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Data assimilation in a multilayer dynamic model for soil moisture estimation in mountain regions

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Components of surface dynamics play a crucial role in soil moisture estimation. To have a correct evaluation of soil moisture dynamic in mountain environment snow melt and accumulation must be properly represented.
The present work has the aim to evaluate energy and mass balance in mountain regions seasonally covered by snow. A variational assimilation scheme is used: land surface temperature from satellite and interpolated ground observed snow depths are assimilated in an objective function constrained by the equations of a four-layer model through Lagrange multiplier.
Forward model is characterized by a 4-layer schematization: two layers of snow, that allow to discriminate between fresh and old snow behavior, and two layer of soil at given depth. Layers temperatures are the state variables related to the energy balance; snow water equivalent and snow density are the state variables related to water balance in snow.
Land surface temperature is estimated from MSG-SEVIRI observations through split-window algorithm provided by Land SAF; satellite observed temperature is compared with upper snow layer temperature, when both snow layers are present, with bottom snow layer temperature when there is only one snow layer or surface soil temperature when there is no snow cover. Spatial resolution of satellite data is around three kilometers; this resolution is not appropriate for alpine regions because it doesn't keep into account big variability of height in space and also geometric problems associated with satellite observation in mountain area. To keep into account problems such as georeferencing, changing in viewing angle and shadowing, a geometric correction to satellite data is applied in order to consider orographic complexity. Correction was made using a digital elevation model at spatial resolution of 400 meters, which is the final resolution of the model. The other assimilated variable is snow depth obtained by geostatistical interpolation of the available snow-gauge observations.
The model is applied in Valle d'Aosta region in North-western Italian Alps and shows a good capability in reproducing soil moisture dynamic and snowpack evolution.