High-Impact Tropical Weather Prediction: Evaluation & Verification of Coupled Air-Sea Model Forecasts of the MJO Using Ocean Vector Winds

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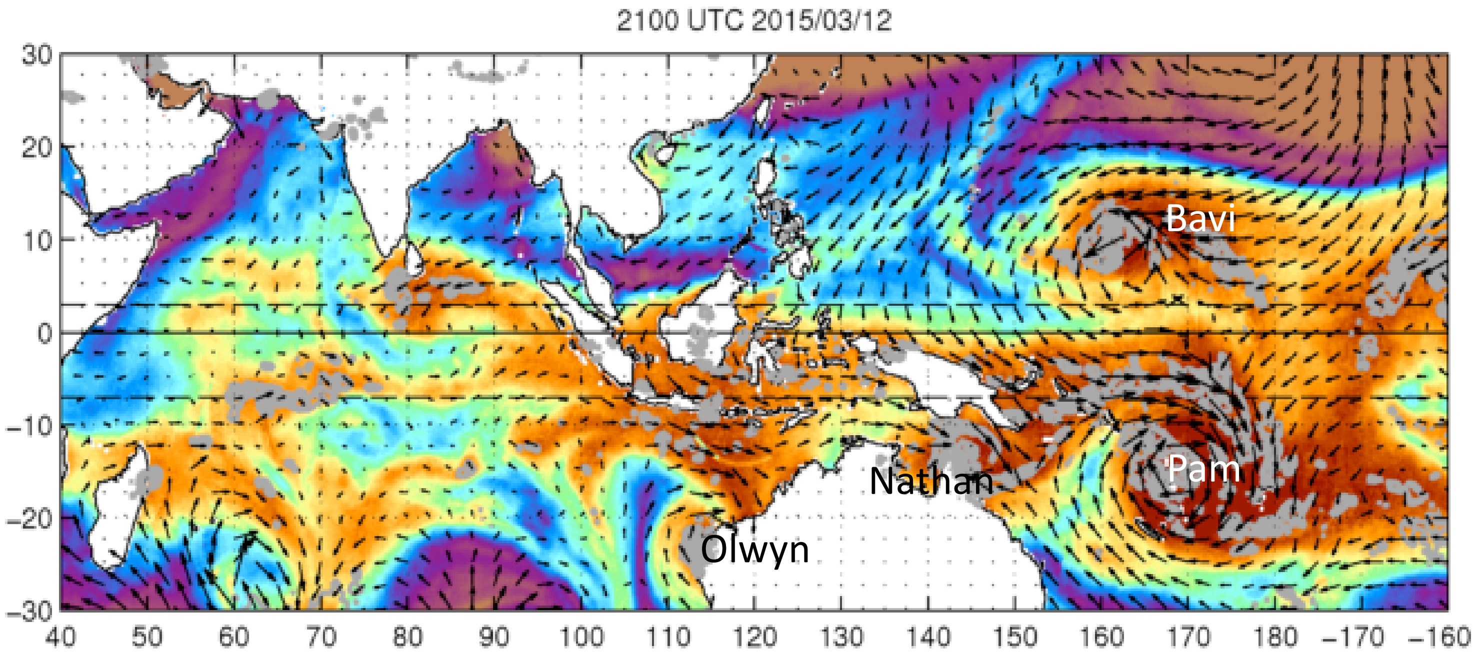


(IOVWST, Sapporo, Japan, 19 May 2016)

Goal:

- Better OBSERVE and PREDICT high-impact tropical weather systems (tropical cyclones, the Madden-Julian Oscillation)

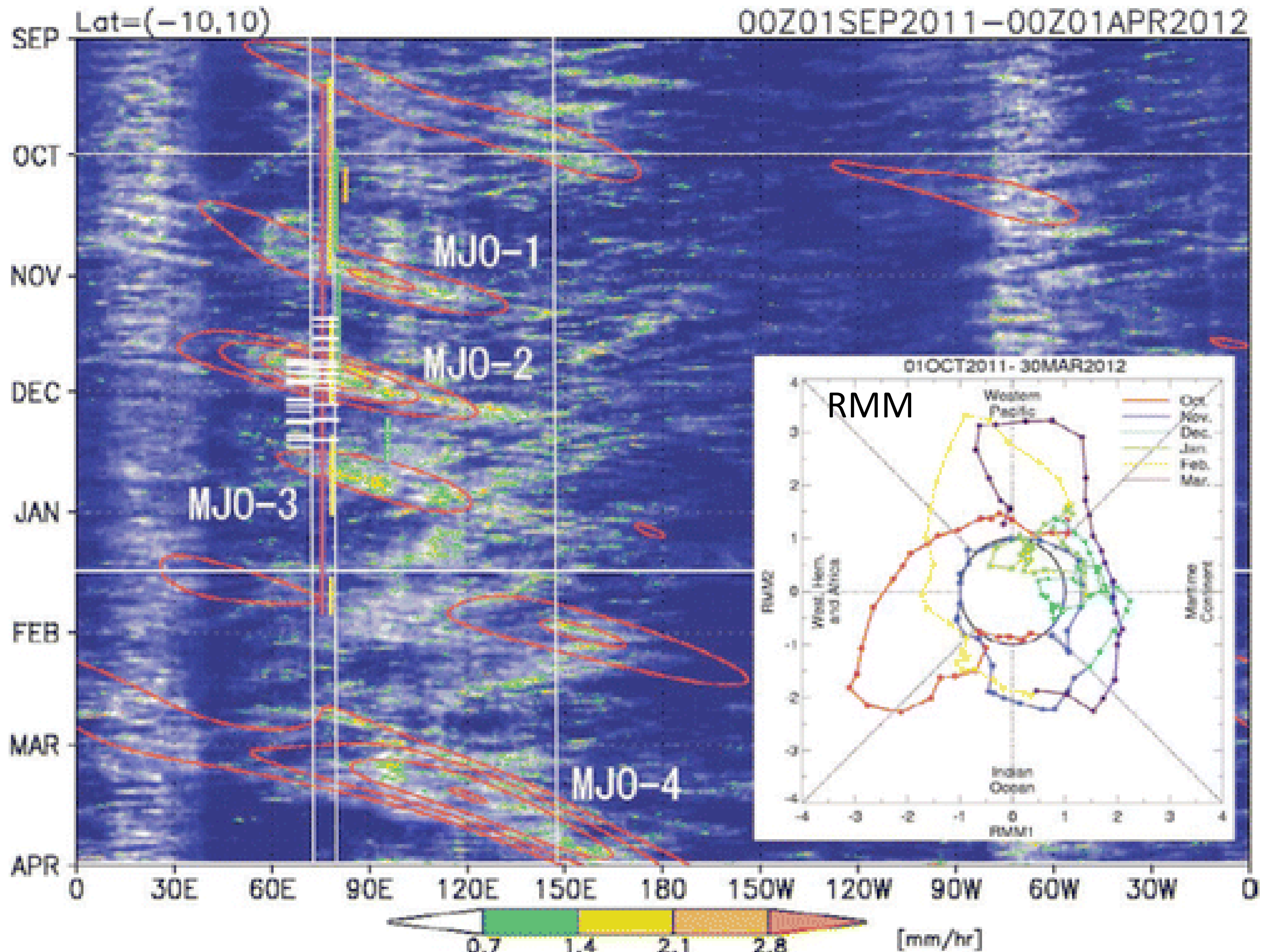
Methods:

