Observational Oceanography II: *in-situ* Process Studies + Goals for the next decade

Meghan Cronin

NOAA Pacific Marine Environmental Laboratory

With slides from Mike Patterson, Director of US CLIVAR

ECCO Summer School 2019 * Friday Harbor Laboratories

What are Observations used for?

From Lecture 1....

- Observations for mapping fields, initiating or nudging models
 - Timely (available through the Global Telecommunication System (GTS) in near realtime)
 - Geographically distributed in coherent array, with known uncertainty and quality
- Observations for validation
 - Independent obs (e.g. not assimilated)
 - High quality, of known uncertainty that is smaller than error of model.
- Observations for improving model physics, parameterizations and understanding of processes
 - Oversampled, high quality observations (e.g. Process Studies)

How many errors can I have?

- Mistakes and Miscalculations
- Mean bias errors & Random uncertainty due to noise
- Systematic biases due to sampling issues
- Systematic biases due to field errors
- Systematic biases dues to calibration errors, model physics errors, etc.
- Error in representation of a mean value by a spot observations.

Motivation for Process studies

Motivation for Process Studies

What are the key mechanisms and processes controlling the climate system? How are these modulated by large-scale variability and general circulation? Improved understanding of these processes can lead to better predictability in the climate system.

If this process cannot be resolved by model, can it be parameterized?

Does the parameterization improve the model state estimates & forecasts?

What are minimum observations/variables needed to resolve and monitor this process? Improved monitoring of these processes can lead to better predictability in the climate system.



Tweets by @USCLIVAR US CLIVAR O

Just released: Rest practices for organizing a Climate Process Team.

the 2018 Fall AGU Town Hall

Panel drive.google.com/file

Nowsgram, May 2019 mailchi mn/050441010647/n

US CLIVAR

U.S. CLIVAR Twitter Page

Subscribe to our mailing list

email address

Subscrib

/d/1hdQgw7...#AGU #Climate

Generated by experts participating in

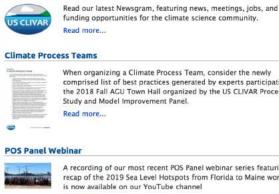
organized by the US CLIVAR PSMI

US CLIVAR CP ...

drive poogle.com

...

2019 May Newsgram



When organizing a Climate Process Team, consider the newly comprised list of best practices generated by experts participating in the 2018 Fall AGU Town Hall organized by the US CLIVAR Process Study and Model Improvement Panel.

A recording of our most recent POS Panel webinar series featuring a recap of the 2019 Sea Level Hotspots from Florida to Maine workshop is now available on our YouTube channel Read more

AMOC webinar series



Tune in on Thursday, May 16 at 12PM EDT for Michael Spall's (WHOI) webinar "Wind-driven variability of the MOC". Read more

Variations, Spring 2019: Stratosphere-troposphere coupling across timescales



While US CLIVAR has traditionally focused on ocean-atmosphere coupling and its role on climate variability, in this edition of Variations we examine the coupling between the two lowest layers of the atmosphere, the troposphere and the stratosphere. Read more ...

» See archived announcements

Funding for US CLIVAR provided by



About US CLIVAR

https://usclivar.org

US Climate Variability and Predictability (CLIVAR) is a national research program with a mission to foster understanding and prediction of climate variability and change on intraseasonal-to-centennial timescales, through observations and modeling with emphasis on the role of the ocean and its interaction with other elements of the Earth system, and to serve the climate community and society through the coordination and facilitation of research on outstanding climate questions.

US CLIVAR research is currently supported by participating programs within five Federal agencies including the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), the National Science Foundation (NSF), the Department of Energy (DOE), and the Office of Naval Research (**ONR**). A US CLIVAR Inter-Agency Group of program managers from these five agencies coordinates and targets funding and resources to support the research activities of the program. Four of these agencies, NASA, NOAA, NSF, and DOE sponsor the US CLIVAR Project Office to work with the SSC and its Panels in coordinating science planning, implementing research activities, communicating research advances and needs, and supporting international engagement and collaboration.

Home About Science USAMOC News & Publications Calendar & Meetings Get Involved Contact Us

Climate Variability and Predictability Program

Panel Descriptions

US CLIVAR

Phenomena, Observations, and Synthesis Panel

US CLIVAR

The Phenomena Observations and Synthesis Panel's (POS) mission is to improve understanding of climate variations in the past, present and future, and to develop syntheses of critical climate parameters while sustaining and improving the global climate observing system.

Predictability, Predictions, and Applications Interface Panel

The Predictability, Predictions and Applications Interface Panel's (PPA) mission is to foster improved practices in the provision, validation and uses of climate information and forecasts through coordinated participation within the U.S. and international climate science and applications communities.

Process Study and Model Improvement Panel

The Process Study and Model Improvement Panel's (PSMI) mission is to reduce uncertainties in the general circulation models used for climate variability prediction and climate change projections through an improved understanding and representation of the physical processes governing climate and its variation.

Funding for US CLIVAR provided by



© 2019 US CLIVAR | Disclaimer | Login US Climate Variability and Predictability Program 1201 New York Ave NW, 4th Floor, Washington DC 20005 202.787.1682 | uscpo@usclivar.org

US CLIVAR Climate Variability and Predictability Program

Home About Science USAMOC News & Publications Calendar & Meetings Get Involved Contact Us

Process Study and Model Improvement Panel

The Process Study and Model Improvement (PSMI) Panel's mission is to reduce uncertainties in the general circulation models used for climate variability prediction and climate change projections through an improved understanding and representation of the physical processes governing climate and its variation. The Panel is comprised of up to 12 experts from the scientific community, each serving a 4-year term. New panelists are selected annually by the Scientific Steering Committee based on nominations submitted through an open call for new members each fall/winter.

PSMI PANEL MENU
PSMI Panel Main Page

Resources

Webi	

Member name	Institution	Term through
Victoria Coles, Co-chair	University of Maryland	Dec. 2020
Kevin Reed, Co- chair	Stony Brook University	Dec. 2020
Amy Butler	NOAA Earth System Research Laboratory/University of Colorado	Dec. 2021
Antonietta Capotondi	University of Colorado/NOAA	Dec. 2022
William Collins	Lawrence Berkeley National Lab/University of California Berkeley	Dec. 2020
Charlotte DeMott	Colorado State University	Dec. 2022
Gregory Foltz	NOAA Atlantic Oceanographic and Meteorological Laboratory	Dec. 2019
Samson Hagos	Pacific Northwest National Lab	Dec. 2020
Taka Ito	Georgia Institute of Technology	Dec. 2019
Hyodae Seo	Woods Hole Oceanographic Institution	Dec. 2019
Janet Sprintall	Scripps Institution of Oceanography	Dec. 2019
Patrick Taylor	NASA Langley Research Center	Dec. 2022
Liping Zhang	Princeton University/NOAA	Dec. 2022

Consider getting on this panel!

