Global Energy and Water Exchanges

GEWEX Organization, Science Questions & Imperatives

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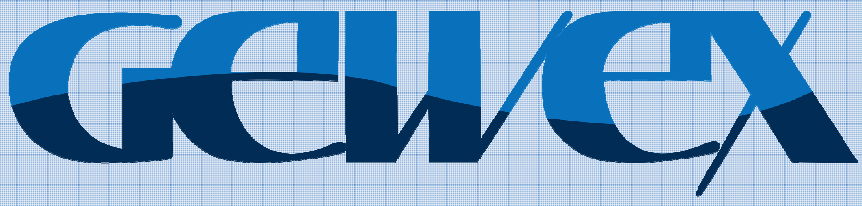
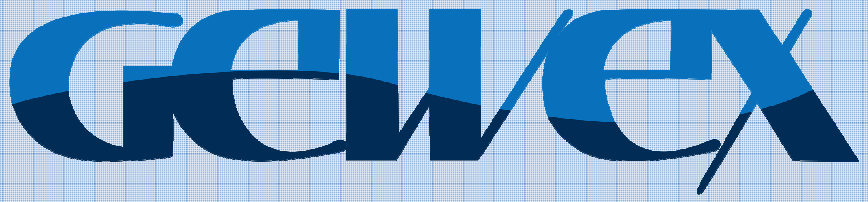


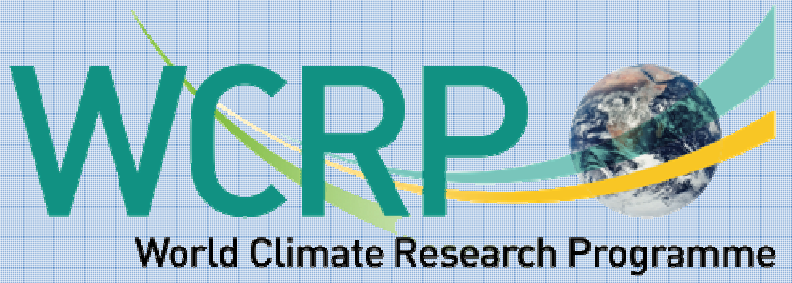
GEO 'IGWCO' GEWEX WCRP

- **Commonalities:**
  - Observations
  - Water (& Energy & Food)
  - Societal & Institutional Challenges
  - International Coordination
- **Global Water Cycle Observations at Various Scales**
- **Relatively weak obvious mutual benefit and impacts**

GEWEX and WCRP

Some back ground information





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.

WCRP
World Climate Research Programme

GEWEX

GEWEX
A brief history

- Born out of the realization that the Earth observational systems at that time (the early 1980's) needed to be improved on if more progress was to be made on the meteorology and global climate research.
- Two feasibility workshops were held in 1987 and 1988 and in the first part of 1990 a science plan was finalized
- In December of 1990 the Global Energy and Water cycle Experiment (GEWEX) was approved by WMO and ICSU as a core project of the World Climate Research Programme (WCRP)

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.

Phase III: 2013 ~ 2022

Science Objectives & Imperatives

- **Building upon the results and experience from Phase I and II the GEWEX community for Phase III has developed through an open and interactive process:**
  - A new Vision and Mission Statement
  - An Imperatives document describing the framework of necessary activities
  - The GEWEX Science Questions to be address in the next 5 to 10 years and which contribute directly to the WCRP Grand Challenges

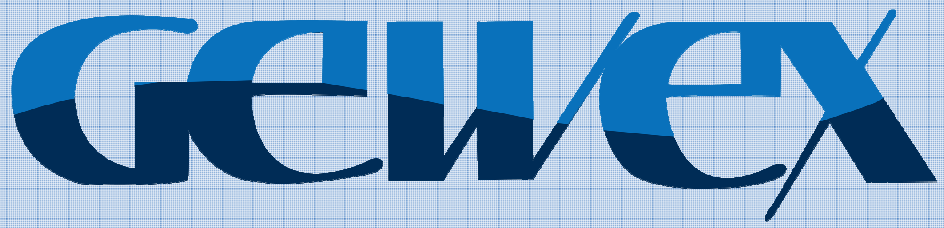
GEWEX Vision

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.



