2016 IDS Workshop

Monday, October 31 2016 - Tuesday, November 1 2016

This is a meeting for all those who analyze DORIS data, use products derived from DORIS data, or who are involved with the DORIS network. The meeting will highlight current developments and the status of scientific results that use DORIS data, and will provide a platform for discussion and coordination of future activities. The session will include oral presentations and posters.

1- Network and constellation: status and evolution

2- Precise Orbit Determination and clock

3- IDS processing for and with ITRF2014

4- Research activities and new applications

Abstracts Book

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Oral

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Research activities and new applications
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Abstract details

DORIS System status and future missions

Cecile Manfredi (CNES, France) ; Jean Marc Walter (CNES, France) ; Pascale Ferrage (CNES, France)

Session: Network and constellation: status and evolution
Presentation type: Oral

Abstract:
DORIS System status and future missions
C. Manfredi, P. Ferrage, J.M. Walter

(1) CNES, Toulouse, France
The DORIS System (Doppler Orbitography and Radio positioning Integrated by satellite) is 26 years old in 2016 and is always maintained at the top level of performance thanks to permanent improvements in the system and its components.
13 DORIS receivers have flown on several Earth observation and altimetric missions since 1990, and many future missions are under preparation. The DORIS constellation will benefit from DORIS system and will warrant the quality of geodetic applications, reference frame and POD contributions to well beyond 2030.
This presentation will focus on the recent improvements of the DORIS system, and on the future missions.

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DORIS Network 2016 Status Report

Jérôme Saunier (IGN, France)

Session: Network and constellation: status and evolution
Presentation type: Oral

Abstract:
Exactly 30 years have passed since the DORIS network started its deployment. The siting of the stations went through three distinct phases: setting-up, densification and renovation. We are now in the modernization phase, focusing on standardization, permanent monitoring and network assessment to better serve the DORIS system and to be in line with its performance level and objectives.

We review progress and report on various aspects of the network: distribution, monumentation, requirements compliance, availability, maintenance, performance…

We detail the main network events and evolution over the last two years (since the last workshop).

Finally, we give outlook for the coming years: context, planned network evolutions, opportunities and on-going actions to meet the current objectives, ensuring a high level of continuity of service.

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VLBI - DORIS compatibility tests at the Geodetic Observatory Wettzell

Thomas Kluegel (BKG, Geodetic Observatory Wettzell, Germany)

Session: Network and constellation: status and evolution
Presentation type: Oral

Abstract:
The co-location of DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite) with other geodetic space techniques is of special interest for the realisation and maintenance of global reference frames like the ITRF (International Terrestrial Reference Frame). While GNSS (Global Navigation Satellite System) receivers are often operated together with DORIS beacons, co-locations with Very Long Baseline Interferometry (VLBI) or Satellite Laser Ranging (SLR) are less frequent. The Geodetic Observatory Wettzell in Germany, which includes 3 VLBI radio telescopes, 2 SLR, several GNSS receivers and a dense local tie network, is therefore an interesting co-location site for the IDS.

However, the common operation of VLBI and DORIS at one site generates Electromagnetic Compatibility (EMC) problems due to the DORIS transmitting power of 40 dBm at 2036 MHz. The power difference can be as high as 15 orders of magnitude between the power of astronomical VLBI sources and the emitted power of the DORIS beacon. While the recorded frequency band itself (S band 2.1-2.4 GHz) is not expected to be influenced directly, the high power at the Low Noise Amplifier (LNA) input could generate spurious signals and overload or even damage the LNA.

In order to find a solution for a common operation, Radio Frequency (RF) interferences at the LNA inputs of the 20 m radio telescope (RTW) and the classical S-/X-/Ka-band TWIN telescope (TTW-1) were investigated varying the telescope azimuths and elevations and testing different locations and RF blocking structures. It has been shown that obstacles like buildings, earth mounds or absorber plates attenuate the signal up to 20 dB. However, the power received at the LNA input is still at a critical level when the radio telescopes point towards the DORIS beacon. In order to minimize the impact of the DORIS emission, an operation mode where the beacon is kept in stand-by mode when no satellite is visible was implemented.

