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Use of the sea surface as reference for GPM dual-frequency radar algorithms

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In airborne and spaceborne radar remote sensing of clouds and precipitation, measurements of the sea surface normalized radar cross section σ^0 are widely used to constrain and condition algorithms for the retrieval of atmospheric parameters. In the Tropical Rainfall Measuring Mission, the Path Integrated Attenuation (PIA) of the Ku-band Preciptitation Radar (PR) are estimated by comparing the surface radar backscatter measured across a distribution of hydrometeors against the surface backscatter cross section σ^0_{clear} measured in the nearby rain-free areas. The PIA is then used as a constraint in the Surface Reference Techniques (SRT) to deduce the vertical rainrate profiles and surface rain rates. A dual-frequency version of the SRT is expected to be used by the planned Global Precipitation Measurement (GPM) mission since the Dual frequency Precipitation Radar (DPR) on board the GPM core satellite will provide co-located and simultaneous measurements of σ^0 at Ku- and Ka- band.

In general, PIA estimates are affected by backscatter measurement errors, unknown surface wind conditions in the raining areas, and sampling errors. Moreover, non-Uniform Beam Filling (NUBF) conditions and contributions by water vapor, cloud liquid water and mixed phase hydrometeors must be accounted for when using the PIA estimate in the rain parameter retrievals. The concept of dual-frequency SRT has been formulated and analyzed in the past. For GPM, the advantages of the Ku/Ka-band SRT approach are that the rain-induced specific attenuation at Ka-band is almost one order of magnitude larger than that at Ku-band, and the availability of simultaneous σ^0measurements at the two frequencies makes it possible to reduce the uncertainty intrinsic to SRT. On the other hand, Ka-band measurements are more affected by cloud liquid water, water vapor and NUBF.

In this work, the high-resolution data acquired by the NASA JPL's Dual-frequency Airborne Precipitation Radar will be used to analyze the characteristics and uncertainties of the dual-frequency measurements of σ^0, with primary focus on the following two aspects:

1. Correlation between Ka- and Ka-band σ^0: Recent experimental results show a well-defined relationship between the σ^0_{clear} measured at Ku-band and at Ka-band. Such relationship, if confirmed, makes it possible to estimate the Ka-band σ^0 directly from the co-located Ku-band σ^0measurements in light rain conditions at which the rain component in Ku-band σ^0 is negligibly small. Hence, one of the major PIA error source, unknown local surface wind, can be largely eliminated.

2. Detection of NUBF: In medium-to-heavy rain condition, the ratio between the PIA obtained at the two frequencies can potentially reveal the presence of NUBF.

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