Determining Heights in the New IGLD (2020)

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On Behalf of the Vertical Control – Water Levels Subcommittee
Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data

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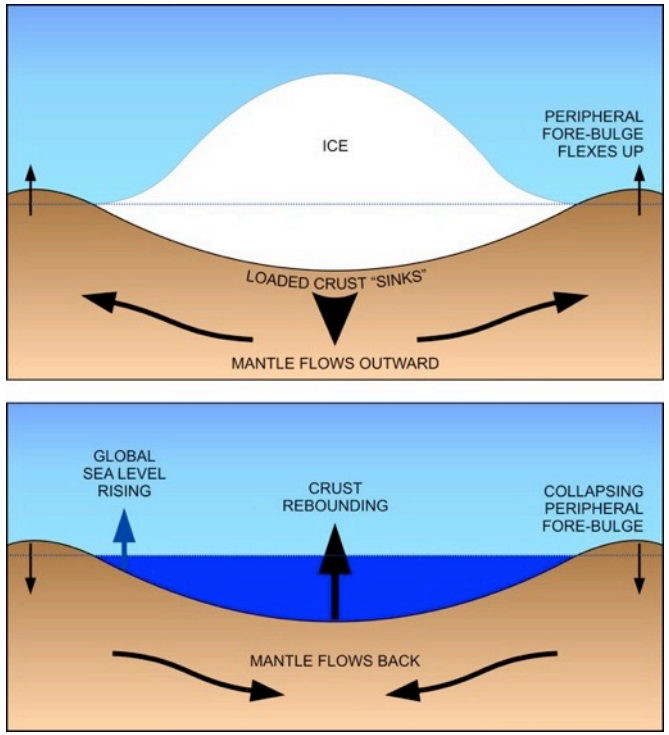
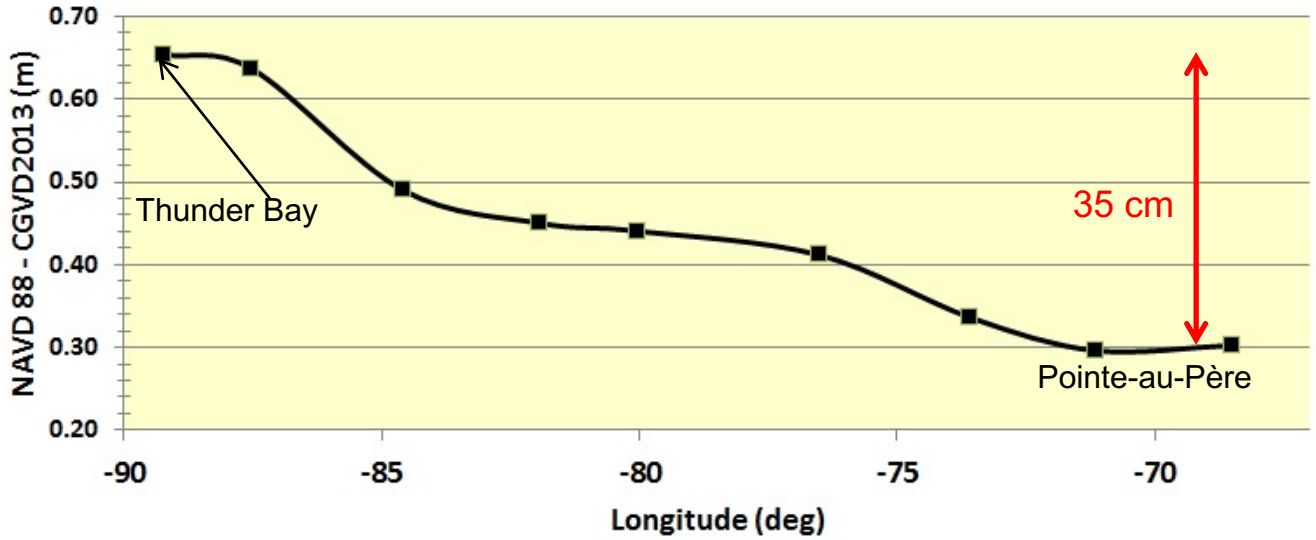
The International Great Lakes Datum

- Official vertical datum used for water level measurements and navigation charts throughout the Great Lakes, their connecting channels and the upper St. Lawrence River
- Defined & maintained by the Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data (CC), a binational committee with representatives from the Governments of Canada and the United States
- Two realizations of IGLD
  - IGLD (1955)
  - IGLD (1985) – current realization based on the NAVD88 datum
  - Both based on expensive, time consuming levelling from MSL at Pointe-au-Père, QC

