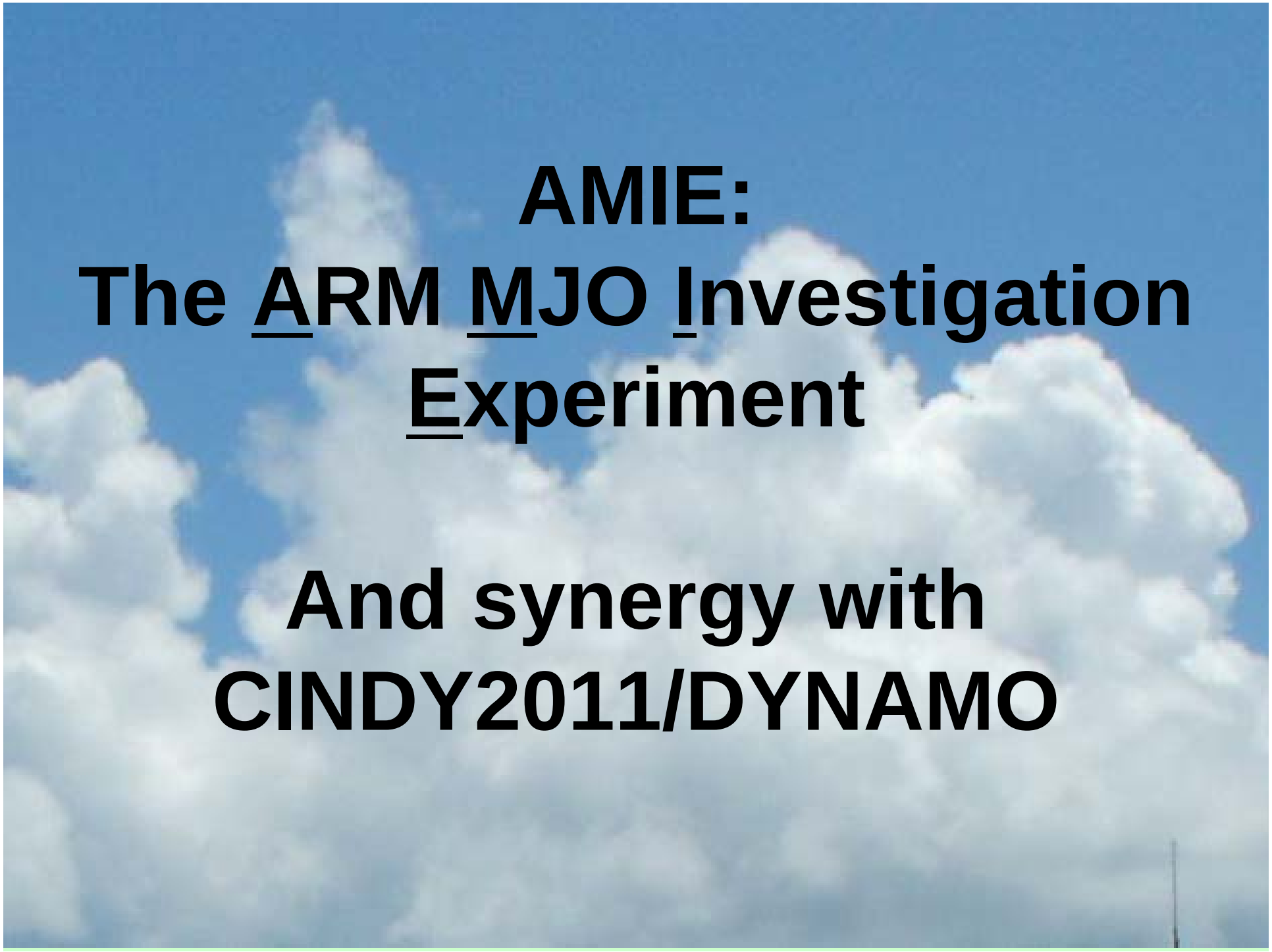

AMIE:
The ARM MJO Investigation Experiment
And synergy with CINDY2011/DYNAMO

AMIE-Manus

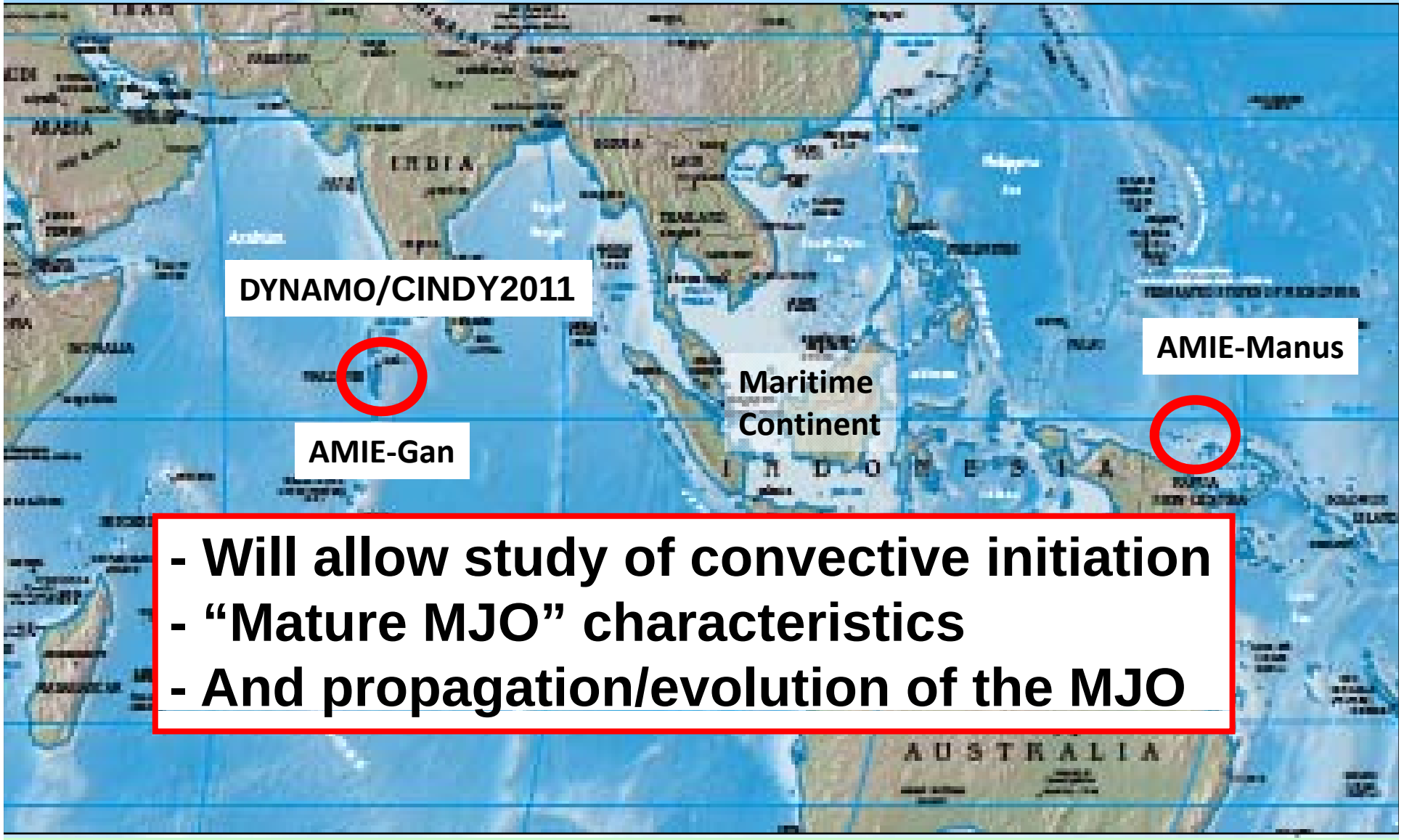
PI: Chuck Long

ARM/ASR TWP Site Scientist

AMIE Science Steering Committee

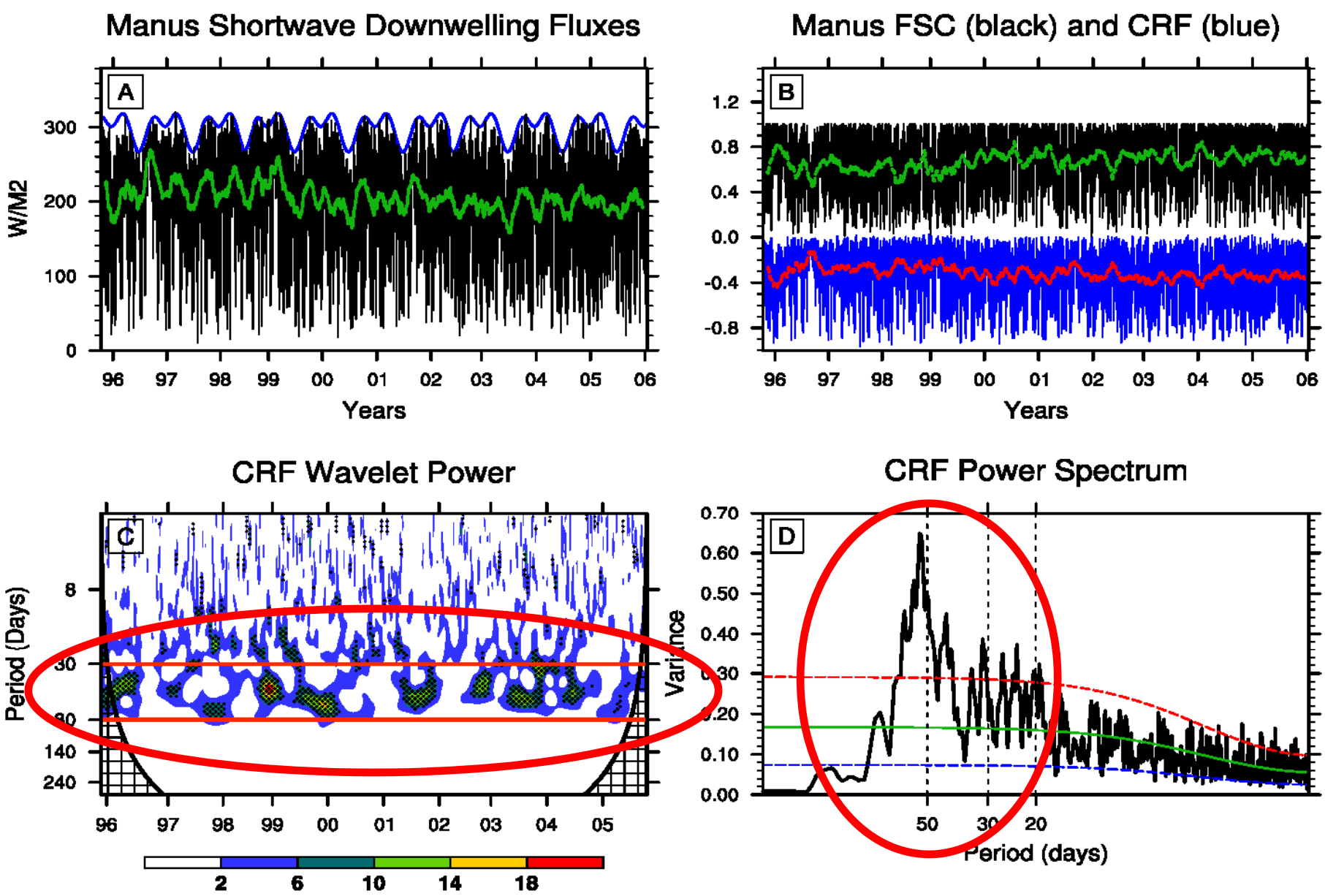
Tony DelGenio, Bill Gustafson, Bob Houze, Christian Jacob, Mike Jensen, Richard Johnson, Steve Klein, Ruby Leung, Xaihong Liu, Ed Luke, Peter May, Sally McFarlane, Pat Minnis, Courtney Schumacher, Andy Vogelmann, Yi Wang, Peter Webster, Xiaoqing Wu, Shaohong Xie, Chidong Zhang

