

The Global Energy and Water Cycle Exchanges Project (GEWEX): Status on its 30th anniversary

Joan Cuxart

Co-chair, GEWEX Hydroclimate panel

2nd Baltic Earth Conference, 11-15 June 2018, Helsingor, Denmark

- 1. World Climate Research Programme (WCRP)**
- 2. The Global Energy and Water Exchanges (GEWEX) project**
- 3. The GEWEX Hydroclimatology Panel (GHP)**
- 4. Regional Hydroclimate Projects (RHPs)**
- 5. WCRP under review**

WCRP (World Climate Research Program)

Joint Scientific Committee lead by Guy Brasseur (MPI), Director

WCRP aims to determine the predictability of climate and the effect of human activities on climate.

Co-sponsored by:

WMO (World Meteorological Organization)

ICSU (Institute Council for Sciences,

with strong bio/social interests) -it has animated "Future Earth"-

IOC (Intergovernmental Oceanographic Commission of UNESCO)

WWRP (World Weather Research Program)

Joint Scientific Committee lead by Sarah Jones (DWD), Director Paolo Ruti.

** WWRP ensures the implementation of a research strategy towards the seamless prediction of the Earth system from minutes to months.*

** WWRP is a WMO initiative*

Both programs are assessed by the WGNE (working group on numerical experimentation)

World Climate Research Programme

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 (JSC)

WCRP MODELLING ADVISORY COUNCIL (WMAC)

WCRP DATA ADVISORY COUNCIL (WDAC)

WORKING GROUPS ON:
 SUBSEASONAL TO INTERDECADAL PREDICTION (WGSIP)
 NUMERICAL EXPERIMENTATION (WGNE)
 COUPLED MODELLING (WGCM)
 REGIONAL CLIMATE (WGRC)



CRYOSPHERE-
CLIMATE



OCEAN-
ATMOSPHERE



LAND-
ATMOSPHERE



TROPOSPHERE-
STRATOSPHERE



REGIONAL CLIMATE
DOWNSCALING

GRAND CHALLENGES

CLOUDS, CIRCULATION AND CLIMATE SENSITIVITY

REGIONAL SEA-LEVEL CHANGE AND COASTAL IMPACTS

CARBON FEEDBACKS IN THE CLIMATE SYSTEM

UNDERSTANDING AND PREDICTING WEATHER AND CLIMATE EXTREMES

NEAR-TERM CLIMATE PREDICTION

MELTING ICE AND GLOBAL CONSEQUENCES

WATER FOR THE FOOD BASKETS OF THE WORLD

JOINT PLANNING STAFF (JPS)



INTERNATIONAL
COUNCIL
FOR SCIENCE

WCRP
World Climate Research Programme

GEWEX mission

Mission: to measure and predict global and regional energy and water variations, trends, and extremes, such as heat waves, floods, and droughts.

How: through improved observations and modelling of land, atmosphere, and their interactions, thereby providing the scientific underpinnings of climate services.

Status: Third phase (2013-22), taking advantage of mature modelling and observing systems.

Guidelines: Science Questions and Imperatives, linked to WRCGP Grand Challenges

International GEWEX Project Office (IGPO)

Located at Washington D.C., endorsed by NASA, the Director is Peter van Oevelen
It supports GEWEX activities, by planning meetings, implementing research goals and producing a quarterly newsletter.

Scientific monitoring

Externally by WCRP's Joint Scientific Committee (JSC, lead by Guy Brasseur)
Internally by its Scientific Steering Group (SSG)
(co-chairs: Graeme Stephens (NASA) and Jan Polcher (CNRS))

GEWEX methodology

GEWEX intends to coordinate science activities to

- i) facilitate research into the global water cycle and interactions between the land and the atmosphere,
- ii) identifying gaps in knowledge, and
- iii) fill them through new studies, reviews of datasets, gathering of experts or other opportunities..

