IDS WORKSHOP

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SESSION 1: IDS AND DORIS SYSTEM NEWS

IDS1_1: The International DORIS Service: current status and perspectives

Authors:
Pascal Willis[1], P. Ferrage[2], B. Garayt[3], F.G. Lemoine[4], M. Chopo[4], G. Moreaux[5], C. Noll[4], M. Otten[6], J. Ries[7], L. Soudarin[5]
[1]IPGP, [2]CNES, [3]IGN, [4]NASA/GSFC, [5]CLS, [6]ESA/ESOC, [7]CSR/UT

Oral Presentation

Abstract text:
Since the start of the International DORIS Service (IDS), the organization has continuously evolved, leading to additional and improved operational products from an expanded set of DORIS Analysis Centers. In the last few years, the Combination Center has successfully launched several inter-comparison campaigns between analysis groups, leading to successive improvements from all of them. More recently, regular combinations of weekly solutions have been performed, providing regular feedback to the IDS Analysis Centers on the quality of their products. The goal of this presentation is to summarize the successive steps taken by the IDS since its creation and to envision possible future evolution in terms of new products and activities.

IDS1_2: DORIS System status and future missions

Authors:
Pascale Ferrage[1], Albert Auriol[1], C. Tourain[1], C. Jayles[1], F. Boldo[2]
[1]CNES, [2]IGN

Oral Presentation

Abstract text:
The DORIS System (Doppler Orbitography and Radio positioning Integrated by satellite) is 22 years old in 2012 and is always maintained at the top level of performance thanks to permanent improvements in the system and its components.

Current “DORIS” Satellites in flight and future missions will be presented with associated on board instrument features, as well as a prediction of the Doris constellation evolution so as to warrant the quality of geodetic applications, reference frame and POD contributions.

DORIS instrument health and performances will be also reminded: coverage and number of measurements, USO behaviour, measurement elementary performance, navigation performance.

The DORIS Stations Network is continuously improved and controlled, a general status will be given: availability, functioning and DORIS signal monitoring.

IDS1_3: DORIS Network, 2012 Status Report

Authors:
Jérôme Saunier[1]
[1]*IGN*

Oral Presentation

Abstract text:
DORIS network is evolving continuously with the objective of better service to the system, improving its accuracy and its reliability. In order to improve the quality of the transmitted signal, CNES and IGN defined a number of system requirements concerning the installation of a DORIS site.

In the last years, many stations have been renovated to better meet these requirements and we still continue to carry out this background task.

The main network events of the last two years are reviewed and various improvement actions are presented with a few examples but lingering over local ties survey because IGN will make a particular effort in future years to improve accuracy.

Then we give up-to-date statistics about network performance and we review the current network co-locations, either with space geodesy techniques or tide gauges.

Finally, planned evolutions like station renovation or network densification are presented.

IDS1_4: DORIS on HY-2A

Authors:
Michel Dejus[1], A. Auriol[1], F. Mercier[1], A. Couhert[1], L. Cerri[1], S. Houry[1], Pr M. Lin[2], Dr Y, Zhang[2], H. Peng[2]
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[2]*NSOAS, National Satellite Ocean Application Service, Beijing, China*

Oral Presentation

Abstract text:
HY-2A is new component of the oceanic Chinese space programs. The satellite has been launched by the CNSA in August 15th 2011 with a sun-synchronous orbit at an altitude of 971km. Repeat cycles of 14 days are planned for the first two years with oceanographic purpose and 168 days geodetic cycles will follow for the third year of the mission. The satellite is equipped with a 5 frequency scanning radiometer, a scatterometer, a Ku / C bands altimeter and a triple frequency radiometer and the orbit is determined thanks to SLR, GPS and DORIS systems.

Since the end of February 2012 DORIS/HY-2A is a new mission for IDS. The DORIS receiver on board HY-2A is working well. DORIS gives measurements with good quality. This presentation shows the characteristics of this mission and some results and performances.

IDS1_5: DORIS ground antennas Radio Frequency characterization

Authors:
Cédric Tourain[1], D. Belot[1], C. Jayles[1]
[1]*CNES*

Oral Presentation

Abstract text:
Several IDS users raised an issue about a possible bias in the position of the phase center of the DORIS ground antennas.

Following a recommendation from IDS Governing Board (Lisbonne 2010), an action was taken to provide calibration results of Alcatel and Starec ground antennas.

A first analysis concerning the Starec antennas has been performed by CNES atenna department, in a dedicated measurment device (BCMA).

This analysis gives important results about phase center position and phase law.

