

Water Quality Analysis Pilot Study for the SEACAR Program: AT008 A03

Report of Task 2E

June 13, 2024

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The purpose of this task was to compare the IDW and RK interpolation models to the outputs of the hydrodynamic model from Task 2C. IDW and RK layers from Tasks 2A and 2B, and Task 2C outputs were compared to generate “difference” maps to show the absolute difference between the interpolated/modelled values. Absolute mean differences were also calculated as a global comparison of the models (i.e., IDW or RK and Task 2C). Model comparisons were made for the two waterbodies that were included in Task 2C: Big Bend Seagrasses, and Charlotte Harbor.

The following is a brief outline of the analysis methods used for Task 2E:

- Hydrodynamic Model outputs from Task 2C were provided as NetCDF formatted files (i.e., a multidimensional file format). Since ArcGIS is not able to utilize the NetCDF outputs, a Python script was developed to convert the outputs to csv format (by Moses Okonkwo from FDEP OEAT). Scripts and csv files are available in the Box folder: <https://usf.box.com/s/703yx44lmgtkqm9vnu9s8u7b8wkw62j1>.
- CSV formatted outputs included the modelled salinity and water temperature values along with lat/long values for every node (point) output by the hydrodynamic model. CSV files were converted to point layers within ArcGIS.
- A Python/ArcPy script was developed to compare the salinity/water temperature value at each modelled point with the associated raster value modelled by the IDW and/or RK interpolation maps. Script and files are available in the Task 2E Box folder: <https://usf.box.com/s/zp1gbch966byoia4t3u97y1192evkbf>.
- Comparisons were generated for each of the time bins that were output from Task 2C with corresponding IDW/RK maps from Tasks 2A/B. Due to the availability of only one Continuous WQ monitoring site in Big Bend Seagrasses, no weekly or monthly IDW maps could be generated and are therefore excluded from the comparison.
 - Big Bend Seagrasses
 - 4-season time bins defined by FDEP for Task 2A
 - 2-season wet/dry time bins defined by FDEP for Task 2B
 - Charlotte Harbor
 - 4-season time bins defined by FDEP for Task 2A
 - 2-season wet/dry time bins defined by FDEP for Task 2B
 - Weekly time bins for 26 weeks before and after Hurricane Irma
 - Monthly time bins for 6 months before and after Hurricane Irma
 - Comparison results for each note/point are included as excel files in the Task 2E Box folder: <https://usf.box.com/s/zp1gbch966byoia4t3u97y1192evkbf>. Files include:
 - Task2E Comparison Results - Seasonal - Salinity.xlsx
 - Task2E Comparison Results - Seasonal - Water Temperature.xlsx
 - Task2E Comparison Results - Weekly Monthly - Salinity.xlsx
 - Task2E Comparison Results - Weekly Monthly - Water Temperature.xlsx
- Although not included as part of the work plan, a comparison was also made between the seasonal hydrodynamic model outputs and the salinity and water temperature values available from the SEACAR database export files. These comparisons should be treated as preliminary.

- Maps for all comparison points were generated for this report using a common symbology for Salinity and Water Temperature based on the minimum and maximum absolute difference for all time bins and waterbodies.
 - Maps are also provided as an ArcGIS Pro within the Task 2E/Task2E_ArcPro_ComparisonResults.
 - The same maps are available as a new ArcGIS Online map: <https://gis.waterinstitute.usf.edu/maps/SEACAR-OEAT-Y2-2C/>

Global Comparisons

The global comparisons provide a summary of the overall differences between PM vs IDW and PM vs RK. The global comparisons were based on the global Mean Absolute Error (MAE) values were calculated as the mean of all absolute difference values for all nodes/points in each season, in all seasons, all week, all months, and each month or week.

Salinity

Global comparisons for salinity values (in parts per thousand / ppt) are provided in the tables below.

Table 1. Salinity: Global comparison of the 2-Season and 4-Season PM vs IDW and PM vs RK salinity models.

<i>Season Definition</i>	MAE PM vs IDW	MAE StdDev PM vs IDW	MAE PM vs RK	MAE StdDev PM vs RK
<i>BBS All Seasons Combined</i>	10.74	6.40	7.52	6.03
<i>2-Seasons Combined</i>	8.14	5.39	6.15	5.91
<i>Dry</i>	5.10	3.67	4.08	3.94
<i>Wet</i>	11.19	5.12	8.22	6.76
<i>4-Seasons Combined</i>	12.03	6.46	8.21	5.97
<i>Fall</i>	10.61	7.29	6.74	5.83
<i>Spring</i>	12.54	6.59	6.96	5.53
<i>Summer</i>	15.85	4.25	12.46	6.05
<i>Winter</i>	9.13	5.23	6.68	4.18
<i>CH All Seasons Combined</i>	6.25	4.75	6.40	4.90
<i>2-Seasons Combined</i>	5.38	3.80	5.39	3.72
<i>Dry</i>	5.94	3.96	6.24	4.14
<i>Wet</i>	4.82	3.54	4.55	3.01
<i>4-Seasons Combined</i>	6.69	5.11	6.90	5.32
<i>Fall</i>	9.62	6.04	9.99	6.35
<i>Spring</i>	5.09	3.29	5.04	3.37
<i>Summer</i>	3.21	2.86	3.33	2.73
<i>Winter</i>	8.84	4.60	9.22	4.79
<i>ALL Seasons, Both Waterbodies</i>	6.68	5.11	6.49	5.01

Table 2. Salinity: Global comparison for Charlotte Harbor of the weekly and monthly time bins for PM vs IDW salinity models.

<i>Season Definition</i>	MAE PM vs IDW	MAE StdDev PM vs IDW	MAE PM vs RK	MAE StdDev PM vs RK
<i>12 Months Combined</i>	8.42	5.28	8.42	5.28
<i>52 Weeks Combined</i>	7.65	4.99	7.65	4.99
<i>All Weeks and Months Combined</i>	7.80	5.05	7.80	5.05

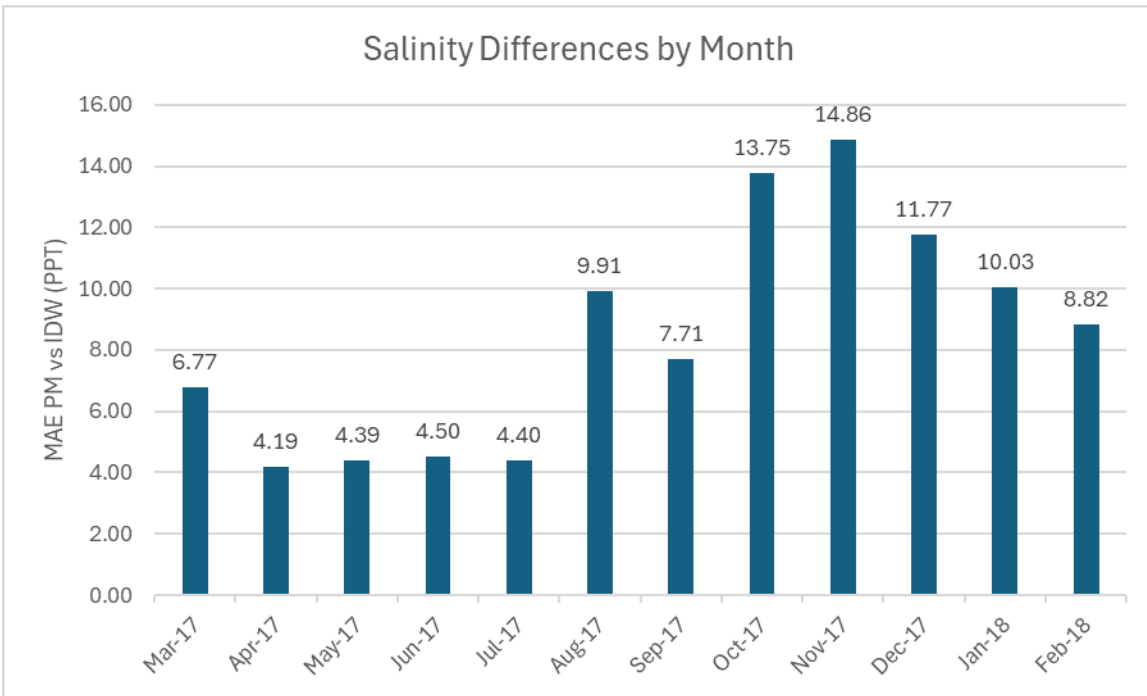


Figure 1. MAE of PM vs IDW Monthly Maps for Charlotte Harbor Salinity (Post-Irma Month started 9/10/2017)

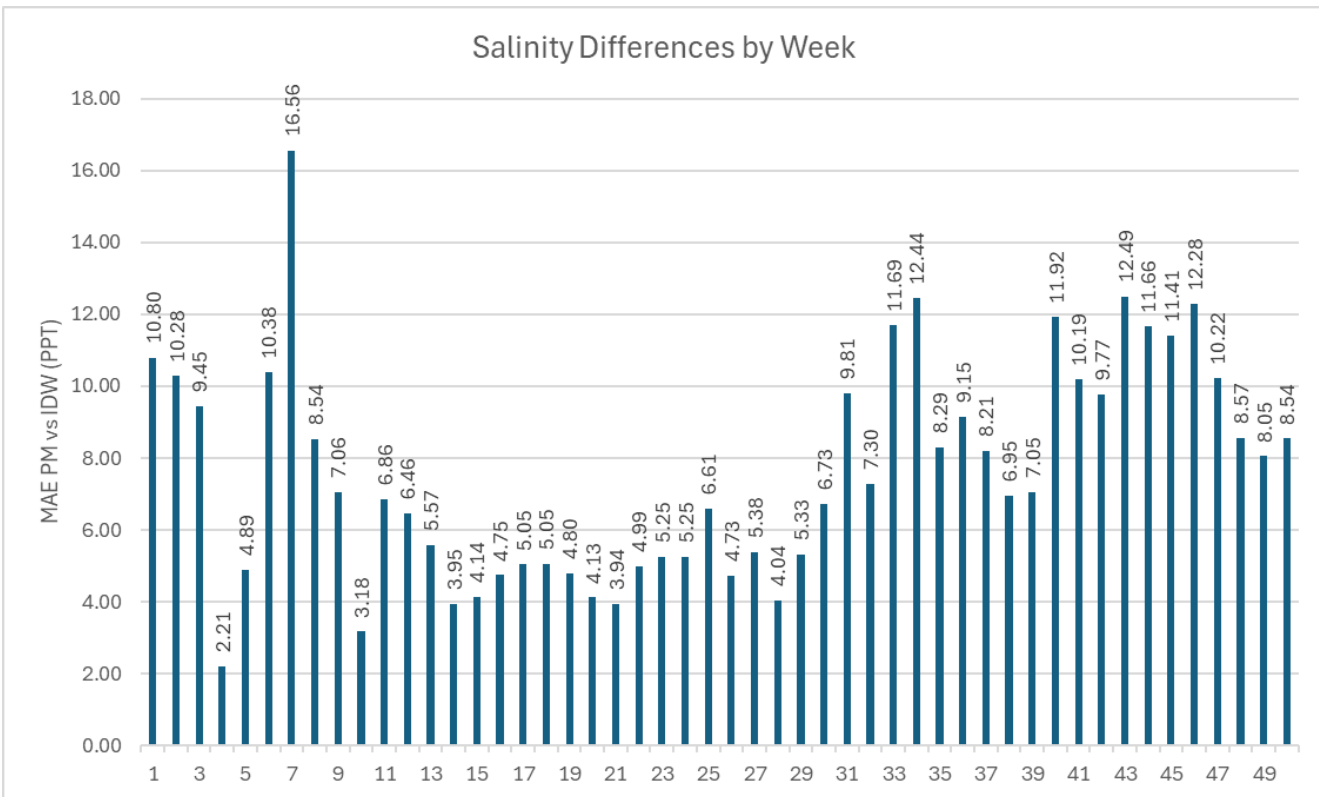


Figure 2. MAE of PM vs IDW Weekly Maps for Charlotte Harbor Salinity (Post-Irma started 9/10/2017, Week 27). Note: week #1 started 3/12/2017.

