Current Status and Future Plans at the Natural Resources Canada (NRCan) Analysis Centre

B. Donahue, R. Ghoddousi-Fard, and Y. Mireault
Canadian Geodetic Survey (CGS), Natural Resources Canada
Email: Brian.Donahue@NRCan.gc.ca

Natural Resources Canada | Ressources naturelles Canada

Canada

Abstract

As an IGS Analysis Center (AC), NRCan has generated since the beginning of the IGS, GPS core products such as GPS satellite orbits, GPS satellite and station clocks, earth rotation parameters and station positions. NRCan has also been involved in the production and promotion of GPS Real-Time (RT) and Near Real-Time (NRT) products and services for more than 12 years. NRCan has more recently begun producing GLONASS orbit and clock products, as well as daily and NRT regional and global TEC maps from daily and RT-IGS GPS stations. Key products and services, like 1Hz GPS station data, 30 second GNSS station data, and GNSS Precise Point Positioning (PPP) continue to be refined and available to the global GNSS community. NRCan also plans to start contributing 1Hz GNSS station data in the near future.

This presentation will summarize the current status of NRCan's core GNSS products as well as our NRT data, products, and services. It will also show results of NRCan's recent contribution to the IGS repro2 campaign, results of NRCan's recently developed GLONASS ultra rapid products, as well as a description of NRCan's ionosphere mapping services.

1. NRCan Participation in the IGS

The NRCan Analysis Center (NRCan-AC) has been contributing GPS products to the International GNSS Service since the early days of the IAG service. The NRCan-AC has also participated in the IGS reanalysis campaigns including the recently completed 2nd reanalysis (repro2) of GPS data collected within the IGS since 1994. The NRCan-AC has also recently begun contributing Ultra-Rapid GLONASS products to the IGS. The day-to-day operations of the analysis center are performed by staff at the Canadian Geodetic Survey in the Natural Resources department of the Canadian federal government. The NRCan-AC contributions are aligned with CGS's mandate to deliver and provide public access to the Canadian Spatial Reference System.

In addition to routinely generating all core IGS products, NRCan is also chairing the RTCM/RINEX Working Group, as well as contributing over 50 stations to the IGS network through the CGS Canadian Active Control System (CGS-CACS), the CGS Regional Active Control System (CGS-RACS), and the Geological Survey of Canada's Western Canada Deformation Array (GSC-WCDA). NRCan has also been involved in the past as the chair of the IGS Real Time Working Group, the Analysis Centre Coordinator, and the Reference Frame Coordinator.

2. NRCan GPS and GLONASS Products

This section summarizes the different characteristics of the current NRCan GPS and GLONASS core products. Some or our products, like the GPS Finals, Rapids and Ultra-Rapids, have been running for several years. In 2011, we added to our family of products daily Rapid and weekly Final GPS+GLONASS solutions as well. Finally, in September 2013 we added Ultra-Rapid GPS+GLONASS solutions. Highlights and results are given in the figures and tables below.

Type	Product Characteristics
Final (weekly)	➢ **GPS only** • Since 1994 • Use of JPL's GIPSY-OASIS II v6.3 • Orbits, 30-sec clocks, ERP and SINEX • Weekly submission for IGS Final combination ➢ **GPS+GLONASS** • Since 2011-Sep-11 • Use of Bernese 5.0 • Orbits, 30-sec clocks and ERP • Weekly submission for IGLOS Final combination • For the time being, station XYZ are constrained as in our Rapid solutions
Rapid (daily)	➢ **GPS+GLONASS** • Since 2011-May-22 (GPS-only solutions, using GIPSY, started in 1994 and was discontinued on 2011-May-21) • Use of Bernese 5.0 • Orbits, 30-sec clocks and ERP • Daily submission for IGR combination
Ultra-Rapid (hourly)	➢ **GPS only** • Since early 2000 • Use of Bernese 5.0 • Orbits, 30-sec clocks and ERP **(every hour!)** • Submission for IGU combination (4x daily) ➢ **GPS+GLONASS** • Since 2013-Sep-13, hr 12 • Use of Bernese 5.0 • Orbits and ERP **(every hour!)** • 30-sec clocks (every 3 hours)

