4-dimensional (4-D) interpolator development overview

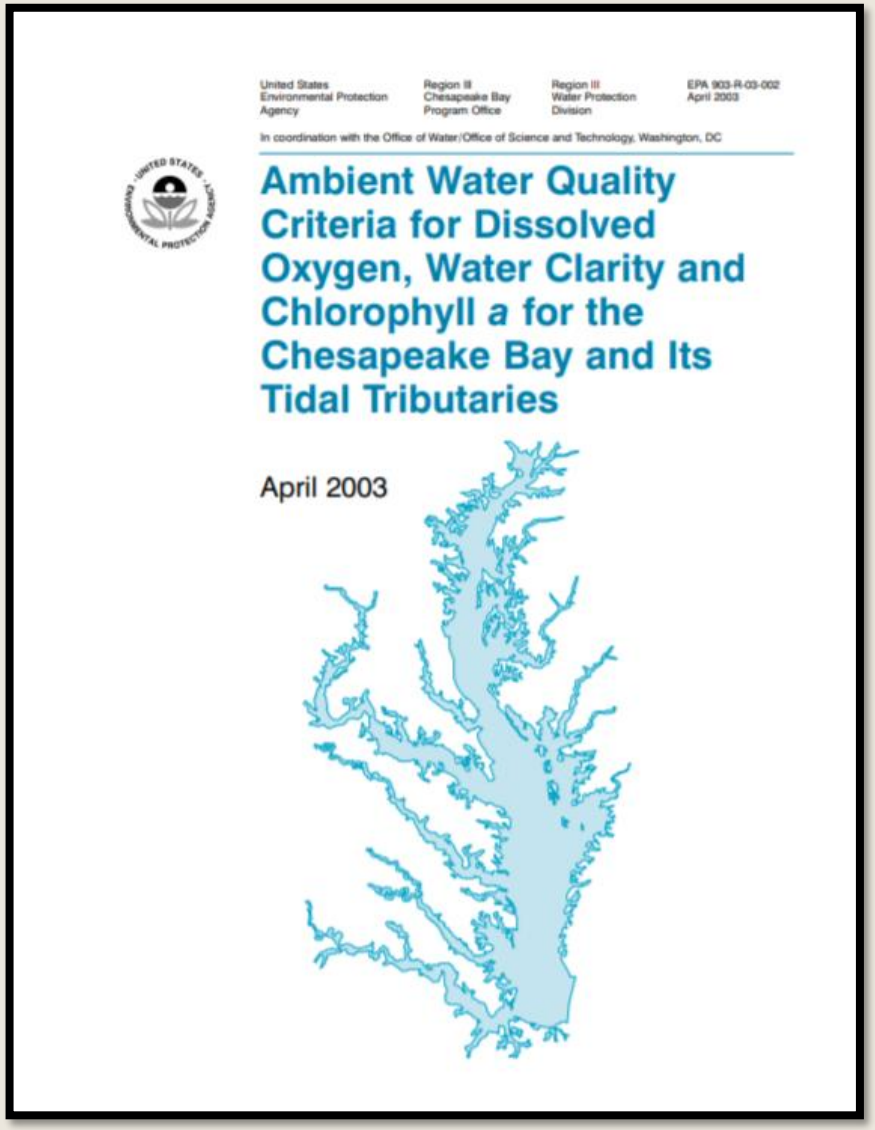
Rebecca Murphy (UMCES/CBP)
Bay Oxygen Research Large Group
Sept. 16, 2024

With input from:

Jon Harcum (Tetra Tech), Elgin Perry (statistics consultant),

Wes Slaughter (UMd), Breck Sullivan (USGS), and Peter Tango (USGS)

Purpose: New interpolation method for criteria assessment



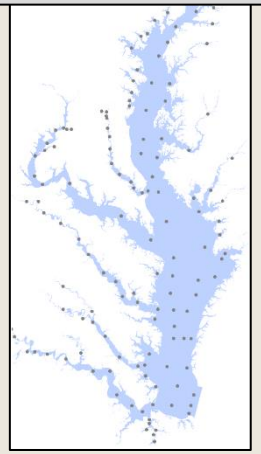
- "…The use of cumulative frequency distributions (CFDs) is recommended for assessing the spatial and temporal water quality criteria exceedances in the Chesapeake Bay".

- Some notes in 2003 about this:
  - *OTHER current criteria assessment methods are based only on temporal variation with measurements evaluated at individual monitoring stations.*
  - *Limitation : it is difficult to determine whether an individual sampling location is representative, and there is potential for bias.*
  - *In size of CB, accounting for spatial variation can be very important and CFD approach represents a significant improvement.*

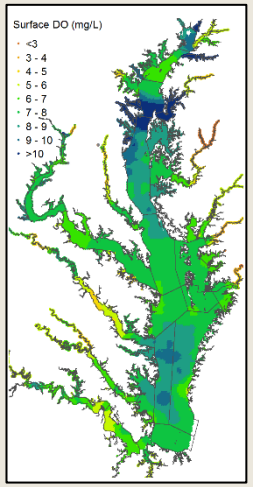
WQS Criterion Assessment

Current approach

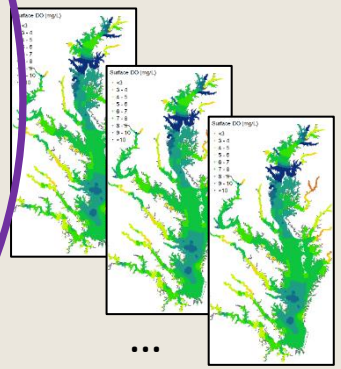
1. Collect bi-weekly to monthly data at each monitoring station



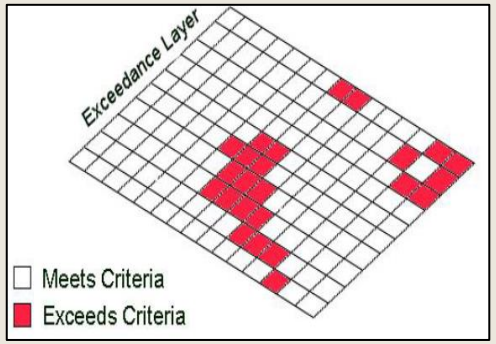
2. Interpolate bay-wide for a single cruise



