



Web Sites for Information about Storms, Big Waves, and Water Levels with an Emphasis on the Great Lakes

by Philip Keillor

Out in the North Atlantic, 75 miles east of Sable Island and 270 miles east of Halifax, Nova Scotia, Canadian data buoy No. 44139 tugs at its deep sea mooring just south of the Banquereau Bank fishing grounds.

"Throughout the day of October 28th 1991, buoy 44139 records almost no activity whatsoever... dinghy-sailing weather on the high seas. At two o'clock the needle jumps, though: suddenly the seas are twelve feet and the winds are gusting to fifteen knots [17 miles per hour]....The wind calms down again and the seas gradually subside." By evening there is a full blown storm. "The waves catch up with the wind speed around 8pm and begin increasing exponentially; they double in size every hour. After nine o'clock every graph line from data buoy 44139 starts climbing almost vertically. Maximum wave heights peak at forty-five feet, drop briefly, and then nearly double to seventy. The wind climbs to fifty knots by 9pm and gradually keeps increasing until it peaks at 58 knots. The waves are so large that they block the anemometer, and gusts are probably reaching ninety knots. That's 104 miles an hour-Gale Force 12 on the Beaufort Scale. The cables are moaning." (*The Perfect Storm* by Sebastian Junger, 1997, W.W. Norton and Company, New York, pp. 104,105.)

Maximum wave heights recorded by data buoys during the storm reached 100 feet. Vessels and their crews were caught in the storm and lost.

Imagine that you had picked up news of the storm the night of October 28, 1991. If the web site had existed then, you could have "observed" the actual weather conditions at the Banquereau Bank buoy by obtaining data being collected by the buoy during the storm.

On August 25, 1998, you could have obtained your own profile of Hurricane Bonnie-a record of the rapidly rising wind speed and wave heights and plunging air pressure at the National Oceanic and Atmospheric Administration's (NOAA's) Buoy 41002, 350 miles east of Charleston, South Carolina, as Hurricane Bonnie approached within 110 miles of the buoy. The following day, you could have observed the strength of the hurricane as the eye passed over the automated weather station at Frying Pan Shoals.

On the Internet, current wind and wave information from the Great Lakes, deep sea, and nearshore data buoys is now accessible to boaters and weather watchers. Other weather, water level, and related information is also available to anyone with a personal computer and Internet access.

These Notes provide a sample of some of the information that can be found on the Internet. More information at each site can be found by using the primary address (<http://...../>) and following routes on the sites that are not described in these focused Notes. Because sites are linked there is usually more than one route to get the information you want. Multiple sites are listed in case one site and its route to the information you need becomes overloaded or is temporarily unavailable.

An Invitation

The Internet is always changing. As you explore and find new sites of some general appeal in these topic areas, please send a brief description and the address to the author at: jkeillor@seagrant.wisc.edu

These Notes will be placed on the following Wisconsin Advisory Services' Sea Grant web page and updated frequently: http://www.seagrant.wisc.edu/advisory/coastal_engr/coast.html

Check out the University of Wisconsin Sea Grant Institute's web site.
<http://www.seagrant.wisc.edu>

Great Lakes Information

GLIN

One of the primary sites for Great Lakes information is the web site for the Great Lakes Commission's Great Lakes Information Network (GLIN). Here you will find information on historical, current, and forecasted lake levels as well as flows between the lakes, weather, and climate.
<http://www.great-lakes.net>

GLIMR

Another primary site for Great Lakes information is the Great Lakes Information Management Resource (GLIMR). This is a Canadian partner to GLIN that provides information on Great Lakes facts and figures, directories, weather forecasts, references, and a Great Lakes Atlas.
<http://www.cciw.ca/glimr/intro.html>

Weather Systems

Continental and Statewide Weather

Here's a site of special interest to boaters and other travelers. It's a map of the continental United States showing the current speed and direction of weather systems with their areas of precipitation. This map of radar images is produced by the National Weather Service (NWS) of NOAA. The radar image map is dated in UTC time (see sidebar) and is at the following site:
<http://win.nws.noaa.gov>

Choose one of these options: (1) *New Enhanced Graphics Version*, (2) *Graphics Version*, or (3) *Text Version*. In the New Enhanced Graphics Version, the point-and-click selections include two satellite images of the U.S., a radar image of present weather systems, and a state map of local weather forecasts. In the Graphics version, select (1) *Local Weather*, (2) your state of interest, and then (3) *Radar* in the upper left portion of the screen to get the radar image of weather systems.

In the radar images of storm systems, the underlined number is the altitude of the tops of the clouds in 100s of feet. For example, "450" refers to an altitude of 45,000 feet. The arrows indicate direction of storm movement, and the speeds are given in *knots* (meaning nautical miles per hour). Multiply the number of knots times 1.15 to get miles per hour.

