Abrupt Sea Surface Temperature Fronts Observed by Saildrones During the First TPOS Mission

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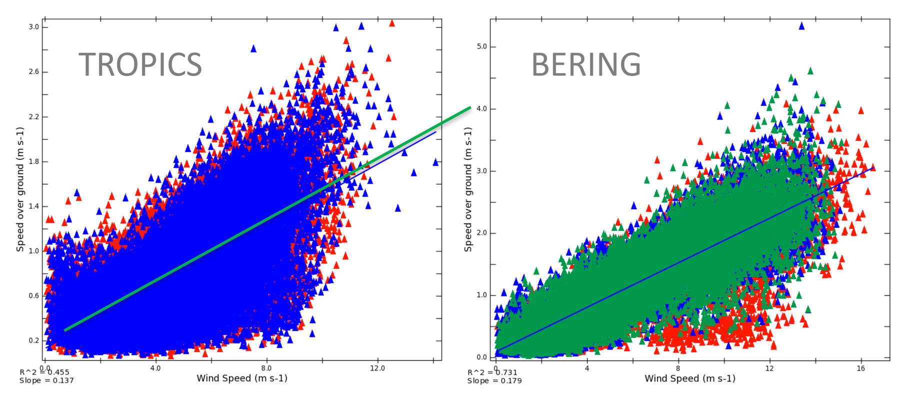
PLATFORM

Saildrone is an unmanned surface vehicle currently being tested by NOAA PMEL. With a speed over ground of up to 8kts, a range of more than 16,000 nautical miles, and endurance of up to 12 months, they potentially could contribute in important ways to the Tropical Pacific Observing System. In this study, we highlight some of the abrupt fronts observed by the Saildrones as they crossed the equatorial cold tongue front.



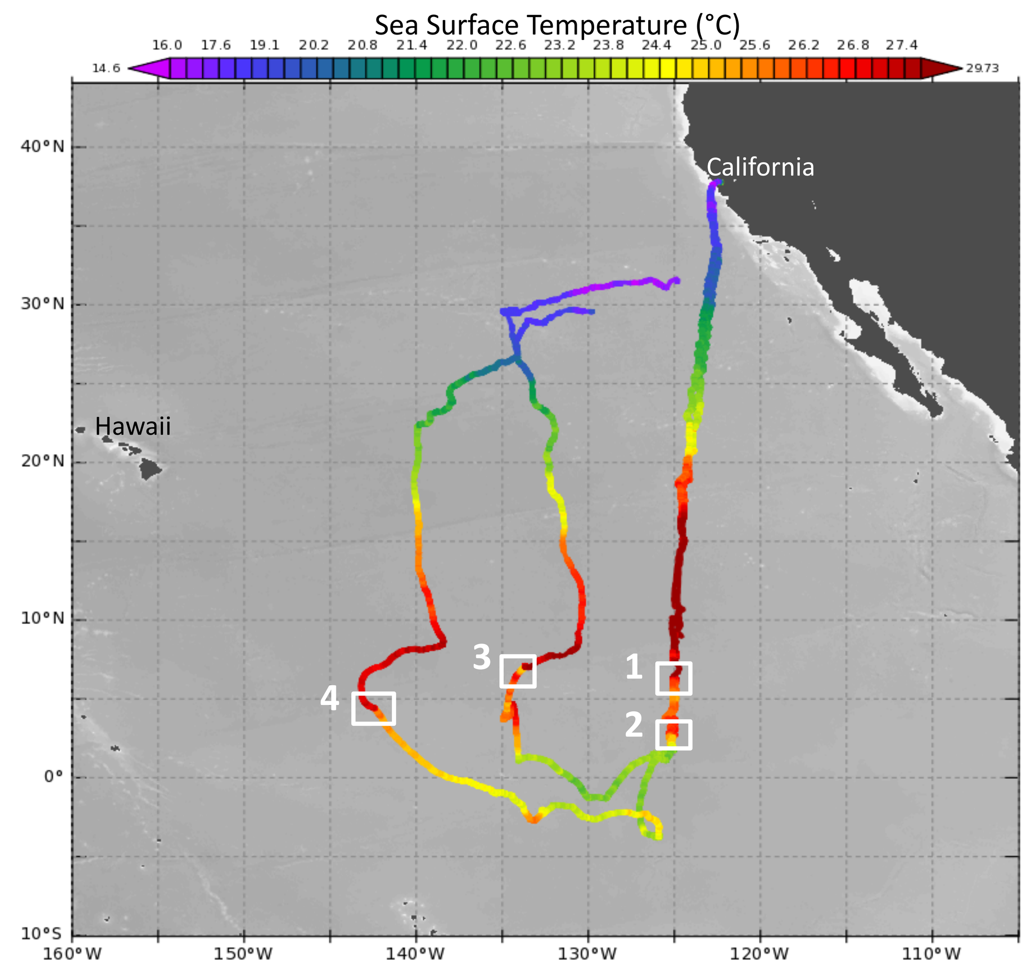
TOP: Third generation Saildrone vehicle. This wing design is too small for effective navigation in the tropics.

