Modeling Light Conditions in the York River Estuary by Anchoring Satellite Imagery with High-Frequency In-Situ Observations

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CBNERR-VA/VIMS High-Frequency Water Quality Monitoring in Virginia Tidal Waters

22 years of monitoring

205,491,940 water quality observations

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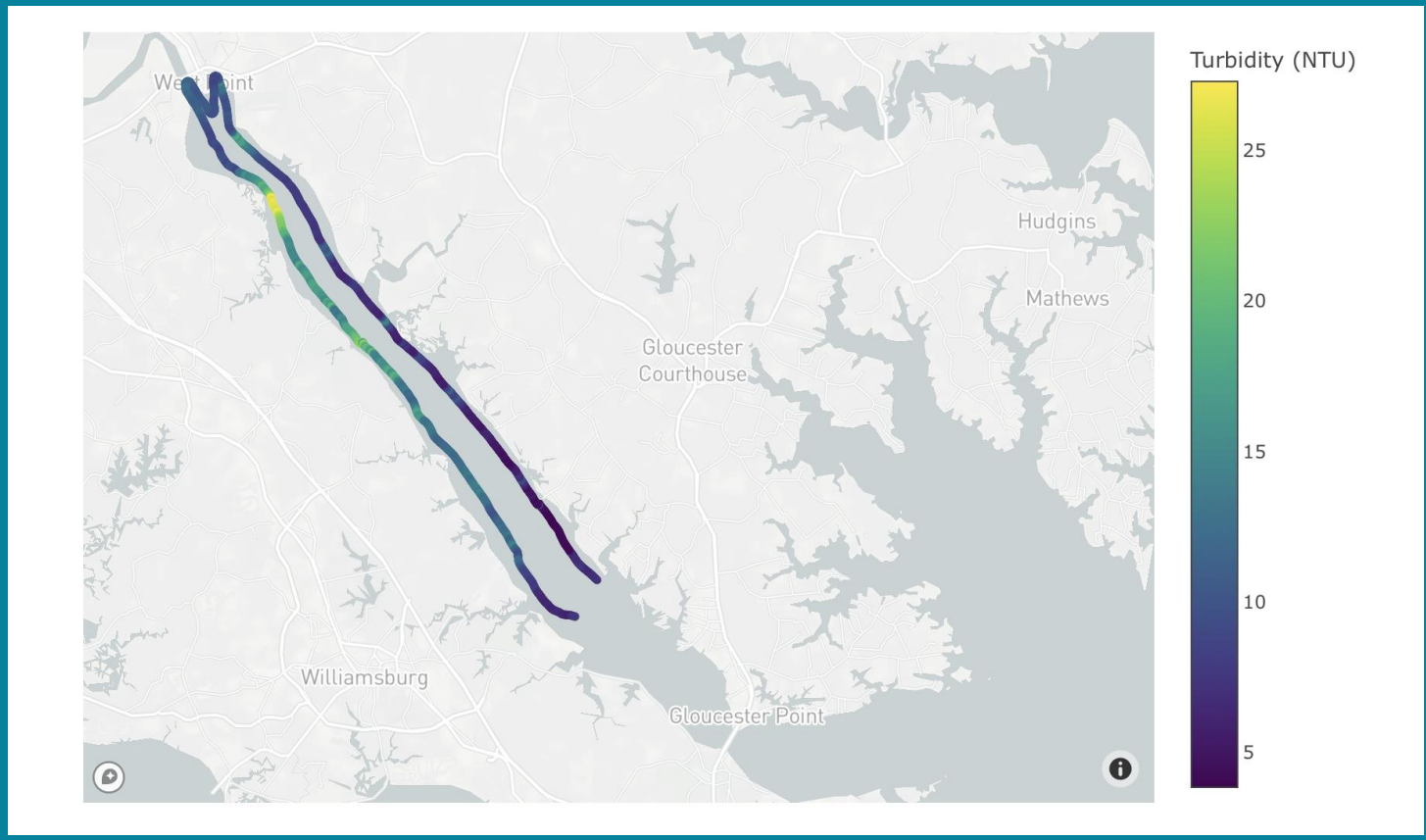
Dataflow Monitoring Platform

