SEAC4RS Cloud Objectives

Relate cloud microphysical and radiative properties to remote sensing observations in contrasting aerosol environments

- stratocumulus & cumulus
- “in-situ” cirrus
- extended cirrus anvils
- cumulus congestus, especially maritime

Derive cloud-aerosol radiative forcing, absorption and heating rates for homogeneous and heterogeneous scenes

Acquire well-characterized cirrus cloud data sets to support polarimeter algorithm development (ACE) => homogeneous

SEAC4RS Cloud-Aerosol-Radiation Goals

SSFR perspective

Investigators: Schmidt/Pilewskie, Platnick/King, Russell, Bucholtz, Hall

Derive cloud-aerosol radiative forcing, absorption and heating rates for homogeneous and heterogeneous scenes

Absorption / radiative forcing of aerosols, gases, and clouds is still problematic to determine under heterogeneous conditions, especially from remote sensing.

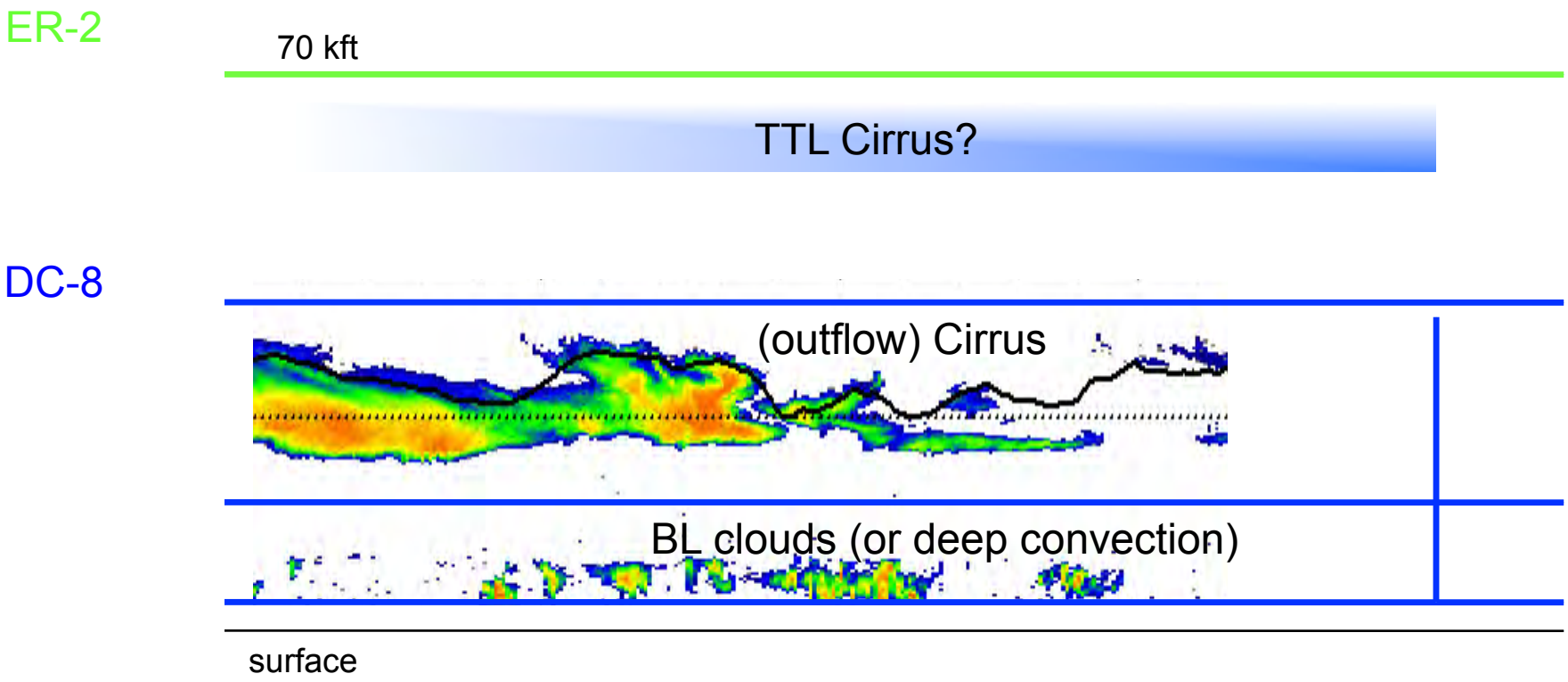
Connect “radiance-world” (cloud-aerosol-gas remote sensing) with “irradiance-world” (forcing/absorption), and remote sensing products to in-situ observations.

