



Global changes in snow hydrology from virtual basins based on INARCH research network

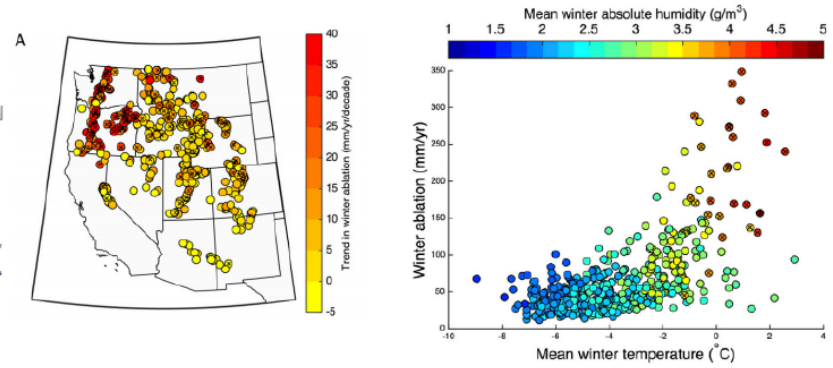
Ignacio López-Moreno, J.W. Pomeroy, E. Alonso, J.Revuelto,
E.Moran-Tejeda



Temperature increase (observed and projected) is a common problem in most snow dominated regions of the world, but snowpacks are likely to respond different to warming

- Warming intensity (observed and projected) is different among mountain sites
- The energy balance of each site lead to different response (sensitivity) to same warming rates

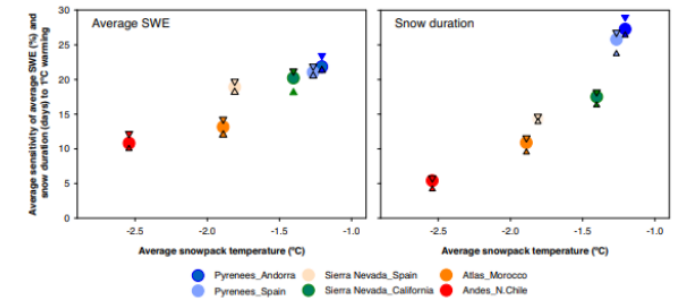
PNAS
Humidity determines snowpack ablation under a warming climate
 Adrian A. Harpok^{1,2,3} and Paul D. Brooks⁴
¹Department of Natural Resources and Environmental Sciences, University of Nevada, Reno, NV 89557; ²Global Water Center, University of Nevada, Reno, NV 89557; and ³Department of Geology and Geophysics, University of Utah, Salt Lake City, UT 84112-0102
 Edited by Andrea Rinoldi, Ecole Polytechnique Fédérale de Lausanne, Lausanne, Switzerland, and approved December 11, 2017 (received for review October 7, 2017)
 Climate change is altering historical patterns of snow accumulation and ablation. Observations with mechanistic understanding of snowpack mass



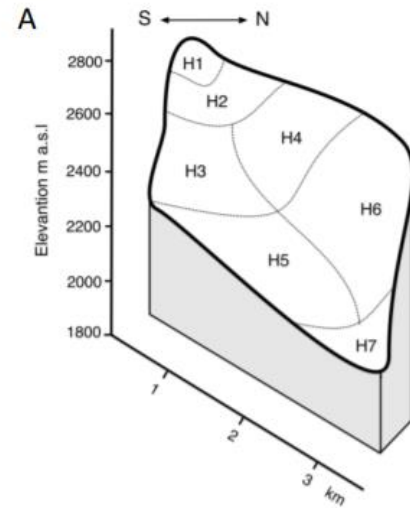
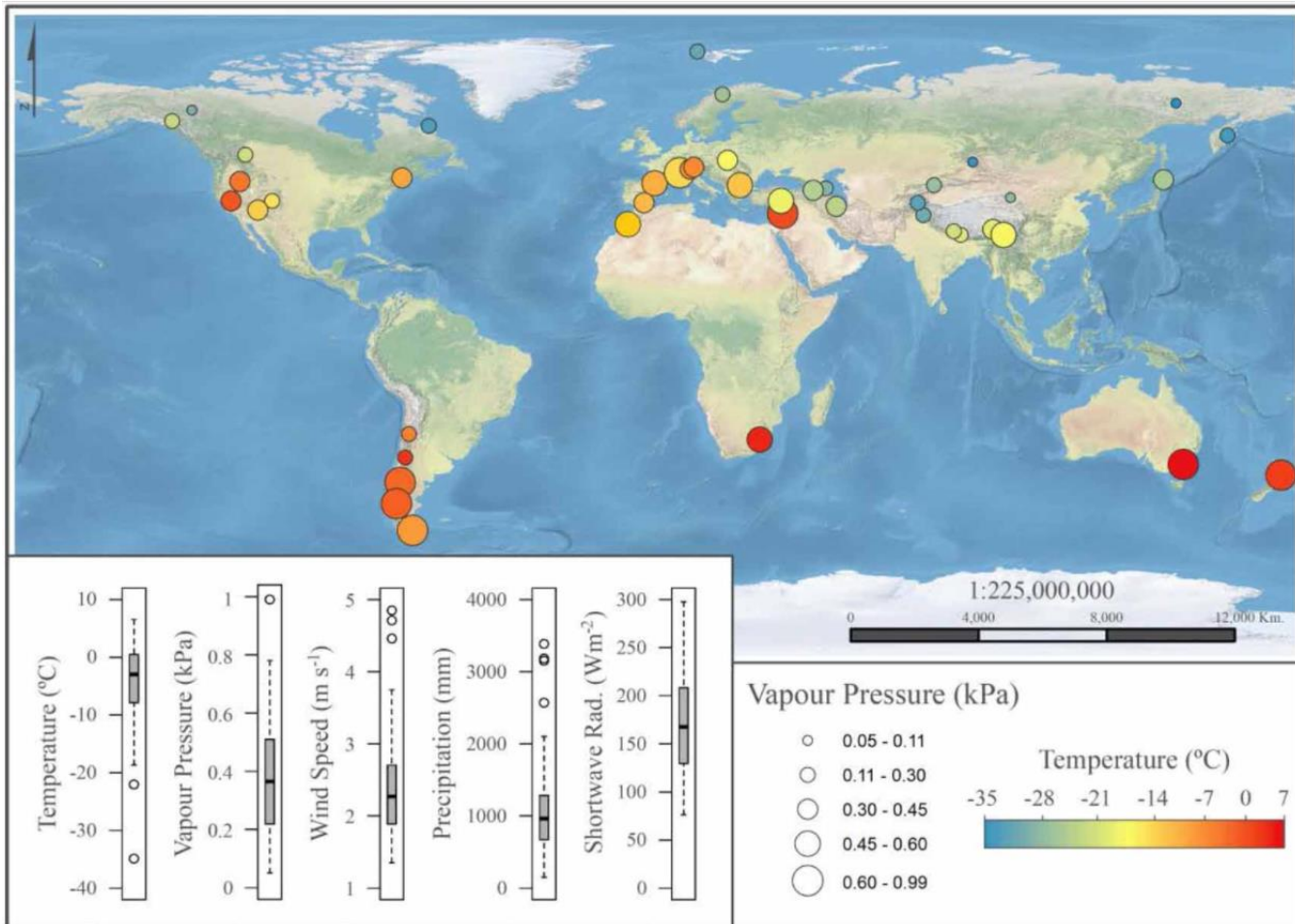
Environmental Research Letters

