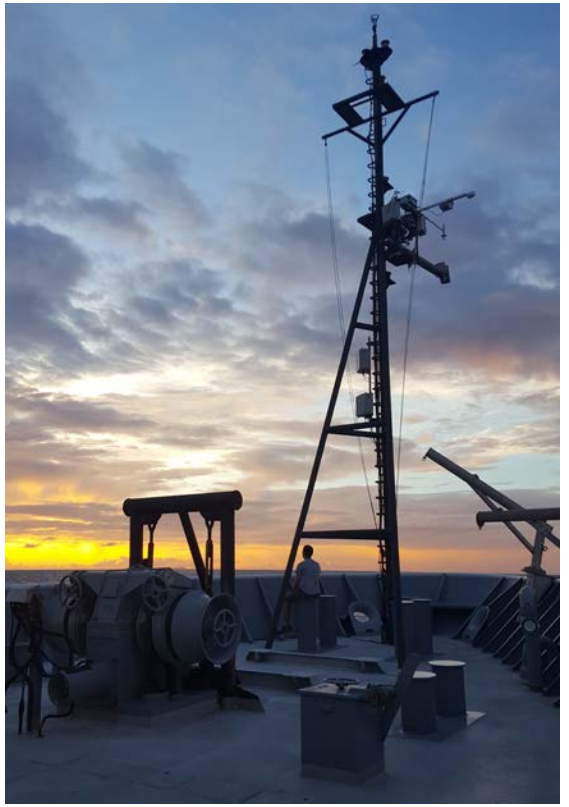
Validation of satellite-based wind observations during PISTON

Timothy Lang
NASA Marshall Space Flight Center



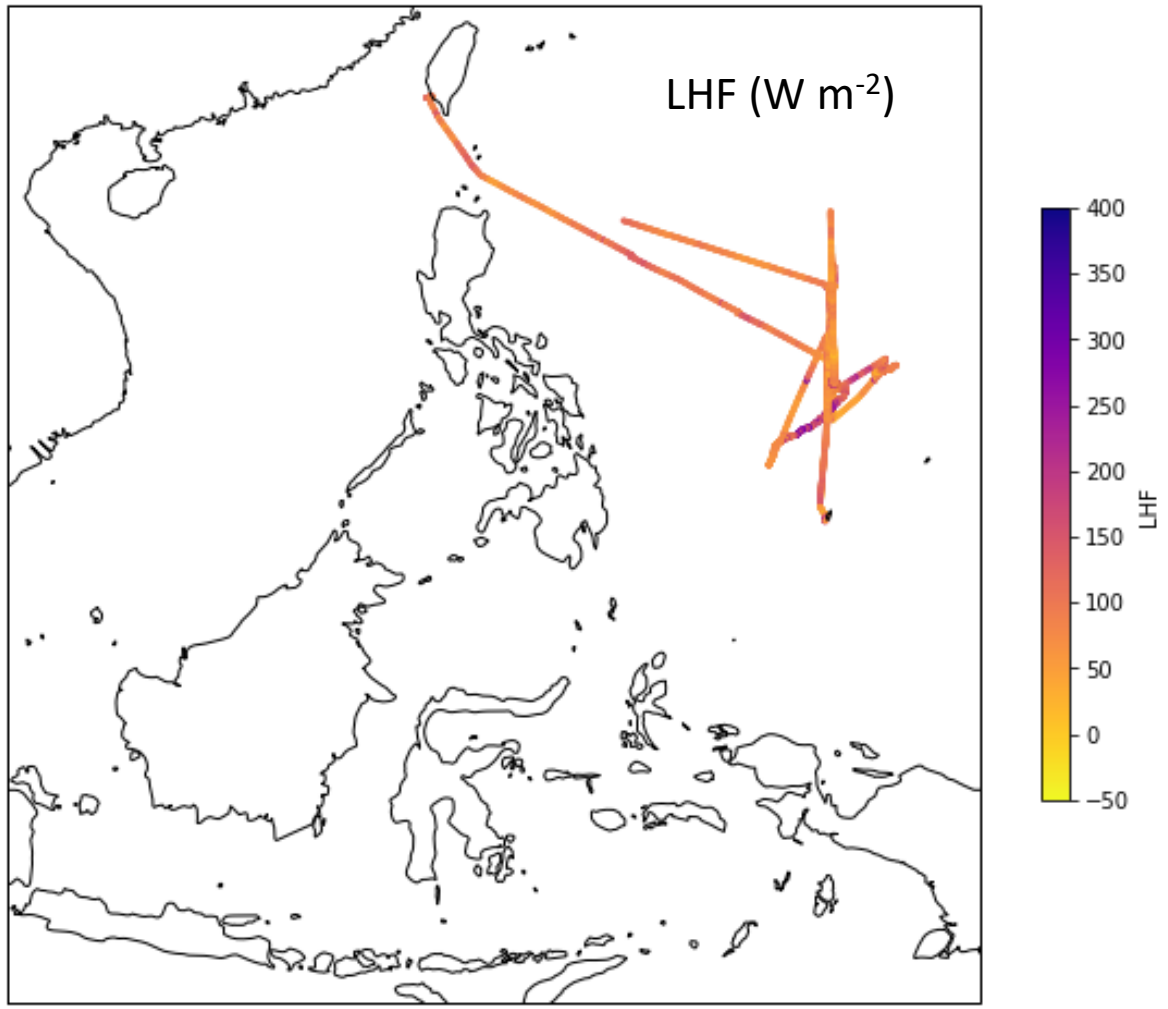
Introduction

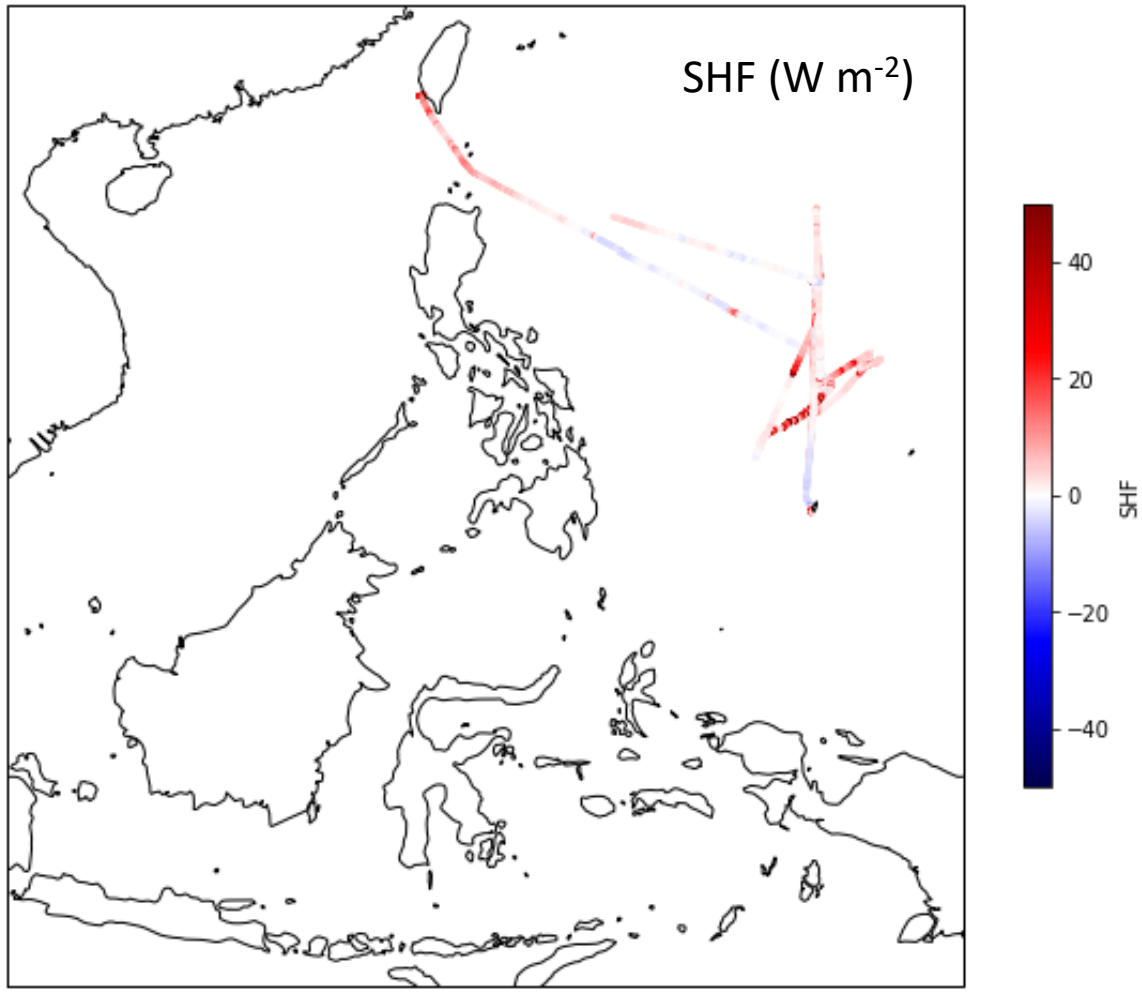
PISTON cruises provide a useful and unique suite of measurements relevant to validating satellite-based ocean wind datasets near tropical convection.

