Using the Saildrone Unmanned Surface Vehicle for Validation of Satellite Derived Sea Surface Salinity from SMAP: The California/Baja Coast Deployment

Salinity Science Team
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Methodology

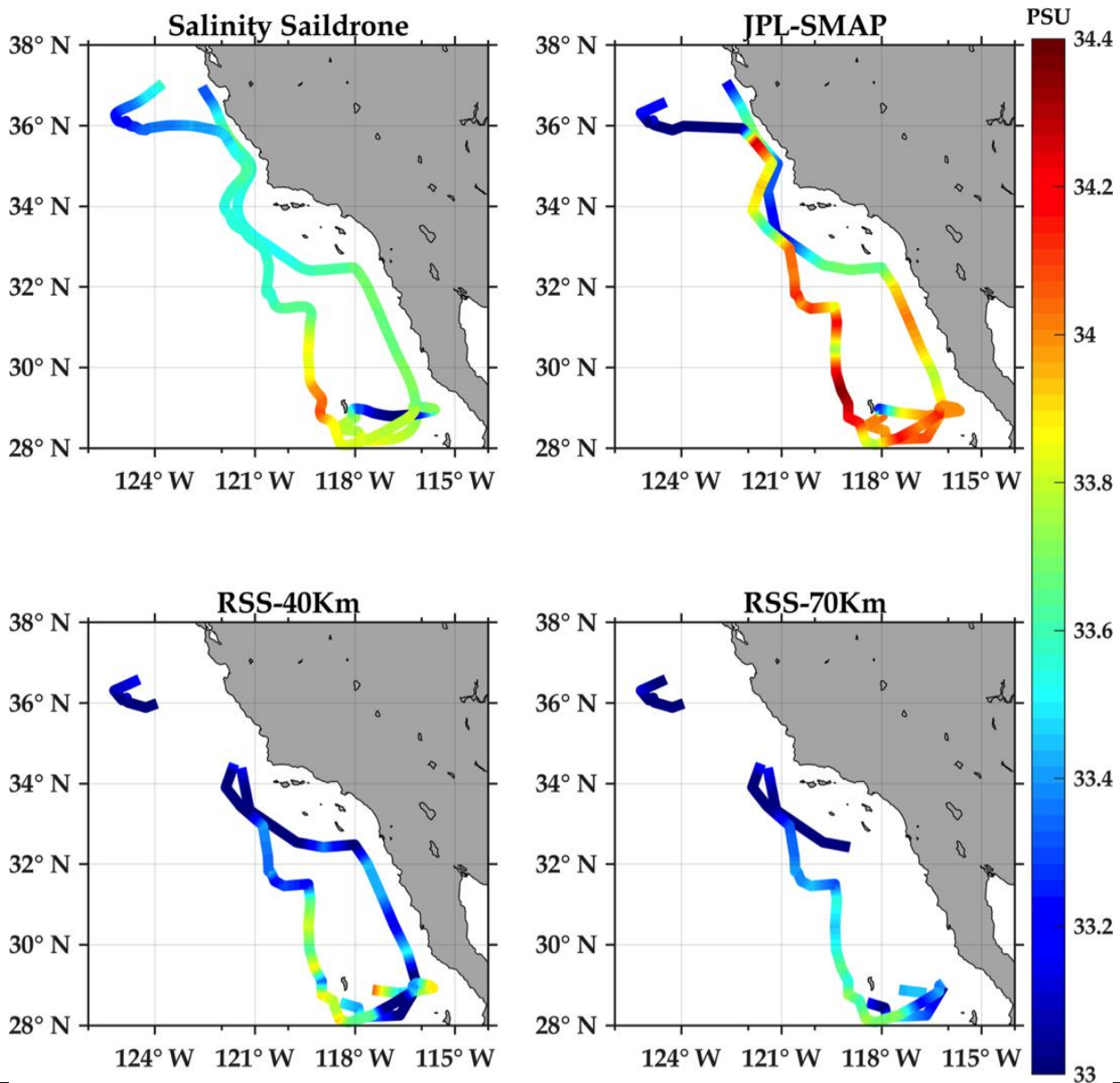
1. Comparisons done directly between Saildrone derived Salinity and three satellite derived products:
    1. Remote Sensing 70km Version 3.0
    2. Remote Sensing 40km Version 3.0
    3. JPL SMAP version 4.2
    4. SST products for purpose of comparison

2. Products used were Level 3 8-day running means.
3. Co-location used was a simple nearest neighbor approach.
4. Biases, Root Mean Square Differences (RMSD), Correlations, and Signal to Noise Ratios were calculated
5. Spectra were calculated to compare spectral slopes with known slopes indicating mesoscale-submesoscale variability
6. Future studies will start to examine gradients and differences based on the products.

