

# Observations and downscaling for alpine hydrological modelling

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# INARCH: International Network for Alpine Research Catchment Hydrology

A crosscut project of the GEWEX Hydroclimatology Panel to better understand alpine cold regions hydrological processes, improve their prediction and find consistent measurement strategies

<http://www.usask.ca/inarch/>





# Urgency for alpine hydrology research

- IPCC AR4 (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
- Alpine regions are data scarce



# INARCH research questions

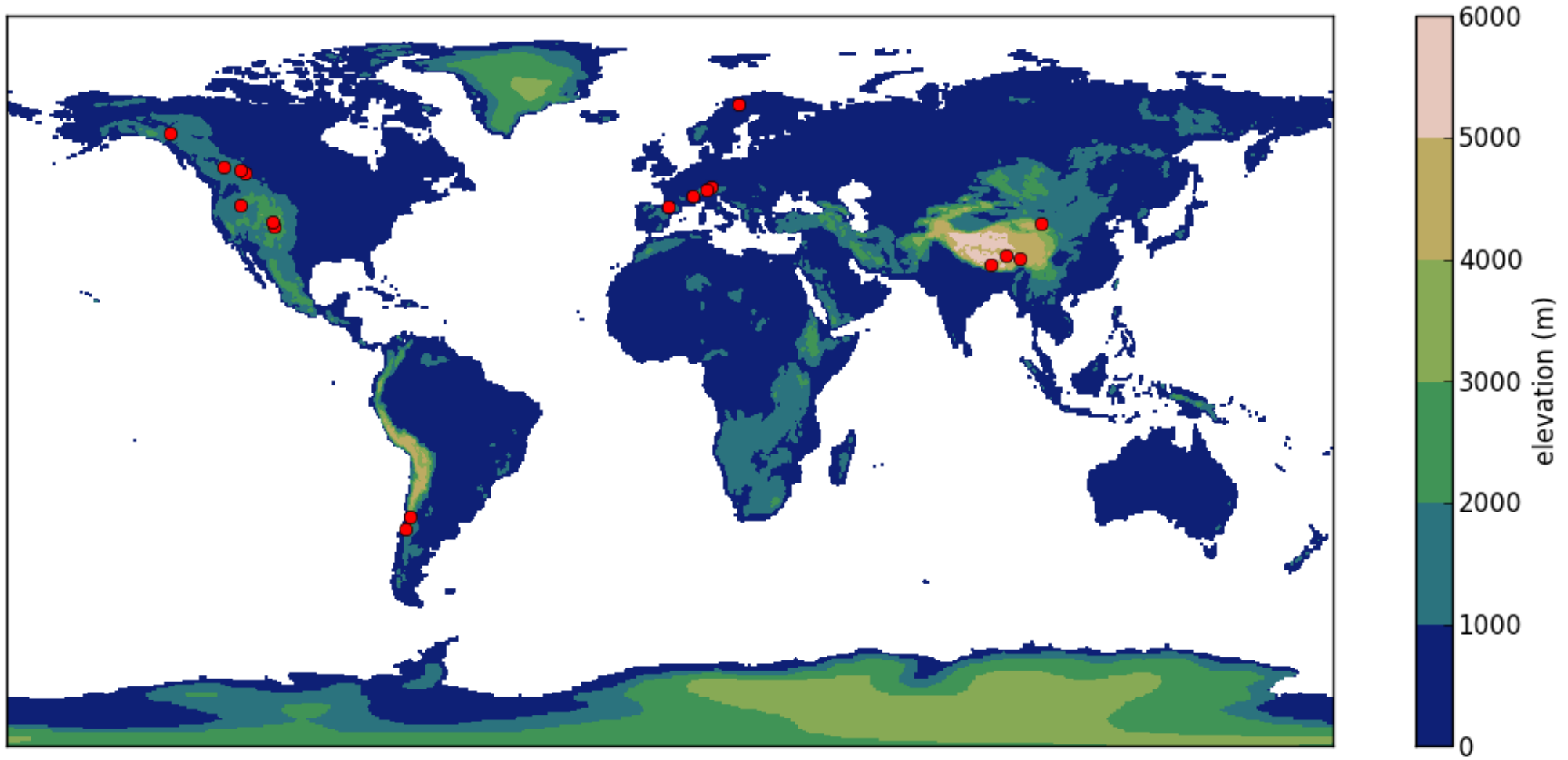
Across the high mountain regions of the Earth:

