Aerosol-Cloud Interactions during Extreme Weather

Cheng-Hsiang Chang [1], Farnaz Hosseinpour [1,2], and Eric Wilcox [1,2]

1. University of Nevada, Reno 2. Desert Research Institute, Reno, NV

Correspondence: Cheng-Hsiang Chang (chenghsiangc@nevada.unr.edu)

Overview

This study aims to improve the knowledge of the aerosol-cloud interactions associated with extreme weather. We use remote sensing and reanalysis products to study a dusty event in June 2020. We find that the over-loaded dust suppressed the sensitivity of clouds to aerosols, and the suppression signal moved westward during the outbreak of this exceptional event.

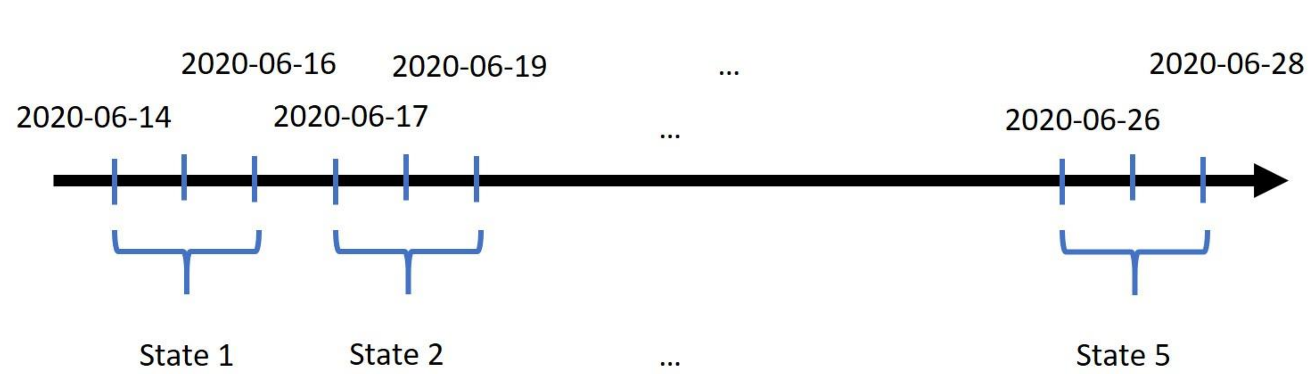
❑ Introduction

This case, dubbed **the "Godzilla" dust plume**, is a record-breaking event carrying exceptional aerosols across the Atlantic Ocean to the United States. This study first focuses on **aerosol-cloud interactions** induced by the "Godzilla" dust plume via NASA satellite and reanalysis products. We find that the westward hot dust might serve as cloud condensation nuclei and heat **the Saharan air layer** (SAL). During the outbreak of this dusty event, the sensitivity of cloud fraction to high-load aerosols would suppress. The assessment may help uncover the role of aerosols in the atmosphere and clouds under **extreme weather events**.

❑ Data and methods

Satellite and reanalysis products. The aerosol optical depth (AOD) and cloud fraction (CF) are given by **MODIS Aqua** (Remer et al., 2005) level 3 daily data. To investigate the atmospheric patterns, we utilize wind and temperature datasets from **MERRA-2** (Gelaro et al., 2017).

Data processing. The time of the dust plume was from June 14th to June 28th, 2020. We divide these fifteen days into five states by composing every three days. To exhibit the anomalies of this extreme dusty event, we set the climatology of June from 2003 to 2019 for comparison. The regions of interest are shown in Figure 1.



