CINDY2011/DYNAMO/AMIE radars

AMF2 — Long (DOE)

- **Vertically pointing K_a-band**
- **X-band polarimetric**
- **K_a-band polarimetric**

SMART-R — Schumacher (Texas A&M)

- **C-band**

NCAR S-PolKa — Houze, Medina (University of Washington)

- **S- and K_a-band polarimetric**

Ship radars — Rutledge, Fairall (CSU, NOAA)*Revelle*

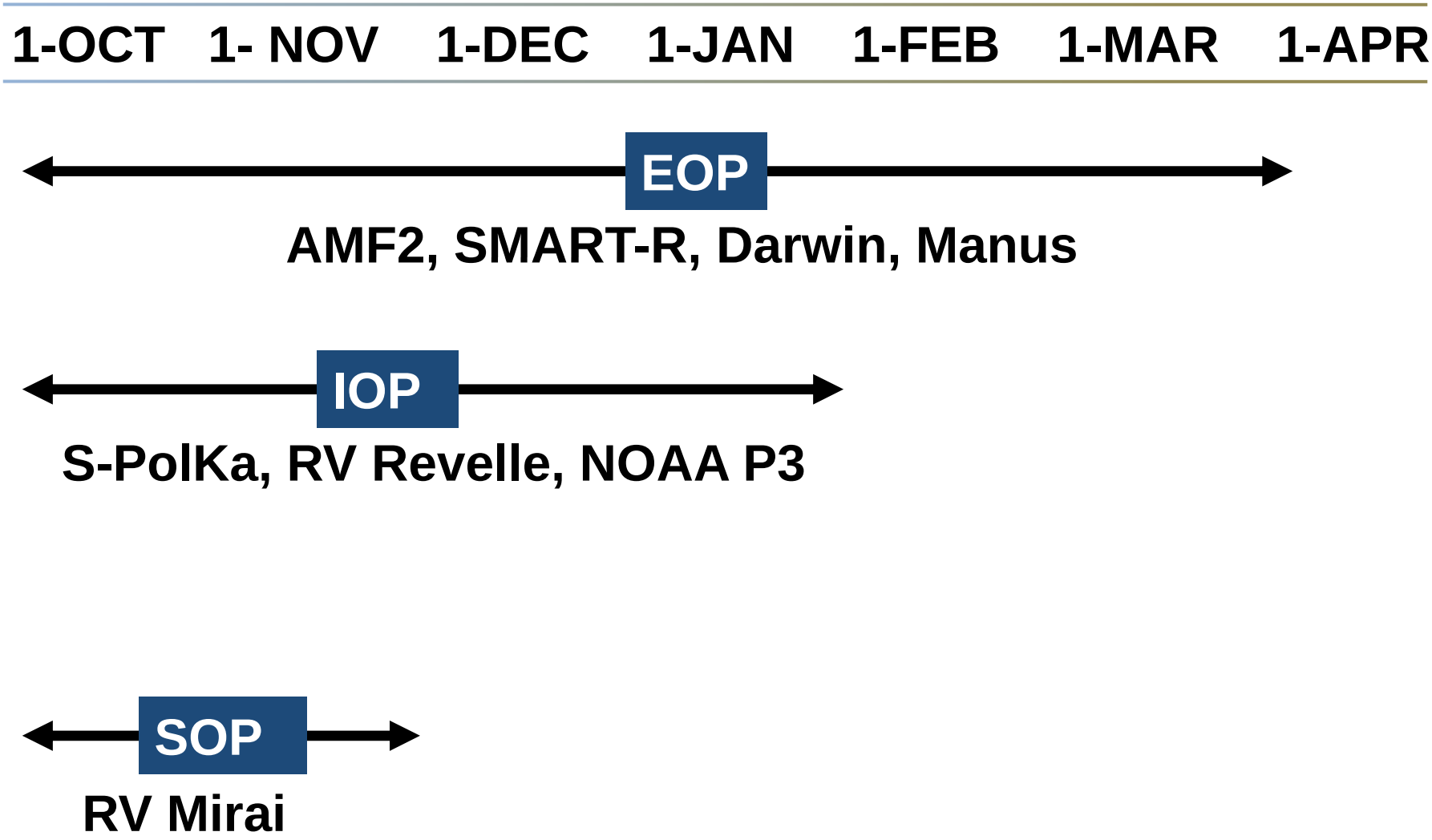
Yoneyama (JAMSTEC)*Mirai*

- **Vertically pointing mm-wavelength**
- **C-band**

Aircraft radar —Jorgensen(NOAA)

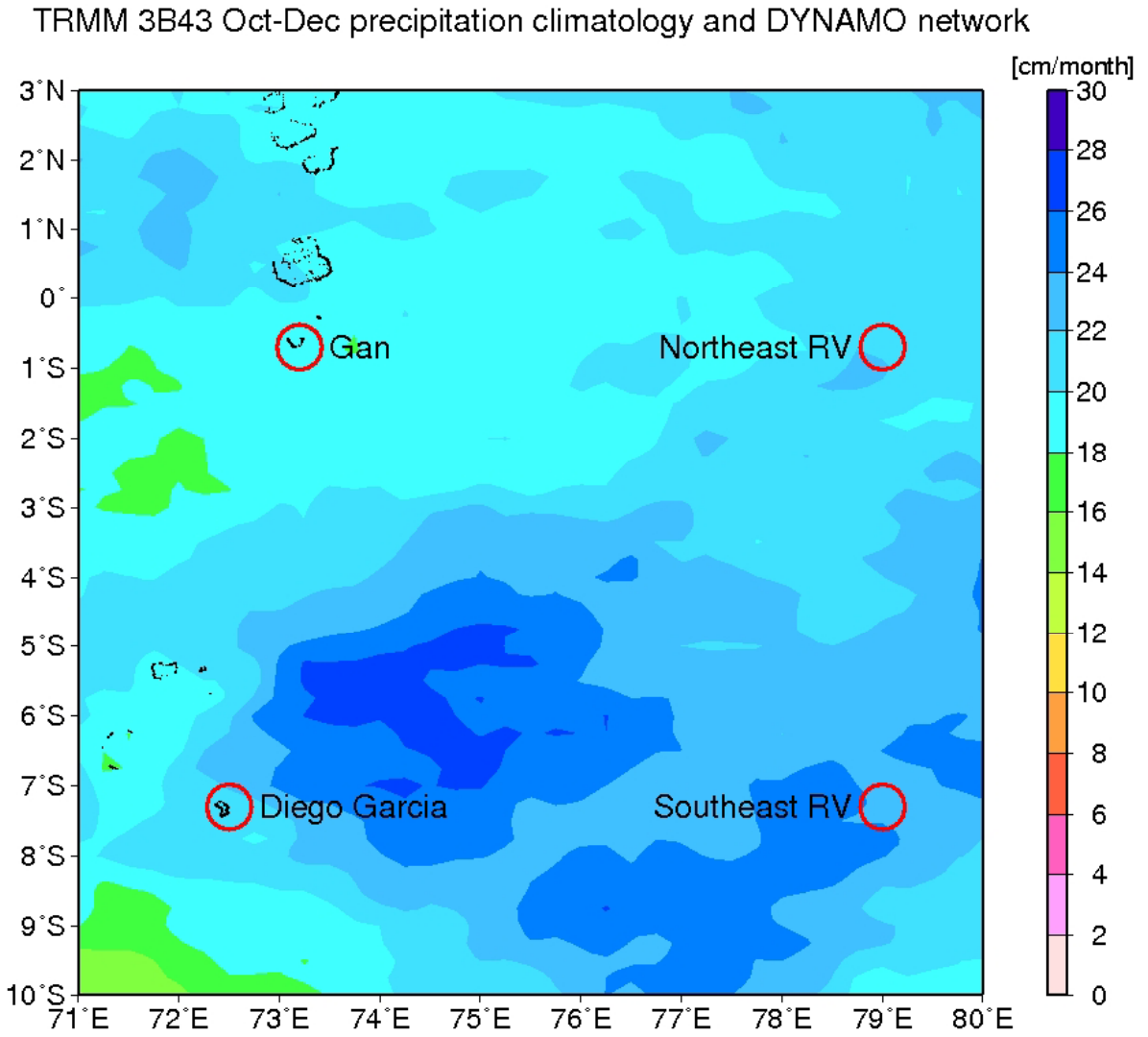
- **X-band dual-Doppler**
- **Lower-fuselage C-band**

Radar timeline

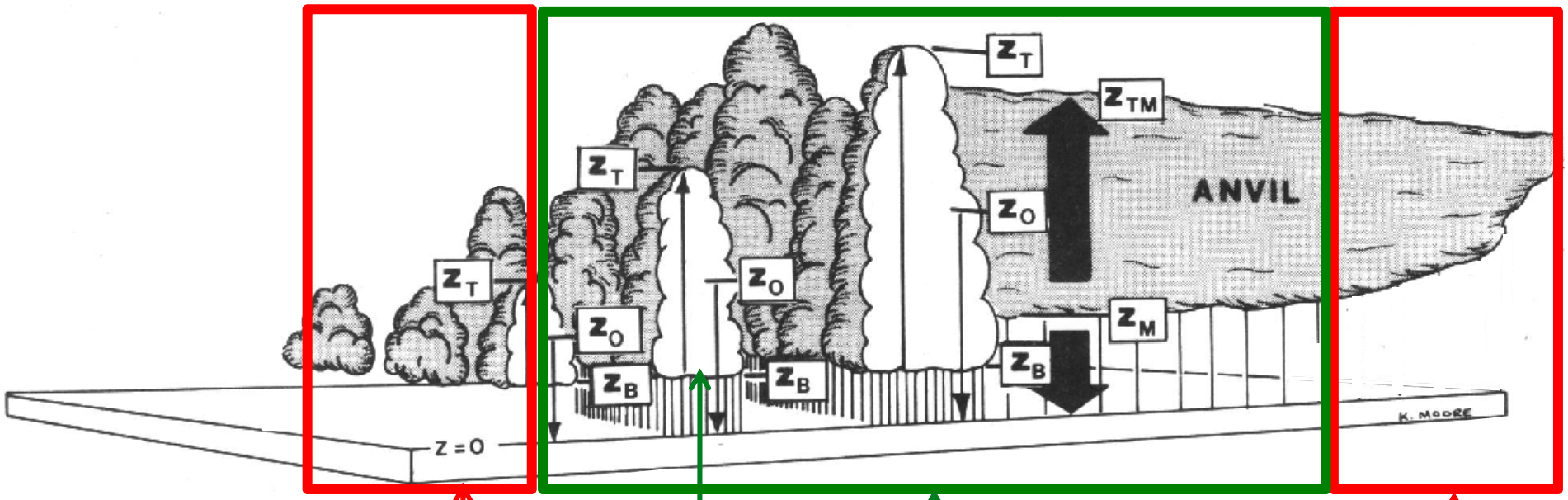


Radar locations (Indian Ocean)

