

NAREF & CBN Velocity Solutions for a New Version of SNARF



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Natural Resources
Canada

Ressources naturelles
Canada

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Outline

NAREF velocity solution (Continuous GPS)

- Data used
- Weekly solutions
- Cumulative (velocity) solution
- Plate motion estimates

CBN velocity solution (Episodic GPS)

- Data used
- Epoch solutions
- Cumulative (velocity) solution

Future plans





NAREF Data

Combination of regional continuous GPS solutions

Regional Solutions	Solutions Since	# Stations Used (GPS Week 1399)
GSD (Bernese)	2001.0	112
GSD (GIPSY)	2001.0	43
PGC WCDA (Bernese)	2001.0	55
NGS CORS (PAGES)	2002.0	762
SIO PBO (GAMIT)	2001.0	140
MIT PBO Combination	2006.0	183





Stations in Multiple Solutions (Stations with Redundant Checks)

GPS Week 1399 – 708 Stations Total

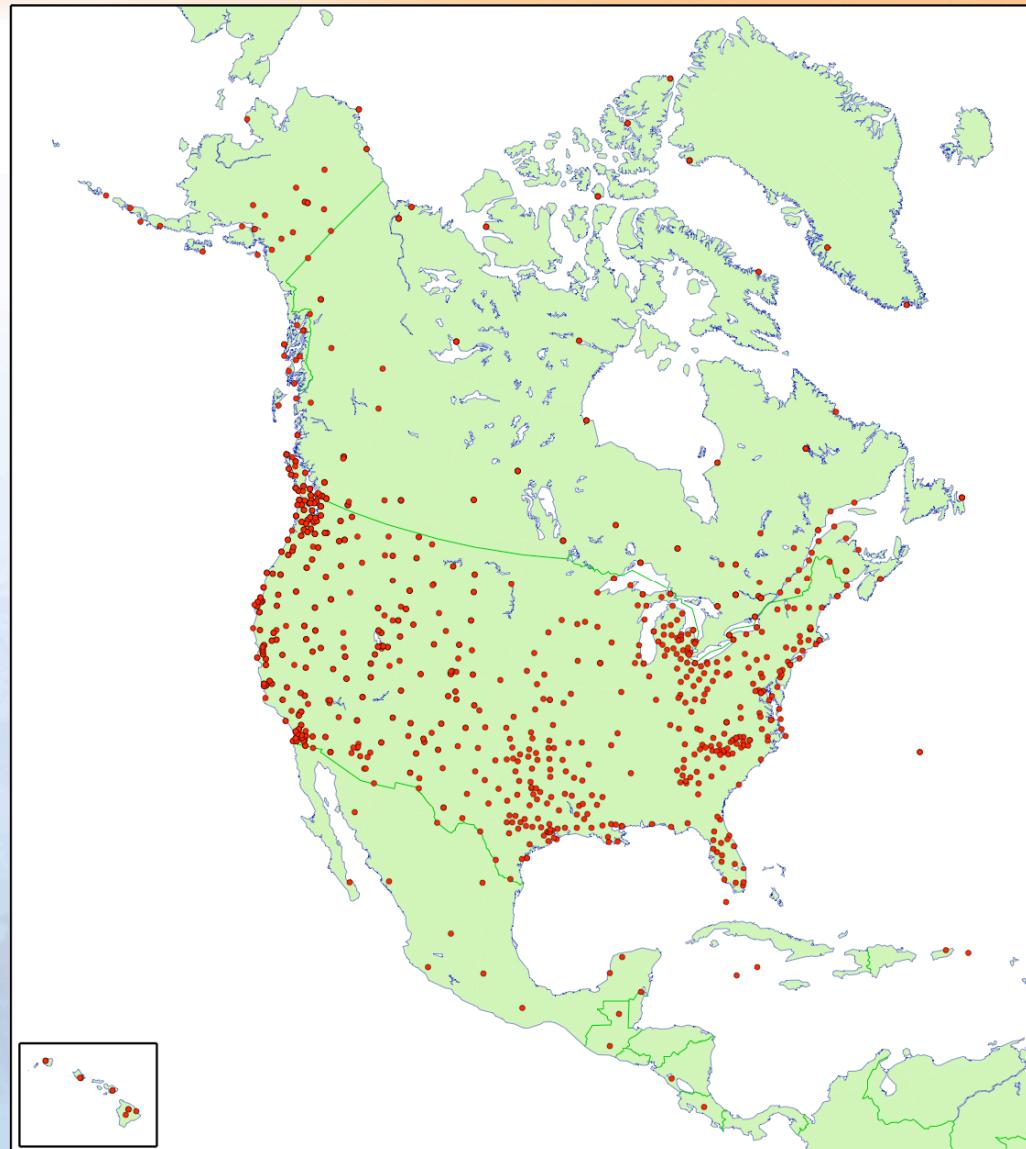
	Number of Stations	Percentage
1 Solution	488	69%
2 Solutions	94	13%
3 Solutions	95	13%
4 Solutions	21	3%
5 Solutions	7	1%
6 Solutions	3	0.4%





