GLEON

Global Lake Ecological Observatory Network

Lessons learned from the Global Lake Ecological Observatory Network

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Argentina
Australia
Austria
Brazil
Canada
Chile
China
Colombia
Denmark
Estonia
Finland
Germany
Hungary
India
Ireland
Israel
Italy
Kenya
Netherlands
New Zealand
Nigeria
Pakistan
Poland
Puerto Rico
Russia
South Korea
Spain
Sweden
Switzerland
Taiwan
Turkey
United Kingdom



GLEON

Global Lake Ecological Observatory Network

An international grass-roots, collaborative network of limnologists, ecologists, information technology experts and engineers that collects and synthesizes high-frequency data from lakes worldwide to sense and forecast change.




Argentina
Australia
Austria
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Chile
China
Colombia
Denmark
Estonia
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Hungary
India
Ireland
Israel
Italy
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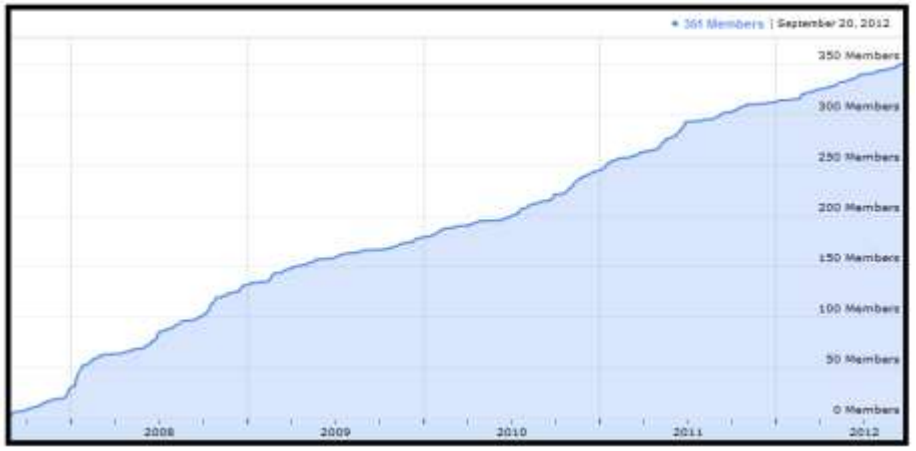
Pakistan
Poland
Puerto Rico
Russia
South Korea
Spain
Sweden
Switzerland
Taiwan
Turkey
United Kingdom