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



# Network of Integrated Alpine Observing & Predicting Systems

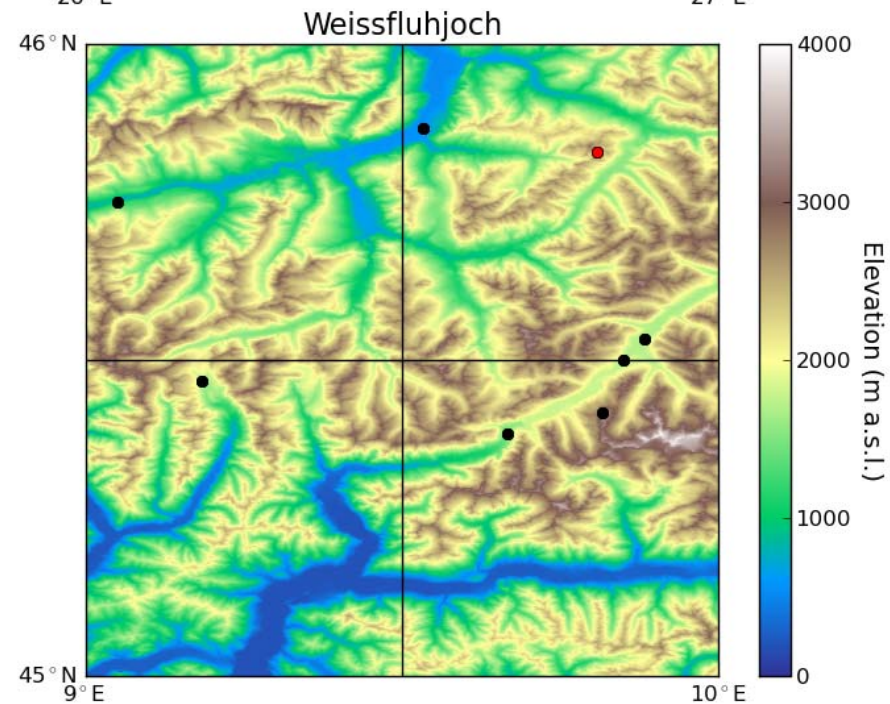
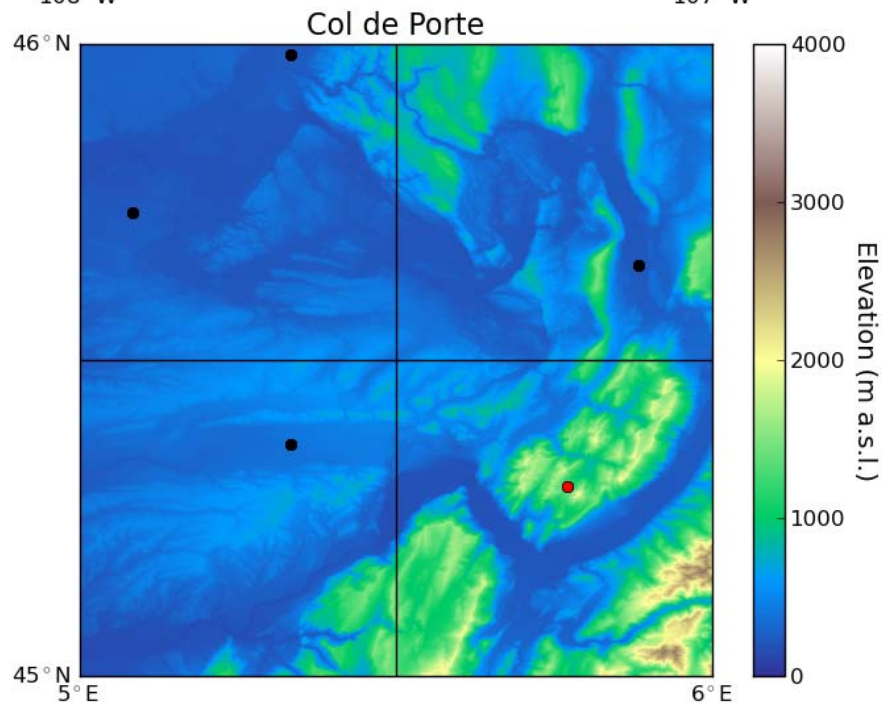
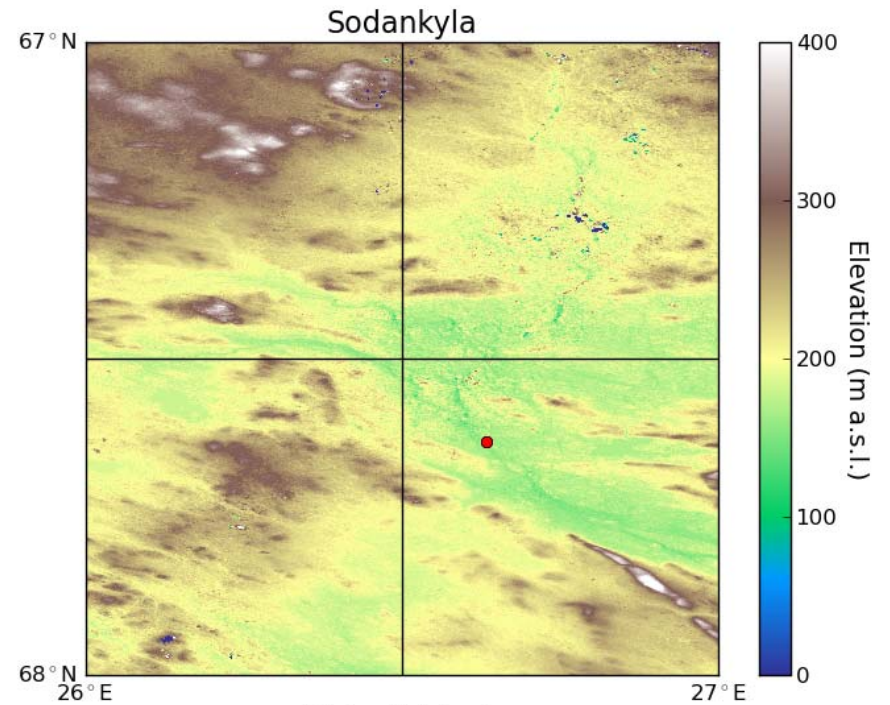
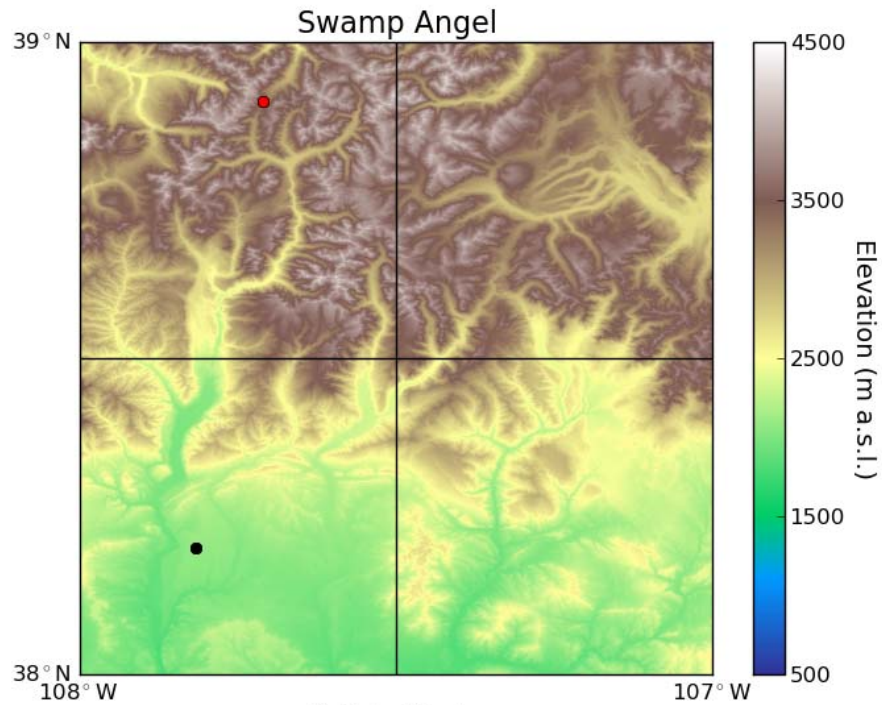
Instrumented alpine catchments with remote sensing, atmospheric modelling, downscaling, data assimilation in order to better evaluate mountain water and energy exchange



