Supplementary Information

Matchup Strategies for Satellite Sea Surface Salinity Validation

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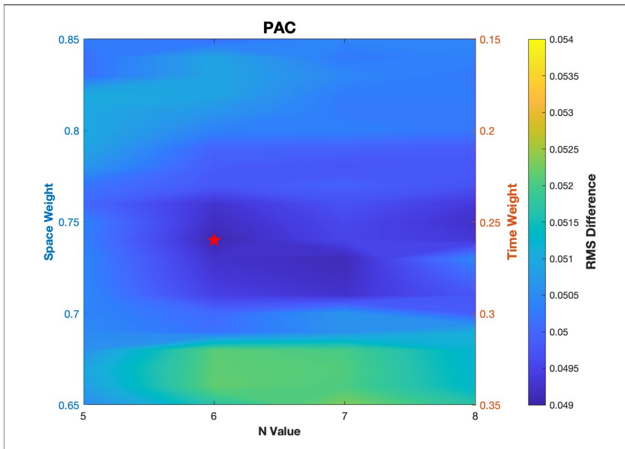
Contour Plots for the SMOS NCLO optimization:



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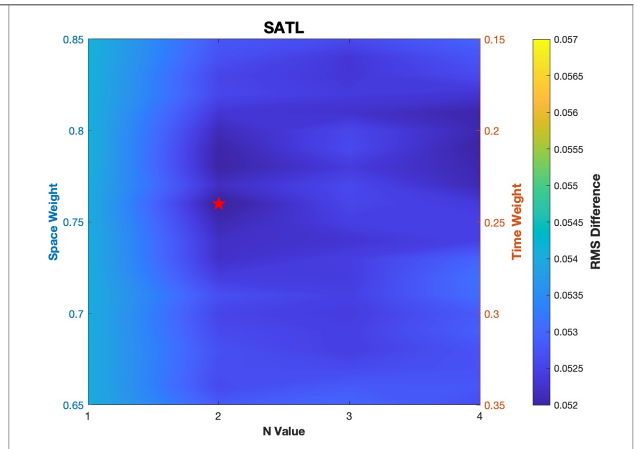

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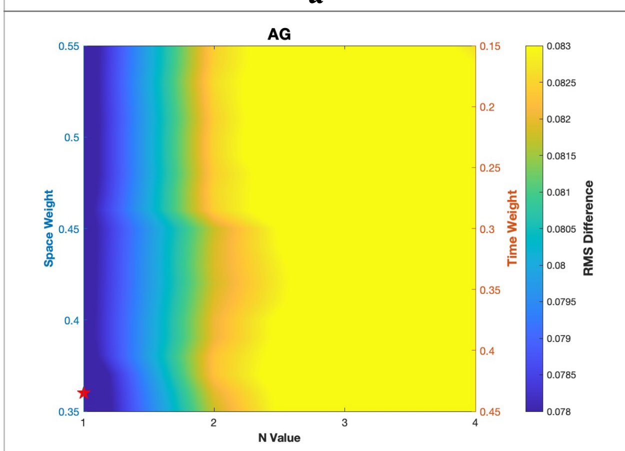

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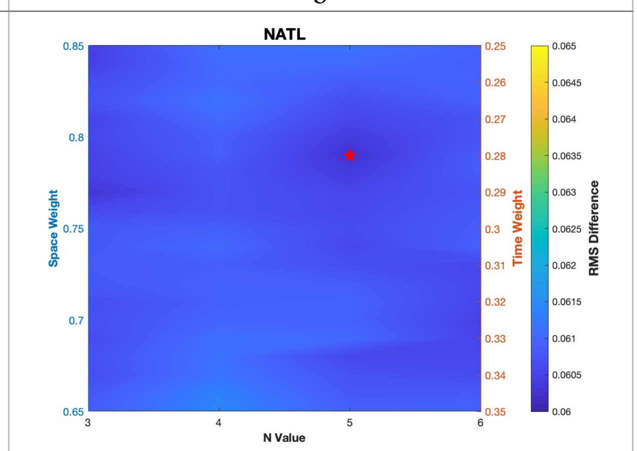

