The 2015-16 El Niño - birth, evolution and teleconnections from scatterometer observations of the ocean surface winds

Svetla Hristova-Veleva, Tong Lee, Bryan Stiles, Ernesto Rodriguez,

F. Joseph Turk, Ziad Haddad

Jet Propulsion Laboratory, California Institute of Technology

EUMETSAT

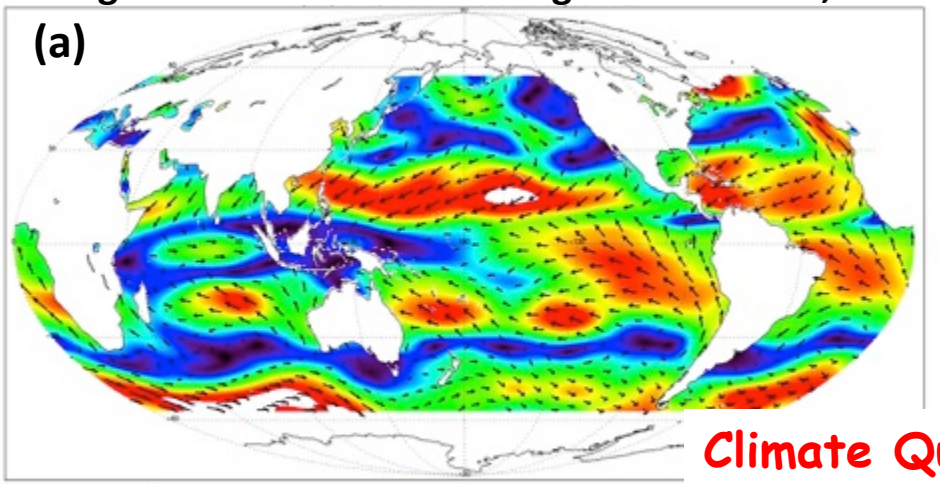
26 September 2016

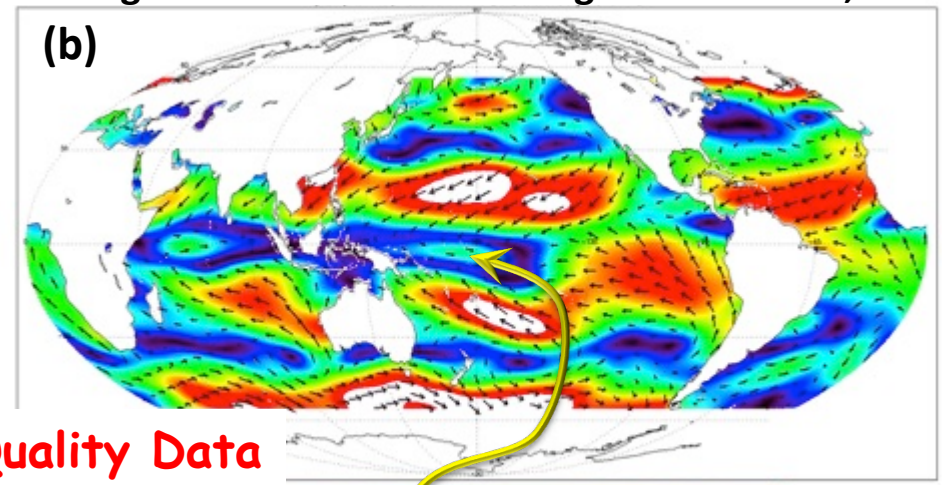
Depicting the 2015-2016 El Nino

- The 2015-16 El Niño event is one of the strongest El Niño observed during the modern instrumentation period, rivaling the two big ones observed by satellites during 1982-83 and 1997-98. Yet, the precipitation anomalies differ from the expectations.
- While El Niño events have a significant impact on the entire Earth System, they are most easily visible in measurements of sea surface temperature (SST), sea surface height and near-surface ocean winds. In fact, the signature eastward-blowing anomalous surface winds in the Western and Central Tropical Pacific are the pre-cursor and the main driver of the El Nino.
- We use observations from NASA's RapidScat, EUMETSAT's ASCAT and also from collocated ECMWF analysis to monitor the evolution of the anomalous winds associated with the 2015-16 El Niño.
- To detect the El Nino signal, we first compute monthly means of the wind speed, the zonal and the meridional wind components. We then perform a low-pass filter to extract the components of the larger-scale circulation and compute the 2015-2016 anomalies with respect to the corresponding months of 2014-2015.

Average for the 2-weeks starting November 22, 2014

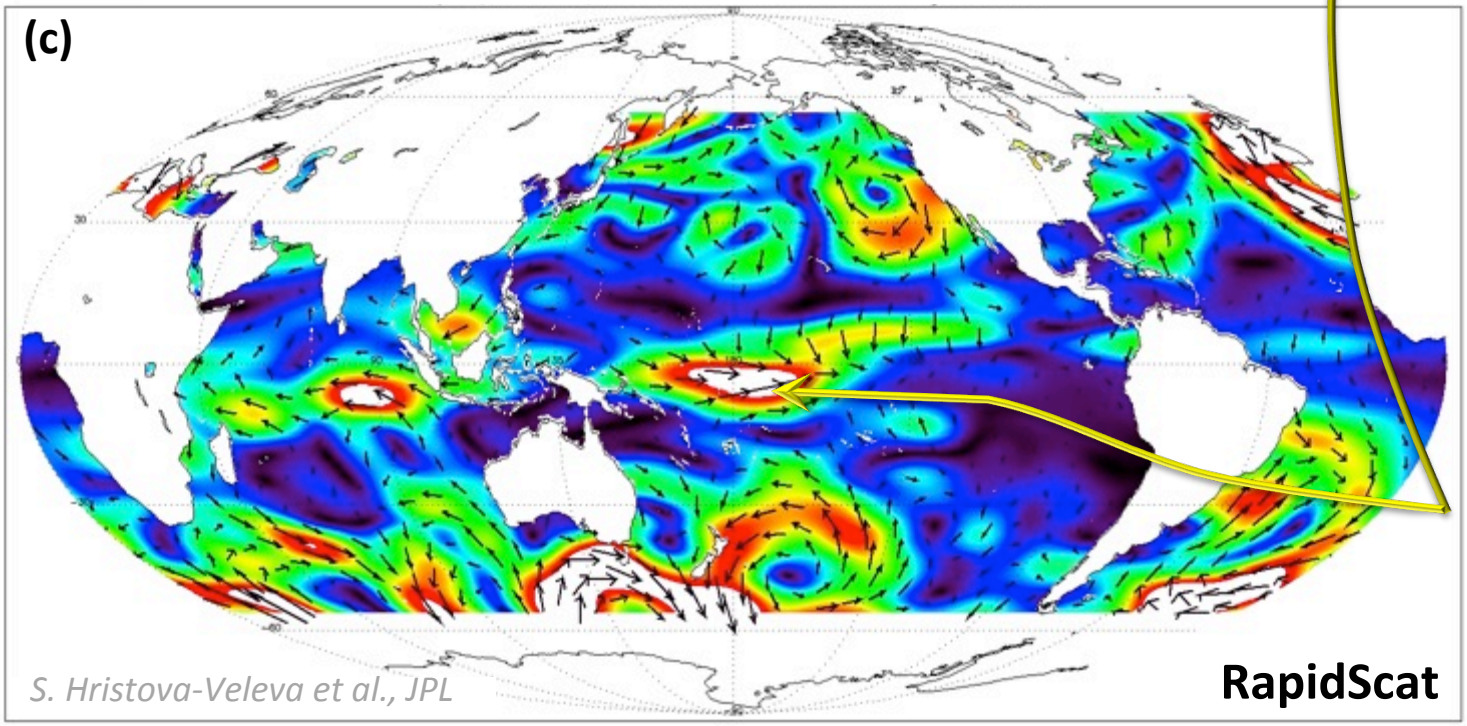
Average for the 2-weeks starting November 21, 2015





