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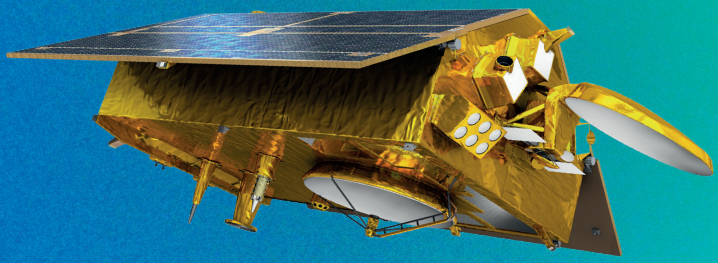
IDS

ACTIVITY REPORT 2025

INTERNATIONAL DORIS SERVICE



International DORIS Service Activity Report 2025

Edited by Laurent Soudarin and Cécile Manfredi

DOI: 10.24400/312072/i02-2026.001

International DORIS Service

Central Bureau

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Preface

In this volume, the International DORIS Service (IDS) documents the work of the IDS components between January 2025 and December 2025.

The IDS 2025 Report presents the current structure of the IDS, provides an overview of the DORIS network and the DORIS satellite constellation, describes the IDS data centers, and reports on the work carried out by the IDS components: Central Bureau, Combination Center, Analysis Coordination, Analysis Centers, Associate Analysis Centers and Working Groups.

The individual reports were contributed by IDS groups in the international geodetic community who make up the permanent components of 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_2025.pdf

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ABOUT IDS

1 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.

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 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 International DORIS Service (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 primary objectives of the IDS are to federate the research and developments related to the DORIS technique, to organize the expected DORIS contribution to IERS and GGOS, and to foster a larger international cooperation on this topic.

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**).

IDS's first contribution to the realization of the ITRF was the provision of individual solutions for ITRF2005 by two analysis centers. In 2006, there were four analysis centers supplying results to 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, the first IDS combined solution 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 computation of 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. In 2023, processing of the 2020.0-2023.0 data was carried out to generate a DORIS contribution to the ITRF2020 extension. In addition, the Combination Centre produced two versions of the DORIS extension to ITRF2020 (DPOD2020), the second version including the estimation of annual and semi-annual signals as well as some post-seismic corrections. In 2021, IDS organized the DORIS days, introductory courses on the DORIS technique and IDS activities. The first edition, initially planned for 2020 at the University of Vienna, Austria, alongside the EGU but postponed due to the Covid health crisis, was held online in November 2021. In 2024, IDS set up two new Working Groups: WG "Integrated Clock Correction Strategies for DORIS" which aims to address the behavior of DORIS clocks, exploiting DORIS clock co-locations in space and on ground, and WG "NRT Ionospheric Applications" whose goal is to advance the use of Near-Real Time DORIS data for ionospheric research applications.

In 2025, two meetings of the Analysis Working Group were organized. The first one was held online on March 24. The second took place in Athens, Greece, on November 6 and 7, hosted by the National Technical University of Athens (NTUA).

In addition, the IDS organized a new edition of the “DORIS Days" on November 3 and 5, 2025. This event was held in a hybrid format, hosted by the National Technical University of Athens (NTUA). The DORIS Days were designed to offer both a foundational and hands-on experience with DORIS and the IDS community, tailored especially to early-career researchers and students.

Logo of the DORIS Days 2025 (designed at IGN with the help of Jérôme Saunier)

Date	Event	Location
2000	DORIS Days https://ids-doris.org/resources/presentations/ids-meetings.html#doris-days-2000	Toulouse, France
2002	IDS workshop https://ids-doris.org/resources/presentations/ids-meetings.html#ids-workshop-2002	Biarritz, France
2003	IDS Analysis Workshop https://ids-doris.org/resources/presentations/ids-meetings.html#ids-workshop-2003	Marne La Vallée, France

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

Date	Event	Location
2004	Plenary meeting https://ids-doris.org/resources/presentations/ids-meetings.html#ids-plenary-meeting-2004	Paris, France
2006	IDS workshop https://ids-doris.org/resources/presentations/ids-meetings.html#ids-workshop-2006	Venice, Italy
2008	Analysis Working Group Meeting https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-03-2008 Analysis Working Group Meeting https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-06-2008 IDS workshop https://ids-doris.org/resources/presentations/ids-meetings.html#ids-workshop-2008	Paris, France Paris, France Nice, France
2009	Analysis Working Group Meeting https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-03-2009	Paris, France
2010	Analysis Working Group Meeting https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-05-2010 Analysis Working Group Meeting https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-10-2010 IDS workshop & 20th anniversary of the DORIS system https://ids-doris.org/resources/presentations/ids-meetings.html#ids-workshop-2010	Darmstadt, Germany Lisbon, Portugal Lisbon, Portugal
2011	Analysis Working Group Meeting https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-05-2011	Paris, France
2012	Analysis Working Group Meeting https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-05-2012 Analysis Working Group Meeting https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-09-2012 IDS workshop https://ids-doris.org/resources/presentations/ids-meetings.html#ids-workshop-2012	Prague, Czech Republic Venice, Italy Venice, Italy
2013	Analysis Working Group Meeting https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-04-2013 Analysis Working Group Meeting https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-10-2013	Toulouse, France Washington, USA
2014	Analysis Working Group Meeting https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-03-2014 IDS workshop https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-03-2014	Paris, France Konstanz, Germany

Date	Event	Location
2015	Analysis Working Group Meeting https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-05-2015 Analysis Working Group Meeting https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-10-2015	Toulouse, France Greenbelt, USA
2016	Analysis Working Group Meeting https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-05-2016 IDS workshop https://ids-doris.org/resources/presentations/ids-meetings.html#ids-workshop-2016	Delft, The Netherlands La Rochelle, France
2017	Analysis Working Group Meeting https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-05-2017	London, United Kingdom
2018	Analysis Working Group Meeting https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-06-2018 IDS workshop https://ids-doris.org/resources/presentations/ids-meetings.html#ids-workshop-2018	Toulouse, France Ponta Delgada, Portugal
2019	Analysis Working Group Meeting https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-04-2019 Analysis Working Group Meeting https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-09-2019	Munich, Germany Paris, France
2021	Analysis Working Group Meeting https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-04-2021 DORIS days 2021 https://ids-doris.org/resources/capacity-building/doris-days.html#dd21	online online
2022	Analysis Working Group Meeting https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-06-2022 IDS workshop https://ids-doris.org/resources/presentations/ids-meetings.html#ids-workshop-2022	online Venice, Italy
2023	Analysis Working Group Meeting https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-04-2023 Analysis Working Group Meeting https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-11-2023	online Saint-Mandé, France
2024	Analysis Working Group Meeting https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-06-2024 IDS workshop https://ids-doris.org/resources/presentations/ids-meetings.html#ids-workshop-2024	online Montpellier, France
2025	Analysis Working Group Meeting https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-03-2025 Analysis Working Group Meeting https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-11-2025 DORIS days 2025 https://ids-doris.org/resources/capacity-building/doris-days.html#dd25	online Athens, Greece hybrid

Table 2. *List of IDS events organized between 2004 and 2025.*

2 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**).