Water Temperature

Global comparisons for water temperature values (in degrees C) are provided in the tables below.

Table 3. Water Temperature: Global comparison of the 2-Season and 4-Season PM vs IDW and PM vs RK water temperature models.

<i>Season Definition</i>	MAE PM vs IDW	MAE StdDev PM vs IDW	MAE PM vs RK	MAE StdDev PM vs RK
<i>BBS All Seasons Combined</i>	3.78	4.24	3.25	3.36
<i>2-Seasons Combined</i>	4.28	4.12	3.46	3.38
<i>Dry</i>	7.65	3.19	5.95	3.00
<i>Wet</i>	0.91	1.06	0.97	1.22
<i>4-Seasons Combined</i>	3.53	4.27	3.14	3.34
<i>Fall</i>	1.57	0.77	1.25	0.75
<i>Spring</i>	1.48	0.94	2.57	1.10
<i>Summer</i>	1.42	1.60	1.21	1.47
<i>Winter</i>	9.65	4.36	7.52	3.75
<i>CH All Seasons Combined</i>	1.06	0.88	0.71	0.59
<i>2-Seasons Combined</i>	0.99	0.79	0.69	0.58
<i>Dry</i>	1.21	0.86	0.98	0.65
<i>Wet</i>	0.76	0.64	0.41	0.31
<i>4-Seasons Combined</i>	1.10	0.91	0.72	0.59
<i>Fall</i>	1.12	0.90	0.72	0.48
<i>Spring</i>	1.27	1.00	0.66	0.54
<i>Summer</i>	0.64	0.55	0.39	0.25
<i>Winter</i>	1.37	0.95	1.12	0.74
<i>ALL Seasons, Both Waterbodies</i>	1.32	1.75	0.92	1.32

Table 4. Water Temperature: Global comparison for Charlotte Harbor of the weekly and monthly time bins for PM vs IDW water temperature models.

<i>Season Definition</i>	MAE PM vs IDW	MAE StdDev PM vs IDW	MAE PM vs RK	MAE StdDev PM vs RK
<i>12 Months Combined</i>	3.08	3.49	3.08	3.49
<i>52 Weeks Combined</i>	2.24	2.43	2.24	2.43
<i>All Weeks and Months Combined</i>	2.40	2.69	2.40	2.69

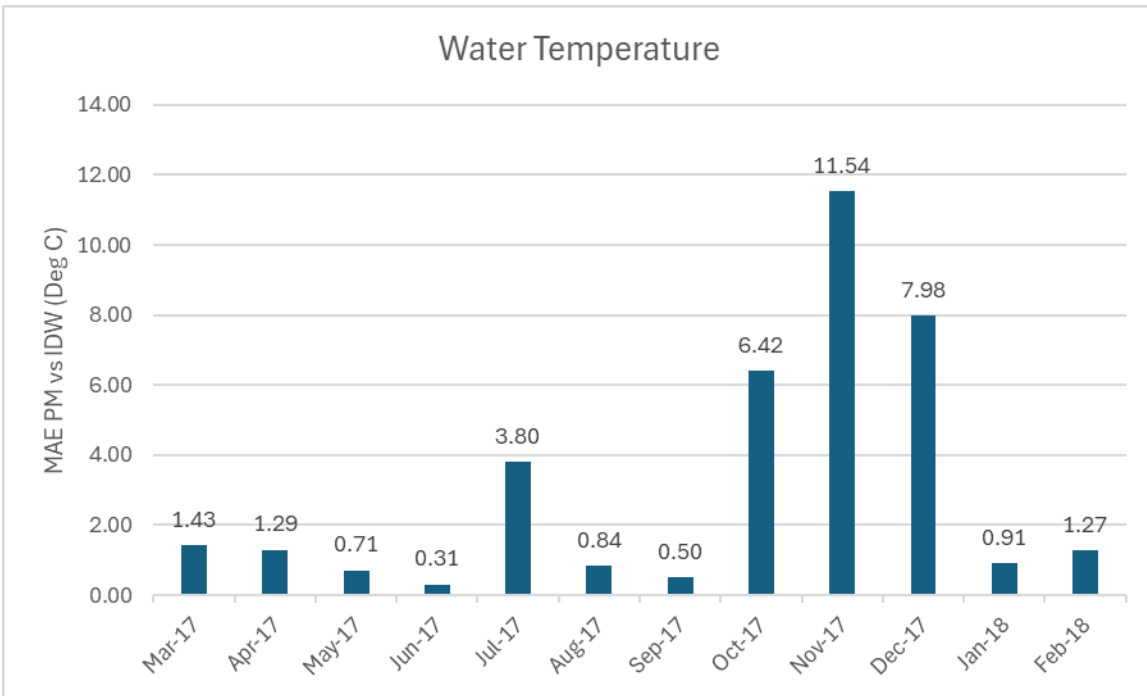


Figure 3. MAE of PM vs IDW Monthly Maps for Charlotte Harbor Water Temperature (Post-Irma Month started 9/10/2017).

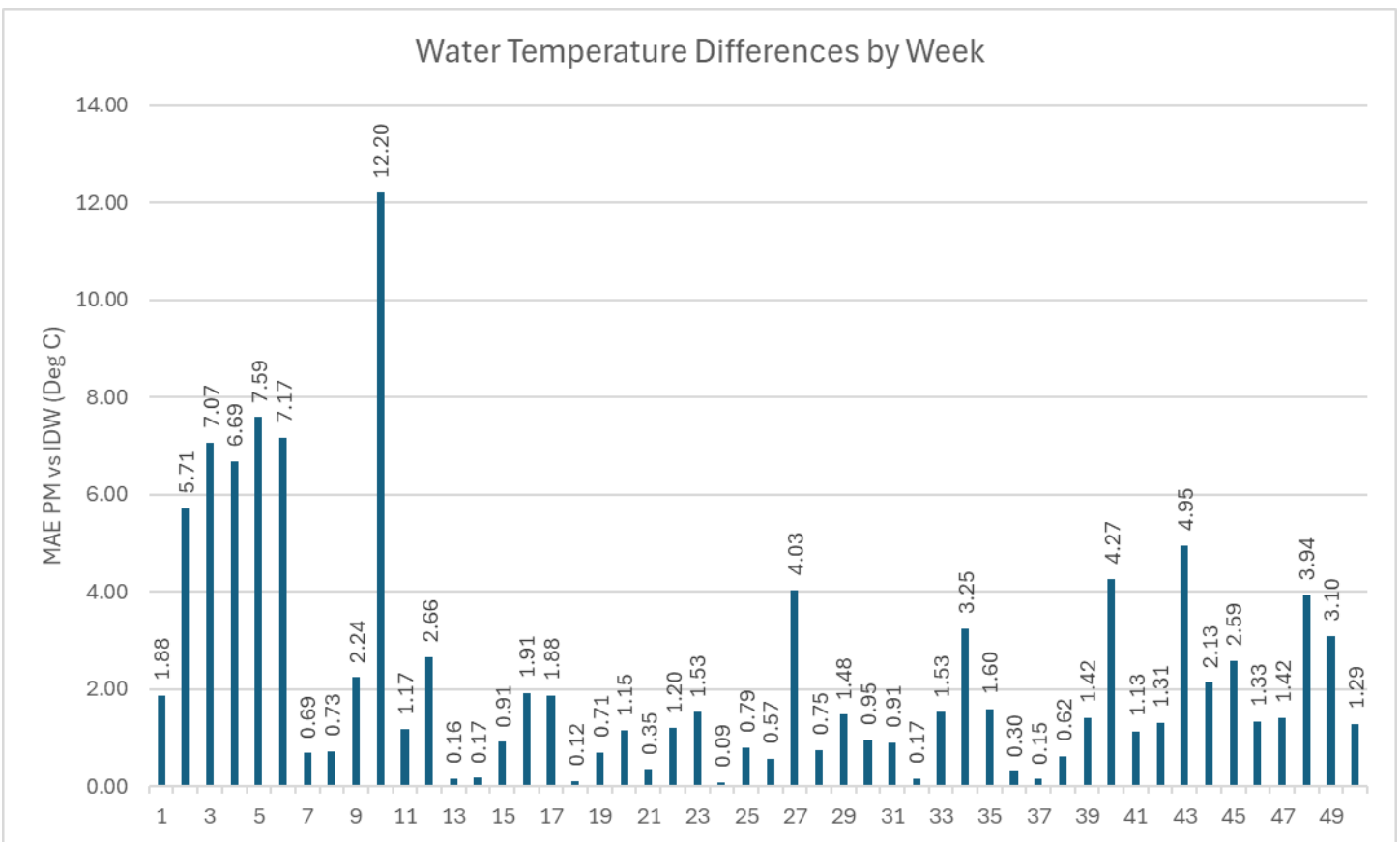


Figure 4. MAE of PM vs IDW Weekly Maps for Charlotte Harbor Water Temperature (Post-Irma started 9/10/2017, Week 27). Note: week #1 started 3/12/2017

Big Bend Seagrasses Maps

Comparisons within the Big Bend Seagrasses section include:

- A preliminary comparison map showing differences between the hydrodynamic model outputs (labelled “Physical Models or PM”) and the values at the corresponding locations within the SEACAR data export.
- Mean absolute differences between values from PM output points and raster values from the associated (i.e., same time bin) IDW/RK maps. Mean differences are calculated for all seasons (2-season and 4-season), for wet and dry seasons, for spring, summer, fall and winter seasons. Weekly and monthly comparisons could not be made due to the lack of IDW maps as a result of an insufficient number of continuous monitoring locations (i.e., only 1).

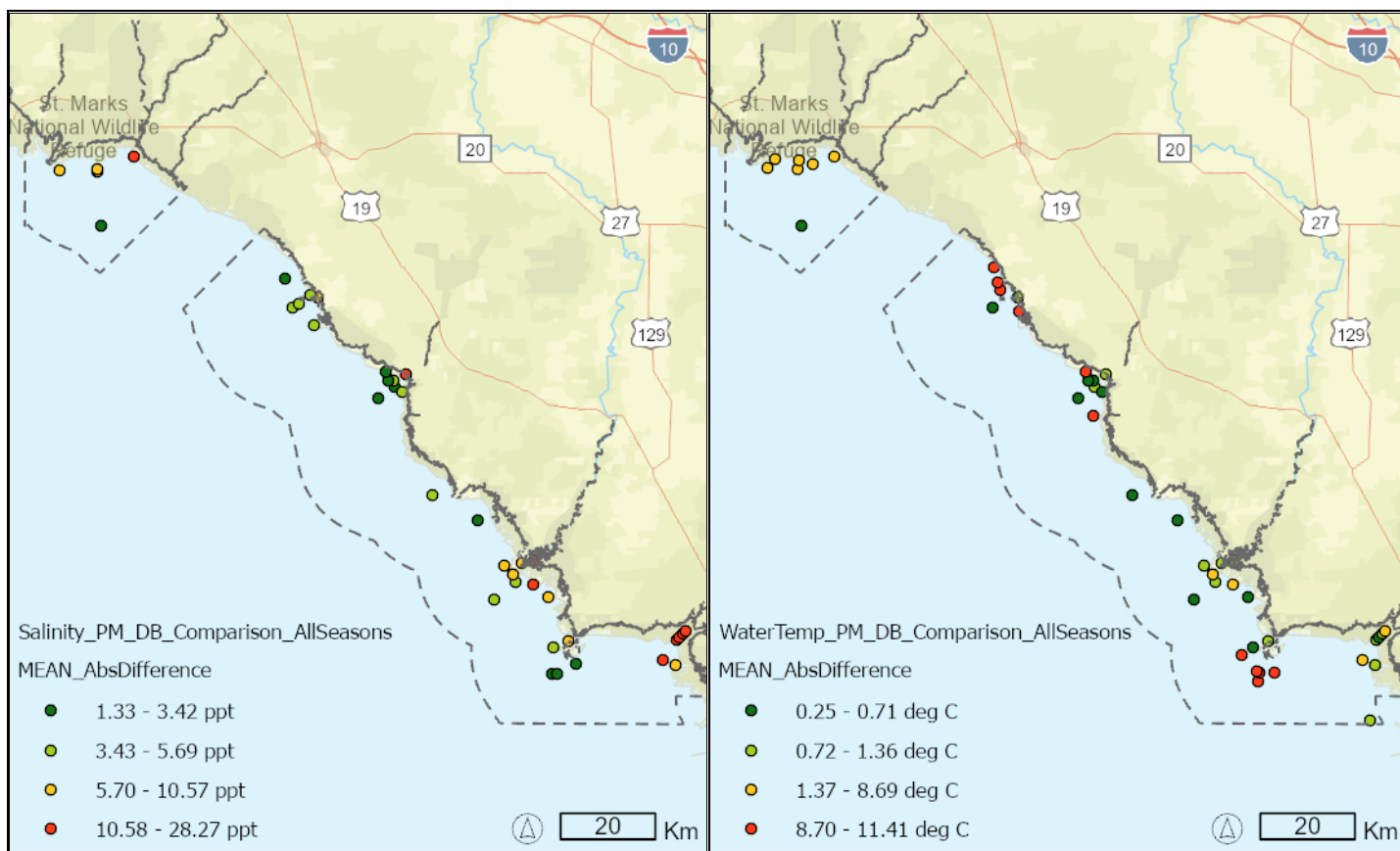


Figure 5. Mean absolute difference for All Seasons between Physical Models and Data Export Values