- Satellites and in situ observations from recent field campaigns (e.g., DYNAMO, ITOP, CARTHE) with a focus on near surface properties and air-sea fluxes
- Evaluation of the coupled model prediction of the MJO and TCs

In this talk:

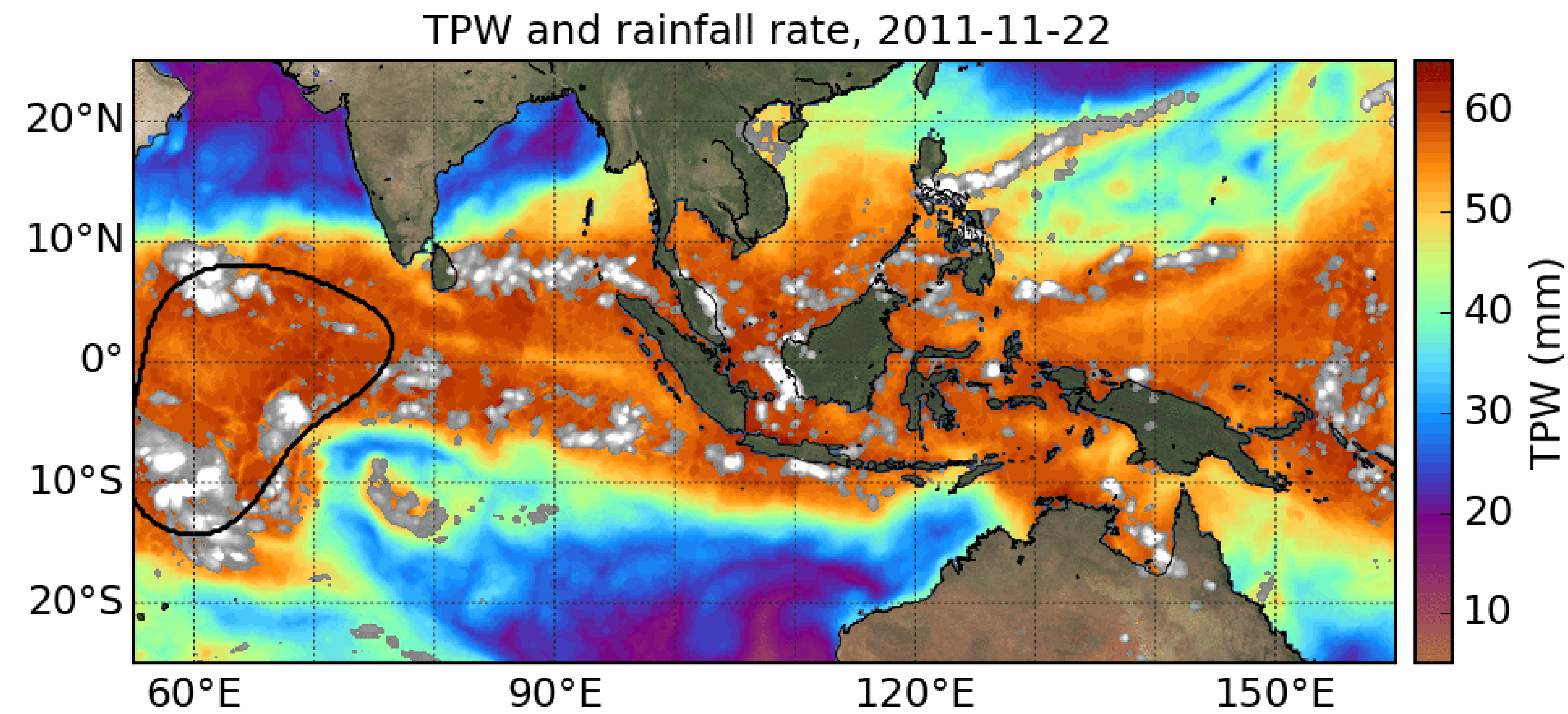
1. Develop an MJO data base for weather and climate applications
2. ASCAT & OSCAT surface winds and DYNAMO observations
3. Coupled atmosphere-ocean modeling of the MJO and model verification using scatterometer winds and OAFlux

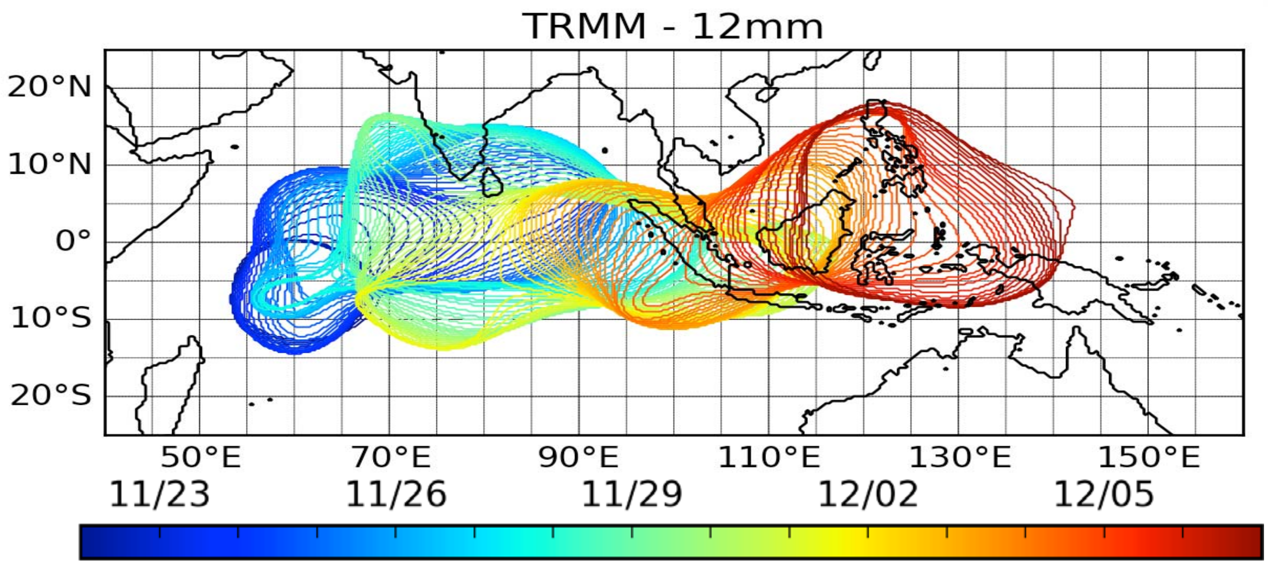
Time-Longitude TRMM 3B42 rainrate & Realtime Multivariant MJO (RMM) Index



