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Intraframe Deformation Modelling in Canada:

NAD83(CSRS) v8.0 Velocity Grid

Binational Geospatial Software Developers Summit
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Canadian Geodetic Survey

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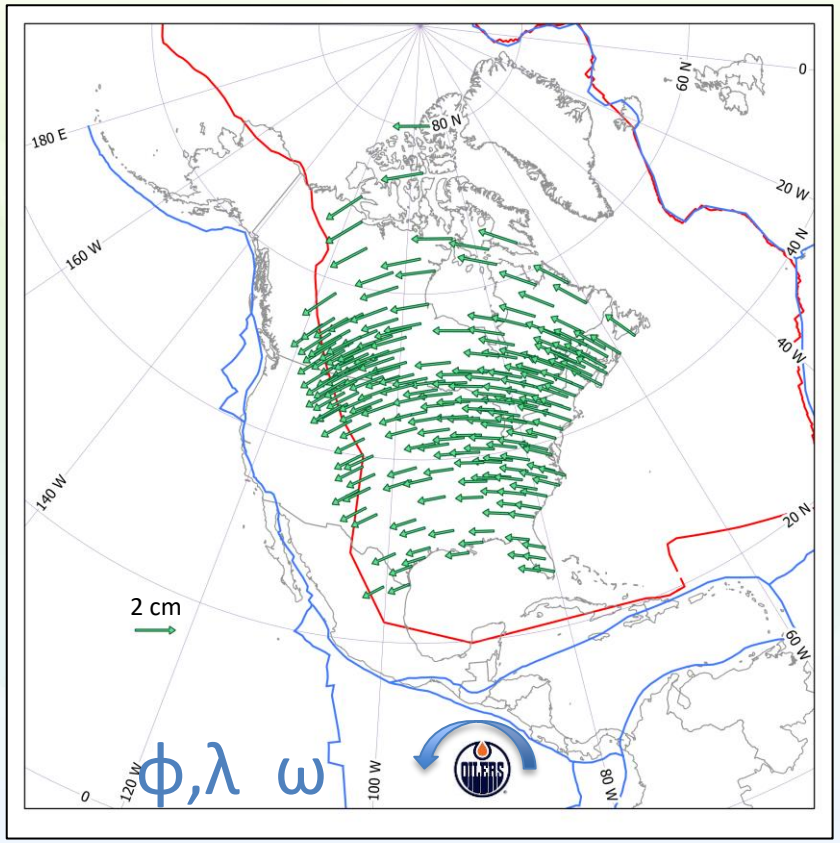
Canada

