluation Studies

This grew out of the obs4mip meeting where data need be constructed (on different time/space scales than panned for ESGF) to probe process understanding was missing in obs4mip II

Five GEWEX-related PROES activities are in development

- Upper Tropospheric Clouds & Convection (UTCC) (Stubenrauch, Stephens) with link to SPARC – integrated data products developed & being assessed
- Ice mass balance (lead Larour, Sophie Nowicki), GEWEX (AORIS) jointly with CLiC – in planning
- Radiative Kernels for Climate (lead Soden) - active
- Mid-lat storms (lead Tselioudis) - dormant
- Low clouds (lead Suzuki, U Tokyo) in planning

Closing comments

- Data Issues (WDAC) – Finer space/time resolution data, object oriented, to advance process level understanding.
- Modeling Issues (WMAC) – high resolution atmosphere and hydrological (regional) modeling. How should this be exploited to aid model development?

Backups

GLASS, Some highlights: CMIP6 / LUMIP

LUMIP: Land Use MIP

What are the effects of land use and land-use change on climate and biogeochemical cycling (past-future)?

Are there regional land management strategies with promise to help mitigate and/or adapt to climate change?

Phase 1 Idealized model experiments:

Improve process understanding/assessment of how models represent impact of changes in land state on climate;
Quantify model sensitivity to potential land cover and land management changes

Phase 2 Realistic model experiments:

Isolate the role of historical and future land cover/use change on climate relative to other forcings, assess potential for climate mitigation through land use

Links with LS3MIP, C4MIP, DAMIP

Co-chairs: D. Lawrence, G. Hurtt (submitted CMIP6 paper)



Goals of the New Initiative

1. Enhance our understanding of aerosol – **precipitation** relationships on a global scale
 - ACPC focus is on the importance of processes on a LOCAL scale as opposed to the intended global scale envisioned here
2. Facilitate connections between all GEWEX cloud-aerosol-precipitation efforts
3. Address the WCRP Grand Science Challenges where possible (Clouds, Circulation and Climate sensitivity; Climate Extremes; Water Availability)

Two Possible Approaches to Goal 1

Enhance our understanding of aerosol – precipitation relationships on a global scale

1. Energetics Framework

- In keeping with the flavor of GEWEX it will be addressed using an energetics framework across multiple scales

Two Possible Approaches to Goal 1

Enhance our understanding of aerosol – precipitation relationships on a global scale

2. Regime Approach

- Global database of co-located aerosol (CALIPSO, MAIA, etc) and precipitation obs (TRMM, CloudSat etc), aerosol transport models (AirChemMIP, AeroCom) and global environmental conditions (reanalysis)
- Assess aerosol-precipitation relationship in a global context and then for a variety of regimes within global context (deep vs shallow; tropical vs mid-latitude; continental vs maritime; high vs low shear; high vs low CAPE)
- Build multidimensional parameter space for each regime
- Test regime findings using various case studies analyzed in the same way
(can we plot case study results on parameter space?)

The International Soil Moisture Network (ISMN) - a GEWEX success story

- A centralized data hosting facility, a „network of networks“, endorsed by GEWEX (thanks Peter!) and sponsored by ESA EOP SMOS.

- **Currently available at the ISMN:**

<http://ismn.geo.tuwien.ac.at/>

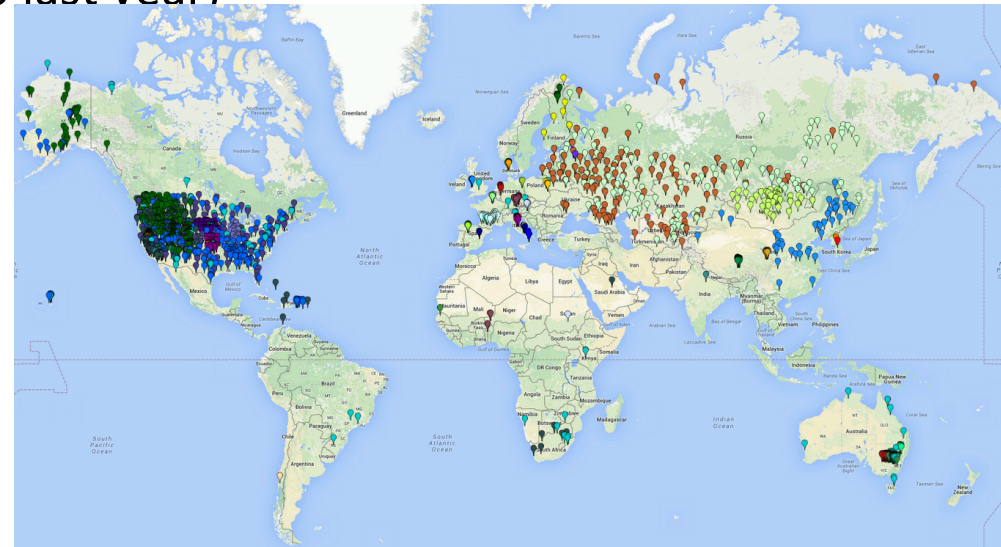
- **49 networks** (42 meeting last year))
- **~ 2050 Stations** (1600 last year)
- **~ 8000 soil moisture datasets** (6500 last year)