AMIE: A 2-prong Campaign



- Will allow study of convective initiation
- “Mature MJO” characteristics
- And propagation/evolution of the MJO

Manus MJO Signal



AMIE-Manus Science

- **Test several hypotheses in current thinking regarding MJO**
  - **Surface energy fluxes drive the MJO**
  - **Stratiform instability mechanism**
  - **“Recharge-discharge” mechanism**
- **Having AMIE-Gan and AMIE-Manus:**
  - **How the MJO changes as it passes over the Maritime Continent, and how this differs in observations vs. models**

Hypotheses

- **Surface energy fluxes (Rad & LH/SH) drive the MJO (Sobel et al., 2008)**
  - **Weakening over Maritime Continent versus strengthening over TWP**
  - **Differences in SW & LW due to cloudiness differences**
  - **Differences in LH/SH due to land/warm ocean surface**

Hypotheses

- **Stratiform instability mechanism (Mapes, 2000)**
  - **Heating and drying by convection stabilize the atmosphere and damp longer-term variability**
  - **Trailing stratiform anvil region cools and moistens the lower troposphere via rain evaporation**
  - **Forcing dataset:**
    - **see if the drying/moistening stabilization/destabilization occurs**
  - **Radars:**
    - **document whether correlated with transition from convective to stratiform rain**