Climate Quality Data

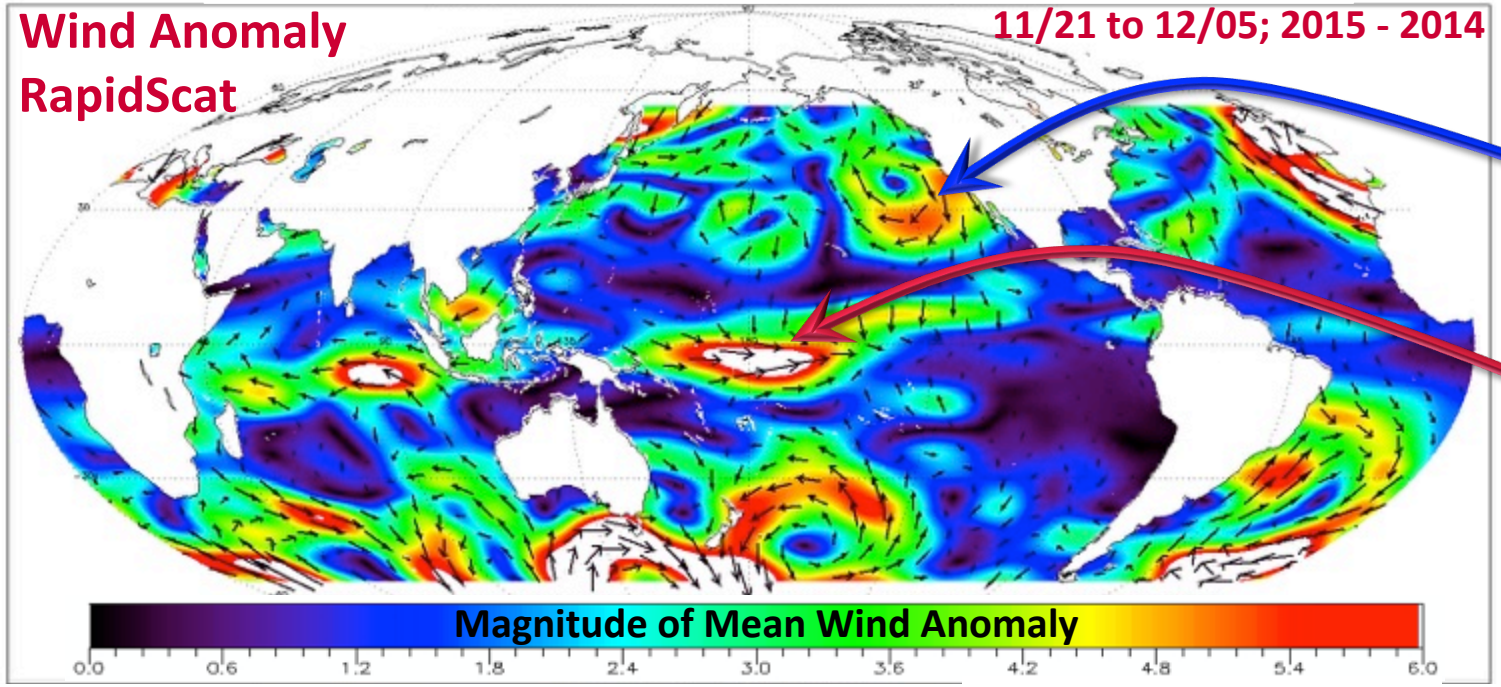
Difference of Nov. 2015 – Nov. 2014 winds from RapidScat



El Niño has widespread influence around the globe.

Weakening or reversal of the easterly trade wind (i.e., westerly wind anomaly) is critical to El Niño development.

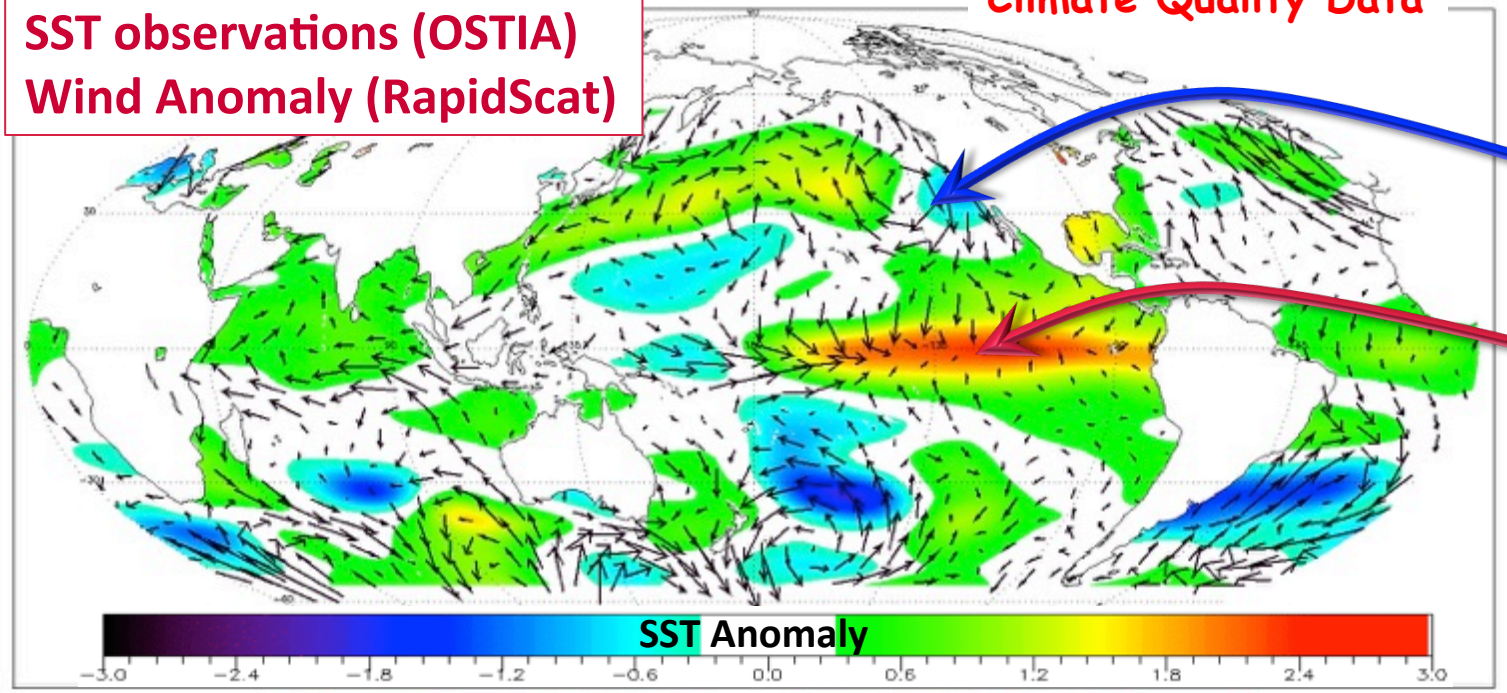
RapidScat observations illustrated wind speeds (color) & vectors in Nov. 2014 and in Nov.2015 (peak of El Niño 2015), and the difference, with the latter showing westerly wind anomaly in the west and convergence in the east.



