Availability and Completeness of IGS Tracking Data

IGSWS2016
International GNSS Service
Workshop 2016
8 - 12 Februar 2016, Sydney, Australia

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Motivation

Availability and completeness of consistent Global Navigation Satellite System (GNSS) tracking data is a basic condition for the generation of best possible analysis products. The steadily increasing number of observation types is monitored for each individual station (and each relevant GNSS). The statistics show among other things that the homogeneity of the reported types is no longer ensured. Particular problems and anomalies concerning International GNSS Service (IGS) observation files are highlighted.

Database

For the data processing (and monitoring) at the Center for Orbit Determination in Europe (CODE), near real-time (hourly) and daily observation files are downloaded from IGS, EUREF, MGEX and other data sources. This includes RINEX 2 and RINEX 3 files from more than 440 stations.

Availability of daily files

Since mid of July 2015 CODE is downloading RINEX 2 and RINEX 3 data from the IGS datapools. Looking at a 120-day period, most of the stations have a complete set of daily RINEX 2 files. The RINEX 3 datapool is still building up and not all sites are yet delivering RINEX 3 data files. For October 2015 to January 2016, we have on average 90 RINEX 3 files per day in our datapool. 350 out of 417 stations submitting RINEX 2 data have a completeness of 95 % and more over a 120 day period.

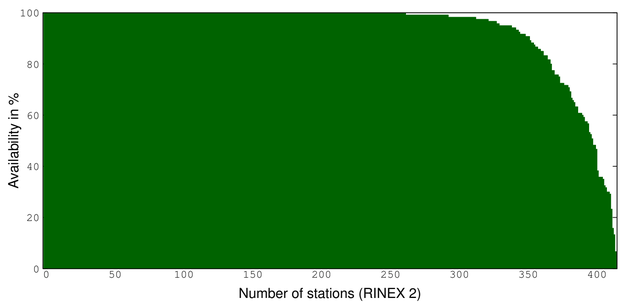

Figure 1: Looking at a 120-day period, most of the stations have uninterrupted time series of daily RINEX 2 observation files.

CODE creates statistics for the downloaded RINEX files and makes them available at:
`ftp://ftp.unibe.ch/aiub/igsdata/rnxdata.sum`
`ftp://ftp.unibe.ch/aiub/igsdata/rnxdata_more.sum`

Satellite-specific observation types

The satellite-wise observation statistics in Figure 3 gives an overview of the current IGS tracking situation:

- RINEX 3 data commonly includes multi-GNSS observations (therefore also GLONASS).
- GLONASS satellite R21 is also tracked on a third frequency (C3Q and L3Q).
- GLONASS extra satellites R26 and R27 (only in RINEX 2 data files) are currently only sampled by few stations.
- The RINEX 2 data includes in addition observations for Galileo, even though this is not foreseen by the RINEX 2 standard.

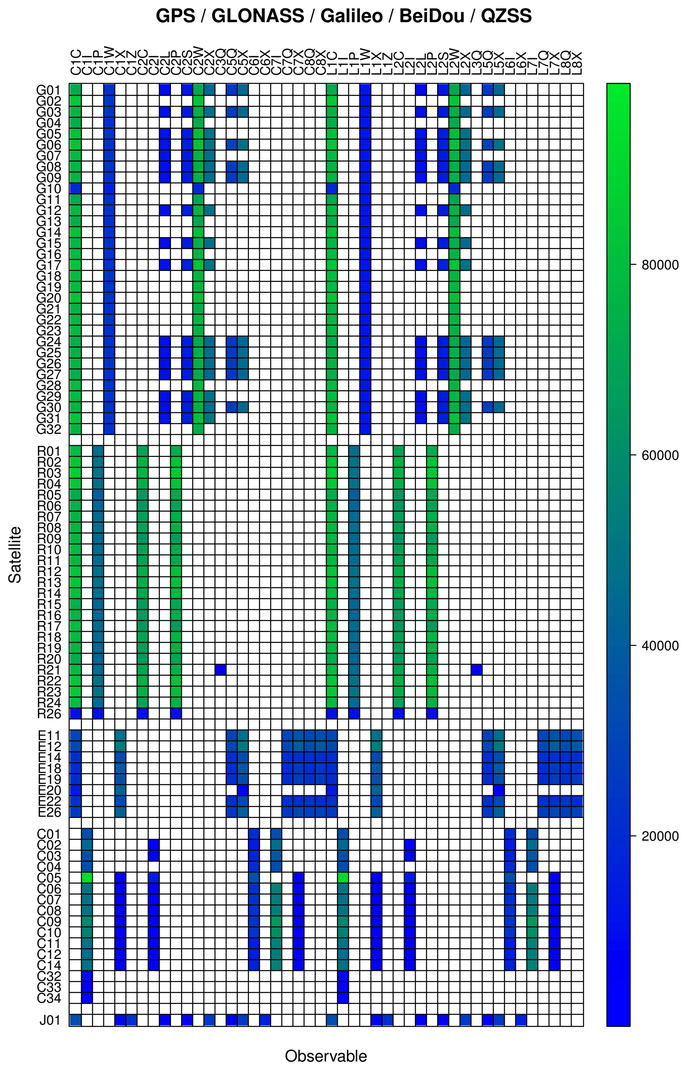

Figure 3: Number of observations per satellite and observable found in the RINEX 3 datapool at CODE for day 280 of year 2015.

