

Defining and implementing a new International Great Lakes Datum

Michael Craymer, Canadian Geodetic Survey, NRCan
Terese Herron, Canadian Hydrographic Service, DFO

on behalf of the
Coordinating Committee on Great Lakes Basic Hydraulic
and Hydrologic Data

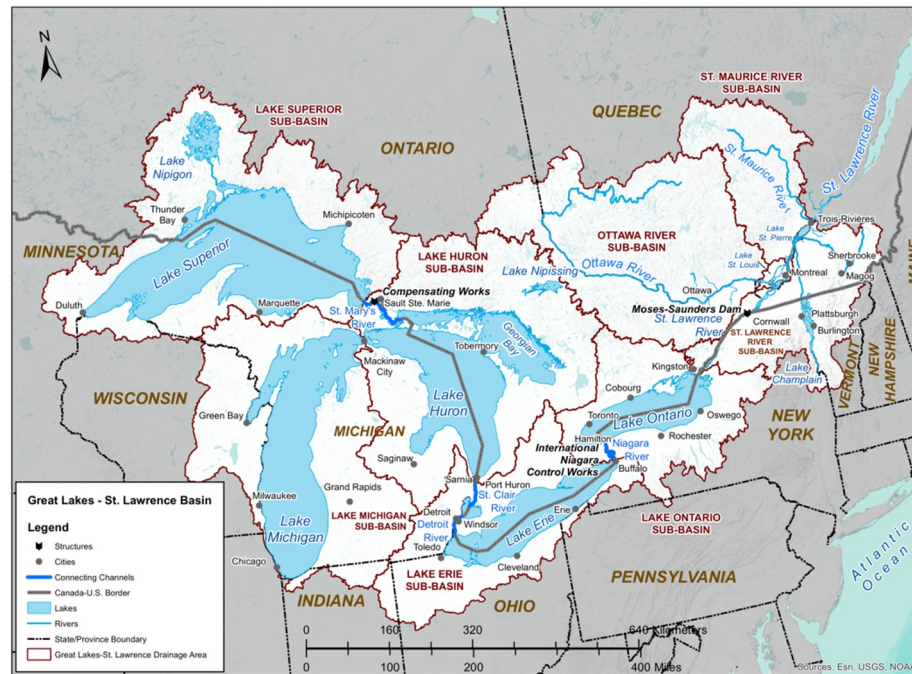
2024 Annual Meeting of the CGU
Carleton University, Ottawa, May 26-29, 2024



What is IGLD?

- **International Great Lakes Datum (IGLD)**
- **Official vertical datum** used for water level measurements and navigation charts throughout the Great Lakes, their connecting channels and the St. Lawrence River
- **Maintained by the Coordinating Committee** on Great Lakes Basic Hydraulic and Hydrologic Data – a binational committee with representatives from Canadian & U.S. governments

Great Lakes – St. Lawrence Basin



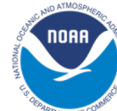
Environment and
Climate Change Canada
Environnement et
Changement climatique Canada



Fisheries and Oceans
Canada
Pêches et Océans
Canada



Natural Resources
Canada
Ressources naturelles
Canada



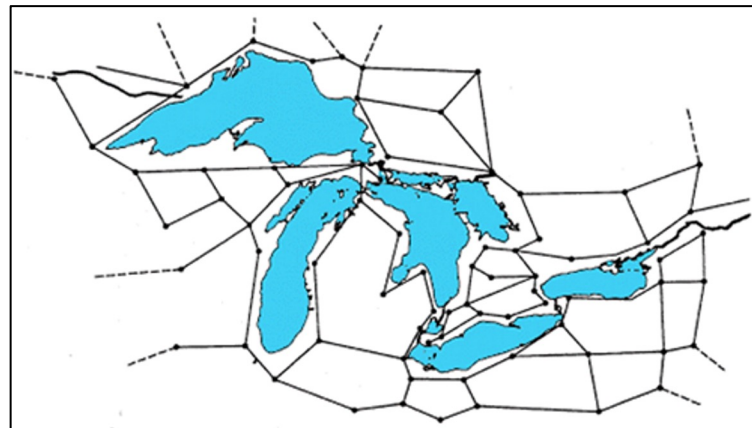
USGS
science for a changing world



**US Army Corps
of Engineers®**

Current IGLD (1985)

