ABOUT
WATER, ENERGY, & CLIMATE

The Global Energy and Water EXchanges project of the World Climate Research Programme

GEWEX

WCRP
World Climate Research Programme

Outline

- Quick introduction to the World Climate Research Program (WCRP)
- Motivation and imperatives of GEWEX
- The structure of GEWEX and the working of its panels
- GEWEX's contribution to the Grand Challenges of WCRP

World Climate Research Programme

Sponsored by the World Meteorological Organization, the International Council for Science and the Intergovernmental Oceanographic Commission of UNESCO.

- **The WCRP Mission:** to facilitate analysis and prediction of Earth system variability and change for use in an increasing range of practical applications of direct relevance, benefit and value to society.

O1. Understanding the climate system

Identify and constrain key processes that critically determine the reservoirs and flows of energy and water – and carbon, aerosols, salt, and other constituents – within and between the components of the Earth System.

O2. Determining predictability on weekly to decadal timescales

Quantify the uncertainties and predictabilities inherent in weekly to decadal time scales of the climate system.

O3. Determining projectability on decadal to centennial timescales

Quantify the sensitivities and emergent constraints inherent in the changing climate system.

O4. Connecting climate science to policy and decision making

Improve the generation and use of decision relevant climate information and knowledge about the evolving Earth system, across space and time scales, to natural variability and climate change.

WCRP Structure

Joint Scientific Committee

Modeling Advisory Council

Joint Planning Staff

Data Advisory Council

Working Groups on: Numerical Experimentation (WGNE), Subseasonal to Interdecadal Prediction (WGSIP), Coupled Modeling (WGCM), Regional Climate (WGRC)

CliC	CLIVAR	GEWEX	SPARC	CORDEX
Cryosphere	Ocean-Atmosphere	Land-Atmosphere	Troposphere -Stratosphere	Regional Climate Downscaling

GEWEX

WCRP World Climate Research Programme

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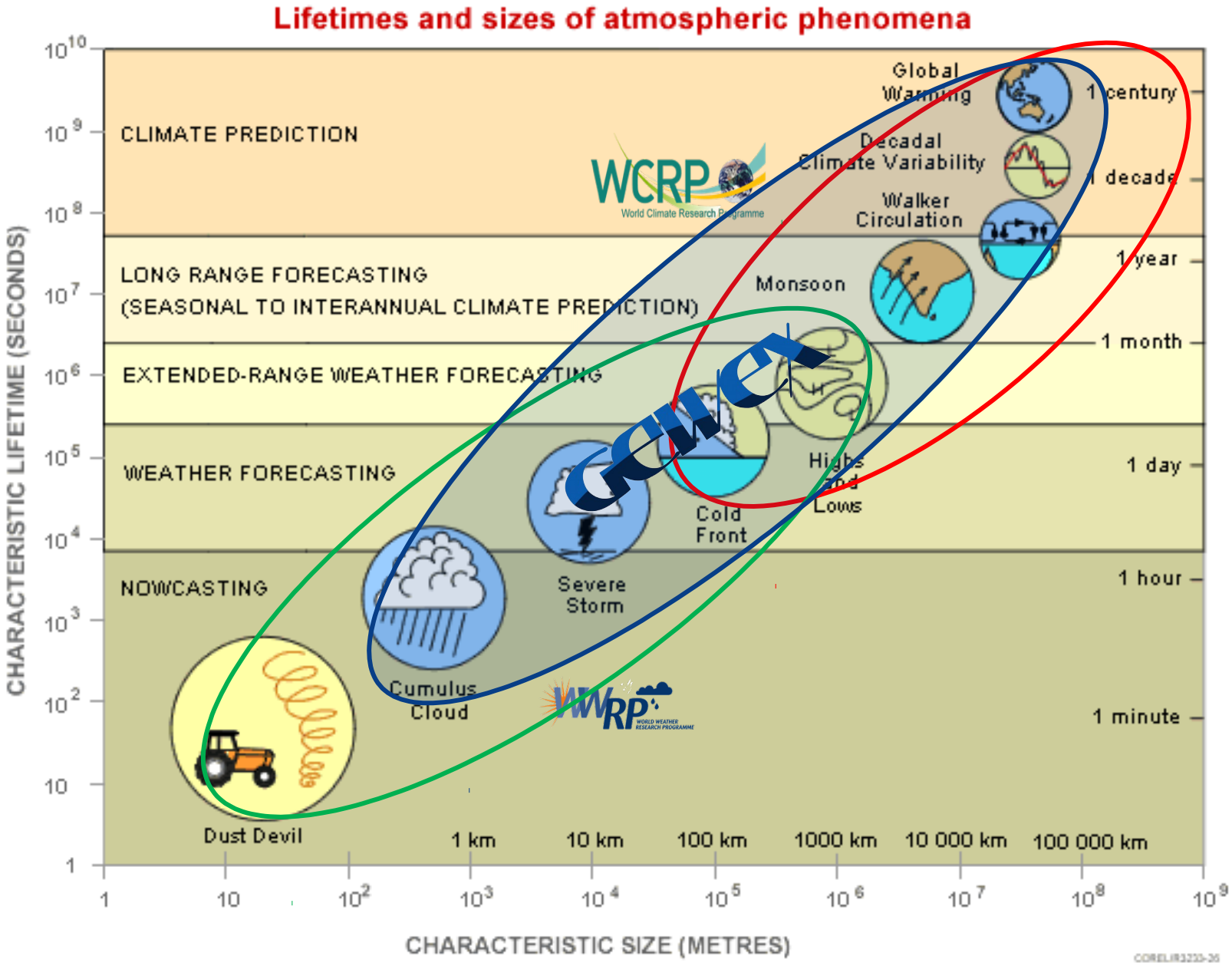
CliC | **CLIVAR** | **GEWEX** | **SPARC** | **CORDEX**

- Melting Ice & Global Consequences
- Regional Seal Level & Coastal Impacts
- Water for Food Baskets
- Weather & Climate Extremes
- Clouds, Circulation & Climate Sensitivity
- Near-Term Prediction (Decadal)
- Carbon & Climate


