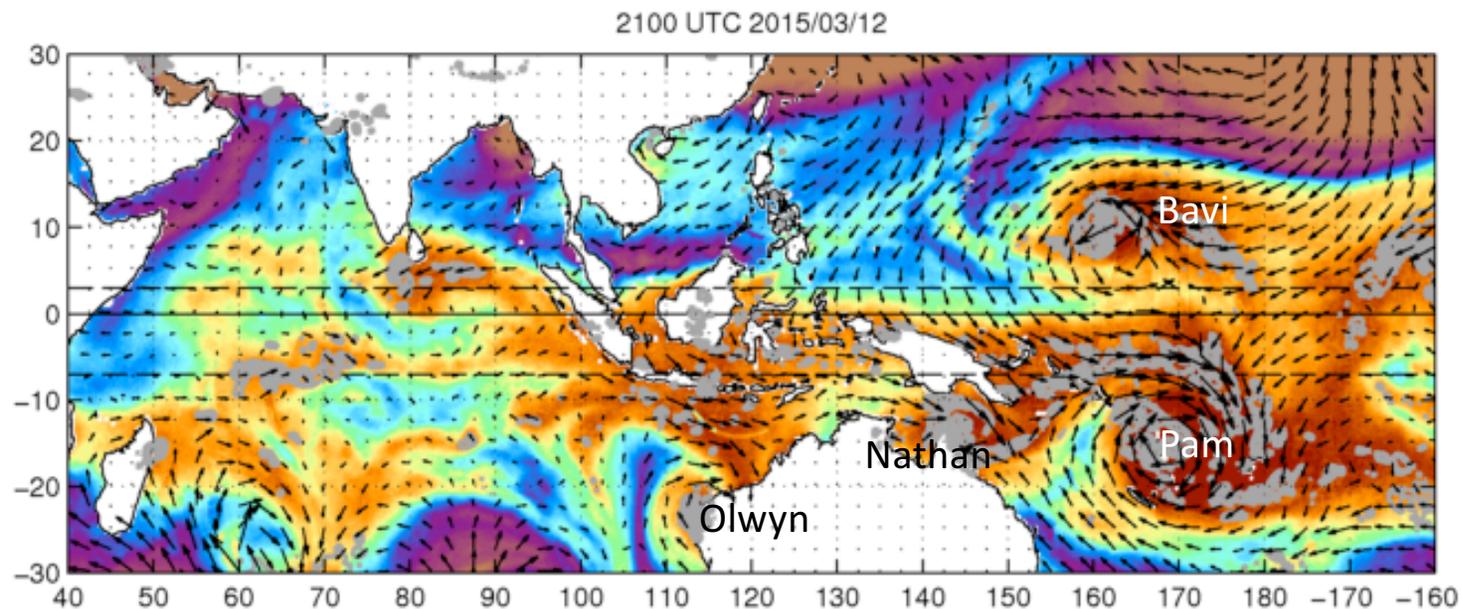


Large-Scale Precipitation Tracking using TRMM-GPM data for MJO Convective Initiation and Propagation

Shuyi S. Chen and Brandon Kerns
RSMAS/University of Miami



(PMM Science Team Meeting, Houston, 24-27 Oct 2016)



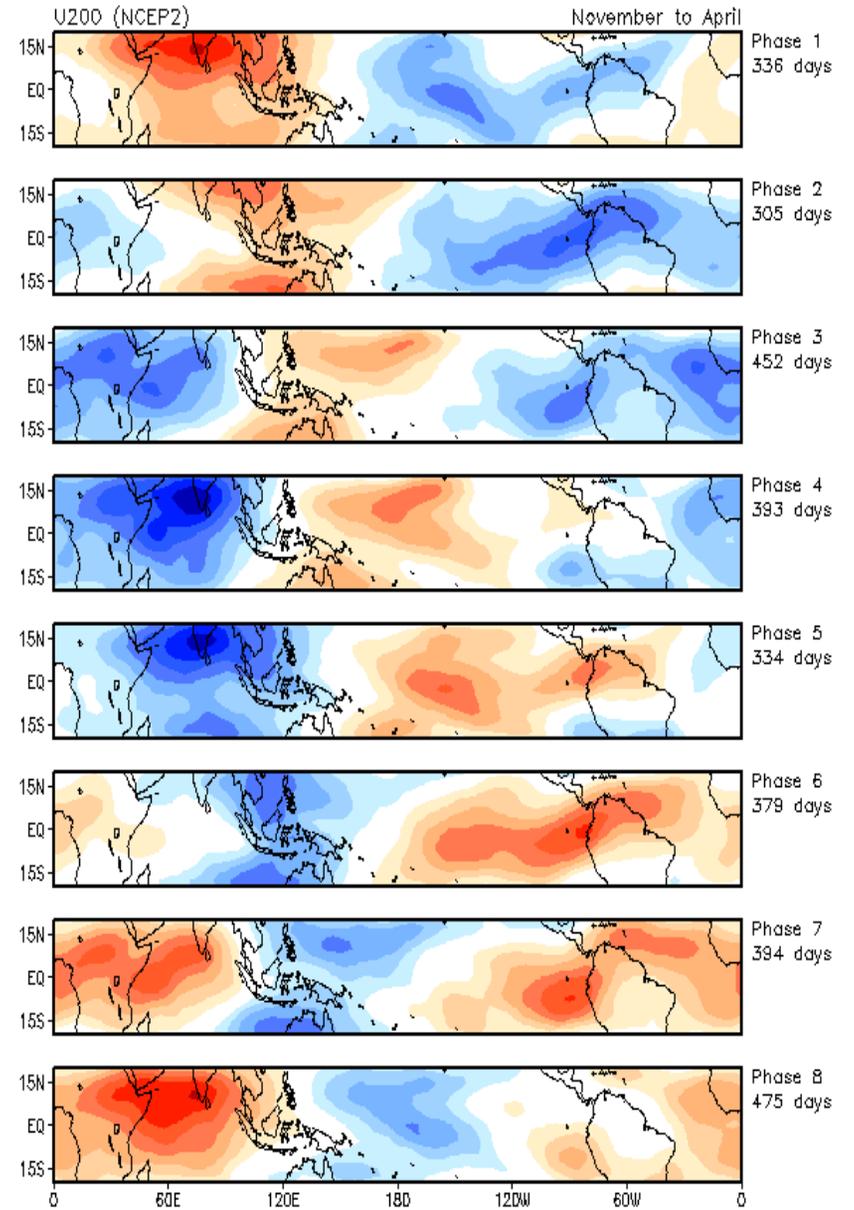
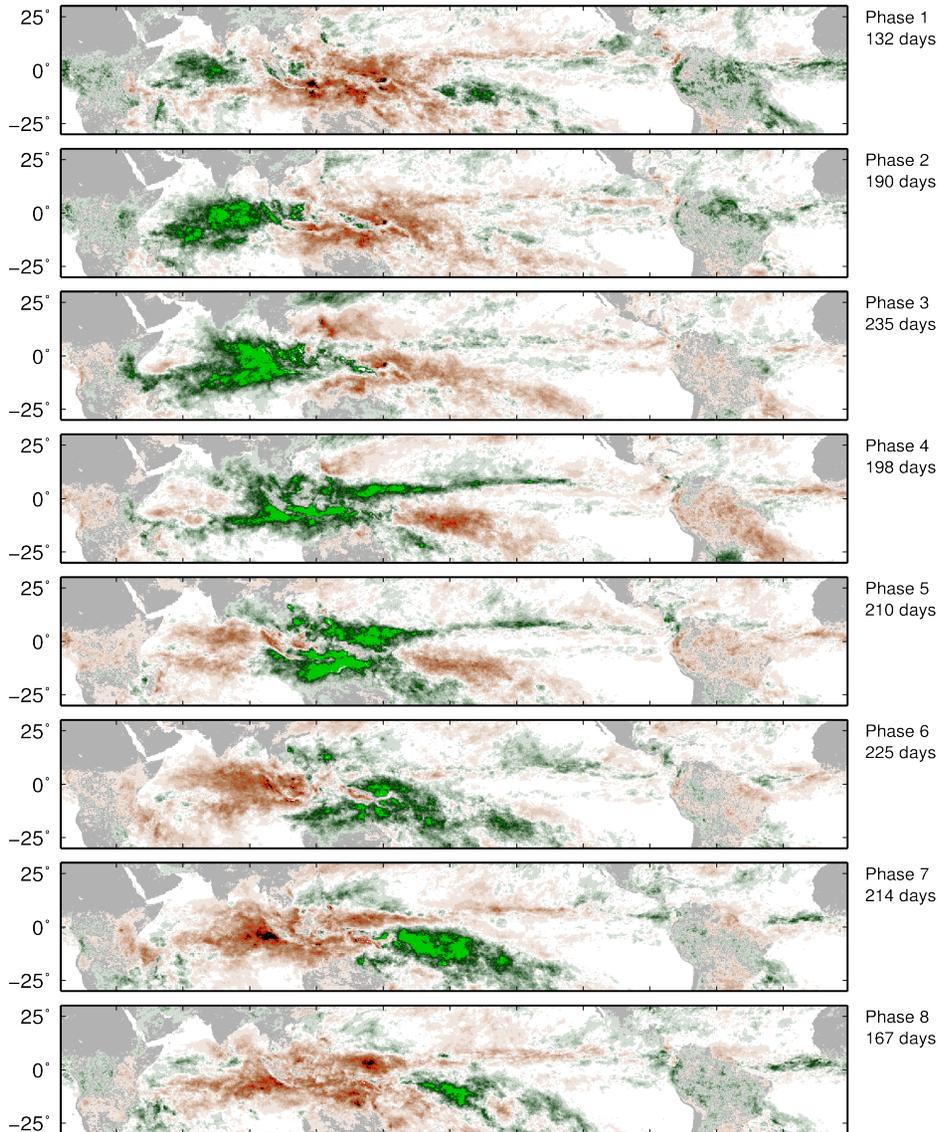
Hurricanes and Coupled Atmosphere-Ocean Systems



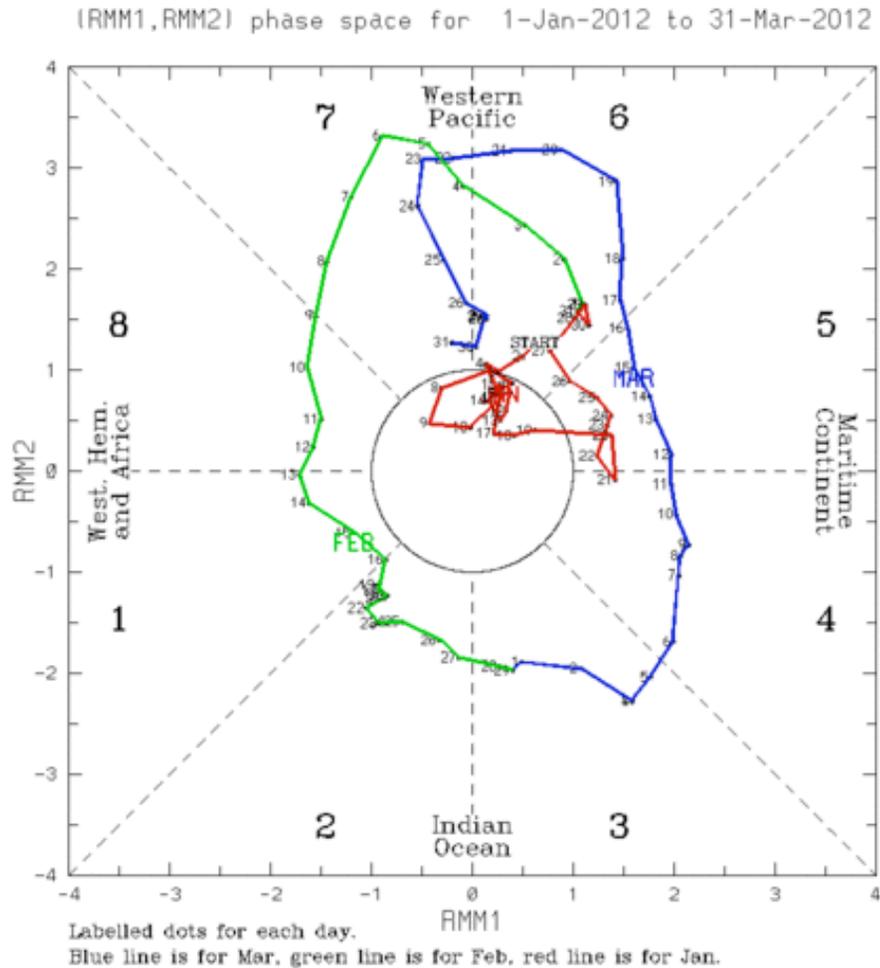
What is the MJO?

