

International Great Lakes Datum: Possible Impacts and What You Need to Know

Jacob Heck, NOAA National Geodetic Survey

Michael Craymer, Natural Resources Canada

Terese Herron, Canadian Hydrographic Service

Laura Rear McLaughlin, NOAA Center for Operational
Oceanographic Products & Services



Overview of IGLD

- International Great Lakes Datum (IGLD) is a common height reference system by which water levels can be measured and meaningfully related to each other
- 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 the Governments of Canada and the United States
- IGLD is updated every 25-35 years due to Glacial Isostatic Adjustment (GIA)
- The next update will be IGLD (2020), expected for release around 2027

Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data



- Formed in 1953
- Ad hoc group of federal experts
- Four subcommittees
 - Hydraulics
 - Hydrology
 - Coordinated Regulation and Routing Model
 - **Vertical Control - Water Levels**
 - Update and revise IGLD
 - Standardize water level data processing



Environment and
Climate Change Canada
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Changement climatique Canada



Fisheries and Oceans
Canada
Pêches et Océans
Canada

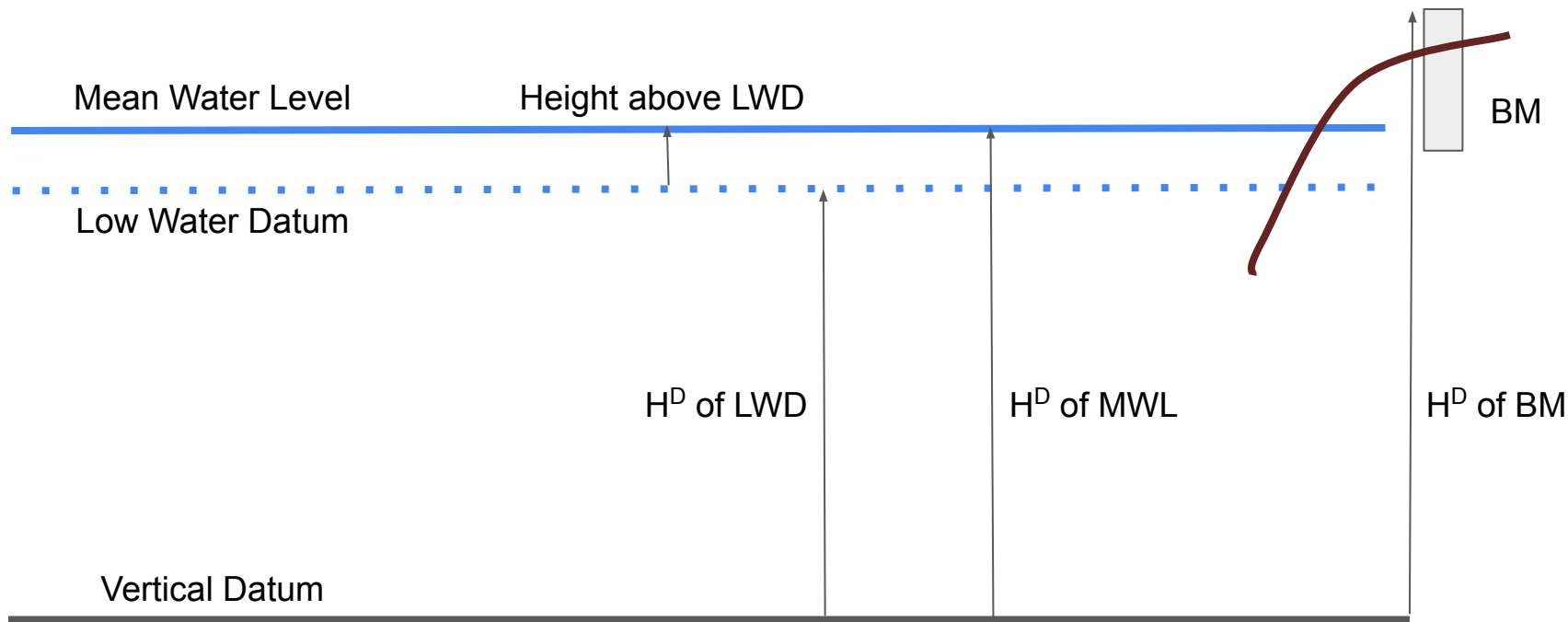


Natural Resources
