99 AEROSOL DYNAMICS AND THEIR CONTRIBUTION TO HURRICANE SANDY

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Aerosols contribution to the formation, invigoration, and weakening of hurricanes has been investigated to some extent, but more research is still needed for a better understanding of their full role with regards to tropical cyclones. While many models and observations point to a general weakening affect, the ability for aerosols to invigorate a hurricane in some non-trivial capacity has also been observed. Aerosols have been known to enhance cloud formation, cloud lifetime, and overall precipitation in appropriate quantities, and some can enhance upward convection and deep cloud formation. Mineral dust, which makes up the sands of the Sahara, are lighter in shade, coarse in features and size, and are partially insoluble, making them capable of being both cloud condensation nuclei and ice nuclei. This makes dust aerosols decently well suited for invigorating cloud and hurricane dynamics when in appropriate quantities.

Hurricane Sandy has been identified as a hurricane that had additional dust aerosols supplied to its system via dust transport from a Saharan Dust event in an amount that is significant but not overloading, making it perfect to analyze for signs of invigoration/enhancement from aerosols. This is confirmed by monitoring a massive dust plume blowing off the western coast of Africa towards the Atlantic on October 8th, 2012 right before the development of Hurricane Sandy and along the path of Invest 99L. The dust storm (or possible rapid chain of dust storms) acted for four days, with its dust trailing into the central Atlantic and into the southern Caribbean Sea. Significant amounts of Saharan dust will stay together in a stable system (which can create the effect known as the Saharan Air Layer) which normally is detrimental to tropical cyclone formation. However, this air layer breaks down and disperses its dust when reaching the Caribbean. HYSPLIT backpropagation shows that the dust in the Caribbean in the days of and before the forming of tropical storm Sandy had origins from this dust storm in the Mauritania region. This makes us believe that dust aerosols capable of enhancing hurricane characteristics played a non-trivial role in the genesis process of Sandy.

Many hurricane parameters are examined and evaluated, with an emphasis put on vertical profiles for temperature and aerosol distribution, although other factors such as humidity and wind shear are also considered and examined due to their importance. MODIS AQUA and TERRA, along with MISR, CALIPSO, and HYSPLIT, among other sources, are used for data gathering. Marine areas around the point of genesis for hurricane Sandy, as well as the route that both Invest 99L and the dust from the Saharan dust event were examined, with emphasis placed on the Caribbean. While the exact extent of the effects of aerosols is beyond the scope of this work due to the presence of un-quantified systems such as the aerosol indirect effect on heating, there is strong evidence that sand from a Saharan dust storm event prior to hurricane formation was ingested into Hurricane Sandy which may have aided the cloud formation and upward convection necessary to a hurricane's genesis and growth. Increased AOD observed by the Moderate Resolution Imaging Spectrometer (MODIS), followed by increased precipitation and a decrease in cloud top temperature was observed. CALIPSO vertical profiles showed the appearance of the suspended dust particles at 3-5 km after the dust storm, as well as significant traces of the dust in higher altitude, deep column clouds in the outer bands of Sandy as it was strengthening into a hurricane (see figure 1 for CALIPSO profiles).

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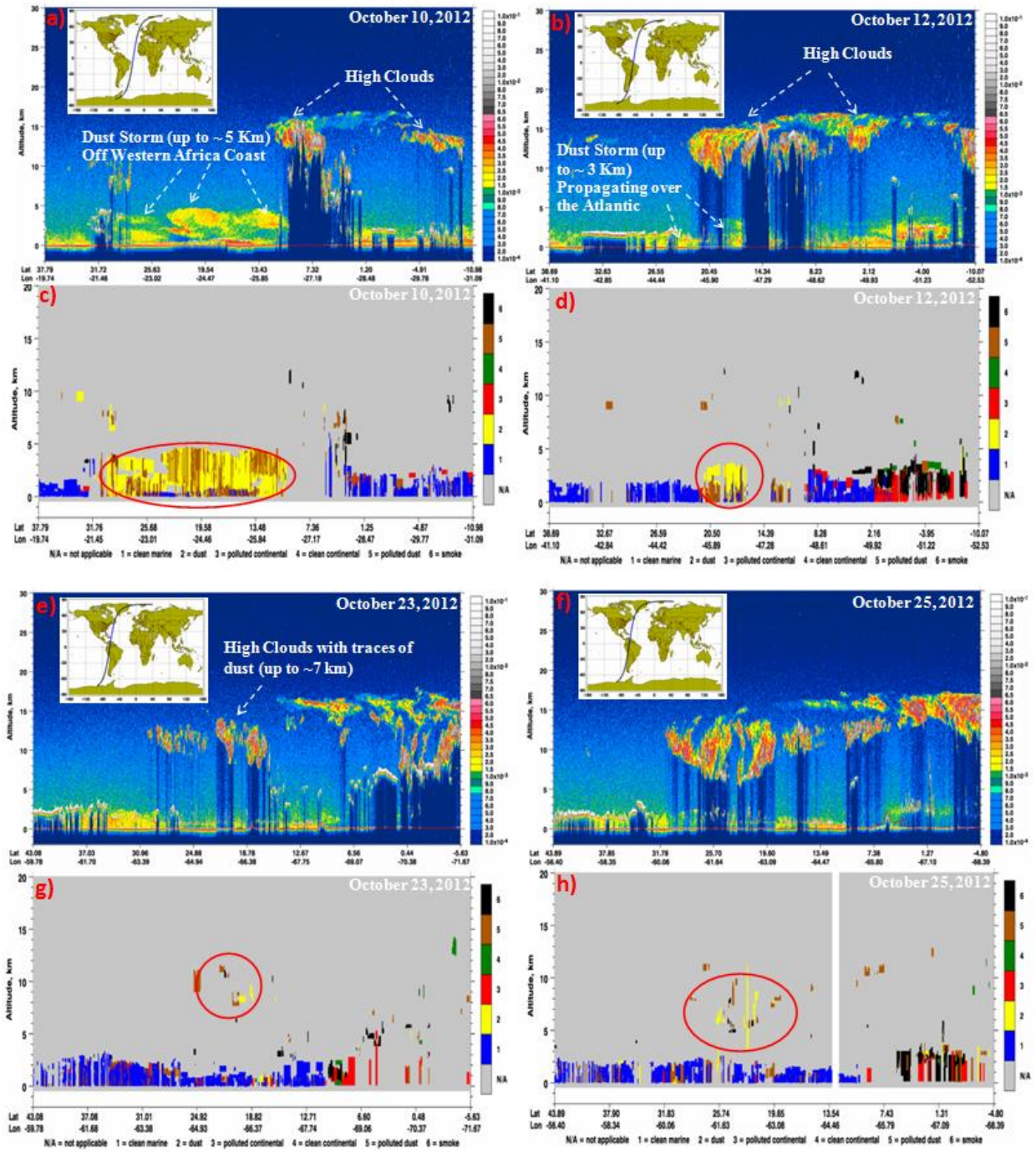

Figure 1.) CALIPSO night-time passes for October 10th, 12th, 23rd and 25th. The 10th and 12th Overpasses monitor the dust from the Saharan as it transports across the Atlantic in a stable, lower altitude layer. The 23rd and 25th monitor an area close enough to Hurricane Sandy to feed its outer bands. Large amounts of dust have dropped off, but a significant portion has been lifted into vertical-oriented clouds.