CSRS Modernization - Overview

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Canadian Geodetic Survey

Binational Geospatial Software Developers Summit
November 30, 2022

Presentation outline

- current situation in Canada
- plans and timelines
- reference frame unification
  - motivation for this summit!

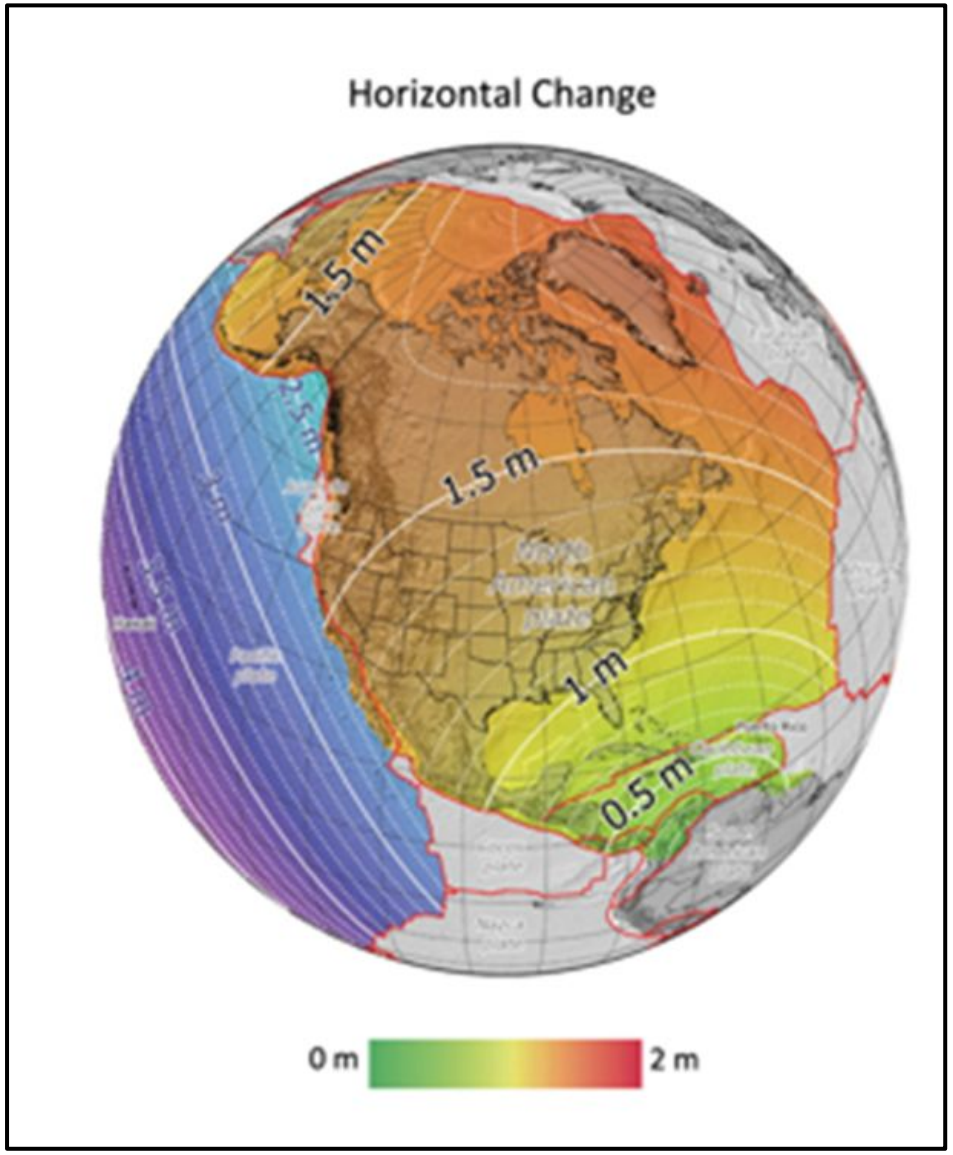
Current Situation

NAD83(CSRS) v.7, epoch 2010

- *Tied to ITRF*
- *Fully dynamic since ~ 2006 (Euler pole, velocity model)*

Issues:

- *Euler pole residual*
- *Epoch transformations for coordinates only (not widely available for data layers and databases)*
- *Many adopted versions and epochs (TBD)*
- ***After 2025: 1.5 meter discrepancy with NATRF2022 at the Canada-US border***



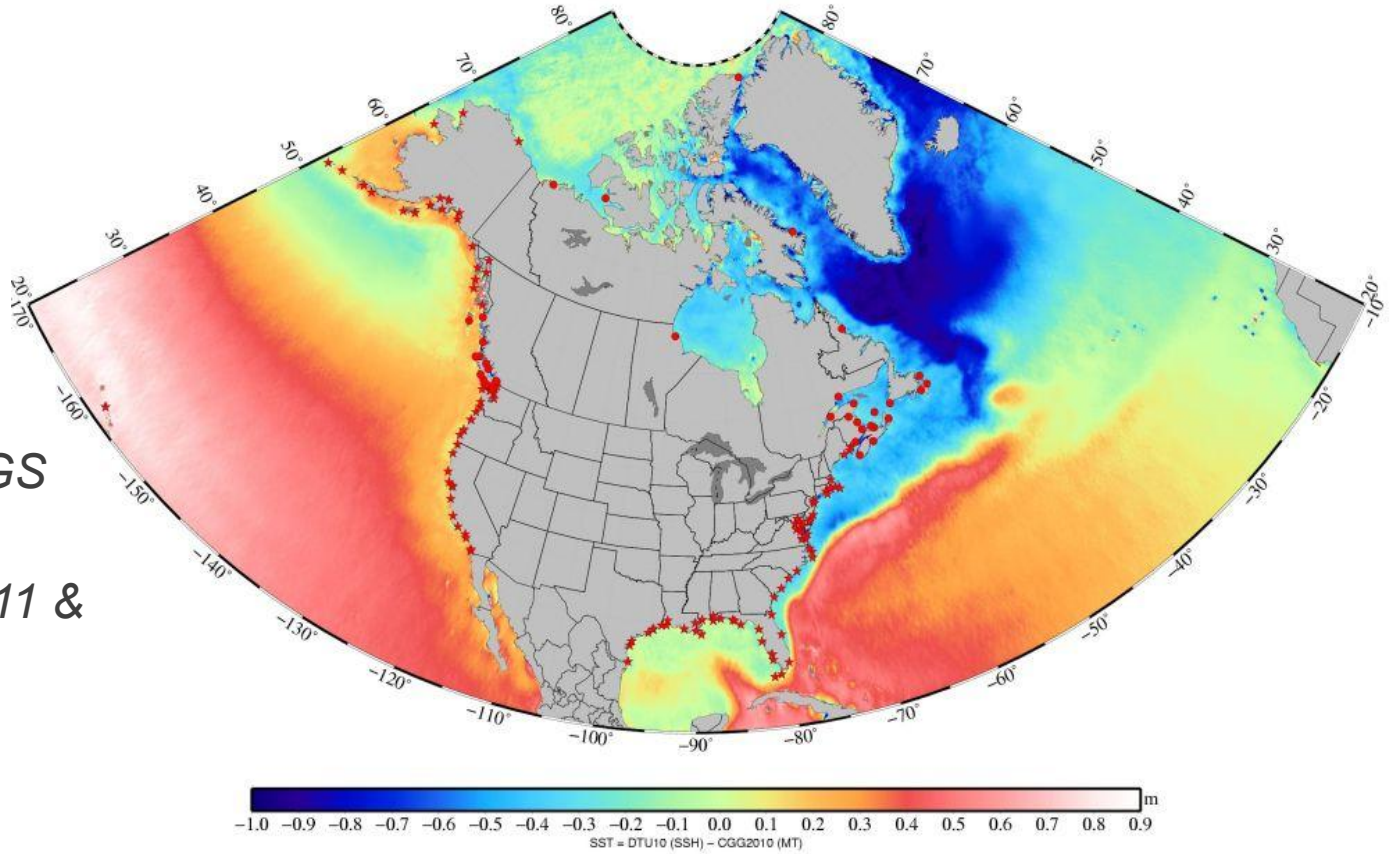
Current Situation

CGVD2013

- *Replaced CGVD28 (2015)*
- *Realized with a geoid model (CGG2013a)*
- *Definition of sea level (W_0) agreed upon with NGS in 2012*
- *Canadian Council of Geomatics Resolutions 2011 & 2013*

Issues:

- *Improved geoid models available*
- *Not adopted by all provinces, some in the process (TBD)*
- *Current realization is different than the planned realization of NAPGD2022*



