A big idea from OceanObs'19: Formation of an Integrated Surface Ocean Observing System (ISOOS)

Recommendations from >13 Community Papers and >300 expert Authors

Cronin, et al. (2019) **"Air-sea fluxes with a focus on heat and momentum"**

Wanninkhof, et al. (2019) **"A Surface Ocean CO_2 Reference Network, SOCONET and Associated Marine Boundary Layer CO_2 Measurements"**

Centurioni, et al. (2019) **"Multidisciplinary Global In-Situ Observations of Essential Climate and Ocean Variables at the Air-Sea Interface In Support of Climate Variability and Change Studies and to Improve Weather Forecasting, Pollution, Hazard and Maritime Safety Assessments"**

Ardhuin, et al. (2019) "**Observing sea states"**

Ardhuin, et al. (2019) **"SKIM, a candidate satellite mission exploring global ocean currents and waves"**

Bourassa, M. A. et al. (2019): "**Remotely Sensed Winds and Wind Stresses for Marine Forecasting and Ocean Modeling"**

Gommenginger, et al. (2019) **"SEASTAR: a mission to study ocean submesoscale dynamics and small-scale atmosphere-ocean processes in coastal, shelf and polar seas"**

Kent, et al. (2019) **"Observing requirements for long-term climate records at the ocean surface"**

O'Carroll, et al. (2019) **"Observational Needs of Sea Surface Temperature"**

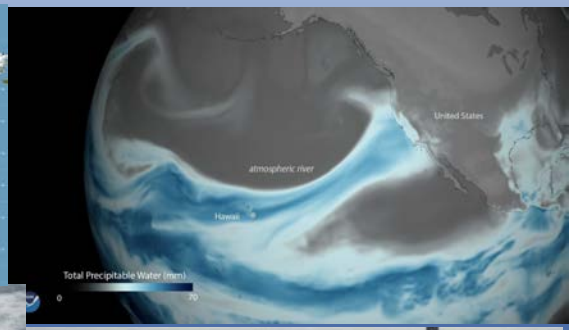
Smith, et al. (2019) **"Ship-Based Contributions to Global Ocean, Weather, and Climate Observing Systems"**

Steinhoff, et al. (2019) **"Constraining the oceanic uptake and fluxes of greenhouse gases by building an ocean network of certified stations: the ICOS Oceans Network"**

Swart, et al. (2019): **Constraining Southern Ocean Air-Sea-Ice Fluxes Through Enhanced Observations"**

Villas Bôas, et al (2019): "**Integrated Observations of Global Surface Winds, Currents, and Waves: Requirements and Challenges for the Next Decade"**

To predict weather and climate influenced by ocean, air-sea heat fluxes must be resolved



Goals for 2030:

3-hourly 25-km Gridded Air-Sea fluxes with "breakthrough" 1-day random uncertainties of:

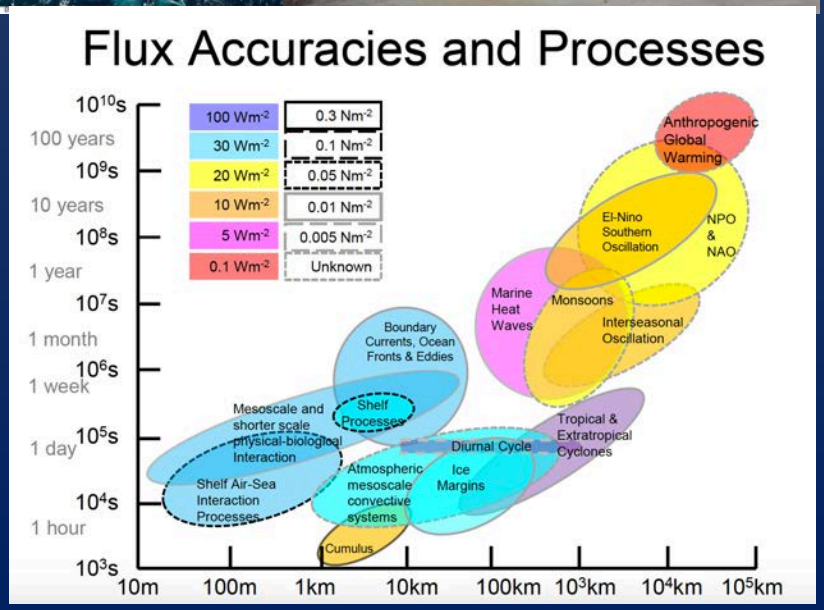
15 W m^{-2} (5%) & 0.01 N m^{-2} (5%)

and Biases less than:

5 W m^{-2} & 0.005 N m^{-2}

Aspirational goal:

"Breakthrough" accuracy for 1-hrly at 10km gridded fluxes.



To predict weather and climate influenced by ocean, air-sea heat fluxes must be resolved

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

Sensible heat flux

$$Q_{sen} = \rho_a C_p C_H U (T_{sea} - T_{air})$$

Air density
Air specific heat capacity
Turbulent exchange coefficient
Wind speed rel sfc
Sea-air temperature difference

