Improving Overland Precipitation Retrieval with Brightness Temperature Temporal Variation

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Current microwave precipitation retrieval algorithms utilize the instantaneous brightness temperature (TB) to estimate precipitation rate. This study presents a new idea that can be used to improve existing algorithms: using TB temporal variation ΔTB from the microwave radiometer constellation. As a proof of concept, microwave observations from eight polar-orbiting satellites are utilized to derive ΔTB. Results show that ΔTB correlates more strongly with precipitation rate than the instantaneous TB. Particularly, the correlation with precipitation rate improved to -0.6 by using ΔTB over the Rocky Mountains and north of 45N, while the correlation is only -0.1 by using TB. The underlying reason is that ΔTB largely eliminates the negative influence from snow-covered land, which frequently is misidentified as precipitation. Another reason is that ΔTB is less affected by environmental variation (e.g., temperature, water vapor). Further analysis shows that the magnitude of the correlation between ΔTB and precipitation rate is dependent on the satellite revisit frequency. Finally, it is shown that the retrieval results from ΔTB are superior to that from TB, with the largest improvement in winter. Additionally, the retrieved precipitation rate over snow-covered regions by only using ΔTB at 89 GHz agrees well with the ground radar observations, which opens new opportunities to retrieve precipitation in high latitudes for sensors with the highest frequency at ~89 GHz. This study implies that increasing the microwave radiometer observation frequency, either from geostationary or small-satellite constellation techniques, can significantly improve precipitation retrieval performance. It also highlights the importance of maintaining the current passive microwave satellite constellation.