Local Weather

The NWS-NOAA site listed above is linked to two commercial sites where radar images of weather systems can be enlarged to show detailed structure of weather systems at a county level. Select either (1) the *Great Links* option or (2) the *satellite, radar, and hot links* option in the Graphics Version. Then select (3) the *UCAR Radar* button. In the Enhanced Graphics Version, select the *USA Composite* buttons for either Weather Services International or The Weather Channel.

Time on the Web

Some web sites indicate time in terms of Greenwich Mean Time (GMT), UTC (Universal Coordinated Time), or Zulu Time (Z) on a 24-hour clock with no need for an AM or PM distinction. The three terms mean the same thing. Subtract four hours from GMT, UTC, or Z time to get Eastern Daylight Time (EDT). Subtract five hours to get Eastern Standard Time (EST) or Central Daylight Time (CDT). Subtract six hours to get Central Standard Time (CST). For example, a map of NEXRAD Radar images produced at 1400 hours UTC was produced at 10 am EDT and 9 am CDT. A map of NEXRAD Radar images produced at 1800 hours UTC was produced at 2 pm EDT and 1 pm CDT.

Water Levels

Coastal U.S. Sea Levels

Oceanographic Products and Services Division, National Ocean Service, NOAA. This site contains preliminary, recent, and historic tidal and other water level information for U.S. harbor gauge sites (including the Great Lakes, Hawaii, Alaska, and Puerto Rico).

http://www.opsd.nos.noaa.gov/data_res.html

Great Lakes Water Levels

The above site also contains recent (preliminary) or historic (verified) lake levels (six-minute, hourly) for period of choice at 28 U.S. recording sites on the Great Lakes.

Great Lakes Water Levels

Great Lakes Environmental Research Laboratory (GLERL)- NOAA. Recent (preliminary) or historic (verified) hourly lake levels for the period of choice for 17 U.S. recording sites on the Great Lakes, Great Lakes surface water temperature contour maps, satellite imagery, and NOAA-National Data Buoy Center (NDBC) midlake buoy data.

<http://www.glerl.noaa.gov/data/data.html>

Great Lakes Water Levels

Buffalo District, U.S. Army Corps of Engineers (USACE). Interactive plots of historic monthly mean Great Lakes water levels (some from as far back as 1860). The time series of lake levels are from one reference water level gauging station on each lake. Also available: mean, maximum, and minimum levels with standard deviation at each gauge site plus daily average lake levels for the current week; recent past, current, and forecast water levels on the Upper St. Lawrence River between Kingston, Ontario, and Montreal, Quebec; other water level and outflow information for Lakes Erie and Ontario.

<http://hank.ncb.usace.army.mil>

Great Lakes Water Levels: Historic Records and Forecasts

Detroit District, USACE, Great Lakes Hydraulics and Hydrology Branch Home Page.

<http://sparky.nce.usace.army.mil/hmpghh.html>

Select one of the *Great Lakes* by clicking on the map. On each lake's page, you will find a six-month lake level forecast, long-term average level and year-to-date average levels, historic levels from 1918 to a recent year, and precipitation from 1918 to yesterday. A table of probable storm rise (surge) values is also available.

Select *Water Levels*. Choose from recent water level data, daily average lake levels and connecting channel water levels, and forecasted water levels. Under *forecasted water levels*, choose from a weekly forecast of Great Lakes lake levels, bimonthly forecast of water depths in connecting channels, six-months forecast of lake levels, a monthly *Lake Level Update* newsletter, and a table of average and extreme lake levels. A table of probable storm rise (surge) values is also available.

Great Lakes Water Levels Forecasts

Canadian Hydrographic Service, Department of Fisheries and Oceans, Canada. Lake level forecasts for the next six months are presented in a table format; including high, most probable, and low forecast lake levels.

<http://chswww.bur.dfo.ca/danp/glfct.html>

Great Lakes Water Levels

Marine Environmental Data Service, Department of Fisheries and Oceans, Canada. Most recent daily and weekly mean and highest and lowest water levels at master water level gauges for each lake.

http://www.meds.dfo.ca/meds/products/e_pt_wlb.html

Great Lakes Water Levels

Great Lakes water levels are available at the GLIN site: <http://great-lakes.net>

Click your way through *Great Lakes to hydrology: levels*. This site also contains graphs of mean monthly lake levels from 1918 to the present and beginning-of-the-month lake levels for 1860 to 1990. You can quickly get to these *hydrographic charts* at:

<http://great-lakes.net/envt/water/levelsh.html>

Present Water Levels by Phone

The Canadian Hydrographic Service, Department of Fisheries and Oceans, provides Voice Announcing Water Level Gauging Stations that give present water levels at 31 stations along the Canadian shores of the Great Lakes plus 6 stations along the shores of the upper St. Lawrence River. Push-button, cellular, or rotary phones can be used. There is a phone number given for each water level recording station at the following address:

<http://chswww.bur.dfo.ca/danp/voice.html>

Storm Surges on the Great Lakes

Detroit District, USACE. Storm probability tables, by lake and by month (only recent months) and storm water level rise at key locations, for these probabilities: 20%, 10%, 3%, 2%, and 1%.