Saildrone

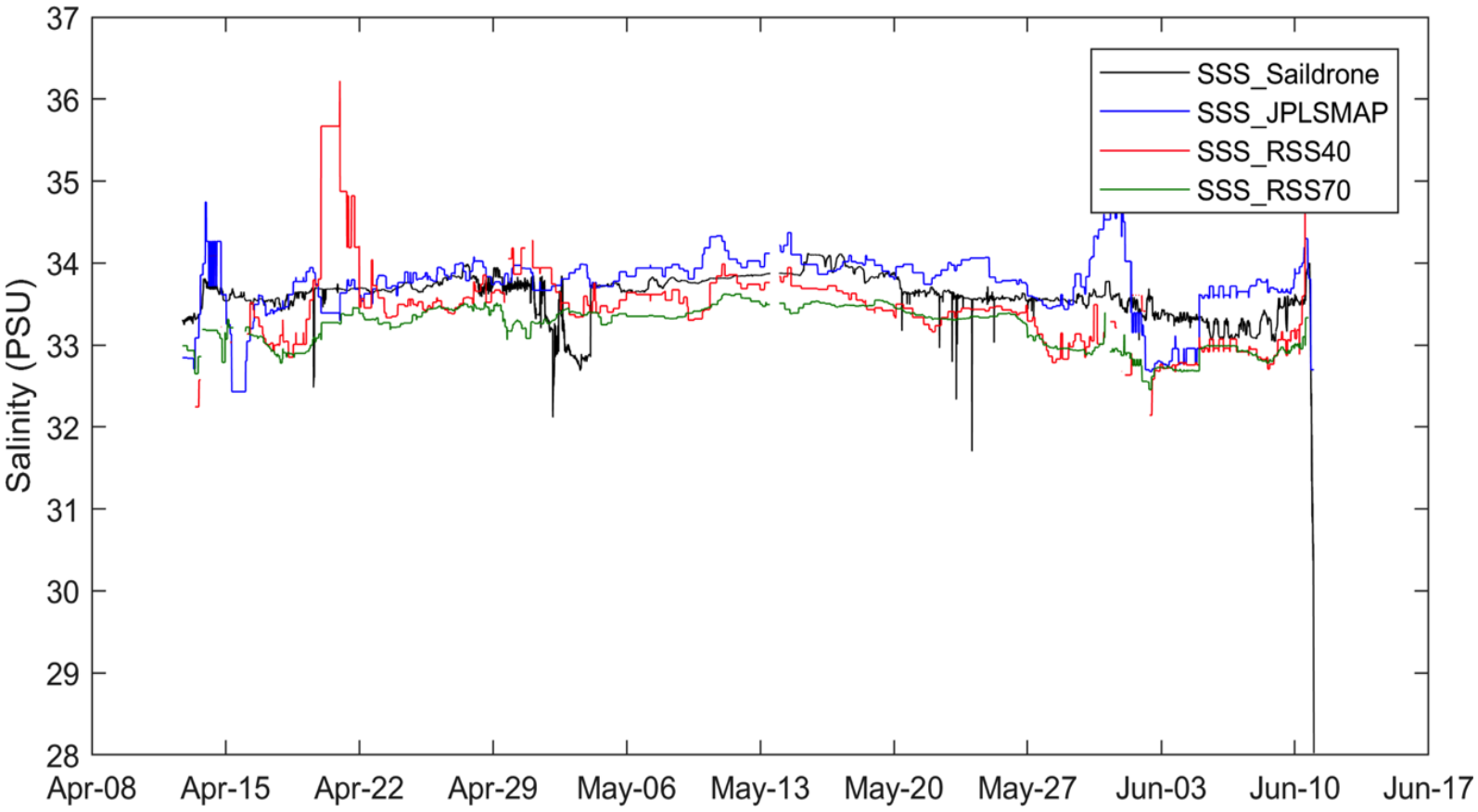
Saildrone is a wind and solar powered unmanned surface vehicle (USV) capable of long distance deployments lasting up to 12 months and providing high quality, near real-time, multivariate surface ocean and atmospheric observations while transiting at typical speeds of 3-5 knots. Data used in this work focused on the California/Baja deployment in April-June of 2018 at one minute sampling with approximately 0.1 spatial sampling. Although Saildrone measures several parameters, including air pressure, wind speed, oxygen, chlorophyll-a, humidity, air temperature, the focus of this work was to validate the salinity and temperature measurements. The salinity and temperature measurements were both derived from the on-board conductivity, temperature, depth (CTD) instrument.