❑ Anomalies associated with the "Godzilla" dust plume

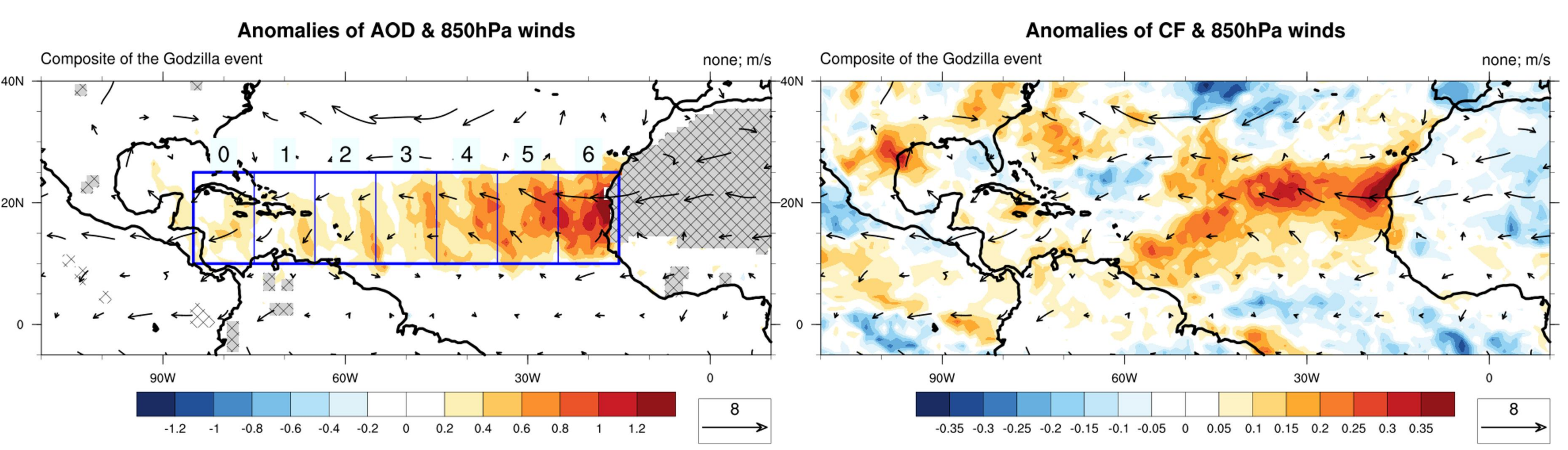
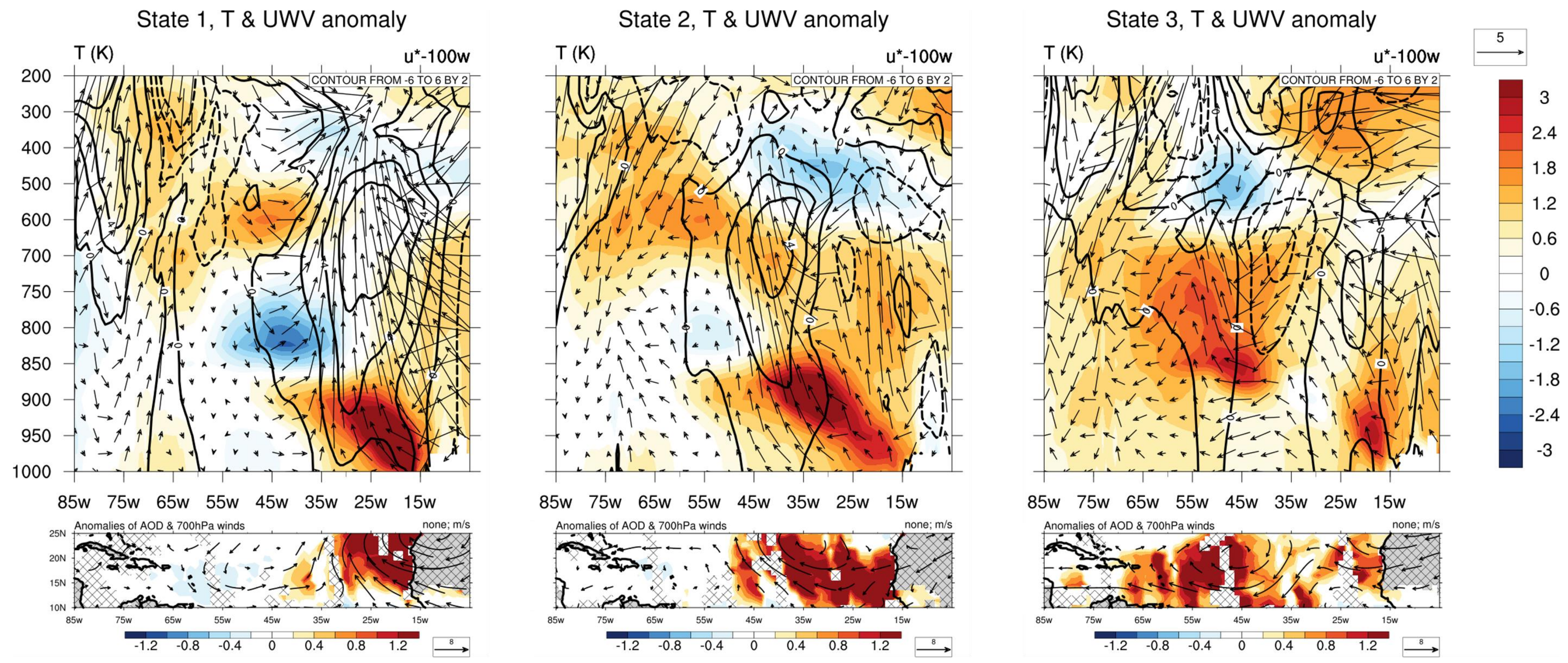


Figure 1. The anomaly of 850hPa winds, AOD (left), and CF (right) during the outbreak of the Godzilla event. The numbers on the left figure represent the regions for investigating aerosol-cloud interactions.