RIGHT: Saildrone Speed Over Ground vs. Wind Speed for tropics (left) and Bering Sea (right). Data points are colored by drone.

Vehicle speeds are much slower in the tropics than the Bering Sea due to lower wind speeds and strong currents. This causes problems with vehicle control, and will be addressed prior to the next mission.

MISSION

Two Saildrones departed San Francisco, CA on September 1, 2017 to begin a 6+ month mission to the tropics. They are now on their return journey. Tropical Instability Waves were very active. As a consequence, Saildrones crossed the northern edge of the equatorial cold tongue front several times both on the southward journey to the equator and their northward journey back home.



Fronts

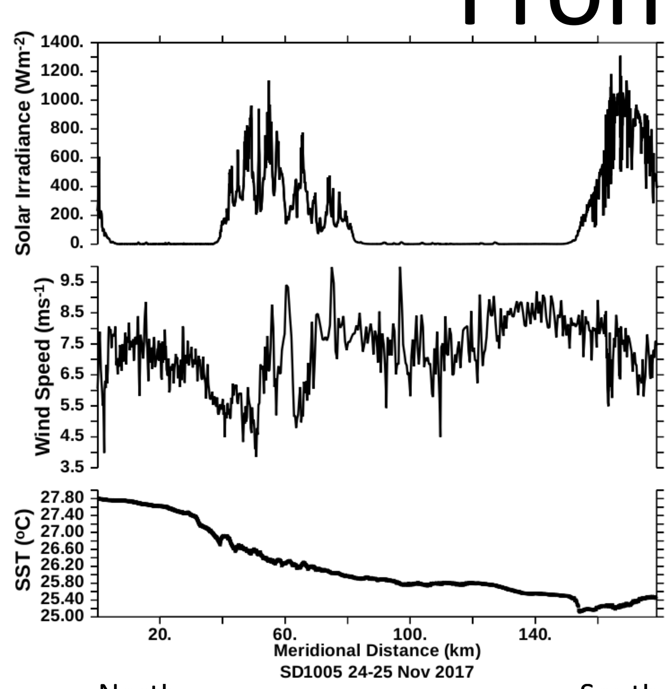
1) Nov 24, 2017, ~6°N
2) Dec 7, 2017, ~2°N
3) Jan 8, 2018, ~4°N
4) Feb 1, 2018, ~4°N

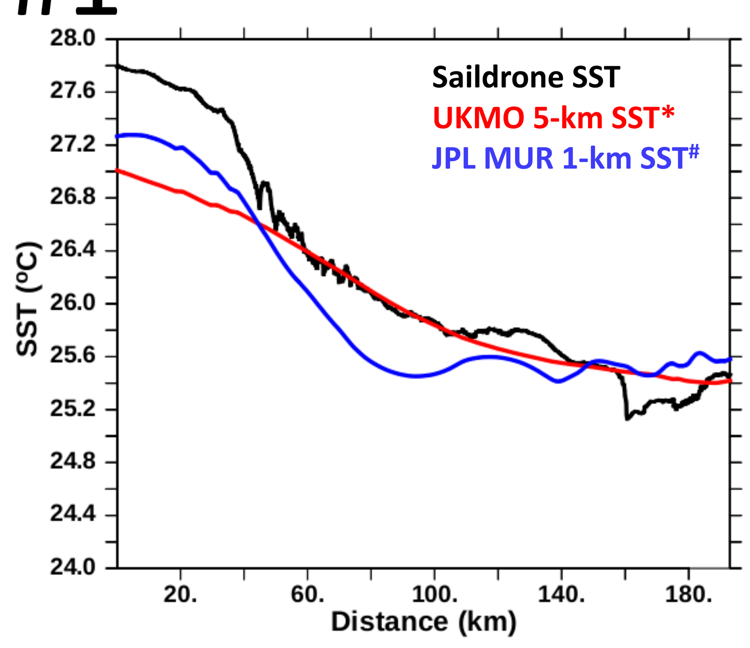
Science questions:

- How sharp are these fronts?
- Are they associated with daytime solar warming? Or oceanographic processes (e.g. meridional convergence)?
- How do gridded products capture these fronts?

RESULTS

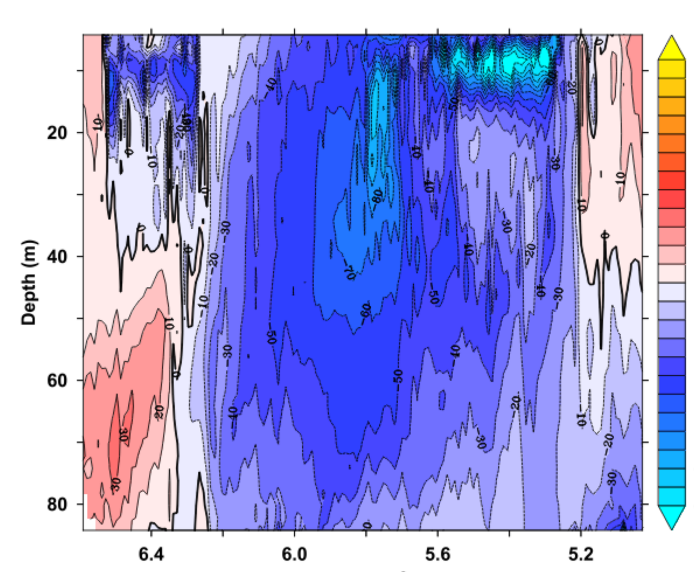
Front #1

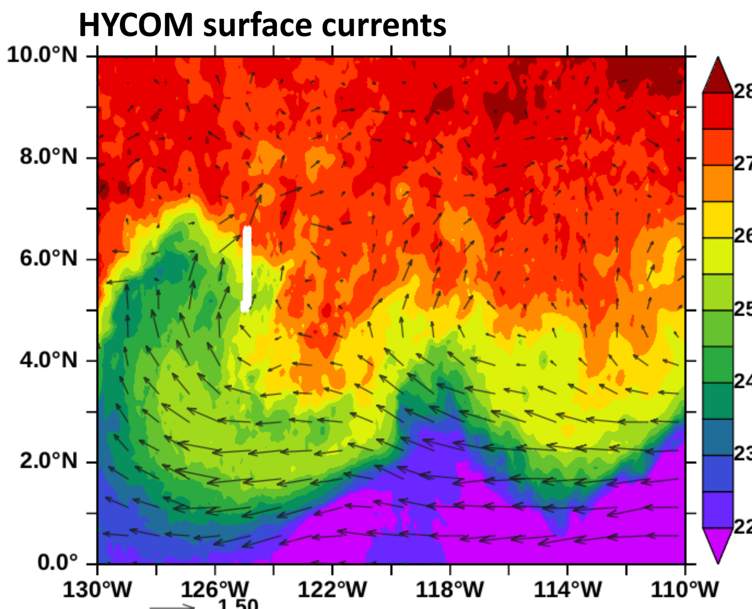




North South

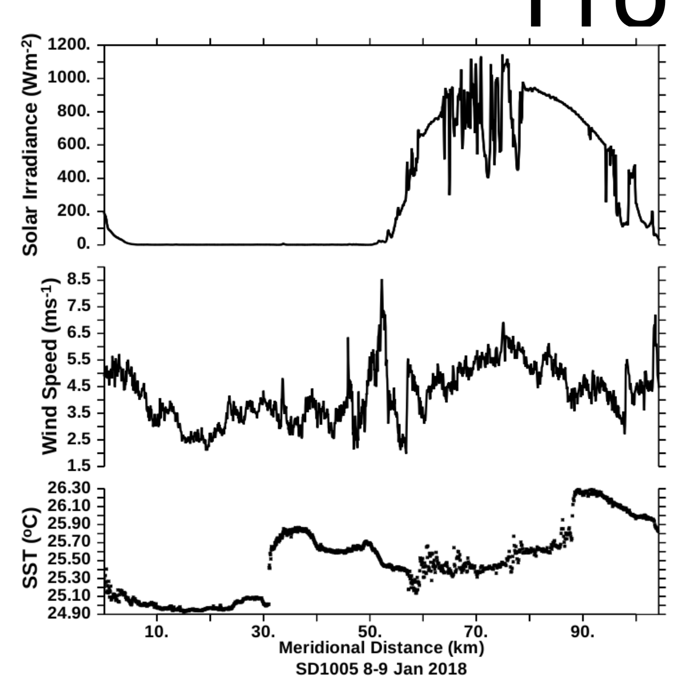
Saildrone track, MUR SST and HYCOM surface currents

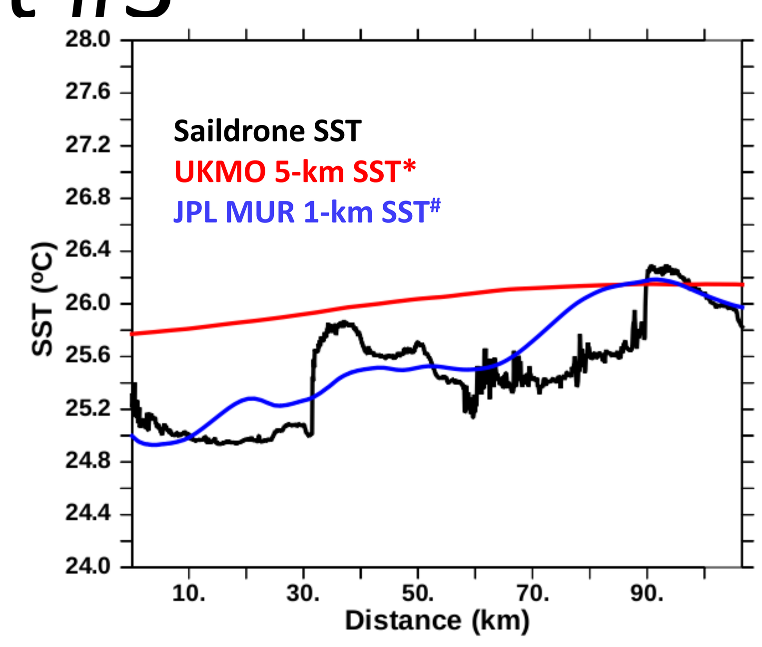




This front at 6°N had a 0.6°C drop in less than 15 km and an overall 1.5°C drop in 60 km. Winds were strong enough to mix solar warming. Large meridional convergence.

