National Aeronautics and Space Administration
Jet Propulsion Laboratory
California Institute of Technology

Using Saildrones to Validate Satellite-Derived Sea Surface Salinity and Sea Surface Temperature along the California/Baja Coasts

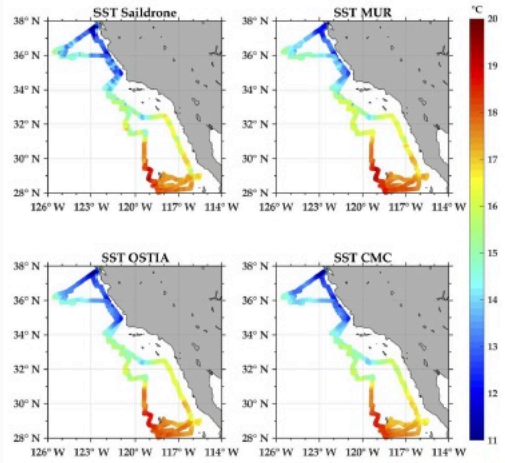

Figure 1. Sea surface temperature (SST) values from a Saildrone CTD, MUR, OSTIA, and the CMC.

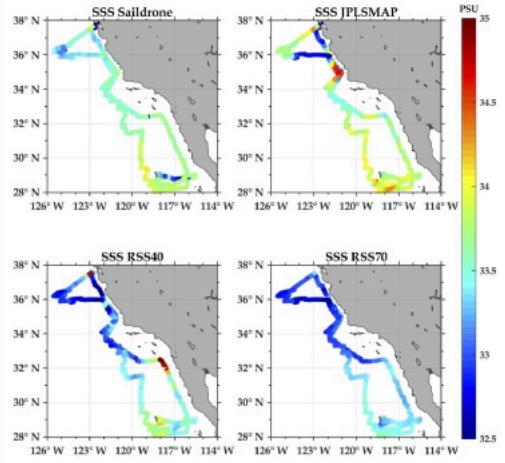

Figure 2. Sea surface salinity (SSS) from a Saildrone CTD, JPLSMAP, RSS40, and RSS70.

Figure: Shows the sea surface temperature (SST) and sea surface salinity (SSS) along the Saildrone deployment for the Saildrone CTD derived and the associated satellite derived products. For the three exemplary satellite derived SST products (MUR, CMC, OSTIA) the comparison with Saildrone shows the similarity in reproducing dominant ocean variability. For the satellite derived SSS products differences exist, especially as the deployment is close to land. Below is a table summarizing the statistics of the comparisons:

Table 1. Bias, RMSD, correlation, and signal-to-noise ratio for MUR, OSTIA, and CMC, with respect to the Saildrone-derived SST. REMSS, K10, and DMI products have been added for comparison.

Parameter	Bias (°C)	RMSD (°C)	Correlation	Signal-to-Noise Ratio
CMC	-0.03	0.43	0.97	4.3
OSTIA	0.04	0.39	0.98	5.0
MUR	0.32	0.42	0.97	4.4
REMSS	0.11	0.43	0.97	4.3
K10	0.16	0.49	0.96	3.7
DMI	0.04	0.5	0.96	3.4

Table 2. Bias, RMSD, correlation, and signal-to-noise ratio for JPLSMAP, RSS40, RSS70, with respect to the Saildrone-derived SSS.

Parameter	Bias (PSU)	RMSD (PSU)	Correlation	Signal-to-Noise Ratio
JPLSMAP	0.13	0.37	0.39	1.0
RSS40	-0.17	0.46	0.39	1.1
RSS70	-0.39	0.22	0.57	1.1

Technology Question: **Validation of remote sensing data sets in coastal waters. Overall this is a difficult problem, as global arrays such as ARGO do not provide data in coastal regions. Yet, these areas are critical as coastal upwelling is essential for maintaining the world's fisheries. The Saildrone deployment along the California/Baja Coasts provides a unique opportunity for validating satellite derived parameters, and thus improve on the monitoring of upwelling in these critical regions of the world's oceans.**

Data & Results:

- Saildrone is an unmanned surface vehicle that has the capability for measuring multiple atmospheric and oceanographic parameters. For this study direct comparisons were done with six satellite derived SST products and two satellite derived SSS products. Overall, SST had correlations above 0.96, while \SSS showed significantly lower correlations, due likely to the limitation of passive microwave sensors close to land the the lower spatial resolution,

Significance: Why are SST and SSS important parameters for monitoring from satellite derived platforms. SST is an essential climate variabiewith direct implications for ocean biology and productivity. The most productive regions of the world's oceans and coastal upwelling regions. SSS is critical to ocean biology, as well as the Earth's water cycle. Validation of SST and SSS is vital for monitoring changes from Earth observation platforms. Results, presented here, are promising for the application of remote sensing to monitor changes in coastal upwelling and associated changes in their productivity.

Reference: Vazquez-Cuervo, J , J. Gomez-Valdes , M. Bouali, L. E. Miranda, E., T. Van der Stoken, WQ Tang, and C. Gentemann, (2019), Using Saildrones to Validate Satellite-Derived Sea Surface Salinity and Sea Surface Temperature along the California/Baja Coast, Remote Sensing, 11 (17), DOI: 10.3390/rs11171964

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Data Sources:
VOCALS: http://podaac.jpl.nasa.gov/

Technical Description of Figure:
The figure shows the comparisons between the sea surface temperature and sea surface salinity from the onboard CTD sensor on the Saildrone vehicle and three exemplary satellite derived products. 1) Sea surface temperature from the NASA Multi-Scale Ultra-High Resolution Sea Surface Temperature (MUR) product, the Operational Sea
Surface Temperature and Sea Ice Analysis (OSTIA) from the UK Met Office, and the optimally interpolated sea surface temperature product from the Canadian Meteorgological Center (CMC). Salinity products included the 40km Remote Sensing Systems, the 70km smoothed Retmoe Sensing Systems and the Jet Propulsion Laboratory Combined Active Passive (CAP) product.

Scientific significance, societal relevance, and relationships to future missions:
Coastal upwelling regions are home to the world's oceans most productive fisheries. These fisheries are sustained by wind driven cold water from depth coming to the surface. The cold water contains nutrients which are essential for productivity. Changes in ocean temperatures, as well as the atmospheric winds, would dramatically impact the vertical motion that is essential for sustaining these critically important regions of the world's oceans. A new surface vehicle, known as Saildrone, provides a unique capability to validate satellite derived products. Saildrone will provide measurements of ocean dynamics not resolved by satellites. Such measurements will provide strong justification for improvements in algorithms in coastal regions, as well as valuable information for future missions that improve on resolution and mutli-parameter capability.