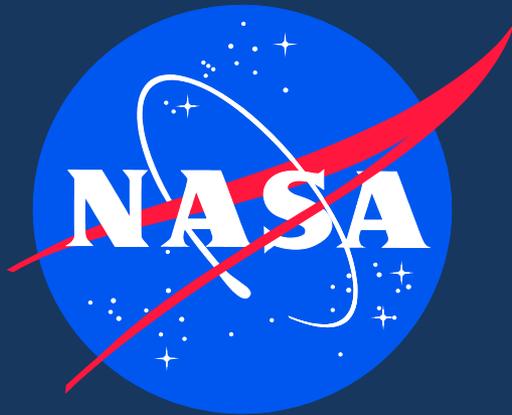


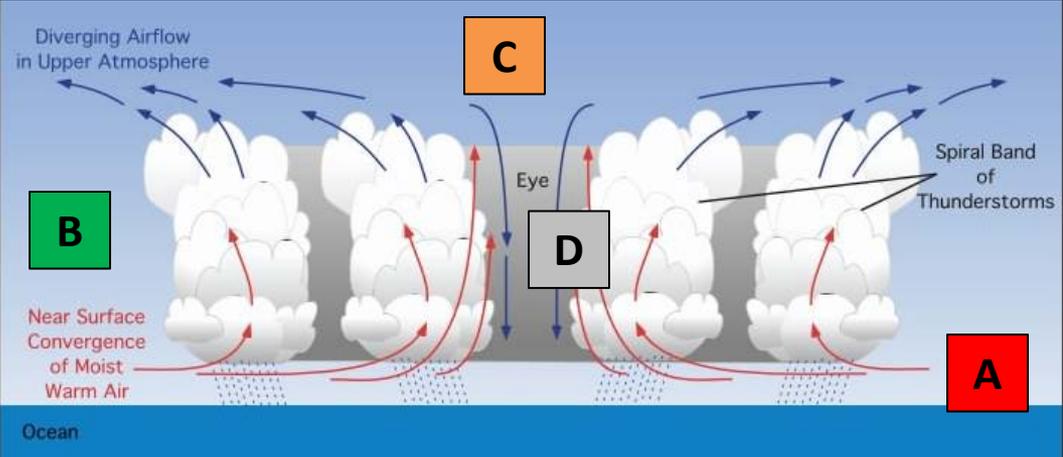
Aerosol Characteristics in the Vicinity of Hurricanes during NASA GRIP



S. Crumeyrolle

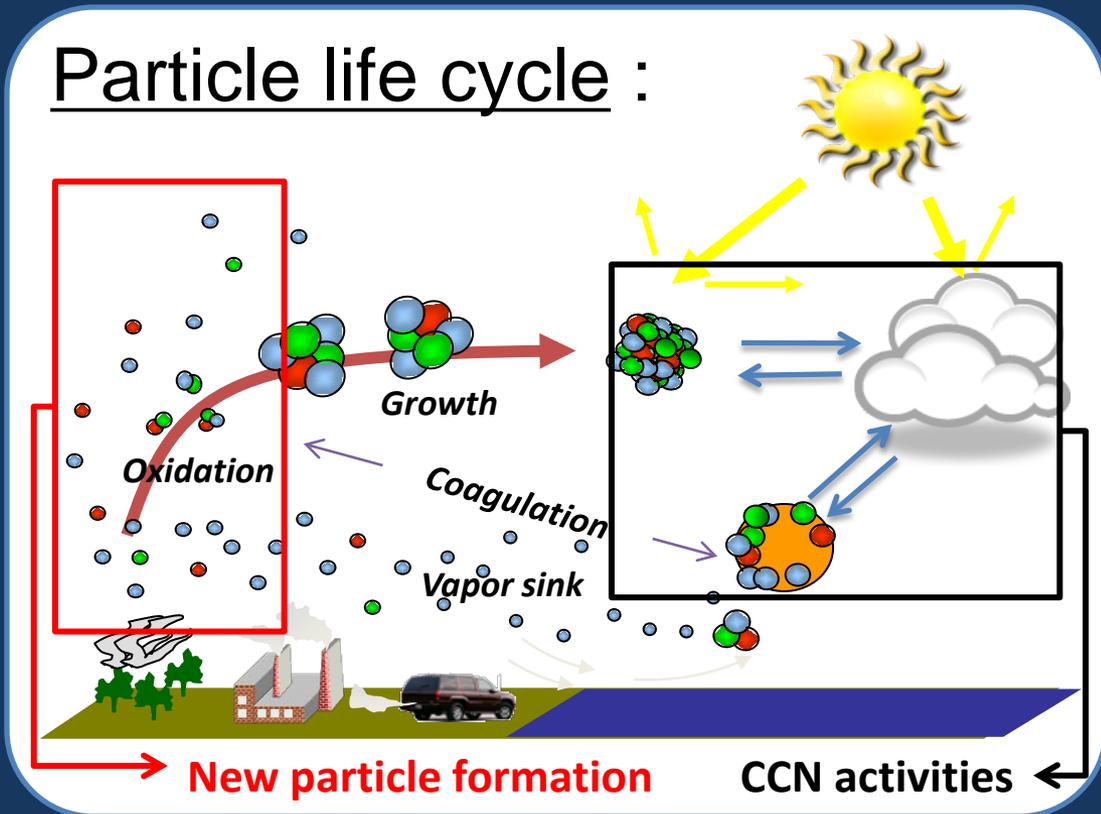
L.D. Ziemba, B.E. Anderson, A.J. Beyersdorf, K.L. Thornhill, E.L.
Winstead, N. DeLeon-Rodriguez, T. Lathem, M. Bergin, T.
Nenes, K. Konstantinidis, J.E. Dibb, C. Corr

