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The Colorado State University Sea-Going and Land Deployable Polarimetric (SEA-POL) Radar

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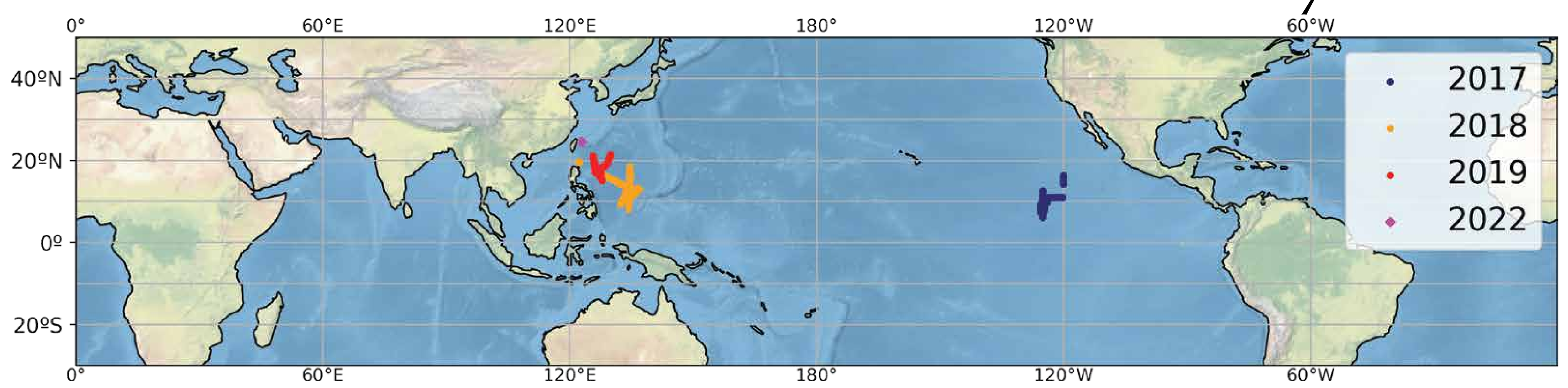
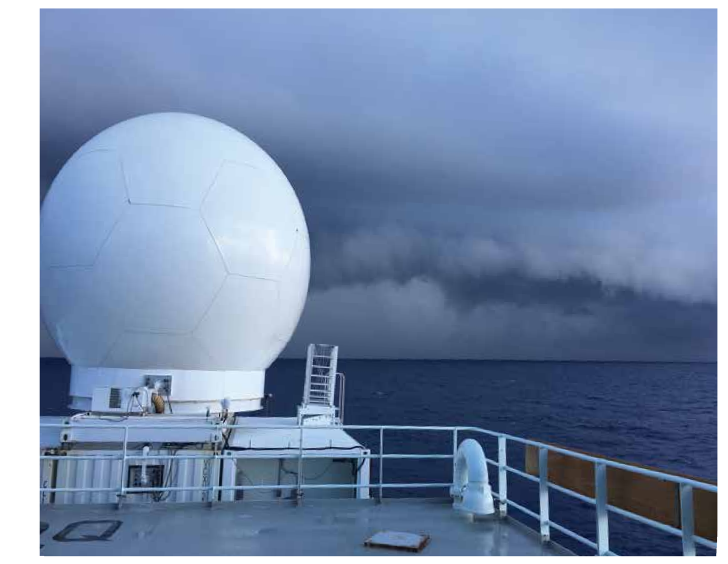
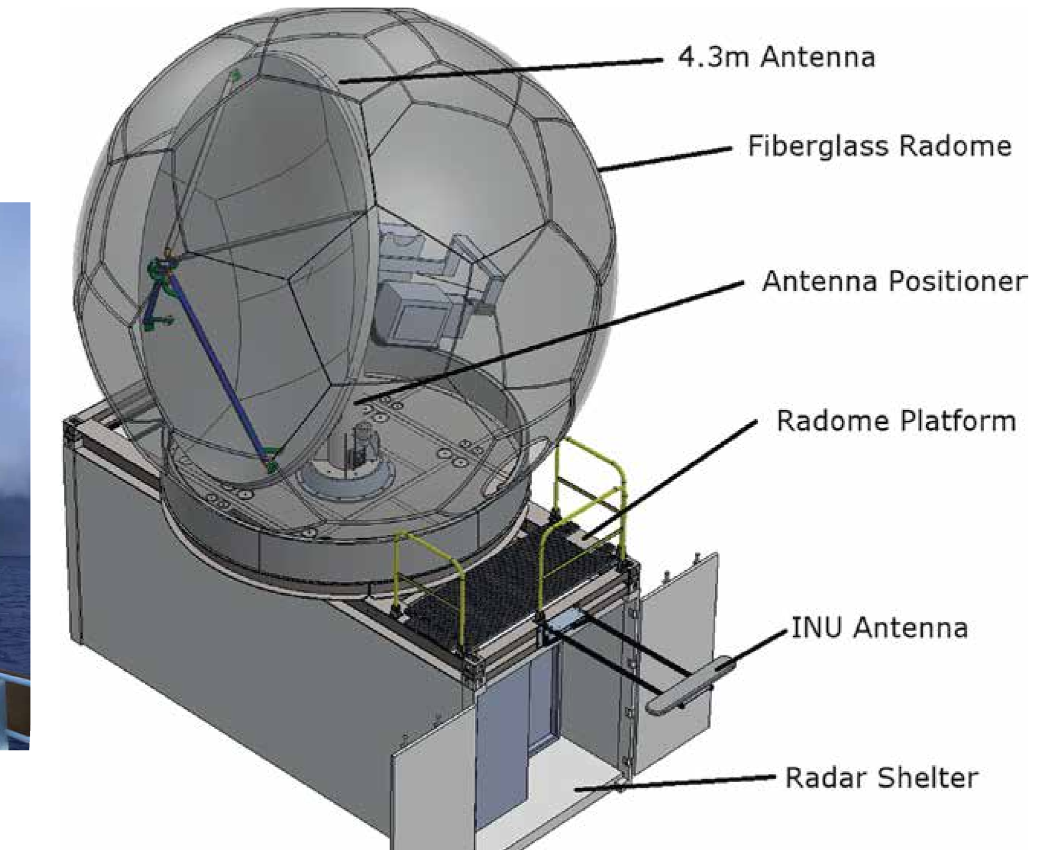


