



IAG Commission 10 – N.A. Subcommittee
NAREF Technical Working Group

NAREF Densification of the ITRF in North America

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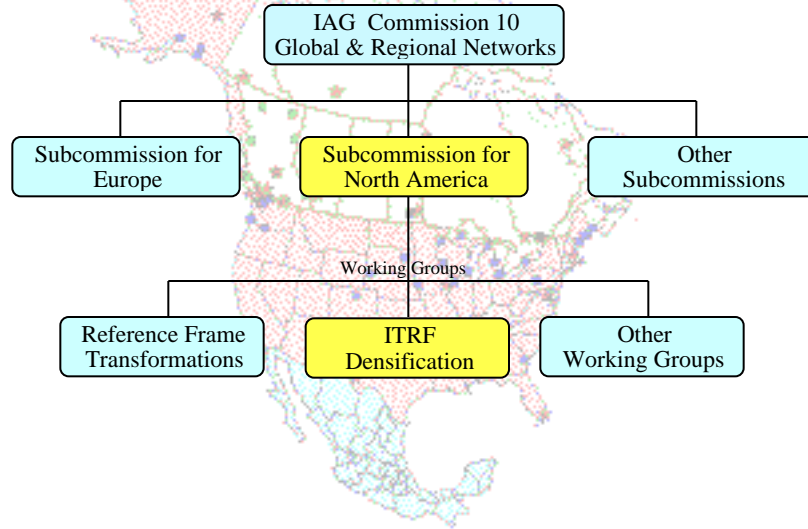
Abstract

Since the beginning of the year, the Geodetic Survey Division of Natural Resources Canada (NRCan) has been computing various Canadian regional GPS solutions in support of the International GPS Service (IGS) initiative to densify the ITRF following their distributed processing approach. The regional solutions have been computed using both GIPSY-OASIS II and the Bernese GPS software following IGS and EUREF guidelines. In addition to all IGS stations in the northern half of North America, the solutions also include all stations of the Canadian Active Control System (CACS), the Western Canada Deformation Array (WCDA), as well as a some selected stations of the US CORS network, the Alaska Deformation Array (AKDA), the Pacific Northwest Geodetic Array (PANGA), the Eastern Basin Range Yellowstone Array (EBRY), the British Columbia Active Control System (BCACS) and the Quebec Permanent GPS Network. In addition to our own solutions, we have been received SINEX files for several weeks from the Pacific Geoscience Centre (WCDA) and the Geophysical Institute of Alaska (AKDA). These solutions are being used to develop, implement and test the combination of different solutions for the NAREF network. With the exception of the NRCan Bernese solution, all show good agreement with each other at the 2 mm level and agreement. The anomalous discrepancy in the vertical components of the Bernese solution are still being investigated. In appropriate weighting of the solution is suspected. Further work will include the use of other SINEX combination software for further checking and the incorporation of more solutions. By the end of the year we hope to eventually begin submitting weekly NAREF combinations to the IGS for incorporation into the IGS polyhedron.

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Subcommission Objective

To provide international focus and cooperation for issues involving the horizontal, vertical, and three-dimensional geodetic control networks of North America, Central America, the Caribbean and Greenland (Denmark).

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Issues to be Addressed

- *Densification of ITRF* in North America and promotion of its use
- *Vertical datum* maintenance & future evolution, incl. NAVD88 and IGLD
- *Standards* for ref. frame transformations & representation of positional accuracy
- *Crustal motion* effects and monitoring, incl. tectonic (west coast) and post-glacial rebound
- *Outreach* to public

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Membership

- *One representative from each country*
 - Canada: Mike Craymer (Commission 10 rep)
 - USA: Dennis Milbert (Commission 10 rep)
 - Greenland/Denmark: Per Knudsen
 - Mexico: TBD
 - Caribbean: TBD
 - Chairpersons from each Working Group
- *Interim Officers*
 - Co-Presidents: Dennis Milbert & Mike Craymer

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Working Groups

- *To address specific technical issues*
- *Current WGs*
 - ITRF Densification – NAREF (est. 1999)
 - Reference Frame Transformations (est. 1997)
 - International Great Lakes Datum – IGLD (est. 2000)
- *Other work by Subcommittee*
 - Outreach & technology transfer through publications, Web site, workshops, symposia, software tools

