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Shallow Convective Snow from a GPM Passive Microwave perspective: strengths and weaknesses of the retrievals.

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Snowfall is produced by different precipitating structures with distinctly different cloud macrophysical and microphysical compositions. Deep cloud structures related to synoptically-forced, large-scale midlatitude weather systems, represent a common snowfall regime. Alternatively, many mid- to high-latitude oceanic and coastal regions are prone to shallow convective snow produced by cold air outbreaks interacting with unfrozen large bodies of water. The regional impact of the shallow convective snow cannot be ignored since they often produce intense snowfall rates and influence regional hydrology. This work focuses on the ability of the Global Precipitation Measurement (GPM) passive microwave sensors to detect and provide quantitative precipitation estimates (QPE) for this particular snowfall mode over the US Great Lakes region. GPM's Microwave Imager (GMI) and constellation sensors brightness temperatures (TB) are clearly able to detect signals related to intense shallow convective snowfall events. The related Goddard PROfiling (GPROF) retrieval products, on the other hand, show weaknesses that need to be identified and advertised in order to improve the algorithm itself. The sensitivity of GPROF to some key parameters used to partition the GPROF a-priori database and converge more efficiently to the solution has been investigated. These parameters are model-derived 2-meter temperature (T2m), total precipitable water (TPW), and background surface type. The effective dependence of the GPROF snowfall rate estimates on the representativeness of shallow convective snowfall environmental conditions in the a-priori database is investigated. Results show that, even if the specific a-priori database is fairly populated, there is no evidence of the actual representativeness of shallow convective precipitation events. The GPM's official GPROF frozen surface and coastal classification is compared to alternative classification schemes based on the low-frequency signal at the time of the radiometer overpass. Finally, the weighting of high frequency channels used in the GPROF algorithm has been reconsidered and an estimation of the error made by slightly changing channel weights has been analyzed. The Multi-Radar/Multi-Sensor (MRMS) QPE database is used as ground reference for qualitative and statistical evaluations.