A map of Sea-Pol radar deployment locations. Lines show ship tracks and diamond indicates land-based deployment.





SEA-POL Summary

The Colorado State University (CSU) Sea-Going and Land-Deployable Polarimetric (SEA-POL) radar has recently been supported as a Community Facility available for deployment requests through the National Science Foundation (NSF). The radar is designed to be portable and rugged from a mechanical and electrical perspective, and constructed to be operable in harsh environments. The radar can be deployed on ships and at remote field sites around the world. It offers platform stabilization for oceanic environments while still having high-quality polarimetric capabilities for all-purpose use. The CSU radar has been deployed in SPURS-2 (2017) and PISTON (2018/2019) shipborne campaigns and on an island for PRECIP 2022. The radar is available for future deployments through the NSF Facilities and Instrumentation Request Process (FIRP).

Past SEA-POL Deployments

- **SPURS-2** (October -November 2017), R/V Roger Revelle
  - San Diego -> Eastern Pacific -> San Diego
- **PISTON** (August -September -October 2018), R/V Thomas G Thompson
  - Kaohsiung City Taiwan -> Palau -> Kaohsiung Taiwan
- **PISTON** (September 2019), R/V Sally Ride
  - Keelung Taiwan -> Western Pacific -> Keelung Taiwan
- **PRECIP** (May -August 2022), land-based on Yonaguni, Japan

Future SEA-POL Deployments

SEA-POL is available for requests through the NSF FIRP!
- Track 1 (Education)
- Track 2 (Single facility)
- Track 3 (Field Campaign)