A four weeks lasting test in operation-on-demand mode was performed at the preferred location behind an earth mound. First results indicate that the perfomance is satisfying and the quality of the correlated VLBI signals is not affected by the operation of the DORIS beacon.

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Co-location: guiding principles of the doris network deployment

Jérôme Saunier (IGN, France) ; Zuheir Altamimi (IGN, France) ; Xavier Collilieux (IGN, France) ; Bruno Garayt (IGN, France) ; Médéric Gravelle (LIENSs, CNRS/Université de la Rochelle, France) ; Jean-Claude Poyard (IGN, France)

Session: Network and constellation: status and evolution
Presentation type: Oral

Abstract:
Co-locations with other space geodesy techniques have always been a major objective throughout the deployment and evolution of the DORIS network. Co-locations of DORIS with tide gauges became scientifically interesting with the launch of TOPEX/Poseidon in 1992, the first satellite using DORIS for oceanography purposes.

After an introduction about site surveys and co-locations, this presentation is divided into two parts to make a separate assessment of co-locations with space geodetic techniques and tide gauges.

We give a current status and examine the distribution and configuration of co-location sites including DORIS since the beginning of the network deployment 30 years ago with a detailed analysis of the tie vectors uncertainties through the ITRS realizations.

We illustrate by few examples the respective contributions of these co-locations to the ITRF determination and the sea level monitoring.

Finally, we provide some definitions and specifications for a good DORIS co-location site and give, in the context of current objectives, the prospects for the DORIS network as regards co-locations.
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Comparison between DORIS oscillators on Jason satellites in terms of radiation sensitivity

Alexandre Belli (Université Franche Comté, OCA-GEOAZUR, UTINAM, France) ; Pierre Exertier (OCA-GEOAZUR, France) ; Hugues Capdeville (Collecte Localisation Satellites, France)

Session: Precise Orbit Determination and clock
Presentation type: Oral

Abstract:
Radiations induced by protons trapped in the South Atlantic Anomaly (SAA) damaged the Ultra Stable Oscillator (USO) provided by the DORIS (Doppler Radiopostioning Integrated on Satellite) system, essentially on the Jason orbit (at 1336 km).
Variations in the relative frequency bias were observed on Jason-1, resulting in data elimination. Despite the growing complexity on the response of the USO to strong radiation influences notably on the short term, a first model has been established [Lemoine and Capdeville, 2006].
The new DGXX generation of DORIS USOs on Jason-2 since 2008, and then on Jason-3 since January 2016, showed a priori, a much less frequency response to radiation effects. This is probably due to a better pre-treatment (pre-irradiation to decrease the sensitivity) of quartz oscillators. Thanks to the picosecond short term stability of the ground-to-space time transfer from a laser ranging station provided by the Time Transfer by Laser Link (T2L2) experiment on-board Jason-2, a recent model (precision of a few 10−13 showed a maximum frequency peak of 1-2 10−12 in term of relativity frequency bias above the SAA area [Belli et al., 2015]. In addition, it has been proved that the USO response tends to decline with age.
Now, we present results about a simultaneous analysis of both relative frequency biases for Jason-2 and Jason-3 which have the same orbit, same phase, same attitude and same platform. We compare the sensitivity of Jason-3 to one of Jason-2, not for the same period, but for the same USO age (since the launch of each mission). In doing so, the expected larger sensitivity of the Jason-3 is estimated to be just 20% above the Jason-2 for the same age.