- Revelle (NE location)
- Mirai (SE location)
- Gan (“Supersite”)



Shipradar science



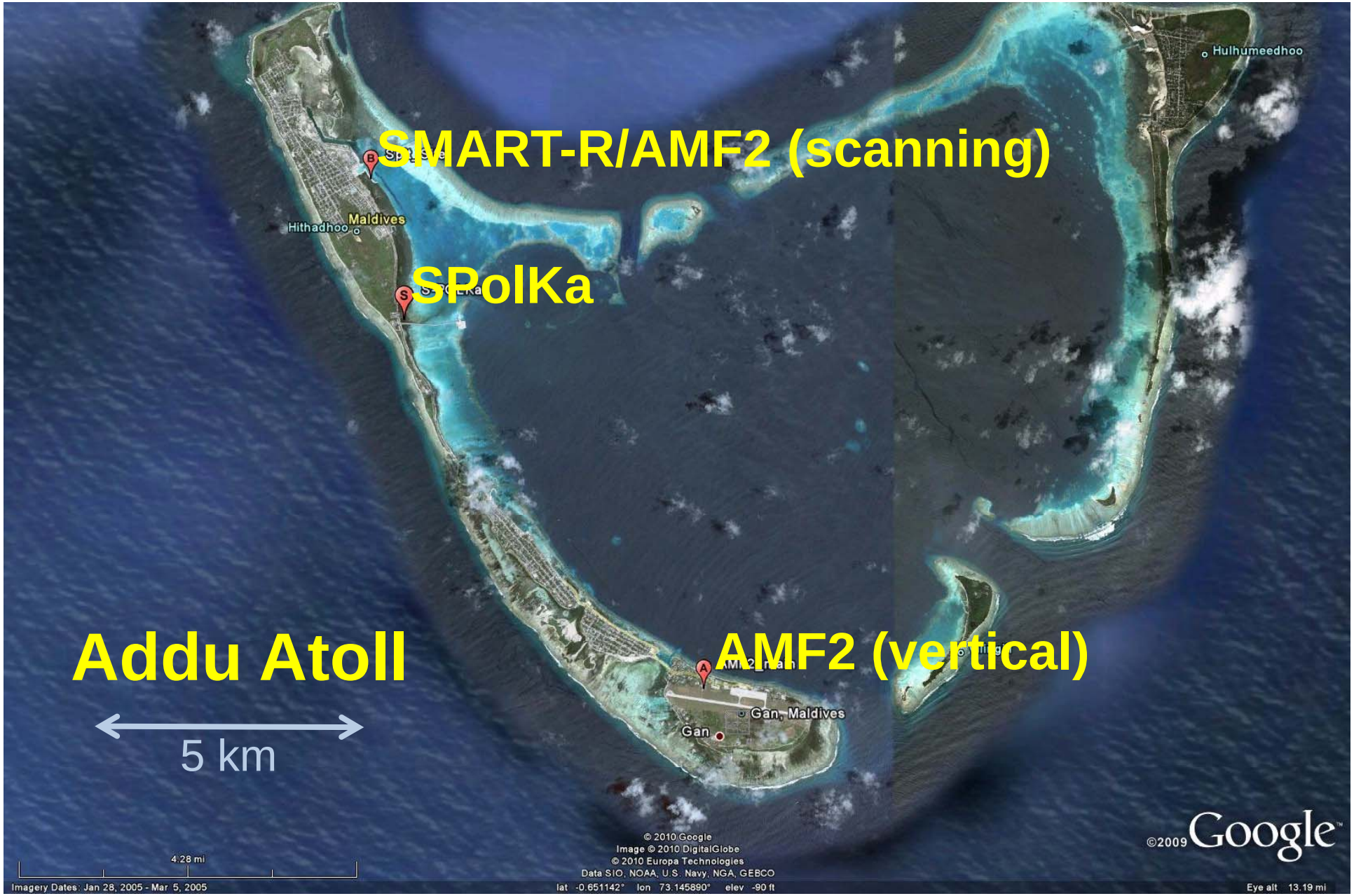
MM-WAVELENGTH
•Vertically pointing W-band

Doppler Air Motions
•C-band scanning

CM-WAVELENGTH
Precipitation
•C-band scanning

MM-WAVELENGTH
•Vertically pointing W-band

Radar locations (Gan Island/Addu Atoll)



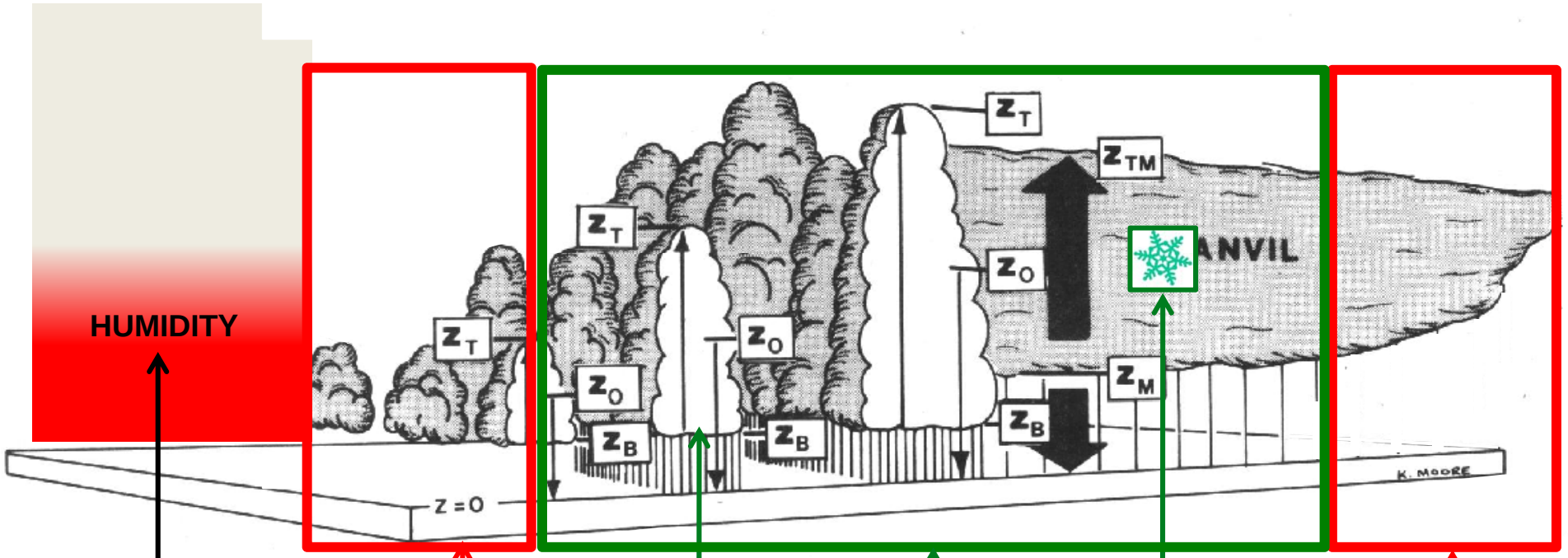
Radar site panoramas

Spit

Wharf

Airport

Supersite radar science



DUAL WAVELENGTH
- SPolKa (S + K_a)

MM-WAVELENGTH
- AMF2 (K_a-vertical)
- AMF2 (K_a)
- SpolKa (K_a)

Doppler Air Motions
- SMART-R(C)
- SPolKa (S)
- AMF2 (X)

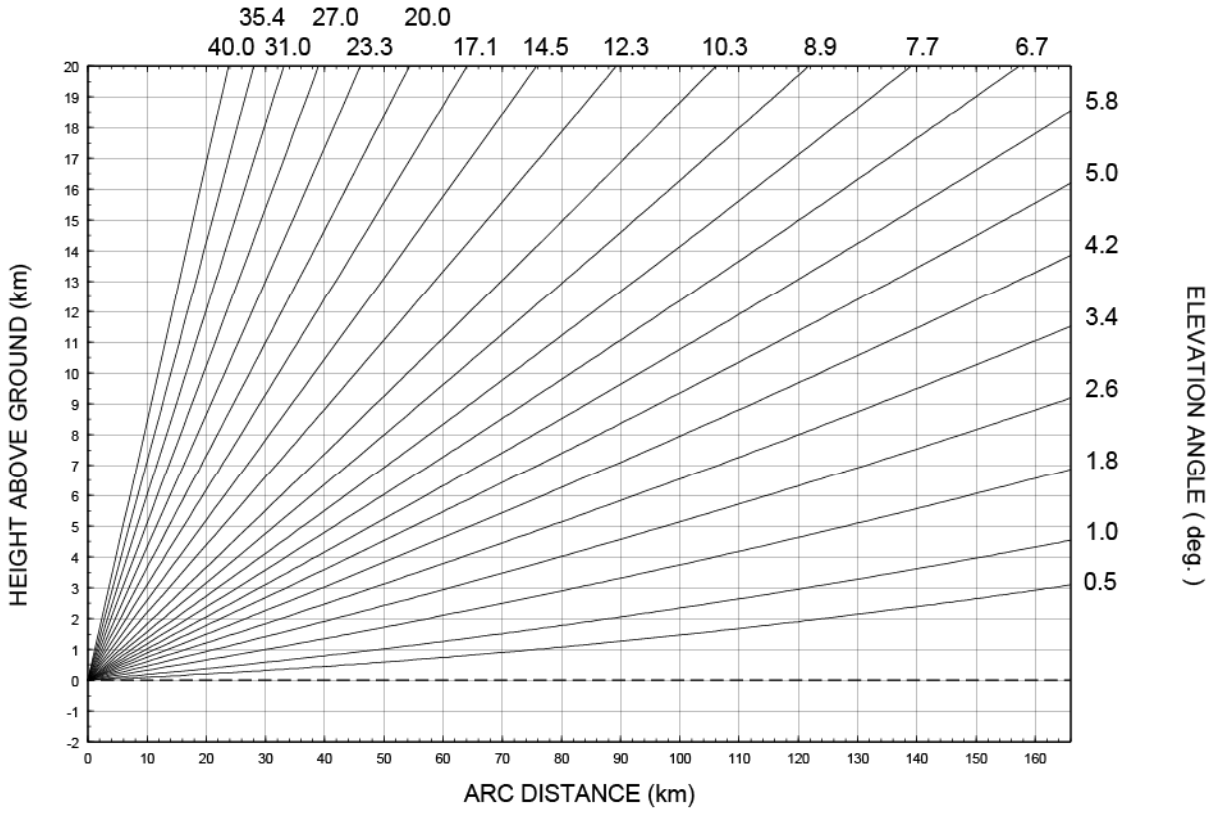
CM-WAVELENGTH
Precipitation
- SMART-R (C)
- SPolKa (S)
- AMF2 (X)
- AMF2 disdrometer