Need to Update IGLD (1985)

- Effects of glacial isostatic adjustment (GIA)
  - ~7mm/yr tilting of Great Lakes Basin (~21cm in 30 yr)
  - Need to update the IGLD datum every 25-30 years
- Systematic error in NAVD88 levelling
  - ~35 cm accumulation of error





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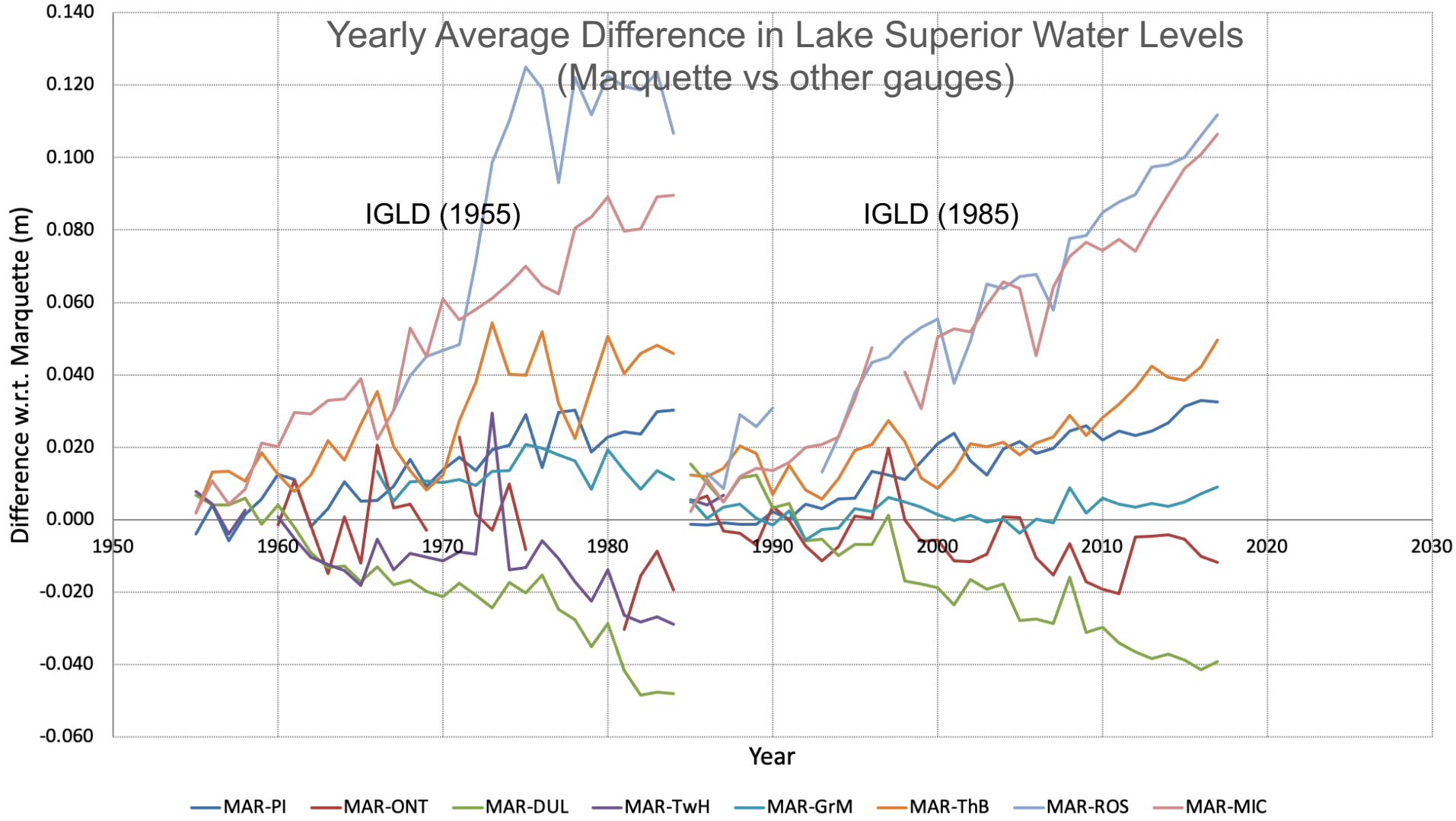
GIA Effect on Water Levels Measurements

