



## Abstract

Since 2013, the G-Nut/Anubis has been steadily enhanced tool designed for a complex quality checking (QC) of all modern GNSS observations and navigation messages. Although the software still handles the legacy format RINEX 2.x, it is mainly designed to fully support new RINEX 3.x. Currently, the tool provides quantitative and qualitative checking, standard point positioning and visualizations of the results. The application supports detailed statistics over observations, signals and frequencies, enables checking file header consistency, provides data for satellite sky plots, performs epoch-wise positioning for static or kinematic mode, detects carrier-phase cycle slip and clock jump, estimates code multipath and signal-to-noise ratio and, provides additional statistics from those results. Along with all GNSS constellations, all G-Nut/Anubis's functionalities include all signals, frequency bands and observation types. The G-Nut/Anubis has been primarily designed as a command-line tool for automated multiple file data quality checking within large data centers. It is thus ready to serve for dissemination and archiving of RINEX 3 files within the RINEX 3 transition plan. Special features are to support a full QC for individual GNSS or multi-GNSS navigation messages and, recently, SP3 files too. Additionally, the software is being modified to serve the EPOS project (European Plate Observing System) for supporting QC of GNSS data at distributed repositories and providing QC meta data for enhanced GSAC-like virtualization service for seamless access to GNSS data. The G-Nut/Anubis is the software distributed under the GNU General Public Licence v3. In January/February, Anubis v1.4 has been released as pre-compiled linux and windows binaries and the source code from the Geodetic Observatory Pecny's web [www.pecny.cz](http://www.pecny.cz).

**Purpose:** G-Nut/Anubis is a tool providing scalable view on RINEX 2.XX/3.XX observations and navigation messages without a need of comprehensive data processing. It is useful for the data quality checking such as identifying incomplete or low quality data immediately after the data collection by GNSS receiver. It provides quantitative and qualitative analyses, standard point positioning, and meta data checking.

### Basic characteristics:

- Developed in C++ (G-Nut core library) for utilization in Linux and Windows command-line mode
- Supports GNSS global (GPS, GLONASS, Galileo, BeiDou) and regional (QZSS) and augmentations (SBAS).

### Processing modes:

- Sequential or parallel processing, verbosity for individual sections

### Algorithms involved:

- Cycle slips and clock jumps detection, phase and code synchronization
- Code multipath and noise for all bands/frequencies, satellite constellations, signals

### Availability:

- Latest release: 1.4.x (beta June 27, 2016)
- Open source (GPLv3): <http://www.pecny.cz> (GNSS, software, Anubis)

### Inputs/Outputs:

- Configuration: via XML file
- Input: observation and navigation RINEX 2.XX/3.XX
- Output: human/machine-readable plain format (easy-to-grep, non-redundant); summary, header, estimates, observations, bands, sky-plot, and multipath sections
- Summary output: XML file (to be further extended for EPOS-IP project)

## New features of G-Nut/Anubis 1.4:

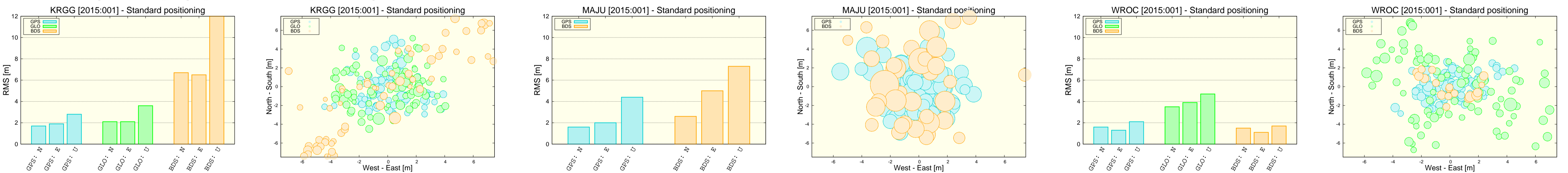
- cascade pre-processing for 2-/3-/4-/5-bands, all signals, constellations (modified algorithm by Zhao et al. 2015)
- improved expected/have observation stats (with/wout navigation messages), elevation-dependent histogram
- storing RINEX3 concatenated multi-GNSS navigation messages
- new observations handling, selecting and filtering (bands, signals, satellites, constellations)
- visualization of results (extraction and plotting Perl modules)
- multi-GNSS positioning and GDOP
- refined internal data structure for a flexible multi-GNSS usage

- signal-to-noise ratio monitoring
- check of unhealthy satellites
- support for Windows
- kinematic data quality checking
- high-rate data processing
- optimized elevation histograms
- sp3 support for satellite positions (NAV precision)

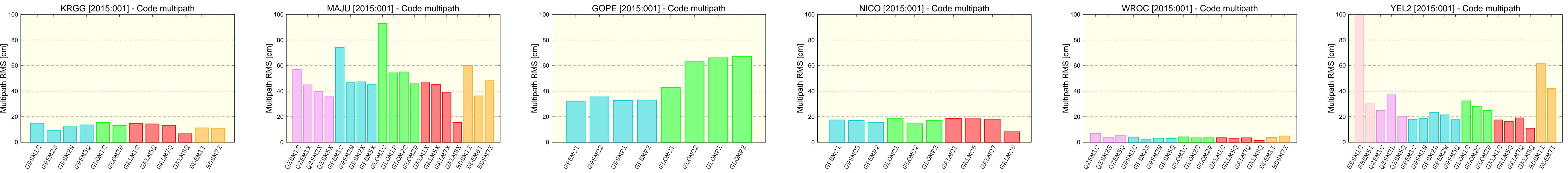
## RINEX 2.XX/3.XX data quality check - selected visualizations

Since G-Nut/Anubis release 1.3 (Jan, 2015) extracting and plotting (perl) modules have been provided for easier visualization of the quality check results. Several examples are showed below. In paralel, new G-Nut/AnubisQ version is under development which will include graphic user interface, multi-platform support, and visualization modules.