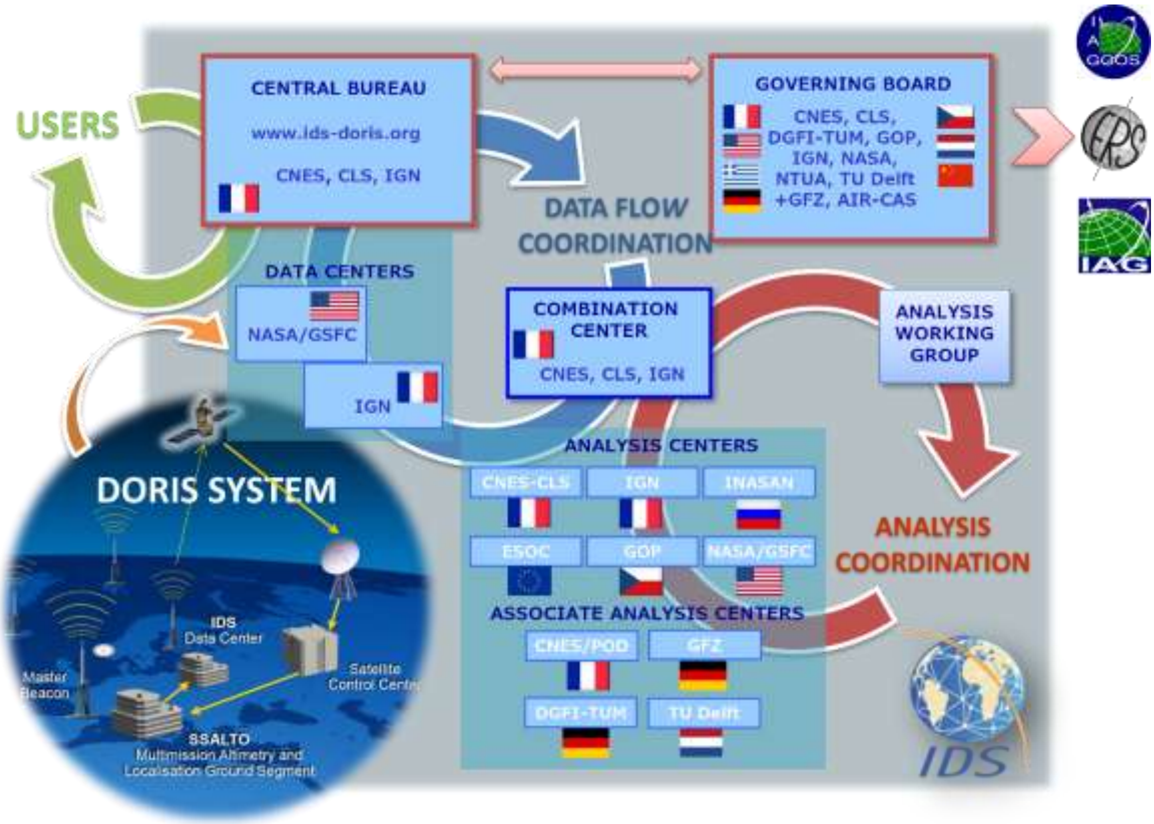

Figure 1. *IDS organization.*

2.1 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, three positions in the IDS Governing Board became vacant at the end of 2024. IDS associates were invited to nominate candidates for the two open positions for the next 4-year term 2025-2028. A Nominating Committee (Frank Lemoine (chair), Karine Le Bail, Laura Sanchez) formed for the election has collected the nominations and established the list of candidates. The elections were held from December 16, 2024, to January 6, 2025.

The members elected by the IDS Associates are the following:

- Analysis Centers' representative: Hugues Capdeville (CLS, France)
- Data Centers' representative: Ross Bagwell (NASA/CDDIS, USA)
- Member-at-large: Maria Tsakiri (NTUA, Greece)

Following the reorganization of the CDDIS team at the beginning of 2025, Ross Bagwell resigned from the post of Data Centers' representative to which he had been elected, and proposed Anna Kelley in charge of DORIS operations at CDDIS to replace him in this position. This proposal was adopted by the Governing Board at its meeting on February 5, 2025, and Anna Kelley becomes the Data Centers' representative on the IDS Governing Board for the period 2025-2028.

At the Governing Board meeting on March 5, 2025, the GB members elected Guilhem Moreaux as the new chairperson of the GB for 2025-2028.

Table 3 gives the list of the GB's members in office on January 1st, 2026.

2.2 REPRESENTATIVES AND DELEGATES

In 2025, IDS representatives and delegates are:

- IDS representatives to the IERS:
  - Analysis Coordinator: Petr Štěpánek
  - Network representative: Jérôme Saunier
- IDS representatives to GGOS Directing Board: Karine Le Bail
- IDS representatives to GGOS Bureau of Products and Standards: Petr Štěpánek
- IDS representatives to GGOS Bureau of Networks and Observations: Jérôme Saunier

2.3 CENTRAL BUREAU

In 2025, the IDS Central Bureau is organized as follows:

- Laurent Soudarin CLS (Director)
- Cécile Manfredi CNES
- Jérôme Saunier IGN
- Guilhem Moreaux CLS
- Frank Lemoine NASA/GSFC

Position	Term	Status	Name	Affiliation	Country
Analysis coordinator	**2023-2026**	Elected	**Petr Štěpánek**	Geodetic Observatory Pecný	Czech Republic
Data Centers' representative	**2025-2028**	Elected	**Anna Kelley**	NASA/GSFC	USA
Analysis Centers' representative	**2025-2028**	Elected	**Hugues Capdeville**	CLS	France
Member at large	**2023-2026**	Elected	**Laura Sanchez**	DGFI-TUM	Germany
Member at large	**2025-2028**	Elected	**Maria Tsakiri**	National Technical University of Athens	Greece
Director of the Central Bureau	Since 2003	Appointed	**Laurent Soudarin**	CLS	France
Combination Center representative	Since 2013	Appointed	**Guilhem Moreaux (chair 2025-2028)**	CLS	France
Network representative	**2025-2028**	Appointed	**Jérôme Saunier**	IGN	France
DORIS system representative	**2025-2028**	Appointed	**Cécile Manfredi**	CNES	France
IAG representative	**2023-2027**	Appointed	**Ernst Schrama**	TU Delft	The Netherlands
IERS representative	**2025-2028**	Appointed	**Mathis Bloßfeld**	DGFI-TUM	Germany
Chair of WG "Integrated Clock Correction Strategies for DORIS"	**Since June 2024**	Ex-officio (non-voting member)	**Patrick Schreiner**	GFZ	Germany
Chair of WG "NRT ionospheric applications"	**Since Nov. 2024**	Ex-officio (non-voting member)	**Ningbo Wang**	AIR-CAS	China

