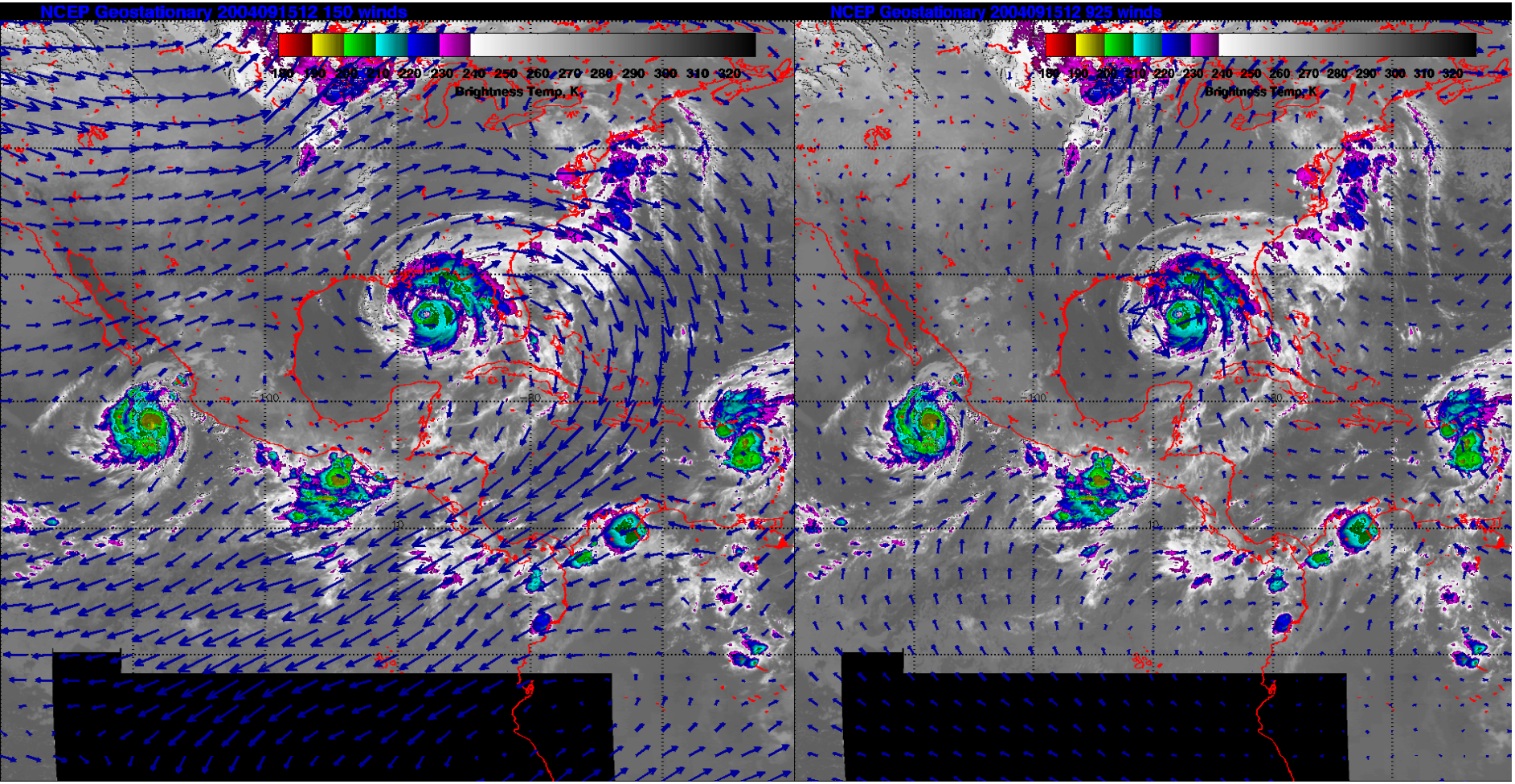
Tropical Cyclones

Lenny Pfister (with help from Karen Rosenlof, Paul Newman, Laura Pan, Dave Starr)

