ICE-T

Science Goals

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- Establish which primary heterogeneous ice nucleation modes are active and important by measuring ice formation in tropical maritime cumulus clouds:
- Identify ice nuclei
  - Olga Majol's objectives
- Characterize secondary ice production processes
- Determine the likely influence of aircraft produced ice on the ICE-T measurements

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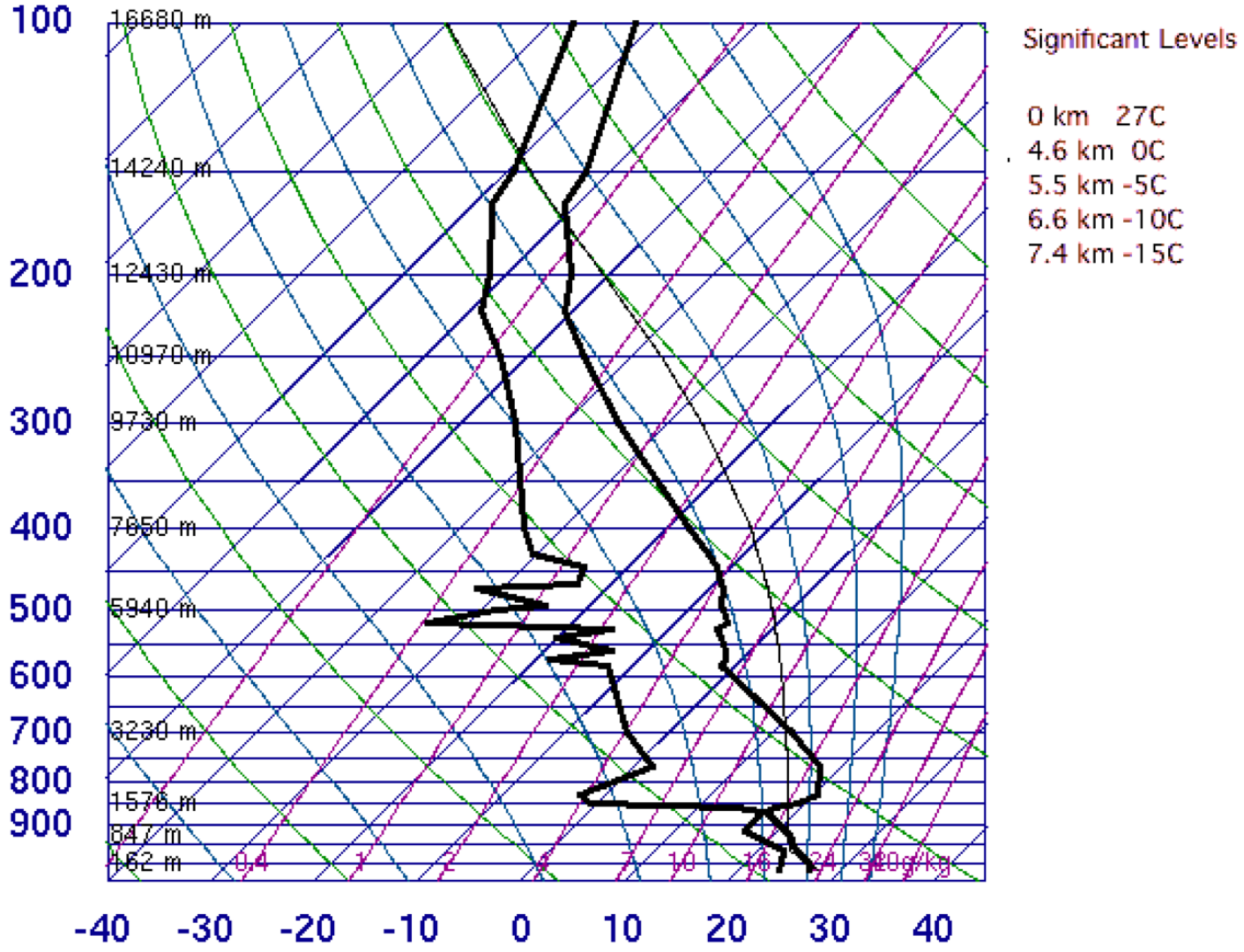