GEWEX Science Questions

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		

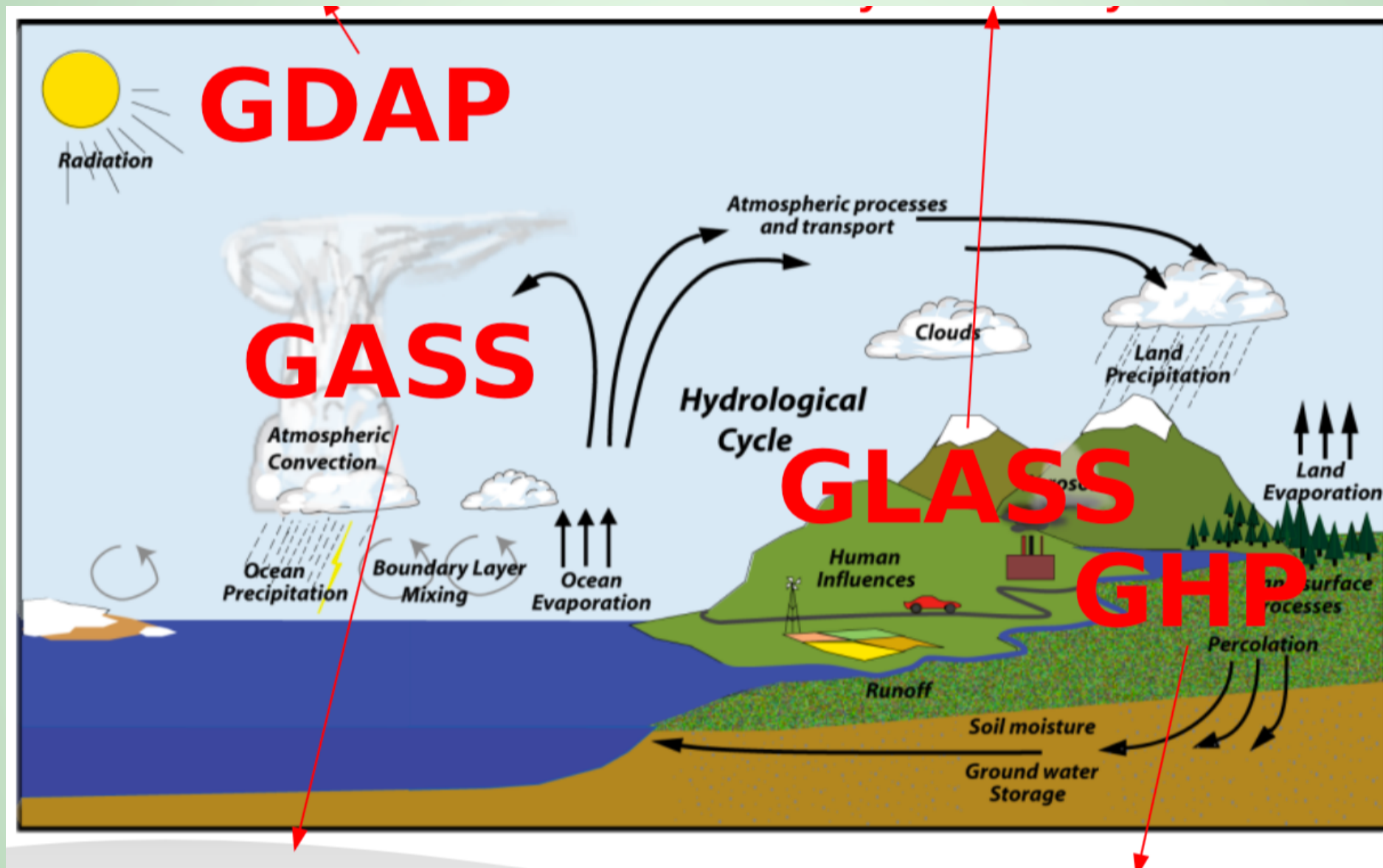
Structure of GEWEX in 4 Panels

GDAP (Data and Assessment)

Radiation and Atmospheric Composition

GLASS

Land/Atmosphere system study



GASS (Atmospheric System Studies)

Atmospheric processes in numerical models

GHP (Hydroclimate)

RHPs, CCc and Data Centers

GDAP (GEWEX Data and Assessment Panel):

Theoretical and experimental insights into radiative interactions and climate feedbacks.

- How can we better characterize the state and the variations of the climate using satellite observations?
- What changes in radiative forcing cause climate change?
- How interactions of radiation with changes of the internal state of the climate affect the climate's sensitivity?
- How do the internal water exchange and transport processes in the climate affect the climate's sensitivity?

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)

GASS (Global Atmospheric System Studies)

Goal: to understand the physical processes and their coupling with dynamics
(with emphasis on the atmospheric branch of the hydrological cycle)

Mission: improving the representation of the atmosphere in weather and climate models

- **Surface drag and momentum transport**: orographic drag, convective momentum transport, drag coefficients, boundary-layer mixing
- **Processes relevant for polar prediction**: stable boundary layers, mixed-phase clouds, coupling to the surface
- **Shallow and deep convection**: stochasticity, scale-awareness, organization, grey zone issues
- **Clouds and circulation feedbacks**: boundary-layer clouds, CFMIP, cirrus
- **Microphysics and aerosol-cloud interactions**: microphysical observations, parameterization, process studies on aerosol-cloud interactions
- **Radiation**: circulation coupling; interaction between radiation and clouds
- **Land-atmosphere interactions**: Role of snow, soil moisture, soil temperature, and vegetation in sub-seasonal to seasonal (S2S) prediction
- **Physics-dynamics coupling**: numerical methods, scale-separation and grey-zone, thermodynamic consistency
- **Next generation model development**: challenge of exascale, dynamical core developments, regional refinement, super-parameterization
- **High Impact and Extreme Weather**: role of convective scale models; ensembles; relevant challenges for model development
- **Precipitation diurnal cycle** over different climate regimes

(Panel currently being reformulated, lines suggested)

