Introduction

The IGS Real Time Service has been operational since April 2013, providing two GPS-only products (IGS01 and IGS02) and one experimental GPS+GLONASS product (IGS03). These are combination solutions generated by processing solution products from a number of Analysis Centres (7 GPS and 8 GPS+GLONASS).

The GPS-only products have been available for several years within the Real Time Pilot Project and their performance is being monitored by making comparisons against IGS batch products and by continuous PPP solutions. GLONASS orbit and clock comparisons are generated against the IGS rapid in order to better assess the individual AC solutions and the IGS03 stream. The poster gives details of the RTS products and recent performance, and highlights issues encountered during the operation of the service.

Product and Data Access

The RTS products are all provided using the RTCM standard. Observation streams use both the older RTCM 3.1 (RTCM 10403.1) formats for GPS and GLONASS and the newer RTCM 3.2 (RTCM 10403.2) standard that defines multi-signal and multi-constellation observables. Product streams for GLONASS use the SSR RTCM format which is defined in RTCM 3.2. The SSR formats for the other constellations have not yet been finalised, but some Analysis Centres are providing products based on a draft version of the standard. Dissemination is via Network Transport of RTCM by Internet Protocol (NTRIP).

Information on user access and software is provided on the RTS website at http://www.igs.org/rts/access. Users can register separately at one or more of the three organisations (IGS Central Bureau/UCAR, BKG, CDIO) operating the IGS RT data centres. Orbit products are available either with respect to the satellite centre of mass (CoM) or the antenna phase centre (APC). The clock products are transmitted with an update interval of 5 seconds. The AC streams and NTRIP mountpoint designations are listed in Table 1 below.

<table>
<thead>
<tr>
<th>Centre</th>
<th>Description</th>
<th>Mountpoint</th>
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<tbody>
<tr>
<td>BKG</td>
<td>GPS+GLONASS orbits and clocks using IGF orbits (CoM/APC)</td>
<td>CLK00/10, CLK01/11</td>
</tr>
<tr>
<td>CNES</td>
<td>GPS+GLONASS orbits and clocks based on IGF orbits (CoM/APC)</td>
<td>CLK90/91</td>
</tr>
<tr>
<td>DLR</td>
<td>GPS+GLONASS+IAG+BEI orbits and clocks (CoM/APC)</td>
<td>CLK92/93</td>
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<tr>
<td>ESOC</td>
<td>GPS orbits and clocks based on IGF orbits (CoM/APC)</td>
<td>CLK01/10, CLK10/11</td>
</tr>
<tr>
<td>GMV</td>
<td>GPS+GLONASS orbits and clocks based on IGF orbits (CoM/APC)</td>
<td>CLK05/06</td>
</tr>
<tr>
<td>WUHA</td>
<td>GPS orbits and clocks based on IGF orbits (CoM/APC)</td>
<td>CLK22</td>
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The coordination of the Analysis Centre activities is the responsibility of the Real Time Analysis Centre Coordinator (RTACC). This role has been fulfilled by ESOC since the start of the Pilot Project in 2008. The RTACC is responsible for monitoring the individual AC streams and for generating and assessing the quality of combined real-time orbit and clock products. Table 2 shows the combined products available within the RTS. Both a single epoch combination product developed by ESOC and a Kalman filter combined product, developed collaboratively by BKG and Czech Technical University (CTU), are available. A GPS+GLONASS Kalman filter combined product has also been developed at BKG and CTU.

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<tr>
<td>ESOC</td>
<td>RT GPS epoch combination from NRCam, BKG, CNES, DLR, ESOC and GMV</td>
<td>IGS01 (APC)</td>
</tr>
<tr>
<td>BKG</td>
<td>RT GPS Kalman-generated combination from NRCam, BKG, CNES, DLR, ESOC, GMV, GFZ and WUHA</td>
<td>IGS02 (APC)</td>
</tr>
<tr>
<td>BKG</td>
<td>RT GPS+GLONASS Kalman-generated combination from BKG, CNES, DLR and GMV streams</td>
<td>IGS03 (APC)</td>
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PPP Performance

Continuous PPP performance results for all streams are available at https://igs.bkg.bund.de/ntrt/ig/ and are displayed on a 24-hour sliding window. They are derived from the BNC PPP client, running in kinematic PPP mode and using observations from a number of receivers whose positions are precisely known. The chart on the right shows the PPP monitoring of the IGS01 combination from 3 sites over a 24-hour period.

Orbit and Clock Performance

The GPS individual AC and combination solutions are monitored by making daily comparisons of the decoded orbit and clock products against the IGS Real Time Service. The clock results for the individual ACs since November 2010 are shown in Figure 1 (left) while the right-hand plot shows the performance of the IGS01 combination. It can be seen that there are significant daily variations in the statistics of the individual RTAC solutions. These are usually due to a problem in a single satellite, which distorts the daily statistics. These distortions are effectively removed by the combination outlier detection logic. The IGS01 clock standard deviation is normally at the 0.1-0.15 ns level. The best individual RTAC solution is normally better, but suffers from occasional outlier problems that the combination is designed to remove.

Main Issues

The majority of issues encountered during the operation of the service have been minor in nature. A common problem is occasional loss of orbit accuracy for the GPS Block 1F satellites during eclipse seasons and when in non-nominal attitude. In the past there have been some issues with RTCM encoding and decoding. These are now almost exclusively confined to GLONASS and more recently only affect satellite R24 in the CNES solution. The cause of such issues is mainly related to the use of outdated ephemerides during encoding of the RTK products.

GPS solution availability has been excellent, with no recorded outages in the last year. The GLONASS combination solution is currently based on only 3 ACs, which means that the loss of a single AC will result in disruption of the GLONASS service.

Conclusions

The RTS products offer a reliable and highly available IGS service for a wide variety of applications.

Acknowledgements

The authors wish to acknowledge the efforts of all the entities involved in providing the IGS Real Time Service, including station operators, Analysis and Data Centres and the staff of the IGS Governing Bureau.