Natural Resources Canada | Ressources naturelles Canada

NRCan Analysis Centre Contributions to the IGS: 1994 – 2004

B. Donahue, Y. Mireault, C. Huot, P. Tétreault and J. Kouba
Geodetic Survey Division (GSD)
Email: Brian.Donahue@NRCan.gc.ca

Canada

Abstract

As part of Natural Resources Canada (NRCan), Geodetic Survey Division's (GSD) primary role is to maintain, continuously improve, and facilitate efficient access to the Canadian Spatial Reference System (CSRS). The CSRS provides a frame of reference for latitude, longitude, height and gravity used as the basis for the nation's georeferencing and related geoscience needs. As such, it provides the foundation for coordinate-based information systems, enabling the integration and interoperability of applications and data with a spatial component. In the early 90's, the growing demands of GPS users resulted in a new focus for the Division, a focus on supporting users' needs for positioning from space. The Canadian Active Control System (CACS) was established during the 1990's to facilitate GPS user access to the CSRS. NRCan's participation in the IGS enables an efficient way of providing, for all Canadians, a positioning and navigation spatial referencing infrastructure based on modern technologies and international standards. NRCan has been an IGS Analysis Centre (EMR) since the 1992 initial IGS pilot phase and provided the initial Analysis Centre Coordination for the IGS. This poster lists some of NRCan's milestones and accomplishments throughout the past ten years as well as on-going activities.

1. NRCan Participation in the IGS –10 years

Date	IGS Activities
1993	Host of a small IGS Analysis Centre (AC) Workshop – Jan Kouba.
1994- …	NRCan Analysis Centre – Jan Kouba, Pierre Tétreault and Brian Donahue.
1994-1998	AC Coordination – Jan Kouba (with the help of Yves Mireault for development and orbit/clock/ERP combinations).
1994-1999	Member of the IGS Governing Board – Jan Kouba.
1997- …	Member of the Ionosphere Working Group (IWG) – Pierre Héroux.
1998-2003	Member of the Troposphere Working Group (TWG) – Caroline Huot.
1998-2004	Chair of the Reference Frame Working Group (RFWG) – Rémi Ferland
1999- …	Member of the IGS Governing Board – Rémi Ferland
2000- …	Member of the IGS Strategic Planning Group – Norman Beck
2001- …	Chair of the Real Time Working Group (RTWG) and member of the IGS Governing Board– Mark Caissy.
2001- …	Member of the Real Time Working Group (RTWG) – Ken Macleod.
2002- …	Member of the IGS Clock Products Working Group – François Lahaye.
2002	Host of the IGS Network, Data and Analysis Centre Workshop "Towards Real-Time" – PierreTétreault
2002-2005	Member of the IGS Governing Board – Norman Beck.
2003- …	Member of the Troposphere Working Group (TWG) – Yves Mireault.

