Data to WQ Assessment

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STAC Advanced Monitoring Workshop

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On behalf of the Bay Oxygen Research Group

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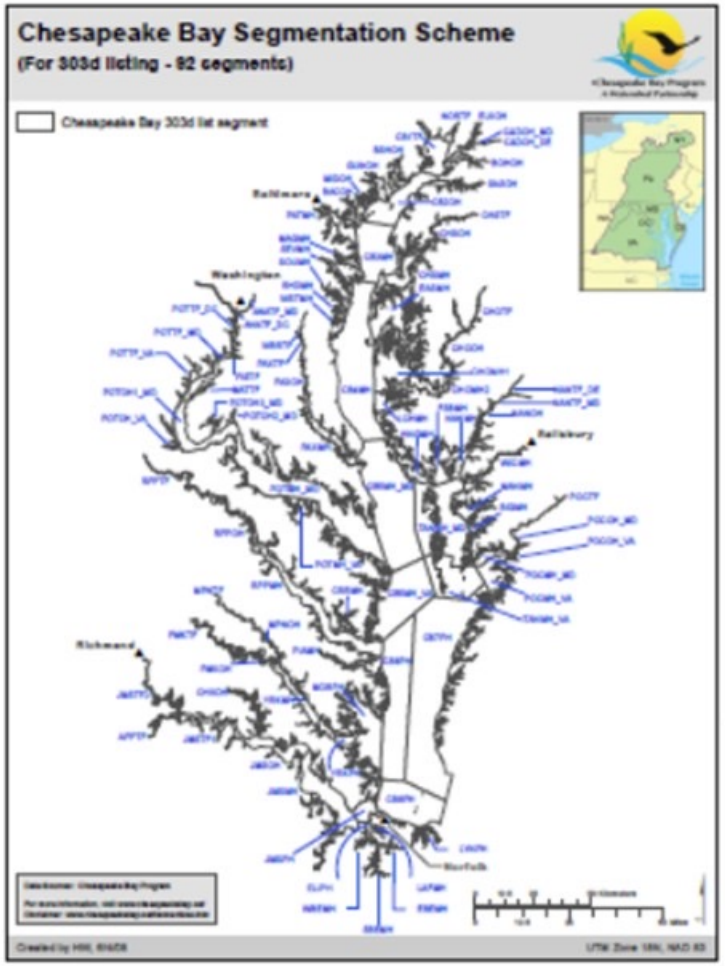
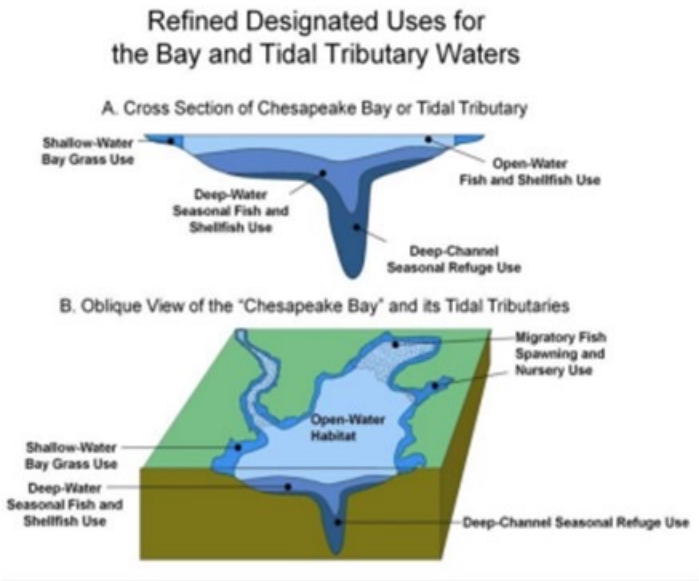
Clean Water Act Water Quality Standards Monitoring and Assessment Issue: A segment must meet **all criteria** in **all applicable designated uses** for a decision on delisting in State water quality standards





No assessment available for approximately 61% (512 of 838) Individual decisions needed to make a full assessment of the bay criteria (PT)