York Mesohaline (YRKMH). October 23, 2024

Surface observations
2-3 sec intervals
25 knots -> obs every 25m



- Primary datasets used for water clarity standards assessment associated with SAV designated use

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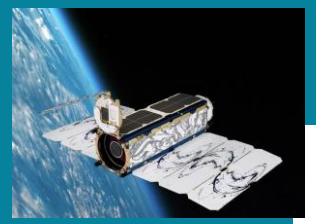
Methods



- Acquire imagery from Planet
  - ~ 3 m resolution, 8 band
  - Near daily coverage in Chesapeake Bay since 2022
- Atmospheric correction (ACOLITE) -> 8 surface reflectance bands
- Match surface reflectance to CBNERR-VA Dataflow turbidity measurements (1000's per day)
- Use random forest regression to estimate turbidity from 8 bands of surface reflectance

8 bands -> Surface Reflectance

Source: Vanhellemont, 2023

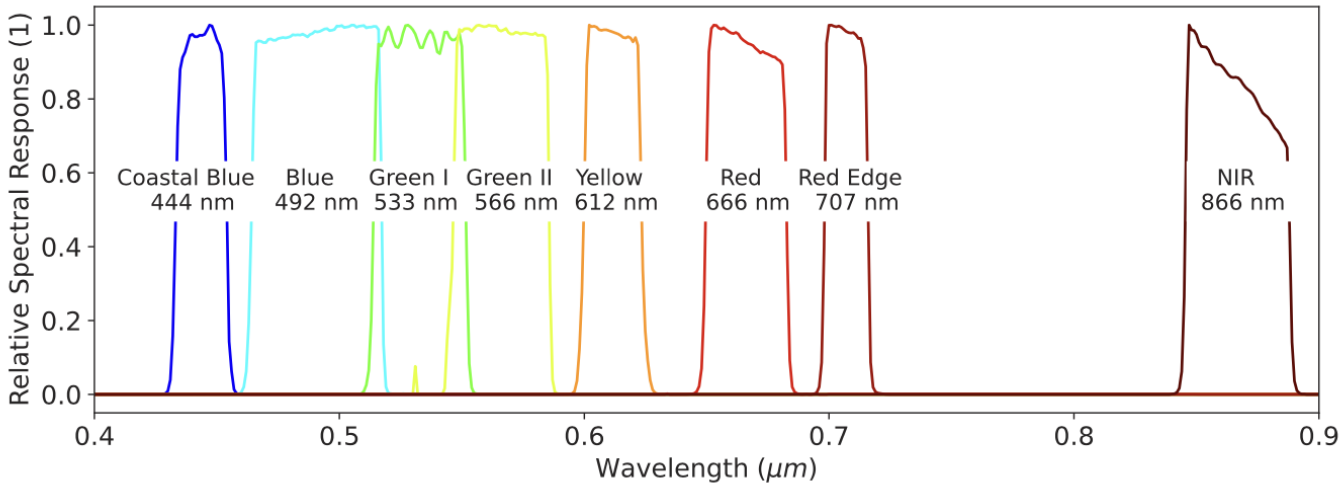
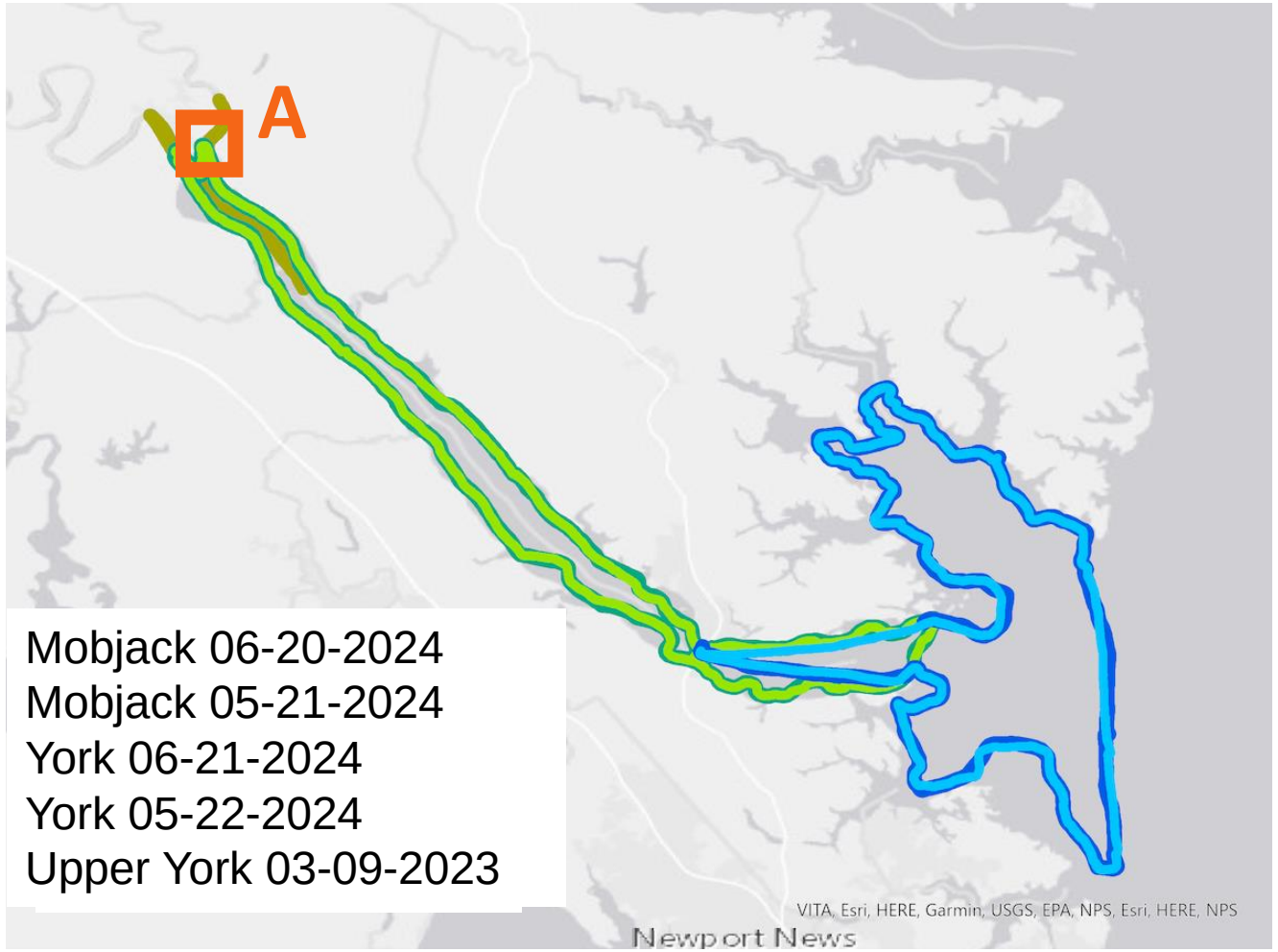
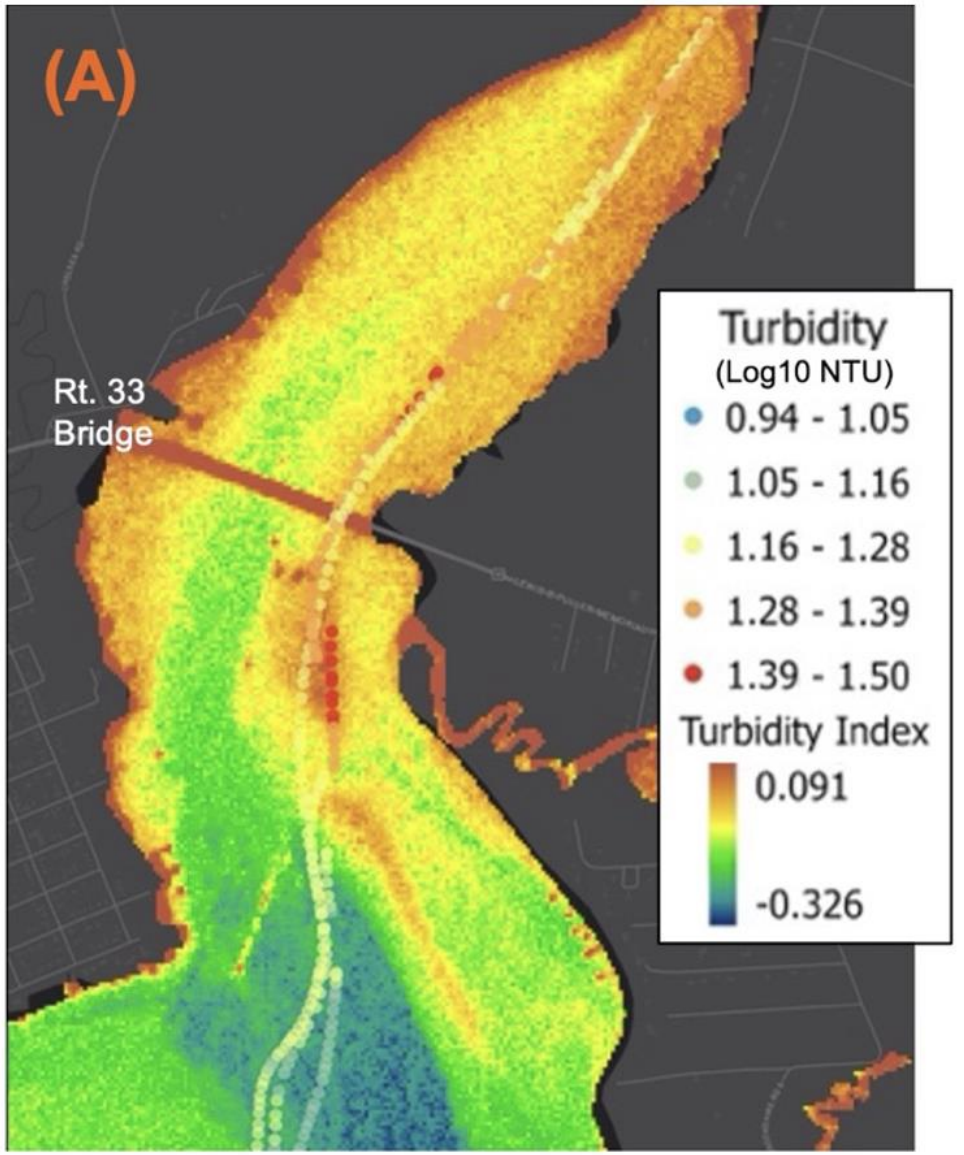


