Progress updates: 4-dimensional (4-D) interpolator

Bay Oxygen Research Large Group
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Summary of recent work

1. Parameterizing spatial correlation (Jon Harcum, Tetra Tech, lead)
2. Dataset structure and compilation (Jon Harcum, Tetra Tech, lead)
3. Pycnocline interpolation (Rebecca Murphy, UMCES/CBP, lead)
4. Exploring use of output in criteria assessment (Elgin Perry lead)

We have summarized on each slide what this work means for future users of the 4-D interpolator. Most of the work to-date is one-time development work. Using the 4-D interpolator in the future should not require updating these methods regularly.

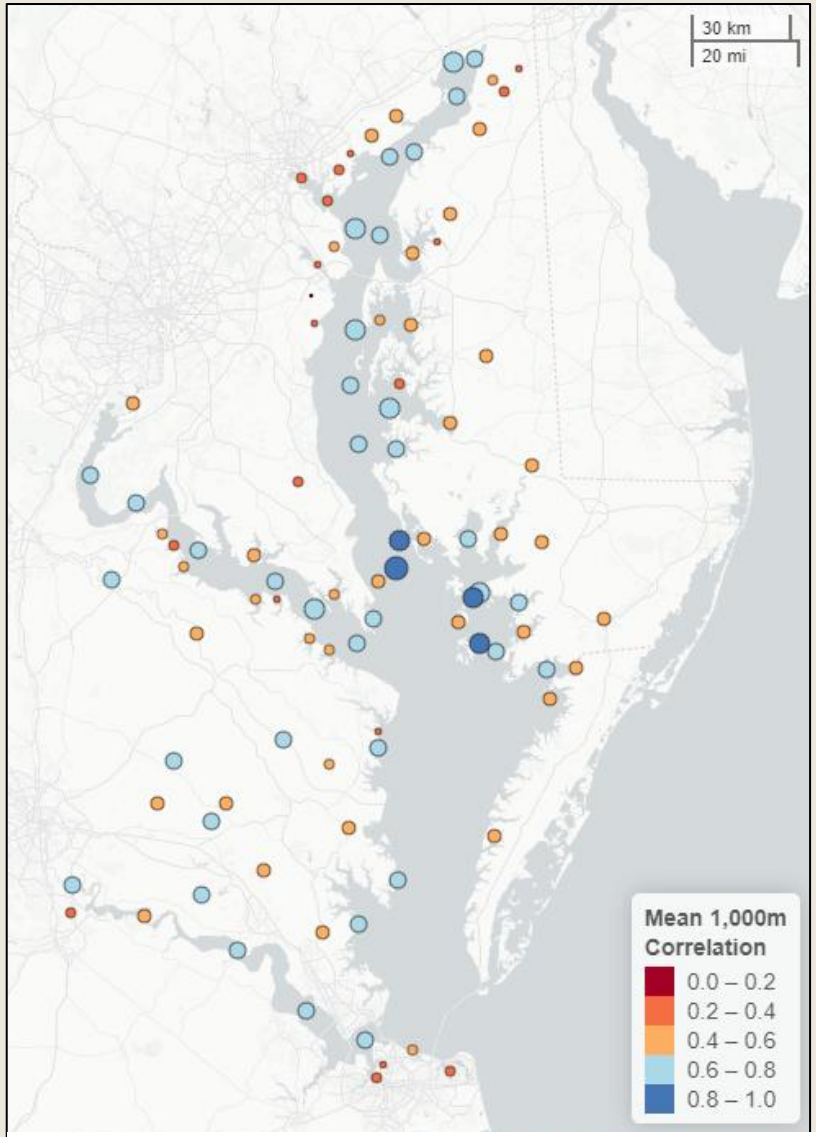
Parameterizing spatial correlation

Wrapped up work computing spatial correlation parameters from 2,755 Dataflow data set from 2001 to 2024.

- **Purpose:** This work ensures that the DO interpolator estimates are spatially correlated grid-cell-to-grid-cell in the same way that DO observations are correlated km-to-km.
- Memo dated 4-10-25 emailed on 4-21-25.

What will future users need to do?

Nothing for an individual interpolation. In the future, we can collaborate on a plan for occasional re-parameterization of components like this with updated data (~5 years?).



Mean 1,000m correlation by station. (From Jon Harcum)

Dataset structure and compilation

Work is underway to build a database structure and data pipeline to compile all high frequency data and fixed station data together.

- **Purpose:** This step will enable us to use ALL high frequency data in EVERY part of the interpolation.
- Overcame data management hurdles by adopting 'Apache Parquet', an open-source file format that is accessible via major programming languages (Python, R, C++, Julia, Rust) as well as tools such as Power BI and Excel for Microsoft 365 via Azure Data Lake.
- Thank you for the individual conversations with data teams (Mark Trice, Dave Parrish, Mike Mallone) and GIS support (Angie Wei).

What will future users need to do?

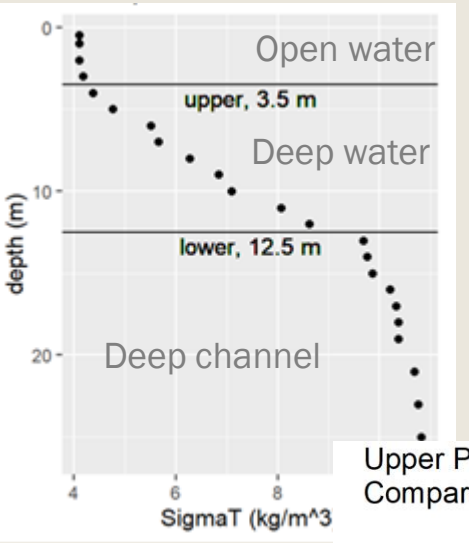
Each year data inputs should be a routine process once we have built the structure. Occasionally updates to the input processing will be made as new types of data become available.

