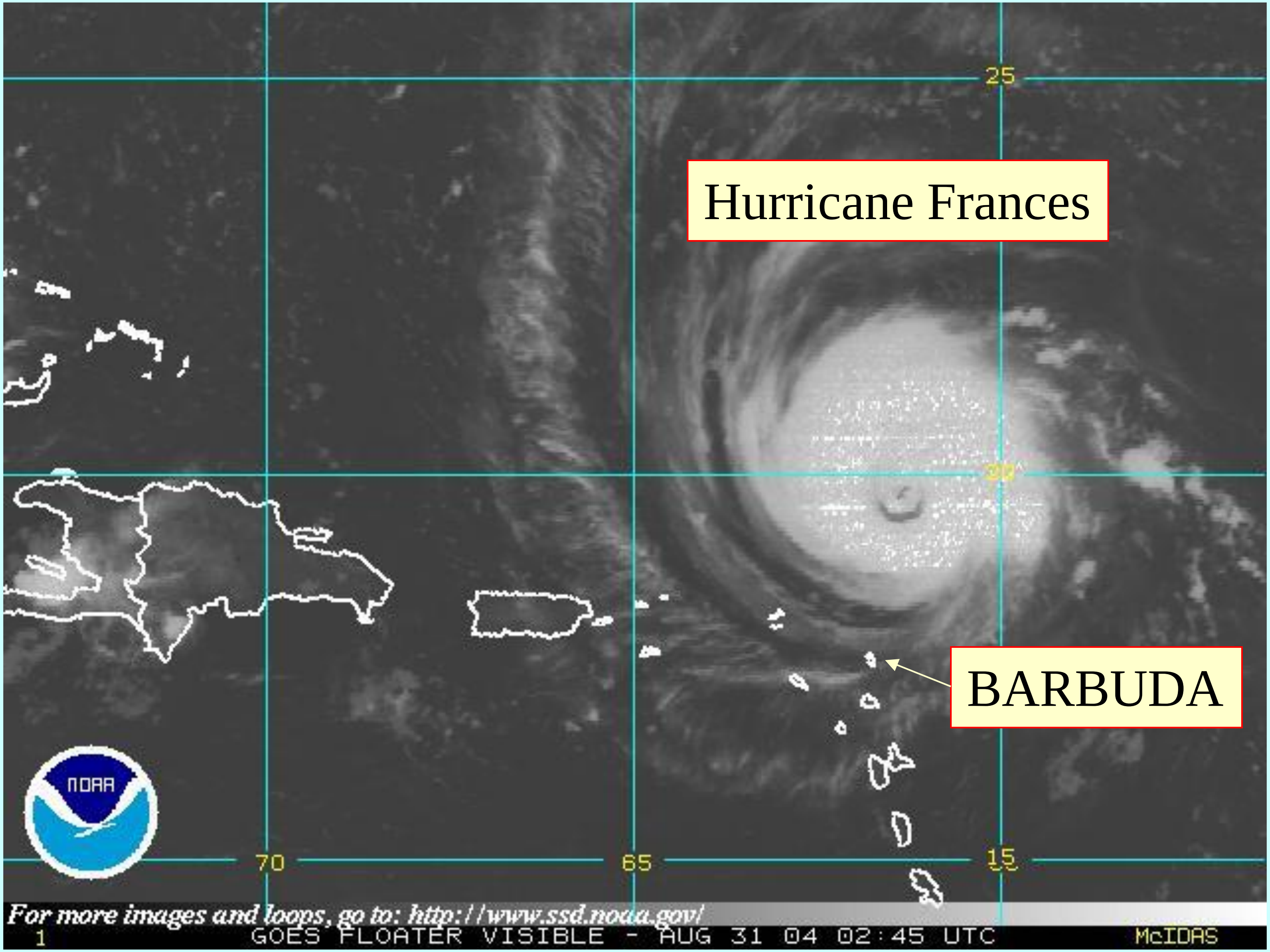
RiCO

Rain In Cumulus over the Ocean

PLANNING MEETING

Whew!



Hurricane Frances
BARBUDA
25
70
65
15
NOAA
For more images and loops, go to: http://www.ssd.noaa.gov/
1
GOES FLOATER VISIBLE - AUG 31 04 02:45 UTC
McIDAS

GOALS OF MEETING

1. Update on facilities deployment and planning

2. Review and discuss the RICO Operations Plan

3. Establish working groups for the field campaign to evaluate data quality and to assess the data to determine if it is satisfactory to address the scientific goals of RICO.

AGENDA

Bob Rauber	Welcome	8:30 am

Facilities deployment and plan

Dick Dirks	Operation Center & Logistics	8:45 am
Mike Daniels	Communications & Network	9:00 am
Jorgen Jensen	C-130 Deployment	9:30 am
Larry Oolman	King Air Deployment	9:45 am
Sonia Lasher-Trapp	BAE-146 Deployment	10:00 am
	COFFEE BREAK	10:15 am
J. Vivekanandan	S-PolKa Radar Deployment	10:45 am
Bruce Albrecht	Seward Johnson Ship Deployment	11:00 am
Steve Semmer	ISFF(PAM)	11:15 am
Terry Hoch	Dropsondes	11:25 am
Ned Chamberlain	GLASS	11:40 am
Olga Mayol	Surface Aerosol Deployment	11:50 am

AGENDA

RICO Operations Plan

	Chapter	Topic	Time
Harry Ochs	1,2	RICO Objectives & Venue	1:00 pm
Bob Rauber	3	RICO Missions	1:20 am
		COFFEE BREAK	2:45 pm
Sonia Lasher-Trapp	7	Modeling studies	3:00 pm
Dick Dirks/ Brigitte Baeuerle	4	Mission planning and execution	3:15 pm
Dick Dirks	5	Facilities, communication, logistics	4:00 pm
Greg Stossmeister	6	Satellite data acquisition	4:15 pm
Bob Rauber	8	Education and outreach	4:30 pm
Steve Williams	9	Data Management	4:45 pm
		RECEPTION	5:15 pm

Thursday September 2, 2004

Working Groups 8:30 am

1) Drop spectra
2) Aerosol (CCN, UGN, CVI, Ground based, etc.)
3) Chemistry
4) State variables/Turbulence/LWC
5) Remote sensing (SPOL, WCR, SABL, Ship based sensors)
6) ISS/GLASS/Dropsonde/Ship Soundings
7) Satellite

Coffee Break 10:00 am

Working Group reports

Group 1	10:30 am	Group 5	11:30 am
Group 2	10:45 am	Group 6	11:45 am
Group 3	11:00 am	Group 7	12:00 pm
Group 4	11:15 am		

Final Comments: Bob Rauber

Meeting ends 12:30 pm

RICO CORE OBJECTIVE: characterize and understand the properties of trade wind cumulus at all scales, with particular emphasis on determining the importance of precipitation.

The Microphysical/Cloud Scale

Research on spectral broadening and the initiation of precipitation in trade wind cumulus

Research on the microphysics of the transition to a mature rainshaft

The Cloud-Interaction Scale

Research on the mesoscale organization of trade wind clouds

The Ensemble Cloud Field Scale

Research on the water budget of trade wind cumulus

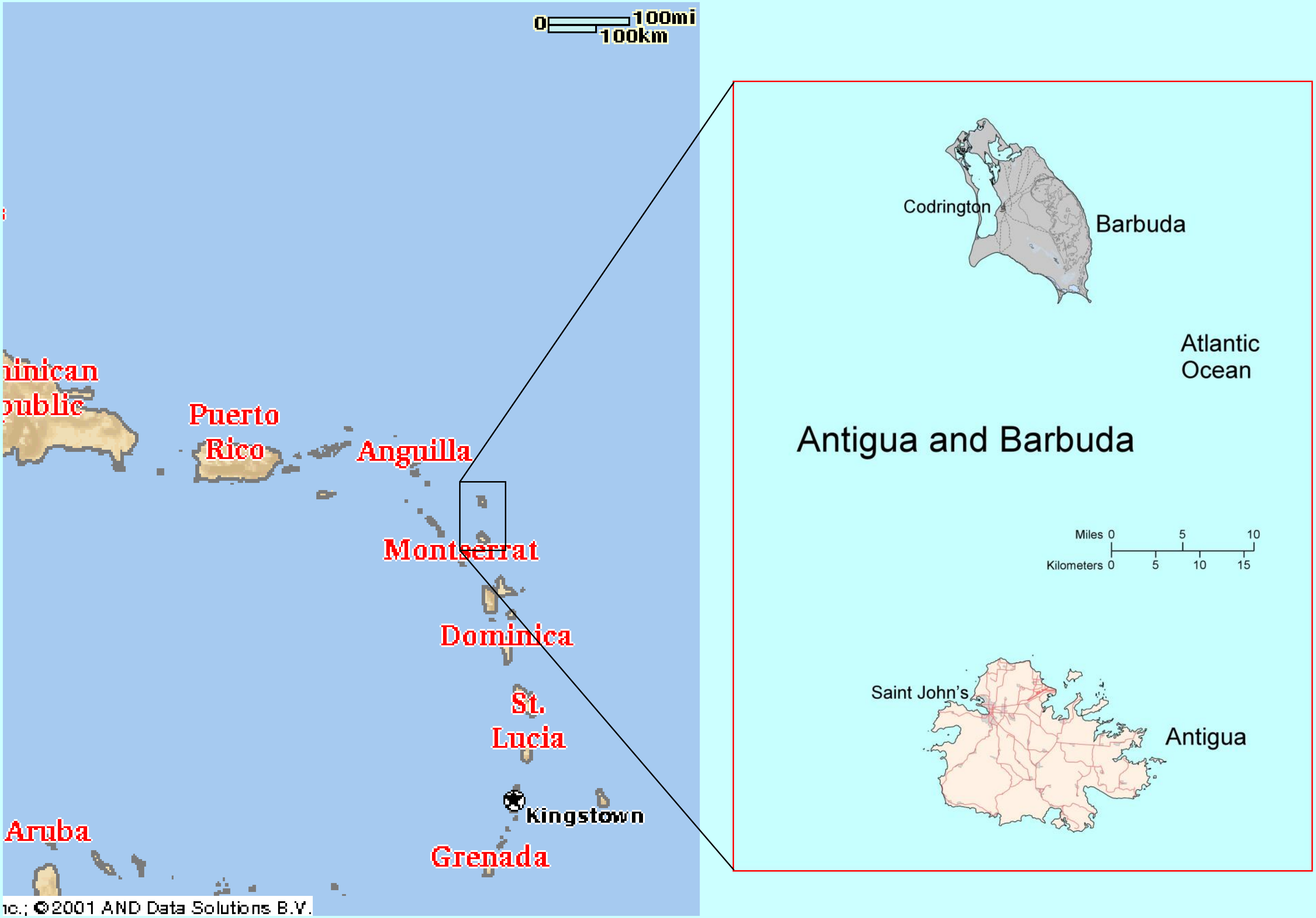
Research on the large-scale trade wind cloud environment

