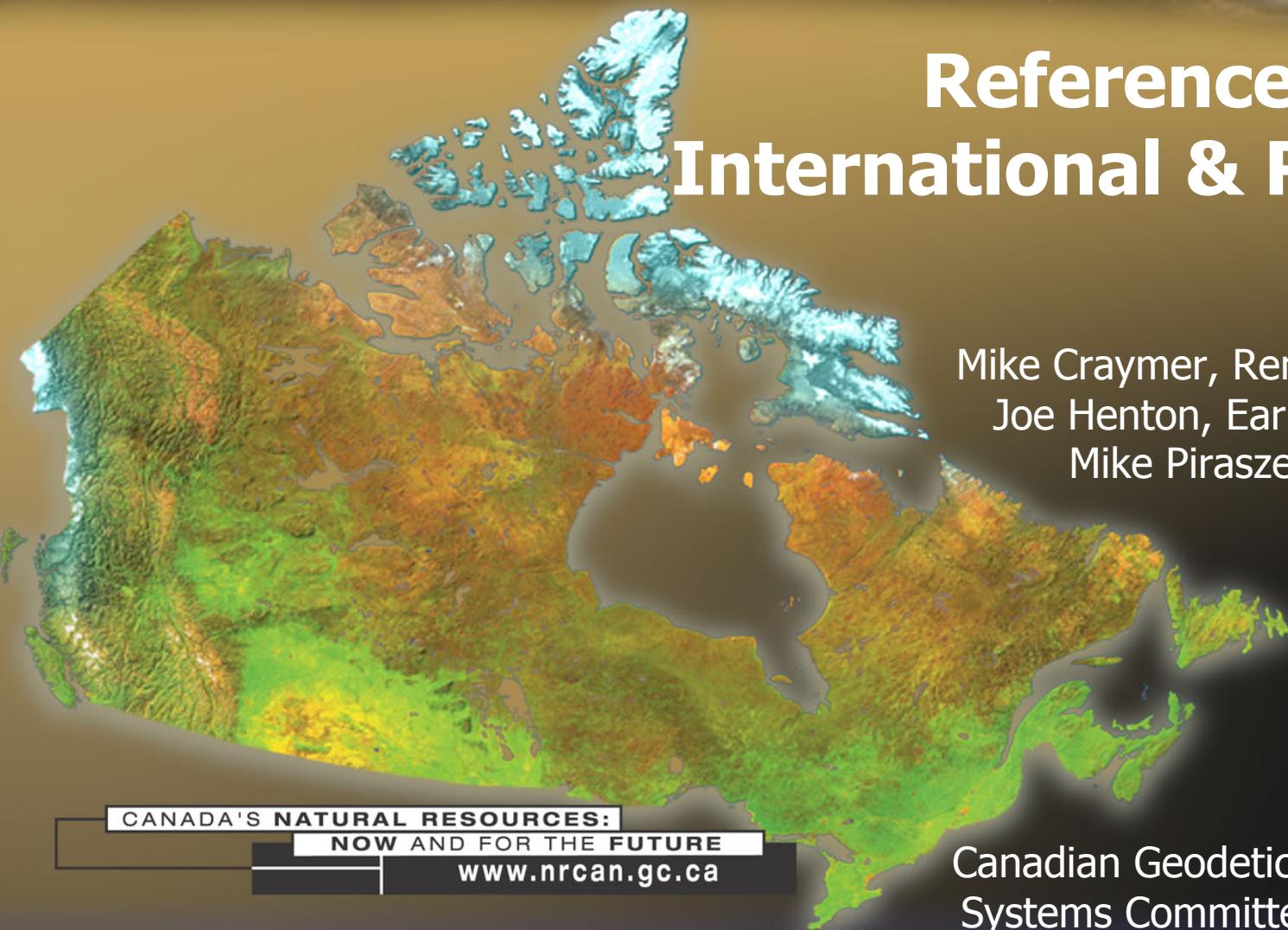




Reference Frames International & Regional



Mike Craymer, Remi Ferland,
Joe Henton, Earl Lapelle,
Mike Piraszewski

CANADA'S NATURAL RESOURCES:
NOW AND FOR THE FUTURE
www.nrcan.gc.ca

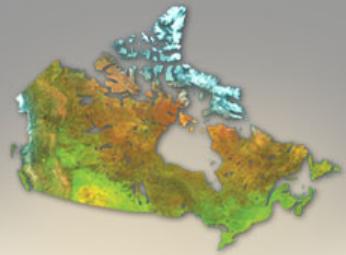
Canadian Geodetic Reference
Systems Committee Meeting
Ottawa, April 19-21, 2010



Natural Resources
Canada

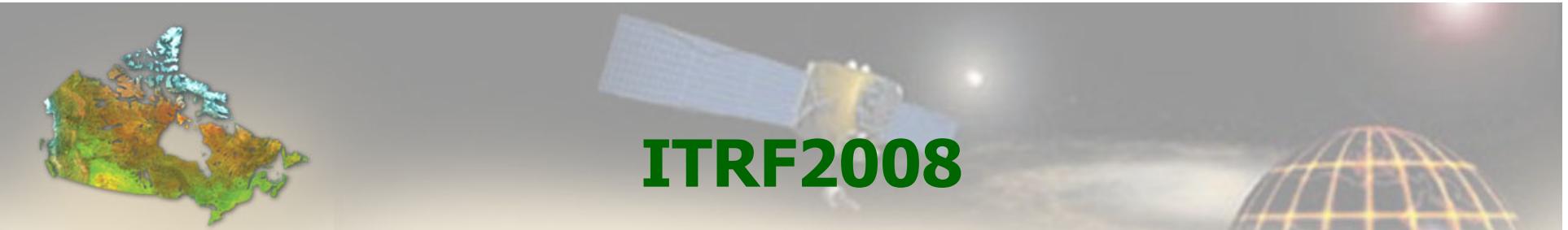
Ressources naturelles
Canada

Canada



Outline

- International
 - ITRF2008
 - WGS84 Update
 - IGS Reprocessing Project (Repro1)
- Regional
 - NAREF Densification
 - Other Regional Velocity Fields
 - NTRF2008



