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Innovative observation of the 3D distribution of aerosols from space

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Air pollution is a major global concern. It causes approximately 4.3 million premature deaths worldwide each year. Since air pollutants are transported far beyond national boundaries, the effectiveness of air pollution control policies clearly depends on our knowledge of the contributions of each source region and the atmospheric transport pathways of air pollution. In this framework, satellite approaches play a fundamental role in observing air pollution from regional to global scales and can potentially provide highly valuable information. However, measuring both the horizontal and vertical distributions of important pollutants, such as aerosols, from space is a challenging problem. Standard satellite observations of the spatial distribution of aerosols mainly describe their horizontal distribution in terms of aerosol optical depth, without information on the vertical, or aerosol vertical profiles only for longitudinal transects using spaceborne lidars.

Recently, new aerosol observational capabilities have been developed using a new generation of multi-hyperspectral spaceborne measurements. These new methods allowed for the first time to observe the three-dimensional (3D) distribution of coarse aerosols from space using hyperspectral thermal infrared measurements from the IASI sensor [1]. Based on a so-called AEROIASI method and for each cloud-free IASI pixel, we derive vertical profiles of desert dust [2] and other finer particles that significantly absorb thermal infrared radiation [3], such as sulfuric acid and ammonium sulfate. In addition, a new method called AEROS5P has enabled the first 3D observation of fine aerosols emitted by wildfires, based on visible and near-infrared hyperspectral measurements from TROPOMI [4].

In the current talk, these new approaches for observing the 3D distribution of aerosols will be presented, including illustrations of the novel insights into the 3D pathways of aerosols that they provide.

Keywords: aerosol 3D distribution, multi-hyperspectral measurements, air quality, climate, synergetic retrieval algorithm

References

[1] Cuesta et al. Three-dimensional distribution of a major desert dust outbreak over East Asia in March 2008 derived from IASI satellite observations, J. Geophys. Res. Atmos., 120, 7099-7127, https://doi.org/10.1002/2014JD022406 , 2015
[2] Cuesta et al. Three-dimensional pathways of dust over the Sahara during summer 2011 as revealed by new Infrared Atmospheric Sounding Interferometer observations. Quarterly Journal of the Royal Meteorological Society, 146(731), 2731-2755, https://doi.org/10.1002/qj.3814 , 2020
[3] Guermazi et al. Quantitative Retrieval of Volcanic Sulphate Aerosols from IASI Observations. Remote Sensing. 2021, 13, 1808. https://doi.org/10.3390/rs13091808 , 2021
[4] Lemmouchi et al. Three-dimensional Distribution of Biomass Burning Aerosols from Australian Wildfires Observed by TROPOMI Satellite observations. Remote Sens., 14 (11), 2582, https://doi.org/10.3390/rs14112582, 2022