In this talk, we will focus on opportunities for using PISTON observations to validate two different scatterometer datasets:

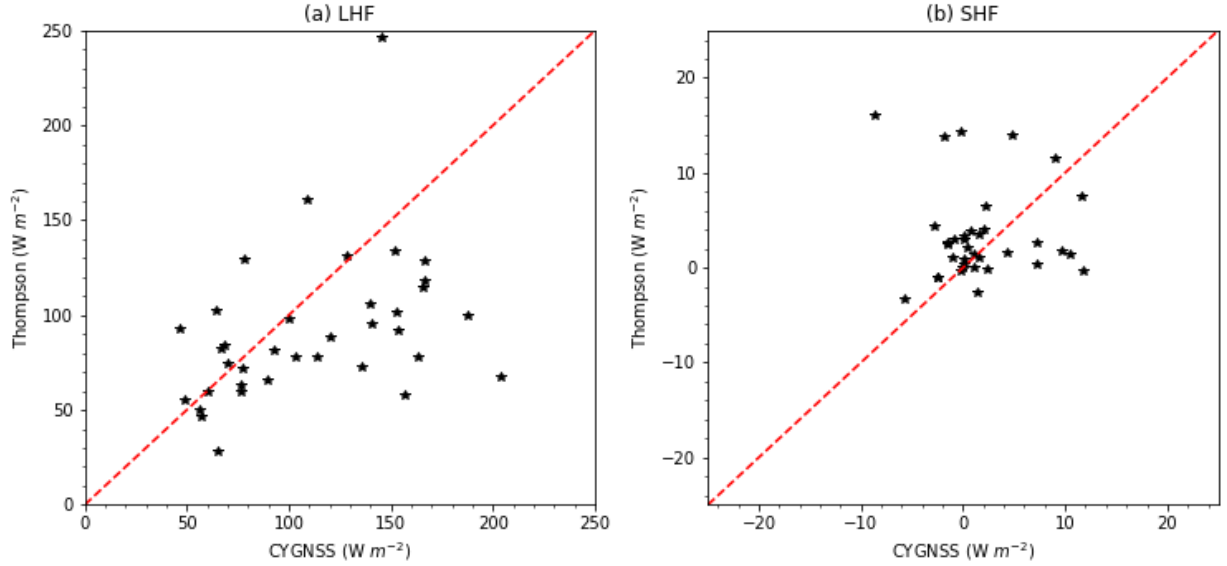
- Cyclone Global Navigation Satellite System (CYGNSS)
- Advanced Scatterometer (ASCAT)

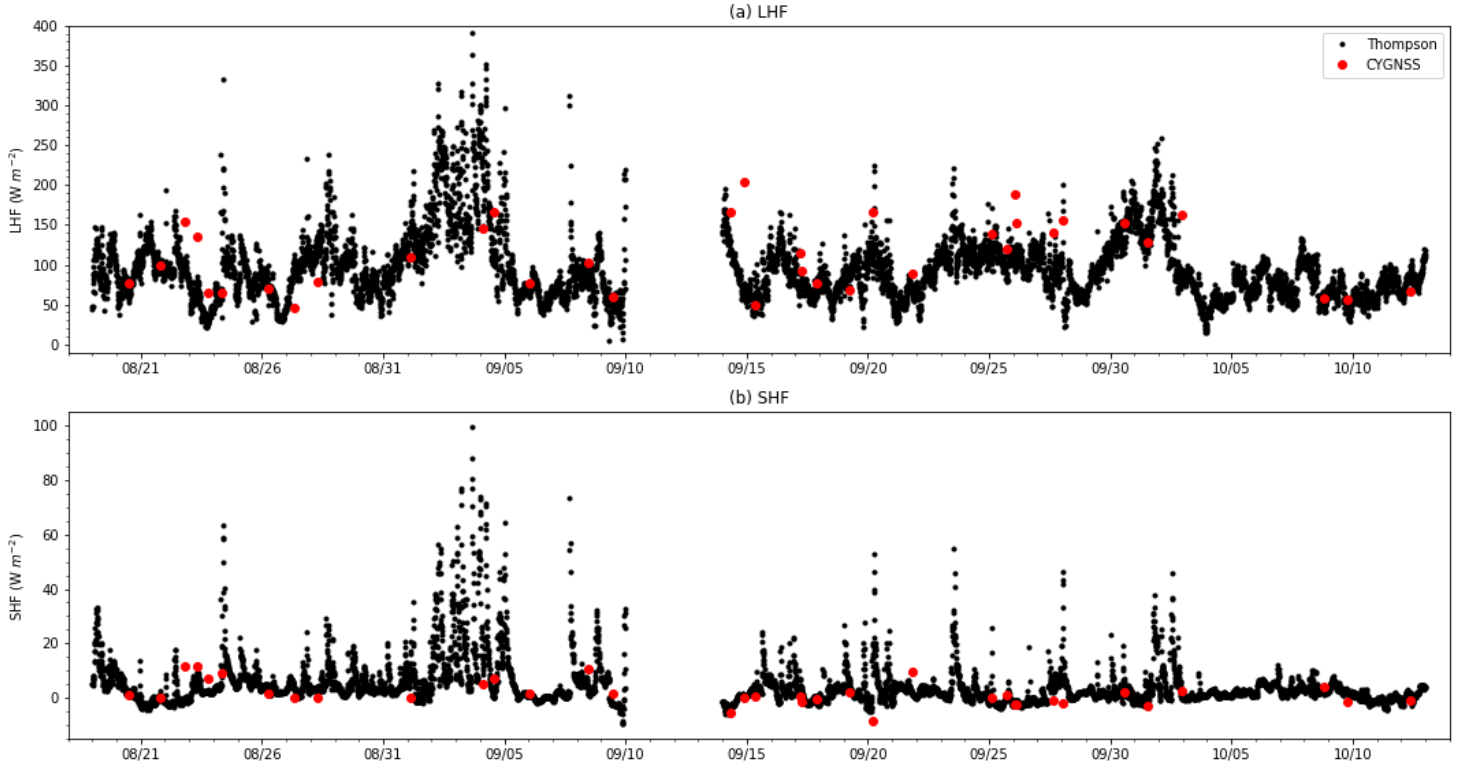
PISTON 2018 Surface Flux Measurements





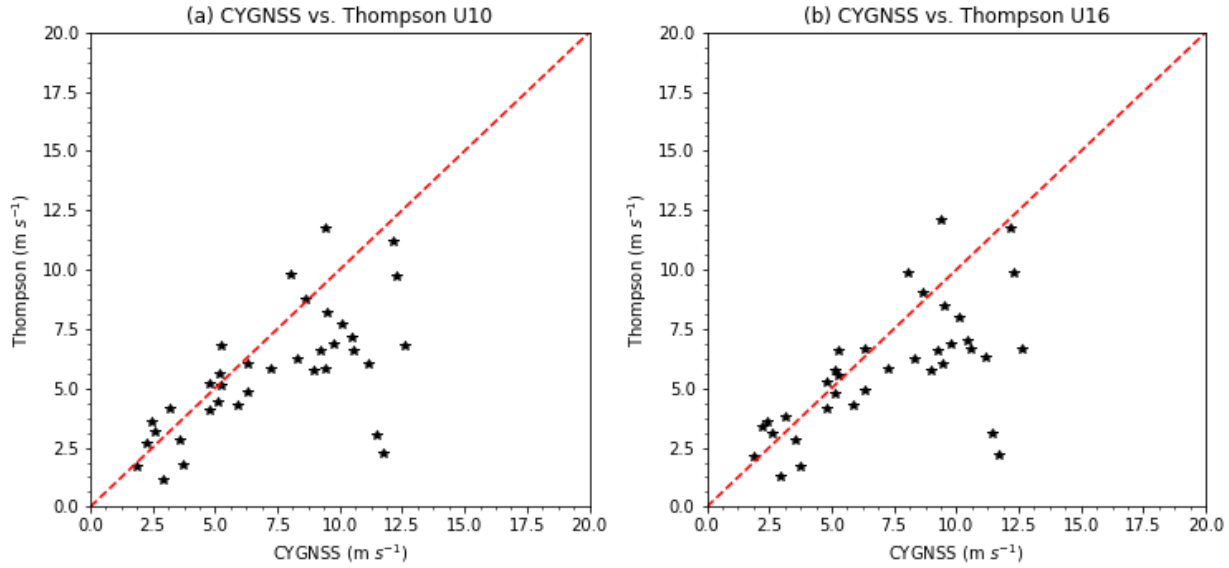
Flux data courtesy of Chris Fairall, NOAA

