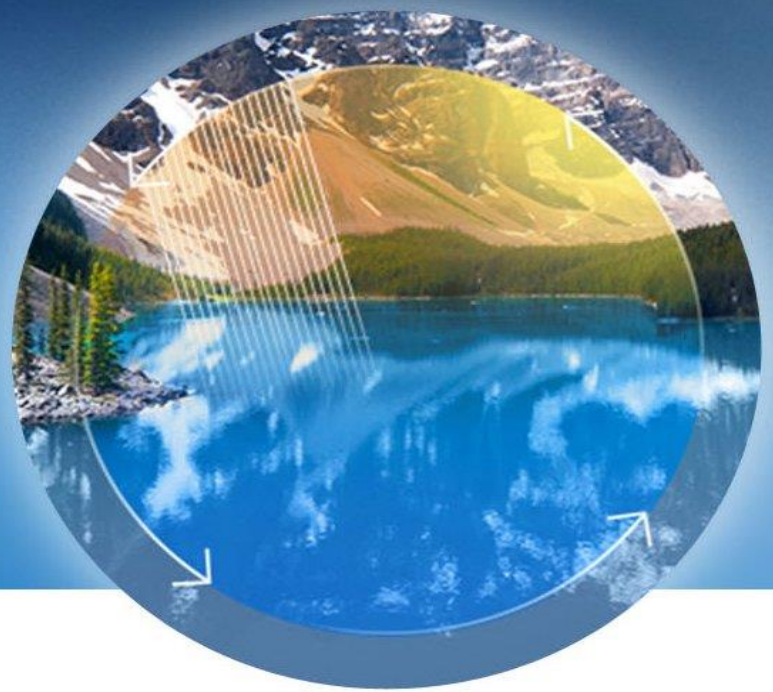
ABOUT
WATER, ENERGY,
& CLIMATE

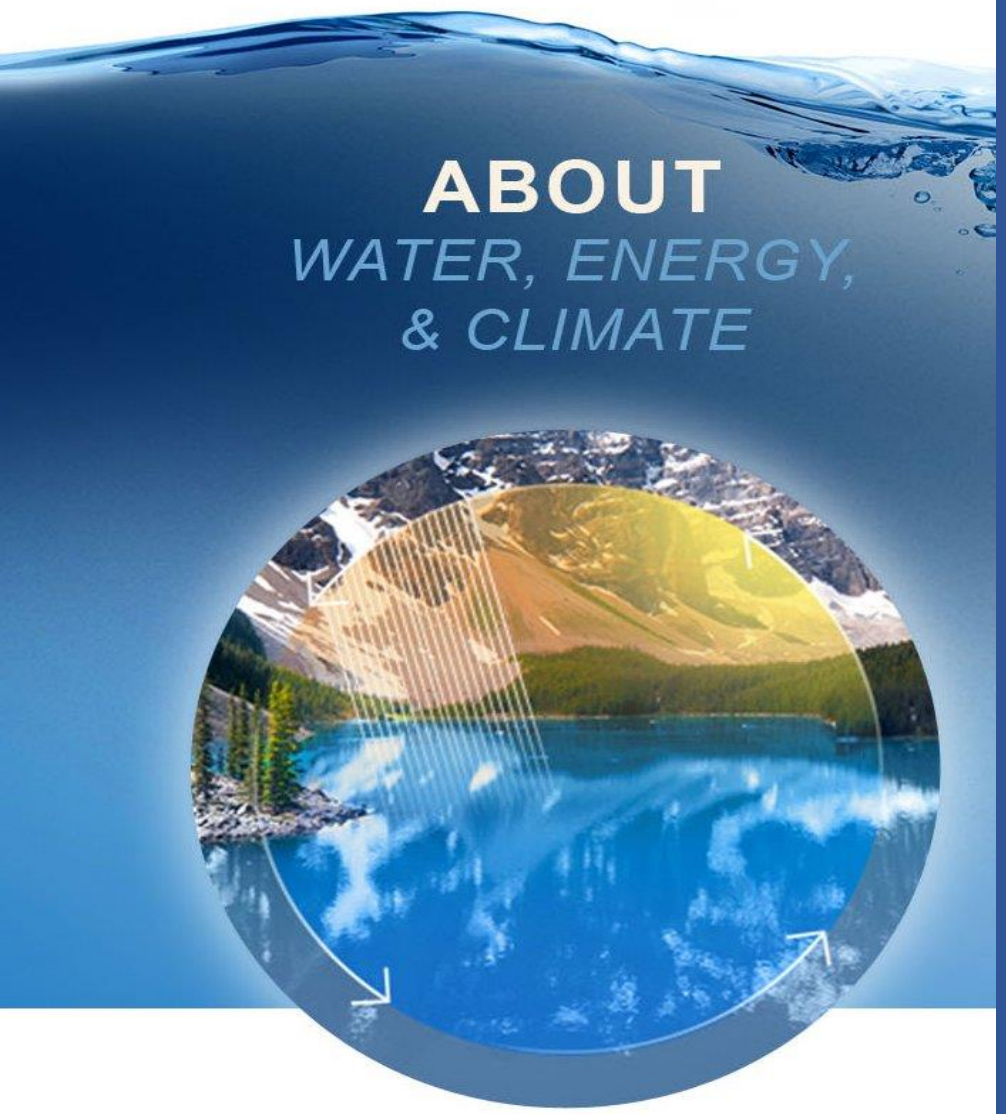


The GEWEX Core Project Report to JSC-39, 2018

Co-chairs
Graeme Stephens, Sonia Seneviratne (outgoing), Jan Polcher (proposed incoming)
Peter van Oevelen, Director IGPO

Outline

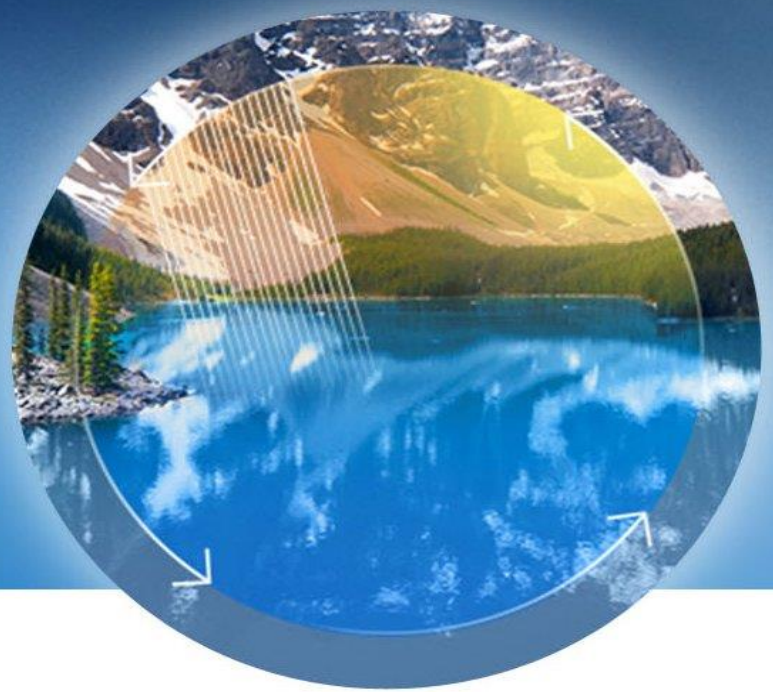
- Highlights of Panel Activities
- Upcoming meetings/activities
- GEWEX looking back and going forward



GEWEX was originally launched because GARP failed to provide adequate quantitative understanding of the atmospheric processes that control climate (Pierre Morel, pers comm).

GEWEX was conceived to exploit the new Earth observations coming on line from EOS and it was formulated as a comprehensive research program (observation including new satellite instruments, data analysis and modeling) focused on fast atmospheric and hydrologic processes, in order to pursue the second objective of GARP (Morel, per comm)

GEWEX



The phases of GEWEX and its evolution

What has remained throughout is focus on processes across all scales, a strong emphasis on meaningful observations and on data stewardship, on EO assessments and on linking all this to model development all for the purpose of understanding and predicting the Earth system

ICSU-WMO-IOC Review recommendations *(partial)*

EARTH SYSTEM PROCESSES ACROSS SCALES
Jointly with WWRP

Energy, Water and Carbon Cycles;
Fundamental Atmospheric Physics (e.g. Convection);
Land-Atmosphere Coupling;
Ocean-Atmosphere Coupling; Cryosphere Processes

CLIMATE VARIABILITY, PREDICTABILITY & PREDICTION

Ocean, Land, Cryosphere, Atmosphere & Solar Drivers; Climate Dynamics, Modes of Variability & Teleconnections; Monthly to Decadal Predictability & Prediction

CLIMATE CHANGE AND EARTH SYSTEM FEEDBACKS
Jointly with AIMES

Climate Change Forcing & Sensitivity; Climate Change Attribution; Climate Change Projections (Global & Regional) for Mitigation & Adaptation; Abrupt Climate Change; Geoengineering Assessment

WCRP Strategic Plan 2019-2029 (Draft)

1) Understanding the climate system

2) Determining predictability on weekly to decadal timescales

3) Determining projectability on decadal to centennial time scale

4) Connecting climate science to policy and decision making

The GEWEX Approach is

an integrated approach to quantify links between energy & water and critical Earth System feedbacks that result. The approach involves:

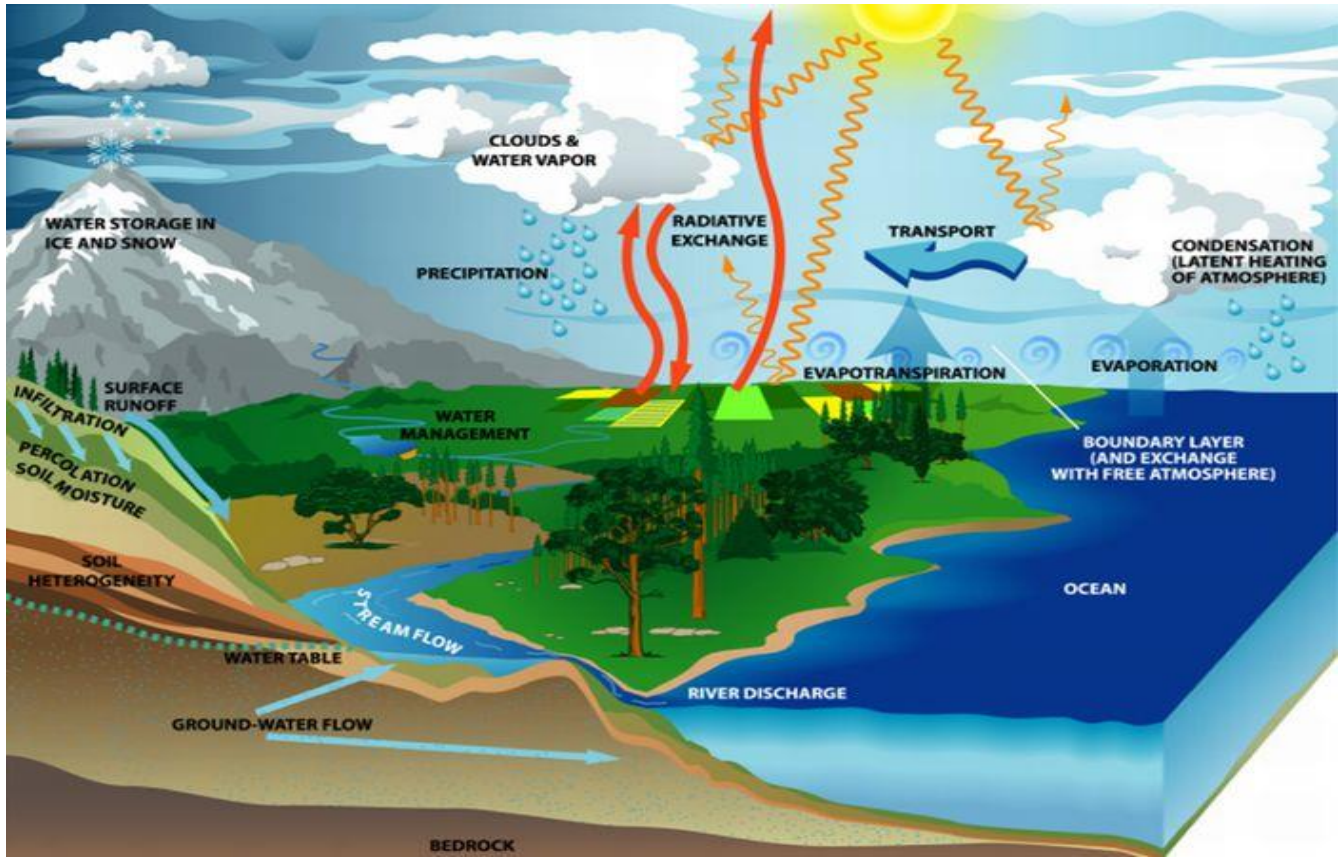
- Stewardship of observations, observing system assessment & definition
- Advance process understanding fundamental to hydrological & hydrometeorological apps, weather and to climate change
- Promote improvement in global, regional and process level modeling, in obs analysis and observing system definition

Two Big Science Questions that motivate GEWEX & we are encroaching more & more onto a third

- *Where does the heat go?*
- *How is the fresh water on the planet changing?*
- ***Where does the carbon go?***

3 fundamental 'reservoir' questions

The GEWEX Approach : Fundamentally addresses its goals framed around the activity of its four main core projects and cross-cut projects (like PROES)



The 4 GEWEX Science Questions sit under these bigger, overarching science questions

GASS: Global Atmospheric System study

GLASS: Global Land System Study

GDAP: GEWEX Data Analysis Panel

GHP: GEWEX Hydroclimatology Panel

The GDAP Activities Portfolio

Panel members
Rémy Roca, chair
Tristan L'Ecuyer, vice-chair
Wouter Dorigo
Andrew Heidinger
Seiji Kato
Christian Kummerow
Hirohiko Masunaga
Isabel Trigo
Claudia Stubenrauch
Tianjun Zhou

Invited members
Graeme Stephens, SSG Chair
Sonia Seneviratne, SSG Chair
Peter van Oevelen, IGPO
William Rossow

« GEWEX » datasets production & Stewardship

Paul Stackhouse	Surface Radiation Budget
Bob Adler	Global Precipitation Climatology Project (GPCP)
Stefan Kinne	Global Aerosol Climatology Project (GACP)
Carlos Jimenez	LandFlux
Caroll Ann Clayson	Seaflux
Bill Rossow and NOAA NCEI	ISCCP **also now moving into next generation ISCCP**
P Brown and C Kummerow	GEWEX Merged and Integrated Product

Ground data network

« GEWE

Claudia Stu
Marc Schrö
Jeffrey Reid
Joint with IP

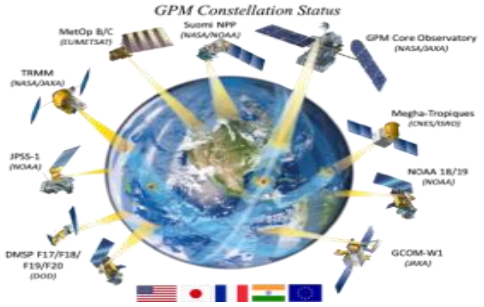
The PROES initiative grew out of the obs4mip meeting where it was clear alternative ways of promoting observations were needed. PROES seeks to push use of observations in a less traditional and less rigid model format to probe process understanding. PROES is a bottom-up effort and the projects vary in size

