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Canadian Contributions to the NAREF Initiative to Densify the ITRF in North America

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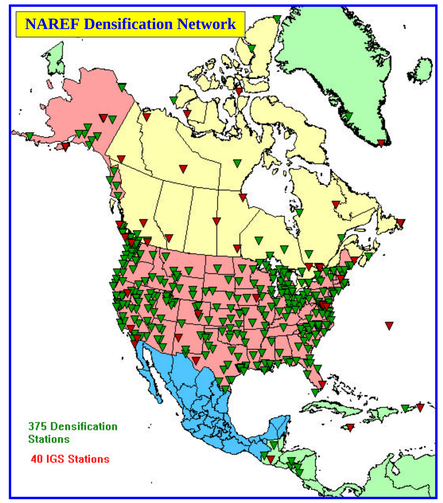
ABSTRACT

In an effort to densify the ITRF in North America, the IGS initiated a program of distributed regional processing to better manage the computational effort. Under the auspices of the North American Reference Frame (NAREF) Working Group, the Geodetic Survey Division (GSD) has been contributing to this initiative on two fronts: the provision of weekly regional GPS solutions for continuous GPS arrays in Canada and the combination and integration of regional solutions for other arrays across North America.

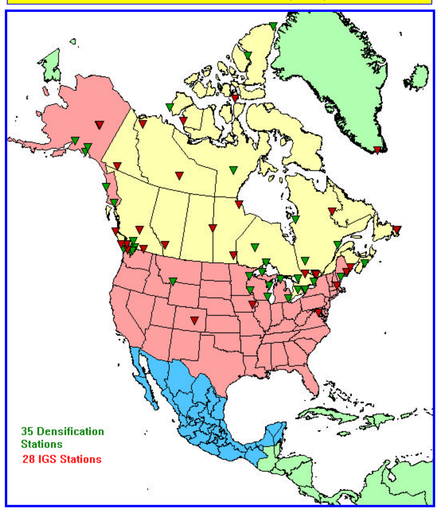
Since the beginning of 2001, GSD has been computing two independent Canada-wide weekly solutions using GIPSY-OASIS II and the Bernese GPS Software. These solutions include all known geodetic-quality, continuous GPS stations across Canada as well as stations from neighboring arrays in the U.S. In additional, we have been receiving regional weekly solutions for two other continuous GPS arrays in North American: the Western Canada Deformation Array from the Geological Survey of Canada - Pacific Division and the Plate Boundary Observatory from the Scripps Institution of Oceanography. The later covers most of the western seaboard of the U.S. Most recently, we have also been receiving weekly solutions from the U.S. National Geodetic Survey for their entire national CORS network. This contribution now makes NAREF truly North American in scope.

GSD has also been combining these regional solutions into weekly NAREF combinations in order to provide a time series of consistent, high accuracy coordinates for continuous GPS stations in North America. Overlap among these regional arrays provide redundancy checks and allow for the determination of correct relative weighting of different solutions and a more realistic assessment of accuracy. The agreement among the regional solutions is generally less than a couple of mm horizontally and about 4-5 mm vertically. Agreement of the minimally constrained NAREF combinations with the IGS weekly combinations is of the order of 2-3 mm horizontally and 5-8 mm vertically. These combinations have been integrated into the IGS global network using a combination of Helmert transformation and a priori weighting of IGS global stations. Agreement of these integrated NAREF combinations with the IGS solutions is about 1 mm horizontally and 4 mm vertically.

NAREF Densification Network

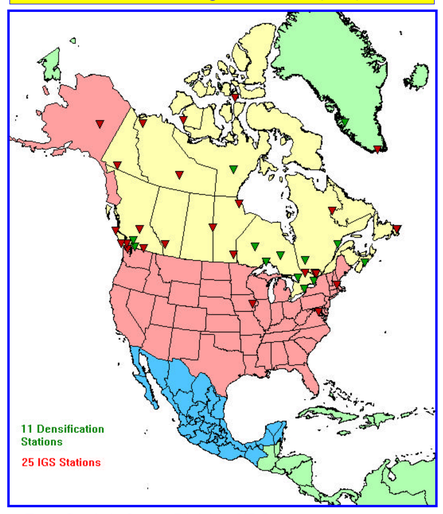


NRCan Bernese Network (GSB)