Terms of Reference

- Review, prioritize, and coordinate US scientific plans for, and programmatic support of, relevant process studies, Climate Process Teams and other investigations that lead to improved parameterizations of critical climate processes, better quantification of climate model uncertainties, improved climate model fidelity, and validation of observing systems aimed at increasing their global utility, as necessary to achieve the goals of CLIVAR. Through its review process, US CLIVAR encouragement of nascent process studies does not imply a formal endorsement.
- Develop and encourage mechanisms (e.g. community workshops, commissioned studies, Working Groups) to further the development and implementation of timely and relevant process studies and a research strategy, including filling gaps.

CLIMATE RESEARCH

BEST PRACTICES FOR PROCESS STUDIES

BY MEGHAN F. CRONIN, SONYA LEGG, AND PAQUITA ZUIDEMA

PROCESS STUDY "BEST PRACTICES"

- Modelers and observationalists should be integrated in the study from the planning stage onward.
- Integrated and synthesized datasets should be generated from the process study observations to provide model-comparable data that can be used as benchmarks for assessing and validating models. Furthermore, diagnostics shown in much-cited published figures should be provided in digital format as "synthesis products."
- Broad use of the data should be encouraged through
 - open data policies;
 - centralized access to all components of the experiment; and
 - data archiving in a user-friendly format, and with sampling information ("metadata") that is necessary for understanding the measurement.

AMERICAN METEOROLOGICAL SOCIETY

JULY 2009 BAMS | 917

Meghan Cronin was co-chair of the US CLIVAR Process Study and Model Improvement Panel from 2005-2008
 Sonya Legg was co-chair of US CLIVAR PSMIP from 2007-2009
 Paquita Zuidema was co-chair of US CLIVAR PSMIP from 2009-2011



Climate Process Teams

For a decade and a half, US CLIVAR has promoted the concept of Climate Process Teams (CPTs). CPTs improve the fidelity of coupled climate models by facilitating the transfer of knowledge from observational and process-oriented research to the development of physical process representation in component ocean or atmosphere global climate models (GCMs). A CPT, as defined by US CLIVAR, is a:

funded multi-institutional project that assembles observation-oriented experimentalists, process modelers, process diagnosticians, theoreticians, and climate model developers from two or more modeling centers into a single project that focuses on a specific process or set of processes to assess model sensitivities to process uncertainties, establish observation and model metrics, and develop, test, and implement parameterization improvements.

NSF and NOAA have co-sponsored two rounds of CPT projects, with the latest projects completing in 2015/16.

In 2015, the US CLIVAR Process Studies and Model Improvement (PSMI) Panel organized a review of CPTs to assess the effectiveness and lessons learned from the CPT approach, main sources of errors/biases in models, opportunities for future model improvement, and potential payoff for future CPT projects. The review committee collected input through questionnaires of seven US modeling center and numerous observational programs, process studies, CPT projects, and US CLIVAR Working Groups, followed by an open community workshop held at NOAA GFDL in September 2015. The information collected informed a 2016 US CLIVAR White Paper.

Below are the key findings from the white paper, best practices for a CPT, and how best to propose a CPT project to the US CLIVAR funding agencies.

https://usclivar.org/climate-process-teams

US CLIVAR has also promoted concept of Climate Process Teams (CPTs).

See their Aug 2016 US CLIVAR CPT White Paper: "<u>Translating</u> <u>Process Understanding to</u> <u>Improve Climate Models</u>" and their "<u>CPT Best Practice</u> <u>Tip Sheet</u>"

Process Studies vetted by the US CLIVAR panels:



AMOC – Atlantic Meridional Overturning Circulation Program (including SAMBA and OSNAP)

CLIMODE – CLIvar Mode Water Dynamic Experiment

DIMES – Diapycnal and Isopycnal Mixing Experiment in the Southern Ocean

DYNAMO – Dynamics of Madden Julian Oscillation

EPIC – Eastern Pacific Investigation of Climate Processes in the Coupled Ocean-Atmosphere System

IASCLiP – Inter-Americas Study of Climate Processes

KESS – Kuroshio Extension System Study

NAME – North American Monsoon Experiment

SPURS – Salinity Processes in the Upper Ocean Regional Study

VOCALS – VAMOS Ocean-Cloud-Atmosphere-Land Study

Process Studies vetted by the US CLIVAR panels:



AMOC – Atlantic Meridional Overturning Circulation Program (including SAMBA and OSNAP)

CLIMODE – CLIvar Mode Water Dynamic Experiment

DIMES – Diapycnal and Isopycnal Mixing Experiment in the Southern Ocean

DYNAMO – Dynamics of Madden Julian Oscillation

Process studies I was involved in & know well

EPIC – Eastern Pacific Investigation of Climate Processes in the Coupled Ocean-Atmosphere System

IASCLiP – Inter-Americas Study of Climate Processes

KESS – Kuroshio Extension System Study

NAME – North American Monsoon Experiment

SPURS – Salinity Processes in the Upper Ocean Regional Study

VOCALS – VAMOS Ocean-Cloud-Atmosphere-Land Study

Using data from historical process studies

- Learn about process studies by going to US CLIVAR website & process study website.
- Access data from process study website or from national data archive (e.g. NOAA's NCEI, NASA's EOSDIC & PODAAC, NSF's NCAR EOL).
- Reach out to the process study PIs.



KESS Observational Plan

Ferry XBT/ADCP

Profiling Float Des

Kuroshio Extension System Study

The warm, northward-flowing waters of the Kuroshio western boundary current leave the Japanese coast to flow eastward into the North Pacific as a free jet — the Kuroshio Extension. The Kuroshio Extension forms a vigorously meandering boundary between the warm subtropical and cold northern waters of the Pacific. A recirculation gyre exists to the south of the Kuroshio Extension. Another may exist to the north. This is also one of the most intense air-sea heat exchange regions on the globe, where the warm Kuroshio waters encounter the cold dry air masses coming from the Asian continent. The Kuroshio Extension system exhibits variations which strongly affect North American climate. Among the diverse fields that will benefit from this work are fisheries and climate research, and understanding storm tracks.

Understanding the processes that govern the variability of and the interaction between the Kuroshio Extension and the recirculation gyre is the goal of this study. Processes coupling the baroclinic and barotropic circulations will be examined by case studies of the local dynamical balances, particularly during strong meandering events. The mechanisms by which water masses are exchanged and modified as they cross the front will be characterized. The objective is to determine the processes governing the strength and structure of the recirculation gyres in relation to the meandering jet.

