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Reference System Modernization in Canada

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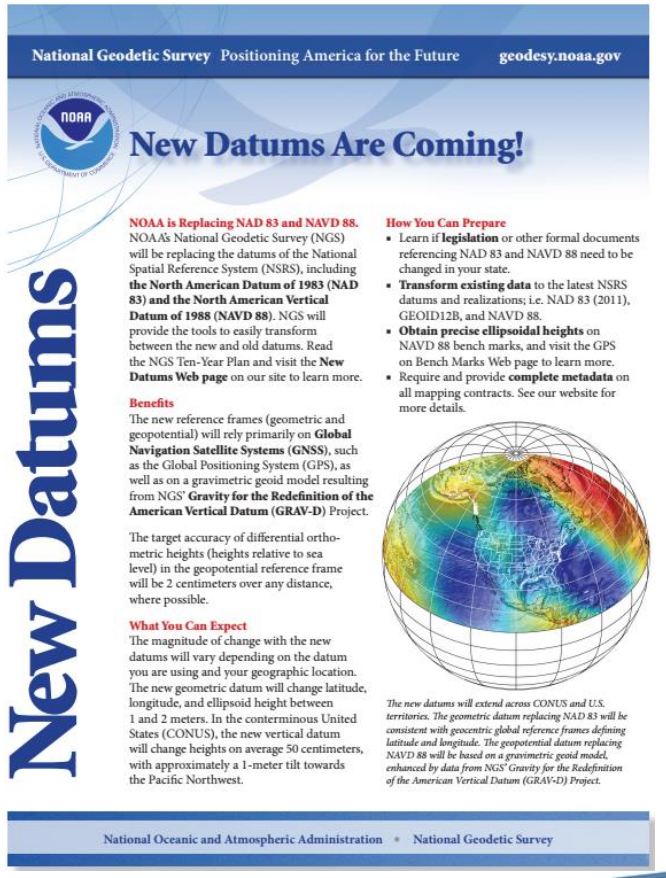
Canada

Outline

- Overview of the Canadian Spatial Reference System (CSRS) modernization
- Practical impacts of the modernized CSRS
- Updates to CSRS products and tools
- Reference system roles and responsibilities in Canada

Canada is planning to modernize their spatial reference system in 2025

- As part of this plan we will replace **NAD83** with a new geometric reference system called the North American Terrestrial Reference Frame of 2022 (**NATRF2022**)
- We will also update our realization of **CGVD2013** with a new North American geoid model (GEOID2022) compatible with **NAPGD2022**
- These modernized systems are being developed as a collaborative effort between the U.S. and Canada



National Geodetic Survey Positioning America for the Future geodesy.noaa.gov

NOAA

New Datums Are Coming!

New Datums

NOAA is Replacing NAD 83 and NAVD 88.
NOAA's National Geodetic Survey (NGS) will be replacing the datums of the National Spatial Reference System (NSRS), including **the North American Datum of 1983 (NAD 83) and the North American Vertical Datum of 1988 (NAVD 88)**. NGS will provide the tools to easily transform between the new and old datums. Read the NGS Ten-Year Plan and visit the **New Datums Web page** on our site to learn more.

Benefits
The new reference frames (geometric and geopotential) will rely primarily on **Global Navigation Satellite Systems (GNSS)**, such as the Global Positioning System (GPS), as well as on a gravimetric geoid model resulting from NGS' **Gravity for the Redefinition of the American Vertical Datum (GRAV-D)** Project.

The target accuracy of differential orthometric heights (heights relative to sea level) in the geopotential reference frame will be 2 centimeters over any distance, where possible.

What You Can Expect
The magnitude of change with the new datums will vary depending on the datum you are using and your geographic location. The new geometric datum will change latitude, longitude, and ellipsoid height between 1 and 2 meters. In the conterminous United States (CONUS), the new vertical datum will change heights on average 50 centimeters, with approximately a 1-meter tilt towards the Pacific Northwest.

How You Can Prepare
- Learn if **legislation** or other formal documents referencing NAD 83 and NAVD 88 need to be changed in your state.
- **Transform existing data** to the latest NSRS datums and realizations; i.e. NAD 83 (2011), GEOID12B, and NAVD 88.
- **Obtain precise ellipsoidal heights** on NAVD 88 bench marks, and visit the GPS on Bench Marks Web page to learn more.
- Require and provide **complete metadata** on all mapping contracts. See our website for more details.

