CGS: Products, Tools & Timelines for the modernized CSRS

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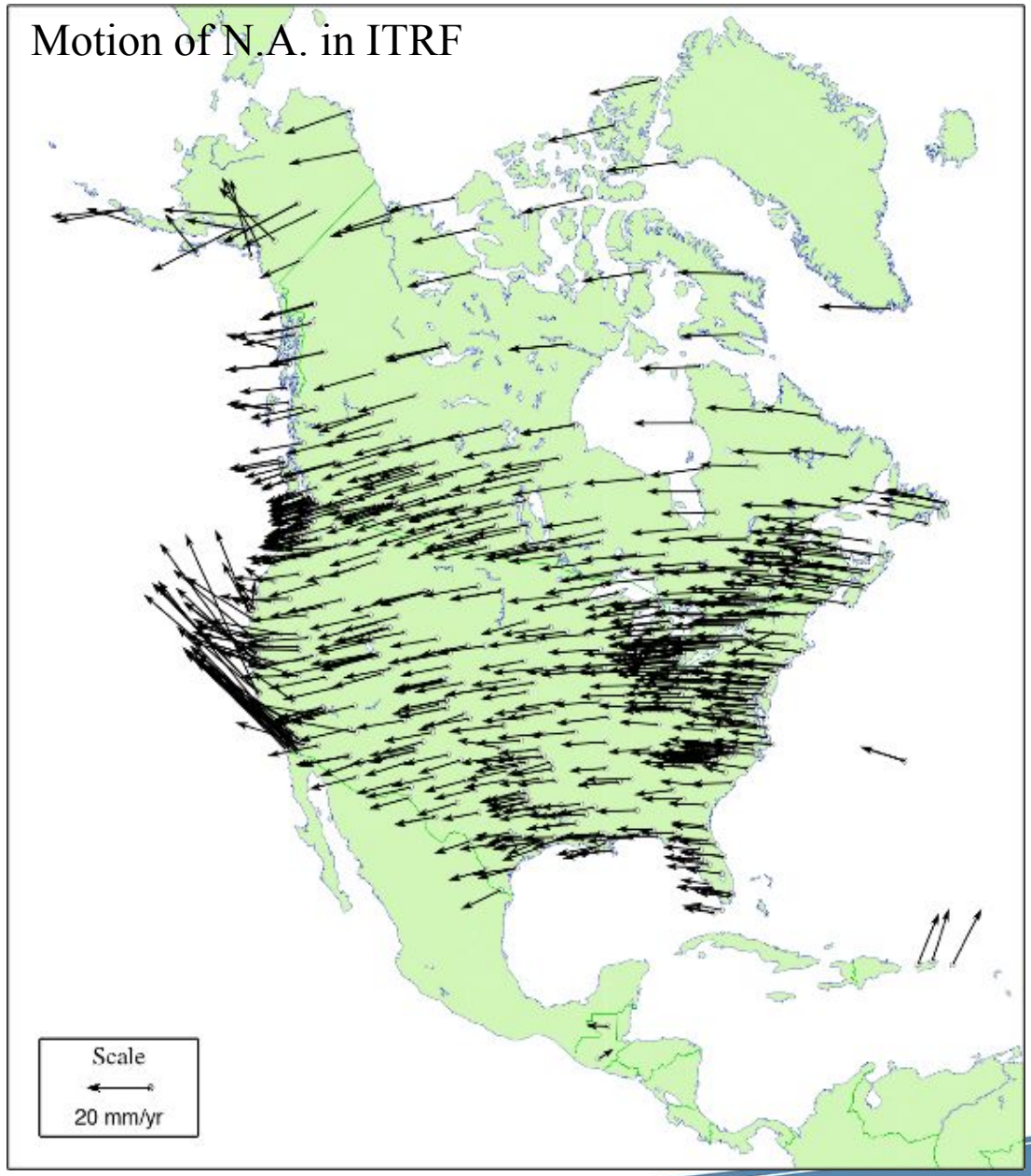
Presentation outline

- Modernized Reference System Products
- Canadian Geodetic Survey Tools
- Unifying Reference Frames in Canada and North America

Products

NATRF2022

- ITRF2020 (now available)
  - NAD83(CSRS) v8 based on full reprocessing of GNSS observation data, and aligned to ITRF2020, to be released in 2023
- North American plate rotation model
  - EPP2022 (common NGS/CGS model)

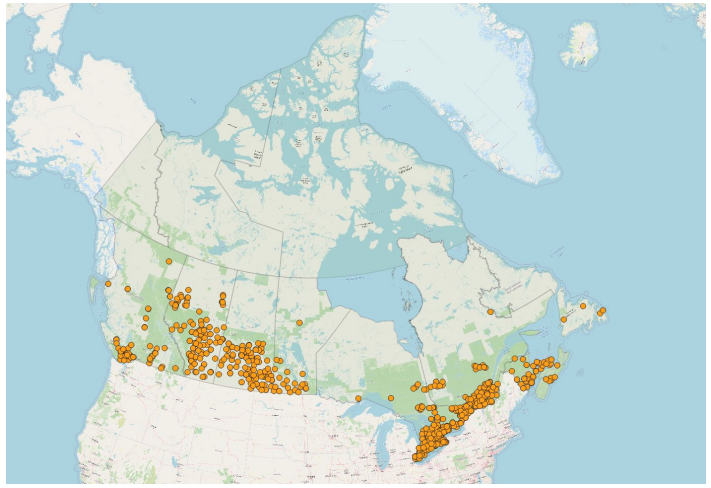


Products

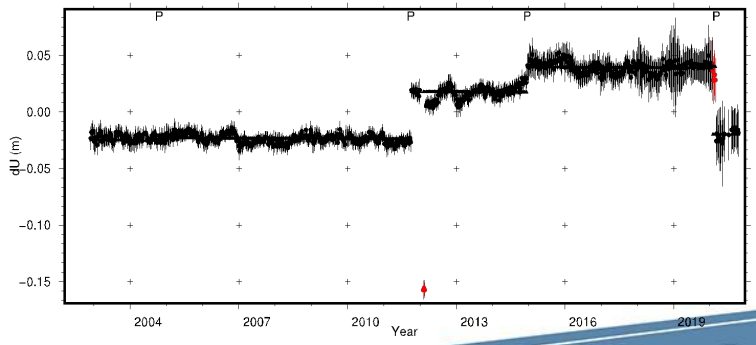
Public and Commercial GNSS coordinates and velocities

- Located primarily in the populated areas
- Commercial providers networks can be integrated into the official national reference system through a *compliance program*
- Coordinate functions for public and compliant commercial ACS networks will be provided in NATRF2022
  - Need to account for position offsets and velocity changes in time (requires geodetic db modernization)
  - May provide seasonal components by 2025 (TBD)