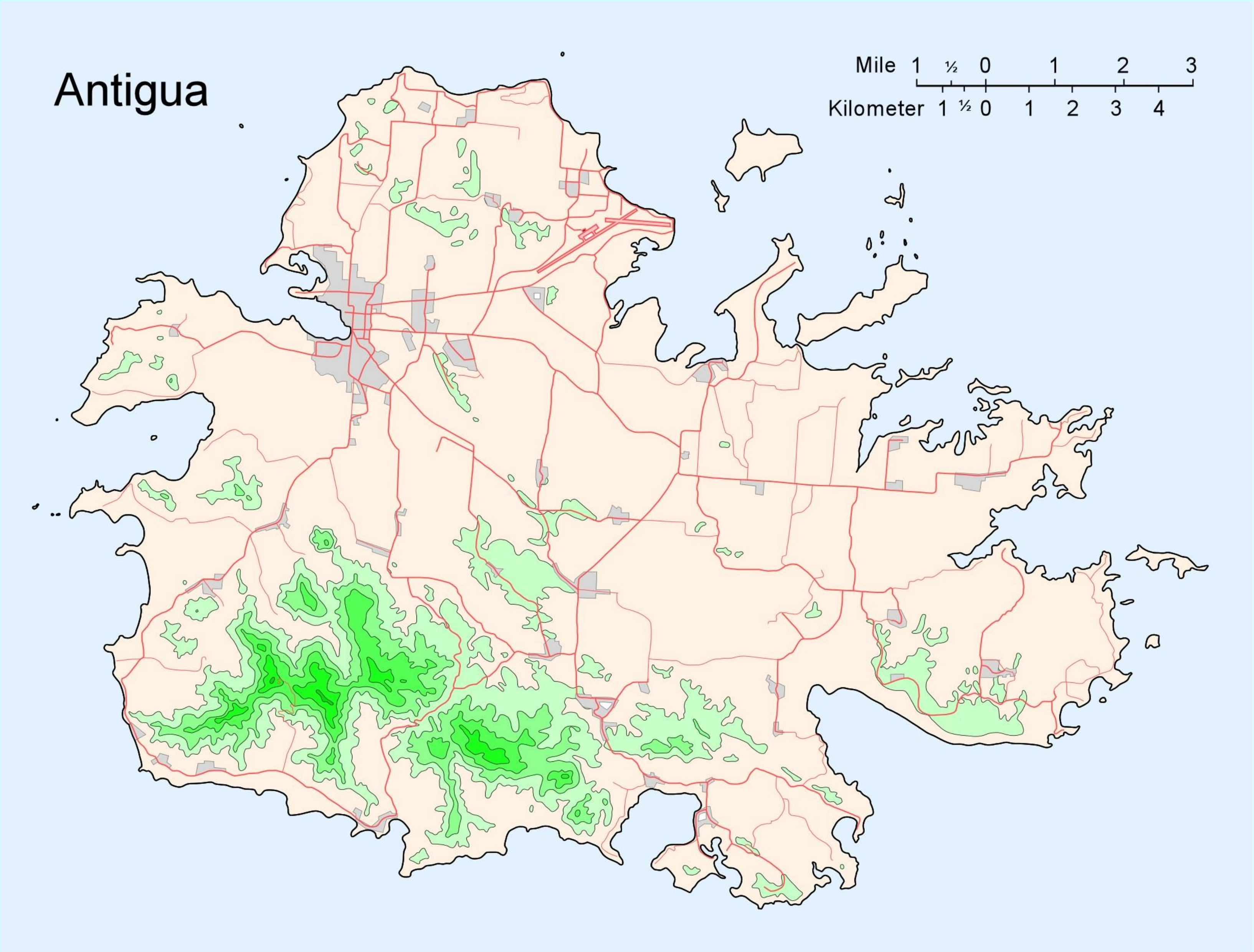
Additional Research

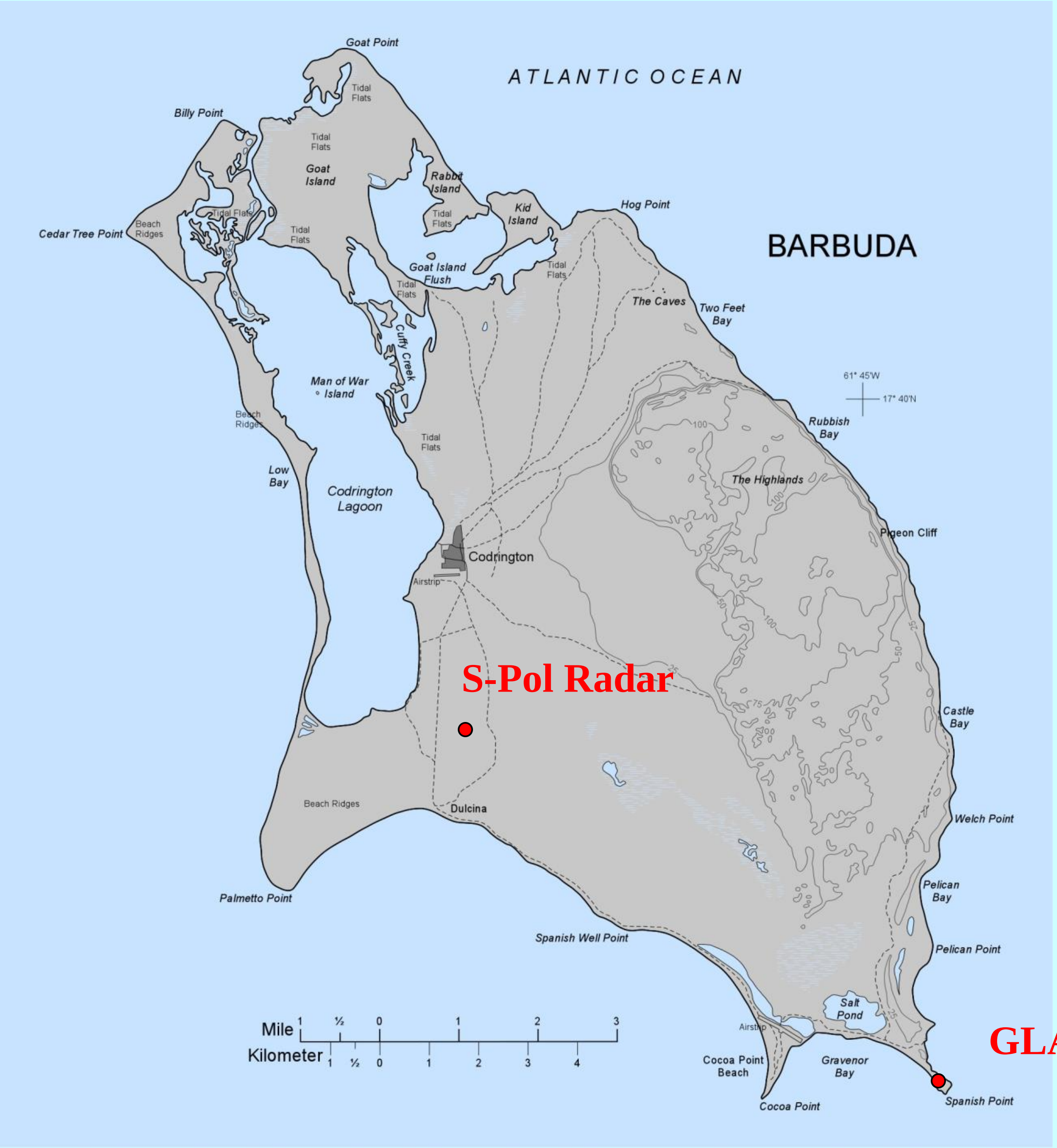
Research on the age of cloud parcels, the chemistry and origin of aerosols, radar remote-sensing, 4) cloud climatologies from satellites, and 5) the effects of clouds on radiation.

General Schedule of Operations for RICO facilities

	24 Nov 04 - 06 Dec 04	07 Dec 04 – 20 Dec 04	21 Dec 04 – 03 Jan 05	04 Jan 05 – 24 Jan 05
Spol Radar	×	×	×	×
NCAR C-130		×		×
Wyoming King Air		×		×
BAE 146				×
Seward Johnson				×
GLASS soundings		×	×	×
PAM-3		×	×	×


0
100mi
100km
Puerto Rico
Anguilla
Montserrat
Dominica
St. Lucia
Kingstown
Aruba
Grenada
©2001 AND Data Solutions B.V.
Codrington
Barbuda
Atlantic Ocean
Antigua and Barbuda
Miles 0 5 10
Kilometers 0 5 10 15
Saint John's
Antigua


