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Interannual Variability of African Dust with Seasonal Distinction in Recent Decades as Characterized by Multiple Remote Sensing Observations

Hongbin Yu (1), Tianle Yuan (1,2), Huisheng Bian (1,2), Mian Chin (1), Qian Tan (3,4), Zhibo Zhang (2), and Paul Ginoux (5)

(1) NASA Goddard Space Flight Center, Earth Sciences Division, Greenbelt, Maryland, United States (Hongbin.Yu@nasa.gov), (2) JCET, University of Maryland at Baltimore County, Baltimore, Maryland, United States, (3) Bay Area Environmental Research Institute, Petaluma, California, United States, (4) NASA Ames Research Center, Moffett, California, United States, (5) NOAA GFDL, Princeton, New Jersey, United States

Dust affects key components of the climate system, including energy, water, and carbon cycles, in many ways. The emission and transport of dust is strongly modulated by surface and meteorological conditions that change in a changing climate. Model simulations of dust variability depend strongly on how the dust life cycle is represented in models, which currently has large uncertainties and is model-dependent. In this study, we acquired an observational understanding of the interannual variability of African dust over the last two decades by analyzing remote sensing measurements from multiple satellites (MODIS, CALIOP, MISR, and IASI) and AERONET. We separated dust from non-dust aerosol by using remote sensing measurements of particle size and shape. These measurements of dust show a consistent interannual variability of dust optical depth in North Africa and tropical North Atlantic Ocean, which is mainly driven by that in spring. The interannual variability has become more pronounced since 2009 when Sahel rainfall varies substantially from year to year. A composite analysis between high-dust years and low-dust years shows that the springtime dust interannual variability in source regions is mainly controlled by surface wind variability that is associated with the northward progression of West African Monsoon. Extended analysis of the dust-monsoon association with historical dust records from the AVHRR remote sensing and Barbados in-situ sampling (up to 36-years) suggests that the West African Monsoon progression could explain 30-40% of dust variability over tropical North Atlantic. In NASA GEOS model, more than half of dust emission variability in spring can be explained by the West African Monsoon variability.