Ecological Modeling and Forecasting

Dave Schwab

GLERL Organizational Themes

- Observing Systems and Advanced Technology
- Information Services and Products
- Ecosystem Dynamics
- Ecological Modeling and Forecasting
Purpose is to develop, test, and implement ecological models on a variety of space and time scales to predict the impacts of physical, chemical, biological, and human induced change on ecosystems.
Goal: To create an integrated ecological modeling system for the Great Lakes which includes predictive and diagnostic models for regional climate (atmosphere), lake ice (cryosphere), ocean/lake circulation (oceanography/hydrodynamics), hydrology (land process), sediment/contaminant transport (beaches), and food webs (production, fish recruitment, invasive species impacts) as well as skill assessment, performance accuracy testing, and uncertainty analysis of these models.
Research on the Great Lakes specifically provides the understanding necessary to make informed, scientifically-supportable decisions and actions, to assess the associated risks, expectations and timelines of management actions, to plan for effective observation and monitoring programs and to identify sensitive and meaningful indicators of ecosystem status.

Research has traditionally been focused on single issues. This focus must transition to an ecosystem approach with greater emphasis on predictive forecasting and adaptive management. Research should be directed towards improving the understanding of natural fluctuations and interactions of ecosystem components. Improvements in predictive capabilities are needed, particularly regarding the impacts of chemical, biological and physical changes on ecosystem structure and function.

Development of such capabilities requires a comprehensive research coordination strategy across partnering institutions.

Great Lakes Regional Collaboration partners include:
- Council of Great Lakes Governors
- Great Lakes and St. Lawrence Cities Initiative
- Great Lakes Congressional Task Force
- Great Lakes Indian Fish and Wildlife Commission
- U.S. Environmental Protection Agency, Great Lakes National Program Office
Different numerical model codes used by GLERL scientists illustrating the need for an integrated modeling framework.

WRF: Weather Research and Forecast / RAMS: Regional Atmospheric Modeling System
CHARM: Coupled Hydrosphere–Atmosphere Research Model
(D)LBRM: (Distributed) Large Basin Runoff Model
LLTM: Large Lake Thermal Model
AHPS: Advance Hydrologic Prediction System
POM/ FVCOM: Princeton Ocean Model/ Finite Volume Coastal Ocean Model
GDWM: GLERL D–Wave Model
CIOM: Community Ice Ocean Model
UTL/ LTL: Upper Trophic Level/ Lower Trophic Level
IBM: Individually Based Models
An **example** from the NOAA Center of Excellence for Great Lakes and Human Health (housed at GLERL) of combining various modeling approaches to create a single end product— in this case: a beach water quality model.

CEGLHH: http://www.glerl.noaa.gov/res/Centers/HumanHealth/

http://www.glerl.noaa.gov/res/glcfs/
Net basin supply is the difference between precipitation and evapotranspiration over both the land and lake portions of the basin. Increased net basin supply is a precursor to the illustrated rises in lake levels.

Work with International Joint Commission on Technical Committee

Ecological Modeling and Forecasting Theme

Presentations:
- Meteorology/Climatology: Brent Lofgren
- Hydrology: Drew Gronewold
- Hydrodynamics: Dave Schwab
- Ice/Climatology: Jia Wang
- Ecology: Craig Stow
Recap

The following slides are for the recap after the five team presentations

Teams

Meteorology/Climatology
Brent Lofgren

Ice/Climatology
Jia Wang

Hydrology
Drew Gronewold

Hydrodynamics
Dave Schwab

Ecology
Craig Stow

Integrated Ecological Modeling Framework
Ecological Modeling and Forecasting

Highlights

Lofgren: Smaller increase in evaporation than previously thought is overbalanced by increased precipitation, leading to a rise in lake levels.

Gronewold: We are developing novel techniques to effectively quantify and communicate uncertainty and risk to water resource managers.

Schwab: Next generation of hydrodynamics models are being coupled with biology and water quality models to produce some of the first ecological forecasts in the Great Lakes.

Wang: Coupled hydrodynamics/ice model (GLIM) has been demonstrated for Lake Erie and an unstructured grid version is in the works.

Stow: Social-ecological systems are complex adaptive systems; understanding how their component parts function doesn’t mean you can predict their overall behavior.

Posters:

Drew Gronewold - Hydrological Forecasting
Drew Gronewold – Sampling variability in Great Lakes beaches
Dima Beletsy - Modeling the transport of larval Yellow Perch in Lake Michigan
Eric Anderson - Operational Forecasts in the Huron-Erie Corridor
Meng Xia - Modeling nearshore wave current interaction with FVCOM
Marjorie Perroud and Brent Lofgren - Simulation of water temperature profiles over the Great Lakes region at a fine horizontal resolution
Doran Mason - Development of a bioenergetics model for Brown Shrimp
Ed Rutherford – Modeling of climate change and land use impacts on fish habitat
David Rockwell, Sonia Joseph, and Dave Schwab – Towards a 60 hour Beach Health Forecast Model for the Great Lakes
Jia Wang - Development of Great Lake Ice-circulation Model (GLIM)
Jia Wang - Severe ice cover in winter of 2008/09: contribution of AO and ENSO
Hongyan Zhang - Food web modeling in Lake Erie
Regional Ecological Forecasting System

Products and Services:
- Ecological warnings, watches, advisories, and information bulletins
- Long-term scenarios and outlooks
- Interactive decision support, visualization aids, and maps
- Education and outreach

Operating Principles:
- Scalable to inform decisions for regional to local management
- Collaborative and community-based
- User-driven for mitigation, adaptation, restoration and recovery
- Effective, reliable and quality controlled with known uncertainties
- Directed to transition research results to validated applications
- Accessible and supportive operational infrastructure and feedback to drive new research
Great Lakes Modeling and Assessment Center

**Partners:** National Centers for Environmental Prediction, CEP, National Weather Service, Great Lakes Environmental Research Laboratory, and Great Lakes Observing System Regional Association

**Capabilities:**
- Observation and Monitoring
- Data Assimilation and Modeling
- Dissemination
- Education & Outreach
- Research to Applications

GLOS: Great Lakes Observing System
http://glos.us/

NECP: NOAA NWS National Centers for Environmental Prediction
http://www.ncep.noaa.gov/

Questions?