References
[Belli et al., 2015] Belli, A., Exertier, P., Samain, E., Courde, C., Vernotte, F., Jayles, C., and Auriol, A. (2015). Temperature, radiation and aging analysis of the {DORIS} ultra stable oscillator by means of the time transfer by laser link experiment on jason-2. Advances in Space Research, pages –.
[Lemoine and Capdeville, 2006] Lemoine, J.-M. and Capdeville, H. (2006). A corrective model for jason-1 doris doppler data in relation to the south atlantic anomaly. Journal of Geodesy, 80(8):507–523.
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Sentinel-3A USO observed through GNSS measurements

Eva Jalabert (CNES, France) ; Flavien Mercier (CNES, France)

Session: Precise Orbit Determination and clock
Presentation type: Oral

Abstract:
Sentinel-3A, an ESA altimetry mission, has been launched earlier this year (February 16, 2016). In order to precisely compute its orbit, a DORIS instrument and a GNSS receiver are embedded. The DORIS technique relies on the precise knowledge of a clock, given by an Ultra Stable Oscillator (USO).

As a low Earth orbiter, Sentinel-3A passes through the South Atlantic Anomaly (SAA), a region above the Earth surface where the energetic particles number is higher than usual, resulting in a higher level of radiation. The DORIS USO performances is degraded when passing through SAA, although the degradation varies depending on the mission considered (Spot5 and Jason 1 are particularly concerned by SAA degradation).
While SAA degradation is not obvious on Sentinel-3A when studying global metrics (RMS residuals over a cycle, …), a close up on the few DORIS passes over SAA shows that the DORIS USO is indeed perturbed.

A very interesting particularity of Sentinel-3A is that the same on-board oscillator is used by both the DORIS instrument and the GNSS receiver. Thus it is possible to estimate the clock using the GNSS measurements. This paper shows the results of using a GNSS-observed clock in the DORIS computation.

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Investigating HY2A radial offset for precise orbit determination and geodesy

Pascal Willis (IGN/IPGP, France) ; Alexandre Couhert (CNES, France)

Session: Precise Orbit Determination and clock
Presentation type: Oral

Abstract:
Satellite physical models are critical metadata for DORIS data processing. In particular, the exact location of the center of phase of the on-board antenna with regard to the center of mass of the satellite is of key importance. We investigate here a possible discrepancy observed for the recent Chinese HY2A satellite using multiple approaches. In a first step, we will directly estimate an empirical parameter (radial offset for the position of the center of phase) for HY2A using all available DORIS data and compare it to similar values obtained for other satellites. In a second step, we will derive indirect estimations obtained using DORIS geodetic data processing. In particular, we will investigate time evolution of the scale of the terrestrial reference frame and station position derived from a Precise Point Positioning (PPP) technique, when compared to a multi-satellite DORIS coordinates or to a nearby GPS stations. Results show that the current documentation for HY2A may need to be modified, using empirical values derived from similar studies.

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Which datation method for DORIS-RINEX data

Pascale Ferrage (CNES, France) ; Christian Jayles (CNES, france) ; Jean Michel Lemoine (CNES, France) ; Hugues Capdeville (CLS, France) ; Guilhem Moreaux (CLS, France)

Session: Precise Orbit Determination and clock
Presentation type: Oral

Abstract:
Which datation method for DORIS-RINEX data
P. Ferrage1, J.M. Lemoine1, C. Jayles1, G. Moreaux2, H. Capdeville2
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Since 2008, a new format of DORIS data is available at IDS data Centers for all satellites equipped with DGXX and DGXX-S DORIS receivers: the “DORIS-RINEX” format, very close to the DORIS raw measurements.
At first, data were provided by a component called SPARINEX, directly using the DIODE on board navigator software for measurements datation. Since January 2015, these data have been re-processed using a new component (PANDOR) which improves DORIS measurements datation accuracy by on ground re-processing. Since then, the DORIS-RINEX data have been provided by PANDOR.
After few reminders of the DORIS-RINEX format and of the principle of the PANDOR processing, we build a comprehensive review on the use of PANDOR in operations in term of performance and accuracy, supports to users, operational consequences. Finally, we will determine the interest or not to continue with PANDOR for operational dissemination.

