Tidal waters interpolator grid:
Proposed resolution modifications
Draft: 4/20/2026

Background

To conduct a dissolved oxygen (DO) criteria assessment in the tidal waters of the Chesapeake Bay, DO data is interpolated to a grid that fills the volume of each segment. The gridded interpolation results are then summarized by segment and time as they are compared to the applicable water quality criteria. A spatial grid exists for the 3-D interpolation approach. For the new space-time (4-D) interpolation, we want to use the same spatial grid as the 3-D tool (Figure 1). This decision was made for consistency, and due to the work already invested to build this interpolation grid.

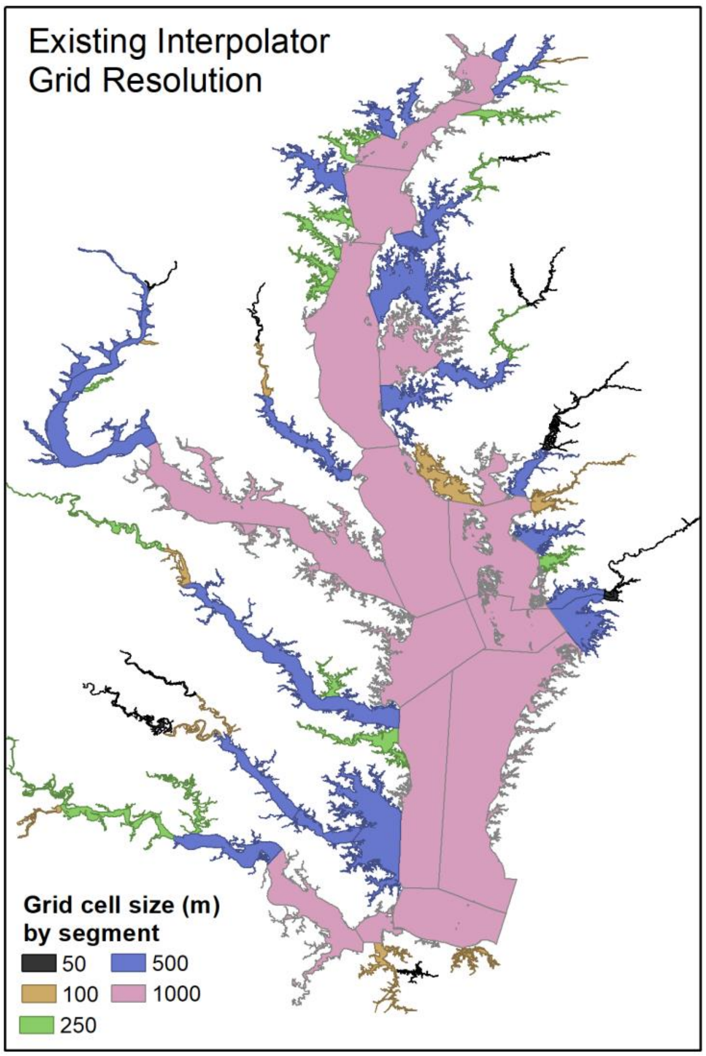


Figure 1. 3D interpolator grid horizontal resolution by segment. Grid cell size indicates both length and width dimensions. All cells are 1m deep.

The original (3-D) interpolation grid consists of grid cells that are all 1m deep. The 1m grid cells are stacked in columns that extend to bottom of the water. The number of grid cells in the vertical varies throughout the Bay based on bathymetry. The grid resolution in the horizontal varies by segment and was designed to allow for finer resolution in segments with more constricted geography than in more open regions. All cells are square when viewed from the surface (e.g., dimensions of a 50 m cell are 50 m long x 50 m wide x 1m deep). Figure 1 color-codes the segments by horizontal grid cells size.

The majority of area of the Bay is covered with 1km x 1km grid cells (pink segments in Figure 1). Additional grid cell horizontal resolutions in the tidal tributaries are 500m, 250 m, 100 m, and 50 m. Table 1 presents the count of segments and total surface area covered by each of these grid cell size resolutions.

Table 1. Segment count by grid size, matching Figure 1

Cell size	Number of segments	Area (km^2)
50 m	15	91
100 m	15	265
250 m	19	497
500 m	26	2,467
1 km	17	8,341

Review of Nov. 2025 discussions

A draft version of the 4-D interpolator was fit to data in every segment of the Chesapeake Bay for one year. Our goal is to implement the tool so that it could be run on a standard 32-GB laptop for ease of transfer to analysts at partner organizations and states, even if run times are longer than they would be on a workstation.

In November 2025, we presented findings that it was not possible to perform simulations with a standard 32-GB laptop for four segments with 50 m grid resolutions: CHOTF, PMKTF, MPNTF, NANOH. One additional segment with a 100 m density (HNGMH) also took a large amount of laptop computer resources in comparison to other segments. The development team did some testing "thinning" the resolution of these five segments to either 100 m or 200 m (for HNGMH) and presented this in a document dated 11-6-25 and a presentation to the Bay Oxygen Research Group on 11-17-25. The take-away from the discussion was that it appeared acceptable to thin these five segments, but that we should consider whether all of the 50 m segments could be thinned to 100 m with minimal impact on the results. The development team undertook this task, and it is documented here.

An additional step we have taken that is documented here is to test whether the resolution of any of the originally 100 m segments should be thinned. This possibility seemed useful as we began generating draft simulation results of all segments and calculating total computing time as well as file space for results.

Results: Grid resolutions

Table 2 includes a list of the 15 segments in the original interpolation grid that have 50 m resolution. As we tested the impact of thinning on these 15 segments, the results and the draft 4D interpolation run-times also led us to consider if any of the 100 m grid cells could be thinned as well. Table 3 lists the 15 segments with originally 100 m resolution.

As shown in Tables 2 and 3, the segments with originally 50 m and 100 m resolutions are spread among the tidal regions. Some have many thousands of grid cells, but several have very few cells due to their small size. The smallest segments will need to be examined closely because reducing resolution may not be the best choice.

Table 2. All originally 50 m grid-cell segments and locations. Counts are the number of total grid cells if the cell length stays at 50 m versus is changed to 100 m.

segment	state	description	count at 50m	count at 100m	discussed previously
ANATF_DC	DC	Anacostia River, DC	4,971	1,247	
NANTF_DE	DE	Upper Nanticoke, DE	1,307	340	
ANATF_MD	MD	Anacostia River, MD	69	15	
CHOTF	MD	Upper Choptank River	5,767	1,473	yes
CHSTF	MD	Upper Chester River	1,345	331	
NANOH	MD	Middle Nanticoke River	17,995	4,482	yes
NANTF_MD	MD	Upper Nanticoke, MD	1,339	348	
PAXTF	MD	Upper Patuxent River	4,406	1,105	
POCOH_MD	MD	Middle Pocomoke River, MD	4,161	1,066	
POCTF	MD	Upper Pocomoke River	1,788	454	
WBRTF	MD	Western Branch Patuxent River	45	14	
EBEMH	VA	Eastern Branch Elizabeth River	2,584	652	
MPNTF	VA	Upper Mattaponi River	7,203	1,813	yes
PMKTF	VA	Upper Pamunkey River	11,452	2,864	yes
POCOH_VA	VA	Middle Pocomoke River, VA	3,039	775	

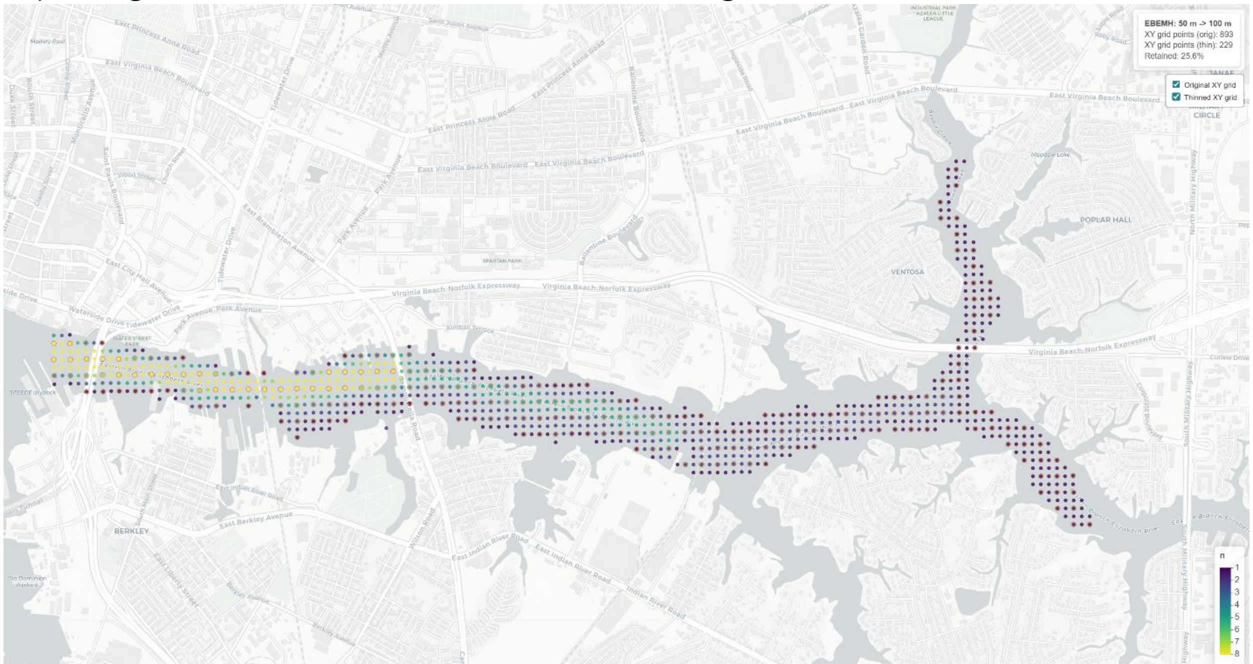
Table 3. All originally 100 m grid-cell segments and locations. Counts are the number of total grid cells if the cell length stays at 100 m versus is changed to 200 m.