… a network of people

GLEON has > 350 individual members



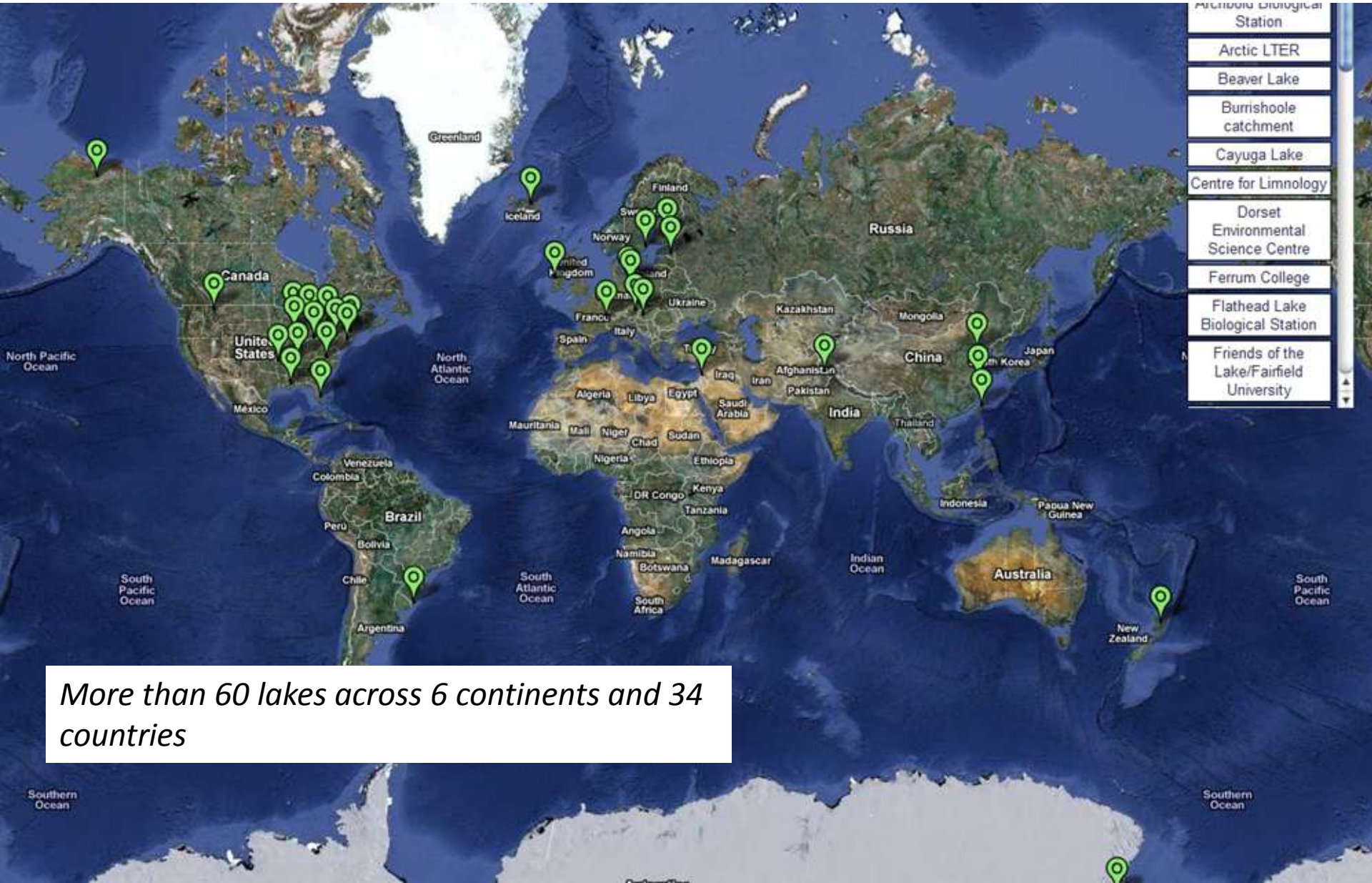
300

200

100

2008 2009 2010 2011 2012

… a network of observatories



More than 60 lakes across 6 continents and 34 countries

Publications

2011

Fragoso, C. R., Motta Marques, D. M. L., Ferreira, T. F., Jans … effects of climate change and eutrophication on a large subt… …delling & *Software, 26,* 1337-1348.

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Hanson, P. C., Hamilton, D. P., Stanley, E. H., Preston, N., L… …f allochthonous dissolved organic carbon in lakes: a quanita… doi:10.1371/journal.pone.0021884

Niu, F., Ré, C., Doan, A., & Shavlik, J. W. (2011). Tuffy: scali… …etworks using an RDBMS. *PVLDB 4(6)*: 373-384.

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Read, J. S., Hamilton, D. P., Jones, I. D., Muraoka, K., Winslow, L. A., Kroiss, R., Wu, C. H., & Gaiser, E. (2011). Derivation of lake mixing and stratification indices f… …vironmental *Modelling & Software, 26(11),* 1325-1336, doi:10.1016/j.envsoft.2011.05.006.

Read, J. S., Shade, A., Wu, C. H., Gorzalski, A., & McMahon, K. D. (2011). "Gradual Entrainment Lake Inverter" (GELI): a novel device for experimental lake mixing … *…ds, 9,* 14-28, doi:10.4319/lom.2010.9.14.

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2010

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Huber, V., … …

Kangur, A., Kangur, P., Kangur, K., Järvalt, A., & Haldna, M. (2010). Anguillicoloides crassus infection of European eel, Anguilla anguilla (L.), in inland waters of Estonia: history of introduction, prevalence and intensity. *Journal of Applied Ichthyology, 26,* 74-80.

Kangur, K., Kumari, M., & Haldna, M. (2010). Consequences of introducing the invasive amphipod Gmelinoides fasciatus into large shallow Lake Peipsi: present distribution and possible effects on fish food. *Journal of Applied Ichthyology, 26,* 81-88.

Langman, O. C., Hanson, P. C., Carpenter, S. R., Chiu, K., & Hu, Y. H. (2010). Control of dissolved oxygen in northern temperate lakes over scales ranging from minutes to days. *Aquatic Biology, 9,* 193-202, …

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… …illiamson, C. E., Hanson, P. C., Cole, J. J., & Kratz, T. (2010). Lake metabolism and the die… …d

… …hwater. *Science, 329,* 637-639.

… Swain, H. M. (2009). Effects of climate variability on transparency and thermal structure in … …ntal and …2009/0175-0217.

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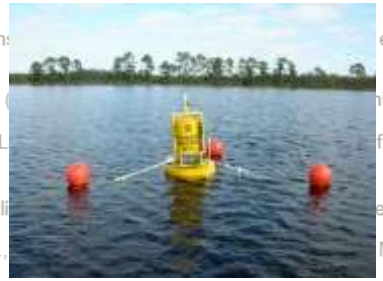
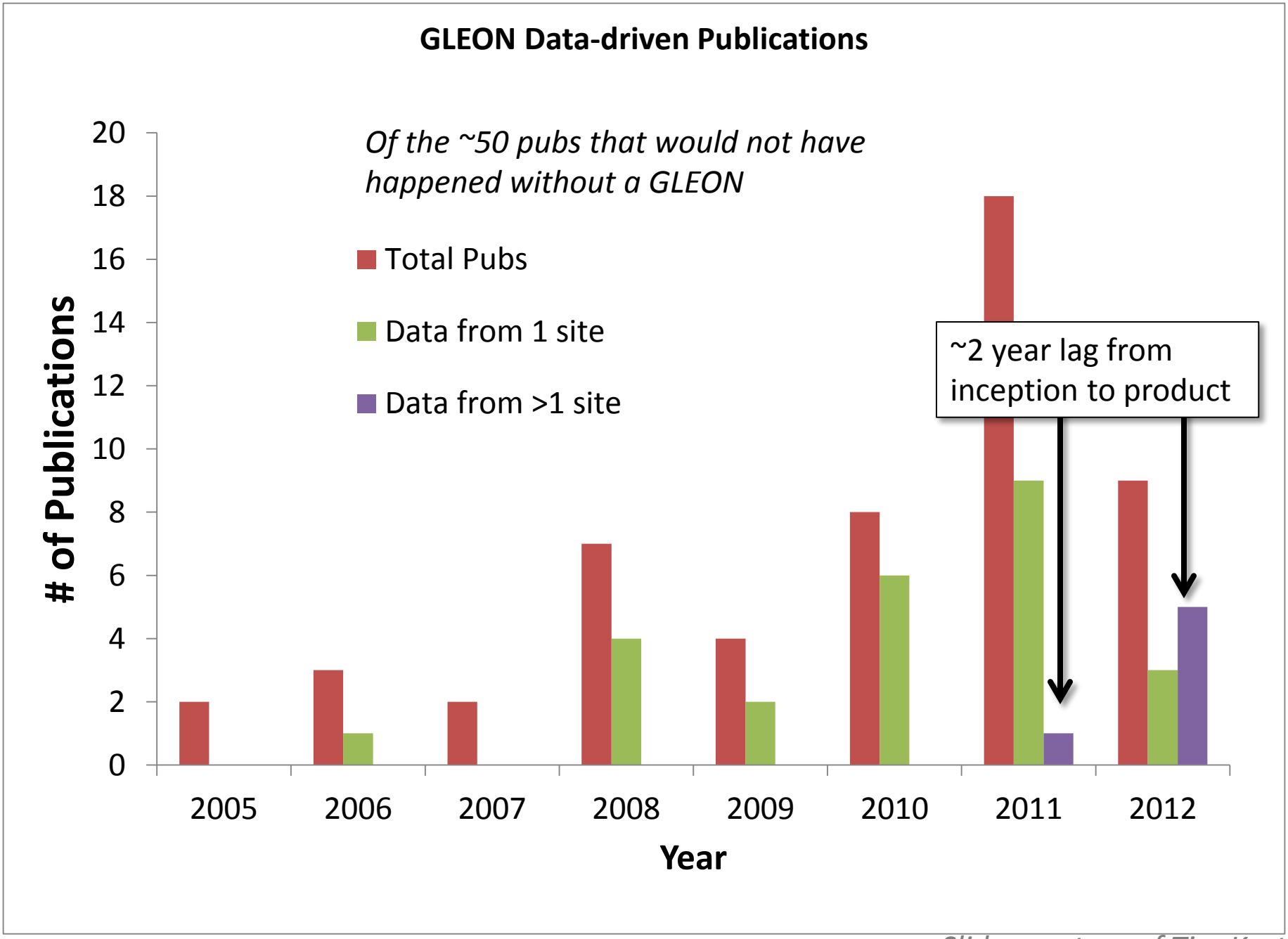
… of intermittent ice cover on lakes for climate-change studies. *Limnology and Oceanography, 54(5),* 1709-1722.