- Effect on UTLS chemical composition and aerosols
- Cloud properties

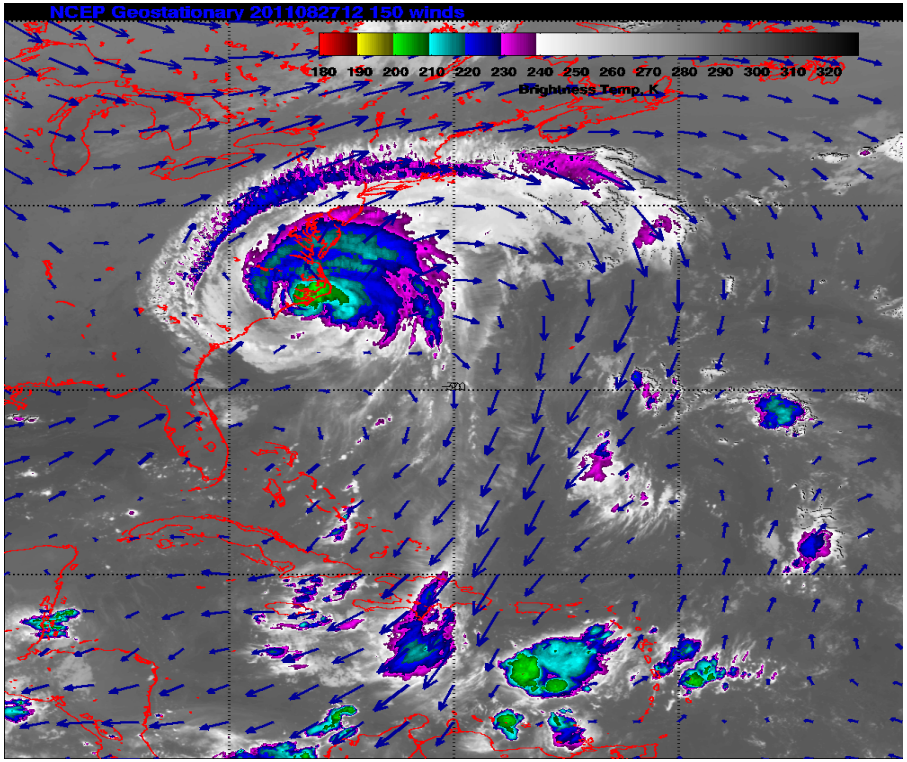
150 mb flow, Ivan, 2004

925 mb flow, Ivan, 2004

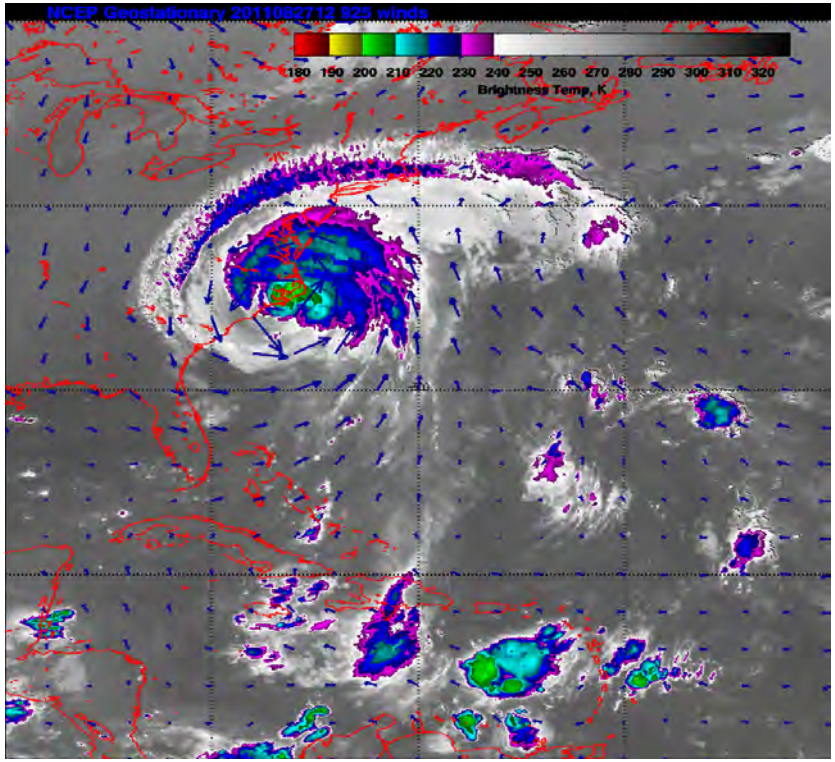


Inflow from Caribbean, outflow to the northeast, curving anticyclonically equatorward

