

Summary of GLEON/CREON Meeting

2 – 4 October

Hsinchu, Taiwan

http://www.nchc.org.tw/event/2006/creon_gleon/

http://www.nchc.org.tw/event/2006/creon_gleon/presentations.php (for presentations of meeting)

Summary of Attendance:

Lakes: Euiam and Soyang Lake, Korea; Lake Rotorua, New Zealand; Kineret, Israel; Lake Paajarvi, Lammi Biological Field Station, Finland; Lake Sunapee, New Hampshire, USA; North Temperate Lakes, Wisconsin USA; Taihu, China (via vtc); Torrens Lake, Australia; Yuan Yang Lake, Taiwan

Coral: Moorea Coral Reef, French Polynesia; Great Barrier Reef, Australia; Kenting Coral Reef; US NOAA Coral Reef Sites; World Bank Coral Reef Initiative

List of Attendees in Appendix

Number of Attendees: 51 in Hsinchu, and additional 6 via VTC

Sponsors:

- National Applied Research Laboratory / National Center for High-performance Computing
- National Science Council – Taiwan
- Taiwan Forest Research Institute
- Academia Sinica
- National Chung Hsing University
- National Museum of Marine Biology and Aquarium
- Forest Nursing Concern Administration
- The Veteran Affairs Commission of the Executive Yuan
- Gordon and Betty Moore Foundation (travel funds)
- National Science Foundation

Short Overview of Meeting

The third meeting of the GLEON and CREON communities was hosted by the National Center for High-performance Computing (NCHC) in Hsinchu, Taiwan. There was a broad array of institutions involved in sponsoring the meeting.

The meeting was preceded by separate field trips. In the GLEON community there was a trip to Yuan Yang Lake (YYL); in the CREON community there was a trip to the Kenting ILTER site, and a day of meetings at National Chung Hsing University.

There were specific scientific, infrastructure, and community building goals for both groups, that built on the outcomes of the previous meeting held in Townsville, Australia during March 2006. A tremendous amount of time was spent in both groups on day 1

D R A F T
Sections need updating

discussing specific scientific goals and outcomes. There was a great deal of effort to stay pragmatic about creating a product in the next five months.

The meeting concluded with a very special event, of Aboriginal Taiwanese dancer (Atayal Tribe) and the Taiwan Hand-puppet show.

The outcomes are summarized in the Action Items below.

Several observations are worth recording:

1. Activities before meeting: Having a field trip prior to the meeting allowed for informal discussions, which in turn made discussions at the meeting more informed as well as easier to engage more of the participants (in particular, it allowed those whose native language was not English to gain some confidence in their speaking).
2. Time between meetings: At the last meeting (March 2006) it was decided that a year between meetings was too long. This was echoed again at this meeting. Despite being at different stages of maturity, both the GLEON and CREON groups expressed a strong desire to continue to meet approximately every six months.
3. Joint Meetings: The GLEON and CREON groups have gained from meeting together, and will likely do so in the future, in specific areas such as IT, controlled vocabularies, education, and ideas for marketing the efforts for increased funding. However, the groups will meet separately in 2007 but will have representatives attend each others meeting.
4. Focus: The groups were more focused in their activities, and made a great deal of progress in identifying specific scientific products (e.g. Papers for GLEON, deployment of a field experiment for CREON) and infrastructure next steps.
5. Education: Common to both groups was the need to address educational issues of involvement of students or postdocs in the activities. Both groups are highly committed to this concept as it will train the next generation of scientists to engage in international, networked-based science projects.
6. Cyberinfrastructure: A particular activity involving both groups is the sharing of information about the cyberinfrastructure from sensors to user. There are existing projects both in Australia and the United States that should be talking to each other; a plan for this to take place was developed during the meeting.
7. Hosting: The effort of the hosts to share part of their culture was very much appreciated and helped move the groups of individuals into a more tightly knit community.
8. Thank you: Thank you to all involved in planning, sponsoring, and hosting the meeting.

