

# Comparison of Surface Fluxes Derived from CYGNSS and Simulated by WRF Model : An MJO Case Study

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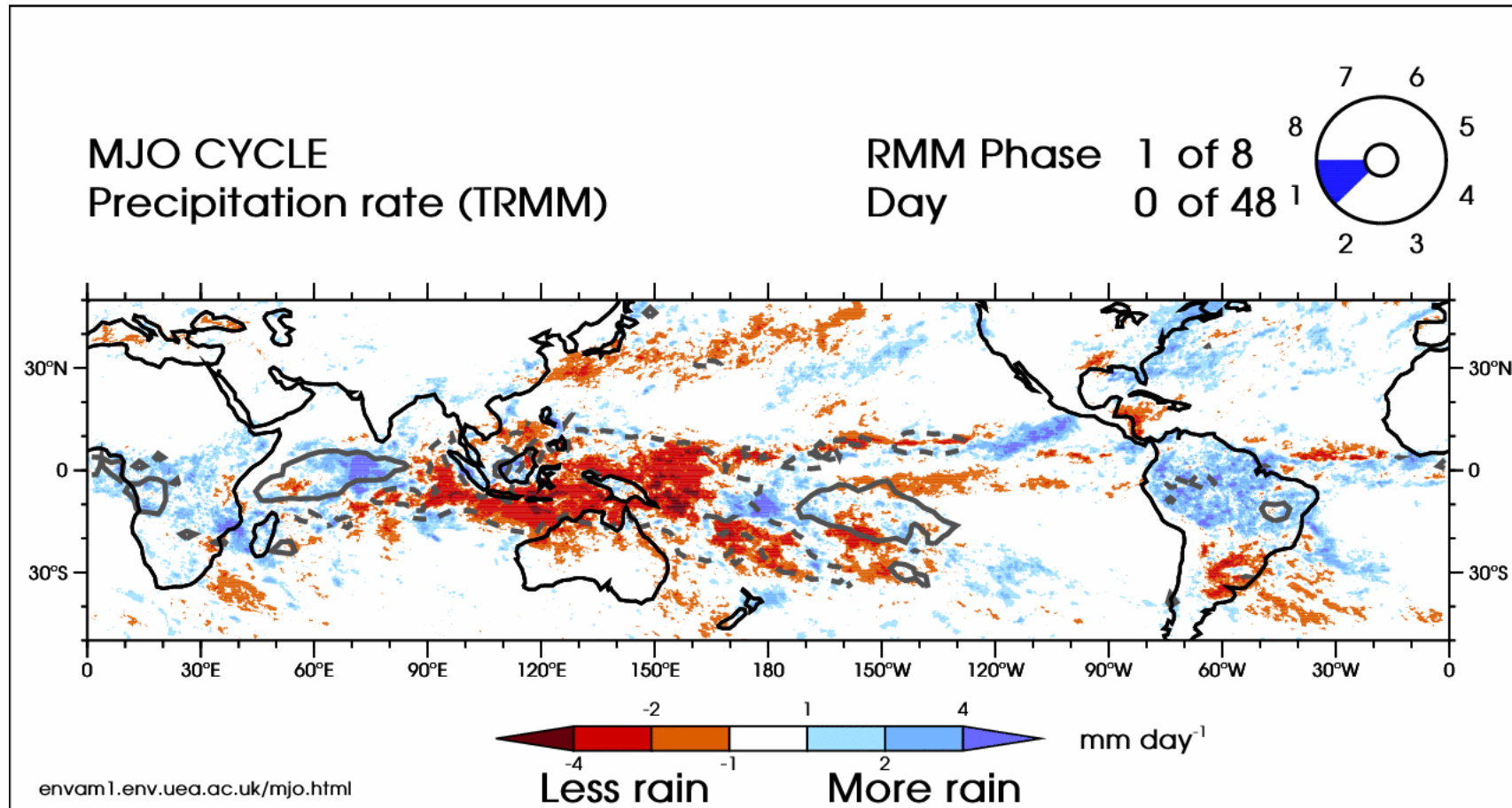
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Takamichi Iguchi (U Maryland, College Park and NASA/GSFC)

Wei-Kuo Tao (NASA/GSFC)

AMS Annual Meeting 2020, Boston MA

# Precipitation Structure of a Madden Julian Oscillation (MJO)

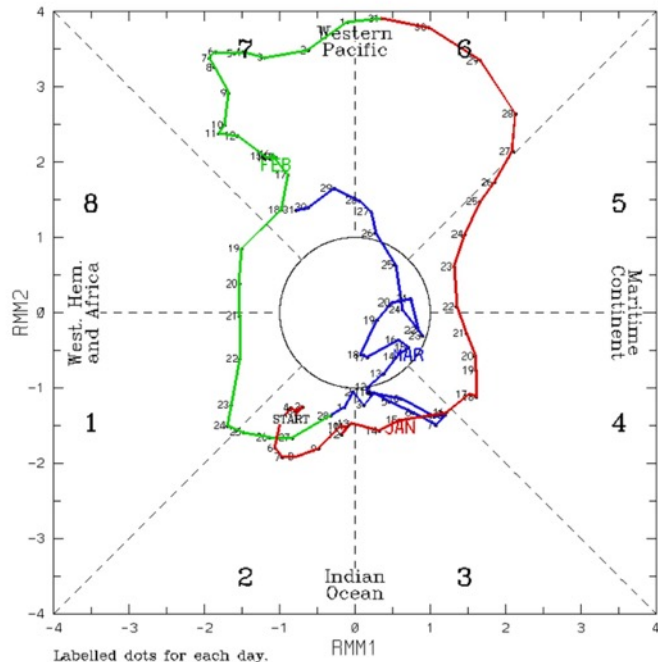


Animation Credit: Professor Adrian Matthews, University of East Anglia, Norwich, UK

# 2017-2018 MJO events with CYGNSS data

## MJO Multivariate Index

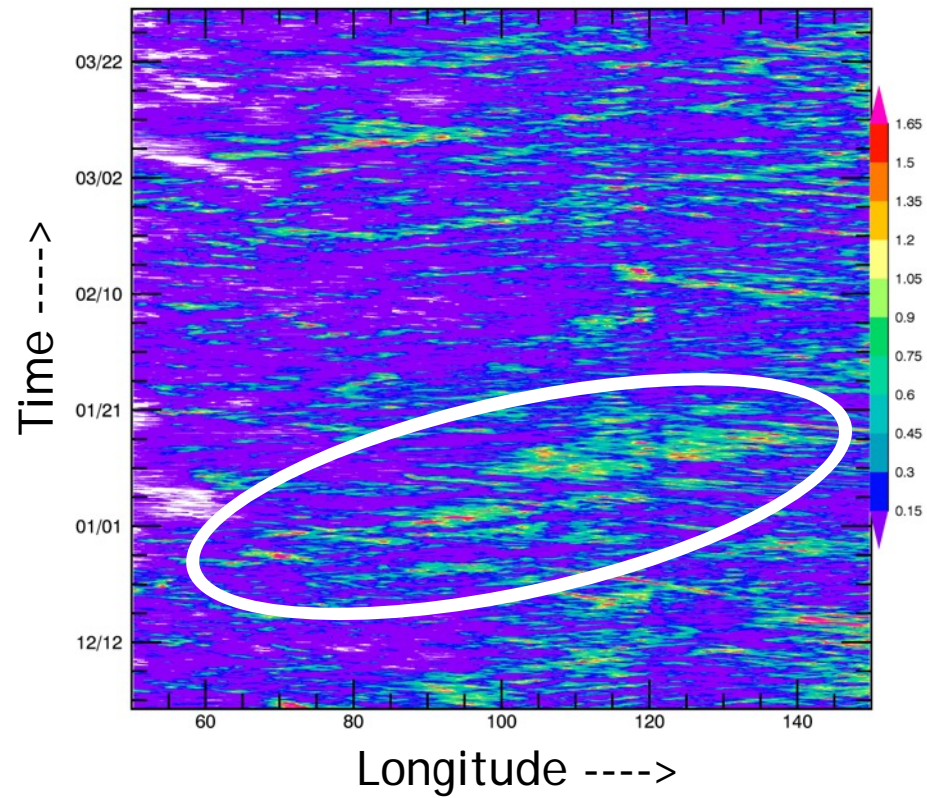
(RMM1, RMM2) phase space for 1-Jan-2018 to 31-Mar-2018