- historical datasets (**since 1952**)

- operational datasets with **near-real time update**

- **Additional variables:**

- Soil temperature
- Air temperature
- Precipitation
- Snow depth
- Snow water equivalent



- „Static“ variables (soil texture, saturation point,..)

HiRes Modeling Initiative

GEWEX CONVECTION-PERMITTING CLIMATE MODELING WORKSHOP

GEWEX Convection-Permitting Climate Modeling Workshop



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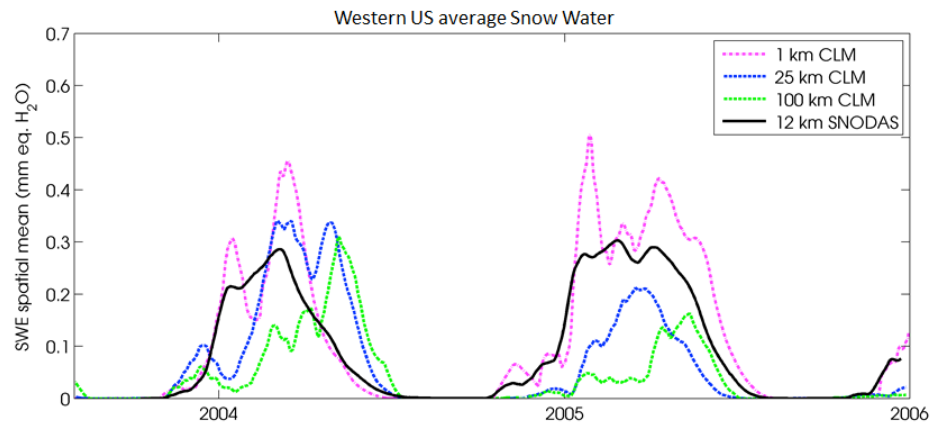
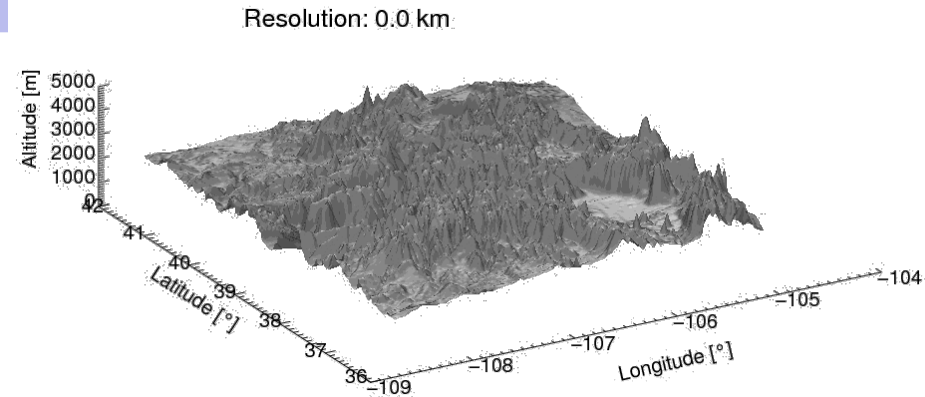
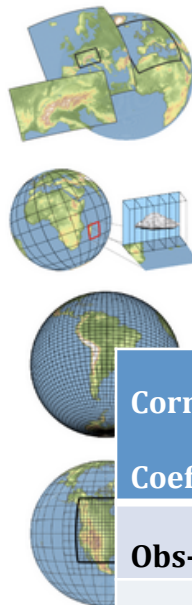
September 6-8, 2016 | NCAR Foothills Laboratory, Boulder, Colorado

The GEWEX Convection-Permitting Climate Modeling Meeting will focus on scientific and technical challenges related to convection-permitting climate modeling (horizontal grid spacing ≤ 4 km). These challenges include the model setup, observational datasets, evaluation techniques, computational resources, model intercomparisons, and the use of convection-permitting simulations in impact research. The 3-day meeting's aim is to foster collaborations and synergies to work on this challenging topic as a community. There will be oral and poster sessions, several invited talks on key topics, and multiple opportunities for discussions and networking.

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Participants will be notified in early July.

Sponsored By:



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