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NRCan Analysis Center Activities

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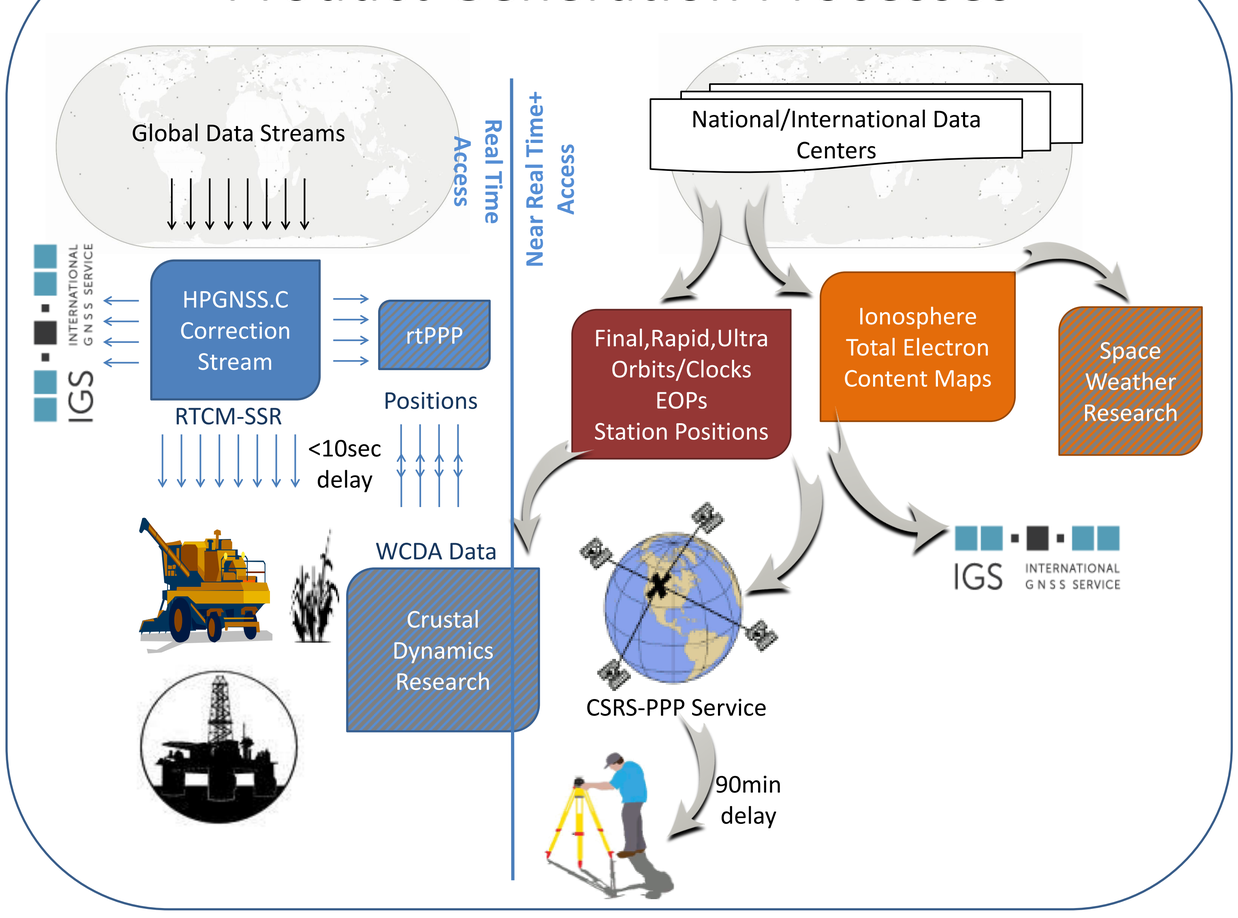
Abstract: The NRCan Analysis Center generates products (labeled em*) for IGS, as it has been since the initial pilot project in 1992. The full complement of products are described along with recent activities and changes to the NRCan station network. A modification of the Clock-RINEX data format to accommodate time-varying instrument delays is also proposed.

Product Generation Processes



NRCan GPS and GLONASS Products

Type	Product Characteristics
Final (weekly)	➢ **GPS only** • Since 1994 and ongoing • Use of JPL's GIPSY-OASIS II v6.3 • Daily Orbits, 30-sec clocks, ERP and SINEX • Weekly submission for IGS Final combination ➢ **GPS+GLONASS** • Since 2011-Sep-11 and ongoing • Use of Bernese 5.2 • Daily 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 5.2 • Daily Orbits, 30-sec clocks and ERP • Daily submission for IGR combination
Ultra-Rapid (hourly)	➢ **GPS+GLONASS** • Since 2013-Sep-13, hr 12 • Use of Bernese 5.2 • Orbits and ERP **(every hour!)** • 30-sec clocks (every 3 hours) • 30-sec GPS-only clocks (every other hours) • Submission for IGU/IGV combination (4 times daily)