Labelled dots for each day.  
Blue line is for Mar, green line is for Feb, red line is for Jan.  
(C) Copyright Commonwealth of Australia 2019. Bureau of Meteorology  
2019

## Surface Rainfall Hovmoller Diagram

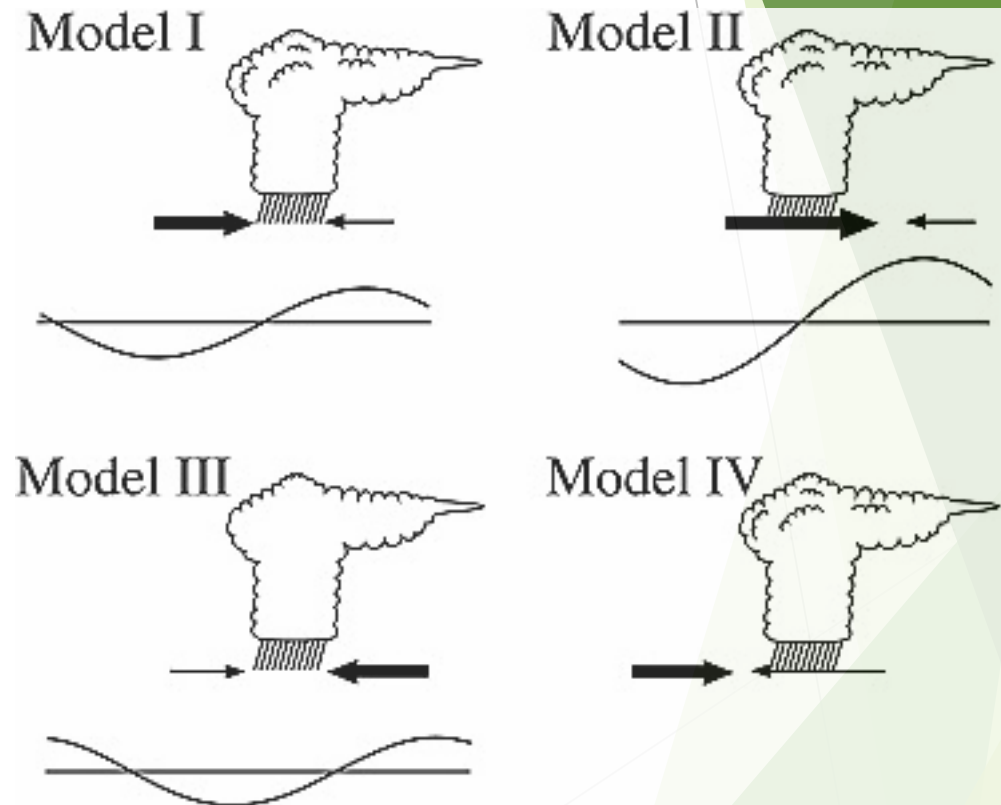
Rainfall Hovmoller, IMERG v5b, -10~10N, 2017~18



# MJO initiation and propagation mechanisms remain a major challenge

## CYGNSS data advantages:

- Can “see” underneath rain;
- High resolution of 25 km can resolve convective systems associated MJO mature phases;

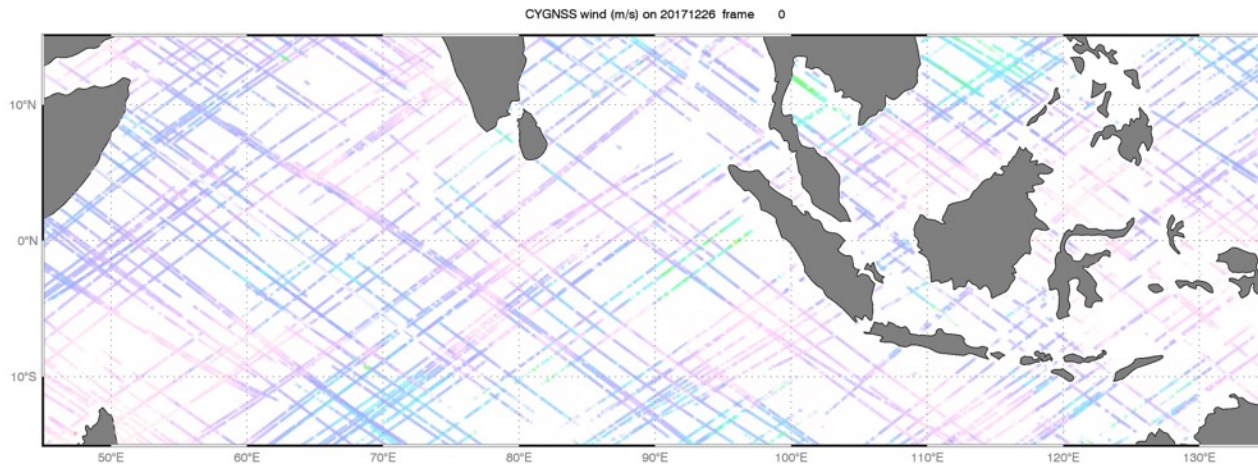
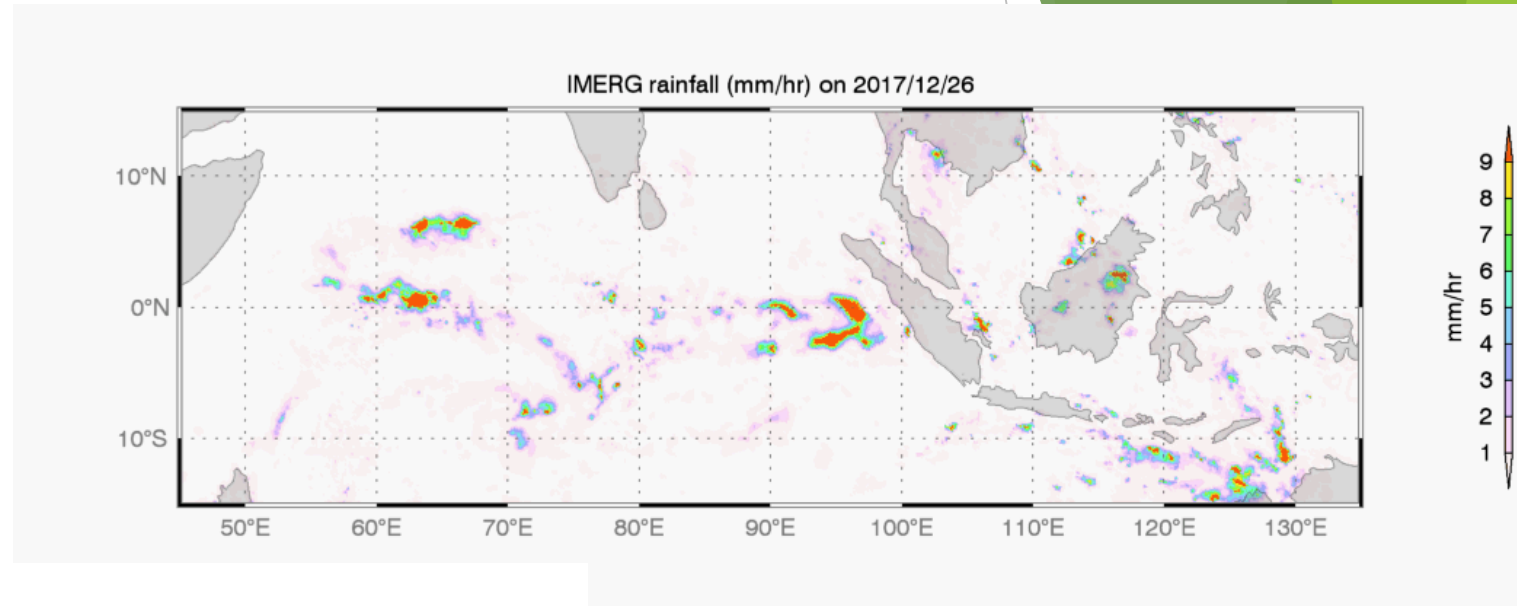