NW alongshore wind anomaly leads to upwelling along the coast

Westerly wind anomaly pushed warmer waters to the east, maintaining central-Pacific warming

Climate Quality Data

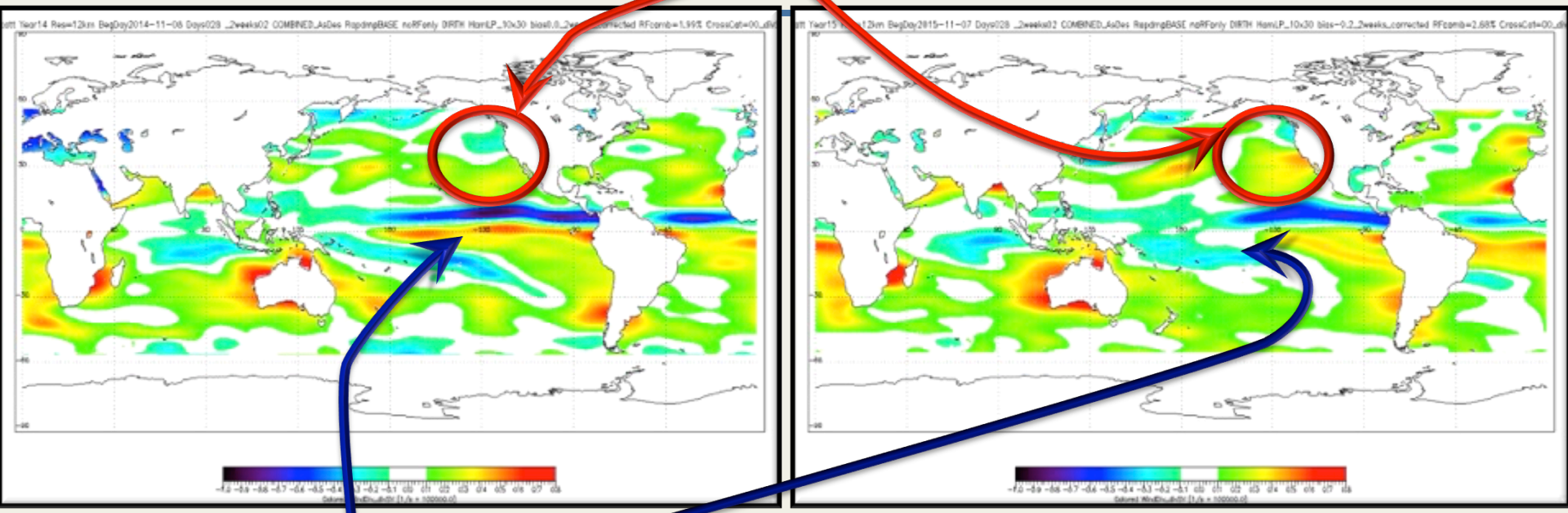


Anomalous cooling related to the coastal upwelling

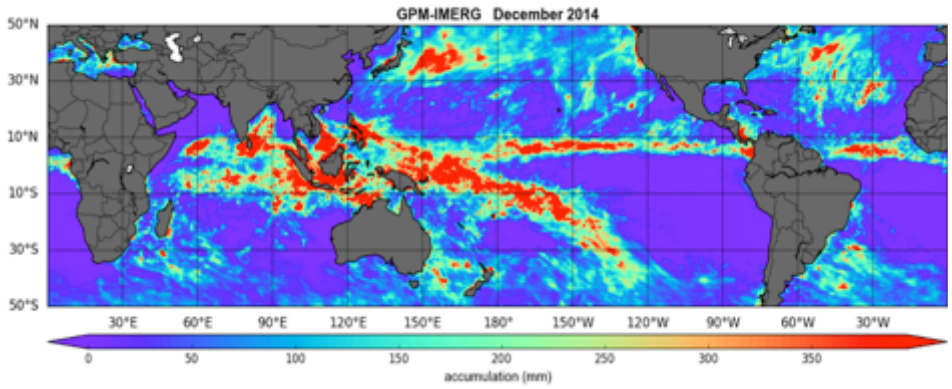
The El Nino warming

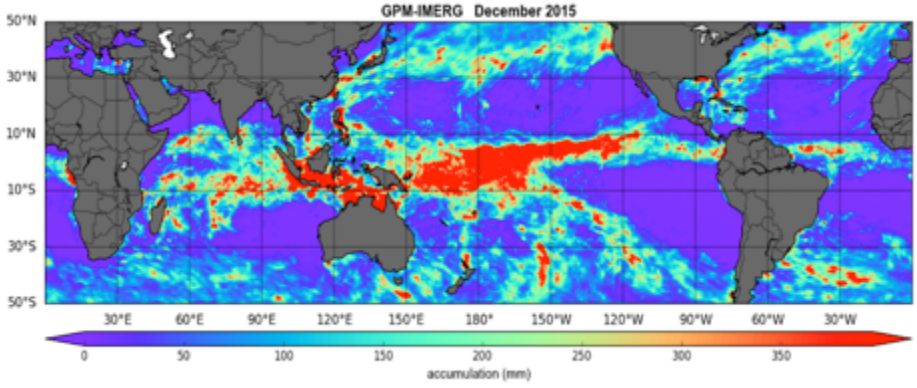
S. Hristova-Veleva et al. JPL

El Niño is known to have basin to global scale teleconnection and impacts. In addition to the characterization of the changes in the tropical Pacific, we will also describe the associated changes in the North and South Pacific. In particular, a strong anticyclonic anomaly is observed in the north-eastern Pacific. This anomalous circulation is likely associated with the **subsidence region (stronger divergence) of a stronger-than-normal Hadley cell**, leading to modification of the midlatitude storm tracks and the related precipitation anomalies



