# Examining tropical oceanic convection using IMERG and CYGNSS

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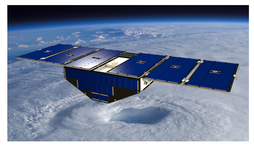
## 1. Introduction

- The Cyclone Global Navigation Satellite System (CYGNSS) is a multi-satellite constellation that measures ocean wind speed using GPS reflectometry.

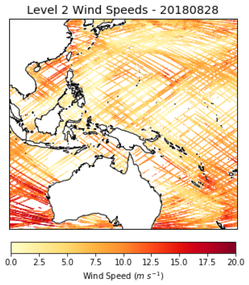


- CYGNSS wind measurements are not as impacted by rainfall, making them useful in and near tropical convective systems.

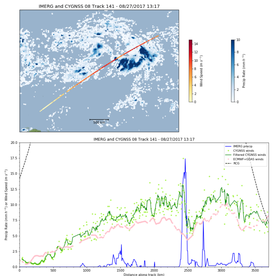
- Combining IMERG with CYGNSS enables the study of wind-precipitation interactions in convection, and shipborne radar can provide context for these analyses.

## 2. Data

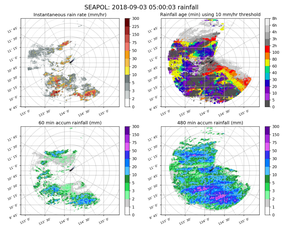
- CYGNSS provides up to 32 measurements of wind speed per second globally. Footprint of each specular point is ~25 km. Rapid revisit near the same location is common.




- Tracks of specular points, formed between individual CYGNSS and GPS satellites, often pass thru convective systems, and thus are matched to IMERG rainfall.



- SEAPOL radar data from Propagation Of Intraseasonal Tropical Oscillations (PISTON) experiment are used to examine convection along CYGNSS tracks in more detail.

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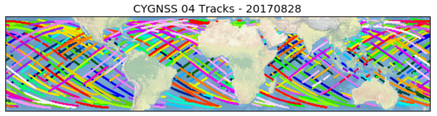
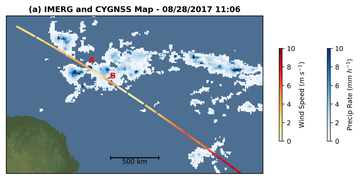
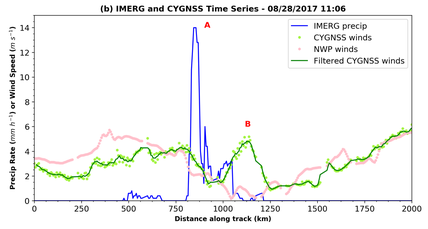
## 3. Analysis of IMERG & CYGNSS Near Convection

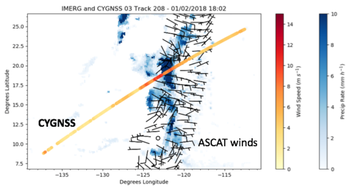
- Hoover et al. (2017) and Ruf et al. (2018) demonstrated the value of a specular point track-based analysis of CYGNSS Level 2 winds. When combined with precipitation data from IMERG, as well as simple filtering of the oversampled CYGNSS data, gust fronts and other surface features near precipitation systems are readily apparent. These gradients are not always observed in NWP analyses.

- Advanced Scatterometer (ASCAT) provides near-surface wind vectors over ocean, but can be affected by rainfall. Combining IMERG with CYGNSS and ASCAT provides a more complete picture near tropical convection.



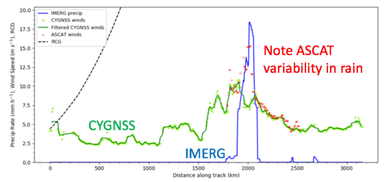



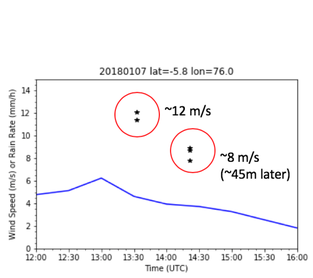

**CYGNSS demonstrates value over conventional scatterometers in rain**

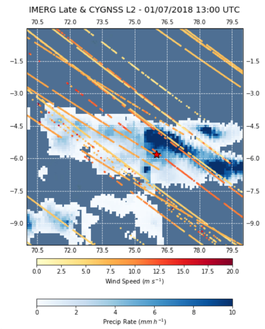
- Comparing 6 months of CYGNSS winds with ASCAT in the vicinity of heavy IMERG rainfall
- Along v2.x CYGNSS specular point tracks, good agreement with ASCAT outside rain
- ASCAT measurement often impacted by rainfall but CYGNSS less sensitive to that, worsening agreement but showing value added by CYGNSS




| CYGNSS - ASCAT | Samples | Bias ($m\ s^{-1}$) | RMSE ($m\ s^{-1}$) |
|---|---|---|---|
| All | 160367 | +0.2 | 2.2 |
| Rain | 54552 | -0.1 | 2.7 |
| No Rain | 105815 | +0.3 | 1.9 |