Introduction



1. Characterize sources of aerosol available to hurricanes:

- A. MBL
- B. Pollution + Dust
- C. Upper Troposphere
- D. Storm/Aqueous Processing

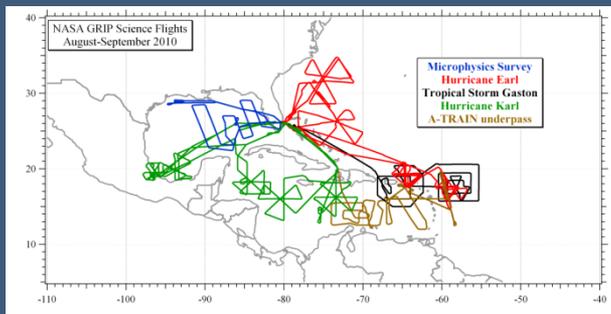
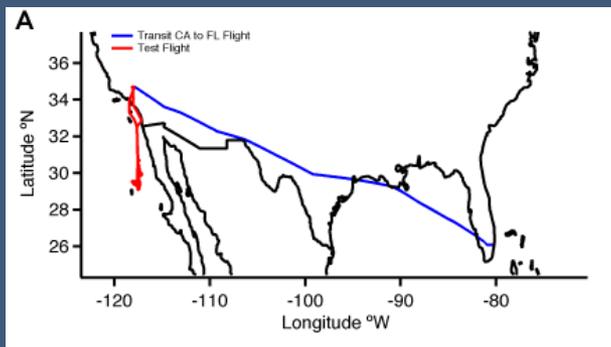


LARGE Measurements during GRIP

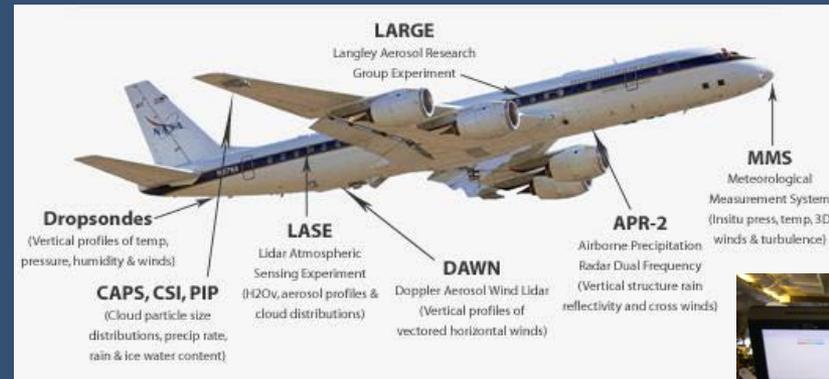
GRIP Flights

9 flights in total :

- generally 10Km height
- 2 hurricanes



LARGE Instrumentation

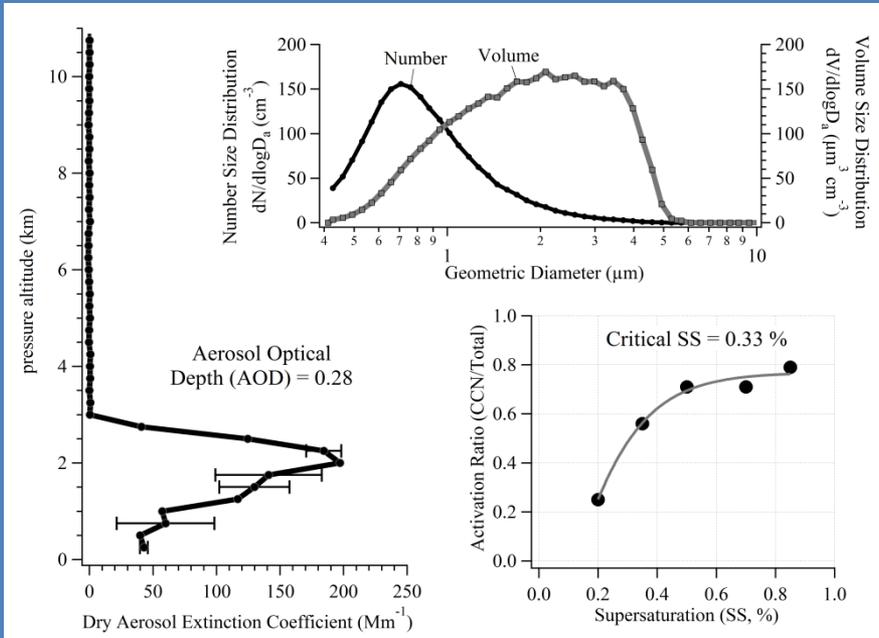


- **Aerosol Concentrations:**
 - Total and Non-Volatile
 - CCN spectra
- **Aerosol Sizes (10 nm -5 μ m):**
- **Optical Properties:**
 - Scattering & Absorption Coefficients (Extinction)
 - Single Scattering Albedo
 - Scat. Angstrom Exponent (aerosol size)
- **Chemical Composition**
 - filter collection and analyses for ionic content and biologic materials

Measurements are
in-situ!