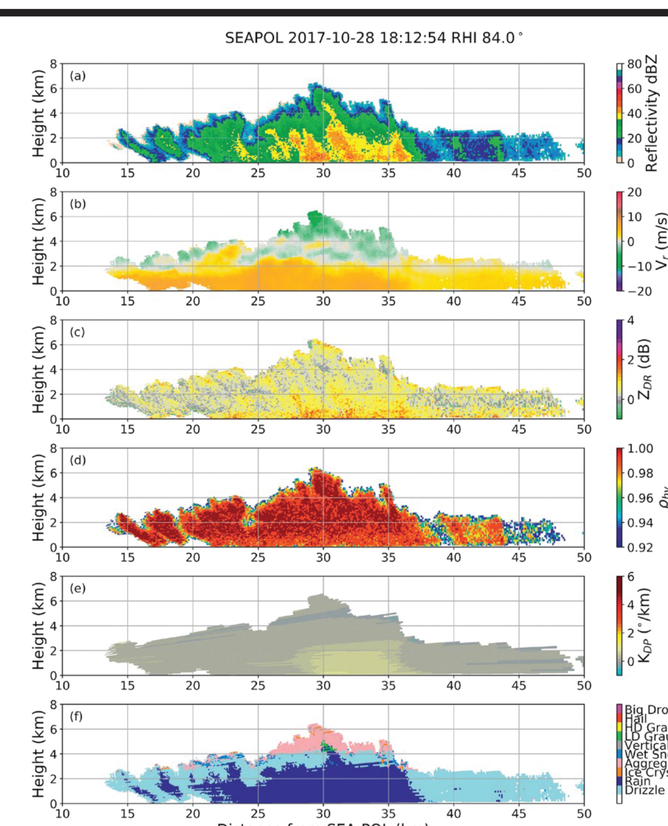
Visit ***seapol.colostate.edu***
Email us at seapol-request@lists.colostate.edu

SEA-POL Technical Specifications

The CSU SEA-POL radar measures dual-polarization data over a range in excess of 200 km. The radar operates at C-band (5.65 GHz, 5-cm wavelength) and has a 4.3 m stabilized antenna system. An inertial navigation unit measures ship motion and sends compensation commands to the antenna positioner. Doppler velocity data is also corrected for ship velocity. This permits high quality data to be collected at sea, correcting for ship roll and pitch. The radar operates in simultaneous transmit and receive mode, as well as horizontal-only mode, with a sensitivity of -7 dBZ at 100 km. The radome is designed to handle wind loads up to 115 mph. A variety of pulse widths, pulse repetition frequencies, and scanning strategies are supported. The radar is packaged in three ISO-668 1C containers for transportability and ease of deployment.

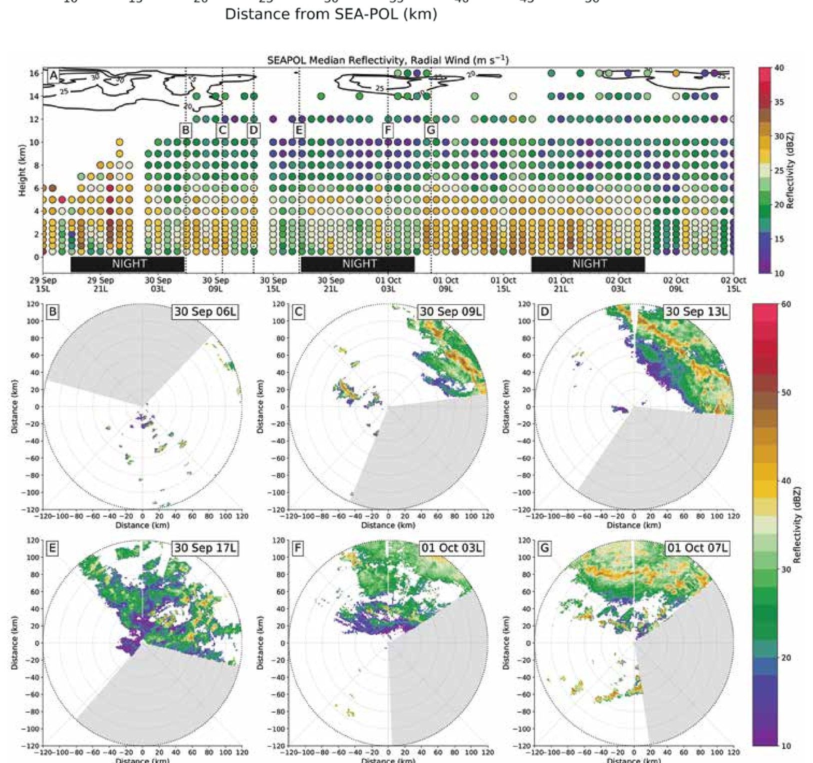
Science with SEA-POL

Example data from the Salinity Processes in the Upper Ocean Regional Study, second field phase (SPURS-2) project



