IDS AWG

Meeting minutes

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Distribution:

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1. Introduction

The last International DORIS Service Analysis Working Group (IDS-AWG) was hosted in CNES on June 11 2018 thanks to our guests Pascale Ferrage and Alexandre Couhert.
The main objectives of this meeting were:

- DORIS mission and system news and DORIS Network Status
- ACs and CC status and schedule
- Status of the IDC ACs associated
- Develop a model for DORIS USO thanks to GNSS measurements
- To discuss about the contribution of the DORIS scale factor and Geocenter to the realization of the ITRF
- To discuss about DORIS Systematic errors and Biases
- Adopt and evaluate the new standards/models recommended by IERS

First, an abstract with the main conclusions of each oral presentation is given. In the following part, we discuss on DORIS systematic errors and biases, on the implementation of DORIS RINEX processing (which is a crucial topic to take into account the DORIS data of the last satellites Jason-3, Sentinel-3A and Sentinel-3B) and on the new standards/models recommended by IERS for the next ITRF. Finally, we give the list of actions in progress and new actions from this meeting discussion.
All the slides displayed during this meeting are available at:
https://ids-doris.org/ids/reports-mails/meeting-presentations.html#ids-awg-06-2018

2. Oral presentations abstracts

2.1. DORIS mission and system news (P. Ferrage)

Currently 7 satellites contribute to IDS. S3B launched in April 25th flies in tandem with S3A since June 6th. Its data (RINEX and orbits) will be delivered very soon since the beginning. Many futures missions are planned (7 to 10). 2 new batches of STAREC antennas (type D) will be deployed from 2019. These antennas have new center of phase positions and new phase law. The 4th generation of beacons (B4G) schedule is on time, tests are in progress with the prototype installed at CLS Toulouse. B4G beacons will be deployed from mid-2019. About on-board DORIS receivers, several actions are in progress to reduce the SAA impacts on positioning: 1) future models of SAA correction will be derived from USO Radiation frequency characterization; 2) Coupled GNSS&DORIS onboard S3 and JCS series, allow to have real time observation of the USO frequency; 3) R&T study to reduce USO radiation sensitivity & better characterization, 4) ongoing R&T feasibility study for a small receiver using both DORIS and GNSS signals.

2.2. DORIS Network Status (J. Saunier)

The current permanent network has 60 stations. Grasse (first devoted to the T2L2 experiment on Jason2) is now part of the permanent network. The main concerns are: the persistent coverage gap in the eastern part of Pacific and the deactivation of the Russian DORIS stations for indefinite period just after the frequency clearance expiration last February. Notwithstanding these difficulties, the network maintains a good availability rate: 90% annual mean of operating stations in 2017. IDS has two dedicated stations for scientific purposes: at Wettzell (DEU) fundamental geodetic observatory since Sept. 2016 and at Mangilao (Guam Islands, USA) commissioned in April 2018. The main network events of the past year are: restarting of the station at Cibinong a year after being out of active service and relocation of the station at Rothera (Antarctica) last February following site refurbishment. In 2018, a new site in San Juan (Argentina) and the relocation at Ny-Alesund (Svalbard, Norway) are planned. Several ongoing projects will continue at Easter Island (Chile), Katherine (Australia), Changchun (China), Reykjavik (Iceland) and Papenoo (French Polynesia). With respect to the equipment, the deployment of the 4th generation beacon currently under development should start from mid 2019 and the deployment of the improved DORIS ground antenna "Starec C" (with phase center position controlled to +/- 1mm) is under way: 13 stations are now equipped. Finally, following successive DORIS/VLBI RF compatibility tests at Greenbelt (2014), Wettzell (2015-2016) and Papenoo (2017), installation specifications were set based on the test findings.