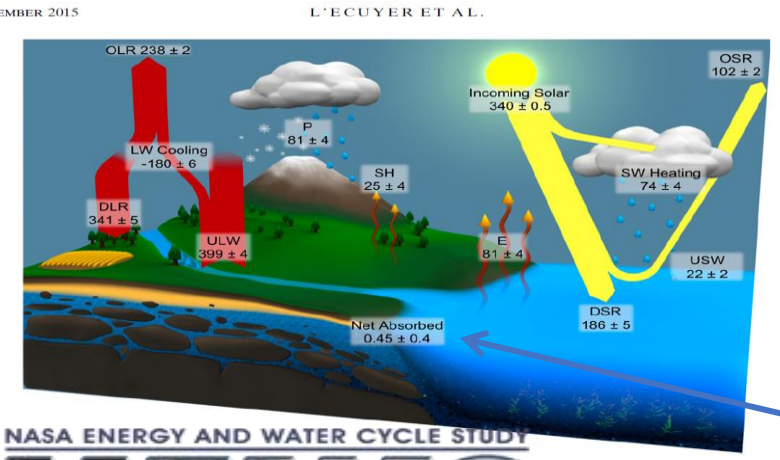
GDAP - data stewardship, data analysis, data integration & observing system assessment

Consistency; the example of energy and water balance and developing effort in EEI (concept heat- joint GEWEX/CLIVAR)

An integrated approach to energy-water-mass consistency based on refined uncertainty characterization – it is now moving toward regional depiction of water and energy balances and this involves even further integration (like ocean heat transport)

Precipitation

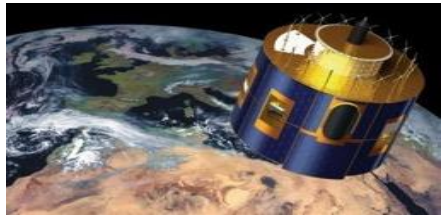




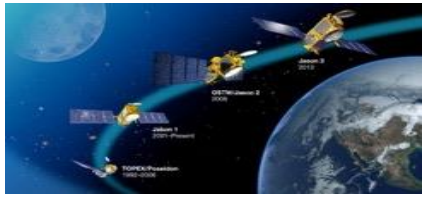
Radiation and sounders

Surface Flux from various sources

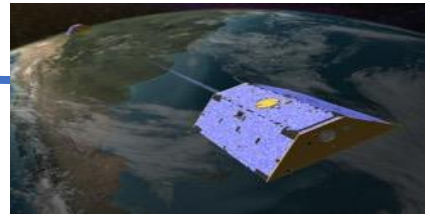
Cloud & aerosol properties



Argo

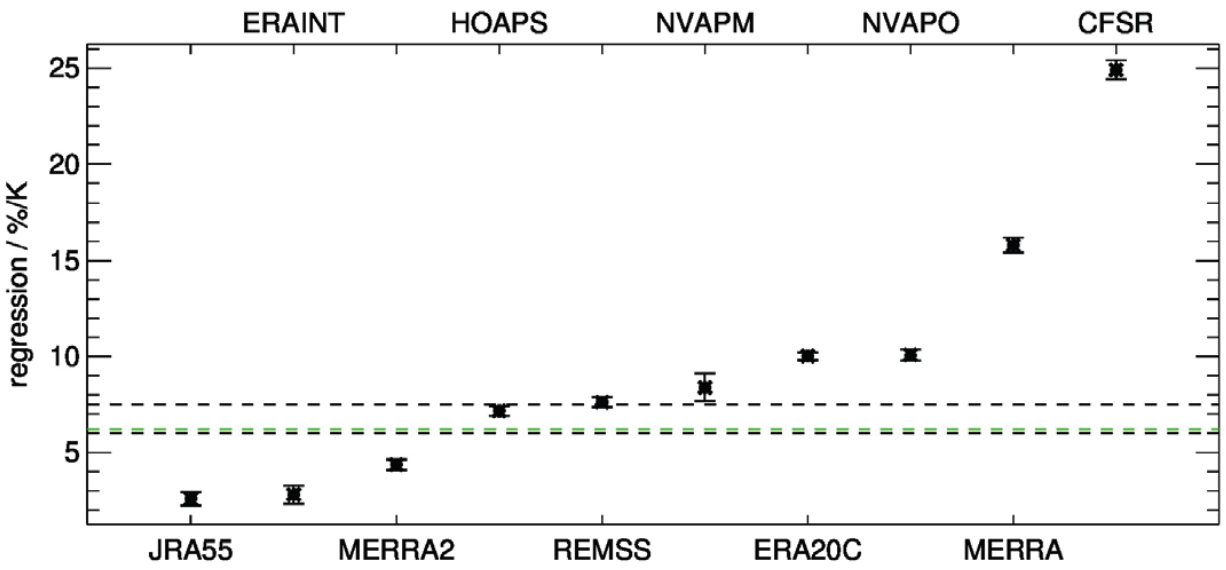


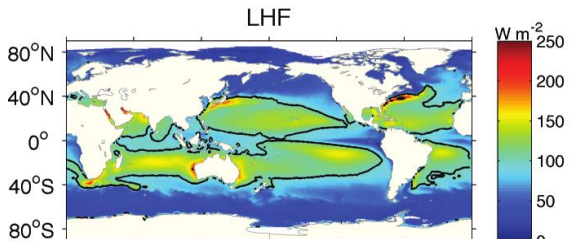
Sea level

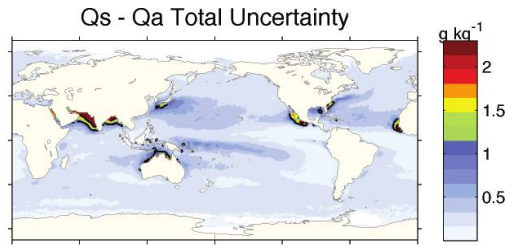


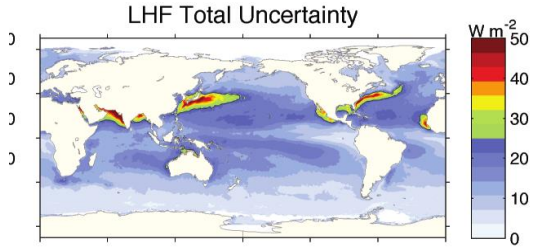
Gravimetry

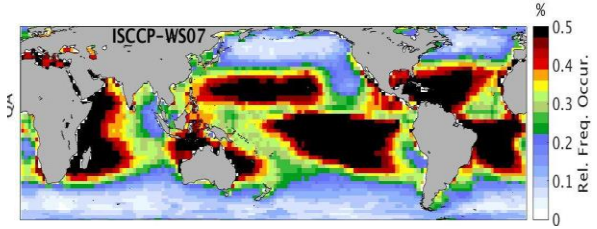
A couple of GDAP highlights and milestones











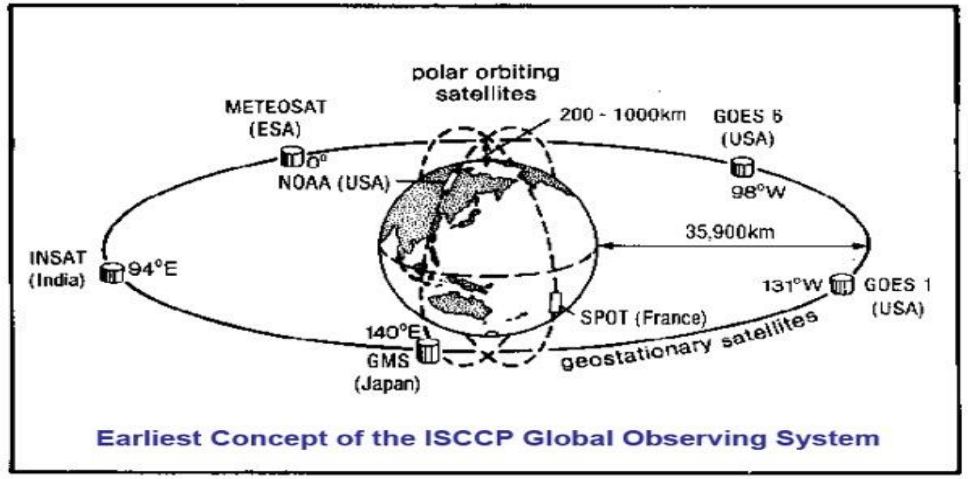
1) Water vapor assessment (Schröder et al., 2017)

This underscores the reason why we can't merely rely on re-analaysis as the source of all climate data records.

2) Sea-Flux example of integrated error characterization (Clayson et al, ongoing)

The GDAP integrated approach to data analysis and data stewardship provides ways of understanding structural errors properties of key climate data products – in this case the Qs-Qa errors relating to certain types of cloud structures (ie weather states) quantified by ISCCP

ISCCP & ISCCP next generation



Earliest Concept of the ISCCP Global Observing System

ISCCP

WCRP
World Climate Research Programme

ISCCP was the first coordinated effort to integrate a network of satellite observations to address global science questions. This has produced a 34 year record of global cloudiness and these data have been instrumental in many other related data efforts

Our goestationary satellite capability has evolved considerably being much more capable today, offering the potential of much deeper insights into cloud processes. GEWEX is leading an effort to exploit these capabilities and develop the next generation ISCCP

GEO-KOMPSAT-2A AMI (Advanced Meteorological Imager)

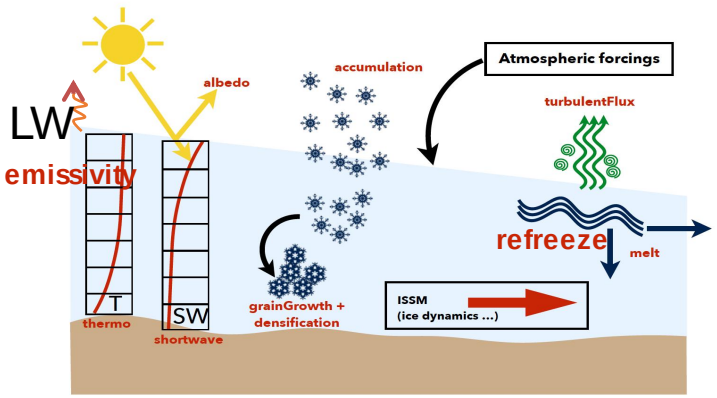
- Multi-channel capacity: 16 channels
- Temporal resolution: within 10 minutes for Full Disk observation
- Flexibility for the regional area selection and scheduling
- Lifetime of meteorological mission: 10 years

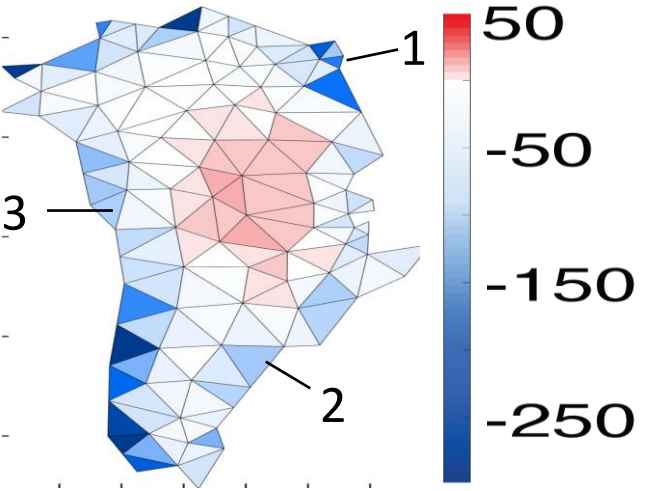
Bands		Center Wavelength Min(um)	Center Wavelength Max(um)	Band Width (Max, um)	Resolution (km)	GOES-R (ABI)	Himawari-8 (AHI)
VNIR	VIS0.4	0.431	0.479	0.075	1	0.47	0.46
	VIS0.5	0.5025	0.5175	0.0625	1		0.51
	VIS0.6	0.625	0.66	0.125	0.5	0.64	0.64
	VIS0.8	0.8495	0.8705	0.0875	1	0.865	0.86
	NIR1.3	1.373	1.383	0.03	2	1.378	
	NIR1.6	1.601	1.619	0.075	2	1.61	1.6
	NIR2.2				2	3.35	2.3
MWIR	IR3.8	3.74	3.96	0.5	2	3.90	3.9
	IR6.3	6.061	6.425	1.038	2	6.185	6.2
	IR6.9	6.89	7.01	0.5	2	6.95	7.0
	IR7.3	7.258	7.433	0.688	2	7.34	7.3
	IR8.7	8.44	8.76	0.5	2	8.50	8.6
LWIR	IR9.6	9.543	9.717	0.475	2	9.61	9.6
	IR10.5	10.25	10.61	0.875	2	10.35	10.4
	IR11.2	11.08	11.32	1.0	2	11.2	11.2
	IR12.3	12.15	12.45	1.25	2	12.3	12.3
	IR13.3	13.21	13.39	0.75	2	13.3	13.3

GEWEX

2018

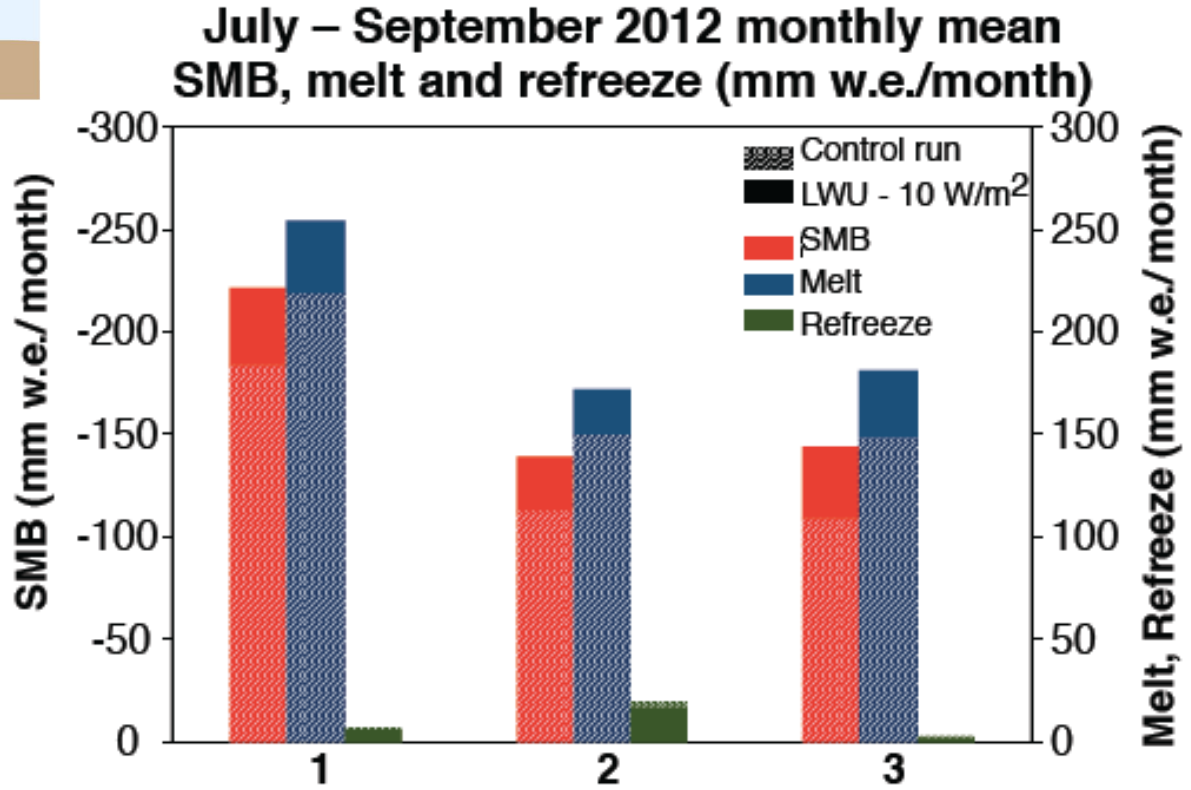
Surface mass and energy balance PROES study
L'Ecuyer & Schegel with Larour and Nowicki

