Validation of SST and SSS Gradients Using the Saildrone Baja and Gulf Stream Deployments

1. Baja
2. Gulf Stream

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GHRSST XXI Meeting

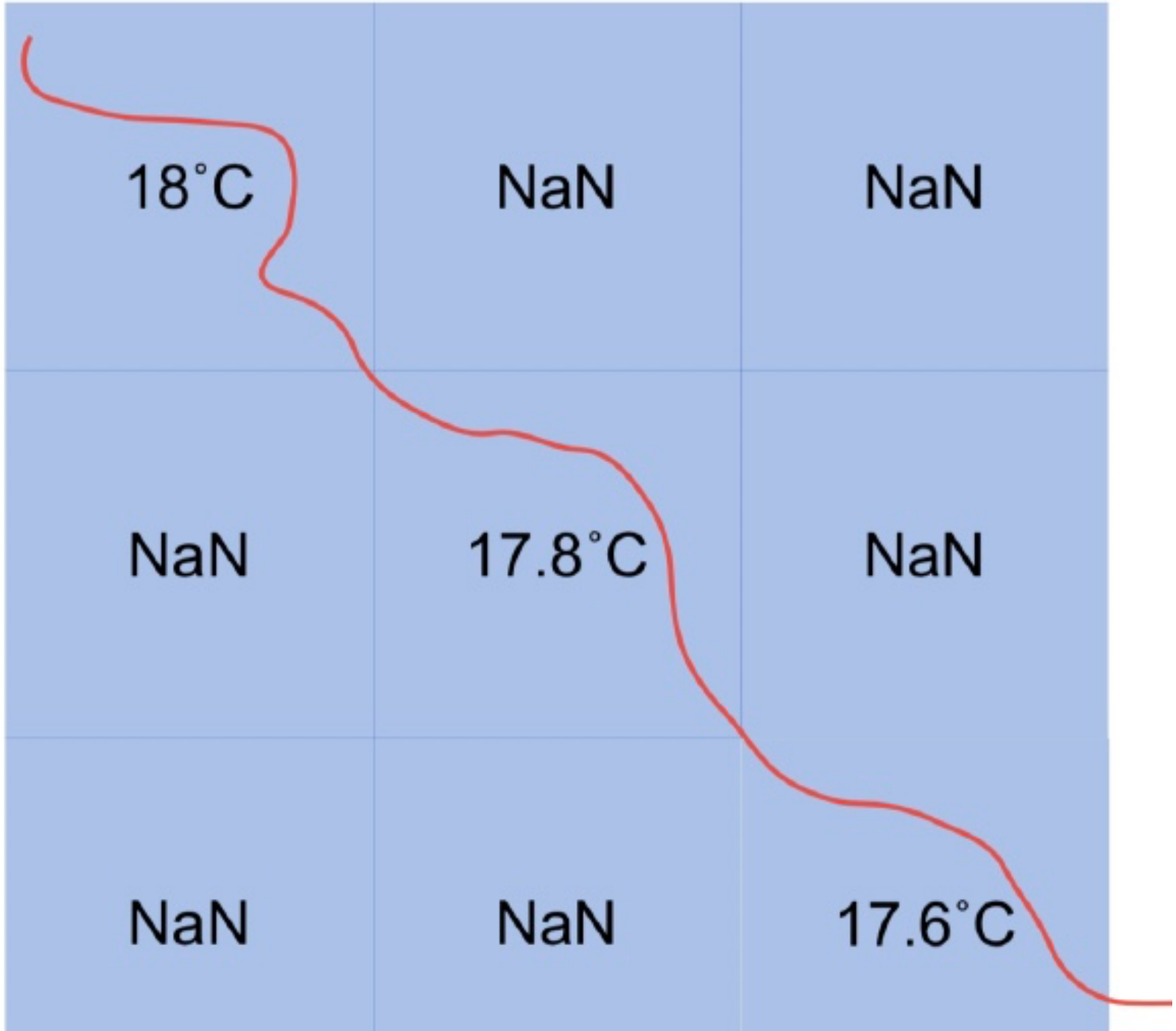
Outline

- **New co-location strategy developed for the derivation and comparison of SST and SSS gradients.**
- **Derivation of comparison statistics for two Saildrone Deployments**
  - **California/Baja 2018**
  - **Gulf Stream 2019**
- **Comparisons with SST gradients derived from GHRSST Level 4 data sets.**
- **Comparisons done with RSS SMAP Version 4.0 and JPL CAP Version 4.2**

- De

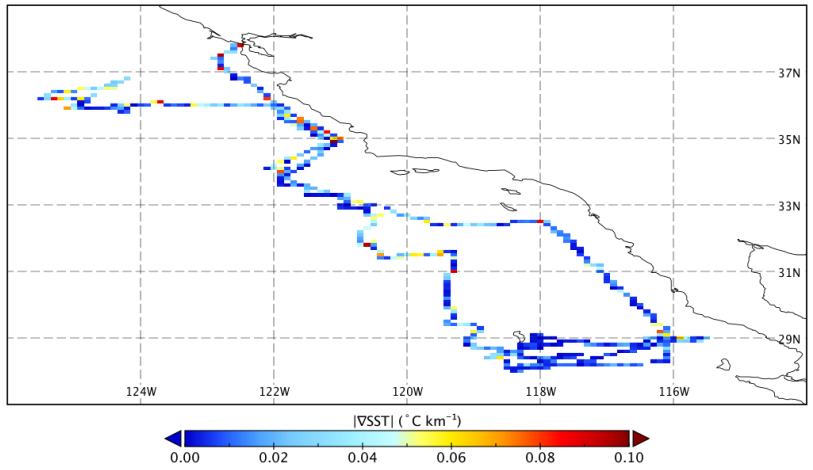
Co-location Methodology

- **For every grid point of a Level 4 SST/SSS product, all Saildrone measurements inside that grid point are averaged**
- **The "average acquisition time" of Saildrone measurements is computed for each grid point and then**
- **Sorted to generate a collocated time series of Level 4 SST/SSS/Saildrone**
- **Gradients are then derived as differences between successive points of the time series and accounting for the distance in space between points**