segment	state	description	count at 100m	count at 200m	discussed previously
C&DOH_DE	DE	C&D Canal, DE	790	177	
C&DOH_MD	MD	C&D Canal, MD	1,623	421	
HNGMH	MD	Honga River	18,568	4,654	yes
PAXOH	MD	Middle Patuxent River	2,718	669	
PISTF	MD	Piscataway Creek	285	71	
WICMH	MD	Wicomico River	5,642	1,450	
APPTF	VA	Appomattox River	151	36	
ELIPH	VA	Mouth to mid Elizabeth River	11,753	2,945	
LAFMH	VA	Lafayette River	339	85	
LYNPH	VA	Lynnhaven River	1,676	406	
MPNOH	VA	Lower Mattaponi River	3,341	844	
PMKOH	VA	Lower Pamunkey River	6,668	1,634	
RPPOH	VA	Middle Rappahannock River	5,355	1,328	
SBEMH	VA	Southern Branch Elizabeth River	2,773	682	
WBEMH	VA	Western Branch Elizabeth River	631	162	

Figures 2 and 3 show two examples segments with the original 50 m grid in panel a and the thinned100 m grid in panel b. EBEMH in Figure 2 shows an example of the thinned grid still covering the segment fairly well. ANATF_MD is the second smallest of the 50 m grids (Table 2), and Figure 3 demonstrates how thinning the grid does not cover the segment as well as the original. Maps for all 50 m-to-100 m thinning are on the 4-20-26 BORG meeting site under Supporting Documents to download in a zip file here.

Figures 4 and 5 show two examples segments with the original 100 m grid in panel a and the thinned 200 m grid in panel b. WICMH in Figure 4 is one of the larger cell count segments, and the thinning maps shows that even the upper part of the tributary still retains good grid cell coverage when thinned. APPTF is the smallest of the 100 m grids (Table 3), and Figure 5 shows how thinning lead to a very small cell count, but the grid still covers the area. Maps for all 100 m-to-200 m thinning are on the 4-20-26 BORG meeting site under Supporting Documents to download in a zip file here.

2a) 50 m grid centroid locations, with 100 m thinned grid outlined in red



2b) 100 m grid centroid locations.

Figure 2. Maps of grid cell centroids for Virgina's Eastern Branch Elizabeth River (EBEMH) at 50 m resolution (a) and 100 m resolution (b).

3a) 50 m grid centroids

3b) 100 m grid centroids

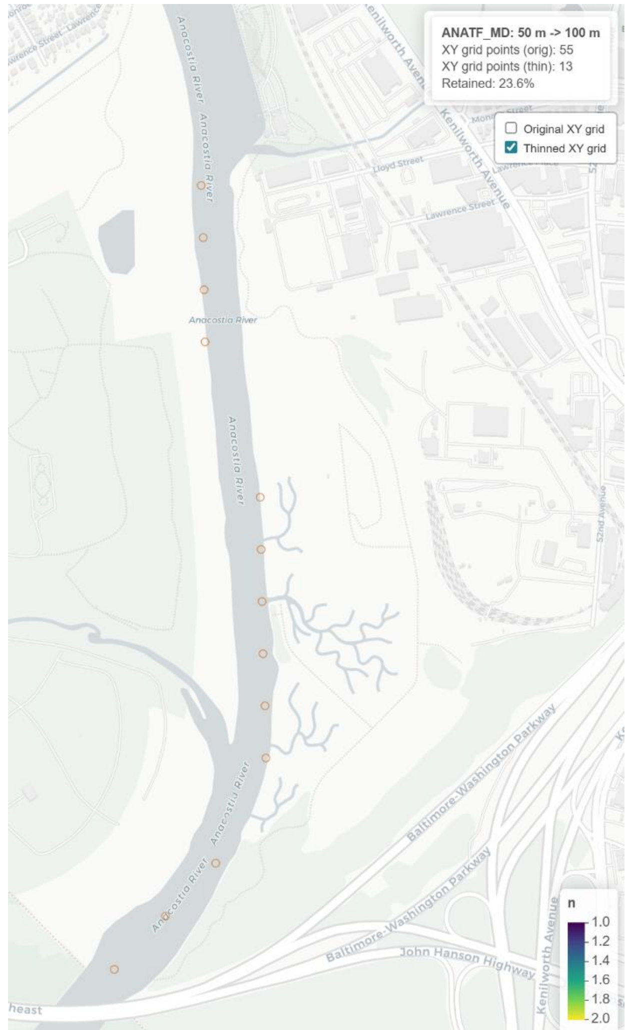
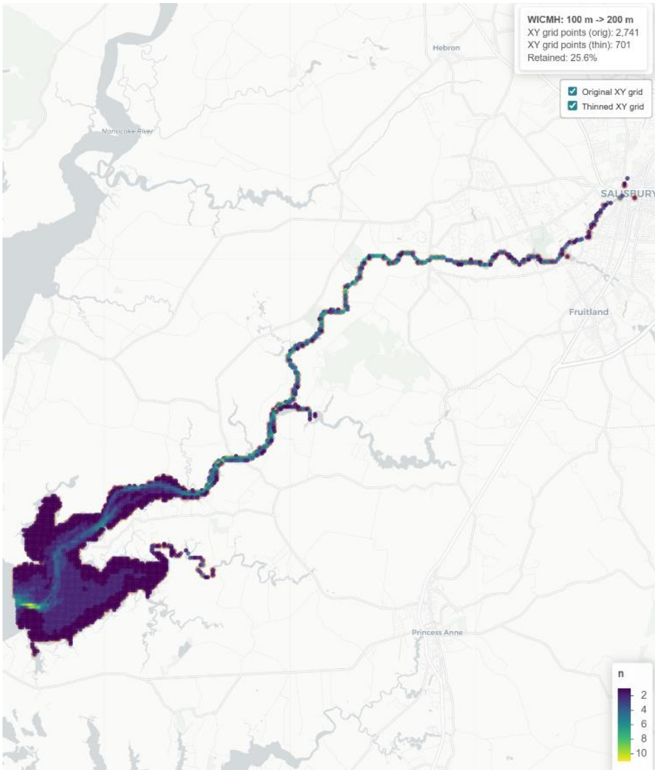


Figure 3. Maps of grid cell centroids for Maryland's Anacostia Tidal Fresh segment (ANATF_MD) at 50 m resolution (a) and 100 m resolution (b).

4a) 100 m grid centroid locations, with 200 m thinned grid outlined in red



4b) 200 m grid centroid locations.