Irene, 150mb



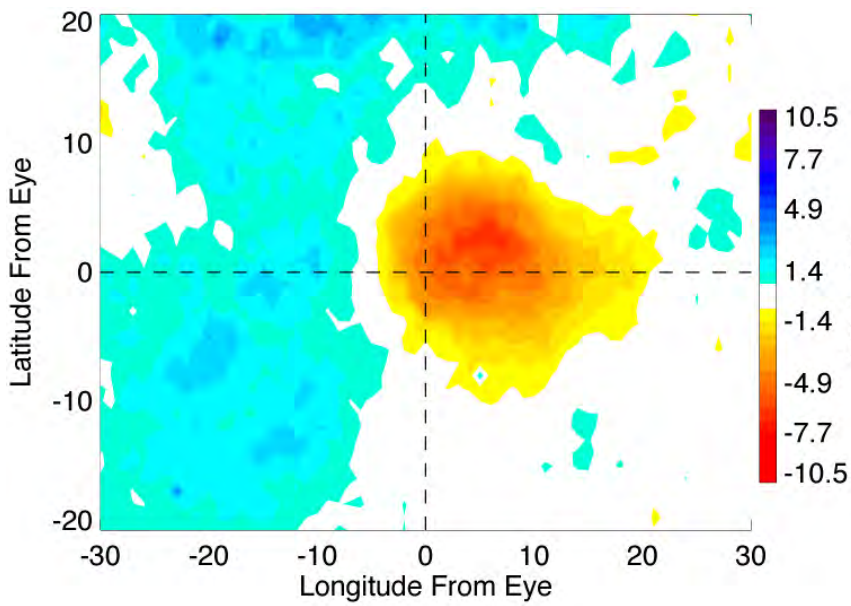
Irene, 925 mb

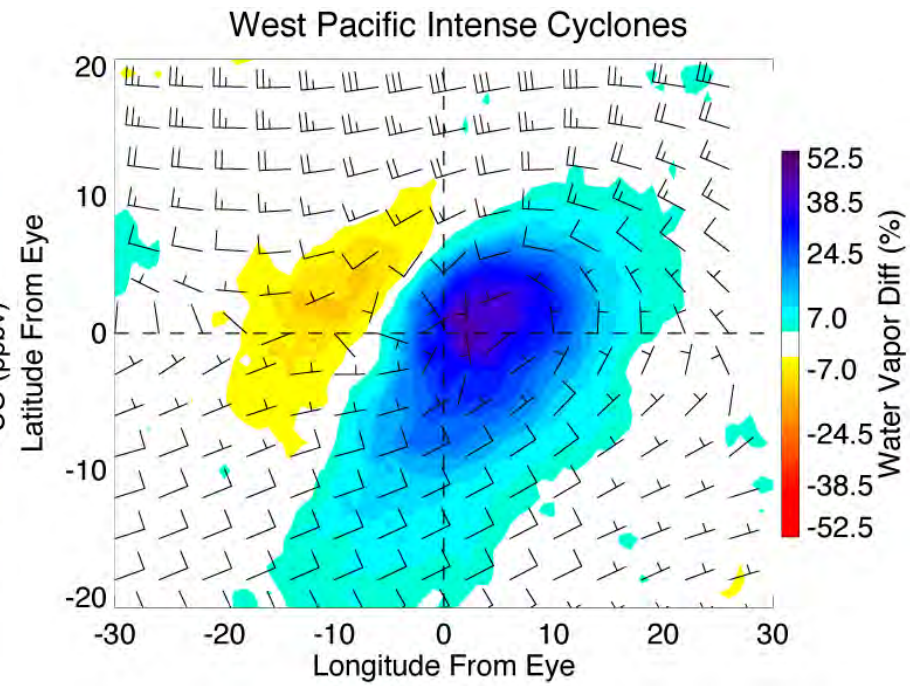


Large scale inflow and outflow patterns. Anticyclonic (of course) outflow pattern often sends air southward. Inflow in this case is partly from continent.

Background

- TCs have significant impact on tropical UT water vapor budget (comparable to other convective regions – figures from E Ray





Background

- Previous (unpublished) study (Rosenlof and Tuck, 1999) suggests TCs could contribute ~20% of the uplift at 70mb between 20-30 degrees latitude.
- Previous aircraft studies of *composition changes* associated with TCs are very limited – typically ER-2 or B-57 flights showing water enhancements (Pfister et al, Kelly et al, 1993).
- No systematic study measuring both inflow and outflow of TCs has been done with aircraft.
- Since TCs are large, with broad inflow and outflow patterns (and often suppress nearby convection), sampling might actually be easier (my opinion).