Lifetimes and sizes of atmospheric phenomena
CLIMATE PREDICTION
LONG RANGE FORECASTING
(SEASONAL TO INTERANNUAL CLIMATE PREDICTION)
EXTENDED-RANGE WEATHER FORECASTING
WEATHER FORECASTING
NOWCASTING
WCRP
World Climate Research Programme
Global Warming
Decadal Climate Variability
Walker Circulation
Monsoon
Highs and Lows
Cold Front
Severe Storm
Cumulus Cloud
Dust Devil
WWRP
WORLD WEATHER RESEARCH PROGRAMME
GEWEX
1 century
1 decade
1 year
1 month
1 day
1 hour
1 minute
CHARACTERISTIC LIFETIME (SECONDS)
CHARACTERISTIC SIZE (METRES)
1 km
10 km
100 km
1000 km
10 000 km
100 000 km

What We Do

The Global Energy and Water EXchanges (GEWEX) project of the World Climate Research Programme (WCRP) facilitates, enables, coordinates international climate and related research activities with an emphasis on land – atmosphere processes and interactions.

From sub-surface processes related to hydrology to atmospheric processes including interactions between the troposhere and the stratosphere

GEWEX Vision

Water and energy are fundamental for life on Earth. Fresh water is a major pressure point for society owing to increasing demand and vagaries of climate.

Extremes of droughts, heat waves and wild fires as well as floods, heavy rains and intense storms increasingly threaten to cause havoc as the climate changes. Other challenges exist on how clouds and aerosols affect energy and climate. Better observations and analysis of these phenomena, and improving our ability to model and predict them, will contribute to increasing information needed by society and decision makers for future planning.

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.

GEWEX Focus

Water and Energy – People & Environment

- 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
- Water and Energy Security are intrinsically related to Food Security – “Water for food baskets of the world” Grand Challenge

Four GEWEX Science Questions

For the next 5 to 10 years

1	Observations and Predictions of Precipitation
2	Global Water Resource Systems
3	Changes in Extremes
4	Water and Energy Cycles and Processes

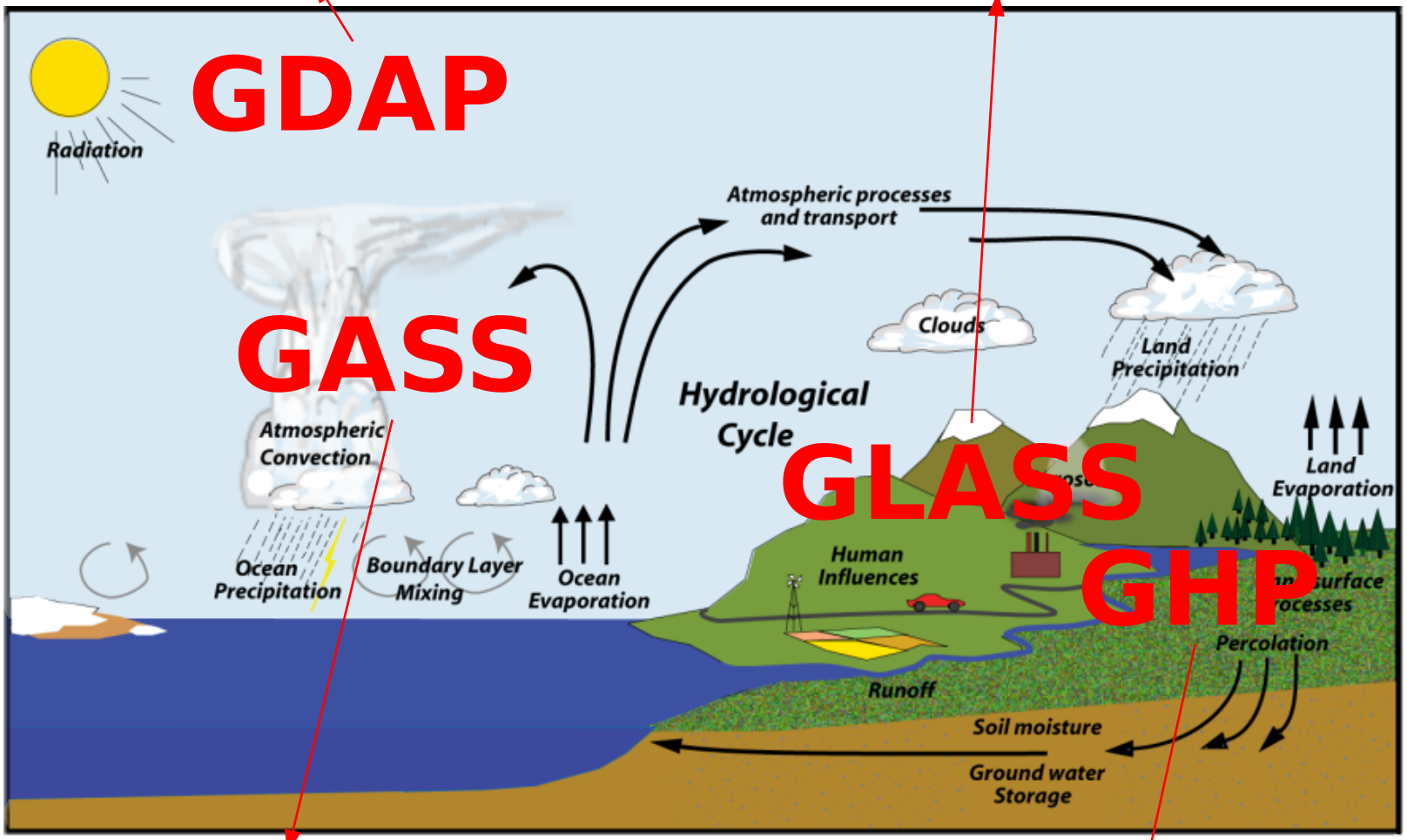
GEWEX Imperatives

Datasets	1	Applications	5
Analysis	2	Technology Transfer	6
Processes	3	Capacity Building	7
Modeling	4		

