Current spatial interpolation method used in Chesapeake Bay

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Approach

- Weighted average prediction of fixed-station data

- Inverse Distance Weighting (IDW) to determine the weights -- higher weights are assigned to closer values.

General: Weighted average prediction

$$\hat{Y}(s_0) = \sum_{i=1}^{n} w(s_i)Y(s_i)$$

s_0 = location (x,y) to predict at

s_i = different x,y location with measured value

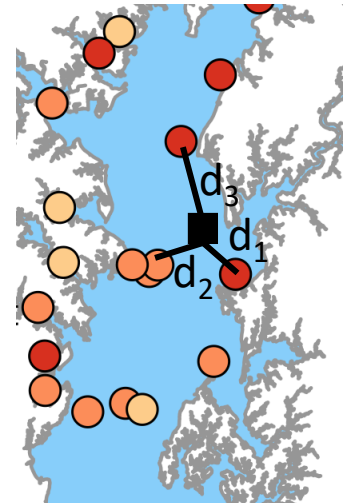$\hat{Y}(s_0)$ = value predicted at location s_0

$Y(s_i)$ = value measured at location s_i

$w(s_i)$ = weight assigned to measured value at s_i

Inverse distance weighting (IDW) squared predictor weights

$$w(s_i) = \frac{1/d_i^2}{\sum_{j=1}^{n}\left(1/d_j^2\right)}$$

d_i = distance between s_o and location s_i

Data & temporal component

- Data used: Long-term fixed monitoring PLUS partner citizen science and calibration from continuous monitoring stations

- Time period: Data collected over approximately 2 weeks is grouped as one snap-shot (e.g., first half of June), although most long-term fixed station monitoring is within a few days of each other.

| Month	Cruise Number	Cruise ID	MD Main	VA Main	Tidal Potomac	Patuxent	Elizabeth	York	Rappahannock	James
Jun	BAY698	201706A	5-7	5-8	12*	1	13-14	--	13	6
Jun	BAY699	201706B	26-28	26-29	--	--	--	20	--	--

Space

- **Fixed interpolation grid:**
  - 51,839 in mainstem that are: 1km x 1km x 1m(depth) in mainstem
  - 186,830 in tribs that go down to 50m x 50m x 1m
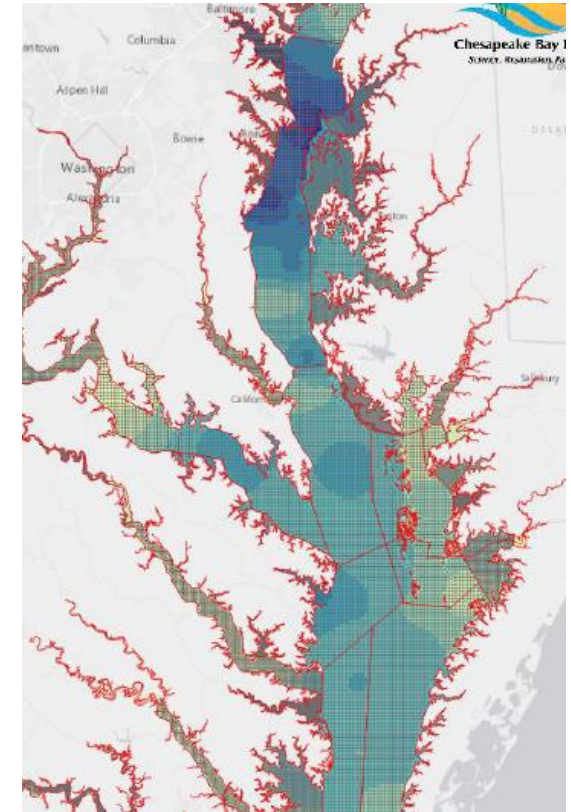
From Zhaoying (Angie) Wei Presentation on 4d visualization of interpolator
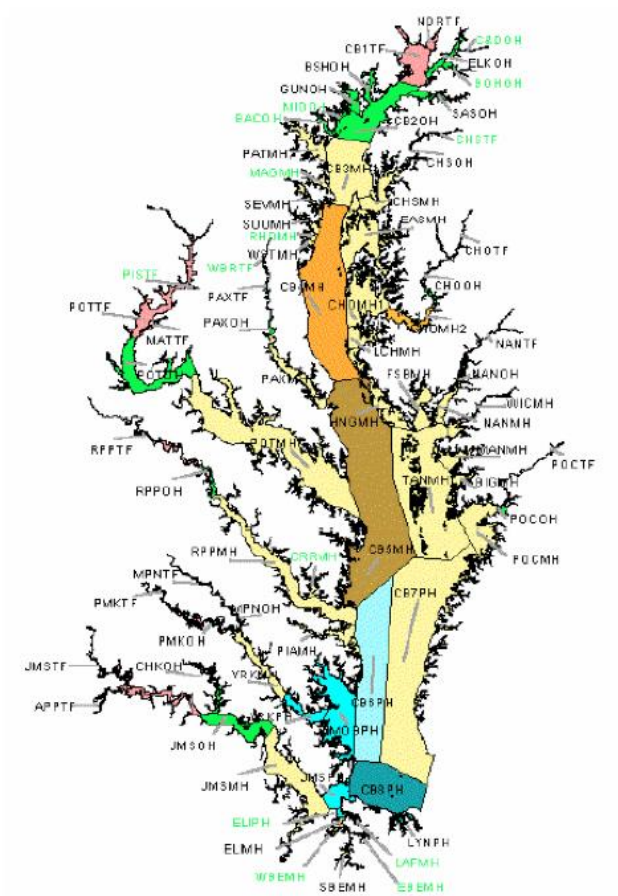
Space

