Real-Time Wide-Area Differential GPS Corrections from Natural Resources Canada

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Abstract

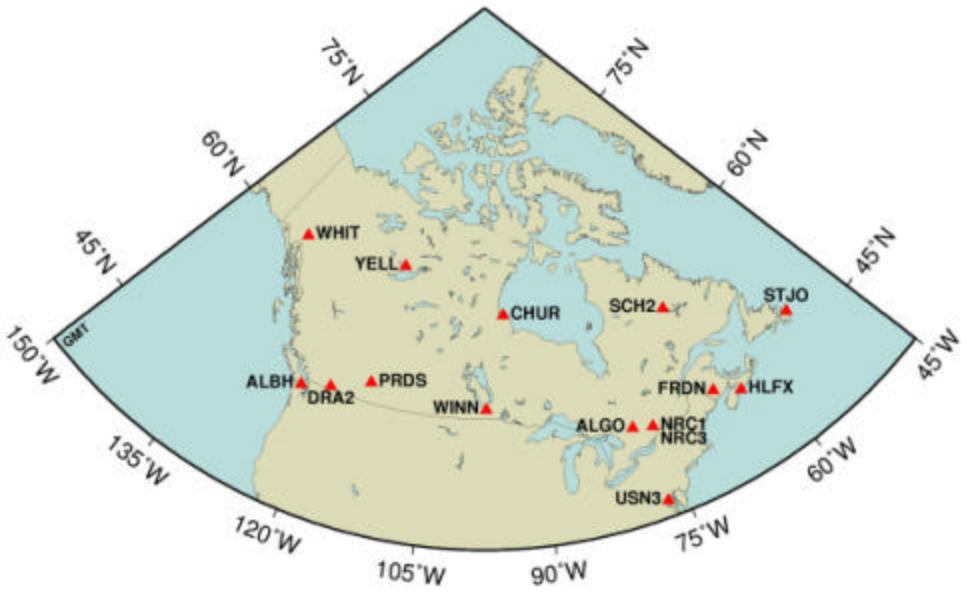
As part of its mandate to provide access to the Canadian Spatial Reference System (CSRS), Natural Resources Canada (NRCan) has been making real-time wide-area differential corrections available to Canadian GPS users for the last 8 years. These corrections (known as GPS*C) are the foundation for the Canadian Differential GPS Service (CDGPS) which has been in operation since October 2003. The GPS*C corrections are provided in a modified-RTCA (MRTCA) format which CDGPS broadcasts via MSAT. The corrections are also available over the internet.

The correction software was developed at NRCan and runs on several Master Active Control Station (MACS) platforms in Ottawa, Ontario. The system currently uses NRCan's contribution to the IGS ultra-rapid orbit product, which in turn uses hourly observation data from the IGS network. The current pseudorange-based corrections are the first step towards high-precision phase-based corrections. The MRTCA message format used by NRCan has the ability to encapsulate sub-centimetre-level corrections to enable a seamless transition to higher quality performance. The current positioning quality within Canada is on the order of 70cm 2drms. Due to the regional observing network, the positioning quality achieved with the phase-based corrections is currently estimated to be 40cm 2drms. To achieve the highest precision of 10cm 2drms requires corrections computed from a global network where satellites can be tracked continuously.