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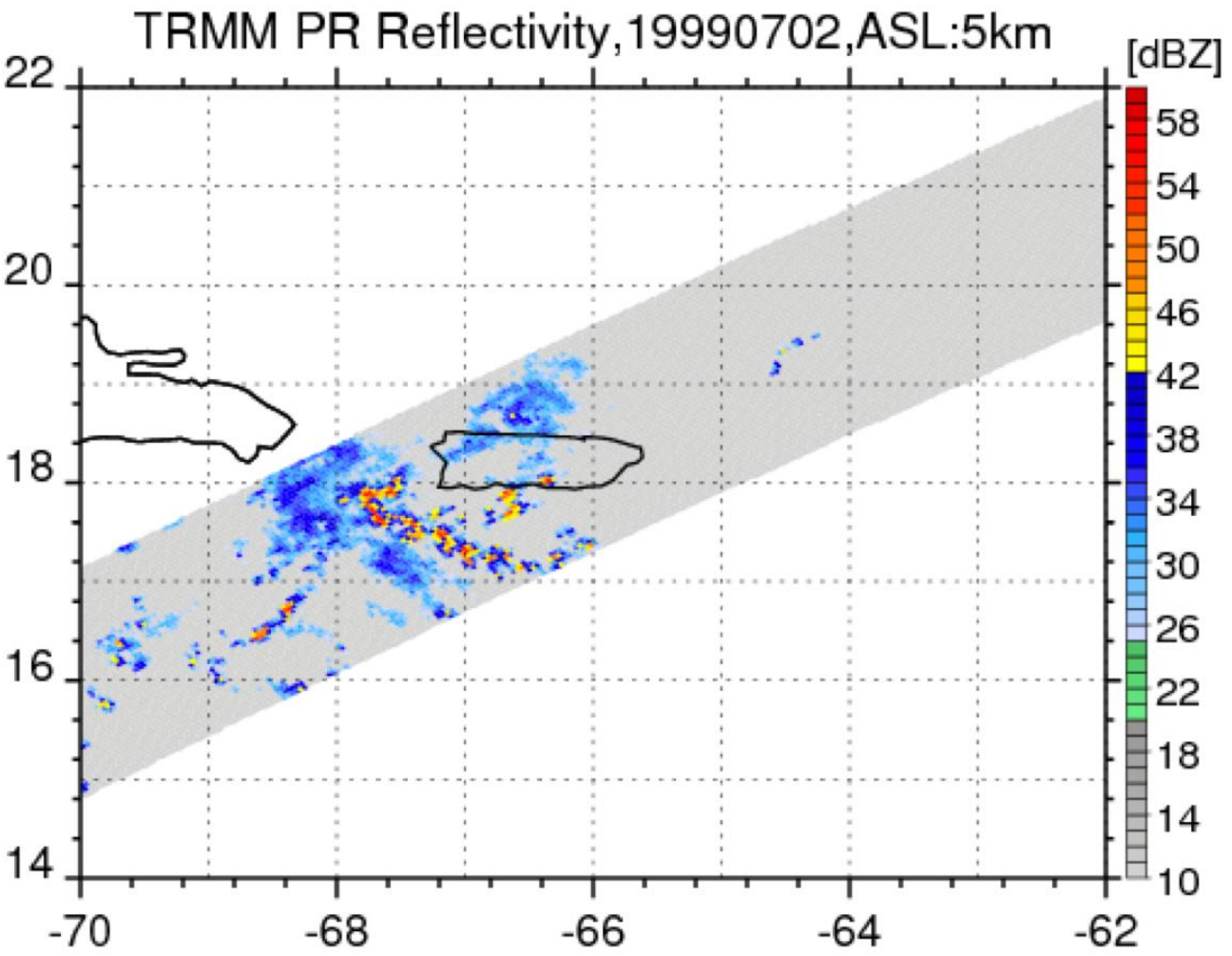