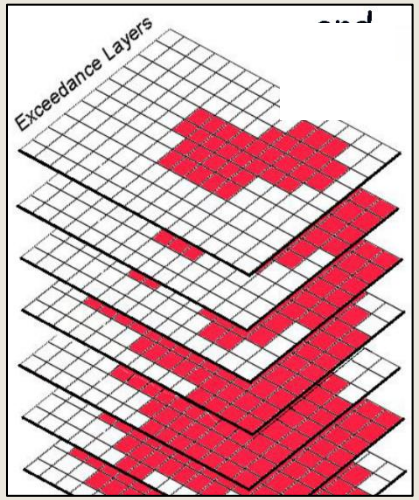
3. Conduct interpolations for a season over the 3-year period



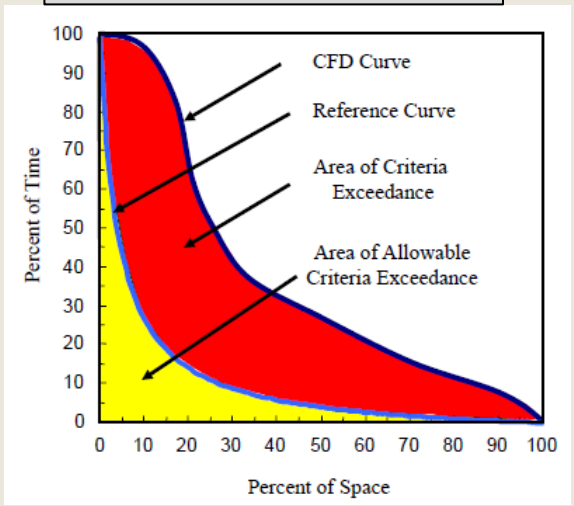
4. Average monthly if 30-day criterion, and compare the interpolated values with appropriate criterion values



5. Repeat Step 4 throughout the 3-year period



6. Calculate the cumulative frequency distribution (CFD) for extent of exceedance in space and time

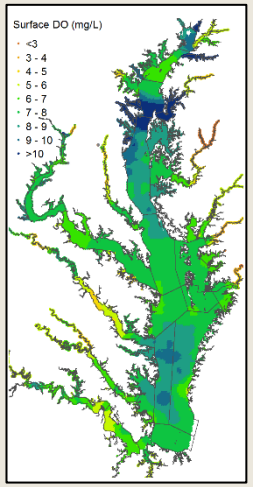


7. Quantify attainment status (attaining or not) for the 3-year period

From Peter Tango

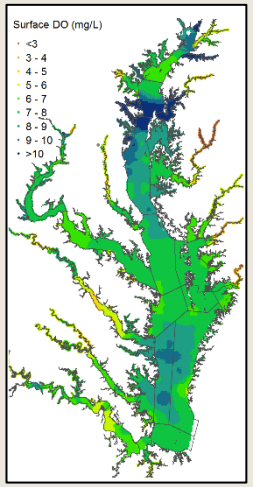
Current interpolation

2. Interpolate bay-wide for a single cruise



Current interpolation

2. Interpolate bay-wide for a single cruise



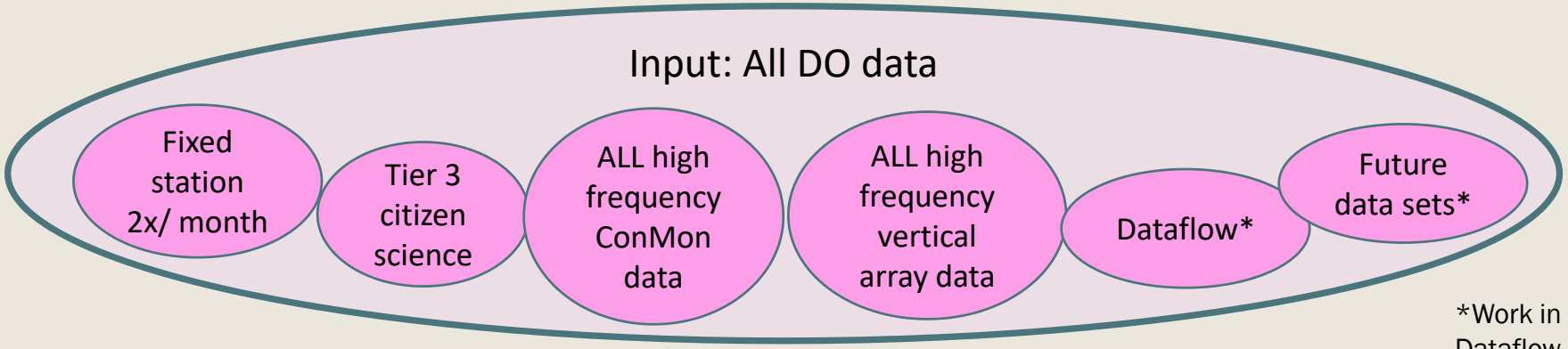
Problems with current interpolation

- Does not use the high frequency data (except the calibration data).
- Vertical layers interpolated horizontally and stacked;
- One cruise at a time, meaning a 2-week period assumed static; and
- Not statistical.