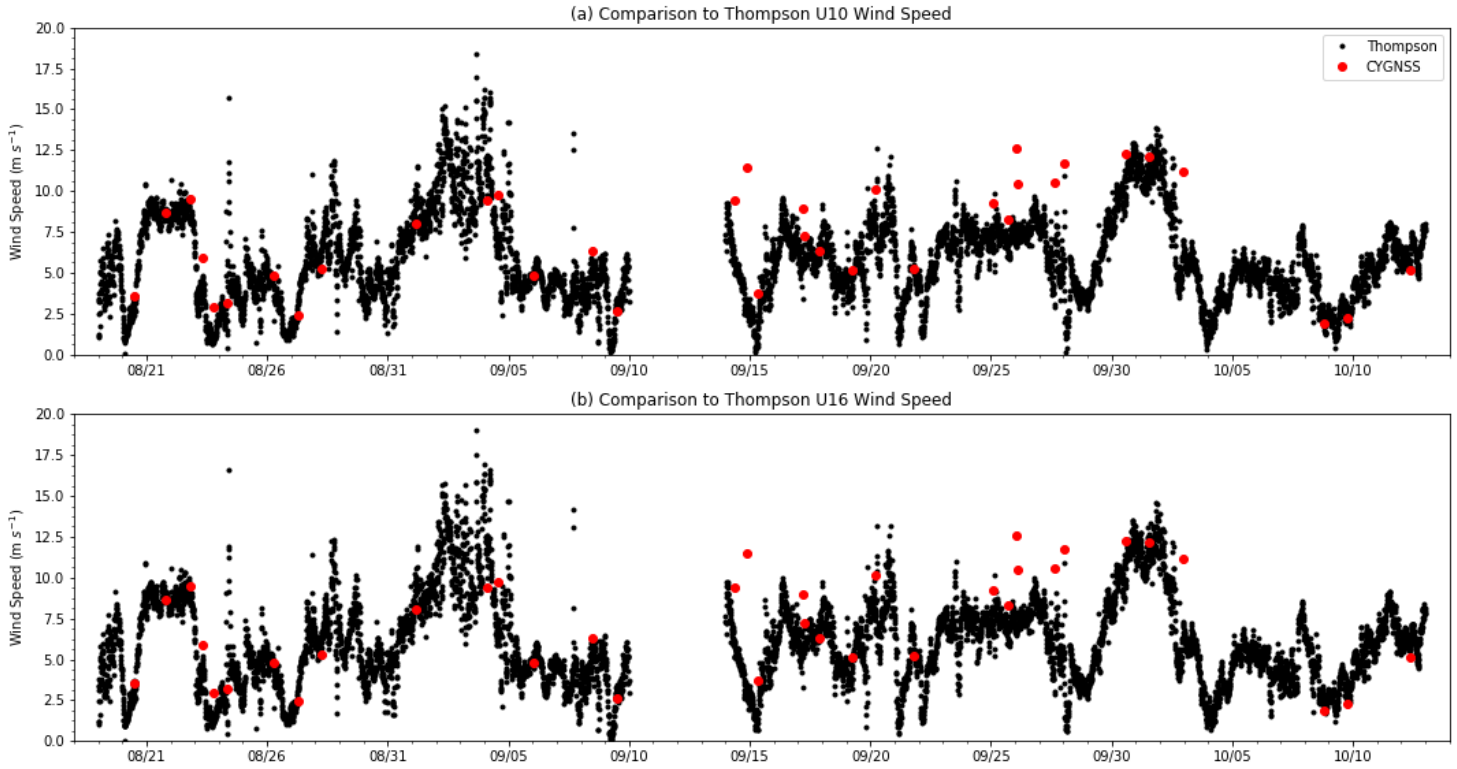




v2.1 CYGNSS Fluxes vs. PISTON 2018

- Hourly averaged observations bookending overpasses within 25 km of ship
- 36 data points
- RMSDs of 50 W m^{-2} for LHF and 7 W m^{-2} for SHF
- CYGNSS bias is +20 W m^{-2} and -2 W m^{-2}, respectively.

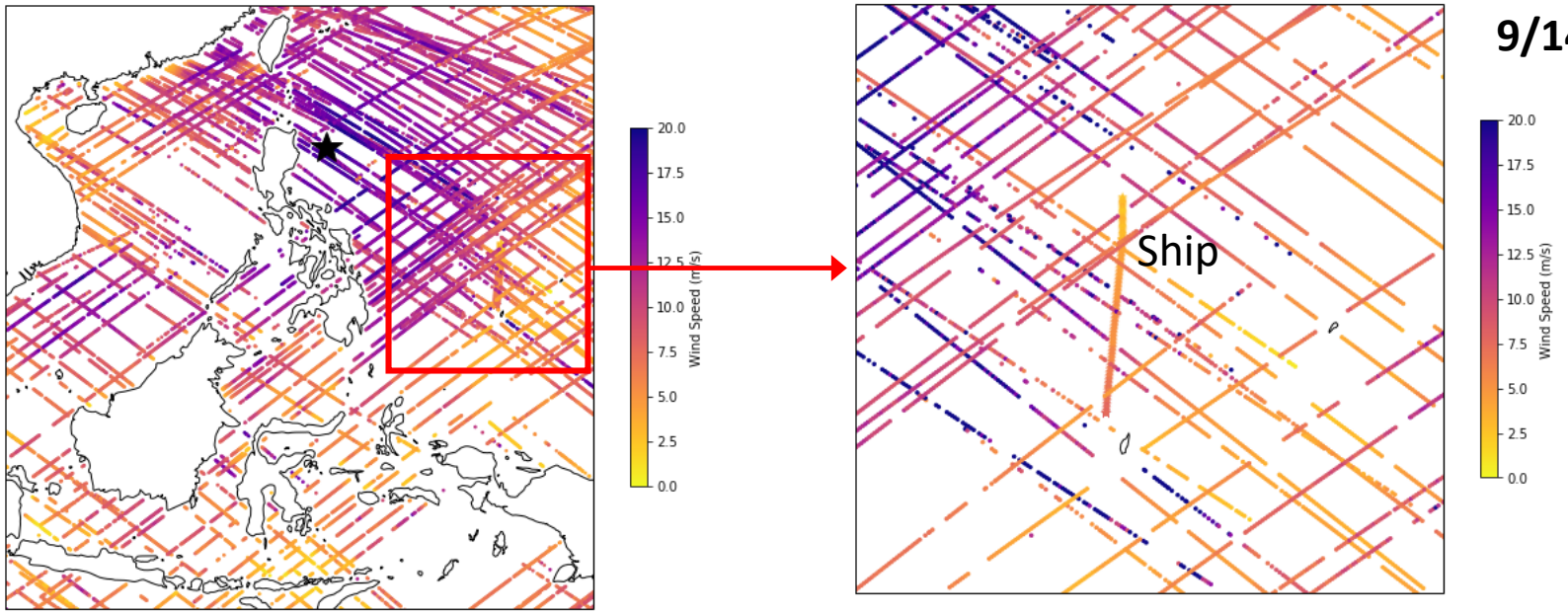




v2.1 CYGNSS winds vs. PISTON 2018

- 36 points for wind speed obs as well
- CYGNSS bias for U10 of +1.7 m/s and an RMSD of 3.1 m/s
- U16 comparison is +1.5 & 3.0 m/s, respectively

