Humans and Hydroclimate in the U.S. (H_2US): A Convergent Science Approach at the Land-Atmosphere Interface

Tim Schneider
Sarah Tessendorf, Peter van Oevelen and the H_2US Affinity Group

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Photo: Dr. Jasper Schneider

Topics for Today

I. H_2US Introduction and Overview
II. Opportunities - Points of Intersection with the Noah-MP Community

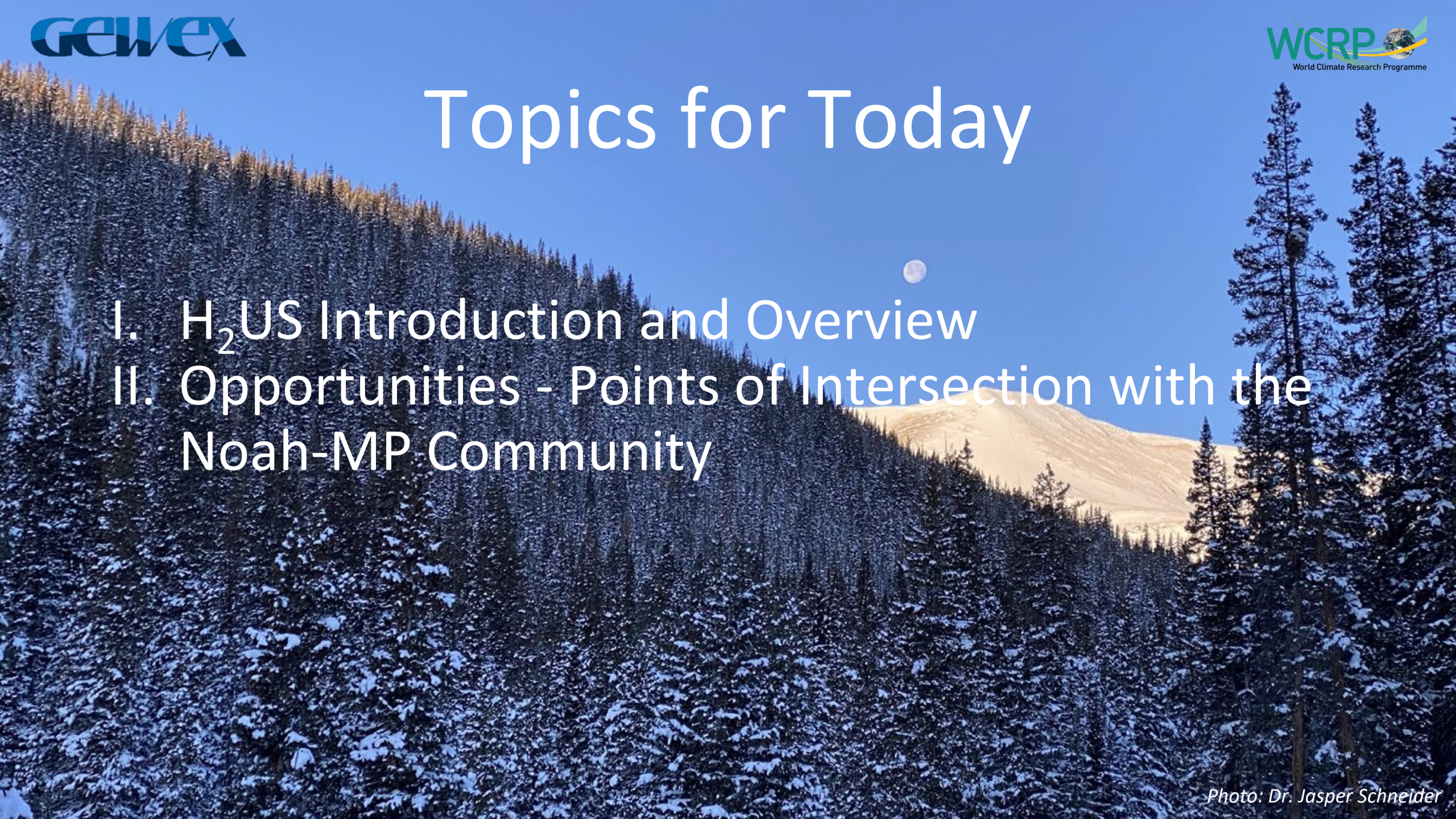
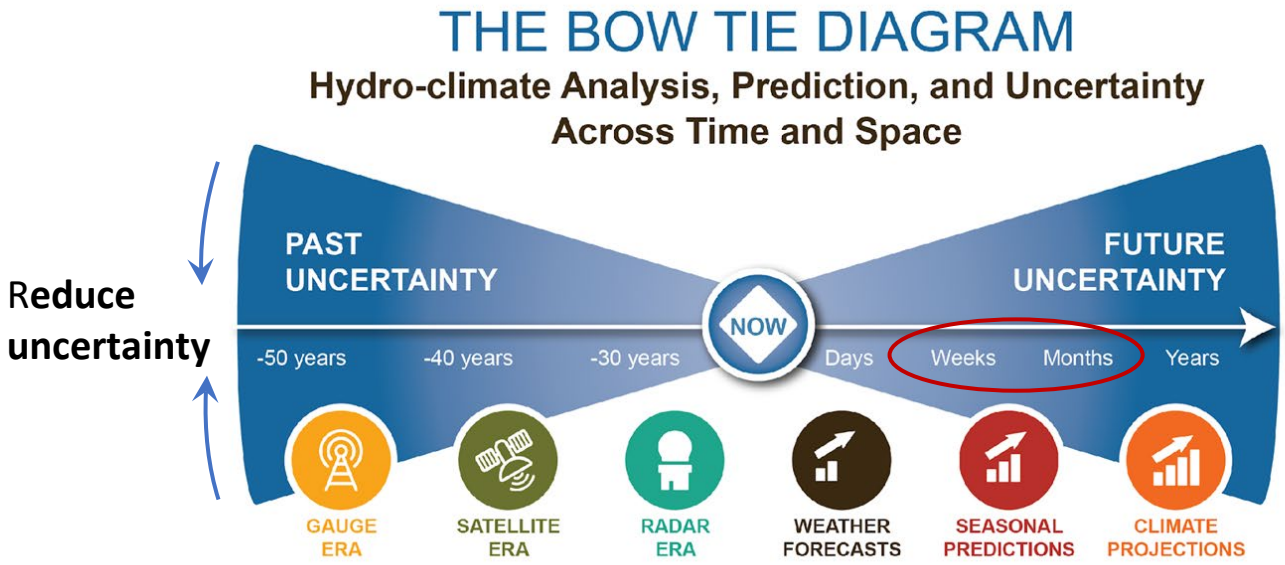
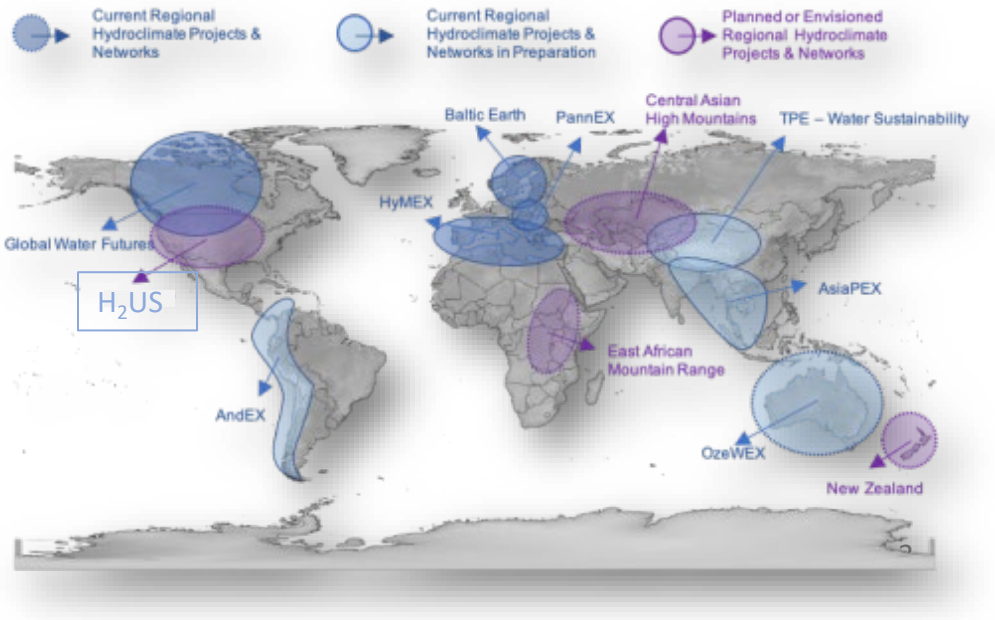