Summary of Action Items from the meeting: GLEON

The action items are categorized into Science; Data, Shared Infrastructure, and Cyberinfrastructure; Dissemination; Education; Funding; Planning and Topics for Next Meeting.

Science

Diel Oxygen Paper: *Tim Kratz, others*

- Status: Data from the following lakes have been submitted:
 - Trout Lake, Trout Bog, Crystal Bog, Sparkling Lake, Lake Mendota: Wisconsin, USA
 - Lake Sunapee, New Hampshire, USA
 - Lake Taihu, China
 - Yuan Yang Lake, Taiwan
 - Esthwaite Water, United Kingdom
 - Lake Kinneret, Israel
 - Lake Rotorua, New Zealand

- Request more data, both from other lakes: Tim will request data and set date for input
- Data will be placed on web site (gleon.org): *Yu Hen Hu*
 - This will be on an unlinked page
 - There will be the raw data as well as the “processed” data (e.g., format changes, comparable units of measurement, missing data treated).
 - The group agreed to share these data among other participants
 - The only concern about sharing data beyond the group is handling the possible large set of questions from researchers outside of GLEON
- Authorship: Anyone who contributed data or helps write the paper will be included as co-author.
- Components of outline:
 - Structure and Introduction: *Tim Kratz*
 - Conceptual Models: *David Hamilton, others*;
 - What are the possible mechanisms (biological, physical) that need to be considered in explaining patterns
 - Features: *Yu Hen Hu, Barbara Benson, Tim Kratz*
 - Explain what the features are (e.g. midnight surge, ...) and the algorithms for detecting them
- Submission: Before Finland Meeting in March 2007

Comment: Yu Hen – is this correct?

Models: *David Hamilton, Paul Hanson*

- The focus on this activity is to look at how to tease apart biological signal from physical signal via modeling.
- Action: Develop action plan, take some initial steps forward, look for grad student to link across two or more institutions in developing model, use data from diel oxygen paper for an initial step forward.

Other Papers (longer time frame):

- Several other longer term papers were discussed, that will be followed up on in parallel. These have been motivated by the GLEON concept and interactions:

D R A F T
Sections need updating

- Features – aimed at an audience in signal processing for the methods used to categorize aspects of the diel oxygen curves, e.g. “midnight surge”, “plateau”, and “morning rise”. *Yu Hen Hu*, others;
- Now Casting: *Chin Wu*, others
- Time Scales: *Paul Hanson*, others

Data, Shared Infrastructure, and Cyberinfrastructure

Controlled Vocabulary

- Common data: *Barbara Benson*
 - An initial list of variables was created (see below). The agreement was to focus only on data captured by sensors. Other steps that need to be taken:
 - Circulate the proposed set of variable names for comments and collect an associated set of sensors / devices that capture the data, including manufacturer, model, and links to specs.
 - Implement the capture of variable and sensor metadata by lake in the lake information database by March
 - Need to consider how to handle the case of a sensor not already on a list. A suggestion was to have vetting of new variable names and sensor types by the Steering Committee.
 -

Metadata about GLEON

- The means to provide metadata about a GLEON site was shown, and a discussion followed as to what else was missing, including
 - Lake pictures, bathymetric maps, URL links, variables measured, sensors used
- The web interface will be modified based on input at meeting. A request will go out to add information. *Barbara Benson, Dave Balsiger*

Web Site

- Design: *Peter Arzberger* to ask a designer (less trees?) to create a prototype look/feel, keeping the simplicity and information utility.
 - Other comments about the site:
 - We should be able to get data out of the site
 - We would want to link the Metadata about GLEON on this site
 - We should think of how to get educational materials (this needs more definition) on the site as well.
- Maintenance: *David Hamilton, David Balsiger* determine transfer to Waikato to maintain site. Agreed that web site maintenance would be shared on a rotational basis.
- Multilingual Site: *Fang-Pang Lin* offered NCHC to help with aspects of making the site multi-lingual.

