Impact of Desert Dust and Biomass Burning on the Radiative Budget of the Sahel

Christopher Phillips, Dr. Udaysankar Nair
UAH Department of Atmospheric Science

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Background:

Observations indicate a decrease in the diurnal temperature range (DTR), which is the difference between daily maximum and minimum temperatures, during the latter half of the twentieth century. Numerous studies indicate that increases in precipitation or cloud cover decrease DTR; however, the Sahel region of Africa suffered an extreme drought during this period while still experiencing a decrease in DTR.

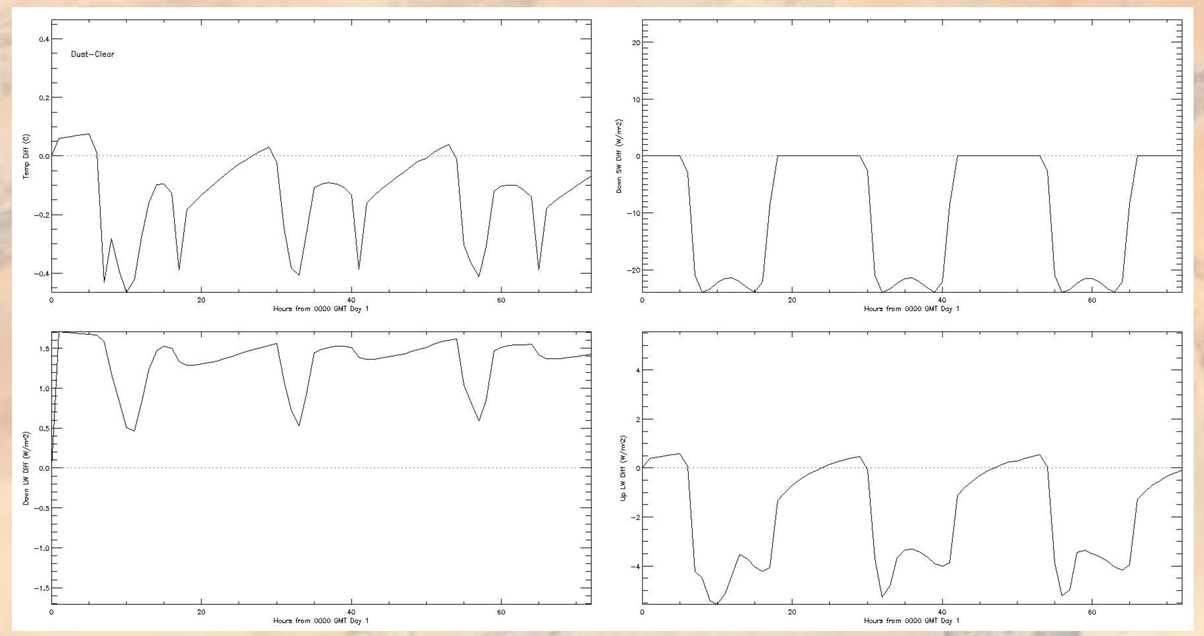

Figure 1 – Mean difference in surface variables for the five case days. Differences are dusty days minus clear days.

Results:

Figure 1 plots the difference between the control runs and the experimental runs for temperature, upwelling radiation, and downwelling radiation. As hypothesized, inclusion of aerosols increases downwelling longwave radiation and increases predawn temperatures.

Figure 2 shows mean differences in standard weather variables as a function of pressure with height. Potential temperature is seen to increase in the middle atmosphere in accordance with aerosol absorption of radiation.

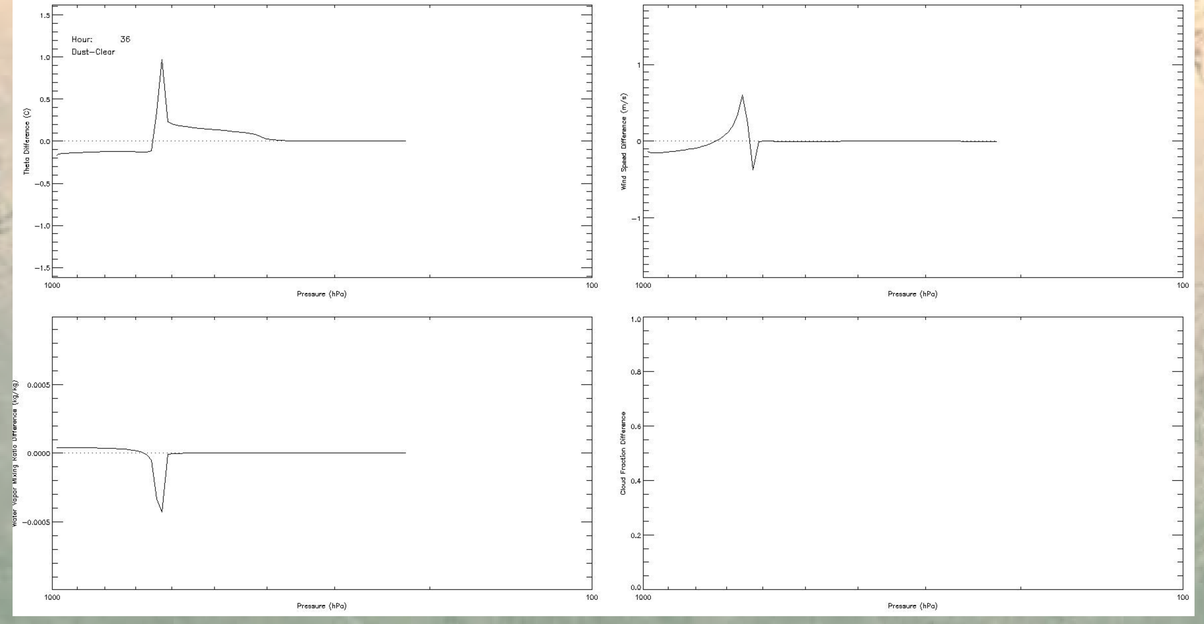

Figure 2 – Mean difference in vertical variables for the five case days at the 36th hour of the model simulation. Differences are dusty days minus clear days.

Project Description:

Hypothesizing that aerosols from desert dust and biomass burning worked to reduce DTR, we utilized a one-dimensional Weather Research and Forecasting (WRF) model to analyze the impacts of aerosols on the region's radiation budget. Aerosol distribution profiles were created from data gathered during the DABEX study in 2006. Five case days provided initial conditions for WRF. The model was then run for both clear and dusty conditions with clear runs functioning as a control group.

Summary:

Working with the WRF model, we modelled five case days from the dry season (Oct-Dec) of the Sahel. Our results demonstrate that atmospheric aerosols are capable of reducing daily maximum temperatures while increasing daily minimums. This project is continuing into Fall of 2014 in order to further quantify the effects of aerosols on the radiation budget. Skills learned during this project include, FORTRAN, IDL, and basic modelling practices. An abstract has been submitted to the 2015 AMS Conference.

Acknowledgements:

I would like to thank Dr. Udaysankar Nair, Dr. Yuling Wu, Dr. Sundar Christopher, and Dr. Bernhard Vogler. This research was supported by funds from the UAH President/Provost's Office, the UAH Vice President of Research, the UAH Atmospheric Science Department, and the Alabama Space Grant Consortium.