Investigating the Seasonal and Diurnal Cycles of Ocean Vector Winds, Precipitation, and Lightning near the Philippines
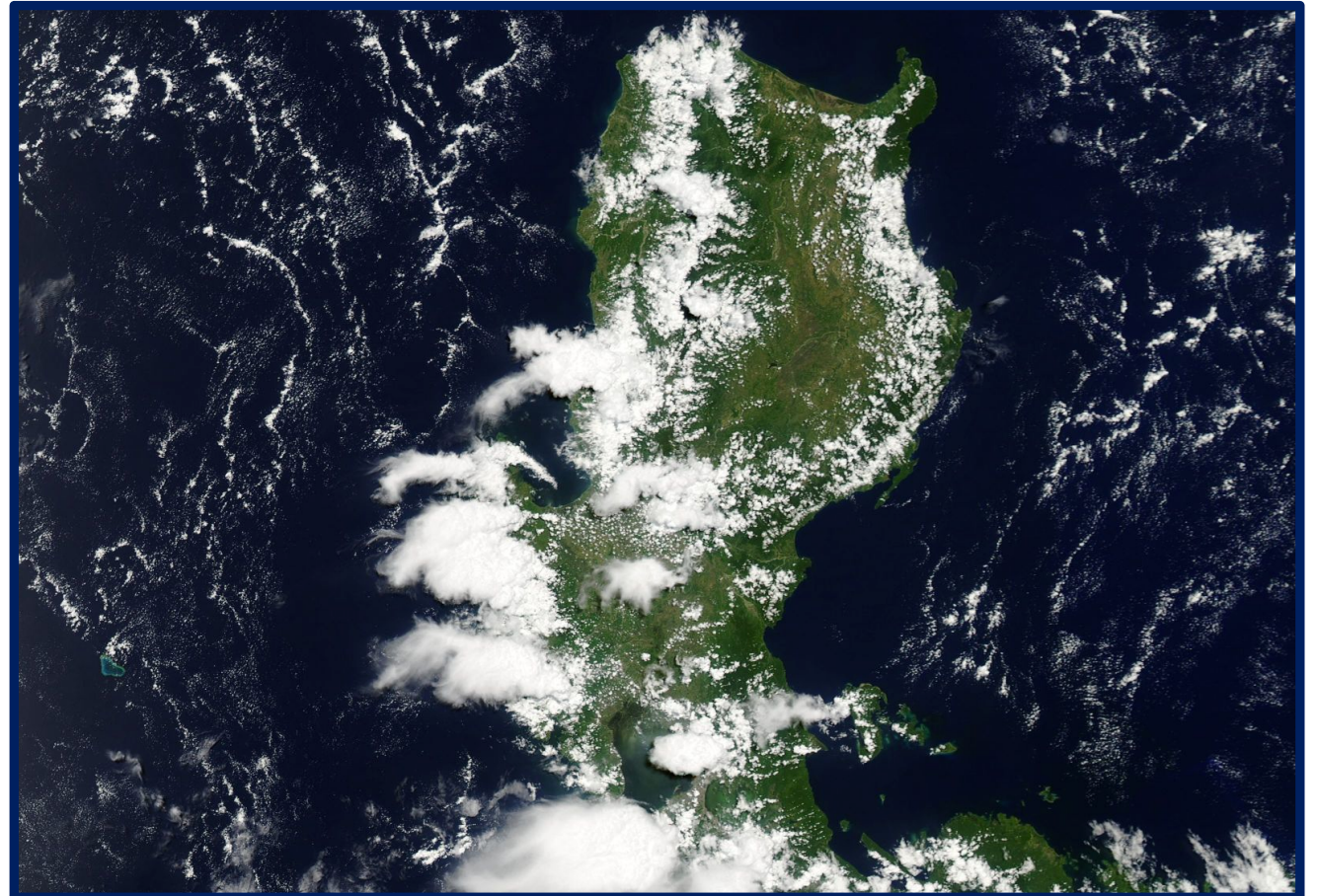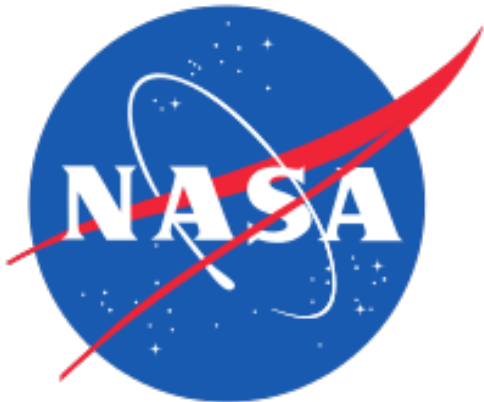
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NASA Marshall Space Flight Center

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Colorado State University

Background

Boreal Summer Intraseasonal Oscillation (BSISO) creates northeastward-moving disturbances, which interact with the strong diurnal cycle of the Maritime Continent, complicating sub-seasonal forecasts.

Key Questions
- Can we characterize the diurnal cycle of vector winds near the west coast of Luzon using satellite-based datasets?
- How does the BSISO affect the intraseasonal variability and diurnal cycle of winds, precipitation, and lightning near the Philippines?

http://onrpiston.colostate.edu
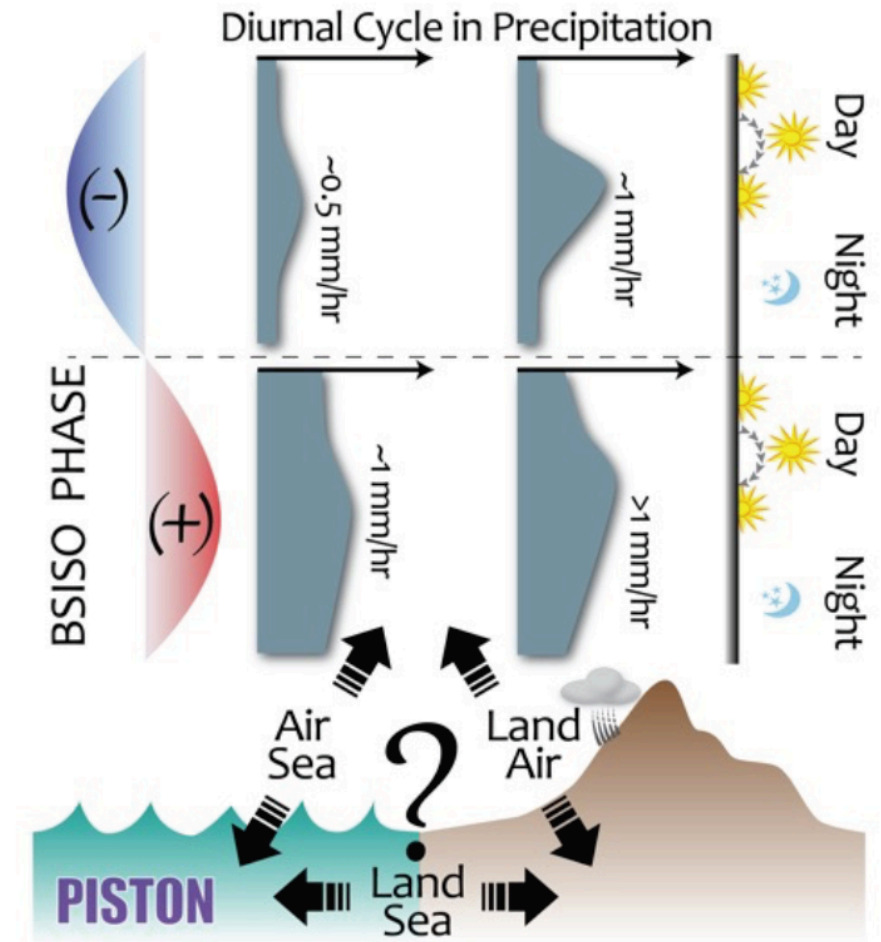
Datasets and Methodology

RapidScat 12.5-km Climate V1.0
- Each relevant swath binned to 0.25-degree, 2-hourly grid
- Diurnal harmonic fit to dataset

Cross-Calibrated Multi-Platform (CCMP) Winds V2.0
- Includes ASCAT-A, WindSat, GMI, AMSR-2, SSMI/S, Buoys assimilated into model
- 0.25-degree, 6-hourly grid

Tropical Rainfall Measuring Mission (TRMM)
- 3B42 Rainfall Product
- Lightning Imaging Sensor (LIS) Flashes

Primary Domain of Interest – 5 °S to 20 °N, 110-130 °E

Luzon

900427 002822 STS31 80 088

https://eol.jsc.nasa.gov/
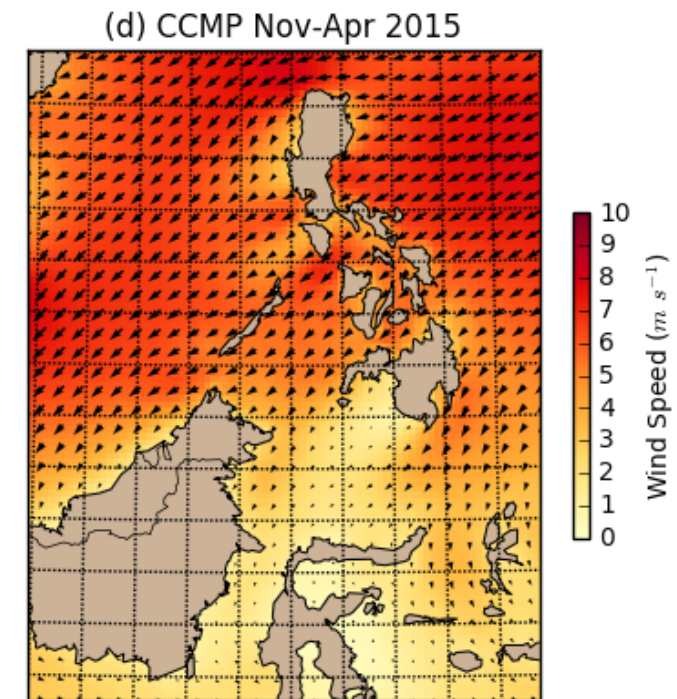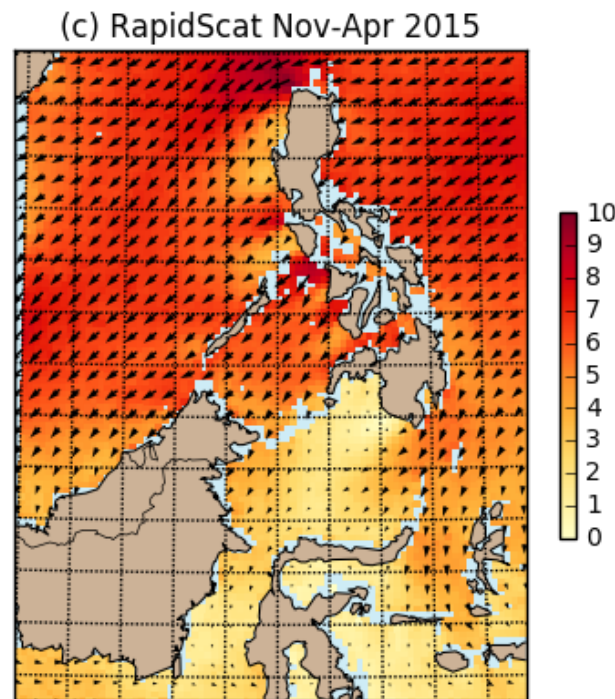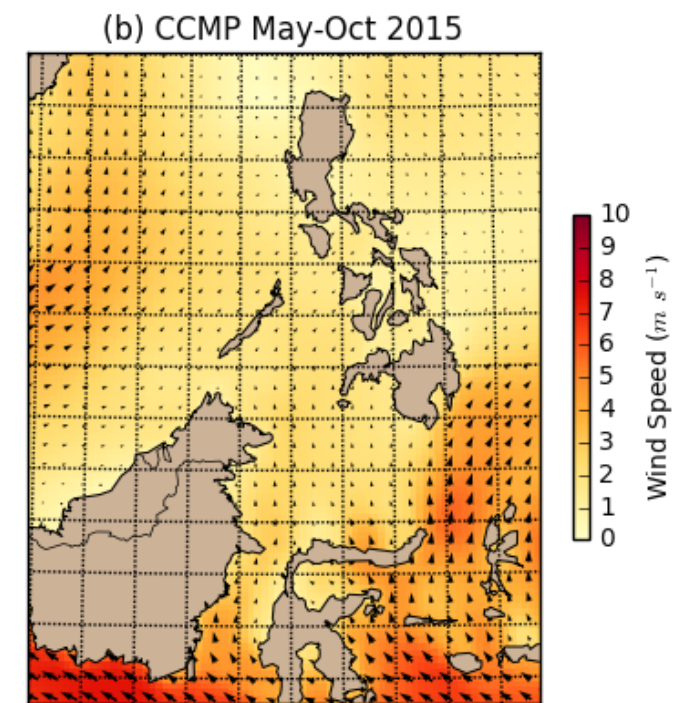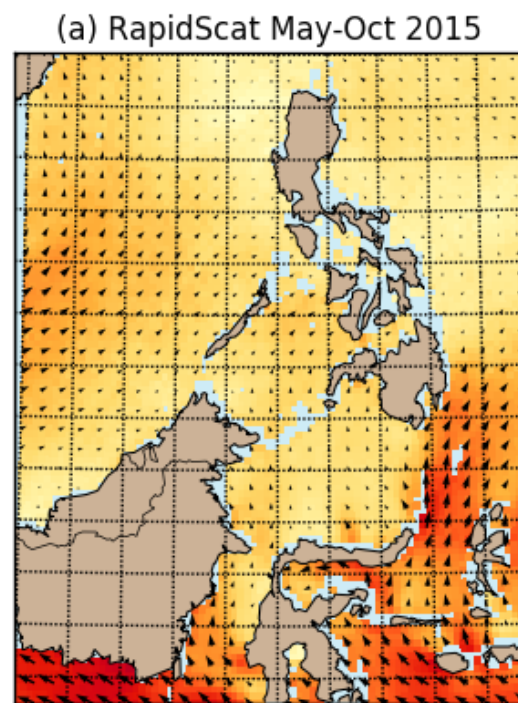
Seasonal Results