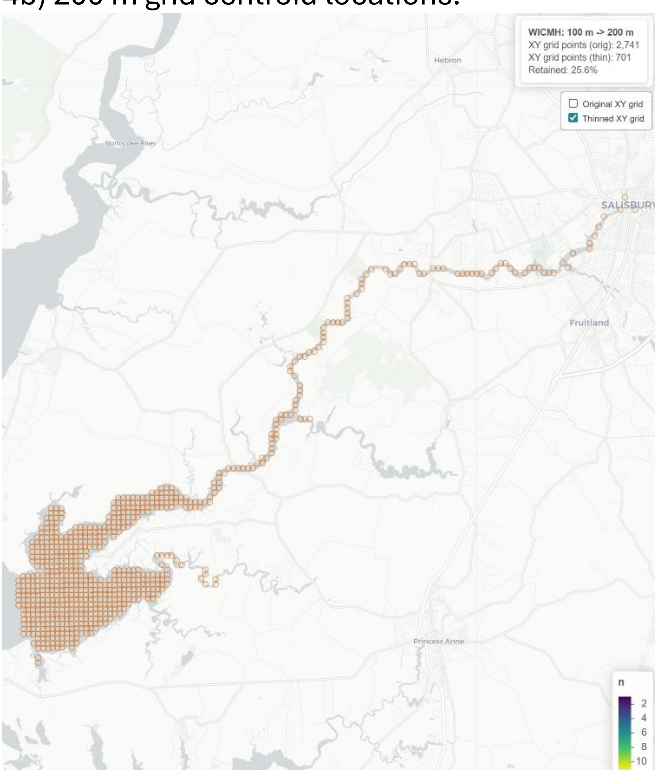
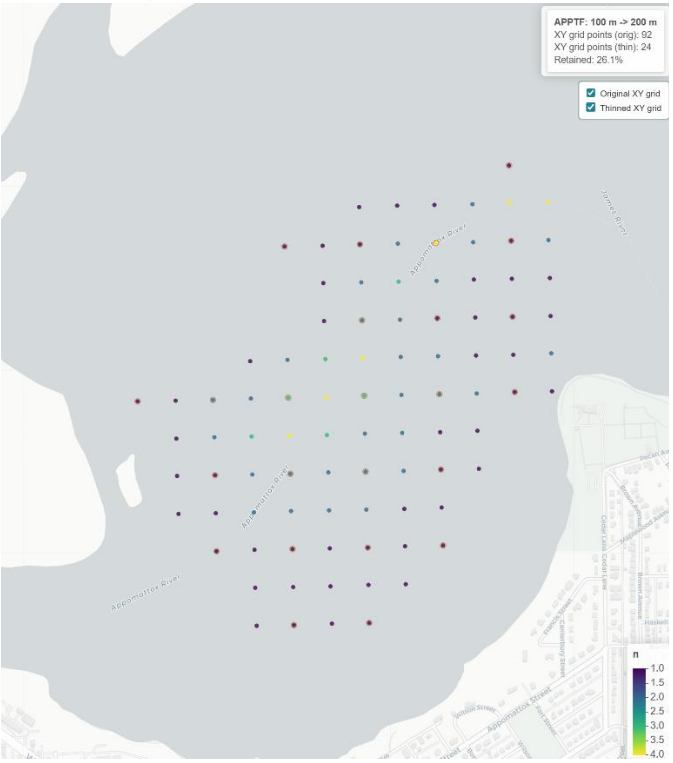


Figure 4. Maps of grid cell centroids for Maryland's Wicomico River (WICMH) at 50 m resolution (a) and 100 m resolution (b).

5a) 100 m grid centroid locations, with 200 m thinned grid outlined in red



5b) 200 m grid centroid locations.

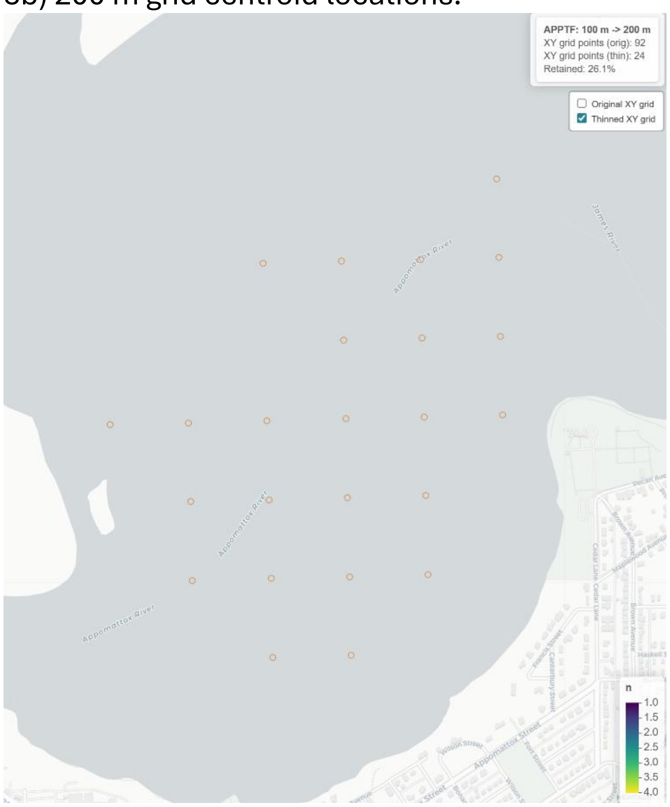


Figure 5. Maps of grid cell centroids for Virgina's Appomattox River (APPTF) at 100 m resolution (a) and 200 m resolution (b).

Results: Depth distribution changes

We summarized the distribution of grid cell depths for each segment with original vs. thinned grid cells. The goal here was to determine whether thinning any of the segment grids resulted in a change in the vertical representation of the segment. If the proportion of very deep cells is different after thinning, for example, this might be a reason not to thin the grid. Figures 6 and 7 show an empirical cumulative density function graph (ECDFs) for each segment with black lines representing the original grids and red lines presenting the thinned grids.

In Figure 6, for most segments, thinned from 50 m to 100 m, the black and red lines overlay each other. A difference is apparent in ANATF_MD. For this segment, the entire grid is only 1 or 2 vertical layers deep (0.5 or 1.5m mean depth). There are also very few cells, so thinning to 100 m resolution resulted in 13% of the grid being 1.5 m deep instead of 20% of it originally. WBRTF does not appear to show up on its graph, but that is because all of the grid in that segment in only 1 layer deep. Therefore, the red and black lines are on top of each other at the top of the graph.

In Figure 7, which displays the effect of thinning from 100 m to 200 m on depth distribution, the results show a noticeable change in depth distributions for APPTF, C&DOH_DE, C&DOH_MD, LYNPH, and WBEMH. These are some of the smaller grid-count segments in this group.

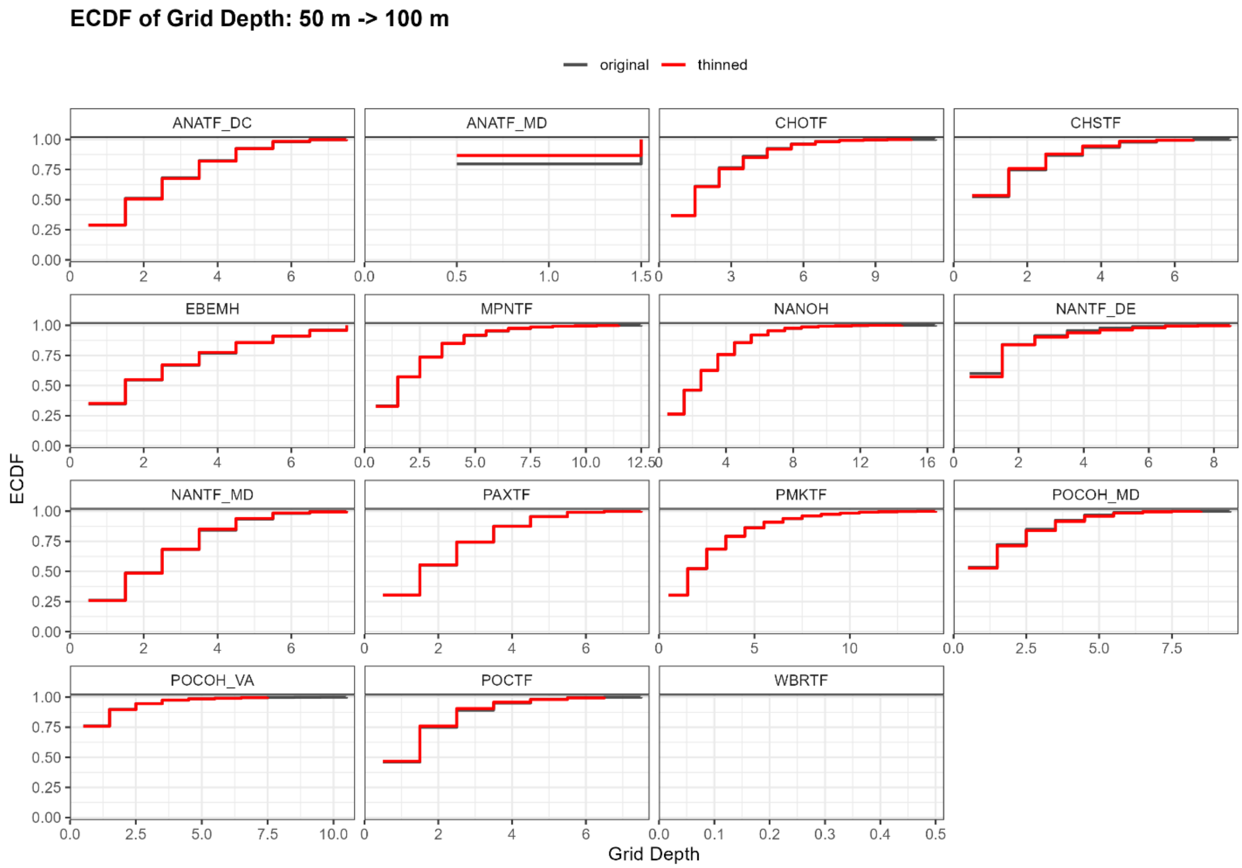


Figure 6. Empirical cumulative density function (ECDF) graphs for each segment with 50 m grid lines (black) and 100 m thinned grid (red). The ECDFs shows the cumulative fraction of grid cells with bottom depth along the x-axis. The x-axis scale is different for each segment due to different bathymetries.