<http://sparky.nce.usace.army.mil/levels/stpbtb.html>

Winds and Waves

Wind and Wave Information from Buoys and Coastal Stations

Buoy and station information, real-time data, archived data, and an index of deep water buoys and coastal or nearshore Coastal-Marine Automated Network (C-MAN) stations are available from NOAA's NDBC. <http://seaboard.ndbc.noaa.gov/>

Select (1) *Real-Time Data*, (2) *NDBC Station locator map*, (3) regional map for location of stations in your area of interest, and (4) station locations of interest on the map. At each station page, you get a description and photo of the station and current conditions of air/sea temperature, atmospheric pressure, wind, and wave conditions. You also can get the latest marine forecast with Notice to Mariners, graphs of conditions over the past few days and a table of the previous 12 observations.

Select *Dial-a-Buoy* to get an explanation of a system for obtaining the wind and wave conditions from any of NOAA's 65 data buoys or the Coastal-Marine Automated Network's (C-MAN) 54 stations in United States coastal and Great Lakes waters by phone.

Dial-a-Buoy

From a push-button phone, you can get present air/sea conditions at automated stations. Anywhere. Anytime. Dial: 228-688-1948. Then follow the verbal prompts (without entering digits too fast). If the web is too busy or if the computer system received your inputs too rapidly, you may need to repeat your phone call. Most stations will also allow you to get the latest National Weather Service forecast for the same area.

Before you place your call, you will need the NOAA buoy or C-MAN station identifier number, or the latitude and longitude of the station location. The station identifier number is much easier to enter by phone. To get this information, access the *station locator map* on the NDBC site given above, or at the following NOAA National Weather Service site.

Wind and Wave Information from Buoys and Coastal Stations

One of the most direct links to the information from automated buoys and coastal stations worldwide is NOAA's National Weather Service site in Tallahassee, Florida.

<http://www.nws.fsu.edu/buoy/>

On the site's global map, select the box for the area from which you want information. An enlarged map of that area shows locations of automated weather recording stations. Click on the station you want for a detailed location map. Very recent observations of wind speed and direction, air temperature, surface water temperature, and wave heights at that station are given along with the latest marine forecast for that site.

Wind and Wave Information for the Great Lakes Only

The NOAA (GLERL) site at Ann Arbor, Michigan, provides access to C-MAN station and NDBC data buoy weather conditions (buoy data are available only from May to November) for the past 36 hours, including winds and waves. This site also offers current marine weather forecasts and a table of months and years for which NDBC buoy data are available.

<http://www.glerl.noaa.gov/data/data.html>

A Global Ocean View of Waves

A global view of present and forecasted ocean wave heights and direction of movement can be seen on one screen. Enlarged views are available for five separate oceans: the North and South Atlantic, the North and South Pacific, and the Indian oceans. This information is available from NOAA's Shipboard Environmental Data Acquisition System (SEAS):

<http://seas.nos.noaa.gov/seas/>

Click on (1) the image of global sea surface temperatures to get *Oceanographic Models*, (2) select *WAM1.0* or click on the map of global waves on the right of the screen. WAM stands for Wave Model. (3) select the present conditions (T0000) or forecast conditions for different future intervals (Txxxx) up to 120 hours (five days) for any of the above oceans. Then the full-screen global ocean map with wave heights and directions will appear. Different color bands represent significant wave heights from 2 to 40 feet. Significant wave heights are the average of the highest one-third of waves present. This value also represents the height of waves estimated by a trained observer. Select an enlarged view of an ocean of interest to you.

Great Lakes Coastal Forecast System

Information on winds, waves, and surface water temperatures is available from the web site of NOAA-GLERL in Ann Arbor, Michigan.

<http://www.glerl.noaa.gov/>

Select (1) *Great Lakes Coastal Forecasting System*, (2) *Nowcast Maps*. A map of present surface water temperatures for Lake Erie appears. Select (3) *show all* in the upper left portion of the screen. Lake Erie maps of surface water temperature, elevation, water currents, wind field, wave heights, and direction appear along with a plot of recent water elevations at Buffalo, Cleveland, and Toledo and vertical profiles of water temperatures across the lake. Go back to *Nowcast Maps*. Select *Superior* or *Michigan* for a Great Lakes map of wind fields over each of the lakes. Select *show all* in the upper left portion of the screen to get both the wind field maps and the wave height maps for all of the Great Lakes.