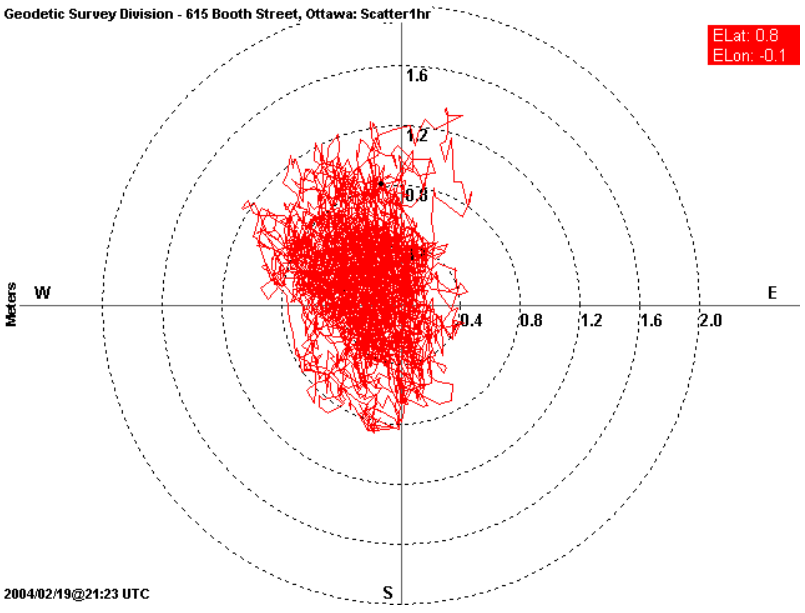
NRCan is currently testing its correction software with a prototype global solution using approximately 20 stations from both the IGS LEO network and the nascent IGS real-time network. Positioning results with these corrections are on the order of 20cm 2drms. It is envisioned that further algorithm and orbit refinement will improve these results. With this level of corrections, not only does high precision navigation become a reality for Canadian GPS users, but also real-time precise time transfer and tropospheric monitoring.

Current NRCan Real-Time Network

The current NRCan real-time network consists of 15 stations. Each one has a dual-frequency GPS receiver connected to an external atomic frequency standard. Data is transmitted at 1Hz to processing facilities in Ottawa. All the stations use a private WAN to deliver the data, except FRDN and HLFX, which use the internet.



Current CDGPS Single-Frequency Positioning Results



For continuously updated results see: http://www.cdgps.com/e/monitoring.htm

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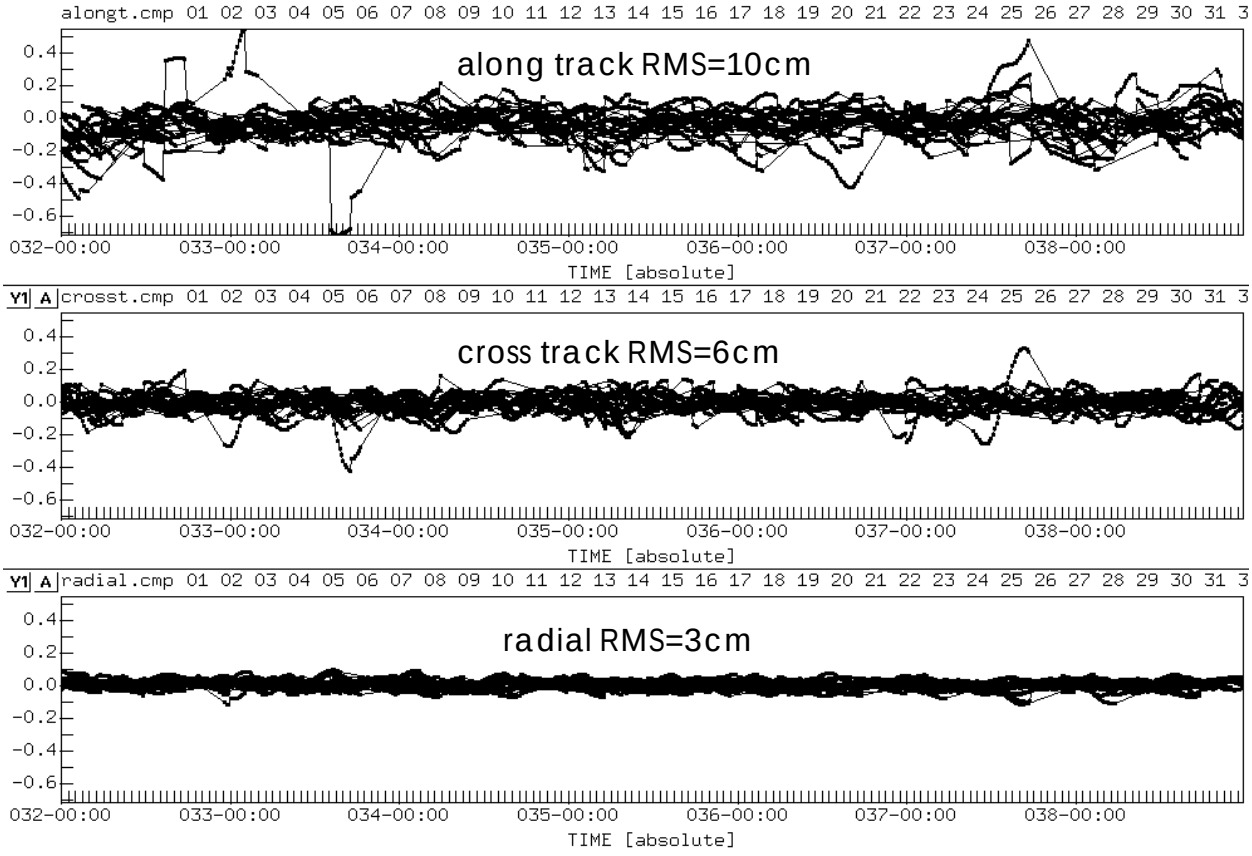
NRCan Ultra-Rapid Orbit — Prediction Quality