Public ACS stations



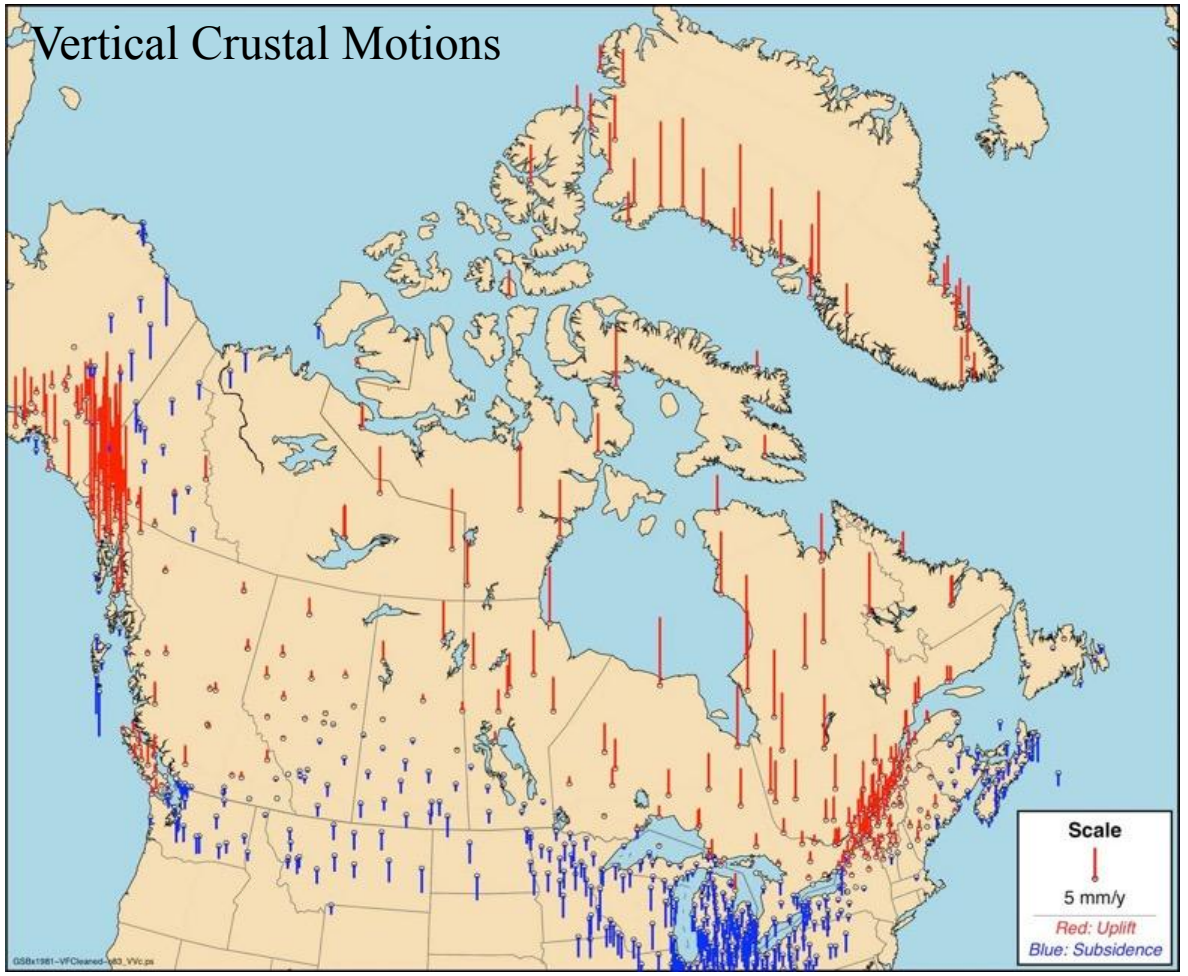
Commercial ACS stations



Products

NATRF2022

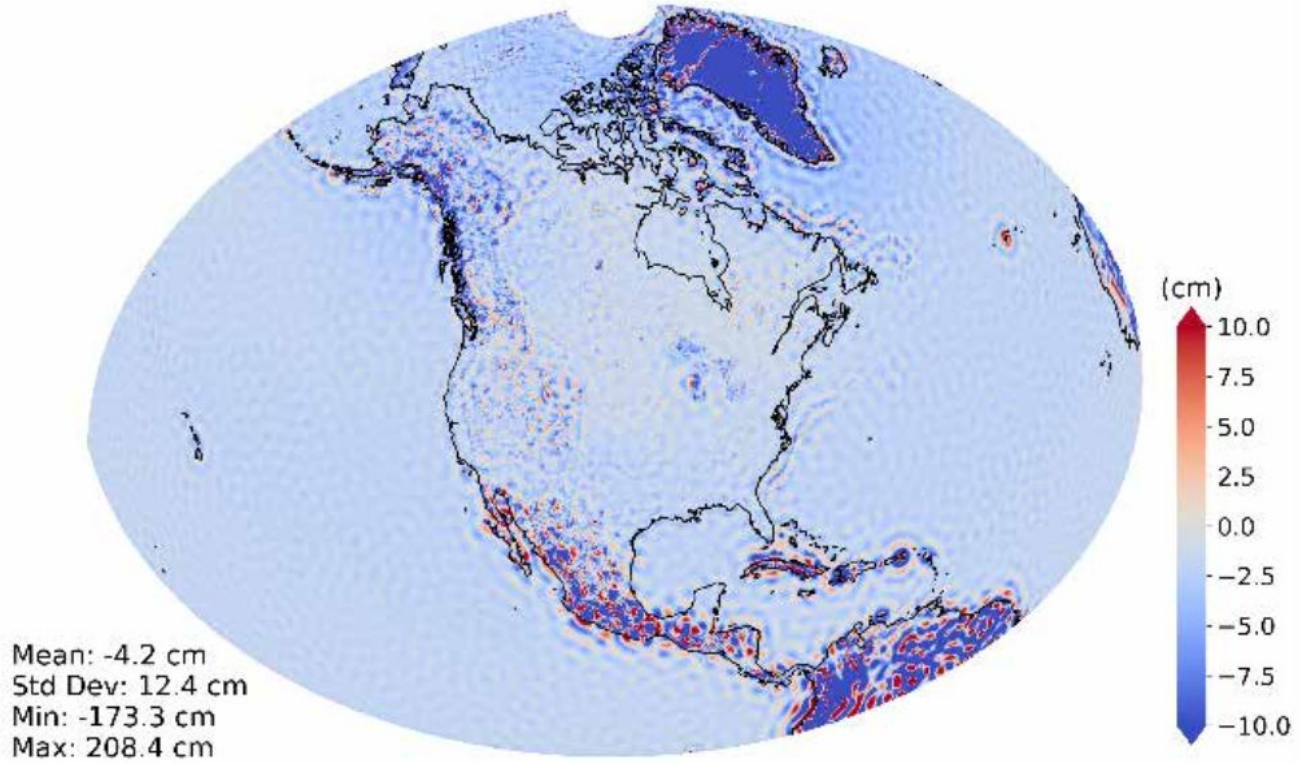
- Deformation model (IFDM 2022)
  - Account for intraframe crustal motion
  - Used for propagating coordinates to different epochs
  - Currently implemented in Canada as a 3d velocity model in an extended NTv2 format
  - In the future we plan to use the DMFM specification for representing the deformation model in the GGXF grid format
  - Modernization schedule not yet determined



Products

NAPGD2022/CGVD2013

- Same definition as CGVD2013 ($W_0 = 62{,}636{,}856.0\ m^2s^{-2}$)
- CGS will release a new realization of CGVD2013 in 2025: CGVD2013(SGEOID2022)
  - Working with NGS towards a common static geoid model for 2025



Difference between NGS and CGS experimental geoids

Standards

- New OGC grid format standards
  - Gridded Geodetic data eXchange Format (GGXF)
  - Deformation Model Functional Model (DMFM)
    - standardized way of representing the deformation model

README.md

GGXF : Gridded Geodetic data eXchange Format

The purpose of the Gridded Geodetic Data Exchange Format (GGXF) project team is to design a file structure and computer storage mechanism for the efficient exchange of regularly gridded geodetic data. There are several open issues that need to be refined in an open collaborative environment. This will be achieved by:

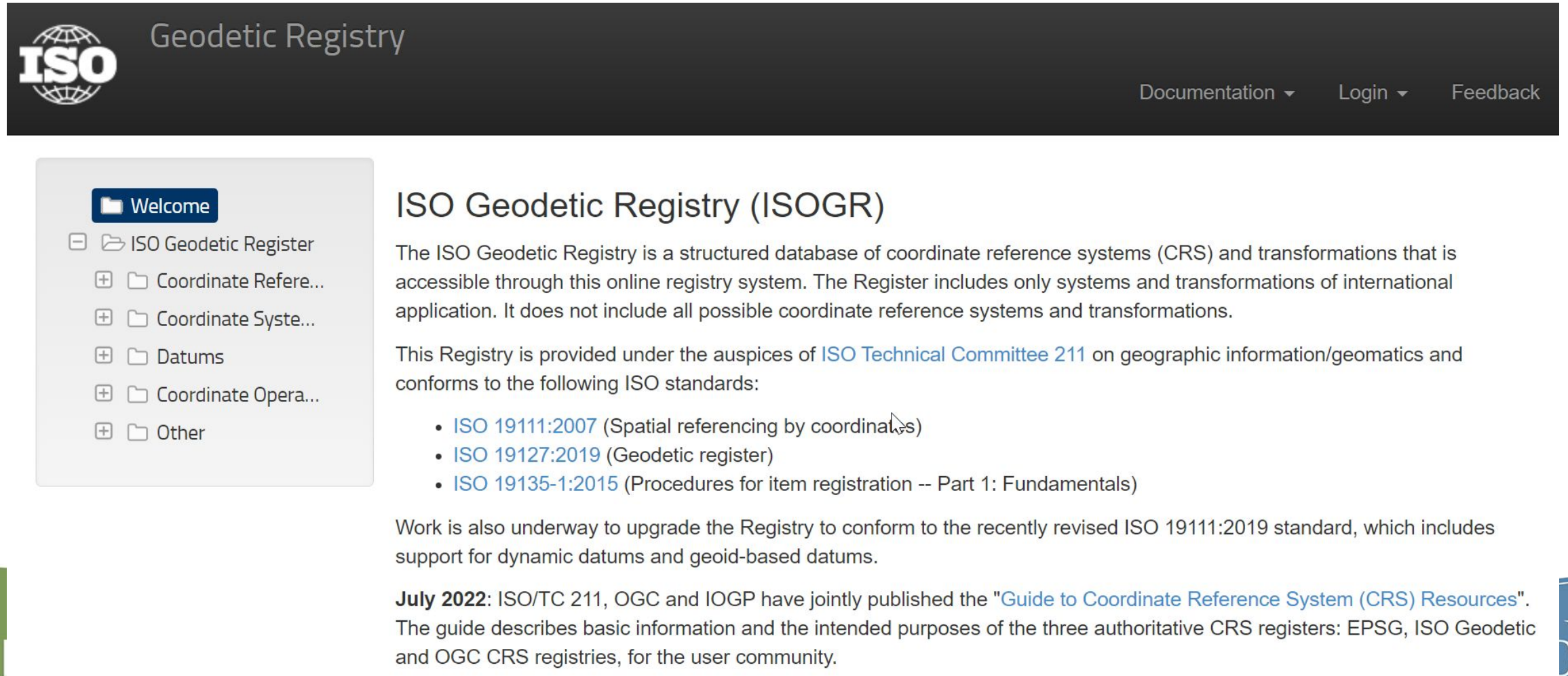
- Defining what is meant by "gridded geodetic data"
- Establishing the use case(s) for the GGXF
- Defining the user needs for a GGXF
- Defining the requirements of a GGXF
- Evaluating existing grid formats used for the exchange of geodetic data
- Determining the deficiencies of existing grid formats
- Designing the grid structure
- Designing the header structure
- Designing the GGXF file structure
- Develop a strategy for encoding the file
- Develop a strategy for promulgating the format as a standard for the geodetic community

The work will be conducted under the auspices of the OGC CRS DWG. The GGXF format is intended to support geodetic gridded data used in coordinate transformations including deformation models. This team is working in close collaboration with the CRS DWG project team developing the "Deformation Functional Model" (DFM) that is specifying these requirements. On completion of the work, a Standards Working Group shall be chartered and materials passed over to the SWG for finalising into a Standard.