Answer question whether in-situ properties are consistent with measured irradiances and radiances; usually they are not!

Spectrally resolved radiance/irradiance measurements help to do this because aerosol-cloud-3D-gas signatures can be used to partition among contributors

We can do this job best if we fly collocated ER-2/DC-8 flight legs that “sandwich” the layer of interest. We *do need the DC-8 below that layer* for at least one leg. In-situ characterization of that layer with the DC-8 afterwards/before will of course also be needed.

Radiation: Coordinated “Sandwiches”



“Sandwich” cloud or cloud-aerosol layer of interest with SSFR/BBR on ER-2/ DC-8, measure:

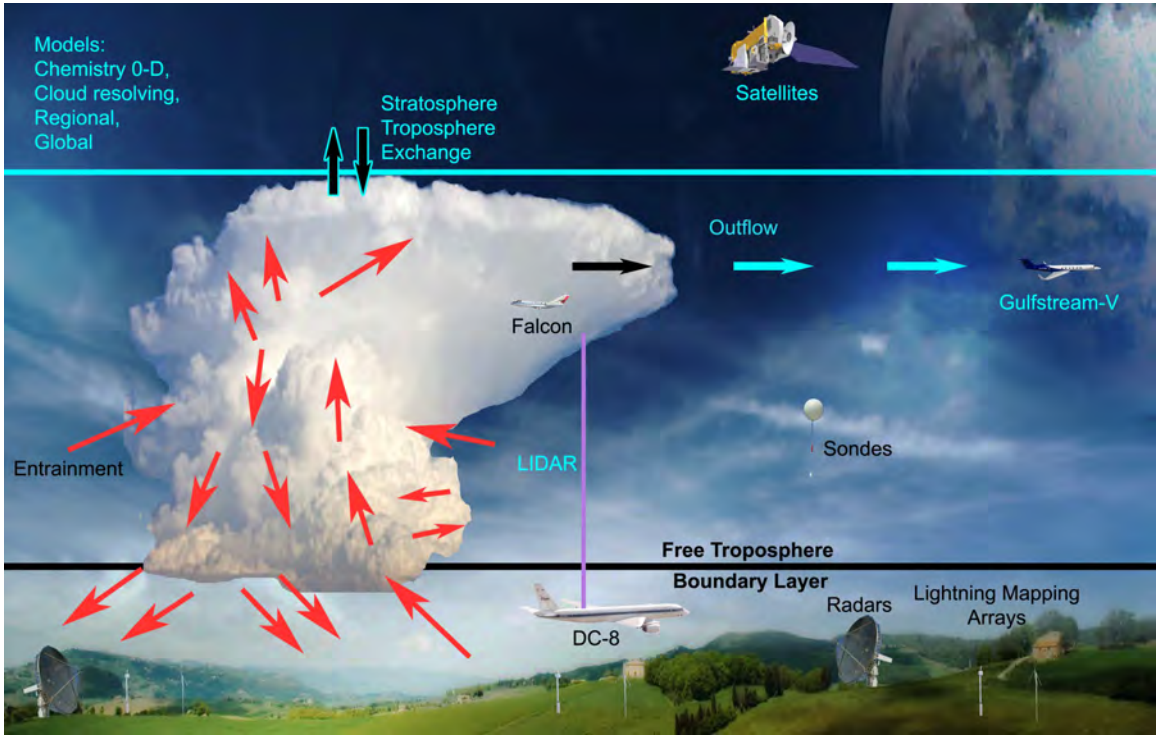
F_{net} *(top)* – F_{net} *(bottom)*

Characterization of convective lifetime in SEAC4RS-US

S. Tanelli and S.L. Durden

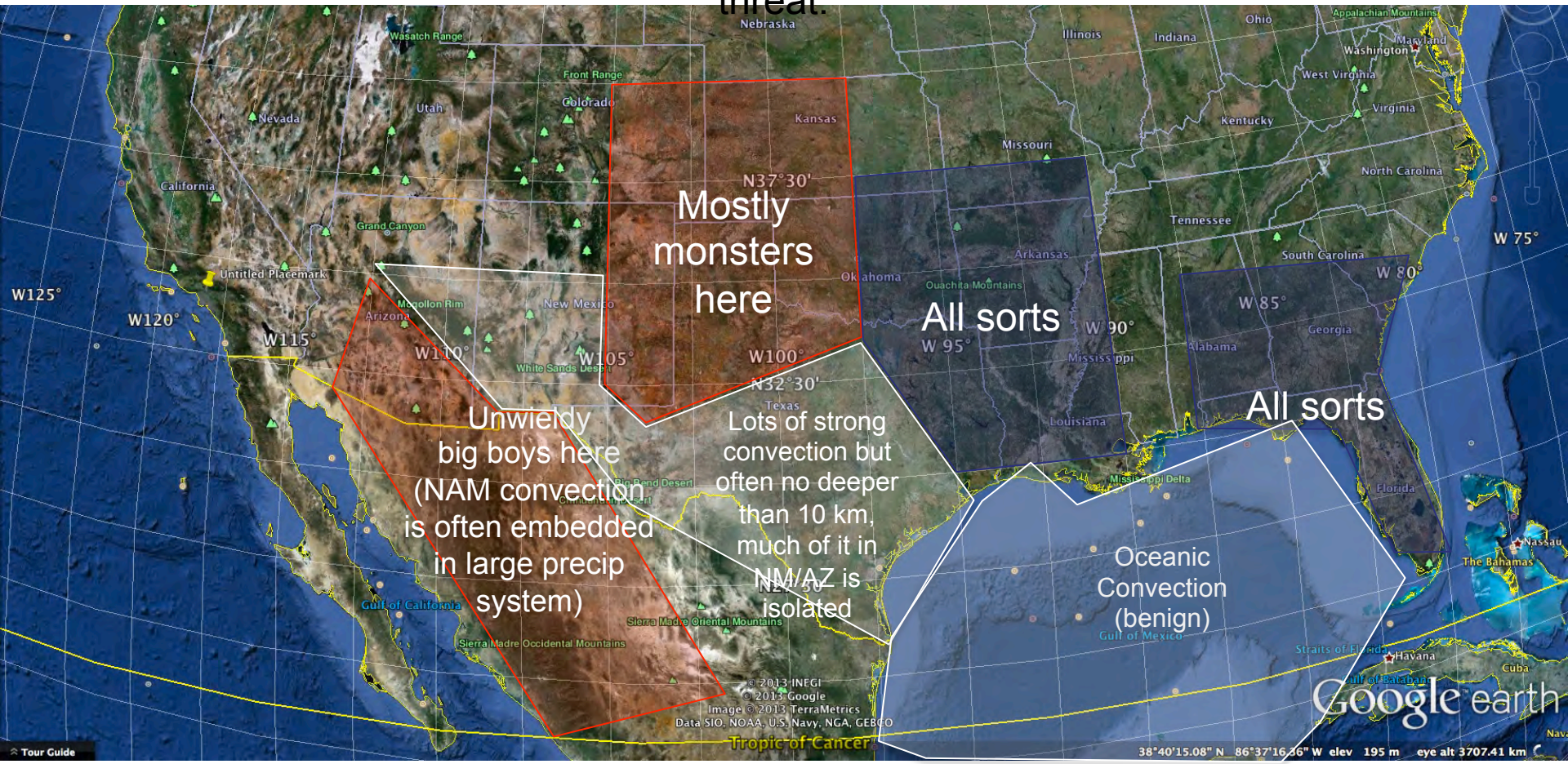
Contributions: J. Mace and D. Starr

Deep Convective Clouds and Chemistry Experiment (DC3) – Schematic Overview



DC3 Sampling of an Air Mass Thunderstorm

August – Convective climatology based on TRMM PR.
A simplified guideline of where to find 'good convection' within 2 hrs of Houston. First cut.
Red = not suitable, Orange = suitable targets present but caution in selecting them, White = preferable, good occurrence and limited risk of it becoming a threat.