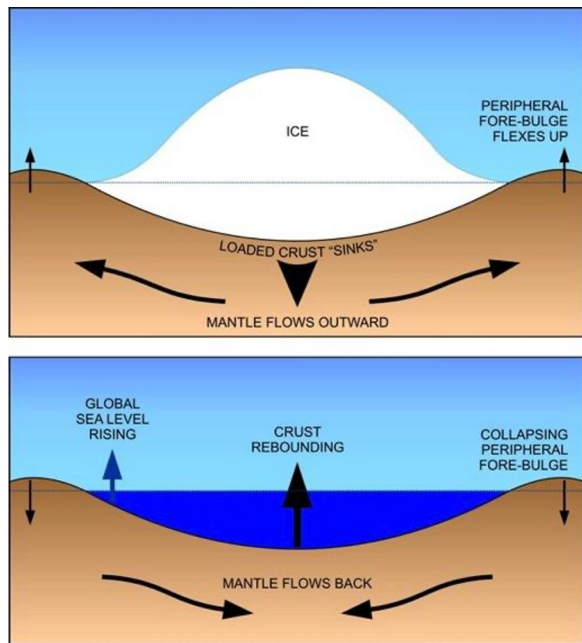
- Replaced original IGLD (1955)
- Based on current vertical datum in U.S. (NAVD88)
- Reference zero is mean sea level at Pointe au Père & Rimouski, Québec over the period 1970-88
- Reference zero (datum) extended inland using leveling
 - Very time consuming & cost prohibitive
 - Datum accessible only where leveling bench marks exist
 - **Affected by systematic errors in long leveling loops**
- Uses **dynamic heights** for managing water levels
 - Geopotential numbers scaled by constant value of Normal gravity at 45° latitude
 - Constant along a level surface such as a lake
- “Hydraulic correctors” used primarily to correct for systematic errors in levelling



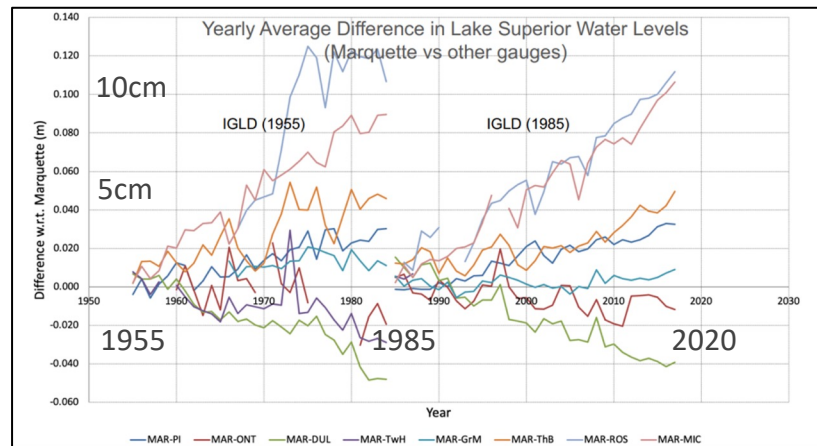
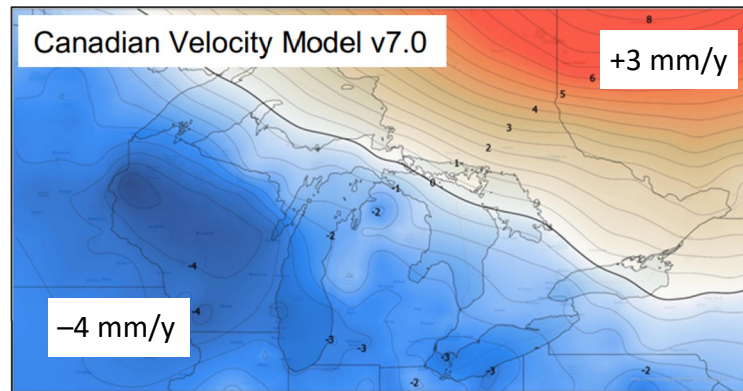
NAVD88 Network Level Loops

Why a new IGLD?

- Impact of GIA – uplifting in north, subsiding in south
- Overall tilting ~ 7 mm/year (21cm or 8" over 30 years)
- Need to update IGLD every 25-30 years => **overdue!**