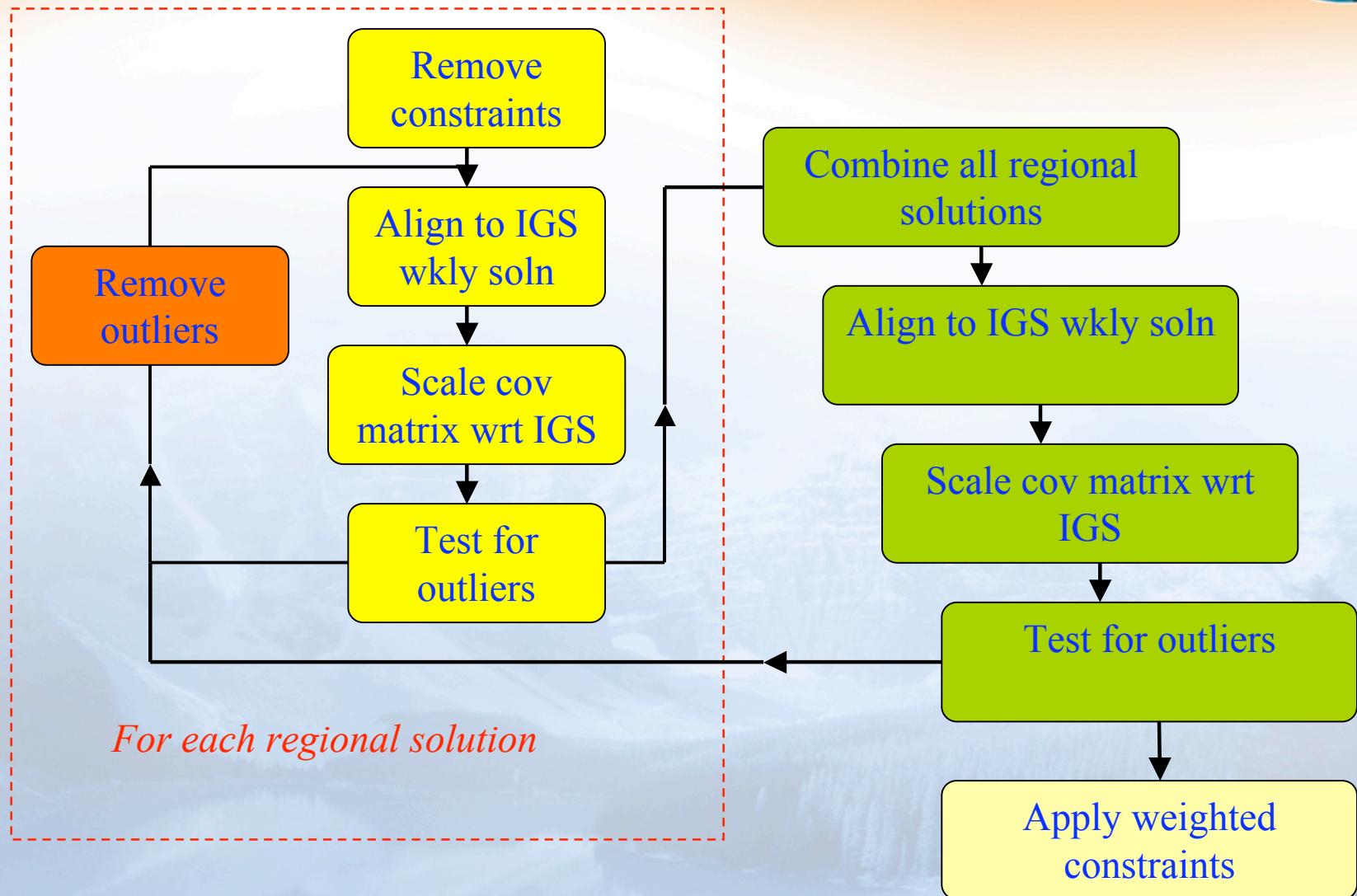
NAREF Combination Network

GPS Week 1399
708 stations total
56 IGS constraint
stations

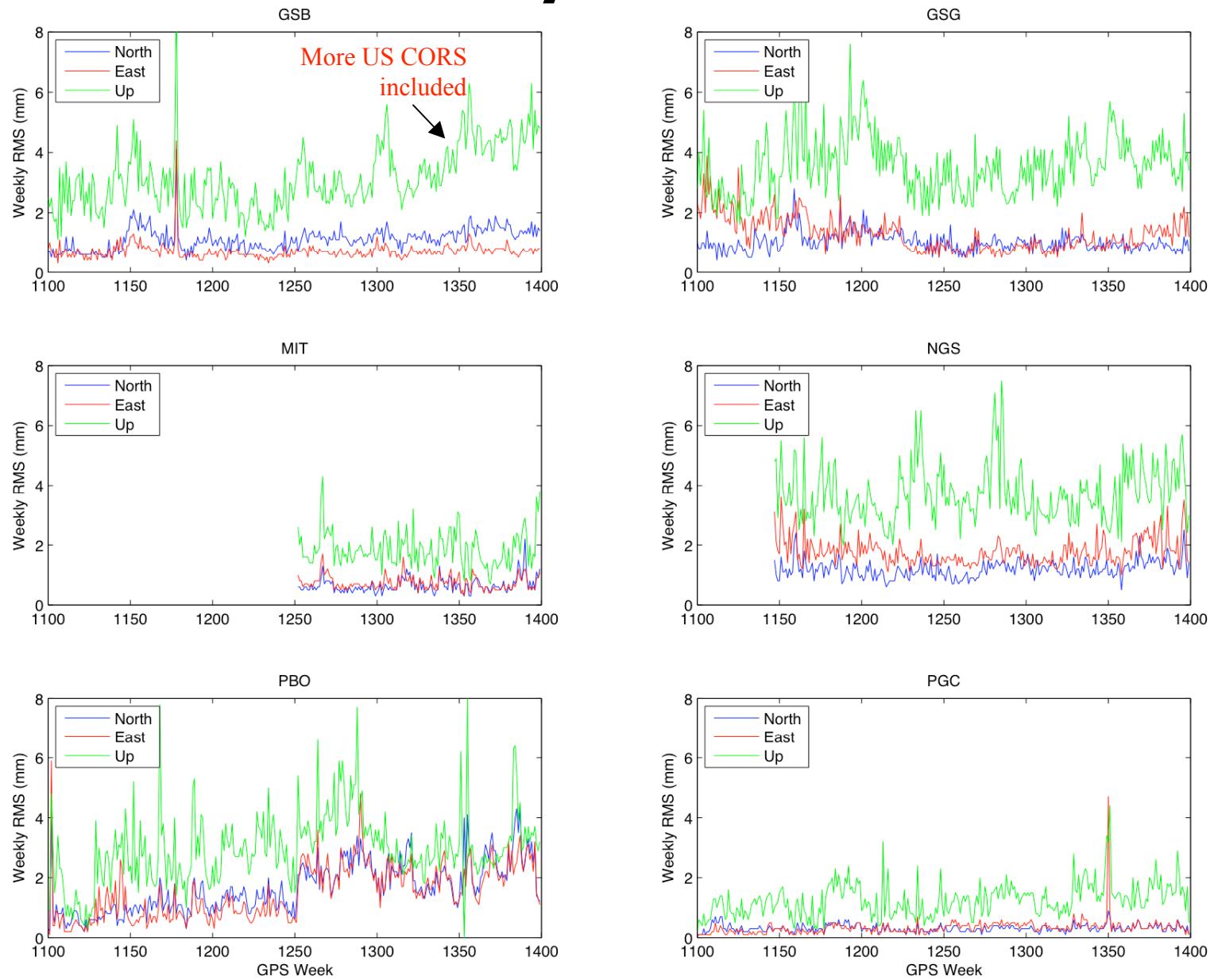




Weekly Combination Procedure

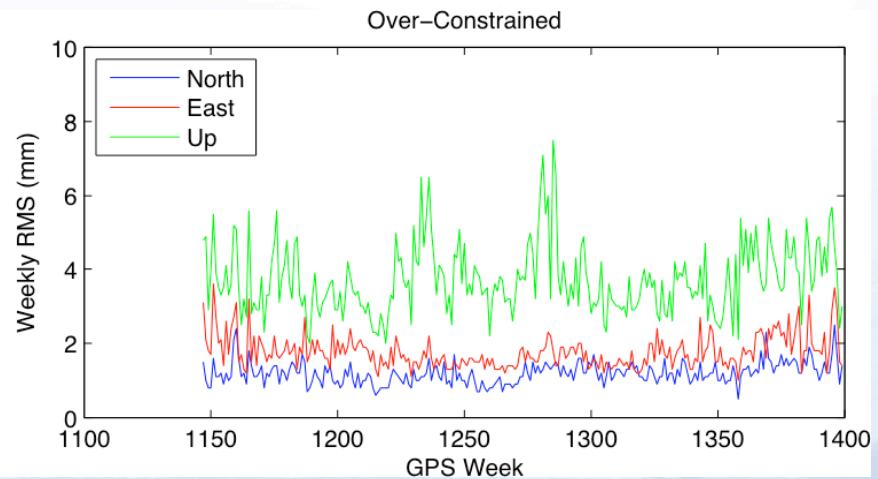
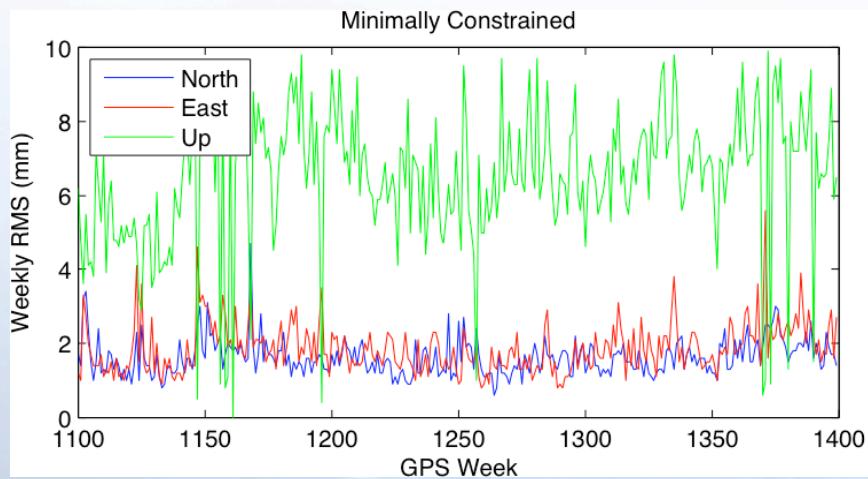


RMS of Weekly Regional Solutions vs. Weekly Combinations





RMS of Weekly NAREF Combinations vs. IGS Weekly Reference Frame





NAREF Cumulative Combination

- 1) Removed a priori constraints from weekly NAREF solutions
- 2) Aligned weekly solutions to IGS05
 - 7 parameter transformation
 - Used 11 N.A. sites in IGS05
 - Propagated IGS05 to epoch of week
- 3) Combined aligned weekly solutions & estimated velocities
 - Used official IGS/ITRF discontinuity table + NAREF discontinuities