Aerosol-Precip – Lidar/Radar GRIP, 2010

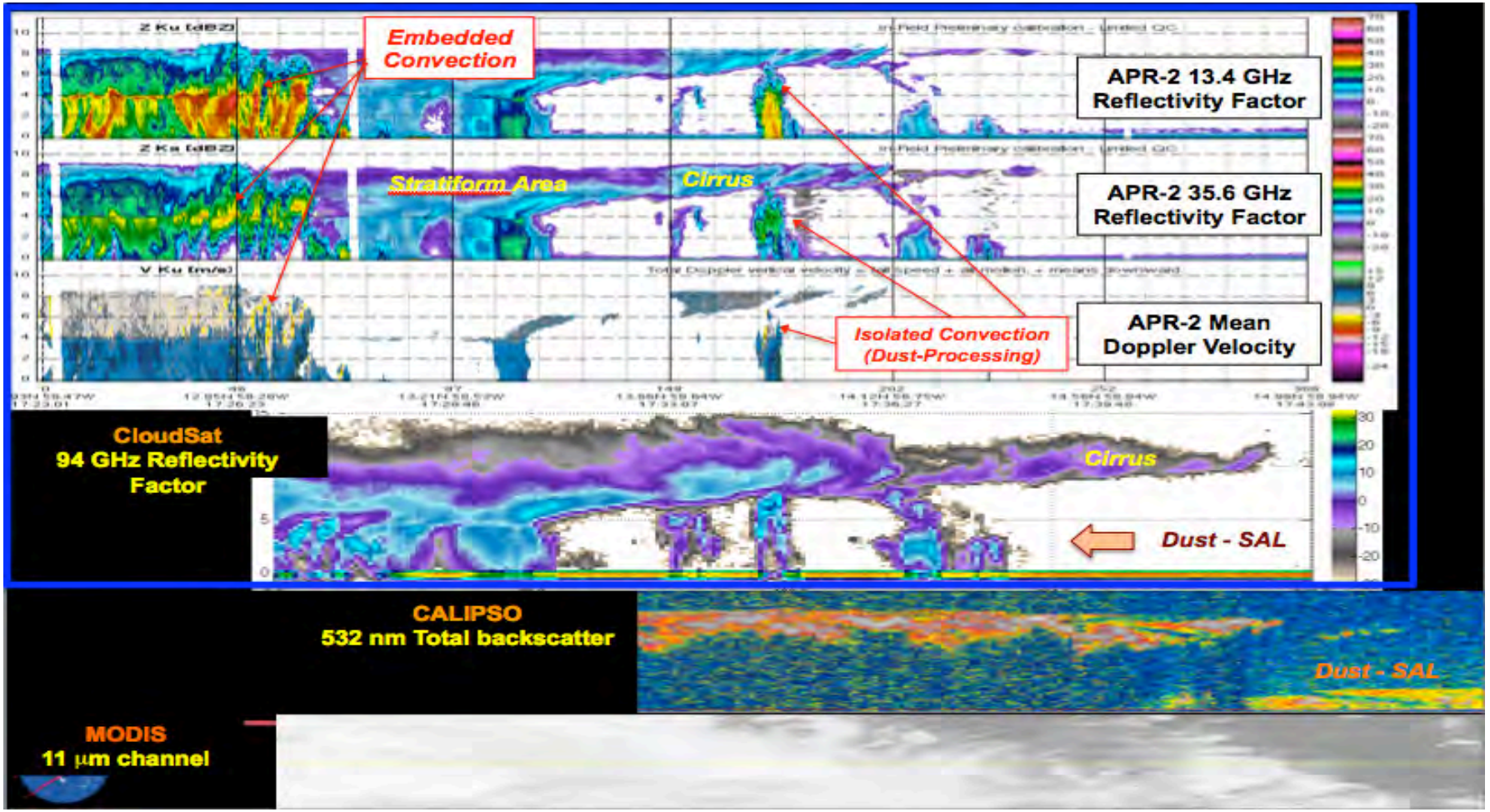
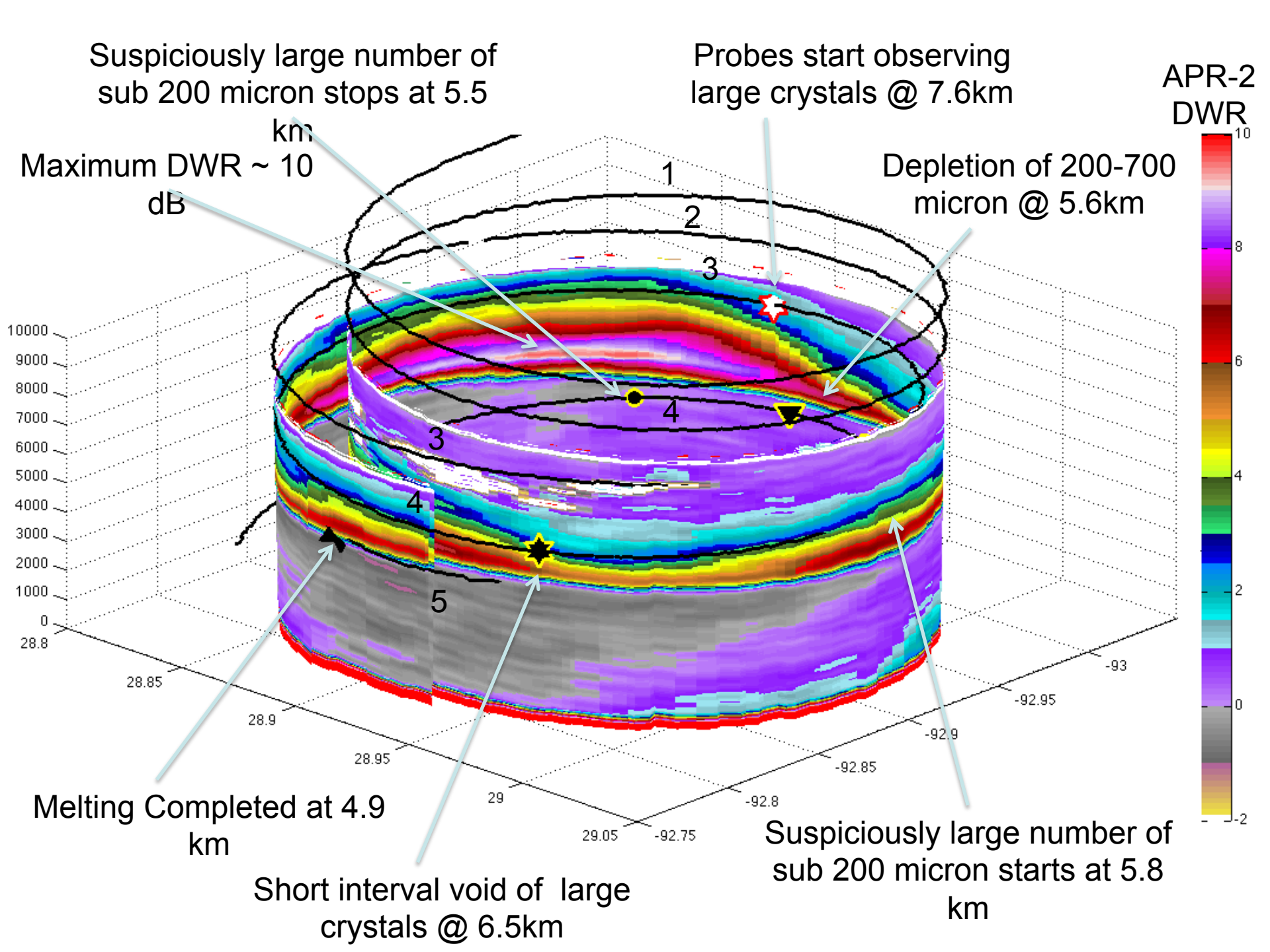


Figure 8. Interaction of a SAL outbreak with the disturbance that will become tropical storm Matthew observed by APR-2, CloudSat and Calipso (LASE data are also available, not shown) during GRIP. In this case the dust loading was first processed by a loose band of isolated convective cells of modest intensity and vertical extent. The anvil resulting from the main convective region to the south (left) is characterized by extremely small ice particles (indicated by the equal reflectivity values at Ku, Ka and W band, and small Doppler velocities, in the anvil region away from convection).