- **Vertical layers:** A linear interpolation is done vertically first to every 1 m, and then those vertically interpolated values are grouped into same-depth-sets for horizontal interpolation.
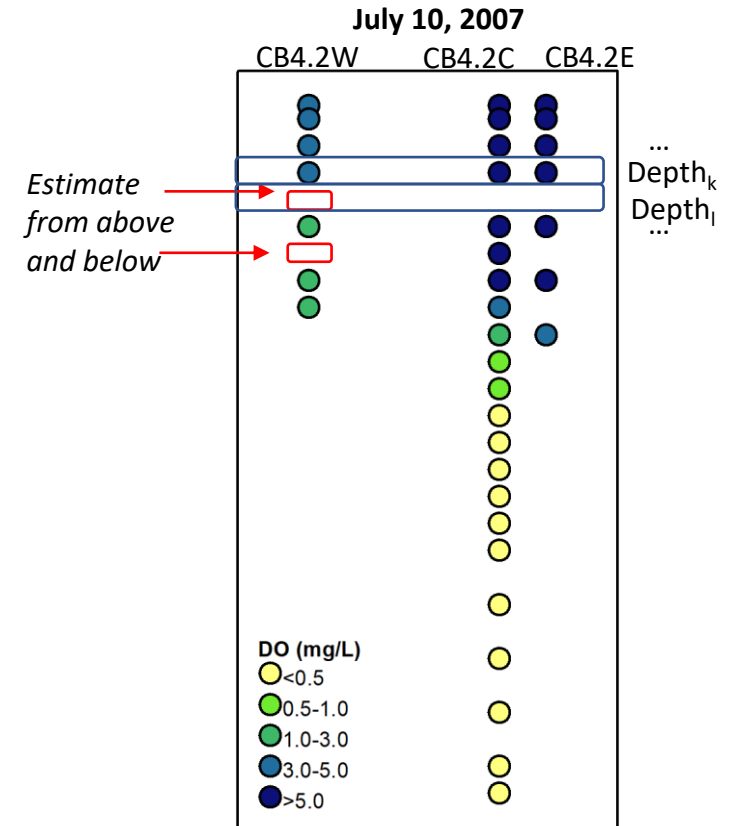
Space

- **Horizontal:** IDW used in the horizontal with samples (or vertically interpolated values) at a single depth within a segment. Regional buffers extending into nearby segments are used in some places.