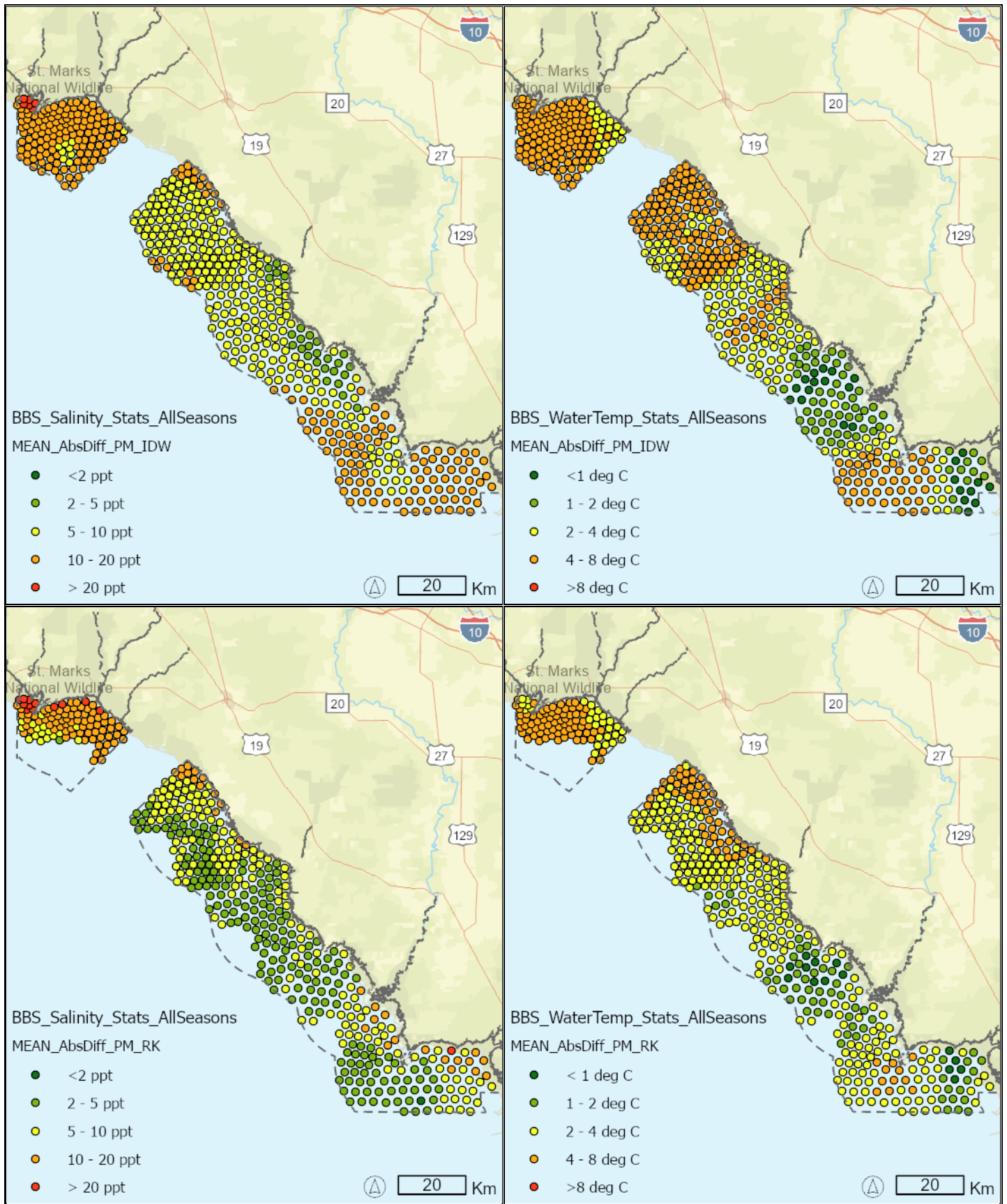


Figure 6. Mean absolute difference for All Seasons between Physical Models and IDW/RK Maps

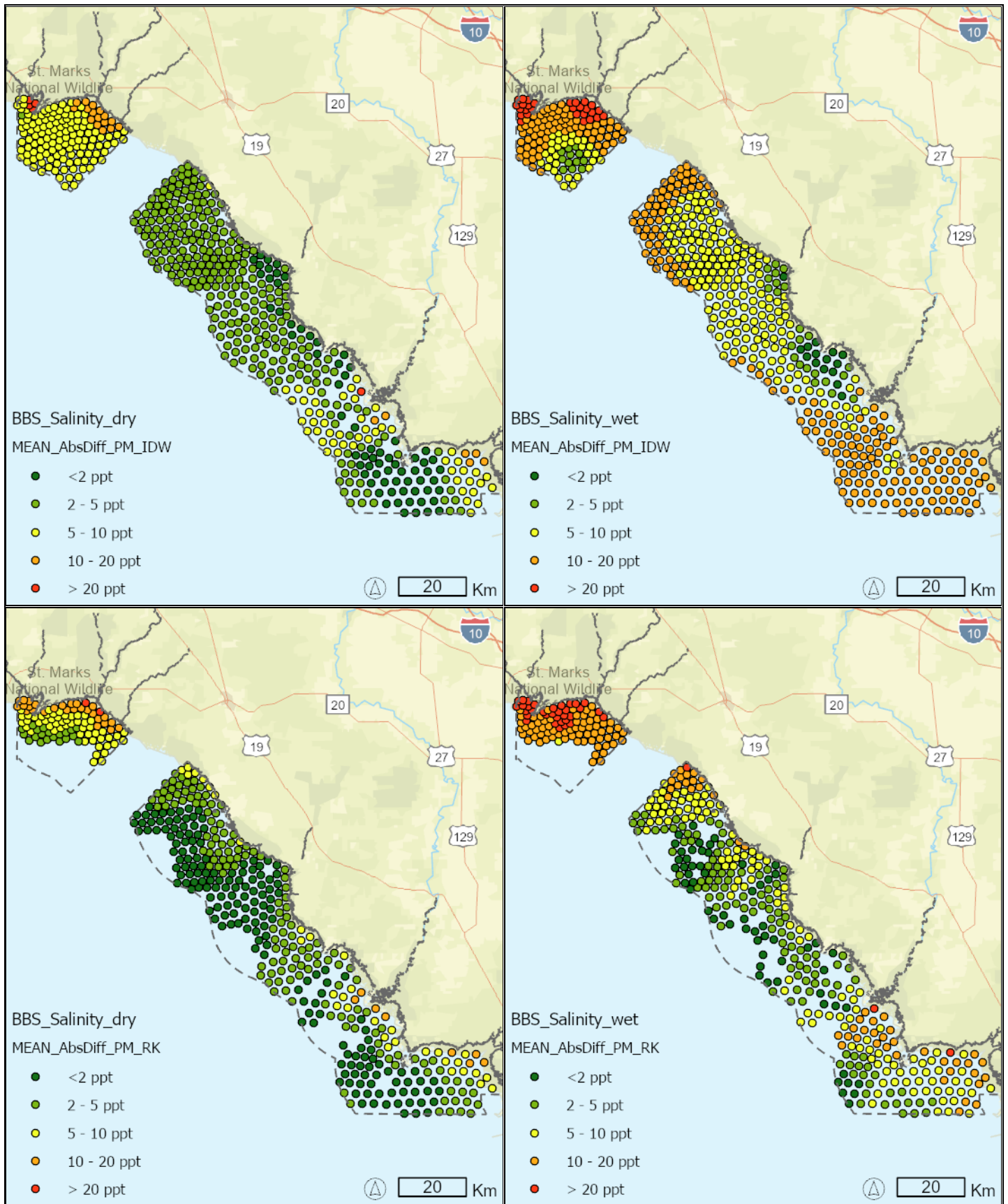


Figure 7. Mean absolute difference in Salinity for the Dry and Wet Seasons between Physical Models and IDW/RK Maps

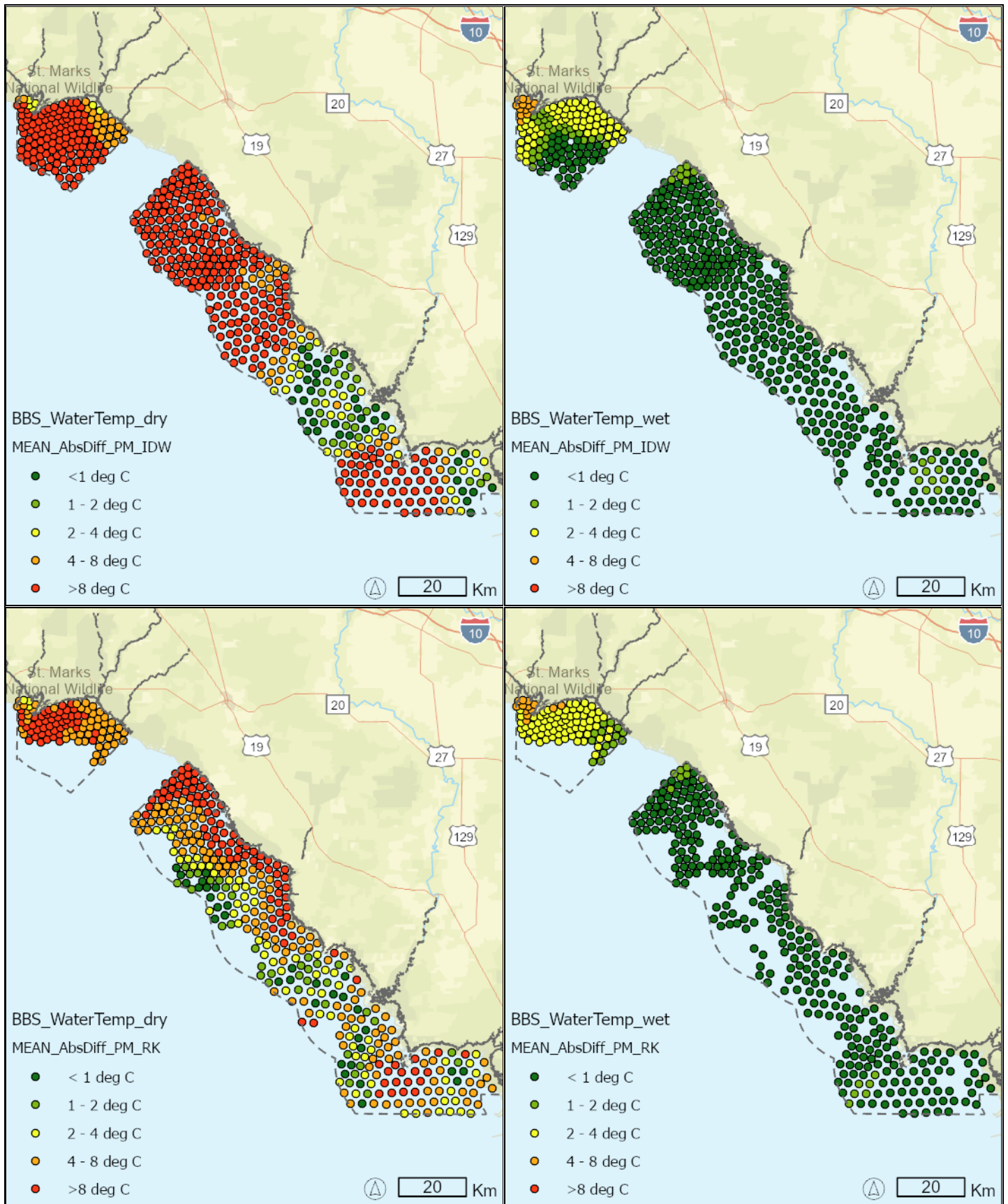


Figure 8. Mean absolute difference in Water Temperature for the Dry and Wet Seasons between Physical Models and IDW/RK Maps