Science Highlights



KEO Surface Buoy

KEO mooring carries a suite of meteorological sensors to measure winds, air temperature, relative humidity, rainfall, and solar and longwave radiation.

https://uskess.whoi.edu/

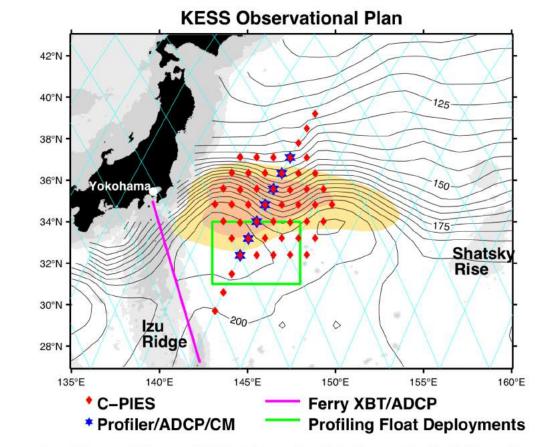
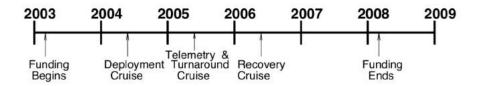


Figure 7: Proposed KESS array of C-PIESs (red diamonds) and MPs (blue stars). Profiling T,S floats will be deployed within the green boxed region. Thin blue lines indicate T/P-Jason 1 ground tracks, the magenta line indicates the TOLEX Ogasawara ferry route. Solid lines are the GDEM mean surface dynamic height contours in dyn cm from Teague et al. (1990). The 2000 and 4000 m isobaths are shaded dark and light gray, respectively. Eddy kinetic energy > 0.18 and 0.24 m²s⁻² is color shaded yellow and orange, respectively. CTD/SADCP observations will be made at all C-PIES sites and in three feature studies.



Objectives:

1) To understand processes coupling the baroclinic and barotropic circulation and variability.

Hypotheses: ...

What's needed: Density and velocity time series, with mesoscale resolution to calculate d/dx, d/dy and d/dt of density and velocity. Sufficient vertical resolution to quantify structure of upper-jet baroclinic front and the deep nearly barotropic fields. "Casestudies" of the local dynamical balances, particularly of largeamplitude events.

2) To determine and quantify cross-frontal exchange processes in the Kuroshio Extension.

Hypotheses:... What's needed

...

3) To determine the processes that govern the strength and structure of the recirculation gyre – its position, elongation, stratification, and subtropical mode water formation within the gyre.

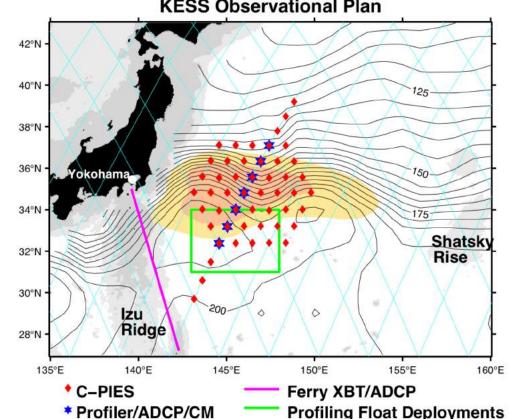
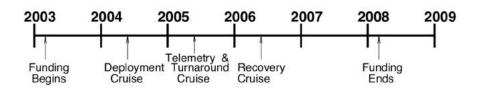
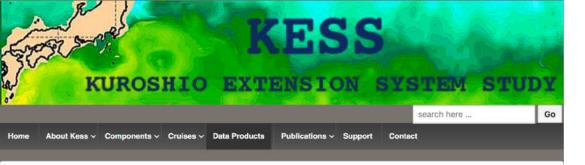


Figure 7: Proposed KESS array of C-PIESs (red diamonds) and MPs (blue stars). Profiling T,S floats will be deployed within the green boxed region. Thin blue lines indicate T/P-Jason 1 ground tracks, the magenta line indicates the TOLEX Ogasawara ferry route. Solid lines are the GDEM mean surface dynamic height contours in dyn cm from Teague et al. (1990). The 2000 and 4000 m isobaths are shaded dark and light gray, respectively. Eddy kinetic energy > 0.18 and 0.24 m²s⁻² is color shaded yellow and orange, respectively. CTD/SADCP observations will be made at all C-PIES sites and in three feature studies.



KESS Observational Plan

https://uskess.whoi.edu/



Data Products

Argo Profiling Floats

University of Hawaii Argo Profiling Floats Data Page

CPIES Data from GSO/URI

Shown below is the KESS CPIES/PIES array superimposed on Smith and Sandwell bathymetry contoured every 1000 m. The CPIES/PIES were moored in water depths ranging from 5300 m on the western side of the array to 6300 m in the east. Data is available for 46 sites. Site designator is given in the upper left hand corner and IES serial number is listed under the triangles. Black is for CPIES sites, red for PIES sites, magenta specifies sites where only telemetry was taken, and yellow designates where instruments were CPIES in 2005, but PIES in 2006. The measurements were made during April 2004 to July 2006 under the sponsorship of the National Science Foundation. The measured quantities include pressure, vertical acoustic round-trip travel time, and currents. All data files in the CPIES archive are provided in ASCII format.

CONTENTS of HOURLY FILES

There are up to three files for each instrument, where XX is the site designator and YYY is the IES serial number:

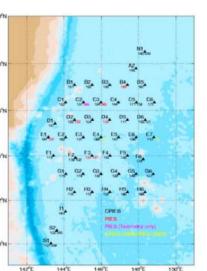
- prs/XX_SNYYY.dat pressure in decibars
- tau/XX_SNYYY.dat vertical acoustic travel time in seconds
- currents/XX_SNYYY.dat u,v velocities in cm/sec

These are the highest quality versions of the data after the least amount of processing. Large data spikes (outliers) and long term drifts have been removed from these records. Details of the processing are provided in the data report. Each file contains year, month, day, hour, minute, second and either pressure, travel time or currents. Missing data values are indicated by NaN.

CONTENTS of 72 HR LOWPASSED FILES

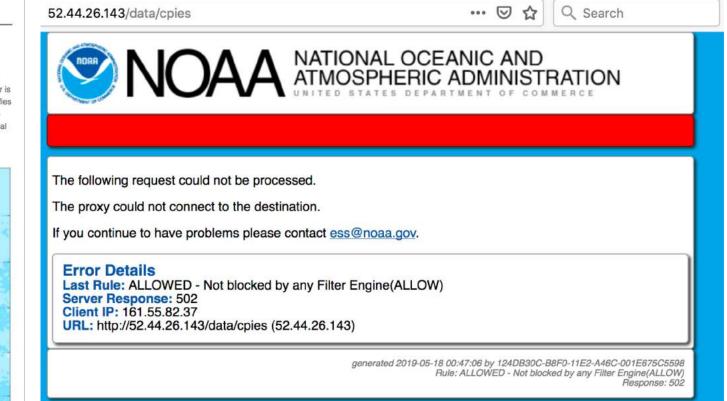
There are up to three files for each instrument, where XX is the site designator:

prs/XX.dat — leveled, demeaned pressure in decibars
 tau/XX.dat — vertical acoustic travel time from 0 to 1400 dbar in seconds



https://uskess.whoi.edu/overview/dataproducts/

Oops! The 2004-2006 process study is done and links to the data on the static website are now broken!







