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Modelling distributed ablation on Juncal Norte Glacier, dry Andes of central Chile

Marco Carenzo (1), Francesca Pellicciotti (1), Jakob Helbing (2), Ruzica Dadic (3), and Paolo Burlando (1)

(1) Swiss Federal Institute of Technology ETH, Institute of Environmental Engineering, Zurich, Switzerland (carenzo@ifu.baug.ethz.ch), (2) Swiss Federal Institute of Acquatic Science and Technology (Eawag), Switzerland, (3) Department of Atmospheric Sciences, University of Washington, Seattle

In the Aconcagua River Basin, in the dry Andes of central Chile, water resources in summer originate mostly from snow and ice glacier melt. Summer seasons are dry and stable, with precipitation close to zero, low relative humidity and very intense solar radiation. The region's economic activities are dependent on these water resources, but their assessment is still incomplete and an effort is needed to evaluate present and future changes in water from glacier and seasonal snow covers in this area.

The main aim of this paper is to simulate glacier melt and runoff from Juncal Norte Glacier, in the upper Aconcagua Basin, using models of various complexity and data requirement. We simulate distributed glacier ablation for two seasons using an energy-balance model (EB) and an enhanced temperature-index model (ETI). Meteorological variables measured at Automatic Weather Stations (AWSs) located on and off-glacier are extrapolated from point observations to the glacier-wide scale. Shortwave radiation is modelled with a parametric model taking into account shading, reflection from slopes and atmospheric transmittance. In the energy-balance model, the longwave radiation flux is computed from Stefan-Boltzmann relationships and turbulent fluxes are calculated using the bulk aerodynamic method. The EB model includes subsurface heat conduction and gravitational redistribution of snow. Glacier runoff is modelled using a linear reservoir approach accounting for the temporal evolution of the system. Hourly simulations of glacier melt are validated against ablation observations (ultrasonic depth gauge and ablation stakes) and runoff measured at the glacier snout is compared to a runoff record obtained from a combination of radar water level measurements and tracer experiments.

Results show that extrapolation of meteorological input data, and of temperature in particular, is the largest source of model uncertainty, together with snow water equivalent initial conditions. We explore several schemes for redistribution of temperature from point measurements and demonstrate that extrapolation of temperature has a larger impact than recalibration of model parameters. Albedo modelling is also crucial for correct prediction of glacier runoff. Both types of approaches have limitations, and we try to highlight their potential in light of the different data availability and potential for evaluation of water resources in the region.