May-Oct: "Monsoon"
Nov-Apr: Trade wind regime

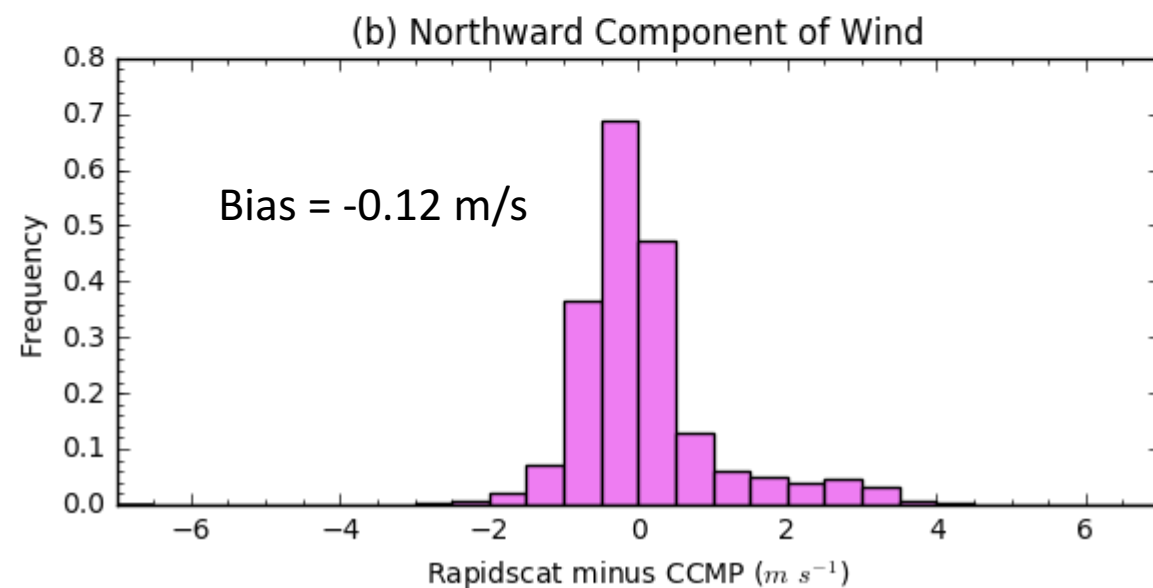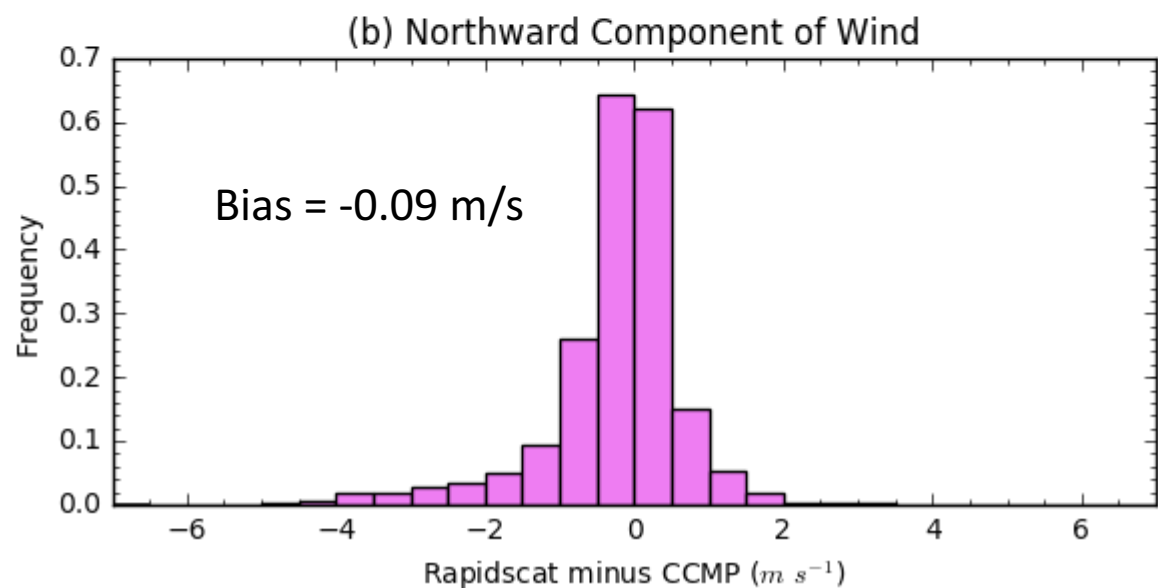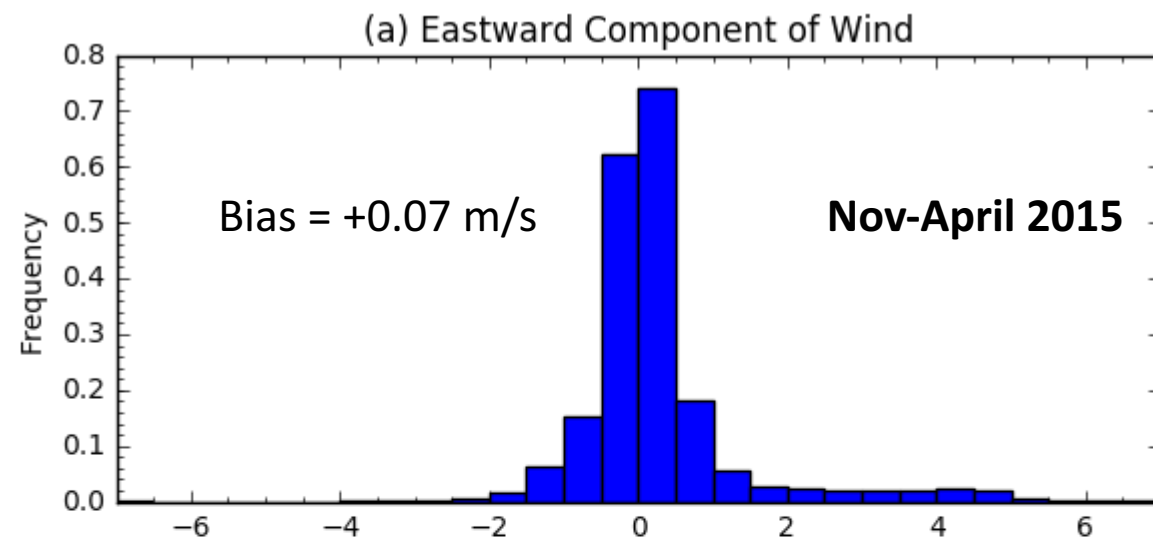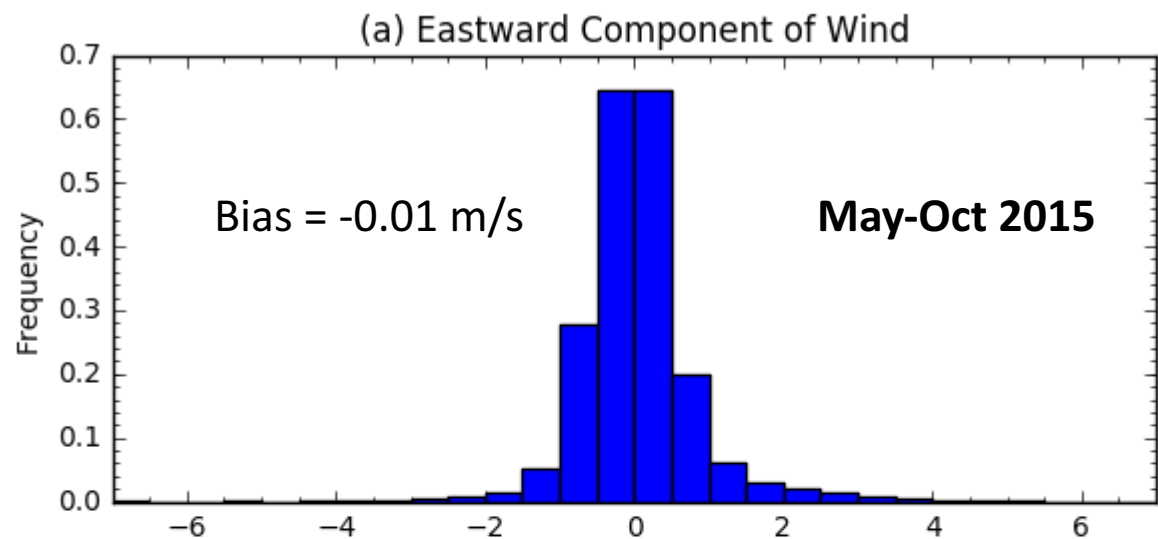Relatively good agreement between RapidScat and CCMP

West of Luzon is region of relatively weak mean winds

Several gap flows observed in both datasets

(RapidScat filtered to remove grid boxes with < 400 samples 2014-2016)
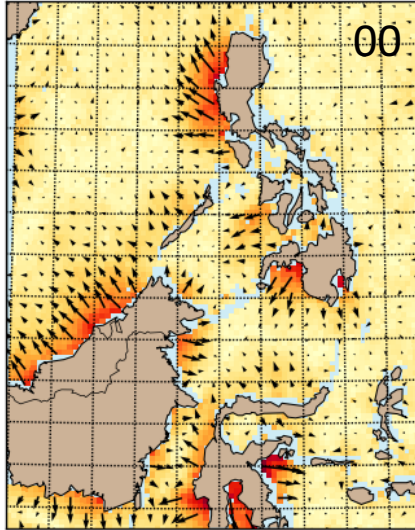

(a) RapidScat May-Oct 2015

(b) CCMP May-Oct 2015

(c) RapidScat Nov-Apr 2015

(d) CCMP Nov-Apr 2015

RapidScat – CCMP, Seasonal Means, Whole Domain

(a) Eastward Component of Wind

Bias = -0.01 m/s   May-Oct 2015

(b) Northward Component of Wind

Bias = -0.09 m/s

Rapidscat minus CCMP ($m\ s^{-1}$)

(a) Eastward Component of Wind

Bias = +0.07 m/s   Nov-April 2015

(b) Northward Component of Wind

Bias = -0.12 m/s

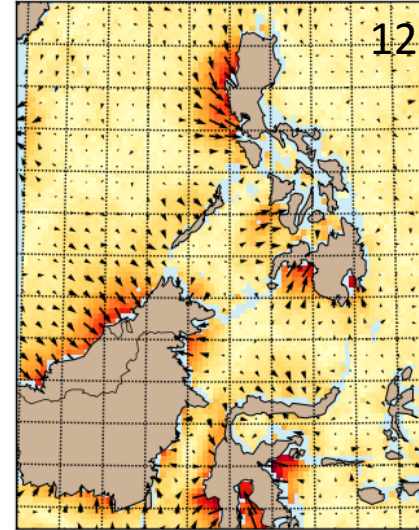Rapidscat minus CCMP ($m\ s^{-1}$)

