Microphysical Observations during PREDICT

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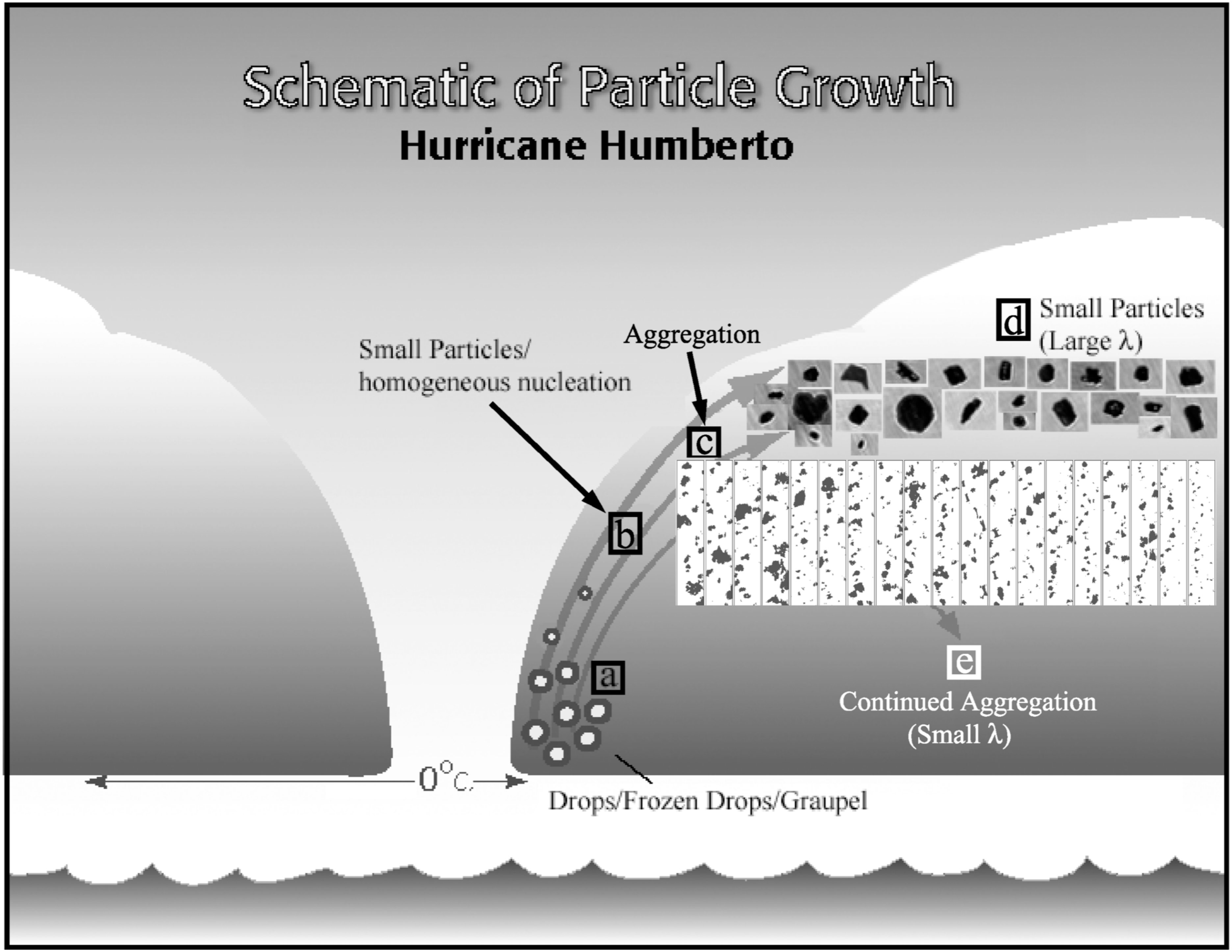
NCAR/MMM

Instrumentation

- SID-2 (1-60 microns with shape)
- 2 FAST 2D probes (10, 25 microns-2 + mm)
- 3D CPI
- CVI
- Aerosols

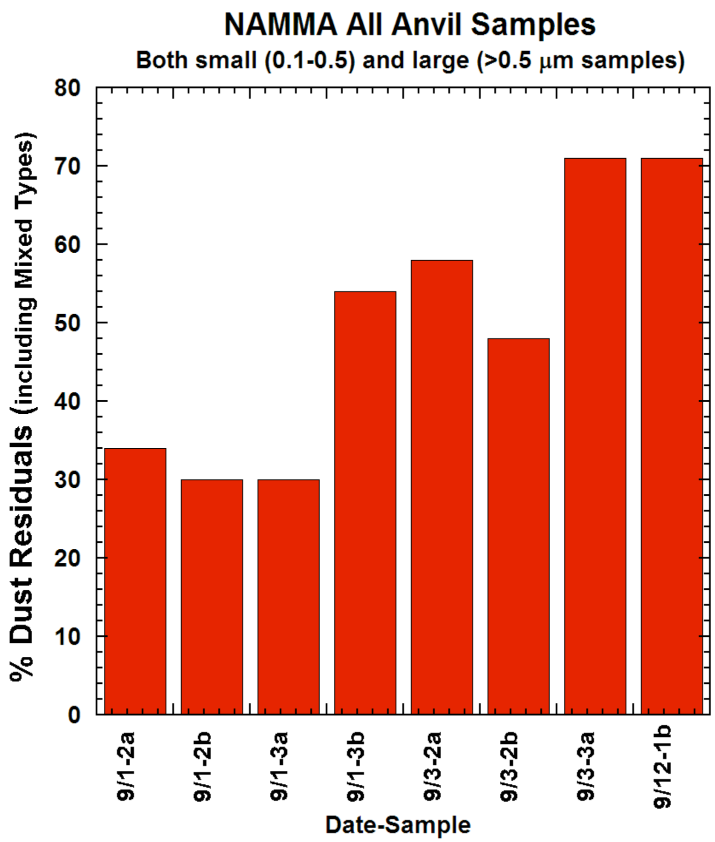
Objectives

- Is there evidence for homogeneous nucleation in the updrafts (implying liquid water to low temperatures)?
- What is the predominant shapes of ice particles lofted into the anvils of developing Atlantic storms?
- Can we detect the influence of dust on ice production in the updrafts?