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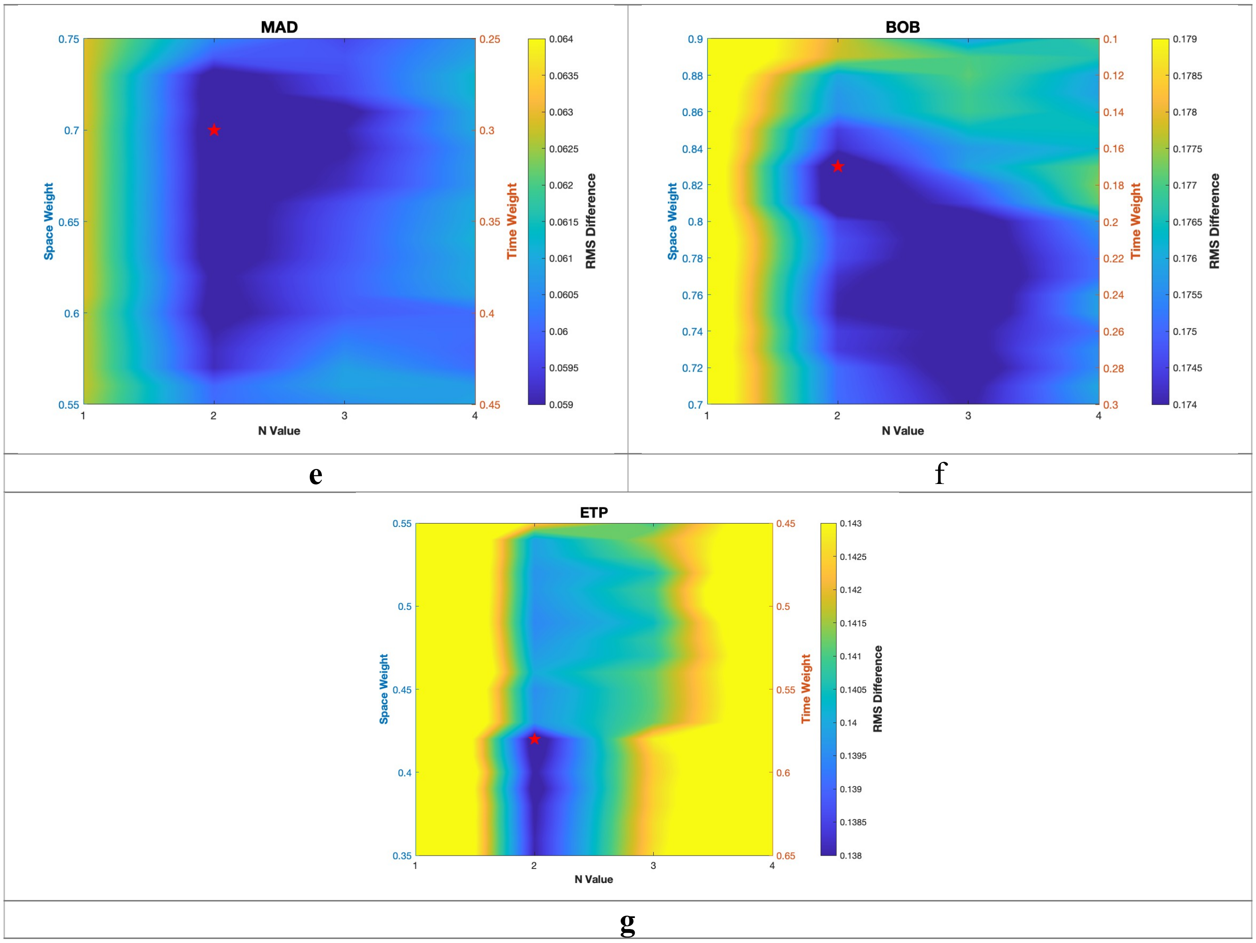
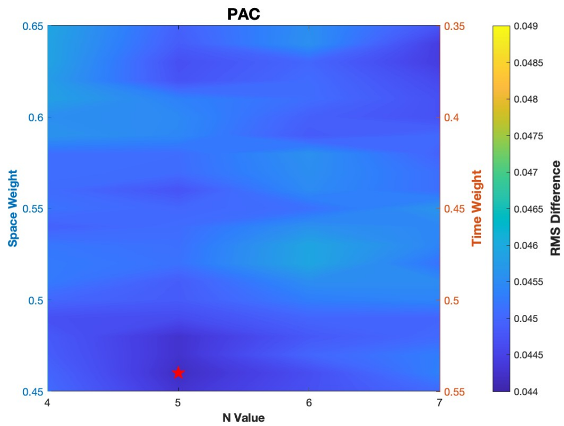


