

# Science Updates from the Manila Observatory leading to CAMP2Ex 2018

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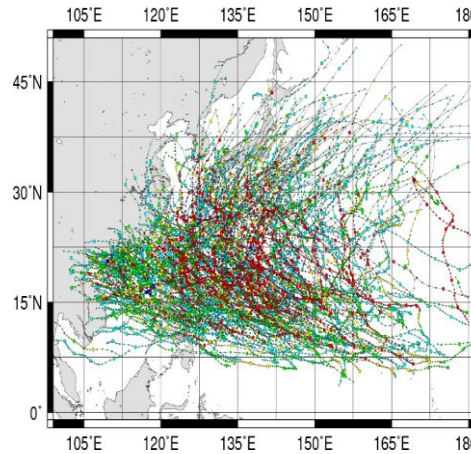
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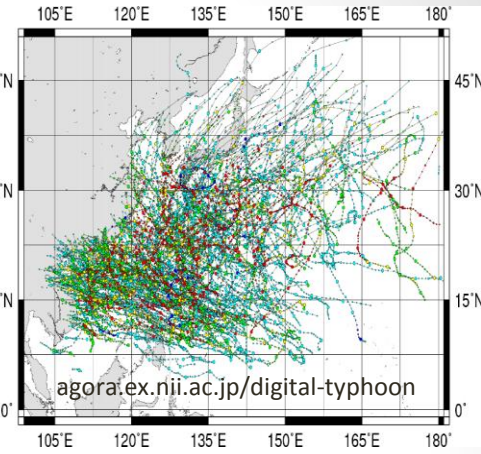
# Main Activities

- Rainfall climatology and spatio-temporal validation of satellite precipitation in the Philippine region
- Analysis of 2011 Vasco cruise whole air samples
- Scoping potential ground-based monitoring instrumentation and suitable sites for pre-mission characterization

# TYPHOONS



Typhoons during El Niño Years (1951-2010)



Typhoons during La Niña Years (1951-2010)

# ENHANCED SOUTHWEST MONSOON

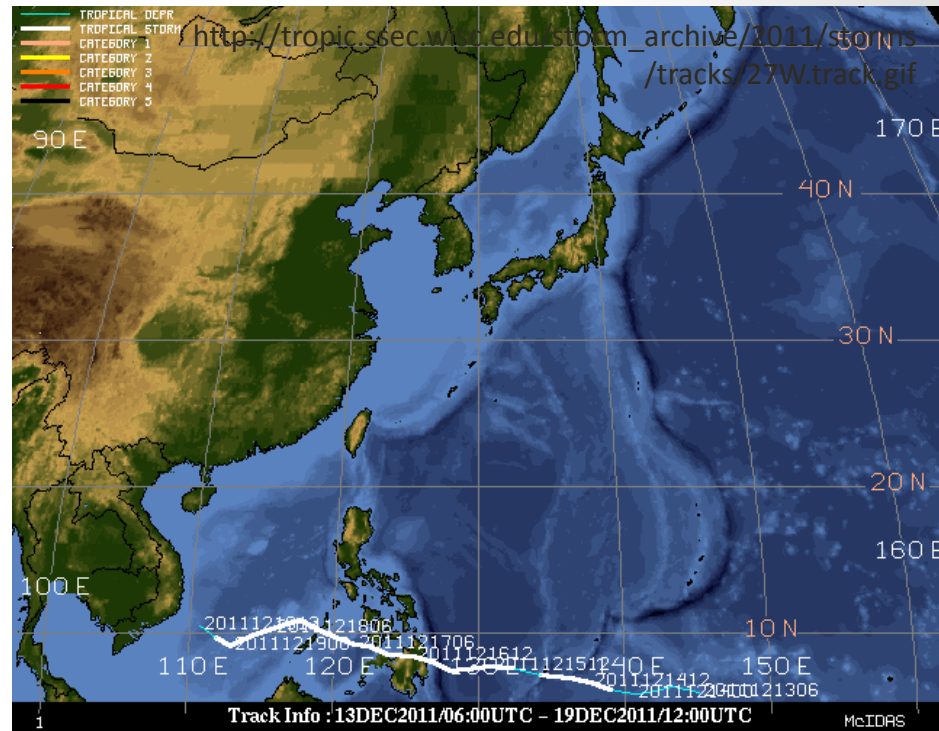
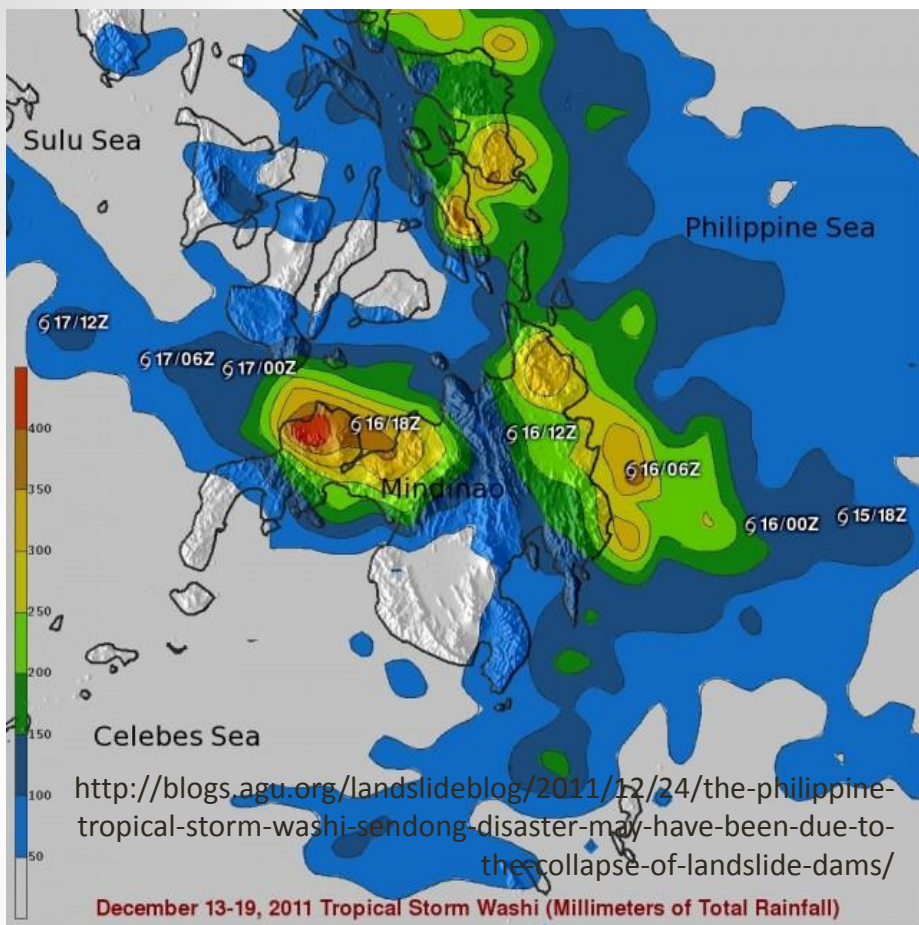


The flood of 2012  
<http://archian.wordpress.com>



The flood of 2013  
<http://www.mb.com.ph>

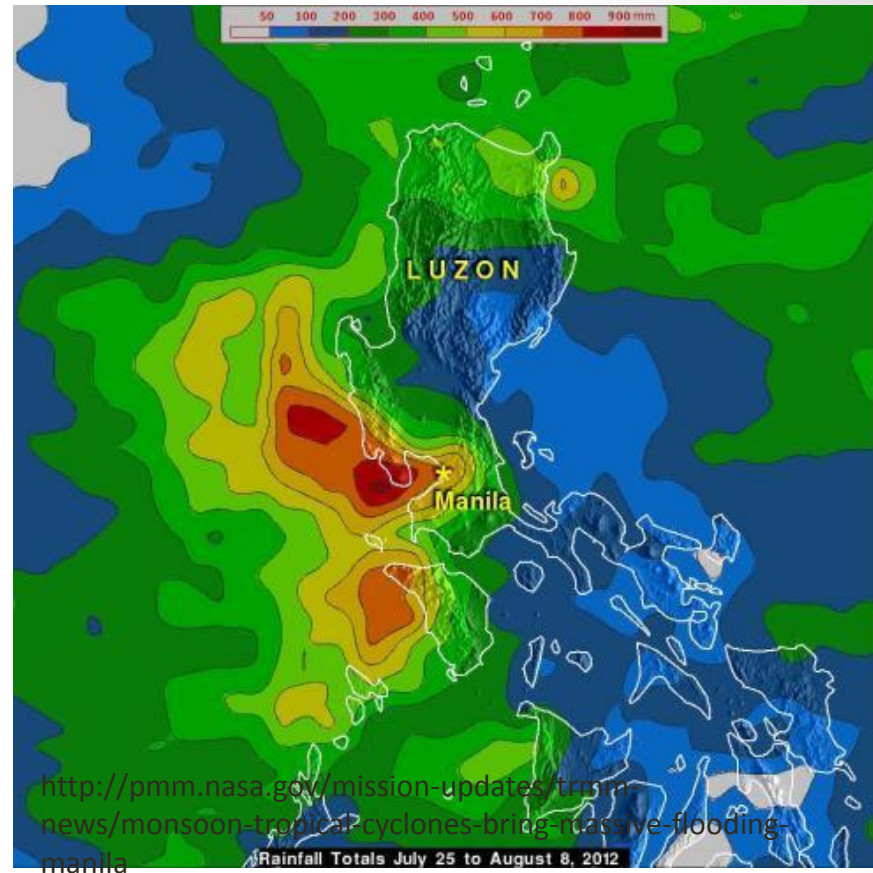
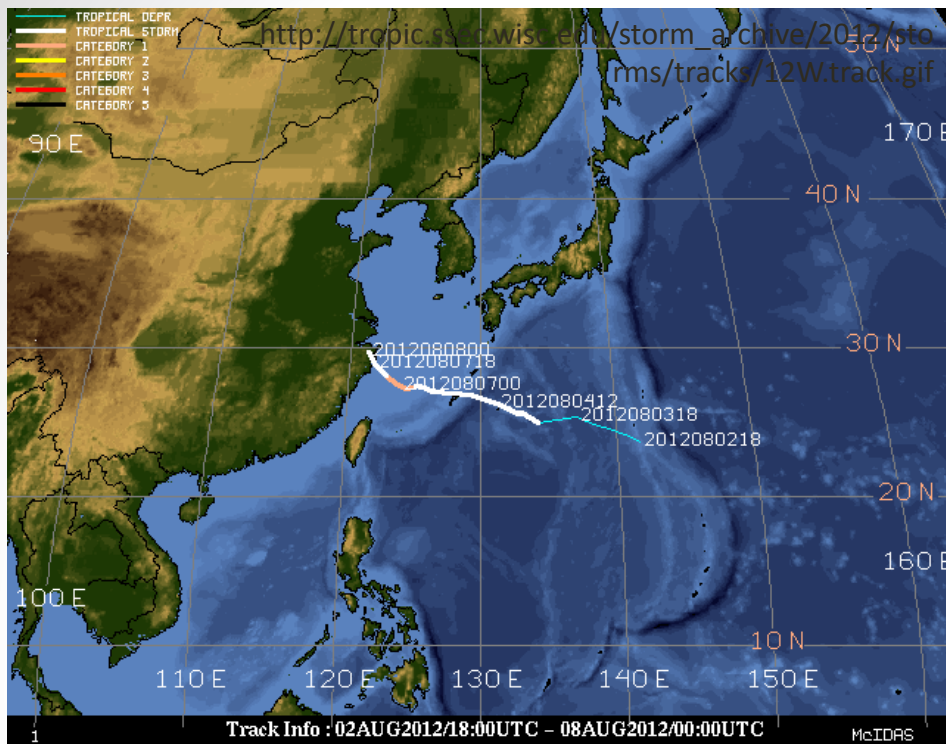




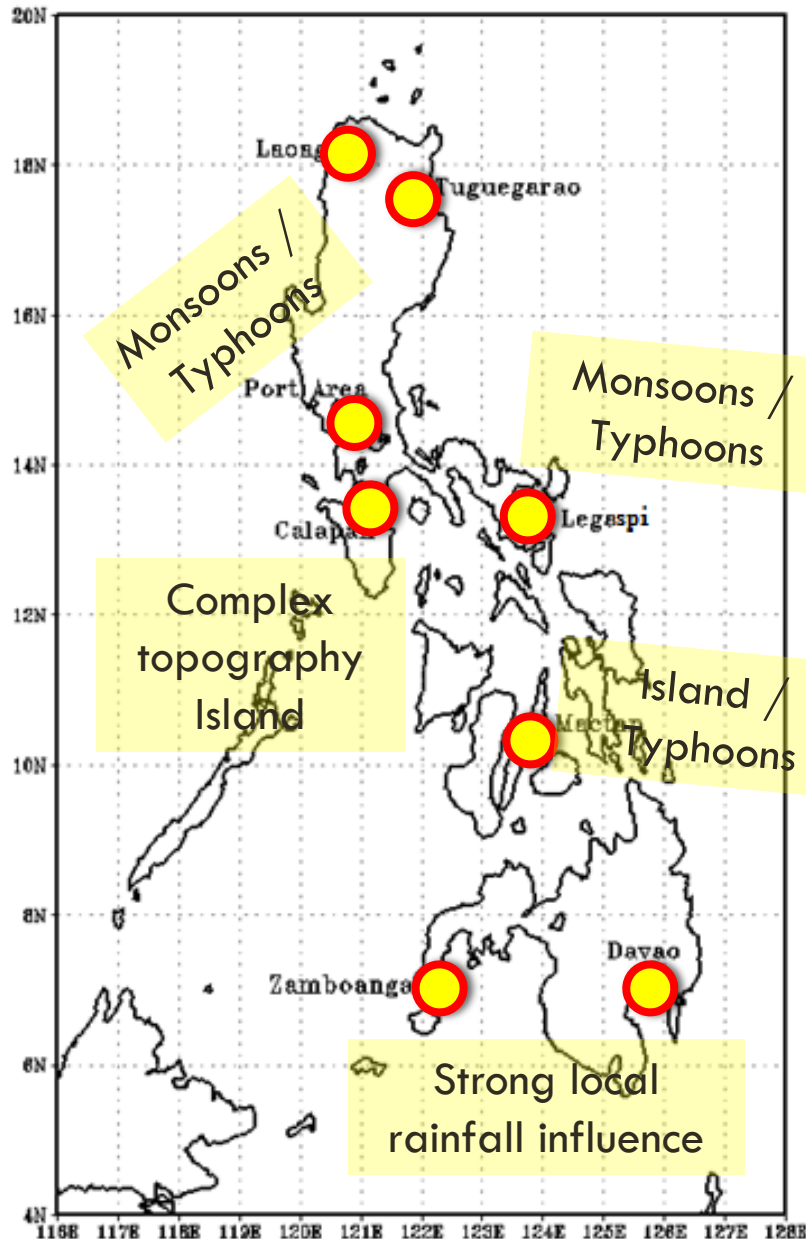
# Sendong (Typhoon Washi)

12/13/2011-12/19/2011





# Enhanced Southwest Monsoon (Typhoon Haikui) 08/01/2012-08/10/2012



## Satellite-based rainfall:

- Climate Prediction Center morphing method (CMORPH)<sup>1</sup>
- Tropical Rainfall Measuring Mission (TRMM 3B42V6)<sup>2</sup>

## Observation data:

- APHRODITE<sup>3</sup> (1998 – 2007)
- PAGASA (Philippine Atmospheric, Geophysical, and Astronomical Services Administration), 8 stations (2003-2005)

# How good are satellite-based rainfall products over the Philippines?

- Where does it perform best? What is the overall performance of satellite-based rainfall estimates?
- When does it perform best? Does it perform better depending on the season?
- What types of rainfall can it capture best? How well can it capture different kinds of rainfall?