IDS1_6: DORIS/DIODE on board PLEIADES PHR1A : Results and lessons learned

Authors:
Christian Jayles[1], L. Cerri[1], M. Dejus[1], A. Auriol[1]
[1]*CNES*

Oral Presentation

Abstract text:
Pléiades PHR1A was launched on December 2011, 17th at 03h00 TAI from Kourou, hosting a DORIS DGXX receiver that was put ON the same day at 09h00 TAI. Orbit acquisition operations have been successfully performed until January 2012, followed by the on-orbit commissionning Phase for the satellite and all its sub-systems. The satellite is today fully operationnal. DORIS, the only on-board equipment providing TAI time and orbit to the spacecraft, has shown a very satisfactory behaviour, either during routine or during large orbit acquisition manoeuvers.

The presentation will detail DORIS-DIODE products delivered to the spacecraft and to the Pléiades system, and will show their compliance to routine phase specifications. DORIS-DIODE behaviour during orbit acquisition thrusts (performed between late December 2011 and beginning January 2012) will also be analysed.

The presentation will show the good agreement, inside Satellite Mission Center orbit restitutions, between DORIS/DIODE data and Doppler/Angular measurements performed by CNES tracking stations.

Finally, on-board real-time position estimations delivered by DIODE, have been compared to ground orbit processings using the ZOOM software (used to compute the centimeter-accuracy orbits in GDR and IGDR products) : results of this comparison will be discussed in the presentation.

A peculiar point in Pléïades mission (w.r.t. other satellites hosting a DORIS receiver), is its extreme mobility: frequent changes in the attitude lead to antenna movements perturbing for position determination accuracy. Compliant to its specifications, DORIS/PLéïades PHR1A mission is an in-flight qualification for the robustness of DORIS receiver and DIODE navigation algorithms.

IDS1_7: From Jason2 to Jason3: DIODE enhancements

Authors:
Jean-Pierre Chauveau[1], C. Jayles[2]
[1]AKKA Technologies, [2]CNES

Oral Presentation

Abstract text:
Since Jason2 launch in June 2008, many improvements have been realised on the DORIS DIODE navigation software. A new version uploaded in January 2010, was designed to correct an approximation in the radiation pressure modelling, and has shown very good results (s, AltiKa - new force models, new algorithms have been tested and have demonstrated even better results. Thanks to DIODE general design, which is independent of the satellite, the last version for Cryosat2 is also compatible and available for Jason2. Jason2 data ground reprocessing has shown significantly increased performances (exploit more complex models (Moon and Sun position, gravity field, beacons frequency drifts, …) and totally new models (rediffused solar radiation pressure, oceanic tidal forces, pole drift, …). These improvements are quite promising, not only for the radial component but also in other directions and for real-time estimated internal parameters (pole coordinates,OUS frequency, …).

SESSION 2: POSTERS

IDS_P1: DORIS: a permanent evolving space technique for geophysical research activities

Authors:
Pascale Ferrage[1], G. Moreaux[2], L. Soudarin[2], F.G. Lemoine[3]
[1]CNES, [2]CLS, [3]NASA/GSFC

Poster

Abstract text:
DORIS (Doppler Orbitography and Radio positionning Integrated by Satellite) was proposed by CNES, GRGS (Groupe de Recherches de Géodésie Spatiale) and IGN in 1982 as a dedicated fully optimised system in support of POSEIDON oceanographic altimetric experiment. To get an in-flight validation of DORIS before TOPEX/POSEIDON, DORIS was flown on board the SPOT2 satellite as a passenger experiment. Recognising the ability of the system to provide both precise positioning of ground beacons and orbit of centimeter-like precision, DORIS was approved for flying on board SPOT3, SPOT4, ENVISAT-1, JASON-1, SPOT5, JASON-2, CRYOSAT-2 and on HY-2A. This poster will introduce the DORIS technique as well as its components, then details scientific activities supported by DORIS, and finally presents major evolutions and perspectives.

IDS_P2: Polar motion and its accuracy analysis Monitored by DORIS Technique

Authors:
Xiaoya Wang[1], Nan Xing[1]
[1]Shanghai Astronomical Observatory

Poster

Abstract text:
High accuracy EOPs are obtained by multi-techniques such as VLBI/SLR/GNSS/DORIS and so on. Because the different techniques have different strengths and weaknesses, we need combine all results from different techniques. Although the EOP from DORIS technique has worse precise than other 3 techniques it will become better with more satellites and more reasonable site distribution. So we apply GEODYN-II to process DORIS data to get SINEX solution. Then we analyze the long series SINEX solution and get EOP. Meanwhile we combine the long series with other techniques to get combined EOP and compare the results with IERS C04.

