Informational Brief to ESCAP/WMO Typhoon Committee Technical Conference Hanoi, Vietnam 27 February 2018

NASA Cloud, Aerosol, Monsoon Processes-Philippines ($CAMP^2Ex$)

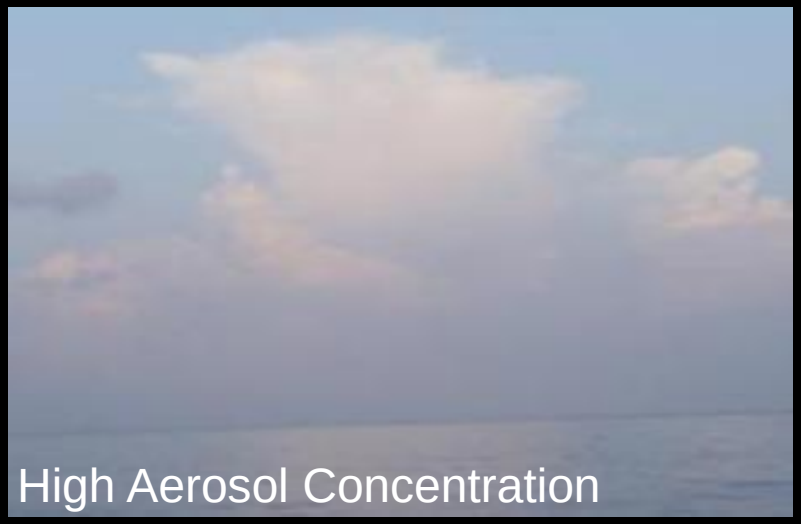
E. Fukada (CSRA contractor), Naval Research Laboratory, Monterey, California

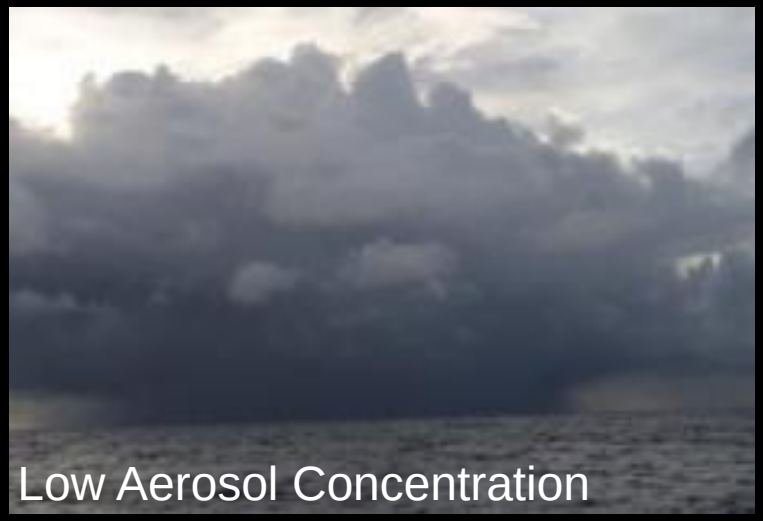
Overview

- NASA Cloud, Aerosol, Monsoon Processes-Philippines (CAMP^{2}Ex);
  - Study multi scale relationships between cloud, radiation & aerosol physics.
  - NASA P3 and SPEC Lear 35 aircraft
  - Operations out of Subic Bay July 24th – August 27th 2018.
  - Focus on diurnal variability using Himawari-8 AHI
- ONR Propagation of Intraseasonal Tropical Oscillations (PISTON)
  - Study the MJO/BSISO propagation and its relation ship to air/sea interaction and diurnal convection.
  - R/V Thompson just west & north of Subic August 16th –October 15 2018
- CAMP^{2}Ex and PISTON are cooperating on mission METOC support

CAMP^{2}Ex: Who's, What's, & Why's

- NASA, Manila Observatory, NRL will conduct an airborne P3 and Lear 35 campaign out of Subic Bay Philippines 24 July – 30 August 2018.
- Research will address these questions:
  - Do aerosol particles influence warm/mixed phase precipitation in tropical environments?
  - Do aerosol induced changes in clouds and precipitation feedback into aerosol lifecycle?
  - How do aerosol particles and clouds influence the earth's energy budget?
- Manila Observatory is addressing the question: How does land use change effects clouds?
- ~100 scientist, including ~20 Philippine scientist will conduct ~16 8-hour P3 and 8 5-hour Lear 35 flights to measure the cloud and pollution environment around the Philippines.





CAMPE²Ex Basics

Rationale: CAMP²Ex is a response for the need to deconvolute the fields of tropical meteorology & aerosol science on fair weather to congestus clouds.

Philippine partners to study land surface impacts on clouds and precipitation.

The NASA P3 (~150 hrs) and SPEC Lear 35 (~45 hours) will be based out of Subic Bay nominally July 24 through Aug. ~29.

Cooperation with PISTON will begin ship obs off shore Aug 16-29

Pristine Conditions

Polluted

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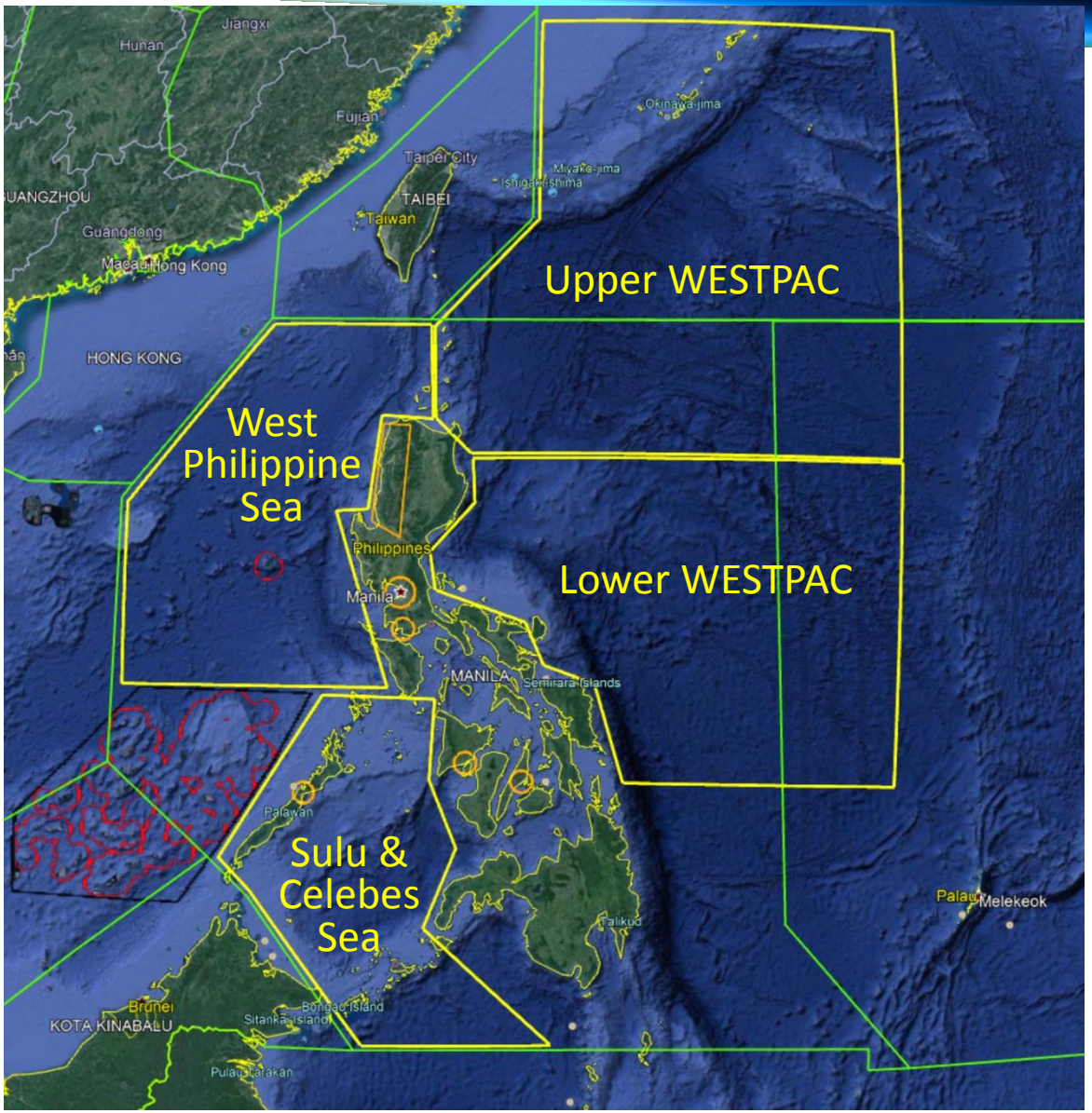
Regions of investigation