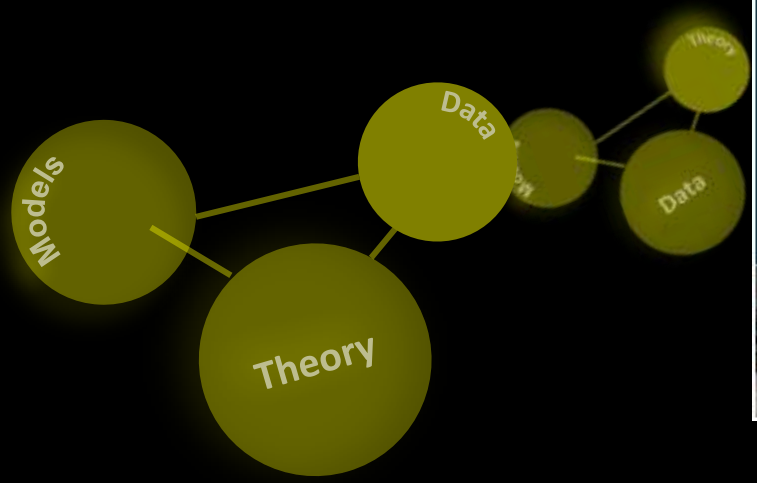
… and a network of data.

This model leads to high productivity

More than 100 publications and more than 200 presentations

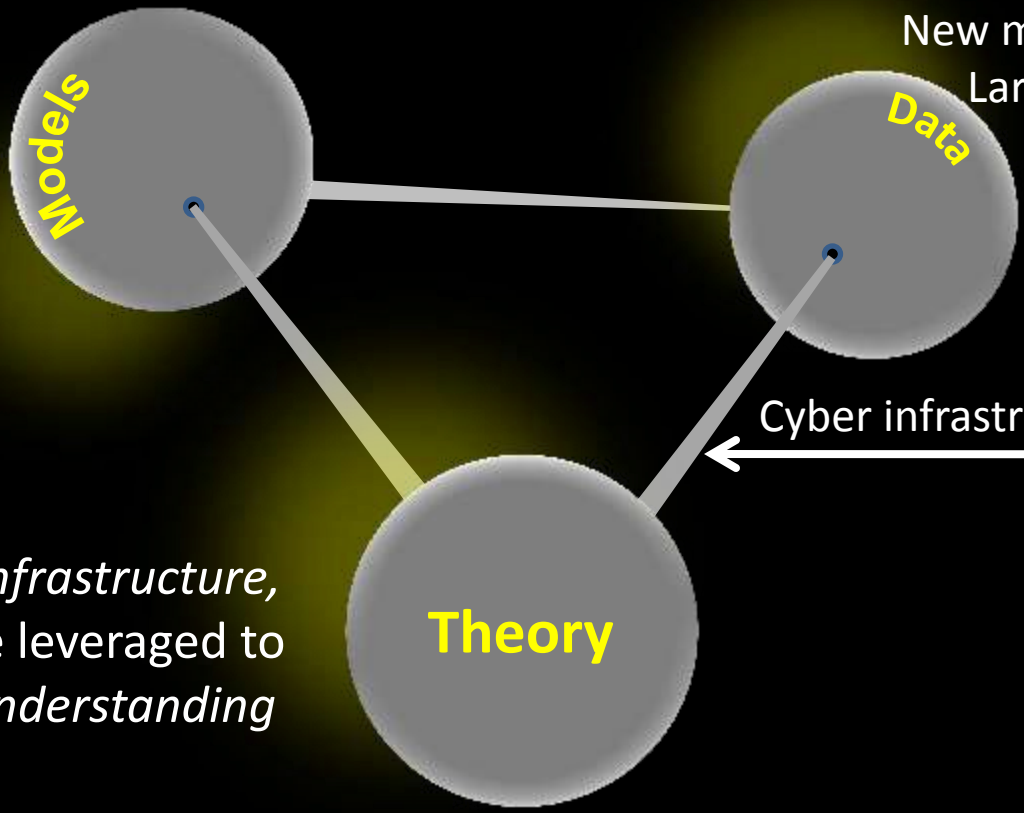


Slide courtesy of Tim Kratz



Adopt other disciplines
Innovate for ecosystems
Numerical simulation

New measurements
Larger gradients
More scales



Cyber infrastructure

Community, cyber infrastructure, data, models can be leveraged to advance *scientific understanding*

What Keeps Us Together and Helps Shape the Science?

