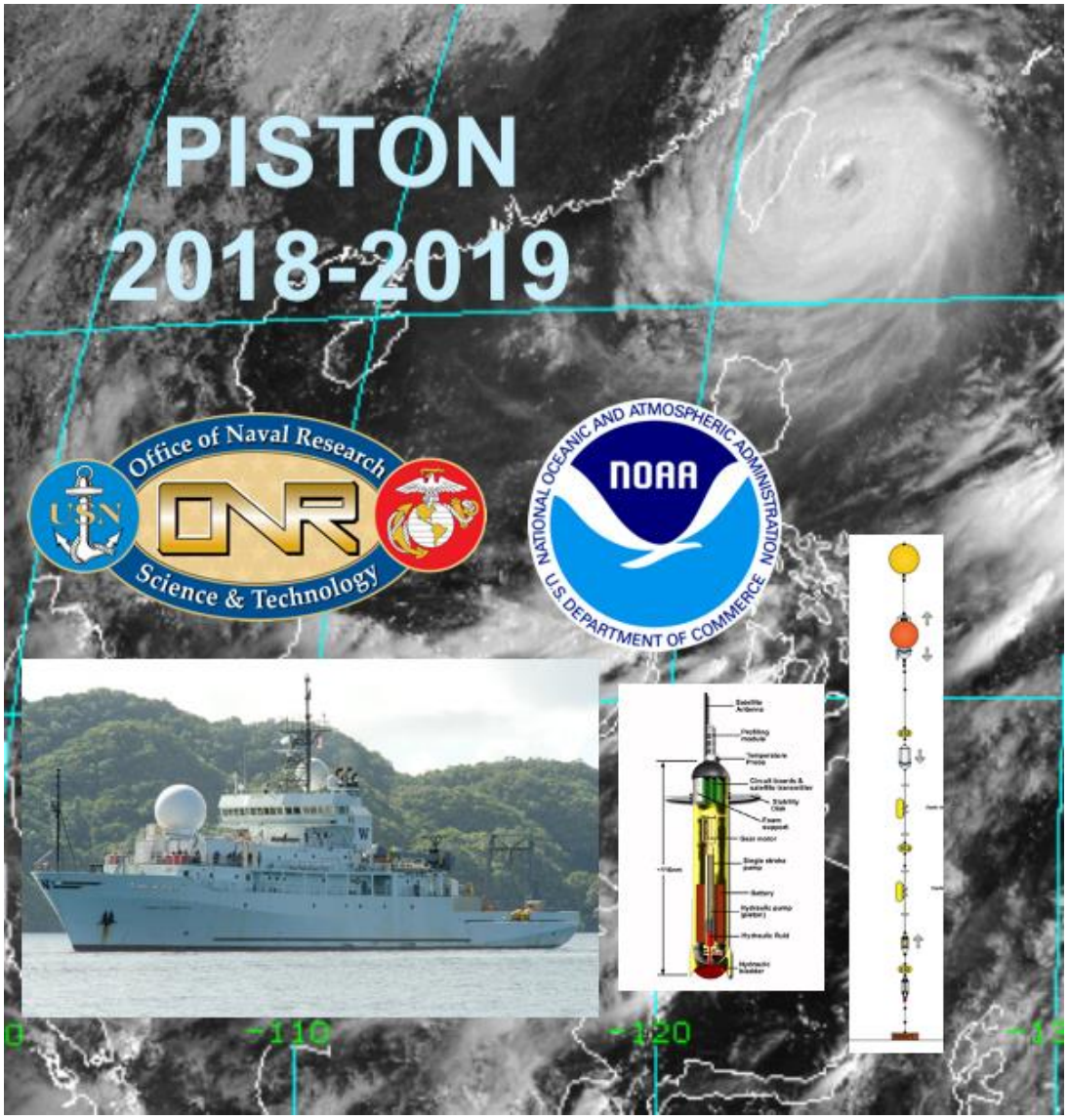
PISTON Data Product User Guide



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Introduction:

The Propagation of Intra-Seasonal Tropcial OscillatioNs (PISTON) field campaign was a joint effort by the Office of Naval Research and NOAA that set out to enhance the prediction capability of multi-scale tropical convection and air-sea interaction in the western Pacific Ocean. Specifically, PISTON took data from the Boreal Summer Intraseasonal Oscillation (BSISO) in the Pacific Ocean north of Palau. To take the atmospheric and oceanographic data, the PISTON campaign primarily used two NOAA research vessels (the *R/V Thomas G. Thompson* and the *R/V Sally Ride*) with similar payloads of oceanographic instruments. These data were supplemented by data from specialized moorings, ocean floats, and radiosondes.

Additionally, PISTON overlapped with its sister campaign, the Clouds, Aerosol and Monsoon Processes-Philippines Experiment (CAMP2Ex). CAMP2Ex used the NASA P-3B and SPEC Learjet 35A Aircraft to measure and characterize aerosols, cloud parameters, precipitation, and trace gases in the region in order to further understanding in three areas: aerosol effect on cloud microphysical and optical properties, aerosol and cloud influence on radiation as well as radiative feedback, and meteorology related effects on aerosol distribution and aerosol-cloud interactions. CAMP2Ex flew 10 flights in direct coordination with PISTON shipboard measurements.

The data from PISTON contained on EARTHDATA Search is in the following formats: NetCDF, Text, CDF, and JPEG. These formats are widely used for scientific data and compatible with various analysis software, such as Python, MATLAB, or GIS tools.

The purpose of this user guide is to contextualize the PISTON mission and give helpful insight into the collections and use of PISTON data.

Citation:

Cite ASDC Data
DOI Citation Formatter

Collection DOIs:

R/V Mirai:	10.5067/SUBORBITAL/PISTON2018-ONR-NOAA/RVMIRAI/DATA001
Island Sondes:	10.5067/SUBORBITAL/PISTON2018-2019-ONR-NOAA/ISLANDS/DATA001
R/V Thompson:	10.5067/SUBORBITAL/PISTON2018-ONR-NOAA/RVTHOMPSON/DATA001
R/V Sally Ride:	10.5067/SUBORBITAL/PISTON2019-ONR-NOAA/RVSALLYRIDE/DATA001
Moorings:	10.5067/SUBORBITAL/PISTON2018-2019-ONR-NOAA/AUTONOMOUS/DATA001

All 5 Collections are described further in the “Data Products” section.

Campaign Overview:

Objectives

PISTON set out to take oceanographic and atmospheric data from the BSISO to gain understanding and enhance the prediction capability of multi-scale tropical convection and air-sea interaction in this region. The BSISO defines the northward and eastward movement of convection associated with equatorial waves, the Madden-Julian Oscillation (MJO), tropical cyclones, and the Maritime Continent monsoon during northern-hemispheric (boreal) summertime. Two guiding questions of study were:

1. How do localized features such as island orography and individual thunderstorms influence tropical intraseasonal oscillations?

2. How does variability in large-scale atmospheric circulations over the South China Sea influence the diurnal cycle, synoptic systems, and interactions between the atmosphere and ocean within the Maritime Continent?

Platforms

PISTON utilized a variety of platforms across the Western Pacific North of Palau to answer these questions. The major platforms were NOAA's *R/V Thomas G. Thompson* (hereafter referred to as the *R/V Thompson*) and *R/V Sally Ride*. The *R/V Thompson* sailed in the late Summer of 2018 while the *R/V Sally Ride* sailed in the summer of 2019. The deployment of the R/V Sally Ride coincided with the CAMP2Ex campaign, so data was coordinated between the two. Both vessels had similar instruments that measured oceanic parameters such as sea surface temperature, salinity, and conductivity and atmospheric parameters such as wind speed, precipitation rate and size, and cloud base height. The full payload and parameters for the *R/V Thompson* and *R/V Sally Ride* can be found in Tables 5 and 6 respectively. Additionally, radar data from Japan's Agency for Marine-Earth Science and Technology's *R/V Mirai* supplemented data from the *R/V Thompson* (Table 3).