Science Question 1

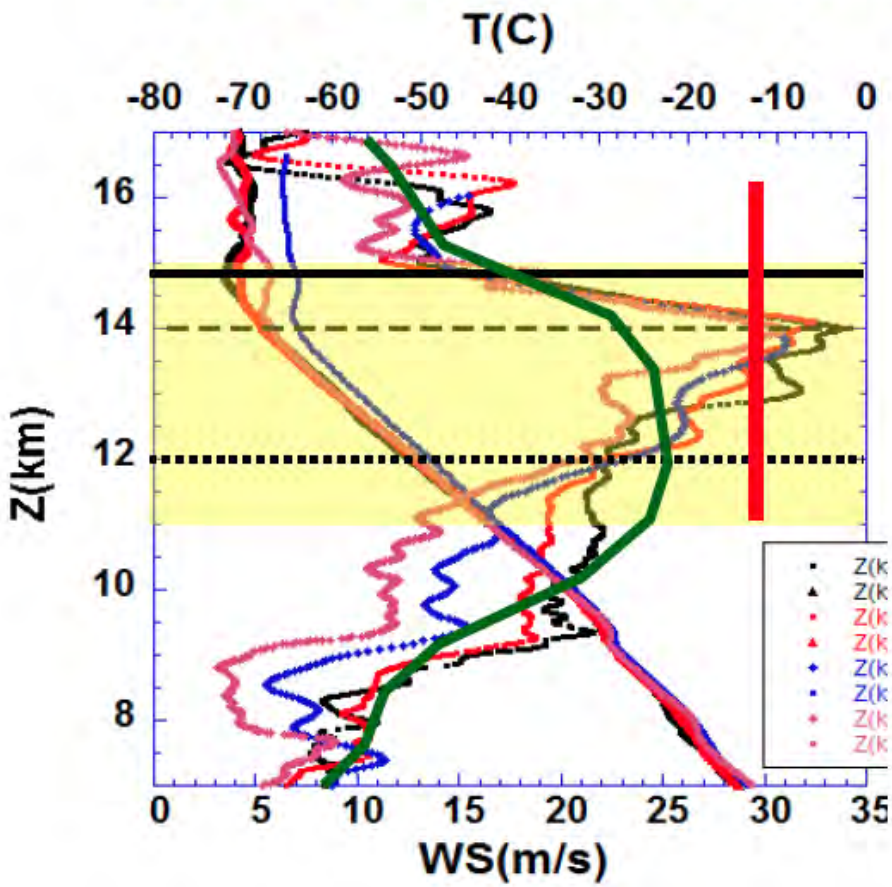
- How do TCs modify the chemical and aerosol environment of the UTLS? How does this relate to the composition of the inflow?
- Instruments needed: in situ sensors on both aircraft, (WAS, water, fast-response tracers, in situ aerosols). Remote ER-2 instruments could also be useful to characterize the aerosol environment outside the storm.
- Flights, DC-8 flights through inflow and outflow jets. ER-2 dives in outflow regions.
- Alternate approach – trajectory analysis from cyclones to sample air a few days after it has exited hurricane. Not a complete analysis, but can use segments of other flights if the opportunity arises (e.g., a tropical flight)
- It would be very valuable to get a good inflow/outflow dataset to compare with models to get the simulated upward transport right.

Science Question 2

- What are the cloud properties of cirrus and how do they evolve as air moves outward from the storm?
- Instruments needed: In situ cloud sensors, ER-2 remote instruments, DC-8 radar.
- Flights, DC-8 across the hurricane with ER-2 overflying using remote instruments.

Why do we need the ER-2?