Sea Surface Topography

Canadian tide gauges **American tide gauges**

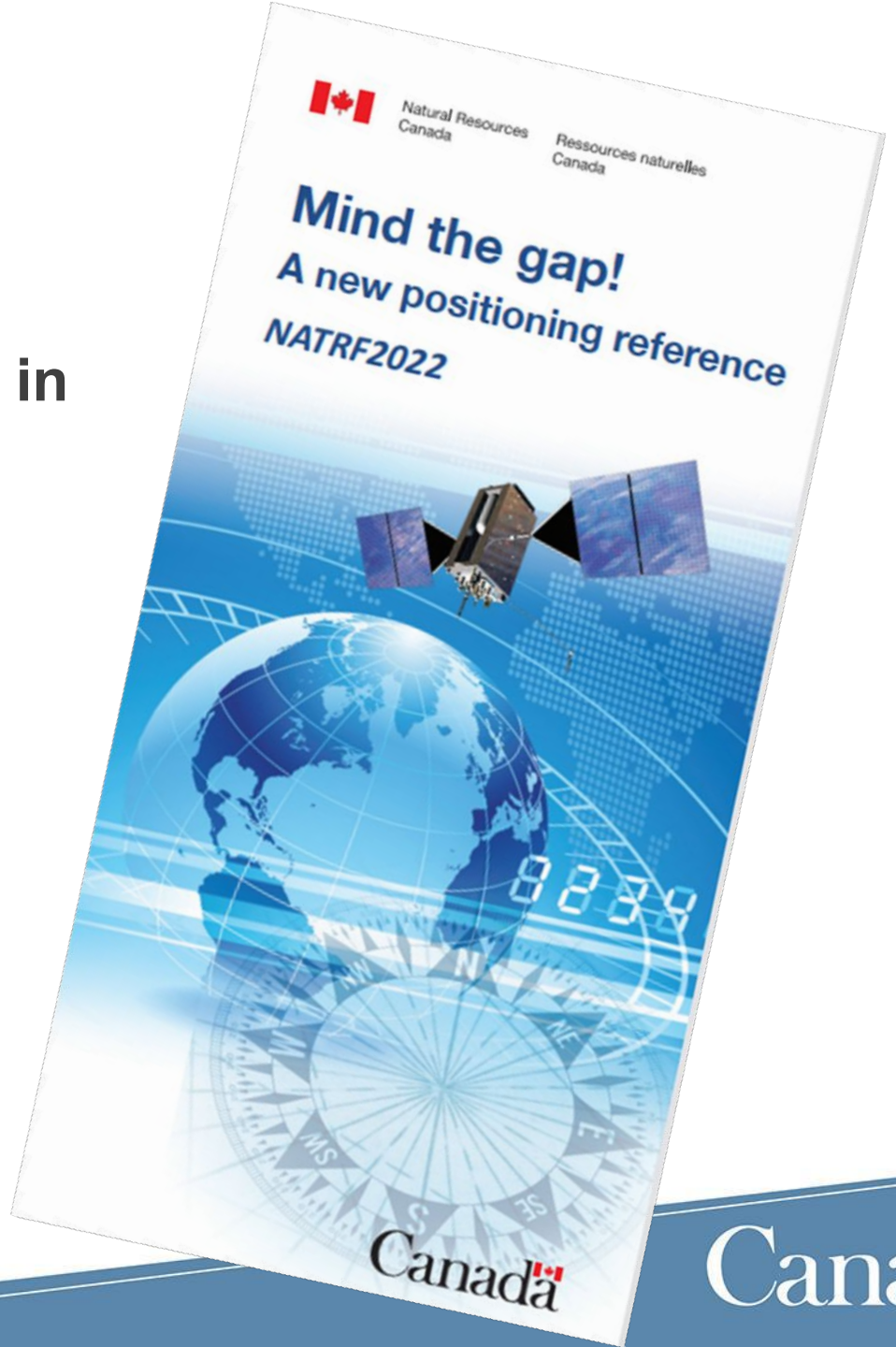
Denis Hains
Director
Geodetic Survey Division
Canada Centre for Remote Sensing
Natural Resources Canada Ressources naturelles Canada
Canada

Juliana P. Blackwell
Director
National Geodetic Survey

Plans and Timelines

NRCan will adopt NATRF2022 in 2025, in parallel with the US

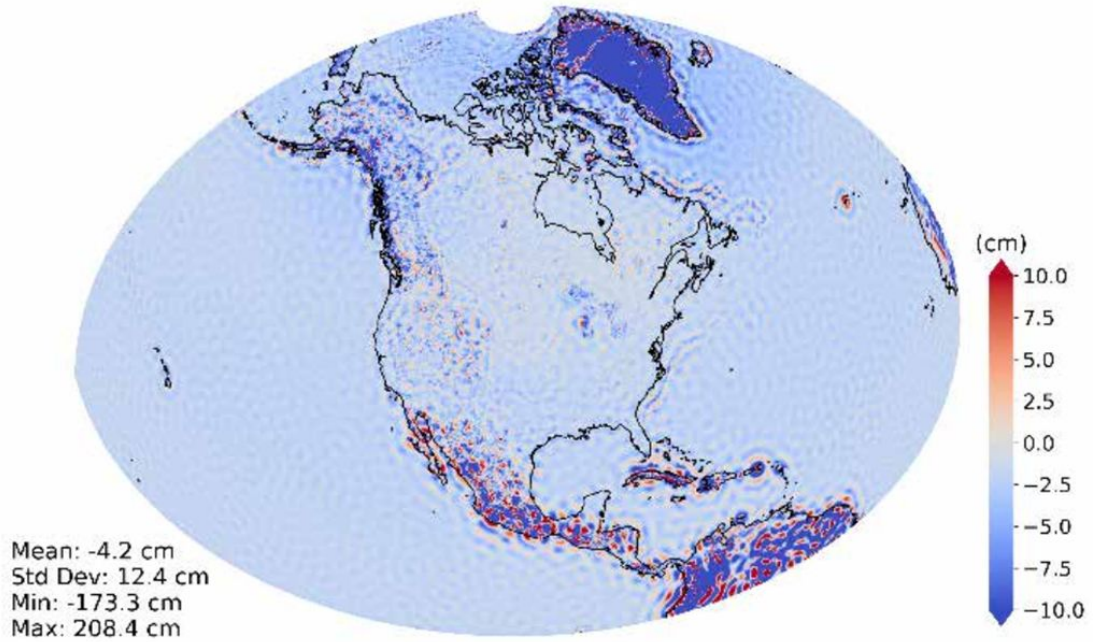
- *Improved definition*
- *Alignment with the US*
- *Opportunity to unify reference frames in Canada*



Plans and Timelines

NRCan will issue a new realization of CGVD2013 in parallel with the US adoption of NAPGD2022

- *Improved geoid model*
- *New geoid model will be common or compatible with the one realizing NAPGD2022*
- *Both geoid-based height systems in the same OGC standard format (GGXF)*

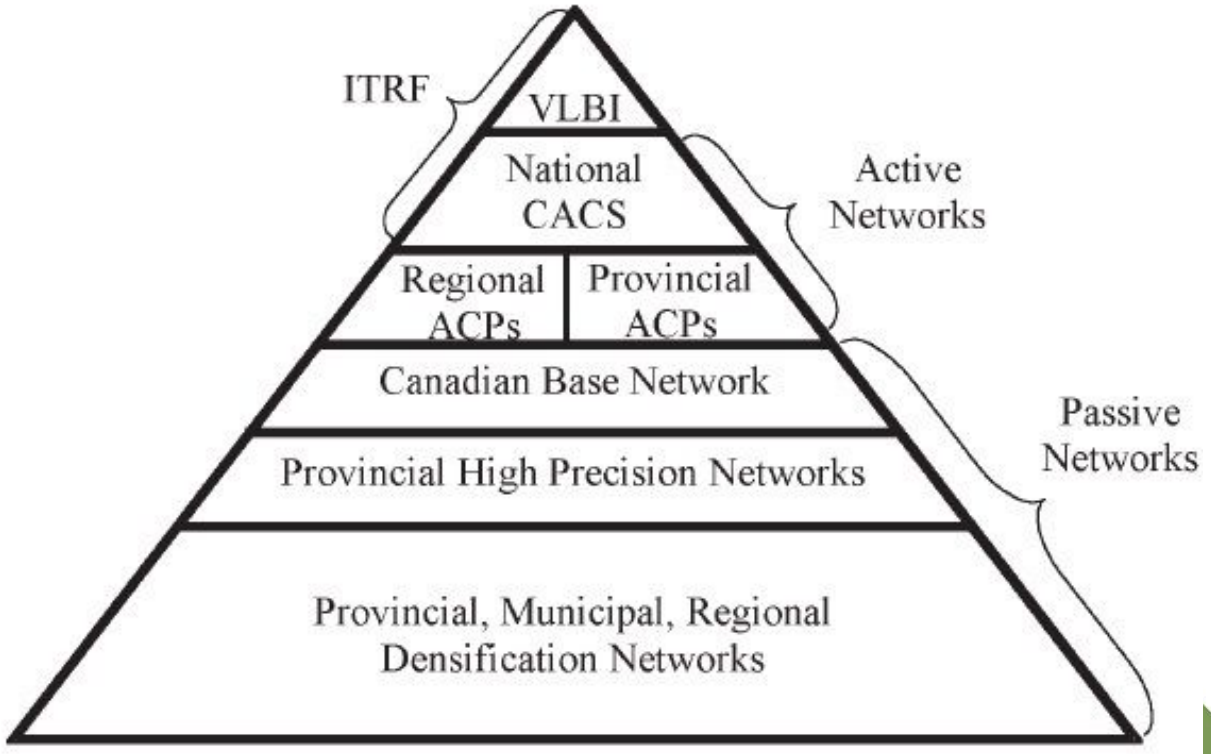


Realization with a common NA geoid model: difference between NGS and CGS experimental geoids

Plans and Timelines

Discussion with provinces since ~2018

- CGRSC: Canadian Geodetic Reference System Committee (Provinces, OGDs, NGS)



CCOG: Canadian Council of Geomatics Resolution, October 2022

F22-0X Reference System Modernization

Whereas the United States plans to adopt new reference frames (NATRF2022[1] and NAPGD2022[2]) in 2025 and Natural Resources Canada (NRCan) is collaborating with U.S. officials to ensure compatibility at the international border, and;
Whereas CCOG subcommittees, the CGRSC and the Cadastral Forum, confirm a willingness to adopt NATRF2022 as a unified geometric reference frame within Canada, and;
Whereas the new US height system (NAPGD2022) will be compatible with the existing Canadian height system (CGVD2013[3]), and;
Whereas NRCan will work to ensure that tools are available for CGRSC and Cadastral Forum members and their stakeholders to update data sets as part of migration towards NATRF2022, and;
Whereas migration to new datums is expected to take several years, and capacity to perform the migration will require new or additional resources in many jurisdictions;
Be it resolved that the CCOG accepts and endorses these measures and encourages all Provincial jurisdictions to promote and facilitate preparation for the adoption of unified reference frames for Canada.