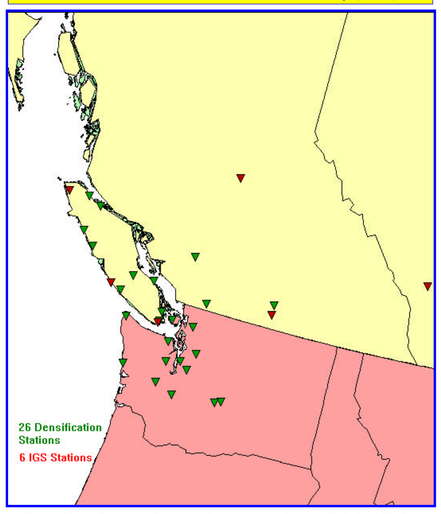
- From Geodetic Survey Division, NRCan
- Bernese GPS Software Version 4.2
- Double differenced observations
- 3 minutes data sampling
- 10 deg elevation cut off
- Fixed IGS precise orbits & ERP
- Tropospheric zenith delay (every 2 hours)
- Niell mapping function (dry)
- Tropospheric gradient (1/day)
- QIF ambiguity resolution with regional ionosphere model
- LOADSDP v.5.0 ocean loading model
- 1 IGS reference frame station (DRAO) constrained to IGS00

NRCan GIPSY Regional Network (GSG)



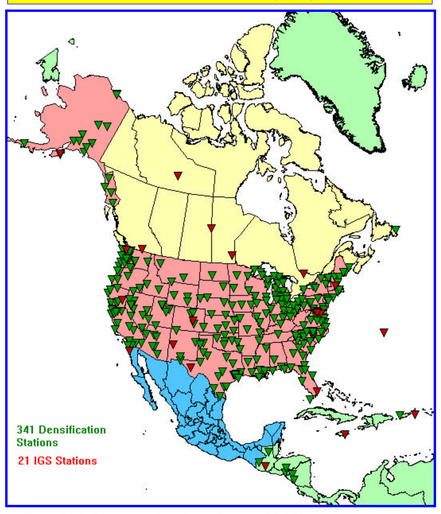
- From Geodetic Survey Division, NRCan
- GIPSY-OASIS II software
- Undifferenced observations
- 7.5 minutes data sampling
- 15 deg elevation cut off
- Fixed IGS precise orbits & ERP
- Tropospheric zenith delay (random walk)
- Niell mapping function (wet)
- Tropospheric gradient (random walk)
- Ambiguity resolution applied
- IERS96 ocean loading model
- 1 IGS reference frame station (DRAO) constrained to IGS00

NRCan Western Canada Deformation Array (PGC)



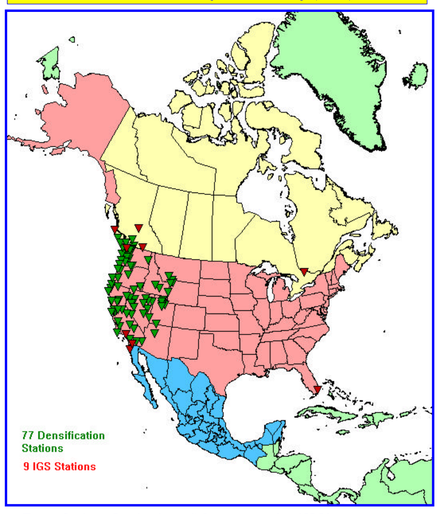
- From Herb Dragert, Pacific Geoscience Centre (PGC), NRCan
- Bernese GPS Software Version 4.2
- Double differenced observations
- 30 second data sampling
- 10 deg elevation cut off
- Fixed IGS precise orbits & ERP
- Tropospheric zenith delay (every 2 hours)
- Niell mapping function (dry)
- Tropospheric gradient (4/day)
- QIF ambiguity resolution
- LOADSDP v5.02 ocean loading model
- 1 IGS reference frame station (DRAO) constrained to ITRF97