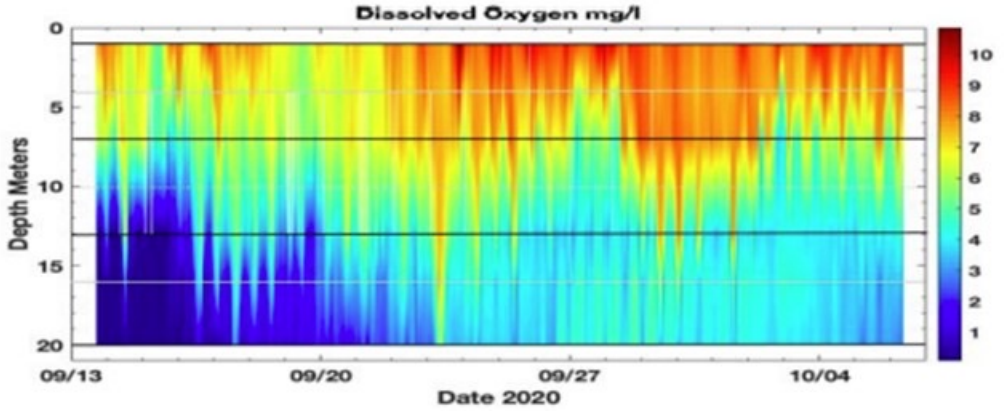
0

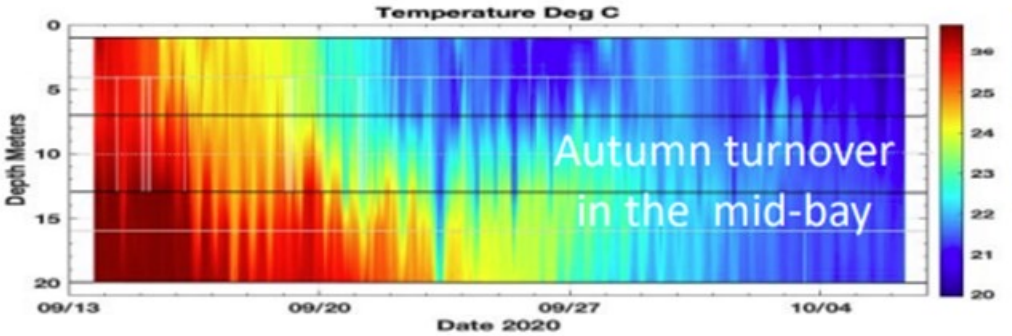
The number of segments we have full monitoring data accounting for to support all criteria assessments needed to make a delisting decision

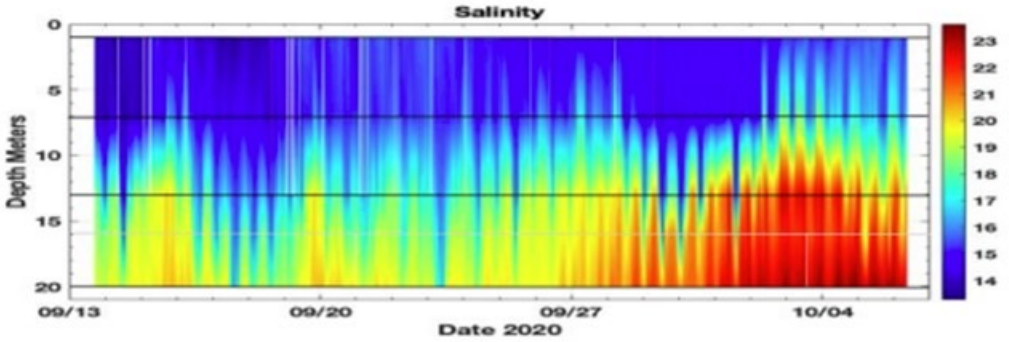
Addressing the data issues: 2019-20 GIT Funded Pilot Project on robust, cost-effective high frequency water quality profiling data collection