LETTER
Different sensitivities of snowpacks to warming in Mediterranean climate mountain areas

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Quantify these differences are difficult because the lack of common meteorological and hydrological information among basins, and the different physical characteristics of each site



Virtual basin: 5.5 km², 1000 m of vertical gradient

- Little vegetation and groundwater recharge
- An elevation that permits the development of a seasonal snowpack



International network for alpine research catchment hydrology: 2021 annual workshop

1. Bias corrected ERA-40 Reanalysis

Temperature
Precipitation
Incoming solar radiation
Air pressure
Wind speed
Air humidity

Bias corrected ERA-40 Reanalysis
0.5° spatial resolution
3 hours time step
1980-2012

2. Download data of the pixel containing the coordinates of the target mountain area (INARCH sites or selected mountains in the world).

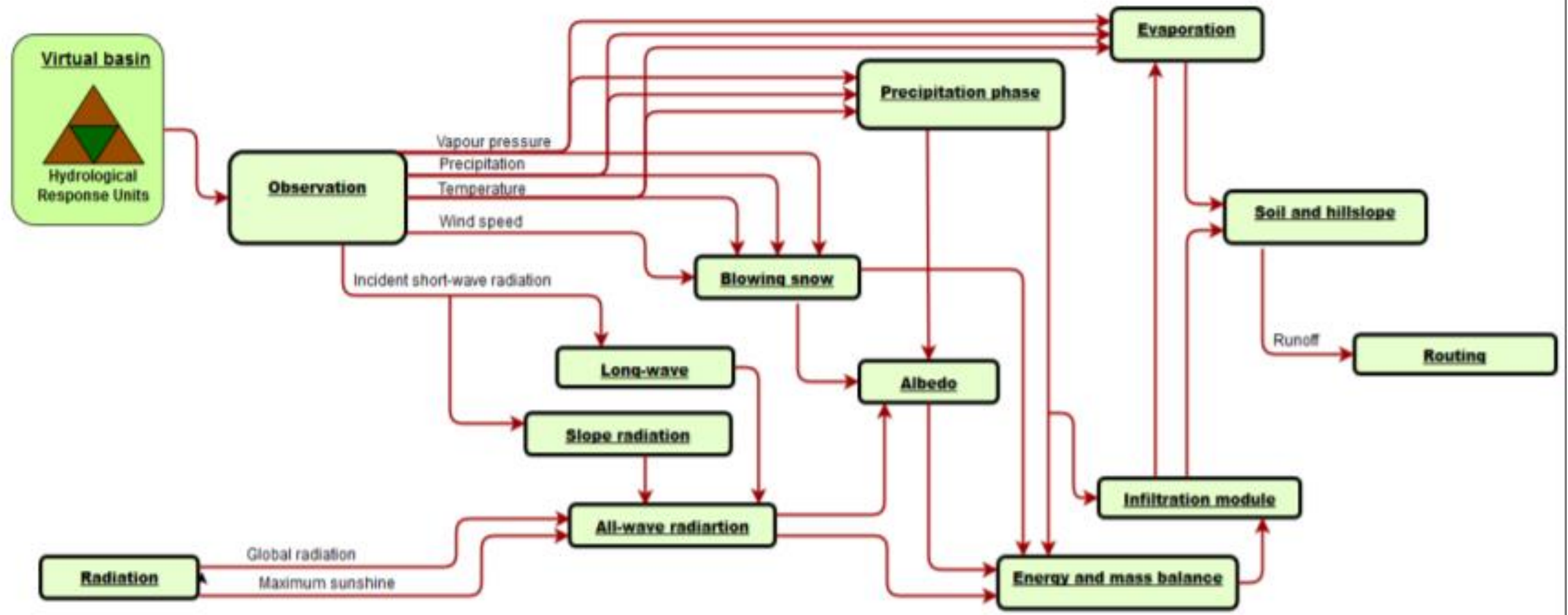
3. Using CRHM for scaling inputs from elevation of the WATCH data centroid to the elevation, slope and aspect of each HRU of the virtual basin.