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Status DORIS RINEX processing at GSFC

Nikita Zelensky (SGT / GSFC, United States) ; Frank G. Lemoine (NASA / GSFC, United States) ; David D. Rowlands (NASA / GSFC, United States) ; Douglas S. Chinn (SGT / GSFC, United States) ; Brian D. Beckley (SGT / GSFC, United States)

Session: Precise Orbit Determination and clock
Presentation type: Oral

Abstract:

We have implemented the use of DORIS RINEX phase data in the GSFC GEODYN data processing system by constructing range-rate measurements, and have processed such tracking data from the Jason-2, Jason-3, SARAL, and Cryosat-2 satellites. We evaluate DORIS POD for these missions using the new RINEX measurements. We also investigate improved RINEX corrections of the Jason-2 USO frequency made possible through the onboard T2L2 instrument with a preliminary analysis using the products described by Belli et al. (2015).

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DORIS rinex procesing at the european space operations cenre

Michiel Otten (ESA/ESOC, Germany) ; Werner Enderle (ESA/ESOC, Germany)

Session: Precise Orbit Determination and clock
Presentation type: Oral

Abstract:
This presentation will show the first results of the European Space Operation Centre (ESOC) IDS solution that makes use of the DORIS RINEX files for the newer satellites. We will show the impact on our IDS solution when switching from the old DORIS format to the new RINEX files for the older missions like Jason-2 as well show the results of the first solution which is completely based on DORIS RINEX files.

With the switch to the DORIS RINEX files the new ESA solution will also for the first time include both Sentinel-3A and Jason-3 we will also show the impact these new satellites have on the ESA solution.

Further we will also give an overview of the changes that have been made to our processing software (NAPEOS) and our satellite modeling since the previous IDS workshop in 2014.
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DORIS preprocessing and weighting function for Jason-1 and OSTM/Jason-2

John Moyard (CNES, France) ; Flavien Mercier (CNES, France) ; Alexandre Couhert (CNES, France) ; Eva Jalabert (CNES, France) ; Sabine Houry (CNES, France)

Session: Precise Orbit Determination and clock
Presentation type: Oral

Abstract:
Some studies related to the geocenter motion or DORIS positioning need to take into account low-elevation measurements and a consistent editing process. A new preprocessing is implemented using DORIS residuals adjustment on tropospheric mapping model corrections.
As low-elevation measurements are now considered, the orbit determination process needs to integrate a weighting function. This paper shows the results on the Jason-1 and OSTM/Jason-2 altimeter missions of these new preprocessing and weighting function.

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DPOD2014: a new DORIS extension of ITRF2014 for Precise Orbit Determination

Guilhem Moreaux (CLS, France) ; Pascal Willis (IGN, Marne-la-Vallee, France) ; Frank Lemoine (NASA, Goddard Space Flight Center, United States) ; Nikita Zelensky (SGT Inc., United States)

Session: Precise Orbit Determination and clock
Presentation type: Oral

Abstract:
As one of the tracking systems used to determine orbits of the altimeter mission satellites (such as TOPEX/Poseidon, Envisat, Jason-1/2/3 & Cryosat-2), the position of the DORIS tracking stations provides a fundamental reference for the estimation of the precise orbits and so, by extension is fundamental for the quality of the altimeter data and derived products. Therefore, the time evolution of the position of both the existing and the newest DORIS stations must be precisely modeled and regularly updated. . To satisfy operational requirements for precise orbit determination and routine delivery of geodetic products, the International DORIS Service maintains the so-called DPOD solutions, which can be seen as extensions of the latest available ITRF solution from the International Earth Rotation and Reference Systems Service (IERS).
In mid-2016, the IDS agreed to change the processing strategy of the DPOD solution. The new solution from the IDS Combination Center (CC) consists of a DORIS cumulative position and velocity solution using the latest IDS combined weekly solutions. The first objective of this study is to describe the new DPOD elaboration scheme and to show the IDS CC internal validation steps. The second purpose is to present the external validation process made by an external team before the new DPOD is made available to all the users. The elaboration and validation procedures will be illustrated by preliminary tests done with the ITRF2008 solution and by the presentation first version of the DPOD2014 (ITRF2014 DORIS extension) and validation.

