GEWEX in Central Asia

Opportunities and Linkages

Presentation for Central Asia Regional Hydroclimate Project Initiative Workshop

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With contributions from:
GEWEX Leadership: Jan Polcher and Xubin Zeng (co-chairs GEWEX SSG)
The Entire GEWEX Community

GEWEX

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Before we beging: What do ‘we’ want?

- Get clarity on what you, Central Asian scientists want
- Develop a network of collaborating and data sharing scientists/researchers – no funding involved
- Establish a Regional Hydroclimate Project in Central Asia
- Develop and implement a field experiment in the realm of hydroclimatalogy and meteorology – pbl, cryosphere,

What is GEWEX

- GEWEX is the Global Energy and Water Exchanges project of the World Climate Research Programme

- Goal: facilitate international research collaboration to advance biogeophysical climate and weather research – special focus over land/atmosphere and global EO datasets

- Around since 1990: almost 4 decades of experience in supporting the international research community

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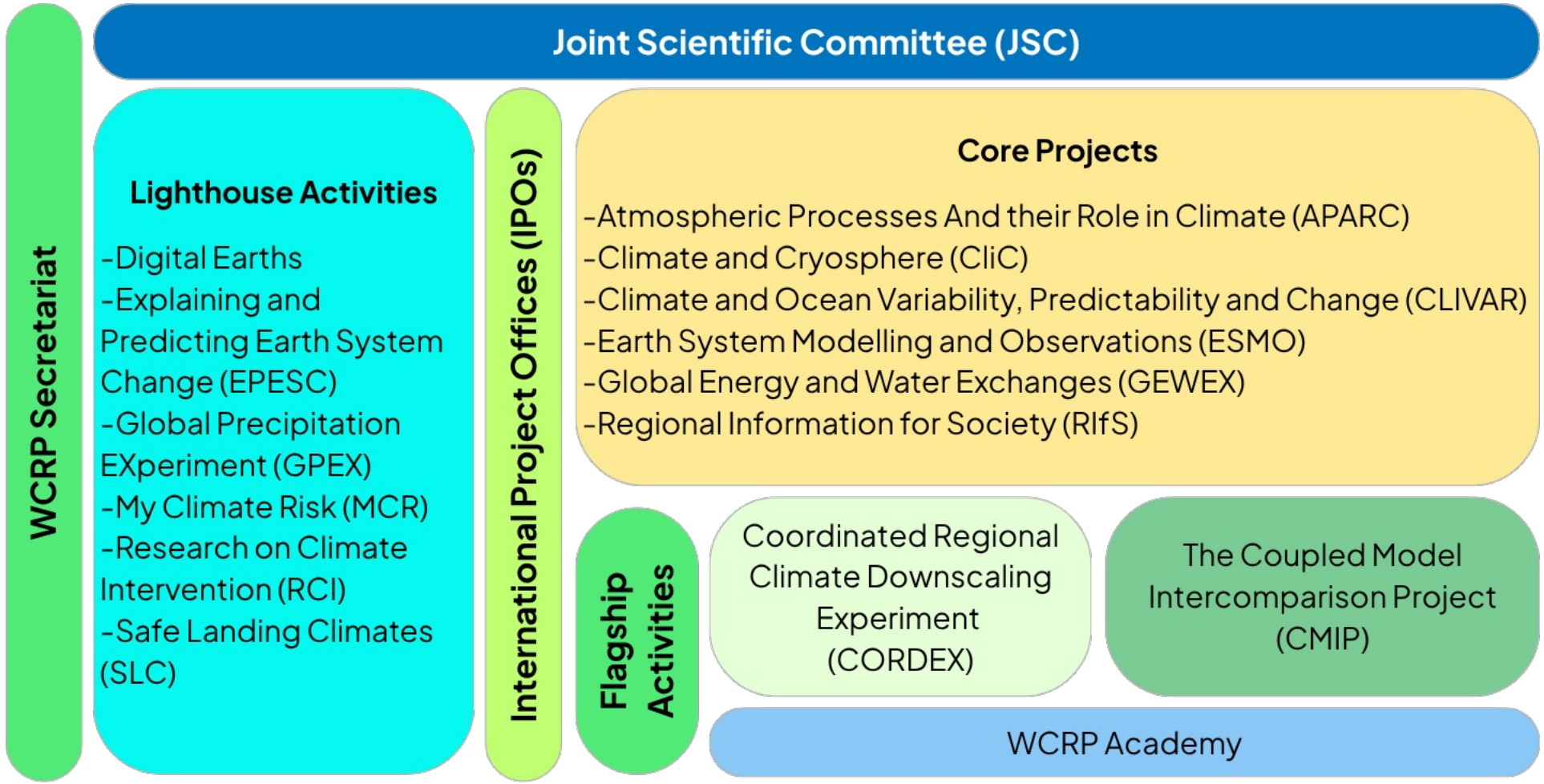
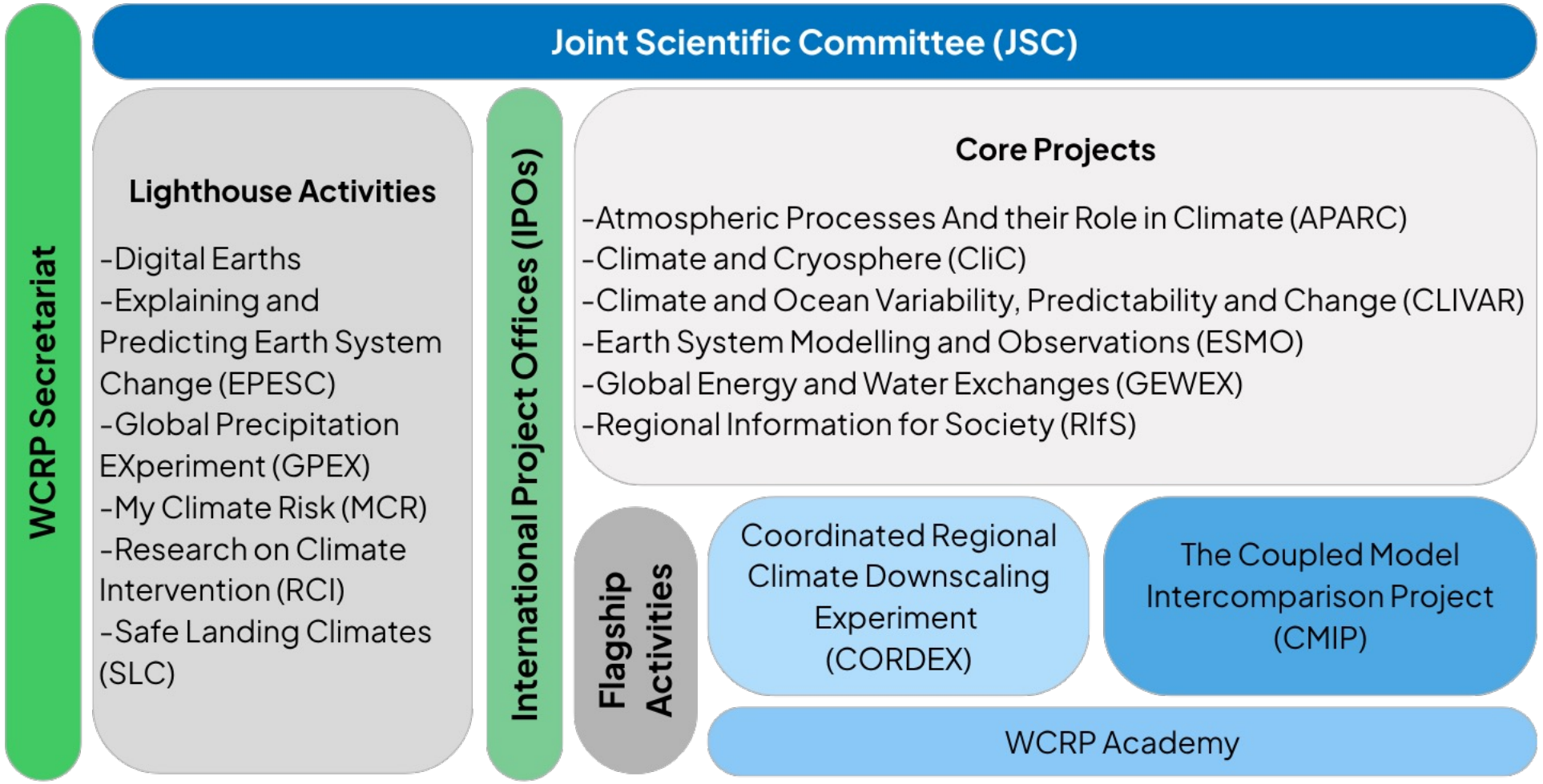
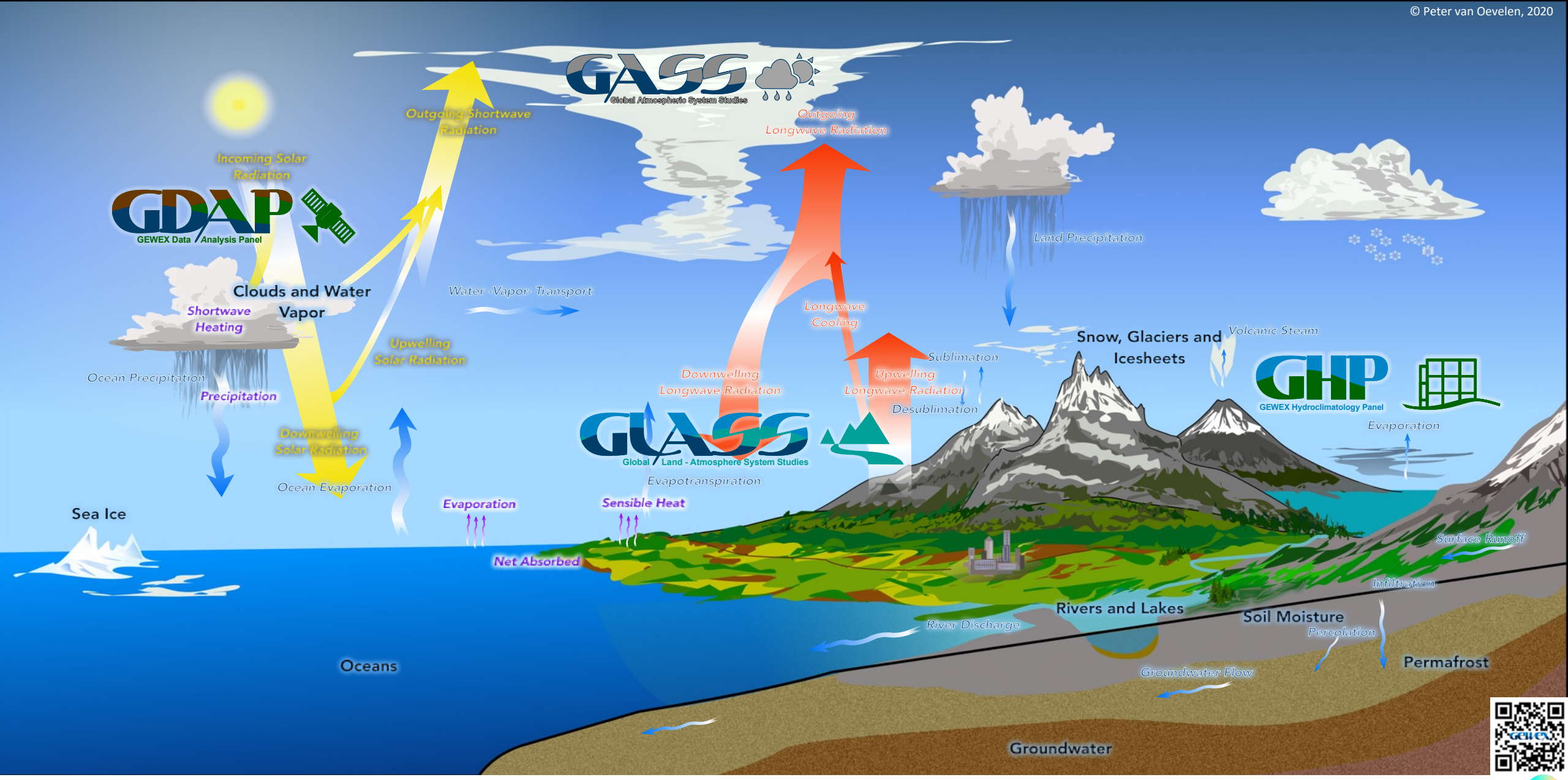
WCRP Organizational Structure