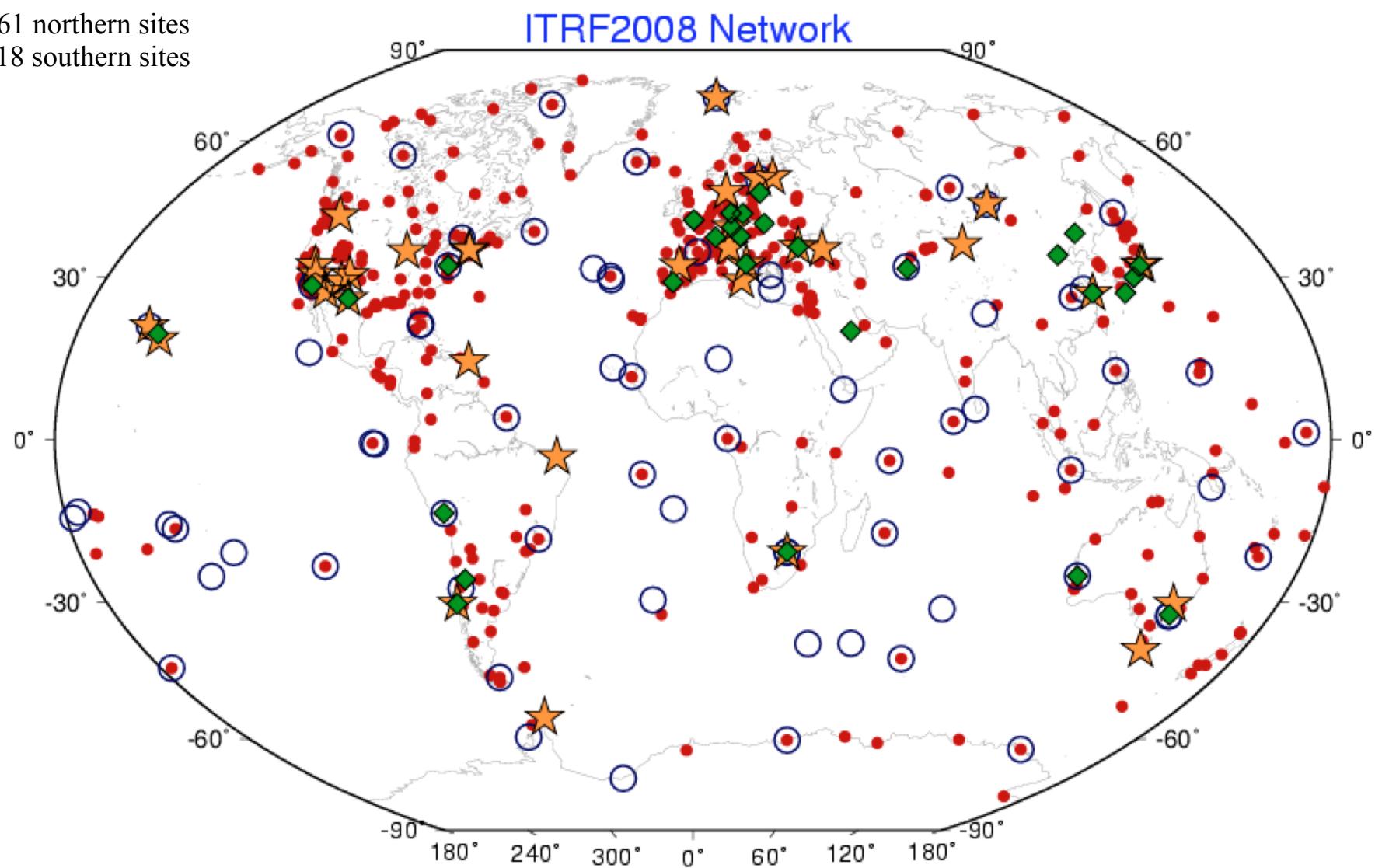
ITRF2008

- Data used
 - VLBI 1980.0 – 2009.0
 - SLR 1984.0 – 2009.0
 - GPS 1997.0 – 2009.5 (Repro1 solutions – see later)
 - DORIS 1993.0 – 2009.0
- Datum definition
 - Origin: SLR
 - Scale: mean of VLBI + SLR (only VLBI used in ITRF2005)
 - Orientation: aligned to ITRF2005
- Methodology similar to ITRF2005
 - Combination of weekly solutions from technique centers
 - Solutions performed by *two Combination Centers*
 - IGN (France – Zuheir Altamimi)
 - DGFI (Munich – Hermann Drewes)
- *Will adopt for next realization of NAD83 when released*

579 sites / 920 stations

584 time series discontinuities

461 northern sites
118 southern sites





ITRF2008P Solution

- Preliminary solution from IGN
 - Improvement in all technique solutions
 - Close to ITRF2005 (negligible differences)
 - ITRF2008P to ITRF2005 transformation (epoch 2005.0)
 $T_x = -0.7 \text{ mm} + 0.2 \text{ mm/y}$ $R_x = R_y = R_z = 0$
 $T_y = -0.4 \text{ mm} + 0.0 \text{ mm/y}$ Scale = **1.14 ppb** – 0.01 ppb/y
 $T_z = -3.8 \text{ mm} - 0.1 \text{ mm/y}$ *Accuracy of VLBI/SRL scale?*
 - ITRF2005/8 have ~2 mm/y TZ drift wrt previous ITRF/NAD83
- Issues
 - *Debate between IGN & DGFI* – mainly about...
 - Use of scale parameters
 - Weighting of inter-technique ties
 - Technique centers performing tests on both solutions
 - Should be resolved at EGU meeting May 2-7
 - Expect to adopt IGN solution – public release in May?
 - Degradation in VLBI & SLR networks – losing sites