MJO Life cycle composite

Intraseasonally Filtered TRMM 3B42 Rainfall (1998–2013 Nov–Apr)



Realtime Multivariate MJO (RMM) Index (Wheeler and Hendon, 2004)



Limitations:

- No spatial information
- Not a direct representation of MJO convection & precipitation
- Cannot compute in regional models

Objectives:

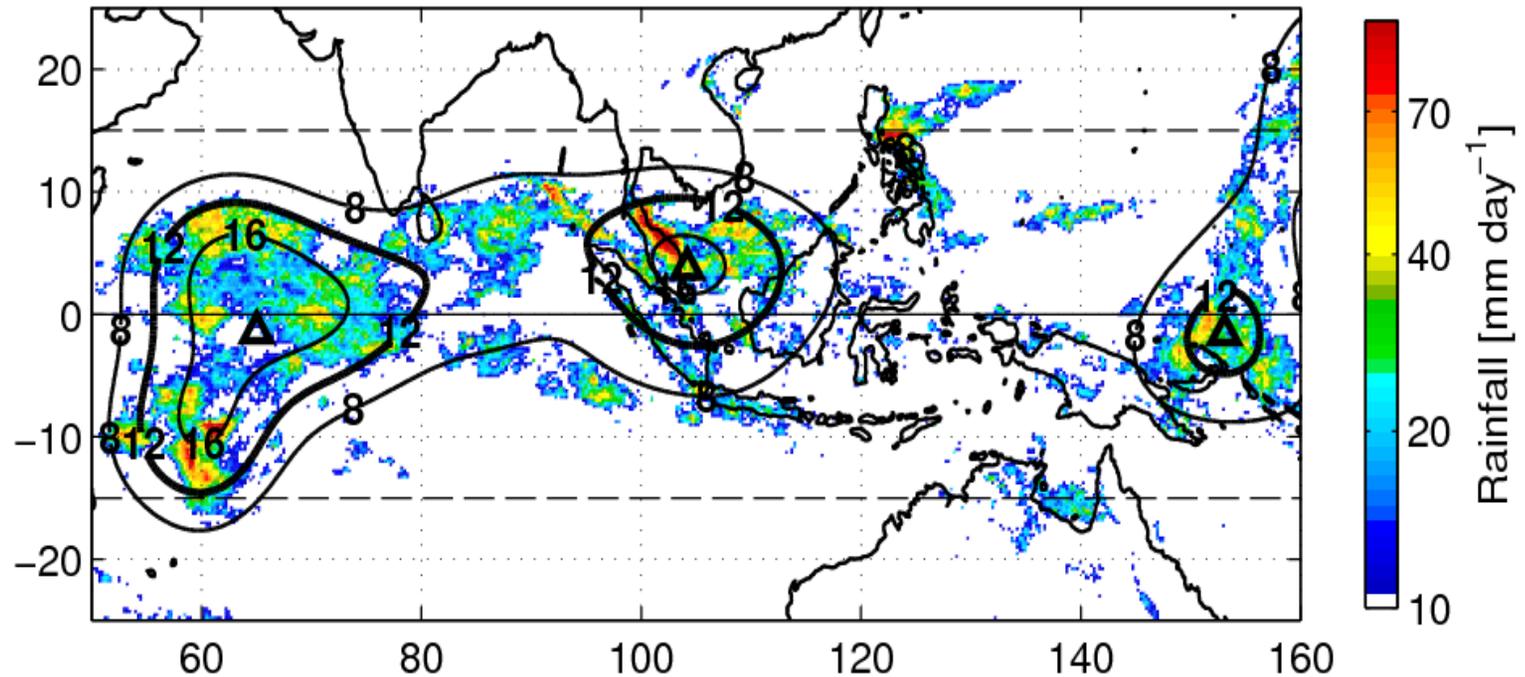
- **To provide a robust and direct measure of MJO convection based on precipitation data**
- **To provide a verification tool for MJO prediction in both global and regional models, and be able to assess predictability and model uncertainty using ensemble forecast**

Large-scale Precipitation Tracking (LPT):

- 3-day accumulated rainfall using 3-hourly TMPA 3B42 data
- Spatial filter ($5^\circ \times 5^\circ$)
- Tracking area of $> 12 \text{ mm day}^{-1}$ ($> 300,000 \text{ km}^2$) in time

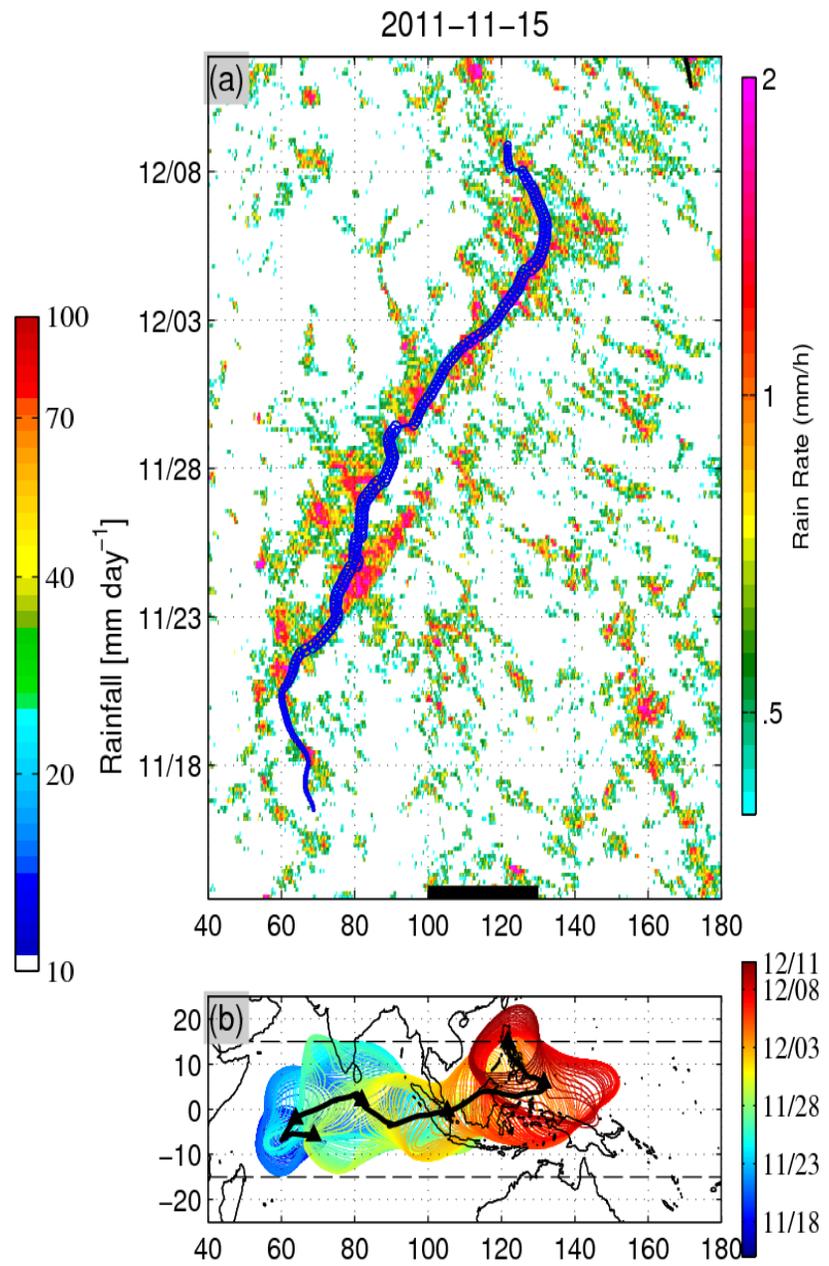
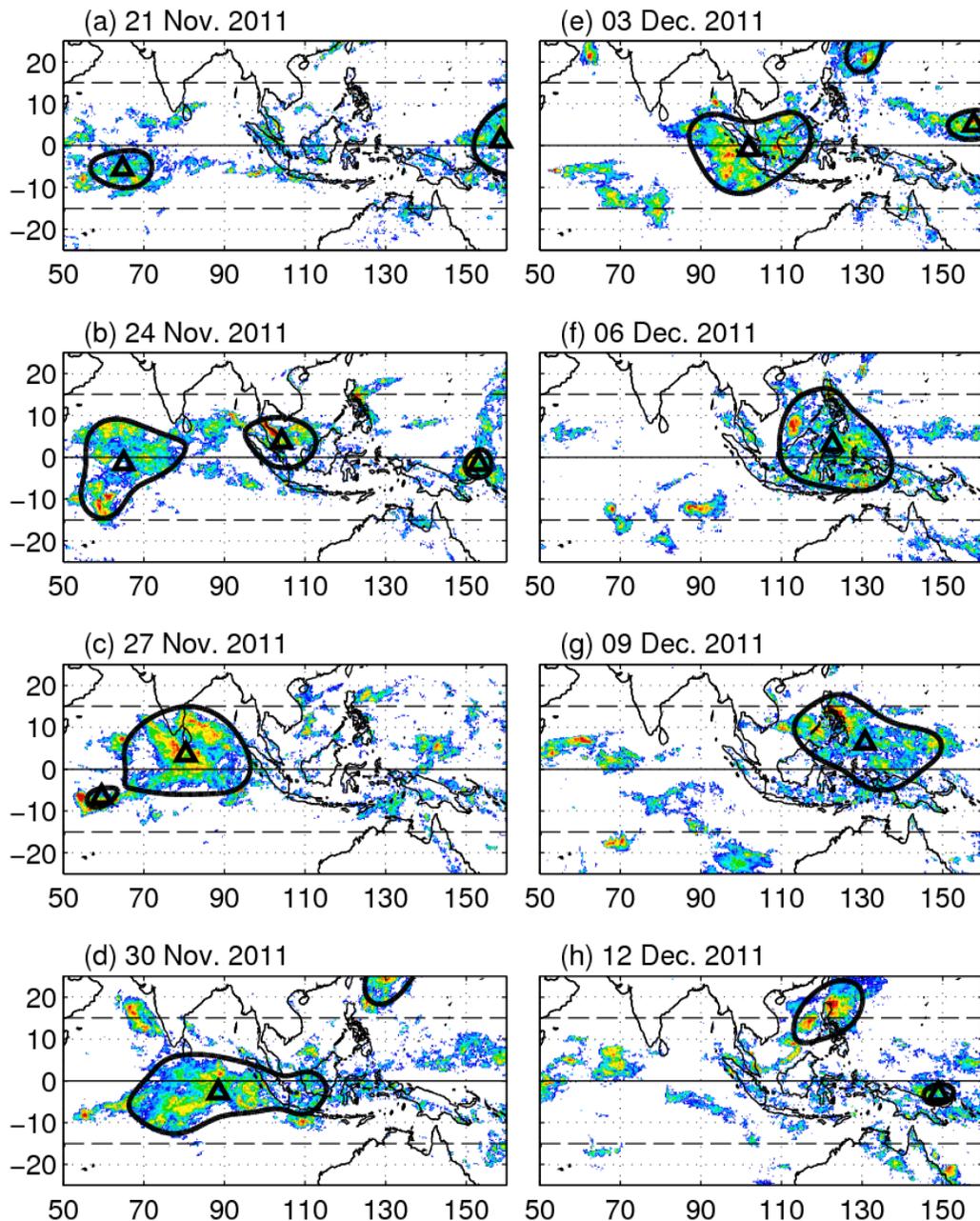
MJO LPT: trackable > 10 days; mean propagation speed $> 2 \text{ m/s}$

3 Day Rain Ending 0000 UTC 24 Nov. 2011



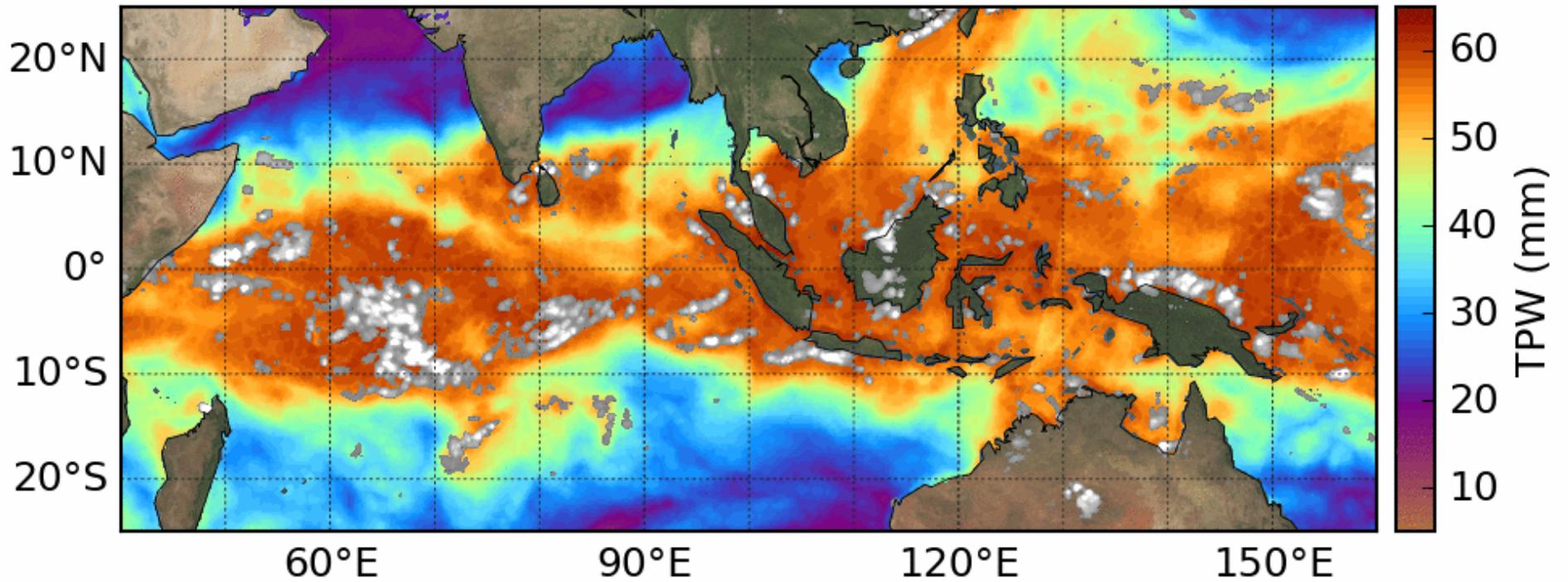
Kerns and Chen (2016, JGR)