EPPs remove most North American Plate motion



Intraframe Velocity Model used to Capture Residual Motion

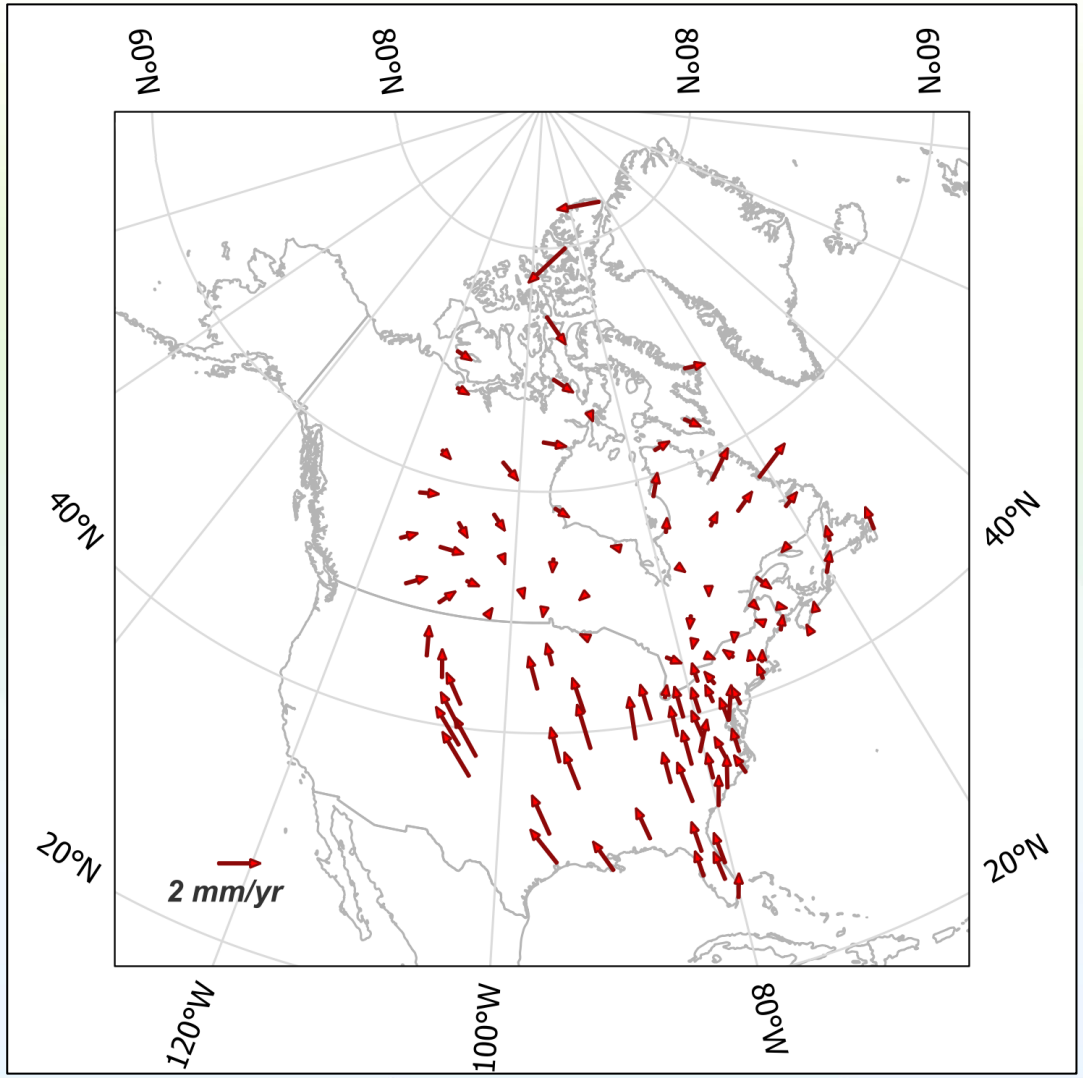
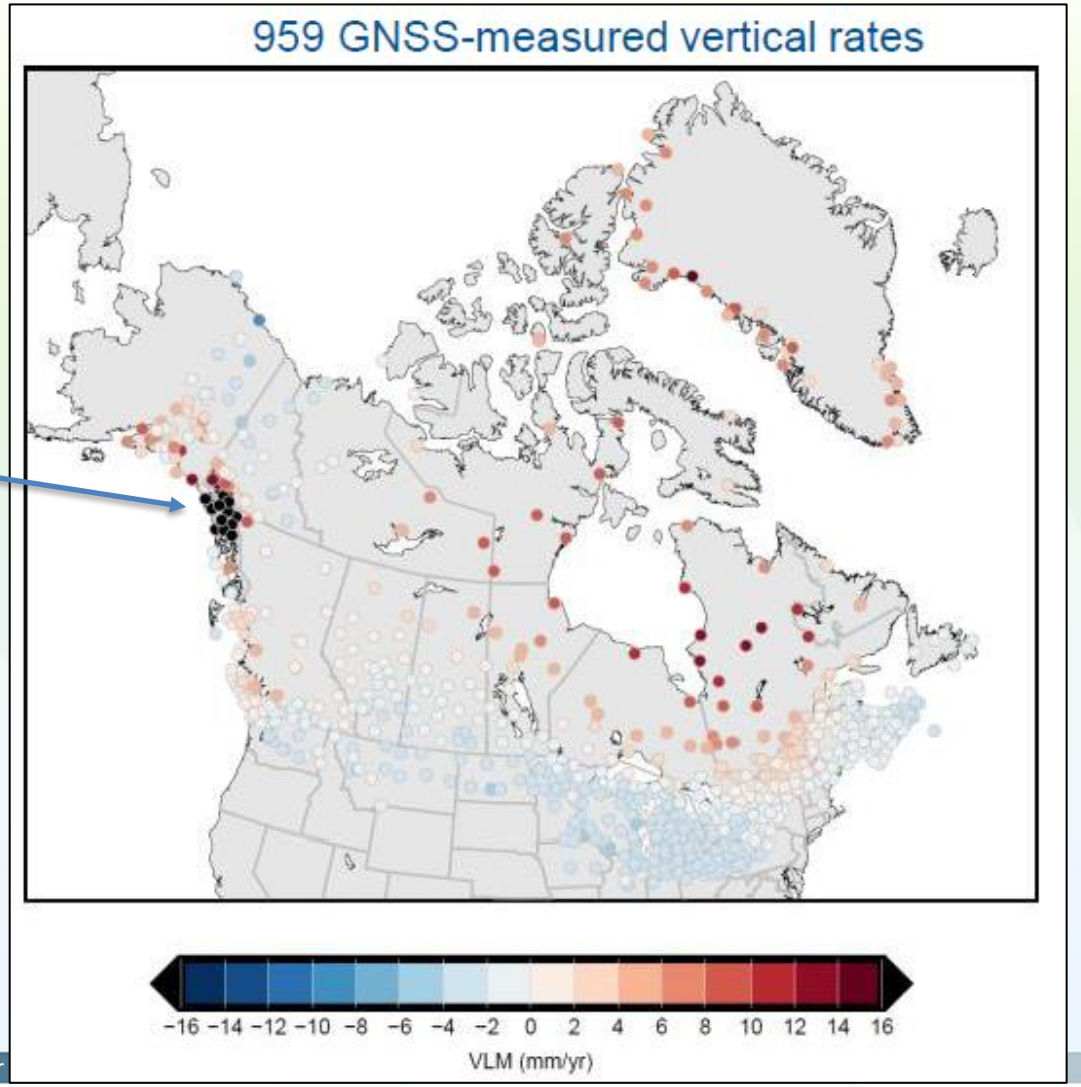