IDS_P3: Combination of space techniques at the normal equation level

Authors:
Daniel Gambis[1],J.Y. Richard[1]
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Poster

Abstract text:
The space geodetic techniques GP S, VLBI, SLR and DORIS can been combined at the level of Normal Equations for recovering geodetic parameters such as terrestrial frame, Earth orientation parameters and troposphere delays. The potential advantage of the method is to improve the accuracy, the time resolution and the overall consistency of the products obtained in the combination.

We present preliminary results derived from the combination of normal equations obtained for the different techniques over two VLBI intensive campaigns referred to as CONT08 and CONT11.

IDS_P4: Comparison of Earth radiation pressure models for DORIS satellites

Authors:
Carlos Rodriguez-Solano[1], P. Štepánek[2], U Hugentobler[1]
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Poster

Abstract text:
At low satellite altitudes the magnitude of the Earth radiation pressure, consisting of reflected (visible) sunlight and emitted radiation, can reach similar magnitudes as the solar radiation pressure. These last two forces together with atmospheric drag are the most important non-conservative forces acting on low orbiting satellites, like DORIS satellites. Consequently, the modeling of Earth radiation pressure is required for precise orbit determination.

Different models exists to compute the radiation reaching the satellites, the models are based on values of the Earth´s surface reflectivity (albedo) and emissivity properties. A very simple model is to assume a constant albedo value of 0.3. More complex models take into account a latitude and time dependency of the reflectivity and emissivity coefficients (e.g. Knocke et al., 1988). In this study we use the reflectivity and emissivity coefficients from the Clouds and the Earth's Radiant Energy System (CERES). This data has been acquired by instruments onboard Earth observation satellites from NASA, like Terra and Aqua. The CERES data provides monthly averages from March 2000 until present, making possible to have a latitude, longitude and time dependency of the reflectivity and emissivity coefficients.

In this study three different Earth radiation models are compared: 1) the constant albedo model, 2) the Knocke et al. (1988) model and 3) the CERES model. The Earth radiation reaching the satellites is then combined with macro-models of the satellites to compute the acceleration acting on the satellites. This acceleration is introduced in the computation of DORIS satellite orbits as done by the Geodetic Observatory of Pecný to access the impact of the different Earth radiation pressure models on the orbits.

IDS_P5: DORIS measurement exploitation for ionosphere studies

Authors:
Cédric Tourain[1], A. Auriol[1], C. Jayles[1]
[1]*CNES*

Poster

Abstract text:
The DORIS System (Doppler Orbitography and Radio positioning Integrated by satellite) is based on a dual Frequency signal.
So, by conception, the DORIS measurement contains information about total electronic content and ionosphere effect.
DORIS DGXX instruments have the availability of measuring simultaneously up to 7 DORIS ground stations signals.
DORIS DGXX measurements are now provided in RINEX format. RINEX is a generic and well known format. It contains dual frequency information useful for ionosphere study.
A reflection and investigation has been initialized. The goal is to define the feasibility, the way and the interest of defining a use of DORIS measurement or derived product for Ionosphere study.
In order to be significant, this work should be shared and supported by people interested in ionosphere study.

IDS_P6: On the proper use of the EIGEN-6 models for altimetric orbit computation over decades

Authors :
Richard Biancale[1], J.M. Lemoine[1], S. Bruinsma[1], F. Reinquin[1]
[1]*CNES/GRGS*

Poster

Abstract text:
The EIGEN-6 Earth gravity models are commonly used for altimetric orbit computation. They are mainly based on GRACE KBR data and provide for that reason a series of time variable coefficients, namely: drift, once per year and twice per year terms up to spherical harmonic degree 50. These terms can be modeled globally over the GRACE period (around 10 years now) or annually.

However extrapolating these time variable terms in the past until the beginning of altimetric missions or even in the near future can generate some degradation of the orbital precision which can lead to noticeable radial discrepancies. Dedicated SLR satellites such as Lageos1/2 or Starlette/Stella are a good help for improving the knowledge of the very low degrees in the past.

We propose to show the orbital impact of these time variable terms and to give certain rules for their application in orbit computation.

SESSION 3: GEODESY AND PRECISE ORBIT DETERMINATION

IDS3_1: Improved DORIS Reference Frame Solutions from NASA GSFC

Authors:
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[1]NASA GSFC, [2]SGT Inc, [3]Emergentspace