Suspiciously large number of sub 200 micron stops at 5.5 km
Maximum DWR ~ 10 dB
Probes start observing large crystals @ 7.6km
Depletion of 200-700 micron @ 5.6km
APR-2 DWR
10
8
6
4
2
0
-2
1
2
3
4
3
4
5
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
28.8
28.85
28.9
28.95
29
29.05
-92.75
-92.8
-92.85
-92.9
-92.95
-93
Melting Completed at 4.9 km
Short interval void of large crystals @ 6.5km
Suspiciously large number of sub 200 micron starts at 5.8 km

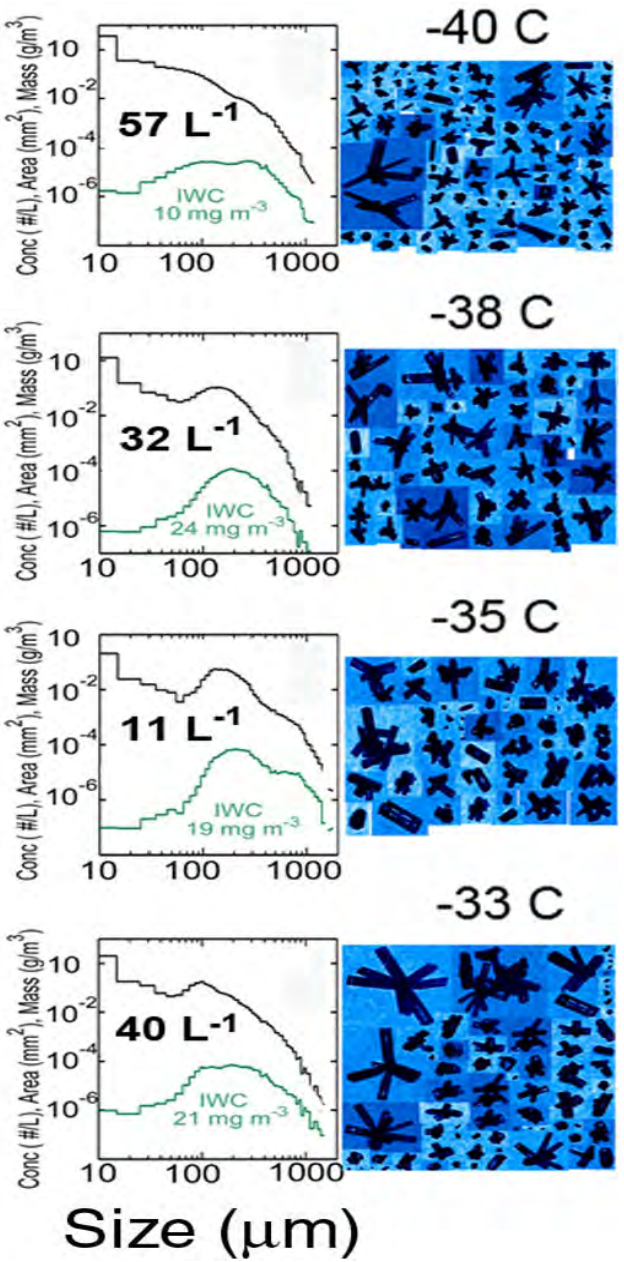
Measurements of Cirrus Microphysical Properties

Science Questions and Objectives:

- What are the concentrations, sizes, and habits of ice crystals in anvil and synoptic cirrus?
- What is the relative importance of heterogeneous freezing (requiring insoluble ice nuclei) and homogeneous freezing of aqueous aerosols for production of ice in the upper troposphere?
- What are the processes that govern the evolution of cirrus ice crystal size distributions?