Range–height indicator (RHI) plots of (a) reflectivity, (b) Doppler radial velocity corrected for storm motion, (c) differential reflectivity, (d) co-polar correlation coefficient, (e) specific differential phase, and (f) hydrometeor classification at 1812:54 UTC 28 Oct 2017 facing east (84° azimuth). From Rutledge et al. (2019)

Example analysis from Propagation of Intra-Seasonal Tropical Oscillations (PISTON) 2018 Project



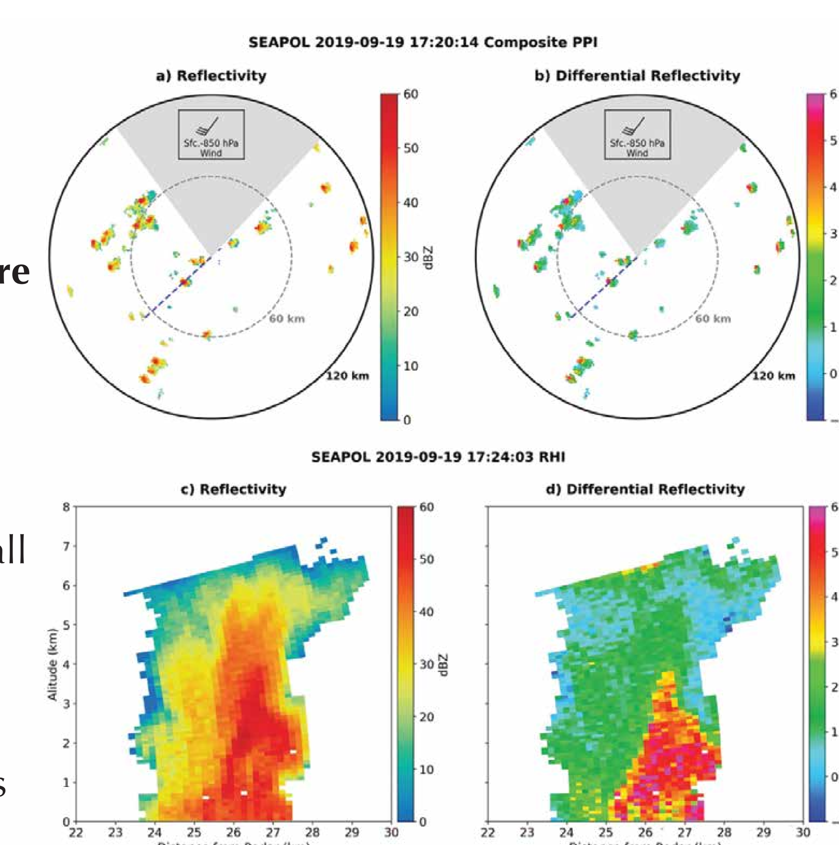
Colored circles in (a) are the evolution of the hourly median reflectivity profile from gridded SEA-POL data. Contoured in black are the relative radial winds of Typhoon Kong-Rey derived from the thermodynamic profiles exceeding 20 m/s. (b)–(h) Vertical dotted lines indicate the times of the corresponding 2-km altitude horizontal cross sections.The gray shaded region is where SEA-POL was not transmitting and collecting observations, which changes with ship heading. Times where no solar radiation is affecting thecloud distributions are denoted for reference. Both colorbars use increments of 2 dBZ; however, the evolution of the median reflectivity and the cross sections use slightly different colorbars because of the differences in the range of values. From Trabing and Bell (2021)