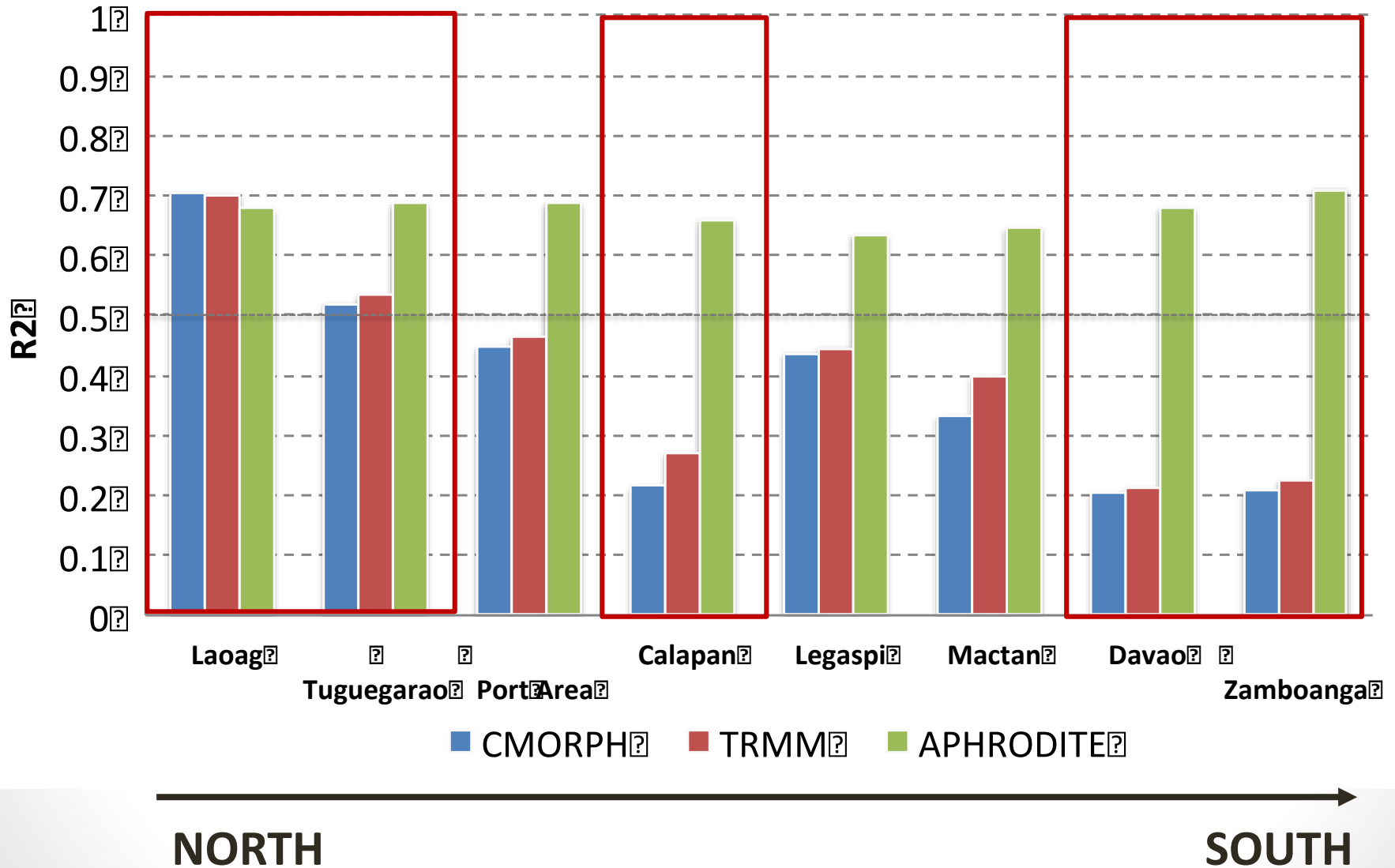
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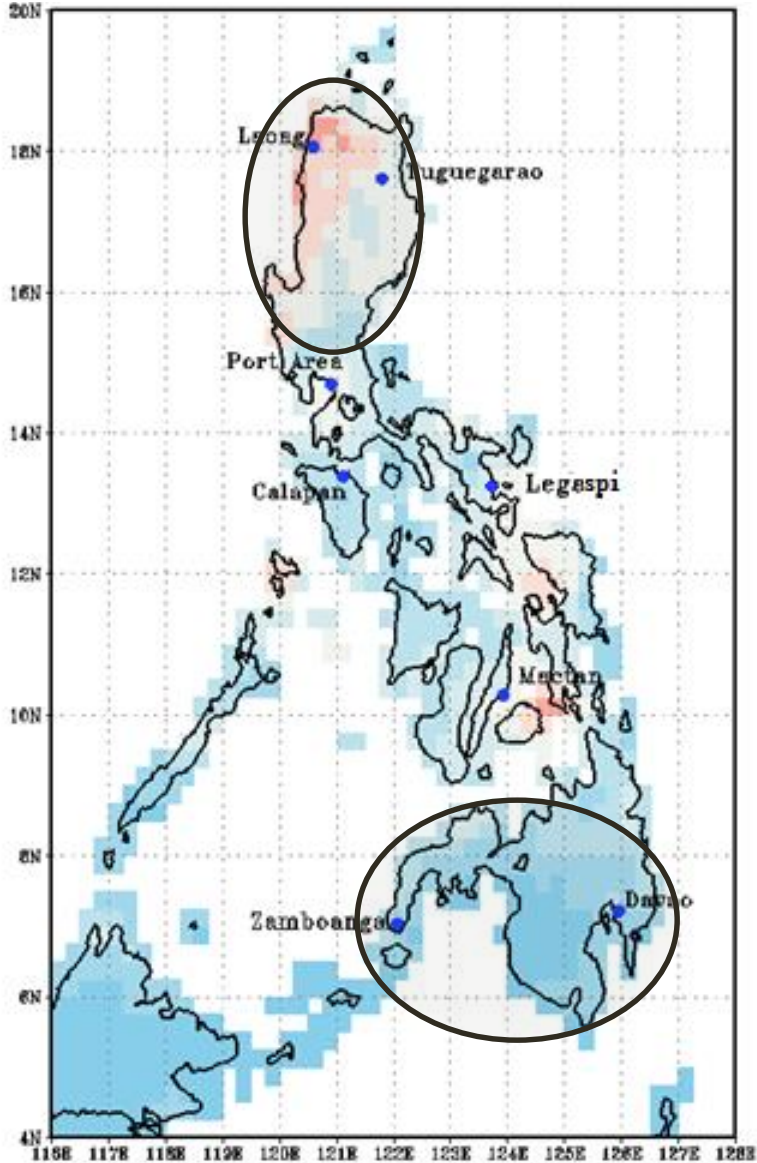
# Where: Overall performance

