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Improving snowfall-rate retrievals over ice and snow surfaces using passive microwave spectral data

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Reliable retrieval of snowfall rates over ice and snow surfaces using satellite-based passive microwave spectrometers is currently an unsolved problem. The challenge results from the large variability of microwave emissivity spectra for surface snow and ice, which can mimic to some degree the spectral characteristics of snowfall. This work is aimed at extending the validity of an existing 15-km resolution global precipitation retrieval algorithm for the Advanced Microwave Sounding Unit (AMSU) (C. Surussavadee and D. H.Staelin,Oct. 2006.) to the difficult case of snowfall rates over snow and ice surfaces. The underlying precipitation rate retrieval algorithm, developed by Surussavadee and Staelin, utilizes AMSU channels 23-191 GHz and neural networks trained with 106 globally and seasonally distributed storms, selected because their morphology revealed by AMSU agreed best with coincident brightness temperatures computed for NCEP-initialized cloud-resolving 15-km resolution numerical weather prediction (MM5) forecasts. The approach explored here is based on the hypothesis that if the atmosphere near 183 GHz is sufficiently opaque so that surface effects are negligible, then the MM5-based retrievals of surface precipitation rates should retain most of their validity. To test this hypothesis an algorithm, that estimates atmospheric opacity using NCEP analyses, has been used to evaluate the use of various thresholds for optical depth at AMSU-B frequencies, to identify certain retrievals as unreliable. For this purpose ninety-six NCEP global analyses were interpolated to NOAA-15 fields of view. For every pixel in these fields the total clear-air optical depth at 183$\pm$7 GHz was evaluated and interpolated in time so as to synchronize the NCEP-based opacity dataset with AMSU precipitation retrievals for 24

days distributed approximately evenly between October 2005 and October 2006. The preliminary results suggest that this NCEP-based approach increases the number of successful snowfall-rate retrievals, and that the number of false detections increases as the opacity threshold is lowered. False alarms can generally be detected by manual examination of sequential NCEP and AMSU observations using all available data in combination with physical considerations. The performance limits of this NCEP-based approach are evaluated.