Diurnal Cycle – 2014-2016
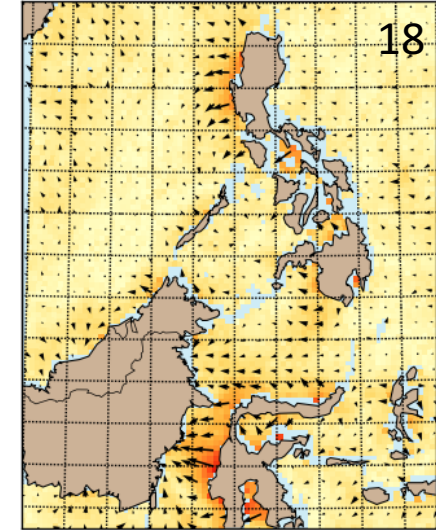

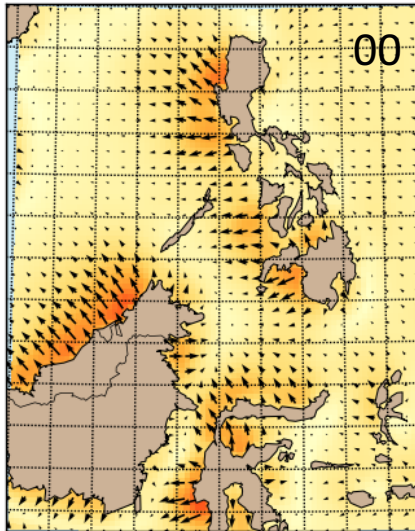(a) RapidScat 00 UTC   (b) RapidScat 06 UTC   (c) RapidScat 12 UTC   (d) RapidScat 18 UTC
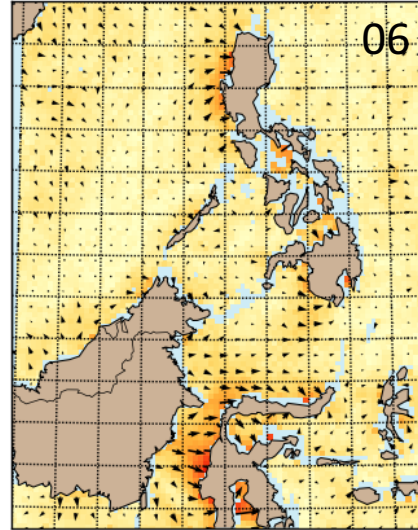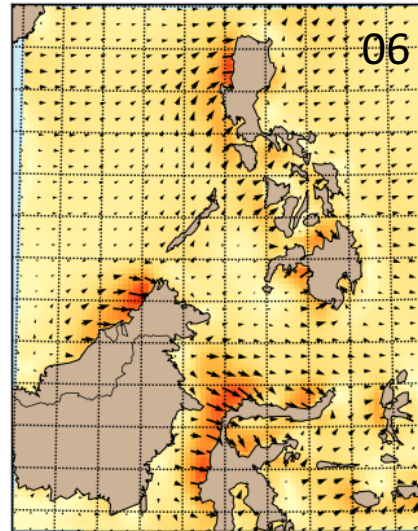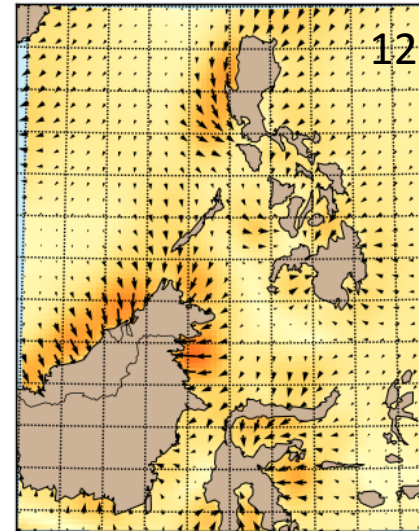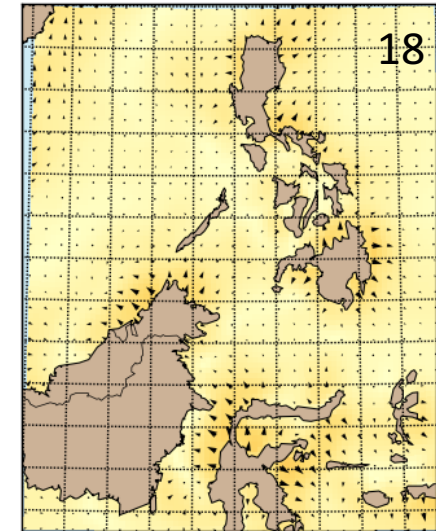
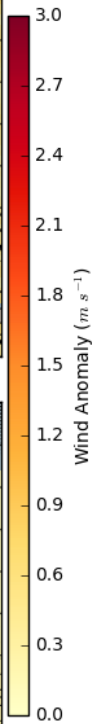(e) CCMP 00 UTC   (f) CCMP 06 UTC   (g) CCMP 12 UTC   (h) CCMP 18 UTC

RapidScat (Diurnal Harmonic)
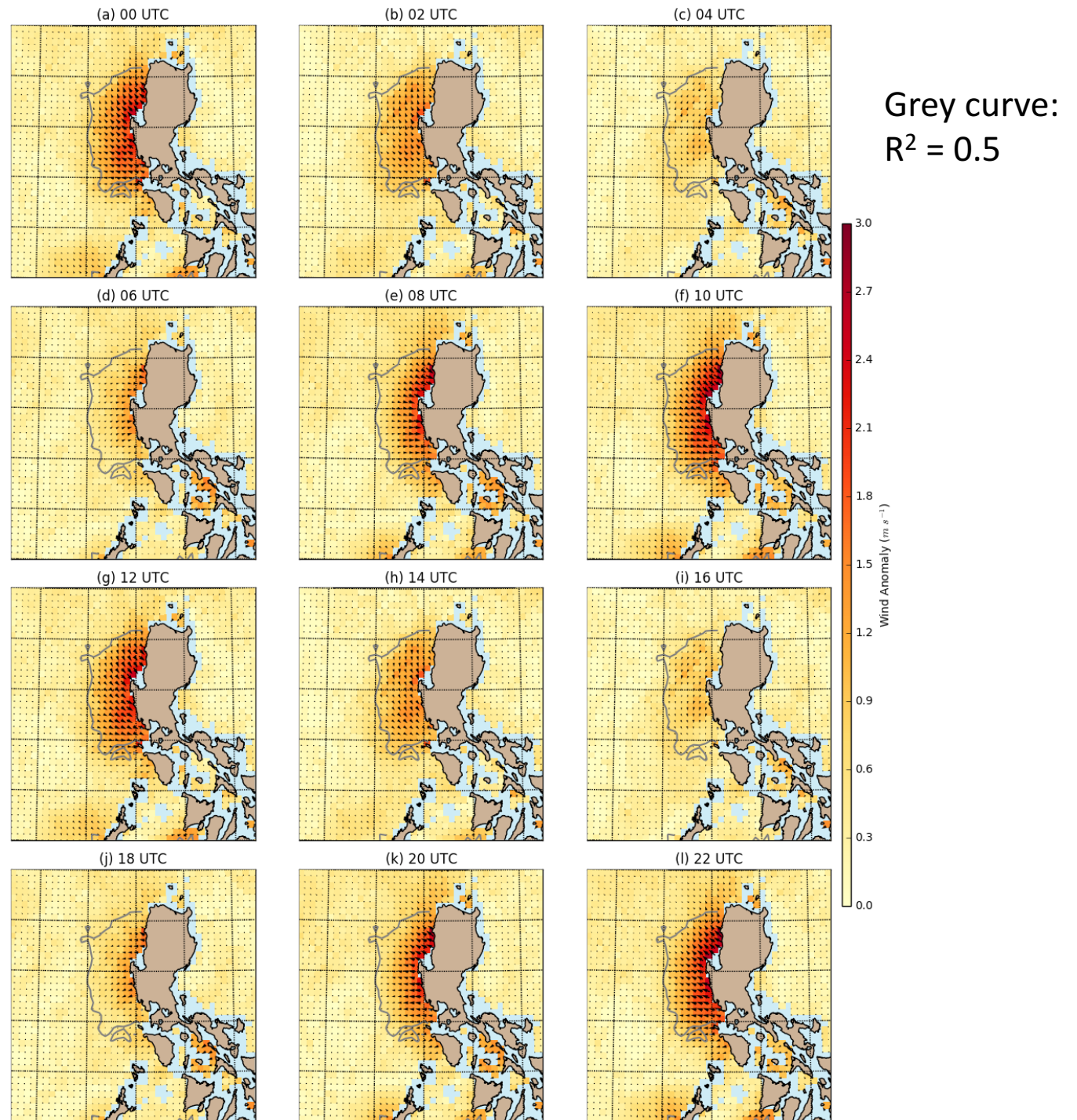
CCMP

Wind Anomaly ($m\ s^{-1}$)