Station Rainfall R<sup>2</sup> values for 2003-2005

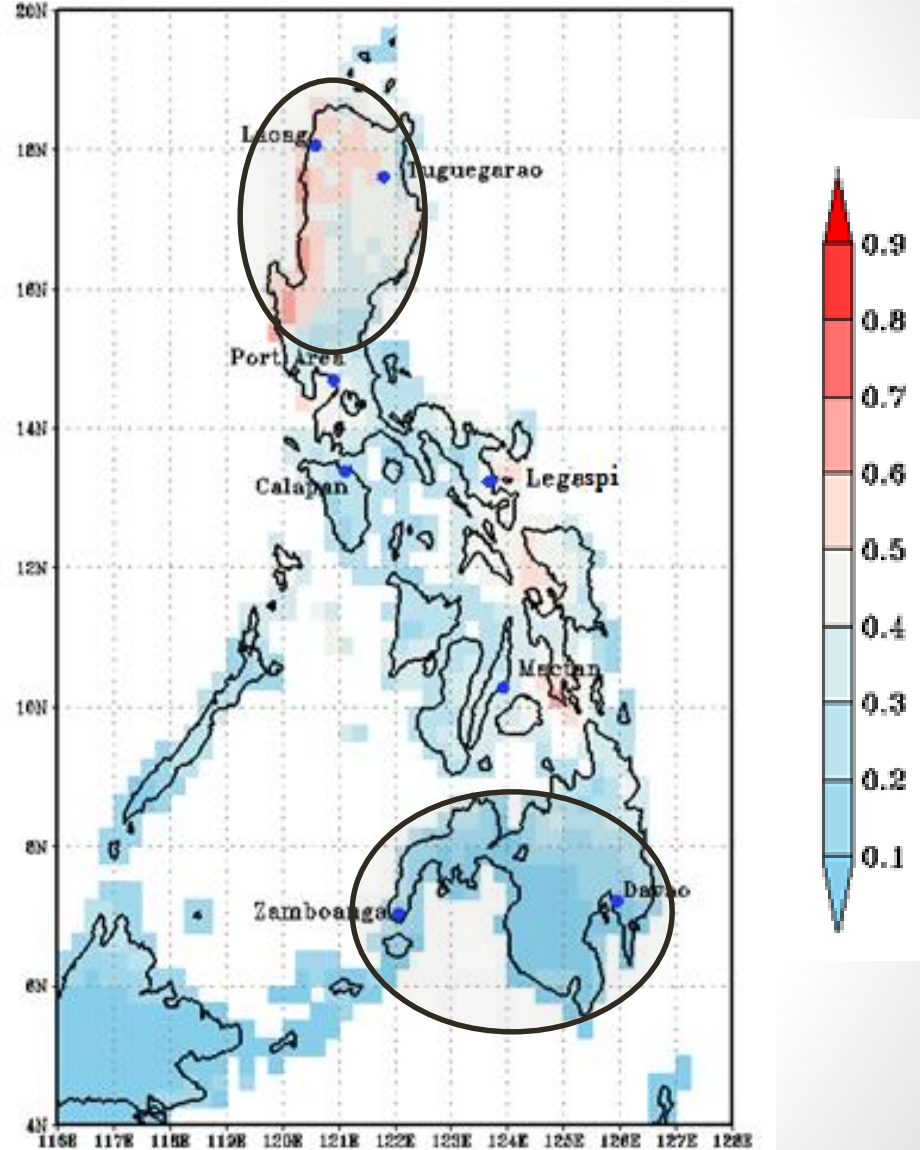


# Where: Overall performance

## Spatial Correlation CMORPH and APHRODITE



## Spatial Correlation TRMM and APHRODITE

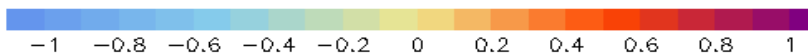
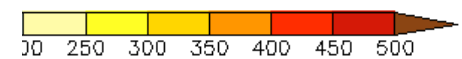
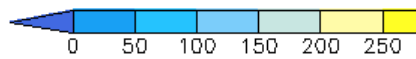
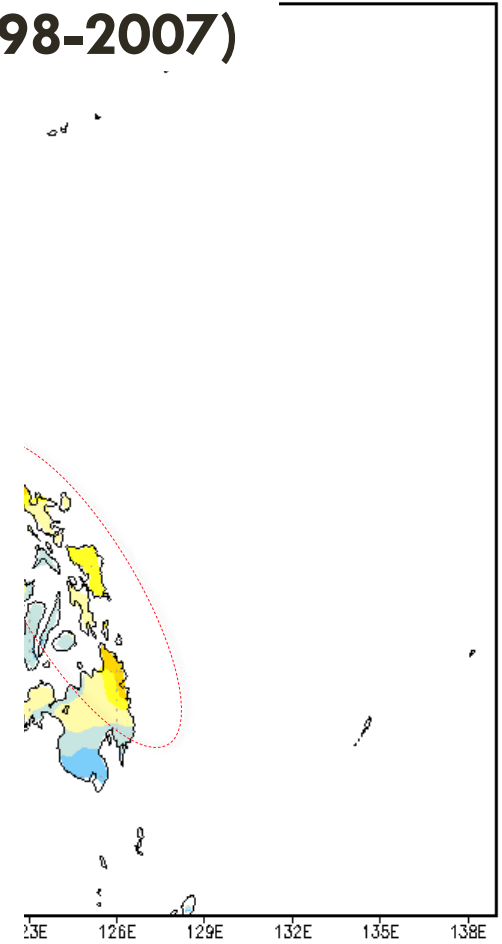
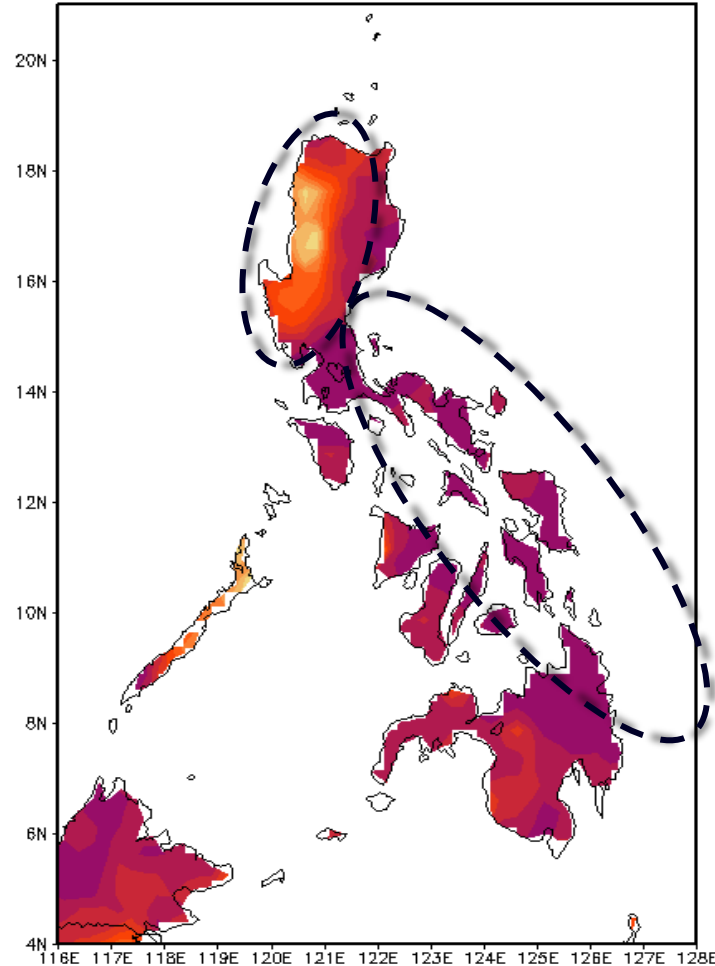
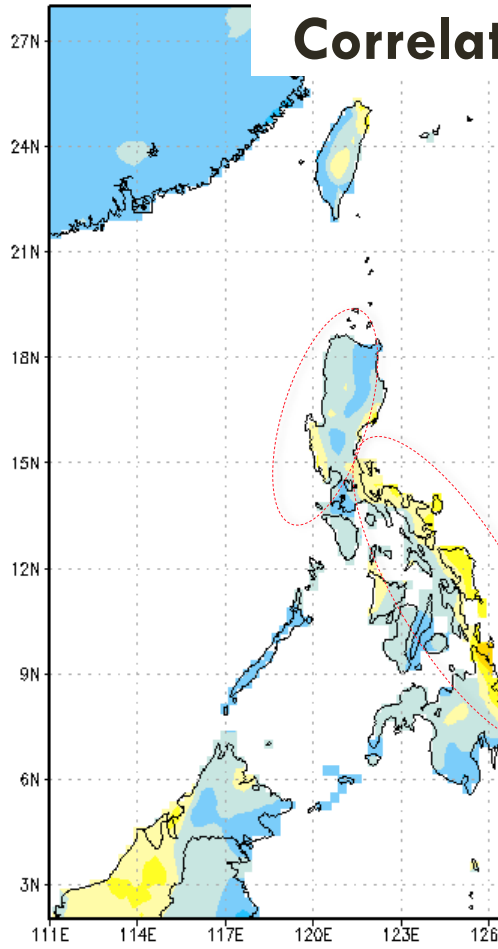


# Where: Overall performance

Ave Monthly Rainfall (mm/month)  
APHRODITE (1998-2007)

Ave Monthly Rainfall (mm/month)  
TRMM (1998-2007)

## Correlation APHRODITE vs TRMM (1998-2007)

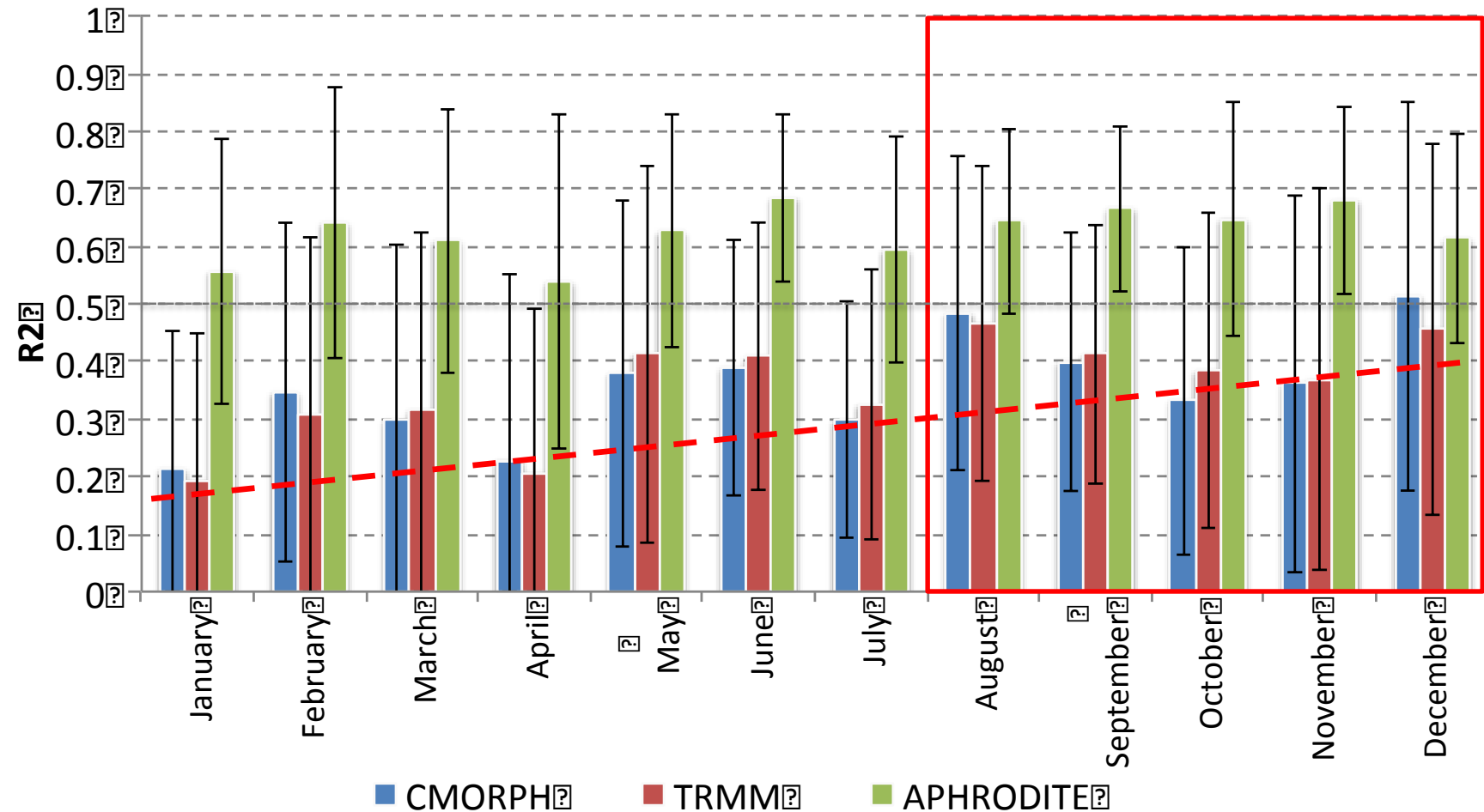


# How good are satellite-based rainfall products over the Philippines?

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# When does it perform best?

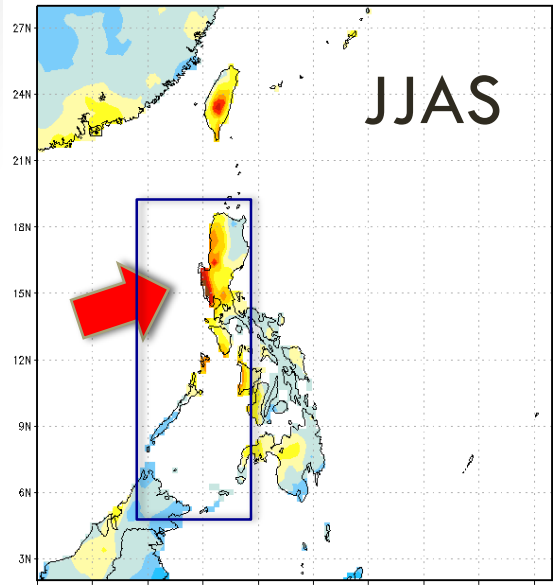
Monthly Rainfall R<sup>2</sup> values for 2003-2005



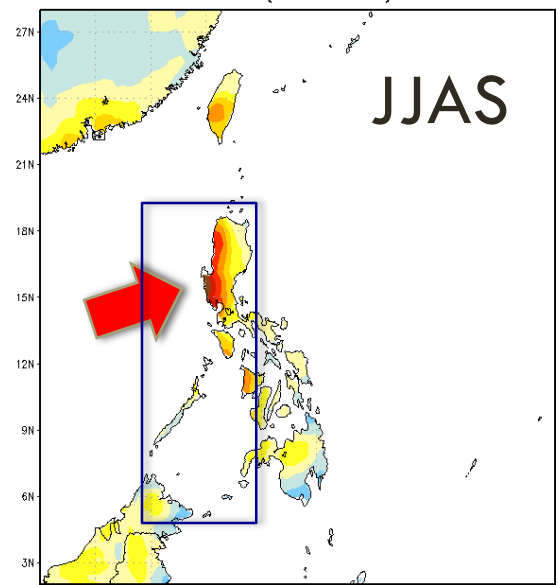
1998-2007

APHRODITE

Average Accumulated Rainfall (JJAS)  
APHRODITE (1998-2007)



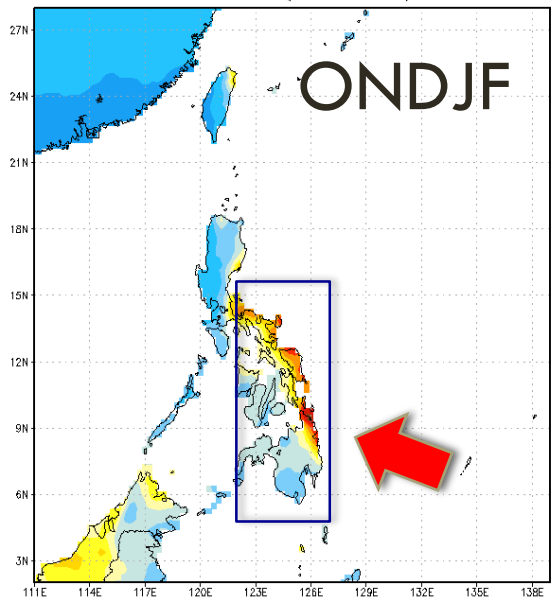
Average Accumulated Rainfall (JJAS)  
TRMM (1998-2007)



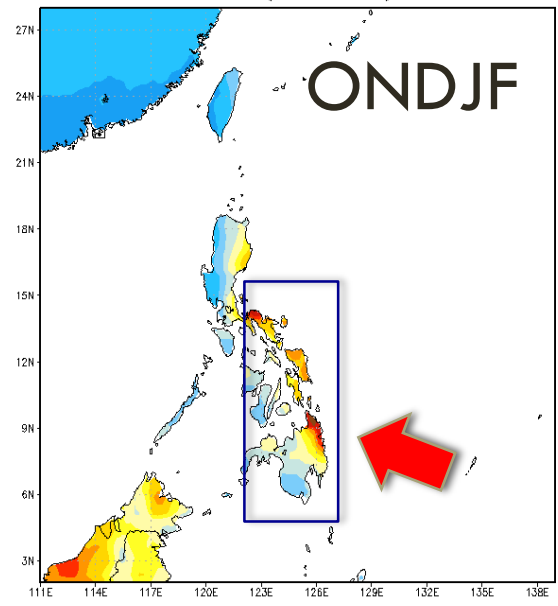
TRMM

APHRODITE

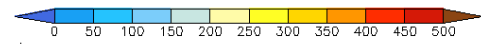
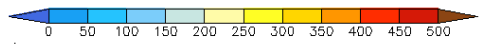
Average Accumulated Rainfall (ONDJF)  
APHRODITE (1998-2007)