In addition to the research vessels, PISTON used radiosondes to measure column profiles of temperature, wind, and pressure. The sondes were launched from the *R/V Thompson*; *R/V Mirai*; *R/V Sally Ride*; and the islands of Guam, Babelthaup, Yap, Dongshadao, and Taiping (Tables 3-6).

The final platforms used by PISTON were special moorings and ocean floats. These devices measured ocean current direction, speed, and temperature. While the moorings were permanent through the study period, the ocean floats were put out in various locations prior to typhoons to focus on specific events for measure (Table 7).

Data Products:

All data products from the PISTON campaign are archived on EARTHDATA. The data are organized into collections by platform. Table 1 below shows these products with their accompanying table number where more information is detailed about each product. In order to access this data, you can either use the query function on EARTHDATA Search or scroll to the respective table and click on the EARTHDATA button. To download the datasets of your choosing, you will need an EARTHDATA account.

Table 1. Data Products Available on EARTHDATA Search

Data Collection	Table Number
R/V Mirai	Table 3
Island Sondes	Table 4
R/V Thompson	Table 5
R/V Sally Ride	Table 6
Ocean Moorings and Floats	Table 7

These datasets feature a combination of Network Common Data Form (NetCDF or .nc), Common Data Form (CDF or .cdf), text (.txt), and Images (.jpeg). NetCDF and CDF files can all be viewed in NASA's Panoply or Hierarchical Data Format (HDF) viewers such as HDFView, whereas text and image files will open locally on your machine. Some files are held together in tape archive (TAR or .tar) files, from which they will need to be extracted before you can directly open the file. TAR files can be unpacked using the 7-Zip application. Once you download a data file, a "README" file may be available that gives details on how to open, read, and use the data.

File naming conventions across all files are self-explanatory and typically include a combination of the instrument, date, time, and temporal resolution. For radiosonde data, information on resolution and location are coded into the name. For instance, the term "hres" indicates the high-resolution raw data while "5hPa" indicates that raw data reprocessed into 5hPa intervals. It should be noted that as radiosondes were launched from multiple places, their data are archived in different collections. The file name includes numbers indicative of where that radiosonde was launched from and thus what collection to which it belongs (Table 2).

Table 2. Radiosonde File Name Locations

Launch Location	Number in file Name	Collection Table Number
Guam	91212	Table 4
Babelthaup	91408	Table 4
Yap	91413	Table 4
Dongshadao	46810	Table 4
Taiping	46902	Table 4
R/V Thompson	99991	Table 5
R/V Mirai	99992	Table 3
R/V Sally Ride	99993	Table 6

Data Tables

Table: 3
Collection: PISTON-ONR-NOAA_RVMirai_2018_1 EARTHDATA
DOI: 10.5067/SUBORBITAL/PISTON2018-ONR-NOAA/RVMIRAI/DATA001
Platform: *R/V Mirai*
Dates: August 13 – September 2, 2018

Data ID	Key Variables	File Format	Instrument	Principal Investigator	Institution
PISTON-SHIP-MIRAI_RV-THOMPSON	3-D volumes of C-band radar reflectivity, Doppler velocity, spectral width, differential reflectivity, specific differential phase, correlation coefficient, rain rate, hydrometeor classification, convective/stratiform partitioning	.cdf	JAMSTEC Mirai C-band polarimetric radar	Masaki Katsumata	Japan Agency for Marine-Earth Science and Technology (JAMSTEC)
Piston-sonde-hres	Vertical profiles of air temperature, pressure, humidity, wind speed and direction	.txt	Vaisala-RS41-SGP	Masaki Katsumata, Steven Rutledge	JAMSTEC, Colorado State University (CSU)

Table: 4
Collection: PISTON-ONR-NOAA_Islands_2018-2019_1 EARTHDATA
DOI: **10.5067/SUBORBITAL/PISTON2018-2019-ONR-NOAA/ISLANDS/DATA001**
Platform: Island Sondes
Dates: August 13, 2018 - October 8, 2019

