

A record-breaking trans-Atlantic African dust plume associated with atmospheric circulation extremes in June 2020

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High concentrations of dust have adverse impacts on society and human health, yet our understanding about extreme dust events is still limited. A record-breaking trans-Atlantic African dust plume was observed during June 14–28, 2020, greatly degrading air quality over large areas of the Caribbean Basin and U.S. Daily $\text{PM}_{2.5}$ concentrations exceeded $50 \mu\text{g m}^{-3}$ in several Gulf States, while air quality index reached unhealthy level for sensitive group in more than 11 States. The magnitude and duration of high aerosol optical depth over the tropical North Atlantic Ocean are the greatest in summer during the past 18 years based on satellite retrievals. We found that this extreme trans-Atlantic dust event is associated with both enhanced dust emissions over western North Africa and atmospheric circulation extremes that favor dust long-range transport. An exceptionally strong African easterly jet and associated wave activities export African dust across the Atlantic toward the Caribbean at middle to lower troposphere, while a westward extension of the North Atlantic subtropical high and an extremely enhanced Caribbean low-level jet further transport the descended, shallower dust layer from the Caribbean Basin onto the U.S. Over western North Africa, enhanced dust emissions are associated with extremely enhanced surface wind speeds over dust source regions and reduced vegetation coverage in the western Sahel. While there are large uncertainties associated with future variations in African dust emissions, model projected atmospheric circulation changes generally favor long-range transport of African dust to the Caribbean Basin and U.S. in a warmer future.