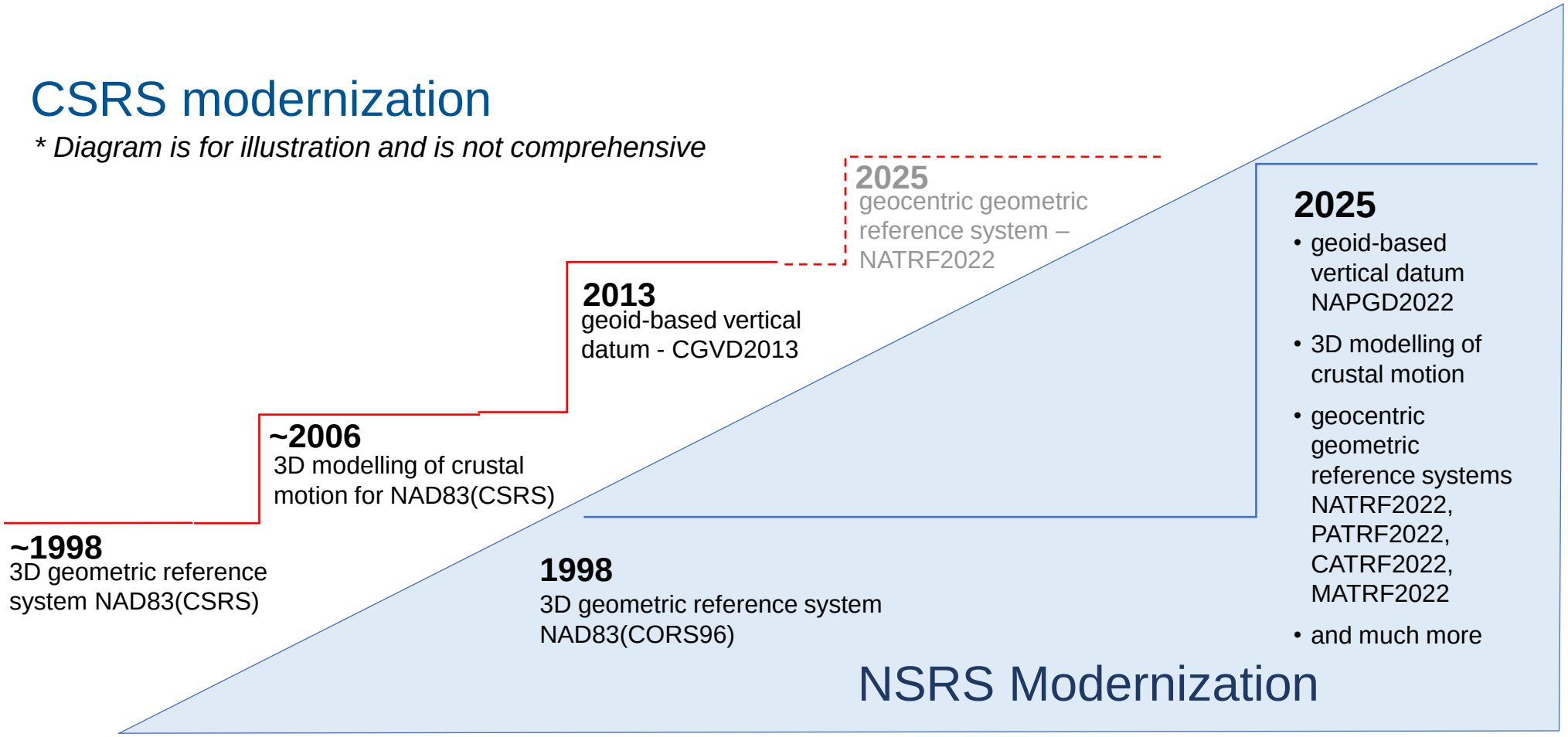
The new datums will extend across CONUS and U.S. territories. The geometric datum replacing NAD 83 will be consistent with geocentric global reference frames defining latitude and longitude. The geopotential datum replacing NAVD 88 will be based on a gravimetric geoid model, enhanced by data from NGS' Gravity for the Redefinition of the American Vertical Datum (GRAV-D) Project.