Weather depending:
First half focus on WESTPAC & Sulu Sea
Second half on West Philippine Sea

P3 alt. range : 18k ft takeoff to
23k ft end
Lear 35 To 38k ft

Green: FIR Boundaries
Yellow: NASA Flight Regions
MO Flight Regions:
- Bagio & Cordillera
- Cebu
- Iloilo
- Manila
- Puerto Princessa



Types of measurements

NASA P-3B

- Aerosol in-situ microphysics:
  - Black carbon
  - Cloud condensation nuclei
  - Composition
  - Light scattering
  - Size distribution
- Aerosol profiles (lidar)
- Cloud cover/properties
  - Cloud cameras
  - Cloud in-situ microphysics
  - Droplet/ice particle size
  - Polarimeter
  - Precipitation
- Cloud/precip remote sensing
  - 94 GHz radar
  - 18-27 GHz radar
  - Microwave radiometer


NASA P-3B

- Tracer Gases (CO_2, CO, SO_2, NOx)
- Radiative balance: Hyperspectral, Solar, & IR flux
- State variables (temperature, wind humidity):
  - In-situ & profile
  - Sea surface temperature

SPEC Lear Jet 35

Aerosol Size

Cloud in-situ microphysics

droplet/ice particle size

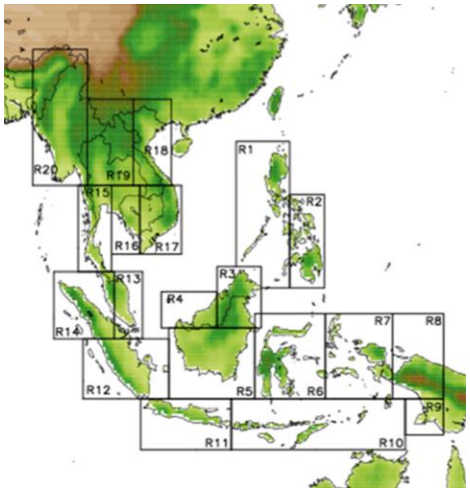
precipitation


SPEC Lear 35

Manila Observatory climate, land use, and air quality

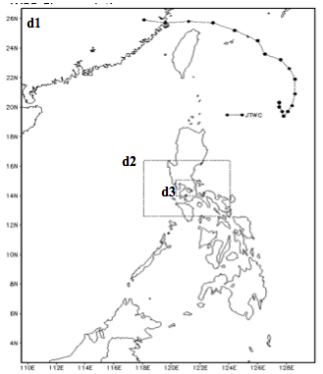
- Process-based performance evaluation of regional climate model over the Philippines
- Understand the role of land use on enhanced SW monsoon events
- Perform a baseline evaluation of regional air quality processes

Coordinated Regional Climate Downscaling Experiment-Southeast Asia (CORDEX-SEA) aims to provide high-resolution climate projections for SEA through joint effort regional climate downscaling among scientists in the region.



- *Isolate key processes/mechanisms that are not captured by the regional climate model, resulting in inability to capture seasonal dynamics.*
- *Identify the appropriate adjustments and modifications to cumulus parameterization schemes for the model to properly simulate rainfall dynamics?*
- *Quantify sensitivity of model climatology to SST*
- *Evaluate the model ability to capture the diurnal cycle and the extreme rainfall events, and the associated physical dynamics.*

Land use and enhanced SW monsoon systems



- *Potential influence of urbanization expansion in Metro Manila on rainfall associated with the SW monsoon season*
- *Importance of microphysics schemes and processes in simulating enhanced SWM rainfall*

Air Quality

- *Document the nature of air quality in convective PBL.*
- *Determine the relative contributions of local vs transported sources.*
- *Investigate the influence of local sources on convective intensity.*

CAMP^{2}Ex Leads & Focal Areas

- Program Science: Hal Maring, NASA HQ
- Mission Science: Jeffrey Reid, U.S. Naval Research Lab, Monterey, CA
- Philippine PI: Gemma Narisma, Manila Observatory
- Philippine Project manager & ground coordinator: James Simpas, Manila Observatory
- Focus area leads
  - Aerosol and Composition: Luke Ziemba, NASA Langley Research Center
  - Clouds and Precipitation: Jay Mace, University of Utah
  - METOC: J.S. Reid & Ed Fukada (CSRA), NRL Monterey
  - Models : Sue van den Heever, Colorado State University
  - Radiation: Larry Di Girolamo, University of Illinois
  - Satellite Remote Sensing: Robert Holz & Chip Trepte, SSEC University of Wisconsin-Madison
- Project Manager: Jhony Zavaleta, NASA Ames Research Center
- Flight Planner: Richard Ferrare, NASA LaRC
- Lead Forecaster: Ed Fukada
- Data Archivist: Gao Chen, NASA LaRC
- Data Auditor: Jian Wang, Brookhaven National Laboratory