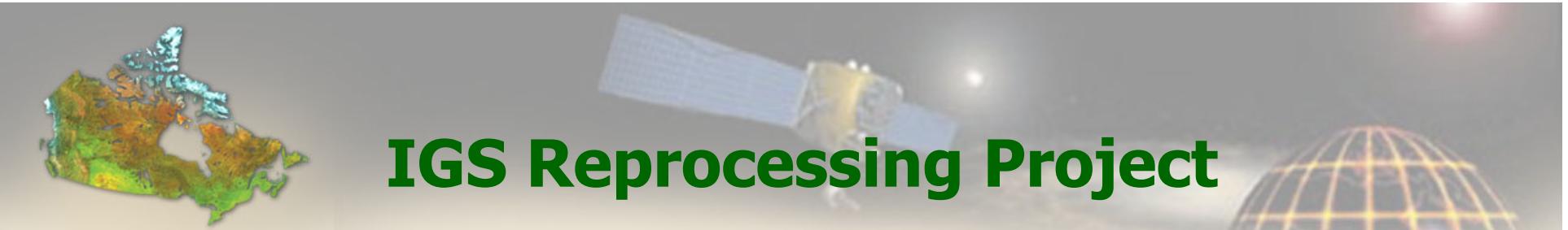


WGS84 Update

- GPS realizations of WGS84

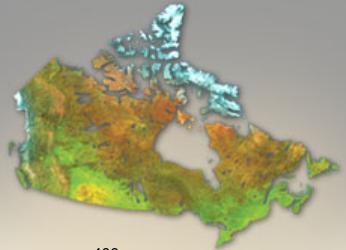
	Epoch	Based on	Implemented
WGS84(G730)	1994.0?	ITRF91	1994-06-29
WGS84(G873)	1997.0	ITRF94	1997-01-29
WGS84(1150)	2001.0	ITRF2000	2002-01-20 (current)

- NGA planning to update WGS84 to ITRF2008
 - According to Jim Slater (NGA) at AGU

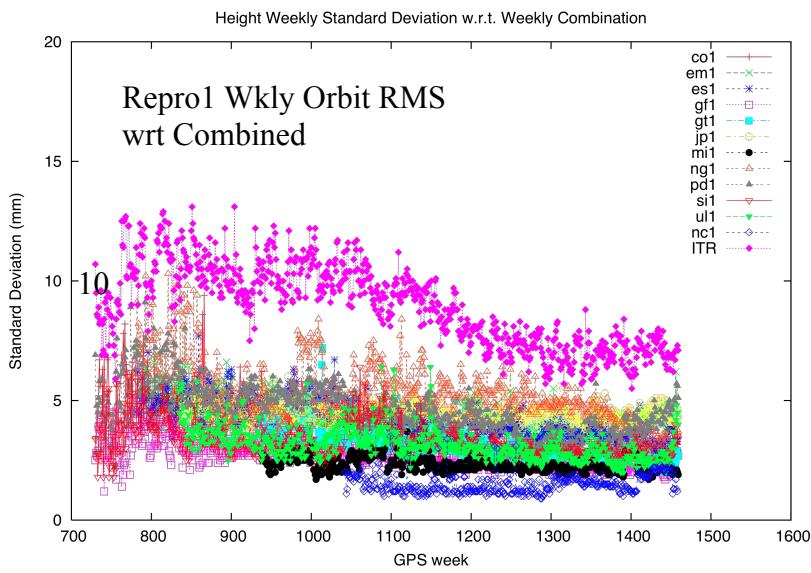
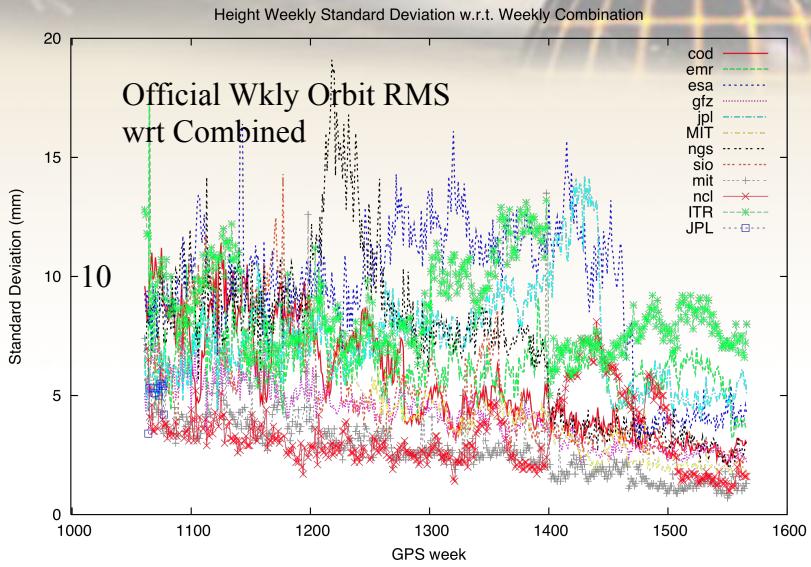
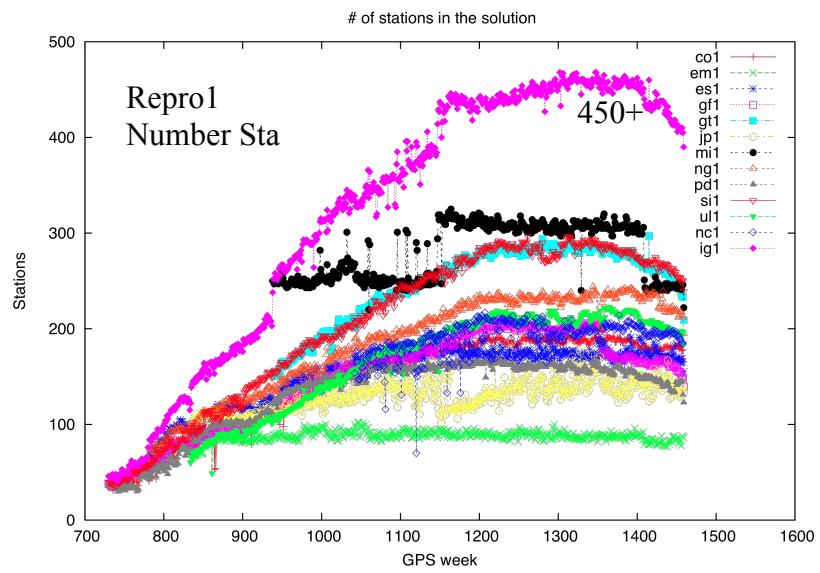
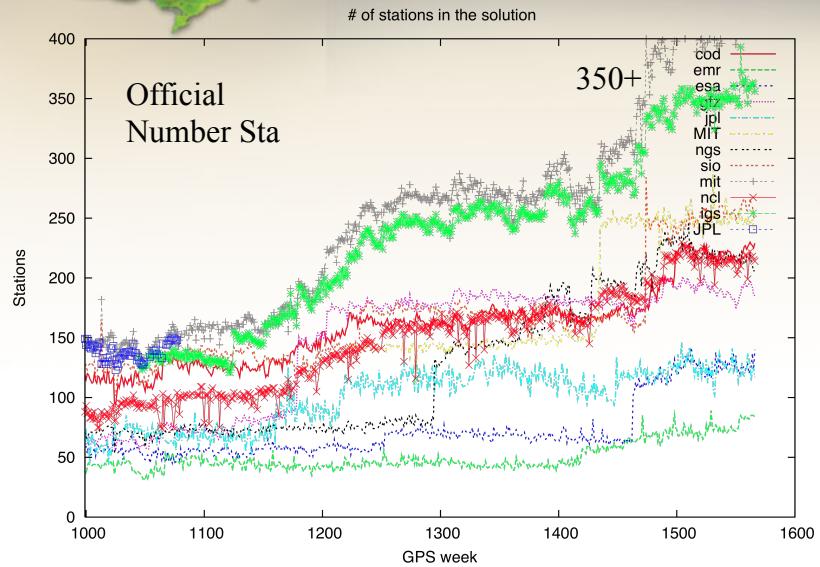