Polarimetric Microphysics
- SPolKa (S)
- AMF2 (X)

MM-WAVELENGTH
- AMF2 (K_a-vertical)
- AMF2 (K_a)
- SPolKa (K_a)

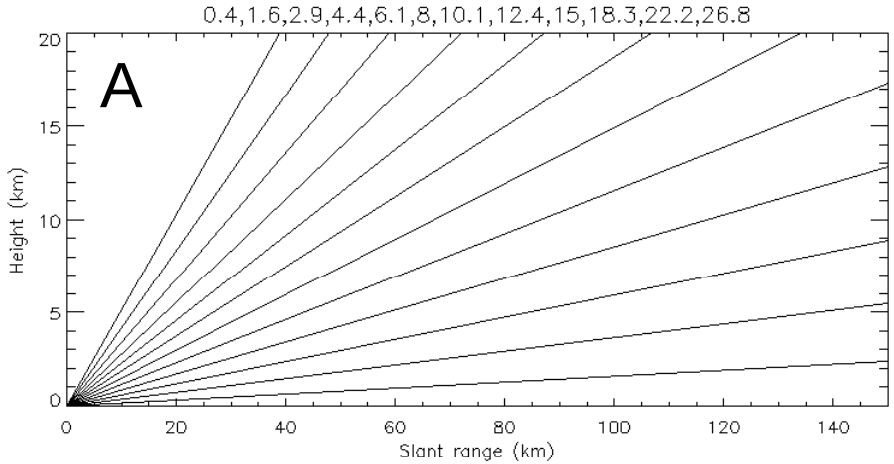
Example scan strategy (ships)

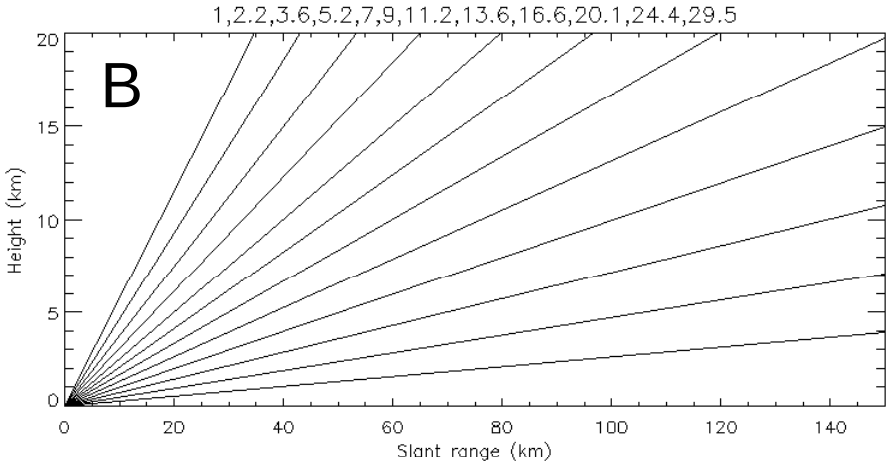
- Ten minute cycle, 24/7
- 21 elevations (from 0.5 to 40.0˚), 8 minutes
- Surveillance scan twice an hour
- RHIs in areas of interest, 1-2 minutes
- Typical range: 120-160 km



Example scan strategy (SMART-R)

- Ten minute cycle, 24/7
- 21 elevations (from 0.4 to 29.5˚), 9 minutes
  - 2 11-tilt scans interleaved, lowest tilt repeated
- Surveillance scan every ten minutes
- RHI over ARM site every ten minutes
- Typical range: 150 km





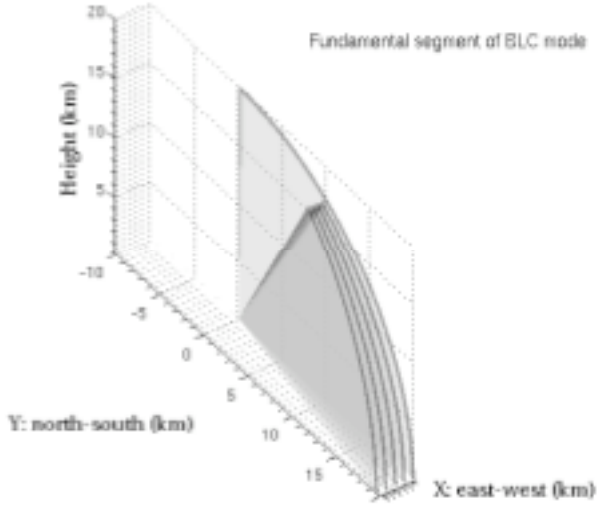
Example scan strategy (SPolKa, AMF2)

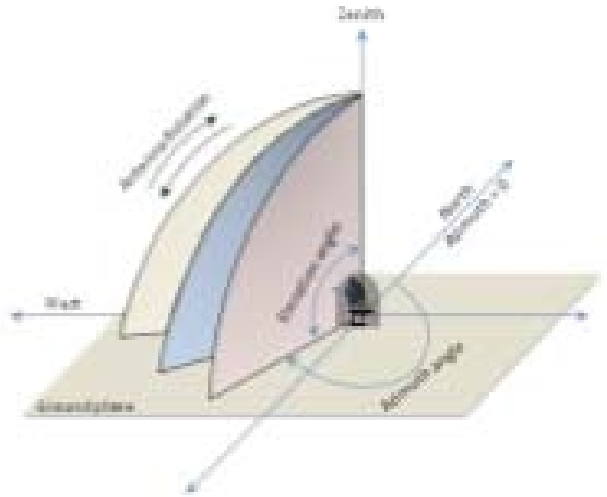
SUPPRESSED

- Ten minute cycle, 24/7
- Sectors: Low-level PPIs (humidity) + low-level RHIs
- Occasional surveillance scan and RHI over ARM site
- Typical range: up to 75 km

ACTIVE

- 15-30 minute cycle, 24/7
- Sectors: Low-level PPIs (humidity) + deeper RHIs
- Occasional surveillance scan and RHI over ARM site
- Typical range: up to 150 km





CINDY2011/DYNAMO/AMIE radar products

- **3-D reflectivity**
  - Rain maps
  - Convective-stratiform maps
  - Echo top
    - Echo type (e.g., shallow, mid level, and deep convection)
  - Reflectivity PDFs by height
    - Threshold area coverage (e.g., 5, 20, and 40 dBZ)
  - Latent heating
  - Cell size
  - Rain/snow water content
- **3-D radial velocity**
  - Divergence profiles (VADs)
  - Dual-Doppler/vertical velocity
- **3-D polarimetric**
  - Hydrometeor ID
  - Improved rain maps (+-20%)
  - Rain water content
  - Mean diameter
- **Dual-wavelength**
  - Humidity retrievals
  - Total LWC
- **Vertically pointing**
  - Profiles of reflectivity, velocities, and spectral width
  - Cloud boundaries
  - Radiative heating profiles

Issues/Integrated radar product

- Siting
  - -AMF2 location
- Scan strategies
  - -suppressed vs active for SPolKa and AMF2
- Real-time products
  - -mostly images, some data exchange
- Calibration
  - -compare against TRMM PR or other standard
- Quality control/interpolation
  - -ensure some consistency
- Drop-size distributions/Z-R relations
  - -SPolKa and AMF2 video disdrometer
- Integrated C-band products
  - -reflectivity PDFs with height, echo-top heights, convective-stratiform classification, rain maps, rain/snow water content estimates, latent heating profiles

US radar staffing

- Technical staff
  - NCAR—2 technicians at all times
  - ARM—1-2 technical staff at all times, ~2 local helpers
  - A&M—engineer for setup/takedown
  - CSU—1 technician at all times
- Scientists from NCAR, UW, A&M, and CSU (includes students)
  - NCAR—2 scientists
  - UW—1-2 people at any time
  - A&M—PI first few months, 2 students at all times
  - CSU—1-2 people at any time
- 15 additional students (~1 month deployment)
  - SPolKa—1 student for humidity calculations
  - SMART-R—4 students for operating SMART-R
  - Revelle—1 student on ship
  - (Aircraft—2 students)
  - (ARM/ship—7 students for soundings)

