

Preliminary Results of an Updated North American GPS Velocity Field

ABSTRACT

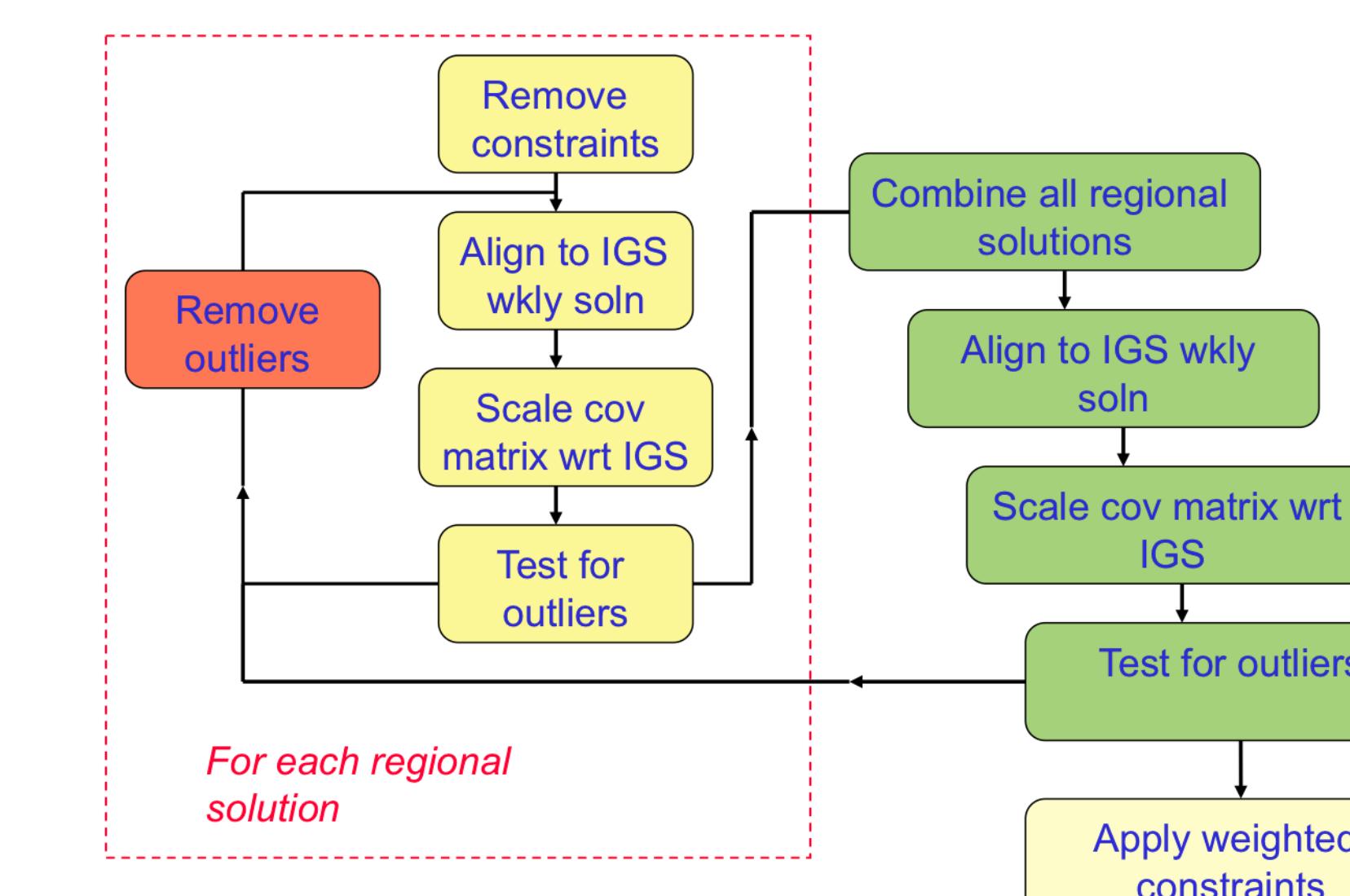
In an effort to improve previous continental-scale GPS velocity fields for North America, we and other collaborators in the North American Reference Frame (NAREF) Working Group have reprocessed, or are in the process of reprocessing, data from nearly all continuous GPS sites in North America (as well as a selection of global sites used to define the reference frame). Previous velocity fields were derived from coordinate time series of somewhat inhomogeneous GPS results due to: (1) the use of relative antenna calibrations that did not include satellite antennas or account for the presence of antenna radomes, (2) the use of different reference frames, (3) the use of IGS precise orbits based on these calibrations and reference frames, and (4) the use of different (evolving) versions of GPS processing software and procedures. This reprocessing effort of all previous data is based on more consistent and accurate absolute antenna calibrations of both station and satellite antennas, the ITRF2005 reference frame and the latest versions of GPS processing software and procedures. Also, more than three additional years of data have been included in the velocity field estimation. The new preliminary time series and velocity results from the different NAREF collaborators are compared with each other and with previous reported results. We also compare these results to new precise point positioning (PPP) solutions that are much more efficient for processing large networks.