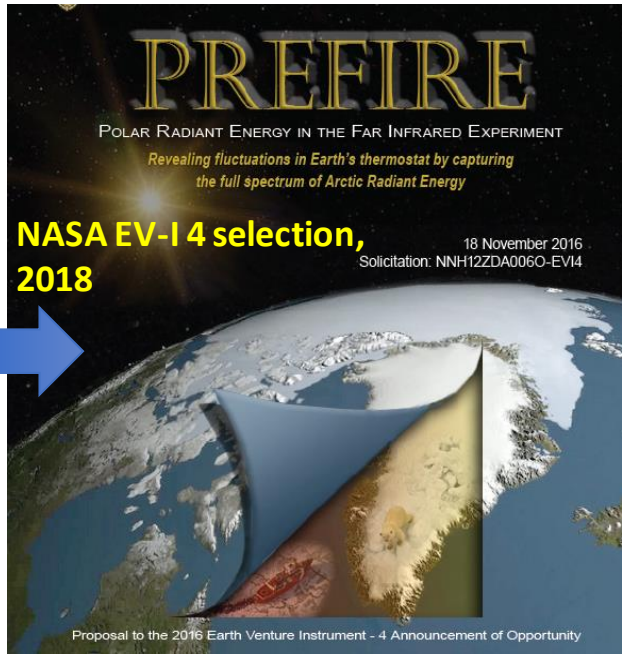




ISSM

Schegel et al., 2018





A change of 10 Wm^{-2} changes the SM, by ~10%

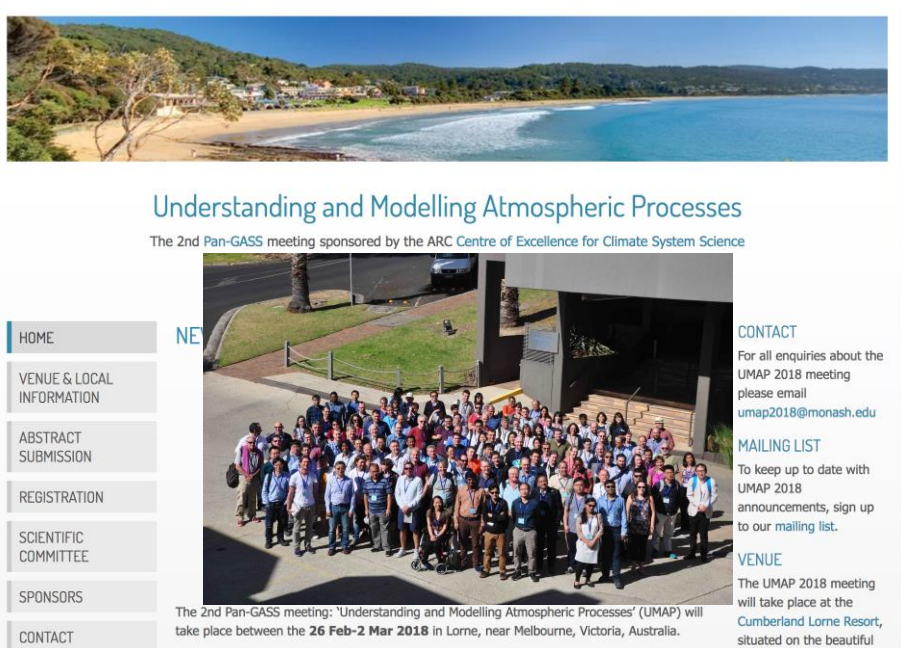
GASS: Global Atmospheric System Studies

Xubin Zeng Daniel Klocke

Goal of GASS: to understand the physical processes and their coupling to atmospheric dynamics, particularly those that define the atmospheric branch of the **hydrological cycle**.

Mission of GASS:

- to facilitate and support the international community that carries out and uses observations, process studies, and numerical model experiments with the goal of developing and improving the representation of the atmosphere in **weather** and **climate** models.
- to coordinate scientific projects that bring together experts to contribute to the development of **atmospheric models**.



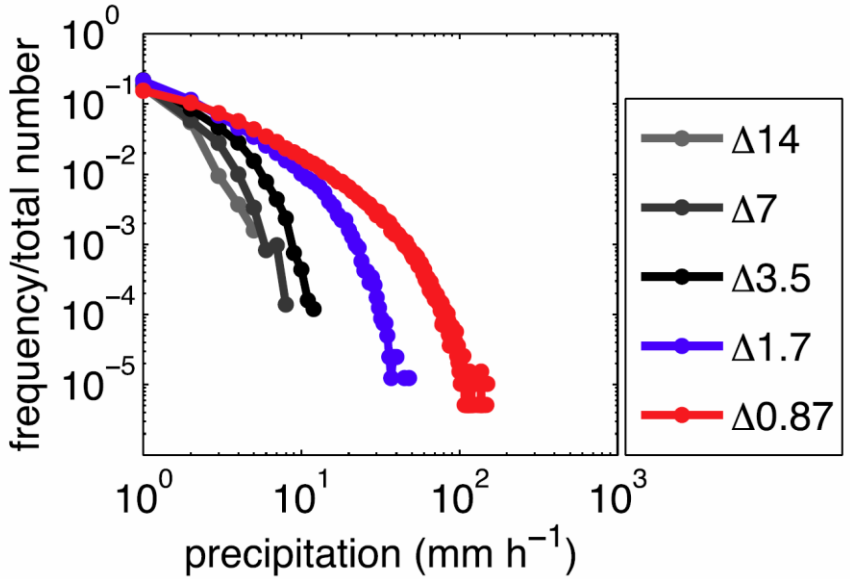
About 160 participants from around 20 countries, including individuals from academia, government agencies, private sector, and international organizations

Panel under construction

Xubin Zeng

Daniel Klocke

- Six projects have been defined by the community and panel is being formed reflecting these and implementation plans are underway
- We are looking to jointly sponsor these efforts with national interests and other international programs
  - **Land temperature and snowpack impacts on sub-seasonal to seasonal (S2S) prediction (using the TPE data over Tibet)**:
  - **Dynamics-physics coupling**
  - **Joint modeling activity over the Caribbean**; and **Grey-zone modeling (using the EUREC4A data around Barbados)**:
  - **Fog modeling intercomparison (using the LANFEX data over UK)**:
  - **Modeling the precipitation diurnal cycle (using the ARM data)**:
  - **Constraining drag processes**:



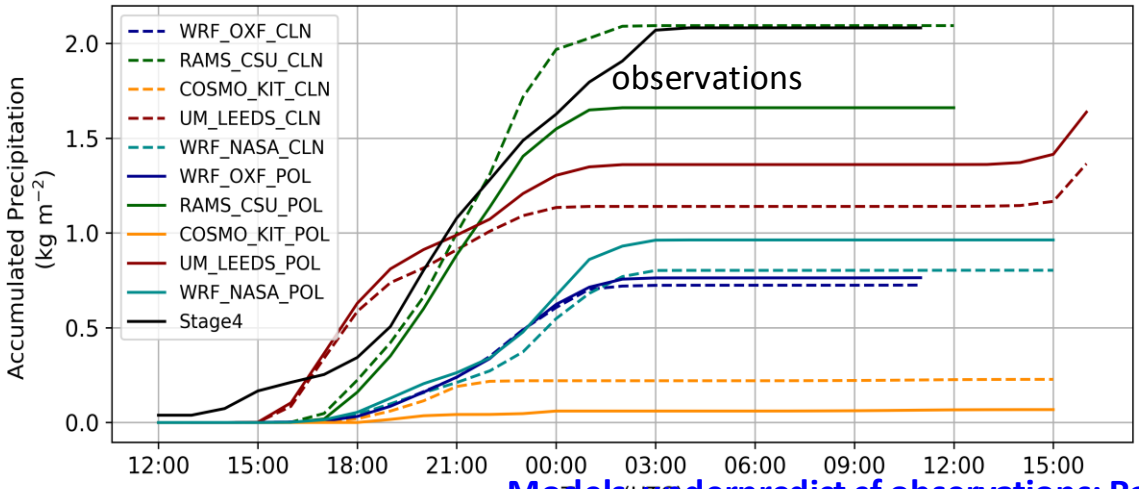
GASS - PROES

Existing PROES activities under GASS:

1) GEWEX Process Evaluation Study on Upper Tropospheric Clouds and Convection (UTCC PROES)- Stubenrauch

2) GEWEX Aerosol-Precipitation (GAP) van den Heever/ Stier (& works closely with ACPC)

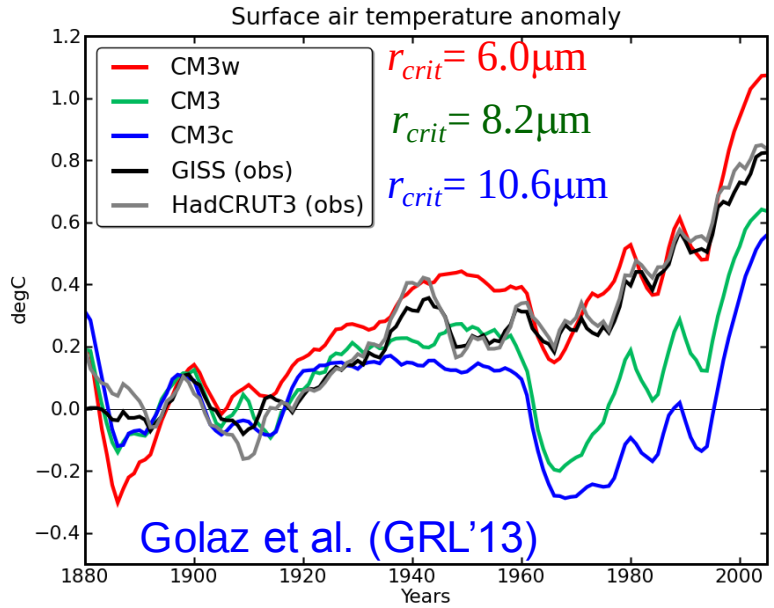
GAP Model Intercomparison



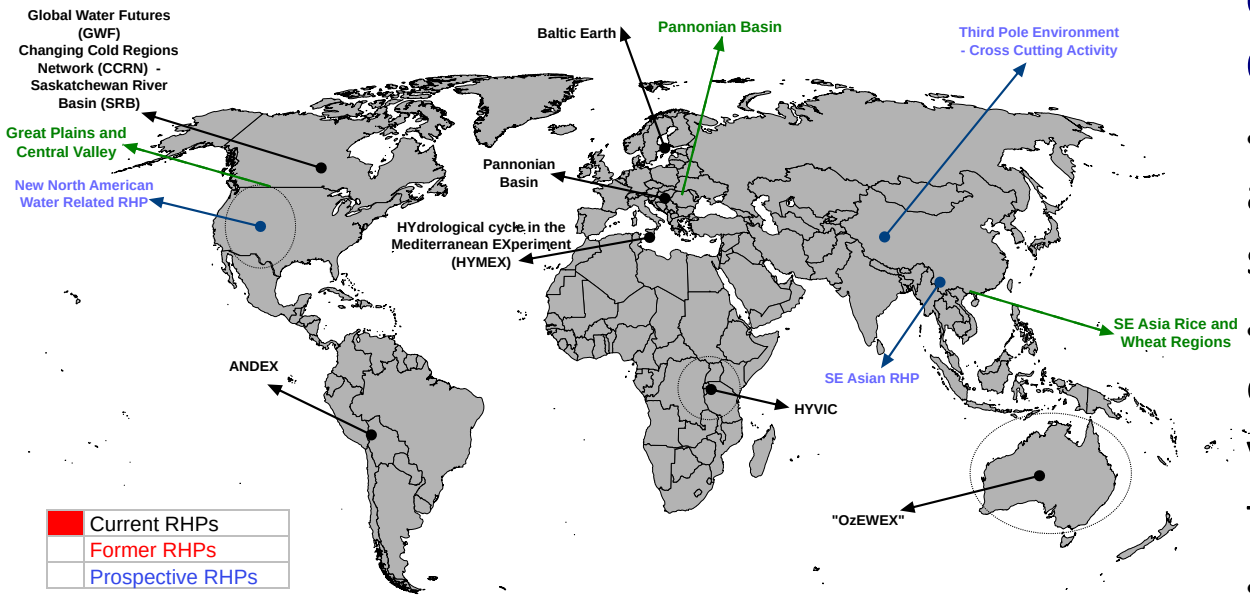
Models underpredict cf observations: Range in aerosol response smaller than differences due to the microphysics and/or other model physics

3) Warm rain process study Suzuki, and 6 modeling centers

In a nutshell – this PROES seeks to examine how well models make rain and the nature of model biases– this example shows how rain is influenced by atmospheric thermodynamics in nature but not in models - PROES works with modeling groups to understand why and how fixes might be developed



GEWEX hydroclimatology Panel , GHP
Co-chairs: Jason Evans and Joan Cuxart



GHP aims to address the GEWEX (and WCRP) Science Questions from a regional and integrated perspective.

- Only at the regional scale can the water cycle be addressed from its physical to human and socioeconomic dimensions
- The Regional Hydroclimate Projects (RHPs) are an essential tool in this endeavour as they bring together various disciplines on water issues. RHPs are foundational to the water GC.
- The cross-cut projects allow GHP to propagate knowledge from one region to another and synthesize results at the global scale. They also allow development and testing of applications developed with the new knowledge (actionable science).