Data ID	Key Variables	File Format	Instrument	Principal Investigator	Institution
Piston-sonde-hres	Vertical profiles of air temperature, pressure, humidity, wind speed and direction	.txt	Vaisala-RS41-SGP	Steven Rutledge	CSU
Piston-sonde-5hPa	Vertical profiles of air temperature, pressure, humidity, wind speed and direction	.txt	Vaisala-RS41-SGP	Steven Rutledge	CSU

Table: 5
Collection: PISTON-ONR-NOAA_RVThompson_2018_1
DOI: **10.5067/SUBORBITAL/PISTON2018-ONR-NOAA/RVTHOMPSON/DATA001**
Platform: *R/V Thomas G. Thompson*
Dates: August 18 - October 13, 2018

Data ID	Key Variables	File Format	Instrument	Principal Investigator	Institution
Piston-EFM	Vertical Component of Electric Field	.nc	Electric Field Meter	Timothy Lang	NASA Marshall Space Flight Center
Piston-ADCP-OS75	Ocean vertical profiles of currents	.nc	Ocean Surveyor 75kHz Acoustic Doppler Current Profiler	James Moum	Oregon State University (OSU)
Piston-ADCP-WH300	Ocean vertical profiles of currents	.nc	Workhorse 300kHz Acoustic Doppler Current Profiler	James Moum	OSU
Piston-Chameleon	Ocean vertical profiles of temperature, conductivity, salinity, pressure, currents (microstructure), vertical current shear, turbulence	.nc	Chameleon microstructure profiler, towed from ship	James Moum	OSU
Piston-CTD	Ocean vertical profiles of temperature, conductivity, salinity, pressure, oxygen, nitrogen saturation, fluorescence, irradiance from 3 to 500 m	.nc	Rosette CTD	James Moum	OSU
Piston-SurfOtter	Ocean vertical profiles of temperature, conductivity, salinity, pressure, vertical current shear, turbulence from 0.1 to 8 m depth	.nc	OSU SurfOtter, towed from ship	James Moum	OSU
piston-SEAPOL	3-D* volumes of C-band radar reflectivity, Doppler velocity, spectral width, differential reflectivity, specific	.tar/ .cdf	CSU SEA-POL dual-polarization Doppler C-band precipitation radar	Steven Rutledge	CSU

	differential phase, correlation coefficient, rain rate, hydrometeor classification, convective/stratiform partitioning [*120 km range, surface-12 km altitude, the aft 80º sector was blanked since it occurred over the ship]				
piston-sonde-hres	Vertical profiles of air temperature, pressure, humidity, wind speed and direction	.txt	Vaisala-RS41-SGP	Steven Rutledge	CSU
Piston-sonde-5hPa	Vertical profiles of air temperature, pressure, humidity, wind speed and direction	.txt	Vaisala-RS41-SGP	Steven Rutledge	CSU
Piston-uctd	Ocean vertical profiles of temperature, conductivity, salinity, pressure from 3 to 400 m depth	.nc	SIO underway CTD (conductivity temperature depth)	Janet Sprintall	Scripps Institute of Oceanography (SIO)
PISTON-Ceilometer-1hour	Cloud Base height, vertical profiles of uncalibrated backscatter from aerosol and marine boundary layer from surface to 7.5 km	.nc	Vaisala CL31 single-wavelength backscatter lidar	Elizabeth Thompson	NOAA Physical Sciences Laboratory (PSL)
PISTON-Ceilometer-10min	Cloud Base height, vertical profiles of uncalibrated backscatter from aerosol and marine boundary layer from surface to 7.5 km	.nc	Vaisala CL31 single-wavelength backscatter lidar	Elizabeth Thompson	NOAA PSL
PISTON-Ceilometer-15s	Cloud Base height, vertical profiles of uncalibrated backscatter from aerosol and marine boundary layer from surface to 7.5 km	.nc	Vaisala CL31 single-wavelength backscatter lidar	Elizabeth Thompson	NOAA PSL
PISTON-disdrometer	Drop size distributions (DSD) and rain rate *[instrument appears to not capture the full*	.nc	ODM-470 optical Disdrometer	Elizabeth Thompson	NOAA PSL