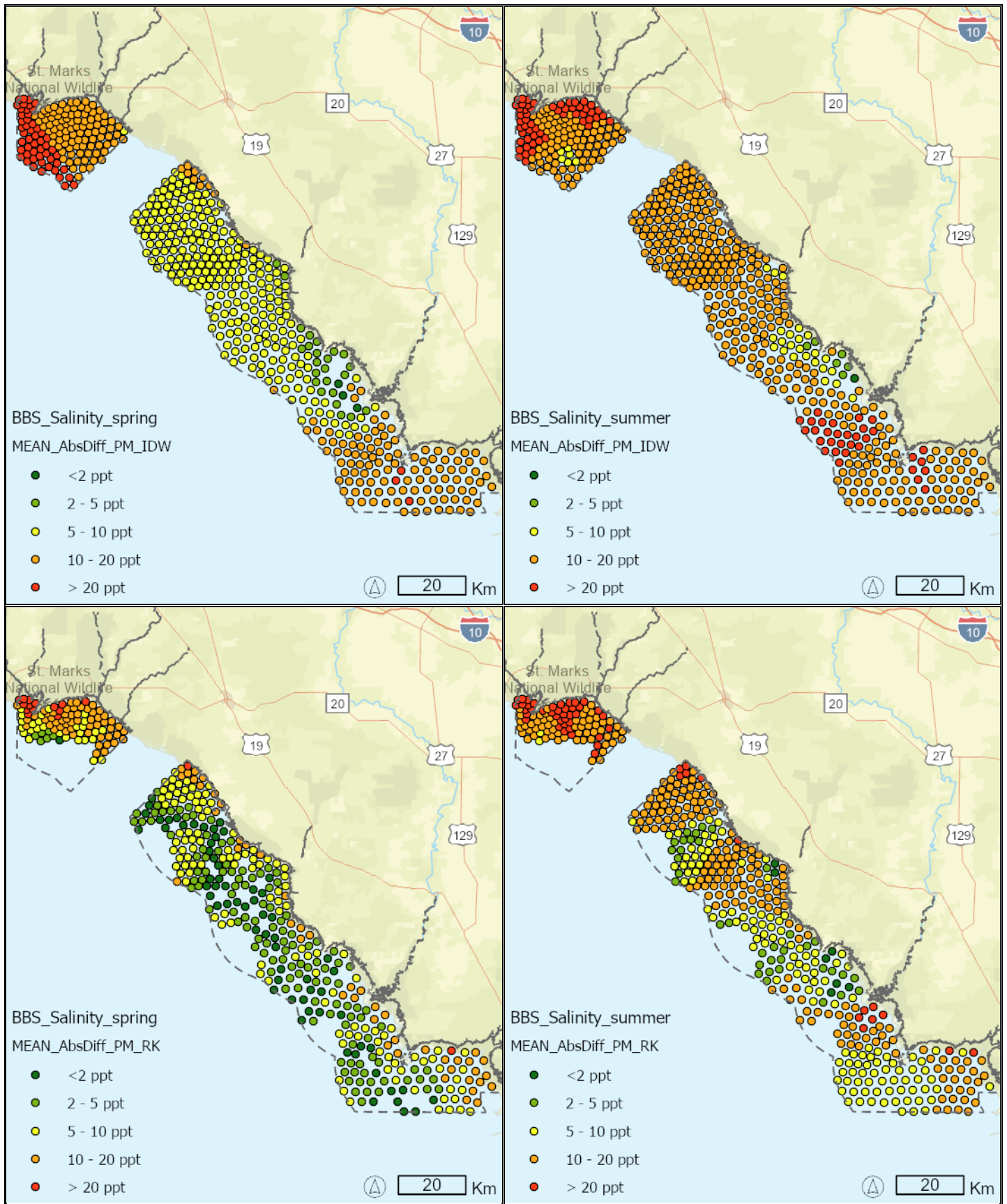


Figure 9. Mean absolute difference in Salinity for Spring and Summer Seasons between Physical Models and IDW/RK Maps

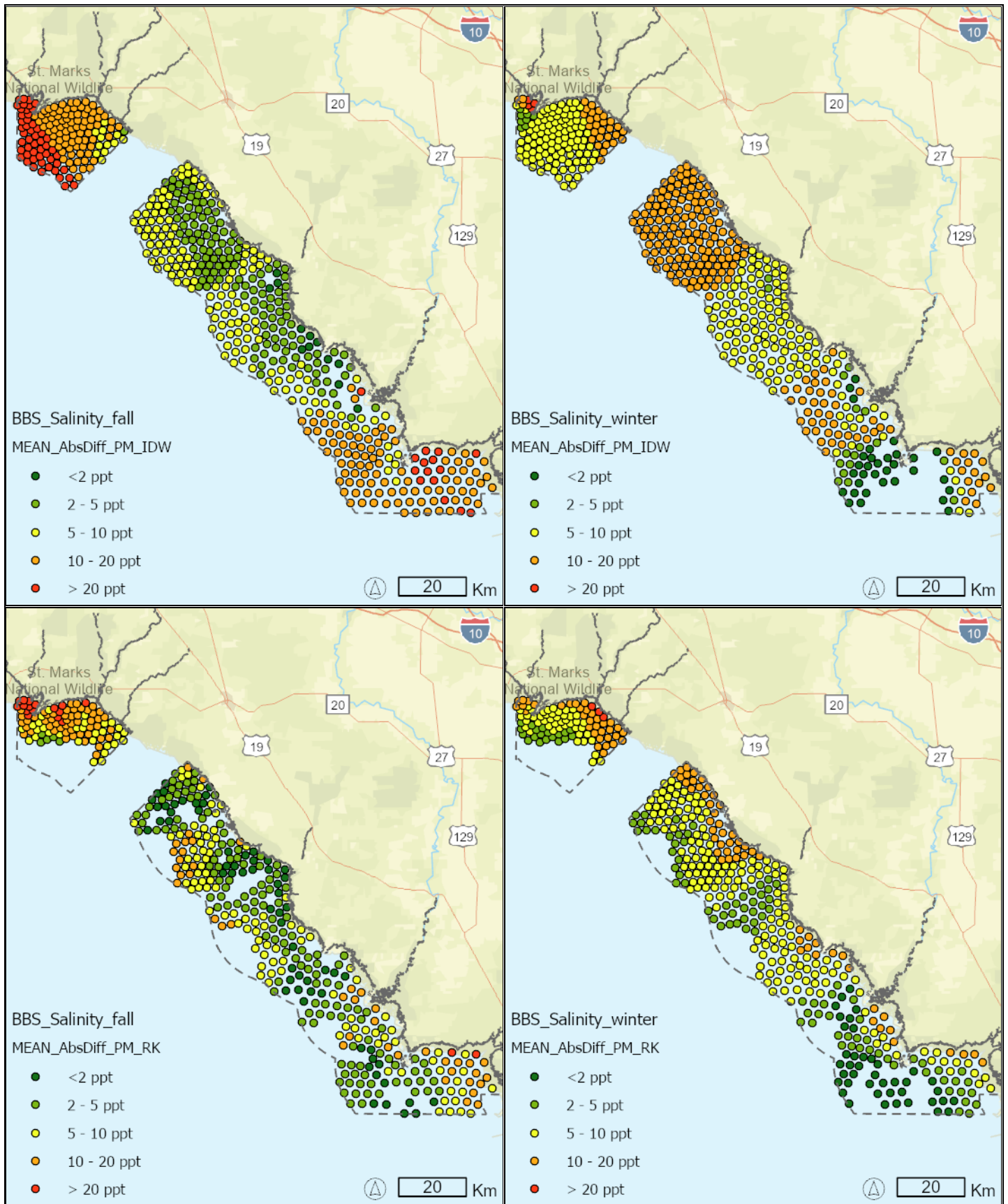


Figure 10. Mean absolute difference in Salinity for Fall and Winter Seasons between Physical Models and IDW/RK Maps

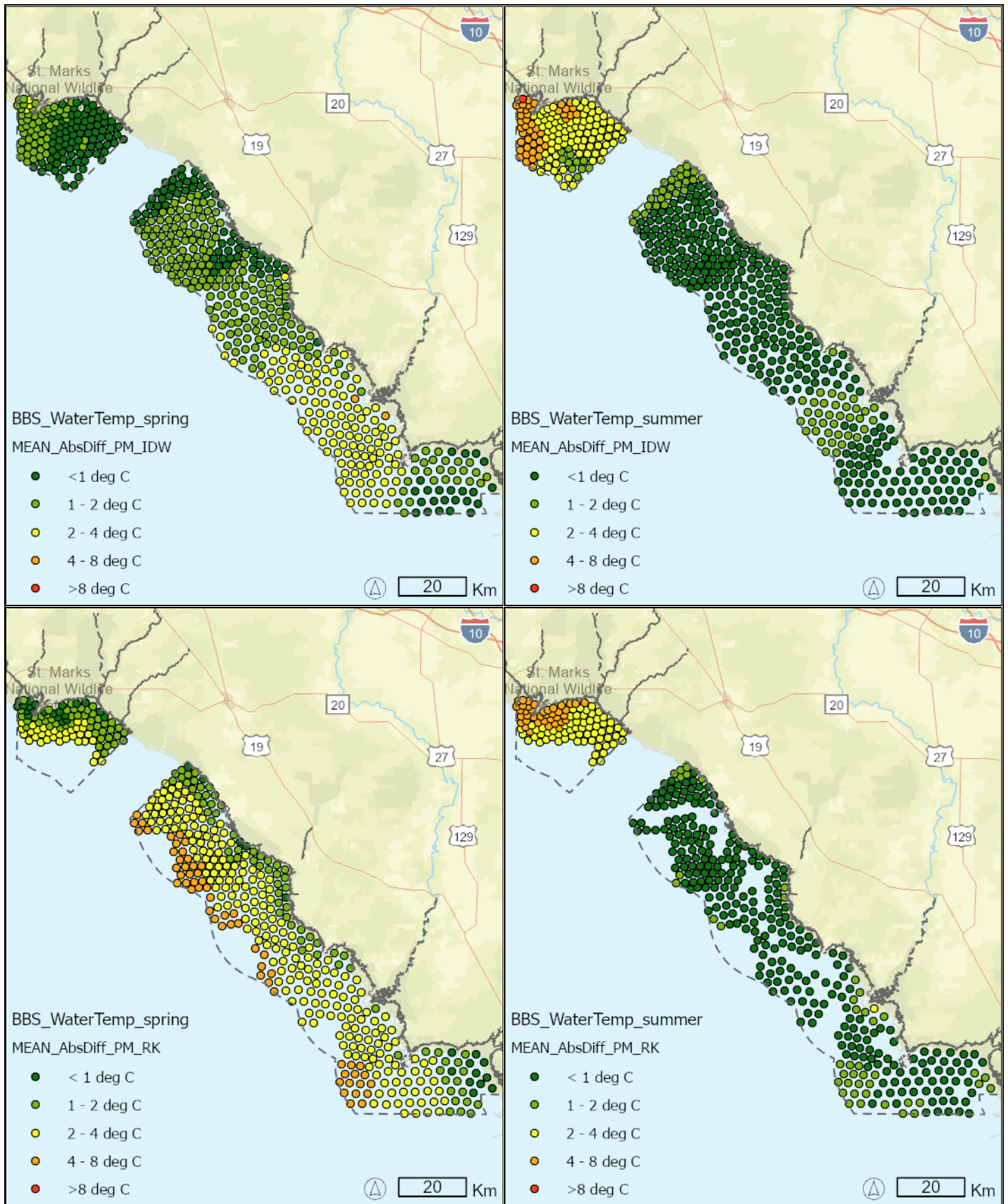


Figure 11. Mean absolute difference in Water Temperature for Spring and Summer Seasons between Physical Models and IDW/RK Maps