CAMP2Ex Selected Instrument PIs

- Aerosol , cloud, and composition in situ
  - Glenn Diskin, NASA LaRC: Trace gas (H20, CO2, CO, CH4, N2O, O3)
  - Paul Lawson, SPEC: Lear 35 and P3 cloud physics
  - Armin Sooroshian UA: DASH Aerosol hygroscopicity
  - Jian Wang, BNL: High time resolution aerosol size
  - Luke Ziemba, NASA LaRC: Aerosol optics, microphysics and chemistry
- Radiation
  - Anthony Bucholtz, NRL: Broadband Solar and IR radiometry, SST
  - Sebastian Schmidt, CU: Hyperspectral solar radiometry
- Remote sensing
  - Richard Ferrare, NASA LaRC: HSRL2
  - Timothy Lang, NASA Marshall: AMPR
  - Geoffrey Smith, NRL: Cloud imaging
  - Simone Tanelli, JPL: APR3
  - Bastiaan van Diedenhoven, NASA GISS: RSP
- State:
  - Sue van den Heever, CSU: Dropsondes and state
  - Lee Thornhill, NASA LaRC, 5 hole probe/3D winds
- Ground
  - Voltaire Velazco, U. Wollongong: TCCON validation

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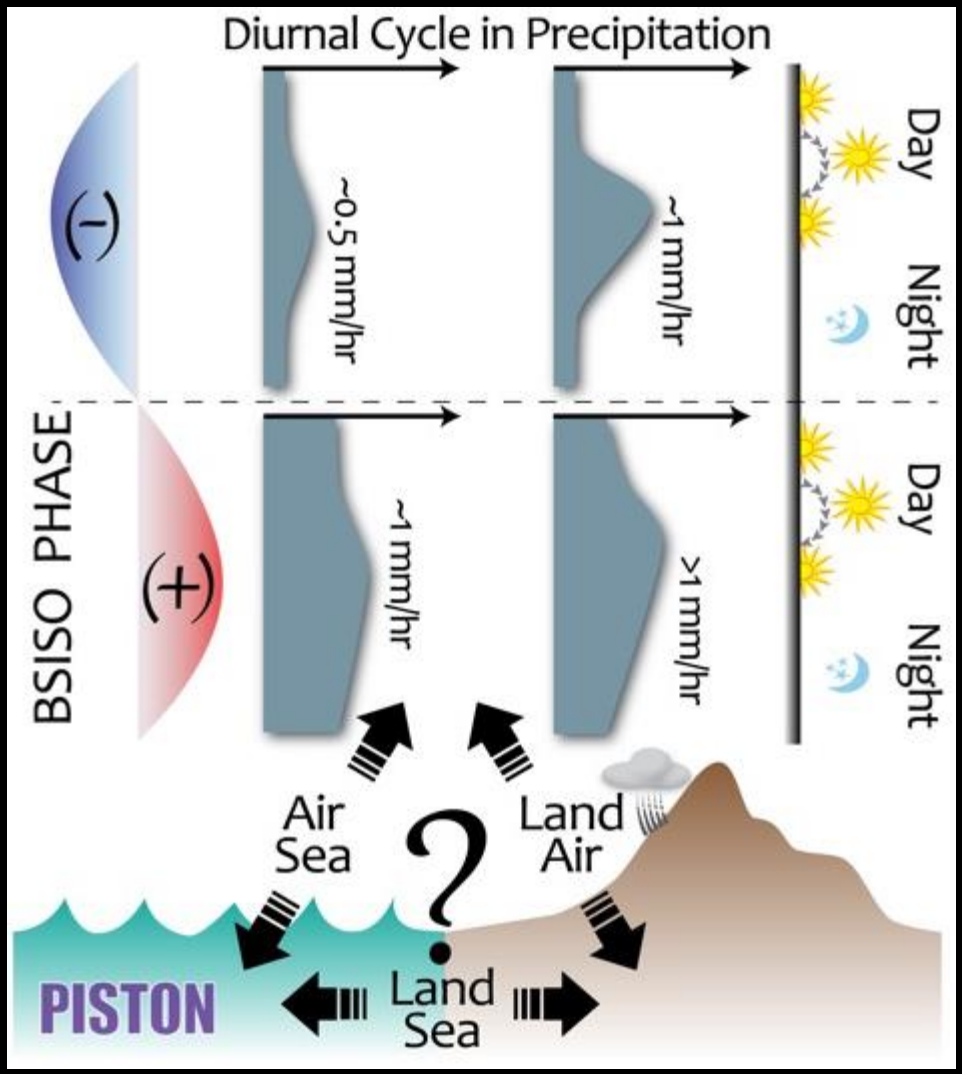
PISTON Science Goals*

Improve seasonal to subseasonal prediction in the South China Sea through *improved understanding of*

- Intraseasonal evolution of the Boreal Summer Intraseasonal Oscillation (BSISO)
- BSISO effects on diurnal precipitation and ocean-atmosphere interaction.
- Land-atmosphere ocean effects on convection from islands
- Atmosphere-ocean interactions:
  - Freshwater and radiative surface buoyancy sources
  - Upper ocean mixing
  - Effects on SST and surface fluxes



*Extracted from Simon de Szoeke, Oregon State University, CAMP2Ex Science Team Meeting Presentation

PISTON Operations: R/V Thompson

- Cruise west of Luzon: 15 Aug-15 Oct, 2018.
- SEAPOL C Band radar
- HSRL and wind LIDAR
- Air sea flux systems
- 3 hourly radiosondes
- Ocean currents and mixing
- Modeling
  - LES to Global scale
  - Air-ocean coupling

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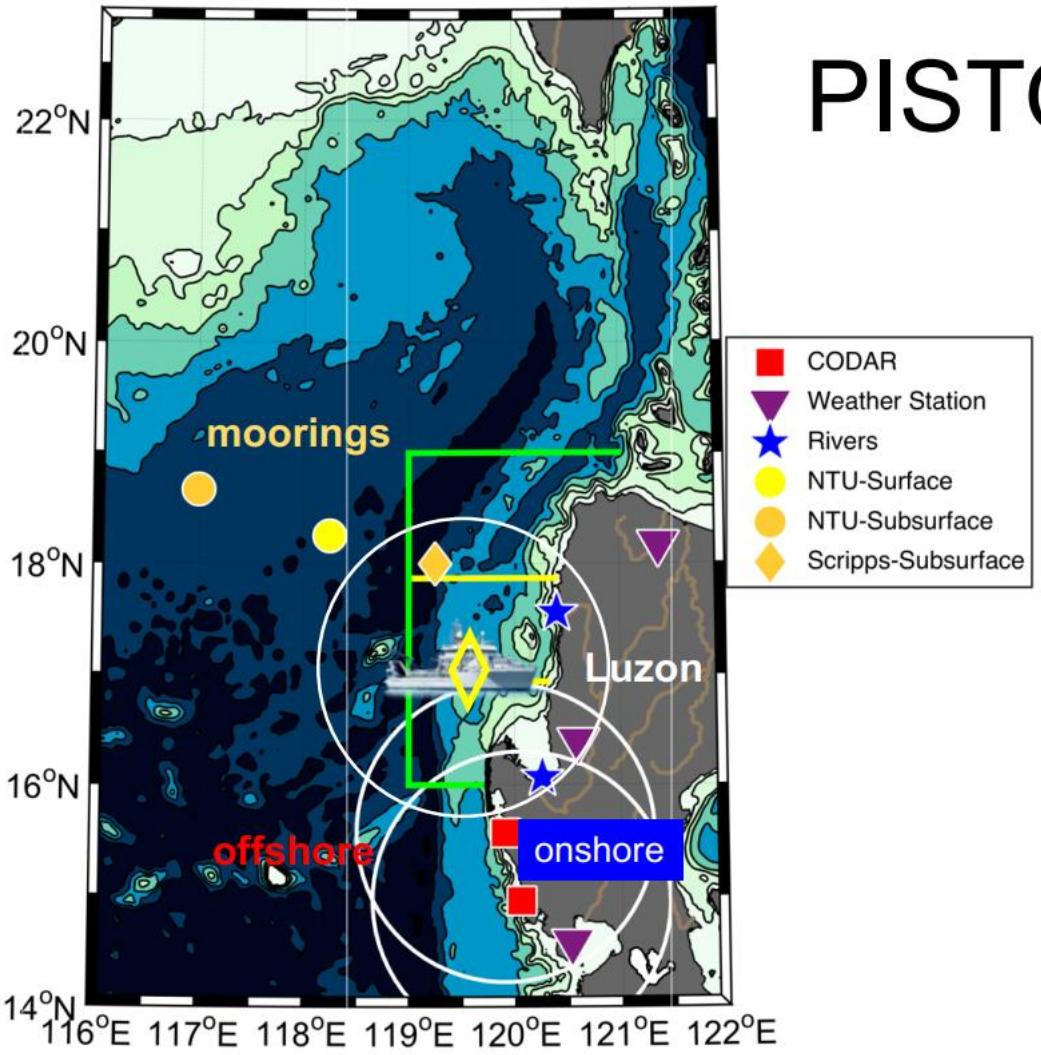
PISTON observing plan