All-Hands' Meetings and Workshops (Working Groups)

Data Sharing

GLEON Student Association/Student Leadership

Governance Structure

Collaborative Climate Committee

GLEON MEETINGS

GLEON 15: November 2013 (Bahia Blanca, Argentina)

GLEON 14: 15-19 October 2012 (Mulranny, Ireland)

GLEON 13 10-14 October 2011 (Lake Sunapee, New Hampshire, USA)

GLEON 12 4-8 April 2011 (Lake Kinneret, Israel)

GLEON 11 17-22 October 2010 (Nanjing, China)

GLEON 10 9-14 May 2010 (Torres, Brazil)

GLEON 9 12-15 October 2009 (Boulder Junction, Wisconsin, USA)

GLEON 8 2-6 February 2009 (Hamilton, New Zealand)

GLEON 7 29 September - 1 October 2008 (Norrtalje, Sweden)

GLEON 6 11-14 February 2008 (Lake Placid, Florida, USA)

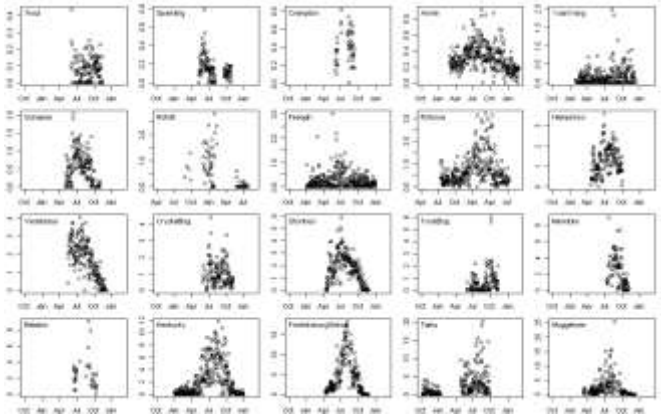
GLEON 5 11-14 August 2007 (Montreal, Quebec, Canada)

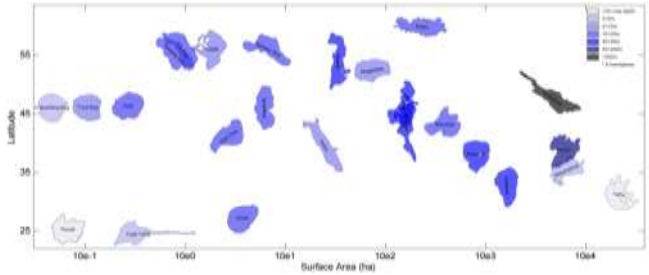
GLEON 4 2-5 March 2007 (Lammi, Finland)

GLEON 3 2-4 October 2006 (Hsinchu, Taiwan)

GLEON 2 29-31 March 2006 (Townsville, Queensland, Australia**)**

GLEON 1 7-9 March 2005 (San Diego, California, USA)





GLEON: Lessons Learned, Opportunities, and Challenges

- **Scientific networks are people networks**
  - Opportunity: GLEON has evolved into a grassroots "learning organization" that is actively doing science
  - Challenge: how to maintain the people, sensor, data network over the long-term

- **Scientists around the world are eager to collaborate**
  - Opportunity: GLEON attracts increasing numbers of experts from around the world and provides a new model for collaboration
  - Challenge: how best to understand, guide, and manage this growth and collaboration

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Lessons Learned, Opportunities, and Challenges (cont.)

- **Students are central to vibrancy of the network**
  - Opportunity: GLEON students and early career scientists are eager to join, engage, and help lead
  - Challenge: to create and implement the model(s) to best train next generation of global, network scientists

- **Public is eager to engage with local science if it is placed in a global context**
  - Opportunity: GLEON engagement with the public is increasingly leading to local community support and growth opportunities
  - Challenge: to find best models for engagement

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Lessons Learned, Opportunities, and Challenges (cont.)

- **Data sharing, both conceptually and technically, requires long-term sustained efforts**
  - Opportunity: GLEON can learn from and inform CI development for network science
  - Challenge: to harmonize globally diverse approaches to CI and data sharing