Figure S1. *Contour plots of the RMS of differences between simulated Argo measurements and the average of the simulated SMOS observations that were chosen for comparison based on a range of N and space_weight values, shown on the X and Y axis, respectively. The N and space_weight combination that yielded the lowest RMS Difference is considered to be optimal for the region, and is marked by a red star (★). A contour plot was generated for each of the seven regions that were studied. Only the four N values and 20 space_weight values that encompass the area with the lowest RMS Differences for each area are shown. The color scale is different for each plot, as RMSD was primarily influenced by location, but each color scale only includes a range of RMSD values 0.005 units long, so the variety of colors present reveals the level of importance of the optimization in each region. a) PAC, b) SATL, c) AG, d) NATL, e) MAD, f) BOB, and g) ETP regions.*

Contour Plots for the SMAP NCLO optimization:


PAC
Space Weight
Time Weight
RMS Difference
N Value
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0.6
0.55
0.5
0.45
0.35
0.4
0.45
0.5
0.55
4
5
6
7
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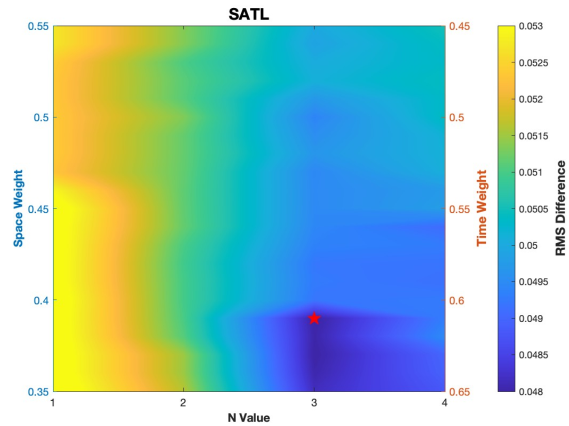
0.0455
0.045
0.0445
0.044

a


SATL
Space Weight
Time Weight
RMS Difference
N Value
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0.45
0.4
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0.55
0.6
0.65
1
2
3
4
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0.0515
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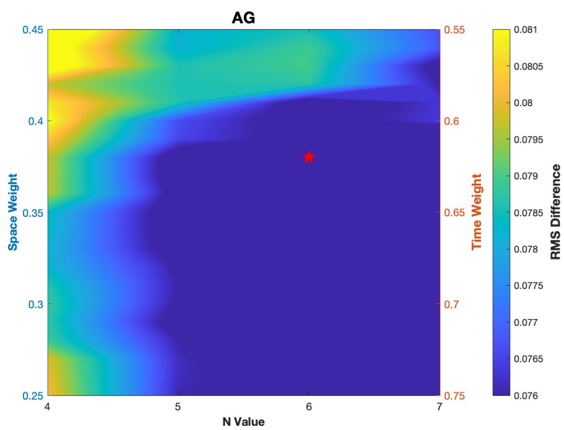
0.0505
0.05
0.0495
0.049
0.0485
0.048

