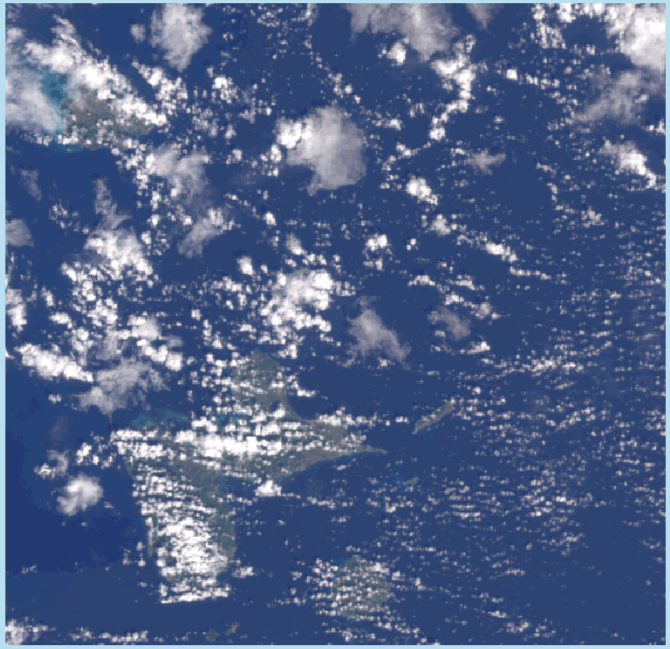
RICO

Rain In Cumulus over the Ocean Experiment

Shallow Precipitating
Caribbean Cumulus Cloud



MISR Image of Antigua
and Guadeloupe

WELCOME TO THE FIRST RICO PLANNING WORKSHOP

RICO

NOVEMBER 24, 2004 – JANUARY 24, 2005

Antigua and Barbuda

AGENDA

TODAY: Wednesday February 25

1. Introduction and welcome 1:00-1:15 pm (Ochs and Rauber)
2. RICO Overview 1:15-2:45 pm (Ochs and Rauber)

Break (1445-1515)

3. Science Goals of Investigators 3:15 to ~9:00 pm (Investigators)

Dinner 1800-1830 (pizza delivered)

AGENDA

TOMORROW MORNING: Thursday February 26

4. Scientific overview committee 8:30-9:00 am
(Ochs/Rauber)

5. Managing the decision process in the field 9:00-9:30 am
(Ochs/Rauber)

6. Data management issues including data policy 9:30-10:00 am
(Dirks/Moore)

Break 1000-1030

7. Operations coordination, operation center requirements and communications 1030-1200 am
(Dirks/Moore/Daniels)

Lunch: 1200-1300

AGENDA

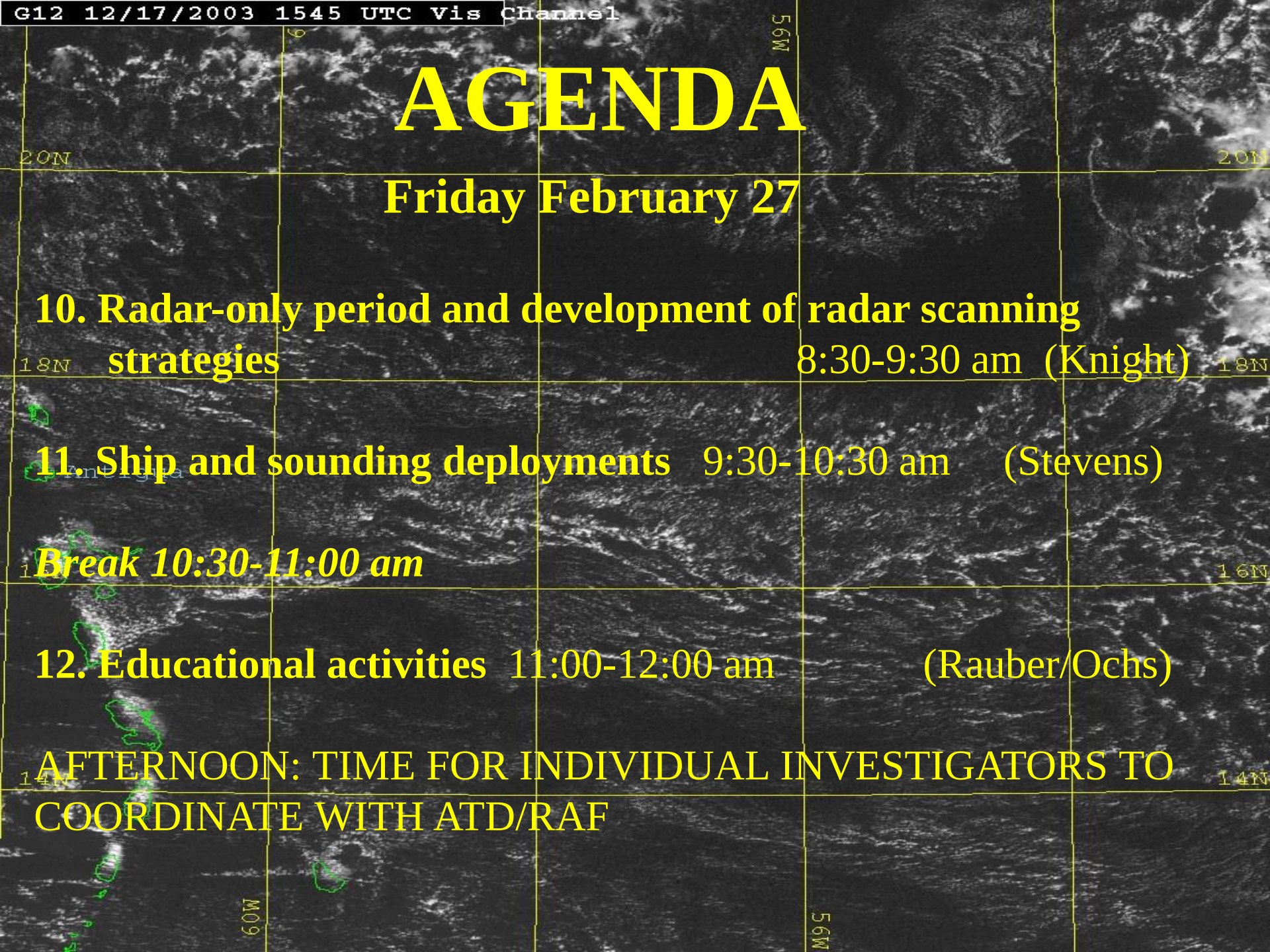
TOMORROW AFTERNOON: Thursday February 26

8. Major RICO facilities 1:00-3:00 pm

C-130:	(Jensen)
BAE-146	(Blyth)
Wyoming King Air:	(Geerts/Oolman)
Radar: K band and S band, other	(Knight/Vivek)
Soundings/PAM	(Stevens)
Satellites	(Di Girolamo)
Ship	(Chris Fairall)

Break 3:00-3:30 pm

9. Flight plans: 3:30-5:30 pm (Rauber/Ochs)



AGENDA

Friday February 27

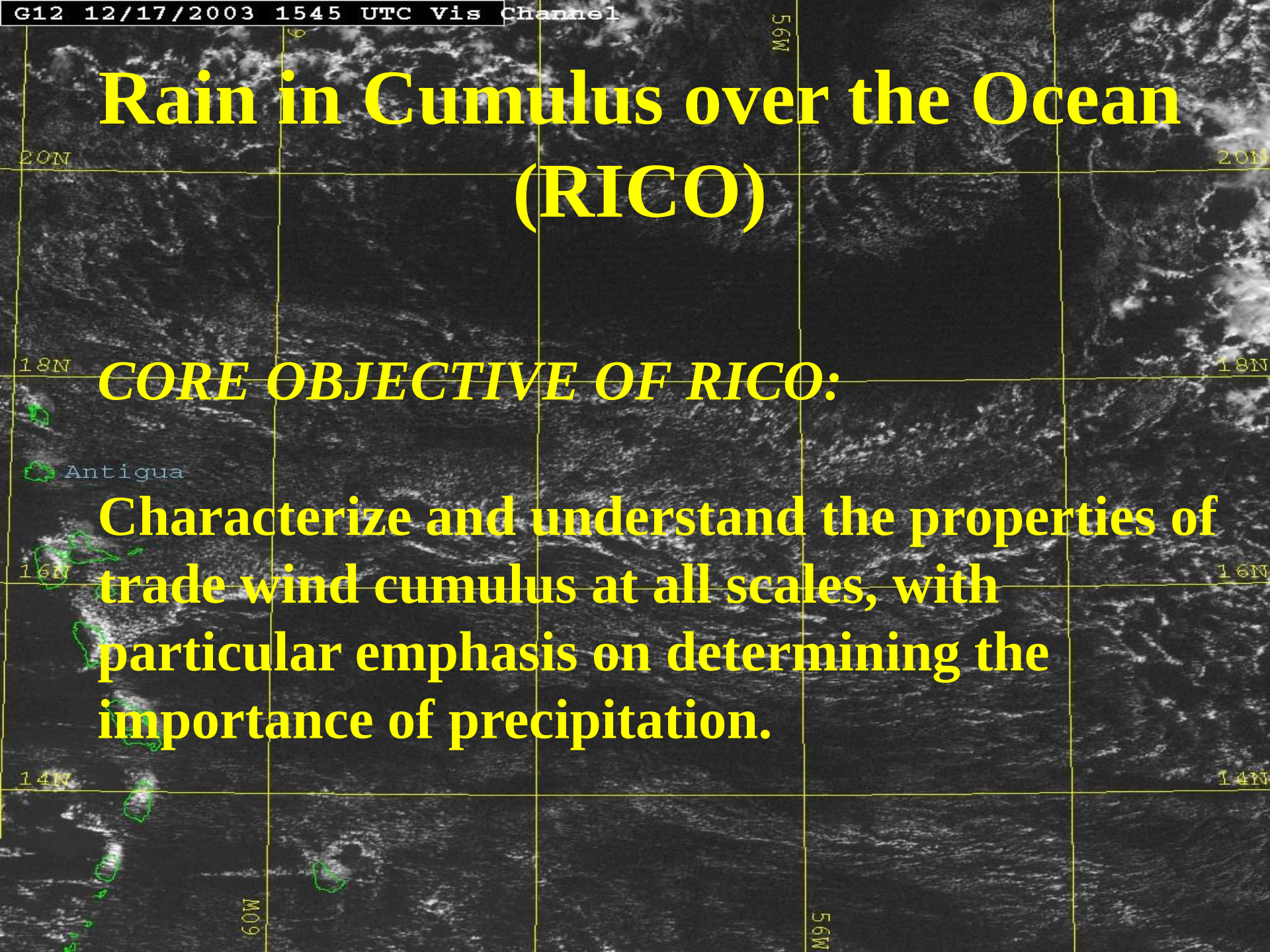
10. Radar-only period and development of radar scanning strategies 8:30-9:30 am (Knight)

11. Ship and sounding deployments 9:30-10:30 am (Stevens)

Break 10:30-11:00 am

12. Educational activities 11:00-12:00 am (Rauber/Ochs)

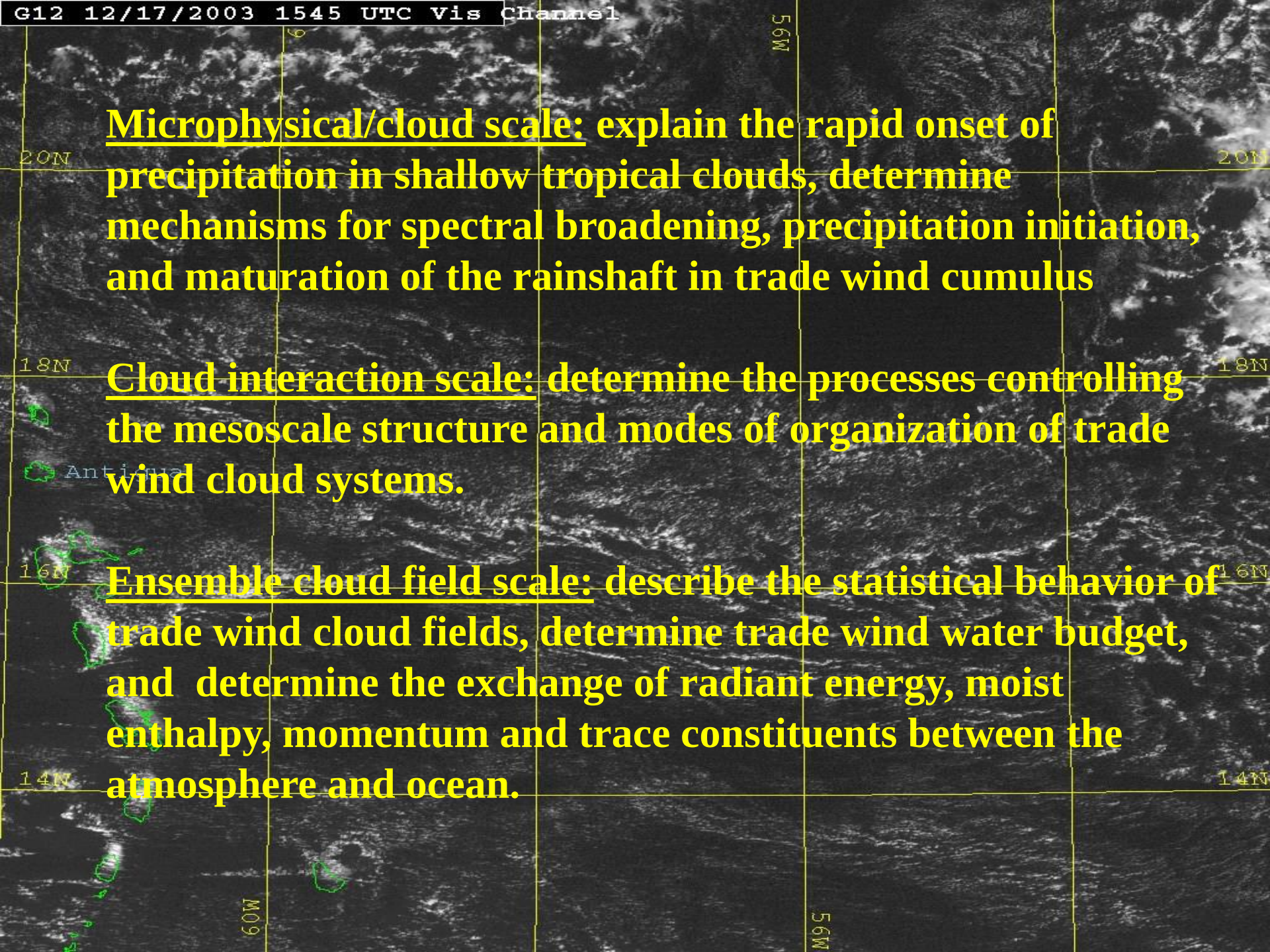
AFTERNOON: TIME FOR INDIVIDUAL INVESTIGATORS TO COORDINATE WITH ATD/RAF



Rain in Cumulus over the Ocean (RICO)

