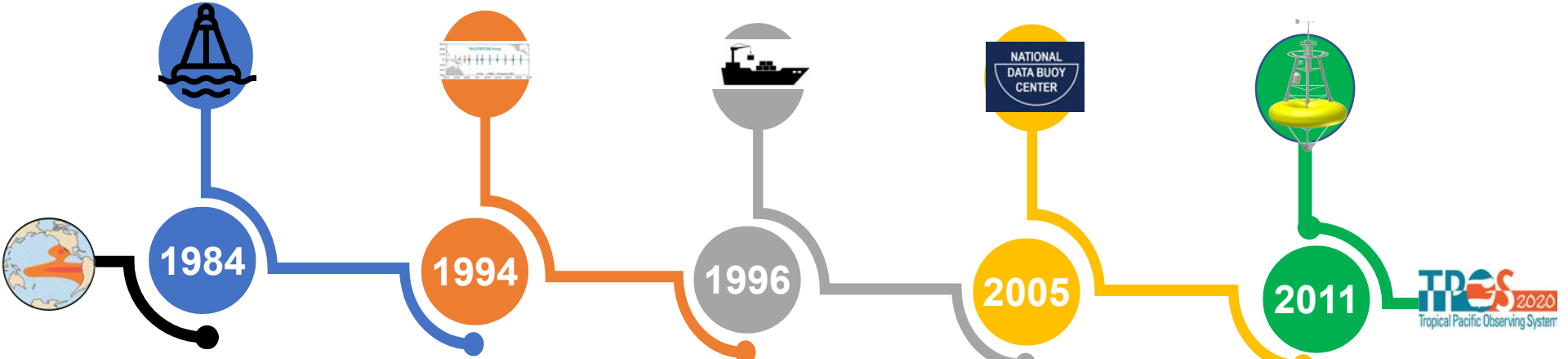
Global Ocean Monitoring and Observing
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION

Sustaining a Moored Ocean Observing System: The Future of the TAO Array within the Tropical Pacific Observing System

Global Ocean Monitoring and Observing Program Review
13 July, 2022

Karen Grissom
NOAA/NWS/National Data Buoy Center, Stennis Space Center, MS 39529 USA

TAO Program History



ATLAS Design

PMEL begins development of array for ENSO & climate research following 1982-83 El Nino.

Array Complete

10 year build-out under the international TOGA program and development NextGen ATLAS .

R/V Ka'imimoana

NOAA Ship Ka' commissioned to service array east of 165E.

