

# Current spatial interpolation method used in Chesapeake Bay

Rebecca Murphy, Richard Tian (UMCES/CBP)

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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  $s_0$

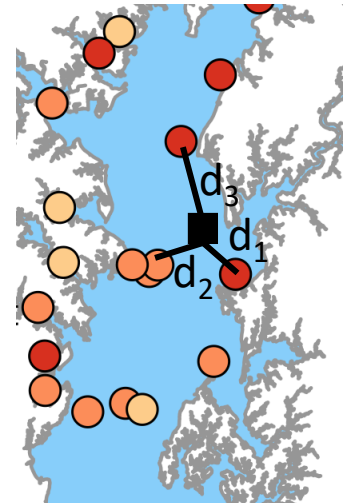
$Y(s_i)$  = value measured at location  $s_i$

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

Inverse distance weighting (IDW)  
squared predictor weights

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

$d_i$  = distance between  $s_0$  and location  $s_i$



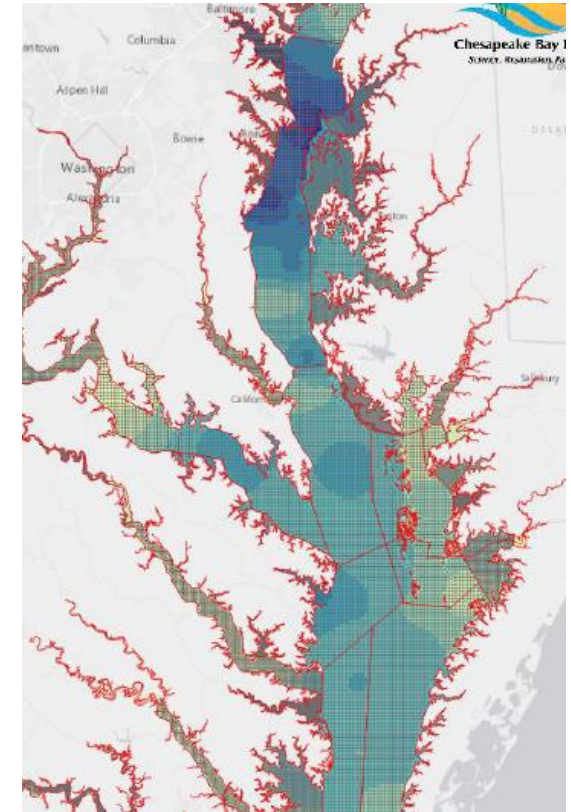
# Data & temporal component

- 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.

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

# Space

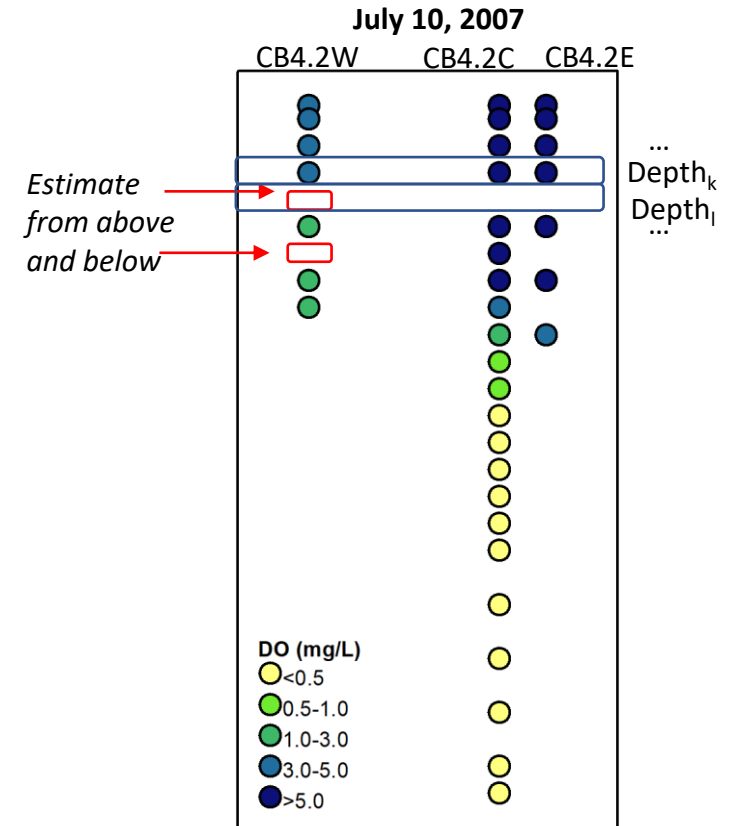
- **Fixed interpolation grid:**
  - 51,839 in mainstem that are: 1km x 1km x 1m(depth) in mainstem
  - 186,830 in tribs that go down to 50m x 50m x 1m