CORE OBJECTIVE OF RICO:

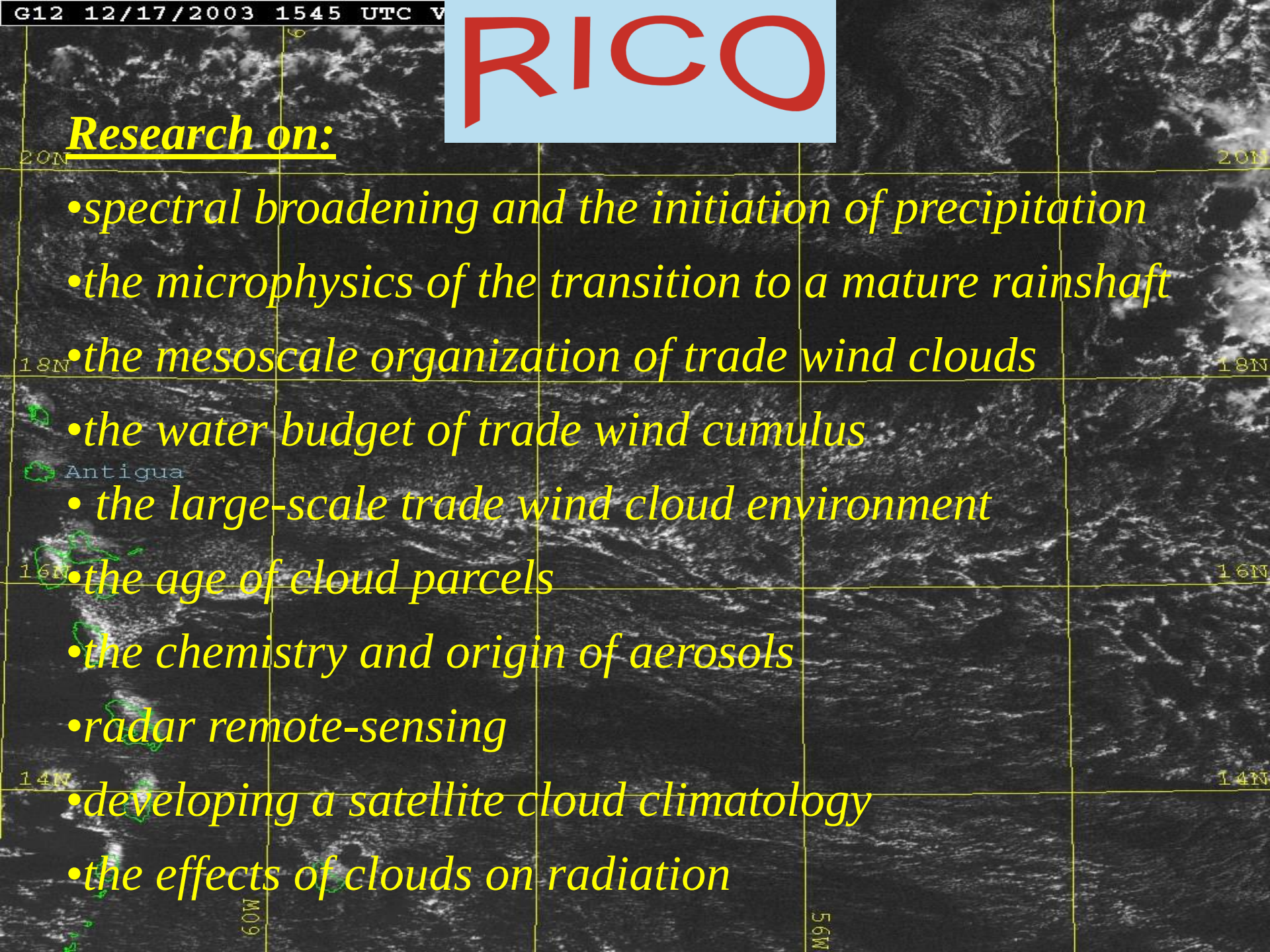
Characterize and understand the properties of trade wind cumulus at all scales, with particular emphasis on determining the importance of precipitation.

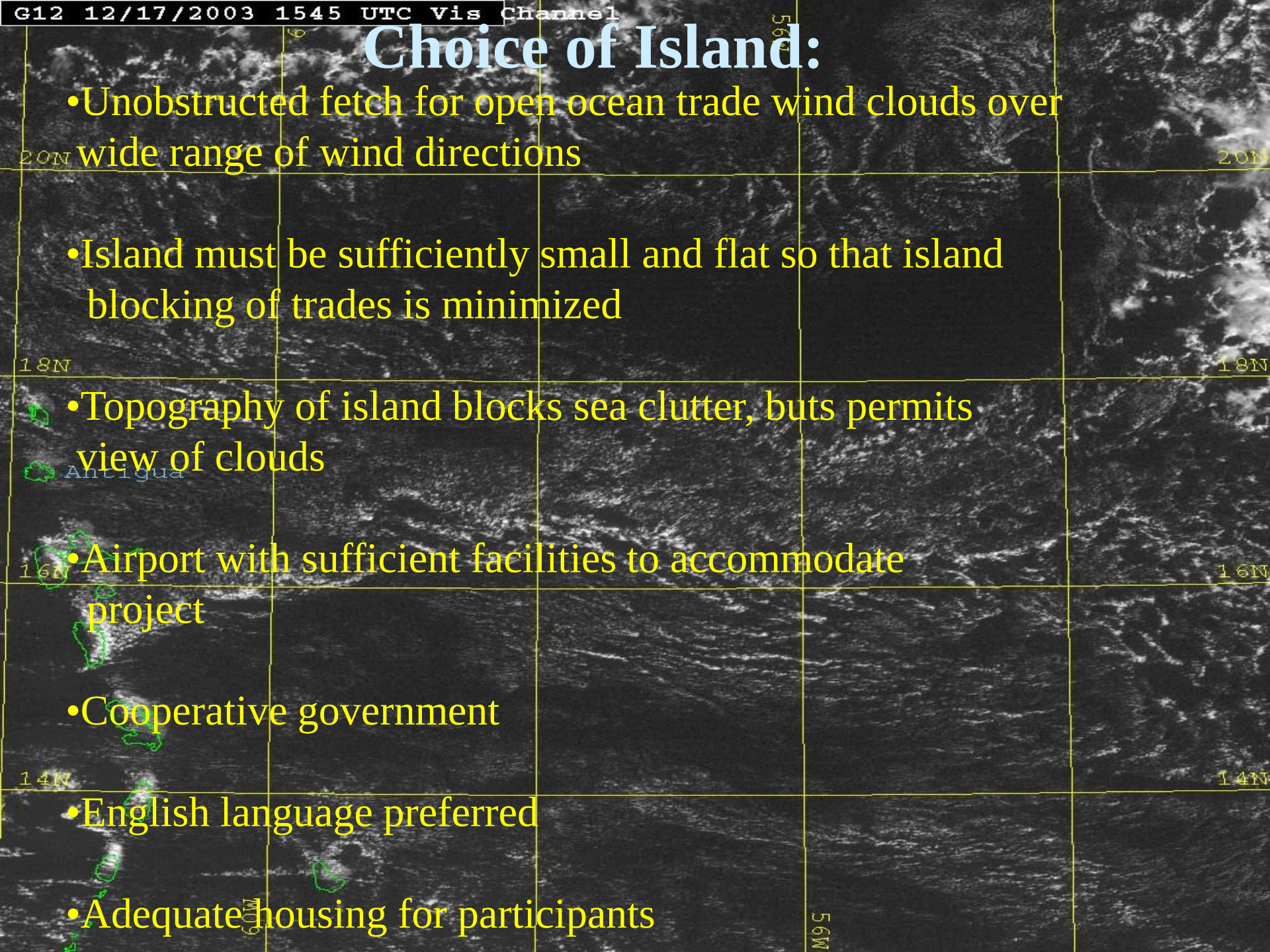


Microphysical/cloud scale: explain the rapid onset of precipitation in shallow tropical clouds, determine mechanisms for spectral broadening, precipitation initiation, and maturation of the rainshaft in trade wind cumulus

Cloud interaction scale: determine the processes controlling the mesoscale structure and modes of organization of trade wind cloud systems.

Ensemble cloud field scale: describe the statistical behavior of trade wind cloud fields, determine trade wind water budget, and determine the exchange of radiant energy, moist enthalpy, momentum and trace constituents between the atmosphere and ocean.


G12 12/17/2003 1545 UTC V
RICO
Research on:
•spectral broadening and the initiation of precipitation
•the microphysics of the transition to a mature rainshaft
•the mesoscale organization of trade wind clouds
•the water budget of trade wind cumulus
• the large-scale trade wind cloud environment
•the age of cloud parcels
•the chemistry and origin of aerosols
•radar remote-sensing
•developing a satellite cloud climatology
•the effects of clouds on radiation
20N
18N
16N
14N
Antigua
60W
56W

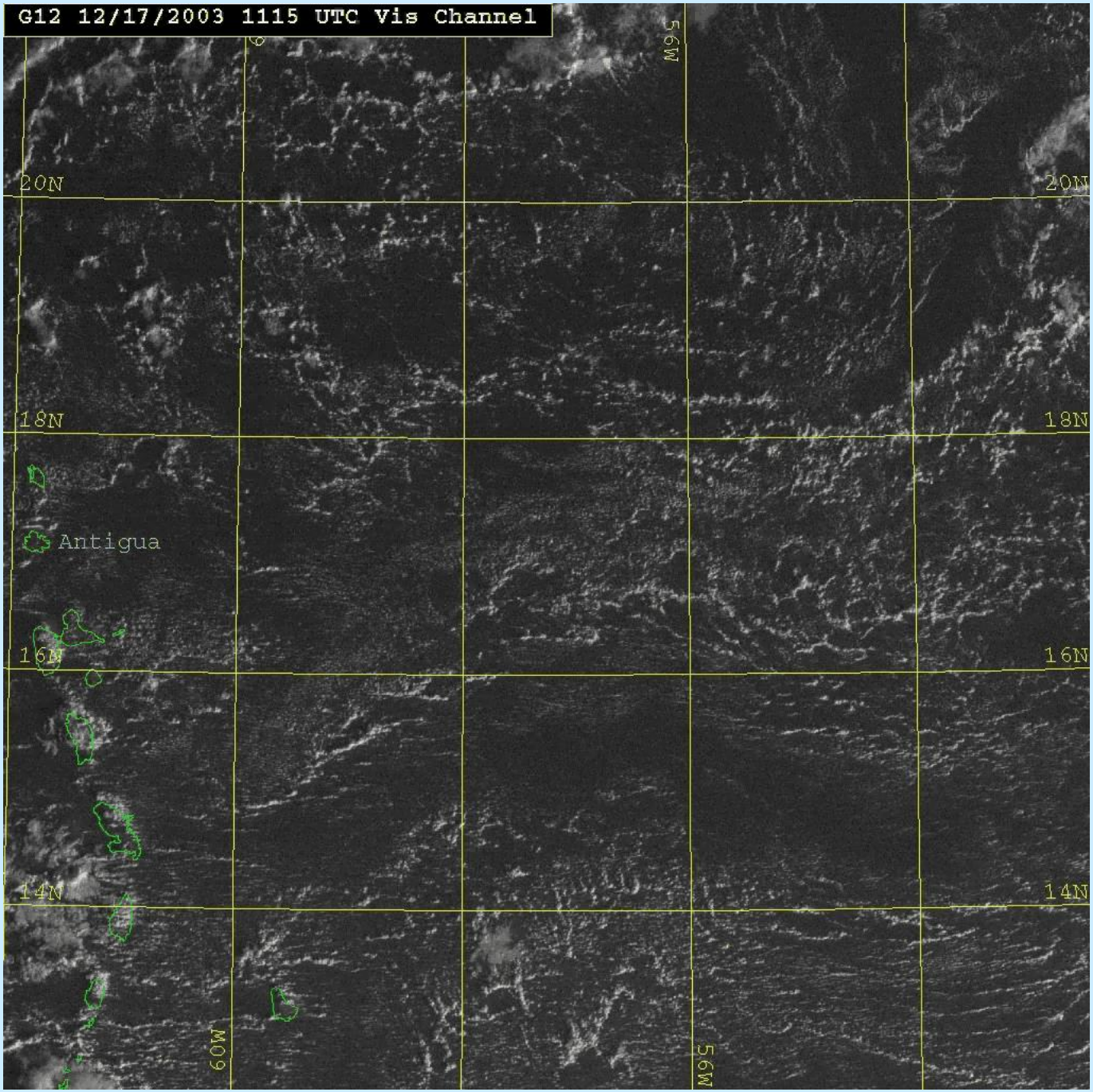


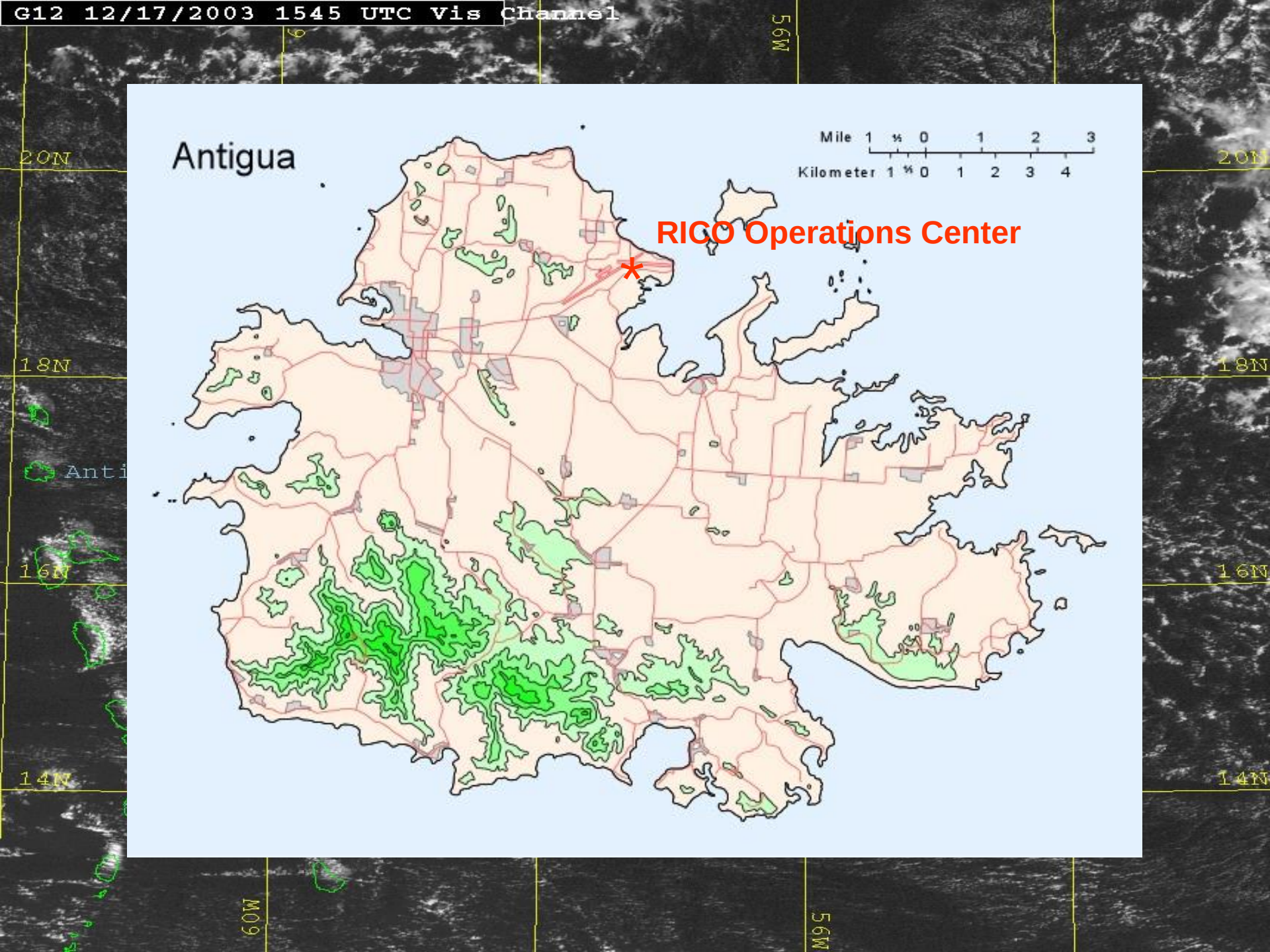
Choice of Island:

- Unobstructed fetch for open ocean trade wind clouds over wide range of wind directions
- Island must be sufficiently small and flat so that island blocking of trades is minimized
- Topography of island blocks sea clutter, buts permits view of clouds
- Airport with sufficient facilities to accommodate project
- Cooperative government
- English language preferred
- Adequate housing for participants

Choice of Island:

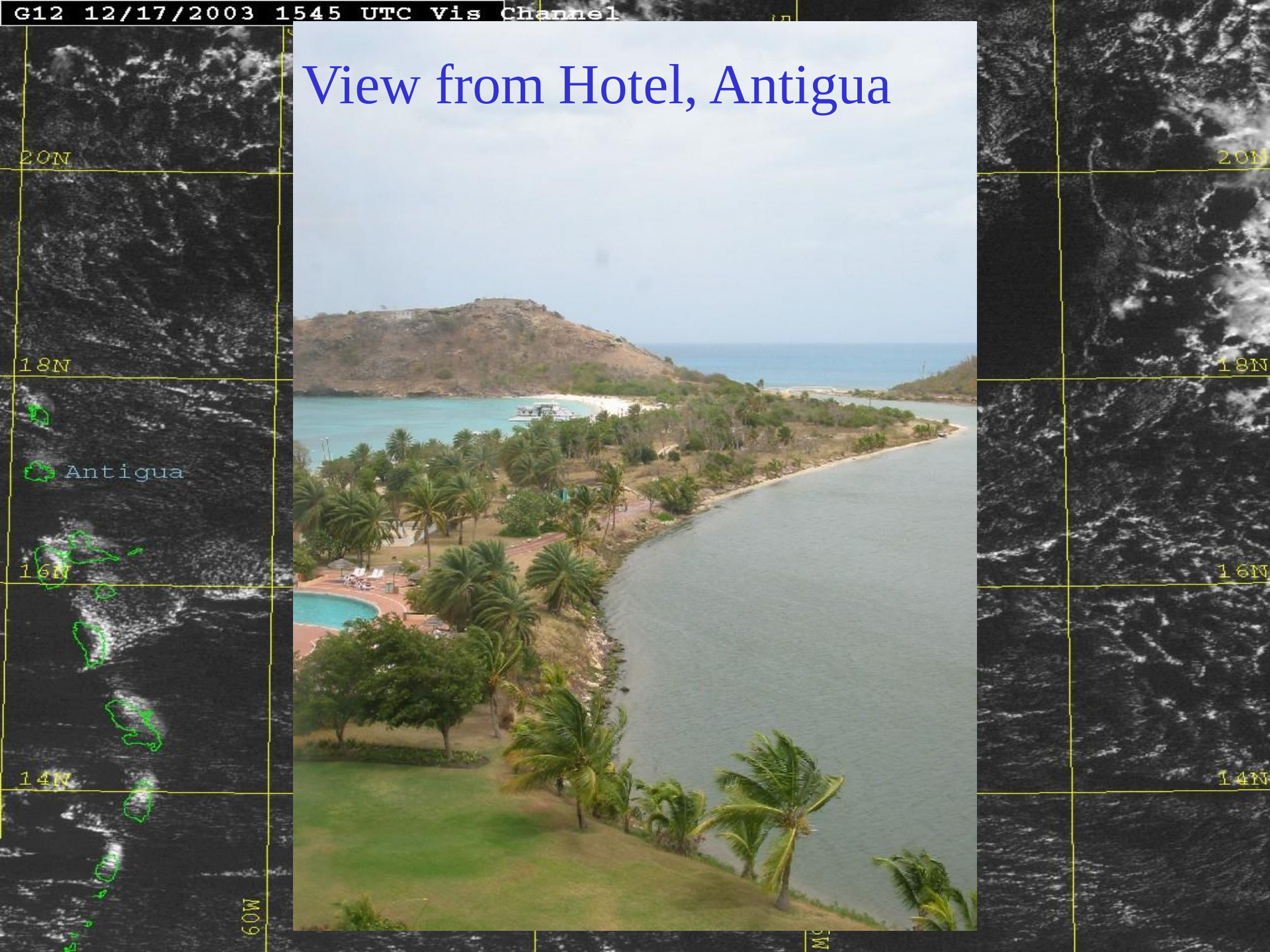
- Unobstructed fetch for open ocean trade wind clouds over wide range of wind directions **BARBUDA**
- Island must be sufficiently small and flat so that island blocking of trades is minimized **BARBUDA**
- Topography of island blocks sea clutter, buts permits view of clouds **BARBUDA**
- Airport with sufficient facilities to accommodate project **ANTIGUA**
- Cooperative government **ANTIGUA & BARBUDA**
- English language preferred **ANTIGUA & BARBUDA**
- Adequate housing for participants **ANTIGUA & BARBUDA**


G12 12/17/2003 1115 UTC Vis Channel
20N
18N
16N
14N
Antigua
60W
56W


G12 12/17/2003 1545 UTC Vis Channel
Antigua
Mile 1 ½ 0 1 2 3
Kilometer 1 ½ 0 1 2 3 4
RICO Operations Center
*
20N
18N
16N
14N
60W
56W

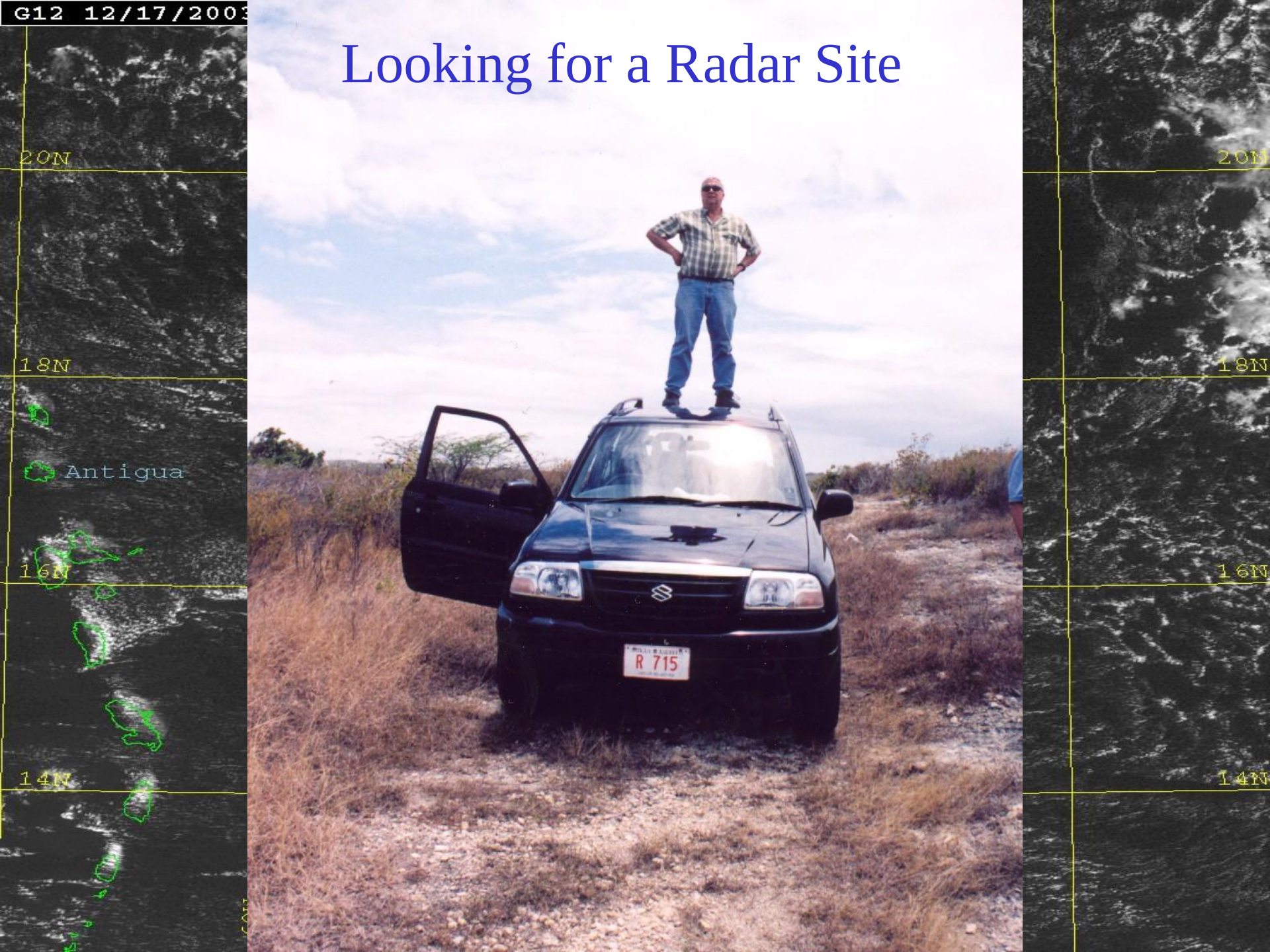

G12 12/17/2003 1545 UTC Vis Channel 1
St. Johns, Antigua

English Harbour Town, Antigua



View from Hotel, Antigua

Looking for a Radar Site




G12 12/17/2003 1545 UTC Vis Channel
Possible Antigua Radar Site

To Barbuda


G12 12/17/2
20N
18N
16N
14N
Antigua
ATLANTIC OCEAN
BARBUDA
Goat Point
Billy Point
Tidal Flats
Goat Island
Rabbit Island
Kid Island
Hog Point
Cedar Tree Point
Beach Ridges
Goat Island Flush
The Caves
Two Feet Bay
Gully Creek
Man of War Island
Rubbish Bay
The Highlands
Low Bay
Codrington Lagoon
Codrington
Pigeon Cliff
Castle Bay
Dunkina
Welch Point
Palmetto Point
Pelican Bay
Spanish Well Point
Pelican Point
Salt Pond
Cocoa Point Beach
Gravenor Bay
Cocoa Point
Spanish Point
Mile
Kilometer