Salinity Products Along the Saildrone Track



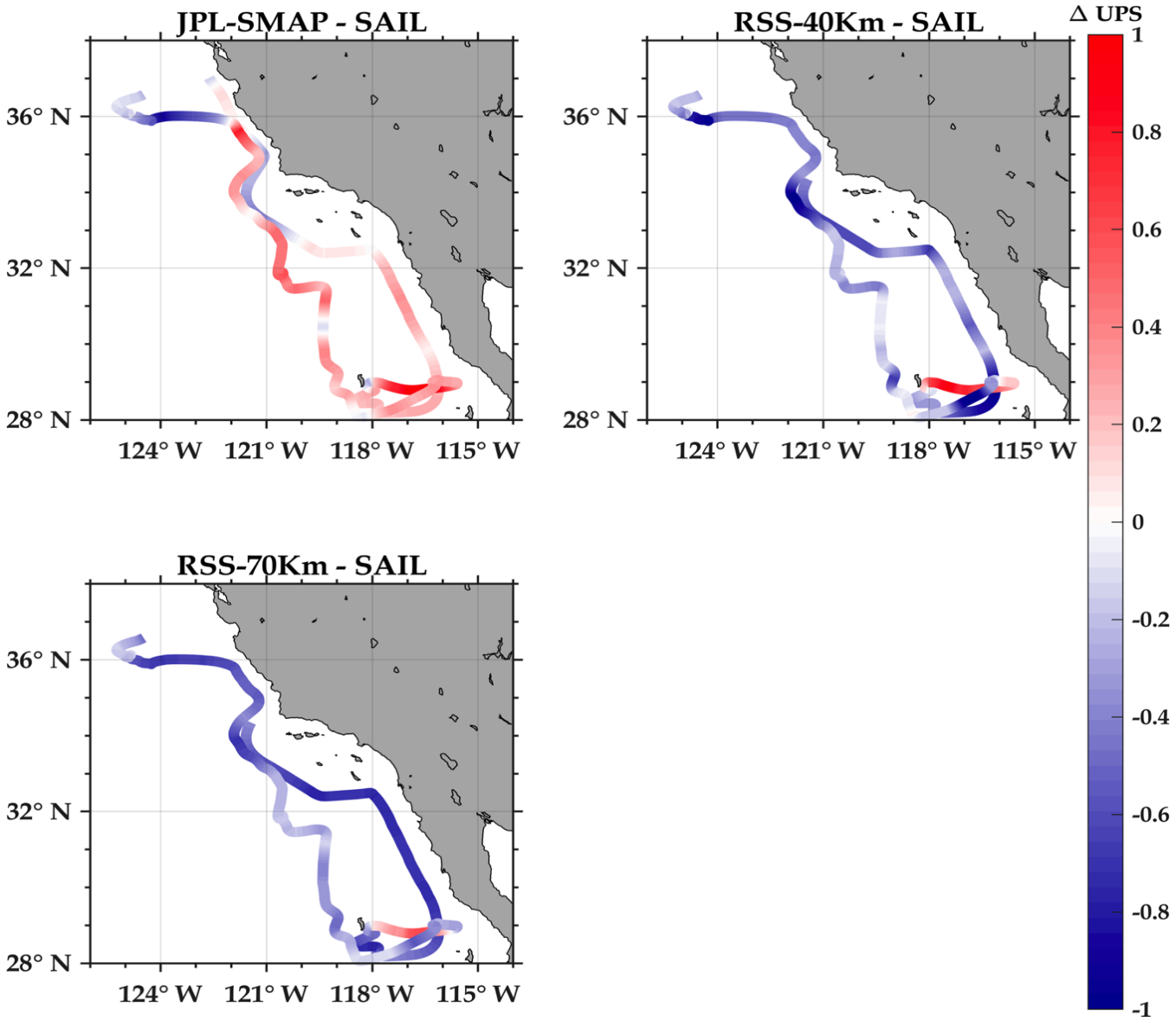
SSS along the Salldrone track for the 4 products. Clear differences observed among the 4 products

Time Series Along the Saildrone Track



Time Series of the four products along the Saildrone track. Visible are biases between the products