*From Zhaoying (Angie) Wei  
Presentation on 4d visualization  
of interpolator*

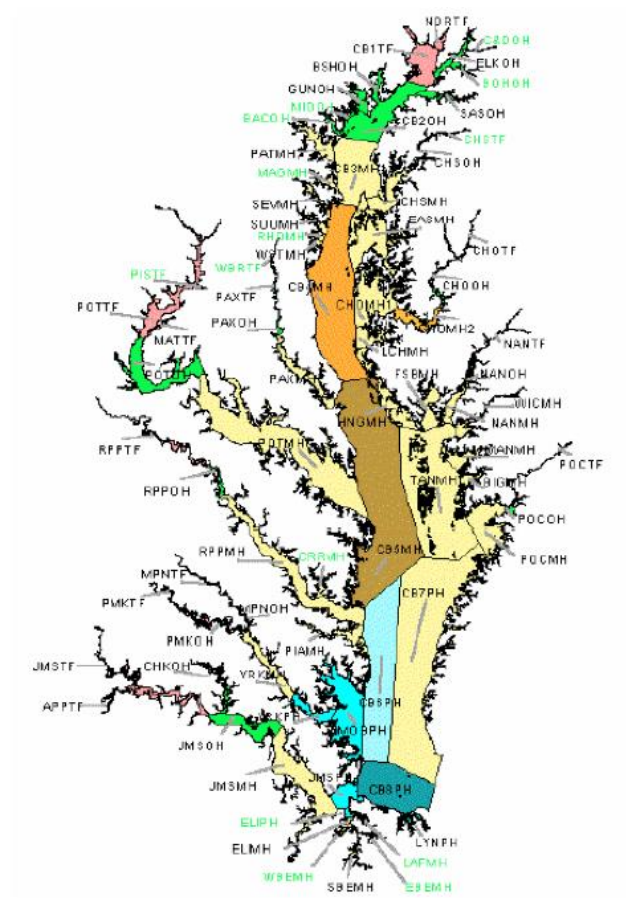
# Space

- **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

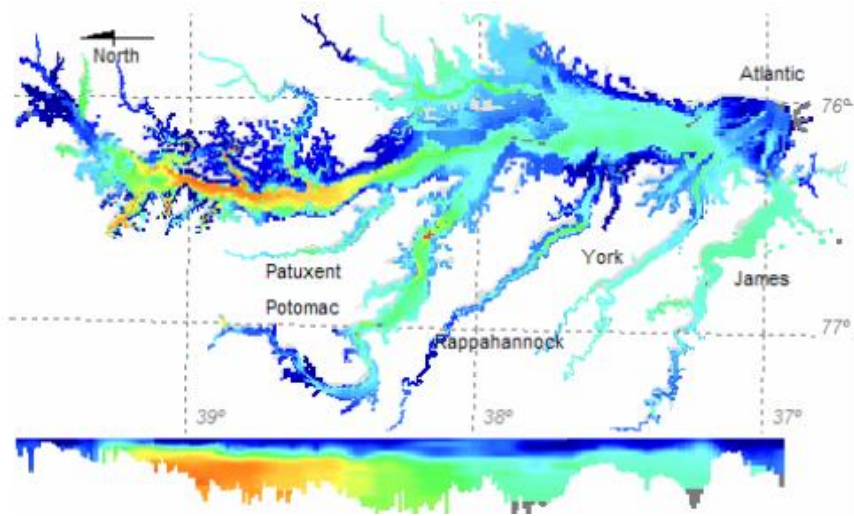
- Originally Visual Basic Program (VOL3D, Bahner 2006) (still currently in use for some)
  - At CBP: Implementation in Fortran, run by Richard Tian each year with current DO
- Outputs: text files can be read in mapping and analysis programs