Table 3. *List of IDS GB members in office on January 1st, 2026.*

DORIS SYSTEM

3 THE NETWORK

Jérôme Saunier / IGN, France

3.1 GENERAL STATUS AND OPERATION

With three new stations (Hanga Roa, Gavdos and Ulaanbaatar) installed and commissioned over the past two years, the DORIS network has begun its densification phase, exceeding the 60-station mark for the first time in its history. The objective is to reach 70 stations to make the network more robust and efficient and better contribute to scientific applications. This goal is not so easy to achieve because any new site project takes a lot of time and, at the same time, it is necessary to maintain the other stations in the network and respond to unexpected events related to the local political or economic context. Stations shut down, host agencies withdraw, and alternative solutions must be found, as is currently the case for the stations in Badary (Russia) and Betio (Micronesia).

The DORIS network has currently 61 stations, including 4 master beacons (Toulouse, Greenbelt, Hartebeesthoek, Kourou), 1 time beacon (Terre-Adelie) and 2 experimental beacons for scientific purposes (Wettzell and Gavdos). With very homogeneous distribution and very long time series for most stations, the ground network is one of the greatest strengths of the DORIS system (see **Figure 2**).

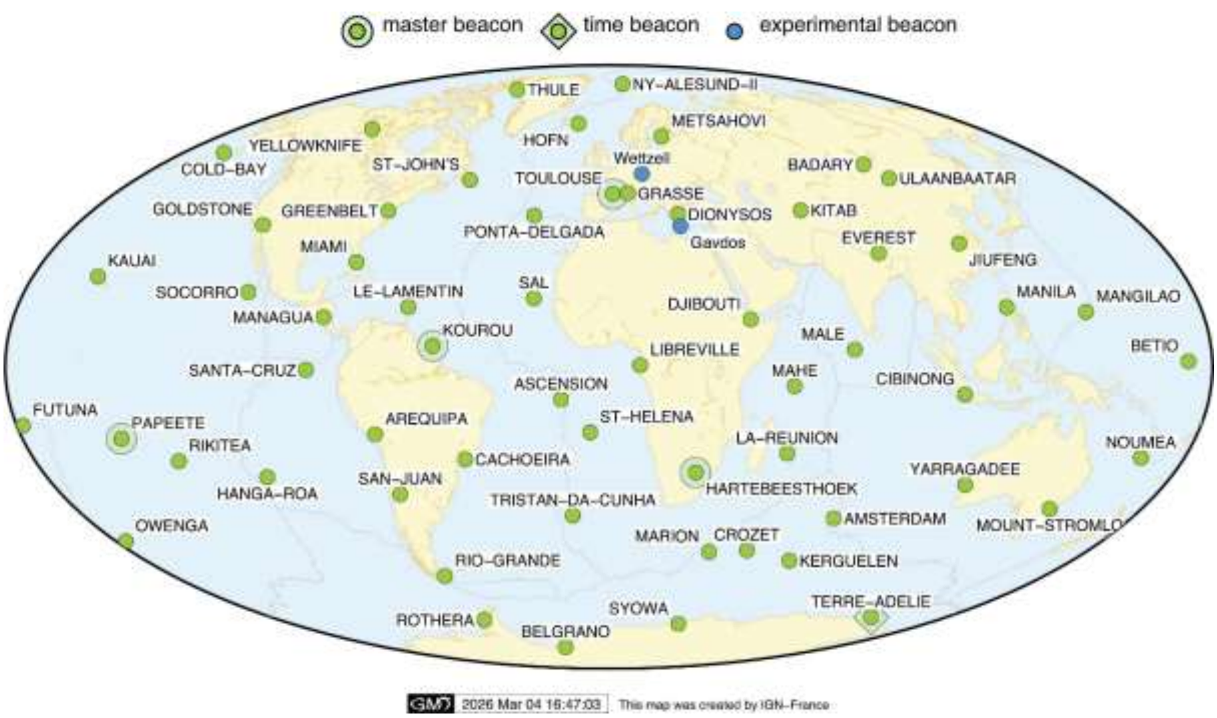

Figure 2. *The DORIS Network: 61 stations.*

The number of stations in service remained above 80% over the year, with a slightly more difficult period in the second half of the year due to several new breakdowns (see **Figure 3**). Four stations that were already out of service last year could not be brought back into service (see **Figure 4**). Cachoeira and Syowa are expected to be renovated and returned to service in 2026. The Amsterdam site suffered a major fire at the beginning of the year, and the station could not be put back into service until the end of the year. However, the rate of stations in operation in 2025 remains very good, with an annual average of 88% of stations in service, thanks to the excellent coordination of the network maintenance teams from CNES, IGN and the host agencies

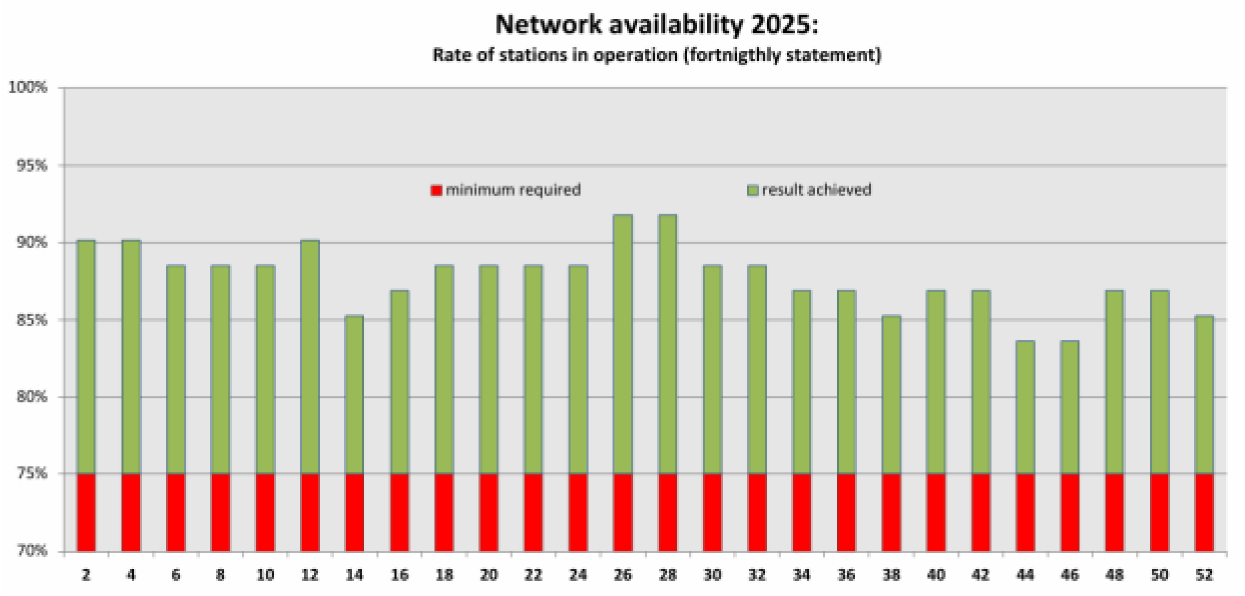

Figure 3. Network availability 2025: Rate of stations in operation (fortnightly statement).