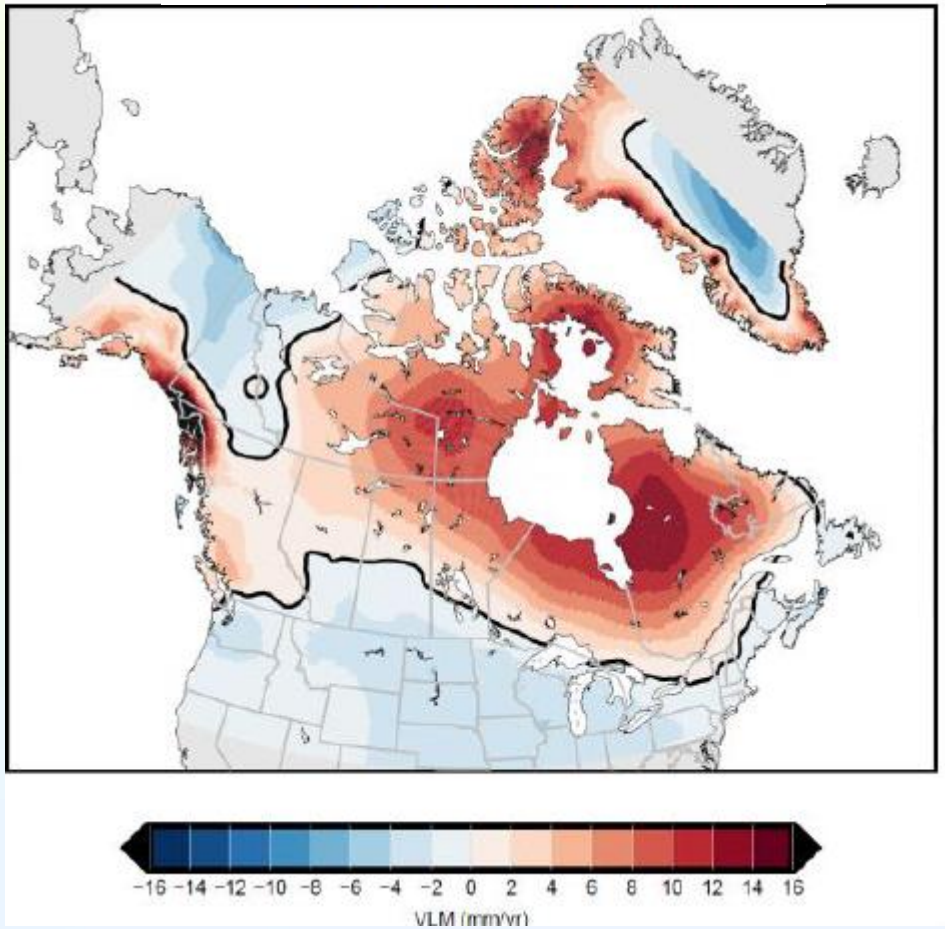
Plate movement that is not captured by EPPs is modelled using an Intraframe Velocity Model

Complex west coast

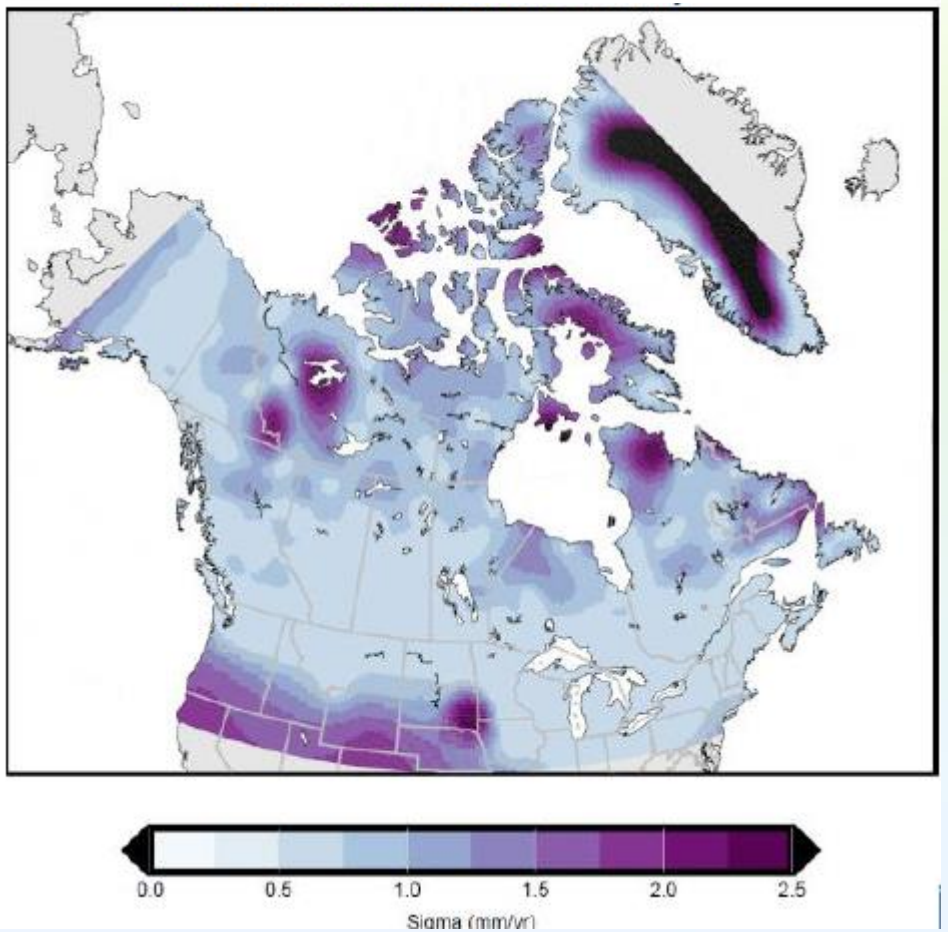


Horizontal and Vertical Land Motion Models Combined with GNSS are Used to Capture Time Dependent Movement