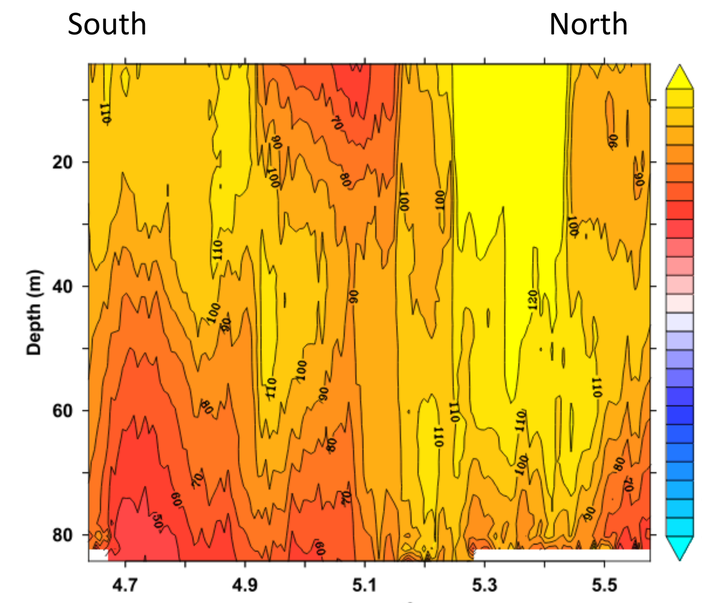
Front #3

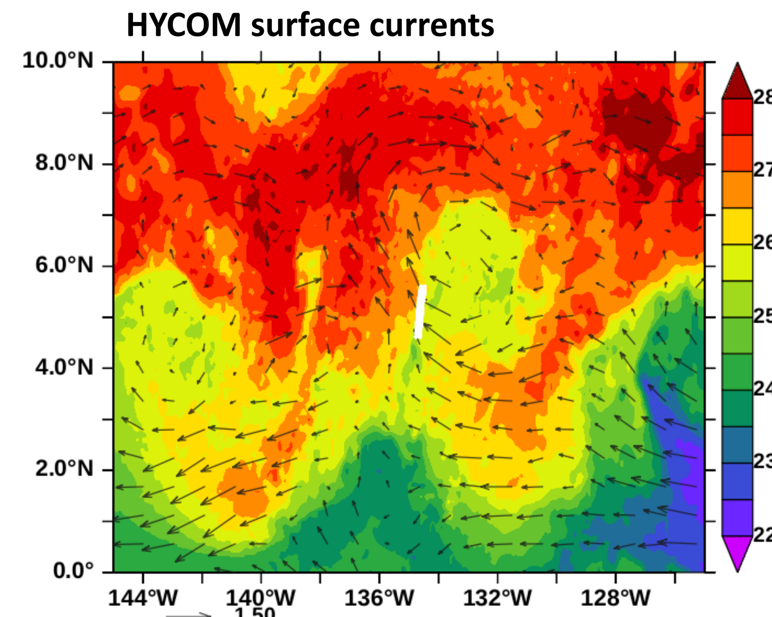




South North

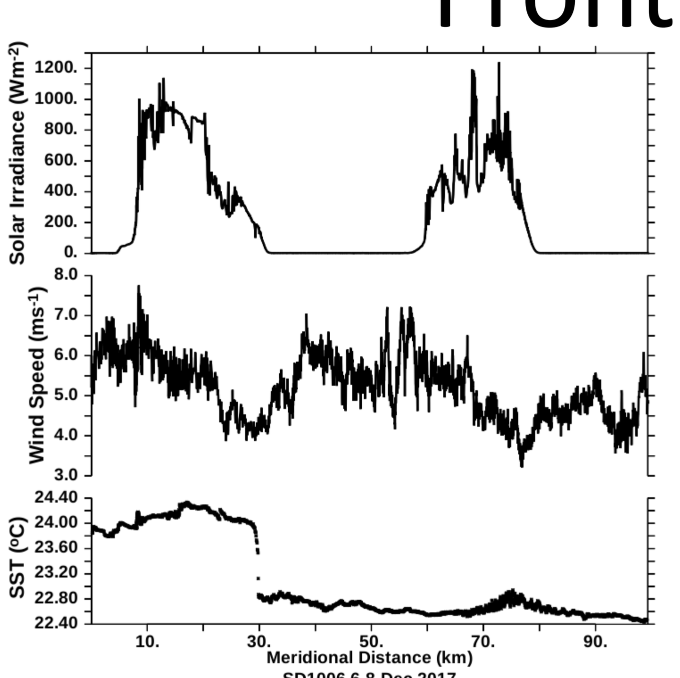
Saildrone track, MUR SST and HYCOM surface currents