Process
of GIA

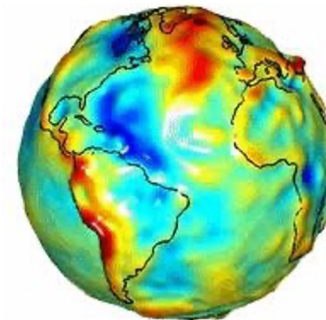


Effect of GIA on Water Level Measurements

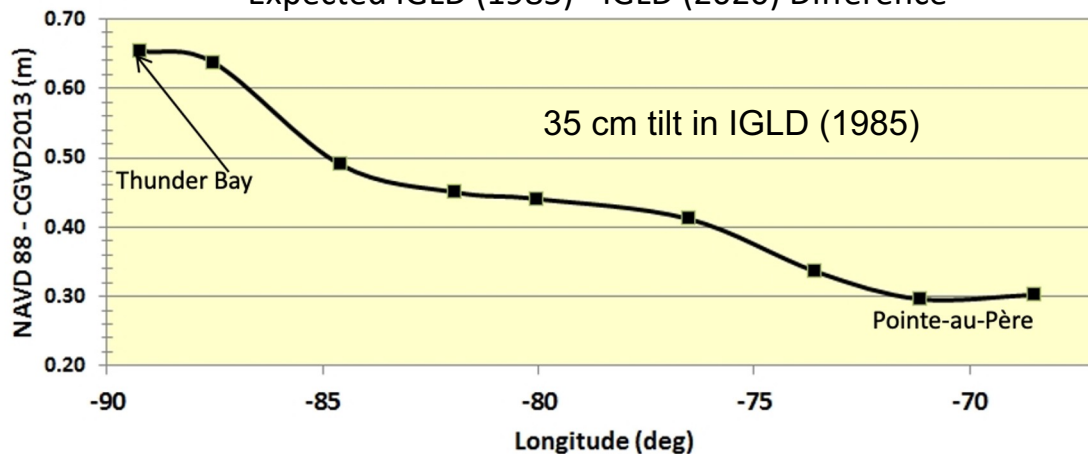
New IGLD (2020)

- Based on the new North American vertical datum (NAPGD2022)
- Reference zero is mean sea level around coasts of North America
- Reference zero (datum) extended inland using a geoid model
 - Same geoid as used for NAPGD2022 & future CGVD2013
 - Defined everywhere, not only where leveling bench marks exist
- Uses dynamic heights
- Heights referenced to 2020.0 (mid-point of 7 year water level obs. period)
- Heights will change 30-65 cm from IGLD (1985)

Geoid

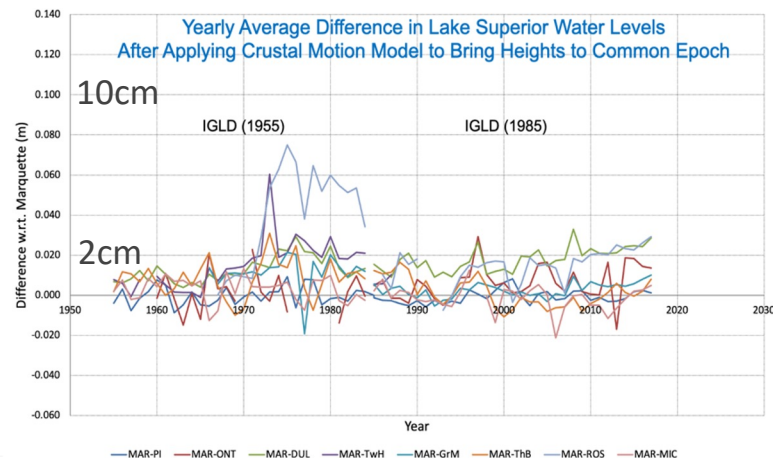
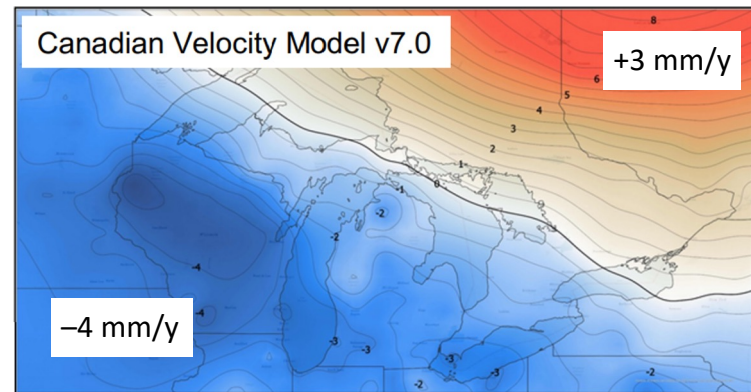


Expected IGLD (1985) - IGLD (2020) Difference



“Dynamic” Nature of IGLD (2020)

- IGLD (2020) will be a time-dependent “dynamic” datum
- Heights will be changing in time due to crustal motion
- Heights can be propagated to any epoch using a crustal velocity model
 - Velocity model will be provided by CGS & NGS
 - Expected to be incorporated into commercial software (e.g., ArcGIS)
 - Preparing guidelines to correct for motions when determining heights of water levels
 - [Example of correcting water level data](#) →