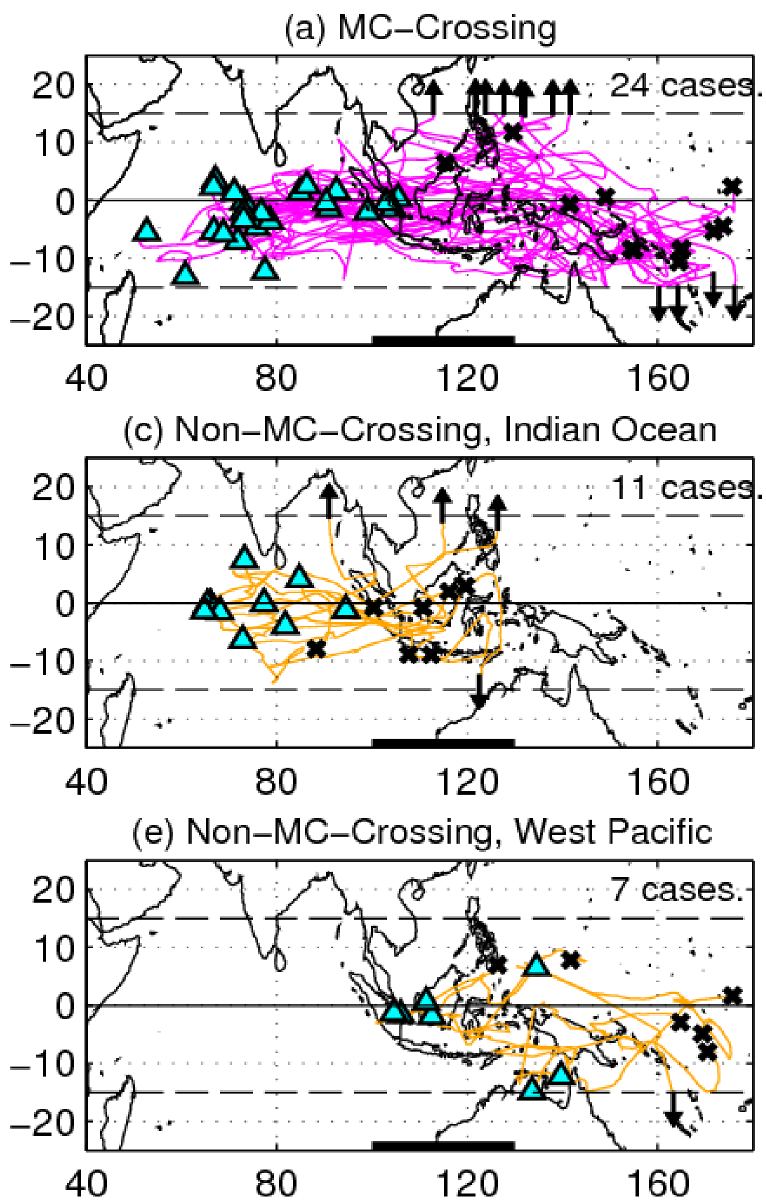
Yoneyama et al. (2013)

Large-scale Precipitation Tracking (LPT), Kerns and Chen (2016, JGR)