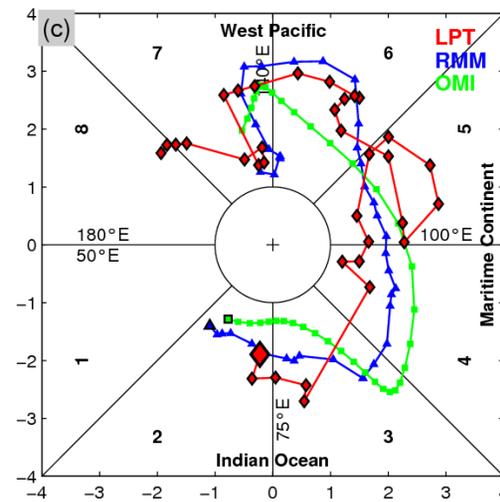
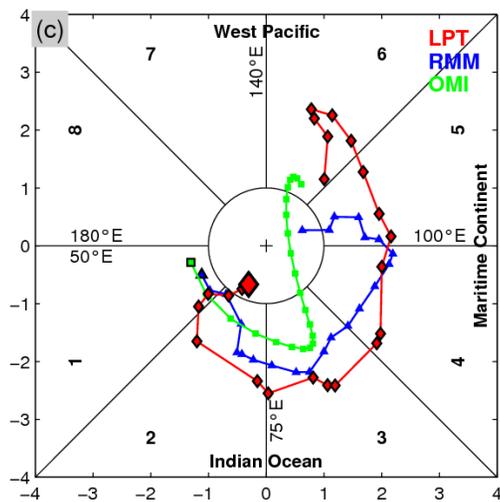
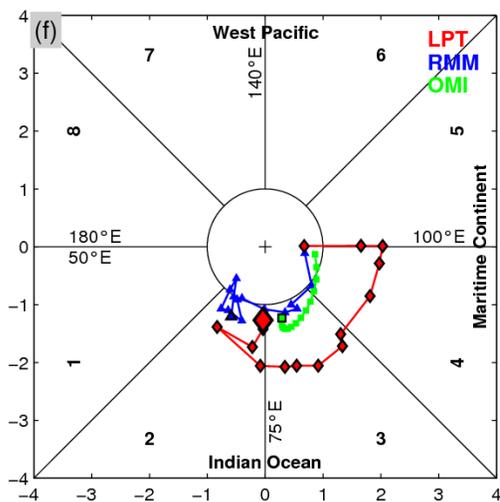
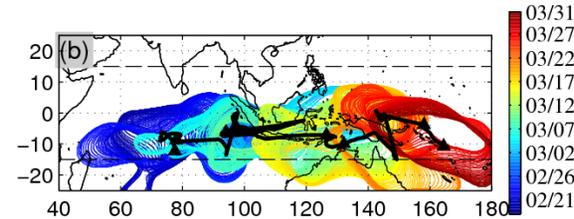
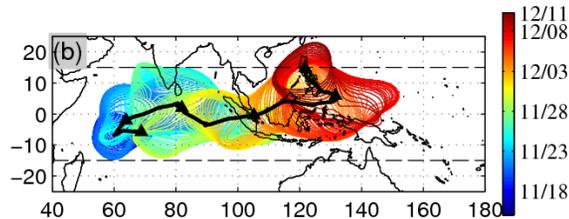
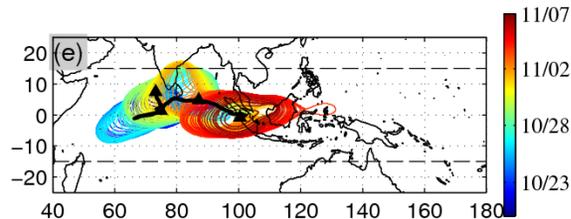
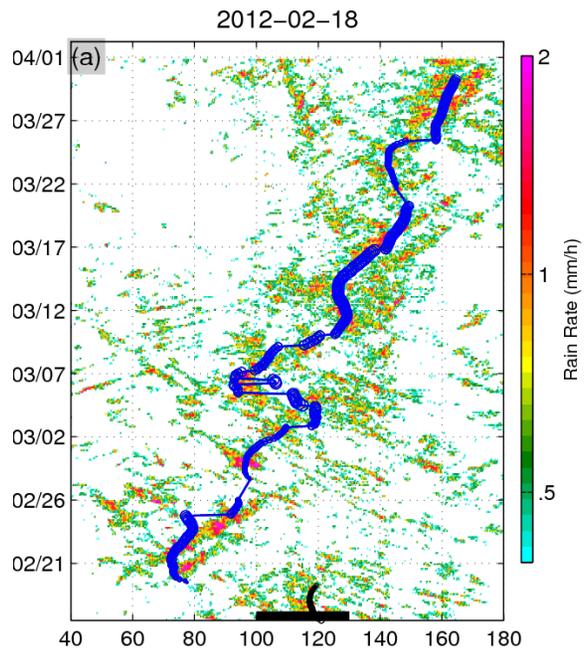
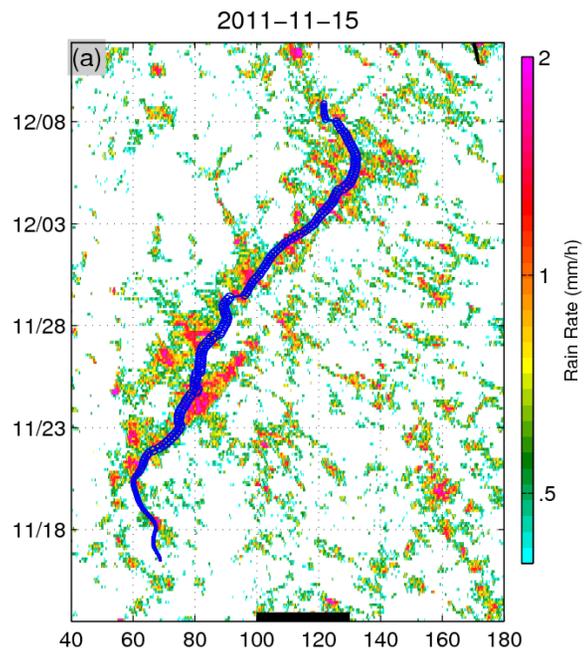
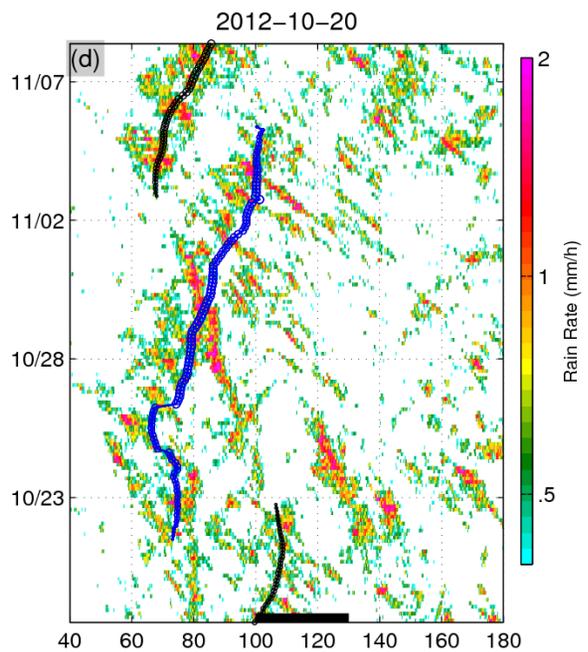
DYNAMO MJO-2 Nov-Dec 2011



MJO Observed during DYNAMO (2011-2012)

TPW and rainfall rate, 2011-11-19

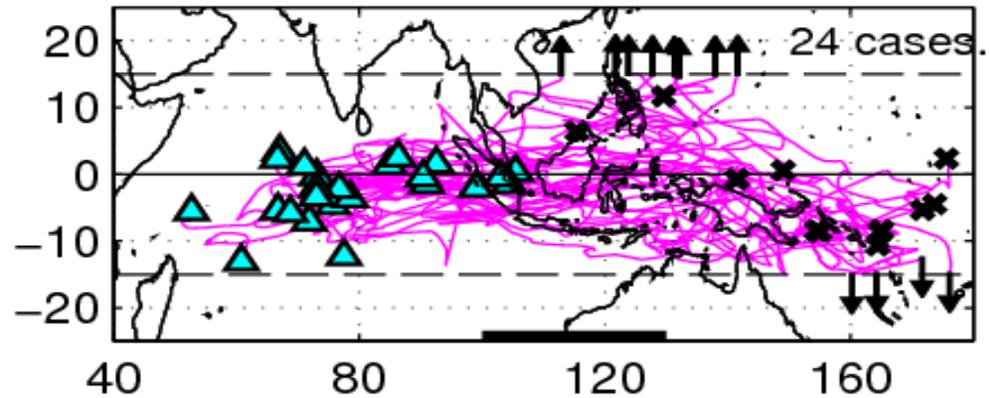




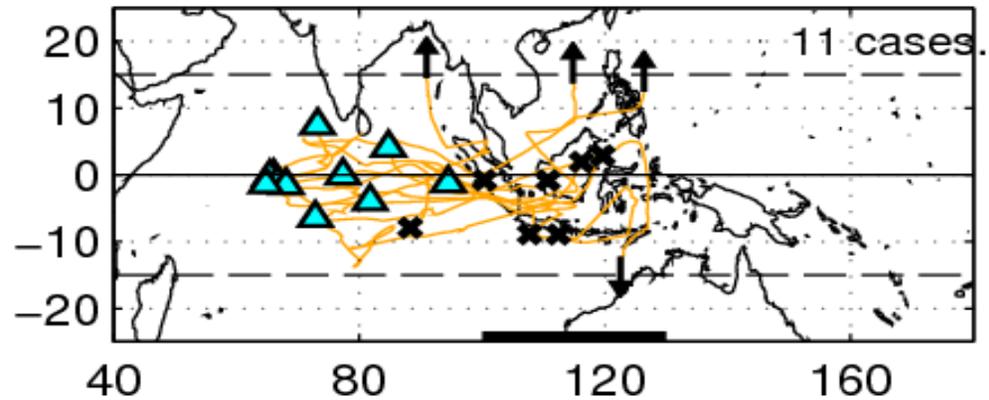
Kerns and Chen (2016, JGR)

The Maritime Continent (MC) barrier effect on the MJO:

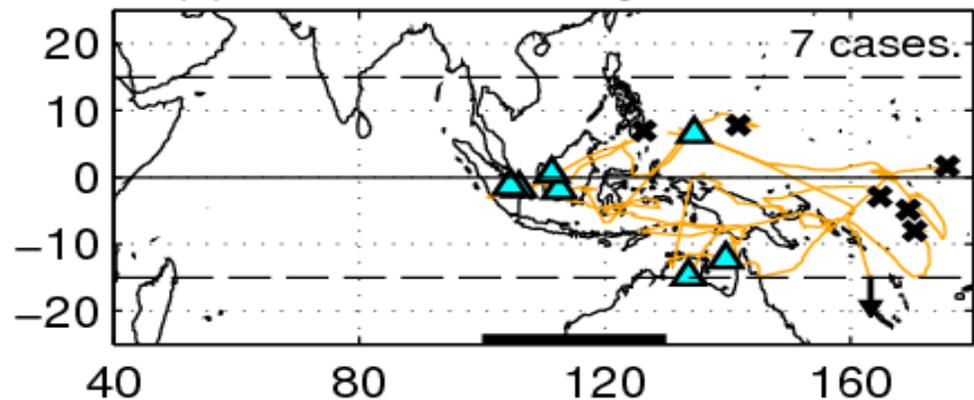
- TRMM 1998-2015 Oct-March
- 30% of all MJO events initiated over the Indian Ocean fail to propagate through the MC

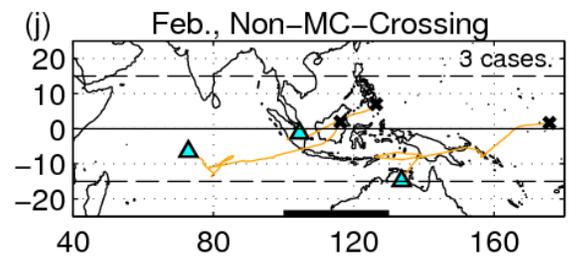
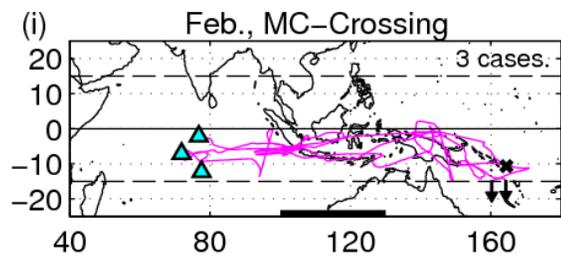
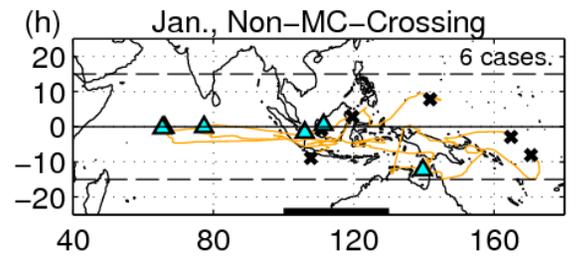
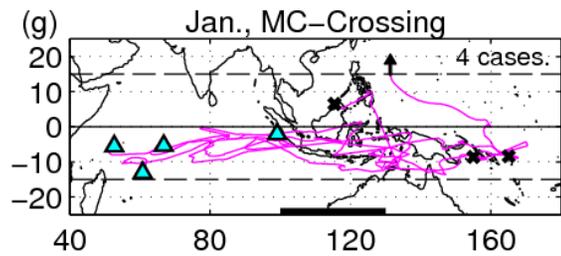
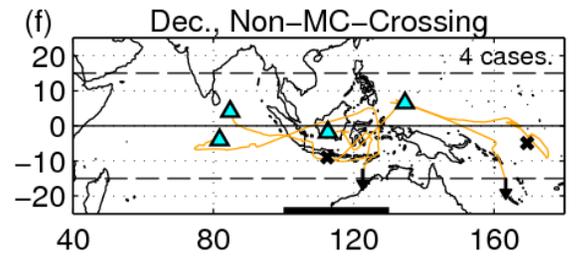
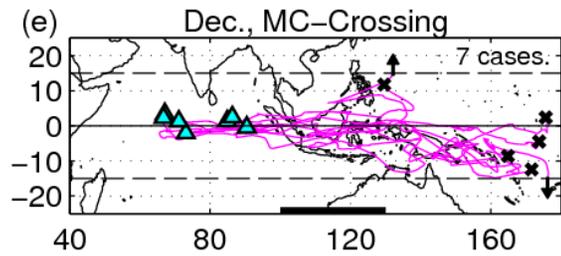
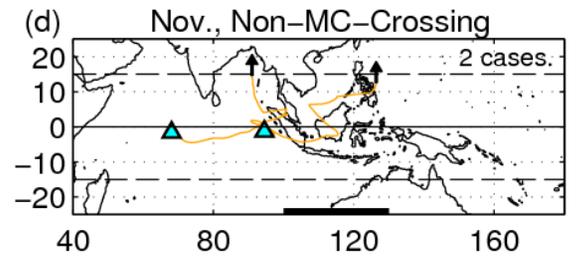
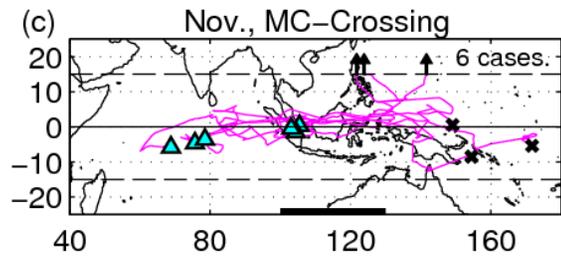
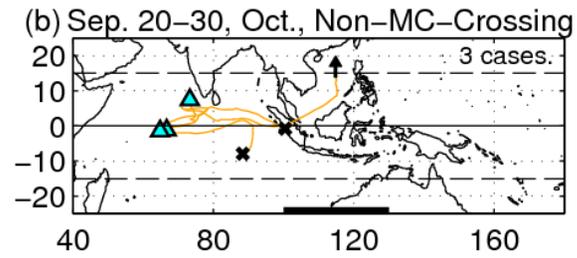
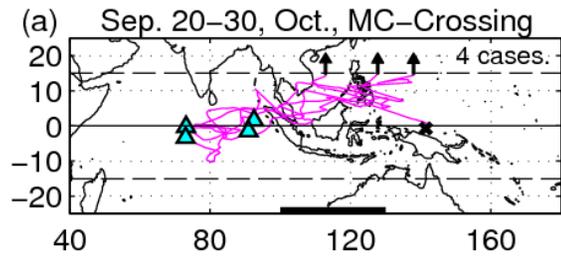