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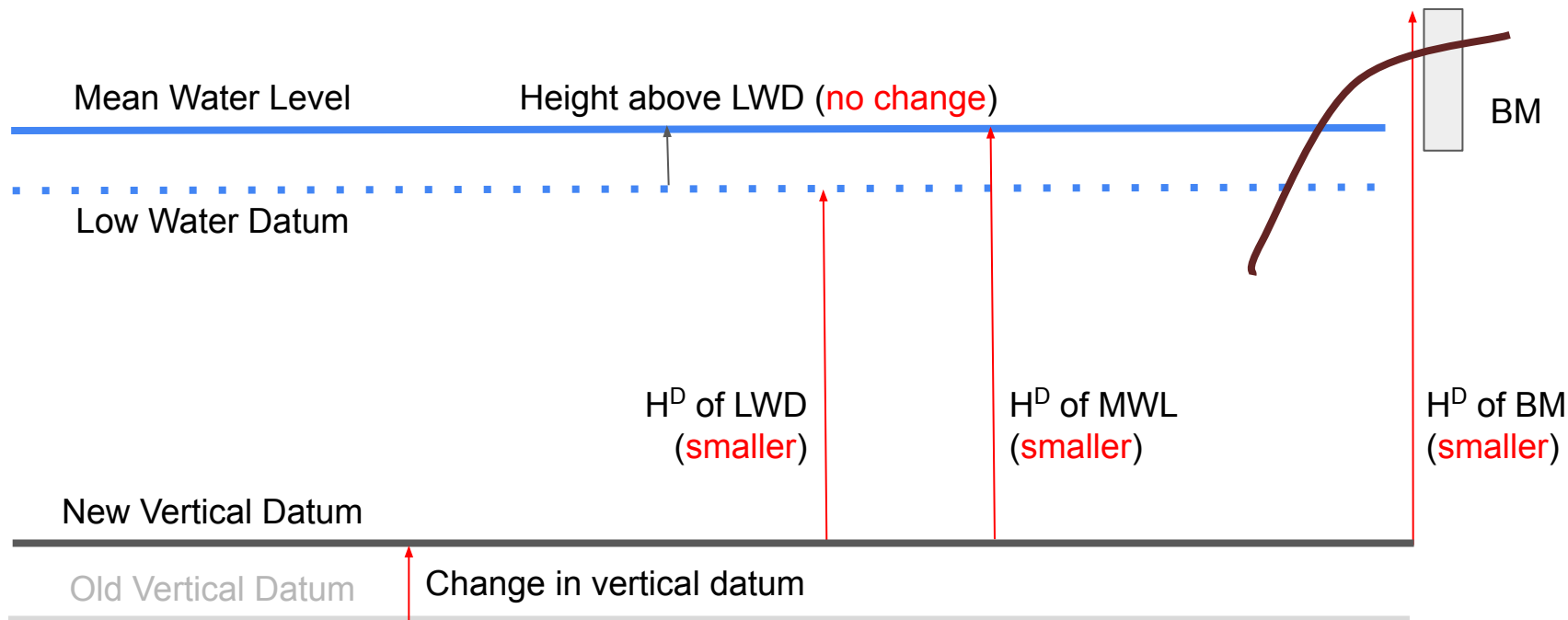


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Change of Vertical Datum

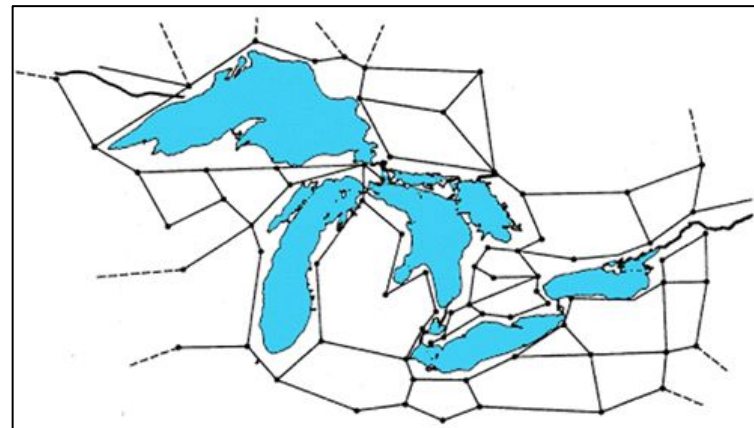


Change of Vertical Datum



Current IGLD

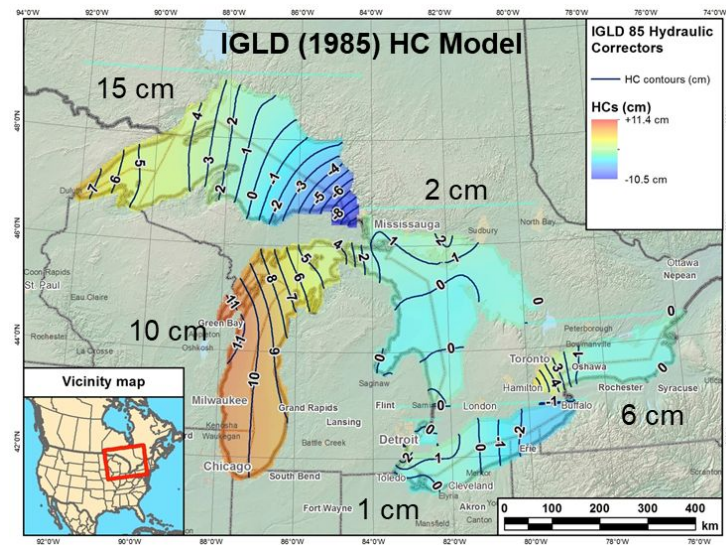
- IGLD (1985) replaced IGLD (1955) in 1992
- Same reference zero as NAVD 88 (mean sea level at Pointe au Père & Rimouski, Québec)
- Reference surface determined from leveling
 - Very time consuming & cost prohibitive
 - Datum accessible only where leveling exists (bench marks)
 - Affected by systematic errors in the leveling
- Uses dynamic heights
- Hydraulic correctors applied to water levels of the lakes to account for hydraulic effects



NAVD88 Network Level Loops

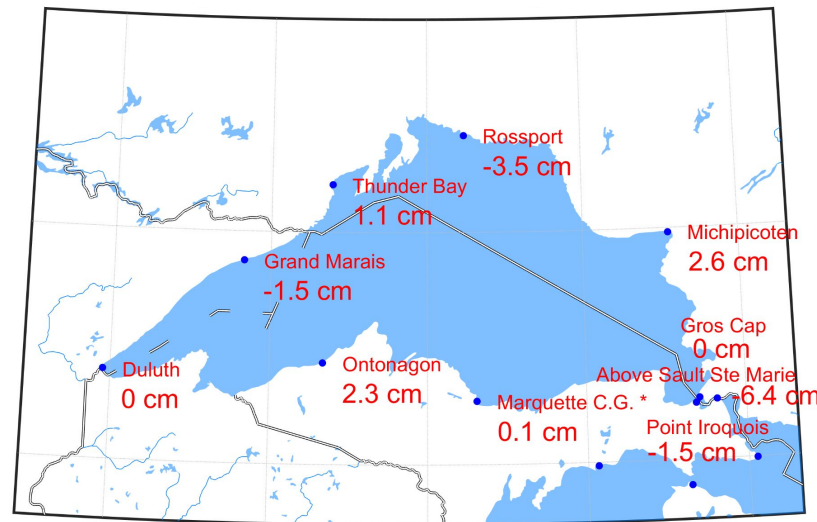
Hydraulic Correctors

- Dynamic heights should be the same at all gauges on a level lake
- In reality this is not the case because of
 - Currents, river discharge, temperature/density variations, prevailing winds, outlet drawdown
 - Creates a lake surface “topography”
 - IGLD (1985) also affected by systematic errors in leveling
- Hydraulic correctors (HCs) adjust the dynamic height at each gauge to agree with a single “master” gauge on each lake
- Effectively removes the lake topography
- Used only for heights of water levels