Oral presentation

Abstract text:
At GSFC, since 2008, we have been routinely processing data to DORIS and SLR satellites from 1993. A SINEX time series, based on processing of DORIS data from 1993 to 2008 (designated wd10) was included in the IDS combination for ITRF2008 (Le Bail et al., 2010; Valette et al., 2010). We have updated this series with the addition of new satellites – Cryosat2 and Jason-2, and the new series (designated wd12) is routinely submitted to the IDS combination center for inclusion in the DORIS operational combination.
In preparation for an eventual reprocessing of all the DORIS data for eventual inclusion in a new ITRF we are now updating our processing standards. As a first step, we update to the ITRF2008 reference frame as expressed through DPOD2008. In addition, we apply the GMF and GPT models for the troposphere, and we update the modeling for the change in pitch of SPOT-5 solar arrays after January 2008. Finally, we consider updated standards for static and time-variable gravity modeling.
With this base series, we compute cumulative solution, expressed in ITRF2008, and examine the week-by-week station solution parameters, in particular scale, WRMS and Helmert transformation parameters. Finally we consider a joint solution with SLR, where the DORIS system is tied to SLR in two ways, first through the orbit computations using satellites tracked by both SLR and DORIS (e.g. TOPEX, Envisat, Jason-2, Cryosat2), and second through explicit ties at collocated sites. As one of the means of testing of these DORIS-only and SLR+DORIS solutions, we examine the vertical rates at sites in the vicinity of tide gauges.

IDS3_2: Update of the SAA corrective model for Jason-1 DORIS data and discussion about a SAA corrective model for Spot5

Authors:
Hugues Capdeville[1], J.M.Lemoine[2]
[1]CLS, [2]CNES

Oral presentation

Abstract text:
The sensitivity of the ultra stable oscillator (USO) of DORIS/Jason-1 to the high energy protons trapped in the Van Allen belts was first pointed out by Willis et al. (2003, 2004). This sensitivity causes a fluctuation of the frequency when the satellite crosses the area of the South-Atlantic Anomaly (SAA). The principal consequence is the impossibility of using the measurements of the DORIS beacons located in the SAA for cm-precision positioning since the real frequency of the on-board oscillator is varying rapidly in that area. Moreover, these DORIS measurements do not

contribute (or little) to the determination of the orbit of Jason-1 because they are eliminated during the pre-processing on residuals criteria.
To correct for this sensitivity to the effects of solar radiation, a model of frequency evolution of the USO was designed and validated by CNES (Lemoine and Capdeville 2006). This model of frequency correction makes a significant improvement in the orbit adjustment. It takes into account the geographical characteristics of the SAA region (1x1 degree SAA grid) as well as parameters of the USO's response to this external stimulation: an amplitude, a relaxation time-constant and a memory effect of the SAA disturbance. This model was optimized and documented in order to be able to deliver an operational module (software) that will be used by the processing centers of DORIS data.
A regular update of the model is done by considering the news DORIS data since the last update. By using data between February 20th 2009 and January 6th 2012, we determine the recent evolution of the parameters of the model. We note that the amplitude parameter is changing at the beginning of this period. In this presentation, we describe this evolution of the model.
Since May 4th 2012, the satellite Jason-1 has been moved to a geodetic orbit. The corrective model for Jason-1 has been updated to take into account the new orbit of Jason-1. The main change is that we can not any more consider the Topex mean ground track (determined over a 7-year period) after the maneuvers performed to move Jason-1 on the geodetic orbit. For the new orbit, since it is drifting, we had to add another capability in the model. We can use an external orbit in a sp3 format. So, before the orbit change, we can use Topex mean ground track or sp3 orbit files, and after change only sp3 files. We present here this evolution of the model and we explain how to use it.

IDS3_3: Evaluation of Atmospheric Loading and Improved Troposphere Modelling

Authors:
Nikita Zelensky[1], F. Lemoine[1], D.S. Chinn[1], K. Le Bail[1], D. Pavlis[2]
[1]NASA GSFC, [2]SGT Inc

Oral presentation

Abstract text:
Forward modeling of non-tidal atmospheric loading displacements at geodetic tracking stations have not routinely been included in DORIS or SLR station analyses for either POD applications or reference frame determination. The displacements which are computed from 6-hourly models such as the ECMWF and can amount to 3-10 mm in the east, north and up components depending on the tracking station locations. We evaluate the application of atmospheric loading in a number ways using the NASA GSFC GEODYN software: First we assess the impact on SLR & DORIS-determined orbits such as Jason-2, where we evaluate the impact on the tracking data RMS of fit and how the total orbits are changed with the application of this correction. Preliminary results show an RMS radial change of 0.5 mm for Jason-2 over 54 cycles and a total change in the Z-centering of the orbit of 3 mm peak-to-peak over one year. We also evaluate the eff ects on other DORIS-satellites such as Cryosat-2, Envisat and the SPOT satellites. In the second step, we produce two SINEX time series based on data from available DORIS satellites and assess the differences in WRMS, scale and Helmert translation parameters.