- **Dissolved oxygen**
- **Temperature**
- **Salinity**

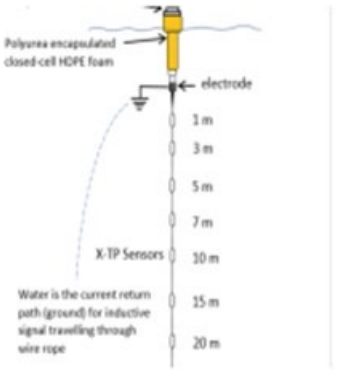
Sept-Oct 2020 mid-Bay CB4.3





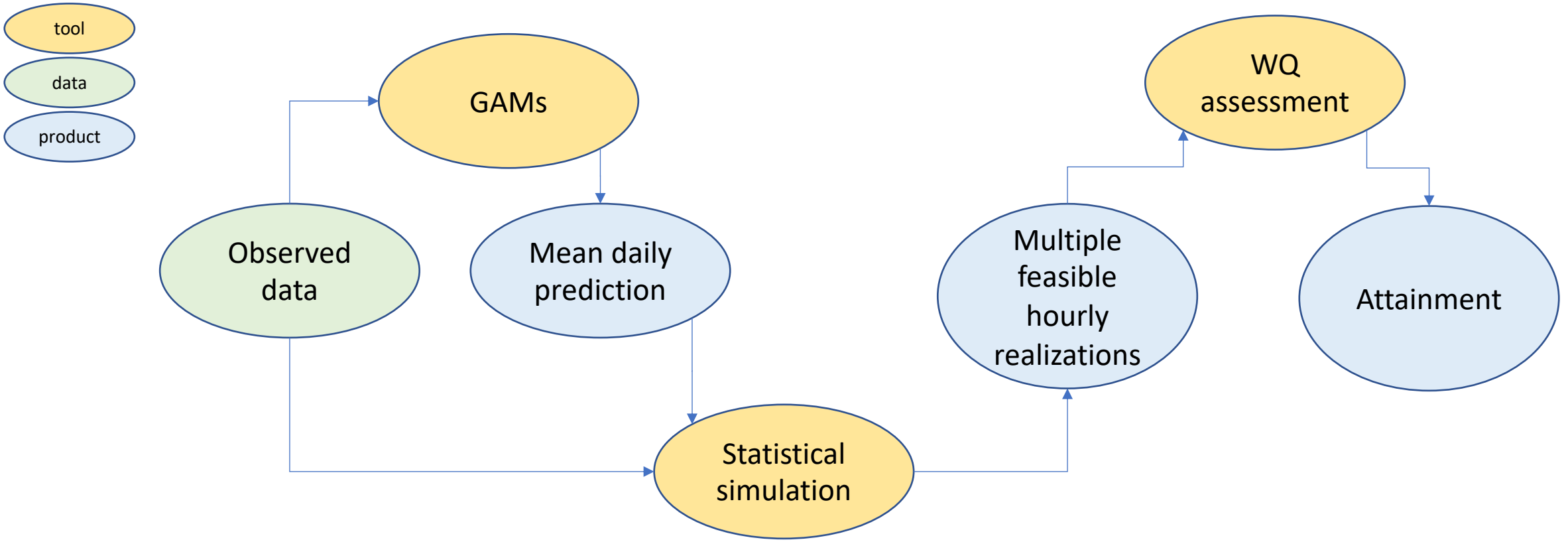


~ $50K instrument with high data return on investment



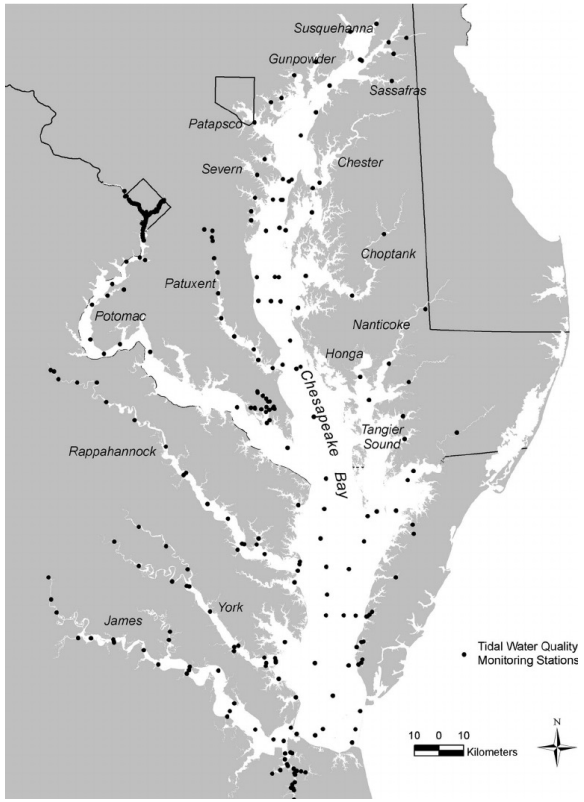
D. Wilson 2020. 2019-2020 Chesapeake Bay Trust GIT-funded pilot project results

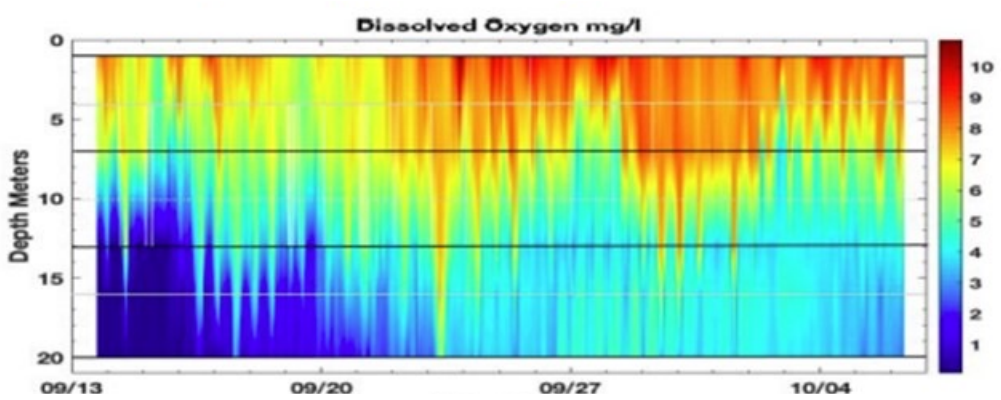
WQ Assessment with 4D interpolator – big picture