- 4) Applied velocity equivalence constraint across discontinuities where appropriate
- 5) Re-aligned cumulative solution to IGS05 (14 parameters)
- 6) Analysed residual time series for additional discontinuities
 - Add to discontinuity table and restart from step (3)
- 7) Optionally included IGS05 solution as a priori constraints





NAREF Velocity Solution

Summary statistics

- Time span of weekly solutions 2001-2006 (wks 1195-1399)
- Number of weekly solutions used 305
- Number of stations available 906
- Number of stations used 578 ([328 omitted*](#))

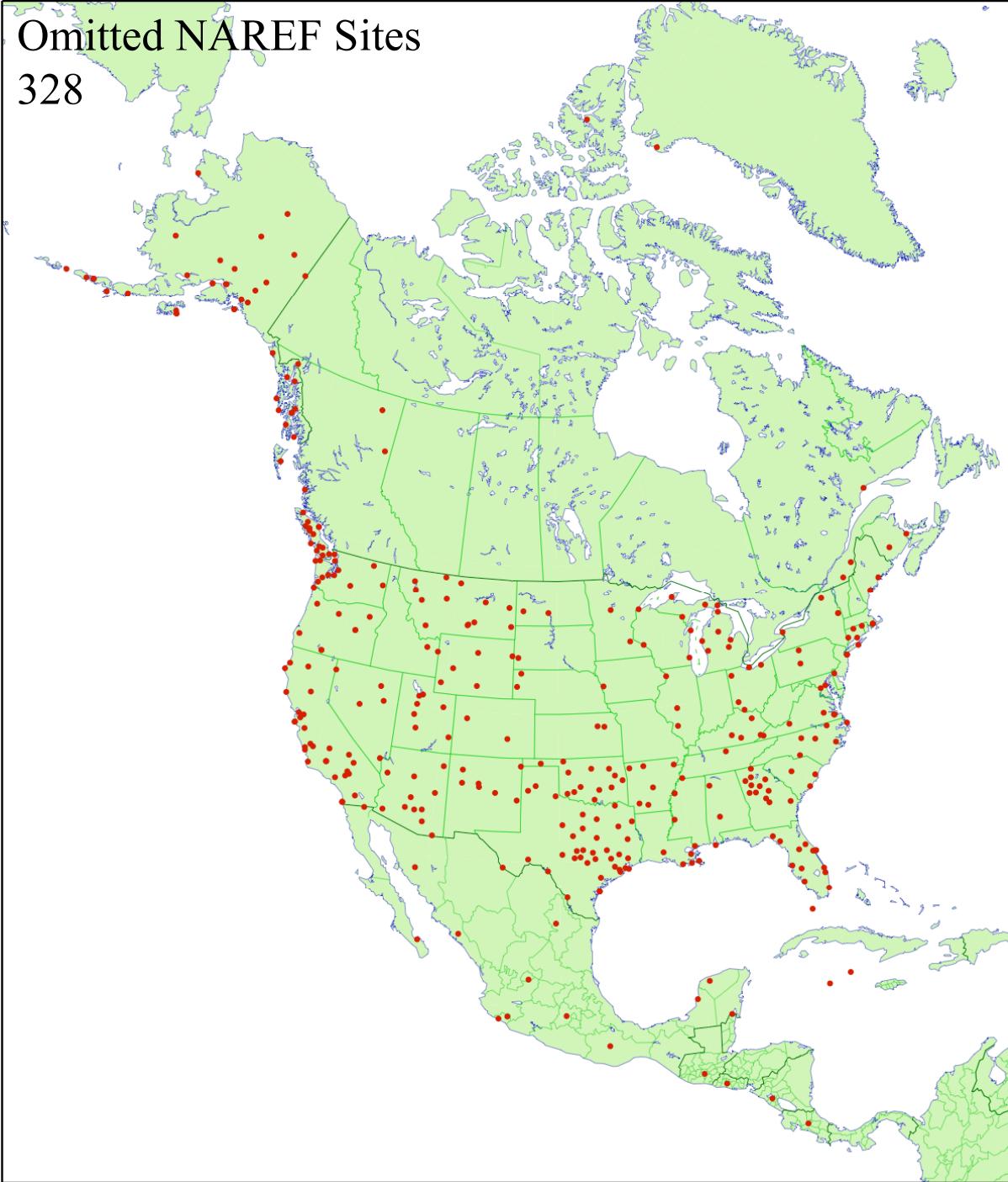
*Reasons for omitting sites

- Short time span (less than 2 yr) ~260 sites
- Collocated/redundant sites (mainly USCG sites) ~50 sites
- “Bad” time series (noisy, gaps, multiple offsets) ~20 sites