HS3 Observations of Leslie's Outflow



7 Sep 2012
1041-1111Z

Black, Red, Blue and Pink lines: Global Hawk observed wind speed and temperature profiles along jet maximum from dropsondes

Green line: COAMPS-TC model wind speed profile

Red line: Satellite wind speed vertical average

Solid black: Tropopause

Dashed: Cirrus top / jet max

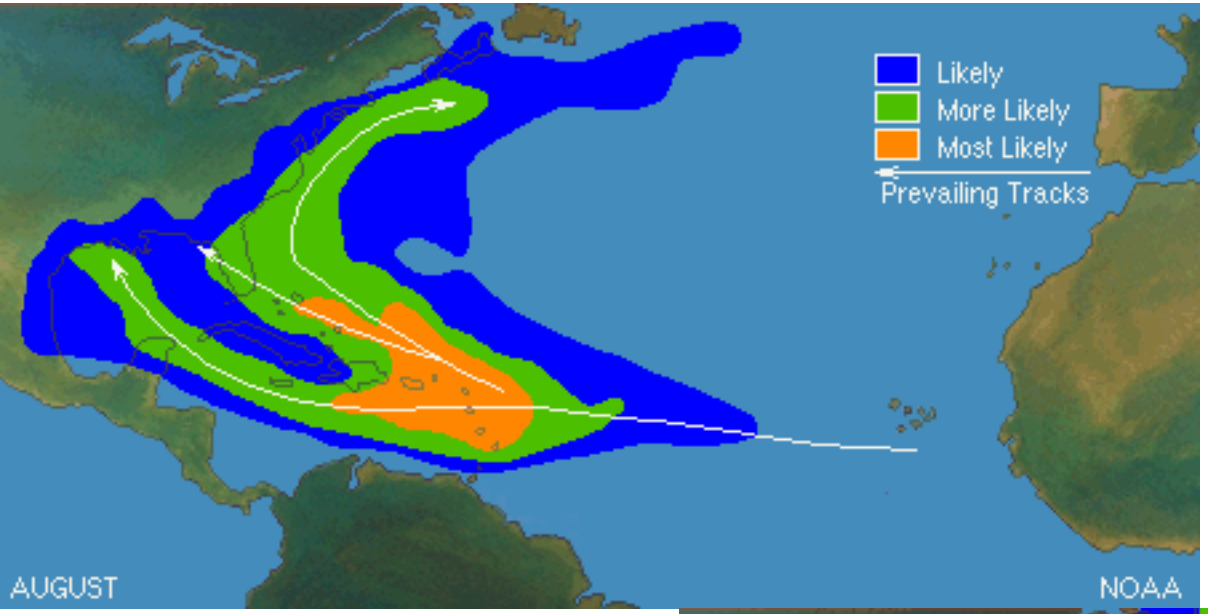
Dotted: Cirrus cloud base

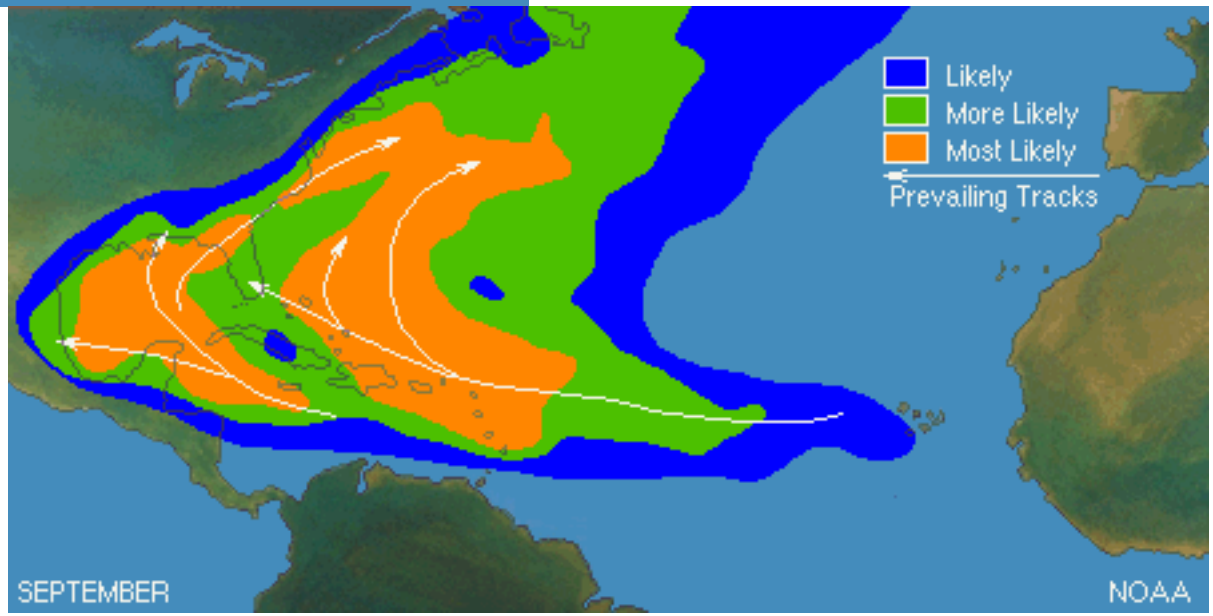
Yellow shading: Cloud Physics Lidar (CPL) domain