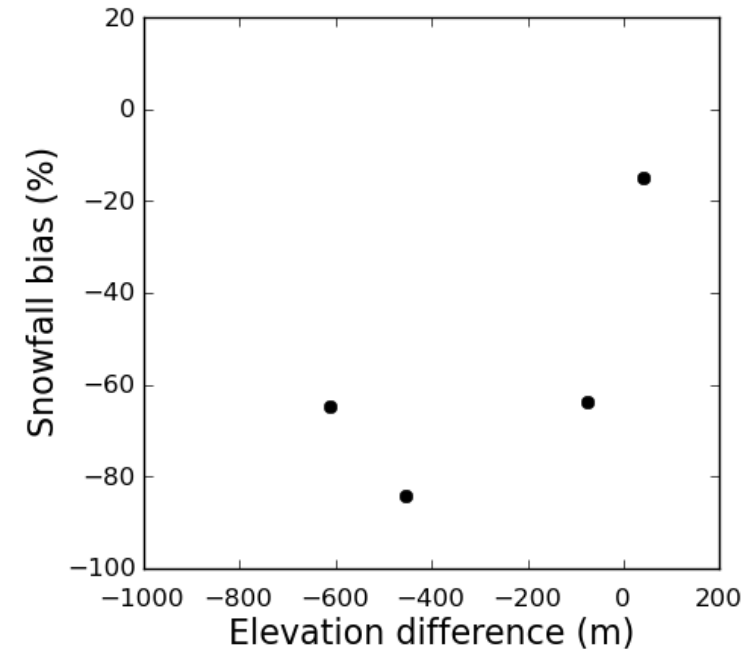
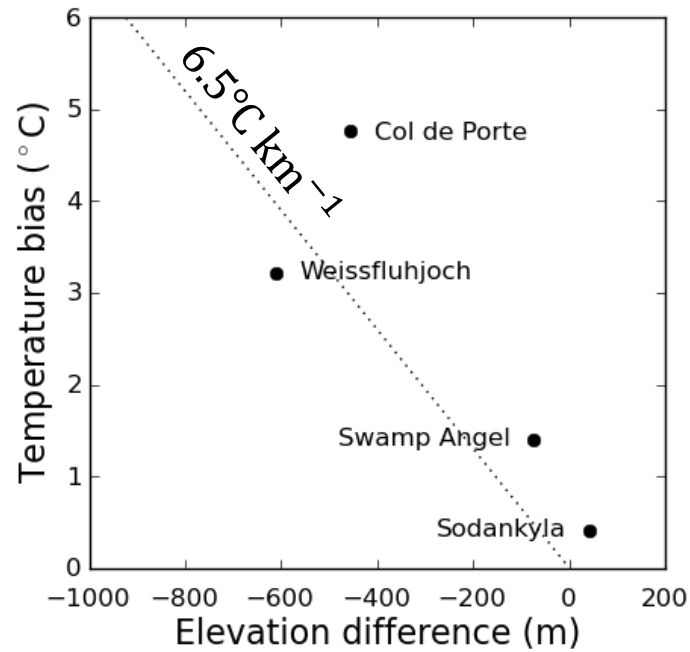
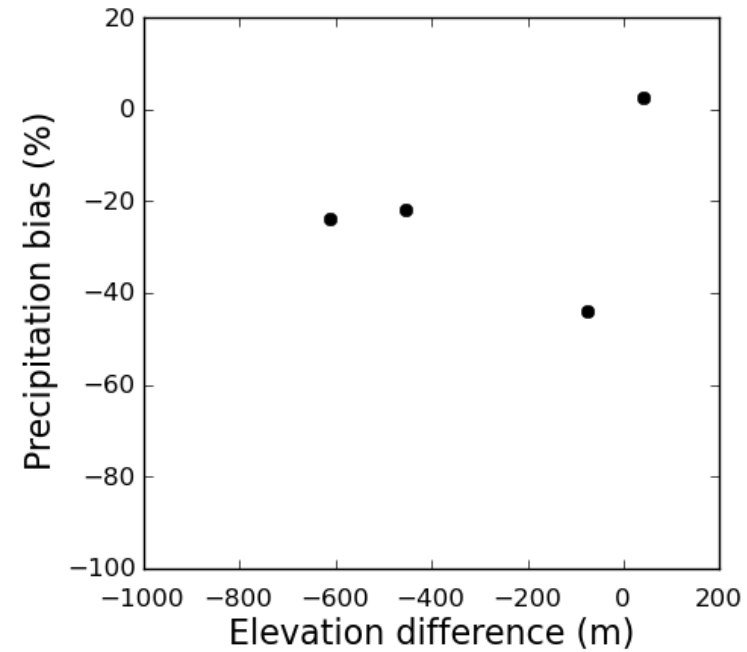
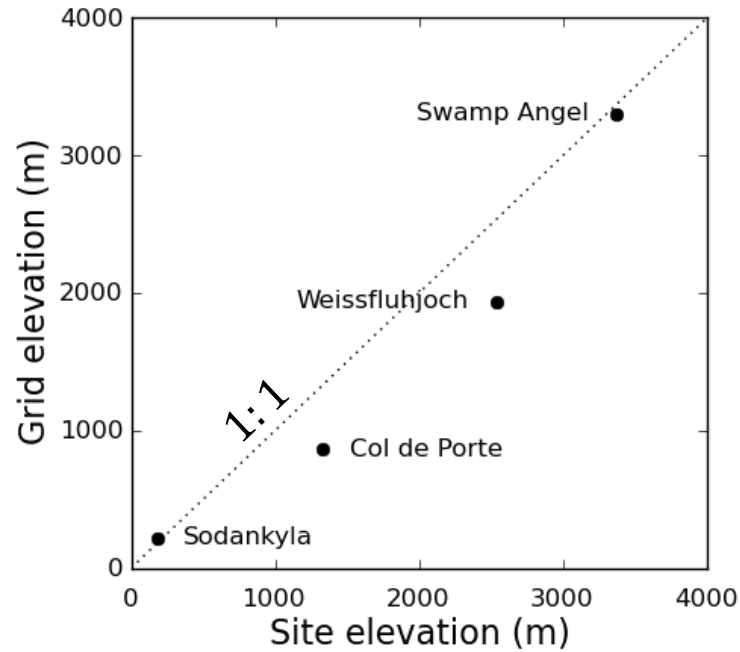
– sites in 8 of the 14 CORDEX domains