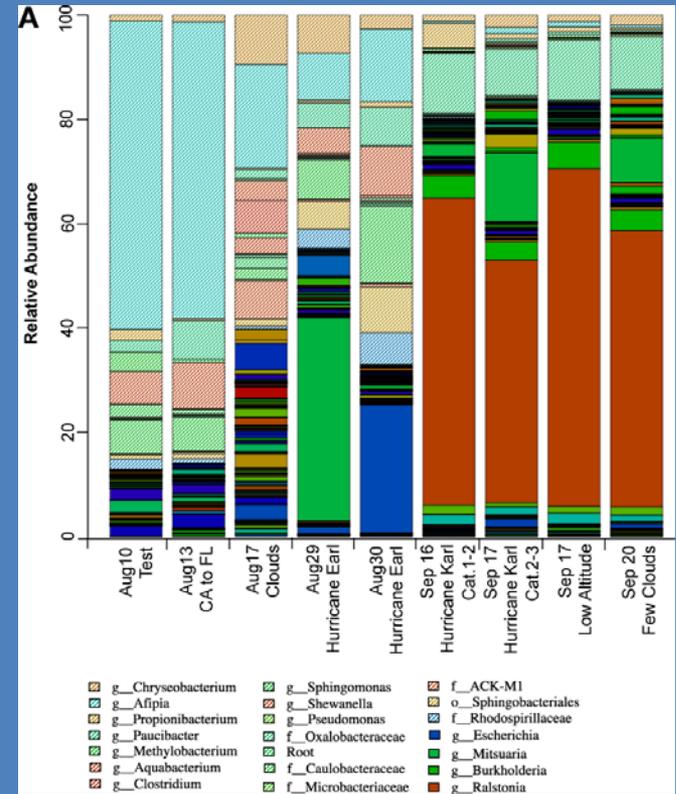
LARGE Analyses

1 Dust Characterization for Pre-Matthew



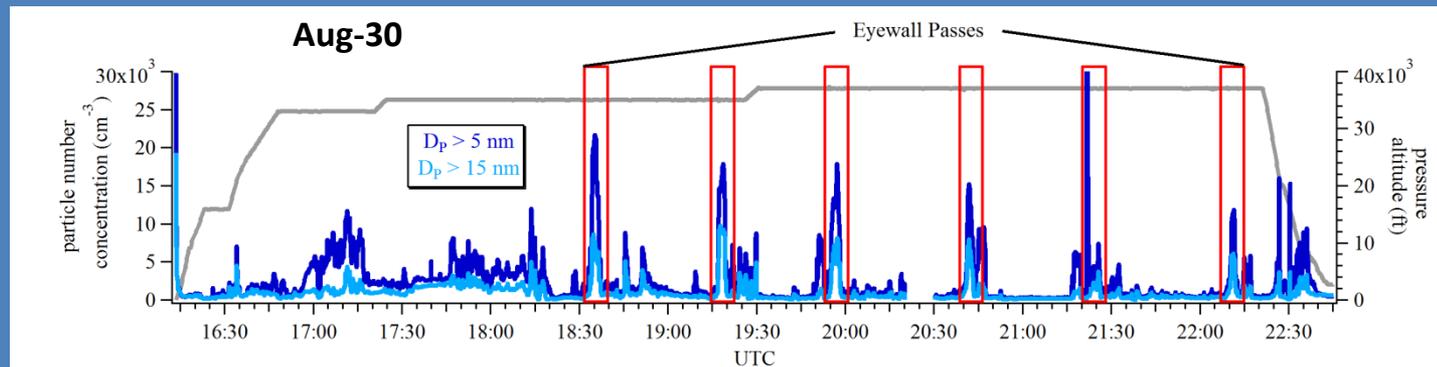
3

Bio-Materials Analyses



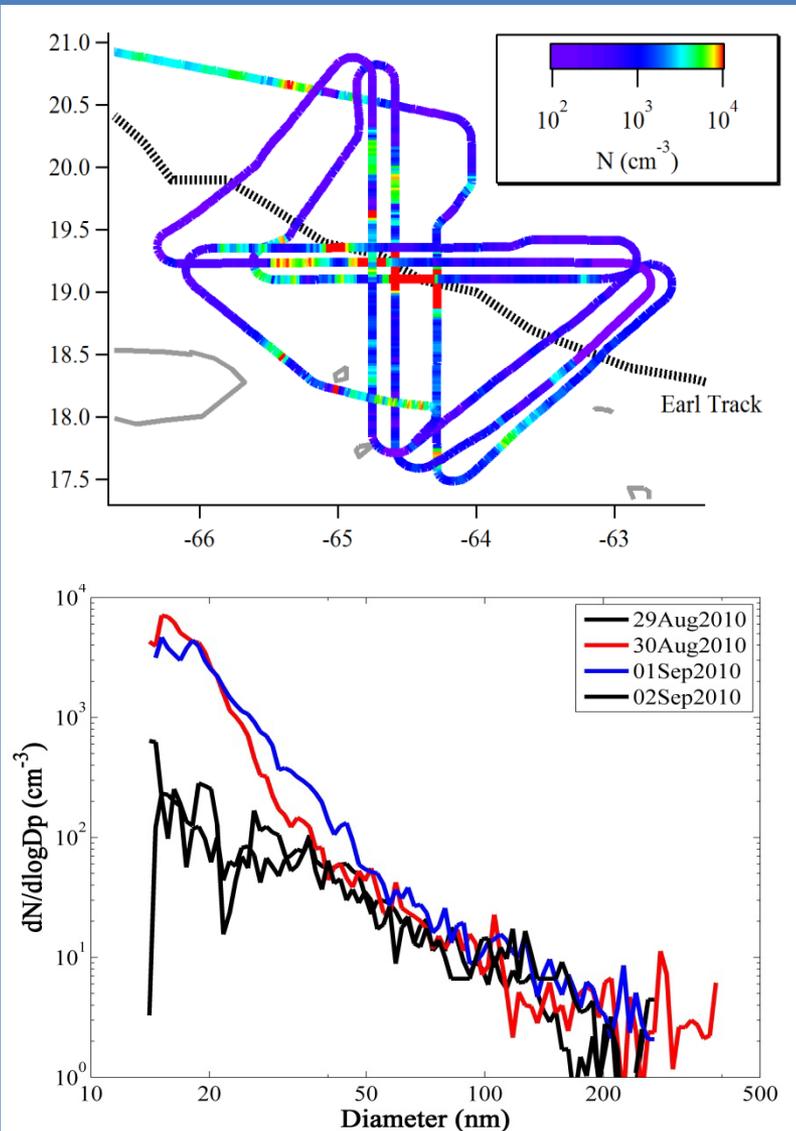
2

New Particle Formation in the Eye of Hurricane Earl



New Particle Formation (NPF): First Observations

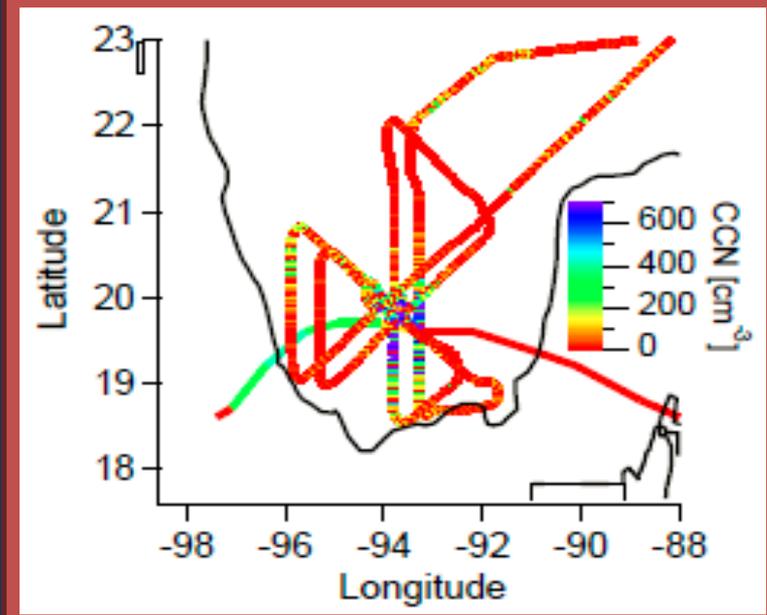
DC8 ~ 10km (LARGE)



- Nucleation events :
 - located in the eye of the hurricane (Earl)
 - 9 periods : 5 on the 30th August
4 on the 1st September