Fig. 3. SuperDove eight band relative spectral response function as provided by Planet.

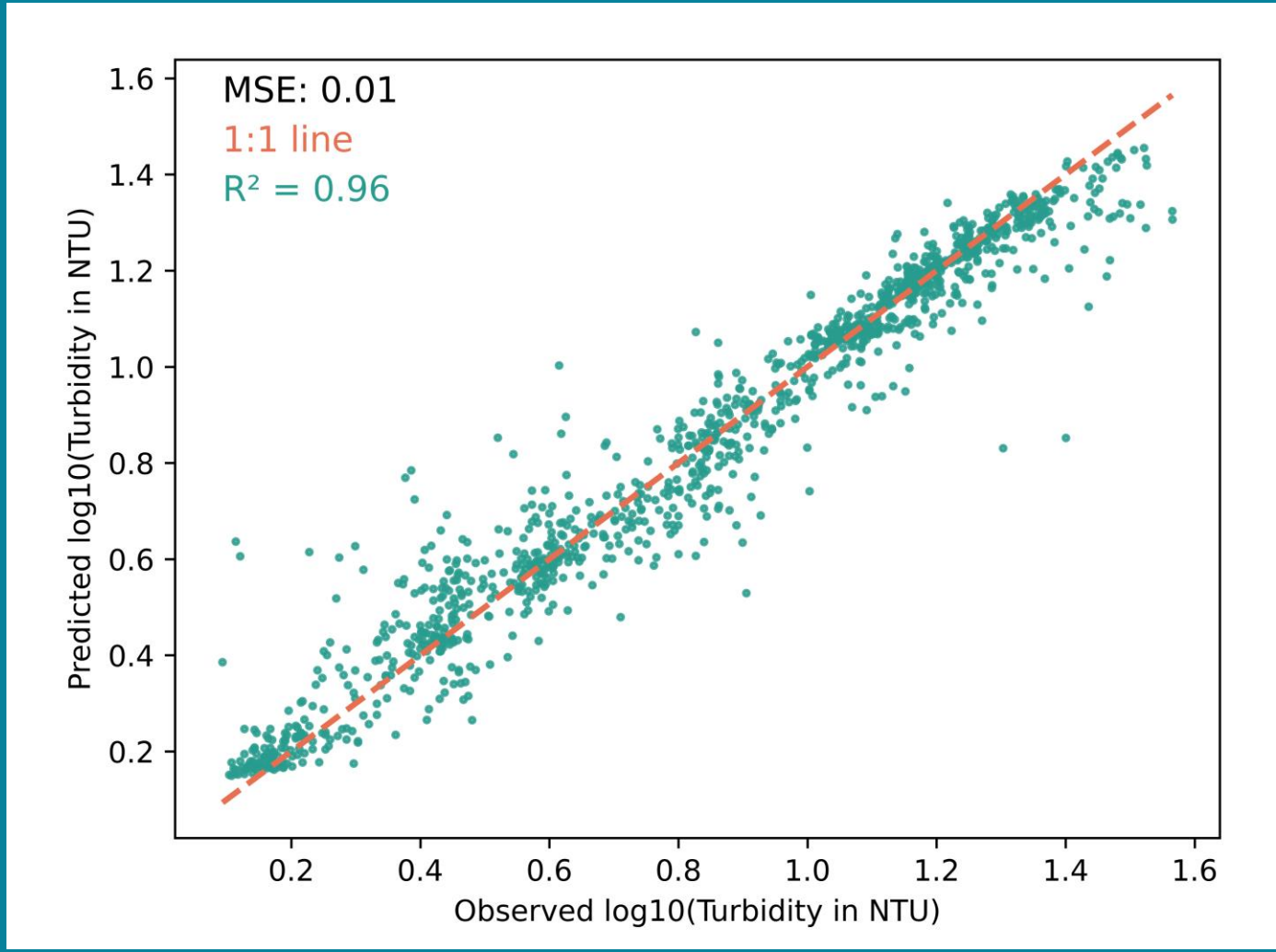
Dataflow and Satellites





Random forest regression with block cross-validation to estimate Turbidity in York River Estuary