Schematic diagrams of four MJO models describing the phase relationship between its convective centers and surface zonal wind. From Zhang and Anderson, JAS, 2003.



# Data Sources (2017 December MJO Case Study)

**IMERG** surface rainfall  
0.1° x 0.1° half-hourly



**CYGNSS** wind retrieval  
0.25° one day orbit

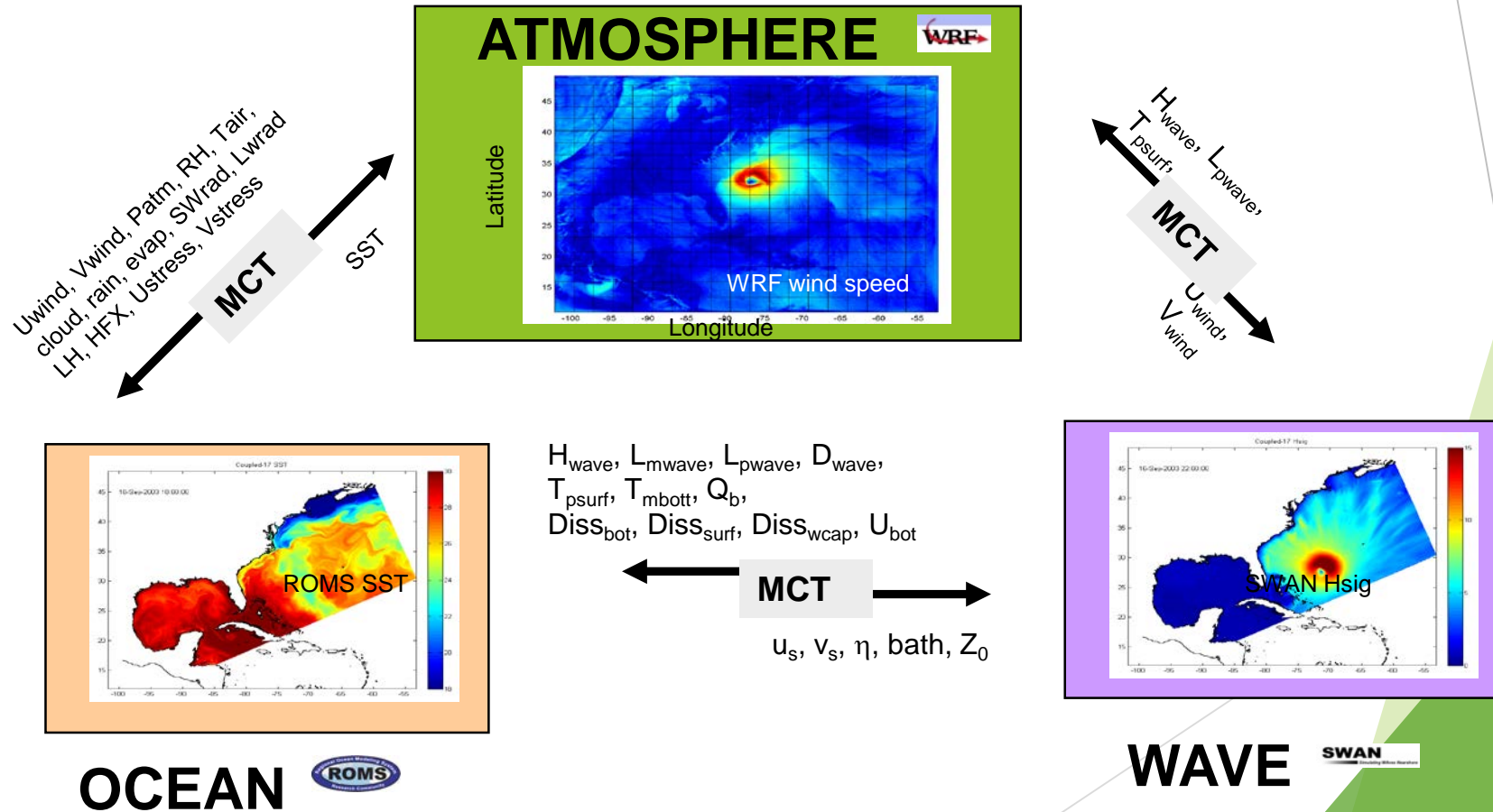