Troposphere refraction is obviously an important correction for radiometric data types such as DORIS. We evaluate recent improvements in DORIS processing at GSFC including the application of the Vienna Mapping Function (VMF1) grids with a-priori hydrostatic (VZHDs) and wet

(VZWDs) zenith delays. We reduce the gridded VZHD to the stations height the procedure recommended by Kouba (2008). We discuss the validation of the VMF1 implementation and its application to the Jason-2 POD processing, compared to corrections using the Niell mapping function and the GMF. Using one year of data, we also assess the impact of the new troposphere corrections on the DORIS-only solutions, most importantly on the scale of the weekly solutions.

IDS3_4: A review of some systematic errors observed in the Precision Orbit Determination of recent Doris satellites

Authors:
Luca Cerri[1], A. Couhert[1], F. Mercier[1], S. Houry[1]
[1]*CNES*

Oral presentation

Abstract text:
In the last 4 years, the Jason-2 , Cryosat-2, and HY2A altimeter satellites have joined the series of DORIS receivers that allow to obtain orbits with the radial accuracy needed to achieve their missions' objectives.
To the extent that this relatively new tracking data will also contribute to the realization of the next release of International Terrestrial Reference Frame , IDS analysts are interested in the close monitoring of all the metrics that might reveal errors in the time series of DORIS beacons coordinates.
We present some of the systematic signatures in the series of those primary and ancillary parameters that are produced in the frame of CNES Precision Orbit Determination activities, and that could potentially impact the ground coordinates estimation, including orbit comparison using SLR and GPS tracking data.

IDS3_5: An accuracy assessment of DORIS orbits: JASON-2

Authors:
Ramesh Govind[1], F. Lemoine[2], D.S. Chinn[2], N.P. Zelensky[3]
[1]*Geoscience Australia*, [2]*NASA/GSFC*, [3] *SGT Inc.*

Oral presentation

Abstract text:
In order to establish certainty and confidence in the measures that describe the aspects of global change as determined from satellite observations, it is necessary to validate and verify the various components of the measuring system. With the increase in the number of DORIS equipped satellites it is necessary to assess the quality of satellite orbits that can be achieved from the DORIS measurements. The Jason-2 satellite, which is equipped for DORIS, GPS and SLR measurements provide the opportunity to make these assessments. Further, the co-location of these techniques at the satellite, can provide a measure of the relationship between the individual tracking networks. For this study, Jason-2 orbits are computed for each measurement technique. The assessment is then performed by examining (a) the residuals of the co-located measurement types, (b) the differences in the respective trajectories and (c) station position estimates. These results are presented giving the r elative accuracy of the techniques and exploring the potential sources of the differences.

SESSION 4: MULTIPLE APPLICATIONS, GEOPHYSICS

IDS4_1: Overview of DORIS Frequency Permits, RFI Issues Worldwide

Authors:
Christian Jayles[1], P. Ferrage[1], C. Tourain[1]
[1]*CNES*

Oral presentation

Abstract text:
Deployment of the DORIS system has begun in 1989. The presentation will first give an overview of DORIS Frequency Permits. A few examples will be given to illustrate how these permits are taken into account in real life, and which consequences are induced on the DORIS station network.
Since its first activation, information has been gathered about DORIS RadioFrequency characteristics, and in particular about RadioFrequency Interference with other systems.
The paper will detail, for the different known systems, the different kinds of interactions with DORIS. What was expected theoritically, what really occurred during those twenty years of operations, what may still be revealed in the future.
Often installed in near vicinity, sometimes in close collocation, DORIS interferences with GNSS, SLR, ARGOS or radiosounding equipments are examined. Sometimes experiments are still necessary. Interactions with SVOM have also been completely detailed. A very interesting experiment is ongoing to measure DORIS-VLBI interactions on the Greenbelt station.

IDS4_2: Space Geodesy Project (SGP) Colocation considerations and Radio Frequency Interference (RFI) Mtigation Techniques

Authors:
Lawrence Hilliard[1], C. Beaudoin[2], B. Corey[2], W. Petrachenko[3]
[1]*NASA Goddard Space Flight Center,* [2]*HYASTACK ,* [3]*NRC-NRC*

Oral presentation

Abstract text:
This paper describes the initial characterizations of the GGAO environment. At the Goddard Geophysical and Astronomical Observatory (GGAO) in Greenbelt Maryland all four geodetic techniques of Very Long Baseline Interferometry (VLBI), Next Generation Satellite Laser Ranging (NGSLR), Global Navigation Satellite System (GNSS), and Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS) are represented. This creates a number of conflicting requirements. The Space Geodesy Project (SGP) is an effort to tie together independent measurements of Earth orientation parameters to attain precise calibration of the terrestrial reference frame. It is important that all four techniques share local environmental conditions so one of the goals of SGP is to prototype a station at GGAO. A spectrum conflict arises among three techniques that share the bandwidth recommended for VLBI2010 by the International VLBI Service for