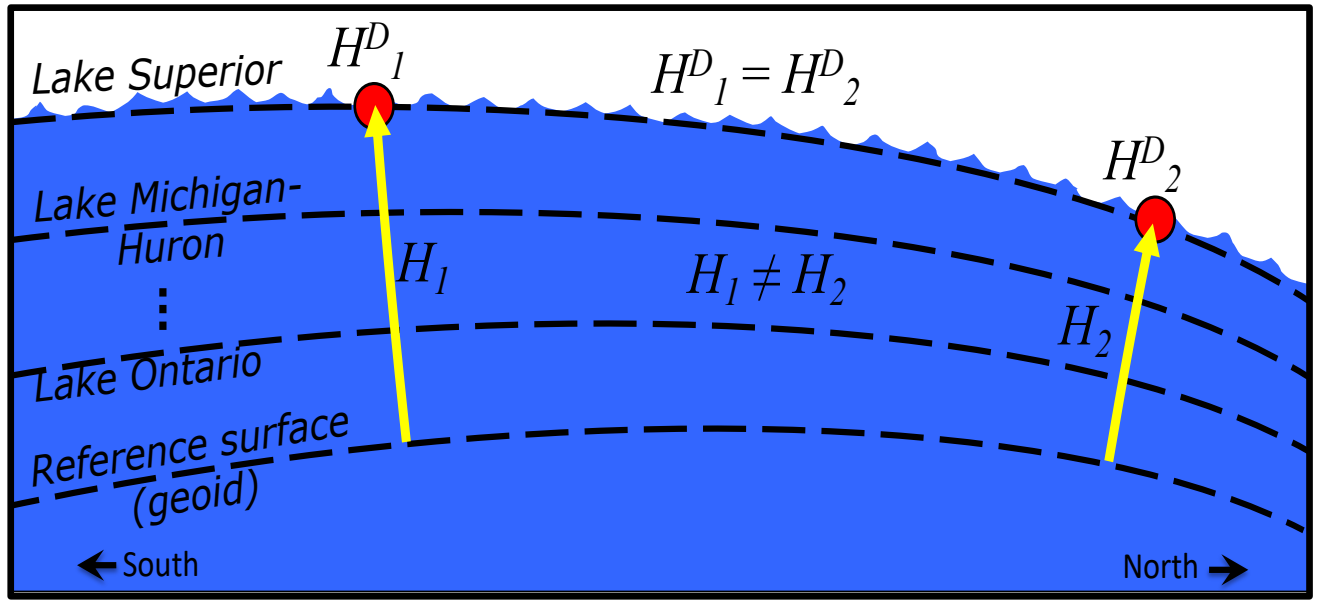


Definition of IGLD (2020)