# Model Descriptions

**COAWST:** Coupled Ocean-Atmosphere-Wave-Sediment Transport Model

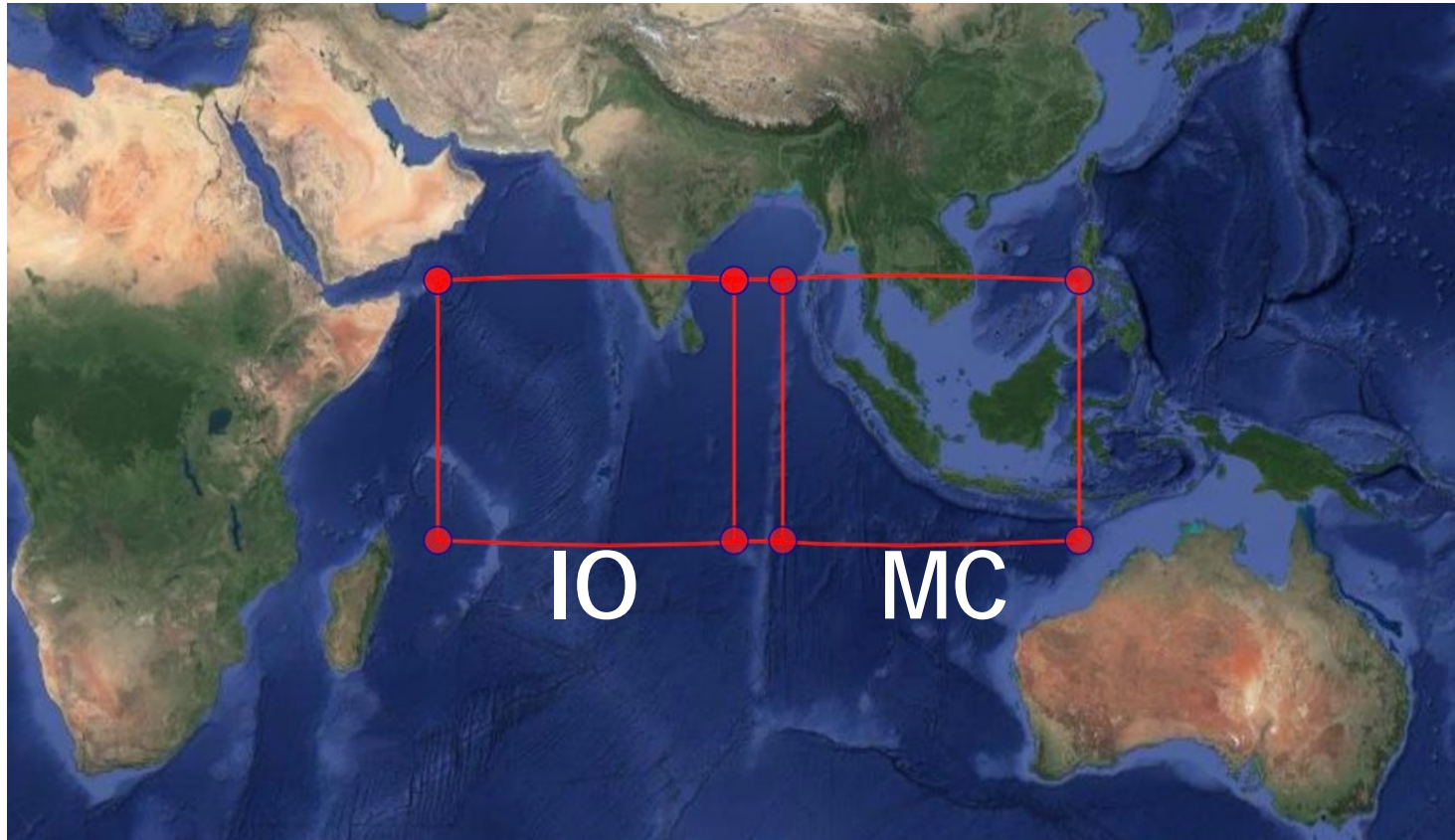
**WRF:** Weather Research and Forecasting Model

**ROMS:** Regional Ocean Modeling System

**SWAN:** Simulating WAve Nearshore model or Wavewatch III model

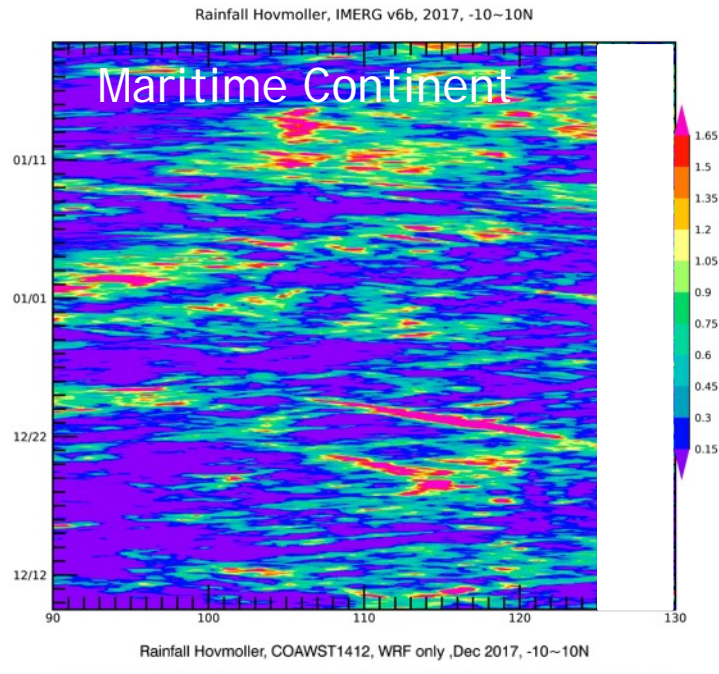
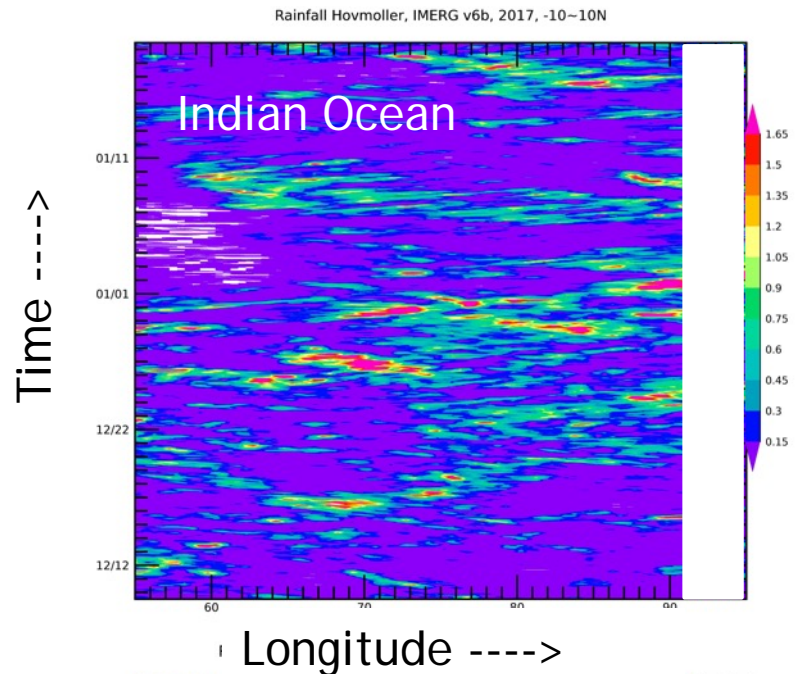