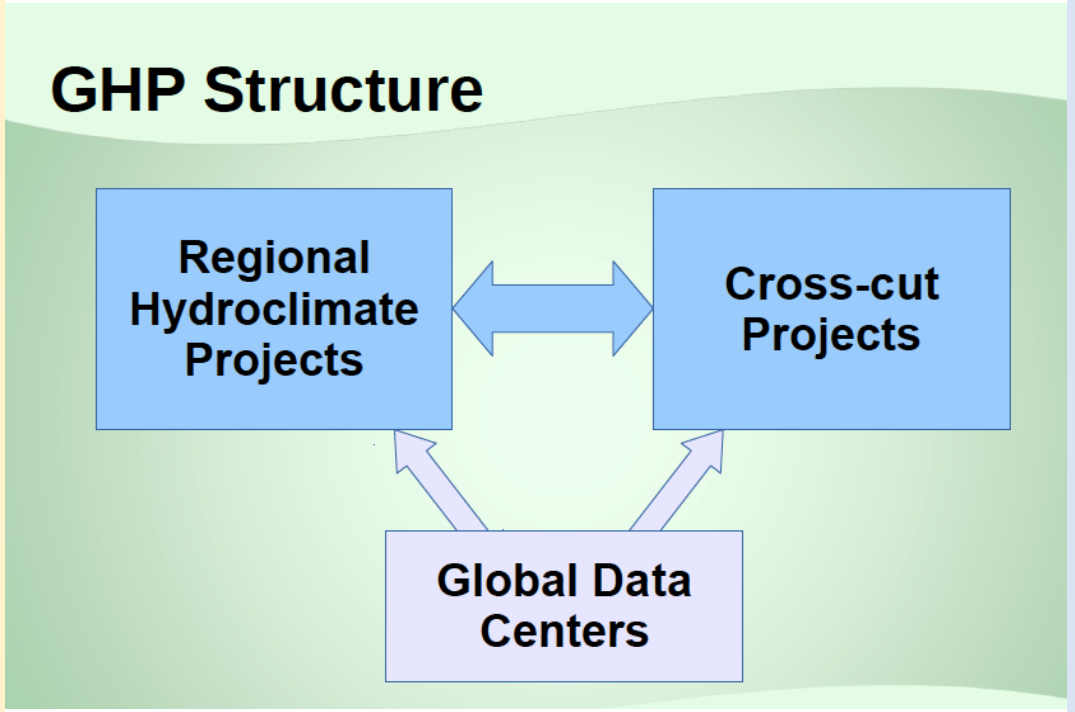
Addressing the water cycle from physical to human and socioeconomic dimensions requires a regional perspective

GHP activities are structured around 3 main activities

RHP Active in 4 continents:
Europe: ***HyMEx*** (2010-2020): High-impact weather events, societal response
Europe: ***Baltic Earth*** (2016-): Sea and land changes, biogeochemical processes
Australia***: OzeWex*** (2015-) Water and energy cycle in Australia
Africa: HyVic (2015-2024): Hydroclimatic variability over Lake Victoria basin
North America: ***CCRN*** (2014-2018): Cryospheric, ecological, hydrological interactions
Recently finished:
Asia: ***MAHASRI*** (2007-2016): Asian Monsoon
Eurasia: ***NEESPI*** (2004-2015): Northern Eurasian climate-ecosystem-societal interact.

Prospective:
Europe: ***PannEx*** (2018?-): Agronomy, air quality, sustainability & water mgnt
America: ***AndEx*** (2019?-): Andes hydroclimate, high impact events, cryosphere...

In discussion: Exploring new possibilities in the Americas and Asia.



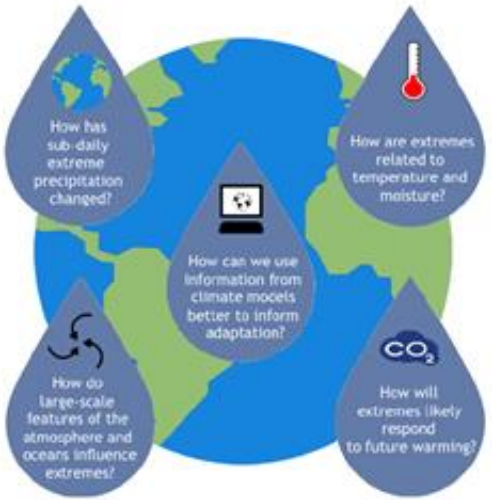
Currently active
- INTENSE (Sub-daily precipitation) (H. Fowler)
- Cold/Shoulder Season Precipitation Near 0°C, (R. Stewart / P. Groisman)
- INARCH (Mountain Hydrology) (J. Pomeroy)

Proposed
- Including water management in large scale models (R. Harding / J. Polcher)

Potential
- GDAP integrated product regional evaluation
- MOUNTerrain (Mountainous Terrain rainfall)
- Evapotranspiration determination.
- Potential CC on "TPE Water Security"

INTENSE – a GHP CC that also connects to the GC and now to GDAP

INTENSE research questions

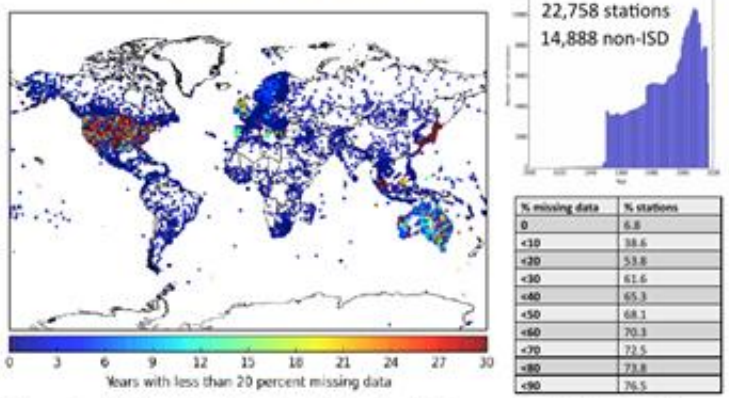


Thanks to:

- Lizzie Kendon and team, Robert Dunn, Nigel Roberts (UK Met Office)
- Stephen Blenkinsop, Renaud Barbero, Steven Chan, Liz Lewis, Selma Guerreiro, Xiao-Feng Li (Newcastle University)
- INTENSE partners (especially Geert Lenderink, Seth Westra, Christoph Schär, Nicolina Ban, Jason Evans, Lisa Alexander)

INTENSE: INTElligent use of climate models for adaptatioN to non-Stationary hydrological Extremes (2M€ ERC Consolidators Grant)

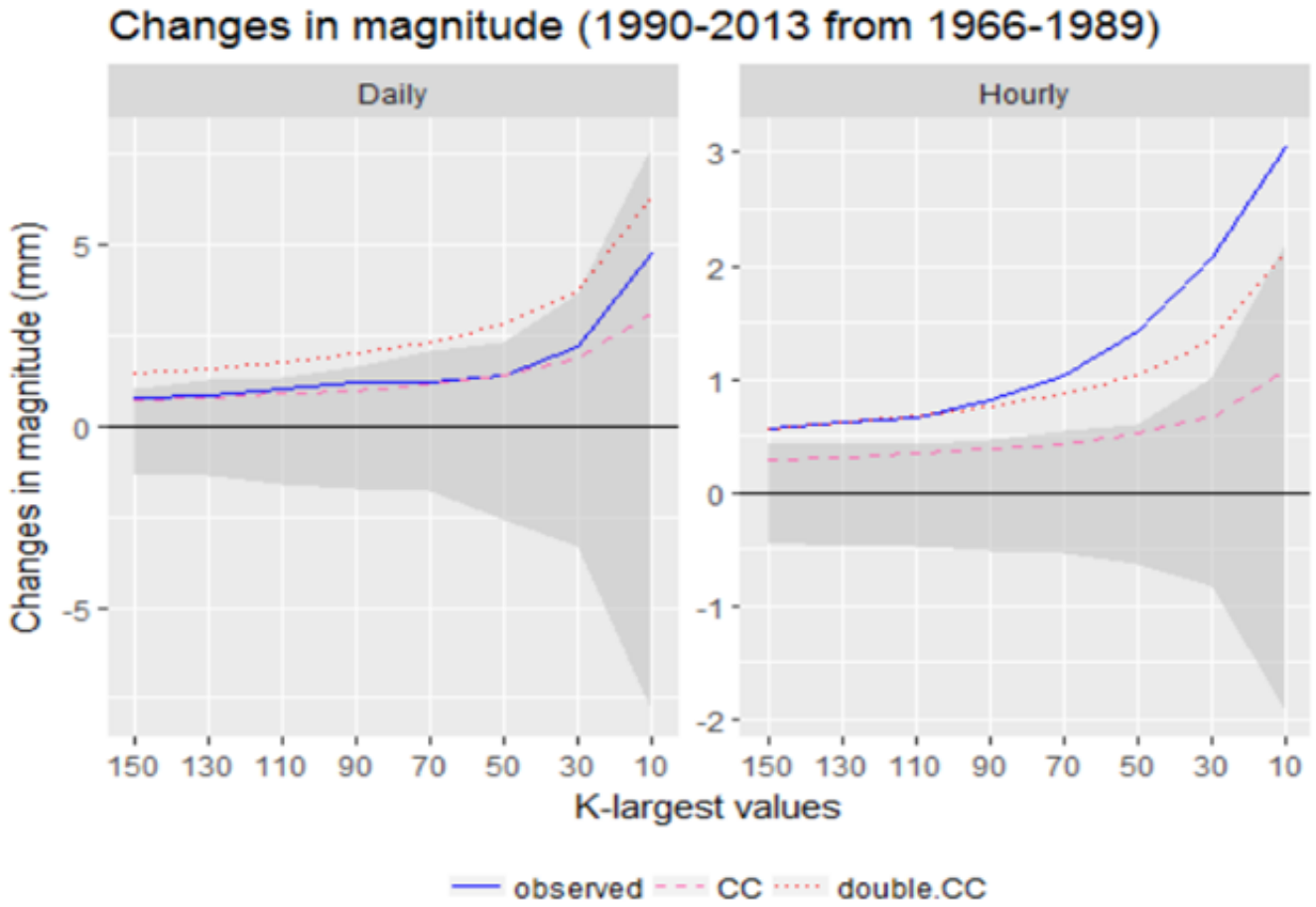
INTENSE: Sub-daily precipitation data collection to date…



% missing data	% stations
0	6.8
<10	38.6
<20	53.8
<30	61.6
<40	65.3
<50	68.1
<60	70.3
<70	72.5
<80	73.8
<90	76.5

Getting: Spain, Argentina, Ecuador, Columbia, Bahamas, the Philippines, New Zealand, a few stations in Kenya, Tuvalu, the Caribbean, South Africa, Colombia, Fiji, Israel , India, Denmark, Slovenia, Iran, Bangladesh, Russia, Hungary, Czech Republic, China, Uruguay, Vanuatu, Hong Kong, Poland, Vietnam, Mexico

Australia: Changes in magnitude



precision=0.1mm

Guerreiro et al., in prep

Global Land/Atmosphere System Study, GLASS
Co chairs: Michael Ek (NCAR/JNT), Gab Abramowitz (UNSW)

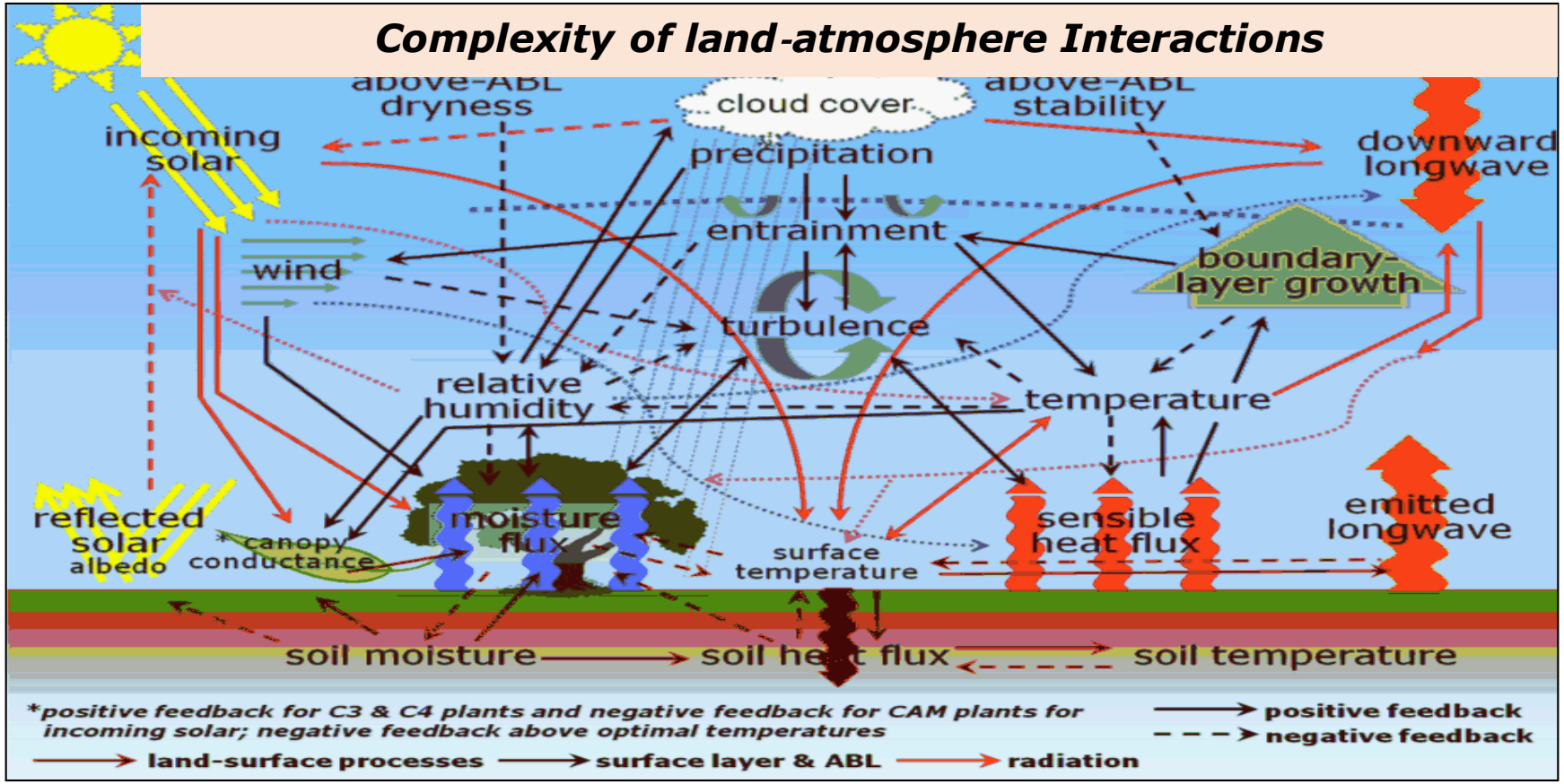


Fig. 3.1. Schematic of the complex interactions between the land surface, atmospheric boundary layer (ABL), and radiation via many variables (temperature, relative humidity, wind and associated turbulence, cloud cover, etc). Adapted from Ek and Holtslag (2004 J. Hydromet., 5, 86-99), courtesy Mike Ek & Kevin Trenberth.

