ESA / ESOC GNSS Observation Network (EGON)

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Abstract

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

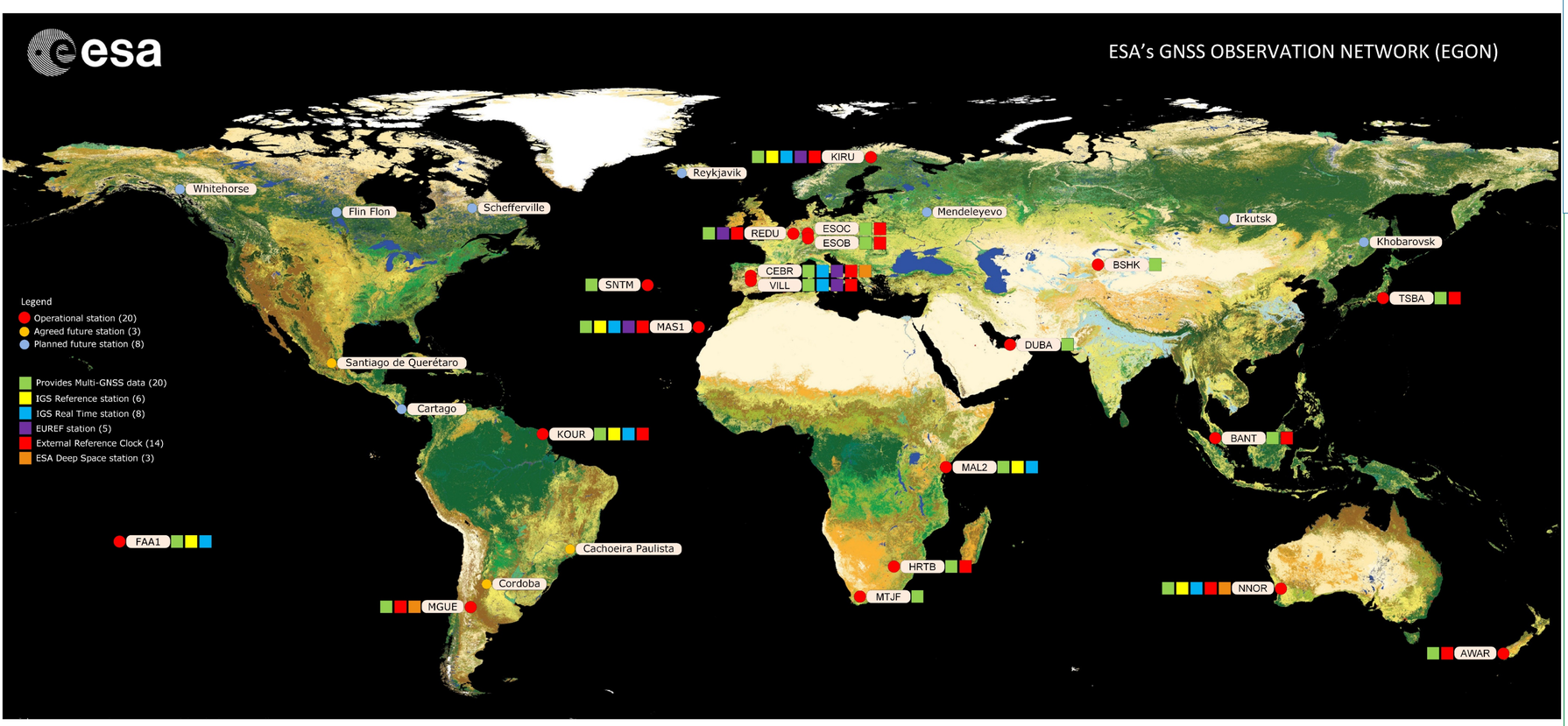
In recent years new station deployments have taken place to strengthen the ESA/ESOC station network for internal project use. In 2017/2018 two new ESOC stations were installed in South Africa (see insert below), and contacts are well underway for new stations in Mexico, Brazil, Argentina, Costa Rica, 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 (EGON)

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**), Maspalomas (**MAS1**), Cebreros (**CEBR**), Villafranca (**VILL**), 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; Awarua (**AWAR**), Banting (**BANT**), Bishkek (**BSHK**), Dubai (**DUBA**), Tahiti (**FAA1**), Hartebeesthoek (**HRTB**), Matjiesfontein (**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.