1. NAREF BACKGROUND

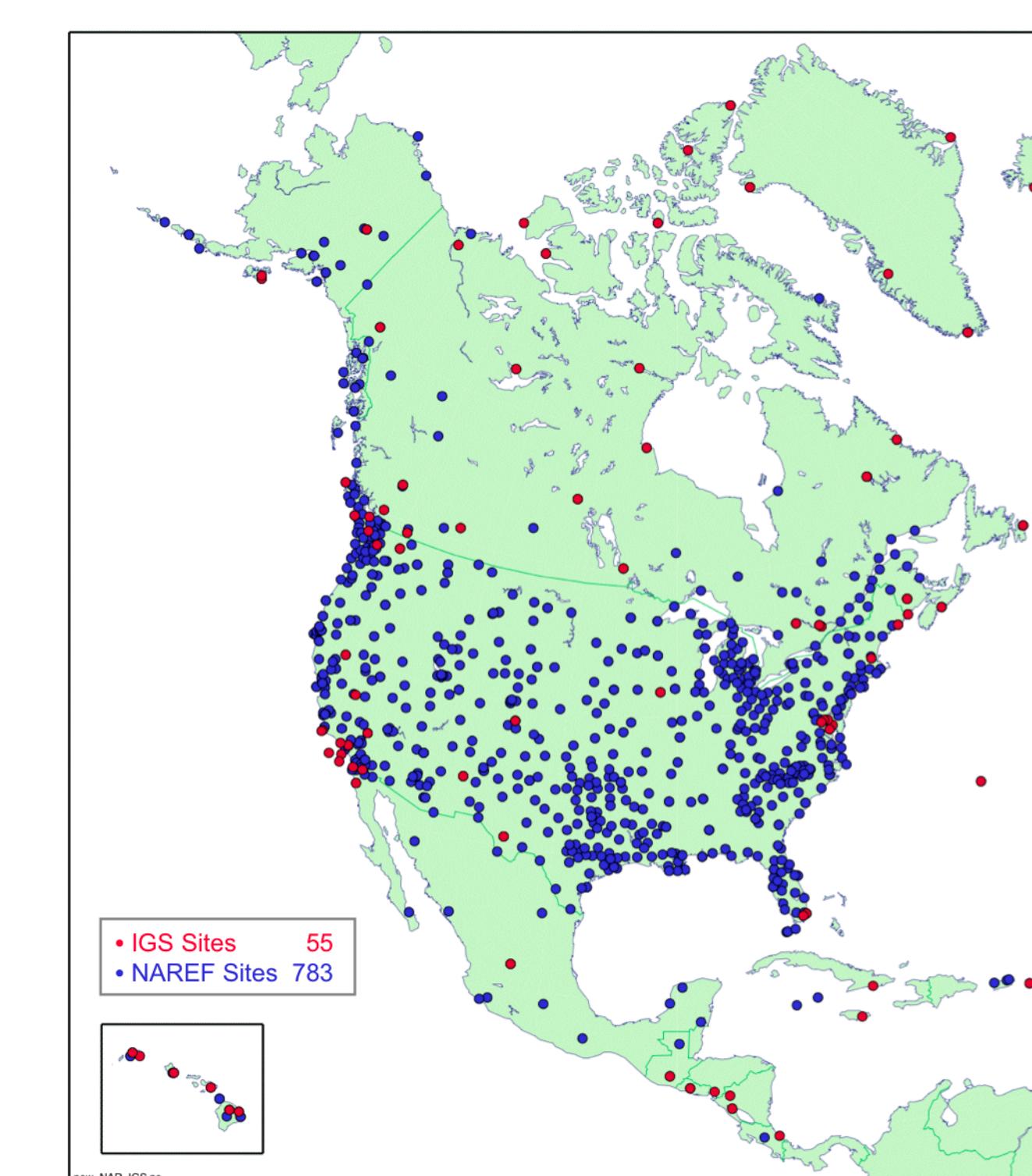
- NAREF – North American Reference Frame Working Group
 - IAG Regional Subcommission 1.3c (Regional Reference Frames for North America)
 - Densification of ITRF in North America
 - Consolidating regional networks into a continental one
 - Integrating into ITRF via IGS global network
- Coordinate & Velocity Solutions
 - Weekly combinations of regional solutions
 - Periodic cumulative (velocity) solutions