	raindrop size spectrum, so DSD parameter retrievals are not provided, and data should be interpreted with caution]				
PISTON-nav-met-sea-1min	Ship navigation/location information and surface flux, meteorology, ocean properties	.nc	Eppley PSP pyranometers, Eppley PIR Pyrgeometers, Gill WindMaster Pro 3-D sonic anemometer, RM Young WXT-520 meteorological station, Vaisala HMT330 humidity and temperature sensor, PSL homemade floating sea snake with thermistor, ship hull-mounted thermosalinograph SBE-45, Optical Scientific Inc. ORG-815-DA optical rain gauge, Vaisala-PTB330 shielded barometer, Licor-7500 IR CO2/H2O gas analyzer, combined PSL and ship systems, Dystron and Donner MP-1 6-axis motion accelerometer, Riegl 1-D ocean wave laser altimeter	Elizabeth Thompson	NOAA PSL
PISTON-nav-met-sea-flux-10min	Ship navigation/location information and surface flux, meteorology, ocean properties	.nc	Same as above plus modelled outputs	Elizabeth Thompson	NOAA PSL
PISTON-nav-met-sea-flux-60min	Ship navigation/location information and surface flux, meteorology, ocean properties	.nc	Same as above plus modelled outputs	Elizabeth Thompson	NOAA PSL

PISTON-radiometer-ret	Cloud Parameters, Brightness temperatures, Liquid Water Parameters	.nc	Radiometrics MP-3000 microwave radiometer	Elizabeth Thompson	NOAA PSL
PISTON-radiometer-Tb	Sky Brightness temperatures, Weather Parameters	.nc	Radiometrics MP-3000 microwave radiometer	Elizabeth Thompson	NOAA PSL
PISTON-rosr-skinSST	Interface level Sea Surface Temperature	.nc	Remote Ocean Surface Radiometer (ROSR, including KT-15 infrared radiometer)	Elizabeth Thompson	NOAA PSL
PISTON-Wband-radar	Corrected Reflectivity, Corrected Power	.nc	W-band Doppler cloud radar	Elizabeth Thompson	NOAA PSL

Table: 6
Collection: PISTON-ONR-NOAA_RVSallyRide_2019_1
DOI: **10.5067/SUBORBITAL/PISTON2019-ONR-NOAA/RVSALLYRIDE/DATA001**
Platform: *R/V Sally Ride*
Dates: August 31 - September 26, 2019

Data ID	Key Variables	File Format	Instrument	Principal Investigator	Institution
PISTON-BAGOHSRL	Vertical profiles and range-height scans of atmospheric boundary layer: 532 nm backscatter cross section, extinction cross section, and depolarization as well as 1064 nm attenuated backscatter cross section and depolarization; Ratios between 532 and 1064 nm gives rough indication of particle size.	.nc	BAGO High Spectral Resolution Lidar	Edwin Eloranta, Robert Holz	University of Wisconsin-Madison
Piston-ADCP-OS38	Ocean vertical profiles of currents	.nc	Ocean Surveyor 38kHz Acoustic Doppler Current Profiler	James Moum	OSU

