Simple Snow Temperature Index Models Account for Important Discrepancies between Snow Water Equivalent Products

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ABSTRACT

Snow water equivalent (SWE) is a routine output from reanalysis systems and offline land-surface schemes, but documented discrepancies among the resulting SWE products impede the assessment of hemispheric-scale snow mass variability and trends. These discrepancies may stem from differing meteorological fields between reanalysis products or different surface observation sources, data assimilation schemes, snow model structure, and parameterizations used.

In this work, we investigate SWE differences between three modern reanalysis products (ERA5, JRA-55, and MERRA-2) from 1980-2020. We force the recently updated B-TIM, a simplified, single-layer temperature index snow model based on Brown *et al*., (2003), with their respective temperature and precipitation fields. B-TIM captures the most important features of snow evolution, whereby precipitation amount and phase mainly influence the resulting snow depth, while temperature influences the snowpack density, but it does not attempt to represent humidity-, radiative-, or wind-related processes. Nonetheless, by standardizing the snow model physics used, we primarily isolate biases in the precipitation and temperature fields as sources of spread.

We identify and correct first-order biases between the JRA-55 and ERA5 forcing data to bring the two B-TIM reconstructed datasets, ERA5rec and JRArec, into closer agreement. This reduces the climatological mean wintertime bias by 50%, indicating the propagation of forcing biases into SWE uncertainty. Through several SWE metrics at the continental scale (e.g. mean SWE, max SWE), we find strong correlations in the range 0.84 to 0.96 between all the reconstructed datasets. This is not observed between the native SWE products, which have correlations below 0.4, suggesting that snow model and data assimilation differences affect the interannual variability of a given product more than relative forcing biases do. We conclude that comparison to a temperature index model helps diagnose some inconsistencies between snow products and help assess the impact of changes in data assimilation schemes and input data.

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