Draft version of GGXF available on GitHub

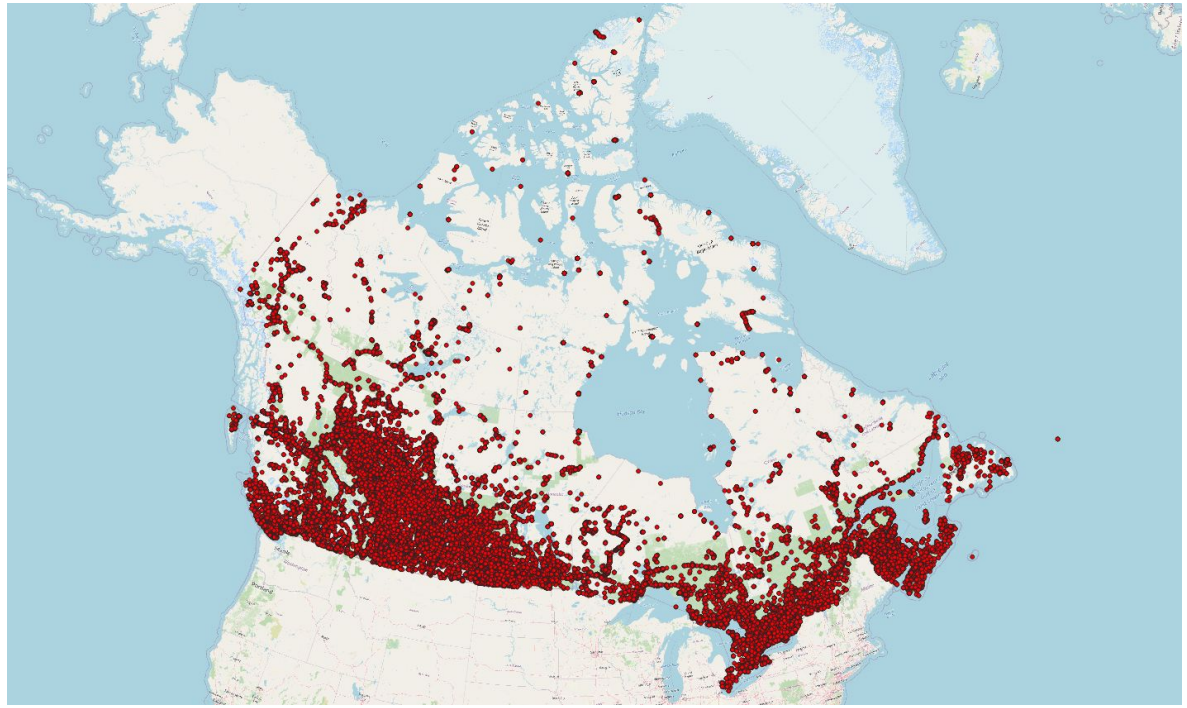
Standards

- ISO Geodetic Registry



CGS Tools: CSRS-PPP

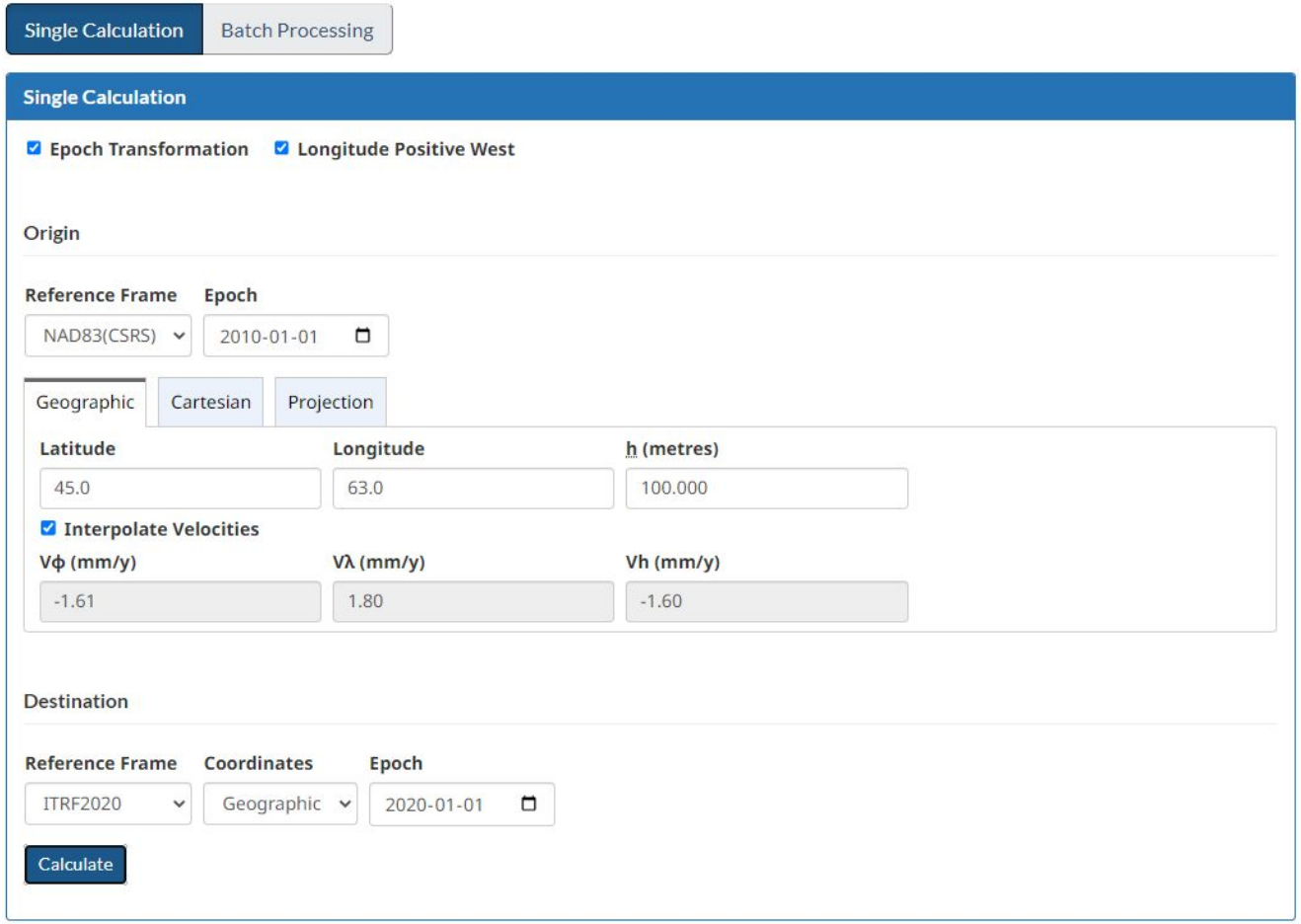
- Used extensively, particularly in remote areas and where passive control is not maintained
- Positions output in NAD83(CSRS) at any epoch or ITRF at epoch of observations
- Currently supports GPS&GLONASS; plan to add Galileo in 2023
- Will include support for NATRF2022 by 2025



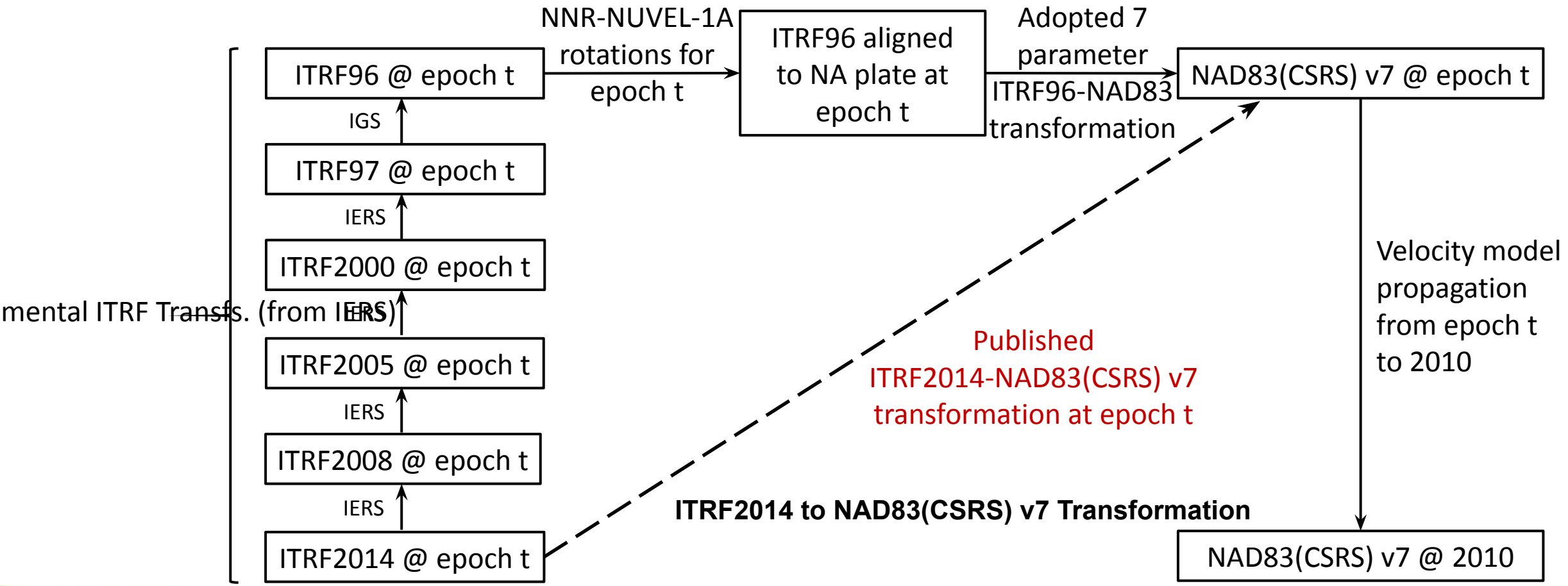
Locations of Canadian CSRS-PPP datasets in 2021

CGS Tools: TRX

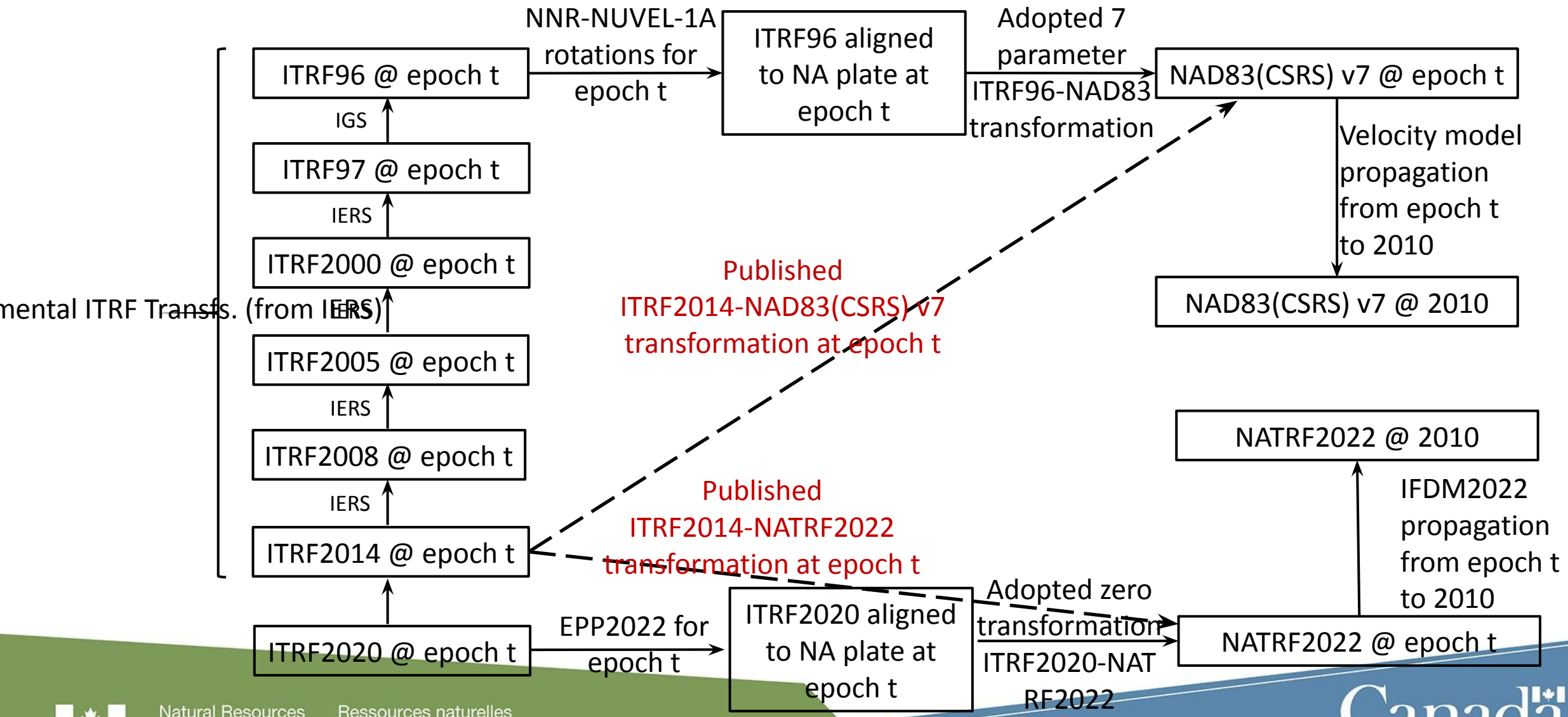
- Transform coordinates between NAD83(CSRS) and the International Terrestrial Reference Frame (ITRF) realizations
- Transform coordinates between epochs using the predicted motions from the Canadian IFDM2022 (name TBD)
- Convert coordinates between geographic, Cartesian, and mapping projections (UTM, MTM, stereographic)
- Will support NATRF2022 by 2025