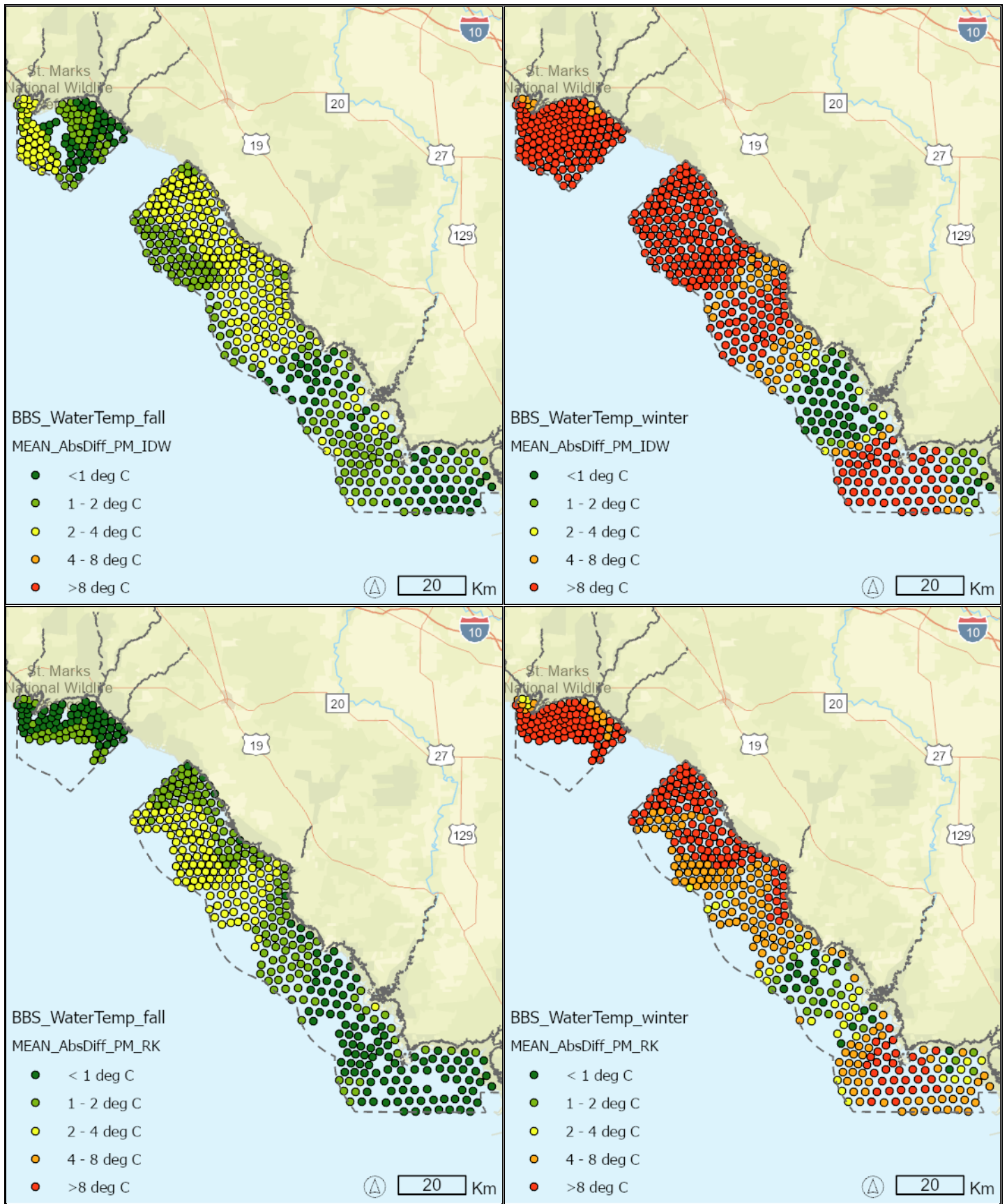


Figure 12. Mean absolute difference in Water Temperature for Fall and Winter Seasons between Physical Models and IDW/RK Maps

Charlotte Harbor Maps

Comparisons within the Charlotte Harbor section include:

- A preliminary comparison map showing differences between the hydrodynamic model outputs (labelled “Physical Models or PM”) and the values at the corresponding locations within the SEACAR data export.
- Mean absolute differences between values from PM output points and raster values from the associated (i.e., same time bin) IDW/RK maps. Mean differences are calculated for all seasons (2-season and 4-season), for wet and dry seasons, for spring, summer, fall and winter seasons, and for all weekly bins and all monthly bins, separately, for Charlotte Harbor.

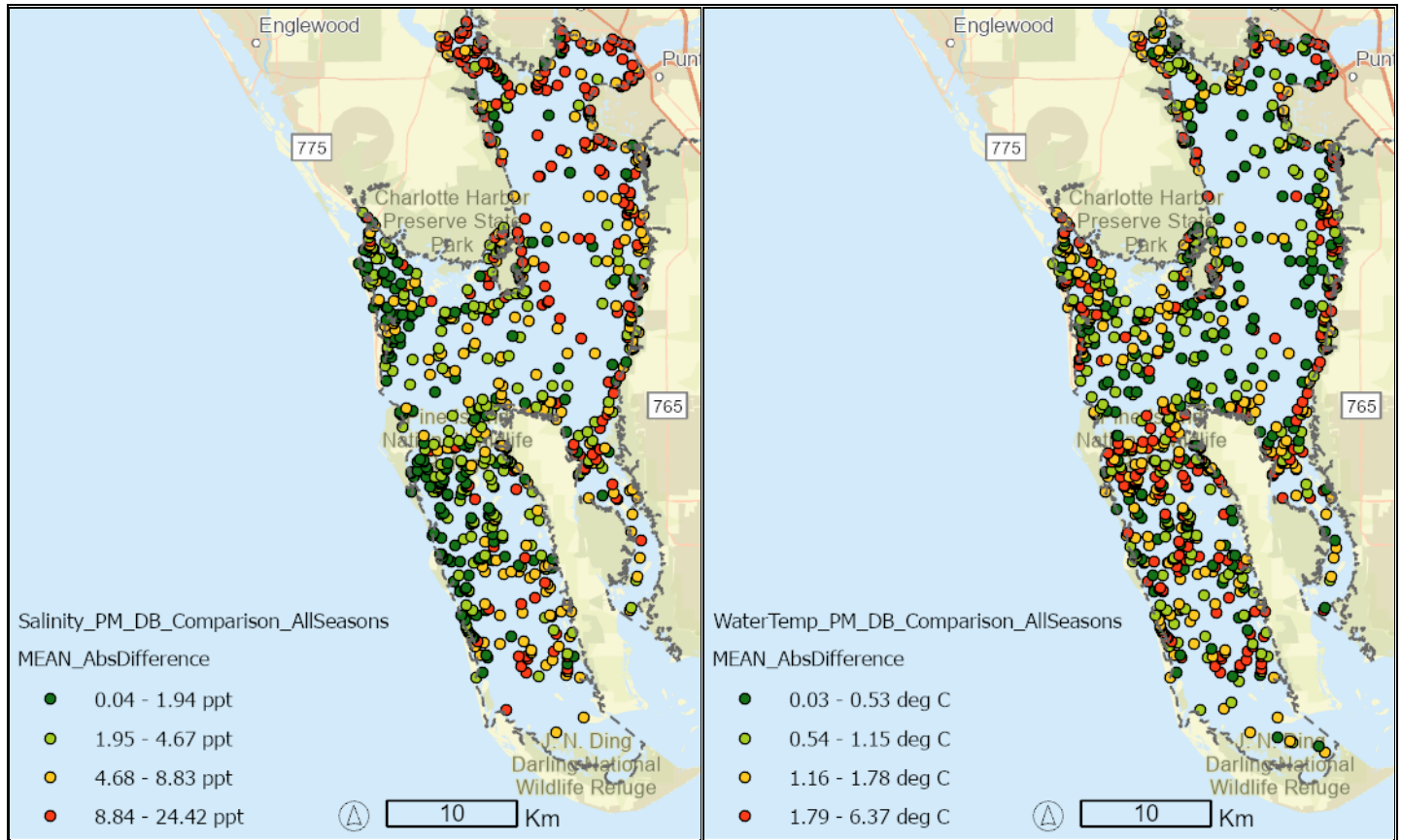


Figure 13. Mean absolute difference for All Seasons between Physical Models and Data Export Values

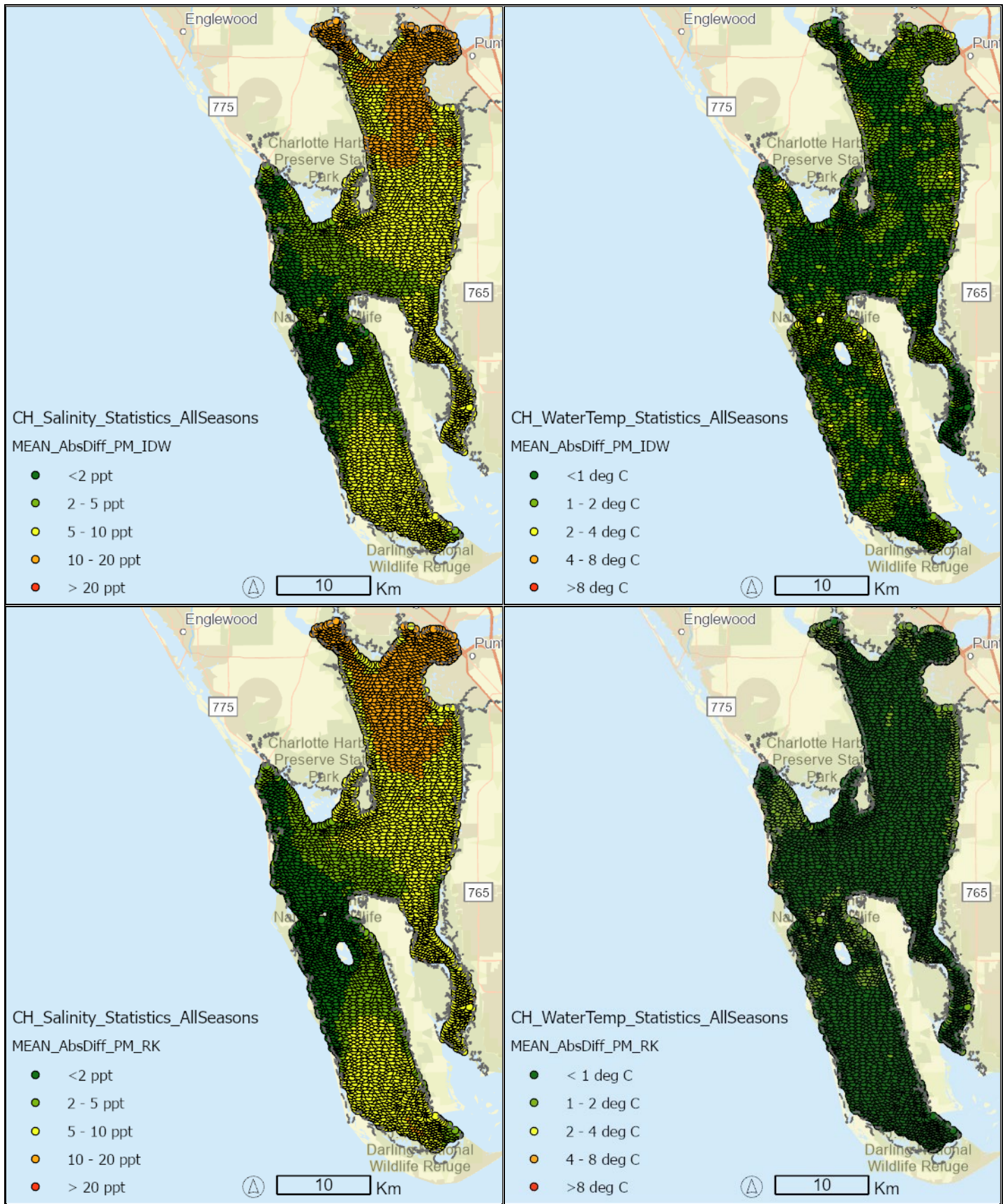


Figure 14. Mean absolute difference for All Seasons between Physical Models and IDW/RK Maps