Cyberinfrastructure Plans and Coordination: Initially *Peter Arzberger*. Time frame for first meeting by end of October depending on schedules.

D R A F T
Sections need updating

- Based on presentations by Tony Fountain, Scott Bainbridge, Cameron Huddleston-Holmes, there were many places of potential sharing of experience, technology.
 - Comment made during meeting that large projects in Australia and US (NEON) should have a way of being in a dialog
- Summarize possible overlapping interests and other possible projects: *Peter Arzberger*
- Arrange vtc with targeted group:
 - Identify where there is synergy by sharing / exchanging ideas or technologies
 - Initial group include: *Ian Atkinson, Cameron Huddleston-Holmes, Scott Bainbridge; Tony Fountain; Barbara Benson, Peter Arzberger*
 - Time frame: End of October for first meeting (specific e-mail will follow)

How to Help a Site Come On-line: *Barbara Benson, Kathy Weathers*

- Observation: Four sites are in the following situation: Sensors are in the water, data are being collected, but there is not a clear next step to house/maintain the data. Thus, there is an opportunity for GLEON to develop suggested approach. For example, consider the following technologies
 - MySQL as common database
 - SRB for collection management
- Group: *Barbara Benson, Kathy Weathers* co-leads; *Paul Hanson, Dave Balsiger, Ken Chiu, Tony Fountain, Todd Hanson, David Hamilton, Lauri Arvoli, Bomchul Kim*

Dissemination

- Lake Observation System: 29 – 31 October 2006, Lake Biwa, Japan: *David Hamilton* and *Bomchul Kim* are representing GLEON. David to give GLEON talk – will share slides on GLEON Web site.
- AGU , 11 – 15 December 2006, San Francisco: *Tony Fountain* will be with Poster, *Kathy Weathers* will be there as well
- SIL – 12–18 August 2007, Montreal (GLEON has special session on use of high-frequency data in limnology)
 - *Tim Kratz* to lead development of paper on GLEON – to give an overview of what it is, what we are trying to accomplish, co-authored by Steering Committee
 - One point is to indicate value of network in doing science
 - Others can respond to the request for papers individually.

Education

- We heard about two projects. These projects led to discussions on funding (below) and other considerations for website.
- Action: Have updates at March Meeting.
- Summary of discussion
 - David Hamilton: A high school teacher, background mathematics, will be looking at development of curriculum material based on lake data.

D R A F T
Sections need updating

Separately, another individual has created material about Rotorua that is being used in New Zealand curricula on water quality.

- Kathy Weathers: The lake association is interested in having data about the lake made available on the web. This will require having a good interface and appropriate compute and data resources.

Funding *Peter Arzberger*

- In order to make significant progress on many of the activities above on a long-term basis, additional funds are needed. Two observations:
 - For the science projects, having postdocs would be excellent to both continue the in-depth analysis of the diel oxygen data as well as to actually conduct the work proposed in the modeling discussion (e.g. teasing apart physical and biological signals).
 - In addition, the needs for good infrastructure for k-12 education or community outreach will be essential. This argues for funding to develop pieces of the GLEON infrastructure.
- Action: Develop white paper that looks at portfolio of needs/opportunities for students, postdocs. This should give a broad portfolio of opportunities.
 - This would require a vision statement of GLEON as well
 - The group will also consider / create list of possible funding sources, e.g. UN, EU
 - One point to highlight (among many others) is the interdisciplinary nature of the problem.
 - *Peter Arzberger* (chair), *Kathy Weathers*, *Paul Hanson*, *Lauri Arvoli*, *David Hamilton*
 - Note: It is assumed that each site will continue to seek its own funding
 - Timeframe: End of November