Observed Data – Kitchen sink approach

Observed data

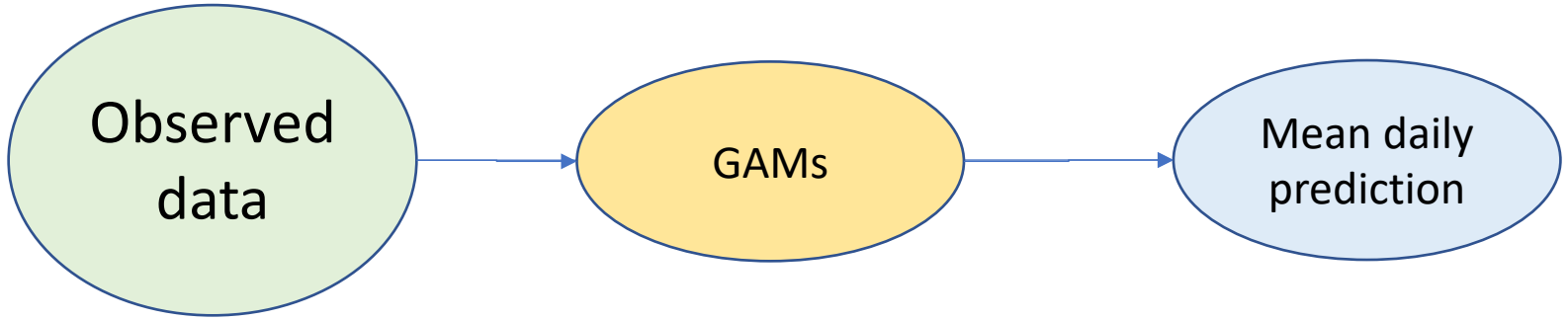


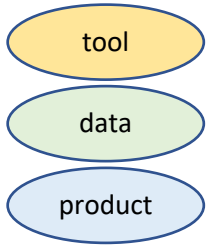


- Temperature
- Salinity
- Density
- …

- Inflows
- Wind
- Tide
- Modeled Hydrodynamics
- …

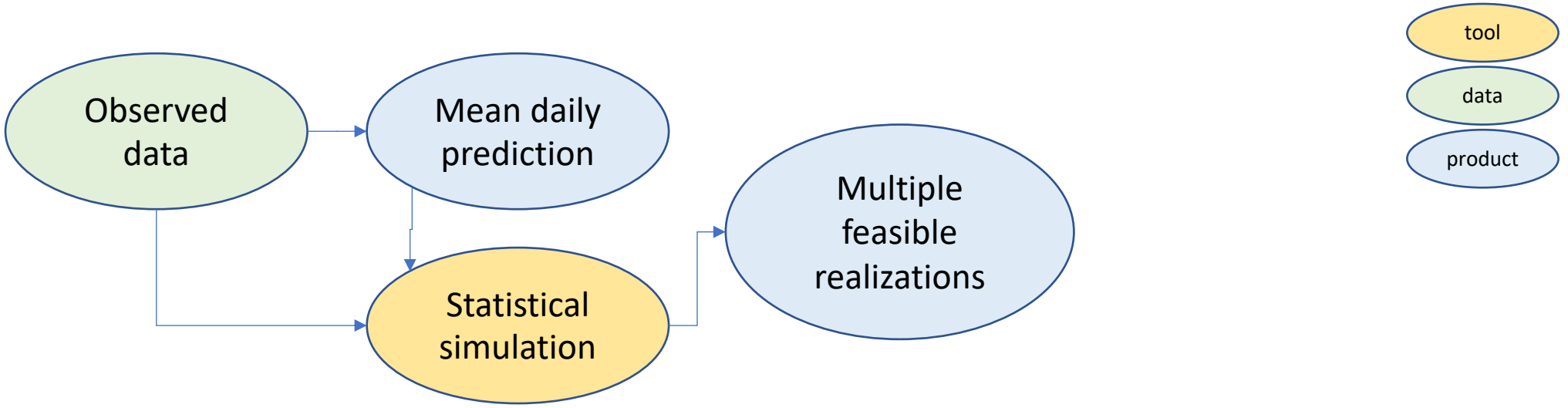
Mean Daily Prediction





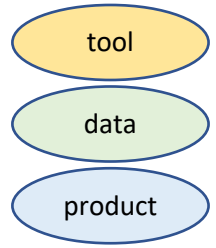
- GAM = Generalized Additive Model
  - Rebecca Murphy and Elgin Perry presentations
- Produces the most likely water quality values for all space and time.
  - Dissolved oxygen
  - Clarity
  - Chlorophyll *a*
  - Pycnocline upper and lower boundary
    - Density => salinity and temperature

Statistical Simulation



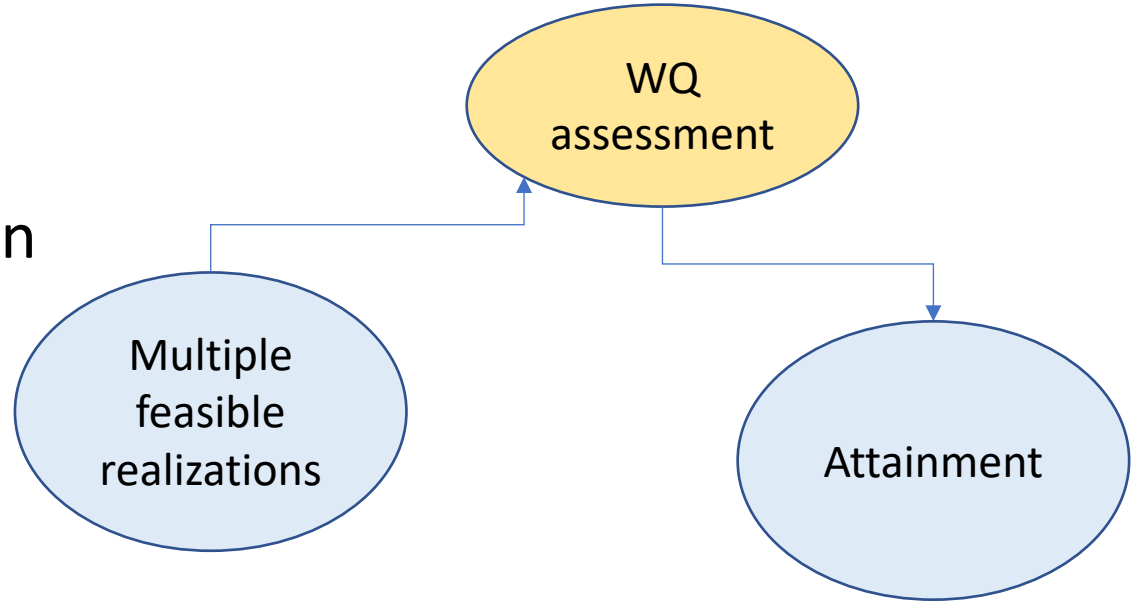
- Statistical simulation
  - Deterministic addition of diel cycling
  - Stochastic autoregressive component to generate multiple feasible realizations
- incorporates observed spatial and temporal correlation.
- Data
  - vertical profiler
  - data flow
  - continuous monitoring data

WQ assessment – Why multiple realizations?