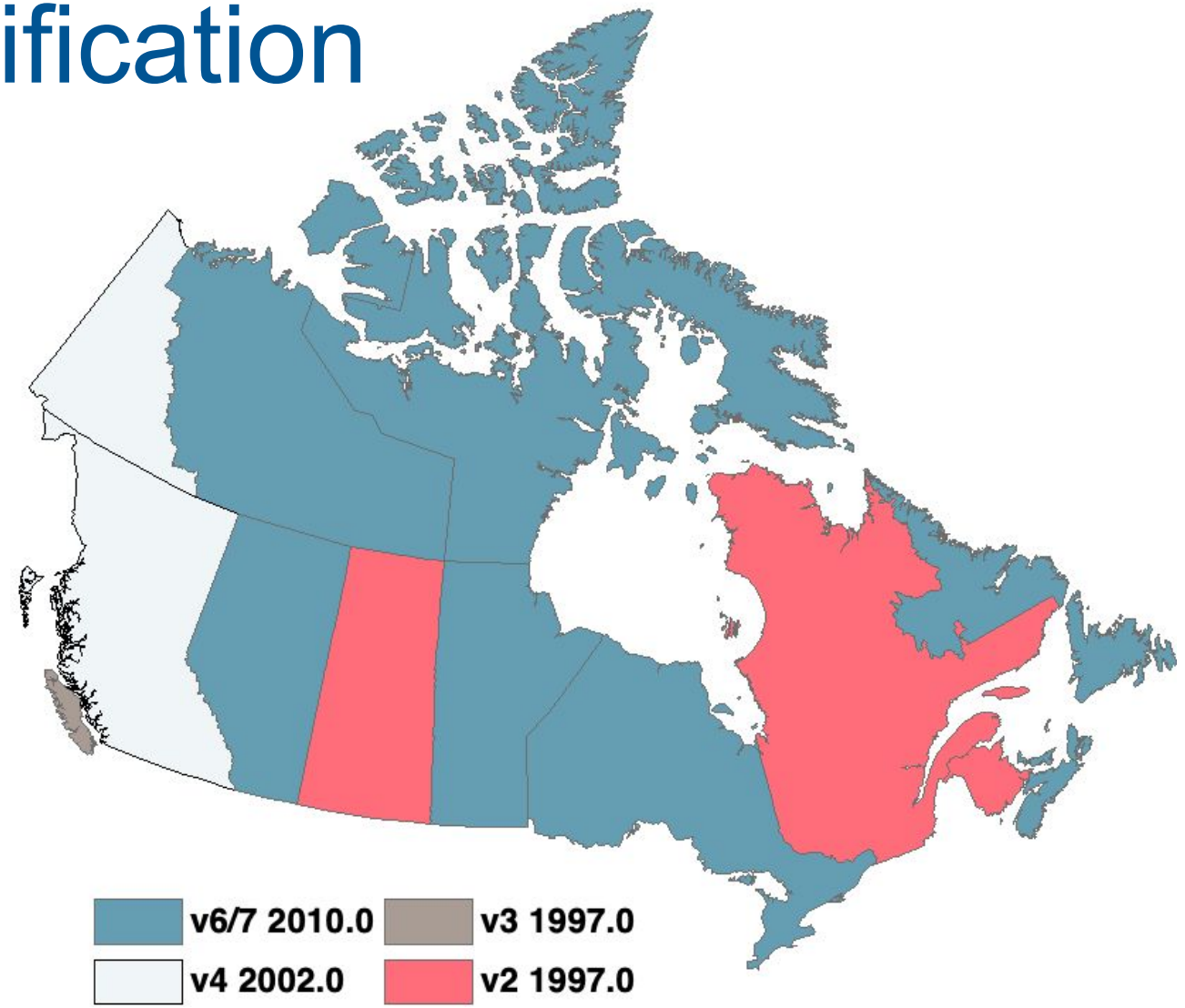
F22-0X Modernisation des systèmes de référence

Attendu que les États-Unis prévoient d'adopter des nouveaux cadres de référence (NATRF2022[1] et NAPGD2022[2]) en 2025 et que Ressources naturelles Canada (RNCan) collabore avec les autorités américaines pour assurer la compatibilité à la frontière internationale;
Attendu que les sous-comités du COCG, le CCSRG et du Forum Cadastral, confirment la volonté d'adopter NATRF2022 en temp que cadre de référence géométrique unifié au Canada;
Attendu que le nouveau système altimétrique des États-Unis (NAPGD2022) sera compatible avec le système altimétrique Canadien existant (CGVD2013[3])*:

Reference Frame Unification

Geometric

- Provincial adopted frames
- Municipalities more complex
- Varying degrees and types of regulatory dependencies



NAD83 version in use

	Adopted	Published online	Available upon request	Used**
BC Vancouver. Is →	v4 2002.0*	v4 2002.0	v3 1997.0	v4 2002.0
	v3 1997.0*	v3 1997.0	v4 2002.0	v3 1997.0
				original
AB	v7 2010.0	v7 2010.0	v4 2002.0	v7 2010.0
	original	original		v4 2002.0
		NAD27		original
				NAD27
SK	v2 1997.0*	v2 1997.0		v2 1997.0
				original
				NAD27
MB	v6 2010.0		v6 2010.0	v6 2010.0
				v2 1997.0
				original
ON	v6 2010.0*	v6 2010.0		v6 2010.0
	original*	original		original
		v3 1997.0		v3 1997.0
				NAD27
QC	v2 1997.0	v2 1997.0		v2 1997.0
	original*	original		original
			NAD27	NAD27
NB	v2 1997.0*	v2 1997.0		v2 1997.0
		ATS77		ATS77
		NAD27		NAD27
PE	v6 2010.0*	v6 2010.0		v6 2010.0*
				v2 1997.0
				original
				NAD27
NS	v6 2010.0*	v6 2010.0		v6 2010.0
		v3 1997.0		v3 1997.0
		ATS77		ATS77
		NAD27		NAD27
NL	v6 2010.0*	v6 2010.0		v6 2010.0
	original*	original		original

	Adopted NAD83	Published online	Available upon request	Used
YT	v4 2002.0	v7 2010.0	v4 2002.0	v4 2002.0
		original		original
				NAD27
NT	v7 2010.0	v7 2010.0	v7 2010.0	v7 2010.0
		original		original
				NAD27
NU	v7 2010.0	v7 2010.0	v7 2010.0	v7 2010.0
		original		original
				NAD27

Notes:

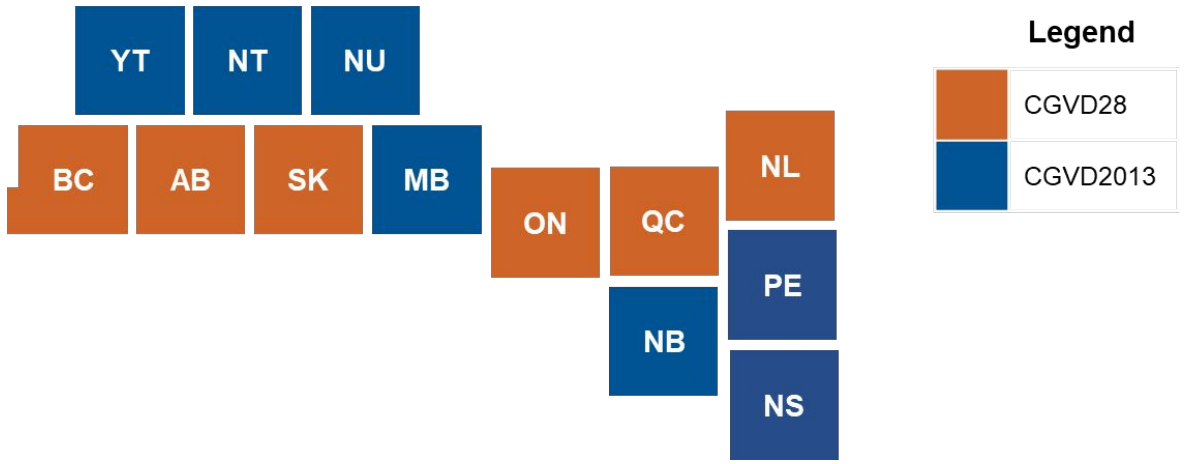
- NAD83(original) shown as original. All cases with version and epochs are for NAD83(CSRS).
- CGS only maintains NAD83(CSRS) v7 2010.0 on ACS, CBNs and through CSRS-PPP.
- For the Yukon, NRCan's Surveyor General Branch maintains parcel datasets for the territory in NAD83(CSRS) v4 2002.0 and makes them available upon request.
- In the Northwest Territories and Nunavut, NRCan's Surveyor General Branch maintains parcel datasets in NAD83(CSRS) v7 2010.0 and makes them available upon request.

Canada

Reference Frame Unification

Heights

- Provincial adopted frames
- Municipalities more complex
- Varying degrees and types of regulatory dependencies