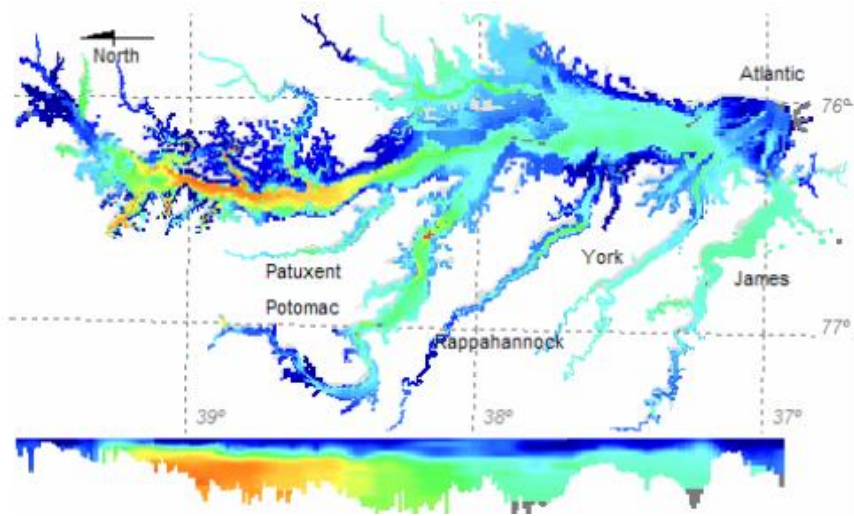Chesapeake Bay Program 1998 segmentation design.

Implementation

- Originally Visual Basic Program (VOL3D, Bahner 2006) (still currently in use for some)

- At CBP: Implementation in Fortran, run by Richard Tian each year with current DO

→ Outputs: text files can be read in mapping and analysis programs

From 2007 Ambient Water Quality Criteria Addendum

Visualizing results
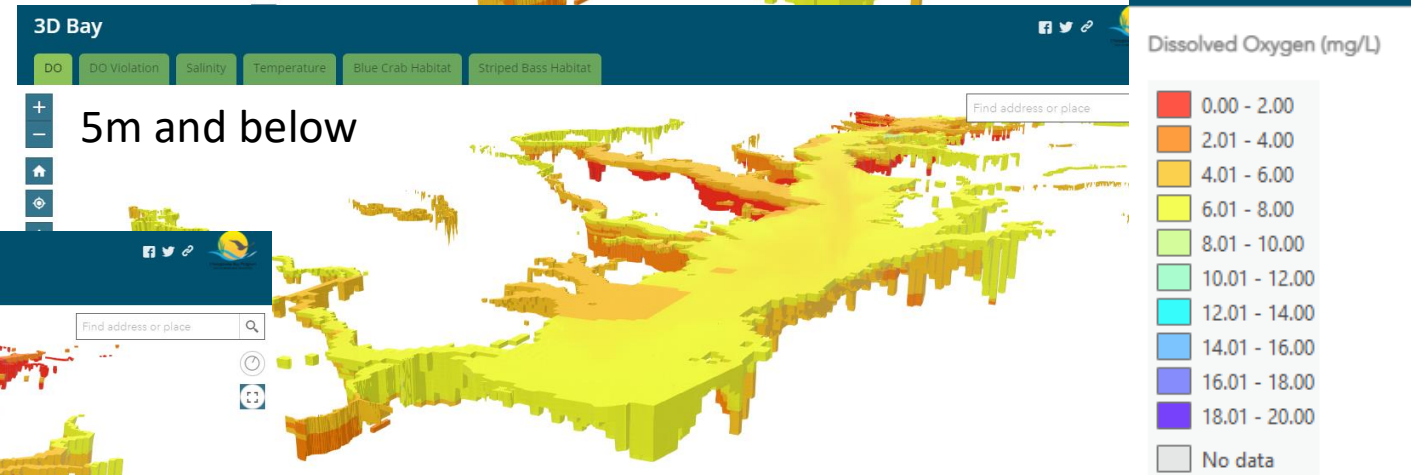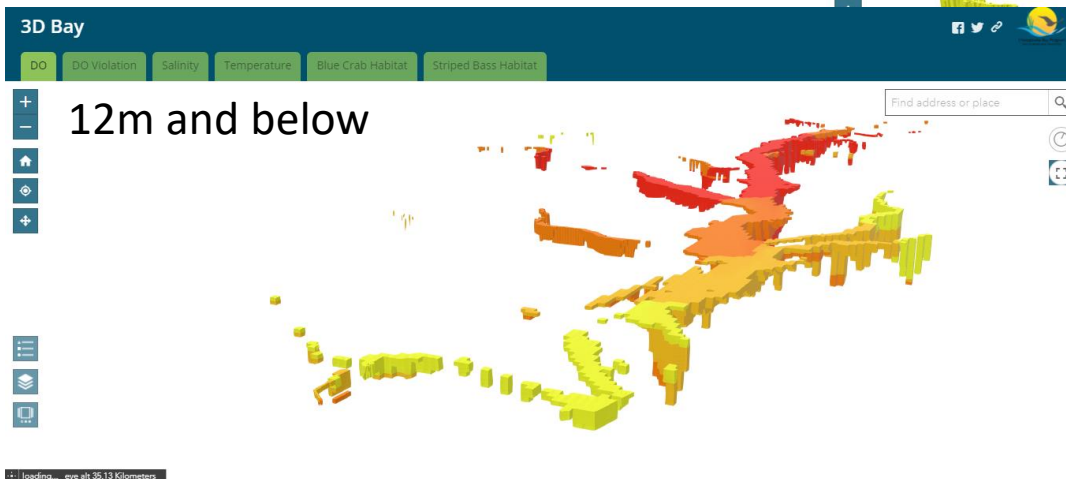
July 2017 interpolation of DO