The screenshot shows the 'Volumetric Interpolator Data Engine' window. At the top, it has a title bar and a main title. Below the title, there are fields for 'Database Name' (C:\Vol3D\403\data1999.mdb) and 'Table Name' (cbpwwq99). A text box for 'Enter Descriptive Title' contains 'Chesapeake Bay Water Quality Analysis'. The 'Choose Parameter' section has a dropdown menu with 'CHLA, Chlorophyll' selected. To the right, 'Interpolator Settings' include 'Minimum Neighbors' (1), 'Maximum Neighbors' (4), 'Horizontal Range (M)' (25000), and 'Missing Value' (-9). Below this, 'Choose Start Date' and 'Choose End Date' both show '1/5/1999'. A 'Transform' section has radio buttons for 'Linear' (selected), 'Log (Base 2)', and '1/Sq Root'. The 'Choose Geography' section has radio buttons for 'All Bay and Tribs' (selected), 'Ches Bay (CB1-CB8)', 'Ches Bay, Mobjack, Tangier', 'Chester', 'Choptank', 'Elizabeth', 'James', 'Nanticoke', 'Potuxent', 'Pocomoke', 'Polomac', and 'Rappahannock'. On the right, 'Detection Limit' has radio buttons for 'Reported Value' (selected), 'One-half Reported Value', and 'Fixed Value' (0.01). Below that, 'Choose Depth Range' has radio buttons for 'Depth Range (m)' (selected), 'Depth Layers', and 'Above Pycnocline', 'Below Pycnocline', 'Surface', and 'Bottom'. The 'Grouping of Data' section has radio buttons for 'All data in single data set' (selected), 'Group by BAY\_CRUISE', 'Group by Cruise\_ID (Yr+Month)', 'Group by Year + Month' (with checkboxes for months 1-12), 'Group by Month' (with checkboxes for months 1-12), 'Group by Season (MM/DD)' (with checkboxes for Spring, Summer, Fall, Winter), and 'Group by Year + Season'. At the bottom, there is an 'Output File Name' field with 'S90105\_095251.d3d' and a 'Browse' button. To the right are 'Create Files...' and 'Done' buttons.