Number of tracked satellites for each IGS station providing RINEX 3

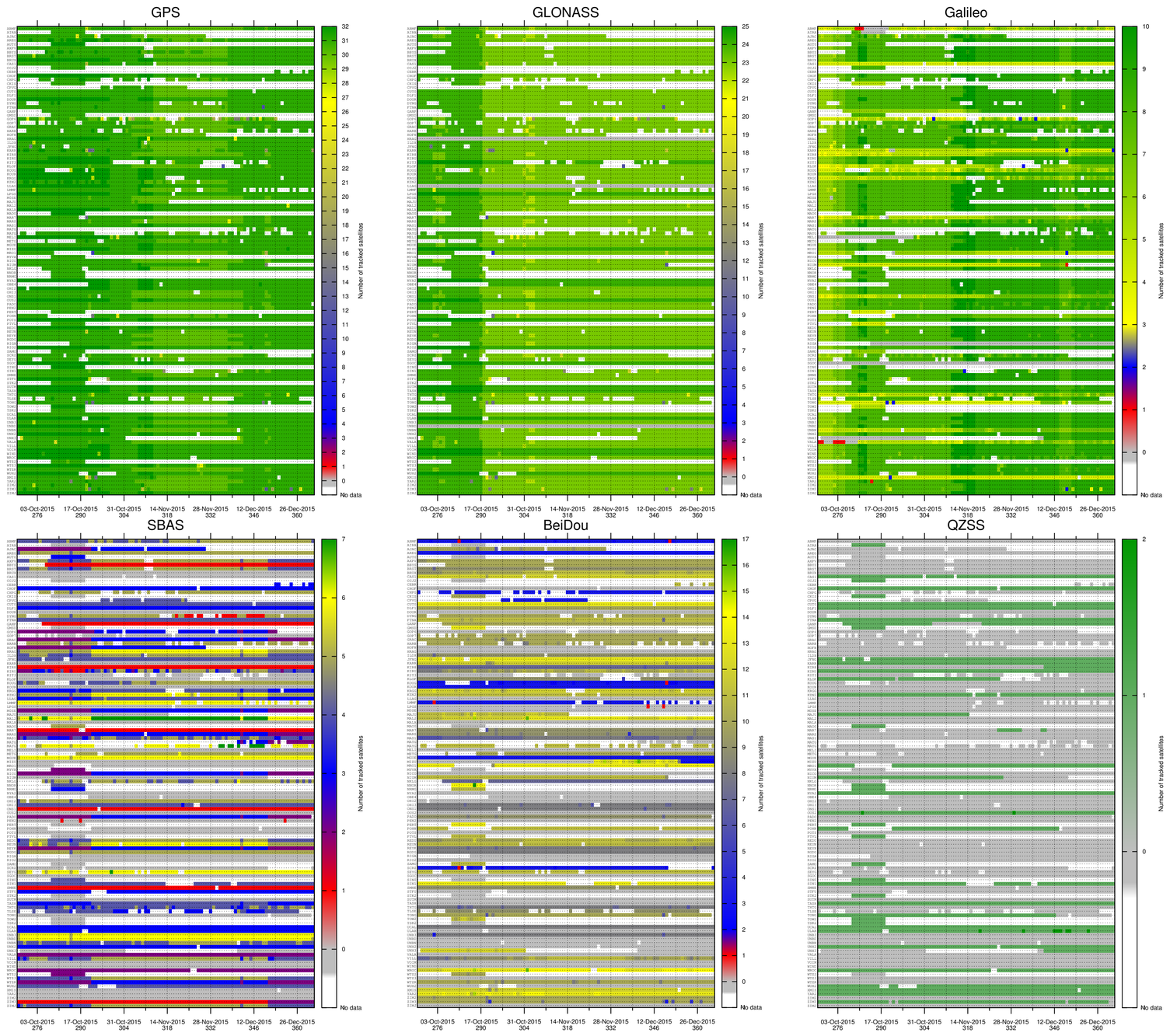

Figure 2: Number of tracked satellites for IGS stations, extracted from the internally established XML meta-database for RINEX 3 data files.