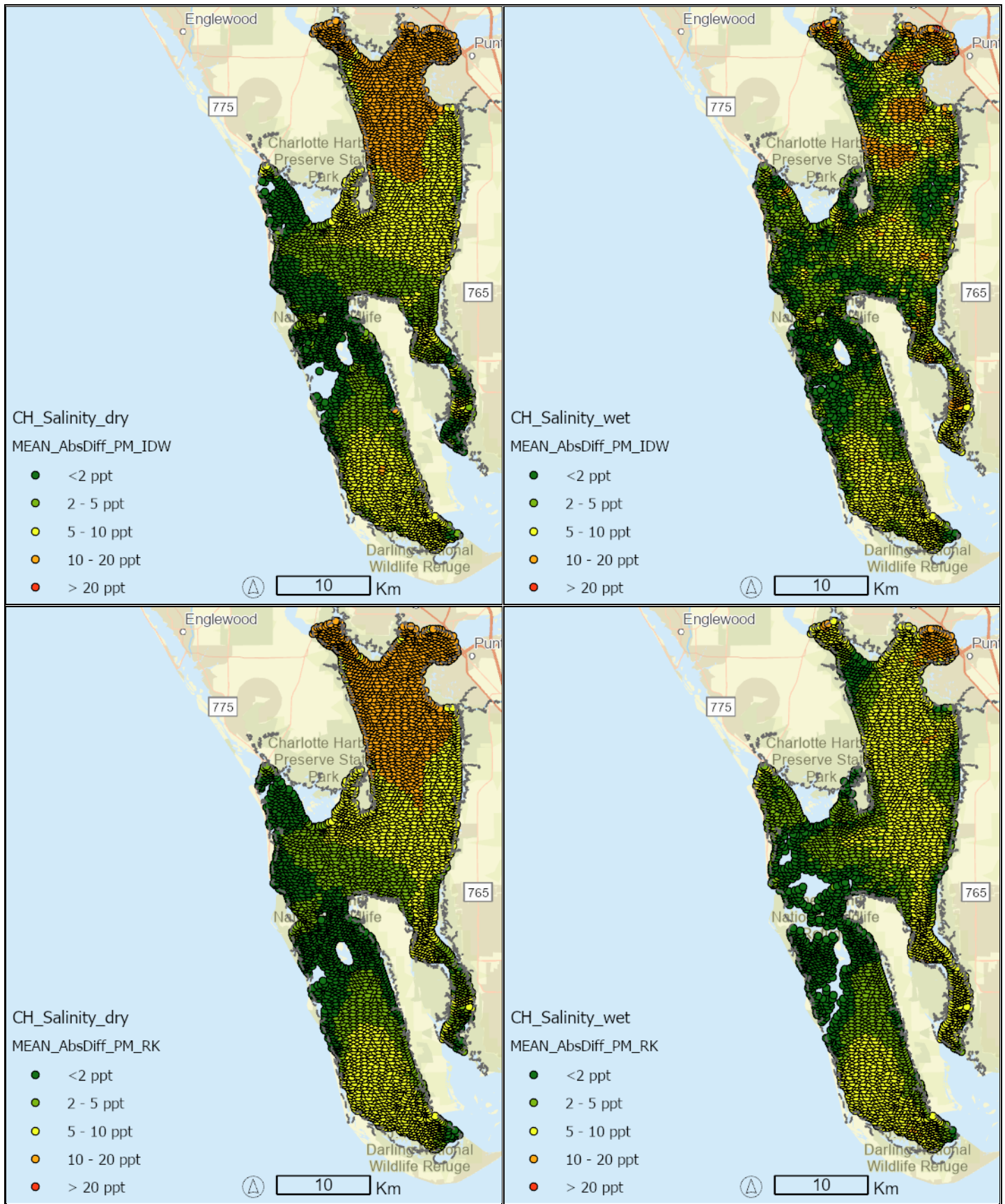


Figure 15. Mean absolute difference in Salinity for the Dry and Wet Seasons between Physical Models and IDW/RK Maps

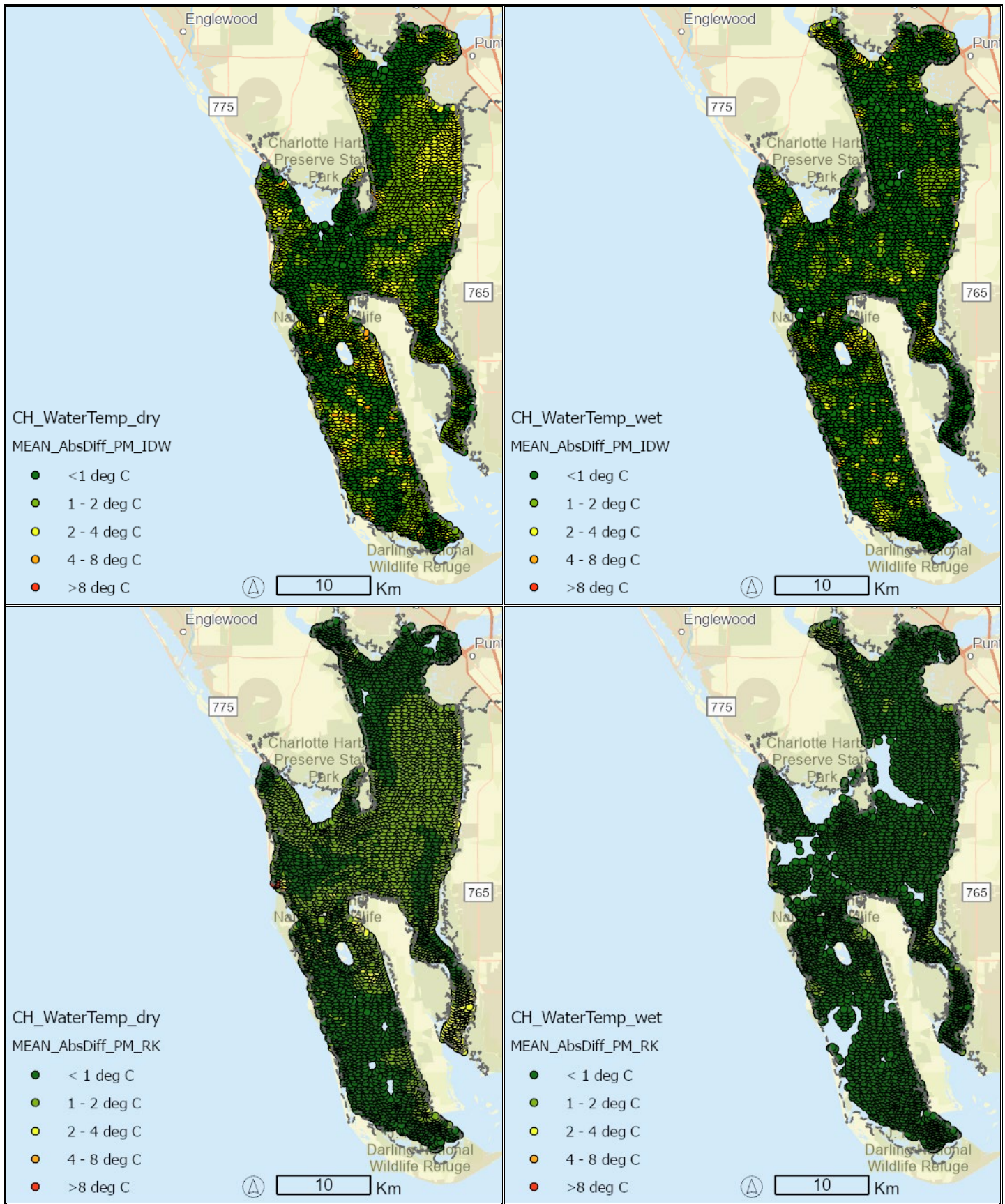


Figure 16. Mean absolute difference in Water Temperature for the Dry and Wet Seasons between Physical Models and IDW/RK Maps

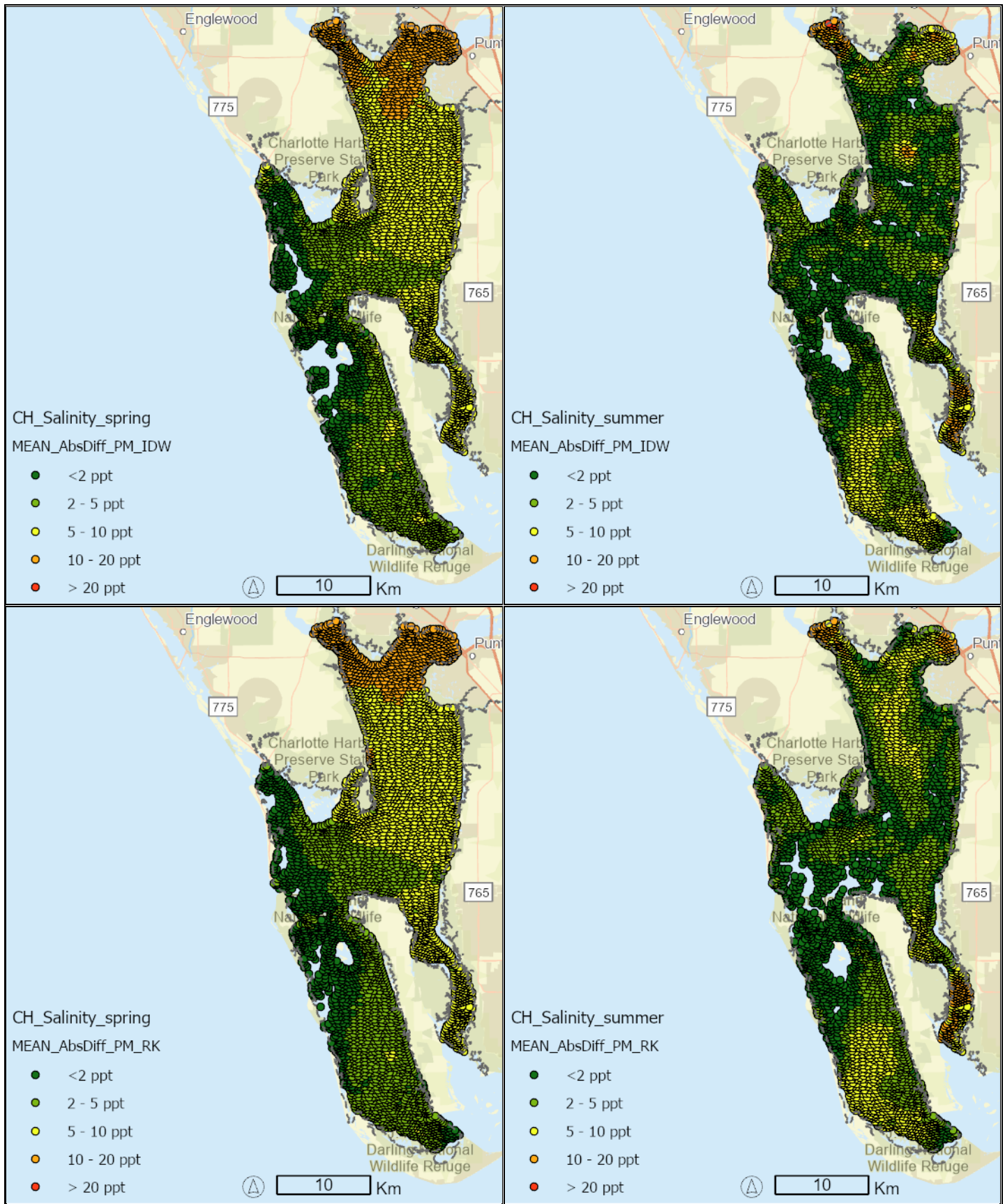


Figure 17. Mean absolute difference in Salinity for Spring and Summer Seasons between Physical Models and IDW/RK Maps