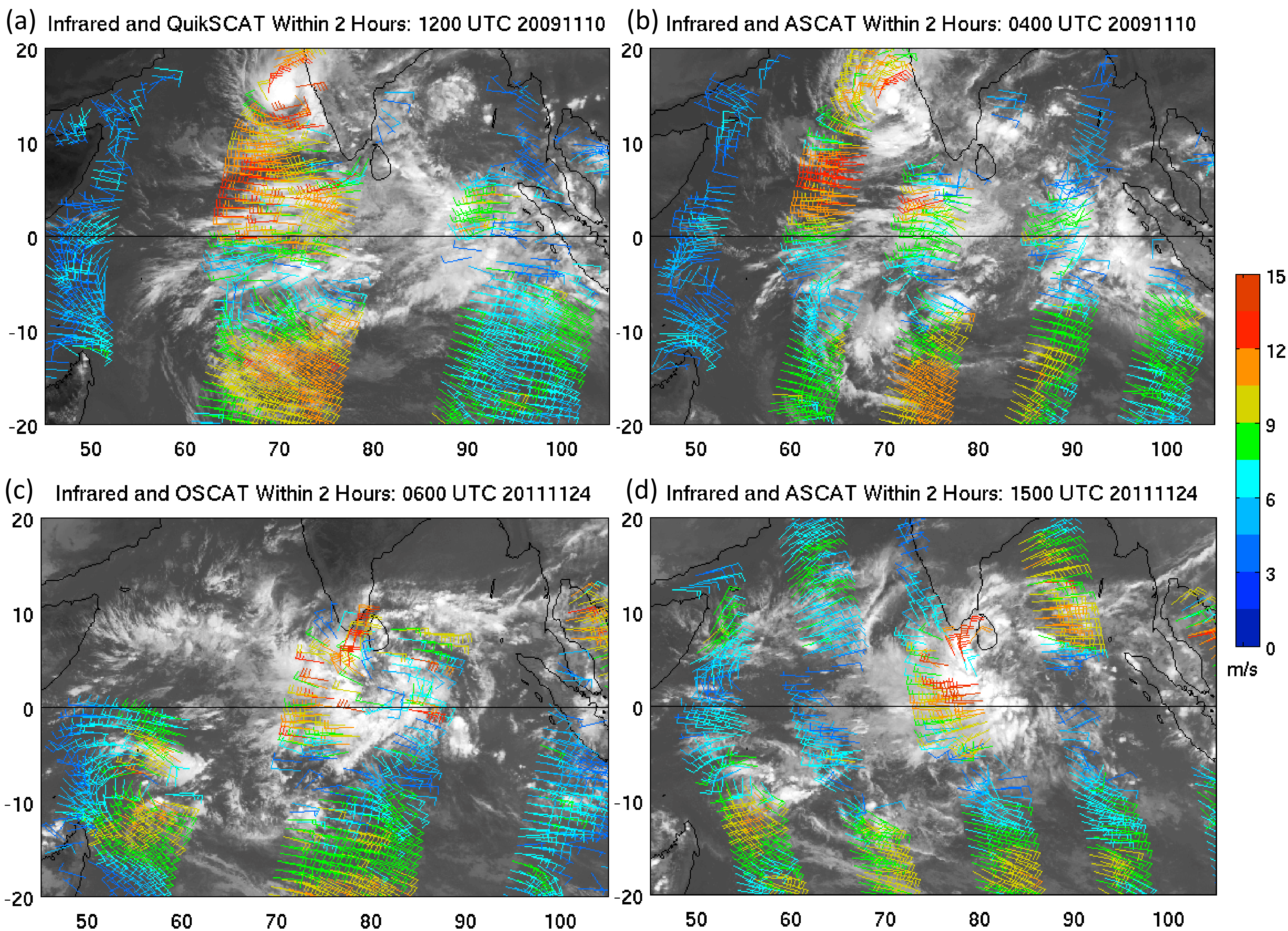


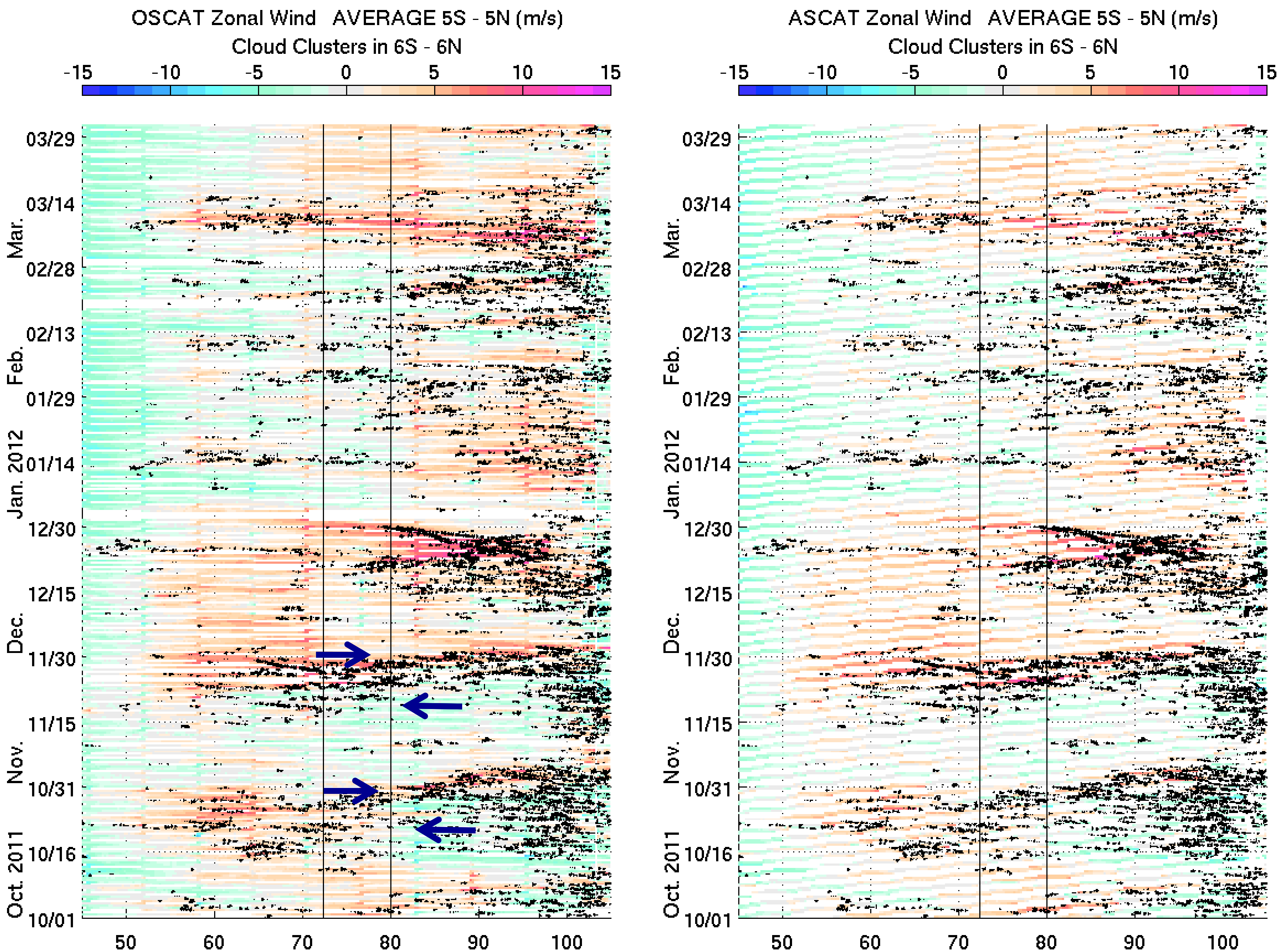
42 MJO LPTs Oct-Feb 1999-2014 TRMM (continued using GPM data)



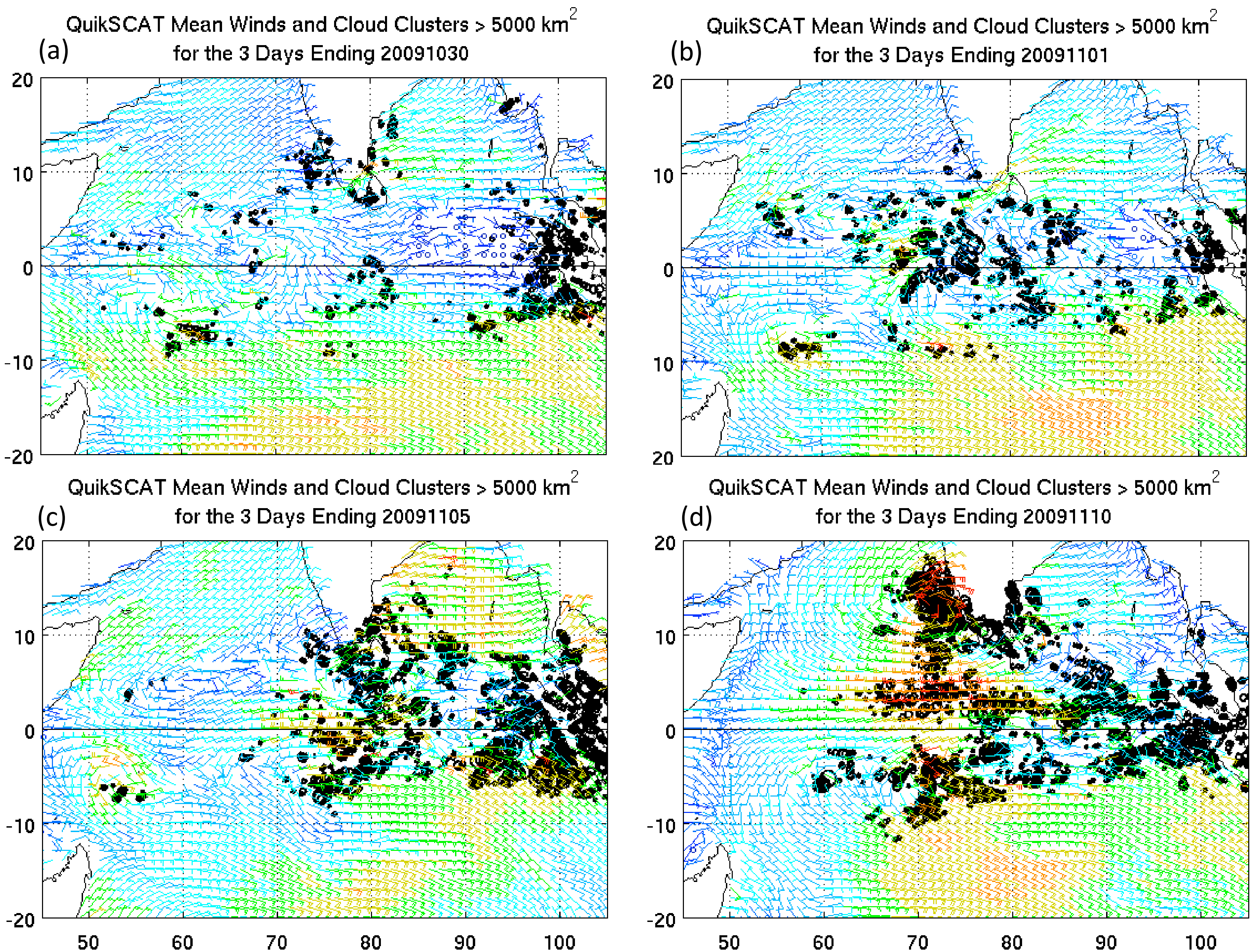
Case	IO or WP	Duration (days)	Speed (m s^{-1})	Volumetric Rainfall (10^6 mm*km^2)	RMM MJO	OMI MJO	Nino 3.4 (Celsius)
1999-12-26	IO	15	5.6	861	No	No	-1.8
2000-02-13	IO	11.5	3.5	474	No	No	-1.6
2001-01-28	WP	35.25	2.4	5024	Yes	Yes	-0.9
2001-11-28	WP	27	3.0	2588	Yes	Yes	-0.3
2003-01-21	IO	14.88	3.4	1028	No	No	+1.1
2003-02-14	WP	11.75	4.6	1083	No	Yes	+0.8
2007-01-13	IO	10.5	6.3	480	No	Yes	+0.5
2008-02-26	IO	8.62	3.6	356	Yes	No	-1.7
2009-01-05	WP	13.38	3.7	846	Yes	Yes	-1.0
2009-01-21	IO	13.25	6.0	539	No	Yes	-1.0
2009-12-29	WP	17	2.5	1283	Yes	Yes	+1.4
2010-12-21	IO	9.38	6.0	563	No	No	-1.7
2011-10-18	IO	18.5	3.7	1314	Yes	No	-1.0
2012-10-20	IO	14.88	3.2	1200	No	No	+0.3
2012-11-01	IO	13.75	3.0	1045	No	No	+0.1
2012-12-22	WP	7.12	4.8	640	No	No	-0.2
2013-11-06	IO	15.25	2.7	765	No	No	-0.2
2014-10-11	IO	9.88	3.6	571	No	No[#]	+0.5