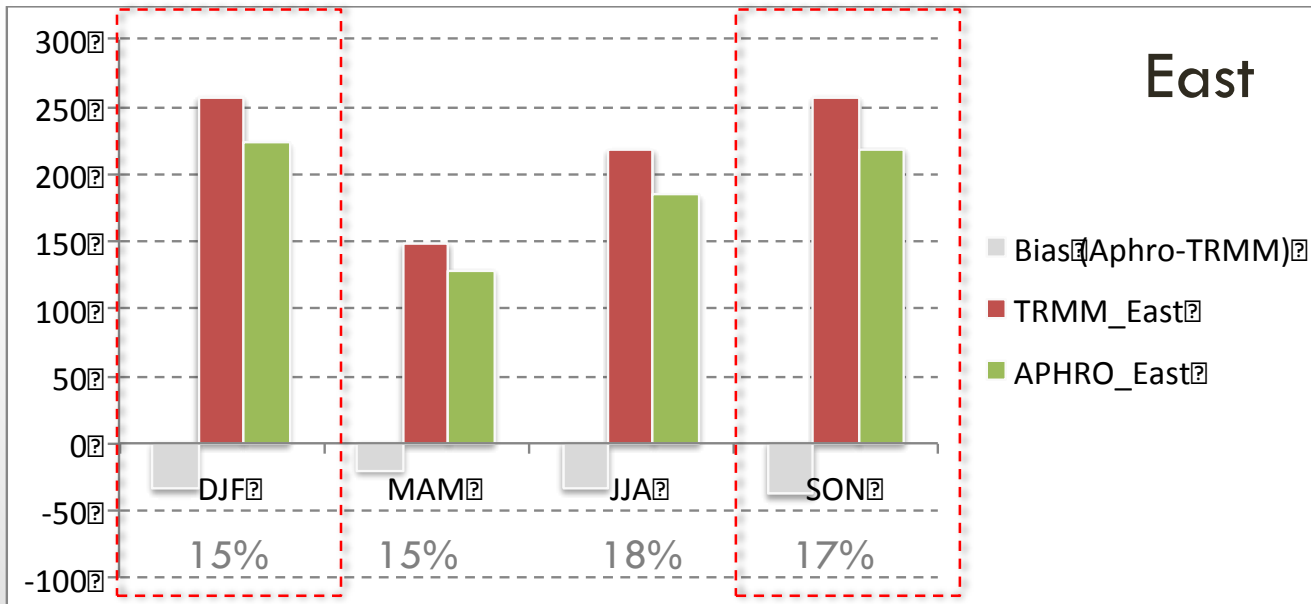
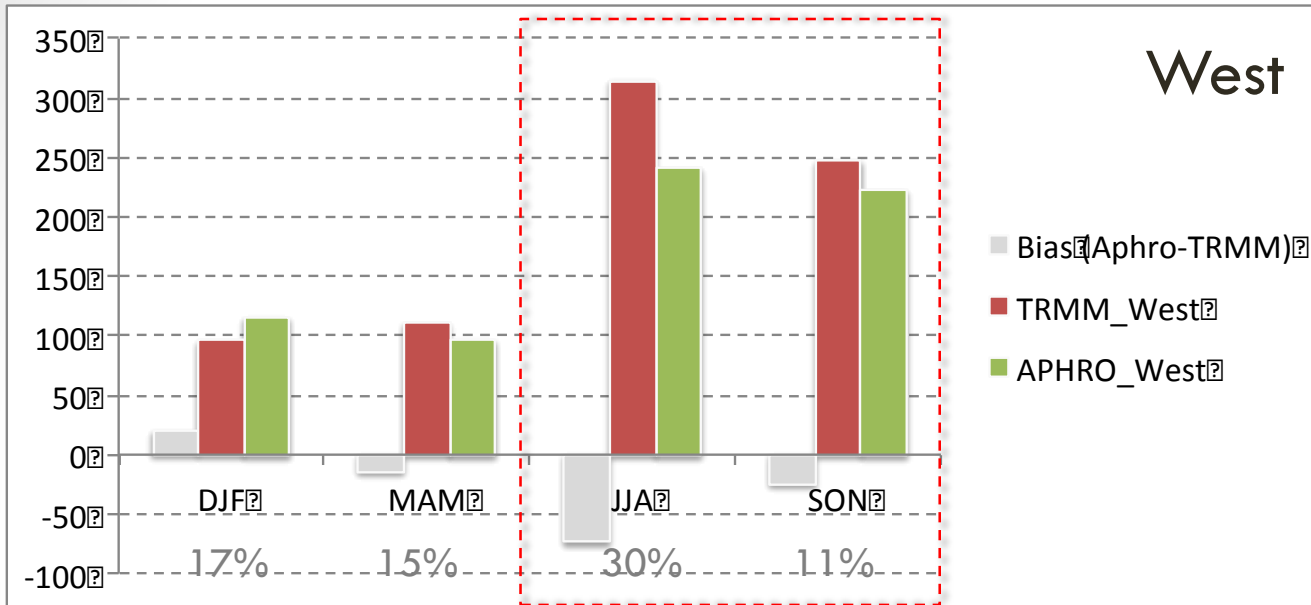
Average Accumulated Rainfall (ONDJF)  
TRMM (1998-2007)



TRMM



# When does it perform best?



Average monthly  
seasonal rainfall  
(mm/month)

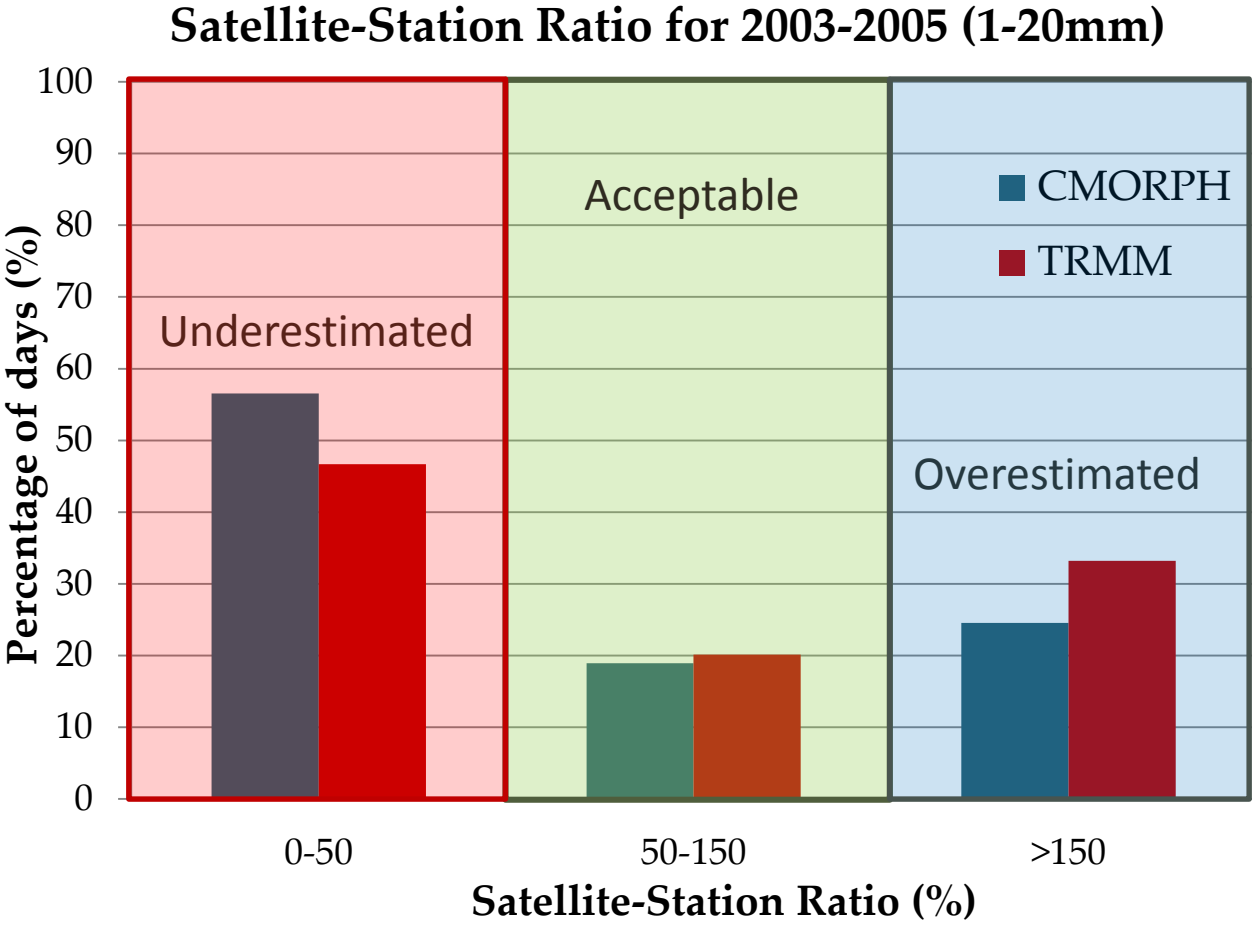
1998-2007

# How good are satellite-based rainfall products over the Philippines?

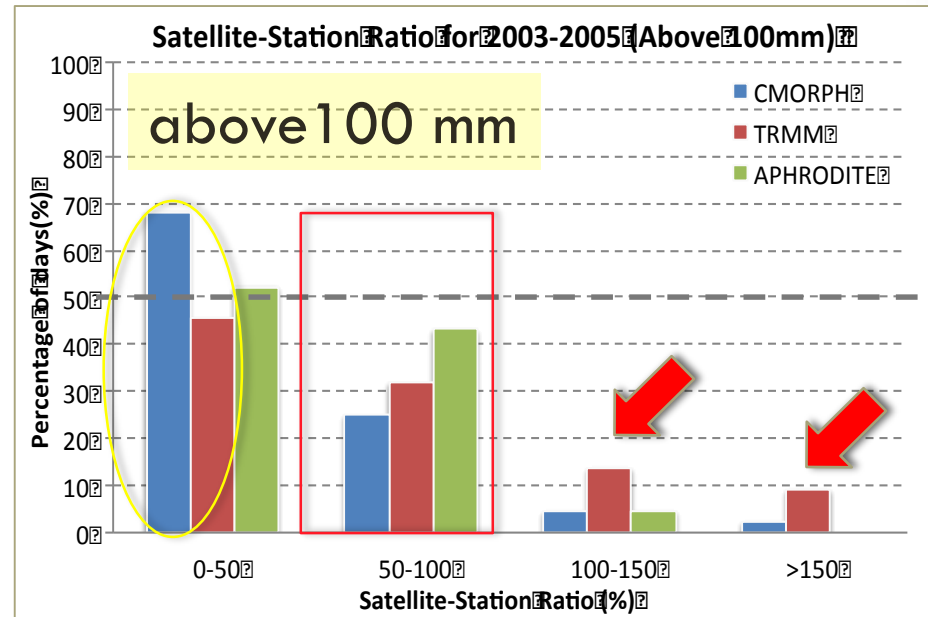
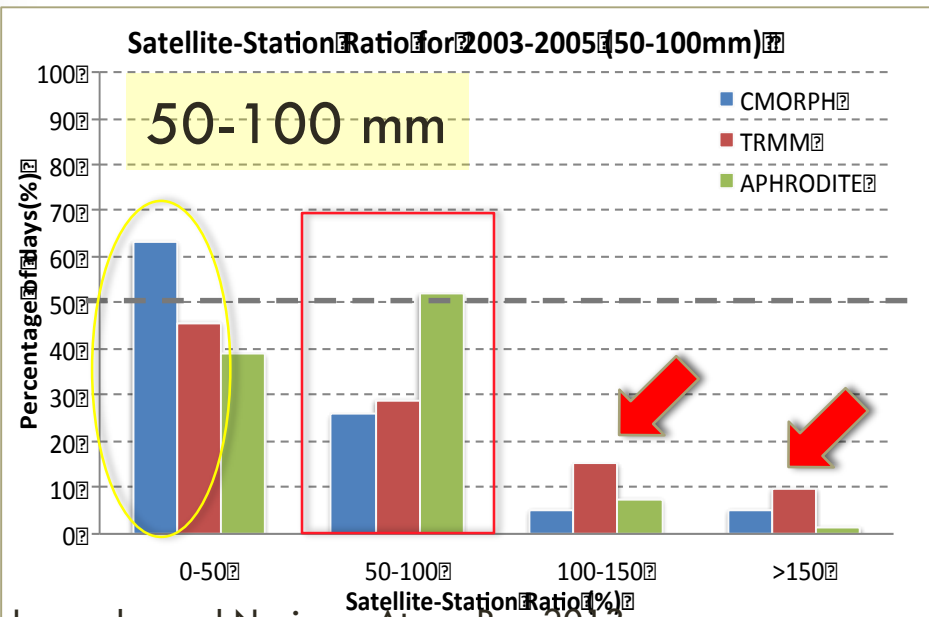
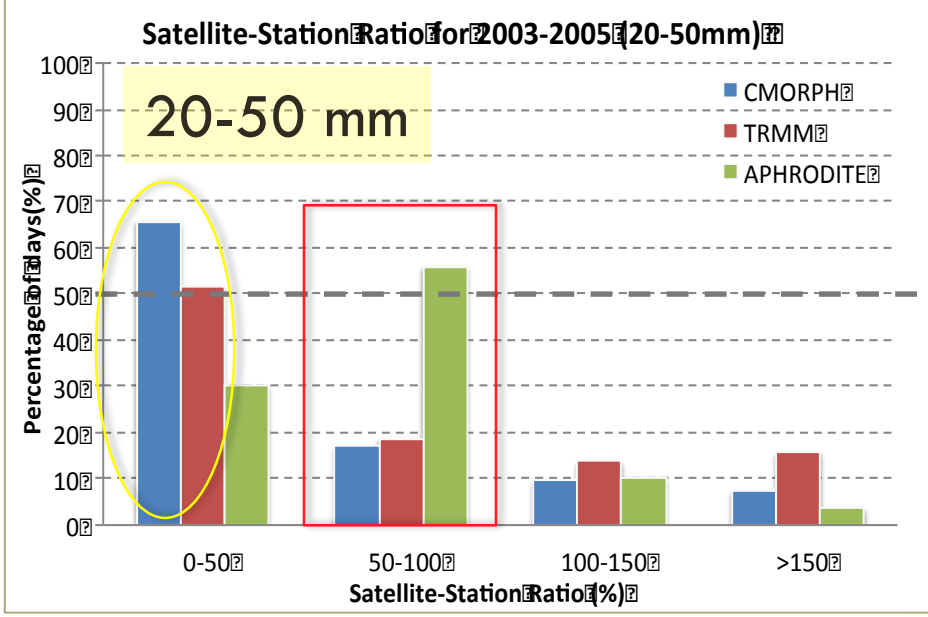
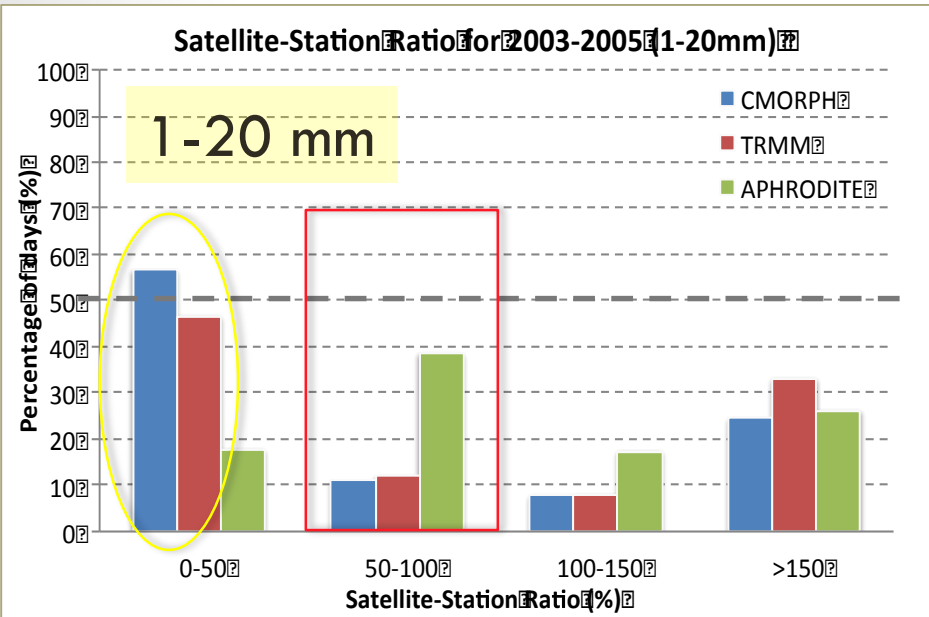
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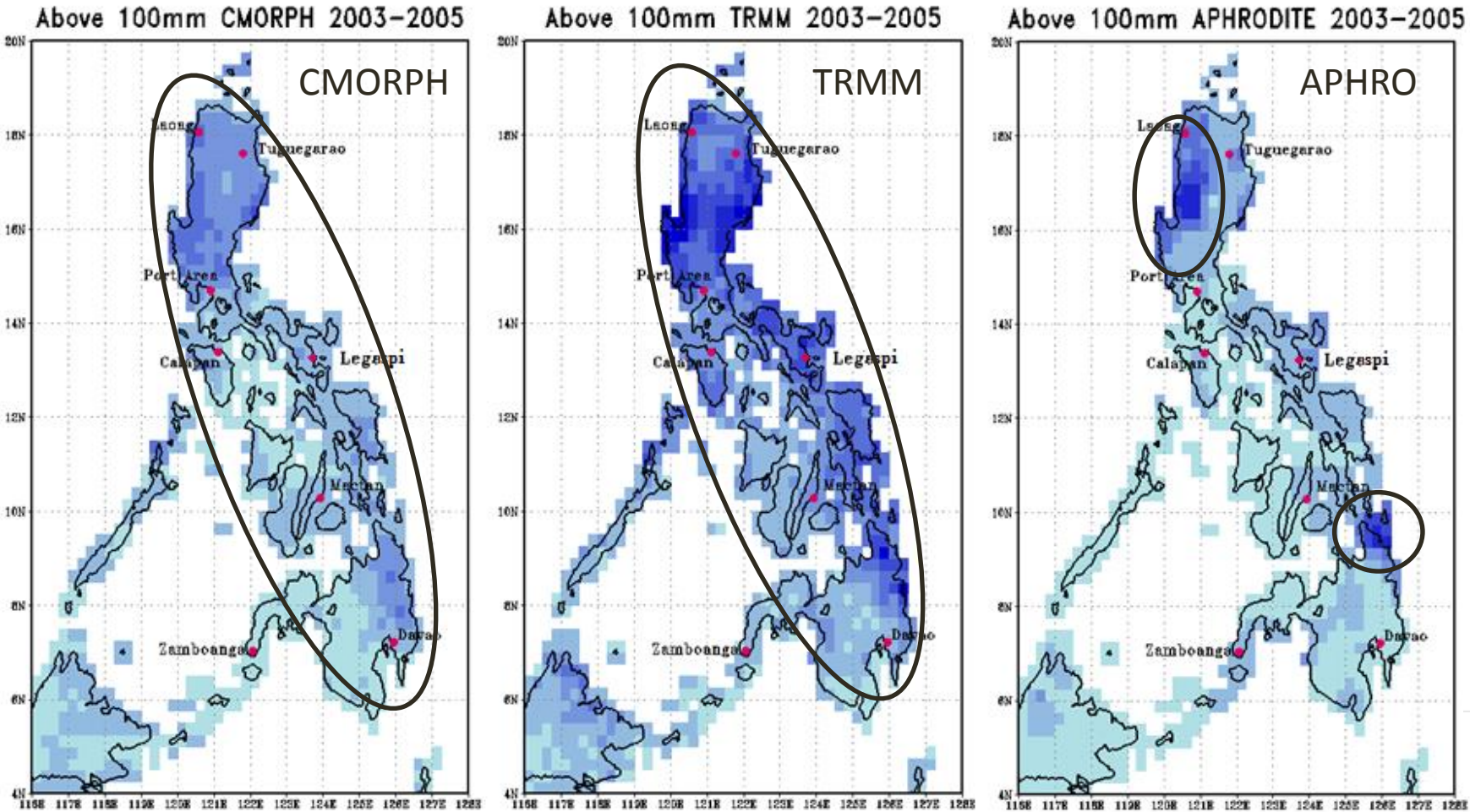
# What types of rainfall are captured best?



