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IDS

ACTIVITY REPORT 2022

INTERNATIONAL DORIS SERVICE

International DORIS Service Activity Report 2022

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International DORIS Service

Central Bureau

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Preface

In this volume, the International DORIS Service documents the work of the IDS components between January 2022 and December 2022. The individual reports were contributed by IDS groups in the international geodetic community who make up the permanent components of IDS.

The IDS 2022 Report describes the history, changes, activities and the progress of the IDS. The Governing Board and Central Bureau kindly thank all IDS team members who contributed to this report.

The IDS takes advantage of this publication to relay the thanks of the CNES and the IGN to all the host agencies for their essential contribution to the operation of the DORIS system. The list of the host agencies is given in the appendix of this Report.

The entire contents of this Report also appear on the IDS website at

https://ids-doris.org/documents/report/IDS_Report_2022.pdf

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ABOUT IDS

1 INTRODUCTION

As other space-techniques had already organized into services - the International GNSS Service (IGS) for GPS, GLONASS, Galileo, Beidou, QZSS, and SBAS (*Beutler et al. 1999*, *Johnston et al. 2017*), the International Laser Ranging Service (ILRS) for both satellite laser ranging and lunar laser ranging (*Pearlman et al. 2002*, *Pearlman et al. 2019*) and the International VLBI Service for Geodesy and Astrometry (IVS) for geodetic radio-interferometry (*Schlueter et al. 2002*, *Nothnagel et al. 2017*) -, the IDS was created in 2003 as an IAG service to federate the research and developments related to the DORIS technique, to organize the expected DORIS contribution to IERS and GGOS (*Rummel et al. 2005*; *Willis et al. 2005, Tavernier et al. 2005*), and to foster a larger international cooperation on this topic.

To date, some 80 groups from 51 different countries have participated in IDS at various levels, including over 60 organizations hosting DORIS stations in 40 countries worldwide.

Two analysis centers contributed as individual DORIS solutions to ITRF2005 and in 2006 four analysis centers provided results for IDS. Since 2008, eight analysis groups have provided results, such as orbit solutions, weekly or monthly station coordinates, geocenter variations or Earth polar motion, that are used to generate IDS combined products for geodesy or geodynamics. All these centers have provided SINEX solutions for inclusion in the IDS combined solution that was submitted in 2009 to the IERS for ITRF2008. In 2009, a first IDS combined solution (*Valette et al., 2010*) was realized using DORIS solutions from 7 Analysis Groups for weekly station positions and daily Earth orientation parameters. In 2012, 6 analysis centers (ACs) provided operational products, which were combined in a routine DORIS combination by the IDS Combination Center in Toulouse. In 2013, several inter-comparisons between ACs were performed (orbit comparisons, single-satellite SINEX solutions for station coordinates). In 2013 and 2014, the Analysis Centers and the Combination Center hardly worked on preparing the DORIS contribution for the new realization of the ITRF. All the DORIS data (since 1993) were processed by the six Analysis Centers. They submitted sets of weekly SINEX solutions to the Combination Center to generate the combined products. Thanks to the numerous exchanges between the groups to address the issues identified, several iterations were performed. The final version of the IDS contribution was submitted to the IERS in 2015. It was then included in the solutions produced by the IERS Production Centers at IGN, DGFI and JPL. The activities of the DORIS analysts in 2016 and 2017 were dominated by the evaluation of these three independent realizations (ITRF2014, DTRF2014, and JTRF2014), and the DPOD2014, which is the DORIS extension of the ITRF for Precise Orbit Determination. They also focused on analyzing the data of the last DORIS satellites Jason-3 and Sentinel-3A, then Sentinel-3B in 2018, defining a strategy to minimize the impact of the sensitivity to the South Atlantic Anomaly effect of their Ultra Stable Oscillator and resolving the scale factor jump of the IDS solution. The years 2019 and 2020 were devoted to preparing and then carrying out the reprocessing of the DORIS data for the ITRF2020. Thanks to the efforts of the Analysis Centers whose activities were deeply affected by the COVID pandemic for two years, the Combination Centre delivered in 2021 the combined DORIS solution contributing to the ITRF2020 realization published in 2022.

This report summarizes the current structure of the IDS, the activities of the Central Bureau, provides an overview of the DORIS network, describes the IDS data centers, summarizes the DORIS satellite constellation, and includes reports from the individual DORIS ACs and AACs.

2 HISTORY

The DORIS system was designed and developed by CNES, the French space agency, jointly with IGN, the French mapping and survey agency, and GRGS the space geodesy research group, for precise orbit determination of altimeter missions and consequently also for geodetic ground station positioning (*Tavernier et al. 2003*).

DORIS joined the GPS, SLR and VLBI techniques as a contributor to the IERS for ITRF94. In order to collect, merge, analyze, archive and distribute observation data sets and products, the IGS was established and recognized as a scientific service of the IAG in 1994, followed by the ILRS in 1998 and the IVS in 1999. It is clear that DORIS has benefited from the experience gained by these earlier services. There was an increasing demand in the late nineties among the international scientific community, particularly the IAG and the IERS, for a similar service dedicated to the DORIS technique.

On the occasion of the CSTG (Coordination of Space Technique in Geodesy) and IERS Directing Board meetings, held during the IUGG General Assembly in Birmingham in July 1999, it was decided to initiate a DORIS Pilot Experiment (*Tavernier et al. 2002*) that could lead on the long-term to the establishment of such an International DORIS Service. A joint CSTG/IERS Call for Participation in the DORIS Pilot Experiment was issued on 10 September 1999. An international network of 54 tracking stations was then contributing to the system and 11 proposals for new DORIS stations were submitted. Ten proposals were submitted for Analysis Centers (ACs). Two Global Data Centers (NASA/CDDIS in USA and IGN/LAREG in France) already archived DORIS measurements and were ready to archive IDS products. The Central Bureau was established at the CNES Toulouse Center, as a joint initiative between CNES, CLS and IGN. The IDS Central Bureau and the Analysis Coordinator initiated several Analysis Campaigns. Several meetings were organized as part of the DORIS Pilot Experiment (**Table 1**).

The IDS was officially inaugurated on July 1, 2003 as an IAG Service after the approval of the IAG Executive Committee at the IUGG General Assembly in Sapporo. The first IDS Governing Board meeting was held on November 18, 2003 in Arles, France. Since then, each year, several IDS meetings were held (**Table 2**).

In 2022, a meeting of the Analysis Working Group was organized and held online.

Initially scheduled for October 2021, and after two postponements, an IDS Workshop took place in Venice from October 31 to November 2, 2022, in conjunction with the meeting of the Ocean Surface Topography Science Team (OSTST).

20Date	Event	Location
2000	DORIS Days http://ids-doris.org/ids/reports-mails/meeting-presentations/doris-days-2000.html	Toulouse France
2002	IDS workshop http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-workshop-2002.html	Biarritz France
2003	IDS Analysis Workshop http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-workshop-2003.html	Marne La Vallée France

Table 1. *List of meetings organized as part of the DORIS Pilot Experiment.*

Date	Event	Location
2004	Plenary meeting http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-plenary-meeting-2004.html	Paris France
2006	IDS workshop http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-workshop-2006.html	Venice Italy
2008	Analysis Working Group Meeting http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-awg-03-2008.html	Paris France
	Analysis Working Group Meeting http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-awg-06-2008.html	Paris France
	IDS workshop http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-workshop-2008.html	Nice France
2009	Analysis Working Group Meeting http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-awg-03-2009.html	Paris France
2010	Analysis Working Group Meeting http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-awg-03-2009.html	Darmstadt Germany
	IDS workshop & 20th anniversary of the DORIS system http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-workshop-2010.html	Lisbon Portugal
2011	Analysis Working Group Meeting http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-awg-05-2011.html	Paris France
2012	Analysis Working Group Meeting http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-awg-05-2012.html	Prague Czech Republic
	IDS workshop http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-workshop-2012.html	Venice Italy
2013	Analysis Working Group Meeting http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-awg-04-2013.html	Toulouse France
	Analysis Working Group Meeting	Washington

Date	Event	Location
	http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-awg-10-2013.html	USA
2014	Analysis Working Group Meeting http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-awg-03-2014.html IDS workshop http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-workshop-2014.html	Paris France Konstanz Germany
2015	Analysis Working Group Meeting http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-awg-05-2015.html Analysis Working Group Meeting http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-awg-10-2015.html	Toulouse France Greenbelt USA
2016	Analysis Working Group Meeting http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-awg-05-2016.html IDS workshop http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-workshop-2016.html	Delft The Netherlands La Rochelle France
2017	Analysis Working Group Meeting https://ids-doris.org/ids/ids/reports-mailss-mails/meeting-presentations/ids-awg-05-2017.html	London United Kingdom
2018	Analysis Working Group Meeting http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-awg-06-2018.html IDS workshop http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-workshop-2018.html	Toulouse France Ponta Delgada Portugal
2019	Analysis Working Group Meeting http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-awg-04-2019.html Analysis Working Group Meeting http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-awg-09-2019.html	Munich Germany Paris France
2021	Analysis Working Group Meeting https://ids-doris.org/ids/reports-mails/meeting-presentations/ids-awg-04-2021.html DORIS days 2021 https://ids-doris.org/ids/reports-mails/meeting-presentations/doris-day-2021.html	online online
2022	Analysis Working Group Meeting http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-awg-06-2022.html IDS workshop http://ids-doris.org/ids/reports-mails/meeting-presentations/ids-workshop-2022.html	online Venice Italy

Table 2. *List of IDS events organized between 2004 and 2022.*

3 IDS ORGANIZATION

Like the other IAG Services, an IDS Governing Board (GB), helped by a Central Bureau (CB), organizes the activities done by the Analysis Centers (AC), the Data Centers (DC), and the Combination Center (CC) (**Figure 1**).

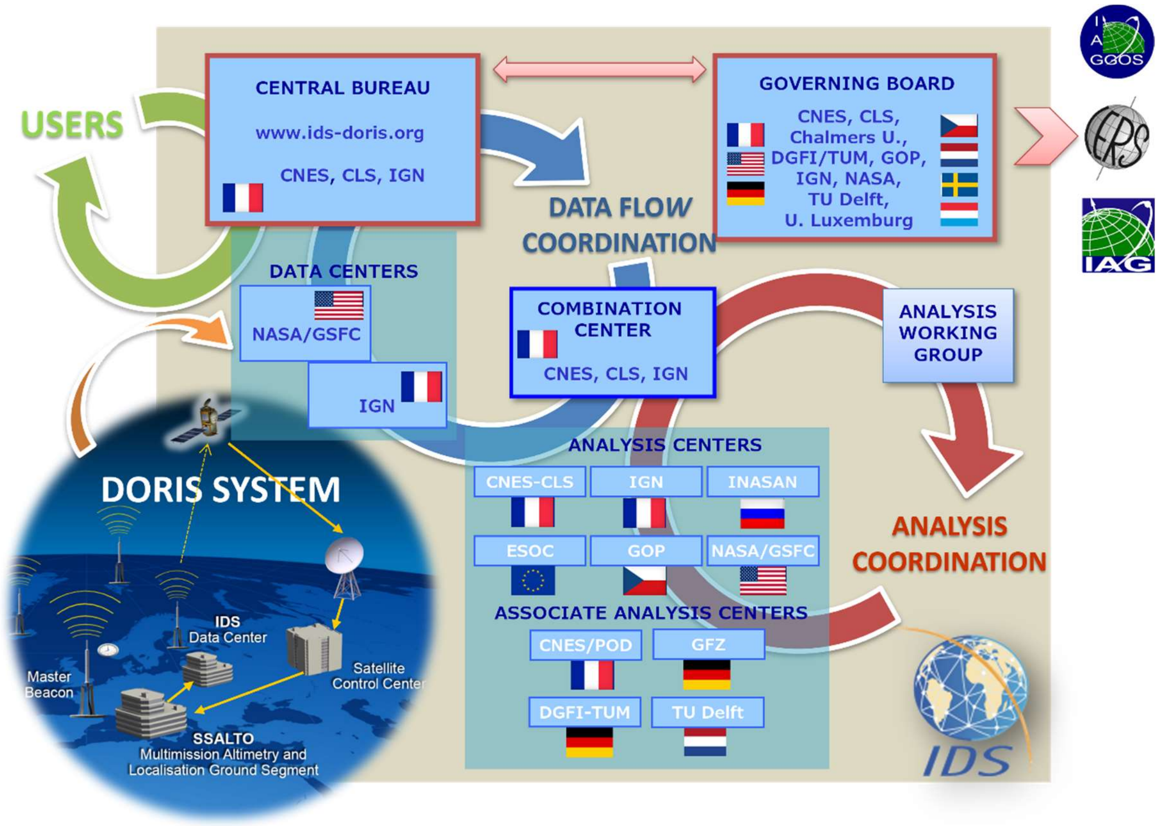


Figure 1. *IDS organization.*

3.1 GOVERNING BOARD

The principal role of the Governing Board (GB) is to set policy and to exercise broad oversight of all IDS functions and components. It also controls general activities of the Service, including restructuring, when appropriate, to maintain Service efficiency and reliability.

The GB consists of eleven voting members and several nonvoting members. The voting membership of the GB is composed of 5 members elected by the IDS Associates, and 6 appointed members. The elected members have staggered four-year terms, with elections every two years. The Analysis Centers' representative, the Data Centers' representative, and one Member-at-Large are elected during the first two-year election. The Analysis Coordinator and the other Member-at-Large are elected in the second two-year election.

In accordance with the Terms of Reference of the IDS, the GB will be partially renewed in January 2023 and January 2025.

Table 3 gives the list of the GB's members in office on January 1st, 2022. Denise Dettmering is an ex officio member of the IDS GB, in the role of Chair of the IDS Working Group on Near Real Time Data.

Position	Term	Status	Name	Affiliation	Country
Analysis coordinator	**2019-2022**	Elected	**Hugues Capdeville** **Petr Štěpánek**	CLS Geodetic Observatory Pecný	France Czech Republic
Data Centers' representative	**2021-2024**	Elected	**Patrick Michael**	NASA/GSFC	USA
Analysis Centers' representative	**2021-2024**	Elected	**Frank Lemoine (chair)**	NASA/GSFC	USA
Member at large	**2019-2022**	Elected	**Claudio Abbondanza**	NASA/JPL	USA
Member at large	**2021-2024**	Elected	**Karine Le Bail**	Chalmers University of Technology	Sweden
Director of the Central Bureau	Since 2003	Appointed	**Laurent Soudarin**	CLS	France
Combination Center representative	Since 2013	Appointed	**Guilhem Moreaux**	CLS	France
Network representative	**2021-2024**	Appointed	**Jérôme Saunier**	IGN	France
DORIS system representative	**2023-2024**	Appointed	**Arnaud Sellé**	CNES	France
IAG representative	**2019-2022**	Appointed	**Ernst Schrama**	TU Delft	The Netherlands
IERS representative	**2021-2024**	Appointed	**Tonie van Dam**	University of Luxembourg	Luxembourg
Chair of WG "NRT DORIS data"	**Nov. 2016-**	Ex-officio (non voting member)	**Denise Dettmering**	DGFI/TUM	Germany

Table 3. *List of IDS GB members in office on January 1st, 2022.*

3.2 REPRESENTATIVES AND DELEGATES

In 2022, IDS representatives and delegates are:

- IDS representatives to the IERS:
  - Analysis Coordinator: Hugues Capdeville and Petr Štěpánek
  - Network representative: Jérôme Saunier
- IDS representative to GGOS Bureau of Networks and Observations: Jérôme Saunier
- IDS representatives to GGOS Bureau of Products and Standards: Petr Štěpánek

3.3 CENTRAL BUREAU

In 2022, the IDS Central Bureau is organized as follow:

- Laurent Soudarin CLS (Director)
- Arnaud Sellé CNES
- Jérôme Saunier IGN
- Guilhem Moreaux CLS

DORIS SYSTEM

4 THE NETWORK

Jérôme Saunier / IGN, France

4.1 GENERAL STATUS AND OPERATION

After the Covid-19 sanitary crisis that considerably complicated field operations and maintenance, 2022 marked the return back to order. All the projects for the network development that were put on hold restarted. On the other hand, the Russo-Ukrainian conflict resulted in the decommissioning of the two Russian DORIS stations (Badary and Krasnoyarsk) from April 2022.

The continuation of the 4th generation beacon deployment while prioritizing stations out of order or showing signs of a fault, enabled the network to retrieve high level of service, with a mean of 88% of active sites over the year (see **Figure 2**) through a strong involvement of the CNES and IGN maintenance teams and the valuable contribution of the local host agencies. After over a year of outage, Cibinong, San Juan, Ny-Alesund II and Futuna were brought back to operation in 2022 (see **Figure 3**).

The map of the DORIS network remains unchanged except the withdrawal of Krasnoyarsk in Russia that has been definitively removed. The network has 58 stations including 4 master beacons (Toulouse, Greenbelt, Hartebeesthoek, Kourou), 1 time beacon (Terre-Adelie) and 1 experimental beacon dedicated to IDS for scientific purposes (Wettzell) (**Figure 4**).

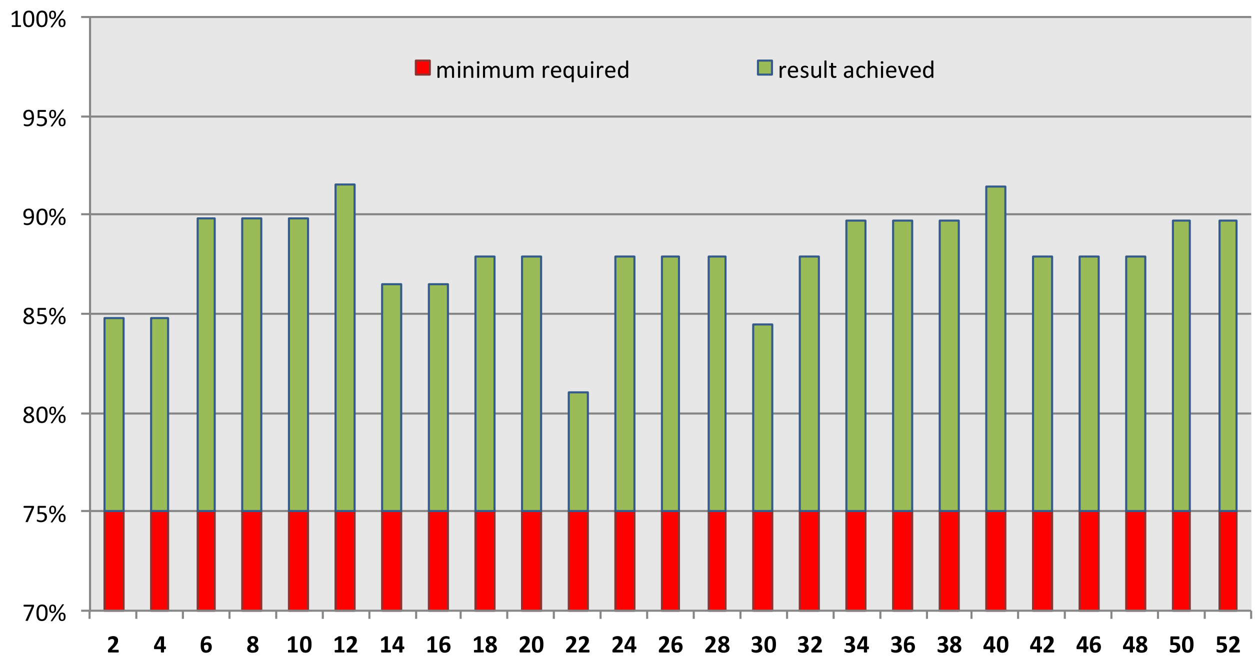


Figure 2. *Network availability 2022: Rate of stations in operation (fortnightly statement).*

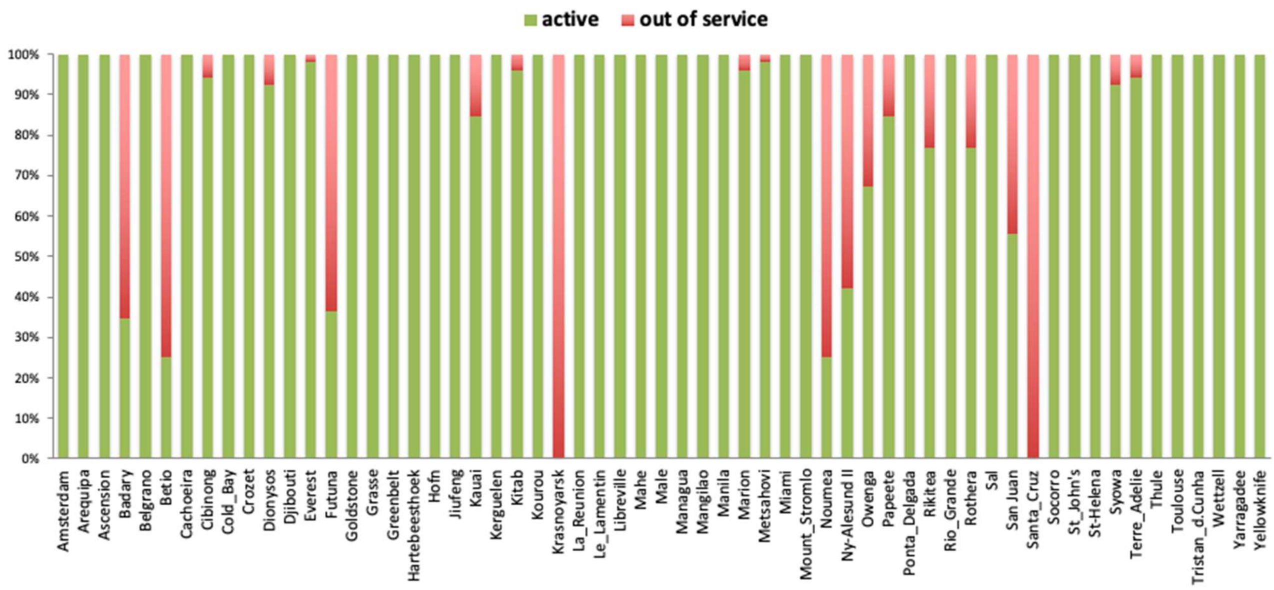


Figure 3. *Network stations activity 2022.*

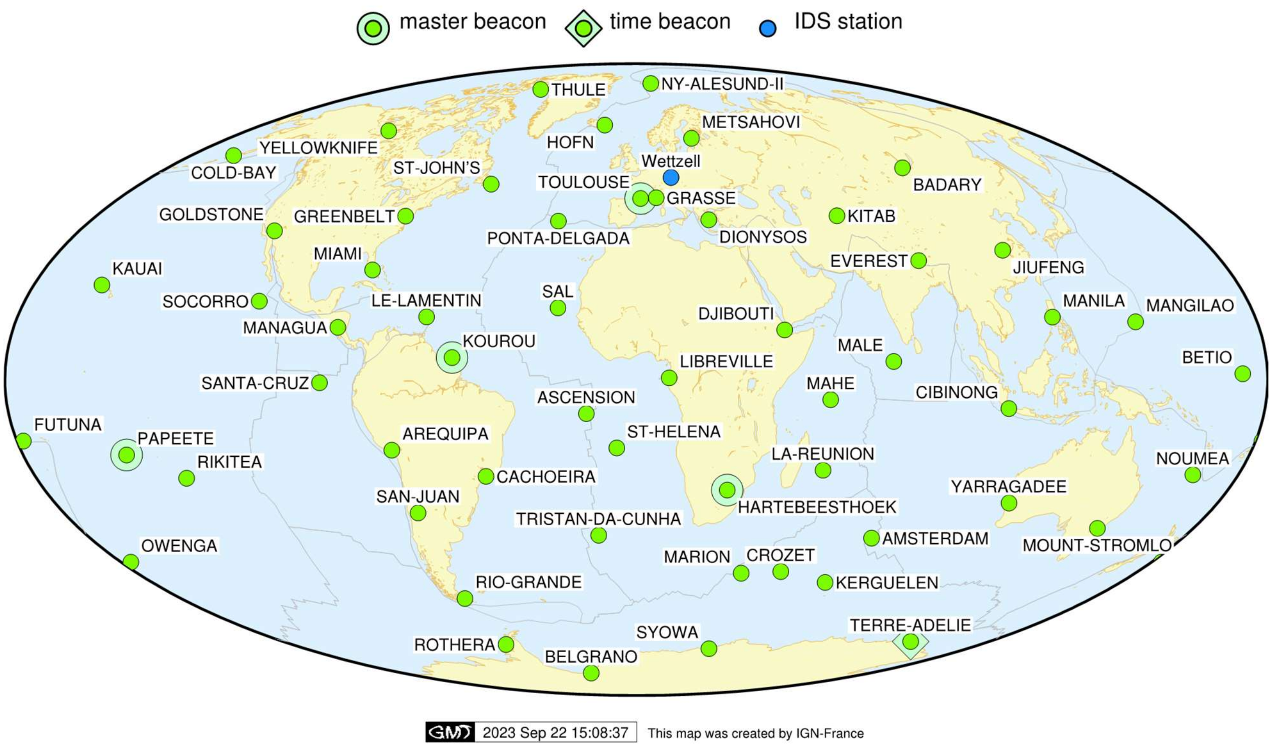


Figure 4. *The DORIS permanent network.*

4.2 EVOLUTION AND DEVELOPMENT

Regarding the ground equipment, we continued the progressive deployment of new antennas (Starec-C from 2014) and new beacons (4th generation from 2019) to replace the ageing stations equipment and take up new challenges in the years to come. At the end of 2022, 50% of the network stations are equipped with the 4th generation beacon and 41% with Starec-C antenna.

In 2022 the following DORIS sites were visited:

- B4G installing at Kourou (French Guyana)
- B4G installing at Hartebeesthoek (South Africa)
- Reconnaissance at Cachoeira Paulista (Brazil) with a view to relocate the DORIS antenna
- B4G installing at San Juan (Argentina)
- Maintenance at Ny-Alesund II (Svalbard, Norway)
- B4G installing at Futuna (France)
- B4G installing at Wettzell (Germany)
- B4G installing at Nouméa (New Caledonia, France)
- B4G installing at Owenga (Chatham Island, New Zealand)

In 2023, the overall objectives are:

- Continuation of the deployment of the 4th generation beacon
- Installation of new DORIS site at Easter Island (Chile)
- Reconnaissance in Ulaanbaatar (Mongolia) with a view to installing new station
- Restarting at Santa-Cruz (Galapagos)
- Installation of new DORIS site in Gavdos Island (Crete, Greece)
- Station renovation at Everest (Nepal)
- Installation of new DORIS site at Katherine (Australia)
- Renovation at Rikitea (French Polynesia)

In order to enhance the network reliability and coverage and to better contribute to geodesy, the densification of the network to have 70 stations is underway with a number of projects near completion. 5 additional sites should be operational in the next two years: Hanga-Roa (Easter Island, Chile), Gavdos (Crete, Greece), Katherine (NT, Australia), Ulaanbaatar (Mongolia) and Kanpur (India).

The DORIS network has a very large number of stations co-located with other techniques, thanks to a continuing effort during the development of the network for the sites selection in order to contribute to the ITRF construction (see **Figure 5**). Co-location surveys have been carried out on each DORIS co-located site, in most cases (75 %) by the IGN, following installation or maintenance operations, providing the ITRF product center with tie vectors that are essential for the combination of the independent reference frames of each technique (https://ids-doris.org/documents/BC/stations/DORIS_ext_ties.txt).

Another major objective for the DORIS network is to multiply co-location with tide gauges: about half (28) of the current stations is located on islands or in coastal areas close to tide gauges so as to contribute to the estimation of vertical land motion and monitoring of sea level (see **Figure 5**).