Photo: Dr. Jasper Schneider

GEWEX US-RHP Mission

A ten-year effort to understand and characterize the Water, Energy, and Carbon Cycles in the Anthropocene: driven by a need for usable modeling tools and actionable products developed in collaboration with stakeholders to address climate justice, and support water, food, and energy security for natural and human systems in a changing future.





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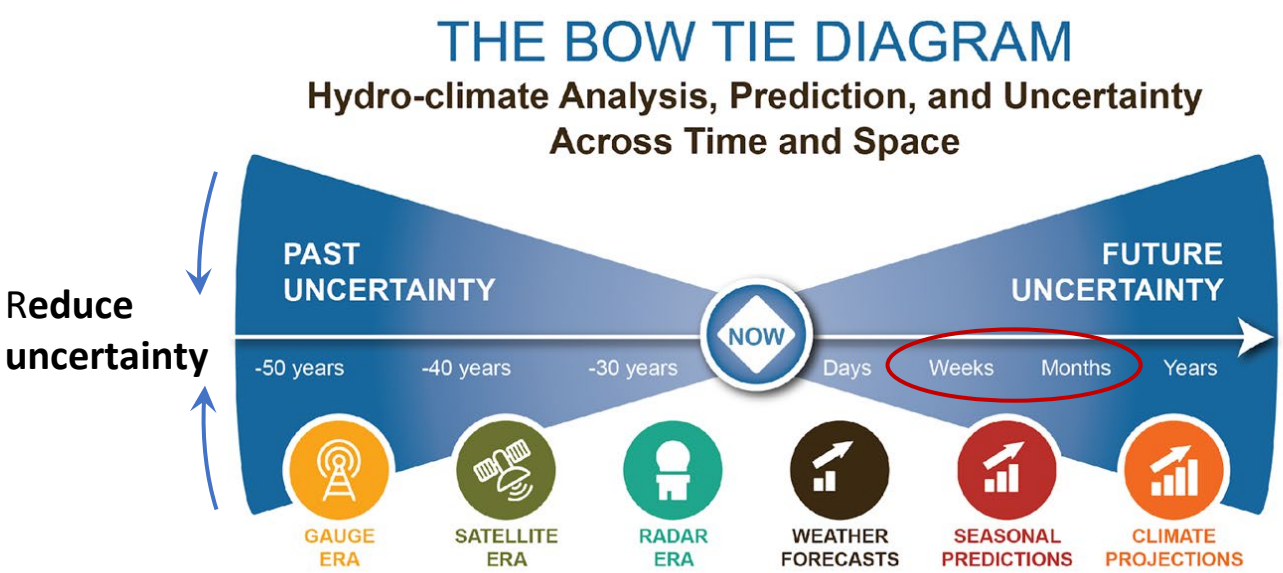


US-RHP Scope

Modeling across scales:

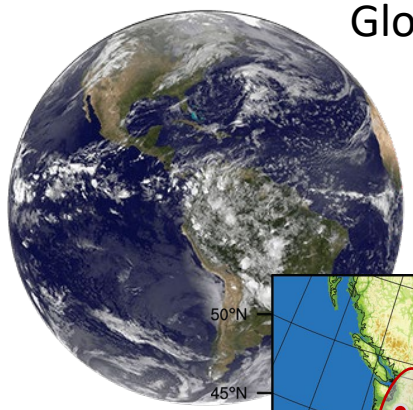
global → **CONUS** → watershed

Coordinated intensive studies, supported by Regional Focal Studies with embedded observational transects

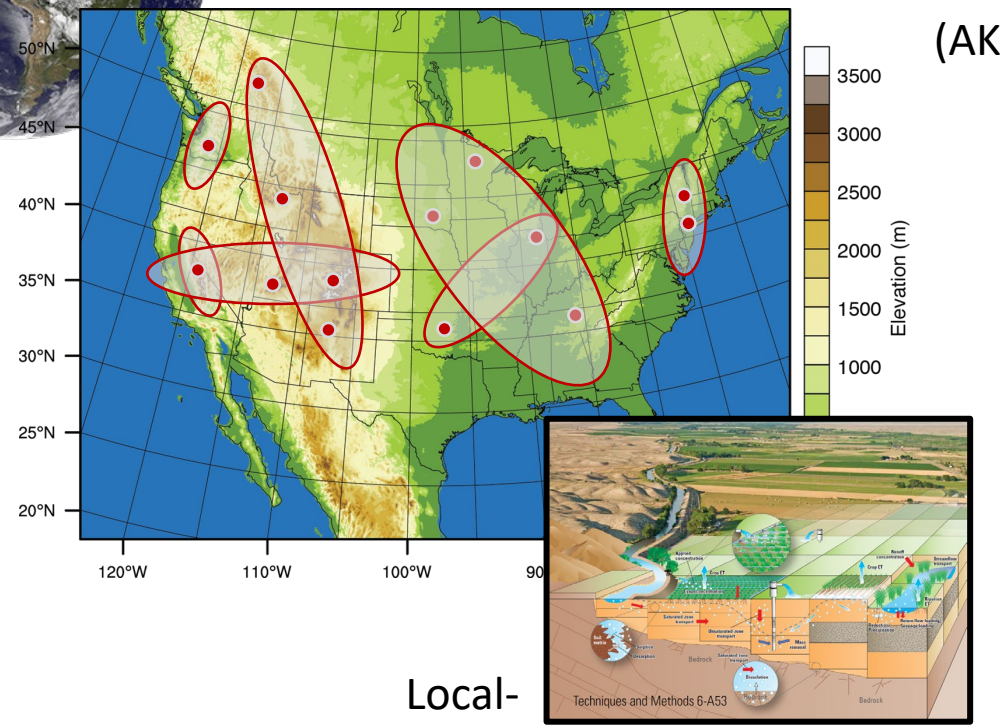
New and leveraged observations, e.g:

- USGS-NGWOS
- AmeriFlux
- NEON / CZO
- DOE/ARM (SAIL)
- NOAA (SPLASH)
- Global Water Futures
- Airborne missions
- Satellites
- GEWEX Land-Atmosphere Feedback Observatories (GLAFOs)
- etc.

Global



Regional - 'Convection Permitting' (AK & HI)



Local-Watershed

US-RHP Scientific Strategy

Thematic Research Areas (Working Groups)

A Complex, Coupled System

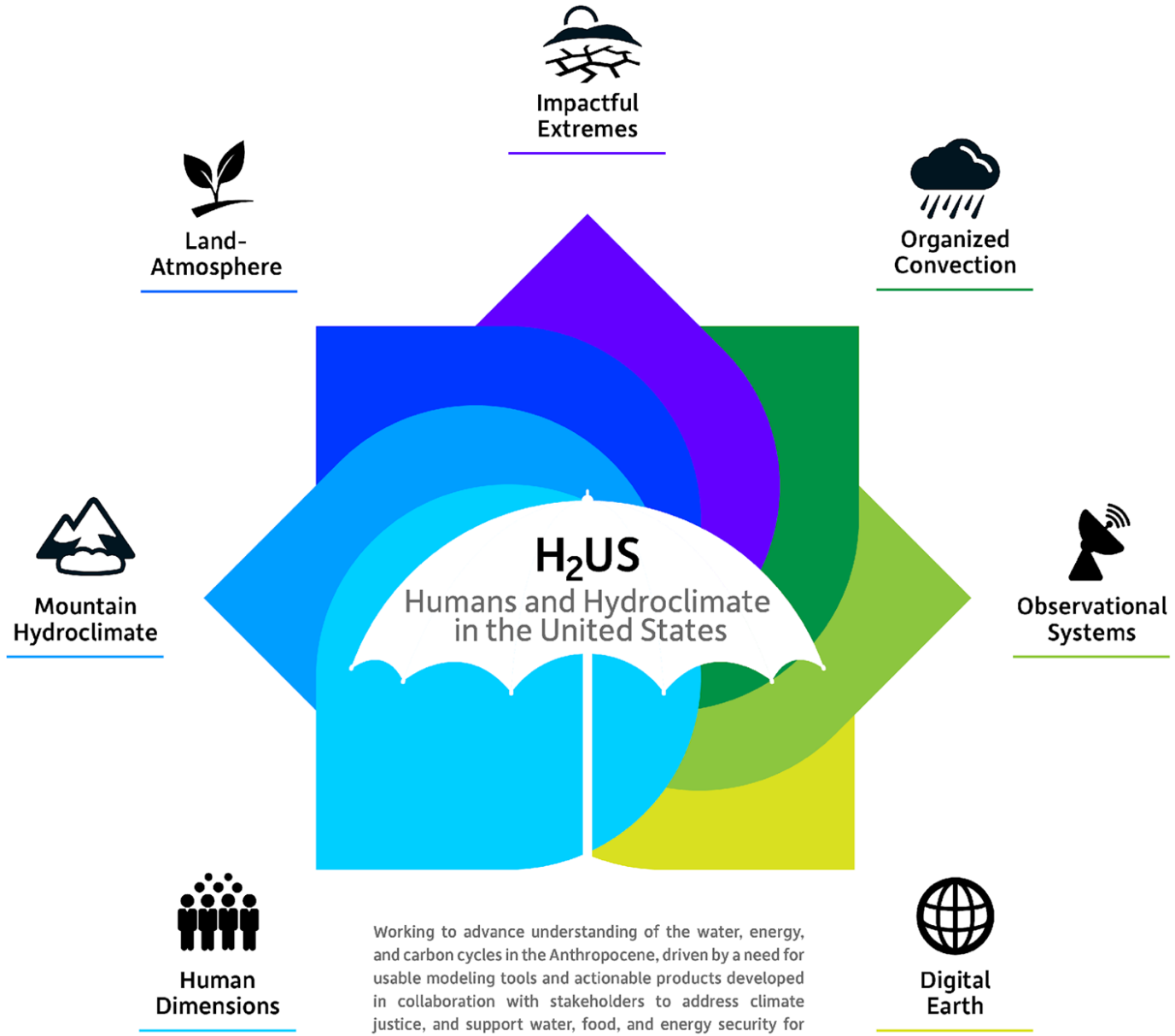
Water: $P + Q_{in} = ET + \Delta S + Q_{out}$

Energy: $R_n + G = \lambda ET + H$

Refine estimates of these terms; quantify their uncertainties; understand how will they change.