Differences Along the Saildrone Track

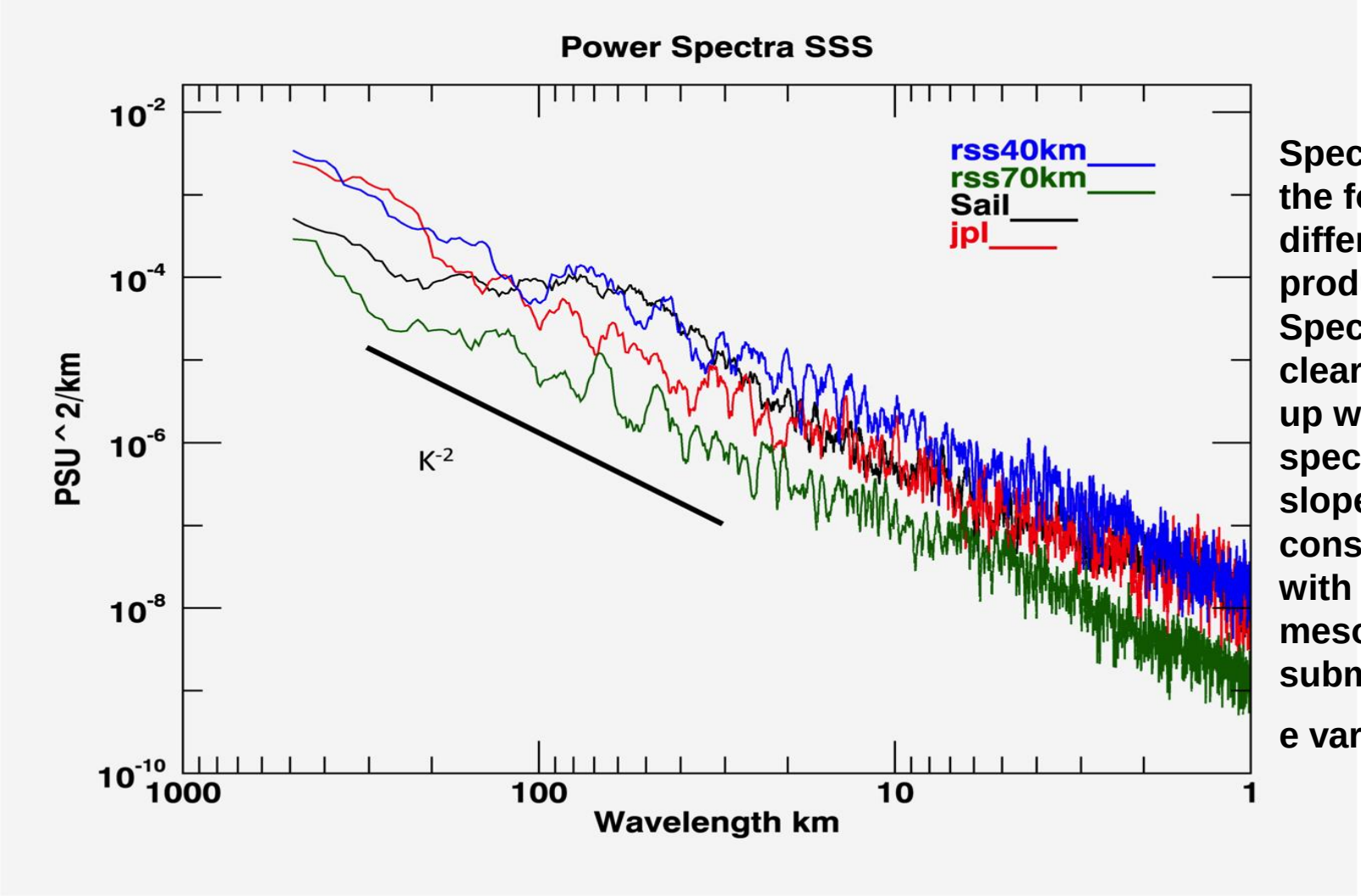


Differences between JPLSMAP-Saildrone, RSS40km-Saildrone and RSS70km-Saildrone.Salty biases exist for the JPLSMAP, while fresh biases exist for RSS70kkm

Statistics using Saildrone SSS (SST shown for comparison)