Kerns and Chen (2016, JGR)


(a) Infrared and QuikSCAT Within 2 Hours: 1200 UTC 20091110
(b) Infrared and ASCAT Within 2 Hours: 0400 UTC 20091110
(c) Infrared and OSCAT Within 2 Hours: 0600 UTC 20111124
(d) Infrared and ASCAT Within 2 Hours: 1500 UTC 20111124
20
10
0
-10
-20
50
60
70
80
90
100
15
12
9
6
3
0
m/s

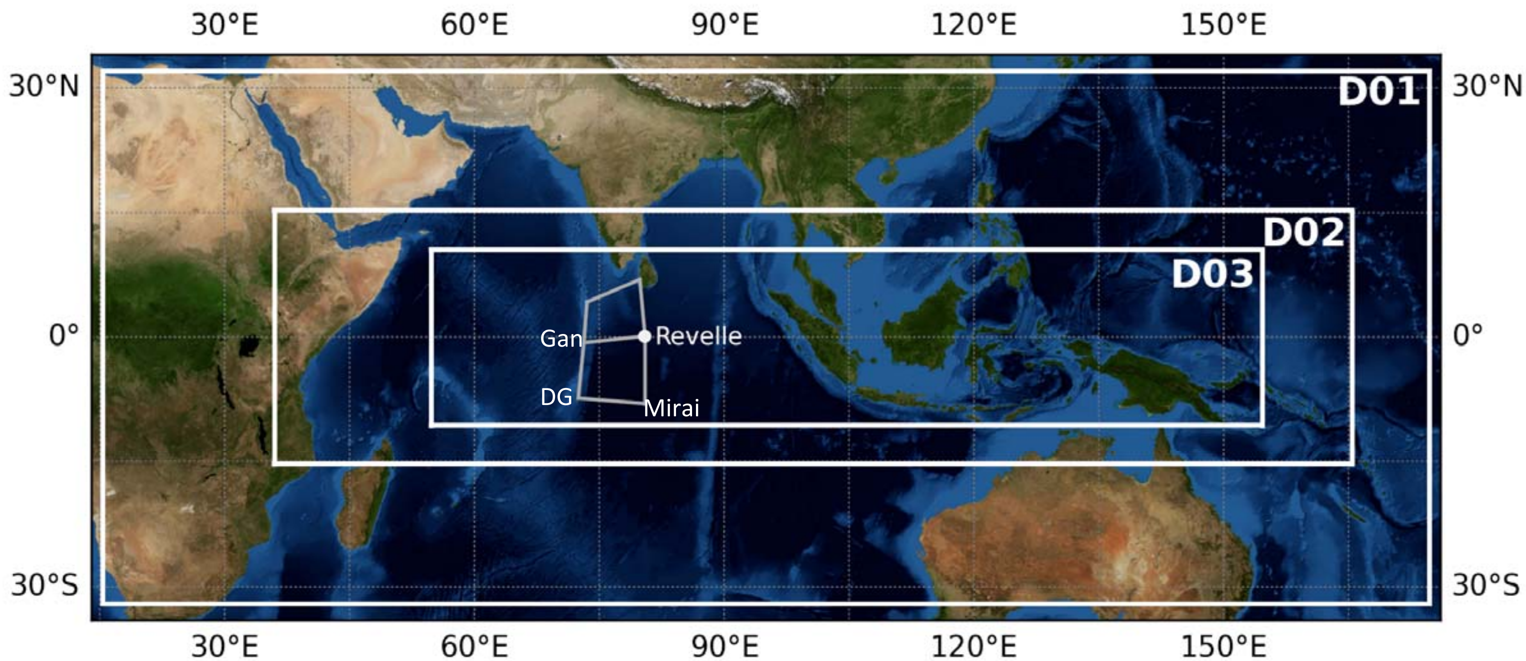


OSCAT Zonal Wind AVERAGE 5S - 5N (m/s)
Cloud Clusters in 6S - 6N
ASCAT Zonal Wind AVERAGE 5S - 5N (m/s)
Cloud Clusters in 6S - 6N
-15 -10 -5 0 5 10 15
03/29
03/14
Mar.
02/28
02/13
Feb.
01/29
Jan. 2012
01/14
12/30
12/15
Dec.
11/30
11/15
Nov.
10/31
Oct. 2011
10/16
10/01
50 60 70 80 90 100