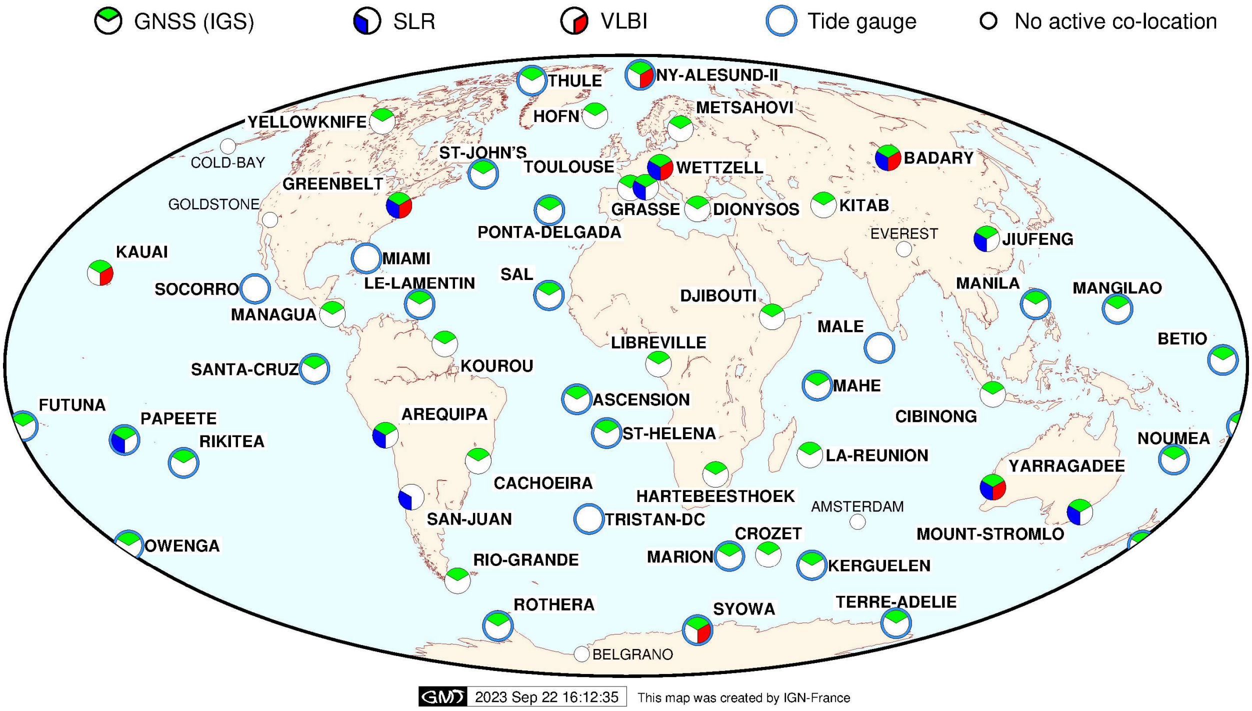


Figure 5. *DORIS stations co-located with other IERS techniques and tide gauges.*

5 THE SATELLITES WITH DORIS RECEIVERS

Arnaud Sellé / CNES, France

As described in **Table 4**, a new DORIS-equipped satellite has been launched in December 2022. It is SWOT (Surface Waters Ocean Topography), the innovative NASA/CNES/CSA/UKSA mission for global survey of the Earth's surface water. Since then, 9 satellites have been in operation in the DORIS constellation, all equipped with 7-channel DGXX-S DORIS on-board receiver, at altitudes between 720 and 1336 km, with near-polar or TOPEX-like inclination (66 deg).

In the next few years, more DORIS satellites are planned: Sentinel-3C and 3D, HY-2E, Sentinel-6B, ….

Figure 6 and **Figure 7** summarize the evolution of the DORIS constellation since the launch of the SPOT-2 satellite in 1990 and includes satellites that are currently planned. In 30 years, nine missions have carried DORIS from the launch of SPOT-2 (1990) to the end of the HY-2A mission (2020). And there are currently nine DORIS instruments in operation, all the same DGXX generation, on board satellites launched between 2010 (Cryosat-2) and 2022 (Swot). Never before have so many DORIS instruments been available to IDS users simultaneously.

Satellite	Start	End	Space Agency	Type
SPOT-2	31-MAR-1990 04-NOV-1992	04-JUL-1990 15-JUL-2009	CNES	Remote sensing
TOPEX/Poseidon	25-SEP-1992	01-NOV-2004	NASA/CNES	Altimetry
SPOT-3	01-FEB-1994	09-NOV-1996	CNES	Remote sensing
SPOT-4	01-MAY-1998	24-JUN-2013	CNES	Remote sensing
JASON -1	15-JAN-2002	21-JUN-2013	NASA/CNES	Altimetry
SPOT-5	11-JUN-2002	1-DEC-2015	CNES	Remote sensing
ENVISAT	13-JUN-2002	08-APR-2012	ESA	Altimetry, Environment
JASON -2	12-JUL-2008	10-OCT-2019	NASA/CNES	Altimetry
CRYOSAT-2	30-MAY-2010	PRESENT	ESA	Altimetry, ice caps
HY-2A	1-OCT-2011	14-SEP-2020	CNSA, NSOAS	Altimetry
SARAL/ALTIKA	14-MAR-2013	PRESENT	CNES/ISRO	Altimetry
JASON-3	19-JAN-2016	PRESENT	NASA/CNES/NOAA/ Eumetsat	Altimetry
SENTINEL-3A	23-FEB-2016	PRESENT	GMES/ESA	Altimetry
SENTINEL-3B	25-APR-2018	PRESENT	GMES/ESA	Altimetry
HY-2C	21-SEP-2020	PRESENT	CNSA, NSOAS	Altimetry
SENTINEL-6A	21-NOV-2020	PRESENT	NASA/CNES/NOAA/ Eumetsat/ESA	Altimetry
HY-2D	19-MAY-2021	PRESENT	CNSA, NSOAS	Altimetry
SWOT	16-DEC-2022	PRESENT	NASA/CNES/ CSA/UKSA	Interferometric altimetry

Table 4. *DORIS data available at IDS data centers, as of December 2022.*

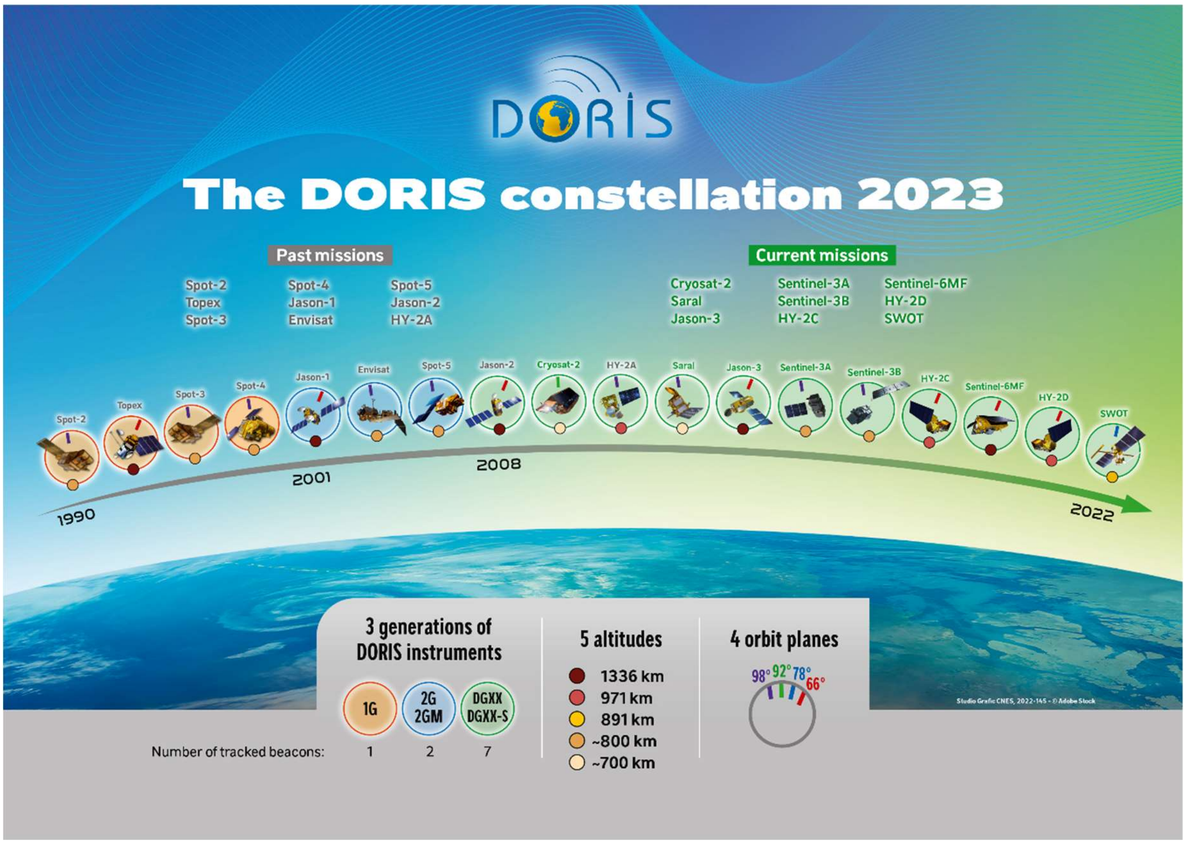


Figure 6. *DORIS satellite constellation and evolution. As of December 2022.*

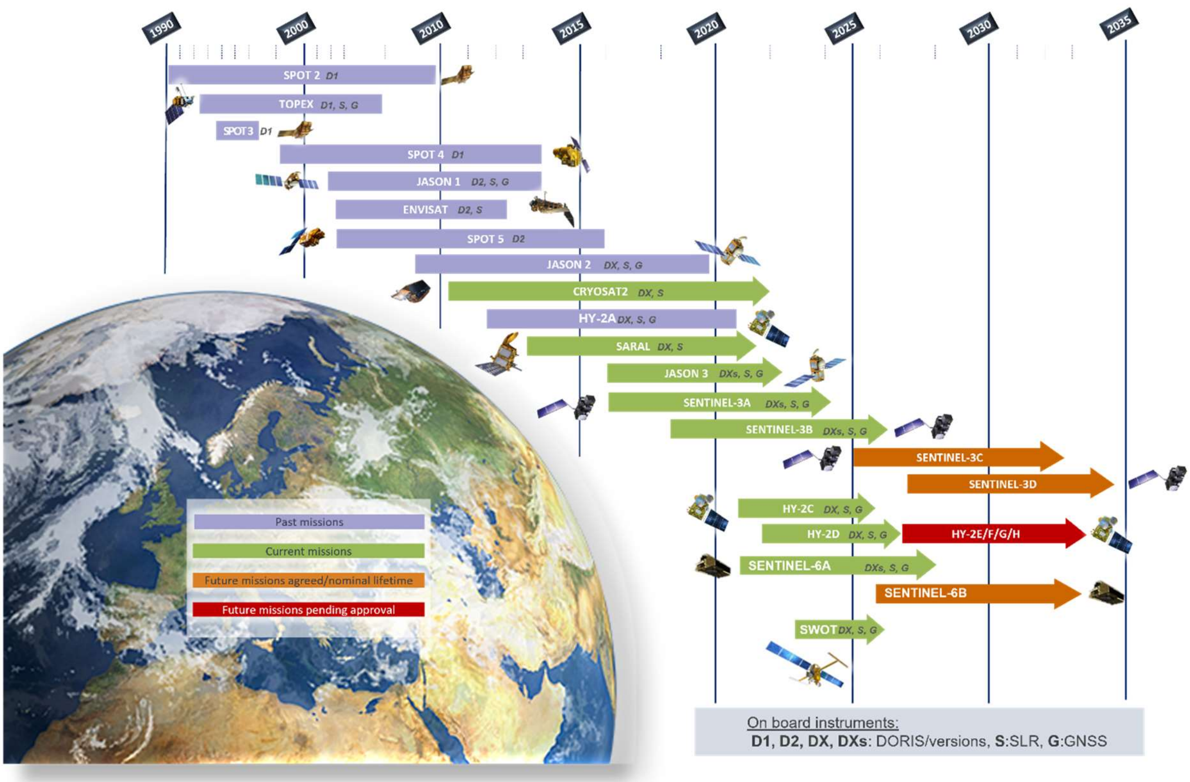


Figure 7. *Past, current and future missions with DORIS. As of December 2022.*

USER SERVICE

6 CENTRAL BUREAU

Laurent Soudarin [1], Arnaud Sellé [2]
[1] CLS, France / [2] CNES, France

The Central Bureau (CB), funded by CNES and hosted at CLS, is the executive arm of the Governing Board and as such is responsible for the general management of the IDS consistent with the directives, policies and priorities set by the Governing Board. It brings its support to the IDS components and operates the information system. This report summarizes the activities of the IDS Central Bureau during the year 2022. An overview of the IDS information system is reminded in appendix.

6.1 CALL FOR HOSTING ONE IDS STATION

In 2022, the IDS launched a call for proposals for an IDS station. The purpose of this call was to describe how institutions and host agencies can express their interest in hosting a DORIS or “IDS Station”. An “IDS station” is distinct from the general network dedicated to orbit determination and may have a specific scientific focus. This call described the system requirements for the installation, the expectations in terms of scientific outcomes and the benefits for the DORIS system and for the IDS. It also described how proposals are to be submitted and evaluated.

The call was sent out on April 27. Eight proposals were received from groups in Europe, Latin America and Asia. All the proposals were evaluated by the IDS Selection Committee and given a grade with respect to eight different criteria:

- Location (network coverage / plate motion contribution / access)
- Co-location with other instruments (geodetic techniques, gravimeter, clocks…)
- Indoor equipment housing conditions
- Antenna environment
- Monument stability
- Maintenance and security
- Host agency abilities (reliability / site surveys / motivation)
- Scientific collaboration

The results were presented to the Governing Board on September 15, who selected two proposals for the second stage of the evaluation. This includes simulations carried out by CNES to see the impact of adding the proposed sites to the existing DORIS network, requesting further information, and online meetings to get to know the candidate teams. The final selection will take place in 2023.

For this operation, the Central Bureau provided support by circulating the call, receiving proposals, organizing the special Governing Board meeting, and sending decision letters to candidates after the first selection round.

6.2 ELECTIONS FOR THE GOVERNING BOARD

In accordance with the Terms of Reference of the IDS, two positions in the IDS Governing Board became vacant at the end of 2022: the Analysis Coordinator and one Member-at-large. The CB managed the actions related to the renewal of these members for the next 4-year term 2023-2026. IDS associates were invited to nominate candidates for the two open positions.

The elections were held from Dec. 9 to Dec. 22, 2022. The members elected by the IDS Associates are:

• Analysis Coordinator: Petr Štěpánek (Pecny Observatory, Czech Republic)

• Member-at-large: Laura Sanchez (DGFI-TUM, Germany)

The Central Bureau carried out or piloted the following actions: proposed timetable; review of the list of associates; appointment of the nomination committee; preparation of the call for candidates and call for votes; posting of the list of candidates on the website, together with their CVs and programs; finding the person to collect the ballots, count the votes and report the results to the GB; updating of the different mailing lists used in the process.

6.3 MEETINGS

The Central Bureau participated in the organization of the AWG meeting held online on June 14, 2022, and the IDS Workshop in Venice, Italy, from October 31 to November 2, 2022 (see links in **Table 2**). It documented the regular GB meetings held online on July 8 and in Venice on November 2. Between the meetings, the CB coordinates the work of the GB.

6.4 IDS WORKSHOP 2022, VENICE

The IDS Workshop is held in conjunction with the Ocean Surface Topography Science Team Meeting organized in Europe. Initially scheduled for October 2021, the Workshop has been postponed twice, and finally took place in Venice a year later, from October 31 to November 2, 2022.

The CB took part in drawing up the program for the IDS Workshop. It presented IDS news. Prior to the Workshop, the CB configured and managed the workshop website https://idsworkshop.aviso.altimetry.fr/ for abstract submission, program posting, forum creation and uploading of presentations. At the end of the Workshop, a final program was created at https://idsworkshop.aviso.altimetry.fr/programs/2022-ids-workshop-complete-program.html with access to abstracts and presentations. It also gives the DOI of each abstract.

The workshop provided an opportunity for exchanges with new participants from Greece, India and Chile.

6.5 DOI ASSIGNATION

For this edition of the IDS Workshop, the CB assigned DOIs to each abstract, via the CNES DOI service. See: https://idsworkshop.aviso.altimetry.fr/programs/2022-ids-workshop-complete-program.html

The metadata associated with the abstracts can be accessed with a tool proposed by DataCite. Example: https://commons.datacite.org/doi.org/10.24400/312072/i03-2022.3675

The Central Bureau also participates in the meetings of the GGOS DOI Working Group

6.6 DATA DISSEMINATION

The Central Bureau works with the SSALTO multi-mission ground segment and the Data centers to coordinate the data and products archiving and the dissemination of the related information. Sentinel-6A CNES POE orbits in POE-F standards have been reprocessed based on several improvements and made available at IDS Data Centers

6.7 IDS CHANNEL

New videos have been added to the IDS channel:
https://www.youtube.com/@internationaldorisservice-7170

DORIS missions:

- DORIS constellation 2022 (Cryosat-2, Saral, Jason-3, Sentinel-3A, Sentinel-3B, HY-2C, Sentinel-6A, HY-2D
- The satellites HY-2C and Sentinel-6A Michael Freilich on their orbits
- DORIS Days 2021:
- Interview of Christian Jayles (CNES, France; DORIS System Engineer): Focus on some specific features of the DORIS system
- Interview of Alexandre Couhert (CNES, France; POD Team Leader): Application of DORIS for the geocenter

6.8 IDS FTP SERVER

The documents and files put on the IDS ftp site in 2022 are listed hereafter.

Updated document:

- « Sentinel-6A POD context »

ftp://ftp.ids-doris.org/pub/ids/satellites/Sentinel6A_PODcontext.pdf

New file:

- History file of Sentinel-6A attitude events

ftp://ftp.ids-doris.org/pub/ids/satellites/s6aatt.txt

Updated file:

- Local tie file

ftp://ftp.ids-doris.org/pub/ids/stations/DORIS_int_ties.txt

Documents and static files available on the ftp server in the ftp://ftp.ids-doris.org/pub/ids/ sub-directories have been copied to the web server in https://ids-doris.org/documents/BC/ to facilitate access by a web browser, as the ftp protocol is no longer supported by recent browser versions.

7 IDS DATA FLOW COORDINATION

Patrick Michael / NASA GSFC, USA

7.1 INTRODUCTION

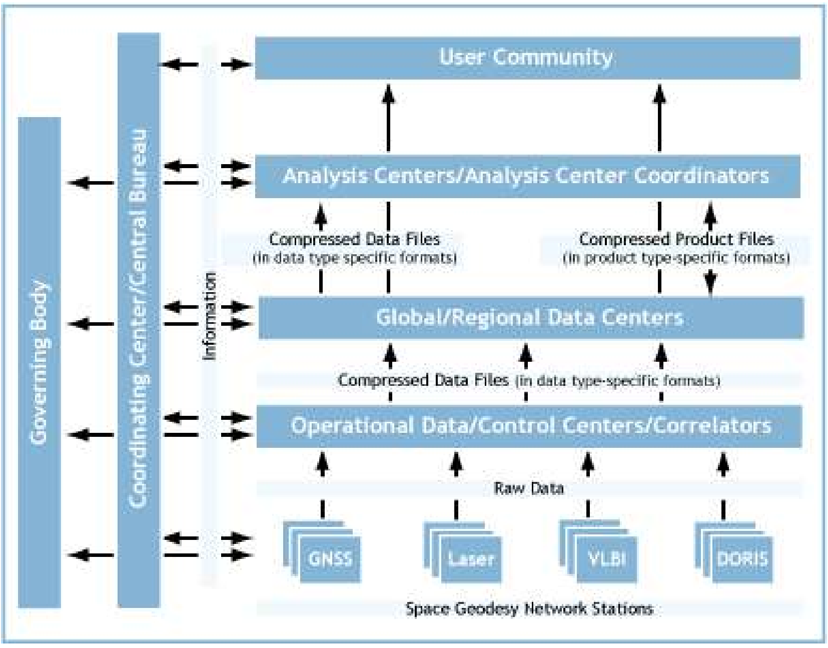
Two data centers support the archiving and access activities for the IDS:

- Crustal Dynamics Data Information System (CDDIS), NASA GSFC, Greenbelt, MD USA
- l'Institut National de l'Information Géographique et Forestière (IGN), Marne la Vallée France

These institutions have archived DORIS data since the launch of TOPEX/Poseidon in 1992.

7.2 FLOW OF IDS DATA AND PRODUCTS

The flow of data, products, and information within the IDS is similar to what is utilized in the other IAG geometric services (IGS, ILRS, IVS) and is shown in **Figure 8**. IDS data and products are transmitted from their sources to the IDS data centers. DORIS data are downloaded from the satellite at the DORIS control and processing center, SSALTO (Segment Sol multi-missions d'ALTimétrie, d'Orbitographie et de localisation précise) in Toulouse, France. After validation, SSALTO transmits the data to the IDS data centers. IDS analysis centers, as well as other users, retrieve these data files from the data centers and produce products, which in turn are transmitted to the IDS data centers.



Network Stations
Continuously operational
Timely flow of data

Data Centers
Interface to network stations
Perform QC and data conversion activities
Archive data for access to analysis centers and users

Analysis Centers
Provide products to users (e.g., station coordinates, precise satellite orbits, Earth orientation parameters, atmospheric products, etc.)

Central Bureau/Coordinating Center
Management of service
Facilitate communications
Coordinate activities

Governing Body
General oversight of service
Future direction

Figure 8. *Routine flow of data and information for the IAG Geodetic Services.*

Directory	File Name	Description
Data Directories		
/doris/data/*sss*	*sss*data*MMM*.*LLL*.Z *sss*.files	DORIS data for satellite *sss*, cycle number *MMM*, and version *LLL* File containing multi-day cycle filenames versus time span for satellite *sss*
/doris/data/*sss*/sum	*sss*data*MMM*.*LLL*.sum.Z	Summary of contents of DORIS data file for satellite *sss*, cycle number *MMM*, and file version number *LLL*
/doris/data/*sss*/yyyy	*sss*rx*YYDDD*.*LLL*.Z	DORIS data (RINEX format) for satellite sss, date YYDDD, version number *LLL*
/doris/data/*sss*/yyyy/sum	*sss*rx*YYDDD*.*LLL*.sum.Z	Summary of contents of DORIS data file for satellite *sss*, cycle number *MMM*, and file version number *LLL*
/doris/data/yyyy	*yyddd*.status	Summary file of all RINEX data holdings for year *yy* and day of year *ddd*
Product Directories		
/doris/products/2010campaign/	*ccc*/*cccYYDDDtuVV.sss*.Z	Time series SINEX solutions for analysis center *ccc*, starting on year *YY* and day of year *DDD*, type *t* (m=monthly, w=weekly, d=daily) solution, content *u* (d=DORIS, c=multi-technique), and solution version *VV* for satellite *sss*
/doris/products/dpod/	*dpodYYYY/dpodYYYY_VV.snx*.Z *dpodYYYY/dpodYYYY_ VV.txt*.Z	DPOD solutions (DORIS extension of the ITRF for Precise Orbit Determination) for year *YYYY (2000, 2005, 2008, 2014)* and solution version *VV* in sinex (*snx*) or text (*txt*) format.
/doris/products/eop/	*cccWWtuVV*.eop.Z	Earth orientation parameter solutions for analysis center *ccc*, for year *WW*, type *t* (m=monthly, w=weekly, d=daily), content *u* (d=DORIS, c=multi-technique), and solution version *VV*
/doris/products/geoc/	*cccWWtuVV*.geoc.Z	TRF origin (geocenter) solutions for analysis center *ccc*, for year *WW*, type *t* (m=monthly, w=weekly, d=daily), content *u* (d=DORIS, c=multi-technique), and solution version *VV*
/doris/products/iono/	*sss*/*cccsssVV*.*YYDDD*.iono.Z	Ionosphere products for analysis center *ccc*, satellite *sss*, solution version *VV*, and starting on year *YY* and day of year *DDD*
/doris/products/orbits/	*ccc*/*cccsssVV*.*bXXDDD*.*eYYEEE*.sp1.*LLL*.Z	Satellite orbits in SP1 format from analysis center *ccc*, satellite *sss*, solution version *VV*, start date year *XX* and day *DDD*, end date year *YY* and day *EEE*, and file version number *LLL*
/doris/products/sinex_global/	*cccWWuVV*.snx.Z	Global SINEX solutions of station coordinates for analysis center *ccc*, year *WW*, content *u* (d=DORIS, c=multi-technique), and solution version *VV*
/doris/products/sinex_series/	*ccc*/*cccYYDDDtuVV*.snx.Z	Time series SINEX solutions for analysis center *ccc*, starting on year *YY* and day of year *DDD*, type *t* (m=monthly, w=weekly, d=daily) solution, content *u* (d=DORIS, c=multi-technique), and solution version *VV*
/doris/products/stcd/	*cccWWtu*/*cccWWtuVV*.stcd.*aaaa*.Z	Station coordinate time series SINEX solutions for analysis center *ccc*, for year *WW*, type *t* (m=monthly, w=weekly, d=daily), content *u* (d=DORIS, c=multi-technique), solution version *VV*, for station *aaaa*
Information Directories		
/doris/ancillary/quaternions	*sss/yyyy/*qbody*YYYYMMDDHHMISS_yyyymmddhhmiss.LLL* *sss*/qsolp*YYYYMMDDHHMISS_yyyymmddhhmiss.LLL*	Spacecraft body quaternions for satellite *sss*, year *yyyy*, start date/time *YYYYMMDDHHMISS*, end date/time *yyyymmddhhmiss*, and version number *LLL* Spacecraft solar panel angular positions for satellite *sss*, year *yyyy*, start date/time *YYYYMMDDHHMISS*, end date/time *yyyymmddhhmiss*, and version number *LLL*
/doris/cb_mirror		Mirror of IDS central bureau files

Table 5. *Main Directories for IDS Data, Products, and General Information.*

The IDS data centers use a common structure for directories and filenames that was implemented in January 2003. This structure is shown in **Table 5** and fully described on the IDS website at *https://ids-doris.org/struct-dc.html*. The main directories are:

- */doris/data* (for all data) with subdirectories by satellite code
- */doris/products* (for all products) with subdirectories by product type and analysis center
- */doris/ancillary* (for supplemental information) with subdirectories by information type
- */doris/campdata* (for SAA-corrected data) with subdirectories by satellite code
- */doris/cb_mirror* (duplicate of the IDS Central Bureau ftp site) with general information and data and product documentation (maintained by the IDS Central Bureau)
- */doris/general* (for miscellaneous information and summary files)

The DORIS mission support ground segment group, SSALTO, and the analysis centers deliver data and products to both IDS data centers (CDDIS and IGN) to ensure redundancy in data delivery in the event one data center is unavailable. The general information available through the IDS Central Bureau ftp site are mirrored by the IDS data centers thus providing users secondary locations for these files as well.

7.3 DORIS DATA

SSALTO deposits DORIS data to the CDDIS and IGN servers. Software at the data centers scans these incoming data areas for new files and automatically archives the files to public disk areas using the directory structure and filenames specified by the IDS. Today, the IDS data centers archive DORIS data from seven operational satellites (CryoSat-2, HY-2A, Jason-2, Jason-3, SARAL, Sentinel-3A, and Sentinel-3B); data from future missions will also be archived within the IDS. Historic data from Envisat, Jason-1, SPOT-2, -3, -4, -5, and TOPEX/Poseidon, are also available at the data centers. A summary of DORIS data holdings at the IDS data centers is shown in **Table 6.** The DORIS data from select satellites are archived in multi-day (satellite dependent) files using the DORIS data format 2.1 (since January 15, 2002). This format for DORIS data files is on average two Mbytes in size (using UNIX compression). SSALTO issues an email notification through DORISReport once data are delivered to the IDS data centers.

DORIS phase data from CryoSat-2, HY-2A, HY-2C, HY-2D, Jason-2, Jason-3, SARAL, Sentinel 3A and -3B, and Sentinel-6A are also available in the format developed for GNSS data, RINEX (Receiver Independent Exchange Format), version 3.0. These satellites have the newer, next generation DORIS instrumentation on board, which is capable of generating DORIS data compatible with the RINEX format; future satellites will also utilize this type of DORIS receiver. These data are forwarded to the IDS data centers in daily files prior to orbit processing within one-two days (typically) following the end of the observation day. Data from Jason-3 and Sentinel 3A and -3B are only available in the RINEX format.