Frequently Asked Questions International Affairs

Contact Us

Earth System Monitor

Posters and Flyers

Photo of the Day

About

Access Data

Submit Data

All Products Search the Archives

Data Services Data Formats & Codes **CD-ROMs & DVDs**

Send2NCEI (S2N)

submitted?

Catalog



· Sea State / Wave Data World Ocean Atlas Oxygen Documentation | Search & Retrieve | Figures Nutrients Biology Data Inorganic Carbon Regional Climatologies Satellite Data Global Ocean Heat and Salt Content Plankton Ocean Acidification SST Climatologies (Pathfinder) Chlorophyll Ocean Color Publications Profile Data Video Data More Parameter More Climatology Products **Project Data Sets** Coastal Data Center Projects Coastal Water Temperatures **Coastal Buoy Data Archive** Global Temperature-Salinity Global Argo Data Repository Global Ocean Currents Joint Archive for Sea Level (2) Ocean Acidification Data Satellite Oceanography World Ocean Atlas / Database Ocean Carbon Data System IOOS Archive Data Portal More Project Data Sets

https://www.nodc.noaa.gov/

NOAA National Centers for **Environmental Information**

The NCEI provides **archival** and access to oceanic, atmospheric, and geophysical datasets from the ocean's bottom to the sun's surface and from million-year-old ice cores to near-realtime satellite retrievals. Limited data from process studies/field campaigns are archived here. Visit https://www.ncei.noaa.gov/

From slide courtesy of Mike Patterson, US CLIVAR director

	NATIONAL CENTERS FOR ENVIRONMENTAL INFORM	ATION	
rmerly the National Oceanographic D		Public Outreach About	
OAA Satellite and Information Service		This Site All of NOAA KESS	Go
Access Data All Products Search the Archives Data Services Data Formats & Codes CD-ROMs & DVDs Submit Data Send2NCEI (S2N) How do I find data that I have submitted? What happens to your data?	OCEAN CARBON D	DATA SYSTEM (OCADS)	
Data Submission Guidelines Public Outreach	Pause Previous Next	0230	56
One NOAA Science Seminars			
Catalog Earth System Monitor Posters and Flyers Dceanography Education	documentation to the National Centers stewardship, and access.	hat allows you to easily submit your data files and related for Environmental Information for long term preservation,	
Catalog Earth System Monitor Posters and Flyers Decenography Education Activities <u>About</u> Contact Us Frequently Asked Questions	S2N Send2NCEI (S2N) is an archiving tool t documentation to the National Centers stewardship, and access. Ocean Climatology • World Ocean Database Documentation Search & Betrieve • World Ocean Atlas Documentation Search & Retrieve Figures • Regional Climatologies	For Environmental Information for long term preservation, Parameters and Data Types • Temperature • Ocean Currents • Salinity • Sea Level • Oxygen • Sea State / Wave Da • Nutrients • Biology Data • Inorganic Carbon • Satellite Data	
Catalog Earth System Monitor Posters and Flyers Decenography Education Activities <u>About</u> Contact Us Frequently Asked Questions	S2N Send2NCEI (S2N) is an archiving tool t documentation to the National Centers stewardship, and access. Ocean Climatology • World Ocean Database Documentation 1 Search & Retrieve • World Ocean Atlas Documentation 1 Search & Retrieve 1 Figures	for Environmental Information for long term preservation, Parameters and Data Types • Temperature • Ocean Currents • Salinity • Sea Level • Oxygen • Sea State / Wave Data • Nutrients • Biology Data • Dianganic Carbon • Satellite Data • Plankton • Ocean Color • Profile Data • Video Data	
Contact Us Frequently Asked Questions International Affairs	S2ND Send2NCEI (S2N) is an archiving tool t documentation to the National Centers stewardship, and access. Ocean Climatology • World Ocean Database Documentation 1 Search & Retrieve • World Ocean Atlas Documentation 1 Search & Retrieve 1 Figures • Regional Climatologies • Global Ocean Heat and Salt Content • SST Climatologies (Pathfinder) • Publications	for Environmental Information for long term preservation, Parameters and Data Types Temperature Salinity Sea Level Oxygen Sea State / Wave Da Salinity Sea Level Sea State / Wave Da Salinity Satellite Data Inorganic Carbon Satellite Data Diankton Chlorophyll Ocean Color Profile Data Video Data More Par Temperatures Coastal Buoy Data Archive ta Repository Satellite Ocean Ourrents Satellite Ocean Ourrents Satellite Ocean Currents Satellite Oce	amotora

Access Data - Submit Data - Intended Use of the Data? - Online Store - Customer Service

Searching on "KESS", 3 clicks later get to:





Q

Home Access Data Submit Data Public Outreach About KESS

Home > Data > Metadata > gov.noaa.nodc:0073269

AND IN CO.

Bottom pressure, vertical acoustic round-trip travel time, and near-bottom currents data collected by Current-and-Pressure-recording Inverted Echo Sounders (CPIES), as part of the Kuroshio Extension System Study (KESS), from 26 April 2004 to 25 June 2006 in the Kuroshio Extension east of Japan (NCEI Accession 0073269)

- 	mea	data set contains Curr surements collected di	uring the Kuroshi	Extension	System Study (KESS) under the		Dataset Citation	
	2004	sorship of the Nationa and June 2006. Data sure, vertical acoustic	are from 46 sites	. The meas	ured quantities i	nclude bottom	n April	Dataset Identifiers	
-								ISO 19115-2 Metadata	
view graphi	c								
Access	Time & Location	Documentation	Description	Credit	Keywords	Constraints	Lineage		
Download	Data n Formats	FTP (downl These data data.	rectly to the URL				nay use any l	FTP client to download these	
Ordering I	nstructions	Contact NC	El for other distri	bution optio	ns and instruction	ons.			
Distributor	Ţ.	Commerce 301-713-32	DOC/NOAA/NESDIS/NCEI > National Centers for Environmental Information, NESDIS, NOAA, U.S. Depa Commerce 301-713-3277 NCEI.Info@noaa.gov						
Dataset P	oint of Contact	Information DOC/NOA/ Commerce 301-713-32 NCEI.Info@	VNESDIS/NCEI :	> National C	enters for Envir	onmental Inform	ation, NESDI	IS, NOAA, U.S. Department of	