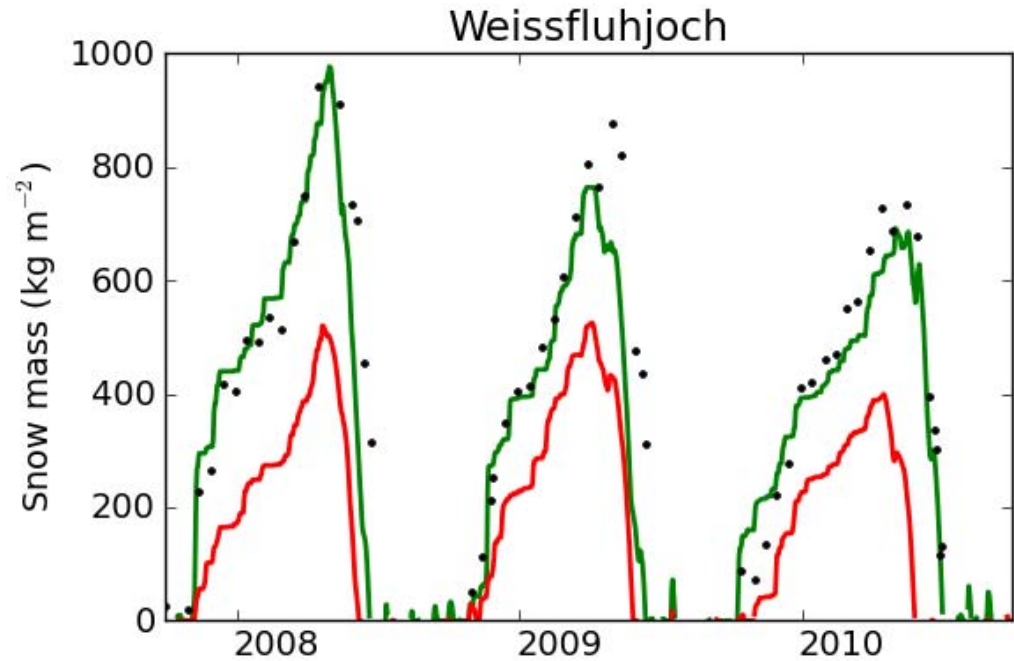
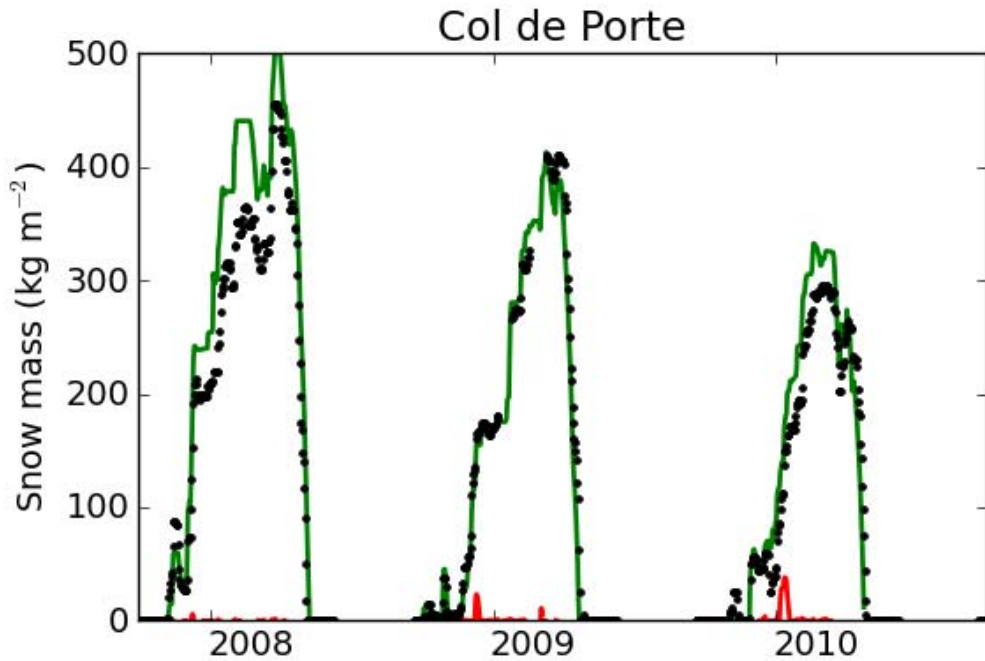
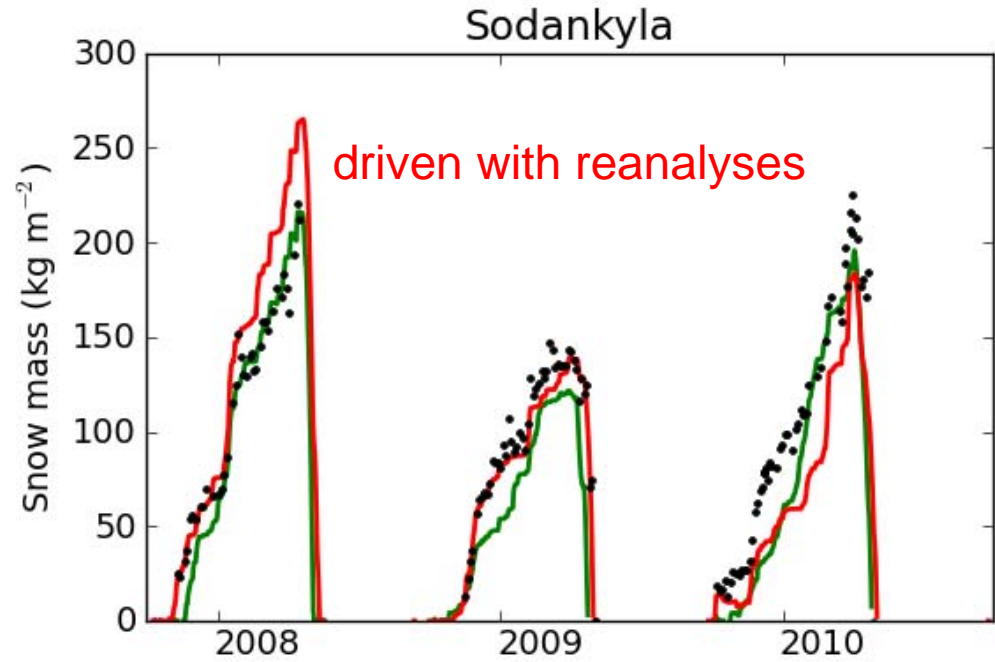