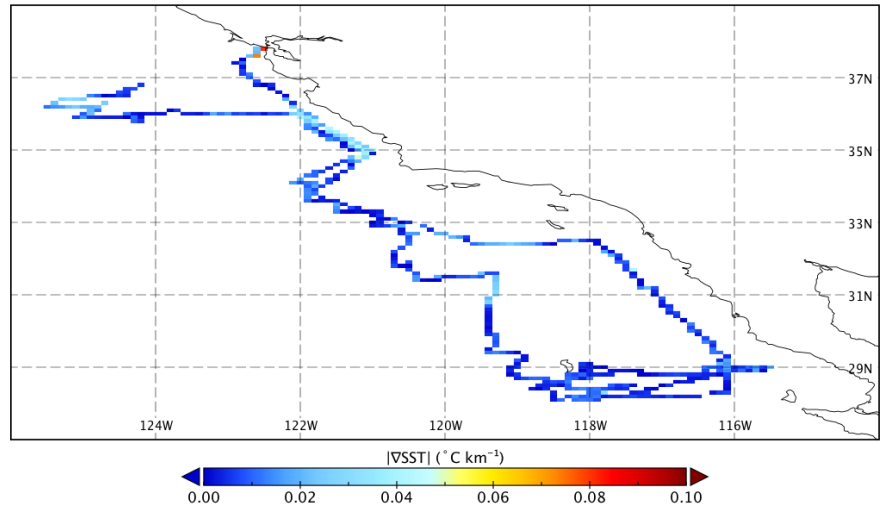

18˚C
NaN
NaN
NaN
17.8˚C
NaN
NaN
NaN
17.6˚C

SST/SSS Gradients
Baja Deployment

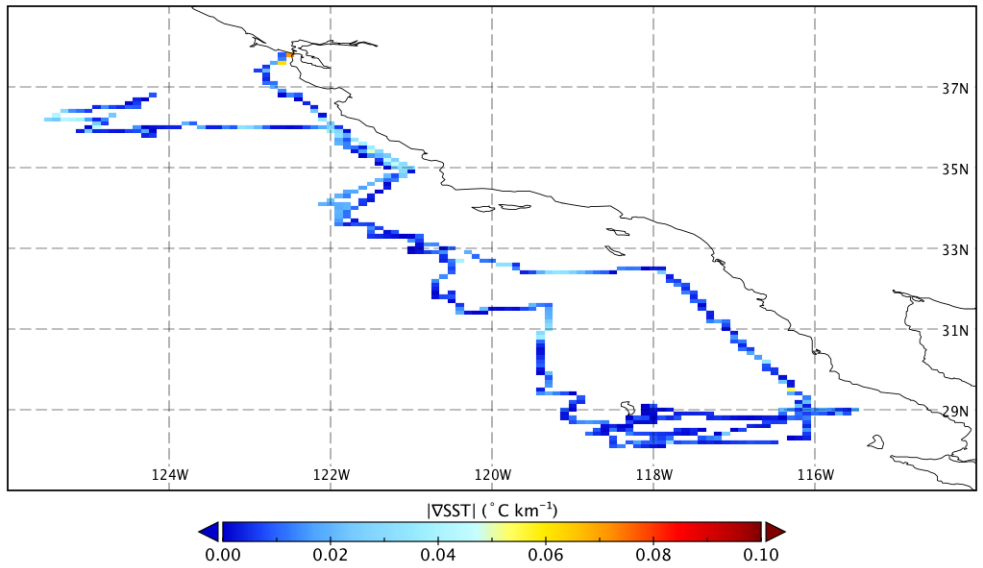
Saildrone SST



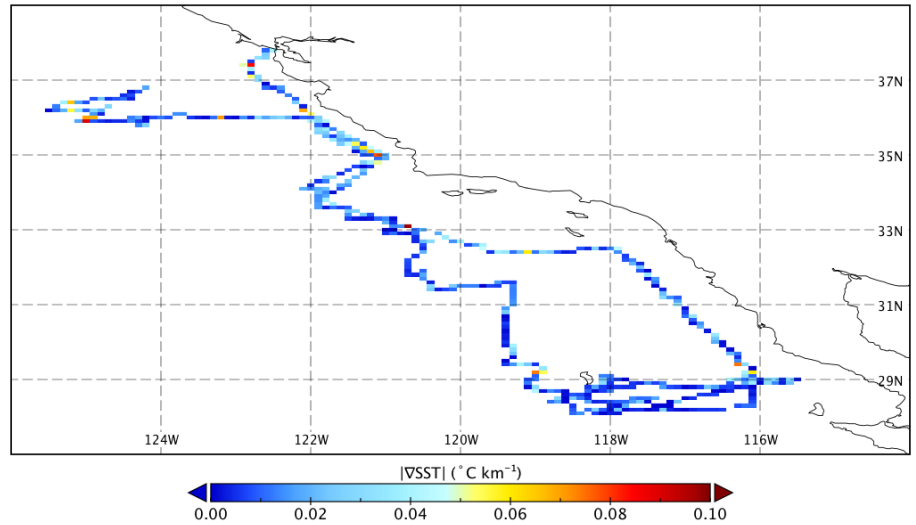
CMC SST



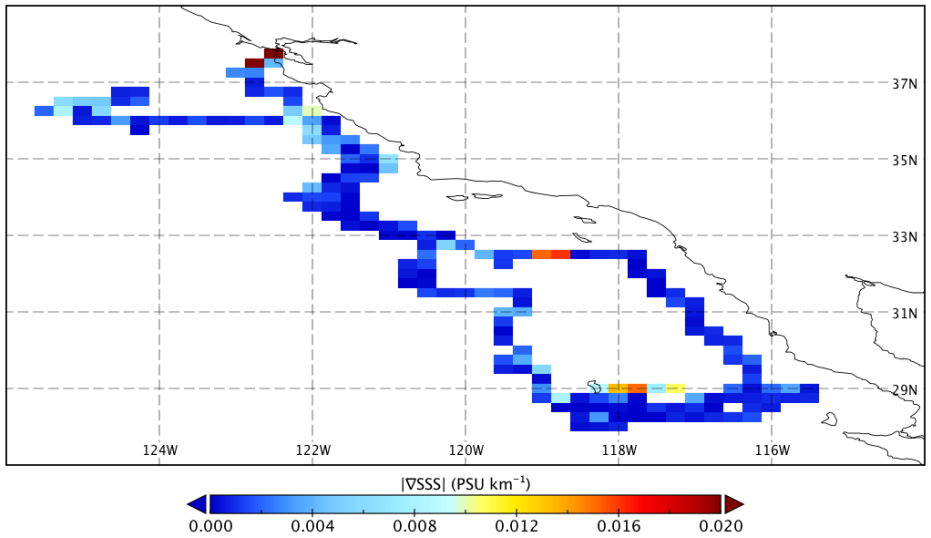
OSTIA SST



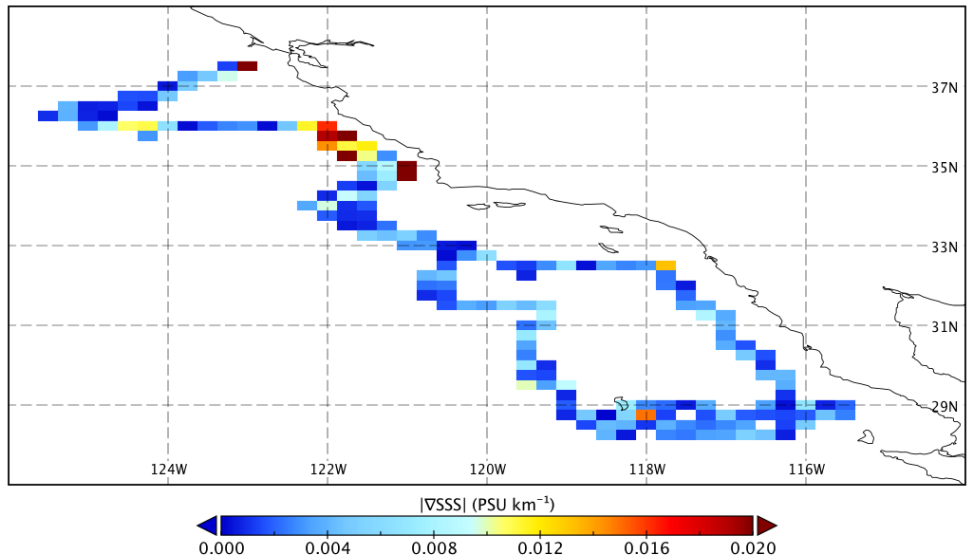
MUR SST



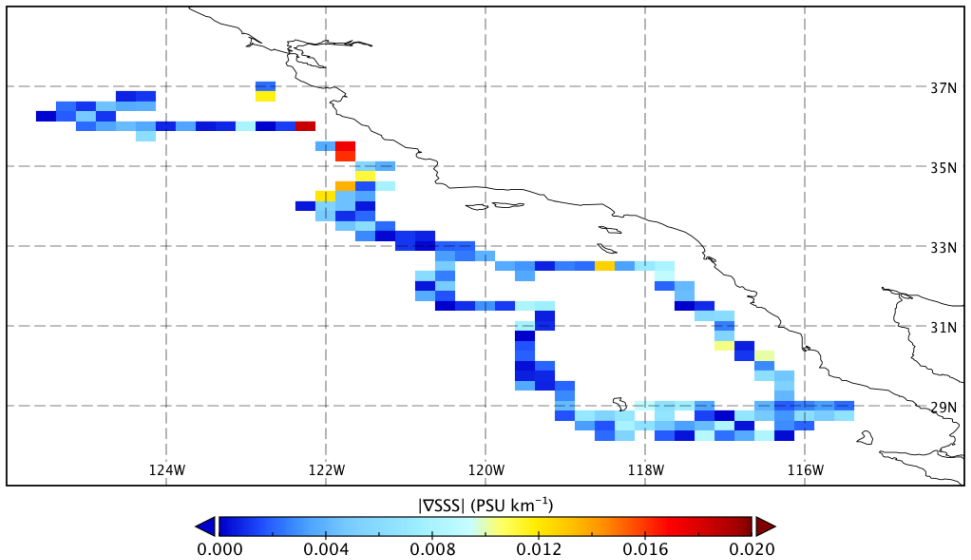