IGS Reprocessing Project

- Achieved weekly products (orbits/coords) – based on
 - Different reference frames
 - Different versions of software
 - Different adopted standards
- Repro1 Project
 - To improve consistency of weekly products (orbits/coords) & velocities
 - Reprocessed all data ~1994 - 2008.0
 - Based on consistent procedures
 - Absolute antenna phase centers (+ calibrations w/ domes)
 - Latest software
 - Consistent standards
 - Expected to finish at end of month
- Issue for PPP
 - Only 5 min interval clocks available prior to 2008
 - Interpolation not as precise => may need to decimate data to 5 min



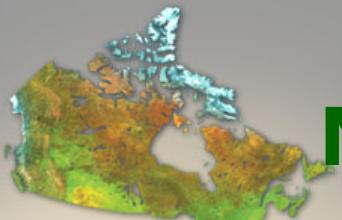
Repro1 Improvements



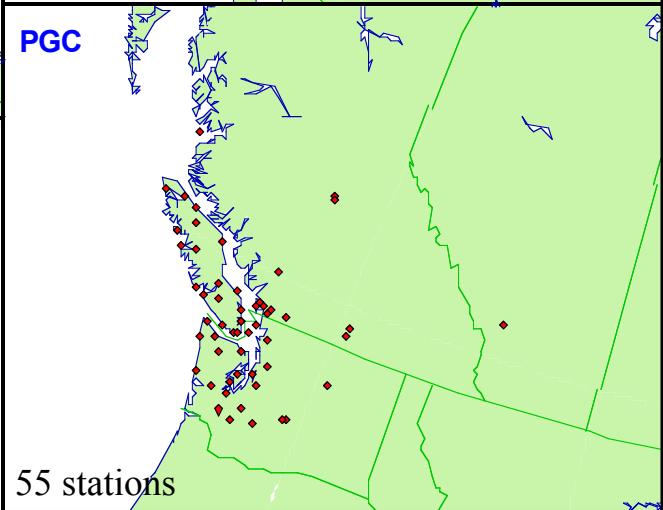
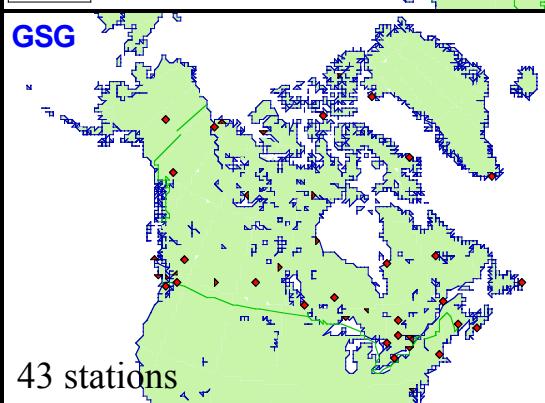
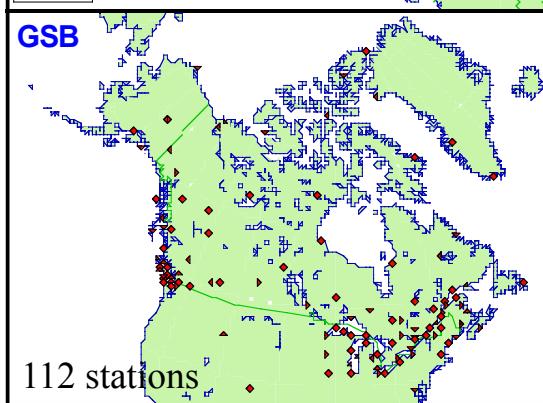
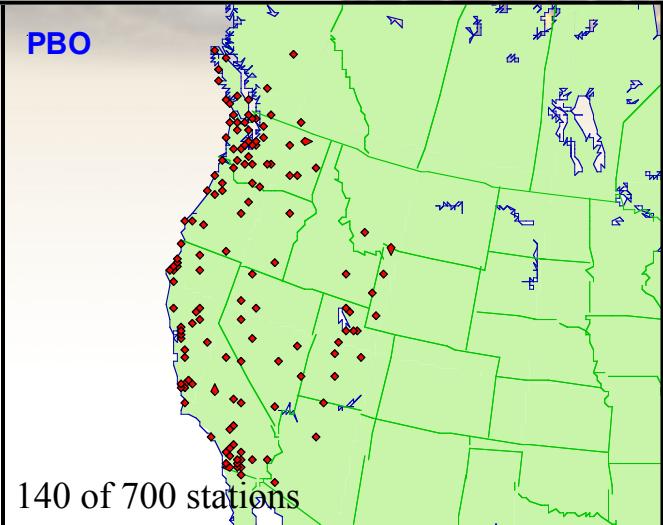