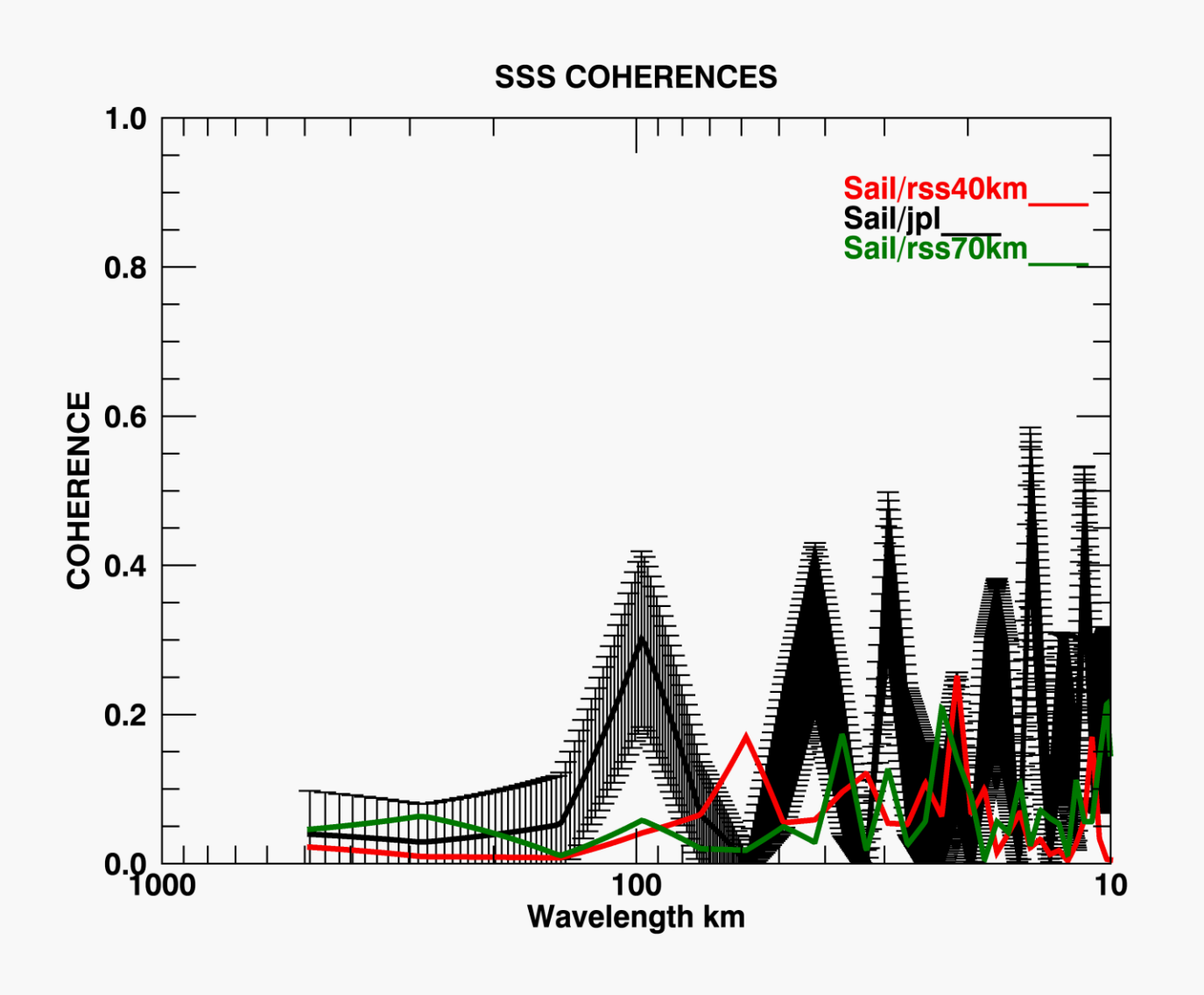
Parameter	Bias (PSU)	RMSD (PSU)	Correlation	Signal to Noise
JPL SMAP	0.15	0.37	0.57	1.3
RSS40km	-0.17	0.45	0.49	1.1
RSS70km	-0.37	0.23	0.57	1.1

Parameter	Bias (°C)	RMSD (°C)	Correlation	Signal to Noise Ratio
CMC	-0.03	0.44	0.97	4.5
OSTIA	0.04	0.39	0.98	6.2
MUR	0.32	0.46	0.97	5.1
REMSS	0.11	0.43	0.97	4.4
K10	0.16	0.49	0.96	4.0
DMI	0.04	0.5	0.96	4.2



Spectra for the four different SSS products. Spectra clearly line up with a spectral slope of -2, consistent with mesoscale-submesoscale variability.

