Submitted Abstract

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Abstract

Mountain glacier shrinking, seasonal snow cover reduction and changes in the amount and seasonality of meltwater runoff are already affecting water availability for both local and downstream uses. Water is needed by different competing sectors including drinking water supply, energy production, agriculture, forestry, tourism, and extremely dry seasons can lead to economic losses. Reducing potential impacts of changes in water availability involves multiple time scales, from the decadal time scale, for the realization of water management infrastructures, to the seasonal scale, to plan the use of water resources and to allocate them with some lead time.

In the framework of the MEDSCOPE ERA4CS project we focused on the seasonal time scale and we developed a climate service prototype to estimate the temporal evolution of the depth and the water content of the snowpack with up to 7 months lead time. Forecasts are initialized on November 1st and run up to May 31st of the following year. The prototype has been co-designed with and tailored to the needs of water and hydropower plant managers and of mountain ski resorts managers.

We present the modeling chain, based on the seasonal forecasts produced by the 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 three high elevation sites in the North-Western Italian Alps, and used as inputs for a physically-based multi-layer snow model (SNOWPACK). The RainFARM stochastic downscaling procedure, adapted for mountain regions, is used for downscaling precipitation data, and stochastic realizations are employed to estimate the uncertainty due to the downscaling method.

The skill of the prototype in predicting the monthly snow depth evolution from November to May in each season of the hindcast period 1995-2015 is demonstrated using station measurements as a reference. We finally discuss implications of the forecast quality at different lead times as well as the added value of bias-correction and downscaling of precipitation data on snow depth forecasts. Real-time snow forecasts for the current season (2021-2022) and for earlier seasons are available on a dedicated web page at the link: http://wilma.to.isac.cnr.it/diss/snowpack/snowseas-eng.html