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Data assimilation of in-situ snow depth and its impact on river discharge

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Cold process associated with seasonal snow cover are a key components of the earth system due to its unique characteristics and large coverage of the Earth's surface. The radiative (albedo), thermal (insulation) and mechanic (roughness) characteristics of a snow covered surface differ greatly from those of a snow-free surface. Snow acts as a fast climate switch with implications ranging from weather forecasts to climate change projections. Snow data assimilation in numerical weather prediction has been mainly driven by the dramatic impact of snow presence on near-surface temperature. In snow dominated regions, snowpack water storage play a fundamental role in water resources and energy production. Two main observations are commonly used to assimilate snow status: satellite snow cover and in-situ snow depth. In this study we assess the impact of sequential data assimilation of in-situ snow depth in the ECMWF land-surface model using optimal interpolation analysis. Each day the model background is used as first guess and merged with in-situ observations of snow depth via optimal interpolation creating analysis. These analysis are then used directly to initialize the next day simulation. Two simulations with and without data assimilation were carried out globally for the period 2000-2014 and are assessed in terms of snow depth, cover as well as it's impact on simulated river discharge. The results show the clear added value of assimilating snow depth information for the evolution of the snowpack simulations, both in terms of snow depth and snow cover. The no data assimilation simulation suffers from a general late melting which is corrected by the assimilation system. However, due to the direct insertion of the assimilated fields the removed water vanishes from the system leading to a deterioration of the river discharge simulations in several northern basins. These results prove the clear added value of the data assimilation system in terms of snow depth and cover, but suggest that other methodologies to update the model state should be investigated in order to correct the model biases and trigger melting so that water and energy can be conserved and the assimilation benefits propagated into other components of the land surface.