Introduction to Remote Sensing for Harmful Algal Blooms

Please type your questions in the Question Box. We will try and get to all your questions, but if we don't, feel free to email Sherry Palacios your question at sherry.l.palacios@nasa.gov

Session 4 Q&A Transcripts

Question 1: How do we estimate spectral shape?

Answer 1: We urge you to look at Slide 19 of this week's slide set to find the equation used for spectral shape. It is also in the publication listed on Slide 18:

Wynne, TT, Stumpf, RP, Tomlinson, MC, Warner RA, Tester, PA, Dyble, J, and Fahnenstiel, GL (2008) 'Relating spectral shape to cyanobacterial blooms in the Laurentian Great Lakes', International Journal of Remote Sensing, 29:12, 3665 – 3672.

Slides available on ARSET website & in Handouts module. Slide 18 gives you the equation that's used for spectral shape. Commonly used algorithm - you may find other sources that have used or modified the eq for the sensor they're using. Initially go to this source, get online, and go from there for the equation.

Question 2: Do the colors in the CI have correlations to toxin levels or cell counts? Is that range published?

Answer 2: The colors (ranging from purple to red) indicate bloom intensity. Refer to the article above (Wynne), but in publications that Sherry's read - HAB bulletin - refers to bloom intensity. If you'd like more detail, go back to the citation on it.

Toxins can't be detected by satellite color information, but bloom intensity - cell count - is more directly visible through satellites. In fact, cyano abundance and CI have a direct relationship (cells/mL = CI * 100,000,000). However, CI doesn't indicate whether or how much toxin production is occurring - only how abundant the cyanobacteria are.

Question 3: How can we access these models or tools?

Answer 3: If you choose to use SeaDAS, the CI algorithm is available as one of the data products. Be aware that the full processing ability is available on Mac, UNIX, and Linux systems, but not on Windows systems.

We've talked already in week 2 and a few other times about using SeaDAS - the CI algorithm is one of the avail algorithms for data products. The unfortunate thing is that Windows doesn't have full capabilities - you need Mac, UNIX, or Linux to do full processing ability - though this functionality for Windows should be coming in a later version of SeaDAS. Another approach is to use the algorithm - you have the equation, you can do the math yourself using image processing software.

Correction: RS Tools was suggested as an option for Windows with ArcGIS, but it doesn't offer image processing - it provides image analysis tools such as time trend analysis and spatial statistics.

Question 4: You mentioned wind data. Can you please share some global publicly available wind data sources? Also their applicability?

Answer 4: From NASA - there is MERRA reanalysis model that provides global surface and upper air winds. More information can be found at https://gmao.gsfc.nasa.gov/reanalysis/MERRA/

MERRA data can be obtained by using Giovanni (https://giovanni.gsfc.nasa.gov/giovanni/)

Another source of wind data are scatterometers flying on various satellites. Data can be found at https://manati.star.nesdis.noaa.gov/datasets/ASCATData.php/

2 sources that Amita's aware of: MERRA (reanalysis model from NASA) - a model in which a lot of satellite data is assimilated. That provides surface winds (referenced in presentation). Giovanni was mentioned in week 2 to get MODIS, but you can also search MERRA or winds, and you'll get the link to download the wind data. About .5 x .6 degree resolution - relatively low resolution. For inland lakes, you have to see how big your reservoir is.

From Satellite scatterometer data produced by JPL. Also available from NOAA site above https://manati.star.nesdis.noaa.gov/datasets/ASCATData.php/. Different satellites carrying scatterometers are available through both NASA and NOAA. Resolution varies from 12.5 km to 50 km depending on which scatterometer you use. Slightly higher res than MERRA, and these scatterometers are used specifically to get surface winds. Unsure how well they resolve inland lakes, since they were designed for ocean surface winds. We see these on Great Lakes and bigger reservoirs you can get this data for sure.

Question 5: What is the possibility of reusing HAB affected freshwater lake water for drinking and irrigation purposes?