GEWEX: Major Components

GEWEX Data Assessment Panel

Global land/Atmosphere System Study



GEWEX Atmospheric System Studies

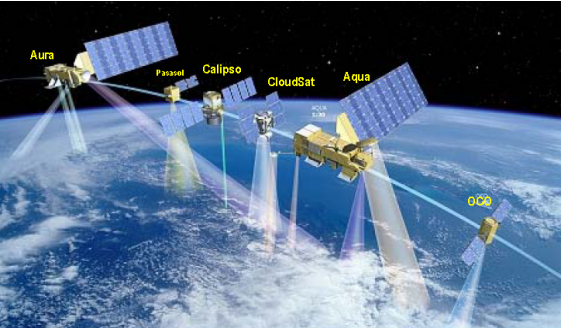
GEWEX Hydroclimate Panel

GDAP Contribution to GEWEX

- **Data stewardship**
  - Clouds- ISCCP
  - Precipitation- GPCP
  - Surface radiation budget
  - Water vapor (GVaP)
  - Surface ocean/land fluxes (E/ET)
  - …Ground water/soil moisture (u.d.)

- **Data assessments**
  - Clouds
  - Precipitation (with APWG)
  - Energy & water balance
  - Other (soil moisture, water vapor, aerosol)

- **Next generation observing systems**
  - ISCCP-NG (under development)



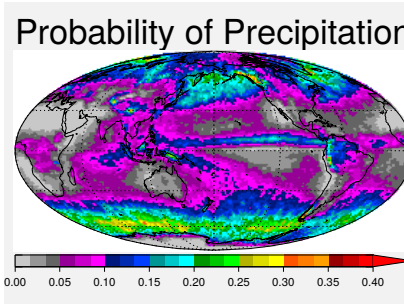
Surface Water balance

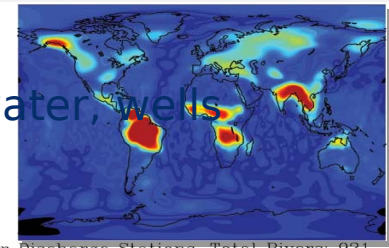
$$\Delta S = P - Q - ET$$

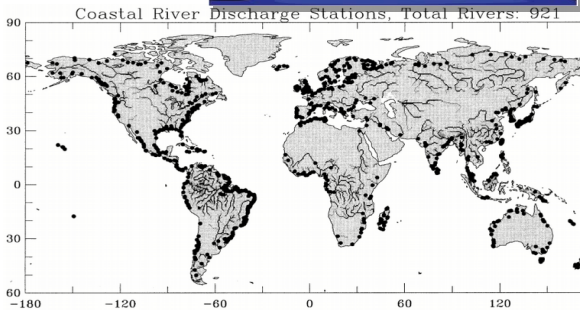
- **Precipitation (P)**
  - In situ: Rain gauges, Snotel
  - RS (**TRMM, CloudSat, AMSR-E, IR**,….)
- **Change in storage (ΔS)**
  - In situ: Groundwater recharge/flow, soil moisture, standing water, wells
  - RS (**GRACE**, SWOT, AMSR-E→SMOS→SMAP)
- **Runoff (Q)**
  - In situ: Stream gauges, Global Runoff Data Center,
  - RS (SWOT)
- **Evaporation/Evapotranspitation (ET)**
  - In Situ: Fluxnet
  - RS Quickscat, AMSR-E, MODIS, **ACOS/OCO,…**

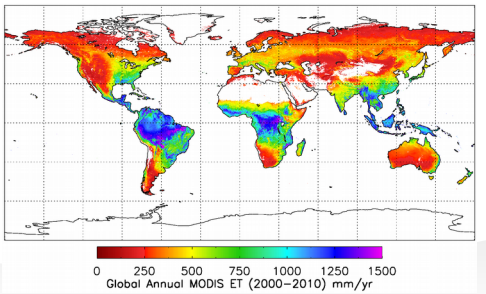
(RS of ET also requires surface net radiation)

- **Global accuracy/consistency/ability?**









GLASS Vision and Mission

The GEWEX Vision

Water and energy are fundamental for life on Earth. Fresh water is a major pressure point for society owing to increasing demand and vagaries of climate. Extremes of droughts, heat waves and wild fires, as well as floods, heavy rains, and intense storms increasingly threaten to cause havoc as the climate changes. Other challenges exist on how clouds and aerosols affect energy and climate. Better observations and analysis of these phenomena, and improving our ability to model and predict them, will contribute to increasing information needed by society and decision makers for future planning.

GLASS role: Better representation of the Earth System by understanding the role of land.

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 interaction, thereby providing the scientific underpinnings of climate services.