- Water Quality assessment is an estimation of the frequency of low-oxygen events
- Using the mean daily prediction would underestimate the frequency of these events

- The assessment is performed by calculating a frequency distribution of spatial violation rates
- The more available estimates of spatial violation rates, the more accurate the frequency distribution



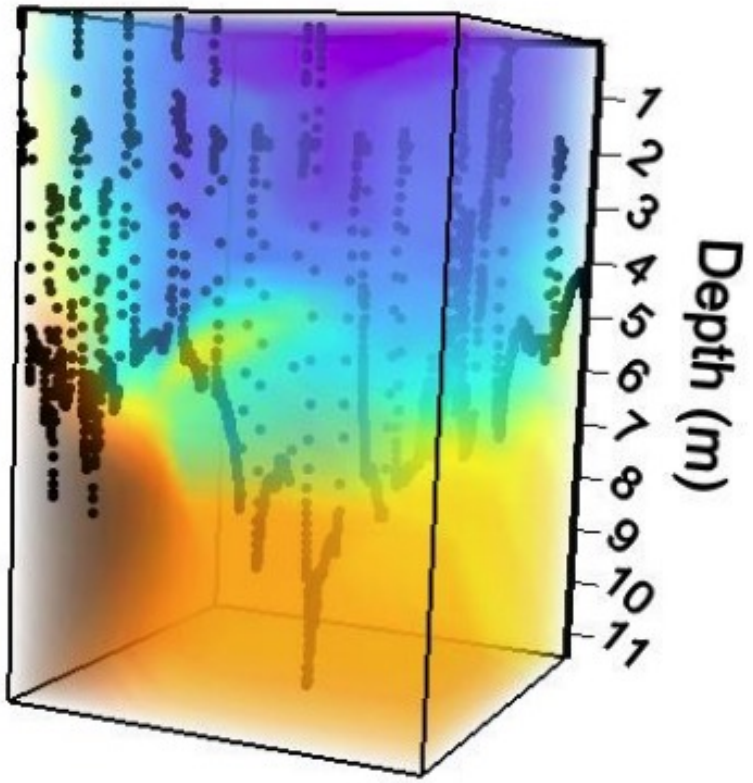
30-day mean – CB3MH – Deep Water

Table 2 Dissolved oxygen criteria and applicable designated uses of the water quality standards for Chesapeake Bay and its tidal tributaries. Assessed criteria and designated uses are set in italics and unassessed criteria and designated uses are in bold.

Designated use	Dissolved oxygen criteria concentration/duration		Temporal application
Migratory fish spawning and nursery use	**7-day mean ≥ 6 mg/L for tidal habitats with 0–0.5 ppt salinity** **Instantaneous minimum ≥ 5 mg/L**		**February 1–May 31**
	Open water fish and shellfish designated use criteria apply		**June 1–January 31**
Shallow water Bay grass use	**Open water fish and shellfish designated use criteria apply**		**Year-round**
Open-water fish and shellfish use	*30-day mean*	*≥ 5.5 mg/L, salinity: 0–0.5 ppt* *≥ 5 mg/L, salinity: > 0.5 ppt*	**Year-round**
	7-day mean	**≥ 4 mg/L**	
	Instantaneous minimum ≥ 3.2 mg/L		
Deep-water seasonal fish and shellfish use	*30 day mean > 3 mg/L* **1-day mean ≥ 2.3 mg/L**		**June 1–September 30**
	Instantaneous minimum ≥ 1.7 mg/L		
	Open-water fish and shellfish designated use criteria apply		**October 1–May 31**
Deep-channel seasonal refuge use	*Instantaneous minimum > 1 mg/L*		**June 1–September 30**
	Open-water fish and shellfish use criteria apply		**October 1–May 31**

Generate a spatially-complete realization of CB3MH-Deep Water oxygen 30-day mean concentration