CGS Tools: TRX under the hood

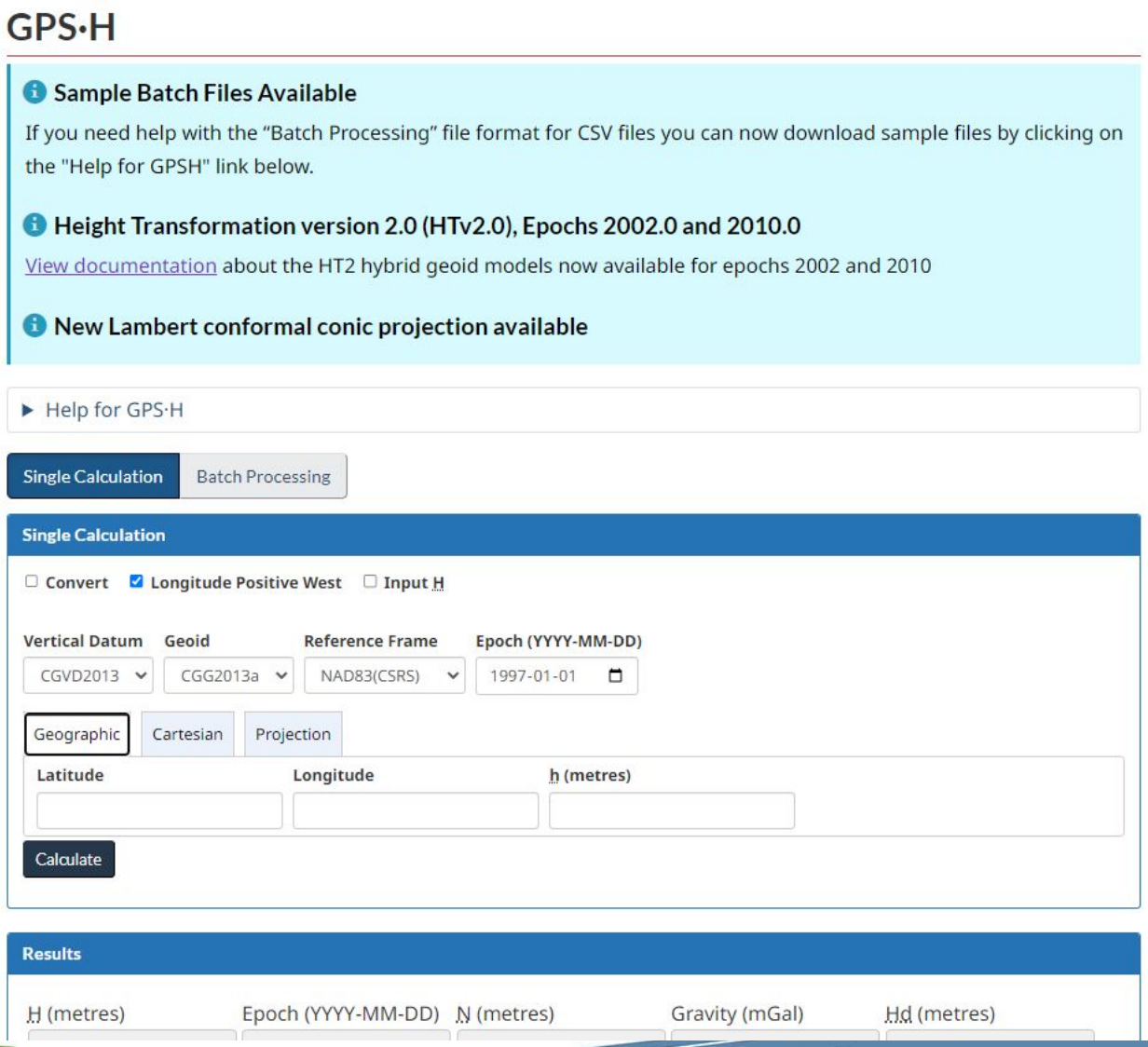


CGS Tools: Modernized TRX under the hood



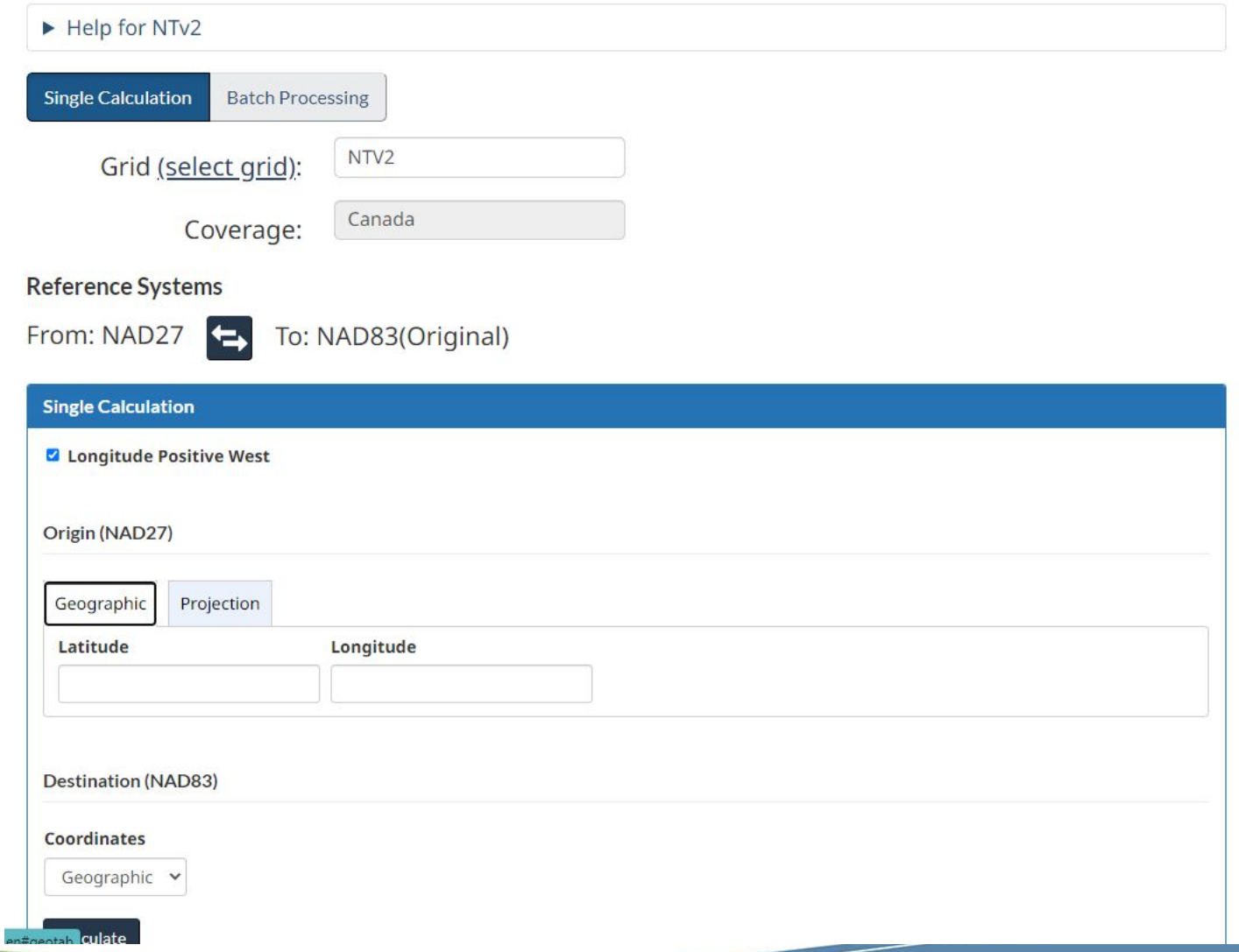
CGS Tools: GPS-H

- Transform ellipsoid heights to CGVD2013 and CGVD28
- Converts between CGVD2013 and CGVD28 at the officially adopted epochs (1997, 2002, 2010) using transformation grids
- Will support updated realization of CGVD2013 (SGEOID2022) by 2025
- Not planning to support IFDM2022 prior to 2025