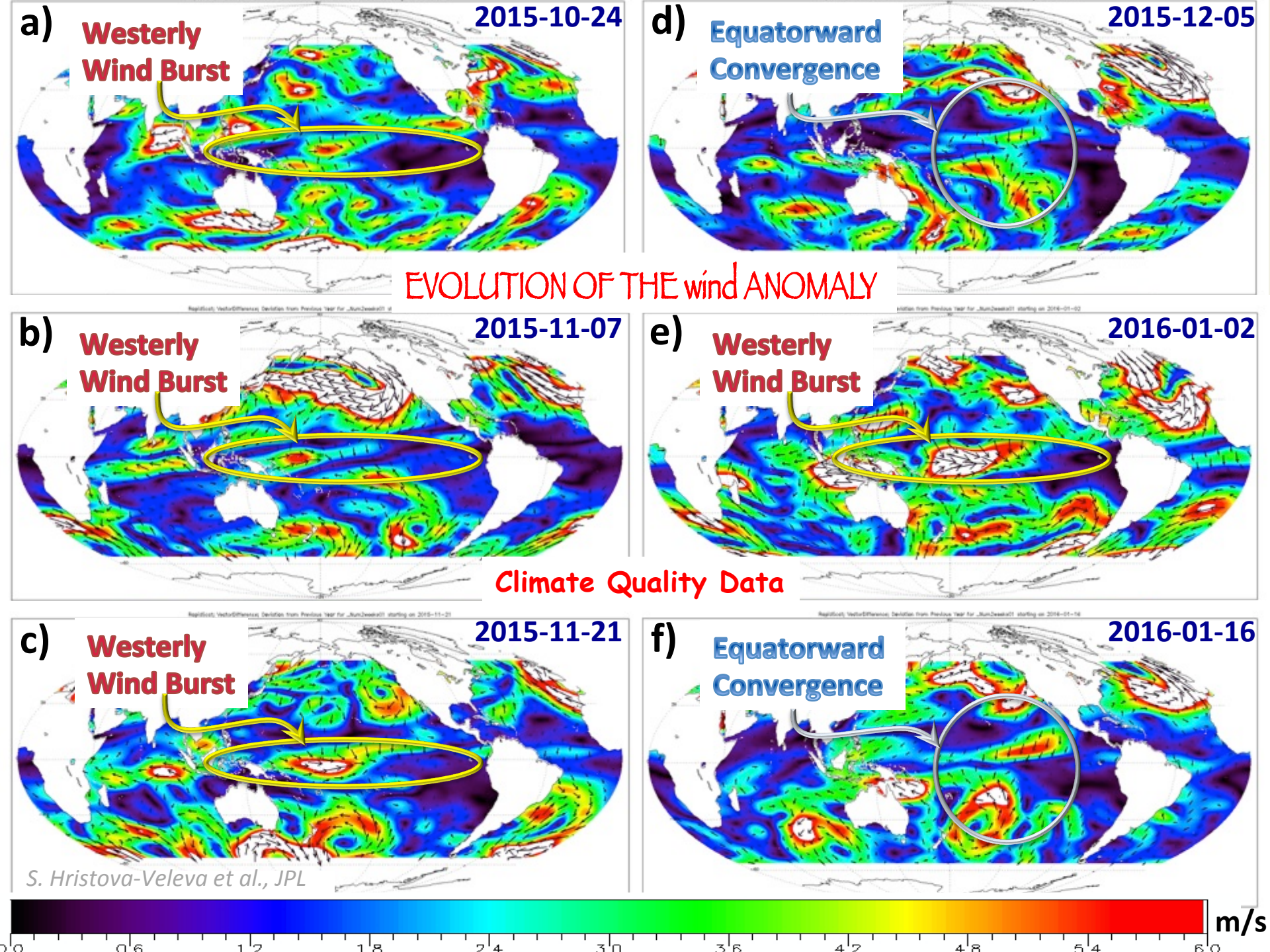
We also perform preliminary qualitative investigations of the relationship between the GPM-derived precipitation and the **surface wind convergence**.