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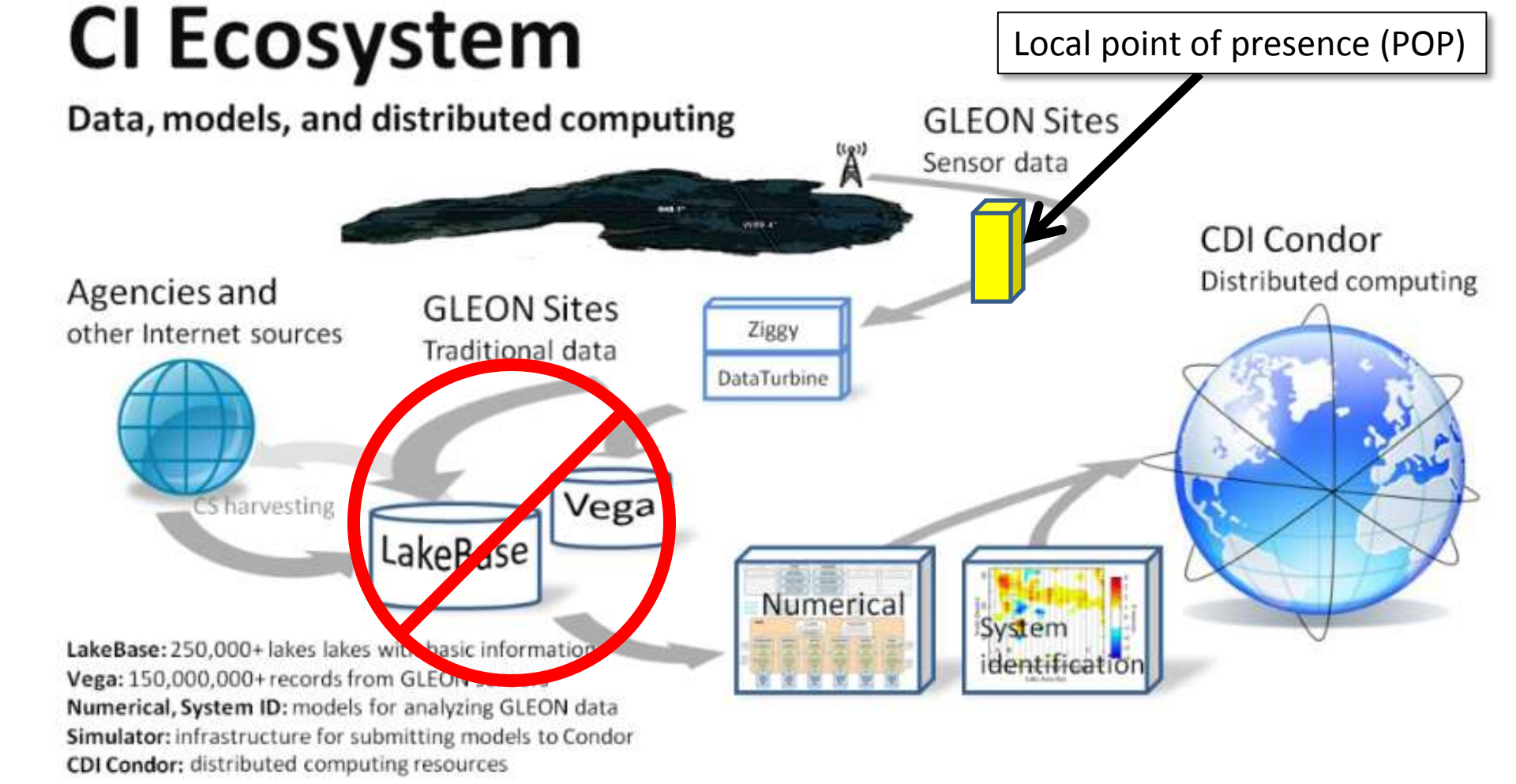
CI Ecosystem

Data, models, and distributed computing



LakeBase: 250,000+ lakes lakes with basic information
Vega: 150,000,000+ records from GLEON
Numerical, System ID: models for analyzing GLEON data
Simulator: infrastructure for submitting models to Condor
CDI Condor: distributed computing resources

CI – What is working…

- Site-level CI (from sensor to POP)
- More sites coming online
- Visualization at the local level
- A technology for storing large data sets
- Data analysis of large data sets
- Community development
- Partnering
- Science is getting done

What isn’t working…

- Centralization: central repository not used for science
- Persistence: little on-going contribution to centralized system
- Data discovery: rarely used
- QA/QC: at all levels
- Sharing: strings are attached
- Efficiency: it is not

Why is it so challenging?

- Ecology today:
  - Data were collected for a specific experiment
  - Incentives for anonymous sharing are not compelling to many
  - Online data discovery is not used much in ecology
  - Ecologists have been slow to adopt standardization
  - General culture of “do it yourself”
- Ecology tomorrow:
  - Address cultural and technological set of issues
  - New paradigm may require a new belief system and/or new accepted practice (more of a market system?)
  - Science drivers and learning by doing
  - Community is eager to experiment
  - PRAGMA expedition

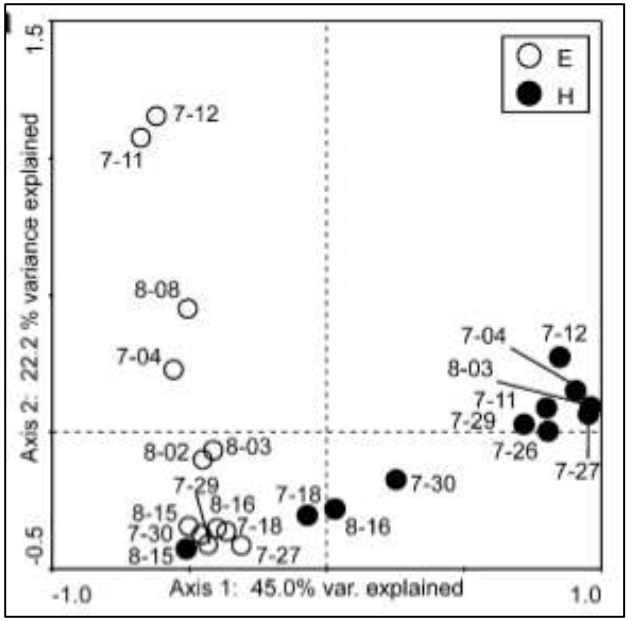
GLEON-enabled science: a research sampler and case study of the data-driven approach to global limnology