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CAMP²Ex-Mission METOC

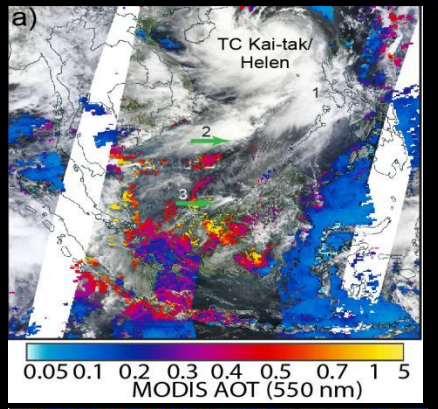
A forward Op center will be established at Subic, with dedicated data servers. Model feeds from Navy, NOAA, ECMWF and UKMO

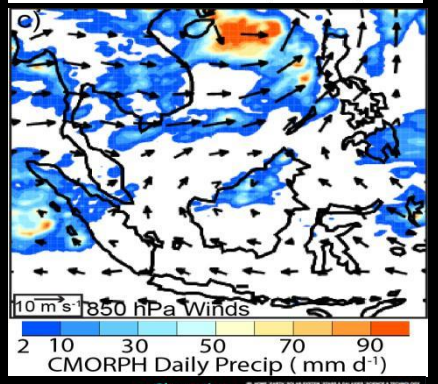
Meteorological Support-NRL:
PI: Jeffrey S. Reid jeffrey.reid@nrlmry.navy.mil; +1 (831) 656-4725
Lead forecaster: **Edward Fukada-NRL/JTWC**; Forecasting: David Peterson; Ensemble forecasts: Juli Rubin; Multi model forecast: Peng Xian; TC forecasting: Charles Sampson

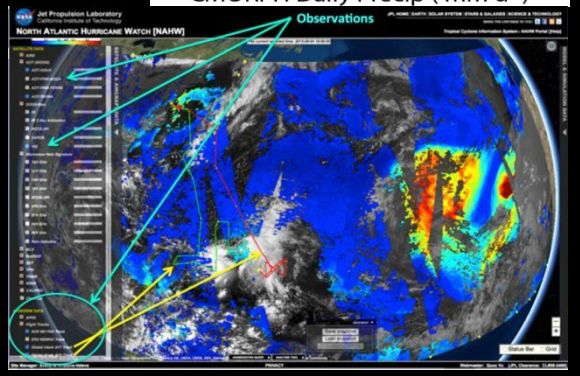
The development of satellite and model data portal to support forecasting & post mission analysis-JPL:
Co-PI Svetla Hristova-Veleva-JPL, Svetla.Hristova@jpl.nasa.gov; +1 (818) 354-7314
Precipitation systems: Joseph Turk; Software engineering: Peggy Li

Mission meteorological and composition reanalysis-GSFC:
Co-PI Arlindo da Silva-GSFC, arlindo.dasilva@nasa.gov; +1 (301) 614-6174
Reanalysis development and analysis: Karla Longo de Freitas

Geostationary and Polar Satellite Product Development
PI Robert Holz SSEC Univ. Wisc. , Robert.Holz@ssec.wisc.edu;
+1 (608) 263-2566
Himiwari-8/AHI, VIIRS, MODIS, CrIS

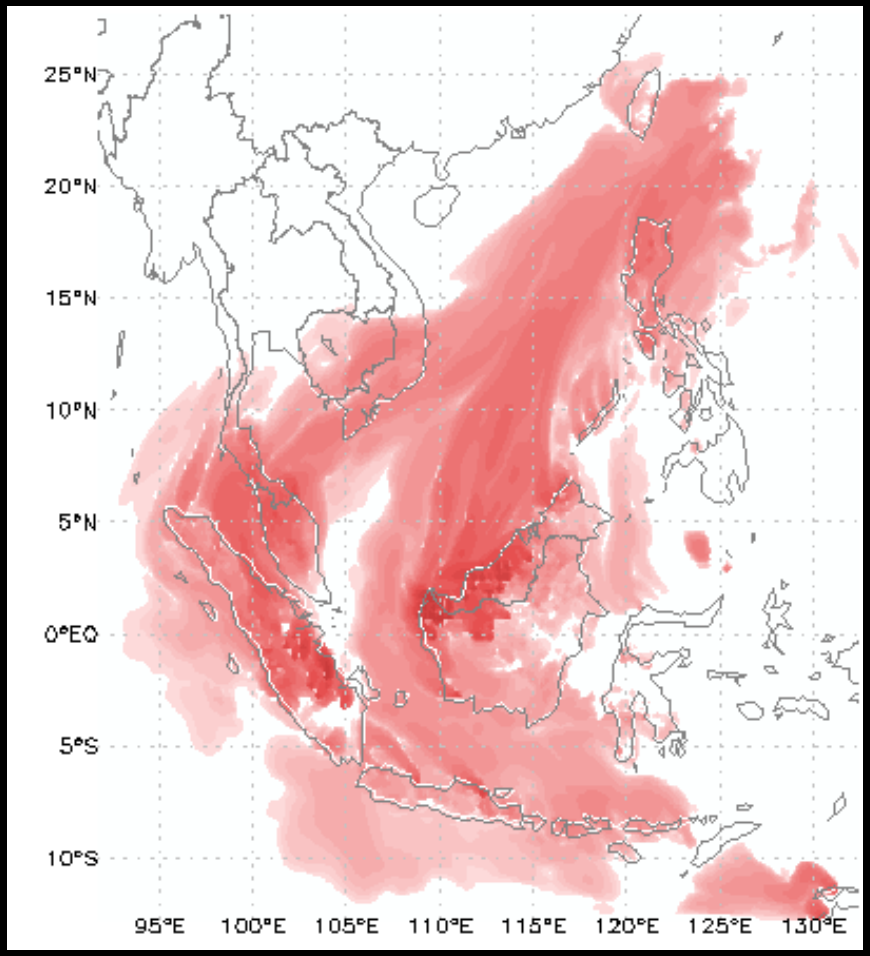






Why the Philippines and Why Now?