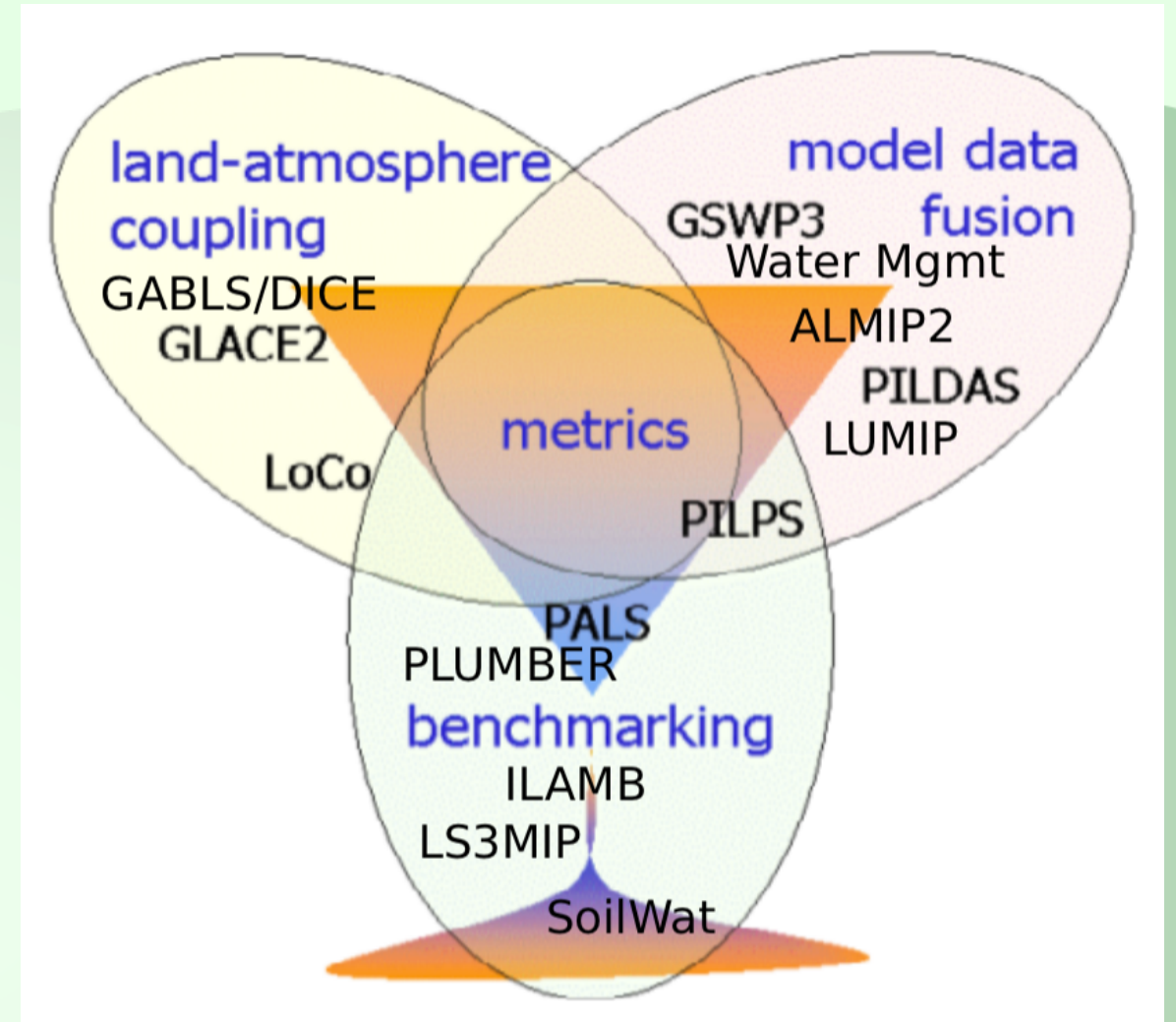
GLASS (Global land/Atmosphere System Study)

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

Some ongoing activities:

- *GASS/GLASS/DICE experiments
- *GEWEX Soil and Water (SoilWat) initiative
- *Protocol for the Analysis of Land Surface models (PALS)
- *PALS Benchmarking Evaluation Project (PLUMBER)
- *Local Land-Atmosphere Coupling (LoCo) Project
- *Land Surface, Snow and Soil Moisture Model Intercomparison Project (LS3MIP)
- *Project for Intercomparison of Land Data Assimilation Systems (PILDAS)



The GEWEX Hydroclimatology Panel (GHP)

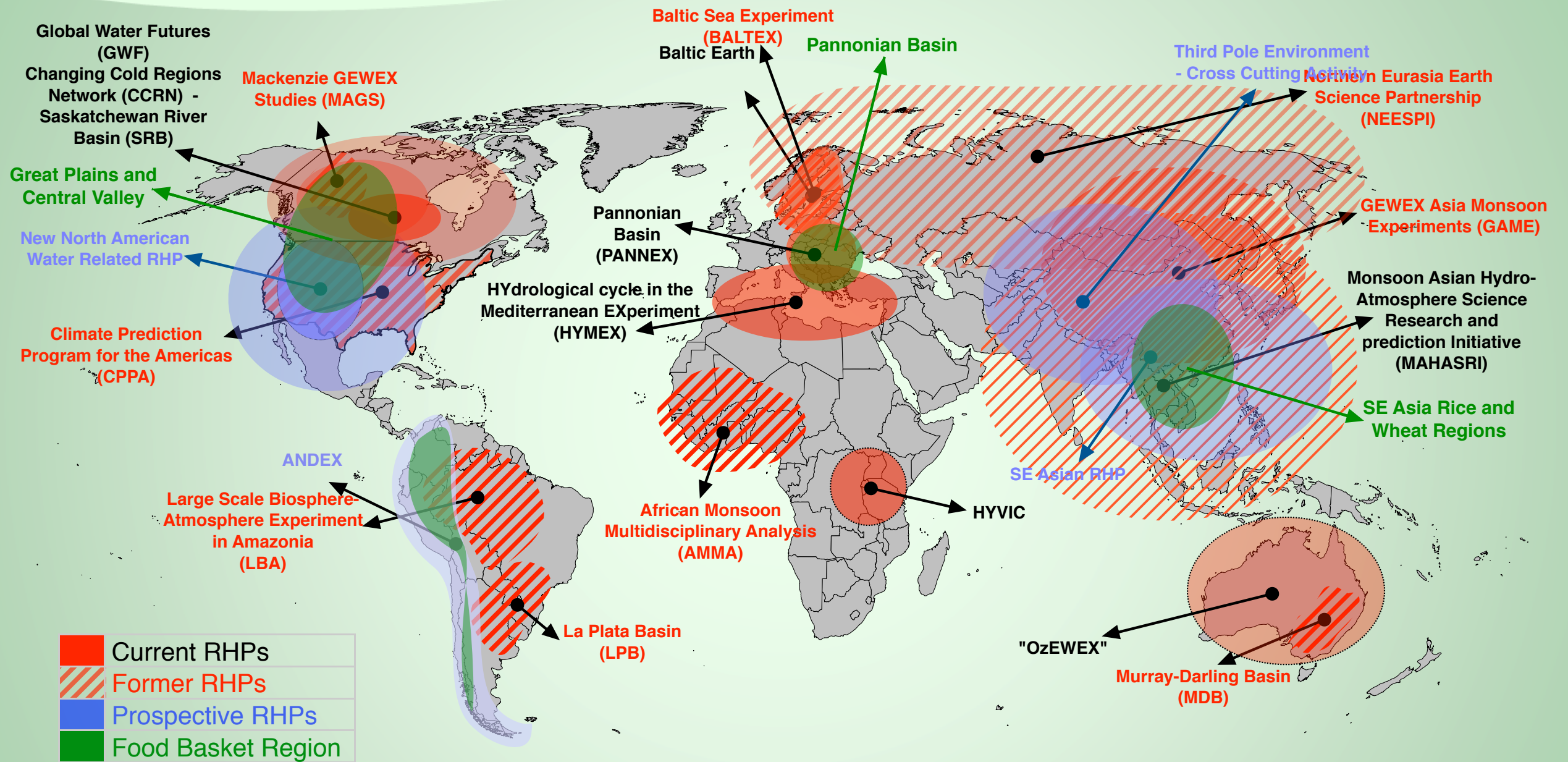
Objectives

- * Understanding and predicting continental to local-scale hydroclimates.
- * Through the study of environmental water and energy exchanges at the regional scale and from an integrative perspective.
- * Consider the many components of the system, from its physical to the economic and social aspects.

