JpGU-AGU Joint Meeting 2017

Remote Sensing of 3D Cloud Microphysics via Radiative Transfer

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Recent advances in multi-view high-resolution instruments and computation power enable, in principle, 3D volumetric recovery of clouds. This is in contrast to current retrievals, which rely heavily on plane-parallel models and 1D radiative transfer. Plane-parallel models do not express the true 3D nature of the atmosphere, thus biasing retrievals. We pose and solve an inverse problem of passive atmospheric scatterer 3D tomography. The approach fits a microphysical 3D volumetric model of scatterers to multi-angular/multi-spectral images. The forward model is a numerical 3D radiative transfer solver. Model to data fit is posed as a high-dimensional optimization problem. The optimization is computationally tractable on large scales, thanks to an efficient algorithm, which we describe.

As a test-case, we apply the approach to cumulus clouds. Validation is done using a synthetic large-eddy simulation. A preliminary experimental demonstration is performed on data acquired by the Airborne Multi-angle Spectro-Polarimetric Imager (AirMSPI).

Keywords: 3360 Remote sensing, 6982 Tomography and imaging, 0629 Inverse scattering, 3311 Clouds and aerosols