(c) Non-MC-Crossing, Indian Ocean

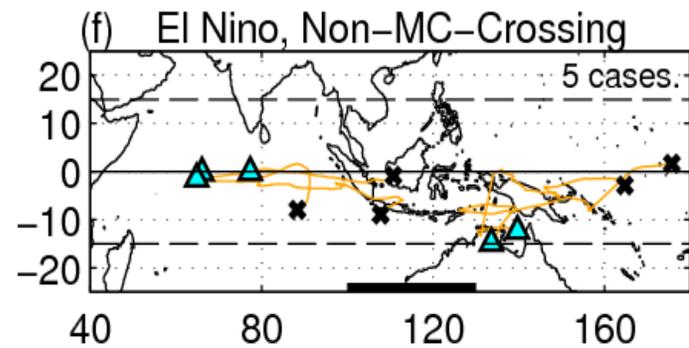
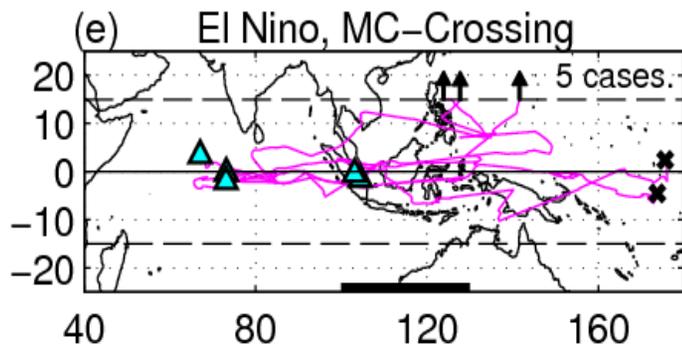
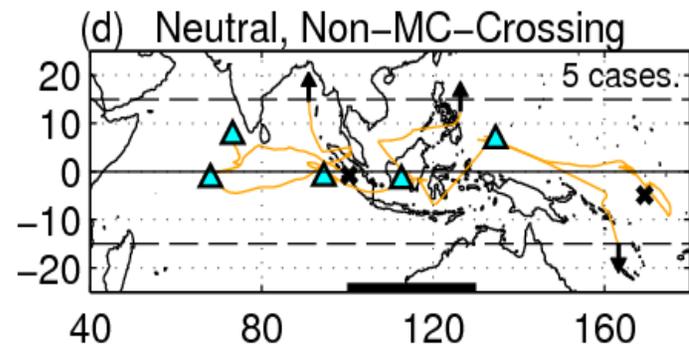
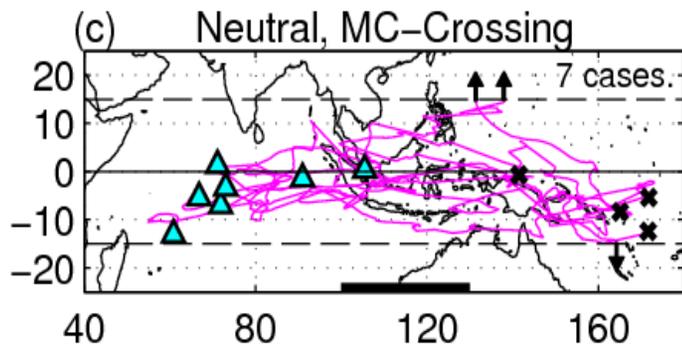
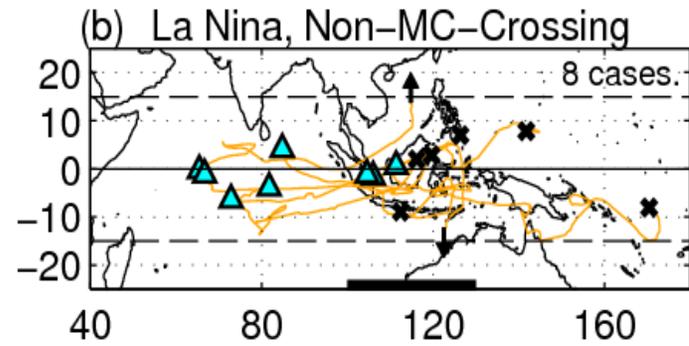
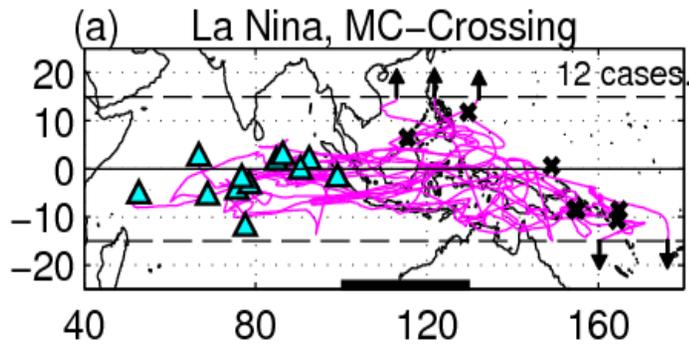


(e) Non-MC-Crossing, West Pacific





Interannual Variability



Kerns and Chen (2016)

Models:

1) ECMWF Integrated Forecasting System (IFS)

- Ensemble System: coupled atmosphere-wave-ocean model (IFSatmos-WAM-NEMO)
- WAve Model (WAM)
- Nucleus for European Modelling of the Ocean (NEMO)

2) Unified Wave INterface-Coupled Model (UWIN-CM)

- WRF
- University of Miami Wave Model (UMWM)
- Hybrid Coordinate Ocean Model (HYCOM)

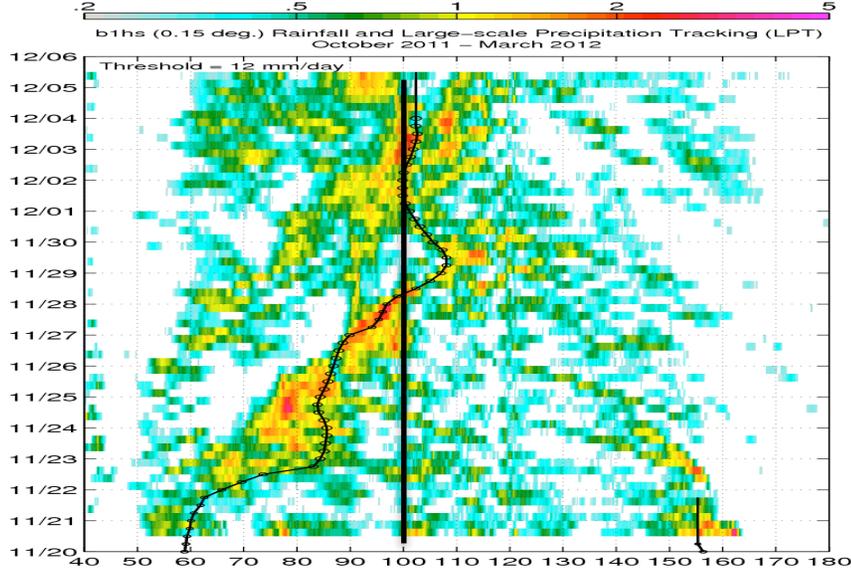
MJO-2 event in DYNAMO (20 Nov-8 Dec 2011)

ECMWF IFS ensemble experiments:

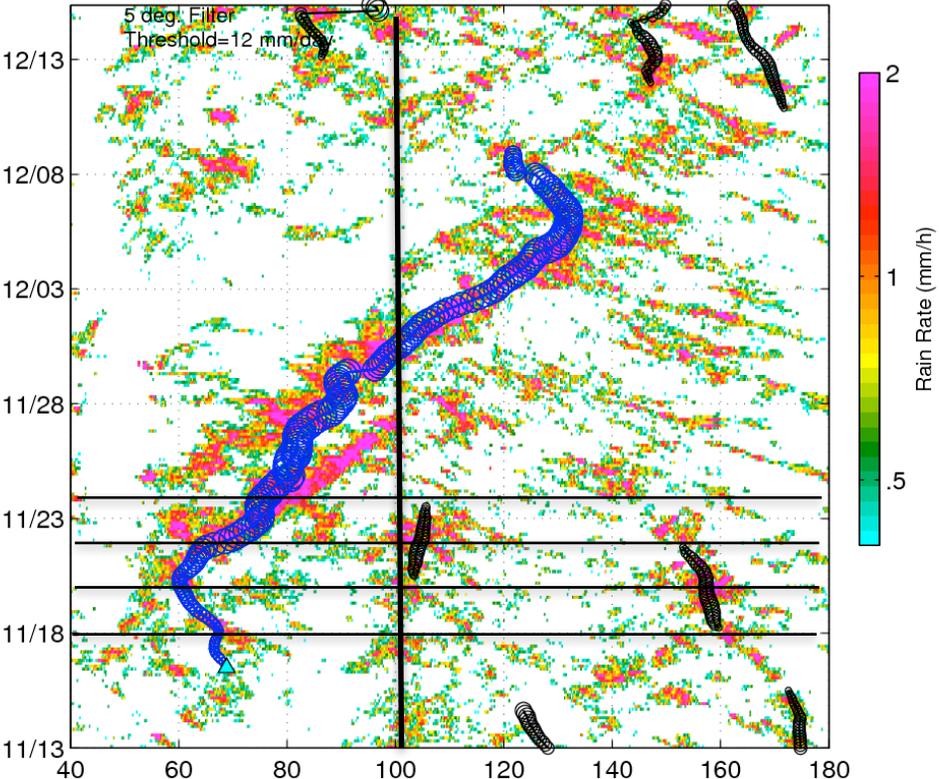
- 4 initial times: 18, 20, 22, 24 November 2011
- Each with 4 perturbation methods:
 1. Initial Condition (IC)
 2. IC+Stochastic Perturbed Param. Tendencies (SPPT)
 3. IC+Stochastic Kinetic Energy Backscatter Scheme (SKEBS)
 4. IC+SPPT+SKEBS

TMPA LPT

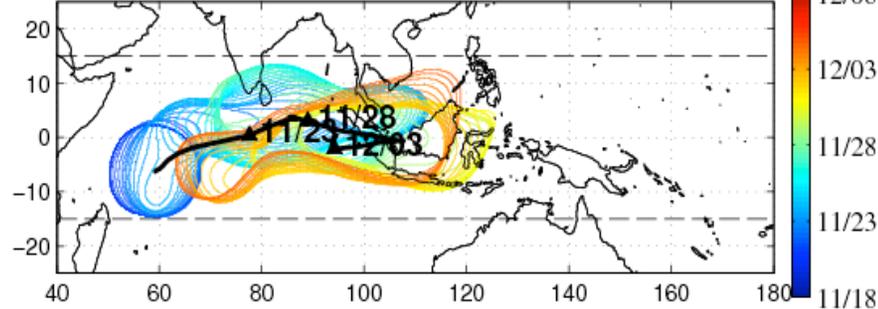
ECMWF Model T1279 (0.15 deg)