GLASS Structure

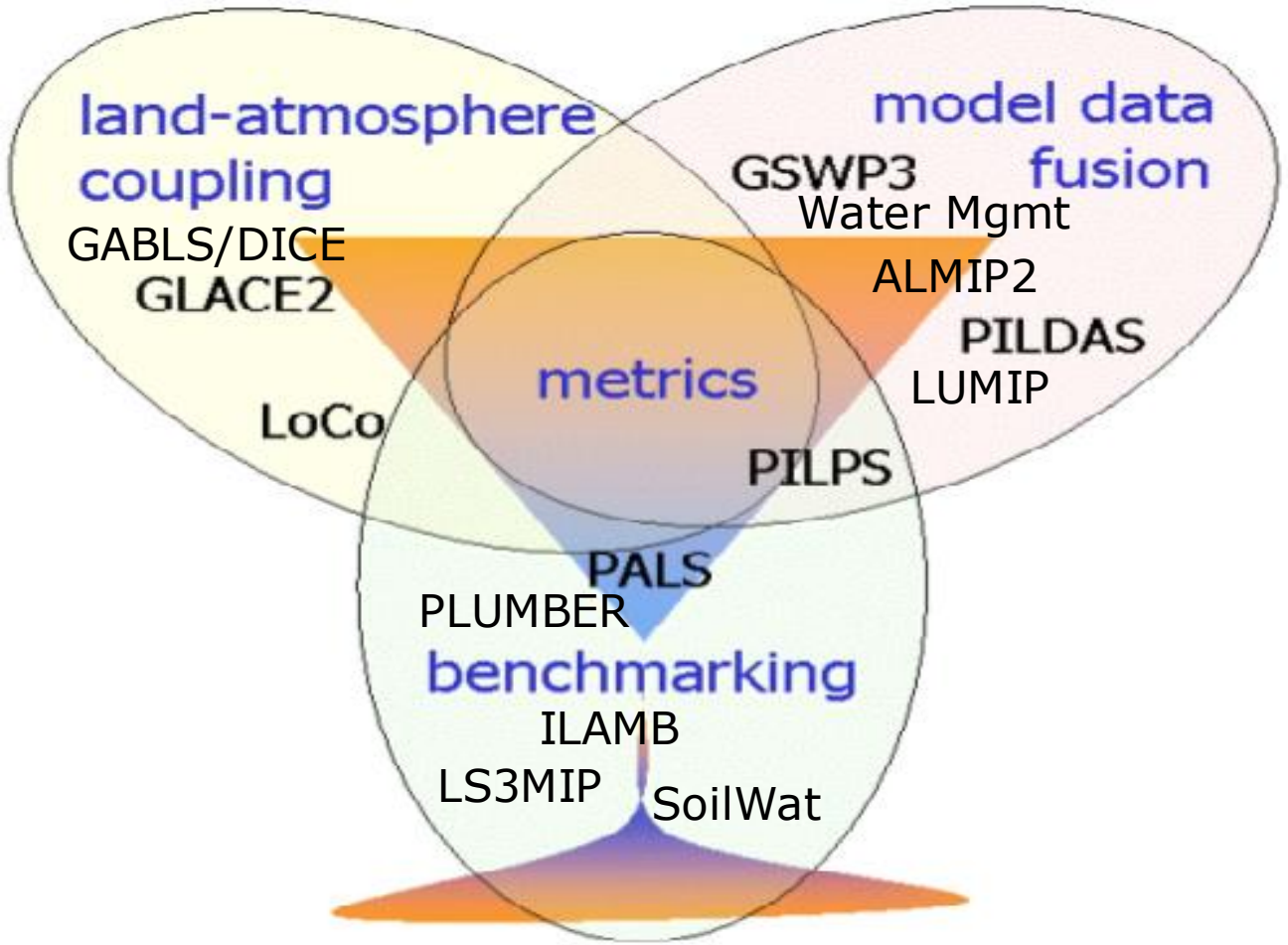
The aim of GLASS is to promote community activities that improve:

1. **our best estimates and the model representation of land atmosphere interaction processes**

1. **our understanding of land/atmosphere feedbacks**

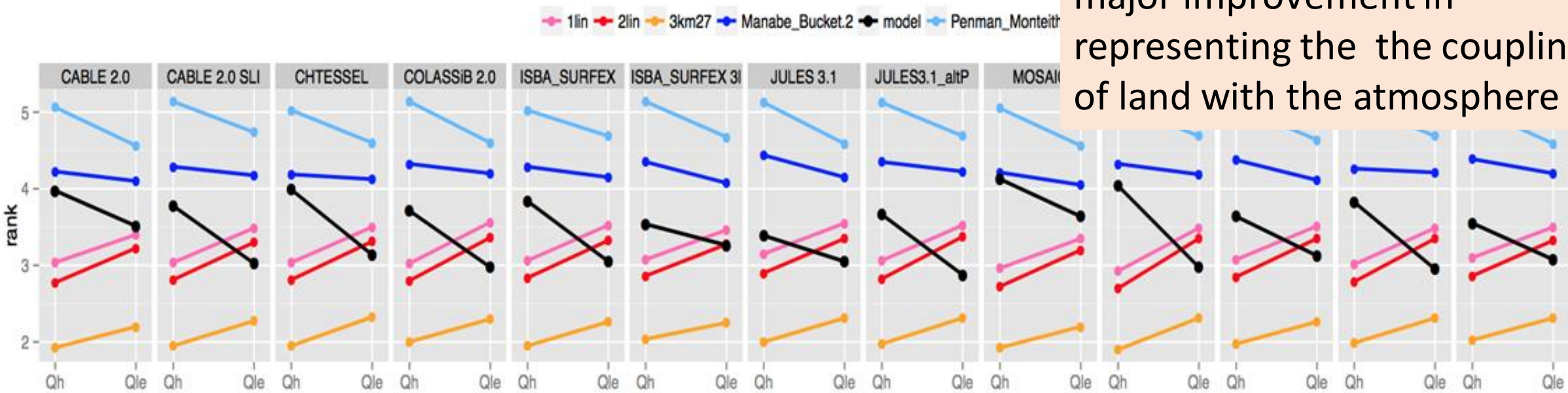
1. **our understanding of the role of land surface in predictability**

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



Headline result from PLUMBER

There is an important message here - there is still a need for major improvement in representing the the coupling of land with the atmosphere

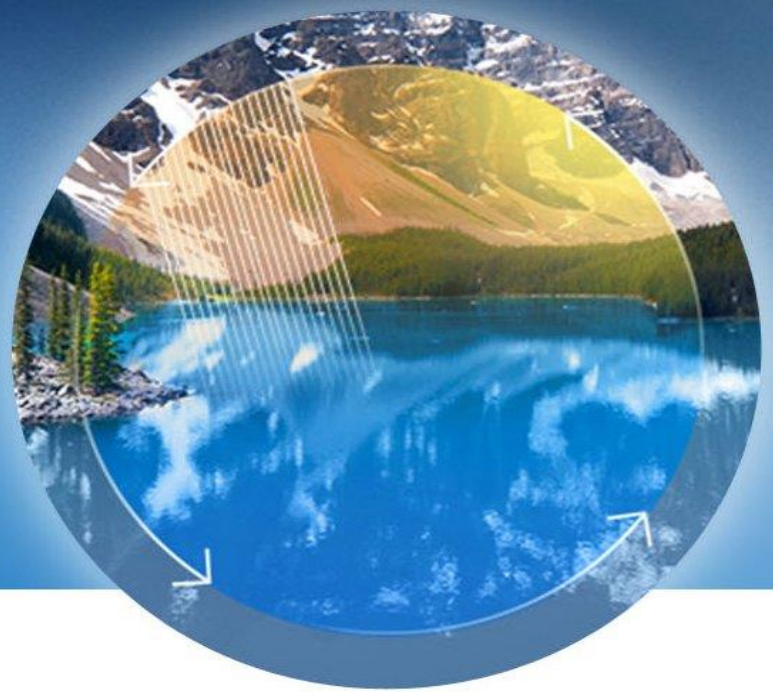


Vertical axis: rank of each LSM (black) against the 5 benchmarks, averaged over:

20 Flux tower sites, 4 metrics: bias, correlation, SD, normalised mean error

- On average, LSMs outperform Penman-Monteith and Manabe bucket
- On average, LSMs sensible heat prediction is worse than an out-of-sample linear regression against downward SW radiation
- For all fluxes, models are comfortably beaten by out-of-sample regression against Swdown, Tair and RelHum

ABOUT
WATER, ENERGY, & CLIMATE



2018 Meetings

GEWEX

JSC-39,Nanjing, April 2018

2018 GEWEX sponsored and related meetings

- AgMIP Meeting, San Jose, CR May 23 – 27
- GLASS Panel Meeting May 3 – May 4 all-day
- **2018 GEWEX International Science Conference May 6 – May 11 all-day**
- 11th HyMeX Workshop – Lecce, Italy May 29 – Jun 2 all-day
- 2nd Baltic Earth Conference Jun 11 – Jun 15 all-day
- The 15th BSRN Scientific Review and Workshop Jul 16 – Jul 20 all-day
- NASA JPL Center for Climate Sciences Summer School 2018 Aug 27 – Aug 31 all-day
- **2nd GEWEX Convection-Permitting Climate Modeling Workshop, Boulder, CO Sept 4 -6**
- **GHP/ANDEX Workshop – Santiago, Chili Oct 22 – Oct 26 all-day**
- UTCC PROES Workshop Oct 22 @ 9:00 am – Oct 23 @ 5:00 pm
- **2018 WCRP Workshop: Toulouse The Earth's Energy Imbalance (EEI) Nov 13 – Nov 16**
- GDAP Meeting – Lisbon, Portugal Nov 26 – Nov 30 all-day

Extremes and Water on the Edge

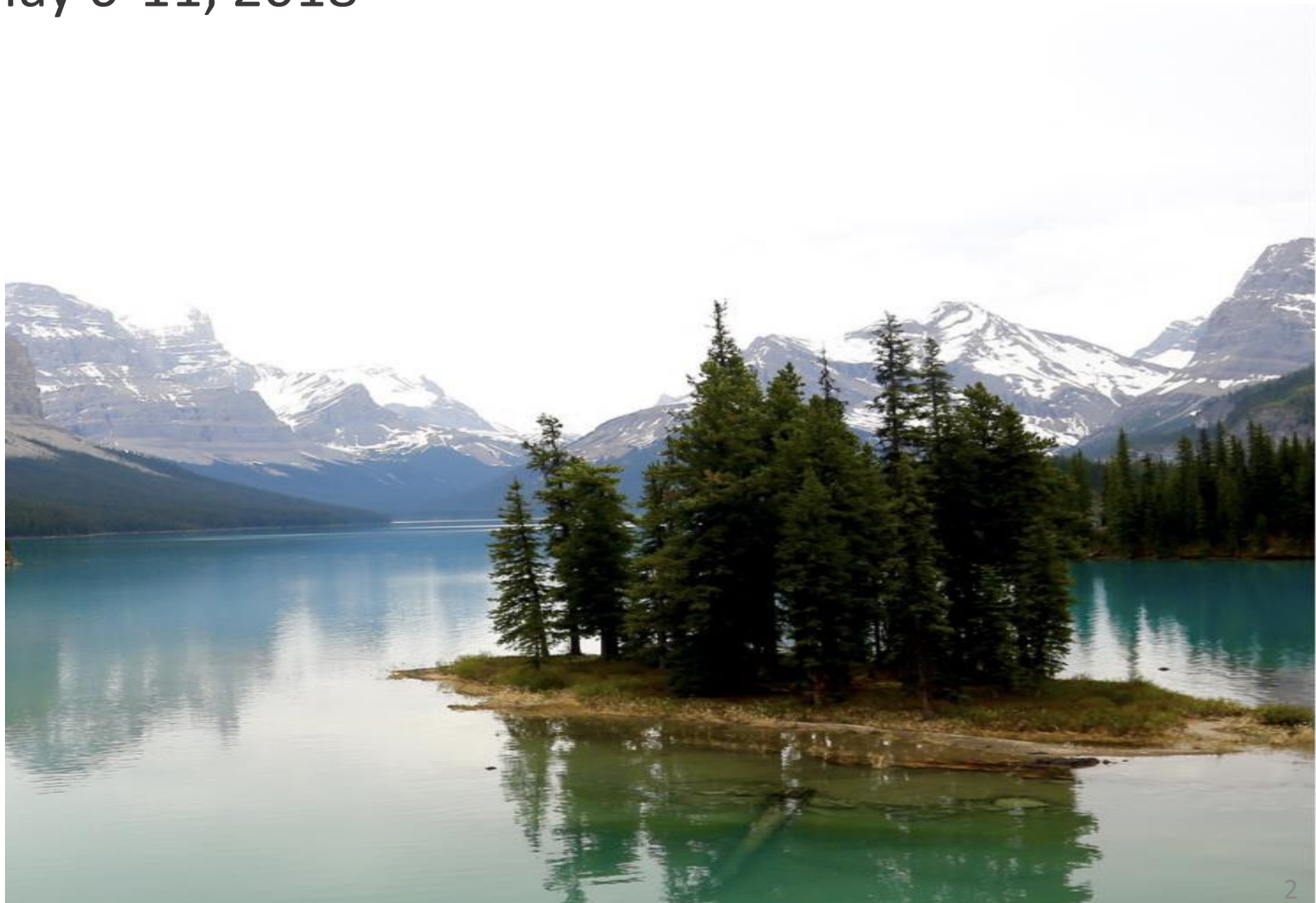
2018 GEWEX Science Conference
Canmore, Alberta, Canada | May 6-11, 2018

Topics include:

Nexus of water, energy, and food | Climate extremes | Extreme weather | Atmospheric modeling and observations | Land modeling and observations | Global energy and water cycles, Mountain and high-latitude hydrology

450+ abstracts received
350 registered
ECS workshop - 70 applicants, space for 40

Program available



Actions from last year

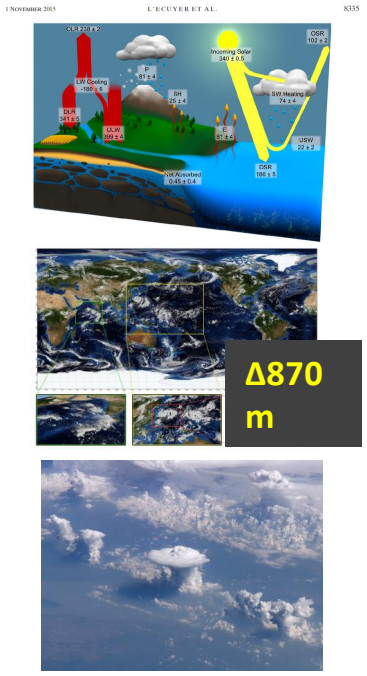
Ensure a strategy for GASS to ensure its linkage to the modeling centers - under way with GASS and its relation to WWRP and with GASS and GLASS relations to WGNE

Improve linkages with relevant groups to underpin the GEWEX focus on atmospheric processes and phenomenon (primarily; GAW - aerosols, Cloud GC, FluxNet) (under way – contemplating a GEWEX/GCOS conference, GLASS & FluxNet, GASS and Cloud GC/CFMIP, not yet GAW and aerosol)

GC-Carbon to present the scientific direction and progress in the GEWEX SSG (not done)

GEWEX going forward

- The third phase of GEWEX
  - Phase I – build up and organization – creation of a structure, regional hydrology
  - Phase II – consolidation and the growing involvement in the human influence e on the water cycle
  - Phase III- period of quantitative Earth system understanding (built on foundation set by phases I and II)



Continue to advance an Integrated observing strategy of the Earth system to quantify reservoirs, processes and feedbacks

Maintain involvement with advances in Earth system modeling across scales –resolving critical hydrological processes like atmos convection

Combine process models, Earth system models and observations for in depth process understanding of feedbacks that define our ability to predict the system

Backups

Phase III: Challenge and the opportunities

Understanding why our climate is changing, and predicting its future, means answering some fundamental questions about heat, water and carbon. We still have much to do on these basic topics

Earth Observing Systems have played and will continue to play a central role in answering those questions and GEWEX has been a leader in this role for WCRP - but progress wont happen in isolation from other observational types, from elementary diagnostics and understanding of processes and from model development .