In the fall of 2012, the IDS Analysis Working Group requested a test data set where data from stations in the South Atlantic Anomaly (SAA) were reprocessed by applying corrective models. Data in DORIS V2.2 format from the Jason-1 satellite (cycles 104 through 536, Jan. 2002 through Jun. 2013) have been submitted to the IDS data centers; a set of SPOT-5 data (cycles 138 through 501, Dec. 2005 through Nov. 2015) have also been submitted and archived. These files are archived at the IDS data centers in campaign directories, e.g., at CDDIS:

ftps://gdc.cddis.eosdis.nasa.gov/doris/campdata/saacorrection/ja1 .and */sp5*
https://cddis.nasa.gov/archive/doris/campdata/saacorrection/ja1 .and */sp5*

Satellite	Time Span	Data Type
CryoSat-2	30-May-2010 through present	Multi-day, RINEX
Envisat	13-Jun-2002 through 08-Apr-2012	Multi-day
HY-2A	01-Oct-2011 through 11-Sep-2020	Multi-day, RINEX
HY-2C	11-Sep-2020 through present	RINEX
HY-2D	15-May-2021 through present	RINEX
Jason-1	15-Jan-2002 through 21-Jun-2013	Multi-day
Jason-2	12-Jul-2008 through 10-0ct-2019	Multi-day, RINEX
Jason-3	17-Feb-2016 through present	RINEX
SARAL	14-Mar-2013 through present	Multi-day, RINEX
Sentinel-3A	23-Feb-2016 through present	RINEX
Sentinel-3B	01-May-2018 through present	RINEX
Sentinel-6A	17-Dec-2020 through present	RINEX
SPOT-2	31-Mar through 04-Jul-1990 04-Nov-1992 through 14-Jul-2009	Multi-day
SPOT-3	01-Feb-1994 through 09-Nov-1996	Multi-day
SPOT-4	01-May-1998 through 24-Jun-2013	Multi-day
SPOT-5	11-Jun-2002 through 30-Nov-2015	Multi-day
TOPEX/Poseidon	25-Sep-1992 through 01-Nov-2004	Multi-day

Table 6. *DORIS Data Holdings Summary.*

7.4 DORIS PRODUCTS

IDS analysis centers utilize similar procedures by putting products to the CDDIS and IGN servers. Automated software detects any incoming product files and archives them to the appropriate product-specific directory. The following analysis centers (ACs) have submitted products on an operational basis to the IDS; their AC code is listed in ():

- European Space Agency (esa), Germany
- Geoscience Australia (gau) (historic AC)
- Geodetic Observatory Pecny (gop), Czech Republic
- NASA Goddard Space Flight Center (gsc) USA
- Institut Géographique National/JPL (ign) France
- INASAN (ina) Russia
- CNES/CLS (lca historically, grg starting in 2014) France
- CNES/SOD (sod) France (historic AC)
- SSALTO (ssa) France

A solution (designated “ids”) produced by the IDS combination center from the individual IDS AC solutions started production in 2012. IDS products are archived by type of solution and analysis center. The types and sources of products available through the IDS data centers in 2005-2021 are shown in **Table 7**. This table also includes a list of products under evaluation from several DORIS analysis centers.

Type of Product	ACs/Products										
	ESA	GAU *	GOP	GRG **	GSC	IDS	IGN	INA	LCA **	SOD *	SSA
Time series of SINEX solutions (*sinex_series*)	X	X	X	X	X	X	X	X	X	X	X
Global SINEX solutions (*sinex_global*)				X			X		X		
Geocenter time series (*geoc*)							X	X	X		
Orbits/satellite (orbits)				X	X				X		X
Ionosphere products/satellite (*iono*)											X
Time series of EOP (*eop*)							X	X			
Time series of station coordinates (*stcd*)	X		X	X	X	X	X	X	X		X
Time series of SINEX solutions (*2010campaign*)		X	X		X		X	X	X		

*Note: GAU and SOD historic solutions

**Note: CNES/CLS transitioned their AC acronym from LCA to GRG in 2014.

Table 7. *IDS Product Types and Contributing Analysis Centers.*

7.5 SUPPLEMENTARY DORIS INFORMATION

In 2009 an additional directory structure was installed at the IDS data centers containing ancillary information for DORIS data and product usage. Files of Jason-1, -2, and -3 satellite attitude information were made available through the IDS data centers. Two types of files are available for each satellite: attitude quaternions for the body of the spacecraft and solar panel angular positions. The files are delivered daily and contain 28 hours of data, with 2 hours overlapping between consecutive files. Analysts can use these files in processing DORIS data to determine satellite orientation and attitude information.

7.6 FUTURE PLANS

The CDDIS and IGN provide reports that list holdings of DORIS data in the DORIS format. The IDS data centers will also investigate procedures to regularly compare holdings of data and products to ensure that the archives are truly identical.

8 IDS DATA CENTERS

8.1 CRUSTAL DYNAMICS DATA INFORMATION SYSTEM (CDDIS)

Patrick Michael / NASA GSFC, USA

8.1.1 INTRODUCTION

The CDDIS is a dedicated data center supporting the international space geodesy community since 1982. The CDDIS serves as one of the primary data centers for the following IAG services, projects and international groups:

- International DORIS Service (IDS)
- International GNSS Service (IGS)
- International Laser Ranging Service (ILRS)
- International VLBI Service for Geodesy and Astrometry (IVS)
- International Earth Rotation and Reference Frame Service (IERS)
- Global Geodetic Observing System (GGOS)

The CDDIS is one of NASA's Earth Observing System Data and Information System (EOSDIS) Distributed Active Archive Centers (DAACs); EOSDIS data centers serve a diverse user community and are tasked to provide facilities to search and access science data and products. The CDDIS is also a regular member of the International Council for Science (ICSU) World Data System (WDS).

8.1.2 OPERATIONAL ACTIVITIES

At the end of 2022, the CDDIS has devoted 146 GB of disk space (83GB or ~57% for DORIS data, 38GB or ~26% for DORIS products, and 25GB or ~17% for DORIS ancillary data and information) to the archive of DORIS data, products, and information (**Figure 9**). During the past year, users downloaded 1949 Gbytes (1,033,799 files) of DORIS data, products, and information from the CDDIS (**Figure 10**).

The CDDIS provides a file that summarizes the RINEX-formatted data holdings each day. Information provided in the status file includes satellite, start and end date/time, receiver/satellite configuration information, number of stations tracking, and observation types. These files are accessible in yearly sub-directories within the DORIS data subdirectory on CDDIS, *ftps://gdc.cddis.eosdis.nasa.gov/doris/data* or *https://cddis.nasa.gov/archive/doris/data*.

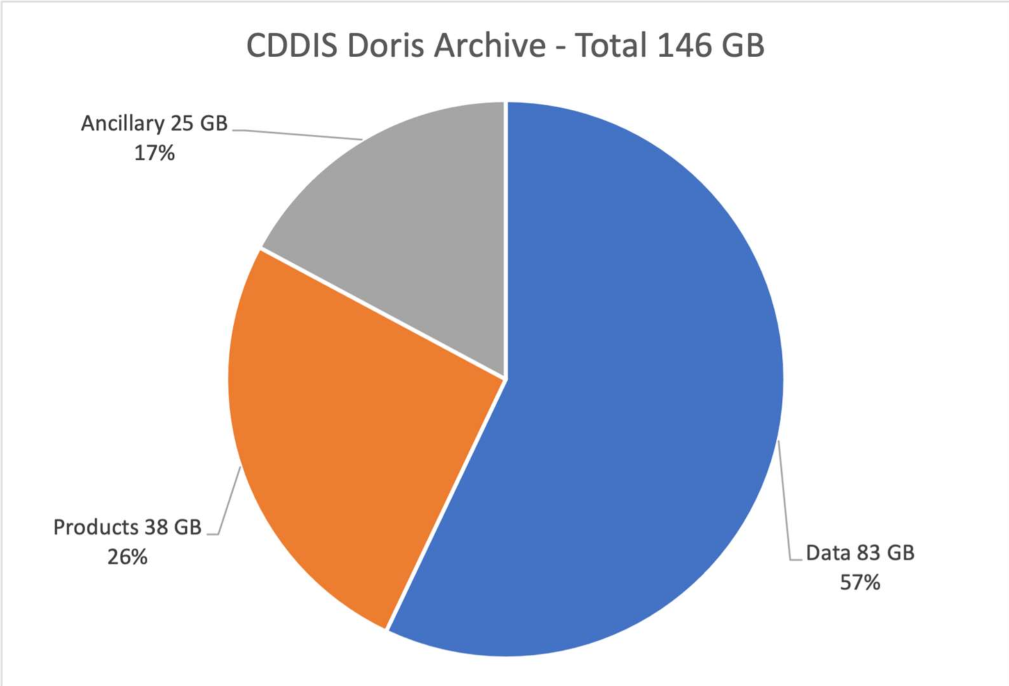


Figure 9. *CDDIS DORIS archive.*

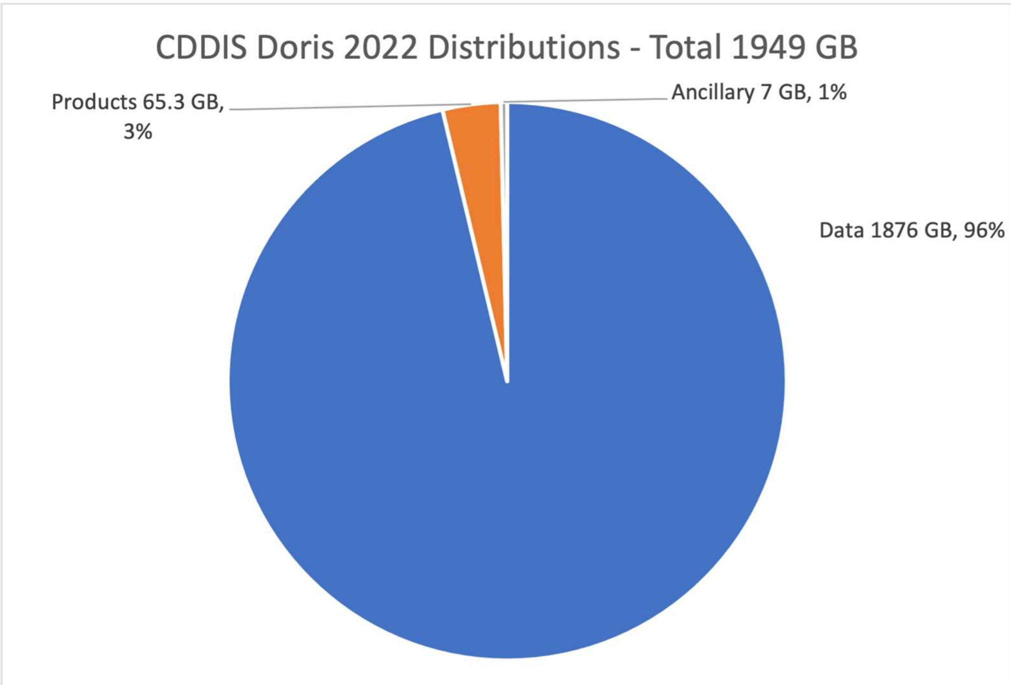


Figure 10. *CDDIS DORIS 2022 distributions.*

8.1.3 RECENT ACTIVITIES AND DEVELOPMENTS

No major recent activities were completed in 2022.

8.1.4 FUTURE PLANS

The CDDIS staff will continue to interface with the IDS Central Bureau (CB), SSALTO, and the IDS analysis centers to ensure reliable flow of DORIS data, products, and information. Enhancements and modifications to the data center will be made in coordination with the IDS CB.

The CDDIS has established Digital Object Identifiers (DOIs) for several of its GNSS data sets; website "landing" pages have been established for these published DOIs. DOIs for additional items, including DORIS data and products, are under development and review prior to registering and implementation.

The CDDIS continues to review and update its ingest procedures to both decrease latency of file delivery to the public archive and to continually improve quality control checks to all incoming data and products. In addition, CDDIS has made it's archive fully available through https.

In response to increased Information Technology (IT) security requirements from both the U.S. Government and NASA, CDDIS was forced to remove unencrypted anonymous ftp access to its archive in the fall of 2020 and in its place put in encrypted ftp or what is commonly called ftp over SSL/TLS. The entire archive with the same directory structure is available using ftp-ssl at gdc.cddis.eosdis.nasa.gov.

8.1.5 CONTACT

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Archive access: ftps://gdc.cddis.eosdis.nasa.gov/doris
https://cddis.nasa.gov/archive/doris
Technical support: support-cddis@earthdata.nasa.gov

8.2 IGN DORIS DATA CENTER

Jérôme Saunier / IGN, France

8.2.1 INTRODUCTION

The IGN Data Center was set up in order to archive and distribute data from French national and international services such as Réseau GNSS Permanent (RGP), EUREF, IGS, and IDS. The IGN Data Center has been operational since 2006. Today the IGN Data Center serves as:

- IGS Global Data Center
- IGS Terrestrial Frame Combination Center
- IDS Data Center
- EUREF Permanent GNSS Network Local Data Center
- REGINA Data Center
- RGP Data Center
- SONEL Data Center

8.2.2 ARCHITECTURE AND DATA ACCESS

To ensure a more reliable data flow and a better availability of the service, two identical infrastructures and configurations have been setup in two different locations at IGN: (1) Saint-Mandé and (2) Marne-la-Vallée.

Each site offers:

- FTP deposit server for data and analysis centers uploads, requiring special authentication
- Free FTP anonymous access to observations data and products
- Independent Internet links

All the DORIS data and products archived and available at IGN GDC may be access through:

- ftp://doris.ign.fr (Saint-Mandé)
- ftp://doris.ensg.eu (Marne-la-Vallée)

8.2.3 OPERATIONAL ACTIVITIES

The IGN Data Center stores about 150 Go for DORIS and the IDS, including data, products, metadata and information. In 2022, regarding IDS section, the number of visits to the data center is stable compared to last year, reaching 5450 visits, but there is a 3-fold increase of the downloaded data volume with 714 Go (906 218 files) of DORIS data downloaded by the users.

The data center operated normally throughout the year with continuous service and very little maintenance for full availability of new IDS data and products.

The interface with the IDS Central Bureau, Combination Center and Analysis Centers enabled reliable provision of data and products. The CNES tool scanning the whole tree structure checked the SSALTO data deliveries (orbits, RINEX, quaternions) regularly to detect missing files and anomalies, and remedial actions were carried out forthwith.

8.2.4 MAINTENANCE AND DEVELOPMENT

The delivery of Near-Real-Time DORIS data and products was implemented at the beginning of 2021 at IGN Data Center: Jason-3 RINEX data and Diode orbits are distributed with a latency of about 2-3 hours. This enables contributing to the ultra-rapid ionosphere VTEC modeling. More NRT DORIS Data from other missions with different orbits (altitude, inclination) should be implemented within the next two years as requested by the IDS WG “NRT DORIS Data”.

Regarding hardware enhancement, the IGN Data Center planned the separation of servers' infrastructure between GNSS data and DORIS data to have full projects independence and avoid mutual interferences.

8.2.5 CONTACT

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Technical support: ids.data.center@ign.fr
Archive access: ftp://doris.ign.fr or ftp://doris.ensg.eu

ANALYSIS ACTIVITIES

9 ANALYSIS COORDINATION

Petr Štěpánek / Geodetic Observatory Pecný, VÚGTK, Czech Republic

9.1 INTRODUCTION

The activities of all the DORIS analysts of the past year 2021 were still affected by COVID pandemic in the first half of the year. One Analysis Working Group meeting was held online in April 2021. The AWG then met only online on June 14, 2022. The other AWG meeting has not been realized since most of the AWG members participated in DORIS IDS Workshop 2022 October 31 – November 2, Venice, Italy.

9.2 ANALYSIS WORKING GROUP MEETING

23 people from 12 institutions and 7 countries attended the virtual AWG meeting on June 14, 2022. The meeting started by welcoming the participants. Then 14 presentations followed. The meeting was closed by discussions. Presentation block started typically with DORIS system and network status reports. The major part of the meeting was devoted to the post-ITRF2020 reprocessing plans and activities of IDS analysis centers and associated analysis centers. The CNES POD team presented how to profit from the tandem phase of Jason-3/Sentinel-6 and Sentinel-3A/Sentinel-3B. Also detail analysis of Tristan Da Cunha data was presented.

Presentations from the AWG meeting are available on the IDS website at:

https://ids-doris.org/ids/reports-mails/meeting-presentations/ids-awg-06-2022.html

9.3 ANALYSIS CENTERS AND COMBINATION CENTER

The IDS covers six Analysis Centers (AC) and four Associate Analysis Centers (AAC) who use eight different software packages, as summarized in **Table 8**. Some analysis centers perform POD analyses of DORIS satellites on a routine basis using other geodetic techniques (SLR and GNSS).

Four ACs fully participate in operational solutions (ESA, GSC, GRG, GOP]. The IGN center has not yet restarted routine solution delivery after the retirement of its long- time responsible Pascal Willis, but its representatives are active and working on a return to operational status. The INA center has problems with a new software package development. The Associate Analysis centers (AACs) GFZ and DGFI-TUM are active in specific DORIS tasks. CNES AAC continues in the POD solutions, including new satellites Sentinel-6A and HY-2C.

The combination center (CC) provides routine weekly IDS SINEX series each 3 months.

Name	Center	Location	Contact	Software	Multi-technique
ESA	AC	Germany	Michiel Otten	NAPEOS	DORIS, SLR, GNSS
GOP (Geodetic Observatory Pecny)	AC	Czech Republic	Petr Stepanek	Bernese	
GRG (GRGS)	AC	France	Hugues Capdeville	GINS	DORIS, SLR, GNSS
GSC (NASA/GSFC)	AC	USA	Frank Lemoine	GEODYN	DORIS, SLR
GN	AC	France	Arnaud Pollet Samuel Nahmani	GIPSY	
INA (Inasan)	AC	Russia	Sergei Kuzin	GIPSY/own development	
CNES	AAC	France	Alexandre Couhert	Zoom	DORIS, SLR, GNSS
GFZ	AAC	Germany	Patrick Schreiner	EPOS	DORIS, SLR, GNSS, VLBI
TU Delft	AAC	The Netherlands	Ernst Schrama	Geodyn	DORIS, SLR
DGFI-TUM	AAC	Gemany	Mathis Bloßfeld Sergei Rudenko	DOGS	DORIS, SLR

***Table 8**. Summary of IDS Analysis Centers (AC) and Associate Analysis Centers (AAC).*

10 COMBINATION CENTER

Guilhem Moreaux / CLS, France

10.1 ACTIVITY SUMMARY

In addition to the routine evaluation and combination of the IDS AC solutions, in 2022, the IDS Combination Center computed the first version of the DORIS extension of the ITRF2020 for Precise Orbit Determination (DPOD2020). The IDS CC also performed some analysis on single satellite solutions as well as on the DORIS evaluation of the ITRF2020.

10.2 IDS ROUTINE EVALUATION AND COMBINATION

At the end of 2022, the time span of the SINEX files of the IDS combined solution was 1993.0-2022.75. These files correspond to the IDS series 19 and 20 (since 2021.0), extension of the IDS contribution to the ITRF2020 (IDS 16). The IDS 20 differs to the IDS 19 series by the addition of the ESA 15 weekly solution.

The routine evaluation includes the analysis of the coordinate time series to detect any change in either the position or the trend which may be the consequence of a geophysical event, of the time evolution of the DORIS constellation, of a new model, of the time evolution of the ground beacon equipment… The analysis of the coordinate time series of the ARFB station at Arequipa from all the IDS ACs revealed a discontinuity in the East direction late 2020 (see **Figure 11**). That discontinuity happens while no geophysical event and no technical event was listed for the station. However, the discontinuity seems to take place while the HY-2A mission is over and stops to contribute to the multi-satellite solutions from the four IDS ACs. That impact of the HY-2A mission on the coordinate time series of the ARFB station may be the consequence of the sensitivity of the HY-2A DORIS receiver to the South Atlantic Anomaly which will be the subject of a forthcoming study.

10.3 DORIS EVALUATION OF THE ITRF2020P

Early 2022, with the delivery of the preliminary version of the ITRF2020, the IDS CC performed some tests on to validate that new solution. The first test showed that all the DORIS stations contained in the 1456 weekly SINEX files of the IDS 16 series (IDS contribution to the ITRF2020) were part of the ITRF2020P, including the DORIS stations with short time spans (such as AJAB, FLOA, IQUB…). The IDS CC also noticed that the latest station SJUC installed at San Juan late 2018 was part of the ITRF2020PO solution and was associated with Post Seismic Deformation corrections. Thus, the IDS CC generated the weekly coordinate time series of SJUC from the ITRF2020P files and compared it with the IDS 16 ones. As depicted by **Figure 12**, we observe a non-negligible offset on the East component. The IDS CC continued the validation of the ITRF2020P with the estimation of the Helmert parameters of the IDS 16 series with respect to that new ITRF realization and compared the results with the ones obtained with ITRF2014. As expected, the main difference concerns the scale from 1993.0 to 2002.5 due to the use of a new phase law for the Alcatel ground antennae for the ITRF2020 processing. The IDS CC also tested the use of the annual and semi-annual ITRF2020P corrections. All the results of that DORIS validation of the ITRF2020P were addressed to the IGN ITRS Combination Center.

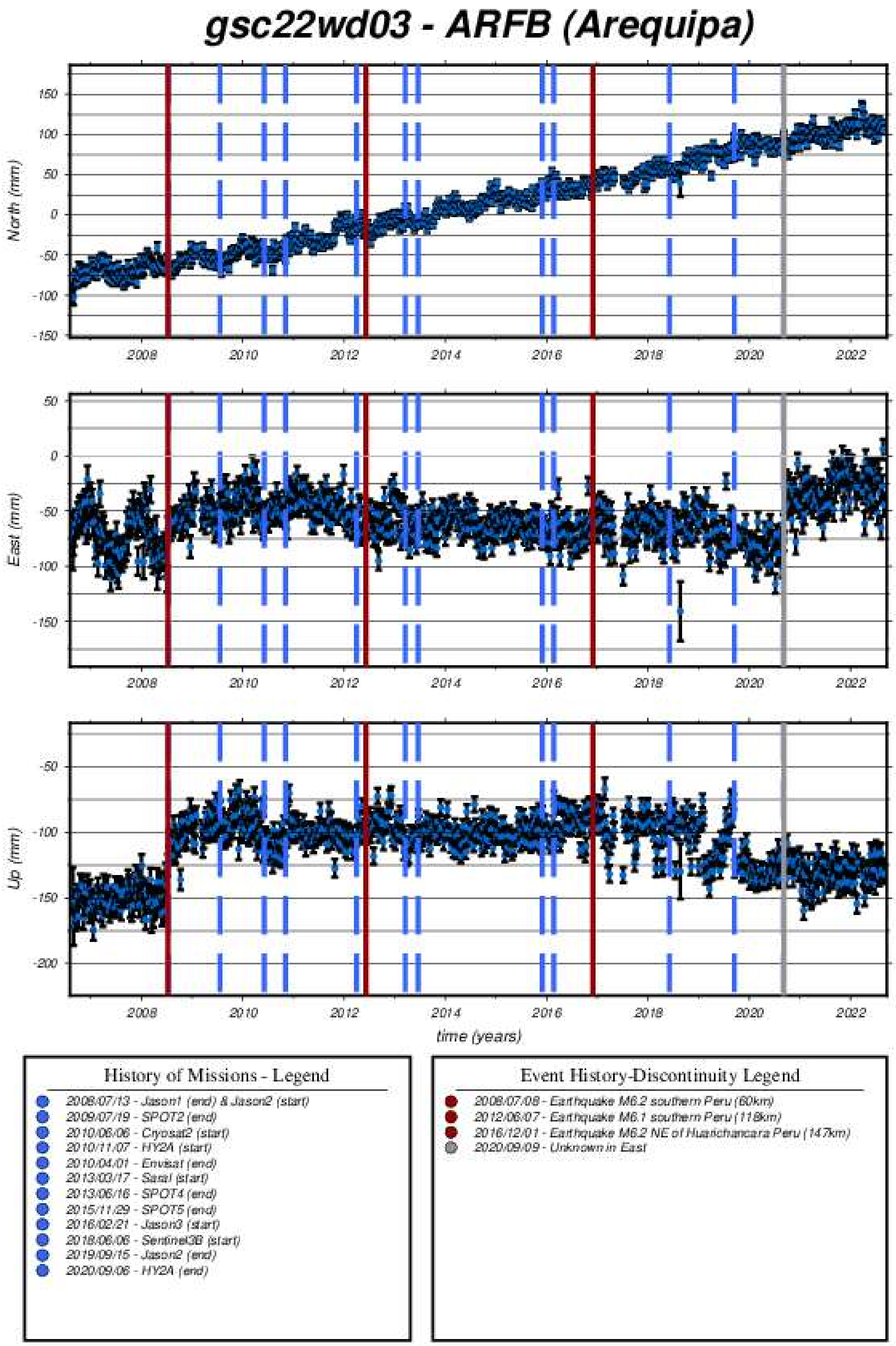

Figure 11. *Coordinate time series of the ARFB station at Arequipa from the GSC 53 series aligned to ITRF2014.*

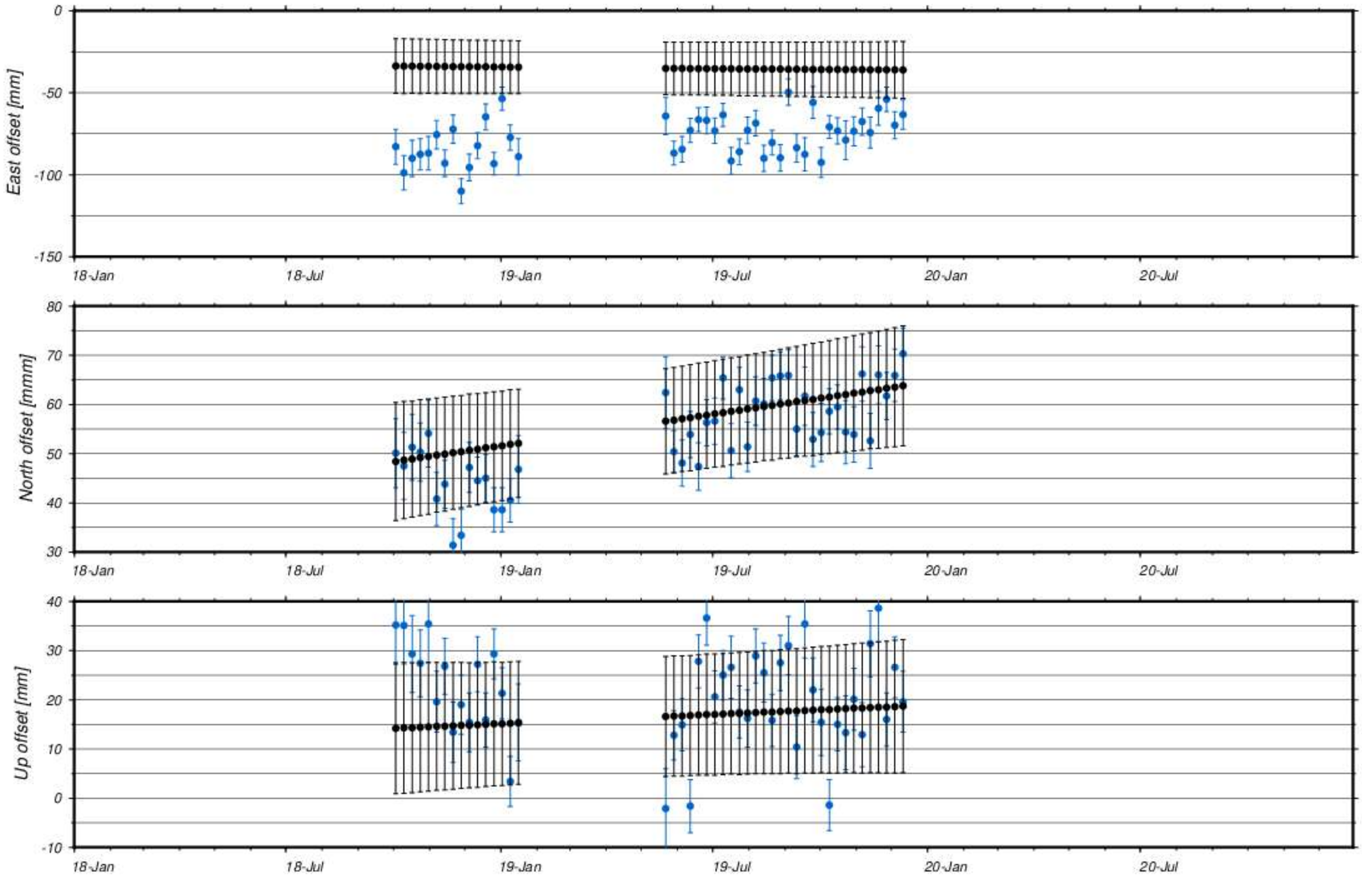

Figure 12. *Coordinate time series of the DORIS station SJUC at San Juan from the IDS 16 series (blue) and ITRF2020P (black).*

10.4 DPOD2020 VERSION 1.0

After any release of a new ITRF solution, the IDS initiates the process for the generation of the first version of a new DPOD solution. Thus, early 2022, the IDS CC started the computation of the DPOD2020 version 1.0 with the estimation of a DORIS station position and velocity cumulative solution (aligned to the ITRF2020) from the IDS 19 series over the time span 1993.0-2022.0. In this section, we present some of the tests the IDS CC performed for the validation of the DPOD2020 version 1.0. All the details on the computation and validation of the DPOD2020 version 1.0 are given in a dedicated paper which is already in review.