Coherence



Coherences of JPLSMAP, RSS40km, RSS70km with Saildrone. Significant peak at 100 km consistent with upwelling scales.

Spectral Slopes

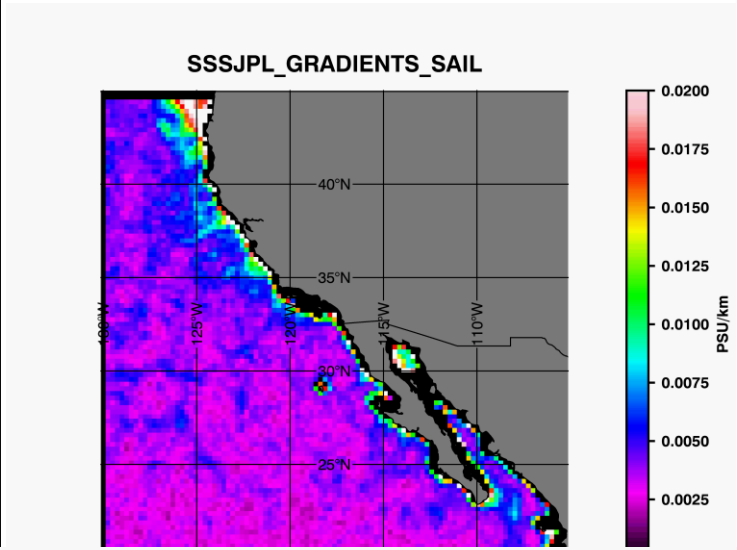
Parameter	(k^{-1})
Sail SST	-2.22
MUR SST	-2.11
OSTIA SST	-2.12
CMC SST	-2.12
REMSS SST	-1.92
DMI SST	-2.02
K10 SST	-2.03
Sail SSS	-1.81
JPLSMAP SSS	-1.69
RSS40km SSS	-1.96
RSS70km SSS	-1.91

