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Benchmarking of snow water equivalent (SWE) products based on outcomes of the SnowPEx+ Intercomparison Project

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Supplementary Material

Figure S1 illustrates product performance over mountainous North American terrain. Performance in mountainous terrain is uniformly worse for all products: bias is at least 50mm greater, uRMSE is at least 100mm greater and correlation is typically lower by 0.25 compared to evaluations in nonmountainous terrain.

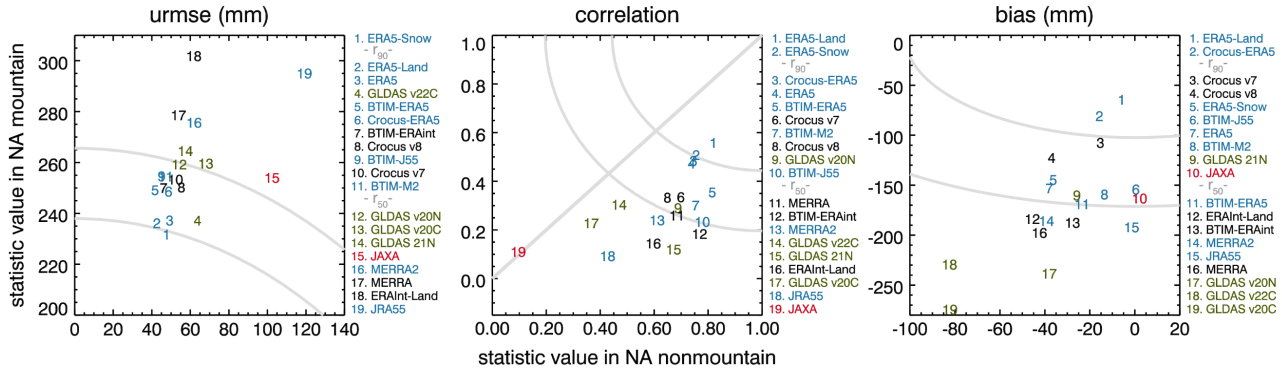

Figure S1. As in Fig. 4 but for nonmountainous versus mountainous performance in North America.

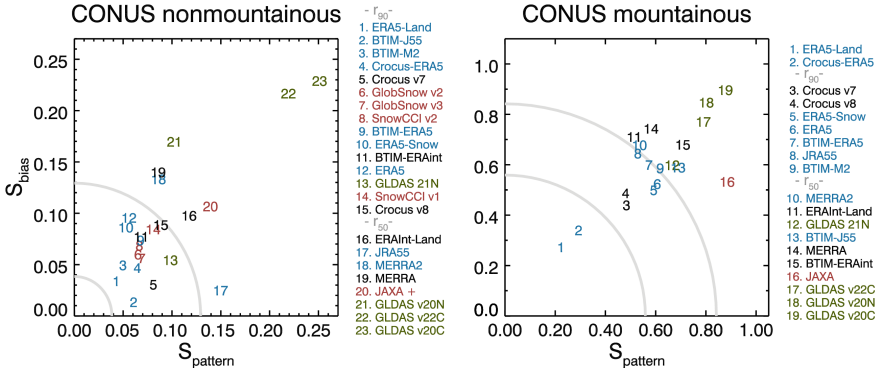

Figure S2. As in Fig. 5 but products are evaluated over the CONUS only.