Last Modified: 2019-02-11T17:36:01Z

For questions about the information on this page, please email: NODC,DataOfficer@noaa.gov

(USA.gov Ready	NCEI About NCEI Employment	Privacy FOIA Information Quality Disclaimer	Take Our Survey Department of Commerce NOAA NESDIS
O KESS	A V Highlight All Match (Case Whole Words	1 of 3 matches	

JPL HOME EARTH SOLAR SYSTEM STARS & GALAXIES let Propulsion Laboratory BRING THE UNIVERSE TO YOU California Institute of Technology PO.DAAC FTP services will be retired on 3 June 2019. For more information and alternate methods of access, please see our latest Announcement Follow Us Data Search tributed Active Archive Center Dataset Discovery Data Access Measurements Missions Multimedia Community Forum About Home Announcements MINDER - PO DAAC FTP RETIREMENT ortant Information for Usen Search Monday, May 6, 2019 Scheduled System Maintenance (Earthdata Wednesday, May 1, 2019 Access Dataset Update: Complete historical records of GRACE Level-2 RL06 datasets now available Wednesday, April 10, 2019 Visualize More » Help Spotlight Events The PO DAAC is pleased to announce the public release of the NAVO GHRSST Level 4 K10-SST version 1.0 GDS2.0 Datase System Alerts State Of the Ocean (SOTO) mage of the Day cyclone Idai was a major tropical storm that made landfall in Africa, an unusual ase, that had unfortunate consequences in Mozamhique es Michael and Willa of 2018 were both storms that intensified rapidly, one Sea Surface Height Anomaly: SARAL, Jason-2 and Jason-3 Measurements from 06-May-2019 to 16-May-2019 he Gulf of Mexico and the other in the Eastern. A suite of tools presented through an interactive, web-based visualization front end. More Ocean Stories

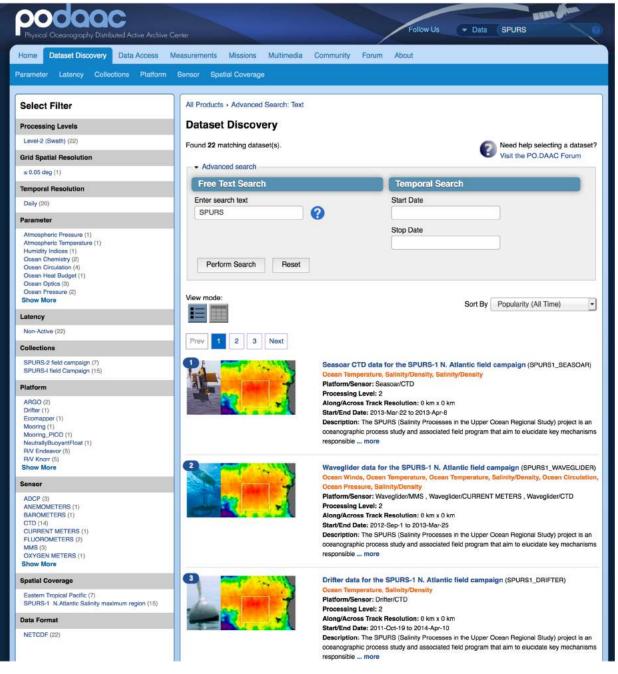
Get PO.DAAC Updates by Email Subscribe »

RSS Feed | Privacy | Data Citation | Glossary | About PO.DAAC | Contact Clearance Number: CL05-0770 Let's see if we can get to the SPURS data....

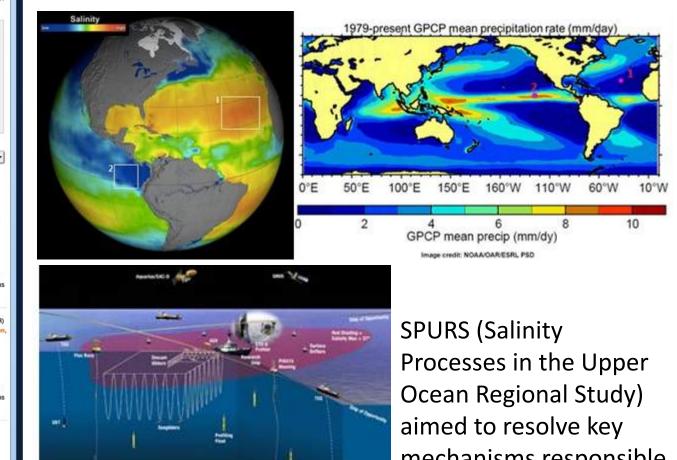
NASA Earth Observing System Data and Info Service (EOSDIS) and the Physical Oceanography Distributed Active Archive Center (PODAAC)

NASA PO.DAAC preserves and provides access to NASA's ocean and climate data. Data from NASAsponsored process studies/field campaigns (e.g., SPURS) are archived here. Visit https://podaac.jpl.nasa.gov/

From slide courtesy of Mike Patterson



Searching on "SPURS" in PODAAC brings up 3 pages of data from SPURS-1 and SPURS-2. Notice nice organization of data in left bar !



Salinity Processes in the Upper Ocean Regional Study (SPURS) Field Experiment mechanisms responsible for near-surface salinity variation.



All Field Projects and Deployments

Below is a comprehensive list of all of EOL's field projects and deployments with links to Data Archive pages and Field Catalogs where appropriate. Please see the Data Management & Services Facility home page for more information on Data Services we provide, as well as a comprehensive list of all the project field catalogs.

Name 👚	Full Name	Date	Data Access	Field Catalog	
3CPO	3CPO Trace Gas Measurements Program	05/31/1988 to 06/20/1988	Data Access		
ABLE-2B	Amazon Boundary Layer Experiment - 2B	03/28/1987 to 05/15/1987	Data Access		
ABLE-3B	Arctic Boundary Layer Expedition -3B	06/09/1990 to 08/31/1990	Data Access		
ACADIS	Advanced - Cooperative Arctic Data and Information Service	07/15/2011 to 04/15/2016	Data Access		
ACE-1	Southern Hemisphere Marine Aerosol Characterization Experiment	10/01/1995 to 12/25/1995	Data Access	Field Catalog	
ACE-ASIA	Asian Pacific Regional Aerosol Characterization Experiment	03/15/2001 to 05/10/2001	Data Access	Field Catalog	
ACE-ENA	Aerosol and Cloud Experiment - Eastern North Atlantic	06/15/2017 to 02/28/2018	Data Access		
ACLAIM	Airborne Coherent Lidar for Advanced In-flight Measurements	03/24/1998 to 04/09/1998	Data Access		
ACME	Airborne Carbon in the Mountains Experiment	05/14/2004 to 08/02/2004	Data Access		
ACME07	Airborne Carbon in the Mountains Experiment 2007	03/01/2007 to 09/30/2007			
ADELE-SPRITE	Airborne Detector for Energetic Lightning Emission Sprite Spectra (ADELE-SPRITE)	08/13/2009 to 09/09/2009	Data Access		
ADRT	Airborne Doppler Radar Tests	05/15/1982 to 07/07/1982			
AESOP/TEXASAQS	Texas Air Quality Study	08/15/2000 to 09/15/2000	Data Access		
AFCGOC	Atmospheric Forcing of Circulation in Gulf Of California	07/14/1983 to 08/04/1983	Data Access		
AFCGOC-II	Atmospheric Forcing of Circulation in Gulf of California - II	03/01/1984 to 03/27/1984	Data Access		
AHATS	Advection Horizontal Array Turbulence Study	06/09/2008 to 08/16/2008	Data Access		
		07/10/1075 to	Data		

NCAR Earth Observing Laboratory

The EOL Data Archive provides archival and access to atmospheric, oceanographic, and other geophysical datasets from scientific process studies/field campaigns for which NCAR/EOL has provided data management support.

