## Sep 14, 2009 MISR: Java Sea YMC Discussion: Aerosol-Cloud Interaction

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# Aerosol and its Impacts in the Maritime Continent

From the onset, we knew that the Maritime Continent posed one of the greatest observation and prediction challenges in all of meteorology.

Do aerosol particles impact the weather and climate here? Certainly the weather and climate impact aerosol particles. And particles can effect clouds. But to what extent does it matter to "climate?"

Even is the null hypothesis proves true, aerosol prediction from local to seasonal scales has many critical societal benefits.

Job #1: What is the state of the regional atmosphere? This is something that has vexed the best meteorologists. Now add composition....



# **YMC** Whitepaper

ecvcle Impact **Meteorology** Aerosol **U**O Aerosol Impact on Meteorology

1. Influences of rainfall and wind on production, transport, and distribution of aerosol, especially biomass burning smoke and natural marine aerosol, on diurnal, synoptic, intraseasonal, and annual timescales;

2. Modulation of the size distributions of aerosol by variability in rainfall, wind, and humidity on synoptic, intraseasonal, and annual timescales;

3. Effects of anthropogenic and natural aerosol on microphysics (e.g., cloud drop size distribution) of different types of clouds;

4. Possible modulation of precipitation from warm cloud and the entire cloud population by anthropogenic aerosol in different tropical environments that fluctuate on synoptic, intraseasonal and seasonal timescales.



•Tropical meteorological modes simultaneously force convection and aerosol lifecycle.

•While we understand aerosol relationships to large scale phenomenon, aerosol impacts on clouds and EO propagation are forced at poorly understood fine scales.

•To make headway in aerosol prediction, we do not need to solve the problem of tropical prediction, but better understand the relationships and sensitivities to tropical phenomenon.



# Large scale dynamics of a typical Maritime Continent aerosol event

"Clean regime" MJO Phase 3-4 Large scale convection environment an ensemble of fine features One week later, MJO Phase 5-6 "High emissions regime" Still modulated by fine to mesoscale convection





Semidirect-Aerosol radiative impact on cloud fraction (D) day and (N) Night. Ge et al., 201434









There have been many studies suggesting aerosol particles invigorate ice processes. But to what extent are observed effects" real?





rm Severity?

(upper panel) and warm (lower panel) phase of ENSO events.

### Are climate impacts have any aerosol relations? There are lots of confounders too.

#### **Thailand** (Sharma & Babel, 2014)

"significant increase in the annual number of warm days and warm nights, with corresponding significant decreases in the annual number of cool days and cold nights. The warm spell duration indicator presents statistical rising trends....There is insignificant decrease in annual total precipitation for nearly all stations... The number of days with rainfall more than 10 and 20 mm has declined over both basins except at Kanchanaburi station."



#### Philippines (Cruz et al., 2013)

"an examination of the rainfall extremes indicate an increasing trend in the number of days without rain"



□ 1961-1970 □1971-1980 □ 1981-1990 ■ 1991-2000 □ 2001-2010

# but large uncertainties too! Final thought on observations: So much data,



#### CAMPEx: Return to the field with a NASA P3 A proposed investigation on aerosol impacts on warm and mixed phased tropical clouds.

#### **Overview:**

- Lead Agency: NASA
- Proposed Dates: Aug-Sept 2018
- Locations: Philippines, Sulu, Celebes & South China Sea, WestPac
- Platform: NASA P3-4,000 nm range

#### **Scientific Objectives:**

- Determine the extent to which aerosol particles are responsible for modulating warm and mixed phase precipitation in tropical environments.
- Investigate if aerosol induced changes in clouds and precipitation feedback into aerosol lifecycle.
- •How do aerosol and cloud radiation covary, relate, and perhaps interact?
- •How does land use change factor into cloud and precipitation change? Is it a confounder for aeroosl impacts?







# SW Monsoon/MC Closing Thoughts and Questions

- We have successfully observed and described the overall nature of the regions aerosol environment. Now what? How do we get to processes and prediction?
- Now that we know the basics of the region, what are the pressing scientific hypotheses? YMC should be hypothesis driven.
- There are large technology and political challenges. Investigators should put some serious thought into isolating risk.