Determining Heights in IGLD (2020)

- Primary access to the new datum will be by GNSS

- GNSS = Global Navigation Satellite Systems such as GPS (US) and systems from other countries
- Provides very high accuracy positioning, especially over long distances
- Provides more accurate & more direct ties to the geoid-based datum
- Local leveling around each gauge will still be required

- Online GNSS data processing tools are provided by both geodetic agencies

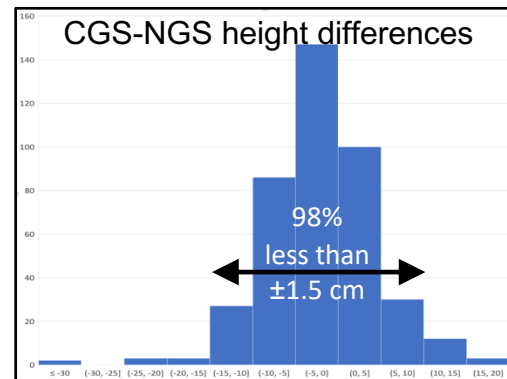
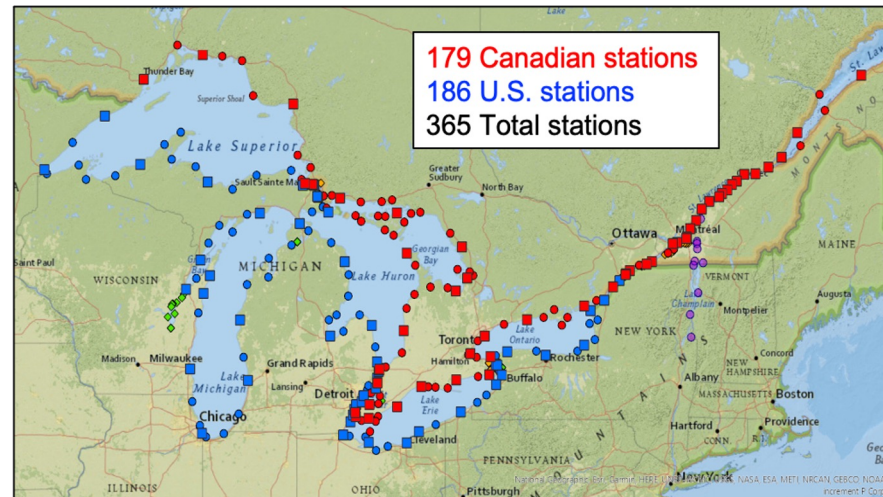
- CSRS-PPP (CGS)
- OPUS-Projects (NGS)



GNSS Setup at Blue Water Bridge, Upper St. Clair River

Moving Water Level Gauges to IGLD (2020)

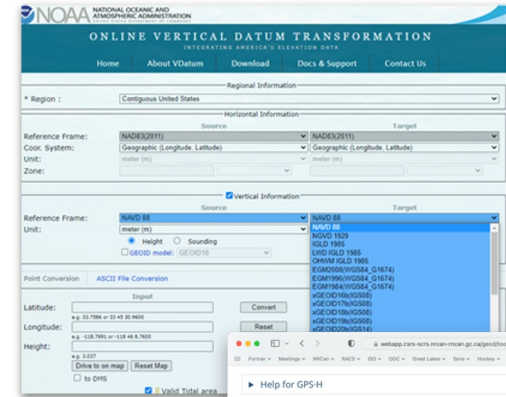
- Need to conduct GNSS surveys at all the water level gauges
- GPS surveys in 1997, 2005, 2010, 2015 at CHS & NOAA permanent gauges
- Major GNSS survey in 2022 included:
 - Permanent gauges (CHS, ECCC, NOAA, USACE, USGS, Seaway, NYPA, OPG)
 - Seasonal gauges for determination of hydraulic correctors
- GNSS processing completed
 - CGS & NGS processed the data independently with different software but using same standards
 - Results agreed to ± 1.5 cm for 98% of benchmarks



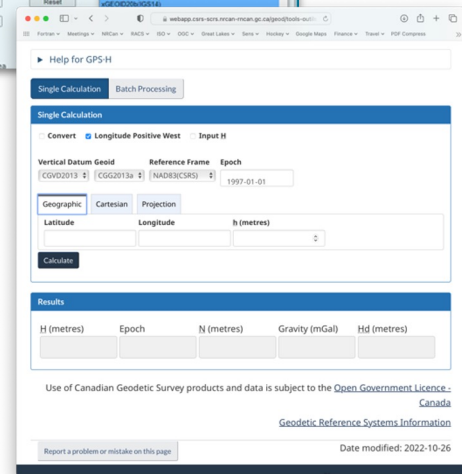
Transformations from Older Datums

- Transformation grids & tools will be needed for moving large data sets from older datums to IGLD (2020)
- Transformation grids & tools will be provided by CGS & NGS
 - GPS-H (CGS)
 - VDatum (NOAA)
- Many commercial GIS developers have also committed to incorporating transformations into their GIS software