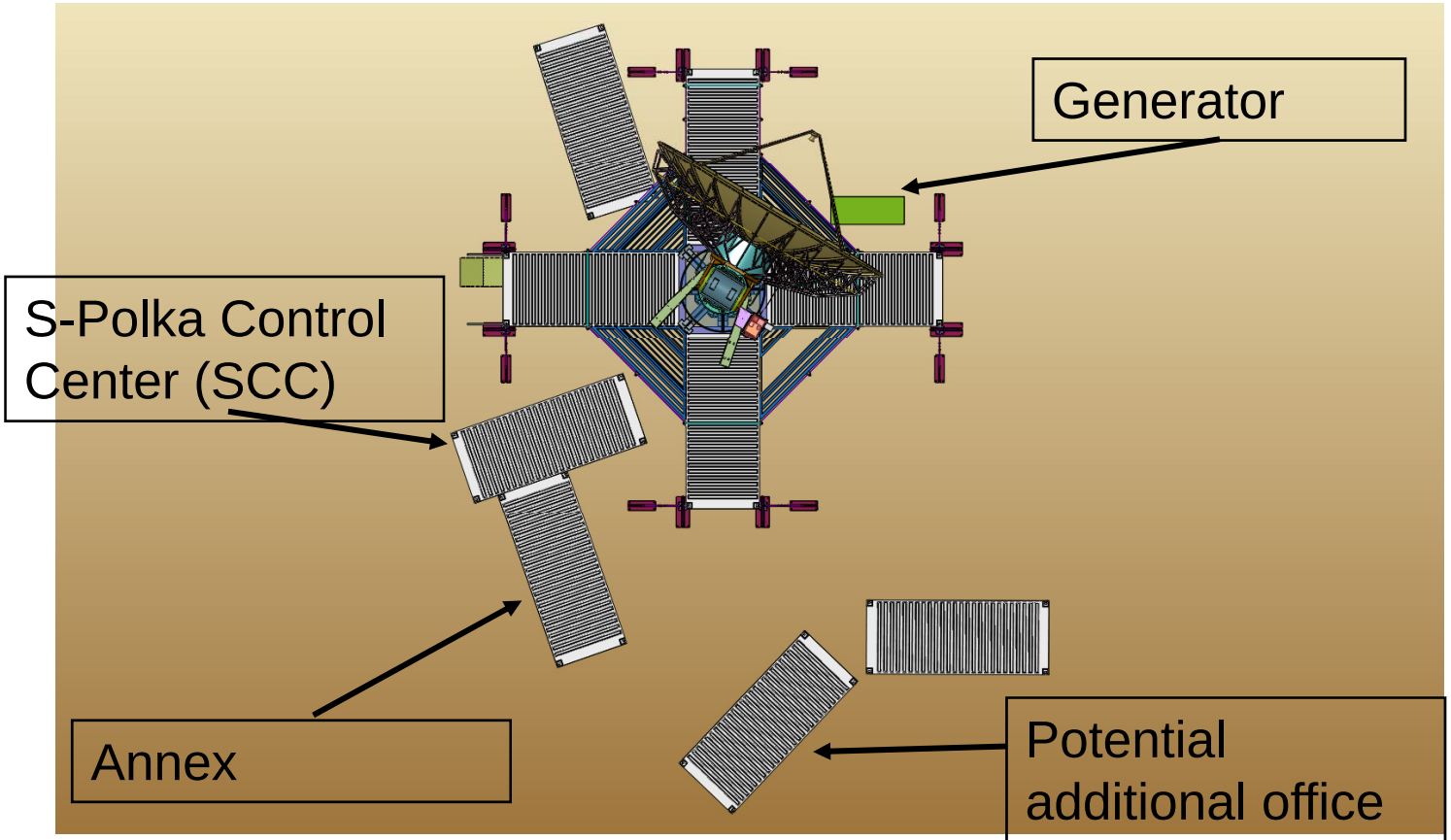
S-PolKa Overview

CINDY Meeting

Jim Moore

4 November 2010

S-PolKa Configuration



- 8 (9??) standard 20 ft seatainers
  - 2 seatainers used for office space (SCC + Annex)
  - 1 seatainer is tech container (some storage + tech space)

S-PolKa Configuration

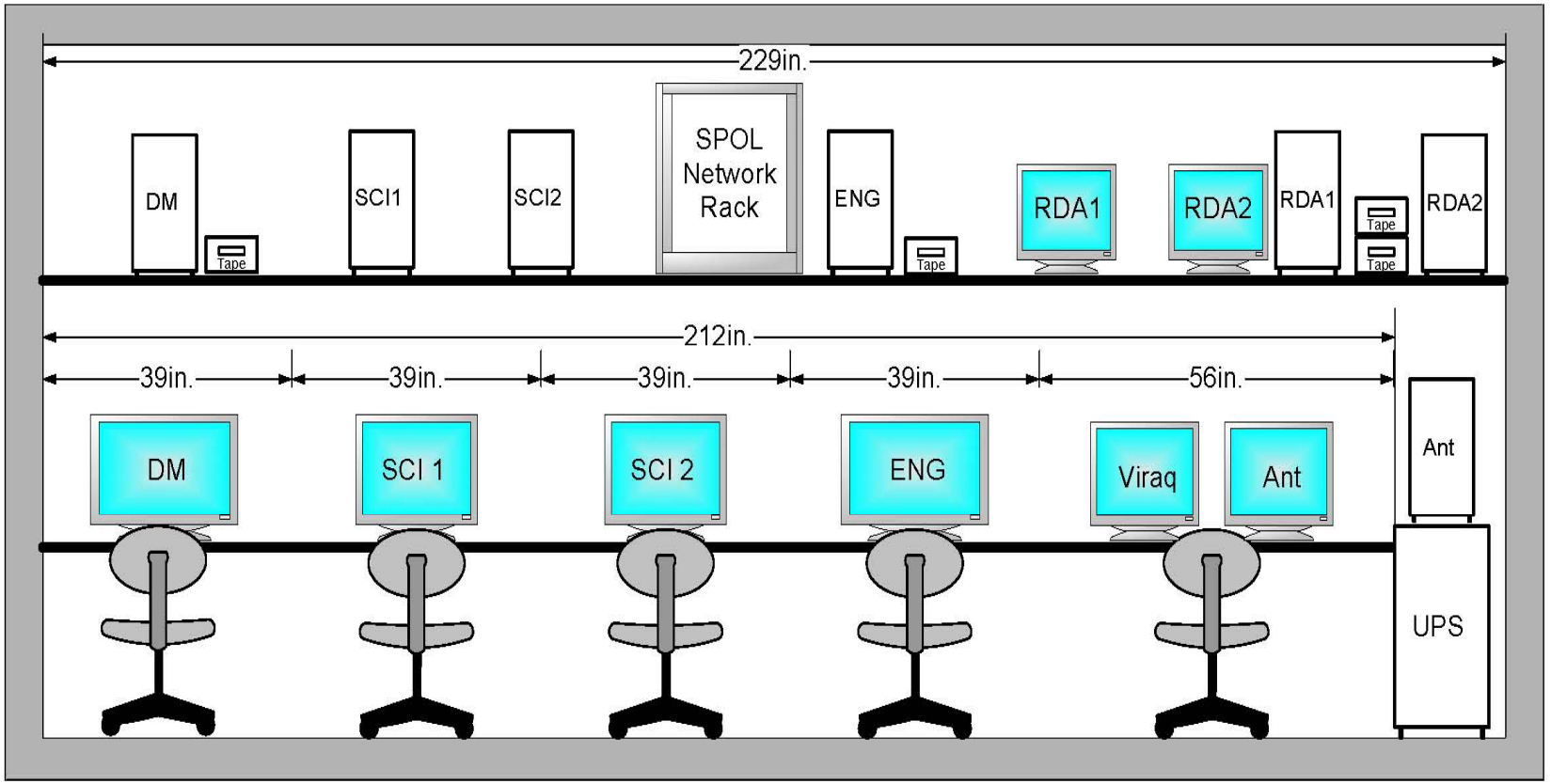
- Capacity of SCC and Annex is 7 to 8 stations
  - Room for visitors and tours
- 4 seatainers form base (no concrete pad)
- Power from diesel generators (fuel delivery)
- Scanning
  - PPI – 5 to 10 min volumes
  - RHI
- Two computer networks
  - S-Pol network – data collection, science display
  - Guest network – visitors plug in laptops etc.

S-PolKa Configuration: SCC

S-PolKa Configuration: SCC

Configuration for TIMREX

SPOL SCC Container



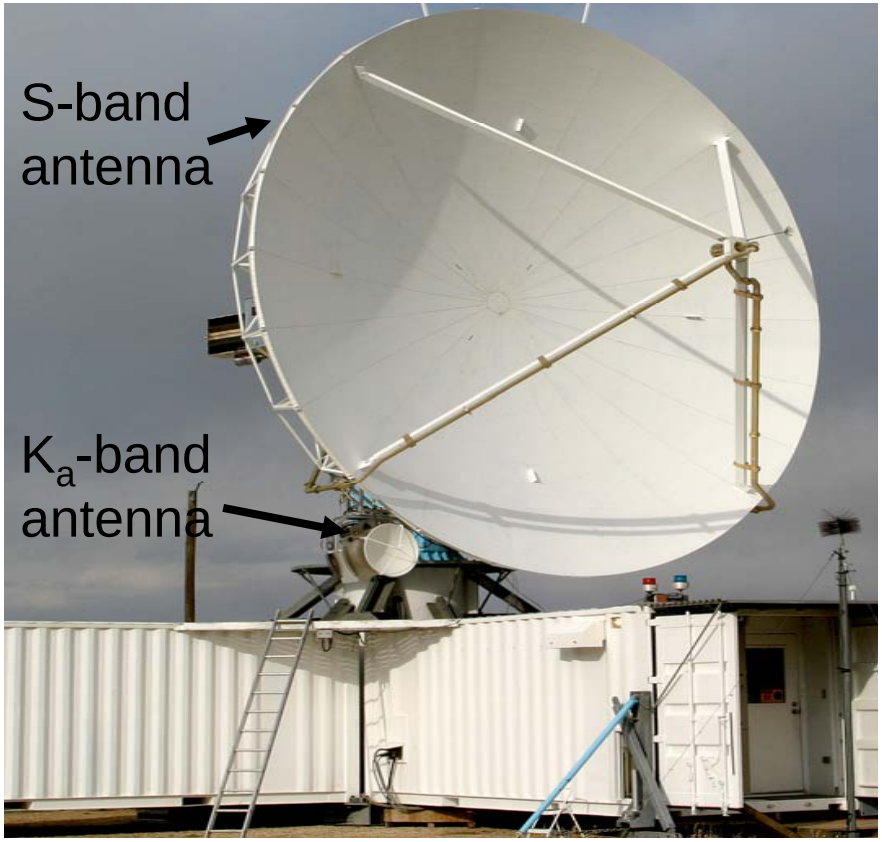
S-PolKa Configuration: Annex

S-PolKa Setup

- Physical setup takes about 14 days
- Planned by 15 September 2011
- 2 weeks configuration and testing
  - Calibration
  - Computer network configuration and displays