National Oceanic and Atmospheric Administration • National Geodetic Survey

Canada has been modernizing in steps

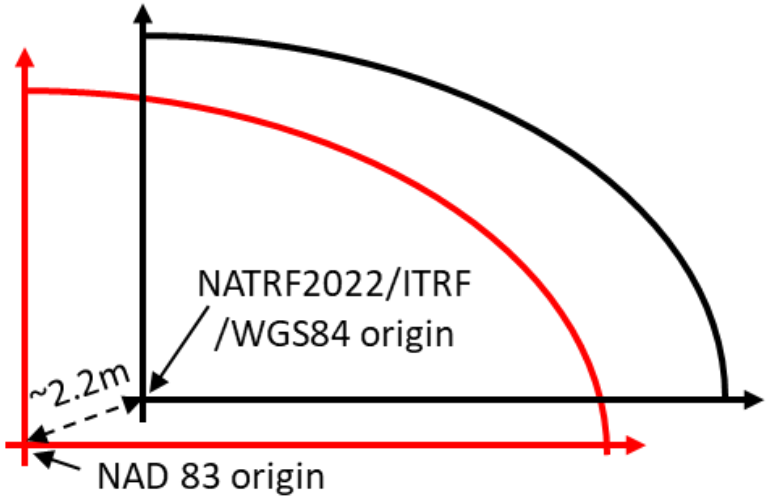
CSRS modernization

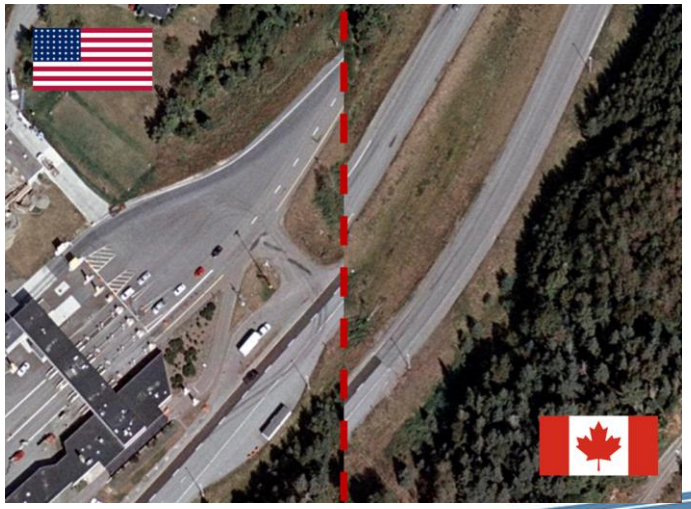
** Diagram is for illustration and is not comprehensive*



Rationale for CSRS modernization

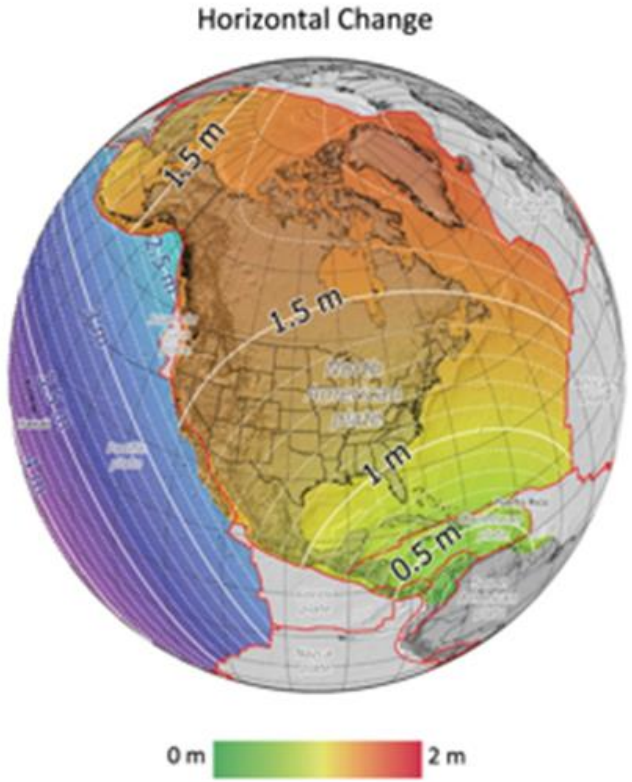
- NAD83 is not a geocentric system as the origin is off by about 2.2m
  - GNSS systems (e.g., GPS) and the ITRF are geocentric
- NATRF2022 better supports precise positioning from space (GNSS)
- Supports compatibility along the Canada / U.S. border and with international standards
- CSRS modernization also provides an opportunity to unify reference system adoption across Canada





