



IGS 2017 Workshop Recommendation: Bias and Calibration WG

Session Chair: Stefan Schaer

Rapporteur: Stefan Schaer

Recommendations:

- The Bias-SINEX Format Version 1.00 shall be considered for final approval by the IGS.
- The IGS analysis and user community are encouraged in making use of this new bias format.
- A potential redefinition of the clock bias convention, in particular from the “rigid” GPS C1W/C2W to a flexible GNSS clock bias convention, has to be addressed by the IGS community.





IGS 2017 Workshop Recommendation: Ionosphere Working Group

Session Chair: Andrzej Krankowski

Rapporteur: Andrzej Krankowski

Discussion Highlights:

- This plenary session, poster session and splinter meeting have been an excellent forum for discussing possible improvements of IGS ionospheric products by incorporating new VTEC GIMs from three new IGS Ionosphere Associated Analysis Centre that include NRCAN, CAS, and WHU.
- The performances of individual processing centres are now compared with the existing four VTEC GIMs. Empirical model such as IRI model and the International LOFAR Telescope datasets are also evaluated. In addition, the newly introduced TEC fluctuation product – ROTI maps – was discussed..

Key Issues:

- Activities of new IGS ionosphere Associated Analysis Centres: NRCAN, CAS, and WHU;
- ROTI maps,
- Possibility of establishing new IONEX 1.1 format in agreement with IGS Bias and Calibration Working Group.

Emerging Ideas:

- The challenge of multi-constellation ionospheric processing quality control and error uncertainties,
- Moving toward multi-constellation ionosphere products including VTEC maps, ROTI maps, scintillation products. ★



IGS 2017 Workshop Recommendation: Ionosphere Working Group

Major Accomplishments Since the Sydney Workshop:

- Three new IGS ionospheric processing centres (NRCAN, CAS, and WHU) have been introduced to the IGS community – already present in CDDIS,
- First version of the TEC fluctuation product (ROTI polar maps) – already present in CDDIS,
- We continue the discussion with the IGS Bias and Calibration Working Group about new IONEX 1.1 format.

Recommendations (please include a projected timeline, if possible):

- Combined products, including the use of all seven processing centres' maps will be computed after establishing a proper weighting scheme.
- Due to an increased number of IGS ionosphere processing centres, specific reprocessing tasks (of period since 1998 until now) are planned to be established and completed within a year.
- The IONEX format shall be updated in order to accommodate contributions using multiple constellations and adequately describe the associated resulting differential code biases – coordination of this task with the IGS Bias and Calibration Working Group has been in progress since 2016 IGS Workshop in Sydney.
- Cooperation with International LOFAR Telescope (ILT) for potential synergies.
- Cooperation with IRI COSPAR group for potential improvement of both IRI and IGS TEC.





IGS 2017 Workshop Recommendation: Scientific Applications of IGS Products

Recognizing the broad participation of >10 distinct scientific disciplines in the session "Scientific Applications of IGS Products", each with quite different requirements, we recommend:

Recommendation 1:

- the IGS continue to maintain an openness to scientific users by organizing participation at future IGS workshops (such as a dedicated special session) and considering scientific diversity in nominations for IGS governance.

Recommendation 2:

- that IGS exploit showcase examples of IGS scientific users to demonstrate the value of IGS to science as a means for improving relationships with users, their funding agencies, and IGS sponsors.

Recommendation 3:

- Step 1: that IGS begin to document which scientific disciplines are using IGS products (and which products, with explanations as necessary);
- Step 2: that IGS work with scientists in the above documented list to develop a table the links each scientific discipline/investigation with IGS product specifications and/or IGS standards, accounting for both current requirements, and desired future requirements. For example:
 - required precision of specific IGS products;
 - level of biases in IGS products/data;
 - types of IGS products (which may need to be expanded or augmented);
 - metadata; and
 - station requirements for special applications, such as GNSS-Multiple Reflections for sea level monitoring.



IGS 2017 Workshop Recommendation: Real Time Working Group

Discussion Highlights:

- Evaluation of the Sydney workshop objectives
- Network transition into receiver generated multi GNSS real time network using RTCM standardized streams
- New mount point naming proposal adopted and implementation plan discuss

Key Issues:

- Standardization of the multi constellation product streams

Emerging Ideas:

- Create new real time ionospheric combination product

Major Accomplishments since the Sydney workshop:

- Establishment of new real time data centers (UCAR Data Center, Geoscience Australia, Shanghai Astronomical Observatory)
- Generation of validated ephemeris streams
- High availability of IGS RT Service with no outages