4. Using CRHM for simulating snow water equivalent, energy balance components and the basin runoff output.

Simulation includes all relevant physical processes affecting snowpack: snow blowing, sublimation...

The aim is not having data that reproduces exactly the conditions of each point, but to ensure we are using coherent inputs gathering much of the climates found in snow dominated basins in the world.

1: CRHM for simulating snow energy and mass balance and the runoff output





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2: Selected indices for snow and runoff series

Snow: rainfall ratio, snow duration and peak SWE

Runoff: Snow melt rate, snow damming and D50

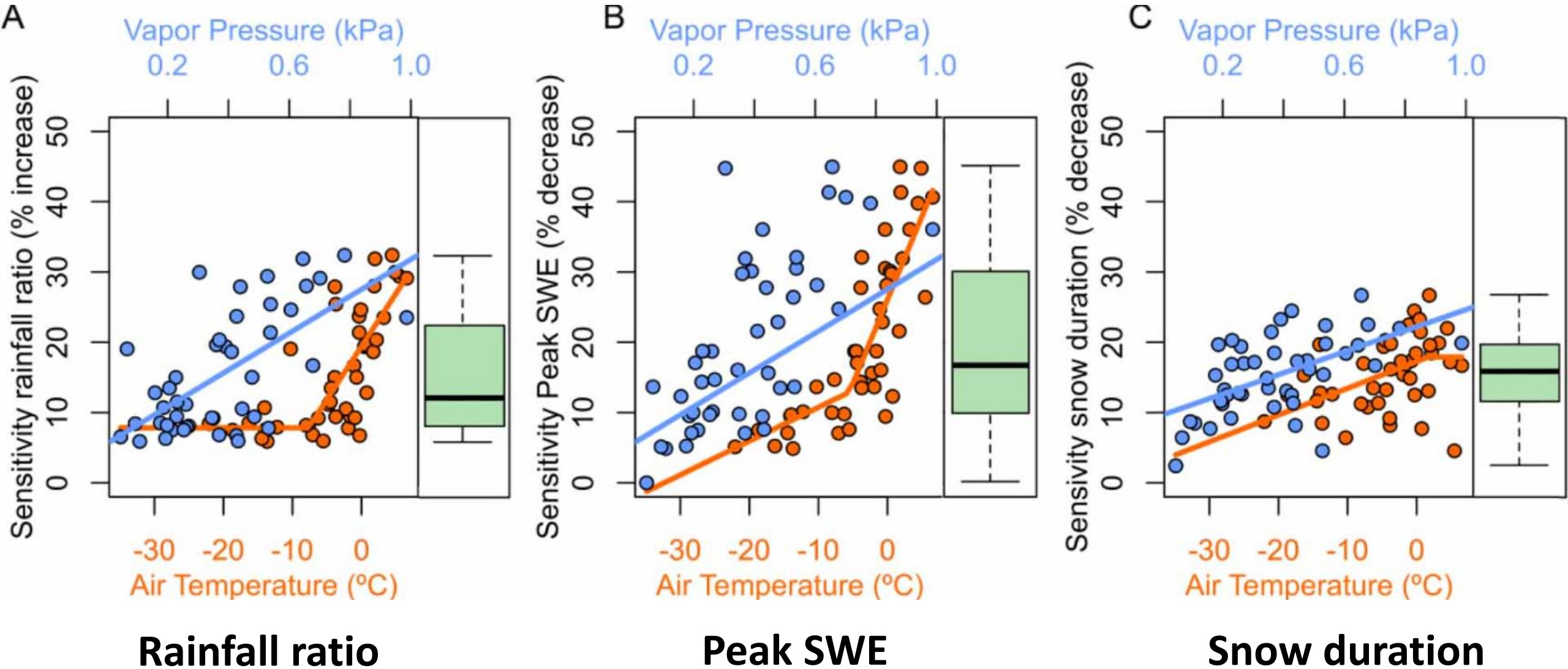
Rain on snow events (<10 mm)



