Ice crystal number concentration estimates from lidar-radar satellite remote sensing

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Recent assessments from the climate research community clearly highlight the emergency to reach a better understanding of aerosol-cloud interactions in order to improve current radiative forcing estimates. Satellite observations are ideal to fulfill this task due to their high temporal and spatial coverage, but their operational products are not always suited to answer these questions. Indeed, while the number concentration of cloud droplets (CDNC) and ice crystals (ICNC) are often considered as some of the most important parameters to quantify aerosol-cloud interactions, they are not yet optimally retrieved from satellite remote sensing. Despite recent efforts to estimate the CDNC, there exists to date no space-borne operational product of the ICNC.

As a first step to fill this gap, this study presents results from a preliminary product of the ICNC obtained from combined CALIPSO/CloudSat observations. The operational liDAR-raDAR (DARDAR) product is used as a basis for these estimations. Climatologies corresponding to the overall A-Train period have been analyzed and show an overall agreement with theoretical expectations. Furthermore, the accuracy of these ICNC retrievals has been rigorously estimated through comparisons with in situ measurements from recent airborne campaigns. Good agreements are found for ice clouds colder than about -40°C, where homogeneous nucleation processes dominate. Limitations have nevertheless been observed due to misrepresentations of the amount of small ice particules (i.e., sizes smaller than 100 microns) in existing parameterizations of the particule size distribution. Subsequently, preliminary applications of this novel dataset to evaluated global climate model predictions and observe aerosol-cloud interactions have been made and will be presented.

Keywords: ice clouds, satellite, retrievals, model evaluation, aerosol-cloud interactions