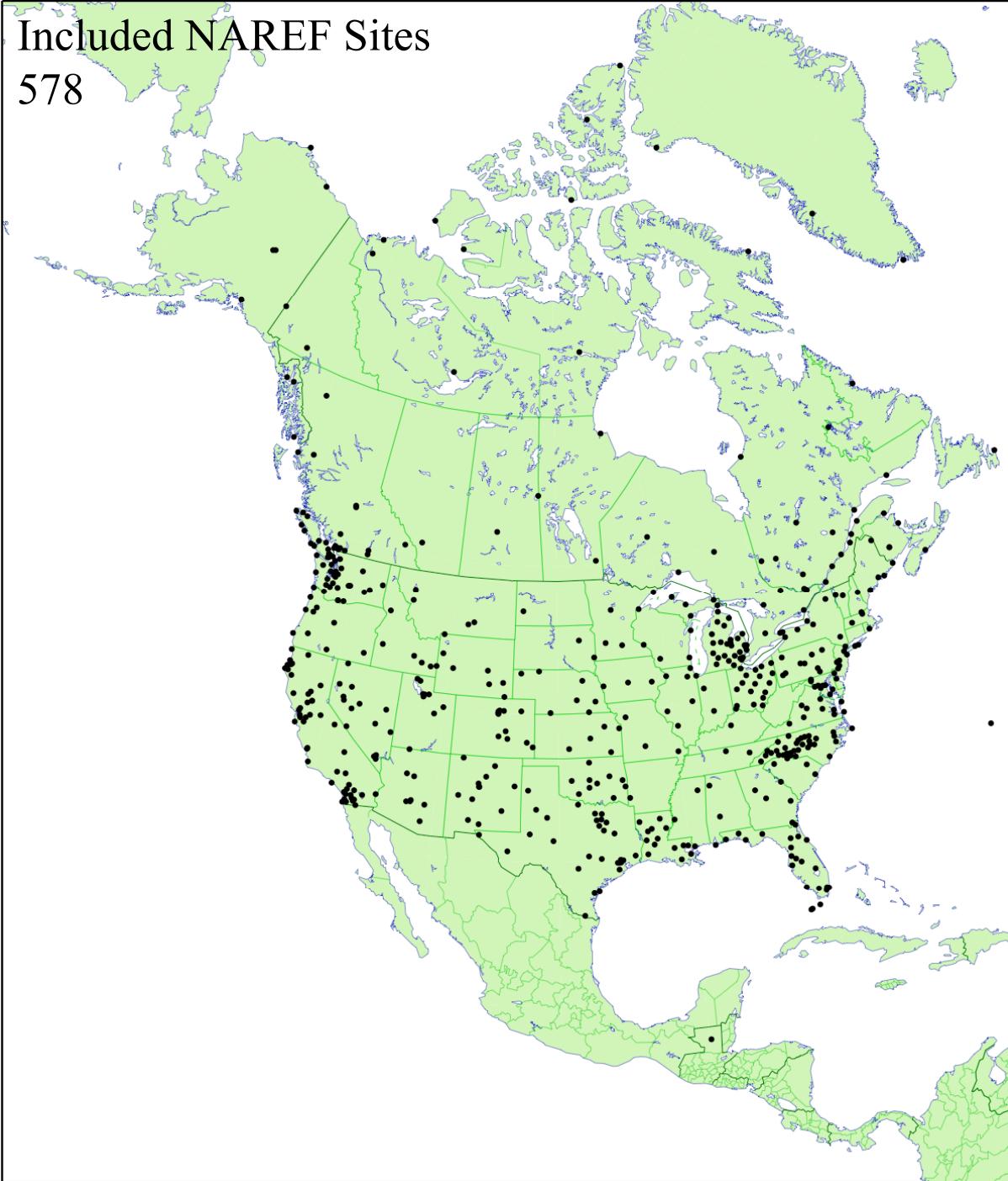


Omitted NAREF Sites

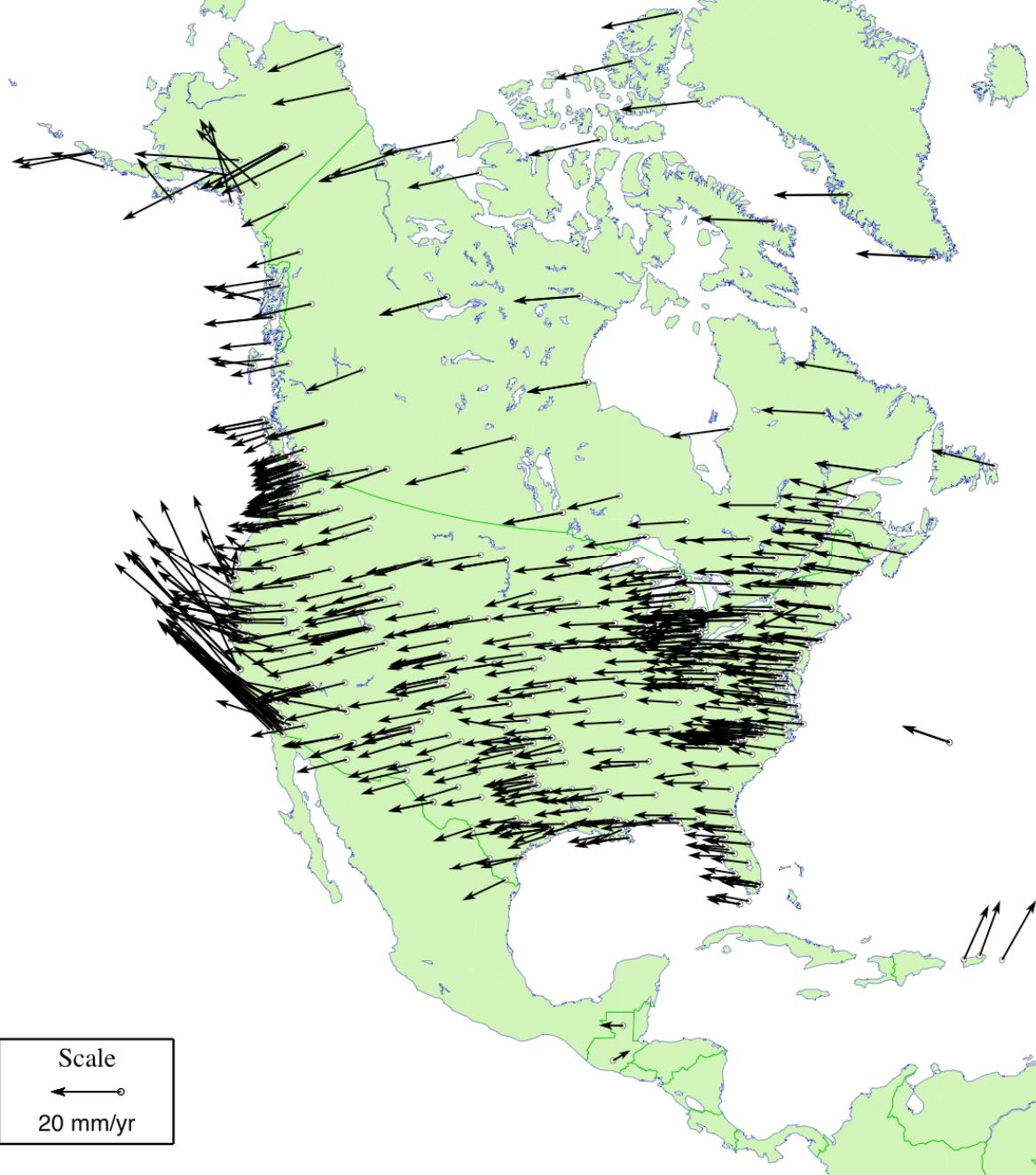
328



Included NAREF Sites
578



NAREF Horizontal Velocities



NAREF Horizontal Velocities w.r.t. ITRF2005 plate motion



NAREF Vertical Velocities

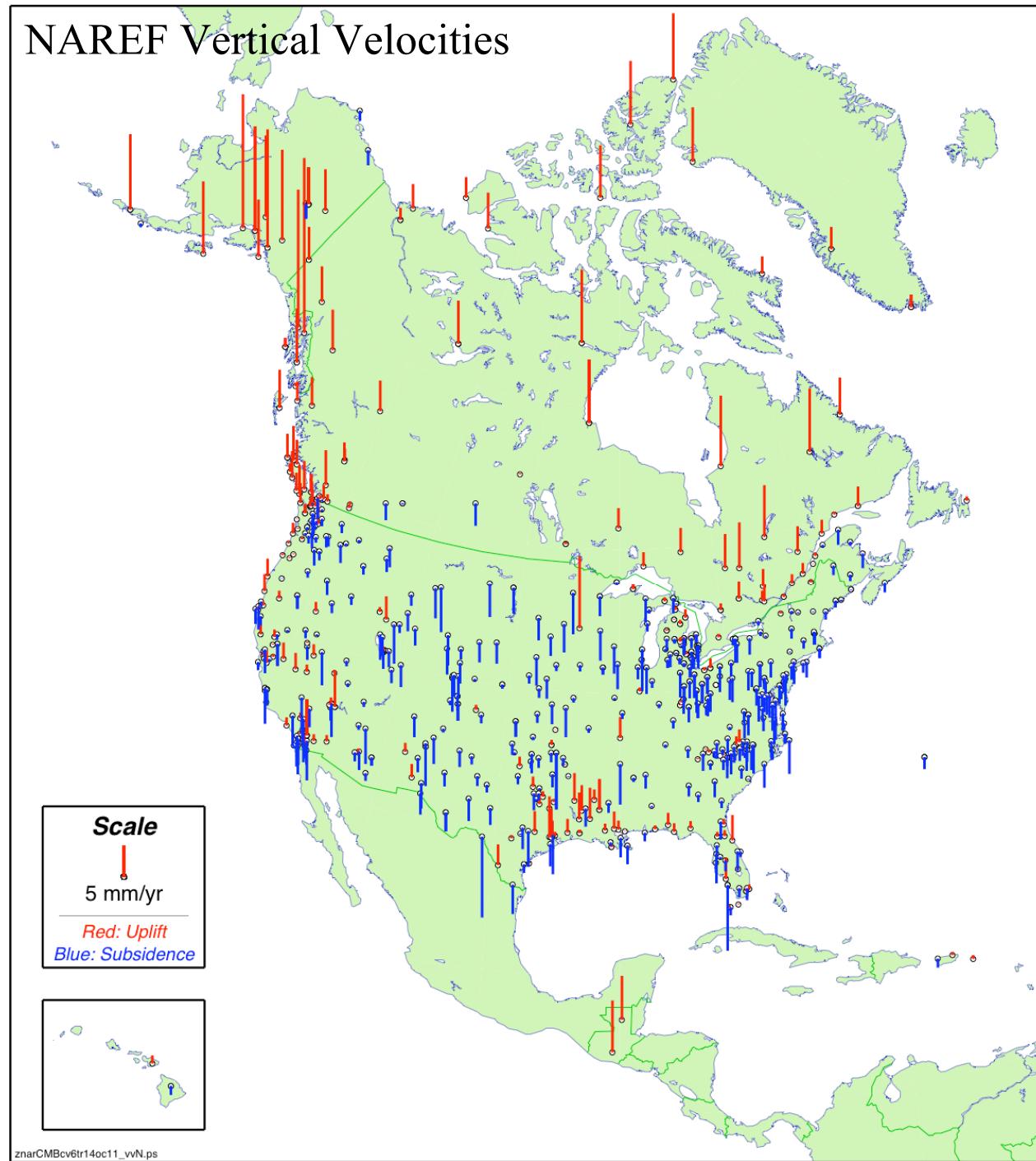




Plate Motion Estimates

Based on same 29 sites used by UNR

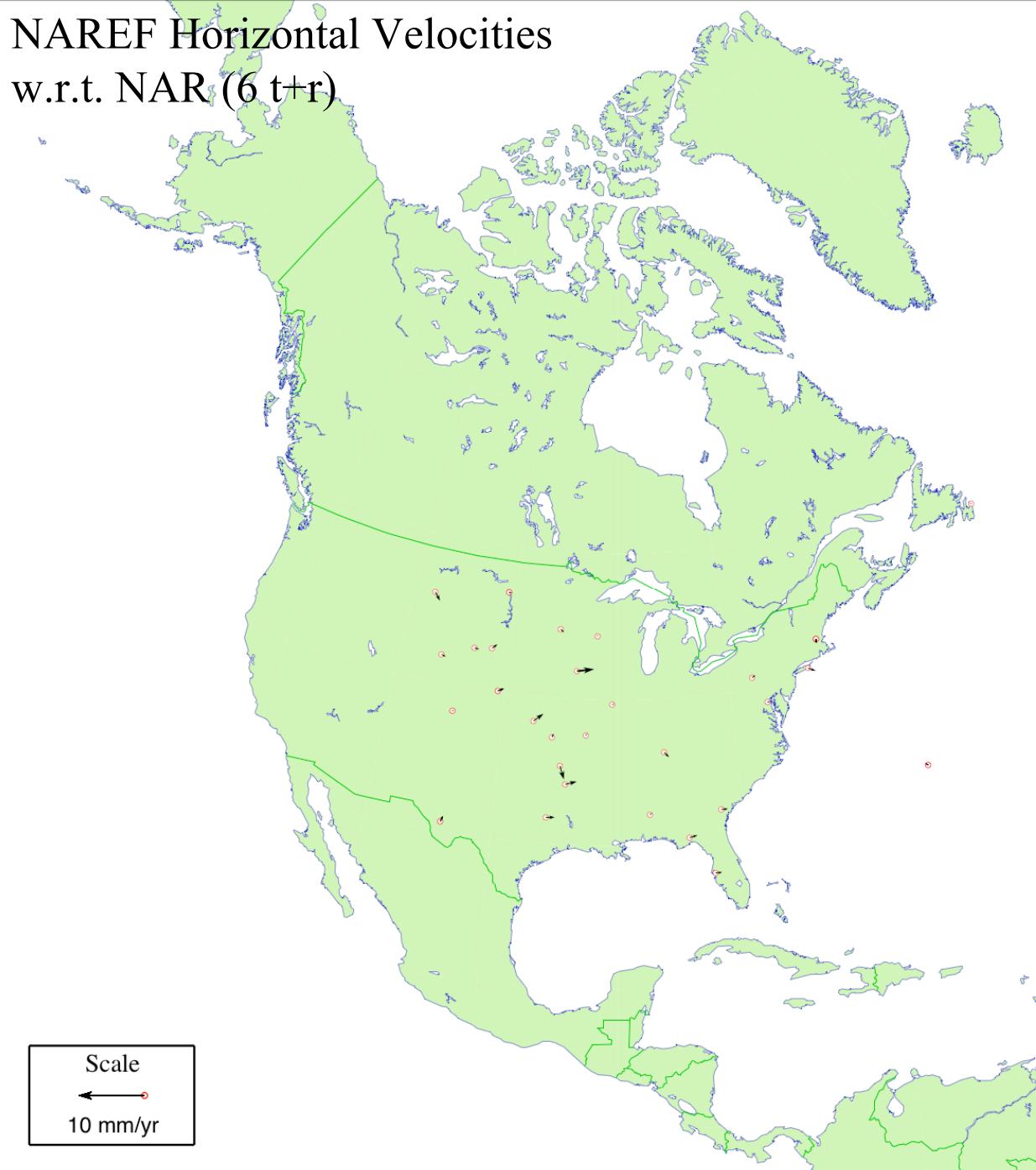
	RY (mas/y)	RY (mas/y)	RZ (mas/y)
ITRF2005	0.0314	-0.6685	-0.0517
UNR (7 t+r+s)	0.0871	-0.7242	-0.1160
NAR (3 r)	0.0263	-0.7079	-0.0524
NAR (6 t+r)	0.4313	-0.5739	-0.0137
NAR (3 t+r+s)	0.4533	-0.5996	-0.0367



NAREF Horizontal Velocities w.r.t. NAR (3 r)



NAREF Horizontal Velocities w.r.t. NAR (6 t+tr)





