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Seasonal forecasting of mountain snow resources: evaluation of a climate service prototype

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Warming trends in the past decades in mountain regions have resulted in glacier shrinking, seasonal snow cover reduction, changes in the amount and seasonality of meltwater runoff (IPCC, 2019), and we expect droughts to become more severe in the future (Haslinger et al., 2014) with consequences for both mountain and downstream economies. Effective adaptation strategies to address and reduce negative climate change impacts involve multiple time scales, from the long-term support of mountain water resource management and the diversification of mountain tourism activities, to the seasonal scale, for the optimization of the available snow resources.

In the frame of the MEDSCOPE project we developed a prototype to generate seasonal forecasts of mountain snow resources, in order to estimate the temporal evolution of the depth and the water content of the snowpack with lead times of several months. The prototype has been tailored on the needs of water and hydropower plant managers and of mountain ski resorts managers. We present the modelling chain, based on the seasonal forecasts of ECMWF and Météo-France seasonal prediction systems, made available through the Copernicus Climate Change Service (C3S). Seasonal forecasts of precipitation, near-surface air temperature, radiative fluxes, wind and humidity are bias-corrected and downscaled to the site of Bocchetta delle Pisse 2410 m a.s.l. in the North-Western Italian Alps, and finally used as input for a physically-based multi-layer snow model (SNOWPACK, Bartelt and Lehning, 2002). The RainFARM stochastic downscaling procedure (Terzago et al., 2018) is used for precipitation data in order to allow an estimate of uncertainties linked to small-scale variability in the forcing.

The skills of the prototype in predicting the snow depth evolution from November 1st to May 31st in each season of the hindcast period 1995-2015 are demonstrated using station measurements as a reference. We show the correlation between forecast and observed snow depth anomalies and we quantify the forecast quality in terms of reliability, resolution, discrimination and sharpness using a set of probabilistic measures (Brier Skill Score, the Area Under the ROC Curve Skill Score and the Continuous Ranked Probability Skill Score). Implications of the forecast quality at different lead times on climate services are discussed.

Real-time snow forecasts for the current season (2020-2021) are available at this link: http://wilma.to.isac.cnr.it/diss/snowpack/snowseas-eng.html