



Great Lakes Workshop Series ***On Remote Sensing of Water Quality***

Interim Results

Workshop 1

March 12-13

Cleveland, OH

Workshop 2

May 7-8

Ann Arbor, MI

Presenter: Larry C. Liou
Space Science Project Office
NASA John H. Glenn Research Center



Acknowledgement



Special thanks to:

- *The NASA Applied Earth Science Program for support*
- *All steering committee members for the steering and co-organizing effort*
- *Dr. Robert Shuchman, Amanda Grimm, Colin Brooks, and Michelle Wienert of Michigan Tech Research Institute for the technical & logistic leadership & support*



Steering Committee



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(Co-Organizer)

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(Co-Organizer)

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Michigan Tech University

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Wisconsin Department of Natural Resources

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Physical Scientist
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Dr. John Bratton

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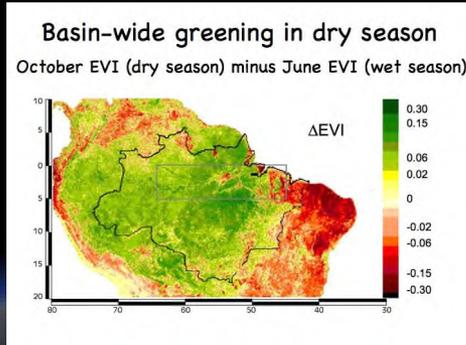
Dr. Jennifer Read

Executive Director
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Dr. John Lekki

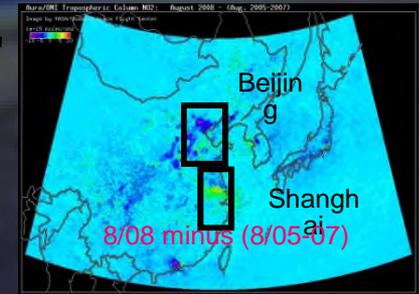
Optical Systems Research Engineer
NASA Glenn Research Center

NASA Earth Science Focus Areas



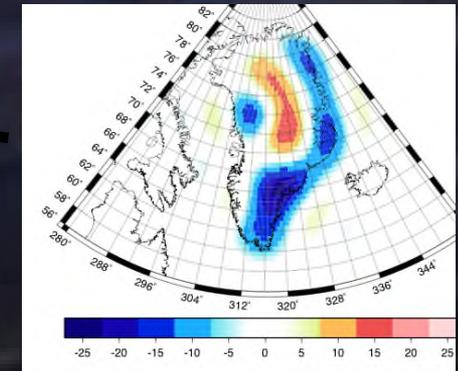
Atmospheric
Composition

Carbon Cycle and
Ecosystems



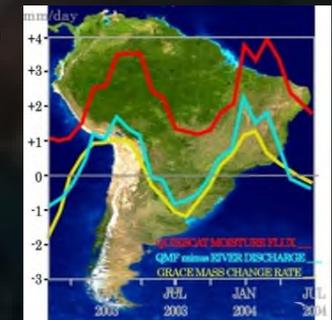
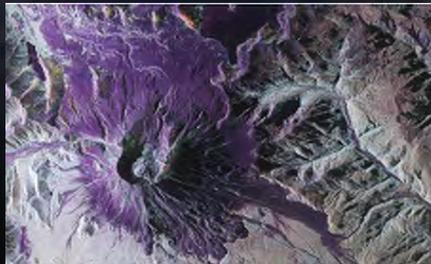
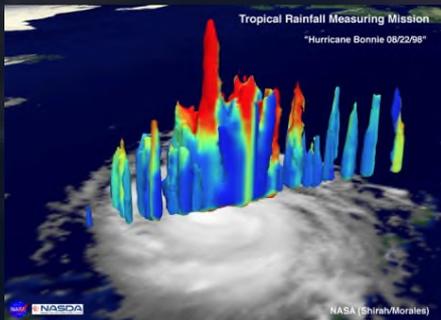
Climate Variability
and Change

Weather



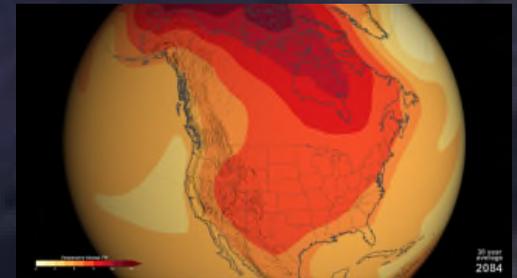
Water and Energy
Cycle

Earth Surface and
Interior



Big Questions of NASA Earth Science

- How is the global earth system changing?
 - Is the current warming trend a reason for concern?
 - What are the sources of change?
- How will the Earth system change in the future?
 - Earth's average temperature may continue to rise to 4° F to 11° F by the end of the 21st century.
 - How can Earth system science help mitigate and adapt?