Visit https://www.eol.ucar.edu/all-field-

projects-and-deployments

From slide courtesy of Mike Patterson, US CLIVAR director

NAMO
2011-2012
Water and they mandfilled hardwater

DATA BY CATEGO

Cloud Properties
 Flux
 Hydrology
 Intercomparison

Land Based
 Lightning
 Model
 Oceanography

Photography
Radar
Radiation
Satellite

Ship Based
 Upper Air
DATA BY SITE

Diego Garcia
 Maldives

Back to DYNAMO

Aerosols
 Aircraft
 Ancillary
 Chemistry

Oceanography

Oceanography		
DYNAMO SeaSoar (Leg 1) Data [Lien, Moum (APL, UnivOfWashington, OSU)]		
IMD Kalpana SST Imagery [(NCAR-EOL)]	2012-11-20	
Microwave/Infrared Satellite-Derived 9km Sea Surface Temperature Data [(REMSS)]	2012-09-28	Documen
MODIS Ocean Color and Sea Surface Temperature Products [(NASA)]	2012-04-24	Documen
NESDIS Ocean Surface Products [(NESDIS-STAR)]	2012-04-24	Documen
NOAA P-3 Airborne eXpendable Bathythermographs (AXBT's) [Wang, Q. (NPS)]	2013-09-23	Documen
NOAA P-3 Airborne eXpendable Conductivity Temperature and Depth Probe (AXCTD) Data [Wang, Q. (NPS)]	2013-09-23	Documen
NOAA P-3 Corrected Radiometric SST Data [D. Khelif (University of California-Irvine)]		
NOAA POES SST and Anomaly Imagery [(NCAR-EOL)]	2012-11-20	
OSCAR Ocean Surface Current Data [(NASA-PO.DAAC)]	2012-08-30	Documen
R/V Baruna Jaya SST Data [Yoneyama, Kunio (JAMSTEC)]	2012-08-02	Documen
R/V Mirai ADCP Shipboard Data [Katsumata, M. (JAMSTEC)]	2013-02-19	Documen
R/V Mirai ADCP Sub-surface Mooring Data [Katsumata, M. (JAMSTEC)]	2013-02-28	Documen
R/V Mirai Biogeochemical Sampling Data [Yoneyama, K. (JAMSTEC)]	Updated 2013-06-06	Documen
R/V Mirai CTD Data [Yoneyama, K. (JAMSTEC)]	2013-02-28	Documen
R/V Mirai LADCP Data [Richards, K. (IPRC-UH)]	2013-02-28	Documen
R/V Mirai MBES Bathymetry Data [Yoneyama, K. (JAMSTEC)]	2013-05-29	Documen
R/V Mirai Oceanic Microstructure Profiling Data [Katsumata, M. (JAMSTEC)]	2013-02-28	Documen
R/V Mirai Sea Surface Water Data [Yoneyama, K. (JAMSTEC)]	2013-02-28	Documen
R/V Mirai XCTD Data [Katsumata, M. (JAMSTEC)]	2013-02-28	Documen
R/V Roger Revelle CTD Data [Moum, J. (Oregon State University)]	2013-03-13	
R/V Roger Revelle Expendable Bathythermograph (XBT) Data [Mourn, J. (Oregon State University)]	2015-09-04	
R/V Roger Revelle Flux, Near-Surface Meteorology, and Navigation Data [Edson, Jim, Chris Fairall, Simon De Szoeke (U. Conn, ESRL-PSD, OSU)]	2012-08-07	Documen
R/V Roger Revelle Seaglider Data [Matthews, A. J. (UEA)]	2012-08-02	
R/V Sagar Kanya CTD Data [Kumar, S. Prasanna (NIO)]	2013-02-28	Documen
Shipboard Automated Meteorological and Oceanographic System (SAMOS) Data Center [(FSU)]		Documen
Oceanography: Buoy		
Argo Float Data [Yamada, H (JAMSTEC)]	2012-08-02	Documen
DYNAMO Moorings Surface and Subsurface Data [Lien, Moum (APL, UnivofWashington, OSU)]	2013-02-19	
GTS LDM Ship and Buoy Observation Data (Global, ASCII) [(NCAR-EOL)]	2012-08-09	Documen
	DYNAMO SeaSoar (Leg 1) Data [Lien, Mourn (APL, UnivOfWashington, OSU)] IMD Kalpana SST Imagery (INCAR-EOL)] Microwave/Infrared Satellite-Derived 9km Sea Surface Temperature Data [(REMSS)] MODIS Ocean Color and Sea Surface Temperature Products [(NASA)] NESDIS Ocean Surface Products (INESDIS-STAR)] NOAA P-3 Airborne eXpendable Bathythermographs (AXBT's) [Wang, Q. (NPS)] NOAA P-3 Corrected Radiometric SST Data [D. Khelif (University of California-Irvine)] NOAA P-3 Corrected Radiometric SST Data [D. Khelif (University of California-Irvine)] NOAA P-3 Corrected Radiometric SST Data [NASA-PO.DAAC)] R/V Baruna Jaya SST Data [Yoneyama, Kunio (JAMSTEC)] R/V Mirai ADCP Sub-surface Mooring Data [Katsumata, M. (JAMSTEC)] R/V Mirai ADCP Sub-surface Mooring Data [Katsumata, M. (JAMSTEC)] R/V Mirai ADCP Data [Yoneyama, K. (JAMSTEC)] R/V Mirai CTD Data [Yoneyama, K. (JAMSTEC)] R/V Mirai ADCP Data [Richards, K. (IPRC-UH)] R/V Mirai ADCP Data [Richards, K. (IPRC-UH)] R/V Mirai XCTD Data [Katsumata, M. (JAMSTEC)] R/V Mirai Saa Surface Water Data [Yoneyama, K. (JAMSTEC)] R/V Mirai Saa Surface Water Data [Yoneyama, K. (JAMSTEC)] R/V Mirai Saa Surface Water Data [Noum, J. (Oregon State University)] R/V Roger Reveile EDD Data [Mourn, J. (Oregon State University)] R/V Rog	DYNAMO SeaSoar (Leg 1) Data [Lien, Mourn (APL, UnivOlWashington, OSU)] 2012-11-20 Microwava/Infrared Satellite-Derived 9km Sea Surface Temperature Data [(REMSS)] 2012-06-28 MODIS Ocean Color and Sea Surface Temperature Products [(NASA)] 2012-06-28 MODIS Ocean Color and Sea Surface Temperature Products [(NASA)] 2012-06-28 NOAA P-3 Airborne eXpendable Bathythermographs (AXBT's) [Wang, Q. (NPS)] 2013-09-23 NOAA P-3 Corrected Radiometric SST Data [D. Khelif (University of California-Irvine)] 2012-06-23 NOAA P-3 Corrected Radiometric SST Data [D. Khelif (University of California-Irvine)] 2012-06-23 NOAA P-3 Corrected Radiometric SST Data [D. Khelif (University of California-Irvine)] 2012-06-23 NOAA P-S Corrected Radiometric SST Data [MASA-POLACO] 2012-08-02 R/V Maria ADCP Shipboard Data [Katsumata, M. (JAMSTEC)] 2013-02-28 R/V Mirai ADCP Subpoard Data [Katsumata, M. (JAMSTEC)] 2013-02-28 R/V Mirai ADCP Data [Yoneyama, K. (JAMSTEC)] 2013-02-28 R/V Mirai ADCP Data [Kichards, K. (IPRC-UH)] 2013-02-28 R/V Mirai ADCP Data [Kichards, K. (IPRC-UH)] 2013-02-28 R/V Mirai ADCP Data [Kichards, K. (JAMSTEC)] 2013-02-28 R/V Mirai ABES Bathymetry Data [Yoneyama, K. (JAMSTEC)] 2013-02-28 R/V Mirai MBES Bathymetry Data [Yoneyama, K.