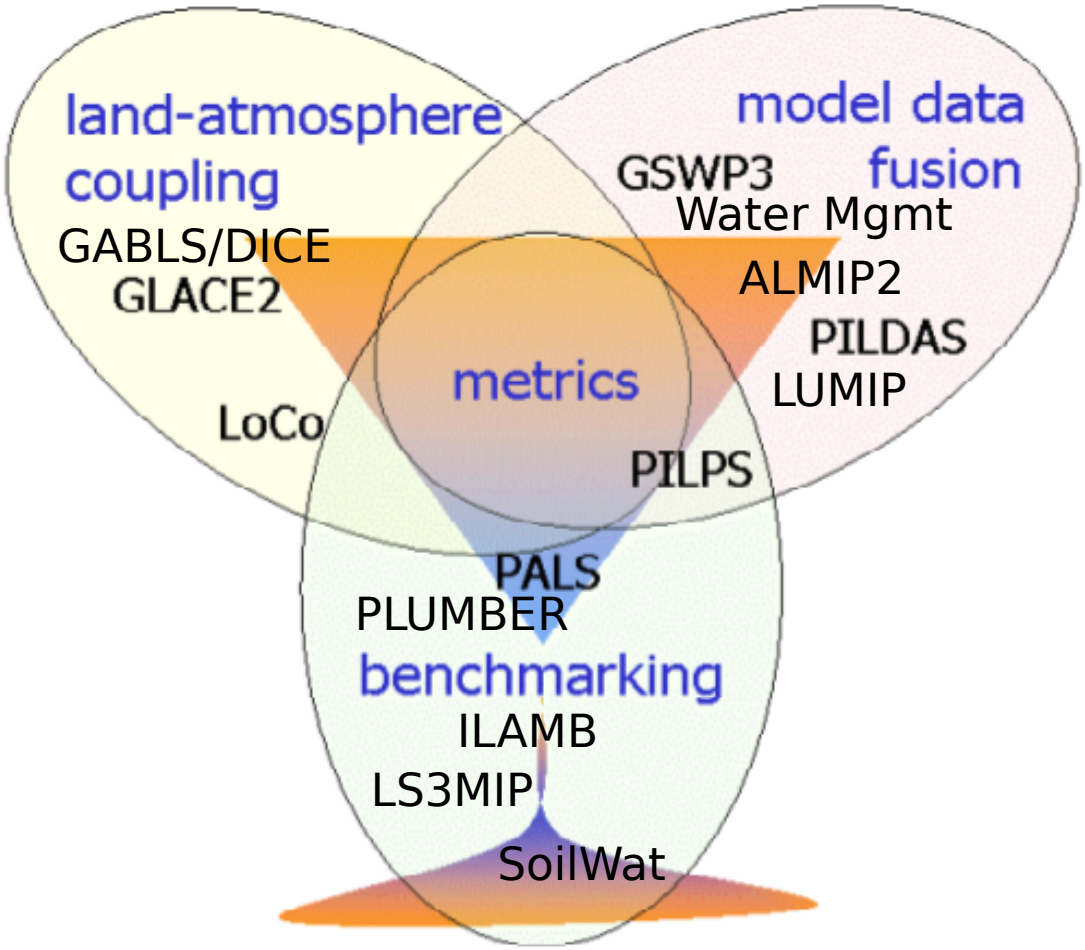
GLASS role: Identify and improve modeling of land-surface processes and land-atmosphere interactions to support the GEWEX Mission.

GLASS Structure

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

- **Our best estimates and the model representation of state variables.**
- **Our understanding of land/atmosphere feedbacks.**
- **Our understanding of the role of land surface in predictability**

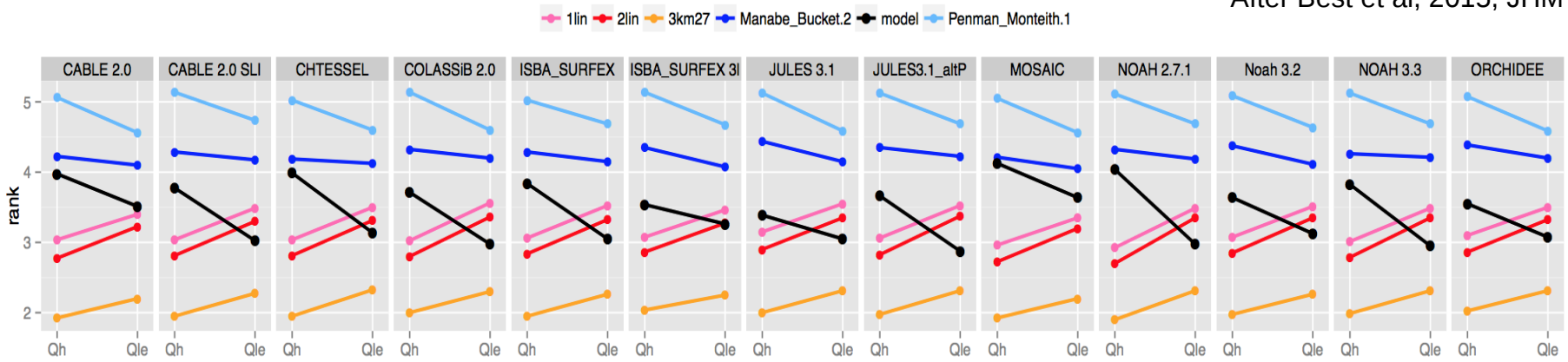
To best achieve these aims, GLASS has been structured into three elements:



The PALS Land sUrface Model Benchmarking Evaluation pRoject (PLUMBER)

- Compares land surface models to benchmarks with performance expectations defined *a priori*.

After Best et al, 2015, JHM



Headline result: Vertical axis: rank of each land surface model (LSM; black) against the 5 benchmarks, averaged over 20 Flux tower sites, 4 metrics: bias, correlation, SD, normalized 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, land models are comfortably beaten by out-of-sample regression against SWdown, Tair and RelHum.
- *Need to make better use of the information in the data sets, with "higher bars".*
- *Look "Deeper": surface-layer turbulence, vegetation/soil processes,* ***hydrology****.*

GHP : Regional Hydroclimate Projects (RHP)

