CIRRUS HORIZONTAL HETEROGENEITY EFFECTS ON CLOUD OPTICAL PROPERTIES RETRIEVED FROM MODIS VNIR TO TIR CHANNELS

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Cirrus are an important part of the Earth radiation budget but an assessment of their role yet remains highly uncertain. Cirrus optical properties such as Cloud Optical Thickness (COT) and ice crystal effective particle size (Re) are often retrieved with a combination of Visible/Near InfraRed (VNIR) and ShortWave-InfraRed (SWIR) reflectance channels. Alternatively, Thermal InfraRed (TIR) techniques, such as the Split Window Technique (SWT), have demonstrated better sensitivity to thin cirrus. However, current satellite operational products for both retrieval methods assume that cloudy pixels are horizontally homogeneous (Plane Parallel and Homogeneous Approximation (PPHA)) and independent (Independent Pixel Approximation (IPA)). The impact of these approximations on cirrus retrievals needs to be understood and, as far as possible, corrected. Horizontal heterogeneity effects can be more easily estimated and corrected in the TIR range because they are mainly dominated by the PPA bias, which primarily depends on the COT subpixel heterogeneity. For solar reflectance channels, in addition to the PPHA bias, the IPA can lead to significant retrieval errors if there is large photon transport between cloudy columns in addition to brightening and shadowing effects that are more difficult to quantify.

The effects of cirrus horizontal heterogeneity are here studied on COT and Re retrievals obtained using simulated MODIS reflectances at 0.86 and 2.11 μm and radiances at 8.5, 11.0 and 12.0 μm, for spatial resolutions ranging from 50 m to 10 km. For each spatial resolution, simulated TOA reflectances and radiances are combined for cloud optical property retrievals with a research-level optimal estimation retrieval method (OEM). The impact of horizontal heterogeneity on the retrieved products is assessed for different solar geometries and various combinations of the five channels. Synthetic cirrus cloud fields used as input to the OEM are generated using a cirrus 3D cloud generator (3DCloud) and a 3D radiative transfer code (3DMCPOL).

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