

Progress Towards a GEWEX Regional Hydroclimate Project over the CONUS

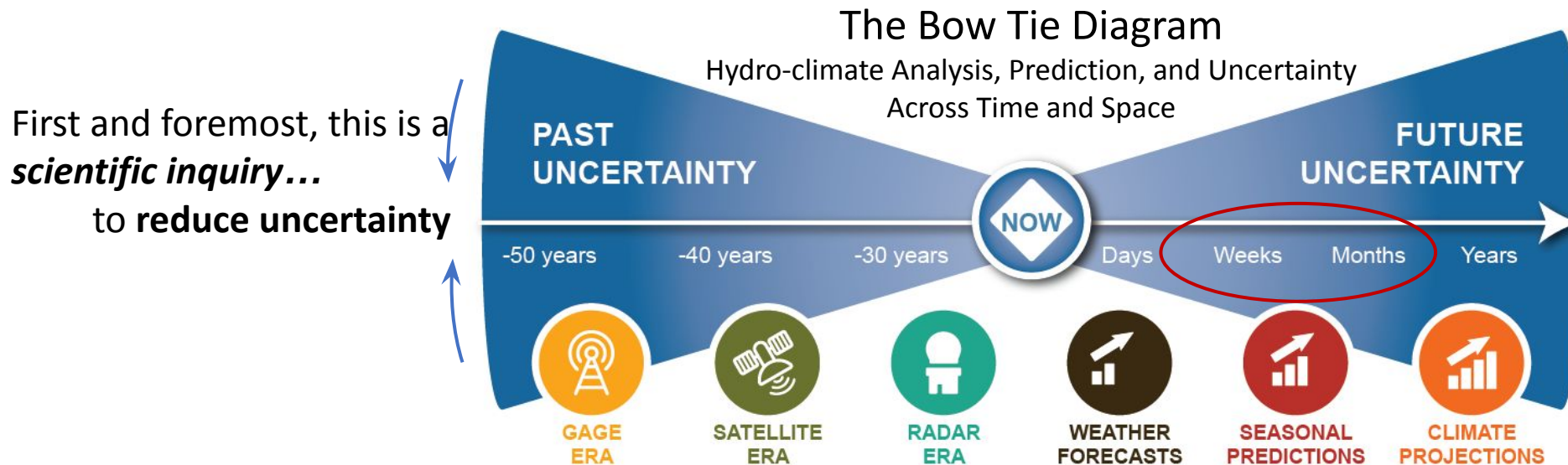
Tim Schneider¹, Sarah Tessendorf¹, Peter van Oevelen²
¹NCAR, ²Director IGPO & GMU

GHP Meeting, Maynooth Ireland
5-7 JULY 2023



GEWEX US-RHP Proposal

A ten-year effort to understand and characterize the water, energy, and carbon cycles (physical processes) in the Anthropocene: driven by a need for useful modeling tools and actionable products developed in collaboration with a multitude of stakeholders to address climate justice, and support water, food, and energy security for natural and human systems in a changing future.



GHP Score Card...

- Good shape
- In Progress
- Remains to be addressed

RHP Criteria*	Status
1. A science plan should state the central science and applications questions to be addressed by the RHP and proposed tasks to achieve it	<ul style="list-style-type: none"> • Plan completed (Ver.1, June 2023) • Working to align with program agencies
2. A coordination mechanism (e.g., a Science Steering Group or equivalent) that includes a GEWEX contact (e.g., SSG chair, or project coordinator).	<ul style="list-style-type: none"> • Project leadership: Schneider, Tessendorf, van Oevelen • Working Group Leads: our scientific advisory group • Affinity Group: an active, diverse, interdisciplinary community <ul style="list-style-type: none"> ○ Actively working to broaden and diversify • GEWEX Contact: Director, IGPO • Web presence actively being developed
3. Adequate resources and personnel with potential sources of funding or existing funding identified.	<ul style="list-style-type: none"> • Resources/Personnel: Supported by NCAR/RAL and small seed funds to support development (GMU; NCAR) – not sustainable over the long run • Ongoing since 2019 – numerous Federal Agencies engaged
4. A end date and an exit plan that includes a science and applications synthesis and data archival procedure.	<ul style="list-style-type: none"> • Planned as a 10-year project • To be explicitly defined in the Implementation Plan
5. A mechanism for collecting, managing, and providing access to hydroclimatological data sets with participation in the international exchange of scientific information and data.	<ul style="list-style-type: none"> • RHP “Hub” (or a Testbed); Digital Earth of the U.S. (DEUS) <ul style="list-style-type: none"> ○ Depends in part on funding mechanisms ○ Specifics to be fleshed out in Implementation Plan