We are at a point in time where the **paradigm is shifting** – model resolutions are now leap-frogging the native resolutions of almost all global satellite observations.

It is unlikely that we will produce fields of observed variables at km-scale and sub-hourly resolutions such as now being produced by models. Will our analysis systems evolve to provide the energy and hydrological information needed on these scales?

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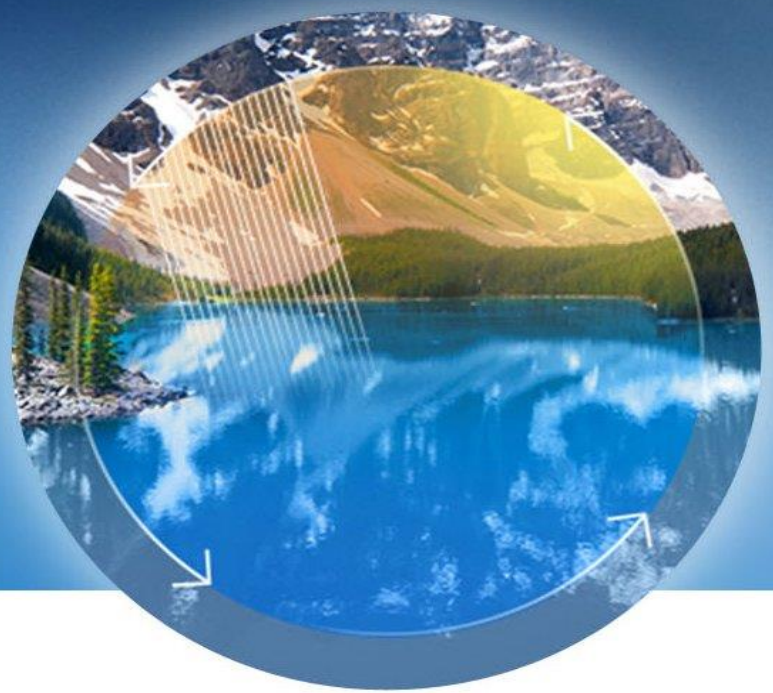
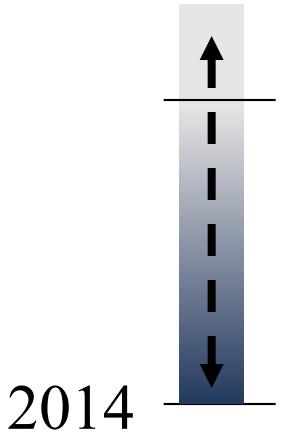
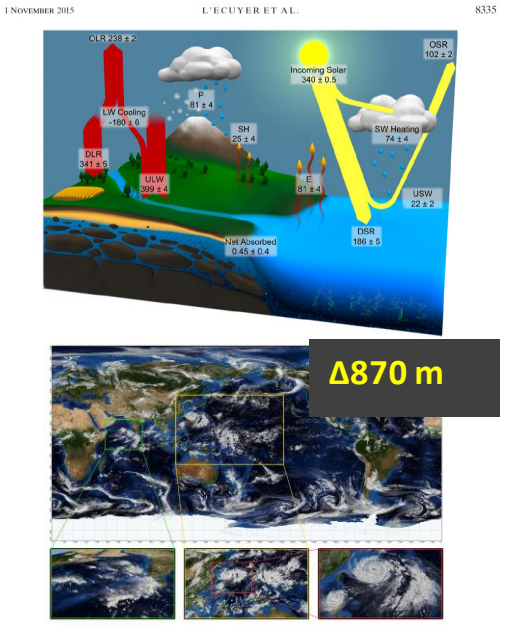


GEWEX Mission: To measure and predict global and regional energy and water variations, trends, and extremes (such as heat waves, floods and droughts), through improved observations and modeling of land, atmosphere and their interactions

Phase III: period of quantitative Earth system understanding





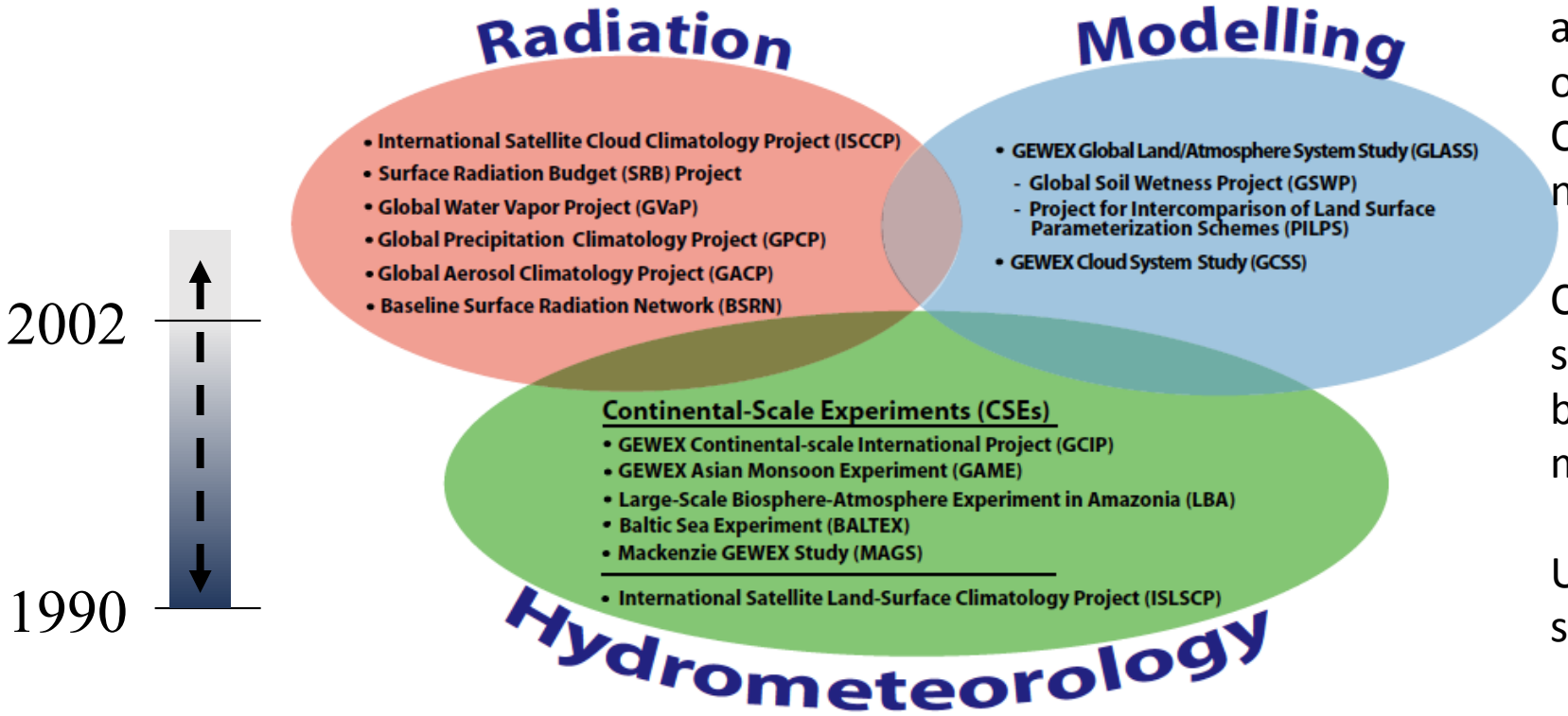
Integrated observing strategies of the Earth system

Advances in Earth system modeling

In depth process understanding

Under construction

PHASE I: 1990-2002 – build up and organization



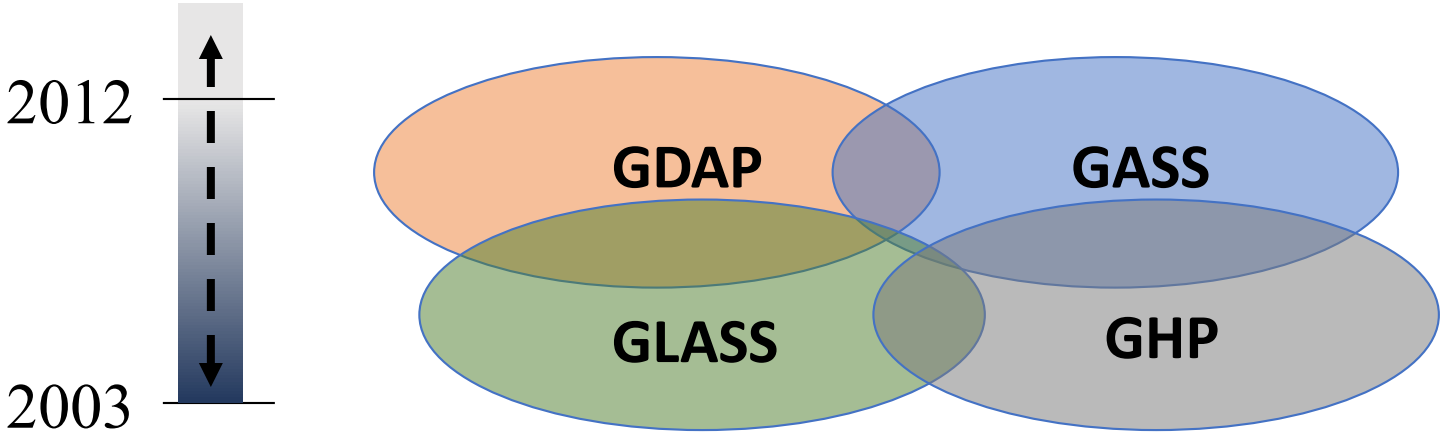
Full uncertainty on key data products needed to quantify water and energy reservoirs were not available. Oversight and important surface network observations also pccurred.
Certain energy fluxes at surface were still not developed

Cloud and precipitation data, although short of what was needed were maturing but these still werent fiully exploited in model deveoplment activities (GCSS)

Understanding the coupling to land surface was developing

Regional hydrolical research foci was becoming an important guiding framework

PHASE I: 2002-2014 – a period of consolidation and focus on the human dimension of the hydrological cycle



Under construction

- Data products began to mature, data records were growing in length (decadal+) and detailed assessments of capabilities were developed (clouds, ERB,..)
- Gaps in representation of water and energy budgets were being filled (eg LandFlux, Seaflux)
- Regional Hydroclimate Projects began to have impact and science flourished and served as the bedrock for the water GC.
- Process level understanding began to engage modeling activities (e.g. CFMIP)
- GEWEX science questions articulated and implementation plan developed

Phase III: Challenge and the opportunities

Understanding why our climate is changing, and predicting its future, means answering some fundamental questions about heat, water and carbon. We still have much to do on these basic topics

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Key science questions in the next 5-10 years

- ***LAND IMPACT*:** Explore the impact of the land processes on Seasonal/Drought Prediction, and other high-impact "Earth System events" on society.

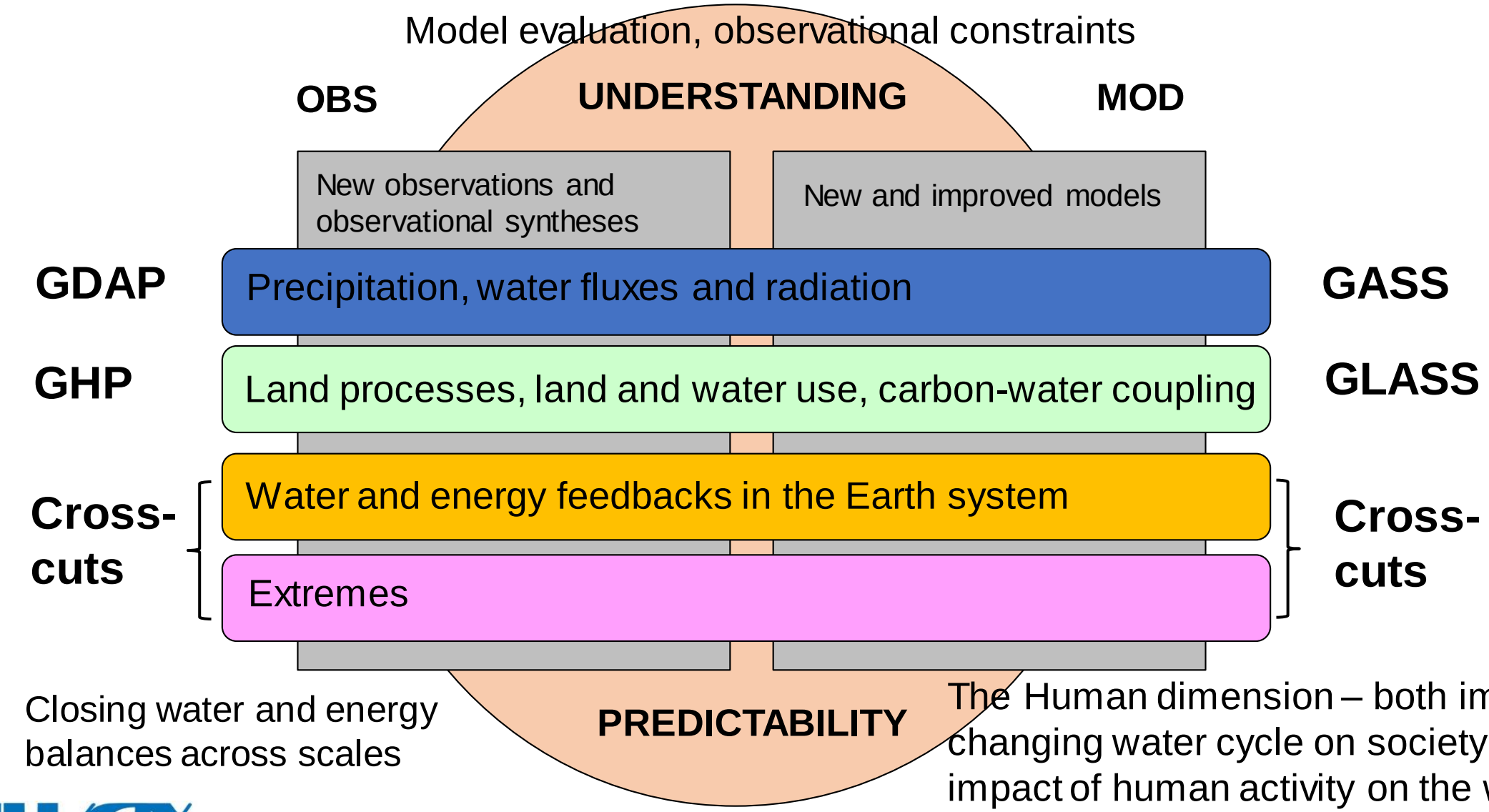
Back to basics: GLASS efforts to understand processes, and observe and model them:

- ***PLUMBER***: Benchmarking land-surface models (LSMs) in uncoupled mode using many fluxnet data sets to thoroughly assess LSM performance. Discuss at GLASS meeting, Canmore, Canada, May 2018.
- ***LoCo*** (Local Land-Atmosphere Coupling): Continues to galvanize the land-atmosphere observing and modeling community in terms of new obs/field programs, establishing new useful "coupling" metrics.

How to most effectively improve our Earth System models?