NCAR Earth Observing Laboratory

Selecting a specific field project takes you to the list of accessible data sets by category, platform, data type, lead scientist, and institution.

Visit <u>https://www.eol.ucar.edu/all-field-</u>

projects-and-deployments

This example shows data from DYNAMO (Dynamics of Madden Julian Oscillation) process study that took place in the tropical Indian Ocean in 2011-2012.

From slide courtesy of Mike Patterson, US CLIVAR director

Using data from historical process studies

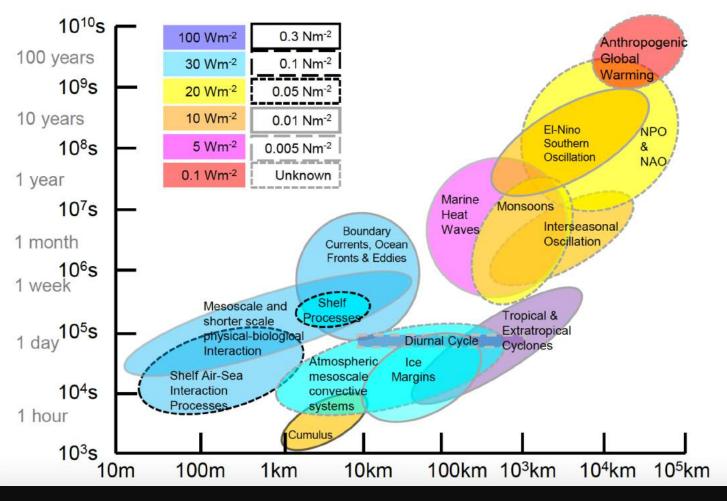
- Learn about process studies by going to US CLIVAR website & process study website.
- Access data from process study website or from national data archive (e.g. NOAA's NCEI, NASA's EOSDIC & PODAAC, NSF's NCAR EOL).
- Reach out to the process study PIs.



Air-Sea Fluxes with a focus on Heat and Momentum

Meghan F. Cronin, Chelle L. Gentemann, James Edson, Iwao Ueki, Mark Bourassa, Shannon Brown, Carol Anne Clayson, Chris Fairall, Tom Farrar, Tatsuya Fukuda, Sarah Gille, Sergey Gulev, Simon Josey, Seiji Kato, Masaki Katsumata, Elizabeth Kent, Marjolaine Krug, Peter Minnett, Rhys Parfitt, Rachel T. Pinker, Paul Stackhouse, Sebastiaan Swart, Hiroyuki Tomita, Douglas Vandemark, Robert Weller, Kunio Yoneyama, Lisan Yu, Dongxiao Zhang

Flux Accuracies and Processes



Goals for 2030: Gridded Air-Sea fluxes with 1-day random uncertainties of: 15 W m⁻² (5%) & 0.01 N m⁻² (5%)

And Biases less than: 5 W m⁻² & 0.005 N m⁻²

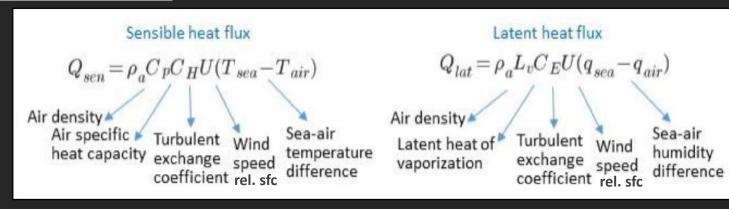
For: 3-hourly at 25 km Aspirational goal: 1-hrly at 10km

Flux EOV/ECV	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Bulk SST	Partial	y met										Ade	quate
Skin Temperature	Partial	y met										Ade	quate
Wind Speed and Direction	Partial	y met										Ade	quate
Air Temperature	Not me	t										Ade	quate
Humidity	Not me	it										Ade	quate
Bulk Surface Currents	Partial	y met										Ade	quate
Skin Surface Currents	Not me	ŧ										Ade	quate
Surface Solar Radiation	Partial	y met										Ade	quate
Surface Longwave Radiation	Partial	y met										Ade	quate
Albedo	Partial	y met											Met
Sea State	Requir	ement l	Jnknow	'n							Require	ement K	nown

Requirement not met / inadequate
Requirement partially met / threshold
Requirement adequately met / breakthrough
Requirement fully met / ideal goal

Need more than 10 essential ocean & climate variables to compute air-sea heat fluxes.

$$Q_{net} = Q_{SW} - Q_{LW} - Q_{lat} - Q_{sen}$$





Air-Sea Fluxes with a focus on Heat and Momentum

- **Two Big Asks:**
- (1) Improved space-based near-surface retrievals of surface humidity and air temperature.
- (2) Regionally distributed in situ network of flux observations, built around an expanded OceanSITES network of reference stations.