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# What types of rainfall are captured best?



Spatial distributions of the number of daily rainfall occurrences exceeding 100 mm for 2003-2005

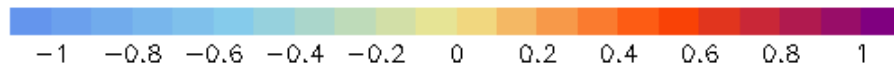
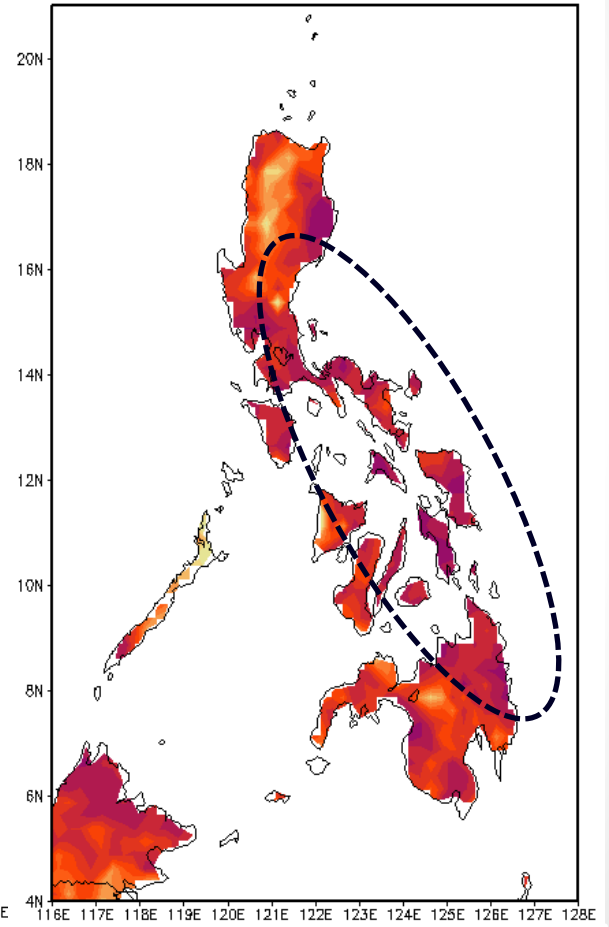
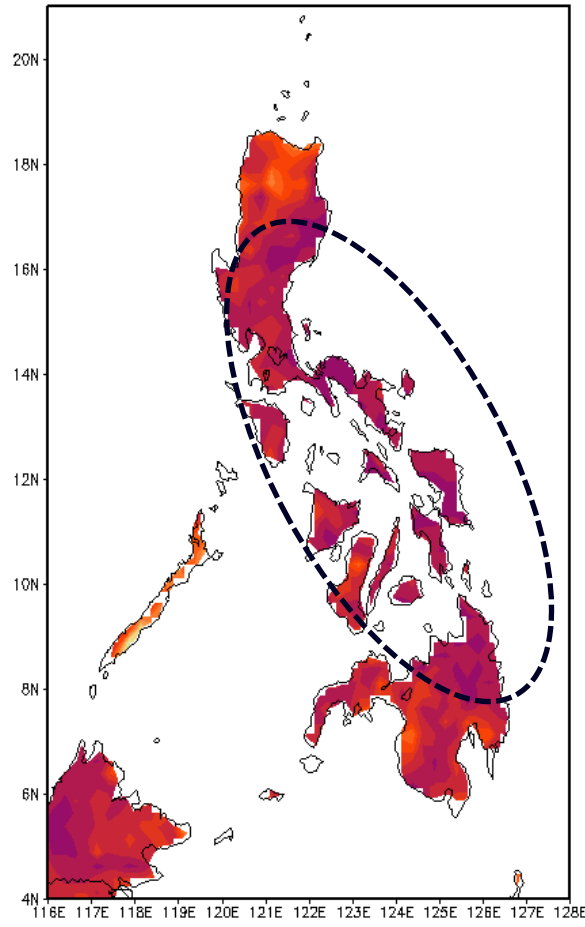
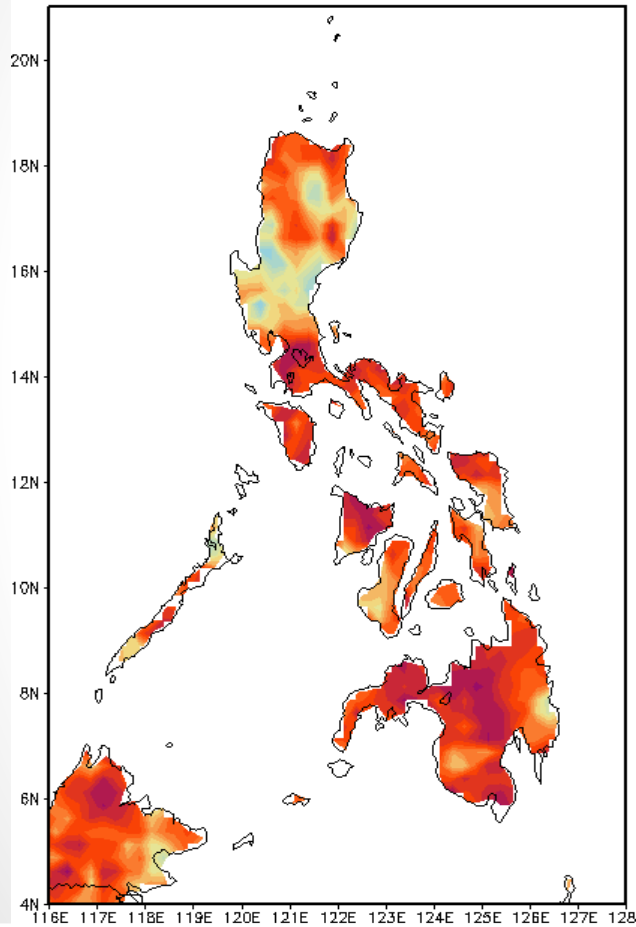
# What types of rainfall are captured best?

Correlation APHRODITE vs TRMM (1998-2007)