IGS 2017 Workshop Recommendation: Real Time Working Group

Recommendations

- Implementation of long RINEX3 file name based mount point naming across all IGS casters
- Raise the level of IT security at IGS Real Time Casters
- Implement quality control of source tables
- Encourage IGS members to implement proposed SSR corrections messages for interoperability testing
- Encourage real time station operators to switch to multi-GNSS tracking
- Start disseminating a real time ionospheric combination product



IGS 2017 Workshop Recommendation: Troposphere Working Group

Discussion Highlights:

- Repro2 processing: poor pre-2010 Repro2 combination clocks create a processing problem for the troposphere estimates
- Tropo comparison website is close to being live. Jan Dousa gave a demo and the group seemed excited to try the interactive website
- Tropo SINEX 2.00 presented by Rosa Pacione and group provided feedback on some ambiguous areas that should be clarified.

Key Issues:

- Repro2 processing
- Tropo comparison website
- Tropo SINEX 2.00

Emerging Ideas:

- Repro2 processing: possible solutions outside of using combination clocks as is with a warning were discussed.
- Tropo comparison website
- Tropo SINEX 2.00 is a simple and flexible design following the philosophy of the SINEX format with regards to metadata description and overall data structure



IGS 2017 Workshop Recommendation: Troposphere Working Group

Major Accomplishments since the Sydney workshop:

- Near completion of the Troposphere comparison database and interactive website hosted on the TWG IGS subdomain

Recommendations:

- **Repro2 processing:** Process test estimates for a short timespan for a couple of processing methods that do not use the Repro2 clocks to compare with the estimates using the Repro2 clocks as a measure of quality. Stations chosen for test estimation should be EPN stations for ease of comparison with EPN reprocessed estimates. TWG will provide feedback and determine best path forward





IGS 2017 Workshop Recommendation: Multi-GNSS Working Group

Key Issues:

- Lack of robotic ground antenna calibrations for new signals and frequencies
- Lack of quality controlled multi-GNSS broadcast ephemeris product and merged multi-GNSS precise products as a basis for IGMA constellation performance monitoring
- Lack of support of IRNSS and BeiDou-3 tracking in IGS network

Major Accomplishments since the Sydney workshop:

- Integration of multi-GNSS stations into the core IGS network and completion of the RINEX3 transition plan
- Incorporation of new solar radiation pressure models yielding improved accuracy and consistency of MGEX orbit and clock products.



IGS 2017 Workshop Recommendation: Multi-GNSS Working Group

Recommendations

- Adopt and implement new SINEX satellite metadata format
- Explore attitude exchange format and conduct test campaign with selected ACs
- Update ANTEX model with full set of (satellite- and frequency-specific) PCOs and PVs of Galileo IOV as published by the EU
- Establish a quality controlled broadcast ephemeris product
- Promote robot calibration of receiver antennas for new constellations and signals
- Promote revision of ANTEX format for improved transmit antenna handling and support of group delays
- *No splinter meetings in parallel to free beer*





IGS 2017 Workshop Recommendation: Multi-GNSS Working Group

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IGS 2017 Workshop Recommendation: Infrastructure Committee



Discussion Highlights:

- *Agreed to leave NavBits data storage efforts to support Radio Occultation missions, the effort to accommodate these data will be abandoned now but it may return from the IGMA group as the Monitoring will likely need the binary bits as transmitted by the spacecraft, but in that case the IGMA/MGEX will need to consolidate a format, contents, naming, frequency and cadence for evaluation by the Infrastructure elements to see how the IGS could support it.*
- *Agreed to investigate how we can extend the station position to ALL IGS network stations, plus to investigate and produce a set of recommendations on what to do with parallel station data when installed during an antenna update exercise.*
- *Discussed the existing site guideline to test new equipment in parallel to existing equipment when performing an upgrade, maybe that data should be stored and used to derive the antenna offset between antenna models. It was agreed to review this and maybe an IGS process could be instituted so the data is processed.*
- *The issue of IGS AC station usage was discussed since sometimes stations have been used by IGS ACs very sporadically leading to bad coordinate estimations and poor integration into the ITRF, but it is not easy to control the station selection algorithms of the ACs so this is a problem with difficult solution. Additionally it was discussed that stations with no known station logs should not continue to be included in the IGS weekly SINEX files ... currently the RF WG excludes stations without valid DOMES numbers from the combined IGS solution they will investigate whether to extend this forced exclusion to stations without site logs.*

Key Issues:

- *Station feedback through the IGS website,*
- *Stations without site logs in the IGS SINEX files*
- *Stations without IGS SINEX solutions but with very good data availability*
- *Supporting new long station name 4 to 9 characters increasingly supported in product formats (clocks, tropo, SINEX)*

Emerging Ideas:

- *Consider what to do with parallel data files for new equipment under test before a station upgrade.*