2.3. **Examples of recurrent performance analysis of DORIS stations (P. Yaya)**

In order to improve the DORIS network robustness, CLS has been regularly investigating since 2005 on station performances in terms of DORIS signal characteristics. Such studies are useful after a station renovation, a new site installation or when a particular problem is raised on the measurements. These studies are presented during the Groupe Performances DORIS at CNES. Both signal phase and amplitude are analyzed, respectively through the residuals of the CNES POD and the on-board received power. Maps and time series are established for a minimum data length (at least 1 month) and compared to environmental information given by the Institut Géographique National such as aerial view, obstruction views or photographies taken onsite. The present work summarizes the results for the last three stations analyzed: Wettzell, Managua and Kitab. Wettzell is an interesting site for colocation of geodetic techniques. In order to avoid any radio-frequency (RF) perturbations between DORIS et VLBI, a successful test including an RF barrier has been undertaken and led to the installation of a permanent DORIS station in 2016. Managua is another example of a successful installation, on the unvisited Carribean tectonic plate. Despite the presence of limited degradation due to ionospheric scintillations, the POE performance of the station is quite good. As for the Kitab station, it was affected by obstructions due to the vegetation around the antenna. It was moved in 2016 on a cleared site (no mask above 15°), dramatically improving the station POD ranking (from 55th in 2015 to 17th in 2016).

2.4. **IDS news (L. Soudarin)**

The Central Bureau reports the latest news concerning the IDS.

Data

Dissemination of Sentinel-3B files will start soon. DORIS raw data and precise orbit files will be available at the Data Centers. History files of the mass and center of mass, maneuvers and attitude will be stored on the IDS ftp server with the update version of the satellite models description. CNES has defined new GDR-F orbit standards (new parametrization, measurement and dynamic models) that will be applied in 2018 to Sentinel-3B, Sentinel-3A, and Jason-3. The corresponding version for the sp3 files delivered by CNES (ssa) will be version 11. We remind that DORIS/RINEX files are delivered with a latency of 1 day (instead of 3 days previously), and have been since January 2017. The corresponding version is 001. During Jason-2's Safe Hold Mode periods, DORIS/RINEX data and solar panel/attitude quaternions files are delivered but not DORIS1B data and the DORIS orbits are

Products

Version #2 for the DPOD2014 and the cumulative solution were provided by the Combination Center in October 2017.

IDS workshop 2018

The next IDS workshop will be held in Ponta Delgada (Azores Archipelago), Portugal, on September 24 and 25. It will be followed by a meeting of the Governing Board on Wednesday 26, in the morning. The other events of the week are the "25 Years of Progress in Radar Altimetry" Symposium (September 24-26) and the OSTST meeting (September 27-28). Logistical details are available on the meeting website at www.altimetry2018.org

Elections

2 positions will be renewed within the Governing Board for 2019-2022:

- Analysis coordinator (currently a tandem: Hugues Capdeville & Jean-Michel Lemoine)
- Member-at-large (currently Marek Ziebart)

The elections will be announced in July. The call for nomination will be open from July to September. The IDS Associates will be invited to vote in October. The two new elected members will start their 4-year terms in January 2019. Interested persons may contact Hugues, Jean-Michel, and Marek.

IDS Annual report 2017

The report is almost ready. All contributions received before the end of April! The Central Bureau thanks all the contributors to the activity report 2017. https://ids-doris.org/documents/report/IDS_Report_2017.pdf

Newsletter

IDS Newsletter #4 was issued in November 2017. The next issue is in preparation and scheduled for this summer. Contributed articles, pictures, cartoons, and feedback are welcome at any time.

Webservice (https://ids-doris.org/webservice)

The network viewer has been upgraded with new features: plate boundaries from Bird, 2003; horizontal velocity vectors from the DPOD2014 solution; Earthquakes with a magnitude >= 6 around the DORIS stations (<500 kms). A new plottool has been created for displaying the position residuals derived from the analysis of the cumulated solution by the Combination Center.

Website (https://ids-doris.org).
A complete review of the document "IDS data structure and formats" is now available as a pdf file that can be easily viewed online and downloaded. https://ids-doris.org/ids/data-products/data-structure-and-formats.html
All the station photos available on the station pages have been gathered in the gallery in two new sections (DORIS equipment, obstruction views).

