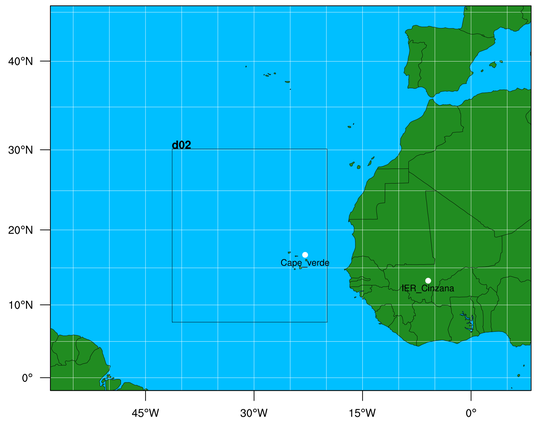
Simulations of the 24-25 August 2013 SAL event

Zhining Tao (zhining.tao@nasa.gov)[1,2], Scott Braun[2], Jainn J. Shi[3,2] and Mian Chin[2]

1. Universities Space Research Association; 2. NASA Goddard Space Flight Center; 3. Morgan State University

The role of Saharan Air Layer (SAL), characterized by an extremely hot, dry and often dust-laden layer of the atmosphere, in tropical storm formation and intensification remains an open scientific question. The Hurricane and Severe Storm Sentinel (HS3) mission is designed to address the question through substantial measurements over three hurricane seasons using two Global Hawks unmanned aircrafts that are equipped with a set of instruments geared toward environmental measurements and understanding of storm inner-core structures and processes. The National Aeronautics and Space Administration (NASA) Unified WRF (NU-WRF) is an observationally driven regional modeling system that represents chemistry, aerosol, cloud, precipitation and land processes at satellite-resolved spatial scales (1-10 km). The NU-WRF has been employed to simulate a SAL event during the HS3 campaign period (August 24 and 25, 2013) to probe the processes associated with dust-layer structure and dust transport in this event. Preliminary results are analyzed and reported in this presentation.

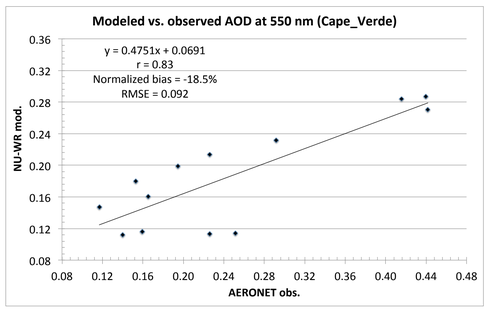
Domain set-up
- Two nested domains with horizontal resolutions at 15 km and 3 km
- 60 vertical layers to 50 mb
- White circles show AERONET sites

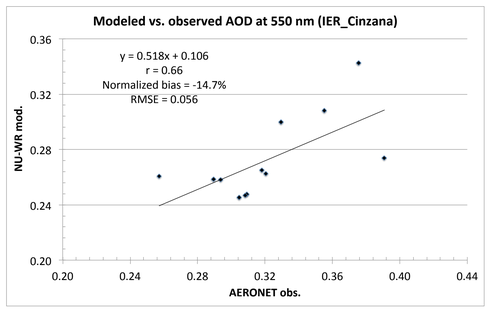


Key NU-WRF set-up
- Goddard GCE microphysics and radiation scheme
- YSU PBL scheme
- new Grell cumulus scheme
- GOCART aerosol scheme

Key input data
- Meteorology LBC: ERA-Interim
- Anthropogenic Emissions: EDGAR
- Biogenic emissions: online MEGAN2
- Aerosol LBC: GEOS5-GOCART
- Biomass burning emissions: FINNv1
- Dust emissions: online GOCART

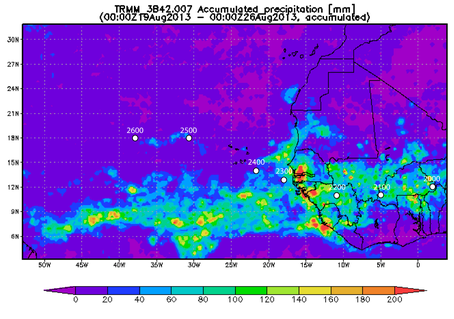
Modeled vs. Observational
- AOD at 550 nm

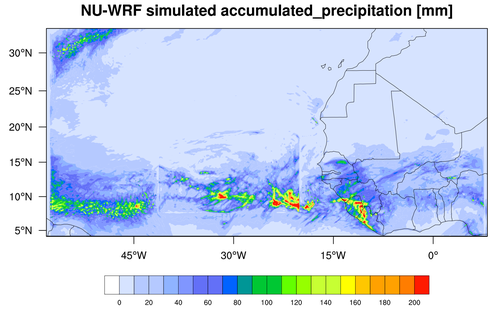




Comparison of hourly AOD at the selected AERONET sites reveals a generally good model performance in AOD simulation with less than 20% normalized bias.