*RHP Criteria at the outset of a project (Francina Dominguez to AG; 7/15/2021)



US-RHP Scope

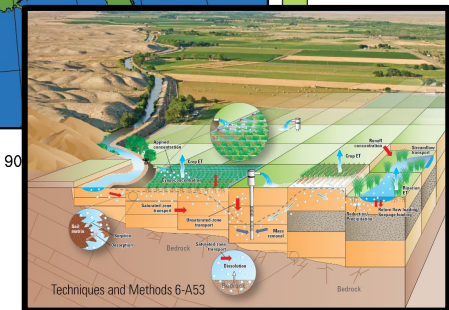
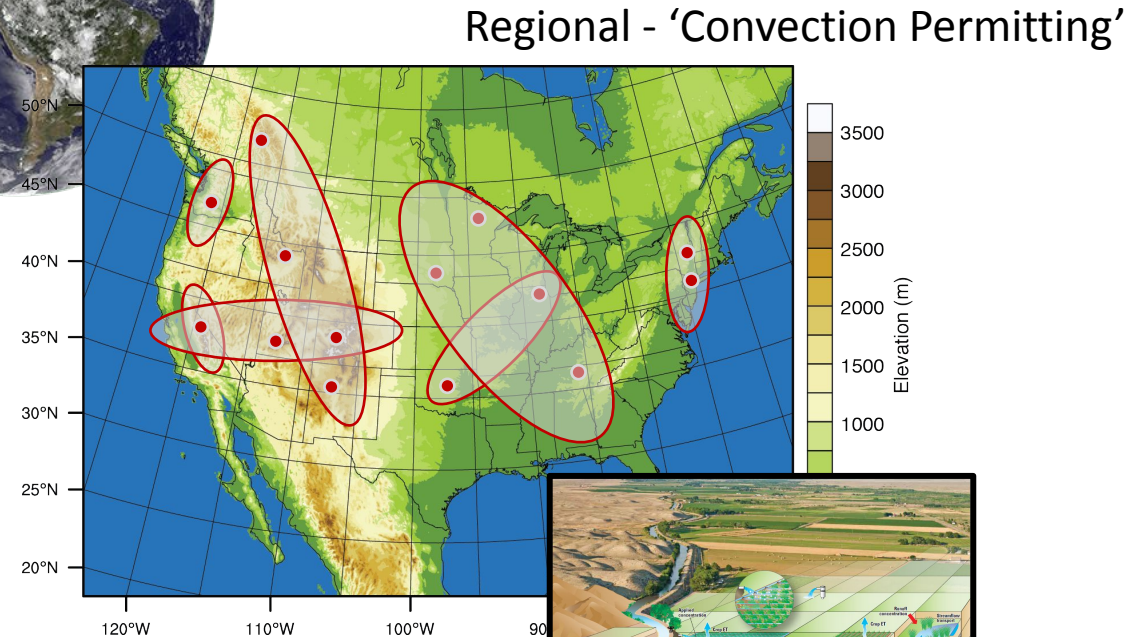
Modeling across scales:

global → **CONUS** → watershed

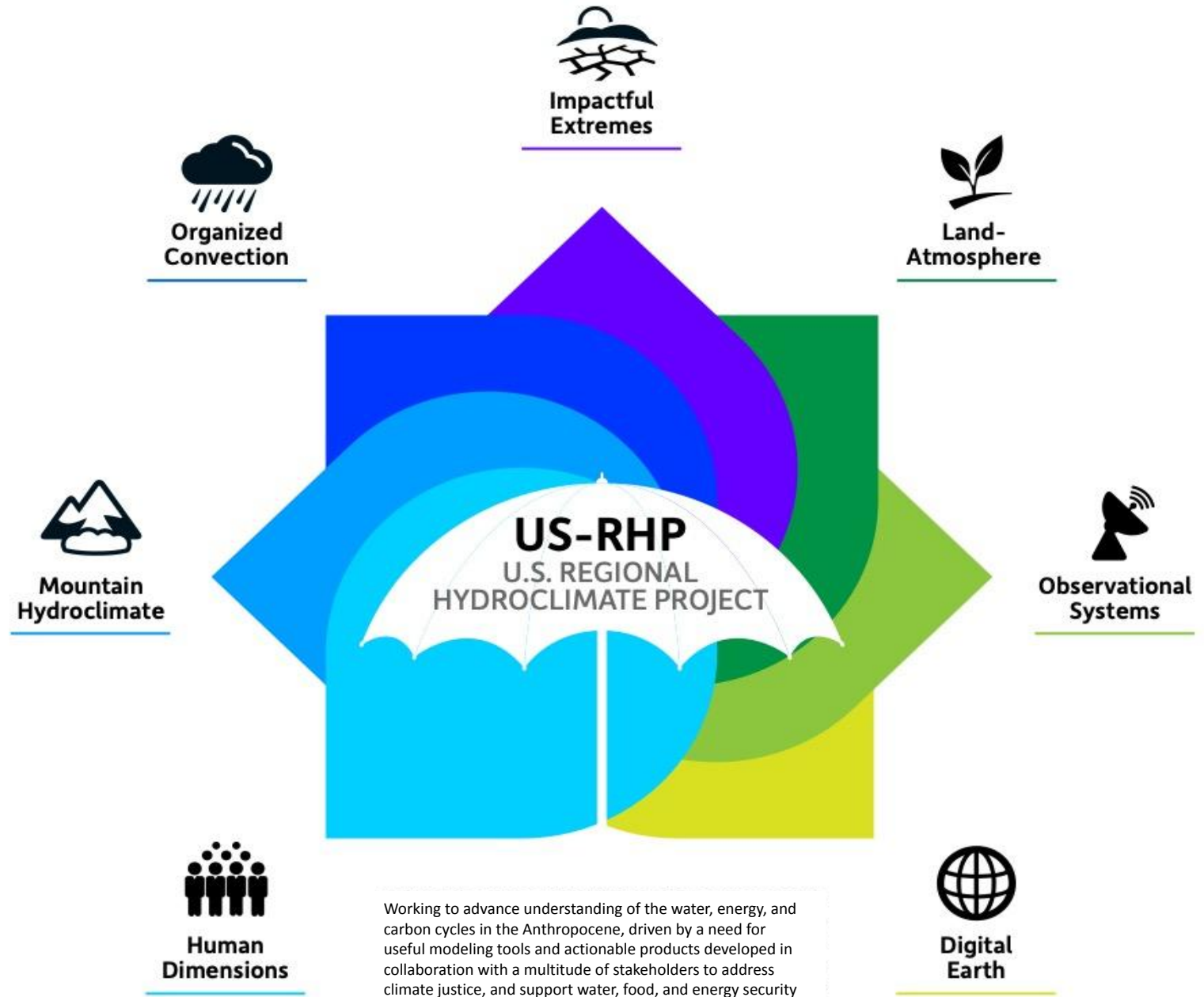
Coordinated intensive studies, supported by Regional Focal Studies with embedded observational transects

New and leveraged observations, e.g:

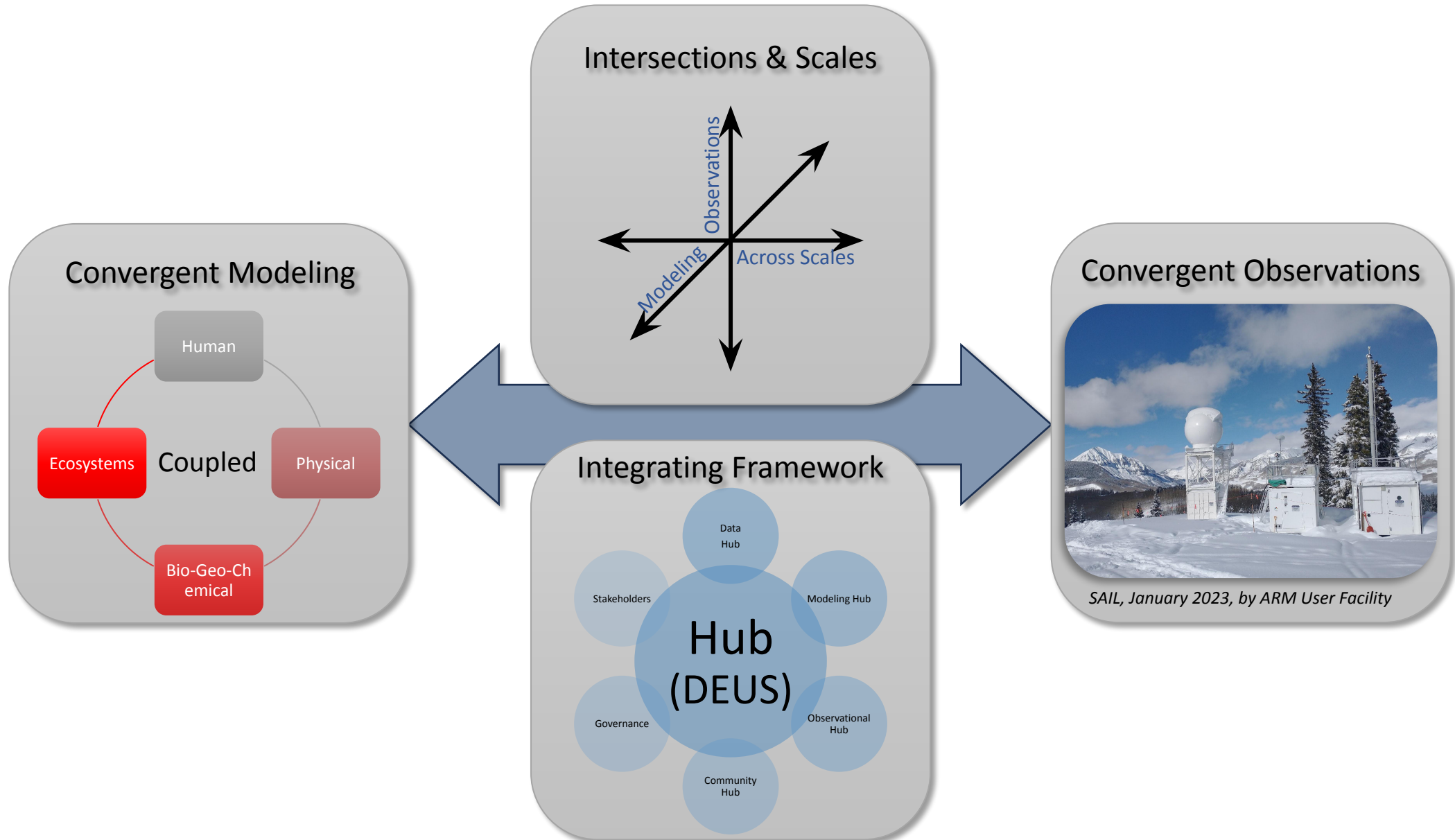
- USGS-NGWOS
- AmeriFlux
- NEON / CZO
- DOE/ARM (SAIL)
- NOAA (SPLASH)
- Global Water Futures
- Airborne missions
- Satellites
- GEWEX Land-Atmosphere Feedback Observatories (GLAFOs)
- etc.



US-RHP Scientific Strategy Thematic Research Areas (Working Groups)



Scientific Strategy: Select Emergent Themes



2.1 Human Dimensions



Gaps

- 1) **Integration and Scales:** There are gaps in how we bridge our understanding of what makes hydroclimate and integrated carbon-water-food-energy knowledge actionable from continental to local scales
- 2) **Co-Production:** Gaps remain on the co-production of actionable knowledge with Indigenous and other communities that are historically underrepresented



2.2 Mountain Hydroclimate



Gaps

- 1) **Complex Terrain:** observations in complex terrain are insufficient to support model development, evaluation, and process understanding
- 2) **Partitioning:** Understanding the distribution and partitioning of precipitation, and a quantitative consensus of the complex fate of this moisture once it is on the ground
- 3) **Uncertainties:** uncertainties associated with anthropogenic hydroclimatic change are large in complex terrain because of the interaction between large scale climate and the terrain



2.3 Land-Atmosphere Processes & Coupling



Gaps

- 1) **Extremes:** There is a lack of knowledge about the role that L-A coupling plays in influencing the evolution of US hydroclimate extremes on S2S to decadal timescales
- 2) **Coupled systems:** There is a lack of knowledge about how L-A feedback affects the coupled snowpack-drought-fire-heatwave system in the US, particularly under climate change
- 3) **LU/LC change:** There is a lack of knowledge in understanding how land use land cover (LULC) change will alter L-A interactions and hence the US hydroclimate under climate change



