Abstract

ESA/ESOC continues to improve, maintain and expand its worldwide network of GNSS stations for the benefit of the international GNSS community through participation in the IGS and the EUREF, plus internal ESA efforts to enhance the data coverage worldwide.

In recent years new station deployments have taken place to strengthen the ESA/ESOC station network for internal project use. In 2017/2018 two new ESOC stations were installed in South Africa (see insert below), and contacts are well underway for new stations in Mexico, Brazil, Argentina, Costa Rica, Russia and Canada. All ESOC stations provide multi-GNSS 15min, Hourly and Daily Rinex 2.11 and Rinex 3 files, as well as GPS CA NBS (NavBits) files.

ESOC Station Network Upgrade 2017-2018

ESOC is committed to provide worldwide data for all GNSS constellations during this year as a result of having completed the upgrade of the equipment for the "legacy network" in 2012-2013, as well as focusing on the establishment of collaborations with third parties in order to install new stations at various new locations if agreements can be reached with the corresponding organizations. As such, following the completion of the upgrade, new stations were deployed in 2014 (SNTM, AWAR), 2015 (BANT, DUBA, TSBA, ESOB, ESOC), 2016 (BSHK), 2017 (HRTB) and 2018 (MTJF).

The entire ESA GNSS network now operates Septentrio PolaRx4 receivers and either SEPCHOKE antennas (most sites) or Leica AR25 antennas (used at MGUE, MAL2, MAS1 and FAA). The only exception is ESOB, which is located directly next to station ESOC, and operates a Javad Tre 3 Delta receiver and Trimble TRM57971 antenna.

New ESA/ESOC stations in South Africa

The latest two additions to the ESOC Station Network are both hosted by the The Hartebeesthoek Radio Astronomy Observatory (HartRAO): the first (HRTB) at their main premises at Hartebeesthoek, the second (MTJF) near Matjesfontein, i.e. just over 1000km apart.

With the installation of a multi-GNSS Septentrio PolaRx4 receiver and Septentrio Chokering MC antenna at each site, the station HRTB became fully operational on September 27th 2017, followed by MTJF on April 4th 2018, providing full coverage and extra redundancy for Southern Africa together with MAL2, as well as enhancing coverage in the Indian and South-Atlantic Ocean.

For the 2nd half of 2018 worldwide coverage is planned to be further enhanced with negotiations with third parties in Brazil, Mexico and Argentina in an advanced stage. Negotiations for new stations in Costa Rica, Iceland, Russia and Canada are also on-going. The map above shows the intended locations for all the new ESOC stations.

Conclusions

ESA/ESOC is fully engaged in supporting the modernization of GNSS data formats and data transfers over our involvement in the RINEX Working Group and the IGS Infrastructure Committee. ESOC remains involved and committed to support the RINEX 3 data format and to the new Multi Signal Message RTCM real-time format, and in the upgraded ESOC station network we look forward to provide the upgraded data formats as part of the MGEX and the Real-Time pilot project.

The ESA/ESOC Navigation Support Office is also committed to providing the highest quality GNSS data by maintaining, improving and expanding the existing station network with modern Septentrio receivers and antennas, providing measurements for all GNSS-constellations.

ESOC multi-GNSS data

The station network is permanently monitored to ensure the data return from each site is complete. In particular checking the "triple station coverage" for each active GNSS satellite in every 24 hour period to detect problems and weak coverage areas.

All GNSS Constellations are covered with at least three ESOC GNSS stations more than 90% of the time as seen in the plots below:

ESOC Network GPS triple station coverage

ESOC Network Galileo triple station coverage

ESOC Network QZSS triple station coverage

ESOC Network Beidou triple station coverage

ESOC Network Glonass triple station coverage

ESOC Network RINEX data

The station network map below shows the ESA GNSS station network, which currently comprises 20 stations. A total of 10 stations at deployed at ESA ESTRACK core/cooperation locations: Kourou (KOUR), Redu (REDU), Messapaoloma (MA21), Cebreros (CEBR), Villafranca (VILA), Kiruna (KIRU), Malargue (MGUE), New Norcia (NNOR), Malindi (MAL2) and Santa Maria (SNTM).

In addition, two stations are deployed at ESA/ESOC's premises in Darmstadt (ESOC and ESOB) connected to ultra-stable H-masers. Finally, 8 stations are deployed at third party sites; Awarau (AWAR), Banting (BANT), Bishkek (BSHK), Dubai (DUBA), Tahti (FAA1), Hartebeesthoek (HRTB), Matjesfontein (MTJF) and Tsukuba (TSBA).

Over 2017 and the first half of 2018, all stations displayed data availability figures close to 100%.

The data’s arrival is monitored every 15 minutes and it is processed in the ESOC IGS processing (Ultras, Rapids and Finals) allowing for data quality and clock stability to be monitored. The ESOC stations also stream data in real-time in support of the IGS Real-Time Pilot Project.