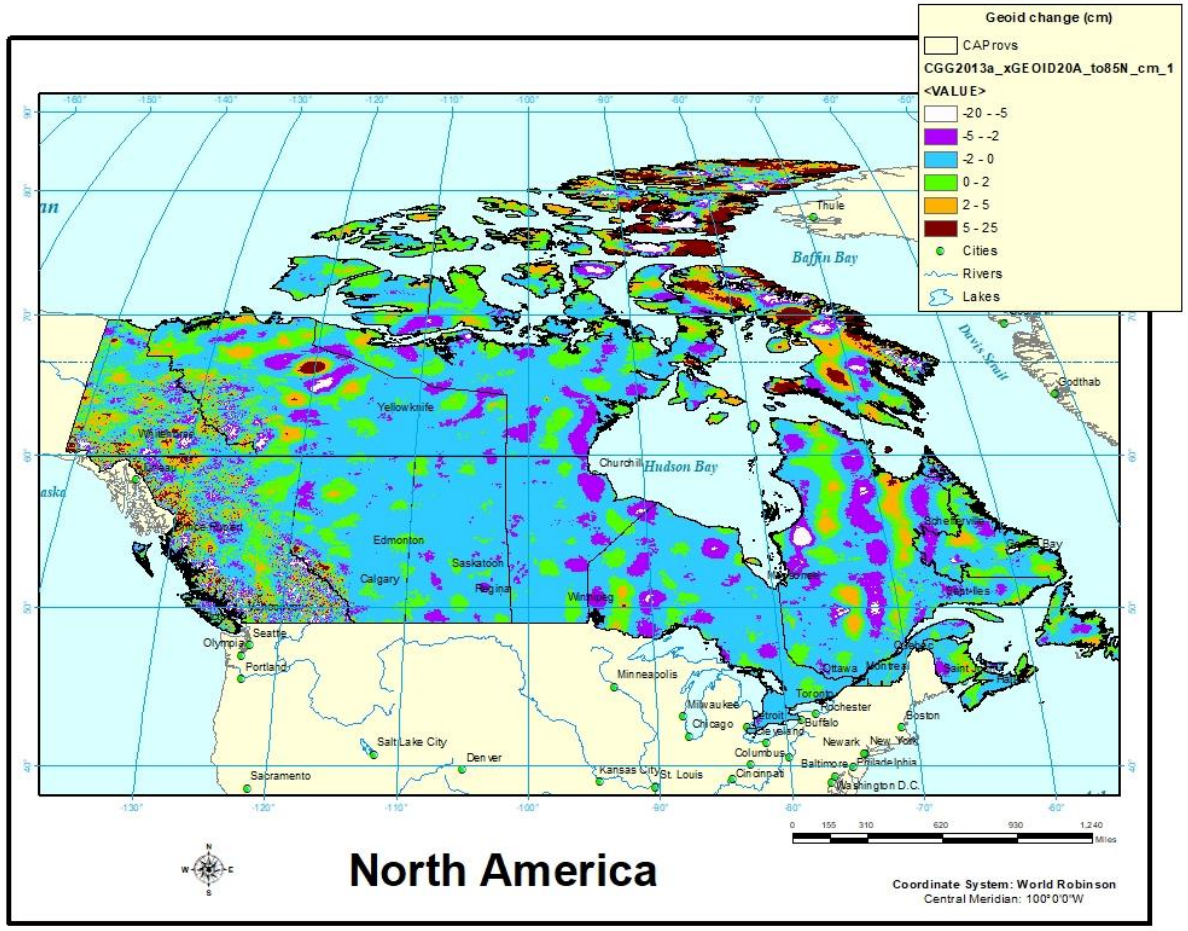
Practical impacts in Canada

- NATRF2022 and NAD83 will have an approximate 1-2 m geometric (latitude, longitude, ellipsoidal height) difference across Canada
- The CSRS will continue to include a 3D model of crustal deformation which is built into CGS services