Planning and Topics for Finland: *Steering Committee*

- Set dates: Likely dates
 - Reception 2 March 2007 (Friday)
 - Meeting 3, 4 March 2007 (Saturday and Sunday)
- Participation: Invite
 - Individuals from Finish funding, EU funding?
 - Local scientists. And European Scientists
 - IT experts from region
- Tentative Set of Topics:
 - Science:
 - Diel Oxygen: Identify next science questions to address, based on what has been learned in writing the paper
 - Models: Review progress, set targets for SIL Meeting
 - Other: If others have specific issues, have them present
 - Review steps taken on Web site including metadata
 - Summarize steps a site could take to come up to speed with respect to database technology

D R A F T
Sections need updating

- Education: Update
- Fund raising: Review progress and potential white paper/prospectus
- Discuss growth of GLEON (to be prepared for SIL)
 - Why are the issues of growth?
 - What are the criteria for being part of the team?
 - What type of Principles and Procedures document is required?
- Other Policy questions
 - Sharing of data
- Interaction with NEON
- Future Meetings:
 - After Finland, there was a discussion and suggestion to meet at SIL (Montreal), either a day before or after. This should be confirmed before Finland – and planned
 - Meetings after SIL. To be discussed
 - Linkage with CREON: Do we want representatives?

Summary of Action Items from the meeting: CREON

Science

A major accomplishment of the CREON working group during the Taiwan meeting was to articulate a research theme and then plan an experiment that can most fruitfully be addressed using a network-level science effort. The research theme developed by the group is: Performance of key functional groups on coral reefs across a range of temperature regimes. This is an especially timely focus of investigation for CREON because both short-term weather events as well as longer-term climate warming involve temperature variation; high water temperatures can be associated with coral bleaching events, resulting in devastating consequences to coral reef communities. Possible key functional groups that could be studied in this context include corals, algae and fish; the group decided that corals would be the initial focus of investigation. The range of temperature regimes under which ecological performance of corals would be measured will be achieved by both within and between site comparisons at Kenting Coral Reef ILTER, Moorea Coral Reef LTER, and several sites on the Great Barrier Reef. Across these spatial scales, the mean, the variance and the temporal structure of sea surface temperature can vary significantly, so it will be possible to make numerous comparisons both within and among sites. The participants recognized that temperature is not the only environmental variable that affects performance of coral reef organisms, but it was viewed as an important and tractable variable for initial studies. The variable for estimation of ecological performance in our initial studies will be skeletal growth of branching coral (probably in the genus *Acropora*).

The group debated a number of different experimental designs that could be used for the first set of coral growth experiments. A two-fold experimental approach was devised, first using empirical data describing both biotic and abiotic processes in order to map patterns of association (i.e., correlation) between the two, and second, to implement manipulative experiments using microcosms to forge cause-and-effect links between biotic processes and abiotic forcing functions. Initially, the experiments will focus on functional groups of scleractinian corals (e.g., branching corals) because of their important ecological roles in coral reef ecosystems and their suitability for experimental investigation. Subsequent experiments will be broadened to address algae and fish. The outcome of these experiments with branching corals will provide a more profound insight into the response of this functional group to changing temperature regimes – notably those associated with global climate change – within the context of biogeographic constraints. Moreover, the analyses will serve as a “proof of concept” for the utility of sensor networks to advance basic science questions in coral reef ecosystems. It was decided that deployment would occur within the next 6 to 10 months, and a committee of six people (two from each site including R. Schmitt, P. Edmunds from MCR, T. Fan and H.-J Lin from Kenting, S. Kininmonth and R. Berkelmans from GBR) was formed to develop the details of the experimental design and deployment plans. This group has already initiated an email exchange of the first draft; a final draft plan of the experimental protocol is due by mid December for review by the larger group.