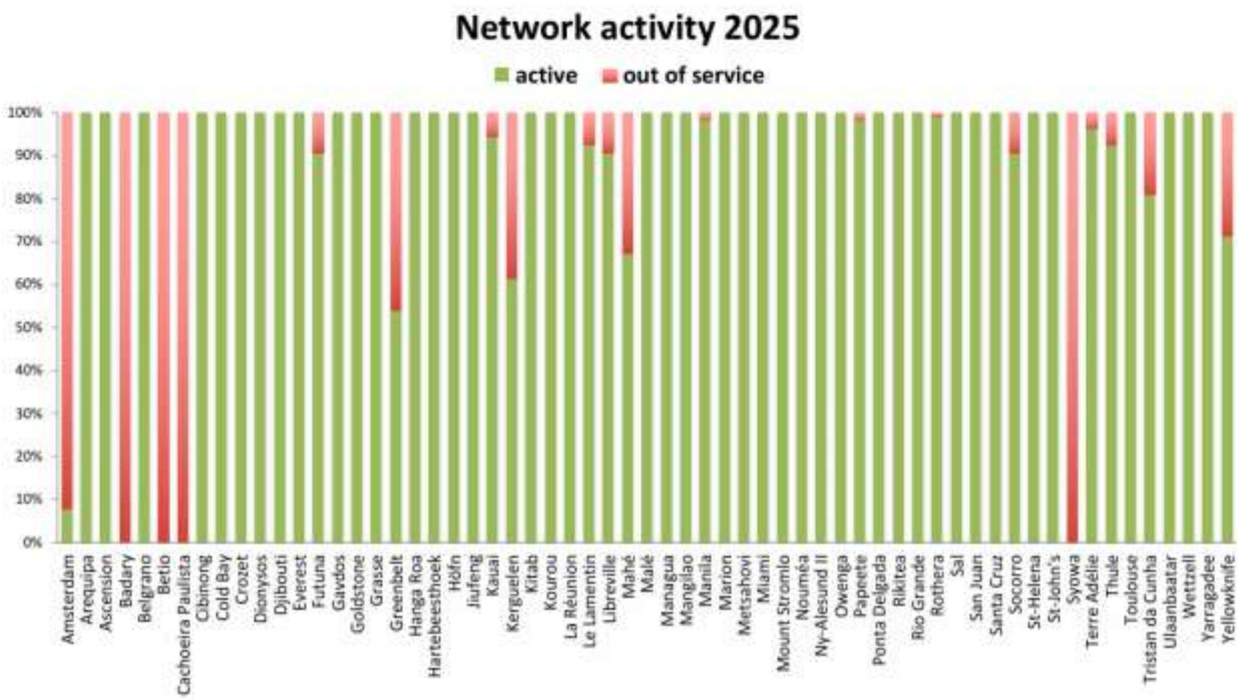

Figure 4. Network stations activity 2025.

3.2 NETWORK MAINTENANCE AND DEVELOPMENT

The gradual deployment of the new generation of antennas (Starec-C from 2014) and beacons (B4G from 2019) continued to improve network robustness and performance. At the end of 2025, we have a total of 47 (77%) of the network stations equipped with a B4G beacon and 31 (51%) with a Starec-C antenna. Following equipment failures, we replaced 8 beacons and 2 antennas, often with the help of local host agencies. In April 2025, the DORIS station at Le Lamentin (French West Indies) was completely renovated: the station was moved 70m northeast to provide a better environment for the antenna, and the beacon was upgraded. On this occasion, a high-precision local site survey including the IGS station “LMMF” was carried out by IGN in order to contribute to the ITRF combination.

The co-location with other geodetic techniques remains a major asset and priority of the network to contribute to the realization of the ITRF. DORIS is co-located with GNSS (51), SLR (11), VLBI (8) and Tide gauges (29). In view of the GENESIS project, future co-locations are planned, as well as connection with external clocks. The current status of co-locations and connections with external clocks is shown in **Figure 5**.

In 2025, the following DORIS sites were visited:

- 4th generation beacon installation in Terre Adélie (Antarctica)
- Station renovation at Le Lamentin (Martinique, French Indies)
- Antenna change in Kerguelen (French Southern and Antarctica Lands)
- Reconnaissance in Kazakhstan with a view to installing new station
- Beacon change at Rio Grande (Brazil)
- External clock change and maintenance at Kourou (French Guyana)
- Reconnaissance in South Korea with a view to installing new station

In 2026, the overall objectives are:

- Continuation of the deployment of the 4th generation beacon
- Installation in a new DORIS site in Kanpur (India)
- Renovation at Cachoeira Paulista (Brazil)
- Installation in a new DORIS site in Katherine (Australia)
- Renovation at Sal (Cape Verde)
- Installation in a new DORIS site in Kazakhstan
- Reconnaissance in French Polynesia in view of future fundamental geodetic observatory
- Renovation at Syowa (Japanese base, Antarctica)

