Water Levels of the Great Lakes

September 2015

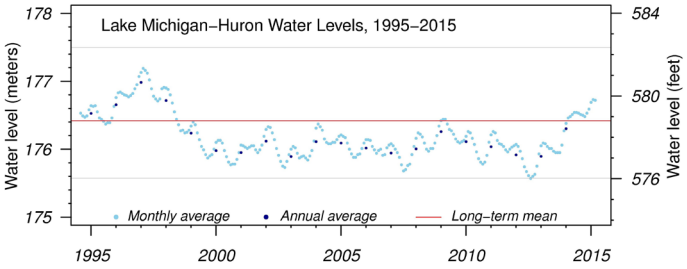
The Great Lakes, their connecting waterways, and their watersheds, comprise the largest surface freshwater system on the planet. The monthly, seasonal, and annual surface water elevations of the lakes fluctuate in response to a variety of factors. This brochure provides a brief overview of historical Great Lakes water level patterns and current water levels, as well as the research NOAA conducts through its Great Lakes Environmental Research Laboratory (GLERL) on seasonal water level forecasts.

Evaporation and Great Lakes Water Levels

What a difference a few years make! All of the Great Lakes are above their monthly average levels for early September. As you know if you vacation near the shores of the upper Great Lakes, this is a marked change from just two years ago, particularly for Lakes Michigan and Huron.

Date	Michigan-Huron water level (ft)	Departure from monthly average level (ft)
8/2013	577.69	-1.41
8/2014	578.80	-.3
8/2015	579.79	+.69

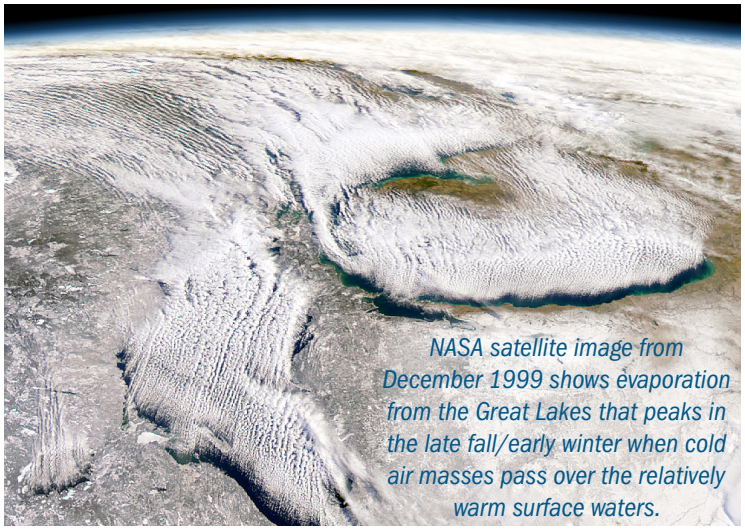
Over a span of two years, the lake-wide monthly average water level for Lake Michigan and Lake Huron has gone from nearly 1-1/2 feet below the monthly average to 2/3 of a foot above the average level. It's worth noting that during the 15 years of low levels on Lakes Superior, Michigan, and Huron, levels on Lake Erie and Lake Ontario remained close to their monthly averages. What caused these recent dramatic fluctuations in the water levels of the upper Great Lakes?



This graph of Lake Michigan-Huron levels for the past 20 years reveals both seasonal fluctuation and longer periods of high and low levels. Light gray lines show the minimum and maximum levels recorded for these lakes in more than 150 years of records.

Precipitation, Evaporation, and Runoff

More than a third of the Great Lakes basin area is occupied by surface water. As a result, air-water interactions play a large role in the weather and climate of our region (think 'lake-effect snow'). Precipitation over the lakes, evaporation, and runoff are the factors that control the seasonal fluctuation of Great Lakes water levels. Hydrologists are analyzing the relationships between these water budget components; trying to improve our data to enhance the accuracy of predictive models. Evaporation over the lakes is a difficult quantity to measure. Generally peaking in the fall to early winter, evaporation is highest when cold air masses are blowing across warm water. A small network of seven stations on islands and lighthouse towers across the Great Lakes has been operating for the past 5-8 years. This data will be used



NASA satellite image from December 1999 shows evaporation from the Great Lakes that peaks in the late fall/early winter when cold air masses pass over the relatively warm surface waters.

to improve predictive models which have relied on modeled over-lake evaporation. Scientists believe high evaporation in the late 1990's played a large role in the 15-year period of very low water levels. Recently, very low evaporation in 2014 contributed to the rapid recovery of water levels of the upper lakes to above average, along with consistently above-average precipitation in 2013 and 2014.