Precision of NRCan Products for 2014

(2014-Jan-01 to 2014-May-30)

Product		Orbits(1) (cm)		Clocks(2) (ns)	
		GPS	GLONASS	GPS	GLONASS
EMU estimated (00-24h) (3)		2	3+	0.08	0.08(4)
EMU predicted (3)	00-03 h	4	8	Not meaningful!	
	03-06 h	4	9		
	09-12 h	5	11		
	21-24 h	12	21		
EMR Rapid and Final (3)		2.0	4.0	0.07	0.09(4)

(1) Orbit RMS after applying a 7-parameter Helmert transformation.
(2) Clock RMS after proper clock alignment.
(3) Comparison against IGR for GPS and IGL for GLONASS.
(4) Comparison against ESA Final products after proper clock alignment and individual satellite bias removal.

Characteristics of Ultra-Rapid (EMU) Products Generation

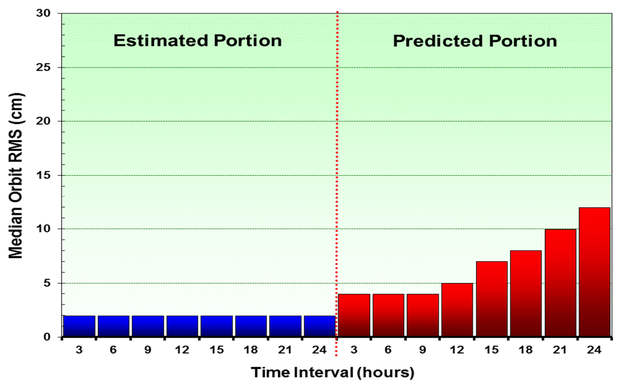
Characteristics		Before 2013 September 09 (emu17571_12)	From 2013 September 09 (emu17571_12)
		'GPS only'	GPS/GLONASS
Station Clusters	Orbit	1 x 50 stations	3 x 30 stations
	Clock	1 x 45 stations	1 x 45 stations
Interval(1)	Sp3	15 min	15 min
	Clk	30 sec	30 sec
Cycle(2)	Orbit	Hourly	Hourly (GNSS)
	Clock	Hourly	Every 3h for _00 _03 _06 _09 ... _21 (GNSS)
			Hourly for _01 _02 _04 _05 _07 _08 ... _22 _23 ('GPS only')
Latency(3)	Orbit	Less than 1h	Less than 1h15 (GNSS)
	Clock	Less than 1h30	Less than 2h for _00 _03 _06 _09 ... _21 (GNSS)
			Less than 1h30 for _01 _02 _04 _05 _07 _08 ... _22 _23 ('GPS only')

(1) Product intervals.
(2) Processing cycle.
(3) Latency from the last available data.

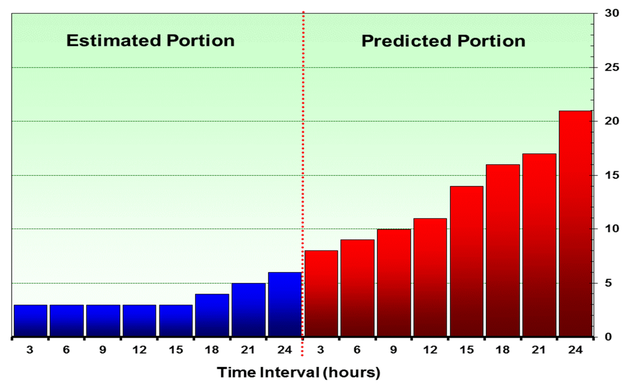
NRCan Ultra-Rapid (EMU) GPS+GLONASS Orbit Results

(2014-Jan-01 to 2014-May-30)