Unique Observations of Large Raindrops during PISTON

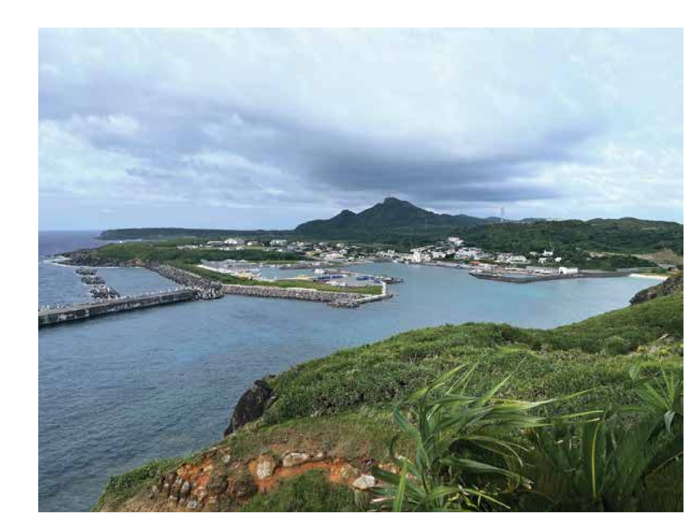
SEA-POL frequently measured very large Zdr (> 5 dB) => >4.5 mm drops

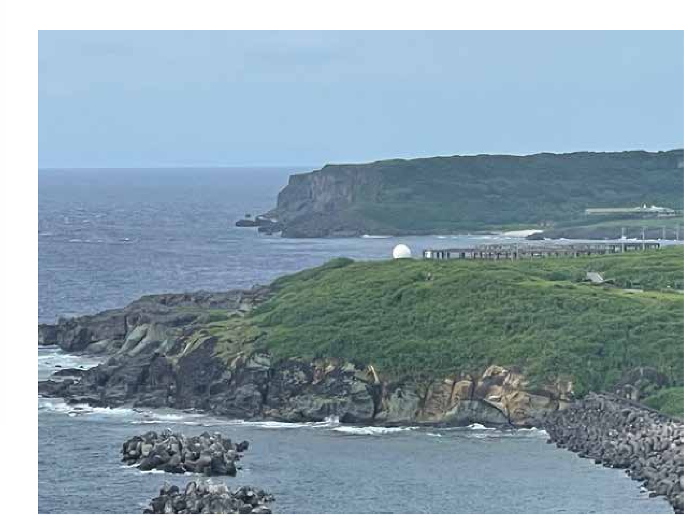
The frequent large Zdr values observed by SEA-POL were determined to be due to several factors:
1. Resonance effects at C-band (5 GHz) and warm temperatures
2. Size sorting (preferentially found high Zdr on upwind edge)
3. Masking of large drops by large concentrations of small drops

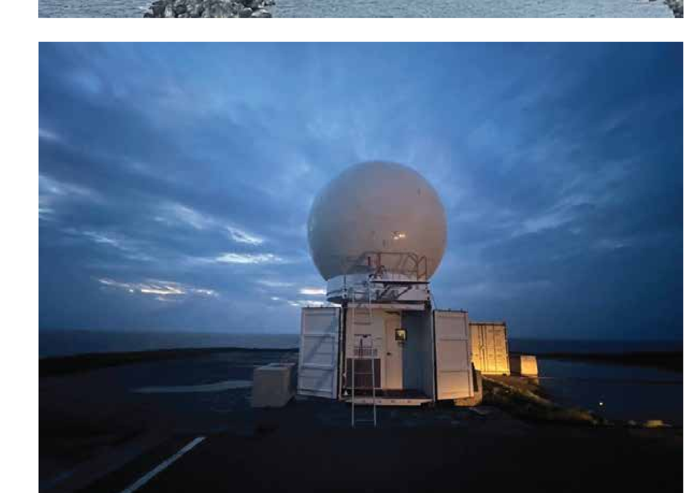
Can drops grow that large under primarily warm rain conditions?
- Updrafts (~3 m/s) and LWCs (1.5 g/m3) frequent in this area support the growth of large (> 4.5 mm drops)
- Large drops were observed by coincident in situ measurements by the SPEC Inc. Learjet



