Mineral dust trends from 16 years of consistent 3D IASI MAPIR v5.1 data

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ABSTRACT

Mineral dust aerosols are particles lifted from barren regions, primarily deserts, by strong winds. These particles can travel thousands of kilometres, mostly within the tropical dust belt but occasionally reaching Europe and beyond. As the most significant tropospheric aerosol in terms of annual mass burden, dust aerosols play a crucial role in the climate system. They absorb, scatter, and emit radiation, affecting the Earth's energy balance across both the solar and terrestrial spectra. Additionally, they indirectly affect the Earth system by causing surface warming or cooling, atmospheric warming within the dust layer, altering atmospheric circulation, and changing the lifespan and physical properties of clouds, as well as the distribution and quantity of rainfall. Moreover, dust aerosols negatively affect human health and various activities such as aviation, solar energy production, and infrastructure. Therefore, studying atmospheric dust load, sources, and their temporal changes is of significant scientific and societal interest.

The Mineral Aerosol Profiling from Infrared Radiances (MAPIR) algorithm utilizes thermal infrared radiances to retrieve vertical profiles of mineral dust (coarse mode) concentration up to an altitude of 10 km. The current version 5.1 is faster than previous versions, allowing the removal of pre-filters that previously led to the omission of atypical events, and enabling the processing of global data.

For climate analyses, including the trends presented here, MAPIR v5.1 has been applied to the IASI/Metop-A reprocessed level 1 radiances (in the form of principal components). Additionally, ancillary data from the IASI reprocessed level 2 surface temperature, atmospheric temperature, and humidity data were used. The algorithm has also been applied to IASI/Metop-C data, utilizing principal components level 1 and PWLR3 level 2 data, which are consistent with the reprocessed IASI/Metop-A data. This ensures a fully consistent data set throughout the IASI life span.

We use this data to derive trends of relevant variables, such as column-integrated aerosol optical depth (AOD), dust mean altitude, specific layer concentration, and the number of events, using various analysis methods. We also compare IASI/Metop-A and IASI/Metop-C time series for the common coverage period to assess their merging. In this contribution, we will present a selection of the most interesting results from these analyses, including a global map of dust AOD trends.

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