2.5. ACs and CC Status

GOP (By P. Stepanek)

The presentation summarizes the recent GOP Analyses center activities. Besides the routine data processing we focus on the RINEX data processing implementation, length of the day (LOD) estimation, Scale consistency in DORIS time series and on systematic effects in the estimated pole coordinates time series. For the LOD estimation experiment, we processed the campaign 2006.0 – 2015.0. The overall accuracy statistics (IERS C04 model used as a reference) reached weighted Mean -31 μs, WRMS 153 μs, formal error 49 μs. The weighted Mean is not stable during the time, depending on the satellite constellation and possibly also on the solar activity cycle. The time series of differences between the estimated LOD and IERS C04 model show a dominating annual signal (sun-synchronized satellites), draconitic signal related to the individual non sun-synchronous satellites and short periodic 14.2 days signal. In another experiment, we tried to detect the source of the systematic effects in the estimated pole coordinates series. The pole coordinates accuracy was improved including the cross-track harmonics in the orbital model (with constraints 5×10-9). In 2016 solutions, the Ypole mean was reduced from 224 μas to 89 μas and Xpole RMS from 648 μas to 418 μas.

GSC (By F. Lemoine)

Frank Lemoine presented a summary of DORIS activities at NASA GSFC. He discussed the development of a new version of GEODYN that will be used for space geodesy analysis (Version 1802). It includes numerous changes, both in the internal models and specific to the different geodetic techniques such as (1) corrections to Earth tide modeling and tidal EOP modeling; (2) Changes in how the implementation of how range-rate and troposphere biases are computed to make the estimation more rigorous; (3) Implementation of the ability to model the IERS2014 mean pole; (4) Changes to accommodate the ability to estimate phase maps for SLR and DORIS data; (5) changes and upgrades to allow for processing of VLBI data (tested with data from CONT14); (6) Changes to GPS processing to allow use of the software for operational GPS POD on ICESAT-2 (scheduled for launch in September 2018). The regular SINEX activities continue for the time being, though the GSC AC is facing funding and manpower limitations that at present have an uncertain outcome for operational deliveries. We have a new postdoc that is employed under NASA auspices, Alexandre Belli. The focus of his work is reduction of systematic errors in SLR and DORIS data. He is working on a presentation for the COSPAR/REFAG meeting in Pasadena (July 2018) on testing improved models of Jason-2 USO using RINEX data. In terms of the status of RINEX processing, we have fully validated the processing for Jason-2 and Jason-3, but need to wire this in in an operational sense for the other satellites.

ESA (By M. Otten)

NAPEOS up to date with the latest standards no major issues foreseen with model implementation for next ITRF iteration. First version of DORIS RINEX converter implemented in NAPEOS. Initial results look good (based on comparison against Jason-2) but some question remain about the correct clock modeling. First IDS results within the next month (single satellite solution using Cryosat-2). Before IDS symposium in September ESOC IDS solution will be routinely available again. Partial reprocessing foreseen (covering the DORIS RINEX period).

GRG (By H. Capdeville)

For the last delivery to IDS CC, GRG AC processed DORIS data from the beginning of the Jason-2 mission (July 2008) until end of Dec. 2017. We built a new serie called grgwd41 with some new additions:

- Introduction of Jason-3 and Sentinel-3A (RINEX data) in the GRG DORIS processing
- Strategy to mitigate the SAA impact for Jason-2 and Jason-3
- Remove the DORIS scale jump in 2012

First, a Status of POD for Sentinel-3A and Jason-3 satellites was given. We compared our orbits to the CNES (GDR-E) and ESOC precise orbits. The independent SLR RMS of fit on Jason-3 and Sentinel-3A orbits were at a good level, comparable to the other orbits evaluated (CNES-GDR-E and ESOC). The DORIS-only Jason-3 orbit differences with CNES GDR-E showed a good agreement between the orbits calculated with GINS and ZOOM (GDR-E). For Sentinel-3A, the agreement was better and the comparison to ESOC orbit gave better results except for cross-track component.
In the new serie we applied a strategy to mitigate the SAA effect. When we applied this strategy of adjusting a frequency polynomial per pass for SAA stations the DORIS residuals are lower. The impact is clearly significant for SAA stations and the number of measurements participating to the processing is higher. We applied also a strategy to add single satellite solution affected by the SAA in the multi-satellite solution (strategy used for Jason-1 in ITRF2014). The strategy gave an improvement in the station position estimation for the SAA stations, especially for the vertical component. Note that the IDS solution provided for the ITRF2014 was worsened by the Jason-2 solution for the SAA stations. When we used the new position of the HY-2A CoM given by the Chinese Project, the HY2A scale was significantly reduced. The increase of the scale factor in 2012 for Jason-2 and Cryosat-2 was due to the change of tropospheric model used by CNES in its POD processing (GDR standards). When we did our own pre-processing when using all doris2.2 data, the scale jump was removed. Since September 2017 we provided Sentinel3-A DORIS-only orbits to Copernicus POD Service. Some results from GMV showed that the quality of Sentinel-3A DORIS-only was at the same level than GPS-only orbits, in particular in radial direction. We plan to use quaternions for the s/c body and solar array for Jason-2 and Jason-3 and to introduce Sentinel-3B in the GRG processing chain.