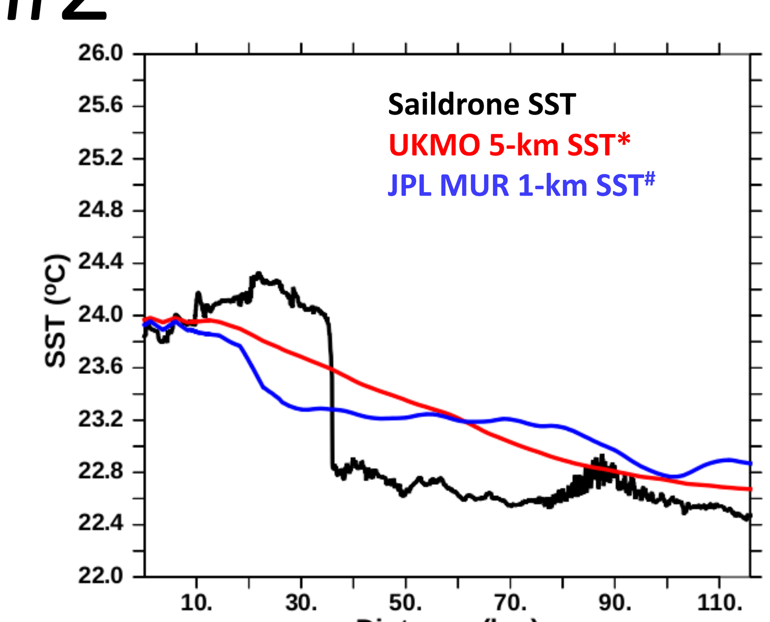




The sharp front at 4.9°N had an increase of 0.4°C in 10 m and a 0.7°C increase in less than 1 km. This was at dusk and so solar warming and nighttime mixing could not contribute to this warming.

