Validation of Snow Water Equivalent Products: Dialed in for Non-Mountain Regions but Challenges Remain in Complex Terrain

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ABSTRACT

We advance the evaluation of gridded snow water equivalent (SWE) products by using reference data from both snow courses and airborne gamma-derived SWE estimates to evaluate fourteen datasets over North America. These products cover a broad range of snow analysis from those based on Earth-observation data (JAXA-AMSR2, Snow CCI SWE v1 and v2), coupled land-atmosphere reanalysis (ERA5, ERA5-Land, ERA5-Snow, GLDASv2.2, MERRA2, JRA-55), snow models of varying complexity driven by reanalysis data (Crocus driven by ERA-Interim and ERA5, Brown Temperature Index Model (TIM) driven by ERA5 and JRA-55), and data assimilation schemes (U. Arizona). We assess product performance across both non-mountainous and mountainous regions and analyze the sensitivity of this performance to the choice of reference data set. In non-mountain areas, product performance is insensitive to the choice of reference dataset and there is strong agreement of reference SWE up to spatial scales of at least 25 km, comparable to the grid spacing of most coarse resolution products. In mountain areas, there is poor agreement between the reference datasets even at short distances (< 5 km) and the choice of reference dataset strongly influences the sign and magnitude of the product errors (bias and RMSE) due to systematic elevation differences among the reference data locations and the product grid cell centroids. Minimizing these systematic elevation-driven biases is essential to a fair evaluation of the product performance and improves the median RMSE of the model-based products by one third and almost 50% using gamma and snow courses, respectively. Our full analysis demonstrates that we can robustly validate product SWE estimates in non-mountain regions and are able to provide relative rankings of product performance in mountain regions.

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