How are water levels predicted?

Forecasts of Great Lakes monthly-average water levels are typically based on computer simulation models. One example is the Great Lakes Advanced Hydrologic Prediction System (AHPS), developed by NOAA-GLERL, which combines historical meteorological data with a series of mathematical models and climate forecasts from NOAA's Climate Prediction Center to simulate multiple variables. The most important variables are overlake precipitation, overlake evaporation, and rainfall-induced runoff. The sum of these variables ("net" supply of water to the basin) is routed through the lakes and connecting channels using models that reflect flow patterns and regulation rules in order to produce a band of probability-based future water levels.

FOR MORE INFORMATION

http://www.glerl.noaa.gov/data/now/wlevels/levels.html

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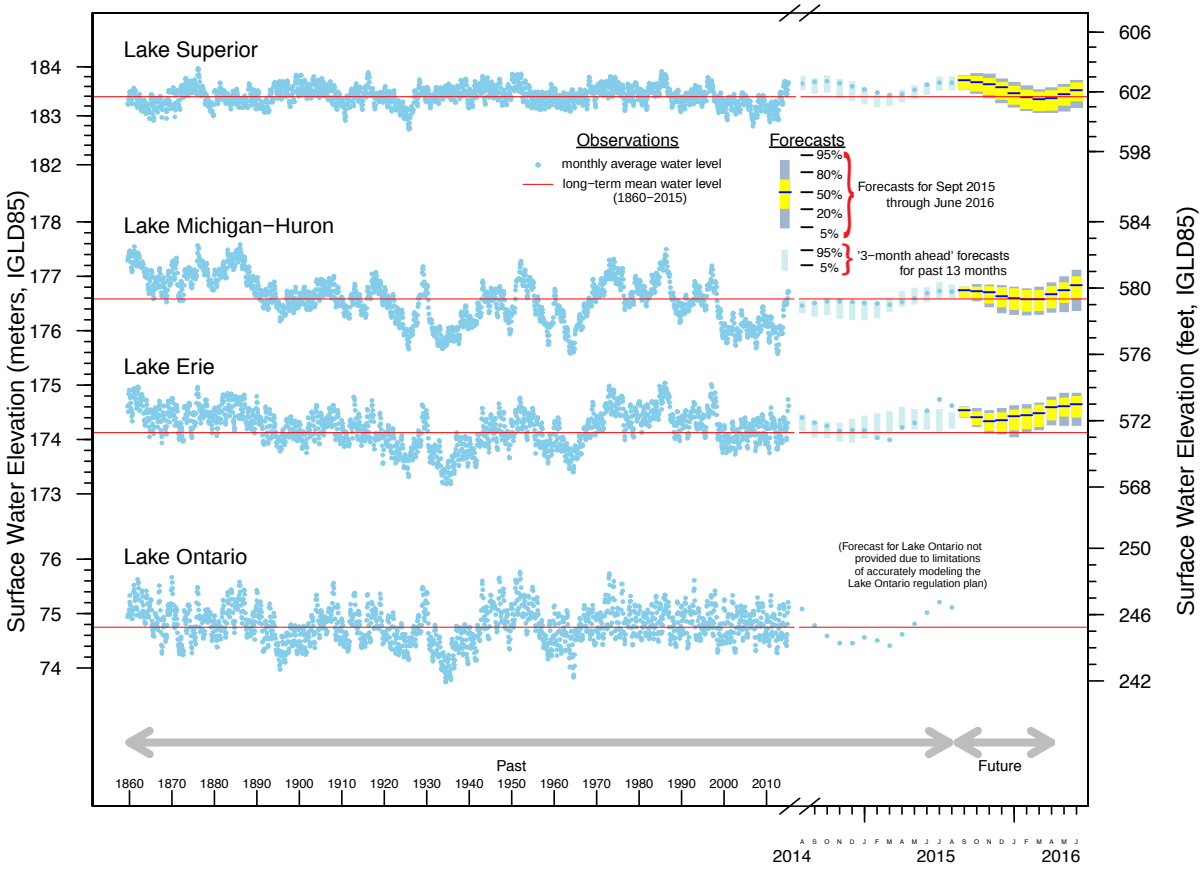
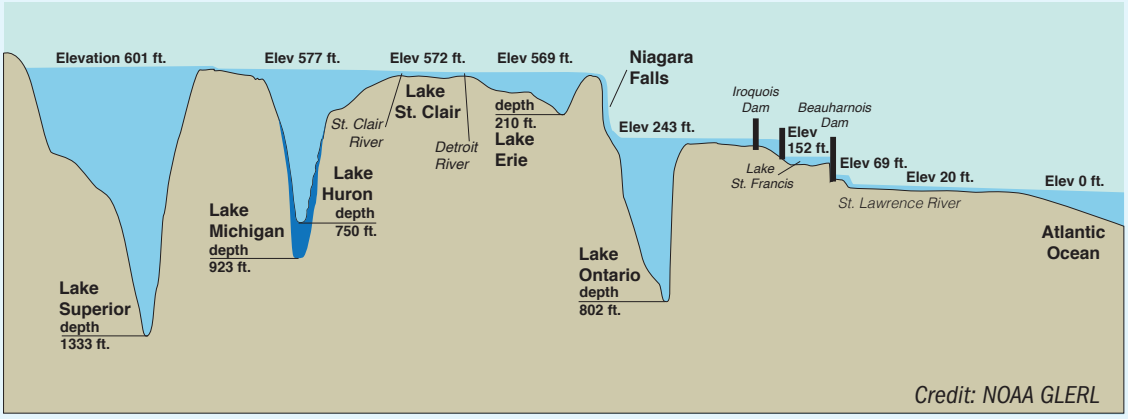
The Current Outlook for Great Lakes levels