S-PolKa Operations

- NCAR S-Pol radar upgraded with simultaneous S-band (10 cm) and K_a-band (0.8 cm) measurement capability (S-PolKa)
  - Matched 1 deg beam widths
  - Matched 150 m range gates
- S-band is non-attenuating
- K_a-band is heavily attenuating



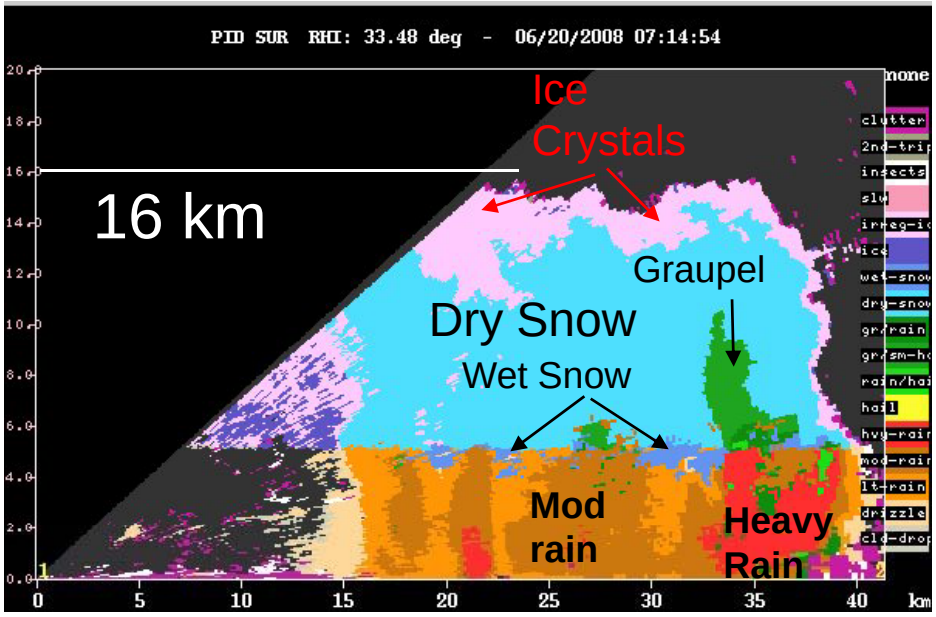
S-PolKa Operations

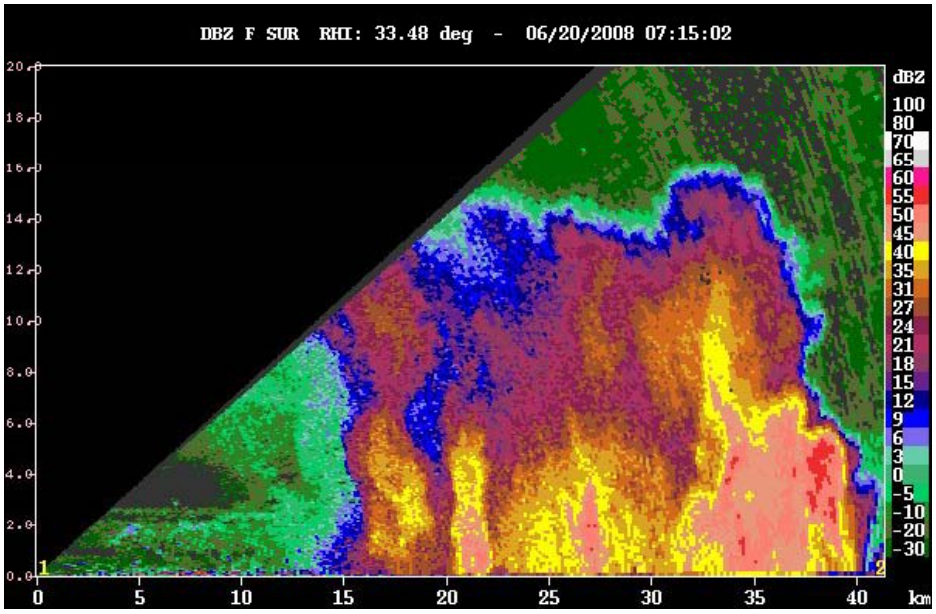
- Some S-band specifications
  - 8 m dish
  - Feedhorm is 9 m above ground at 0 deg el
  - Peak power ~ 1 Megawatt
  - Pulse duration 1 to 4.5 μs
  - Frequency = 2.7 to 3.0 GHz
  - Max range = 150 km
  - PRF ~ 1 ms
  - Fast alternating H and V transmit dual-polarization

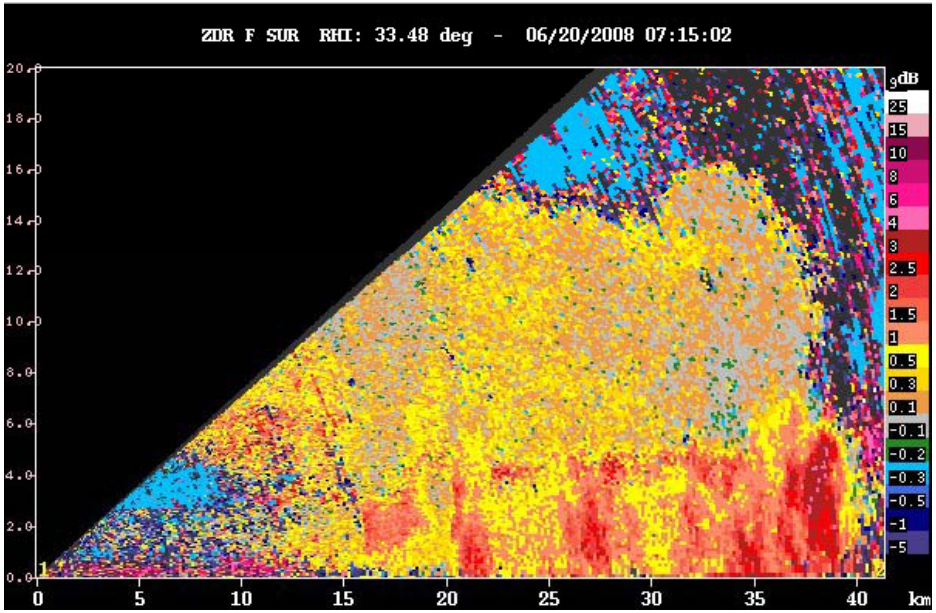
S-PolKa Operations

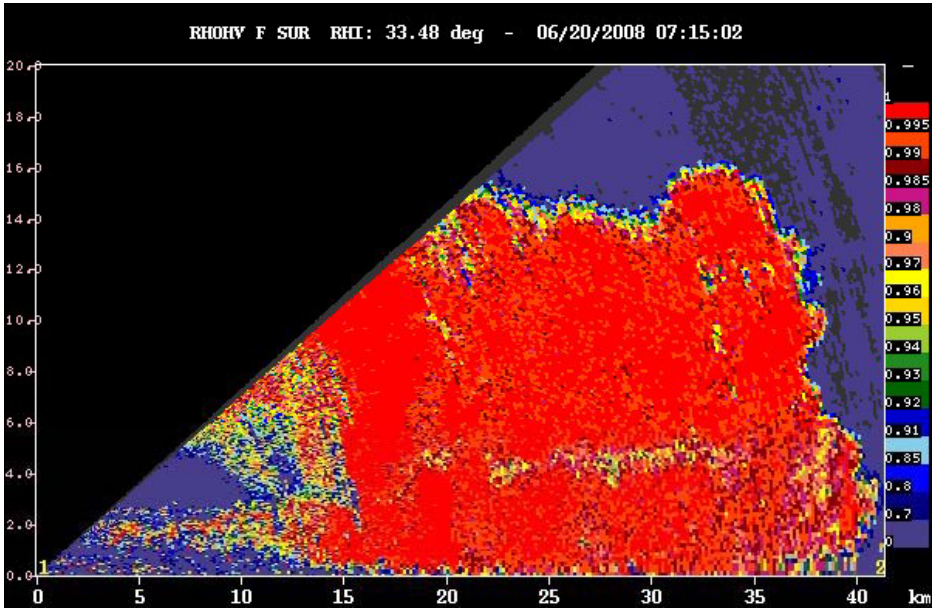
- Some K_a-band specifications
  - 0.7 m dish
  - Feedhorm is ~ 5 m above ground at 0 deg el
  - Peak power ~ 40 to 45 Kilowatt
  - Pulse duration up to 1 μs
  - Frequency = 34.6 GHz
  - Max range = 75 km
  - PRF ~ 1 ms
  - Simultaneous H and V transmit