As usual, the computation of the cumulative solution begins with the analysis of the coordinate time series of all the DORIS stations over the entire time span to update the discontinuity file which contains dates of both the coordinate jumps and the velocity changes. That step is also used to update the velocity constraint file to force nearby stations or multiple segments of the same station to have the same velocity unless a velocity discontinuity was observed (e.g. due to an earthquake). From the analysis of the IDS 19 coordinate time series, we ended up with 105 discontinuities at 42 of the 88 DORIS sites between 1993.0 and 2022.0. Note that nearly half (52) of these discontinuities have a seismic or a geophysical origin, 19 are associated with technical events (such as an antenna change, beacon or USO change), while nearly one-third (34) have an unknown origin. In addition to the above-mentioned velocity constraints, the DORIS-to-DORIS surveyed ties can also be used as constraints in the stacking of the IDS 19 series. Therefore, we generated two versions of the cumulative solution: with (designated by DPOD2020 v1.0) and without (designated by DPOD2020 v0.0) the surveyed ties as constraints. Then, we computed the coordinate differences with ITRF2020 at the mean epoch of each time segment of all the stations.

As indicated in **Table 9**, the use of the 112 surveyed ties over 57 DORIS as constraints slightly reduces the coordinate differences with ITRF2020 (which also use some DORIS-to-DORIS surveyed ties as constraints). Moreover, the impact of adding the surveyed ties as constraints induce coordinate differences with mean, median and RMS values below 2 mm compared to the solution without such constraints. As a consequence, we decided to use these DORIS-to-DORIS surveyed ties as stacking constraints in the computation of the DPOD2020 version 1.0.

The IDS CC continued the validation process of the DPOD2020 version 1.0 by analyzing the largest station position differences (at the mean epoch of each time segment of each station) with ITRF2020 depicted by **Figure 13**. As expected, we observe that the highest station position differences between DPOD2020 version 1.0 and ITRF2020 are associated with stations either localized in the SAA region (ex: Arequipa, Ascension, Cachoeira, Libreville, Saint-Hélène, Santiago, Tristan Da Cunha) or with very short time span (ex: Flores, Iquique, San Juan). The differences with the SAA stations are the consequence of the contribution of the GNSS solutions to the DORIS ITRF2020 by the use of GNSS-to-DORIS surveyed ties. The differences we observe for the sites with very short time span may be explained by the impact of adding or rejecting a few weeks in the estimation of the mean positions and velocities. In overall, eighty percent of the 3D station position differences between DPOD2020 version 1.0 and ITRF2020 are smaller than 10 mm.

Unit = mm	DPOD2020 v1.0 vs v0.0	DPOD2020 v0.0 vs ITRF2020	DPOD2020 v1.0 vs ITRF2020
Maximum	16.51	41.28	40.86
Mean	0.77	6.37	6.16
STD	1.28	5.25	5.10
RMS	1.49	8.25	7.99
Median	0.42	4.98	4.78

Table 9. *Statistics of the station coordinate differences between DPOD2020 v0.0 (without ties as constraints), DPOD2020 v1.0 (with ties as constraints) and ITRF2020.*

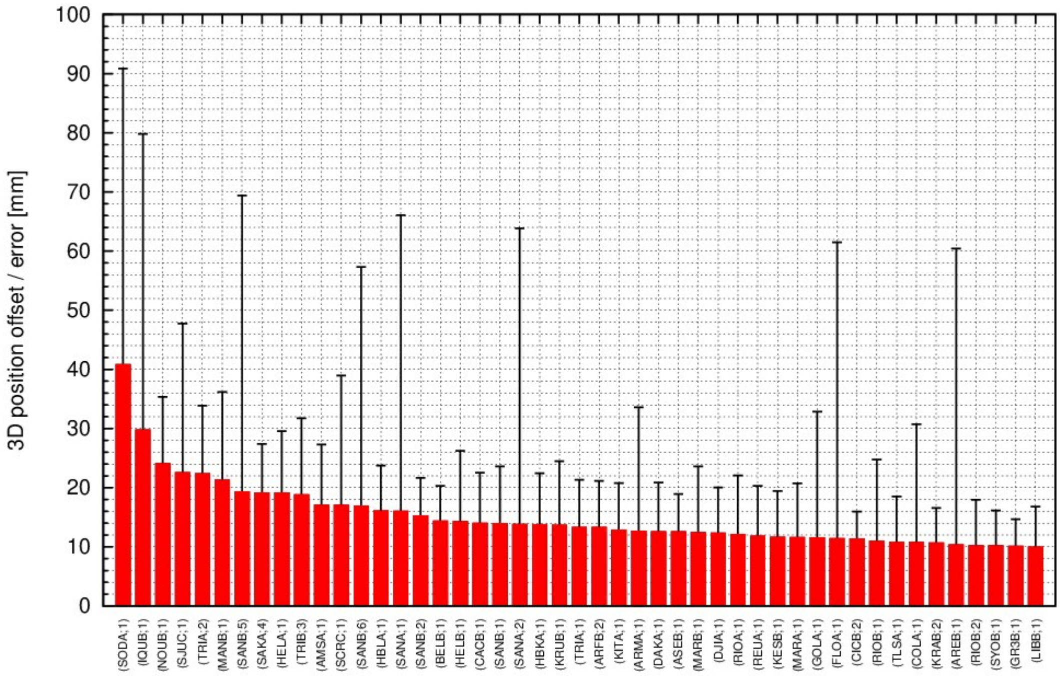

Figure 13. *3D position differences between DPOD2020 version 1.0 and ITRF2020. We only show differences larger than 10 mm. The black vertical bars represent the 3D formal errors of the DPOD2020 positions.*

Unit = mm	DPDO2020 v1.0	ITRF2020
Number of ties	110	105
Number of sites	56	55
Maximum	45.20	49.16
Mean	13.63	13.49
STD	9.08	9.70
RMS	16.36	16.59
Median	10.49	11.36

Table 10. *Main statistics of the DORIS-to-DORIS tie residuals from DPOD2020 version 1.0 and ITRF2020.*

Unit = mm	DPDO2020 v1.0	ITRF2020
Number of ties	87	84
Number of sites	50	48
Maximum	56.23	63.88
Mean	16.82	14.76
STD	10.62	11.47
RMS	19.86	18.65
Median	14.05	12.27

Table 11. *Main statistics of the DORIS-to-GNSS tie residuals from DPOD2020 version 1.0 and ITRF2020.*

Then, the IDS CC estimated the DORIS-to-DORIS tie vector residuals (i.e. differences between the estimated and measured ties) and compared them with the ones obtained with ITRF2020. From **Table 10,** we can see that the DPOD2020 version 1.0 and ITRF2020 give similar DORIS-to-DORIS tie residuals. In addition, we observed that eight percent of the DORIS-to-DORIS tie residuals were smaller than 20 mm and that the largest residuals were associated with stations in the SAA region.

We also had a look at the DORIS-to-GNSS tie residuals from DPOD2020 version 1.0 and ITRF2020. In that case, the positions of the GNSS stations were deduced from the ITRF2020 (including Post Seismic Deformation corrections). As indicated in **Table 11**, the DPDO2020 version 1.0 gives slightly larger residuals than ITRF2020. That may be explained by the fact that IGN used the DORIS-to-GNSS ties as constraints while computing the ITRF2020. The largest DORIS-to-GNSS tie residual was obtained for the SJUC DORIS station at San Juan. That large value may be the consequence of the fact that San Juan is in the SAA region and by the very short time span of SJUC (30 weeks only).

10.5 COMMUNICATIONS

In 2022, the IDS Combination Center joined the EGU where it had an oral presentation titled "DORIS assessment of the 2020 ITRF Realization(s)". In October, the IDS CC attended the REFAG2022 and the IERS UAW in Thessaloniki. The IDS CC also joined the AGU Fall meeting where it had an oral presentation on the first version of the DPOD2020 solution. Last but not least, the IDS CC contributed to the two next papers as, respectively, first and second author.

Moreaux, G.; Lemoine, F.G.; Capdeville, H.; Otten, M.; Štěpánek, P.; Saunier, J.; Ferrage, P., 2023. The international DORIS service contribution to ITRF2020, in New Results from DORIS for Science and Society, E.J.O. Schrama and D. Dettmering (Eds.), *ADVANCES IN SPACE RESEARCH*, 72(1):65-91, DOI: 10.1016/j.asr.2022.07.012 **OPEN ACCESS**

Štěpánek, P.; Moreaux, G.; Hugentobler, U.; Filler, V., 2023. The GOP Analysis Center: DORIS contribution to ITRF2020, in New Results from DORIS for Science and Society, E.J.O. Schrama and D. Dettmering (Eds.), *ADVANCES IN SPACE RESEARCH*, 72(1):92-107, DOI: 10.1016/j.asr.2022.11.038 **OPEN ACCESS**

10.6 FUTURE PLANS

In 2023, in parallel to the routine delivery of the IDS weekly combined solution and its associated products (coordinate time series of the DORIS stations, EOP time series), the IDS Combination Center plans to work on the second version of the DPOD2020 and to support the IDS Acs in improving the mitigation of the South Atlantic Anomaly on the new missions.

11 ANALYSIS CENTER OF THE GEODETIC OBSERVATORY PECNY (GOP)

Petr Štěpánek / Geodetic Observatory Pecný, Czech Republic

11.1 GENERAL DESCRIPTION

DORIS data have been routinely processed since day 270 of 2022. The new standard of wd68 has been applied, differing from the previous standard wd67 by adding satellites Sentinel-6, Hy-2C and Hy-2D. For Sentinel-6, the measured attitude has been applied, for Hy-2C/D satellites the nominal attitude model has been implemented. The South Atlantic Anomaly (SAA) mitigation strategy has been applied for satellites Jason-3, Sentinel-6A and Hy-2C. As a major part of this strategy, some stations we used only for orbit determination for these satellites. This approach has been realized by using satellite-specific alias names for the SAA stations. In the wd67 standard, these alias stations remained in the final weekly SINEX files. In new wd68 standard, the alias stations are eliminated from the normal equation system and not present in the final SINEX files.

11.2 CHANGES IN PROCESSED SATELLITE CONSTELLATION

Figure 14 displays a scale of single/satellite solutions w.r.t. DPOD 2014. The scale related to the new satellites (Sentinel-6, Hy-2C, Hy-2D). The inclusion of these satellites into the combination then results in the scale increase around 3mm.

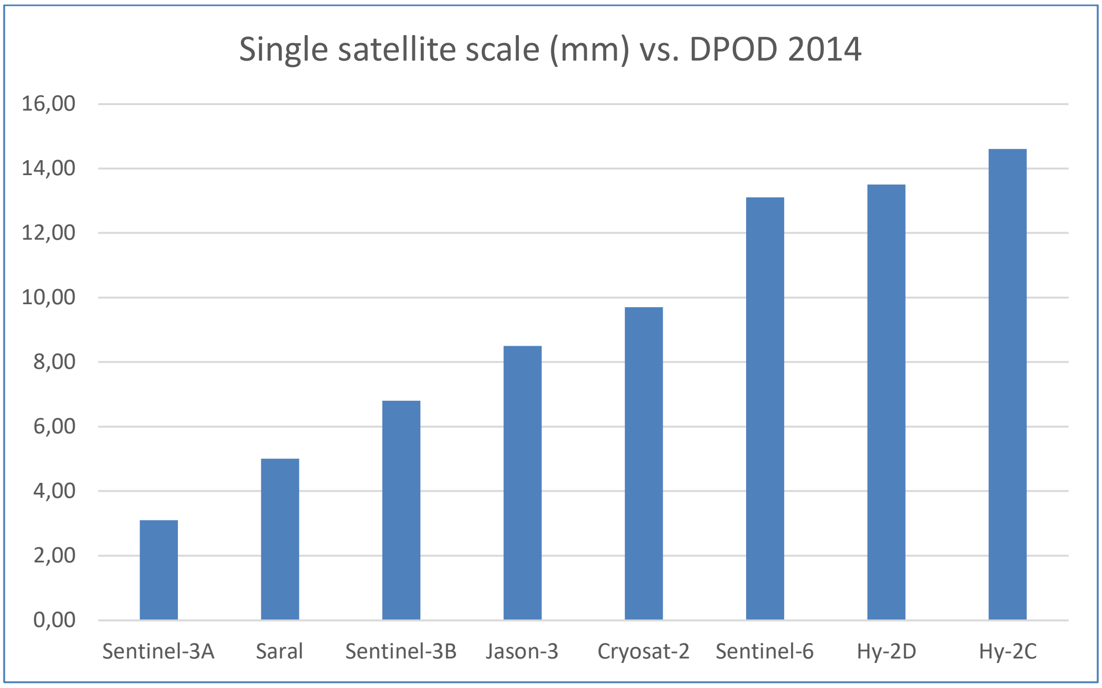

Figure 14. *Single Satellite scale w.r.t. DPOD 2014 (day 270/2021 – day 270/2022).*

USO of satellites Sentinel-6A and Hy-2C is affected by the SAA effects. **Figure 15** shows post-fit observation residuals for each of DORIS stations. The values are displayed for the satellites Hy-2C and Hy-2D. The level of residuals is similar for both satellites outside the SAA area. In contrary, for SAA stations CADB, ARFB, SJVC, KRWB, ASEB and HEMB, the Hy-2C residuals are significantly higher.

The processing of new satellites has been verified by several test. **Table 12** displays comparison of the estimated orbits (DORIS only) and the CNES/SSALTO orbits (multi-technique) used as a reference. There is a bias of 2.9 cm detected in along-track direction for Sentinel-6. The other Mean and RMS differences reached expected values. The estimated solar radiation pressure scaling coefficient reached 0.999 for Sentinel-6, 1.061 for Hy-2C and 1.049 for Hy-2D.

Table 13 presents weekly repeatability WRMS for solutions with different satellite constellation to evaluate impact of new satellites. When all three new satellites included, the WRMS decreased by 5% in Latitude, by 12% in Longitude and by 10% in Height.

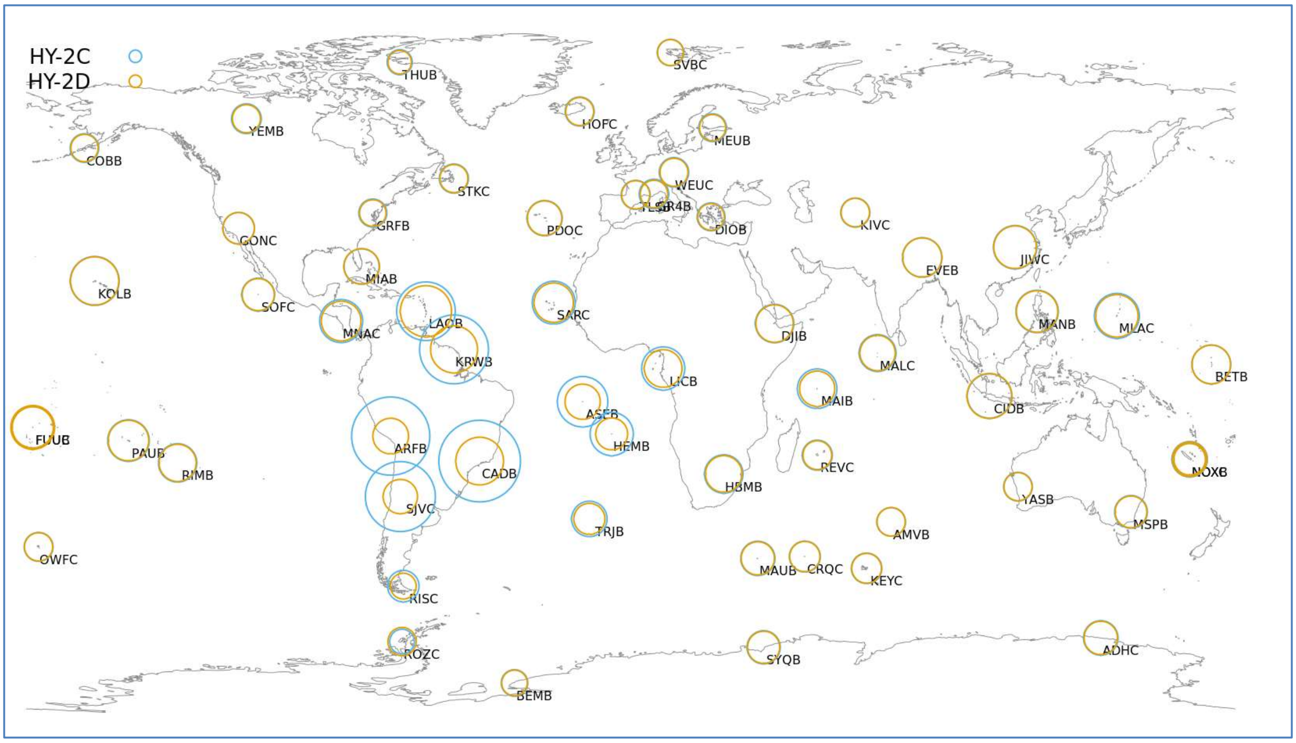

__Figure 15.__ Post-fit observation residuals for satellites Hy-2C and Hy-2D.

Satellite	Mean radial (cm)	Mean along (cm)	Mean cross (cm)	RMS r adial (cm)	RMS along (cm)	RMS cross (cm)
Sentinel-6	-0.1	-2.9	0.0	0.9	2.8	4.0
Hy-2C	0.0	-0.1	0.2	1.0	3.0	4.2
Hy-2D	0.0	-0.2	0.1	1.0	2.8	2.7

Table 12. *Mean and RMS of estimated DORIS orbits. CNES/SSALTO multi-technique orbits used as a reference*

Satellite combination	Lat (mm)	Lon (mm)	H (mm)
Cryosat-2,Saral, Sentinel -3A,3B, Jason-3 (= 5 sats)	6.55	8.98	7.65
5sats + Sentinel-6	6.55	8.97	7.49
5sats + Hy-2D	6.29	8.40	7.24
5sats + Sentinel-6 + Hy-2D	6.22	8.04	7.00
5sats + Sentinel-6 + Hy-2D, 2C	6.25	7.86	6.90

Table 13. *Station repeatability WRMS*

11.3 FUTURE PROSPECTS

We plan to generate a weekly single satellite solutions at routine level. Even if single satellite solutions are not an official product, we will make them available for IDS combination center. We also plan to generate DORIS-only orbits as a product.
We are working on a project proposal together with Technical University Munich to extend our previous cooperation on DORIS USO behavior estimation by GNSS observation, profiting from unique architecture of Sentinel satellites.

12 CNES/CLS ANALYSIS CENTER (GRG)

Hugues Capdeville [(1)], Adrien Mezerette [(1)], Jean-Michel Lemoine [(2)]
[(1)] CLS, France / [(2)] CNES/GRGS, France

12.1 INTRODUCTION

The CNES and CLS participate jointly to the IDS as an Analysis Center. The processing of the DORIS data is performed using the GINS/DYNAMO software package developed by the GRGS.
We continued the standard routinely processing. We analyzed the DORIS data with 3.5-day arcs for the following satellites: Cryosat-2, Saral, Jason-3, Sentinel-3A and Sentinel-3B. The CNES/CLS AC also provides routinely the Sentinel orbit to the Sentinel Copernicus POD Quality Working Group (QWG). Since the end of year 2021, we also provide the Sentinel-6A orbit.
The main activities during 2022 were to add the satellite Sentinel-6A, HY-2C and HY-2D in our processing chain and to analyze our single satellite solutions in term of Helmert parameters.

12.2 INTRODUCTION OF THE SENTINEL-6A, HY-2C AND HY-2D SATELLITES IN GRG PROCESSING CHAIN

The satellites Sentinel-6A, HY-2C and HY-2D have been introduced in our processing chain. The macromodel was made from the document available on the IDS web site (https://ids-doris.org/documents/BC/satellites/DORISSatelliteModels.pdf). We also implemented the nominal attitude law for Sentinel-6A and HY-2(C&D) in our GINS software. We use quaternions for Sentinel-6A when available and nominal attitude law for HY-2C and HY-2D.
For both directions (tangential and normal), the average amplitude of the empirical accelerations is less than 4.10^{-9} m/s^2, showing that the modeling of the macromodel and attitude laws is correct. The level of DORIS RMS residuals for Sentinel-6A is slightly lower than Jason-3 (see **Table 14**). Let us recall here that for Jason-3, the level of DORIS RMS is slightly higher compared to Jason-2, explained by its higher sensitivity to the SAA. There is a ~59-day periodic signal (draconic period) in DORIS RMS residuals for Sentinel-6A satellite, even when we use quaternions for attitude satellite (as for Jason-3). Compared with HY-2D, the level of DORIS RMS residuals for HY-2C is higher (see **Table 14**), certainly due to the strong impact of SAA on HY-2C.
We compared our Sentinel-6A orbit with external GPS orbits (CNES POD orbit POE-F, combined orbit from CPOD, JPL and GSFC). As shown in **Figure 16,** there is a good agreement between GRG orbit and external orbits (under 1 cm RMS), better with JPL (0.8 cm RMS) and worse with GSFC (0.97 cm RMS). There is a 59-day periodic signal in the radial component, especially with POE-F orbit, probably due to the use of a different solar radiation pressure model (direct solar). We also compared our HY-2C and HY-2D DORIS orbit to CNES POD team orbit POE-F. There is a good agreement between GRG orbit and POE-F (~0.9 cm RMS) and there is no bias.

Satellite	DORIS RMS (mm/s)	OPR amplitude average (10^{-9} m/s^2)		Solar Radiation Coefficient
		Along-track	Cross-track	
Cryosat-2	**0.369**	**2.6**	**2.4**	**1.00**
Saral	**0.346**	**1.4**	**2.0**	**1.00**
Jason-3	**0.369**	**1.0**	**2.2**	**0.99**
Sentinel-3A	**0.377**	**2.5**	**1.6**	**1.00**
Sentinel-3B	**0.390**	**1.5**	**1.9**	**1.00**
Sentinel-6A	**0.363**	**1.9**	**2.7**	**1.05**
HY-2C	**0.405**	**1.3**	**2.5**	**1.00**
HY-2D	**0.370**	**0.6**	**2.1**	**1.00**

Table 14. *DORIS RMS of fit and OPR Acceleration Amplitude / Radiation pressure coefficient. Mean of 90 weeks (from December 2020 to September 2022) and 57 weeks for HY-D (from August 2021)*

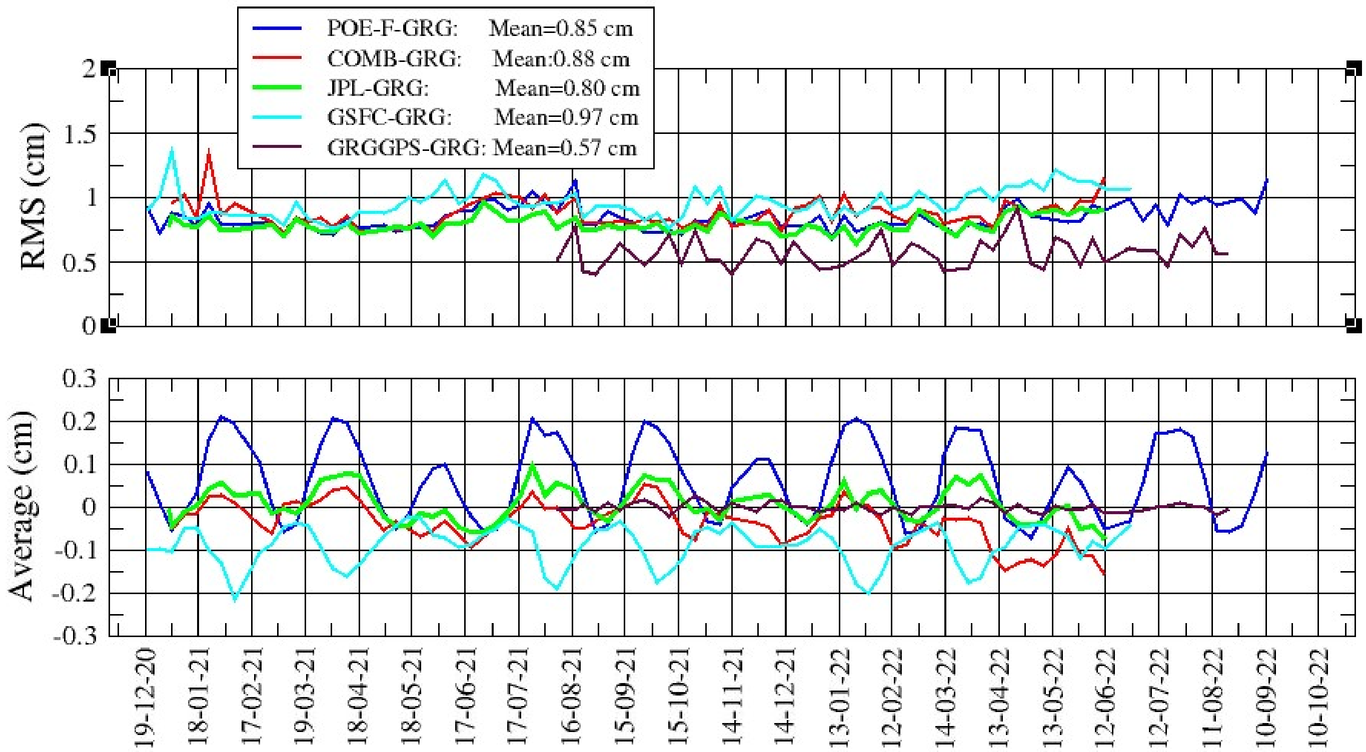

Figure 16. *Weekly RMS and Avg. Radial orbit differences (in cm) for Sentinel-6A.*

12.3 ANALYZES OF OUR SINGLE SATELLITE SOLUTIONS

We have determined the single satellite solutions and we compared to DPOD2014 (computed by CATREF). Remember that the DORIS scale factor and geocenter are the combination of each single DORIS satellite solutions. It is therefore important to analyze the scale factor and geocenter of the single satellite solutions in order to improve the combined solution.

Figure 17 gives the scale of HY-2A and the active mission Cryosat-2, Saral, Jason-3, Sentinel-3A, Sentinel-3B, Sentinel-6A, HY-2C and HY-2D. The Jason-3 scale (in green) increases since the start of the mission and less since 2020, a possible SAA effect. The Sentinel-6 scale (in red) is at the same level as the other satellites, and HY-2C (in blue) and HY-2D (in magenta) scales are higher. An offset in Z direction of DORIS Center of Phase could be the cause.