Piston-ADCP-OS150	Ocean vertical profiles of currents	.nc	Ocean Surveyor 150kHz Acoustic Doppler Current Profiler	James Moum	OSU
Piston-ADCP-WH300	Ocean vertical profiles of currents	.nc	Workhorse 300kHz Acoustic Doppler Current Profiler	James Moum	OSU
Piston-Chameleon	Ocean vertical profiles of temperature, conductivity, salinity, pressure, currents (microstructure), vertical current shear, turbulence,	.nc	OSU Chameleon, towed from ship	James Moum	OSU
Piston-CTD	Conductivity, Temperature, Density	.nc	Rosette CTD	James Moum	OSU
Piston-SurfOtter	Ocean vertical profiles of temperature, conductivity, salinity, pressure, vertical current shear, turbulence from 0.1 to 8 m depth	.nc	OSU SurfOtter, towed from ship	James Moum	OSU
Piston-Skycam-HEMIS	Sky camera hemispheric visible images	.tar/ .jpeg	Hemispheric sky camera	Betsy Reid	US Naval Research Lab at Monterrey
Piston-Skycam-unfold	Unfolded sky camera images	.tar/ .jpeg	Hemispheric sky camera	Betsy Reid	US Naval Research Lab at Monterrey
piston-SEAPOL	3-D* volumes of C-band radar reflectivity, Doppler velocity, spectral width, differential reflectivity, specific differential phase, correlation coefficient, rain rate, hydrometeor classification, convective/stratiform partitioning [*120 km range, surface-12 km altitude, the aft 80º sector was blanked since it occurred over the ship]	.tar/ .cdf	Dual-polarization Doppler C-band precipitation radar	Steven Rutledge	CSU

piston-sonde-hres	Vertical profiles of air temperature, pressure, humidity, wind speed and direction	.txt	Vaisala-RS41-SGP	Steven Rutledge	CSU
Piston-sonde-5hPa	Vertical profiles of air temperature, pressure, humidity, wind speed and direction	.txt	Vaisala-RS41-SGP	Steven Rutledge	CSU
Piston-halo-lidar	Vertical profiles of vertical velocity, vertical velocity variance, atmospheric boundary layer depth, relative/uncalibrated aerosol loading, non-precipitating cloud base height between 0-3500 m altitude	.nc	Halo Photonics Streamline XR Doppler lidar	Simon de Szoeke	OSU
PISTON-Ceilometer-1hour	Cloud base height and vertical profiles of uncalibrated backscatter from aerosol and marine boundary layer from surface to 7.5 km	.nc	Vaisala CL31 single-wavelength backscatter lidar	Elizabeth Thompson	NOAA PSL
PISTON-Ceilometer-10min	Cloud base height and vertical profiles of uncalibrated backscatter from aerosol and marine boundary layer from surface to 7.5 km	.nc	Vaisala CL31 single-wavelength backscatter lidar	Elizabeth Thompson	NOAA PSL
PISTON-Ceilometer-15s	Cloud base height and vertical profiles of uncalibrated backscatter from aerosol and marine boundary layer from surface to 7.5 km	.nc	Vaisala CL31 single-wavelength backscatter lidar	Elizabeth Thompson	NOAA PSL
PISTON-nav-met-sea-1min	Ship navigation/location information and surface flux, meteorology, ocean properties	.nc	Eppley PSP pyranometers, Eppley PIR Pyrgeometers, Gill WindMaster Pro 3-D sonic anemometer, RM Young WXT-520 meteorological station, Vaisala HMT330 humidity/temperature sensor, PSL homemade floating	Elizabeth Thompson	NOAA PSL

			sea snake with thermistor, ship hull-mounted thermosalinograph SBE-45, Optical Scientific Inc. ORG-815-DA optical rain gauge, Vaisala-PTB330 shielded barometer, Licor-7500 IR CO2/H2O gas analyzer, combined PSL and ship systems, Dystron and Donner MP-1 6-axis motion accelerometerPIR, modelled outputs		
PISTON-nav-met-sea-flux-10min	Ship navigation/location information and surface flux, meteorology, ocean properties	.nc	Same as above	Elizabeth Thompson	NOAA PSL
PISTON-nav-met-sea-flux-60min	Ship navigation/location information and surface flux, meteorology, ocean properties	.nc	Same as above	Elizabeth Thompson	NOAA PSL
PISTON-rosr-skinSST	Ocean skin sea surface temperature	.nc	Remote Ocean Surface Radiometer (ROSR, including KT-15 infrared radiometer)	Elizabeth Thompson	NOAA PSL
PISTON-Wband-radar	Vertical profiles of W-band radar reflectivity, Doppler velocity, spectral width, 2D non-precipitating and precipitating cloud statistics from surface to 6.5 km	.nc	W-band Doppler cloud radar	Elizabeth Thompson	NOAA PSL