Answer 5: When the bloom ends, toxins in the environment reduce. To be certain, it is important to test the water for toxins before allowing use.

If you would like to know more on this topic, and on topics related to cyanoHABs and drinking water, follow this link:

https://www.epa.gov/ground-water-and-drinking-water/cyanotoxins-drinking-water

Sherry's experience is more in remote sensing and Wilson has brought expertise to toxins. Wilson provided a lot more information in EPA link on groundwater and drinking water, and more info on cyanotoxins in drinking water. A lot of links on best practices and advice to management on when it's safe to open the water source for drinking water purposes.

Question 6: I will need more practical training before I will be able to apply those techniques for monitoring of lakes in Greece... Any suggestions?

Answer 6: We encourage you to look into the SeaDAS website for how to use the image processing software (there are tutorials online). There you will build some of the skills you will need to derive CI, chlorophyll, and other data products relevant to HAB monitoring.

Question 7: What information is there that addresses cyanotoxins being a concern to crops irrigated by affected surface water?

Answer 7: ome information is at this link:
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3202786/

Question 8: Could you please advice me is it possible to monitor chlorophyll and suspended sediments from mobile apps ?

Answer 8: Advise to go look at hydrocolor app and read the website carefully. They also have the articles they cite in the document. Since they provide more information on the actual practical use, how far off the water, it also provides info about the algorithm used, the uncertainties. It's important to understand your phone only provides some level of information and there might be wide uncertainty boundaries. At the same time, it may provide important qualitative information on tracking HABs in your environment.

Question 9: Can we have detailed information on mobile apps on HAB monitoring

Answer 9: Links to apps in slide set - we mentioned a few of the monitoring apps. Hydrocolor is one, the different apps that were a part of cyanobacteria collaborative, the phyto app (working on another release). If you don't want to wait for links, you can go through the PDFs and follow the links on the slides.

Question 10: It was great to see the Florida specific applications for me. One area I'm really interested in is the Indian River Lagoon Estuary. It is over 150 miles long but not super wide. Is there a way to get more data for this coastal estuary, is more data likely with Landsat 8 data?

Answer 10: Right now, they've been looking at inland lakes, so estuaries are a little more complicated - more going on. Looking at those as well and there is MERIS/OLCI data available. Indian River Lagoon looks like it's between the coast and barrier islands on Atlantic side. Most of it appears to be wider than 900 m (3 x 3 window of 300-m pixels), so some data from OLCI (Sentinel 3 sensor) should be available. Hopefully down the road Landsat will be able to provide that information as well. Stay tuned and hopefully if it's too small for MERIS or OLCI, we can use Landsat.

Question 11: When you download the Chl-a app on your iphone, at what distance and angle is needed to take an image of the water body

Answer 11: For the CyAN project, the app provides CI data from OLCI (chl-a isn't directly given there). If I'm understanding the question correctly, since these image products are already orthorectified, distance and view angle shouldn't matter. Another thing to consider, though, might be solar elevation angle. For example, you could restrict your analysis to images that were collected when solar angle was 45 degrees or greater. This ensures that the sun is high in the sky, and thus light reflected off the surface should behave as expected.

Question 12: Can anyone provide what kind of atmospheric correction algorithms is adopted ?

Answer 12: For the CyAN project's use of MERIS imagery, top of atmosphere reflectance was used; see these references for details:

http://www.sciencedirect.com/science/article/pii/S1470160X17302194

http://www.sciencedirect.com/science/article/pii/S1568988317300288

Question 14: When comparing the Chl-a for Landsat 8 and MERIS, do we take a 3 by 3 per pixel for each satellite data or you take the mean of a 3 by 3 pixel values for landsat 8 and compare it with meris or modis chla data

Answer 14: Just to clarify, our work on CyAN hasn't involved comparisons between MERIS/OLCI and Landsat. The comparisons we're making are between satellite measurements and in situ data, and for that we use the single MERIS/OLCI or Landsat pixel corresponding to the in situ sample coordinates. The 3x3 window is used to determine whether a lake is large enough to be resolvable by (visible to) a given satellite. Once we determine that it is large enough, pixels on the edge of that lake are removed so that there's no interference from land in the spectral signal; all remaining pixels are then used.