Geodesy and Astrometry. The VLBI2010 development system is designed to receive 2-14 GHz with a 12-meter antenna observing over the full sky.
The DORIS technique transmits to DORIS receiver equipped satellites at 2036 MHz with an omnidirectional antenna pattern and a 10 Watt transmitter. The Laser Hazard Ranging System (LHRS) radar used with the NGSLR operates at 4 kiloWatts peak power at 9.4 GHz, which is also in the VLBI 2010 broadband frequency range. In the case of MOBLAS7 (another LHRS at GGAO), the radar standoff range to VLBI is 160m and that of the NGSLR radar is 200m.
Several types of analysis and tests have been used at GGAO to characterize the geodetic measurement systems. Antenna side lobe gain is an important modeling assumption that has recently been calibrated by our tests. From the calibrated side lobes it has been possible to improve our RFI susceptibility models. Characterizing the DORIS beacon at low elevation angles has been shown to agree with the modeling. The LHRS radar is less predictable in the presence of metallic safety rails, however its emission agrees well with the model when the rails are removed.
Current work continues on the side lobe analysis and methods of absorbing and shielding the transmitting antennas at low elevation angles. Operational masks for the radar and the VLBI field system have given the two techniques a temporary workaround and high pass filters have been introduced to isolate RFI at frequencies below 3.5 GHz from sensitive broadband components. This filtering has limited our ability to measure the susceptibility of the VLBI 2010 receivers to frequencies near the DORIS frequency.
Design solutions that match gain and sensitivity for the entire VLBI 2010 band are under development.

IDS4_3: Tropospheric parameters from DORIS in comparison to other techniques during CONT campaigns

Authors:
Johannes Boehm[1], K. Teke[2], P. Willis[3]
[1]Vienna University of Technology, [2]Hacettepe university, [3]IGN/IPGP

Oral presentation

Abstract text:
Since 2002 continuous campaigns of Very Long Baseline Interferometry (VLBI) observations over two weeks have been carried out every third year (CONT02, CONT05, CONT08, CONT11) to acquire the best possible state-of-the-art VLBI data. Thus, these campaigns are perfectly suited for comparing tropospheric parameters with other microwave-based space geodetic techniques like Doppler Orbitography by Radiopositioning Integrated on Satellite (DORIS) or Global Navigation Satellite Systems (GNSS) at co-located sites. We compare estimates of zenith total (wet) delays and horizontal gradients from these space geodetic techniques and with parameters derived from Numerical Weather Models (NWM) like the global operational analysis data of the European Centre for Medium-Range Weather Forecasts (ECMWF), or Water Vapor Radiometry (WVR) at specific sites. In this presentation, we focus on tropospheric estimates from DORIS, and we investigate the effect of using different approaches for the estimation of the parameters. For example, we compare solutions with different descriptions of the stochastic behavior or different geophysical background models like mapping functions. The assessment is carried out per station as well as for the different CONT campaigns which took place in different seasons and with different availabilities of observable satellites. Consequently we find a dependency on latitude as well as season. We will also discuss the estimation of tropospheric gradients with DORIS, which is quite difficult due to the partly non-uniform distribution of satellites in the sky.

IDS4_4: Contributions of DORIS to ionosphere modeling

Authors:
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Oral presentation

Abstract text:
The Earth's ionosphere is a dispersive medium for microwaves. Thus, space-geodetic observation techniques using at least two signal frequencies can provide information on the electron density distribution. Nowadays, most of the data driven ionosphere models are based on terrestrial GNSS measurements. However, other space-geodetic techniques - such as radio occultation data from space-borne GPS receivers, satellite altimetry, and DORIS - can also be used for ionosphere modeling. By combining different techniques one can take advantage of their different sensitivities concerning the estimation of ionospheric parameters as well as of their different spatial and temporal distribution.
At DGFI, we work on the development of multi-dimensional models of the ionosphere from the combination of modern space-geodetic satellite techniques. Our approach consists of a given background model and an unknown correction part expanded in terms of B-spline functions in order to derive regional or global models of the vertical electron content (VTEC). Different space-geodetic measurement techniques are used to estimate the unknown model coefficients. Variance component estimation is applied to take into account the different accuracy levels of the observations.
In this contribution, we focus on DORIS observations and their capability to derive ionospheric parameters. Although DORIS was primarily designed for precise orbit computation of satellites, it can be used as a tool to study the Earth's ionosphere. We test different DORIS data sets (from different receivers and different products) on their capability for ionosphere VTEC modeling in combination with other space-geodetic techniques.