About the TX translation, as shown on the left in **Figure 18**, the TX for Jason-3 (in green) and for Sentinel-6A (in red) have a behavior different compared to other satellites. They have the same inclination of 66° and same altitude (~1336 km). The TX for HY-2C (in blue) and HY-2D (in magenta) is between that of Jason-3 and the other satellites. They have the same inclination as Jason-3 and Sentinel-6A but an altitude close to the other satellites. About the TY translation, TY for Jason-3 (in green), Sentinel-6A (in red), HY-2C (blue) and HY-2D (magenta) have a behavior different compared to other satellites (different inclination). TY for Cryosat-2 (in black) is slightly lower from mid-2019 (inclination of 92°). So, we have two main families with respect to the inclination:

- 66° inclination: Jason-3, Sentinel-6, HY-2C and HY-2D
- Polar inclination (~99°): other satellites except Cryosat-2 (92°)

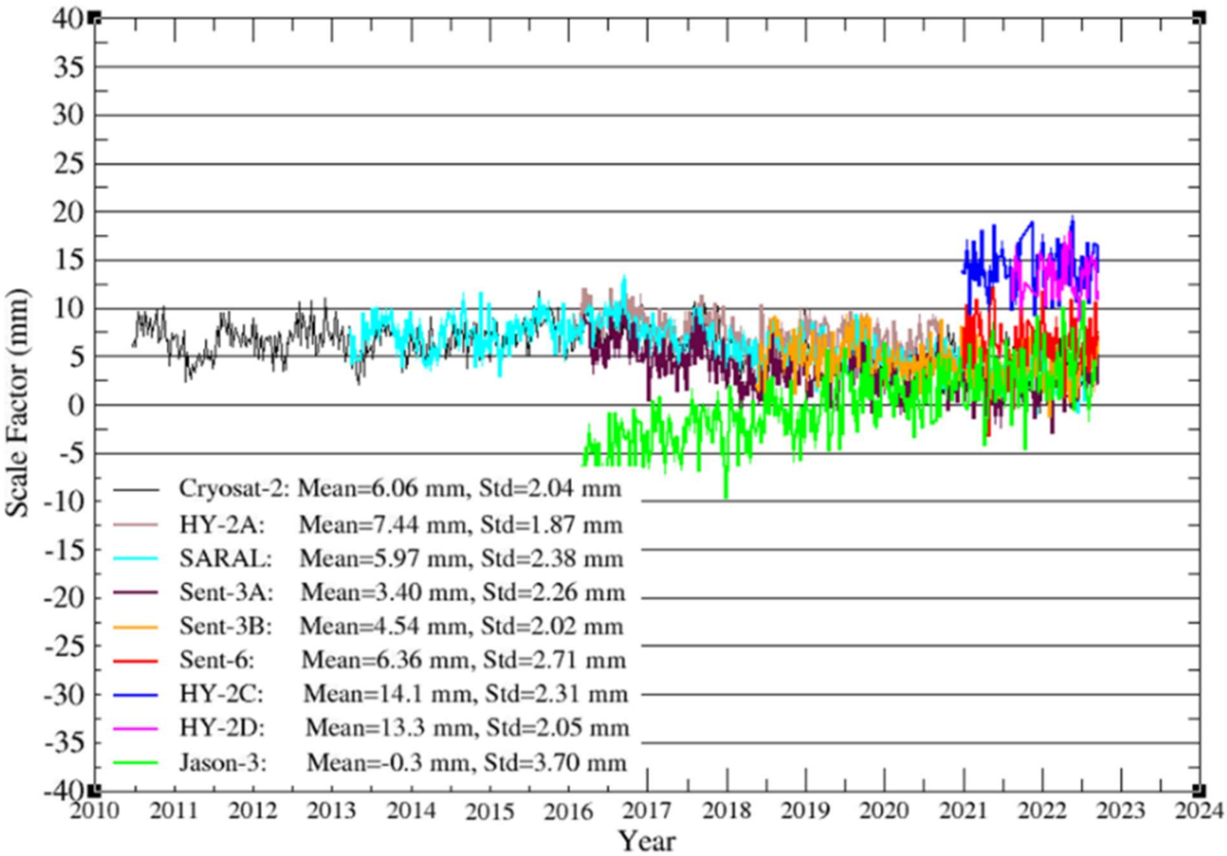

Figure 17. *Scale Factor from single satellite solutions.*

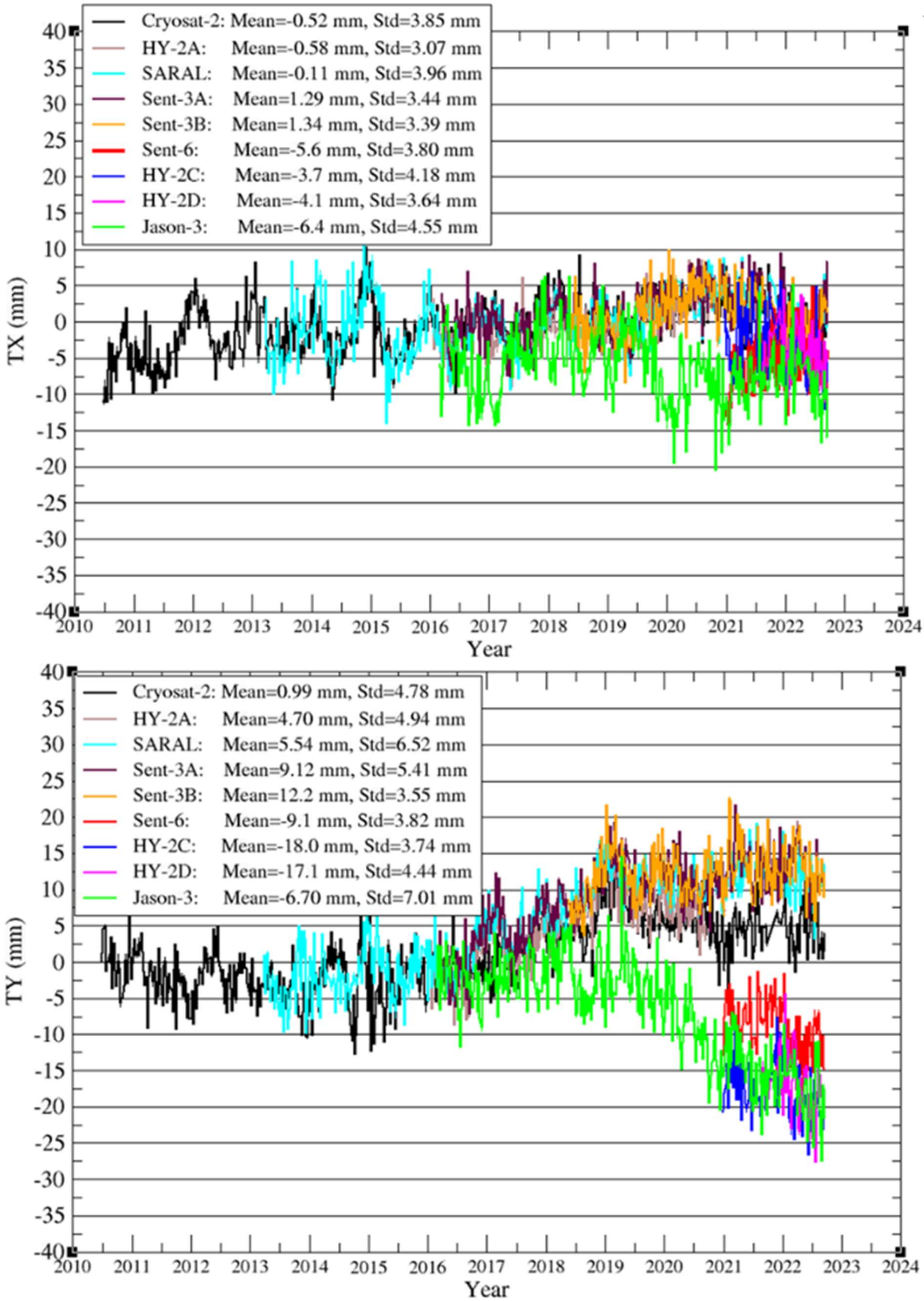

Figure 18. *TX (top) and TY (bottom) from single satellites.*

We also looked at the impact of the South Atlantic Anomaly effect on the station position estimation. As the Saral USO is not affected by SAA (or very little), we use the Saral single satellite solution as a reference. In this study (see **Figure 19**) we consider the following stations: Cachoeira, Arequipa, Kourou, Le Lamentin, and for high altitude satellite Ascension and Saint Helena. Note that San Juan is not included due to the limited number of observations over time.
We calculated the differences between the Jason-3/Sentinel-3A/Sentinel-3B/Sentinel-6/Cryosat-2/HY-2C/HY-2D and Saral solutions in North/East/Up components. SAA impact on Jason-3 seems to decrease over time. Sentinel-6A and HY-2C solution are more impacted than HY-2D. Awaiting a data corrective model for the active DORIS satellites we could apply SAA mitigation strategies for at least Sentinel-6A and HY-2C. In the future, we plan to include GPS clock estimates for Sentinel satellites in DORIS geodetic solutions.

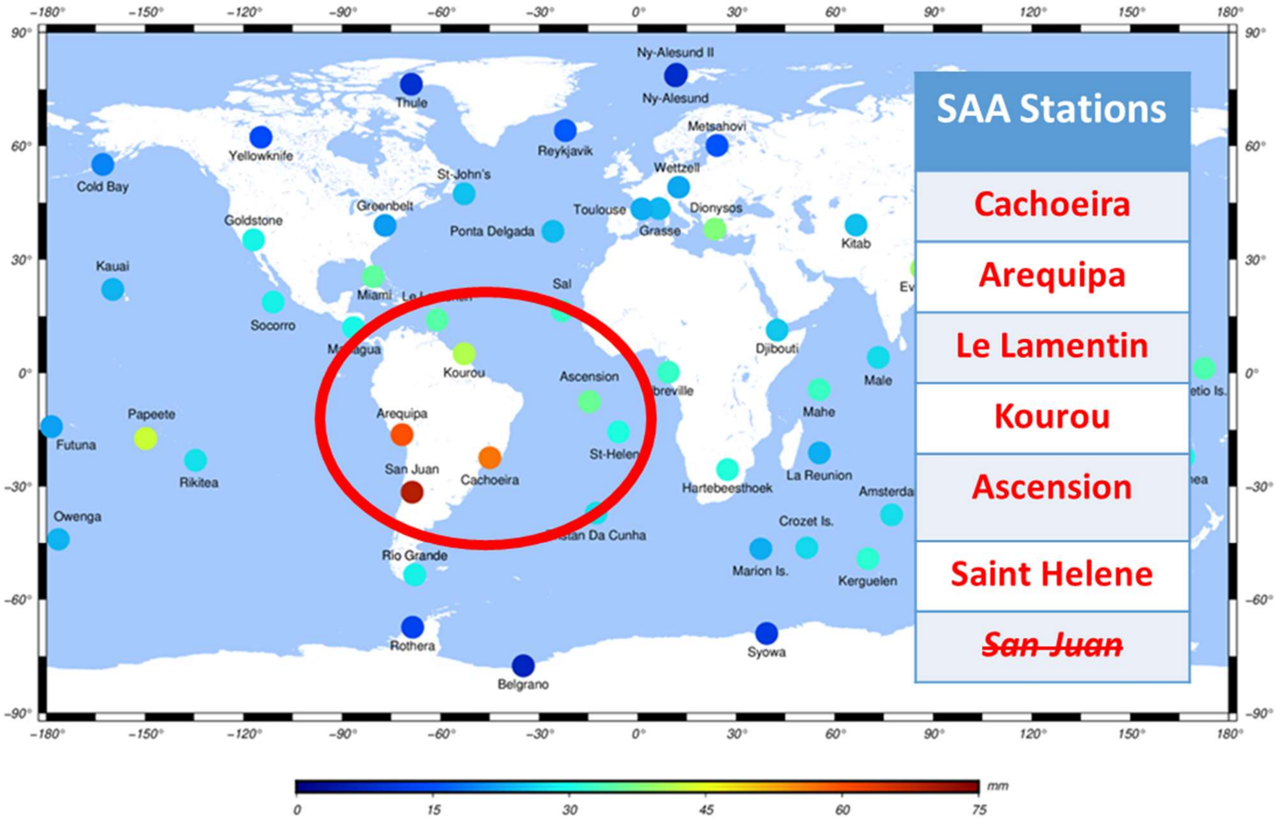

__Figure 19.__ SAA stations.

12.4 CONTRIBUTION TO IDS MEETINGS

The Analysis Center's representatives participated in 2022 to the AWG virtual meeting in June. We also participate to the IDS Workshop and OSTST in October/November in Venice (Italy). We presented the following works:

- AWG:

"CNES/CLS (GRG) IDS Analysis Center report"

https://ids-doris.org/images/documents/report/AWG202206/IDSAWG202206-Capdeville-GRG.pdf

- IDS Workshop:

"Analyzes of the CNES/CLS IDS Analysis Center solutions for the contribution to the ITRF2020 and beyond"

https://idsworkshop.aviso.altimetry.fr/fileadmin/user_upload/IDSWS2022/Presentations/IDS22ITF-Analyzes_of_the_CNES_CLS_IDS_Analysis_Center_solutions_for_the_contribution_to_the_ITRF2020.pdf

DOI: 10.24400/312072/i03-2022.3493

- OSTST (POD session)

"Precise Orbit Determination of DORIS satellites by CNES/CLS IDS Analysis Center in the frame of our contribution to the ITRF2020 and beyond"

https://ostst.aviso.altimetry.fr/fileadmin/user_upload/OSTST2022/Presentations/POD2022-Precise_Orbit_Determination_of_DORIS_satellites_by_CNES_CLS_IDS_Analysis_Center_in_the_frame_of_our_contribution_to_the_ITRF2020.pdf

DOI: 10.24400/527896/a03-2022.3457

13 GSFC/NASA ANALYSIS CENTER (GSC)

F.G. Lemoine [(1)], D.S. Chinn [(2)], N.P. Zelensky [(3)], X. Yang [(2)]
[(1)] Geodesy & Geophysics Laboratory, NASA GSFC, Greenbelt, Maryland, U.S.A.
[(2)] KBR Inc., Greenbelt, Maryland, U.S.A.
[(3)] Earth System Science Interdisciplinary Center (ESSIC), University of Maryland, U.S.A.

13.1 STATUS OF POD AND CURRENT OPERATIONAL SERIES

For the year 2022, we maintained gscwd52 as the operational series, pending the implementation of further improvements, and the addition of new satellites (see **Table 15**). We continue operational analysis of the DORIS data from the DORIS satellite constellation, and summarize in **Table 16** the POD results for the new satellite data used in ITRF2020 as well as for the processing we have done since the submission of our ITRF2020 analysis center contribution. The operational procedure is always to perform an SLR+DORIS-based orbit determination first, perform the data editing with respect to this orbit, and then afterwards complete the DORIS-only POD with those data edits, and create the DORIS-only normal equations for the different satellites of a given week. The SLR fits refer to an average 'weighted' RMS of fit over all the sampled arcs. The non-core stations of the International Laser Ranging Network (ILRS) are downweighted by different factors from 3 to 10X with respect to the weighting applied for the core stations. At least in regards the SLR RMS of fit, we see the excellent POD performance. Note that empirical accelerations (along-track & cross-track) are adjusted daily per satellite. For HY-2A we adjust in addition an along-track constant term, and tightly constrain the estimation of drag coefficients (Cd's). For Jason-2 and Jason-3, we always perform an additional orbit determination step, where we remove the empirical accelerations, and adjust per arc the solar radiation reflectivity coefficients (Cr). Subsequently the adjusted value of Cr is held fixed for the final DORIS+SLR and DORIS-only POD runs.

Another way to evaluate the quality of the POD is to analyze the amplitude of the empirical accelerations. We report these in **Table 17** where we show the average and RMS of the amplitudes of the daily along-track and cross-track once-per-rev (OPR) accelerations. The accelerations indicate reasonable performance with two exceptions. The Cryosat-2 accelerations are anomalously high with respect to the other satellites. This indicates that there exists some sort of dynamical mismodeling, or possibly that we have a setup error. Also, the accelerations for Saral are higher. Being in a face-on orbit with respect to the Sun, and possibly with some amount of self-shadowing, estimation of improved macromodel parameters has proven difficult. The interesting results come from the comparison of the empirical accelerations for Sentinel-3A and Sentinel-3B. We isolate first the accelerations for the satellites over the same period (green background columns in **Table 17**, 180603 & 180606 to 220911). Also, we isolate the accelerations for the two satellites for the Sentinel-3A+3B tandem period (June – October 2018). Our conclusion is that empirical accelerations for Sentinel-3B are slightly higher than for Sentinel-3A, even though the two satellites are supposed to be identical, and the same micromodel is used for both satellites. If this is not traced to a setup error or other anomaly, it may be useful to retune the a priori micromodel for Sentinel-3B.

Series	Description	Comment
gscwd52	gscwd51 + Sentinel-3B starting 180610	Deliveries started 2021-10-18 to the NASA CDDIS. This is the current operational series.

Table 15. *Status of GSC DORIS SINEX solutions for 2022*

Satellite	First Arc	Last Arc	No of Arcs	Avg. No. SLR obs. per arc	Avg. No. DORIS obs. per arc	Avg. SLR fit per arc (cm)	Avg. DORIS fit per arc (WRMS, mm/s)
Cryosat-2	150104	220911	492	991	62854	1.060	0.3953
HY-2A	150104	200906	336	623	83104	1.069	0.3818
Jason-2	150104	190908	227	2687	127916	0.883	0.3819
Jason-3	160223	220911	378	2560	135051	0.902	0.4075
Saral	150104	220828	415	1118	80500	0.973	0.3778
S3A (α)	160508	201231	282	990	76517	0.741	0.3869
S3B (β)	180606	201227	163	849	76590	0.752	0.4015
(α) *No SLR data for Sentinel-3A from 2016-0306 to week of 2016-0508. Sentinel-3A still included in SINEX solution gscwd51 starting on 160302.* (β) *Sentinel-3B not included in the ITRF2020 submission, but is now part of the operational series, gscwd52.*							

Table 16. *POD Summary for DORIS Satellites using SLR+DORIS data*

Satellite	First Arc	Last Arc	No of samples	Along-track accels (nm/s^2)		Cross-track accels (nm/s^2)	
				Average	RMS	Average	RMS
Cryosat-2	150104	220911	2838	2.351	5.346	4.371	6.290
HY-2A	150104	200906	2094	0.481	0.600	2.312	2.817
Jason-2 (α)	150104	190908	1410	0.597	0.855	2.359	2.768
Jason-3 (α)	160223	220911	2363	0.667	1.056	1.644	2.343
Saral	150104	220828	2182	1.854	2.551	0.861	1.106
S3A	160508	220911	2316	0.525	0.622	1.126	1.490
S3A (γ)	180603	220911	1546	0.506	0.604	1.137	1.503
S3B β)	180606	220911	1583	0.940	1.110	1.367	1.689
S3A (δ)	180617	181014	128	0.654	0.714	0.961	1.196
S3B (δ)	180617	181016	130	0.919	1.039	1.161	1.384
(α) For Jason-2 & Jason-3 Cr's were adjusted per arc in a separate POD step and then held fixed. (β) Sentinel-3B was not included in ITRF2020, but is now part of the operational series, gscwd52. (γ) Selecting Sentinel-3A arcs that are coincident with Sentinel-3B for comparison (180603 to 220911). (δ) Sentinel-3A & Sentinel-3B comparison limited to S3A-S3B tandem mission period.							

Table 17. *Summary of Empirical Accelerations for DORIS Satellites (2015-2022)*

13.2 SUMMARY OF RECENT DORIS/RINEX PROCESSING

The second major activity of the analysis center in 2022 was to process the Saral, HY-2A, and Cryosat-2 RINEX data. The objective was to switch to using the DORIS/RINEX data rather the DORIS/V2 data. The DORIS/V2 data were used for the GSC DORIS Analysis Center contribution to ITRF2020. We processed the DORIS/RINEX data for these three satellites from June 10, 2010 to September 6, 2022, as summarized in **Table 18**. All of the data (DORIS/V2 and DORIS/RINEX) were re-imported and processed from scratch to avoid potential issues with missing stations or other anomalies. With co-author DSC, we carefully quality-controlled the arcs, and through comparisons cleaned up a few anomalous setups. We used the dpod2014v5.5 station set for both sets of data, but of course in the RINEX processing made the separate correction to compute the ionosphere-free phase center for the ground antennae and for the satellite antennae, as we do for the Sentinel-3A+B satellites and Jason-3. We note that typically the DORIS/RINEX-based data arcs have 3.3% to 3.8% more data than the DORIS/V2-based data arcs. Also the RMS of fit is slightly higher for the DORIS/RINEX-based data arcs by 0.001 to 0002 mm/s. We note that other analysis centers have also made this observation.

As part of the quality control, we systematically compared the DORIS/V2-based and the DORIS/RINEX-based orbits (for DORIS-only orbits). We found that for Saral the average RMS orbit differences were: Radial, 1.59 mm; Along-track 9.39 mm; Cross-track, 5.54 mm. For Cryosat-2, we found that the average RMS orbit differences were, Radial, 1.45 mm; Along-track, 4.79 mm, and Cross-track, 3.01 mm. In general the Cryosat-2 V2 vs. RINEX orbits were more consistent (especially in the along-track direction) than with the Saral V2 vs. RINEX orbits.

We compared the reference frame solutions for the three satellites, DORIS/RINEX vs DORIS/V2. In **Figure 20**, we show an example of the Scale of the station coordinate solutions from the DORIS/RINEX vs the DORIS/V2 data for Cryosat-2 single-satellite solutions, compared to the scale for the gscwd52 series, with respect to DPOD2014_v5.5.

Satellite	Data	No of arcs	Avg. No of DORIS obs	RMS (mm/s)	Avg. no . of SLR obs	RMS (cm)	Data Span
Cryosat-2	RINEX	800	62785	0.3931	940	1.106	2010/06/10 – 2022/09/11
	V2	800	60847	0.3914	940	1.098	
HY-2A	RINEX	535	82225	0.3820	597	1.036	2011/11/07 – 2020/09/06
	V2	535	79311	0.3801	597	1.026	
Saral	RINEX	537	79200	0.3784	1053	0.886	2013/03/07 – 2022/08/28
	V2	535	76276	0.3775	1053	0.882	

Table 18. *GSC DORIS/RINEX processing summary (comparison with DORIS/V2)*

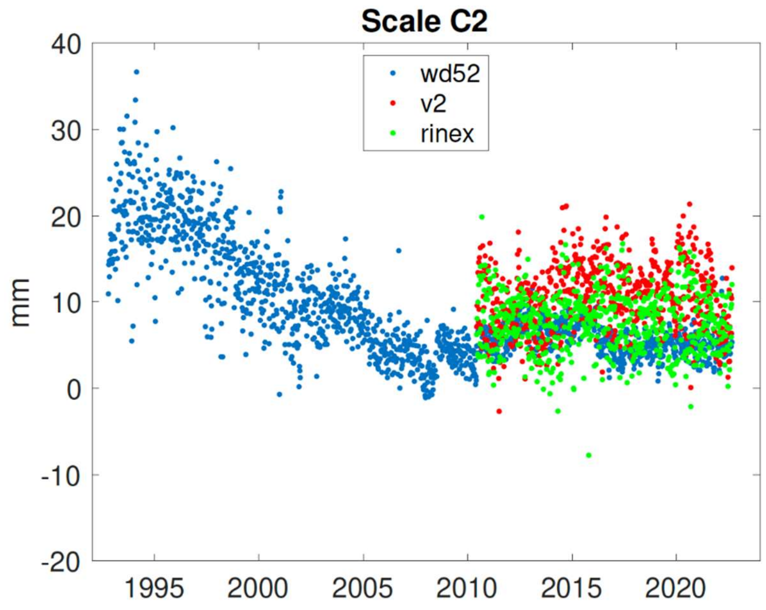

Figure 20. *Scale of Single-Satellite Cryosat-2 solutions, and the gscwd52 series w.r.t. DPOD2014_v5.5.*

We expected the scale of the DORIS/RINEX and DORIS/V2-based solutions to be aligned. However we found a scale offset (V2-RINEX) of +3.95 mm. The Cryosat-2 DORIS V2 scale was 10.56 $\pm$ 3.82 mm, whereas the Cryosat-2 DORIS/RINEX scale was 7.61 $\pm$ 3.71 mm. We also found (V2-RINEX) scale offsets of 2.62 mm for single-satellite solutions of HY-2A, and (V2-RINEX) scale offsets of +3.16 mm for Saral. It is curious that the scale offsets are all approximately in the same direction and of the same magnitude. While the uncertainty intervals do overlap, we expected more alignment in the scales between the V2-based and the RINEX-based solutions. Other AC's seemed to confirm that the V2-based and RINEX-based solutions should be more aligned in the scales that they provide. We will continue to investigate this discrepancy.

13.3 SUMMARY

1. We have completed the RINEX processing for Cryosat-2, HY-2A and Saral, and compared the POD performance, computed orbits, and station repeatability (WRMS).
2. We will update our operational combination to replace the V2-based normal equations with the RINEX-based normal equations, and create and an updated series.
3. We will update our Jason-2 T2L2 processing, and re-evaluate its inclusion in the weekly combination. We will be happy to share the updated frequency model with other ACs.
4. We will investigate the anomalous modelling (higher empirical OPR amplitudes) that we find on Cryosat-2, compared to the other satellites.
5. Time and resources permitting, and pending the introduction of the new satellite attitude models into GEODYN, for HY-2C & HY-2D, we will include the newer DORIS satellites into the operational DORIS processing.

14 INASAN ANALYSIS CENTER (INA)

Sergey Kuzin / Institute of Astronomy RAS, Russia

14.1 MAIN ACTIVITIES

In 2022, INASAN (ina) DORIS Analysis Center (AC) performed the activities listed hereafter:

- The ability of the DORIS/RINEX data processing has been implemented in the last GIPSY-OASIS II version (version 6.4). Raw data were transformed to the format suitable for GIPSY (method: *Lemoine, 2016*);
- The macromodels and attitude laws (CNES documentation) for all new DORIS satellites have been implemented (HY-2C, HY-2D, Jason-3, Sentinel-3A, Sentinel-3B, Sentinel-6A);
- Quaternion and solar panel files have been implemented for Jason-1, Jason-2 and Jason-3;
- The following models were used for the DORIS/RINEX data processing:
  - Gravity field: goco02s.fit2.all
  - Cutoff angle: 10 deg
  - Tropo map:GMF
  - Iono-free phase centers were used both satellite and ground antennas
  - Set of coordinates and velocities DPOD2014 (version 055).

DORIS data have been routinely processed since the beginning of each mission till the end of the mission for HY-2A and Jason-2 satellites and since the beginning of each mission till the end of 2022.0 for Saral, HY-2C and HY-2D satellites. For Jason-2 satellite DORIS data were processed both RINEX and DORIS2.2 formats. **Figure 21** shows the DORIS residuals for Jason-2 from RINEX and DORIS2.2 data. A rather good agreement is obtained between the RINEX and DORIS2.2 data. The DORIS RINEX RMS (0.427 mm/s) of fit is slightly higher as compared with DORIS2.2 (0.404 mm/s) data for Jason-2. **Figure 22** shows the DORIS residuals for HY-2A, HY-2C and HY-2D only from RINEX data. For HY-2C and HY-2D there is a 2-month signal in the DORIS residuals.

14.2 FUTURE ACTIVITIES

In 2023, the INASAN DORIS Analysis Center plans to work on:

- Processing DORIS RINEX data for all satellites
- Obtaining merged solutions
- Implementing quaternions processing for Cryosat-2 and Sentinel-3A and Sentinel-3B
- Implementing AOD1B de-aliasing model
- Delivery INA SINEX solutions to IDS for validation

14.3 REFERENCE

Lemoine, J.M.; Capdeville, H.; Soudarin, L., 2016. Precise orbit determination and station position estimation using DORIS RINEX data, in Scientific Applications of DORIS in Space Geodesy, F. Lemoine and E.J.O. Schrama (Eds.), ADVANCES IN SPACE RESEARCH, 58(12):2677-2690, DOI : 10.1016/j.asr.2016.06.024

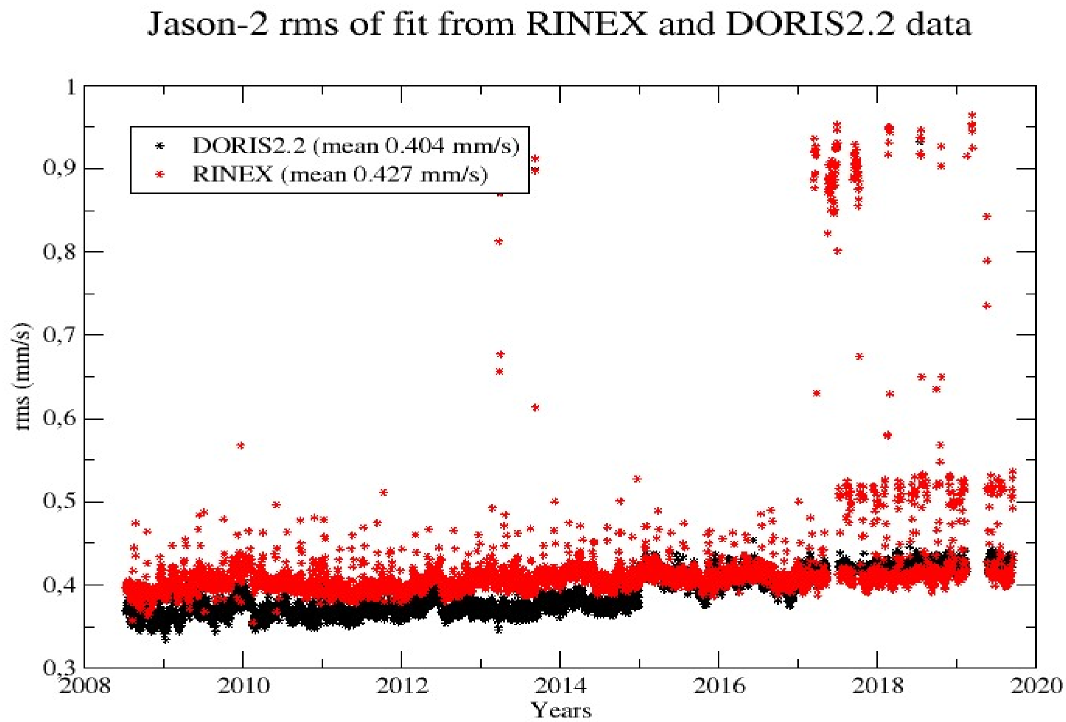

Figure 21. *DORIS RMS of fit for Jason-2 RINEX and DORIS2.2 data.*

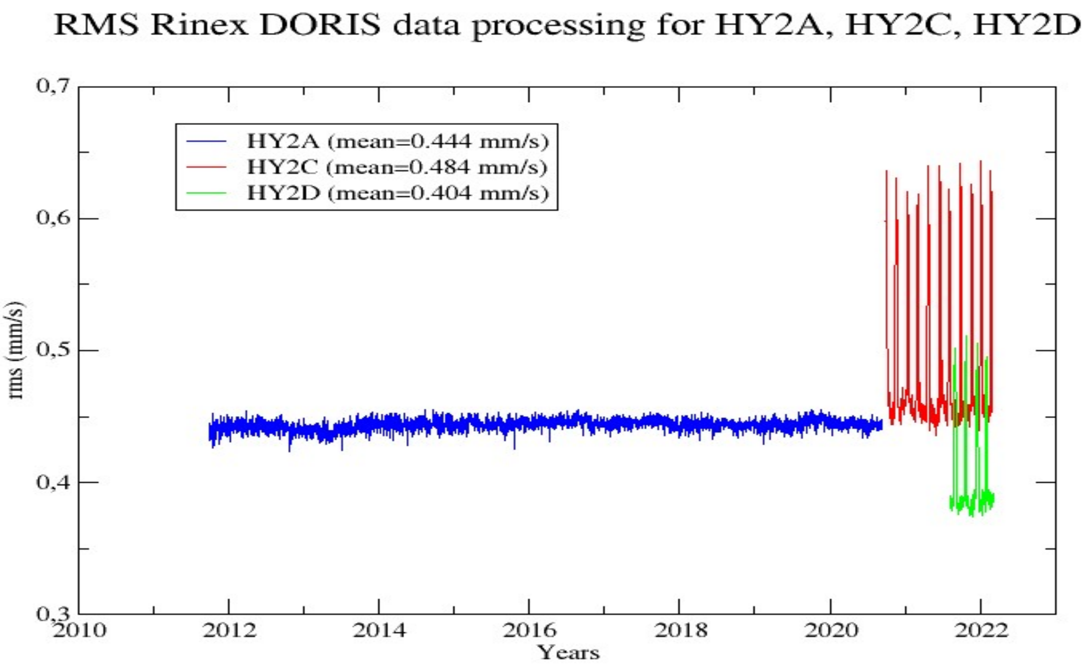

Figure 22. *DORIS RMS of fit for HY2A, HY2C and HY2D RINEX data.*

15 IGN/IPGP/JPL ANALYSIS CENTER (IGN)

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15.1 CONTEXT

Until 2019, the Institut national de l'information géographique et forestière (IGN) utilized the GIPSY/OASIS software package (developed by the Jet Propulsion Laboratory, Caltech, USA) to generate all DORIS products for geodetic and geophysical applications. However, this software is no longer supported by JPL as it has been superseded by the RTGx/GipsyX software. Moreover, with Pascal Willis' retirement in 2020 and the prevailing health crisis (COVID-19), the analysis center's operations could not be resumed normally by Samuel Nahmani and Arnaud Pollet. Indeed, at the time of his departure, RTGx/GipsyX was not yet operational for processing DORIS measurements. Only tests related to the processing of RINEX measurements on the Jason-2 satellite had been conducted.