Status of the IDS Combination Center activities (By G. Moreaux)
The presentation begins by the status of al the IDS ACs and CC series available at the IDS Data Centers as well by the overall performances of the series from 2016.0 to 2018.0 in terms of scale and geocenter with respect to the ITRF2014 and EOPs with respect to the IERS C04 series. Then, we focus on the latest GRG and GSC series and show that the major updates on these series (implementation of SAA mitigation strategy for Jason-2, Jason-3 and new CoM-CoP value for HY-2A) reduce the multi-satellite solution scale offsets wrt ITRF2014.

2.6. Status of the IDS data processing at DGFI-TUM (S. Rudenko, M. Bloßfeld, F. Lemoine)

Sergei Rudenko presented the current status of the IDS data processing at DGFI-TUM. In particular, the structure of DGFI Orbit and Geodetic parameter estimation Software (DOGS) and the recent improvements in Jason-2 modelling at DGFI-TUM, such as updates in the Jason-2 macromodel and some other, were presented. An importance of using true (instead of nominal) satellite attitude has been shown exemplary for Jason-1. The challenges in attitude data handling and interpolation for Jason-1 and Jason-2 were discussed and the impact of using refined satellite attitude handling on RMS and mean fits of SLR observations was illustrated for Jason-2. A short review of the DORIS-related models implemented in DOGS was done. Some results of processing SLR and DORIS data of Jason-2 using DOGS were presented, and an outlook of the DORIS-related models to be implemented in DOGS and problems to be solved was given.

2.7. Development of stochastic models for DORIS simulations in GGOS-SIM (A. Reinhold, R. Koenig)

Aside of GGOS-SIM, a German project aiming at simulating all space-geodetic techniques for the generation of global Terrestrial Reference Frames (TRFs) in view of the objectives of the Global Geodetic Observing System (GGOS), we evaluate real Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS) observations from the satellites JASON-1, JASON-2, and ENVISAT for the period 2008 to 2014. These missions are part of the ensemble of missions that was used for the contribution of the International DORIS Service (IDS) of the International Association of Geodesy (IAG) to the recent International TRF, the ITRF2014. Precise Orbit Determination (POD) is used to generate conditions for simulations close to reality and to develop a stochastic model for simulation. The resulting characteristics of the observations in space and time are evaluated and presented. In the end a stochastic model of elevation dependent weighting can be obtained, that is different for the ENVISAT and JASON satellites, but general for all stations.

2.8. **Copernicus POD Service - Sentinel-3A orbit determination based on DORIS observations (H. Peter)**

The Sentinel-3 orbit products from the Copernicus POD Service are all based on the GPS observations only, SLR is used for validation, and DORIS observations are not yet used. In order to have the capability of using all three observation techniques within the Copernicus POD Service effort has been taken to also initiate the DORIS processing for Sentinel-3A. The first step has been to implement the conversion of the phase observations from the DORIS RINEX observation files to Doppler observations as they were used from the DORIS v2.2 observation files. Based on these Doppler observations DORIS-only orbits as well as combined DORIS+GPS and DORIS+SLR orbits are generated. Different arc lengths and orbit parametrizations are analyzed to find the optimal settings. Comparisons to DORIS orbits from CNES and CLS already show a good performance and quality of the CPOD DORIS orbits being not yet on exactly the same level though. Further investigations are needed to improve the DORIS orbits:

- check again the conversion of the DORIS phase observables to Doppler

- find the best settings for the observations (elevation cut-off, elevation-dependent weighting, a priori sigma, relative weighting to GPS)

One goal is to have DORIS-only and combined S-3 orbit solutions available for a proper internal CPOD comparison of the three observation techniques.