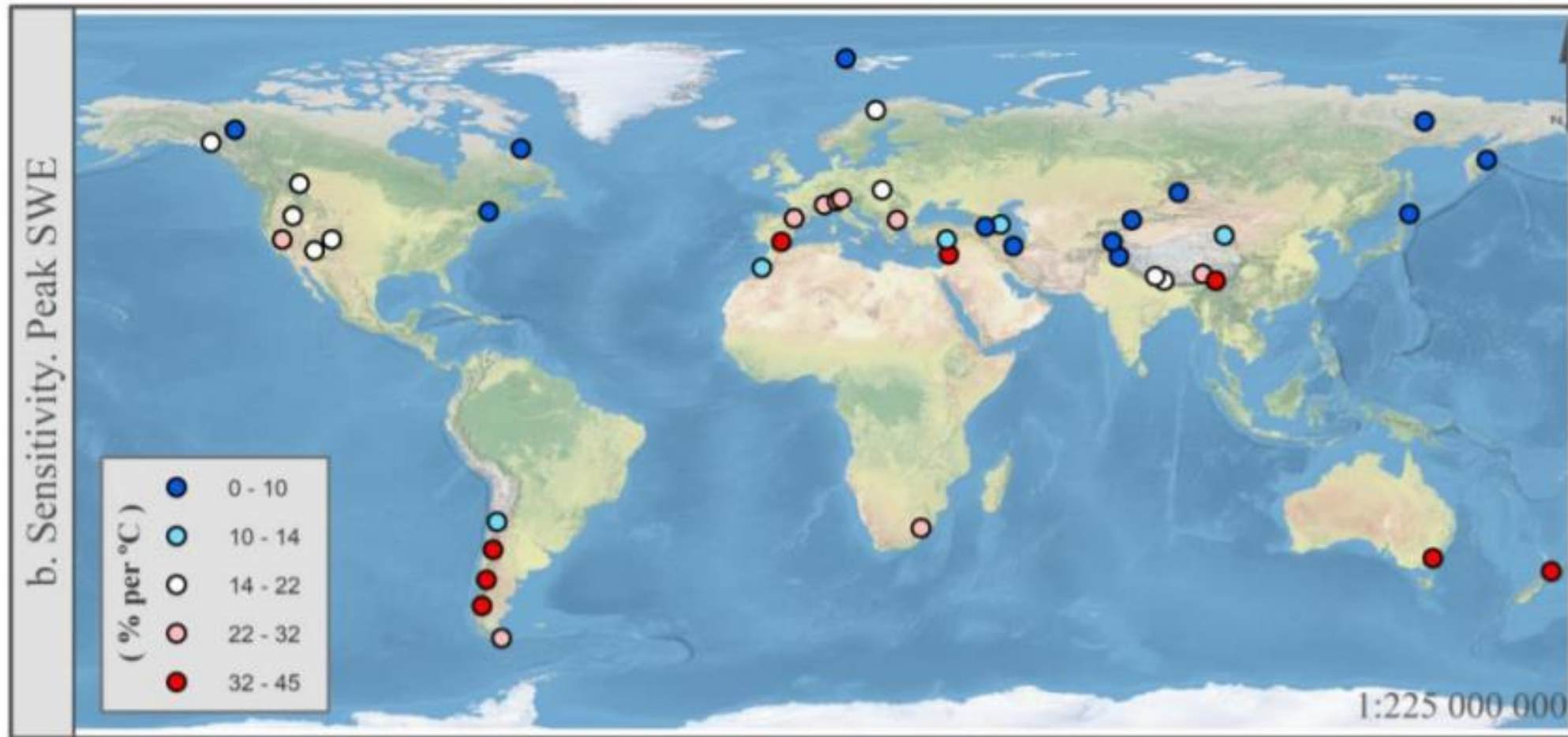
3: Calculation of indices under observed (step 1) and warmer climate (+1, 2...5°C)

Objectives

1) To quantify the spread in snow and hydrological sensitivity across the world and