Earth Sciences Sector



Canadian Base Network (CBN)



Natural Resources
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SLIDE 19

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CBN Data & Episodic Solutions

CBN (Canadian Base Network) episodic data

- Using 27 repeated campaign surveys from 1994 to 2006
 - 1st campaign 1994-1999 (no 1998)
 - 2nd campaign 2001/2002
 - 3rd campaign 2005/2006
 - Several other smaller campaigns
- Each stations occupied multiple times in each campaign
 - 3-5 independent occupations
 - 24 hr observation sessions

All epochs processed with Bernese GPS Software v5.0

- Same processing strategy as for continuous GPS





CBN Cumulative Combination

- 1) Removed a priori constraints from individual CBN solutions
- 2) Aligned solutions to common sites in IGS05
 - 7 parameter transformation
 - IGS05 propagated to epoch of each CBN solution
- 3) Each CBN covariance matrix scaled by WRMS of residual from alignment
- 4) Combined all aligned/scaled CBN solutions (summation of normals) & estimated velocities
 - Used official IGS/ITRF discontinuity table for IGS sites
 - Optionally included translations for each solution
- 5) Applied velocity equivalence constraint across discontinuities where appropriate
- 6) Re-aligned cumulative solution to IGS05 (14 parameters)
- 7) Optionally included IGS05 solution as a priori constraints

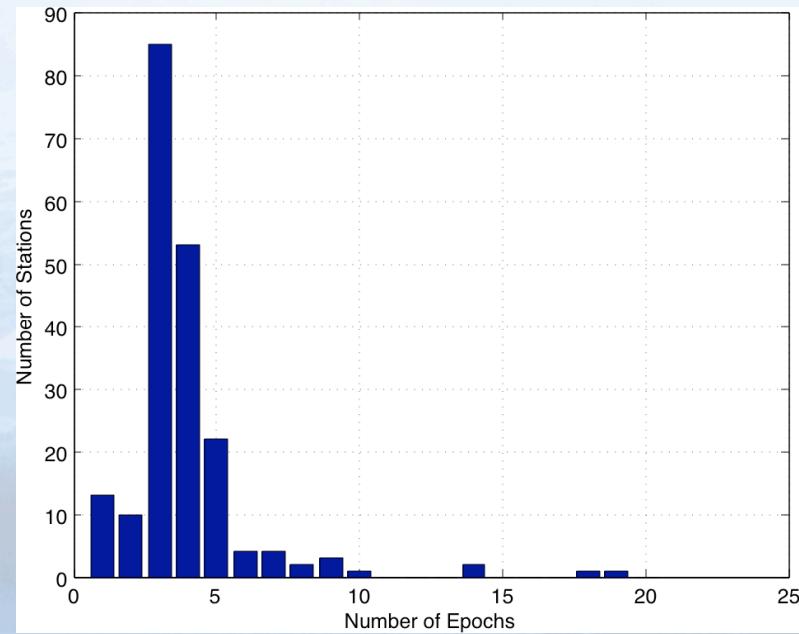
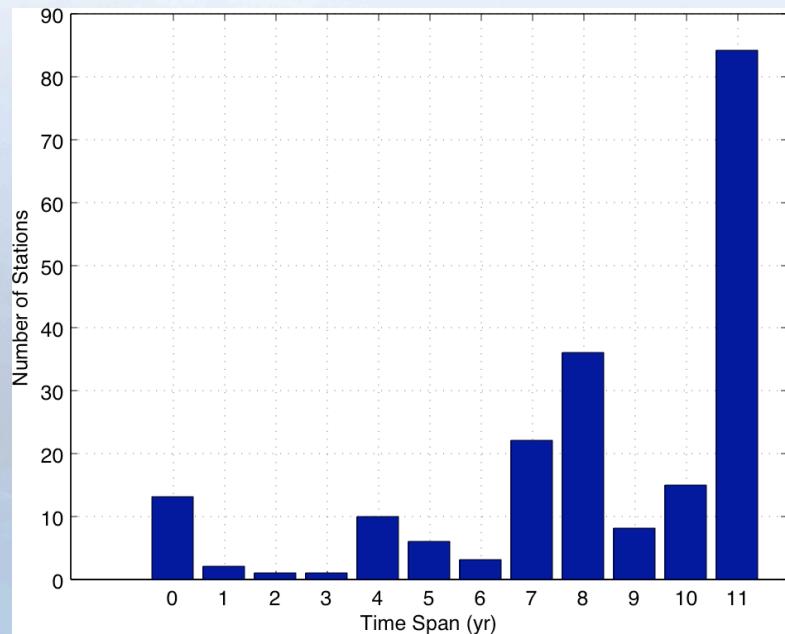