Antigua
Mile 1 ½ 0 1 2 3
Kilometer 1 ½ 0 1 2 3 4

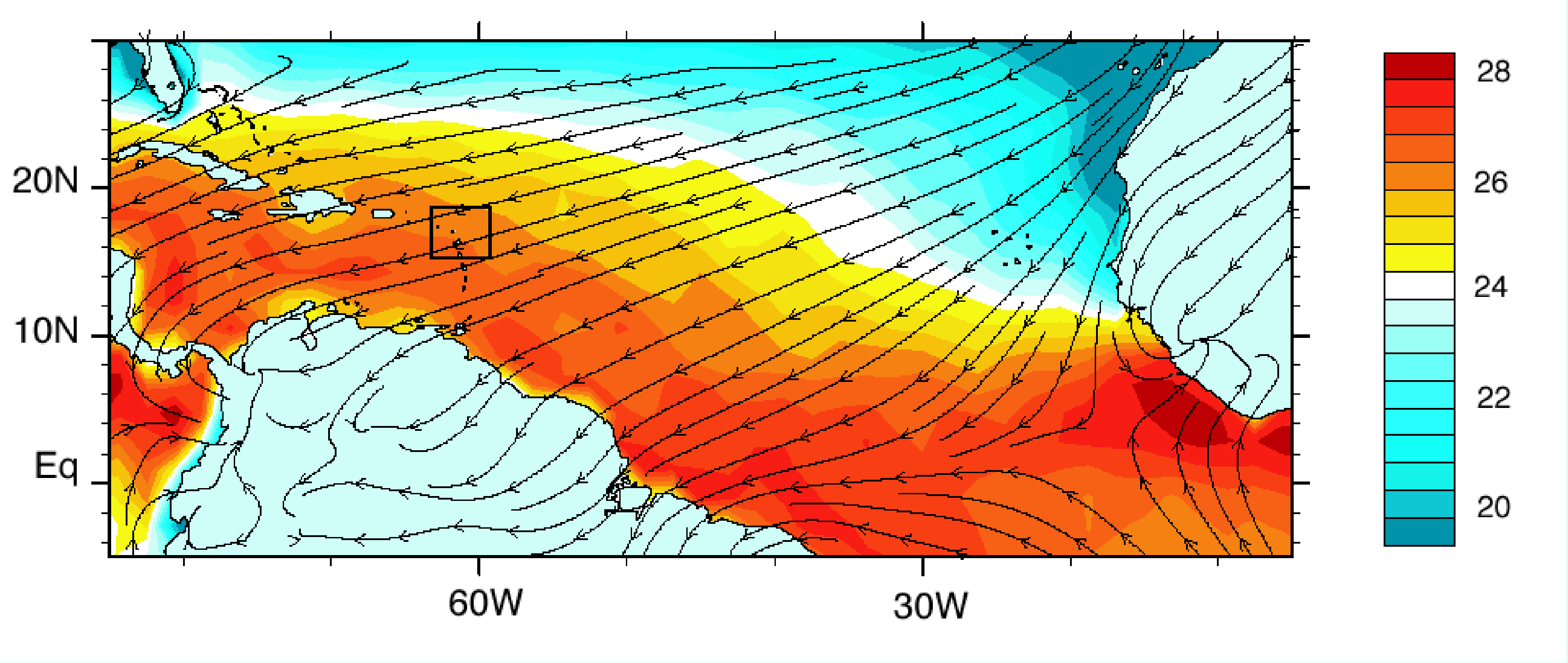


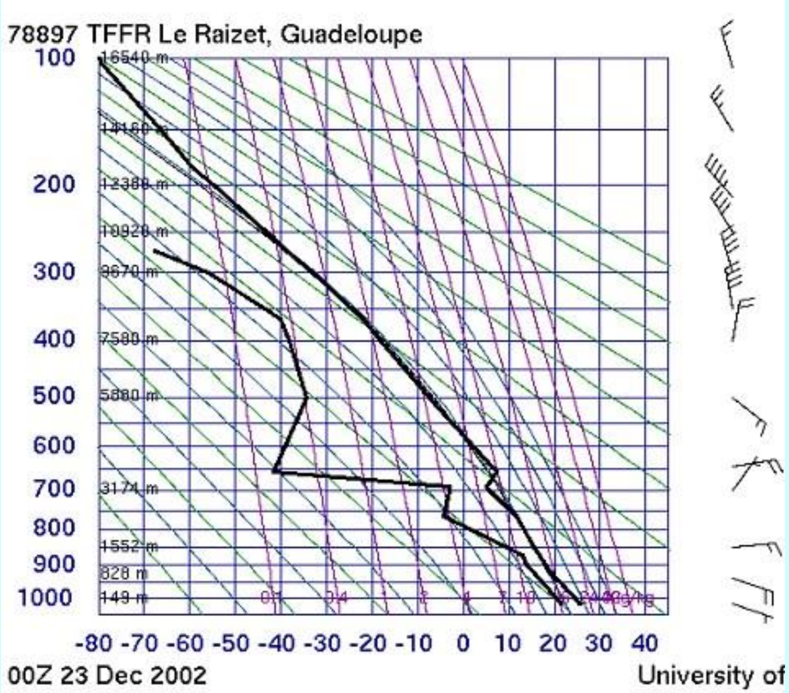
S-Pol Radar

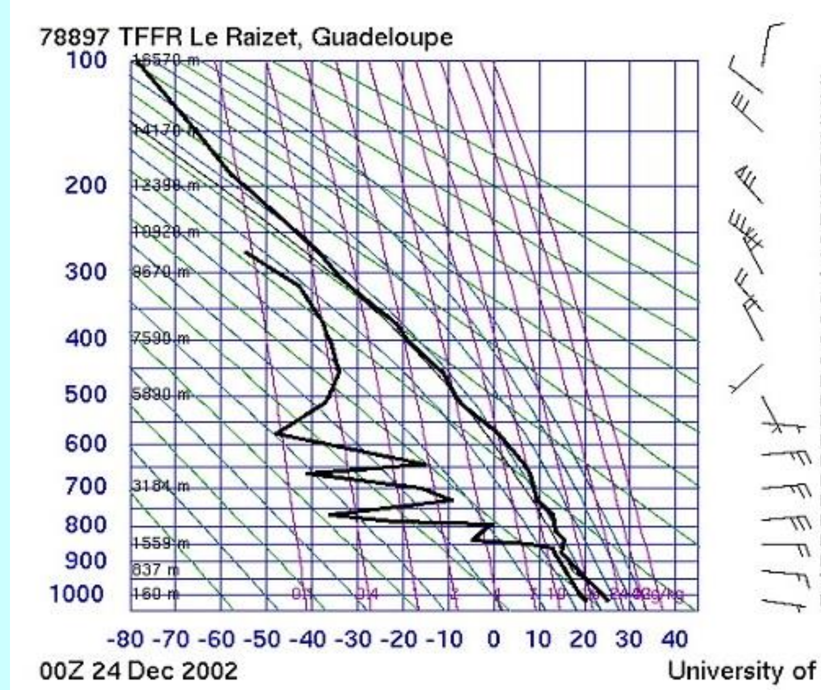
GLASS/PAM

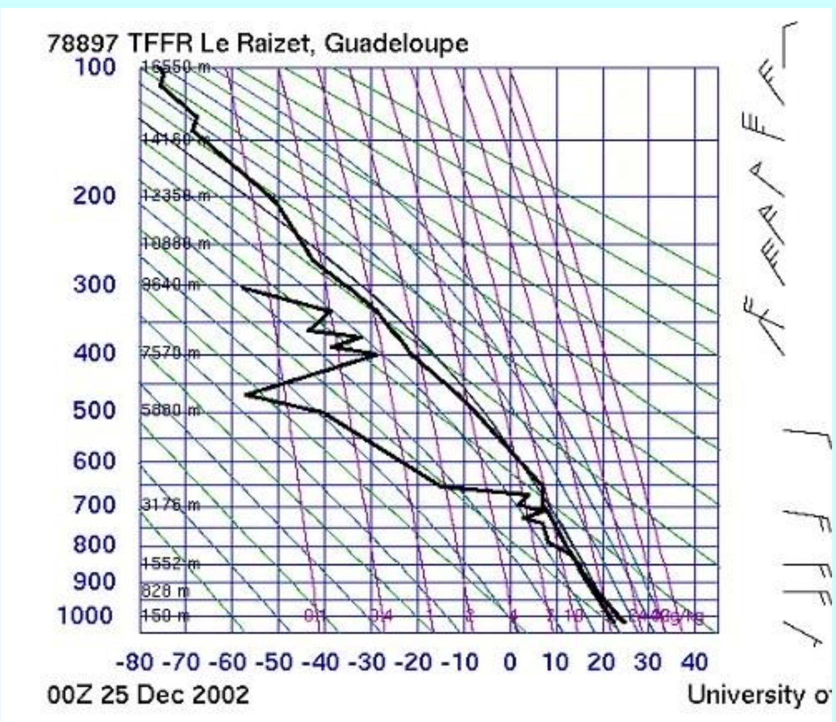

Puerto Rico (U.S.)
SAN JUAN
Bayamón
Carolina
Caguas
Mayagüez
Ponce
Arecibo
Aguadilla
Isabela
Quebradillas
Manatí
Vega Baja
Río Grande
Luquillo
Fajardo
Cabezas de San Juan
ISLA DE CULEBRA
Sonda de Vieques
Naguabo
Juncos
Humacao
Yabucoa
Cayey
Guayama
Coamo
Salinas
Santa Isabel
Guayanilla
Yauco
Guánica
Boquerón
San Germán
Cabo Rojo
Maricao
Adjuntas
Utuado
San Sebastián
Rincón
Añasco
Barranquitas
Comerío
Cerro de Punta
1338
El Yunque
1065
CORDILLERA JAICOA
CORDILLERA CENTRAL
Punta Agujereada
Punta Borinquen
Punta Higüero
Punta Guanajibo
Punta Las Tunas
Punta Puerto Nuevo
Punta Salinas
Punta Puerca
Punta Guayanés
Punta Tuna
Punta Ola Grande
Punta Brea
Punta Oeste
Punta Este
Isabel Segunda
Esperanza
ISLA DE VIEQUES
Pasaje de Vieques
ISLA DESECHEO
ISLA MONITO
ISLA MONA
Canal de la Mona
ISLA CAJA DE MUERTOS
Bahía Sucia
Bahía de Guayanilla
Bahía de Rincón
Grappler Bank
3440
3650
1670
55
801
35
20
70
2650
2940
3685
18
Scale 1:3,000,000
0 50 100 km
0 50 miles
67
Longitude West 66 of Greenwich

Mean streamlines for 10 m winds from NCEP climatology for January superimposed on sea surface temperatures. RICO experimental area is in the box.



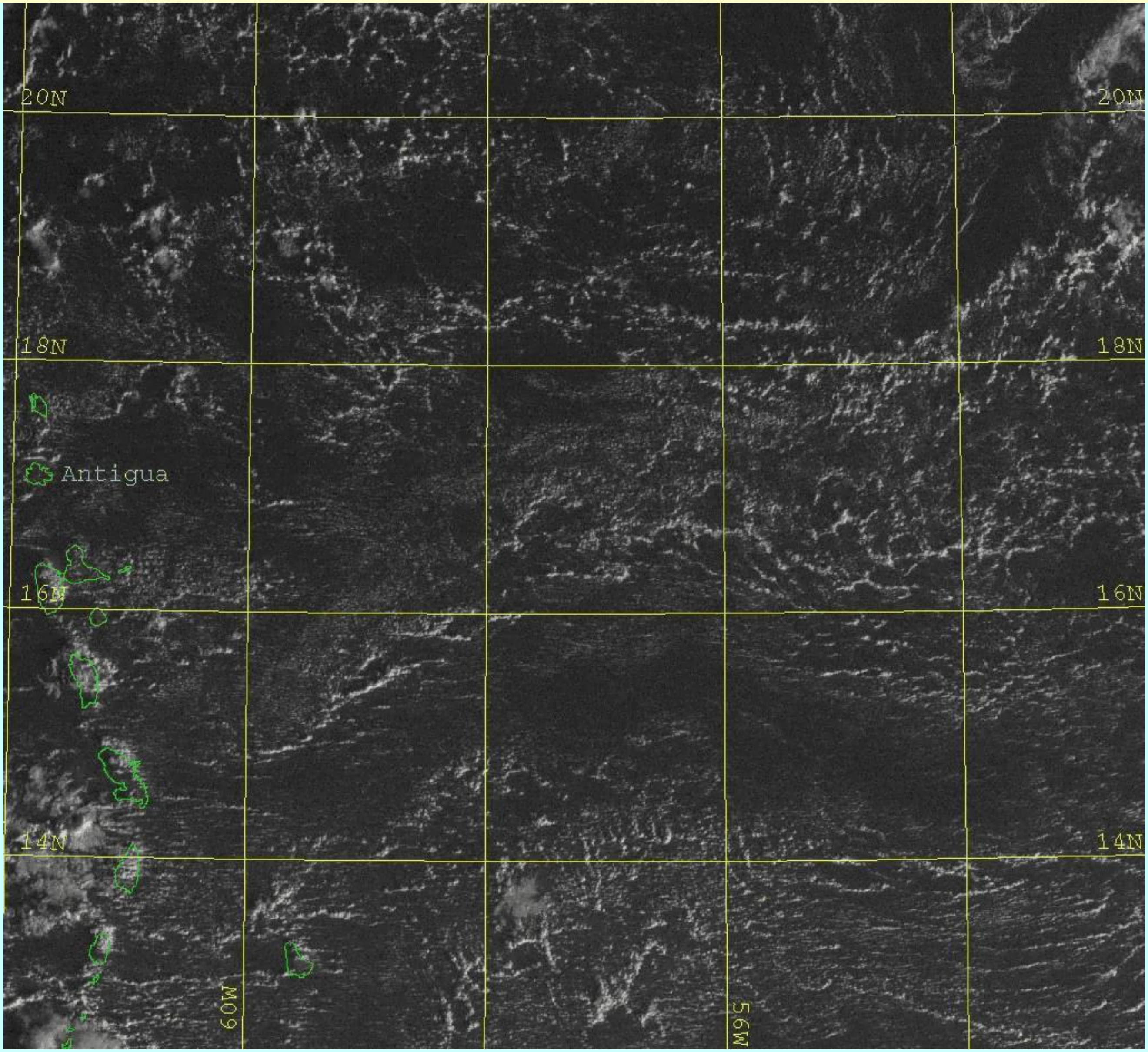






Three 00 UTC soundings from December 23, 24, and 25, 2002 from Le Raizet, Guadeloupe, about 175 km south of Barbuda.

Visible 1 km resolution GOES satellite image of the Atlantic Ocean east of Antigua and Barbuda on 17 December 2003 at 1115 UTC showing typical organizations of trade wind cumulus.



General principles for Missions

The following represent science-driven principles which we hope to guide mission choice and design:

1. Every C-130 flight will have segments designed to characterize aerosol near the sea surface and just below cloud base, and to determine area-averaged fluxes of heat, moisture, and momentum.

Baseline measurements will be flown in 30 km radius circles made at three levels: 1) a dropsonde segment, flown at (I + 1000 m), where I is the inversion height; 2) a near-surface segment; and 3) a cloud base segment flown at (LCL-100), where LCL is the lifting condensation level.

General principles for Missions

2. Flight operation areas will be defined with reference to the region scanned by the S-Pol radar. Changes in flight operation areas will be coordinated with the radar. Ship placement will be coordinated with S-Pol. The baseline measurements in (1) above will be made with reference to the ship and radar.

3. Three types of studies will be conducted: 1) Statistical Studies (Eulerian, environmental sampling and unorganized convection), 2) Process studies (Lagrangian – sustained organized cloud systems, targets of opportunity), and 3) Coordinated studies (e.g. special coordination with ship remote sensing scans, intercomparison flights).

General principles for Missions

4. During periods of cloud penetrations for statistical sampling of cloud properties, each aircraft will sample at a single flight level for at least 30 minutes, and preferably longer, before changing levels. During flights, clouds will be sampled at a variety of levels by each aircraft.

5.A high priority will be to take advantage of targets of opportunity when they move into the radar domain. Targets of opportunity include 1) long steady cloud lines; and 2) long lived cloud clusters with emergent convective towers.

6. The S-Pol scan strategies must meet two objectives: 1) gather adequate statistics on rainfall in trade wind cumulus and 2) obtained detailed measurements to support cloud microphysical studies.

General principles for Missions

7. Flight levels for statistical sampling will be at fixed increments with respect to the lowest in-cloud level (LCL+ 100 m) or the ocean surface (S). Rainshaft sampling will be S + 300 m. The exact levels will be chosen based on our experience with the clouds during the radar only period. One flight level (H) will be chosen to sample the tops.

8. Flights will be scheduled to maximize opportunities to sample Saharan dust events if they occur and to coordinate with overpasses of polar orbiting satellites.