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Review of IDS contribution to ITRF2014

Zuheir Altamimi (IGN France, France)

Session: IDS processing for and with ITRF2014
Presentation type: Oral

Abstract:
The IDS contribution to the ITRF2014 is a combined time series of weekly station positions and daily Polar Motion coordinates, spanning the period 1993.0 - 2015.0. In this paper we review the main DORIS results of the ITRF2014 analysis, including some inter-comparisons of station seasonal signals between DORIS and other techniques at co-location sites.

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Research activities at the IDS Combination Center

Guilhem Moreaux (CLS, France)

Session: IDS processing for and with ITRF2014
Presentation type: Oral

Abstract:
First, the IDS Combination Center (IDS CC) will present the latest results of the evaluation of the operational multi-satelliteseries from the IDS Analysis Centers. The evaluation will address the analysis of both the Helmert parameters of the series with respect to ITRF2014 and the Earth rotation parameter differences with respect to the IERS C04 series.
Second, the IDS CC will show the research activities he conducted mainly from the feedbacks from the IERS Production Centers on the IDS contribution to ITRF2014. These activities include analysis of the station position performance degradation between 1993 and 2002.
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GSC Analysis Center Improvements in DORIS Satellite Processing Following ITRF2014

Frank Lemoine (NASA GSFC, United States) ; Douglas Chinn (SGT Inc, U.S.A) ; Nikita Zelensky (SGT Inc., U.S.A.) ; Karine Le Bail (NVI Inc., U.S.A.)

Session: IDS processing for and with ITRF2014
Presentation type: Oral

Abstract:
As part of its DORIS contribution to ITRF2014 the GSC analysis center processed data from January 1993 to December 2014, contributing 1141 SINEX files in the form of normal equations for inclusion in the DORIS combination for ITRF2014. The work for ITRF2014 included numerous improvements in the measurement and force modeling as compared to the submission for ITRF2008, well as the inclusion of new satellite data such as data to Jason-2, Cryosat-2 and HY-2A. We evaluate further updates to the processing including the application of ITRF2014 as an a priori; As a test of force model improvements, we quantify the improvements in the determination of the geophysical parameters from the use of the solar array quaternions on Jason-2. On all the DORIS satellites we have noticed the dramatic increase in the RMS of fit vs. elevation below 20 degrees of elevation, probably due to multipath. We experiment with the use of downweighting function for this lower elevation data and evaluate the impact on the solutions for the geophysical parameters. One of the puzzles in the processing for ITRF2014, was the observation that the scale of the HY-2A solution was biased by ~16mm with respect to other satellites (Jason-2 and Cryosat-2) when the scale of the single satellite station coordinate solutions was compared to a reference (DPOD2008). We investigate different strategies to mitigate this anomalous behavior.

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The main results of the DORIS data processing in the INASAN Analysis Center for the ITRF2014

Sergey Kuzin (Institute of Astronomy of the RAS, Росси́я)

Session: IDS processing for and with ITRF2014
Presentation type: Oral

Abstract:
We present results of the DORIS data processing for the ITRF2014 carried out in the Institute of Astronomy, Russian Academy of Sciences for the time period 1993.0 - 2015.0. The evaluated SINEX free-network (inawd08) weekly solutions for station positions and polar motion have been submitted to the IDS Combination Center. We applied the upgraded models of the gravity field, troposphere, and used corrected data for Spot5 satellite which permitted us to improve the result precision for Helmert transformation parameters and EOP. The agreement with the IERS C04 solution turns out better than 0.1 mas with a dispersion of 1 mas. The evaluated amplitudes of annual geocenter variations derived from inawd08 weekly solutions are 3.4±0.5 mm, 4.4±0.5 mm, and 3.3±1.0 mm for X, Y, and Z components, respectively. The recovered amplitudes and phases are in a good agreement with the geophysical models. The results of single satellite campaign related to the scale increase in 2012 for IDS combination are studied. Unlike other Analysis Centers, we did not apply a phase center law for ground antennas. It was shown that the correction for the phase center variation (PCV) of ground DORIS antennas results in the shift of the mean scale factor by 1.24 ppb (i.e., ~ 8 mm) with respect to the case without correction.