World Climate Research Programme

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- 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.
- The two overarching objectives of the WCRP are:
- 1) *to determine the **predictability of climate***; and
  2) *to determine the **effect of human activities** on climate*
- Progress in understanding climate system variability and change makes it possible to address its predictability and to use this predictive knowledge in developing adaptation and mitigation strategies. Such strategies assist the global communities in responding to the impacts of climate variability and change on major social and economic sectors including food security, energy and transport, environment, health and water resources.

GEWEX

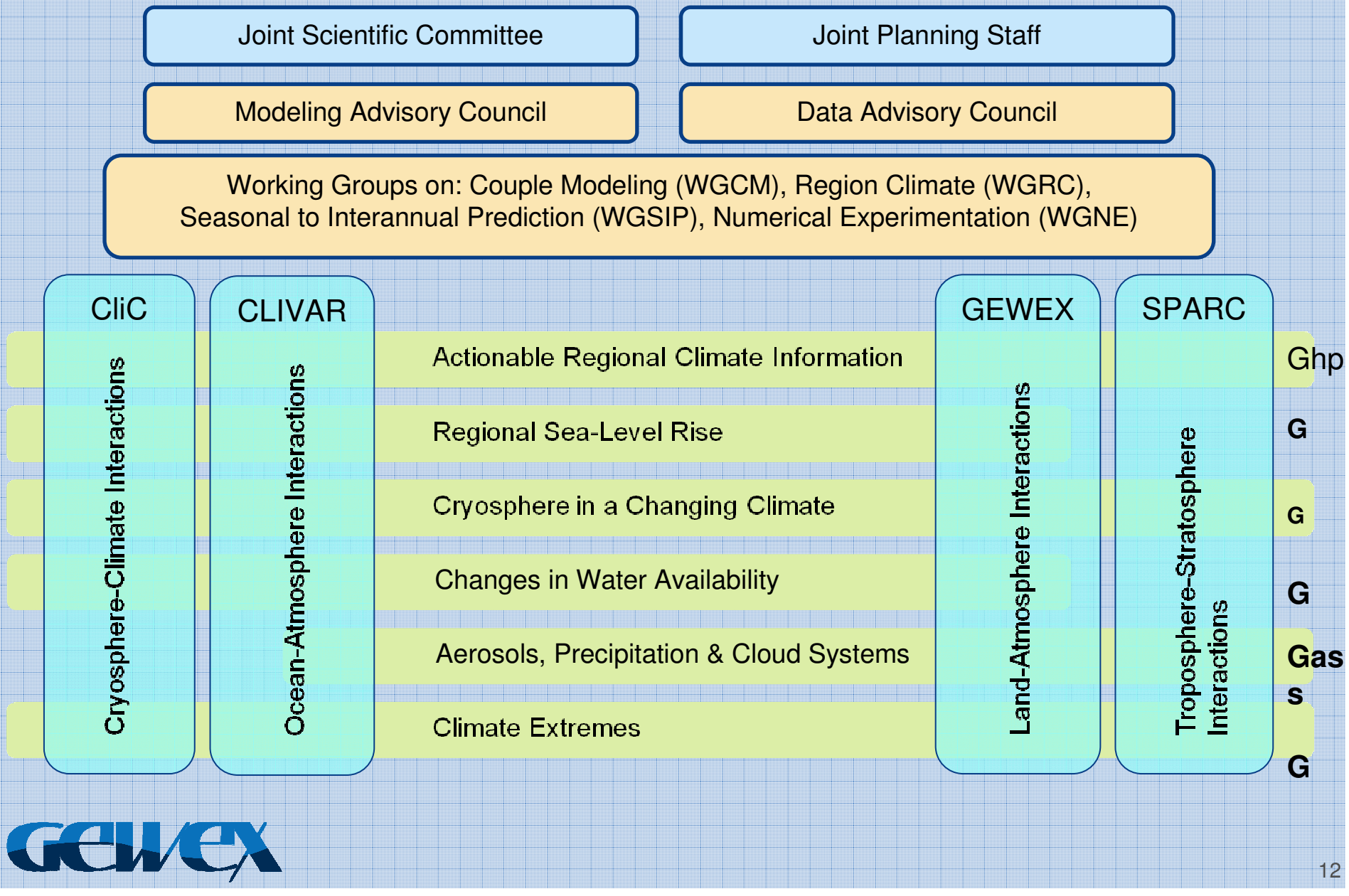
WCRP World Climate Research Programme

Six WCRP Grand Challenges

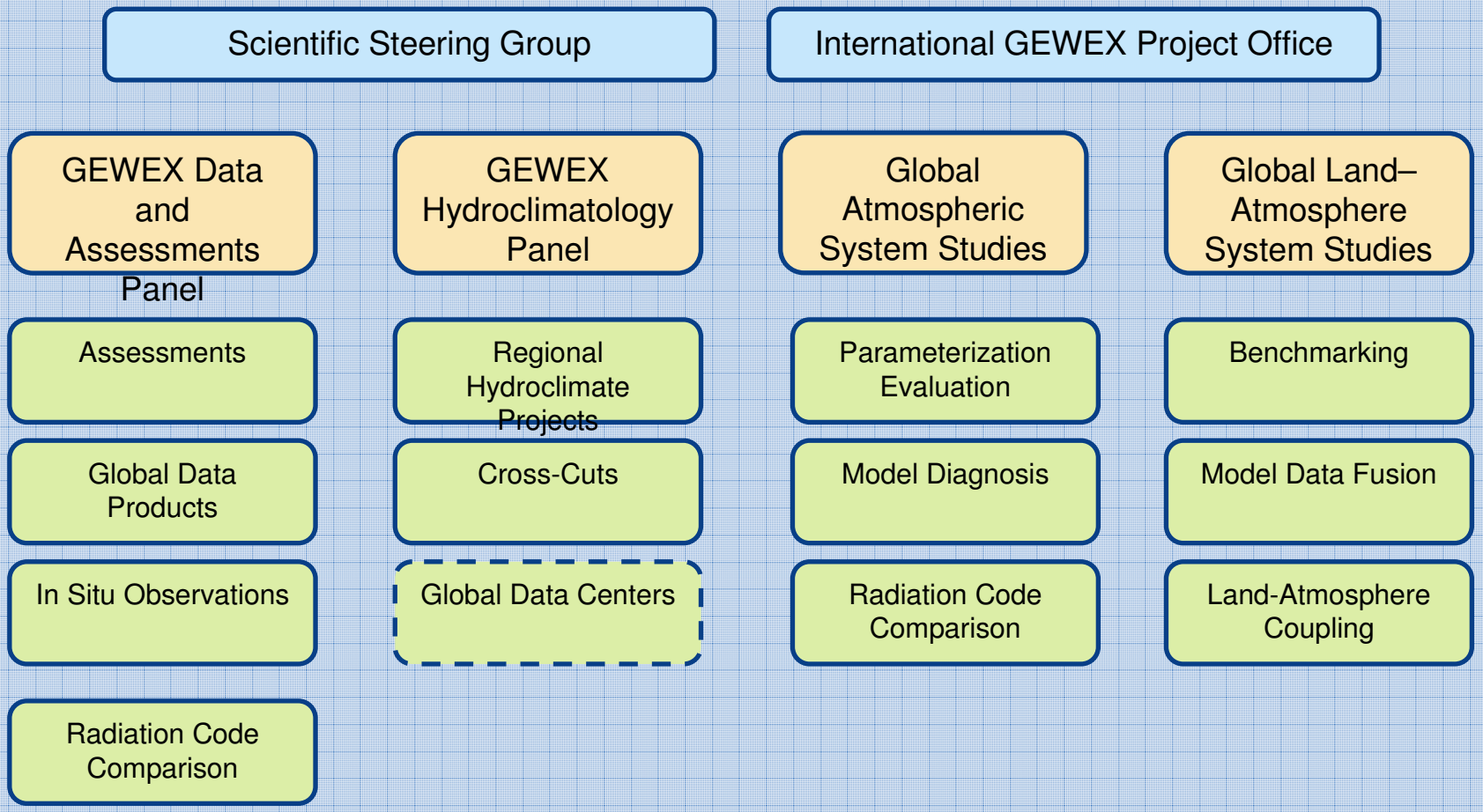
To inspire the community to become involved. They are specific and focused while identifying barriers and ways to advance the science, and they should capture the imaginations of funding agencies, science program managers, and the public.