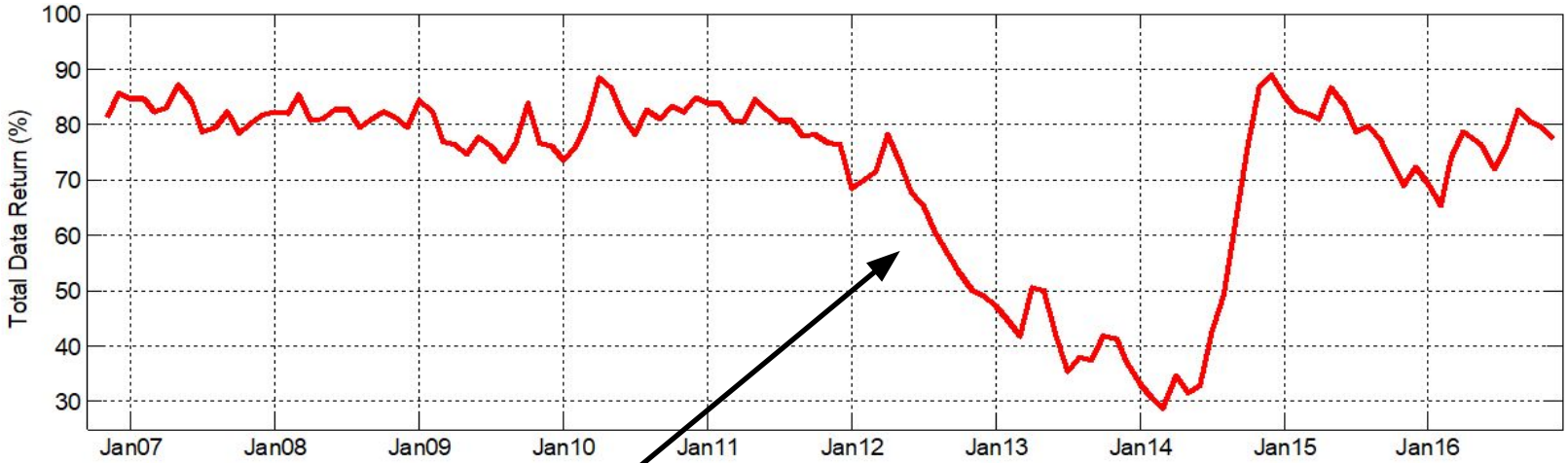
Transition to NDBC

The array is declared operational by NOAA and transitioned from PMEL to NDBC.

TAO Refresh

The impending obsolescence of the technology results in an NDBC TAO Refresh, complete in 2011 .

The Turning Point

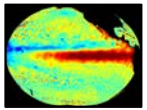


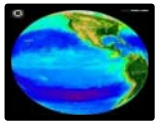
Data availability is coupled to the number of days at sea servicing buoys.

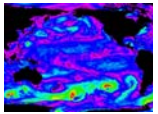
The Tropical Pacific Observing System

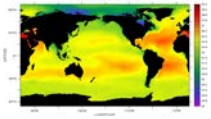
Satellite Observations:

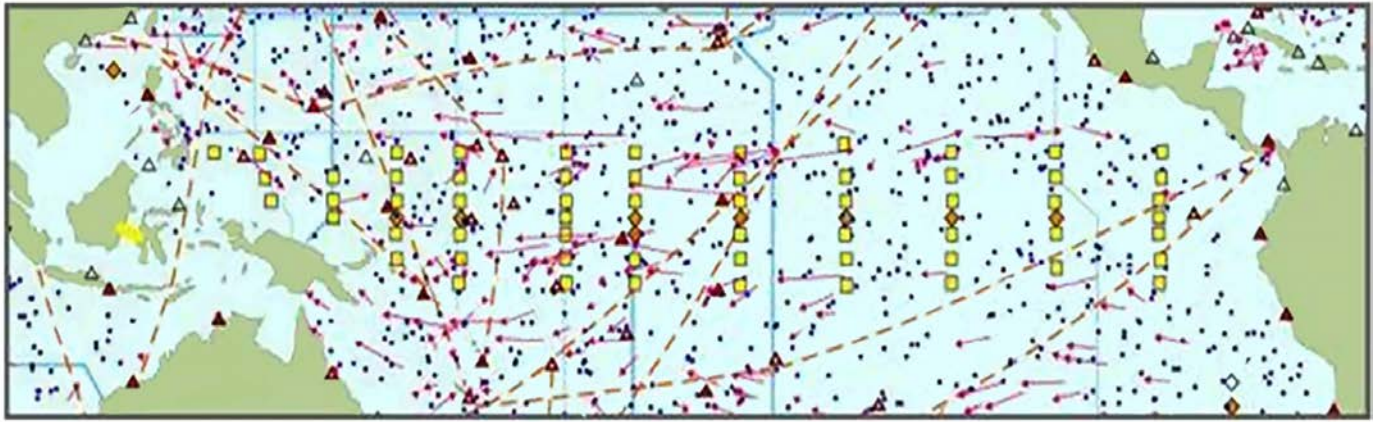

SST


SSH


Ocean Color


Wind


Salinity



In situ Observations:


VOS


Drifters


Tide Gauges


XBT


Buoys


ARGO


Go-SHIP


Emerging Tech.

The intersection of Science, Technology, Research and Operations

TPOS 2020: GOMO Role

- Supported/advocated the integrated vision of TPOS 2020 Project
- Advanced TPOS as a agency priority
- Facilitate cross NOAA Line Office Collaboration, OAR:NWS & PMEL:NDBC
- Lead/coordinate the NOAA TPOS Working Group (TWG)
- Lead coordination of NOAA Implementation Plan Team (aka Tiger Team)
- Sponsored a series of pilot projects on in-situ technology to contribute to TPOS 2020