GPS Portion vs IGS Rapid



GLONASS Portion vs IGLOS Final

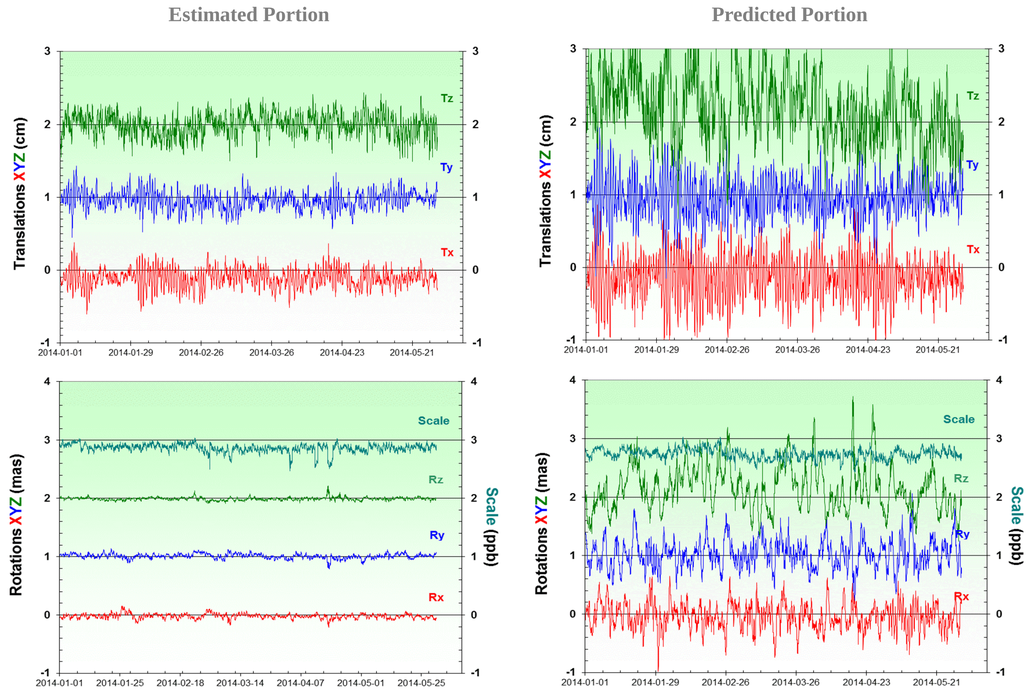


Highlights
- GPS and GLONASS data processed together
- 3 clusters (~35-40 stations each)
- Ambiguity resolution for GPS only!

Results
- Preliminary results show that GLONASS orbits are at least 1.5 times (estimated part) to 2 times (predicted part) worse than GPS!

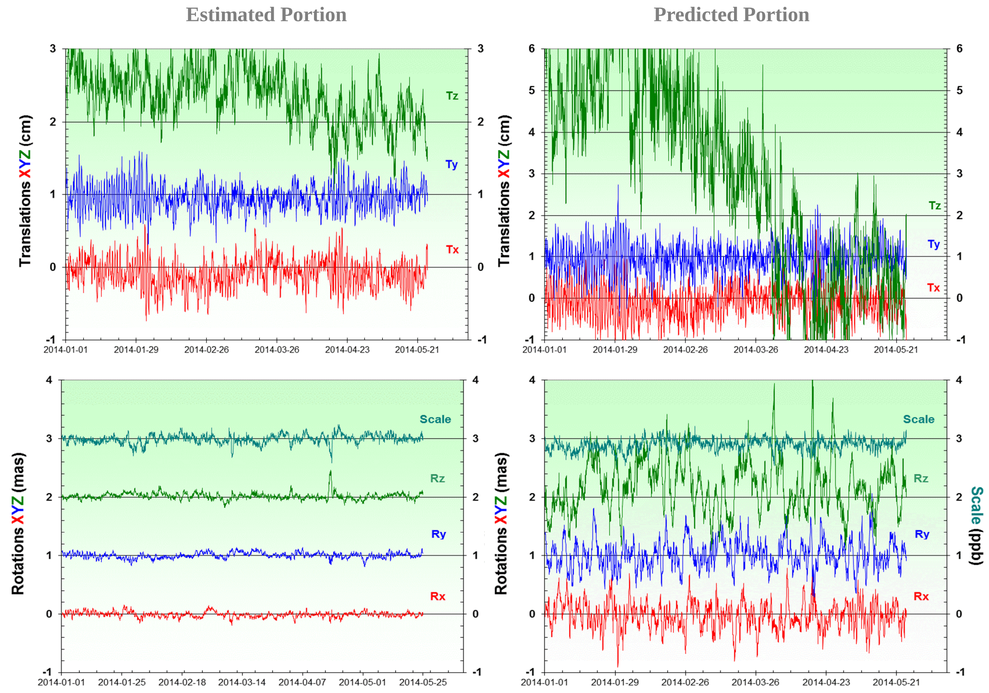
Helmert Transformations EMU vs IGR (GPS)