 - Earl stage : C2-4 the 30th August
C3-4 the 1st September

*What could cause these events ?
Are DC8 and P3 observations related?*

P3 ~ 2-3km (GIT)



Support for gas-to-particle conversion??

OMI → column integrated SO_2
- precursor to H_2SO_4
and new particles

results inconclusive
(aqueous processing?)

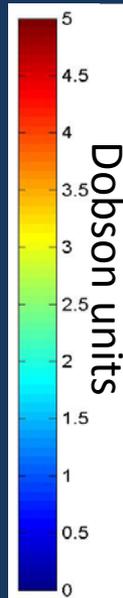
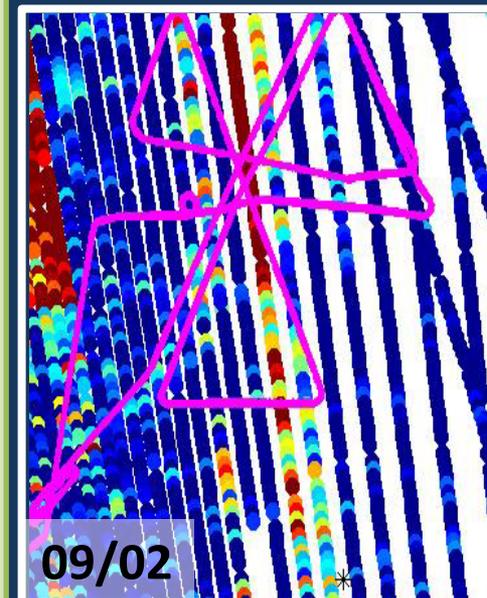
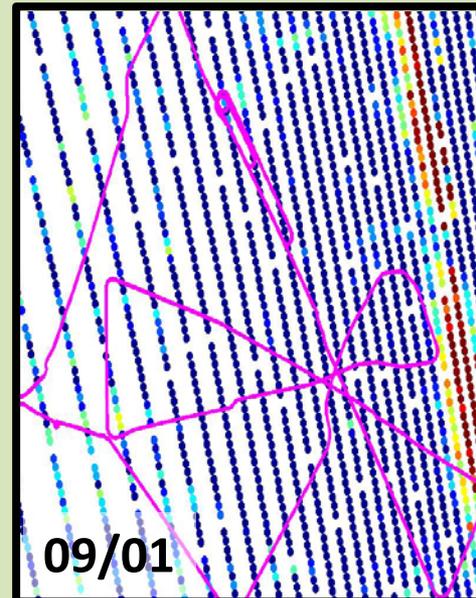
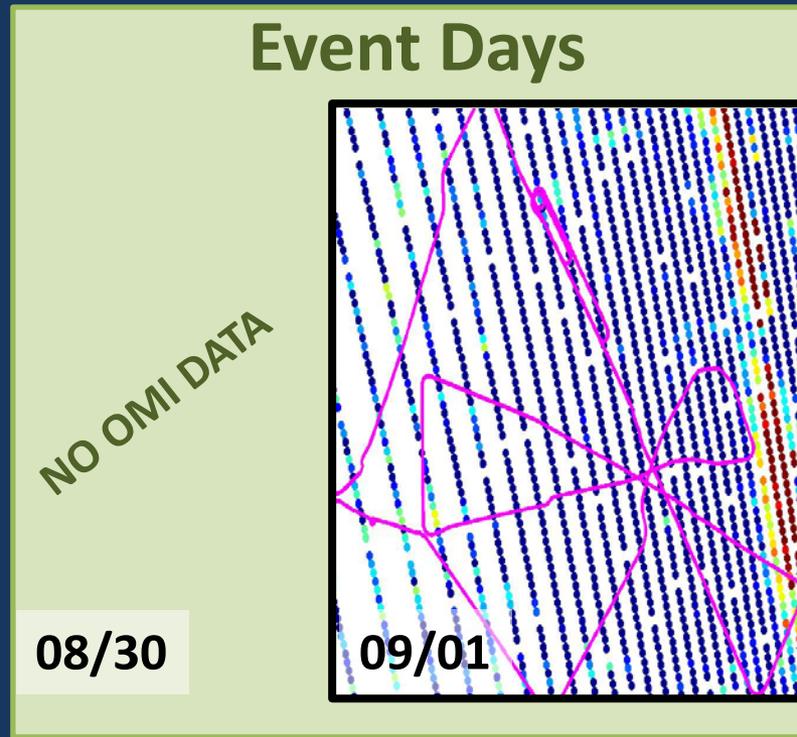
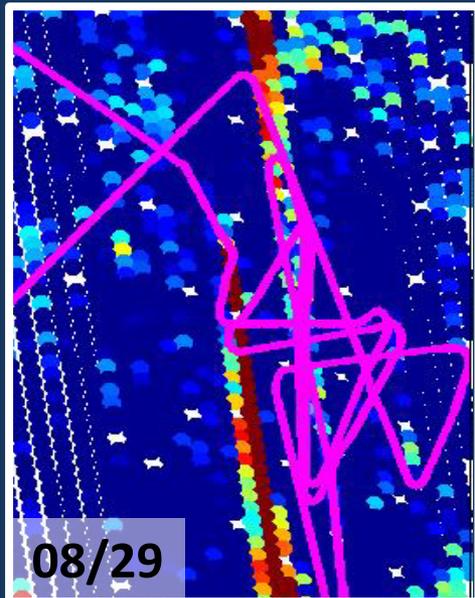
Positive impacts