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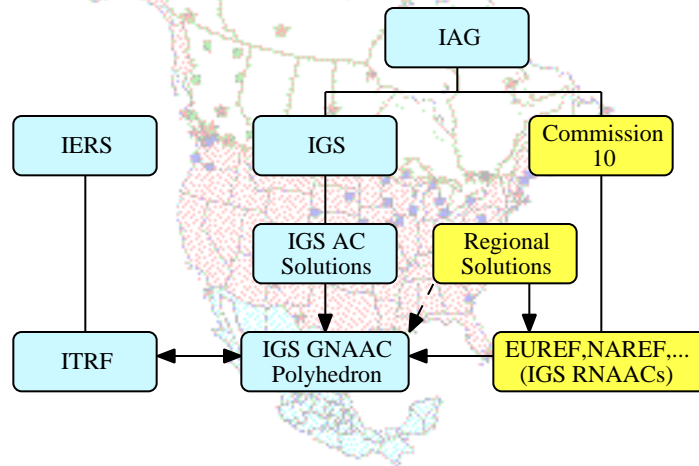
NAREF Objectives

- To densify the ITRF reference frame in NA
- Consolidate regional networks into a continental one
- Integrate into ITRF via IGS global network
- Produce coordinate solutions
 - Weekly solutions/combinations for GNAACs
 - Cumulative solutions with velocity estimates for stations not included in GNAAC polyhedrons

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Distributed Processing



NAREF Members

- *De facto Chairman*
 - Mike Craymer, NRCan
- *Current Members/Contributors*
 - NRCan: Mike Pirazewski, Caroline Huot
 - PGC (WCDA): Herb Dragert
 - Univ. of Alaska (AKDA): Jeff Freymueller ??
 - NGS (CORS): Mark Schenewerk ?
 - JPL: has also expressed interest



Standards

- *Station Selection*
 - 24 hr data, 10 deg. elev. mask angle
 - Continuous operation (min. 5 days/week?)
 - Stable & recoverable monumentation
- *Data Archiving*
 - Most regional data already archived at CDDIS or SOPAC
 - Ensure complete/consistent meta-data in RINEX, SINEX, Log files

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Standards (con't)

- *Regional Processing*
 - Follow IGS & EUREF standards as much as possible
 - Fixed IGS orbits & ERPs (preferably “final”)
 - Redundant solutions for quality control
- *Combination of Solutions*
 - Accumulate normals of each solution
 - Realistic scaling of covariance matrices – *difficult*
 - Two independent combinations for quality control

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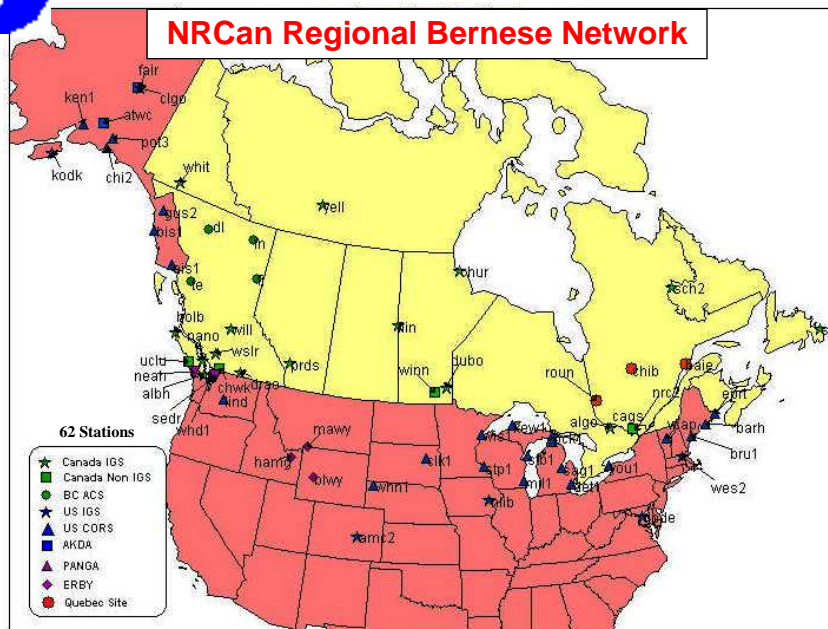
Current Activities