IDS4_5: Ionospheric Radio Scintillations and TEC Using the CITRIS Reception of DORIS Transmissions

Authors:
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Oral presentation

Abstract text:
The scintillation and tomography receiver in space (CITRIS) instrument that orbited the Earth near 560 km altitude in a 35.4 degree inclination was used to detect signals from the ground-based array of more than 50 DORIS UHF/S-Band radio beacons established at sites around the world by the French Centre National d'Etudes Spatiales (CNES) and the Institut Géographique National (IGN). The CITRIS receiver was on the US Air Force Space Test Program satellite STPSAT1 which was launched on 3 September 2007. CITRIS recorded ionospheric total electron content (TEC) and radio scintillations with a unique ground-to-space geometry for two years. The new instrument was

developed to study the ionosphere using data obtained with the UHF and S-Band radio transmissions from the DORIS beacons because the ionospheric radio scintillations can seriously degrade the performance of many space geodetic systems incl uding the DORIS precise satellite orbitography system and GNSS. The ionospheric data was based on radio signals sampled at a rate of 200 Hz by the CITRIS receiver. The data from the space-based CITRIS receiver was compared with ground radar observations of equatorial plasma bubbles. Future CITRIS-like cubesats are planned to use DORIS for ionospheric observations.

IDS4_6: DORIS Observations from Future LEO Constellations

Authors:
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Oral presentation

Abstract text:
Study of the upper atmosphere has advanced to the point where a compelling need has emerged for a global real-time specification of the most important observations used as inputs to climate models. For the ionosphere, plasmasphere and magnetosphere we must generally use a proxy measurement, the local free electron density (ED), as direct measurements of the state variables are generally not available. ED can be measured with coherent dual-band techniques, in the form of total electron count (TEC) rays between a transmitter and receiver pair. Fortunately, a number of such transmitters exist in the form of radio navigation systems -- GNSS and DORIS. Their dual-band configuration is normally used to remove ionospheric effects, but that simultaneously allows them to serve as ionospheric probes. We first discuss the relative characteristics of the various ionospheric datasets one can gather using RF probes. Then we discuss our proposal for the DORIS Ionospheric Global Real-time Observatory (DIRGO). It would place DORIS receivers on the Iridium-NEXT constellation of communications satellites, which has hosted payload space designed to accommodate scientific experiments. The Iridium launches begin in 2015, with the advantage of real-time global coverage using six planes of eleven satellites each in polar orbits, providing a robust infrastructure for integrating hosted instruments, command and control, and data retrieval with data delivery on the order of a few seconds.

DIRGO could simultaneously serve the scientific and space weather communities with real-time observations of ionospheric TEC and scintillation observables. The instrument would be based on a TRL-8 software-defined radio developed by the Applied Physics Laboratory and flown on several space missions. We emphasize the ionospheric feature sizes that could be resolved, 100 km scale or less horizontally; and how the data sets obtained could help illuminate the transition from persistent to turbulent structures. This dataset, combined with a number of others, would allow our first real-time mesoscale monitoring of the ionosphere. We show orbit simulations used to optimize the density of deployed instruments, then review the status of and outlook for full program funding.

SESSION 5: IDS ANALYSIS ACTIVITY

IDS5_1: Research activities at the IDS Combination Center

Authors:
Guilhem Moreaux[1], L. Soudarin[1], F. Lemoine[2], P. Willis[3], P. Stepanek[4], R. Govind[5], S. Kuzin[6], P. Ferrage[7]
[1]CLS, [2]NASA/GSFC, [3]IGN/IPGP, [4]Pecny Observatory, [5]Geoscience Australia, [6]Institute of Astronomy RAS, [7]CNES

Oral presentation

Abstract text:
For the preparation of ITRF2008, the IDS processed data from 1993 to 2008, including data from TOPEX/Poseidon, the SPOT satellites and Envisat in the weekly solutions. Since the development of ITRF2008, the IDS has been engaged in a number of efforts to try and improve the reference frame solutions. After a presentation of the routine activities conducted at the IDS Combination Center (IDS CC), we report on recent results on IDS CC research activities. These activities include analysis of the last results of the single satellite campaign designed to better understand the DORIS satellite contributions to geocenter and scale as well as preliminary results on the impact of the new DORIS missions (Cryosat-2 and HY-2A). Then, we discuss the prospects for continued improvement in the DORIS contribution to the next international reference frame.

