Characteristics of ice over stratiform rain: Global statistics from the Dual-frequency Precipitation Radar and the proposed retrieval scheme

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Stratiform rain and the overlying ice that generates it are important components of the Earth's climate system. From a microphysics perspective, it is the ice mass concentration and the ice size that control the mass flux through the melting level, and by extension the underlying rain rate. The Dual-frequency Precipitation Radar (DPR) on NASA's core Global Precipitation Measurement satellite is the first space-borne instrument with dual-wavelength capabilities with the potential of better linking ice and rain microphysical properties in stratiform conditions. In this paper we seek to establish to what degree the relationship between the dual-wavelength ratio in the regions immediately above and below the melting layer can add a constraint on the ice particle modelling needed for retrieving profiles of ice size and concentration. Emphasis is placed on DPR observations over the deepest precipitation columns with a confidently identified bright band where the relatively horizontally uniform conditions associated with stratiform rain minimize the issue of non-uniform beam filling. The analysis indicates that in the current DPR algorithm a sharp reduction in retrieved mass flux from ice to rain phase is observed, which is inconsistent with the expectation that mass flux should not vary so drastically across the bright band under conditions of stratiform rain. Moreover, recent in situ measurements seem to suggest that, at least over the tropics, ice clouds are characterized by greater mass concentrations but smaller sizes than previously realized. For few case studies with DPR data, we demonstrate that a reduction of size and an increase of content of ice is necessary to match precipitation rates in rain and snow (i.e. if a constant mass flux is assumed through the melting region). Moreover, the potential of dual frequency observations for characterizing the density of ice is also discussed.

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