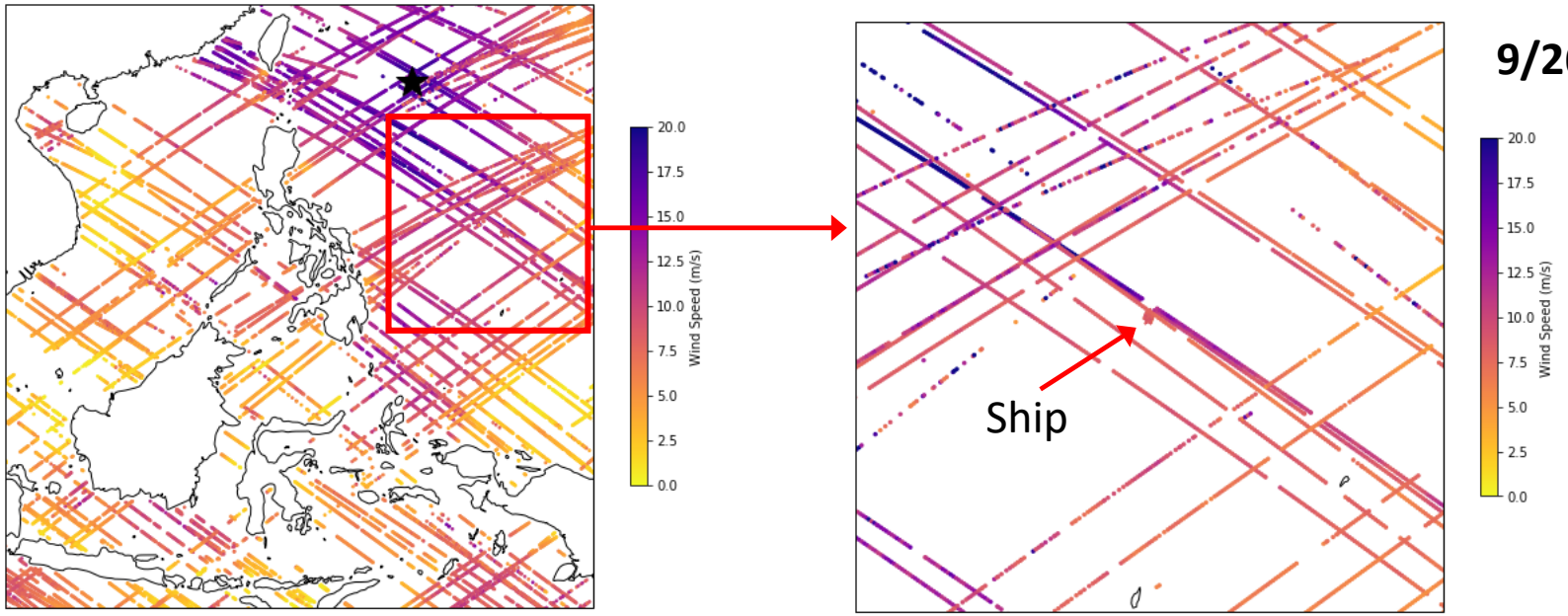
Examination of two wind speed overestimates



9/14/2018

Context

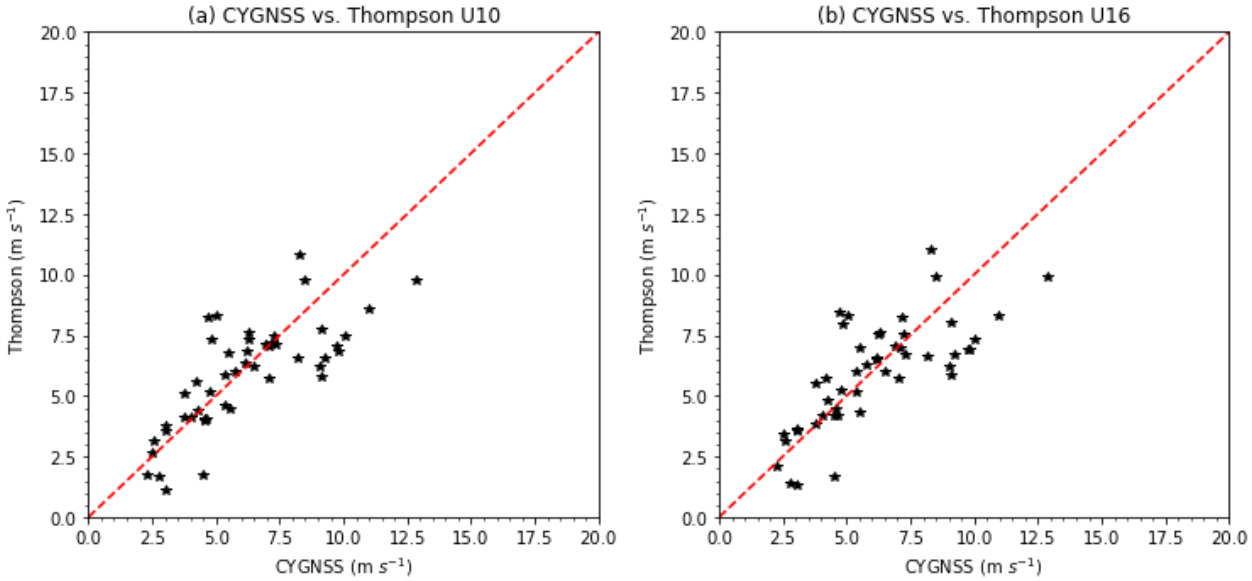
Typhoon Mangkhut

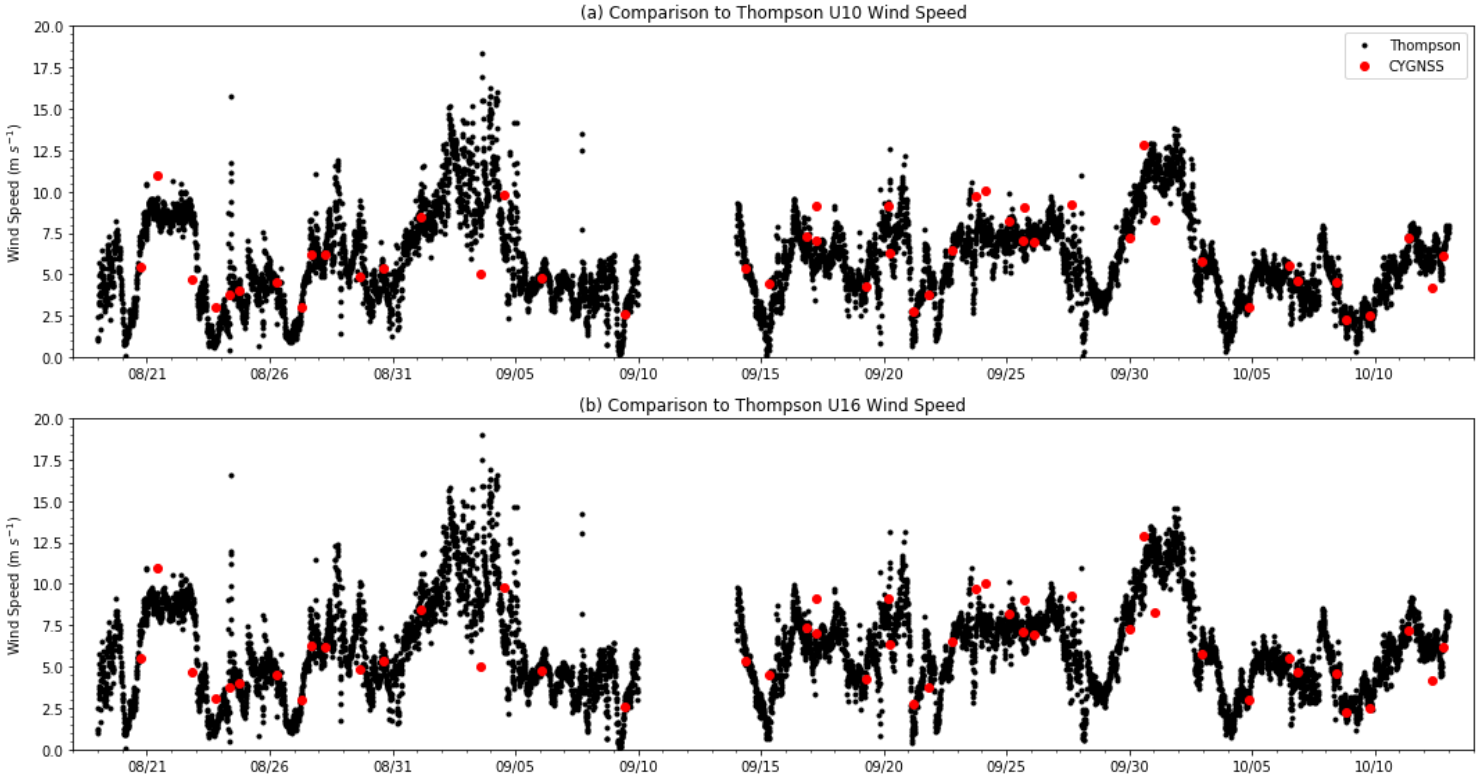


9/26/2018

Context

Typhoon Trami





CDR v1.0 CYGNSS

(Includes track-wise debiasing)