❑ The relationship between dust and the Saharan air layer



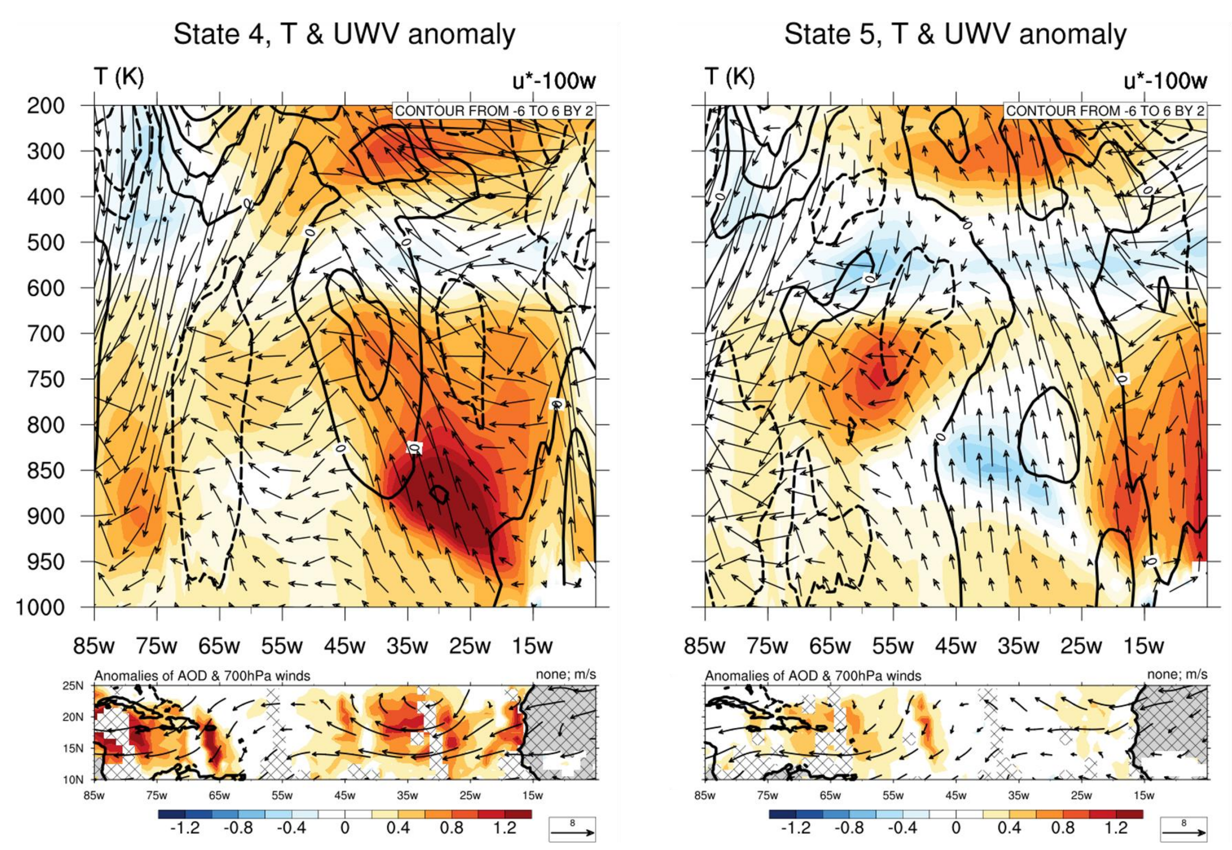


Figure 2. The evolution of AOD, winds, and temperature anomalies. The shadings of the upper figures in each state are temperature anomalies, vectors are anomalies of $u \times -100\omega$, and contours are v-wind anomalies. The lower ones in each state show the anomalies of AOD and 850hPa winds.