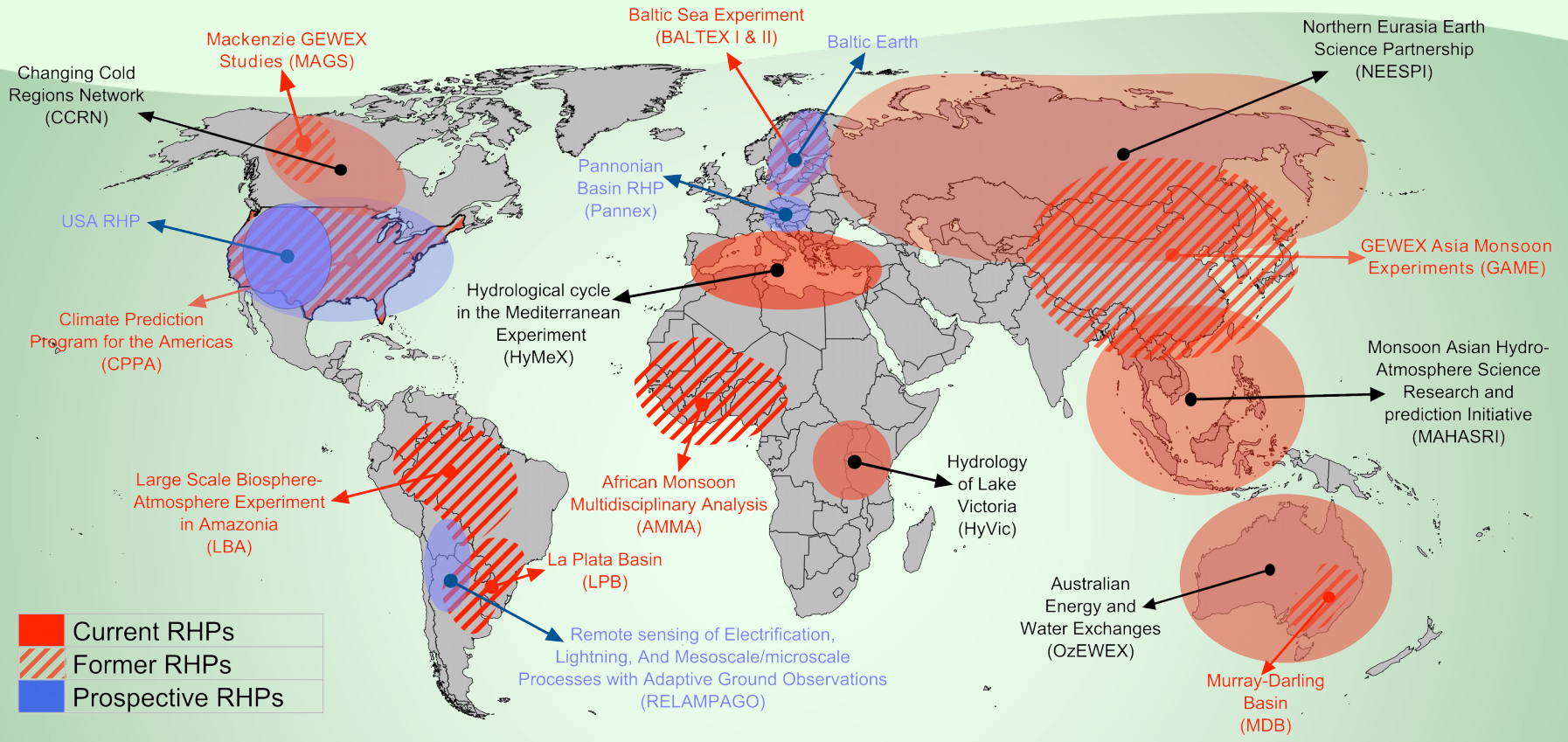
GEWEX

- Energy & Water Exchanges
- Land-atmosphere focus

Other aspects of RHPs

- Carbon
- Land/Sea Interaction
- Ecosystems
- Engineered systems
- Human systems

GEWEX REGIONAL HYDROCLIMATE PROJECTS



Completed

MAGS, CPPA, GAME, LBA, LPB, MDB, AMMA, BALTEX, NEESPI, MAHASRI

Active

HyMeX, CCRN

Initiating

HyVic, OzEWEX

Prospective

Baltic-Earth, PannEx, USA RHP, RELAMPAGO

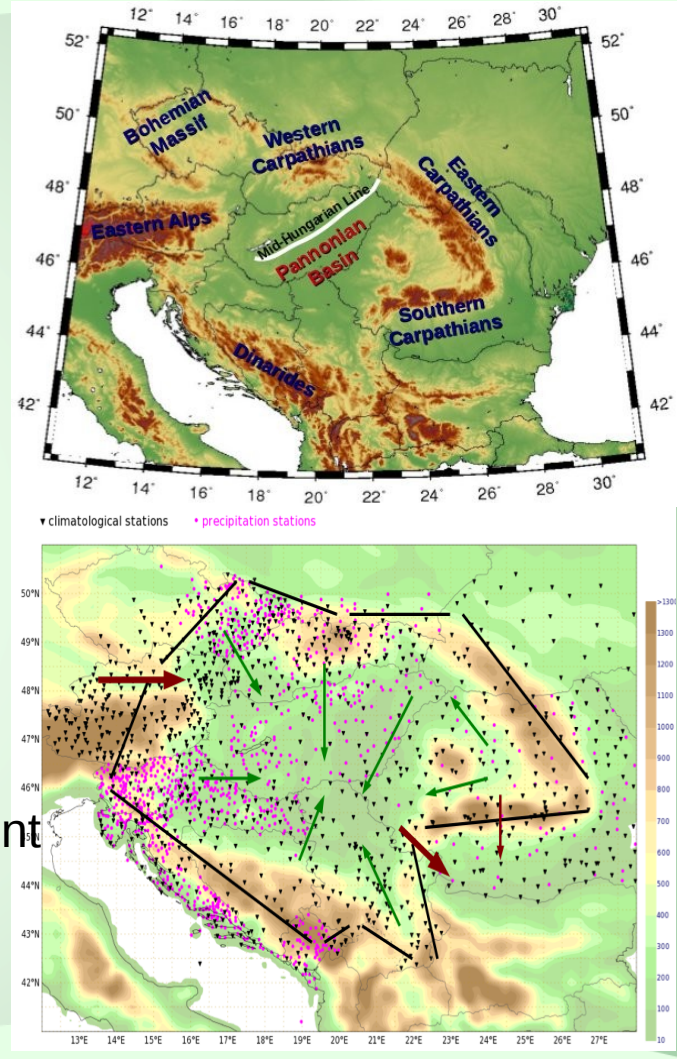
GHP

GEWEX

PannEx

1. Physical Motivation

- Practically a closed basin, with a large low central plain (100 m asl) surrounded by mountains with elevations nearing 2000 m asl, being a very good test area for many geophysical processes (natural or human-induced)
- The Pannonian basin is a transition area between Mediterranean, Atlantic and continental climates.