identify simple drivers of this variability; 2) to anticipate how climate warming will affect snow hydrology and the occurrence of ROS events

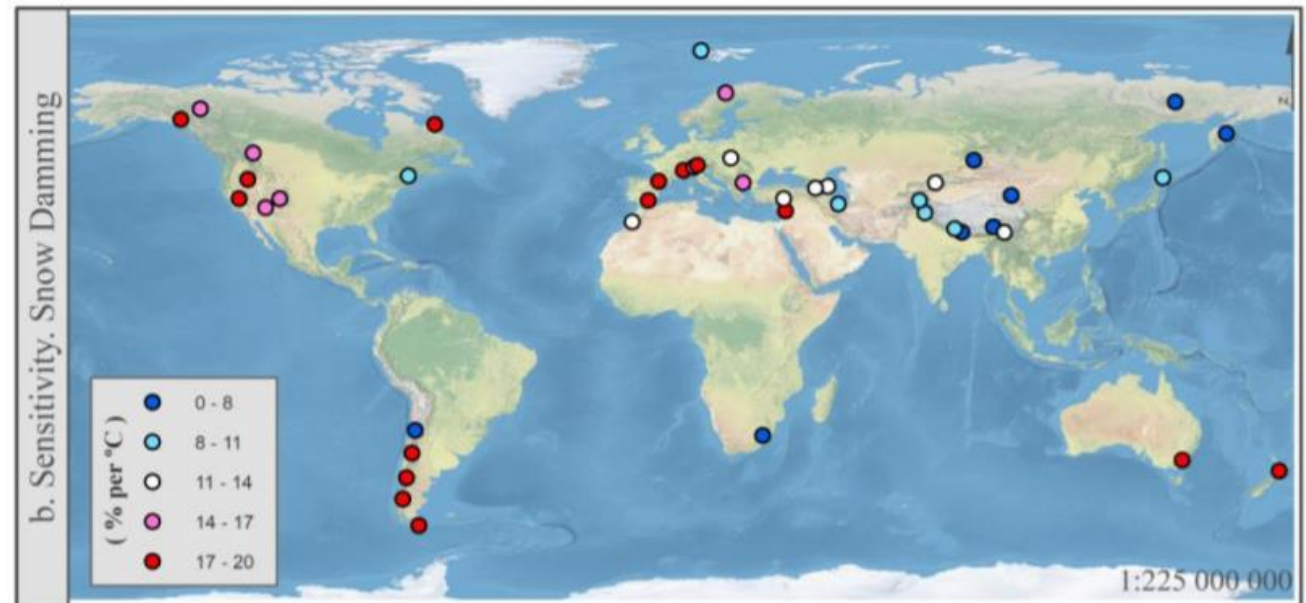
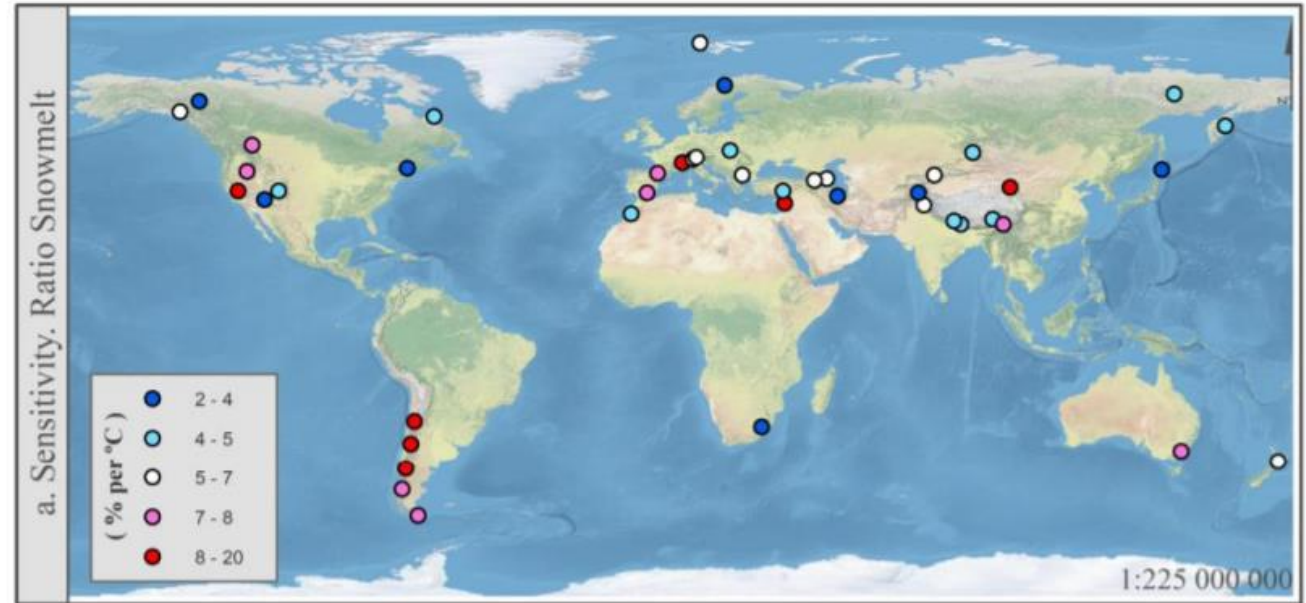