3. COMBINATION OF REGIONAL SOLUTIONS

- Combination procedure

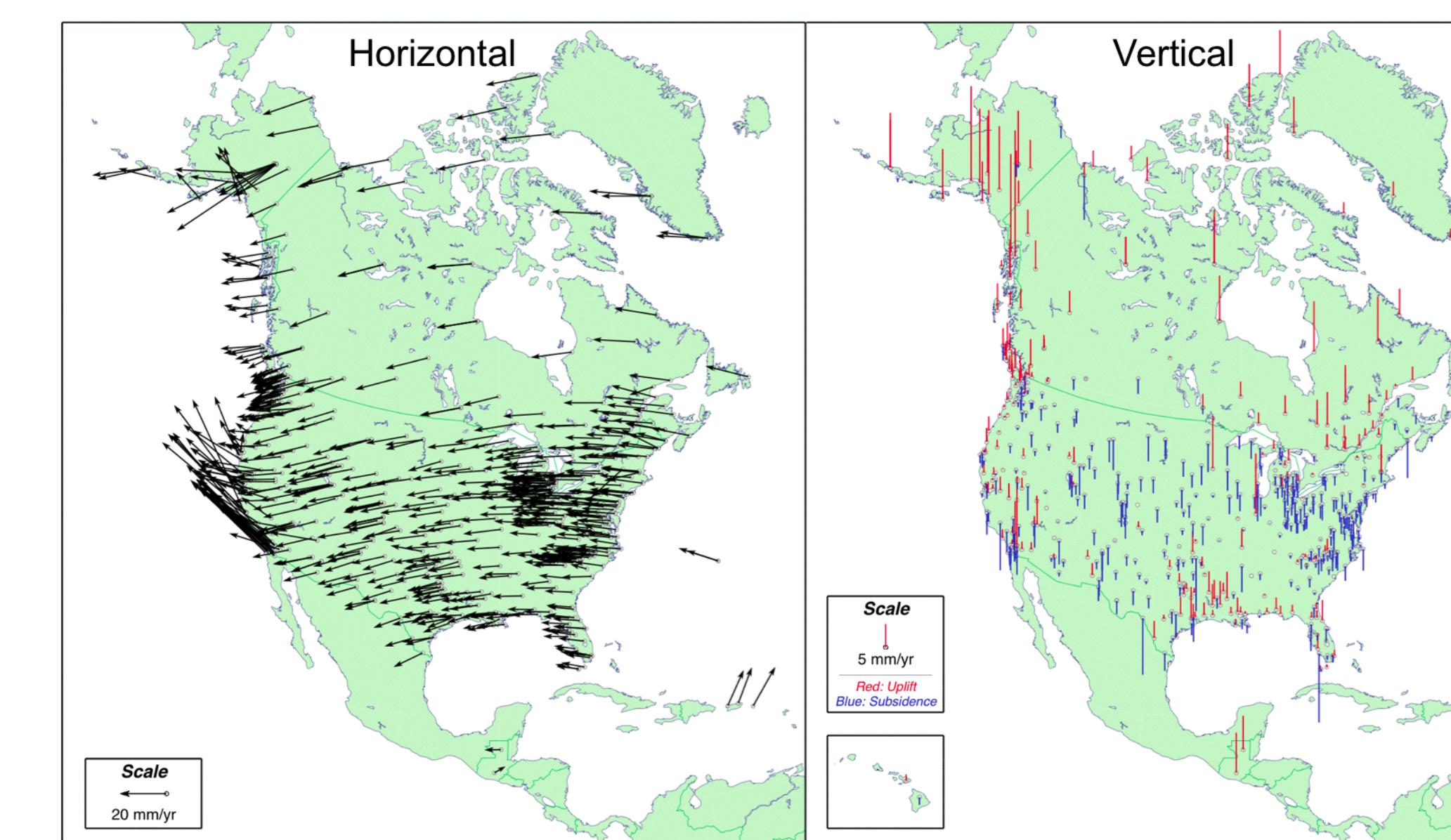


- Combined NAREF network (GPS week 1399)



4. COMBINATION OF REGIONAL SOLUTIONS

- Previous Velocity Solution 2001-2006 (GPS Weeks 1195-1399)