WCRP Organizational Structure





GEWEX

The GEWEX Panels:

- GEWEX Data Analysis Panel — *Global Datasets Analysis and Assessments*
- Global Atmospheric System Studies — *Atmospheric Processes - Dynamics*
- Global Land–Atmosphere System Studies — *Land-Atmosphere Interactions and Processes*
- GEWEX Hydroclimatology Panel — *Regional Focused Processes and Hydroclimate Projects*

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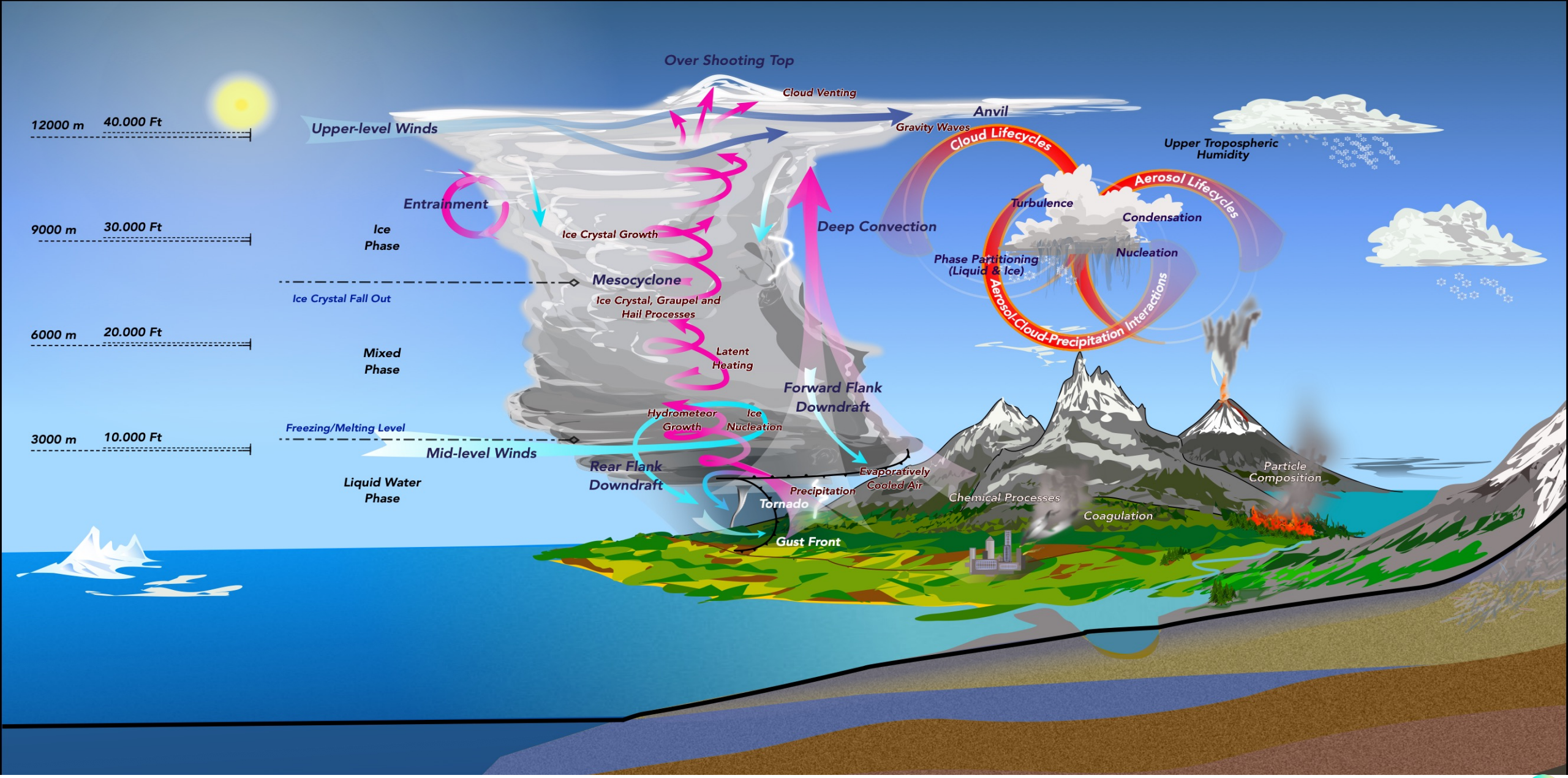

- *Weather and Climate*
- *Global Hydrological, Energy and Carbon Cycles*
- *Process Focused*

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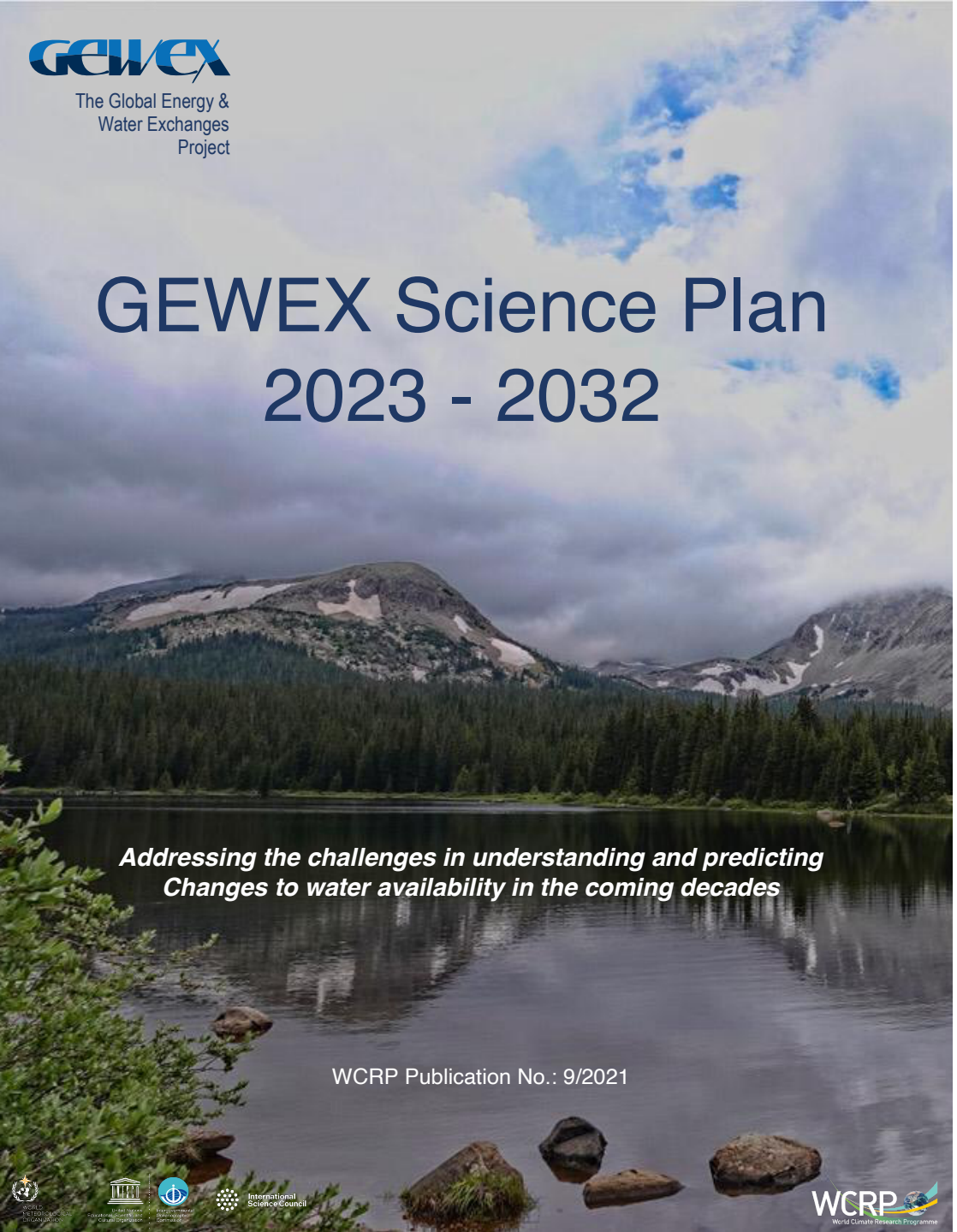

https://www.gewex.org/about/science/gewex-science-goals/

- https://www.gewex.org/gewex-content/uploads/2022/05/GEWEX-science-plan-v8.pdf

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Goal # 1: Determine the extent to which Earth's water cycle can be predicted

a) **Reservoirs:** What is the rate of expansion of the fast reservoirs (atmosphere and land surfaces), what is its spatial character, what factors determine this and to what extent are these changes predictable?

b) **Flux exchanges**: To what extent are the fluxes of water between Earth's main reservoirs changing and can these changes be predicted and if so on what time/space scale?

c) **Precipitation Extremes:** How will local rainfall and its extremes change under climate change across the regions of the world?