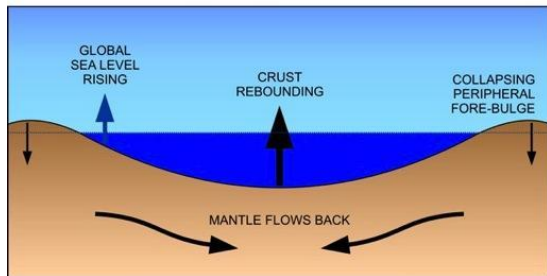
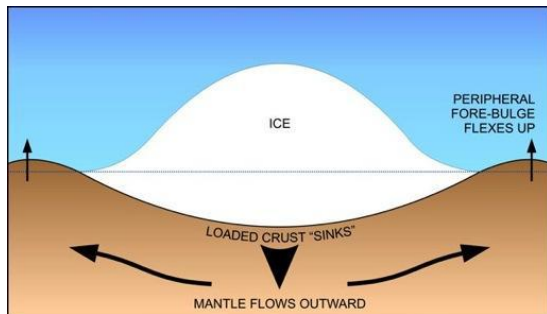
Hydraulic Correctors

- Hydraulic correctors for IGLD (1985)
 - Dominated by errors in leveling around each lake
 - Effectively correcting for those errors as well as lake topography
- Hydraulic correctors for IGLD (2020)
 - Will represent true lake topography
 - Recent analyses have shown the corrections are much smaller than for IGLD (1985)
 - The map on the right show **preliminary** estimates for Lake Superior indicating values about an order of magnitude smaller than for IGLD (1985)

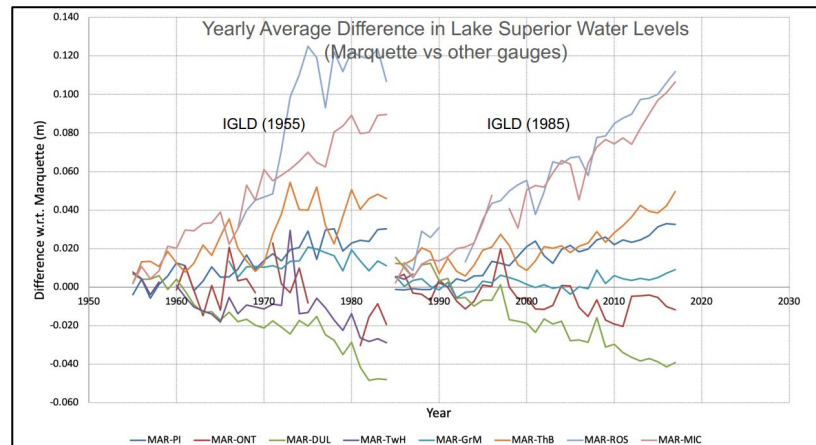
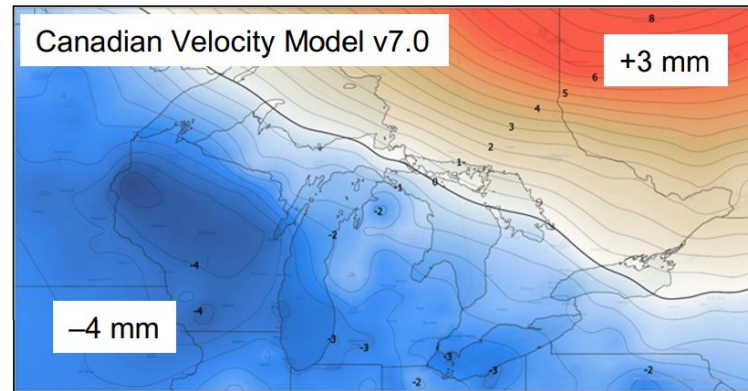


Why a new IGLD?

- *Uplifting in north subsiding in south*
- *Overall tilting ~ 7 mm/year (21cm or 0.7' over 30 year)*
- *Need to update IGLD every 25-30 years*