- ***Hierarchical Model Development (HMD)***: Component-by-component testing with increased levels of connection, building to a fully-coupled system, *with* benchmarks of performance at each HMD stage. GLASS-related HMD activities: PLUMBER (land-only), DICE (single column), LoCo (limited-area/regional coupling), etc. Extensive "data mining" effort required for driving/forcing & validation data sets.

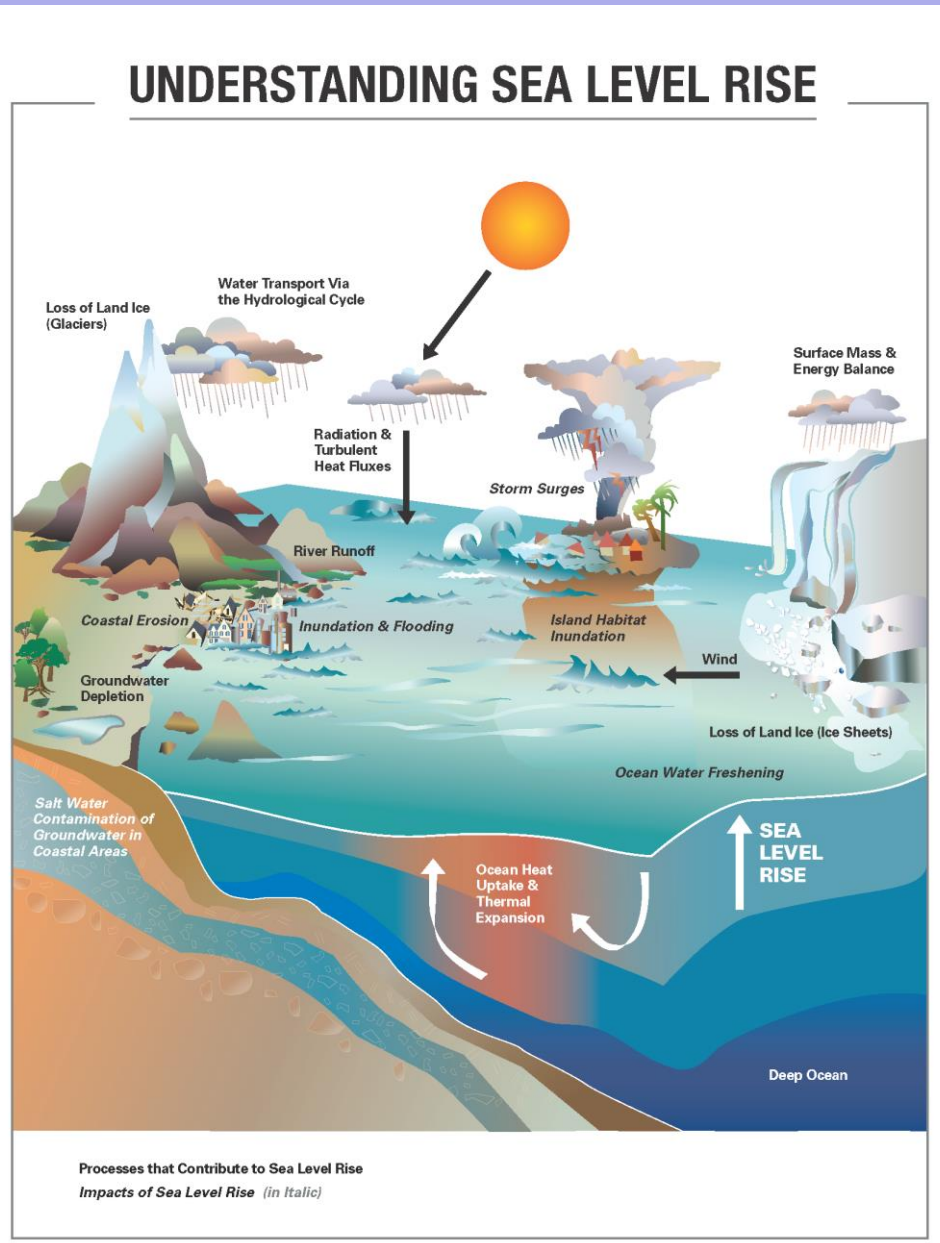
The 4 GEWEX Science Questions sit under these bigger, overarching science questions



Closing water and energy balances across scales

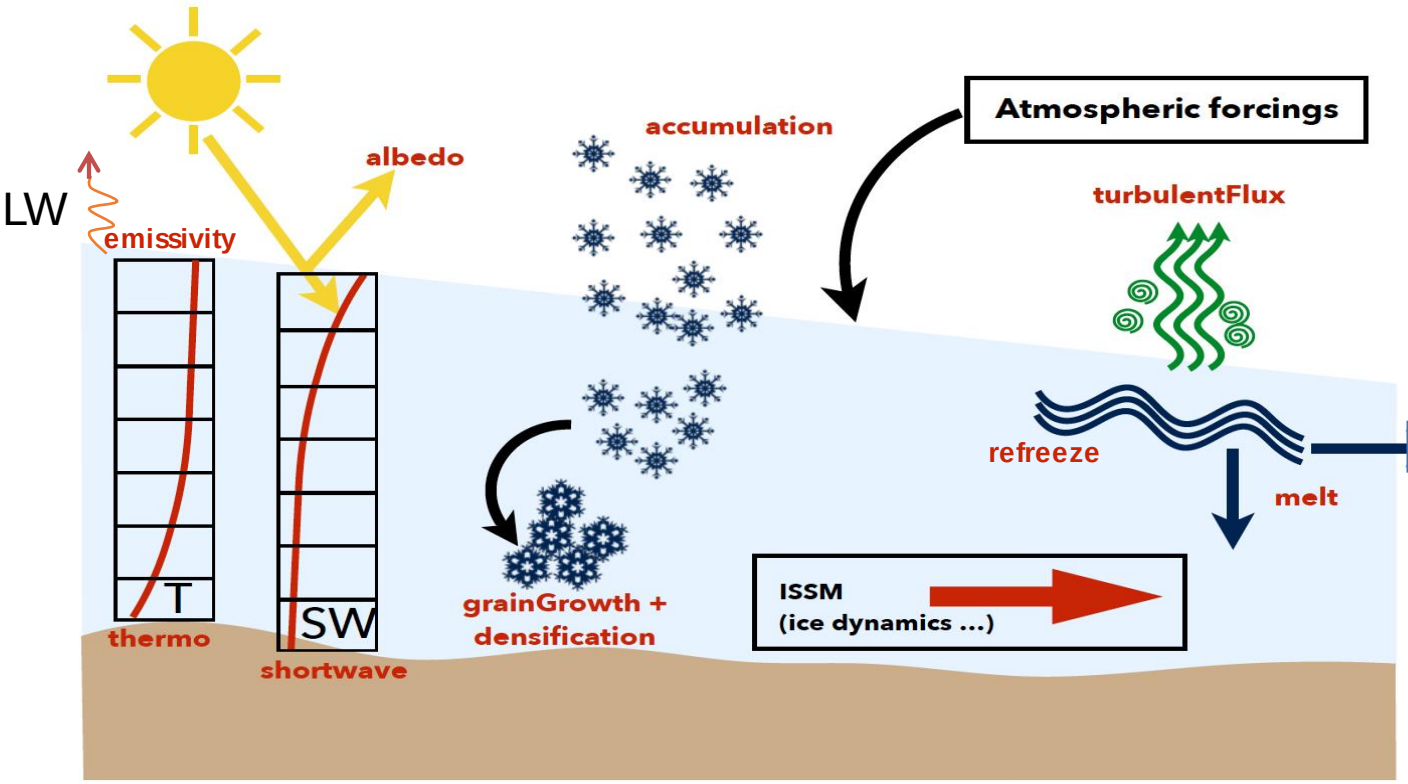
The Human dimension – both impact of changing water cycle on society and the impact of human activity on the water cycle

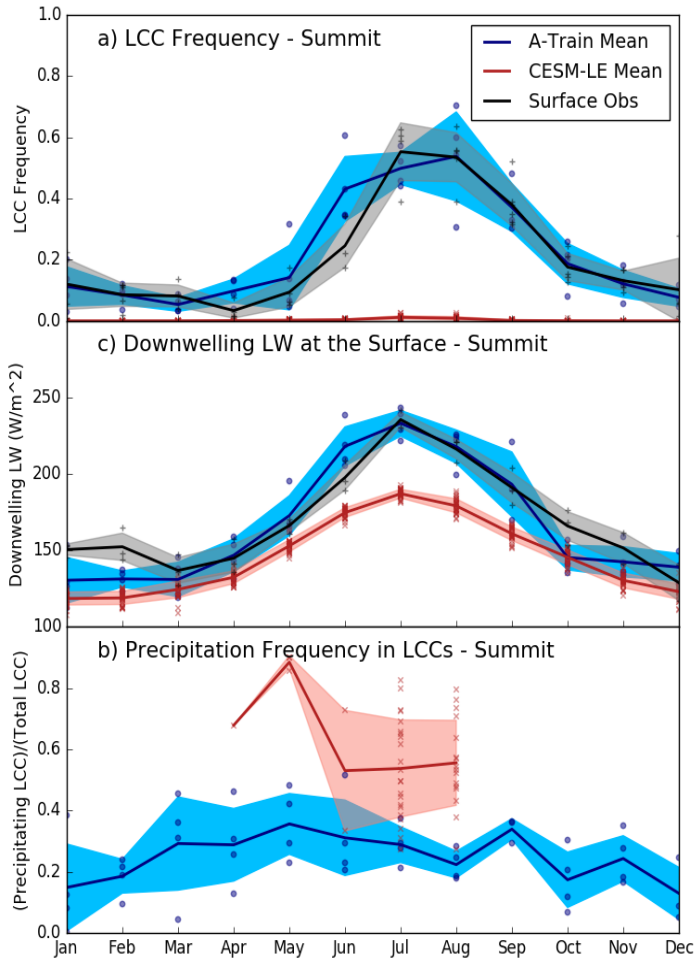
Illustrating the complexity of the Earth system



ESAS2017-2017 Decadal Survey, NRC, 2018

Surface mass and energy balance PROES study
L'Ecuyer & Schegel with Larour and Nowicki



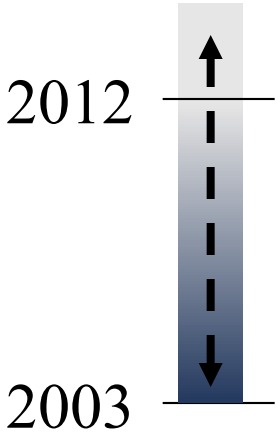


Model biases in surface energy balance (and mass balance too) can be substantial

Alignment with WCRP Grand Challenges (GC) and GEWEX Science Questions (SQ)

	WCRP GC							GEWEX GSQ			
GLASS Projects	Melting Ice	Clouds, Circulation and Climate Sensitivity	Carbon Feedbacks	Weather and Climate Extremes	Water for Food	Regional Sea-Level Change and Coastal Impacts	Near-term Climate Prediction	Observations and Predict-ions of Precipitation	Global Water Resource Systems	Changes in Extremes	Water and Energy Cycles and Processes
PALS			✔	✔	✔		✔		✔	✔	✔
PLUMBER				✔	✔		✔		✔	✔	✔
ALMIP2		✔							✔		✔
PILDAS								✔	✔	✔	✔
GSWP3				✔	✔				✔	✔	✔
LS3MIP				✔	✔			✔	✔	✔	✔
Anthro Water		✔			✔				✔		✔
LUMIP			✔	✔	✔				✔	✔	✔
ILAMB			✔	✔	✔		✔		✔	✔	✔
SoilWat			✔	✔	✔		✔		✔	✔	✔
DICE		✔		✔				✔		✔	✔
LoCo		✔		✔	✔			✔		✔	✔

PHASE I: 2002-2014 – the human dimension



PHASE II: 2003-2012 period of information gathering and water resource increasing interaction with the water resource and applications communities

Objectives

- Produce consistent research quality data sets complete with error descriptions of the Earth's energy budget and water cycle and their variability and trends on interannual to decadal time scales, and for use in climate system analysis and model development and validation
- Enhance the understanding of how energy and water cycle processes function and quantify their contribution to climate feedbacks
- Determine the geographical and seasonal characteristics of the predictability of key water and energy cycle variables over land areas and through collaborations with the wider WCRP community determine the predictability of energy and water cycles on a global basis.
- Develop better seasonal predictions of water and energy cycle variability through improved parameterizations encapsulating hydrometeorological processes and feedbacks for atmospheric circulation models
- Undertake joint activities with operational hydrometeorological services and hydrological research programs to demonstrate the value of new GEWEX prediction capabilities, data sets and tools for assessing the consequences of global change.

WMO/IOC

GLOBAL CLIMATE OBSERVATIONS, ANALYSES & MONITORING

ECVs;
Climatologies;
(Coupled) Global & Regional Reanalyses;
Climate Change Detection

WCRP CAPABILITY THEMES

EARTH SYSTEM PROCESSES ACROSS SCALES *Jointly with WWRP*	CLIMATE VARIABILITY, PREDICTABILITY & PREDICTION	CLIMATE CHANGE AND EARTH SYSTEM FEEDBACKS *Jointly with AIMES*
Energy, Water and Carbon Cycles; Fundamental Atmospheric Physics (e.g. Convection); Land-Atmosphere Coupling; Ocean-Atmosphere Coupling; Cryosphere Processes	Ocean, Land, Cryosphere, Atmosphere & Solar Drivers; Climate Dynamics, Modes of Variability & Teleconnections; Monthly to Decadal Predictability & Prediction	Climate Change Forcing & Sensitivity; Climate Change Attribution; Climate Change Projections (Global & Regional) for Mitigation & Adaptation; Abrupt Climate Change; Geoengineering Assessment

WCRP CROSS-CUTTING RESEARCH PROJECTS (*on occasions with WWRP, Future Earth…..*)

Examples: Regional Sea Level Rise, Coastal Impacts and Cities,
Weather and Climate Extremes, now and in the future
Water Cycle and the Food Baskets of the World
Fate of the Antarctic and Greenland Icesheets
Is the Jet Stream changing its Behaviour?
Climate Change and Human Health

WCRP WORKING GROUP ON CLIMATE MODEL DEVELOPMENT *jointly with WGNE*

Identifying Systematic Errors; Improving Climate Models & Building Next Generation Earth System Models; Planning for Exascale Computing

WCRP WORKING GROUP ON CLIMATE INFORMATION FOR REGIONS

Regional downscaling methods; Application-inspired Climate Science; Transdisciplinary Engagement

WMO/ICSU

GLOBAL ATMOSPHERIC COMPOSITION

GHG Monitoring;
Air Quality Prediction;
Atmospheric Chemistry Processes & Modelling

CLIMATE CHANGE ASSESSMENTS AND CLIMATE SERVICES (UNFCCCC, IPCC, GFCS, Copernicus, VIACS, ……..)