Evaluation of the measurements in the field

Six working groups will be responsible for evaluating data quality and assessing the data to determine if it is satisfactory to address the scientific goals of RICO

1. Cloud and raindrop spectra
2. Aerosol measurements (including CCN, UGN, CVI etc.), Atmospheric chemistry measurements
3. Soundings (Dropsondes, GLASS, Aircraft, Ship etc., and aircraft state parameters/LWC/Turbulence
4. Remote sensing (SpolKa, WCR, SABL, Ship remote sensors)
5. Satellite
6. Forecasting

RADAR-ONLY PERIOD November 24 to December 6

Technical questions related to radar operations:

- How should a volume sector be defined to maximize opportunities to observe entire cloud lifecycles with sufficient temporal and spatial resolution?
- What is the best scanning strategy to define cloud heights with sufficient accuracy?
- How can the K-Band be used most effectively?
- Where is sea clutter a problem and what are there wind/wave conditions where sea clutter is particularly bad?
- What is the utility of using PPI vs RHI scans?
- What standard levels should the aircraft fly based on cloud depths and lifetimes?
- What is the best PRF to use?
- Should we oversample?

S-POLKa RADAR OPERATIONS

Table 3.1: Beam geometry for the S-Pol radar.

Angle	Distance													
	15	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**
0.75	0.23	0.31	0.39	0.47	0.56	0.64	0.73	0.83	0.92	1.02	1.12	1.23	1.34	1.45
1.75	0.50	0.66	0.83	0.99	1.17	1.34	1.52	1.70	1.88	2.07	2.26	2.45	2.65	2.84
2.75	0.76	1.01	1.26	1.52	1.78	2.04	2.30	2.57	2.84	3.11	3.39	3.67	3.95	4.24
3.75	1.02	1.36	1.70	2.04	2.39	2.73	3.09	3.44	3.80	4.16	4.52	4.89	5.26	5.63
4.75	1.28	1.70	2.13	2.56	2.99	3.43	3.87	4.31	4.76	5.20				
5.75	1.54	2.05	2.57	3.08	3.60	4.13	4.65							
6.75	1.80	2.40	3.00	3.60	4.21									
7.75	2.06	2.75	3.43	4.12										
8.75	2.32	3.09	3.86											
9.75	2.58	3.43	4.29											
10.75	2.84	3.78												
11.75	3.09	4.12												
12.75	3.35													
13.75	3.60													
14.75	3.86													
15.75	4.11													
Beam Width (km)														
	0.26	0.35	0.44	0.52	0.61	0.70	0.79	0.87	0.96	1.05	1.13	1.22	1.31	1.40

Angle	Distance													
	85	**90**	**95**	**100**	**105**	**110**	**115**	**120**	**125**	**130**	**135**	**140**	**145**	**150**
0.75	1.56	1.68	1.80	1.92	2.05	2.18	2.31	2.44	2.58	2.72	2.86	3.01	3.16	3.31
1.75	3.05	3.25	3.46	3.67	3.88	4.10	4.31	4.54	4.76	4.99	5.22	5.45	5.69	5.93
2.75	4.53	4.82	5.11	5.41	5.71	6.01	6.32	6.63	6.94	7.25				
Beam Width (km)														
	1.48	1.57	1.66	1.75	1.83	1.92	2.01	2.09	2.18	2.27	2.36	2.44	2.53	2.62

Sector scanning mode:

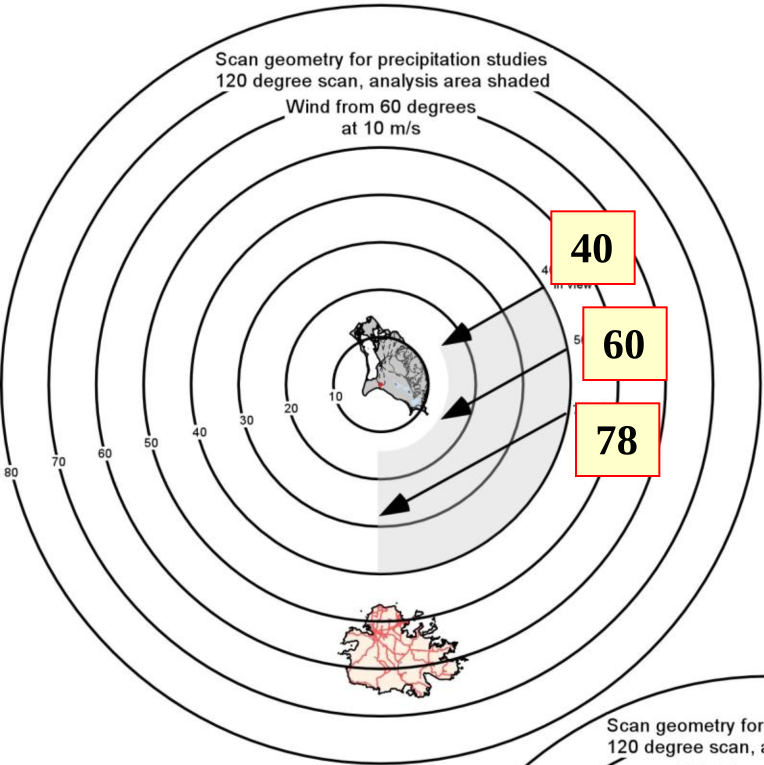
Radar sampling of clouds through complete life cycles

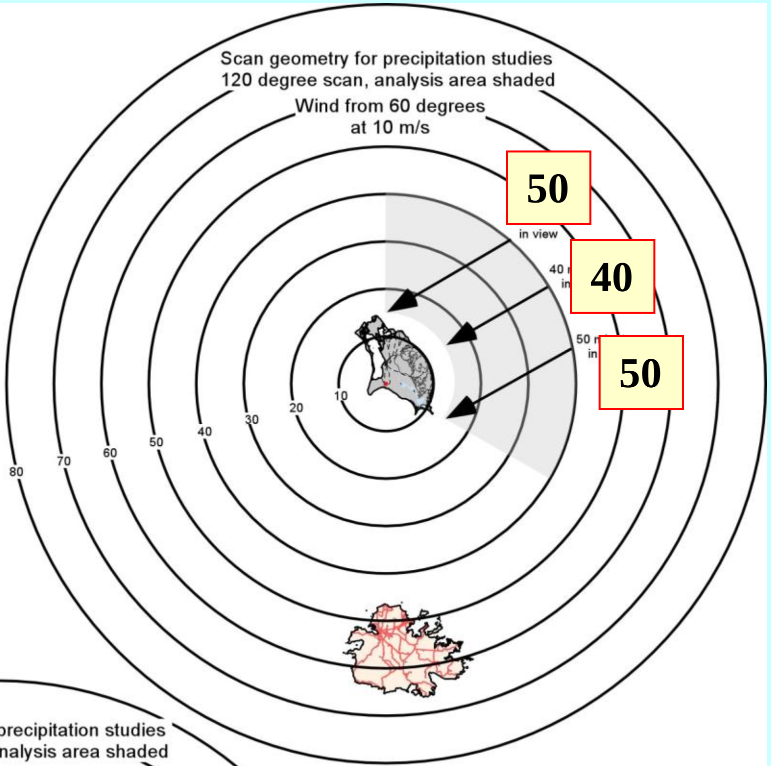
Expected cloud lifetimes: ~ 30 – 40 minutes

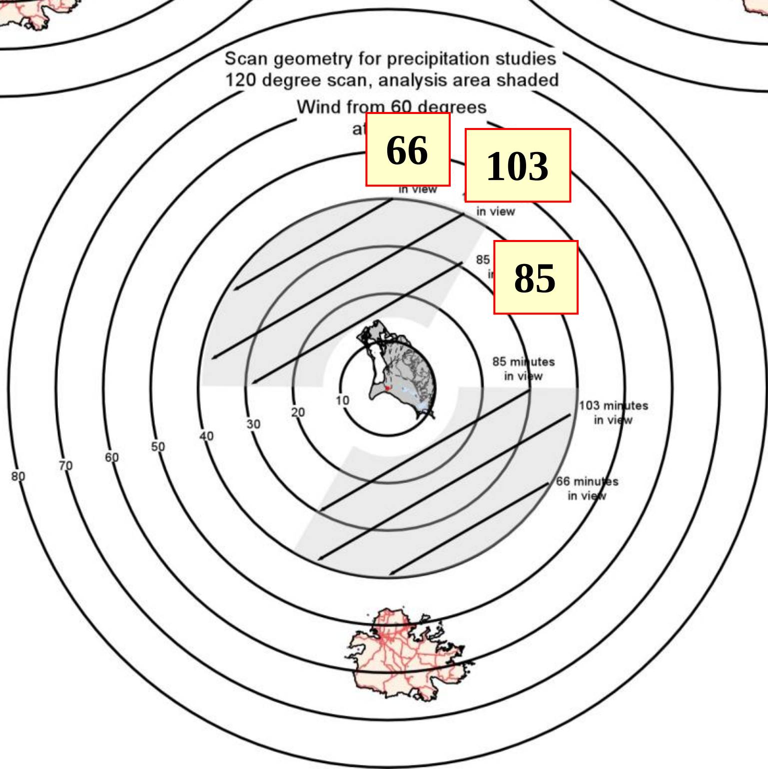
Require ~ 10 complete sample volumes/cloud lifetime

Example: PRF = 1000 s^{-1}
64 pulses/average for Z_H and Z_V (128 total)
Scan rate of 8 degrees/sec
Averaging volume = 1.02 degrees
12 elevations

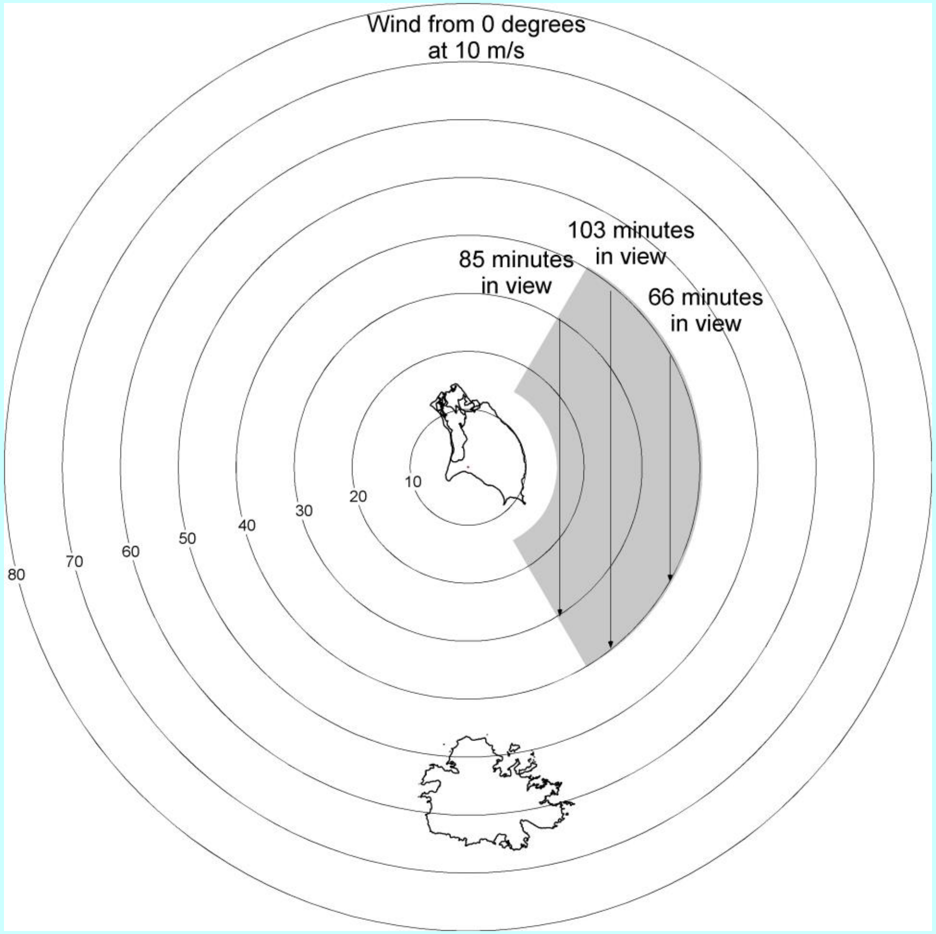
120 degree sector can be scanned in 3.5-4.0 minutes