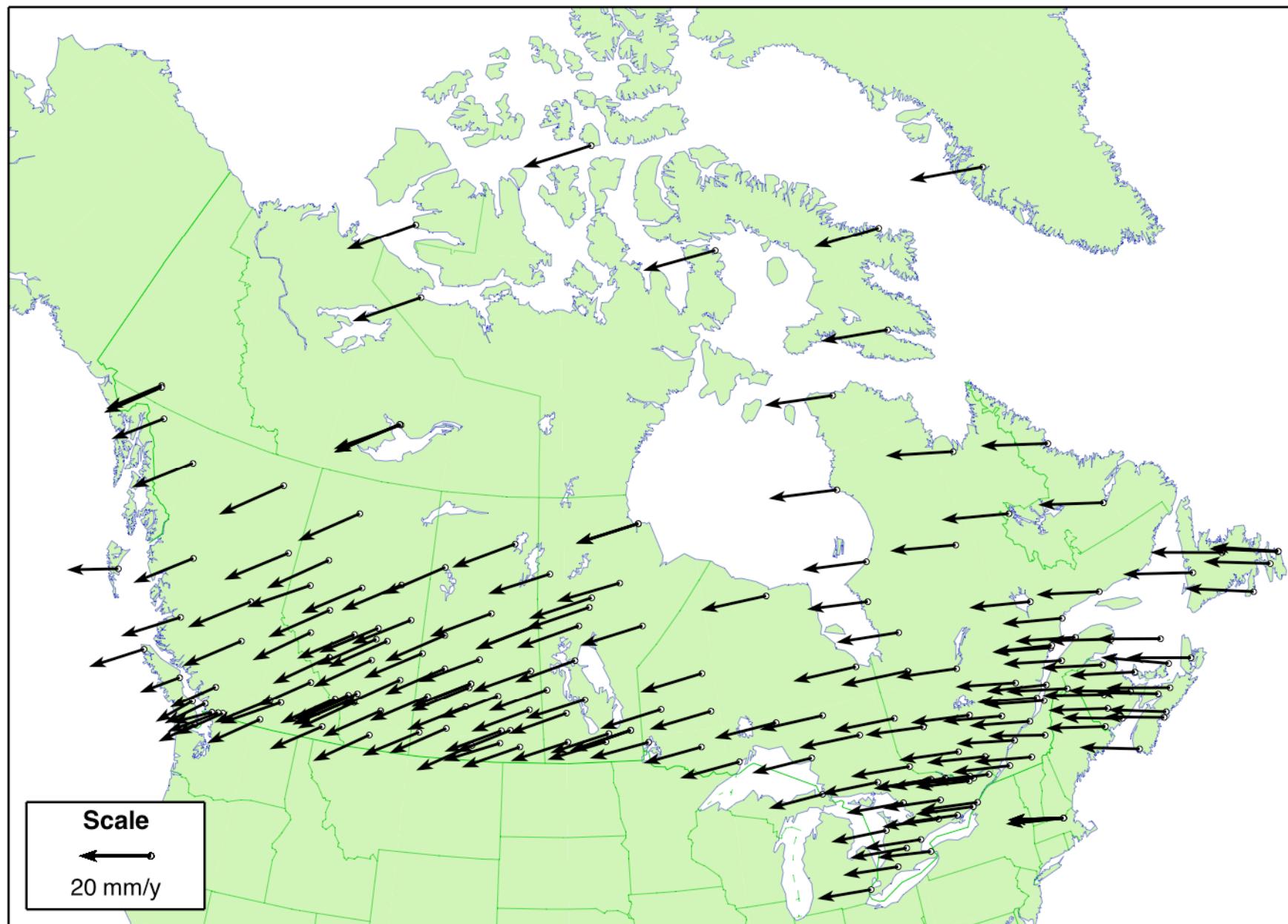
CBN Velocity Solution

Summary statistics

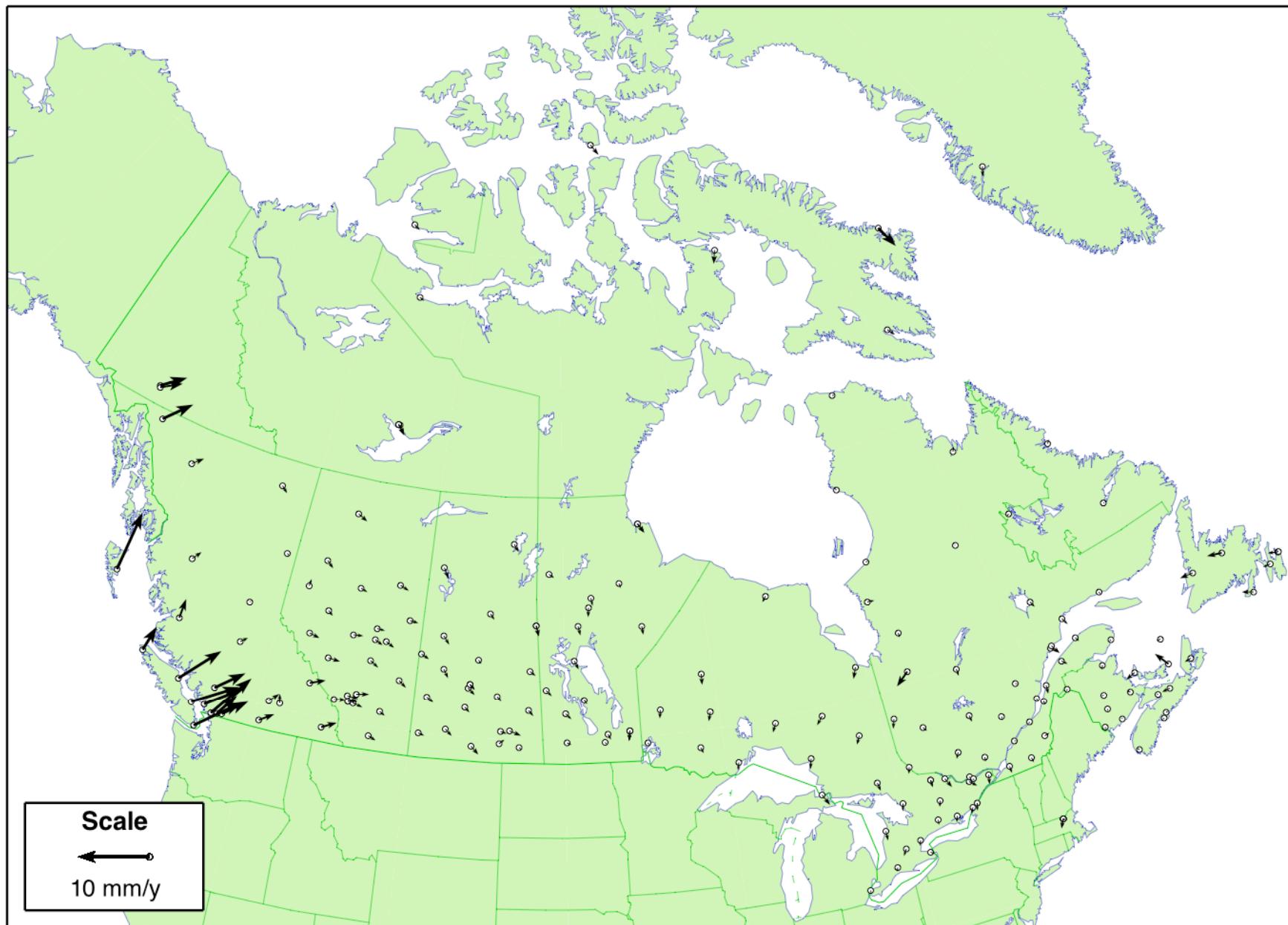
- Time span of episodic solutions 1994-2006 (12 yr)
- Number of episodic solutions 27
- Number of stations (incl. IGS sites) 206
- Total number of parameters 1,170