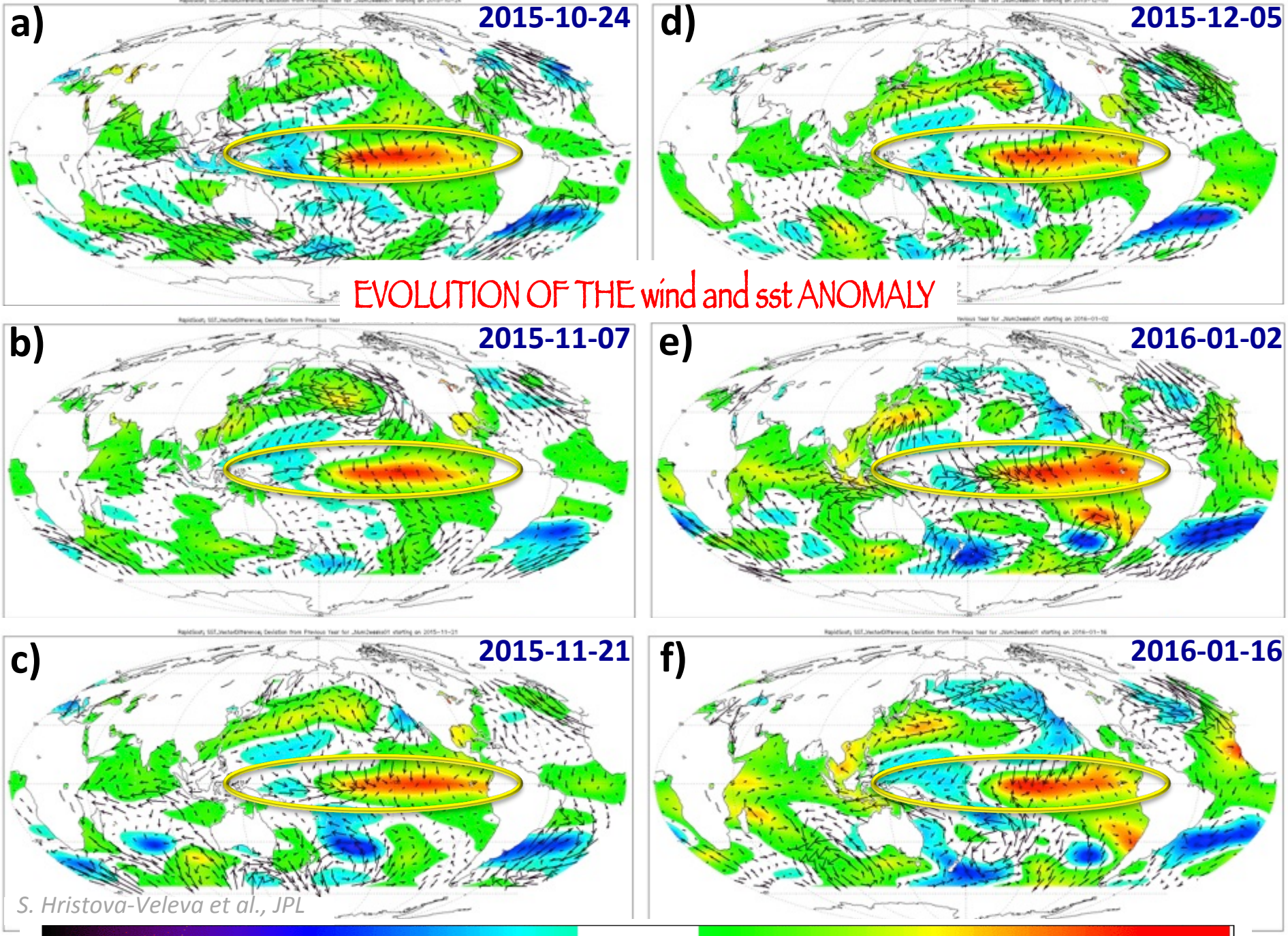


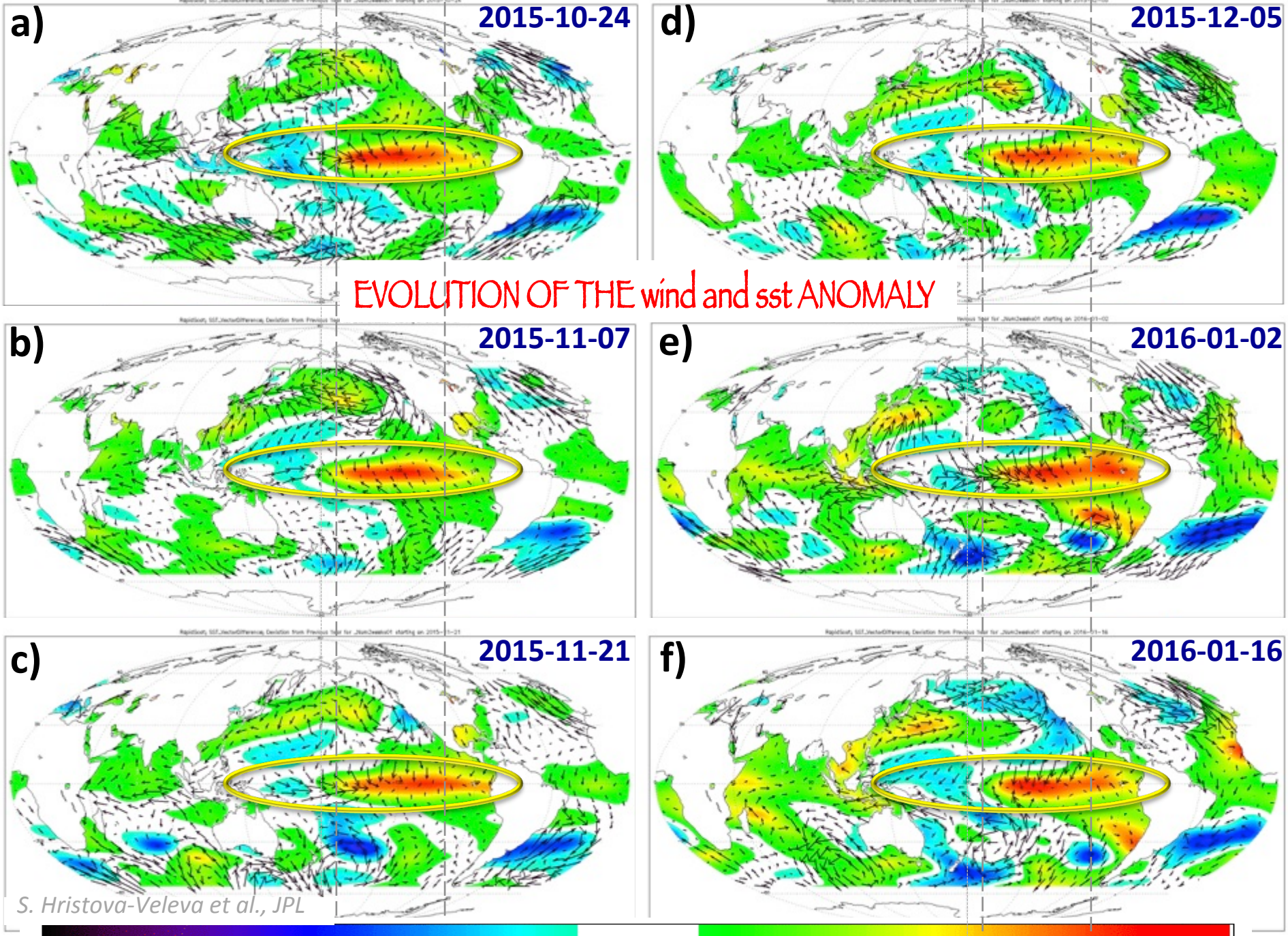


Evolution

- **We find fast-evolving wind anomalies and relate them qualitatively to the evolution of the SST field as depicted in the observations-based OSTIA product.**

