Validation of IWCs in GME and COSMO-EU with CloudSat CPR data

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The correct prediction of precipitation is of high economic and social significance. Therefore QUEST (Quantitative Evaluation of Regional Precipitation Forecast Using Multidemsional Remote Sensing Observations) – a joint project within the priority program SPP 1167 granted by the German Research Foundation (DFG) – is dedicated to the evaluation of quantitative precipitation forecasts. Weaknesses in the treatment of cloud processes in numerical weather prediction (NWP) models are identified by studying the whole process chain of precipitation development.

Within QUEST, the present study focusses on the evaluation of ice water contents (IWCs) in the global NWP model GME and the regional NWP model COSMO-EU (both operational at the German Weather Service DWD). Reflectivity data from the cloud profiling radar (CPR) on board of CloudSat are especially well-suited for model evaluation due to the global coverage in comparison to sparse ground-based sites. Besides, the quality of the observed reflectivity factors has been proven to be very good (*Protat et al., 2009*).

For relating model IWCs with measured reflectivity factors, two approaches are undertaken: observation-to-model and model-to-observation. In the first approach, the radar-only IWC retrievals are compared to the model output fields. However, the uncertainties are not easily assessed, because within the optimal estimation technique of this 'official' retrieval algorithm the reflectivity factor is composed of three unknowns. Additionally, the retrieval is constrained by a priori information containing ECMWF temperatures and the CloudSat CPR reflectivity values themselves. For the second approach, simulated reflectivity factors are calculated by applying the radar simulator QuickBeam to the GME output fields and then compared to the observed reflectivity factors of the CloudSat CPR. For this, the microphysical parameterizations of the NWP models are implemented in the radar simulator QuickBeam. The second approach offers a better control in the comparison since for example grid cells affected by high attenuation can be filtered out.

Both case studies and a statistical approach are undertaken. The case studies include frontal clouds in the mid-latitudes, a tropical warm pool event, and a pure ice cloud. For the statistical approach certain criteria are applied in order to limit the sample to (1) only pure ice phase , (2) completely cloudy scenes, (3) only stratus, and (4) no strong attenuation due to other hydrometeors. The longer time period of the statistical approach also allows the selection and investigation of different specific cloud situations, as for example stratiform/convective cases. First comparisons reveal that the new microphysical scheme of the GME leads to an improved representation of the total IWC with only a slight systematic underestimation.

Future investigations will extend to other retrieval algorithms, such as lidar-radar algorithms, which include measurements from the CALIPSO lidar CALIOP which flies in formation with CloudSat within the A-Train. Such an algorithm may improve the validation of IWCs at cloud top height, where small IWCs prevail which lie outside the detection range of the CloudSat CPR and are so far excluded from comparison.