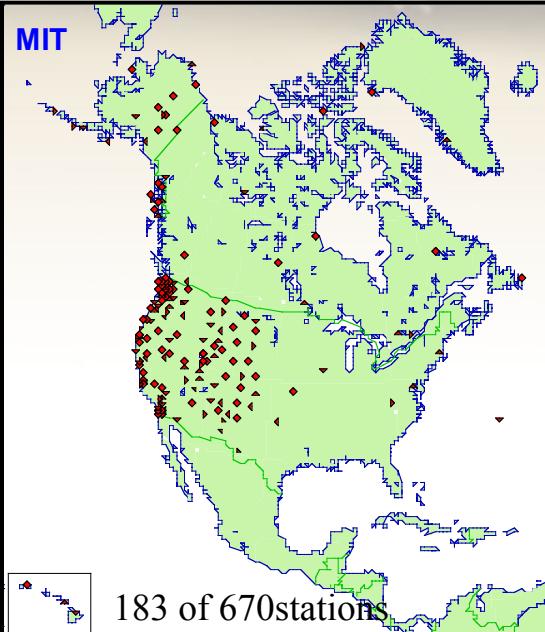
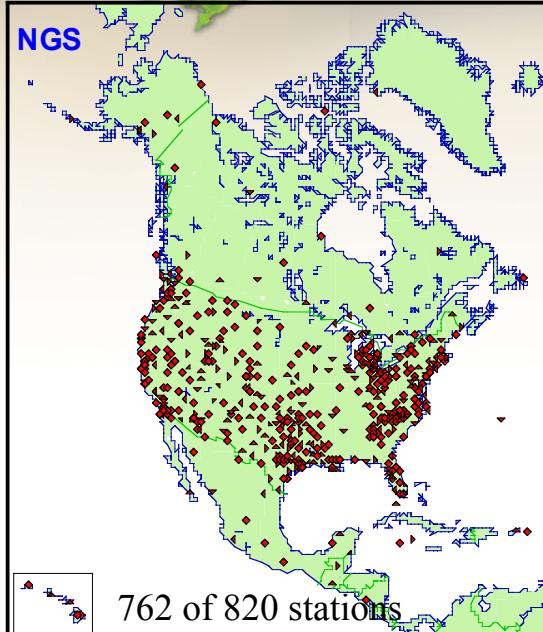


NAREF Densification

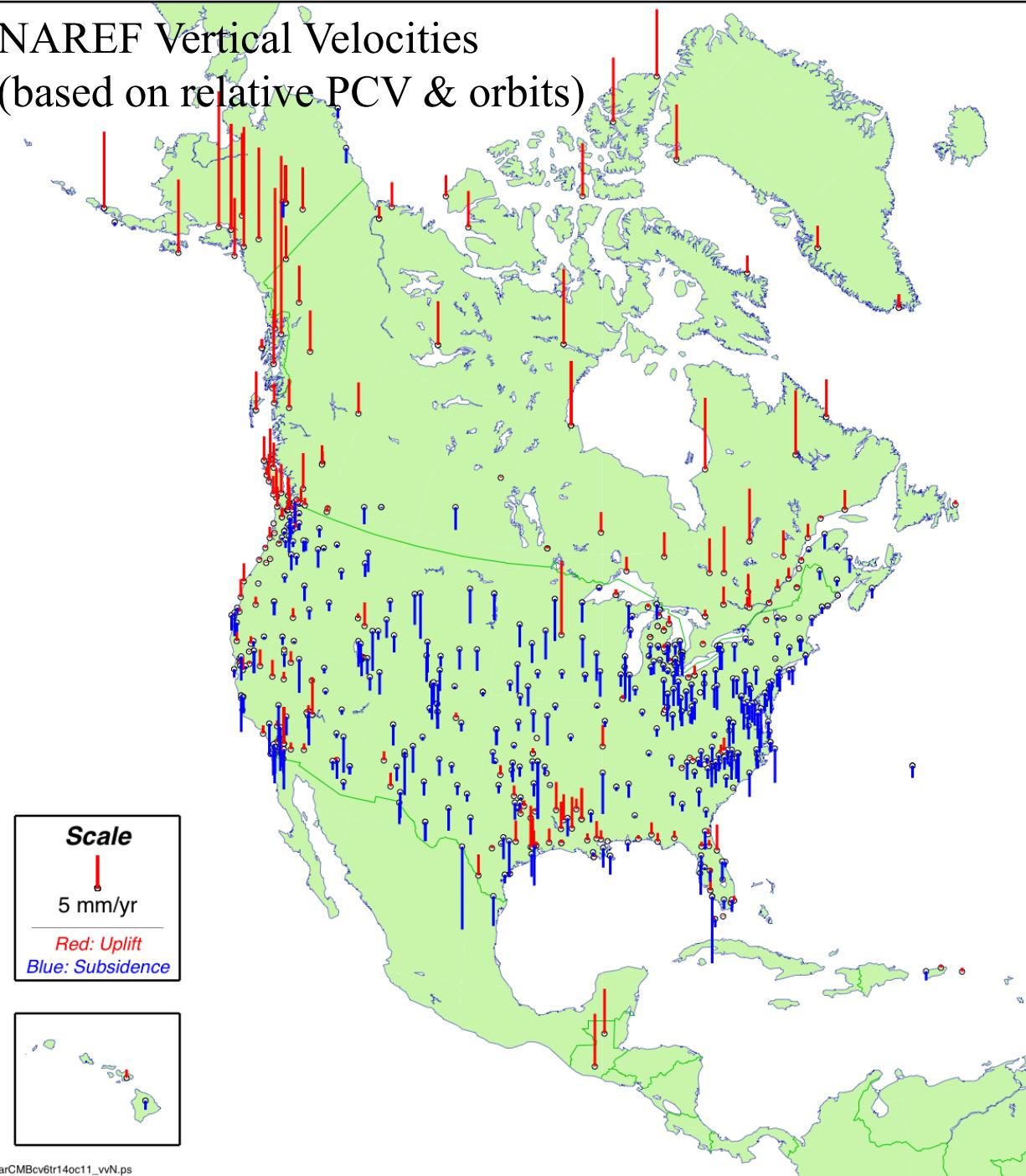
- NAREF objective
 - To densify the ITRF global network in North America
 - Produce weekly densification coordinate solutions & periodic vel solns
 - 6 regional contributors – see plot
 - *Including provincial ACPs* in GSD solutions
- GPS week 1400 (Nov/06)
 - IGS introduced new procedures for week 1400 (abs PCV w/ ant. domes)
 - NAREF solutions were on hold while
 - Contributors implemented new procedures
 - NRCan updated solution combination software
- Current velocity solution
 - Same one since late 2008 – see plot
 - Using data up to GPS week 1400
 - Incorporated CBN velocity solution for velocity grid – see plot
 - *Used for NAD83 epoch transformation*