2.4 Impactful Extremes



Gaps

- 1) **Cascading/compounding events:** extreme events and their impacts can and do interact with each other in complex and challenging ways that are not necessarily well understood, and are intertwined with heightened societal impact and feedback
- 2) **Definitions:** defining what an extreme event is, and we do not understand how these definitions may or may not apply in a changing future, nor how we integrate an understanding of how humans adapt to changing extremes
- 3) **Understanding and predictions:** disentangling the local and remote mechanisms driving impactful extremes can be a challenge; limitations of key observations exacerbate these challenges; and many open questions remain regarding the main drivers of prediction skill and predictability, especially at S2S time scales



2.5 Organized Convection and Precipitating Systems



Gaps

- 1) **Changing precipitation:** a major challenge is understanding how precipitation accumulation as well as the distribution of instantaneous rainfall rates will change in the future
- 2) **Multi-scale nature of convection:** biases exist as a function of the models' spatial scale and their parameterizations of cloud microphysics, turbulence, and planetary boundary layer and surface parameterizations; improvement in models has been hampered by observational or reanalysis-based datasets that were too coarse in resolution or contained large uncertainties
- 3) **Frameworks:** frameworks, model intercomparisons, and evaluation datasets at high resolution will be needed to advance hydroclimate modeling capabilities, as well as assess societal risks associated with hydroclimate extremes

Contributions to GPEX (WCRP Lighthouse Activity)

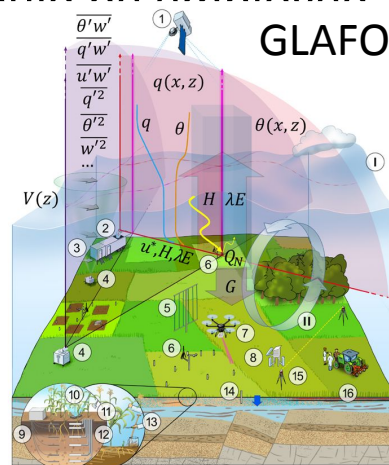


2.6 Advancing Observational Systems



Gaps

- 1) **Thematic topics:** each of the thematic sections in the plan, from Human Dimensions (§2.1) to Organized Convection and Precipitating Systems (§2.5), have identified observational gaps that need to be addressed
- 2) Our models are “outstripping” our observations
- 3) **Observations of L-A processes:** observations of bedrock to boundary layer processes are insufficient in quantity, comprehensiveness, and geospatial/temporal coverage; new instruments and approaches are available and should be employed