Peak SWE sensitivity



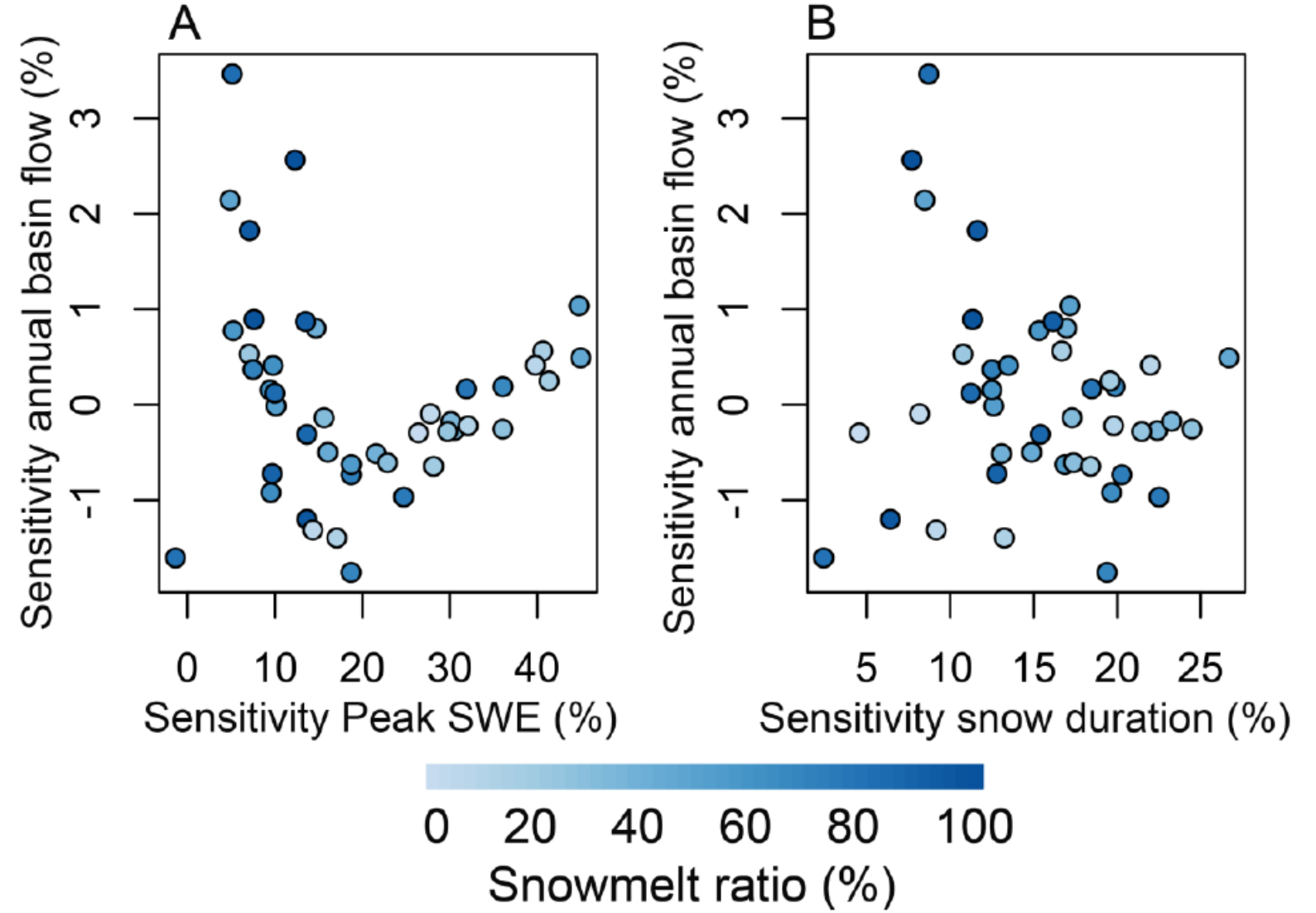
**Ratio snowmelt
sensitivity**

Ratio snow damming