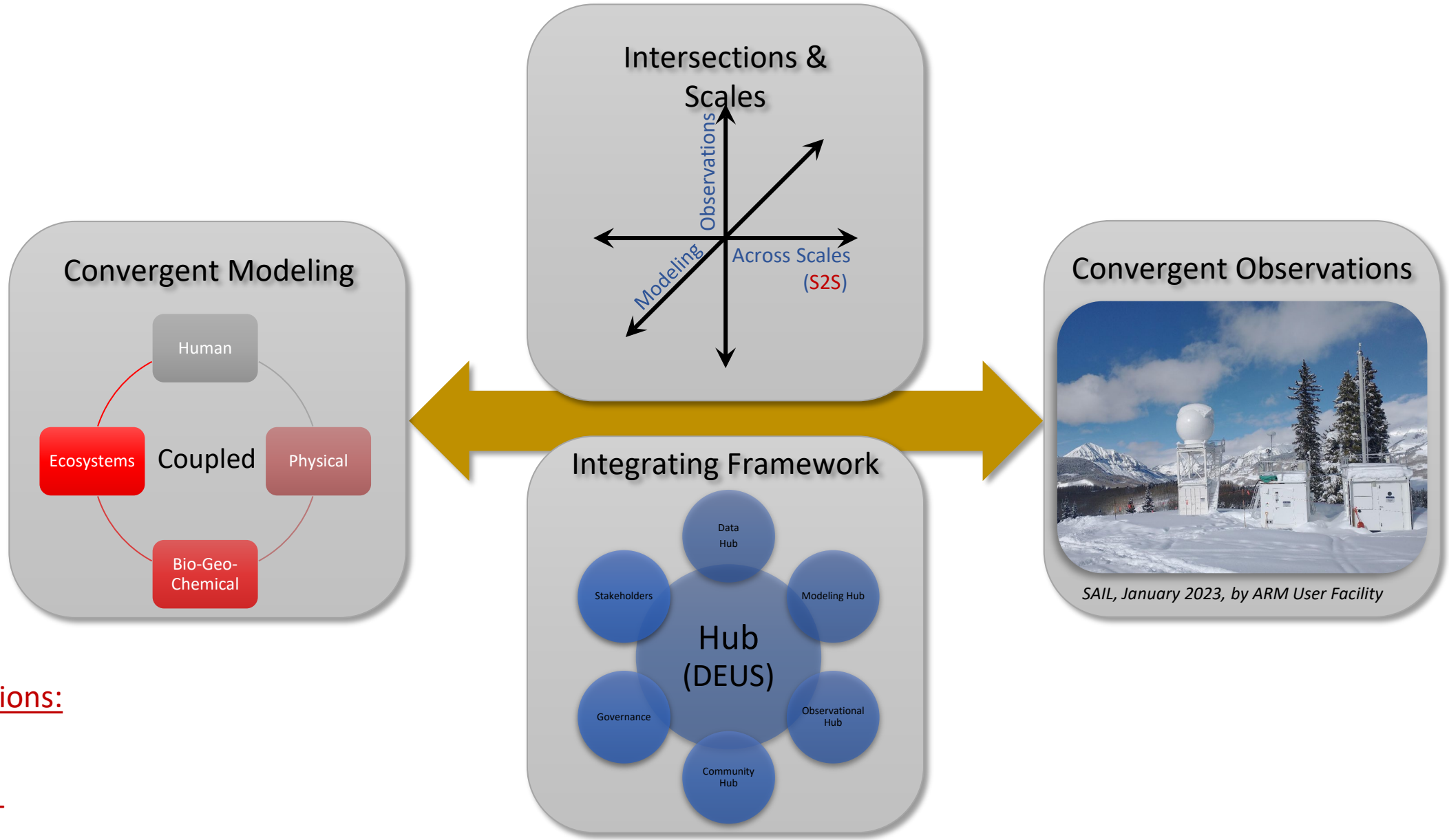
The *Carbon Cycle* most directly ties in through the "R_n" (energy) and "**ET**" terms.

Anthropogenic influences are manifold and impact all of these cycles through GHG emissions; land use/land cover change; and water resource management.