V8 Vertical Land Motion Predictions



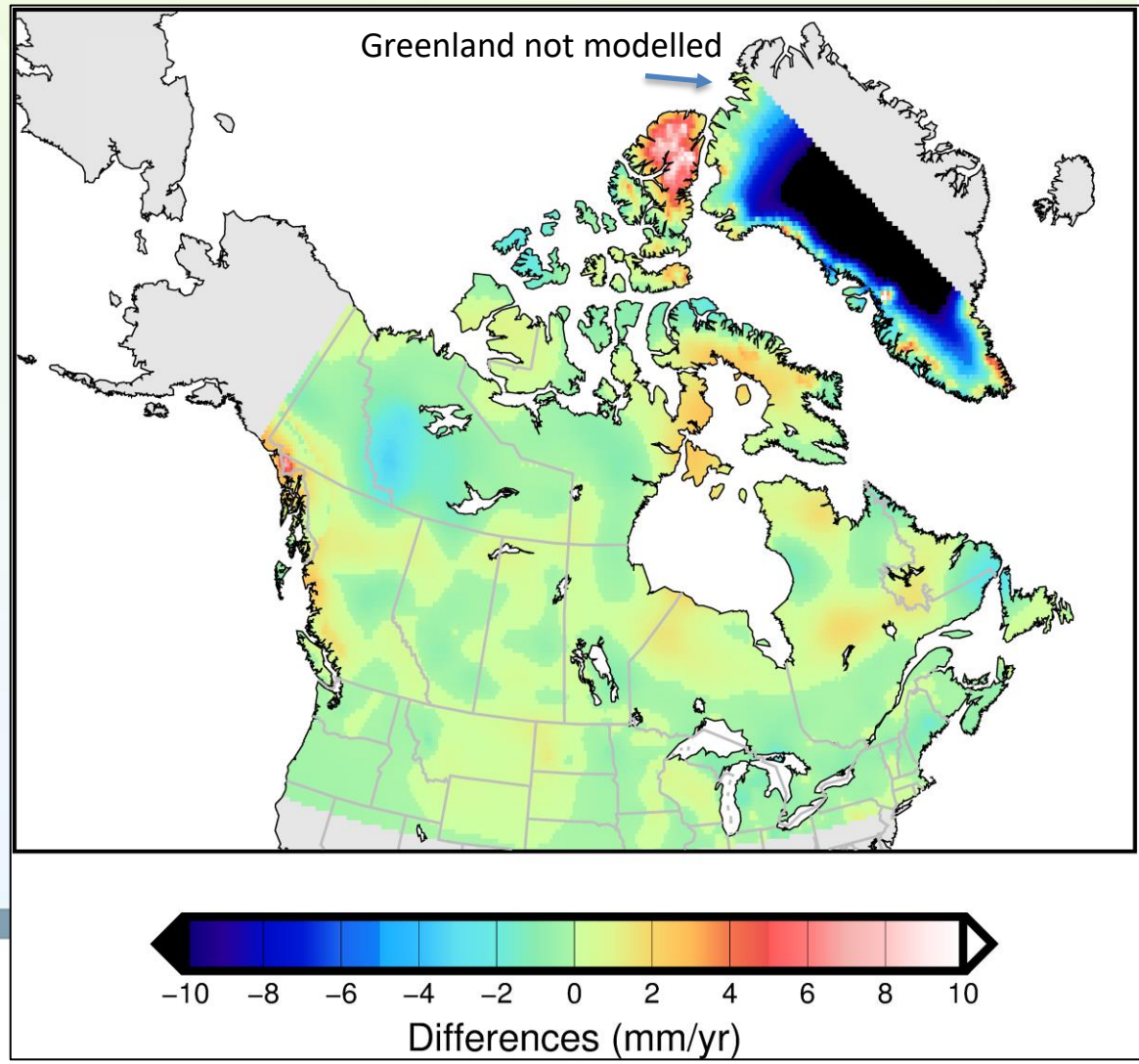
V8 Vertical Land Motion Uncertainty Predictions



V8 Velocity Model Updates

- 6 more years of data at existing stations
- New stations filling coverage gaps
- Public ACS data reprocessed using repro3 products, new standards and models and the new Bernese v5.4 GNSS software;
- Updated modelling of offsets caused by earthquakes, equipment changes and other disruptions
- Improved GIA modelling