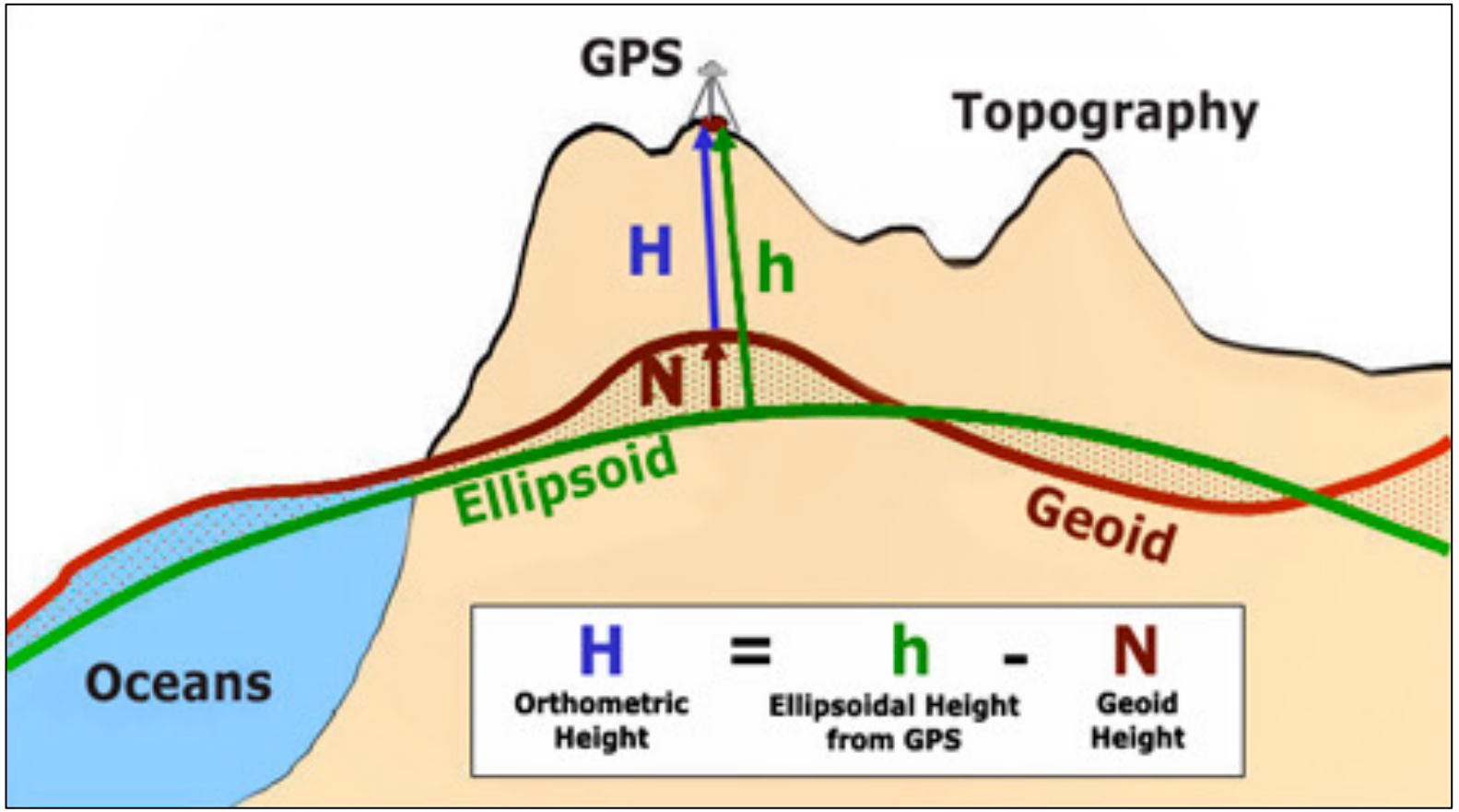
- Reference zero
  - Geopotential value (*Wo*) of MSL around the coasts of North America
  - Same definition as for CGVD2013 and forthcoming NAPGD2022
  - 31 cm above MSL for IGLD (1985)
- Reference surface
  - Equipotential surface to which heights are referenced
  - Extension of reference zero inland
  - IGLD (2020) using the same geoid model as NAPGD2022
  - Unlike levelling, geoid model is defined everywhere
  - Geoid model will be compatible with CGVD2013
- Reference epoch for heights: 2020.0
  - Central epoch of 7 year water level observation period

Dynamic Heights

- Orthometric heights (H)
  - Physical distance above reference surface (geoid)
  - 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 water level management
  - Used by all IGLD realizations