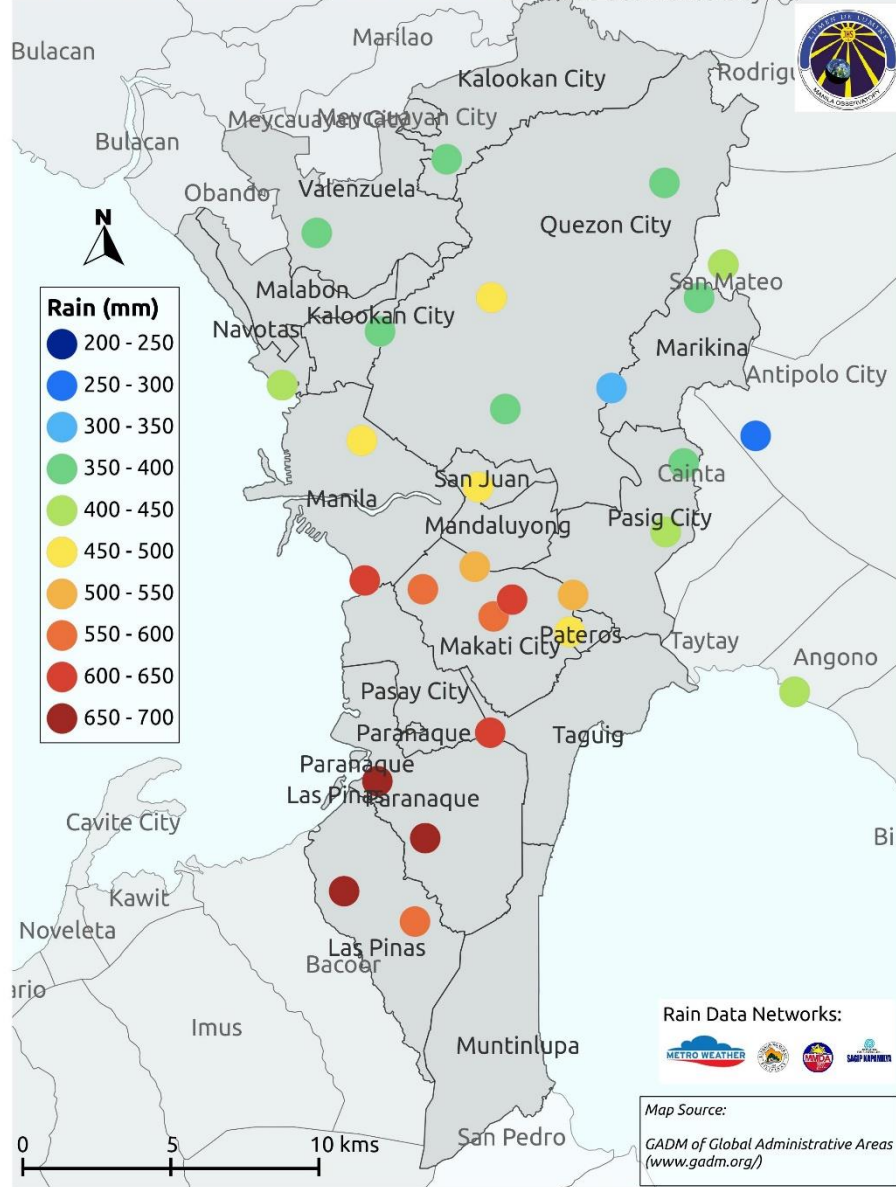
25<sup>th</sup> percentile

75<sup>th</sup> percentile

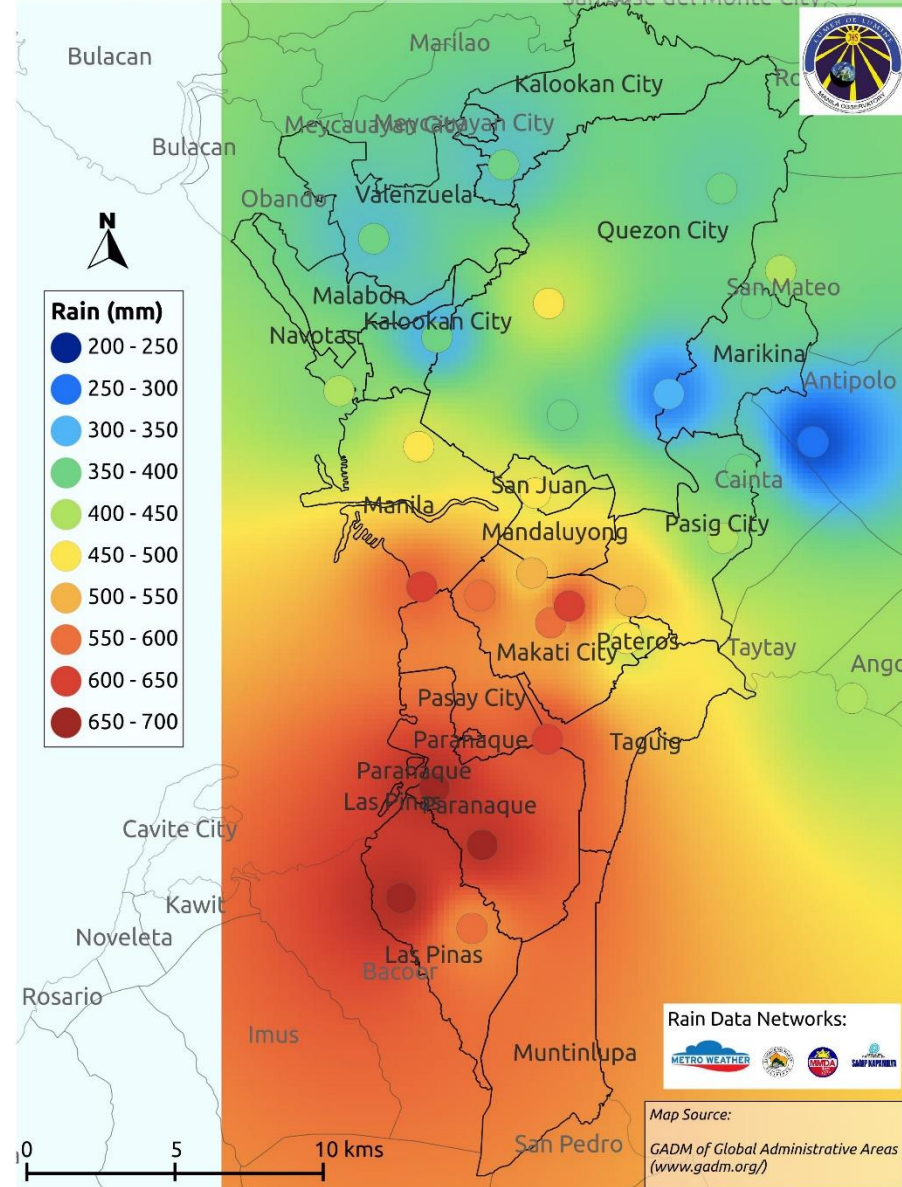
90<sup>th</sup> percentile



# 5-Day Accumulated Rain (August 17-21, 2013) from Weather Stations in and around Metro Manila



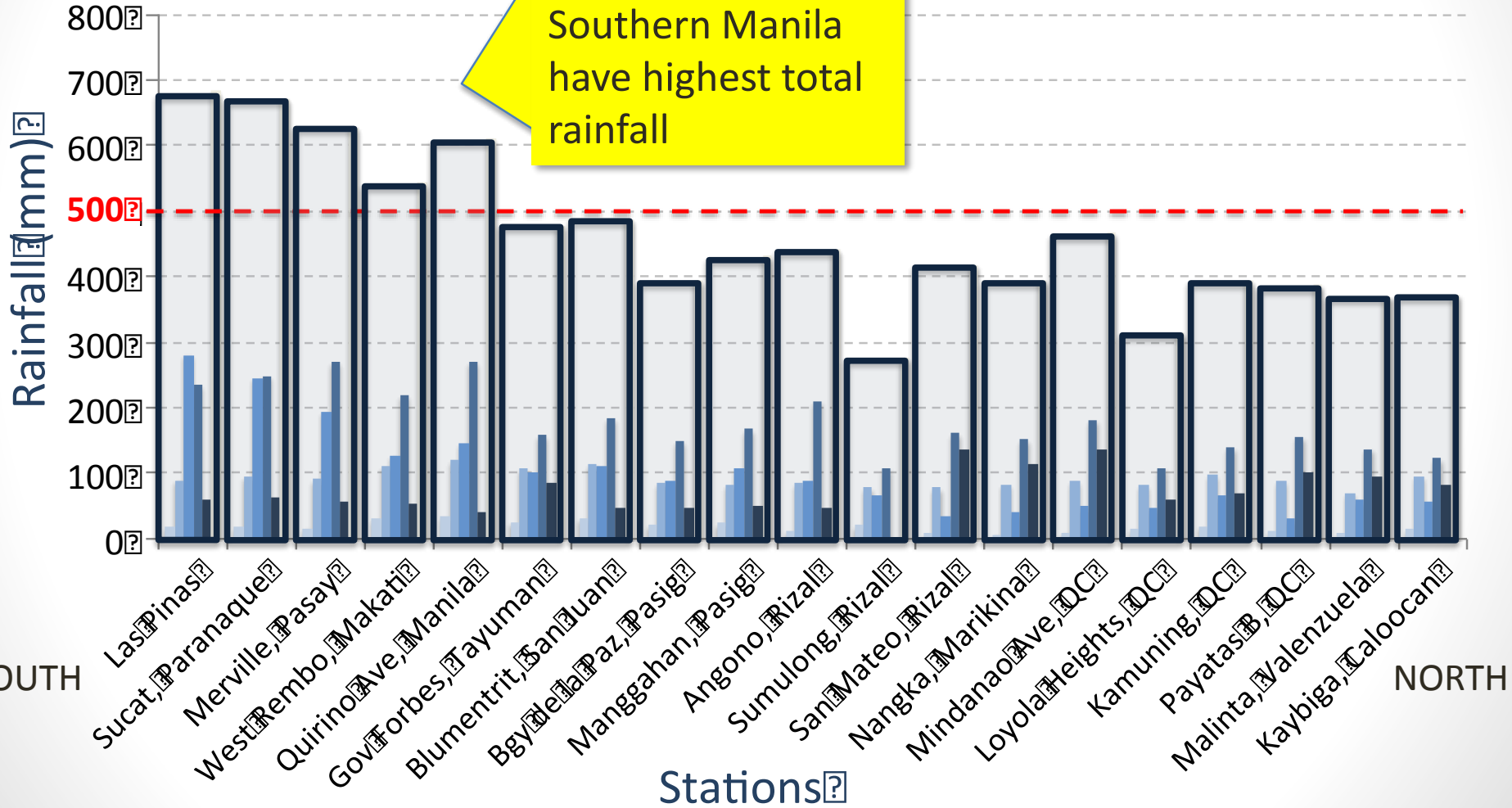
# 5-Day Accumulated Rain (August 17-21, 2013) from Weather Stations in and around Metro Manila



# 5-DAY RAINFALL FROM 17-21 AUGUST 2013

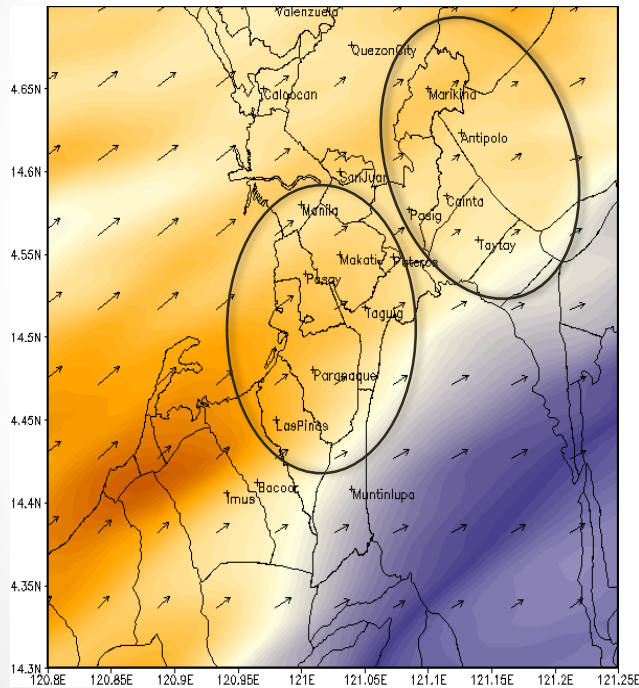
Blue bars inside box are rain totals for each day (different shades are for the different days)  
 Box is the sum of the daily rain values (blue bars) inside

Stations in Southern Manila have highest total rainfall

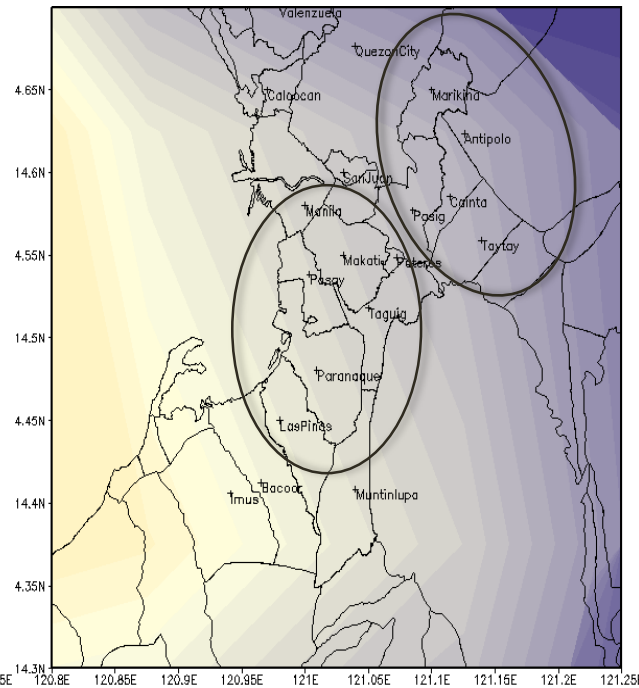


# Enhanced Southwest Monsoon 2013, Metro Manila 5-day Accumulated Rainfall 17-22 August 2013

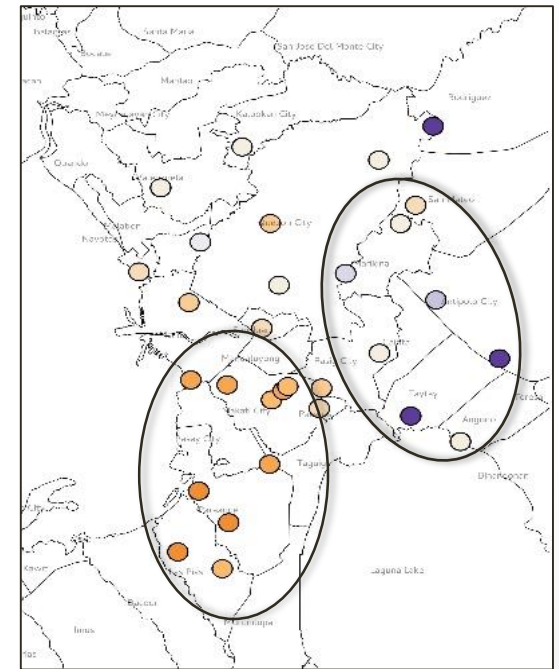
## WRF Simulation (1km)



## TRMM



## Station data



0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800

# How good are satellite-based rainfall products over the Philippines?

## Where does it perform best?

- 2003-2005: rainfall in north captured best, 0.5-0.7  $r^2$  (*Station data*)
- 1998-2007: rainfall in eastern part of the Philippines are captured best (*Aphrodite*)

## When does it perform best?

- 2003-2005: Performs well during rainy season (Aug, Sept, Dec) – (*Station data*)
- 1998-2007: Captures well SW and NE rainfall (*Aphrodite*)

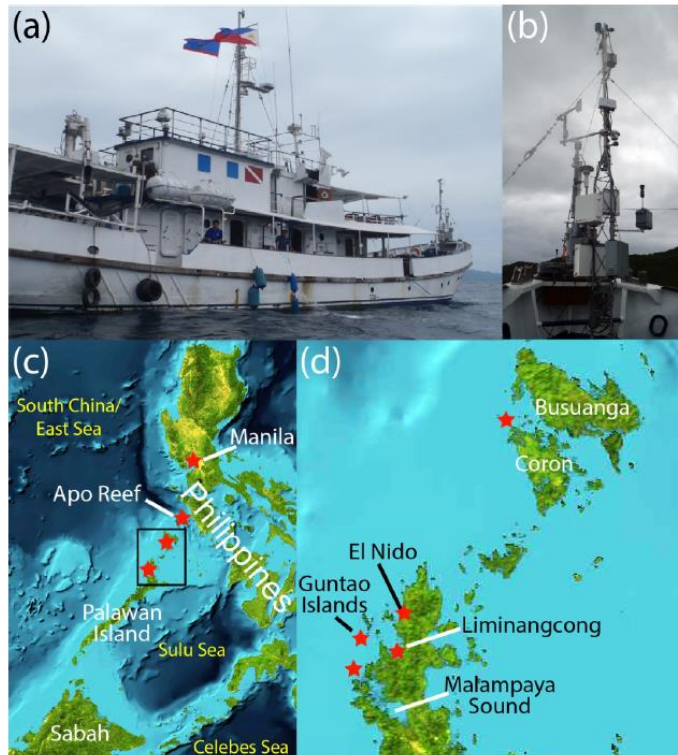
## What types of rainfall can it capture best?