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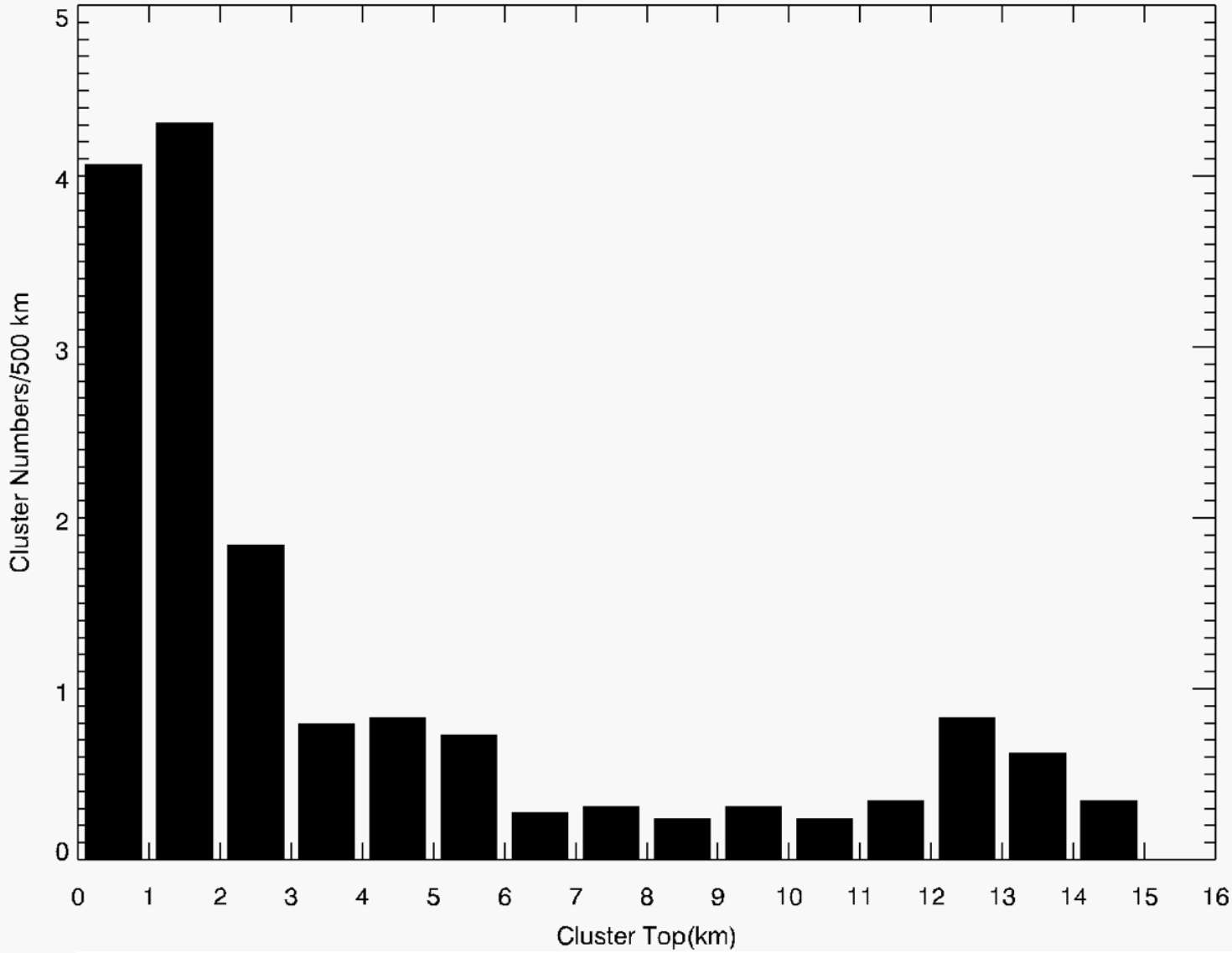