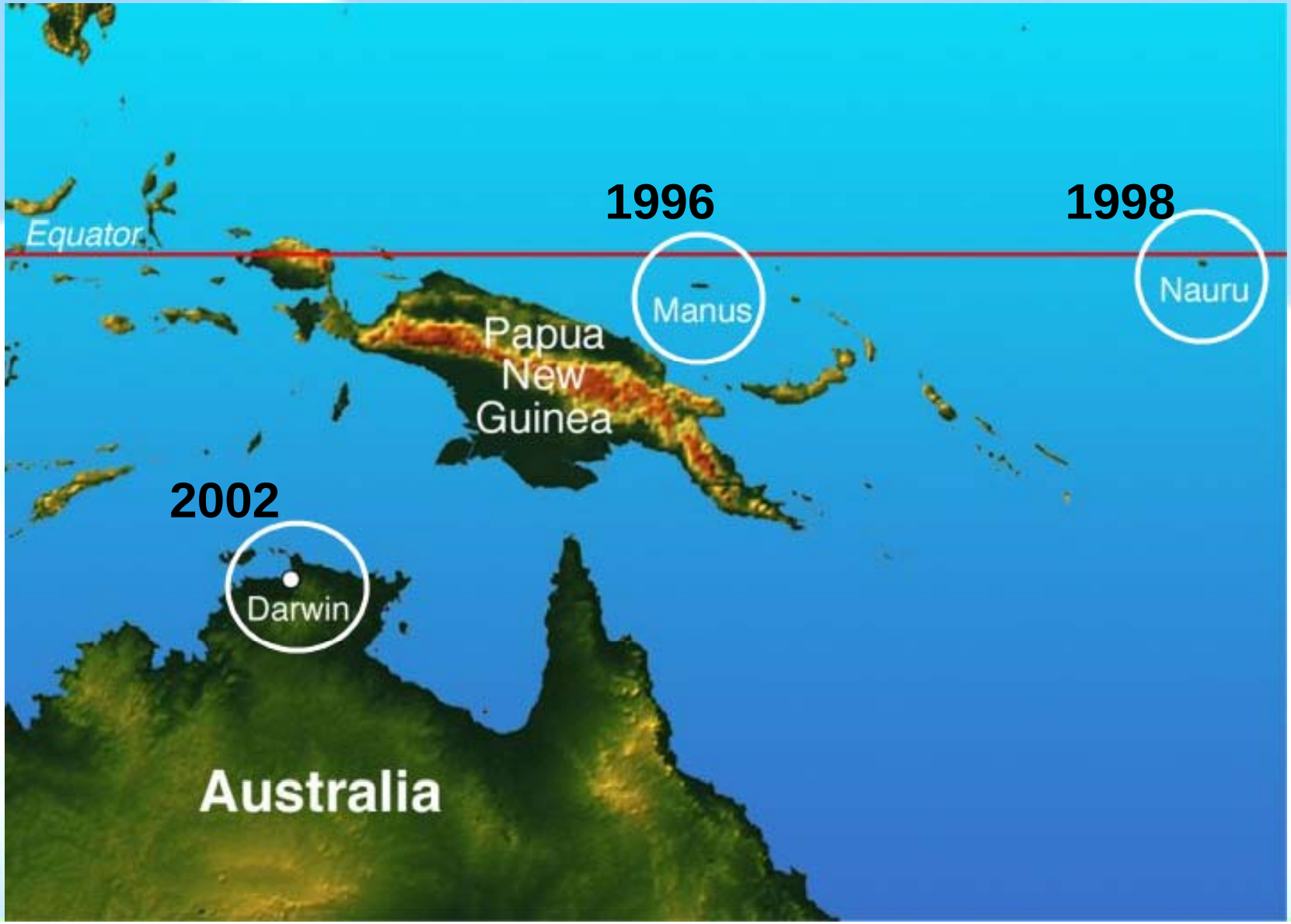
Hypotheses

- **“Recharge-discharge” mechanism**
  - **(Bladé and Hartmann, 1993; Hu and Randall, 1994, Kemball-Cook and Weare, 2001)**
  - **Transition between shallow and deep convection as tropospheric humidity varies**
  - **Suppressed phase: a dry free troposphere is a hostile environment for rising convective parcels**
  - **Cells detrain moisture, making the environment somewhat less hostile for the next convective event**
  - **Eventually, the troposphere becomes moist enough for deep convection to occur, active phase**
  - **Repeat**