This NEW interpolation will:

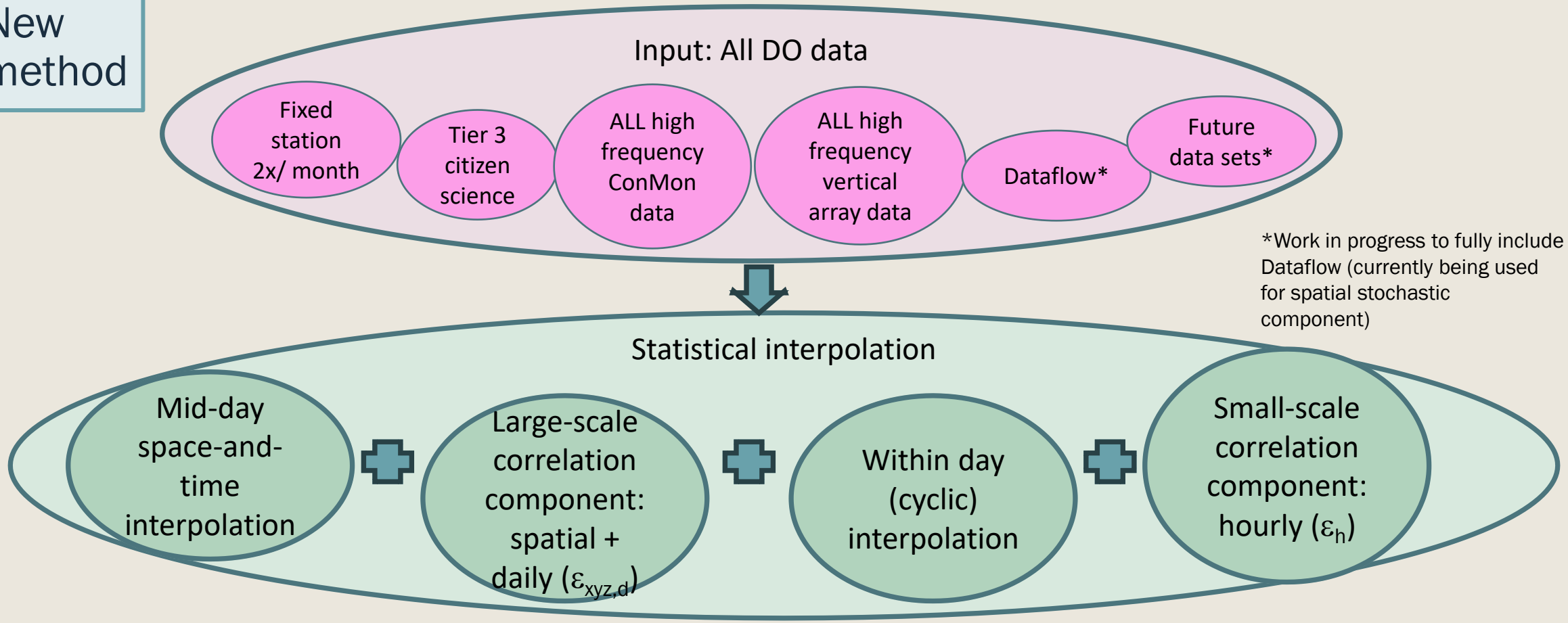
- Use **ALL high frequency data** (ConMon and vertical array)
- Interpolate all data together, not in layers.
- Interpolate in time, so that we do not have to artificially split time periods.
- Statistical – allowing for uncertainty bounds if needed.

New method



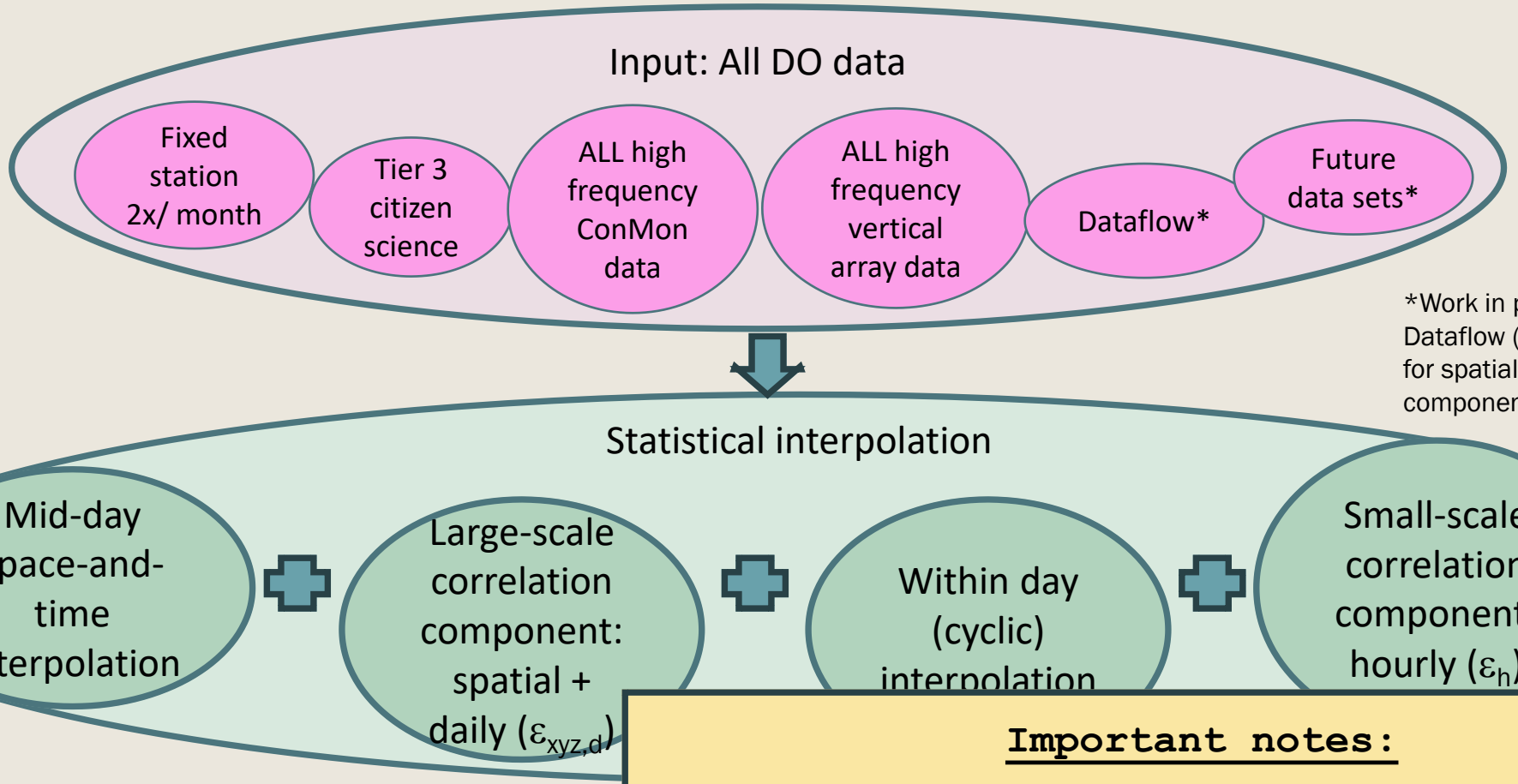
*Work in progress to fully include Dataflow (currently being used for spatial stochastic component)