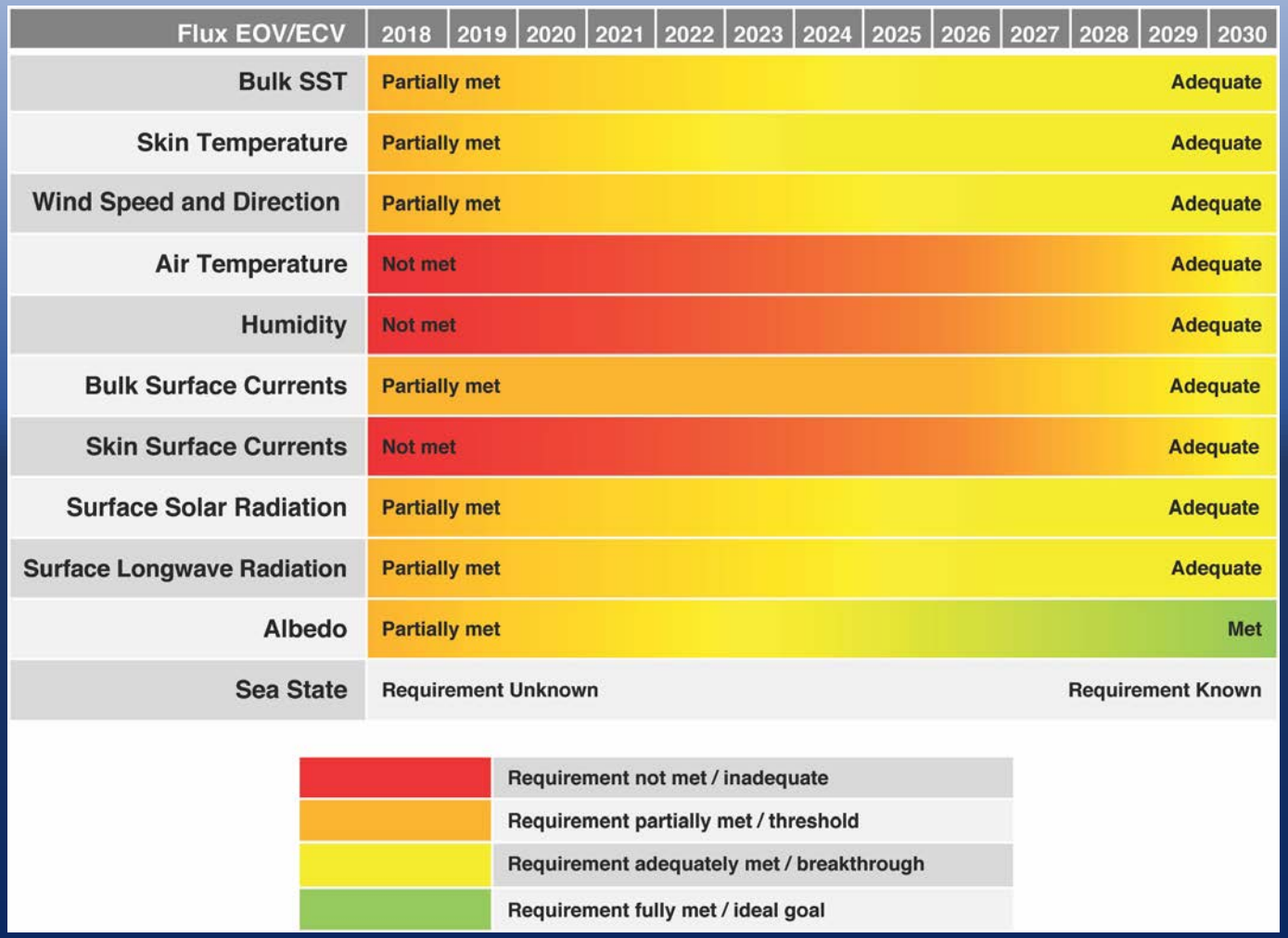
Latent heat flux

$$Q_{lat} = \rho_a L_v C_E U (q_{sea} - q_{air})$$

Air density
Latent heat of vaporization
Turbulent exchange coefficient
Wind speed rel sfc
Sea-air humidity difference

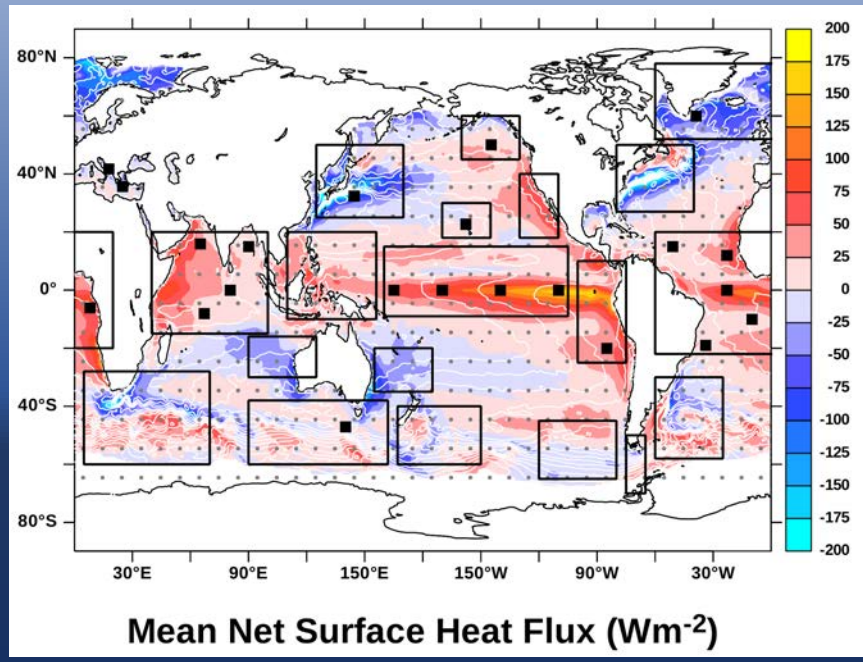
Need more than 10 essential ocean & climate variables to compute air-sea heat fluxes.

To predict weather and climate influenced by ocean, air-sea heat fluxes must be resolved



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

OceanObs'19 Recommendation: Create an Integrated Surface Ocean Observing System (ISOOS)



- OceanSITES surface platforms that measure Net Surface Heat Flux
- Key regions needing new OceanSITES flux platforms
- 10°x10° gridpoints. With 1000 platforms, each gridbox could have 2-3 platforms.