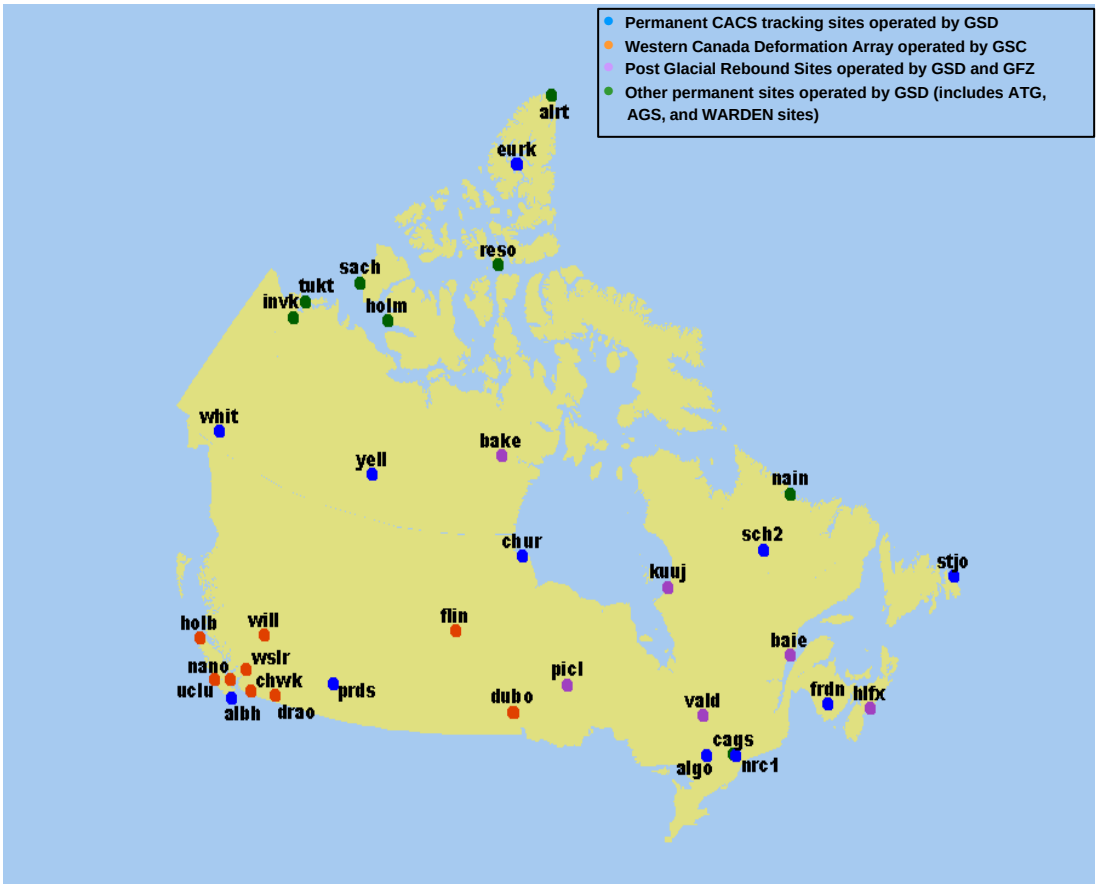
NRCan Analysis Centre Contributions to the IGS: 1994 – 2004

B. Donahue, Y. Mireault, C. Huot, P. Tétreault and J. Kouba
Geodetic Survey Division (GSD)
Email: Brian.Donahue@NRCan.gc.ca

Natural Resources Canada | Ressources naturelles Canada

Canada

2. Canadian Active Control System (CACS)



2.1 History of CACS Stations Contributing to IGS

Station	Installation Date
ALGO	January 19, 1991
YELL	January 21, 1991
DRAO	February 27, 1991
ALBH	May 4, 1992
STJO	May 24, 1992
HOLB	July 24, 1992
PRDS	July 25, 1992
CHUR	April 24, 1993
WILL	October 6, 1993
NRC1	April 25, 1994
UCLU	May 5, 1994
NANO	May 13, 1995

Station	Installation Date
FLIN	June 5, 1996
WHIT	June 7, 1996
NAIN	August 1, 1996
WSLR	September 12, 1996
DUBO	October 18, 1996
SCH2	June 29, 1997
CHWK	November 17, 1998
CAGS	February 2, 2000
INVK	August 5, 2000
RESO	August 5, 2000
HOLM	July 22, 2001

Station	Installation Date
EURK	November 1, 2001
BAKE	November 1, 2001
VALD	November 1, 2001
BAIE	November 4, 2001
PICL	December 1, 2001
HLFX	December 19, 2001
ALRT	July 15, 2002
KUUJ	July 17, 2002
SACH	July 28, 2002
FRDN	July 1, 2003
TUKT	August 21, 2003