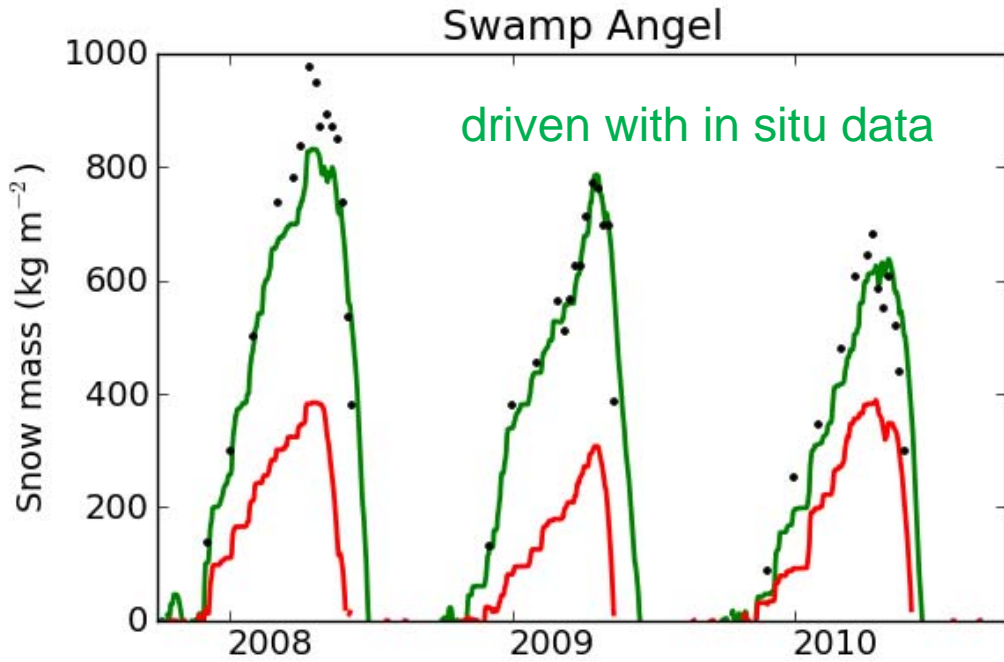
# Alpine research sites and synoptic stations



