MichiganTech Research Institute

Highlights from Workshop 1, March 12-13 2014, NASA Glenn Research Center

Larry Liou, NASA Glenn Research Center

Dr. Robert Shuchman, Michigan Tech Research Institute

Great Lakes Workshop Series on Remote Sensing of Water Quality

Workshop 2: May 7-8, 2014, NOAA GLERL, Ann Arbor, MI

Developing the Great Lakes RS Community

- Approx. 60 in-person attendees and 18 web participants took part in Workshop 1
- Participants were able to make new connections and share ideas
- Workshop 2 and the community website will facilitate continuing growth of this regional thematic research community
  - All plenaries from Workshop 1 are online and those from Workshop 2 will be shortly
  - Executive summaries of both workshops will be released by Memorial Day

Great Lakes Remote Sensing in Context

- Workshop 1 indicated NASA's strong interest in providing next-gen satellites pertinent to GL problems
- As indicated by some of the Workshop 1 plenary talks, under the GLRI, the EPA, NOAA, USGS, USFWS, and NPS have embraced the use of remote sensing to solve problems, e.g.,
  - Invasive species monitoring
  - Nuisance vegetation growth
  - HABs
  - Water quality monitoring
  - Bathymetric mapping

Great Lakes Remote Sensing Priorities: Sensor Optimization

- Most instruments in orbit are optimized for land or open ocean in terms of band placement, temporal repeat and dynamic range
- Higher spatial and temporal resolution are important for better mapping of the Great Lakes nearshore and AOCs
  - Would also enable us to sense more of the ponds & rivers that impact the Lakes
- Enhanced dynamic range in the visible bands would increase water quality capabilites
- A range out to 3500 nm will allow differentiation of siliciclastics and carbonates

Great Lakes Remote Sensing Priorities: Hyperspectral Imaging

- Group came to consensus on positive support of the continuing development of PACE, GeoCape, HyspIRI, Sentinel-3, and OLCI
- Hyperspectral provides potential to separate algal & mineral composition
- Need for hyperspectral capabilities available on a shorter timescale
  - Aircraft or drones on demand
  - Venture class (disposable) satellites and microsats

Great Lakes Remote Sensing Priorities: Research Gaps

- Methods are needed for better nearshore retrieval of chl, other CPAs
- Differentiation of substrate types/texture from RS data
- Extend river plume mapping capabilities to smaller plumes
- Different parameterization of turbidity – instead of retrieving mass concentration, should we be looking at the cross-sectional area of particles?

Great Lakes Remote Sensing Priorities: User-Friendly Data Portal

- Many potential end users don't know much about what's already available
- Need for an "information-agnostic applications portal" for end users who are not remote sensing-savvy
  – One-stop shopping that includes remote sensing products, in situ data and model outputs
  – Tailored to region and either type of user or issue of interest (e.g., *E. coli*)
  – Outreach would be needed so potential end users know about the resource
  – Demand for terrestrial and nearshore data as well as offshore water quality

Great Lakes Remote Sensing Priorities: Data & Modeling Integration

- Need better integration between remote sensing data, in situ data & modeling communities
  - In many cases (for example phosphorus), the item of interest can't be remotely sensed but we can sense proxies that would be useful for modeling to derive the end product
    - Examples: E. coli, phosphorus, microplastics, surfactants, hypoxia, mussel densities
  - Increase use of RS to validate and improve forecasting methods
  - RS is better used as a component of an integrated system rather than as standalone tools
  - Modeling and RS should inform each other

Great Lakes Remote Sensing Priorities: Technology Gaps

- Power-charging docking stations for remote / unmanned mobile devices (underwater, airborne)
- Cabled observatories in the Great Lakes – deployment for longer time periods than buoys
- Wireless data transmission underwater – more rugged, fewer cables
- Crowd-sourcing data collection tools / technologies – making it easier for the citizen scientist to contribute data
- Ice thickness sensors – use for shipping, science / impacts of a changing climate
- Webcams – digital imaging sensors that are easily
- SAR platforms – no U.S. data source currently exists for radar data for ice monitoring, vegetation mapping, etc.
- Cubesats & other small satellites – could be used more to lower the cost of satellite imagery collection & make it more frequent
- Buoys, gliders, AUVs, UAVs, surface vehicles, balloons – there is a need to take greater advantage of these rapidly developing hardware platforms

Great Lakes Remote Sensing Priorities: Algorithm Development

- Community responsibility for algorithms – need to open up algorithm development to be testable by others
- Applying multiple algorithms to the same problem – there's no single approach that works best for all datasets
  - Similar experiments conducted in different environments – what works in one lake might not in another

Great Lakes Remote Sensing Priorities: Algorithm Validation

- What constitutes “real validation”?
  - Everyone has their own metrics, they’re sometimes hard to interpret
- Strict cal/val would give us confidence and help with algorithm development
- Standard suite of measurements with strong cal/val standard needed
  - Protocols for collection of calibration data, data storage & processing methods
  - Central community archive for regional RS calibration data
  - Community data gathering cruises would be useful for validating models under development

Great Lakes Remote Sensing Priorities: Atmospheric Correction

- Atmospheric (aerosol) correction needs to be coincident with the scene
- Two ways to do that
  - Ground-based instrumentation
  - Instrumentation on the same or a close-following platform
- Some atmospheric correction procedures have been validated over land but not water and currently produce negative radiance values over water
- It would be really usefult to advise users when/where to use different corrections, provide warnings on data fidelity

Future Directions

- Can we use higher-resolution sensors and/or other data types from drones, etc. to characterize within-pixel variability for ocean color products?
- Potential for increasing role for public/private partnerships (ex. Google Earth Engine)
- We should reach out to non-remote sensing scientists (ex: those who do lakewide experiments) about how aerial/fine scale remote sensing could benefit their research in the near term