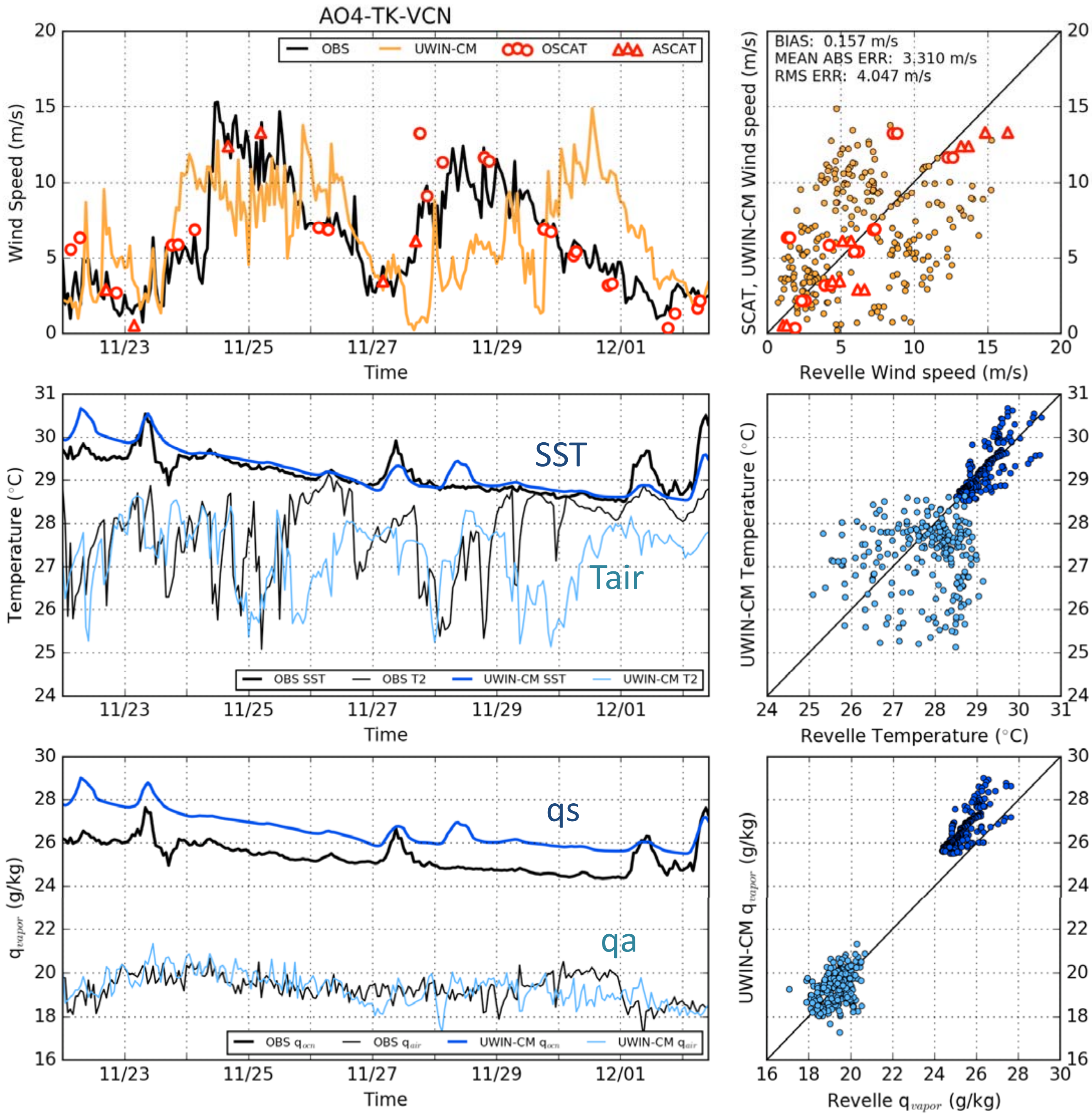

QuikSCAT Mean Winds and Cloud Clusters > 5000 km^2
(a)
for the 3 Days Ending 20091030
QuikSCAT Mean Winds and Cloud Clusters > 5000 km^2
(b)
for the 3 Days Ending 20091101
QuikSCAT Mean Winds and Cloud Clusters > 5000 km^2
(c)
for the 3 Days Ending 20091105
QuikSCAT Mean Winds and Cloud Clusters > 5000 km^2
(d)
for the 3 Days Ending 20091110
20
10
0
-10
-20
50
60
70
80
90
100

Unified Wave-Interface Coupled Model (UWIN-CM):

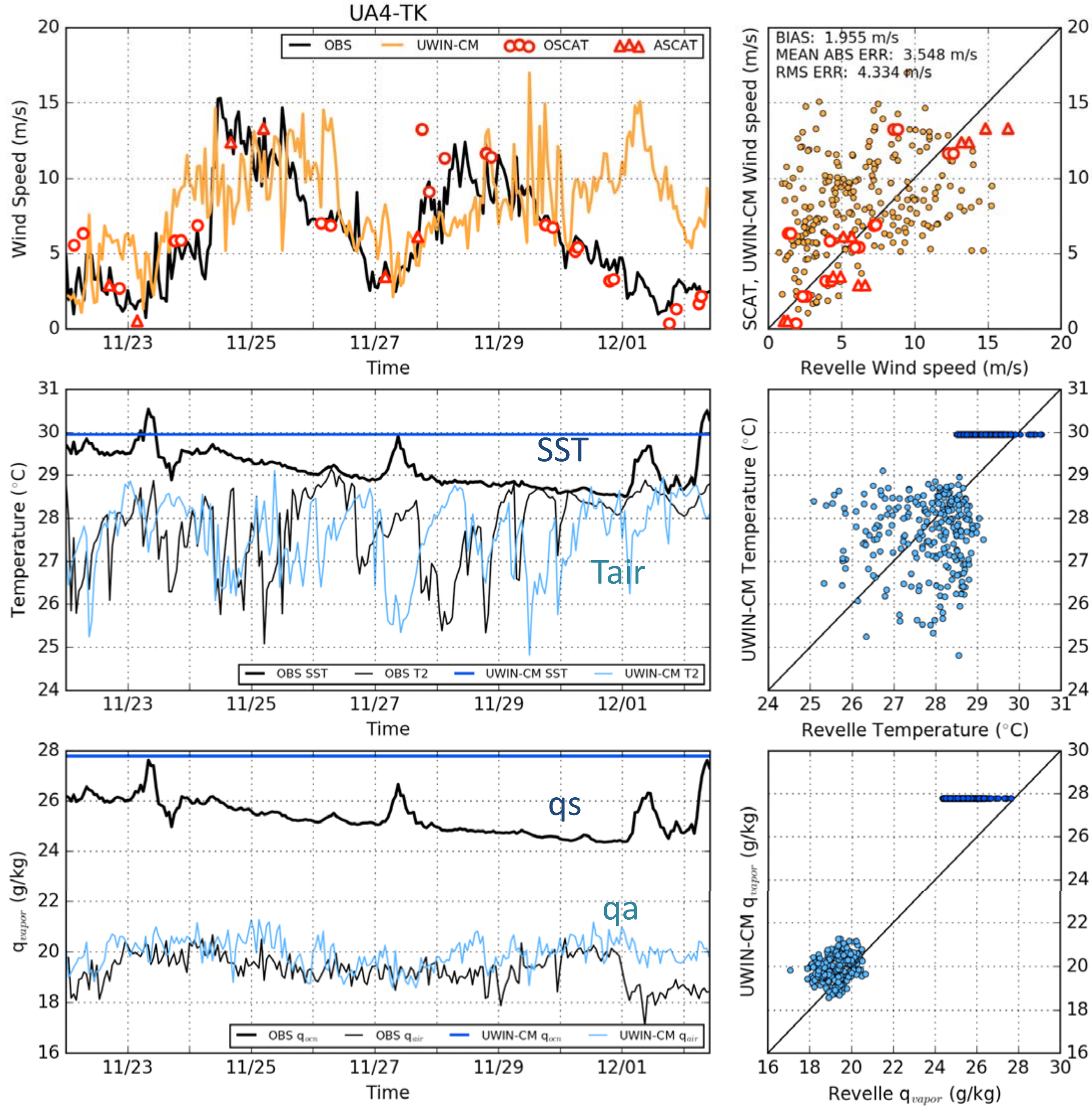
- Weather Research and Forecasting (WRF) v3.7.1:
  12-4-1.3 km nested grids, 44 vertical levels
  physics: YSU PBL, Donelan+Garrat sfc., WSM6 microphy
  Initial and boundary conditions from ECMWF analysis fields
- University of Miami Wave Model (UMWM) v1.2:
  4 km, 0.01 Hz
- HYbrid Coordinate Ocean Model (HYCOM) v2.2.34:
  1/25 degree (~4 km) horizontal resolution, 32 vertical levels;
  Initial and boundary conditions from global 1/12 deg. HYCOM