The NRCan corrections filter uses the NRCan Ultra-Rapid Orbit Product as a source for the satellite coordinates. These are computed on a 3-hour cycle compared to the current 12-hour cycle for the combined IGU product. The latency for the internal product is the same as the combined and hence we use the 2-5 hour portion of the predicted orbits. These plots compare those portions for one week with the combined IGS Rapid Orbit (y-axis units are metres).



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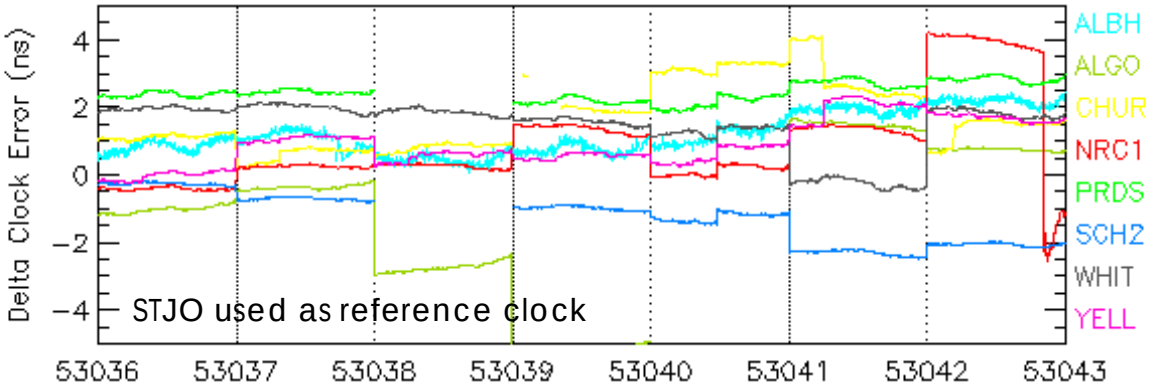
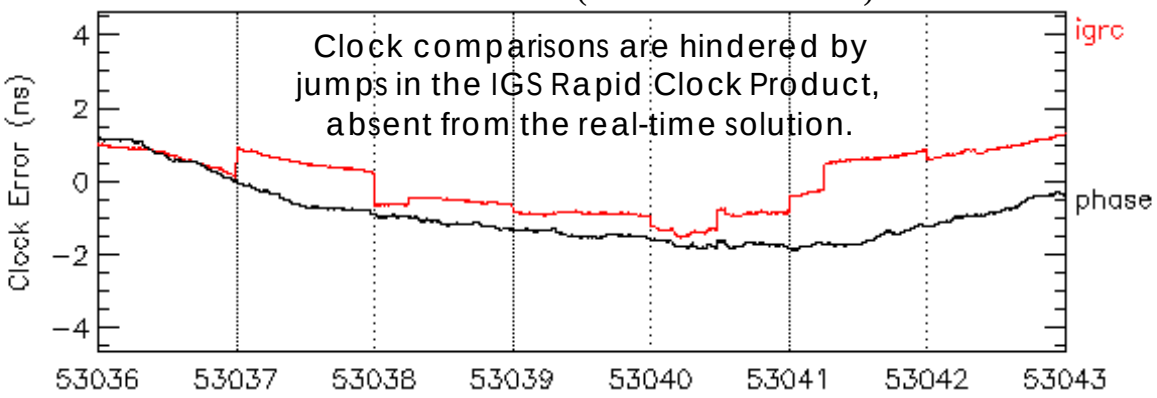
Real-Time GPS·C(Phase) Products compared to IGS Products