Increased Precursors concentration
Decreased Temperature

Negative impacts

Pre-existing particle concentration

Event Days



Are the CCN and Nucleation Events Related ?

Assume: Particles are formed at 10km and are transported down the eye-column

GR = 35nm/h is the maximum observed on Earth

Gas



N_{3-10}

Vertical wind speed observed by the DC-8

Estimation of the maximum diameter increase (ΔD_p)



$$\Delta D_p = GR * W * \Delta \text{Altitude}$$

Date (yyyymmdd)	20100830	20100901
Median W (m/s)	-0.9	-1.2
Time (h)	2.5	1.7
Distance between P3 and DC8 (km)	8.1	7.6
ΔD_p (nm)	0 → 87	0 → 60

Activation diameter for pure H_2SO_4 particles

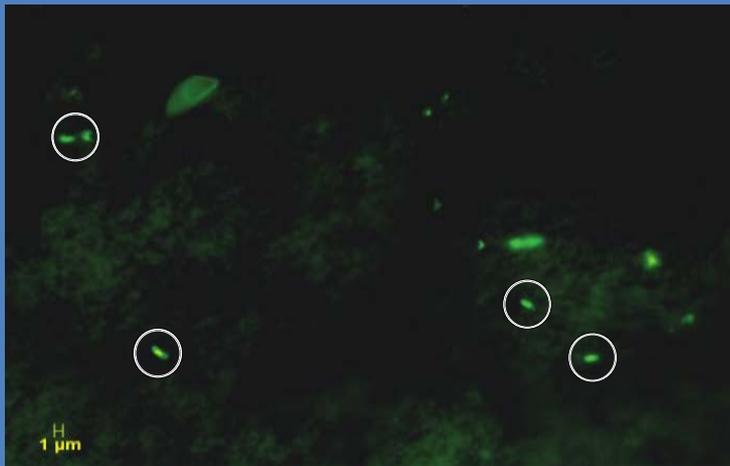
SS (%)	Diameter
0.3	55
0.6	35

Growth of freshly-formed particles to CCN between the P3 and DC8 is possible

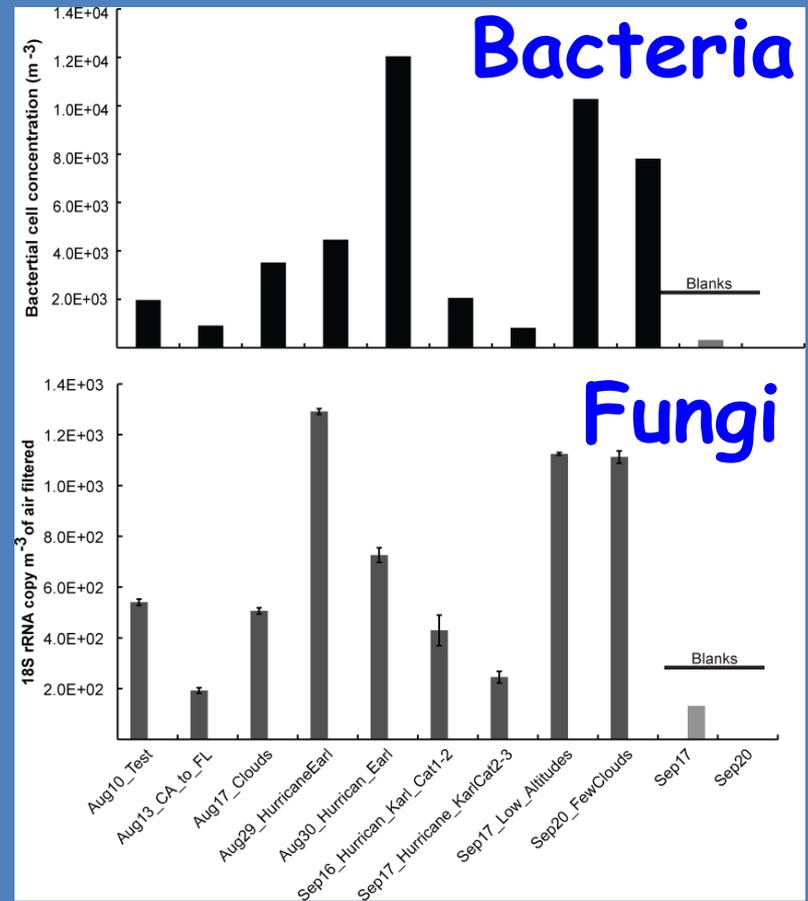
Bio – aerosol Measurements

- Bio-aerosols can be very effective CCN and IN
- Organisms have known sources
- Analyses aim both to quantify organisms and group them into 'families'

> 60% of cells intact/alive



qPCR microscopy



1-13% of particles (>0.5μm)
contain biological material!