Saildrone SSS



JPLSMAP SSS

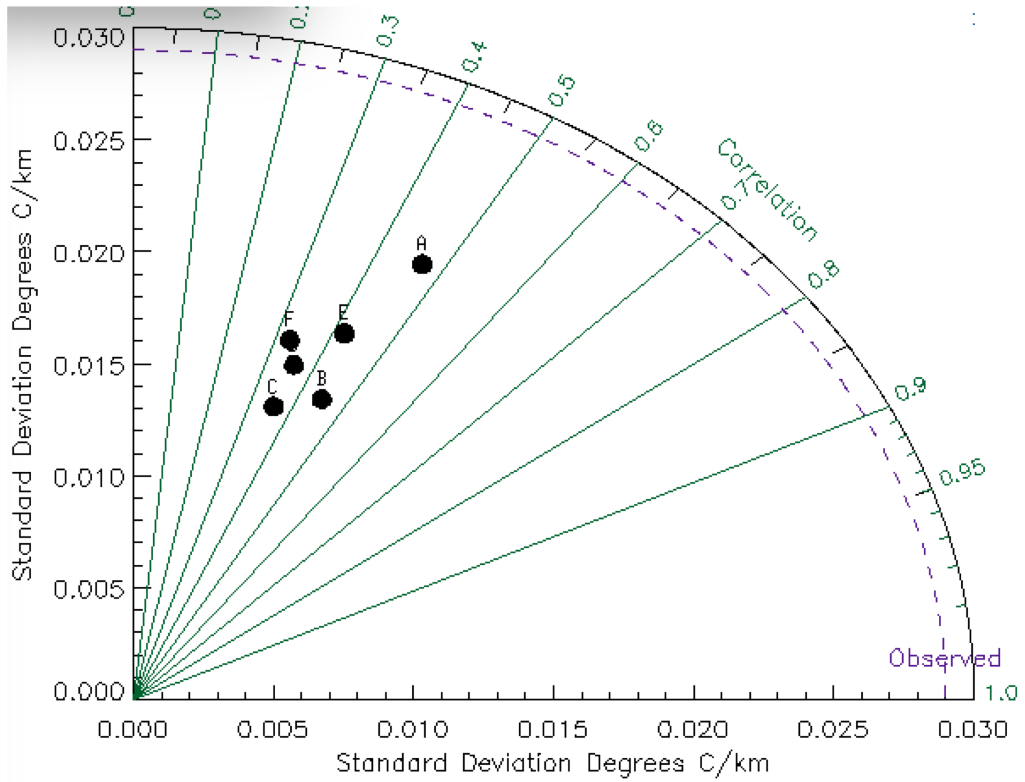


RSS40km SSS



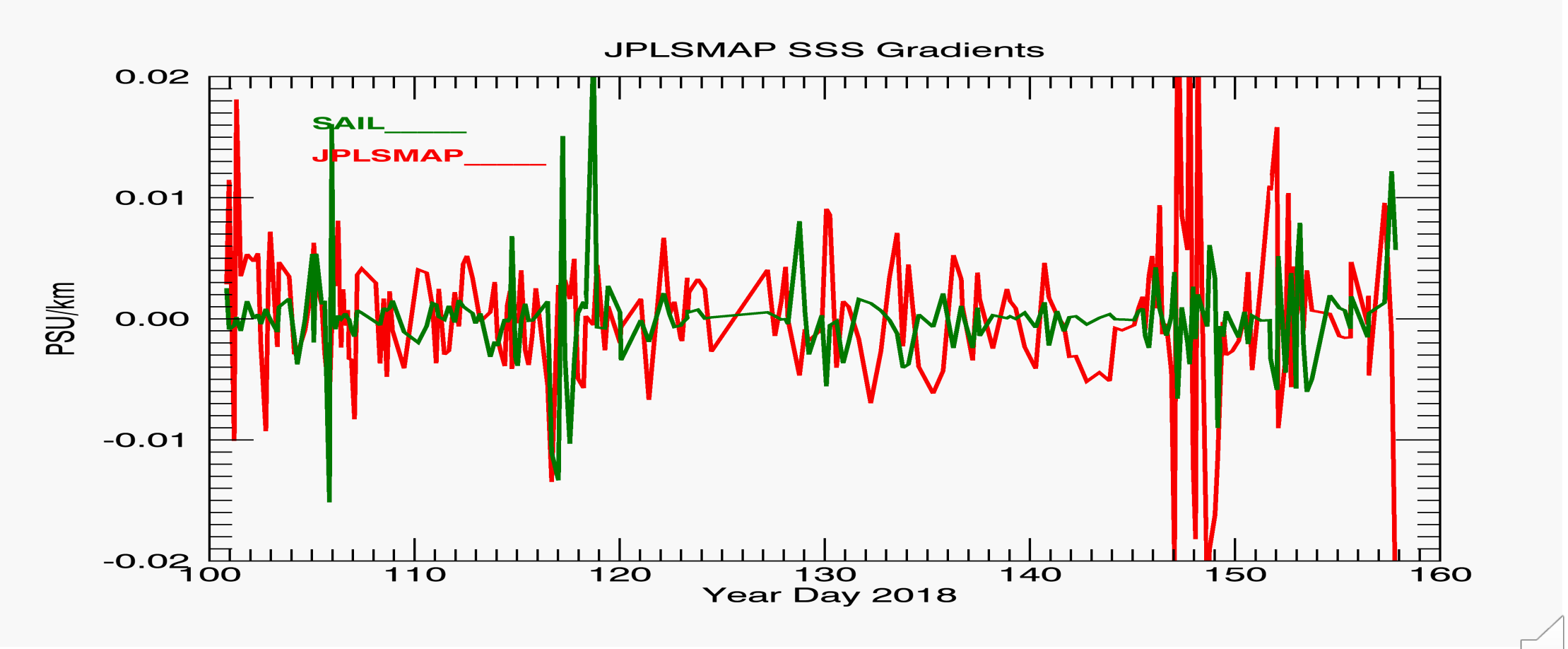
–	–	Bias	RMSE	Correlation
CMC	SST	-0.074	0.417	0.975
	$\lvert\nabla SST\rvert$	-0.009	0.022	0.315
K10	SST	0.137	0.475	0.969
	$\lvert\nabla SST\rvert$	-0.007	0.022	0.293
REMSS	SST	0.075	0.401	0.977
	$\lvert\nabla SST\rvert$	-0.007	0.023	0.243
OSTIA	SST	0.022	0.365	0.980
	$\lvert\nabla SST\rvert$	-0.008	0.022	0.306
DMI	SST	0.040	0.489	0.966
	$\lvert\nabla SST\rvert$	-0.008	0.023	0.255
MUR	SST	0.285	0.500	0.975
	$\lvert\nabla SST\rvert$	-0.003	0.021	0.395
JPLSMAP	SSS	0.141	0.414	0.429
	$\lvert\nabla SSS\rvert$	0.002	0.005	0.128
RSS v4	SSS	-0.170	0.336	0.464
	$\lvert\nabla SSS\rvert$	0.002	0.004	0.072