Ionospheric products

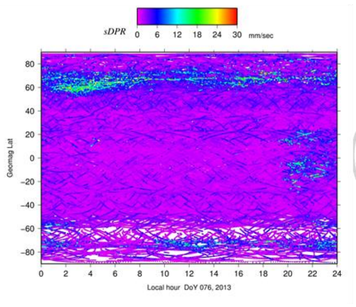
Regional NRT
~40 1Hz stations in Canada and adjacent regions

Regional daily
~90 stations in Canada and adjacent regions

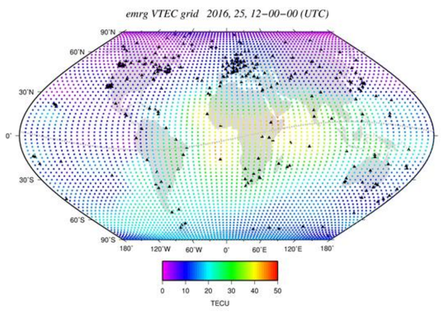
Global NRT
~140 1Hz RT-IGS stations

Global daily
~350 global stations (mostly IGS)

→ Resumed submission to IGS data centers since April 2015



By-products:
- P1P2, P1C1 and P2C2 DCB
- GPS phase ionospheric irregularity monitoring (DPR)
- Higher order ionospheric effects

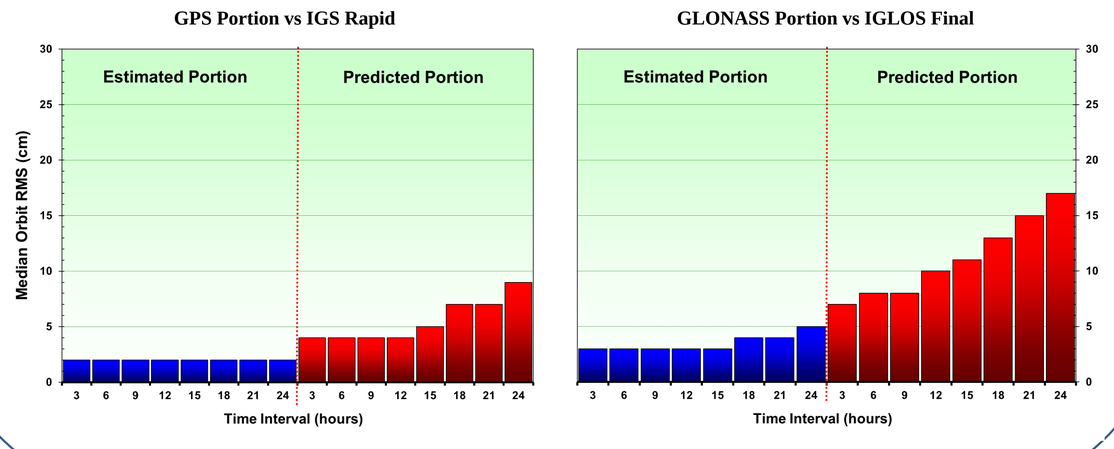


Precision of NRCan Products for 2015

Product		Orbits(1) (cm) GPS	Orbits(1) (cm) GLONASS	Clocks(2) (ns) GPS	Clocks(2) (ns) GLONASS
EMU estimated (00-24h) (3)		2	3+	0.08	0.08(4)
EMU predicted (3)	00-03 h	4	7	Not meaningful!	
	03-06 h	4	8		
	09-12 h	4	10		
	21-24 h	9	17		
EMR Rapid and Final (3)		2.0	4.0	0.08	0.08(4)

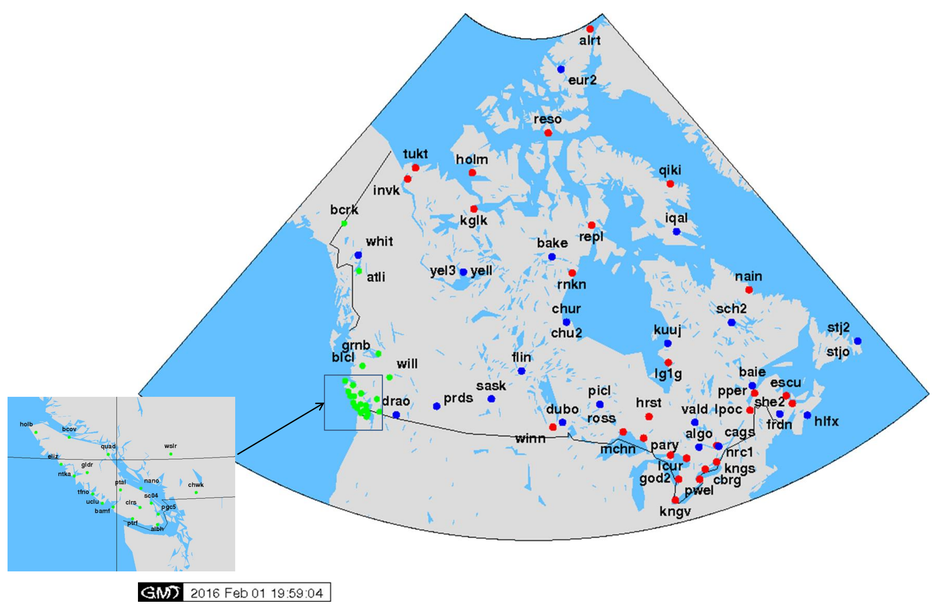
(1) Orbit RMS after applying a 7-parameter Helmert transformation.
(2) Clock RMS after proper clock alignment.
(3) Comparison against IGR for GPS and IGL for GLONASS.
(4) Comparison against ESA Final products after proper clock alignment and individual satellite bias removal.