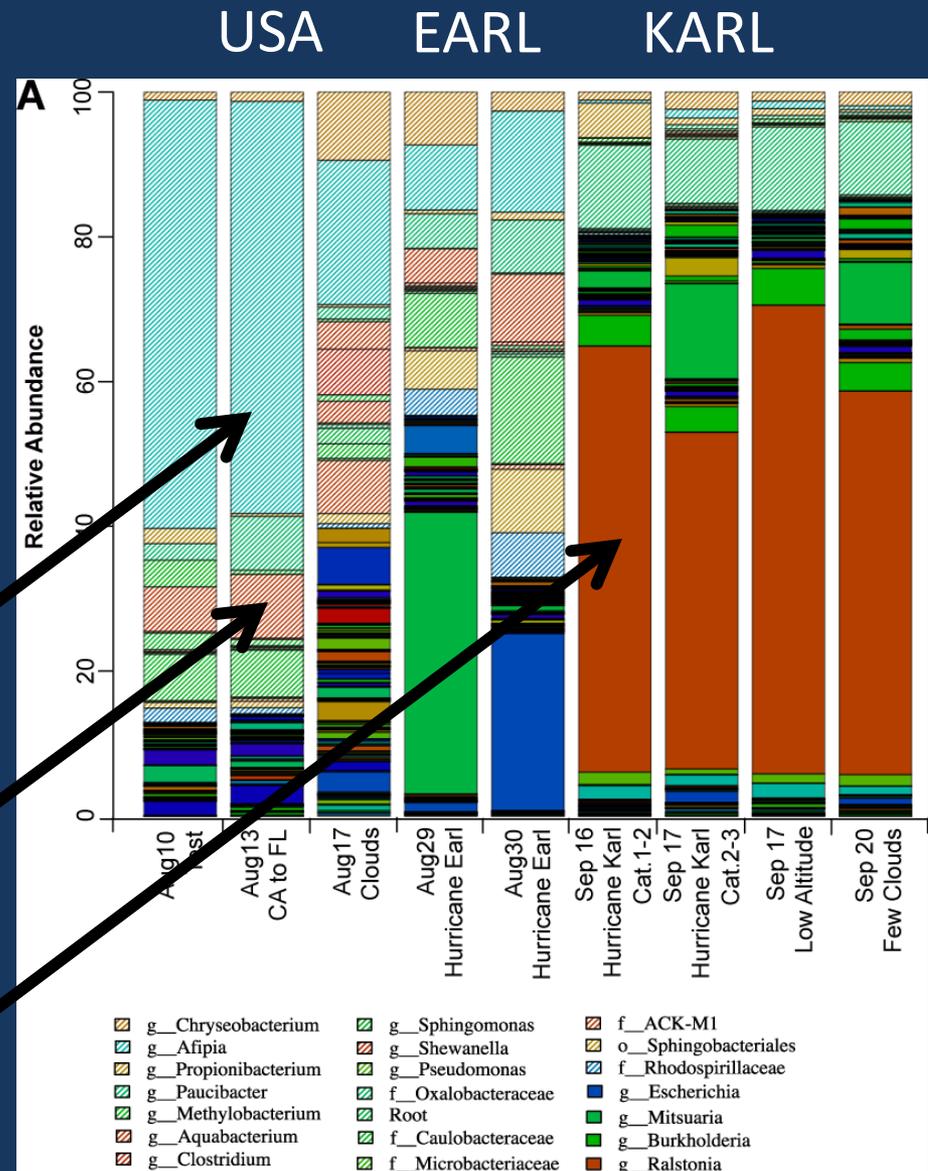
The Microbiome of the Troposphere

- Different hurricanes showed dramatically different microbiome
- 17 OTUs are found in all samples
- Microbial cells stay aloft (and alive!) for long times

Afipia
(uses DMSO)

Oxalobacteria
(oxalate oxidizers)

Burkholderia
(uses C1/C2)



Conclusions

- 1. Dust aerosol was only encountered during low-level legs of Pre-Matthew in conjunction with CALIPSO underpass**
 - CCN closure studies are ongoing
- 2. Unique new particle formation was observed**
 - Gas-to-particle conversion mechanism is inconclusive, may indicate importance of aqueous processing
 - Growth during eye-subsidence may explain high CCN concentrations at lower levels
 - Fate of newly formed particles requires modeling effort → feedback
- 3. Bio-aerosol analyses showed potential:**
 - Use as a source apportionment tool
 - Effects on overall CCN/IN activity due to 'high' concentrations
 - Laboratory testing aims to specifically quantify the efficiency of bacterial groups to act as CCN/IN