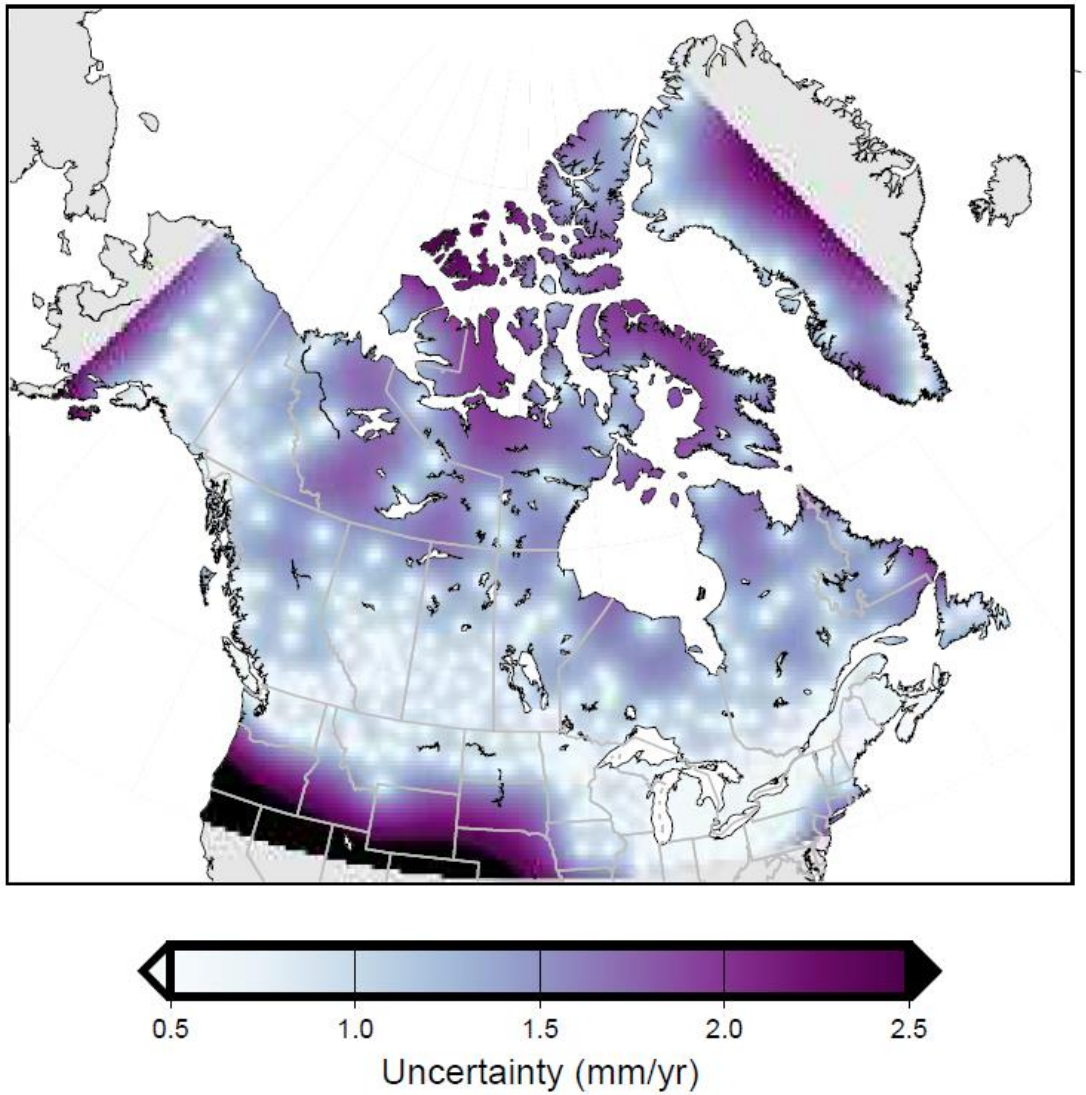
V8 vs V7 Vertical Model Differences



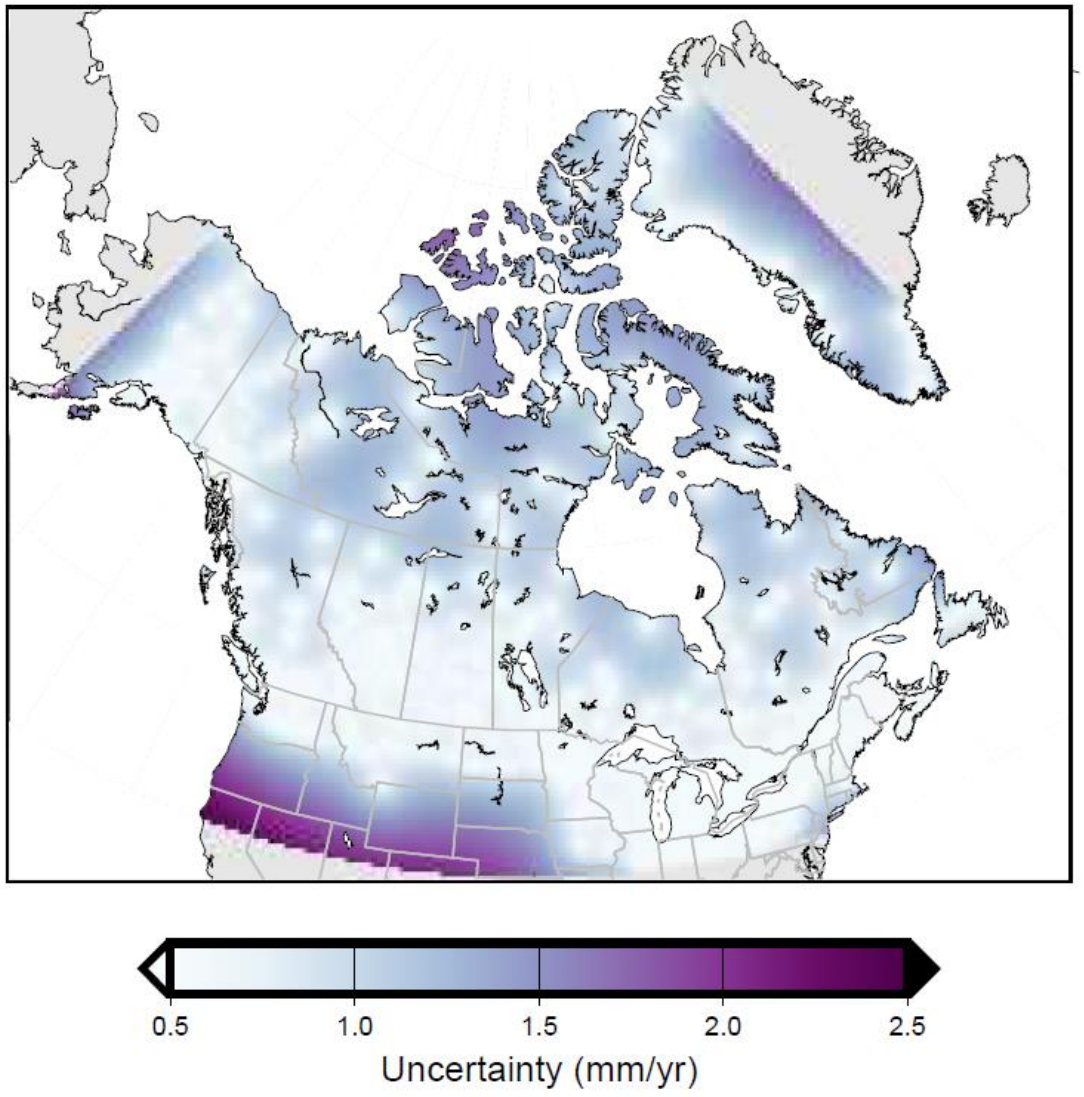
CGS encourages the use of our VM to propagate geodetic coordinates