*From 2007 Ambient Water Quality Criteria Addendum*

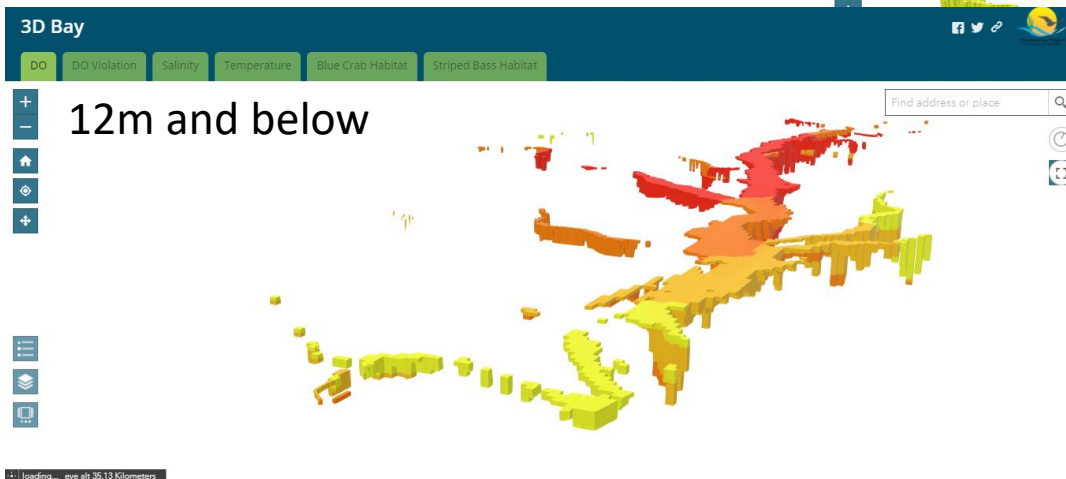
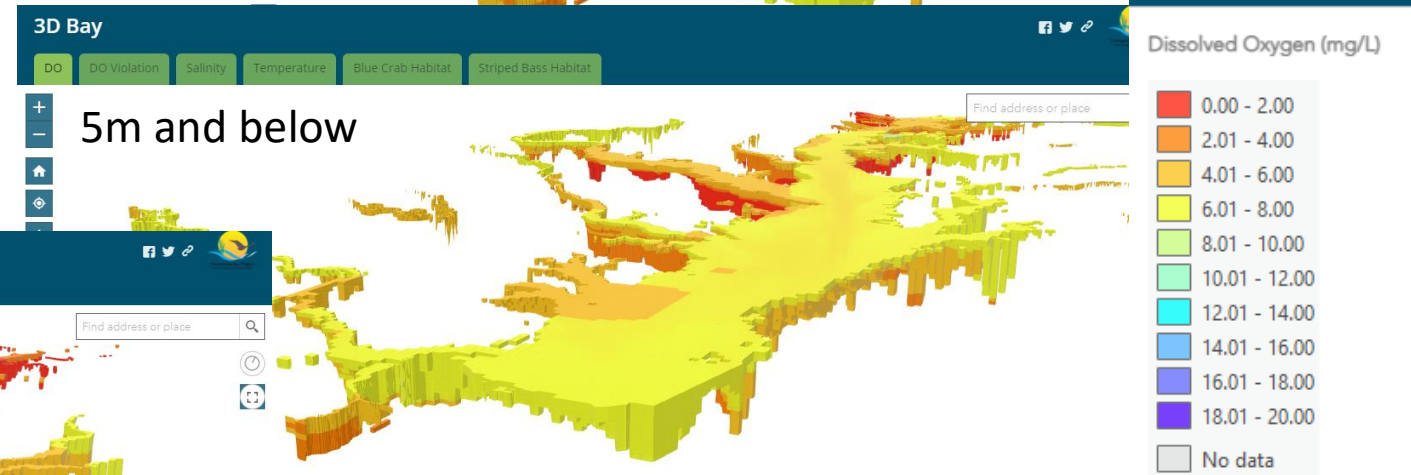
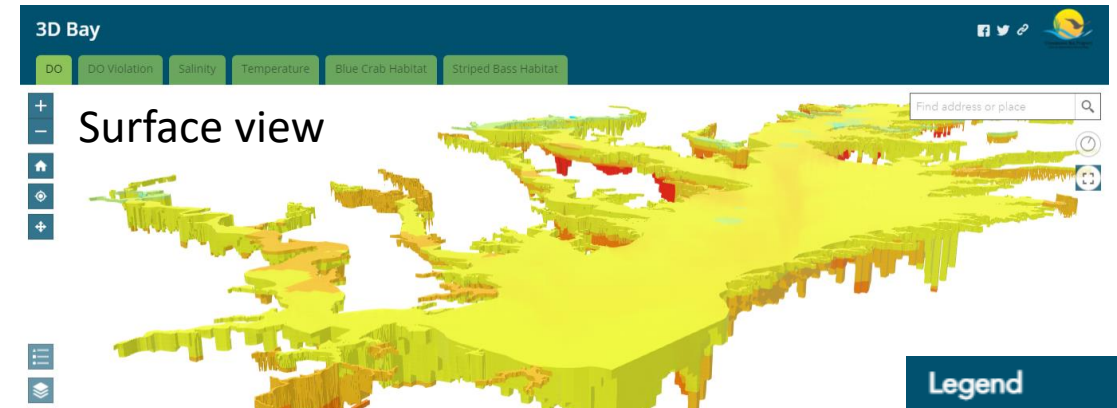


# Visualizing results



VOL3d program output

## July 2017 interpolation of DO



Zhaoying (Angie) Wei: beta tool

<https://bit.ly/2loRqbm> 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
- ?