CGS Tools: NTv2

- NTv2 is a tool to apply a distortion model in grid format
- NTv2 grid to transform from NAD27 to NAD83, or other legacy to modern systems
- Some provinces plan to update their distortion models to support NATRF2022 for lower accuracy datasets



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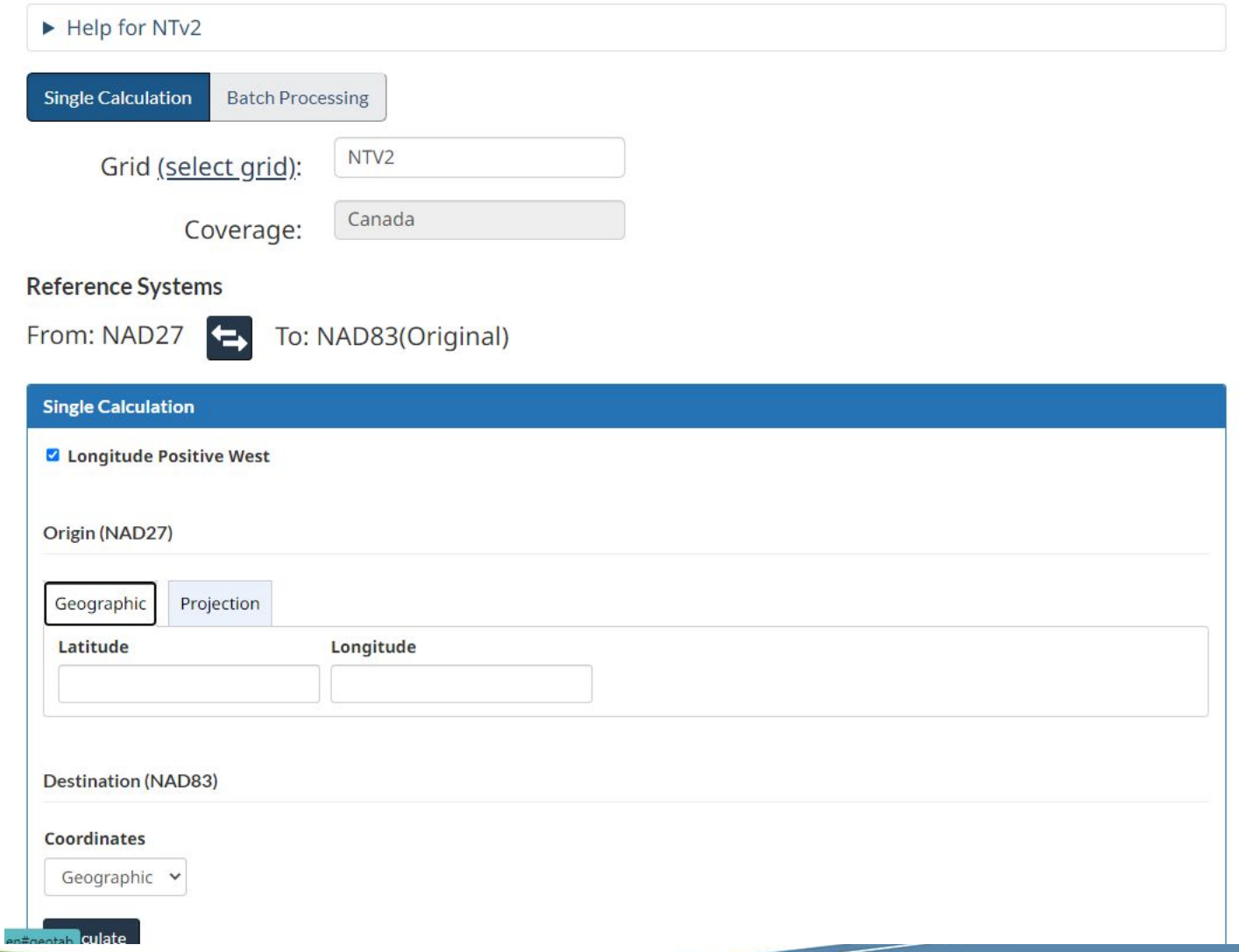
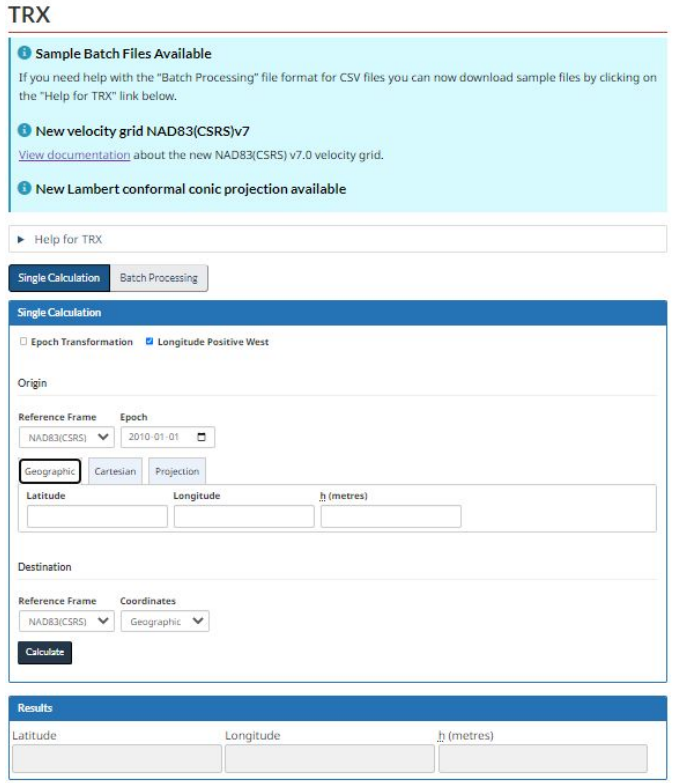
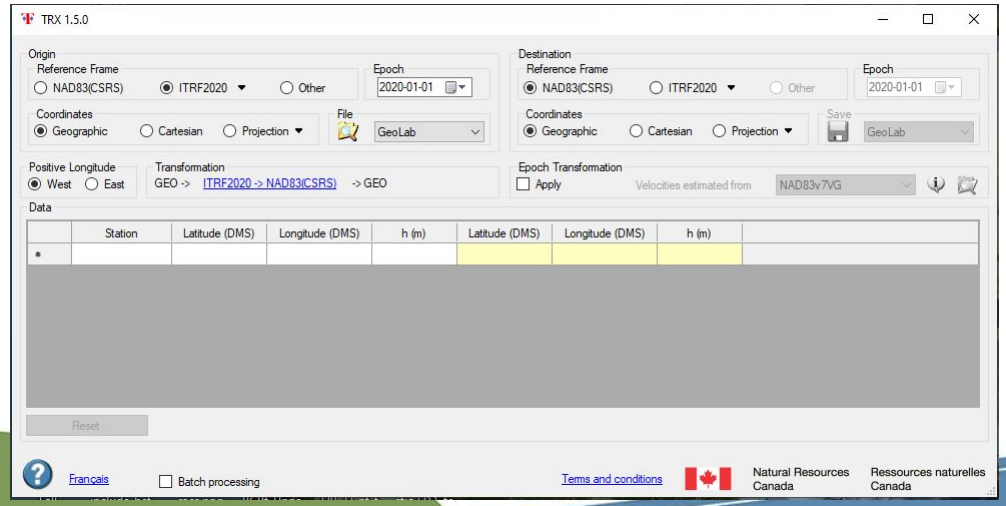