Data, Shared Infrastructure, and Cyberinfrastructure

There was extensive discussion of instrument deployments that had been achieved by the sites since the Townsville meeting in March 2006. CTDs were deployed at Kenting and at Moorea; both are streaming data to the internet. We examined some recent temperature data from the Kenting Coral Reef ILTER site, in which local upwelling results in tremendous daily variation in nearshore water temperatures, and this stimulated much discussion about possible responses of coral reef systems to such dramatic temperature fluctuations, as well as possible experimental approaches that will be necessary to capture biological responses to these physical processes.

Membership and goals of the CREON IT/IM Committee were discussed and refined. It was decided that the committee would function best if there were two members from each of the three core sites (Kenting, GBR, MCR), each pair would include one scientist and one IM person. In addition, we sought representation from the World Bank Coral Reef Project. Membership on the committee now stands as follows: A. Brooks and L. Washburn (MCR), P.-J. Meng and Y.-C. Chang (Kenting), S. Bainbridge and R. Johnson (GBR), and B. Durnota (World Bank). The group will seek advice from T. Fountain (UCSD) and I. Atkinson (JCU), and will work on data standards, networking issues and coordination of efforts and exchanges with GLEON.

Future Meetings

The decision was made to meet in approximately 6-8 months (March to May 2007), possibly in Santa Barbara (or Australia). The meeting could also include interactions with UCSD people, including P. Arzberger, and T. Fountain, possibly via vtc. Since the GLEON group is meeting separately from CREON during 2007, it was decided that it will be of high importance to have a joint meeting of CREON and GLEON in 2008 so that opportunities for synergy are not lost.

Goals for the next meeting were established. These include:

- Further development of cyberinfrastructure issues to permit data sharing from deployed CTDs at the three core sites
- Review and meta-analysis of studies of effects of temperature (and other variables) on coral growth (this will include presentations and discussion of data from previous studies)
- Development of additional research themes for network-based investigation
- Formation of plans to sustain and grow CREON
- Development of strategy for graduate and postdoctoral student involvement

D R A F T
Sections need updating

Summary of Discussion – JOINT IT Meeting

Opportunities for Information Sharing and Future Collaborations

Cyberinfrastructure: From Sensors to User – a complete data and analysis environment

Wednesday 4 October 2006

Present: Cameron Huddlestone-Holmes (JCU), Scott Bainbridge (AIMS), Barbara Benson (NTL-LTER, UWI), Tim Kratz (NTL-LTER, UWI), Todd Hanson (SIO), Peter Arzberger (UCSD)

Others to Involve (initially): Ian Atkinson (JCU), Tony Fountain (SDSC)

Preface: Based on presentations by Scott Bainbridge, Tony Fountain, Cameron Huddlestone-Holmes (all can be found at http://www.nchc.org.tw/event/2006/creon_gleon/presentations.php), there seemed to be a great deal of overlap in the conceptual design of an end-to-end cyberinfrastructure from sensors to users that included the analysis tools and control and management of instruments. In addition, there were similar discussions of metadata for the systems. Based on that realization, a group met at a break at the 3rd GLEON and CREON Joint Workshop to map out possible overlaps and to discuss next steps.

Overlaps:

See table below for some obvious areas of overlap. We note that the JCU/AIMS groups and the NSF Automating Scaling Group both involved Rick McMullen. Both groups are using Gridsphere, both are working on aspects of data QA/QC, and more ...

Next Steps:

1. Create and circulate notes (Arzberger to draft)
2. Schedule a vtc among those present and Ian Atkinson and Tony Fountain (Arzberger to schedule)
3. Prior to vtc and during vtc identify other projects that might be relevant (all)

VTC Topics (possibly more than can be covered in one meeting):

1. Explore “face-to-face” areas of overlap, plans for the future, approaches taken.
2. Identify possible “low hanging fruit” for collaborations
3. Identify other individuals, groups to be brought into a broader collaboration
4. Identify sources of funding to enhance the collaboration (e.g., special US Australian collaborative funding opportunities)
5. Other

Note: Funding for the project at JCU/AIMS is for five years. On the US side there is a proposal pending (2 years of funding if successful) and there is NEON (but the funding path is not completely clear). It is the opinion of this author that to take full advantage of similarities and have real collaboration, significant funding must be available on both sides. There is the possibility of using PRAGMA to help a bit with this, which is funded for five years, but in a very targeted fashion.