# Case Study Design



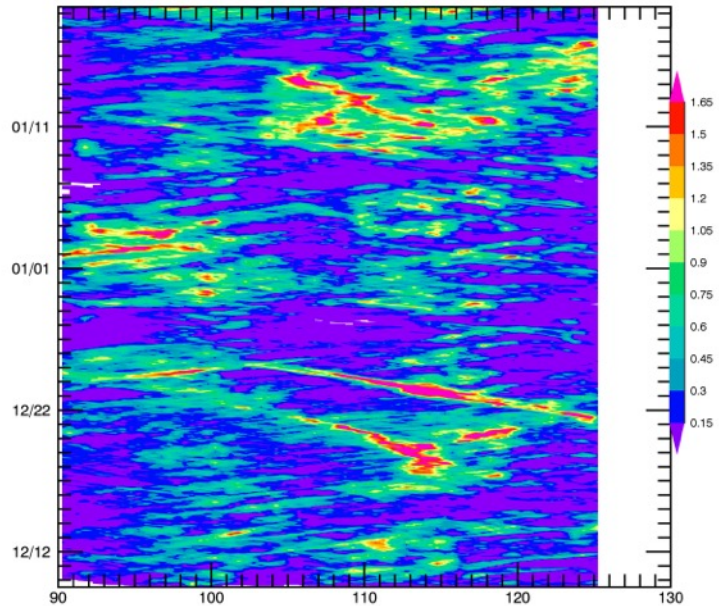
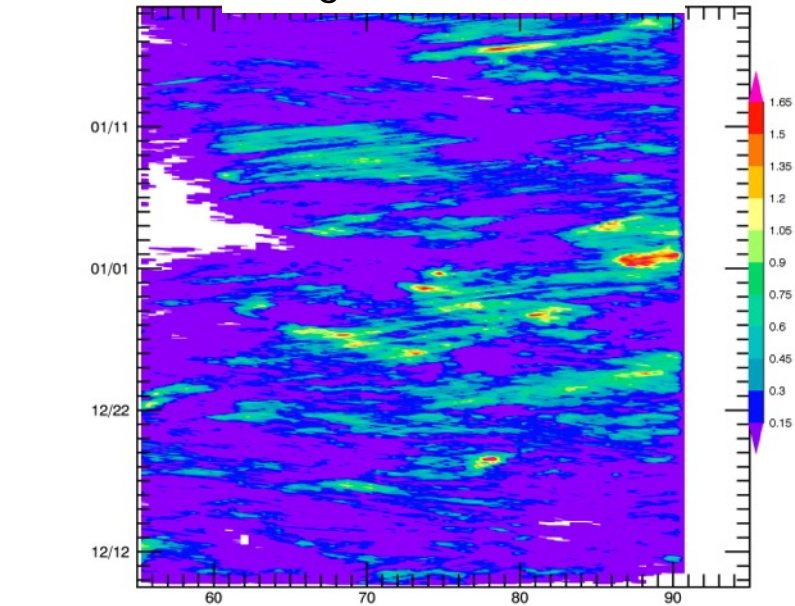
Two Single Domain Simulations, 4 km resolution, 51 vertical layers. WRF model uses ERA-interim, ROMS uses HYCOM analysis as initial and boundary condition. 40-day simulations starting Dec. 10, 2017.