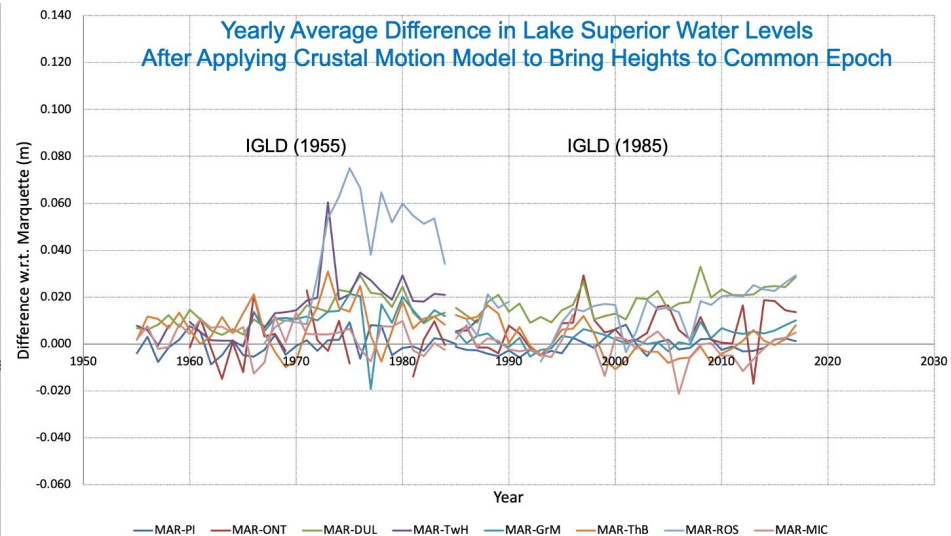
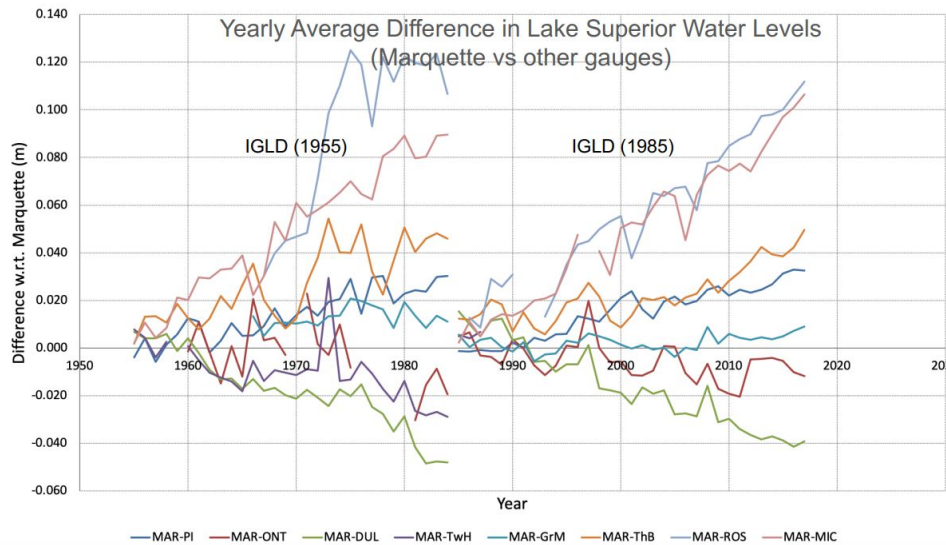


Process of glacial isostatic adjustment



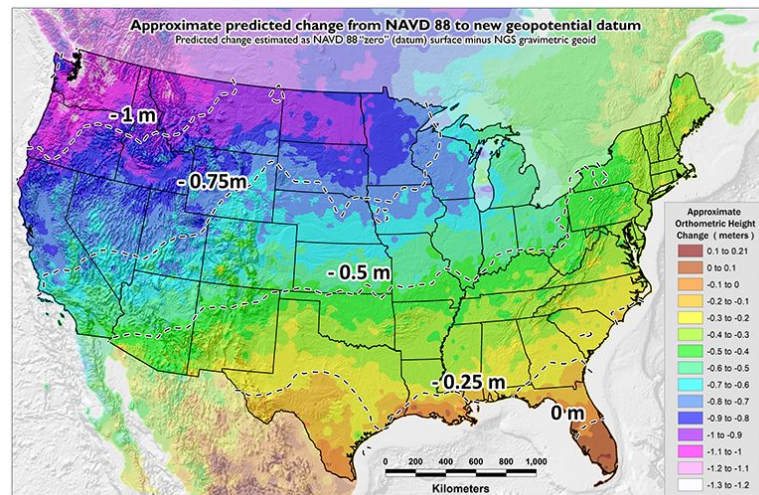
Effect of GIA on Water Level Measurements

Water Level Measurements Corrected for GIA



North American-Pacific Geopotential Datum of 2022

- NAVD 88 is being replaced by NAPGD2022
- Based on a geoid model
 - Geoid defined by gravity data
 - Not dependent on expensive leveling
 - Defined everywhere
 - Height determined via GNSS (more efficient) and references to the NATRF2022 ellipsoid
 - Local leveling will still be needed
- Time-dependent
 - Coordinates will keep up with physical changes
- Compatible with CGVD2013
 - Using identical reference zero
 - Canada expected to adopt the new geoid model
 - Will harmonize national vertical datums for IJC's International Watersheds Initiative
- IGLD (2020) will be based on NAPGD2022



IGLD (2020) Defining Attributes

● Reference Zero

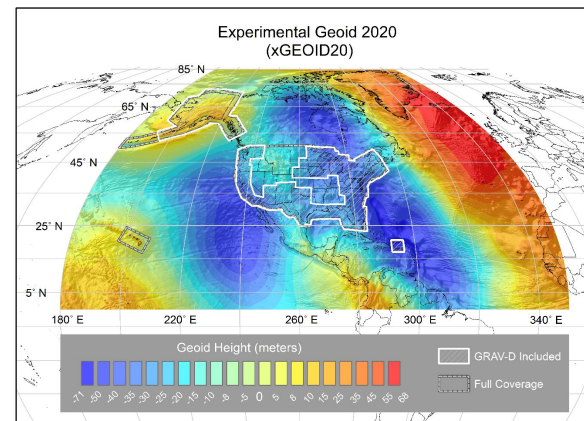
- A geopotential value representing mean sea level around the coast of North America
- Same value as geoid-based North American-Pacific Geopotential Datum of 2022 (NAPGD2022) and the geoid-based Canadian Geodetic Vertical Datum of 2013 (CGVD2013)