RapidScat 2-hourly Diurnal Harmonic

Oct 2014 - August 2016

Peak winds closer to 10 (onshore) and 22 UTC (offshore) than 00/12

Diurnal influence extends ~200 km west

Grey curve:
$R^2 = 0.5$

Sampling Considerations

- Binning and averaging non-optimal; more sophisticated methods being explored
- However, near Philippines there does not appear to be a major diurnal bias in sampling
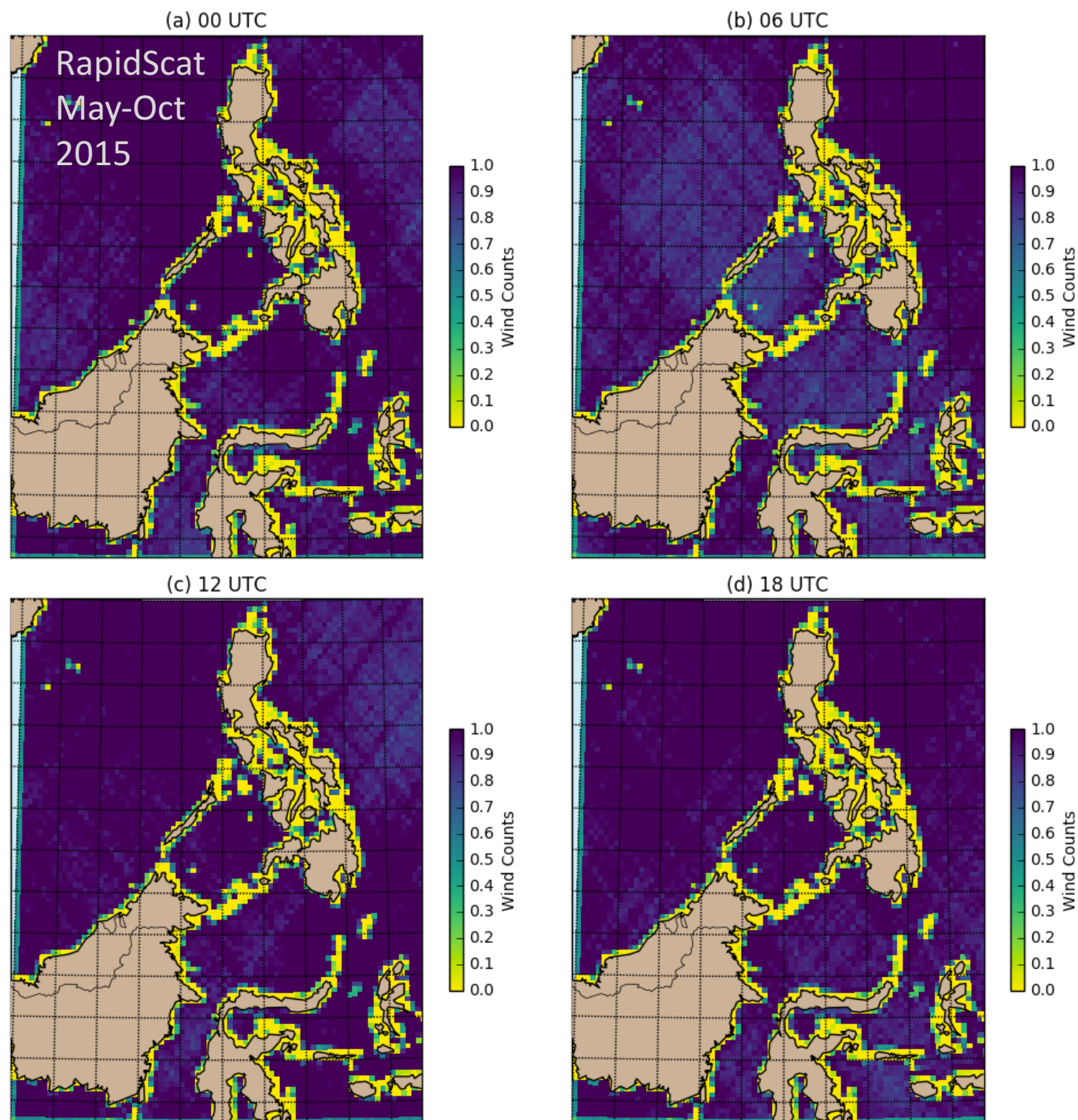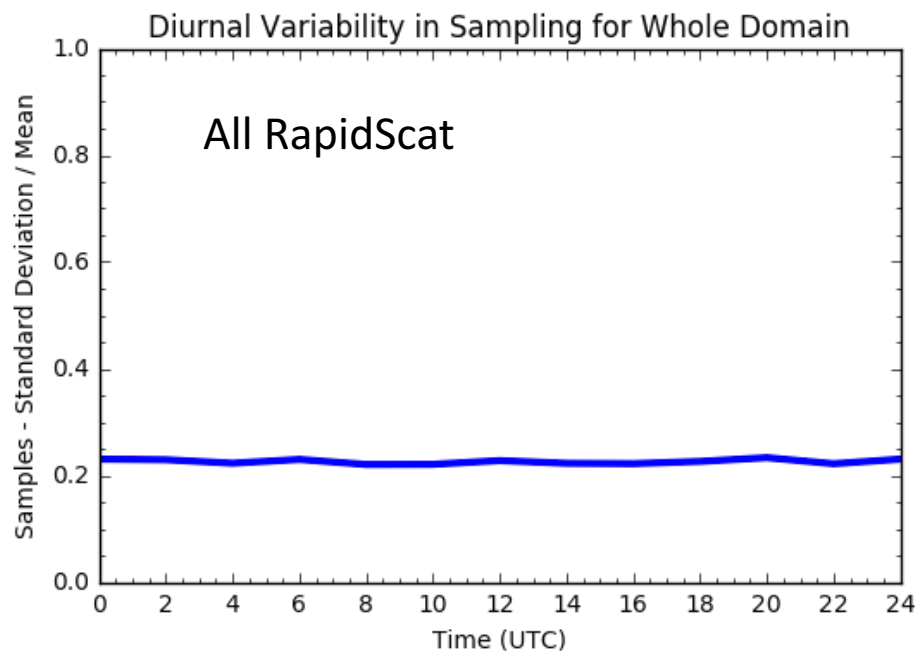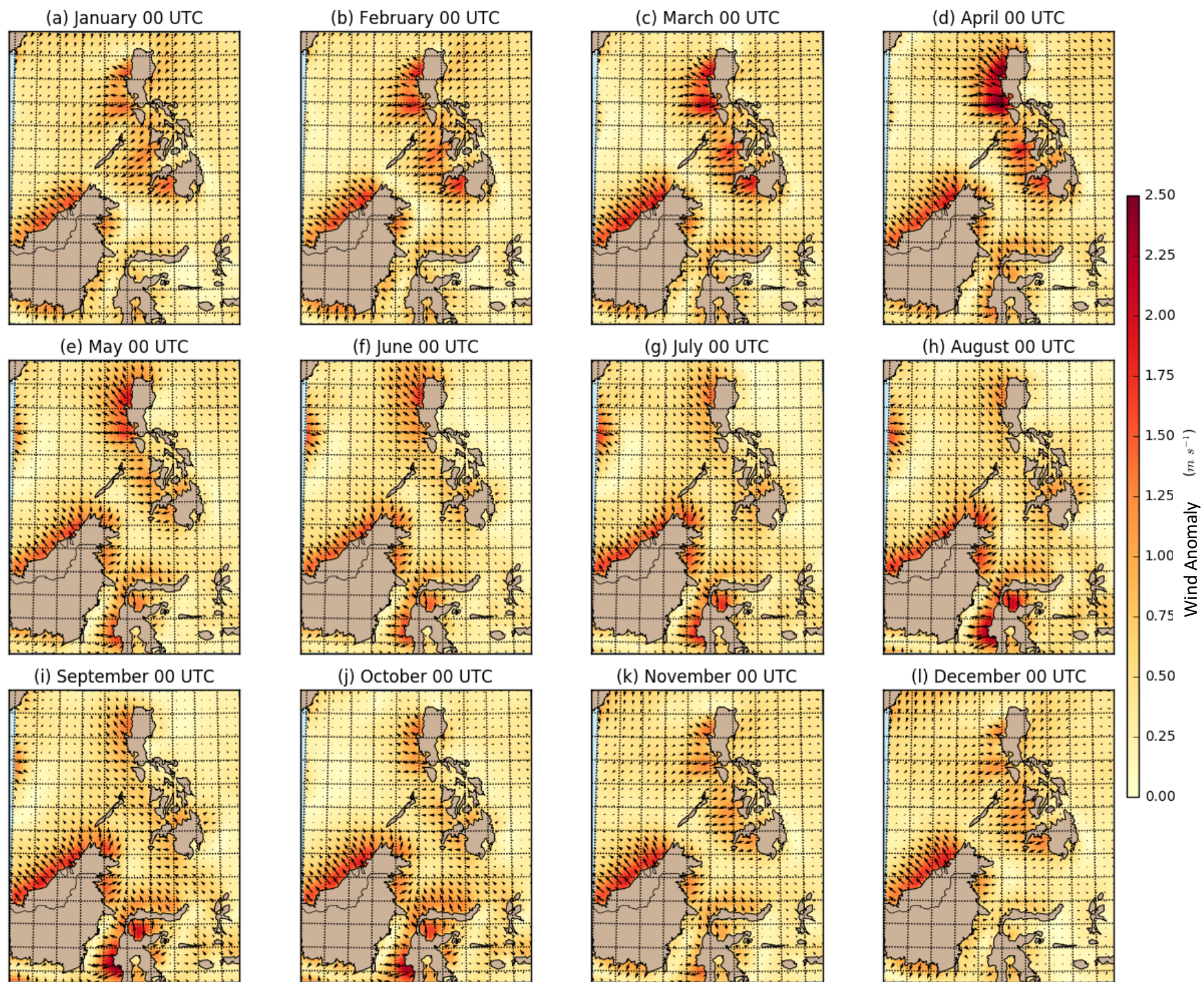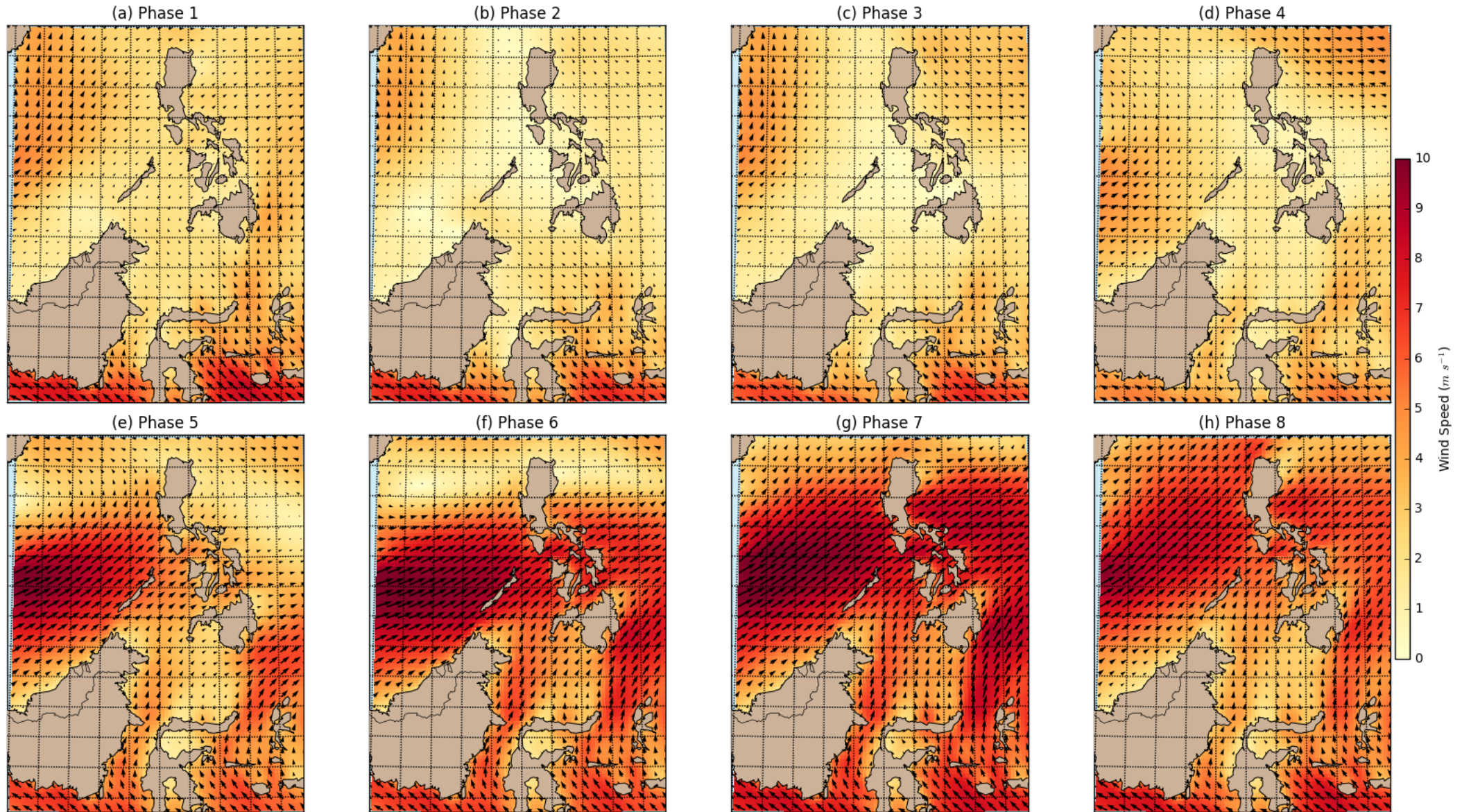
CCMP Diurnal Cycle