Cronin et al. (2019) **"Air-sea fluxes with a focus on heat and momentum"**

Satellite Platforms

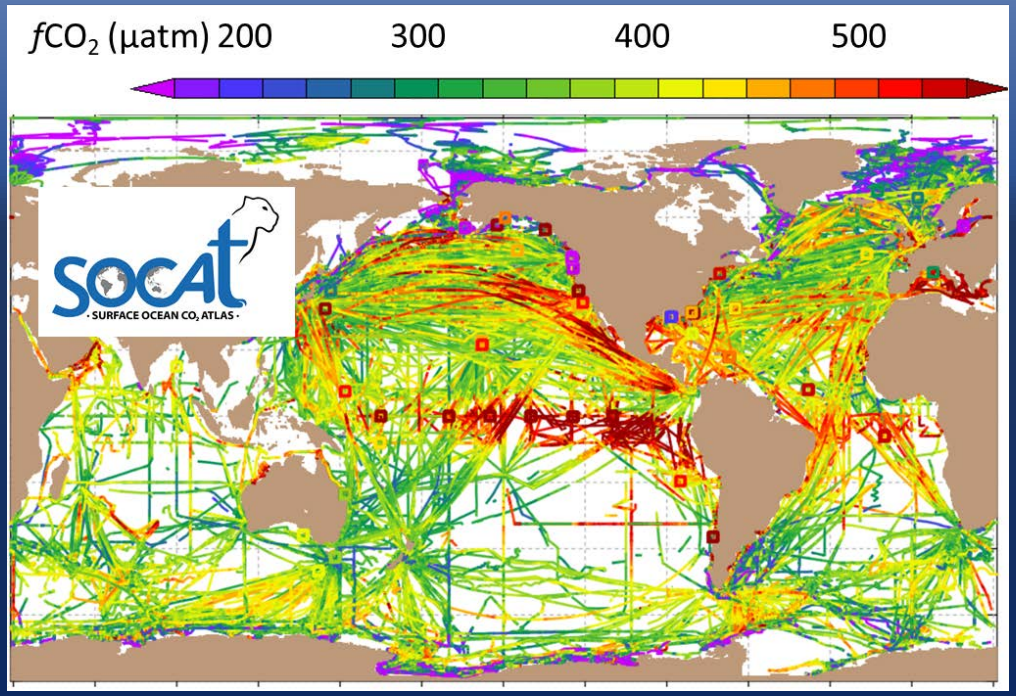
Fixed Platforms

Mobile and Drifting Platforms

OceanObs'19 Recommendation: Create an Integrated Surface Ocean Observing System (ISOOS)

Established Platforms:

Surface ocean CO_2 flux: all seawater pCO_2 measurements collected since 1957



New Technologies:

Wanninkhof et al. (2019) **"A Surface Ocean CO_2 Reference Network, SOCONET and Associated Marine Boundary Layer CO_2 Measurements"**

Near-term steps for creating an Integrated Surface Ocean Observing System (ISOOS)

1. Identify **stakeholders** and **champions** for expansion of observations for multi-disciplinary and multifunctional ISOOS

2. Create a **Task Team** that would report to **GOOS** OOPC, IOCCP, and Biology&Ecosystem **Panels**. Terms of Reference:

   i. Identify relevant OO19 Community White Papers (CWP) and **Common Recommendations and Roadmap activities** across the different communities (e.g. weather, climate, carbon, biology and ecosystems).

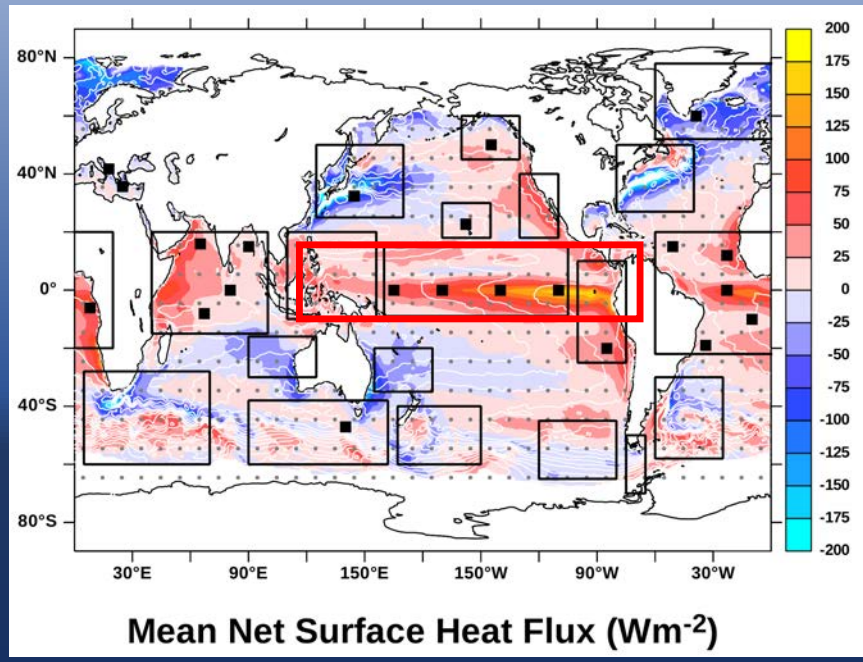
   ii. Provide expertise to regional observing systems for design studies, priorities, … similar to **SOFLUX and TPOS-2020 PBL Task Teams**.

   iii. Perform array designs

   iv. Perform intercomparisons across platforms to ensure interoperability

   v. etc. **Contact Meghan.F.Cronin@noaa.gov**

OceanObs'19 Recommendation: Create an Integrated Surface Ocean Observing System (ISOOS)



- OceanSITES surface platforms that measure Net Surface Heat Flux
- Key regions needing new OceanSITES flux platforms

TPOS-2020

- 10°x10° gridpoints. With 1000 platforms, each gridbox could have 2-3 platforms.