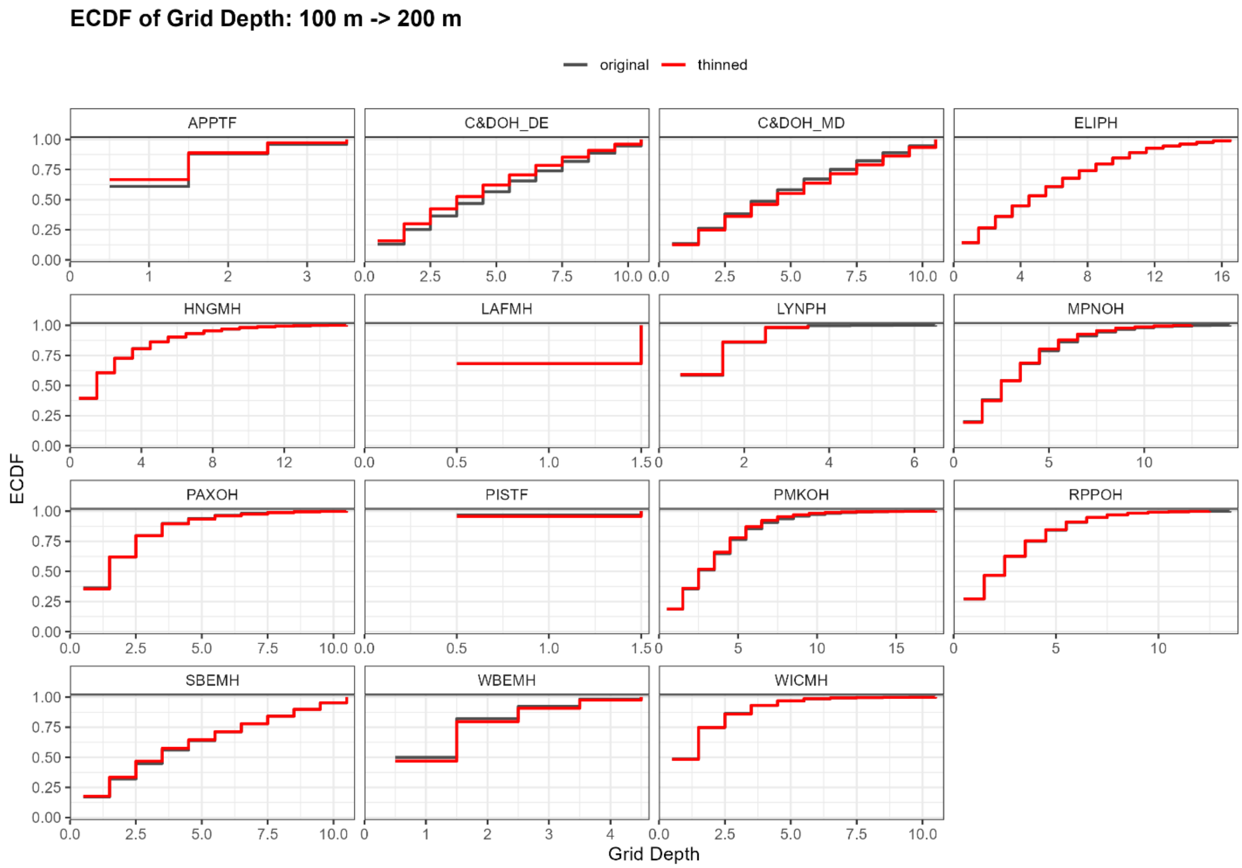


Figure 7. Empirical cumulative density function (ECDF) graphs for each segment with 100 m grid lines (black) and 200 m thinned grid (red). The ECDFs shows the cumulative fraction of grid cells with bottom depth along the x-axis. The x-axis scale is different for each segment due to different bathymetries.

Results: DO interpolation impact

An analysis was done to compare interpolation results computed for all of the segments in Tables 2 and 3 both with and without grid thinning. Comparisons are made by superimposing empirical distribution functions (EDFs) of simulated DO from the original grid and the thinned grid. Comparing the EDFs allows one to readily assess differences in the proportion of observations in violation of any DO criterion. Specifically, we ran interpolations for 2022 data and output three simulations for comparison between original and thinned grid DO and generated EDFs for the first day of every month in 2022. Three simulations were used to be sure our conclusions do not change with more simulations. However, keep in mind these are still draft 4D interpolator results (version in March 2026) and should not be considered final.

50 m to 100 m

Example DO EDFs are shown in Figure 8 for:

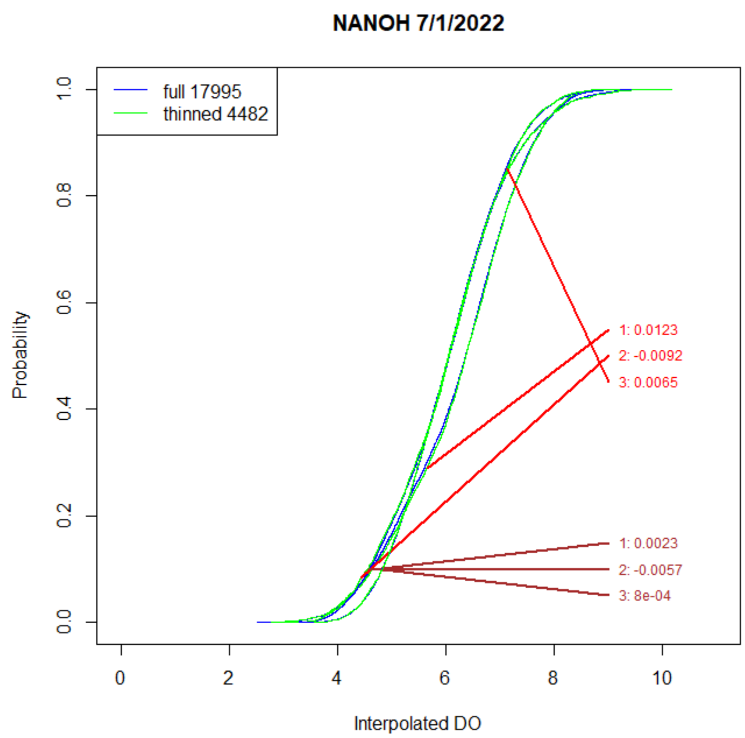
a) two segments with little difference due to thinning (NANOH, EBEMH), and
b) segments with the largest difference (WRBMH) and a relatively moderate difference (CHSTF).

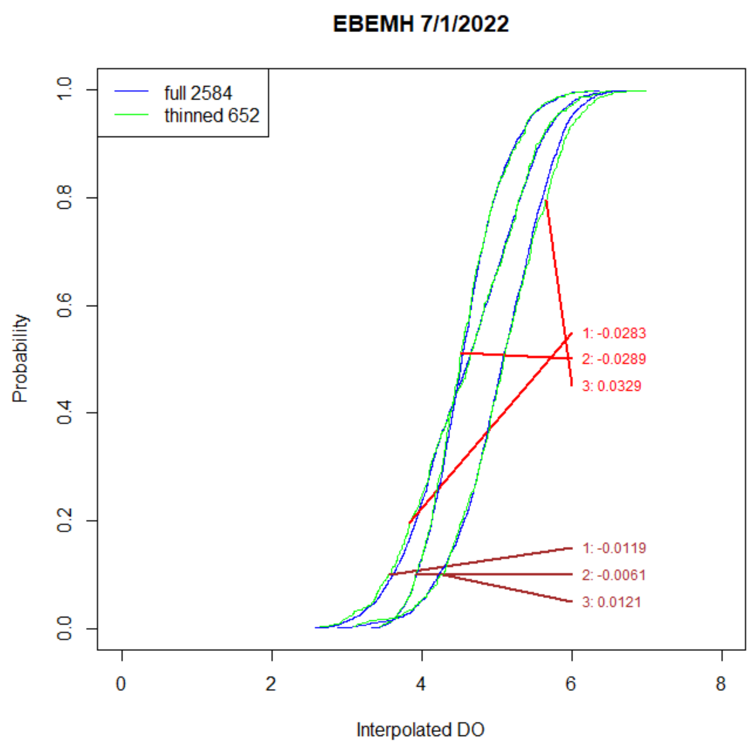
Similar graphs to Figure 8 were generated for each of the segments considered and the first day of every month in 2022. These are available to anyone who wants to examine them in more detail (email rmurphy@chespeakebay.net for a link).