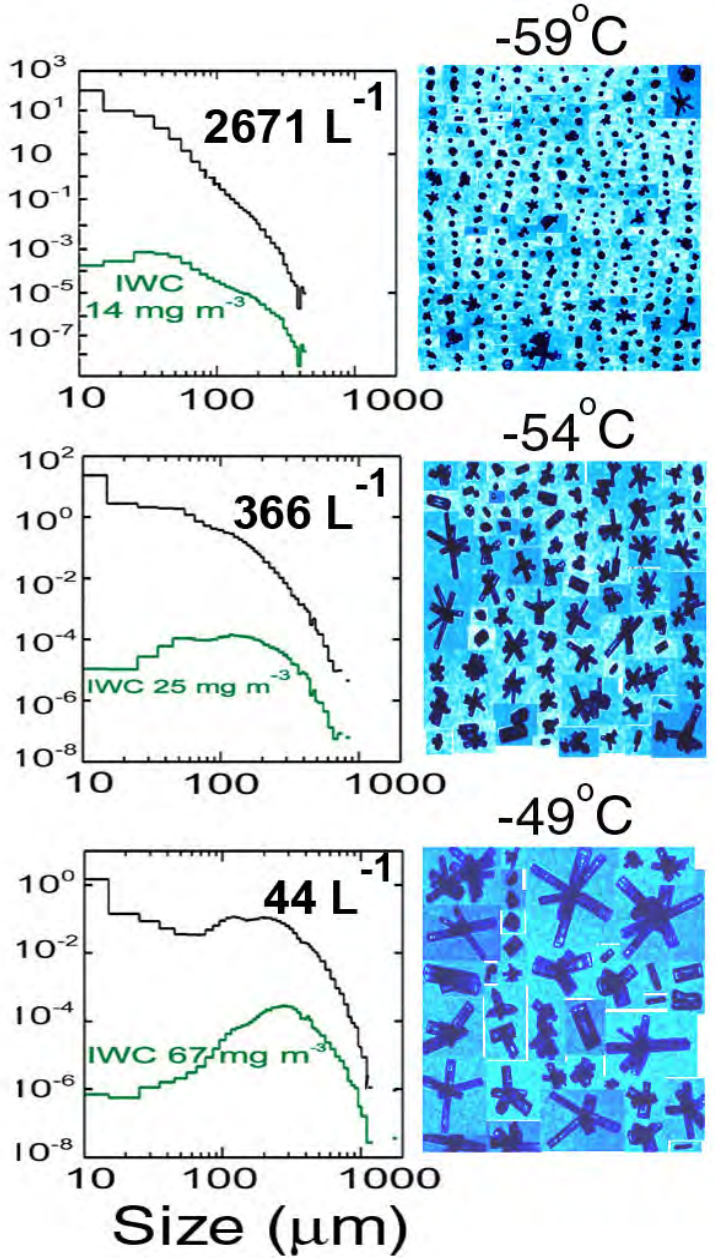
- Contribute to the *currently limited* dataset of cirrus microphysical properties for evaluation and improvement of both remote-sensing retrieval algorithms and cirrus parameterizations used in global models.