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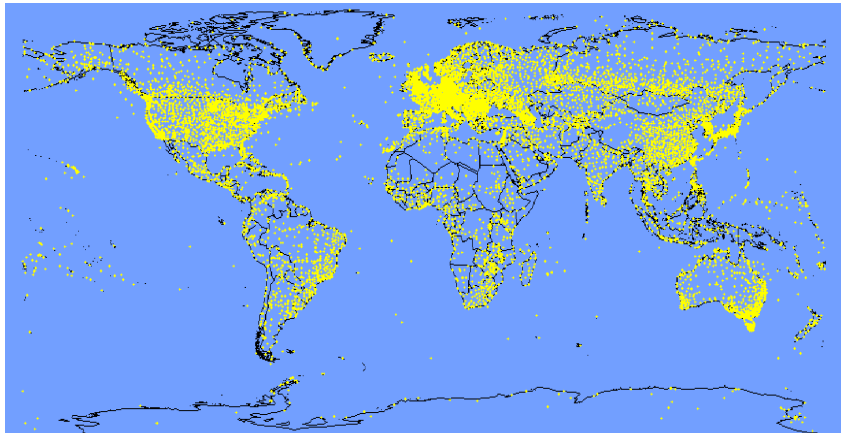
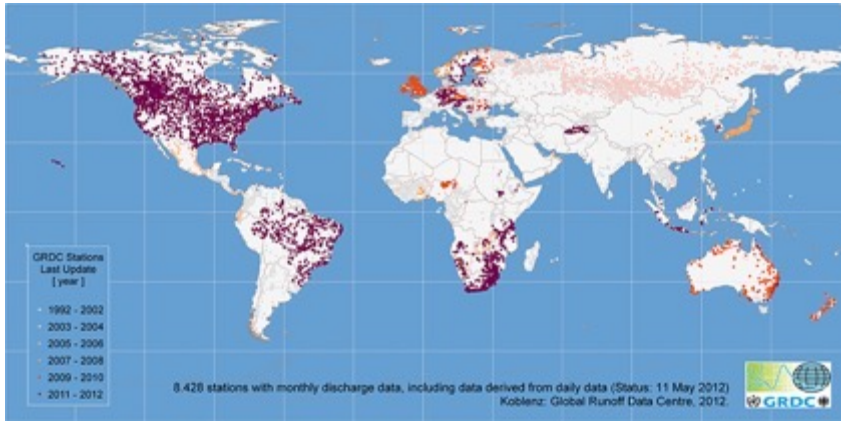
Inadequacy of Surface Observations

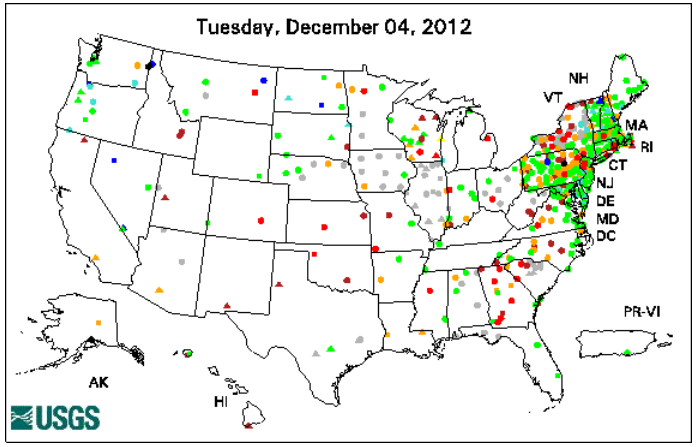


Global Telecommunication System meteorological stations. Air temperature, precipitation, solar radiation, wind speed, and humidity only.

Eight countries make groundwater data publicly available through the Global Groundwater Monitoring Network.



River flow observations from the Global Runoff Data Centre. Lighter circles indicate greater latency in the data record.



USGS Groundwater Climate Response Network.

Issues include coverage gaps, delays, measurement continuity and consistency, data format and QC, political restrictions

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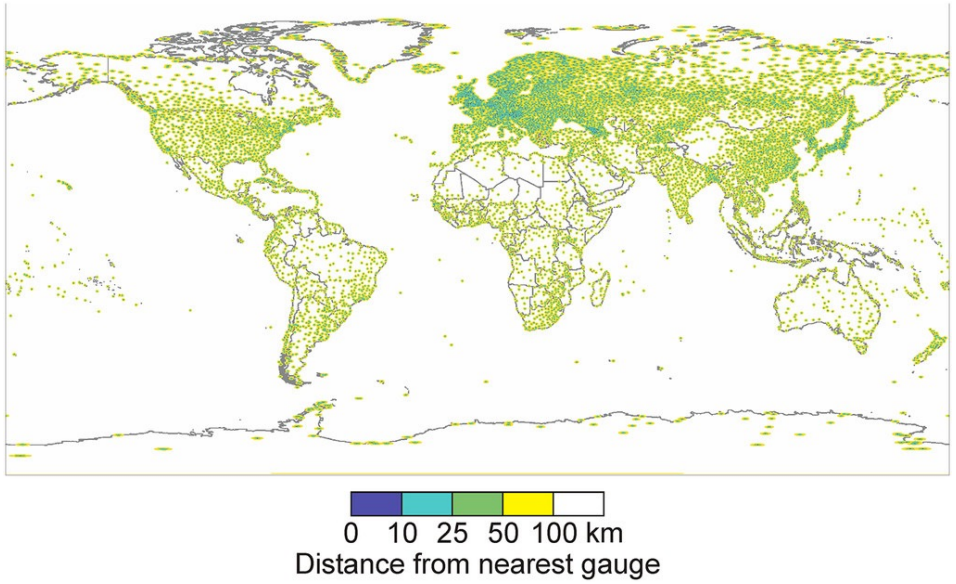
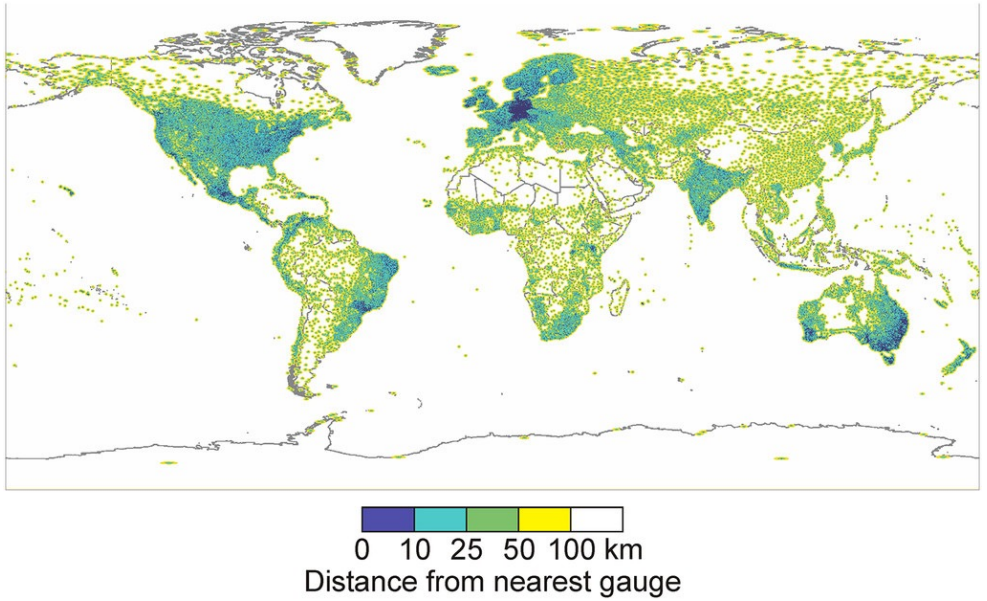
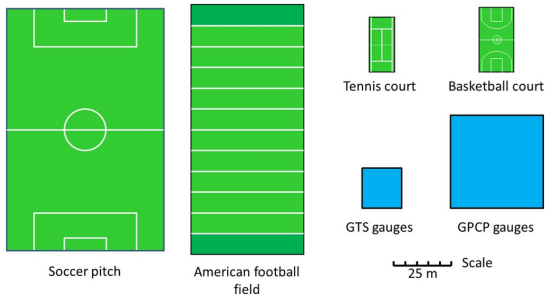
So, How Much of the Earth's Surface *Is* Covered by Rain Gauges?



Map showing the distance to nearest GTS gauge, typical of 3-hourly/daily measurements available in near–real time; blank areas in the figure are beyond 100 km from the nearest gauge. (8 – 12K first class stations)



Map showing the distance to nearest GPCC gauge, typical of all regular and reliable gauge measurements; blank areas in the figure are beyond 100 km from the nearest gauge. (~65K-100K stations)



	Dimensions	Area	Equivalent gauges[a]
Soccer pitch	105 × 68 m	7140.0 m^2	178,500–562,204
Center circle of soccer pitch	9.15-m radius	263.0 m^2	6,575–20,709
American football	109.7 × 48.8 m	5353.4 m^2	133,834–421,524
Tennis court	23.78 × 10.97 m	260.9 m^2	6,522–20,541
Basketball (FIBA)	28.0 × 15.0 m	420.0 m^2	10,500–33,071

[a] Range based upon 400- to 127-cm^2 orifice areas.

Kidd, C., Becker, A., Huffman, G. J., Muller, C. L., Joe, P., Skofronick-Jackson, G., & Kirschbaum, D. B. (2017). So, How Much of the Earth's Surface Is Covered by Rain Gauges?, *Bulletin of the American Meteorological Society*, *98*(1), 69-78. Retrieved Jul 6, 2022, from https://journals.ametsoc.org/view/journals/bams/98/1/bams-d-14-00283.1.xml

Goal # 2 (GS2): Quantify the inter-relationships between Earth's energy, water and carbon cycles to advance our understanding of the system and our ability to predict it across scales

a) **Forcing-feedback understanding**: How can we improve the understanding of climate forcings and feedbacks formed by energy, water and carbon exchanges?

b) **ABL process representation**: To what extent are the properties of the atmospheric boundary layer (ABL) defined by sensible and latent energy and water exchanges at the Earth's surface versus within the atmosphere (i.e., horizontal advection and ABL-free atmosphere exchanges)?

c) **Understanding Circulation controls:** To what extent are exchanges between water, energy and carbon determined by the large-scale circulations of the atmosphere and oceans?

d) **Land-atmosphere interactions**: How can we improve the understanding of the role of land surface-atmospheric interactions in the water, energy and carbon budgets across spatiotemporal scales?