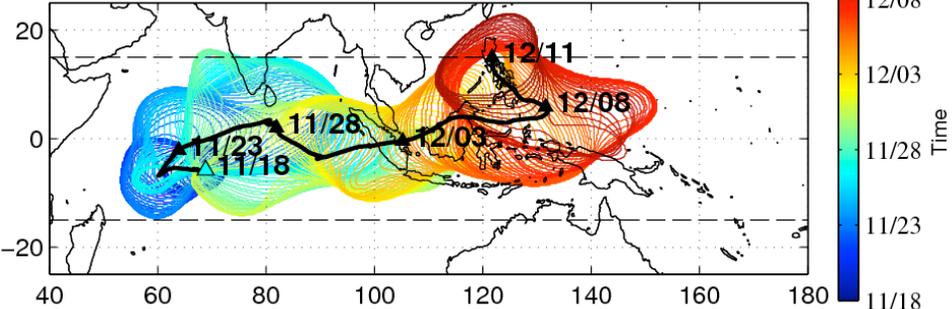
a. 2011–2012-2: 11/15 2011 – 12/11 2011



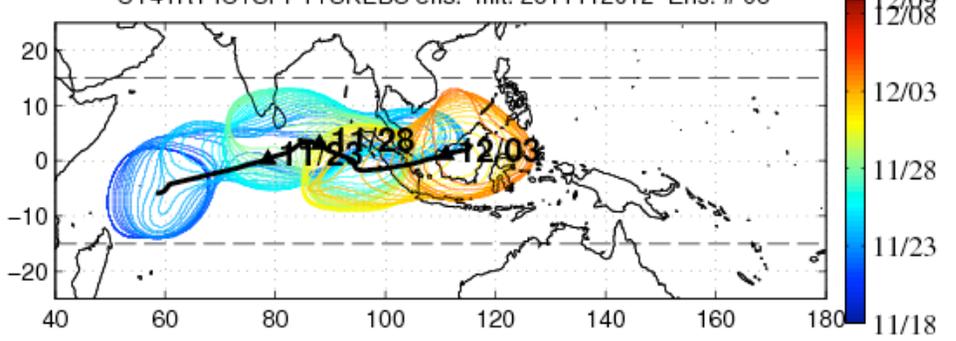
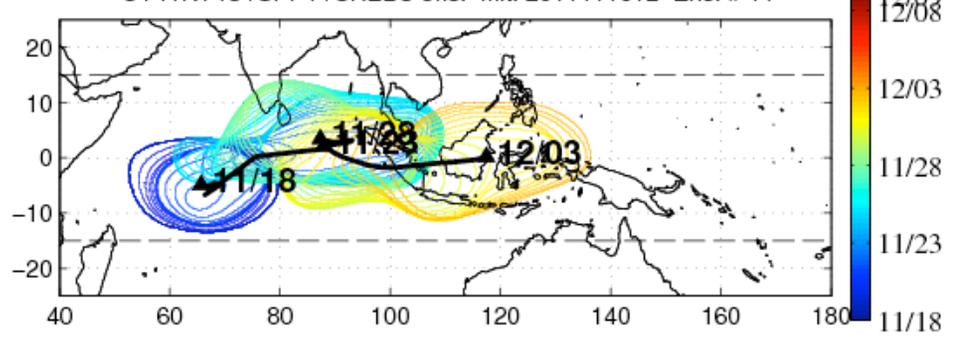
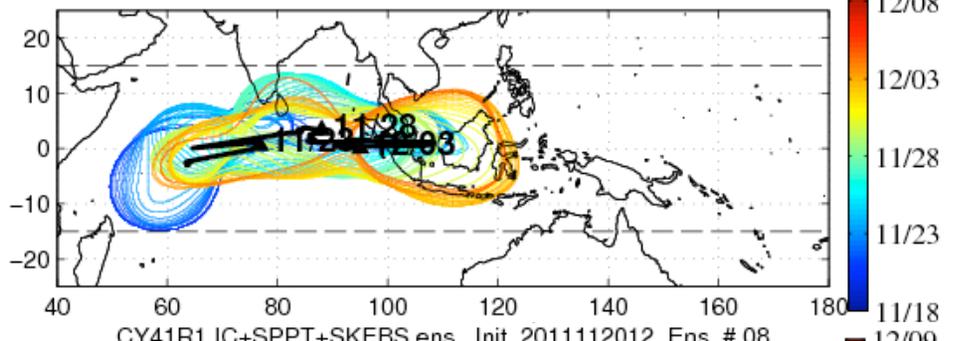
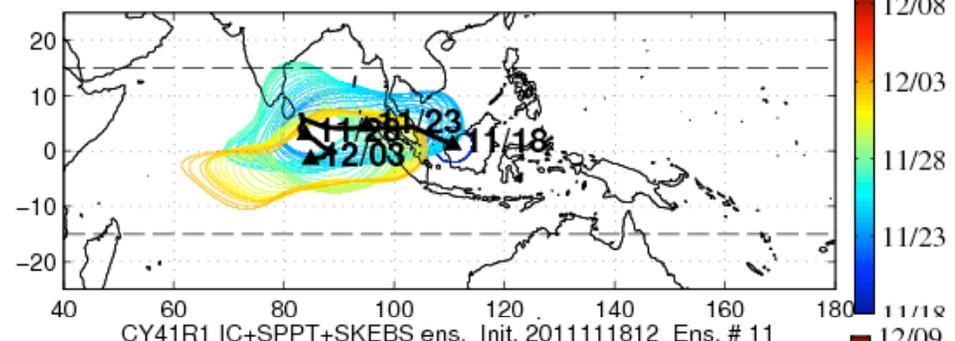
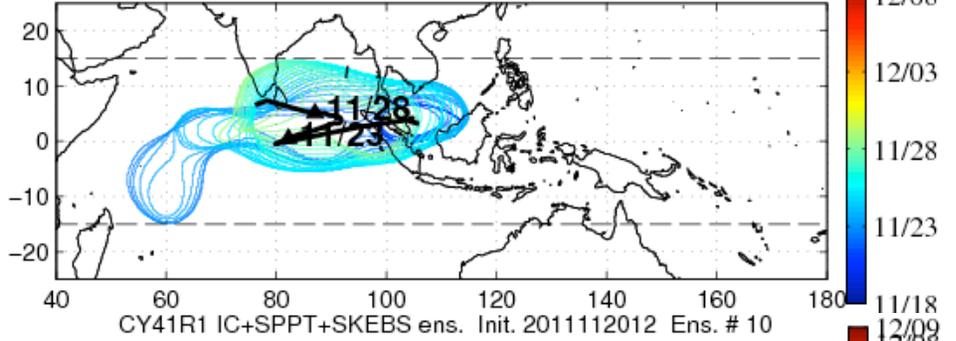
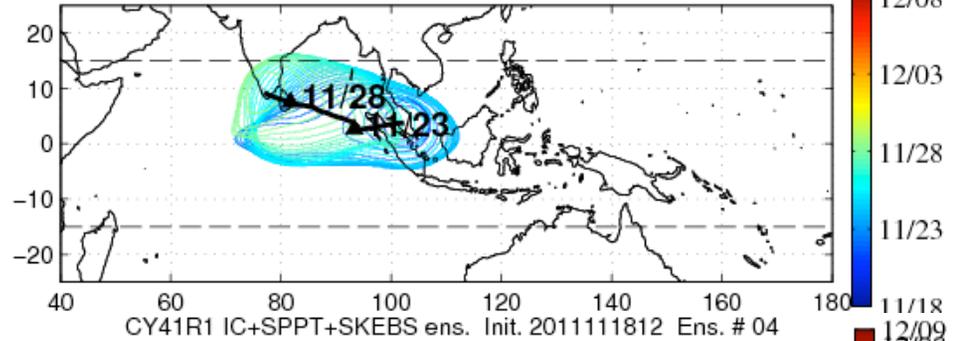
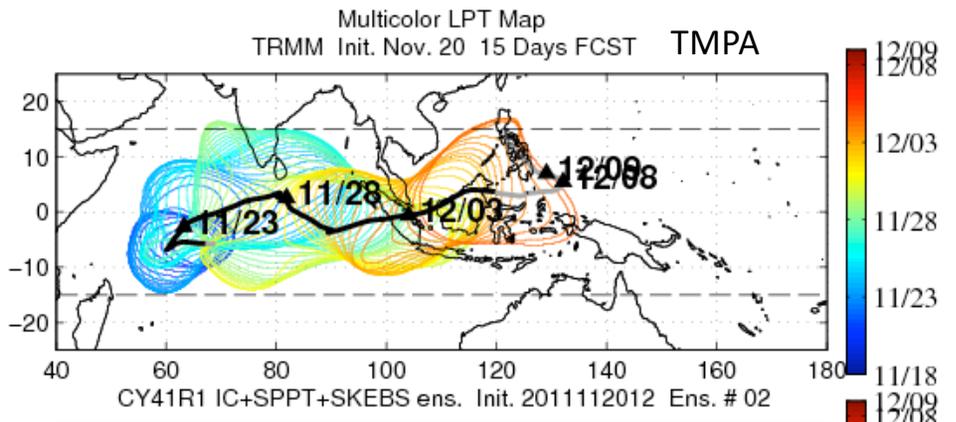
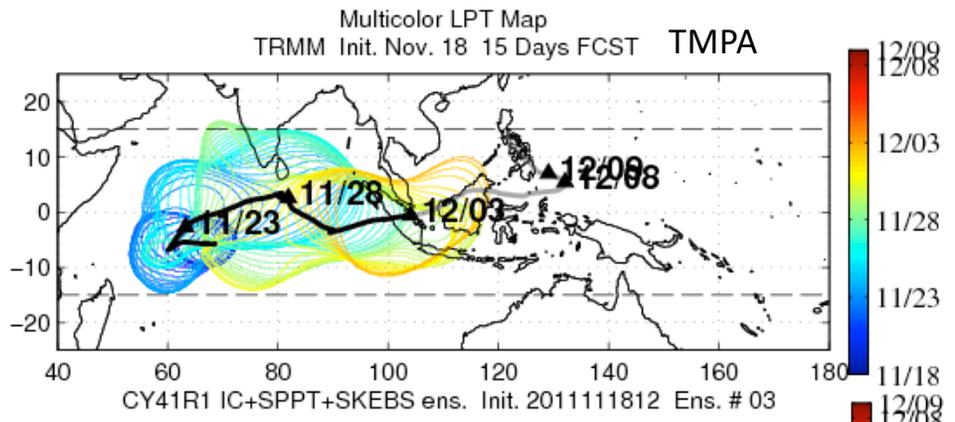
Multicolor LPT Map
CY41R1 res: 0.15 deg Init. 2011112012



b.



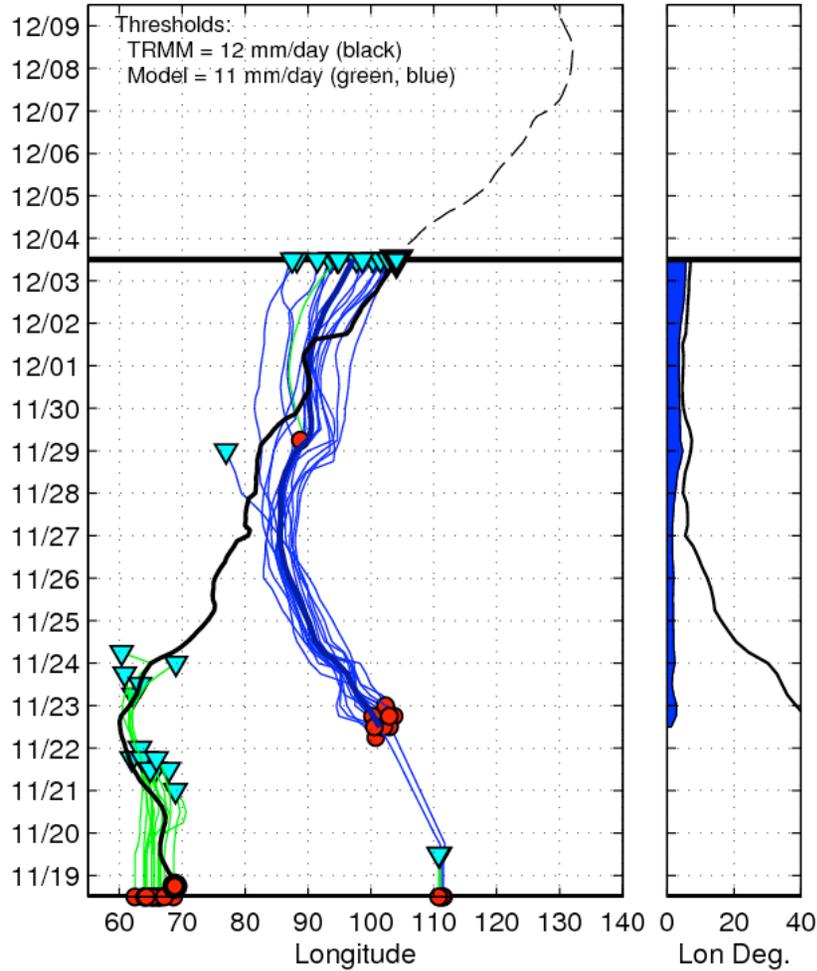
Kerns and Chen (2016, JGR)



IC

LPT for CY41R1 IC ens.
Init: 20111118 1200 UTC

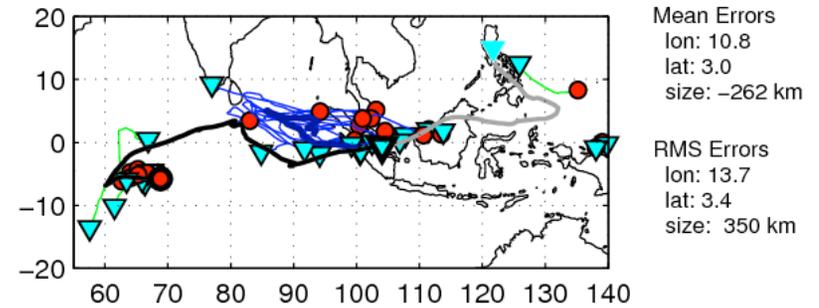
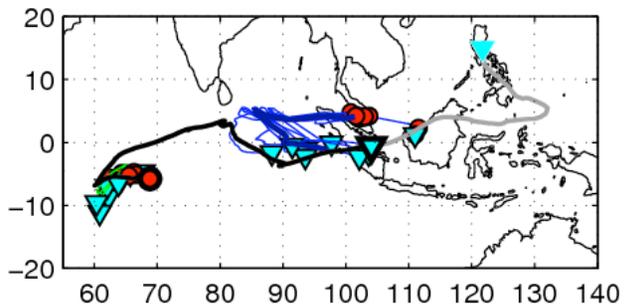
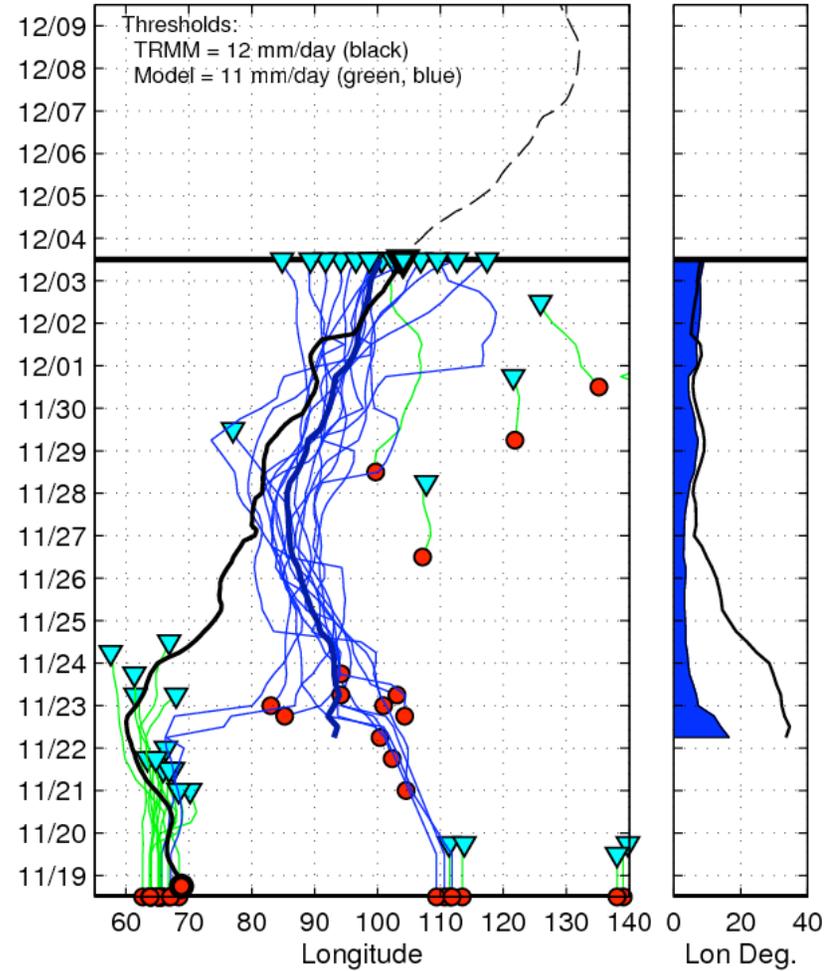
Lon STDEV



