



Real Time IGS Pilot Project (RT-PP) Status Report

**IGS Workshop
Newcastle UK,
June 28, 2010**

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Overview

- RT-Pilot Project Submissions
- Stations
- Data Centres
- Data and Correction Formats
- Analysis Centres
- Combination Results
- Next Steps
- Summary

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Real-Time Pilot Project Proposals

- RT-PP Submissions → 36 agencies responded
 - 24 agencies offered to provide station data
 - 11 agencies offered RT file archive centre services
 - 9 agencies offered to stream RT data
 - 11 agencies offered RT Analysis Centres services
 - 5 agencies offered RT Associate Analysis Centres services
 - 1 agency offered Analysis Centre Coordinator service
 - 7 agencies offered Network Management services
 - 11 agencies offered to be RT users





Agencies Contributing Station Data

NRCan	Natural Resources Canada	Canada
GSA	Geoscience Australia	Australia
ESOC	European Space Operation Centre (ESA)	Europe/Global
TRIGNET	South Africa Chief Directorate: Surveys and Mapping	South Africa
BKG	Bundesamt für Kartographie und Geodäsie	Europe/Global
IBGE	Instituto Brasileiro de Geografia e Estatística	Brazil
GFZ	GeoForschungsZentrum	Europe/Global
GEONET	New Zealand GNS Science and Earthquake Commission	New Zealand
DPGA	Dutch Permanent GPS Array	Netherlands
SOPAC	Scripps Orbit and Permanent Array Center	USA

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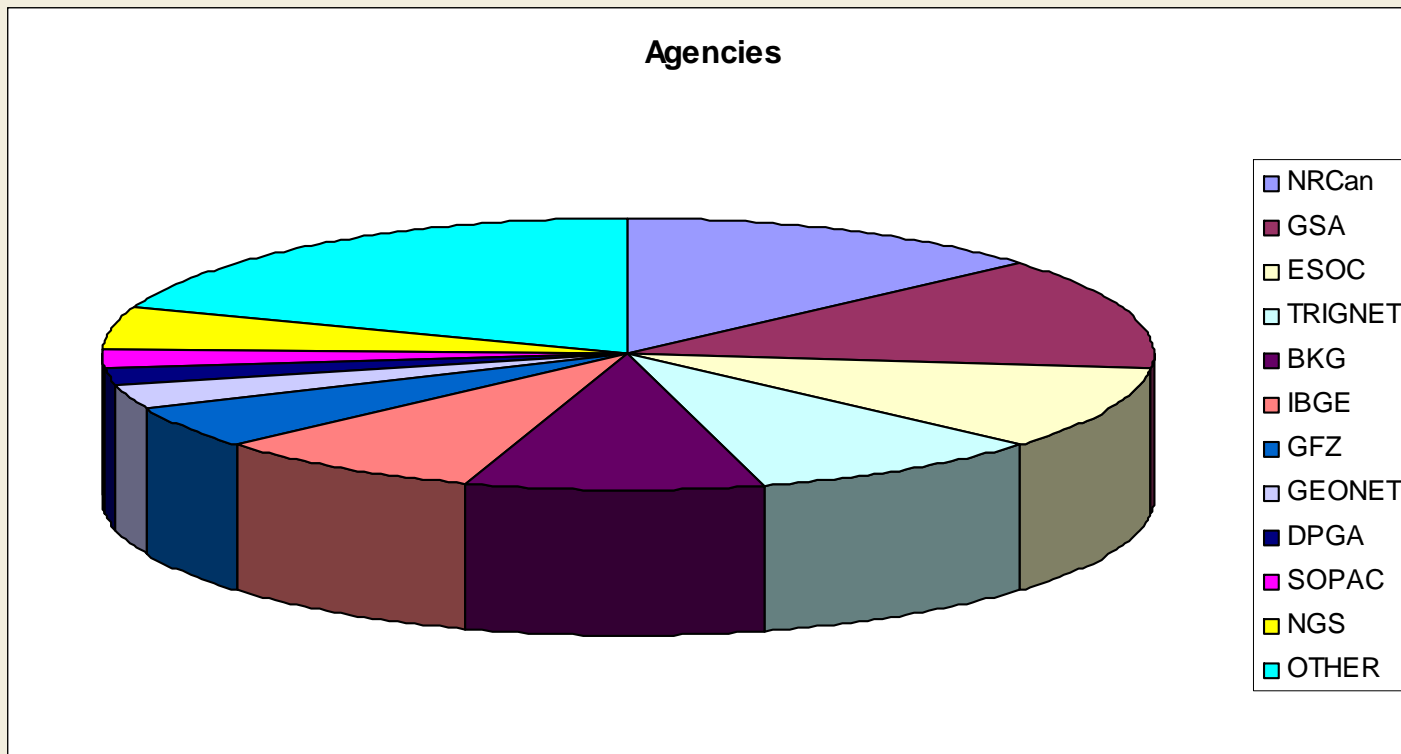
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Agencies Contributing Station Data