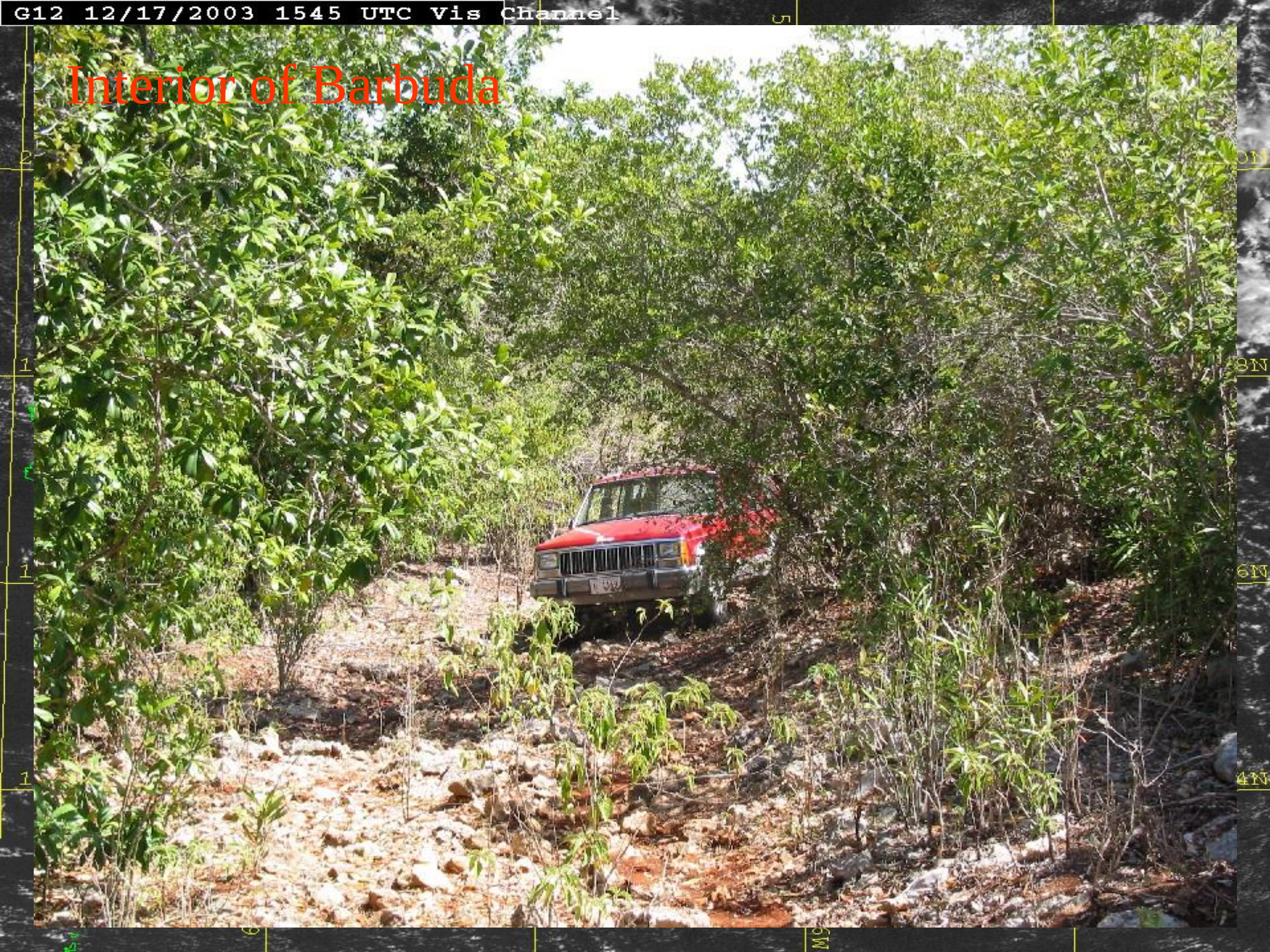
Intrepid Crew on Barbuda

Barbuda Airport

Looking for a Sounding Site


G12 12/17/2003 1545 UTC Vis Channel
Eastern Shore, Barbuda


G12 12/17/2003 1545 UTC Vis Channel 1
Eastern Shore, Barbuda


G12 12/17/2003 1545 UTC Vis Channel 1
Interior of Barbuda


G12 12/17/2
20N
18N
16N
14N
Antigua
ATLANTIC OCEAN
BARBUDA
Goat Point
Billy Point
Cedar Tree Point
Hog Point
Goat Island
Rabbit Island
Kid Island
Goat Island Flush
Man of War Island
Codrington Lagoon
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Low Bay
The Caves
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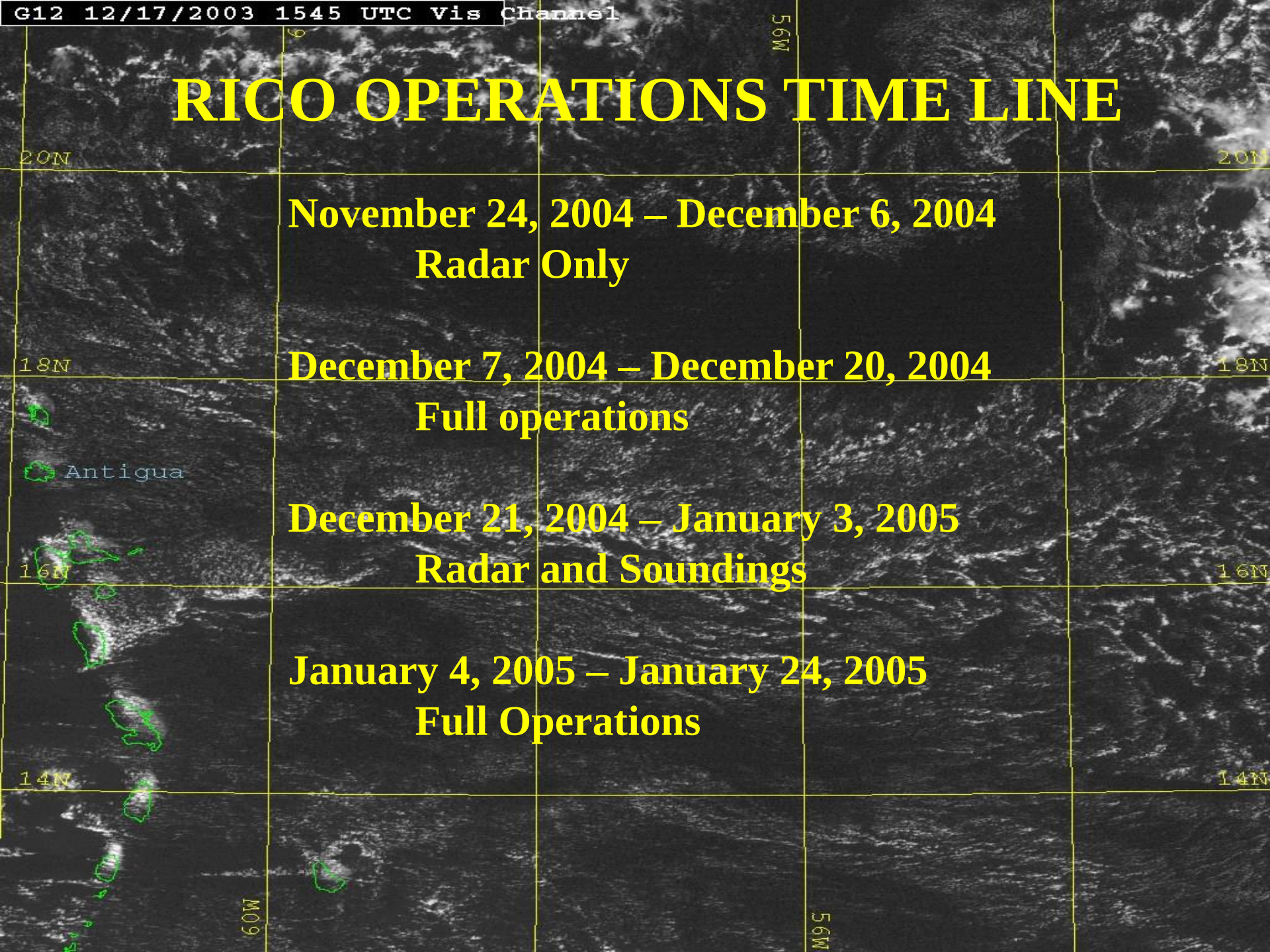
Duncina
Salt Pond
Cocoa Point Beach
Gravenor Bay
Cocoa Point
Spanish Point
SPolka
Sounding PAM
Mile
Kilometer



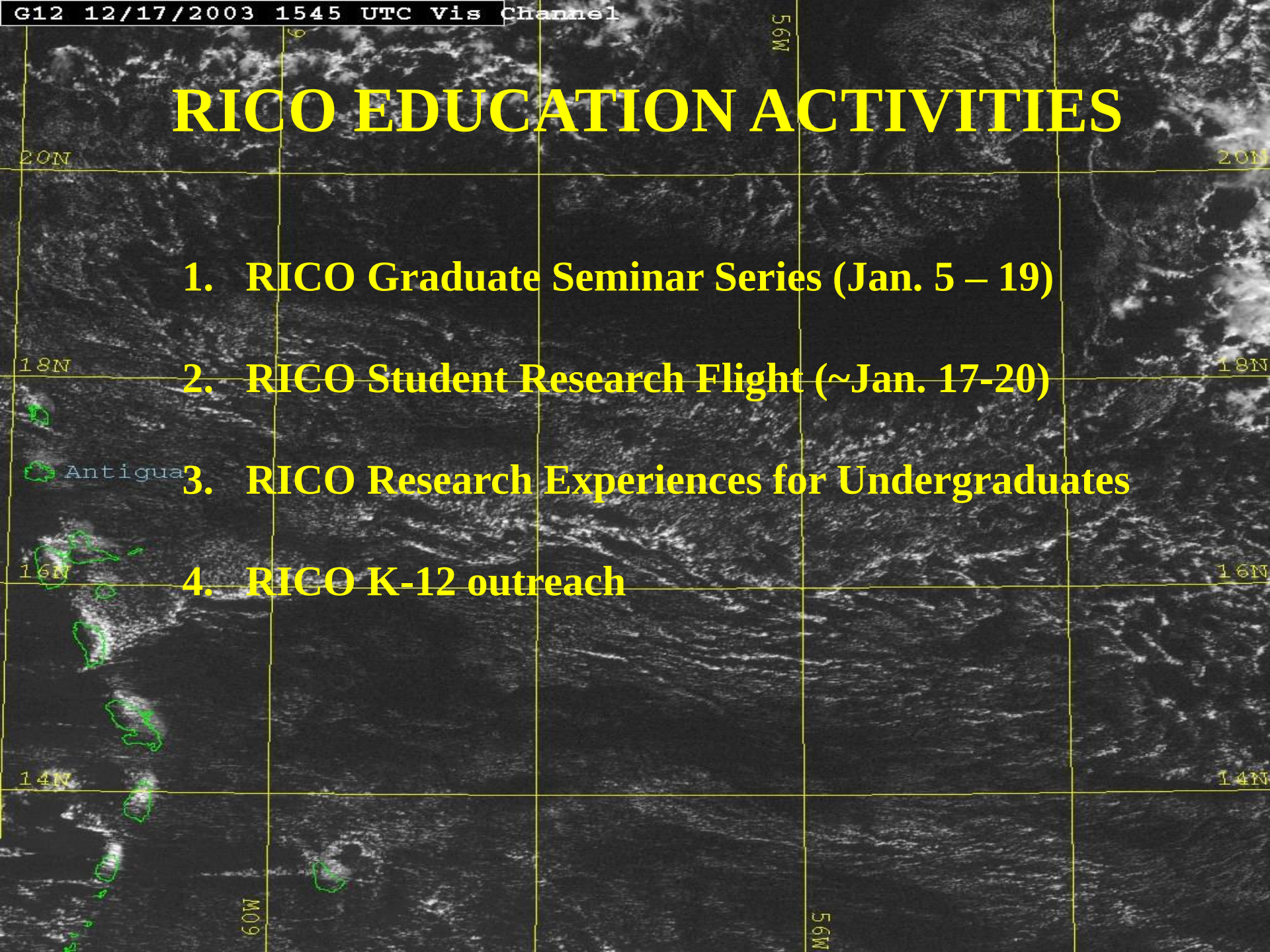
RICO OPERATIONS TIME LINE

November 24, 2004 – December 6, 2004
Radar Only

December 7, 2004 – December 20, 2004
Full operations

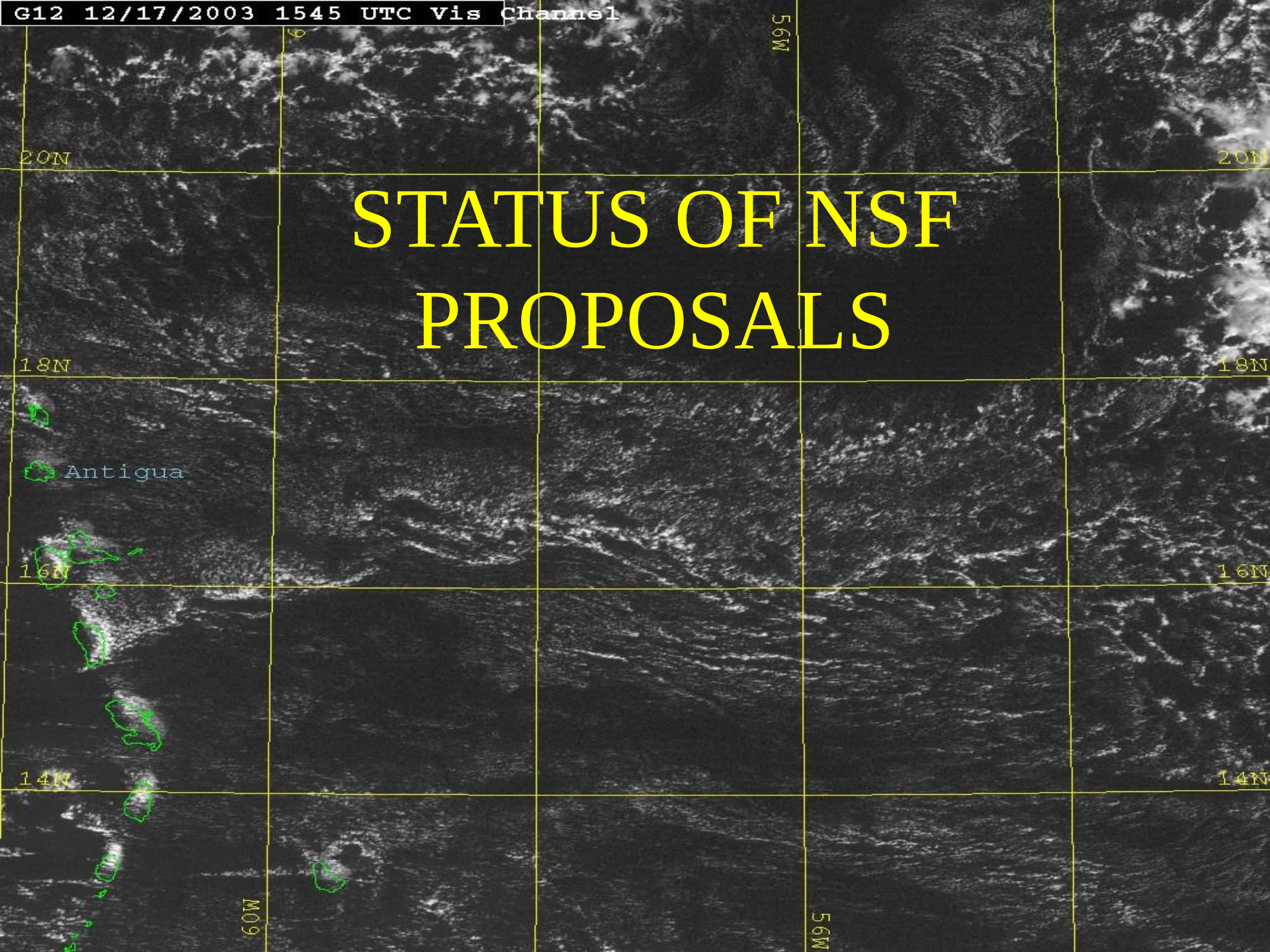
December 21, 2004 – January 3, 2005
Radar and Soundings