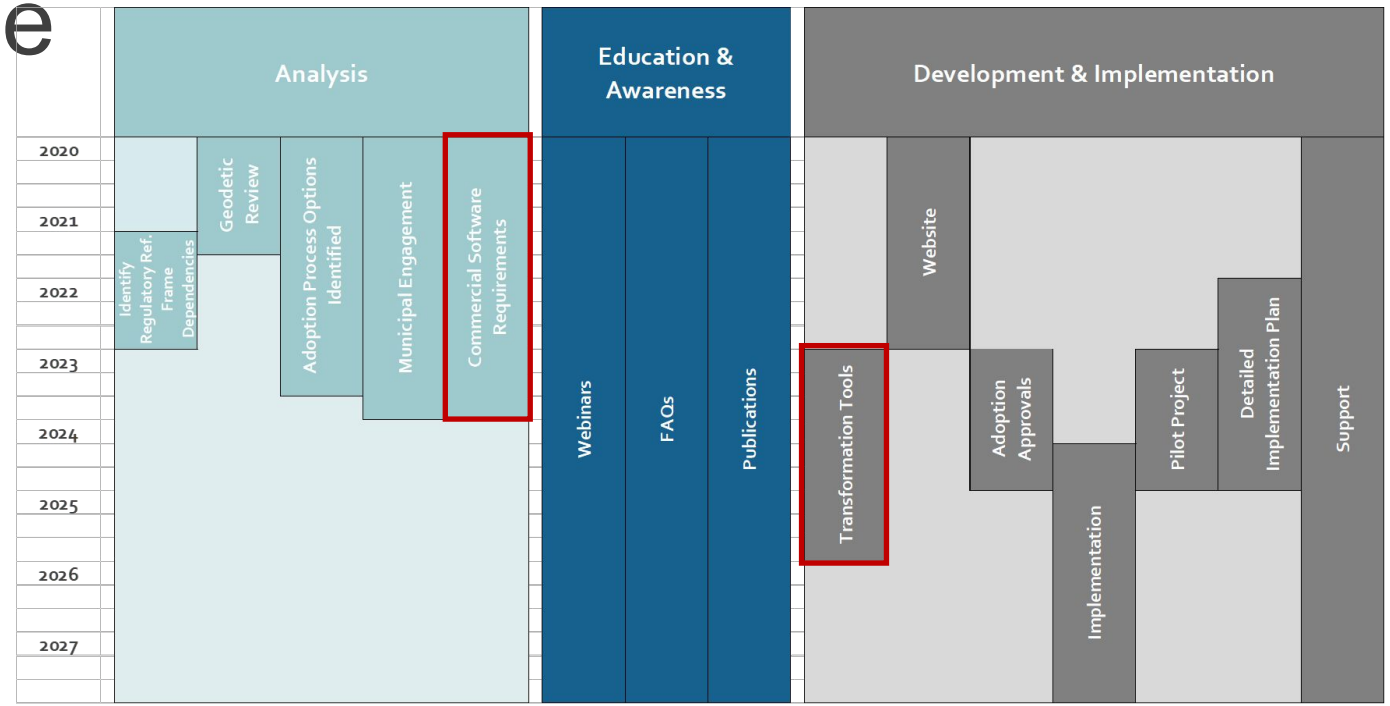
	Adopted	Published online	Available upon request	Used
BC	CGVD28	CGVD28		CGVD28
				CGVD2013
AB	CGVD28	CGVD28		CGVD28
		CGVD2013		CGVD2013
SK	CGVD28			CGVD28
MB	CGVD2013		CGVD2013	CGVD2013
			CGVD28	CGVD28
ON	CGVD28	CGVD28		CGVD28
		CGVD2013		CGVD2013
QC	CGVD28	CGVD28		CGVD28
		CGVD2013		
NB	CGVD2013	CGVD2013		CGVD2013
		CGVD28		CGVD28
PE	CGVD2013			CGVD2013
				CGVD28
NS	CGVD2013	CGVD2013		CGVD2013
		CGVD28		
NL	CGVD28	CGVD28		CGVD28
		CGVD2013		CGVD2013
YT	CGVD2013	CGVD2013		CGVD2013
		CGVD28		CGVD28
NT	CGVD2013	CGVD2013		CGVD2013
		CGVD28		CGVD28
NU	CGVD2013	CGVD2013		CGVD2013
		CGVD28		CGVD28

Reference Frame Unification

CGRSC

Unified Reference Frame Task Team

- RFMod Roadmap
  - Regulatory Dependencies
  - Municipalities



Reference Frame Unification

Stakeholder input (regulatory dependencies survey, closing December 15):

*'We have already updated to NAD83(CSRS) CGVD2013. It took months & significant effort on our part & our partners at the Province … to 1) validate our method 2) to migrate our GIS holdings from ATS77, CGVD28…We also logged a ticket with *** to incorporate WKID* 8083 into their software so we could stop using a custom coordinate system which allowed for proper projection on-the-fly by the software and *** business partner applications. This was probably a year in process. Once incorporated into ***'s software we had to migrate our GIS data again to WKID 8083, from the custom coordinate system even though they were the same spatial location. This was a matter of making the software aware this was a recognized defined coordinate system.'*

**WKT ID 8083*

Reference Frame Unification

- Importance of the connection between geospatial software and geodetic registries
- Years of planning and effort for migration
- Jurisdictions need to know what tools they will have at their disposal

What we are telling our stakeholders

- CGS will adopt NATRF2022 and a new realization of CGVD2013 in parallel with the US.
- maintaining several systems as other jurisdictions migrate
- Core products will be available and implemented in CGS Tools for 2025
  - coordinate transformations
- ***We are working with geospatial software developers to ensure the availability of tools for data layer transformations***

Thank you!

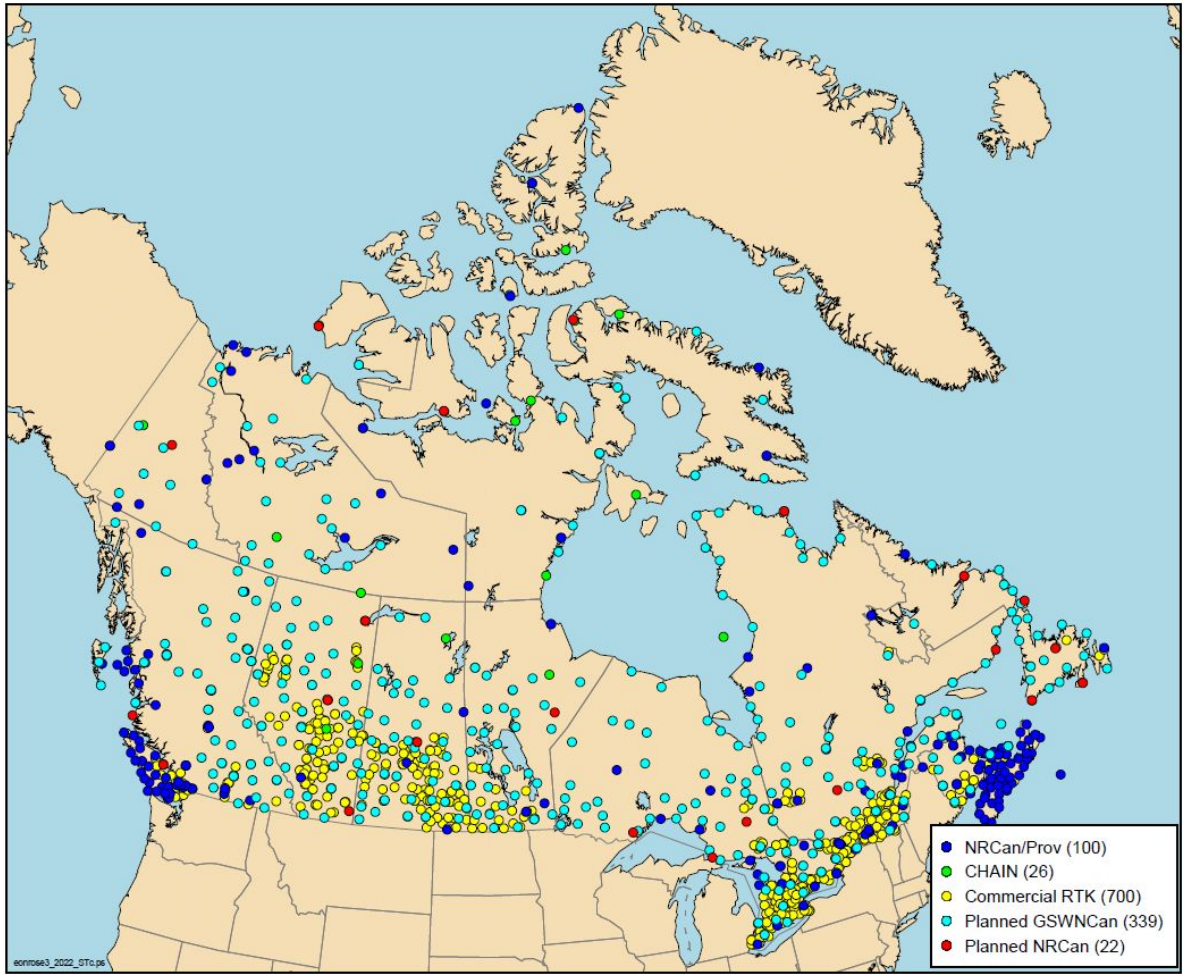
Questions?

NATRF2022

Limitations of existing geodetic services

Public and Commercial RTK services

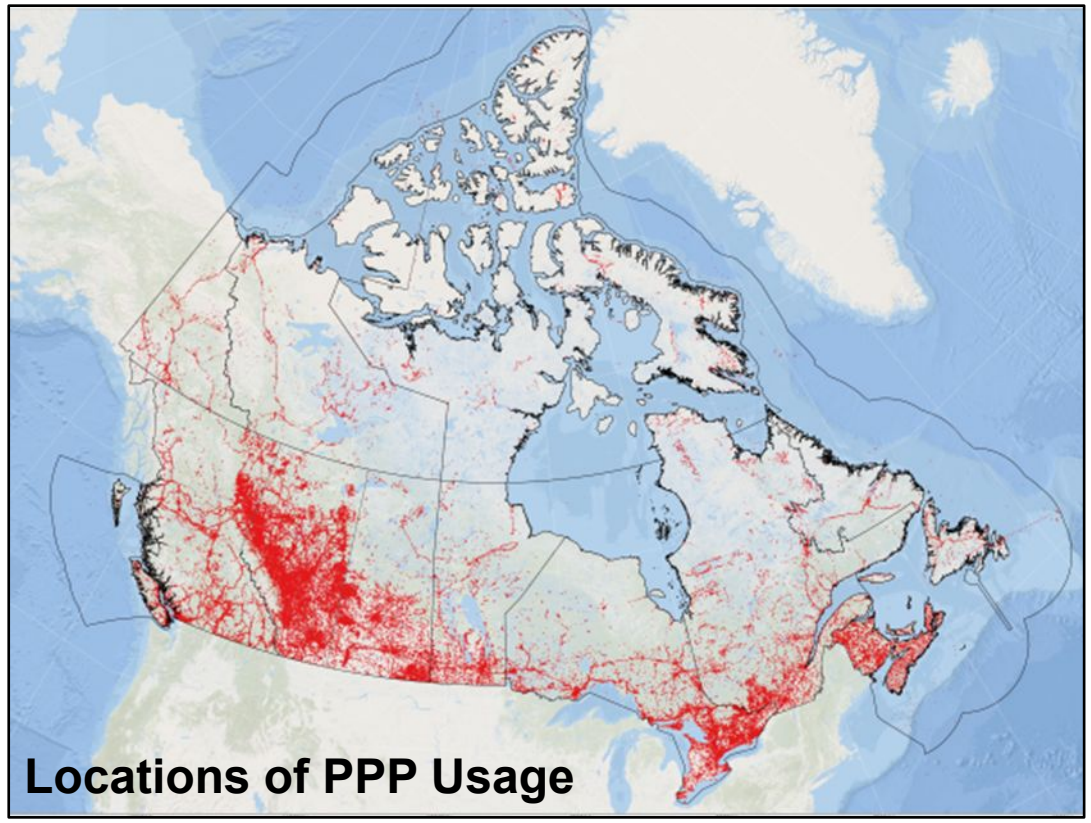
- Located primarily in the populated areas
- Commercial providers networks are not always compatible with each other or require multiple subscriptions