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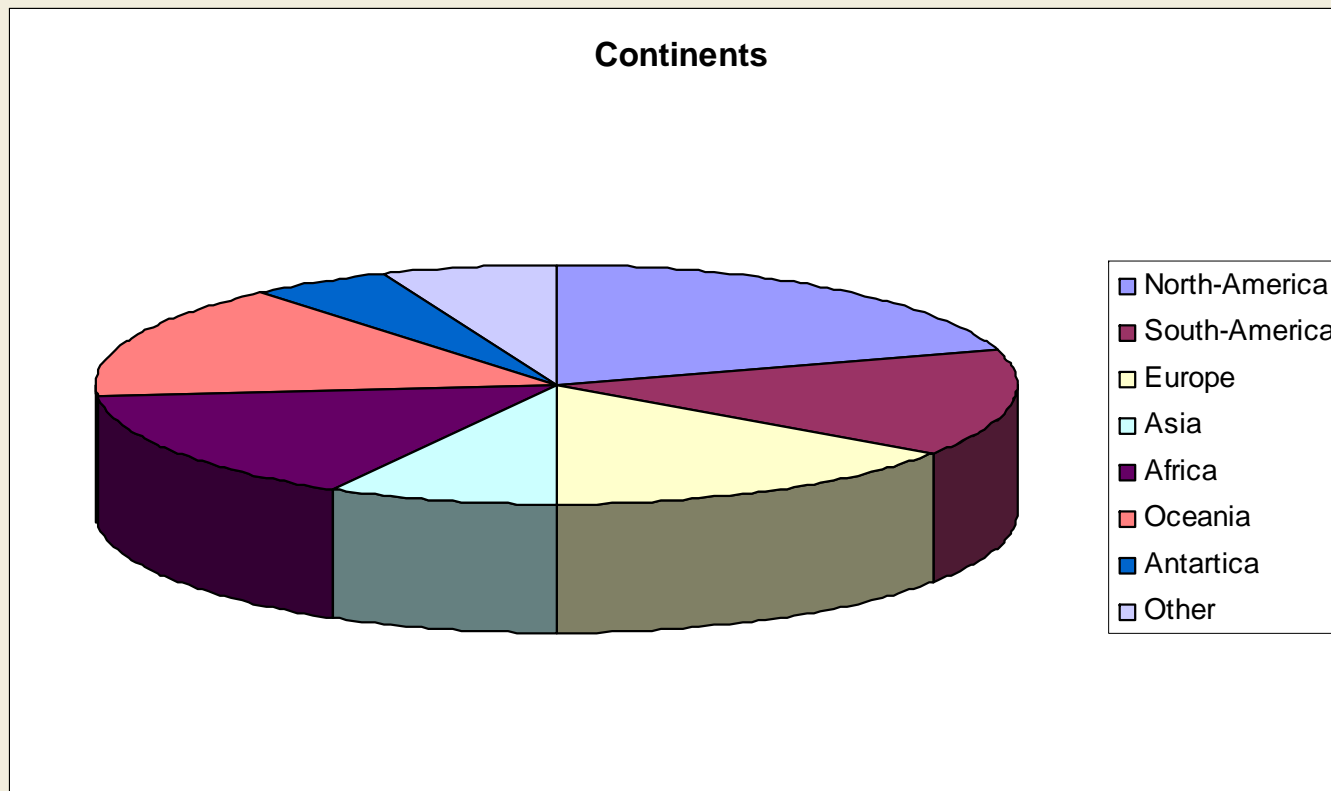
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Station Data by Geographic Region