Three types of projects:

- * Regional Hydroclimatological Projects (RHPs), bringing together various disciplines on water and energy related issues
- * Cross-Cutting projects (CCs) to propagate knowledge between regions and synthesize results at the global scale.
- * Global Data Centers that collect and distribute data.

RHPs (former, current, prospective) and selected Food Basket areas



RHP Status

Active in 4 continents:

- Europe: **HyMeX** (2010-20) =====> High-impact weather events, societal response
- Baltic Earth** (2016-) =====> Sea and land changes, biogeochemical processes
- PannEx** (2017-) =====> Agronomy, air quality, sustainability & water management
- Australia: **OzEWEX** (2015-19) =====> Water and energy cycle in Australia
- Africa: **HyVic** (2015-2024) =====> Hydroclimatic variability over Lake Victoria basin

Recently finished:

- Asia: **MAHASRI** (2007-2016) =====> Asian Monsoon
- Eurasia: **NEESPI** (2004-2015) =====> Northern Eurasian climate-ecosystem-societal interact.
- North America: **CCRN** (2014-2018) => Cryospheric, ecological, hydrological interactions

Prospective:

- North America: **GWF** (2018-) =====> Hydroclimate in Canada river basins (Science plan available)
- South-America: **ANDEX** (2019?-) ==> Climate, water and vulnerability in the Andes (workshop in Oct)
- Asia: A cross-cutting activity on Water Sustainability in the Third Pole Environment (under discussion)

Wishing list:

- Western USA =====> Related to water management
- Southeast Asia: ==> Related to the Monsoon



The three phases of an RHP

Prospective phase, making a **project plan** (science plan + implementation plan + coordination mechanism)

Initiating phase, after endorsement of the Project Plan by GEWEX's SSG,

Fully working RHP: 5 to 10 years, to enhance science, implement results and tools at the regional level,

GHP shall facilitate interaction with other RHP and GEWEX and WCRP actions.

An annual report/update of the Science plan is required showing adequate progress.

RHPs: Multiple formats and origins

Often a previous structure or network that decide to adhere to the RHP commitments

More recently new RHPs are being formed according to the suggested structure (SQ, WG & CC)

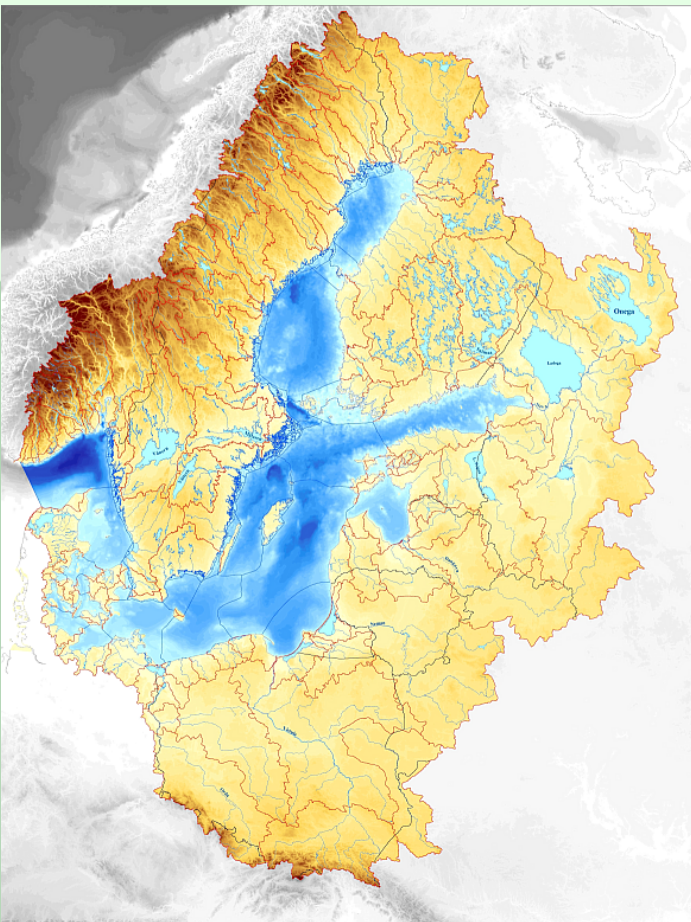
SQ: Science Questions, WG: Working Groups; CC: Cross-cutting actions

Usually multinational, but national efforts also exist (OzEWEX, GWF)

Leadership may be from one country (HyMeX) or multilateral (PannEx, Baltic Earth)

RHPs must have relation with GEWEX's Science Questions and Imperatives, but might also address other subjects (Food production, pollution control, ...).

Experimental campaigns to address the Science questions are usually planned, but an optimized use of the available information is a major asset.