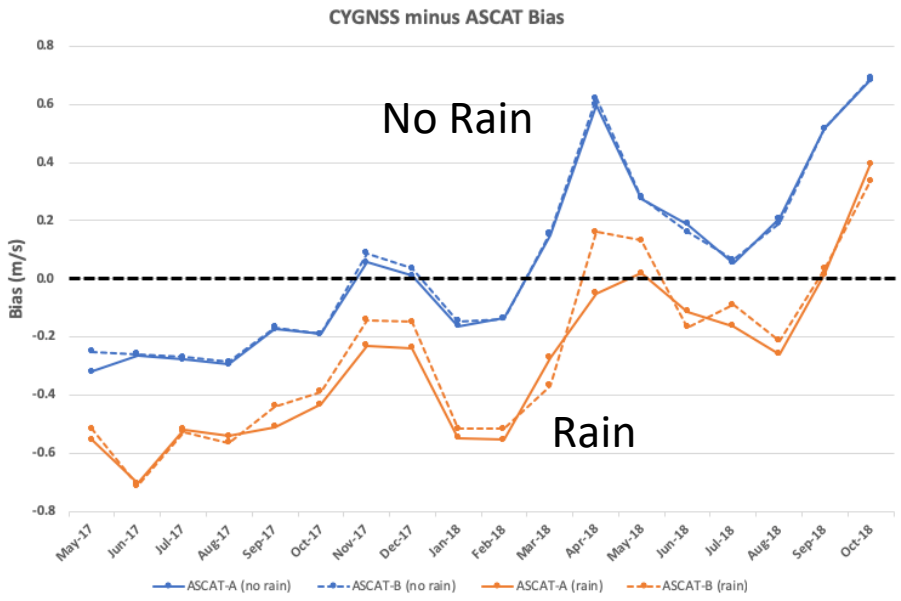
- 48 points for wind speed obs
- CYGNSS bias for U10 of +0.3 m/s and an RMSD of 1.7 m/s
- U16 comparison is +0.2 & 1.7 m/s, respectively

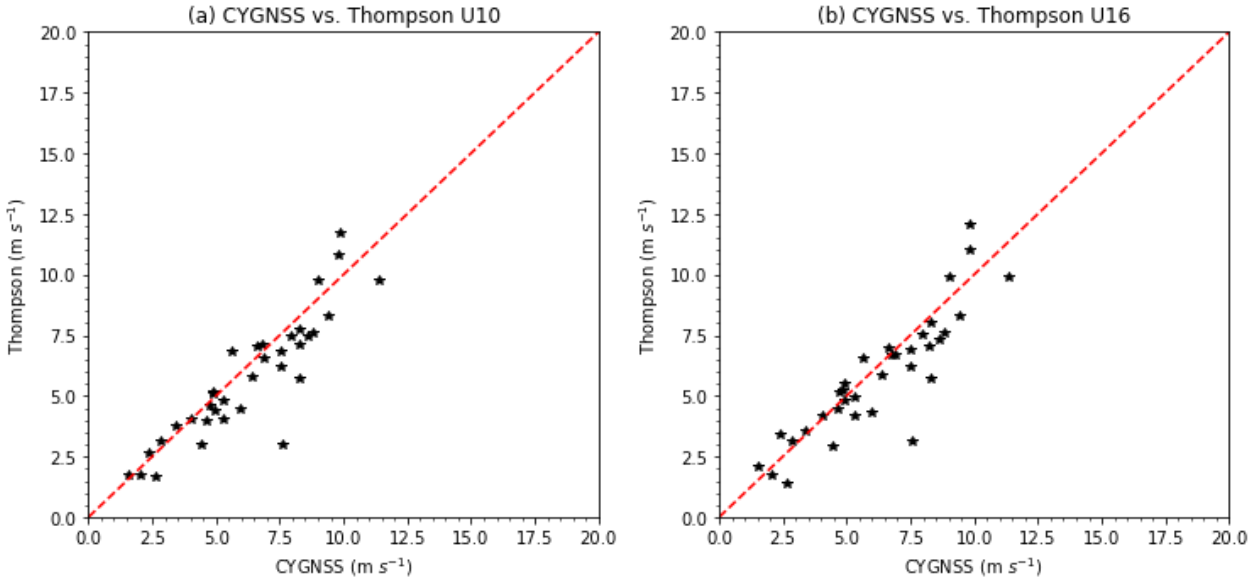
CDR v1.0 Changes Relative to ASCAT A & B

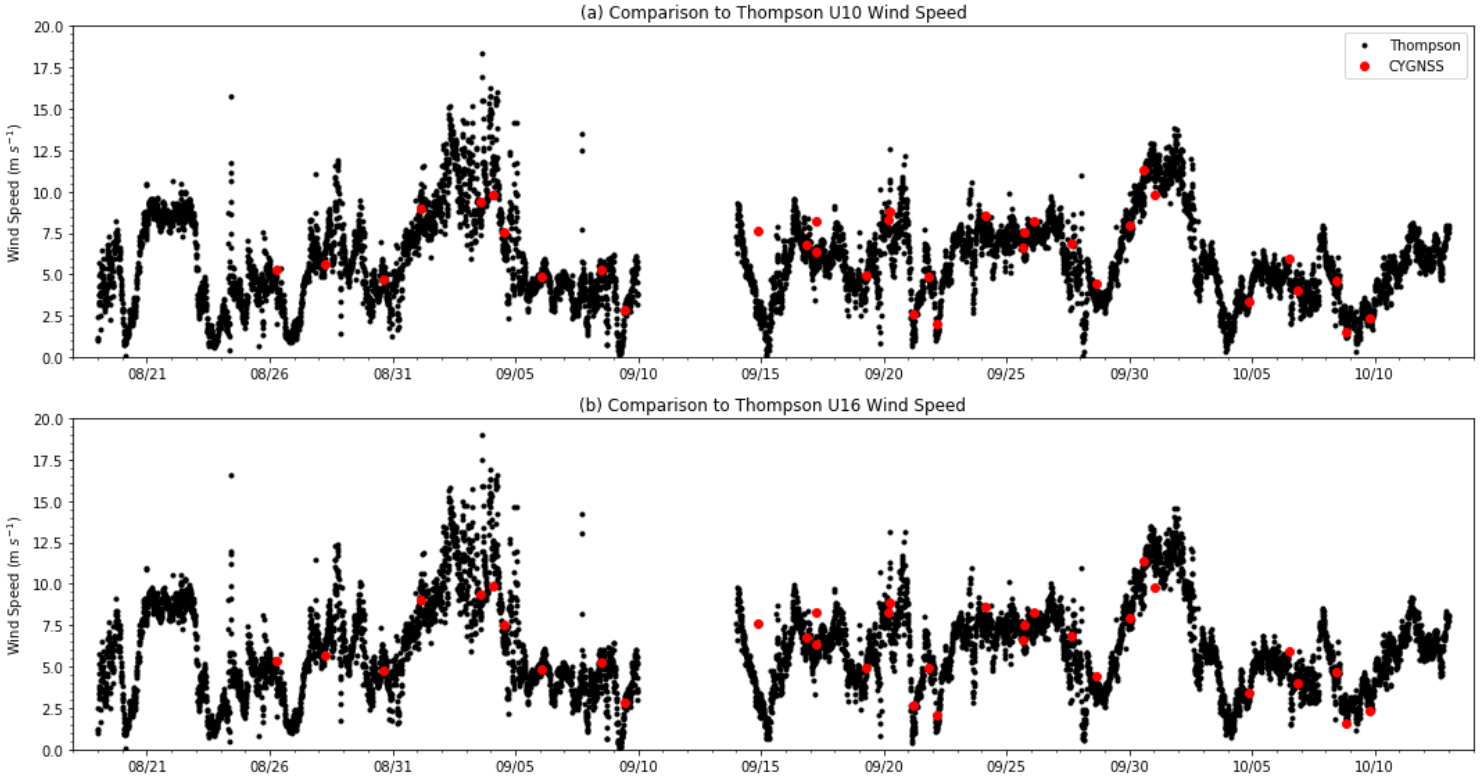
Global CYGNSS-ASCAT September 2018

	V2.1 ASCAT-A	CDR V1.0 ASCAT-A	V2.1 ASCAT-B	CDR V1.0 ASCAT-B
RMSD (m/s) (No Rain)	1.76	1.76	1.76	1.74
Bias (m/s) (No Rain)	+0.52	-0.25	+0.52	-0.23
Matchups (No Rain)	1.307 M	1.704 M	1.323 M	1.729 M
RMSD (m/s) (Rain)	2.46	2.60	2.43	2.62
Bias (m/s) (Rain)	+0.01	-0.68	+0.03	-0.69
Matchups (Rain)	100 K	125 K	95 K	121 K