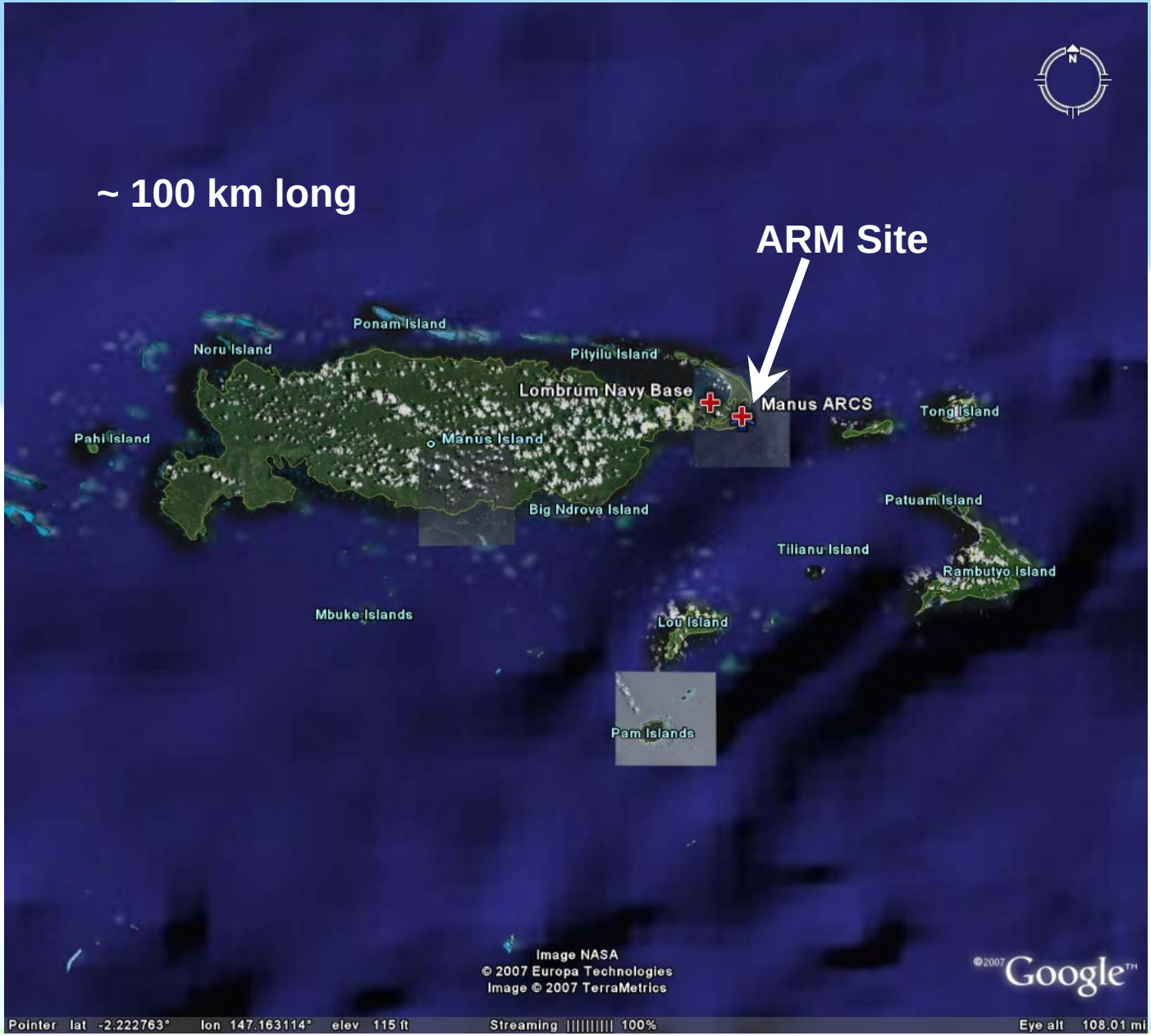
AMIE-Manus Design

- Launch 8 sondes/day for duration
  - Better capture the vertical evolution
  - Use microwave radiometer to interpolate sonde profiles through time
- Take advantage of new C-band and scanning cloud radars, etc.
- Deploy small system at Navy Base
  - study small scale variability