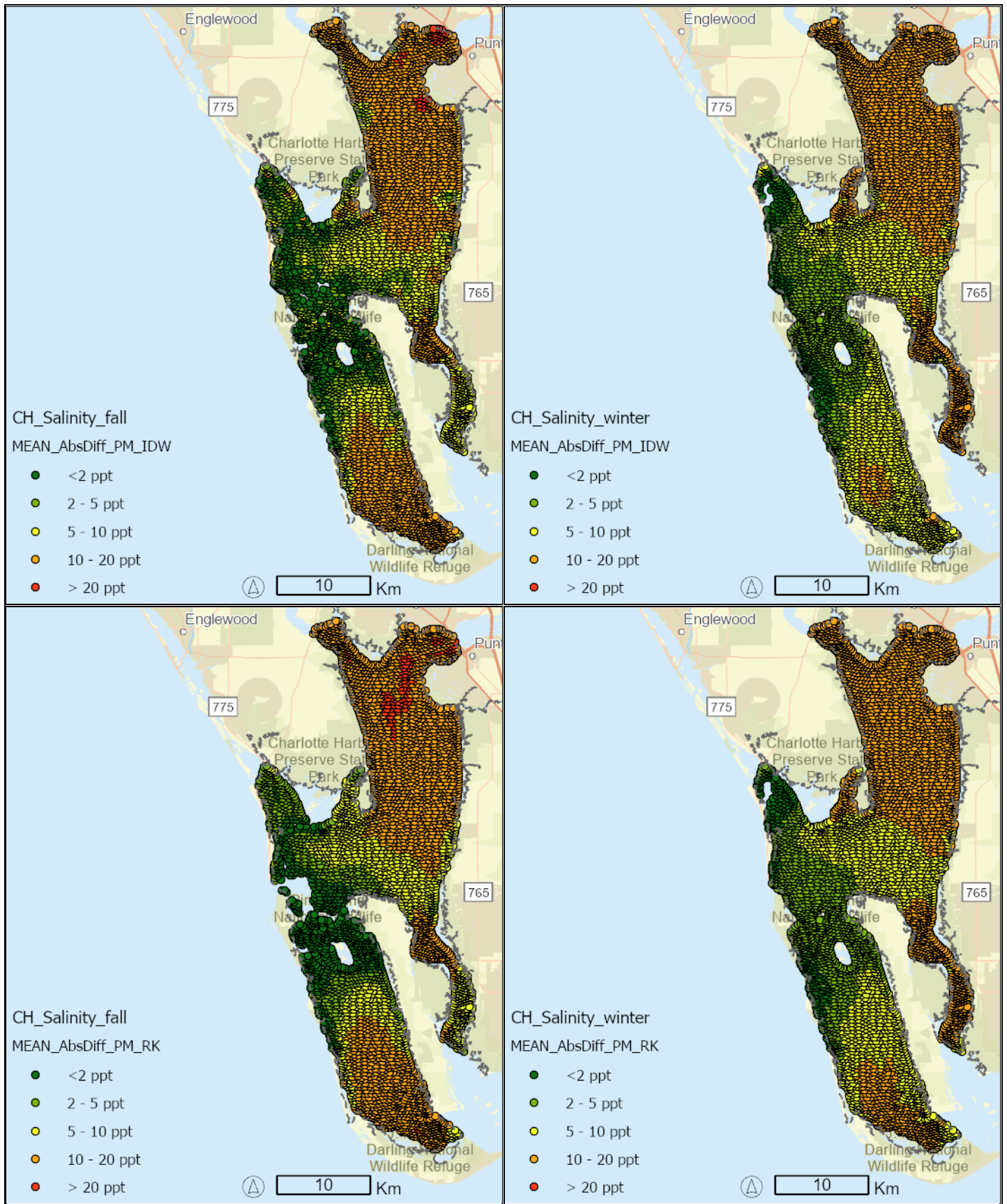


Figure 18. Mean absolute difference in Salinity for Fall and Winter Seasons between Physical Models and IDW/RK Maps

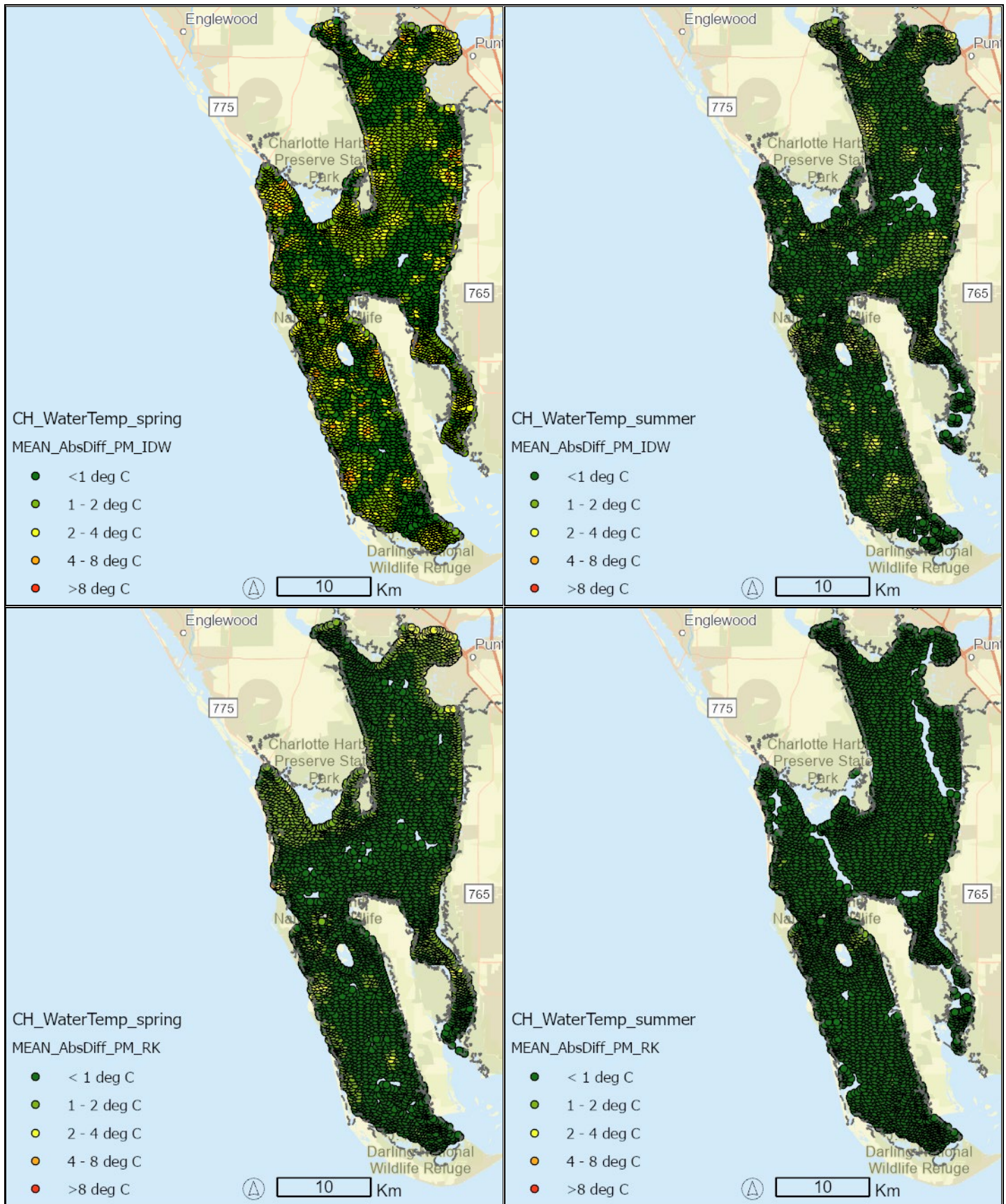


Figure 19. Mean absolute difference in Water Temperature for Spring and Summer Seasons between Physical Models and IDW/RK Maps

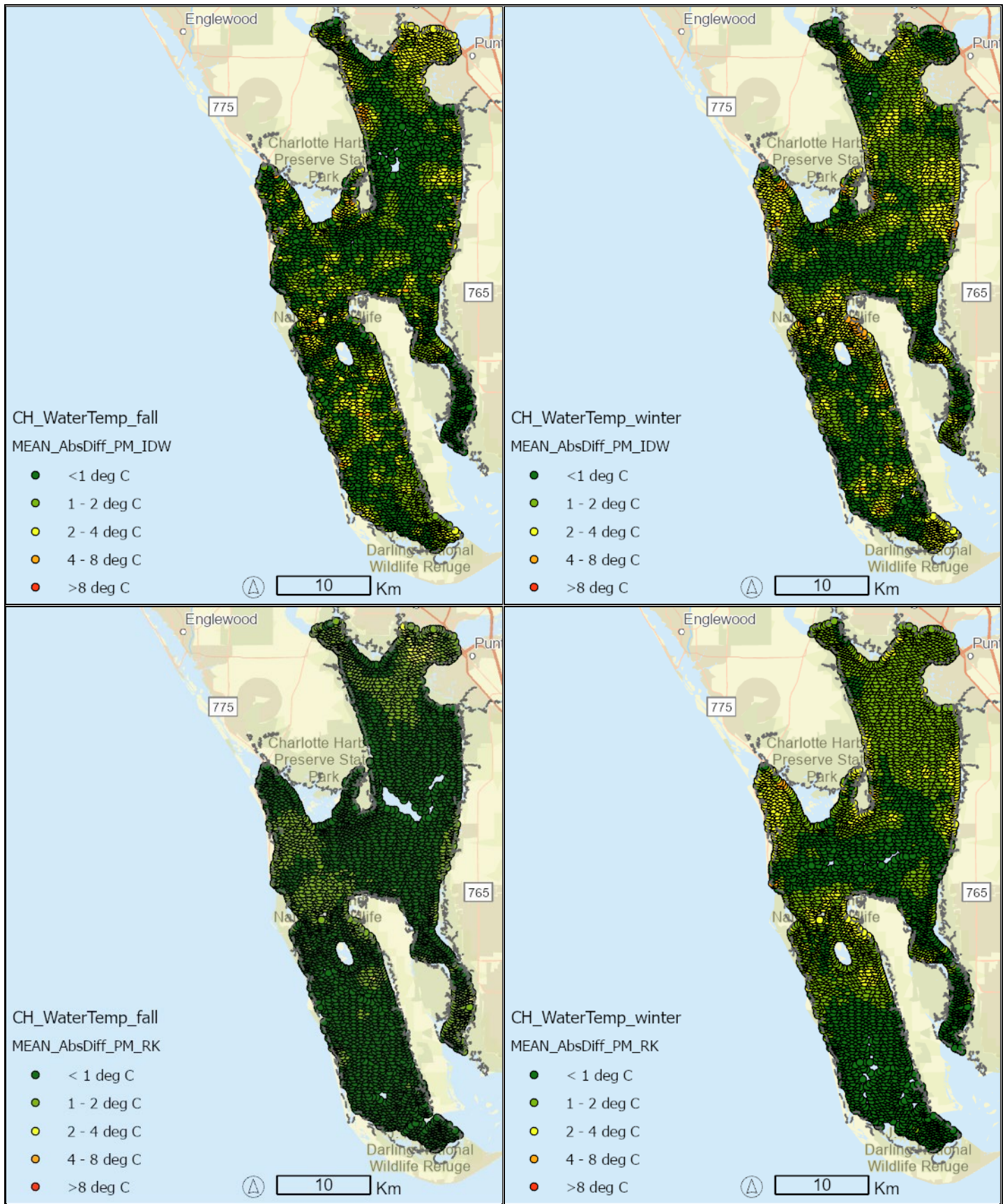


Figure 20. Mean absolute difference in Water Temperature for Fall and Winter Seasons between Physical Models and IDW/RK Maps

Direction of Differences

The general direction of the differences is very consistent. The physical models generally estimate higher water temperature for both Big Bend and Charlotte Harbor (PM minus IDW/RK is negative), but lower salinity for Big Bend, and higher salinity for Charlotte Harbor. Tables and maps on the following pages illustrate the general direction of the differences.