IMERG/Model  
Precipitation  
Comparisons

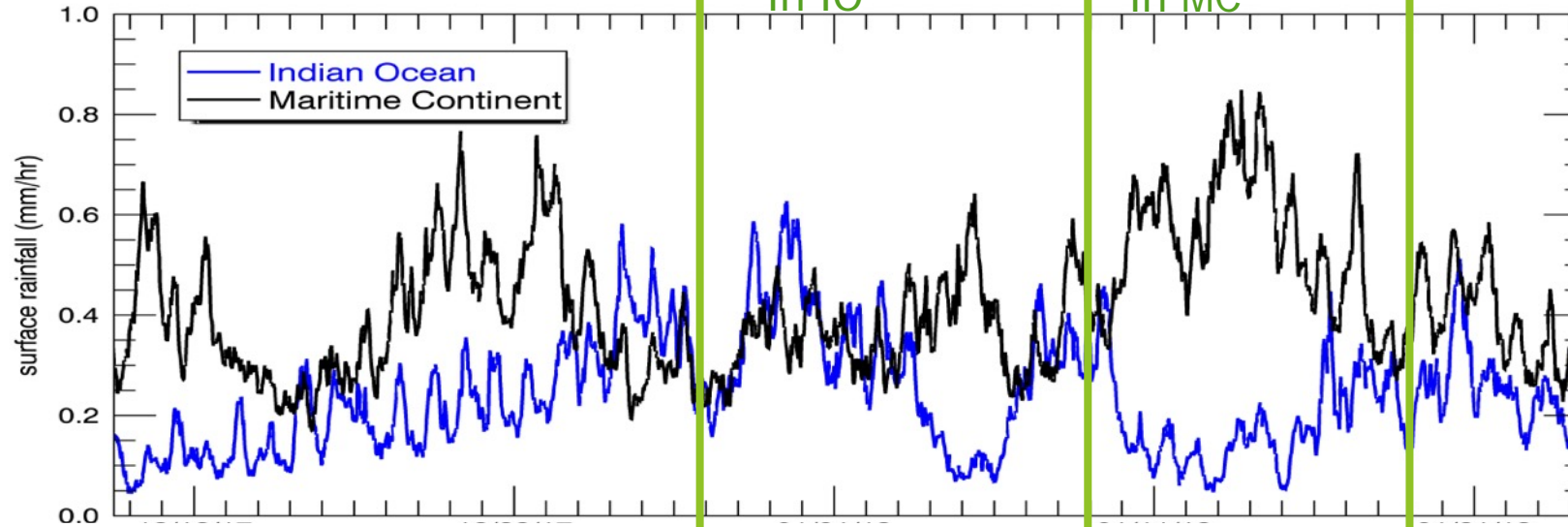
IMERG Retrieved  
Surface Rainfall



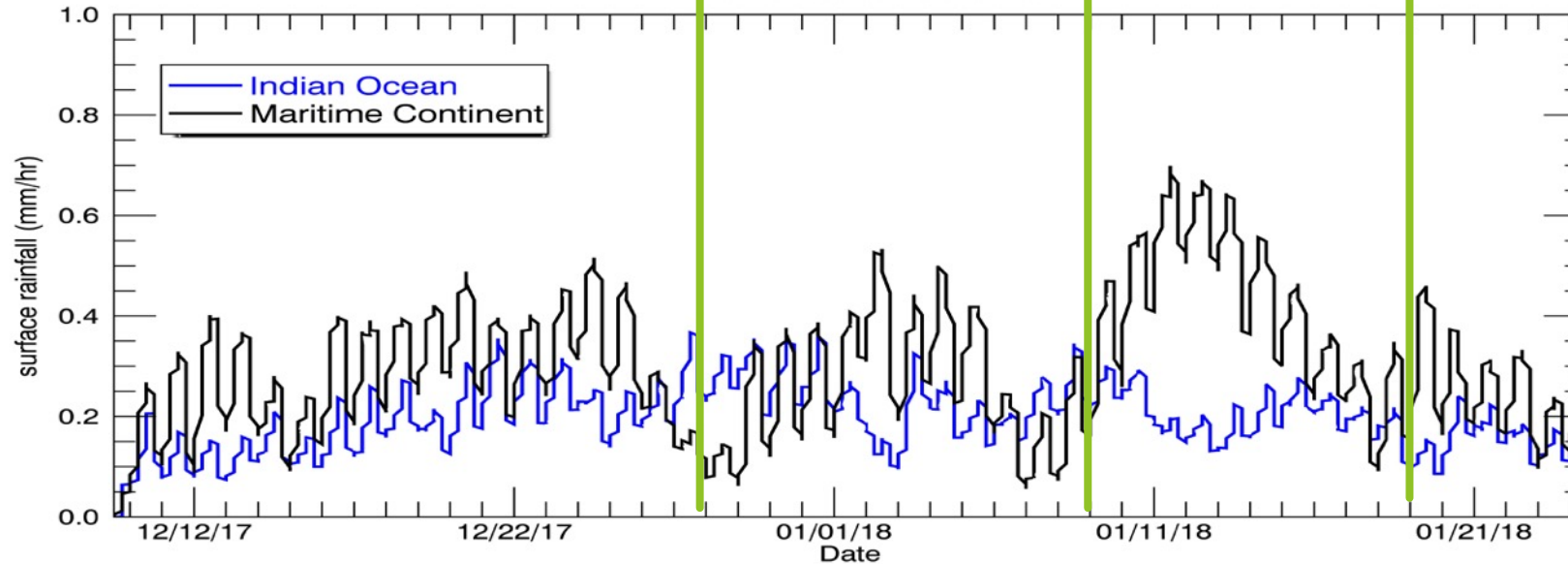
WRF Model Simulated  
Surface Rainfall



# Domain Mean Surface Rainfall Comparisons In Indian Ocean and Maritime Continent



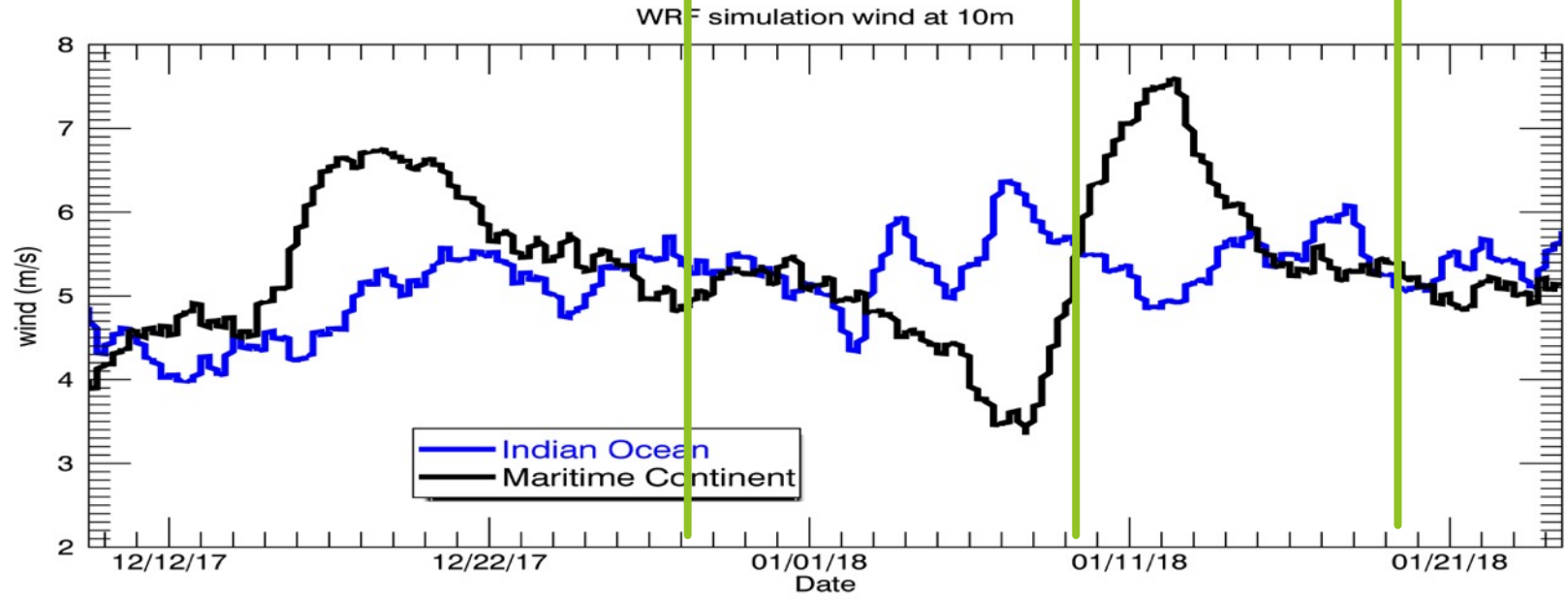
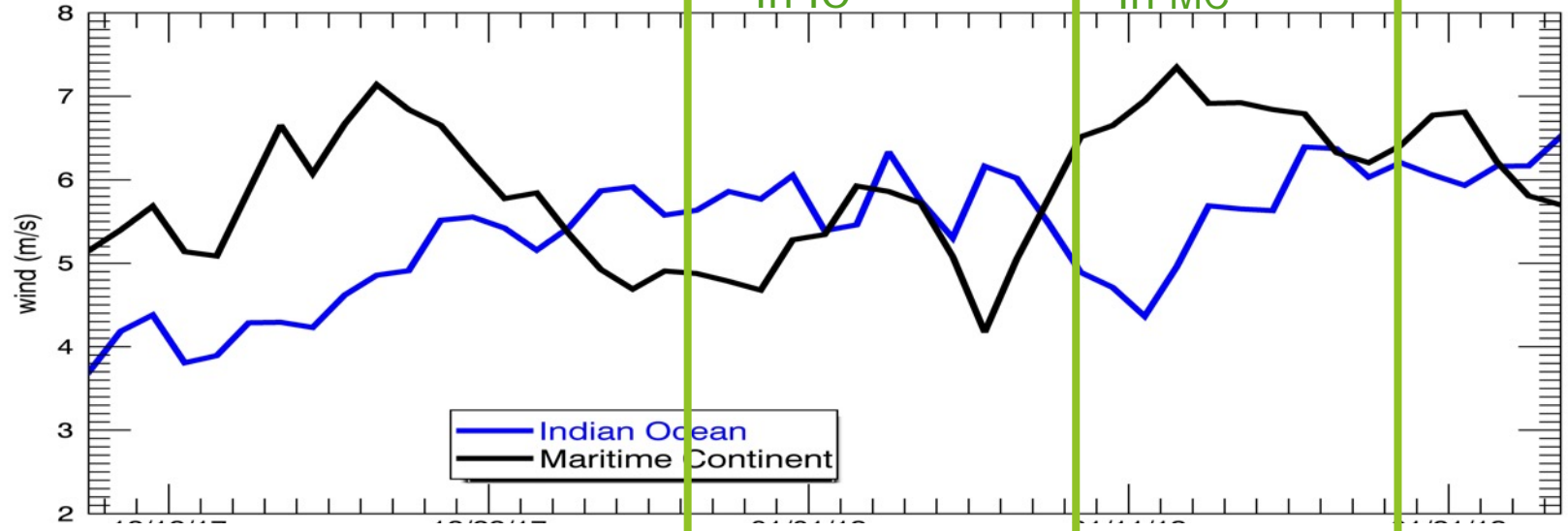
WRF simulated surface rainfall