CGS Tools: Usage options

- CGS geometric and vertical datum transformation tools are available as:
  - Web tools
  - Downloadable PC versions
  - API's (documentation coming in 2023)
    - Could support a beta integrated product



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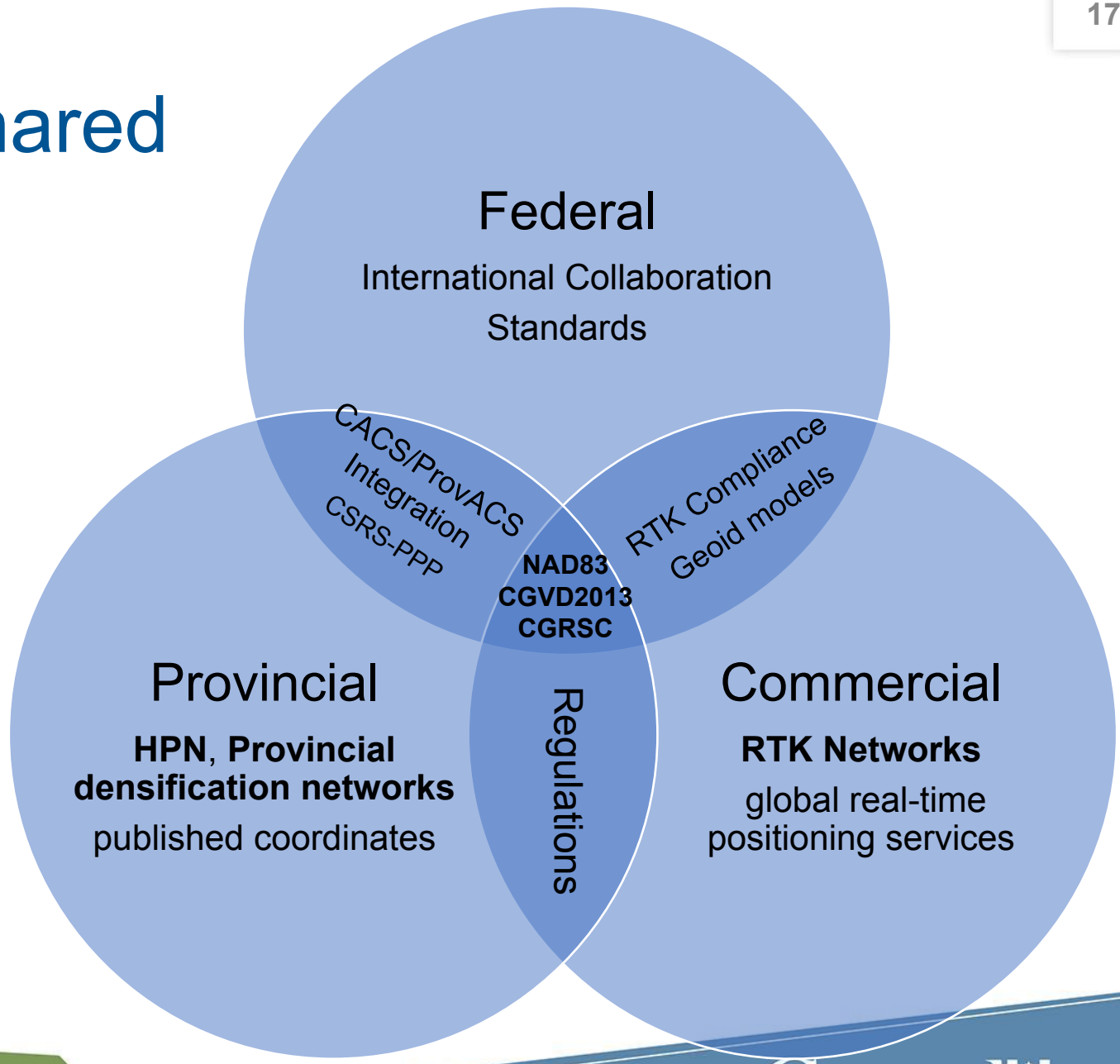
Geodetic services are a shared responsibility in Canada

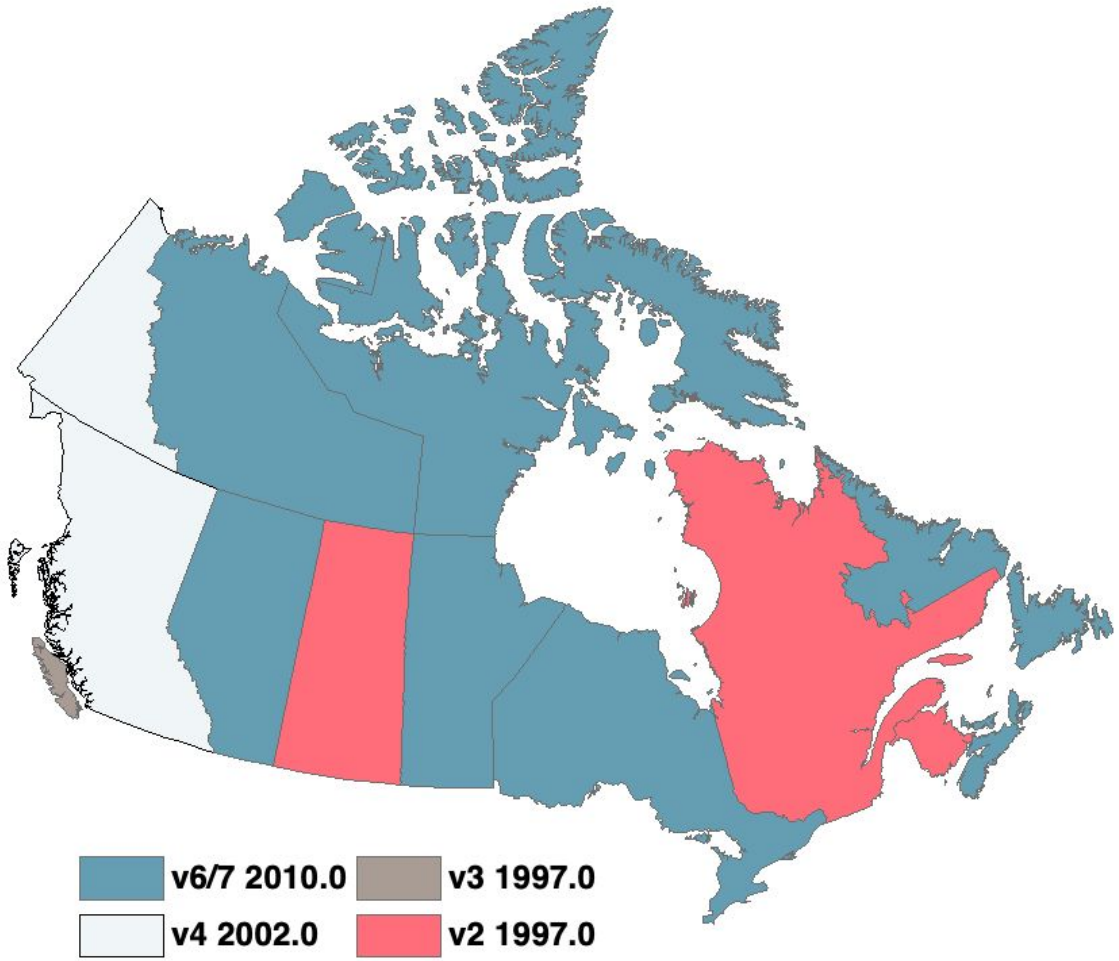
- Defining the reference system is a federal mandate (NRCan/SGB/CGS)
- Delivering the reference frame (e.g., providing access) is a shared responsibility, and coordinated through the **CGRSC (Canadian Geodetic Reference System Committee),** a subcommittee of the Canada Council on Geomatics