January 4, 2005 – January 24, 2005
Full Operations

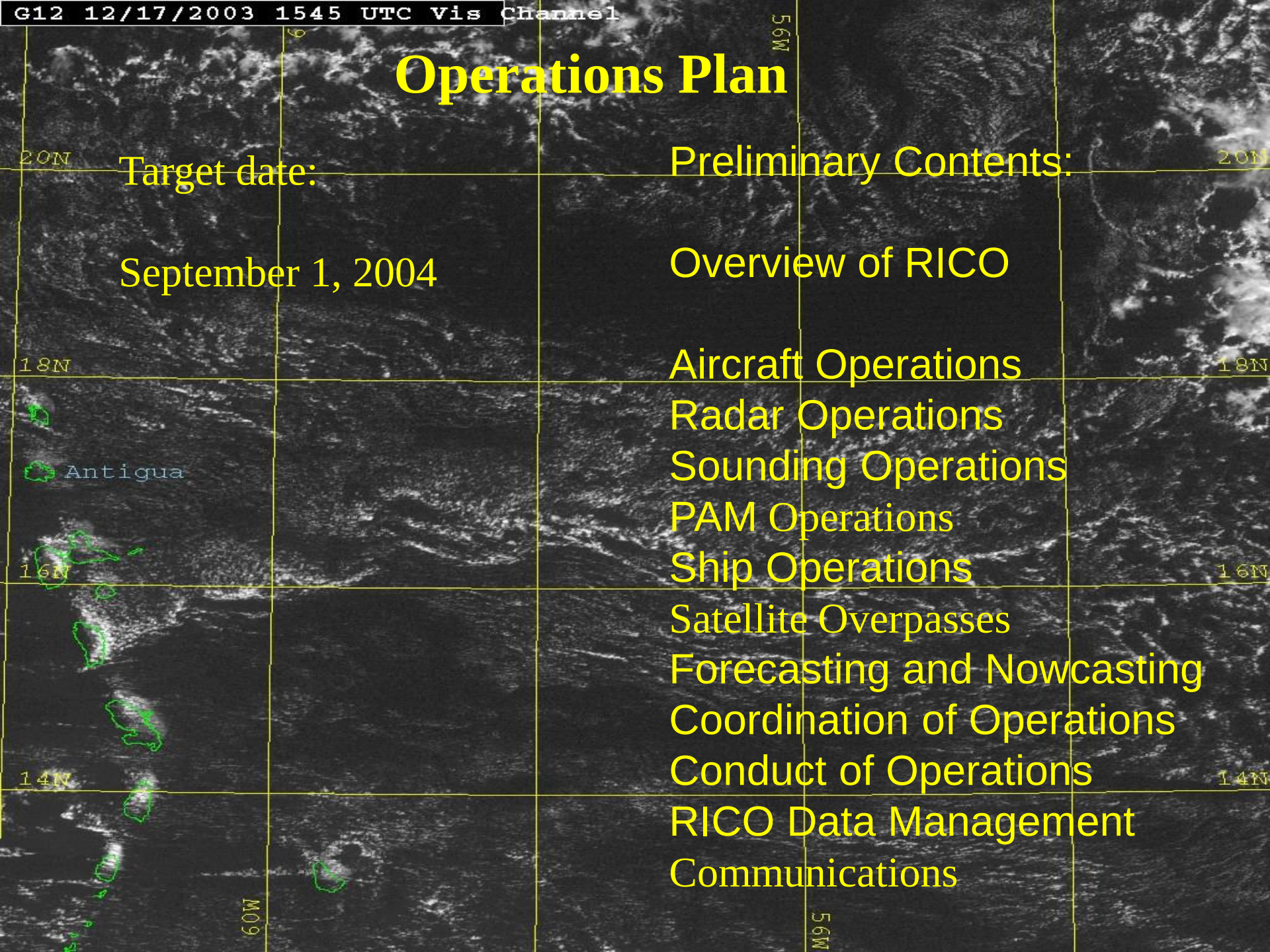


RICO EDUCATION ACTIVITIES

1. RICO Graduate Seminar Series (Jan. 5 – 19)
2. RICO Student Research Flight (~Jan. 17-20)
3. RICO Research Experiences for Undergraduates
4. RICO K-12 outreach



STATUS OF NSF PROPOSALS



Operations Plan

Target date:

September 1, 2004

Preliminary Contents:

Overview of RICO

Aircraft Operations
Radar Operations
Sounding Operations
PAM Operations
Ship Operations
Satellite Overpasses
Forecasting and Nowcasting
Coordination of Operations
Conduct of Operations
RICO Data Management
Communications

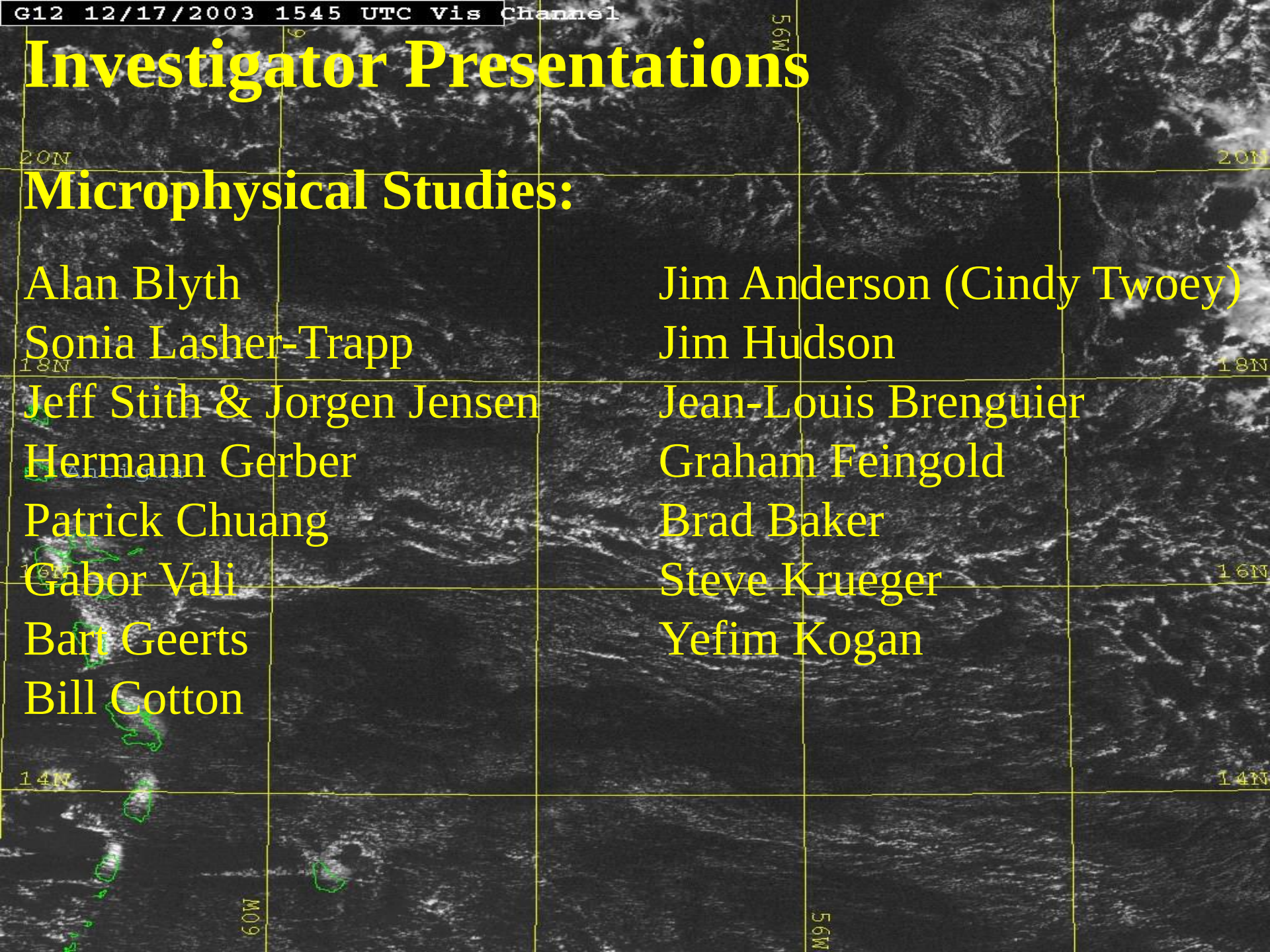
Investigator Presentations

Radar and microphysical studies:

Bob Rauber/Harry Ochs (Neil Laird, Larry Di Girolamo)
Charles Knight

Ensemble scale studies:

Bjorn Stevens
Charles Wood (Sandra Yuter)
Bruce Albrecht (Chris Fairall, Jeff Hare)

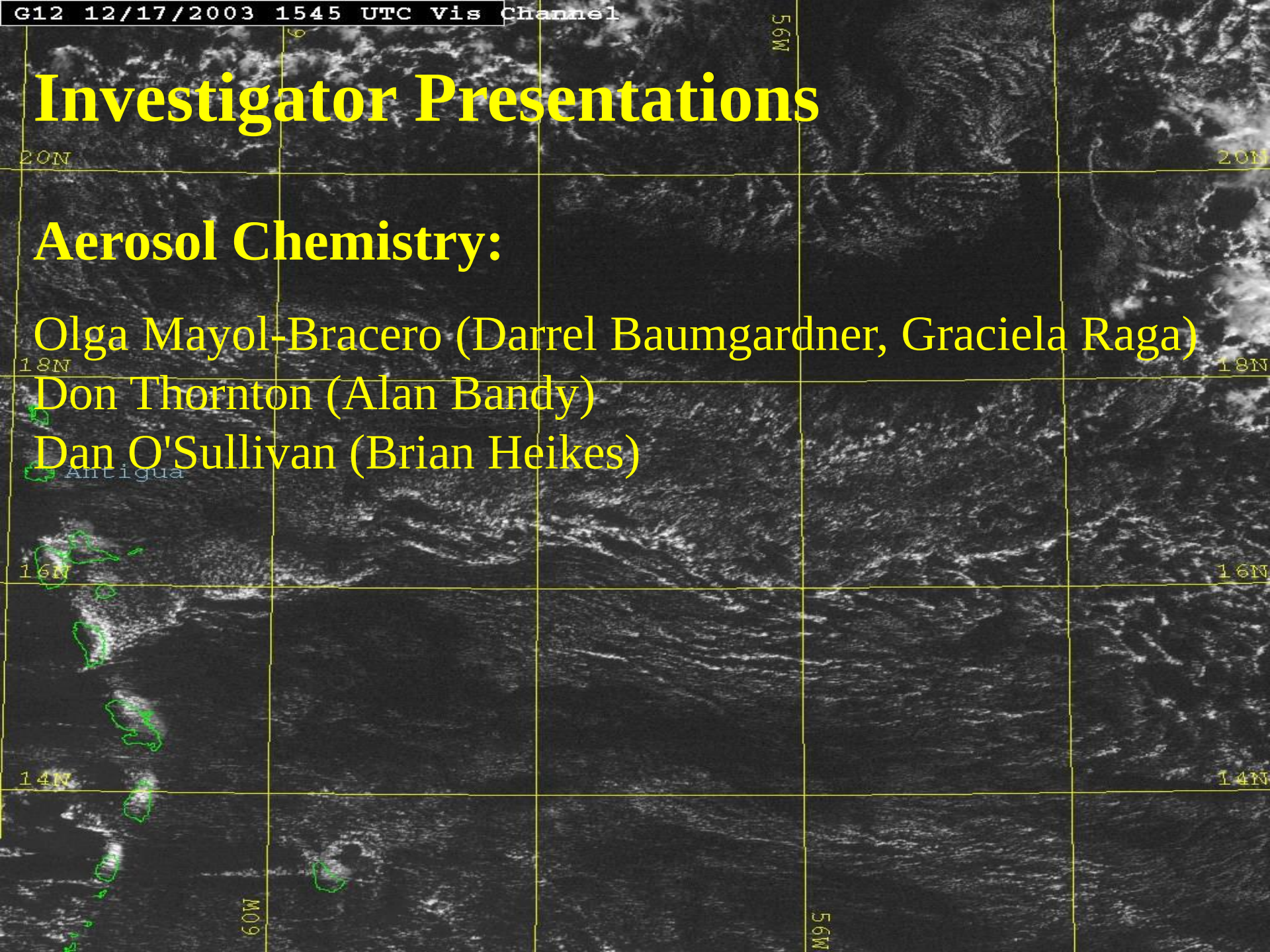


Investigator Presentations

Microphysical Studies:

Alan Blyth
Sonia Lasher-Trapp
Jeff Stith & Jorgen Jensen
Hermann Gerber
Patrick Chuang
Gabor Vali
Bart Geerts
Bill Cotton

Jim Anderson (Cindy Twoey)
Jim Hudson
Jean-Louis Brenguier
Graham Feingold
Brad Baker
Steve Krueger
Yefim Kogan



Investigator Presentations

Aerosol Chemistry:

Olga Mayol-Bracero (Darrel Baumgardner, Graciela Raga)
Don Thornton (Alan Bandy)
Dan O'Sullivan (Brian Heikes)

Precipitation Studies in Trade Wind Clouds The RICO Experiment

Bob Rauber
Harry Ochs
Neil Laird
Larry Di Girolamo

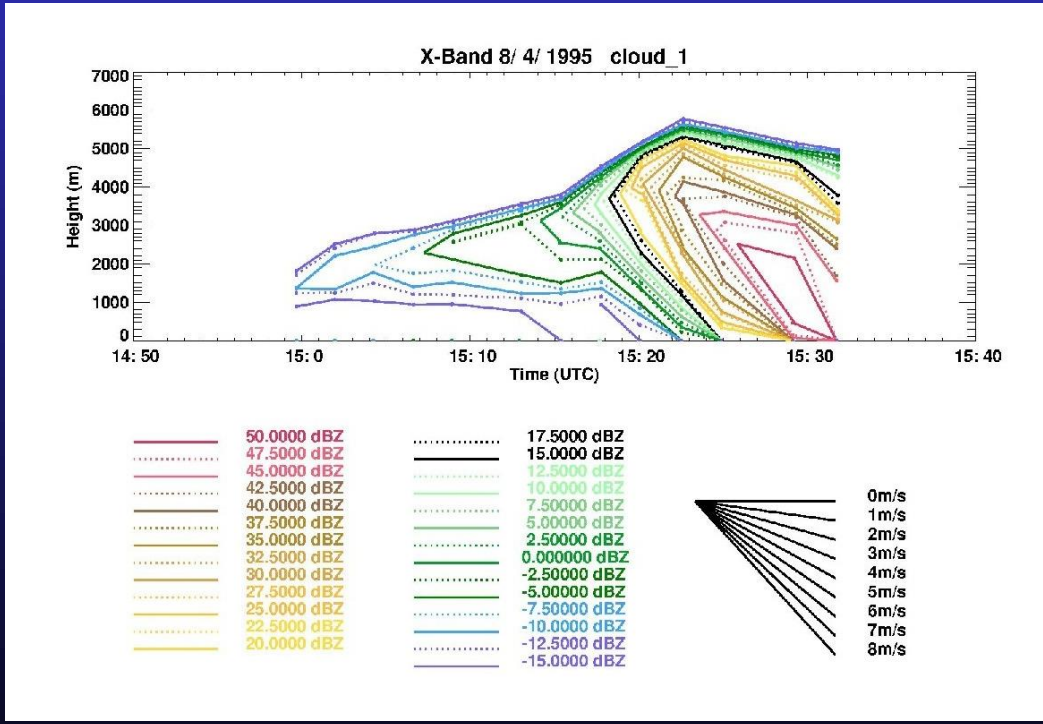
Department of Atmospheric Sciences
University of Illinois at Urbana Champaign

RESEARCH GOALS

1. Quantify and understand physics responsible for the rapid onset of precipitation in trade wind cumuli. We are focusing our research on the role of ultragiant nuclei in initiating precipitation.

Redundant measurements with CSIRO Giant Aerosol Impactor system, DRI cloud scope, 260X, 2DC, X Probe, CPI, FSSP, SPEC 2D-S Stereo probe.

Radar studies with dual polarization, dual wavelength Spolka



RESEARCH GOALS

2. Assess the microphysical effects of long-lived low-level cloud patches on emerging cumuli.

RESEARCH GOALS

3. Determine the dominant microphysical processes associated with the transition between the initiation phase of precipitation and the subsequent evolution to the mature rain shaft.

Are the mechanism(s) responsible for the first precipitation drops distinct from those that ultimately lead to the bulk of the precipitation in the mature rainshaft?

RESEARCH GOALS

4. Determine the impact of clouds on the moisture, turbulence and aerosol content of the trade wind layer.

   Determine the properties of detrained air and examine how the changes in the trade wind layer impact future cloud development.