- 2003-2005: Captures better heavy rainfall amounts (>50mm) (*Station data*)
- Tend to overestimate extreme rainfall, captures well 75% percentile (*Aphrodite*)

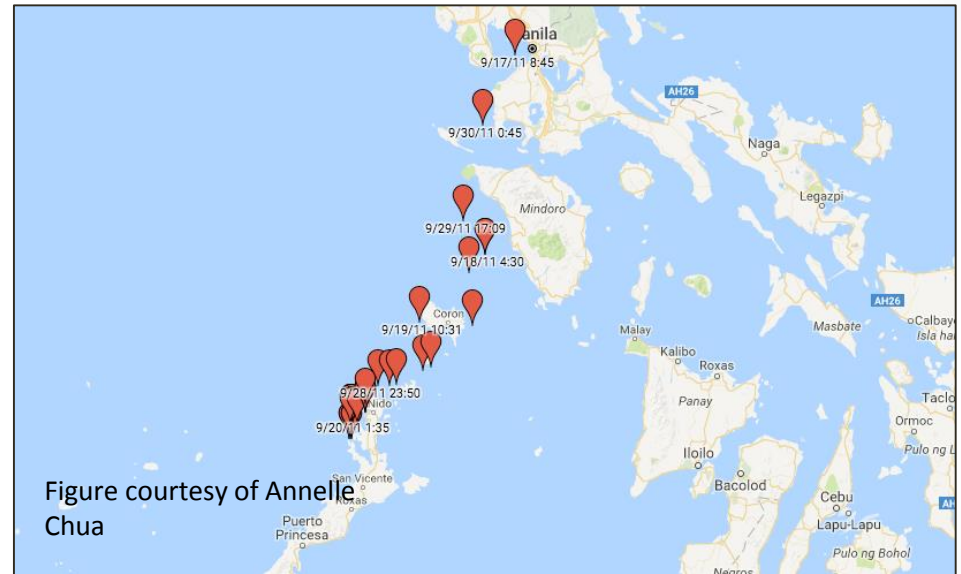


# Investigating Reactive Trace Gas Chemistry in the South China Sea/ East Sea during the SW Monsoon Season

Vasco Cruise, September 17-30, 2011



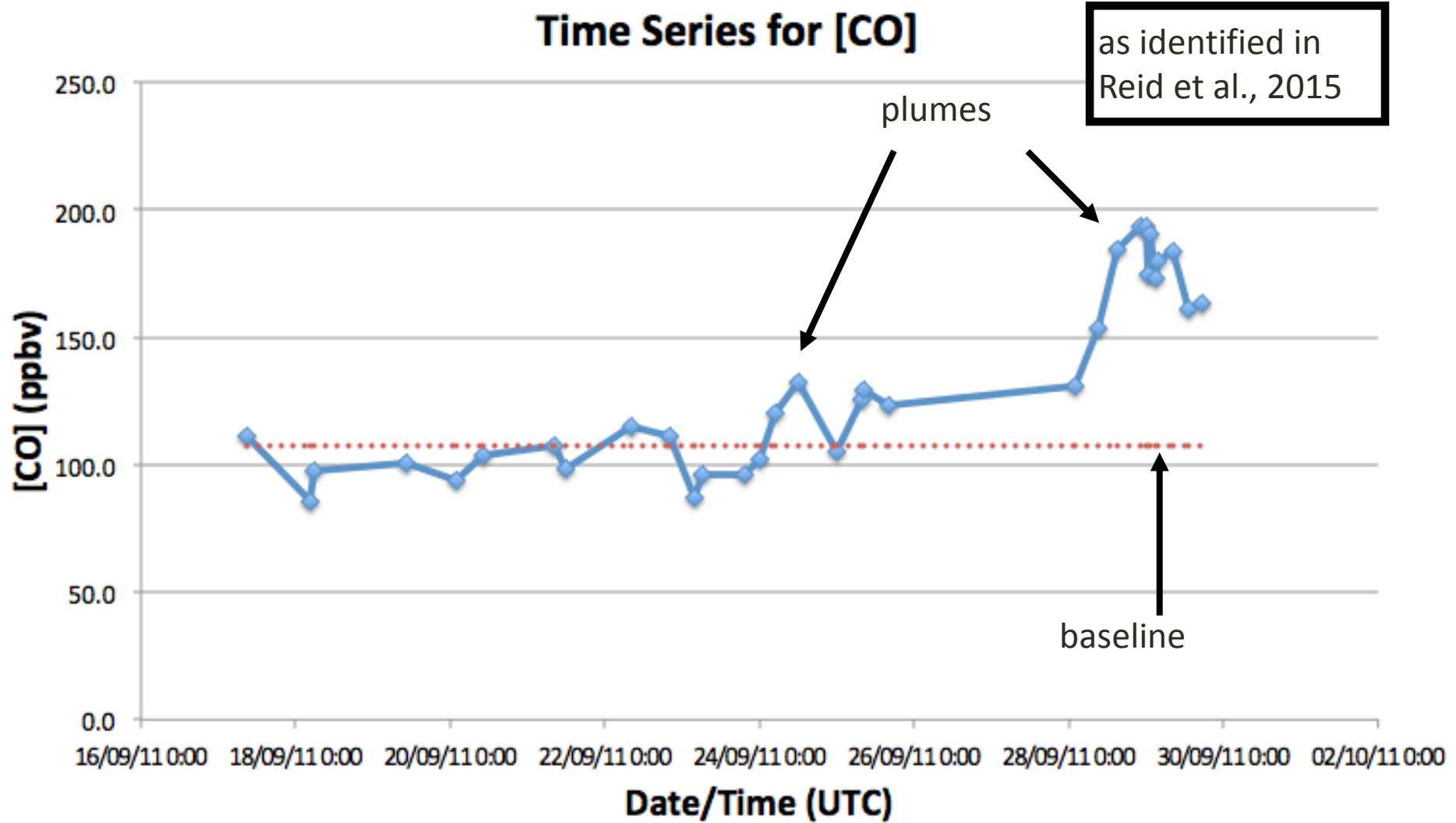
**Figure 1.** (a) The M/Y *Vasco*; (b) bow flux tower during the cruise. (c) Map of cruise area, stars mark key areas of sampling. (d) Enlargement of the northern Palawan/Coron sampling sites.



- 46 whole air gas samples from 2011 field campaign (analyzed in Donald Blake's lab in UC Irvine)
- 60+ trace gases

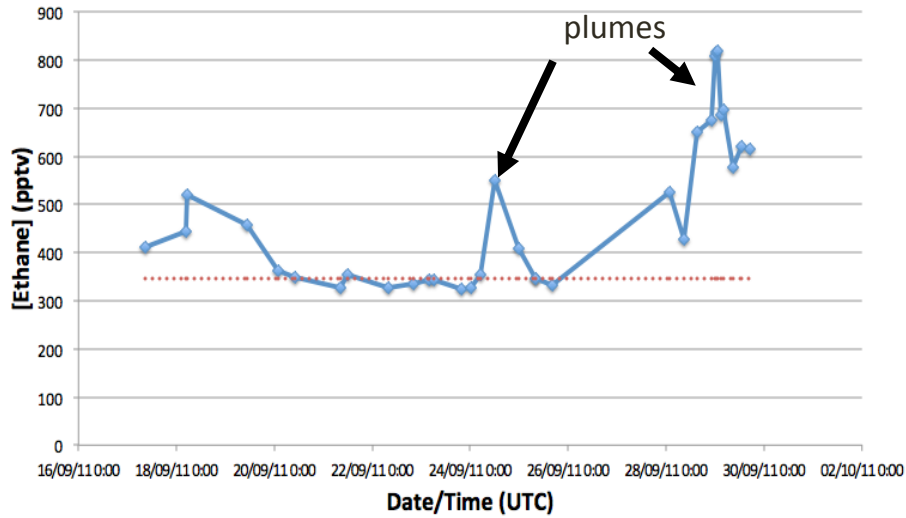
Figure from Reid et al., 2015

# Vasco Cruise 2011 Trace Gas Data

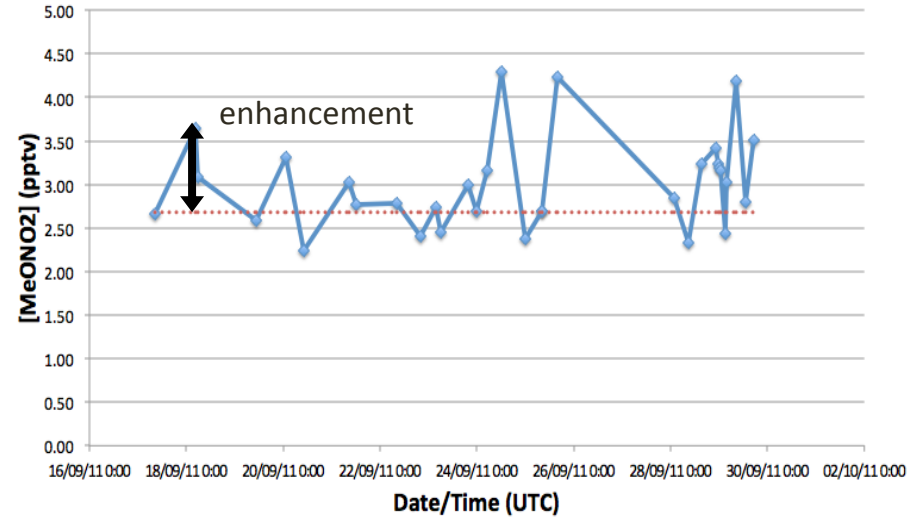


# Sample Time Series trends of Trace Gases

### Time Series for [Ethane]



### Time Series for [MeONO2]

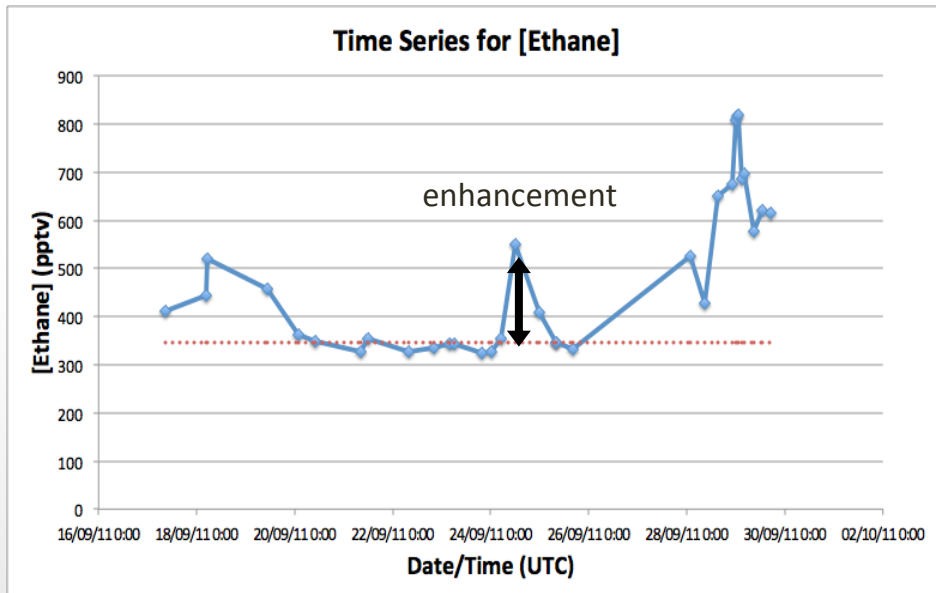


## Objectives

1. Determine trace gas emissions from biomass burning – usually expressed as emission ratios (ER) or emission factors
2. Identify sources and determine their contributions to observed elevated concentrations of trace gases (using a receptor modeling technique)

# Determination of Emission Ratios (ERs)

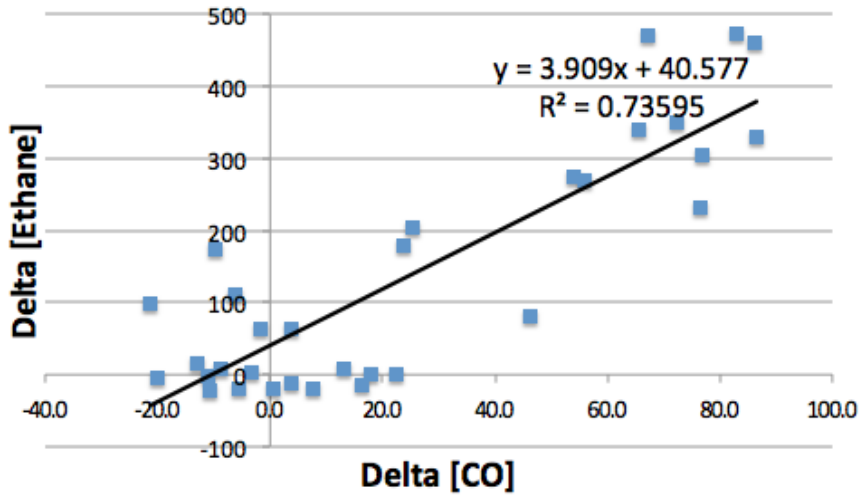
- Trace gas emissions can be expressed as emission ratios
- ER – excess mixing ratio of trace gas X above its baseline value divided by the enhancement above baseline of a simultaneously measured reference gas



