On the decadal scale correlation between African Dust and Sahel rainfall: the role of Saharan heat Low-forced winds

Weijie Wang, Amato Evan, Cyrille Flamant, Christophe Lavaysse

To cite this version:
On the decadal scale correlation between African dust and Sahel rainfall: the role of Saharan Heat Low-forced winds

Weijie Wang, Amato Evan, Cyrille Flamant and Christophe Lavaysse

contact: wjwang@ucsd.edu

Introduction

By mass, aeolian dust is the most pervasive aerosol in the atmosphere. The presence of suspended dust affects the local energy balance through direct and indirect effects, modifies the hydrological cycle via radiative forcing and modification of cloud microphysical properties, and is a vehicle for the long-range transport of nutrients to global oceans and terrestrial land surfaces.

North Africa is the world’s largest dust source; accounting for more than 55% of the global dust emissions. Long-term in-situ observations at and coral reef proxy and satellite have shown that dust emission from North Africa peaked during the mid-1980s and has followed a downward trend through at least the late 2000s. Studies have found dust cover over the Atlantic is anticorrelated with precious-year Sahelian precipitation. However, there are several aspects of such a theory that are not consistent. For example, satellite imagery suggests that the vast majority of dust-precipitation. However, there are several aspects of such a theory that are not consistent. For example, satellite imagery suggests that the vast majority of dust-emission regions lie to the north of the vegetated region of the Sahel. Here we reconcile this contradiction by showing that both Saharan surface wind fields over the major regional dust-emitting regions, and the northward propagation of the monsoon flow and thus Sahel rainfall, are forced by the thermodynamic state of a meteorological feature termed the Saharan Heat Low.

Data and Methods

The Saharan heat low (SHL)

The SHL is defined as the atmospheric thickness between the 700 hPa and 925hPa levels, using geopotential height from ERA Interim reanalysis.

Precipitation

The Version 2 Global Precipitation Climatology Project (GPCP).

Dust aerosol optical depth

Retrieved from satellite radiance measurements from the Advanced Very High Resolution Radiometer (AVHRR).

Dust emission rates

Derived from Spinning Enhanced Visible and Infrared Imager infrared dust index images.

Winds

ERA Interim reanalysis

Results

Climatology (A) and anomaly (B) of precipitation and winds

Histogram count of 10 m wind speed

Conclusion

We show that interannual variability in Sahelian rainfall, and surface wind speeds over the Sahara, are the result of changes in lower tropospheric air temperatures over the SHL. As the SHL warms an anomalous tropospheric circulation develops that reduces windspeeds over the Sahara and displaces the monsoonal rainfall northward, thus simultaneously increasing Sahelian rainfall and reducing dust emission from the major dust “hot-spots” in the Sahara.

Publication