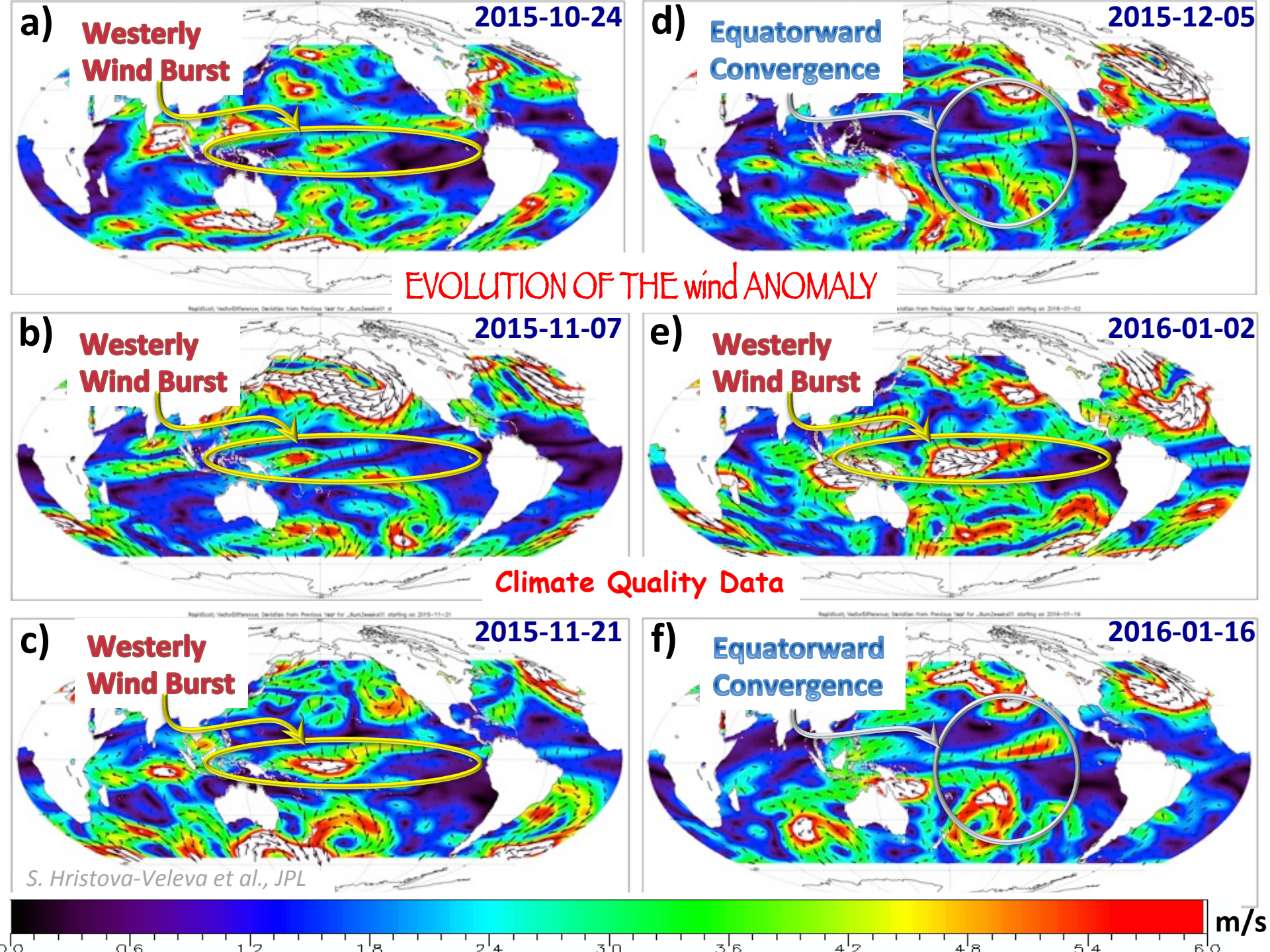

a)
Westerly
Wind Burst
2015-10-24
d)
Equatorward
Convergence
2015-12-05
EVOLUTION OF THE wind ANOMALY
b)
Westerly
Wind Burst
2015-11-07
e)
Westerly
Wind Burst
2016-01-02
Climate Quality Data
c)
Westerly
Wind Burst
2015-11-21
f)
Equatorward
Convergence
2016-01-16
S. Hristova-Veleva et al., JPL
m/s
0.0
0.6
1.2
1.8
2.4
3.0
3.6
4.2
4.8
5.4
6.0

