Session: C1 Poster: M240A

Climatological analysis of MISR, MODIS and OMI aerosol products in East Asian dust source regions

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Climate and aerosol transport models rely on satellite aerosol products to constrain model initializations and predictions. Satellite gridded products over bright desert sources are especially challenging to interpret and use for modeling constraints because satellites may not fully capture the sporadic nature of dust events, and differences exist among satellite products. To assess the reliability of a satellite-based climatology derived from different sensors in East Asian desert regions, we analyzed 10-year Terra Multi-angle Imaging SpectroRadiometer (MISR), 7-year Aqua Moderate Resolution Imaging Spectroradiometer (MODIS) Deep Blue, and 5-year Aura Ozone Monitoring Instrument (OMI) aerosol data, focusing on the two largest dust source regions: the Taklimakan and the Central Gobi. The realism of satellite characterization of Asian dust was also evaluated against independent data. We found reasonable agreement in multi-year mean MISR, MODIS and OMI aerosol optical thickness (AOT) and OMI aerosol index (AI) spatial distributions in the Taklimakan and Central Gobi in all months, with the exception of April, dustiest month of the year. The spring AOT inter-annual variability and anomalies, in contrast, show very good agreement in April, as well as reasonable agreement in other spring months, which in turn agree with meteorological surface observations. The seasonal cycle of AOT and OMI AI derived from three sensors agree over the Central Gobi; however, the MISR seasonal cycle in the Taklimakan is inconsistent with the other satellite or meteorological observations. Satellite AOT inter-annual and seasonal variability are in reasonable agreement with those of AERONET despite various differences in coincident AOT values. The major differences between the sensors' AOT values found for high dust loadings (high AOT and AI) are likely due to differences in satellite sampling, aerosol retrieval methods, and cloud screening techniques. Although our results point out current limitations of satellite data for constraining total dust loadings and spatial distributions during months of high dust activity, the data are valuable to constrain AOT off-season spatial distributions and inter-annual variability/anomalies in Asian dust sources.