b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Space Weight
Time Weight
RMS Difference
N Value
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0.3
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0.75
4
5
6
7
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0.078
0.0775
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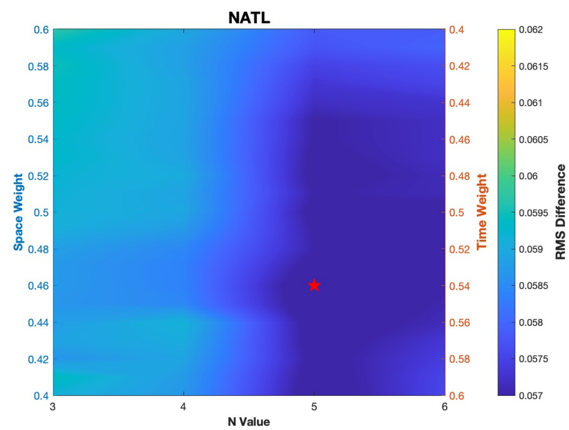
0.076

c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Time Weight
RMS Difference
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0.44
0.42
0.4
0.4
0.42
0.44
0.46
0.48
0.5
0.52
0.54
0.56
0.58
0.6
3
4
5
6
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0.0615
0.061
0.0605
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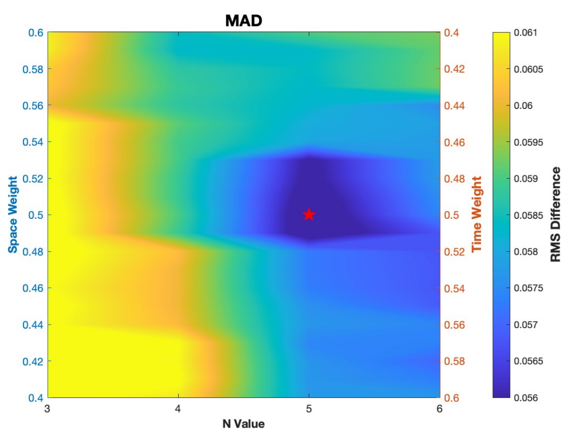
0.058
0.0575
0.057

d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Space Weight
Time Weight
RMS Difference
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0.44
0.42
0.4
0.4
0.42
0.44
0.46
0.48
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0.54
0.56
0.58
0.6
3
4
5
6
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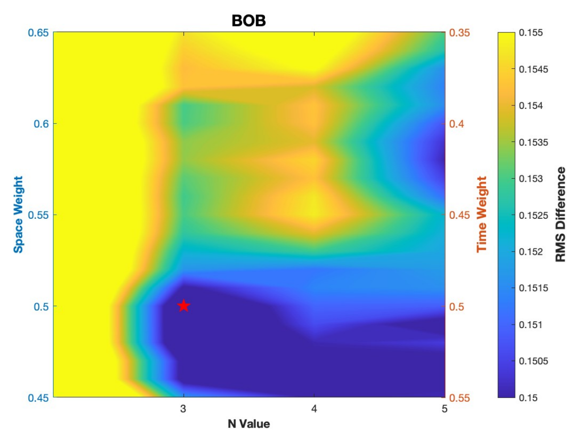
0.0565
0.056

e


BOB
Space Weight
Time Weight
RMS Difference
N Value
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0.5
0.55
3
4
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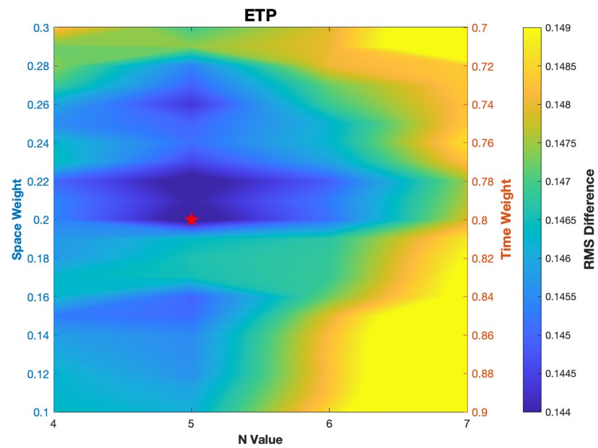
0.1515
0.151
0.1505
0.15