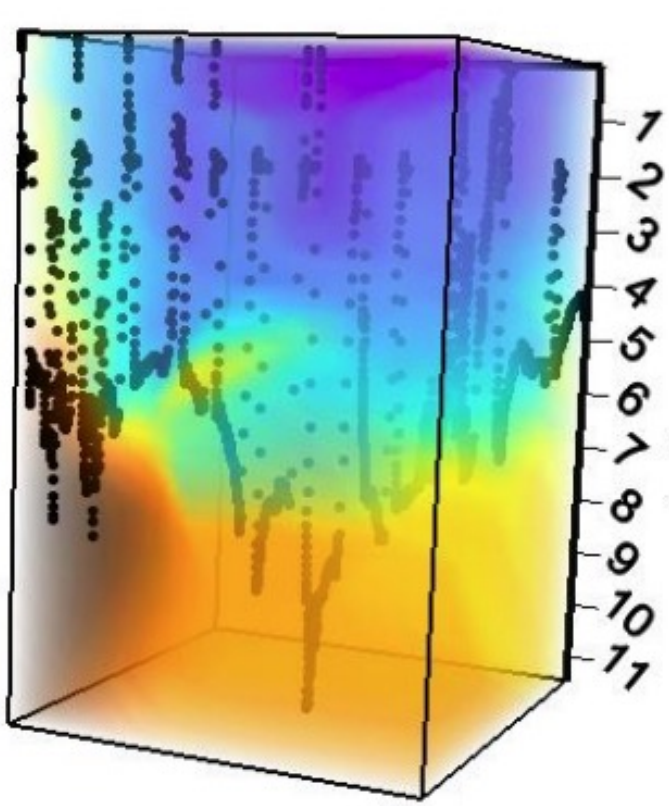
T = day1-day30



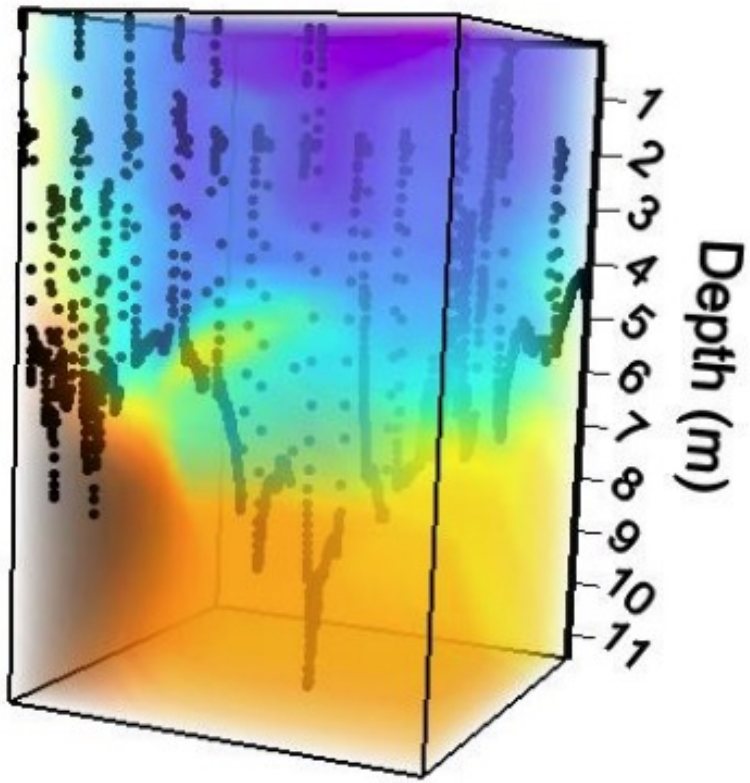
Calculate the fraction of the volume below 3 mg/l