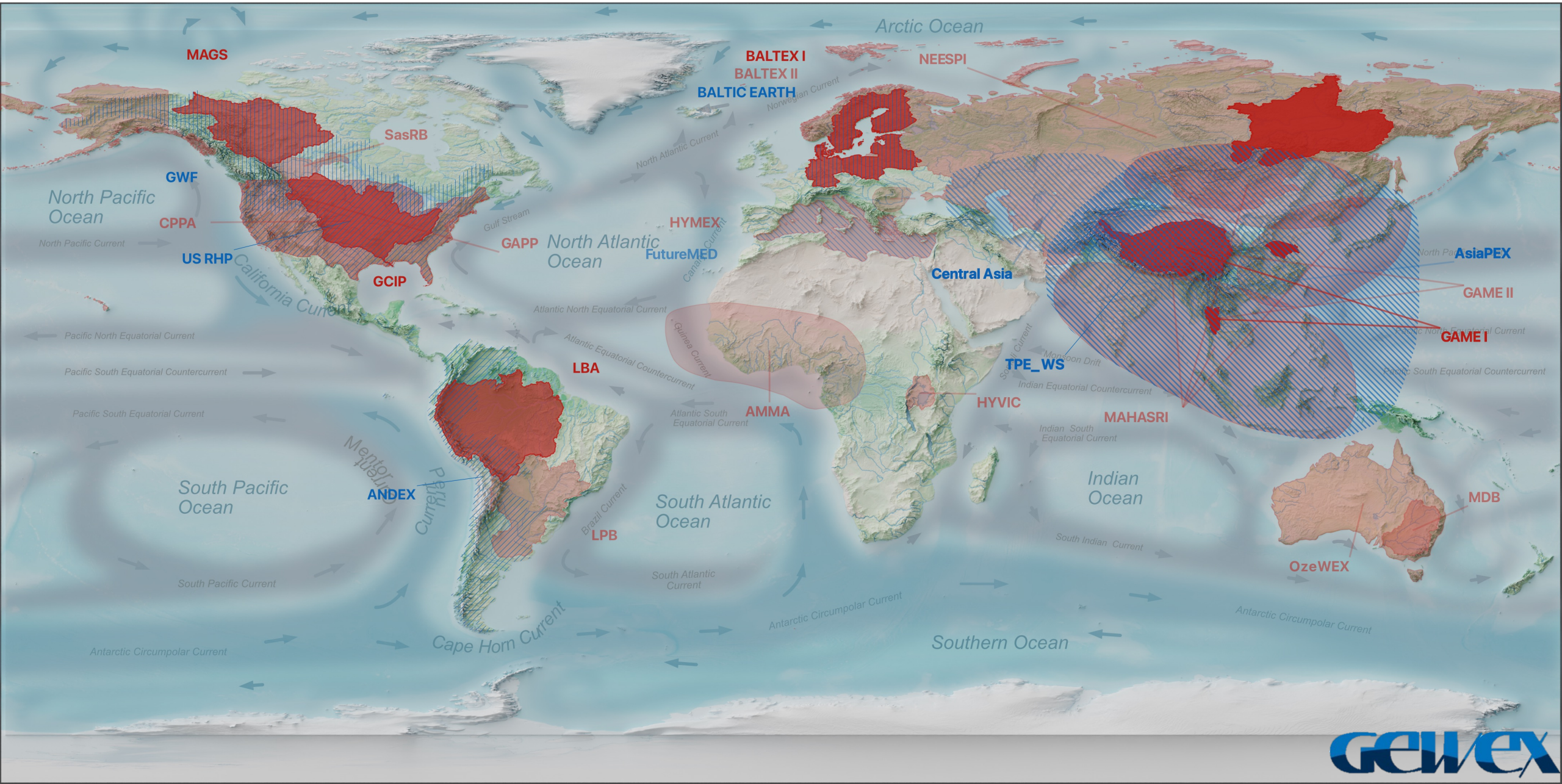
Goal # 3 (GS3): Quantify anthropogenic influences on the water cycle and our ability to understand and predict changes to Earth's water cycle.

a) **Anthropogenic forcing of continental scale water availability**: To what extent has the changing greenhouse effect modified the water cycle over different regions and continents?

b) **Water management influences**: To what extent do water management practices and land use change (e.g., deforestation) modify the water cycle on regional to global scales?

c) **Variability and trends of water availability**: How do water & land use and climate change affect the variability (including extremes) of the regional and continental water cycle?

GEWEX Regional Hydroclimate Projects



The rationale for Continental Scale Experiments (CSEs)

- An international group of GEWEX affiliates held a meeting in 1990 to determine the priorities for a continental-scale experiment and the best location for it. It heard arguments for different research priorities (the what) and different large basins around the world (the where).
- **Mississippi:** extremes, macroscale hydrologic modelling, data analysis for the water balance, energy budget products.
  Mackenzie: flow regime of northern rivers, cold region hydrometeorology **Baltic Sea**: effect of runoff from many rivers on the dynamics and ecosystems of the Baltic Sea.
- **Eastern Asia**: A N-S transect of land areas from Thailand to northern Russia to enable intercomparisons of land processes in different climate regimes.

* LBA - **Amazon:** Water and energy balance over a large tropical forest; assessment and prediction of the climate effects of deforestation.

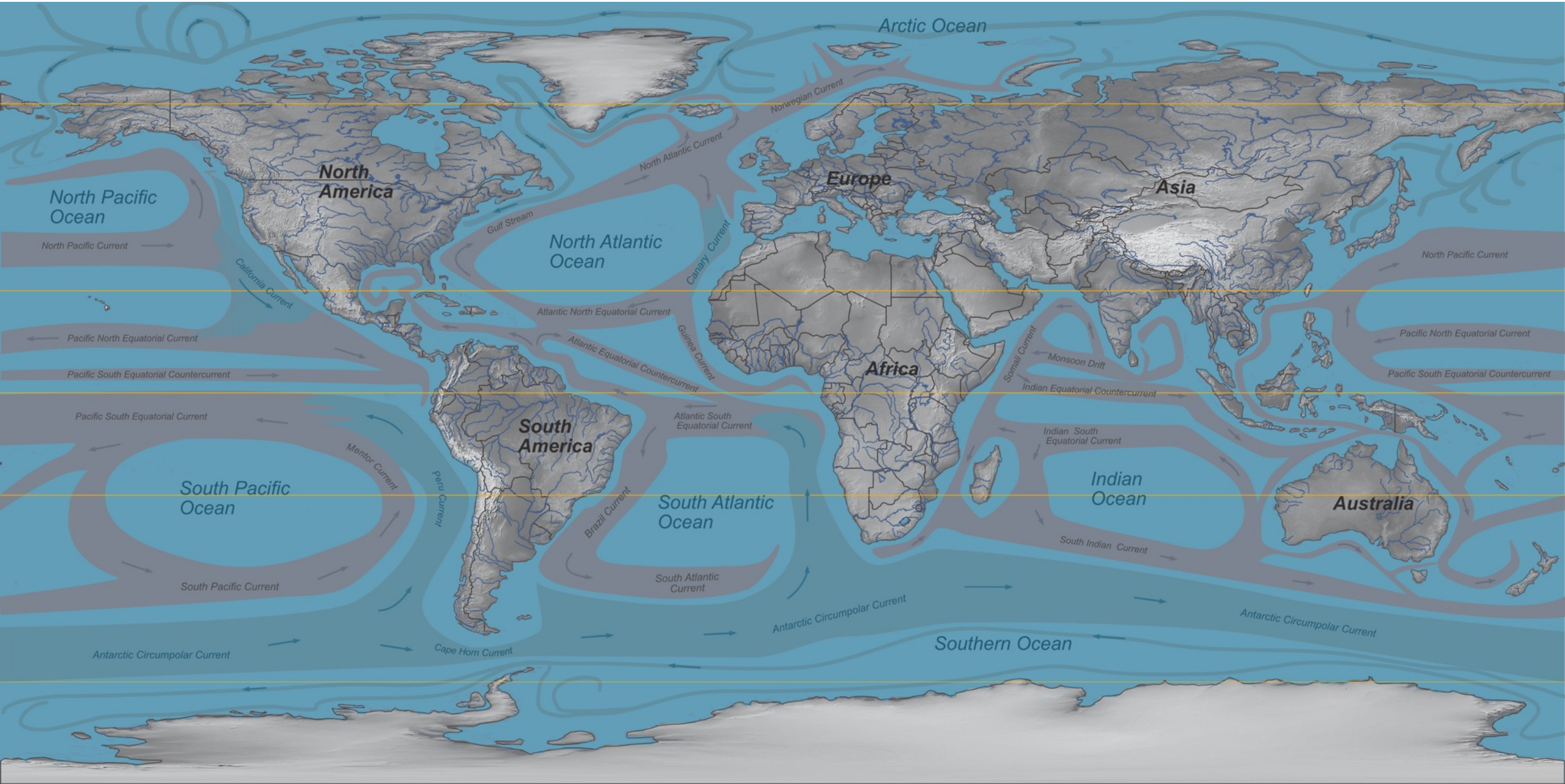
* - proposal presented at a subsequent GEWEX meeting.

From CSEs to RHPs

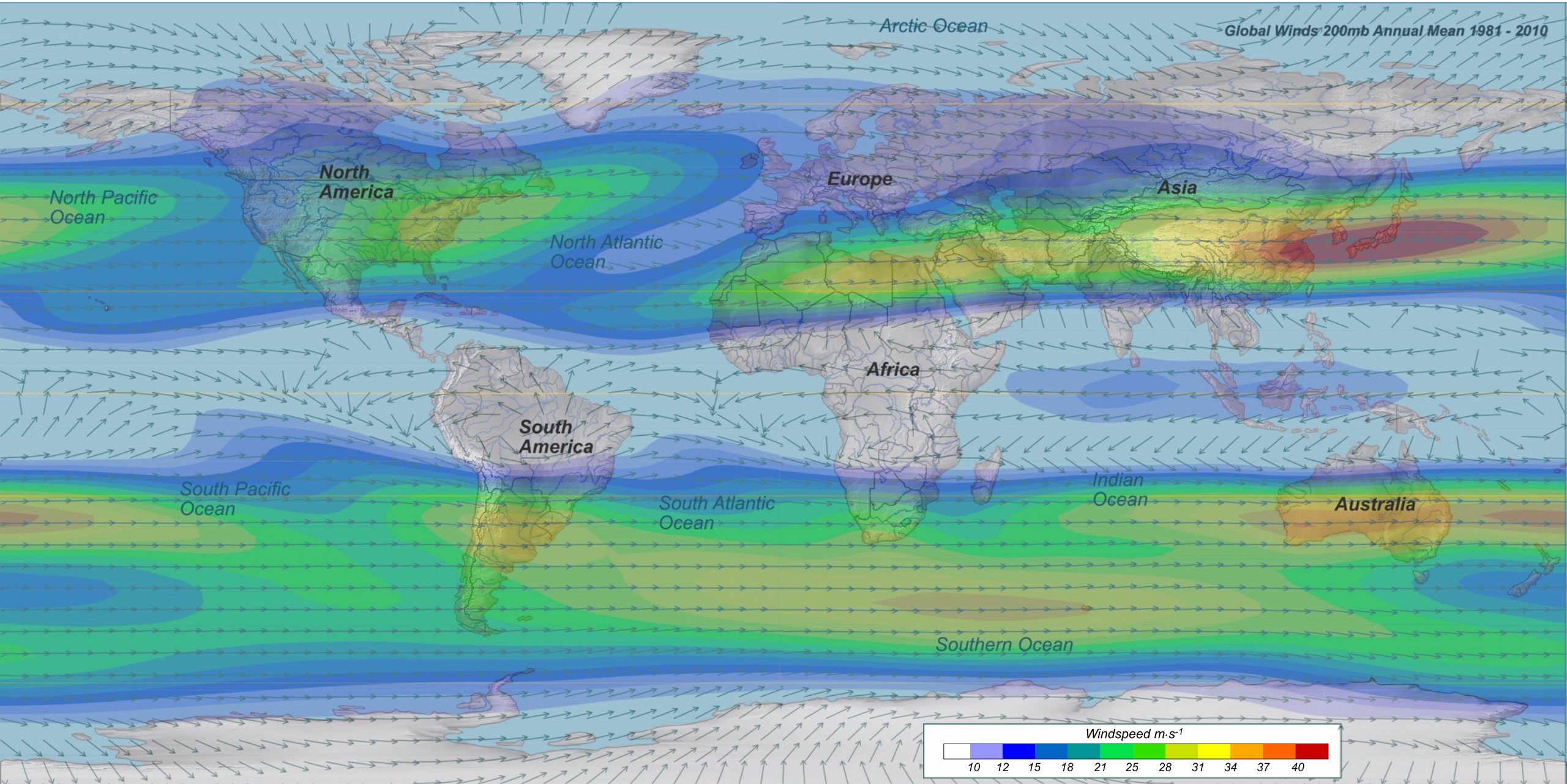
- Concept of Continental Scale Experiments established in early 1990s
  - *"A continental scale experiment was needed to develop the ability to measure and model the components of the water and energy cycles over a macroscale land surface"*
- GEWEX Continental Scale International Project (GCIP)
  - Envisioned in 1990, Science Plan in 1992, Implementation Plan in 1993 and NOAA-OGP directs funding to GCIP projects
- Others followed suit: Mackenzie River Basin (MAGS), Baltic Sea (BALTEX), Asia (GAME) and Amazon (LBA)