Max outflow is at 14 km, DC-8 ceiling is about 13 km, so having ER-2 make soundings outside storm in outflow is preferable

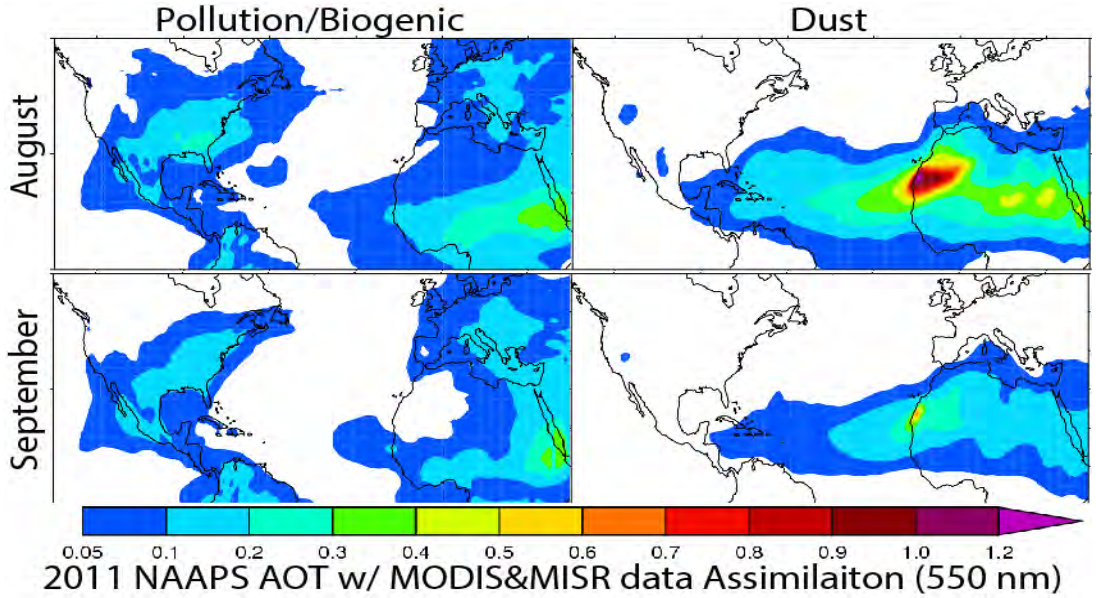
(from Peter Black's presentation)

When should we fly?