RESEARCH GOALS

5. Determine the contribution of precipitation to the energy balance in the trade wind regime.

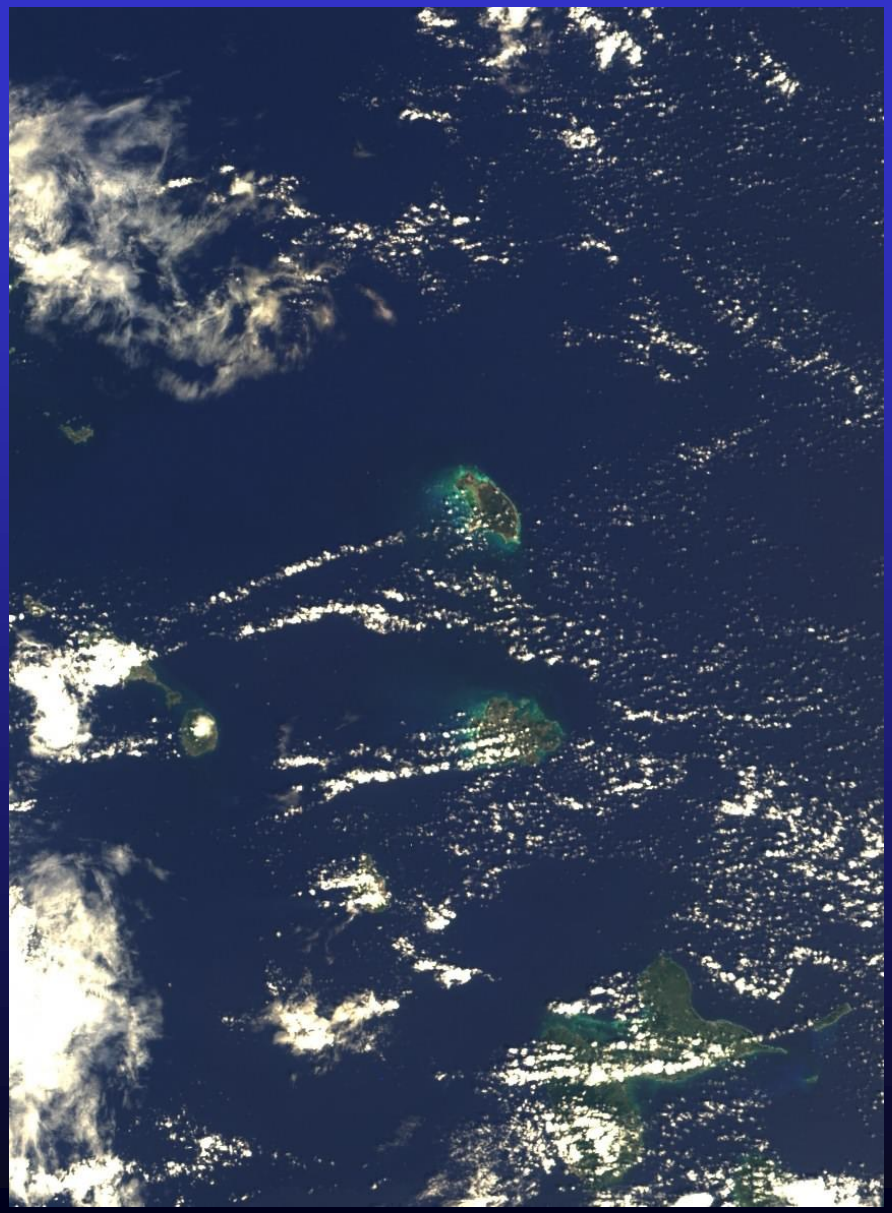
   Estimate the precipitation efficiency of trade wind clouds.

   *The precipitation efficiency is defined here as the ratio of the precipitation-generated latent heat input to the atmosphere (W m^{-2}) to the ocean surface latent heat flux (W m^{-2}).

RESEARCH GOALS

6. Develop statistical analyses of trade wind precipitation that can be used to estimate precipitation from satellite determined trade wind cloud coverage over the ocean.

*Investigate how RICO data can be used to estimate trade wind precipitation using satellite remote sensors.



Scientific overview committee

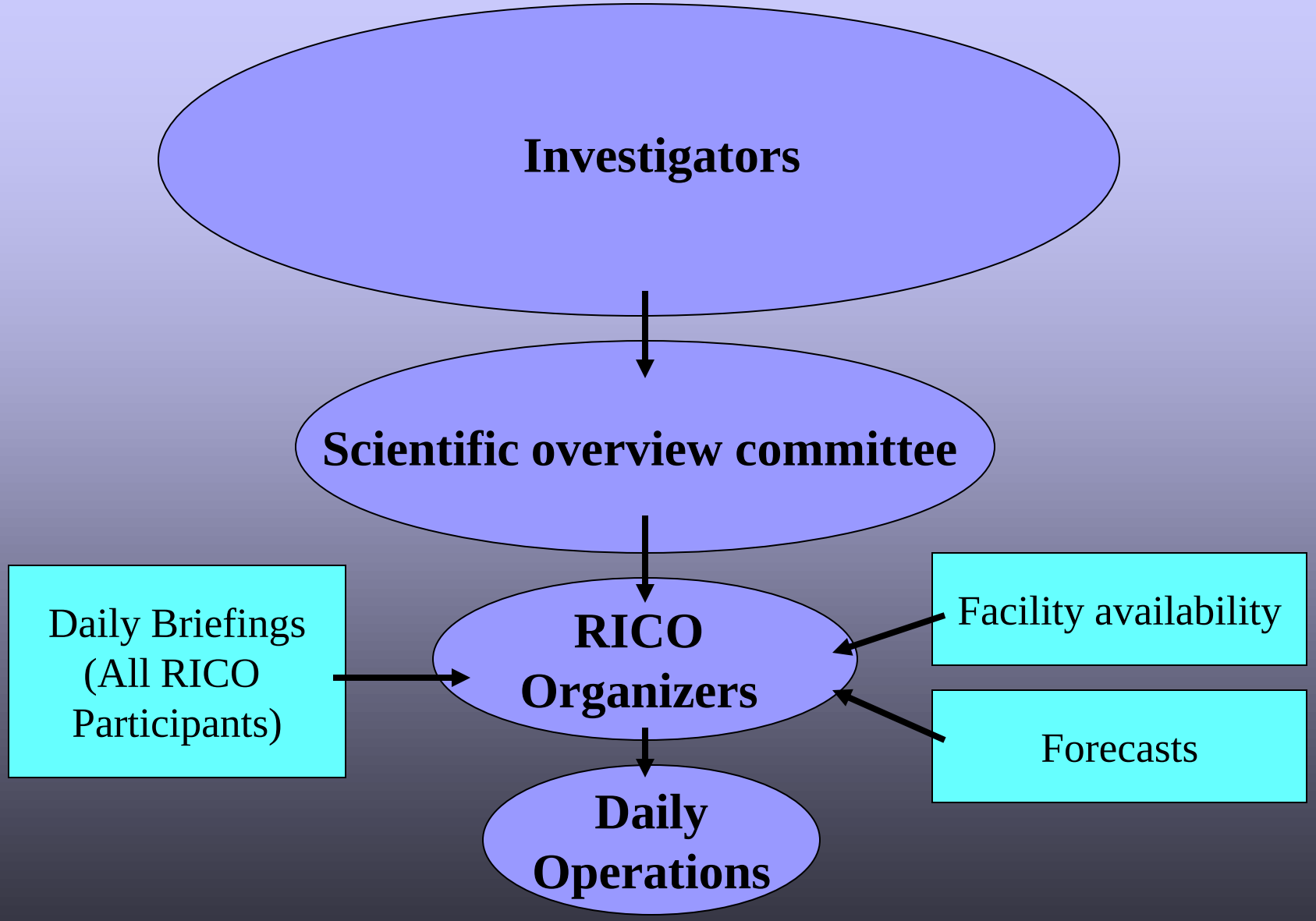
Purpose:

To insure that goals of principal investigator groups are met in the field

Membership:

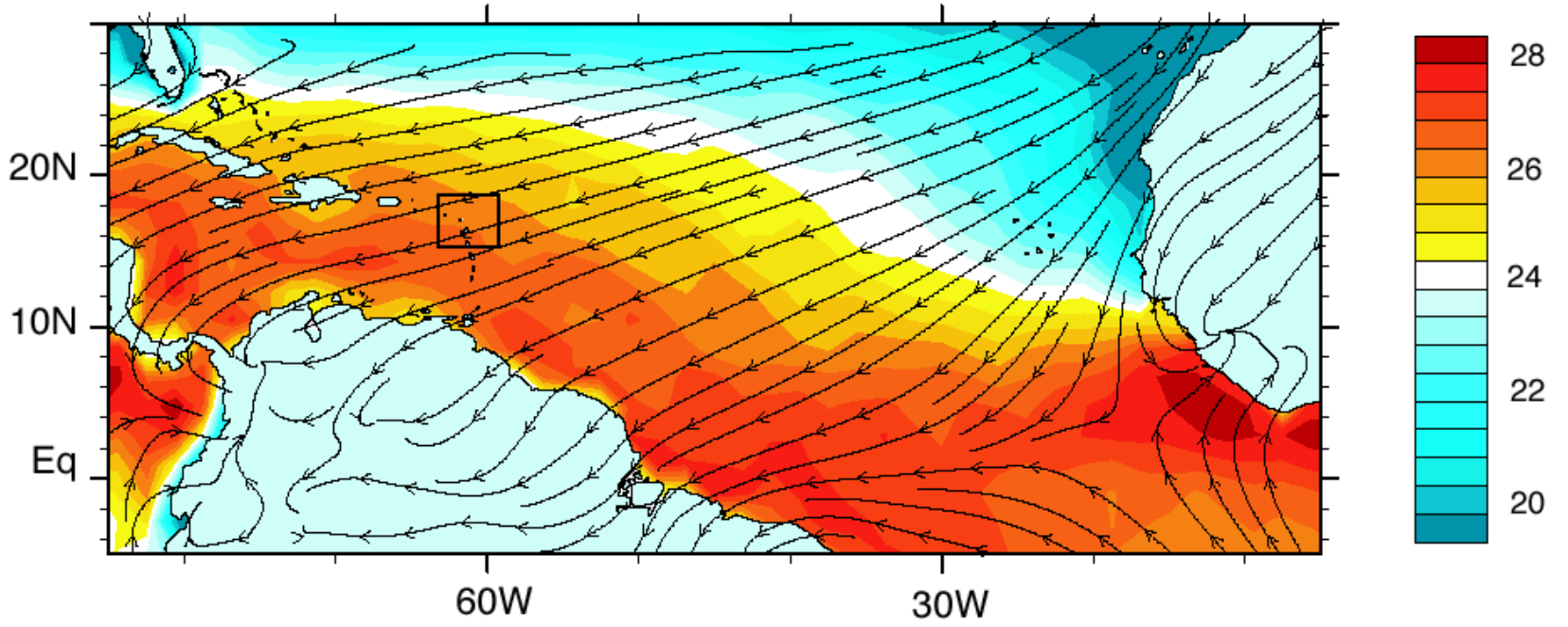
Organizers: Rauber, Ochs, Knight, Stevens
Research Groups: one representative from each group
Others: one representative from JOSS and RAF

Managing the decision process in the field



PROPOSED FLIGHT PATTERNS

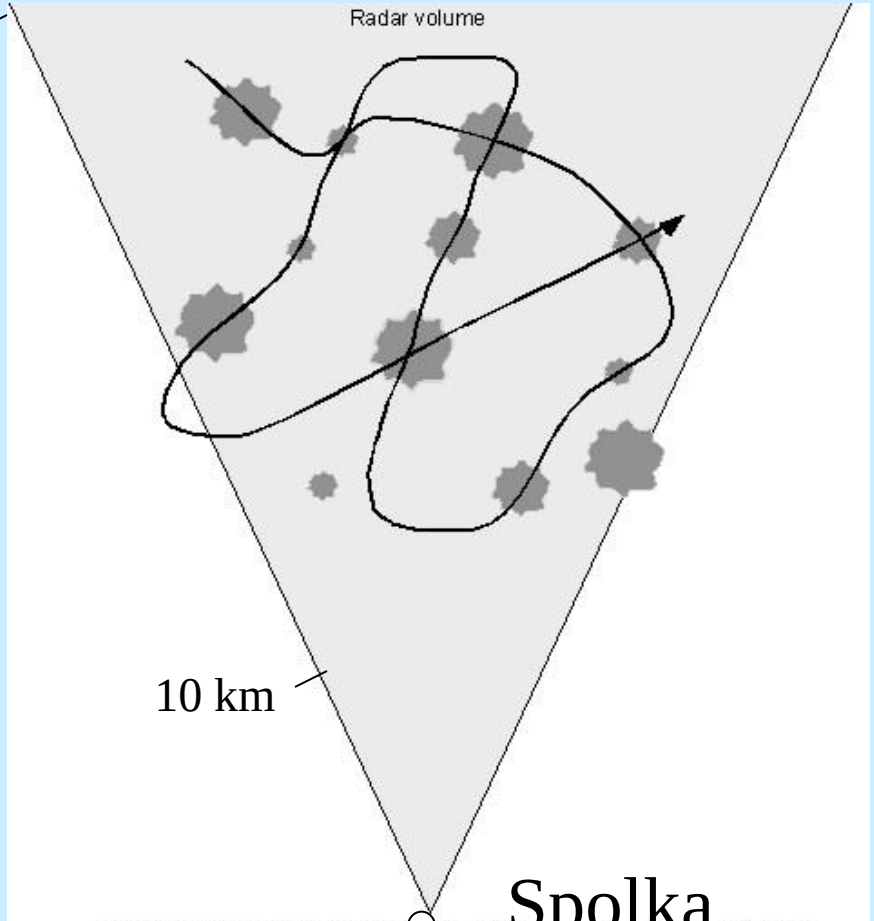
Flow pattern and area of flight operations



Mean Streamlines of 10m winds for January NCEP Climatology superimposed on Sea Surface Temperatures. RICO experimental area boxed and detailed in figure below.