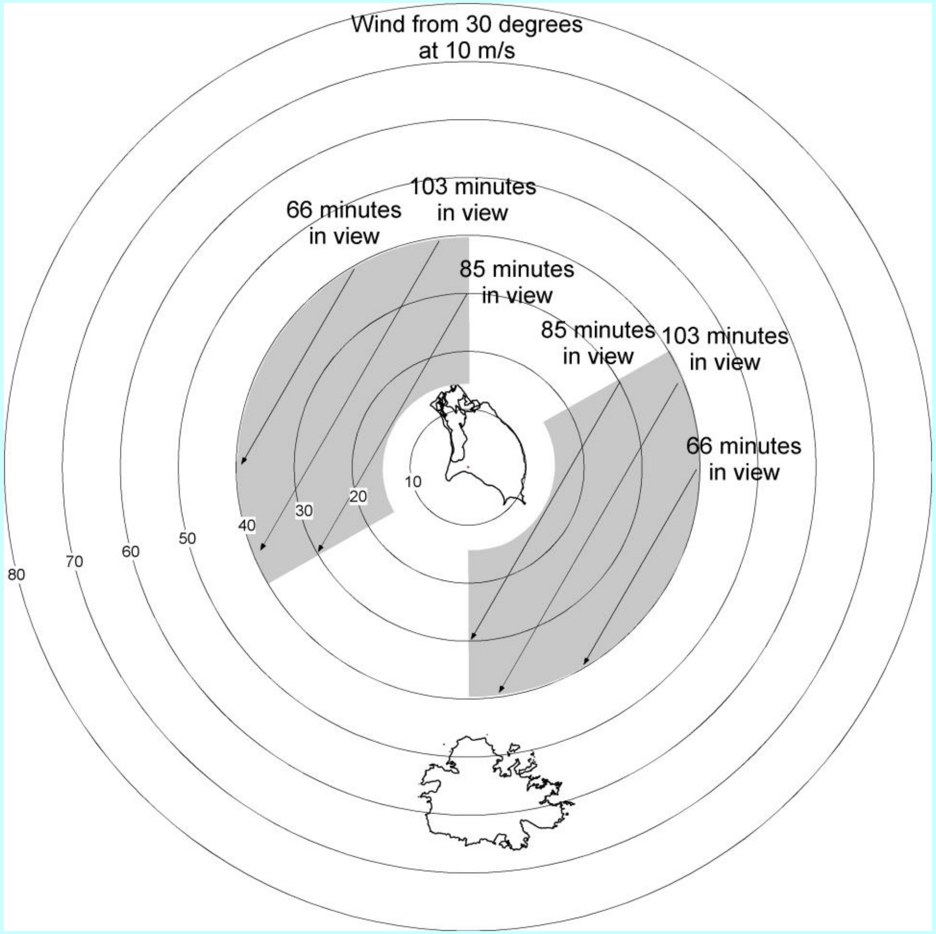




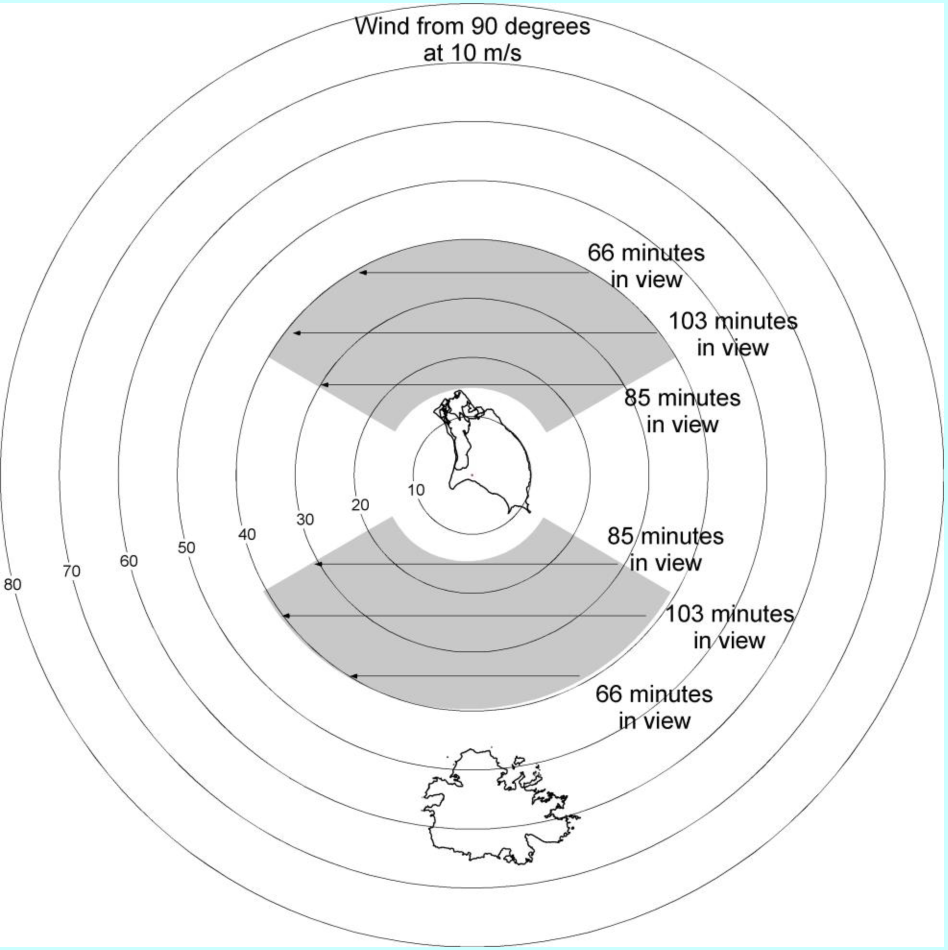


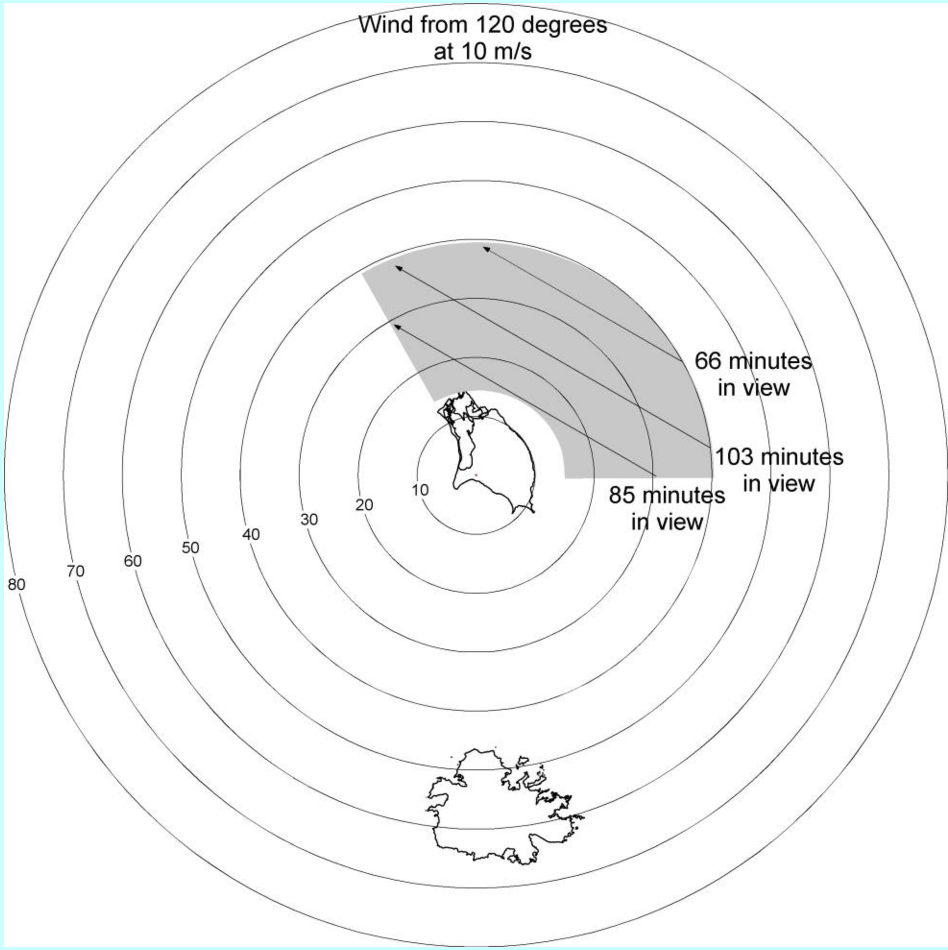
Examples of 120 degree sectors and the time (min) a cloud would be within the 15-40 km range of the radar for a 60^{o} wind