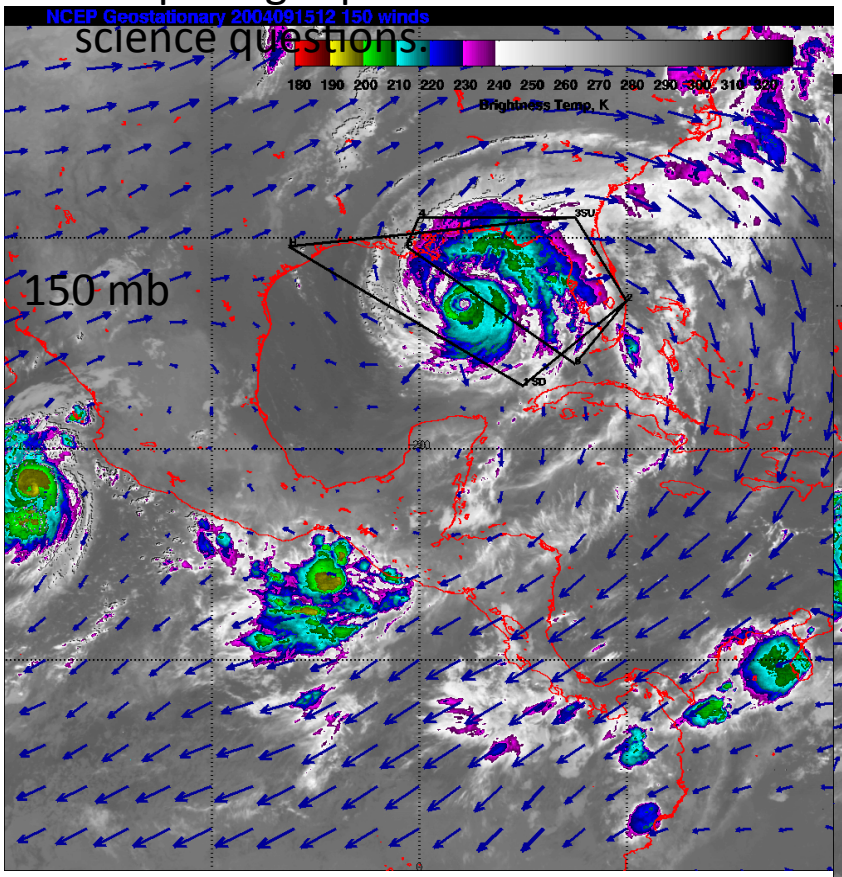


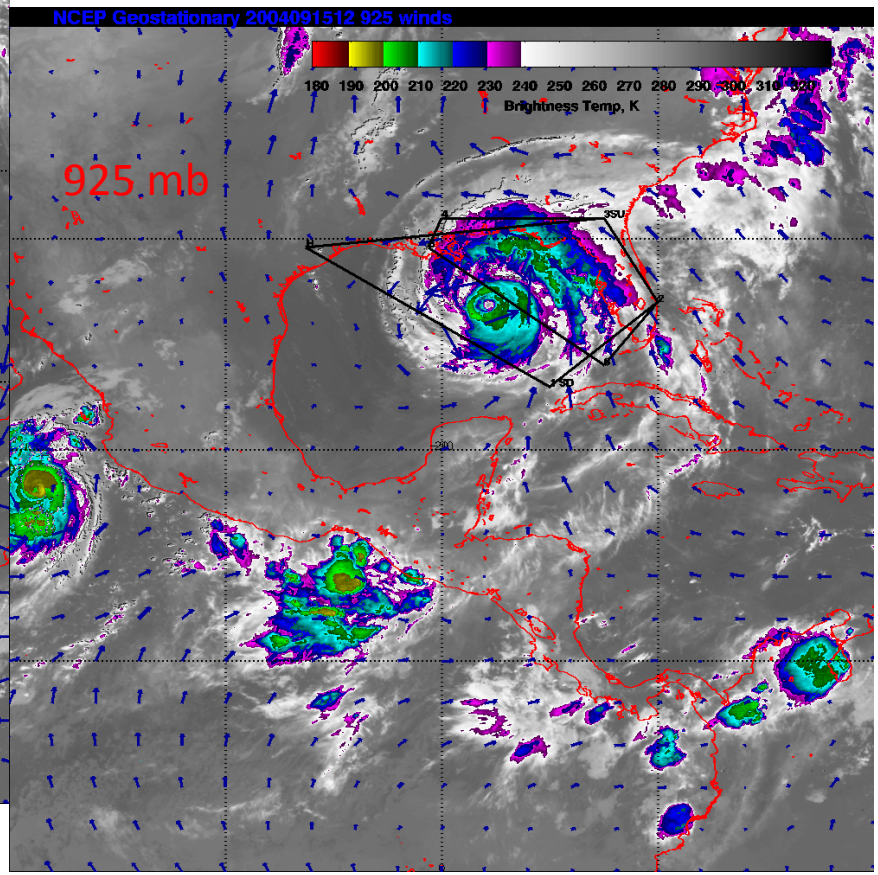
Sahara dust suggests August.



From Jeff Reid – Dust and hurricanes clearly preferable in August

Sample flight plan for Ivan – best case – hurricane nearby – answers both science questions.





- Houston to south point at cruise altitude
- Spiral to 500-1000 feet.
- Boundary layer run n'eastwrd, then n'westwrd to north point to sample inflow
- Spiral up to cruise
- Fly west, then, south, then s'eastwrd across storm (cloud run)
- Turn n'eastwrd, then n'westwrd to sample outflow

Saharan Air Layer – HS3 is interested in this – difficult to reach

SAL is not in BL – not necessarily part of the inflow?