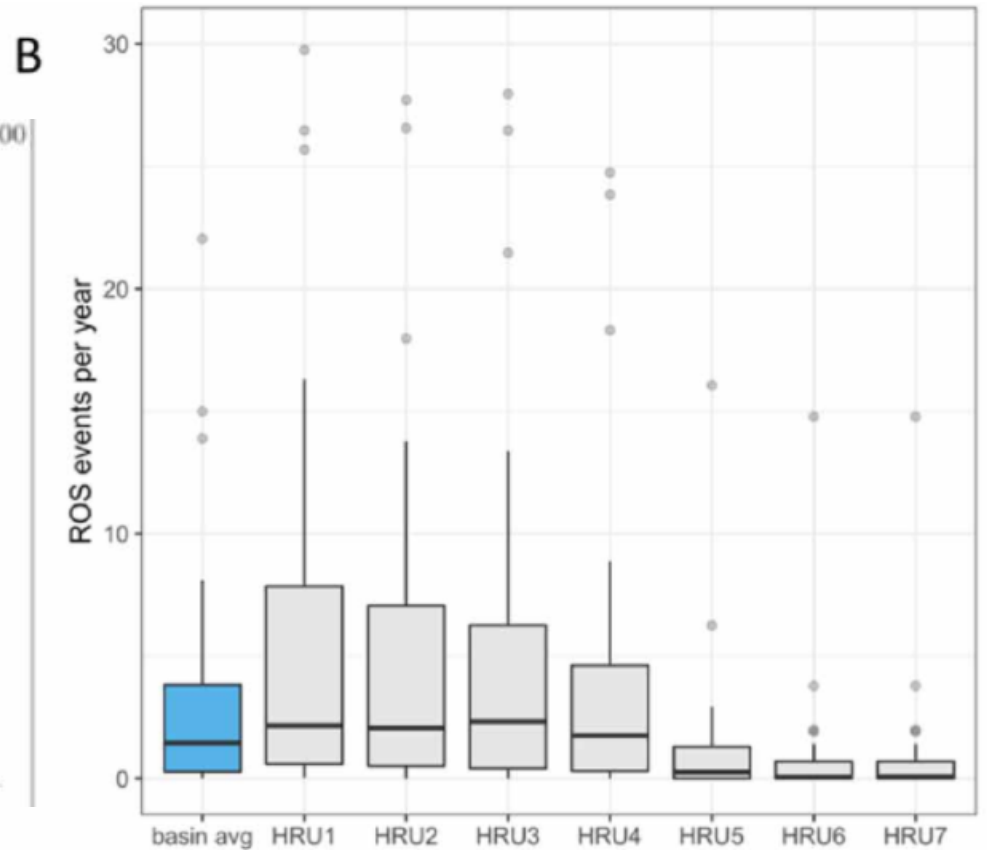




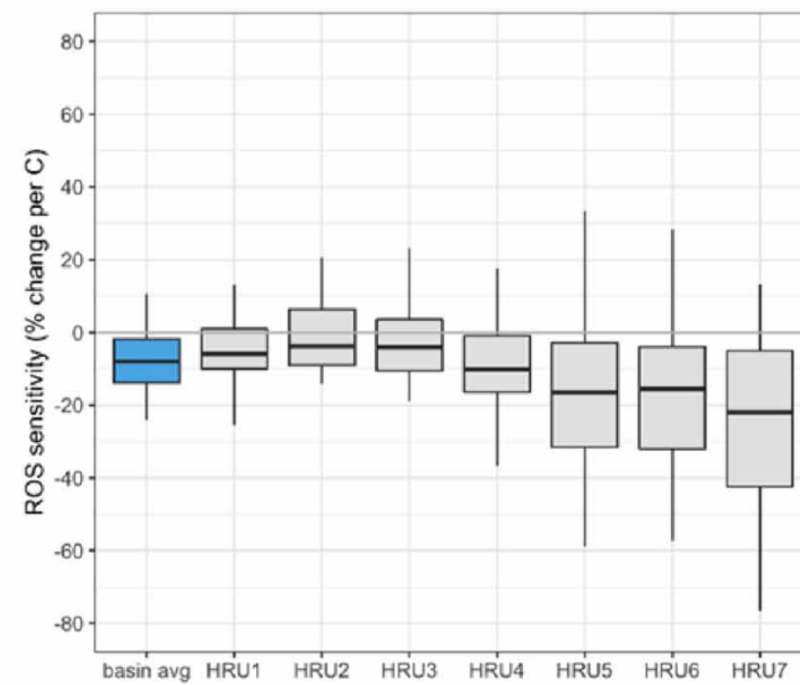
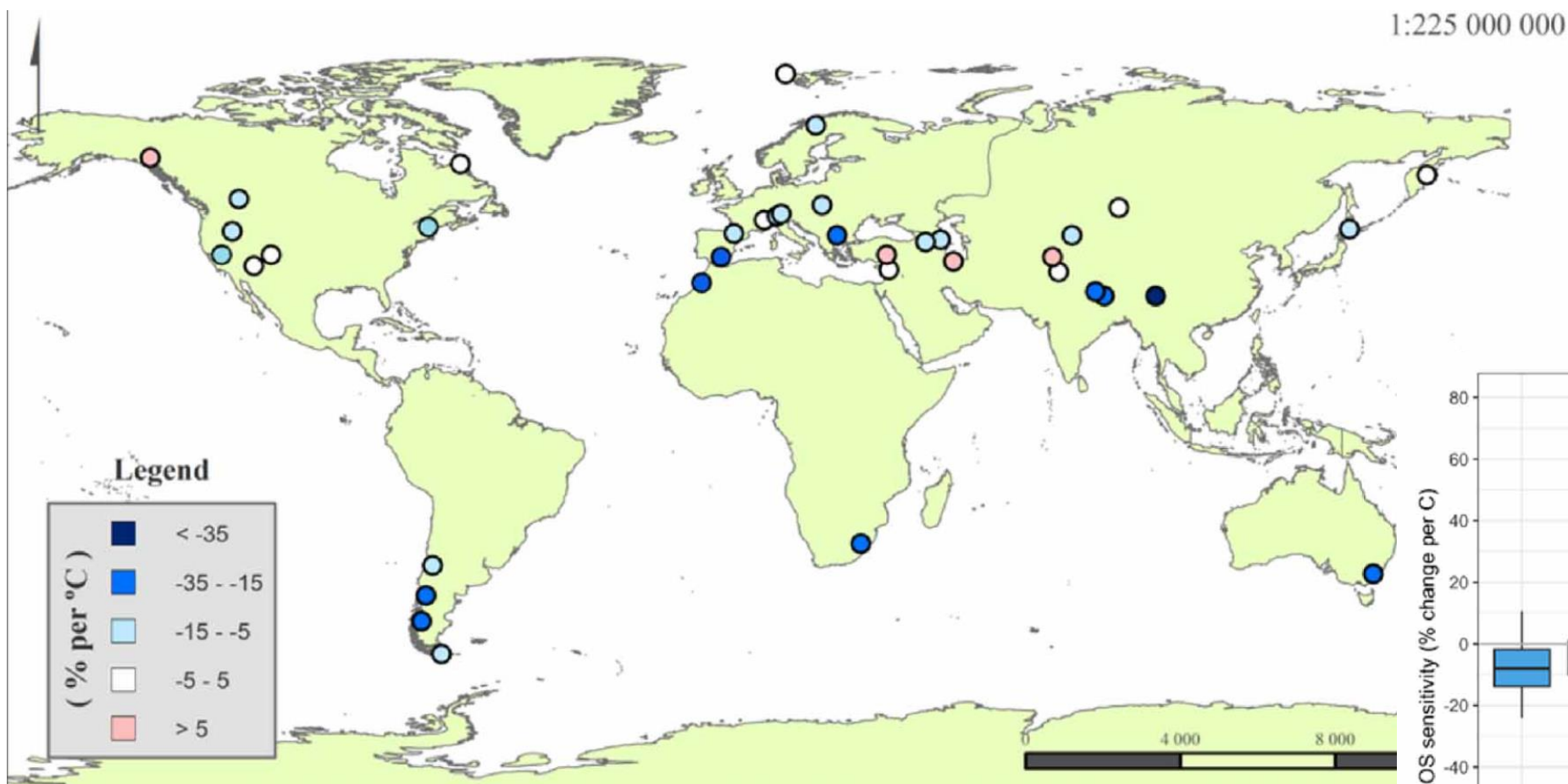
Annual runoff sensitivity