Autonomous Surface Vessels: Saildrone

Moored Buoys: Direct Covariance Flux System

Moored Buoys: Ocean Boundary Layer

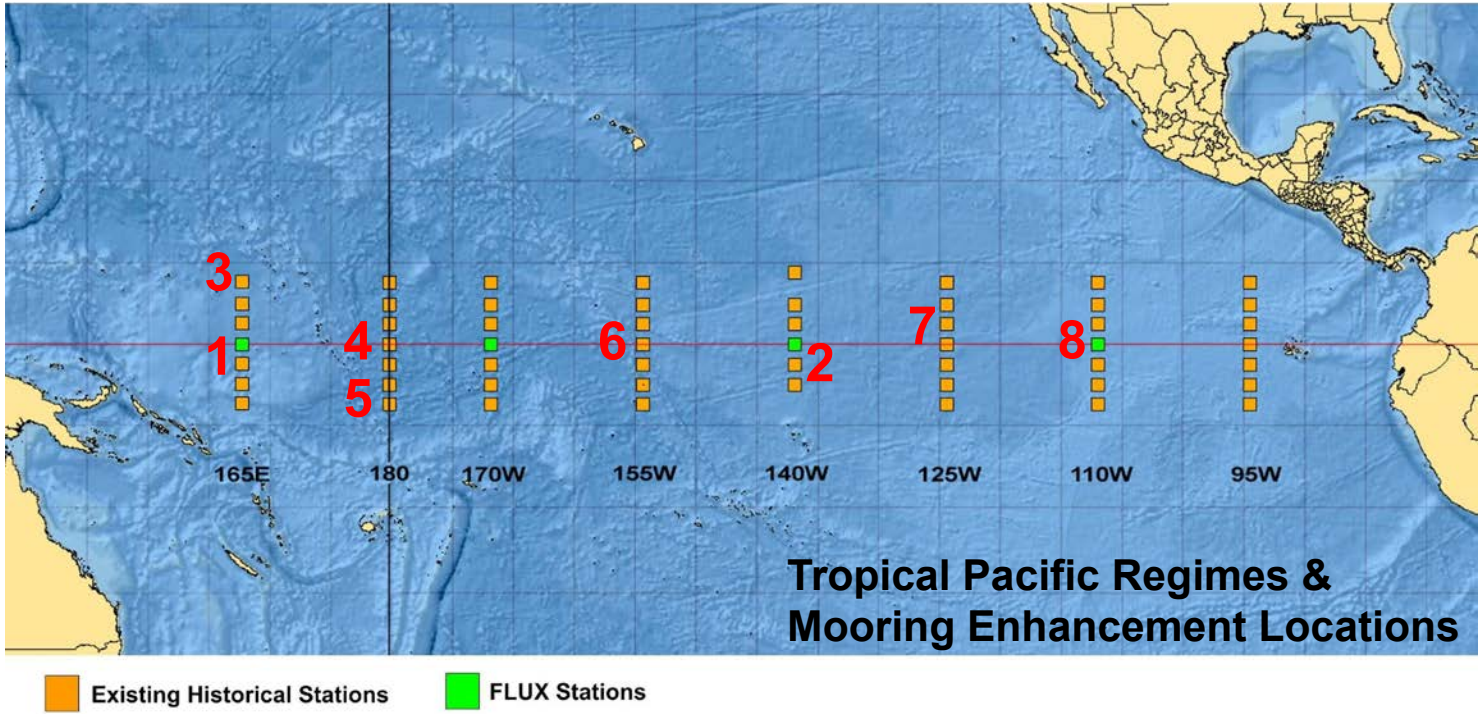
Profiling Floats: Rain, Wind, & BCG

Profiling Floats: BCG, bio-productivity, CO2 fluxes, & hypoxia

Profiling Floats: Improvements to technology

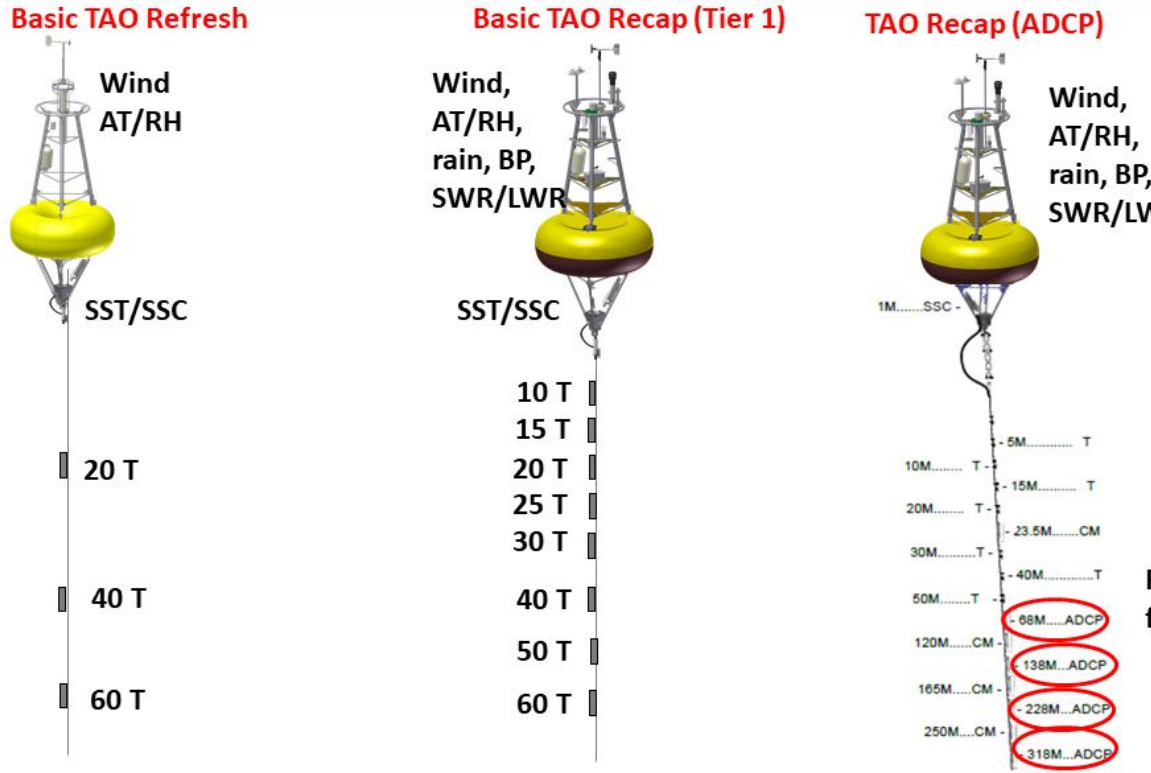
TPOS Pilot Projects