{Coastal Coupling – TBD}

Scientific Strategy: Emergent Themes

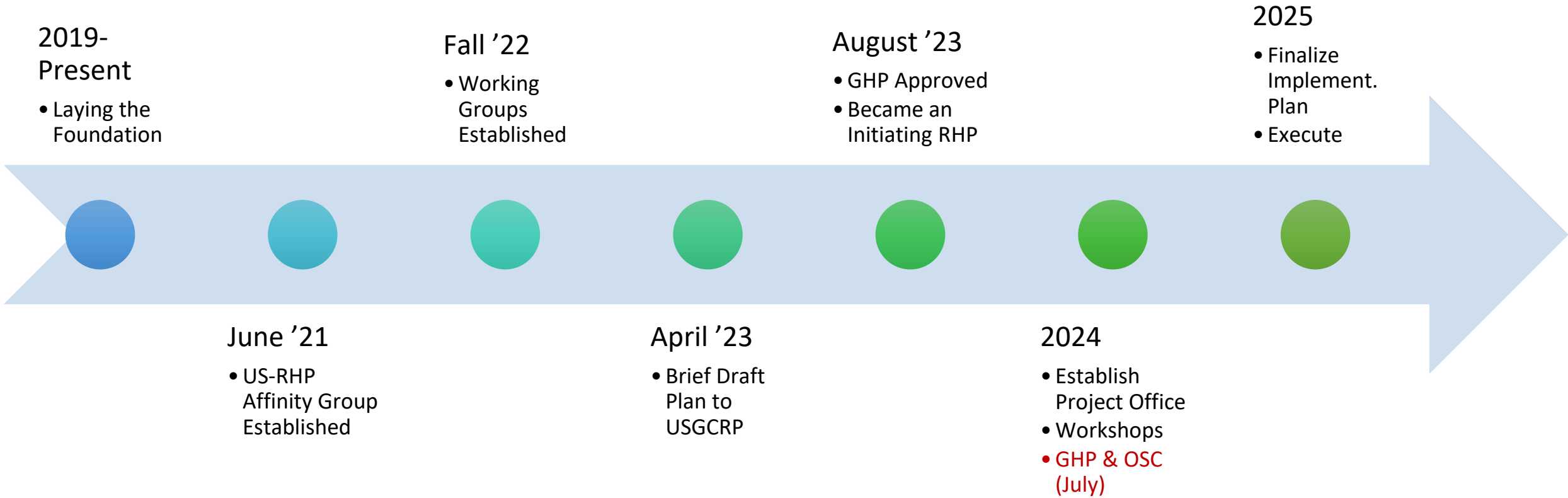


Intersections:

- GPEX
- IHTM
- ESPAT

US-RHP Timeline

It's a marathon – not a sprint



Plan for Support

Initial/Short-Term

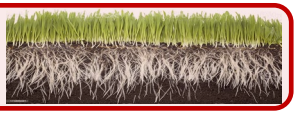
- **Establish Project Office (1-3 FTEs)**
  - To provide scientific leadership
  - Project management, coordination
  - Administrative and technical support
  - Travel
- **Support for one or more workshops**
  - Including travel for key participants (scientific advisory group) and facilitation
- A modest amount of support for each of the WGs to work on the **development of the US-RHP Implementation Plan**

Long-Term

Identify and secure sustained sources of funding.

Two successful, current GEWEX RHPs provide paradigms that bookend how the US-RHP can succeed:

- Global Water Futures (GWF): On the ***"moon shot"*** end of the spectrum, is the GWF RHP in Canada
- Baltic-Earth: A ***"grassroots"*** approach



There are a range of possibilities between these two extremes.

- The US-RHP is committed and will be agile and creative in our approach
- Realistically, we will begin with a grassroots effort and grow with moonshot aspirations

Opportunities

- L-A processes and coupling – an Earth System "bedrock to boundary layer" approach
  - Integrated modeling and observational studies
  - What are the observational gaps?

- How do we integrate humans into our modeling systems?
  - Processes (e.g. irrigation, urban, etc.)
  - Socioeconomic responses to change (i.e. climate LU/LC, loss of biodiversity, etc.)