Why Central Asia?

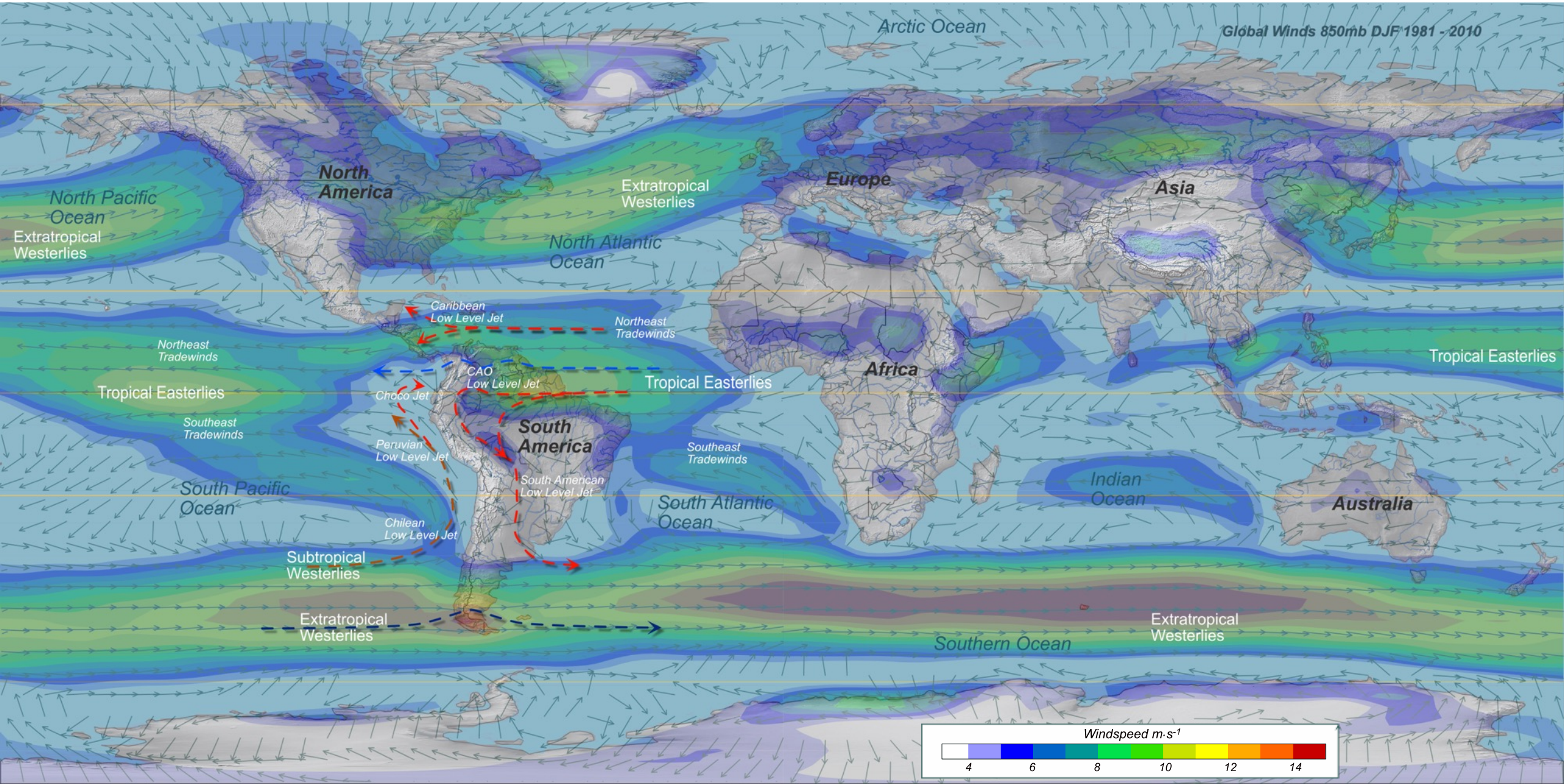
Major Ocean Currents



Global Winds at ~12 Km (200mb)



Global Winds at Surface (850mb)