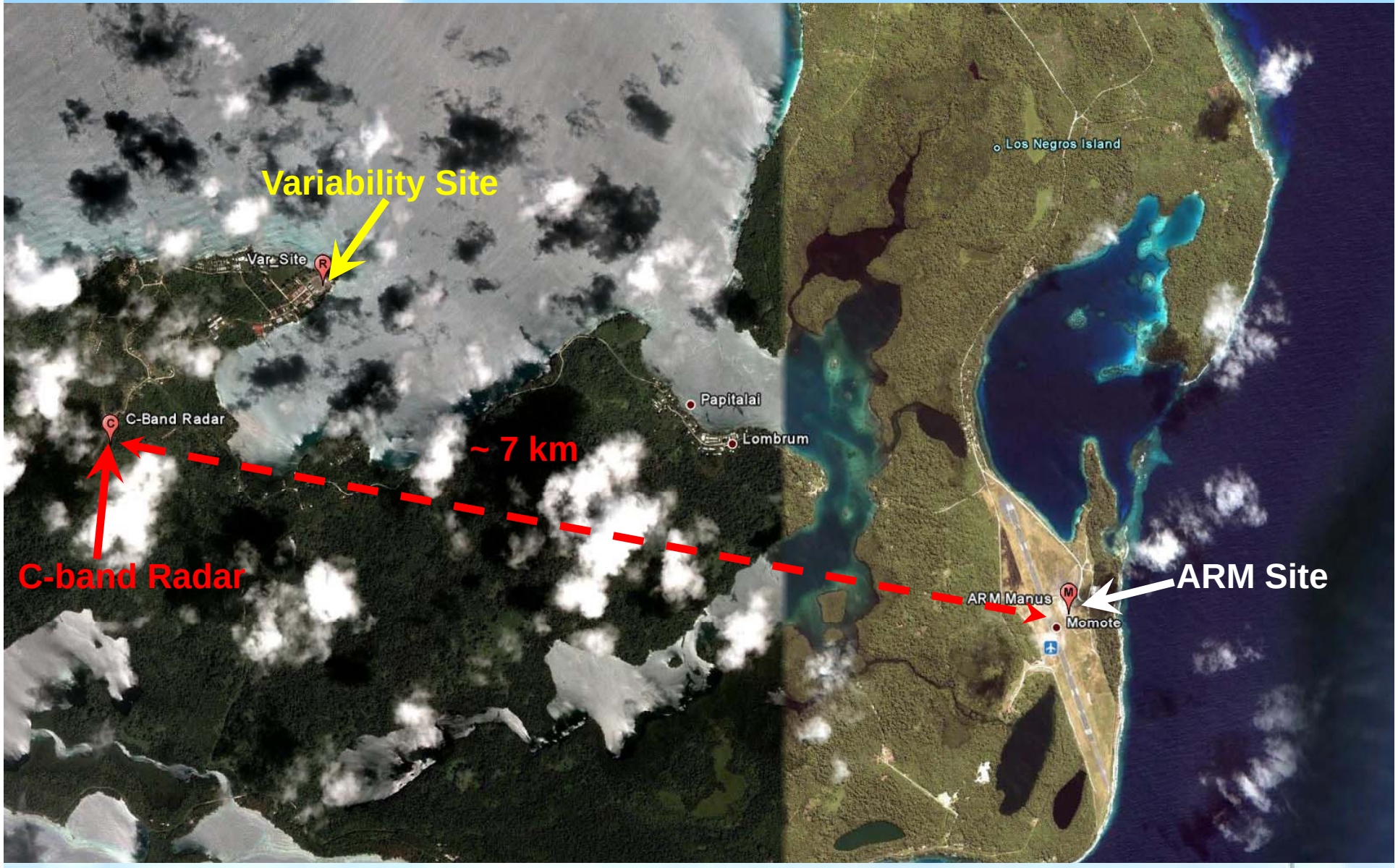
ARM TWP Sites



Manus ARM Site



AMIE-Manus Sites



Manus Instruments

Instrument	Info	Variables
Scanning ARM Cloud Radar (SACR)	Active, Scanning X-band (8-12.5 GHz) and Ka-band (35 GHz)	radar reflectivity, radial velocity, and spectrum width
MilliMeter Cloud Radar (MMCR)	Active, Vertically pointing, 35 GHz	Vertical radar reflectivity, doppler spectra
Scanning C- band Precipitation Radar	Active, (4-8 GHz)	3-Dimensional cloud reflectivity, precipitation, and velocities
Micropulse Lidar (MPL)	Active, (532 nm)	Cloud and aerosol properties
Boundary Layer Cloud System (Ceilometer, Present Weather System, and Sunphotometer)	eye-safe laser	Cloud, surface meteorology, and aerosol properties
Microwave Radiometer, 3 Channel (MWR3C)	Passive, K-Band (20-30 GHz), and W-Band (89 GHz)	Vertical or 2-Dimensional profiles of precipitable water vapor and liquid water path
Digicora Radiosonde System	Sondes	Atmospheric profiles of temperature, water vapor, horizontal winds, and pressure
Meteorology (MET)		Temperature, relative humidity, wind speed and direction, rainfall, and barometric pressure
Total Sky Imager (TSI)		Daylight sky images, fractional sky cover
Atmospheric Emitted Radiation Interferometer (AERI)	Passive, 3-19.2 microns	Vertical spectral LW radiance
Downwelling Radiation (SKYRAD)	Passive, broadband SW and LW	SW, LW, SW Diffuse and Direct irradiance, infrared sky temperature
Upwelling Radiation (GNDRAD)	Passive, broadband SW and LW	SW and LW irradiance, infrared skin temperature
Multifilter Rotating Shadowband Radiometer (MFRSR)	Passive, 415, 500, 615, 673, 870, and 940 nm	Aerosol optical depth, cloud optical depth, fractional sky cover
2-Dimensional Video Disdrometer (2DVD)	Passive	Drop Size Distributions, Precipitation

Darwin Activities

- MJO influences both Indian and Australian monsoons
  - Onset and strength
- Darwin data will be used to document
- Darwin C-POL used for forcing data set for 6 months of AMIE period

Darwin Instruments

Instrument	Info	Variables
Scanning ARM Cloud Radar (SACR)	Active, Scanning X-band (8-12.5 GHz) and Ka-band (35 GHz)	radar reflectivity, radial velocity, and spectrum width
MilliMeter Cloud Radar (MMCR)	Active, Vertically pointing, 35 GHz	Vertical radar reflectivity, doppler spectra
Raman Lidar (RL)	Active, (355, 387, and 408 nm)	Vertical profiles of water vapor mixing ratio, cloud and aerosol related quantities
Doppler Lidar (DL)	Active, (353 nm)	Clear air vertical velocities and cloud properties
Micropulse Lidar (MPL)	Active, (532 nm)	Cloud and aerosol properties
Boundary Layer Cloud System (Ceilometer, Present Weather System, and Sunphotometer)	eye-safe laser	Cloud, surface meteorology, and aerosol properties
Microwave Radiometer, 3 Channel (MWR3C)	Passive, K-Band (20-30 GHz), and W-Band (89 GHz)	Vertical or 2-Dimensional profiles of precipitable water vapor and liquid water path
Digicora Radiosonde System	Sondes	Atmospheric profiles of temperature, water vapor, horizontal winds, and pressure
Meteorology (MET)		Temperature, relative humidity, wind speed and direction, rainfall, and barometric pressure
Weather Transmitter (WXT-520)		Temperature, relative humidity, wind speed and direction, rainfall, and barometric pressure
Total Sky Imager (TSI)		Daylight sky images, fractional sky cover
Atmospheric Emitted Radiation Interferometer (AERI)	Passive, 3-19.2 microns	Vertical spectral LW radiance
Downwelling Radiation (SKYRAD)	Passive, broadband SW and LW	SW, LW, SW Diffuse and Direct irradiance, infrared sky temperature
Upwelling Radiation (GNDRAD)	Passive, broadband SW and LW	SW and LW irradiance, infrared skin temperature
Multifilter Rotating Shadowband Radiometer (MFRSR)	Passive, 415, 500, 615, 673, 870, and 940 nm	Aerosol optical depth, cloud optical depth, fractional sky cover
2-Dimensional Video Disdrometer (2DVD)	Passive	Drop Size Distributions, Precipitation
Eddy Correlation (ECOR) system	Passive, sonic anemometer and assoc. Inst.	surface turbulent fluxes of momentum, sensible heat, latent heat, and carbon dioxide.

Darwin Instruments: Aerosols

Instrument	Variables
Humidigraph (Scanning Relative Humidity with 3 single wavelength nephelometers)	Aerosol scattering coefficient as a function of relative humidity
Cloud Condensation Nuclei (CCN)	Condensation nuclei spectra
Particle Soot Absorption Photometer (PSAP), 3 Wavelength	Aerosol absorption coefficient
Nephelometer, 3 Wavelength	Aerosol scattering coefficient
Condensation Particle Counter (CPC)	Condensation particle concentration, 10 nm to >3000 nm
Hygroscopic Tandem Differential Mobility Analyzer (HTDMA)	Aerosol growth factor as a function of humidity
Dual Column Cloud Condensation Nuclei Counter (CCN)	Number of aerosols that activate to become cloud condensation nuclei two independently selectable supersaturations
Aerosol Chemistry Speciation Monitor (ACSM)	Aerosol mass and composisiton
Ozone Monitor	Ozone concentration