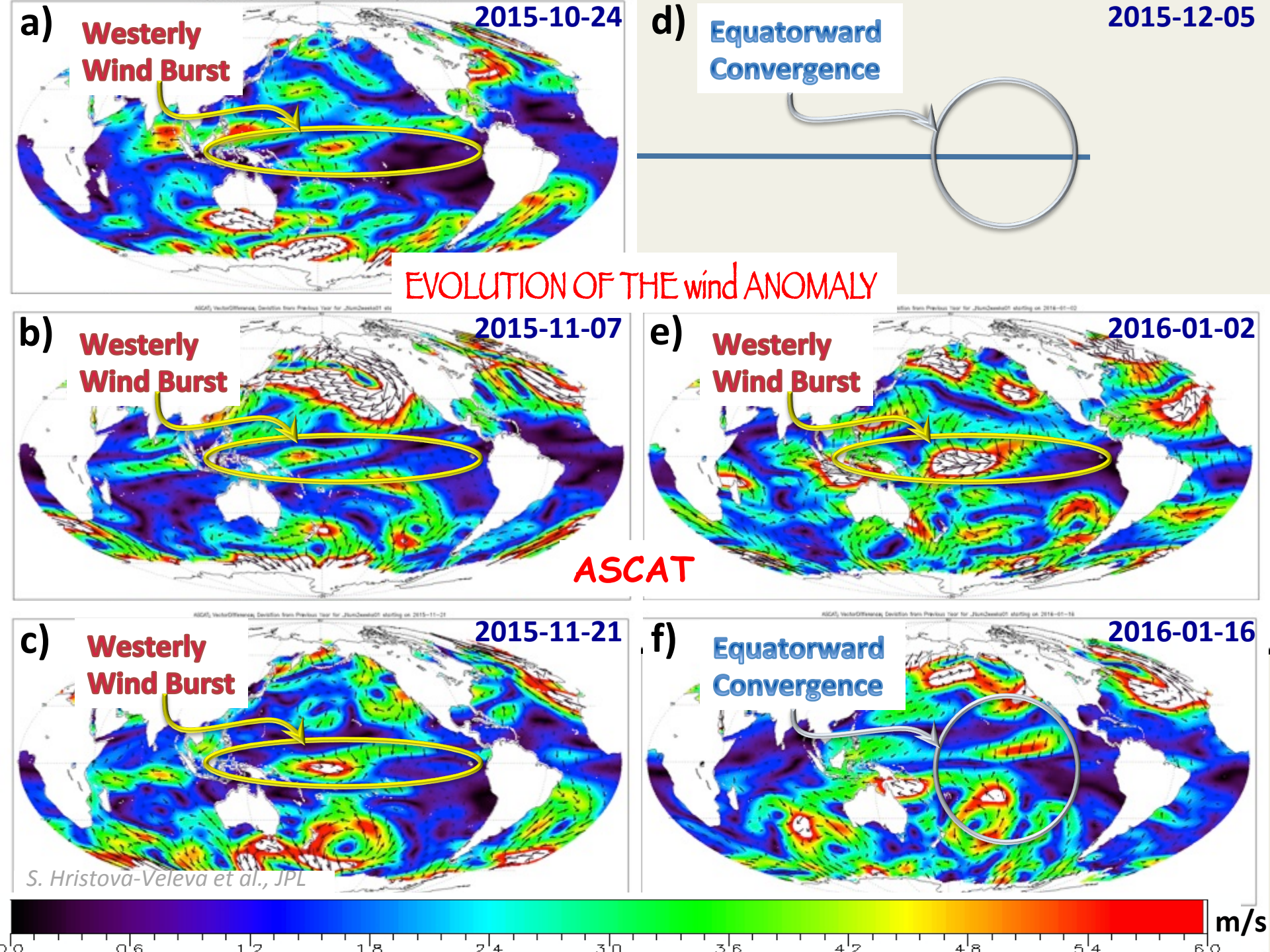

a)
2015-10-24
d)
2015-12-05
EVOLUTION OF THE wind and sst ANOMALY
b)
2015-11-07
e)
2016-01-02
c)
2015-11-21
f)
2016-01-16
S. Hristova-Veleva et al., JPL
−3.0
−2.4
−1.8
−1.2
−0.6
0.0
0.6
1.2
1.8
2.4
3.0
Deg


a)
2015-10-24
d)
2015-12-05
EVOLUTION OF THE wind and sst ANOMALY
b)
2015-11-07
e)
2016-01-02
c)
2015-11-21
f)
2016-01-16
S. Hristova-Veleva et al., JPL
−3.0
−2.4
−1.8
−1.2
−0.6
0.0
0.6
1.2
1.8
2.4
3.0
Deg

RapidScat, ASCAT, ECMWF: is the signal the same?

- Next we compare the strength of the El Nino surface wind anomalies as depicted from RapidSCAT to that determined from ASCAT, and from collocated ECMWF analysis.

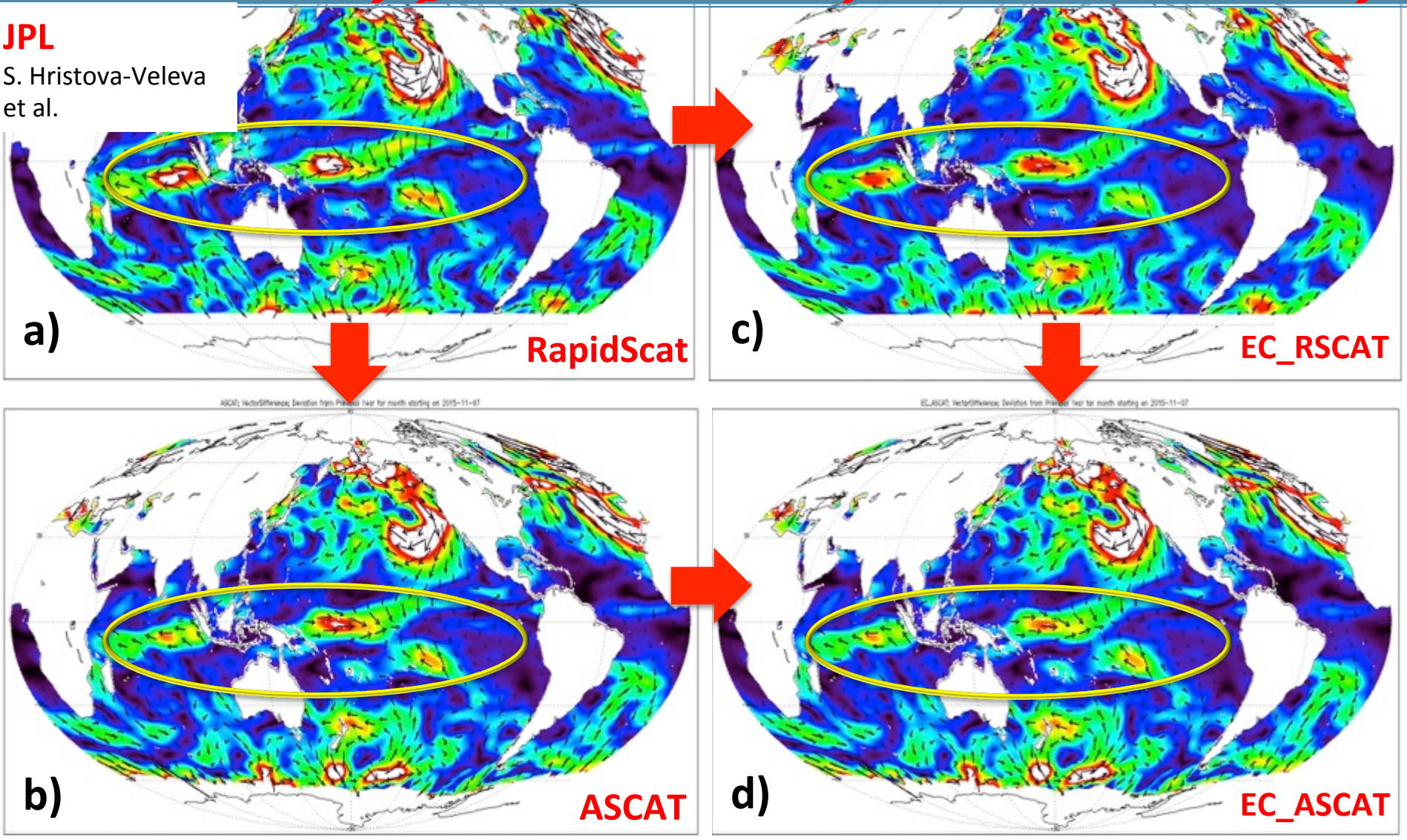

a)
Westerly
Wind Burst
2015-10-24
d)
Equatorward
Convergence
2015-12-05
EVOLUTION OF THE wind ANOMALY
b)
Westerly
Wind Burst
2015-11-07
e)
Westerly
Wind Burst
2016-01-02
Climate Quality Data
c)
Westerly
Wind Burst
2015-11-21
f)
Equatorward
Convergence
2016-01-16
S. Hristova-Veleva et al., JPL
m/s
0.0
0.6
1.2
1.8
2.4
3.0
3.6
4.2
4.8
5.4
6.0


a)
Westerly
Wind Burst
2015-10-24
d)
Equatorward
Convergence
2015-12-05
EVOLUTION OF THE wind ANOMALY
b)
Westerly
Wind Burst
2015-11-07
e)
Westerly
Wind Burst
2016-01-02
ASCAT
c)
Westerly
Wind Burst
2015-11-21
f)
Equatorward
Convergence
2016-01-16
S. Hristova-Veleva et al., JPL
m/s

The 2015-16 El Niño evolution and teleconnections inferred from RapidScat, ASCAT and ECMWF winds: does diurnal variability affect the characterization of El Nino-related wind anomaly?