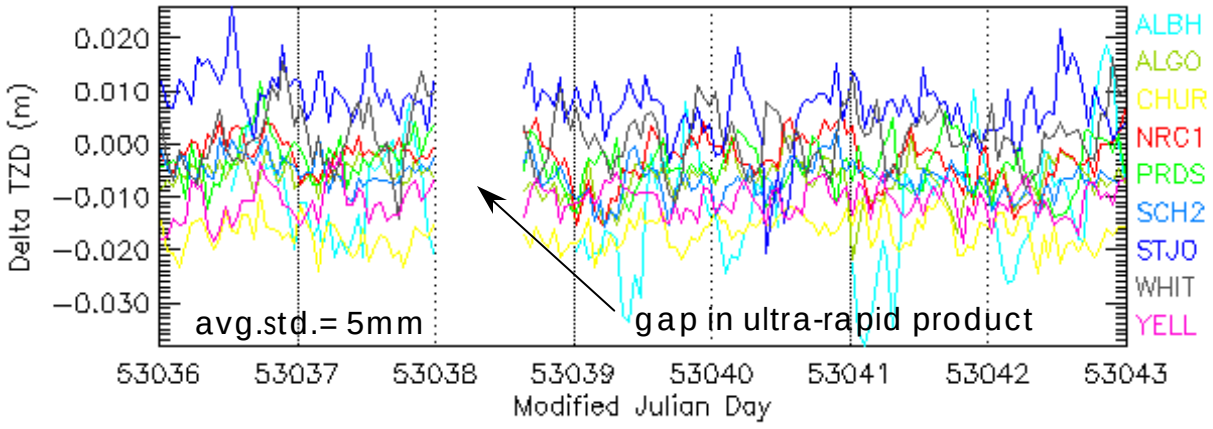
IGS(Rapid)-GPS·C(Phase) Station Clock Error Differences



YELL-STJO Clock Error (Linear trend removed)