Estimated Portion | Predicted Portion



Helmert Transformations EMU vs IGL (GLONASS)

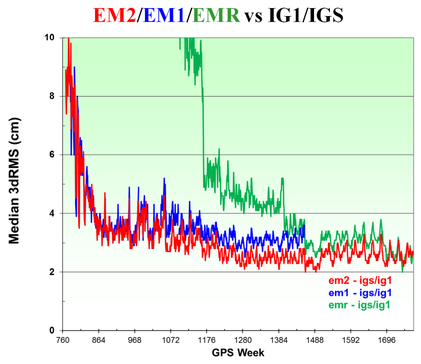
Estimated Portion | Predicted Portion



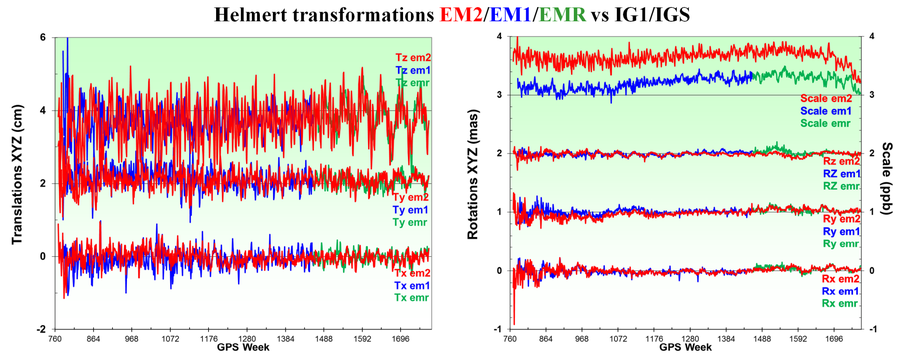
3. NRCan Participation in IGS repro2

The NRCan-AC recently re-estimated the core IGS GPS products for the years 1994 to 2013. This 2nd IGS reprocessing campaign (repro2) was carried out between April and June 2014 and took a total of 10 weeks using JPL's GIPSY-OASIS v6.3 software running on 4x16cpu Linux servers. The NRCan repro2 products (em2) were estimated following the latest set of IGS recommended models. The following graphs compare the emr, em1, and em2 orbit results.

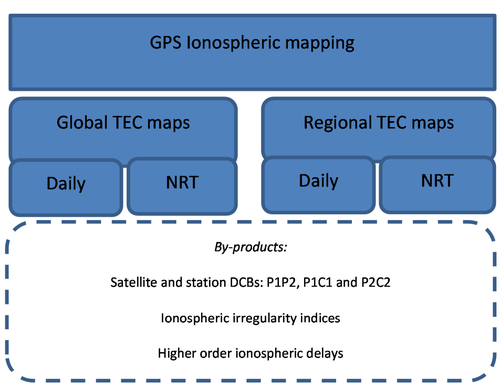
Median RMS Orbit differences
EM2/EM1/EMR vs IG1/IGS



Helmert transformations EM2/EM1/EMR vs IG1/IGS



4. NRCan GPS Ionospheric Mapping



For further information see the poster titled: "GPS ionospheric mapping at Natural Resources Canada" by R. Ghoddousi-Fard in the "Ionosphere Modelling and Observation" session.