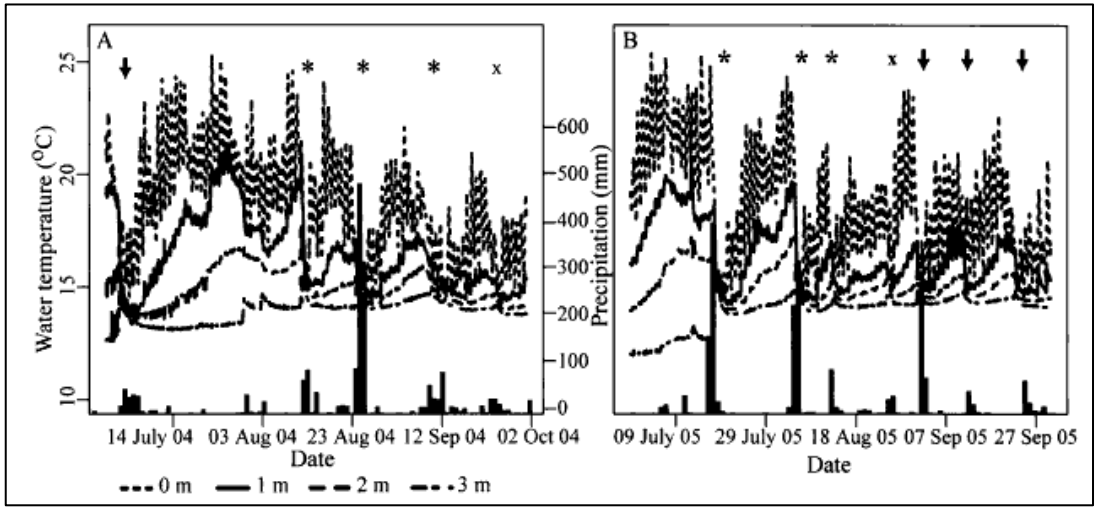
Cayelan Carey
Center for Limnology
University of Wisconsin