Taylor Diagram SST Gradients

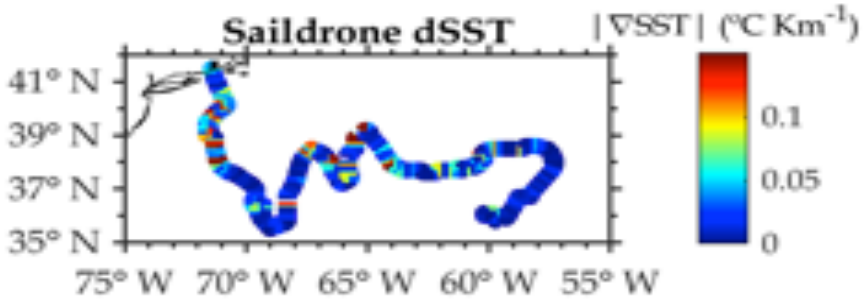


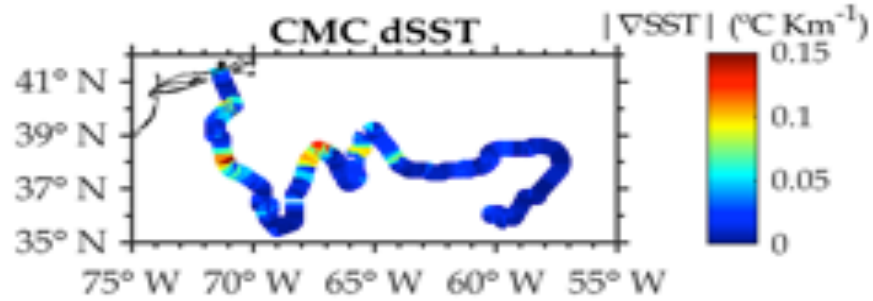
A=MUR
B=OSTIA
C=CMC
D=DMI
E=K10
F=REMSS

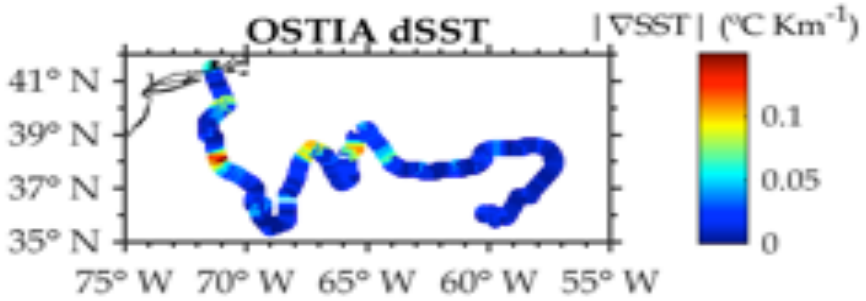
JPLSMAP

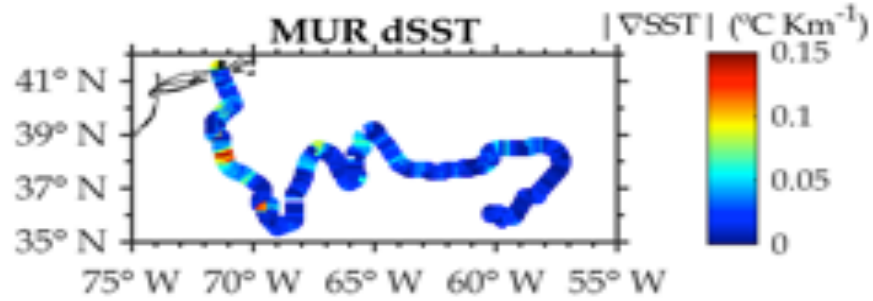

JPLSMAP SSS Gradients
SAIL
JPLSMAP
PSU/km
0.02
0.01
0.00
-0.01
-0.02
100
110
120
130
140
150
160
Year Day 2018