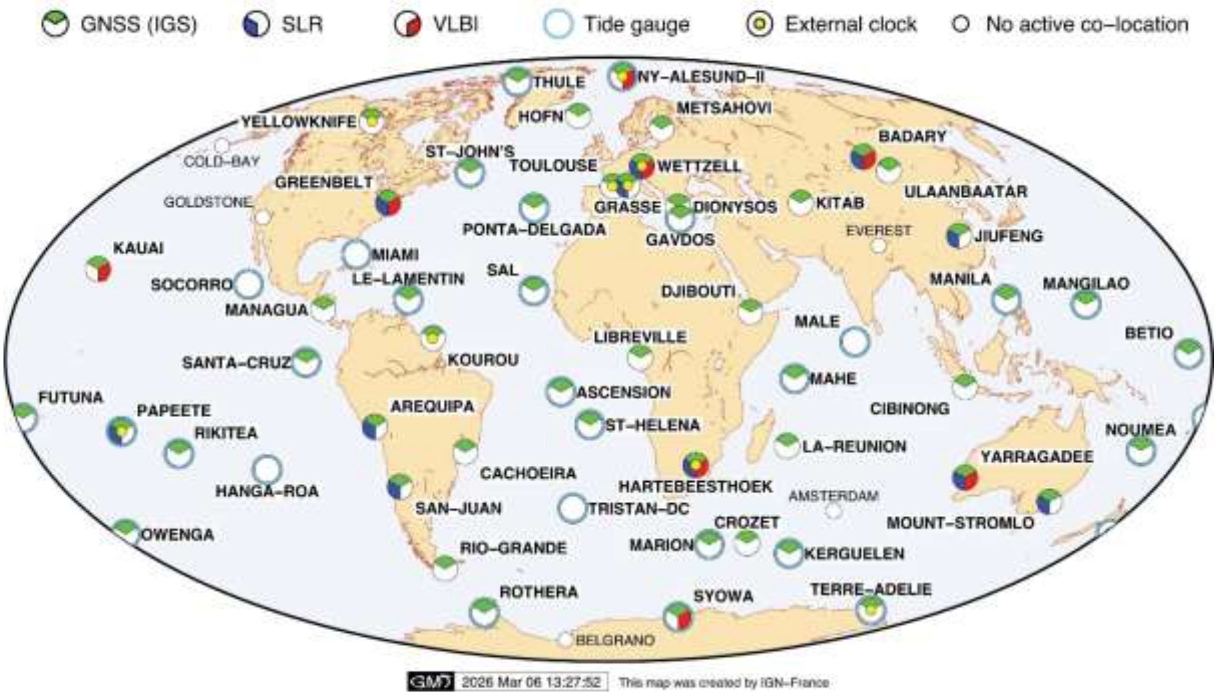

Figure 5. *DORIS stations co-located with other IERS techniques and tide gauges.*

4 THE SATELLITES WITH DORIS RECEIVERS

Cécile Manfredi / CNES, France

4.1 CURRENT STATUS

Since November 17, 2025, following the successful launch of the Sentinel-6B satellite, which has joined its twin, Sentinel-6A, the DORIS constellation now comprises ten satellites in flight. Each carries a 7-channel DORIS DGXX or DGXX-S on-board receiver with orbits at altitudes ranging from 720km (CryoSat-2, the lowest) to 1336km (Jason-3, Sentinel-6A and 6B the highest) following either near-polar orbits or TOPEX-like inclinations of 66 degrees. This current configuration represents an unprecedented availability of DORIS instruments, offering IDS users access to more simultaneous data sources than ever before. Thus, **Table 4** shows DORIS data availability at IDS data centers, as of December 2024.

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
Sentinel-6B	17-NOV-2025	PRESENT	NASA/CNES/NOAA /Eumetsat/ESA	Altimetry

Table 4. *DORIS data availability at IDS data centers, as of December 2024.*

4.2 FUTURE PROSPECTS

The DORIS system's future looks promising, with several missions planned in the coming years and beyond offering long-term visibility for the constellation evolution:

Near-term missions (next 1 or 2 years)

- **Sentinel-3C**
  This mission is part of ESA's Copernicus program, continuing the Sentinel3 series for ocean and land observation.
  Its launch is scheduled in autumn 2026.
- **HY2-E**
  This satellite will be the next in China's HY-2 series of observation and monitoring ocean satellites.
  Its launch is planned on 2026 1st July.
- **HY2-F**
  One year after HY2-E, the launch of this Chinese altimetry mission is scheduled for 2027.

Mid-term missions

- **Sentinel-3D**
  This mission is part of ESA's Copernicus program, continuing the Sentinel-3 series for ocean and land observation.
  Projected launch 2027/2028.
- **Genesis**
  This ESA scientific geodesy mission will carry the four techniques including DORIS. The latest model of the DGXX-S generation will be carried on board and will meet the challenge of taking measurements at 6000 km.
  The launch is scheduled for 2028.
- **Sentinel-6C**
  ESA's third reference altimetry mission is planned for 2030.
  It remains to be confirmed whether DORIS is on board.

Long-term potential missions:

- **Sentinel-3 NG Topo**

  Two ESA satellites, successors to the Sentinel-3 series, awaiting confirmation.

  Launch is tentatively set for 2032, potentially carrying DORIS instruments provided by CNES.

- **Sentinel-6 NG**

  Ensuring continuity of reference missions, with a projected launch in 2035.

- **Chinese Altimetry Missions**

  NSOAS and CNSA confirm plans to continue altimetry satellites with a New Generation of satellites HY-6. The first satellite should be planned in 2027.

This mission roadmap hereafter (**Figure 6**) provides visibility into the DORIS constellation's evolution well into the 2030s. The mix of confirmed and potential missions across various space agencies (ESA, CNES, CNSA, NASA, etc.) demonstrates the ongoing international commitment to the DORIS system and its critical role in Earth observation, oceanography, and geodesy.