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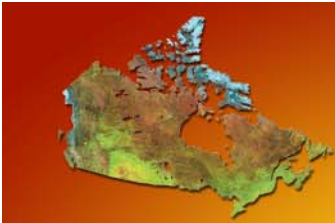


Real-Time Streams www.igs-ip.net

- 64 Contributors
- 36 Countries
- 185 Streams

- Addis Ababa University - Ethiopia (2)
- Agenzia Spaziale Italiana - Italy (1)
- Agricultural University of Wroclaw - Poland (1)
- Alfred Wegener Institut - Germany (1)
- Ashtech - France (1)
- Astrogeodynamical Observatory - Poland (1)
- Astronomy and Space Science Institute - Korea (1)
- Brazilian Institute of Geography and Statistics - Brazil (9)
- Bucharest Technical University of Civil Engineering - Romania (1)
- Bundesamt fuer Eich und Vermessungswesen - Austria (2)
- Clark Fortune McDonald Associates - New Zealand (1)
- Croatian Geodetic Institute - Croatia (2)
- DIST Universita di Cagliari - Italy (1)
- European Space Operations Centre - Germany (4)
- Federal Agency for Cartography and Geodesy - Germany (37)
- Finnish Geodetic Institute - Finland (1)
- Florida International University Miami - U.S.A. (1)
- FOMI Satellite Geodetic Observatory - Hungary (1)
- Geodetic and Cartographic Institute - Slovakia (1)
- Geodetic Institute University Warszawa - Poland (1)
- GeoForschungsZentrum Potsdam - Germany (13)
- GeoNet - New Zealand (3)
- Geoscience Australia - Australia (22)
- GOP Research Institute of Geodesy Topography and Cartographie - Czech Republic (1)
- GPS Solutions Inc. - U.S.A. (1)
- GSOC/DLR German Space Operations Center - Germany (2)
- Institut Geographique National - France (3)
- Instituto Geografico Nacional - Spain (1)
- Instituto Geografico Portugues - Portugal (3)
- Instytut Geodezji i Kartografii Warszawie - Poland (1)
- Istanbul Technical University - Turkey (1)
- Istituto Nazionale di Ricerca Metrologica I.N.R.I.M - Italy (1)
- L'equipe du reseau Banian - New Caledonia (2)
- Nanyang Technological University - Singapore (1)
- NASA Stennis Space Center - U.S.A. (1)
- National Geographic Information Institute - Korea (1)
- National Land Survey - Sweden (6)
- National Oceanic and Atmospheric Administration National Geodetic Survey - U.S.A. (7)
- Natural Resources - Canada (13)
- Naval Observatory - U.S.A. (1)
- NERC Space Geodesy Facility - United Kingdom (1)
- Point Inc. - Canada (2)
- Puerto Rico Seismic Network - Puerto Rico (1)
- Puget Sound Reference Network - U.S.A. (1)
- Regional Centre for Mapping of Resources for Development - Kenya (1)
- Regional Centre for Training in Aerospace Surveys - Nigeria (1)
- Rocco V. D'Andrea Inc. - U.S.A. (1)
- Royal Observatory - Belgium (1)
- Scripps Orbit and Permanent Array Center - U.S.A. (1)
- Solucoes em Posicionamento Global SPG - Brazil (1)
- Surveys and Mapping - South Africa (2)
- SwissTopo - Switzerland (1)
- Technical University Delft - The Netherlands (1)
- Teodonivel - Brazil (1)
- Trimbase Ltda - Brazil (1)
- Universidad de Cordoba - Argentina (1)
- Universidad del Zulia - Venezuela (1)
- Universidad de Rosario - Argentina (1)
- Universidade da Baira Interior UBI/CGUL/IDL - Portuga (1)
- Universidade Estadual Paulista UNESP/FCT - Brazil (4)
- University NAVSTAR Consortium - U.S.A (1)
- University New South Wales - Australia (1)
- University of New Brunswick - Canada (1)
- University Padova - Italy (2)