The operations of the IGN Analysis Center (AC) align with the schedule of the International DORIS Service. The primary objective of the data produced is to contribute to the combination center for generating DPOD solutions (DORIS extension of the ITRF for Precise Orbit Determination). Our foremost priority is to ensure that the AC becomes operational as swiftly as possible, thereby fully participating in this activity and contributing its products to the data and service hubs.

15.2 PRODUCTS DELIVERED IN 2022

The IGN Analysis Center currently has the capability to process DORIS measurements from all satellites presently in orbit, as well as nearly all past satellites. We implemented scripts to convert GipsyX's internal files into DORIS SP3 format files. This step was necessary for the internal validation of our products by the IDS. At this time, we are not yet equipped to perform a complete reprocessing of historical DORIS measurements. This is due to the need to incorporate the attitude law and the TOPEX/POSEIDON macromodel into GipsyX, which requires special precautions.

The orbits generated by the AC have been undergoing validation by the IDS since October 2022. Although the initial feedback from the analysis coordinator has been highly positive, we are still awaiting the results of a more comprehensive evaluation. While the validation of our orbit products by the IDS is in progress, no operational products were delivered in 2022.

15.3 NEW DEVELOPMENTS

Since December 2021, we have been participating in the evaluation of the preliminary solution of ITRF2020 (ITRF2020P), which was made available to various IDS analysis centers. To facilitate this, we had to continue the restart of the Analysis Center (AC) and incorporate the ability to use ITRF2020P into GipsyX. We also carried out an evaluation of ITRF2020P by examining its impact on the measurement residuals of DORIS satellite orbit calculations and on the orbits themselves.

We conducted a comparative study on the utilization of ITRF2020, ITRF2014, and DPOD2014 for DORIS measurement processing. Some results were presented at the IDS workshop at OSTST in Venice in October 2022 (*Pollet & Nahmani, 2022*) ant at the AGU Fall Meeting (*Nahmani et al., 2022*). Following discussions with the team from the IERS ITRS center led by Z. Altamimi, we decided to conduct a more comprehensive comparative study with new products that are currently available or will be available soon (DTRF2020).
We are working in collaboration with X Papanikolaou to support the establishment of a new DORIS analysis center in Greece (*Papanikolaou et al., 2022*).
We offered two internships to engineers in 2022 on DORIS issues that we initially considered non-priority. The first internship enabled us to evaluate the impact of different models on the orbits of various DORIS satellites. The second internship allowed us to determine if DORIS measurement processing was affected by multicollinearity effects. The conclusions from these internships led to adjustments in the initially planned schedule for 2023.

15.4 REFERENCES

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Papanikolaou, X., Zacharis, V., Tsichlaki, M., Nahmani, S., Pollet, A., Tsakiri, M., & Galanis, J. (2022). Development of an in-house DORIS processing software. IDS Workshop, Venice. https://doi.org/10.24400/312072/i03-2022.3437

Pollet, A., & Nahmani, S. (2022). Comparison between DPOD2014 and ITRF2020P: impact on the DORIS satellite orbits. IDS Workshop, Venice. https://doi.org/10.24400/312072/i03-2022.3339

16 GFZ ASSOCIATE ANALYSIS CENTER

Patrick Schreiner, Anton Reinhold, Karl Hans Neumayer, Rolf König / Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences, Oberpfaffenhofen, Germany

16.1 INTRODUCTION

The activities of the Associate Analysis Center (AAC) at the Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences (GFZ) in 2022 continued the effort to develop the GFZ AAC into an International DORIS Service (IDS) analysis center (AC). The repertoire of satellites to be processed has been further expanded and additional functions, as e.g., onboard frequency drift determination, have been added to GFZ's Earth Parameter and Orbit System (EPOS) software. In addition, the environment for combination solutions was expanded (*Reinhold et al., 2022*), and further validations with the IDS Combination Center (CC) were carried out. Since EPOS-OC also allows combined processing with several other observation techniques, a study on Sentinel satellites was conducted with a focus on multi-technique Precise Orbit Determination (POD) and reference frame determination with DORIS alone, contributing to the DORIS special issue of ASR (*Schreiner et al., 2023*).

16.2 PRECISE ORBIT DETERMINATION

In the previous years, the set of DORIS satellites processed at GFZ was greatly expanded. Subsequently, in 2022, the satellites Cryosat-2 and SARAL were implemented and reprocessed for the full mission period. Accordingly, only the SPOT satellites and the HY series satellites are missing from the set of satellites processed at GFZ which are equipped with a DORIS receiver. The implementation of these satellites is planned for 2023. Typical post-fit residuals of the two newly implemented satellites are 0.39 mm/s for Cryosat-2 and 0.37 mm/s for SARAL, SLR validations show typical mean RMS values of 1.4 and 1.2 cm, respectively. All orbits generated by the GFZ IDS AAC are made available on the GFZ Information System and Data Center (ISDC) in certain releases (*Schreiner et al., 2022*).

16.3 EXTERNAL ORBIT COMPARISON

Schreiner at al. (2023) contributed to the DORIS special issue of ASR with a study focusing on the orbit determination of the satellites Sentinel-3A, -3B and -6A MF with different observation techniques. Post launch reference point calibrations were performed with different observation techniques and combinations and their coincidence was analyzed. Based on the orbits determined with DORIS alone, weekly local reference frames were generated and evaluated with DPOD2014 with respect to the reference frame defining parameters, i.e., origin, scale and orientation.

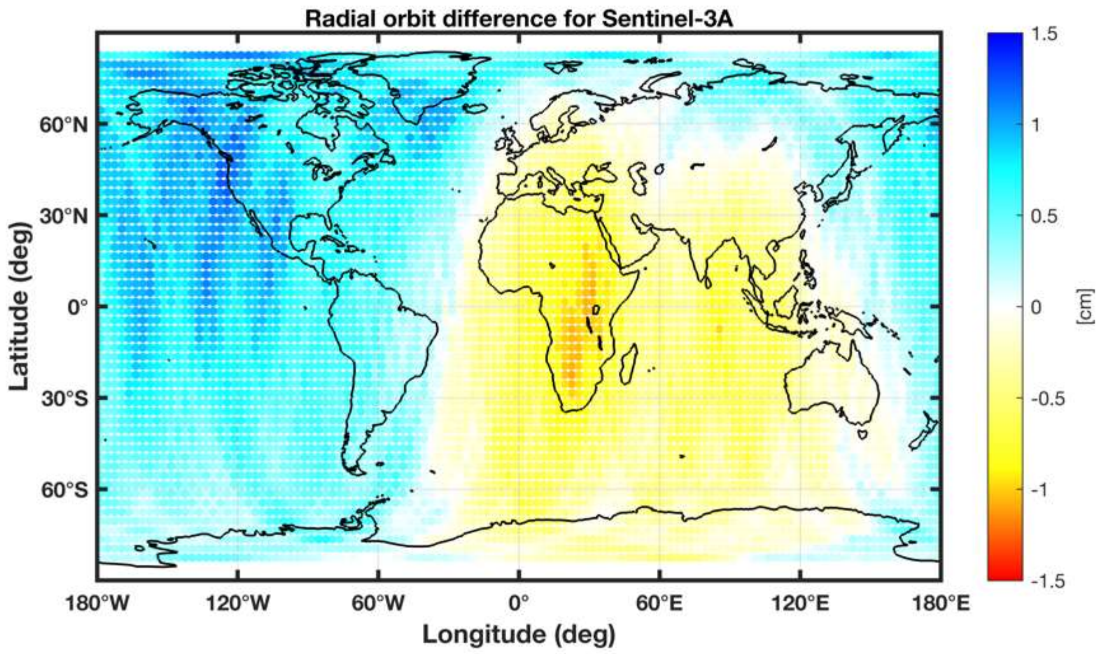


Figure 23. *Radial orbit differences for Sentinel-3A in comparison to CPOD combined orbit solution.*

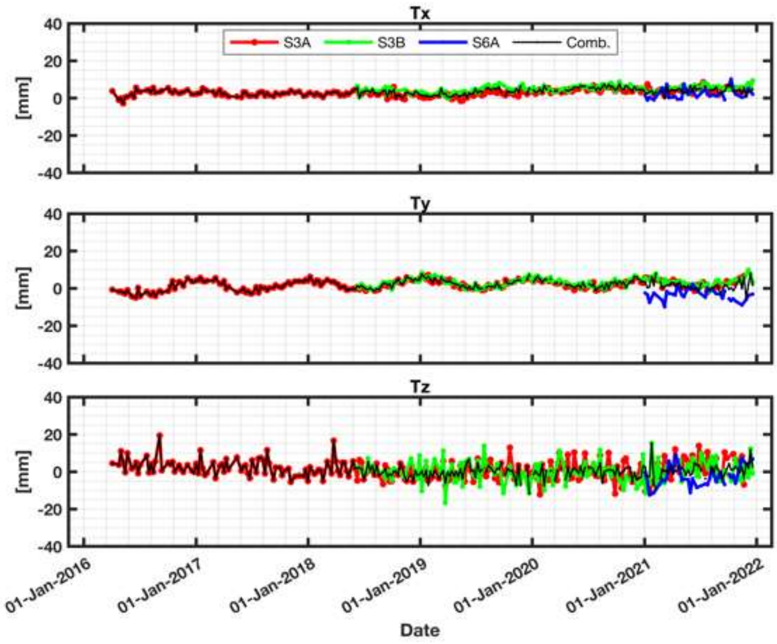
The processed orbits were compared with an external combined orbit solution by the Copernicus POD (CPOD) quality working group, which is assumed to have the highest absolute position accuracy with minimal residual error. RMS values in the range of 7 to 8 millimeters in radial direction could be achieved in the orbit comparison for all satellites (see **Figure 23**), which are on the level of GPS-based orbits also processed with EPOS-OC. Geographic analysis of the orbit comparison showed a slight west-to-east pattern, but this pattern is also found in other DORIS-based orbits from other groups as shown in *GMV (2022)*. This is assumed to be caused by the gravity field model used. Tests with GRACE-FO gravity field models generated at GFZ are ongoing.

16.4 REFERENCE FRAME DETERMINATION

In this same study as above, based on the orbits determined using only DORIS, weekly local reference frames were determined for each satellite alone and in combination. The standard deviations of the translations in comparison with the DPOD2014 range between 1 and 3 millimeters in X and Y direction and between 4 and 6 millimeters in Z direction (see **Figure 24**). The scale comparison showed a drifting behavior over the years for Sentinel-3A, which is still under investigation. For Sentinel-3A and 6A-MF the scale determination shows no significant difference to DPOD2014, with standard deviations of 1 to 2 millimeters (see **Figure 24**).

The repeatability of the station position determination shows values for the combined solution in terms of mean arc wise standard deviation for North, East and Height of 2-4 mm, 5-9 mm and 5-7 mm respectively.

In this study, Earth rotation parameters (ERPs) were also determined (pole coordinates and LOD) and the a-posteriori values were compared with the EOP14C04 time series. The pole coordinates show mean standard deviations of about 200 micro arcseconds and LOD of 20-40 microseconds.



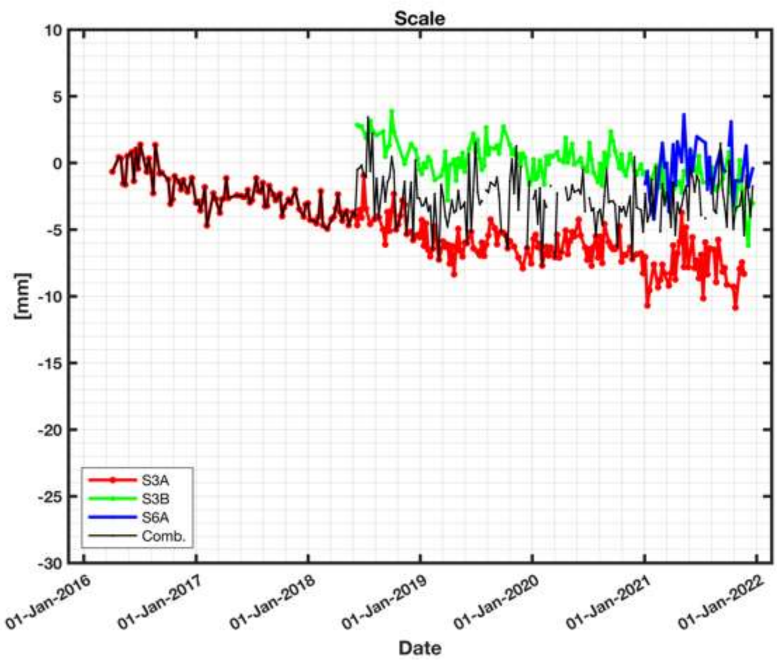


Figure 24. *Translation (top) and scale (bottom) of the determined TRF in comparison to DPOD2014.*

16.5 PRESENTATIONS

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17 DGFI-TUM ASSOCIATE ANALYSIS CENTER

Sergei Rudenko, Mathis Bloßfeld and Julian Zeitlhöfler / Deutsches Geodätisches Forschungsinstitut der Technischen Universität München (DGFI-TUM)

17.1 INTRODUCTION

The activities of the DGFI-TUM Associate Analysis Center (AAC) of the International DORIS Service (IDS) in 2022 included the following:

- Further elaboration of the DOGS-OC (DGFI-TUM Orbit and Geodetic parameter estimation Software – Orbit Computation) library used for precise orbit determination (POD) using SLR and DORIS observations,
- Computation of new orbits of TOPEX/Poseidon, Jason-1 and Jason-2 using DORIS observations,
- Investigation of the radial orbit errors of contemporary altimetry satellite orbits derived using various types of observations, including DORIS data,
- Investigation of ITRF2020 for altimetry satellite POD using SLR observations.

17.2 FURTHER ELABORATION OF THE DOGS-OC LIBRARY

In 2022, the following models and improvements have been implemented in the DOGS-OC library:

- Earth's time-variable gravity field model EIGEN-GRGS.RL04.MEAN-FIELD (*Lemoine et al., 2019*),
- ocean tide models FES2014 (*Lyard et al., 2021*) and EOT20 (*Hart-Davis et al., 2021*),
- thermospheric density model NRLMSIS2.0 (*Emmert et al., 2021*),
- handling and smoothing of observed geomagnetic storm and solar flux indices (*Matzka et al., 2021*),
- station-dependent SLR measurement correction model for TOPEX/Poseidon (*Zeitlhöfler et al., 2023*),
- correct computation of partial derivatives of DORIS station coordinates,
- correct application of the center-of-mass correction for DORIS observations.

17.3 IMPROVEMENTS IN DGFI-TUM ALTIMETRY SATELLITE ORBITS BASED ON DORIS MEASUREMENT

New orbits of TOPEX/Poseidon, Jason-1 and Jason-2 were derived in 2022 using the improvements in DORIS data processing specified above. This resulted in the reduction of RMS fits of DORIS observations for all three satellites, namely by 28.2% (from 0.762 to 0.547 mm/s) for TOPEX/Poseidon, 13.3% (from 0.515 to 0.446 mm/s) for Jason-1, and 16.1% (from 0.497 to 0.417 mm/s) for Jason-2 (cf. **Figure 25**). The most significant reduction of the RMS fits was obtained due to the correct handling of the center-of-mass correction for DORIS observations.

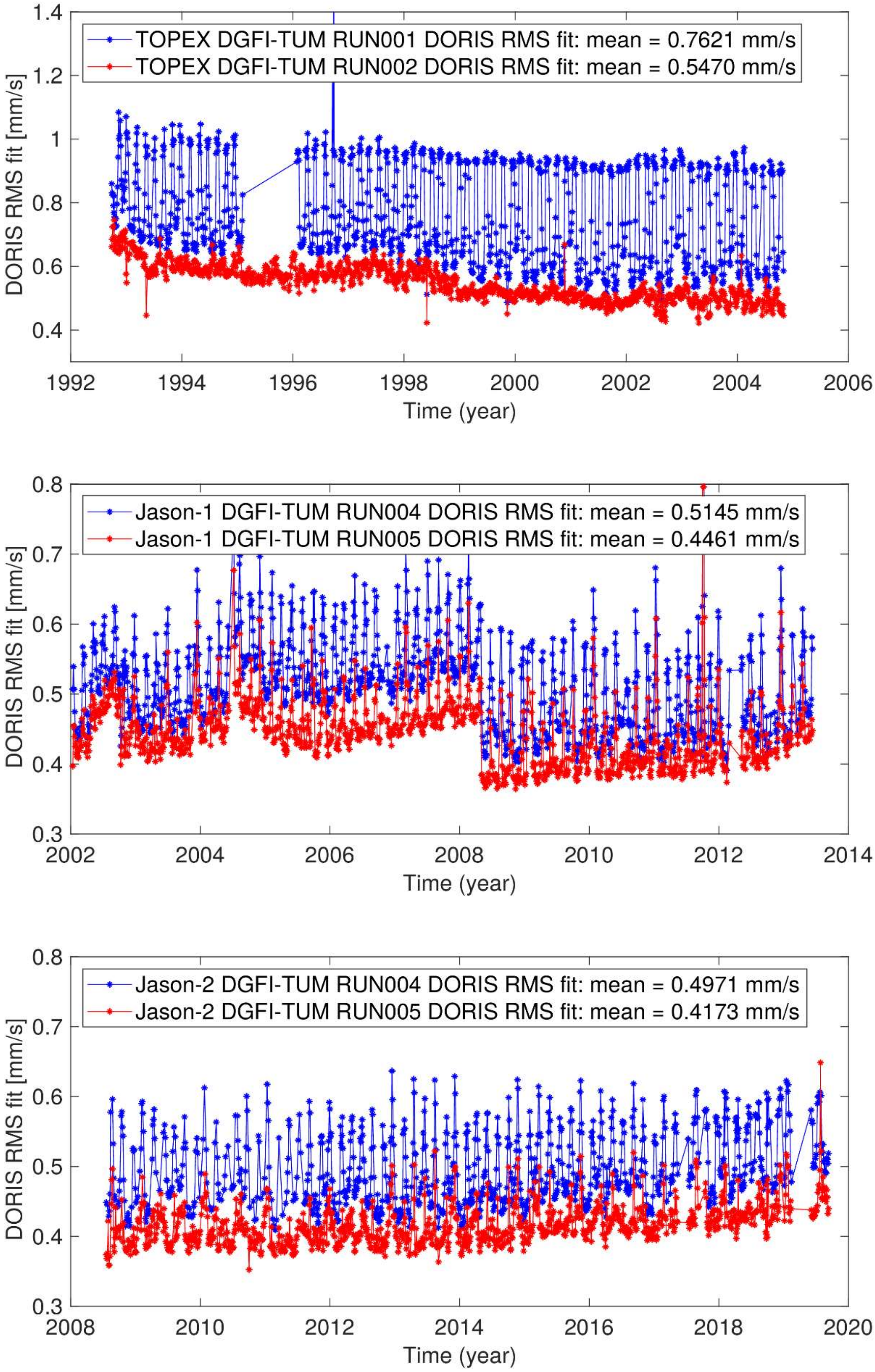

Figure 25. *RMS fits of DORIS observations of TOPEX/Poseidon (top), Jason-1 (middle), and Jason-2 (bottom) of DGFI-TUM orbits derived in 2021 (blue line) and 2022 (red line) using DORIS observations.*

17.4 INVESTIGATION OF THE RADIAL ORBIT ERRORS OF CONTEMPORARY ALTIMETRY SATELLITE ORBITS

A review of the main improvements in the POD of altimetry satellites in the last 30 years (1992 – 2022) was performed by *Rudenko et al. (2023)*. The authors conclude that the main improvements in orbit quality have been obtained due to significant improvements in reference system realizations, the modeling of both, the Earth time-variable gravity field and periodic effects in the system Earth (non-linear loading effects at stations etc.). Moreover, the use of GPS and DORIS measurements in addition to SLR measurements as well as the technological enhancements of all geodetic techniques further improved the orbit quality. Comparisons of contemporary orbit solutions of altimetry satellites derived by various institutions show that satellite positions of the orbits derived using DORIS and GPS observations agree in the radial direction (being important for altimetry applications) at the RMS level of 0.4 – 1.0 cm for Jason and Sentinel-3 satellites (**Figure 26**) and of 1.9 cm for TOPEX/Poseidon. Orbits computed using just SLR observations show larger differences in the radial direction compared to these orbits with RMS values for the SLR-only orbits of 1.2-1.8 cm for the Jason satellites and 1.6-2.2 cm for TOPEX/Poseidon. More interesting results on this study can be found in *Rudenko et al. (2023)*.

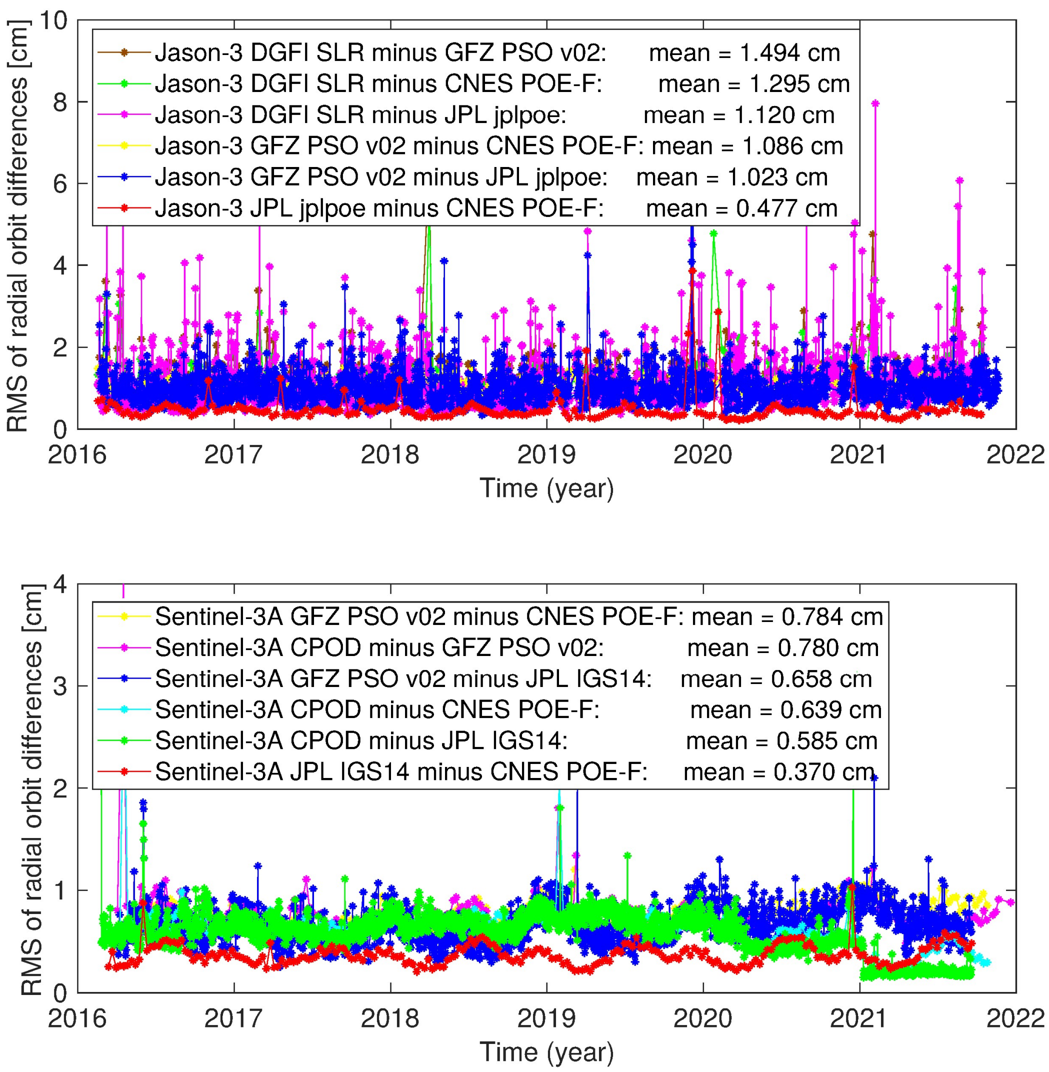

Figure 26. *The RMS values of the radial orbit differences of contemporary Jason-3 (top) and Sentinel-3A (bottom) orbits computed by various institutions (from Rudenko et al., 2023).*

17.5 AN INVESTIGATION OF ITRF2020 FOR ALTIMETRY SATELLITE POD USING SLR OBSERVATIONS

SLR observations to altimetry satellites are used not only for their POD, but also for validation of orbits derived using just DORIS or/and GPS observations. A new realization of the International Terrestrial Reference Frame – ITRF2020 (*Altamimi et al., 2023*) – was published recently. POD tests of this realization performed at DGFI-TUM in 2022 using SLR observations showed an increase of the respective RMS fits, when using ITRF2020 instead of SLRF2014, from 2.34 to 2.57 cm (cf. **Figure 27**). Post-seismic deformations as well as annual and semi-annual variations of stations coordinates were used for ITRF2020 (cf. 'ann.' in **Figure 27**). After an extensive investigation, we came to the conclusion that the problem is related to missing (at that time) long-term mean range biases (RBs) of SLR stations that were derived for the period 1993.0 to 2020.5 and subtracted from the observations used to compute the time series of station positions provided to the ITRS Combination Centers. These time series served as input to the recently published ITRS 2020 realizations. The estimation of arc-wise (3.5 day arcs) RBs for SLR stations reduces the RMS fits to 1.79 and 1.73 cm for SLRF2014 and ITRF2020, respectively (cf. **Figure 27**). Based on these results we conclude that for a proper use of ITRF2020 and the two other ITRS 2020 realizations (DTRF2020 and JTRF2020) either the long-term mean RBs used to derive these realizations should be used or arc-wise RBs should be estimated for each station during the POD (*Rudenko et al., 2022c*).