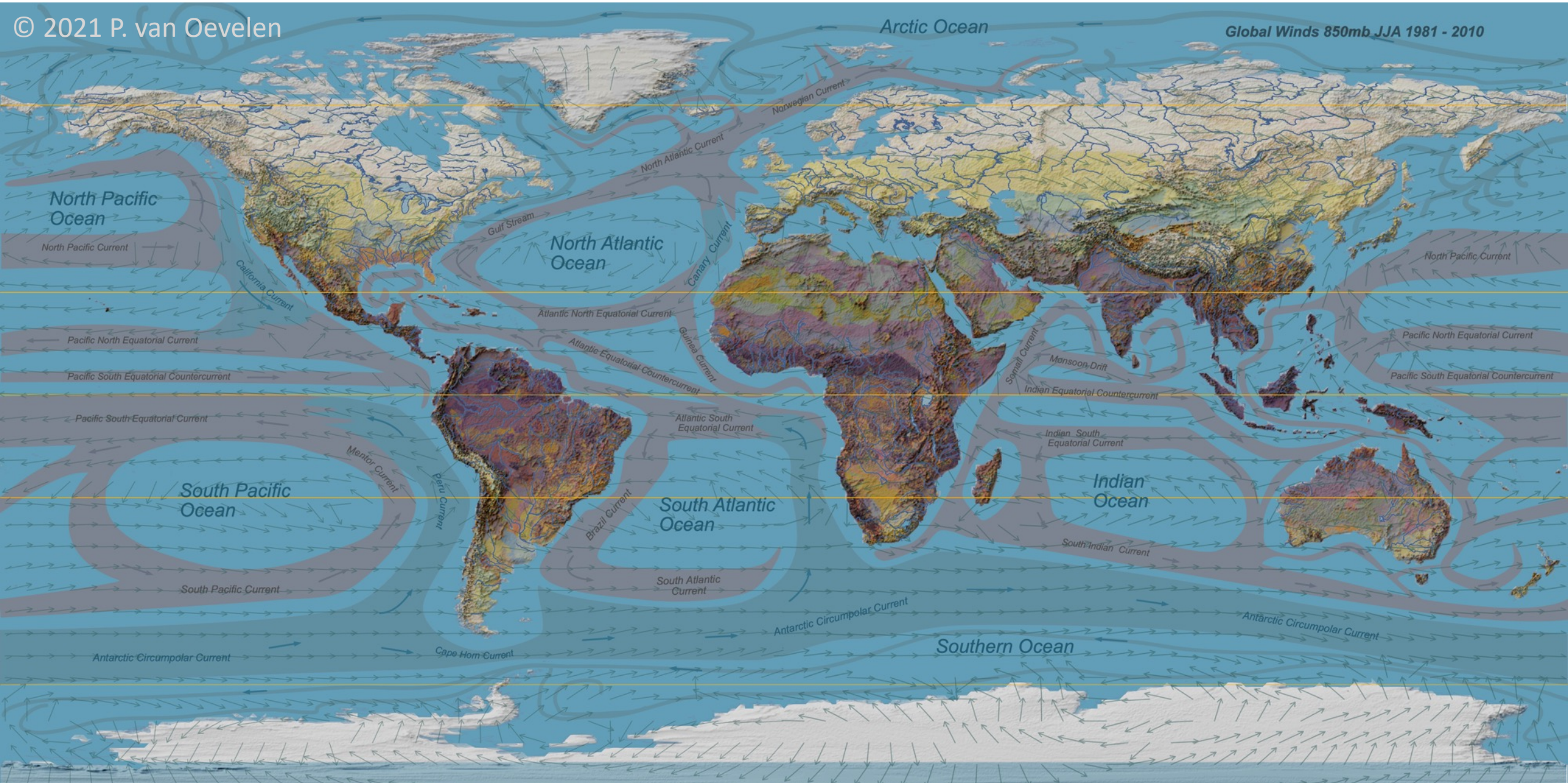


Monsoons

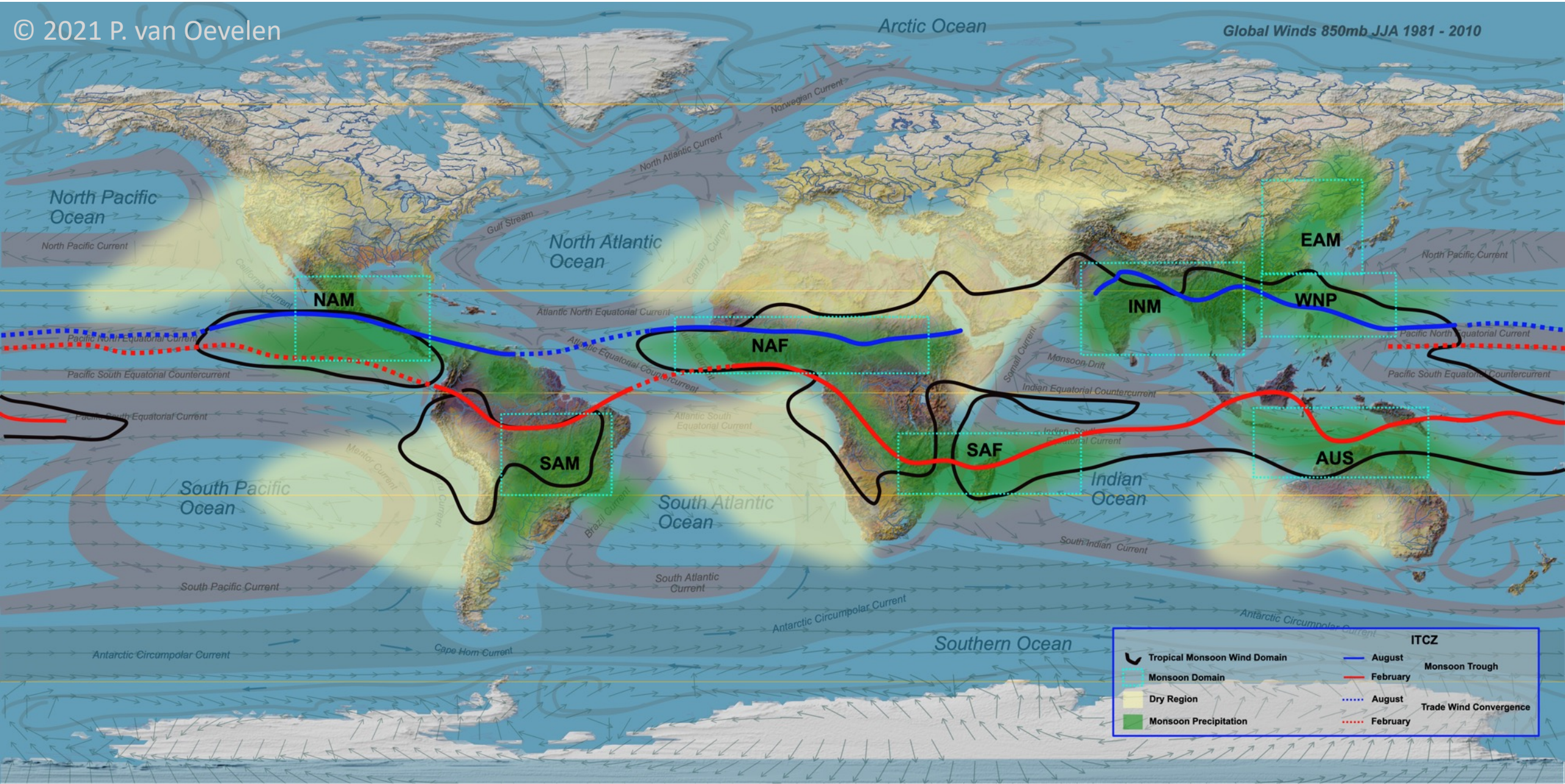
A monsoon is traditionally defined as a seasonal reversing wind accompanied by corresponding changes in precipitation

These days it is also used to describe seasonal changes in atmospheric circulation and precipitation associated with annual latitudinal oscillation of the Intertropical Convergence Zone between its limits to the north and south of the equator. Usually, the term monsoon is used to refer to the rainy phase of a seasonally changing pattern, although technically there is also a dry phase. The term is also sometimes used to describe locally heavy but short-term rains

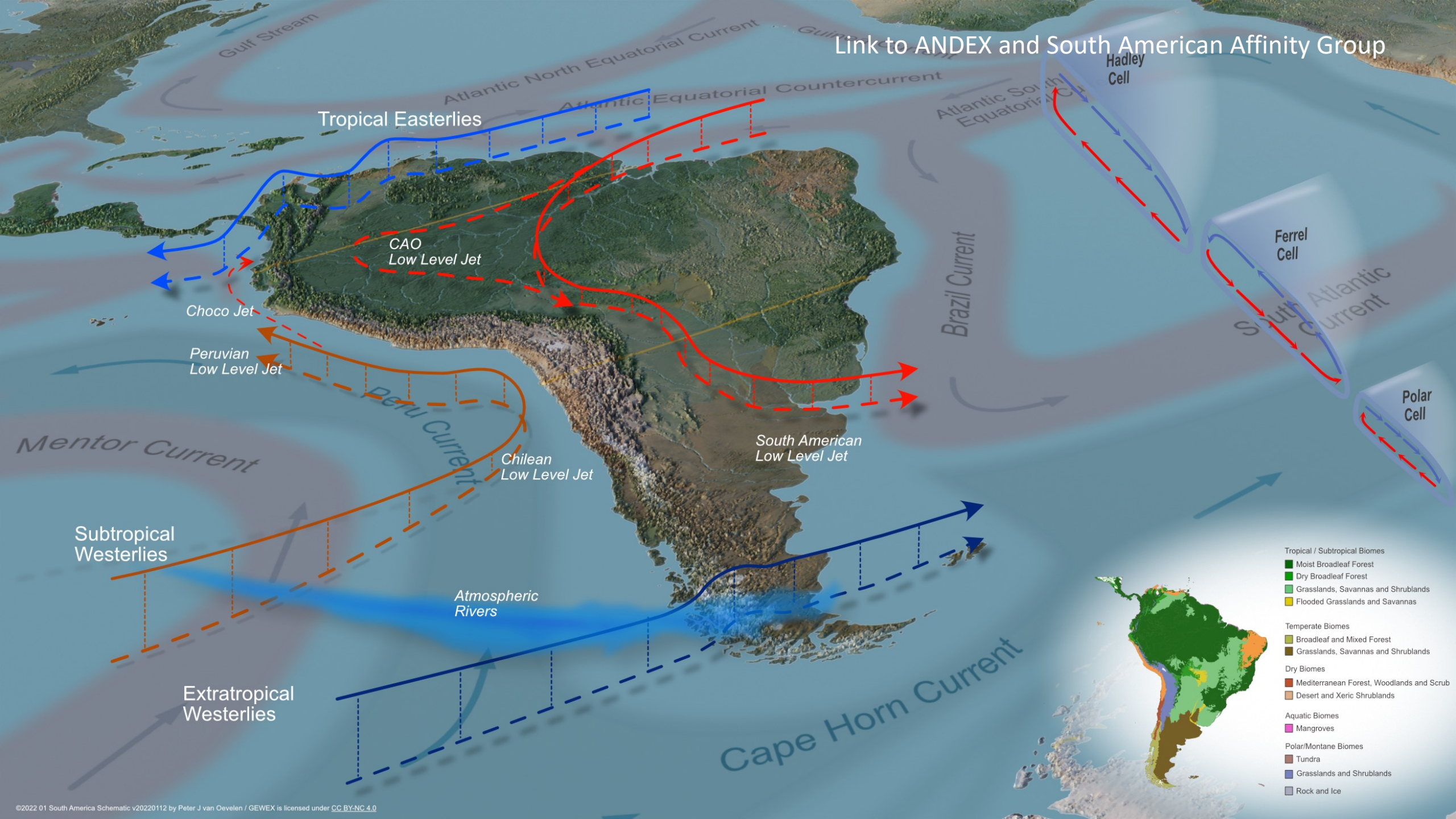
Global Circulations Define Monsoon Regions



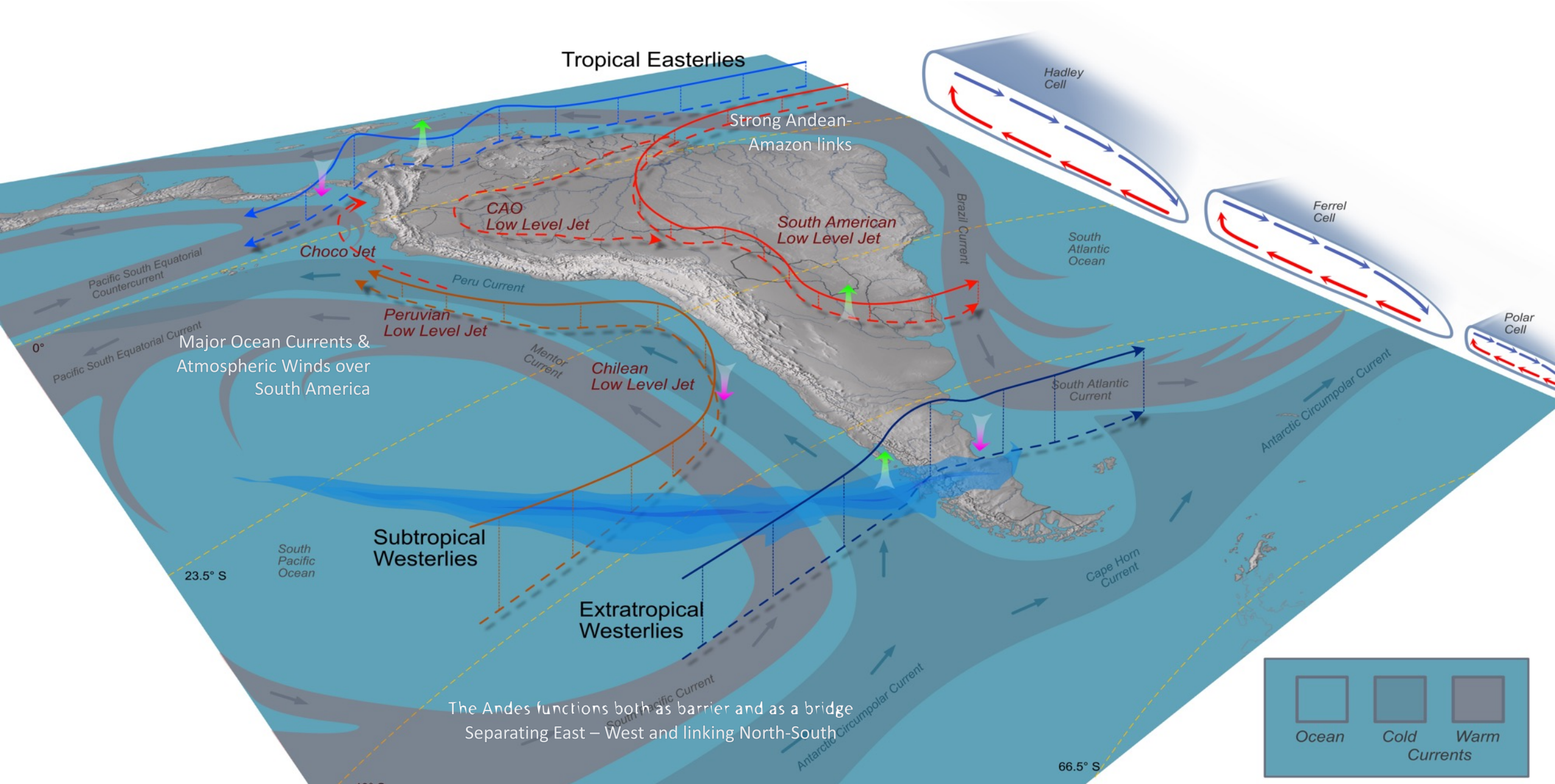
Monsoon Regions & WCRP Monsoons Panel WG Domains