Practical impacts in Canada

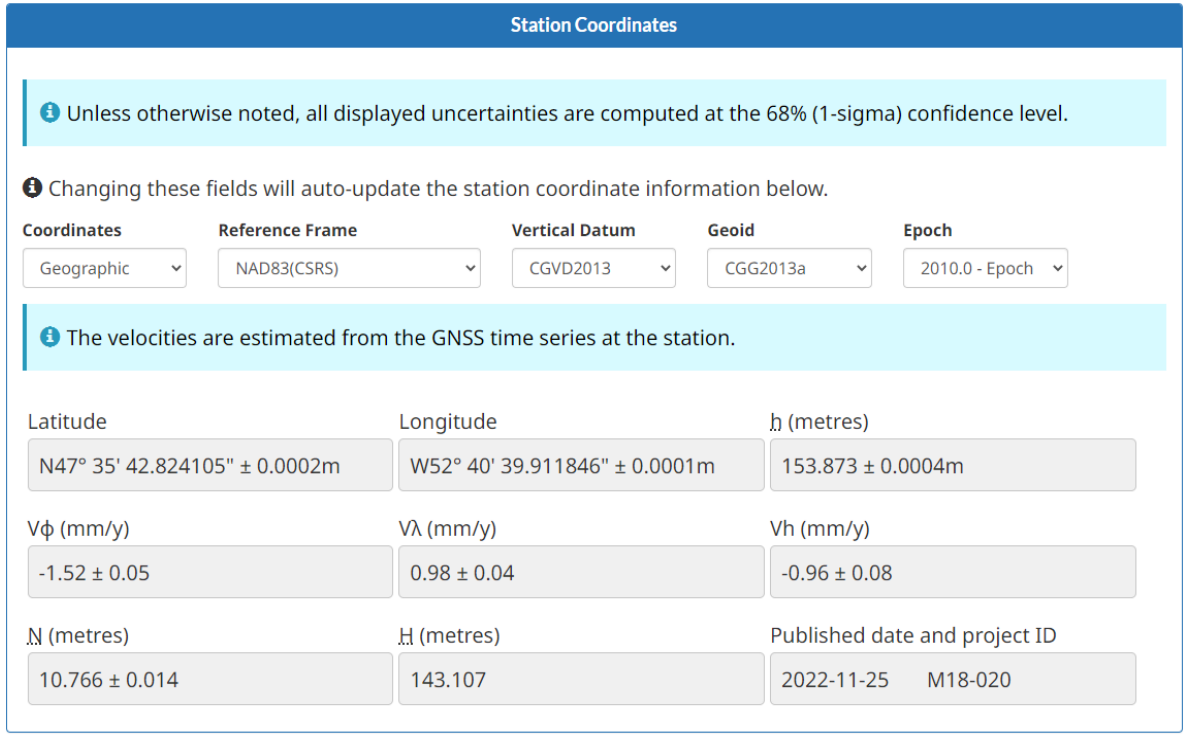
- The updated realization of the vertical datum, CGVD2013(GEOID2022), will cause orthometric height differences of up to several cm's in southern Canada
- CGVD2013 and NAPGD2022 will be compatible along the Canada / U.S. border