ALL

LPT for CY41R1 IC+SPPT+SKEBS ens.
Init: 20111118 1200 UTC

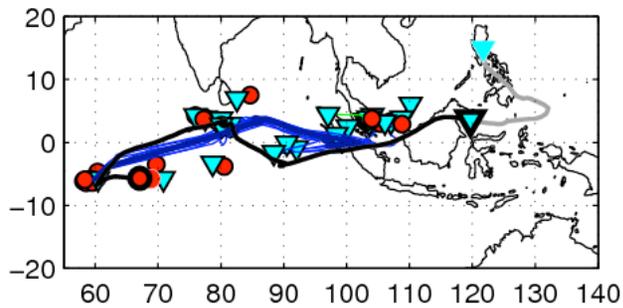
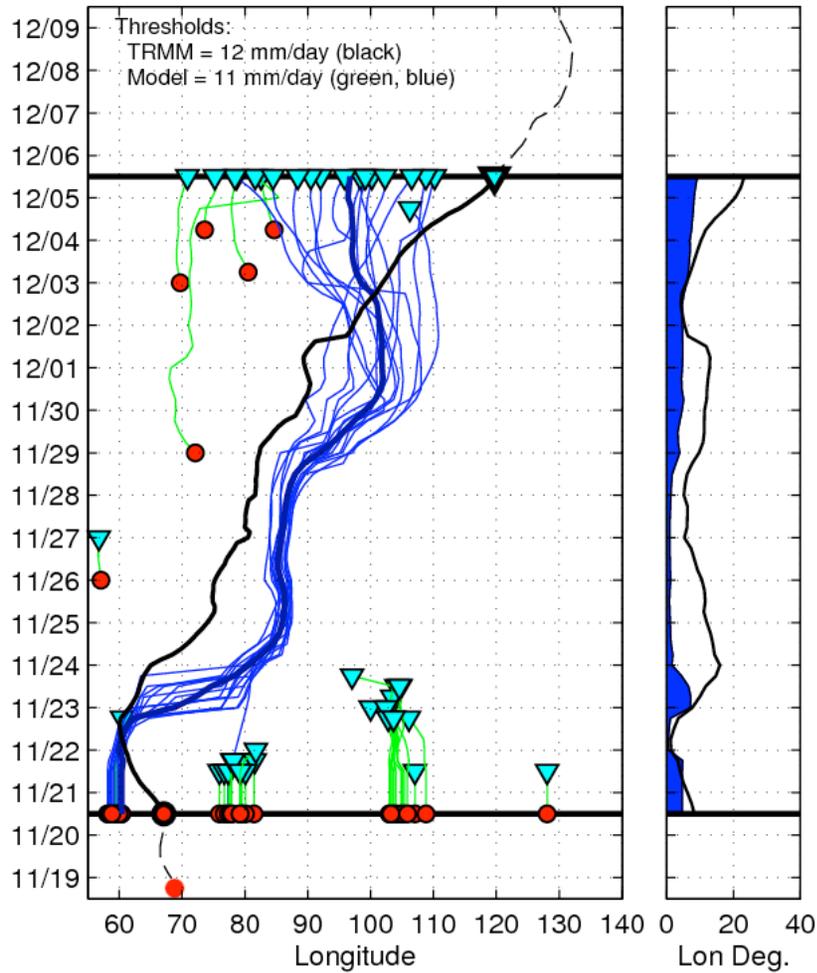
Lon STDEV



IC

LPT for CY41R1 IC ens.
Init: 20111120 1200 UTC

Lon STDEV



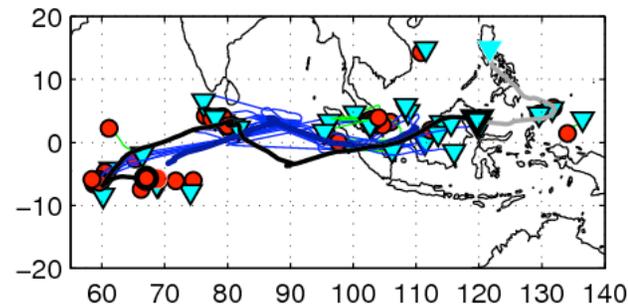
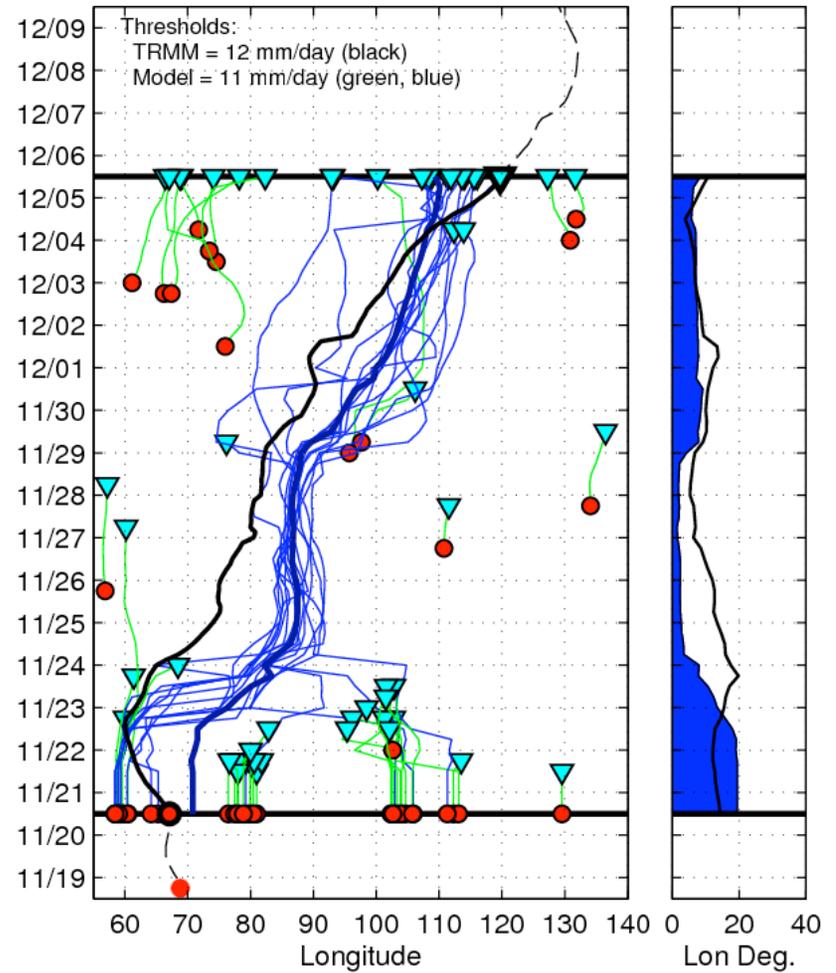
Mean Errors
lon: 3.3
lat: 1.1
size: -21 km

RMS Errors
lon: 9.9
lat: 2.1
size: 241 km

ALL

LPT for CY41R1 IC+SPPT+SKEBS ens.
Init: 20111120 1200 UTC

Lon STDEV



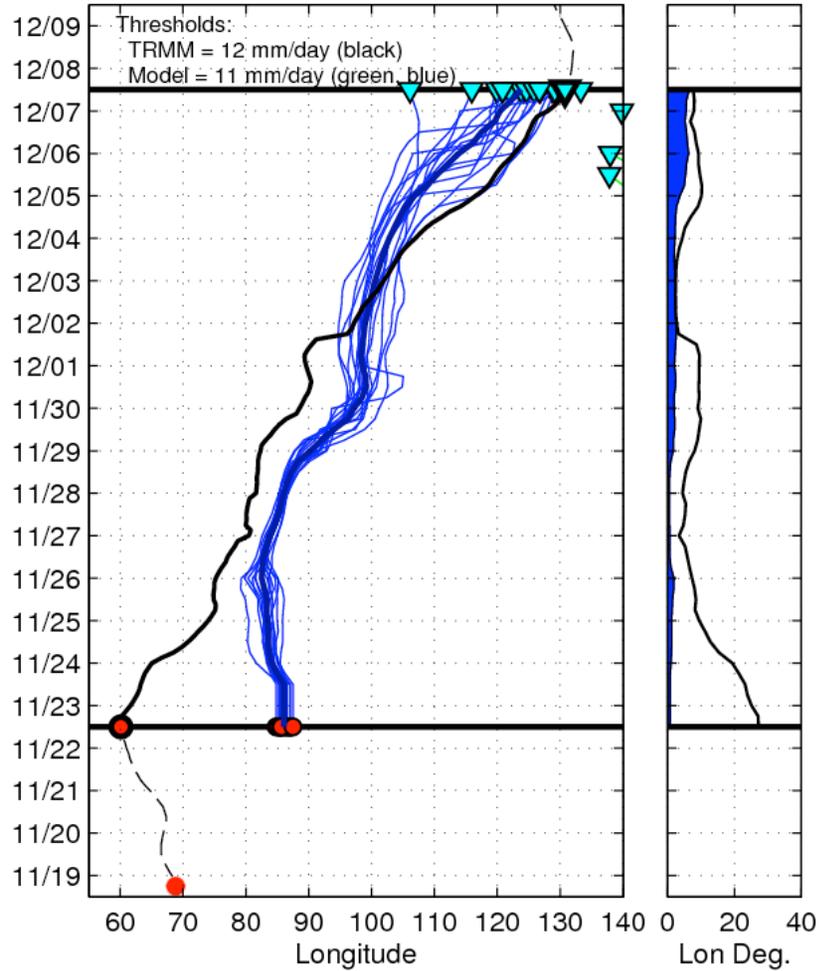
Mean Errors
lon: 7.4
lat: 1.7
size: -43 km

RMS Errors
lon: 12.3
lat: 2.6
size: 277 km

IC

LPT for CY41R1 IC ens.
Init: 20111122 1200 UTC

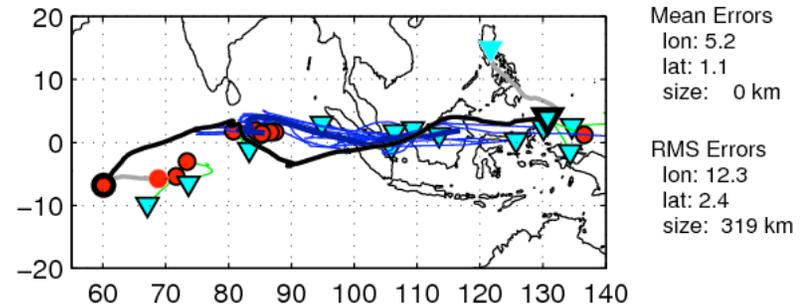
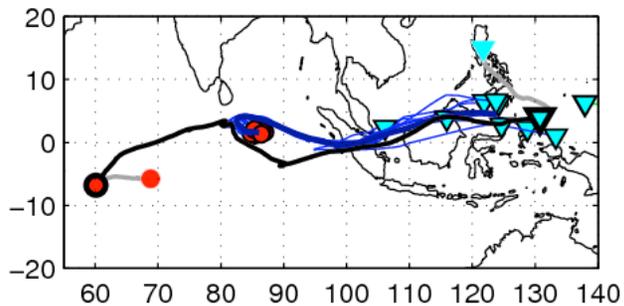
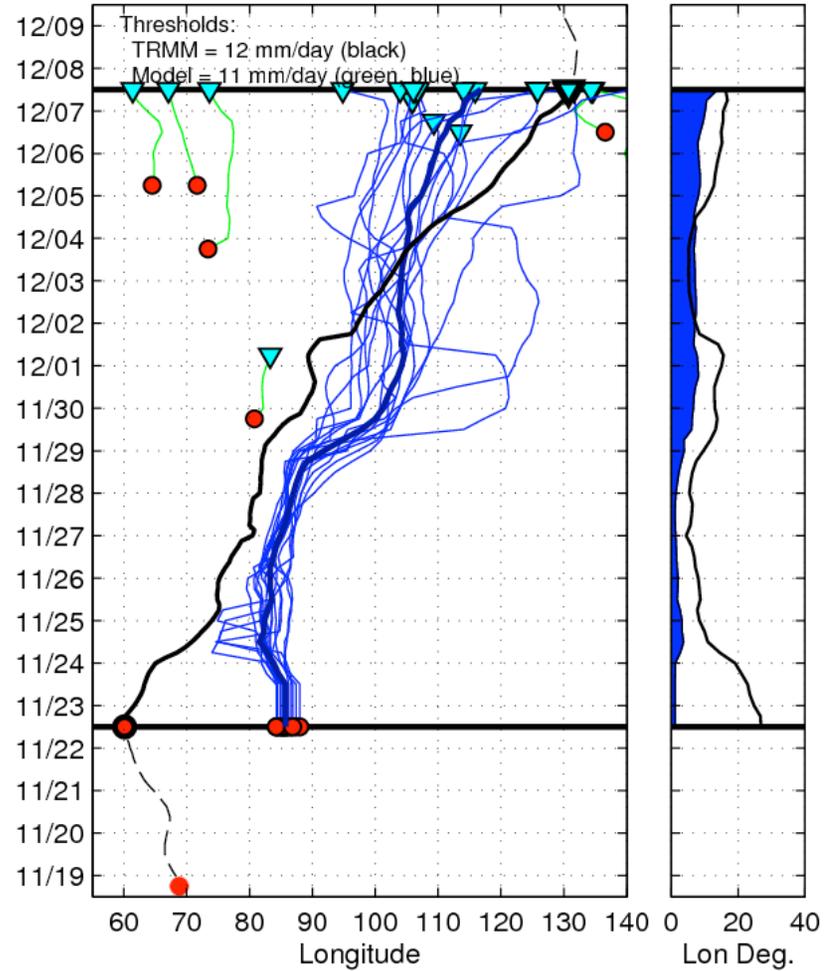
Lon STDEV