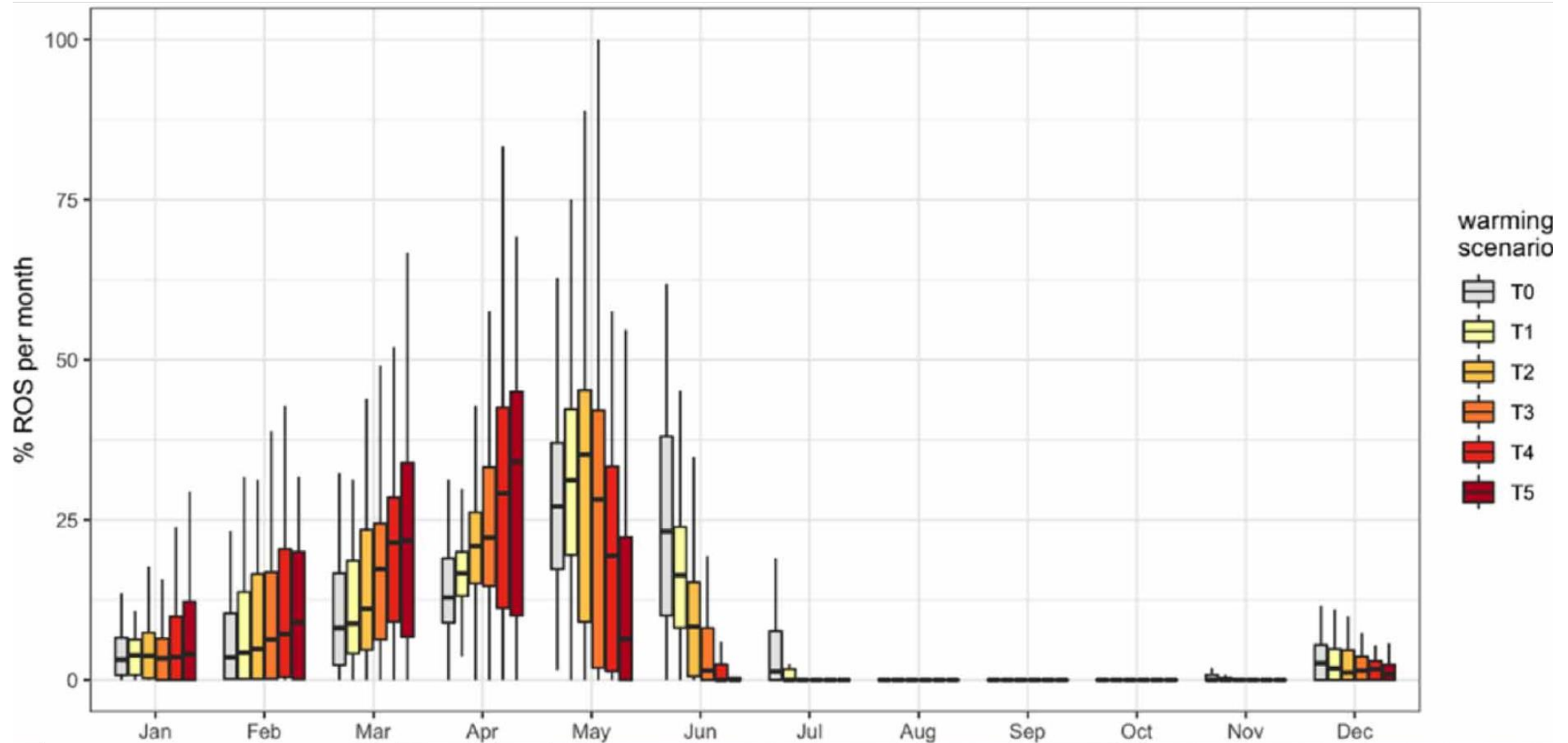
Rain on snow events



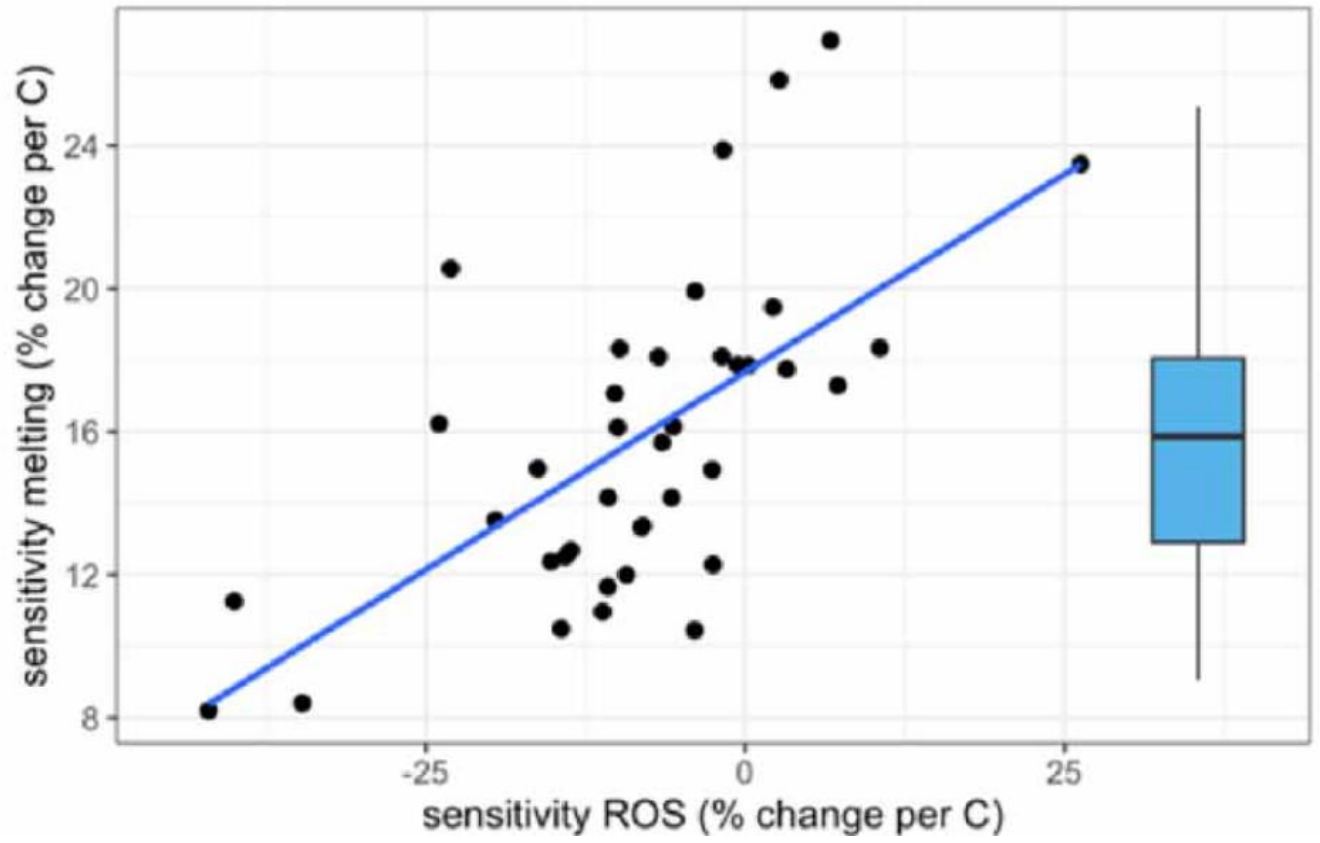
Sensitivity of rain on snow events



Seasonal distribution of rain on snow events under a warmer climate



Snow melting during ROS events



In the remaining ROS events snow melting and generated runoff is expected to increase.



Results highlight (1) the complex response of snowpack and (particularly) snow hydrology to climate warming;
(2) but also that these type of analyses permits to get a good idea on the more/less vulnerable mountain areas to climate warming; and
(3) demonstrate that physically based models are able to represent the main hydrological processes under a large variety of climates in snow dominated regions.