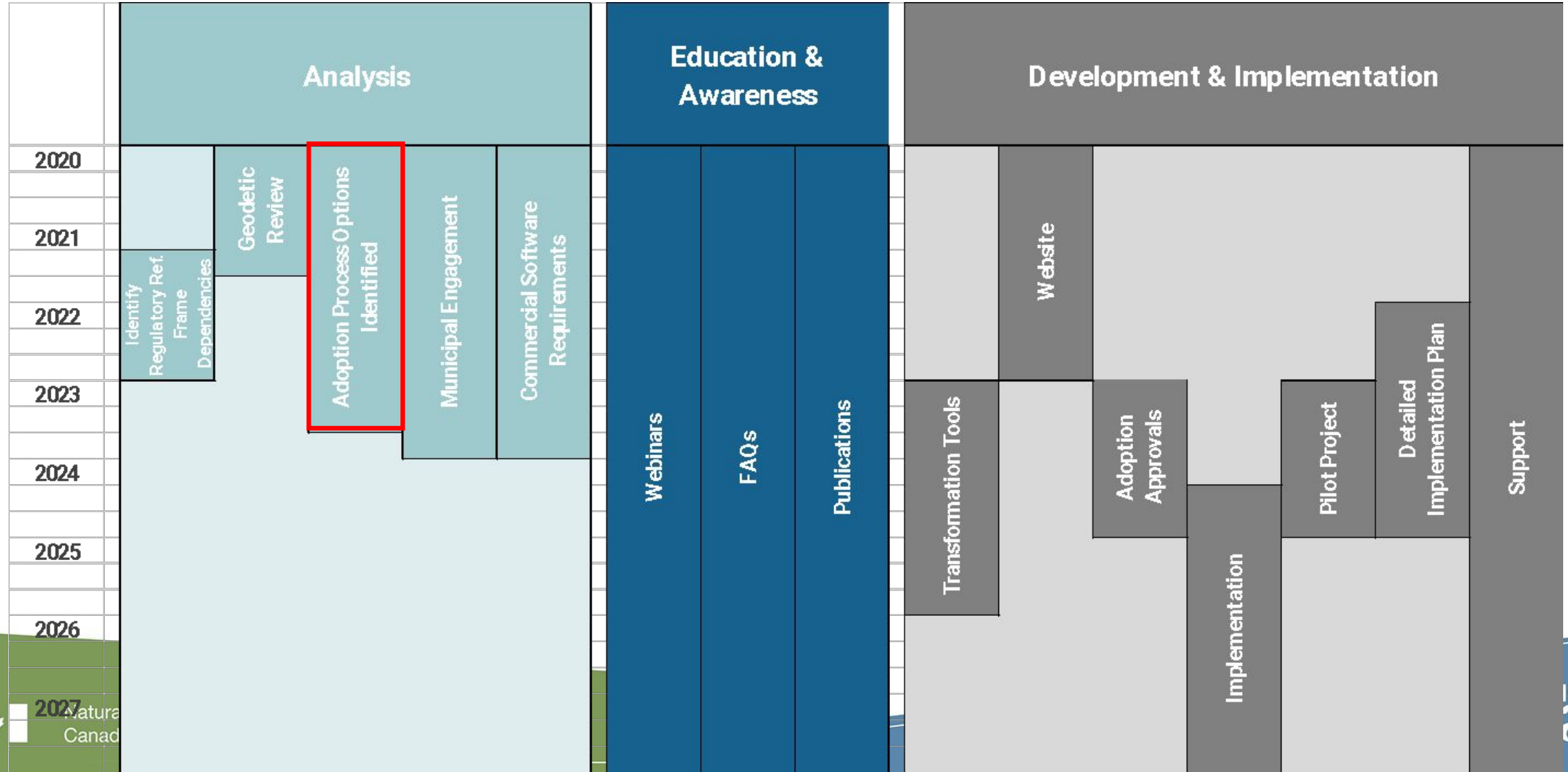
Current and planned locations of active control stations in Canada

CGS Tools: CSRS-PPP

- Precise Point Positioning (PPP) uses precise orbits in current ITRF
- Results at epoch of data
- Need to transform to NAD83(CSRS) & propagate to desired epoch – done by CSRS-PPP
- CSRS-PPP used extensively, esp. in remote areas
- Doesn't provide a direct tie to local control which is a requirement in some jurisdictions – will see differences shown in previous maps