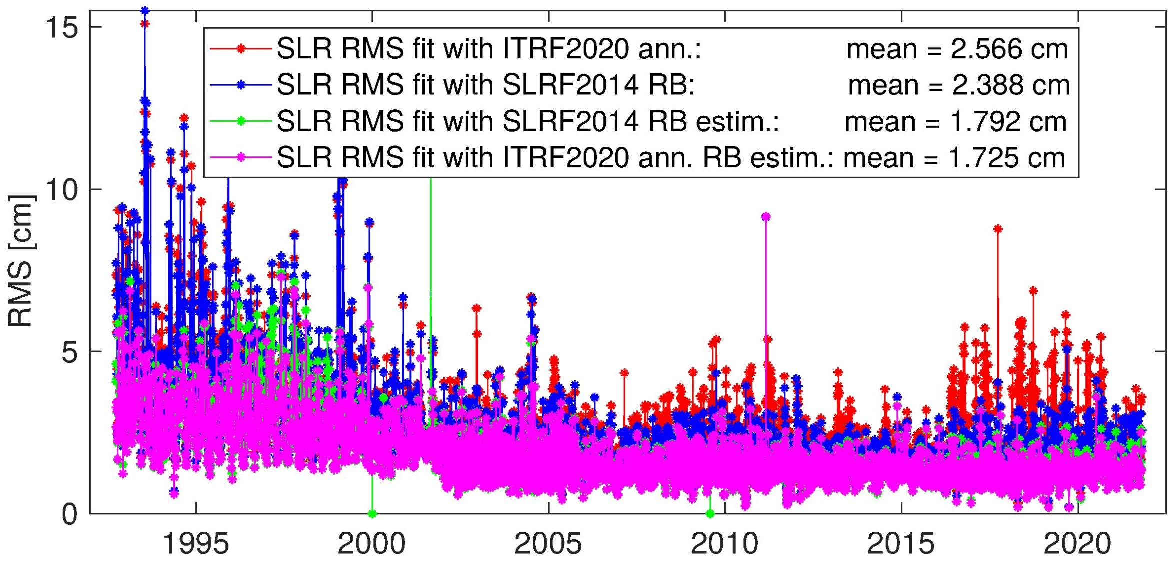

Figure 27. *RMS fits of SLR observations to TOPEX/Poseidon, Jason-1, Jason-2 and Jason-3 obtained using ITRF2020 and SLRF2014 without and with the estimation of SLR range biases.*

17.6 PRESENTATIONS

Rudenko S., Bloßfeld M., Kehm A., Dettmering D., Zeitlhöfler J., Glomsda M., Angermann D., Seitz M.: Precise orbit determination of SLR and altimetry satellites using ITRS2020 realizations. The 22nd International Workshop on Laser Ranging, Guadalajara, Spain and online, 2022a, https://mediatum.ub.tum.de/doc/1691829/1691829.pdf

Rudenko S., Bloßfeld M., Zeitlhöfler J.: Recent activities on orbit determination for altimetry satellites at DGFI-TUM. IDS Analysis Working Group Meeting, online, 2022b, https://mediatum.ub.tum.de/doc/1661753/1661753.pdf

Rudenko S., Bloßfeld M., Zeitlhöfler J., Kehm A., Dettmering D., Glomsda M., Angermann D., Seitz M.: Application of the ITRS2020 realizations for precise orbit determination of SLR and altimetry satellites. IAG International Symposium on Reference Frames for Applications in Geosciences (REFAG 2022), Thessaloniki, Greece, 2022c, https://mediatum.ub.tum.de/doc/1690403/1690403.pdf

Rudenko S., Dettmering D., Bloßfeld M., Zeitlhöfler J., Alkahal R.: On the accuracy of contemporary orbits of altimetry satellites in the radial direction. 2022 Ocean Surface Topography Science Team Meeting, Venice, Italy, 2022d, DOI: 10.24400/527896/a03-2022.3323. https://mediatum.ub.tum.de/doc/1691786/1691786.pdf

Zeitlhöfler J., Bloßfeld M., Rudenko S., Dettmering D., Seitz F.: Station-dependent satellite laser ranging measurement corrections for TOPEX/Poseidon. Frontiers of Geodetic Science (FroGS), Essen, Germany, 2022a, https://mediatum.ub.tum.de/doc/1690362/1690362.pdf

Zeitlhöfler J., Bloßfeld M., Rudenko S., Dettmering D., Seitz F.: Station-dependent satellite laser ranging measurement corrections for TOPEX/Poseidon. 22nd International Workshop on Laser Ranging, ILRS, Guadalajara, Spain and online, 2022b, https://mediatum.ub.tum.de/doc/1691927/1691927.pdf

17.7 REFERENCES

Altamimi Z., Rebischung P., Collilieux X., Métivier L., Chanard K. (2023) ITRF2020: an augmented reference frame refining the modeling of nonlinear station motions. Journal of Geodesy, 97, 47, DOI: 10.1007/s00190-023-01738-w.

Emmert J. T., Drob D. P., Picone J. M., Siskind D. E., Jones M., Mlynczak M. G., et al. (2021): NRLMSIS 2.0: A whole-atmosphere empirical model of temperature and neutral species densities. Earth and Space Science, 8, e2020EA001321, DOI: 10.1029/2020EA001321.

Hart-Davis M.G., Piccioni G., Dettmering D., Schwatke C., Passaro M., Seitz F. (2021): EOT20: a global ocean tide model from multi-mission satellite altimetry. Earth System Science Data, 13, 3869–3884, DOI: 10.5194/essd-13-3869-2021.

Lemoine J.-M., Biancale R., Reinquin F., Bourgogne S., Gégout P. (2019): CNES/GRGS RL04 Earth gravity field models, from GRACE and SLR data. GFZ Data Services, DOI: 10.5880/ICGEM.2019.010.

Lyard F. H., Allain D. J., Cancet M., Carrère L., Picot N. (2021): FES2014 global ocean tide atlas: design and performance, Ocean Science, 17, 615–649, DOI: 10.5194/os-17-615-2021.

Matzka J., Stolle C., Yamazaki Y., Bronkalla O., Morschhauser A. (2021): The geomagnetic Kp index and derived indices of geomagnetic activity. Space Weather, 19, e2020SW002641, DOI: 10.1029/2020SW002641.

Rudenko S., Dettmering D., Zeitlhöfler J., Alkahal R., Upadhyay D., Bloßfeld M. (2023): Radial orbit errors of contemporary altimetry satellite orbits. Surveys in Geophysics, 44, 705–737, DOI: 10.1007/s10712-022-09758-5.

Zeitlhöfler J., Bloßfeld M., Rudenko S., Dettmering D., Seitz F. (2023): Station-dependent satellite laser ranging measurement corrections for TOPEX/Poseidon. Advances in Space Research, 71(1), 975–996, DOI: 10.1016/j.asr.2022.09.002.

18 WORKING GROUP "NRT DORIS DATA"

Denise Dettmering / DGFI-TUM, Germany

18.1 INTRODUCTION

The overall objective of this working group is to thoroughly evaluate the usefulness, requirements, and prospects of near real-time (NRT) DORIS data, focusing on ionospheric research applications.

Currently, DORIS NRT products for the Jason-3 mission are available from the IGN data center with a latency of about three hours, namely NRT DORIS observations (in RINEX format) and NRT orbit information (in sp3 format). The products are freely accessible via the following directories:

ftp://doris.ign.fr/pub/doris/data/ja3/NRT/

ftp://doris.ign.fr/pub/doris/products/orbits/ssa/ja3/NRT/

The distribution of NRT products from additional missions is planned for the near future.

In 2022, the main work of the WG was focused on the usage of NRT DORIS data for the evaluation of GNSS-based ionospheric real-time maps. Moreover, the data has been used to help in the combination of different GNSS maps.

18.2 USING NRT DORIS DATA FOR VALIDATING GNSS IONOSPHERIC MAPS

To validate the quality of real-time GNSS-derived ionospheric maps (RT-GIMs) the concept of DORIS differential Slant Total Electron Content (dSTEC) assessment is applied. The dSTEC observations are defined as the difference between the time-dependent STEC along a phase-continuous arc and the STEC measured at the highest satellite elevation. DORIS dSTEC is an extension of the existing GNSS dSTEC validation method and can be calculated directly from the dual-frequency DORIS carrier phase measurements of modern DORIS receivers. Taking advantage of the large relative frequency ratio between DORIS L1 (2 GHz) and L2 (400 MHz) frequencies, the theoretical precision of DORIS-derived dSTEC reaches 0.028 TECu, which is about 10 times better than that of GNSS L1/L2 based dSTEC. Such ultra-precise DORIS dSTEC observables should significantly benefit the quality assessment of RT-GIMs.

Using NRT DORIS data from the Jason-3 satellite and GPS/GLONASS data from IGS stations, we evaluated the performance of RT-GIMs provided by different institutions and the combined IGS product. The correlation analysis between GNSS dSTEC validation and DORIS dSTEC validation is shown in **Figure 28**. The RMS of the RT-GIM dSTEC discrepancy with respect to the GNSS-dSTEC values is larger than that of the discrepancy referring to the DORIS values since most of the values are below the symmetry line. Overall, the Pearson correlation coefficient between DORIS- and GNSS-dSTEC assessments is 0.81. The result shows that the proposed DORIS NRT data can be used as an independent reference to validate the quality of ionospheric maps. When used to validate GNSS-derived GIMs they can be considered completely independent of any input data set (unlike GNSS dSTEC).

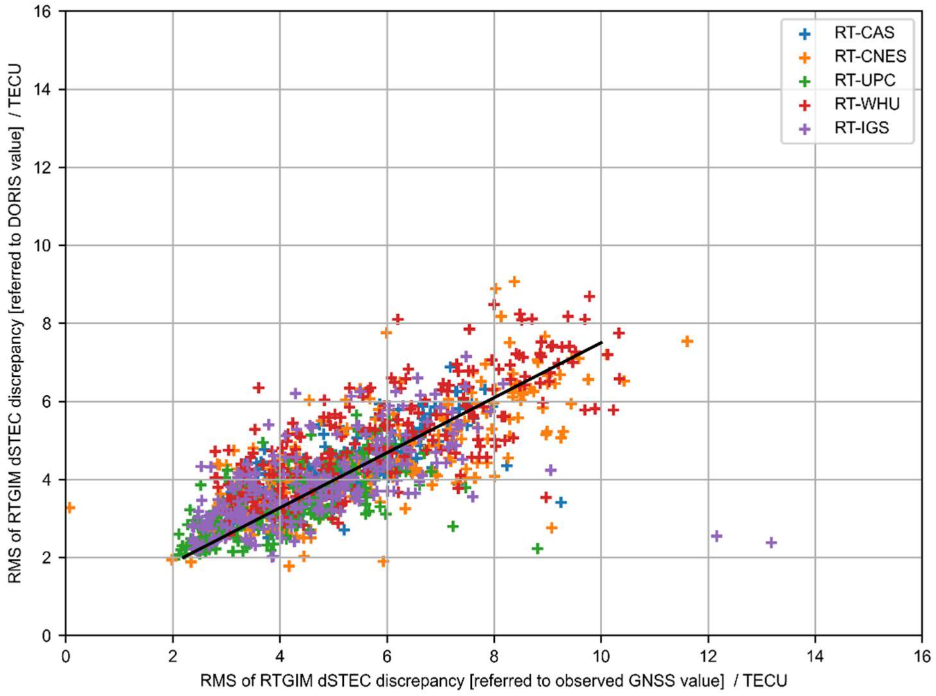

Figure 28. *RMS of RT-GIM dSTEC discrepancy referring to DORIS data versus that referring to GPS/GLONASS data during DOY 001-110, 2022.*

18.3 USING NRT DORIS DATA FOR COMBINING GNSS IONOSPHERIC MAPS

The IGS generates combined RT-GIM products using different RT-GIM solutions from different analysis centers. The combination is based on weighting factors derived from performance metrics generated using GNSS observations (GNSS dSTEC). As the DORIS dSTEC analyses have proven to be an independent and precise reference for validating GNSS-generated ionospheric models, dSTEC information derived from Jason-3 NRT DORIS data can also be used as a quality indicator and weighting factor of RT-GIMs from different analysis centers.

When comparing the combined maps from the two weighting strategies, similar results show a similar distribution of the global ionospheric total electron content with only small differences due to the different weighting of individual models. The performance of the DORIS-dSTEC combined RT-GIM and GNSS-dSTEC combined RT-GIM is assessed by comparison with Jason-3 VTEC. A significant negative systematic bias of about 4 TECu is found between Jason-3 VTEC and RT-GIM from both weighting strategies. When comparing the root mean square error, the DORIS-dSTEC-combined RT-GIM slightly outperforms the GNSS-dSTEC-combined RT-GIM (4.7 TECu instead of 4.8 TECu), indicating an improvement of about 2% due to the improved weighting based on validation by DORIS NRT data.

18.4 FUTURE WORK

Based on NRT DORIS data from the Jason-3 satellite, it is shown that DORIS dSTEC can be used to independently validate the quality of ground-based GNSS ionospheric maps. In addition to Jason-3, the dissemination of NRT DORIS data from other missions (such as Sentinel-3) is planned, which will extend the coverage of DORIS ionospheric observations and benefit the ionosphere-related analysis. The next step will be the generation and dissemination of near real-time and rapid combined ionospheric maps using DORIS data from additional satellite missions.

APPENDIX

19 IDS AND DORIS QUICK REFERENCE LIST

1. **IDS website**
   https://ids-doris.org/

2. **Contacts**
   Central Bureau ids.central.bureau@ids-doris.org
   Governing Board ids.governing.board@ids-doris.org

3. **Data Centers**
   CDDIS: https://cddis.nasa.gov/archive/doris/
   IGN: ftp://doris.ensg.eu and ftp://doris.ign.fr

4. **Tables of Data and Products**
   https://ids-doris.org/ids/data-products/tables-of-data-products.html

5. **IDS web service**
   https://ids-doris.org/webservice
   DOR-O-T for DORis Online Tools (pronounced in French like the given name Dorothée) is the IDS web service developed to promote the use of the DORIS products. The current version of the service provides tools to browse time series in an interactive and intuitive way, and a network viewer.

6. **Citation**
   The following article is suggested for citation in papers and presentations that rely on DORIS data and results:

   Willis, P.; Lemoine, F.G.; Moreaux, G.; Soudarin, L.; Ferrage, P.; Ries, J.; Otten, M.; Saunier, J.; Noll, C.; Biancale, R.; Luzum, B., 2016. The International DORIS Service (IDS), recent developments in preparation for ITRF2013, IAG SYMPOSIA SERIES, 143, 631-639, DOI: 10.1007/1345_2015_164

7. **DORISmail**
   The DORIS mail service is used to send information of general interest to the DORIS community. To send a DORISMail, use the following address: dorismail@ids-doris.org

8. **List of the documentation**
   It gives a table compiling links to the various pages providing documents, grouped in four categories: DORIS system components; IDS information system; Publications, presentations; Documents.
   https://ids-doris.org/ids/reports-mails/documentation.html

9. **List of presentations given at DORIS or IDS meetings**
   Full list of presentations given at DORIS or IDS meetings with the corresponding access links
   https://ids-doris.org/ids/reports-mails/meeting-presentations.html

10. **List of documents and links to discover the DORIS system**
    https://ids-doris.org/analysis-coordination/documents-related-to-data-analysis.html

11. **List of DORIS publications in international peer-reviewed journals**
    https://ids-doris.org/ids/reports-mails/doris-bibliography/peer-reviewed-journals.html

12. **Overview of the DORIS system**
    https://www.aviso.altimetry.fr/en/techniques/doris.html

13. **Overview of the DORIS satellite constellation**
    https://ids-doris.org/doris-system/satellites.html

14. **Site logs**
    DORIS stations description forms and pictures from the DORIS installation and maintenance department: https://ids-doris.org/doris-system/tracking-network/site-logs.html

15. **Virtual tour of the DORIS network with Google Earth**
    Download the file at https://ids-doris.org/doris-system/tracking-network/network-on-google-earth.html and visit the DORIS sites all around the world.

16. **IDS video channel**
    Videos of the DORIS-equipped satellites in orbit
    https://www.youtube.com/@internationaldorisservice-7170

17. **IDS Newsletters**
    Find all the issues published in color with live links on the IDS website
    https://ids-doris.org/ids/reports-mails/newsletter.html

18. **Photo Gallery**
    https://ids-doris.org/ids/gallery.html

19. **More contacts**
    For particular requests, you may also contact the following persons:

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E-mail: jerome.saunier@ign.fr

20 IDS INFORMATION SYSTEM

20.1 WHAT AND WHERE

IDS has three data/information centers:

- CB: the Central Bureau web and ftp sites at CLS
- DC: the Data Center(s): * CDDIS: web and ftp sites * IGN: ftp sites
- AC: the Analysis Coordination webpages on the CB web site

The baseline storage rules are as follows:

- CB produces/stores/maintains basic information on the DORIS system, including various standard models (satellites, receivers, signal, reference frames, etc).
- DC store observational data, products, and ancillary information required for the use of these data and products + formats and analysis descriptions.
- AC refers to CB and DC information on the data and modeling, and generates/stores analyses of the products.

Two criteria are considered for deciding where files are stored/maintained:

1. the responsibility for their content and update,
2. the ease of user access.

To avoid information inconsistencies, duplication is minimized. Logical links and cross referencing between the three types of information centers are systematically used.
Products are deposited in ad hoc DCs areas. The analysis centers need to have an account at both DCs.

A description of the data structure and formats is available at:
https://ids-doris.org/ids/data-products/data-structure-and-formats.html

20.2 WEB AND FTP SITES

20.2.1 IDS WEB SITE

address: https://ids-doris.org (or https://www.ids-doris.org)

The IDS web site gives general information on the Service, provides access to the DORIS system pages on the AVISO web site, and hosts the Analysis Coordination pages.

It is composed of four parts:

- "IDS" describes the organization of the service and includes documents, access to the data and products, event announcements, contacts and links.
- "DORIS System" allows to access general description of the system, and gives information about the system monitoring and the tracking network.

- “Analysis Coordination” provides information and discussion areas about the analysis strategies and models used in the IDS products. It is maintained by the Analysis Coordinator with the support of the Central Bureau.
- "Web service" gives access to DOR-O-T, the IDS Web service that proposes a family of plot tools to visualize time series of DORIS-related products and a network viewer to select sites.

It is supplemented by a site map, a glossary, FAQs, a history of site updates, news on the IDS and news on DORIS.

The main headings of the “IDS” parts are:

- Organization: structure of the service, terms of reference, components
- Data & Products: tables of data and products, information and data center organization, data structure and formats, access information to the IDS Data Centers and to the Central Bureau ftp site.
- Documentation: synthetic table of the documentation available, newsletters, documents of the IDS components, DORIS bibliography including DORIS-related peer-reviewed publications and citation rules, meeting presentations, mail system messages, etc.
- Meetings: calendars of the meetings organized by IDS or relevant for IDS, as well as links to calendars of other international services and organizations.
- Contacts and links: IDS contacts, directory, list of websites related to IDS activities
- Gallery: photo albums for the DORIS stations (local teams, equipment, obstruction views) and IDS meetings.

The headings of the “DORIS system” part are:

- The DORIS technique (a link to the official DORIS website): a description of the DORIS system on the AVISO web site.
- Tracking network: Site logs, station coordinate time series, maps, network on Google Earth, station management.
- Satellites: information on the DORIS missions.
- System monitoring: table of events that occurred on the DORIS space segment and ground segment, classified into 4 categories ("Station", "System", "Earthquake", "Data"), station performance plots from the CNES MOE and POE processings.

The headings of the “Analysis Coordination” part are:

- Presentation: a brief description of this section
- Combination Center: information about the activity and products, cumulative solution, DPOD, contributions to ITRF2008, ITRF2014 (list of standards used by IDS Analysis Centers) and next ITRF2020
- Documents for the data analysis: about the DORIS system’s components (space segment, ground segment, stations, observations), the models used for the analysis, the products and their availability.
- About DORIS/RINEX format: all the material related to the DORIS/RINEX gathered on one page.
- DORIS related events: history of the workshops, meetings, analysis campaigns...
- Discussion: archive of the discussions before the opening of the forum.

DORIS and IDS news as well as site updates are accessible from the Home page. Important news is displayed in the box “Highlights”. The lists of news about the DORIS system and IDS activities (also widely distributed through the DORISmails) are resumed respectively in the two headings “What’s new on DORIS” (https://ids-doris.org/doris-news.html) and “What’s new on IDS” (https://ids-doris.org/ids-news.html). The history of the updates of the website is given in “Site updates” (https://ids-doris.org/site-updates.html).

The IDS web site is maintained by the Central Bureau.

20.2.2 IDS WEB SERVICE

address: https://ids-doris.org/webservice (or https://apps.ids-doris.org/apps/)

DOR-O-T for DORis Online Tools (pronounced in French like the given name Dorothée) is the IDS web service developed to promote the use of DORIS products. The current version of the service provides tools to browse time series in an interactive and intuitive way. Besides products provided by the CNES Orbitography Team and the IDS components (Analysis Centers and Combination Center), this service allows comparing time evolutions of coordinates for DORIS and GNSS stations in co-location, thanks to a collaboration with the IGS Terrestrial Frame Combination Center.

The tools proposed by this web service are:

- a NETWORK VIEWER to select sites
- a family of PLOT TOOLS to visualize the following time series:
  - **Station position** differences at observation epochs relative to a reference position: North, East and Up trended time series.
  - **Orbit residuals** and amount of station measurements from CNES Precise Orbit Ephemeris processing: RMS of post-fit orbit residuals, total and validated number of DORIS measurements per arc.
  - **Combination parameters** i.e. outputs of the IDS Combination Center analysis: WRMS of station position residuals, scale and translation parameters, number of stations used in the analysis.
  - **Earth Orientation Parameters** from the IDS Combination Center analysis (Xp, Yp, LOD).
  - **Position residuals** of the cumulative solution from the IDS Combination Center analysis (North, East, Up)

20.2.3 IDS FTP SERVER

address: ftp://ftp.ids-doris.org/pub/ids

The IDS ftp server gives information on the DORIS system, and provides analysis results from the Analysis Coordination’s combination center.

The main directories are :

- ancillary: documents about the DORIS ancillary data *(such as bus quaternions and solar panel angles of Jason-1 and Jason-2)*
- centers: documents for the analysis centers
- combination_center: products and reports of the combination center
- combinations: working directory of the combination center

- data: documents about the DORIS data *(format description 1.0, 2.1, 2.2, and RINEX, POE configurations for GDRB, GDRC, …)*
- dorismail: archive of the mails of DORISmail mailing list
- dorisreport: archive of the mails of DORISreport mailing list
- dorisstations: archive of the mails of DORISstations mailing list
- events: lists of events occurring on the DORIS system
- ids.analysis.forum: archive of the mails of ids.analysis.forum mailing list
- products: format descriptions of the products *(eop, geoc, iono, snx, sp1, sp3, stcd)*
- satellites: documents and data related to the satellites *(macromodels, nominal attitude model, center of mass and center of gravity history, maneuver history, instrument modelling, corrective model of DORIS/Jason-1 USO frequency, …)*
- stations: documents and data related to the stations *(sitelogs, ties, antennas phase laws, …)*

The contain is described in the document "IDS data structure and formats" (https://ids-doris.org/ids/data-products/data-structure-and-formats.html).

The IDS ftp site is maintained by the Central Bureau. There is a mirror site at CDDIS: ftp://cddis.gsfc.nasa.gov/pub/doris/cb_mirror/ and at IGN: ftp://doris.ensg.eu/pub/doris/cb_mirror/

20.2.4 DORIS WEB SITE

Address: https://www.aviso.altimetry.fr/en/techniques/doris.html

The official DORIS web site is hosted by the Aviso website which is dedicated to altimetry, orbitography and precise location missions. The DORIS pages present the principle of the system, its description (instruments onboard, ground beacons, control and processing center, system evolutions, Diode navigator), the applications and the missions. The site is maintained by the Aviso webmaster with the support of the IDS Central Bureau.

20.2.5 DATA CENTERS' FTP AND WEB SITES

Data and products, formats and analysis descriptions are stored at the CDDIS and IGN Data Centers. A detailed description is given in the report of the Data flow Coordinator.

The contain stored on the ftp sites is also described in the document "IDS data structure and formats" (https://ids-doris.org/ids/data-products/data-structure-and-formats.html).

Address of the CDDIS web site:
https://cddis.nasa.gov/Data_and_Derived_Products/DORIS/DORIS_data_and_product_archive.html
Address of the CDDIS http site: https://cddis.nasa.gov/archive/doris/
Address of the IGN ftp site: ftp://doris.ensg.eu/pub/doris/ (or ftp://doris.ign.fr/pub/doris/)

20.3 THE MAIL SYSTEM

The mail system of the IDS is one of its main communication tools. Depending on the kind of the information, mails are distributed through the DORISmail, DORISreport or DORISstations. The mails of these four lists are all archived on the mailing list server of CLS. Back-up archives of the text files are also available on the Central Bureau ftp server for the DORISmails and the DORISreports.

A description of the mailing lists can be found on the IDS web site on the page: http://ids-doris.org/report/mails.html

Dedicated mailing lists were also created for the Central Bureau, the Governing Board and the Analysis Working Group, but without archive system.

20.3.1 DORISMAIL

e-mail: dorismail@ids-doris.org

The DORISmails are used to distribute messages of general interest to the users' community (subscribers). The messages concern:

- Network evolution: installation, renovation…
- Data delivery: lack of data, maneuver files
- Satellite status
- Status of the Data Centers
- Meeting announcements
- Calls for participation
- Delivery by Analysis Centers
- etc…

The messages are moderated by the Central Bureau.

They are all archived on the mailing list server of CLS at the following address:
http://lists.ids-doris.org/sympa/arc/dorismail

They are also available in text format on the IDS ftp site: ftp://ftp.ids-doris.org/pub/ids/dorismail/

20.3.2 DORISREPORT

e-mail : dorisreport@ids-doris.org

This list is used for regular reports from Analysis Centers, from the Analysis coordination and from the CNES POD team. The DORISReport distribution list is composed by Analysis Centers, Data Centers, IDS Governing Board and Central Bureau, CNES POD people delivering data to the Data Centers (subscribers).

They are all archived on the mailing list server of CLS at the following address:
http://lists.ids-doris.org/sympa/arc/dorisreport

They are also available in text format on the IDS ftp site: ftp://ftp.ids-doris.org/pub/ids/dorisreport/

The list is moderated by the Central Bureau and the CNES POD staff.

20.3.3 DORISSTATIONS

e-mail : dorisstations@ids-doris.org

This mailing list has been opened to distribute information about station events (data gap, positioning discontinuities).

The messages are archived on the mailing list server of CLS at the following address: http://lists.ids-doris.org/sympa/arc/dorisstations.

They are also available in text format on the IDS ftp site: ftp://ftp.ids-doris.org/pub/ids/dorisstations/

The archive contains also the mails distributed on the analysis forum before the creation of the dedicated list.