# In situ met data and reanalyses

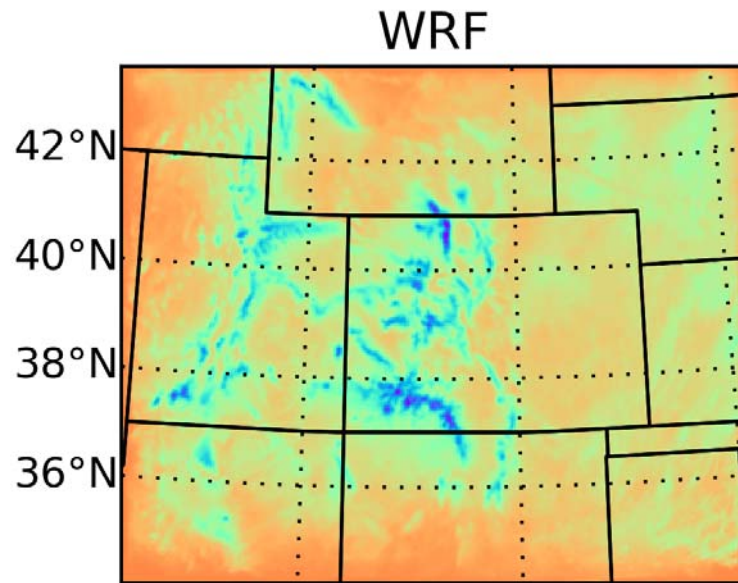


# Snow mass simulations

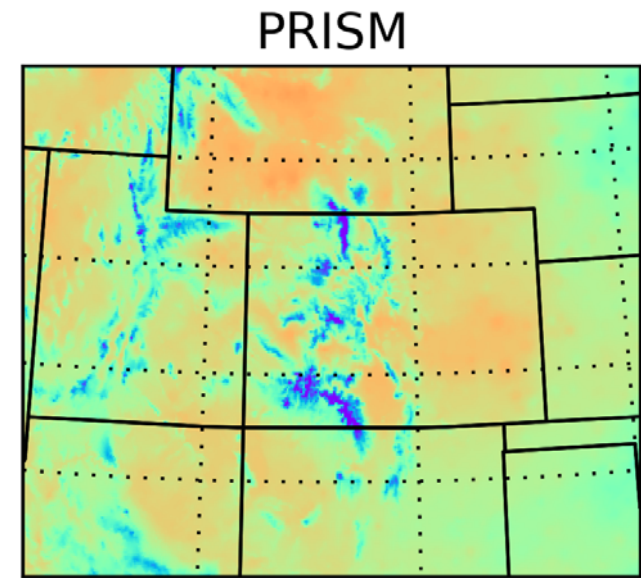
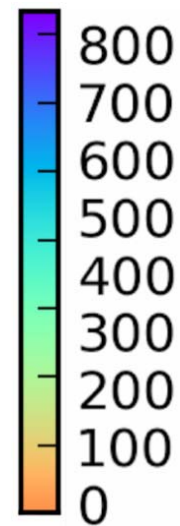
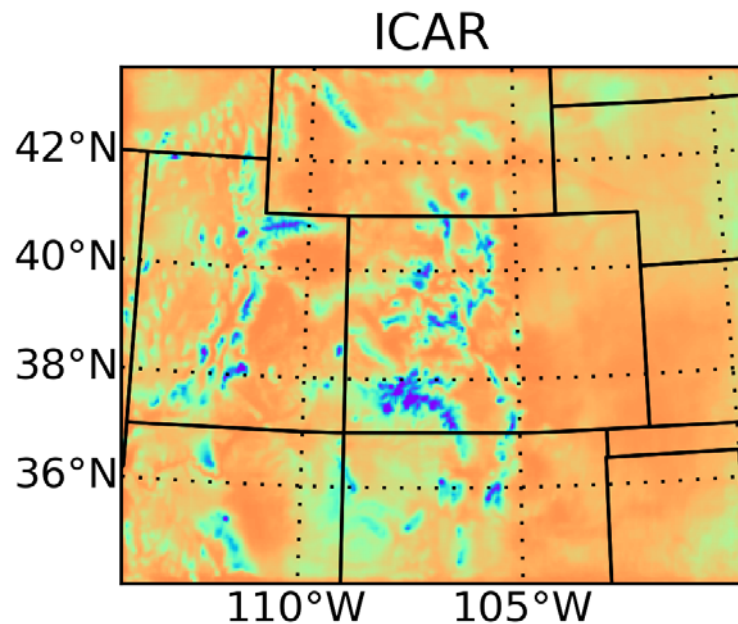




# Precipitation downscaling



Accumulated October – May precipitation for western US

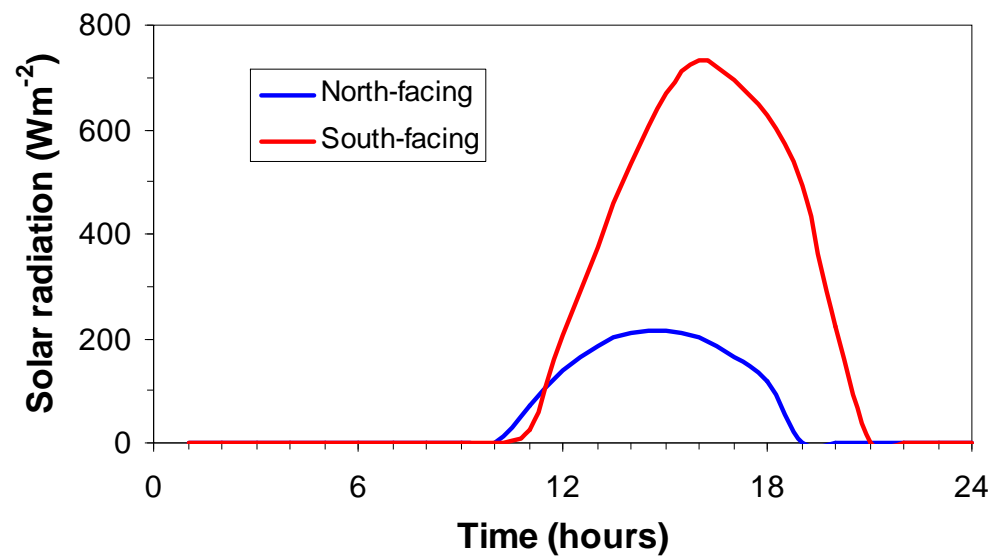


Intermediate Complexity Atmospheric Research model

Results from Ethan Gutmann

*J. Hydrometeorol.*, **17**, 957 – 973 (2016)