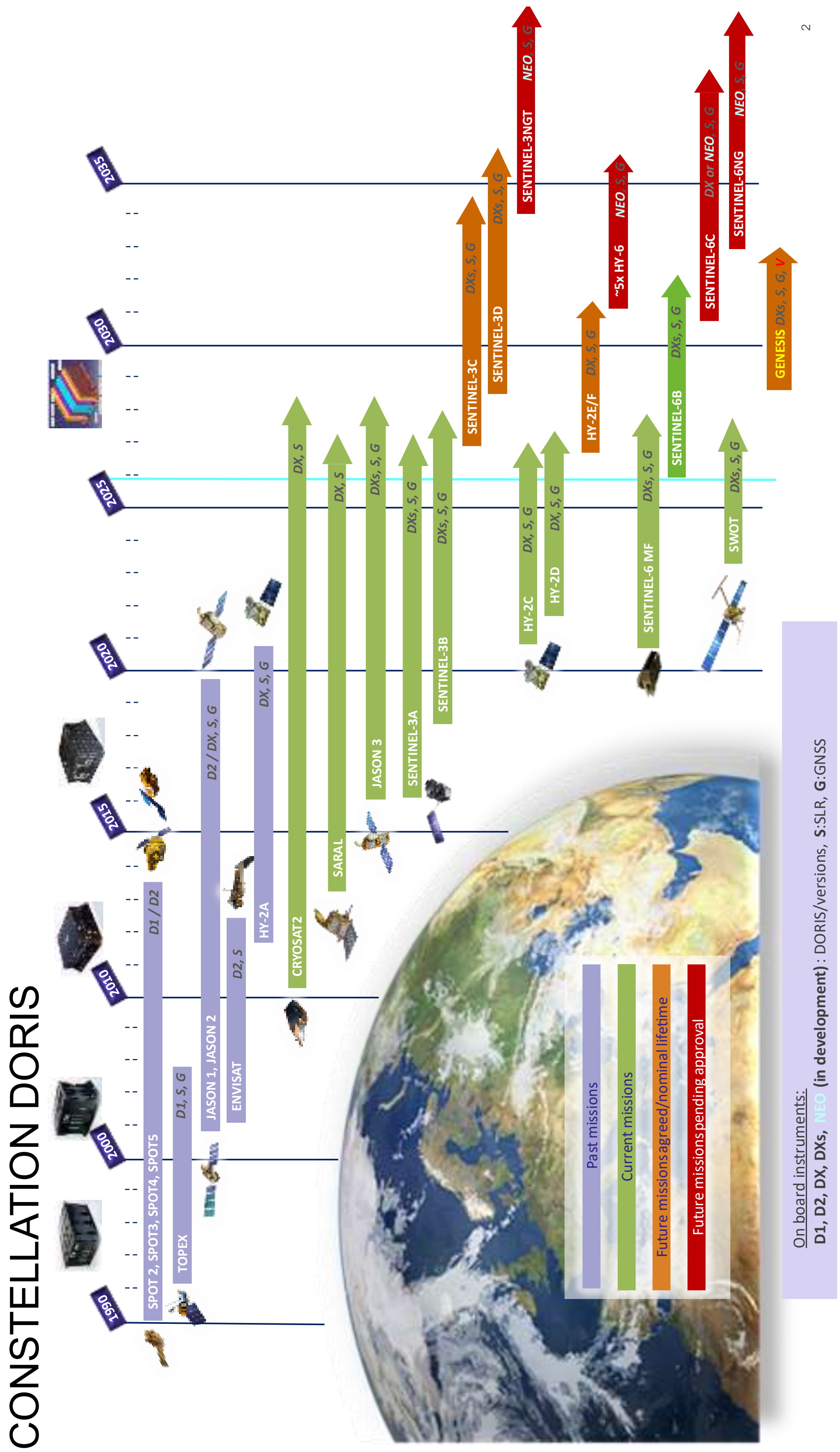

Figure 6. *DORIS constellation's evolution well into the 2030s*

USER SERVICE

5 CENTRAL BUREAU

Laurent Soudarin [1], Cécile Manfredi [2]

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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 2025. An overview of the IDS information system is provided in the appendix to this Report.

5.1 IDS MEETINGS

The Central Bureau participated in the organization of the AWG meetings held online on March 24, and in Athens, Greece, on November 6 and 7, hosted by the National Technical University of Athens (NTUA) (see links in **Table 2**).

The CB organized and facilitated the Governing Board meetings held virtually on February 5 (welcome for new GB members), March 6 (election of the GB chair) and April 8 (outreach activities), and provided support to the GB chair for the meetings on September 25 and November 28.

5.2 DORIS DAYS 2025

The IDS organized a new edition of the "DORIS Days" on November 3 and 5, 2025. This event was held in a hybrid format, hosted by the National Technical University of Athens (NTUA). The DORIS Days were designed to offer both a foundational and hands-on experience with DORIS and the IDS community, tailored especially to early-career researchers and students.

The first day was devoted to general lectures on DORIS, IDS and precise applications. The lectures, held online on Monday, November 3, from 13:00 to 16:00 UTC, were attended by seventy-three people. The second day, held at the School of Rural Surveying & Geoinformatics Engineering on the NTUA's Zografou Campus on Wednesday, November 5, from 7:00 to 14:10 UTC, consisted of introduction sessions on DORIS data processing, combining theoretical lectures and guided hands-on exercises using Jupyter Notebook. Fifty-eight people participated in the sessions, including 40 online and 18 on-site.

The list of speakers is as follows: Karine Le Bail, Guilhem Moreaux, Petr Stepanek, Cécile Manfredi, Jean-Michel Lemoine, Laurent Soudarin, Xanthos Papanikolaou, Dimitris Anastasiou, Ernst Schrama, Samuel Nahmani, Arnaud Pollet.

The program is at:
https://ids-doris.org/images/documents/CapacityBuilding/DorisDays2025/DORIS_DAYS_2025_schedule.pdf.

All course materials (presentations, recordings) are available on the IDS website, along with links to the IDS GitHub repository where the notebooks are located, all referenced with DOIs, citations, and usage licenses.

The organization committee consisted of Maria Tsakiri (NTUA), Karine Le Bail (Chalmers Univ.), Xanthos Papanikolaou (NTUA), Guilhem Moreaux (CLS), and Laurent Soudarin (CLS).

It met seven times via videoconference to prepare for the event (on May 16, May 26, June 10, July 29, September 19, October 3, and October 17), and held a final meeting on January 16, 2026, to review the DORIS days and make recommendations. The committee relied on the responses to the evaluation questionnaire sent to all participants.

The Central Bureau played an active role in organizing and facilitating these two days. It carried out the following actions to support the Organizing Committee:

- setting the agenda and content;
- creating a section on the IDS events page (https://ids-doris.org/ids/meetings/ids-meetings.html) and posting information online;
- creating and posting a registration form;
- promoting the event through various channels (LinkedIn post, DorisMail, emails to GGOS, IAG, and services);
- creating an IDS account on GitHub to make Jupyter notebooks available;
- collection of registrations, distribution of logistical information;
- preparation of three PowerPoint presentations for the first day;
- analysis of participation over the two days;
- preparation and mailing of participation certificates;
- preparation and mailing of a course evaluation questionnaire for participants;
- formatting of presentations and video recordings of the sessions;
- creating a Capacity Building section on the website with DORIS Days and Jupyter Notebooks pages to make the educational materials from these days available;
- definition of citations, assignment of DOIs, addition of CC licenses.

5.3 WORKING GROUP SUPPORTS

The BC has established quarterly meetings with the chairs of the Working Groups Integrated Clock Correction Strategies for DORIS (Patrick Schreiner, GFZ) and NRT Ionospheric Applications (Ningbo Wang, AIR/CAS) to gather their requirements for support from the IDS.

In August, Ningbo announced that, in collaboration with the BKG, the validation results for global real-time TEC maps based on NRT DORIS data are now regularly posted on the IGS Real-Time Service (RTS) website. The validation results are updated daily, with a 24-hour delay:

https://igs.org/rts/monitoring/

5.4 IDS WEB SITE

The IDS website was launched in April 2000 as a set of HTML pages and updated in February 2007. A second major version, developed using the Joomla CMS, went live in 2010. A new version of the website was launched in May 2025.

The goal of this third version, still built on Joomla, is to make the site clearer for users. A new template has been implemented, while maintaining the site's visual identity.

The information provided by the site has been organized into six sections, compared to four in the previous version: IDS, Network & Station, Missions & System, Data & Products, User Corner, Resources.

We have chosen to limit the site structure to three levels (Section > Level 1 > Level 2). The first page of each section provides a description of its content. In addition to the structure defined by the menus, several ways to find information are available: an alternative menu on the home page (Discover IDS, Discover DORIS, DORIS system monitoring), a list of documentation organized into five categories (Outreach, DORIS system components, IDS information system, Publications and presentations, Documents), and classification of the User Corner content by user type (beginner, competent, expert).