New method



*Work in progress to fully include Dataflow (currently being used for spatial stochastic component)

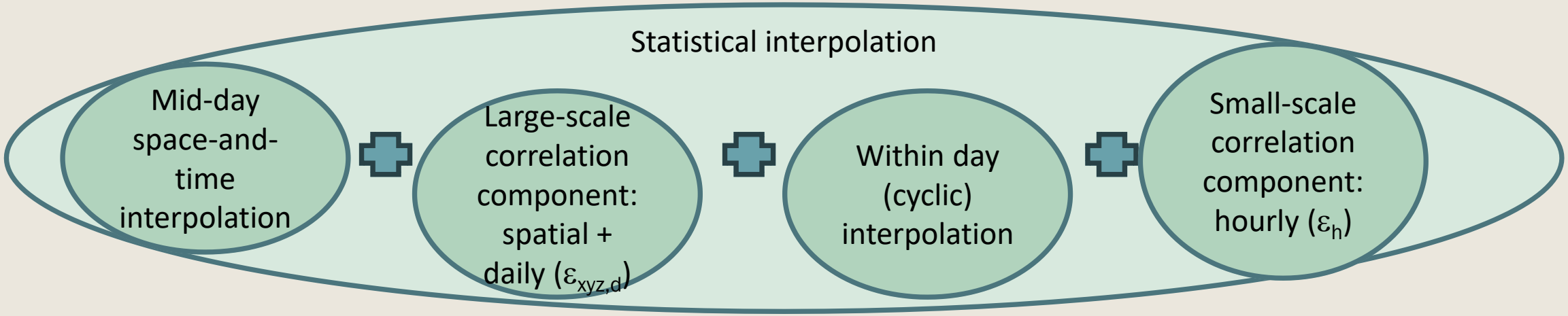
New method



*Work in progress to fully include Dataflow (currently being used for spatial stochastic component)

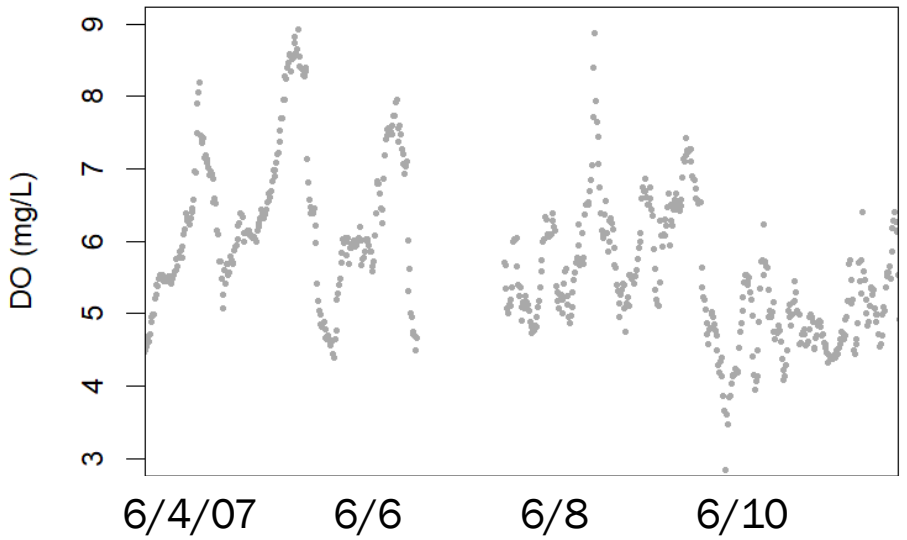
Important notes:

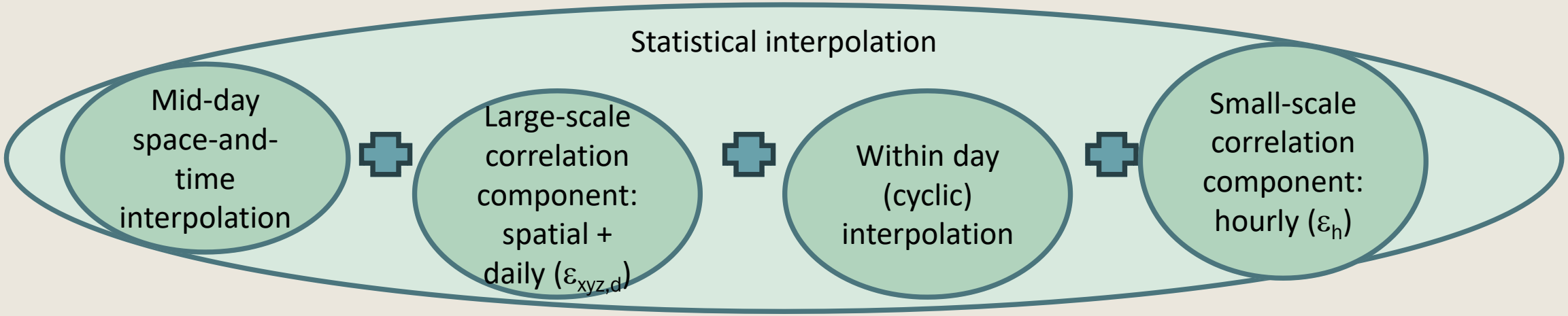
- **The 4 interpolation pieces listed here were designed to represent different spatial and temporal features of the DO data.**
- **Ultimately, it is the SUM of these 4 components that will be used, NOT any incremental results.**