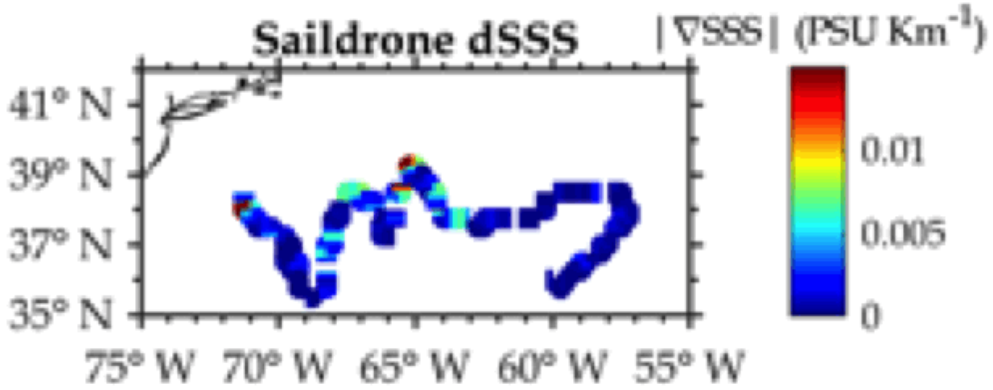
Gulf Stream

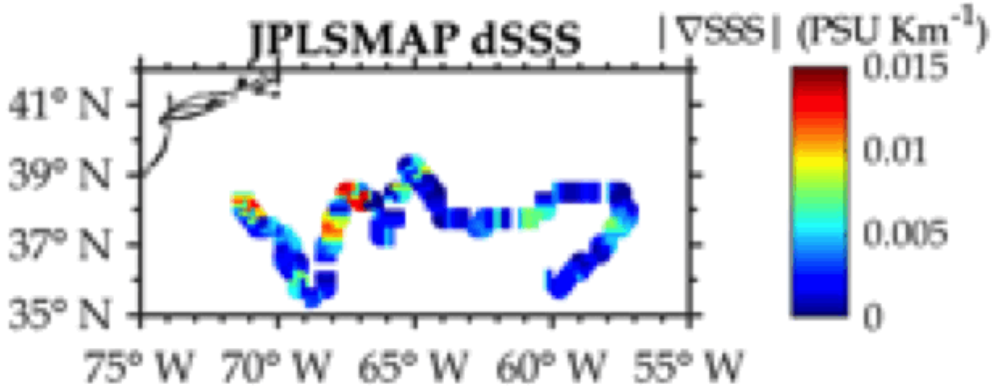

Saildrone dSST
|∇SST| (°C Km-1)
41° N
39° N
37° N
35° N
75° W 70° W 65° W 60° W 55° W
0.1
0.05
0

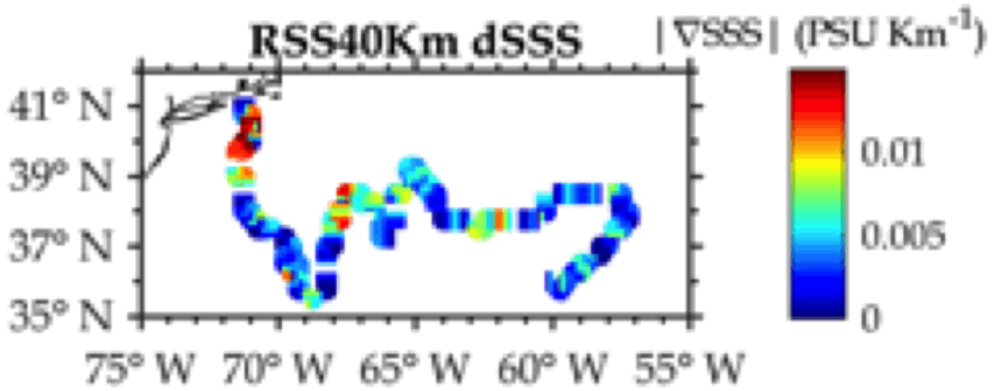

CMC dSST
|∇SST| (°C Km-1)
41° N
39° N
37° N
35° N
75° W 70° W 65° W 60° W 55° W
0.15
0.1
0.05
0


OSTIA dSST
|∇SST| (°C Km-1)
41° N
39° N
37° N
35° N
75° W 70° W 65° W 60° W 55° W
0.1
0.05
0


MUR dSST
|∇SST| (°C Km-1)
41° N
39° N
37° N
35° N
75° W 70° W 65° W 60° W 55° W
0.15
0.1
0.05
0


Saildrone dSSS
|∇SSS| (PSU Km-1)
41° N
39° N
37° N
35° N
75° W
70° W
65° W
60° W
55° W
0.01
0.005
0