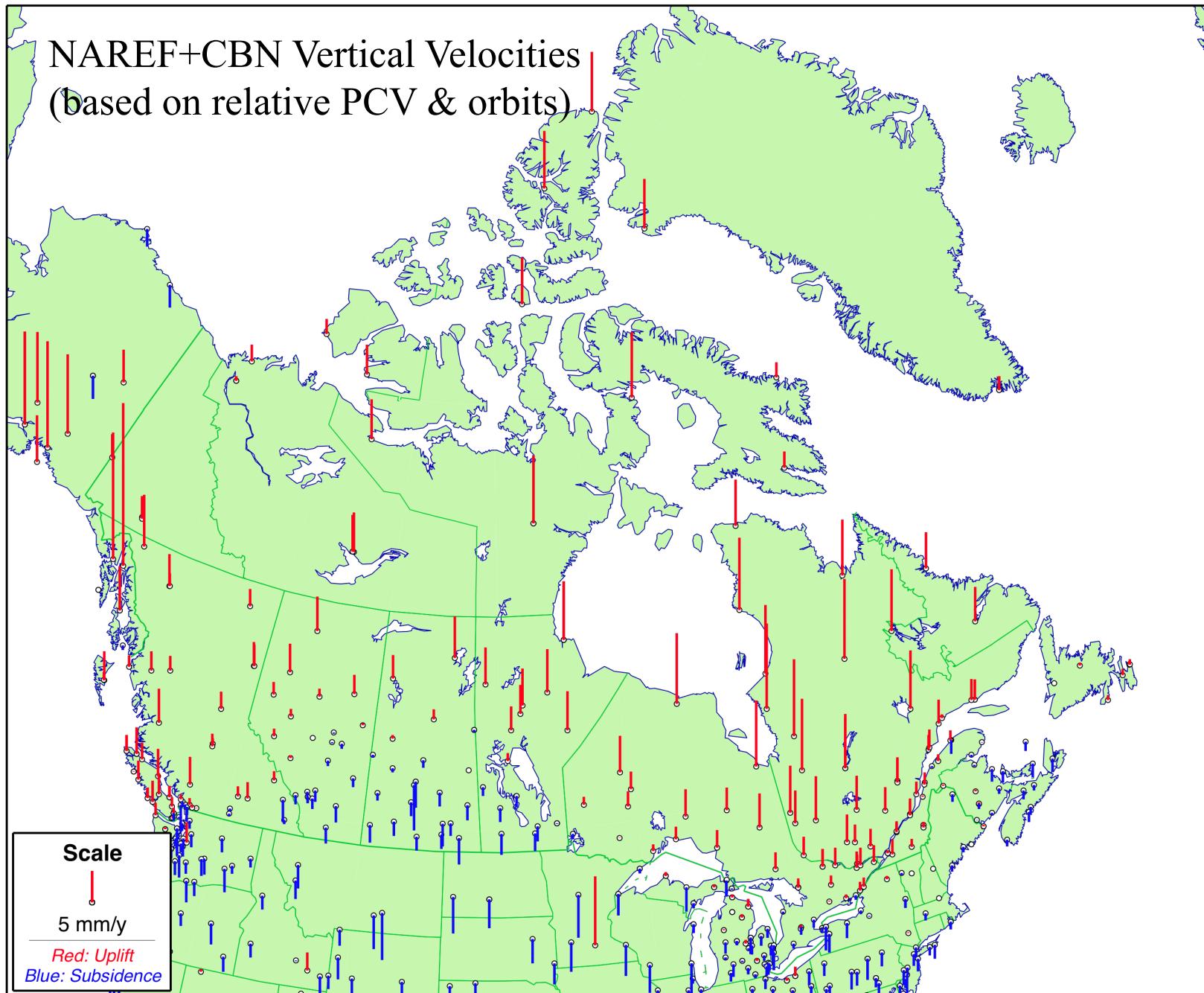
NAREF Contributors (wk 1399)