Aerosols ↔ **Hurricanes**
effects

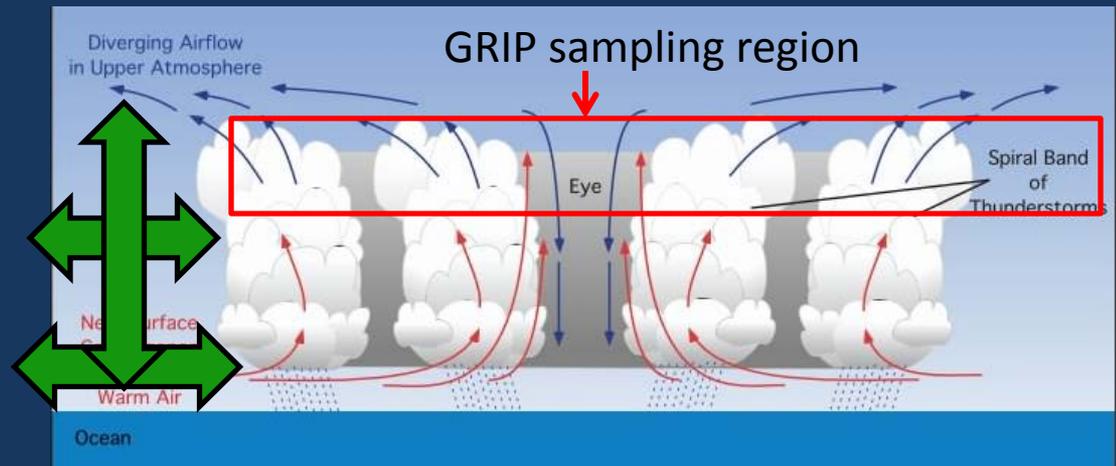
Follow-on Activities

1. Use of a dedicated in-situ aircraft may be necessary for better characterization of input aerosols:

- Characterization of aerosols at the periphery of storm
- Vertical profiles to determine altitude-dependence of transported aerosol
- MBL sampling to determine influence of wind speeds on sea-salt injection
- More extensive, fast-response chemical composition for dust ID

2. Measurements of gas-phase species would greatly improve our ability to assess:

- Airmass source regions
- Nucleation tendency



Acknowledgments

People

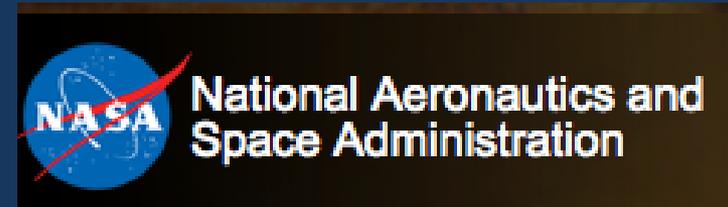
Anderson group @ NASA LaRC

Kostas group @ Georgia Tech

Nenes group @ GaTech

Dibb group @ GaTech

Funding

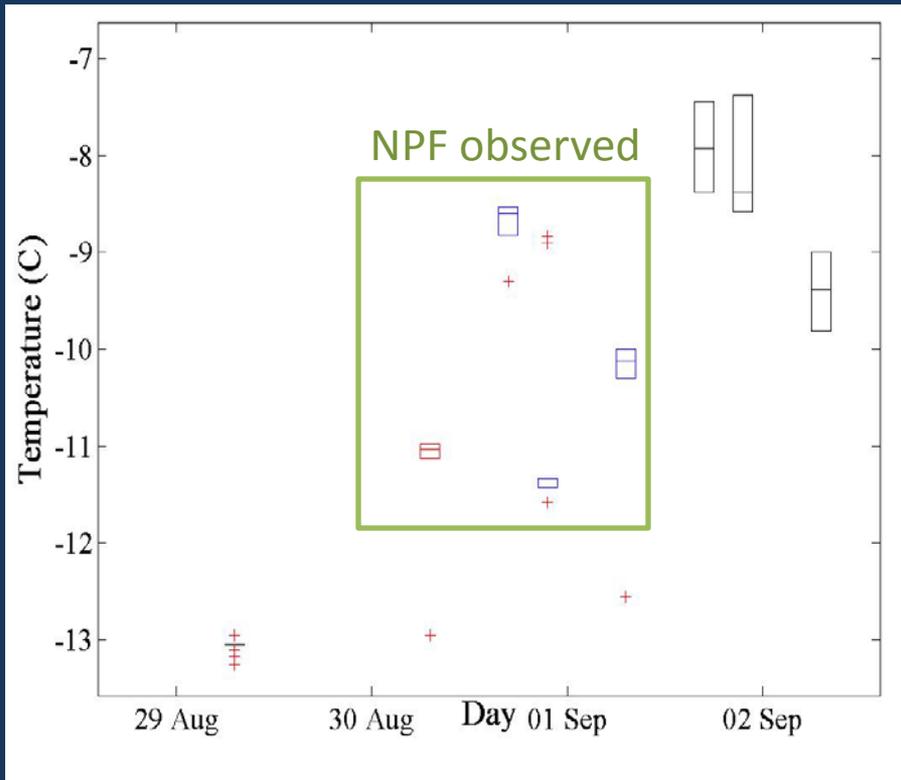


Which factors might influence NPF events ?

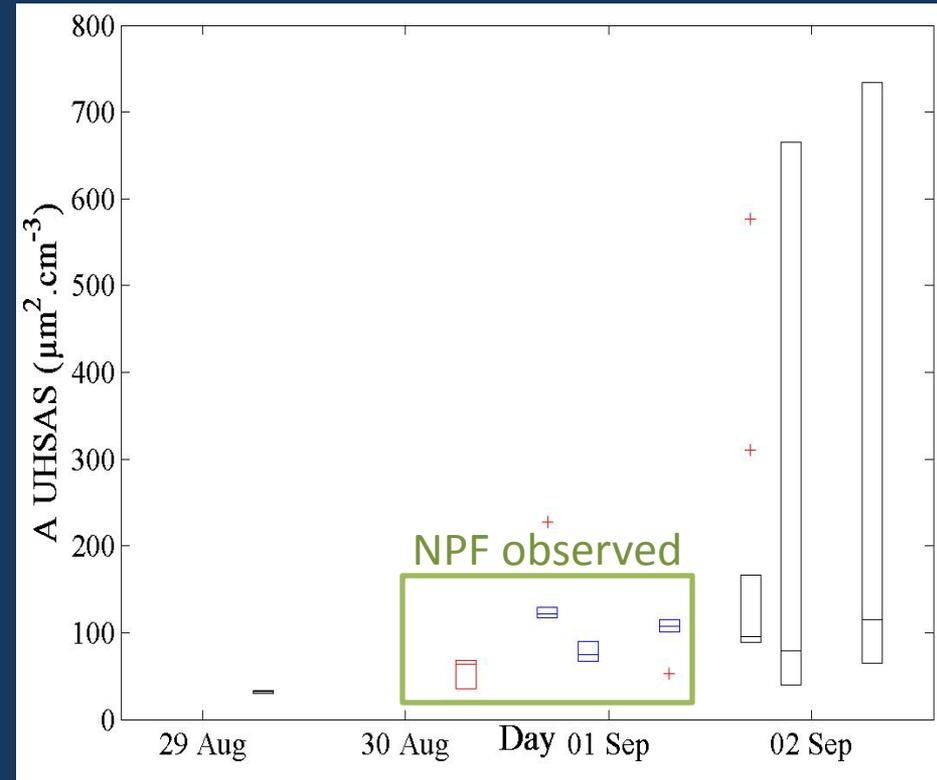
- NPF were observed between -12 and -8C
- non-NPF eyes were generally colder/warmer than during NPF events