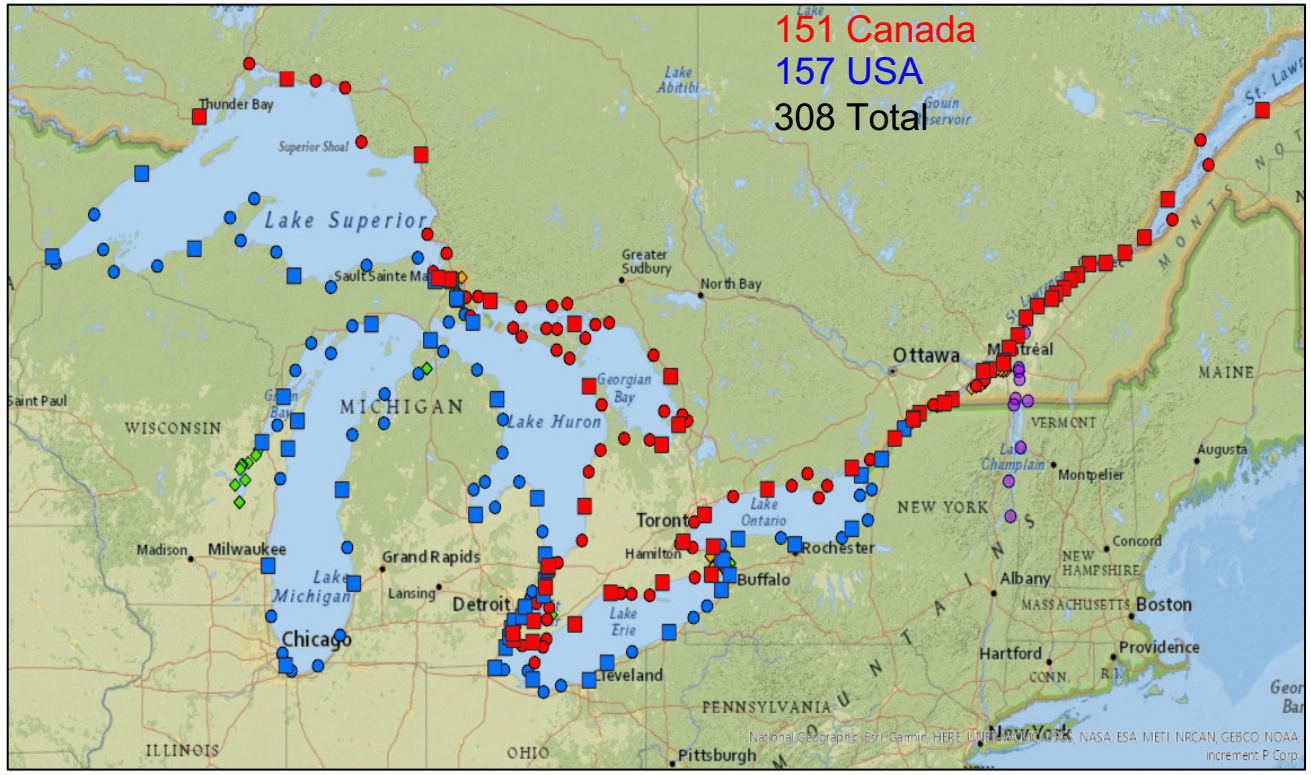
IGLD (2020) Heights from GNSS



- IGLD (2020) heights determined via GNSS
  - Accurate & efficient
- h & N to be referenced to the same NATRF2022 reference ellipsoid
- Dynamic heights are derived from H using a gravity model

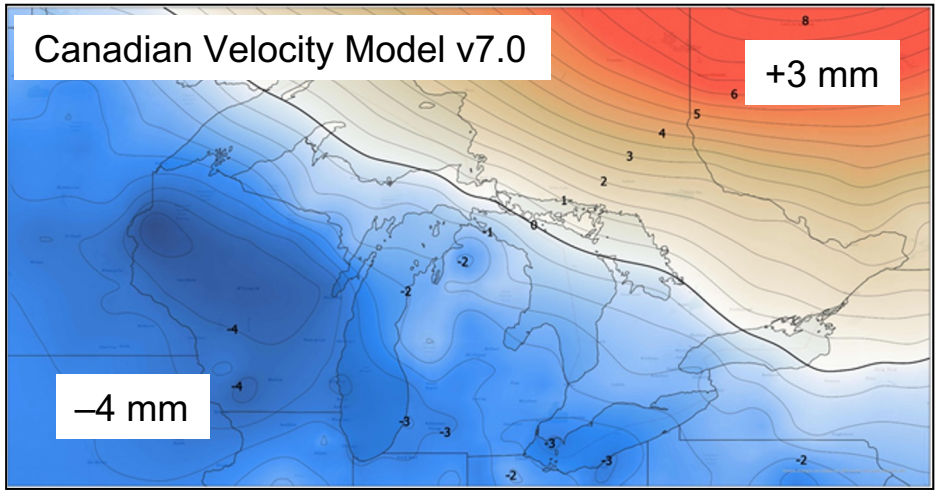
Updating Heights to IGLD (2020)

- GNSS provides the most accurate way to tie to the IGLD (2020) datum
- Planning a high accuracy GNSS survey at Great Lakes water level gauges
  - Schedule for later this summer
  - Occupying 300+ GL gauges
  - Coordinated effort among multiple U.S. and Canadian agencies
  - Led by the geodetic agencies



Dynamic Nature of IGLD (2020)

- IGLD (2020) & NAPGD2022 are dynamic datums
- Heights are changing due to regional & local crustal motions
- A velocity model will be used to propagate heights between epochs
  - Estimated from a long time series of CACS & CORS positions
  - Implemented as an interpolation grid
  - Can be used to account for crustal motion by propagating heights to a common reference epoch
  - Model will be provided by CGS & NGS
  - Expected to be also incorporated into commercial software