(1) Improved space-based near-surface retrievals of surface humidity and air temperature.

Improved vertical resolution and accuracy of temperature and humidity profiles. This could be done for example by combining a 5-channel C- to Kaband digital radiometer with a 50 and 183 GHz hyperspectral digital sounder.

Improved algorithms relating near-surface retrievals to surface humidity and air temperature.

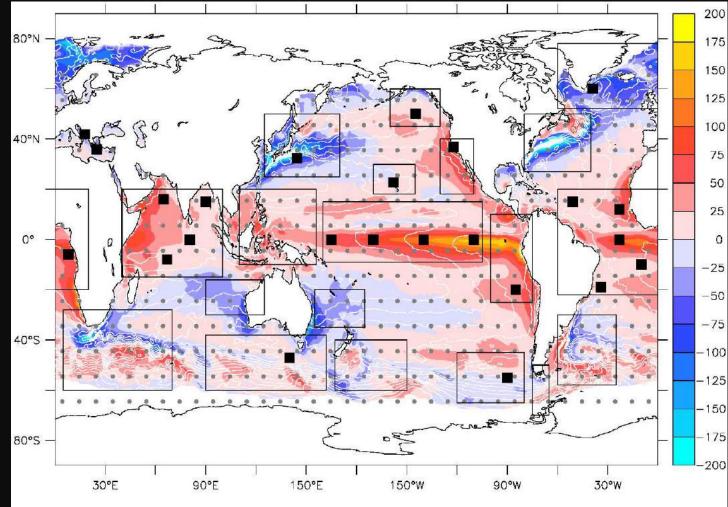
Simultaneous retrievals of SST, surface wind speed and direction, and profiles of near-surface air temperature and humidity (as well as rain, water vapor, soil moisture, sea ice concentration).

Sensible heat flux Latent heat flux $Q_{lat} = \rho_a L_v C_E U(q_{sea} - q_{air})$ $Q_{sen} = \rho_a C_p C_H U(T_{sea} - T_{air})$ Air density Air specific 🖌 Turbulent Wind Sea-air bea-air Turbulent heat capacity temperature exchange speed vaporization difference difference coefficient rel. sfc coefficient rel. sfo

(2) Regionally distributed in situ network of flux observations, built around an expanded OceanSITES network of reference stations.







Mean Net Surface Heat Flux (Wm^{-2})



Cronin et al. OO'19 Community Whitepaper

Roadmap for Expansion of in situ Array

- Evaluate cross-platform, cross-product, & ocean vs. land-based comparisons to quantify uncertainties and improve best practices and model physics and parameterizations.
 - Ocean & Land Baseline Surface Radiation Network (BSRN)?
- Form an international Autonomous Surface Vehicles (ASV) expert group to coordinate data stream, evaluate data, and develop best practices and standardizations.
- Perform **array design studies** and **pilot studies** to raise Technical Readiness Levels for flux platforms.
- Improve bulk algorithms, including role of sea state, and parameterizations of albedo and emissivity.
- Improve coupling physics in NWP.

Roadmap for Optimization of Satellite Retrievals

- Improve resolution of satellite retrievals, time coincidence of remotely-sensed flux EOVs/ECVs, and algorithms relating retrievals to near-surface conditions.
- Improve parameterizations for transforming bulk EOV/ECV into bulk algorithm state variables.

		-					e		1000000			
Flux EOV/ECV	Concernant of the		2020 20	021 2022	2023	2024	2025	2026	2027	2028		
Bulk SST	Partial	ly met									Ad	equate
Skin Temperature	Partial	ly met									Ad	equate
Wind Speed and Direction	Partial	ly met									Ad	equate
Air Temperature	Not me	it									Ad	equate
Humidity	Not me	it									Ad	equate
Bulk Surface Currents	Partial	ly met									Ad	equate
Skin Surface Currents	Not me	et									Ad	equate
Surface Solar Radiation	Partial	ly met									Ad	equate
Surface Longwave Radiation	Partial	ly met									Ad	equate
Albedo	Partial	ly met										Met
Sea State	Requir	ement U	nknown							Requir	ement	Known
	In situ p Gove ulk algo	R 2021 te, & hy latform rmance l flux ne rithm, a Impro	equireme 2022 brid flux intercon for ASV r de esigns & twork with twork with twork with	nt adequat nt fully me 2023 product i nparisons tetwork, s velopmen creation th expand hissivity p of couplin	t / ideal g 2024 ntercon , raising tandard t & revie of a glol ed Ocea paramete g physic	goal 2025 g TRL ization w bal <i>in s</i> nSITE erization	2026 ons & d for AS\ h, best p itu is s n devel	/ iractice	ons	28 2	2029	2030

Optimize satellite moisture and air temperature profile

or near-surface measureme



Cronin et al. OO'19 Community Whitepaper

Roadmap for Expansion of *in situ* Array

- Evaluate cross-platform, cross-product, & ocean vs. land-based comparisons to quantify uncertainties and improve best practices and model physics and parameterizations.
 - Ocean & Land Baseline Surface Radiation Network (BSRN)?
- Form an international Autonomous Surface Vehicles (ASV) expert group to coordinate data stream, evaluate data, and develop best practices and standardizations.
- Perform array design studies and pilot studies to raise Technical Readiness Levels for flux platforms.
- Improve bulk algorithms, including role of sea state, and parameterizations of albedo and emissivity.
- Improve coupling physics in NWP.

Roadmap for Optimization of Satellite Retrievals

- Improve resolution of satellite retrievals, time coincidence of remotely-sensed flux EOVs/ECVs, and algorithms relating retrievals to near-surface conditions.
- Improve parameterizations for transforming bulk EOV/ECV into bulk algorithm state variables.

Flux EOV/ECV	2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030
Bulk SST	Partially met Adequate
Skin Temperature	Partially met Adequate
Wind Speed and Direction	Partially met Adequate
Air Temperature	Not met Adequate
Humidity	Not met Adequate
Bulk Surface Currents	Partially met Adequate
Skin Surface Currents	Not met Adequate
Surface Solar Radiation	Partially met Adequate
Surface Longwave Radiation	Partially met Adequate
Albedo	Partially met Met
Sea State	Requirement Unknown Requirement Known
2018 2019 NW	Requirement fully met / ideal goal 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 P, satellite, & hybrid flux product intercomparisons & evalutions In situ platform intercomparisons, raising TRL for ASV Governance for ASV network, standardization, best practice development & review
E	Array designs & creation of a global <i>in situ</i> flux network with expanded OceanSITES Bulk algorithm, albedo, emissivity parameterization development, Improvement of coupling physics in NWP
	Coordination of satellite constellation's equator crossings Optimize satellite moisture and air temperature profiles for near-surface measurements