NASA Water Research



- **Water & Energy Cycle**
- **Water Resource**
 - **Quantity**
 - **Quality**
 - **Decisions/Management**
 - **Capacity Building**



Glenn Research Center Water Research



- **Coordinate water quality research**
- **Help organize the Great Lakes and other remote sensing communities and activities**
- **Coordinate in-situ and remote sensing measurements**
- **Develop instrument for in-situ and remote sensing measurements**
 - ✓ **Test and validation**



Goal for the Workshop Series

Identification of gaps in science and technology for remote sensing of water quality

Featuring:

- ***An emphasis on Great Lakes waters***
- ***Building upon results of past workshops***
- ***Formulation of potential, short, pilot projects***



Objectives for the Workshops

Workshop 1

March 12-13

Cleveland, Ohio

- **Identify gaps between availability and needs of water quality data**
- **Identify science, technology, & missions required for satisfying the needs**



Objectives for the Workshops

Workshop 2

May 7-8

**@ Great Lakes Environmental Research Lab (GLERL, NOAA)
Ann Arbor, MI**

- Conclude identification of gaps & define research/technology/mission needs**
- Foster Great Lakes remote sensing and community development and data sharing**



Workshop 1 Format



➤ Plenary talks in morning

- Lay ground information for breakout discussions in afternoon

➤ Afternoon breakout discussion topics

Day 1

1. Update sensor requirements
2. Identify gaps in remote sensing data and derived product
3. Identity technology gaps (sensors, instrument, & hardware)

Day 2

4. New potential applications for remote sensing of inland waters
5. Algorithms/modeling current approaches: Status, strengths, and deficiencies
6. Platform/mission gaps and recommendations



Workshop 2 Format



➤ Plenary talks

- Lay ground information for breakout discussions in afternoon

➤ Breakout discussion topics

Day 1

1. Moving forward with a regional remote sensing strategy
2. Data distribution of Great Lakes remote sensing data
3. Algorithm comparison studies

Day 2

4. Create plan to maintain an active Great Lakes RS community
5. Remote sensing derived products sharing & credit to originators
6. Define time series RS datasets (i.e. HABs, primary productivity)



Workshop 1 Outcome



Highly Successful!

- ❖ **Initial gap information collected**
- ❖ **70 individuals attended**
 - **60 attended in person**
 - **10 attended via web conferencing**
 - **International participants**
- ❖ **Several joint projects took birth**



Workshop 1 Outcome (Continued)



Breakout Session Results

- Breakout Session Results are still being compiled
- Samples are provided here for illustration purpose only

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Breakout Session 4: New potential applications for remote sensing of inland waters

Application	Spatial scale required	Temporal scale required	Remote sensing input data needed	End Users	Priority (High, Medium, Low)	Remarks
Mapping invasives and/or emergent aquatic plant species	10-1 m	Annual, seasonality	Hyperspectral and/or high-resolution multispectral data, fusion with radar may improve accuracy, LIDAR, in Situ	Local communities, harbor managers, regulators, state/federal agencies	High	Both emergent (Phragmites) and submerged (Eurasian watermilfoil) species, should cladophora be included?
Bottom substrate/sediment type maps for habitat mapping, fisheries, modeling, substrate	30 m - 5 m	Update every ~5 years to reflect changes caused by e.g. sediment redistribution, drossesnd reef expansion	Side-scan sonar, acoustic bottom surveys, hyperspectral imagery, LIDAR	Ecologists, fisheries scientists, geologists	Medium	Last lakewide mapping effort was ~1960s
Dangerous (rip) current hazard maps	10-100 m	Updated every 5 years	Multispectral aerial imagery, bathymetric lidar	NOAA, Coast Guard, beach authorities, coastal engineers	High	
Real-time dangerous current alerts Nearshore-winds, waves, and currents	10-100 m	Daily	Surface wind speeds from scatterometers, wave height from SAR altimeter	NOAA, beach authorities, emergency response, and landowners	High if available real-time or within hours	Better SAR and scatterometer temporal and spatial coverage needed for this to be useful

Great Lakes Workshop Series on Remote Sensing of Water Quality

Breakout Session 4: New potential applications for remote sensing of inland waters

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Great Lakes Workshop Series on Remote Sensing of Water Quality
data required for existing

Remarks
MODIS and VIIRS fall short of its spectral band set, 100 m resolution would allow for much better mapping/modeling
spectral geologic application

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struments, & other hardware)

Remarks
SAR



Workshop 1 Outcome

(Continued)



Breakout Session Results **Preliminary**

1. Update Sensor Requirements:
 - i. Eight sensors were identified including ocean color, hyperspectral, synthetic aperture radar, etc
 - ii. Many associated input were recorded



Workshop 1 Outcome

(Continued)



Breakout Session Results **Preliminary**

2. Identification gaps in remote sensing data and derived product
 - i. Higher resolution, better data/model integration, & better portal are needed
 - ii. Airborne data is needed



Workshop 1 Outcome

(Continued)



Breakout Session Results **Preliminary**

3. Identity technology gaps (sensors, instrument, & hardware)
 - Improved spatial & temporal resolution, 3D water column profiling, & sensors for pH, HABs toxicity, phosphorous, Nitrogen, CO₂, etc



Workshop 1 Outcome

(Continued)



Breakout Session Results **Preliminary**

4. New potential applications for remote sensing of inland waters
 - i. Algal composition mapping
 - ii. illicit discharges
 - iii. Microplastics
 - iv. Plume & water clarity



Workshop 1 Outcome

(Continued)



Breakout Session Results **Preliminary**

5. Algorithms/modeling current approaches: Status, strengths, and deficiencies

Algorithms were listed & briefly assessed:

- a. Harmful algal bloom
- b. Chlorophyll
- c. Primary production
- d. And many more



Workshop 1 Outcome

(Continued)



Breakout Session Results **Preliminary**

6. Platform/mission gaps and recommendations
 - i. Hyperspectral missions, satellite & frequent & routine airborne
 - ii. Landsat Continuity Mission
 - iii. Single of fleet of small satellites
 - iv. UAV, AUV, kite, balloons, routine airborne flights
 - v. Existing, abundant, routine commercial flight platform



Workshop Information

Website for the Workshop Series:

- <http://mtri.org/workshops/nasagreatlakes2014/index.html>
- For Workshop 2 registration, input, agenda, and documents



Questions? Inputs?

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