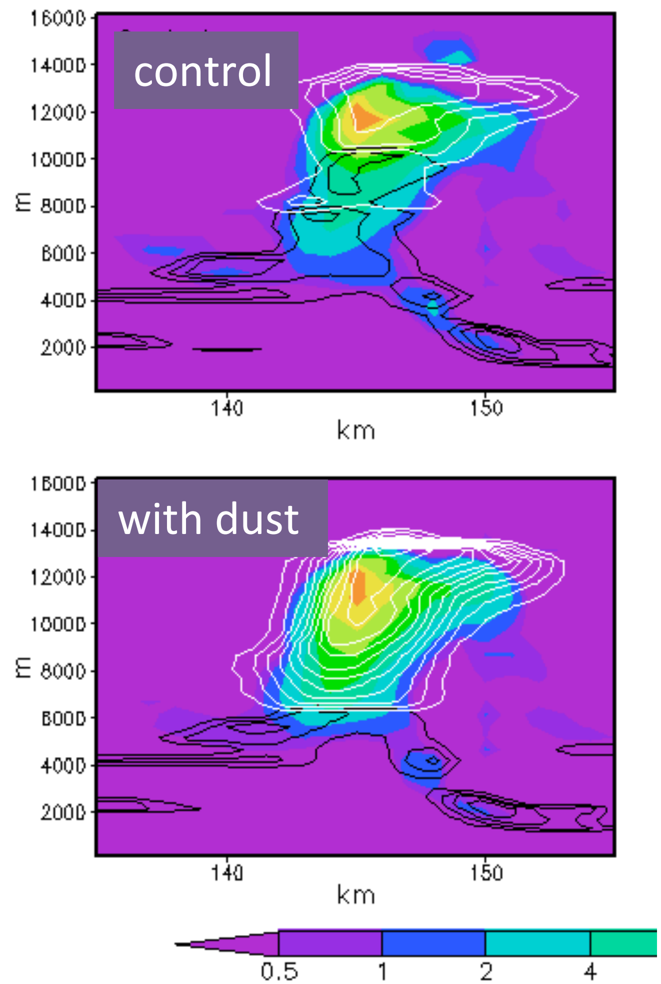


Schematic of Particle Growth
Hurricane Humberto
Small Particles/
homogeneous nucleation
Aggregation
d
Small Particles
(Large λ)
c
b
a
e
Continued Aggregation
(Small λ)
0°C
Drops/Frozen Drops/Graupel

What is impact of Saharan Dust on Deep Convection?



RAMS simulations show dust substantially changes cloud microphysical properties (collaboration w/ Sue van Den Heever, CSU). Propose to use CVI to not only sample ice water content, but dust content in PREDICT cirrus anvils.



In NAMMA in Eastern Atlantic, ALL anvil cirrus sampled contained Saharan dust within ice crystals. Dust also shown to act effectively as cloud condensation nuclei (Twohy et al., 2009). If only a fraction of this dust reaches the Caribbean, could enhance natural background of (low) CCN and IN.

Twohy and van Den Heever NSF Proposal Project Summary

The effects of mineral dust on organized convective systems over the Atlantic will be investigated. This research extends naturally from the airborne measurements of dust and clouds made during the NAMMA (NASA African Monsoon Multidisciplinary Activities) field experiment. Preliminary, simple simulations using measured inputs obtained from the NAMMA field campaign show significant potential impacts of dust particles on cloud microphysics, particularly on the ice phase processes. We will use RAMS (Regional Atmospheric Modeling System), a regional, cloud-resolving model developed at Colorado State University and further improved by this work, to perform additional idealized simulations. The lifecycle of an actual storm (Tropical Storm Debby) influenced by Saharan dust in the eastern Atlantic will also be simulated in detail. Through this work, the integrated effects of dust as cloud condensation nuclei and ice nuclei will be investigated. The dynamical and radiative impacts of the Saharan Air Layer, which contains the dust, would also be studied. The results from these simulations would be compared with the data obtained during the field campaign to assess the relative importance of dust as cloud condensation nuclei and ice nuclei on storm development and precipitation efficiency. Additionally, the relative importance of aerosol direct effects, aerosol indirect effects and the environmental characteristics (humidity, temperature, wind shear) of the SAL layer itself will also be assessed. Data related to aged dust impacts would be obtained by participation in a field program focused on tropical cyclones in the mid and western Atlantic. The project teams a researcher with in-depth knowledge of regional cloud modeling with an instrument flight scientist with years of experience analyzing and interpreting aircraft data.

Broader impacts include field experience and training aboard the NSF Gulfstream research aircraft for a graduate student who will be supported by this project. Aspects of this research will also be incorporated into graduate classes on mesoscale meteorology and cloud microphysics taught by one of the PIs at Colorado State University, and in the training of students to use mesoscale models. While the project focuses on simulations using a regional model, our new parameterization scheme of ice nucleation could be adjusted for use in other regional and global climate models. Improving our knowledge of aerosol forcing on both microphysical and mesoscale processes contributes to our understanding of the global climate change problem. Detailed assessment of the impacts of the SAL and the dust within it on convective systems downwind of the west coast of Africa may also contribute to our understanding of the initial stages of hurricane development.