20.3.4 OTHER MAILING LISTS

ids.central.bureau@ids-doris.org: list of the Central Bureau

ids.governing.board@ids-doris.org: list of the Governing Board

ids.cbgb@ids-doris.org: private common list for the Central Bureau and the Governing Board.

ids.awg@ids-doris.org: list of people who attend the AWG, and/or analysis center representatives.

ids.analysis.coordination@ids-doris.org: list of the Analysis Coordination

20.4 HELP TO THE USERS

e-mail : ids.central.bureau@ids-doris.org

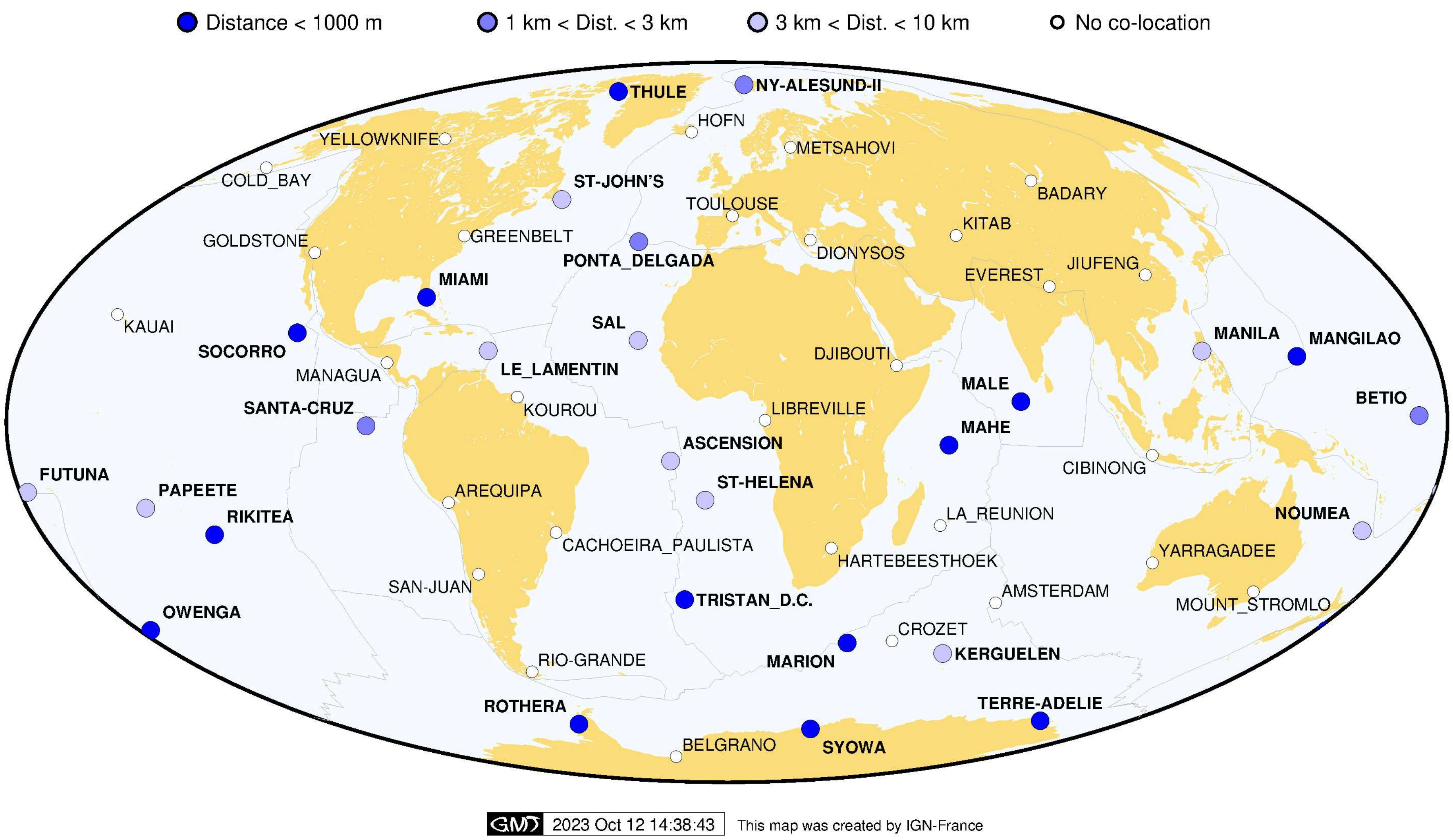
The contact point for every information requirement is the Central Bureau. It will find a solution to respond to user's need. A list of contact points has been defined for internal use depending on the kind of questions.

21 DORIS STATIONS / CO-LOCATION WITH TIDE GAUGES

The table and the figure below are managed by IGN and the University of La Rochelle within the framework of their collaboration on « Système d'Observation du Niveau des Eaux Littorales » (SONEL, http://www.sonel.org).

DORIS Name	Long	Lat	Country	Start date	Distance (m)	GLOSS id	PSMSL id
ASCENSION	-14.33	-7.92	UK (SOUTH ATLANTIC)	28/02/97	6500	263	1831
BETIO	172.92	1.35	KIRIBATI	22/10/06	1600	113	1804
FUTUNA	-178.12	-14.31	FRANCE (POLYNESIA)	18/10/11	4400	353	2244
KERGUELEN	70.26	-49.35	FRANCE (TAAF)	05/04/93	3300	23	1849
LE LAMENTIN	-61.00	14.60	FRANCE (MARTINIQUE)	29/06/13	7000	338	1942
MAHE	55.53	-4.68	SEYCHELLES	20/06/01	300	339	1846
MALE	73.53	4.20	MALDIVES	15/01/05	500	28	1753
MANILA	121.03	14.53	PHILIPPINES	26/02/03	9700	73	145
MANGILAO	144.80	13.43	USA (GUAM IS.)	12/04/18	830	------	2130
MARION ISLAND	37.86	-46.88	SOUTH AFRICA	01/01/90	410	20	------
MIAMI	-80.17	25.73	USA (FLORIDA)	10/02/05	180	332	1858
NOUMEA	166.42	-22.24	FRANCE (CALEDONIA)	27/01/05	7000	123	2134
NY-ALESUND II	11.83	78.93	NORWAY (SVALBARD)	19/10/18	2500	345	1421
OWENGA	-176.37	-44.02	NEW ZEALAND (CHATHAM IS.)	20/01/14	80	------	------
PAPEETE	-149.61	-17.58	FRANCE (POLYNESIA)	27/07/95	7000	140	1397
PONTA DELGADA	-25.66	37.75	PORTUGAL (AZORES)	02/11/98	1500	245	258
RIKITEA	-134.97	-23.13	FRANCE (POLYNESIA)	23/09/06	800	138	1253
ROTHERA	-68.13	-67.57	UK (ANTARCTICA)	01/03/03	170	342	1931
SAL	-22.98	16.78	CAPE VERDE	15/12/02	5700	329	1914
SANTA CRUZ	-90.30	-0.75	ECUADOR	01/04/05	1600	------	1472
SOCORRO	-110.95	18.73	MEXICO	09/06/89	580	162	1821
ST-HELENA	-5.67	-15.94	UK (SOUTH ATLANTIC)	01/06/89	5900	264	1845
ST. JOHN'S	-52.68	47.40	CANADA (TERRE-NEUVE)	27/09/99	3600	223	393
SYOWA	39.58	-69.01	JAPAN (ANTARCTICA)	10/02/93	1000	95	1396
TERRE ADELIE	140.00	-66.67	FRANCE (ANTARCTICA)	01/02/97	500	131	2231
THULE	-68.83	76.54	DENMARK (GREENLAND)	28/09/02	450	343	------
TRISTAN DA CUNHA	-12.31	-37.07	UK (SOUTH ATLANTIC)	10/06/86	120	266	------

Co-location with tide gauge



22 DORIS STATIONS / HOST AGENCIES

The local teams that take care of the DORIS stations contribute in large part with skill and efficiency to the high quality of the DORIS network improving continuously its robustness and reliability.

The following table gives the list of the organizations involved as host agencies of the DORIS stations.

Station name	Host agency	City, Country
Amsterdam	Institut Polaire Paul Emile Victor (IPEV)	Base Martin-de-Viviès, île Amsterdam, Sub-Antarctica, FRANCE
Arequipa	Instituto Astronómico y Aeroespacial P. Paulet Universidad Nacional de San Agustin (UNSA)	Observatorio de Characato, Arequipa, PERU
Ascension	ESA Telemetry & Tracking Station	Ascension Island, South Atlantic Ocean, UK
Badary	Badary Radio Astronomical Observatory (BdRAO, Institute of Applied Astronomy)	Republic of Buryatia, RUSSIA
Belgrano	Instituto Antártico Argentino (DNA)	Buenos Aires, ARGENTINA
Betio	Kiribati Meteorological Service	Tarawa Island, Republic of KIRIBATI
Cachoeira Paulista	Instituto Nacional de Pesquisas Espaciais (INPE)	Cachoeira Paulista, BRAZIL
Cibinong	Badan Informasi Geospatial (BIG)	Cibinong, INDONESIA
Cold Bay	National Weather Service (NOAA)	Cold Bay, Alaska, U.S.A.
Crozet	Institut Polaire Paul Emile Victor (IPEV)	Base Alfred Faure, archipel de Crozet, Sub-Antarctica, FRANCE
Dionysos	National Technical University Of Athens (NTUA)	Zografou, GREECE
Djibouti	Observatoire Géophysique d'Arta (CERD)	Arta, Republic of DJIBOUTI
Everest	Ev-K2-CNR Association	Bergamo, ITALY
Futuna	Météo-France	Malae, Wallis-et-Futuna, FRANCE
Goldstone	NASA / GDSCC	Fort Irwin, California, U.S.A.
Grasse	Observatoire de la Côte d'Azur (OCA)	Grasse, FRANCE
Greenbelt	NASA / GSFC / GGAO	Greenbelt, Maryland, U.S.A.
Hartebeesthoek	HartRAO, South African National Space Agency (SANSA)	Hartebeesthoek, SOUTH AFRICA

Station name	Host agency	City, Country
Höfn	National Land Survey of Iceland Landmælingar Islands (LMI)	Akranes, ICELAND
Jiufeng	Innovation Academy for Precision Measurement Science and Technology (APM)	Wuhan, CHINA
Kauai	Kokee Park Geophysical Observatory (KPGO)	Kauai Island, Hawaï, U.S.A.
Kerguelen	Institut Polaire Paul Emile Victor (IPEV)	Base de Port-aux-Français, archipel de Kerguelen, Sub-Antarctica, FRANCE
Kitab	Ulugh Beg Astronomical Institute (UBAI)	Kitab, UZBEKISTAN
Kourou	Centre Spatial Guyanais (CSG)	Kourou, FRENCH GUYANA
La Réunion	Observatoire Volcanologique du Piton de La Fournaise (IPGP)	Ile de la Réunion, FRANCE
Le Lamentin	Météo-France	Martinique, French West Indies, FRANCE
Libreville	ESA Tracking Station	N'Koltang, GABON
Mahé	Seychelles Meteorological Authority	Mahé Island, Republic of SEYCHELLES
Male'	Maldives Meteorological Service (MMS)	Male, Republic of MALDIVES
Managua	Instituto Nicaragüense de Estudios Territoriales (INETER)	Managua, NICARAGUA
Mangilao	University of Guam (UoG)	Guam Island, USA
Manila	National Mapping and Ressource Information Authority (NAMRIA)	Taguig, Republic of the PHILIPPINES
Marion	Antartica & Islands Department of Environmental Affairs (DEA)	Marion Island Base, SOUTH AFRICA
Metsähovi	Finnish Geospatial Research Institute National Land Survey (NLS)	Masala, FINLAND
Miami	Rosenstiel School of Marine and Atmospheric Science (RSMAS)	Miami, Florida, U.S.A.
Mount Stromlo	Mount Stromlo Observatory, Geoscience Australia (GA)	Mount Stromlo, Canberra, AUSTRALIA
Nouméa	Direction des Infrastructures, de la Topographie et des Transports Terrestres	Nouméa, New Caledonia, FRANCE
Ny-Ålesund II	Institut Polaire Paul Emile Victor (IPEV) Kartverket (Norwegian Mapping Authority)	Ny-Ålesund, Svalbard, NORWAY
Owenga	Land Information New Zealand (LINZ)	Chatham Island, NEW ZEALAND
Papeete	Observatoire Géodésique de Tahiti, Université de la Polynésie Française (UPF)	Fa'a, Tahiti, Polynésie Française, FRANCE
Höfn	National Land Survey of Iceland Landmælingar Islands (LMI)	Akranes, ICELAND

Station name	Host agency	City, Country
Ponta Delgada	CIVISA / IVAR Universidade dos Açores	Ponta Delgada, Azores, PORTUGAL
Rikitea	Météo-France	Archipel des Gambier, Polynésie Française, FRANCE
Rio Grande	Estación Astronómica de Rio Grande (EARG), Universidad Nacional de la Plata (UNLP)	Rio Grande, ARGENTINA
Rothera	British Antarctic Survey (BAS)	Rothera Research Station, Adelaide Island, Antarctica, UK
Sal	Instituto Nacional de Meteorologia e Geofisica (INMG)	Sal Island, CAPE VERDE
San Juan	Observatorio Astronómico Félix Aguilar Universidad Nacional de San Juan (UNSJ)	San Juan, ARGENTINA
Santa Cruz	Fundación Charles Darwin (FCD)	Santa Cruz Island, Galápagos, ECUADOR
Socorro	Instituto Nacional de Estadística y Geografía (INEGI) Secretaría de Marina Armada (SEMAR)	Aguascalientes, MEXICO Socorro Island, MEXICO
St John's	Geomagnetic Observatory, Natural Resources Canada (NRCan)	St. John's, CANADA
St-Helena	Met Office Saint-Helena Government	Longwood, St Helena Island, South Atlantic, UK
Syowa	National Institute of Polar Research (NIPR)	Syowa Base, Antarctica, JAPAN
Terre Adélie	Institut Polaire Paul Emile Victor (IPEV)	Base de Dumont d'Urville, Terre-Adélie, Antarctica, FRANCE
Thule	National Space Institute at the Technical University of Denmark (DTU Space)	Kgs. Lyngby, DENMARK
Toulouse	Collecte Localisation Satellites (CLS)	Ramonville, FRANCE
Tristan da Cunha	Communications Department of TDC	Tristan da Cunha Island, South Atlantic, UK
Wettzell	Geodetic Observatory Wettzell (BKG)	Bad Kötzting, GERMANY
Yarragadee	Yarragadee Geodetic Observatory, Geoscience Australia (GA)	Yarragadee, AUSTRALIA
Yellowknife	Natural Resources Canada (NRCan)	Yellowknife, CANADA

23 BIBLIOGRAPHY

The following list compiles articles related to DORIS published in 2022 in international peer-reviewed journals

The full list since 1985 is available on the IDS website at http://ids-doris.org/ids/reports-mails/doris-bibliography/peer-reviewed-journals.html (follow IDS > Reports & Mails > DORIS bibliography > Peer-reviewed journals)

2022

Ampatzidis, D.; Thaller, D.; Wang, L., 2022. The Correlations of the Helmert Transformation Parameters as an Additional Auxiliary Diagnostic Tool for Terrestrial Reference Frames Quality Assessment, IAG SYMPOSIA, :, DOI : 10.1007/1345_2022_164 OPEN ACCESS

Seitz, M.; Bloßfeld, M.; Angermann, D.; Seitz, F., 2022. DTRF2014: DGFI-TUM's ITRS realization 2014, ADVANCES IN SPACE RESEARCH, 69(6):2391-2420, DOI : 10.1016/j.asr.2021.12.037

Zeitlhöfler, J.; Bloßfeld, M.; Rudenko, S.; Dettmering, D.; Seitz, F., 2022. Station-dependent satellite laser ranging measurement corrections for TOPEX/Poseidon, ADVANCES IN SPACE RESEARCH, 71(1):975-996, DOI : 10.1016/j.asr.2022.09.002

24 NEWSLETTERS

Launched in April 2016, the IDS Newsletter aims to provide regular information on the DORIS system and the life of IDS to a wide audience, from the host agencies to the other sister services. The issues are distributed electronically. They can also be downloaded from the IDS website at https://ids-doris.org/ids/reports-mails/newsletter.html (follow IDS > Documentation > Newsletter)

To subscribe to the newsletter, please send an e-mail to ids.central.bureau@ids-doris.org, with "Subscribe Newsletter" in the subject.

The following list gives the content of the newsletters issued from #1.

IDS Newsletter #10 (April 2023)

DORIS is on SWOT

Using Near-Real-Time DORIS data for validating real-time GNSS ionospheric maps
(D. Dettmering, DGFI-TUM, N. Wang, AIR-CAS)

IDS contribution to the 2020 realization of the International Terrestrial Reference Frame
(G. Moreaux, CLS)

Höfn, new DORIS site in Iceland (J. Saunier, IGN)

The host agency in short: Höfn (G.H. Kristinsson, LMI)

IDS life

The DORIS constellation 2023

IDS Newsletter #9 (September 2021)

A new method for monitoring the geocenter motion using DORIS observations (A. Couhert, CNES)

Doppler crossings on-board DORIS receiver carrier satellites
(C. Jayles, CNES, J.P. Chauveau, CLS, P. Yaya, CLS)

Major renovation at Réunion Island (J. Saunier, IGN)

La Réunion: the host agency in short (P. Kowalski, OVPF)

The 4th generation of DORIS beacon (J. Saunier, IGN)

IDS life

HY-2D, a new DORIS carrier satellite

IDS Newsletter #8 (December 2020)

2020 celebrates 30 years of the DORIS system

2020, two new missions have joined the DORIS constellation

IDS and DORIS milestones

IDS life

Pascal Willis retires

IDS Newsletter #7 (January 2020)

DORIS in Latin America: more sun, more warmth, and more rythm (J. Saunier, IGN)

The host agencies in short: San Juan (R. C. Podestá, OAFA) and Santa Cruz (J. Carrión, CDF)

IDS life

IDS & DORIS quick reference list

IDS Newsletter #6 (February 2019)

The synergy of SLR and DORIS as geodetic techniques (F. Lemoine, A. Belli, C. Noll, NASA GSFC)

The Azores: a key location occupied by DORIS for three decades (J. Saunier, IGN, C. Jayles, CNES, G. Moreaux, CLS, P. Yaya, CLS)

Ponta Delgada: the host agency in short (R. TF. Marques, CIVISA)

Tribute to Richard Biancale (F. Lemoine, NASA, L. Soudarin, CLS, JM. Lemoine, CNES, P. Ferrage, CNES, JP. Boy, EOST)

IDS life

IDS Newsletter #5 (September 2018)


IDS

DORIS stations in Polar Regions, an ongoing challenge for continuous operation

[DORIS stations in polar regions, an ongoing challenge for continuous operation](#) (J. Saunier, IGN)

[Focus on Rothera on the Antarctic Peninsula](#) (J. Saunier, IGN)

[Rothera: the host agency in short](#) (D.G. Vaughan, BAS)

[DORIS on Sentinel-3B: and now seven!](#) (CNES)

[Jason-2, ten years after](#) (CNES)

[IDS meetings: a time to remove the nose from the grindstone](#) (G. Moreaux, L. Soudarin, CLS)

[IDS life](#)

IDS Newsletter #4 (November 2017)


IDS

Station re-location at Kitab (Uzbekistan) to get better visibility

[Station re-location at Kitab (Uzbekistan) to get better visibility](#) (J. Saunier, IGN)

[Kitab: the host agency in short](#) (D. Fazilova and S. Ehgamberdiev, UBAI)

[DPOD2014: a new DORIS extension of ITRF2014 for Precise Orbit Determination](#) (G. Moreaux, CLS)

[IDS life](#)

IDS Newsletter #3 (December 2016)


IDS

IDS held its Workshop 2016 in La Rochelle

[IDS held its Workshop 2016 in La Rochelle](#) (L. Soudarin, CLS)

[Looking back over 30 years of DORIS network development](#) (J. Saunier, IGN)

[Six DORIS receivers operating in orbit and several more to come](#) (P. Ferrage, CNES)

[IDS life](#)

IDS Newsletter #2 (July 2016)

2015 Nepal Earthquakes moved the DORIS station on Everest by a few centimeters (G. Moreaux, CLS)

DORIS-VLBI compatibility tests at the Geodetic Observatory Wettzell (T. Klügel, BKG)

DORIS in Managua (J. Saunier, IGN)

IDS life

IDS Newsletter #1 (April 2016)

A high performing network (J. Saunier, IGN)

Two new DORIS instruments in orbit

(P. Ferrage and C. Manfredi, CNES)

DORIS back in Goldstone (J. Saunier, IGN)

DORIS contributes to the International Terrestrial Reference Frame (G. Moreaux, CLS)

IDS life

25 GLOSSARY

AAC

Associate Analysis Center

AC

Analysis Center

AGU

American Geophysical Union.

AVISO

Archiving, Validation and Interpretation of Satellite Oceanographic data. AVISO distributes satellite altimetry data from TOPEX/Poseidon, Jason-1, Jason-2, ERS-1 and ERS-2, and Envisat, and DORIS precise orbit determination and positioning products.

AWG

Analysis Working Group

CB

Central Bureau

CDDIS

Crustal Dynamics Data Information System

CLS

Collecte Localisation Satellites. Founded in 1986, CLS is a subsidiary of CNES and Ifremer, specializes in satellite-based data collection, location and ocean observations by satellite.

CNES

Centre National d'Etudes Spatiales. The Centre National d'Etudes Spatiales is the French national space agency, founded in 1961.

CNRS

Centre National de la Recherche Scientifique. The Centre National de la Recherche Scientifique is the leading research organization in France covering all the scientific, technological and societal fields

CryoSat-2

Altimetry satellite built by the European Space Agency launched on April 8 2010. The mission will determine the variations in the thickness of the Earth's continental ice sheets and marine ice cover.

CSR

Center for Space Research, the University of Texas

CSTG

Coordination of Space Technique in Geodesy

DC

Data Center

DGXX

DORIS receiver name (3rd Generation)

DIODE

Détermination Immédiate d'Orbite par DORIS Embarqué. Real-time onboard DORIS system used for orbit determination.

DORIS

Doppler Orbitography and Radiopositioning Integrated by Satellite. Precise orbit determination and location system using Doppler shift measurement techniques. A global network of orbitography beacons has been deployed. DORIS was developed by CNES, the French space agency, and is operated by CLS.

DPOD

DORIS extension of the ITRF for Precise Orbit Determination. The so-called DPOD product is a set of coordinates and velocities of all the DORIS tracking stations for Precise Orbit Determination (POD) applications.

ECMWF

European Centre for Medium-range Weather Forecasting

EGU

European Geosciences Union

EOP

Earth Orientation Parameters

Envisat

ENVIronmental SATellite Earth-observing satellite (ESA)

ESA

European Space Agency. The European Space Agency is a space agency founded in 1975. It is responsible of space projects for 17 European countries.

ESA, esa

acronyms for *ESA/ESOC* Analysis Center, Germany

ESOC

European Space Operations Centre (ESA, Germany)

EUMETSAT

EUropean organisation for the exploitation of METeorological SATellites

GAU, gau

acronyms for the *Geoscience Australia* Analysis Center, Australia

GB

Governing Board

GDR-B, GDR-C, GDR-D, GDR-E

Versions B, C, D, and E of **Geophysical Data Record**

geoc

Specific format for geodetic product: time series files of coordinates of the terrestrial reference frame origin (geocenter)

eop

Specific format for geodetic product: time series files of Earth orientation parameters (EOP)

GFZ

GeoForschungsZentrum, German Research Centre for Geosciences

GGOS

Global Geodetic Observing System

GNSS

Global Navigation Satellite System

GLONASS

Global Navigation Satellite System (Russian system)

GOP, gop

acronyms for the *Geodetic Observatory of Pecný* Analysis Center, Czech Republic

GRG, grg

Acronyms for the CNES/CLS Analysis Center, France (see also LCA))

GRGS

Groupe de Recherche de Géodésie Spatiale

GSC, gsc

acronyms for the *NASA/GSFC* Analysis Center, USA

GSFC

Goddard Space Flight Center (NASA).

HY-2

HY (for **HaiYang** that means 'ocean' in Chinese) is a marine remote sensing satellite series planned by China (HY-2A (2011), HY-2B (2012), HY-2C (2015), HY-2D (2019))

IAG

International Association of Geodesy

IDS

International DORIS Service

IERS

International Earth rotation and Reference systems Service

IGN

Institut national de l'information géographique et forestière, French National Geographical Institute (formerly Institut Géographique National)

IGN, ign

acronyms for *IGN/IPGP* Analysis Center, France

IGS

International GNSS Service

ILRS

International Laser Ranging Service

INA, ina

acronyms for the *INASAN* Analysis Center, Russia

INASAN

Institute of Astronomy, Russian Academy of Sciences

IPGP

Institut de Physique du Globe de Paris

ISRO

Indian Space Research Organization

ITRF

International Terrestrial Reference Frame

IUGG

International Union of Geodesy and Geophysics

IVS

International VLBI Service for Geodesy and Astrometry

Jason

Altimetric missions (CNES/NASA), follow-on of TOPEX/Poseidon. Jason-1 was launched on December 7, 2001, Jason-2 on June 20, 2008, and Jason-3 on January 17, 2016.

JOG

Journal Of Geodesy

JASR

Journal of Advances in Space Research

LCA, lca

Former acronyms for the CNES/CLS Analysis Center, France (previously LEGOS/CLS Analysis Center)

LEGOS

Laboratoire d'Etudes en Géodésie et Océanographie Spatiales, France

LRA

Laser Retroreflector Array. One of three positioning systems on TOPEX/Poseidon and Jason. The LRA uses a laser beam to determine the satellite's position by measuring the round-trip time between the satellite and Earth to calculate the range.

MOE

Medium Orbit Ephemeris.

NASA

National Aeronautics and Space Administration. The National Aeronautics and Space Administration is the space agency of the United States, established in 1958.

NCEP

National Center for Environmental Prediction (NOAA).

NLC, ncl

acronyms for *University of Newcastle* Analysis Center, UK

NOAA

National Oceanic and Atmospheric Administration. The National Oceanic and Atmospheric Administration (NOAA) is a scientific agency of the United States Department of Commerce focused on the studies of the oceans and the atmosphere.

OSTST

Ocean Surface Topography Science Team

POD

Precise Orbit Determination

POE

Precise Orbit Ephemeris

Poseidon

One of the two altimeters onboard TOPEX/Poseidon (CNES); Poseidon-2 is the Jason-1 altimeter.

RINEX/DORIS

Receiver INdependent EXchange. Specific format for DORIS raw data files, based on the GPS-dedicated format

SAA

South Atlantic Anomaly

SARAL

Satellite with ARgos and Altika

Sentinel-3

The Sentinel-3 satellites fit into the Copernicus program, a joint project between Esa and European Union. They are dedicated to Earth monitoring and operational oceanography. Sentinel-3A was launched on February 16, 2016, and Sentinel -3B on April 25, 2018.

Sentinel-6

The Sentinel-6 mission is part of the Copernicus program and is a result of international cooperation between Esa, Eumetsat, European Union, Noaa, Cnes and Nasa/JPL. Sentinel-6 Michael Freilich (also named Jason-CS / Sentinel-6A) is the follow-on to Jason-3. It carries a radar altimeter to measure global sea-surface height, primarily for operational oceanography and for climate studies.

SINEX

Solution (software/technique) Independent Exchange. Specific format for files of geodetic products

SIRS

Service d’Installation et de Renovation des Balises (IGN). This service is in charge of all the relevant geodetic activities for the maintenance of the DORIS network.

SLR

Satellite Laser Ranging

SMOS

Service de Maintenance Opérationnelle des Stations (CNES). This service is responsible for the operational issues of the DORIS stations

snx see SINEX

SOD

Service d'Orbitographie DORIS, CNES DORIS orbitography service

SPOT

Système Pour l'Observation de la Terre. Series of photographic remote-sensing satellites launched by CNES.

sp1, sp3

Specific format for orbit ephemeris files

SSALTO

Segment Sol multimissions d'ALTimétrie, d'Orbitographie et de localisation precise. The SSALTO multi-mission ground segment encompasses ground support facilities for controlling the DORIS and Poseidon instruments, for processing data from DORIS and the TOPEX/Poseidon, Jason-1, Jason-2 and Envisat-1 altimeters, and for providing user services and expert altimetry support.

STCD

STation Coordinates Difference. Specific format for time series files of station coordinates (geodetic product)

STPSAT

US Air Force **Space Test Program SATellite.** The first satellite **STPSAT1** was launched in 2007 with a new DORIS receiver called CITRIS. This experiment is dedicated to global ionospheric measurements.

SWOT

Surface Water Ocean Topography. Swot is a joint project including Nasa, Cnes, the Canadian Space Agency and the UK Space Agency. The goal is to join both land hydrology and oceanography communities in a single satellite. The technology for Swot is a Ka-band Radar Interferometer (KaRIn, 0.86 cm wavelength).

TOPEX/Poseidon

Altimetric satellite (NASA/CNES).

USO

Ultra-Stable Oscillator

UTC

Coordinated Universal Time. Timekeeping system that relies on atomic clocks to provide accurate measurements of the second, while remaining coordinated with the Earth's rotation, which is much more irregular. To stay synchronized, UTC has to be adjusted every so often by adding one second to the day, called a leap second, usually between June 30 and July 1, or between December 31 and January 1. This is achieved by counting 23h59'59", 23h59'60" then 00h00'00". This correction means that the Sun is always at its zenith at noon exactly (accurate to the second).

VLBI

Very Long Baseline Interferometry.

WG

Working Group

ZTD

Zenith Tropospheric Delay

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DORIS

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The IDS is a service of the International Association of Geodesy **(IAG)**. It contributes to the International Earth rotation and Reference frames Service **(IERS)** and the Global Geodetic Observing System **(GGOS)**.
It is a network member of the International Science Council World Data System **(WDS)**.