- How do we integrate ecosystems into our modeling systems?
  - Not just the carbon cycle, but ecosystem response

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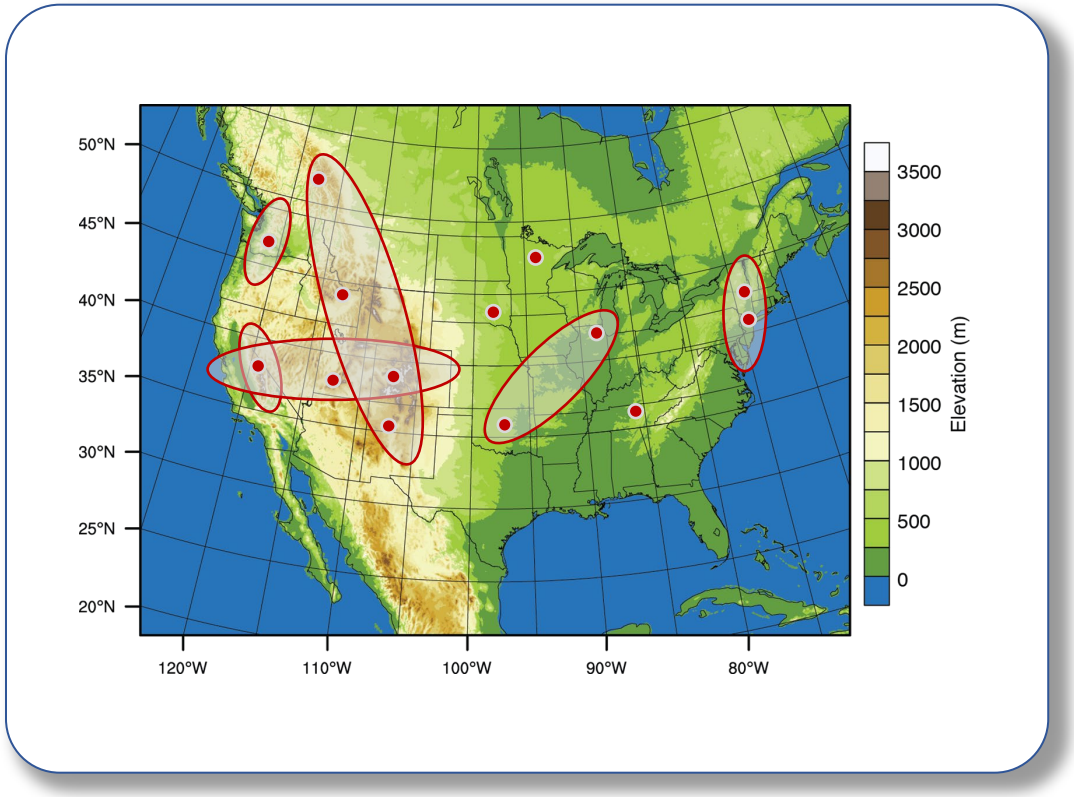
Opportunities: Leverage CONUS404

- Created to drive hydroclimate science, products and services with and for the USGS and the community
- Baseline simulations that have benefited from advancements in Noah-MP
- ***Retrospective:**
  43-years and growing - WY1980-WY2022
  https://rda.ucar.edu/datasets/ds559.0/
- **Future (PGW):**
  Target: 42-years ("WY2022-WY2063")
  In progress; complete through "WY2059")

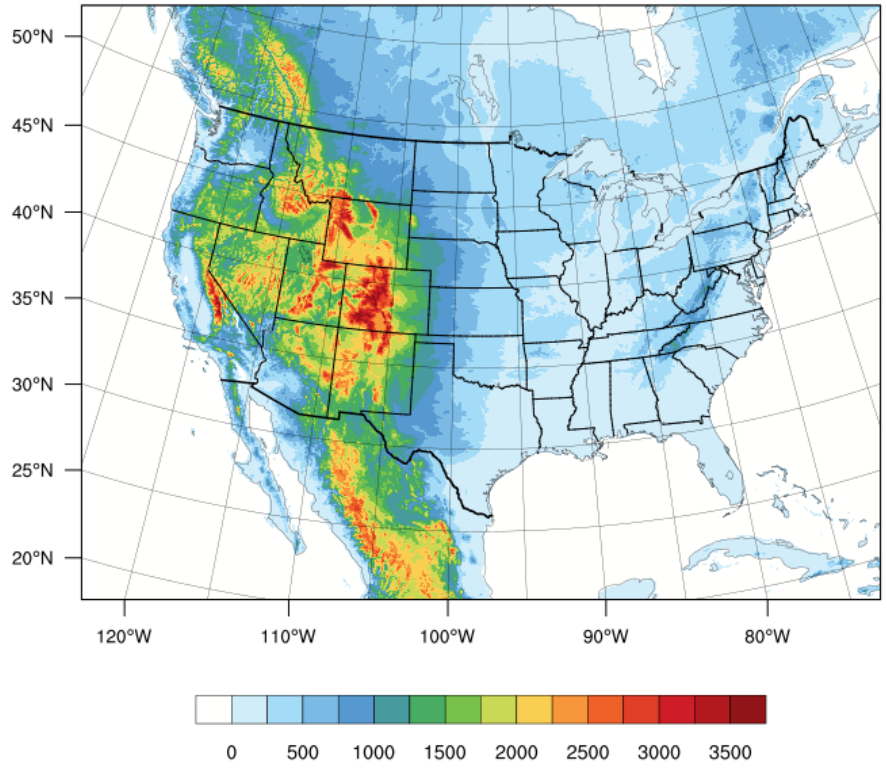


* About: https://www.usgs.gov/data/conus404-four-kilometer-long-term-regional-hydroclimate-reanalysis-over-conterminous-united