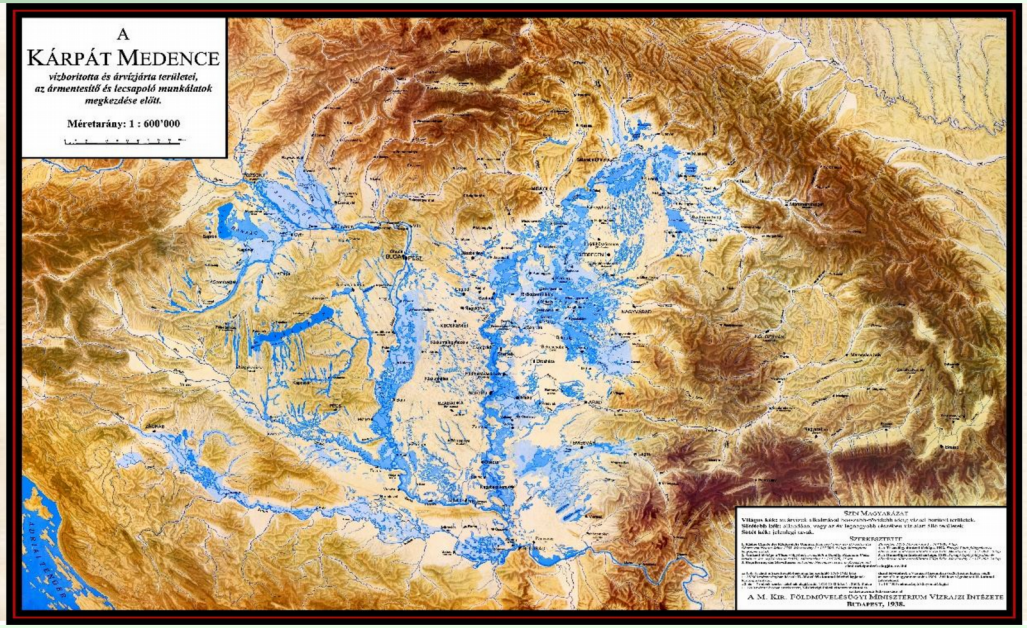


2. Opportunity

a) The area is fragmented in many different countries, sometimes with difficult communication amongst them.
b) Good research institutions and universities, some recent activities of networking, but no international visibility
c) Countries in good position to receive EU research funding.
d) Area between the HyMeX and Baltic Earth areas.
e) GEWEX fosters intra-basin cooperation

Pannonian basin : A managed system

- Since the 19th century flood control measures were introduced along the Danube and its tributaries
- Fields were drained to make them arable.
- The Danube was developed as a waterway (Tiza river was shortened by 453km between 1846 and 1880).

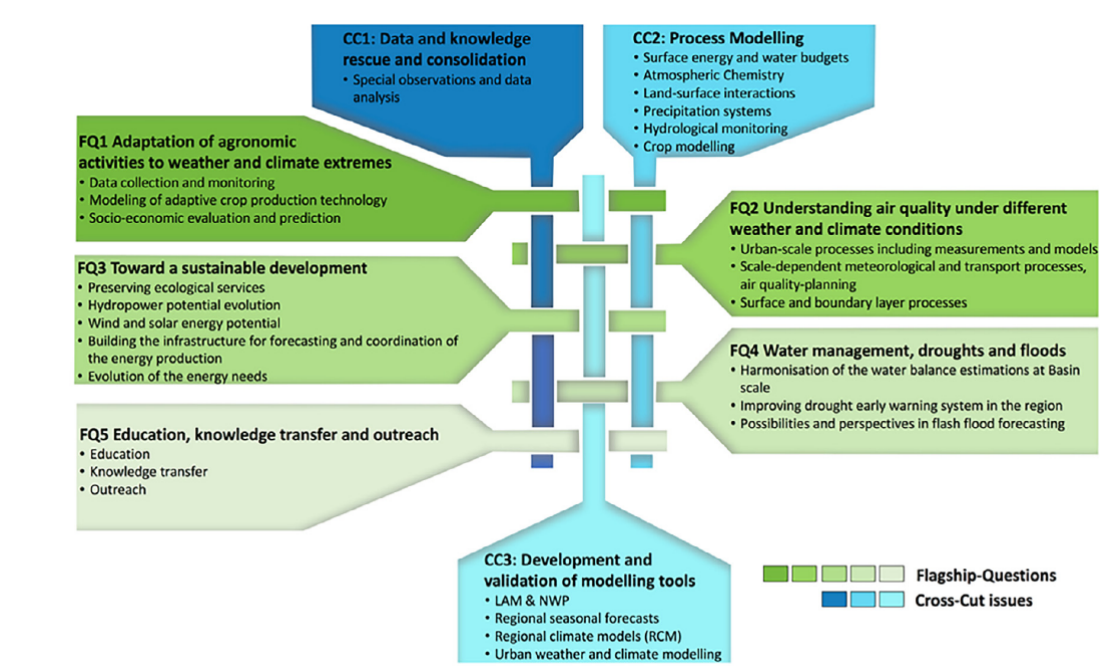


Blue regions used to be floodplains !

The Flagship questions for PannEx

A number of workshops in the region allowed the scientists of the these countries to identify scientific priorities :

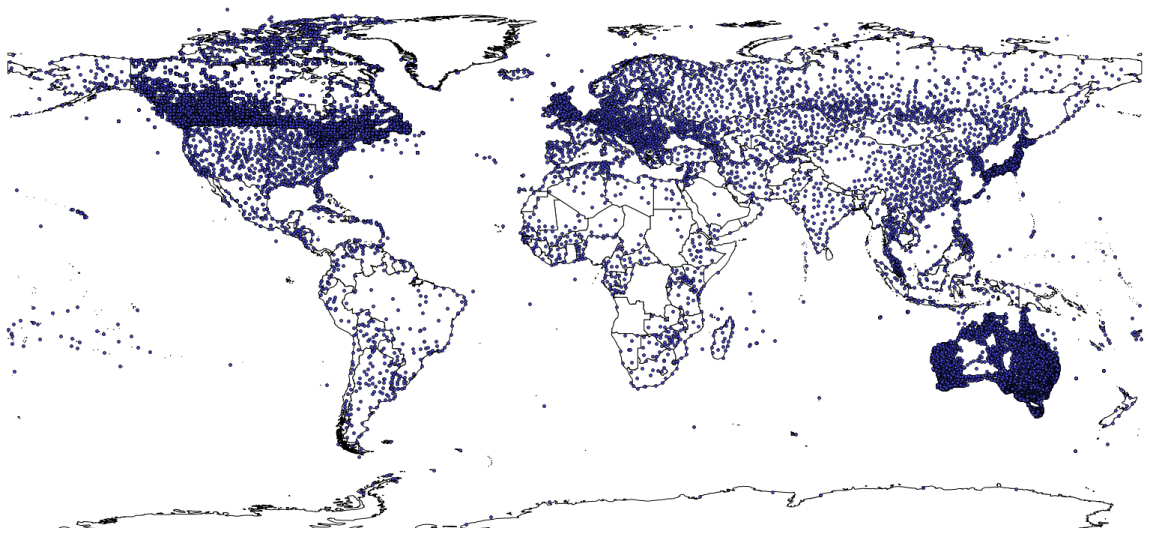
1) Adaptation of agronomic activities to weather and climate extremes
2) Understanding of air quality under different weather and climate conditions
3) Water management, droughts and floods
4) Toward a sustainable development
5) Education, knowledge transfer and outreach