IMERG

WRF

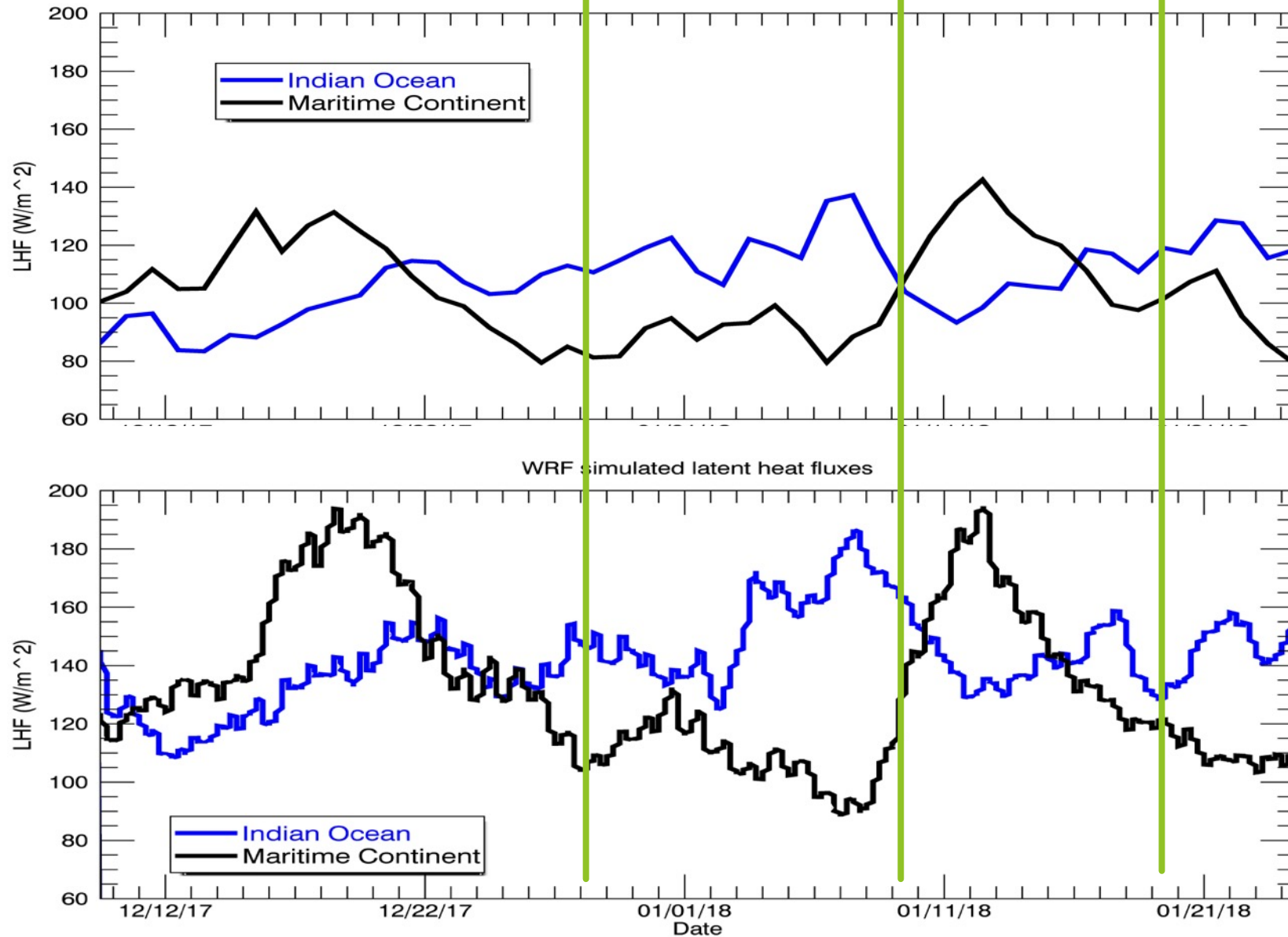
# Mean Surface Wind Speed Comparisons In Indian Ocean and Maritime Continent



CYGNSS

WRF

# Mean Latent Heat Fluxes Comparisons In Indian Ocean and Maritime Continent

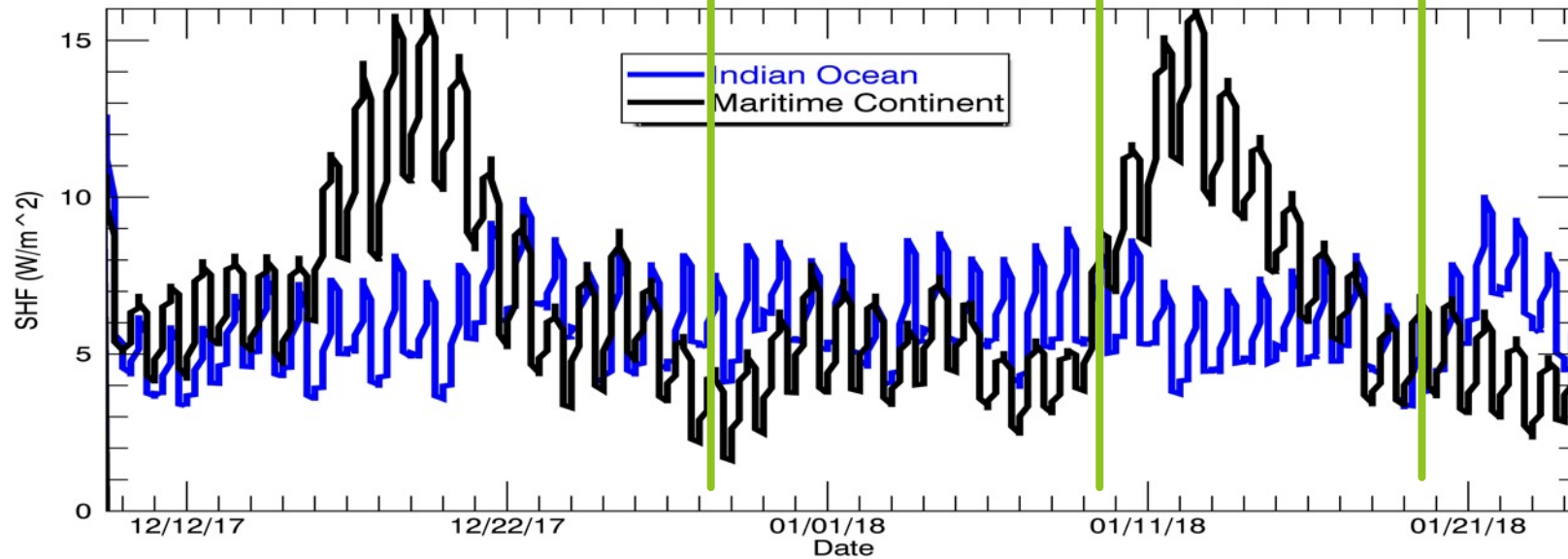
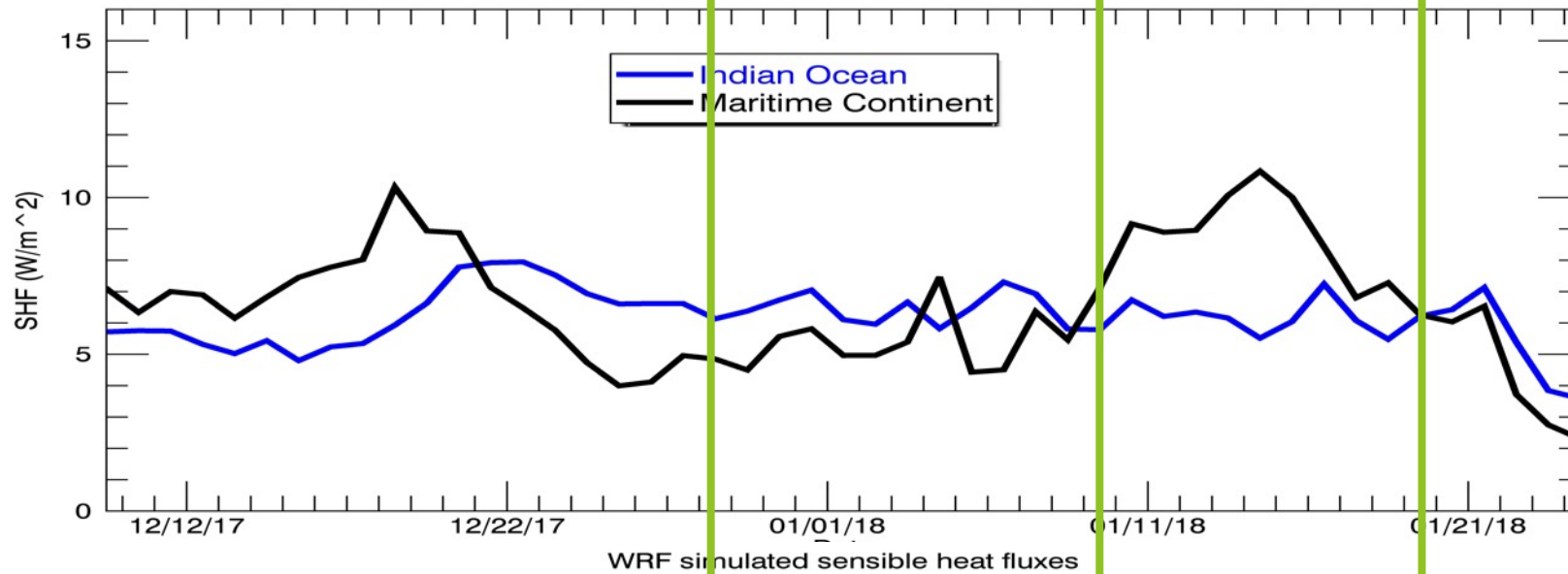


