

Influence of the Saharan Air Layer (SAL) on the Development and Intensity of Atlantic Hurricanes

Christopher Spells

*Department of Atmospheric and Planetary Sciences, Hampton University
Hampton, VA 23668*

The 2008 hurricane season was the 4th busiest year since 1944 and the 3rd most costly season behind the 2004 and 2005 hurricane seasons. This could be related to a weakening of the Saharan air Layer (SAL), a layer of warm, dry, dusty air propagating over the cooler Atlantic Ocean. During the 2008 hurricane season, there were 16 tropical storms, 8 hurricanes, and 5 major hurricanes of category 3 or higher.

In contrast to the 2008 season, the (SAL) has been blamed for the production of fewer North Atlantic hurricanes during the 2006 and 2007 hurricane seasons. The number of tropical storms and hurricanes produced in 2006 (9 named storms) paled in comparison to the historical hurricane season of 2005 (in which there were 28 named storms). The forecast for the 2006 hurricane season called for above average activity (the average is 10 storms per year). Predictions for the 2006 hurricane season called for above average hurricane activity because sea surface temperatures (SST) were above normal, vertical wind shear was low, and sea level pressure was reduced (*Lau and Kim, 2007*). However, the summer of 2006 produced an active SAL season, maybe due to the lack of rain received in the Sahel, or sub-Saharan Desert.

I have continued working with data from the NASA African Monsoon Multidisciplinary Analyses (NAMMA), which gives good data on the humidity, temperature, and wind velocities and wind directions within the SAL. This mission took place in August and September of 2006 in the Cape Verde Islands, approximately 350 miles west of Senegal, which is on the west coast of Africa. Data was taken via a NASA DC-8 which used dropsondes to gather data, along with other instruments onboard the plane and by ground instruments. NAMMA data can be very

helpful with my research because some flights occurred simultaneously with the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) passes over the same area.

There is an extensive set of data of CALIPSO overpasses of SAL outbreaks. The data gathered during the NAMMA mission examine the vertical wind profile in the SAL, whether dust particles from the SAL can act as cloud condensation nuclei (CCN), and developing tropical systems off the west coast of Africa.

In the spring of 2008, I had a great opportunity to conduct research as part of the fourth Aerosol and Ocean Science Expedition (AEROSE IV), a series of Trans-Atlantic research cruises conducted aboard the National Oceanic and Atmospheric Administration's (NOAA) Ship Ronald H. Brown. The goal of the AEROSE missions is to take a collection of atmospheric measurements to study the microphysical and chemical evolution of aerosols propagating from the African continent, especially Saharan dust. In-situ measurements taken on AEROSE missions are compared with satellite data (including CALIPSO) and numerical models. These measurements enable scientist to study the regional atmospheric and oceanographic impacts of aerosols as they travel across the Atlantic.

The AEROSE IV mission began in Montevideo, Uruguay on 27 April 2008 and ended 19 May 2008 in Charleston, South Carolina. The original plan was to set sail from Montevideo on 16 April 2008, sail to 23°W, and take measurements along a transect of the West African coast as Saharan Air Layer (SAL) outbreaks moved over the Atlantic Ocean. We were supposed to disembark in Barbados on 18 May 2008, but due to ship problems, the Ronald H. Brown was ordered to sail straight to its home port of Charleston.

I was responsible for making particulate matter (PM) 2.5 micrometer (μm) and PM 10 measurements. There were four different particle samplers in which I worked with. There were

two, three stage, PM 2.5 samplers which trapped airborne smoke and dust particles. One sampler was used for chemical analysis, while the other was used for biological analysis. There was also a Cyclone Impactor which sampled PM 10, and an automated PM 10 bulk sequential sampler which was capable of measuring temperature and humidity while sampling and could sample for different durations (for our purpose 12 or 24 hours).

Aside from being responsible for the particulate samplers, I was also responsible for a daily weather forecast which focused on frontal passages, aerosol transport, and wind directions at different altitudes of the troposphere. I also participated in radiosonde and ozonesonde launches, which provided in-situ measurements of temperature, humidity, pressure, and ozone concentration (ozonesonde), as well as taking aerosol and ozone sun photometer measurements.

I planned on using the data taken on the initial AEROSE IV track to study the chemical, physical, and radiative properties of the SAL, and how those properties change as the SAL traverses the Atlantic Ocean. I anticipated using satellite data validated with in-situ measurements from radiosondes and PM 2.5 and PM 10 to study the aforementioned properties during the evolution of the SAL as we intercepted outbreaks. More specifically, I intended to use this data to draw more concrete relationships between SAL interactions with Atlantic tropical cyclones, and how the SAL might affect tropical cyclone formation and intensities

During the modified AEROSE mission, we did not intercept any new SAL outbreaks because we did not sail past 28°W, nevertheless, we did get background information of aerosols and ozone over the Western Atlantic. This was the first time that an abundant amount of measurements were taken in the Western Atlantic Ocean during an AEROSE mission. When I get access to the data, I will be able to use it as background information for my PhD dissertation when there are little to no atmospheric dust outbreaks over the Western Atlantic. Also, satellite

and in-situ data from the AEROSE IV campaign will be compared to data over the same region in which atmospheric dust is abundant in the middle atmosphere.

I want to utilize the experience on the NOAA Ship Ron H. Brown in my dissertation to discuss my use of hands on research to gather data. Through my experience I will discuss the methods and instrumentation utilized for in-situ measurements of aerosols and trace gases at the surface in my dissertation.

Reference

Lau, W.K.M., and J.M. Kim (2007), How nature foiled the 2006 hurricane forecasts, *Eos Trans. AGU*, **88**(9), 105-107