Chesapeake Bay Program
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Integrated Trends Analysis Team (ITAT)

Workgroup Meeting

Wednesday, March 25th, 2026
10:00 – 11:00 AM

Visit the meeting webpage for meeting materials and additional information.

This meeting was recorded for internal use only to assure the accuracy of meeting notes.

Agenda

I. Welcome, Introductions & Announcements **(10:00-10:05 AM)**
*Lead: **Breck Sullivan** (U.S. Geological Survey, USGS) ITAT Co-coordinator, and **Kaylyn Gootman** (U.S. Environmental Protection Agency, EPA) ITAT Co-coordinator.*

Upcoming Conferences, Meetings, Workshops and Webinars

- Choose Clean Water Conference – May 18-20, 2026. Lancaster, Pennsylvania.
- Chesapeake Community Research Symposium – June 1-3, 2026. Annapolis, Maryland. ***Registration is now open here!***
- Restore America's Estuaries' 2026 Coastal & Estuarine Summit – September 22-25, 2026. San Francisco, California.

II. Optical water typing in optically complex waters: a case study of Chesapeake Bay **(10:05 – 10:30 AM)**

Request Action: Informational.
Lead: Anna Windle DiPaola (National Aeronautics and Space Administration, NASA).
Materials: Meeting webpage. You can access the Journal article here.

Anna Windle: I will provide an overview of one of my chapters from my dissertation where I studied satellite and drone-based remote sensing of water quality in the Chesapeake Bay. I will also introduce ongoing work using new hyperspectral data from the recently launched PACE satellite (Plankton, Aerosol, Cloud, ocean Ecosystem).

Water quality monitoring is important for understanding ecosystem health, detecting environmental change, and evaluating management actions. Monitoring is typically conducted through field sampling, numerical models, or satellite remote sensing. Our work centers on remote sensing, which relies on how sunlight interacts with water through two important processes: absorption (light taken up by water molecules and matter) and scattering (light redirected by substances such as phytoplankton, colored dissolved organic matter (CDOM), suspended sediments, and water itself). The portion of light that is scattered back out of the water is what satellites measure.

This signal is quantified as remote sensing reflectance (R_{rs}), which varies across wavelengths depending on water conditions. Different spectral shapes correspond to different water types: turbid upper Bay waters tend to peak in red wavelengths, mid-Bay waters peak in green, and clearer ocean waters peak in blue. These spectral patterns can be used to infer both water color and composition. Satellite remote sensing, including techniques like blue-to-green reflectance ratios, enables large-scale estimation of chlorophyll, a proxy for phytoplankton biomass, and has significantly advanced ecosystem monitoring.

The core of the study focused on optical water typing (OWT), which classifies water bodies based on their spectral characteristics. Using satellite data from the Ocean and Land Colour Instrument (OLCI) on Sentinel-3 satellites, we analyzed over 64 million pixels from 2016–2022 alongside Chesapeake Bay Program monitoring data. Applying clustering methods, we identified 10 distinct OWTs, which were further grouped into three categories: brown, green, and blue waters. Satellite observations provided much higher temporal coverage than field sampling, allowing for more detailed spatial and seasonal analysis.

The results revealed clear patterns across the Bay. Brown, sediment-rich water types were most common in the upper Bay and tributaries, especially during high-flow conditions. Green water types were more prevalent in the mid-Bay during summer, while blue, clearer waters dominated the lower Bay and expanded northward seasonally. These patterns aligned well with expected gradients in turbidity, phytoplankton productivity, and water clarity.

By pairing OWTs with in situ measurements, we evaluated how water quality variables differed across classifications. While some variables, such as Secchi depth, followed expected trends from turbid to clear waters, others like chlorophyll showed more complex behavior. Notably, total nitrogen (TN) exhibited stronger and more statistically significant differences across water types than chlorophyll. This finding suggests that water color may track nutrient loading more effectively than chlorophyll alone and this highlights the influence of phytoplankton physiology on optical signals.

Additionally, freshwater flow from the Susquehanna River strongly influences both OWTs and water quality. Wet years corresponded to more turbid, nutrient-rich conditions and greater prevalence of brown water types, while dry years were associated with clearer, bluer waters. TN increased during high-flow periods, particularly in the upper Bay, whereas chlorophyll patterns were less consistent due to light limitation and downstream bloom dynamics.

Building on this work, at NASA we have been able to explore hyperspectral data from the PACE satellite, which provides much higher spectral resolution than traditional multispectral sensors. While OLCI uses 12 bands, PACE captures over 100 wavelengths, enabling detection of subtle spectral features. Initial comparisons showed that hyperspectral data retain similar overall patterns but reveal additional detail that may help distinguish phytoplankton types, detect harmful algal blooms (HAB), and better resolve complex optical signals in the Bay.

Hyperspectral remote sensing has strong potential to improve water quality monitoring and management. OWTs could help guide targeted sampling, identify areas with persistent sediment or clarity issues, and support water quality assessments. Future work will expand the PACE analysis across its full mission, integrate it with Chesapeake Bay monitoring data, evaluate improved bio-optical algorithms, and incorporate phytoplankton taxonomy data for validation. Overall, the use of full spectral signal rather than relying on a single metric like chlorophyll can offer a more comprehensive understanding of water quality dynamics and could enhance predictive modeling and management efforts.