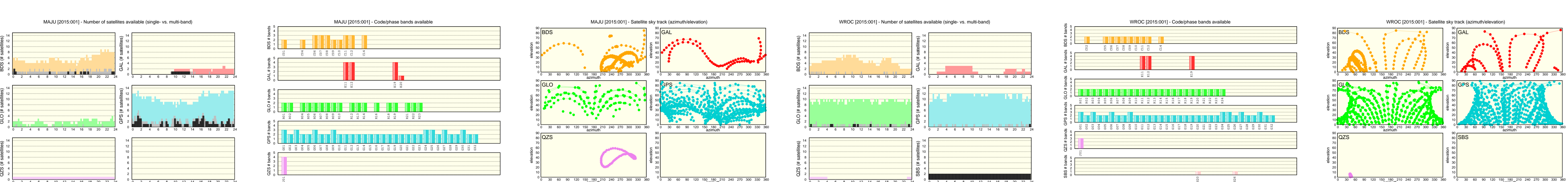
From left to right: Example graphs for standard positioning at KRGG, MAJU and WROC stations.



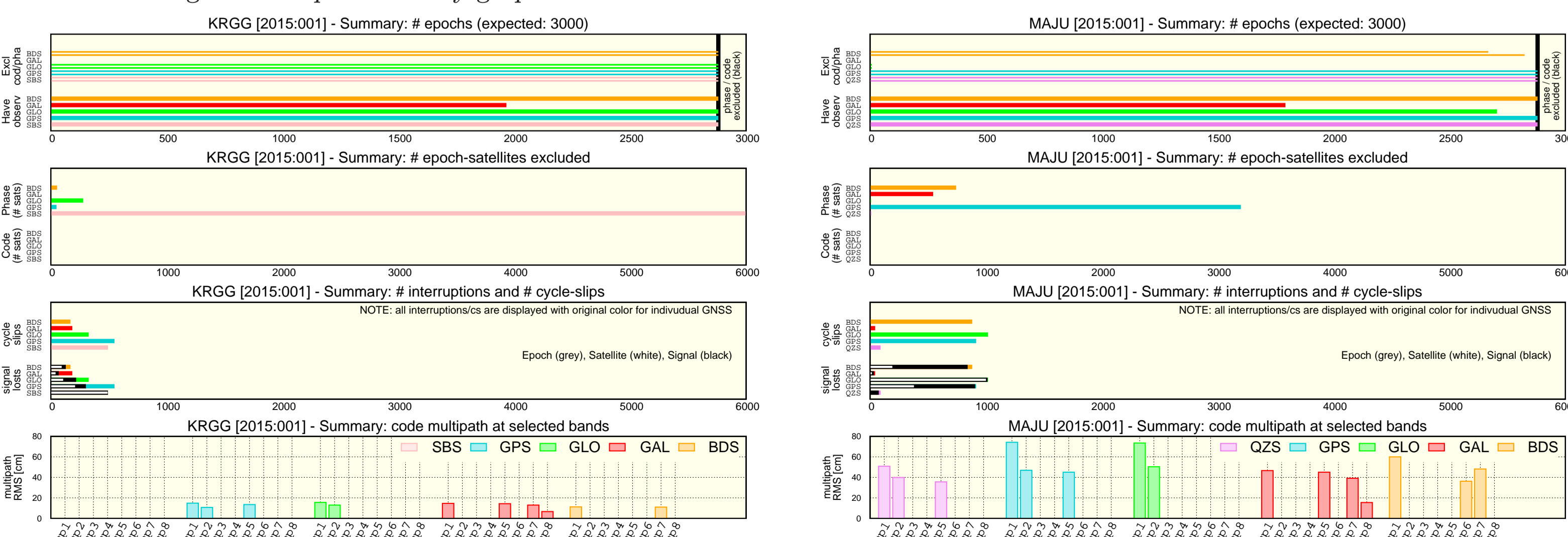
From left to right: Example graphs for code multipath and noise monitoring at KRGG, MAJU, GOPE, NICO, WROC and YEL2 stations.



From left to right: Selected graphs of bands, signals and satellite availabilities for MAJU and WROC stations.



From left to right: Example summary graphs for KRGG and MAJU stations.



## References:

Vaclavovic P, Dousa J (2014), G-Nut/Anubis: Open-Source Tool for Multi-GNSS Data Monitoring with a Multipath Detection for New Signals, Frequencies and Constellations, In: IAG Symposia Series, Springer, Vol. 143, doi:10.1007/1345\_2015\_97

Vaclavovic P, Dousa J, Gyori G (2013), G-Nut software library - state of development and first results, Acta Geodynamica at Geomaterialia, 10(4):431-436, doi:10.13168/AGG.2013.0042.

Zhao Q, Sun B, Dai Z, Hu Z, Shi C, Liu J (2015), Real-time detection and repair of cycle slips in triple-frequency GNSS measurements, GPS solut, 19(3):381-391, doi:10.1007/s10291-014-0396-2