International Network for Alpine Research Catchment Hydrology

INARCH 2022 Closing

John Pomeroy, Ignacio López Moreno, James McPhee, Chris DeBeer

2022 Annual INARCH Workshop

20 October 2022

https://inarch.usask.ca

INARCH Workshop Statement 2021

- We have completed our Phase 1 Science Plan and have a suite of well-instrumented research basins, high-resolution forcing meteorological datasets, and advanced snowdrift-permitting and glacier-resolving hydrological models that are exemplars of **Integrated High Mountain Observation and Prediction Systems (IHMOPS)**.
- We have used the IHMOPS to improve our scientific understanding, and evaluate observed changes, data and models around the world. The models are being used to estimate the sensitivity of the high mountain cryosphere and hydrology to climate change.
- We need to
  - provide common and archived observations for basin diagnosis and modelling through a Common Observation Period Experiment (COPE),
  - enhance basin observations with novel and more sensors,
  - Improve, downscale and correct atmospheric forcing datasets using basin observations,
  - develop, improve, compare, and apply multiscale high-fidelity cryosphere-hydrological-water management models to river basins originating in high mountains
  - work with communities to develop plans to predict future water scenarios, build capacity, enhance forecasting systems, answer questions on water futures and evaluate the sustainability of proposed water management solutions.

INARCH Phase II Science Questions

1. How different are the observation and measurement approaches amongst INARCH basins and do we expect distinctive differences in our understanding of basin response and hydrological predictability because of the sampling schemes, and data quality and quantity?
2. How do the predictability, uncertainty and sensitivity of energy and water exchanges vary with changing atmospheric thermodynamics, ecosystem structure and water management in various high mountain regions of the Earth?
3. What improvements to high mountain energy and water exchange predictability are possible through improved physics in, coupling of, and downscaling of models in complex terrain, and improved and expanded approaches to data collection and assimilation?
4. To what extent do existing model routines have global validity, are transferable, and meaningful in different mountain environments for providing service to society?
5. Can mountain systems be predicted and managed to find solutions to help achieve water sustainability in river basins under climate change?

Eventually contribute to answering - How have mountain atmospheric-cryospheric-hydrological-ecosystem-human systems co-evolved to their current states and how will they respond to climate change over the next century?

Summary of Observatories and Measurement Techniques

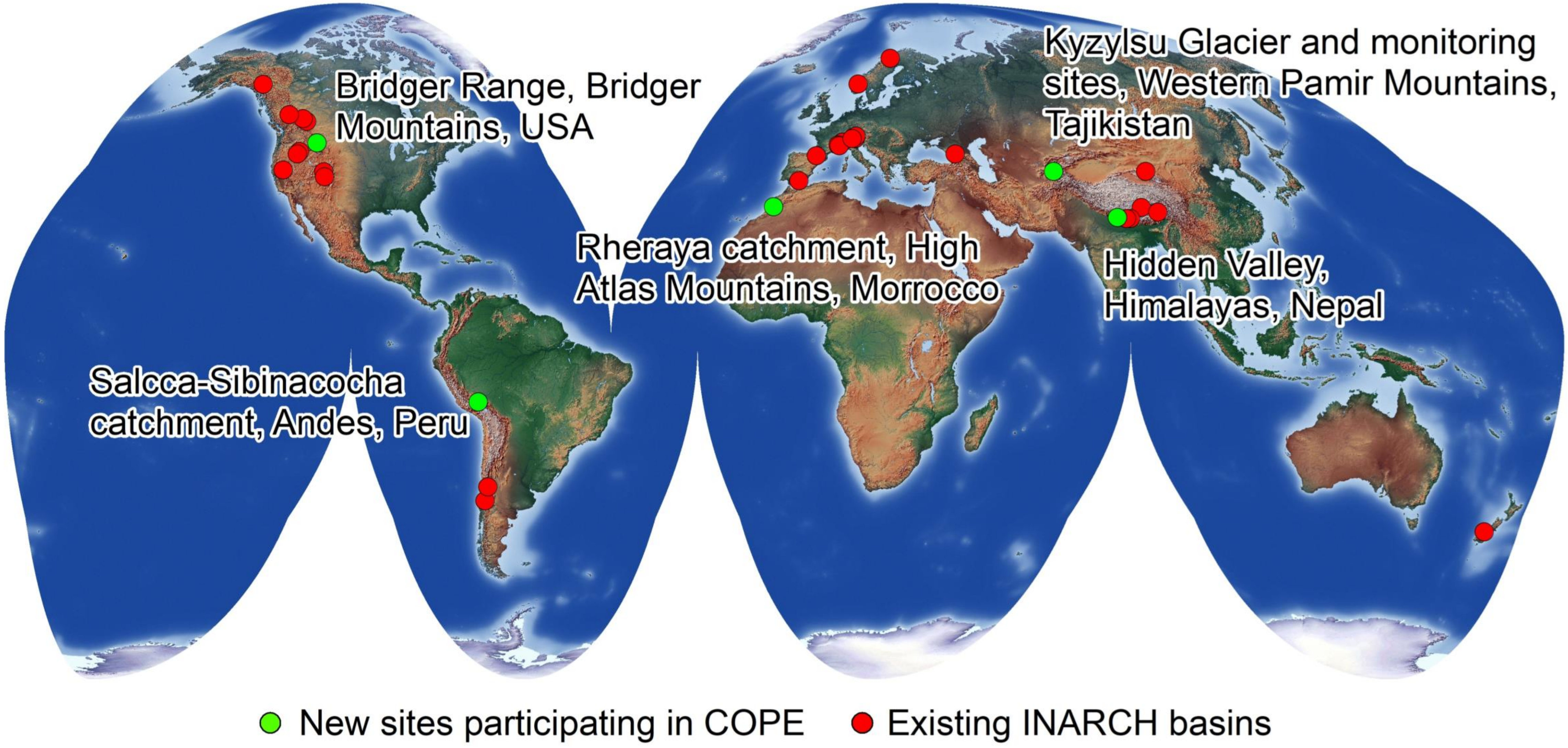
- Advances in using isotopes to supplement hydrometeorological observations and diagnostic modelling, including model calibration and structural design decisions from isotopic data.
- Advances in satellite observations of snow depth, but limited to non-steep and non-forested sites. Density is still a challenge.
- Advances in field techniques to include basin-scale gravimetry, UAV LiDAR & IR, tower and terrestrialLiDAR
- Expansion of INARCH instrumented basins to all inhabited continents and new mountain ranges (Pamirs, High Atlas)
- Advances in reanalysis data in Andes, North America (historical)
- INARCH basins are starting or ready for COPE observing period