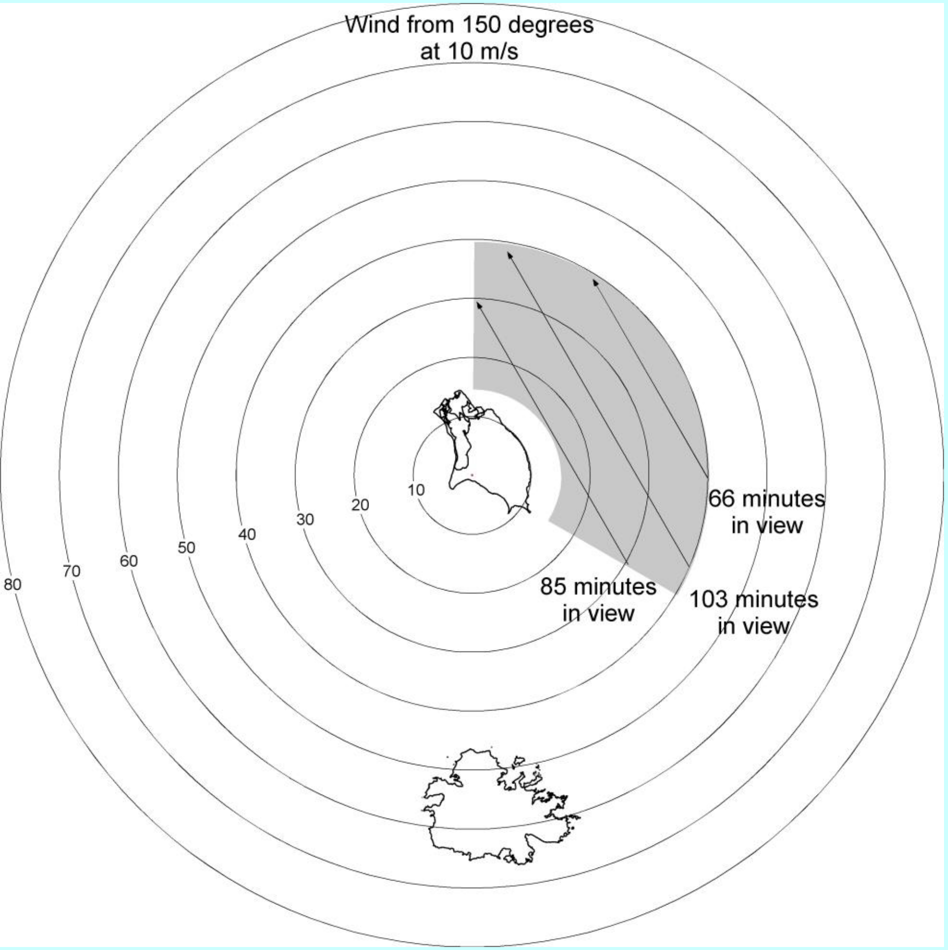


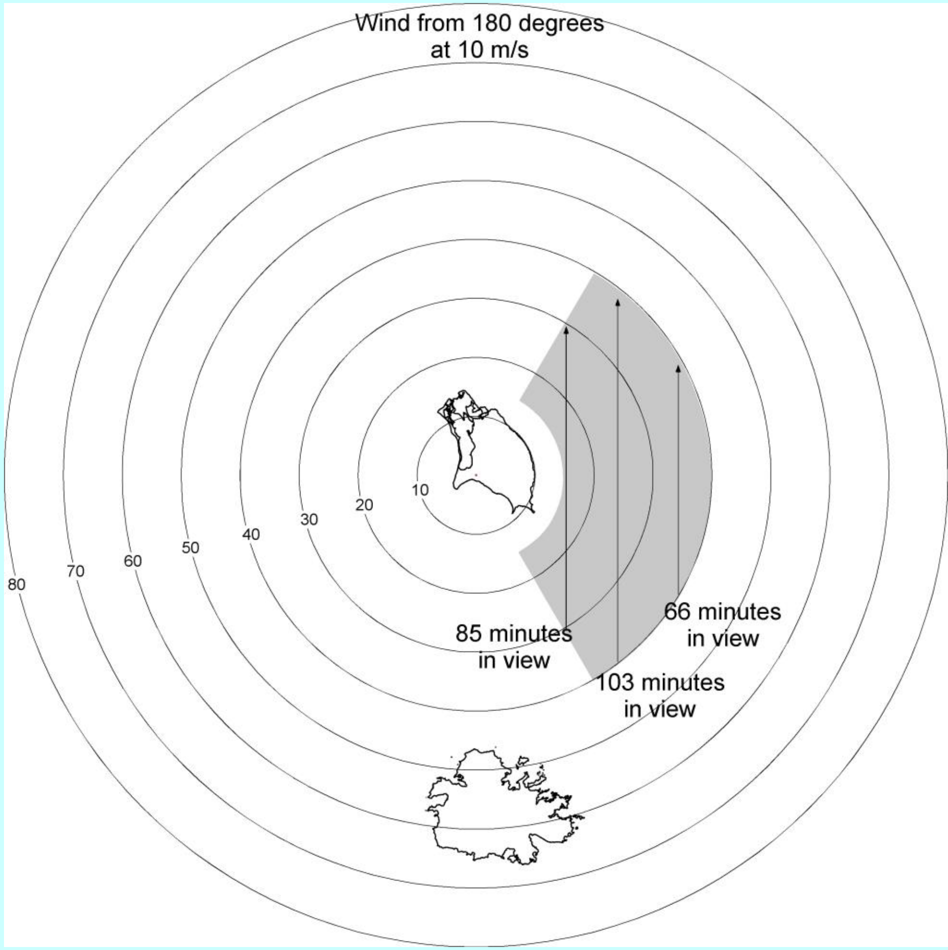
Preferred sectors for winds from 0^o and 30^o





Preferred sectors for winds from 90^{o} and 120^{o}



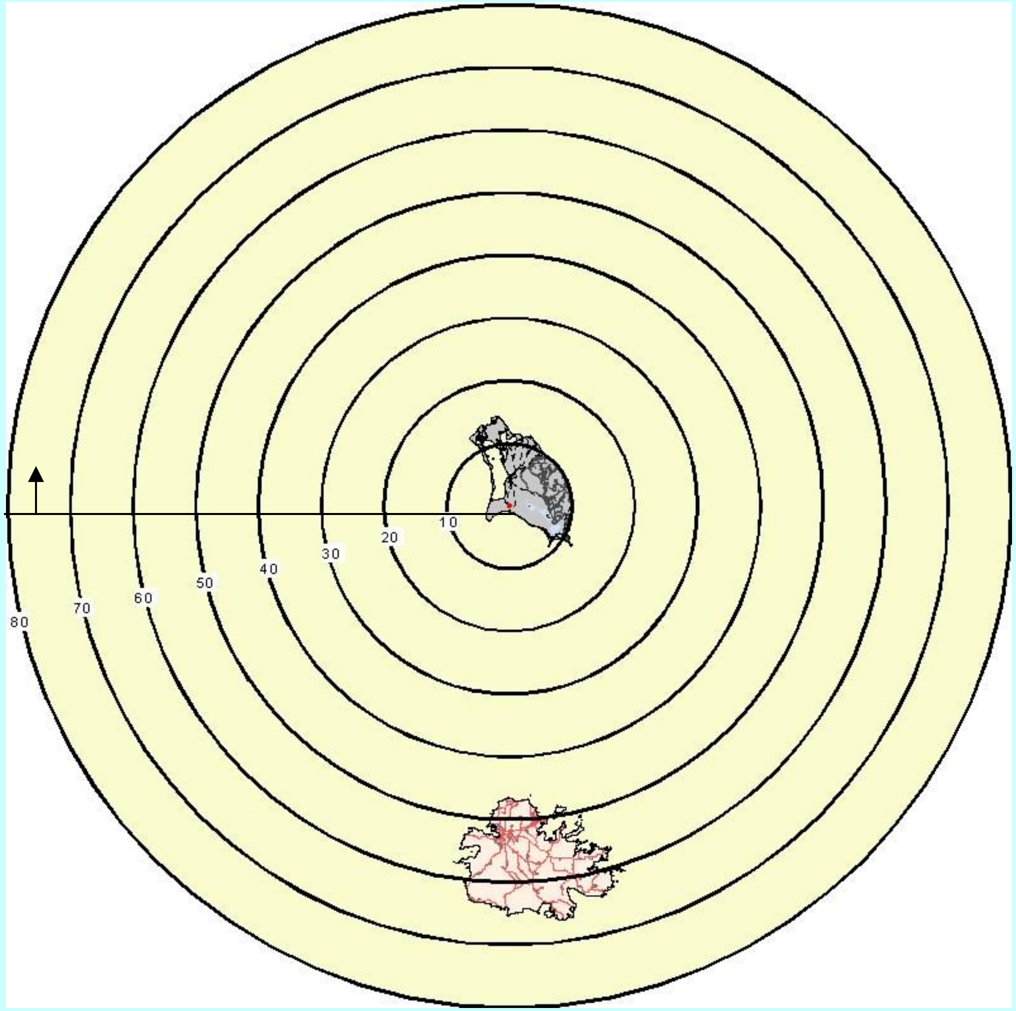


Preferred sectors for winds from 150^{o} and 180^{o}

Surveillance scan:

Lowest elevation 360^o scan for routine surveillance, timed with GOES satellite image once per hour

8^o sec = 45 sec



RHIs

1. Routine RHI to sample trade wind inversion.

   Single RHI from 0^o to 90^o elevation taken from edge of sector scan upward at the end of a volume approximately one-half hour from surveillance scan

RHIs

2. Targeting cloud lifecycles:

128 samples
12 degree elevation
Adjacent 1^o beams in azimuth

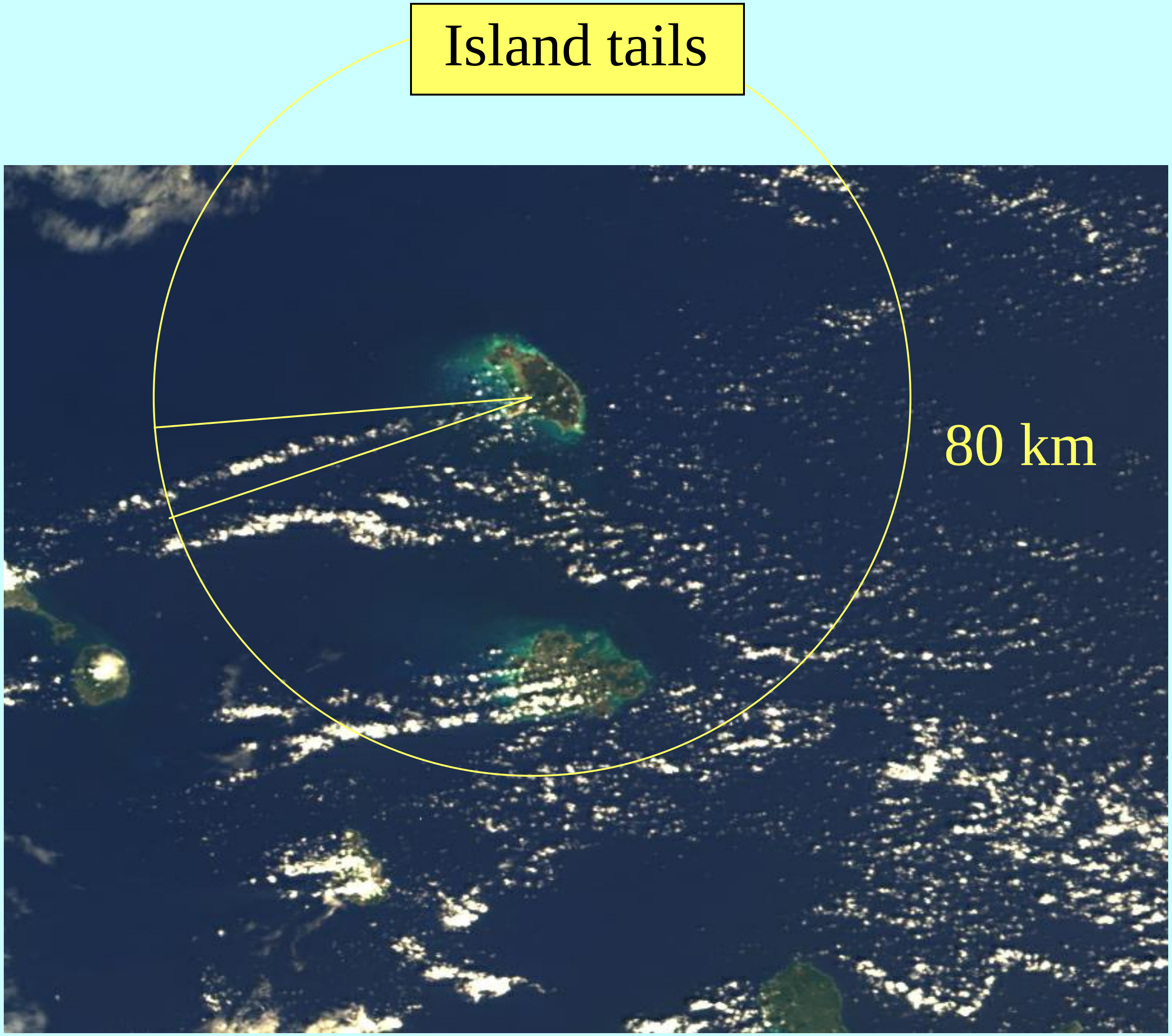
3 to 4 minute repeat sampling requires no more than 30^o azimuth

Advantage: Very high vertical, essentially instantaneous view of cloud structure

Disadvantage: With clouds moving 10-15 m/s, it will be difficult to track cloud in any direction other than directly into the wind or directly downwind, since the RHI sector will have to be shifted continually without guidance about where the target cloud is located .

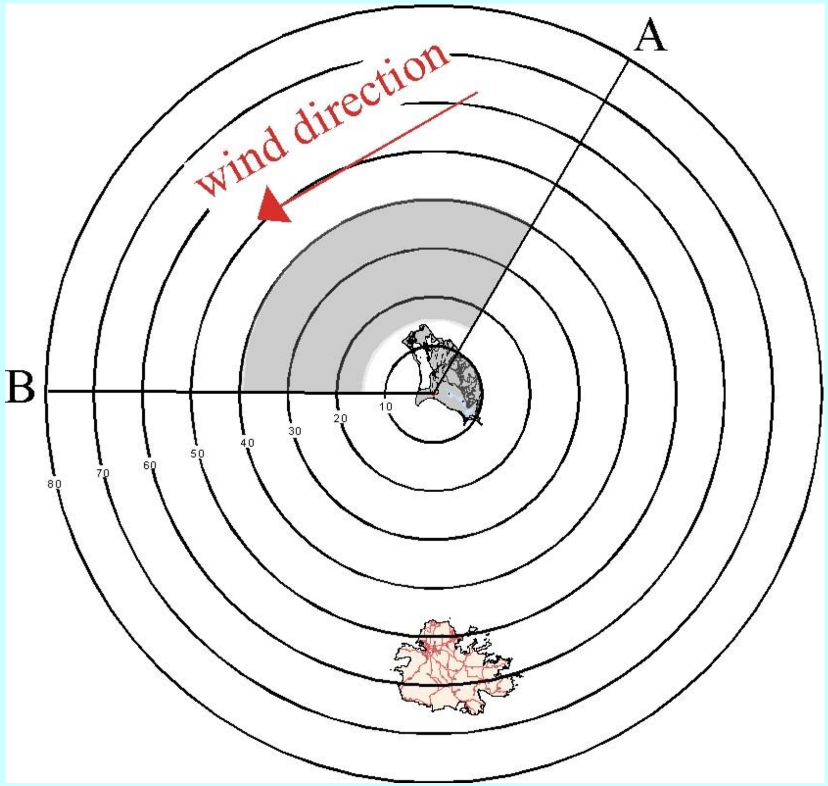
Disadvantage: Only one cloud can be targeted, since clouds at different distances cross 30^o sector at different rates