Cronin et al. (2019) **"Air-sea fluxes with a focus on heat and momentum"**

Satellite Platforms

Fixed Platforms

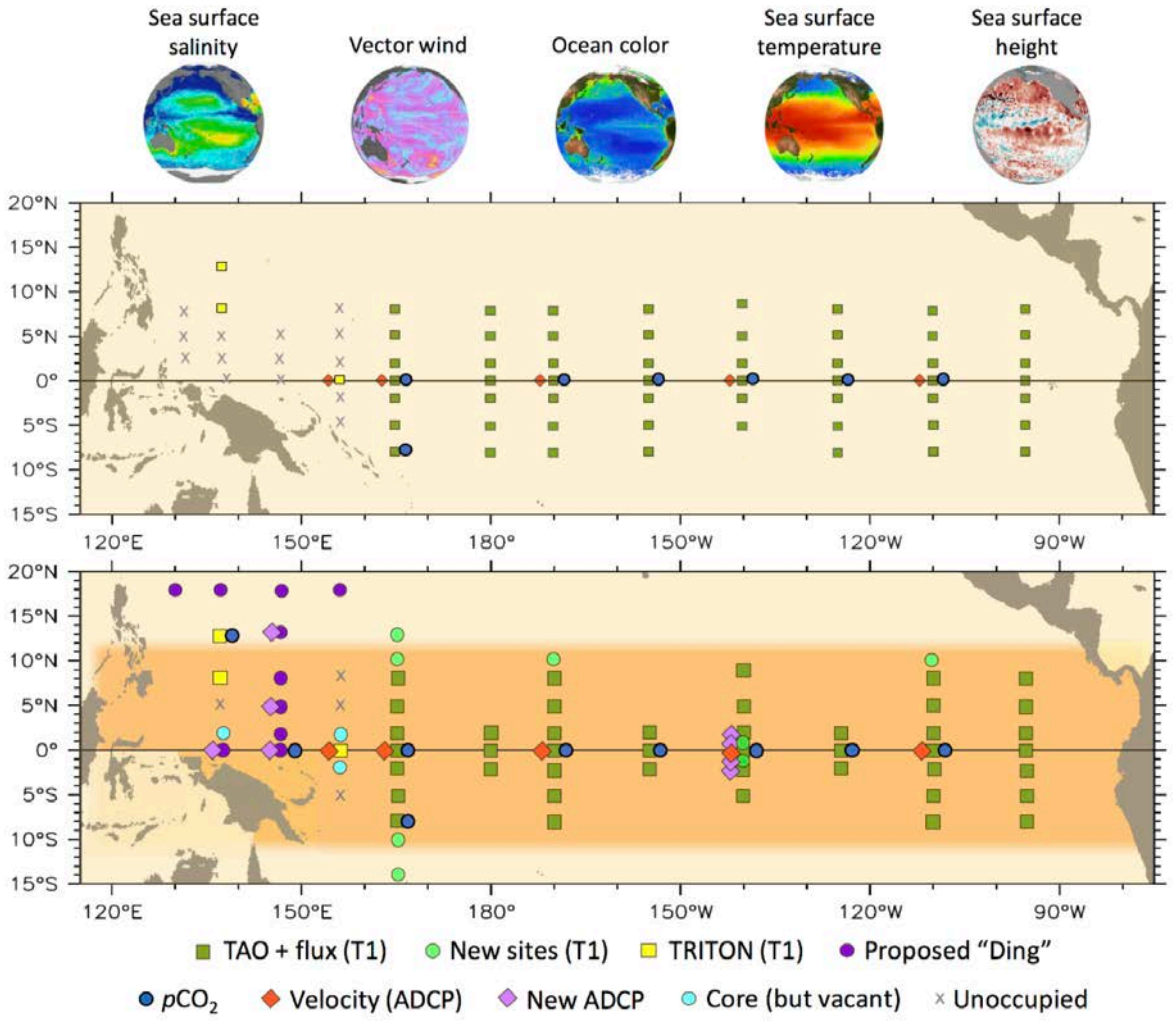
Mobile and Drifting Platforms

TPOS 2020 Tropical Pacific Observing System

Present Tropical Moored Array (TMA)

https://www.pmel.noaa.gov/tao/

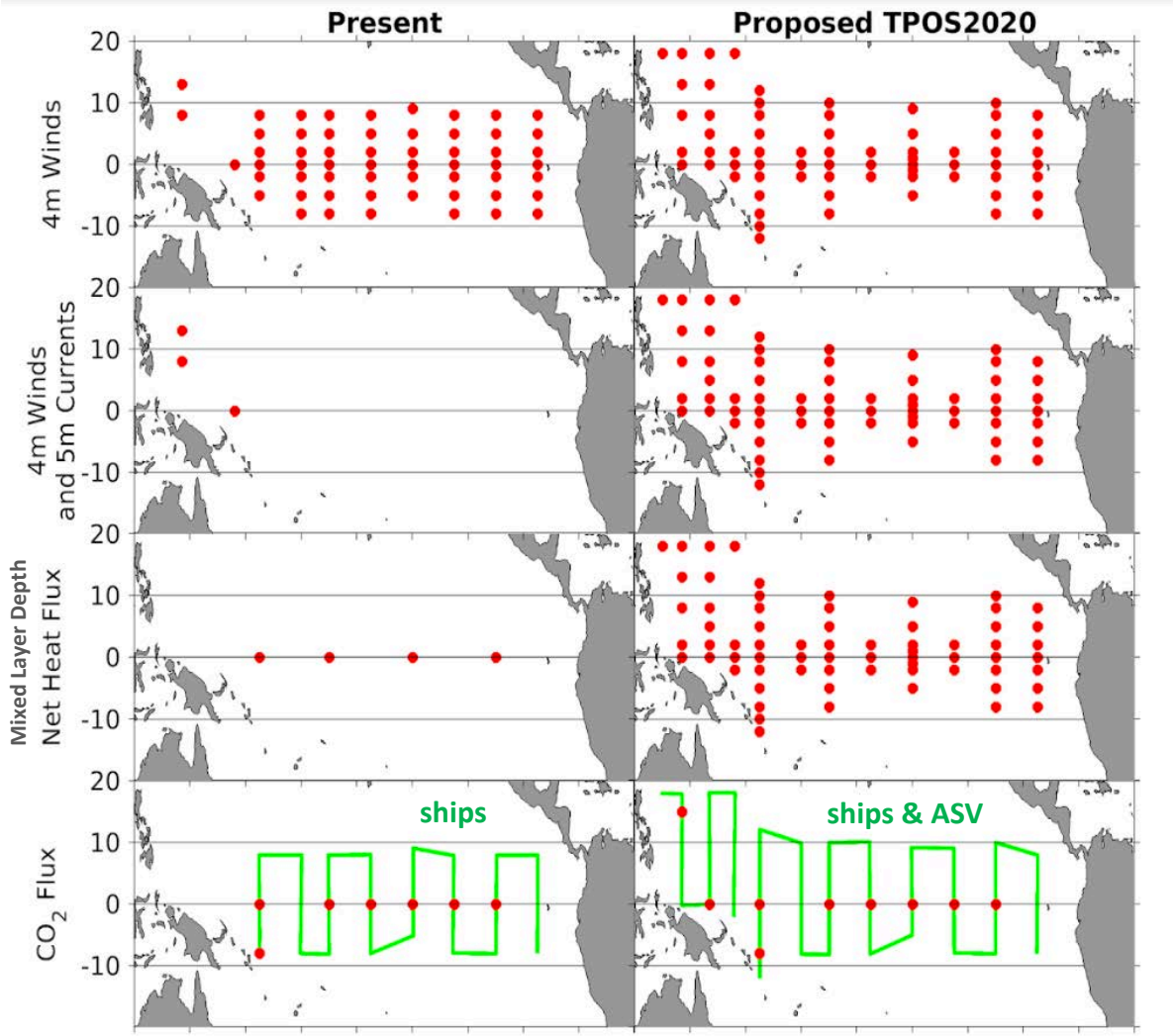
Proposed TPOS TMA high priority sites and double Argo region (dark orange)