“Enhanced Ocean Boundary Layer Observations on NDBC TAO Moorings”



1. West Pac warm pool (2S 165E)
2. Ekman divergence (2S 140W)
3. ITCZ (8N 165E)
4. Edge of warm pool (0 180)
5. SPCZ (8S 180)
6. Strong Eq trades (0 155W
7. Cold tongue front (2N 125W)
8. Core cold tongue (0 110W)

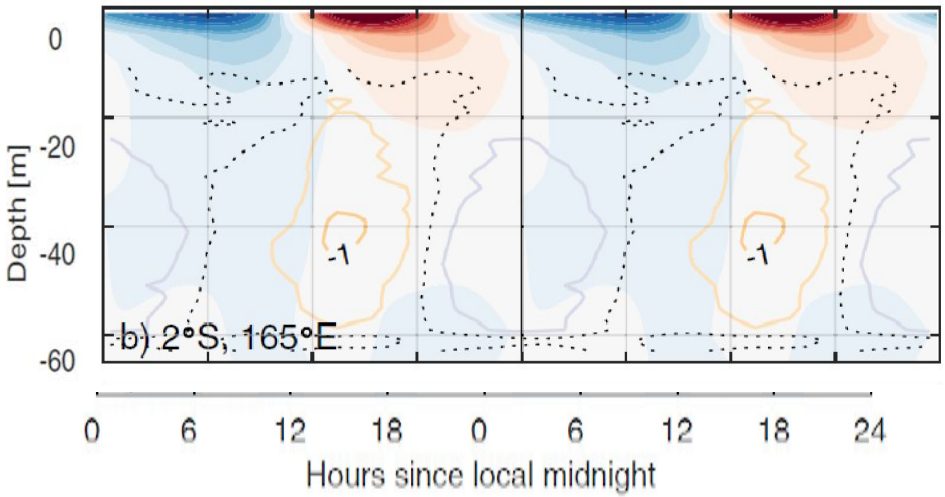
New Technology and Observations: The Redesign of an Array