- *Regional Solutions*
 - NRCan (CACS, WCDA, AKDA, northern CORS) – Regional GIPSY and Bernese solutions
 - PGC (WCDA) – Regional Bernese solutions
 - GIA (AKDA) – Extracted from global GIPSY solutions
 - NGS (CORS) – Soon?
- *NAREF Combinations*
 - Presently using Bernese ADDNEQ2 software
 - Will also use Remi Ferland’s SINEX Software for QC
- *See poster*

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NRCan Regional Bernese Network

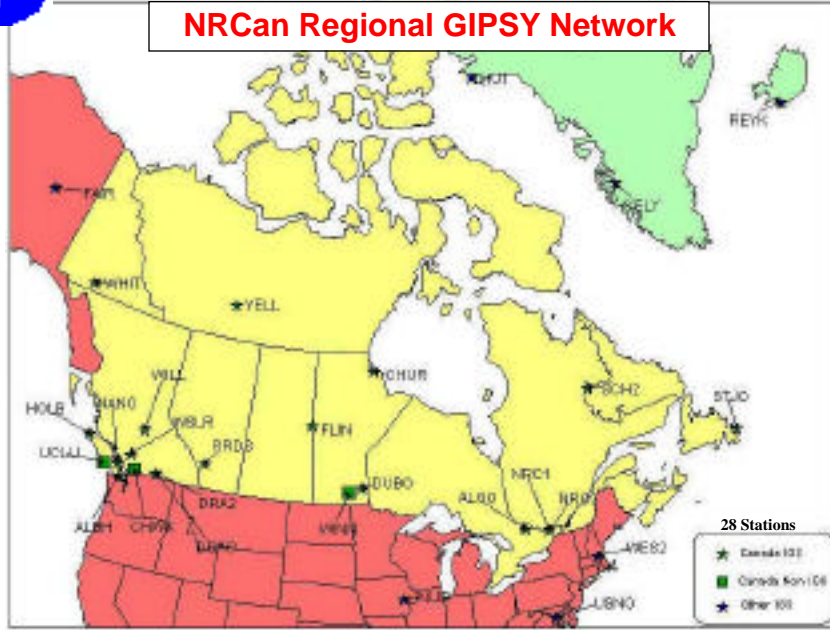


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NRCan Regional GIPSY Network

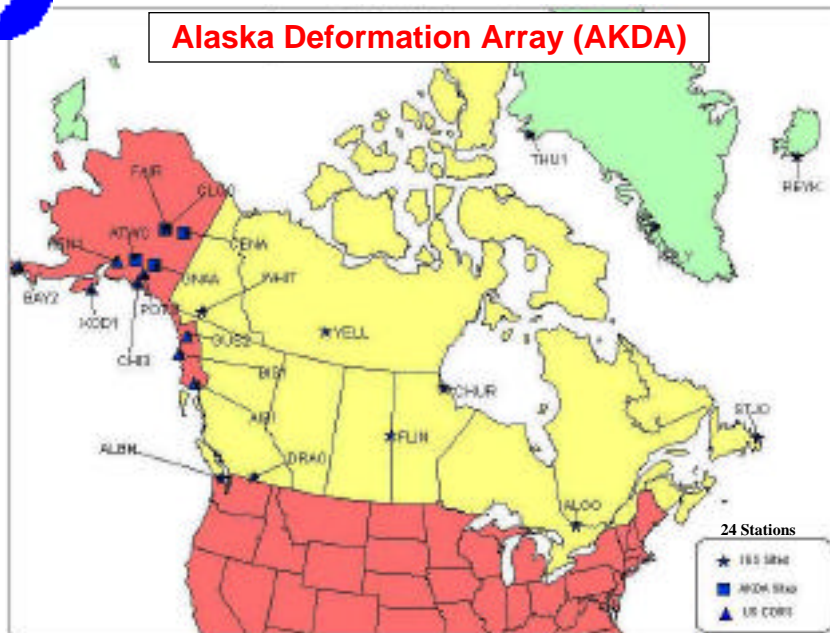


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Alaska Deformation Array (AKDA)

