GEWEX and GPEX Perspectives on EESM Activities Towards a Digital Earth

Xubin Zeng
University of Arizona
GEWEX SSG Co-Chair, GPEX Interim SSG Chair

2024 EESM PI Meeting, Rockville, MD
August 6-9, 2024

WORLD METEOROLOGICAL ORGANIZATION
International Science Council
unesco Intergovernmental Oceanographic Commission
WCRP World Climate Research Programme

WCRP Organizational Structure

WCRP Secretariat

Joint Scientific Committee (JSC)

Lighthouse Activities

- Digital Earths
- Explaining and Predicting Earth System Change (EPESC)
- Global Precipitation EXperiment (GPEX)
- My Climate Risk (MCR)
- Research on Climate Intervention
- Safe Landing Climates (SLC)

Ongoing Activities and Fora

- Fixed-term projects
- Rapid updates, syntheses, assessments, gap analysis
- Conferences and workshops
- Diversity and capacity building: ECRs, regions
- Communications and outreach

International Offices

Core Projects

- Atmospheric Processes And their Role in Climate (APARC)
- Climate and Cryosphere (CliC)
- Climate and Ocean Variability, Predictability and Change (CLIVAR)
- Earth System Modelling and Observations (ESMO)
  - including the Coupled Model Intercomparison Project (CMIP)
- Global Energy and Water Exchanges (GEWEX)
- Regional Information for Society (RIfS)
  - including the Coordinated Regional Climate Downscaling Experiment (CORDEX)

Support Unit

WCRP Academy

www.wcrp-climate.org

World Climate Research Programme (WCRP)

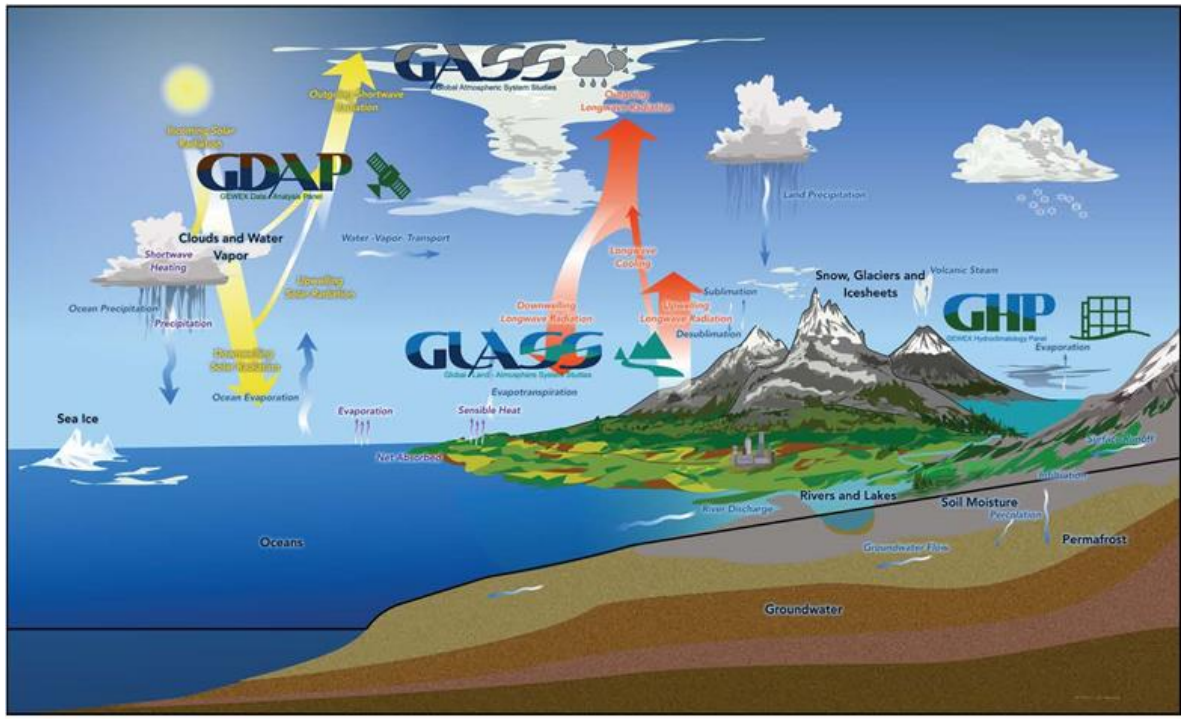
Three Overarching but Connected Goals of GEWEX:

- **Goal 1:** Determine the extent to which Earth's water cycle can be **predicted** (reservoirs, flux changes, and precipitation extremes).