- PPP coordinates are calculated at survey epoch in ITRF
- User typically wants coordinates at reference epoch in NAD83CSRS (NATRF2022) (1997.0, 2002.0, 2010.0)
- Velocity model enables the epoch adjustment
- Uncertainty is propagated so that the user is aware of added error in coordinates

NORTH



EAST



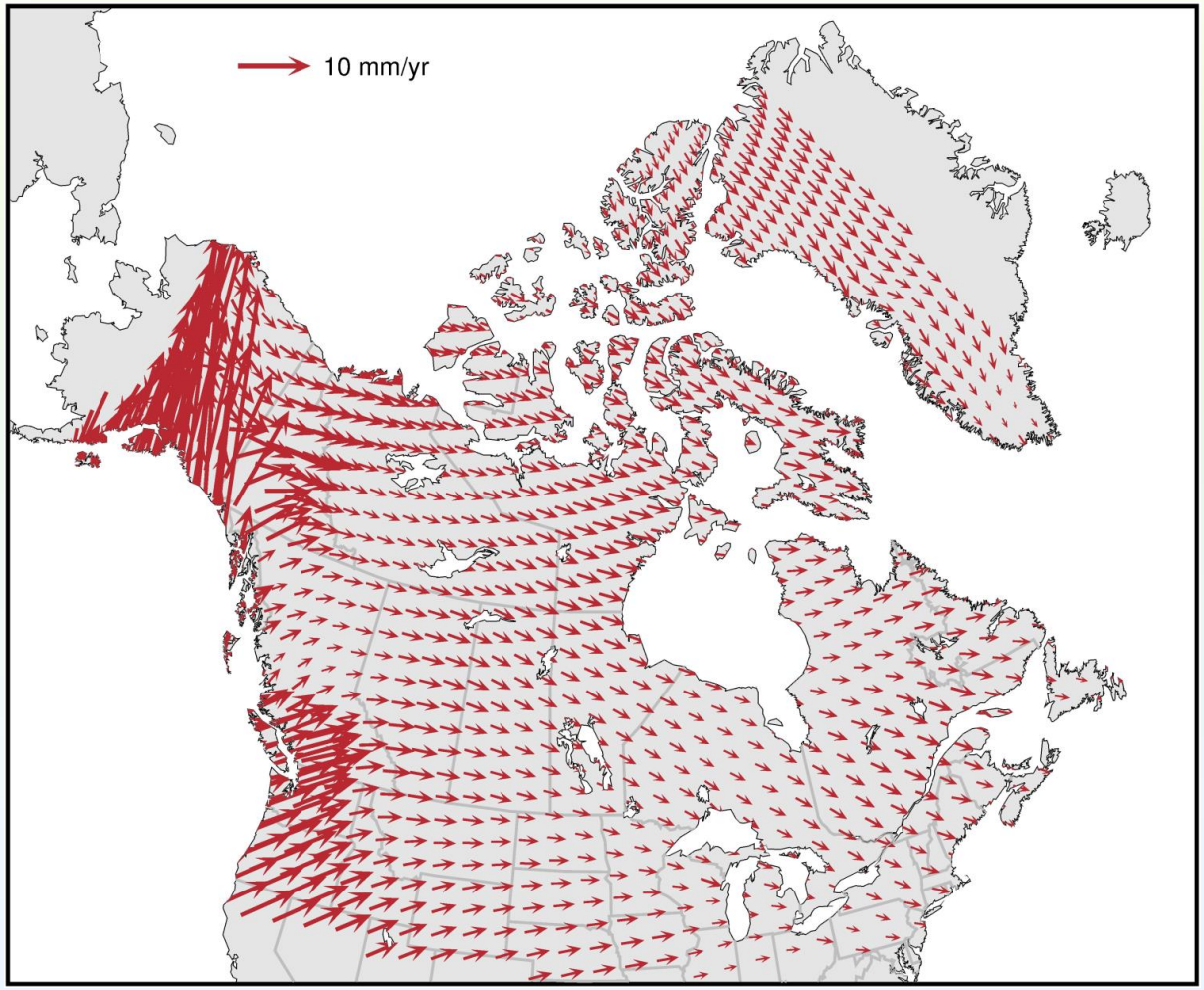
FAQs

What format is velocity grid in?	• NTv2_Vel Grid File Format • GGXF implementation is being pursued
Where can I get the velocity grid?	https://webapp.csrs-scrs.nrcan-rncan.gc.ca/geod/data-donnees/transformations.php
What happens after an earthquake?	• CGS strives to provide updates to the velocity model on an annual basis. During the update process, station position time series are analyzed before computing new velocities. While equipment change offsets can be easily modelled, post-seismic deformation after an earthquake may take many years to stabilize and appropriately model. CGS is currently researching the integration of Block Modelling techniques to more closely capture movement in tectonically active areas. For the highest accuracy positioning requirements, there is no substitute for a present-day measurement at the points of interest.