IGS 2017 Workshop Recommendation: Infrastructure Committee



IGS

Major Accomplishments since the Sydney workshop:

- Added 31 stations to the Network,
- removed 16 long-standing absent stations from the network,
- implemented combined RINEX 3 multi-GNSS mixed navigation file at CDDIS: **BRDC00IGS** files
- created **RX3name** binary command tool to generate long filenames from short filenames
- Achieved 100% RINEX 3 longname for RINEX 3 capable stations (at CDDIS)

Recommendations:

Timeline for all : IGS Workshop 2018

- To implement a **Station product participation table** for the IGS station webpage to show each station inclusion in the different IGS products
- To create a way forward to provide at least weekly **positions for ALL IGS network stations**, rather than just having the stations that Final ACs have selected
- To investigate and create a plan of what to do with **parallel station installation data** when upgrading antennas; whether to use the data to estimate the “antenna change” offsets, where to store
- To support the Antenna WG in the new test activity to **check available individual antenna calibrations** in the existing IGS stations
- To request **NSWE pictures from station antennas**
- To request **antenna’s ground plane distance to the ground** (local height) (< 10cm accuracy)



IGS 2017 Workshop Recommendation:

Reference Frame and Analysis Working Groups



Emerging Ideas:

- The most difficult part of the implementation of combining different constellations will be in the clock combination. We will be dependent upon the bias SINEX file before we can implement ACC 3.0.
- Sub-daily EOPs will be addressed at the UAW

Major Accomplishments since the Sydney workshop:

- Adoption of the IGS14/igs14.atx framework

Recommendations:

- Include the Wuhan rapid products as a fully weighted solution.
- Include the GFZ TIGA solution with the missing IGS stations into the Reference Frame IGS combination.
- Propose the extension of SINEX to allow for a 9 character Station/Marker name
- Investigate the extension of statistical reporting for the final products, and the underlying model used to compute the 7-day arcs, and orbital overlaps.
- Tabulation of antenna transmit power values in SINEX file for testing purposes.
- Set-up a location for testing the implementation of models between different ACs and encourage model developers to test data and parameter sets. ★

IGS 2017 Workshop Recommendation: Antenna Working Group



IGS

Key Issues:

- Include disclosed PCO/PCV patterns of the IOV satellites into the IGS ANTEX file (and same for FOC after testing their consistency)
- Considering information on group phase variation for an intermediate update of the current ANTEX V1.4 (to V1.5)

Recommendations:

- Promote to study the impact of individual calibrated antennas on IGS analysis products. Station managers as well as ACs are encouraged to participate by either contributing individual calibrated receiver patterns or by analyzing the data made available. The AC's shall coordinate their efforts and define the methodology for the analysis.
- Consider in-situ calibrations techniques
- Recommend the comparison of antenna calibrations between the calibrations centers
- Proposal for an “experimental” ANTEX file containing non-standard IGS patterns
- Include disclosed PCO/PCV patterns of the IOV satellites into the IGS ANTEX file (and same for FOC after testing their consistency)
- Considering information on group phase variation for an intermediate update of the current ANTEX V1.4 (to V1.5) (by the end of September 2017)
- Considering a major update of the ANTEX format in conjunction with the MGEX satellite meta data developments (ANTEX V2.0)



IGS 2017 Workshop Recommendation: Orbit Modelling Working Group



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Discussion Highlights:

- Draconitic Period artefacts in GPS; Strategy for Repro3;
- Acquisition of satellite structure/materials/phase centre;
- Scientific topics (mass history/centre of mass, aging of optical/thermal properties, star cameras/accelerometers)

Key Issues:

- Draconitic artefacts aliasing into geophysical interpretation of signals;
- planning for Repro3 in advance of ITRF2020

Emerging Ideas:

- successful development and application of *a priori* satellite models with improved precision

Major Accomplishments since the Sydney workshop:

- diverse testing of radiation pressure modelling methods;
- ground based measurement of antenna power for antenna thrust;
- improved orbital precision;
- insight into GPS Block IIF behaviours

Recommendations:

- Draconitic effects in network solutions are significant and the problem needs to be solved. These effects appear similar in all AC solutions. We need to put thought into the origins of this problem
- ACs should start considering and discussing their strategies for Repro3 leading into ITRF2020 ★

IGS 2017 Workshop Recommendation: Communications Interest Session



IGS

Recommendations

- Work with AMs as organizational representative liaison to their organization's communication team for collaborative content creation
- Develop resource pool for multiple levels of communications and education materials
- Engage university geodesy programs to develop lesson plans that familiarize students with accessing and using IGS data and products
- Consider formation of a formal Communications and Education interest group