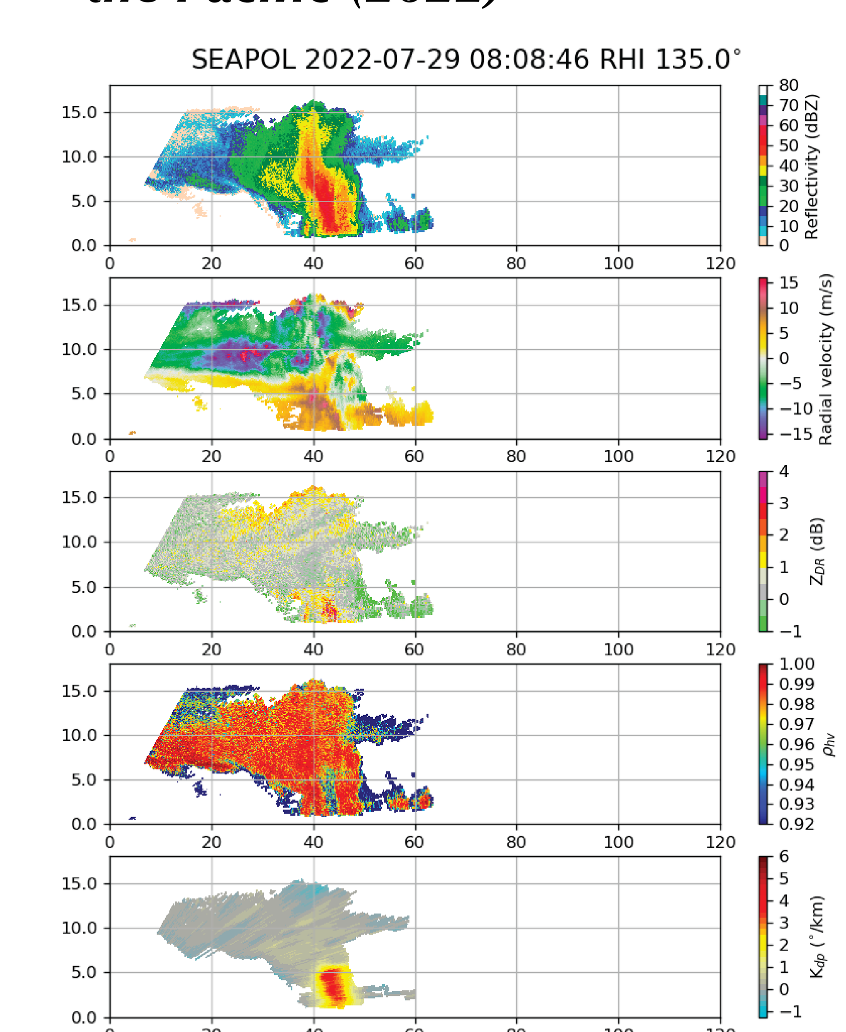
From Chudler et al (2022)







Example data from the Prediction of Rainfall Extremes Campaign in the Pacific (2022)



A surge of moisture came into the region on 29 July during IOP 9 that helped produce a strong linear MCS over the ocean observed by CSU SEA-POL radar (right). Echo tops were near 15 km, with heavy rain evident in the polarimetric variables: (a) reflectivity, (b) Doppler velocity, (c) differential reflectivity, (d) correlation coefficient, and (d) specific differential phase.

Publications using SEA-POL

- Chudler, K., S. A. Rutledge, and B. Dolan, 2022: Unique radar observations of large raindrops in tropical warm rain during PISTON. Mon. Wea. Rev. 150 (10), 2719-1736.
- Chudler, K. and S. A. Rutledge, 2021: The coupling between convective variability and large-scale flow patterns observed during PISTON 2018-2019. J. Climate, 34, 7199-7218.
- Rutledge, S.A., V. Chandrasekar, B. Fuchs, J. George, F. Junyent, B. Dolan, P.C. Kennedy, and K. Drushka, 2019: SEA-POL Goes to Sea.Bull. Amer. Meteor. Soc.,100, 2285–2301,https://doi.org/10.1175/BAMS-D-18-0233.1
- Rutledge, S.A., V. Chandrasekar, B. Fuchs, J. George, F. Junyent, P. Kennedy, and B. Dolan. 2019. Deployment of the SEA-POL C-band polarimetric radar to SPURS-2. Oceanography32(2):50-57,https://doi.org/10.5670/oceanog.2019.212
- Sobel, A. H., J. Sprintall, E. D. Maloney, Z. K. Martin, S. Wang, S. P. de Szoeke, B. C. Trabing, and S. A. Rutledge, 2021: Large-Scale state and evolution of the atmosphere and ocean during PISTON 2018.J. Climate, 34, 5017-5035.
- Trabing, B. C., and M. M. Bell, 2021: Observations of Diurnal Variability under the Cirrus Canopy of Typhoon Kong-rey(2018). Mon. Wea. Rev., 149,, 2945-2964.