



# 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 <b>GPS</b> Array	Netherlands
SOPAC	Scripps Orbit and Permanent Array Center	USA

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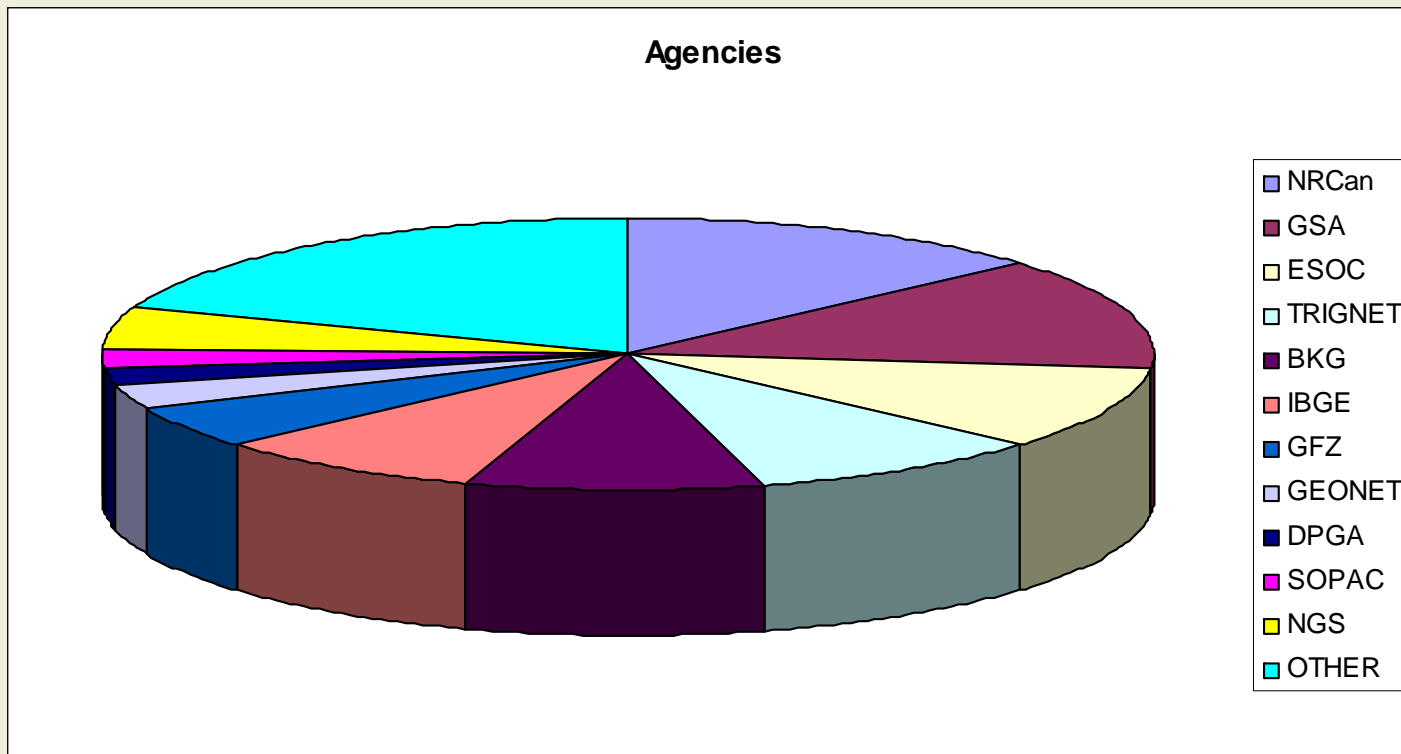
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# Agencies Contributing Station Data