RT - PP Network



GM 2010 May 18 13:13:17



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RT-PP Data Centres

- BKG serves as central distributor for most RTIGS contributors and also their own stations (130+ stations)
- NRCan (12 Canadian, 7 ESA and 11 others)
- Geo Science Australia (13 stations)
- IBGE, Brazil (8)
- TrigNet South Africa (7 stations)
- NGS recently started contributing (5 Stations)
- Approximately 130 RTIGS stations available

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RT-PP GNSS Observation Data Formats

- Station data is available:
 - In NTRIP RTCM 3.x format (GPS + Glonass)
 - In RTIGS SOC format (GPS)
- Following Miami workshop recommendations
 - IGS is now a member of Radio Technical Commission for Maritime Services (RTCM)
 - RTWG and IGS IC is investigating (RTCM) data formats and protocols.

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RTCM - High Precision GNSS Observation Format

- New format is compatible with RINEX 2.x and 3.0 standard
- Based on Magellan/Ashtech Multiple Signal Message format
- Precision of the observations increased to meet the needs of the IGS
- Binary format suitable for real-time stream and file based users

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Proposal to RTCM

- Station change control mechanism
 - Key to managing a real-time network and applications
 - Issue Of Data Station (IODS)
 - Integer flag stored in each message
- IODS will provide notice to the user when a station change has occurred.
- Will enable updating station meta-data (logs) in near real-time

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RT-PP Correction Format and Protocol

- RTCM State Space Representation correction message types selected to deliver RT-PP orbit and clock corrections
- RTCM members expected to approve the format this summer or early fall
- Receiver manufactures will then implement the correction format in the receiver firmware
- NTRIP protocol will be used to distribute RTCM-SSR corrections

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RT-PP Correction Protocol Continued..

- RTCM SSR provides an Internet Protocol (IP) correction delivery channel
- Currently most State Space corrections are delivered by a satellite broadcast – expensive to operate
- Next generation communication satellites are IP based
- Communication chipsets will be available to system integrators
- Smart cell phones also offer IP services

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RT-PP Analysis Centres

- All analysis centres are providing GPS corrections
 - Exception: BKG with GPS + GLONASS
- Total of 7 analysis centres contributing GPS Orbit and Clock correction files:
 - BKG, DLR, ESOC, NRCan, GMV, GFZ and TUW
- Total of 6 analysis centres contributing RTCM SSR data in real-time
 - TUW, GFZ, BKG, DLR, Geo++ and ESOC
- Product descriptions on <http://igs.bkg.bund.de/ntrip/orbits>

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Orbit and Clock Correction Combination

- ESOC are running both a real-time and a daily file combination
- The combined solution is compared to the IGS Rapid
- Results have improved over the last year and currently most agency results are: orbit ~40-50mm RMS and clock corrections are ~0.25 ns RMS and 0.12 ns sigma
- The RT combination combines both orbit and clock corrections. Clock results are : ~0.20 ns RMS and ~0.10 ns sigma.