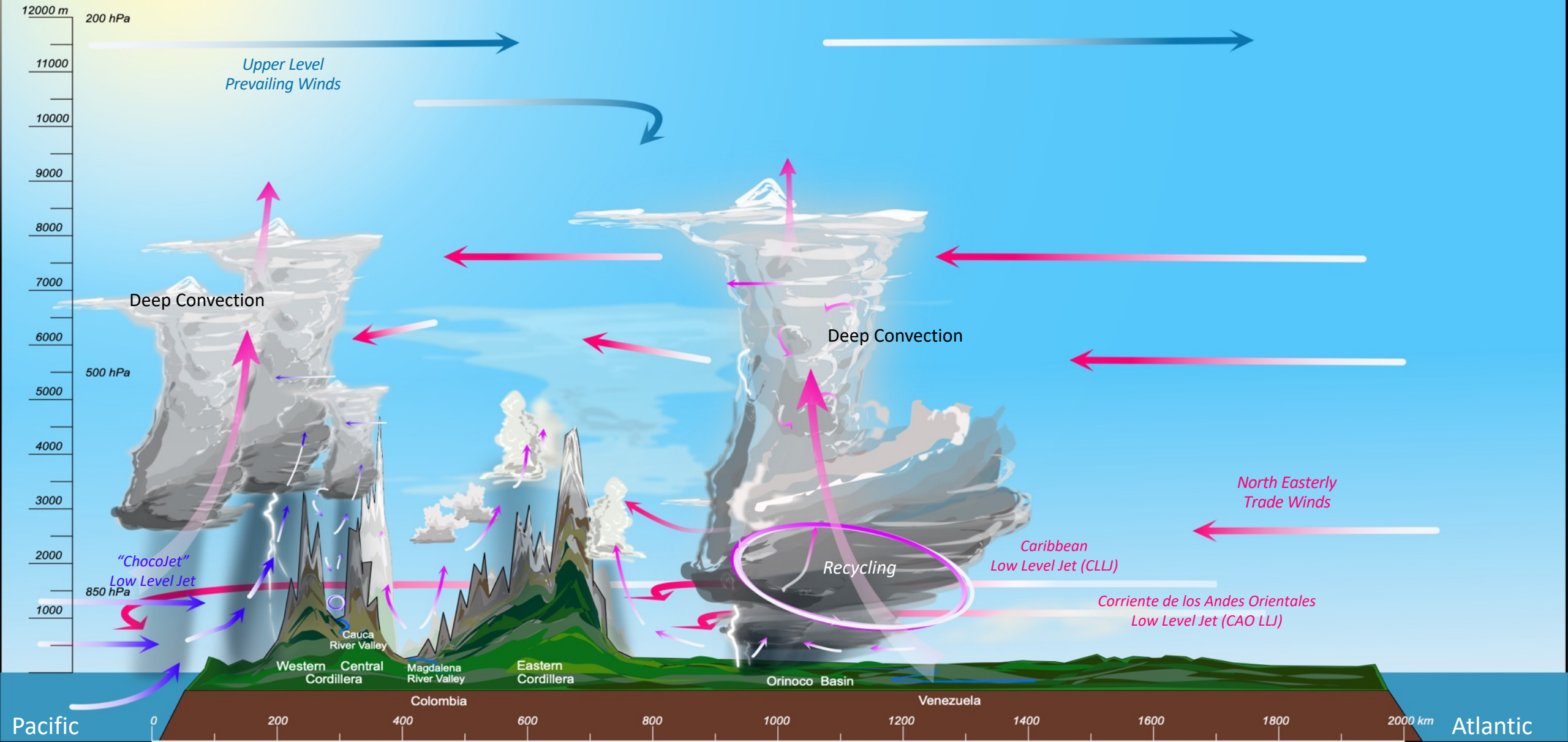
Link to ANDEX and South American Affinity Group



Major Ocean Currents & Atmospheric Winds over South America



Cross Section South America from Colombia to Venezuela
5°N 77°W – 9°N 60°W



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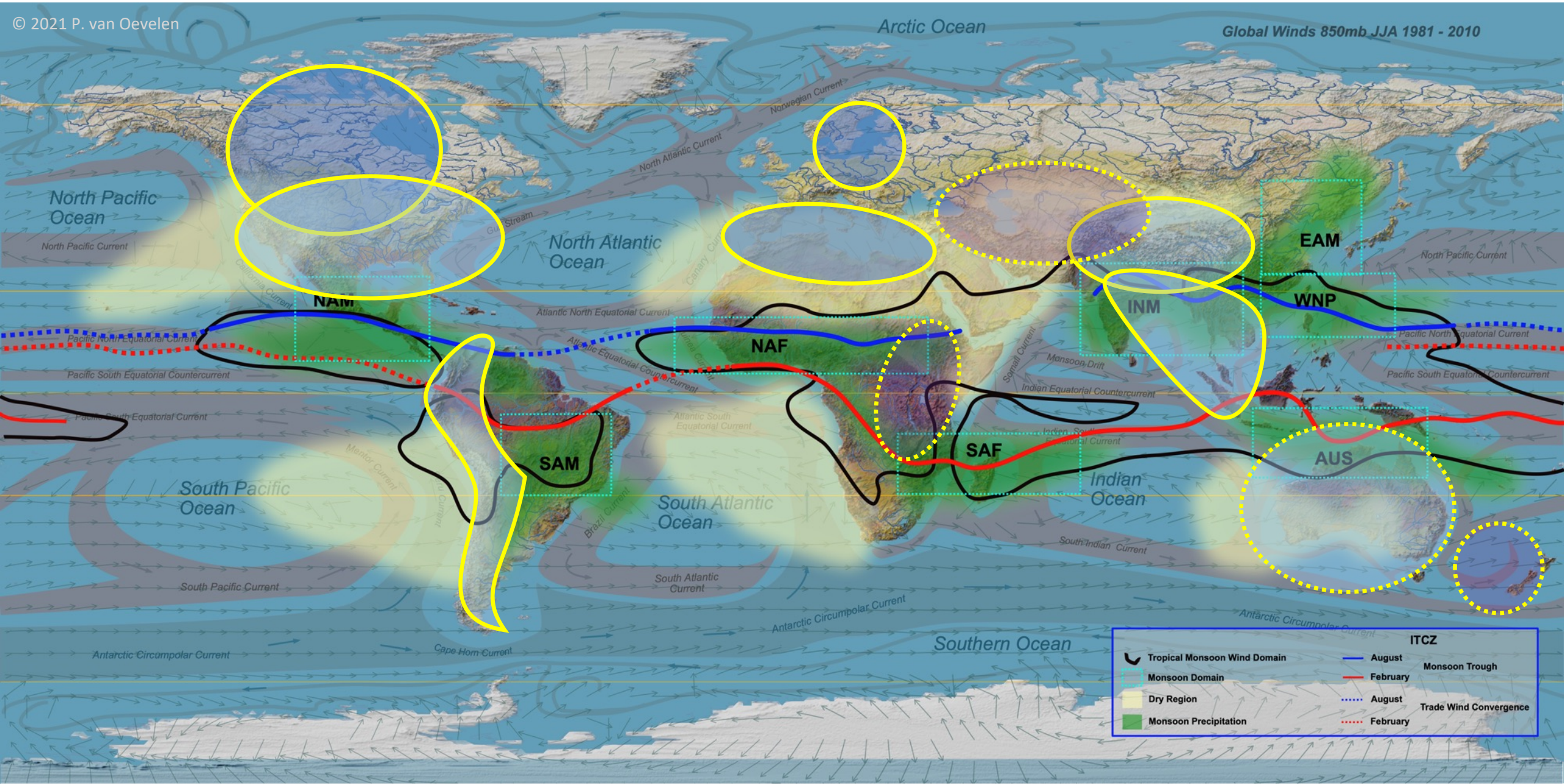


The GEWEX Regional Hydroclimate Projects

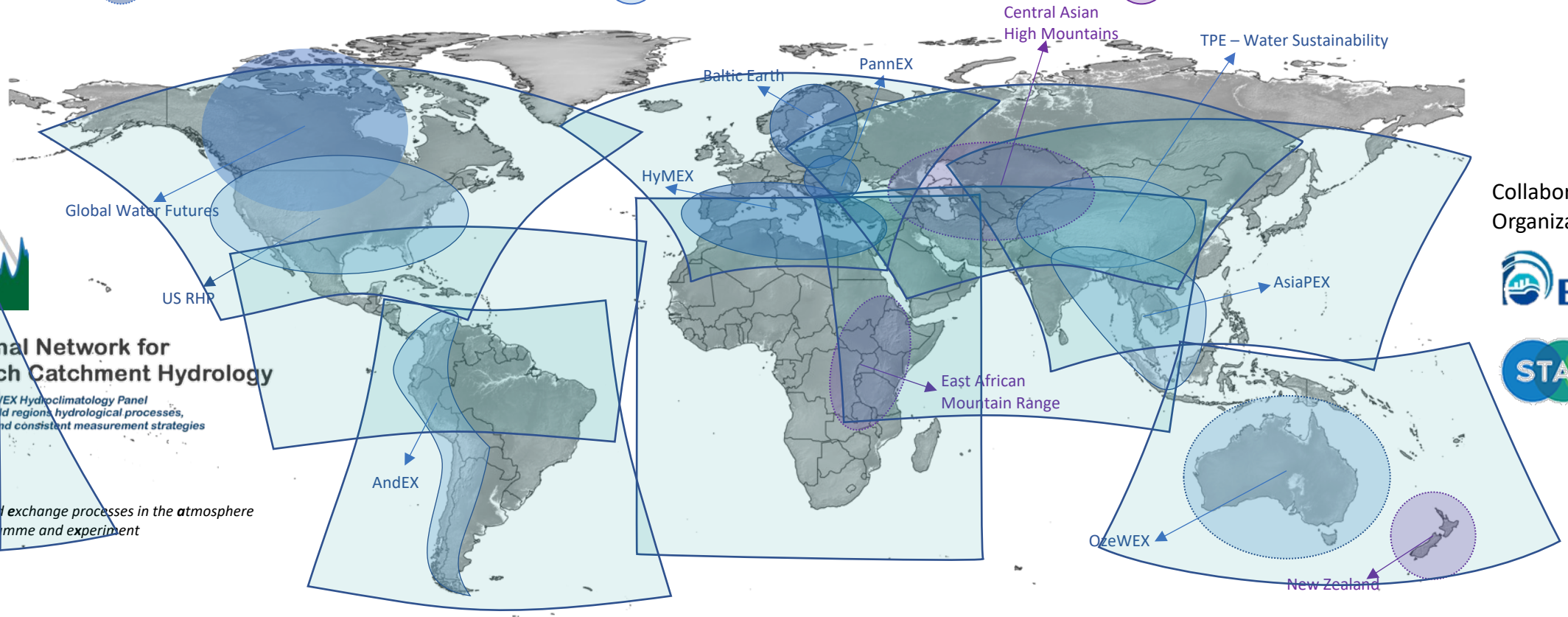
- Regional Hydroclimate Projects (RHPs) & Networks
  - *Modeling, Observations, Predictions and Projections, Impacts studies etc.*
  - *South America Affinity Group, OzeWEX as a regional network*
- Crosscutting Activities
  - *TeamX , Mounterrain (in development), INARCH, Irrigation (new), ET (new)*