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.

The PolarRx4 Septentrio receivers installed provide all the expected measurements for the GNSS constellations as available: GPS, GLONASS, Galileo, QZSS, Compass, SBAS, EGNOS, etc. As of mid-2013, ESOC has been contributing with daily, hourly and high rate multi-GNSS RINEX 3 data to the IGS network, plus continuing with the regular RINEX 2 submissions. Since the beginning of 2016, ESOC has been providing RINEX 3 files with the correct "long names".

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.

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 Matjiesfontein, i.e. just over 1000km apart. With the installation of a multi-GNSS Septentrio PolarRx4 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.

HRTB (pictured here to the left) is co-located in the same antenna field as the IGS station HRAO, whereas MTJF is part of an entirely new infrastructure at a remote site with a mobile data connection. Clear horizon performance is excellent for HRTB with just a few trees and shrubs obstructing the view for very low elevations. For MTJF, mountainous terrain towards the South provides some masking for low elevations, but the average total number of GNSS satellites tracked is still within 5% of that of HRTB.

Conclusions

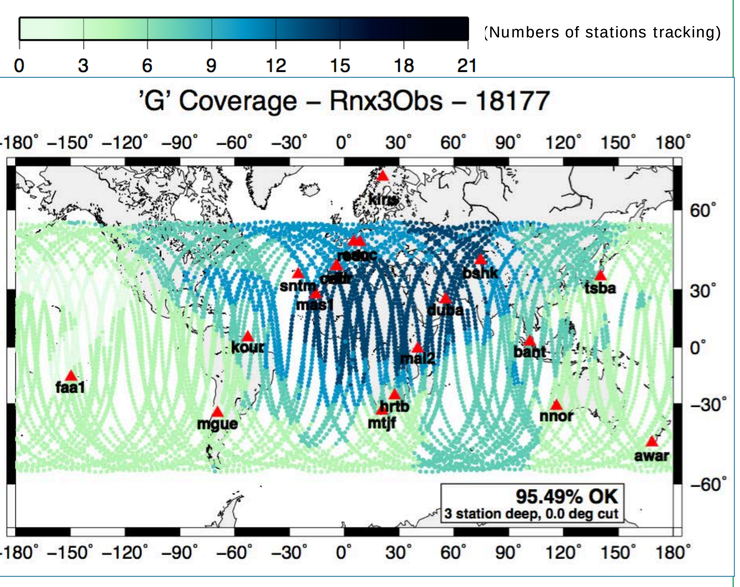
ESA/ESOC is fully engaged in supporting the modernization of GNSS data formats and data transfers through our involvement in the RINEX Working Group and the IGS Infrastructure Committee. ESOC remains involved and committed to support the Rinex 3 data format and to the new Multi Signal Message RTCM real-time 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.

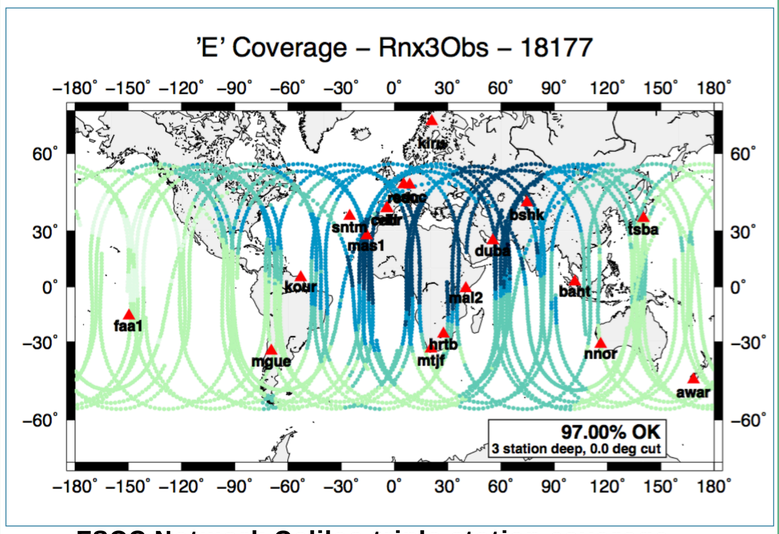
ESOC multi-GNSS data

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.