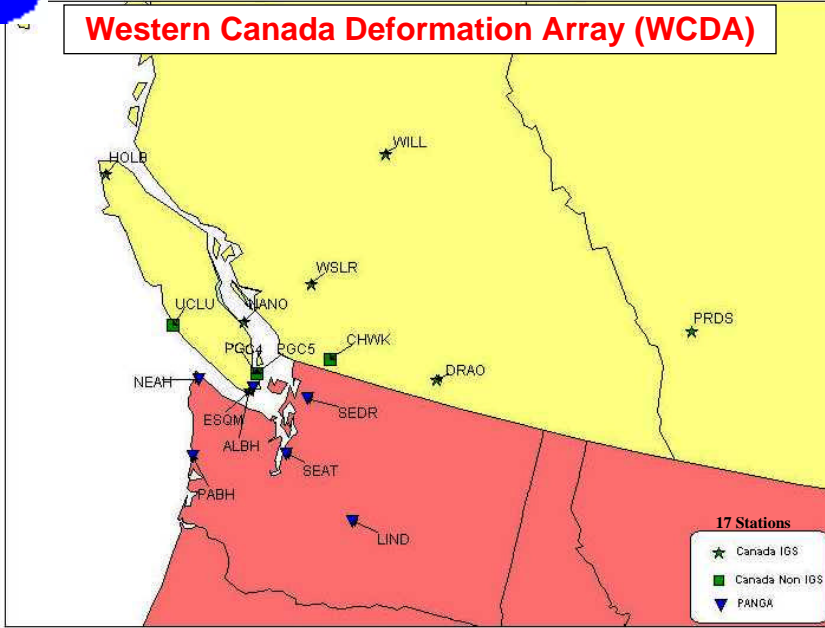


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Western Canada Deformation Array (WCDA)

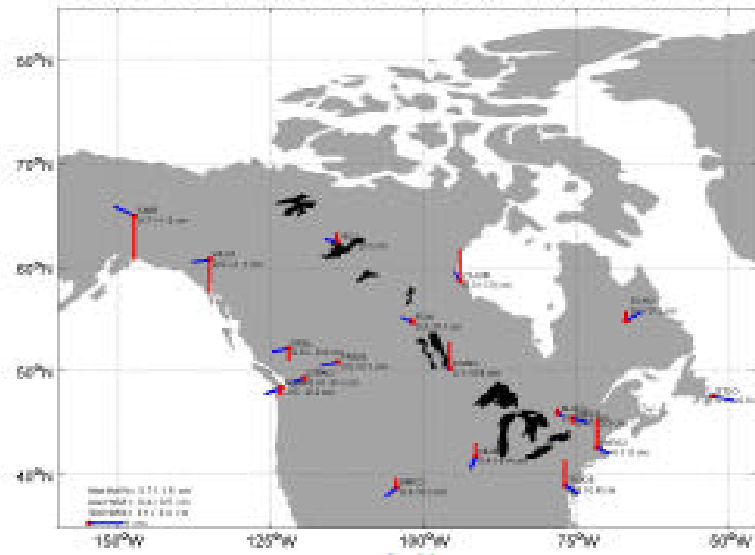


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Week 1070 Differences Bernese HRCam Solution - IGS weekly