f



g

Figure S2. *Contour plots of the RMS of differences between simulated Argo measurements and the average of the simulated SMAP observations that were chosen for comparison based on a range of N and space_weight values, shown on the X and Y axis, respectively. The N and space_weight combination that yielded the lowest RMS Difference is considered to be optimal for the region, and is marked by a red star (★). A contour plot was generated for each of the seven regions that were studied. Only the four N values and 20 space_weight values that encompass the area with the lowest RMS Differences for each area are shown. The color scale is different for each plot, as RMSD was primarily influenced by location, but each color scale only includes a range of RMSD values 0.005 units long, so the variety of colors present reveals the level of importance of the optimization in each region. a) PAC, b) SATL, c) AG, d) NATL, e) MAD, f) BOB, and g) ETP regions.*

Figures S1 and S2 show a contour of the RMSD values calculated in different regions using the NCLO method on the SMOS and SMAP satellites, respectively, when N and *space_weight* are varied. The N and *space_weight* combination that produced the lowest RMSD value was considered optimum. The results of this optimization are summarized in **Figure 5** of the paper. The results of these optimizations differ from the results of the Aquarius optimization shown in **Figure 4** in that they the optimum N values and *space_weights* are typically lower. This is likely because the SMOS and SMAP satellites have a much higher spatial resolution than the Aquarius satellite and therefore the *space_weight* does not need to be as high to get a good spatial match. The actual optimized values of N and *space_weight* for all three satellites are listed for reference in **Table S1**.

Final Parameters and RMSD data from the N closest optimization

Region	Satellite	Optimum N	Optimum SW	RMSD with these parameters
	Aquarius	2	0.83	0.075

PAC	SMOS	6	0.74	0.051
	SMAP	5	0.46	0.045
SATL	Aquarius	3	0.63	0.097
	SMOS	2	0.75	0.052
	SMAP	2	0.75	0.050
AG	Aquarius	2	0.81	0.14
	SMOS	1	0.36	0.077
	SMAP	6	0.38	0.075
NATL	Aquarius	1	0.90	0.11
	SMOS	4	0.87	0.61
	SMAP	5	0.46	0.057
MAD	Aquarius	1	0.97	0.11
	SMOS	2	0.70	0.060
	SMAP	5	0.50	0.058
BOB	Aquarius	1	0.62	0.29
	SMOS	2	0.83	0.18
	SMAP	3	0.50	0.16
ETP	Aquarius	6	0.54	0.24
	SMOS	2	0.20	0.14
	SMAP	5	0.20	0.14

Table S1 - *Optimum values of N and space_weight found for each region and each satellite using the NCLO method.*