Pycnocline

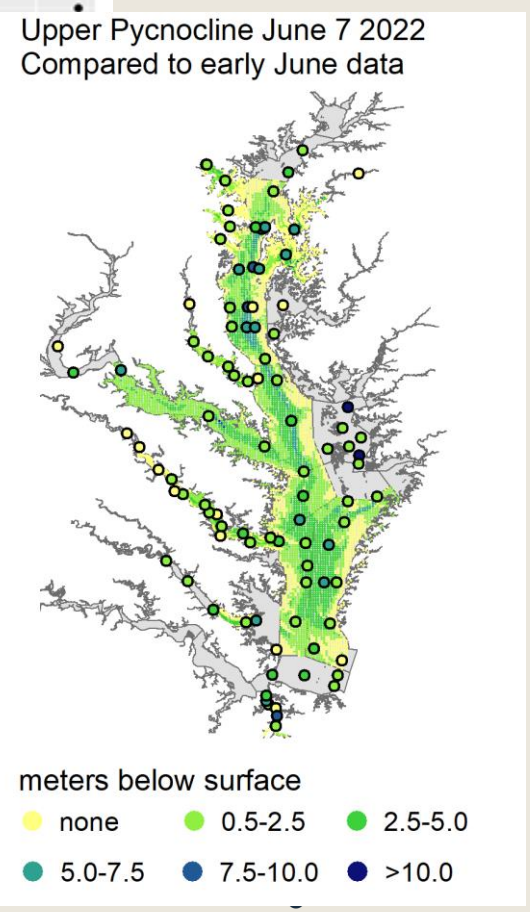
Work is underway on a pycnocline space-time interpolation method.

- **Purpose:** The upper and lower depths of the pycnocline are needed to delineate the boundaries of the designated uses in the 4-D oxygen interpolation output.
- Method was presented to development team, and agreement was made to interpolate a daily pycnocline.
- Currently we are finalizing the structure of a pycnocline interpolation to use and examining results with comparison to the current approach.

Density and Pycnocline: CB4.3C 7-11-2017



Upper Pycnocline June 7 2022
Compared to early June data



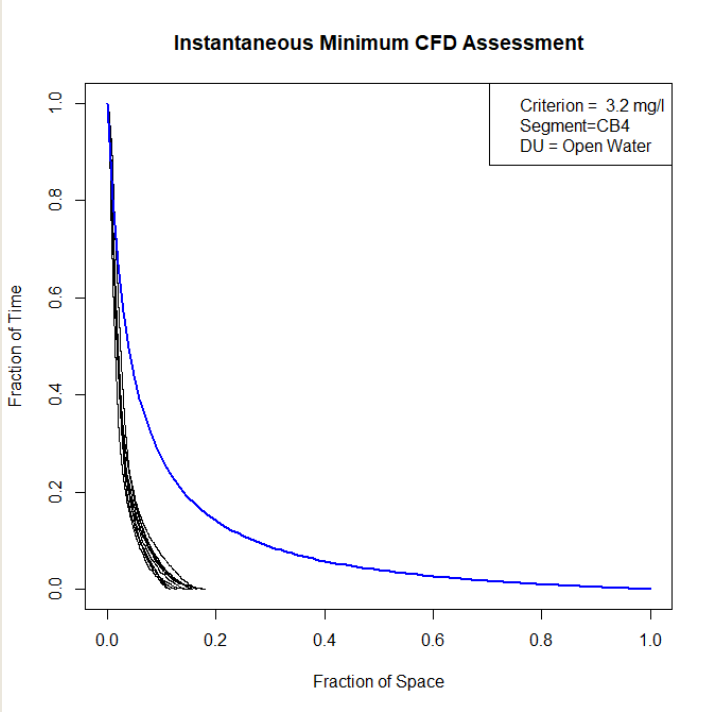
What will future users need to do?

This is one-time method development. New data each year will feed into the pycnocline interpolation. Ideally, users will be able to examine pycnocline results used in an assessment, which would improve transparency over the current approach.

Link to criteria assessment

Working with draft 4-D DO results to explore how the interpolation output could be used in criteria assessment.

- **Purpose:** Generate examples for the CAP workgroup to discuss short-term criteria methods and using the 4-D output.
- Used multiple draft 4-D interpolator simulation sets for CB4MH in 2022 and the top 1-5m of results as an example of Open Water to compare with the 10% CFD curve.
- Also compared frequency of instantaneous criteria violations from the vertical arrays with the same frequency computed from nearby interpolator results.



Example: CFD assessment curves for the instantaneous minimum criterion in segment CB4 for the period 6/1/2022-8/31/2022 (From Elgin Perry)

What will future users need to do?

This is one-time method development. Ideas can be discussed at CAP. Ultimately users will need to summarize the results, which will include more criteria than currently.

Summary of next steps

- **Pycnocline:** Build the pycnocline interpolation into the 4-D tool and integrate it with DO results.
- **Case study:** 4-D interpolation compared to current and other approaches (e.g., Fishing Bay).
- **Parameter refinements:** Needed because first-draft methods did not always use all data
  - *Depth correlation parameters,*
  - *Temporal correlation parameters,*
  - *Daily and tidal cycles,*
  - *Modifications as results are examined throughout all segments.*
- Work with **CAP workgroup** on using 4-D output for criteria assessment and on new questions that arise from methods to evaluate the short-term criteria.
- Documentation and users' guidance.