CloudSat radar top height distribution for the month of July in the 500 x 500 km^2 domain within range of the C130's base at St. Croix.

Flight Patterns

Clear Air Sampling

Stair-Step Patterns: Ascending and Descending

Statistical Sampling

APIP Studies

-What specific flight patterns are desirable for the radar/lidar goals?

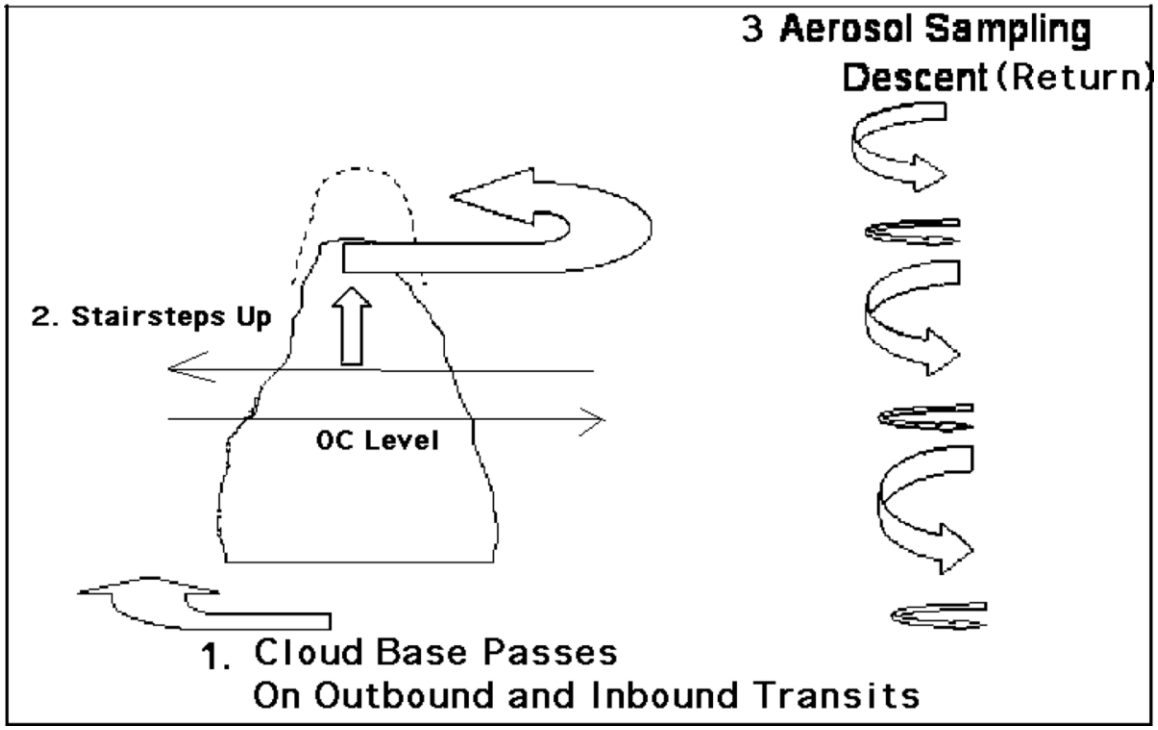
-We should attempt to use remote sensing to identify APIP signatures.

1. Quasi-Lagrangian Ascent

An ideal experiment will be to sample an isolated growing region of a cloud, so that the history of the upper cloud regions could be documented as the rising top encounters the 0°C temperature level and above (Fig. 4.1). Sampling near the ocean surface is conducted during climbout and descent and at other times as needed. The C130 first penetrates cloud 100 m above the base to characterize the aerosol, then climbs to the 0°C level and looks for a target cloud either visually and/or with the aid of the downward looking WCR Doppler measurements. Details of the penetrations include:

- A penetration 100 m above cloud base is made upon entry into the area of cloud sampling to characterize the aerosol (from the CVI residual particles).
- The second cloud penetration is made in a developing cloud at about the 0°C (4.5 km) level to document dynamical and thermodynamic characteristics of the updraft, as well as particle size distributions produced by the warm rain process.
- The growing cloud top is subsequently sampled during its ascent to document the appearance of the first ice.
- The flight strategy should be oriented relative to the direction of shear whenever significant shear is present, where shear is defined here as vertical shear of the horizontal wind. When shear is present (visually and/or in soundings), then the strategy will be to make the first penetration perpendicular to the shear, and subsequent passes up-shear and down-shear. This provides a measurement of the shear-induced structure by using both in-situ and remote sensing.

The specific climb rates of the C130 for the various horizontal legs can be determined following the first transit through the cloud.