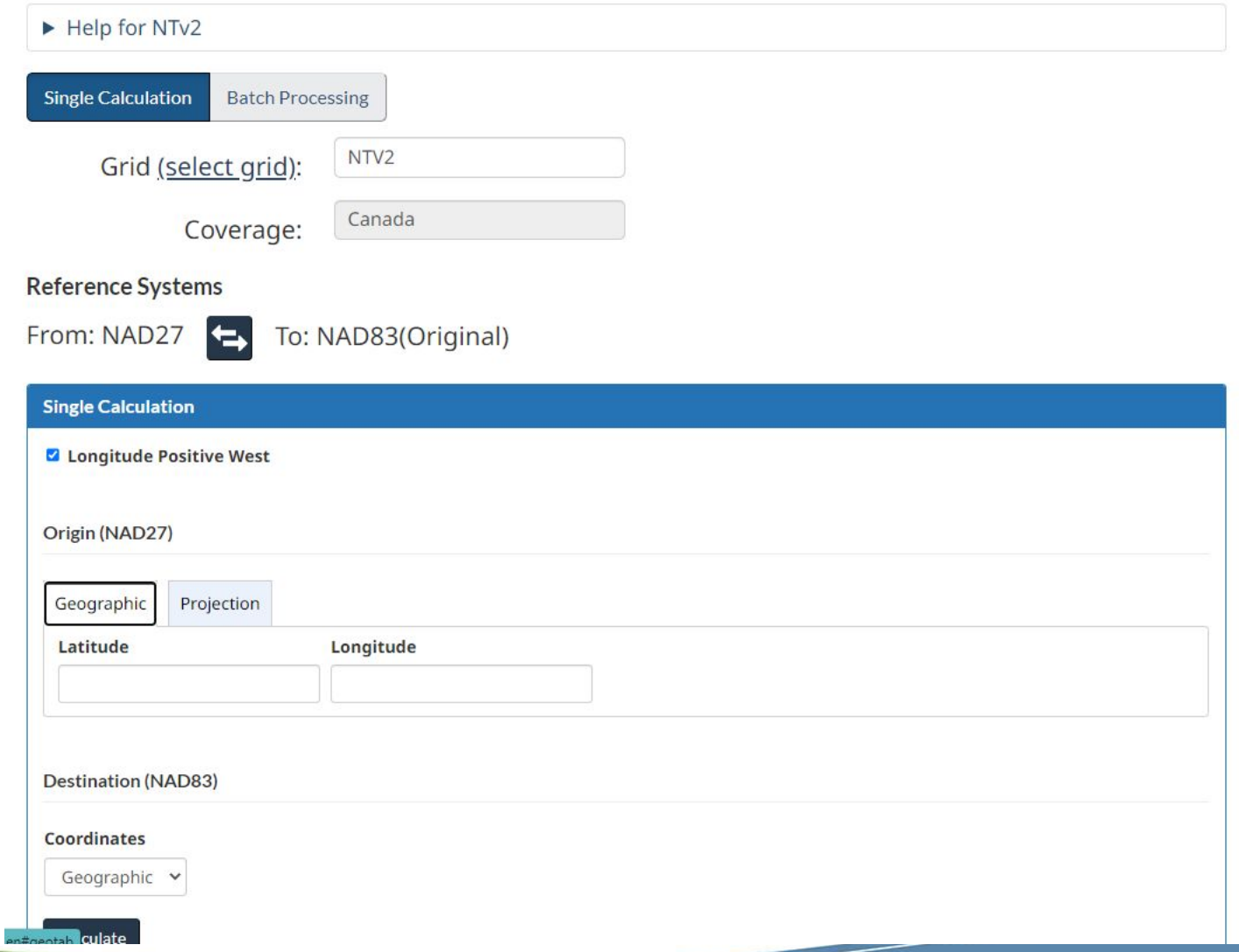


URF Task Team Roadmap

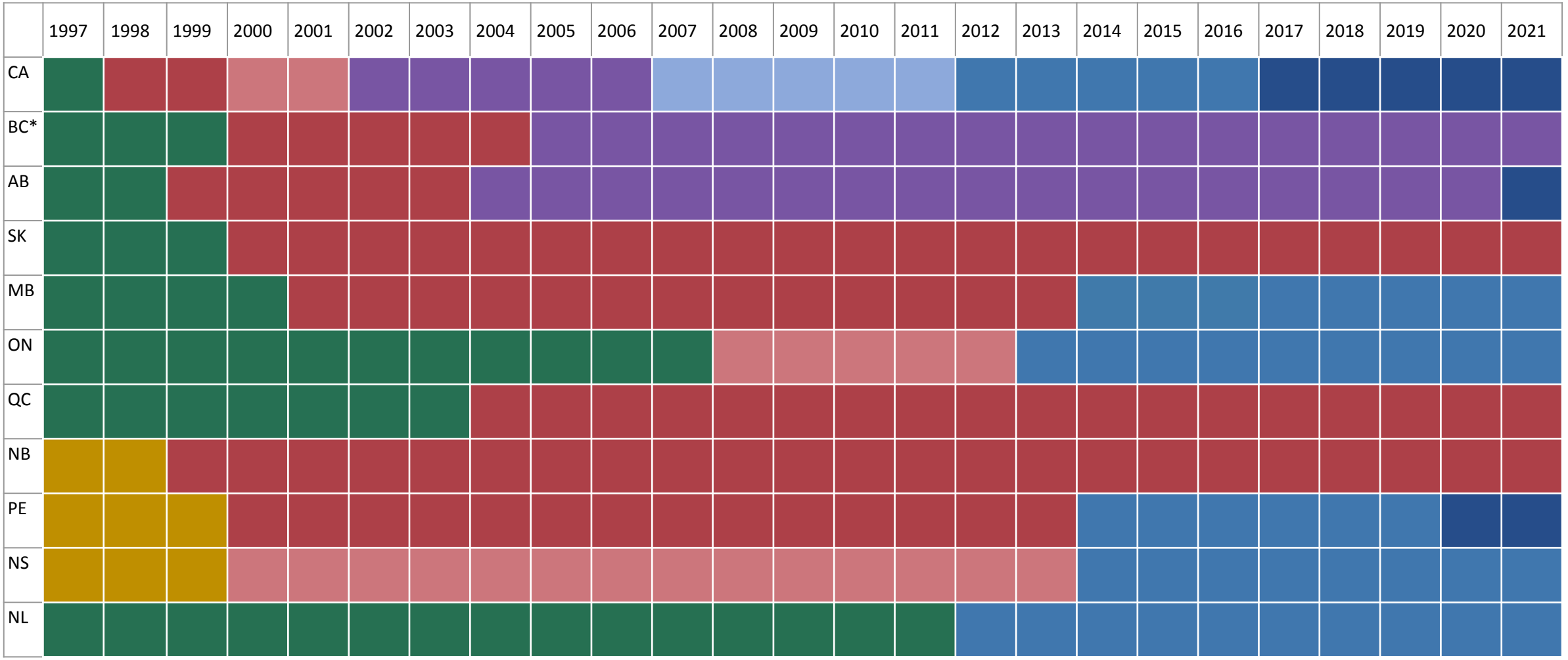


CGS Tools: NTv2

- NAD27 includes distortions
- 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.



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

Products

- New OGC grid format standards (phased roll out?)
  - 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:

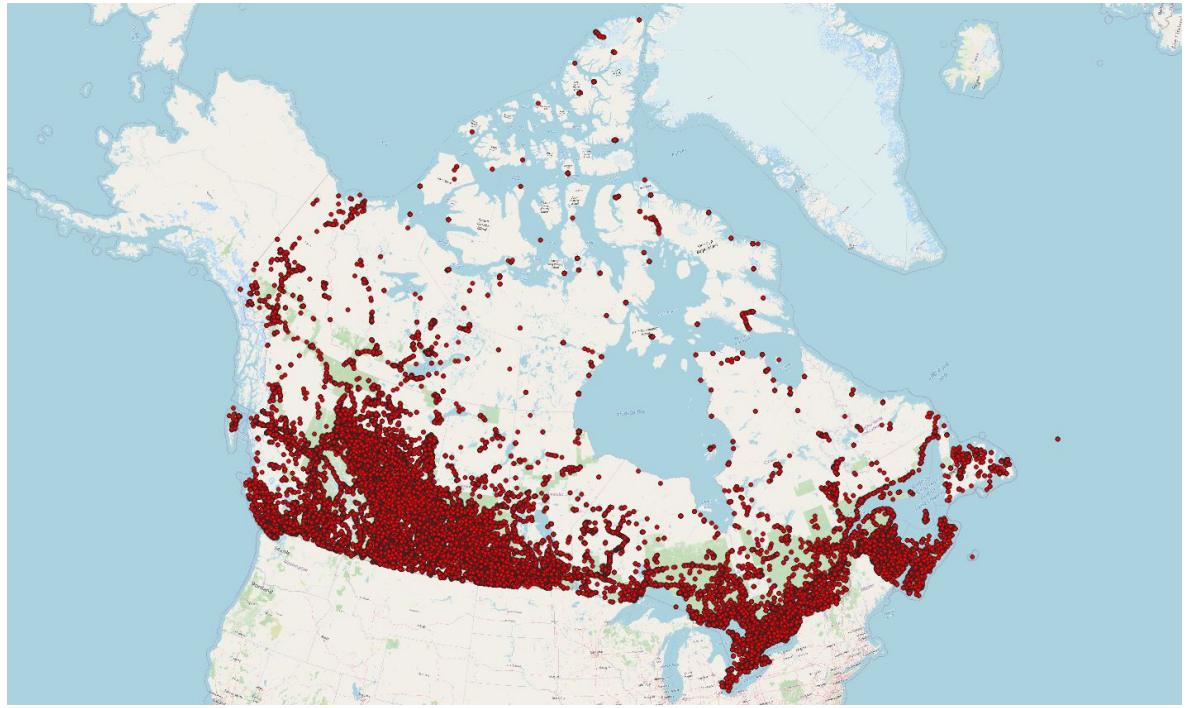
- Defining what is meant by "gridded geodetic data"
- Establishing the use case(s) for the GGXF
- Defining the user needs for a GGXF
- Defining the requirements of a GGXF
- Evaluating existing grid formats used for the exchange of geodetic data
- Determining the deficiencies of existing grid formats
- 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

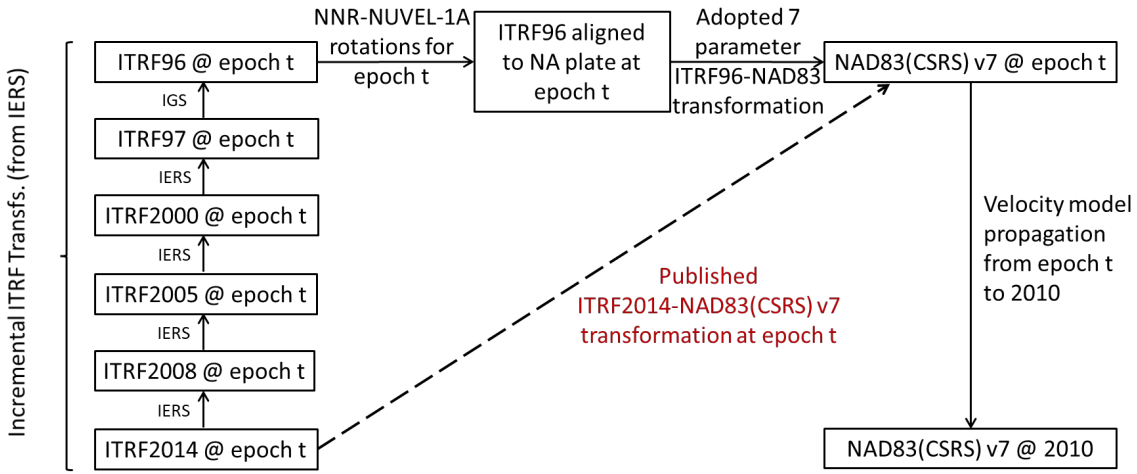
CGS Tools: CSRS-PPP

- Used extensively, particularly in remote areas and where passive control is not maintained
- Positions output in any frame and epoch as defined by the user.