CYGNSS

WRF



# Mean Sensible Heat Fluxes Comparisons In Indian Ocean and Maritime Continent

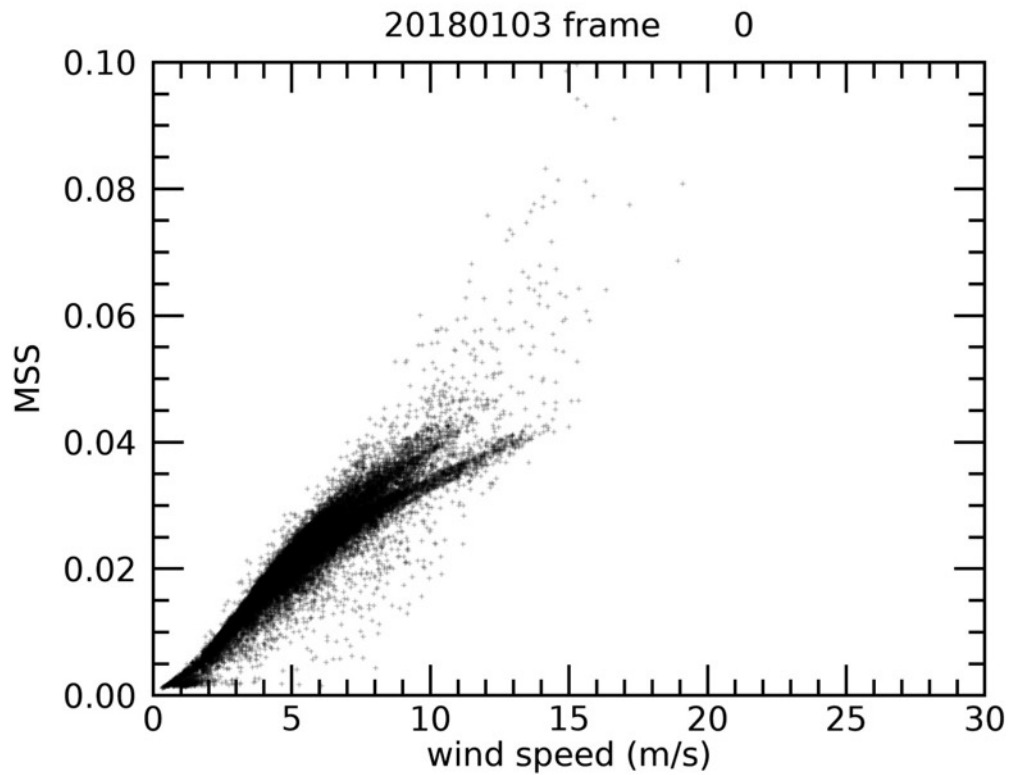


CYGNSS

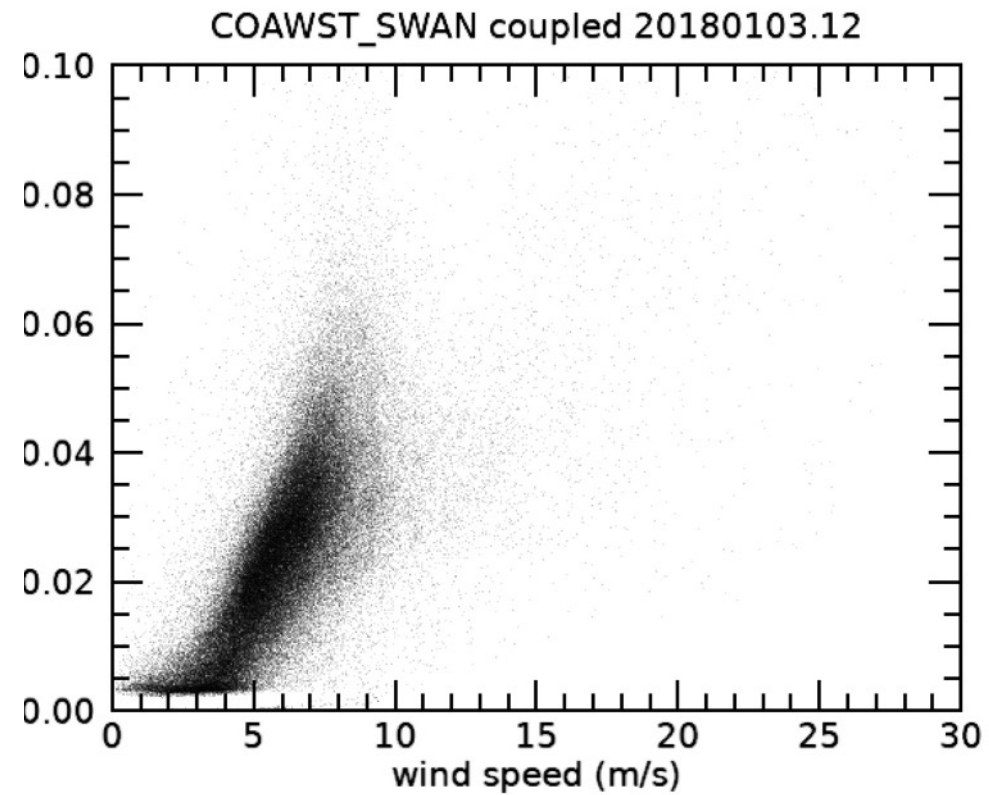
WRF

# Mean Square Slope (MSS) comparison between CYGNSS retrieval and SWAN wave model simulation

CYGNSS



SWAN



# Conclusions

## ► The Good:

CYGNSS observed temporal and spatial variations in surface wind and fluxes are consistent with MJO general structures, and compare reasonably well with COAWST model simulations.

## ► The Bad:

Mean values of CYGNSS retrieved surface fluxes are lower than WRF simulations. This is troublesome because the IMERG observed mean surface rainfall is higher than model simulation;

The MSS vs. wind have different trends for CYGNSS observation and SWAN wave model simulation, especially at higher wind velocities.

## ► The Ugly:

WRF model needs to be nudged (T and Q) to get good MJO precipitation signals.

We could not make sense of WaveWatch III model coupled in the system work yet.