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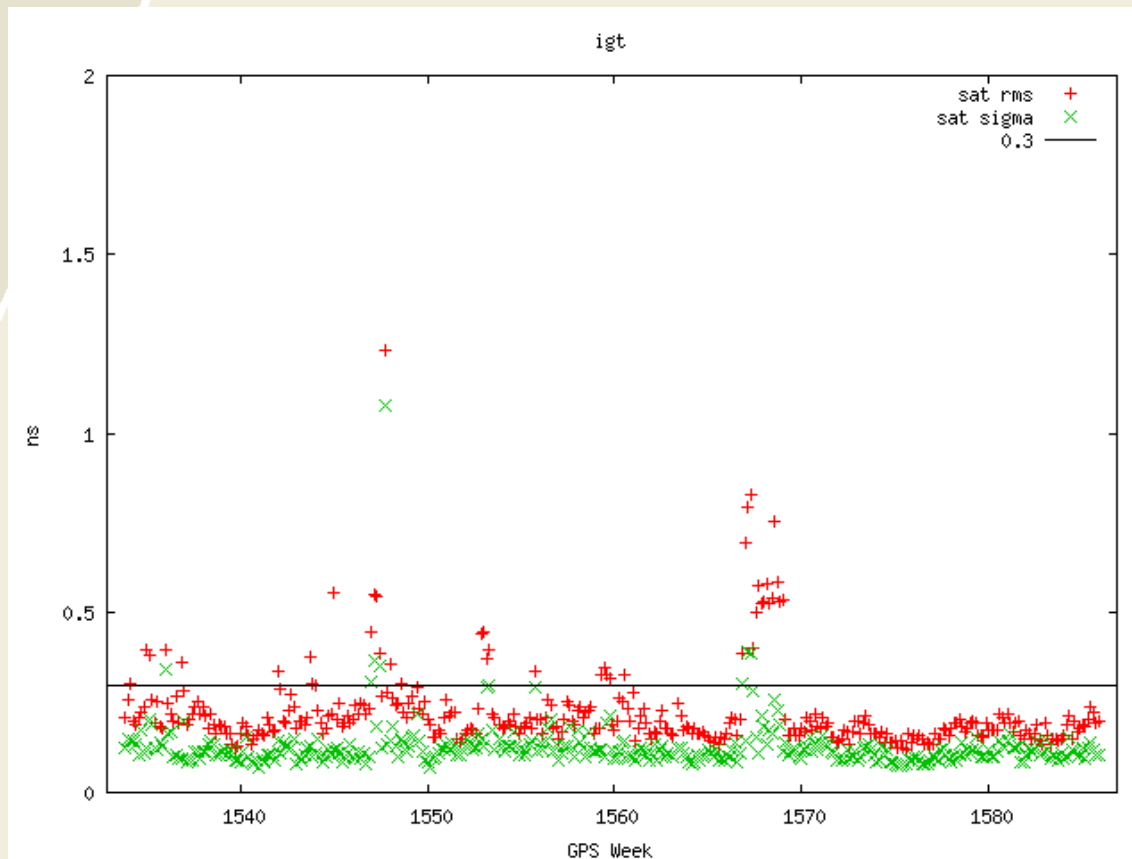
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Combination Time Series



sat-clk rms +
sat-clk sigma x

Pilot Target 0.3 ns
Currently < 0.25 ns

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Average of last 7 days (June 17-23/10)