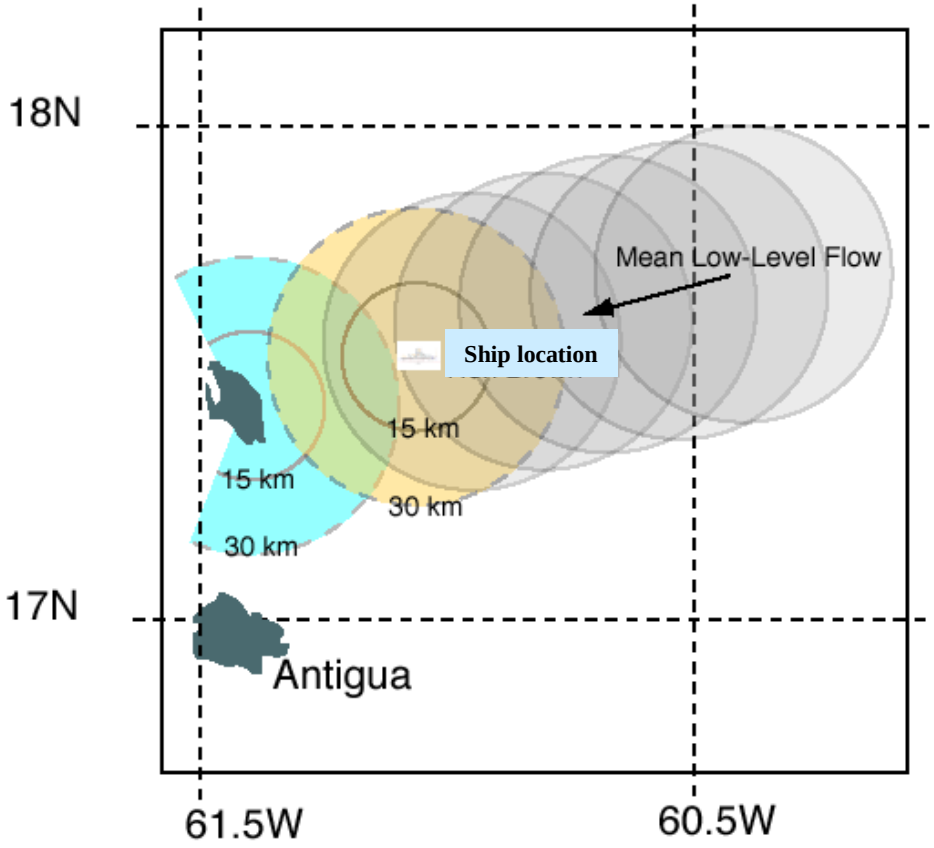
Statistical studies of properties of trade wind cumulus (Daylight and Night Flights)

Pattern A: (both daytime and nighttime) Sampling of clouds at various stages of life cycles at constant altitude. This pattern will be flown entirely within the volume swept by the SPOL radar. Several altitudes will be flown. Targeting will be done visually or, at nighttime, with the weather avoidance radar if echoes can be identified.



FLIGHT PATTERN A: C-130 constant level flights through any available cloud. If clouds are in lines then C-130 would take advantage of alignment. S-POL doing sector PPI's. C-130 stays within S-POL limit radials. This pattern will be executed at several levels in the cloud layer.

Pattern B: (Both daytime and nighttime) Wide (D = 60 km) circles moving with the mean trade wind flow. Each loop pattern is at different level and the direction reverses after each loop. Flight levels are one loop below cloud base, two loops in the cloud layer and one loop above the cloud layer. During flights coordinated with the King Air, the King air will fly Pattern A (daylight) or Pattern G (daylight) within the circle, but at a different altitude.



Overview of RICO large-scale strategy. S-Pol operations centered at Barbuda with associated radar study area indicated in blue. Research ship (if available) study area indicated by orange shaded area. 60km flight circles drifting with mean low level flow indicated by shaded grey circles. The overlap between the orange and blue area defines the mesoscale study region and the preferred location of radar calibration flights.

King Air and BAE-146 options during Pattern B with C-130

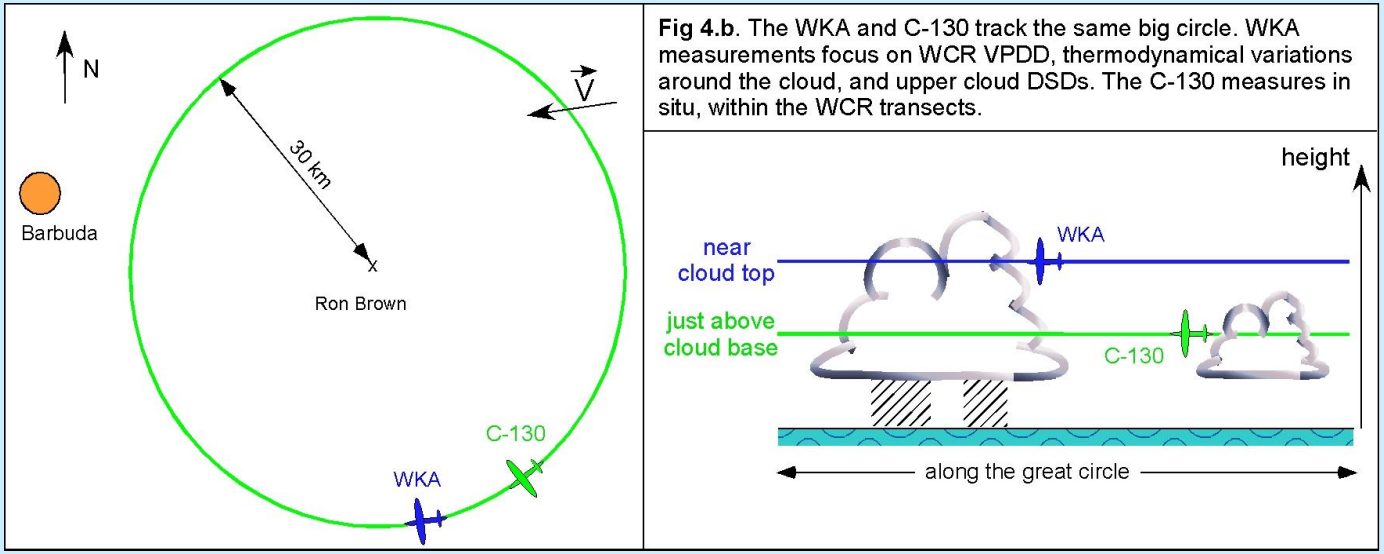
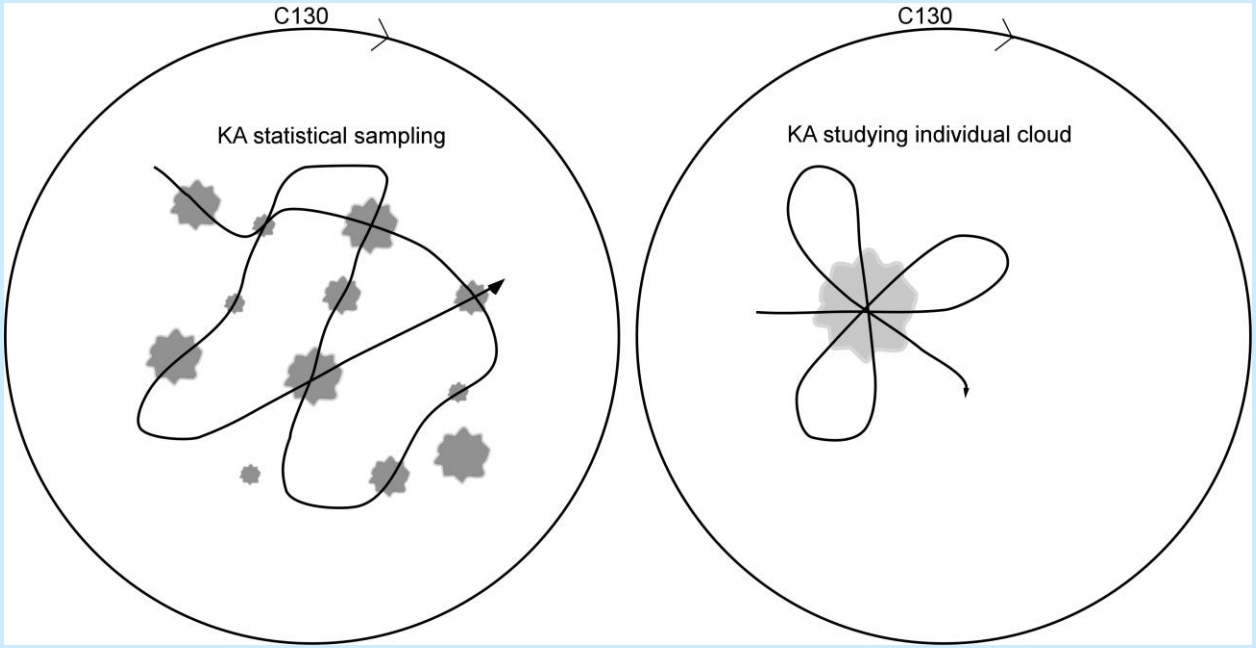
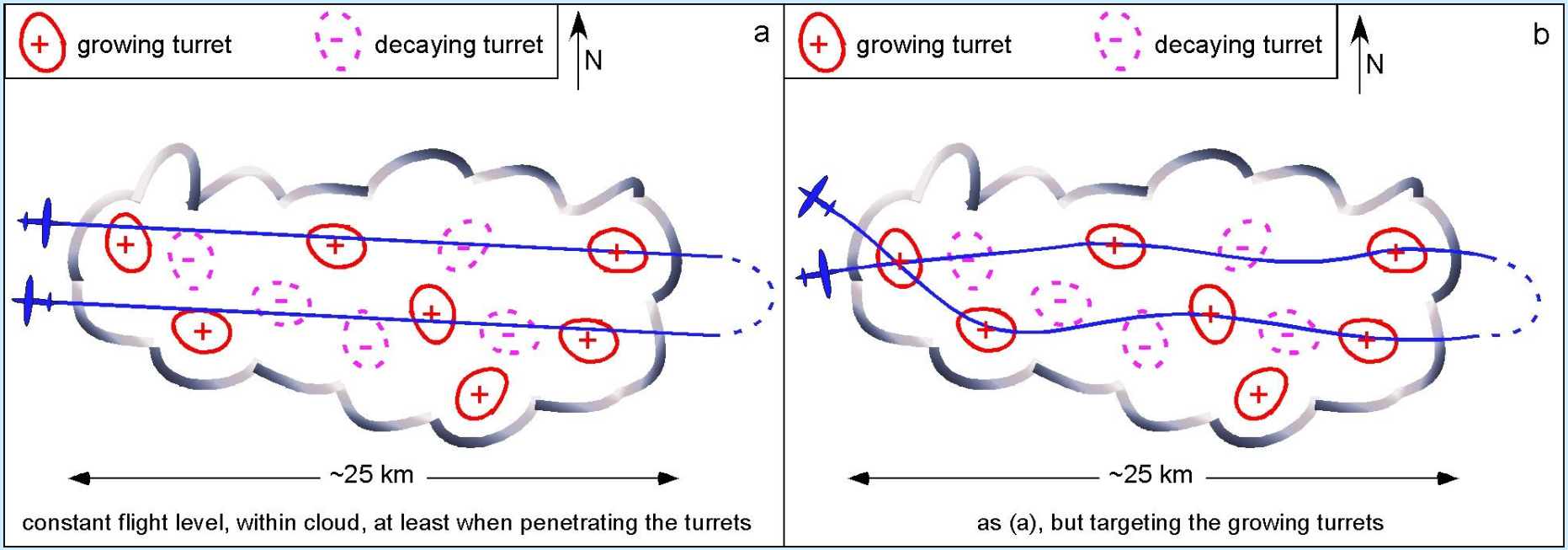


Fig 4.b. The WKA and C-130 track the same big circle. WKA measurements focus on WCR VPDD, thermodynamical variations around the cloud, and upper cloud DSDs. The C-130 measures in situ, within the WCR transects.

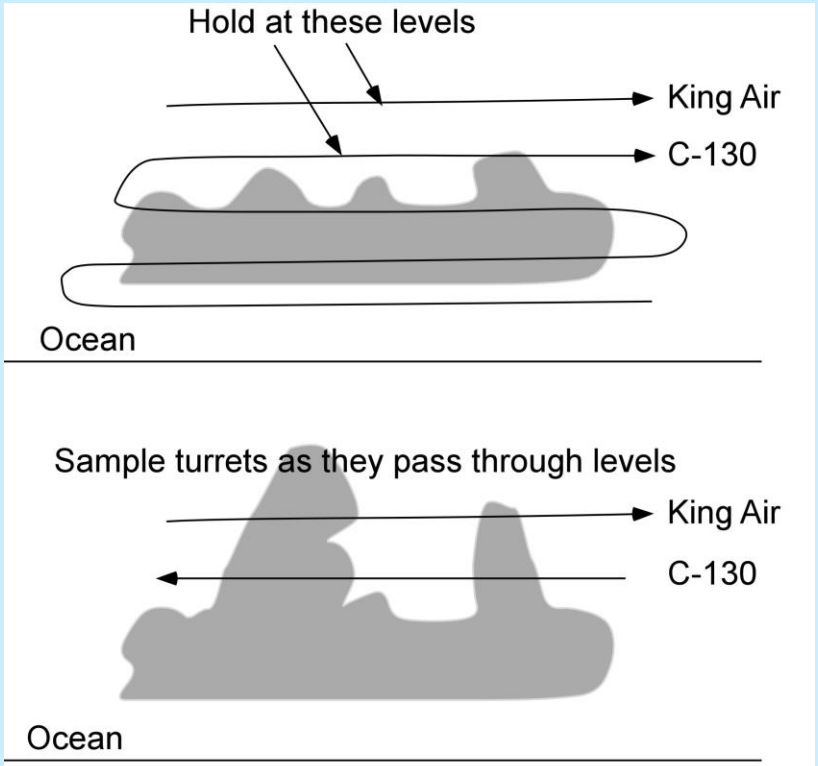


Pattern C: (daytime): Sampling of cumulus towers emerging from cloud patches. The top panels show example strategies for one aircraft. The bottom shows a cross section with two aircraft (left) or one aircraft (right). The lowest level track would be at the lowest safe altitude above the ocean surface. A pass below cloud base and within the low level cloud deck would occur, followed by continuous passes trough the turrets. With two aircraft, the C-130 would do the low level passes up to the lower turret level, while the King Air would sample the turrets continually at a higher altitude.



