National Aeronautics and Space Administration
**Jet Propulsion Laboratory**
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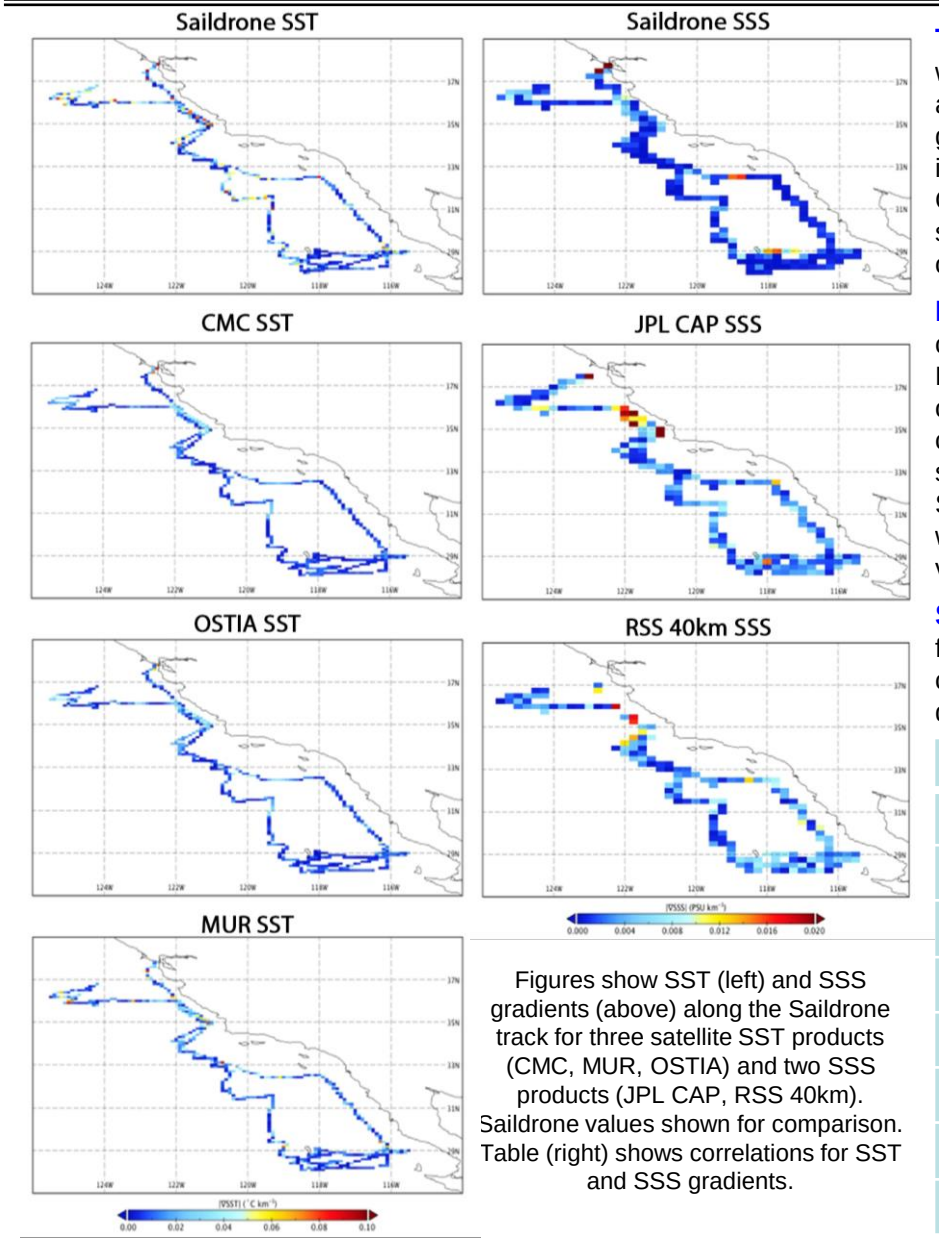
# Comparisons of Satellite-Derived Sea Surface Temperature (SST) and Sea Surface Salinity (SSS) Gradients using the Saildrone California / Baja and North Atlantic Gulf Stream Deployments




Figures show SST (left) and SSS gradients (above) along the Saildrone track for three satellite SST products (CMC, MUR, OSTIA) and two SSS products (JPL CAP, RSS 40km). Saildrone values shown for comparison. Table (right) shows correlations for SST and SSS gradients.

**Technology Question:** Validation of remote sensing data sets in coastal waters, specifically as they relate to gradients and frontal features. Traditional arrays such as Argo and moored buoys do not provide the capability to validate gradients. Identification of gradients and fronts are critical for fisheries and issues of biodiversity. The Saildrone deployments along the California/Baja Coasts, as well as the Gulf Stream, provide a unique opportunity for validating satellite derived SST and SSS gradients in two critical areas of the world's oceans, coastal upwelling zones, and western boundary currents.

**Data & Results:** Saildrone is an unmanned surface vehicle that has the capability for measuring multiple atmospheric and oceanographic parameters. Because it has one minute continuous sampling, it provides a unique opportunity for the validation of SST and SSS gradients. For this study, direct comparisons were done with six satellite-derived SST products and two satellite-derived SSS products from SMAP. Overall, correlations (see table) for SST gradients ranged from 0.25 for DMI to 0.39 for MUR. SSS correlations were considerably < 0.15. Results indicated that high correlations for absolute values of SST and SSS with Saildrone do not translate to gradients.

**Significance:** Results indicate that Saildrone provides a unique opportunity for validation of gradients. This is critical as the the validation of gradients is critical for applications of remote sensing to submesoscale and mesoscale dynamics as well as air-sea coupling.

| Data Set | Parameter | Bias | RMSD | Correlation |
|---|---|---|---|---|
| CMC | SST | -0.074 | 0.417 | 0.975 |
| | \|∇SST\| | -0.009 | 0.022 | 0.315 |
| K10 | SST | 0.137 | 0.475 | 0.969 |
| | \|∇SST\| | -0.007 | 0.022 | 0.293 |
| REMSS | SST | 0.075 | 0.401 | 0.977 |
| | \|∇SST\| | -0.007 | 0.023 | 0.243 |
| OSTIA | SST | 0.022 | 0.365 | 0.980 |
| | \|∇SST\| | -0.008 | 0.022 | 0.306 |
| DMI | SST | 0.040 | 0.489 | 0.966 |
| | \|∇SST\| | -0.008 | 0.023 | 0.255 |
| MUR | SST | 0.285 | 0.500 | 0.975 |
| | \|∇SST\| | -0.003 | 0.021 | 0.395 |
| JPL CAP | SSS | 0.141 | 0.414 | 0.429 |
| | \|∇SSS\| | 0.002 | 0.005 | 0.128 |
| RSS 40 km | SSS | -0.170 | 0.336 | 0.464 |
| | \|∇SSS\| | 0.002 | 0.004 | 0.072 |

**Reference:** Vazquez-Cuervo, J.; Gomez-Valdes, J.; Bouali, M. Comparison of Satellite-Derived Sea Surface Temperature and Sea Surface Salinity Gradients Using the Saildrone California / Baja and North Atlantic Gulf Stream Deployments. *Remote Sens.* 2020, *12*, 1839, https://doi.org/10.3390/rs12111839

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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 gradients and sea surface salinity gradients 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 Meteorological Center (CMC). Salinity products included the 40km Remote Sensing Systems, the 60km smoothed Remote 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. The low correlations of the gradients, compared to the actual correlations of the the parameter themselves, provide the evidence for the need for high resolution remote sensing data in the world's coastal regions, inclusive of hyperspectral data.