Special opportunity to observe cloud lifecycles with RHIs:



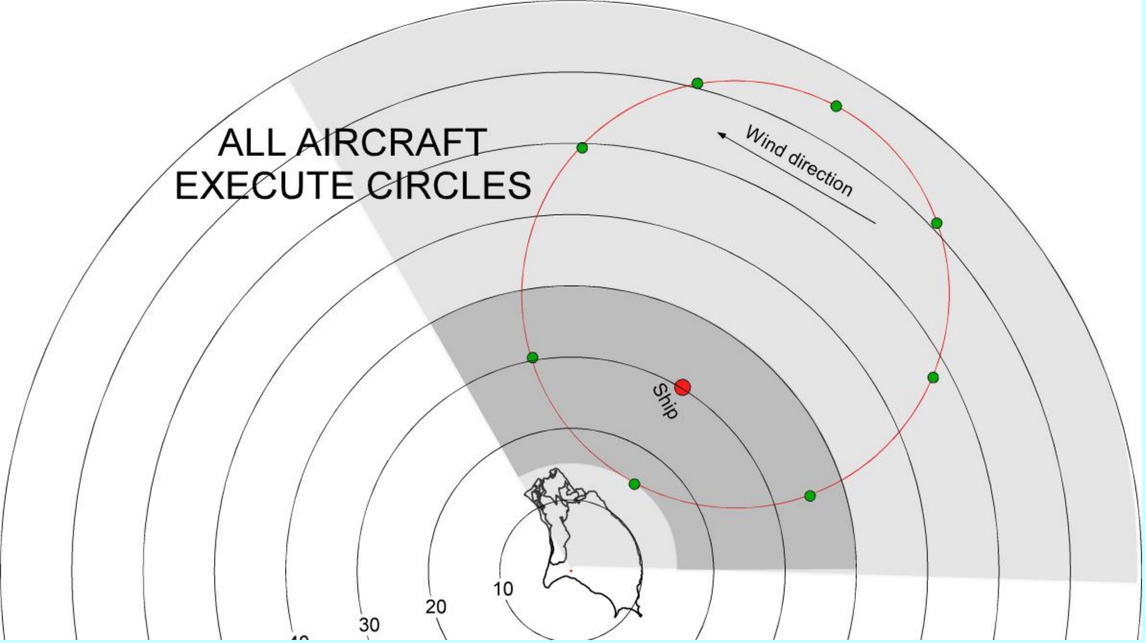
Proposed Standard sequence repeated each hour:

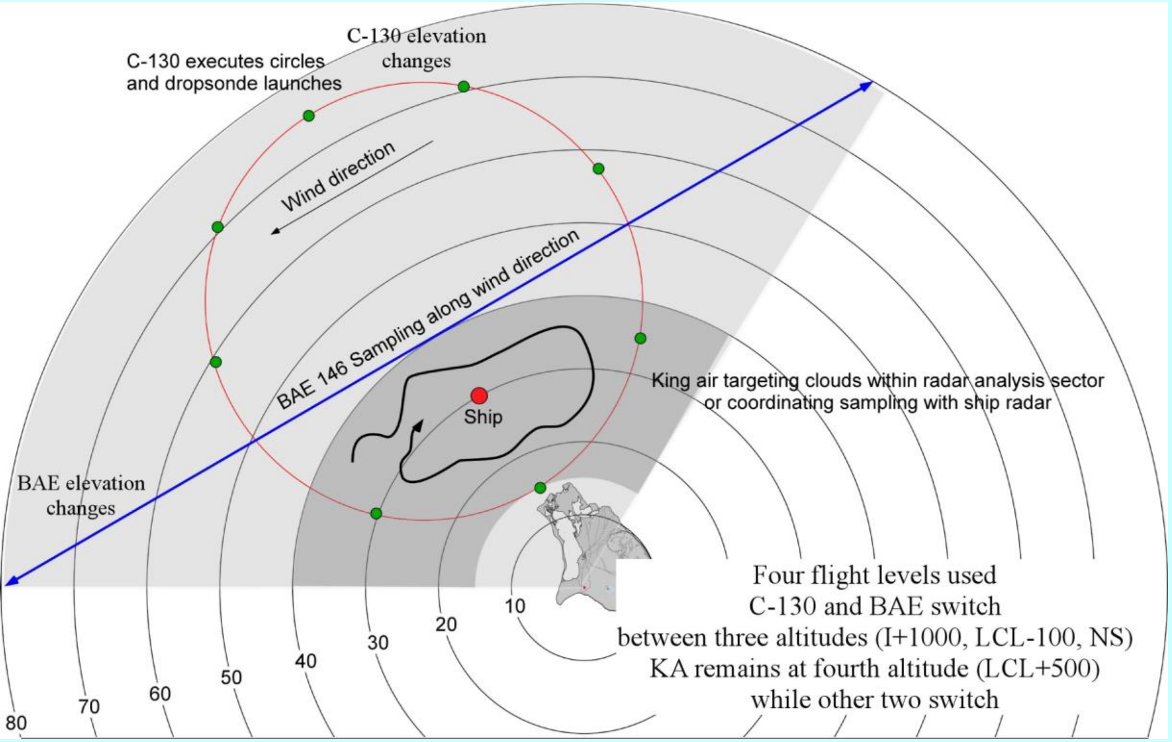
1. Surveillance scan A/0.75° El to A/0.75° (45 sec)
2. Sector volume A to B to A to B
   (12 scans ending at A) (~ 3.5 min)
3. Repeat (2) 7 times (~28 min)
4. RHI at A from 0.75° to 90° and return to 0.75°. (30 sec)
5. Repeat (2) 7 times (~28 min)



To be tested and refined during radar only period

FLIGHT OPERATIONS





Statistical studies

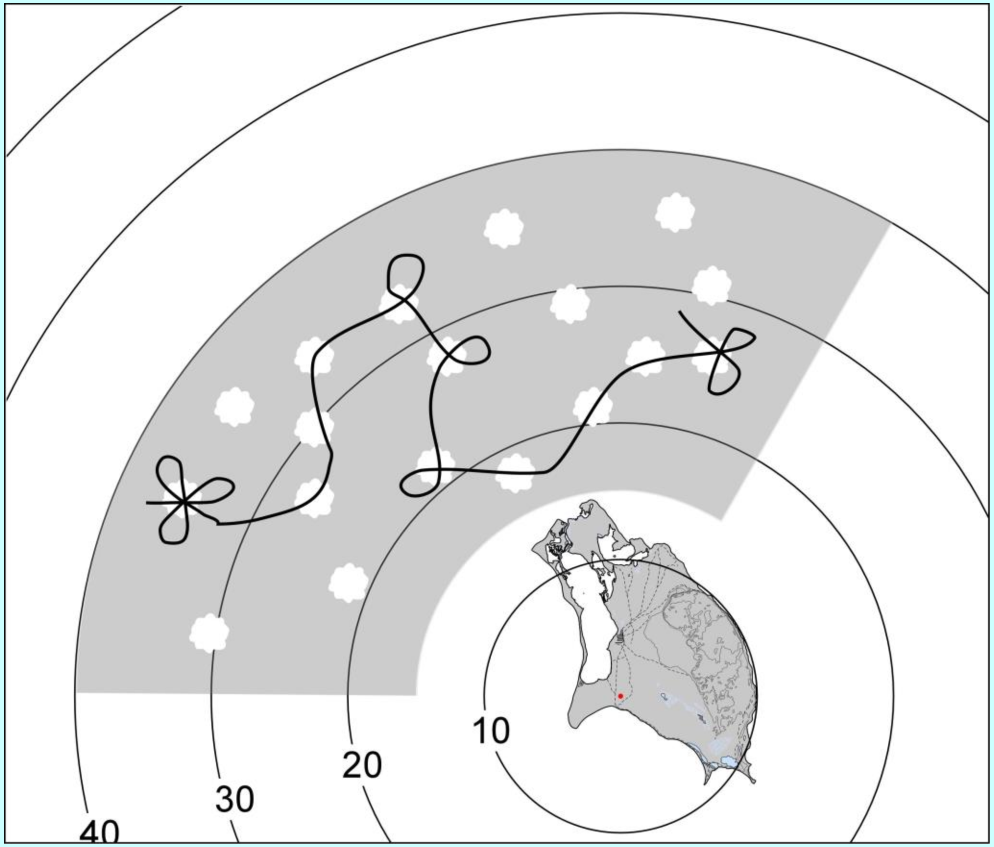
Characterization of the trade wind environment

Two potential options

Aircraft will obtain data to determine surface fluxes of heat, moisture and momentum, aerosol characteristics including giant CCN, thermodynamic profiles, the structure of the trade wind inversion, and the cloud distribution and structure.

Statistical sampling of cloud properties

Flight pattern will consist of a series of constant altitude legs that intersect as many clouds and rainshafts as possible, within a wide sector. Flight levels for statistical sampling will be at fixed increments with respect to the lowest in-cloud level (LCL+ 100 m) or the ocean surface (S).

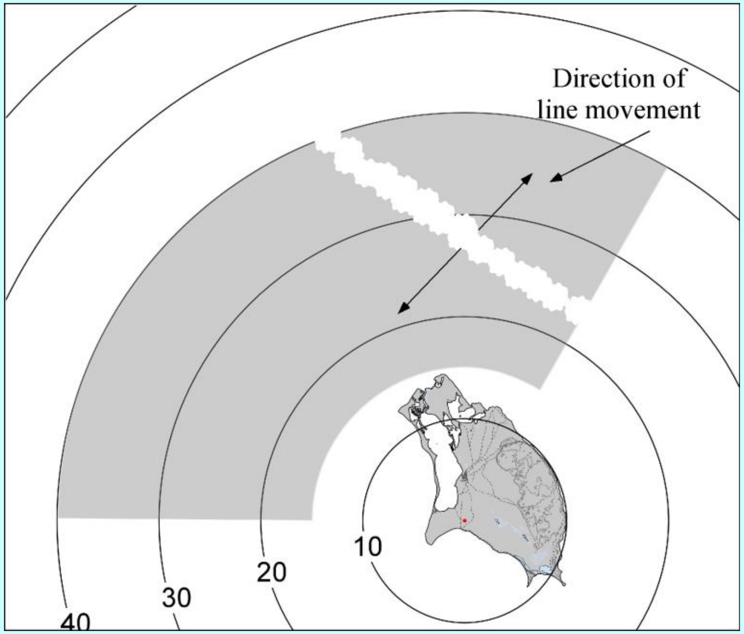


Targets of opportunity: Cloud lines

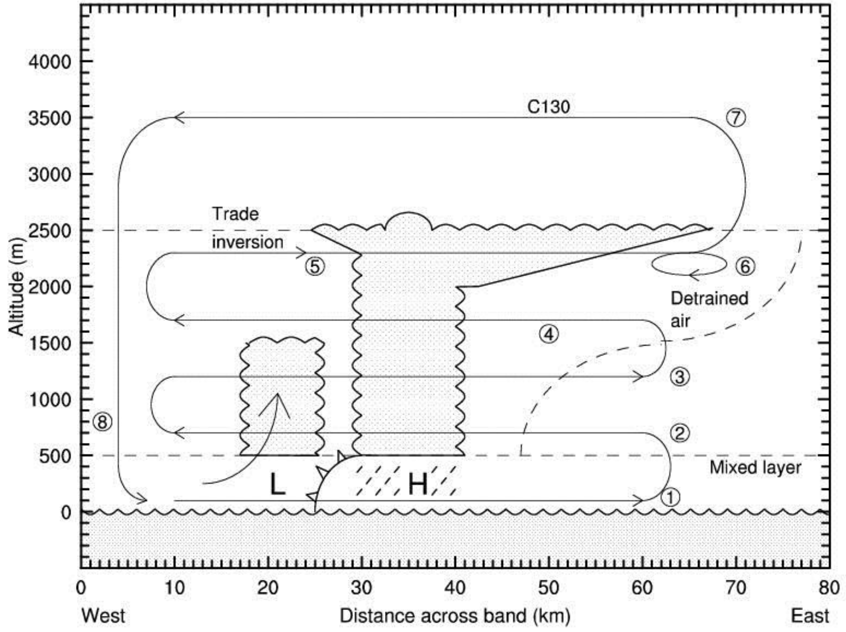
Flight plan involves C-130, King Air.