Monthly 1997-2016
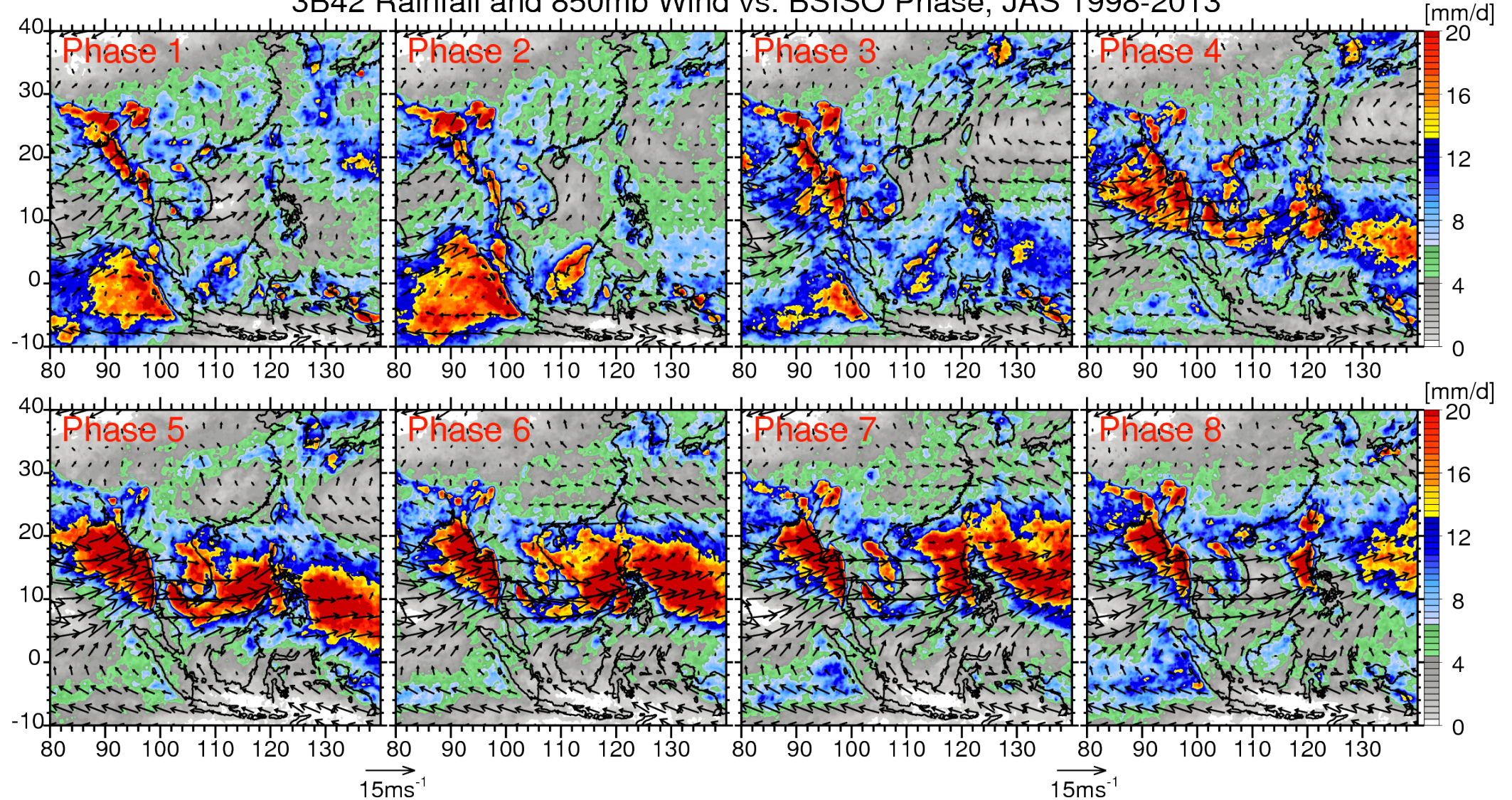
00 UTC

Amplitude peaks in April

CCMP Winds by BSISO Phase – July-September 1997-2013, Magnitude > 1

(a) Phase 1   (b) Phase 2   (c) Phase 3   (d) Phase 4

(e) Phase 5   (f) Phase 6   (g) Phase 7   (h) Phase 8
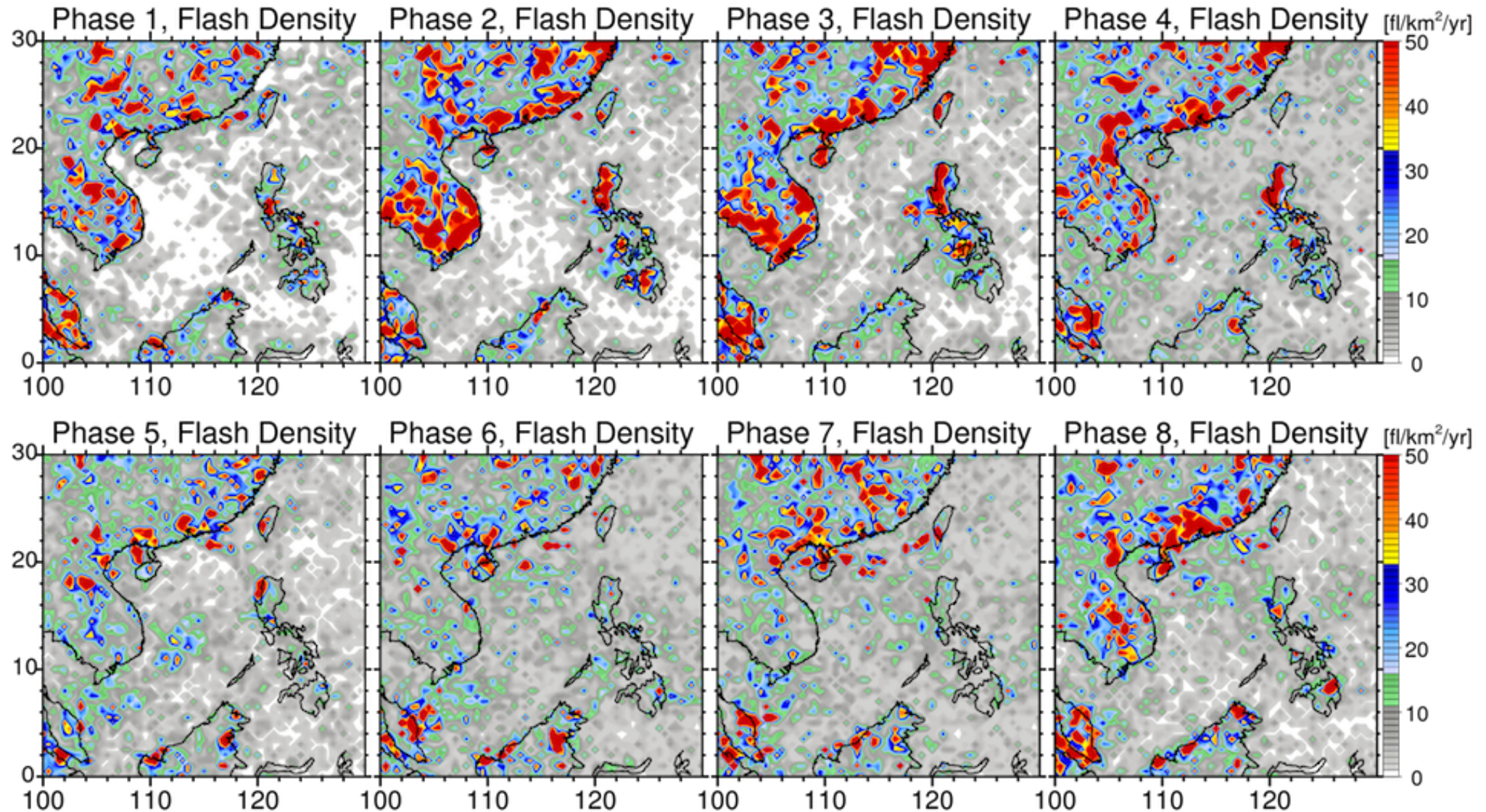
Wind Speed ($m\ s^{-1}$)

TRMM and ECMWF

3B42 Rainfall and 850mb Wind vs. BSISO Phase, JAS 1998-2013
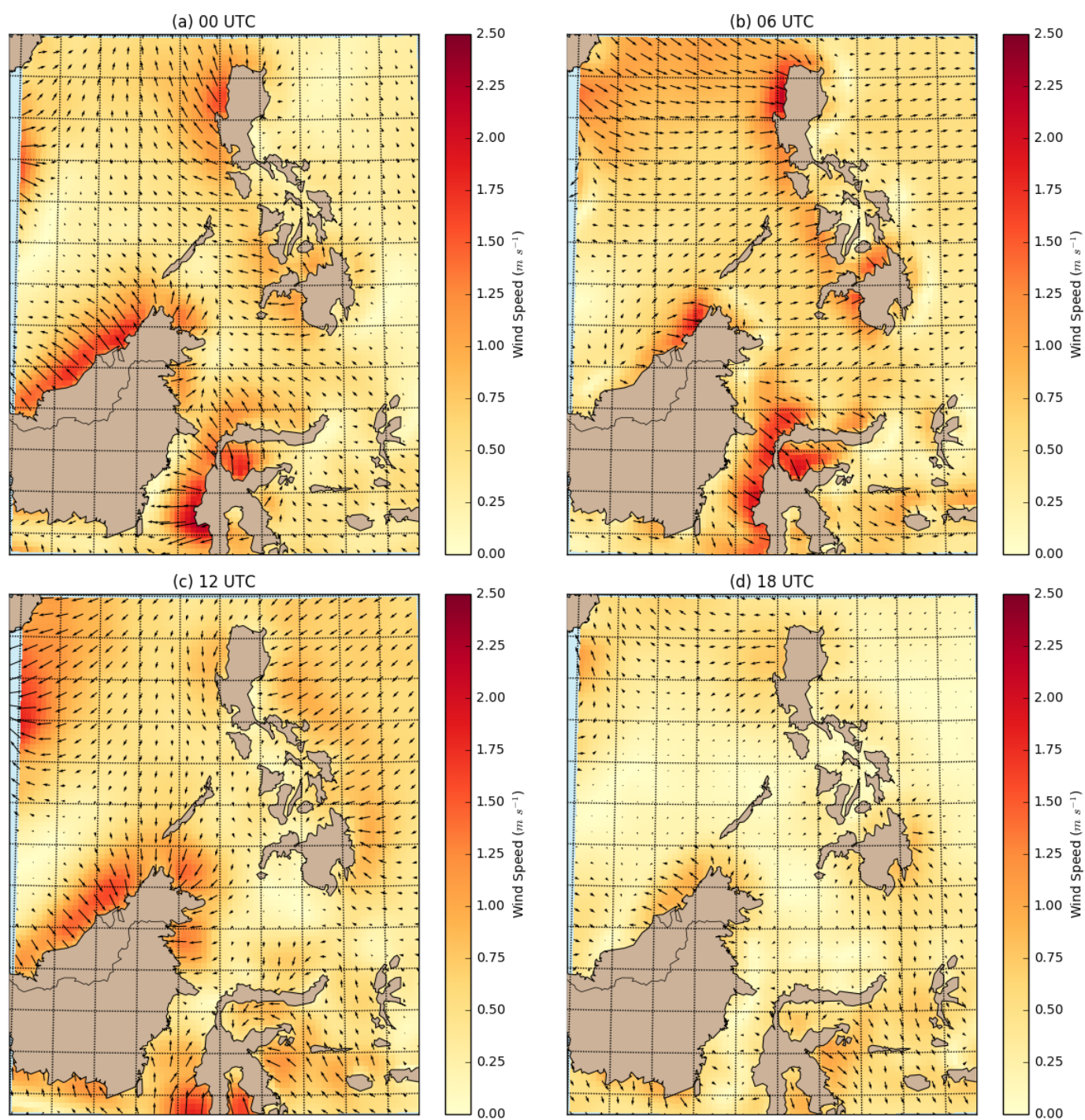
TRMM LIS Flash Density by BSISO Phase, JAS
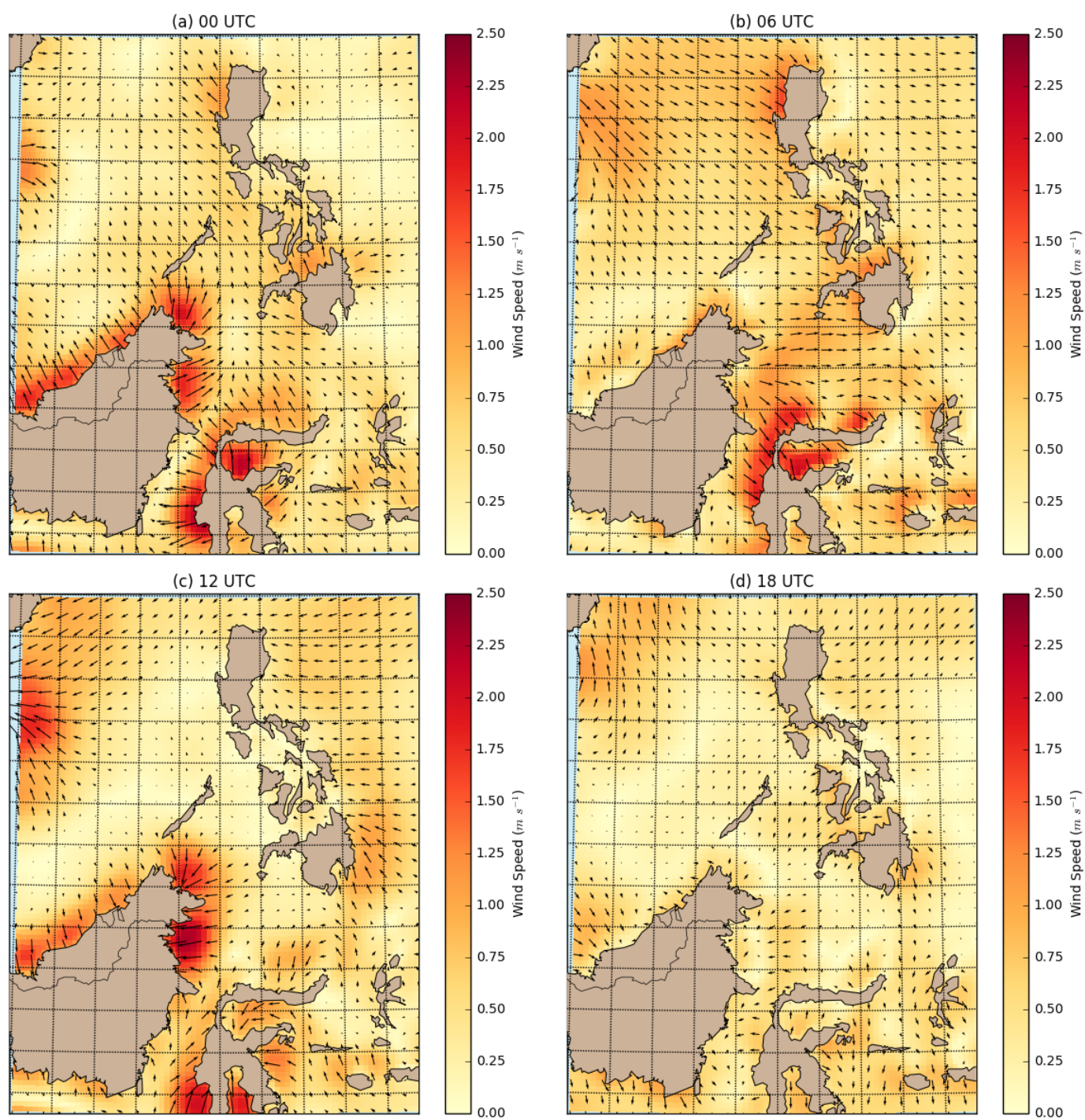
Inactive BSISO