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Assessment of ITRF2014 for precise orbit determination of altimetry satellites

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Session: IDS processing for and with ITRF2014
Presentation type: Oral

Abstract:
A terrestrial reference frame (TRF) is a basis for precise orbit determination of Earth orbiting satellites. New GFZ VER13 precise orbits of altimetry satellites ERS-1 (1991-1996), ERS-2 (1995-2003), TOPEX/Poseidon (1992-2005), Envisat (2002-2012), Jason-1 (2002-2013) and Jason-2 (2008-2015) have been derived at the time intervals given in the ITRF2014 terrestrial reference frame realization by adding the information on the stations missing in the ITRF2014 from DPOD2008 and SLRF2008, since no DPOD2014 and SLRF2014 are available yet. This allows using the same set of stations for precise orbit determination. The orbits are computed using satellite laser ranging (SLR) data and single satellite altimeter crossover differences for ERS-1, by using additionally PRARE (Precise Range and Range-rate Equipment) data for ERS-2. SLR and DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite) measurements have been used to derive orbits of four other satellites. The Cartesian X, Y, Z coordinates of PRARE stations used for precise orbit determination of ERS-2 were estimated at each orbital arc, since they are missing in the ITRF. The quality of GFZ VER13 orbits is compared with the quality of GFZ VER11 (2015) orbits derived using the same up-to-date background models for precise orbit determination, but using a previous ITRF realization, namely, ITRF2008. We have found that using ITRF2014 generally improves orbit quality, as compared to using ITRF2008. Thus, the mean values of the root-mean-square (RMS) fits of SLR observations reduced (improved) by 1.8, 3.1, 2.4 and 8.8% for ERS-2, Envisat, Jason-1 and Jason-2, respectively, and are almost not impacted for ERS-1 and TOPEX/Poseidon, when using ITRF2014 instead of ITRF2008. The internal orbit consistency in the radial direction being important for altimetric applications and being characterized by the satellite position differences in this direction at two-day arc overlaps reduced (improved) by 0.4, 0.6, 2.4, 5.1 and 7.1% for ERS-2, ERS-1, Jason-1, Jason-2 and TOPEX/Poseidon, but slightly (by 0.7%) increased for Envisat. We provide also the results of the single-satellite altimetry crossover analysis of VER13 orbits, as compared to VER11 orbits, investigate scatter and frequencies of radial errors and geographically correlated errors obtained using new orbits, and show the impact of the ITRF realizations used on the radial orbit differences, sea level heights and sea level rates.

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Impact of the low elevation measurements on the DORIS scale factor

Hugues Capdeville (CLS, France) ; Jean-Michel Lemoine (CNES, France)

Session: IDS processing for and with ITRF2014
Presentation type: Oral

Abstract:
All the DORIS Analysis Centers observe a jump in the scale factor of their combined solution in 2012. The introduction of the HY-2A solution seems to cause the largest jump in the DORIS scale. However, some investigations show that the Jason-2 and Cryosat-2 solutions are also responsible of the DORIS scale jump. This contribution in the scale jump seems fully explained by a variation in the number of low elevation measurements included in the processing. We propose here to demonstrate the origin of this scale jump by several tests in particular by taking into account another data format (RINEX) and by processing DORIS data with different cutoff angles. We plan also to analyze the impact of the low elevation measurements on the height station position estimation and the Helmert parameters (scale factor and geocenter).
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Is the CryoSat-2 orbit accuracy affected by space weather

Ernst Schrama (Associate Professor Faculty of Aerospace TU Delft, Nederland)

Session: Research activities and new applications
Presentation type: Oral

Abstract:
We produce CryoSat-2 orbit solutions since June 2010 where we make of DORIS and satellite laser ranging tracking data. For CryoSat-2 the production of the orbits started in a solar minimum, next we went through a weak solar maximum from which we are currently returning to a minimum. To incorporate Sun's output in precision orbit determination use is made of the F10.7 proxy variable which is a space weather constant. The F10.7 variable is measured at 2800 MHz and it is an excellent indicator for solar activity, and therefore it becomes relevant for a thermospheric model. We expect that drag and solar radiation pressure on the spacecraft are affected. In this talk we will show that it is likely that variations of F10.7 are also visible in tracking data residuals, this means that the accuracy by which CryoSat-2 orbit can be determined will be affected. Different strategies will be discussed in an attempt to minimize the effect of F10.7 variations on the orbit.