NRCan Analysis Centre Contributions to the IGS: 1994 – 2004

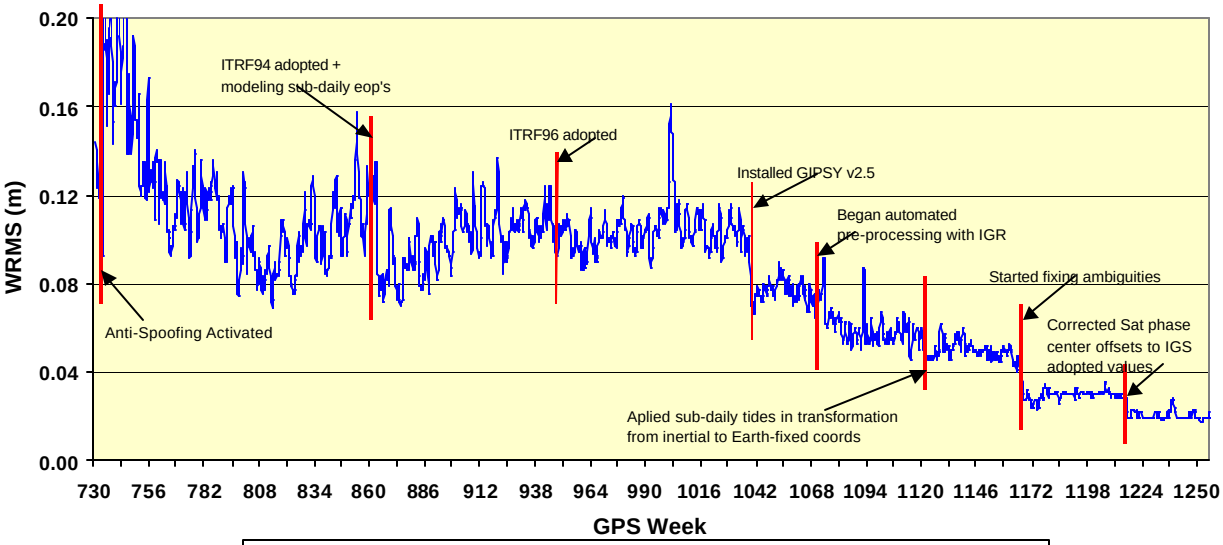
B. Donahue, Y. Mireault, C. Huot, P. Tétreault and J. Kouba
Geodetic Survey Division (GSD)
Email: Brian.Donahue@NRCan.gc.ca

Natural Resources Canada | Ressources naturelles Canada

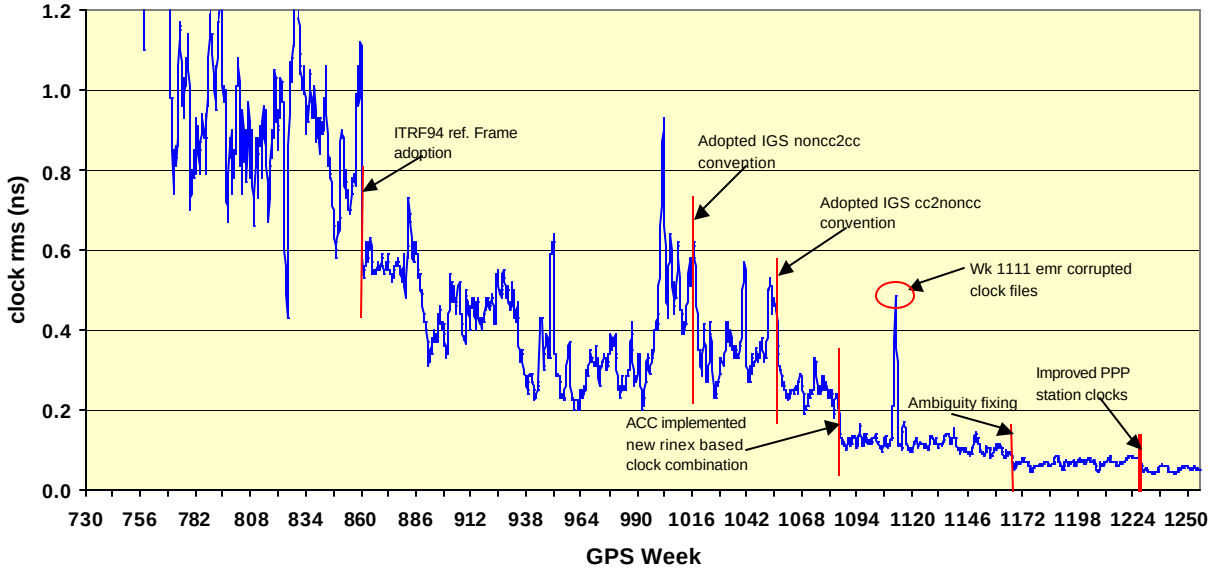
Canada

3. Some of NRCan Final and Ultra Rapid Products Results

3.1 Final Orbits and Clocks RMS



— IGS - NRCan (emr) Final Orbits (7 day avg)