AMIE-Manus

- **Significant synergy with CINDY2011 and DYNAMO**
- **Allows expansion of studies beyond initiation**
- **Data analyses and products similar to AMIE-Gan**

Radiative Flux Analysis

Requires downwelling SW total and diffuse, 1-min

Parameter	Meas./Retr.	Comments
Downwelling Total SW	Measured	Unshaded Pyranometer
Clear-sky Total SW	Retrieved	Long and Ackerman, 2000, JGR
Diffuse SW	Measured	Shaded Pyranometer
Clear-sky diffuse SW	Retrieved	Long and Ackerman, 2000, JGR
Direct SW	Measured	Sun Tracking Perheliometer
Clear-sky direct SW	Retrieved	Long and Ackerman, 2000, JGR
Upwelling SW	Measured	Pyranometer
Clear-sky Upwelling SW	Retrieved	Long, 2005, ARM
Downwelling LW	Measured	Pyrgeometer
Clear-sky Downwelling LW	Retrieved	Long and Turner, 2008, JGR
Upwelling LW	Measured	Pyrgeometer
Clear-sky Upwelling LW	Retrieved	Long, 2005, ARM
Clear-sky periods	Retrieved	Long and Ackerman, 2000, JGR [daylight only]
Air Temperature	Measured	Temperature sensor
Relative Humidity	Measured	Humidity sensor
Total Sky Cover	Retrieved	Long et al., 2006, JGR [daylight only]
LW Effective Sky Cover	Retrieved	Long and Turner, 2008, JGR; Durr and Philipona, 2004, JGR [low/mid cloud only]
Cloud Vis optical depth	Retrieved	Barnard and Long, 2004, JAM; Barnard et al., 2008, TOASJ [Skycover>90% only]
Cloud SW transmissivity	Retrieved	Long and Ackerman, 2000, JGR [daylight only]
sky brightness temperature	Retrieved	Long, 2004, ARM
cloud radiating temperature	Retrieved	Long, 2004, ARM [LW Scv>50% only]
clear-sky LW emissivity	Retrieved	Marty and Philipona, 2000, GRL; Long, 2004, ARM