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Impact of the South Atlantic Anomaly effect on the position station estimation of the last DORIS satellites

Hugues Capdeville (CLS, France) ; Jean-Michel Lemoine (CNES, France)

Session: Research activities and new applications
Presentation type: Oral

Abstract:
The satellites Jason-3 and Sentinel-3A were added in the DORIS processing chain of the CNES/CLS Analysis Center. The DORIS Ultra Stable Oscillators for these satellites are sensitive to the South Atlantic Anomaly (SAA) effect at a level which is lower than that of Jason-1, but still 4 to 5 times higher than that of Jason-2. So, for the POD of these 3 satellites (Jason-2&3 and Sentinel-3A), the SAA effect can be neglected but for the station position estimation, it must be taken into account. Indeed, we show here the impact on the station position estimation for some stations in the vicinity of the SAA area by comparison of the single satellite solutions. Thanks to the extremely precise time-tagging of the T2L2 experiment on-board Jason-2, A. Belli and the GEOAZUR team managed to draw up a model that accurately represents the variations of Jason-2 USO's frequency. This model will be evaluated by analyzing its impact on the position estimation of the SAA stations. While awaiting a DORIS data corrective model for the others satellites Jason-3 and Sentinel-3A, a solution will be proposed to minimize the SAA effect on the orbit and also and in particular on the station position estimation.

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Recent DORIS analysis at Geodetic Observatory Pecny

Petr Stepanek (Geodetic Observatory Pecny, VUGTK, Česko) ; Vratislav Filler (Geodetic Observatory Pecny, VUGTK, Czech Republic) ; Michal Buday (Geodetic Observatory Pecny, VUGTK, Czech Republic)

Session: Research activities and new applications
Presentation type: Oral

Abstract:
The analysis center at Geodetic Observatory Pecny (GOP) is officially associated with IDS since 2008. DORIS data are processed using a modified version of the Bernese GPS Software, recently updated to the version 5.2. In this paper, we summarize the changes that have been recently implemented, characterize the solutions we have developed and provide perspectives on possible future improvements. First, we present changes of the models and analysis strategy used for these computations after the ITRF 2014 data reprocessing. Second, we present the recent analysis and applications, particularly long time series analysis, LOD estimation with geodetic precision including the parameter correlation analysis, phase processing and usage of DORIS in epoch reference frames.

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DORIS-DIODE : Real-Time Earth Pole Coordinates computed in space

Christian Jayles (CNES, France) ; Jean-Pierre Chauveau (Akka I&S, France)

Session: Research activities and new applications
Presentation type: Oral

Abstract:

Keywords : DORIS, DIODE, Earth Pole Coordinates, Real-Time, On-Board, Navigation

ABSTRACT :

As presented in Constance (2014), Earth Pole coordinates estimates are computed by the recent versions of the on-board software : DIODE has been refined and is now able to produce an estimation in real-time. These data are sent to the ground system through new telemetry packets (the Auxiliary Data) and this in a few hours delay.

These estimations may be interesting to produce a Near-Real-Time estimation, or to initialize longer delay adjustments.
Ground mixing of the results of 2 satellites may help refining these estimates.

This presentation shows results of operational real-time computations performed on-board Jason-3 and Sentinel-3A since their launch at the beginning of 2016.

Results are compared with IERS estimations. Discrepancies are being analysed and future trends are discussed

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Using DORIS data in an OPerational Tool for Ionospheric MApping and Prediction

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Session: Research activities and new applications
Presentation type: Oral

Abstract:
At DGFI-TUM, a study has been conducted to combine different satellite observation techniques to develop an operational tool for ionospheric mapping, prediction and forecasting within the scope of an ongoing joint research project (OPTIMAP).