Table: 7
Collection: PISTON-ONR-NOAA-Autonomous-Uncrewed_2018-2019_1
DOI: **10.5067/SUBORBITAL/PISTON2018-2019-ONR-NOAA/AUTONOMOUS/DATA001**
Platform: Ocean Floats and Moorings
Dates: August 23 – November 9, 2018

Data ID	Key Variables	File Format	Instrument	Principal Investigator	Institution
PISTON-FloatTrajectory	Ocean vertical profiles of temperature, salinity, pressure/depth, depth-mean currents (over profiling range of about 0 to 200 m), position (logged at the surface)	.nc	SOLO II Ocean Floats	Shaun Johnston	SIO
PISTON-moored-velocity	Current Velocity, Temperature, and Pressure	.nc	Two full-depth ocean moorings at roughly 12.3N and 15.75N, 135E containing: ADCP SBE56 and RBRsolo T thermistors, SBE 37 CTDs, Acoustic Doppler Current Profilers at 75, 300, and 1000 kHz, OSU chipod microstructure packages, McLane Moored Profilers	Matthew Alford & James Moum	SIO, OSU
PISTON-moored-temperature	Depth, Temperature	.nc	Mooring - Temperature Logger	Matthew Alford & James Moum	SIO, OSU

Resources:

Reference Websites

AMS Collection of PISTON and CAMP2Ex Articles
ASDC PISTON Website
CAMP2Ex Website
CSU PISTON Website
ASDC PISTON Website
PISTON AGU Abstract

Relevant Publications

Johnston, S., Rudnick, D. L., Brizuela, N., & Moum, J. N. (2020). Advection by the North Equatorial Current of a cold wake due to multiple typhoons in the western Pacific: Measurements from a profiling float array. Journal of Geophysical Research: Oceans, 125, e2019JC015534, https://doi.org/10.1029/2019JC015534

Johnston, T. M. S., Wang, S., Lee, C.-Y., Moum, J. N., Rudnick, D. L., & Sobel, A. (2021). Near-inertial wave propagation in the wake of Super Typhoon Mangkhut: Measurements from a profiling float array. Journal of Geophysical Research: Oceans, 126, e2020JC016749, https://doi.org/10.1029/2020JC016749

Moran, K., Pezoa, S., Fairall, C. W, Williams, C., Ayers, T., Brewer, A., de Szoeke, S. P., & Ghate, V. (2012). A Motion-Stabilized W-Band Radar for Shipboard Observations of Marine Boundary-Layer Clouds. Boundary-Layer Meteorol. (2012) 143: 3, https://doi.org/10.1007/s10546-011-9674-5

Rutledge, S. A., Chandrasekar, V., Fuchs, B., George, J., Junyent, F., Dolan, B., Kennedy, P. C., & Drushka, K. (2019). SEA-POL Goes to sea, Bulletin of the American Meteorological Society, 100(11), 2285-2301, https://doi.org/10.1175/BAMS-D-18-0233.1

Acronyms:

ADCP	Acoustic Doppler Current Profiles
BSISO	Boreal Summer Intraseasonal Oscillation
CAMP2Ex	Clouds, Aerosol and Monsoon Processes-Philippines Experiment
CDF	Common Data Format
CSU	Colorado State University
CTD	Conductivity, Temperature, Depth
HDF	Hierarchical Data Format
JAMSTEC	Japan Agency for Marine-Earth Science and Technology
NetCDF	Network common data format
NOAA PSL	NOAA Physical Sciences Laboratory
OSU	Oregon State University
PISTON	Propagation of Intra-Seasonal Tropcial OscillatioNs
SIO	Scripps Institute of Oceanography