Produce an estimate for each summer month in 3 years

T = day1-day30

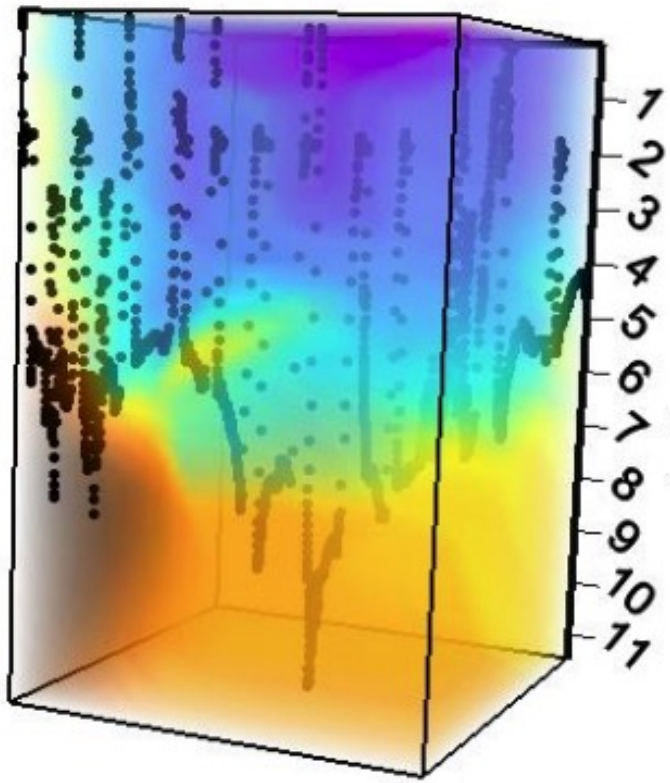


T = day31-day60

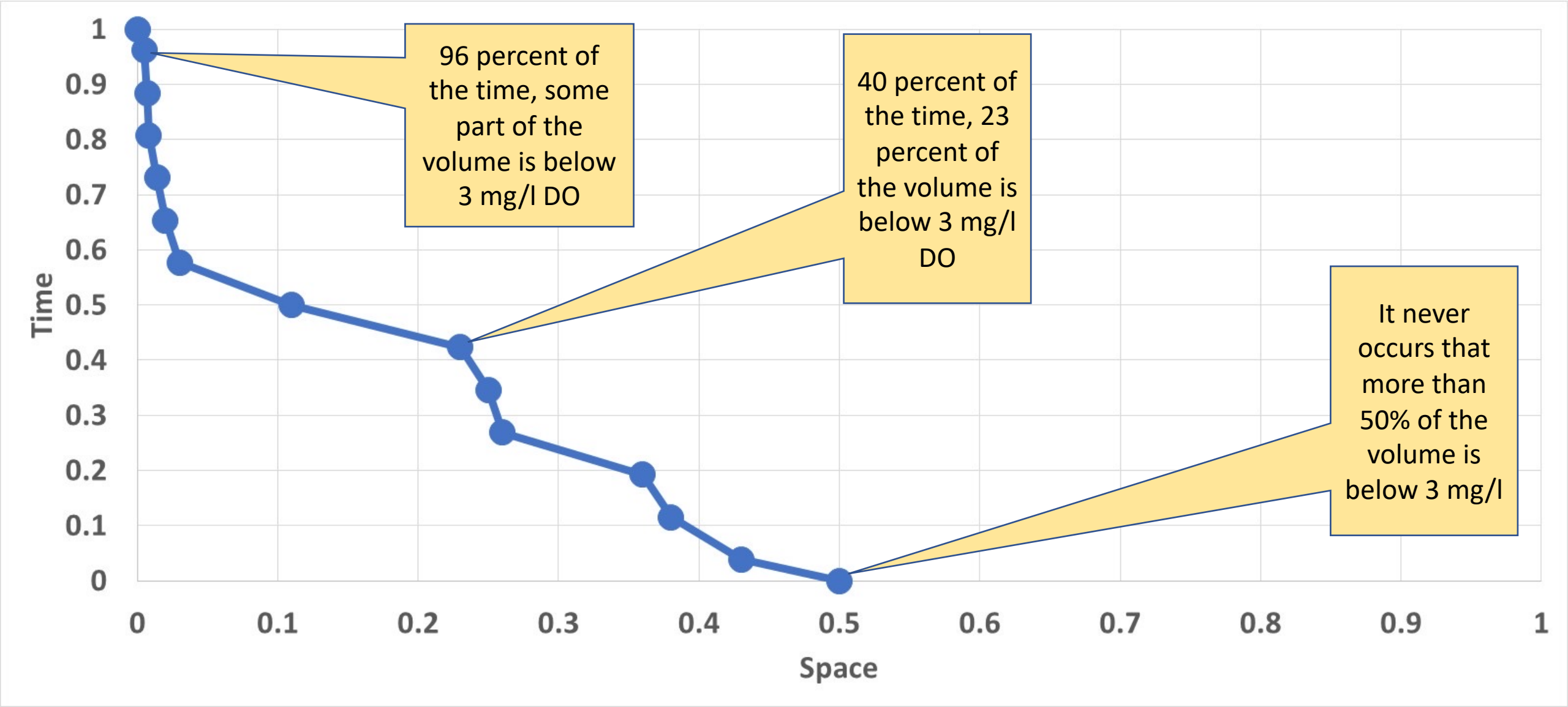


…

T = day90-day120

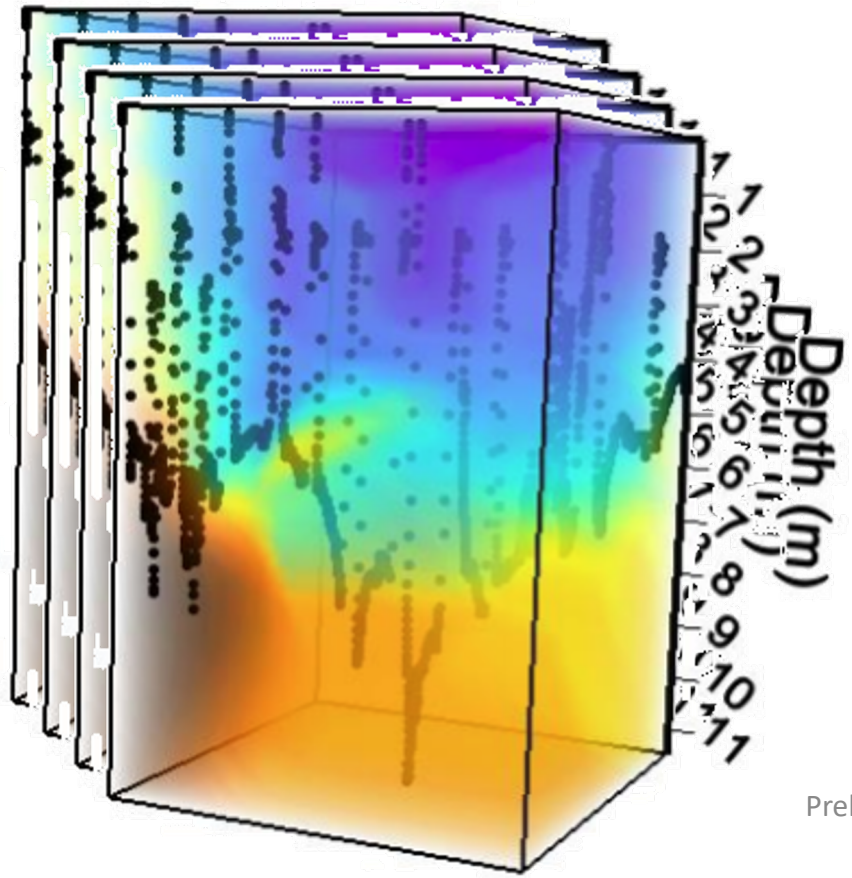


Typical 30-day mean curve: 4 months x 3 years



However, GAM results of the most likely value will underestimate the fraction of volume with extreme values