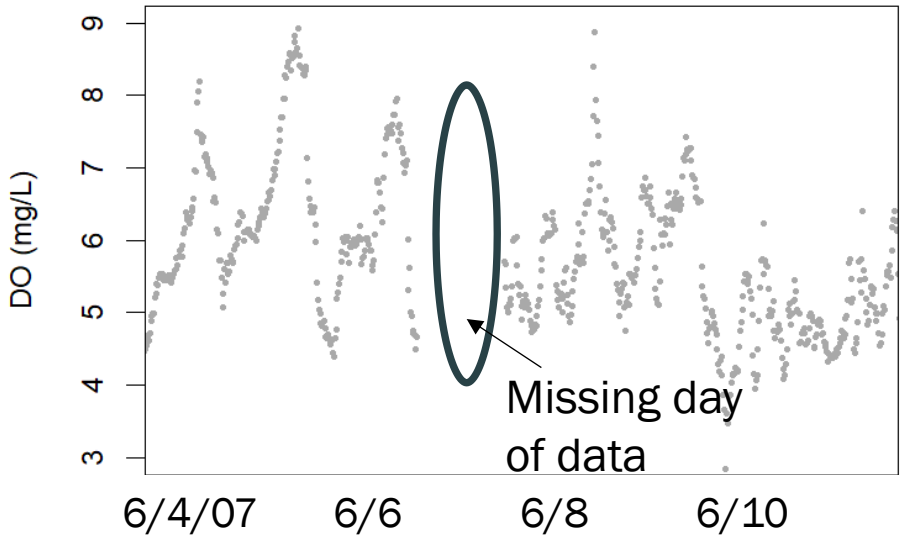
Simple example

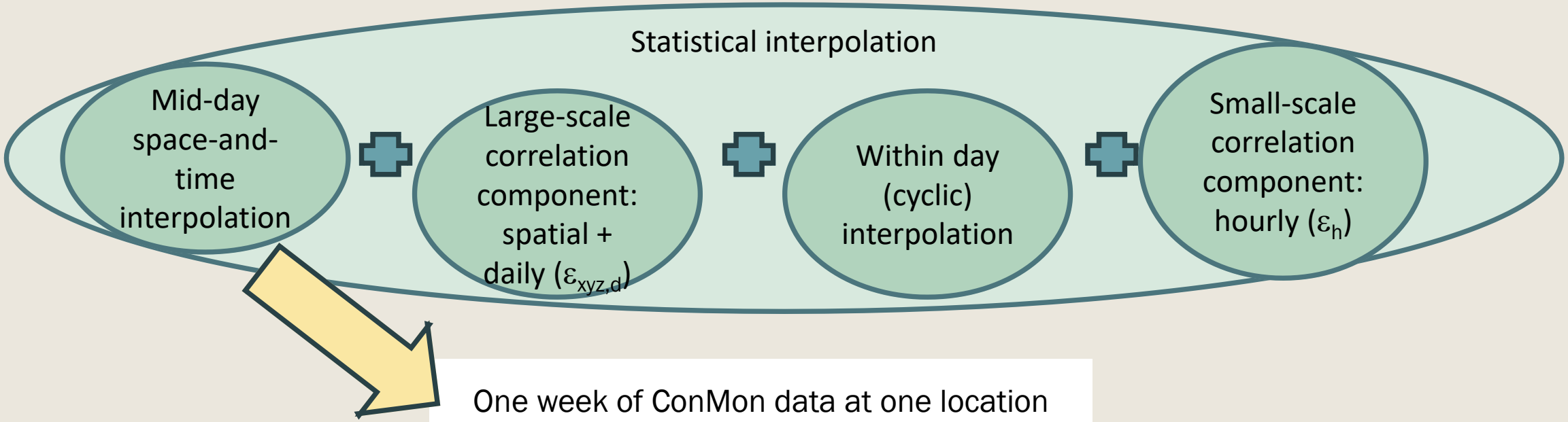
One week of ConMon data at one location





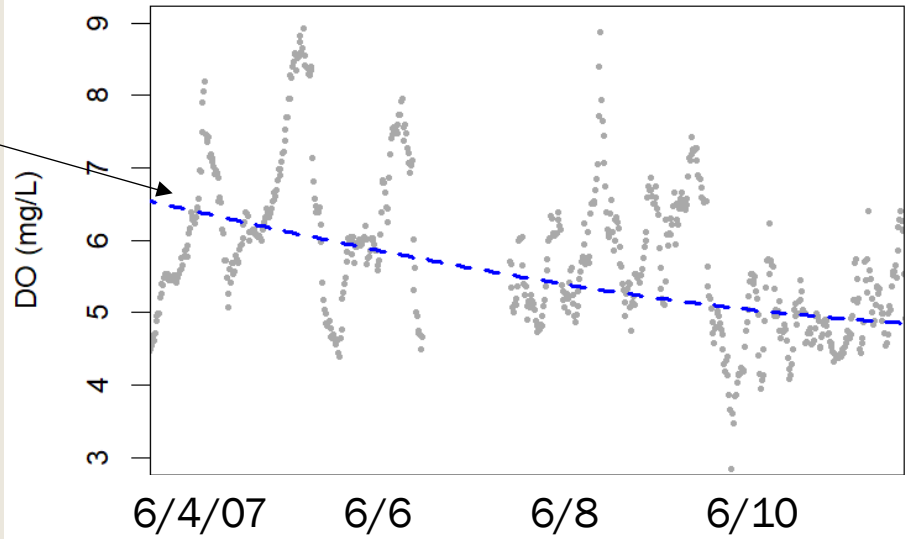