Figure 8 and similar graphs show the cumulative fraction of grid cells at each DO level. For example, in the first graph below (NANOH), approximately 0.2 or 20% of the grid cells on 7/1/22 have DO < 5 mg/L. Our goal here is to determine if thinning will change the DO results, so we want to examine how closely the blue and green lines overlap for a simulation. To aid in quantifying that, we have computed the difference between each pair of lines at the point where they are most separated. These locations and differences are labeled in red. The lower set of labels (in darker text) shows the difference at approximately the 10% spot on the distributions. As these examples show, the difference in the curves at 10% is almost always less than the maximum difference. Since the 10% comparison has similarities to criteria evaluation, our focus on the maximum difference is a conservative comparison of the curves.

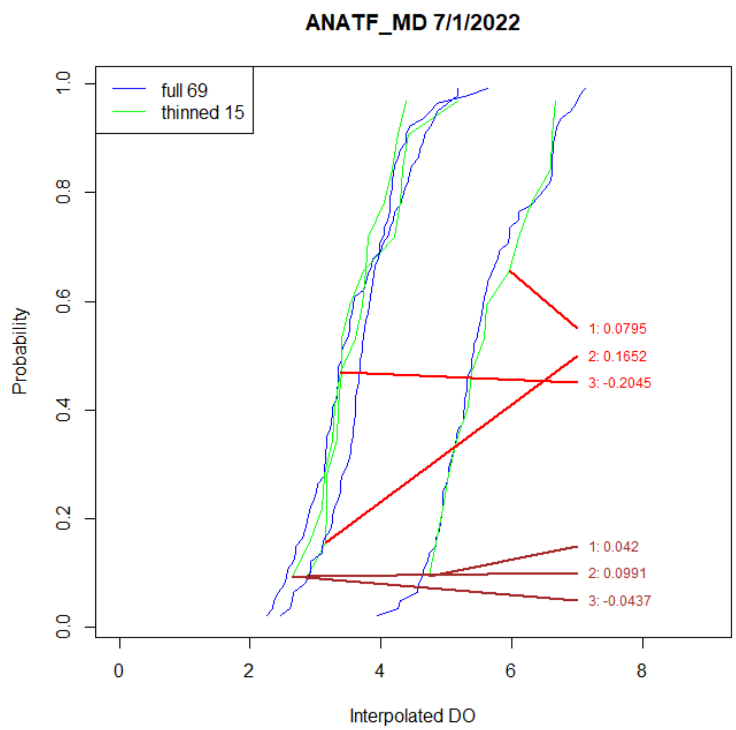
The results from all 15 segments' EDFs (e.g., Figure 8) are aggregated in Figures 9 and 10. For Figure 9, the values presented for each EDF (e.g., Figure 8) as red text quantifying the maximum difference between the two curves were aggregated and plotted. For each segment, there is one line for each month with the red to blue showing the range of the maximum absolute difference across the three simulations. Figure 9 shows that two segments, WBRTF and ANATF_MD, have much larger differences than the other segments. In addition, there is no clear seasonal pattern to the differences. Keep in mind, the values plotted in Figure 9 are the maximum difference in each EDF curve.

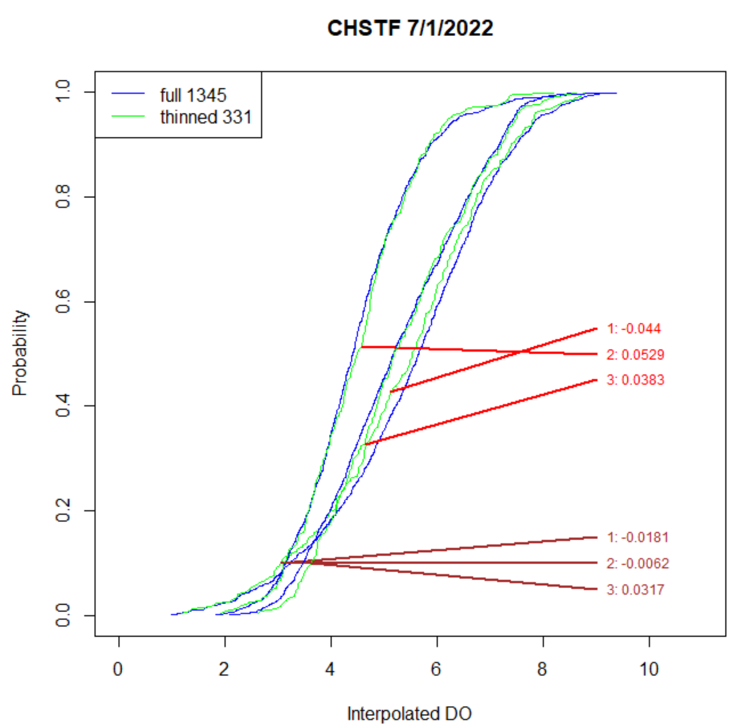
Figure 10 was created to determine whether bias exists in the difference between the curves. For example, do the thinned grids tend to produce only higher or lower oxygen values than the original grid? The very symmetric shape of the differences around zero in Figure 10 suggest this is not the case. Therefore we are not concerned about bias by thinning the interpolator grids from 50 to 100 m.





Figures 8. EDFs for example segments thinned from 50 m (blue lines) to 100 m (green lines). The top set of lines (in red) indicates the largest difference between each curve pair. The lower set of labels indicates the difference near the 10% DO threshold on each curve.





Figures 8 (cont). EDFs for example segments thinned from 50 m (blue lines) to 100 m (green lines). The top set of lines (in red) indicates the largest difference between each curve pair. The lower set of labels indicates the difference near the 10% DO threshold on each curve.

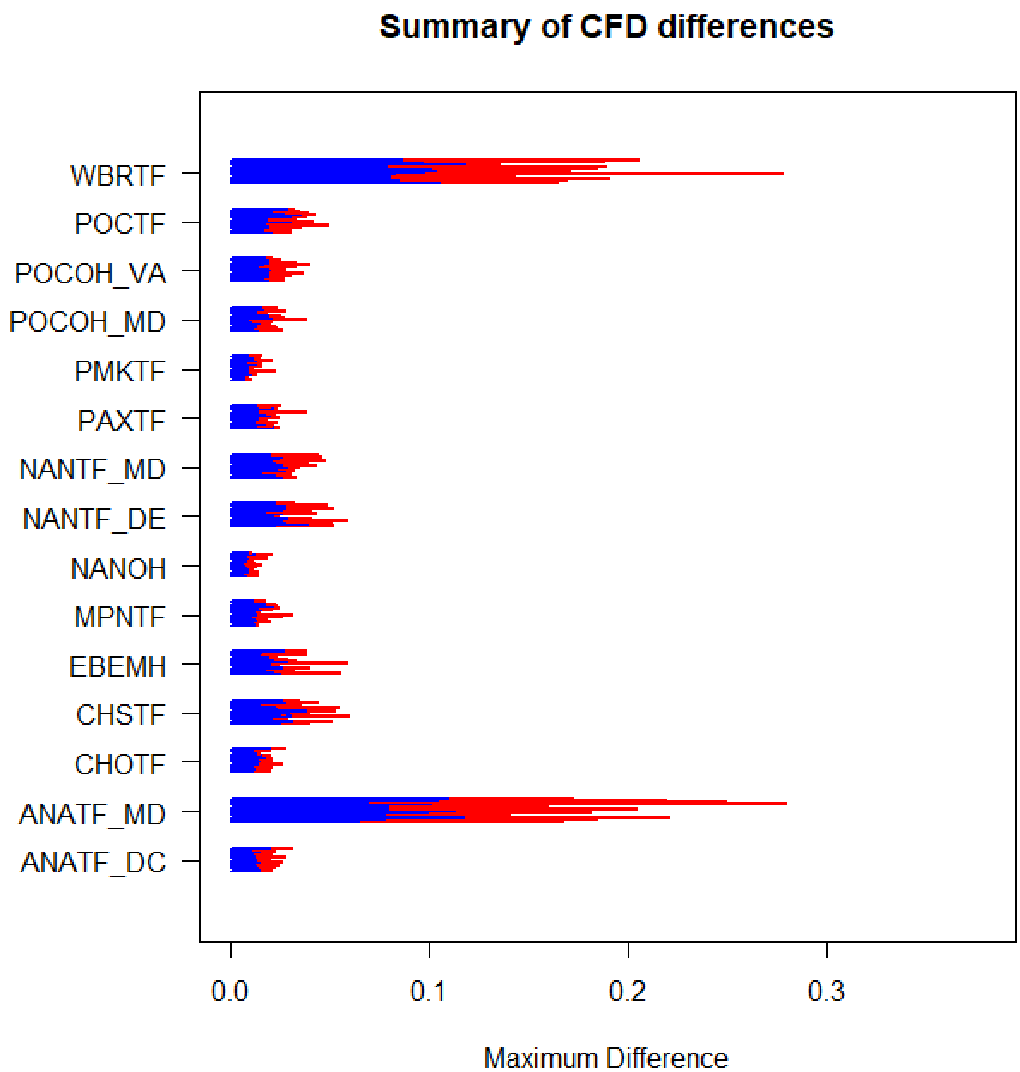


Figure 9. Summary of absolute value of maximum differences for each originally 50 m grid segment. Each segment includes 12 lines, one for the first day of each month. The furthest distance for each line (red) is the maximum of the absolute difference between the thinned and non-thinned distribution curves from the 3 simulations. The length of the blue lines is the smallest maximum difference from the 3 simulations.