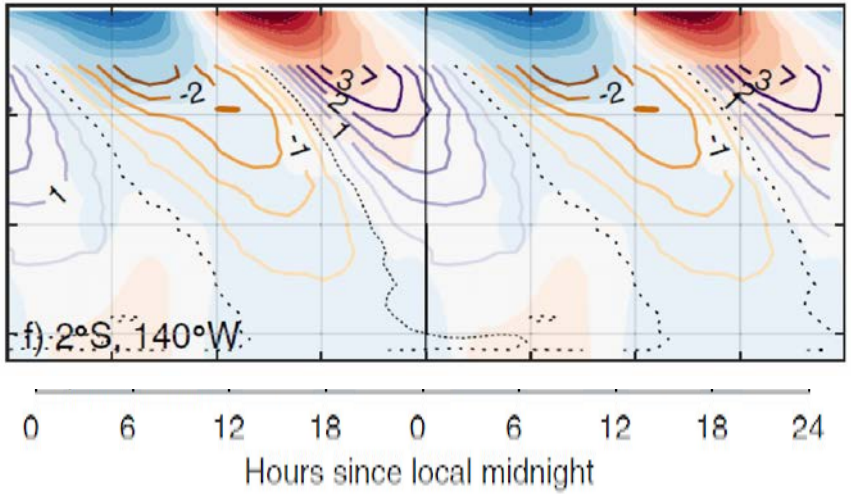
Real-time current profile from ~11 m - 315 m