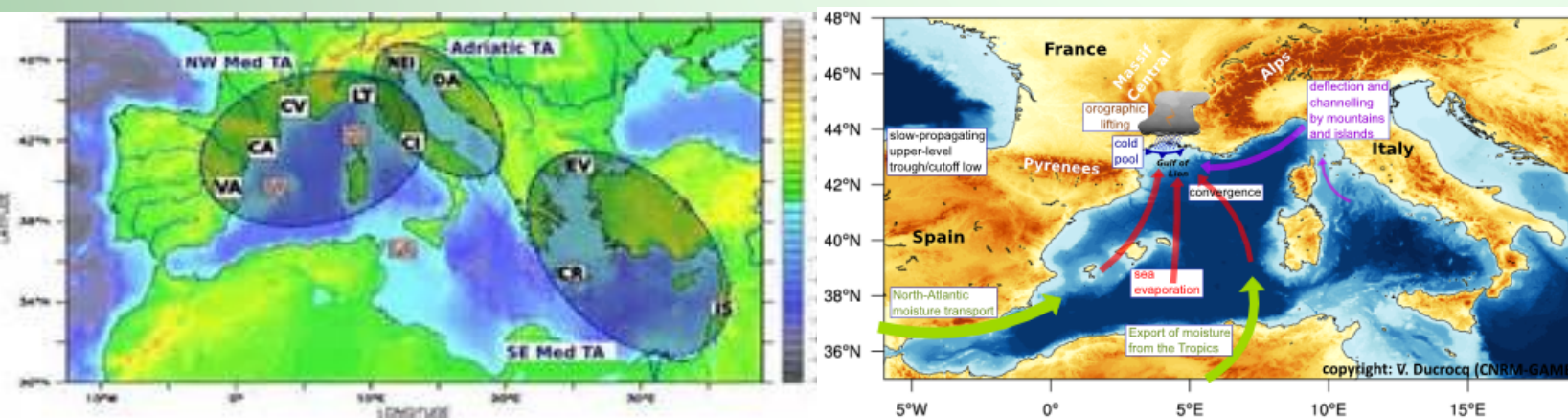


Baltic Earth

- GC1: Salinity dynamics in the Baltic Sea
- GC2: Land-Sea biogeochemical feedbacks in the Baltic Sea region
- GC3: Natural hazards and extreme events in the Baltic Sea region
- GC4: Understanding sea level dynamics in the Baltic Sea
- GC5: Understanding regional variability of water and energy exchanges