TPOS 2020 Tropical Pacific Observing System

What are the differences?

--Better air-sea interaction

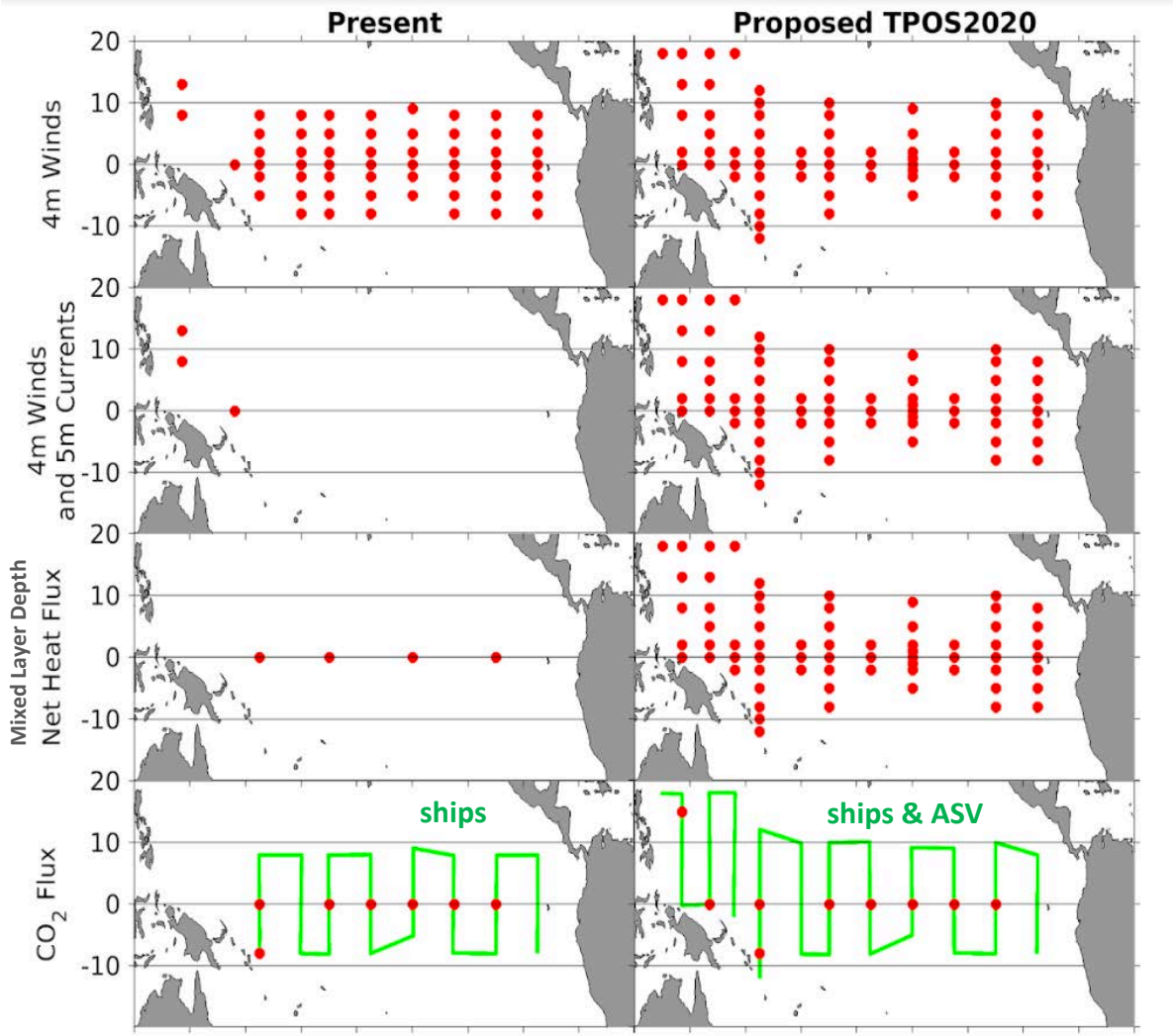


Which sites should be instrumented first?
second?...

TPOS 2020 Tropical Pacific Observing System

What are the differences?