Summary of Predictions, Comparisons, Validity

- Advances in deployment of ecohydrological models to explore co-evolution of snow and vegetation and models addressing vegetation change (shrubification, forest change), revised interception, greening, drought and management
- Improvements in atmospheric model forcing of precipitation phase and wind fields, high resolution nested models for dynamical downscaling (greater extent).
- Downscaling of atmospheric models to complex terrain snow models at snow-drift permitting scales (<100 m) applied at continental scales – intercomparison and evaluation against satellite and surface observations are needed to assess model outputs. Standardized comparisons to areal metrics need to be developed.
- Improvements in data assimilation techniques for prediction.
- Examination of parameter uncertainty, transferability and machine learning techniques in hydro-cryosphere modelling. Noted that calibration from streamflow of physically based parameters in hydro-cryospheric modelling should focus on routing and subsurface rather than observable surface parameters (equifinality, self deception)
- Comparisons of impacts of climate change on cryosphere and hydrology in different glaciated and snow dominated basins show different sensitivities to climate change.
- Identification of the distinctive research needs for marginal snowpacks – e.g. ground heat flux

Common Observing Period Experiment (COPE)

2022–2024



COPE and Data Management

- COPE represents a unique opportunity to implement, focus and accelerate model comparison and validation, observation comparison, and collaboration to compare process operation and model improvements on INARCH testbed basins.
- GWFNet data catalogue can help INARCH researchers find each other, papers, models, instrumented sites, data records, model outcomes.
- Need for INARCH researchers to provide information to Stephen for cataloguing.
- Keeping long term research basins going remains a continual challenge
- Specific COPE research projects need to be developed – same model for elasticity to change applied at different basins, observed response to extremes and climate differences, comparative eco-hydrology, new model testing?
- Plan for several papers from COPE analyses/comparisons and an overarching COPE data paper.

INARCH Statement 2022

We have

- begun Phase 2, started COPE,
- expanded investigators, observations, basins, mountain ranges, and models,
- implemented a data cataloguing system, snowdrift-resolving models continentally,
- explored new measurement techniques, data assimilation, parameter uncertainty and machine learning,
- started linking to ecosystems and downstream water resources;
- informed a proposed UN Year of Glacier Preservation and contributed to WMO, UNESCO, WCRP, UN Water Decade

We need to

- Develop detailed science investigations in COPE and ensure that it is used by other groups (WMO, intercomparison projects)
- Apply atmospheric/hydrological/other models to INARCH basins for the COPE period
- Co-develop plans to and share experiences on increase mountain community/regional science and decision making capacity

INARCH 2023

- The INARCH bid selection committee met over cigars and whiskey and after careful consideration of imponderable factors selected………

- IDAHO! Autumn possibly Oct.

Observe, Predict, Protect