Phases 1-3
Magnitude > 1

CCMP
JAS 1997-2013

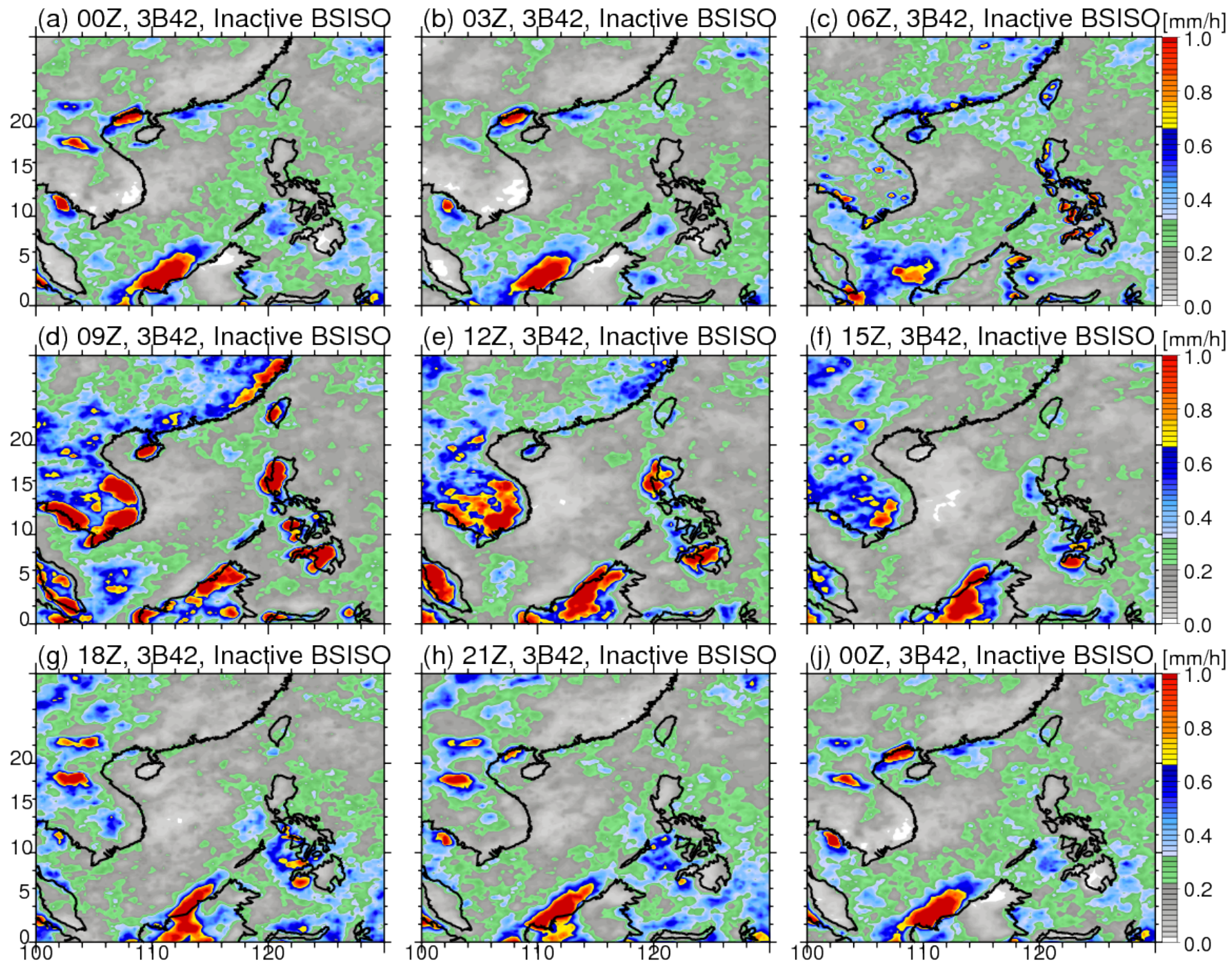# Active BSISO

Phases 5-7
Magnitude > 1

CCMP
JAS 1997-2013

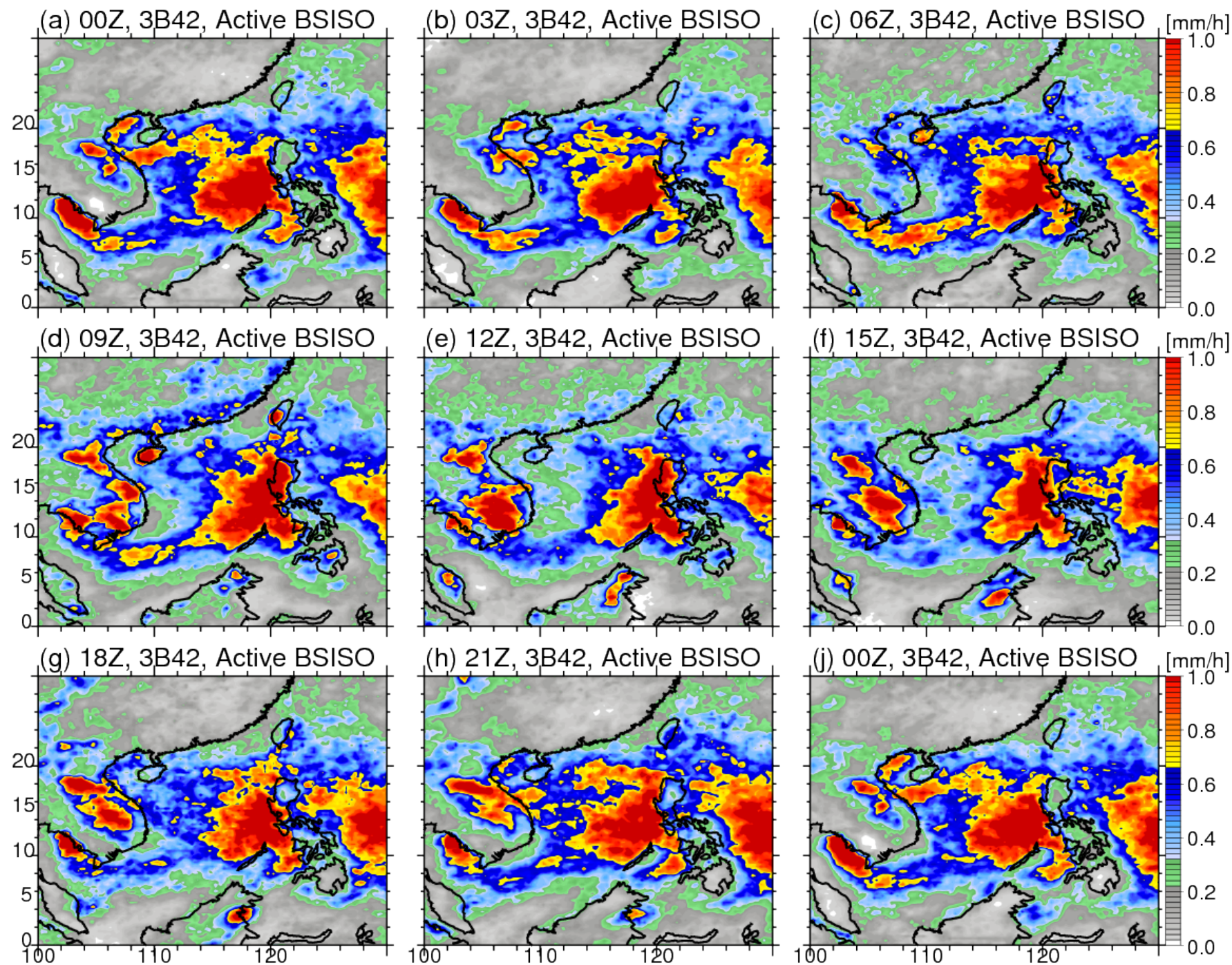# Inactive BSISO

Phases 1-3
Magnitude > 1

TRMM 3B42
JAS 1997-2013

Active BSISO

Phases 5-7
Magnitude > 1

TRMM 3B42
JAS 1997-2013

(a) 00Z, 3B42, Active BSISO [mm/h]
(b) 03Z, 3B42, Active BSISO
(c) 06Z, 3B42, Active BSISO [mm/h]
(d) 09Z, 3B42, Active BSISO
(e) 12Z, 3B42, Active BSISO
(f) 15Z, 3B42, Active BSISO [mm/h]
(g) 18Z, 3B42, Active BSISO
(h) 21Z, 3B42, Active BSISO
(j) 00Z, 3B42, Active BSISO [mm/h]

Conclusions

CCMP and RapidScat agree on many basic characteristics of the seasonal and diurnal cycle of ocean vector winds near the Philippines

Offshore flow near Luzon peaks at 22 UTC (06 L), and onshore flow peaks at 10 UTC (18 L) – Corresponds well to behavior of precipitation and lightning

CCMP shows diurnal cycle amplitude near Luzon peaks in April, as trade wind regime is transitioning to monsoonal flow