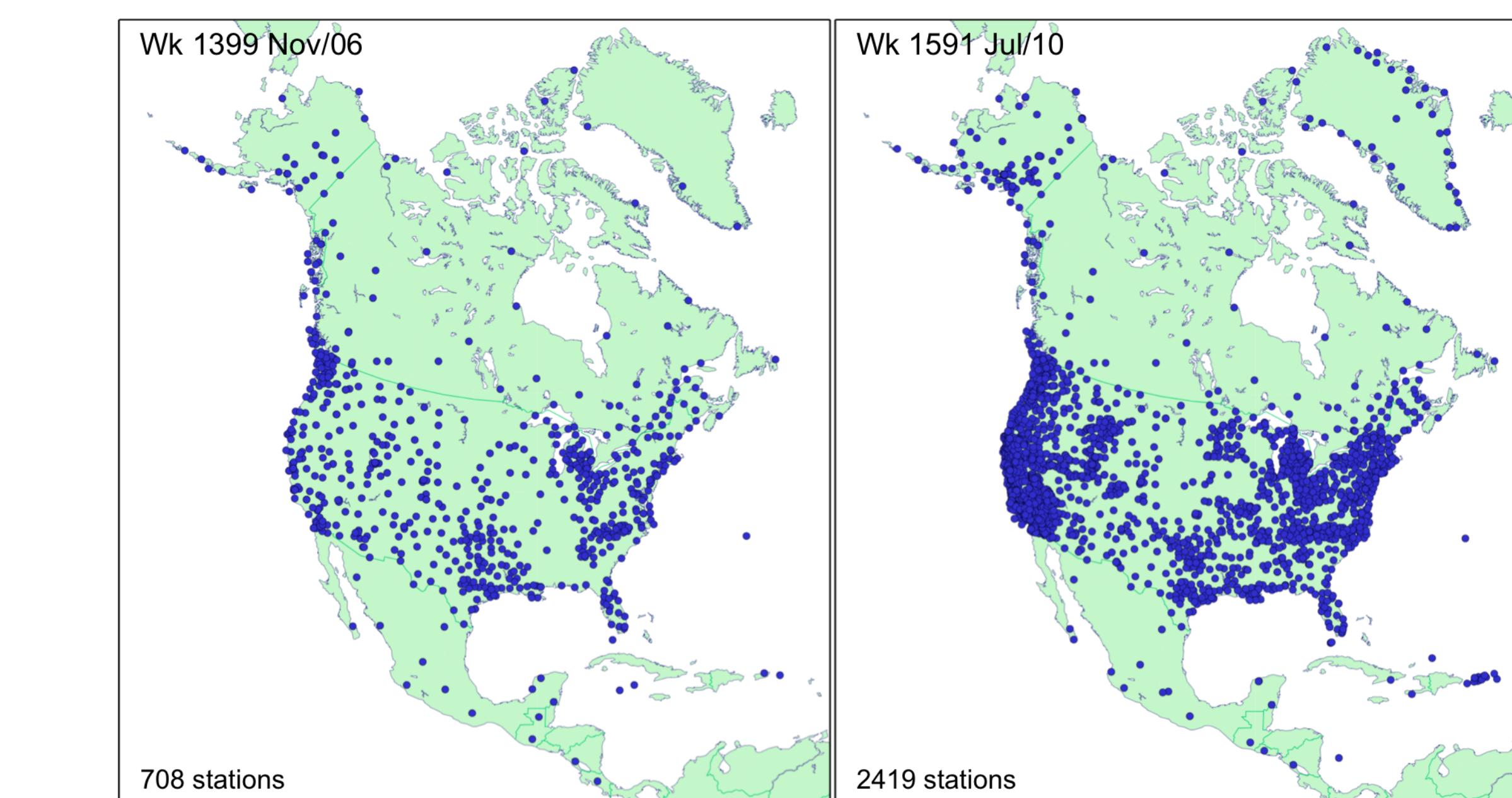
Limitations

- Relative antenna phase center offsets (PCO's)
 - No satellite antenna PCO's
 - Ignored effect of antenna radomes
 - IGS adopted absolute PCO's since GPS week 1400 (\Rightarrow offset)
- Reference frame realized via IGS sites in N.A. only (\Rightarrow net. effect)
- Different (evolving) software used throughout time series
- Different reference frames used throughout time series

5. NEW REGIONAL SOLUTIONS & COMBINATION

Regional Solutions

- Reprocessing all data using...
- New IGS "repro1" products throughout time series in IGS05 frame
 - More consistent
 - Common reference frame throughout
 - Absolute antenna PCO's for receivers and satellites
 - Absolute PCO's account for effect of radomes
 - Latest software & procedures used throughout
- More data
 - More stations (>2400 for GPS week 1591 July/10)
 - More redundant solutions for more stations
 - More historic data (~1996 to date)



- Solution Redundancy (overlap of regional solutions)
 - Need redundancy/overlap between solutions, especially for checks on antenna heights
 - Old solutions had limited overlap
 - New solutions have much more overlap but also more stations w/o any

No. Stations in	Wk 1399 (old)	Wk 1509 (new)
1 solution	488 69%	1016 62%
2 solutions	94 13%	400 24%
3 solutions	95 13%	176 11%
4 solutions	21 3%	25 2%
5 solutions	7 1%	22 1%
6 solutions	3 0.4%	4 0.2%

Weekly Combination & Velocity Solution

- Reference frame realized using global IGS sites (IGS05)
 - Avoids so-called network effect
- Enhancing SINEX combination software
 - To handle very large networks
 - More efficient matrix computations (LAPAK)
- Will implement automated detection of time series offsets
 - Too many stations to visually inspect all time series
 - Procedure developed by NGS