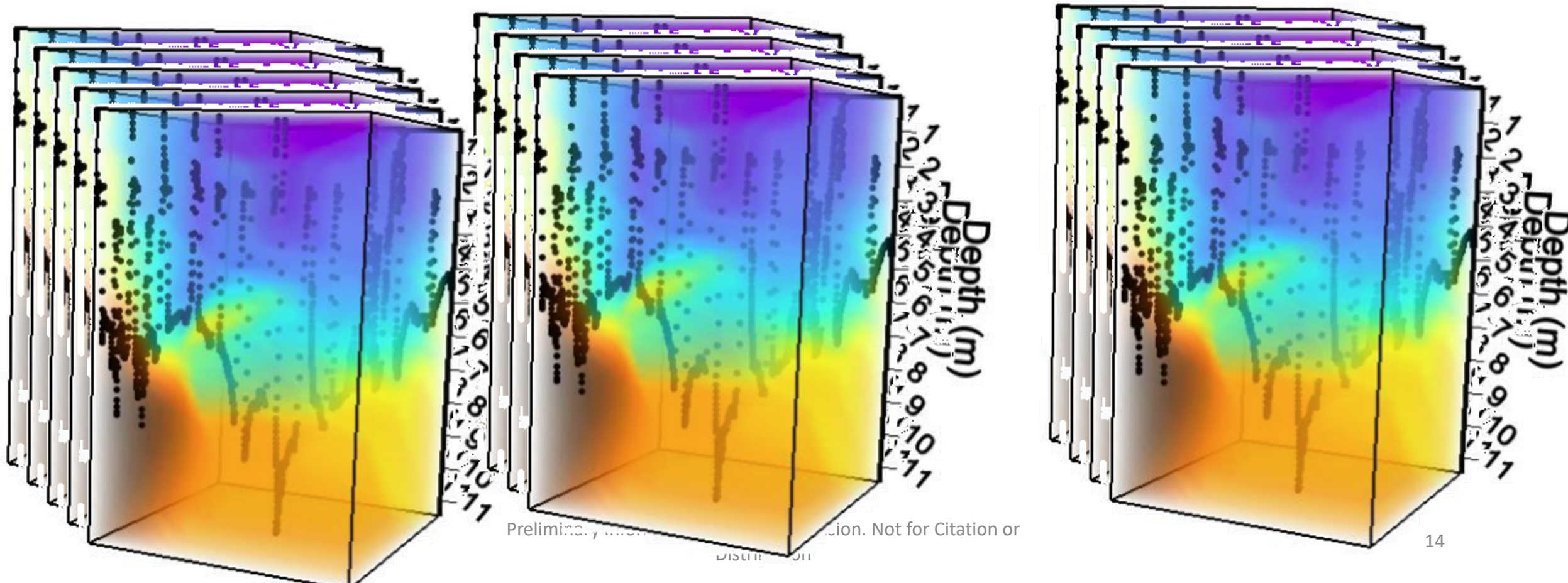
T = day1-day30



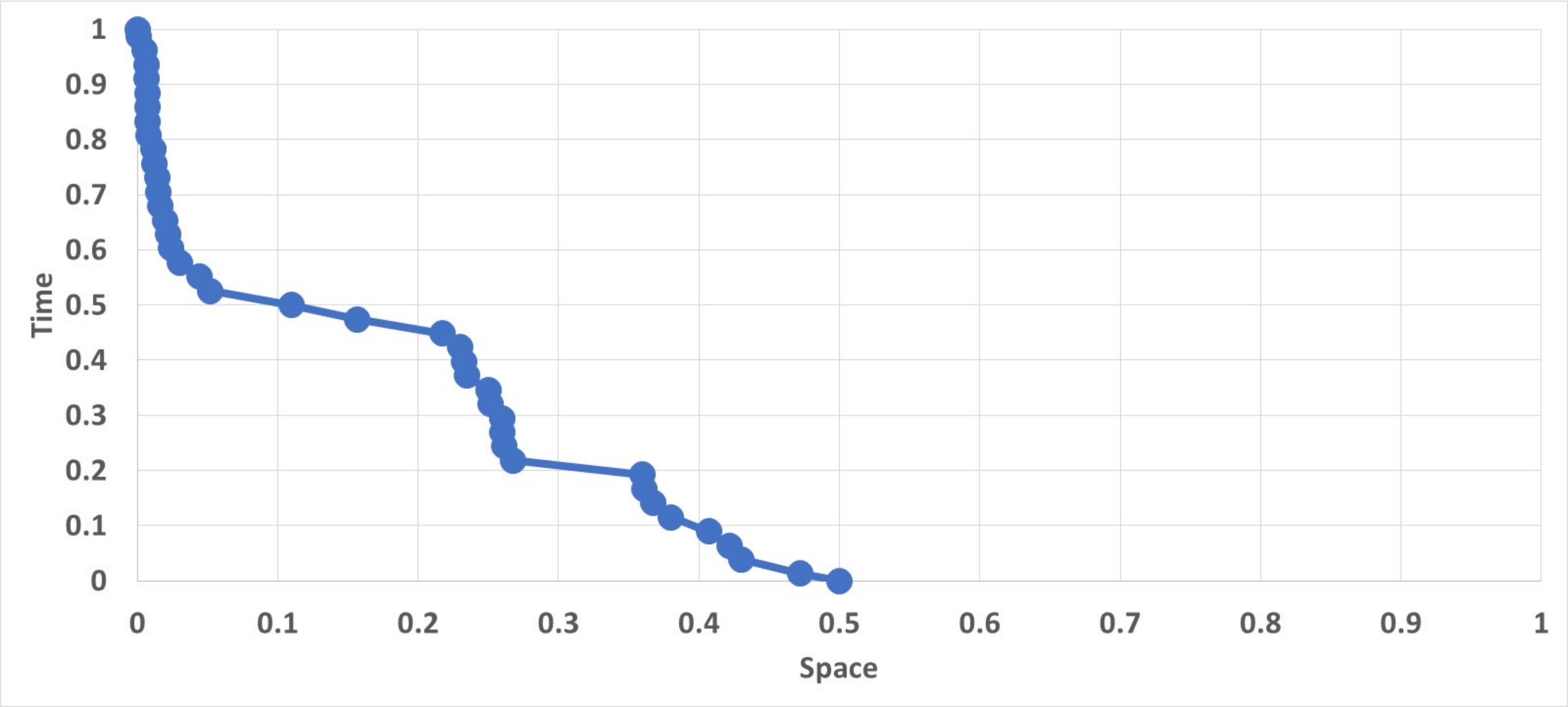
Need to have an accurate estimate of the fraction of the volume below 3 mg/l given the observations.

Enough realizations need to be produced to produce an accurate temporal distribution

T = day1-day30 **T = day31-day60** **…** **T = day90-day120**



A stochastic simulation could generate a more robust curve



WQ Assessment with 4D interpolator
Later Today: GAMs