Hydrological cycle in the Mediterranean Experiment (HyMeX)

2010-2020



WG1: The water budget of the Mediterranean Sea

WG2: The continental hydrological cycle and related water resources

WG3: Heavy rainfalls, flash-floods and floods

WG4: Intense sea-atmosphere interactions

WG5: Societal and economic impacts

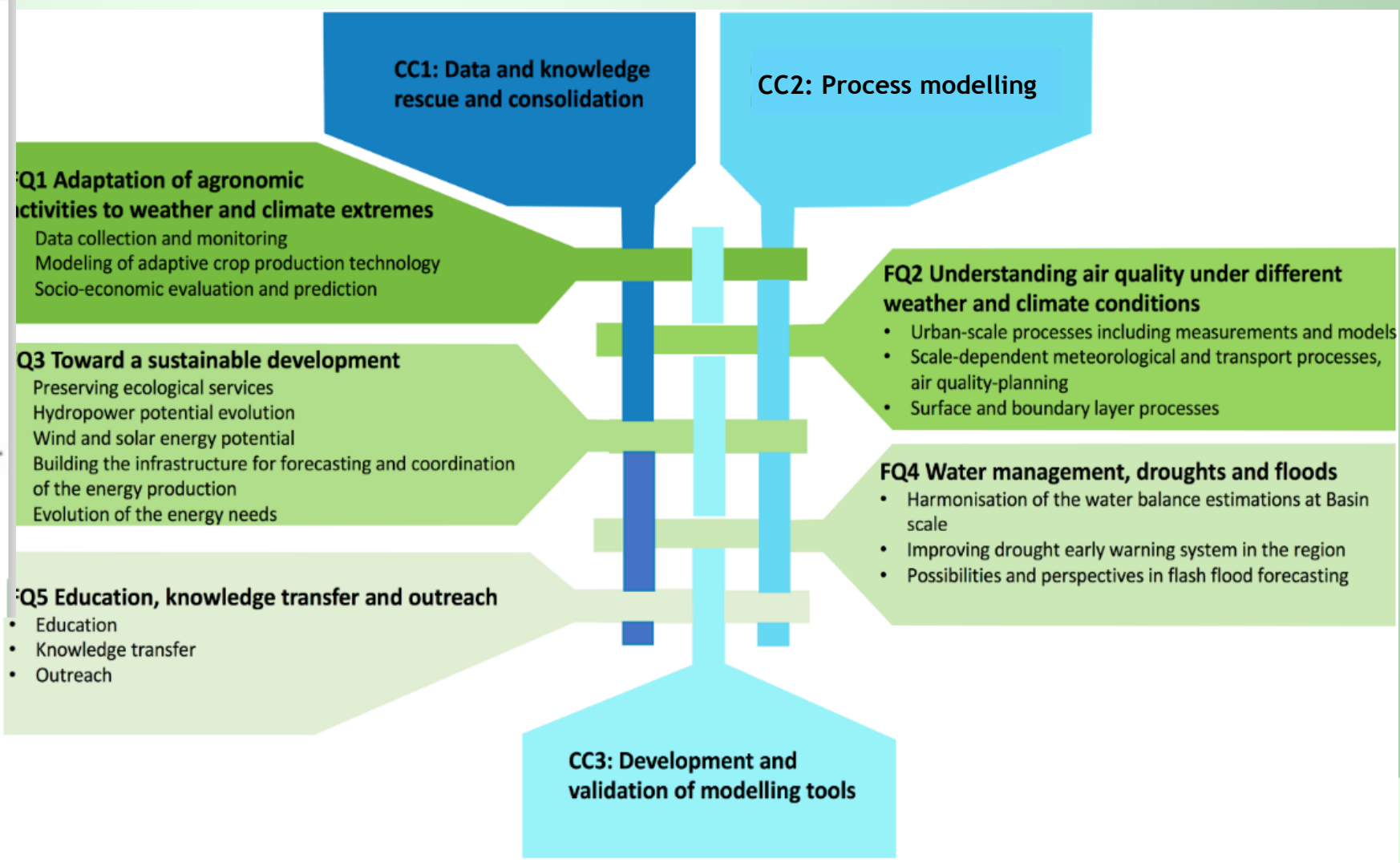
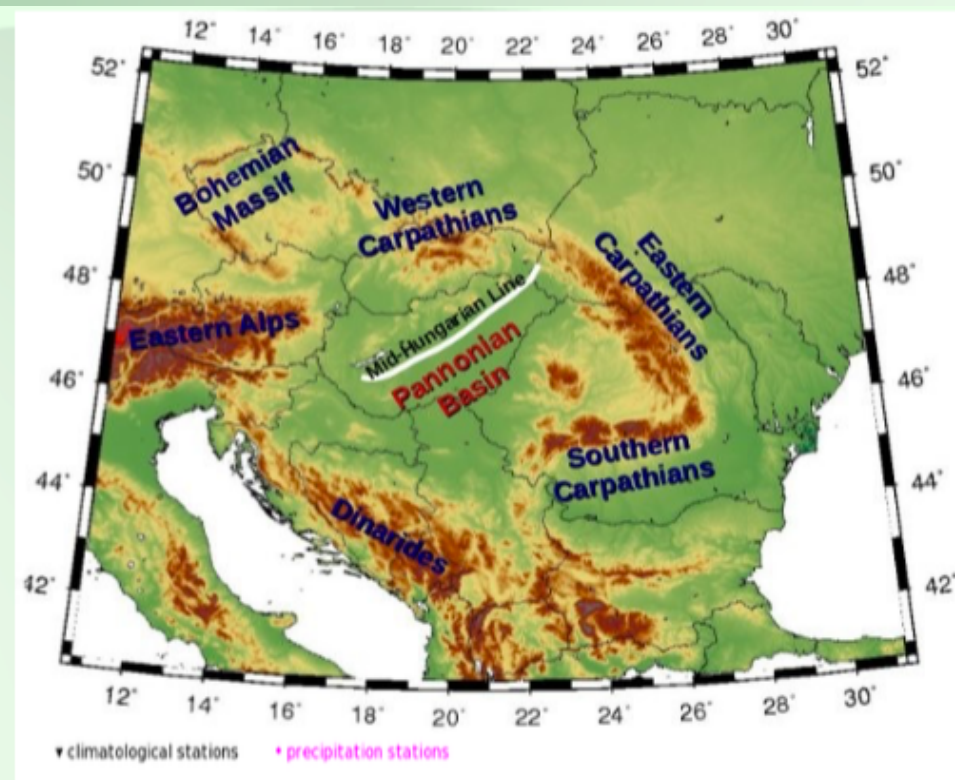
PannEx