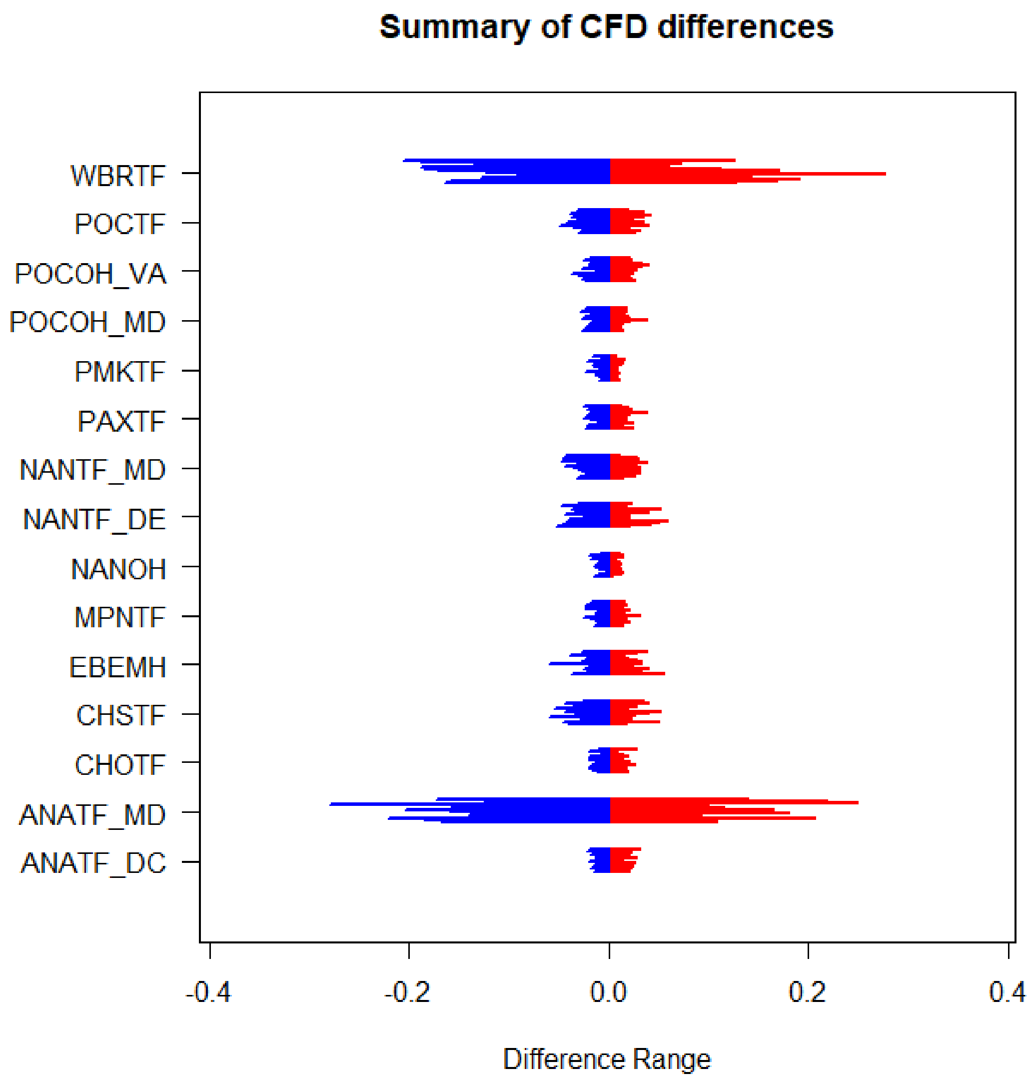
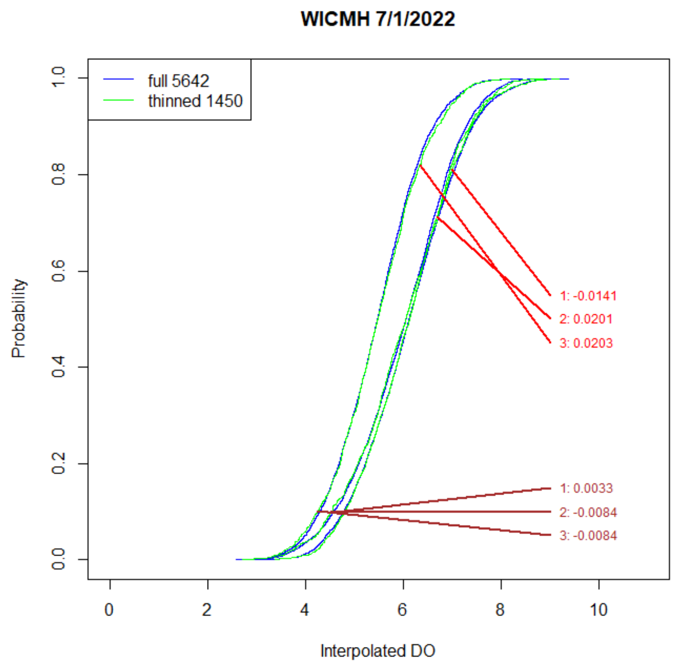
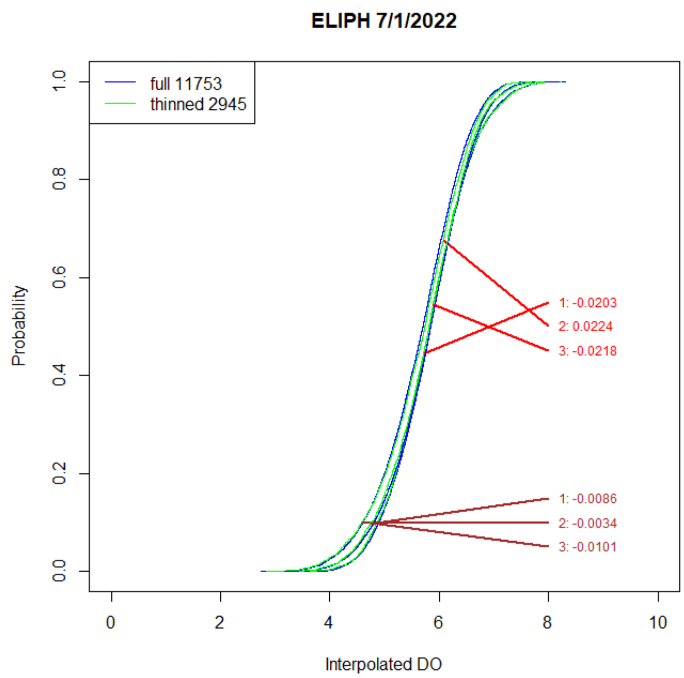


Figure 10. Summary of maximum differences for each originally 50 m grid segment, designed to look for bias. Each segment includes 12 lines, one for the first day of each month. The lines show the largest positive (red) and negative (blue) difference between the original and thinned curves across the simulations tested.