3 Aerosol Sampling
Descent (Return)
2. Stairsteps Up
0C Level
1. Cloud Base Passes
On Outbound and Inbound Transits

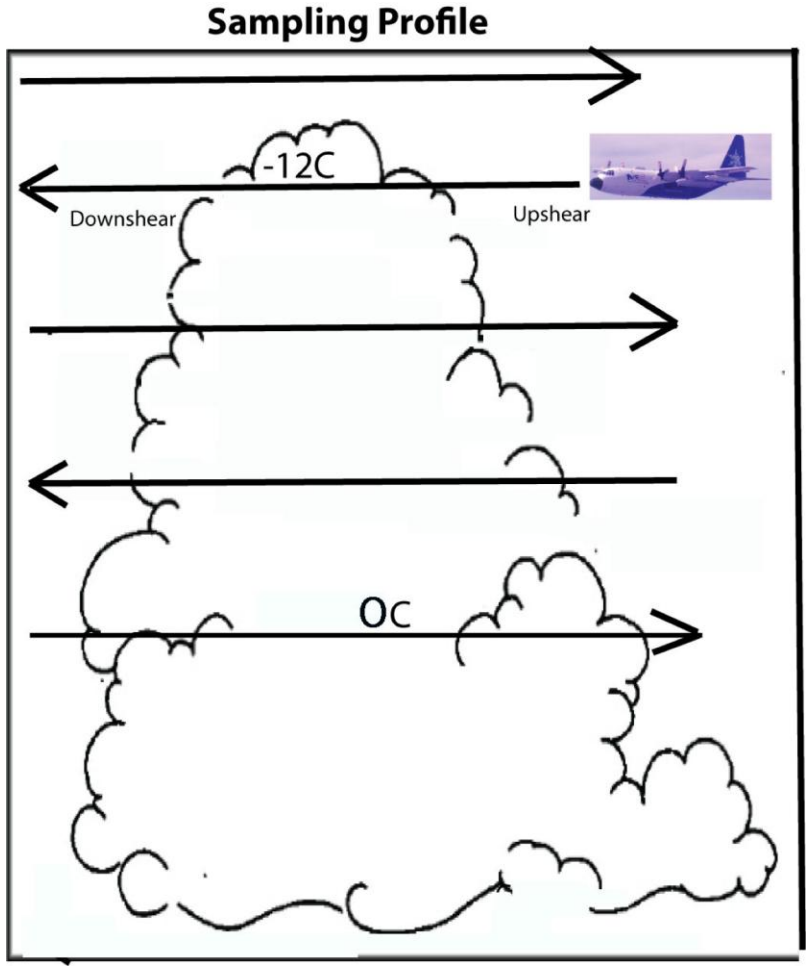
2. Descending Pattern

This pattern is designed to characterize primarily the tops of individual or several targeted maritime cumulus clouds, and to minimize the potential impact of APIPS on the dataset. If the updrafts remain active, the C130 will descend through cloud in a stair-stepped pattern.

First, the C130 makes a penetration through a cluster of cumulus clouds at a temperature near 0°C (4.5 km) and/or to avoid APIP production, climbs to a height from 2000 to 5000 feet above the tops of a developing, candidate cloud or cluster of clouds (Fig. 4.2). An over flight provides a radar and lidar overview at the beginning of a cloud sampling sequence. This remote sensing information indicates the stage of development of the liquid phase, vertical velocity structure, and the location and status of ice phase development.

Thereafter, the tops of candidate cumulus clouds will be penetrated, with preference given to clouds that have a dome-like top, indicating that the updrafts are likely to be active. With wind shear near cloud tops, cloud is carried down-shear. If the sheared portion is in the temperature range of interest, the evolution of the droplet to ice transition can be characterized in passes along the direction of the shear vector. This pattern might give us information on secondary ice production—the Hallett-Mossop process, for example.

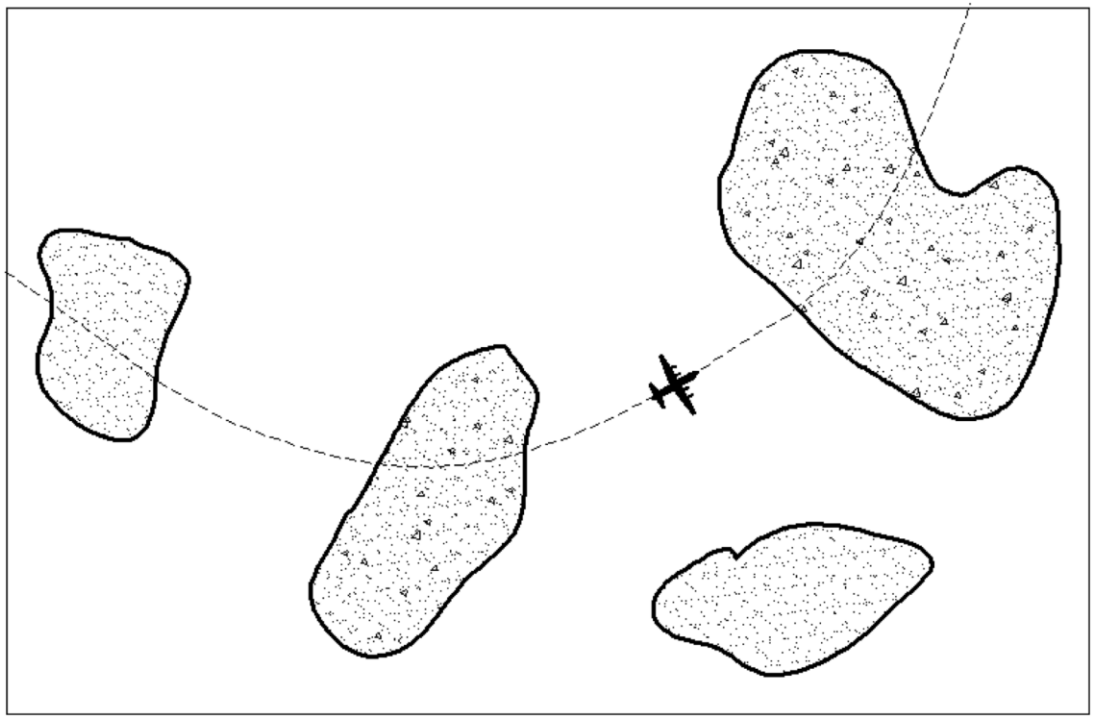
Following the sampling near cloud top, profiling will be conducted primarily from cloud top downwards (to reduce the chance of sampling APIPS in the updrafts). Penetrations are made as rapidly as possible.



