INARCH:
International Network for Alpine Research
Catchment Hydrology
Inaugural Workshop, Kananaskis,

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Urgency

► to IPCC (2014) WG II report – “In many regions, changing precipitation or melting snow and ice are altering hydrological systems, affecting water resources in terms of quantity and quality”

► Alpine catchments receive and produce a disproportionately large fraction of global precipitation and runoff.

► Snowfall does not equal accumulation on the ground!

► Snow, ice, and phase change domination of alpine hydrology means that it is especially sensitive to temperature change.
Significance

- Ongoing change in climate has already resulted in shorter seasonal snowcover duration, earlier spring hydrographs, greater rainfall fraction of total precipitation, glacier volume decline, ground thaw and woody vegetation increase in many alpine catchments.

- Some alpine catchments are contributing to higher frequency of floods and/or droughts.
Alpine Regions are Data Scarce

Left Side: (Viviroli et al. 2011).
Right Side: (Pomeroy, Sinclair - in preparation).
Objective

To better understand alpine cold regions hydrological processes, improve their prediction, diagnose their sensitivities to global change and find consistent measurement strategies.
Sub-Objectives

1. How different are the measurement standards and how do these affect scientific findings?
2. How do the predictability, uncertainty and sensitivity of alpine catchment energy and water exchange vary with changing atmospheric dynamics?
3. What improvements to alpine energy and water exchange predictability are possible through improved physics, downscaling, data collection and assimilation in models?
4. Do existing model routines have a global validity?
5. How do transient changes in perennial snowpacks, glaciers, ground frost, soil stability, and vegetation impact alpine water and energy models?
Data Requirements

Surface based data requirements for this project will primarily be met by

- openly-available detailed meteorological and hydrological observational archives from long-term research catchments at high temporal resolution in selected heavily instrumented alpine regions,
- atmospheric model reanalyses,
- downscaled climate model as well as regional climate model outputs.
Data Standards

► At least 5 years of continuous data with hourly sampling intervals for meteorological data, daily precipitation and streamflow, and regular snow and/or glacier mass balance surveys

► The ideal sites will be Integrated Alpine Observing and Predicting Systems (IAOPS). IAOPS are classified for assessment as:
  ▪ CLASS A: sites receiving technology transfer and developing towards CLASS B to E.
  ▪ CLASS B: Single measurement points with highly accurate driving data and snow or glacier data,
  ▪ CLASS C: gauged catchments that contain Class B sites and detailed vegetation coverage, soils, topography, snowcovered area, glacier mass balance or permafrost information,
  ▪ CLASS D: domains for which high resolution gridded meteorological data is available that includes CLASS C sites,
  ▪ CLASS E: the same as CLASS D but gridded meteorological data is also available as climate change scenarios.
Activities

1. Facilitate exchange and collaboration
2. Improve algorithm development.
3. Examine hydrological model sensitivity to atmospheric change.
4. Demonstrate improvements to model predictability.
5. Evaluate mountain forcing fields.
6. Evaluate downscaling schemes.
7. Foster research and development.
8. Facilitate education and training.

AGU Fall Meeting 2015 - Session C027: Improved Understanding and Prediction of Mountain Hydrology through Alpine Research Catchments
Instrumented alpine catchments with remote sensing, atmospheric modelling, downscaling, data assimilation in order to better evaluate mountain water and energy exchange.
International Collaboration through Field & Model Experiments

Upper Heihe River Basin, 4150 m China
Zugspitze, 2650 m Germany
INARCH Scientific Steering Group

- Matthias Bernhardt (BOKU, Austria)
- Tobias Jonas (SLF, Switzerland)
- Xin Li (CARERRI-CAS, China)
- Ignacio Lopez Moreno (IPE, Spain)
- Yaoming Ma (ITP-CAS, China)
- Danny Marks (USDA-ARS, USA)
- James McPhee (Univ de Chile, Chile)
- John Pomeroy (Univ Saskatchewan, Canada)*
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- Vincent Vionnet (Meteo-France, France)
INARCH Participants

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INARCH: International Network for Alpine Research Catchment Hydrology

Canada – Canadian Rockies, BC & Yukon;
USA – Reynolds Creek, ID; Senator Beck, CO.
Chile - Upper Maipo & Upper Diguillín River Basins, Andes,
Germany – Schneefernerhaus & Zugspitze;
France – Arve Catchement, Col de Porte & Col du Lac Blanc;
Switzerland – Dischma & Weissfluhjoch;
Austria - OpAL Open Air Laboratory, Rofental
Spain – Izas, Pyrenees;
China – Upper Heihe River, Tibetan Plateau,
Nepal – Langtang Catchment, Himalayas
Sweden – Tarfala Research Catchment

Integrated Alpine Observing and Predicting Systems (IAOPS), initial sites to be considered
Linkages

► UNESCO-International Hydrological Programme efforts on climate change impacts on snow, glacier and water resources within the framework of IHP-VIII (2014-2021) ‘Water Security: Responses to Local Regional and Global Challenges’.

► International Commission for Snow and Ice Hydrology (IAHS-IUWG-ICSU)

► GHP Projects
  - Precipitation phase
  - Mountain precipitation
  - Changing Cold Regions Network
Purpose of 1st Workshop

- Global Review of Alpine Observations
  - Recommend common measurement strategies
  - Promote collaboration
  - Assess archiving and access to datasets
- Review role of groundwater, glaciers and snow in alpine hydrology
  - What are persistent uncertainties?
  - How might these be reduced?
- Assessment of modelling
  - How can we test and improve model physics, downscaling and parameterisation?
- Modelling Changing Alpine Hydrology and Climate
  - How sensitive are alpine snow and ice regimes around the world to global change?
- Network structure and future activities
- “Statement” for Year 1 of INARCH
Next Steps?

► Special Issue of *Earth System Science Data.*
► Synthesis paper on diagnosing the sensitivity of global alpine snow regimes to warming temperatures.
► Review paper on advances in alpine hydrology?
► Second workshop