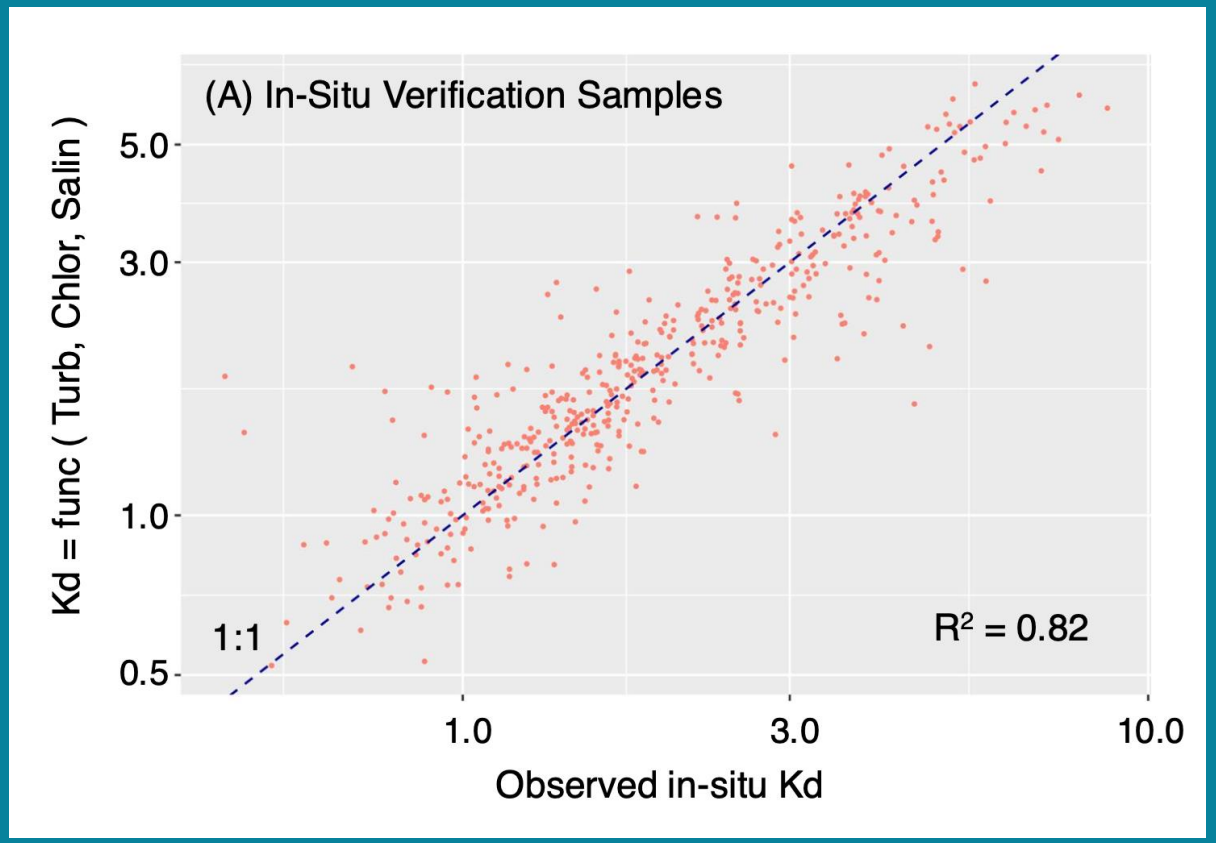
- Handles non-linear relationships and complex interactions b/w variables
- No assumptions related to data distributions
- Block cross-validation helps address spatial autocorrelation – ensure train & test split are spatially independent