2.9. **Pre-GRACE era recovery of time-varying DORIS-based mass concentration parameters for TOPEX/Poseidon precise orbit determination (J. Moyard)**

Local mass anomalies, i.e. mascons, are used to complement to the GRACE-derived time-varying gravity field models used in the standard POD solutions. Relying on multi-missions DORIS measurements, both long-term and seasonal variations are investigated to improve the performance of the reprocessed TOPEX/Poseidon (T/P) precise orbits. The orbit determination process was based on the POE-E standards with a static gravity field. In this study, the adjusted mascons improve slightly the TOPEX orbit performance. Sub millimetric improvements in global SLR RMS and mean improvement of 4.75mm^2 on crossover variances are obtained.

2.10. **A model for DORIS USO in the SAA (E. Jalabert)**

The processing of the DORIS measurements relies on a precise model of the on board Ultra Stable Oscillator (USO) frequency. Unfortunately, the important radiations in the South Atlantic Anomaly (SAA) perturb the USO behavior and produce localized in time (~20 minutes) peaks in the frequency when the satellite flies through it. These peaks are not modelled in standard DORIS processing, as the DORIS USO model is a third degree polynomial computed over 7 to 10 days. Therefore, DORIS measurements are not correctly processed when the satellite passes through SAA, and this can degrade significantly the orbits and station positioning (as on Jason 1). Satellites are not impacted the same way by the SAA. It depends on the altitude and on the oscillator hardware. On Sentinel3A, the GPS and DORIS receiver use the same USO. It is therefore possible to estimate independently the frequency of the USO using GNSS measurements. From the observation of this frequency anomaly, we constructed a model which can be used independently in the DORIS processing, by adjusting parameters related to the USO sensitivity to SAA. This model improves Sentinel3A and Jason3 residuals. The presentation will show how the model has been constructed, and the effects on DORIS phase residuals and station positioning. The results on Jason3 could probably be improved. The main issue is to properly place the SAA impacted area.

2.11. **Analyze of the DORIS scale factor and geocenter from single satellite solutions (H. Capdeville)**

The DORIS scale factor and geocenter is the combination of each single DORIS satellite solutions. We proposed to analyze the scale factor and geocenter of these single satellite solutions in order to improve the combined solution. Indeed, previous studies showed that single satellite solutions can have some large scale or geocenter values, such as the HY-2A scale. We have already identified a high value for Tz translation for several satellites (Envisat, HY-2A and Sentinel-3A). The objective of this study was to analyze each single satellite solutions in terms of scale and

geocenter, to understand and resolve the potential problem. Our solution and one older result from IDS CC giving several ACs solutions (GOP, GSC, INA) observed a bias for the SPOT-4 translation Tz (5 cm). As shown by our result and one older result from IDS CC with the GSC solution, the SPOT-5-only scale clearly showed sawtooth pattern with breaks. The discontinuities are of the order of -20 mm. Although no obvious cause has been found, efforts to understand these variations should continue, in particular to understand if something intrinsic to the SPOT-5 DORIS USO might be the cause. For Envisat, we identified a high bias in Tz translation (~ -10 cm) also showed by previous results from IDS CC. For Sentinel-3A we observed a high bias in Tz translation (~ 6 cm). Note also that The Tz translation for satellite with 2 solar panels (one on each side) is not impacted. Tz translation bias could be related to a wrong position in the cross-track direction for DORIS receiver phase center (CoP) or for Center of gravity (CoG). Then, we have estimated the distance between the satellite CoG and DORIS CoP, first for Envisat and Sentinel-3A. We found a cross-track offsets of 2.5 cm for Envisat and 2 cm for Sentinel-3A. After that, we looked at the impact of the use of the DORIS CoP value estimated. When we took into account the new position of DORIS phase center, we did not see significantly impact on the orbit. However, when we used the CoP estimated, the Tz bias vanished and the solution was more consistent with the ITRF-DPOD2014. Same analysis should be done for the others DORIS satellites. Others ACs and associated ACs could estimate the distance between the satellite CoG and DORIS CoP and provide theirs values to Analysis Coordinators.

