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Snow modelling in the land surface models: verification and climate change impacts using UTOPIA

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The peculiar physical properties of snow (like albedo, thermal inertia and conductivity) differ significantly from physical properties of other Earth's surfaces like soil or canopy. For this reason, a complete model for studying momentum, heat and water vapour exchange processes at the atmosphere-soil-vegetation interface must take into account snow processes. Snow layer can be considered as similar to a soil layer of variable depth, since it can store liquid water within it. Snow is involved both in hydrological budget (since it produces runoff when it melts) and in energy budget (since it is involved in energy transfers, by conduction, radiation or convection, in the surface layer or versus the underlying surface). Finally, snow covers the soil or vegetation surface and its temperature is relevant for the exchanges of heat and water vapor in the surface layer. For all those reasons, snow presence is important for short-term meteorological simulations, as well as for long-term climatic simulations, and thus its evolution must be properly modelled.
In this presentation, based on the study funded by project Nextsnow (http://www.nextdataproject.it/?q=it/content/p2-nextsnow), the main outline of the scheme used in the University of Torino model of land Processes Interaction with Atmosphere (UTOPIA) will be presented. The scheme calculates the energy balance of the snow layer determining water equivalent of the snow mass and its inner liquid water content. Snow precipitation, when not observed, is parameterized from rainfall.
The scheme has been validated against the data gathered in some stations located on mountain in the northwestern Italy, on the Alps. Most stations were belonging to ARPA Piemonte (the Regional Agency for Environmental Protection, managing more than 400 meteo-hydrological stations in Piemonte region, NW Italy), and in those stations usually snow depth and several meteorological parameters were available. One station, Torgnon, located in Valle d'Aosta (a small region in the corner of NW Italy) was specially equipped with instruments able to determine snow parameters. The simulation results show that the UTOPIA is able to accurately predict the amount of snow and the snowpack accumulation and melting times, even if, in some occasions, there are some deviations in the snow depth.
Some sensitivity experiments were performed by manipulating input data, in order to evaluate how much input data quality is influencing the quality of the simulations, and to identify the most relevant parameters.