ALL

LPT for CY41R1 IC+SPPT+SKEBS ens.
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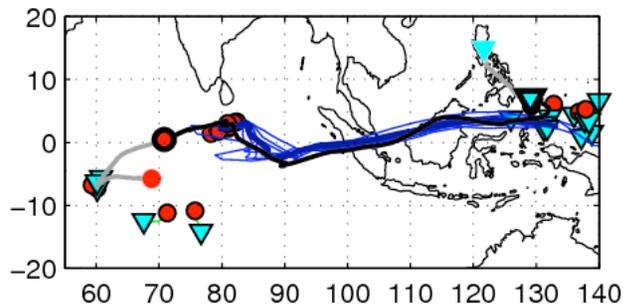
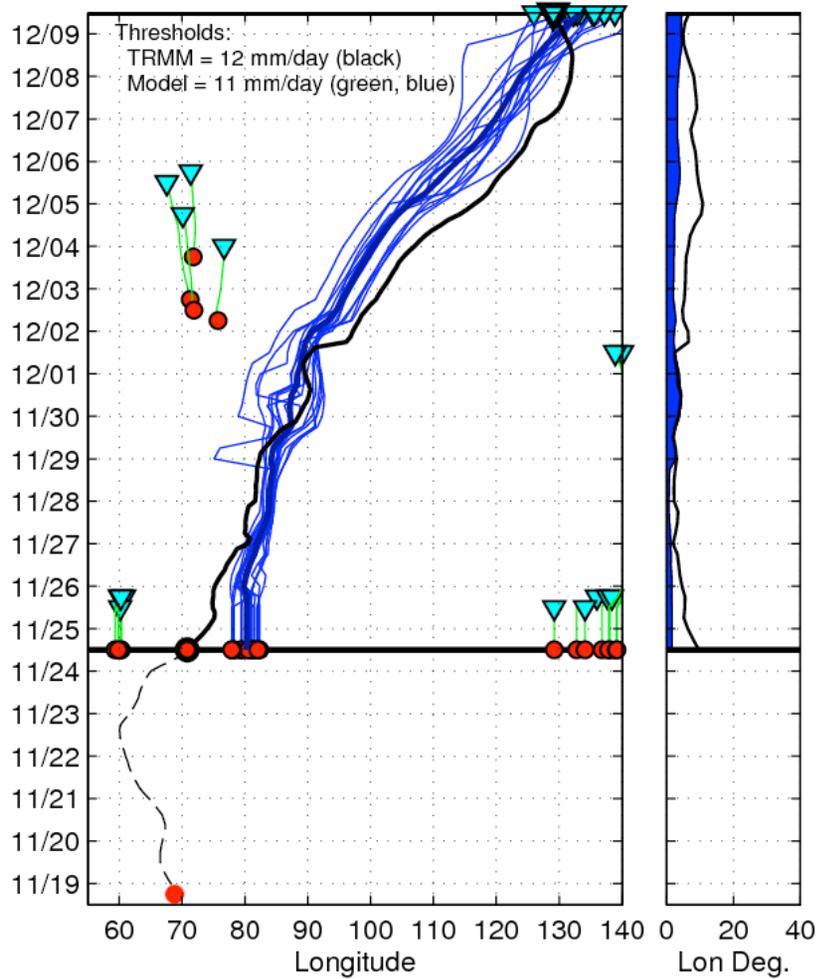
Lon STDEV



IC

LPT for CY41R1 IC ens.
Init: 20111124 1200 UTC

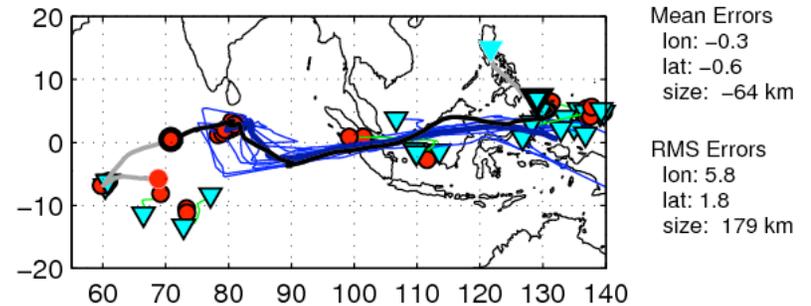
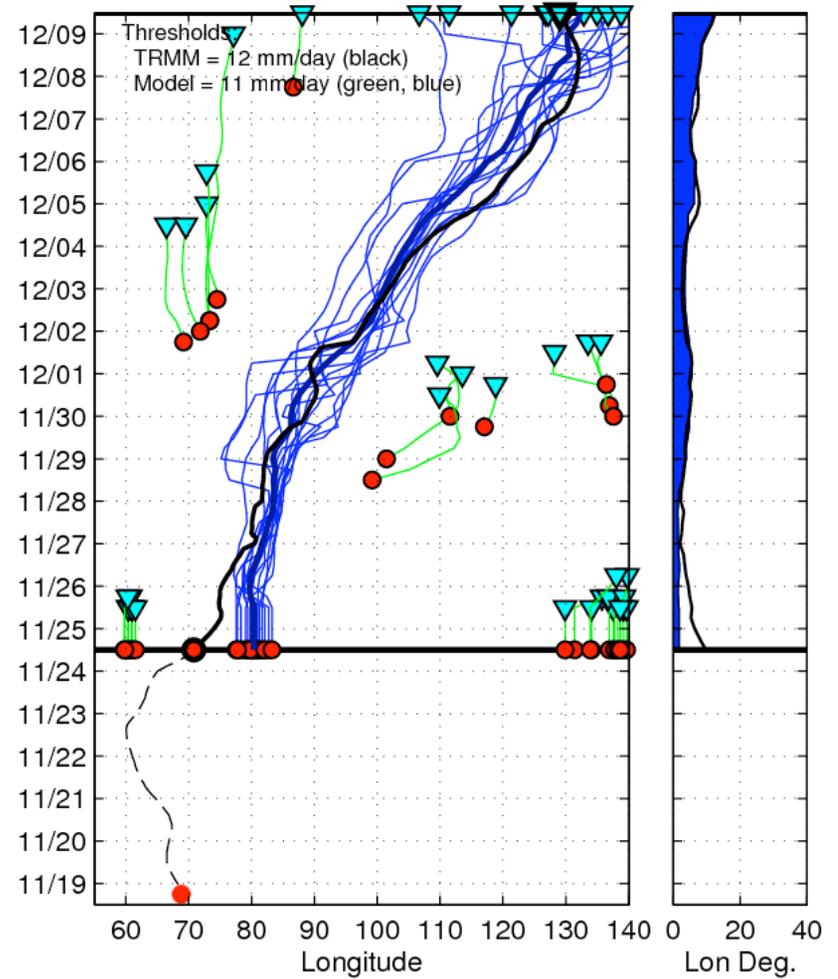
Lon STDEV



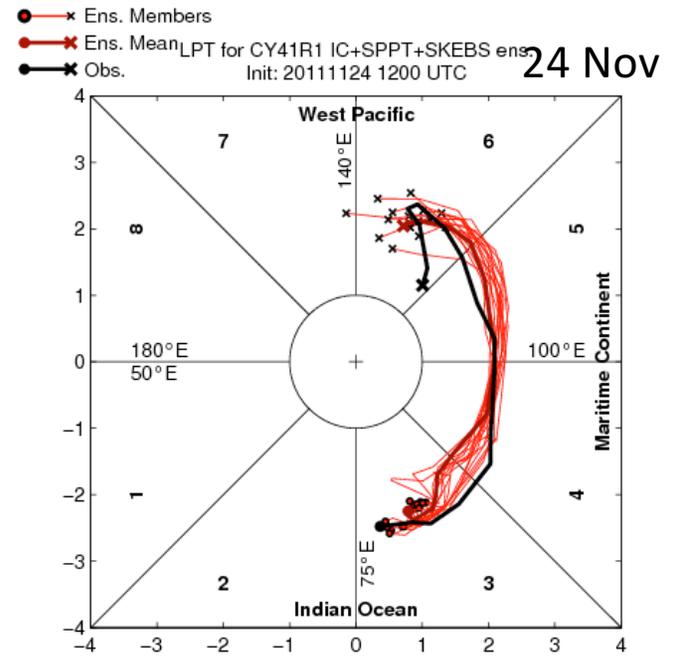
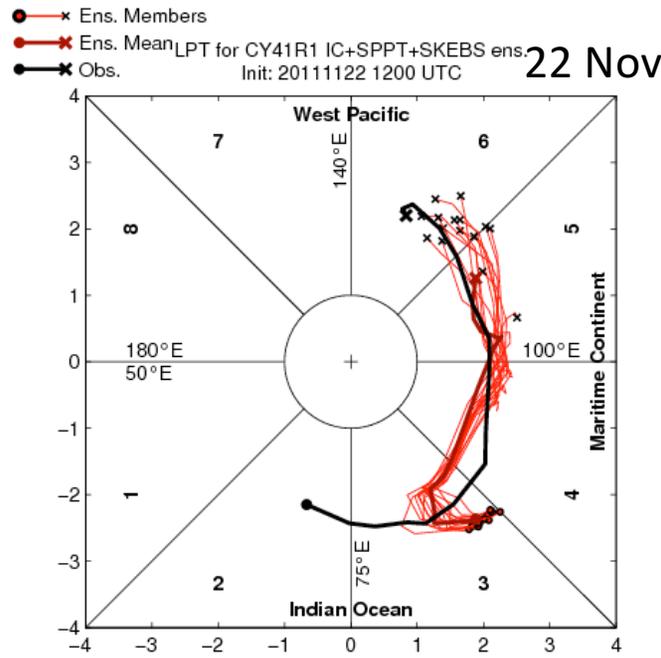
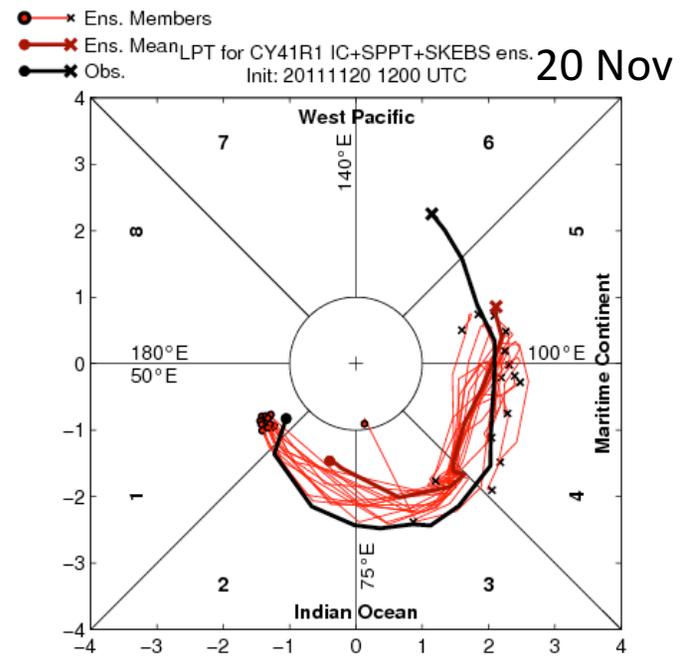
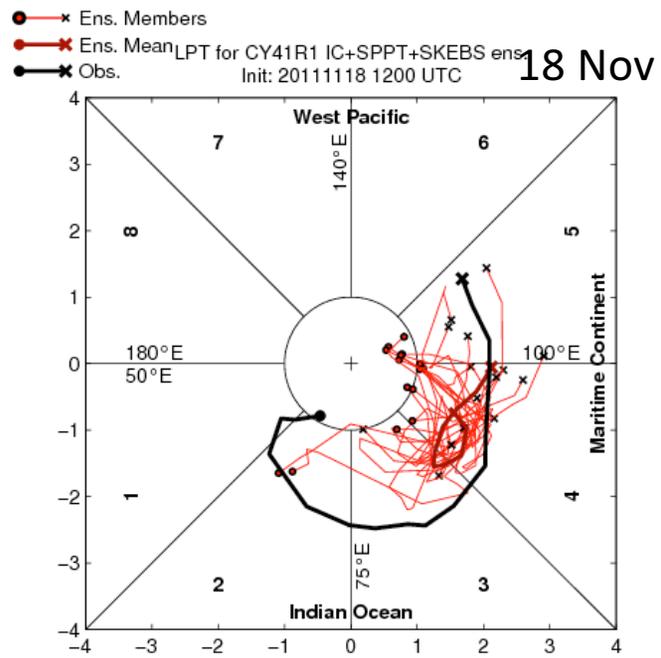
ALL