- **Goal 2:** Quantify the **interrelationships** between Earth's energy, water, and carbon cycles to advance our understanding of the system and our ability to predict it across scales.

- **Goal 3:** Quantify **anthropogenic** influences on Earth's water cycle and our ability to understand and predict it.

DOE contributions: EESM, ARM, Ruby Leung, Shaocheng Xie, …

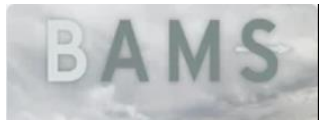


The focus of the four GEWEX panels in relation to the global and regional water and energy cycles (© P. van Oevelen, 2020)

The First 30 Years of GEWEX

Graeme Stephens, Jan Polcher, Xubin Zeng, Peter van Oevelen, Germán Poveda, Michael Bosilovich, Myoung-Hwan Ahn, Gianpaolo Balsamo, Qingyun Duan, Gabriele Hegerl, Christian Jakob, Benjamin Lamptey, Ruby Leung, Maria Piles, Zhongbo Su, Paul Dirmeyer, Kirsten L. Findell, Anne Verhoef, Michael Ek, Tristan L'Ecuyer, Rémy Roca, Ali Nazemi, Francina Dominguez, Daniel Klocke, and Sandrine Bony

Online Publication: 19 Jan 2023
Print Publication: 01 Jan 2023
DOI: https://doi.org/10.1175/BAMS-D-22-0061.1
Page(s): E126–E157



Global Precipitation Experiment - A New World Climate Research Programme Lighthouse Activity

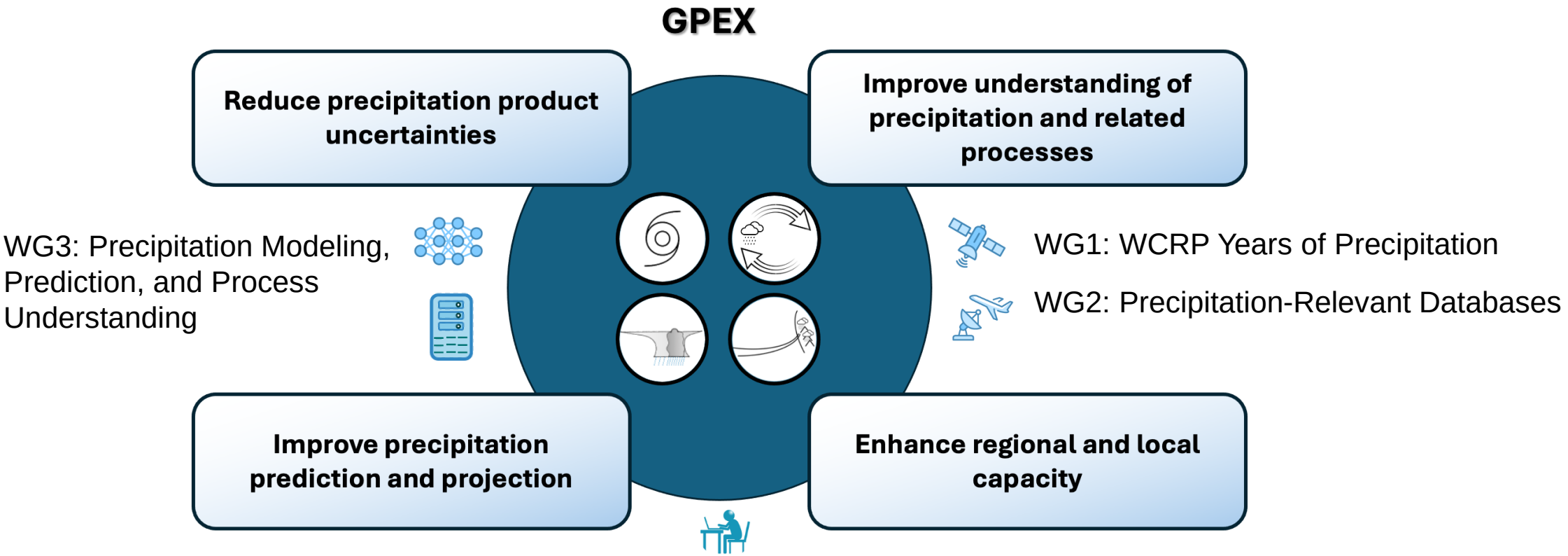
Xubin Zeng, Lincoln Alves, Marie-Amélie Boucher, Annalisa Cherchi, Charlotte DeMott, A.P. Dimri, Andrew Gettelman, Edward Hanna, Takeshi Horinouchi, Jin Huang, Chris Lennard, L. Ruby Leung, Yali Luo, Meloth Thamban, Hindumathi Palanisamy, Sara C. Pryor, Marion Saint-Lu, Stefan P. Sobolowski, Detlef Stammer, Jakob Steiner, Bjorn Stevens, Stefan Uhlenbrook, Michael Wehner, and Paquita Zuidema