--Better air-sea interaction



Meghan's idea for near-surface Current Meter Priorities*:

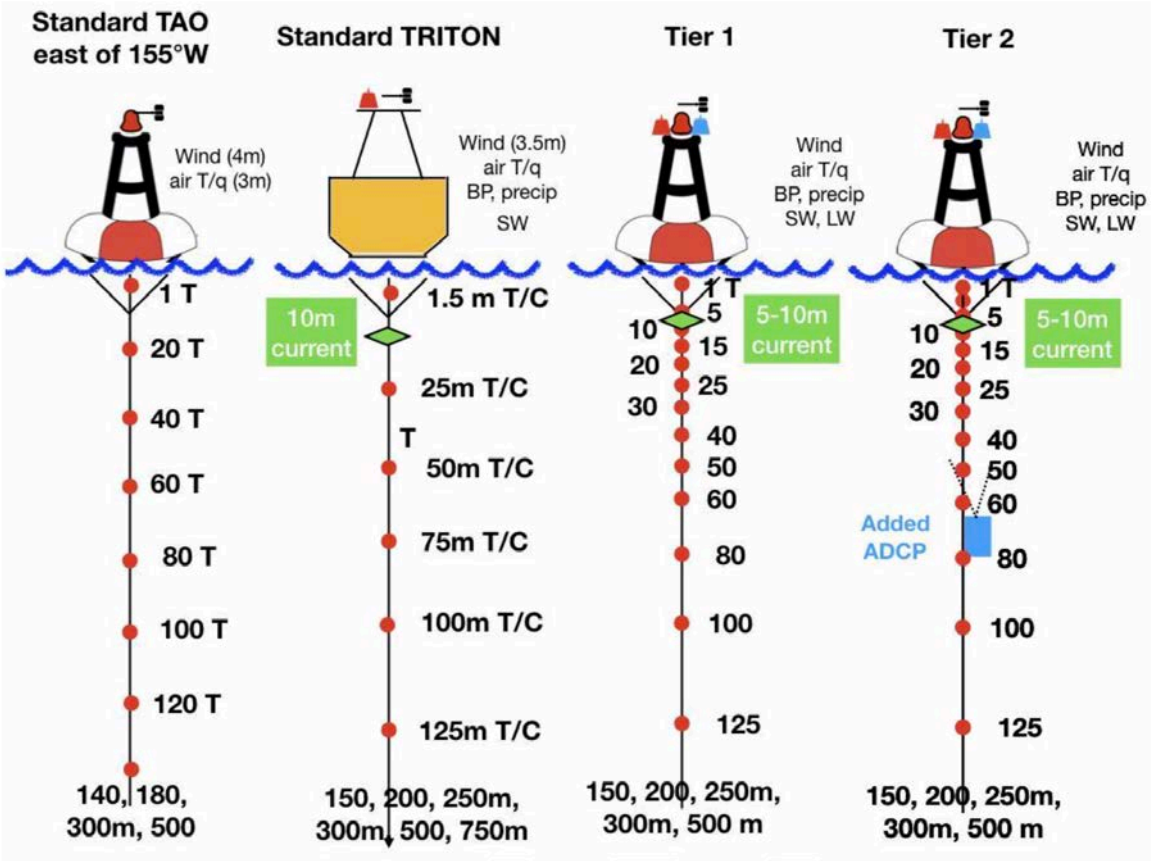
1. Equator, except 95W
2. Meridional lines
   i. 165E
   ii. 110W
   iii. 140W
   iv. 170W
3. Remaining 2N
4. Remaining 2S
5. 95W meridional

*Assuming W. Pac already covered

What are the differences?

--Better air-sea interaction

How will it be done?



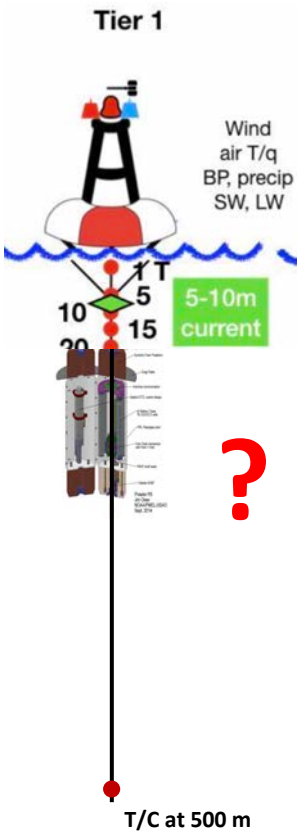
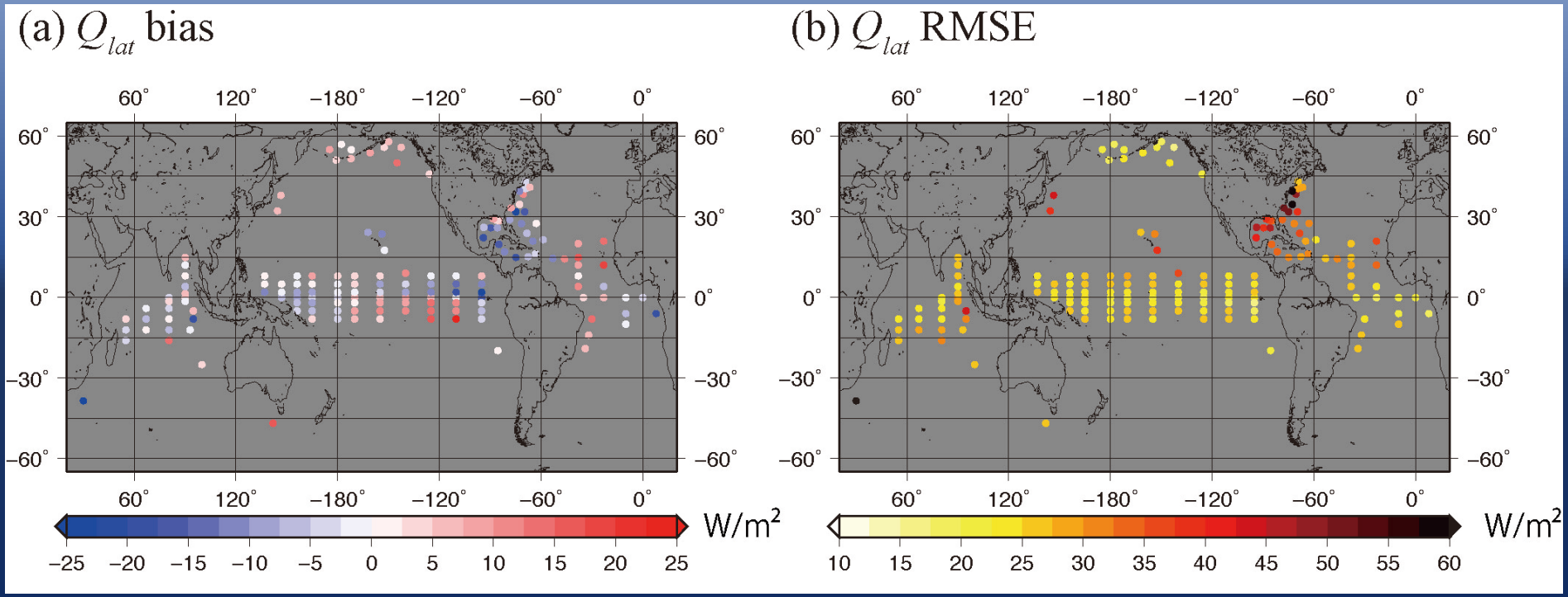