Stair-stepped descending flight pattern

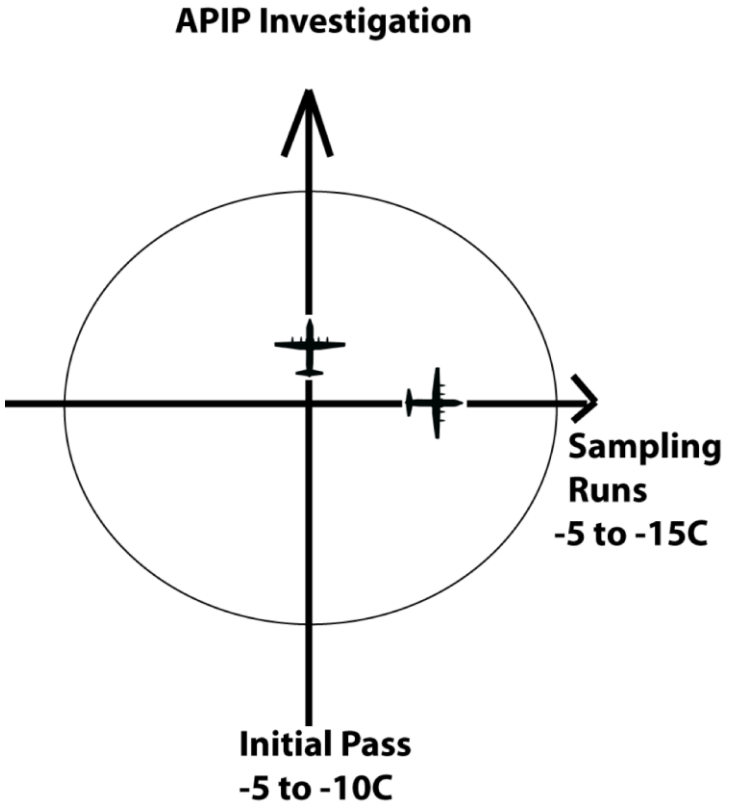
Statistical Sampling

- 1. Transit to operating area
- 2. Profile descent to below cloud to provide an environmental profile.
- 3. Fly straight and level legs 100 m above the ocean surface to characterize below-cloud aerosol and chemistry
- 4. Fly at least one leg through cloud at 100 m above cloud base to characterize the cloud droplet spectrum and to characterize the properties of the aerosols as derived from the CVI residuals. The height of the cloud base, the aerosol concentration just below base, and the cloud spectra just above the base are critical parameters for understanding the microphysics of these clouds and the role of dust.
- 5. Ascend to -10°C level and perform series of runs through different cumulus clouds.
- 6. Descend to -5°C level and perform a series of runs through different cumulus clouds.
- 7. If cloud top is well defined then characterize aerosol and chemistry just above. Perform downward looking remote sensing runs.



Statistical sampling flight pattern

APIP Investigations



Flight pattern designed to identify APIP production in the -5 to -10°C temperature range.

Other Considerations

Fuel for 6 hour flights

Time to reach 23000 feet is about 25 minutes

Barbados-1 ½ hour transit

Clearances needed with foreign locations-which ones?

Will get sounding from C130 on climbout and descent

We should develop likely case profiles for each flight pattern including time, temperature, # of cloud passes and put this information into a spreadsheet

Low altitude sampling ~500 feet above sfc is planned during transits to and from study areas. Sampling in those regions near target clouds is desirable

Low altitude sampling should be coordinated with Olga's ground aerosol station In Puerto Rico

For flight planning, episodes of Saharan dust will have emphasis

What are the preferred sampling strategies for WCR and WCL?

Desirable to sample in areas with surveilance radar and avoiding lower altitudes Near islands because of clearance issues.