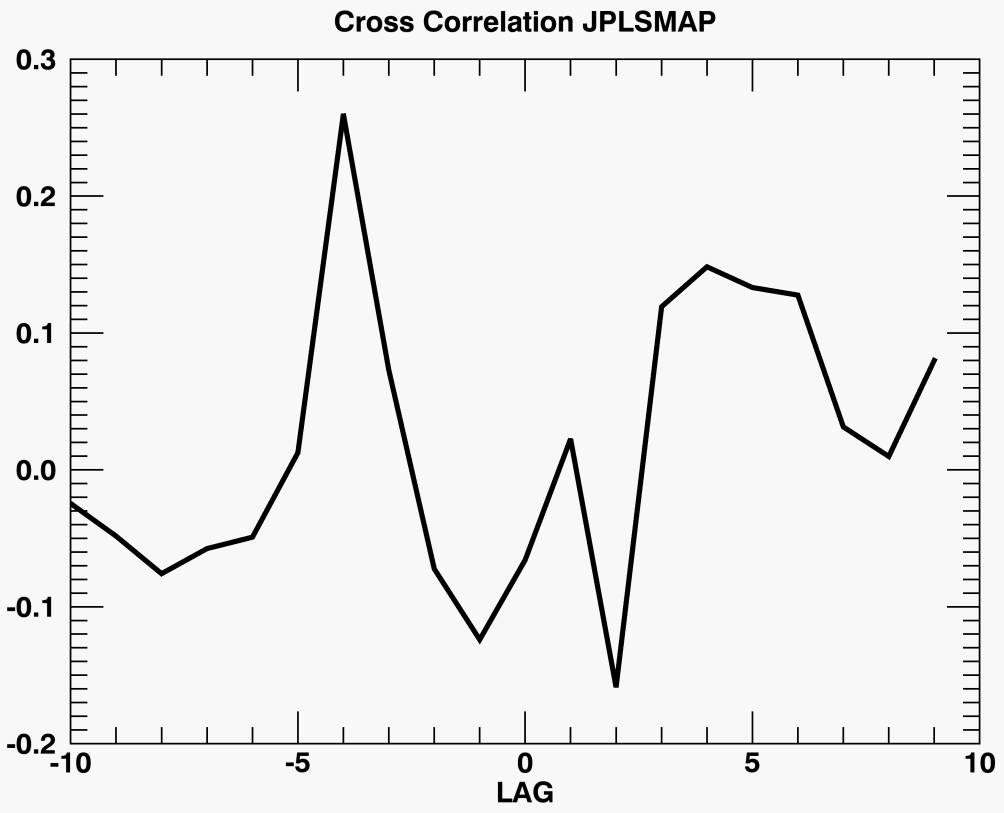

JPLSMAP dSSS
|∇SSS| (PSU Km-1)
41° N
39° N
37° N
35° N
75° W
70° W
65° W
60° W
55° W
0.015
0.01
0.005
0

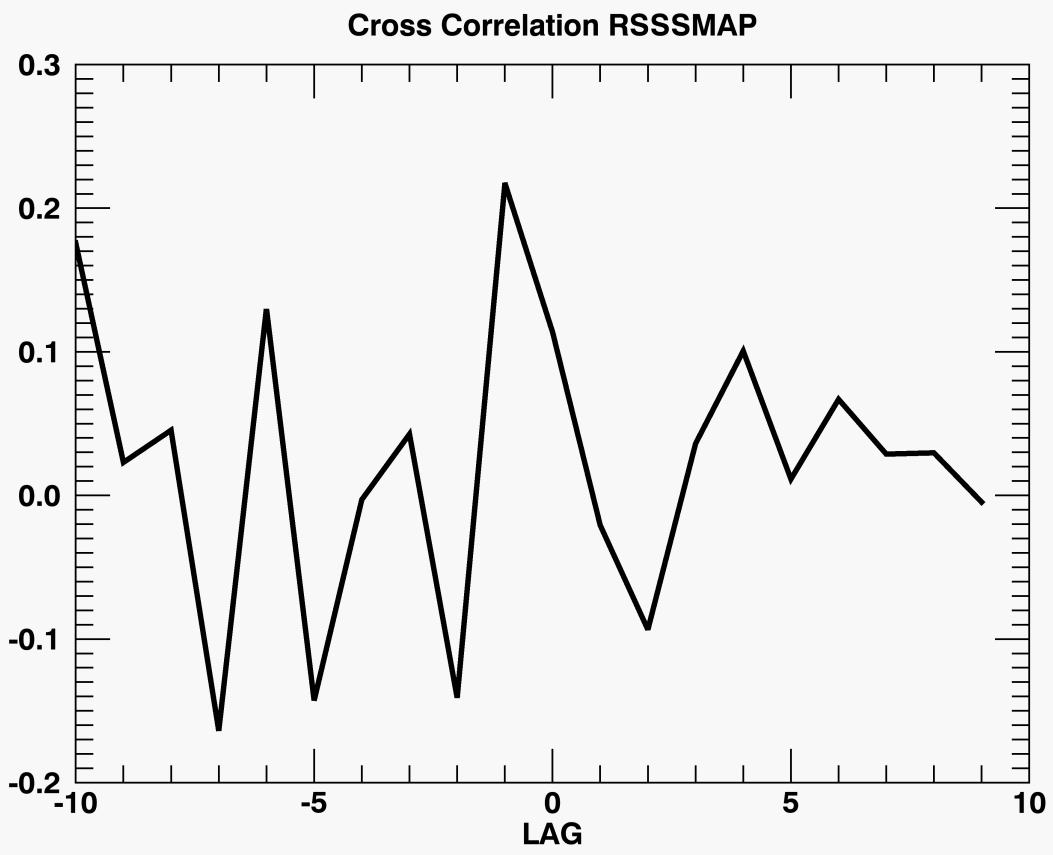

RSS40Km dSSS
|∇SSS| (PSU Km-1)
41° N
39° N
37° N
35° N
75° W
70° W
65° W
60° W
55° W
0.01
0.005
0

–	–	Bias	RMSE	Correlation
CMC	SST	-0.350	1.310	0.962
	$\lvert\nabla SST\rvert$	-0.012	0.054	0.374
K10	SST	-0.688	1.928	0.917
	$\lvert\nabla SST\rvert$	-0.009	0.062	0.072
REMSS	SST	-0.085	0.962	0.977
	$\lvert\nabla SST\rvert$	-0.016	0.055	0.342
OSTIA	SST	-0.209	1.185	0.968
	$\lvert\nabla SST\rvert$	-0.012	0.053	0.371
DMI	SST	0.002	1.401	0.951
	$\lvert\nabla SST\rvert$	-0.017	0.058	0.210
MUR	SST	-0.051	1.057	0.975
	$\lvert\nabla SST\rvert$	-0.010	0.054	0.321
JPLSMAP	SSS	-0.325	0.437	0.591
	$\lvert\nabla SSS\rvert$	0.001	0.006	0.084
RSS v4	SSS	-0.151	0.457	0.932
	$\lvert\nabla SSS\rvert$	0.001	0.007	0.140