1. Action-oriented regional climate information
2. Regional sea level
3. Cryosphere in a changing climate
4. Cloud and climate sensitivity
5. Changes in water resources
6. Prediction and attribution of extreme events

WCRP Organization

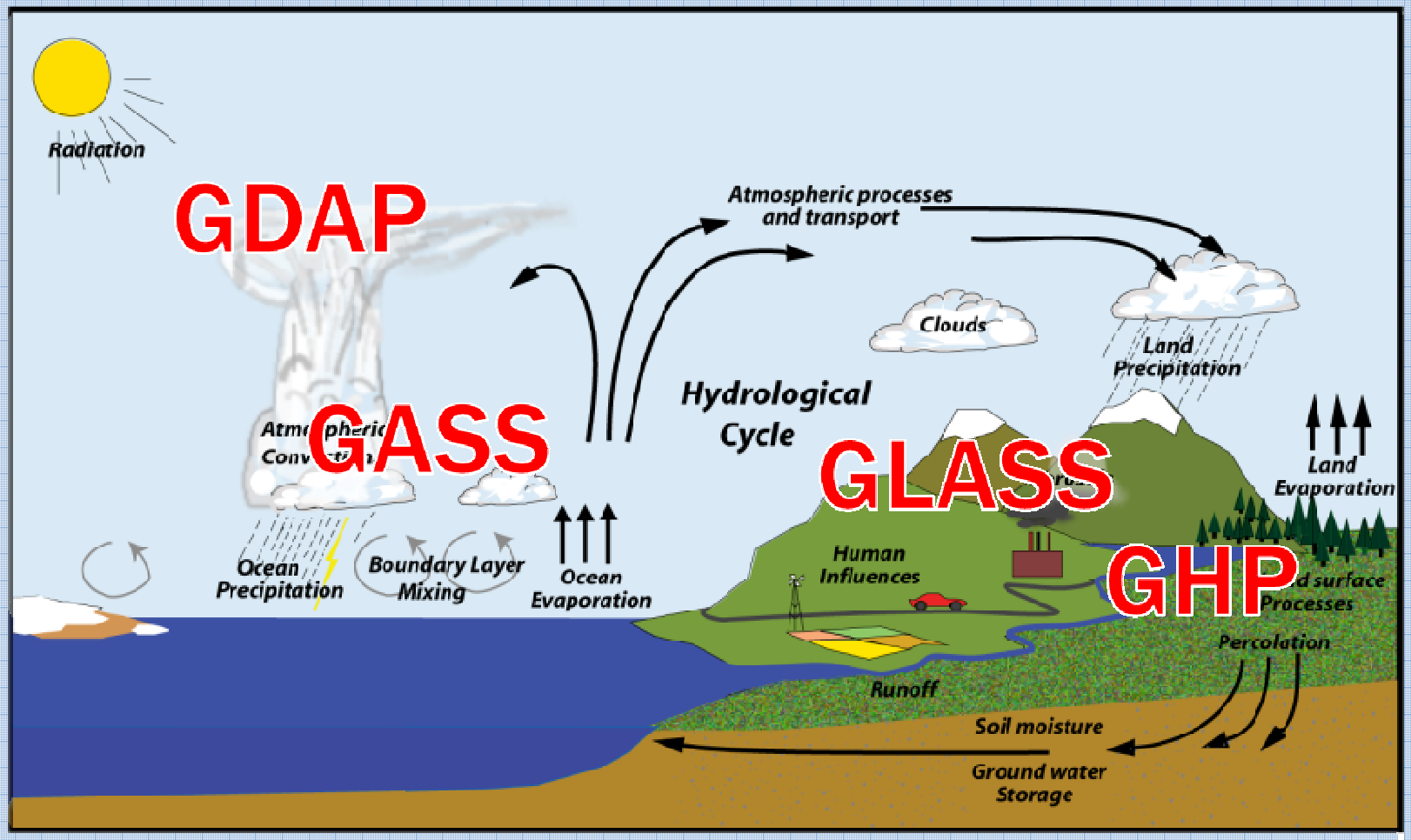


GEWEX Organization



GEWEX Science

GEWEX: Major Components



GEWEX Science Questions

- Are these questions actionable/action-oriented?
  - I.e. are they tractable, and is there a way forward?
- What new opportunities have arisen that relate to observations (such as new satellites; proposed field projects), models (computers, better resolution, new models like CMIP5), ideas?
- What benefits might accrue? What are the impacts? Why does it matter? Are there links to food, water, health, energy, biodiversity…?

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

1. Observations and Predictions of Precipitation

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

- How well can precipitation be described by various observing systems and what basic measurement deficiencies and model assumptions determine the uncertainty estimates at various space and time scales
- How do changes in climate affect the characteristics (e.g., distribution, amount, intensity, frequency, duration, type) of precipitation, with particular emphasis on extremes of droughts and floods?
- How much confidence do we have in global and regional climate predictions of precipitation?

GEWEX

2. Global Water Resource Systems

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

- How do changes in land surface and hydrology influence past and future changes in water availability and security
- How do changes in climate affect terrestrial ecosystems, hydrological processes, water resources and water quality, especially water temperature?
- How can new observations lead to improvements in water management?

3. Changes in Extremes

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

- What are the short-term, mid-term and strategic requirements for the existing observing systems and data sets, and which observations are needed to accurately quantify trends in the intensity and frequency of extremes on different space/time scales?
- How can models be improved in their simulation and predictions or projections of the magnitude and frequency of extremes?
- How can the phenomena responsible for extremes be better simulated in models?
- How can we promote development of applications for improved tracking and warning systems arising from extremes?