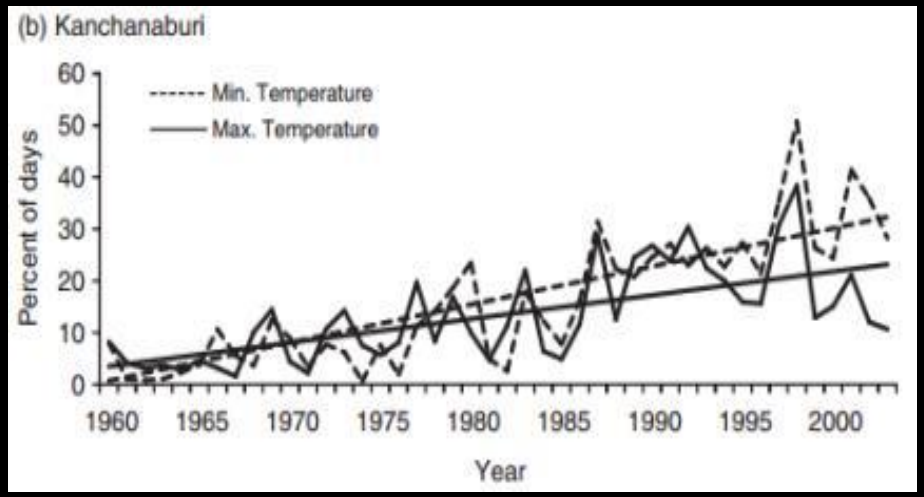
- Southwest Monsoon provides a conveyor belt of smoke and pollution from the Maritime Continent, resulting in strong gradients in particle concentrations.
- Luzon is near the boundary between the tropical and subtropical regime.
- Strengthening and weakening monsoon flow results in variable shear, humidity profile, and cloud structure.
- Strong precipitaiton diurnal cycle and heavy cirrus suggest cloud-radiation feedbacks.
- At a local peak in regional remote sensing capability, in particular with the addition of Himiwari-8/AHI, and hopefully HARP.



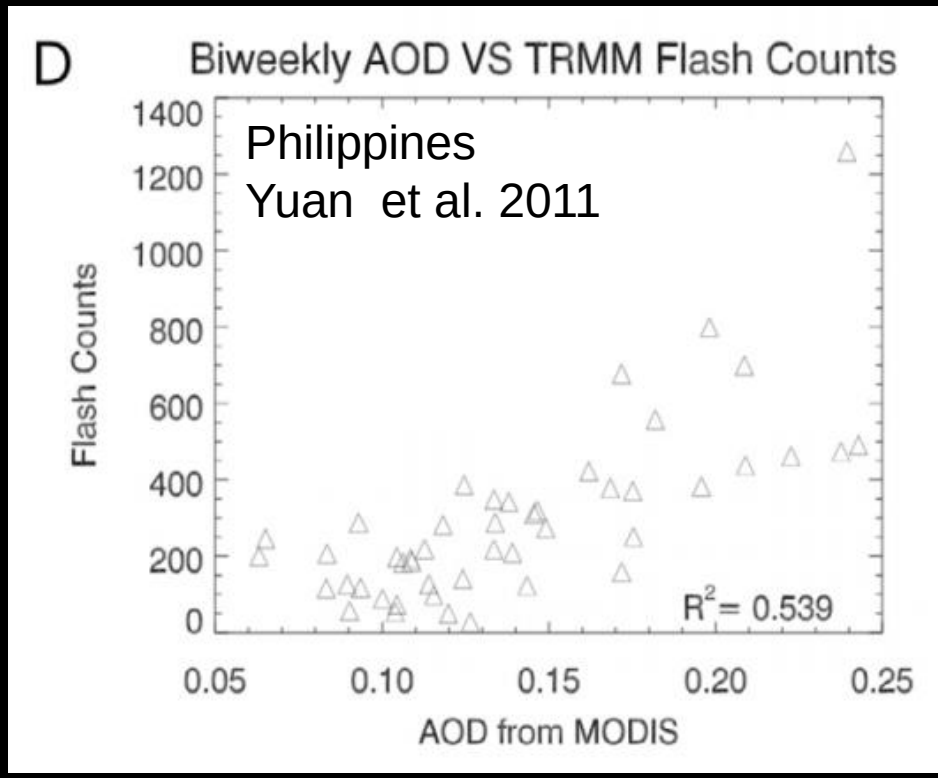
COAMPS Smoke Aug 11-12, 2007

Climate change in SE Asia: Monsoon precip is not changing, but the number of "no rain days" is increasing. Meteorology vs aerosol effects? We need to know the sensitivities.

Thailand: "significant increase in the annual number of warm days & warm nights, with corresponding significant decreases in the annual number of cool days and cold nights. The number of days with rainfall more than 10 and 20 mm has declined over both basins except at Kanchanaburi station."

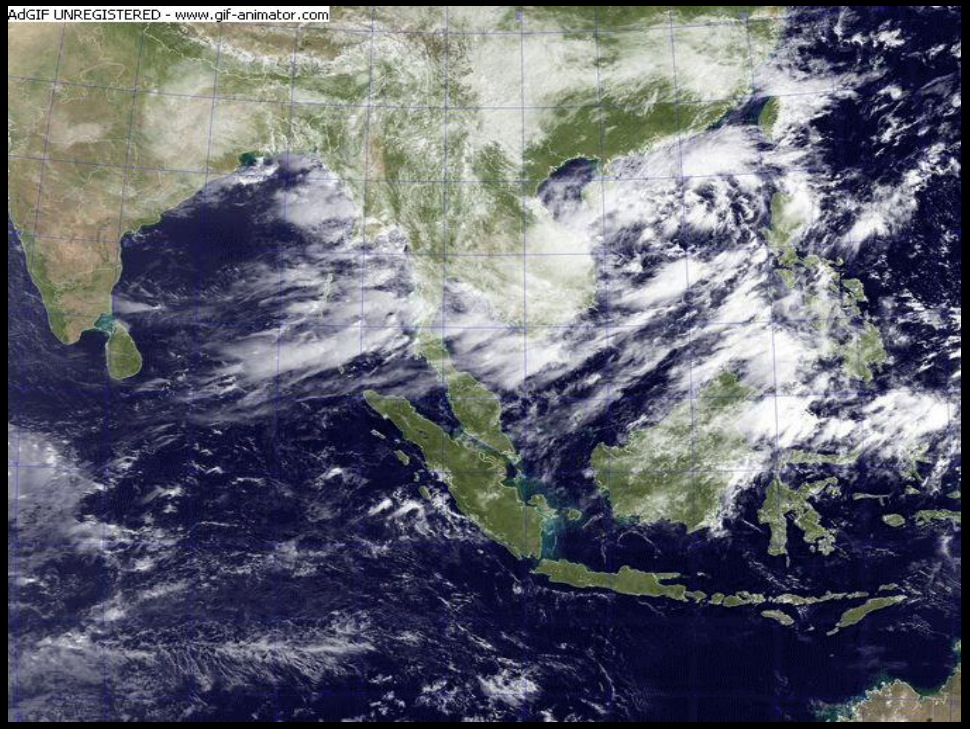


Cruz et al., 2013: Philippines
"an examination of the rainfall extremes indicate an increasing trend in the number of days without rain"