Question 15: How can an international audience apply CyAN beyond the U.S. or if he could provide helpful information on how people can use cyan in their region?

Answer 15: Wilson: The the EPA won't be expanding the tool beyond the U.S., the approach is viable for anywhere around the world. The satellites have global coverage. We'll be making a lot of the code to develop the mobile app available on GitHUB at the end of this project. Methods

for applying extent and magnitude of HABs - all things different folks can integrate into their own projects. They can use it to assess where and how much HABs are happening in their area.

Also hoping to apply code to match satellite overpass with in situ data collection for the purpose of validating satellite data locally. You could use that code to pinpoint when/where those match ups occur. And potentially changing parameters in those algorithms to make it more regionally accurate. You're welcome to contact Wilson or other folks on the project to ask advice if you want to do it in your own area. But given the data availability and the tools down the road, it should be something people can do anywhere in the world.

Question 16: How do we encourage citizen scientists to participate? How do we educate the public to take data? Are they aware of HABS? I am just wondering how we get others unlike ourselves to do this.

Answer 16: Citizen Science has been approached in different ways. One example that we talked about in this presentation is the Phytoplankton Monitoring Network. The website for this program is really descriptive about their history and how they engage with the volunteers in the program. I encourage the questioner to look at their website (listed below) and look through it. If the person has more questions, there are contact people listed under staff who might be able to provide more information.

https://products.coastalscience.noaa.gov/pmn/

There are organizations on the web that also provide support to people in developing citizen science programs (e.g., http://citizenscience.org/). That might be a source that could help.

Additionally, NASA Earth Sciences published a call for proposals in 2016 for citizen science projects (https://science.nasa.gov/blogs/roses-2016/2016/4/20/amendment-8-47-citizen-science-earth-systems-program). I don't know if this solicitation will be offered again in the future, but it might be worthwhile to keep an eye on the Research Opportunities in Space and Earth and Science (ROSES) call that is published in February of each year. If you would like more information about where to look for these ROSES solicitations, it is advisable to just do an internet search in February of each year for "NASA ROSES" and then the year for the most recent list of opportunities. You will be directed to the nspires website (https://nspires.nasaprs.com/external/) where you can find more information about how to apply for NASA funding, and also will provide the interface for submitting a proposal.

Question 17: What does the actual quantity that CI index provide? Is it the total mass of the toxic algae or total algae?

Answer 17: see question 2 above

Question 18: For these forecasting tools to predict 72 hours ahead of time...what is the temporal resolution for images being used to generate these predictions? do the other parameters need to be continuous (weather, currents etc)?

Answer 18: For the Forecasting tool, they are providing information on the most recent satellite image. They model that to the current HAB bulletin.

Question 19: Is there any research group studying data quality of in-situ data available at the water quality.us webportal?

Answer 19: Not aware of any groups that are assessing the accuracy of the WQP data directly, but the USGS is compiling data from there and elsewhere and determining data quality to ultimately use only the most reliable data. So their work is quite similar to what's being asked in the question.

Question 20: just to clarify- the new EPA app doesn't forecast ahead of time...just explains a summary of past conditions?

Answer 20:We are not doing any forecasting yet - it is a summary of past conditions, but also houses current data.

Question 21: Do the HAB frequency maps account for changes in seasonality? Like florida having year round temperatures whereas areas in the north seem to only experience conditions in the summer? Do they still appear on the map with large magnitude of difference in # of occurrences?

Answer 21: Regardless of region or climate, the calculation is the same: the portion of the year that the CI exceeds the WHO High threshold. This ensures that any comparisons made between lakes (in the same region or different) are meaningful, "apple-to-apple" comparisons. Weighting by length of bloom season would be challenging because it would require some criterion of defining bloom season, which is subjective and might change between years if climate varies. Another metric that may be relevant to this question is duration (forthcoming), which will provide insight into length of bloom season.