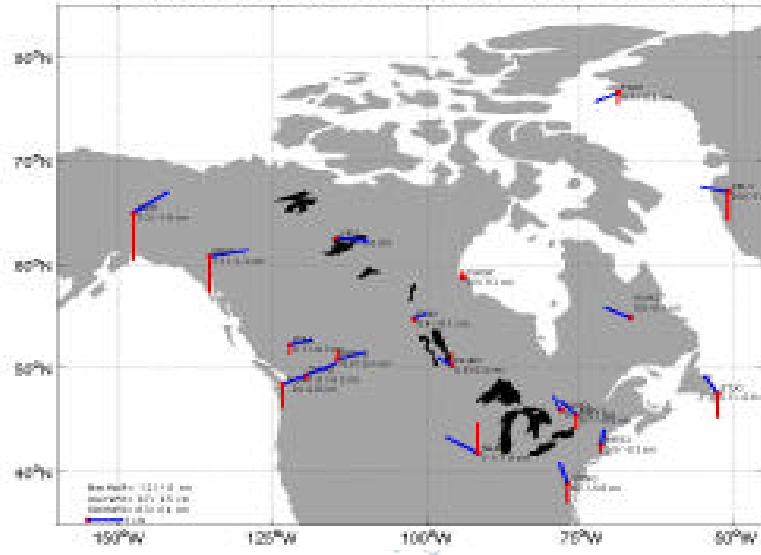


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Week 1070 Differences Gipsy NRCan Solution - IGS weekly

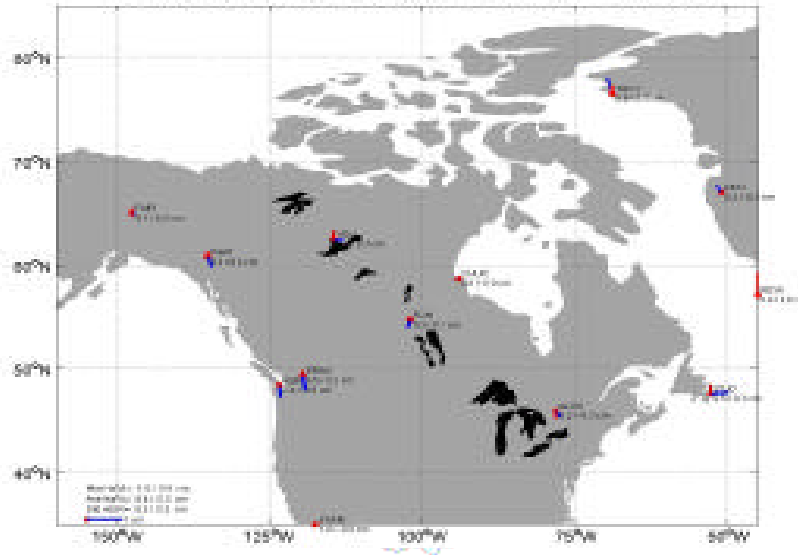


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Week 1070 Differences Gipsy AKDA Solution - IGS weekly

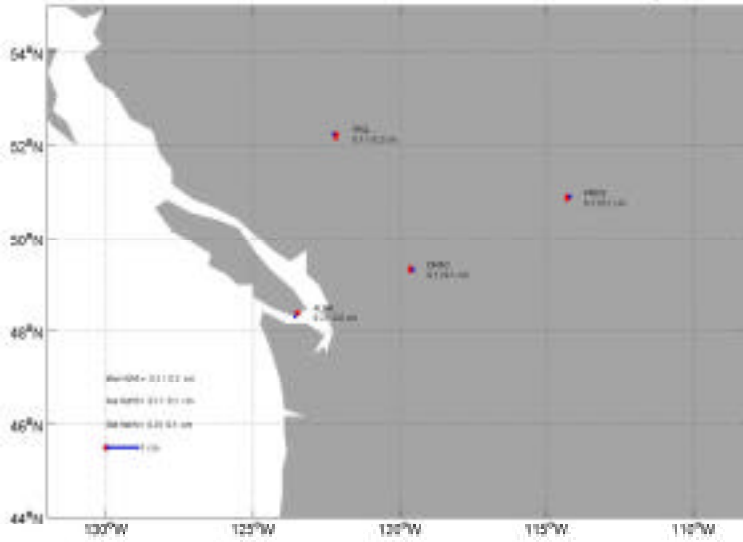


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Week 1070 Differences PGC Bernese Solution - IGS weekly