- NPF events were observed with low preexisting aerosol surface area (SA)
- 02-Sept showed high variability with greater SA

Temperature effect ?

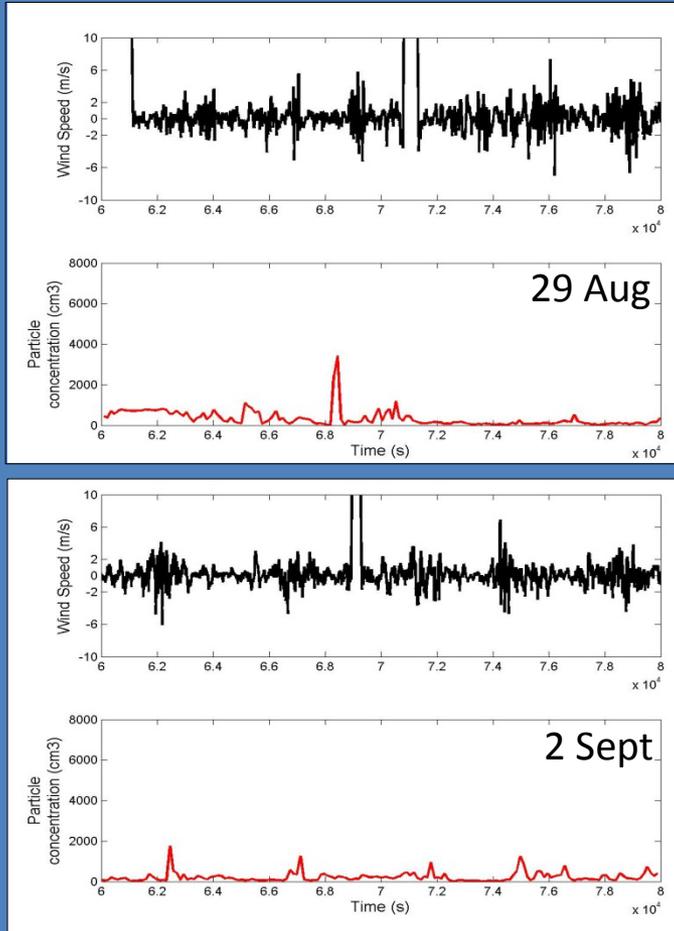


Pre-existing surface ?

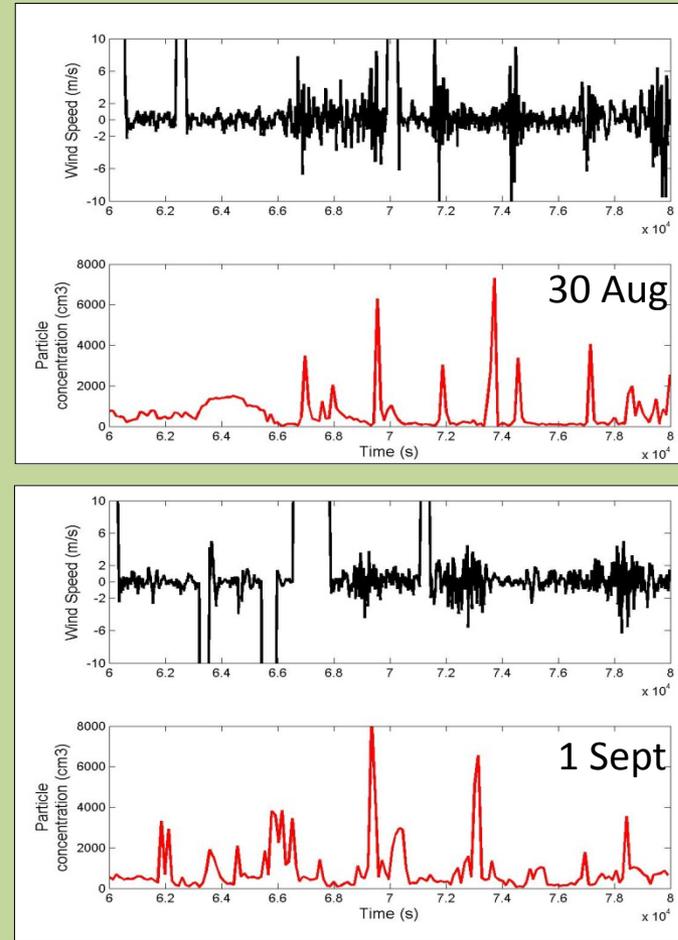


Does the vertical winds have an impact ?

No-New Particle Formation



New Particle Formation



- Similar variability in vertical wind speed is observed for new particle formation (NPF) and non-NPF data \rightarrow unlikely to be driving events