2. Statistics of SST/SSS and SST/SSS gradients for the selected Level 4 products

Cross-Correlations

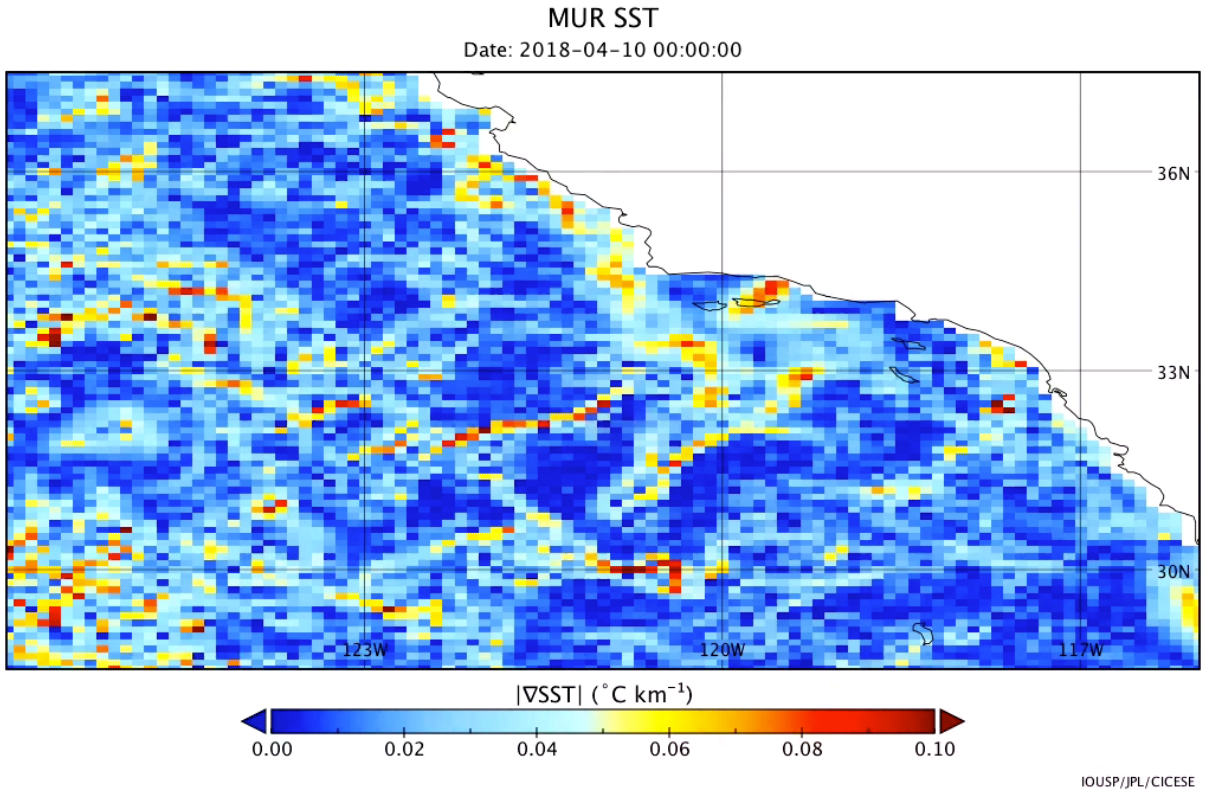


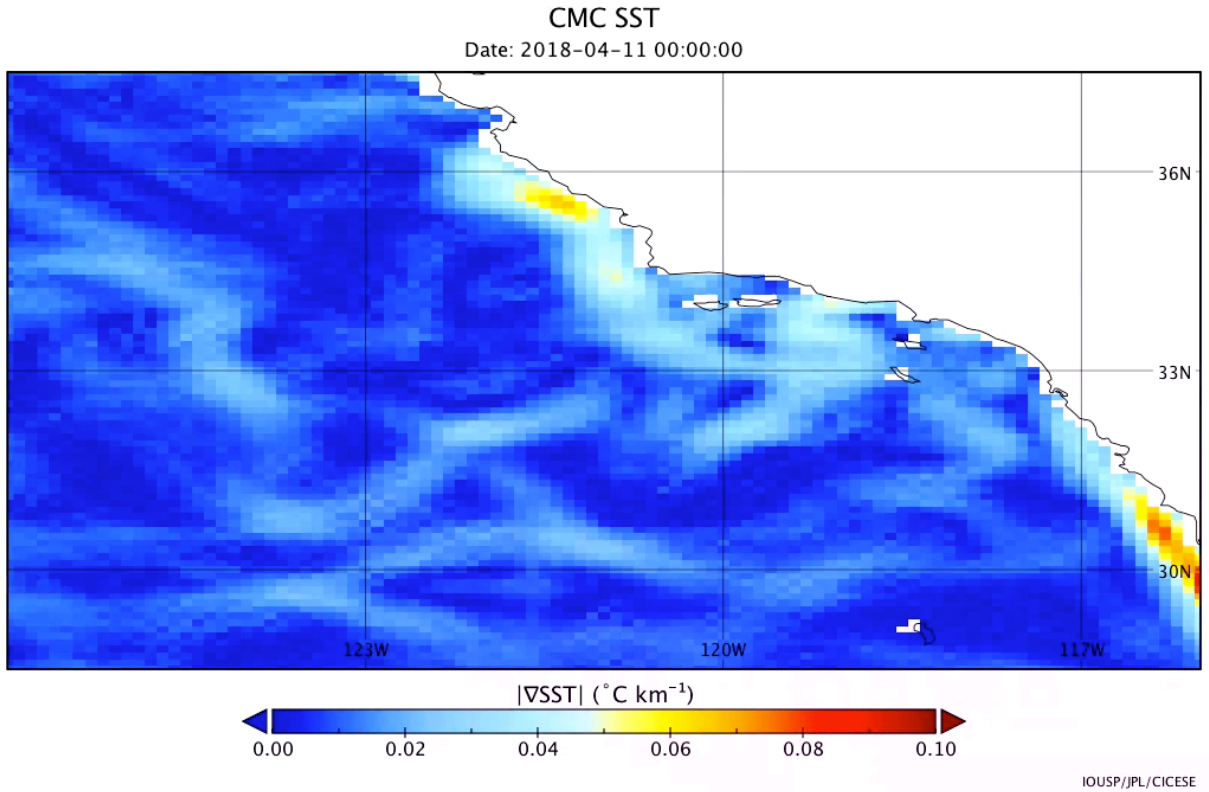


Conclusions

- **Correlations between the GHRSST Level 4 SST products and Saildrone were above 0.90, indicative that, overall, the GHRSST L4 products are doing a good job at reproducing the SST values in the Baja/California coastal upwelling region and the Gulf Stream.**
- **However, correlations of SST gradients drop significantly with larger differences between the products. For the California/Baja deployment the MUR derived SST gradients showed the best correlation.**
- **For the Gulf Stream deployment SST showed clear relationships to major frontal features associated with the Gulf Stream. Correlations range from 0.3 to 0.4.**
- **A primary conclusion is that comparisons of SST gradients are critical for applications to coastal regimes, where mesoscale-submesoscale dominate. Statistical relationships that apply to correlations between SST and in-situ data do not necessarily apply to gradients. The Saildrone deployments provide an excellent platform for validating and the application of SST gradients.**

Animation SST Gradients Baja





Animations Gulf Stream