S-PolKa Product Examples: Hydrometeor ID





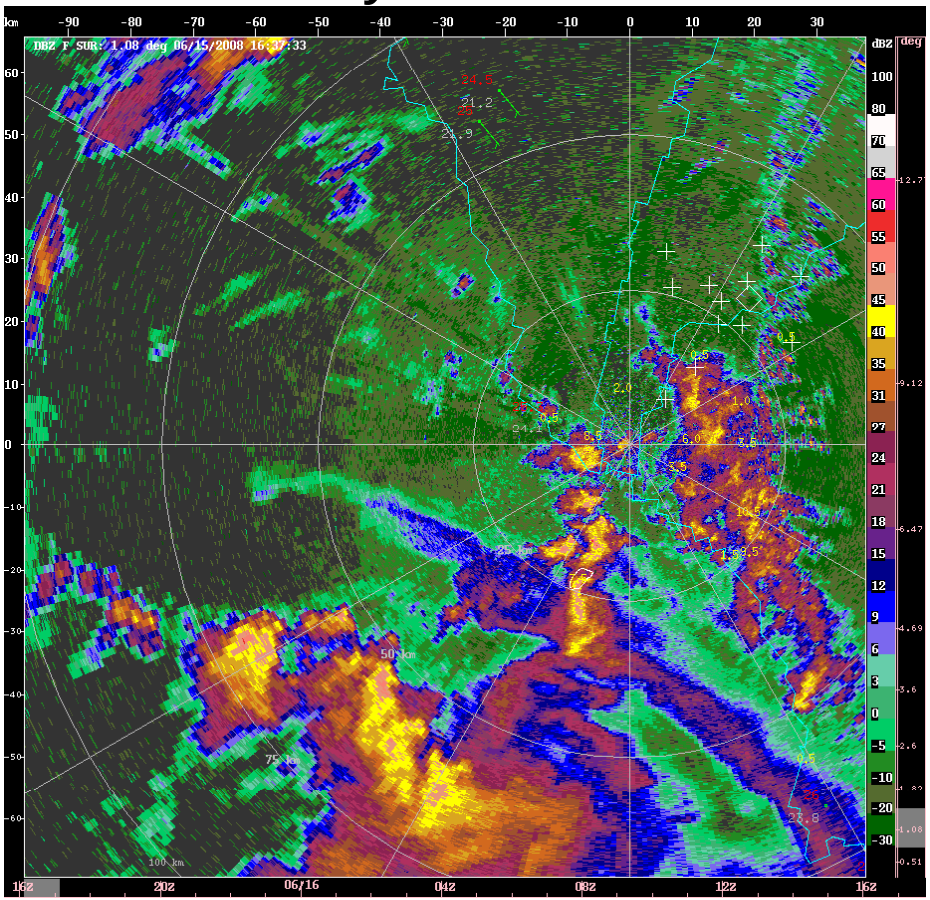




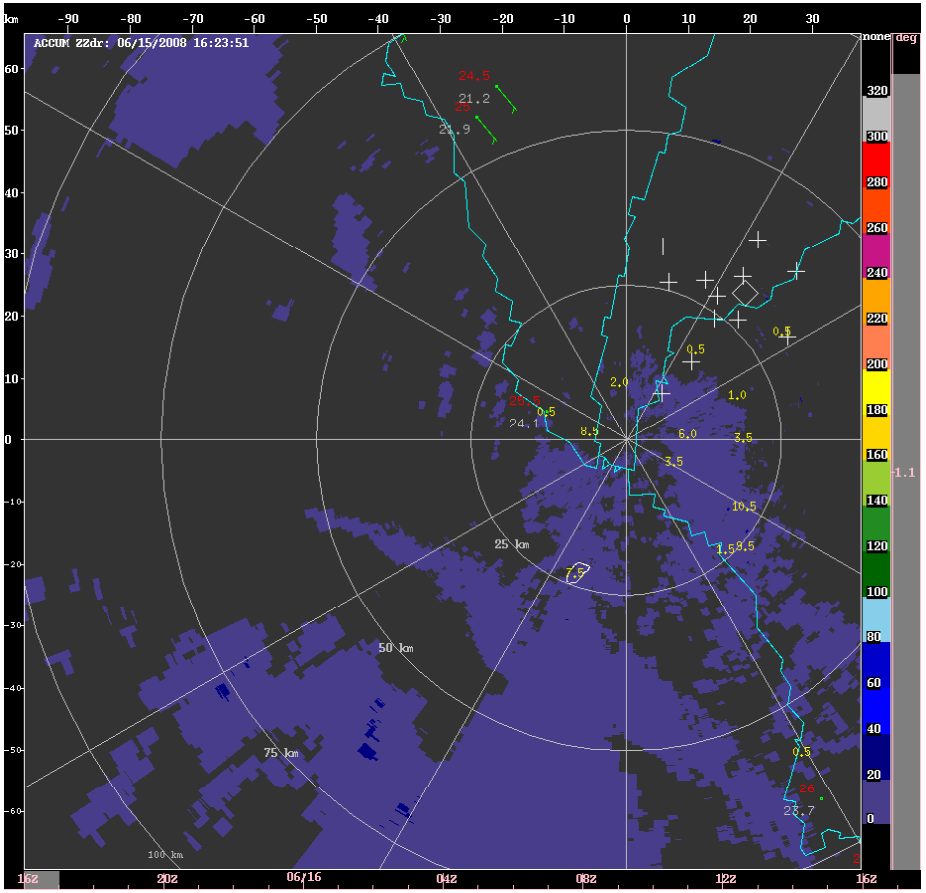
S-PolKa Product Examples: Rain Accumulation

