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Constructing 3D ice cloud fields using radar and passive millimeter/submillimeter observations

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Passive submillimeter and microwave sensors like the Ice Cloud Imager (ICI) on the upcoming MetOp-SG-B satellite have a great potential for estimating the bulk mass of ice clouds. They also have to some extent the potential to provide information about the vertical structure of ice clouds, but compared to a nadir looking cloud radar their vertical resolution is coarse. Nadir looking cloud radar satellites like CloudSat with its $94\,\mathrm{GHz}$ radar provide high resolution vertical profiles of ice water content (IWC) but are limited to along track measurements, whereas ICI has a wide swath of about $1700\,\mathrm{km}$ but provides only limited information about the vertical structure.

Here we aim to bring together the strengths of the passive sensors and radar to enhance satellite measurements of ice clouds. We combine the wide swath of ICI with a hypothetical nadir looking $94\,\mathrm{GHz}$ cloud radar to construct 3D fields of IWC. ICI and the cloud radar observations are simulated using the Atmospheric Radiative Transfer Simulator (ARTS).

We assume that the nadir looking cloud radar flies on the same orbit ahead of Metop-SG-B, so that it provides quasi coincidental along track measurements with the oblique looking ICI. ICI is a conical scanning radiometer with 53° local incidence angle. Our approach is similar to the approach of H. Barker and his coworkers for the EarthCARE mission. The along track ICI and radar measurements are used to construct vertical IWC profiles for the across track ICI measurements. Local (in time and space) ad-hoc databases are formed from the along track ICI measurements and from IWC profiles estimated from the quasi coincidental radar measurements. The 3D fields of IWC are then estimated by the most likely IWC profiles of the respective local ad-hoc databases and ICI measurements.