GHP Cross-cut Projects - Objectives

- Target GEWEX science questions
- Tackle issues best addressed through large collaborative projects
- Should test and evaluate applications of the knowledge produced in RHPs.
- Generate interactions between RHPs and keep completed RHPs involved
- CC projects are also a tool for collaboration with other GEWEX panels and WCRP projects.
- A way for the broader Community to get involved in GEWEX/GHP.
- INARCH, Cold/Shoulder Season Precipitation Near 0ºC project, INTENSE

INTENSE : Main achievements, the database

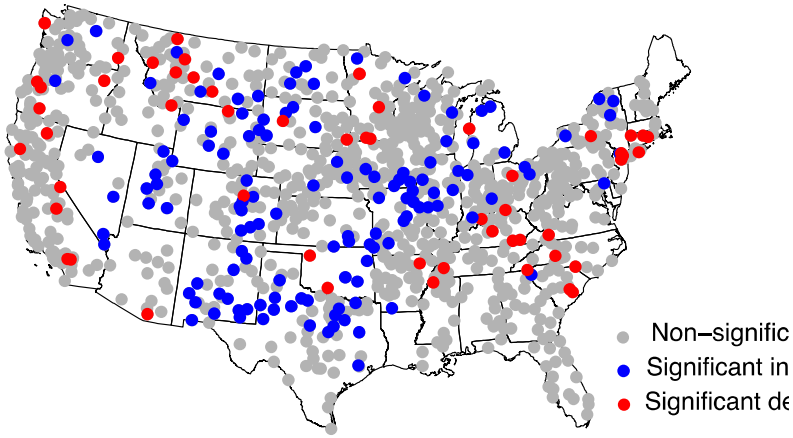


- Developed standard request letter and identified routes through to correct data provider for many locations with Lisa Alexander.
- Sub-daily precipitation data has been collected for: USA, Australia, Canada, Japan, Malaysia, UK, Netherlands, Singapore, HadISD (UK Met Office sub-daily dataset comprising precipitation and other variables).
- The database is now co-managed with DWD in the team which produces the GPCC global dataset.

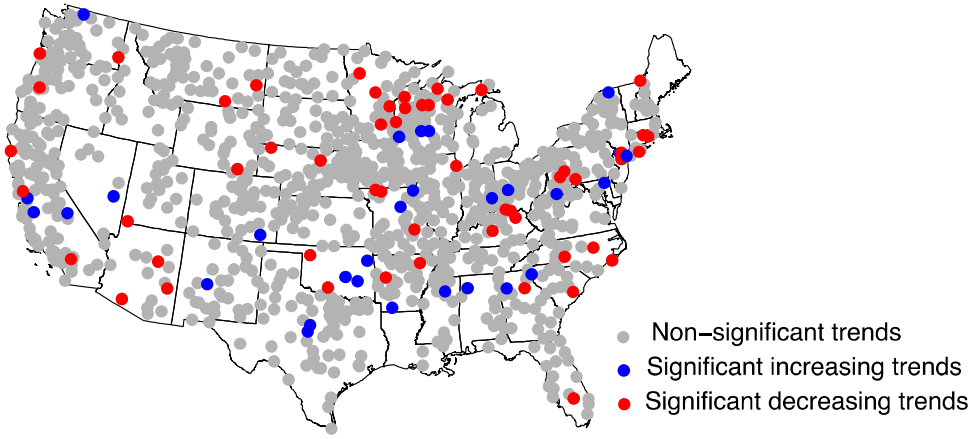
Trends in extreme Precipitation

Newcastle University
UK | Malaysia | Singapore

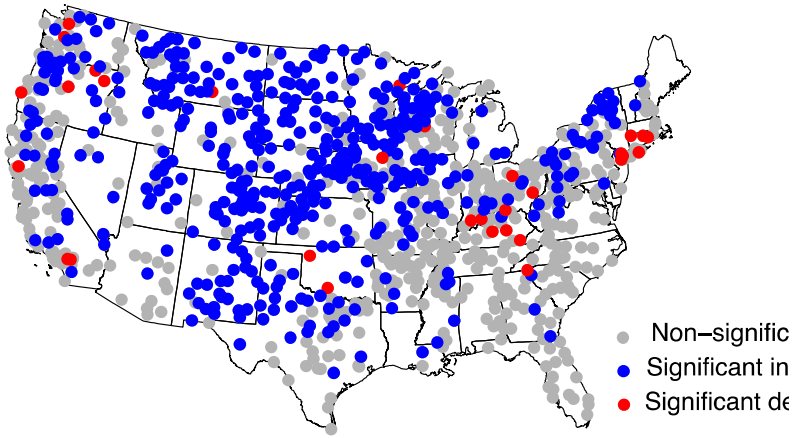
a) Trends in DJF heavy rainfall events (daily scale)