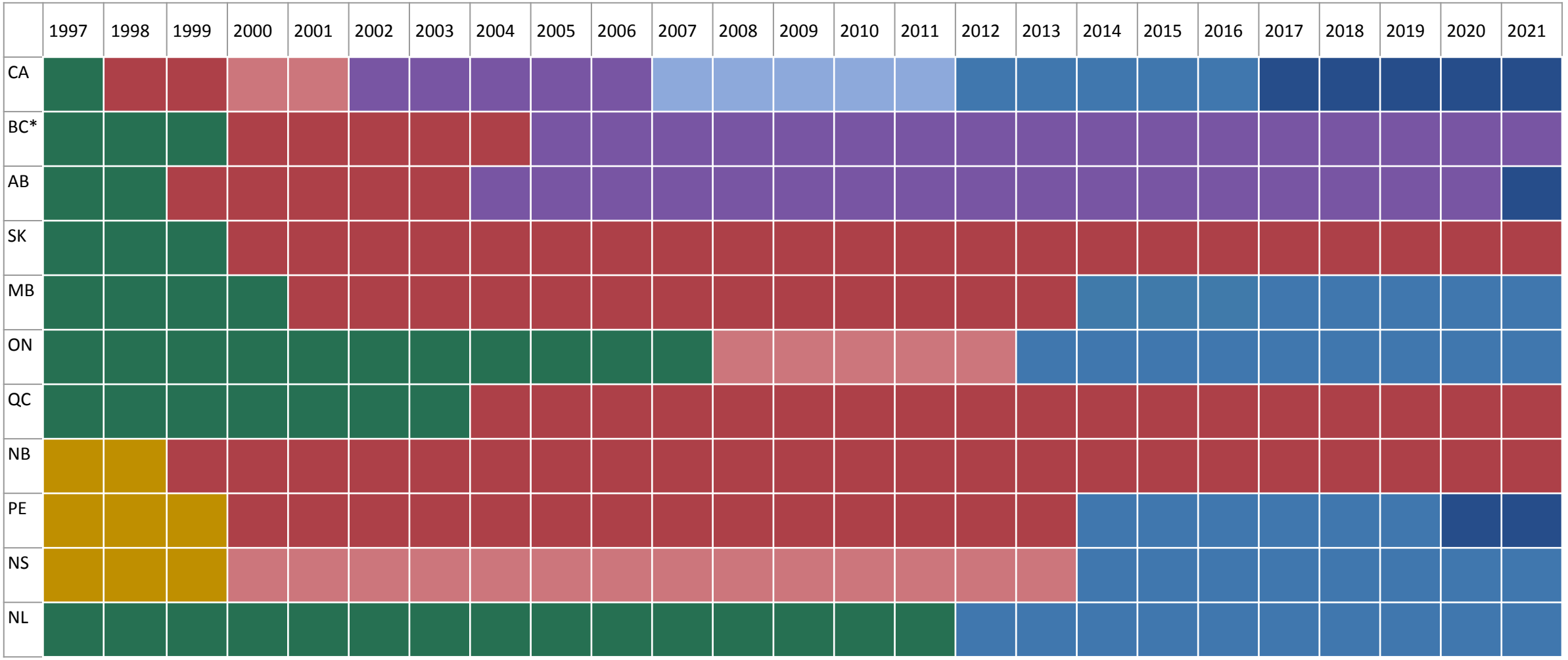
Reference frame adoption in Canada

- 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



NAD83 Adoption History

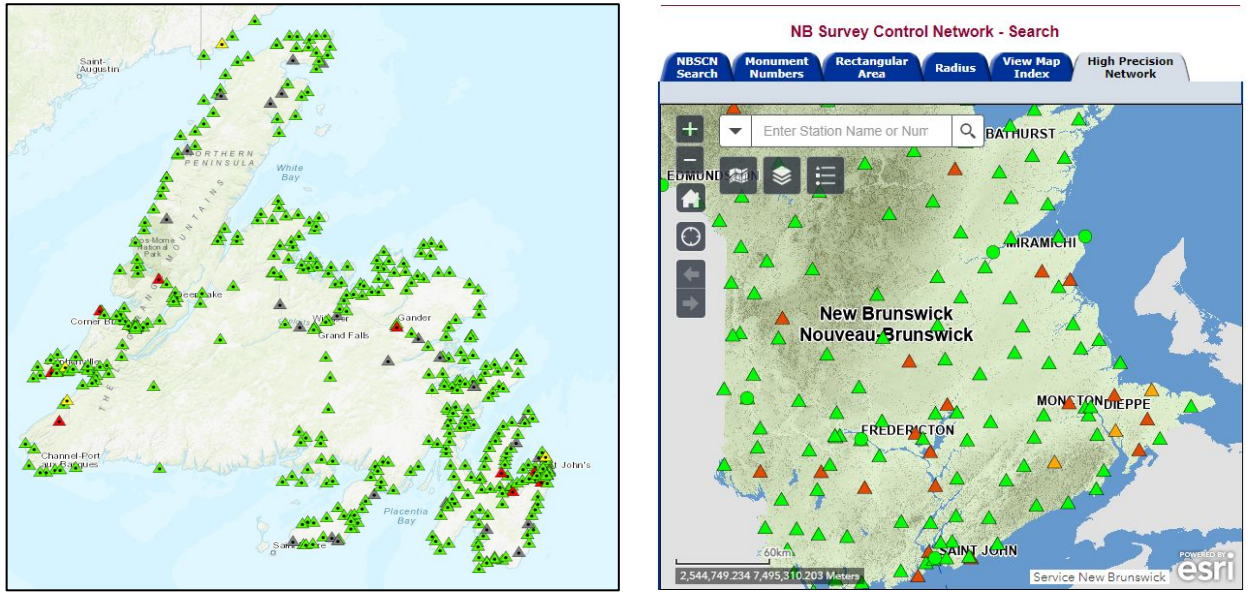


NAD27	ATS77	NAD83 Original	NAD83 v2 1997	NAD83 v3 1997	NAD83 v4 2002	NAD83 v5 2006	NAD83 v6 2010	NAD83 v7 2010

Role of provincial geodetic services

Provincial geodetic control networks

- Passive control networks are still widely used in many jurisdictions but are not always well supported
- Some provinces maintain High Precision Networks (HPN)
- Working with Provinces on a plan to migrate their geodetic infrastructure to NATRF2022
- Provincial timeline is sometime after 2025



Examples of provincial HPN networks in NB and NL

What we need in Canada from commercial geospatial software providers

- Geospatial tools which support
  - New Geodetic Grid eXchange Format (GGXF) or some other agreed upon standard
  - Dynamic reference systems to allow federal, provincial, and municipal agencies to migrate existing NAD83(CSRS) epoch 1997 and 2010 geospatial data holdings to NATRF2022 epoch 2020
    - Examples:
      - Federal road network - NAD83(CSRS) epoch 2010 -> NATRF2022 epoch 2020
      - Provincial cadastral fabric – NAD83(CSRS) epoch 1997 -> NATRF2022 epoch 2020
      - Municipal infrastructure layers – NAD83(CSRS) various epochs -> NATRF2022 epoch 2020
- These tools will support the unified adoption of NATRF2022 in Canada

Important takeaways

- Core modernization products will be available and implemented in CGS Tools by 2025
- Unifying reference frames will enable efficiencies but require both geodetic and geospatial tools
  - 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