Configuration of the CONUS404 simulation

Weather Research and Forecast (WRF) model simulation on Denali

- WRF version: V3.9.1.1 with improved physics
- Single domain: 1368×1016 grid points, 4-km grid spacing, 51 vertical levels
- Major subgrid physics: Thompson microphysics, YSU Boundary Layer, RRTMG radiation, NoahMP land surface coupled to Miguez-Macho ground water scheme
- Spectral nudging of geopotential, temperature, and winds above the boundary layer, using the same technique as in CONUS1
- Initial and boundary data: 3-hourly 0.25-degree ERA5
- Simulation period: 43 water years from Oct 1, 1979 - Sept 30, 2022 (WY's added incrementally on annual basis)



Model Domain (5464 km x 4064 km)

Slide from/after: Lulin Xue et al.

CONUS404 PGW: Design

PGW = CTRL + Δ Δ = PROJ - HIST

Both PROJ and HIST periods must be chosen to be long enough to reduce the effects of internal variability (average of ~ 30 years) or use ensemble means.

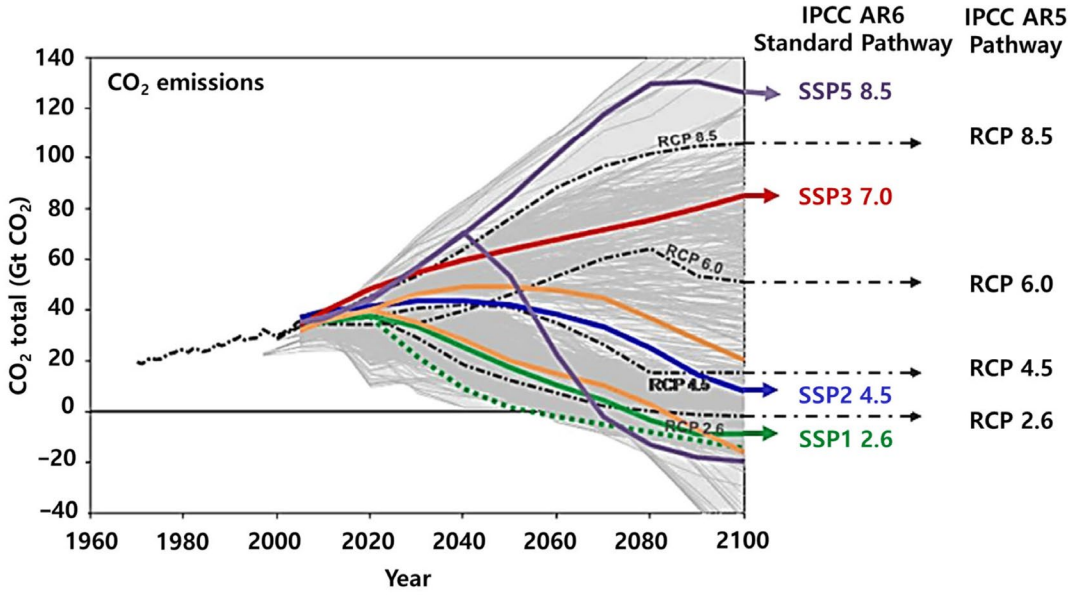
CONUS404 used **ERA5** initial and boundary conditions from ~WY1980 - 2021 (**CTRL**).

Δ represents a near-term climate change signal: **PROJ** covers WY2022 - 2063 and **HIST** covers WY1980 – 2021.

PROJ and HIST are based on the **100-member ensemble mean data** of the CESM2 Large Ensemble Community project (**LENS2**).

LENS2 used the Shared Socioeconomic Pathways radiative forcing scenario 3 (**SSP3-7.0**) for future projection.

CONUS404 PGW = ERA5_WY1980-2021 + LENS2_WY2022-2063 – LENS2_WY1980-2021



* Plans to add 2 WYs

Slide from/after: Lulin Xue et al.

An Invitation

- *GEWEX Overview:*
  https://www.gewex.org/h2us/

- *H_2US Affinity Group:*
  https://ral.ucar.edu/projects/humans-and-hydroclimate-united-states-h2us
  See links to "Summary Level Science Plan" and to join the AG

Join the H_2US Affinity Group:

THANK YOU!

Contact: Tim Schneider / tls@ucar.edu / m: 720-725-2745