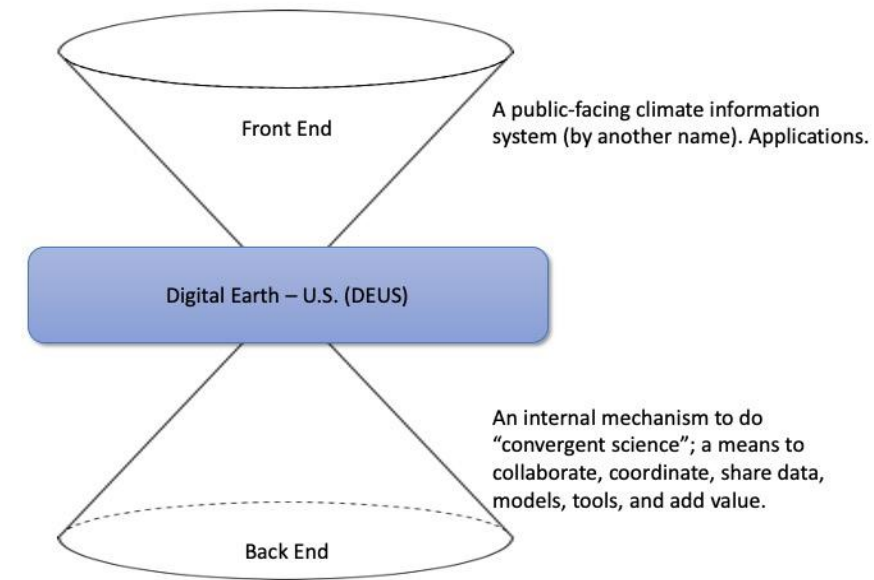


2.8 Digital Earth for the US (DEUS)

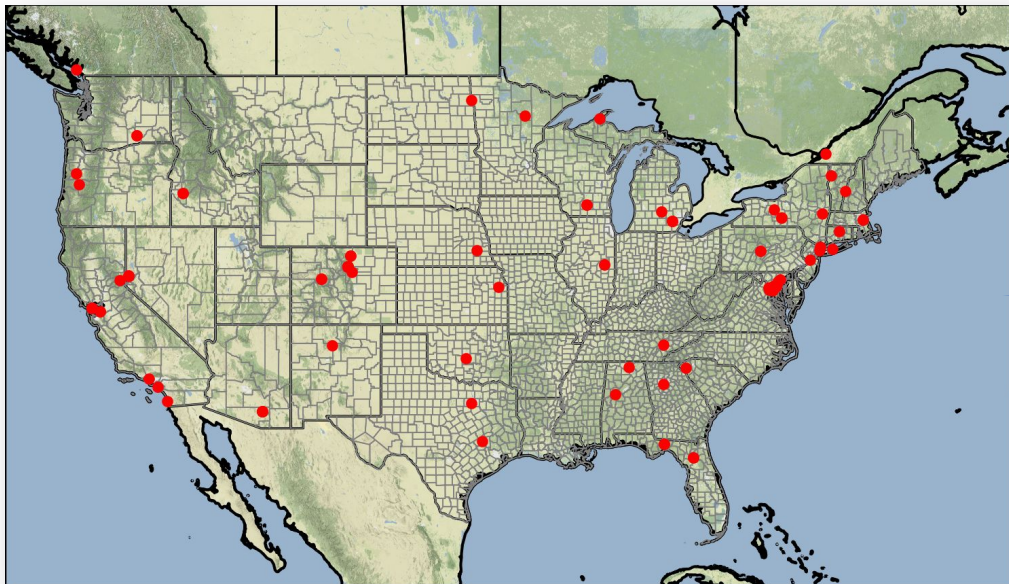
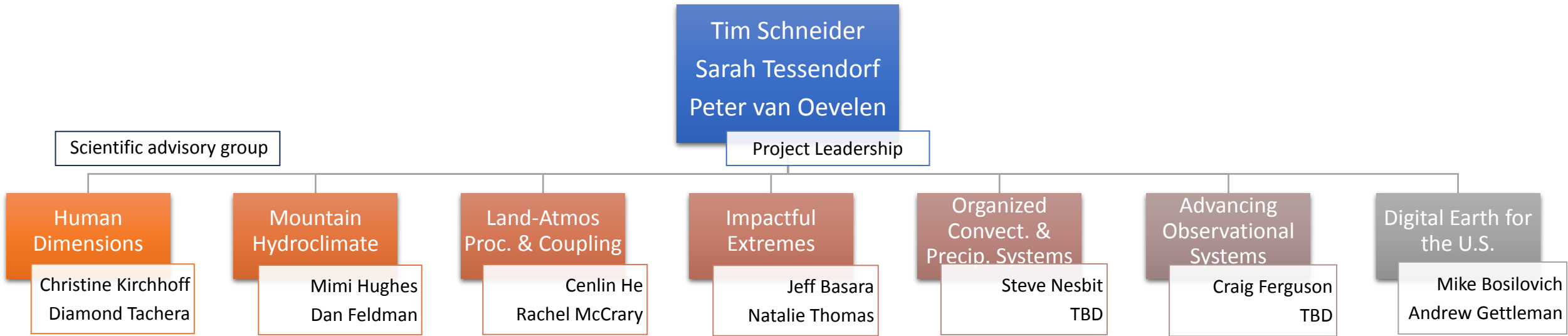


Gaps

- 1) **Thematic topics:** The science plans and questions in this document require a prediction and analysis system of the scale of an integrated Digital Earth to effectively meet the needs identified herein
- 2) We need a means to integrate data from a wide range of source: (social surveys, observations, model-derived, etc.) to create a comprehensive picture of the United States regional weather and hydroclimate
- 3) We need an information system that will advance open science, connection to applied users, and integrate human dimensions



US-RHP Leadership & Coordination



Our foundation: a diverse, interdisciplinary, 161 member strong (and growing) Affinity Group

Updated: 6/22/2023

Not shown:



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

US-RHP Timeline

It's a marathon – not a sprint

2019-Present

- Laying a Foundation

Fall '22

- Working Groups Established

July '23

- GHP Meeting
- Goal: Initiating RHP

FY2025

- Finalize Implementation Plan
- Execute

June 2021

- US-RHP Affinity Group Established

April '23

- Brief Draft Plan to USGCRP

FY2024

- Establish Project Office
- Plan/Execute Workshops

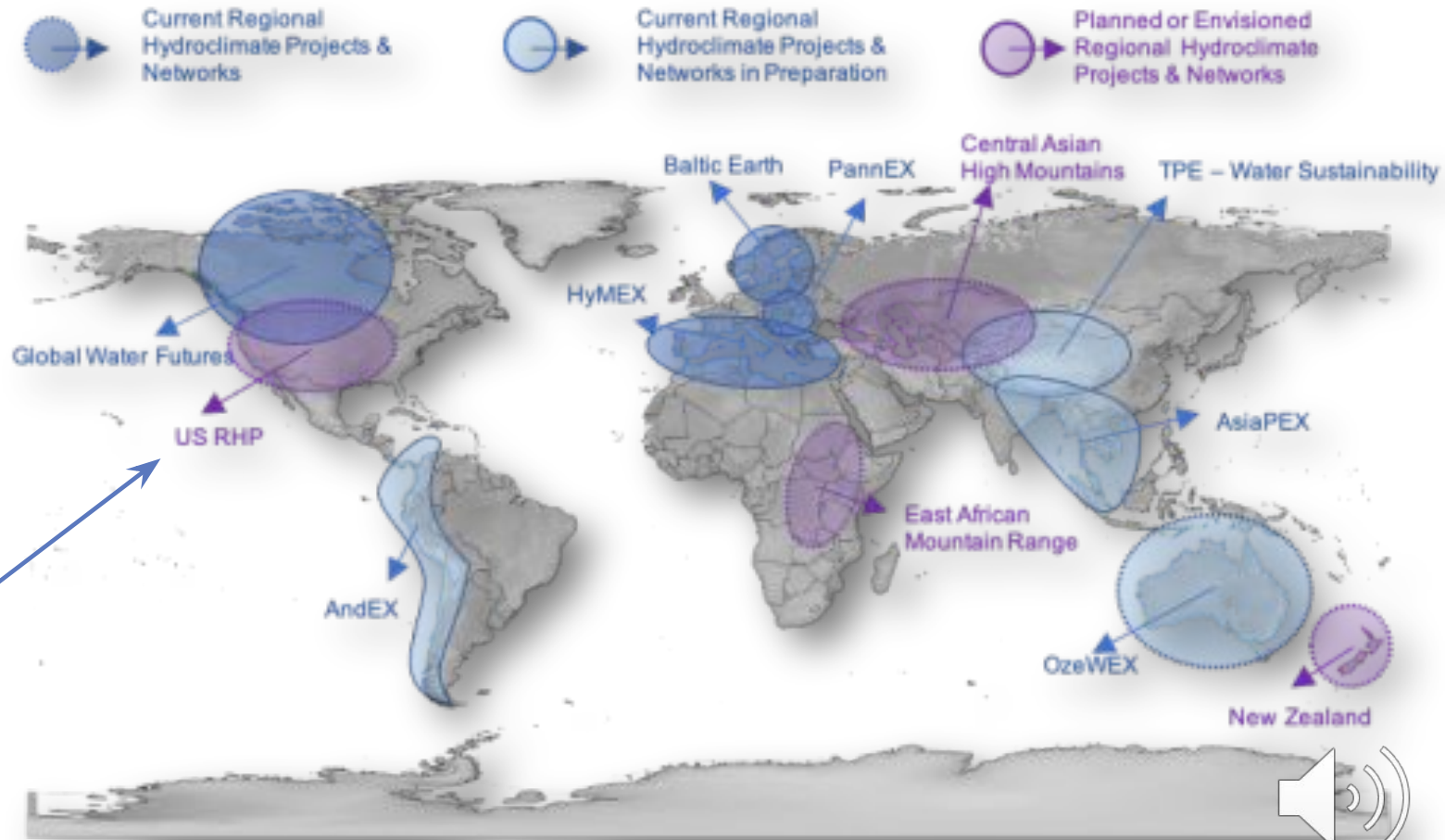


Our Request: Initiating RHP Status

We respectfully request status as an *Initiating RHP*.

The community has endeavored to address the criteria laid out for us and we feel that we have adequately done so.

Let's make it blue!





Thank You!

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