Active BSISO phases associated with weaker diurnal cycle of ocean vector winds – Consistent with more cloud cover/precipitation suppressing sea breeze
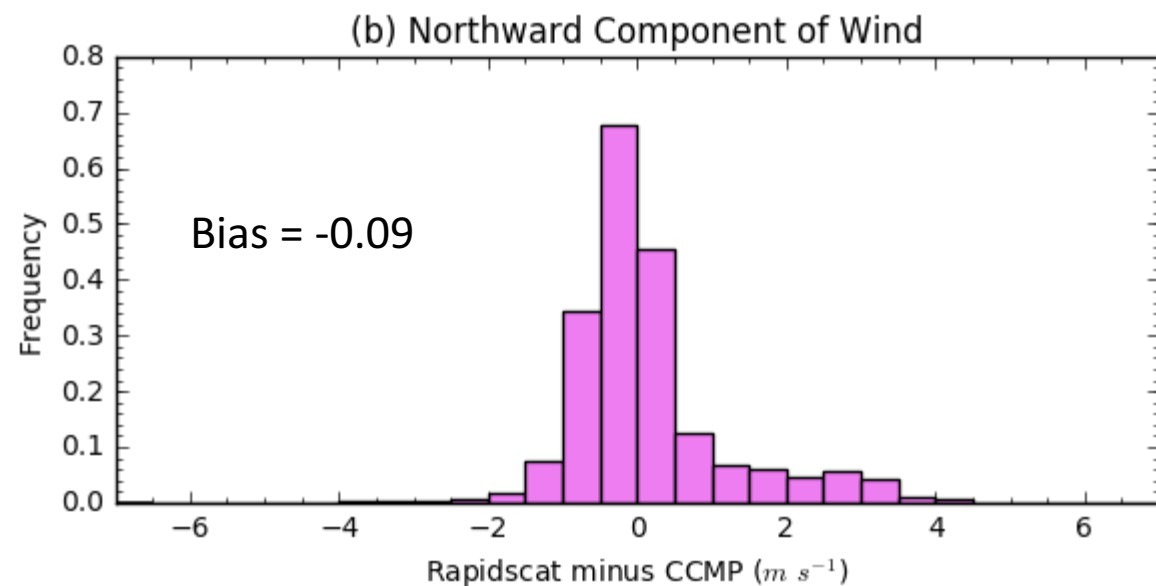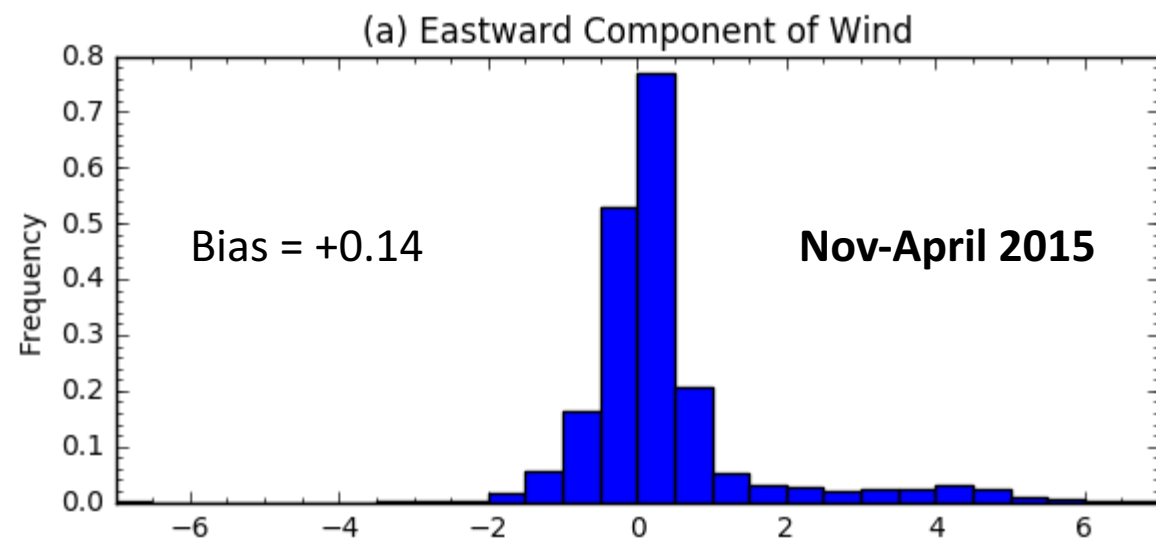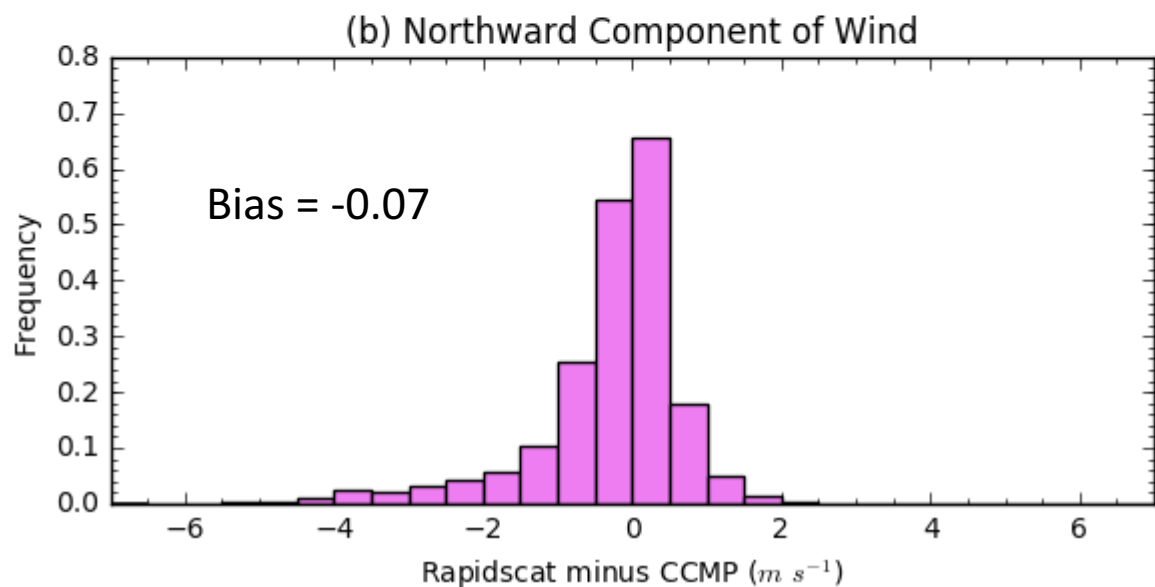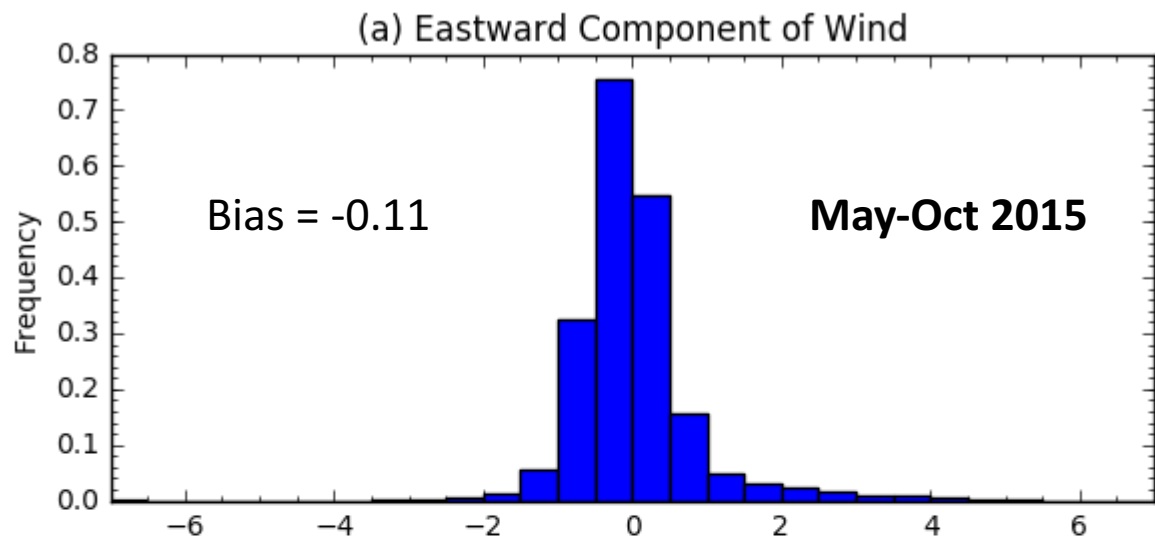
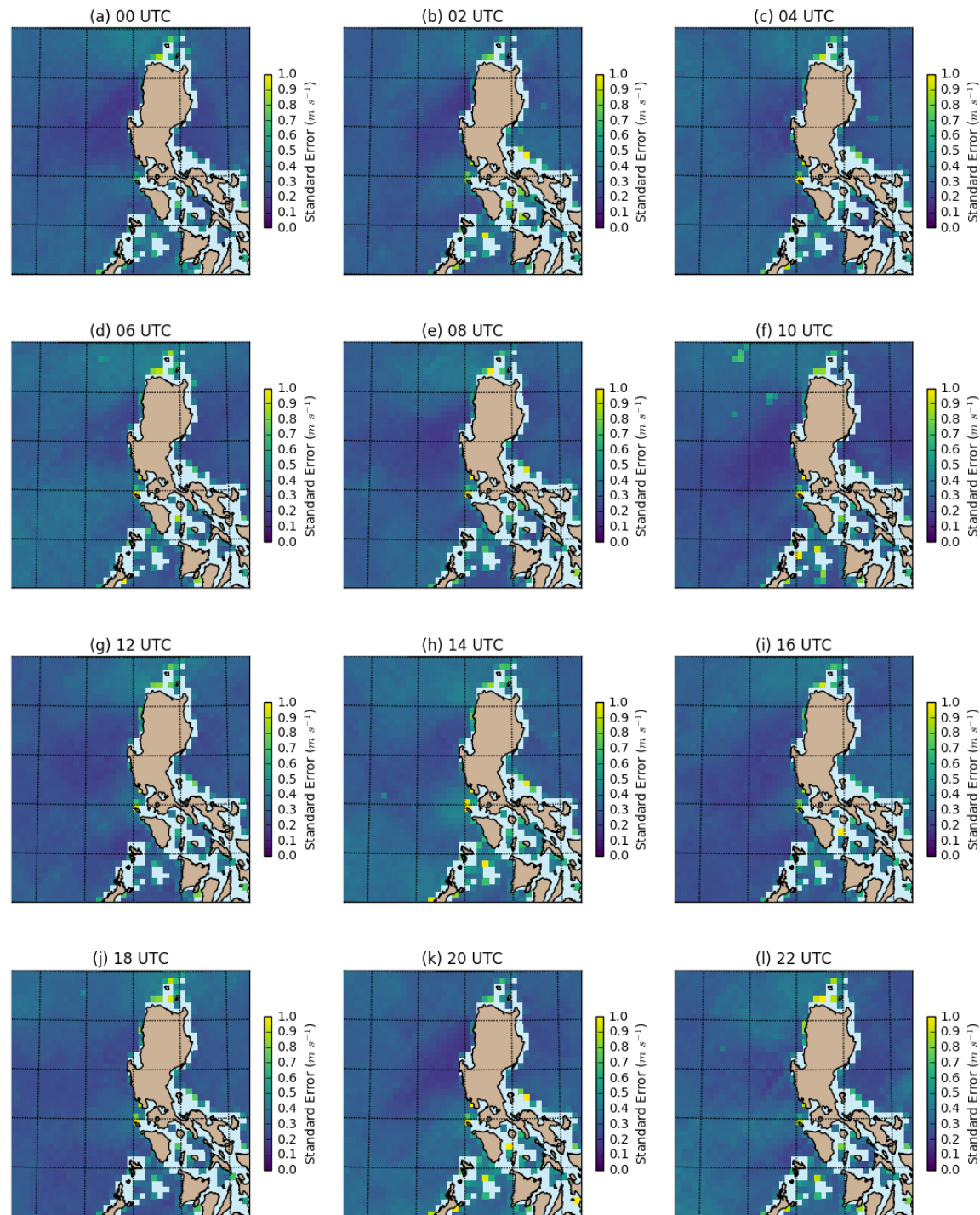"In situ" study of winds/precipitation will occur during PISTON 2018

BACKUP SLIDES

RapidScat – CCMP, Seasonal Means, Whole Domain (rain flagged removed)