2.12. **Consistent DORIS scale series 2011.0-2017.0 (P. Stepanek)**

We analyzed the scale of the DORIS solutions w.r.t. DPOD (ITRF) 2014 (version 1) with the main goal to explain the scale inconsistencies and to find the optimal solution reaching low-biased and consistent scale time series. Our analysis profited from 4 different strategies based only on GOP Analysis center solution, using DORIS Doppler exchange format data 2.2. A difference in the sequence of the solutions directly corresponded to one of the changes in the solution settings: data elevation dependent weighting (sin2 E), application of data validity indicators and application of phase center - reference point correction. We processed multi-satellite and single-satellite solutions for time period 2011.0 - 2017.0. Our analysis examined scale inconsistency issues in 2011/2012 and in 2015. 2011/2012 scale increment is explained as a result of the concurrence of changes in satellite constellation and change in the provider data validity standards for Cryosat-2 and Jason-2. The scale increment in 2015 is explained as the effect of change in the standards for phase center - reference center corrections. Moreover, comparing the solutions with and without elevation dependent data downweighting using the same elevation cut off (10 degrees), we found a significant reduction of scale bias and scale variation applying data downweighting. We demonstrated that the solution, which is completely free from the additional data associated with observations and applies the data downweighting law, eventuates in a consistent scale time series with the lowest offset w.r.t. DPOD 2014 (12.7±2.3 mm for 2011.0- 2017.0).

2.13. **DPOD2014 version3.0 (G. Moreaux)**

The presentation is devoted to the introduction to the latest preliminary version of the DPOD2014 which has been just made available to the IDS POD validation group for external validation. After presenting the new DORIS stations included in that version, the IDS CC shows the results of the internal validation process which include comparison of mean positions and velocities with both the ITRF2014 and the DPOD2014 version 2.0. The IDS CC also shows the performances in terms of DORIS-to-DORIS and DORIS-to-GNSS tie vector residuals.

2.14. **How DORIS observations can independently contribute to the realization of the ITRF origin (A. Couhert)**

This paper focuses on the geocenter motion observation and draws the perspective of using DORIS data to contribute to the realization of the ITRF origin. The processes responsible for the corruption of the current IDS DORIS-based geocenter estimates are analyzed and mitigated, to provide reliable independently derived geocenter coordinates, using DORIS observations from the OSTM/Jason-2 satellite. The analysis presented here reveals that DORIS and SLR geocenter solutions (from Jason-2 or LAGEOS) are sensitive to station heights modeling errors, making their estimation necessary (as well as station biases for SLR). Unfortunately, for LAGEOS-only solutions, the contribution of the Yarkovsky-Schach perturbation is not negligible (estimated of 2-3 mm for the Z coordinate). Thus, even with less observability per pass for the DORIS technique, its large and homogeneous network should allow a better realization for the center-of-figure (CF).

2.15. **ITRF: seasonal station motions and geocenter motion (Z. Altamimi)**

Z. Altamimi works on seasonal signals. The objectives are:

- Evaluate and understand technique differences at co-location sites
- Concentrate on annual & semi-annual signals
- Combine them at co-location sites
- Provide them in a coherent Reference Frame (CM or CF/CN)
- Provide a coherent annual geocenter motion model compatible with ITRF2014

He focusses on DORIS results.

Here the conclusion:

- DORIS Geocenter motion is not reliable, except maybe in the Y component.
- GNSS draconitic signals must be estimated.
- The amplitude variations of Annual Geocenter motion from SLR (in mm):

  Gx: 0.9 – 2.2 (±1.3) / Gy: 3.0 – 3.8 (±0.8) / Gz: 1.6 – 3.0 (±1.4)

- Level of agreement at co-location sites still to be carefully investigated.

3. Discussions

3.1. **DORIS systematic errors and biases**

Attempt to mitigate the non-conservative force model error on Jason series (draconitic signal at 117 days)
Recommendation: Inter-comparison of the 2 or 3 time series of quaternions and solar panel angles available among the groups who have pre-processed them (CNES, GFZ, GSFC). When the inter-comparison is satisfactory, then a homogeneous time series will be made available to all analysis centers.