D R A F T
Sections need updating

e-mail addresses: cameron.hholmes@jcu.edu.au; s.bainbridge@aims.gov.au;
bjbenson@wisc.edu; tkkratz@wisc.edu; parzberg@ucsd.edu; ian.atkinson@jcu.edu.au;
fountain@sdsc.edu; tshansen@hpwren.ucsd.edu

The following table indicates common tools and the people who develop them.

IT Component/Tool	AU Activities	US Activities
Web service at Sensor	Use CIMA (Rick McMullen)	Developed in NSF Auto-Scaling project: Fountain, Ken Chiu, Rick McMullen, Sameer Tilak
Kepler		Ilkay Altintas
QA/QC		Yu Hen Hu (U WI)
Grid Sphere		Jason Novatny (at UCSD)
Link to Models		Karan Bhatia (SDSC); Sriram Krishnan
GAMA		Karan Bhatia (SDSC)
SRB		Arcot Rajasekar (SDSC)
Data Turbine/Antelop		Tony Fountain/Todd Hanson

Some other projects that might be of interest or people to consider

- SEEK
- NCEAS/CENS/Kepler CI-Environment
- Michael Mirtl – ontologies
- MBARI –

D R A F T
Sections need updating

Appendices:
List of Participants:

<u>Brooks, Justin</u>	Australia, Adelaide, Torrens Lake	Justin.Brookes@sawater.com.au
Gao, Guang (VTC)	China, Taihu	guanggao@niglas.ac.cn
<u>Zhu, Guangwei</u> (VTC)	China, Taihu	gwzhu@niglas.ac.cn
Lu, Heng (VTC)	China, Taihu	HengLu@niglas.ac.cn
<u>Arvola, Lauri</u>	Finland, Lammi Field Station, U Helsinki, Lake Paajarvi	lauri.arvola@helsinki.fi
<u>Nishri, Ami</u>	Israel, Lake Kinneret	nishri@ocean.org.il
<u>Kim, Bomchul</u>	Korea, Soyang and Euiam	bkim@mail.kangwon.ac.kr
<u>Hamilton, David</u>	NZ, Waikato, Lake Rotorua	d.hamilton@waikato.ac.nz
McBride, Chris	NZ, Waikato	cmcbride@waikato.ac.nz
Trolle, Dennis	NZ, Waikato	dt24@waikato.ac.nz
<u>Chiu, Charles</u>	Taiwan, AS	bochiu@gate.sinica.edu.tw
Tsai, David	Taiwan, AS	d91622004@ntu.edu.tw
Chen, Po-Wen (Stephen)	Taiwan, NCHC	c00cbw00@nchc.org.tw
Chou, Hsiu-Mei	Taiwan, NCHC	c00xmz00@nchc.gov.tw
<u>Lin, Fang-Pang</u>	Taiwan, NCHC	c00fpl00@nchc.org.tw
Tsai, Whey-Fone	Taiwan, NCHC	c00wft00@nchc.org.tw
King, Hen Biau	Taiwan, TFRI	hbking@tfri.gov.tw
Lu, Sheng-Shang	Taiwan, TFRI	sslu@mail.tfri.gov.tw
Wang, Tong-Chi	Taiwan, TFRI	tongchi@tfri.gov.tw
<u>Weathers, Kathy</u>	US, Lake Sunapee	weathersk@ecostudies.org
Chang, Bill	US, NSF	wychang@nsf.gov
Balsiger, Dave	US, U Wisconsin	dbalsiger@wisc.edu
Benson, Barbara	US, U Wisconsin	bjbenson@wisc.edu
Hanson, Paul	US, U Wisconsin	pchanson@wisc.edu
Hu, Yu Hen	US, U Wisconsin	yhhu@wisc.edu
Kimura, Nobuwaki	US, U Wisconsin	nkimura@cae.wisc.edu
<u>Kratz, Tim</u>	US, U Wisconsin	tkkratz@wisc.edu
Wu, Chin	US, U Wisconsin	chinwu@engr.wisc.edu
<u>Arzberger, Peter</u>	US, UCSD	parzberg@ucsd.edu
Fountain, Tony (VTC)	US, UCSD	fountain@sdsc.edu
Tilak, Sameer (VTC)	US, UCSD	sameer@sdsc.edu
Shin, Peter (VTC)	US, UCSD	kg@sdsc.edu