(a) 00 UTC (b) 02 UTC (c) 04 UTC
(d) 06 UTC (e) 08 UTC (f) 10 UTC
(g) 12 UTC (h) 14 UTC (i) 16 UTC
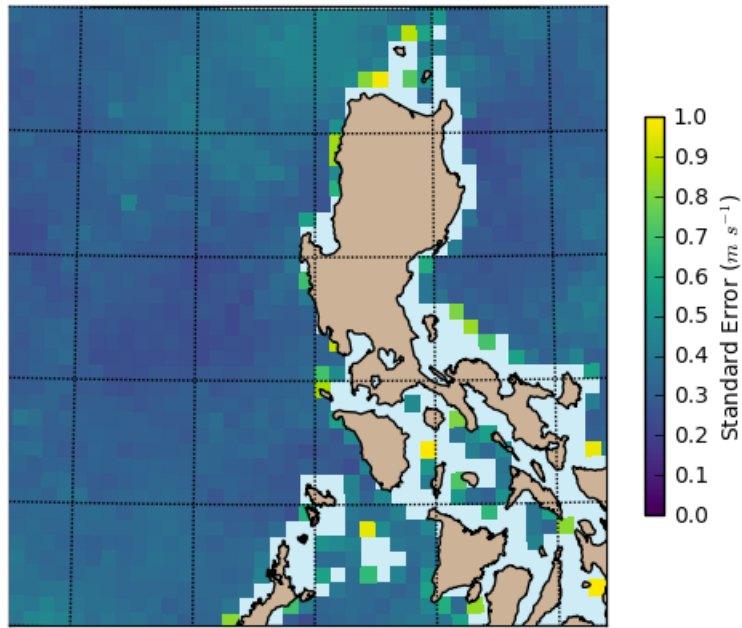(j) 18 UTC (k) 20 UTC (l) 22 UTC
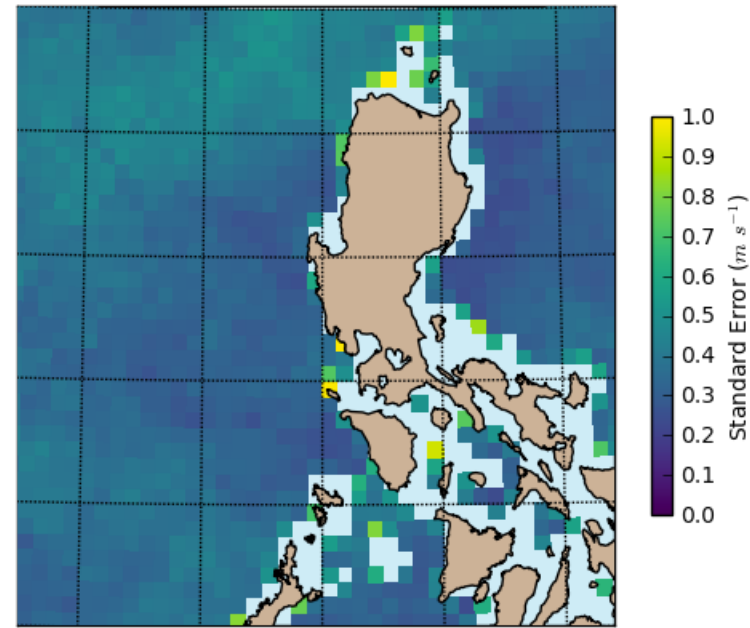
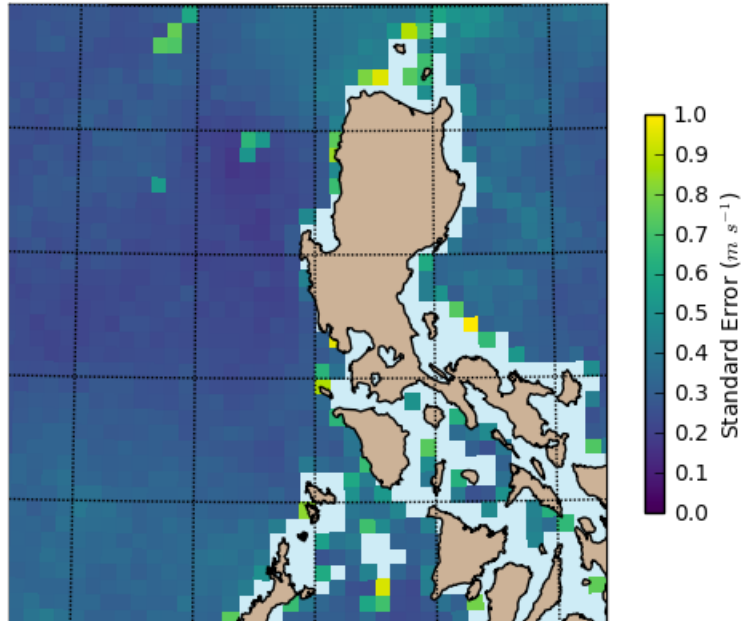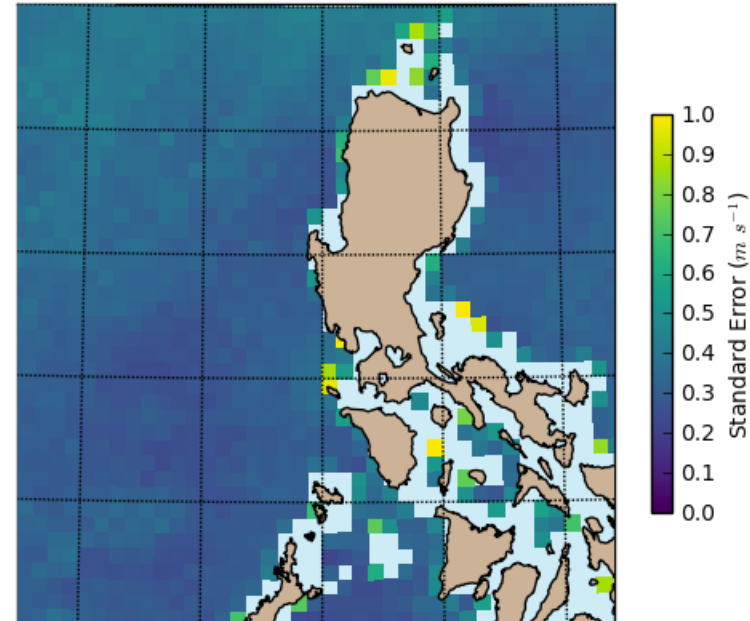Entire RapidScat Dataset

U component

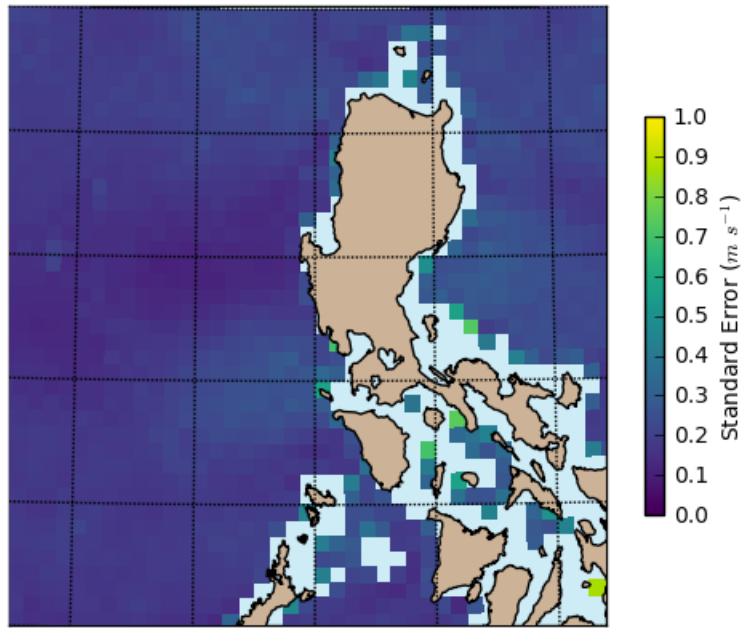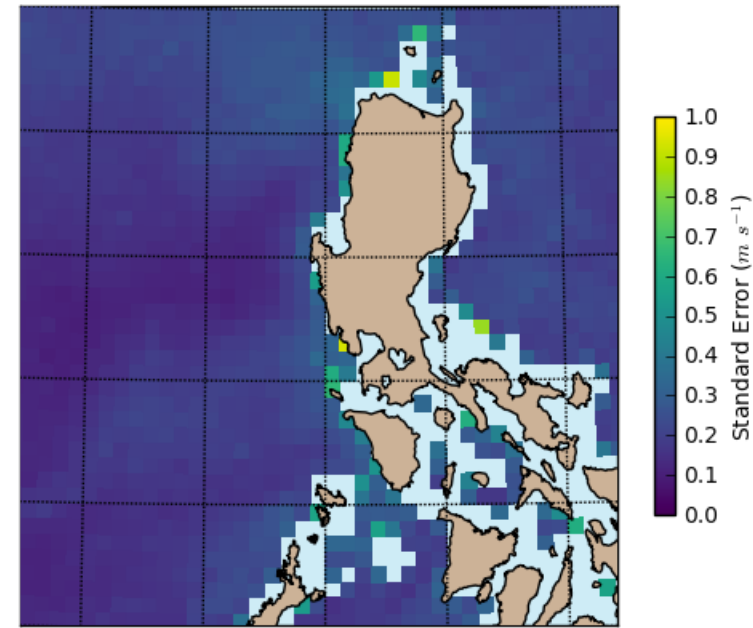(a) 00 UTC   (b) 06 UTC   (c) 12 UTC   (d) 18 UTC
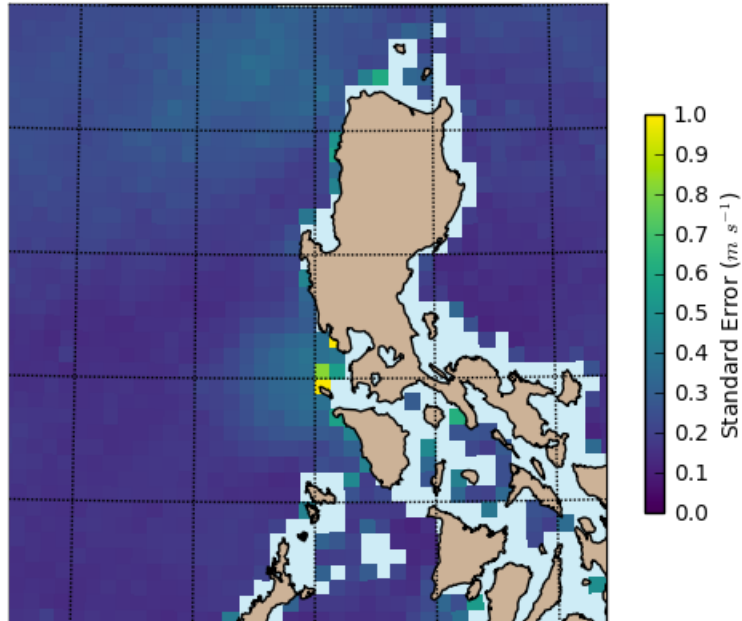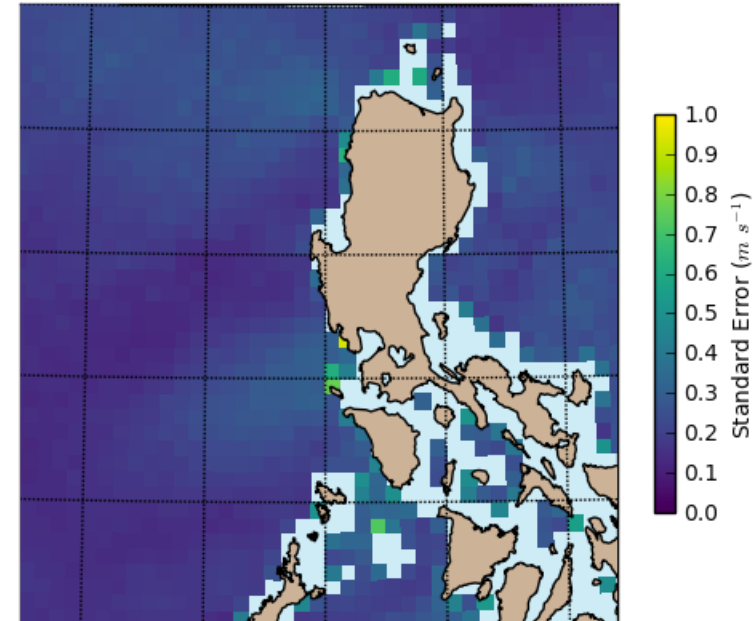
May-Oct 2015

U component

(a) 00 UTC

(b) 06 UTC

(c) 12 UTC

(d) 18 UTC

Nov-Apr 2015

U component

(a) 00Z, Flashes, Jun-Sept
(b) 03Z, Flashes, Jun-Sept
(c) 06Z, Flashes, Jun-Sept
(d) 09Z, Flashes, Jun-Sept
(e) 12Z, Flashes, Jun-Sept
(f) 15Z, Flashes, Jun-Sept
(g) 18Z, Flashes, Jun-Sept
(h) 21Z, Flashes, Jun-Sept
(j) 00Z, Flashes, Jun-Sept