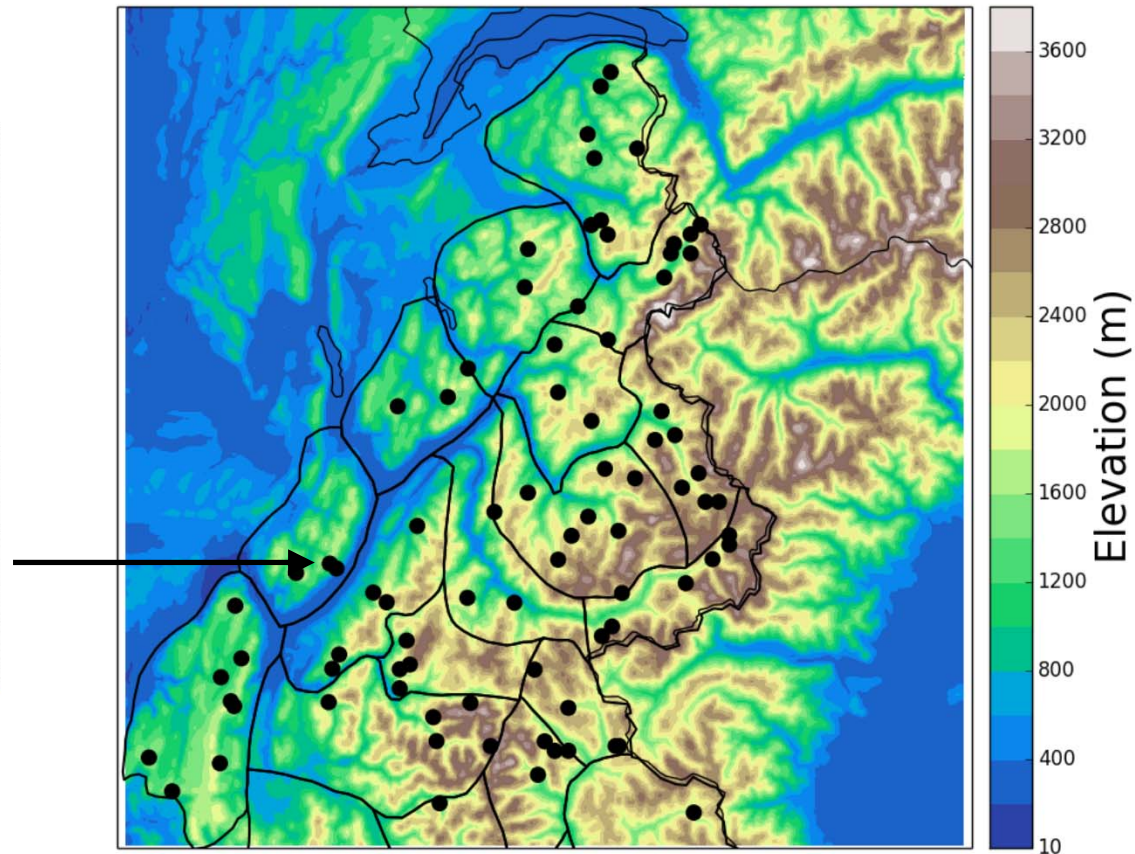
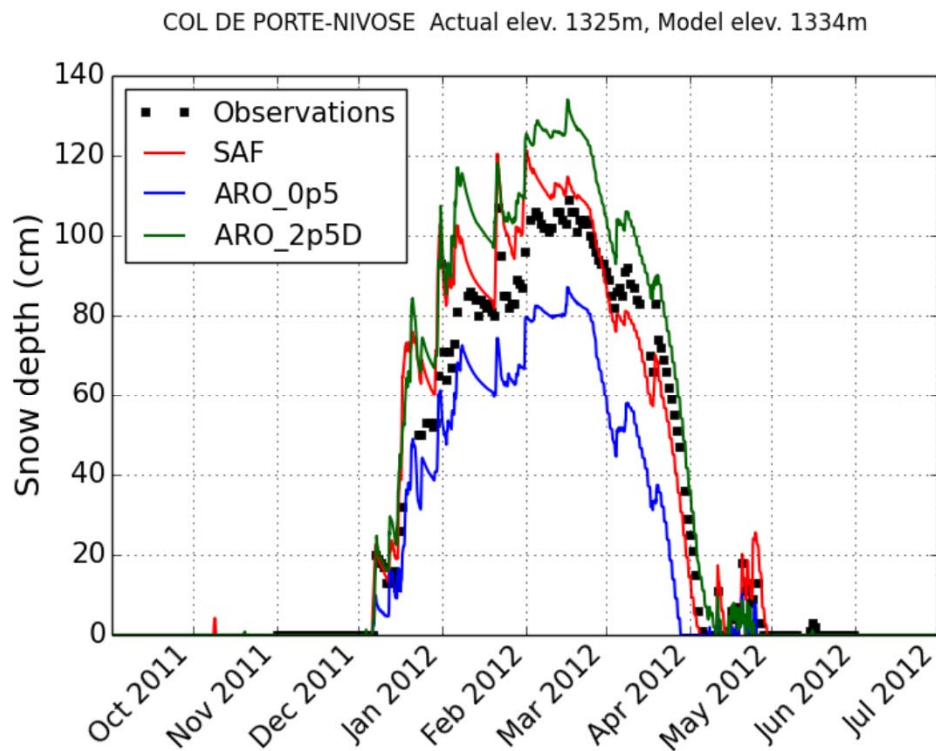
# Radiation downscaling