SPARTICUS Profile In Thin, Warm Cirrus

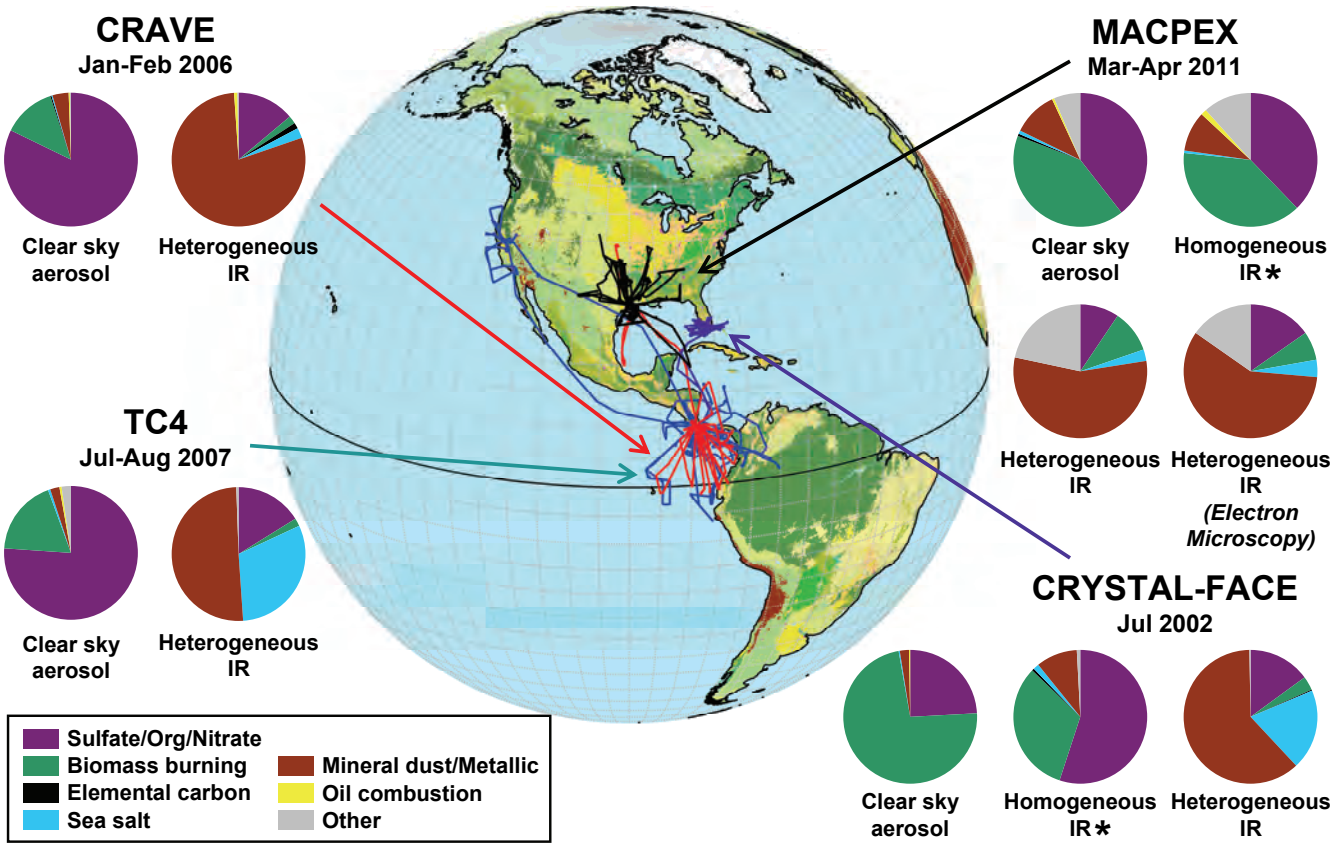


SPARTICUS Profile In Cold, Thick Cirrus

P. Lawson



Heterogeneous versus homogeneous nucleation



- Analysis of ice crystal residual composition suggests dominance of heterogeneous nucleation (Cziczo et al., in press)
- Statistical comparison between simulated and observed ice concentrations suggests balance between heterogeneous and homogeneous ice nucleation.

Cirrus Sampling Strategy

- **Aircraft required:** DC-8 or Learjet (ER-2 desirable for remote-sensing)
- **Meteorological conditions:** Any type of cirrus (anvil, synoptic, orographic, tropical)
- **Flight pattern:** Stair steps with 10-20 min legs, ramps, or spirals would suffice. Attempt to sample full depth of cloud system. (Past emphasis has been on cloud top.)
- **Duration and frequency:**
  - As much time in cirrus as possible
  - Limited-duration sampling should be possible en route to other targets
  - Convective detrainment sampling should provide anvil cirrus measurements
  - Extensive sampling of cirrus systems close to base is desirable
  - Stacked-aircraft coordination with the DC-8 and/or Learjet acting as in situ aircraft and the ER-2 serving as the remote-sensing platform should provide useful data for evaluating polarimeter retrievals of cirrus.