Figure 7.3: Schematics comparing the instrumentation of the current TAO and TRITON moorings- on the left, with those of the new enhanced TMA Tier 1 and Tier 2 - on the right. In the subsurface red dots and black text indicate the depths of temperature and salinity measurements, and green diamonds velocity measurements. Tier 2 moorings will have an upward looking current profiler (blue rectangle). Above the surface, parameters are noted as: Wind = wind speed, air T/q = air temperature and specific humidity, BP = barometric pressure, precip = rainfall, downwelling SW and LW = shortwave and longwave radiation respectively.

In Situ Array is being used to assess uncertainty in satellite data.

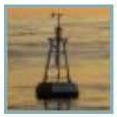


Example: J-OFURO3 satellite based latent heat flux (Tomita et al. 2019)

Data

Related

Indian Ocean - R...
Research Moored Array for African-Asian-Australian Monsoon Analysis

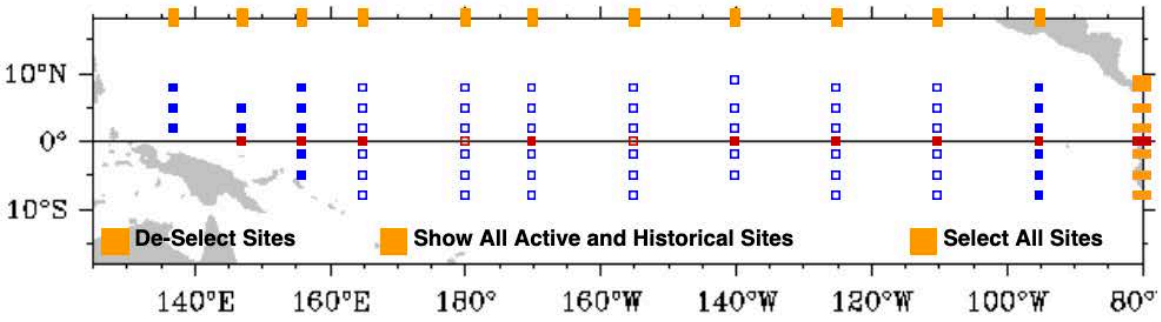


Atlantic Ocean -...
Prediction and Researched Moored Array in the Atlantic (PIRATA)

Oceansites Flux Data

Show Instructions New High Resolution Data

TAO/TRITON (Pacific) | PIRATA (Atlantic) | RAMA (Indian)



Time Series | Time Section | Lat Lon Map

One Variable One Site Separate Plots Overlay

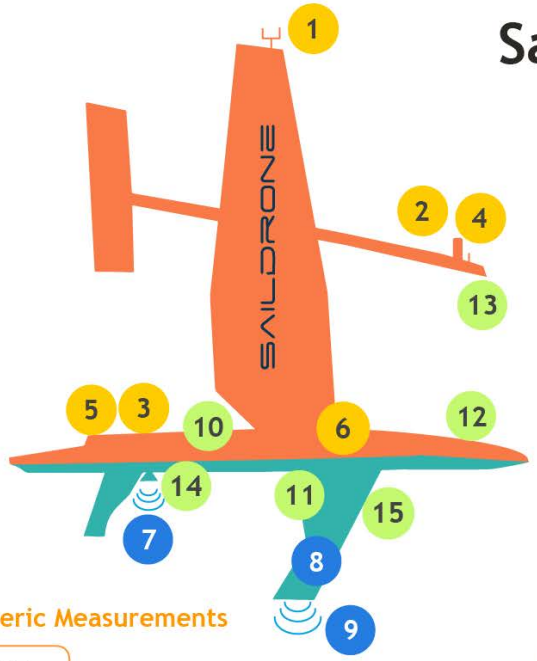
Sensible	Net Shortwave	Evaporation	Zonal Wind Stress	Stress Vectors
Sensible (Rain)	Net Longwave	Precipitation	Meridional Wind Stress	Buoyancy
Latent	Net Heat Flux	Evap - Precip	Wind Stress Magnitude	Wind Speed @ 10m

1998 | MAR | 9 — 2020 | FEB | 19 — High Res no LW (Rel Wind Speed)

files by site | ASCII | Compression

Definitions | Availability | Clear | Deliver | Display

Saildrone Sensor Suite



Specifications

Length: **7 m**
Height: **4.6 m (above water line)**
Depth: **2 m**
Weight: **545 kg, (fully loaded)**
Speed: **Transit - 3 Kt, Max - 8 Kt**
Payload Power: **30W Steady state**
Payload Capacity: **100 kg**
Max deployed duration: **12 months**
Longest voyage: **16,100 km**

Atmospheric Measurements

- Wind Speed, Wind Direction — 1 Anemometer @ +5.0m, Gill WindMaster 3D Ultrasonic 20Hz
- Sunlight & Infrared Radiation — 2 Sunshine Pyranometer @ +2.5m, Delta-T Devices SPN1
- Sunlight & Infrared Radiation — 3 Pyrgeometer +0.7m, Eppley PIR
- Air Temperature, Humidity — 4 Meteorlogical Probe @+2.4m, Rotronic HC2 - S3 with rad shield
- Air Pressure — 5 Digital Barometer @ +0.3m, Vaisala BAROCAP® PTB210
- Air pCO_2 — 6 CO_2 System @ +0.5m, PMEL ASVCO$_2$