LPT for CY41R1 IC+SPPT+SKEBS ens.
Init: 20111124 1200 UTC

Lon STDEV

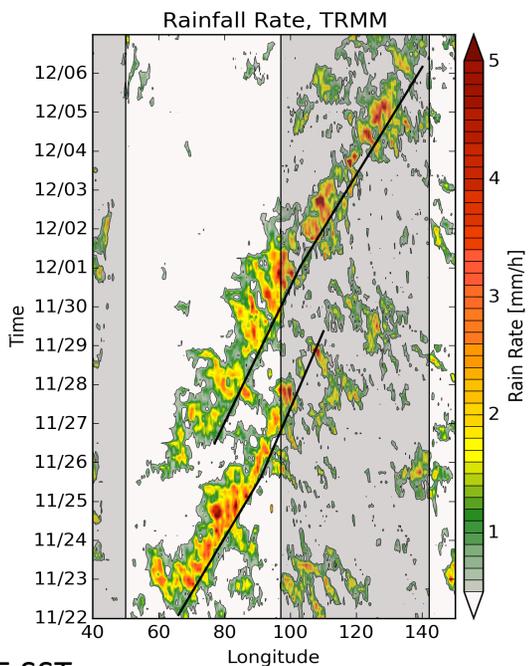


LPT IC+SPPT+SKEBS

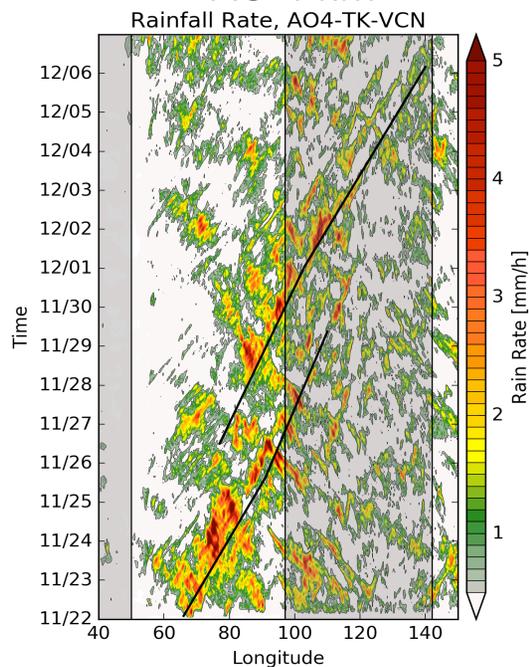


UWIN-Coupled Model

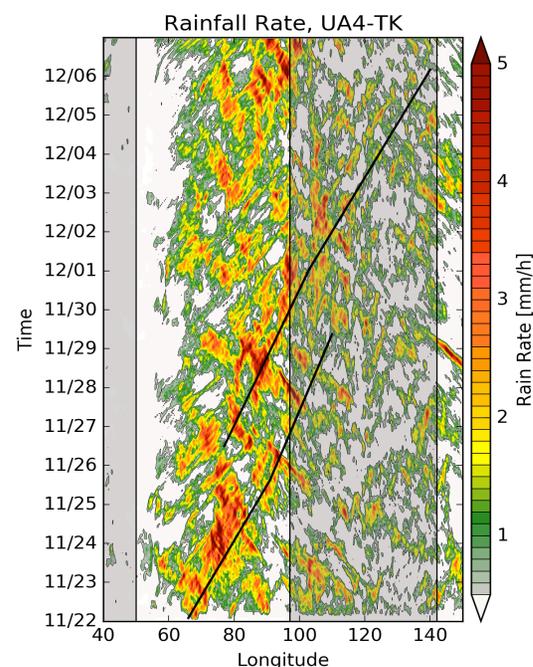
Obs



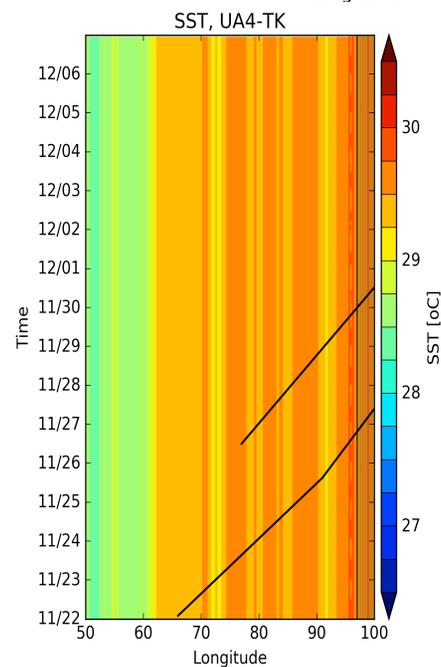
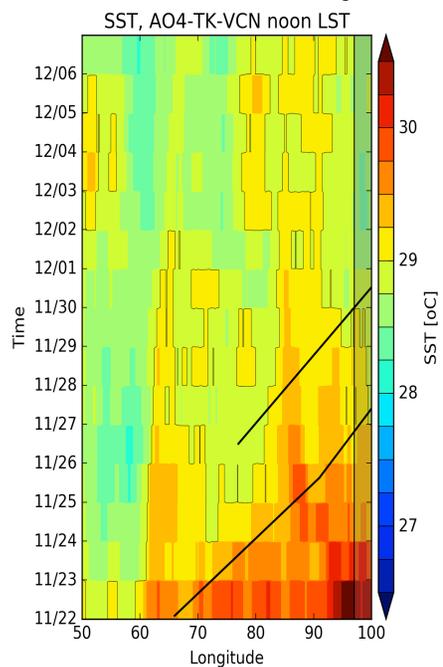
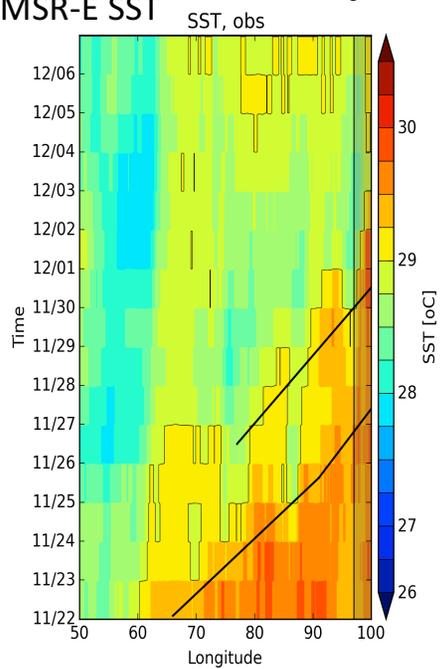
AO 4 km



UA 4 km



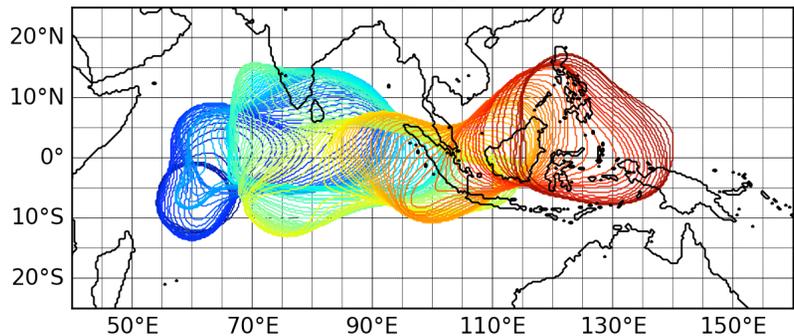
TMI/AMSR-E SST



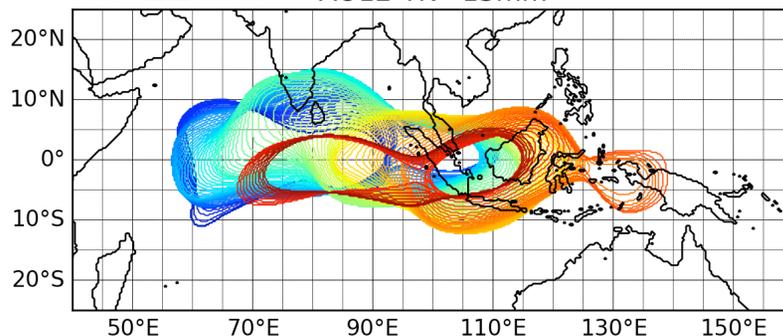
11/23 11/26 11/29 12/02 12/05



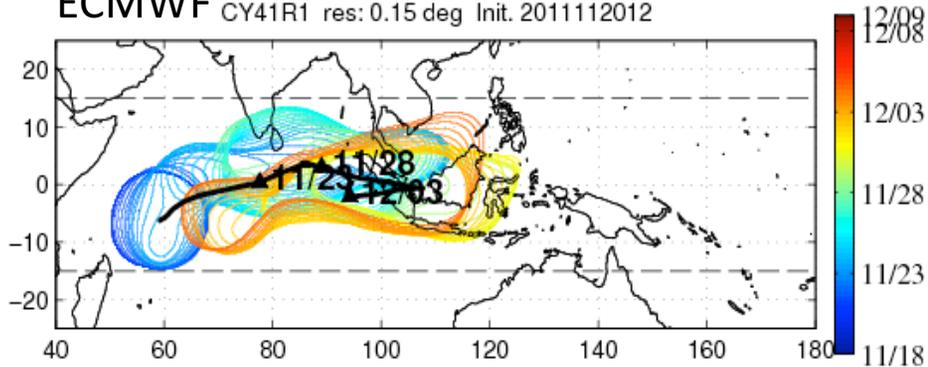
TRMM - 13mm



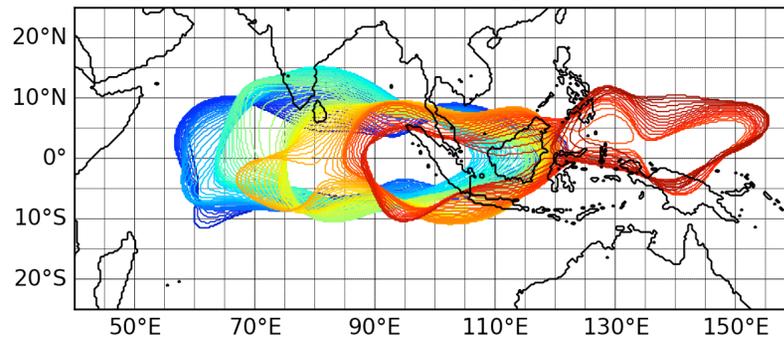
AO 12 km AO12-TK - 13mm



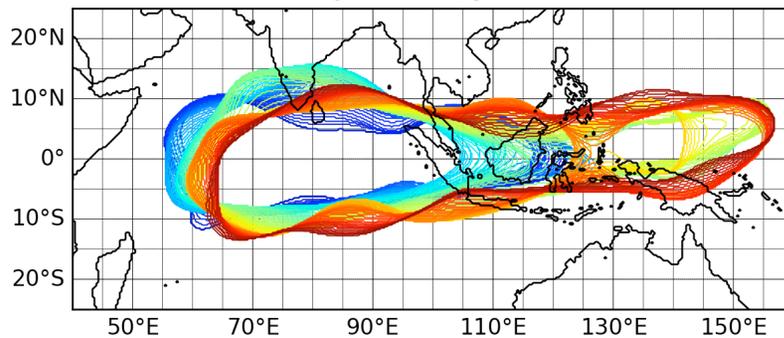
ECMWF Multicolor LPT Map
CY41R1 res: 0.15 deg Init. 2011112012



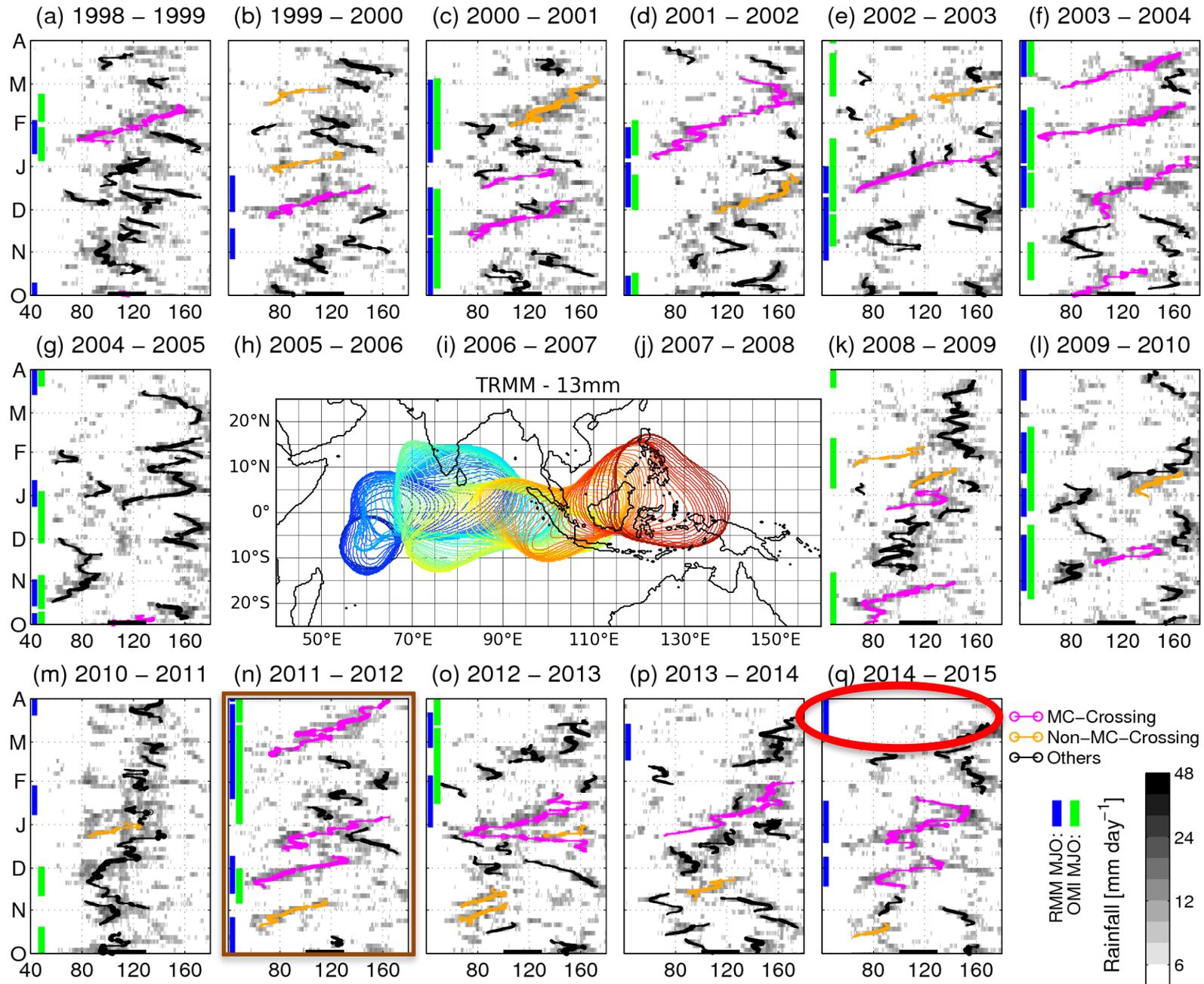
AO 4 km AO4-TK-VCN - 13mm



UA 4 km UA4-TK - 13mm



MJO "Catalog" 1998-2015 (TMPA) – continuing after 2015 (IMERG)



SUMMARY

- **Large-scale Precipitation Tracking (LPT) provides a robust and direct measure of MJO convection, which can capture the spatial structure and its variability**
- **LPT can be used for verification of MJO prediction in both global and regional models**
- **TRMM-GPM (TMPA-IMERG) data provides an unique MJO climatology database for weather and climate research**