Front #2

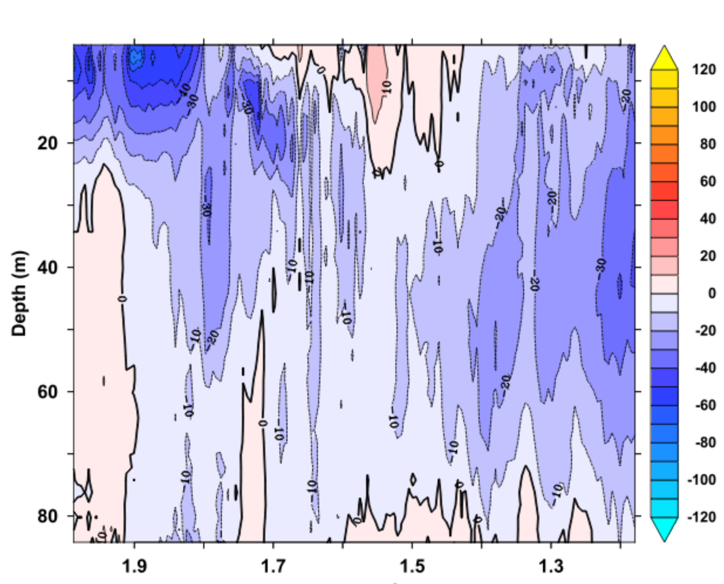


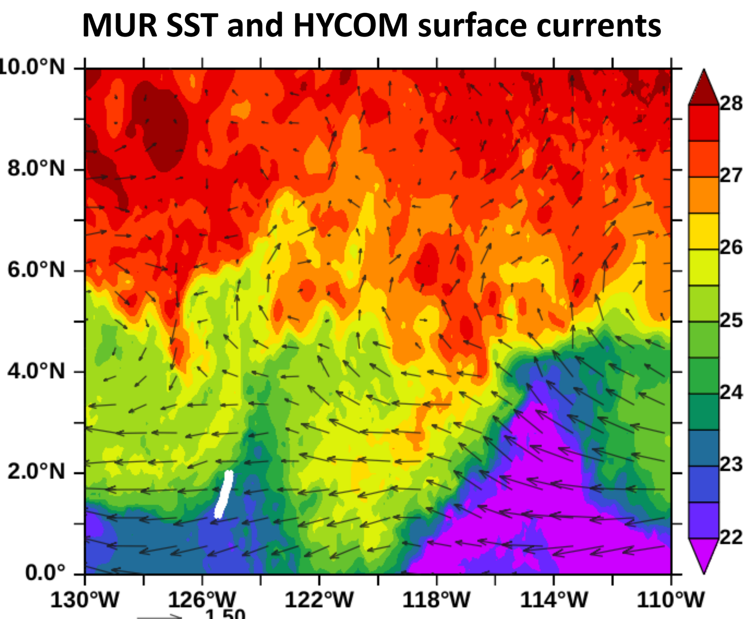


North South

Saildrone track

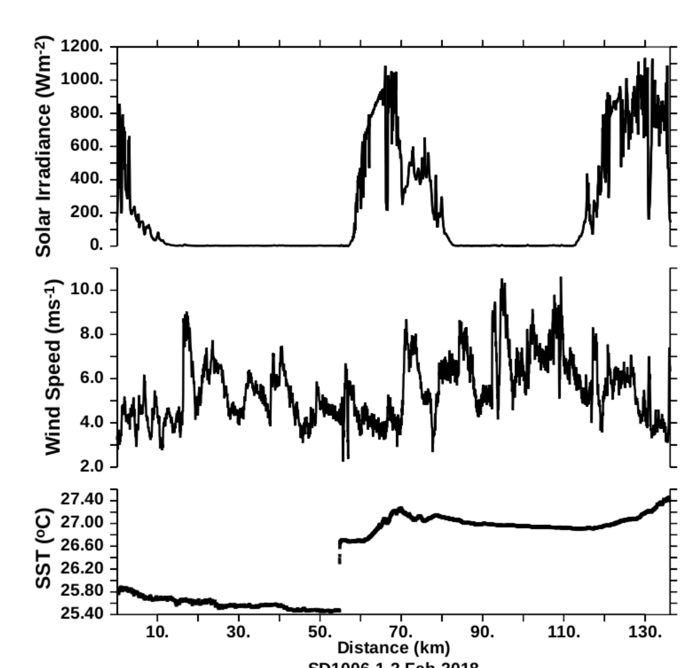
MUR SST and HYCOM surface currents

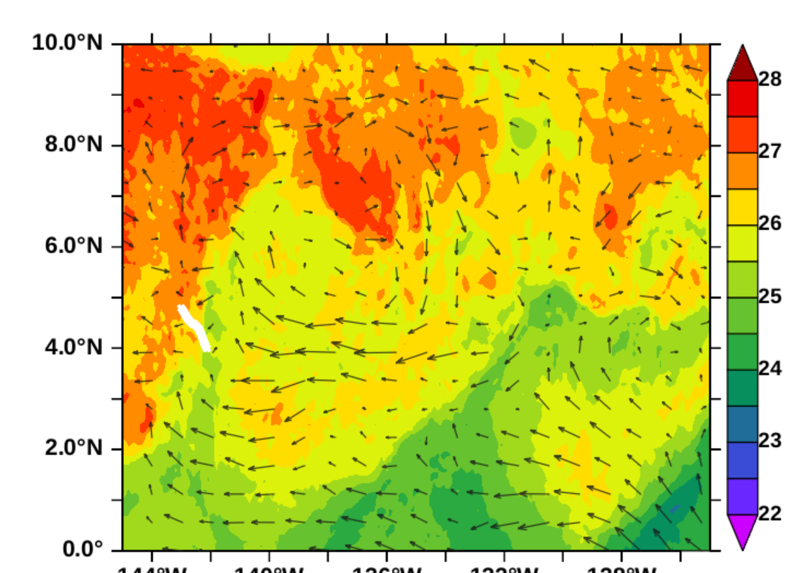




This front had a 0.9°C drop in less than 30 m and an overall 1.1°C drop in 1 km! This was at dusk, when winds were weak. Very large meridional convergence in the upper 15 m, but divergence below.

Front #4





South North

Saildrone track

MUR SST and HYCOM surface currents

This front had an increase of 0.8°C in 50 m and a 1.1°C increase in 125m. This was at dawn and it is unlikely that solar warming is contributing to this warming.

A Group for High Resolution Sea Surface Temperature (**GHRSST**) products:

*** UK Met Office (UKMO) 0.054° GHRSST,** specifically produced to be used as a lower boundary condition in Numerical Weather Prediction (NWP) models.

 # JPL Multiscale Ultrahigh Resolution (MUR) 0.01° GHRSST.

CONCLUSION

Saildrone are excellent vehicles for observing fronts. Extremely abrupt fronts were observed as the vehicles crossed the northern edge of the equatorial cold tongue. In some cases, these fronts were less than 1 km wide, providing challenges for satellite and numerical model gridded products. Care must be made though to distinguish fronts from diurnal warming and cooling along the vehicle trajectory. We confirm that several of these abrupt temperature changes were sharp fronts associated with oceanic processes, including surface meridional convergence.

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