TAO/TPOS Enhancements: Diurnal cycles

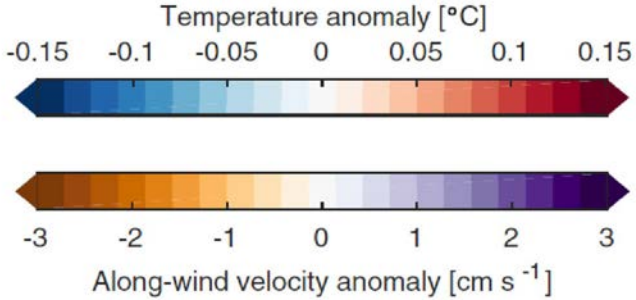
West Pacific Station



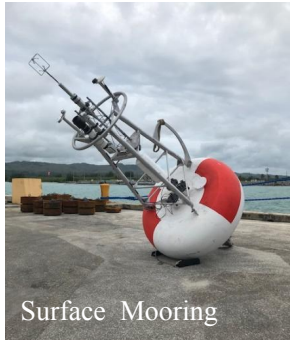
East Pacific Station



Masich et al., 2021



TPOS Enhanced DCFS Mooring



Deployment

- Date: October 4, 2019
- Location: 0°, 165°E

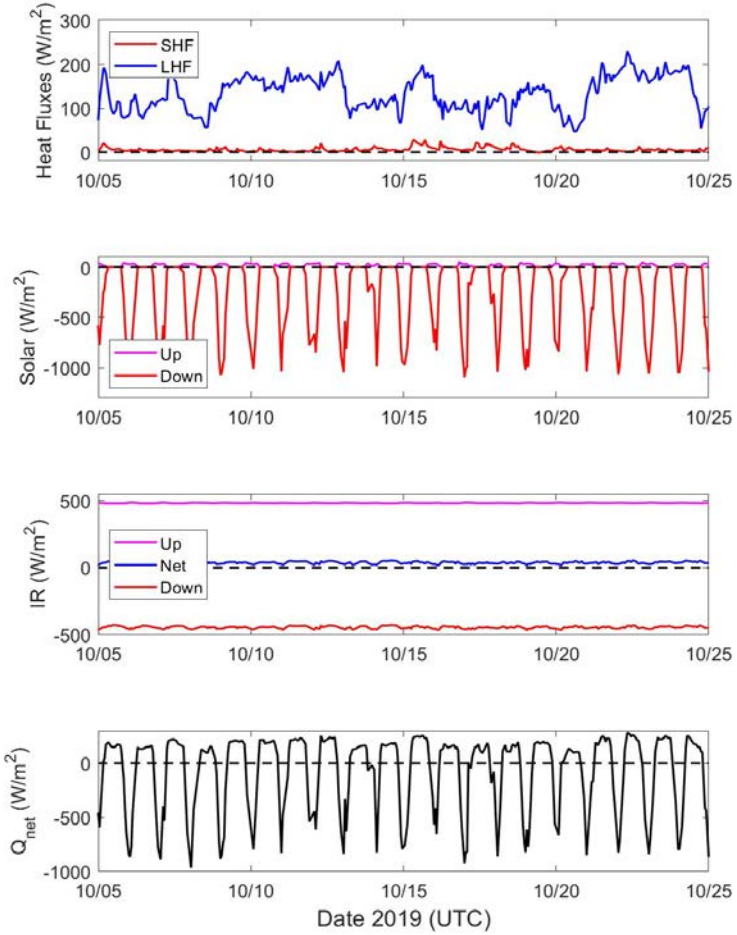
Instrumentation

- 3-axis Sonic Anemometer
- 3-axis Motion Package
- Solar and IR Radiometers
- Redundant RH/T_{air} Sensors
- Barometer
- Rain Gauge
- T_{sea} and Salinity Sensors
- ADCP/ADV Daisy-chain

Real-time Delivery of

- Direct Covariance Surface Stress and Buoyancy Fluxes
- Radiative Fluxes
- Bulk Sensible and Latent Heat Fluxes
- Net Heat Flux
- Near Surface Currents
- Ocean Current Profiles

Heat Budget Terms



Edson et al., 2020

Pilot Project Publications

tropicalpacific.org/projects/mooring-enhancement/

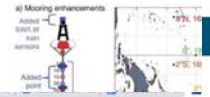
TROPICAL PACIFIC OBSERVING SYSTEM

Enhanced Ocean Boundary Layer Observations on NDBC TAO Moorings

PIs: Karen Grissom (NOAA/NWS/NDBC), William Kessler (NOAA/PMEL), Meghan Cronin (NOAA/PMEL), and Jessica Masich (NRC, NOAA/PMEL)

Description

NOAA's Pacific Marine Environmental Laboratory and National Data Buoy Center installed Acoustic Doppler Current Profilers on Tropical Atmospheric Ocean moorings at nine sites across the tropical Pacific. These sensors measured velocity in the near-surface ocean between seven meters and 65 meters depth, typically a the 'blind spot' in the water column for observations of ocean currents.



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Conferences > OCEANS 2017 - Anchorage

Adding a real-time current profile to NDBC TAO moorings for enhanced ocean boundary layer observations

Publisher: IEEE | Cite This | PDF

Karen Grissom ; James E. Elliott ; Travis Singelton ; William Thompson ; Jennifer Keene All Authors

35 Full Text Views

Abstract

Document Sections

I. Introduction

II. System Design

III. Operational Field Test

IV. Results & Discussion

V. Conclusions

Abstract:
A known characteristic of the Tropical Pacific is the interaction between the zonal winds and the equatorial thermocline, which allows coupled variability like ENSO to evolve. However, this fundamental feedback is the least understood and most poorly modeled element of the tropical climate system. To increase our knowledge of the mechanisms controlling this feedback process, NOAA's National Data Buoy Center (NDBC) and Pacific Marine Environmental Laboratory (PMEL) have collaborated on a joint project to enhance operational NDBC Tropical Atmosphere Ocean (TAO) moorings. The four-year project is part of a larger internationally coordinated effort, TPOS 2020, to refine components of the Tropical Pacific Observing System. The goal of this project is to develop the methodologies to better resolve near surface stratification in real-time to support operational climate forecasting and ENSO research. To this end, eight TAO moorings, in regimes that span the phenomena of the mixed layer processes in the tropical Pacific, will be upgraded with new capabilities and added value. Some of these new capabilities include a real-time current profile for the upper 70 meters, and enhanced vertical resolution of the temperature-salinity

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JGR Oceans

Volume 126, Issue 4
April 2021
e2020JC016982

Research Article | Open Access

Diurnal Cycles of Near-Surface Currents Across the Tropical Pacific

Jessica Masich, William S. Kessler, Meghan F. Cronin, Karen R. Grissom

First published: 02 April 2021 | https://doi.org/10.1029/2020JC016982 | Citations: 1

SECTIONS — PDF — TOOLS — SHARE

Figures | References | Related | Information

Recommended

Near-surface variability of temperature and salinity in the near-tropical ocean: Observations from profiling floats