C-130: cover entire extent from the surface to about 1 km above cloud top.

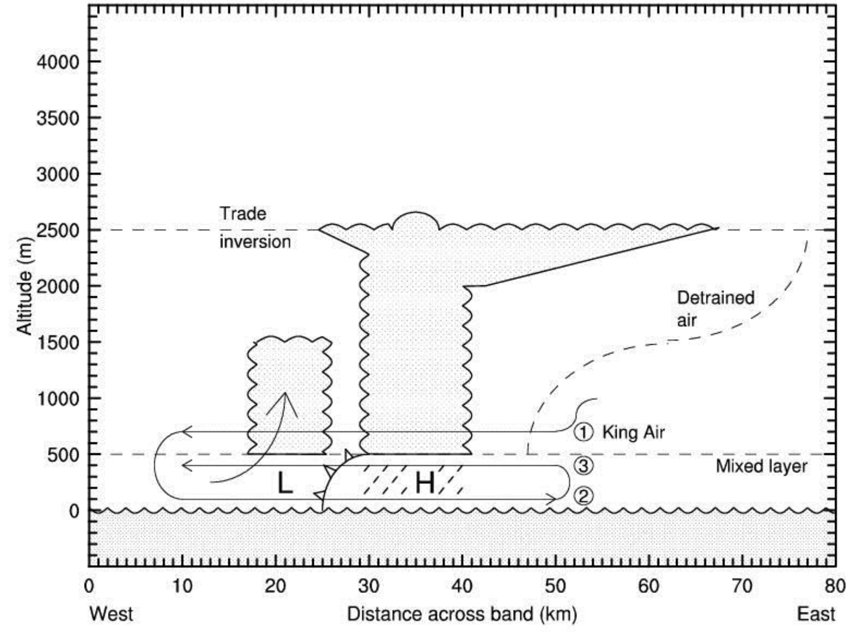
King Air: Concentrate on altitudes from near surface to above cloud base.



C-130

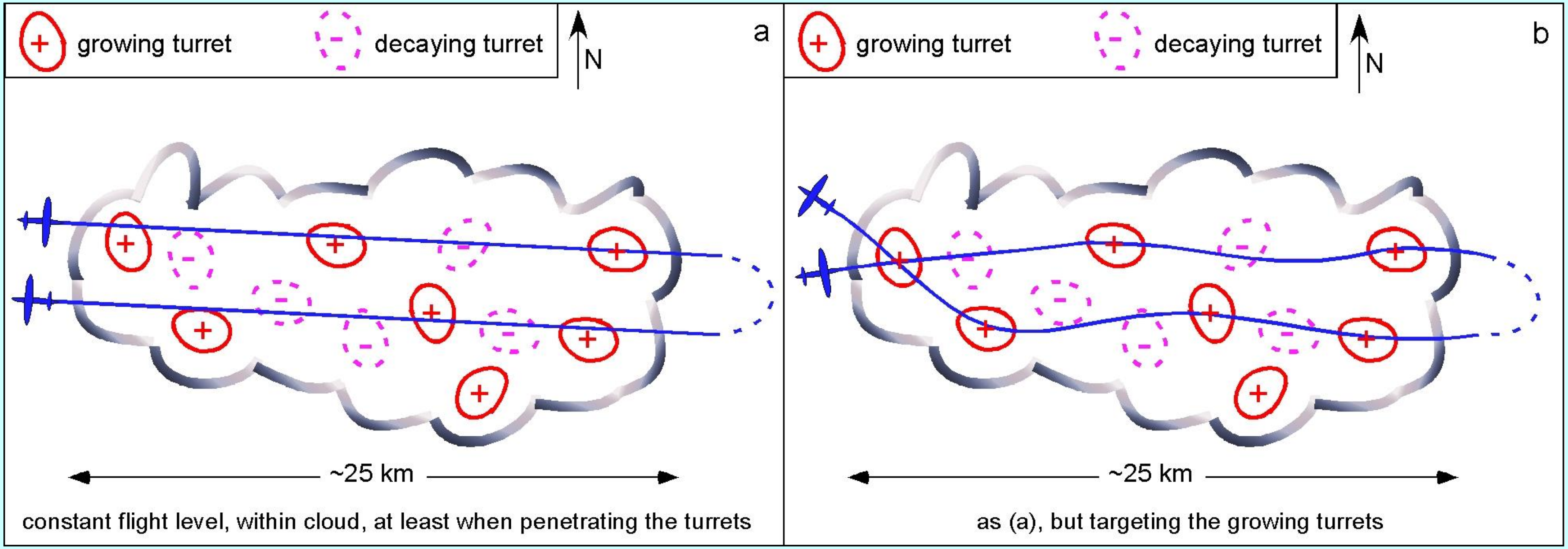


King Air



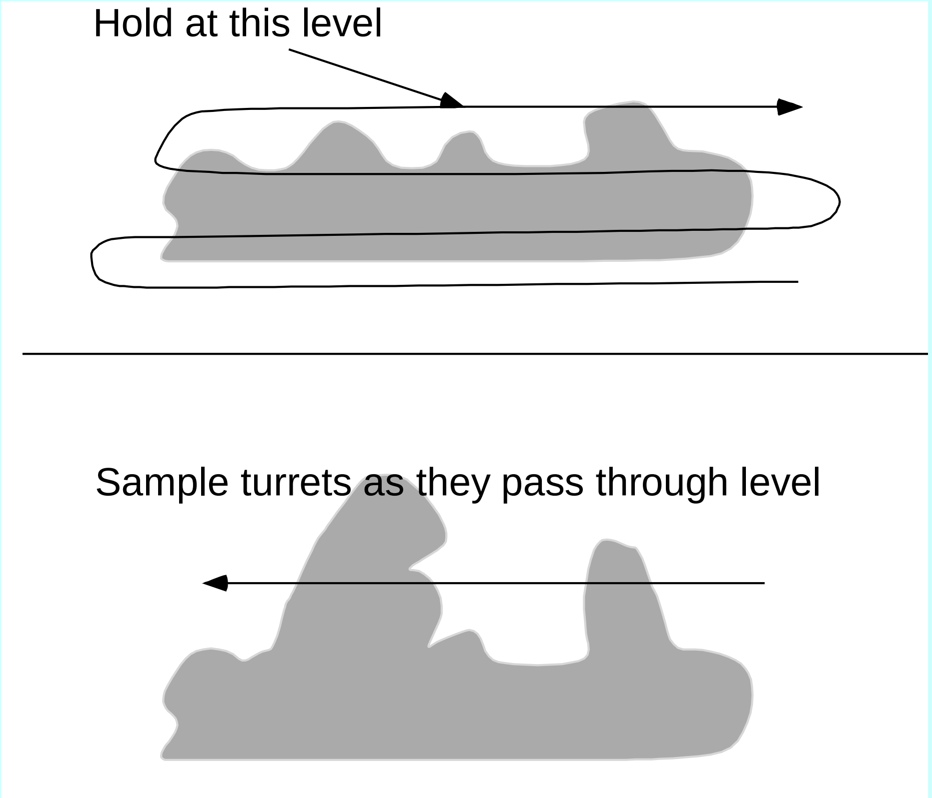
Targets of opportunity: Cloud clusters

Long lived cloud clusters, with emergent cloud towers. Our goal is to understand the influence on the low level cloud patch on rain formation in the emerging towers.

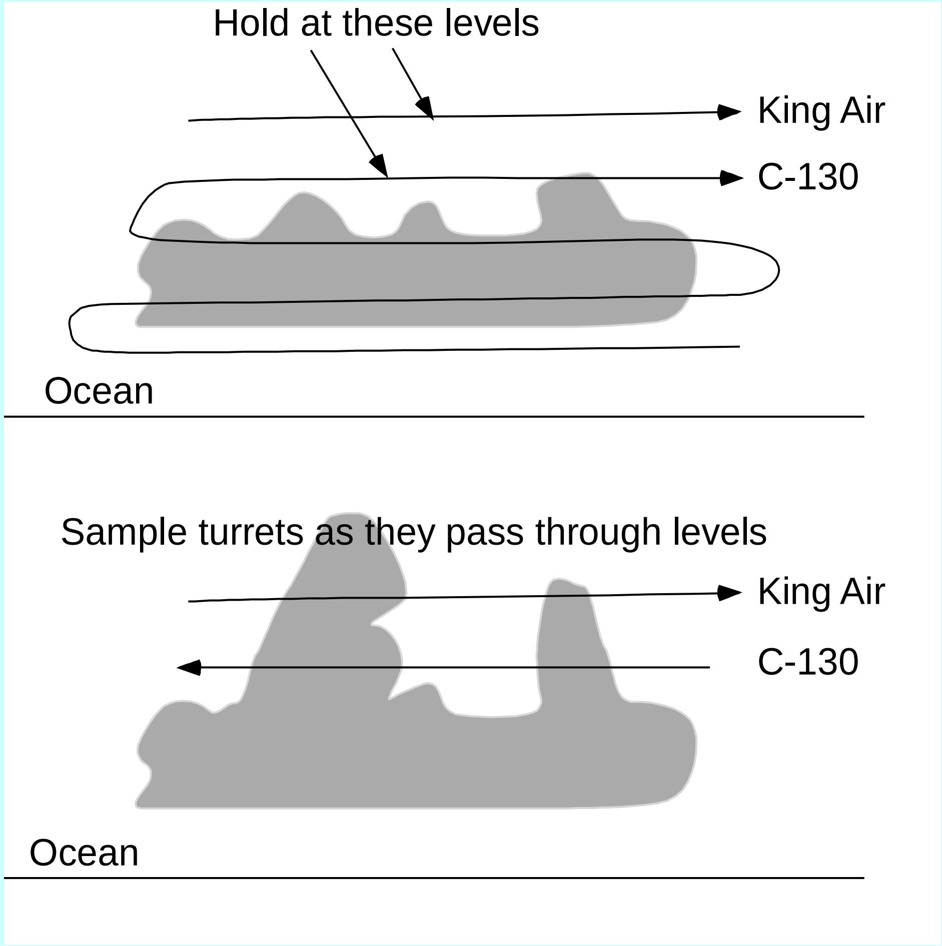


Vertical cross section showing potential sampling strategies For cloud patches with emerging towers

Single aircraft



Two aircraft (or three)



RICO Graduate Seminar Series

New concept for field campaign:

"RICO Graduate Seminar Series"

Last three weeks of the field campaign (i.e., in early January)

ALL SCIENTISTS SHOULD VOLUNTEER TO GIVE A SEMINAR!!!!

The RICO Graduate Student Seminar Series: 5-22 January 2005

Date	Speaker	Title
05 January 05	Rauber and Ochs	RICO: Overview of the field experiment
06 January 05		
08 January 05		
09 January 05		
11 January 05		
12 January 05		
14 January 05		
15 January 05		
17 January 05		
18 January 05		

RICO Student Flight

A special aspect of RGSS will be a dedicated flight of six hours that will be designed by participating students.

The students will coordinate this flight with radar operations, and design the flight to be consistent with the goals of RICO.

The flight will take place at the end of the RGSS.

Students coordinate and analyze data from this flight and will encourage them to publish their results in the Bulletin of American Meteorological Society.

Action Item

WE NEED THE NAMES AND EMAIL ADDRESSES OF ALL YOUR GRADUATE STUDENTS WHO WILL BE IN THE FIELD IN JANUARY BEFORE YOU LEAVE THIS MEETING.

A SHEET IS PROVIDED FOR YOU TO LIST ALL OF YOUR STUDENTS

JENNIFER DAVISON, A GRAD STUDENT AT U OF I WILL CONTACT THE STUDENTS TO GET THEM ORGANIZED BEFORE THE FIELD CAMPAIGN

Media and Outreach

Media and outreach day: Coordinated with local schools and media to provide access to the instruments and scientists participating in RICO.