— NRCan (emr) Final Clock RMS (10 day average)

NRCan Analysis Centre Contributions to the IGS: 1994 – 2004

B. Donahue, Y. Mireault, C. Huot, P. Tétreault and J. Kouba
Geodetic Survey Division (GSD)
Email: Brian.Donahue@NRCan.gc.ca

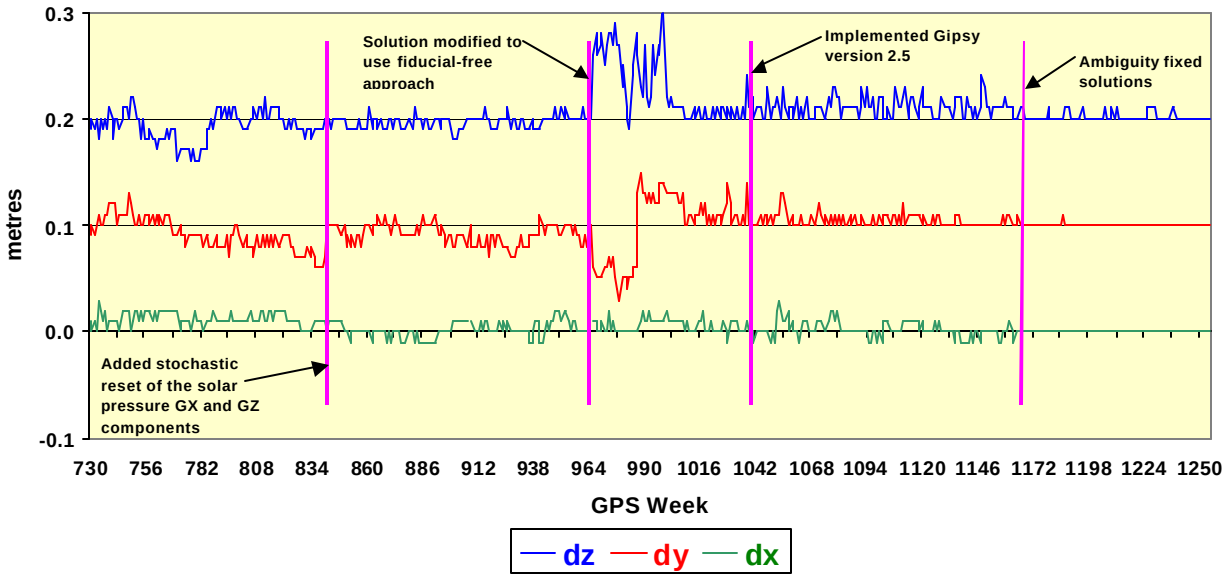
Natural Resources Canada | Ressources naturelles Canada

Canada

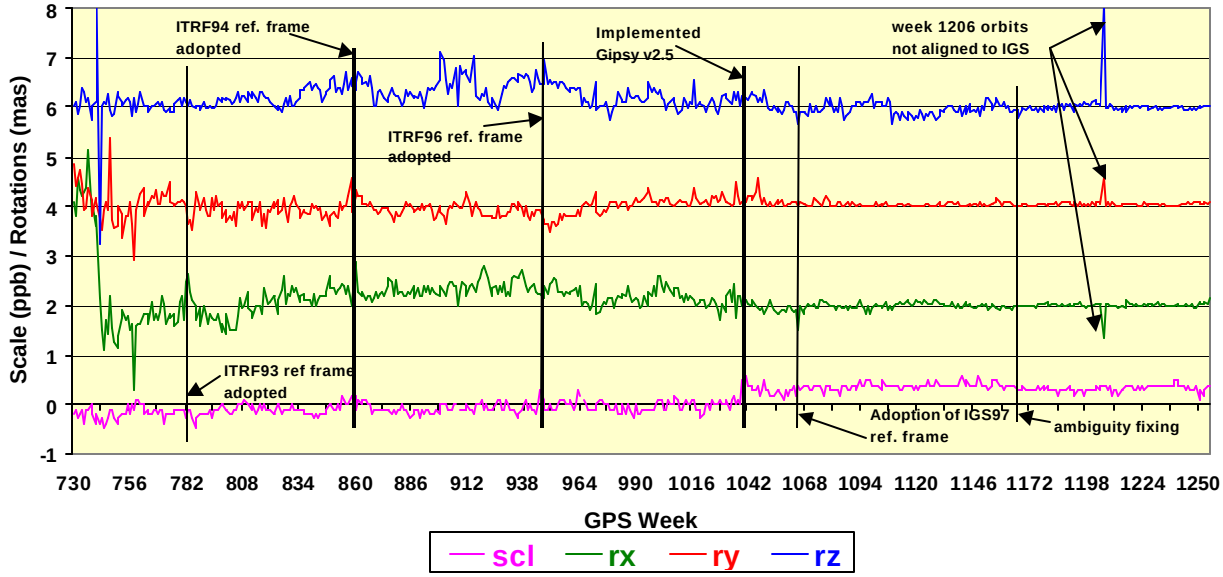
3. Some of NRCan Final and Ultra Rapid Products Results