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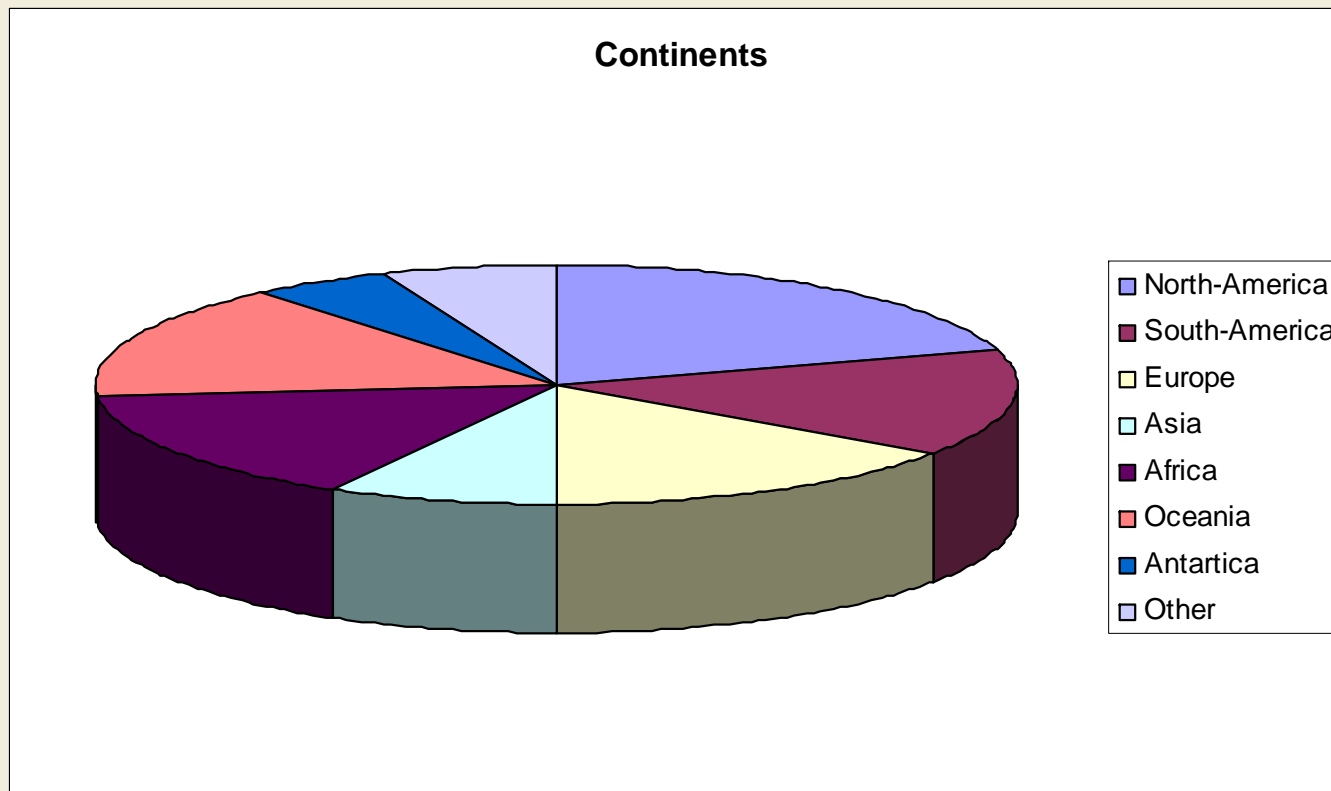
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# Station Data by Geographic Region



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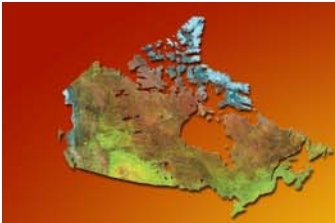