Also: Correction for Tilt from Horizontal

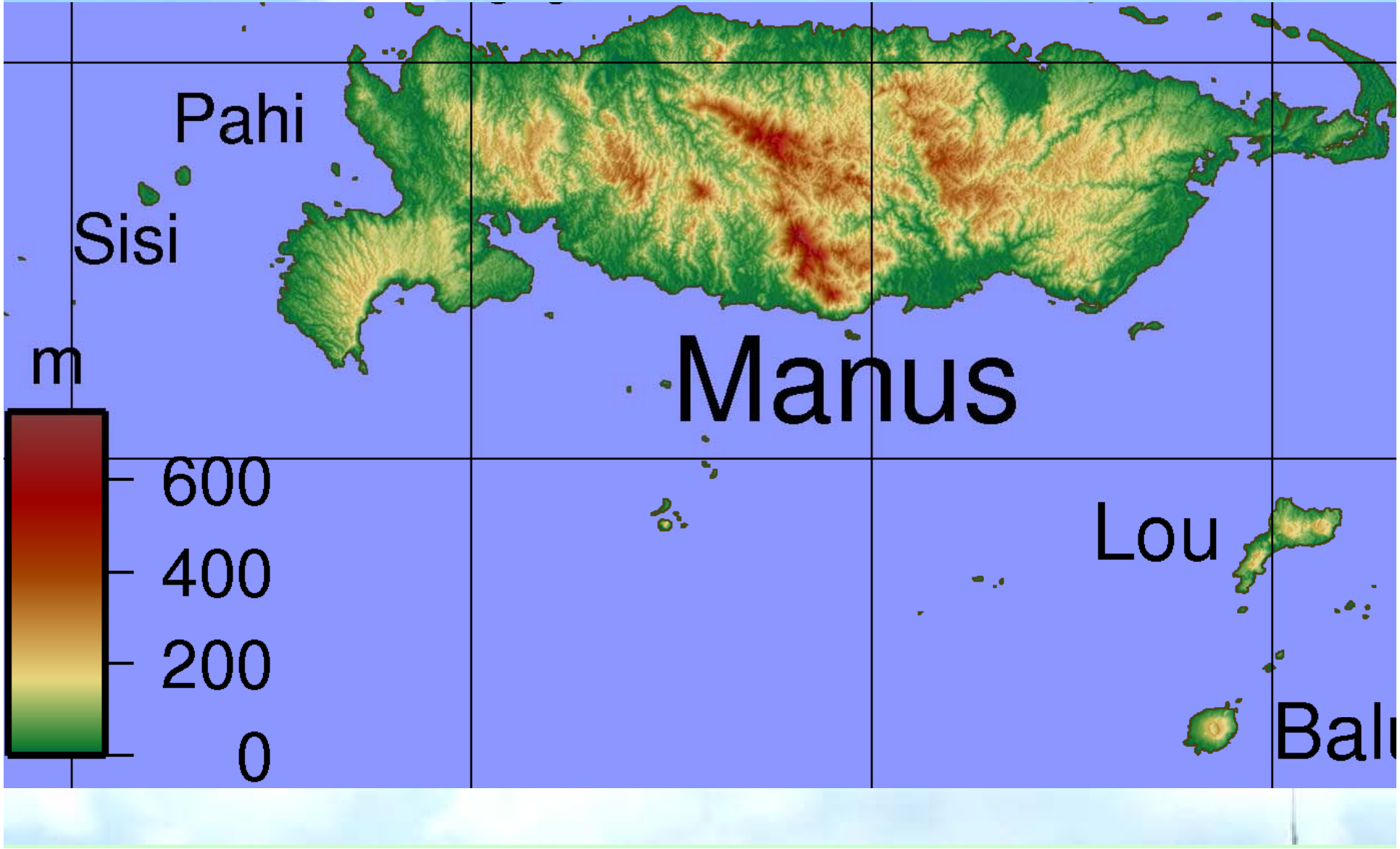
SPN-1 Total/Diffuse Radiometer

- **Eliminates need for sun-relative azimuthal orientation**
- **Measures Total and Diffuse SW with no moving parts**
- **Uses 7 detectors and a patented shading pattern**
- **Weighs 940 g**

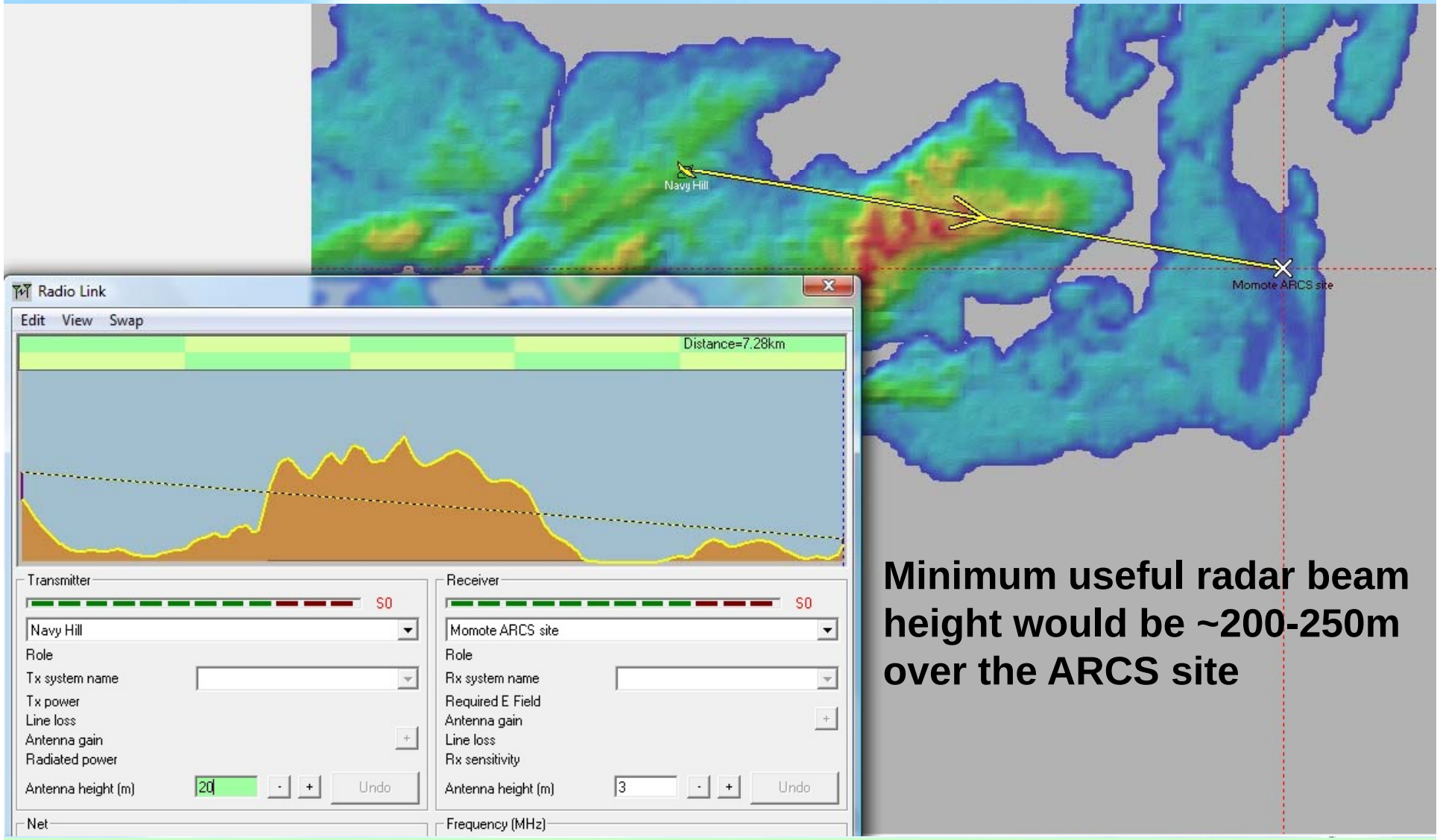
Thank You

chuck.long@pnl.gov

Manus Topography



Manus Radar path



Minimum useful radar beam height would be ~200-250m over the ARCS site

150m & 200m Radar Coverage