What velocity is extracted from a coordinate mapping function to be integrated into the velocity model?	• The most recent velocity in the mapping function is typically used in the velocity model. This value reflects present day geodynamics. If someone is trying to determine a historic coordinate value, a mapping function may be more appropriate to use for a nearby station.

Final Thoughts

- The velocity model is a critical piece of geodetic computations in Canada

- It will continue to be enhanced to meet the needs of our stakeholders
  - Ongoing plate sampling / observations
  - Enhanced GIA modelling
  - Integrated Block modelling



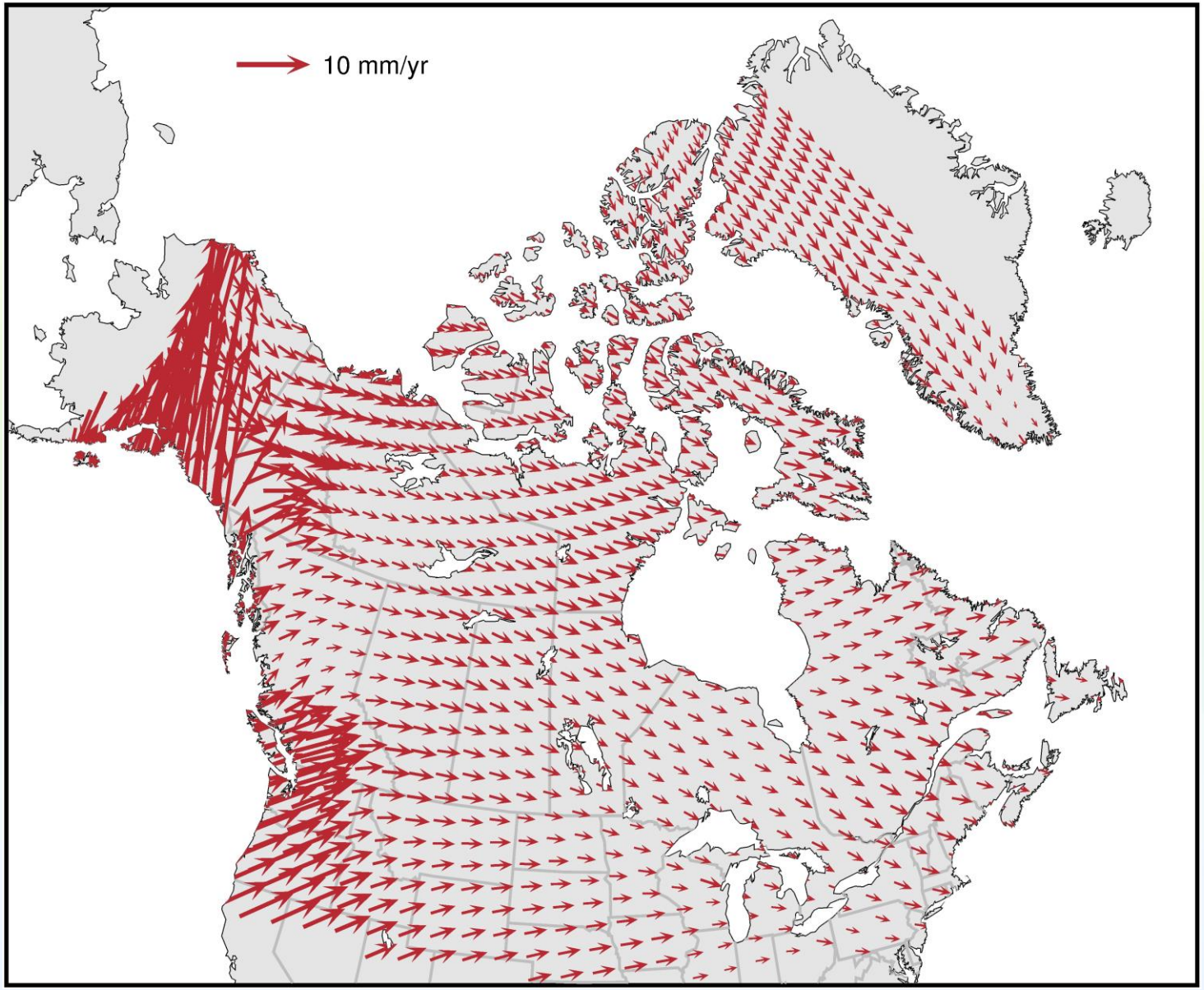
Extras

NAD83(CSRS) v8.0 Velocity Grid

- The NAD83(CSRS) version 8.0 Velocity Grid can be used to interpolate velocities to any point in Canada for propagating NAD83coordinates from one epoch to another. The grid is used in the TRX and CSRS-PPP software from the Canadian Geodetic Survey.