# Real-Time Streams [www.igs-ip.net](http://www.igs-ip.net)

- 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>





## 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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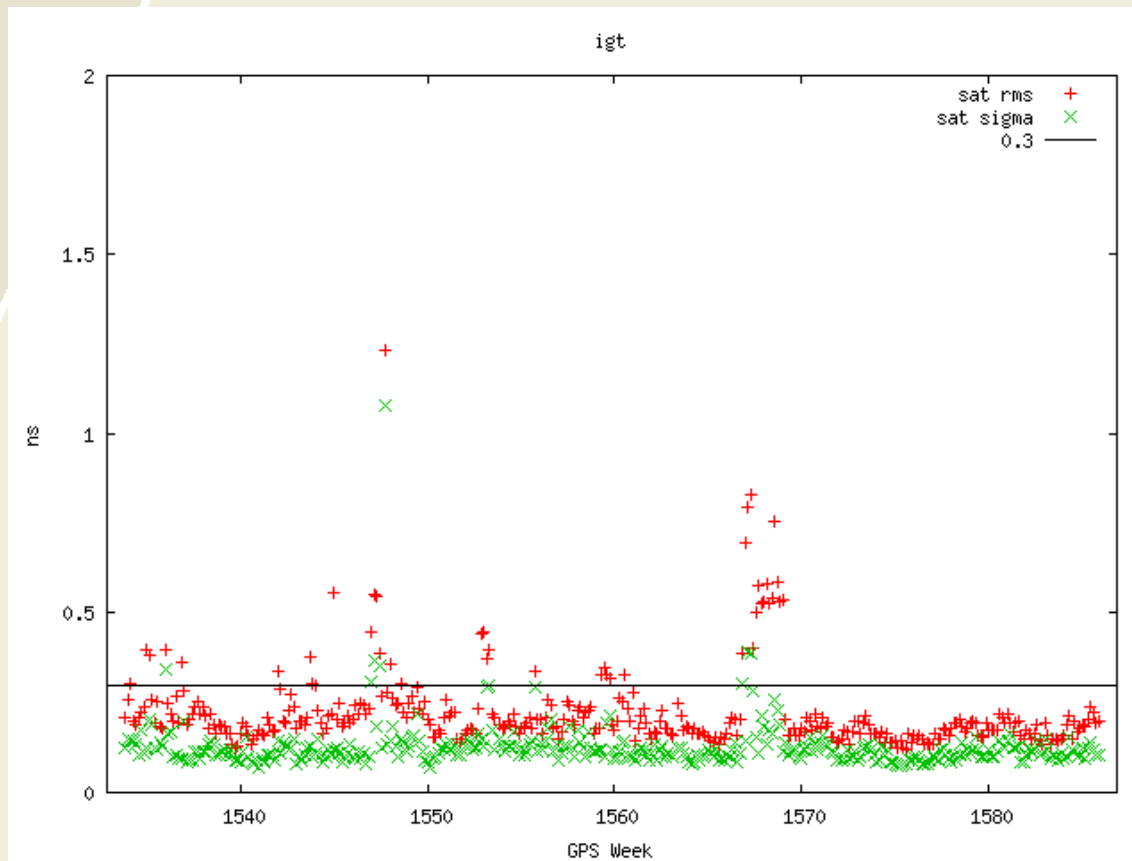
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# Combination Time Series



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)