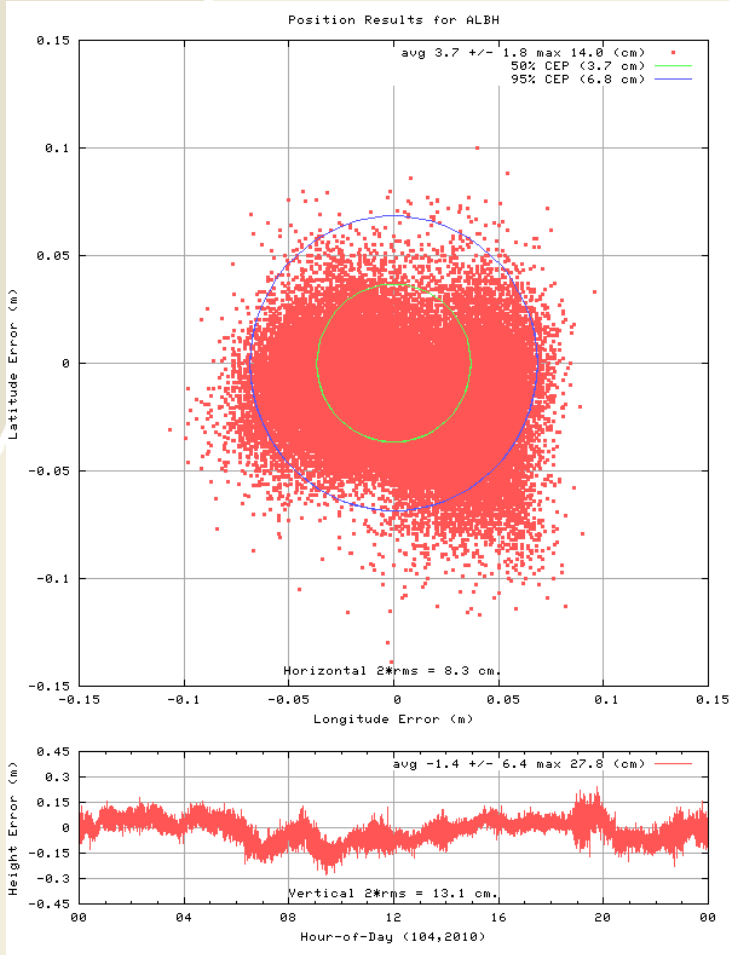
Analysis Centre	Orbit RMS (mm)	Sat. Clock RMS (ns)	Sat Clock Sigma (ns)
Combination		0.17	0.11
RT - Combination	40.95	0.17	0.11
BKG	46.5	0.22	0.11
DLR	49.9	0.22	0.14
ESOC	47.9	0.21	0.11
NRCan	37.9	0.22	0.11
GMV	78.7	0.43	0.16
GFZ	53.0	0.60	0.35
TUW	264.2	0.77	0.54

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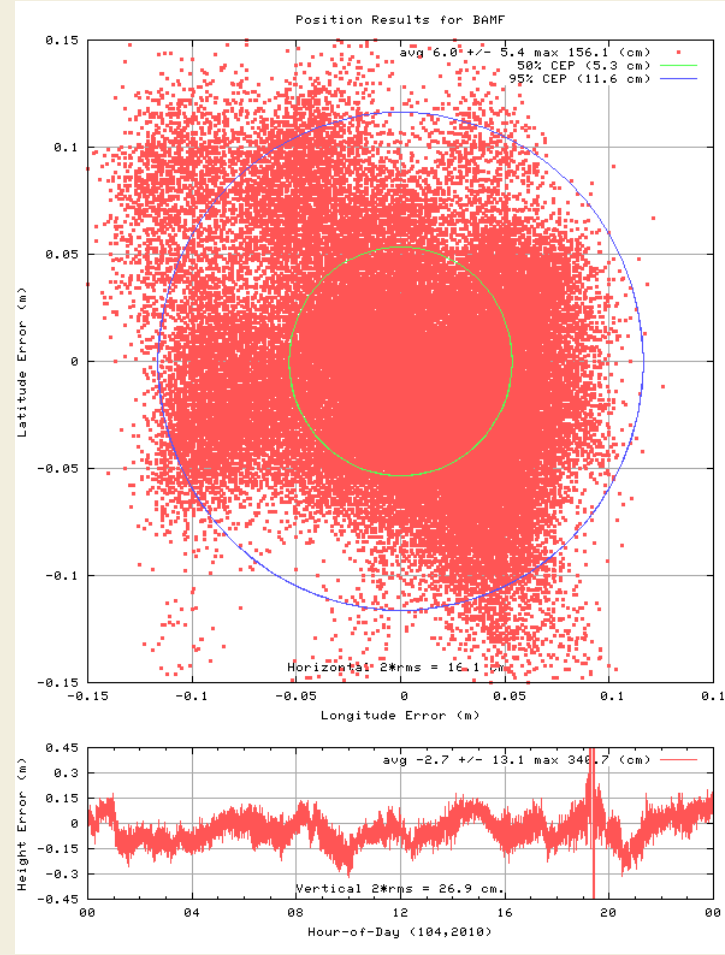