CGG2013a – xGEOID20A

CSRS Access: CACS and RTK coordinate functions

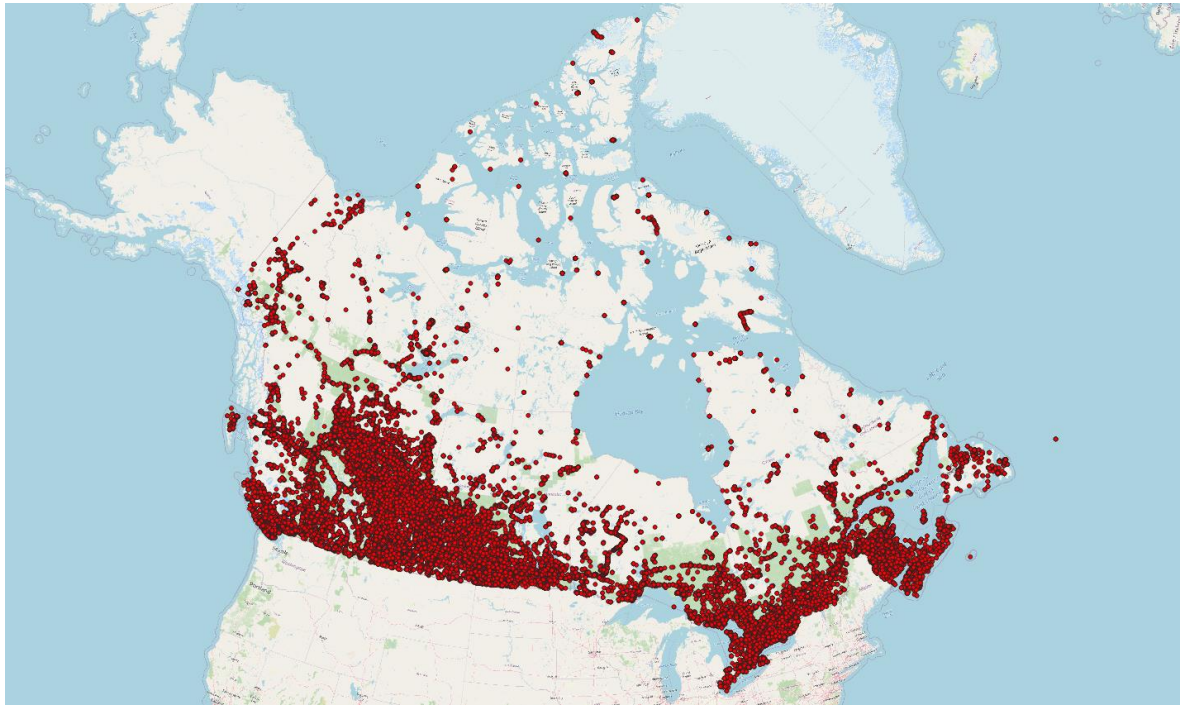
- CGS will provide NATRF2022 coordinate functions for public active control and campaign stations by 2025
- These coordinate functions will be the physical realization of NATRF2022
- Coordinate functions in NATRF2022 will also be provided for Commercial RTK networks that are part of the NRCan RTK compliance program



CACS dynamic station report

CSRS Access: CSRS-PPP

- Used extensively, particularly in remote areas and where passive control is not maintained
  - Allows users to set their own survey control
- Currently supports GPS&GLONASS; plan to add support for Galileo by 2024
- Will include support for NATRF2022 and CGVD2013(GEOID2022) by 2025