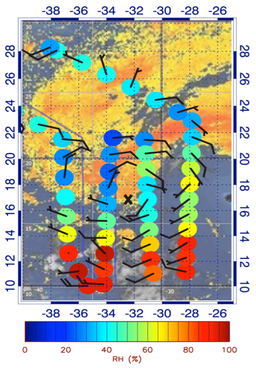
- Precipitation



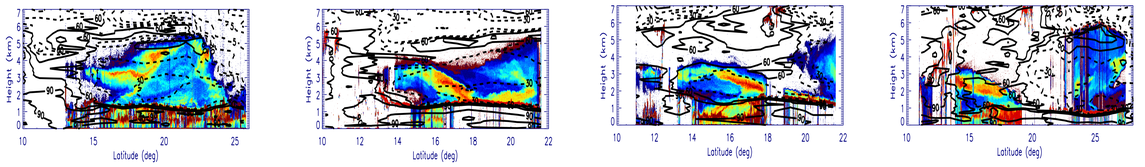


Both TRMM and NU-WRF show a rain belt lying between about 5-10°N (ITCZ). It is dry to the north of the ITCZ. However, NU-WRF misses some heavy rain along the coastal regions of Senegal and Guinea-Bissau while overestimating precipitation over the ocean between 20W and 25W.

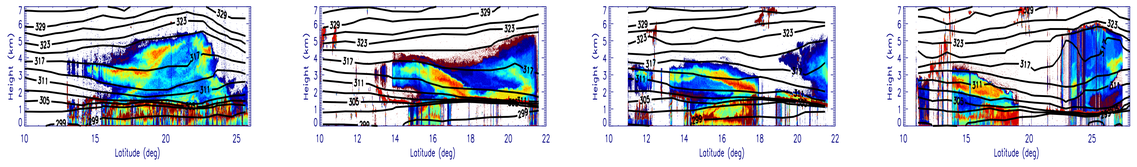
August 24-25 2013 SAL event – Global Hawk view



800 hPa RH (dots) and wave-relative winds collected in 4 flight legs moving from west to east. The background image is the GOES SAL product.

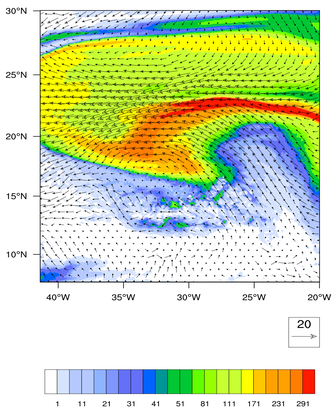


Cross sections (from west to east) of RH (contours) and dust (shaded). Dust laden SAL is about 1-4 km above ground, driest near the base of the layer, and characterized by higher RH near or just above the top of the layer. Very dry air is typically present above the SAL. The dust layer extends southward to 11°N in the east and but only to 13.5°N in the west.

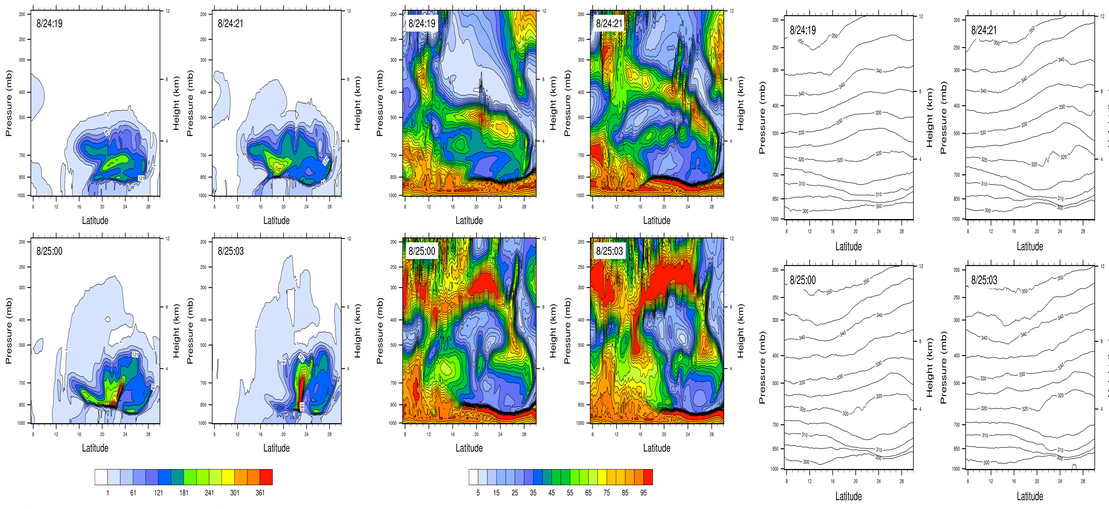


Cross sections (from west to east) of potential temperature (contours) and dust (shaded). At the base of the SAL, the vertical gradient of potential temperature is very large indicating the suppressed vertical motion. Within the dust layer, stability is much weaker than elsewhere.

August 24-25 2013 SAL event – NU-WRF results



800 hPa dust (μg kg^{-3}) and winds over 3 km domain. The zone of high dust coincides with a region of convergence to the NE of the wave.



Cross sections (from west to east corresponding to 8/24:19, 8/24:21, 8:25:00, and 8/25:03) of dust (left, μg kg^{-3}), RH (center, %), and potential temperature (right, K). The dust layer is typically between 850 and 500 hPa with lower RH than the surrounding air and a moist layer near the top. Similar to the observations, very high stability is found at the base of the dust layer, with weaker stability in the dust layer.

Comment and Future Work

NU-WRF generally captures the major features of a SAL event observed on August 24-25, 2013. The 3D structures of the dust layer, RH, and potential temperature compare well to the measurements qualitatively. In the future, more quantitative analysis will be carried out. A series of sensitive experiments, e.g., switching on and off aerosol-cloud-radiation interactions, will be conducted to explore the impact of these processes on dust layer structure.