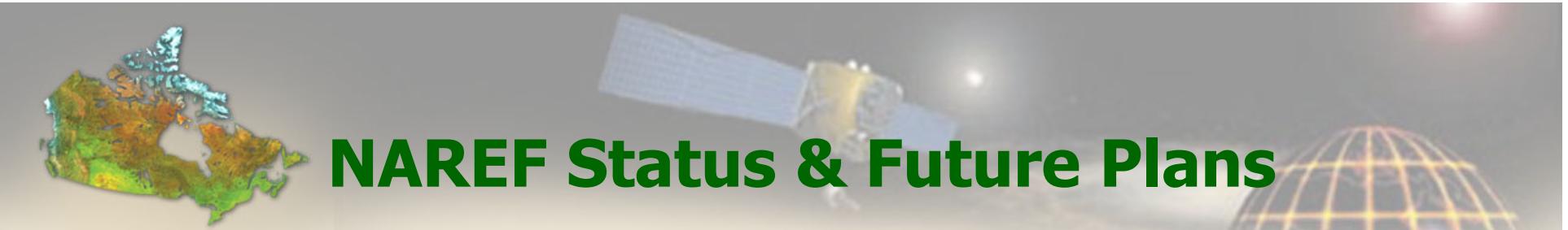


NAREF Vertical Velocities (based on relative PCV & orbits)



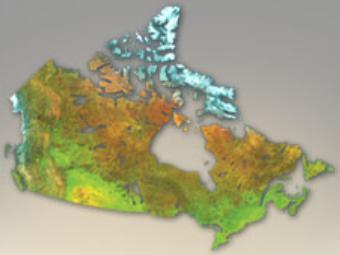
NAREF+CBN Vertical Velocities (based on relative PCV & orbits)



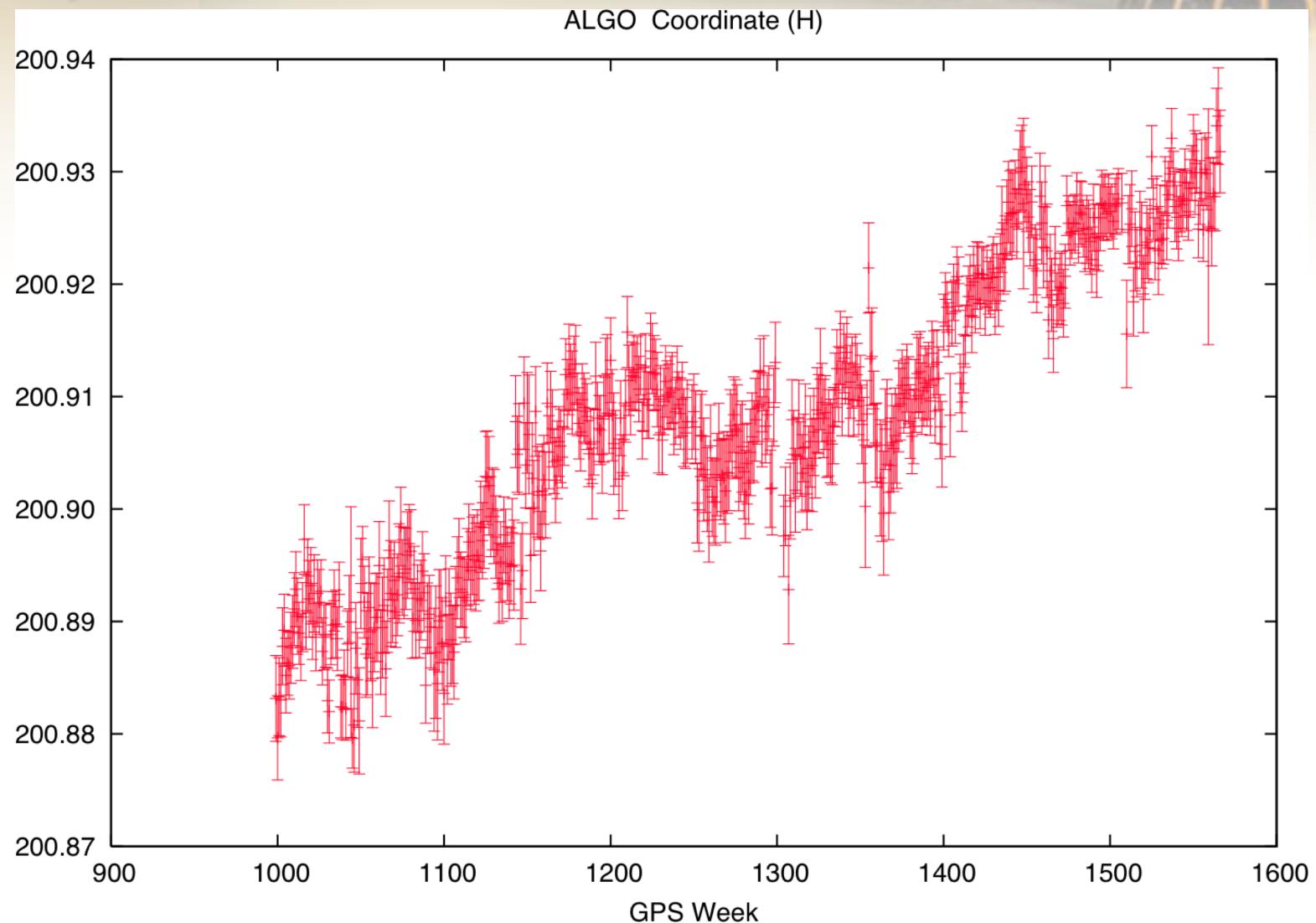


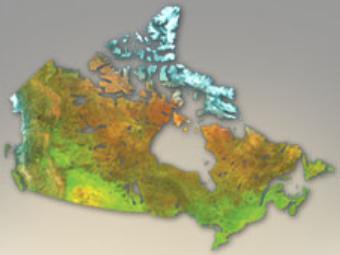
NAREF Status & Future Plans

- Weekly combinations up to GPS week 1519 (Feb/09)
 - Over 1700 stations after this
 - Need to update combo software again
- Hope to be up-to-date by end of year
- *Will reprocess all data with Repro1 orbits*
 - To obtain
 - More consistent coordinate time series – see ALGO example
 - More accurate velocities
 - SIO & NGS already finished using own Repro1 orbits
 - Will also trying reprocessing with CSRS-PPP
 - *Notify me of new prov. ACPs* with stable monumentation
 - Hope to finish by end of year
 - Depends on progress of contributors (MIT & GSC-Pacific)

