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Monitoring and modeling the snowpack dynamics in the Arve upper catchment for hydrological purposes

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Snow accumulation and its evolution over space and time have major importance for the hydrological cycle, especially at high elevations. The characteristics of mountain valley, such as a wide altitudinal range, large glaciated areas, snow presence all along the year; when combined with specific meteorological conditions like heat waves or extreme rain events, may originate dramatic flash floods, potentially affecting populated areas. Thus, improving snowpack monitoring and forecasting tools are needed to strength the reliability of warning systems.
Nowadays, accurately characterising and simulating snowpack evolution over large areas still represents a challenge, and uncertainties arise. The study presented here is focused in analysing two different types of simulation of the snowpack dynamics, performed with different discretization approaches, distributed or semi-distributed, and how these could move forward assimilating remote sensing data from satellites. The considered study area is the Arve catchment at Chamonix, in the French Northern Alps. This valley has the previously mentioned characteristics: it comprises a large elevation range (between 1000 to 4800m asl, with large areas above 2000m asl) and about 32% of its extension (200km2) is glaciated. Thus, the hydrological cycle of this area is highly dependent on the snowpack and the glacier melt dynamics.
The snowpack of the Arve catchment has been simulated from 1990 to 2014 with the Crocus model integrated within the SURFEX modelling platform. The input fields are provided by the SAFRAN reanalysis system and the simulations have been performed with both a semi-distributed (classifying terrain by aspect, elevation, slope and land use/land cover) and a distributed (250m spatial resolution grid cells over the study area) approaches. The use of these two approaches using the same snowpack model and same meteorological forcing, enables their comparison in terms of river discharges at several outlets; showing the main strengths and weaknesses of each. Additionally, the two procedures have been evaluated with snow covered area information from MODIS images.
One limitation noticed with both, semi-distributed and distributed simulations, are deviations from the observed snowpack evolution, especially in the accumulation and the fast melting periods. Because of the high complexity of meteorological processes in mountain areas that control the snowpack evolution and the lack of in-situ observations concerning the snowpack evolution; both the meteorological forcing inputs and the land surface models are not able to reproduce all the processes. This way such deviations must be reduced for appropriately reproducing melting dynamics. A discussion on perspectives of remote sensing data assimilation for improving the simulations of snowpack dynamics will be given.