Aerosol, cloud, and radiation science is always within a meteorological context

It is often taken for granted that to model atmospheric composition the underlying meteorology must be correct. But what does this mean in a region that is difficult to predict, simulate or even observe?



Just a few phenomenon

ENSO! Dramatic but a small part of the story….

Monsoonal Cycle

MJO/BSISO

Tropical Waves

Tropical Cyclones

Diurnal Phenomenon, Orographic, Sea Breeze, etc…

Organized and Individual Cloud Perturbations

Which of these do we need to worry about? Depends on the question.

Year of Maritime Continent

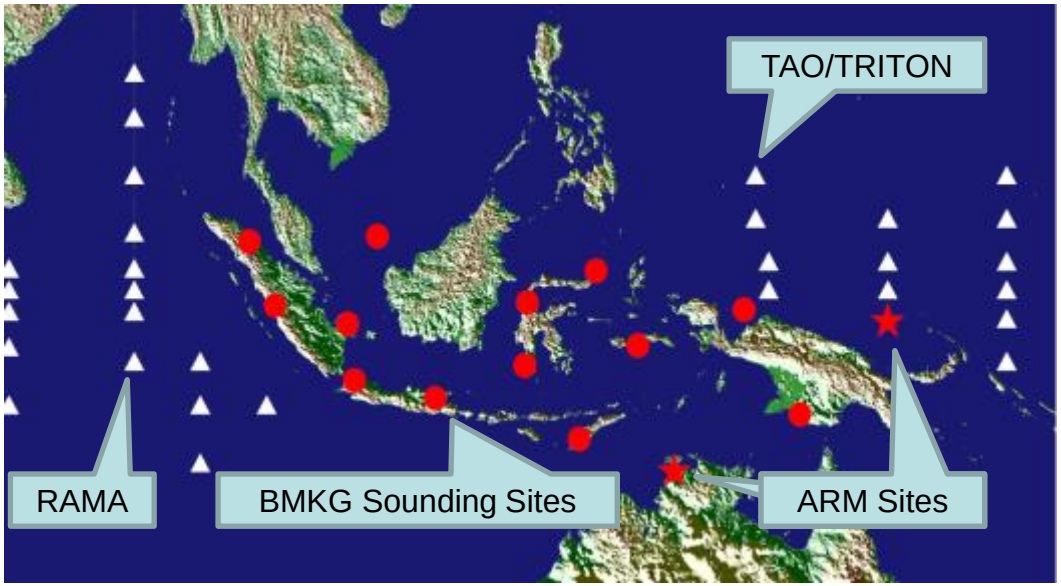
< Purpose > To understand various climate phenomena over and around the Maritime Continent from the interdisciplinary view points based on a whole one year observation.

< Expected Period >
April 2017 – March 2019

Slide from K. Yoneyama & M. Katsumata, JAMSTEC

< Major Themes (to be added) >

1) Atmospheric Convection
   - Modulation of the MJO
   - Local circulation vs. Large-scale Disturbances
   - Initiation of westward-propagating cloud system
   - Australian monsoon
2) Oceanography
   - Indonesian Through Flow
   - Coastal Upwelling
   - Indian Ocean Dipole



< Expected Participants >

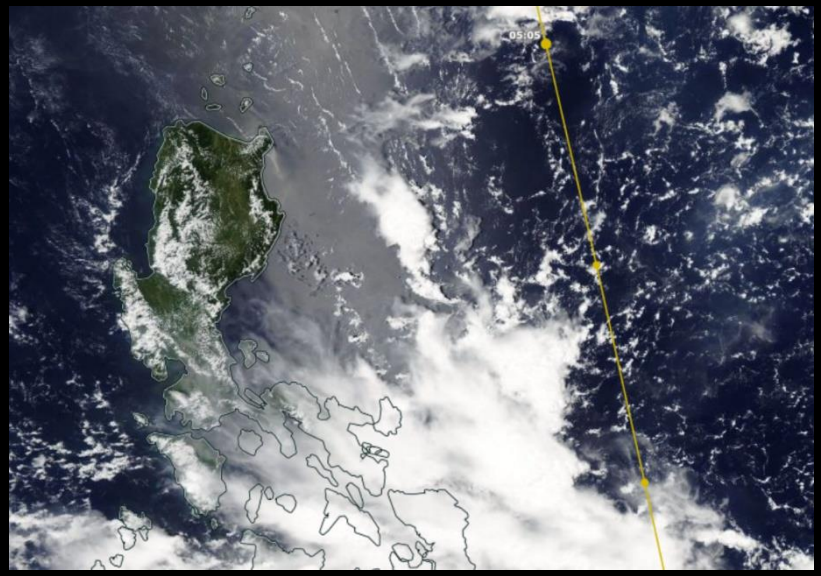
* Community workshop in 2015. Based on personal communication, several groups are interested in this campaign idea. They include;

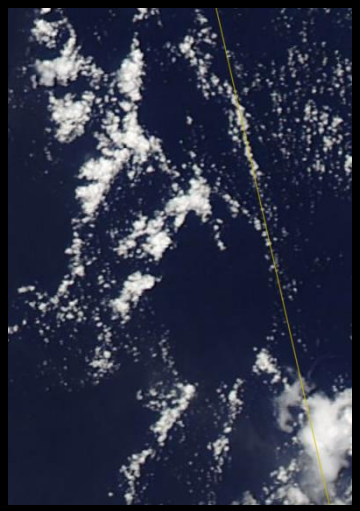
Japan	JAMSTEC, Kyoto Univ.
Indonesia	BMKG, BPPT
U.S.	ONR, NASA, DoE, Univ. of Miami, NRL, PNNL, CU, UCSD
France	LMD, LEGOS
Australia	CAWCR, Monash Univ.