IGS(Ultra-Rapid)-GPS·C(Phase) Tropospheric Zenith Delay Differences



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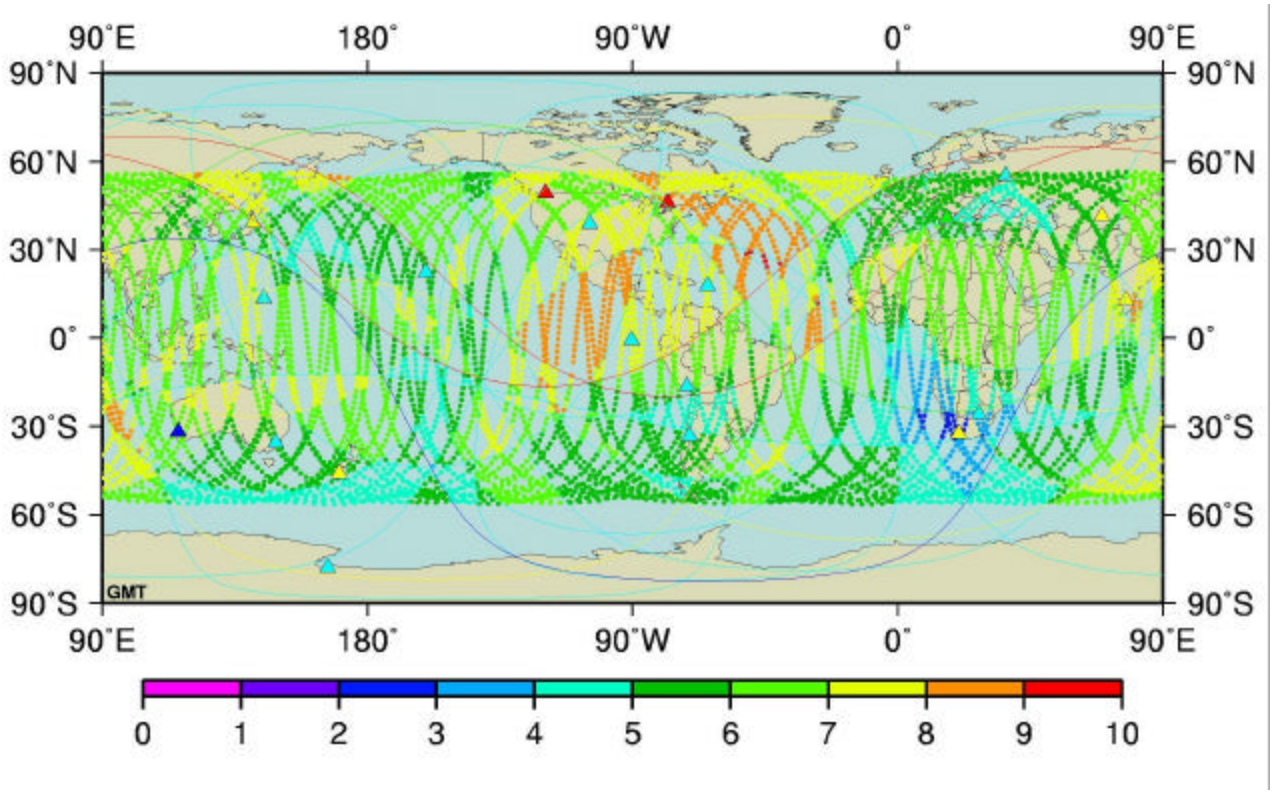
Satellite Observability Map for Prototype Near- Real-Time Network

In preparation for the arrival of high-rate observation data from the real-time IGS network, the NRCan corrections filter is being tested with a global network of stations extracted, in part, from the IGS LEO network. These stations provide high-rate (1 sec) data in 15 minute files, allowing phase-based, "GPS·C (Global)", corrections to be computed with a 2-hour delay. This plot shows 20 stations from various agencies providing satellite observability from between 2 and 9 stations. Observability is computed assuming an elevation mask angle of 10 degrees, the extent of which is drawn around each station.



Station	ALGO	AMC2	AREQ	BAN2	CRO1	DRAO	GLPS	GUAM	HRAO	KOKB
Agency	NRcan	JPL	JPL	GFZ	JPL	NRCan	JPL	JPL	JPL	JPL
Source	rtIGS	rtIGS	LEO	LEO	LEO	rtIGS	LEO	LEO	LEO	LEO
Station	MATE	MCMZ	MIZU	MOBN	OUS2	PERT	SANT	SUTM	TASH	TIDB
Agency	BKG	JPL	GFZ	JPL	GFZ	ESOC	JPL	GFZ	GFZ	JPL
Source	LEO	JPL	LEO	LEO	rtIGS	LEO	LEO	LEO	LEO	rtIGS

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Dual-Frequency Positioning Accuracy with IGS Products and NRCan Corrections

One week of continuously corrected positions (5min, post-processed)
using CORS station Parry Sound, Lake Superior, Ontario.
Legend values are mean, standard deviation and maximum (cm), respectively;
y-axis units are metres.