Southern Taiwan, 2008

Reflectivity

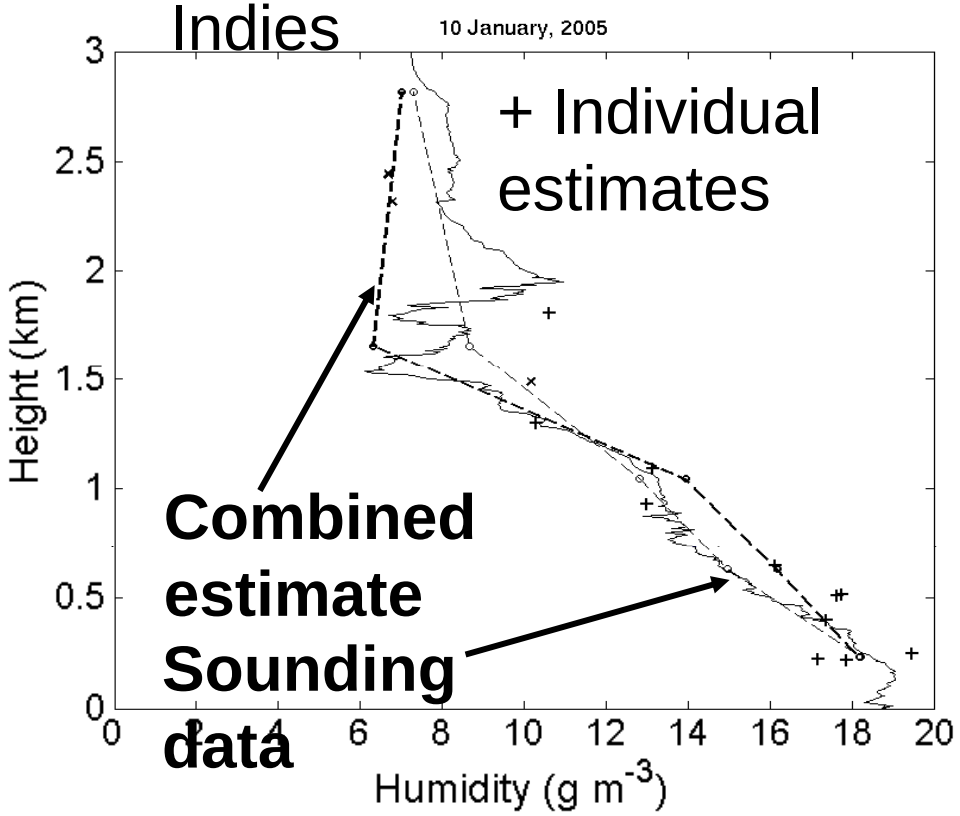


Rain accumulation

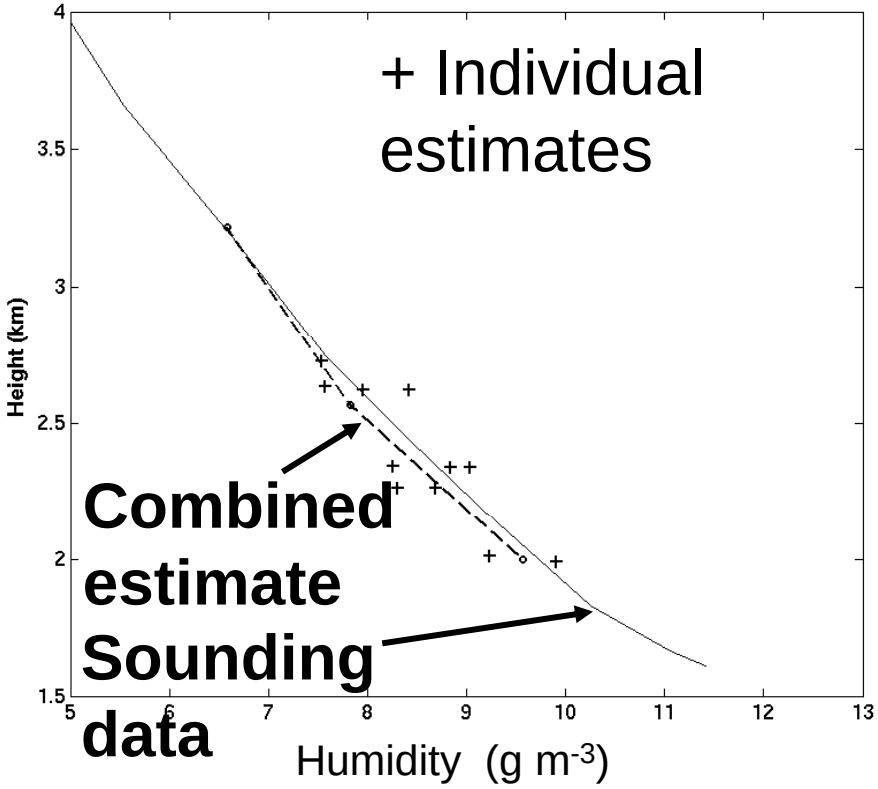


S-PolKa Product Examples: Dual-wavelength humidity

Tropical: Barbuda, West Indies

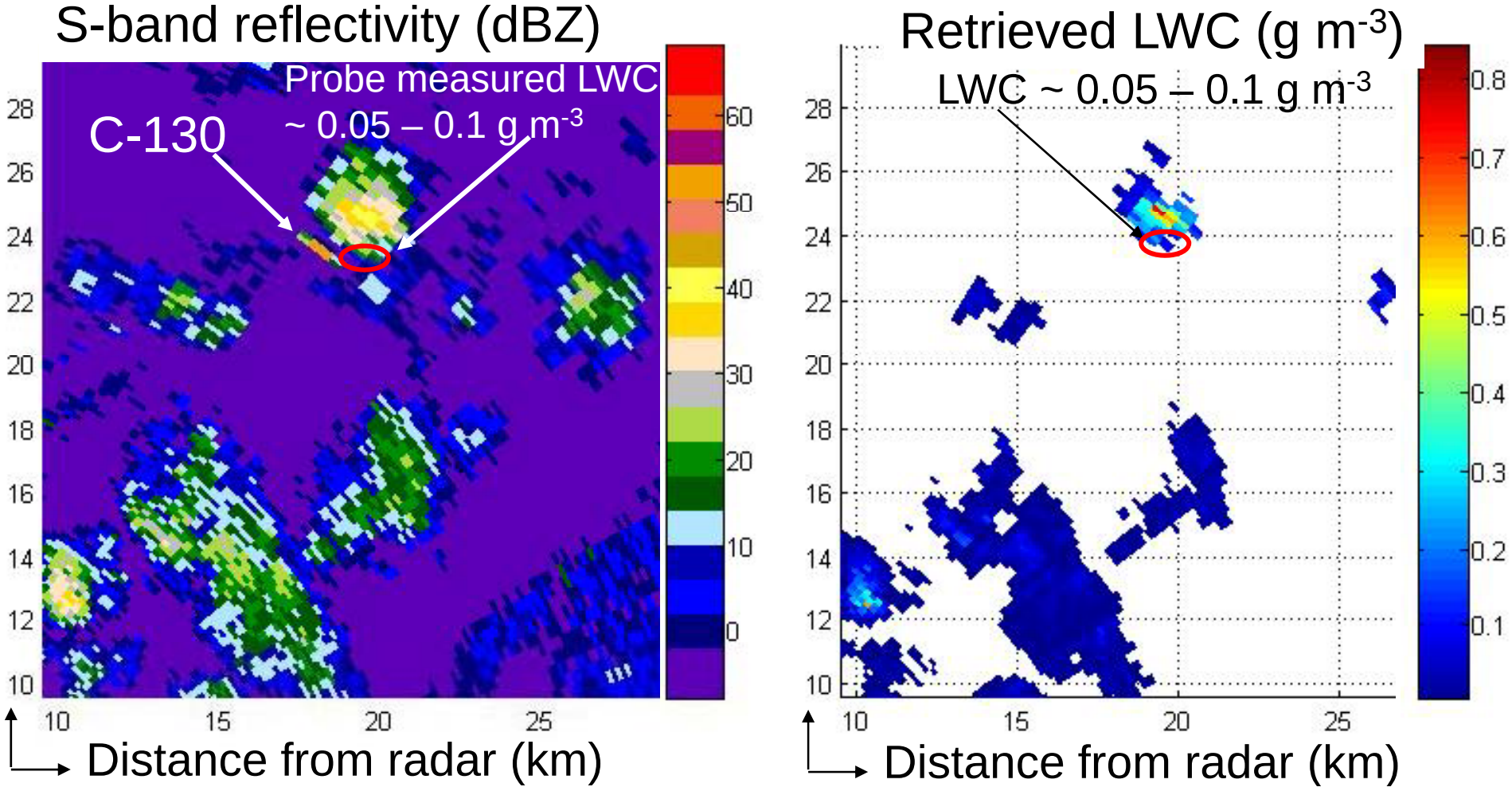


Continental: Colorado



S-PolKa Product Examples: Dual-wavelength LWC

Attenuation based LWC estimate is independent of DSD



Atmospheric Observations from the Revelle

TOGA C-band Doppler Radar

NOAA HSRL Doppler Lidar

NOAA W-band radar

NCAR ISS

Aerosol measurements

Who is involved…

- Brewer/Wolfe/Fairall
  - W-band radar, high resolution lidar
- Rutledge
  - C-band scanning Doppler radar
- Johnson
  - Ship Integrated Sounding System, 915 MHz profiler and radiosonde
- Bates
  - Aerosol, CCN measurements

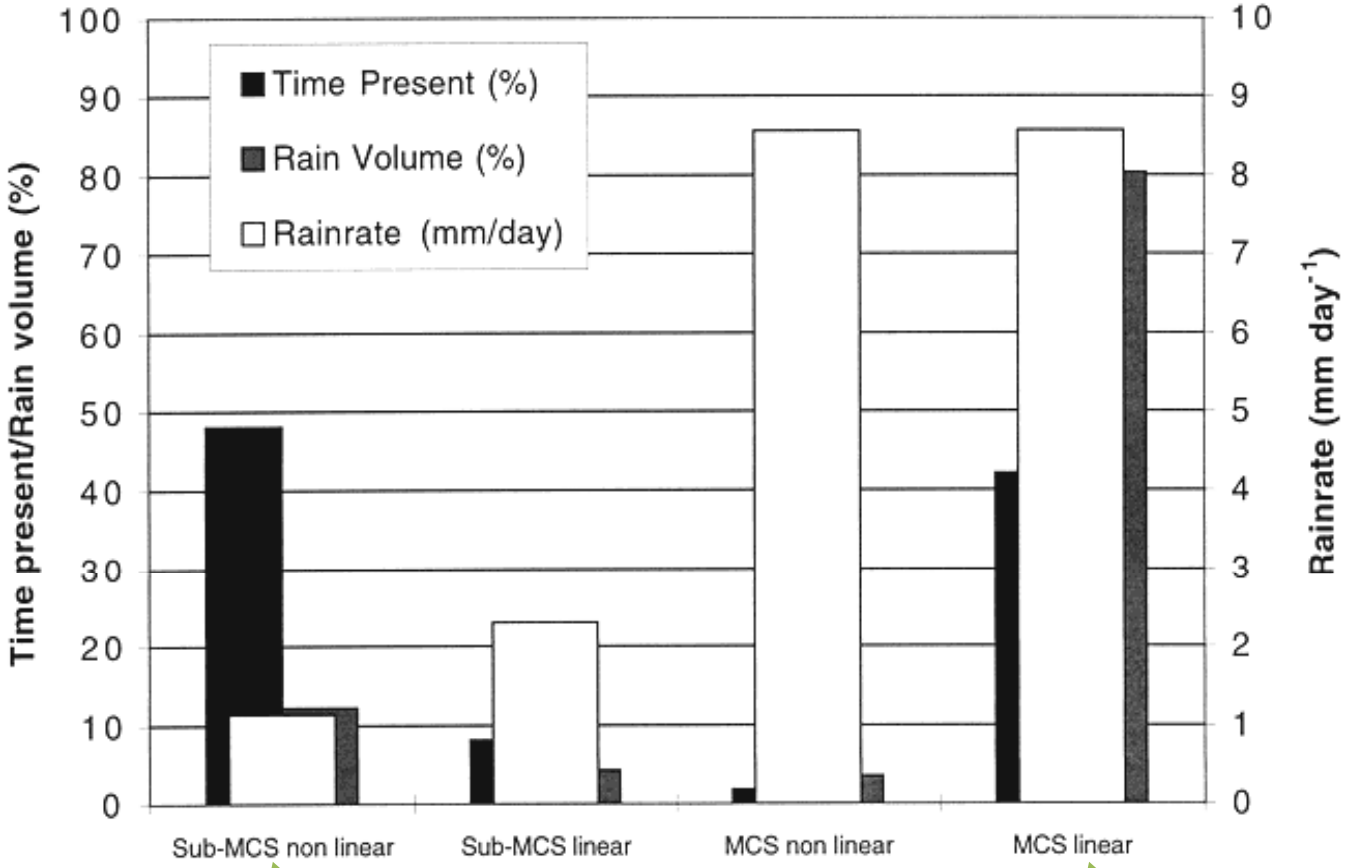
NASA-TOGA radar

- Used successfully in TOGA COARE and elsewhere
- 5 cm Doppler radar, single polarization
- State of the art signal processor upgrade to be done before field campaign
- Will collaborate with NASA/Wallops personnel for installation
- New INU-type stabilization system to be acquired
- Radar installed at Darwin in August 2011

Objectives for TOGA based research

- Document 3-D structure of precipitating clouds over the course of MJO initiation and link to moisture field
- Characterize convective and mesoscale structure, and degree of convective organization and link to environmental shear
- Estimate divergence profiles from VAD scans to diagnose heating profiles and the nature of these profiles as the MJO evolves
- Document the 2-D flow structure in organized convective systems and compare to conceptual models for momentum transport
- Produce high quality rain maps based on TOGA reflectivity data (S-polKa polarimetric data will help develop appropriate Z-R relationships)

TOGA COARE observations of mesoscale organization and rainfall contributions



Rickenbach and Rutledge (1998)