Table 5. Salinity: Direction of differences using Mean Difference of the 2-Season and 4-Season PM vs IDW and PM vs RK salinity models.

<i>Season Definition</i>	MAE PM vs IDW	Mean Difference PM vs IDW	MAE PM vs RK	Mean Difference PM vs RK
<i>BBS All Seasons Combined</i>	10.74	10.56	7.52	6.43
<i>2-Seasons Combined</i>	8.14	7.93	6.15	5.74
<i>Dry</i>	5.10	4.85	4.08	3.62
<i>Wet</i>	11.19	11.01	8.22	7.86
<i>4-Seasons Combined</i>	12.03	11.87	8.21	6.77
<i>Fall</i>	10.61	10.35	6.74	3.04
<i>Spring</i>	12.54	12.31	6.96	5.02
<i>Summer</i>	15.85	15.80	12.46	12.43
<i>Winter</i>	9.13	9.03	6.68	6.59
<i>CH All Seasons Combined</i>	6.25	-5.76	6.40	-6.17
<i>2-Seasons Combined</i>	5.38	-4.80	5.39	-5.17
<i>Dry</i>	5.94	-5.87	6.24	-6.20
<i>Wet</i>	4.82	-3.73	4.55	-4.14
<i>4-Seasons Combined</i>	6.69	-6.24	6.90	-6.66
<i>Fall</i>	9.62	-9.08	9.99	-9.73
<i>Spring</i>	5.09	-5.03	5.04	-5.04
<i>Summer</i>	3.21	-2.04	3.33	-2.68
<i>Winter</i>	8.84	-8.81	9.22	-9.21
<i>ALL Seasons, Both Waterbodies</i>	6.68	-4.19	6.49	-5.13

Table 6. Water Temperature: Direction of differences using Mean Difference of the 2-Season and 4-Season PM vs IDW and PM vs RK water temperature models.

<i>Season Definition</i>	MAE PM vs IDW	Mean Difference PM vs IDW	MAE PM vs RK	Mean Difference PM vs RK
<i>BBS All Seasons Combined</i>	3.78	-2.66	3.25	-2.47
<i>2-Seasons Combined</i>	4.28	-3.26	3.46	-2.32
<i>Dry</i>	7.65	-7.36	5.95	-5.33
<i>Wet</i>	0.91	0.84	0.97	0.69
<i>4-Seasons Combined</i>	3.53	-2.36	3.14	-2.54
<i>Fall</i>	1.57	-0.37	1.25	-1.01
<i>Spring</i>	1.48	-0.93	2.57	-2.55
<i>Summer</i>	1.42	1.42	1.21	0.70
<i>Winter</i>	9.65	-9.54	7.52	-7.30
<i>CH All Seasons Combined</i>	1.06	-0.36	0.71	-0.42
<i>2-Seasons Combined</i>	0.99	-0.43	0.69	-0.48
<i>Dry</i>	1.21	-0.61	0.98	-0.83
<i>Wet</i>	0.76	-0.25	0.41	-0.14
<i>4-Seasons Combined</i>	1.10	-0.32	0.72	-0.39
<i>Fall</i>	1.12	0.28	0.72	-0.09
<i>Spring</i>	1.27	-0.63	0.66	-0.41
<i>Summer</i>	0.64	-0.09	0.39	-0.09
<i>Winter</i>	1.37	-0.84	1.12	-0.95
<i>ALL Seasons, Both Waterbodies</i>	1.32	-0.58	0.92	-0.59

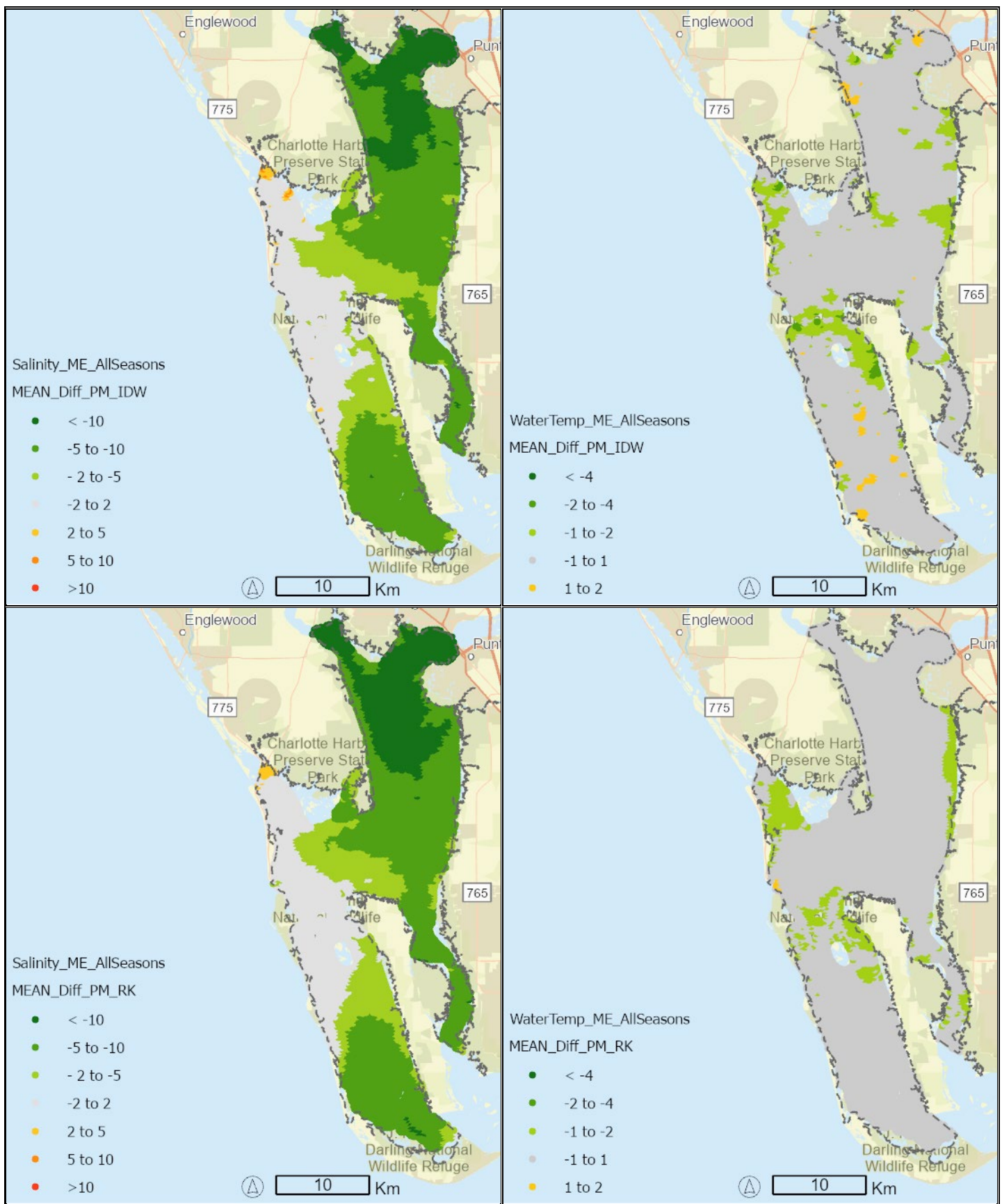


Figure 21. Mean difference for All Seasons between Physical Models and IDW/RK Maps

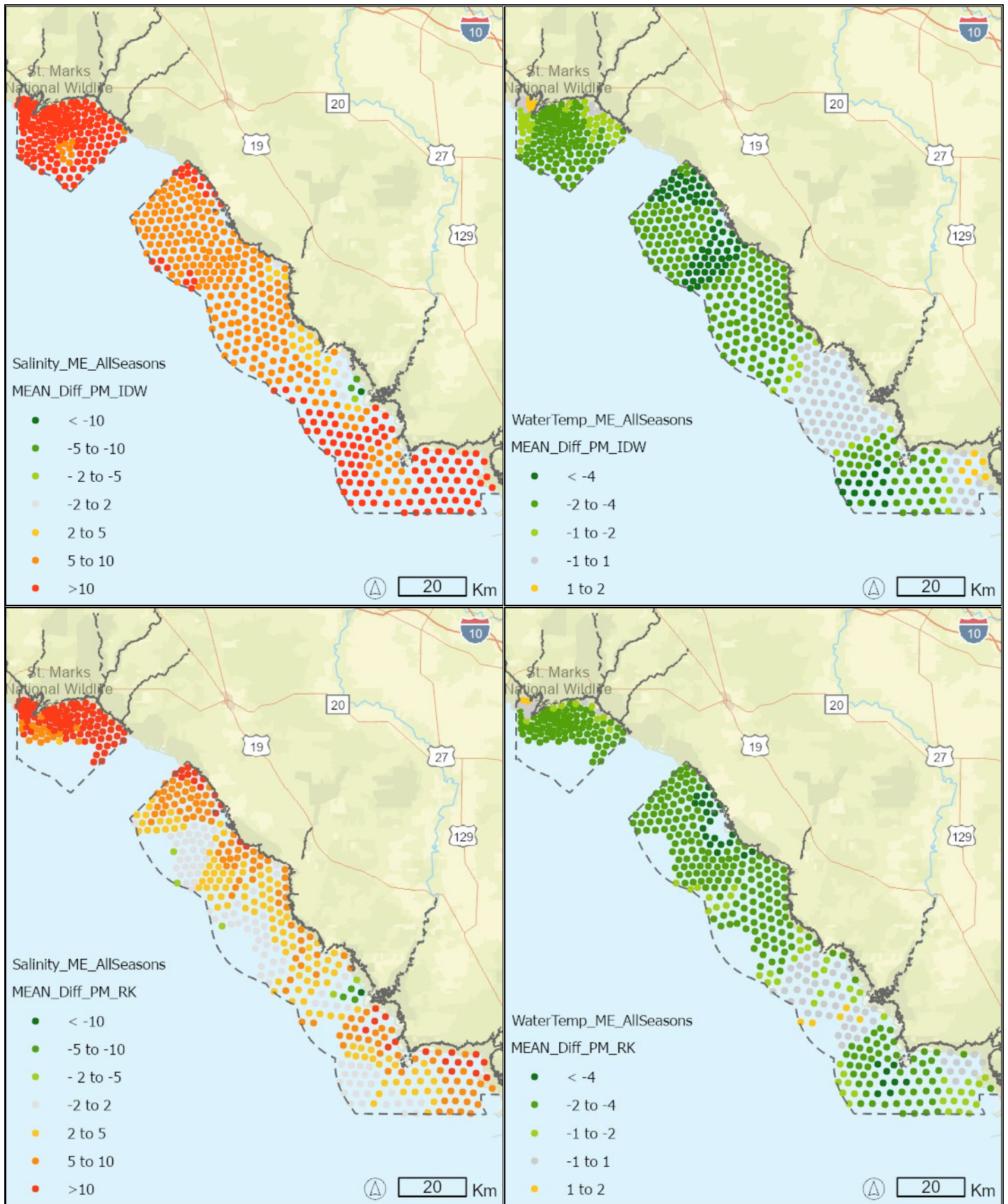


Figure 22. Mean difference for All Seasons between Physical Models and IDW/RK Maps