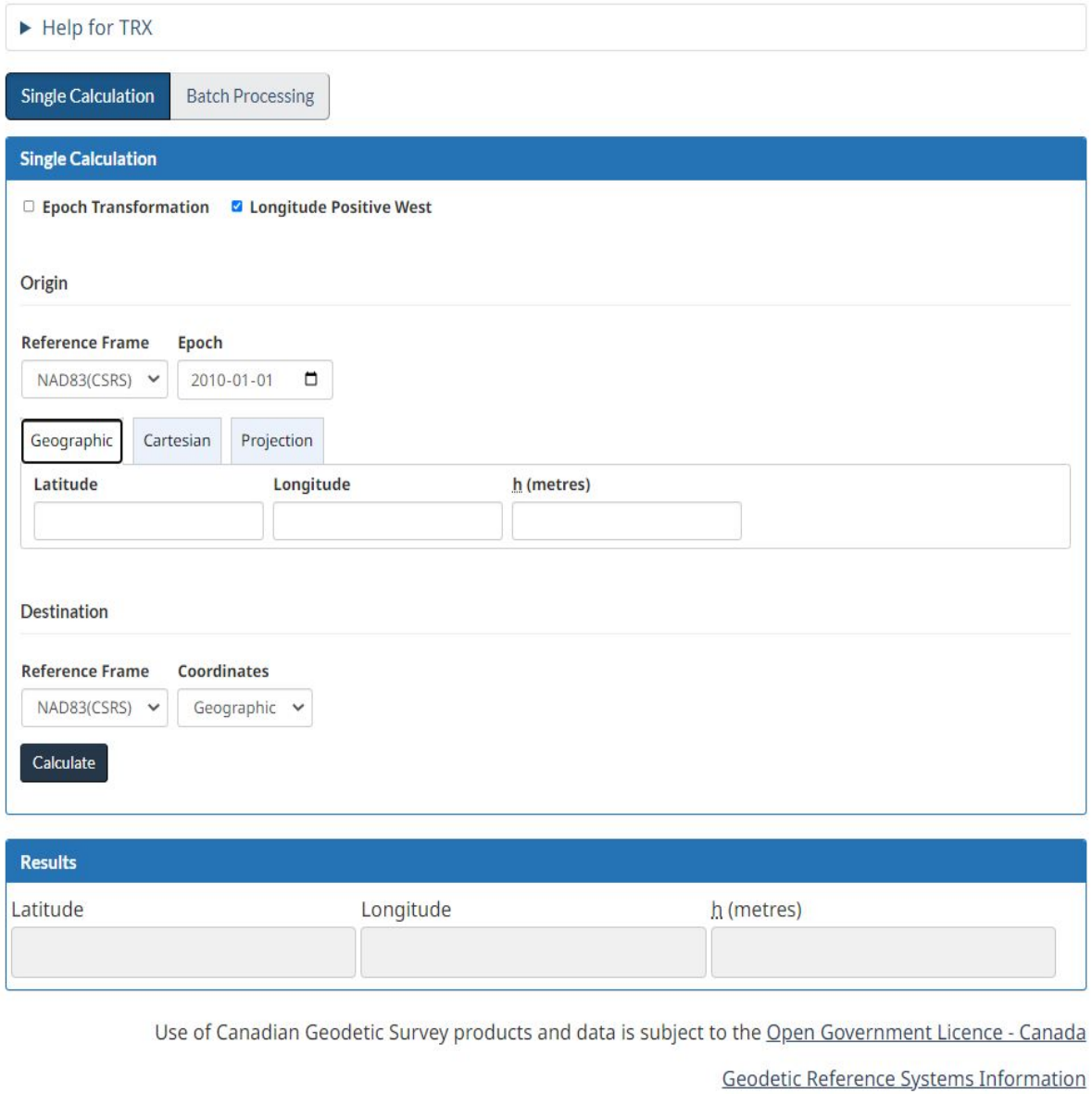


Locations of Canadian CSRS-PPP datasets in 2021

CGS Tools: TRX



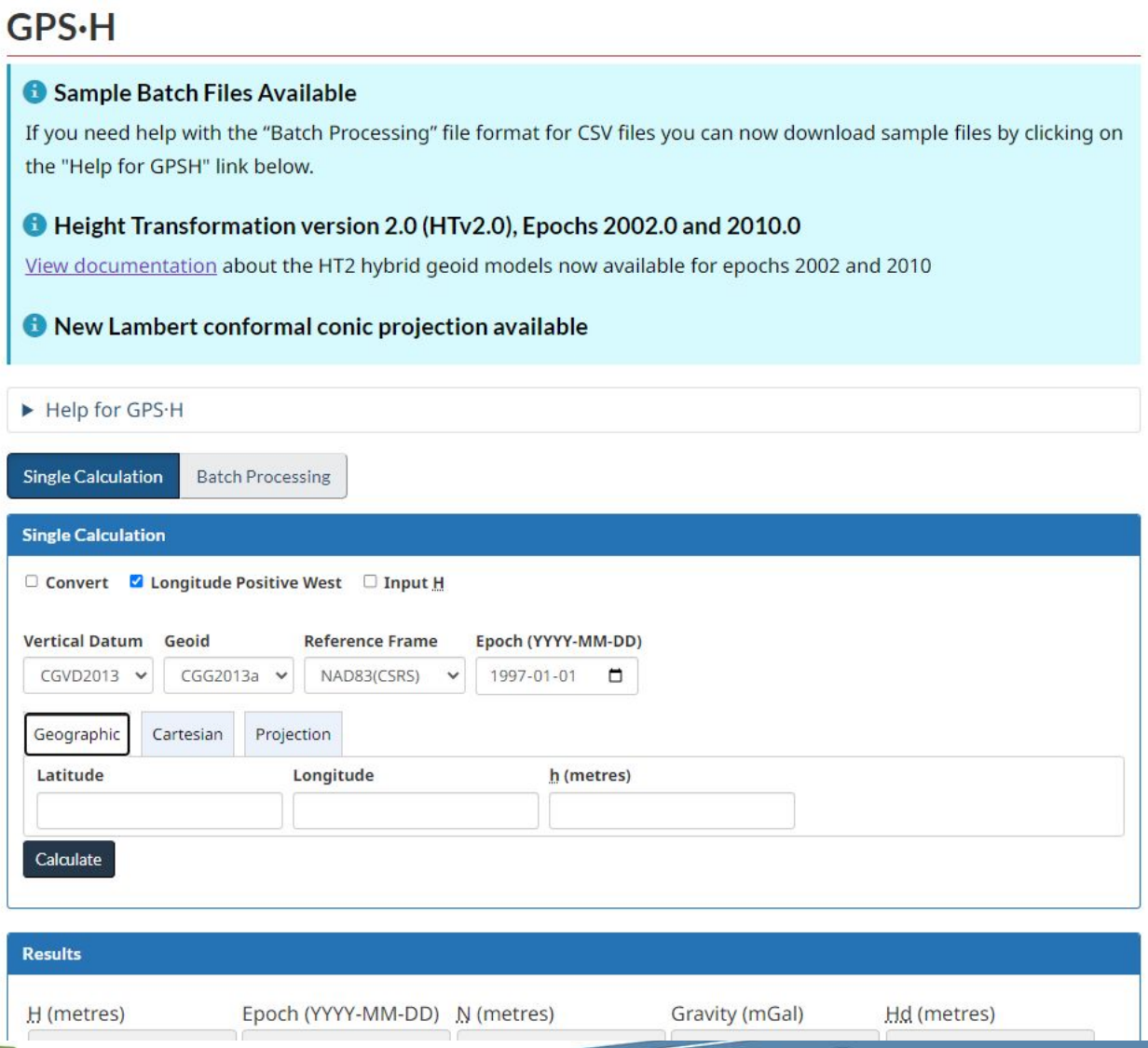
ITRF2014 to NAD83(CSRS) v7 Transformation



Geodetic Reference Systems Information

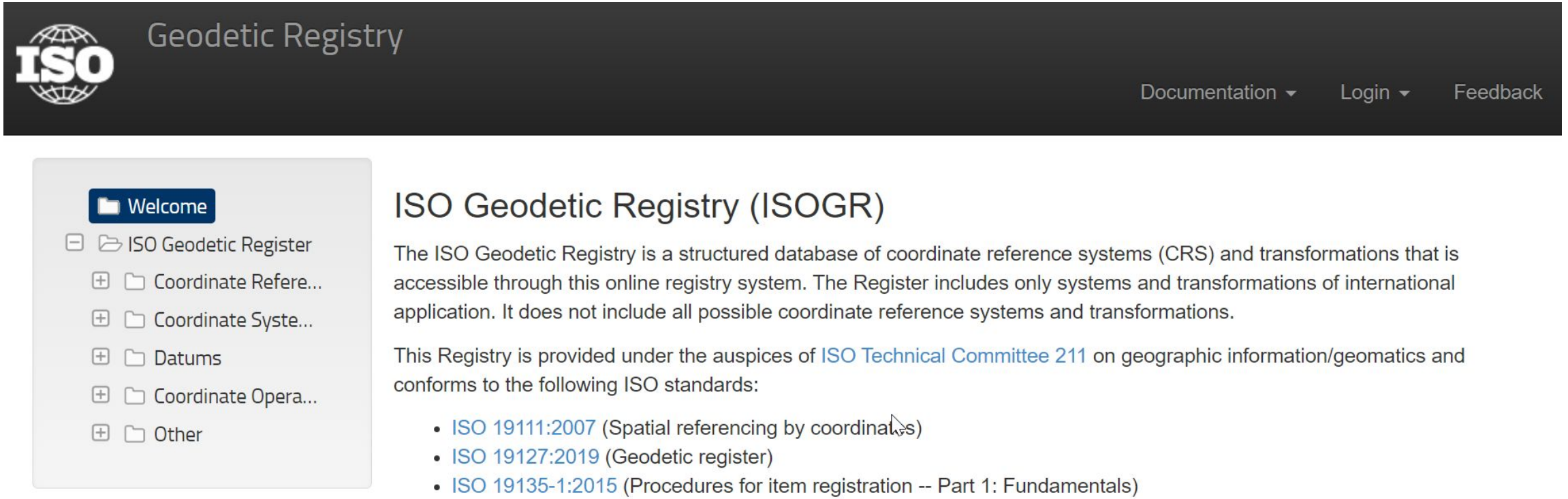
CGS Tools: GPS-H

- Tool to transform ellipsoid heights to CGVD2013 and CGVD28
- Transforms between the two at the officially adopted epochs (1997, 2002, 2010) using transformation grids