Verification of GLONASS frequency channel numbers

GLONASS frequency channel numbers are verified regularly for all tracking data collected at CODE. A data screening procedure is performed in a dedicated mode for the complete range of possible GLONASS frequency numbers. It is assumed that the frequency number with the biggest number of valid observations (after the screening procedure) has been used by the receiver. Each thus obtained number is then compared to the default/reference frequency number (as defined in our given satellite information which is consistent with the broadcasted frequency number). By this verification procedure, common switches in the GLONASS frequency channel numbers and also anomalies with respect to particular tracking stations (and receiver models) may be detected with short latency.
Fig. 4 reveals two striking events: the GLONASS constellation change for R18 (from #801 to #743) on 22-Feb-2013. A specific receiver group (mostly JAVAD) continued collecting data from the previous SV #801 (see IGS Mail #6734). The second "line" corresponds to the most recent constellation change (for R18) on 11-Apr-2014, where 3 receivers continued to record data with the old frequency channel number, namely SVTL (JAVAD TRE_G3TH DELTA) as well as HERS and BJNM (both SEPT POLARX3ETR), where the problem disappeared not until the reset of the receiver (requested from our side). We detected another anomaly regarding the satellites R17 and R27 on 27-Jan-2016 (IGSMAIL #2740).

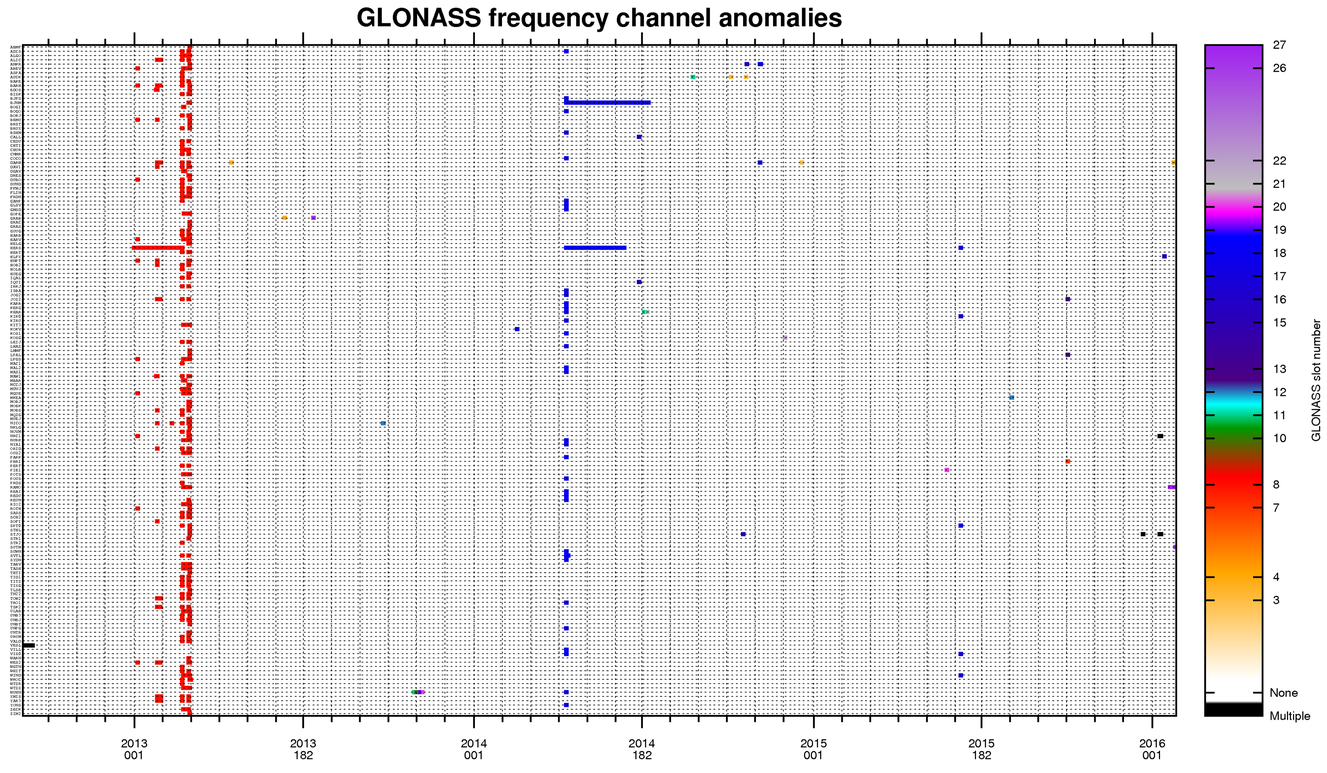

Figure 4: IGS stations with GLONASS frequency channel anomalies (out of 243 stations tracking GLONASS).

Summary and conclusions

Systematic quality control for GNSS tracking data is indispensable to ensure best possible analysis products. To keep the running receiver firmware (version) up to date may help to improve the data quality and completeness.
We are confronted with an increasing number of signals, frequencies and satellite systems. This is asking for a new level of details in reporting on the data generation (frequency *and* tracking mode), otherwise derived GNSS analysis products may become biased.
We developed an XML-based meta-data monitoring of our datapool, allowing for fast, flexible and efficient extraction of information necessary for station selection and processing. It allows even for complex queries and is thus offering a powerful tool for detection and detailed monitoring of irregularities in the IGS tracking data.

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