3.2 Final Orbits Helmert Transformations

Note: Translations offset by 0.1m



Note: Rotations offset by 2 mas



NRCan Analysis Centre Contributions to the IGS: 1994 – 2004

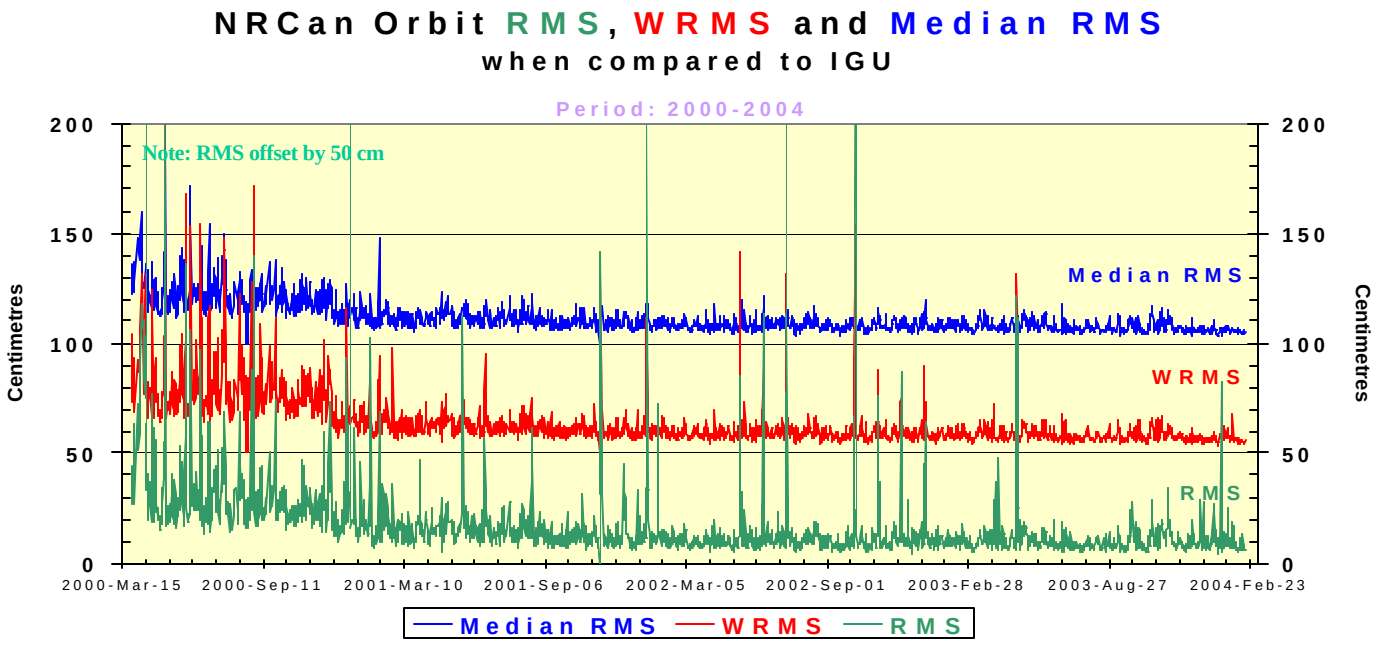
B. Donahue, Y. Mireault, C. Huot, P. Tétreault and J. Kouba
Geodetic Survey Division (GSD)
Email: Brian.Donahue@NRCan.gc.ca

