Saildrones: Global Class Autonomous Surface Vehicles for Air-Sea Interaction Observation

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Workshop: Observational campaigns for better weather forecasts

ECMWF | Reading | 10-13 June 2019
SAILDROME

Unmanned Surface Vehicle (USV)

Green Tech.: 
*Wind propulsion; Solar power electronics.*

Long Endurance: 
12-month; 16,100 km.

Large Payload: 
>100 kg; Large number of sensor packages.
Saildrones: Global Class Autonomous Surface Vehicles for Air-Sea Interaction Observation

- CRADA PMEL-Saildrone Inc 2014
- Bering Sea summer 2015-2016 (surface MetOcean, acoustic fish biomass)
- Tropical Pacific Observing System (TPOS) and NOAA Tech. Development 2016-2019 (Air-sea heat, momentum and CO₂ fluxes, ADCP upper ocean currents)

Meinig et al. 2019 OceanObs’19
Autonomous Surface Vessels as Low-Cost TPOS Platforms for Observing the Planetary Boundary Layer and Surface Biogeochemistry

Co-PIs: M. Cronin, D. Zhang, A. Sutton, C. Meinig
Postdoc: Samantha Wills

Testing the ability of Saildrone to make climate-quality measurements in the Tropics

Three 6-month missions:
1) NASA salinity study (SPURS II) and 125°W section (Sept. 2017)
2) Equatorial sections 140°W, with and against currents (Oct. 2018)
3) Cluster of 4 drones, adaptive sampling around 140°W (June 2019)
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Legend:
- TAO buoys
- TAO buoy with CO₂ flux sensors
- NASA SPURS II Study Site
- Saildrone Mission #1
- Saildrone Mission #2
- Saildrone Mission #3

Please advise: grid spacing, where, etc.
Off-the-shelf Sensors (data put on GTS):
- Air Temperature and Relative Humidity
- Air Pressure
- SST (@0.6m)

Wind and Wind Stress (Bulk and covariance)

ADCP currents (upper 100m)

Air-sea heat fluxes (LW and SW radiation, bulk latent heat and sensible heat)

Waves (significant wave height and period)

BGC Suite
- Air pCO2
- Sea surface pCO2 and pH
- Dissolved Oxygen
- Chla, CDOM, Red Backscatter
Two TPOS Saildrones launched from dock in San Francisco Bay, for return trips of the Equatorial Pacific. No ship time!
Tropical Pacific TPOS Mission 2017: San Francisco – San Francisco

Time series of SST and SSS along one Saildrone track

SST

SSS
Tropical Pacific TPOS Mission 2017: San Francisco – San Francisco

**SST**

Time series of SST and SSS along one Saildrone track

**SSS**

**SST**
Tropical Pacific TPOS Mission #1, 2017: San Francisco – San Francisco

SST

Time series of SST and SSS along one Saildrone track

SSS

SST

Saildrone tracks around SPURS2 WHOI buoy
Saildrone Tracks over JPL MUR SST and HYCOM Surface Currents
Saildrone ADCP:
Equatorial Undercurrent (EUC) during the two crossings of Equator
TPOS Mission #2, 2018: Honolulu - Honolulu

7-day Saildrone tracks

Saildrone tracks over MUR SST and HYCOM currents
TPOS Mission #2, 2018: Honolulu - Honolulu

7-day Saildrone tracks
Conclusion

Saildrones have proven to be

1. Reliable, long-range, long-endurance, GREEN autonomous ocean observing platforms, especially ideal for observing fronts and adaptive sampling.

2. Capable of making measurements of 22 Essential Ocean and Atmospheric Variables, including air-sea heat, momentum, CO2 fluxes, and upper ocean currents, critical for understanding air-sea interaction processes.

Future Work *(transition to operation)*

1. Test and Improve strategies in navigating and target-sampling complex ocean and atmospheric environments and processes. *“Better use of forecast for observational campaigns”*

2. Evaluate the benefits of saildrone data (high frequency simultaneous ocean and atmospheric measurements, crossing fronts, adaptive) to Numerical Weather Prediction (NWP) models. *“Better diagnose model errors and improve forecasts”*
NWP forecasts benefit Saildrone operation

2019 Joint Mission for Observing Arctic Sea Ice Environment

PMEL, UW/JISAO, ESR, UW/APL, and Saildrone, Inc.

Chidong Zhang et al.

Through narrow Bering Strait Reaching the Melting Ice Edge

Unescorted, Remotely Controlled 1000s km Away

NWP GFS wind forecast

HYCOM ocean current forecast

Loop 2. 2 vehicles: 1-D line
• Evaluate benefits of saildrone observations to NWP reanalysis and forecast
• Design Targeted Observations

BIASEs of T2m and Q2m in ERA5

7-day Saildrone tracks during TPOS Mission #2

Saildrone Q2m vs. ERA5 Q2m

ERA5 along saildrone track
- Evaluate benefits of saildrone observations to NWP reanalysis and forecast
- Design Targeted Observations

BIASEs of T2m and Q2m in ERA5

7-day Saildrone tracks during TPOS Mission #2

ERA5 along saildrone track