One week of ConMon data at one location

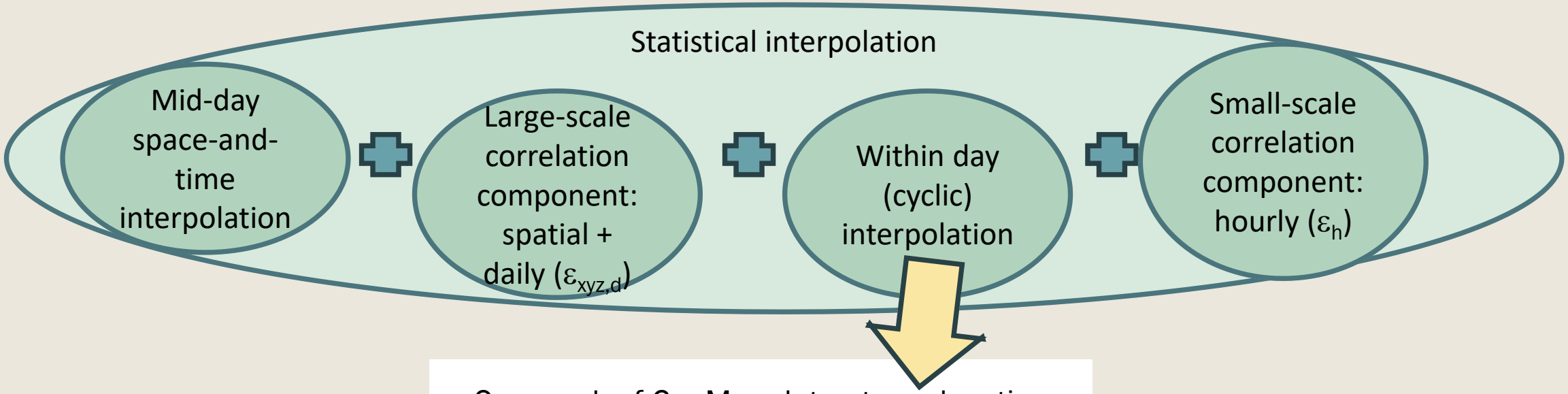




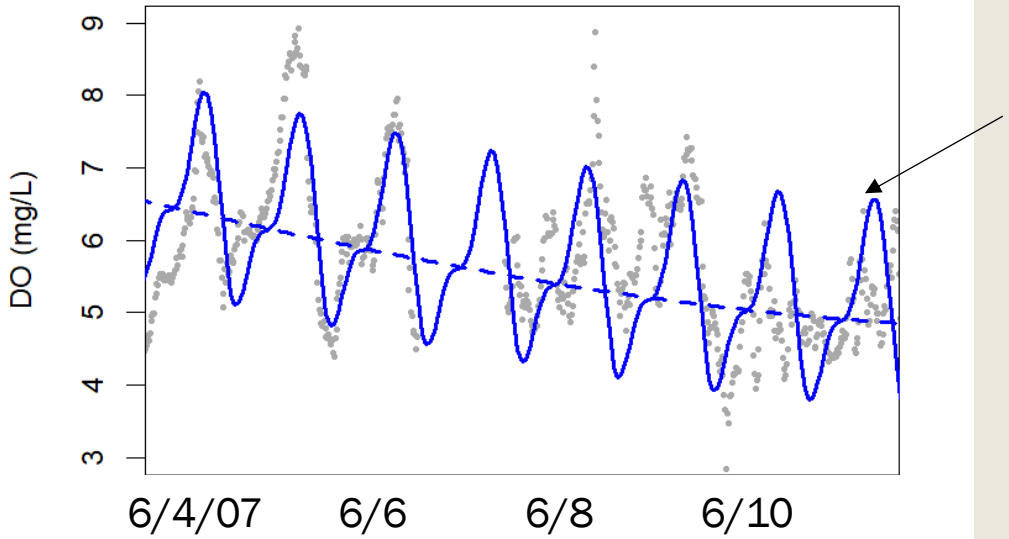
Mid-day interpolation:
Represents the gradual decrease observed in the data over this week.