Precipitation assessment: Joint IPWG-GEWEX effort

#	Name	Leads	Short description
1	Standard quality assessment	T. Kubota and H. Masunaga	catalogue with summary descriptions; intercomparisons; regime sorted statistics;quality & traceability (including WDAC doc+ FIDUCEO)
2	Uncertainty	J. Turk and P. Kirstetter	uncertainty metrics (detection, estimation); intrinsic uncertainty (sensitivity); algorithm limitations;
3	Consistency	A. Beranghi and D.B. Shin	water and energy budgets consistency; regional budgets; ancillary datasets (description and assessment for robustness)
4	Evaluation of analysis data from numerical models	H.J. Kim and G. Balsamo	performance metrics; model scales (spatial and temporal)
5	Ground based data	C. Kidd and S. Durden	sources (including weather radar where available); calibration and uncertainty characterization of sources, including polarimetric ground radars
6	Validation at weather scales in regions without ground measurements	R. Ferraro	consistency with other remotely sensed data at weather scales; consistency with reanalysis
7	Variability and trends	F.J. Tapiador	sub-seasonal, seasonal, annual, inter-annual; extremes and the ability to capture them faithfully; correlation with climate indices;
8	End users applications	Z. Haddad and G. Huffman	phenomenological assessment (consistency with agricultural indices, etc); latency issues;
9	Recommendations to algorithms developpers	G. Huffmanf and Z. Haddad	assessment of assumptions underlying the algorithms , including retrievals from ground measurements (physical validation);
10	Programmatic recommendations	G. Stephens and V. Levizzani	product sensitivity to satellite constellation configuration; sensitivity to instrument capability and performance , including ground /airborne instruments product sensitivity to satellite constellation configuration; sensitivity to instrument capability and performance , including ground/airborne instruments

Also Linked to extremes GC, INTENSE

- Initiative born of International Soil Modeling Consortium (ISMC) and GEWEX communities
- Aims to improve interactions and integration of soil and subsurface processes in present climate models
- Planning workshop June 2016 in Leipzig, 25-30 people, 2 days:
    1. survey representation of soil processes in climate models with emphasis on revisiting the pedotransfer functions used to convert soil information to parameters for modeling (Harry Vereecken and Anne Verhoef)
    2. assess the utility of more resolved soil maps, a sensitivity analysis (SoilParameterMIP) to evaluate several climate models using old and new soil maps and parameters (Lukas Gudmundsson, Matthias Cuntz)
    3. survey of groundwater database and strategies for incorporating groundwater in climate models (Stefan Kollet, Anne van Loon and Peter van Oevelen)

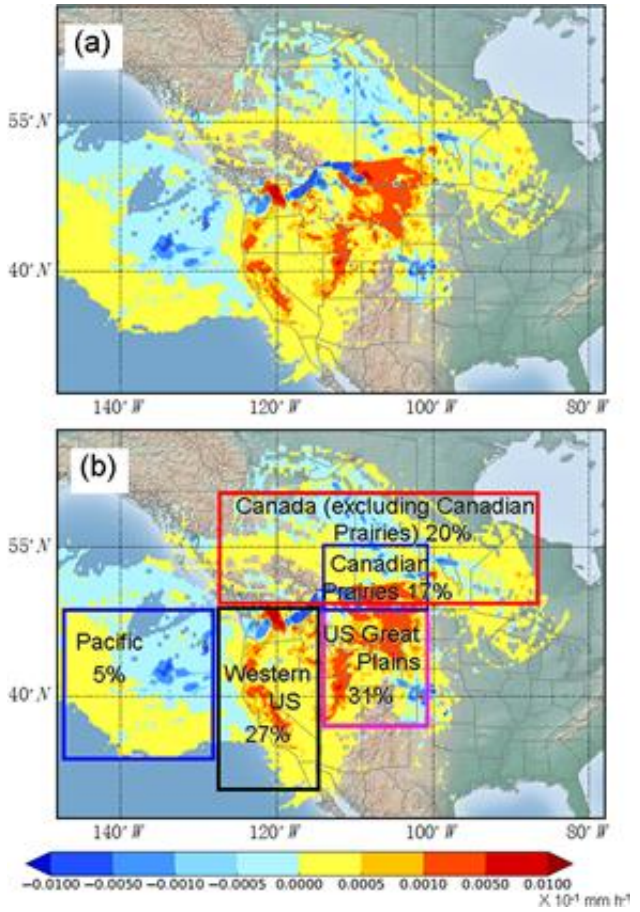
- Now drafting perspective paper to clarify needs, objectives, future directions of the SoilWat initiative (Sonia Seneviratne, Peter van Oevelen, Gerrit de Rooij, and Dani Or)
- *Initiative 1:* survey already underway
- *Initiative 2 (SP-MIP):* scoping document distributed
- *Initiative 3:* discussion underway seeking a global groundwater database, historical and current, with the aim of committing contributing countries/monitoring authorities to submit their data to the database and possibly create a global archive of historical groundwater data.
- Second SoilWat workshop planned in 2017 to report progress and discuss processes not addressed in this workshop (e.g. soil and plant processes, human interactions)

CCRN RHP – Examining extreme events

The Weather Research and Forecasting (WRF) Model was used to simulate this event and was validated against several observation datasets.

The application of a conventional convective/stratiform separation algorithm shows that convective activity was dominant during the early stages, then evolved into predominantly stratiform precipitation later in the event.

The HYSPLIT back-trajectory analysis and regional water budget assessments using WRF simulation output suggest that the moisture for the precipitation was mainly from recycling antecedent soil moisture through evaporation and evapotranspiration over the Canadian Prairies and the U.S. Great Plains.



Moisture sources for Alberta June 23 flood event

Li Y, Szeto K, Stewart RE, et al (2017) A Numerical Study of the June 2013 Flood-Producing Extreme Rainstorm over Southern Alberta. J Hydrometeor 18:2057–2078 . doi: 10.1175/JHM-D-15-0176.1

2018 GEWEX Open Science Conference:
Extremes and Water on the Edge

Coast Canmore Hotel, Canmore, Alberta, Canada

Pre-Conference Events and Side Meetings

THURSDAY–SATURDAY, 3–5 MAY 2018

Joint Young Earth System Scientists (YESS) and Young Hydrologic Society (YHS) Early Career Researcher (ECR) Workshop: (By Invitation)
Orchid and Cougar-Grizzly Rooms

Details are available at: *https://www.gewexevents.org/events/2018conference/ecr/*

SATURDAY, 5 May

09:00-12:00 **PLUMBER-2 Planning Meeting** (By invitation) *Wolverine Room*

18:30-21:00 **Community Event with GEWEX Scientists**
Canmore Collegiate High School Theatre and Lobby
Talks by Kevin Trenberth (NCAR), Martyn Clark (NCAR) and John Pomeroy (USASK), followed by a panel discussion and refreshments

SUNDAY, 6 MAY

0630-1730 **Columbia Icefield Tour** (Meet in lobby)

0900-1700 **CLIVAR/GEWEX Monsoon Panel Meeting** (By invitation)
Wapiti Room

1700-1030 **Conference Registration**
Lobby

1900 **Reception**
Wildrose Ballroom

2018 GEWEX Open Science Conference

Preliminary Program

For details on poster sessions and program updates, see: https://www.gewexevents.org/events/2018conference

MONDAY, 7 May

07:30-09:30 Registration

08:30-10:05 Opening Plenary

08:30 Opening and Introduction – Peter van Oevelen (IGPO) and John Pomeroy (USASK)

Welcome
08:35 – Honorable Stephen Lucas, Deputy Minister of Environment and Climate Change Canada
08:45 – Honorable Shannon Phillips, Minister of Environment and Parks, Government of Alberta
08:55 – John Borrowman, Mayer of Canmore

Invited Talks
09:05 – The Changing Cold Regions Network—Integrating Disciplines Across Regions to Deliver New GEWEX Science Howard Wheater (USASK)
09:25 Global Water Futures Program and its Science Contributions to GEWEX – John Pomeroy (USASK)
09:45 Extremes and water on the edge: Including the human footprint – Sonia Seneviratne (ETHZ)

10:05 Lightning Poster Talks (followed by coffee break)

11:00-12:30 Morning Parallel Sessions

Session 1. Open Session on Water and Extremes Research
Session 23A. Land-Atmosphere Interactions and Climate Predictability, Including S2S Prediciton *(Continued on Tuesday)*
Session 9. Energy and Water Budget Closure and Advances in Assessment Techniques

12:30-14:45 Poster Session 1 (see conference website for schedule)
12:30-14:45 Lunch (provided in the Concourse)

14:45-16:45 Afternoon Parallel Sessions (followed by coffee break)

Session 25. High-Resolution Modeling and Resolved/Permitted Convection
Session 16. Heat Waves and Heat Extremes in the Past, Present, and Future Climate
Session 14. The Mountain Water Cycle

17:15-18:15 Plenary-Extreme Weather in a Changing Climate

17:15 Water and Extremes from Space – Jin Huang (NOAA/CPO)
17:35 A value chain approach to Extreme Earth – Paolo Ruti (WMO/WWRD)
17:55 Attributing human induced changes in extreme weather – Michael Wehner (LBNL)
18:15 Adjourn

Breakfast and lunch are provided to conference attendees as part of the registration from 7–11 May. Breakfast is served each day at 07:00

TUESDAY, 8 May

08:30-10:00 **Plenary on Extremes**

08:30 The WCRP Grand Challenge on Weather and Climate Extremes – Lisa Alexander (UNSW)
09:00 How much information is required to well-constrain local estimates of future precipitation extremes? – Francis Zwiers (Pacific Climate Impacts Consortium)
09:30 Exploiting the climate archives for meaningful events – Bart van den Hurk (KNMI)

10:00 **Lightning Poster Talks (followed by coffee break)**

11:00-12:30 **Morning Parallel Sessions**

Session 19. Detection and Attribution of Climate Extremes
Session 23B. Land-Atmosphere Interactions and Climate Predictability, Including S2S Prediction *(Continued from Monday)*
Session 7. Cold Regions Earth System Changes, Including Precipitation Occurring Near 0°C

12:30-14:45 **Poster Session 2** *(see conference website for schedule)* **and Lunch provided in the Concourse**

14:45-16:45 CLIVAR/GEWEX Monsoon Panel Meeting (by invitation) Wapiti Room

14:45-16:45 **Afternoon Parallel Sessions**

Session 18. Addressing the Challenge of Compound Events and Session 26. Documenting Extremes
Session 17. Storms and High Impact Weather
Session 10. Global Energy and Water Cycles, Clouds and Radiation

17:15-18:15 **Plenary – Water and Extremes from Space**

17:15 Studying Extremes with Satellite Observations: Before, During and After – Jared Entin (NASA)
17:35 ESA Earth Observing Program and Opportunities for GEWEX – Diego Fernandez (ESA)
17:55 JAXA Earth Observing Program and Opportunities for GEWEX – Riko Oki (JAXA)
18:15 Adjourn

WEDNESDAY, 9 May

08:30-10:05 **Plenary on Water**

08:30 Climate Change and Mountain Hydrology: Results from the Global Energy and Water Exchanges Project – Roy Rasmussen (NCAR)
09:00 Integrating human water management into land surface models – Jan Polcher (LMD)
09:30 Novel approaches for benchmarking – Martyn Clark (NCAR)

10:00 **Lightning Poster Talks**

11:00-12:30 **Morning Parallel Sessions**

Session 5. Irrigation Hydrology and **Session 11**. Water Cycle Over the Breadbaskets
Session 21. Climate Extremes, Ecosystems and Society: Impacts, Feedbacks and Emergency Risks
Session 15A. Land-Atmosphere Interactions and Water Cycle over the Third Pole Region *(Continued on Thursday)*

12:30-14:45 **Poster Session 3** *(see conference website for schedule)* **and Lunch provided in Concourse**

14:45-16:45 **Afternoon Parallel Sessions (followed by coffee break)**

Session 20. Droughts in Present and Future Climate
Session 4. Sub-daily Rainfall Extremes and **Session 6.** Changes in Rainfall Intensity and Distribution
Session 2. Regional Hydroclimate Projects

17:15-18:15 **Plenary – Land and Water Use in a Changing Climate**

17:15 The NEXUS of Land, Food, Energy and Water: Water Management in Global Models – Richard Harding (CEH)
17:35 Land and water management in Earth System Models: Opportunities and challenges – David Lawrence (UCAR)
17:55 Adjourn

19:30 **Conference Dinner (Keynote: Alan Betts)**

THURSDAY, 10 May

08:30-10:05 **Plenary on GEWEX Panels**

08:30 GEWEX Hydroclimatology Panel (GHP) – Jason Evans (UNSW)/Joan Cuxart (UIB)
08:50 GEWEX Data and Analysis Panel (GDAP) – Rémy Roca (OMP/LEGOS)/Tristan L'Ecuyer (UW-Madison)
09:10 Global Land/Atmosphere System Study (GLASS) – Gab Abramowitz (UNSW)/Michael Ek (NCAR)
09:30 Global Atmospheric System Studies (GASS) – Xubin Zeng (U. Arizona)/Daniel Klocke (DWD)
09:50 Discussion

10:00 **Lightning Poster Talks (followed by coffee break)**

11:00-12:30 **Morning Parallel Sessions**

Session 24. Benchmarking and Metrics
Session 3. Evapotranspiration Determination and **Session 22**. Soils in Water and Climate Models
Session 15B. Land-Atmosphere Interactions and Water Cycle over the Third Pole Region *(Continued from Wednesday)*

12:30-14:45 **Poster Session 4** *(see conference website for schedule)* **and Lunch provided in the Concourse**

14:45-16:45 Compound Events Side Meeting (by invitation) *Wapiti Room*

14:45-16:45 **Afternoon Parallel Sessions (followed by coffee break)**

Session 8. Modeling for Extremes
Session 12. Satellite Observations for Extremes, Water Cycle Processes and Land-Atmosphere Interactions
Session13. The Human–Climate-Water Nexus, Climate Change and Water Security

17:15-18:15 **Plenary on Land Based Predictability**

17:15 Title TBA – Andrew Pitman (TBC)
17:35 On the relevance of diurnal cycle model improvements to represent climate extremes – Gianpaolo Balsamo (ECMWF)
17:55 Confronting forecast models, reanalyses and land surface models with global remote sensing estimates of land-atmosphere coupling – Paul Dirmeyer (GMU)
18:15 Adjourn

Friday, 11 May

08:30-10:00 **Plenary on Early Career Researchers**

08:30 Why tracking the Earth's energy imbalance is an imperative – Kevin Trenberth (NCAR)
09:00 Results from Early Career Researcher (ECR) Workshop and ECR Competition Prizes – YESS/YHS

10:15-11:15 **New Activities in GEWEX**

10:15 A comparison of functional descriptions for estimating hydraulic and thermal properties in land-surface models: implications for the energy and water balance – Anne Verhoef (U. Reading)
10:30 ANDEX, A Hydroclimate Research Program for the Andes and a Prospective GEWEX Regional Hydroclimate Project (RHP) – Germán Poveda (UNAL)

11:15-12:45 **Closing Plenary**

11:15 Interactions between the water and carbon cycles – Eleanor Blyth (CEH)
11:45 Future strategic directions for WCRP – Guy Brasseur (WCRP)
12:15 The ever increasing importance of international research collaboration in climate sciences – Peter van Oevelen (IGPO)
12:30 GEWEX progress, challenges and opportunities – Graeme Stephens (NASA-JPL)

12:45 **Conference Adjourns**

12:45-14:30 **Lunch provided in Concourse**

14:30-17:30 **Side Events**

Knowledge Action Network on Extremes
Water for Food Baskets and Regional Hydroclimate Projects for the Americas