Impact of aerosol non-sphericity on the satellite remote sensing of CO_2

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Existing algorithms for satellite remote sensing of CO_2 assume that all atmospheric aerosol particles are spherical. This assumption, however, is only valid for the atmosphere in the absence of dust particles that are non-spherical by their nature. Here, a theoretical analysis is conducted for the dusty atmosphere to analyze the impact of aerosol non-sphericity on the accuracy of CO_2 retrievals from space. The analysis begins by adding new capabilities to the UNL-VRTM, a UNified and Linearized Vector Radiative Transfer Model [1] (http://unl-vrtm.org) which can calculate both the four Stokes parameters and their respective sensitivities to aerosol properties. The new capability builds upon the existing non-spherical scattering property database [2,3] and develops an analytical method to calculate the Jacobians of these scattering properties to aerosol size distribution parameters, index of refraction, and particle shape factors. With this new capability, the UNL-VRTM is upgraded to compute radiative transfer for the spectrum of Tan-Sat [4], and the subsequent retrieval of CO_2 [5] is conducted by using the UNL-VRTM synthetic data. In the presentation, we will describe the development and validation of UNL-VRTM's new capabilities and provide an analysis of CO_2 retrieval errors due to the lack of consideration of aerosol non-spherical shape in dusty conditions.

References

[1] Wang, J., *et al*., 2014: A numerical testbed for remote sensing of aerosols, and its demonstration for evaluating retrieval synergy from a geostationary satellite constellation of GEO-CAPE and GOES-R. *J. Quant. Spectrosc. Radiat. Transfer* **146**, 510–528.

[2] Meng, Z., *et al*., 2010: Single-scattering properties of tri-axial ellipsoidal mineral dust aerosols: a database for application to radiative transfer calculations. *J. Aerosol Sci.* **41**, 501–512.

[3] Dubovik, O., *et al*., 2002: Non-spherical aerosol retrieval method employing light scattering by spheroids. *Geophys. Res. Lett*. **29**, 1415.

[4] Chen, X., *et al*., 2017: Angular dependence of aerosol information content in CAPI/TanSat observation over land: effect of polarization and synergy with A-train satellites. *Remote Sens. Environ*. **196**, 163–177.

[5] Liu, Y., *et al*., 2018: The TanSat mission: preliminary global observations. Sci. Bull. **63**, 1200–1207.

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