One week of ConMon data at one location

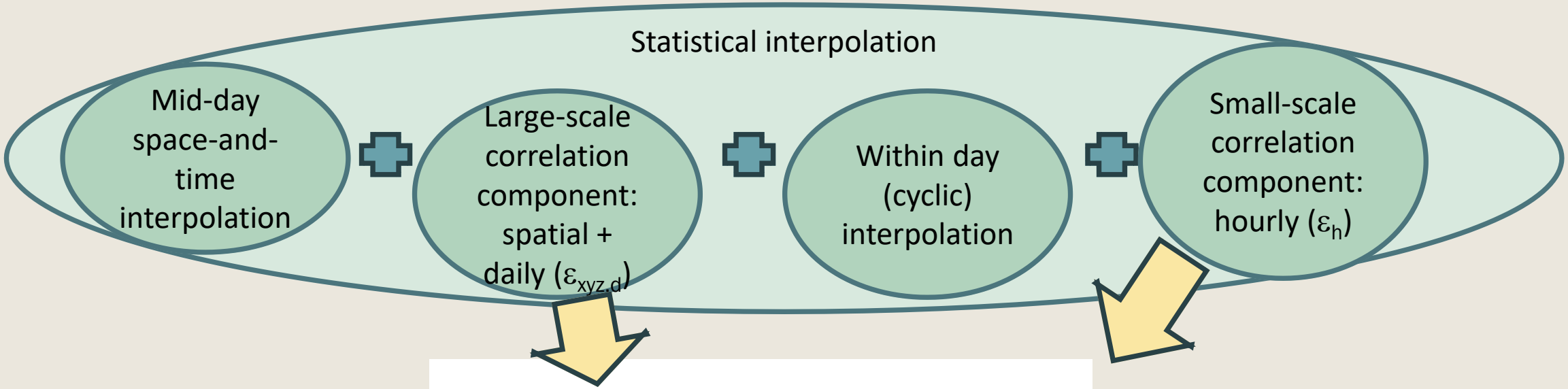




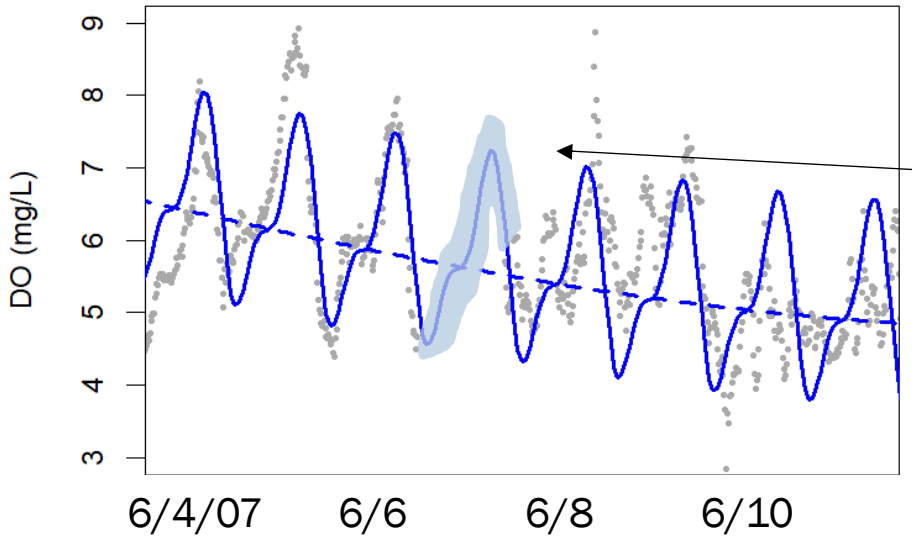
One week of ConMon data at one location



Within day (cyclic) interpolation:
Added to the daily interpolation and represents the diel and tidal cycles *(in practice, cycles will vary daily and by location)*



One week of ConMon data at one location



Multiple realizations: Correlation components provide multiple realizations. *(Very rough drawing here– see Elgin's presentation for real results).*

First, try entire approach in a pilot location: **Elgin's presentation**

Statistical interpolation

Mid-day space-and-time interpolation

+

Large-scale correlation component: spatial + daily ($\varepsilon_{xyz,d}$)

+

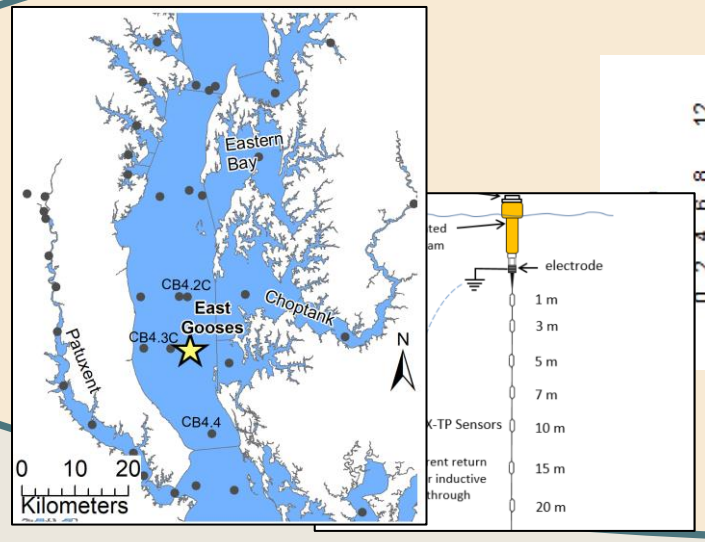
Within day (cyclic) interpolation

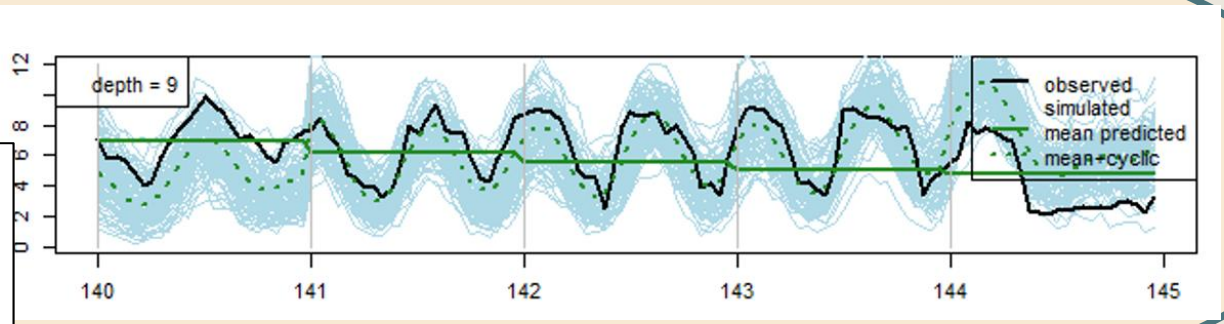
+

Small-scale correlation component: hourly (ε_h)