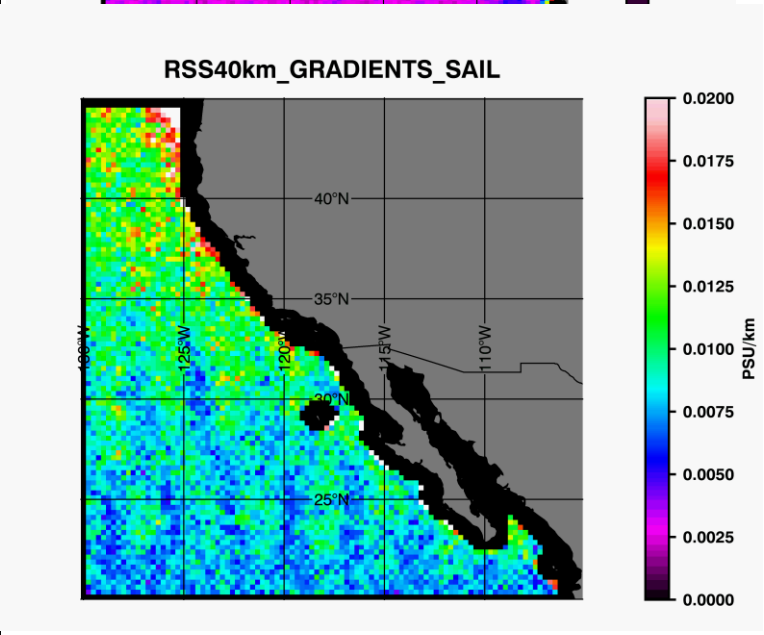
Conclusions

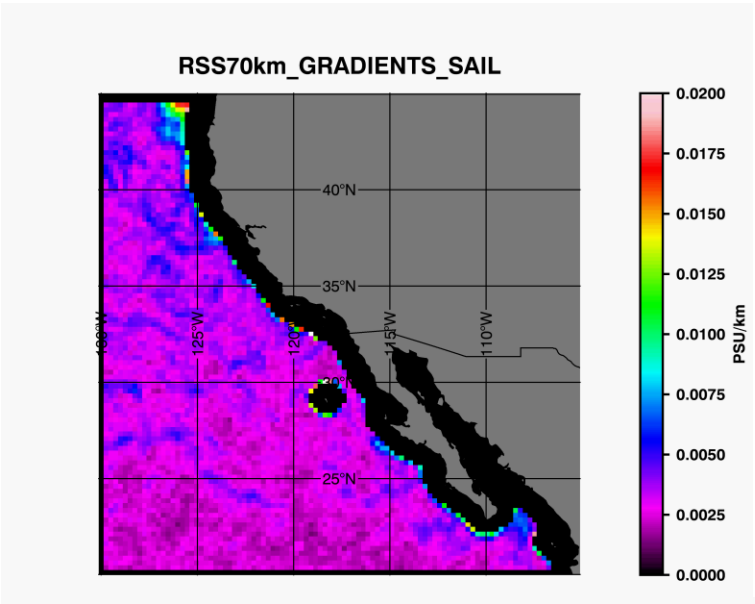
- Observed Biases between the Saildrone Sea Surface Salinity (SSS) and the three satellite products are consistent with previous results. The JPLSMAP product showed overall positive biases while the RSS40km and RSS70km products showed negative biases.

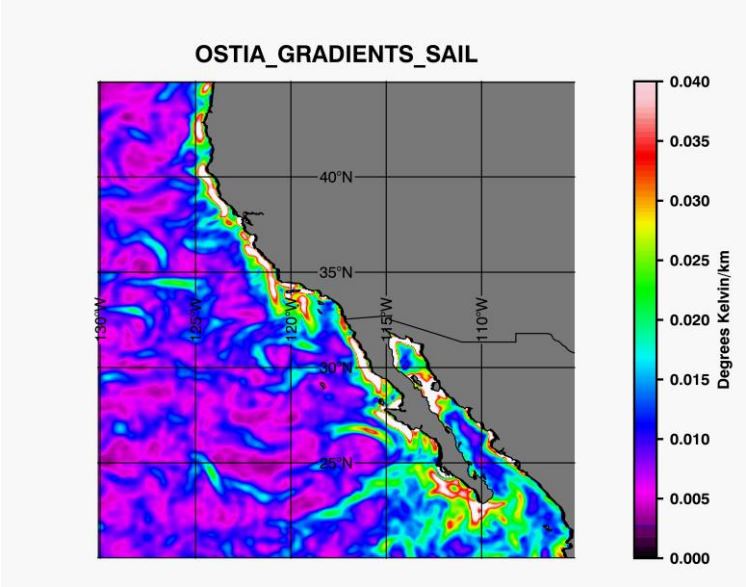
- Compared with SST, correlations for the SSS products were significantly reduced. Two possible explanations are the lower inherent resolution of the SSS data, and issues with land contamination. For example the daily variability of the Saildrone SST is 0.4°K. Overall the RMSD of the different products with respect to Saildrone SST was 0.4°K or less. Thus the differences between the SST products could be explained by the inherent daily variability not resolved by the satellite derived SST. For SSS, the daily variability was 0.1 PSU, significantly lower than the RMSD differences of 0.3 PSU. Overall, other factors, besides the inherent daily variability resolved by the Saildrone USV, must be contributing to the SSS differences.
- Coherences show a peak at 100kilometers, consistent with known upwelling scales off the California Coast
- Spectral Slopes are consistent with known scales of mesoscale to submesoscale variability

Future Work (Examination of Gradients, SMAP and OSTIA SST)