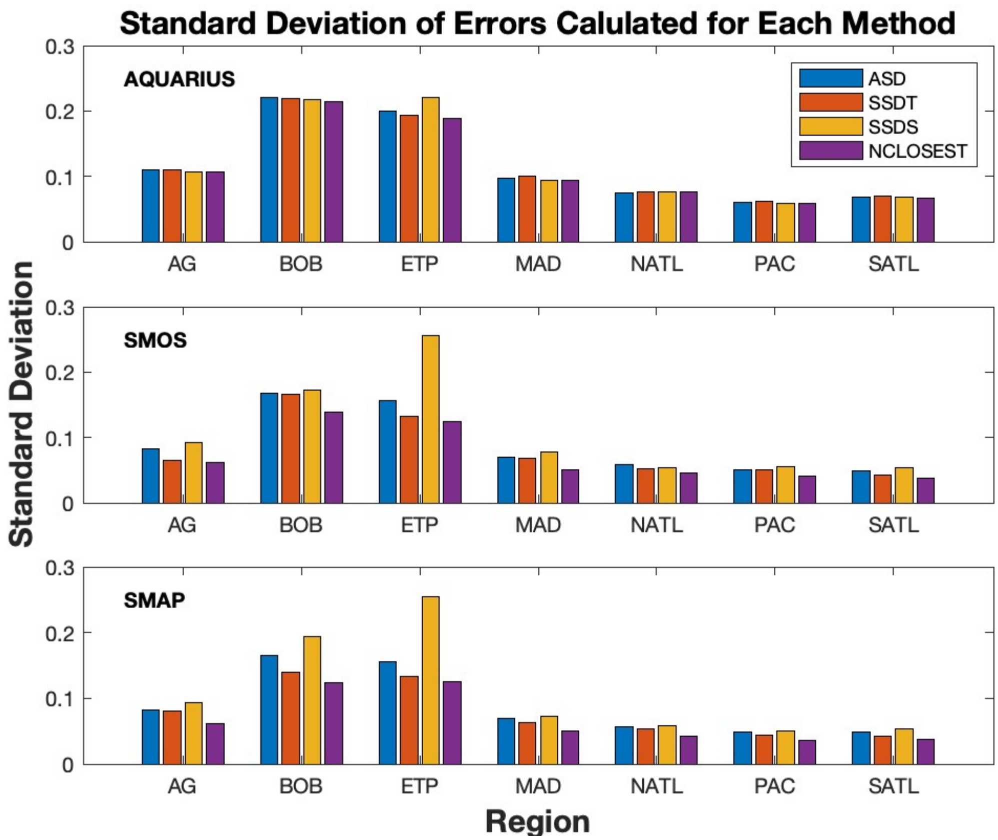
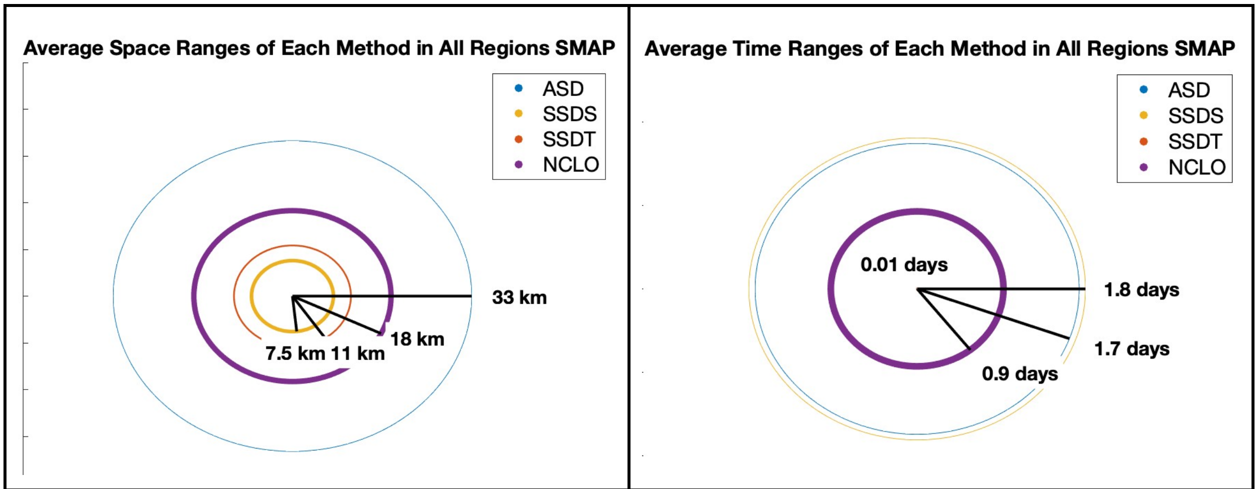