Oceanic Subsurface Measurements

- Ocean Current — 7 ADCP @ -0.3m, Teledyne RDI 300 kHz Workhorse Sentinel
- Marine Mammal Presence — 8 Passive Acoustic Recorder @ -1.3m, Greenridge Sciences Inc. Acousonde
- Fish Biomass, Bathymetry — 9 Scientific Echosounder @ -1.8m, SIMRAD WMINI; Multi-beam Sonar @ -1.8m, Norbit iWBMS

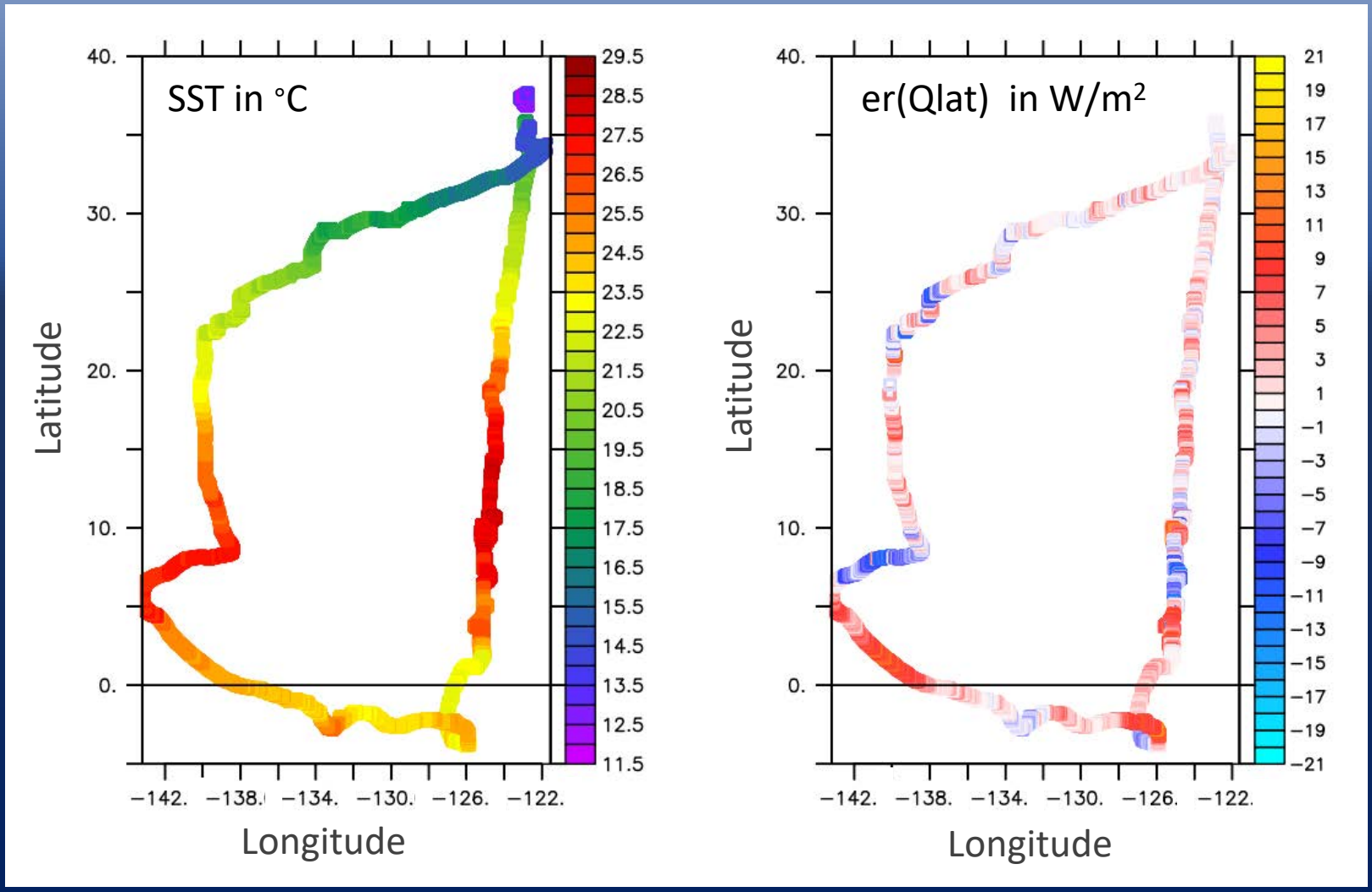
Oceanic Surface Measurements

- Wave Height & Period — 10 Dual GPS & IMU, Vectornav / KVH
- Seawater pCO_2 & pH, Dissolved Oxygen, Water Temperature, Salinity — 11 CO_2 System, PMEL ASVCO$_2$ @ -0.5m, Honeywell Durafet @ -0.5m, Aanderaa Optode @ -0.5m, Sea-Bird Scientific SBE PRAWLER @ -0.6m
- Magnetic Field — 12 Magnetometer, Barrington MAG 648
- Skin Temperature — 13 SST IR Pyrometer @ +2.2m, Heitronics KT15 II
- Chla, CDOM Concentration, Red Backscatter — 14 Fluorometer and Backscatter @ -0.2m, Sea-Bird Scientific WET Labs Eco Triplet
- Water Temperature, Salinity — 15 Thermosalinograph CTD @ -0.6m, Teledyne RDI Citadel TS-NH

A mobile surface flux and surface current profile platform

Tested in the Tropical Pacific as a pilot study for TPOS-2020

Latent Heat Flux should be calculated from winds relatieve to currents. Use Saildrone to estimate er(Qlat) = Qlat(no Currents) – Qlat(with Currents)



frontiers
Research Topics

Abstracts deadline 27th March 2020

Manuscripts deadline 30th September 2020

Energy, Water, and Carbon Dioxide Fluxes at the Earth's Surface

Topic Editors:

Meghan Cronin, NOAA PMEL, USA
Carole Anne Clayson, WHOI, USA
Simon Josey, NOC, UK
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