❑ The relationship between AOD and CF

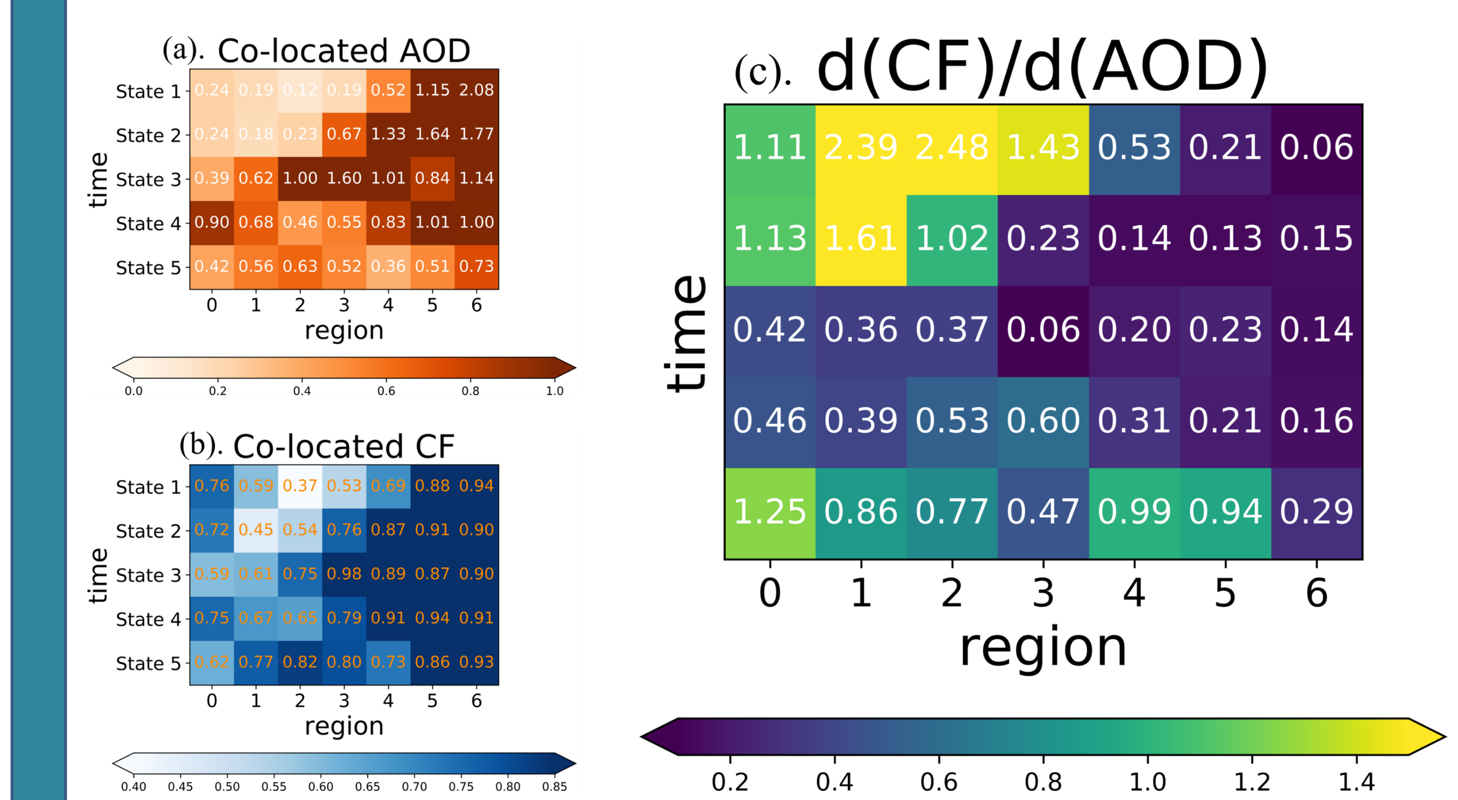


Figure 3. The mean of (a) AOD and (b) CF, as well as (c) the linear regression between CF and AOD after co-located.

❑ Conclusions and future work

- The "Godzilla" dust plume increased the aerosols accumulated over the Atlantic Ocean, and the mineral dust might change cloud properties by acting as cloud condensation nuclei.
- Hot dust facilitated convection development, and the entrainment caused cooling. The whole atmospheric structure moved westward with aerosol anomalies.
- High-load aerosols suppressed the sensitivity of CF. The suppression signal moved westward systematically.

Future work.

1. The cloud height and phase variations
2. The influence of aerosol-cloud interactions on radiation budget and hydrological cycle

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