GLEON Working Group Structure

Microbial communities reset after typhoon events

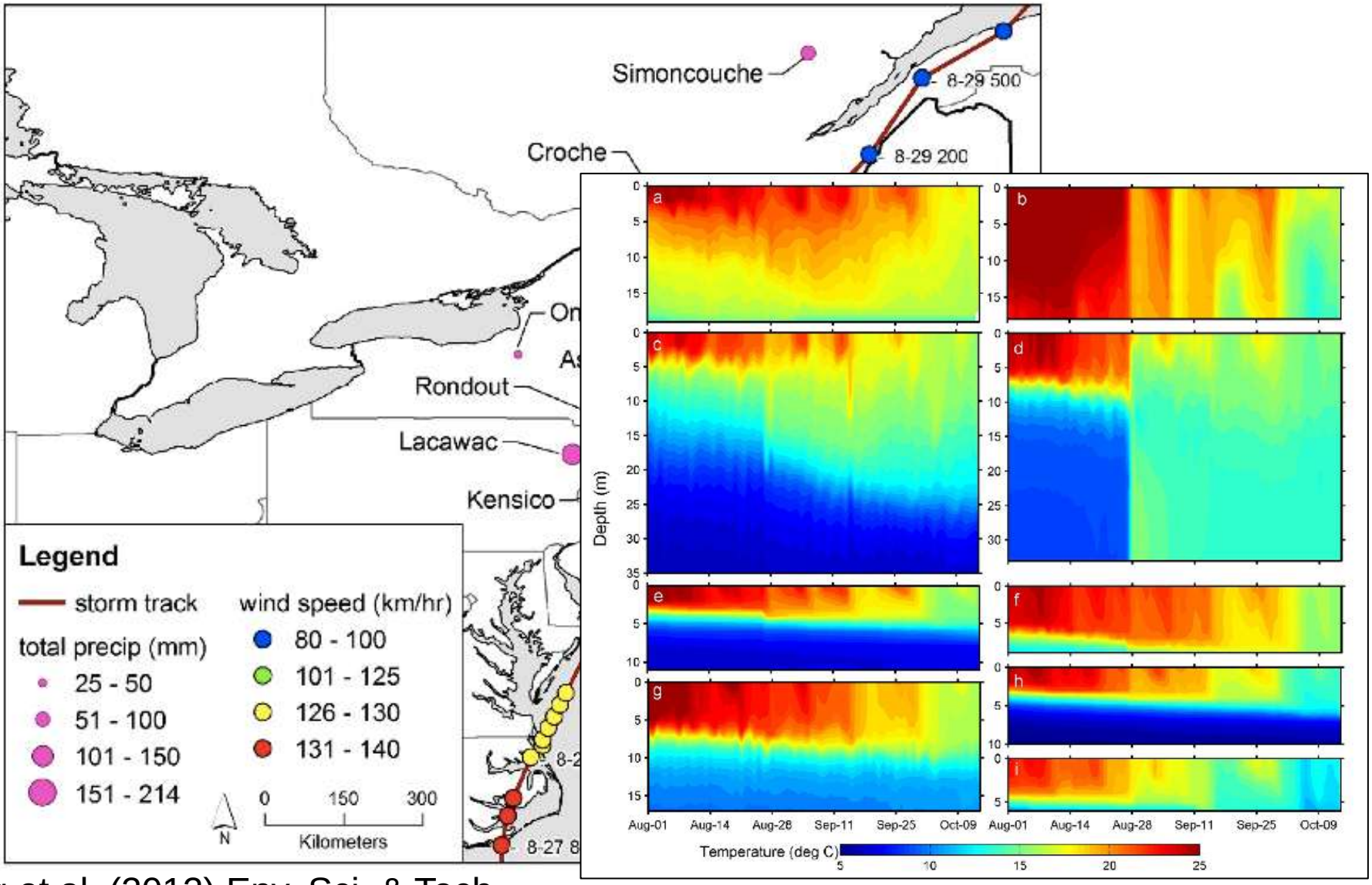
Yuan Yang Lake, Taiwan





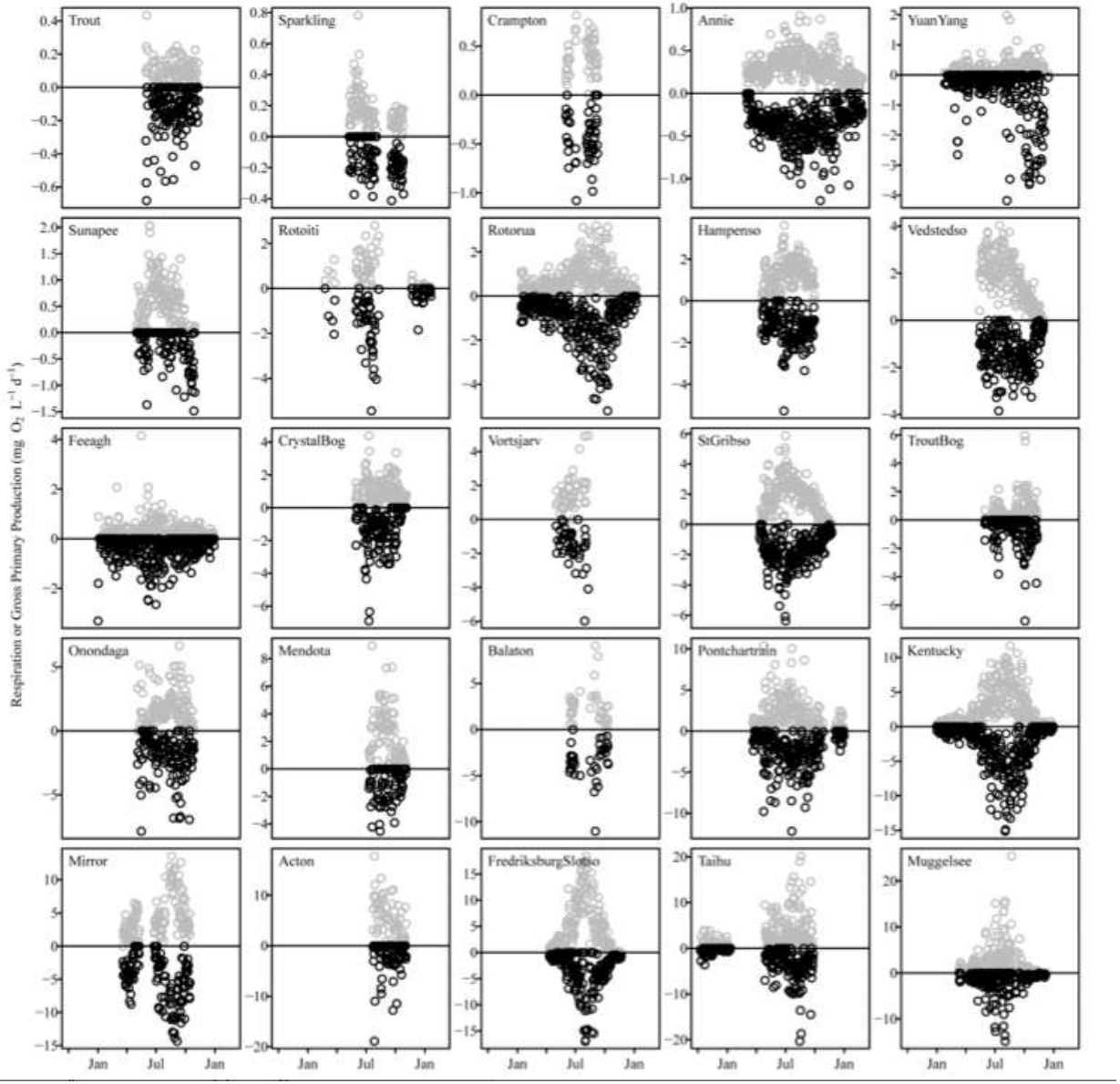
Shade et al. (2010) Env. Microbiol.

Monitoring episodic storm events



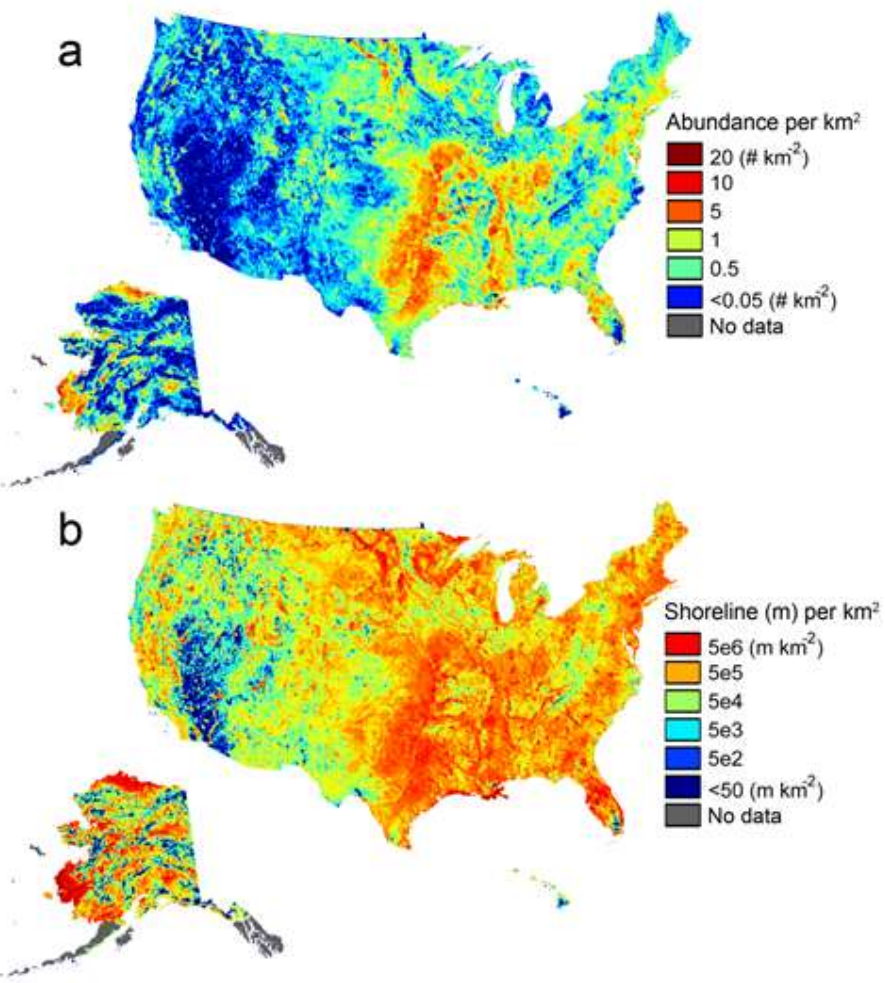
Klug et al. (2012) Env. Sci. & Tech.