NGS CORS Network (NGS)



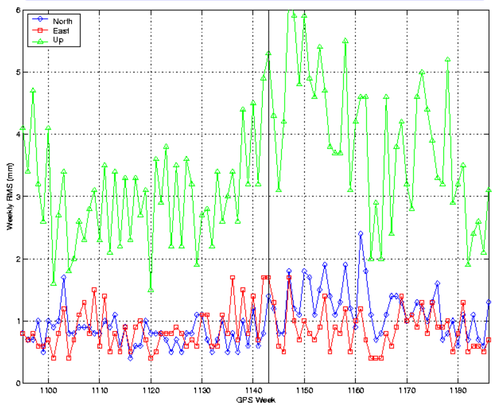
- From U.S. National Geodetic Survey (NGS)
- Page5, v0205.22
- Double differenced observations (iono-free combination)
- 30 second data sampling
- 15 deg elevation cut off
- Fixed IGS rapid orbits & ERP
- Tropospheric zenith delay (every 2 hours)
- Niell mapping function (dry & wet)
- No tropospheric gradient estimation
- No integer ambiguity resolution
- IERS 96 ocean loading model
- 8 IGS stations constrained to ITRF2000 values

SIO Plate Boundary Observatory (GSB)

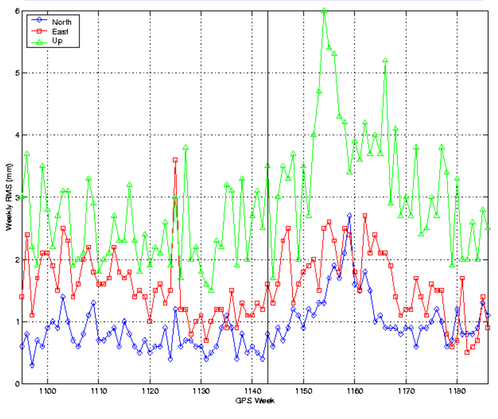


- From Scripps Institution of Oceanography (SIO)
- GAMIT v9.72 software
- Double differenced observations
- 2 minute data sampling for final solution
- 10 deg elevation cut off
- Fixed SIO precise orbits & ERP
- Tropospheric zenith delay (random walk)
- Niell mapping function (dry & wet)
- Tropospheric gradient (1/day)
- Ambiguities resolved for lines < 500 km
- IERS 96 ocean loading model
- IGS reference frame stations loosely constrained to IGS00

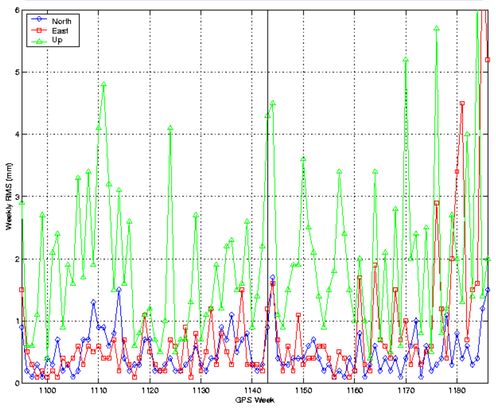
Weekly RMS of GSB Residuals



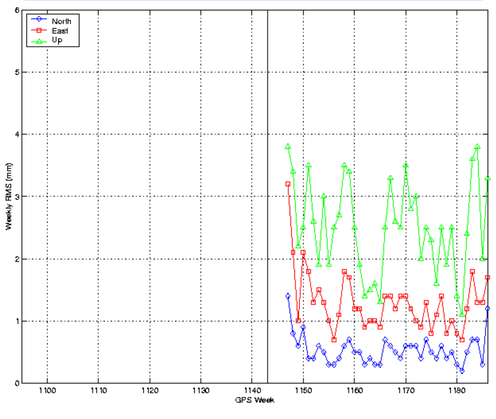
Weekly RMS of GSG Residuals



Weekly RMS of PGC Residuals



Weekly RMS of NGS Residuals



Weekly RMS of PBO Residuals