This version of the site offers several new features (maps of satellite trajectories and station visibility, a converter from calendar days to CNES or NASA Julian days and vice versa, and a list of variables observed by DORIS). URL redirects have been set up from the pages of the previous version of the site to the pages of the new site.

A document presenting the changes made in this version of the site has been prepared and posted online at *https://ids-doris.org/documents/2025-IDSwebsiteV3.pdf*.

A new section "Capacity building" was created following the DORIS Days. It includes three pages: DORIS Days, Jupyter Notebooks, and Summer Schools, the latter containing presentations and recordings from the 2025 summer schools in which the IDS participated.

5.5 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. In 2025, the distribution of Sentinel-6B dataset (RINEX/DORIS data and CNES POE sp3 orbits) has been implemented. The CB coordinated the efforts of the data centers to archive the CNES POE-G orbits for Jason-3, Sentinel-3A, Sentinel-3B, and Sentinel-6A.

The CB has posted quaternion files in ORBEX format generated by the CNES/CLS Analysis Center for 2024 for HY-2C and HY-2D. The datasets are accompanied by a note and a description of the format. See: *ftp://ids-doris.org/pub/ids/ancillary/quaternions/*.

The format (netcdf) and data rate (24 data points per second) of the SWOT quaternion files delivered to the IDS and available from the IGN since June 2024 do not meet the expectations of the Analysis Centers. Since February 2025, they have been replaced by quaternions derived from DORIS Attitude telemetry (text format identical to Jason-3 quaternions, with one data point per second). The dataset is available as of February 1, 2023. The history of SWOT solar panel angle files has been updated to cover the same period.

In 2026, the SWOT solar panel XML files will be replaced by files in a format identical to that of the Jason-3 solar panel files.

5.6 DOCUMENTATION

The documents and files made available in 2025 are listed hereafter with their https access.

- a new document listing stations connected to an external time/frequency reference

https://ids-doris.org/documents/BC/stations/DORIS_external_time_frequency_references.txt

- a new version of the satellite macromodels document;
- new version of the DORIS SINEX master file;
- the document "SPOT satellite geometry handbook";
- the technical report for version 5 of DPOD2020 provided by the CC;
- 11 new or updated sitelogs (AMVB, ARFB, DIOB, EVEC, GONC, HBMB, HOGC, JIWC, MAMC, OWGC, ULAC);
- new photos in the gallery;
- materials from the DORIS Days 2025 and 2021 events (presentations, video recordings, notebooks);
- presentations from the March and November AWG meetings;
- materials from the presentations at the Sirgas Virtual School and at the first GGOS IberAtlantic summer school;
- the poster presented at the IAG Scientific Assembly in Rimini;
- the IDS presentations at AGU 2024 and IAG Scientific Assembly 2025;
- the technical report for version 5 of DPOD2020 provided by the CC.

The BC also shared in the website's FAQs a summary of orbit changes and tandem phases for DORIS missions, as well as a list of stations with short operational periods, mainly from the early years of the system in the 1990s.

https://ids-doris.org/resources/faq.html#FaqSpaceSegment

https://ids-doris.org/resources/faq.html#shortlifestations

5.7 DOI ASSIGNMENT

The BC has assigned DOIs to several items and created corresponding landing pages on the IDS website. The items, licensed under CC-BY, are grouped by collection and accessible on the site via a link added to the "Discover IDS" menu in the footer:

- Activity Reports Collection (*https://ids-doris.org/activity-reports.html*). All IDS annual activity reports have a DOI and a landing page.

- IDS Products Collection (*https://ids-doris.org/ids-products.html*). The CB has begun assigning DOIs to IDS products (DORIS differential slant total electron content, contribution to ITRF2020, GSC std2400 orbits) and will continue to do so in 2026.
- Technical notes collection (*https://ids-doris.org/technical-notes.html*). The CB has begun assigning DOIs to technical documents. The first ones are the documents “DORIS satellite models”, “DORIS system ground segment models”, POE standards and DORS data formats.
- Workshop abstracts collection (*https://ids-doris.org/workshop-abstracts.html*). The abstracts for the 2018, 2022, and 2024 workshops have DOIs. DOIs will be assigned for 2014 and 2016 editions.

In addition, DOIs have been assigned to the DORIS Days page and the Jupyter Notebooks page, respectively 10.24400/312072/i05-2025.001 and 10.24400/312072/i06-2025.001.

5.8 PARTICIPATION IN THE GGOS DATA AND INFORMATION SYSTEMS COMMITTEE

The CB (L. Soudarin and J. Saunier) was asked by Roger Fraser (Department of Transport and Planning, Australia) to contribute to the DORIS technique within the GGOS Data and Information Systems Committee. The first work in which the CB is involved concerns the adoption of the GeodesyML format for sitelogs. The CB analyzed the content of DORIS and GNSS sitelogs and identified the DORIS-specific features to be taken into account in GeodesyML. A summary document was drafted and submitted to the committee on July 11. The document was presented at the committee meeting on September 17.

5.9 PUBLICATIONS AND PRESENTATIONS

During the reported period, the Central Bureau published issue #12 of the IDS Newsletter (see the appendix). It managed the edition of the annual activity reports of the service for 2024 and wrote the IDS contribution for the IAG 2023–2025 report, available on the IAG website with the DOI: 10.82507/iag-travaux2025_ids.

The CB presented the "status and plans of the International DORIS Service" (*https://ids-doris.org/documents/report/meetings/IAG2025_IDSstatusAndPlans-LSoudarin.pdf*) at the IAG Scientific Assembly held in September in Rimini, Italy, and the scientific applications of DORIS and the activities of the International DORIS Service to the French community during the “Journées du groupe de Géodésie et Géophysique (G2)”

The Central Bureau gave a presentation on the DORIS system for the virtual school “Terrestrial Reference Frame. Geodynamic and Atmospheric Monitoring 2025” organized by SIRGAS and held from June 3 to 12. The presentation of these PowerPoint slides was recorded in English by Frank Lemoine and in Spanish by Jérôme Saunier. The recordings in MP4 format are available on the IDS YouTube channel:

- English version: *https://www.youtube.com/embed/WxHSxuDmNfM*
- Spanish version: *https://www.youtube.com/embed/kZkzlAKq_fg*