GEWEX

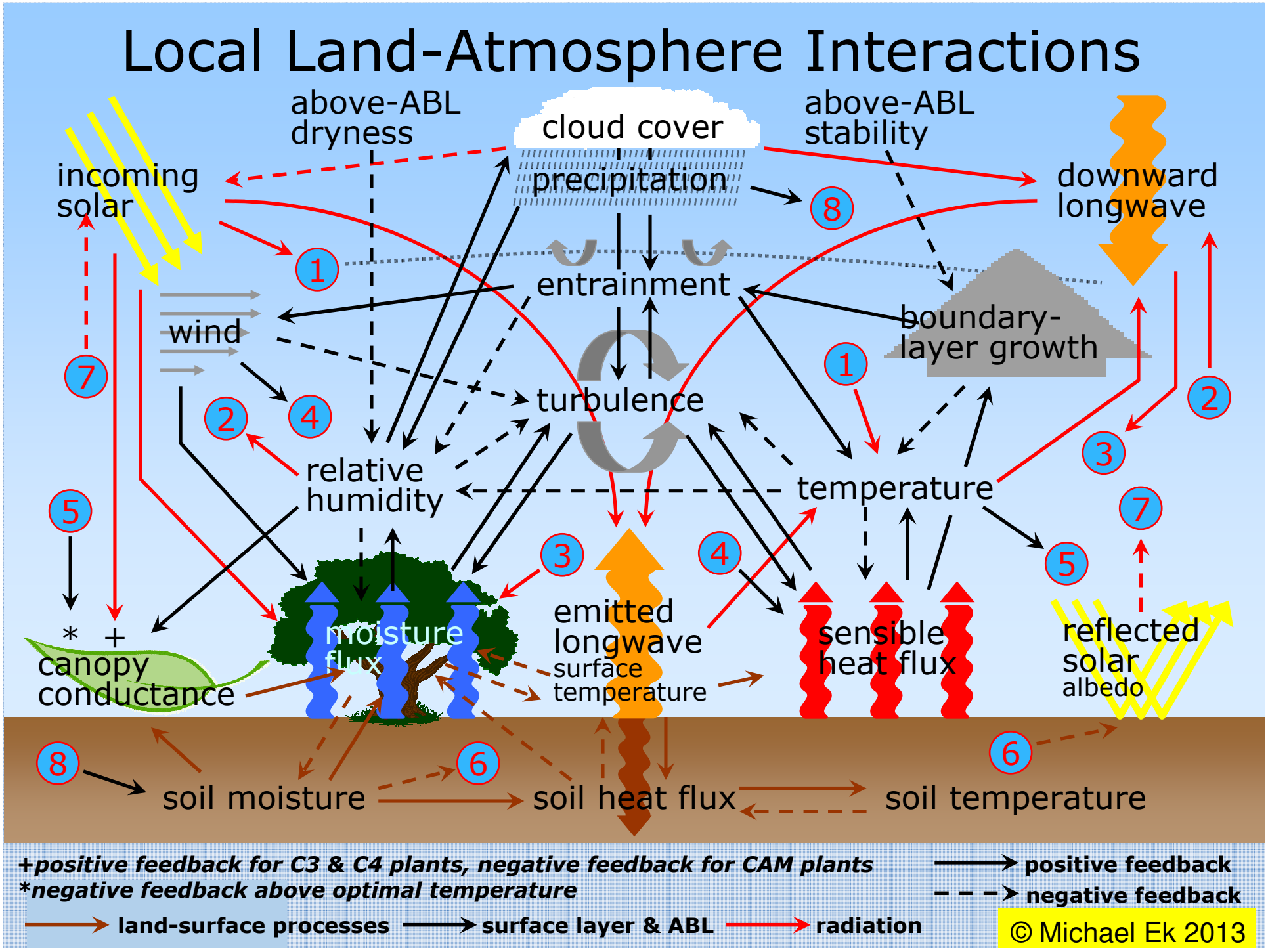
4. Water and Energy Cycles and Processes

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

- Can we balance the energy budget at the top-of-atmosphere?
- Can we balance the energy budget at the surface of the Earth?
- Can we further track the changes over time?
- Can we relate the changes in surface energy budget with atmospheric-oceanic processes and long-term variability
- Can we improve confidence in feedbacks associated with cloud-aerosol-precipitation interactions in the climate system?

GEWEX

Local Land-Atmosphere Interactions



Two looming challenges

- Hydrology of high terrain (e.g the third pole) - poorly instrumented, global data sets (e.g. precipitation) have huge errors, and our understanding of the water cycle in these regions is poor
- Closing the surface energy balance - we have closure @ 10-20 Wm^{-2} which is too coarse for most climate applications

Closing Thoughts:

One of the important ingredients for progress on the GCs is not only the development of new data sets but more importantly a careful assessment of their accuracy and the development of tools to bring them together in a much more integrated way.

GEWEX Imperatives

The Imperatives – things that must be done - provide a strategic view of GEWEX activities for 15 years beyond 2013. They form the framework for a more focused set of GEWEX Science Questions (GSQs) whose main focus is on the 5-10 year period from 2013-2022.

GEWEX Imperatives

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

Conclusion

The successful implementation of the WCRP Grand Challenges and associated science questions described here depend significantly upon the GEWEX Imperatives: observations and data sets, their analyses, process studies, model development and exploitation, applications, technology transfer to operational results, and research capacity development and training of the next generation of scientists.

They involve all of the GEWEX Panels and will benefit greatly from strong interactions with other WCRP projects such as CLIVAR, SPARC, and CliC and other sister global environmental change research programs such as the IGBP, the International Human Dimensions Programme (IHDP), and DIVERSITAS.

Acknowledgement

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