The research-oriented forecast generated by NOAA-GLERL's AHPS on September 15 indicates that the water levels of Lakes Superior, Michigan, Huron, and Erie are expected to follow their typical seasonal trends at above average levels; remaining above their monthly and long-term averages into summer of 2016. The uncertainty expressed in the forecast shown here is based on observed weather patterns and Great Lakes water levels from 1948 to present, along with NOAA Climate Prediction Center's regional forecasts. The 5 and 95% bands are expected to contain the observed water level 90% of the time. The NOAA-GLERL AHPS forecasts are used by the U.S. Army Corps of Engineers and Environment Canada as part of their operational water level forecasting systems (http://www.lre.usace.army.mil/Missions/GreatLakesInformation/GreatLakesWaterLevels/WaterLevelForecast/MonthlyBulletinofGreatLakesWaterLevels.aspx).



GREAT LAKES SYSTEM PROFILE

The Great Lakes and their respective watersheds and waterways all flow downhill to the ocean. Within the Great Lakes system, water flows from Lake Superior via the St. Marys River into Lake Huron. Lakes Michigan and Huron are joined at the Straits of Mackinac, which allows these two lakes to act as one hydrologic system. The upper lakes meet the lower lakes at the Huron-Erie corridor, which is comprised of the St. Clair River, Lake St. Clair, and the Detroit River. Lake Erie flows over Niagara Falls and into Lake Ontario before flowing through the St. Lawrence River into the Atlantic Ocean.



What is IGLD?

IGLD refers to the International Great Lakes Datum, an elevation benchmark (reference point) against which all water level gauging stations in the Great Lakes are compared. This reference point was last established around 1985. IGLD requires updating about every 30 years because the land surface around the Great Lakes is constantly changing in elevation due to the 'bounce back' of the earth's crust following the retreat of the glaciers during the last ice age (also referred to as isostatic rebound).

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