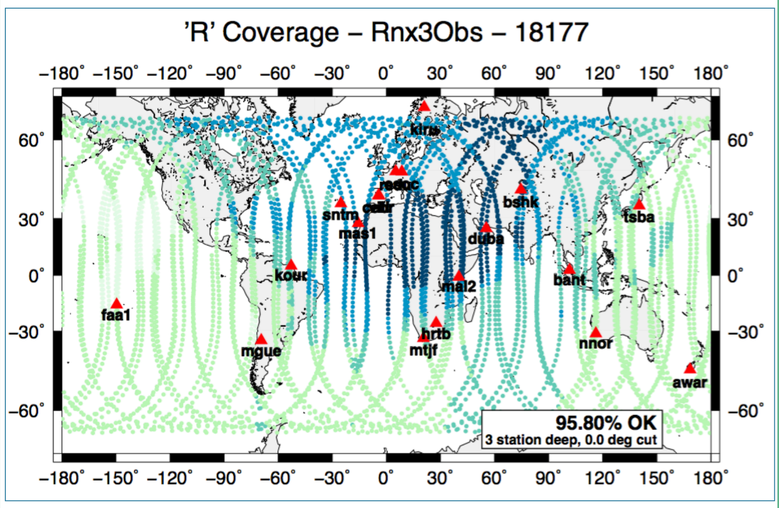
All GNSS Constellations are covered with at least three ESOC GNSS stations more than 90% of the time as seen in the plots below:



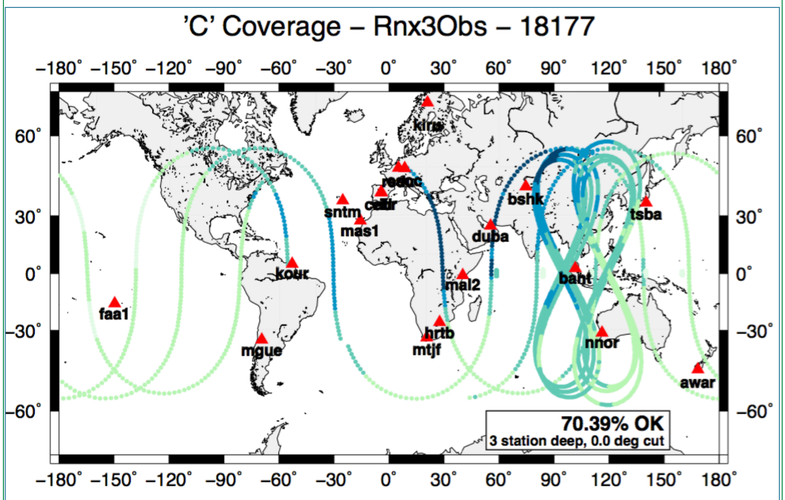
ESOC Network GPS triple station coverage



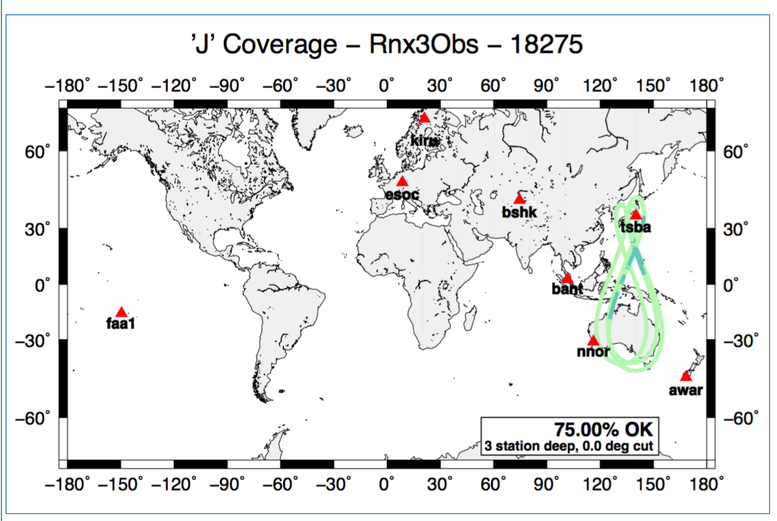
ESOC Network Galileo triple station coverage



ESOC Network Glonass triple station coverage



ESOC Network Beidou triple station coverage



ESOC Network QZSS triple station coverage