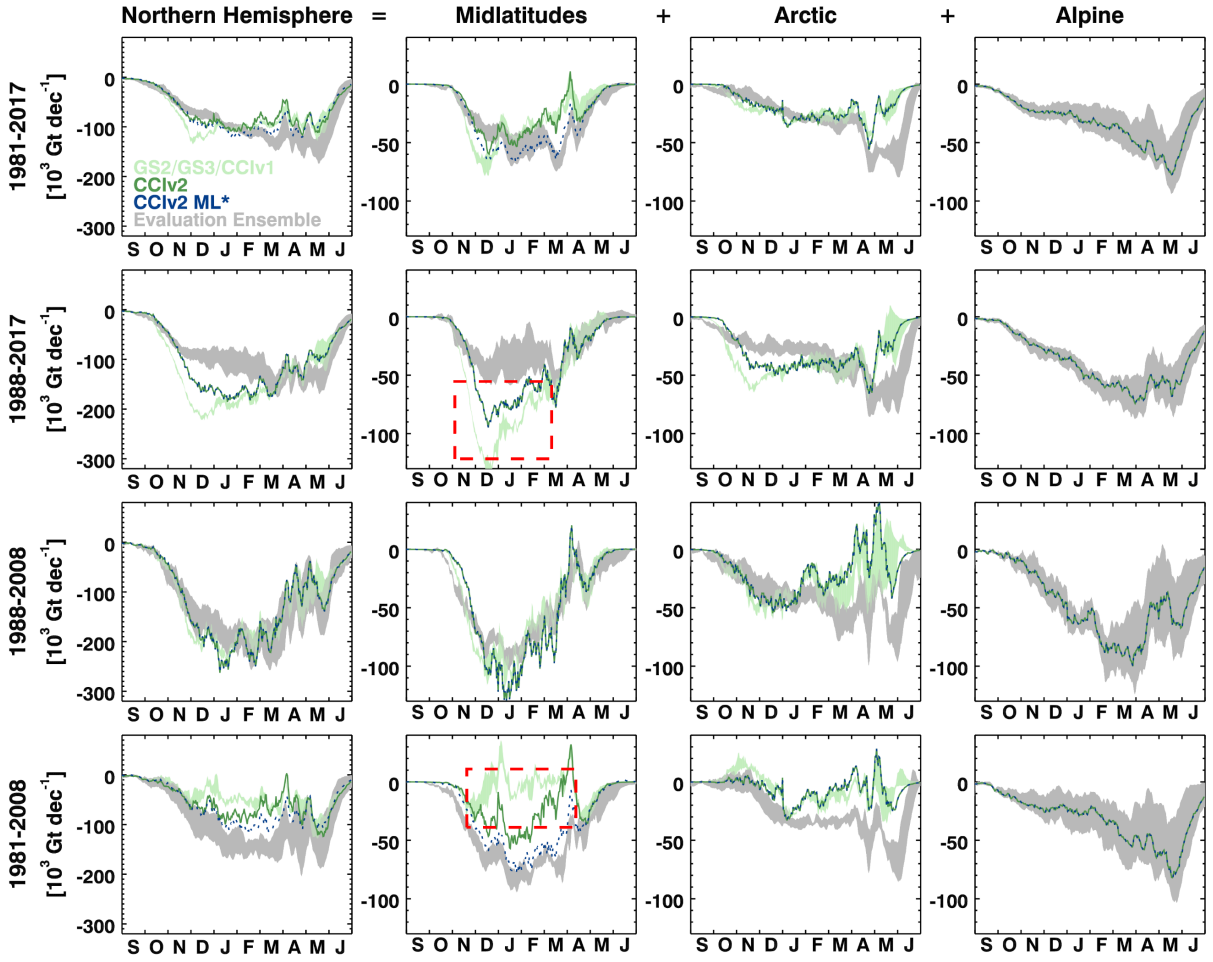

Figure S3. Range in snow mass trends by trend period (rows) and region (columns) for the evaluation ensemble (grey) and GS/CCI SWE products. Red boxes highlight lack of agreement between the GS/CCI products and the two reanalysis groups. Also shown are altered Snow_cci v2 trends where mean anomalies from the evaluation ensemble replaced the original Snow_cci values in midlatitude regions for the 1981-1987 portion of the time series (blue). GS/CCI products do not provide SWE estimates in alpine regions so mean anomalies from the evaluation ensemble (illustrated in the fourth column) are used to calculate total NH trends for comparison.

Figure S3 compares regional snow mass trends from the evaluation ensemble and the ensemble of GS/CCI products over several overlapping periods. It illustrates that all four GS/CCI products have spurious trends across midlatitude regions when anomalies from the 1981-1987 or 2009-2020 portion of the dataset are included, but that the products are consistent with the evaluation ensemble during the 1988-2008 period. Compared to its predecessors, the Snow_cci v2 data set has better agreement with the evaluation ensembles over both the early and late portions of the record. These results are consistent with analysis

from Mortimer et al. (2022) which identified changepoints in 1987 and 2009 in products based on heritage PMW Tb input data (Knowles and Brodzik, 2000; Armstrong and Hardman, 1994) such as Snow_cci v1. When the same analysis was applied to products based on newer reprocessed PMW Tb input data (Brodzik et al., 2016) the 1987 changepoint was identified but not the one in 2009. However, our analysis suggests that in the Snow_cci v2 product, which is based on the newer PMW Tb input data, the discrepancy has been ameliorated but not removed entirely. Also shown is an altered version of Snow_cci v2 constructed by replacing its snow mass anomalies in midlatitude regions over the 1981-1987 period with the average anomalies from the evaluation ensemble. Trends from this altered version of Snow_cci v2 are more consistent with the evaluation ensemble, suggesting that much of the variability present in the product is reasonable apart from the aforementioned discontinuities. Further improvements to trends in forthcoming Snow_cci products are also discussed briefly in Section 4.

References

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