Evaluation of WRF coupled with Noah using an improved albedo parameterization scheme during a severe snow event over the Tibetan Plateau

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Snow falls frequently over the Tibetan Plateau, and is a vital component of the widespread cryosphere which has vital feedback to climate change. Snowfall and the subsequent evolution of the snowpack have a large effect on surface energy balance and water cycle. Albedo, the main determinant of net radiation flux, is a major driver of land surface processes. However, the current widely used Noah land surface model does not describe snow albedo correctly, although it keeps snow-related variables i.e. snow cover and age into account. In our study, the impact of an improved albedo parameterization scheme in WRF coupled with Noah was investigated. In the improved albedo scheme, albedo was parameterized as functions of snow depth and age which was developed using remote sensing retrievals of albedo. Numerical experiments were conducted to model a severe snow event in March 2017. The performance of WRF coupled with Noah applying the improved albedo scheme was compared with that of applying the default albedo scheme and with that of WRF coupled with CLM applying CLM’s complex albedo scheme. First, the improved albedo scheme largely reduces the WRF coupled with Noah albedo overestimation in the southeastern Tibetan Plateau, remarkably reducing the large cold bias estimates by 0.7 °C air temperature RMSE. Second, the improved albedo scheme gives the highest correlation between the satellite-derived and the model estimated albedo, contributing to achieve the SWE spatial pattern, heavy snow belt and maximum SWE estimates in eastern Tibetan Plateau. Remarkable underestimation of albedo in WRF coupled with CLM contributes to regional maximum SWE underestimation and failure in heavy snow belt estimates.

In addition, WRF default land cover and green vegetation fraction were out of date but played a large impact on estimates of air temperature, albedo and SWE. Updated land parameters led to improve the model performance in simulating the severe snow event, by reducing albedo RMSE by 1%-4%. The choice of the algorithm to retrieve green vegetation fraction had a large impact on the accuracy of green vegetation fraction retrievals. It remains open to debate the optimal algorithm to estimate land surface properties in the complex topographic Tibetan Plateau.