# Operational downscaling

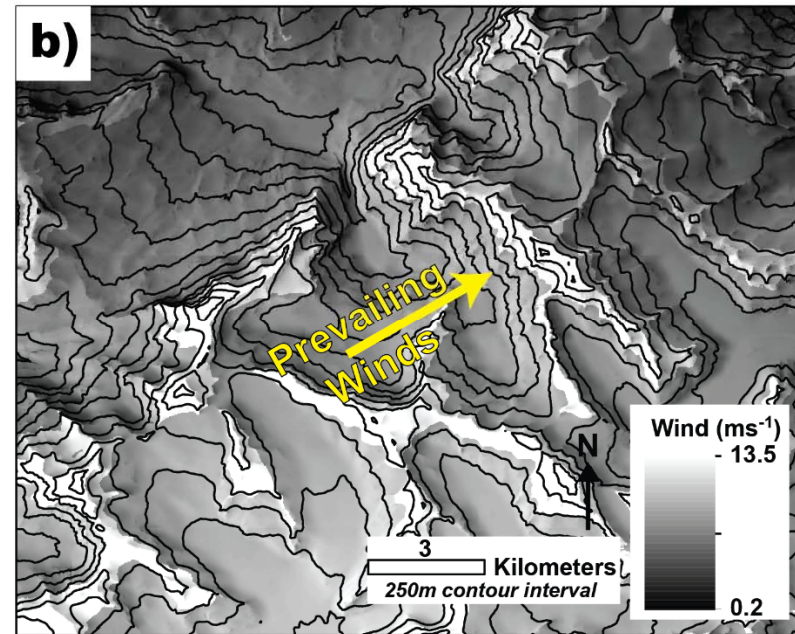
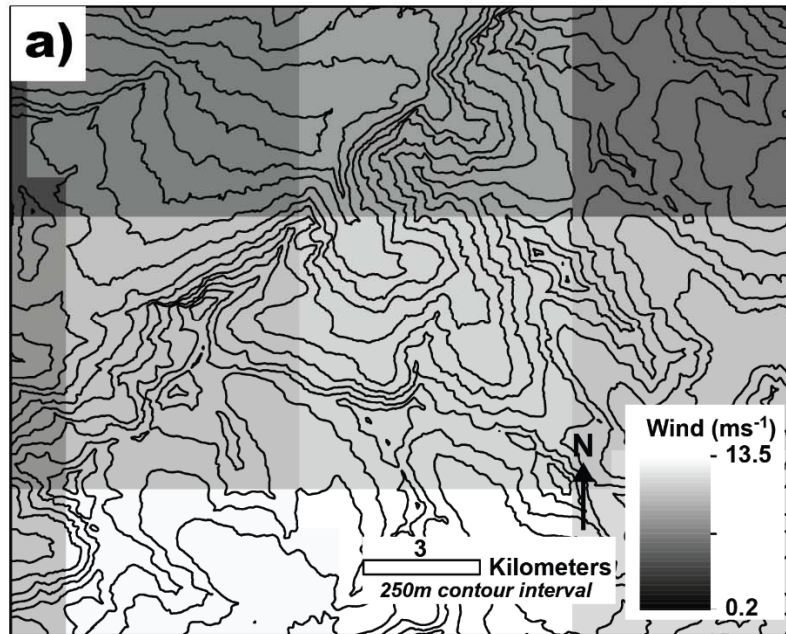
NWP products are now issued at 2.5 km resolution or better for the French Alps, Swiss Alps and Canadian Rockies



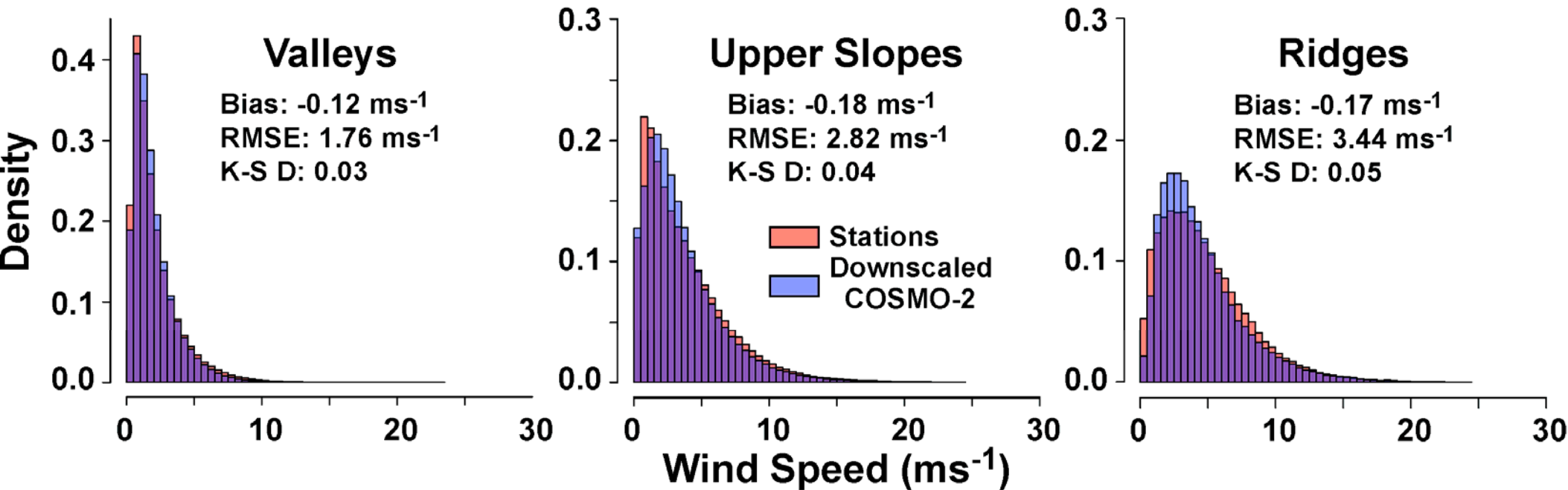
Crocus snow model driven with AROME forecasts – results from Vincent Vionnet  
*J. Hydrometeorol.*, in review



# Wind downscaling



Observations, 2.2 km COSMO-2 forecasts and downscaling for Swiss Alps  
– results from Adam Winstral



# INARCH next steps

- Special Issue of *Earth System Science Data*
- **Mountain downscaling toolbox**
- Synthesis paper on diagnosing the sensitivity of global alpine snow regimes to warming temperatures.
- Review paper on advances in alpine hydrology
- Encourage expansion of global hydroclimate projects to mountain areas
- Second workshop 6-7 Oct 2016 – Grenoble, France

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