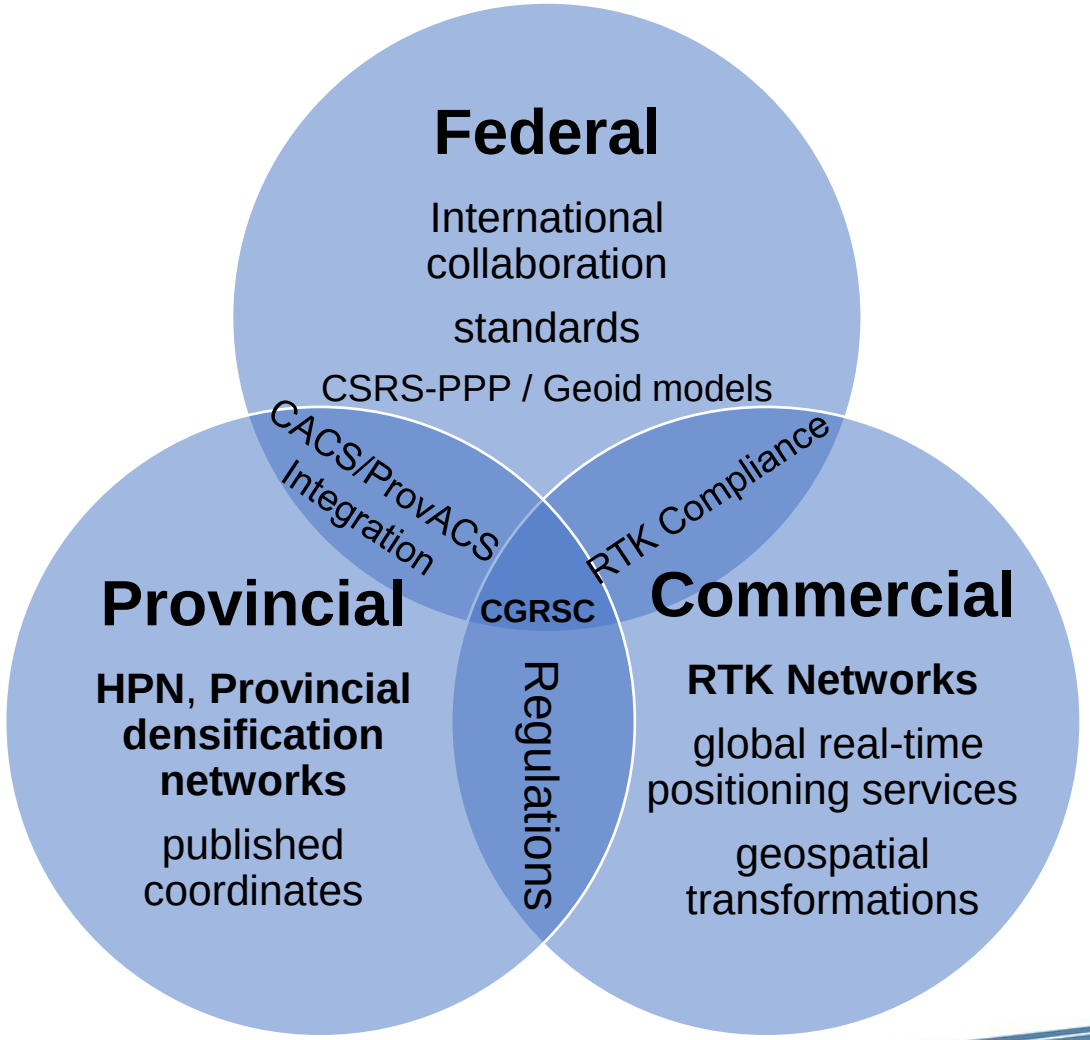
Locations of Canadian CSRS-PPP datasets in 2021

CSRS transformation tools: TRX and GPS-H

- TRX and GPS-H can be accessed as web applications, downloaded and installed on a Windows PC, or directly through our CSRS API
- Tools will be upgraded to support NATRF2022, CGVD2013(GEOID2022), and the updated national deformation model (Canada's IFDM2022) by 2025
- CGS tools support the transformation and conversion of coordinates; for other geospatial datatypes (e.g., LiDAR), we will be relying on commercial geospatial software providers
  - CGS and NGS have been communicating with the geospatial software providers to help them prepare