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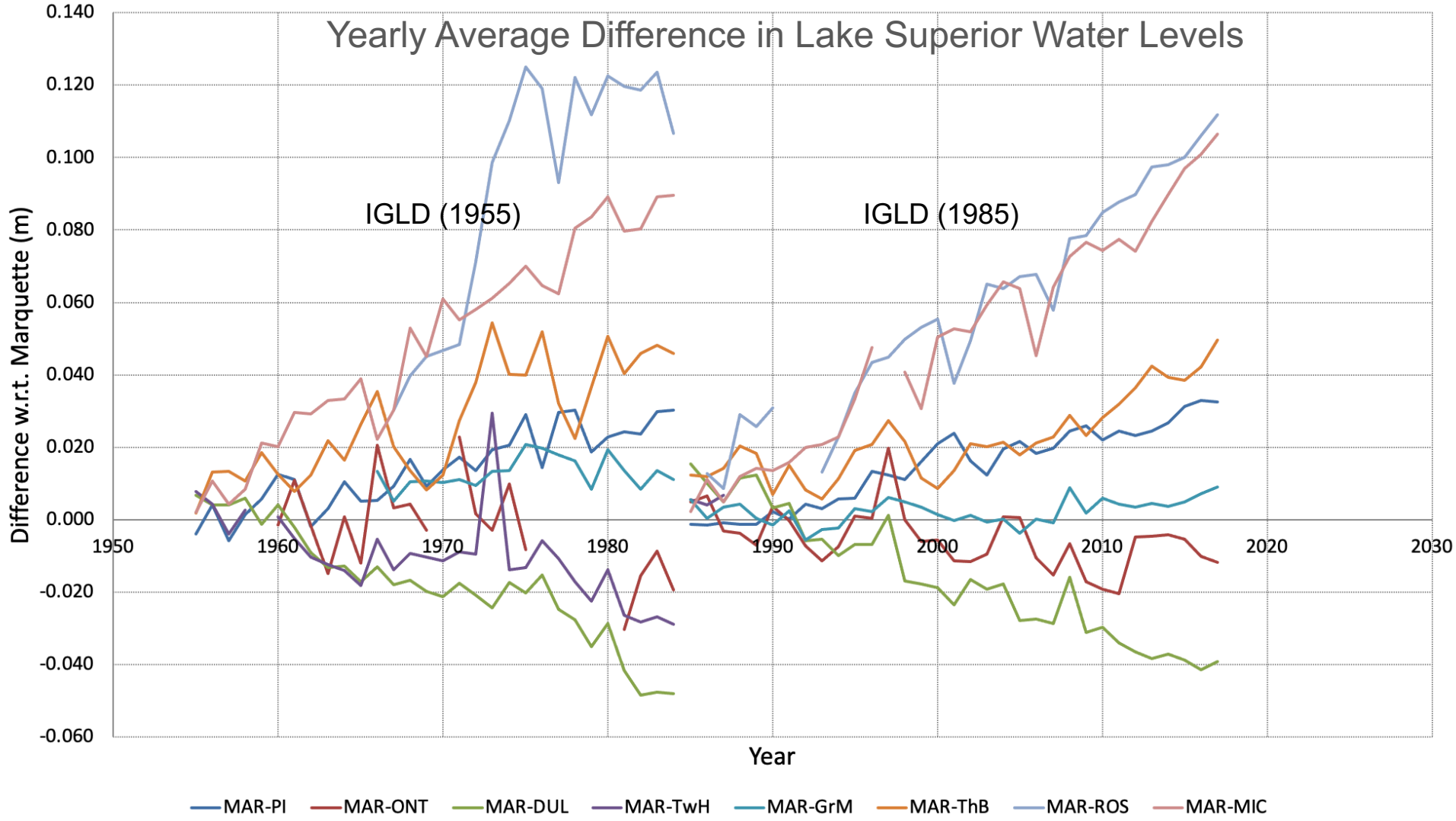
Water Levels Measurements