Terrestrial GNSS (e.g. GPS and GLONASS) observations provide a high-resolution coverage of the continental regions and have very high importance to study the variations of the ionospheric Vertical Total Electron Content (VTEC). However, large data gaps exist due to inhomogeneous global distribution of the GNSS observations sites, especially over the oceans. Thus, data acquired from additional satellite-based techniques such as GPS radio occultation measurements from the Formosat-3/COSMIC mission, altimetry and DORIS data, e.g. from the Jason-2 or Sentinel-3A mission can mitigate the data gap problem as well as contribute to a data densification on the terrestrial regions. In this context, carrier-phase data tracked by the on-board DORIS receivers are processed to provide total electron content observations for improving the spatio-temporal data coverage in VTEC modelling.

The spatial VTEC distribution in DGFI's ionosphere modeling approach is represented by B-spline series expansions. The corresponding B-spline series coefficients together with additional technique-dependent unknowns such as GNSS Differential Code Biases, the DORIS phase ambiguity bias, and other inter-technique biases are estimated by a Kalman filter which allows sequential processing of the observations in a predictor-corrector mode.

Within this contribution, all the aforementioned observations are exploited in a sequential data preprocessing and filtering framework which is capable of assimilating observations from different space geodetic techniques to estimate ionospheric target parameters. In particular, the contribution of the DORIS data to the quality of the estimated VTEC products is investigated.

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The International DORIS Service: Current achievements and future challenges

Pascal Willis (IGN/IPGP, France) ; Frank Lemoine (NASA, United States) ; Laurent Soudarin (CLS, France) ; Guilhem Moreaux (CLS, France) ; Pascale Ferrage (CNES, France)

Session: Research activities and new applications
Presentation type: Oral

Abstract:
Since the creation of the International DORIS Service (IDS) in 2003, major efforts have been made toward increasing international participation, leading to the regular delivery of geodetic products, and the delivery of a DORIS technique combination for the development of updated realizations of the International Terrestrial Reference Frame (ITRF). The goal of this presentation is to summarize the successive steps leading to the creation of this international service, as well as to review the recent achievements made by its many components. In particular, availability of multiple products on the IDS Web site (time series of station coordinates, metadata) should facilitate the use of IDS products among the scientific community in conjunction with results from other space geodesy techniques and other sources of data. While many improvements were made on the technical side (both for the satellite and for the ground segment), and while this system may continue for at least the next 10 or 15 years, IDS products are not still known and properly used by a large scientific community. We may then discuss the new challenges that the IDS will be facing in the next years and envision possible evolution of this international service.
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DORIS time series analysis by using ARMA models

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Session: Research activities and new applications
Presentation type: Poster
Poster number: NEWDOR_001

Abstract:
DORIS is the satellite navigation system applied in geodesy for precise determination of the position on the Earth's surface. The IDS community has been generating weekly station state solutions for more than 50 DORIS network stations worldwide since their installations for regular monitoring of recent kinematics of the Earth's crust. One site in Uzbekistan is participating in this project - Kitab (KIUB) permanent observation station. The KIUB station has been operating regularly since 1991. During the past few years numerous models for analyzing and forecasting of time series have been developed by researchers. Data analysis to the station time series aims to extract useful signals, such as crustal deformation, seasonal variations of station dynamics etc. The statistical analysis along with real physical data combination is necessary to refine and interpret physical processes. Generally, permanent station time series also include various types of signals, as both real and apparent causes (such as miss-modeled errors, effects of observational environments, random noise or any other effects produced by analysis software and settings of a prior stochastic models). Autoregressive moving average (ARMA) method is applied to modeling the time series of position changes of 9 DORIS sites (lca11wd02 weekly solution) time series from 1993 to 2012: ARFB, BADB, EASB, EVEB, GRFB, HBMB, KIUB, LICB and MEUB. Regression analysis of height components with tropospheric parameters (pressure and temperature) are also considered.

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