● Reference Surface

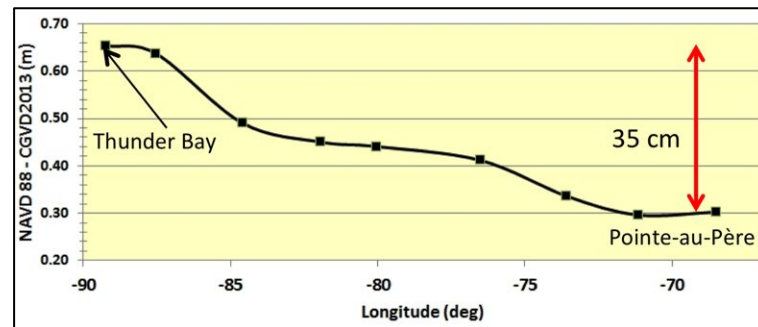
- NAPGD2022 geoid model representing the reference zero
- Defined everywhere over the Great Lakes – St. Lawrence River system, not only where leveling and bench marks exist

● Reference Epoch

- 2020.0 is the reference epoch for the heights
- Same as the central epoch of the 7-year water level observation period of 2017–2023

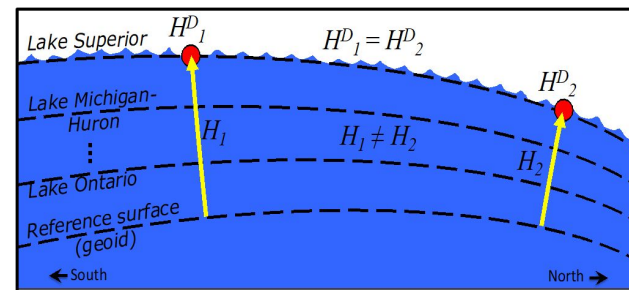


Expected IGLD (1985) - IGLD (2020)

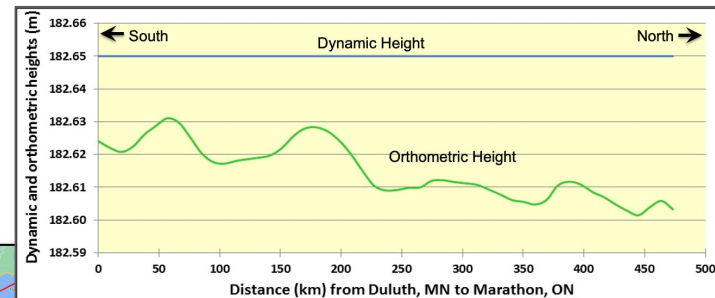


IGLD (2020) Attribute: Dynamic Heights

- Orthometric heights (H)
 - Typical heights used in most applications
 - Physical distance above reference surface (geoid)
 - Not constant along a level surface (like a lake) because equipotential convergence as you go north
 - Geopotential numbers scaled by local gravity
- Dynamic heights (H^D)
 - Geopotential numbers scaled by a constant gravity value
 - Constant along a level (lake) surface by definition
 - Enables the measurement of hydraulic head for water level management
 - Used by all IGLD realizations



Dynamic heights, H^D , and orthometric heights, H .



Determining Heights via GNSS

- ***Primary access to the datum will be via GNSS***

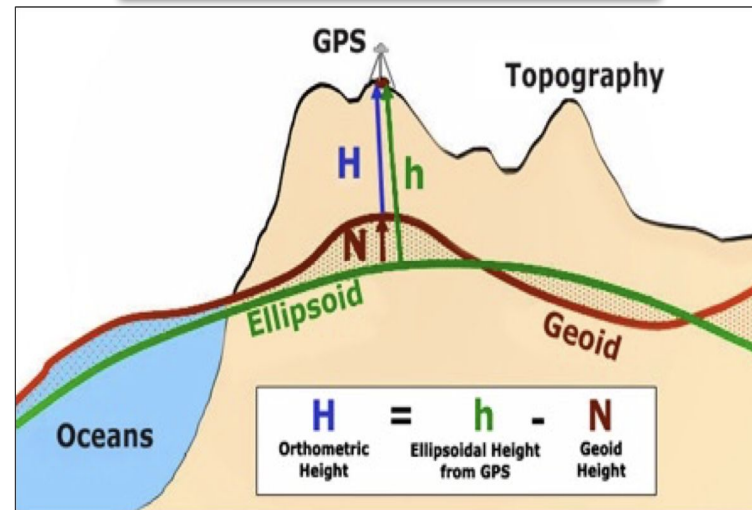
h = ellipsoidal height obtained from GNSS

N = geoid height obtained from geoid model
(provided by CGS & NGS)

H = Orthometric height

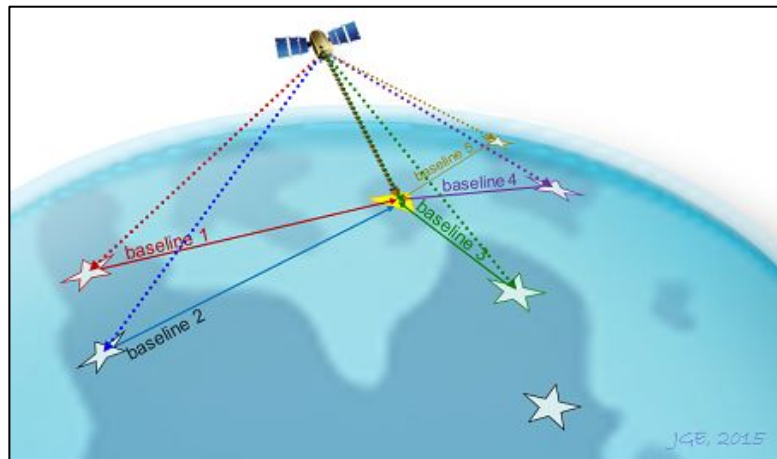
h & N must be referenced to the same reference ellipsoid (NAD83/2011)

- Online conversion tools provided by CGS & NGS
- Local leveling will still be required