IDS5_2: Current research activities at GOP DORIS analysis center

Authors:
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Oral presentation

Abstract text:
The analysis center at Geodetic Observatory Pecný (GOP) is officially associated in IDS since 2008. DORIS data are processed using a modified version of the Bernese GPS Software. Data are analyzed in a stepwise process, based on single-satellite daily solutions and their combination. As a standard output, SINEX files corresponding to weekly multi-satellite solutions are delivered to IDS data centers. In addition, long time series of estimated parameters are analyzed, i.e., station coordinates and transformation parameters, ERP parameters, satellite orbits, ZTD and frequency offset.
A reduced-dynamical orbit modeling, based on empirical and pseudo-stochastic orbit parametrization, has been used for GOP DORIS solutions as the only possibility of the Bernese GPS Software. Recently, in cooperation with Technische Universität München, a new orbit model is developed, including precise modeling of non-conservative forces. The paper presents a comparison of both approaches.

Analyses of the SPOT-5 DORIS data revealed the significant effect of the South Atlantic Anomaly (SAA) on the SPOT-5 onboard oscillator. Estimated parameters like station coordinates and ZTD are affected as well. The recent study of this phenomenon is presented, including possibilities on how to compensate the data corruption.

IDS5_3: Recent improvements in DORIS processing at the European Space Operations Centre

Authors:
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[1]*ESA/ESOC*

Oral presentation

Abstract text:
The Navigation Support Office of the European Space Operation Centre (ESOC) of ESA has been involved in routine processing of DORIS data since the launch of Envisat in 2002. With the ITRF2008 call for participation ESOC decided to participate in all three geodetic satellite tracking techniques: SLR, GPS and DORIS. This led to ESOC becoming a full Analysis Centre for the IDS.
This presentation gives a summary of the activities ESOC has performed since the last IDS Workshop in 2010. The focus of the presentation will be on the improvements that have been made to the latest ESA IDS solutions (esawd06) compared to the esawd05 solution. Further, the effect of including the new Chinese HY2-A satellite into the ESA solutions will be shown.

IDS5_4: Comparaison of Stations coordinates, estimated by DORIS and GLONASS measurements for collocated sites

Authors:
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Oral presentation

Abstract text:
During the last twenty years DORIS system confirmed its excellent abilities for different geodetic and geophysical applications. DORIS system is one of the important parts of the GGOS system. IERS uses DORIS measurements for development of the ITRF solutions.

At the end of 2011 constellation of the GLONASS was completed and now 24 satellites are in operation at three orbital planes, 8 satellites in each. Inclination of the orbit is 64.80, height 19100 km and revolution time 11h 15min.

Analysis of the GLONASS data, obtained at the IGS sites, and DORIS data, obtained from IDS sites, have been performed with the use of GIPSY-OASIS II software. Results of an estimation of the GLONASS station positions were compared with the DORIS estimations at the collocated sites. Both solutions are related to the ITRF2008 coordinate system. Differences between solutions are in the limit of a few cm.

IDS5_5: DORIS positioning: performance assessment from the last data processing at CNES/CLS Analysis Center

Authors:
Laurent Soudarin[1], H. Capdeville[1] ,J.M. Lemoine[2], P. Schaeffer[1]
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Oral presentation

Abstract text:
At the end of 2011, the CNES/CLS Analysis Center has entirely re-processed the whole DORIS data set for orbit determination and tracking station coordinate estimation. In addition to SPOT-2, -3, -4, -5, Topex/Poseidon and Envisat, the DORIS/DGXX measurements of Jason-2 and Cryosat-2 are included in the products delivered to the IDS (combined multi-satellite weekly SINEX, orbits in sp3 format). The new processing was motivated by upgrades brought to the GINS/DYNAMO software and the availability of new models. The objective of this presentation is to show the impact of this reprocessing on the terrestrial reference frame. Station positioning performances are discussed. We look at the noise reduction of the coordinate time series and earth orientation, and the effect on the geocenter and the scale. We focus on the vertical position evolution of some stations collocated with tide-gauges. The contribution of the Chinese HY-2A satellite into our solutions is also shown.

IDS5_6: Implementation and use of the DORIS RINEX phase measurement in the GINS software

Authors :
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[1]CNES, [2]CLS

Oral presentation

Abstract text:
Since the launch of the new generation DGXX DORIS receiver, the DORIS basic measurement is no longer provided as a Doppler measurement, but is now available as an ambiguous phase measurement as well as a pseudo-range measurement, thus similar in many respects to a GNSS measurement. This new type of DORIS data is now provided in the DORIS RINEX format, but it is also still provided in the former Doppler-type DORIS 2.2 format. Three satellites carry today the DGXX receiver: Jason2, Cryosat2 and HY2A.

We have implemented and tested the new DORIS phase measurement in the GINS software and compared the use of this new type of measurement with the traditional Doppler measurement.

The comparison will be expressed in terms of orbital fit residuals and DORIS station network adjustment.