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

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



Cross-cut Projects List

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

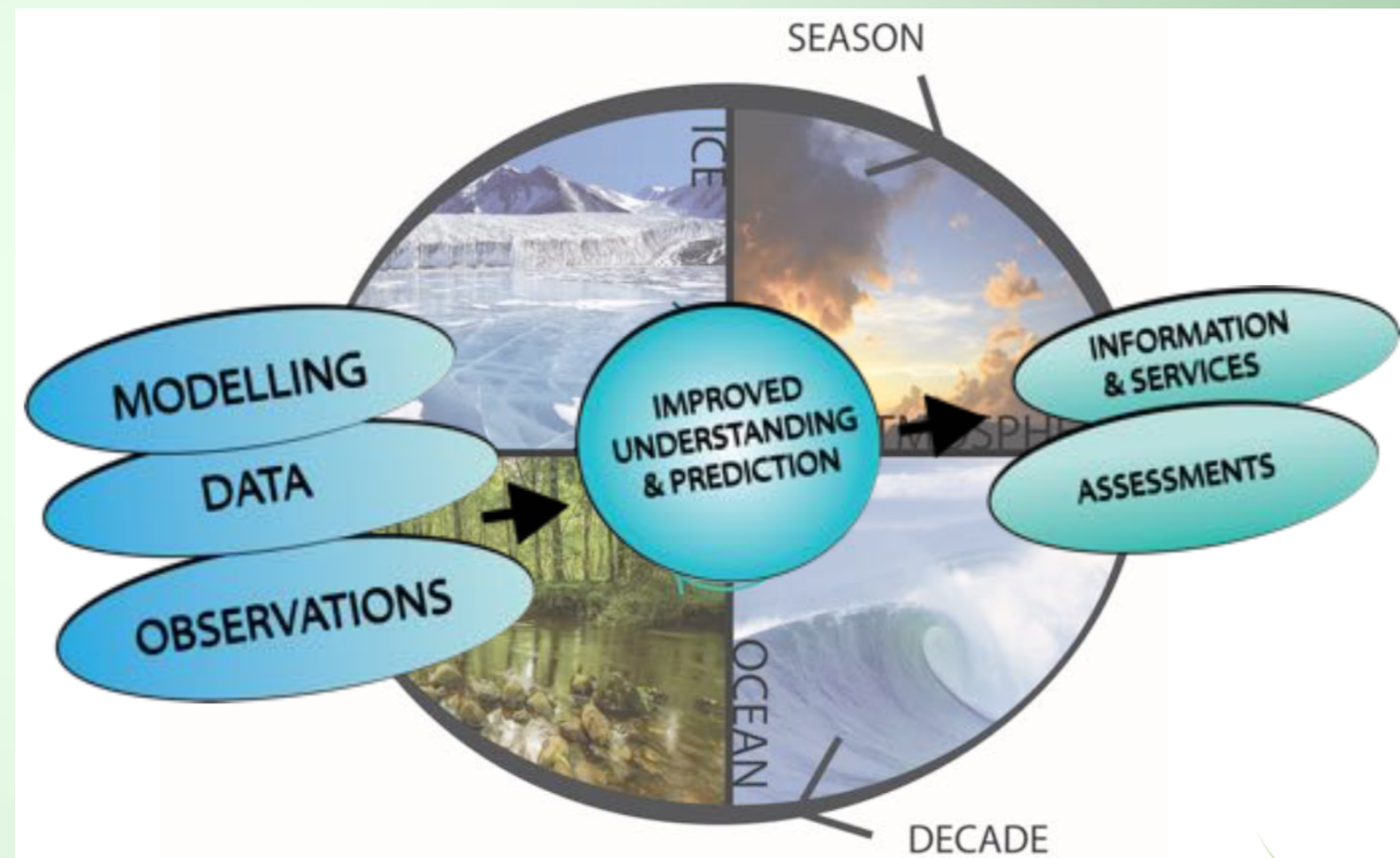
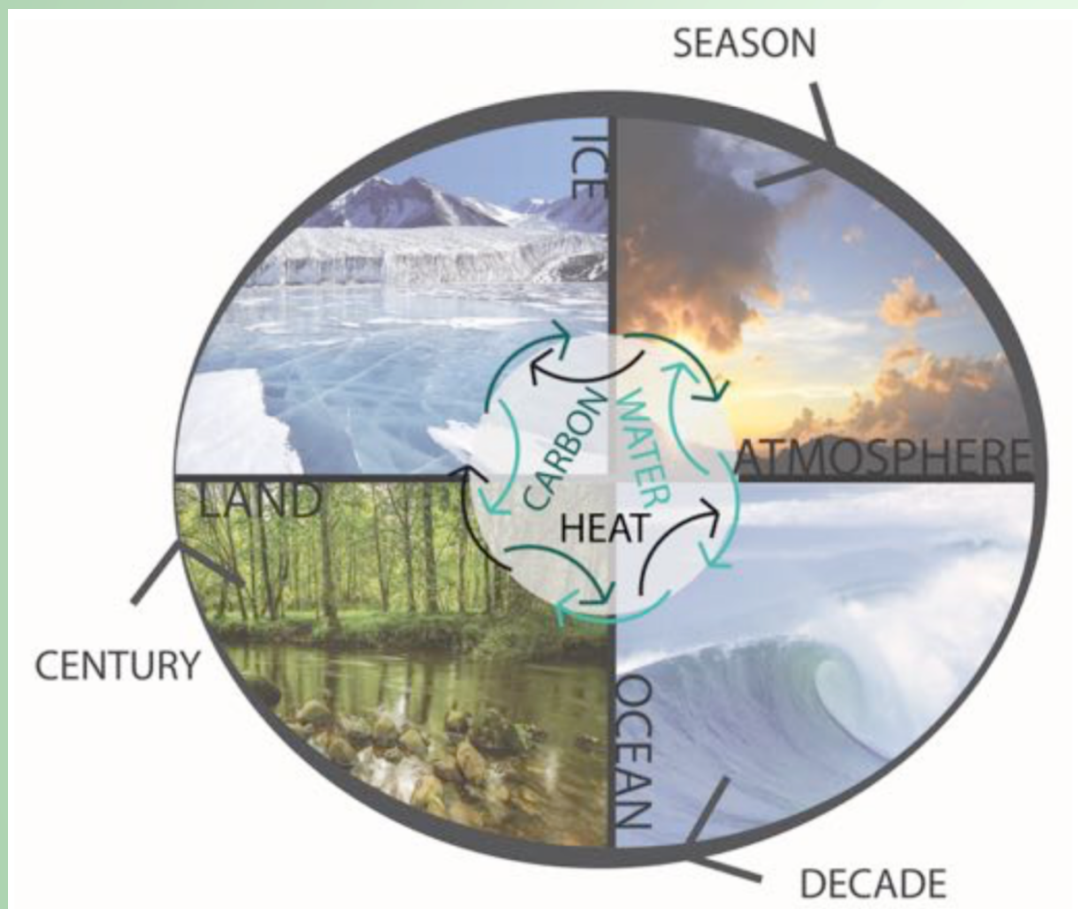
- TPEWS (Third Pole Environment Water Sustainability)
- Including water management in large scale models (R. Harding / J. Polcher)

Potential

- GDAP integrated product regional evaluation
- Determining Evapotranspiration
- MOUNTerrain (Mountainous Terrain rainfall)

WCRP under review

WCRP has been under review that has been completed recently and guidance has been provided, that shall result in a new strategic science plan (2019-29) and an implementation plan (2019-23)



G. Brasseur (GEWEX conf, 2018)

WCRP SWOT Summary

STRENGTHS

- Active global science community collaborating toward common goals
- Excellent reputation and legitimacy (long history of global leadership) and strong co-sponsor backing
- Global research products
- Participation of leading scientists – strong scientific expertise

WEAKNESSES

- Overly complex structure
- Lack of clarity of focus/vision and boundaries
- Insufficient funding – complex and competitive
- Ineffective communication, successes not well showcased
- Not well connected to National Research Programmes, funding agencies, services etc. – requires global travel
- Reliance on voluntary efforts

OPPORTUNITIES

- Climate important to societal questions, particularly climate change
- Benefits (funding, in kind) associated with closer collaboration with operational agencies, international programs, etc. (stakeholders)
- Leadership needed to capitalize on new technologies
- Many emerging areas of research

THREATS

- Budget cuts and inefficient funding - leading to demotivation of volunteers/community
- Organizations with overlapping or perceived as overlapping mandates
- Fast-changing and reactive political landscape
- Perception that fundamental climate science is 'done' - reduction in support for fundamental science - perceived as irrelevant

26 September to 12 November 2017,
49 responses

WCRP under review



INTERNATIONAL
COUNCIL
FOR SCIENCE



G. Brasseur (GEWEX conf, 2018)



Vision and Mission

- **Vision**

A world that uses relevant and authoritative climate science to ensure a resilient present and future for humankind and the planet.