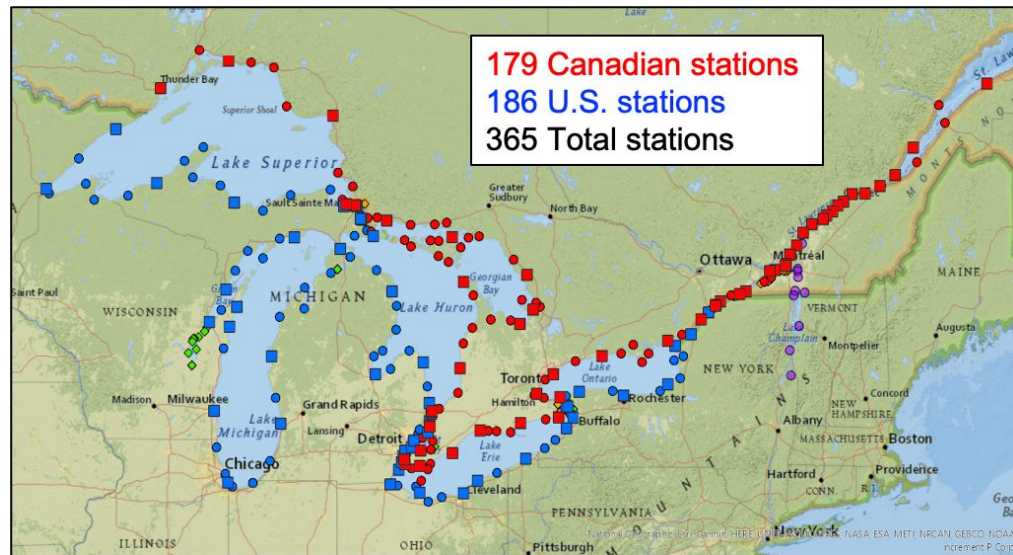
GNSS Processing Tools

- Free online GNSS processing services
 - NRCan's CSRS-PPP (precise point positioning service) — used world-wide — reference frame defined by precise orbits
 - NGS's OPUS traditional baseline processing service — uses data from nearby permanent GNSS stations (CORS) to tie to geometric reference frame (NAD83 or NATRF2022)
 - Online tools to be provided by NRCan & NGS for converting from GNSS ellipsoidal heights to IGLD (2020) dynamic heights
- Receiver manufacturers' processing software



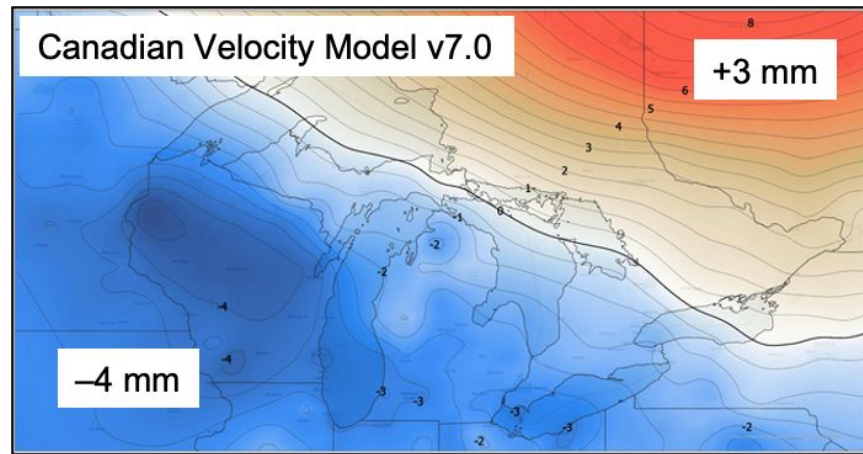
Moving Water Level Gauges to IGLD (2020)

- Need to determine IGLD (2020) heights for all water level gauges/benchmarks
- Previous GPS surveys in 1997, 2005, 2010, 2015
- 2022 GNSS survey completed and expanded to include:
 - Permanent gauges (CHS, ECCC, NOAA, USACE, USGS, Seaway, NYPA, OPG)
 - Seasonal gauges for determination of hydraulic correctors
- Presently processing data



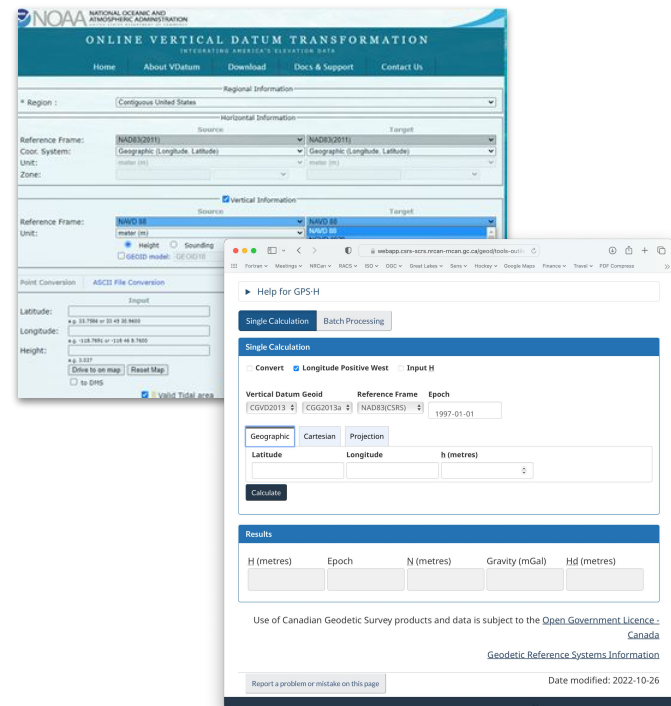
“Dynamic” Nature of IGLD (2020)

- IGLD (2020) & NAPGD2022 are time-dependent (dynamic) datums
- Heights are changing in time due to regional & local crustal motions
- **A deformation model will be used to propagate heights to a common epoch**
- Estimated from a long history of GNSS positions of CACS & CORS stations
- Used to account for crustal motion by propagating coordinates to a common reference epoch (i.e., 2020.0)
- Deformation models (interpolation grids) Will be provided by CGS & NGS
- Expected to be also incorporated into commercial software (e.g., ArcGIS)