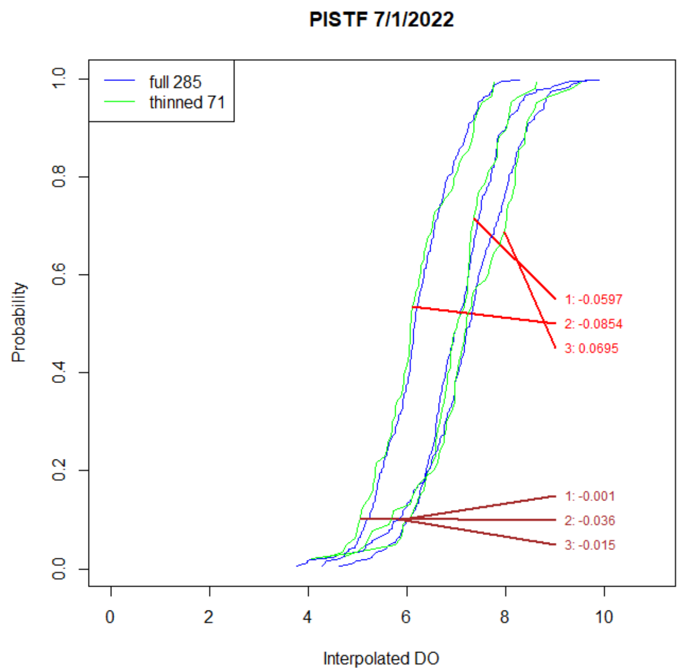
100 m to 200 m

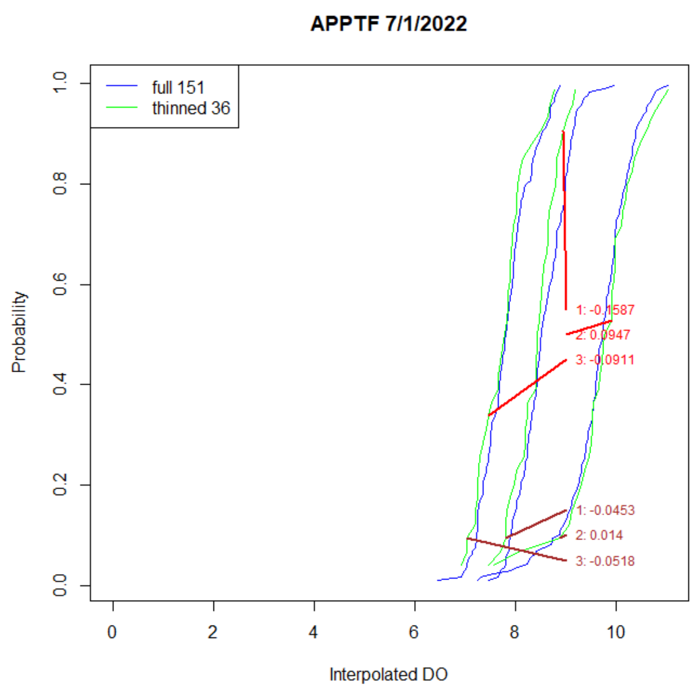
Example graphics are shown in Figure 11 for DO interpolation result comparison between originally 100 m segments thinned to 200 m. These are described above for Figure 8. Figure 11 shows two examples (WICMH and ELIPH) with little discernable difference between the DO results with and without thinning, as well as two segments (PISTF and APPTF) that have slightly more difference in the DO with thinning. Results for the 100 m to 200 m thinning tests are summarized in Figures 12 and 13, similar to above.





Figures 11. EDFs for example segments thinned from 100 m (blue lines) to 200 m (green lines). The top set of lines (in red) indicates the largest difference between each curve pair. The lower set of labels indicates the difference near the 10% DO threshold on each curve.





Figures 11 (cont). EDFs for example segments thinned from 100 m (blue lines) to 200 m (green lines). The top set of lines (in red) indicates the largest difference between each curve pair. The lower set of labels indicates the difference near the 10% DO threshold on each curve.

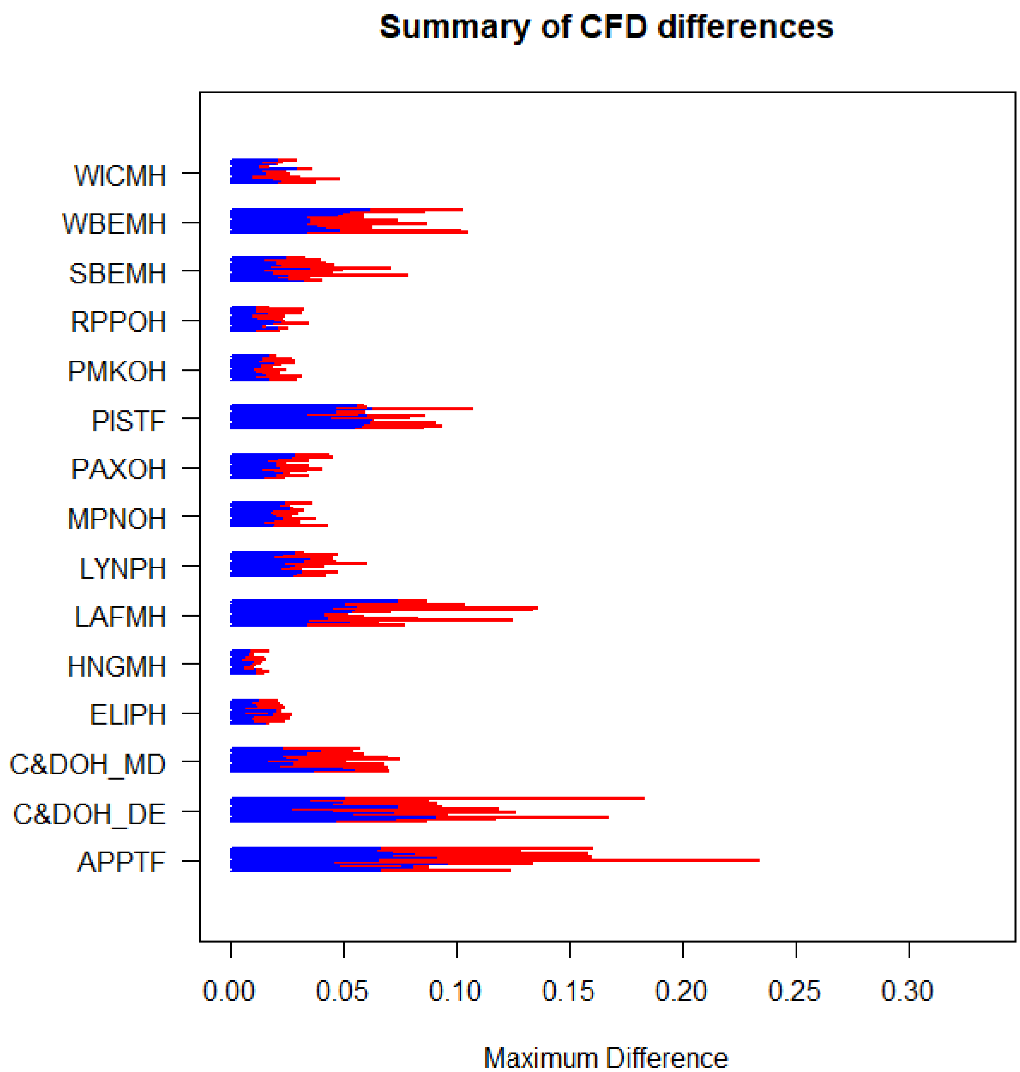


Figure 12. Summary of absolute value of maximum differences for each originally 100 m grid segment. Each segment includes 12 lines, one for the first day of each month. The furthest distance for each line (red) is the maximum of the absolute difference between the thinned and non-thinned distribution curves from the 3 simulations. The length of the blue lines is the smallest maximum difference from the 3 simulations.