V2.1 Bias Trends







NOAA CYGNSS

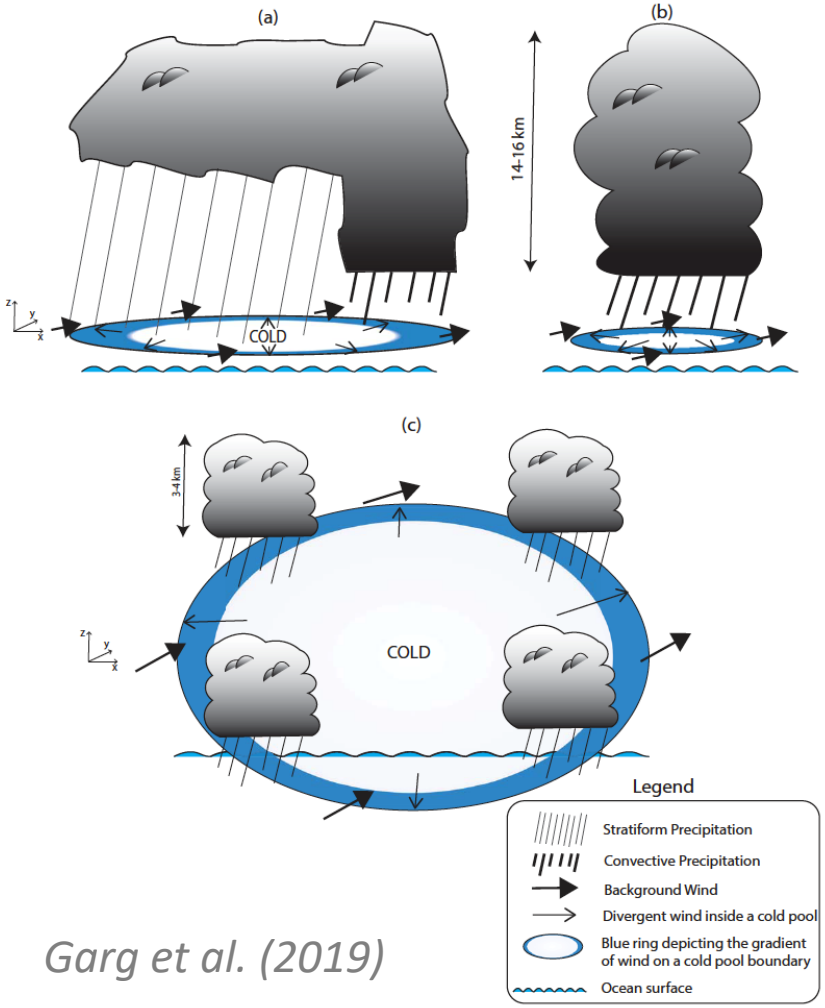
(Includes track-wise debiasing)

- 35 points for wind speed obs
- CYGNSS bias for U10 of +0.5 m/s and an RMSD of 1.2 m/s
- U16 comparison is +0.4 & 1.3 m/s, respectively

Gradient Features

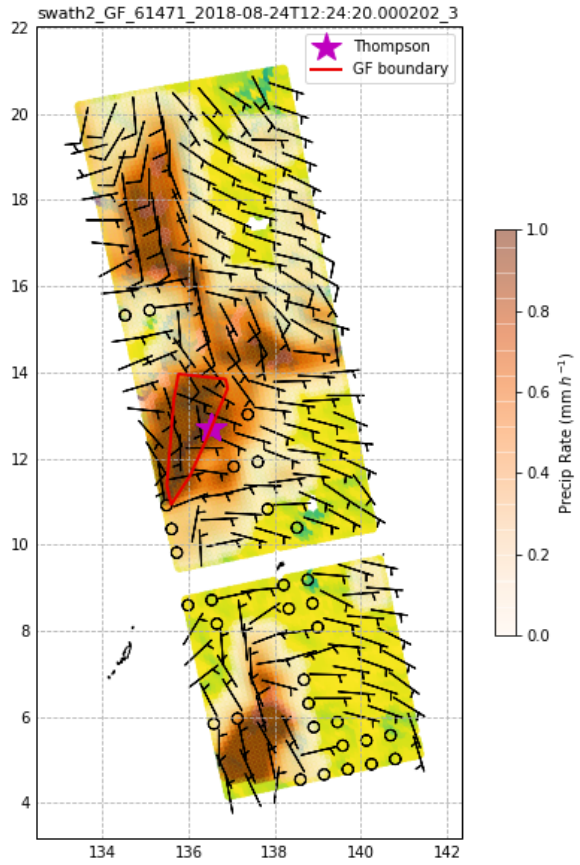
- New technique for detecting cold pools over oceans using scatterometer observations
- Exploit cold pool tendency to feature steep wind gradients at boundaries
- Wind gradient tensor is key parameter
- Less sensitive to directional errors than divergence or vorticity
- Initial validation using DYNAMO and buoy observations simulations

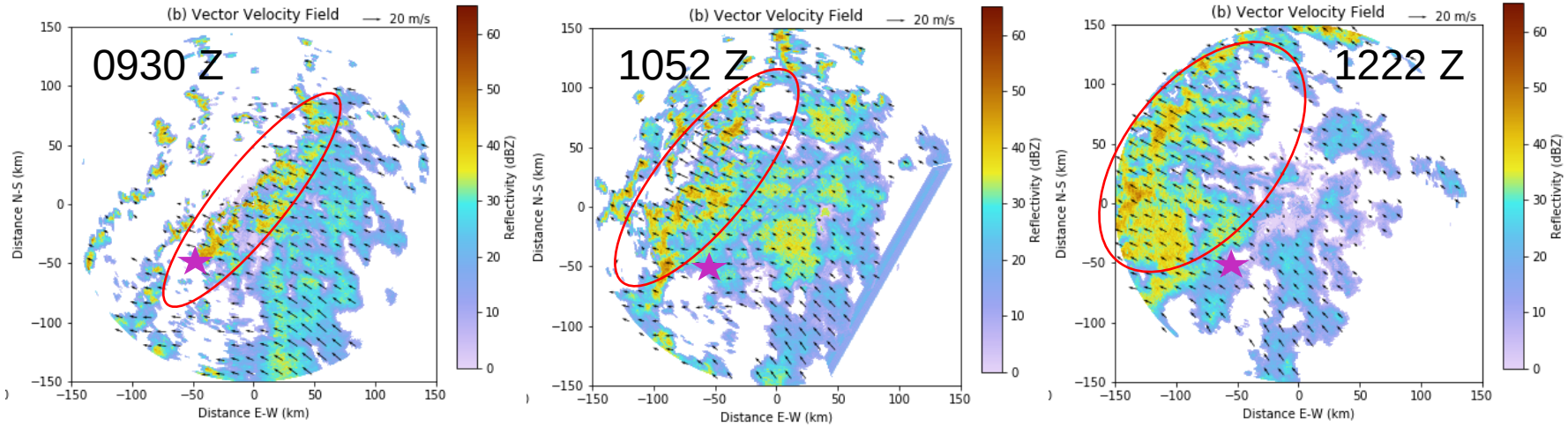
$$|\nabla\vec{V}| = \begin{bmatrix} \frac{\partial u}{\partial x} + \frac{\partial v}{\partial x} \\ \frac{\partial u}{\partial y} + \frac{\partial v}{\partial y} \end{bmatrix}$$