Transformations from Older Datums

- Transformation grids & tools will be provided by CGS & NGS to enable moving large data sets from older datums to IGLD (2020)
- Will use a common (binational) grid format based on international standards
- GPS-H (Canada) & VDatum (US) transformation tools
 - GNSS ellipsoidal heights to orthometric & dynamic heights
 - Transform heights between datums
 - Supports batch processing of stations
 - Desktop applications available
 - REST APIs available

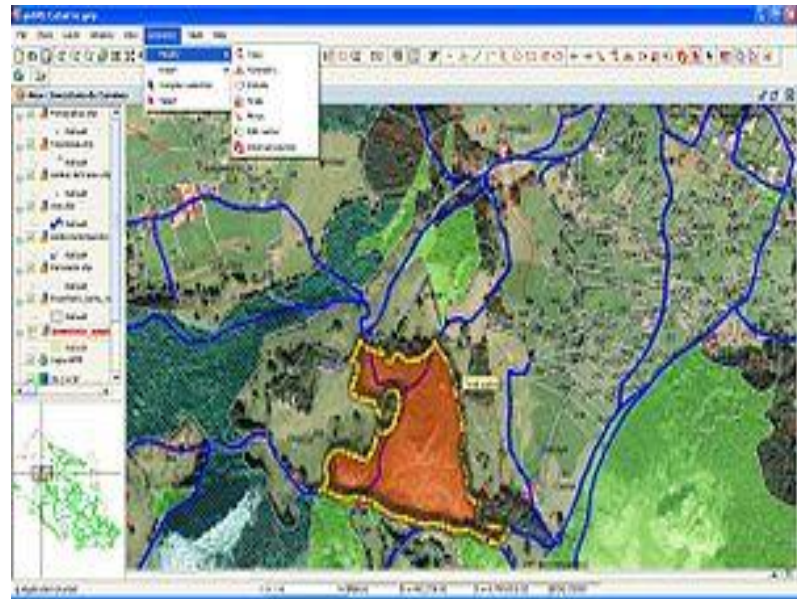


Commercial GIS Tools

Transformation grids are expected to be implemented in many GIS software. CGS & NGS are working with software developers to ensure they have what they need.

Geospatial Software Developers Summit

- Hosted by CGS & NGS, Nov 30 – Dec 1, 2022
- 19 federal & provincial government participants
- 17 participants from 13 software companies
- Commercial & open source software represented
- Most developers committed to having transformation tools ready by 2025
- Alpha & Beta products to be provided by CGS & NGS to help developers prepare



Impacts of Updating IGLD

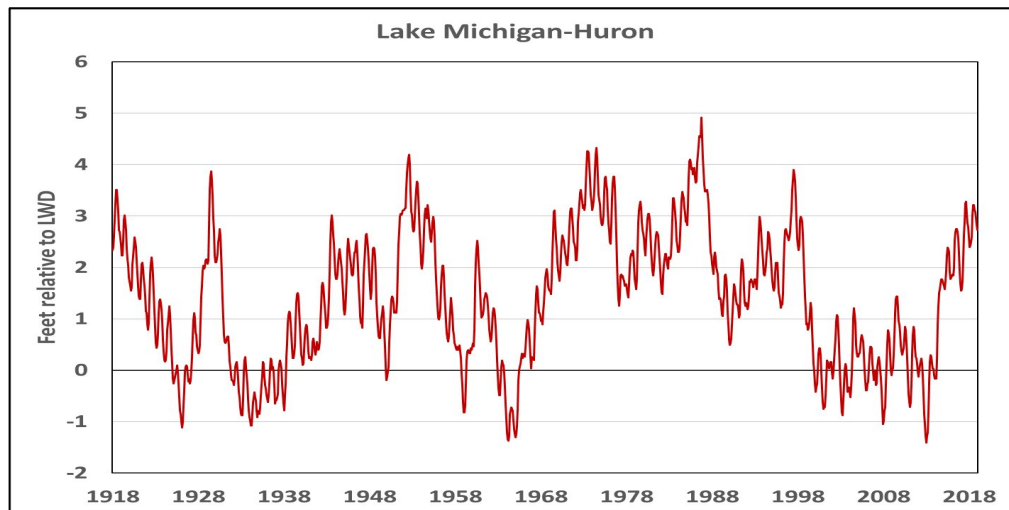
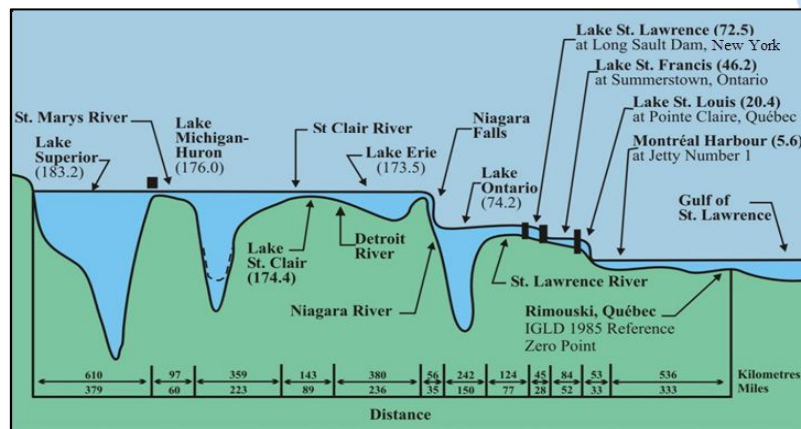
Updating water levels to a new IGLD will have significant impacts on many operations, products and services in the Great Lakes region