Climate and Weather Information

NOAA's National Climatic Data Center (NCDC) in Asheville, North Carolina, is the major source of archived weather and climatic data for the United States. Some information is available on-line:

<http://www.ncdc.noaa.gov>

The site offers a climate visualization system that allows visual browsing of data available on line at the NCDC. Select (1) *climate resources*, (2) *get/view online climate data*, and (3) *climate visualization*. To get radar images of weather systems for a particular day, month, or year, go back to the main page. Select (1) the *radar* tab, (2) *get/view online radar data*, and (3) *National Mosaic Reflectivity Images*. There is also information on climate extremes, weather events, and other subjects of interest.

Wave Climate Information

Coastal Engineering Research Center, Waterways Experiment Station, The U.S. Army Corps of Engineers. The following site has information on how to obtain written reports containing hindcast (predicted past) coastal deepwater wave conditions from the Wave Information Study (WIS). A 20-year record for the Atlantic, Gulf, and Pacific coasts (1956-1975); a 32-year record for Great Lakes coasts (1956-1987); and a new 20-year record for the Atlantic coast that includes hurricanes (1975-1995).

<http://bigfoot.cerc.wes.army.mil/>

The above site is that of the U.S. Army Corps of Engineers' Coastal Hydraulics Laboratory, which includes the Coastal Engineering Research Center. The laboratory and center are part of the Waterways Experiment Station in Vicksburg, Mississippi.

The WIS reports can be followed by selecting (1) the *Information* symbol, (2) *Coastal Engineering Information Search*, (3) *Research Library*, (4) *Publications*, (5) *Coastal Engineering Publications*, (6) *Wave Information Studies (WIS) Related Publications* and (7) *Reports*. In the Reports section, scroll down through a long list of out of print or superceded publications until you get to the WIS report that gives wave information for your area of interest. The Reports section also gives addresses and information for ordering copies of the WIS reports.

Ocean Images from the Space Shuttle

The following site has a list of still images taken from various shuttle flights. Images include coasts, islands, local wind effects, waves, and pollution.

http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/OCDST/shuttle_oceanography_web/oss_contents.html

Oceanography and Weather for K-12 Teachers

Visit the Woods Hole Oceanographic Institution's home page:

<http://www.whoi.edu/index.html>

Select *Animation and Video Gallery* for a set of animations and videos that explain the activities of the Institution. This requires software capable of handling video and animation.

Or, select (1) *Education Programs*, (2) *K-12*, (3) *K-12 Resources*, and (4) *Weather* to get descriptions of specific products to explain weather to primary and secondary school students.

Ordering Navigation Charts and Nautical Maps

National Ocean Service, NOAA. Listed under Products and Services: nautical charts, tide tables, and the Great Lakes Hydrograph (a multidecade graph of mean monthly lake levels).

<http://www.nos.noaa.gov/>

Canadian Hydrographic Service, Department of Fisheries and Oceans, Canada.

http://www.chshq.dfo.ca/chs_hq/prodserv.html

Surface of the Earth

Look at the following National Geophysical Data Center (NGDC) web site for surface features of the land and seafloors of the world.

<http://www.ngdc.noaa.gov>

Select: (1) *Marine Geology and Geophysics* (MGG), (2) *Images* (on the left side of the screen), and follow additional steps to get the information indicated below:

Surface of the Earth

Select (3) *Global Relief*, and (4) *Surface of the Earth Poster*.

Beneath the Watery World

Select (3) *Estimated Seafloor Topography from Satellite Altimetry*, (4) click on the *rotating globe*. Under Quick Contents, select (5) *Globe Gallery* or *Image Gallery-NOAA*. Under *Image Gallery-NOAA*, select (6) *New Global Seafloor Topography from Satellite Altimetry*, then choose (7) one of the images available for a *World View* or regional views.

A Wild Flight over the Bottoms of Lakes Superior and Michigan

Go to *Images* and select (1) *Great Lakes Geomorphology*, and (2) *Go for a wild animated GIF (or .mpeg) ride over Lake Superior and Lake Michigan*. To observe the route of this flight, look at the following site:

http://www.ngdc.noaa.gov/mgg/image/IR_Path.GIF

Great Lakes Lakebed Graphics

At the same NGDC web site, go to (1) *Images*, select (2) *Great Lakes Geomorphology*, then select (3) *Bathymetry of (name of lake) Poster*. In August 1998, color images of the lakebeds of Lakes Michigan, St. Clair, and Erie are available.

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