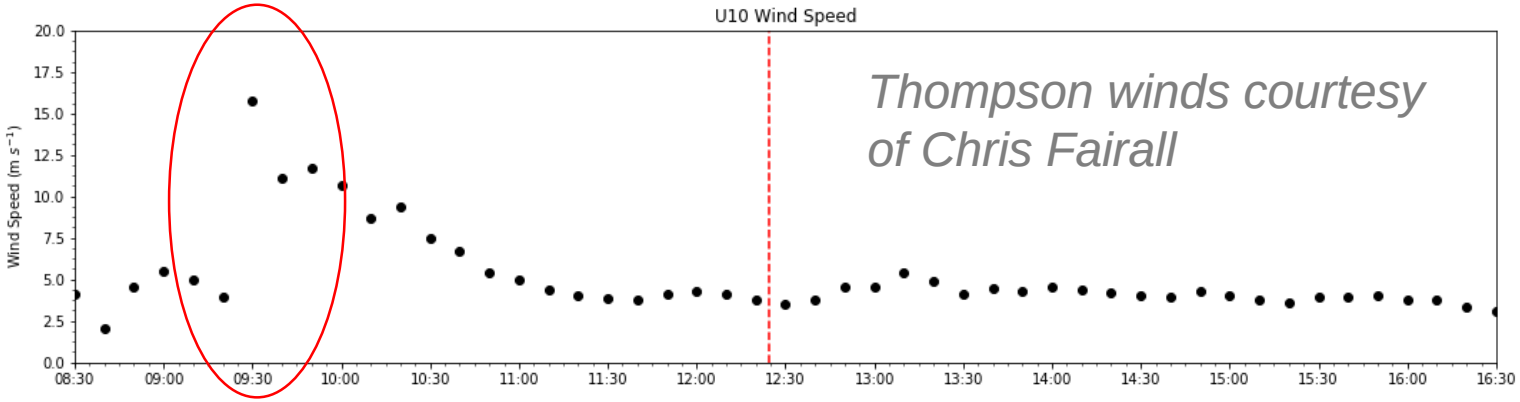
Garg et al. (2019)

PISTON 2018 GF Example

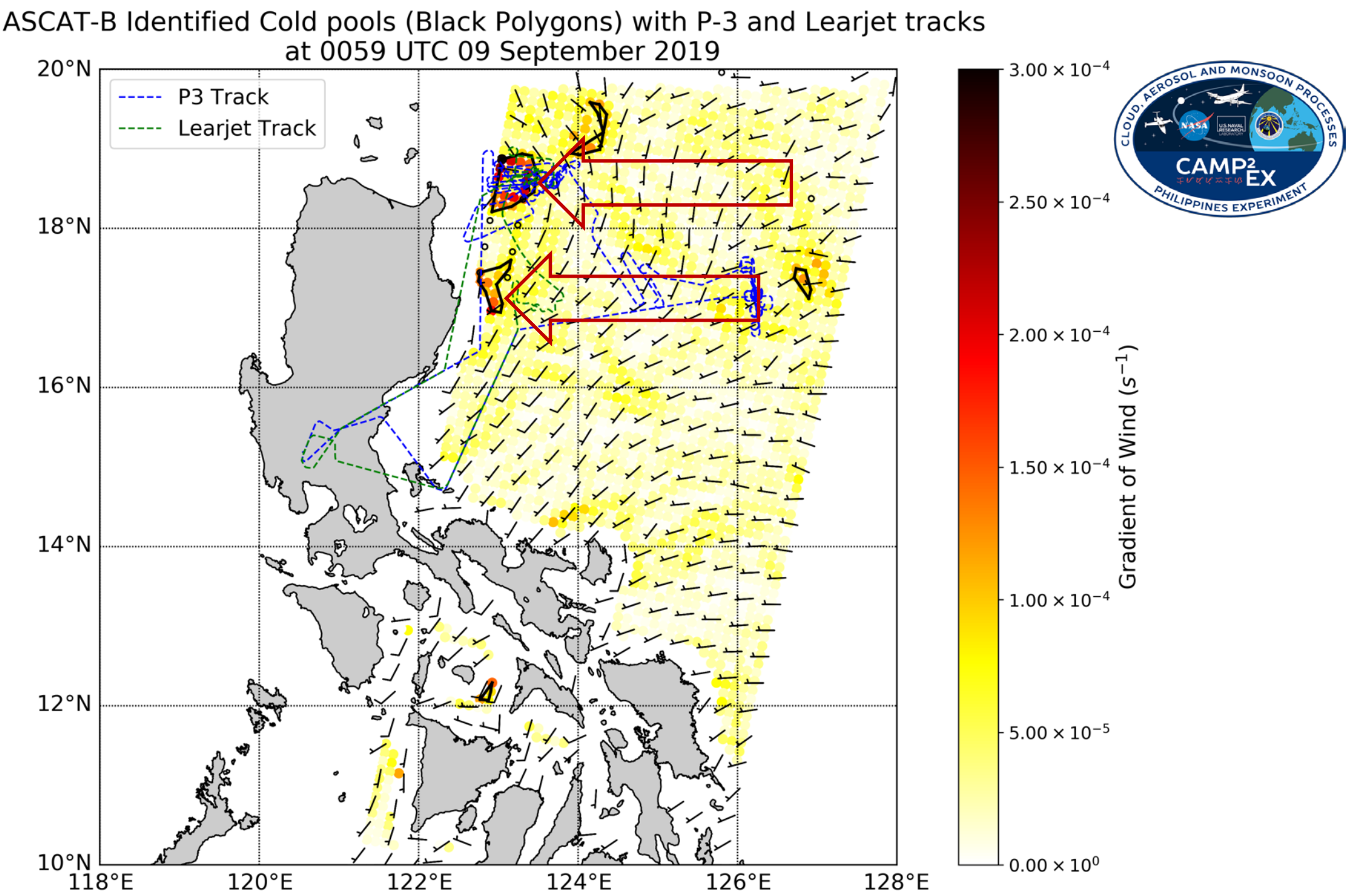




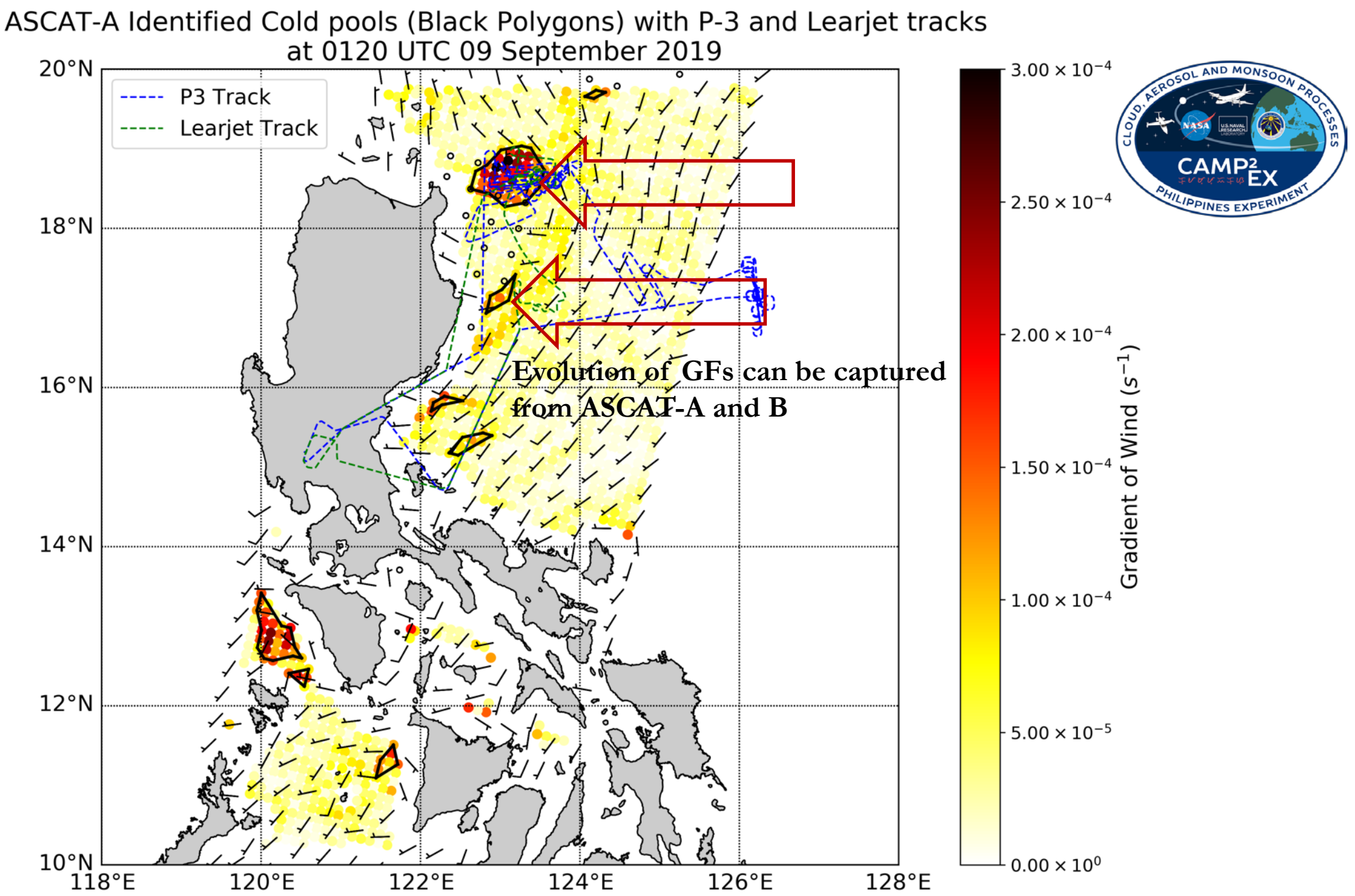
Mirai radar courtesy of Masaki Katsumata