Hourly DO realizations at one example station

=

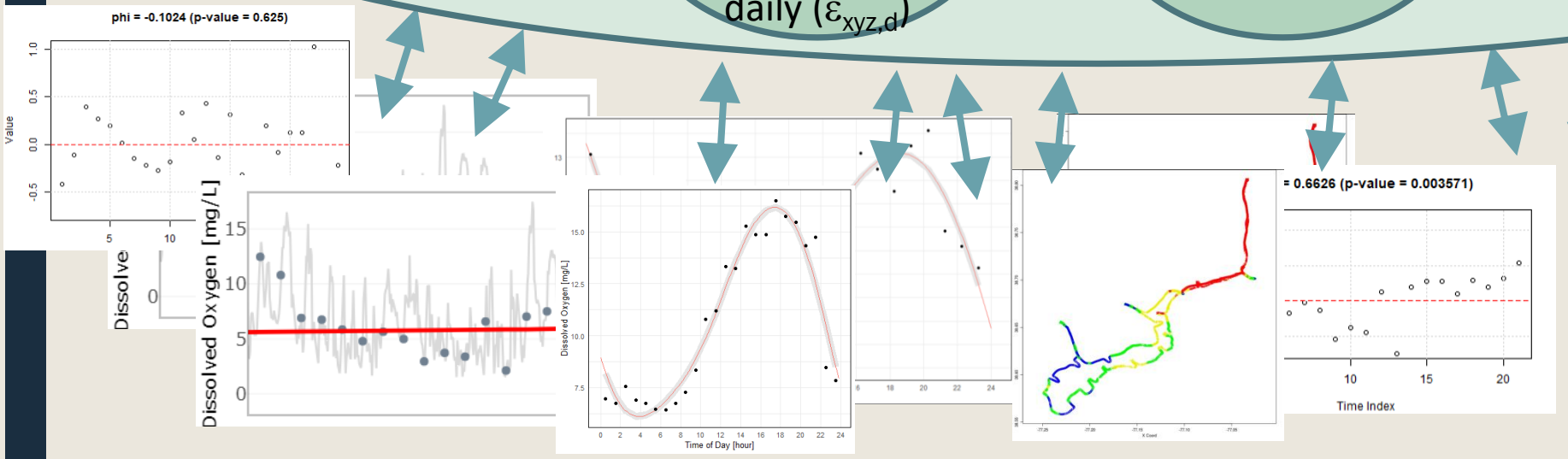




In parallel, prepare for applying bay-wide: **Jon's presentation**

Statistical interpolation

- Mid-day space-and-time interpolation
- Large-scale correlation component: spatial + daily ($\varepsilon_{xyz,d}$)
- Within day (cyclic) interpolation
- Small-scale correlation component: hourly (ε_h)



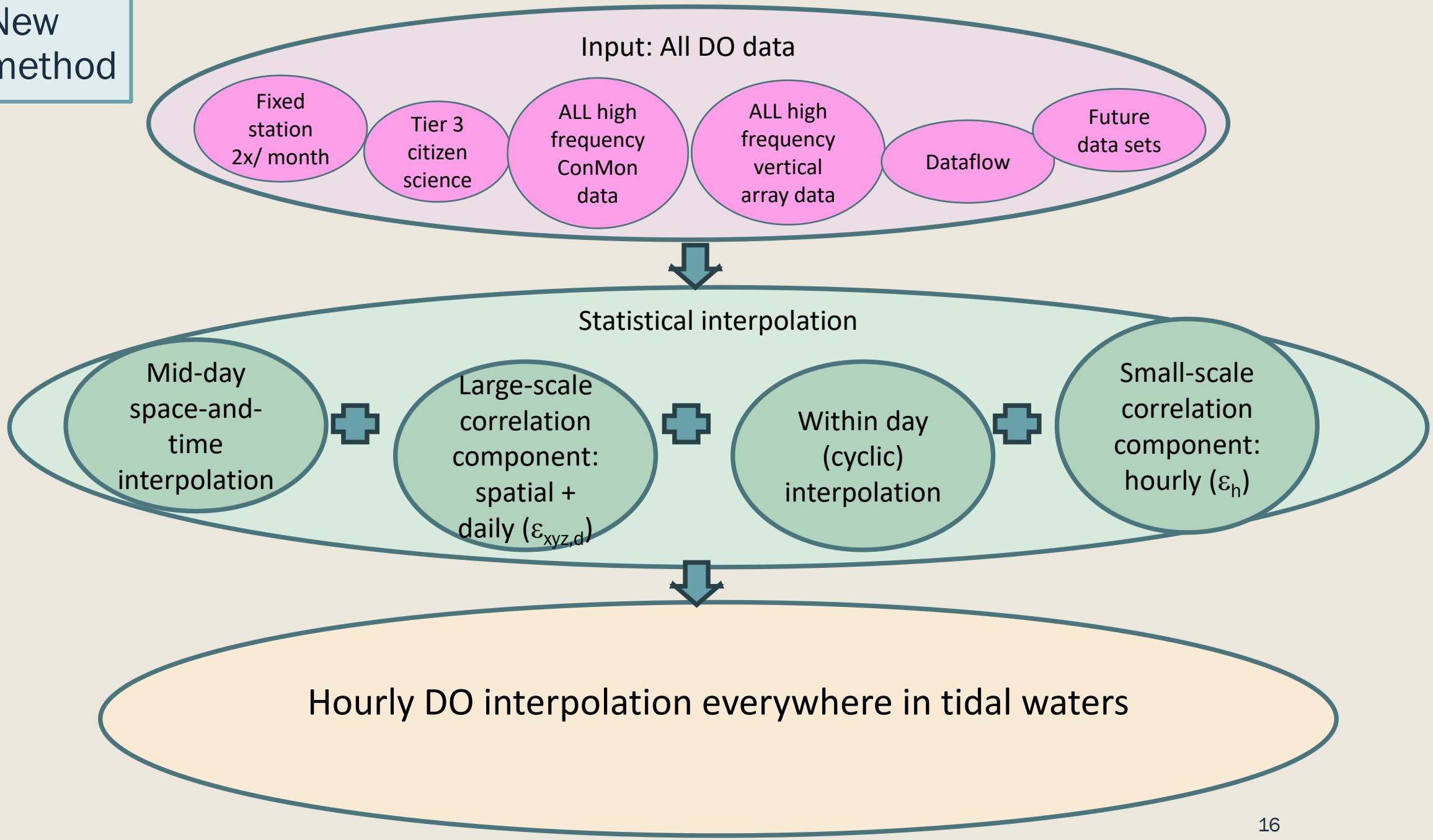
...

Generate parameters from <u>all data, everywhere</u>. Interpolate them.

=

Hourly DO interpolation everywhere in tidal waters

New method


Input: All DO data
Fixed station 2x/ month
Tier 3 citizen science
ALL high frequency ConMon data
ALL high frequency vertical array data
Dataflow
Future data sets
Statistical interpolation
Mid-day space-and-time interpolation
Large-scale correlation component: spatial + daily ($\varepsilon_{xyz,d}$)
Within day (cyclic) interpolation
Small-scale correlation component: hourly (ε_h)
Hourly DO interpolation everywhere in tidal waters

4d interpolator development timeline