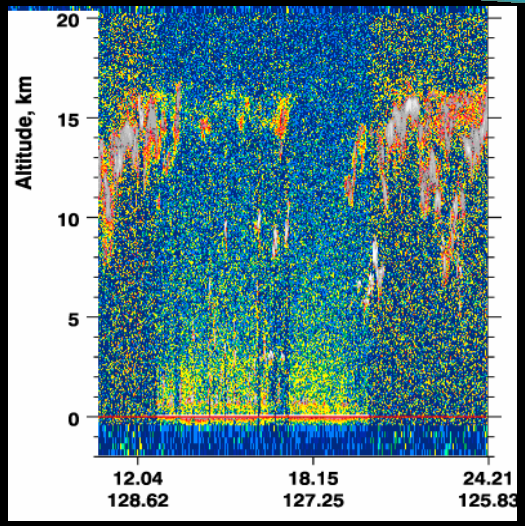
Partnerships

Two Cloud Patterns Defined by Vertical Shear

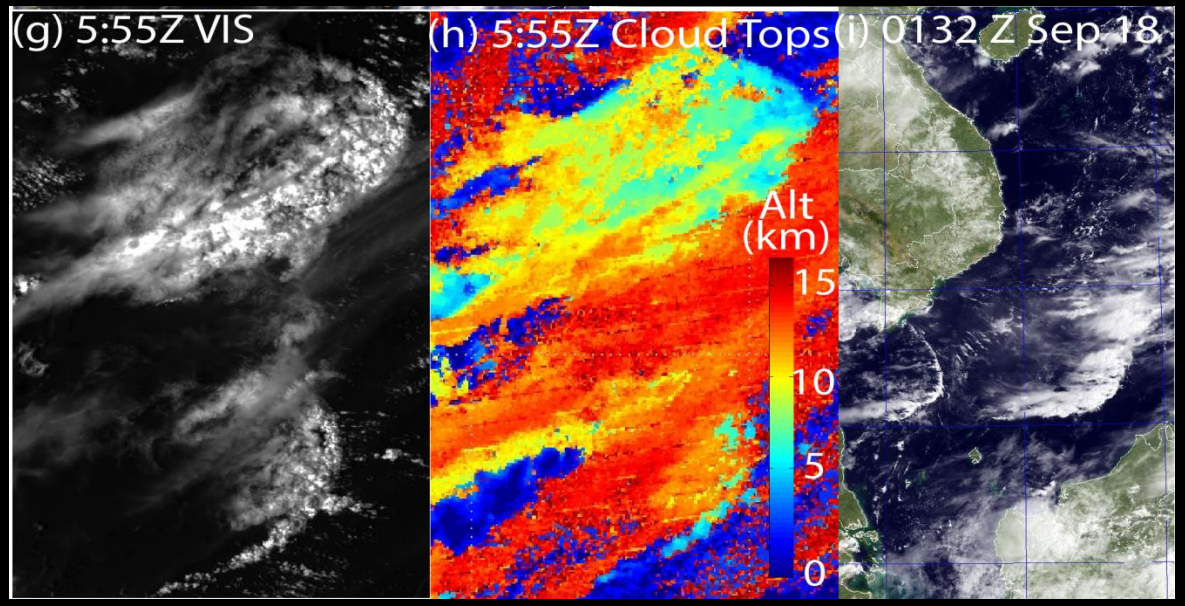
Low shear







High Shear
Squall lines



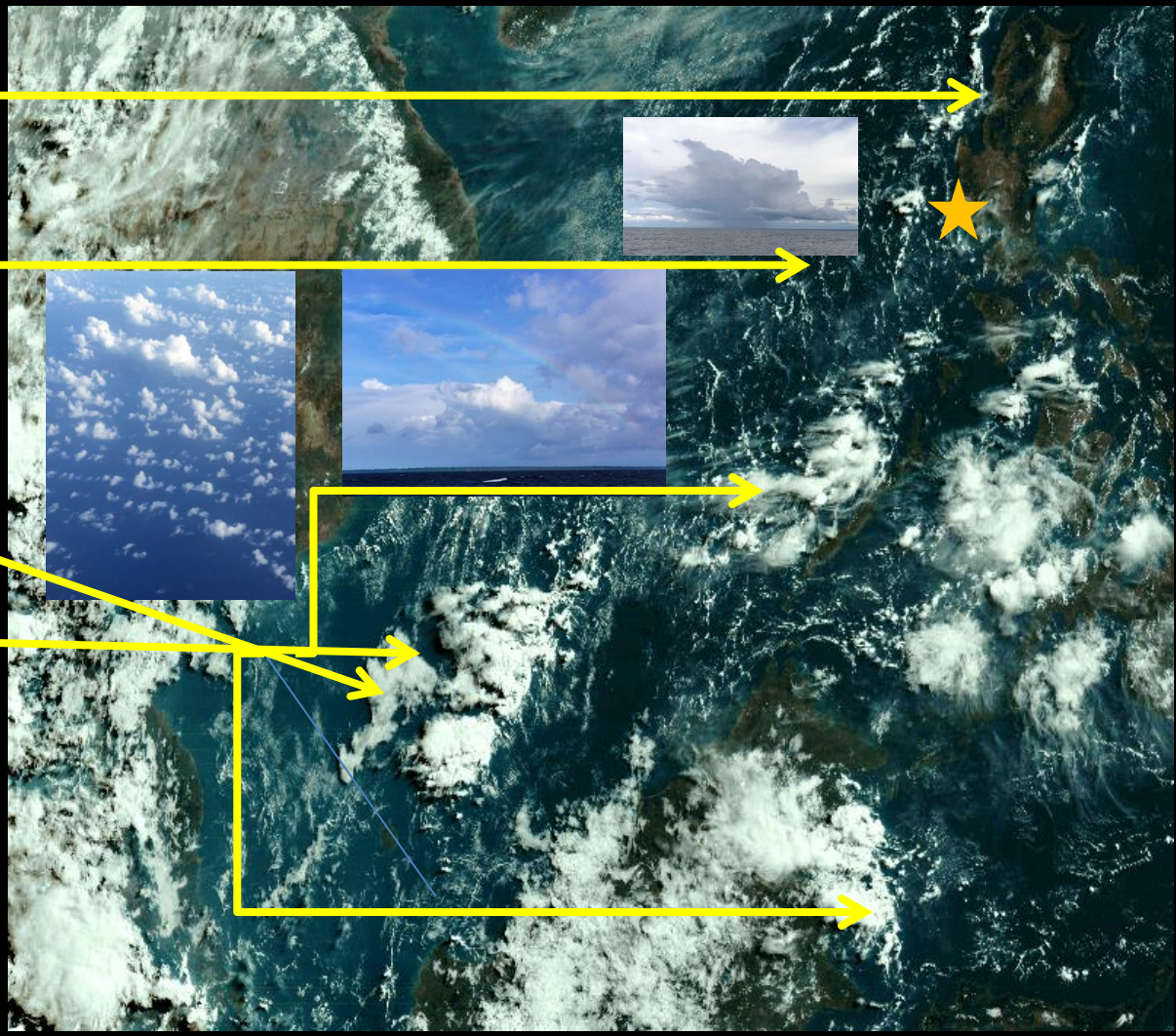
Cloud Patterns "Routinely" Observed; To Be Studied