Thompson winds courtesy of Chris Fairall



Analysis courtesy of Piyush Garg, UIUC

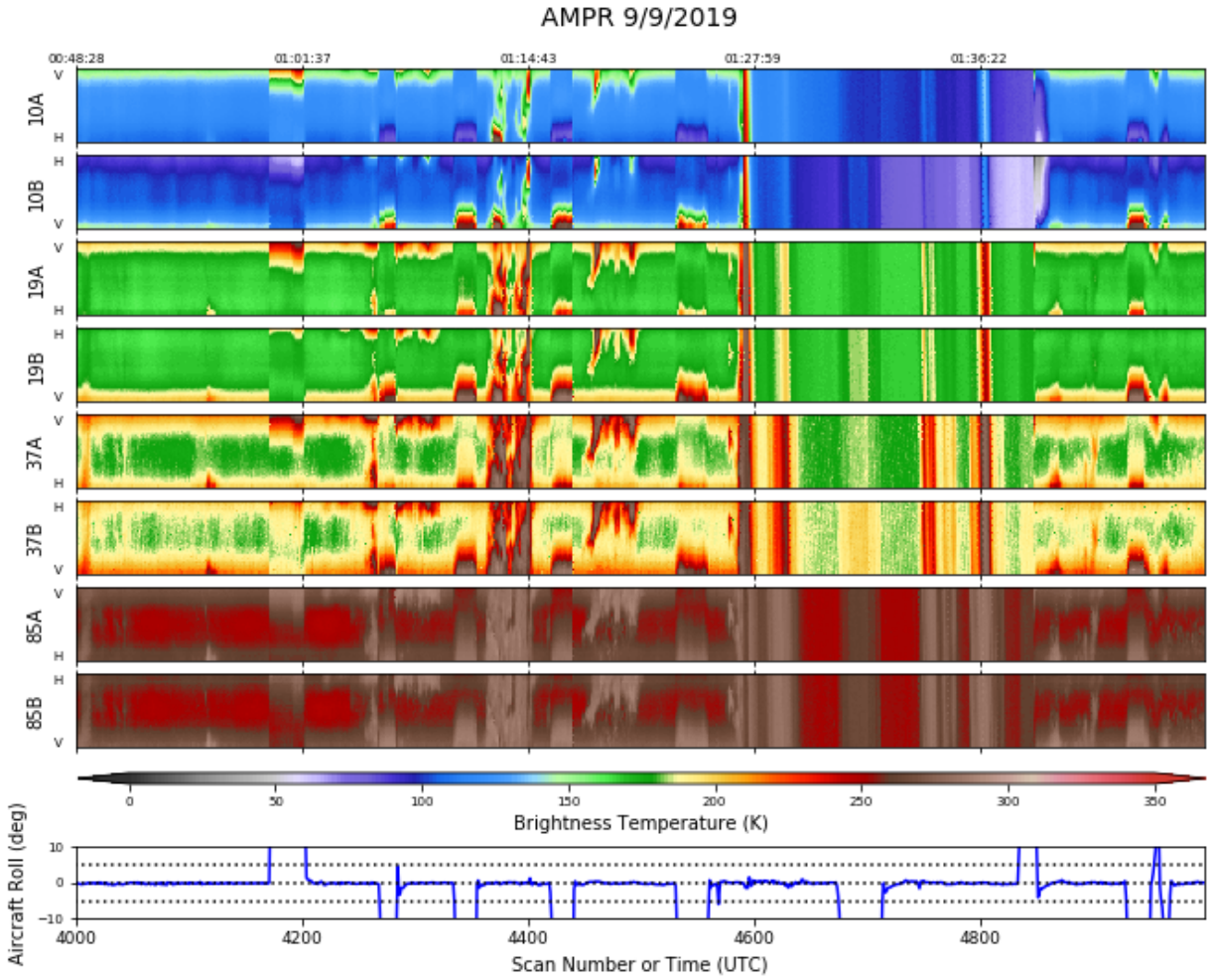


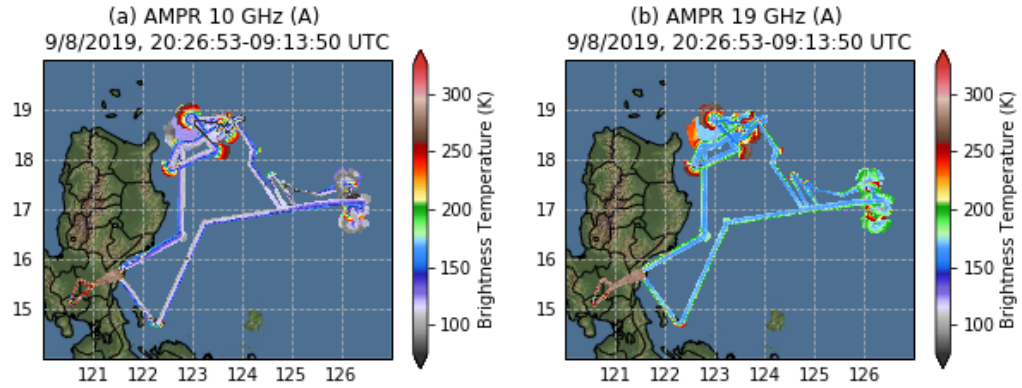
Analysis courtesy of Piyush Garg, UIUC

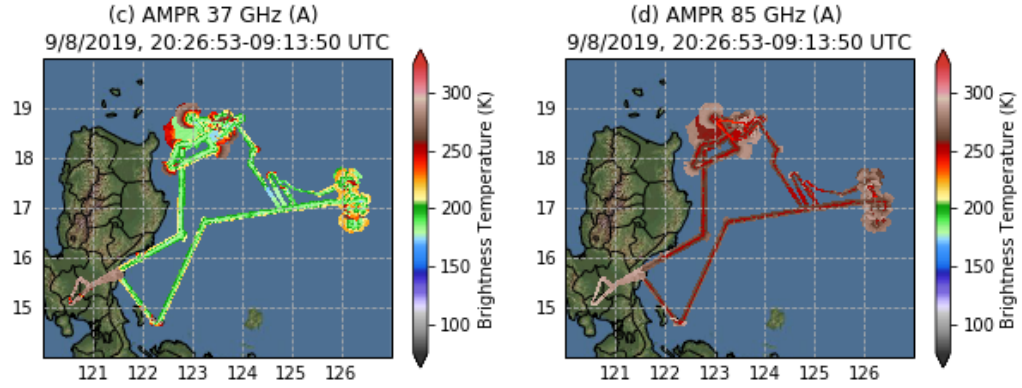
Picture courtesy of Jay Mace, Univ of Utah

Advanced Microwave Precipitation Radiometer (AMPR)

- AMPR sampled near the PISTON study area during multiple CAMP^{2}Ex flights, and is capable of retrieving ocean surface wind speed in the vicinity of convection







Conclusions

- PISTON 2018 and 2019 present great opportunities to validate satellite-based wind measurements in the vicinity of tropical convection
- CYGNSS v2.1 comparison (both fluxes and winds) indicate need for satellite data quality improvements, but new CDR v1.0 and NOAA data show significant promise
- CYGNSS capable of detecting convective gust fronts near convection
- ASCAT gradient features provide an additional opportunity to observe cold pool boundaries from space
- AMPR data from CAMP^{2}Ex flights will also provide near-surface wind retrievals