Online Publication: 02 May 2024

DOI: https://doi.org/10.1175/BAMS-D-23-0242.1

Bulletin of the American Meteorological Society

DOE contributions: EESM, ARM, Ruby Leung, Andrew Gettelman, Michael Wehner, …



WG3: Precipitation Modeling, Prediction, and Process Understanding

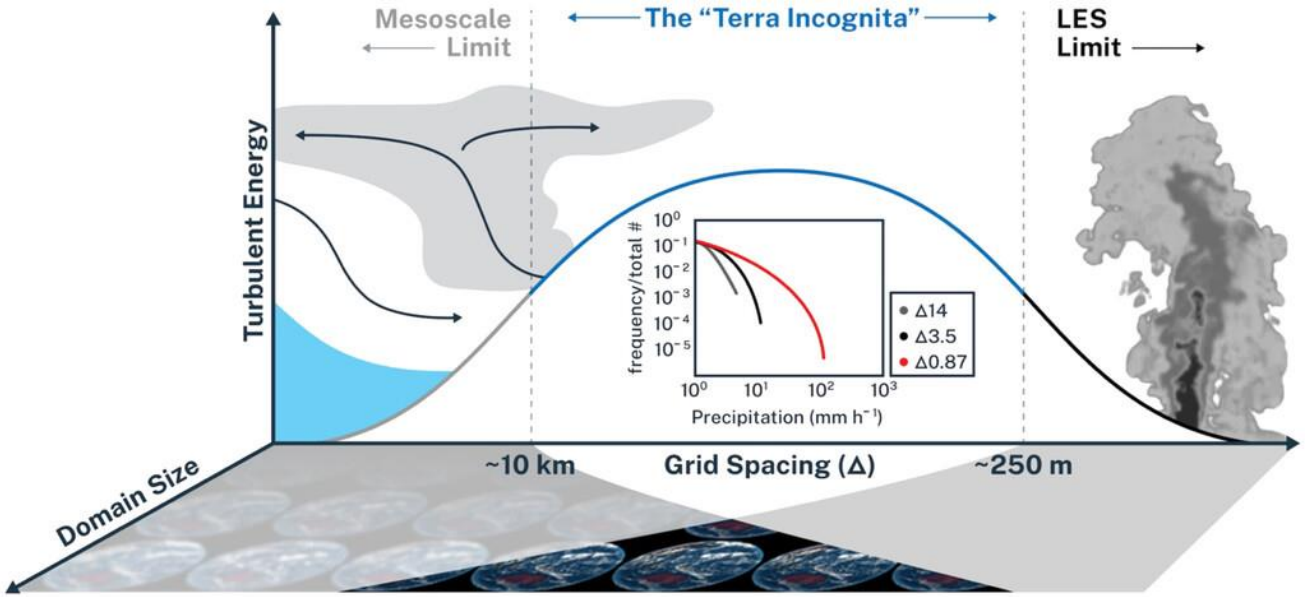
WG1: WCRP Years of Precipitation

WG2: Precipitation-Relevant Databases

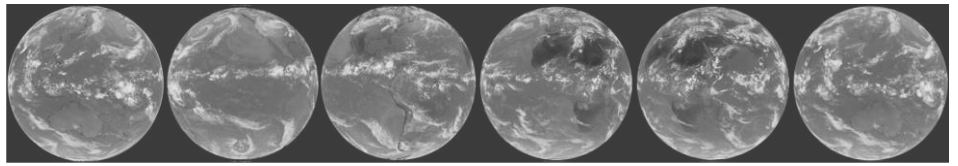
WG4: National/Regional Activities and Capacity Development

Perspectives on “Strengthening EESM Integrated Modeling Framework – Towards a Digital Earth”

Potential Opportunity: 3D cloud data



Stephens et al. (2023, BAMS)



GEWEX Project: ISCCP-NG
- Global observations for km-scale modeling

- 10minute, 2km global
- Output: 3-D Cloud properties

Prior GASS projects from local to global cloud-resolving modeling —
A GEWEX legacy, leading to Digital Earth and Digital Twins