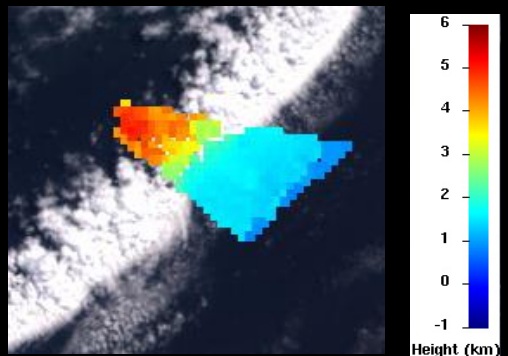
Orographic effects & diurnal cycle

Isolated convection along convergence lines

AltoCu

Organized in Squall Lines from Super cells





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Operational Challenges and Benefits

- Challenge: Complicated Airspace
  - Offset/Benefit: Numerous convective mechanisms and/or patterns in a previously unstudied region.
- Challenge: Weather and composition models have difficulty with the monsoon
  - Offset: Project will have the remote sensing payload and onsite forecasters.
- Challenge: Luzon diurnal cycle can produce heavy/strong convection
  - Challenge/Benefit: Forecast and observe

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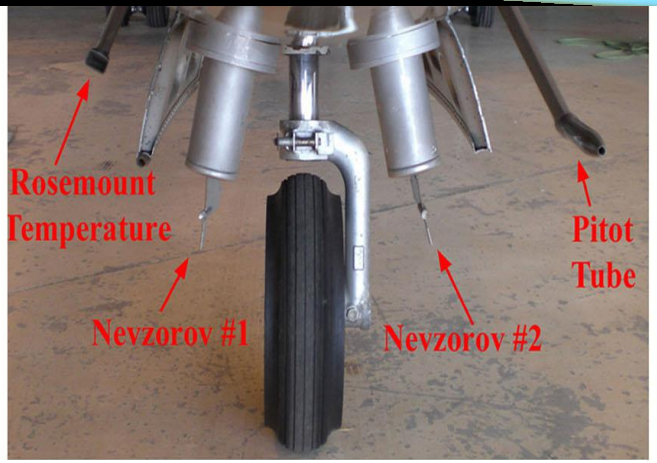
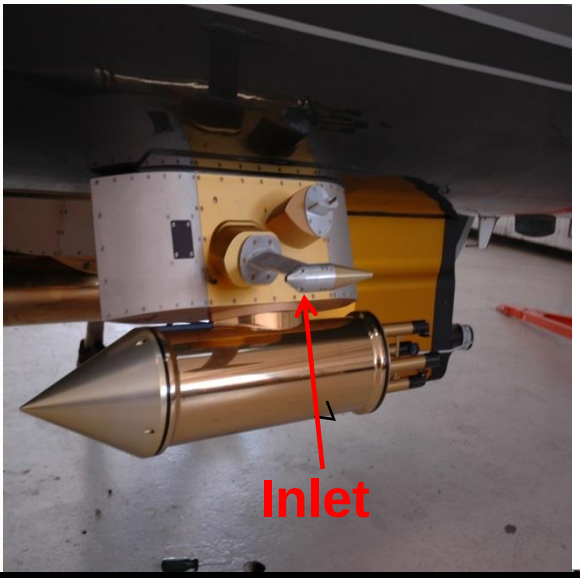
Learjet Microphysics and Air Motion Instrumentation





CAMP2Ex Flight Plans

- Avoid tall/large cloud patterns
  - Flight hazard; turbulence, hail,
  - Damage to instruments
- Avoid tropical cyclone circulation
- Measure/observe CU pattern type clouds
- Avoid contested islands/areas.

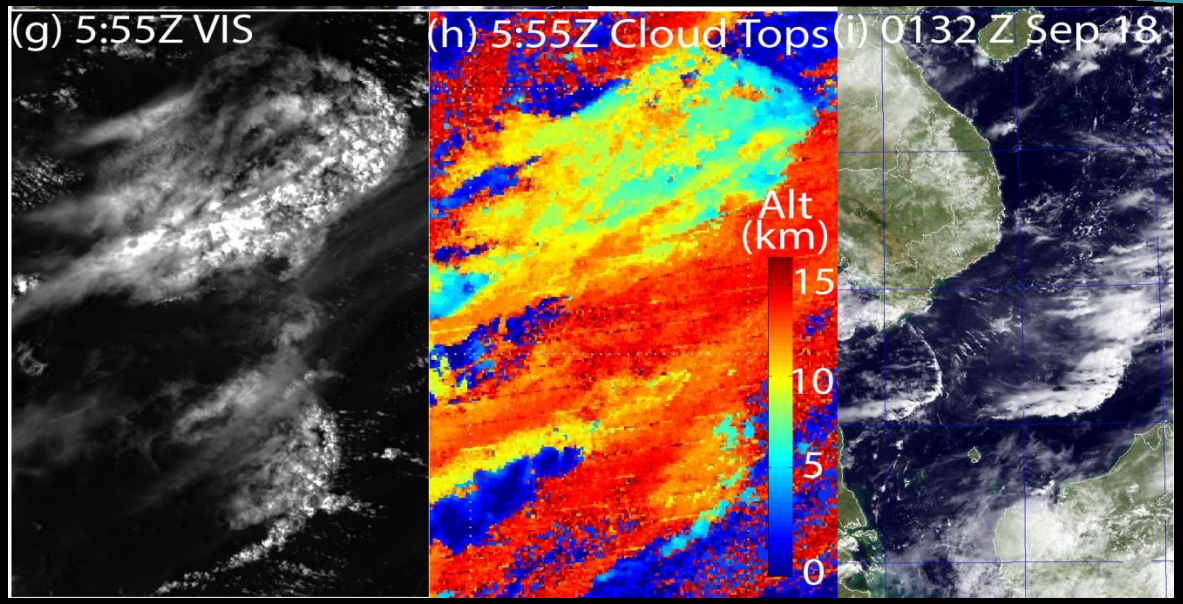
Environment A: Fair weather clouds, <12 kft
Fly over, in, and around

Environment B: Congestus, tops to 12-22 kft
Above and around, & if not growing, tops

Environment C: Linear convection Around and above

Mostly <18 kft, with isolated deep convection.

Can create large but non-precipitating cirrus plumes



No Go: Deep convection or deepening convection above 22 kft. Need good visibility

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Closing thoughts: What makes CAMP²Ex different?

1) The research domain has never had airborne measurements of the aerosol and cloud environment, and hosts highly diverse meteorology.
2) The science will be driven by hypotheses rather than open ended "Science questions."
3) Cross cutting from microphysics, through radiation and meteorology. Success requires interdisciplinary approach… and teamwork.
4) Required observations for science are reliant on airborne remote sensing.
5) Strong diurnal/temporal evolution component. Case in point, first major field campaign to take advance of ABI/AHI geostationary technology.
6) Instrument teams are given enough time to analyze and publish their results.
7) Unprecedented data visualization
8) Sister missions such as PISTON and those embedded in the Year of the Maritime Continent will give additional context to the airborne mission.

Questions?

CAMP2Ex Point-of-Contact

Dr. Jeff Reid, Lead-scientist, NRL Monterey

Email: jeffrey.reid@nrlmry.navy.mil