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Estimation of a snow depth climatology over Siberia from the synergy of satellite passive microwave brightness temperatures and simulated soil temperatures

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The snowpack is a key variable of the hydrological cycle. In recent years, numerous studies have demonstrated the importance of long term monitoring of the Siberian snowpack on large spatial scales owing to evidence of increased river discharge, changes in snow fall amount and alterations with respect to the timing of ablation. This can currently only be accomplished using remote sensing methods. The main objective of this study is to combine satellite passive microwave brightness temperatures with the soil temperatures of a new land surface forcing and simulation database to improve and evaluate the satellite snow depths computations. A dynamic snow depth retrieval algorithm is used to account for the spatial and temporal internal properties of the snow cover. The passive microwave radiances used to derive snow depth were measured by the Special Sensor Microwave/ Imager (SSM/I) data between July 1987 and July 1995.

The evaluation of remotely sensed algorithms is especially difficult over regions such as Siberia which are characterized by relatively sparse surface measurement networks. In addition, existing gridded climatological snow depth databases do not necessarily correspond to the same time period as the available satellite data. In order to evaluate the retrieval algorithm over Siberia for a recent multi-year period at a relatively large spatial scale, a land surface scheme reanalysis product from the Global Soil Wetness Project - Phase 2 (GSWP-2) has been used. First, the high quality GSWP-2 input forcing data were used to drive a land surface scheme (LSS) in order to derive a climatological near-surface soil temperature. Four different snow depth retrieval methods

are compared, two of which use the new soil temperature climatology as input. Second, a GSWP-2 snow water equivalent (SWE) climatology is computed from several state-of-the-art LSS over the same time period covered by the SSM/I data. This climatology was compared to the corresponding fields from the retrievals. This study reaffirmed the results of recent studies which showed that the inclusion of ancillary data into a satellite data-based snow retrieval algorithm, such as soil temperatures, can significantly improve the results. The current study also goes a step further and reveals the importance of including the monthly soil temperature variation into the retrieval, which improves results in terms of the spatial distribution of the snowpack. Finally, it is shown that further improved predictions of SWE are obtained when spatial and temporal variations in snow density are accounted for.