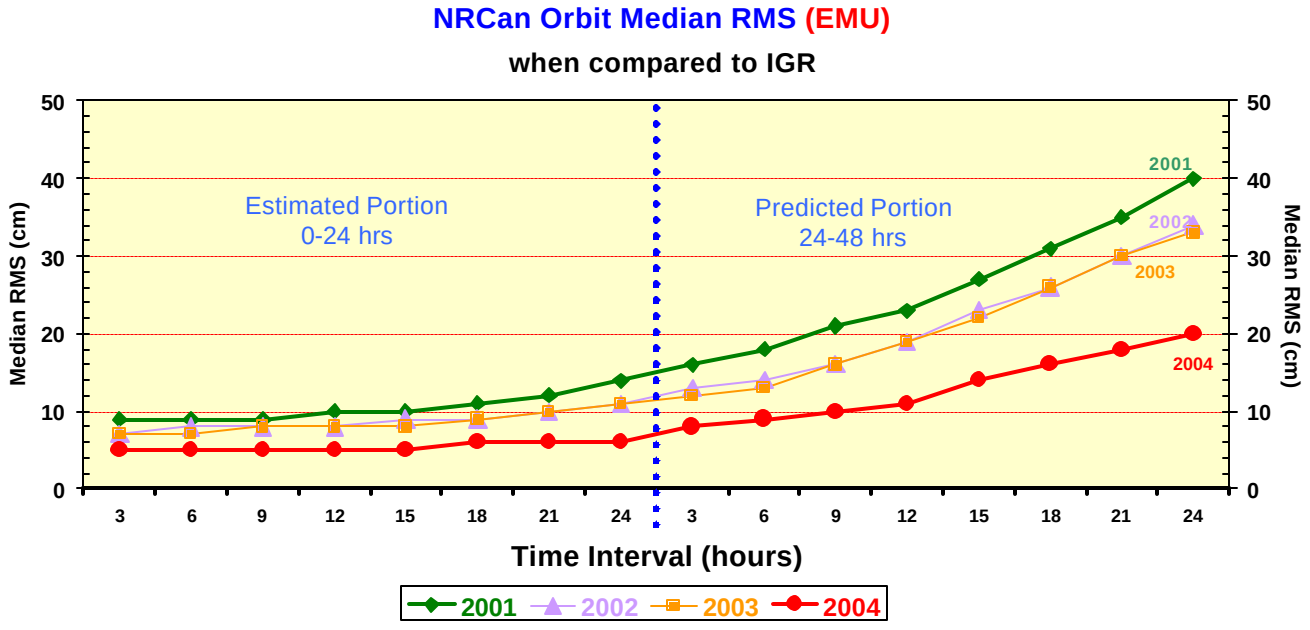
Natural Resources Canada | Ressources naturelles Canada

Canada

3. Some of NRCan Final and Ultra Rapid Products Results

3.3 Ultra Rapid Orbits RMS





Natural Resources Canada | Ressources naturelles Canada

NRCan Analysis Centre Contributions to the IGS: 1994 – 2004

B. Donahue, Y. Mireault, C. Huot, P. Tétreault and J. Kouba
Geodetic Survey Division (GSD)
Email: Brian.Donahue@NRCan.gc.ca