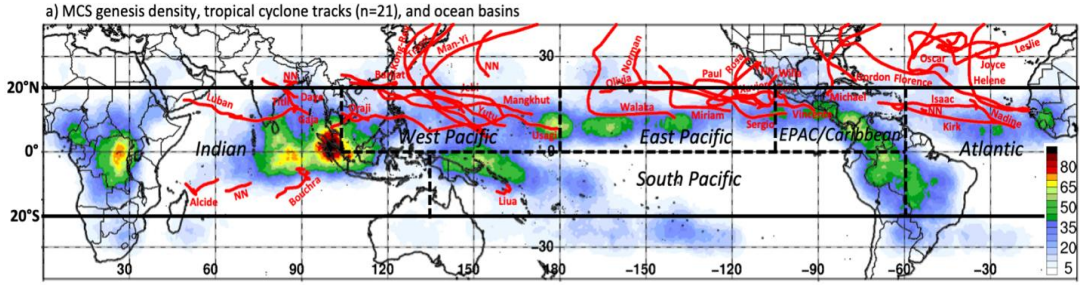
Perspectives on “Strengthening EESM Integrated Modeling Framework – Towards a Digital Earth”

Potential Opportunity: Organized Storms

GPEX will coordinate global field campaigns with in situ, airborne, and satellite measurements of the atmosphere, land, and ocean through the WCRP Years of Precipitation, focusing on different storm types:

- atmospheric rivers,
- mesoscale convective systems,
- monsoons,
- tropical cyclones

GEWEX is organizing various activities, including the tracking of organized storms.



MCS genesis density (total: 4000) and tropical cyclone tracks (red lines; 21) for 1 Sep–30 Nov 2018.

Galarneau et al. (2022, Atmos. Sci. Lett.)

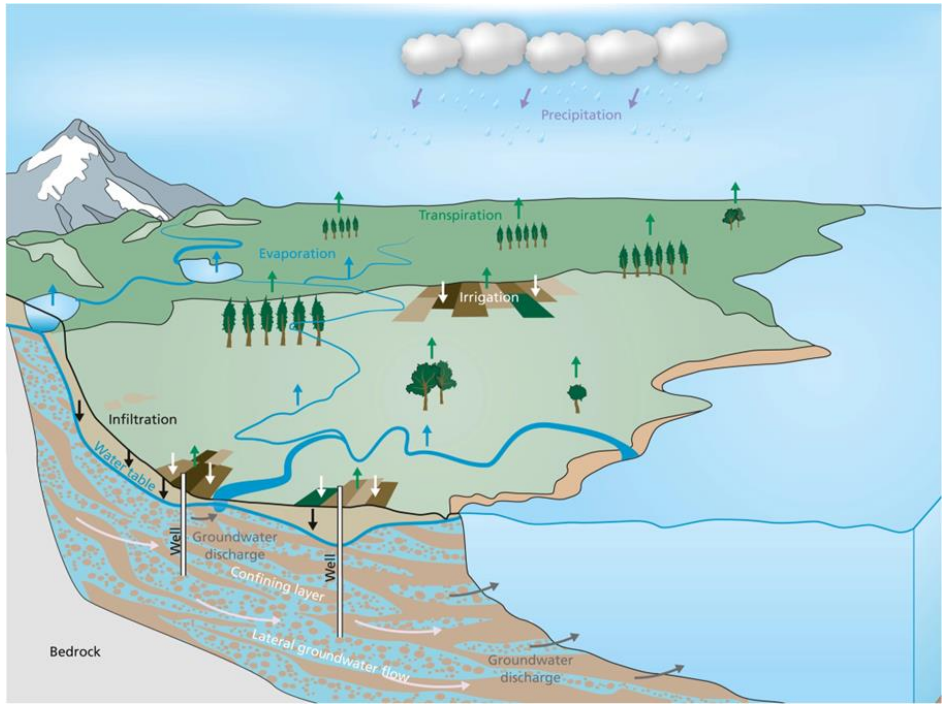
Perspectives on “Strengthening EESM Integrated Modeling Framework – Towards a Digital Earth”

Grand Challenge: Lateral movement of land surface and ground water and human activities (e.g., urban, irrigation, other water consumptions, water resources-related operations) at km-scale modeling

- Important for land coupling to the atmosphere and oceans
- Important for water cycle and carbon cycle

GEWEX is organizing various activities, including groundwater, flooding, irrigation modeling

This requires the coordinations among the three EESM program areas: ESMD, RGMA, and MSD.



GEWEX

Groundwater Modeling in GEWEX: Closing the Terrestrial Water Cycle from the Regional to the Global Scale

Stefan Kollet[1], Laura Condon[2], and Peter van Oevelen[3]