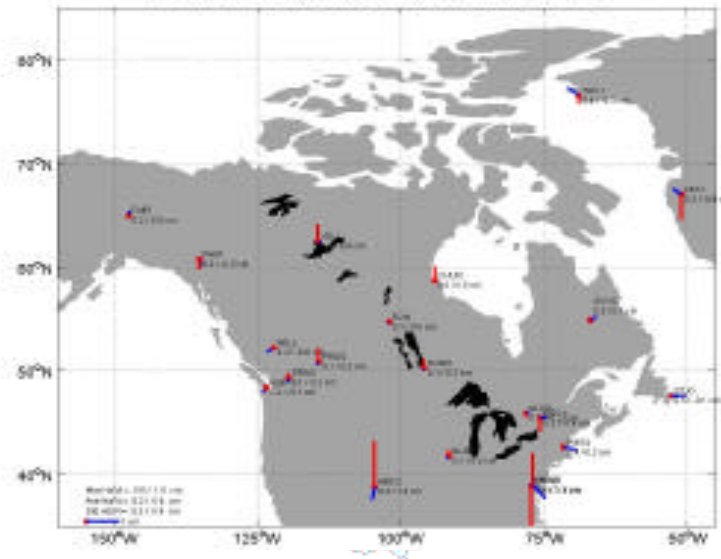


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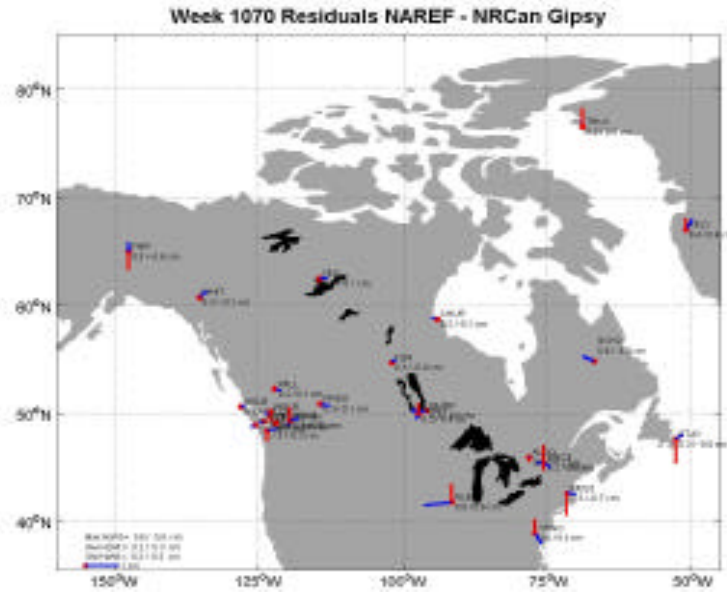
Week 1070 Differences Combined NAREF - IGS



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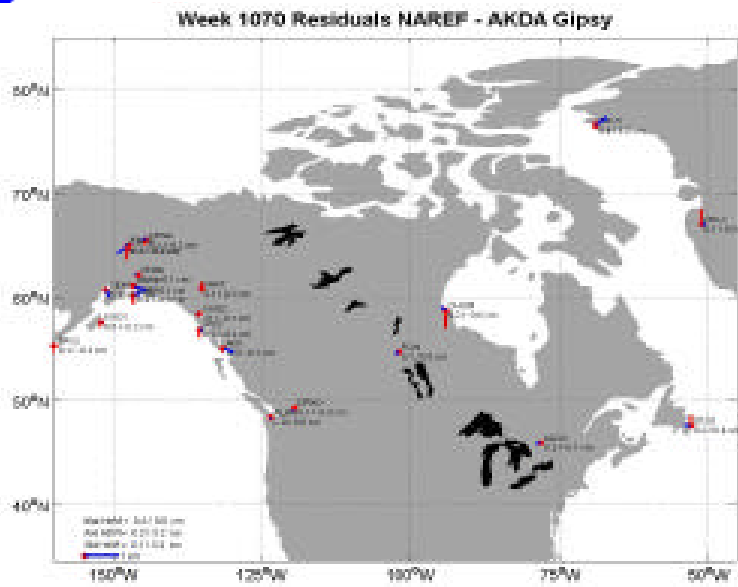
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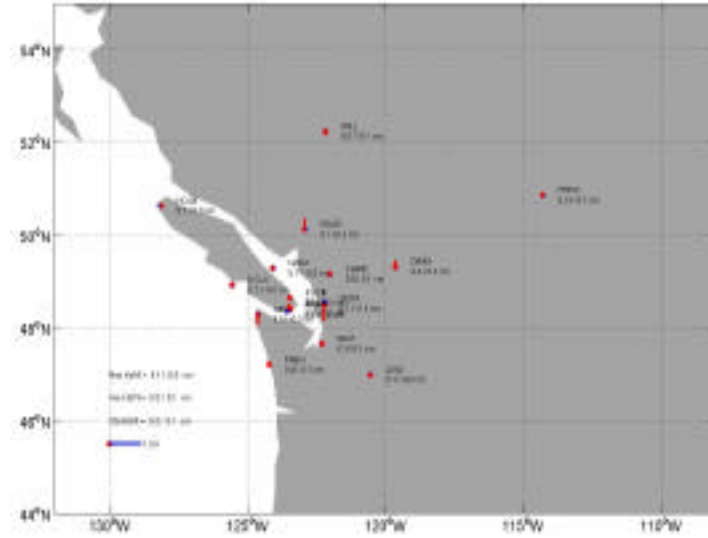