Jessica E. Anderson, Stephen C. Riser

Journal of Geophysical Research: Oceans

Near-surface variability of temperature

Abstract

Solar radiative heat and wind-forced momentum can be trapped at the surface and transmitted into the ocean interior via a daily descending shear layer that mixes heat and momentum downwards. Here, we characterize the extent of this mechanism across the tropical Pacific via seven mooring deployments spanning the eastern and western tropical Pacific and the Inter-Tropical and South Pacific Convergence Zones. We find a

uring SPURS with the inclusion of an infrared hygrometer to make fast-response
asurement of latent and sensible heat fluxes from the buoyancy flux. This was
ep well and additional batteries. Efforts are currently underway to reduce the power
power platforms.

ng are finding their way onto operational buoy arrays. This abstract describes a

Parameters

IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing
Published: 2020

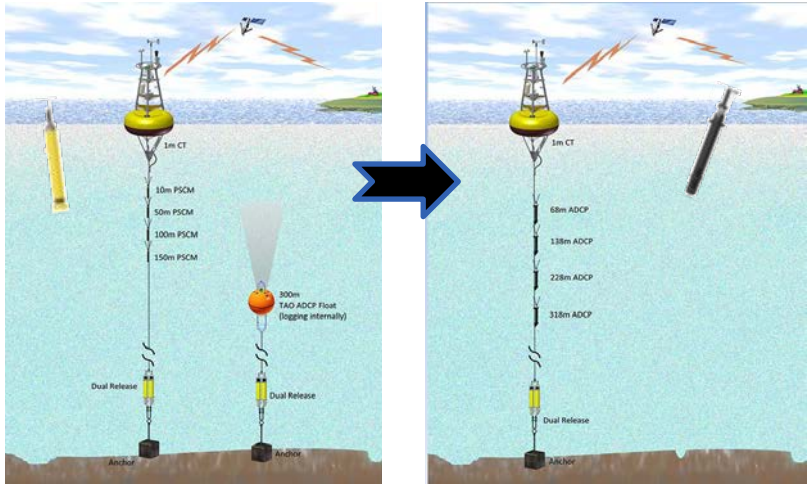
Regional Air-Sea interactions (RASI) climatology for central america coastal gap wind and upwelling events

- Full Article: PDF

View issue TOC
Volume 32, No. 2
Pages 122 - 133

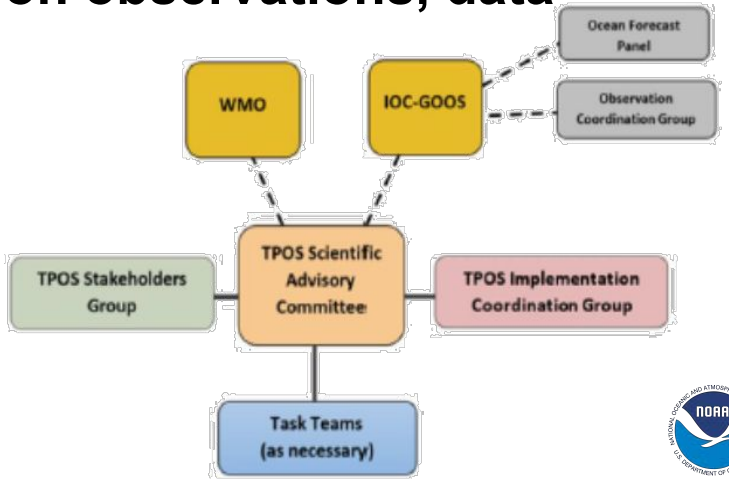
Transition Research to Operations

- GOMO facilitate the transition of technology to operational status
- Revitalize observing system backbone based upon a series of GOMO-funded TPOS pilot projects and TPOS
- Garnered support for TPOS science recommendations as described in the TPOS 2020 Final Report



TPOS: The Path Forward

- Recapitalize TAO to modernize & provide value-added new technologies - Reconfigured "backbone" array
- **Observations to advance understanding of ENSO and tropical Pacific physical and biogeochemical variability.**
- **Work with national/international ocean observing programs to implement the TPOS recommendations on observations, data management, & models/DA**
- **Build community consensus on future of Tropical Pacific – new TPOS Governance**



Thank You

Karen.Grissom@noaa.gov