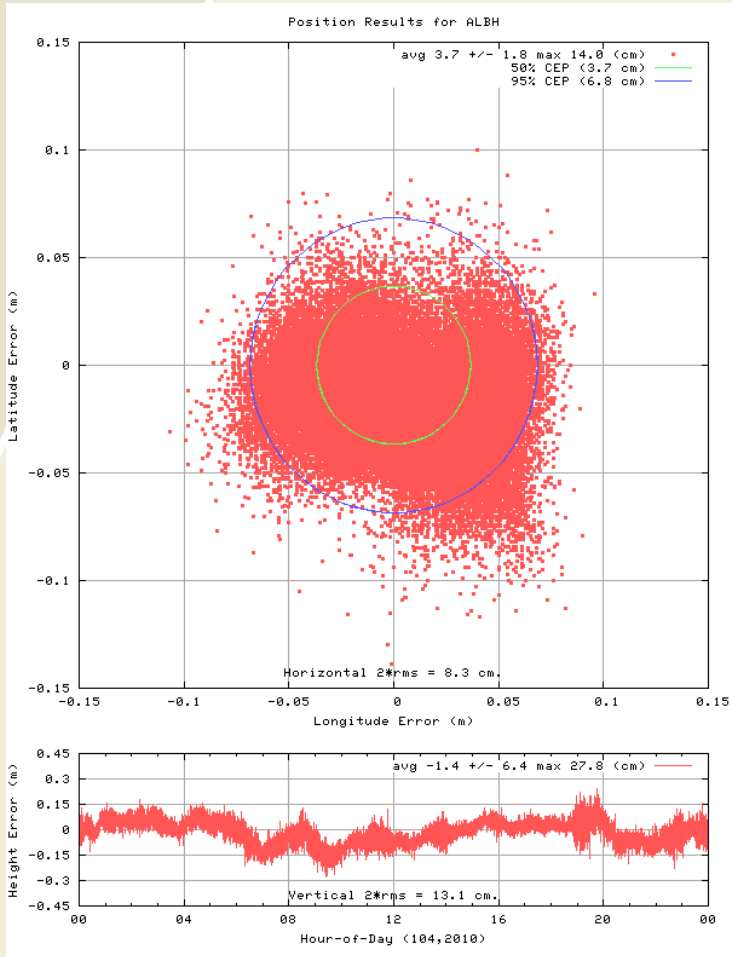
Analysis Centre	Orbit RMS (mm)	Sat. Clock RMS (ns)	Sat Clock Sigma (ns)
<b>Combination</b>		<b>0.17</b>	<b>0.11</b>
<b>RT - Combination</b>	<b>40.95</b>	<b>0.17</b>	<b>0.11</b>
<b>BKG</b>	<b>46.5</b>	<b>0.22</b>	<b>0.11</b>
<b>DLR</b>	<b>49.9</b>	<b>0.22</b>	<b>0.14</b>
<b>ESOC</b>	<b>47.9</b>	<b>0.21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

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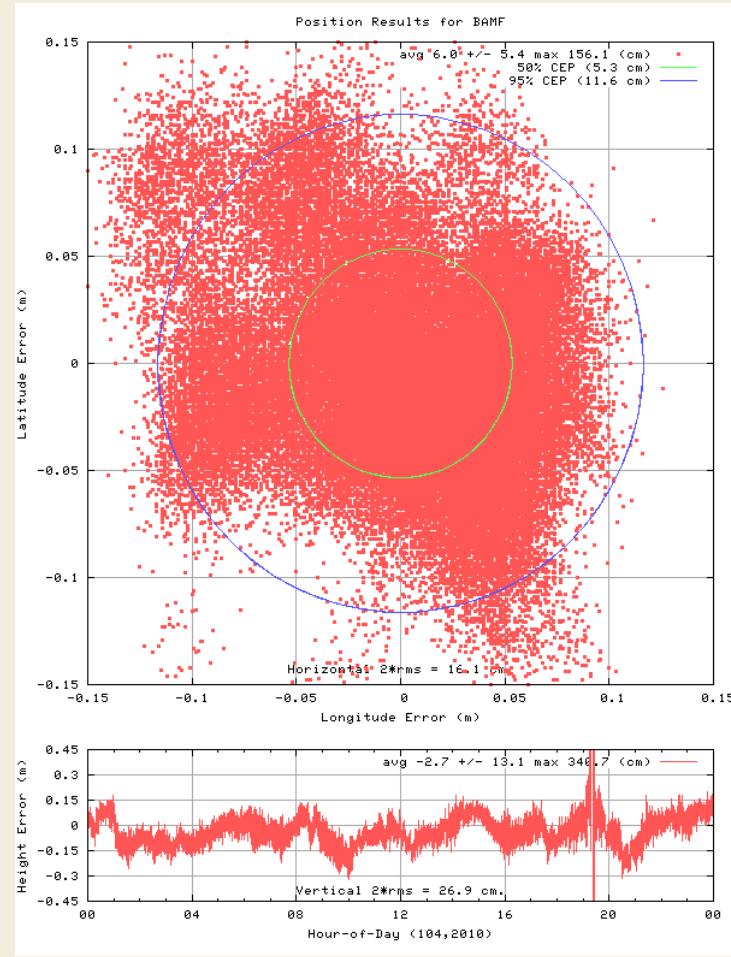


# Positioning Accuracy



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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