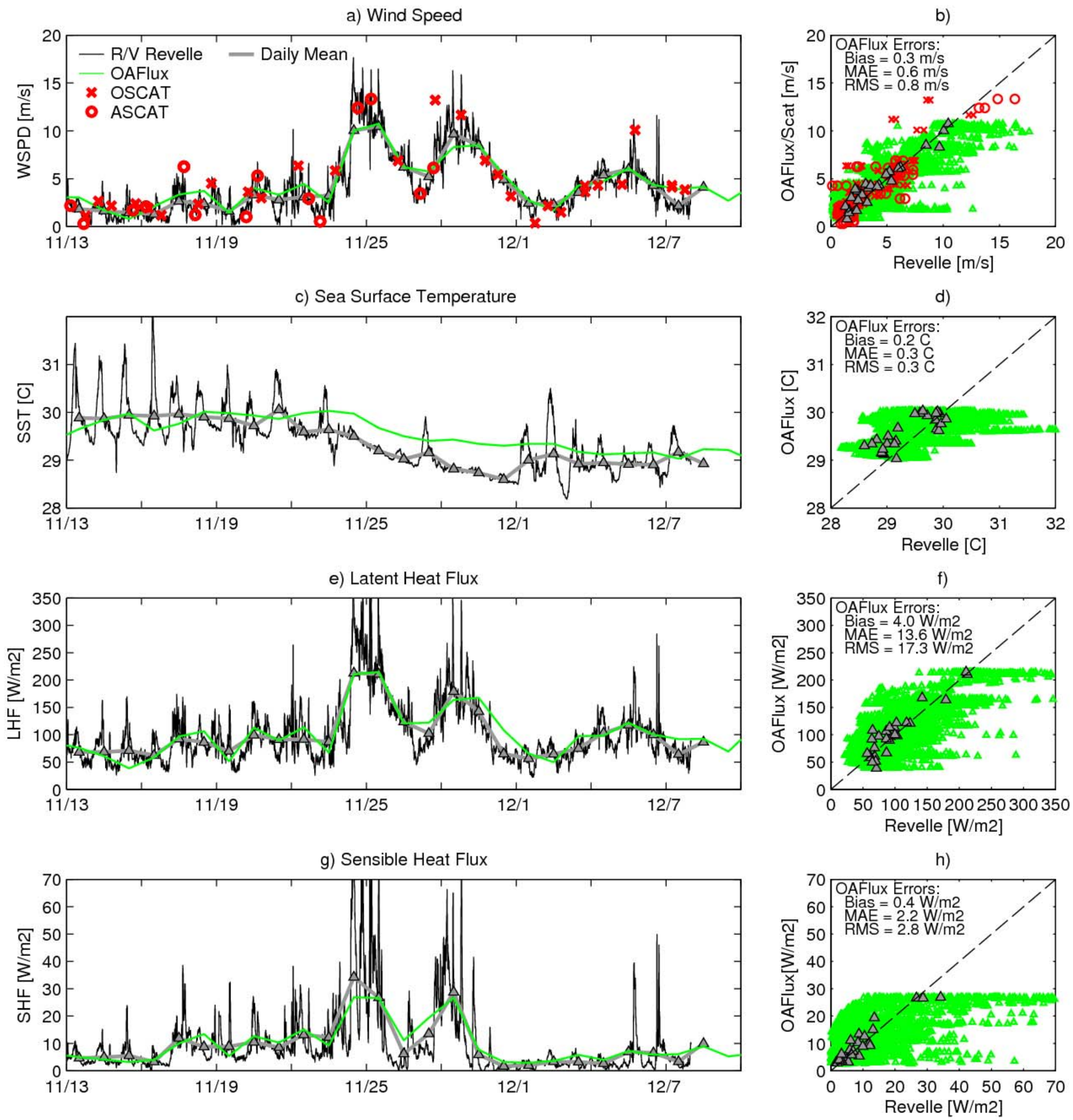
UWIN-CM (WRF-HYCOM)