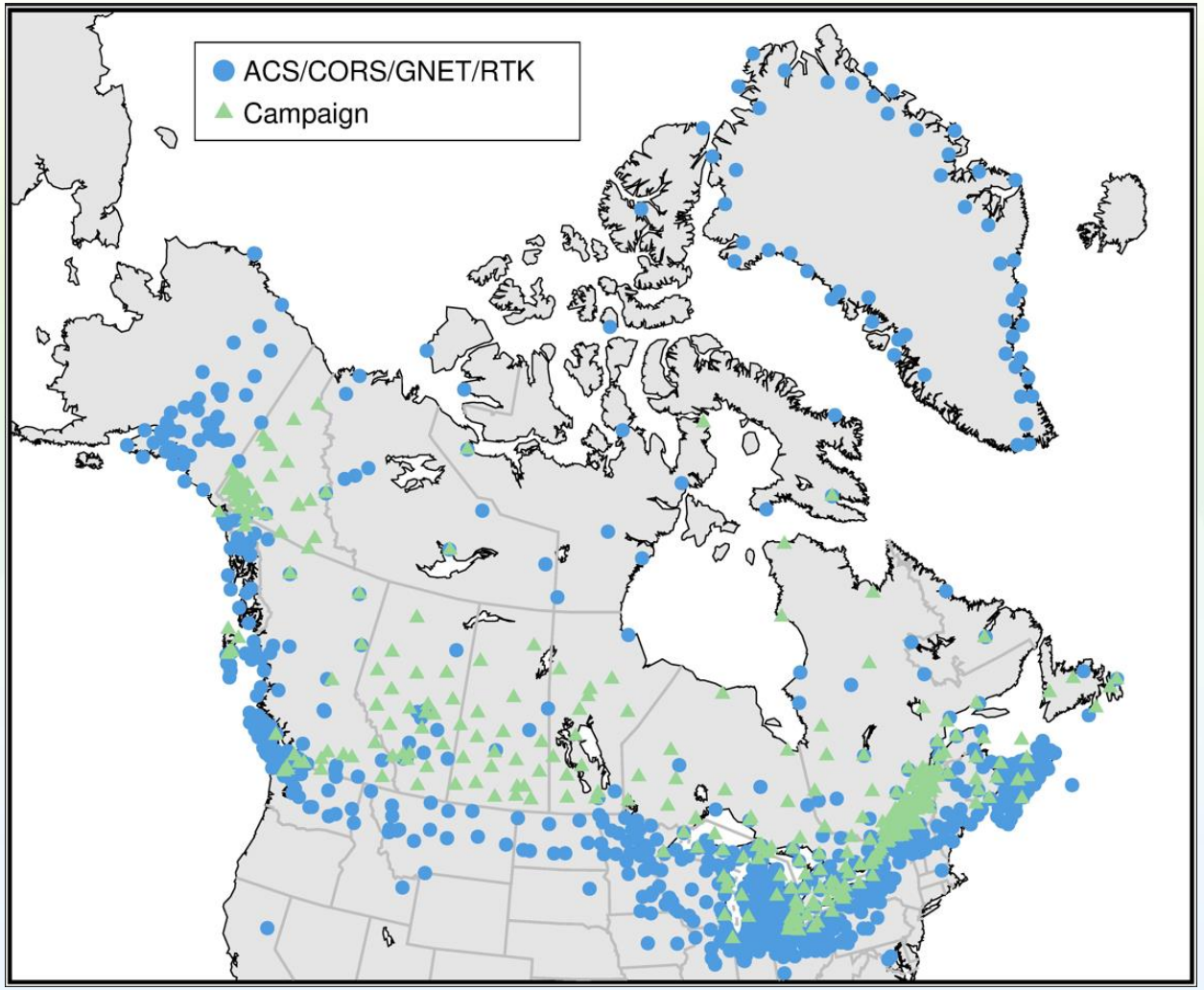
- Version 8.0 of the velocity grid was derived from the combination of a GIA model with the GSBx-2294v2-PV-N83.snx GPS velocity solution using data up to GPS week 2294(Dec 30, 2023) and IGS repro3 orbits in the IGb14/ITRF2014 reference frame and realigned to IGS20/ITRF2020. The GPS solution and merged GIA model were then transformed to NAD83(CSRS) v8 and combined together into a GIA-GPS hybrid grid for the vertical component that provides more reliable results in northern Canada where there are few GPS stations.

- WARNING: The GPS velocity field upon which the velocity grid is based is still rather sparse along the west coast of Canada, especially along the BC north coast, the Yukon and western NWT. The GIA will have some impact in northern BC, southwest Yukon and Alaska. South of that, the signal is not so large and the more recent active tectonic deformation occurring in the region will be the dominant signal. The grid is therefore still not very reliable in this region. USE AT YOUR OWN RISK!



Horizontal Velocity Model

High-accuracy, velocities across the North American Plate have been determined to estimate Euler Pole Parameters (EPPs)



Challenges

- In tectonically active areas, the velocity model may not be representative of current geodynamics. When in doubt…reobserve