Positioning Accuracy



2*rms
8.3cm

2*rms
13.1cm



2*rms
16.1cm

2*rms
29.9 cm
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RT-PP – Next Steps

- Need to improve real-time data collection network over: Pacific Ocean, Western South America, Central and Northern Africa, India, Russia and China
- Data collection and correction distribution network is good but needs to be more robust and latency reduced.
- Need to work toward implementing RTCM-HP observation data format and all analysis centres need to support the RTCM SSR Correction format.
- Continue to improve RT Orbit and clock solutions
- Work towards a reliable global Glonass data collection network and then implement an Orbit and Clock solution
- Prepare to transition to IGS RT-service (data+products or products?)

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Summary

- RT-PP data collection network enables the reliable computation of GPS Clock corrections. Orbits are IGS Ultra Rapid Predicted.
- Daily file and real-time combination being produced by ESOC. Current combination accuracy meets the RT-PP objective.
- RTCM-HP observations are planned and RTCM-SSR messages have been selected
- Need to improve redundancy and latency of data and correction distribution network
- Many thanks to all RT-PP contributors.

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Questions?

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Links to RTIGS and RT-PP Information

- General info: <http://www.rtigs.net>
- Products: <http://igs.bkg.bund.de/ntrip/orbits>
 - Caster: <http://products.igs-ip.net/home>
- Observations: <http://igs.bkg.bund.de/ntrip/observations>
 - Caster: <http://products.igs-ip.net/home>
- PPP Monitoring: <http://igs.bkg.bund.de/ntrip/ppp>
- Software: <http://software.rtcn-ntrip.org>
- Applications: <http://igs.bkg.bund.de/ntrip/applications>

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RT-PP GNSS Observation Data Formats

- Existing RTCM data format only provides either CA or P2 or P1 or P2 observations so not all observations are available.
- Code and phase resolution does not meet RINEX measurement resolution standards, RTCM - code 0.02m and phase 0.0005m.





RTCM - High Precision (HP) GNSS Observation Formats and Station Description Messages being Developed

- RTIGS Working group and Infrastructure Committee working through RTCM SC-104 to establish new binary GNSS formats.
- New messages and formats designed to enable the creation of standard RINEX 2.x and 3 files.
- Binary format suitable for real-time stream and file based users

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Proposed RTCM- HP GNSS Obs. Format

- Based on proposed Magellan/Ashtech Multiple Signal Message format
- Precision of the observations increase to meet the needs of the IGS
- Key Features:
 - Supports all GNSS constellations
 - Supports 64 SV's per constellation
 - Supports 24 Signals per SV
 - Observation resolution: code 1mm, phase 1/1024 of a cycle and SNR 0.1 db-Hz, doppler also supported
 - Station Change control mechanism
 - Data compression

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Proposed RTCM Station Description Formats

- Proposed Station description message types :
 - Station – describes station, marker type, agency etc.
 - Receiver – serial and model number, clock type etc.
 - Antenna – serial and model number
 - Meteorological Sensor – serial and model number
 - Meteorological data – temperature, pressure and relative humidity

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Proposed RTCM Change Control Mechanism

- Station change control mechanism is called : Issue Of Data Station (IODS). Integer flag stored in each message
- IODS will provide notice to the user when a station change has occurred.
- Station data user can then decide if the change significantly affects their application.
- Example of a IODS event is: a new antenna is installed, IODS value changes, all station messages contains the new IODS value. Station data user determines if the antenna change affects the usability of the data.

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