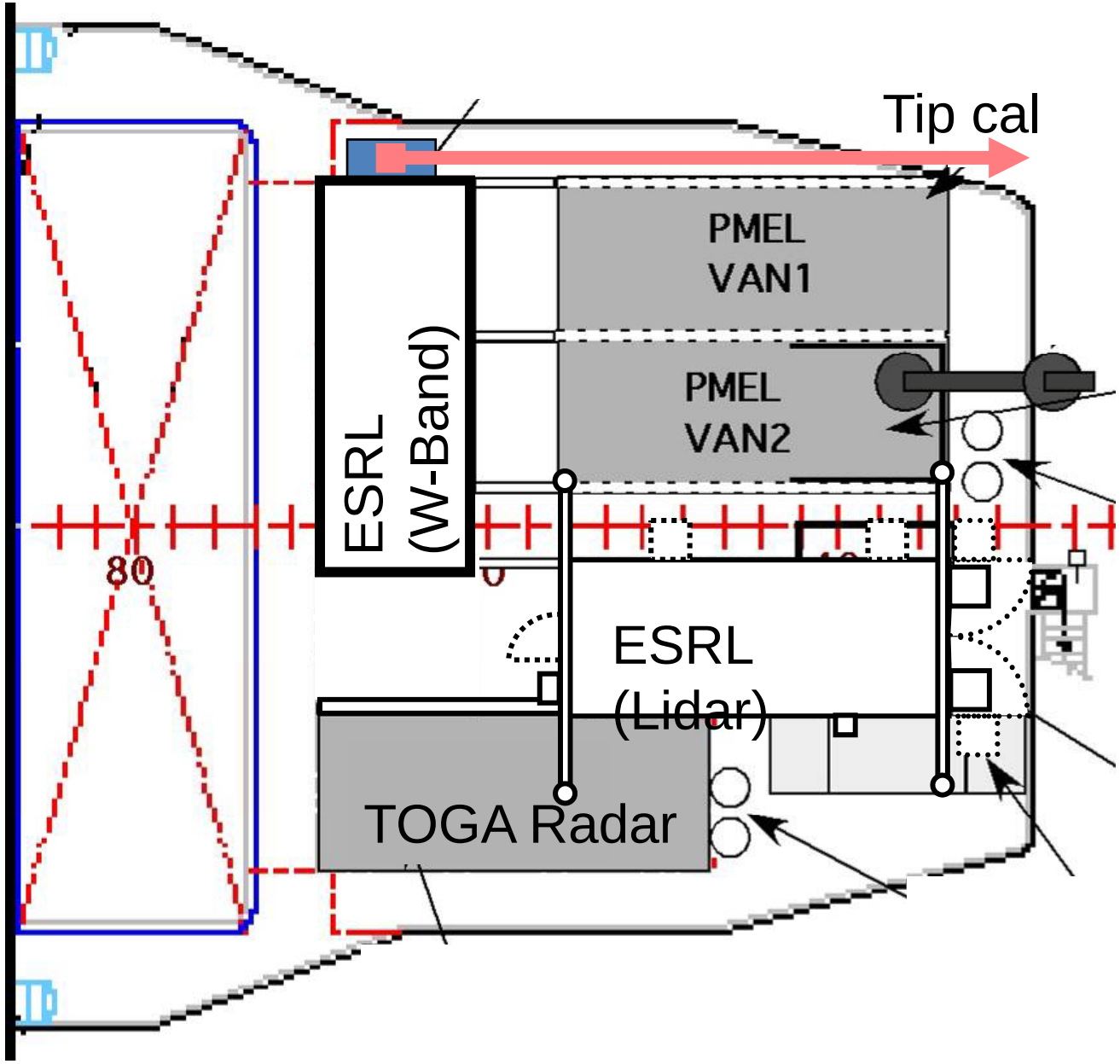
Light wind and post MJO westerly phase

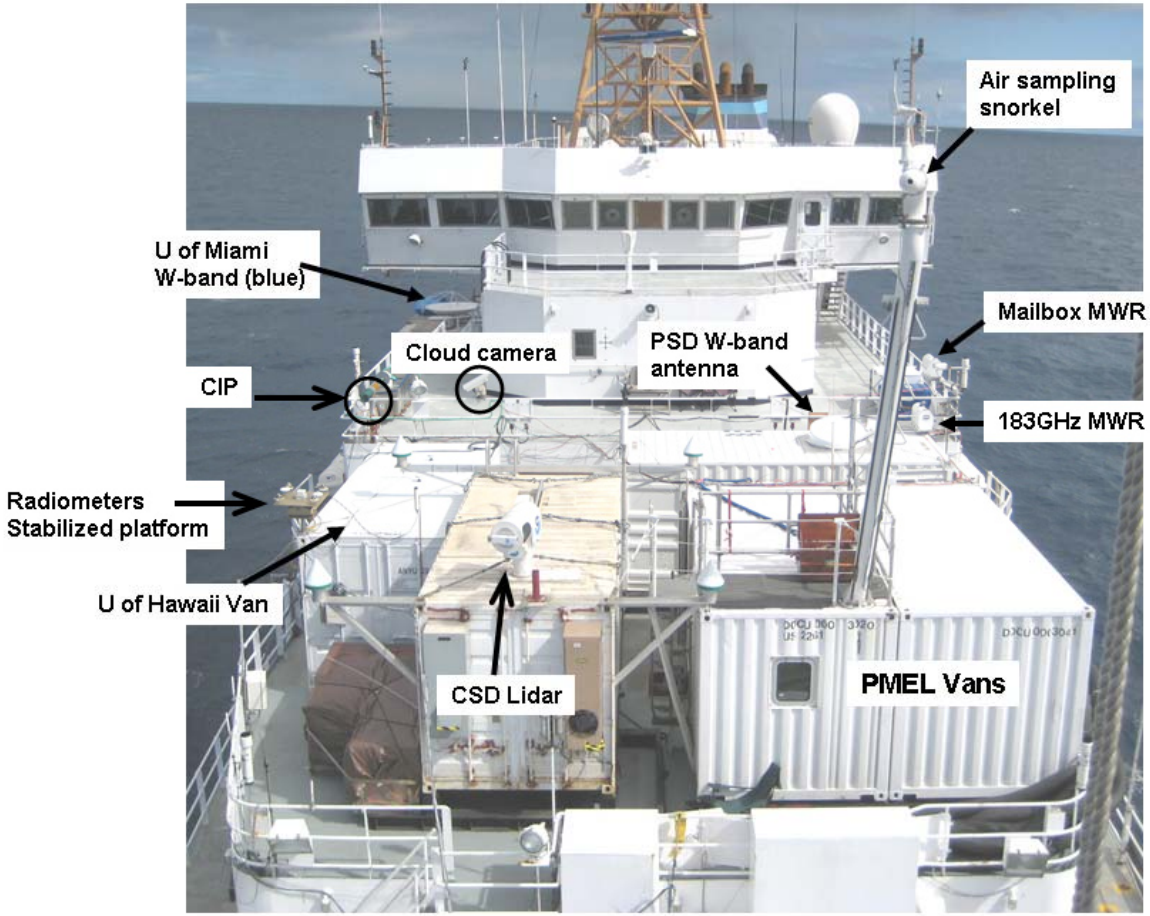
Pre-MJO and at leading portion of MJO

R/V Revelle

Built: 1996
Length: 277’
Beam: 52'5”
Draft (max): 17’
Crew: 22
Scientific berthing: 37

Revelle O2 deck Placement w/ PMEL Frames

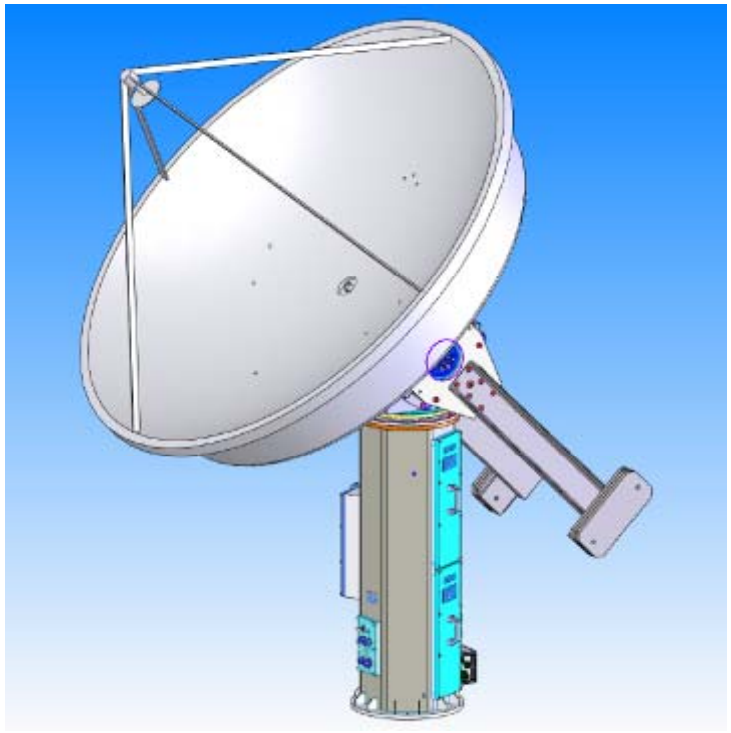




Example of similar installation on the R/V Ronald Brown

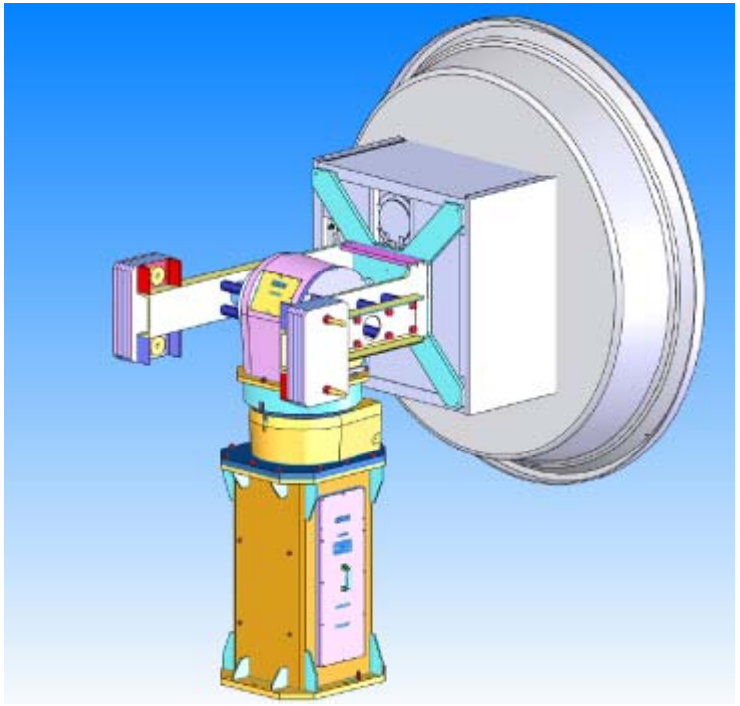
ARM AMF2 X-SACR

- 9.7 GHz
- 20 kW peak power
- 1.82 mdiameter antenna
- 1.4˚ beamwidth
- Transmit equal V/H power or horizontal polarization
- Dual polarization V/H receiver



ARM AMF2 Ka-SACR

- 35.3 GHz
- 2.0 kW peak power
- 1.82 mdiameter antenna
- 0.33˚ beamwidth
- Transmit horizontal polarization
- Dual polarization V/H receiver



SMART Radar

- C-band (5.5 cm), Doppler radar jointly owned by Texas A&M and University of Oklahoma
- 2.54 m antenna, ~1.5° beamwidth (circular)
- International 4700 dual-cab diesel truck (~2.6 m wide, ~10 m long, ~4.1 m tall, ~11,800 kg) with 10-kW diesel generator
- Reflectivity, radial velocity, and spectrum width measured out to 150 km radius