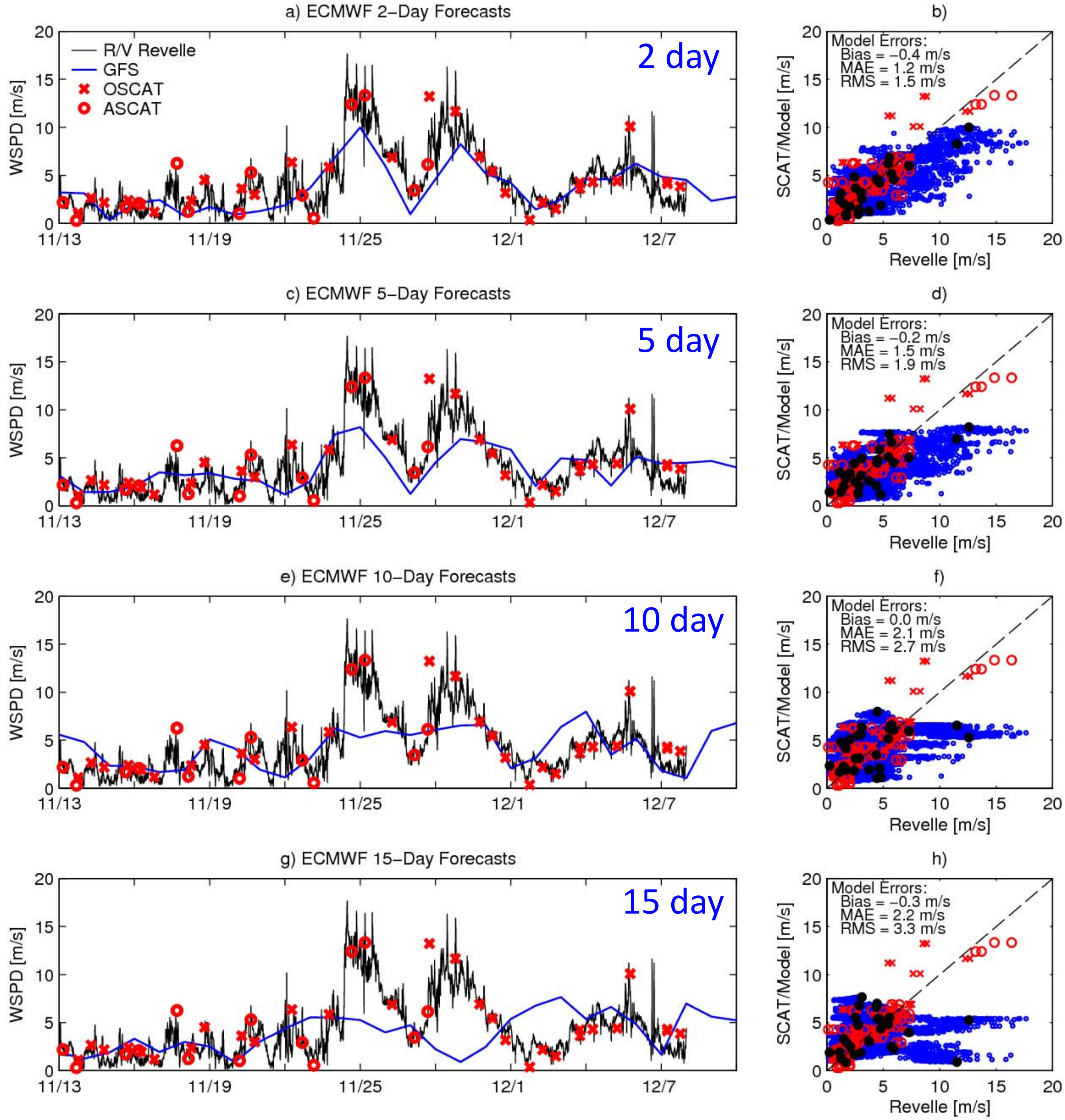
WRF (Uncoupled)



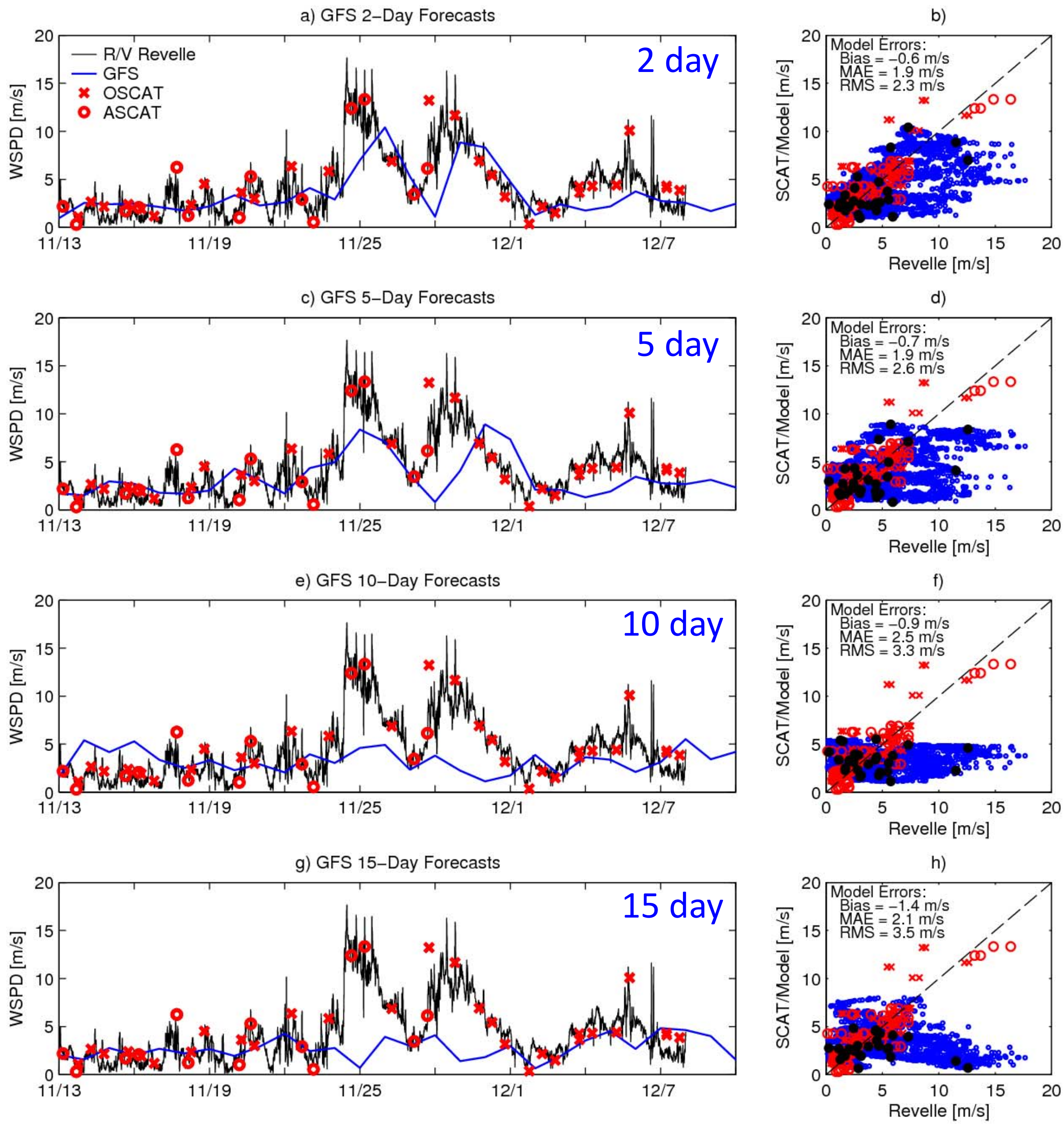
OAFlux (daily)



ECMWF forecasts



GFS forecasts



Summary and Next Step

- **Large-scale Precipitation Tracking (LPT) using TRMM-GPM made it possible for building an MJO data set for weather and climate applications**
- **ASCAT, OSCAT, and OAFlux data are compared with the in situ DYNAMO observations**
- **Air-sea coupling significantly improves model biases**
- **Building the MJO data base (e.g., wind, rain, SST, air-sea fluxes)**

Suggestions???

- **Evaluating and improving air-sea coupling physics in UWIN-CM**