Geodetic services are a shared responsibility in Canada

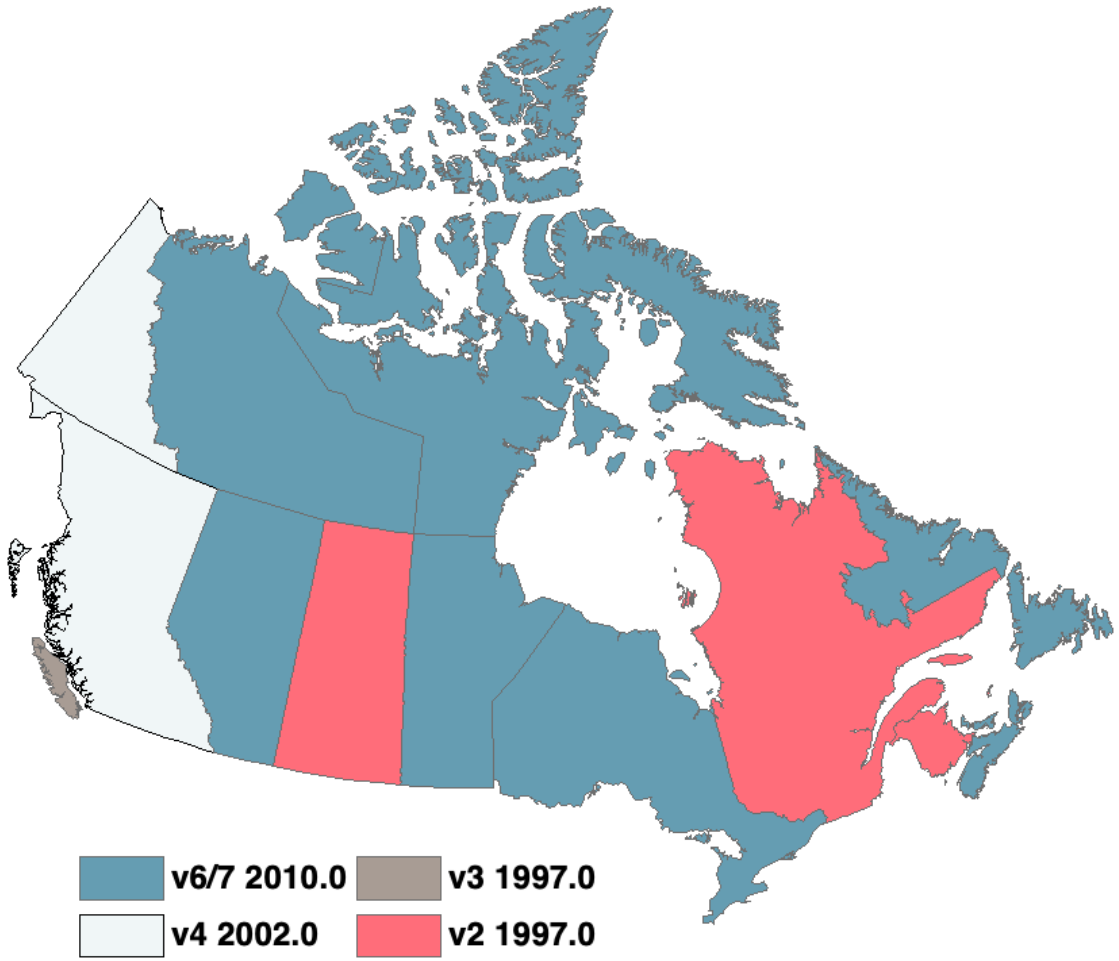
- Defining the reference system is a federal mandate (NRCan/SGB/CGS)
- Provinces have the authority to regulate reference system usage in their jurisdictions
- Delivering the reference frame is coordinated through the **CGRSC (Canadian Geodetic Reference System Committee),** a subcommittee of the Canada Council on Geomatics



Reference frame adoption in Canada

- Different NAD83(CSRS) versions across Canada
- Differences between versions and epochs that must be properly addressed
- Confusing when working across provinces and for commercial services

NATRF2022 is an opportunity for a common reference frame in Canada



Provinces are developing plans for NATRF2022 adoption

- Plans are being developed within the CGRSC and are tied to accuracy requirements, current context, and capacity
- Options for migrating geodetic passive control in order of increasing accuracy (and cost):
  - **Transform**: Use transformation software like TRX to estimate new coordinates in NATRF2022 (quality?)
  - **Re-adjust**: Using existing observations, re-compute NATRF2022 coordinates
  - **Re-survey**: Return to the field and collect new precise GNSS observations
  - **Expand:** Some provinces have plans to expand HPN networks
    - crowd-sourcing / Adopt-a-monument?
- Provinces also need to update regulations (NAD83 ➡ NATRF2022)

Important takeaways

- Canada will adopt NATRF2022 and update CGVD2013 in parallel with the U.S. modernization in 2025
- Core modernization products will be available and implemented in CGS services by 2025
- Modernizing and unifying reference frames will enable efficiencies but require both geodetic and geospatial tools to support migration
  - CGS will provide the tools to update coordinates but will rely on geospatial software to provide the tools for data layer migration
- CGS is working with the Canadian provinces to plan for a unified modernization sometime after 2025

We’d like to hear from you if you have feedback or questions regarding reference system modernization in Canada

CGS : geodeticinformation-informationgeodesique@nrcan-rncan.gc.ca

Thank you!