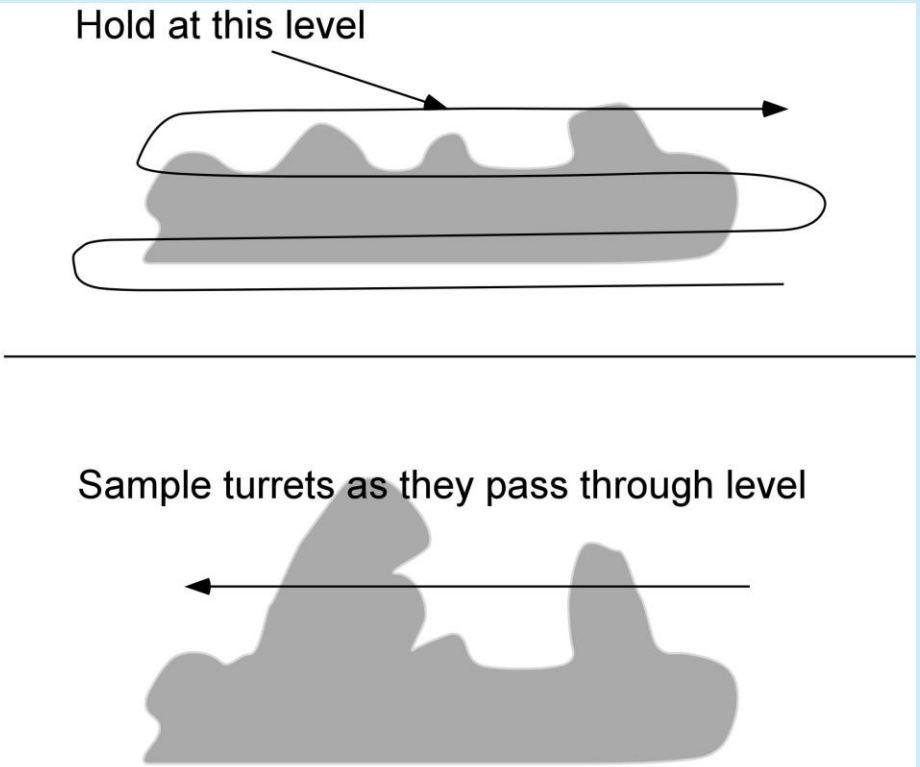
Pattern C: (daytime): Sampling of cumulus towers emerging from cloud patches-

Two aircraft



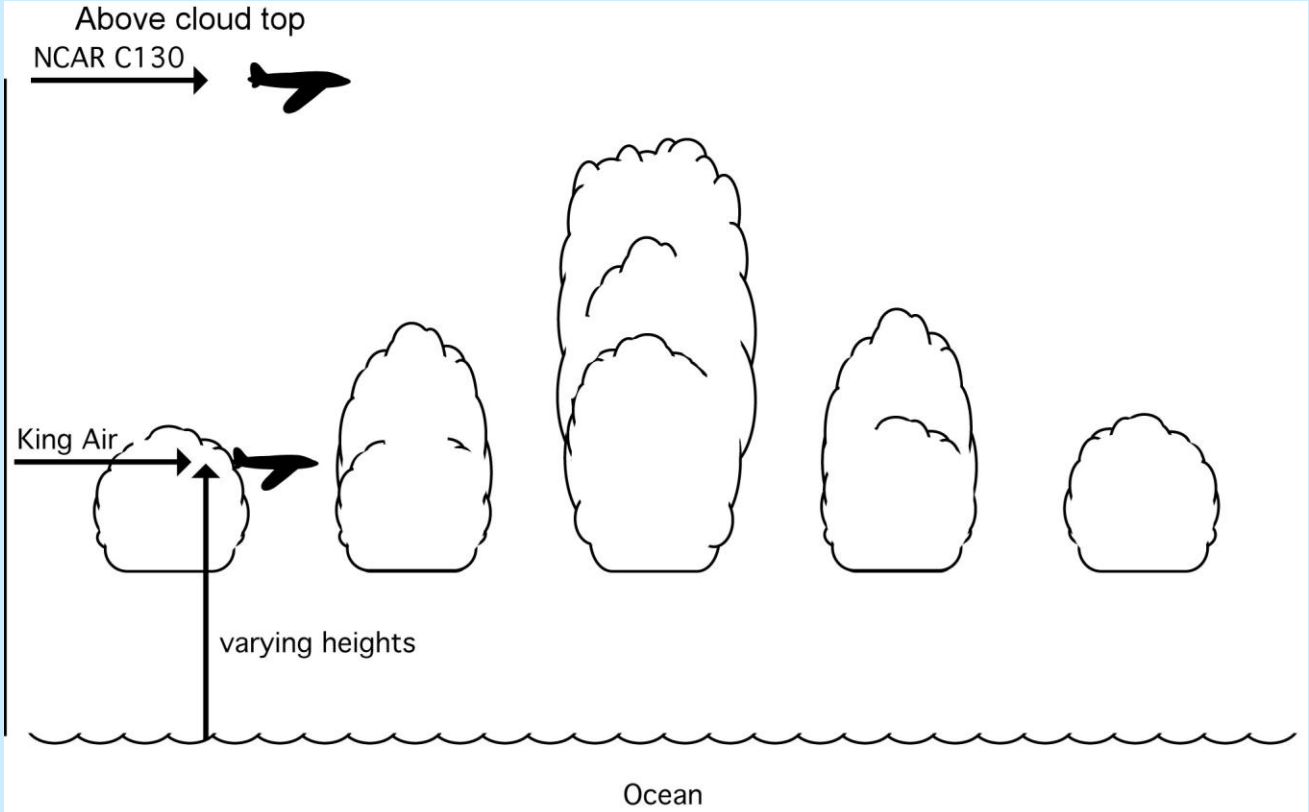
Pattern H: Multiple Aircraft Track through turrets emerging from cloud patches. C-130 first samples below shallow cloud patch, then within cloud patch and then flies holding pattern just above cloud patch. As cumulus tower emerges from patch C-130 samples tower with multiple penetrations. King Air penetrates at higher levels. Pattern will be flown multiple times at various in tower levels to develop microphysical picture of typical evolving cumulus tower.

One aircraft



Pattern C. Single Aircraft C-130 Track. C-130 first samples below shallow cloud patch, within cloud patch and then flies holding pattern just above cloud patch. As cumulus tower emerges from patch C-130 samples tower at single level. Pattern will be flown multiple times at various levels in tower to develop microphysical picture of typical evolving cumulus tower.

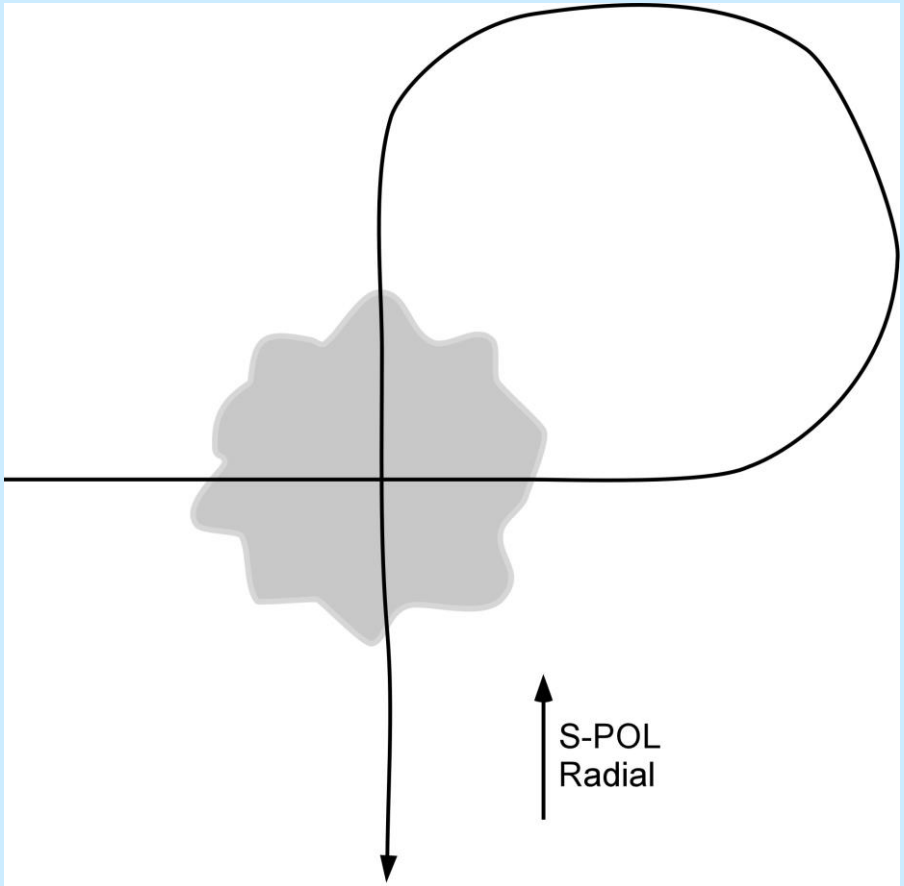
Pattern E: (daylight) Cloud entrainment and halo studies using SABL. The C-130 will fly above the cloud layer and the King Air will fly at different altitudes in the cloud layer. For eye safety, the C-130 will maintain at least a 6000 ft altitude separation above the King Air.



Flight Pattern E: Coordinated flights for cloud radiation studies using SABL

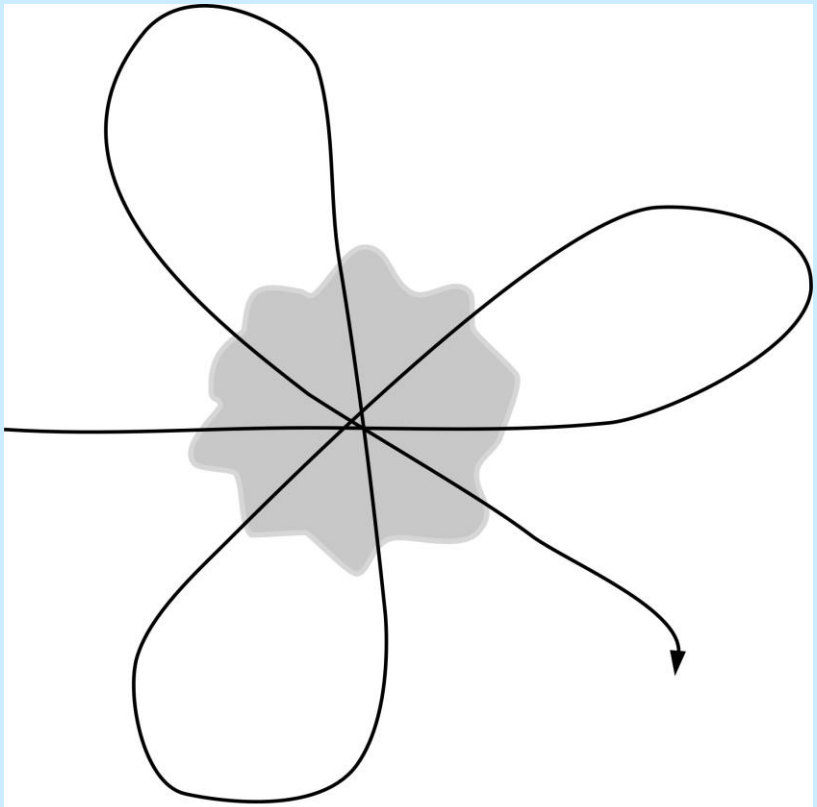
Process studies of trade wind cumulus (all in daylight hours)

Pattern F: Cross pattern through a single trade wind cloud. These will be done at cloud altitudes ranging from cloud base to cloud top.



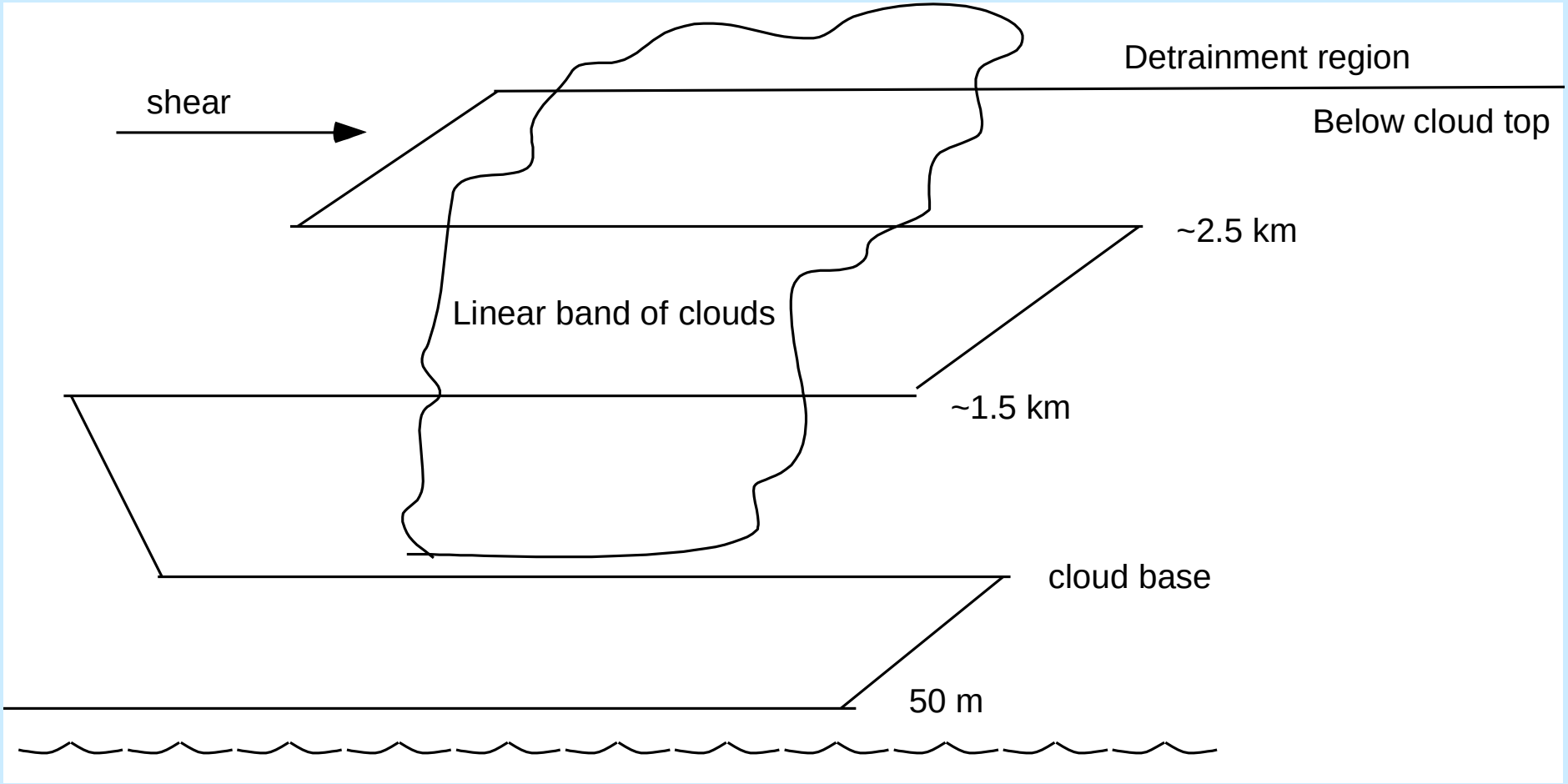
Flight Pattern F: C-130 flights at various levels in cloud. Penetrations are parallel and perpendicular to S-POL radar radial. Clouds at various distances from radar.

Pattern G: Cross pattern through a single trade wind cloud. These patterns will be done at various altitudes between cloud base and cloud top.



Flight Pattern G: C-130 constant level single cloud penetrations coordinated with King Air. This pattern would be flown at cloud base, mid cloud or cloud top as needed. Cloud is nearly directly upwind of the radar. C-130 would start pattern offshore and follow cloud toward shore.

Pattern H: When a persistent line of cumulus convection is present, characterization of the microphysical evolution of the clouds from the initial aerosol near the sea surface, through cloud base, into the cloud detrainment region is possible. This is the scenario most amenable to cloud age studies using chemical tracers.



RICO EDUCATION ACTIVITIES

1. **RICO Graduate Seminar Series (Jan. 5 – 19)**
2. **RICO Student Research Flight (~Jan. 17-20)**
3. **RICO Research Experiences for Undergraduates**
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