Discussion:

Q from chat: *Klaus Huebert:* Do you have a correlation coefficient for the flow vs. mean wavelength relationship hinted at in in the upper panel?

- ***A from chat:*** *Anna Windle:* Overall, the spatial extent of six of the ten OWTs significantly correlated with freshwater flow (Pearson correlation coefficient p value <0.05)." The paper has more info on which OWTs had a significant correlation with freshwater flow.

Q from chat: *Elgin Perry:* Have you tried using discriminant analysis to differentiate HAB vs. non-HAB or bloom vs. non-bloom? Essentially, would a multivariate technique like Principal Component Analysis (PCA) help with identifying the principal axes that best differentiate the groups? Lastly, this problem would be well-suited for machine learning (ML) approaches like neural networks, to improve the classification performance.

- ***A:*** *Anna Windle:* PCA is what I am currently doing with PACE data to relate phytoplankton groups with different modes of variability within the data. Also, ML has been done with this dataset (Greg Silsbe, Horn Point Laboratory) where they applied a mixture density network to relate satellite data to TN. This model has performed really well and hopefully that is published soon.

Q: *Breck Sullivan:* Were there any restrictions around using PACE data? I know their can be a big learning curve to using it and even getting access to the data is an uphill battle.

- ***A:*** *Anna Windle:* All NASA and OLCI data is free for public use. PACE data is updated every day and can even be streamed from the Cloud.

Q from chat: *Mukhtar Ibrahim:* what about submerged aquatic vegetation (SAV)? Can SAV be distinguished from other submerged features using these methods.

- ***A:*** *Anna Windle:* In short, yes! SAV signals can likely be detected, particularly in areas like the Susquehanna Flats, but current spatial resolution (300 m) with PACE limits the ability to distinguish it as a separate OWT. Higher spatial resolution closer to 50–100m would likely improve detection.

Comment from chat: *Anna Windle:* Here is a page that hosts tutorials to access NASA ocean color data, including PACE: https://nasa.github.io/oceandata-notebooks/.

III. Tributary Summaries (10:30 – 10:45 AM)

Request Action: Informational.
Lead: Breck Sullivan (USGS).

Materials: Meeting webpage.

Breck Sullivan: With the support of our State partners and others at the Chesapeake Bay Program Office (CBPO), ITAT publishes Tributary Summary Reports, which are different reports on the 12 major tributaries in the Chesapeake Bay Watershed. The reports synthesize water quality status, trends and influencing watershed and tidal factors. These reports provide detailed technical information. They are typically published alongside Story Maps (Geonarratives) that function as a more accessible, interactive format designed for broader audiences such as local organizations, educators, and decision makers. Additionally, in the Geonarrative, we include a section called "For the Community" which showcases local organizations working within the tributary watershed for that report. This is a way for our readers to get connected with local organizations working towards improving the Bay health.

Recent updates include the release of the Choptank Geonarrative, the Maryland Mainstem Geonarrative, and the upcoming York Geonarrative. These products incorporate the latest tidal trends data, watershed characteristics, land use, and best management practices (BMPs). Tributary summary reports are also progressing, with the Lower Eastern Shore report recently published and the Maryland Mainstem report expected soon following USGS review. Additional reports, including the York and Choptank summaries, are currently in development with support from Franklin and Marshall College interns.

You can access the full list of Tributary Summaries and Story Maps here.

IV. 2025 Tidal Trends Planning **(10:45 – 11:00 AM)**

Request Action: Informational, for discussion.
Lead: Rebecca Murphy (University of Maryland Center for Environmental Science, UMCES).
Materials: Meeting webpage.

Rebecca Murphy: We have recently updated the R package we use for running tidal trends (baytrends) that can be accessed here. Every year, jurisdictions get their 2025 results around Spring and the ITAT group starts to share and distribute data with CBPO for compilation in late summer. In the Generalized Additive Model (GAM) Trends List for 2025, we highlight in the far-right column the different periods needed for short- and long-term status and trends. It should be noted that short-term analyses should start in 2016 for a full 10-year short-term window. Review the full Trends list for 2025 here.

V. Adjourn **(11:00 AM)**

Next meeting: April 22nd from 10 AM – 12 PM.

Attendance:

Anna Windle (NASA)
Gabriel Duran (CRC)
Breck Sullivan (USGS)
Michael Lane (ODU)
Jon Harcum (Tetra Tech)
Allison Welch (CRC)
Mukhtar Ibrahim (MWCOG)
Elgin Perry (Consultant)
Rebecca Murphy (UMCES)
George Onyullo (DOEE)
Klaus Huebert (MDDNR)
Carl Friedrichs (VIMS)
Christopher Mason (USGS)
Renee Karrh (MDDNR)
Cynthia Johnson (VADEQ)
Anthony Timpano (VADEQ)
Qian Zhang (UMCES)
Tish Robertson (VADEQ)
Blessing Edje (DOEE)