Detecting Falling Snow from Space

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There is an increased interest in detecting and estimating the amount of falling snow reaching the Earth's surface in order to fully capture the atmospheric water cycle. An initial step toward global spaceborne falling snow algorithms includes determining the thresholds of detection for various active and passive sensor channel configurations, snow event cloud structures and microphysics, snowflake particle electromagnetic properties, and surface types. In this work, cloud resolving model simulations of a lake effect and synoptic snow event were used to determine the minimum amount of snow (threshold) that could be detected by the following instruments: the W-band radar of CloudSat, Global Precipitation Measurement (GPM) Dual-frequency Precipitation Radar (DPR) Ku and Ka band, and the GPM Microwave Imager (GMI) channels from 10 to 183±7 GHz. Eleven different snowflake shapes were used to compute radar reflectivities and passive brightness temperatures. Notable results include: (1) the W-Band radar has detection thresholds more than an order of magnitude lower than the future GPM sensors, (2) the cloud structure macrophysics influences the thresholds of detection for passive channels, (3) the snowflake microphysics plays a large role in the detection threshold for active and passive instruments, (4) with reasonable assumptions, the passive 166 GHz channel has detection threshold values comparable to the GPM DPR Ku and Ka band radars with ~0.05 g m-3 detected at the surface, or an ~0.5-1 mm hr-1 melted snow rate (equivalent to 0.5-2 cm hr-1 solid fluffy snowflake rate). With detection levels of falling snow known, we can focus current and future retrieval efforts on detectable storms and concentrate advances on achievable results. We will also have an understanding of the light snowfall events missed by the sensors and not captured in the global estimates.