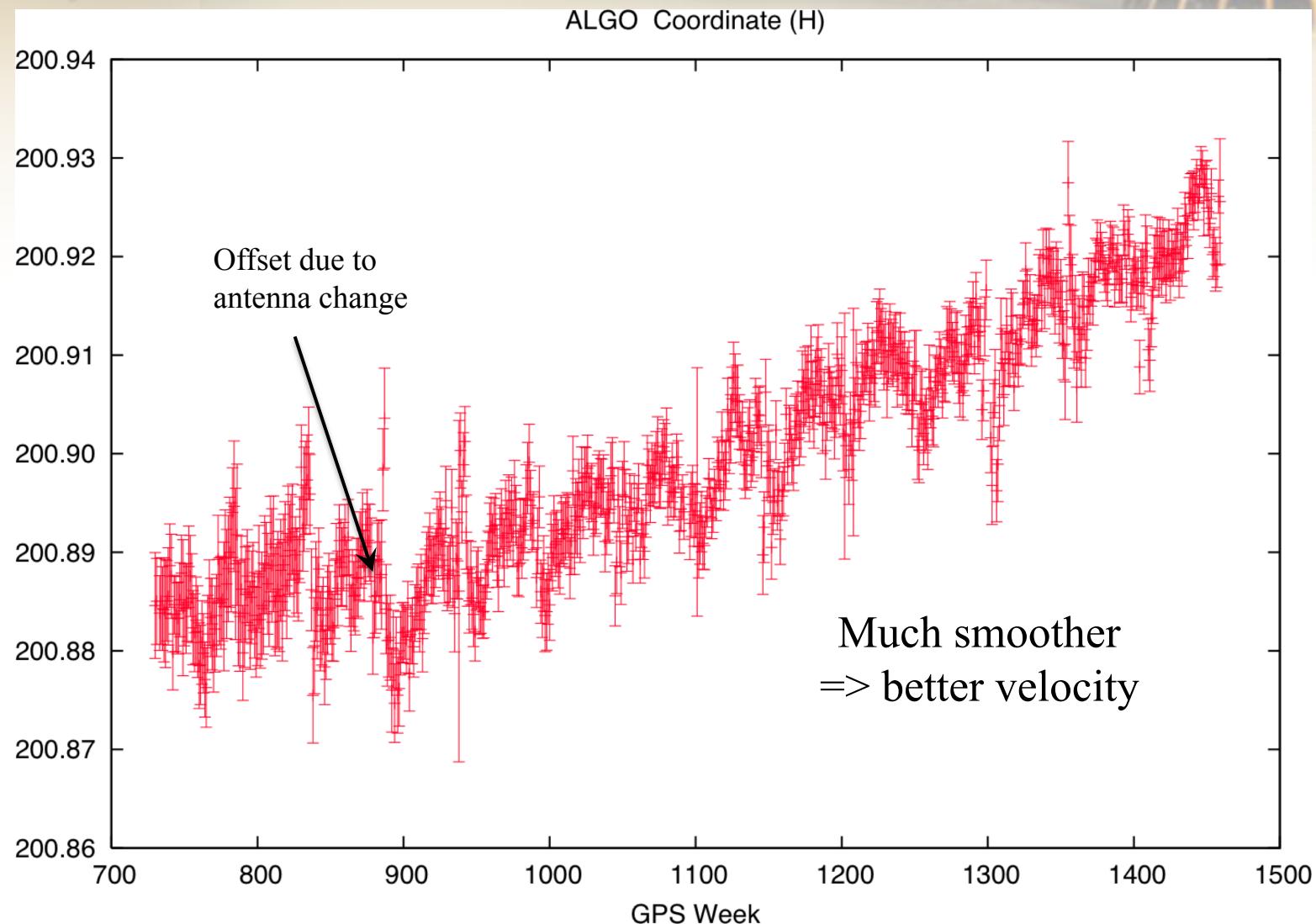


Original Time Series





Repro1 Time Series





Other Regional Velocity Fields

- IAG Regional Dense Velocity Fields Working Group
 - Densifying the global ITRF velocity field
 - Combining regional velocity solutions on a global scale
 - Combining only velocities due to use of *different offsets in time series*
 - NAREF contributed densification solution for North America
 - Combination of NAREF+MIT+CBN velocity fields
 - Submitted in late 2009
 - Generating a new velocity combination in 2010
 - Will eventually move to weekly solutions to avoid problems with offsets
- NGS Multi-Year CORS Solution
 - Using NGS Repro1 orbits
 - Reprocessed all data since 1995 – discontinuities a problem
- UNAVCO Western Regional Velocity Field Working Group
 - Similar to IAG WG but only to densify western US velocity field
 - Mostly academics involved – chaired by Tom Herring (MIT)
 - Submitted NAREF & CBN velocity solutions Oct/09



NTRF2008

- North American Terrestrial Reference Frame
 - New reference frame fixed to North American tectonic plate
 - Based on ITRF2008
 - Successor to SNARF (Stable North American Reference Frame)
- Need to define plate motion – the main problem
 - Will investigate different methods of estimating plate motion
 - Want to use sites in Canada but affected by GIA
 - Horizontal component can bias plate motion estimate
 - May use a GIA model to remove effect (e.g., ICE-6G)
- Expected to eventually replace NAD83
 - At least in U.S. by 2018
 - Will likely be based on the latest ITRF & plate motion estimate
 - Can easily transformations between reference frames & epochs