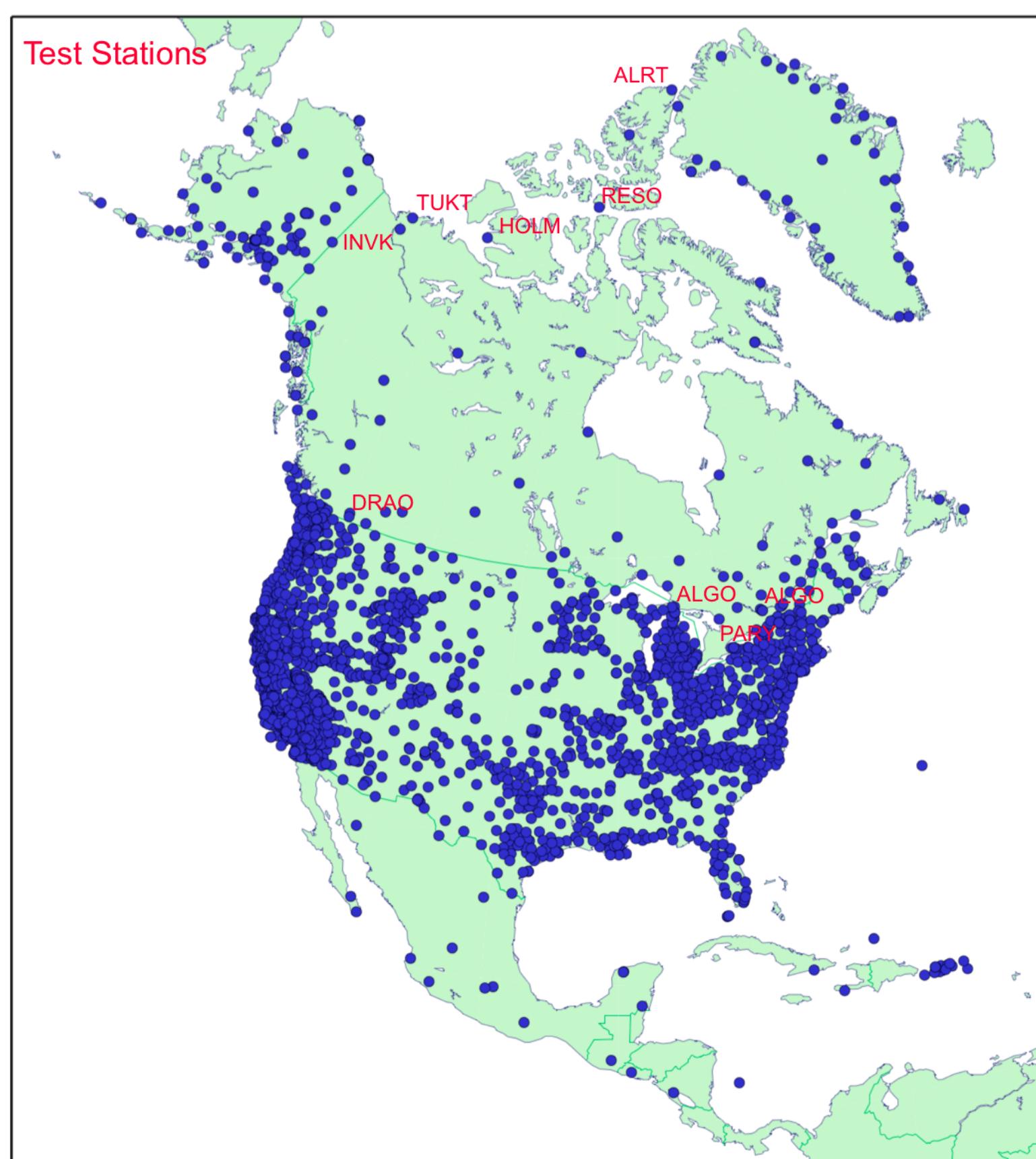
Current Reprocessing Status

- NGS & SIO have completed all reprocessing
- Others in progress
- Hope to finish all reprocessing finished by March 2010

6. PRELIMINARY RESULTS

Comparison of Time Series

- NAR: Old NAREF solutions
- IGS: IGS "repro1" weekly solutions
- GSB: NRCAN/Bernese solutions (prelim)
- PPP: NRCAN PPP solutions (daily)
- All solutions aligned to IGS05 reference frame
- GSB solution still in progress (only a partial time series from 2005 to 2010 available)
- PPP solutions aligned to IGS05 only through "repro1" IGS orbits. Will eventually align daily solutions to IGS05 on a network basis.
- Comparing estimated velocities and RMS of residuals
- Using IGS sites to compare with IGS "repro1" results (except for PARY)



Vertical Velocity Comparisons

Site	Velocities (mm/y)				Residual RMS (mm)			