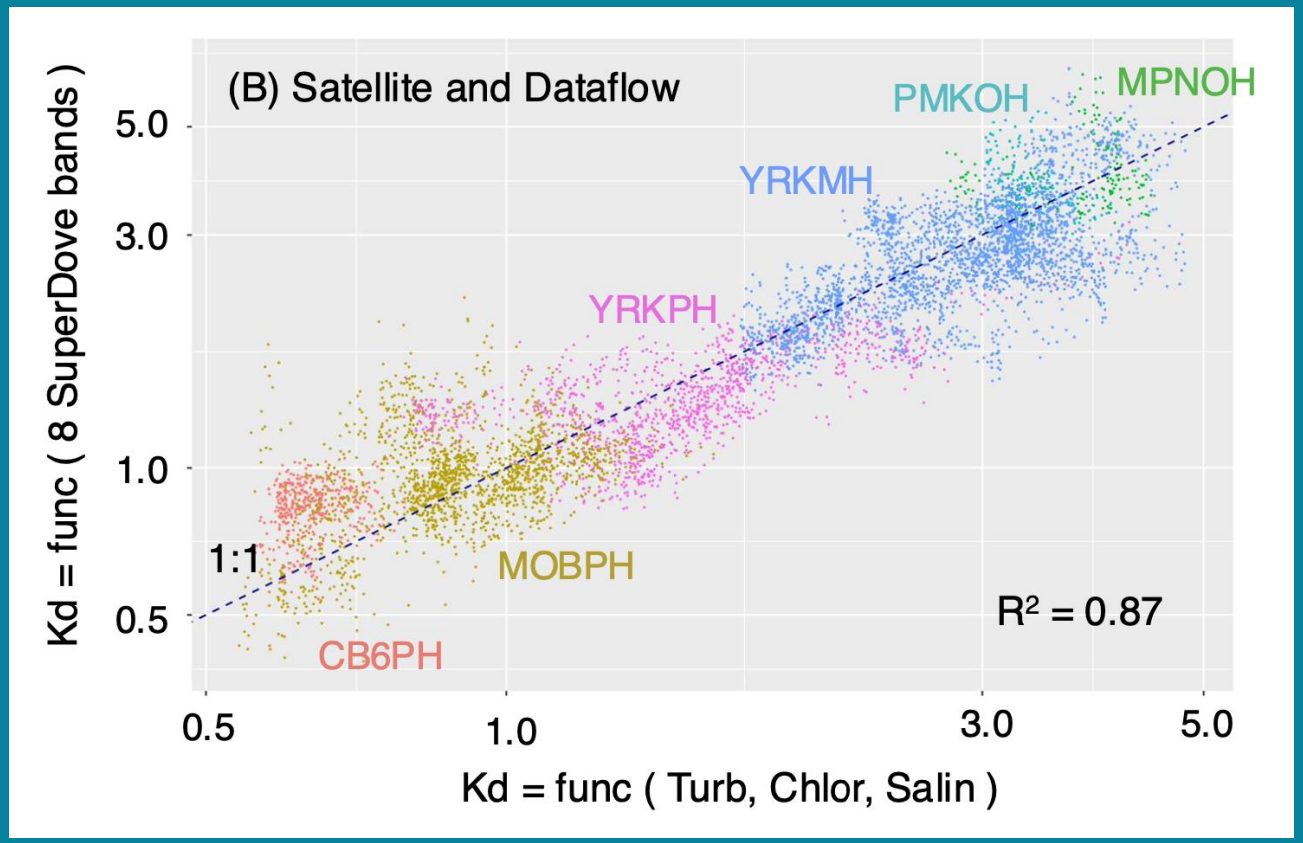


Dataflow: 03/29/2023, 05/21/2024, 05/22/2024, 06/20/2024, 06/21/2024

Dataflow, Satellites, and Water Clarity next steps

- Rather than Turbidity ~ Surface Reflectance:
  1. Kd ~ Turbidity + Chlorophyll + Salinity (CDOM)
  2. Kd ~ Surface Reflectance





Summary

- Early data exploration shows promise for anchoring satellite imagery with dataflow monitoring platforms to estimate light conditions
- Potential for incorporating available satellite data into water clarity assessments

Challenges

- Water clarity standards assessment built on estimates of water clarity attenuation coefficient (Kd)
  - Requires hierarchical modeling approach based on Kd ~ turbidity + chlorophyll + CDOM/Salinity
  - Identify error associated with turbidity/Kd estimates
- Spatial and Temporal autocorrelation
  - Block cross-validation may be an approach
- High-Resolution Planet imagery is relatively new (since 2022)

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