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



NRCan GNSS Network

The current NRCan public GNSS network consists of 21 core stations (blue) operated by the Canadian Geodetic Survey (CGS), 27 regional stations (red) operated by CGS, as well as 24 regional sites (green) operated by the Geological Survey of Canada (GSC). Several of the most important sites including algo, chur, drao, prds, stjo, and yell have multiple monuments in order to monitor the stability of the monument and the data quality.



Proposed Extended Clock-RINEX Format

Precise Point Positioning with Ambiguity Resolution (PPP-AR) requires precise corrections for all system equipment delays. Unique delays can exist on all signals (code and phase) and may not be constant. The most general solution then is to treat the equipment delays in the same manner as the clock errors. Hence, it is proposed to extend the current Clock-RINEX format to provide time-constant equipment delay biases and time-varying equipment delay signals time-tagged with the clock errors. At the same time, other physical corrections that directly affect the phase can be provided (e.g. the antenna orientation yaw angle).

80 character version

```
----|---1|0---|---2|0---|---3|0---|---4|0---|---5|0---|---6|0---|---7|0---|---8|
     3.00           CLOCK DATA          GPS                 RINEX VERSION / TYPE
TORINEXC V9.9       USNO                19960403 001000 UTC PGM / RUN BY / DATE
EXAMPLE OF A CLOCK DATA ANALYSIS FILE                       COMMENT
IN THIS CASE ANALYSIS RESULTS FROM GPS ONLY ARE INCLUDED    COMMENT
No re-alignment of the clocks has been applied.             COMMENT
G    4 C1W L1W C2W L2W                                      SYS / # / OBS TYPES
G    4 C1P C2P C1C C2C                                      SYS / # / BIAS TYPES
   GPS                                                      TIME SYSTEM ID
    10                                                      LEAP SECONDS
G CC2NONCC          p1c1bias.hist @ goby.nrl.navy.mil       SYS / DCBS APPLIED
G PAGES             igs05.atx @ igscb.jpl.nasa.gov          SYS / PCVS APPLIED
     7    AS    AR    BR    BS    DR    DS    YS           # / TYPES OF DATA
USN  USNO USING GIPSY/OASIS-II                              ANALYSIS CENTER
     1 1994 07 14  0   0   0.000000 1994 07 14 20 59  0.000000# OF CLK REF
USNO 40451S003                      -.123456789012E+00 ANALYSIS CLK REF
     1 1994 07 14 21   0   0.000000 1994 07 14 21 59  0.000000# OF CLK REF
TIDB 50103M108                      -0.123456789012E+00 ANALYSIS CLK REF
     4    ITRF96                                            # OF SOLN STA / TRF
GOLD 40405S031           1234567890 -1234567890 -1234567890SOLN STA NAME / NUM
... Snipped ...
     27                                                     # OF SOLN SATS
G01 G02 G03 G04 G05 G06 G07 G08 G09 G10 G13 G14 G15 G16 G17 PRN LIST
G18 G19 G21 G22 G23 G24 G25 G26 G27 G29 G30 G31             PRN LIST
G01  -0.123456E+00 -0.123456E+00 -0.123456E+00              SYS / PCOS APPLIED
G01  -0.123456E+00 -0.123456E+00 -0.123456E+00 -0.123456E+00SYS / BIAS APPLIED
                                                            END OF HEADER
AR AREQ 1994 07 14 20 59  0.000000  6   -0.123456789012E+00 -0.123456789012E+01
-0.123456789012E+02 -0.123456789012E+03 -0.123456789012E+04 -0.123456789012E+05
AR HARK 1994 07 14 20 59  0.000000  2     .123456789012E+00   .123456789012E+00
AS G16  1994 07 14 20 59  0.000000  2    -.123456789012E+00  -.123456789012E-01
DS G16  1994 07 14 20 59  0.000000  0
YS G16  1994 07 14 20 59  0.000000  2    -.123456789012E+00  -.123456789012E-01
```

BR: Bias Rx
BS: Bias SV
DR: Discontinuity Rx
DS: Discontinuity SV
YS: Yaw angle

Constants

Explicit SV PCO values

Clock Frq & FrqDrft + sigmas

Version extended beyond 80 characters

```
AR AREQ 1994 07 14 20 59  0.000000  6   -0.123456789012E+00 -0.123456789012E+01 -0.123456789012E+02 -0.123456789012E+03 -0.123456789012E+04 -0.123456789012E+05
BR NRC1 1994 07 14 20 59  0.000000  4     .123456789012E+00   .123456789012E+00   .123456789012E+00   .123456789012E+00
BS G16  1994 07 14 20 59  0.000000  4    -.123456789012E+00  -.123456789012E-01   .123456789012E+00   .123456789012E+00
```

Time-varying