Geospatial Tools

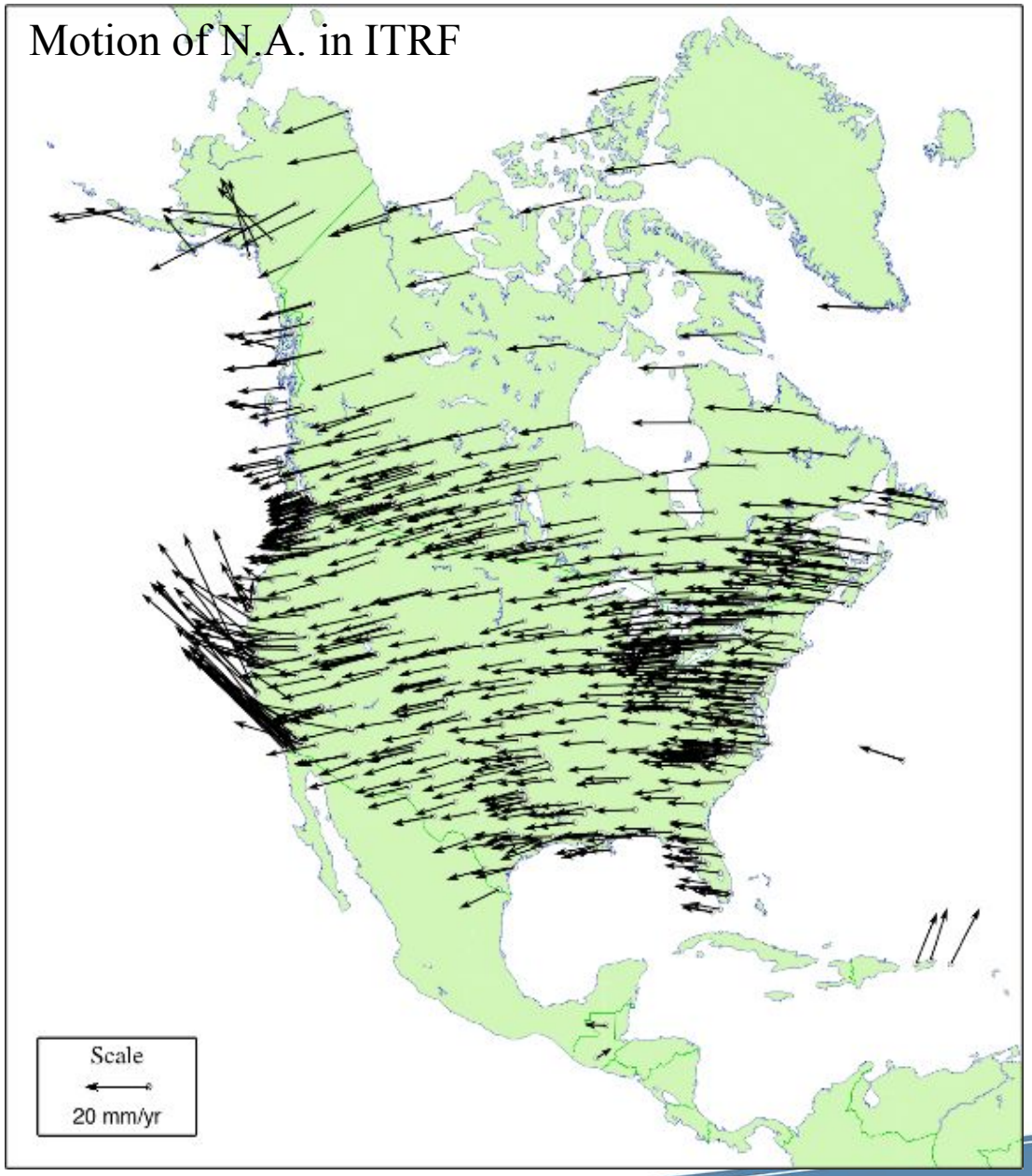
- ISO Geodetic Registry



Products

NATRF2022

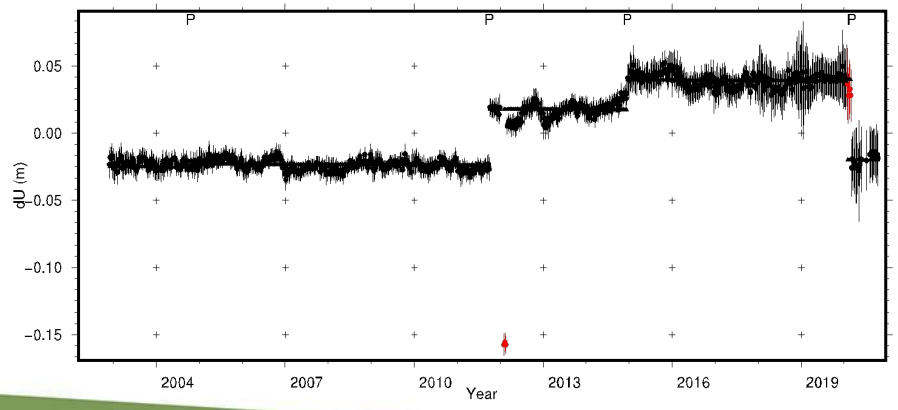
- ITRF2020 (available, CGS testing)
- North American plate rotation
  - Euler pole (NGS/CGS)

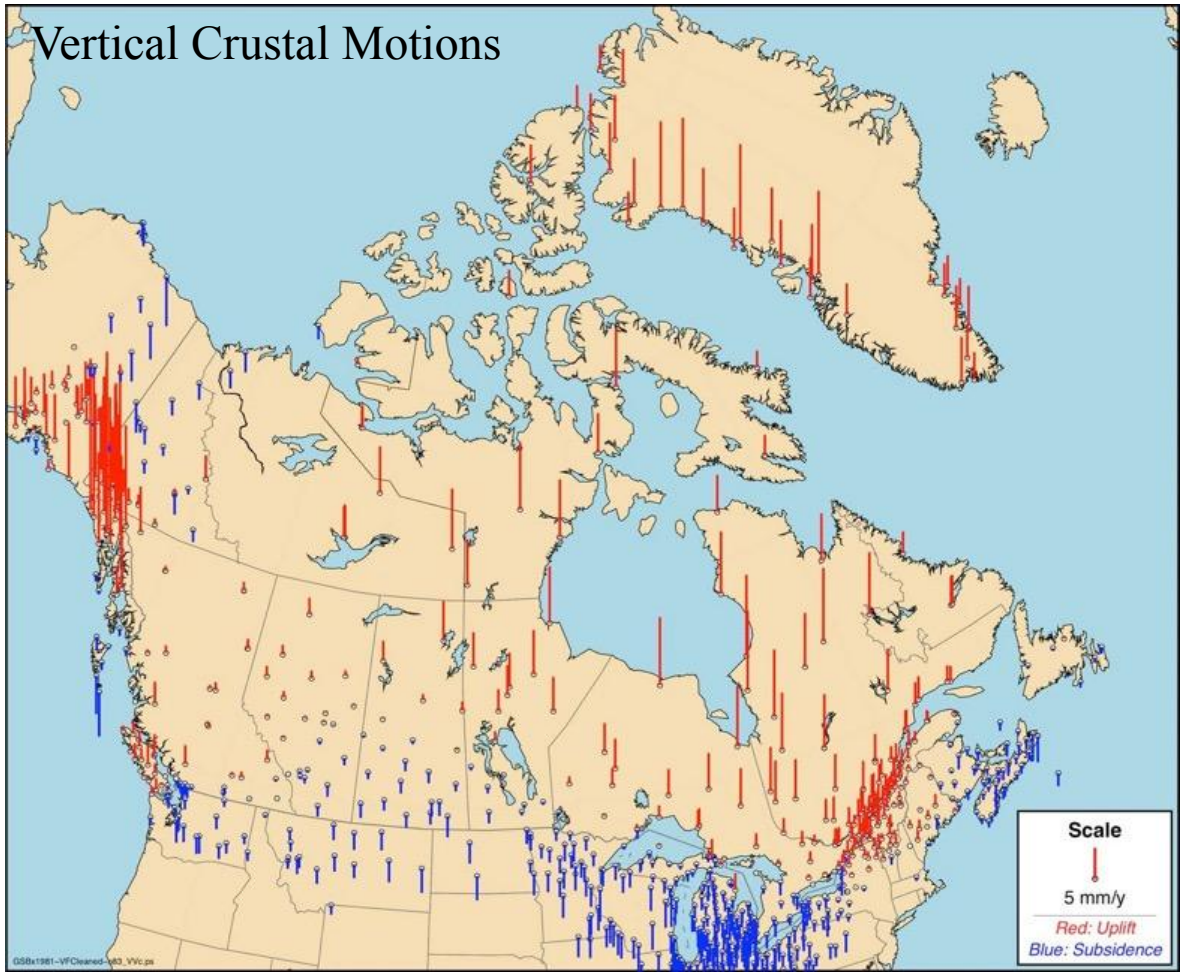


Products

NATRF2022

- Deformation model
  - account for intraplate crustal motion to allow changing coordinate epochs
  - Common velocities (NGS/CGS)

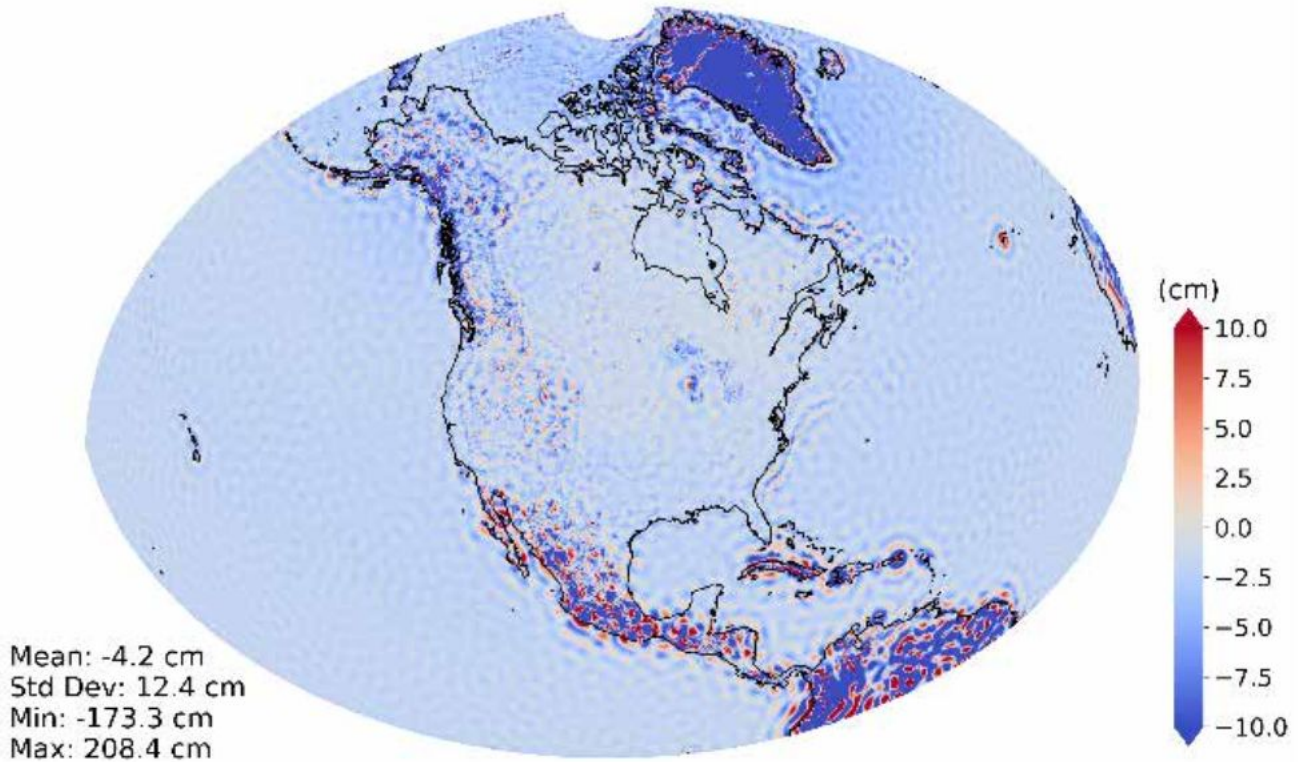




Products

CGVD2013: 2025 update

- Canadian provincial and oth stakeholders prefer to keep the name CGVD2013
- Canada may adopt the nam NAPGD2022 once both NSRS & CSRS include dynamic heights



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