Mitigate the SAA effect on DORIS USOs
Some IDS recommendations have been made recently and will be made at the same time as IERS recommendations by using SAA models or corrected data when they are available (Jason-1 and SPOT-5) and by applying SAA mitigation strategy. No consensus on this point has be found. Some studies are still on-going. A document which will consider the different possibilities could be written by the analysis coordinators.
Note that it would be interesting that CNES POD team provides to all analysis centers the estimate of the on-board frequency variations of Sentinel-3A that they have obtained through the connection between DORIS USO and the GNSS receiver.

DORIS scale factor

- Reduce HY-2A scale factor by using the last spacecraft CoM position

Everybody will use the latest official HY-2A CoM coordinates available through the IDS.

- Remove the scale jump in 2012 by making their own preprocessing when using DORIS2.2 data

It is agreed that each analysis center does its data editing with its own standards.

- Tropospheric point

It is also agreed NOT to define a common cut-off angle, a common data down-weighting law at low elevation or a common mapping function of the tropospheric correction. A working group could analyze the impact of the cutoff angle/ data down-weighting law at low elevation / mapping function of the tropospheric correction on the scale factor and vertical positioning.

- Resolve the scale sawtooth pattern of SPOT-5

Not yet understood, no connection detected with any recorded event on the satellite.

3.2. **Implement RINEX DORIS processing**

(Crucial topic to take into account the DORIS data of the last satellites Jason-3, Sentinel-3A and Sentinel-3B)

This is currently the major and most urgent issue for DORIS processing. In order to speed up the process and to help the analysis centers in their implementation, two recommendations have been issued:

- Considering the difficulties of the different ACs to implement the RINEX format and the fact that the three analysis centers which have satisfactorily implemented it (CNES POD team, GSFC, GRG) have chosen to process it as a Doppler measurement (i.e. a difference of phase measurements between epochs), it is recommended to use this method in a first step and not to try to implement the DORIS RINEX format strictly as a phase measurement (similarly to what GNSS does). The reason for that is the need to use an (unavailable at the moment) refined clock model for the DORIS clocks since it is impossible, by opposition to GNSS, to compute a clock offset at each epoch because of the lack of redundancy of the DORIS measurements compared to the GNSS measurements.
- It has been asked to the analysis centers who have successfully implemented the RINEX measurement (for instance GRG, CNES POD team, GSFC) to help the other analysis centers by
  1) Creating a "cook-book" explaining step by step the implementation process. This cook-book ought to be easier to use than the published articles on this topic. It is recommended in particular to explain clearly which data fields in the RINEX files have to be used as they are, and which ones need to be discarded or filtered before use.
  2) Providing to the IDS ACs for reference a set of the different data corrections (i.e. iono, tropo, CoM/CoP, etc.) computed for 2 satellites over one week: Cryosat-2 and Jason-2.

3.3. **Implement any new phase law for ground antenna**

For past antenna all ACs have implemented the phase laws (STAREC, ALCATEL). For the future type D antennas, a new phase law should be implemented when it will be available at the IDS.

3.4. **Adopt and evaluate the new standards/models recommended by IERS**

- Implement linear mean pole model for the next ITRF reprocessing
  (NB not until reprocessing has started, otherwise a velocity discontinuity will be introduced into the time series).

Recommendation: implement the linear mean pole model from the new IERS standards, BUT clearly distinguish the times series computed with this new standard from the ones computed with the old standards.

Jean-Michel Lemoine's remark: the gravity field used in that case (in particular the C(2,1)/S(2,1) time series) need to be compatible with the new standards, otherwise there will be an inconsistency between the gravity field and the pole tide.

- Develop and implement diurnal-subdiurnal tidal EOP models based on Desai-Sibois (2016) approach -- model fits to geodetic data will only redistribute technique systematic errors.

It is not yet implemented and tested.

- Adopt post EGM2008 static gravity field based on ~all GRACE & GOCE data. Highest-fidelity time-variable gravity (TVG) model (degrees >1) using GRACE + SLR + geophysical fluid models for full space geodetic era, consistent with GRACE + GOCE standards

Generally, the IDS ACs uses the last TVG models available. To be used with corresponding dealiasing models (atmosphere and ocean).

- Find cause of 13.63/13.66 d signal in time series & fix tide model responsible.

It is recommended to use FES2014. Some tests have to be conducted.

IERS Conventions updates to document all the above.