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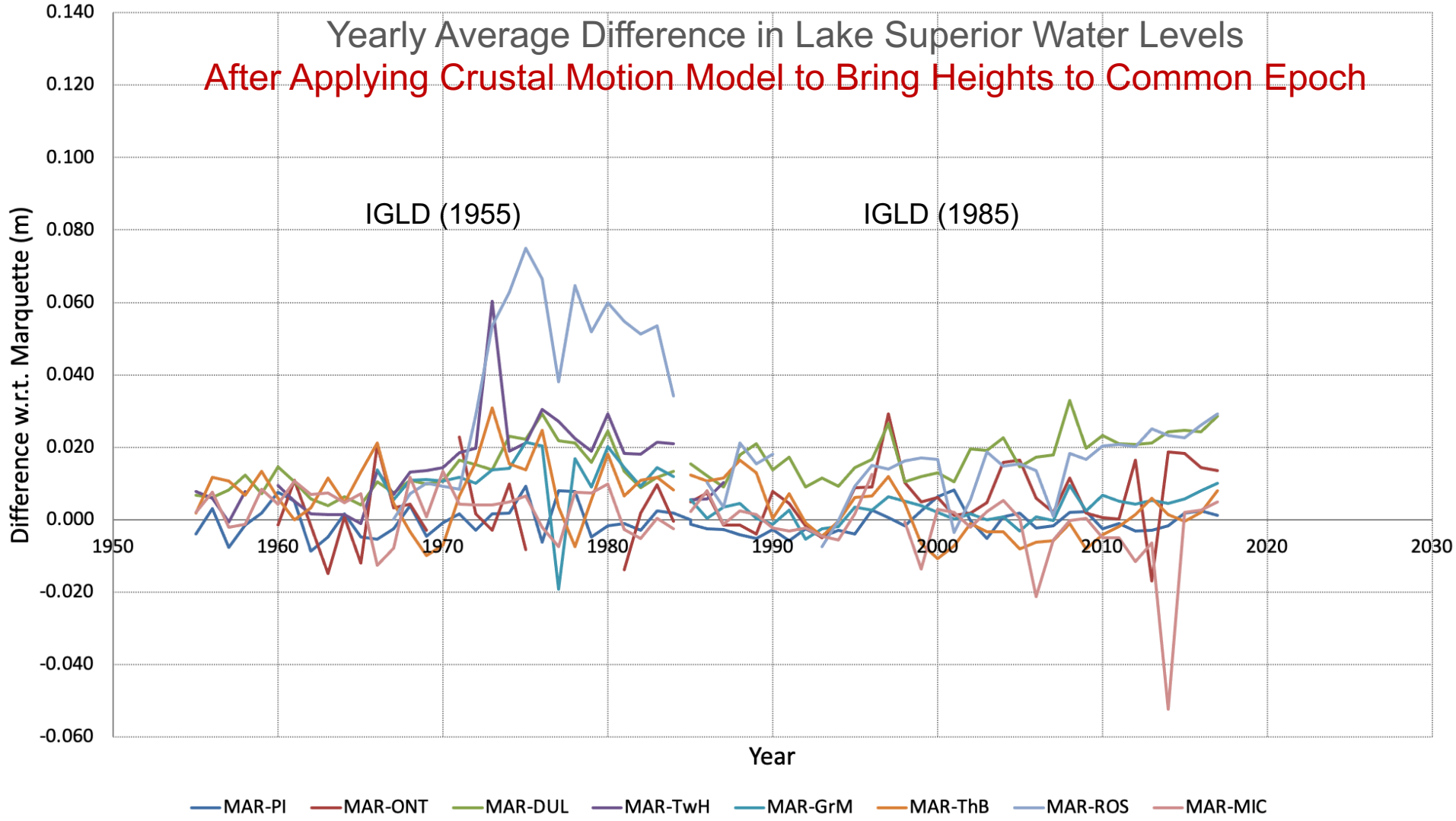
Water Levels Measurements



Transformations & Tools

- Transformations
  - Can be used to convert large amounts of data to IGLD (2020)
  - Transformations will be determined using the 2022 GNSS survey campaign
  - Will have limited accuracy due to uncertainties & biases in old IGLD heights
- Other Tools
  - GNSS processing services (CSRS-PPP & OPUS)
  - Velocity model (TRX & HTDP)
- Commercial software
  - Working with developers to ensure their users have these tools
  - Planning a binational workshop with developers this fall
- Guidelines
  - Will be provided for determining heights in IGLD (2020)
  - Similar procedures as for working in CGVD2013 & NAD3(CSRS)

For More Information

IGLD datums

- Website: https://GreatLakesCC.org/
- Email: info@GreatLakesCC.org

New NAPGD2022 & NATRF2022 datums

- https://geodesy.noaa.gov/datums/newdatums/