Canada

4. Processing Modifications and Milestones

Date	GPS Wk	Modification / Milestone
Jan. 1994	730	Official start of the IGS combination on January 2nd 1994. NRCan contributing daily precise orbits, clocks, and EOP parameters.
Feb. 1994	734	Activation of Anti-Spoofing resulted in degradation in quality of the EMR orbit and clock solution. Receiver hardware and software updates during 1994 improved the orbit and clock solutions to pre-AS levels.
Feb. 1996	841	Once per day stochastic reset of the solar pressure GX and GZ components was implemented. Also introduced consistent orientation of the daily orbit files with the weekly station and EOP combined solutions.
Jul. 1996	860	Start of Official Rapid products, adoption of ITRF94 station coordinates for rapid/final, began modelling of diurnal and sub-diurnal EOP components, and started estimating polar motion rates.
Jan. 1997	887	Began estimating 2-day orbit Prediction (EMP).
Mar. 1997	895	Started contributing to the IGS pilot project for the estimation of tropospheric zenith delay.
Jul. 1998	964	NRCan began production of daily global ionospheric map.
Jul. 1998	965	EMR Final solution was modified to use fiducial-free approach. At the same time the data arc was extended from 24 to 30 hours.
Dec. 1998	988	Began Rapid/Final submission of 15-minute interval station and satellite clock corrections in clock rinex format.
Dec. 1999	1039	Implementation of JPL's GIPSY-OASIS Version 2.5 software for Final solution. Rapid solution was upgraded starting with week 1041.
Mar. 2000	1054	NRCan officially started submitting Ultra Rapid orbits using Bernese v4.2 software. Also Rapid product submissions were discontinued until week 1094 due to problems with EOP estimation.
Jul. 2000	1070	Implemented preprocessing strategy for Final solution utilizing IGR orbits and clocks and performing PPP to validate station rinex files.
Dec. 2000	1092	Predicted orbits discontinued and started using an orbit fit for the Ultra Rapid (IGR, IGU, EMU).
Jun. 2001	1114	First 1-hr Ultra Rapid Troposphere Zenith Delay submission.
Jul. 2001	1121	Began applying sub-daily (12h/24h) ocean tides in the transformation from inertial to Earth-fixed coordinates (sp3).
Nov. 2001	1139	Implementation of JPL's GIPSY-OASIS Version 2.6 software for Final solution. The Rapid solution was also upgraded to version 2.6 starting with GPS Week 1142.
May 2002	1165	Began augmenting our global Rapid/Final clock solutions by estimating station clocks with PPP (fixing emr Rapid orbits and clocks).
May 2002	1167	Implementation of integer ambiguity resolution in Rapid/Final.
Oct. 2002	1190	First Ultra Rapid clock submission.
Apr. 2003	1216	For both the Final and Rapid solutions satellite antenna phase center offsets were applied align them to the IGS conventions.
May 2003	1218	Started using moon shadow events in the Ultra Rapid orbits.
Jan. 2004	1252	Implementation of integer ambiguity resolution in the Ultra Rapid and better consistency between orbits and ERP.

NRCan Analysis Centre Contributions to the IGS: 1994 – 2004

B. Donahue, Y. Mireault, C. Huot, P. Tétreault and J. Kouba
Geodetic Survey Division (GSD)
Email: Brian.Donahue@NRCan.gc.ca

5. Utilization of IGS Products at NRCan

NRCan is a contributor to all IGS products and reports and conversely makes use of those products to continuously monitor and improve its contribution. NRCan also makes use of the IGS combined products to help achieve its objective of providing the Canadian Spatial Reference System (CSRS).

5.1 CSRS: Realization, Maintenance and Access

IGS Products are used by NRCan as …

- Input to precise point estimation process used to assess the quality of RINEX station observations needed for maintenance of the CACS and for distribution to Data Centres and/or clients
- Input to GPS network processing software for orbit improvement, coordinate estimation in terrestrial reference frame and consistency among antenna types
- Input to NRCan Regional processing for Canadian contributions to NAREF (Final Orbits)
- Constraints for NAREF regional solutions (weekly global solutions)
- Input to NRCan On-line Precise Point Positioning (PPP) Service to compute precise station coordinates, clock and TZD using GPS RINEX observation data submitted over the Internet **(http://www.geod.nrcan.gc.ca/index_e/products_e/services_e/ppp_e.html)**

5.2 Validation and Continuous Improvement of NRCan Contribution to the IGS

NRCan uses …

- IGU orbits as a priori orbits for EMU production
- IGS summaries and reports (igs, igr and igu) for detecting problems in NRCan IGS contribution
- IGS orbits and clocks to assess, using PPP statistics, the quality of RINEX station observations used for the computation of FINAL IGS products. Data weighting and rejection is automatically performed based on the PPP results