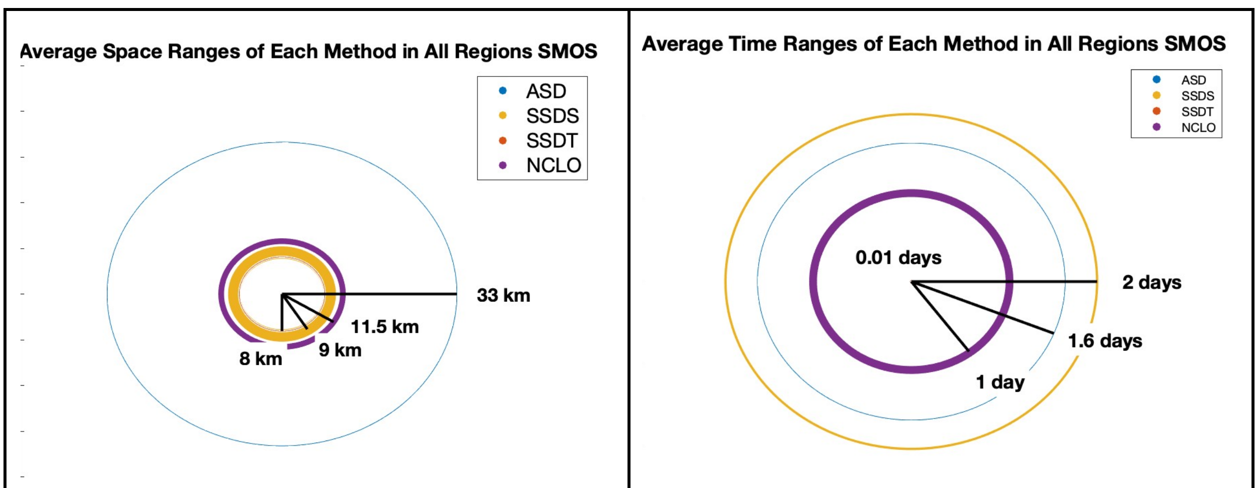
Figure S3 *The Standard Deviations of the differences produced by each matchup method in each region using each satellite data set.*

Figure S3 shows the standard deviations of the errors produced by each method using each satellite in each region. Overall, the SSDS method appears to have the highest standard deviation of all the methods. This makes sense because the location of Argo float emergence is relatively random and may or may not be close to a satellite track during any given measurement. Meanwhile, the time between satellite passes through the area of the Argo float with a 50km radius are relatively consistent.



a	b

Figure S4 *The mean (over all regions) space (**a**) and time (**b**) windows encompassed by each of the four matchup methods using the SMAP satellite. As indicated by the legend, ASD windows are shown in blue, SSDS in yellow, SSDT in orange, and NCLO in purple. The size of the circles indicate the size of the average window covered. The thickness of the lines is proportional to the standard deviation between the mean space (by a factor of 2) and time (by a factor of 16) ranges calculated for the seven individual regions.*



a	b

Figure S5 *The mean (over all regions) space (**a**) and time (**b**) windows encompassed by each of the four matchup methods using the SMOS satellite. As indicated by the legend, ASD windows are shown in blue, SSDS in yellow, SSDT in orange, and NCLO in purple. The size of the circles indicate the size of the average window covered. The thickness of the lines is proportional to the standard deviation between the mean space (by a factor of 2) and time (by a factor of 16) ranges calculated for the seven individual regions.*

Figures S4 and S5 show the time and space windows covered with each method when applying them to SMAP and SMOS, respectively. These figures show that the space window of SSDS, SSDT, and NCLO is way smaller than the 50 km encompassed by the ASD method in the case of both satellites. This is consistent with the conclusions drawn from **Figure 10,** which shows these ranges for the Aquarius satellite.