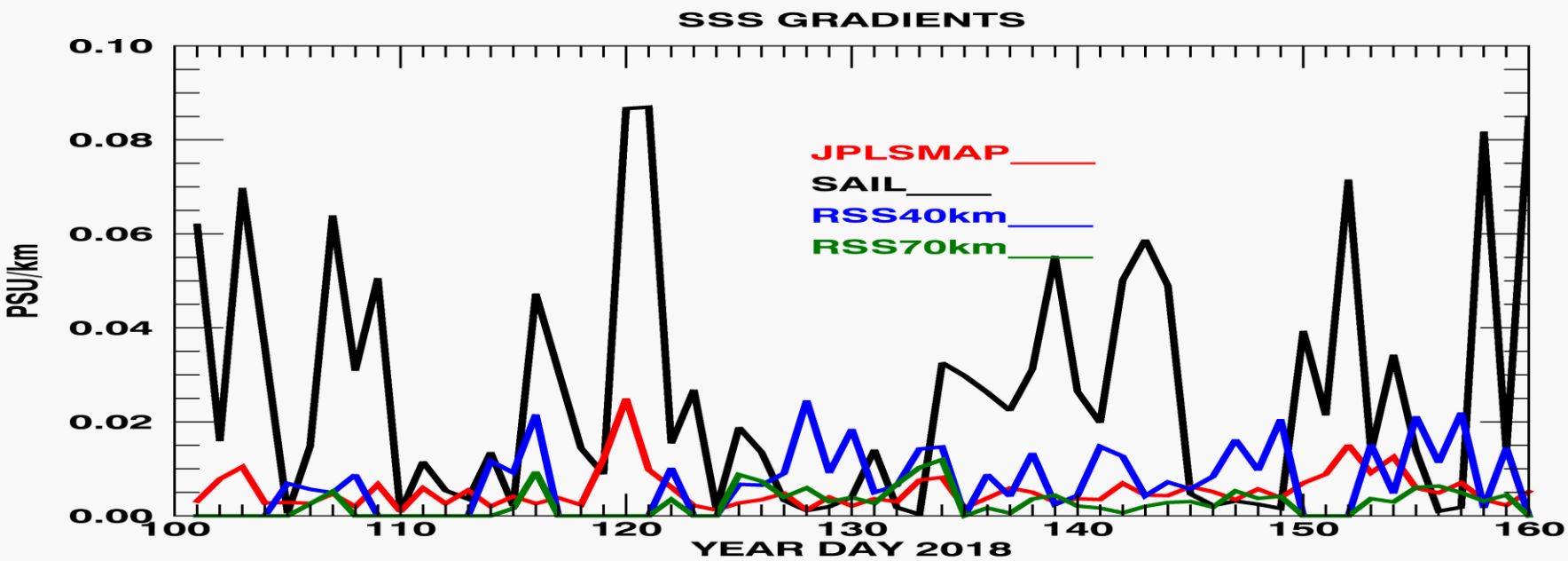


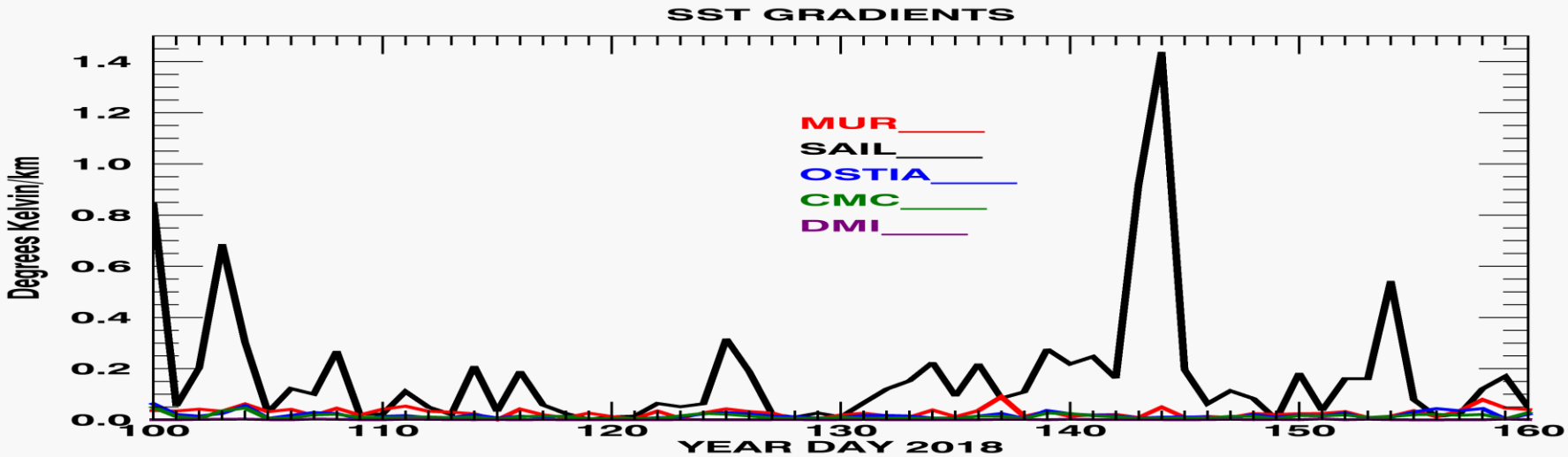






Time Series SSS Gradients





Gradient Statistics

Parameter	Statistic (PSU)
JPL bias	-0.0227180
RSS40 bias	-0.00966065
RSS70 bias	-0.0164596
JPL RMSD	0.0372098
RSS40 RMSD	0.0255087
RSS70 RMSD	0.0272101
correlation jpl/sail	0.74
rss40/sail	0.35

Thank you! Questions?