- Global Observational Data Sets Assessments and Analyses <-> e.g. with International Precipitation Working Group, International Soil Moisture Network, Global Runoff Data Center and Global Precipitation Climatology Center
- Process Studies -> "PROES" – Process Evaluation Studies and GEWEX Land Atmosphere Feedback Observatories (GLAFO), Monsoons
- Regional Observational Campaigns (short and long term) -> e.g. LIAISE

Current Regional Hydroclimate Projects & Networks

Current Regional Hydroclimate Projects & Networks in Preparation

Planned or Envisioned Regional Hydroclimate Projects & Networks



GEWEX INARCH

The International Network for Alpine Research Catchment Hydrology

A cross-cut project of the GEWEX Hydroclimatology Panel to better understand alpine cold regions hydrological processes, improve their prediction and find consistent measurement strategies

TEAMx

Multi-scale transport and exchange processes in the atmosphere over mountains – programme and experiment

Collaborating Organizations:

BAR

START

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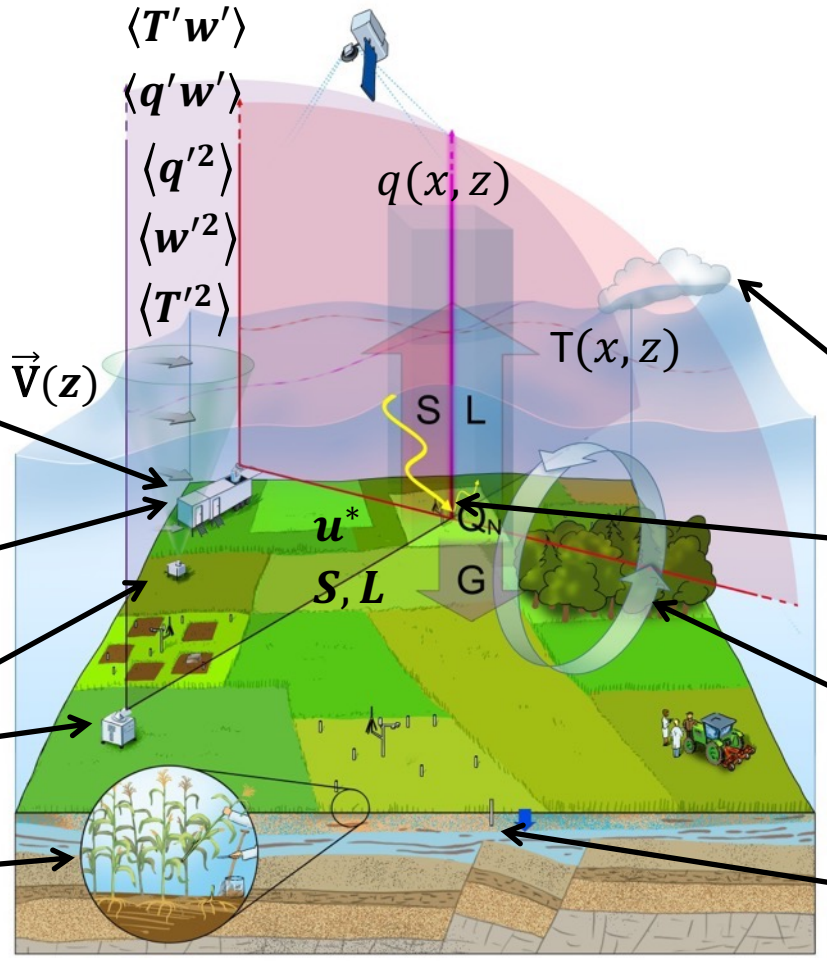
GWF ANDEX HyMeX PannEX Baltic Earth AsiaPEX OzEWEX TPE THIRD POLE ENVIRONMENT

The GEWEX-GLASS Land-Atmosphere Feedback Observatory (GLAFO)



Vertically staring Doppler, WV, T, and CO_2 lidar systems, AERI, MWR, cloud radar

Scanning Doppler, WV, T, and CO_2 lidar systems

Scanning Doppler lidar

LAI, albedo, root water uptake

Planetary boundary layer top

Surface energy balance, isotope sensors

Mesoscale vortex

Soil moisture and temperature

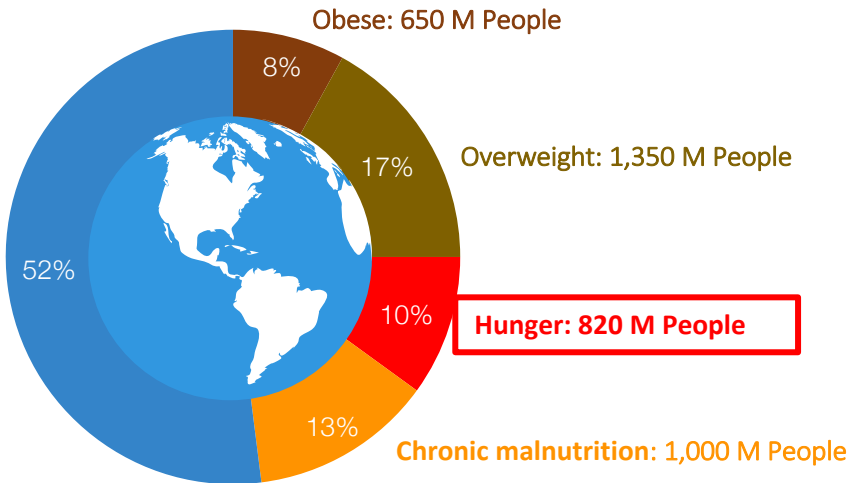
A combination of vertical staring instruments will be the starting point.
In a next step, scanning instruments will be added.

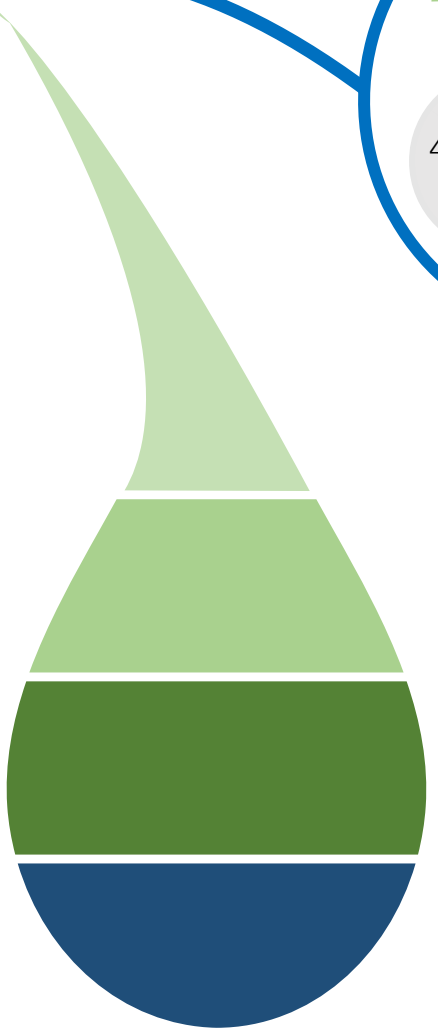
Wulfmeyer et al. BAMS 2018, DOI:10.1175/BAMS-D-17-0009.1

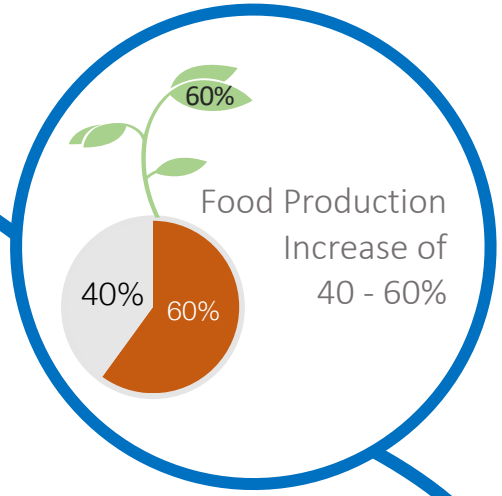
Slide courtesy: ***Volker Wulfmeyer***

Future of our Food

World population growth
from 2015 to 2050
from 7.4 to 9.7B People







Globally 70% of Total Water Withdrawals are for Agriculture
(100% = 3862 km^3)=> 2703 km^3

Water is a renewable resource!!

Yet despite that an increase of 60% will be near impossible…
And most of the production increase will need to be in Africa
As well as the water availability

Future of our Water

Key Objectives in Asian Region

- Strengthen regional scientific networks, connecting scientists and practitioners
- Engage climate applications and policy communities in translating state of the art scientific knowledge
- Stewardship and improvement of observational networks and monitoring programs
- Transfer state of the art scientific knowledge to applications and policy
- Improve understanding of regional weather, climate variability and change
- Improve climate predictions and weather & hydrological forecasting – high res. modeling (<<4km)

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Observations in High Mountain Asia Regions

- Improving observations and observational networks (e.g. radiosondes, rain radar, snowpack, run-off, citizen science etc.) paramount in improving our knowledge, models and predictions for processes in complex terrain and linking global and regional phenomena

- Data sharing and open access increases capacity and capabilities and fosters collaboration – linking to global initiatives e.g. Digital Earth

- Integrating **local and indigenous** knowledge supports broader understanding and wider applicability of climate information

Key Messages for Policy and Decision Makers

- Sustainable development in monsoon regions needs robust knowledge, long-term support and smart investments
- Lack of key observations hinders a comprehensive understanding of hydro-climate processes, with implications for maladapted policy and investment
- Predictions in high mountainous terrain suffer from large uncertainties that can only be tackled through better understanding ⇆ better observations & more appropriate models (ensembles)

- Continued strong need for process studies and improved observations to support sustainable development

Thank you for your attention!

Contributors: Jan Polcher, Xubin Zeng, Graeme Stephens, Rupa Kumar Kolli, Volker Wulfmeyer, German Poveda, Rene Garreaud, Ali Nazemi, Francina Dominguez, Kirsten Findell, Anne Verhoef, Oscar Hartogensis, Daniel Klocke, Sandrine Bony, Remy Roca, Tristan L'Ecuyer, Michael Ek, Paul Dirmeyer, Michael Bosilovich, Bob Su, B.J. Sohn, John Pomeroy, Chris DeBeer, Jon Padgham, Yaoming Ma, Xin Li, Li Jia, Toru Terao, and many many more!

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Thank You

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