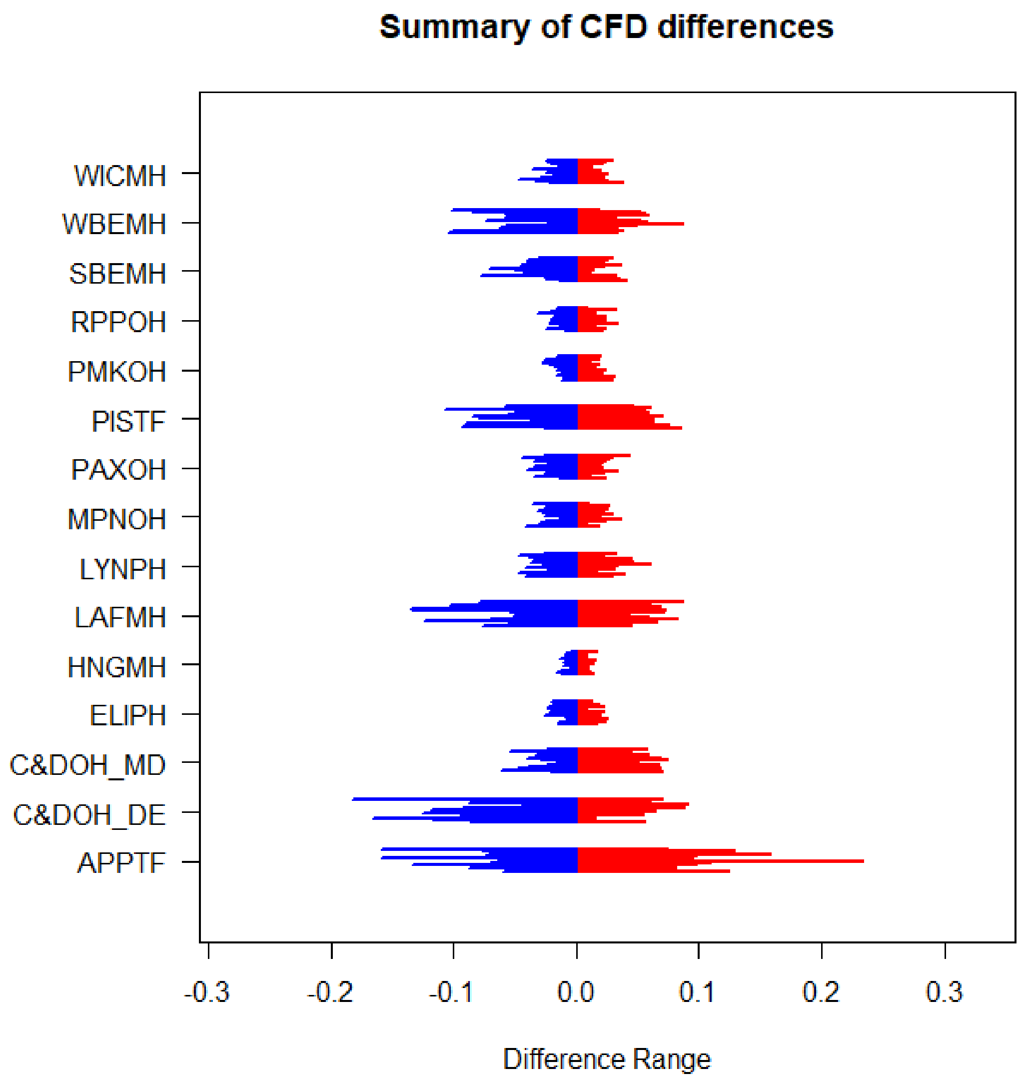


Figure 13. Summary of maximum differences for each originally 100 m grid segment, designed to look for bias. Each segment includes 12 lines, one for the first day of each month. The lines show the largest positive (red) and negative (blue) difference between the original and thinned curves across the simulations tested.

Summary

Results and initial notes for all segments considered are tabulated in Table 4 and 5. The tables are sorted by state and include:

- The grid cell count without and with thinning;
- A grid count rank for each of these 15 segments;
- Values aggregated from Figures 10 and 12 which are:
    - 1) the mean across months and simulations between the EDF differences, and
    - 2) the maximum difference averaged across the months. These are provided to simplify the take-aways and are shaded with the largest values darkest.
- A column of notes considering the findings from both examining the maps, the depth distributions and the impact on the DO results.

There will be run-time and file size benefits to thinning grids. However, we only want to thin a grid if the spatial coverage of the segment is still sufficient and if there is no expected impact on the conclusions from the DO analysis. With these thoughts in mind, we put some notes in Table 4 and 5 based on close examination of the grid maps and EDF results. Our suggestions based on these notes are tabulated at the very end in Table 6.

Table 4. Summary of results for originally 50 m grid segments. Mean and max absolute difference are computed between DO EDF curves each month in 2022 tests. Gray shading is to help see the variation in the values, with darkest shading representing the biggest differences between curves for original vs. thinned grid.

segment	**state**	**count with 50m**	**count with 100m**	**Grid count rank (1= fewest)**	**EDF Mean absolute difference**	**EDF Max absolute difference**	**50m to 100m: Notes on difference between original and thinned**
ANATF_DC	DC	4,971	1,247	11	0.018	0.032	Little difference
NANTF_DE	DE	1,307	340	4	0.035	0.058	Grid coverage gets fairly sparse in thinned grid.
ANATF_MD	MD	69	15	2	0.144	0.279	There is a DO impact, and the segment is small for thinning
CHOTF	MD	5,767	1,473	12	0.017	0.028	Little difference
CHSTF	MD	1,345	331	3	0.034	0.060	Grid coverage gets fairly sparse in thinned grid.
NANOH	MD	17,995	4,482	15	0.011	0.021	Little difference
NANTF_MD	MD	1,339	348	5	0.030	0.048	Little difference
PAXTF	MD	4,406	1,105	10	0.020	0.038	Little difference
POCOH_MD	MD	4,161	1,066	9	0.019	0.038	Little difference
POCTF	MD	1,788	454	6	0.030	0.049	Little difference
WBRTF	MD	45	14	1	0.134	0.278	There is a DO impact, and the segment is small for thinning
EBEMH	VA	2,584	652	7	0.028	0.059	Little difference
MPNTF	VA	7,203	1,813	13	0.017	0.031	Little difference
PMKTF	VA	11,452	2,864	14	0.012	0.023	Little difference
POCOH_VA	VA	3,039	775	8	0.023	0.040	Little difference

Table 5. Summary of results for original 100 m grid segments. Mean and max absolute difference are computed from DO EDF curves each month in 2022 tests. Gray shading is to help see the variation in the values, with darkest shading representing the biggest differences between curves for original vs. thinned grid.

segment	state	count with 100m	count with 200m	Grid count rank (1= fewest)	EDF Mean absolute difference	EDF Max absolute difference	100m to 200m: Notes on difference between original and thinned
C&DOH_DE	DE	790	177	5	0.080	0.182	Segment seems small for thinning
C&DOH_MD	MD	1,623	421	7	0.047	0.074	Segment seems small for thinning
HNGMH	MD	18,568	4,654	15	0.011	0.017	Little difference
PAXOH	MD	2,718	669	8	0.026	0.045	Little difference
PISTF	MD	285	71	2	0.064	0.107	Segment seems small for thinning
WICMH	MD	5,642	1,450	12	0.023	0.048	Little difference
APPTF	VA	151	36	1	0.093	0.233	There is a DO impact, and the segment is small for thinning
ELIPH	VA	11,753	2,945	14	0.016	0.027	Little difference
LAFMH	VA	339	85	3	0.065	0.136	Segment seems small for thinning
LYNPH	VA	1,676	406	6	0.034	0.060	Segment seems small for thinning
MPNOH	VA	3,341	844	10	0.025	0.042	Little difference
PMKOH	VA	6,668	1,634	13	0.018	0.032	Little difference
RPPOH	VA	5,355	1,328	11	0.019	0.034	Little difference
SBEMH *	VA	2,773	682	9	0.033	0.078	Segment seems small for thinning
WBEMH	VA	631	162	4	0.058	0.105	Segment seems small for thinning

Suggestions

Using the information compiled, we generated a set of suggestions for these original 50 m and 100 m grid resolution segments (Table 6). BORG members, especially state partners are welcome to suggest adjustments to these lists. In general, there is not much impact on the DO distribution analysis, especially when compared to the variability between simulations. At the same time, any segment with more than 3-4% change in the mean absolute EDF difference made our list of segments to consider not thinning.

Two of the original 50 m segments (ANATF_MD and WBRTF) are very small and loose significant coverage when thinned to 100 m. CHSTF and NANTF_DE are a little larger, and there is not much DO impact from thinning. But due to thinned grid coverage in narrower stretches of those segments, we think the 50 m grids are more representative of those segments. All other original 50 m segments still appear to have good spatial coverage at 100 m, plus the DO analysis indicates thinning the grids will impact any conclusions about DO.

For the originally 100 m segments, we suggest that 8 of them stay at 100 m. This is mostly due to the size of the segments and wanting the best grid coverage). The other 7 appear to still have good spatial coverage and no change in the DO distributions with thinned 200 m grids.

In summary, if we thin any of these segments (particularly the ones discussed in Nov.), it will aid in the usability of the 4D tool in terms of runtimes and output file sizes.

Table 6. Draft suggestions for grid resolution changes*: Available for discussion, changes, and decision from the team*

segment	state	Discussed previously
Originally 50m, keep at 50m		
NANTF_DE	DE	
ANATF_MD	MD	
CHSTF	MD	
WBRTF	MD	
Originally 50m, thin to 100m		
ANATF_DC	DC	
CHOTF	MD	yes
NANOH	MD	yes
NANTF_MD	MD	
PAXTF	MD	
POCOH_MD	MD	
POCTF	MD	
EBEMH	VA	
MPNTF	VA	yes
PMKTF	VA	yes
POCOH_VA	VA	

segment	state	Discussed previously
Originally 100m, keep at 100m		
C&DOH_DE	DE	
C&DOH_MD	MD	
PISTF	MD	
APPTF	VA	
LAFMH	VA	
LYNPH	VA	
SBEMH	VA	
WBEMH	VA	
Originally at 100m, thin to 200m		
HNGMH	MD	yes
PAXOH	MD	
WICMH	MD	
ELIPH	VA	
MPNOH	VA	
PMKOH	VA	
RPPOH	VA	