JPL

S. Hristova-Veleva et al.



Summary

- We find that the signal is stronger in the scatterometer observations (either RapidScat or ASCAT) as compared to that determined from collocated ECMWF analysis suggesting that the model, even during the analysis stage, is not capturing very well the large-scale circulation.

- Furthermore, the signal is stronger in the RapidScat observations as compared to that from non-collocated, independent ASCAT observations.

- Most importantly, analysis of the El Nino signal in collocated ECMWF winds shows that the ECMWF winds that are collocated with RapidScat show a stronger El-Nino signal than the ECMWF winds that are collocated with ASCAT. Hence, the signal might be stronger when sampling through the diurnal cycle, as RapidScat does.

- The dependence of the strength of the ECMWF El-Nino signal on whether the model winds are sampled (collocated with) RapidScat or ASCAT shows the importance of sampling and the significance of the diurnal variability that is not well understood.

Summary

- We find that the signal is stronger in the scatterometer observations (either RapidScat or ASCAT) as compared to that determined from collocated ECMWF analysis suggesting that the model, even during the analysis stage, is not capturing very well the large-scale circulation.

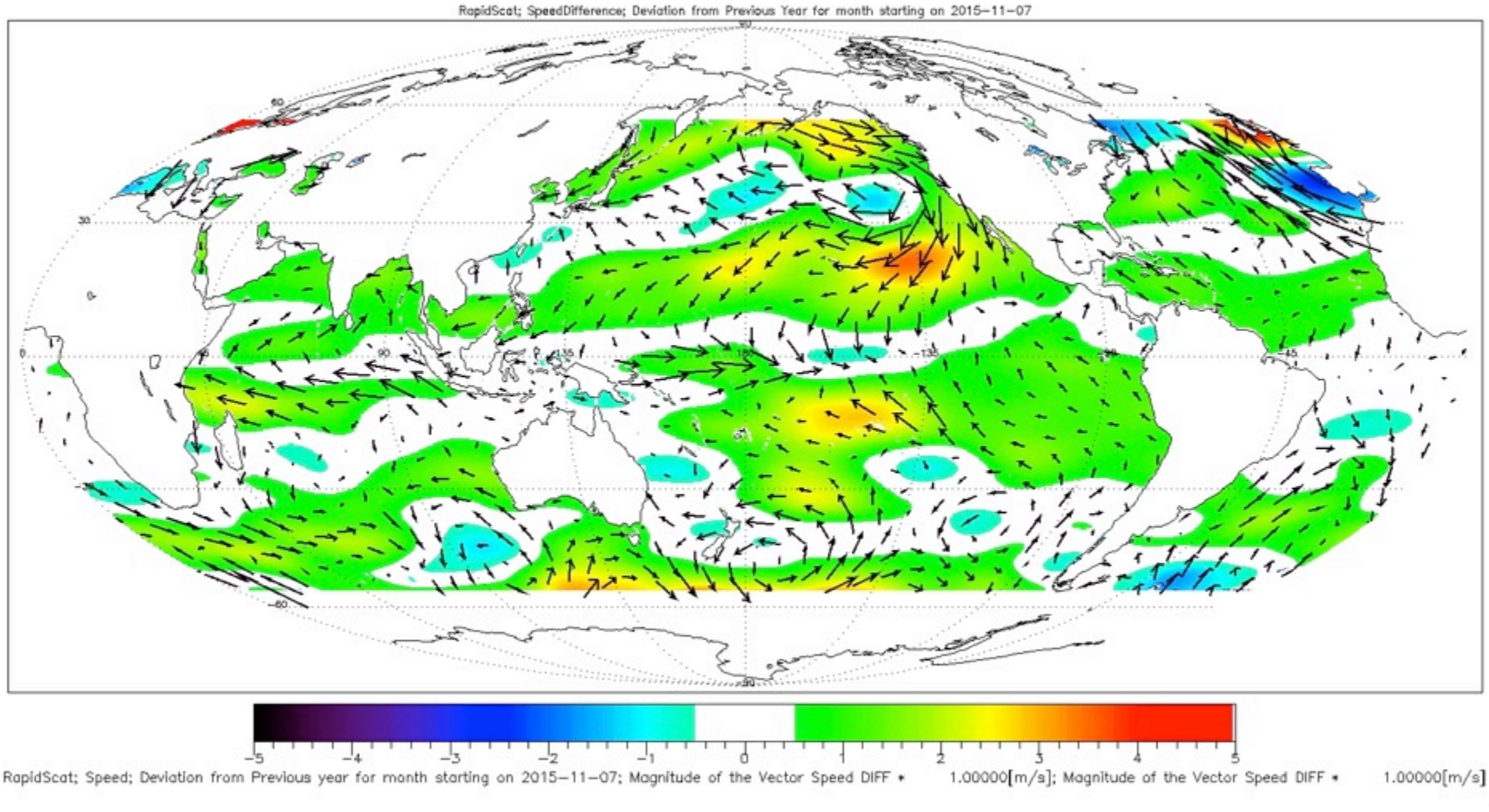
- Furthermore, the signal is stronger in the RapidScat observations as compared to that from non-collocated, independent ASCAT observations.

- Most importantly, analysis of the El Nino signal in collocated ECMWF winds shows that the ECMWF winds that are collocated with RapidScat show a stronger El-Nino signal than the ECMWF winds that are collocated with ASCAT. Hence, the signal might be stronger when sampling through the diurnal cycle, as RapidScat does.

- The dependence of the strength of the ECMWF El-Nino signal on whether the model winds are sampled (collocated with) RapidScat or ASCAT shows the importance of sampling and the significance of the diurnal variability that is not well understood.

Backup

RapidScat;
MEAN Difference from Previous Year for month starting 2015-11-07



Note: The colors represent the magnitude of the mean speed difference.
The vectors represent the meant vector difference

S. Hristova-Veleva
JPL

El Niño is known to have basin to global scale teleconnection and impacts. In addition to the characterization of the changes in the tropical Pacific, we will also describe the associated changes in the North and South Pacific. In particular, a strong anticyclonic anomaly is observed in the north-eastern Pacific. This anomalous circulation is likely associated with the **subsidence region (stronger divergence) of a stronger-than-normal Hadley cell**, leading to modification of the midlatitude storm tracks and the related precipitation anomalies.

We also perform preliminary qualitative investigations of the relationship between the GPM-derived precipitation and the **surface wind convergence**.