- **Mission**

The World Climate Research Programme (WCRP) develops, shares and applies climate knowledge that contributes to societal well-being by supporting international climate research.

The Programme, working in partnership with many international initiatives, ensures the implementation of a climate research strategy on observation, analysis and prediction of climate system variability and change from weeks to century time scales and from local to global spatial scales.

WCRP under review

Current:

The World Climate Research Programme (WCRP) facilitates analysis and prediction of Earth system change for use in a range of practical applications of direct relevance, benefit and value to society. WCRP aims to determine the predictability of climate and the effect of human activities on climate.

Current:

GEWEX Imperatives

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

Imperatives

Building the capacity needed to execute globally coordinated climate science

1. Hierarchy of Earth and climate system **models**
2. **Observations** and datasets in support of climate science
3. Timely **assessments** of the state of the climate system
4. Open access, **high-end computing** and **data infrastructure**
5. Supporting a vibrant **climate research community** around the world
6. Communication and **education**
7. Outreach and **societal engagement**
8. Institutional and programmatic **partnerships**

WCRP Strategic Plan

Overarching Objectives

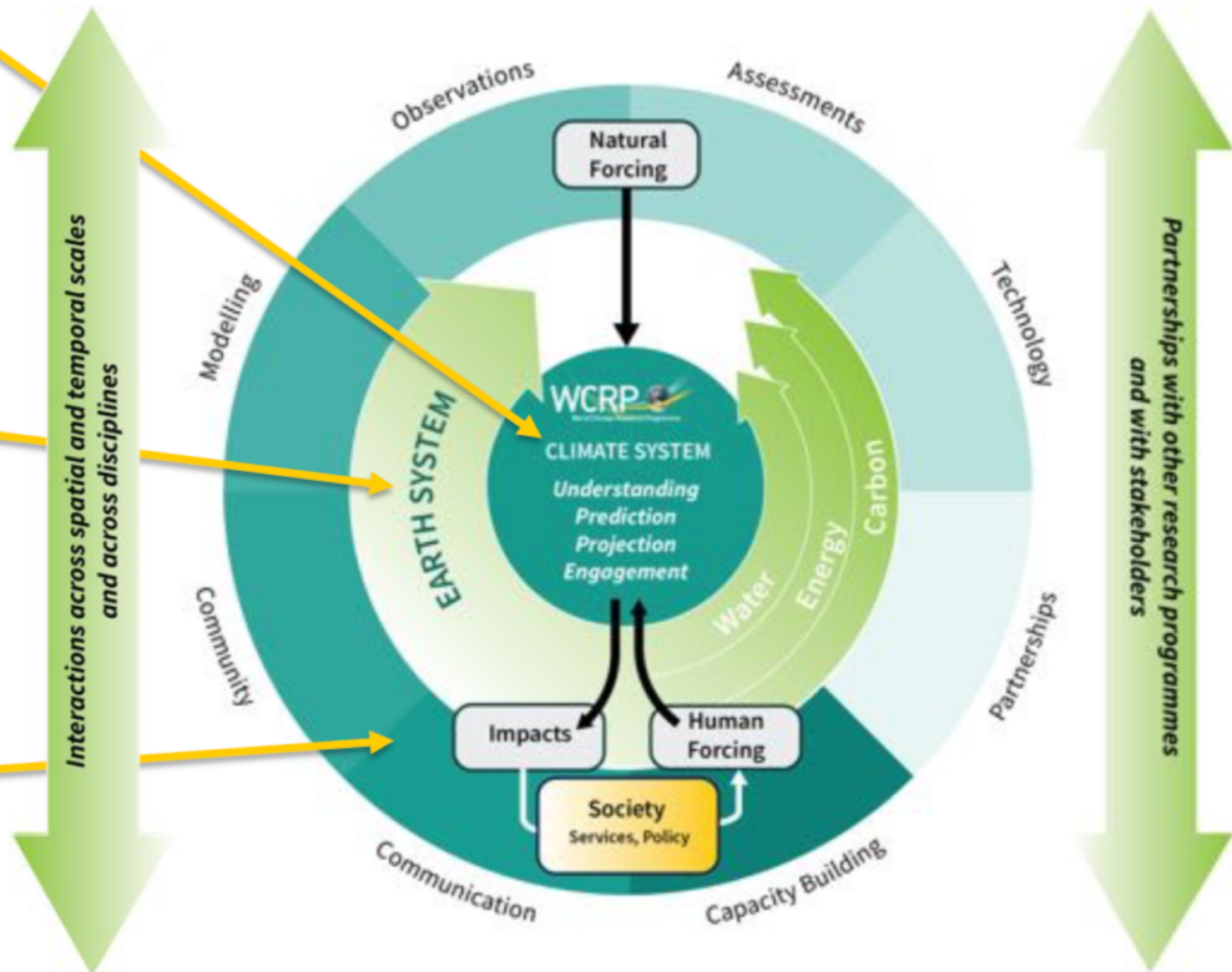
Focuses on the far horizon - the scientific research required to address current and future challenges and take advantage of opportunities

Emphases

Highlights the bedrock science that must be supported and nurtured as new communities form and re-form around evolving scientific foci in support of the Objectives

Imperatives

WCRP tools and capabilities, including those focused on technical capacity and those relating to human capacity driven activities



INTERNATIONAL COUNCIL FOR SCIENCE



Key points

WWRP and WCRP are looking for ways to converge, climate and weather share a lot.

WCRP Grand challenges, questions and imperatives facilitate a common framework for diverse activities.

These WCRP items are not excluding specific developments of interest in each area.

Core Groups of WCRP are open to all parties interested in cooperation, look for your area of activity/expertise!

The traditional way of organizing activities regionally is through RHP's, which are locally ruled, and report to GEWEX about their achievements.

The link between RHP's is made through Cross-cut actions and in the GHP annual meeting.

Proposing a Cross-Cut action is an "individual" initiative, and joining current CCs is always possible.