VOL3d program output

Surface view

5m and below

12m and below

Legend

Dissolved Oxygen (mg/L)

	0.00 - 2.00
	2.01 - 4.00
	4.01 - 6.00
	6.01 - 8.00
	8.01 - 10.00
	10.01 - 12.00
	12.01 - 14.00
	14.01 - 16.00
	16.01 - 18.00
	18.01 - 20.00
	No data
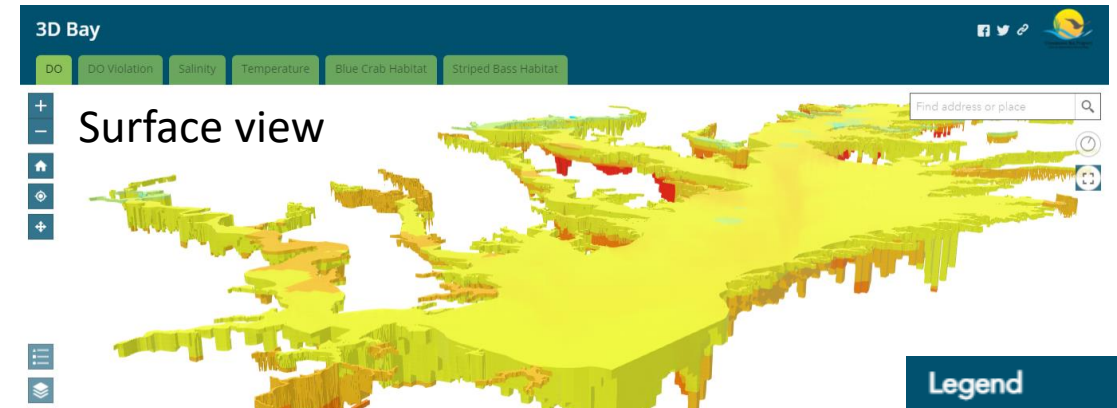
Zhaoying (Angie) Wei: beta tool
https://bit.ly/2IoRqbm and
https://chesbay.maps.arcgis.com/apps/MapSeries/
index.html?appid=9ece32c58926433a99e066c4fe6edd78

For DO criteria analysis

- DO is interpolated bay-wide (3D result)
- Pycnocline
  - Is calculated at each column of data using salinity & temp
  - Pycnocline upper depth is interpolated in 2D
  - Pycnocline lower depth is interpolated (as % of water below pyc) in 2D
- DO interpolations are then split into DUs (i.e., open water, deep water, deep channel). And fraction of the water volume exceeding each applicable DO criterion for each DU/segment/cruise (or 30-day period) is computed and used in the CFD.

Discussion: what features do we need to keep, and what new features are needed?

Keep:

- Usability for partner analysts
- Feeds into CFD/criteria assessment process
- Visualization of results
- ?

New needs:

- Temporal interpolation instead of snap-shots in time
  - Output at a temporal and spatial level to assess short-term criteria
  - Output that can aid in habitat assessments
- Uncertainty in the predictions (at least for diagnostics)
- Incorporation of more available data streams & types
- ?