- Economic viability and safety of commercial and recreational navigation, including charts, ports/harbors and dredging of navigation channels
- Water level regulation and forecasting
- Coastal zone management and planning, including flood & erosion prediction and response, and coastal structure design, construction & maintenance
- Coastal habitat restoration under the Great Lakes Restoration Initiative (GLRI)
- Legislation may need to be updated to reflect IGLD (2020)

The Coordinating Committee is conducting outreach efforts like this one to inform and get feedback from stakeholders

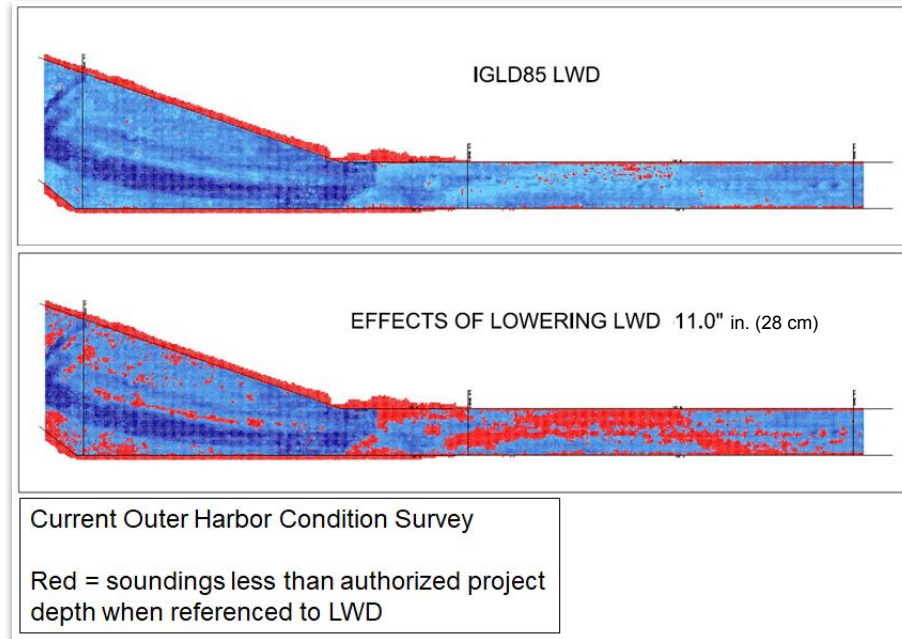
Low Water Datum (LWD)

- LWD (aka Chart Datum) is the navigational chart datum, one for each of the Great Lakes and Lake St. Clair
- Depths for harbor improvement authorizations are also referred to LWD
- Current LWD was established using pre-1930s data
- Water diversions, channel modification and erosion, outflow regulations, and climate change effects may all have changed current low water datum levels
- Reviewing in conjunction with the IGLD 2020 update



Impacts of the Low Water Datum Change

- Additional dredging to maintain new depths at significant costs
- A new LWD would require changes to all navigational charts for the Great Lakes and the connecting channels
- Additional dredging and changes to navigation charts, documentation, and legislation would be very costly



Lake Superior

Status of IGLD Update

- Data processing of 2022 IGLD survey campaign underway
- Seasonal gauging continuing in Canada until 2024 - completed in U.S.
- Need for hydraulic correctors in IGLD (2020) being investigating
- NAPGD2022 on track for release in 2025 - basis for IGLD (2020)
- IGLD (2020) is planned for release in 2027 - dependent on NAPGD2022
- Discussing the impact of updating Low Water Datum with stakeholders

Impacts of Updating IGLD in Michigan

- Need to update heights at state harbors
- Height associated with Ordinary High-Water Mark
- Legislative impacts (Act 451 of 1994, others?)
- Example: State Plane Coordinate System
 - NOAA-NGS partnered with NSPS to draft model law that states can use to update state plane coordinate systems

NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION ACT (EXCERPT)

Act 451 of 1994

Part 325

GREAT LAKES SUBMERGED LANDS

Part 339, Sec. 33911: “(3) A deed granted under this part shall not include a portion of the original lease that is submerged or lies below the elevation of 575.3 International Great Lakes Datum (IGLD 1985).”

MICHIGAN COORDINATE SYSTEMS

Act 9 of 1964

AN ACT to describe, define, and officially adopt certain systems of coordinates for designating the position of points on or near the surface of the earth within this state.

History: 1964, Act 9, Eff. Aug. 28, 1964 ;-- Am. 1988, Act 154, Imd. Eff. June 14, 1988

Template Draft NSRS Legislation

(updated October 16, 2019)

How to use this template:

- 1) Whenever the word “state” is used below, it should be taken to mean “state or territory”
- 2) The intent of this template is to augment, not fully replace, existing state laws dealing with a state-specific coordinate system and its relationship to existing or prior datums of the National Spatial Reference System (NSRS).

Resources



IGLD

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

[Email: info@GreatLakesCC.org](mailto:info@GreatLakesCC.org)

NATRF2022 & NAPGD2022

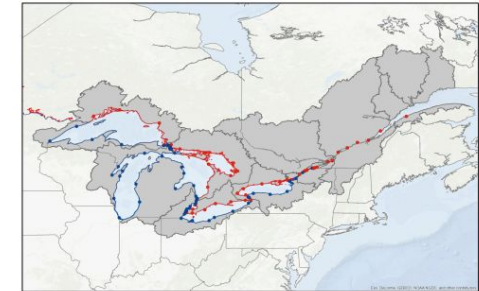
<https://geodesy.noaa.gov/datums/newdatums/index.shtml>



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

Questions?

Dr. Jacob Heck, NOAA NGS

jacob.heck@noaa.gov

Dr. Michael Craymer, NRCan

Michael.Craymer@nrcan-rncan.gc.ca

Laura Rear McLaughlin, NOAA CO-OPS

laura.rear.mclaughlin@noaa.gov

Terese Herron, CHS

Terese.Herron@dfo-mpo.gc.ca