	IGS	GSB	PPP	NAR	IGS	GSB	PPP	NAR
ALGO	3.6	3.1	3.5	3.1	4.2	5.7	7.7	2.9
ALRT	5.9	5.9	6.2	9.2	7.2	8.4	9.0	8.4
CAGS	3.8	2.7	3.5	1.7	6.0	9.7	8.8	4.0
DRAO	0.8	1.1	0.5	0.3	4.8	4.1	9.0	2.4
HOLM	3.2	2.8	0.1	3.6	4.0	4.8	7.9	5.6
INVK	-0.4	0.1	-0.4	-3.4	8.2	7.5	10.6	10.8
PARY	0.7	1.0	1.1		4.9	6.5	3.0	
RESO	5.9	6.1	5.6	6.0	4.3	4.7	7.5	6.4
TUKT	-0.7	-1.0	-1.1	3.8	4.6	5.2	7.8	4.8

- Good agreement between IGS, GSB and PPP velocity estimates in spite of very preliminary state of GSB and PPP results
 - GSB time series nearly half the length of other time series
 - PPP are only daily solutions not explicitly aligned to IGS05
- NAR results exhibit more discrepancies with respect to IGS estimates
- PPP results exhibit greater noise than others due to daily solutions
 - Expect weekly averages and network alignment to reduce noise level

- Example time series for RESO