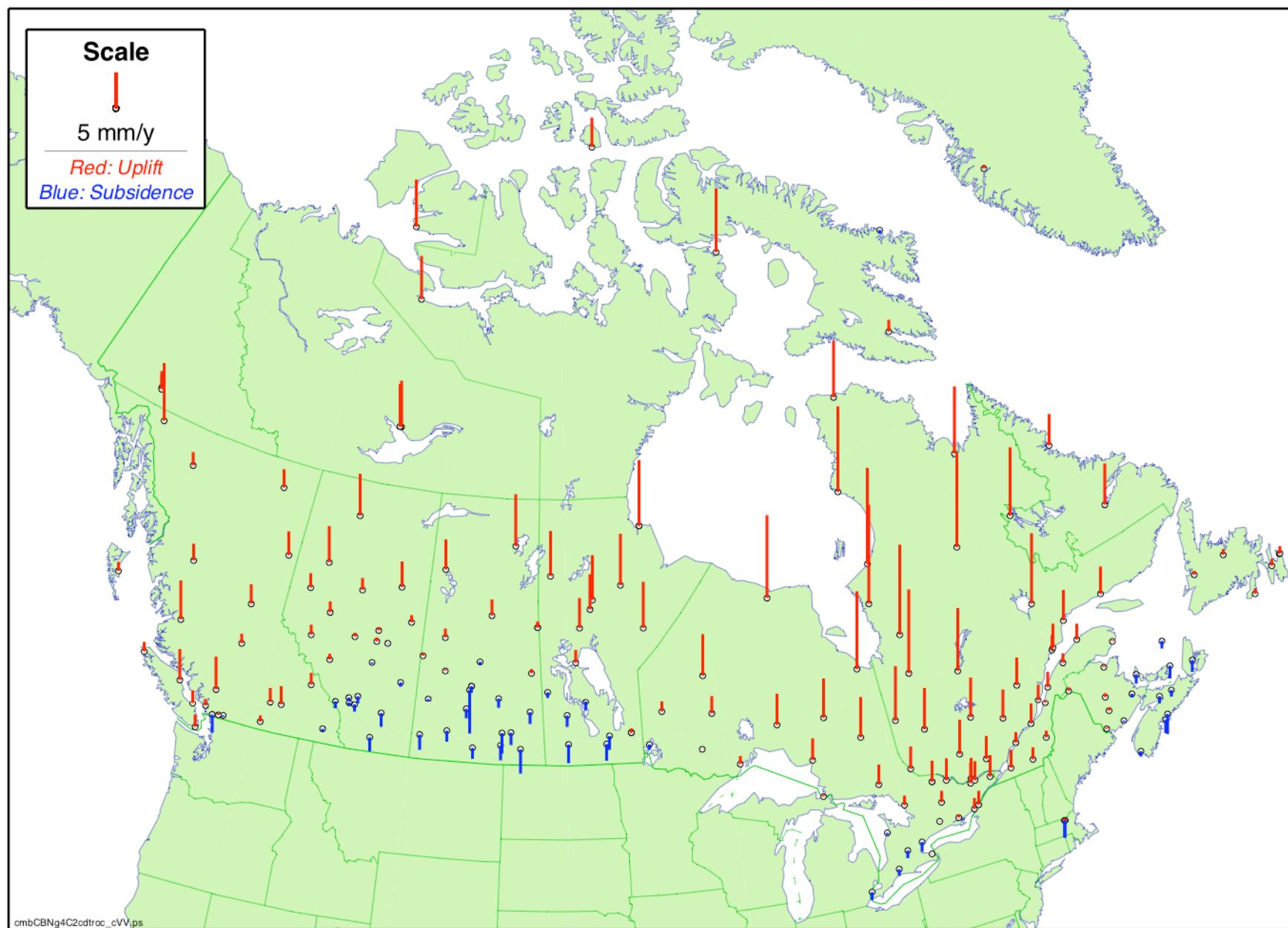
CBN Horizontal Velocities



CBN Horizontal Velocities w.r.t. ITRF2005 Plate Motion



CBN Vertical Velocities





Future Solutions

Need to reprocess all data again due to...

IGS adoption of absolute PCV since week 1400

- Solutions since 1400 incompatible with older ones
- Need reprocessed older IGS orbits with absolute PCV

Including more NAREF stations

- Upgrading SINEX software to handle >2000 stations
- Will include all sites submitted by contributors
- Will include more global stations for better frame realization

Additional redundancy in NAREF combination

- SIO will process all Canadian & many more CORS stations
- Will provide more redundancy for CORS stations

No new CBN surveys planned until after 2010

- Only eastern part in support of new IGLD





Acknowledgements

NAREF regional solution contributors

- NGS – Mike Cline et al.
- SIO – Peng Fang & Yehuda Bock
- PGC – Herb Dragert
- MIT – Tom Herring
- GSD GIPSY solution – Caroline Huot & Brian Donahue

SINEX combination software

- Remi Ferland





Time Series Offsets