3.5. **IDS position for the next ITRF**

When all the new standards/models will be validated, it will take at least 6-8 months for ACs to reprocess the full history of DORIS observations. From the IDS Combination Center point view, to do the evaluation and to elaborate the combination will take between 9 to 12 months. So, for these reasons the IDS has proposed an ITRF2020. The reprocessing could start in the second half of 2019.

4. Actions review

Analysis coordinators propose to do orbit comparison between all ACs. They need to have orbits in sp3 format (terrestrial frame, TAI scale). Then, on voluntary basis and for test purpose (maybe not on regular basis), ACs and associated may deliver their sp3 orbit to the CDDIS/IGN data centers in the appropriate directory.

Here, we give the list of the open actions, the news actions are in red:

Action	Title	Description	who	date	status
AWG_01	SPOT5 scale issue	provide the list of suspect attitudes for SPOT satellites (apart from 2011).	F. Lemoine		open
AWG_02	ITRF2014 processing	IDS BC invites ACs to check the information given in the Table on the IDS website at http://ids-doris.org/contribution-itrf2013.html. The table was filled in before it was decided to include year 2014 for the ITRF.	All ACs		open
AWG_03	Inclusion of Jason-3 and Sentinel-3A in the multi-satellite solution	Provide to IDS CC single satellite solutions for evaluation	GRG AC (done) and Volunteer ACs		open
AWG_04	Mitigate the SAA effect on DORIS USOs	When it will be available ACs could test the model of Belli for Jason-2 to analyze its impact on the position estimation of SAA stations	Volunteer ACs		open
AWG_05	Mitigate the SAA effect on DORIS USOs	Write a document which will consider the different possibilities (corrective models (for Jason-1, SPOT-5), …)	Analysis Coordinators		open
AWG_06	Mitigate the SAA effect on DORIS USOs	CNES POD team provides to all analysis centers the estimate of the on-board frequency variations of Sentinel-3A that they have obtained through the connection between DORIS USO and the GNSS receiver.	CNES POD team		open
AWG_07	DORIS scale HY-2A high scale	Use the last spacecraft CoM position provided by the Chinese Project	All ACs		open
AWG_08	DORIS Scale Increase in 2012	Each analysis center should do its data editing with its own standards when using all DORIS2.2 data. ACs should reprocess all data using these homogeneous editing criteria for the whole period of each satellite having data in 2012.	All ACs		open
AWG_09	DORIS Scale Tropospheric point	A working group could analyze the impact of the cutoff angle/ data down-weighting law at low elevation / mapping function of the tropospheric correction on the scale factor and vertical positioning.	Volunteer ACs and associated		open
AWG_10	Mitigate the non-conservative force model error	Inter-comparison of the 2 or 3 time series of quaternions and solar panel angles available among the groups who have pre-processed them.	CNES, GFZ, GSFC		open
AWG_11	Implement DORIS RINEX processing	Creating a “cook-book” explaining step by step the implementation process. It is recommended in particular to explain clearly which data fields in the RINEX files have to be used as they are, and which ones need to be discarded or filtered before use.	GRG AC, CNES POD team		open
AWG_12	Implement DORIS RINEX processing	Providing to the IDS ACs for reference a set of the different data corrections (i.e. iono, tropo, CoM/CoP, etc.) computed for 2 satellites over one week: Cryosat-2 and Jason-2.	GRG AC, CNES POD team, GSFC		open
AWG_13	New standards/models recommended by IERS	Adopt and evaluate the new standards/models recommended by IERS	All ACs		open
AWG_14	Orbit comparison	On voluntary basis and for test purpose (maybe not on regular basis), ACs and associated may deliver their sp3 orbit to the CDDIS/IGN data centers in the appropriate directory: ftp://cddis.gsfc.nasa.gov/pub/doris/products/orbits/	Volunteer ACs and associated		open

5. Next Meeting

5.1. Next IDS Workshop

The next IDS workshop will be held in Ponta Delgada (Azores Archipelago), Portugal, on September 24 and 25. It will be followed by a meeting of the Governing Board on Wednesday 26, in the morning. The other events of the week are the "25 Years of Progress in Radar Altimetry" Symposium (September 24-26) and the OSTST meeting (September 27-28). Logistical details are available on the meeting website at

www.altimetry2018.org

5.2. Next AWG

The next IDS AWG will take place in April 2019.