**Eulerian Perspective – Watch CYGNSS & IMERG from single location**



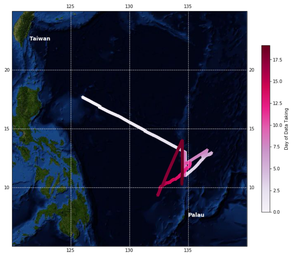

- Evidence for convective variability near rainfall
- Limited samples when Block IIF excluded
- Impact of calibration offsets between observatories?

## *Acknowledgments*

*Support was provided by the NASA Weather and the ONR PISTON programs. CYGNSS and ASCAT data are available publicly at the NASA PO.DAAC. IMERG data were obtained from NASA EOSDIS. Contact Steve Rutledge at CSU for SEAPOL data. The NASA PyGNSS software is available on GitHub. #MadeWithPyART*

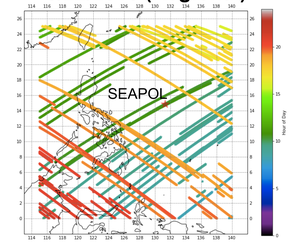
## 4. Comparison with PISTON Observations

- SEAPOL is a C-band polarimetric Doppler radar mounted on the forward O2 deck of the *R/V Thomas G Thompson* for the ongoing PISTON field campaign in the Western Pacific, near Palau.

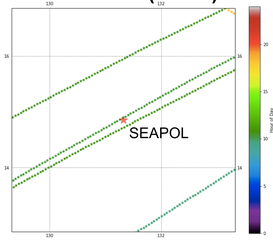


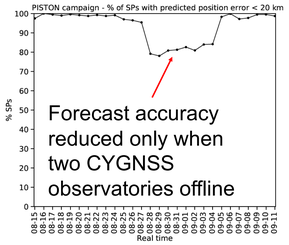

- CYGNSS overpass forecasts influenced SEAPOL scanning choices, in particular RHI targets. Goal was to do vertically resolved scanning along CYGNSS tracks, attempting to confirm the inference of gust fronts in CYGNSS wind gradients near heavy IMERG precipitation.

**8/22/2018 (Regional)**




**8/22/2018 (Zoom)**



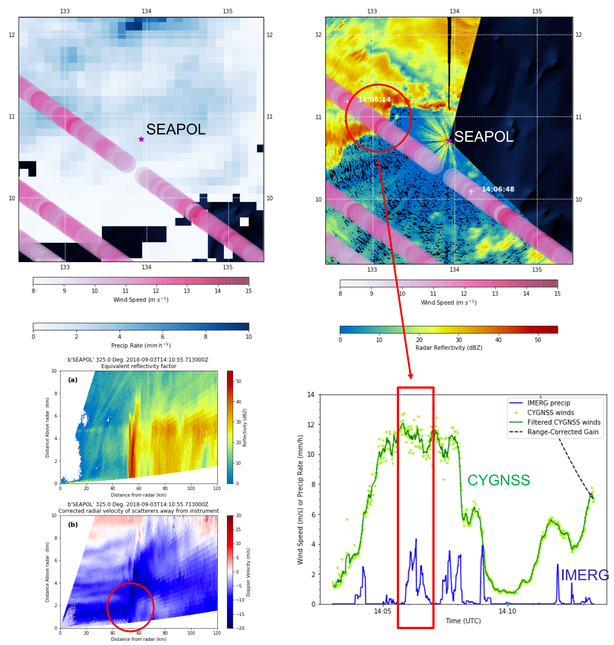




- CYGNSS sampled a quasi-linear convective system during a regime of strong westerly flow

- Comparison with SEAPOL shows winds are strongest near convective line, due to influence of gust front

- SEAPOL radar provides hi-res 3D context for coarser 2D IMERG & CYGNSS, and confirms CYGNSS utility near MCSs

**9/3/2018 1400 UTC IMERG, CYGNSS, and SEAPOL**




## 5. Conclusions

- IMERG is proving to be an indispensable tool for mapping precipitation over the global tropical oceans. Combining IMERG with wind observations along CYGNSS specular point tracks enables the identification and mapping of gust fronts and other wind features near tropical convection.
- Future work will combine CYGNSS with a Precipitation Feature database in order to better understand the global distribution of convective wind features.