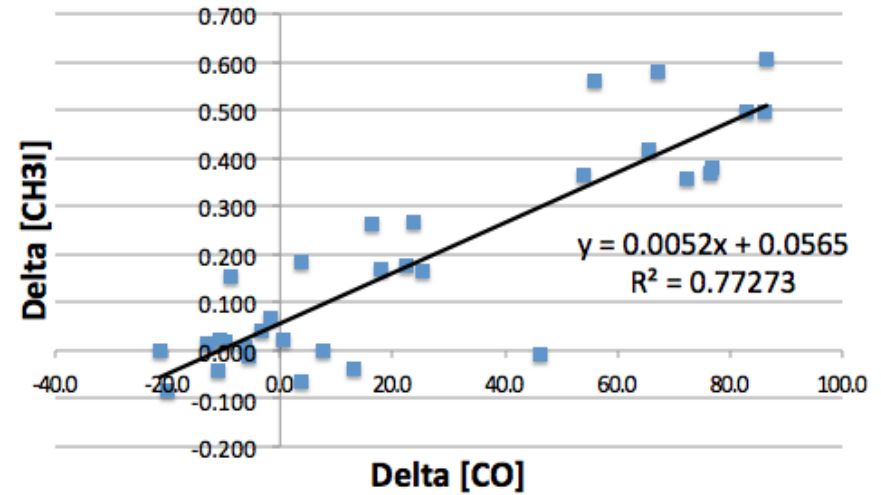
$$ER_{X/CO} = \frac{\Delta X}{\Delta CO} = \frac{X_{plume} - X_{bkgd}}{CO_{plume} - CO_{bkgd}}$$

# Observed Emission Ratios: Initial Results (ppt VOC per ppb CO)

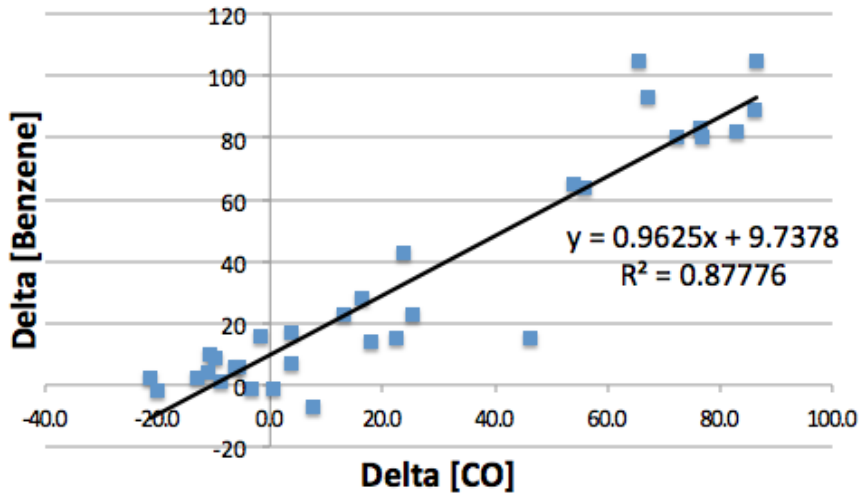
### Delta [Ethane]: Delta [CO]



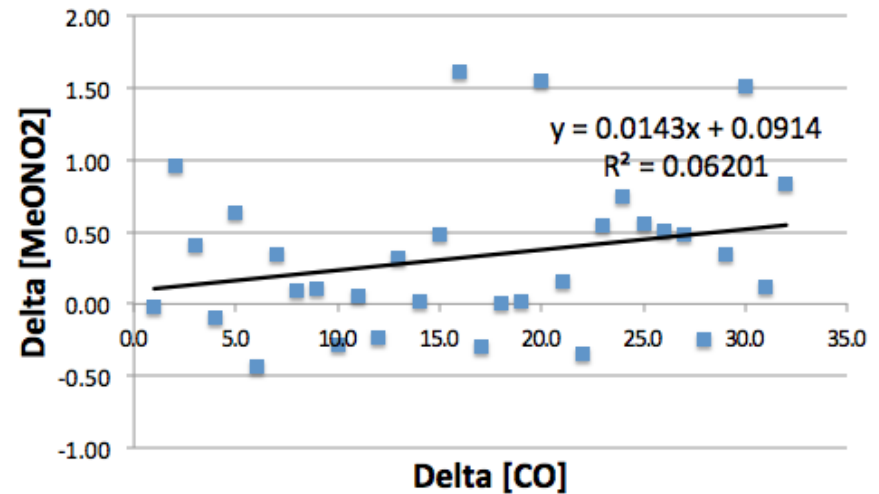
### Delta [CH3I]: Delta [CO]



### Delta [Benzene]: Delta [CO]



### Delta [MeONO2]: Delta [CO]



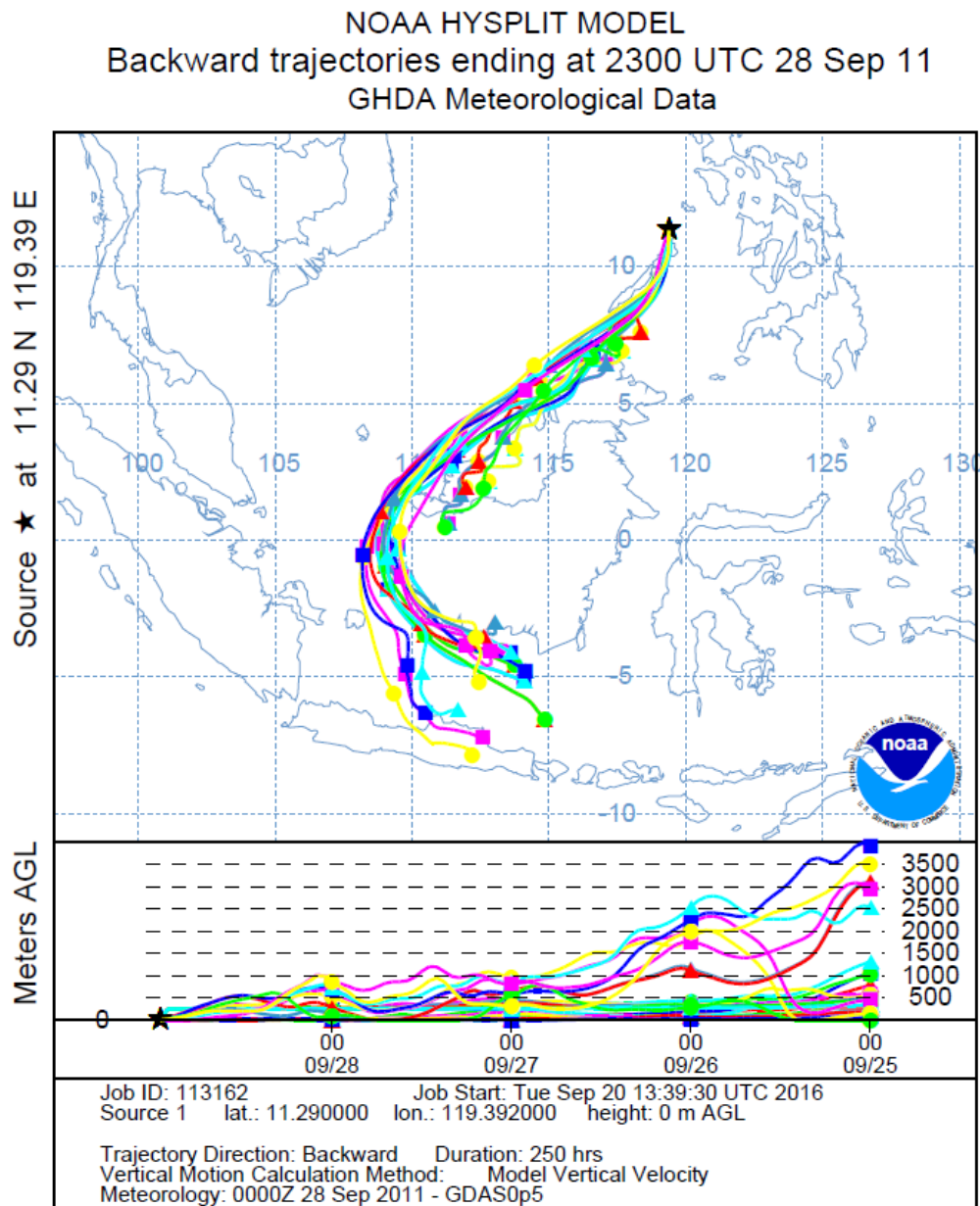
## Examples of Observed ERs

	observed ratio (pptv VOC/ppbv CO)	R <sup>2</sup>
<b>ethane</b>	3.91	0.736
<b>ethyne</b>	3.75	0.905
<b>benzene</b>	0.96	0.878

- Of the 60+ species, only eleven showed significant R<sup>2</sup> values.
- Looking at those that did not show good correlation with the Delta VOC: Delta CO trendline:
  - anthropogenic sources — ex: CFCs (IPCC)
  - short lifetimes — ex: Propene, lifetime of 0.8 days (IPCC)

# Determination of Transport time to approximate plume age

## Example: Within Plume





## Age-corrected ERs

- by the time the air parcel reaches the measurement points, some of the species have been significantly removed by reaction with OH
- We need to correct for age (using transport time of  $\sim 2$  days determined from back trajectories)

## Examples of Age-corrected ERs

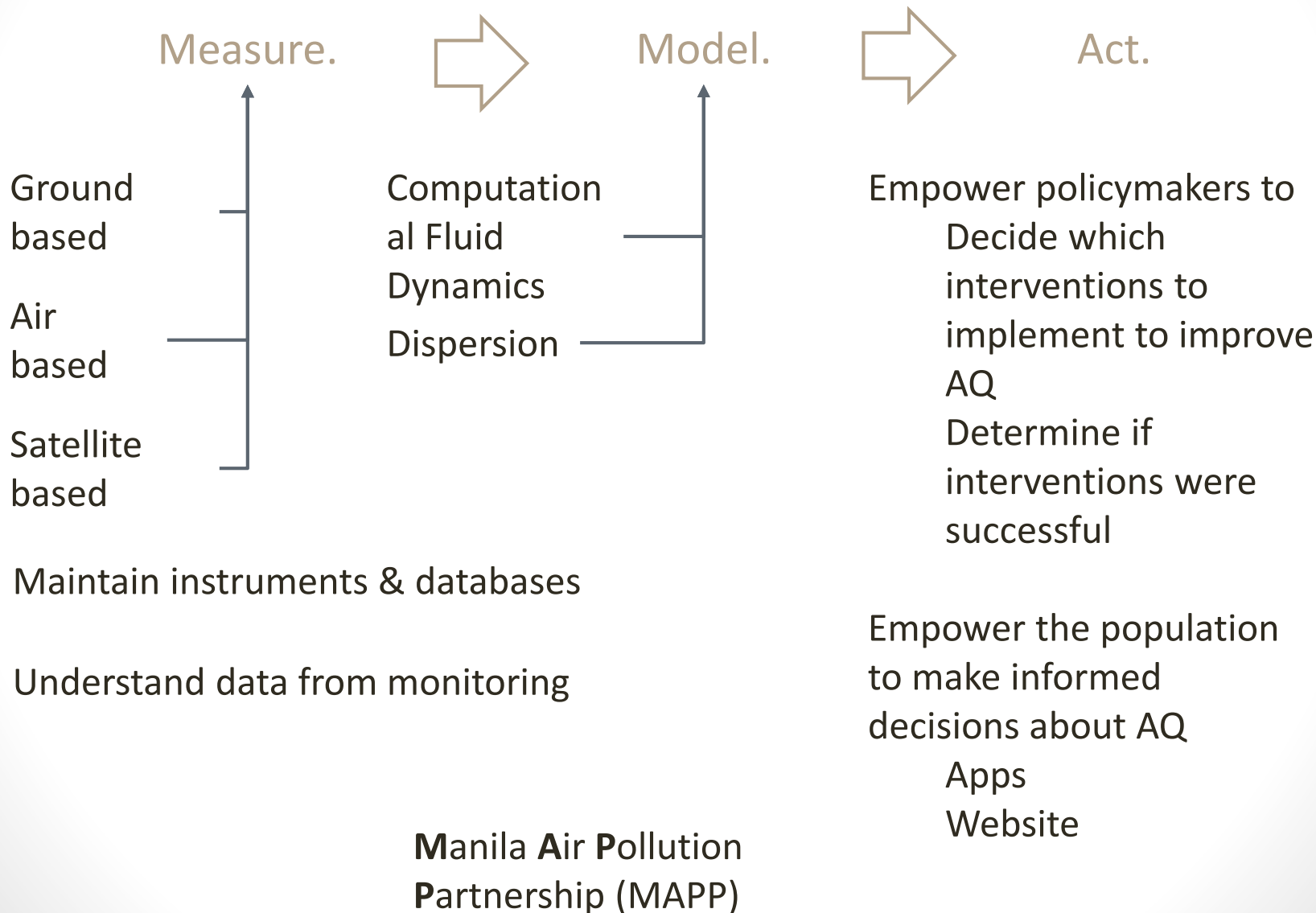
	ER <sub>t</sub> (pptv/ppbv)	k (mol <sup>-1</sup> s <sup>-1</sup> )	lifetime <sup>a</sup>	ER <sub>0</sub> (t=1 d)	ER <sub>0</sub> (t=2 d)	ER <sub>0</sub> (t=3 d)
<b>Ethane</b>	3.91	2.50E-13	78 d	4.22	4.56	4.93
<b>Ethyne</b>	3.75	9E-13	23 d	6.71	12.02	21.52
<b>Benzene</b>	0.96	1.20E-12	17 d	2.17	4.91	11.09

a: Sources: [ftp://ftp.soest.hawaii.edu/engels/Stanley/Textbook\\_update/Science\\_297/Fischer-02.pdf](ftp://ftp.soest.hawaii.edu/engels/Stanley/Textbook_update/Science_297/Fischer-02.pdf),  
[https://www.wmo.int/pages/prog/arep/gaw/ozone\\_2010/documents/Ozone-Assessment-2010-complete.pdf](https://www.wmo.int/pages/prog/arep/gaw/ozone_2010/documents/Ozone-Assessment-2010-complete.pdf)

## Next steps . . .

- Verify the estimated photochemical age using emission ratios from pairs of trace gases
- Perform source apportionment to identify sources and their contributions to observed enhancements in trace gas concentrations
- Determine sensitivity to the assumed concentration of OH (uncertainty analysis): typical tropical values of OH

# Manila Air Pollution Partnership (MAPP) Project Objectives



# In summary...

- There is a need to improve the performance of precipitation satellite products for the region
- There is a need to better understand the sources of aerosols and co-emitted trace gases in order to nail down more precisely aerosol-meteorology interactions
- Ground-based measurements in the Philippines need to be ramped up in the months leading to CAMP2Ex 2018