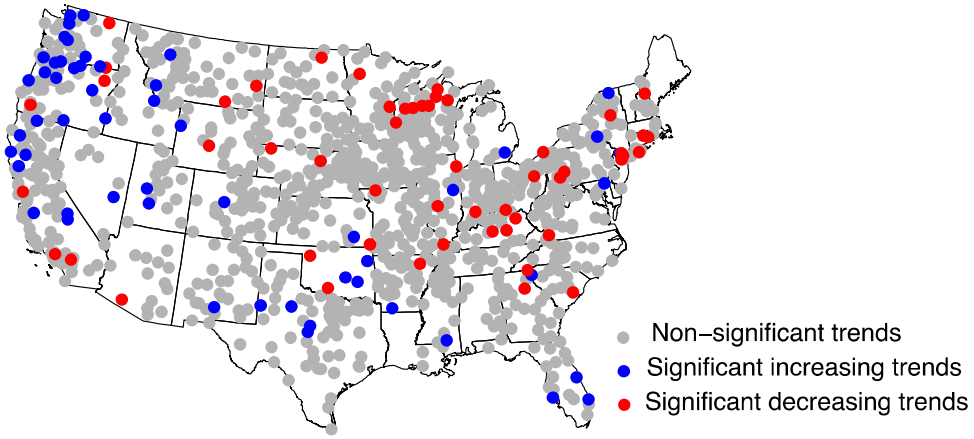
a) Trends in JJA heavy rainfall events (daily scale)



b) Trends in DJF heavy rainfall events (hourly scale)



b) Trends in JJA heavy rainfall events (hourly scale)



Weather & Climate Extremes

- 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?

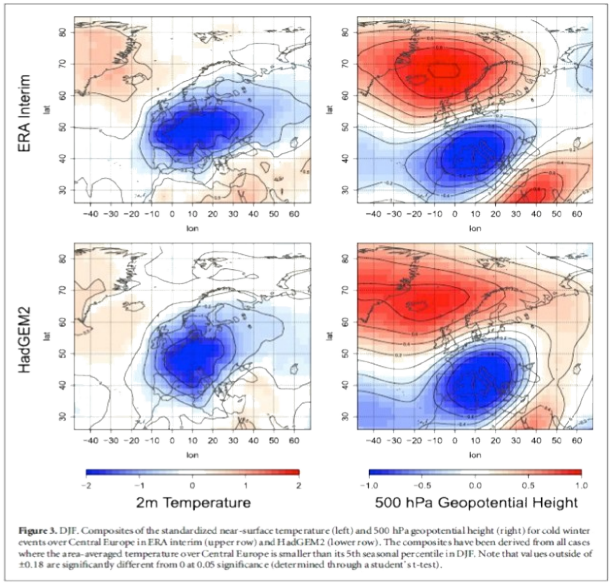


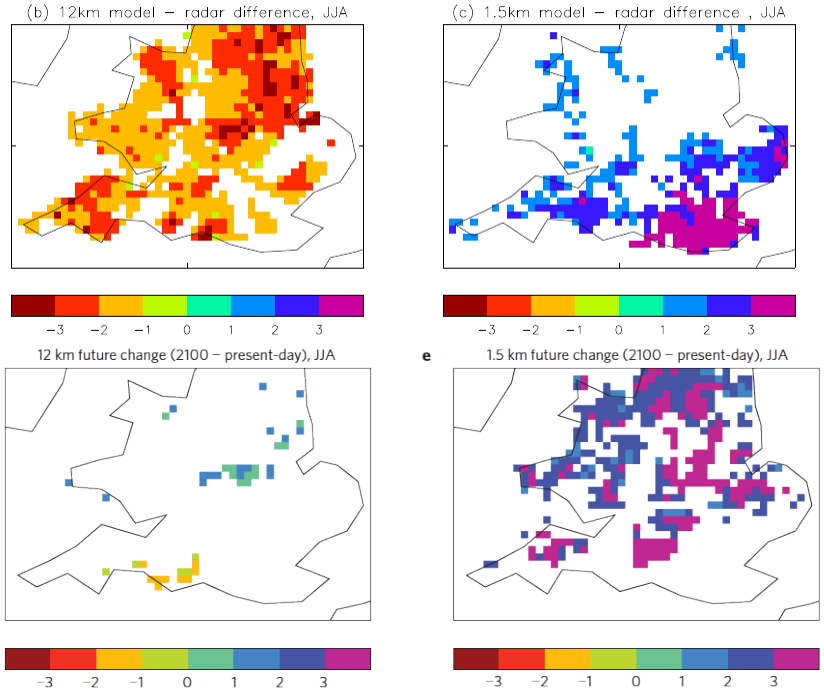
Figure 3. DJF. Composites of the standardized near-surface temperature (left) and 500 hPa geopotential height (right) for cold winter events over Central Europe in ERA interim (upper row) and HadGEM2 (lower row). The composites have been derived from all cases where the area-averaged temperature over Central Europe is smaller than its 5th seasonal percentile in DJF. Note that values outside of ±0.18 are significantly different from 0 at 0.05 significance (determined through a student's t-test).

Source: Krueger et al., 2015, ERL

Heavy hourly rainfall [mm/h]

Radar - model

2100 - present



Source: Kendon et al. 2014, Nature Climate Change

Water for the food baskets of the world

Observational based studies :

- Should be based on RHP in regions of intense agriculture.
- Better quantify human control on the water cycle.
- Process studies on surface atmosphere interactions.
- Promote inter-disciplinary analysis.

Enhancing predictive capabilities :

- Propose model inter-comparisons to promote model development.
- Re-visit the past evolution which combine climate change and increasing human intervention.
- Consolidate process knowledge in our models.

GEWEX

WMO IOC ICSU International Council for Science WCRP World Climate Research Programme

Conclusion

- GEWEX represents the global hydo-climatological community.
- It serves the community by fostering and coordinating international exchanges.
- GEWEX promotes exchanges with other fields in Earth System Sciences to ensure application of the knowledge produced.
- GEWEX is looking forward to a stronger Canadian contribution through GWF.

Thank you very much Canada for hosting the 2018 GEWEX conference !


Great Plains and
Central Valley
Pannonian Basin
SE Asia Rice and
Wheat Regions

Thank You

MORE INFORMATION ON:

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