Bainbridge, Scott	Australia, AIMS	s.bainbridge@aims.gov.au
<u>Kininmonth, Stuart</u>	Australia, AIMS	s.kininmonth@aims.gov.au
Gigan, Gilles	Australia, JCU	gilles.gigan@jcu.edu.au

D R A F T
Sections need updating

Huddleston-Holmes, Cameron	Australia, JCU	cameron.hholmes@jcu.edu.au
Durnato, Bohdan	Australia, World Bank	bohdan@tjurunga.com ; bohdan@decisci.com
Hong, Grace,	Great Britan, London School of Economics	gswhong@gmail.com
Liu, Pi-Jen	Taiwan, National Chung Hsing University	pijenliu@hotmail.com
Fan, Tung-Yung	Taiwan, National museum of marine biology & aquarium	tyfan@nmmba.gov.tw
Jan, Rong-Que	Taiwan, Academia Sinica	rqjan@ccvax.sinica.edu.tw
Lai, Kun Chi	Taiwan, Academia Sinica	east0122@gate.sinica.tw
Meng, Pei-Jei	Taiwan, Academia Sinica	pjmeng@nmmba.gov.tw
Shao, KT	Taiwan, Academia Sinica	zoskt@gate.sinica.edu.tw
Wu, Hsin-hui	Taiwan, Academia Sinica	elviscat@iis.sinica.edu.tw
Yang, Alan	Taiwan, Academia Sinica	jieluen@gate.sinica.tw
Chang, Yang-Chi	Taiwan, National Sun Yat-Sen University	changyc@mail.nsysu.edu.tw
Lee, Meng Tsung	Taiwan, National Sun Yat-Sen University	_a311528@ms34.hinet.net
Wang, Jazz	Taiwan, NCHC	jazz@nchc.org.tw
Lin, Hsin-Juh	Taiwan, NCHU	hjlin@dragon.nchu.edu.tw
Carpenter, Bob	US, CSU-Northridge	robert.carpenter@csun.edu
Edmunds, Peter	US, CSU-Northridge	peter.edmunds@csun.edu
Peng, Tsung-Hung	US, NOAA	Tsung-Hung.Peng@noaa.gov
Brooks, Andy	US, UCSB	brooks@lifesci.ucsb.edu
Holbrook, Sally	US, UCSB	holbrook@lifesci.ucsb.edu
Schmitt, Russ	US, UCSB	schmitt@lifesci.ucsb.edu
Hansen, Todd	US, UCSD	tshansen@sdsc.edu

List of Variables for Controlled Vocabulary:

GLEON Variable List (measurement types)

In-lake Measurements

water temperature
dissolved oxygen concentration
dissolved oxygen saturation
chlorophyll fluorescence
phycocyanin
pH
conductivity
colored dissolved organic matter fluorescence
carbon dioxide

D R A F T
Sections need updating

partial pressure of carbon dioxide
redox
nitrate
chloride
shortwave light penetration
PAR light penetration
turbidity
velocity
water level

Wave Measurements

wave height
wave period

Meteorological Measurements

wind speed
wind direction
global shortwave radiation
photosynthetically active radiation
longwave radiation
ultraviolet radiation
relative humidity
air temperature
precipitation
barometric pressure