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Sensitivity of Aerosol Multi-Sensor Daily Data Intercomparison to Level 3 Dataday Definition

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One of the main goals of current research on the global distribution and impact of aerosols is the development of a multi-sensor merged or composite dataset of aerosol properties. With more and more aerosol data being available, at various spatial and temporal scales, from various spaceborn sensors, it is difficult to reach consensus derived from these heterogeneous observations. It is important to identify the sources of the differences observed by the various satellite datasets with each other and with model data. One approach has been to compare gridded Level 3 daily data that show differences usually attributed to differences in calibration, retrieval algorithms, cloud filtering, processing details and other issues.

In the present paper, we address other aspects of differences between daily Level 3 aerosol data measured by different sensors that significantly contribute to the overall differences in the area around the international dateline, i.e., around the 180 deg longitude. One aspect is the different definition of the data day employed by different science teams; another is related to the fact that, for example, sensors onboard the Terra satellite perform aerosol (daytime) measurements during the descending part of the orbit, while those on Aqua (being part of the A-Train constellation) performs aerosol measurements in the ascending mode. These differences lead to significant time difference between measurements made by sensors on different satellites in some areas, thus (due to spatial and temporal variability of aerosols) lowering correlation between aerosol measurements.

We demonstrate that (i) the effect of dataday definition leads to having spatially close measurements coming from orbits separated by about 23 hours (usually, these are the first and last orbits of a day) and (ii) the actual overpass time difference (several hours) is also being modulated by Terra and Aqua daytime measurements being collected during descending and ascending nodes respectively.

The so-called spatial dataday definition that preserves the spatial continuity going from one orbit to another has been employed by AIRS, OMI, TOMS, TOVS, AVHRR for atmospheric products and most of the ocean data products. MODIS atmospheric group, on the other hand, has chosen to include Level 2 granules that span a 24-hour (00:00:00 to 23:59:59 UTC) interval, which leads to discontinuities around the dateline.

We demonstrate that when the spatial dataday definition is applied to MODIS data, the artifact around the dateline in the correlation map between Terra and Aqua goes away.

We conclude that to compare daily Level 3 data in a reasonable way, data from all sensors should be processed consistently using the spatial dataday definition.