How do production rates compare among lakes?



Solomon et al. (Accepted) L&O

Spatially extensive…



- What is the continental extent of lakes and shoreline in the U.S.?
- How much carbon is imported into aquatic systems, and how is that flux distributed spatially and across different size and types of systems?
- What scaling laws can we use to determine the distribution of lake ecosystems and biogeochemical processes across the landscape?

Luke Winslow et al. (In prep.)

Challenges and opportunities to look outside the GLEON box…

Challenge	Opportunity
Individual data management, resulting in redundancy and inefficiency	Are there data standards and workflows that we should be adopting across the network?
Traditional data management approaches (emailed Excel spreadsheets) are common	How do handle curated datasets? QA/QC? Need more training, standardized code and data formats; need incentive to do this
Not all data are equal	Should we be publishing “high value” datasets so that providers can receive credit?
Discussing, developing, and reiterating authorship policies is important	For us to collaborate on an equal playing field, we need to keep data providers engaged during every step of the project. Improves the science, strengthens the perspectives, and maintains data-sharing

Challenge	Opportunity
“Big data” management and analysis skills are in great demand but low supply	Improved training (workshops, tutorials) that are accessible to the community Connecting projects that need certain skills with skill sets
Difficulty in finding and accessing data needed for a project	Improved community interactions
Dominated by one or two disciplines	Collaborate across networks and organizations to apply our shared knowledge
People network is driving the science network; science is limited by availability and access of data	Does this need to change?

GloboLakes-GLEON Connect Points

- “Virtual expeditions” could be used to engage GLEON resources in Globo science
- Synergies in connecting lakes to their landscapes
- GLEON provides another mechanism for reaching the broader science community (expanding the effort and reach)
- Organizational infrastructure

Thank you!

(G14 in Mulranny, Ireland)

Table 1. GLEON students who have graduated recently or whose graduation is imminent.

2012: Alo Laas, Ph.D., Estonia University of Life Sciences (Estonia)
2012: Karin Sparber, Ph.D., University of Limerick (Ireland)
2012: Jordan Read, Ph.D., University of Wisconsin
2012: Emily Kara, Ph.D., University of Wisconsin
2012: Luke Winslow, M.S., University of Wisconsin
2012: Cayelan Carey, Ph.D., Cornell University
2012: Yangqing Ding, Ph.D., Nanjing Institute of Geography & Limnology,
Chinese Academy of Sciences (NIGLAS; China)
2012: Shujun Dai, M.S., NIGLAS
2011: Lesley Knoll, Ph.D., Miami University (Ohio)
2011: Kevin Rose, Ph.D., Miami University, Ohio
2011: Steven Sadro, Ph.D., UC Santa Barbara
2011: Marla Lima, M.S., IPH-Universidade Federal do Rio Grande do Sul, Brazil.
2011: Mino Sorribas, M.S., IPH-Universidade Federal do Rio Grande do Sul, Brazil.
2011: Linlin Cai, M.S., NIGLAS
2011: Linlin Zhao, M. S., NIGLAS and Hohai University
2010: Yan (Larry) Shen, M.S., NIGLAS
2010: Robyn Smyth, Ph.D., UC Santa Barbara
2010: Ina Bloch, Uppsala University (Sweden)

Summary

- Ecologists are eager to share data
  - Incentives need to match value system
  - Bar needs to be very low
  - We can learn from (or collaborate with!) others
- Entering a new era of science, in which ecologists are exploring new scales, technologies, new collaborations
  - A new kind of ecology?
  - A new kind of ecologist?
- Learning by doing – entering a new ‘science space’
- Work has already begun!

GLEON

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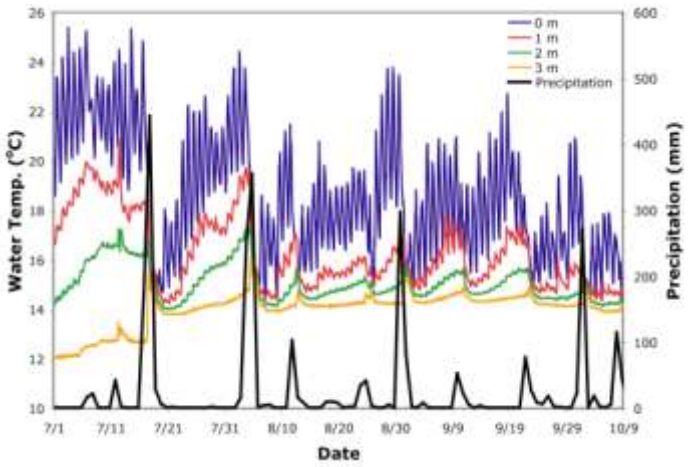
GLEON provides a new model for doing science

Argentina
Australia
Austria
Brazil
Canada
Chile
China
Colombia
Denmark
Estonia
Finland
Germany
Hungary
India
Ireland
Israel
Italy
Kenya
Netherlands
New Zealand
Nigeria
Pakistan
Poland
Puerto Rico
Russia
South Korea
Spain
Sweden
Switzerland
Taiwan
Turkey
United Kingdom



People, Sensors, Data



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