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Week 1070 Residuals NAREF - WCDA Bernese

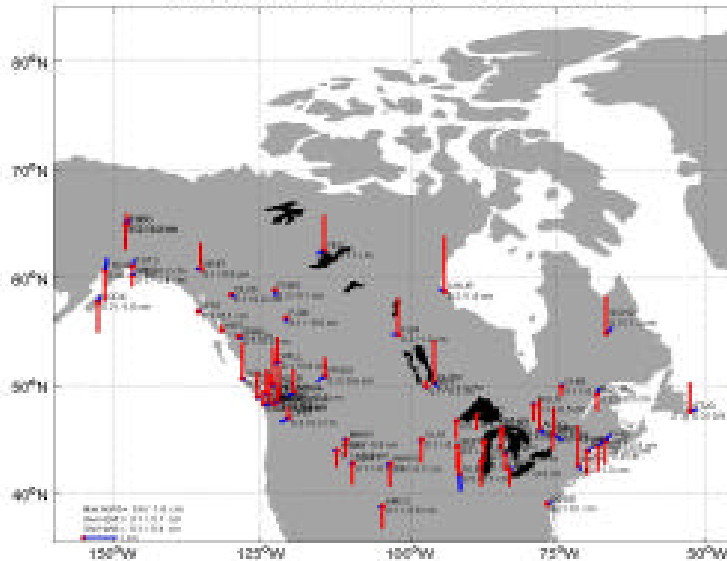


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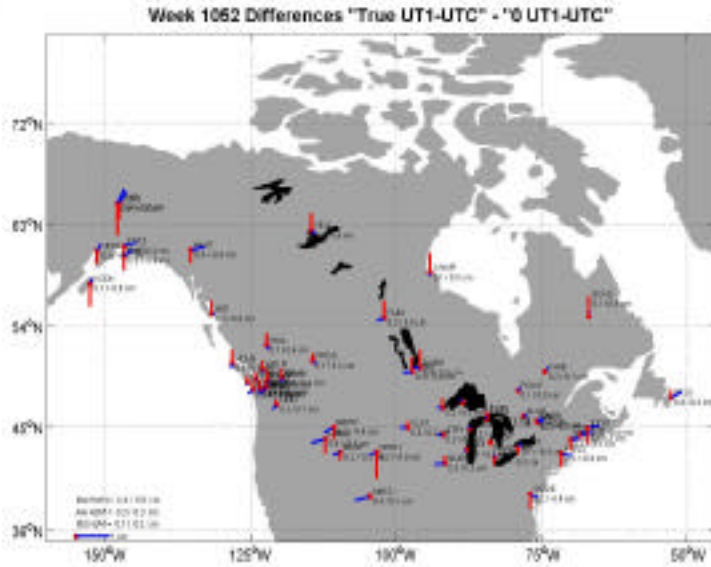


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Week 1070 Residuals NAREF - NRCan Bernese



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Further Work

- *Further test combination methodology*
 - Use independent software for checking
 - Better estimation of realistic covariance matrix scaling
- *Incorporate additional solutions*
 - NGS(CORS) & SIO regional solutions
 - Other regional solutions: ERBY, PANGA, etc.
- *Begin submission of weekly combinations to IGS* – Aiming for end of year

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