VDatum



GPS-H



Remaining Tasks



- ☐ Perform **2026 GNSS survey** to validate heights at permanent gauges
- ☐ Determine **final IGLD (2020) gauge heights**, velocities and crustal motion model
- ☐ Determine **transformations** between IGLD (2020) and other datums, including IGLD (1985)
- ☐ Update **water level gauge histories**
- ☐ Convert **LWD & interconnecting channel step charts** to IGLD (2020)
- ☐ **Expect to publish & adopt IGLD (2020) in 2027**

More Information

<https://www.greatlakescc.org/en/international-great-lakes-datum-update>

Email: info@GreatLakesCC.org



Coordinating Committee on Great Lakes
Basic Hydraulic & Hydrologic Data



Updating the International Great Lakes Datum (IGLD)



Prepared by the
Vertical Control – Water Levels Subcommittee
on behalf of the
Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data

September 2017

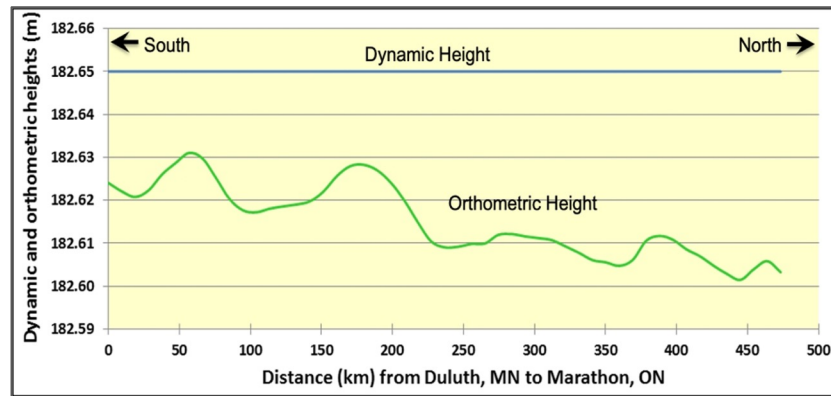
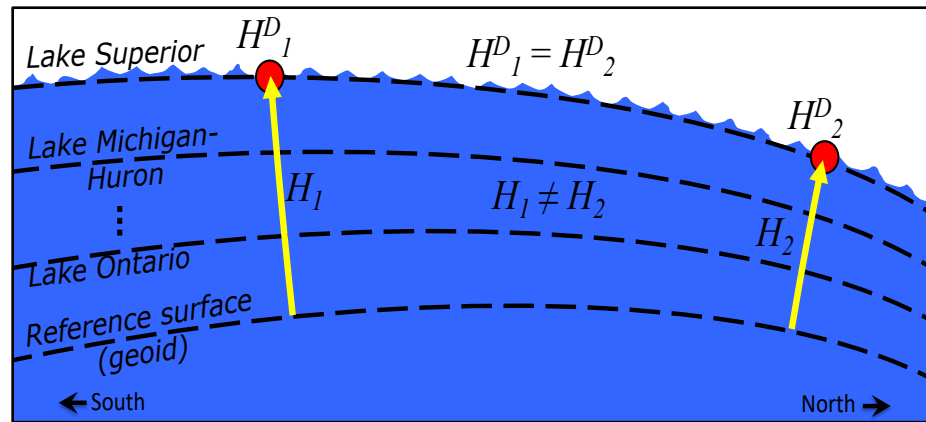
Orthometric vs Dynamic Heights

- Orthometric heights (H)

- Physical distance above reference surface (geoid)
- Most commonly used type of height
- Not constant along an equipotential surface such as a lake

- Dynamic heights (H^D)

- Geopotential numbers scaled by constant value of Normal gravity at 45° latitude
- Constant along an equipotential surface (lake)
- Enables the measurement of hydraulic head for managing water levels & flows



Impacts of Updating IGLD



Commercial and recreational navigation, including charts, ports/harbors



Water level **regulation and forecasting**



Shoreline management and planning, including **flood & erosion prediction and response**, and **shoreline structure design, construction & maintenance**



Legislation may need to be updated to reflect IGLD (2020)



The international **Coordinating Committee is conducting outreach** efforts like this one to inform stakeholders