6 DATA FLOW COORDINATION

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6.1 INTRODUCTION

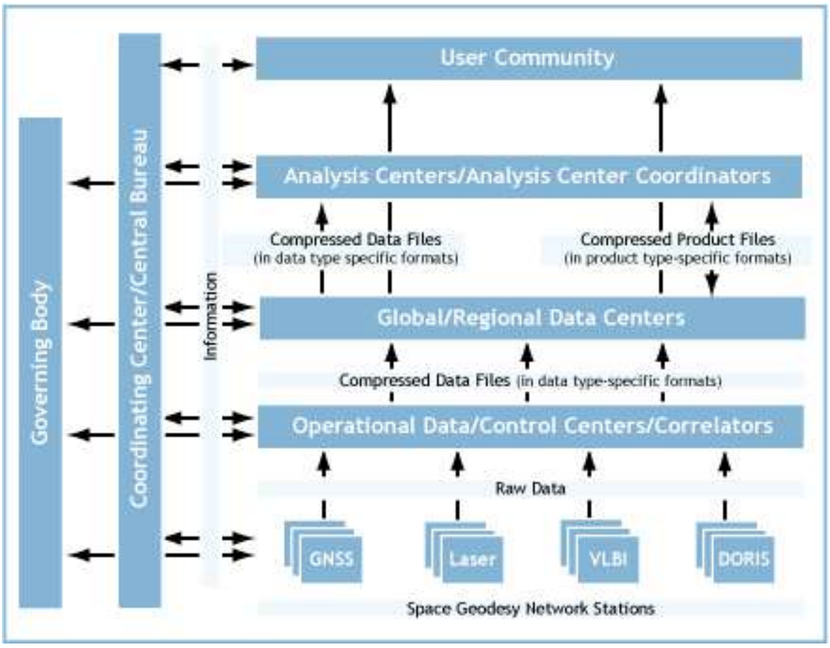
Two data centers support the archiving and access activities for the IDS:

- 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.

6.2 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 7**. 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 7. *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	DORIS data for satellite *sss*, cycle number *MMM*, and version *LLL*
	sss.files	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*	Spacecraft body quaternions for satellite *sss*, year *yyyy*, start date/time *YYYYMMDDHHMISS*, end date/time *yyyymmddhhmiss*, and version number *LLL*
	sss/qsolp*YYYYMMDDHHMISS_yyyymmddhhmiss.LLL*	Spacecraft solar panel angular positions for satellite *sss*, year *yyyy*, start date/time *YYYYMMDDHHMISS*, end date/time *yyyymmddhhmiss*, and version number *LLL*
/doris/general		Summary files and miscellaneous information

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/data-products/data-structure-and-formats.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/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 is mirrored by the IDS data centers thus providing users with secondary locations for these files as well.

6.3 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 ten operational satellites (CryoSat-2, Jason-3, SARAL, HY-2C, HY-2D, Sentinel-3A, Sentinel-3B, Sentinel-6A, Sentinel-6B, and SWOT); data from future missions will also be archived within the IDS. Historic data from SPOT-2, -3, -4, -5, Envisat, TOPEX/Poseidon, Jason-1, Jason-2 and HY-2A, 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, Sentinel-6A, Sentinel-6B, and SWOT 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, Sentinel 3A and -3B, Sentinel-6A, Sentinel-6B, HY-2C and -2D, and SWOT 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-Oct-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
Sentinel-6B	21-Nov-2025 through present	RINEX
SPOT-2	31-Mar-1990 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
Swot	12-Jan-2023 through present	RINEX
TOPEX/Poseidon	25-Sep-1992 through 01-Nov-2004	Multi-day

Table 6. *DORIS Data Holdings Summary.*

6.4 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 in 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 (https://ids-doris.org/ids/organization/analysis-centers.html):

- 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

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.*

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 2005-2026 are shown in **Table 7**. This table also includes a list of products under evaluation from several DORIS analysis centers.

6.5 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. Quaternions and solar panel angles of SWOT have been made available to the IGN Data Center and the CDDIS Data Center.

6.6 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.

7 CRUSTAL DYNAMICS DATA INFORMATION SYSTEM (CDDIS) DATA CENTER

Anna Kelley / SSAI INC, @ NASA Goddard Space Flight Center, Greenbelt, Maryland, 20771, USA

7.1 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 Astronomy (IVS)
- International Earth Rotational 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).

7.2 OPERATIONAL ACTIVITIES

As of the end of 2025, the CDDIS has dedicated 174 GB of disk space to the archive of DORIS data (106 GB: ~61%), products (43 GB: 24%), and information (25 GB: 15%) (see **Figure 8**).

During the year 2025 users downloaded DORIS files from the CDDIS, totaling 1.54 TB of data (see **Table 8**, **Figure 9** and **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 the yearly subdirectories within the DORIS data directory on CDDIS: *ftps://gdc.cddis.eosdis.nasa.gov/doris/data* or *https://cddis.nasa.gov/archive/doris/data*.

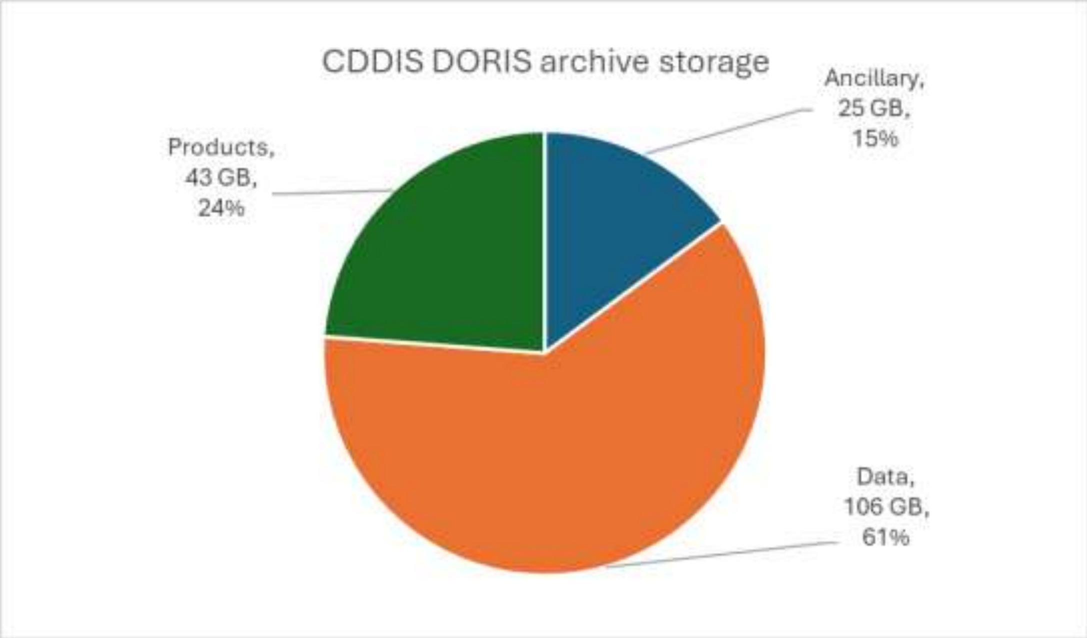


Figure 8. *The CDDIS DORIS archive storage components.*

	HTTP files	FTP files	HTTP volume	FTP volume
Data Files	2,877,251	46,206	1.93 TB	32.36 GB
Product Files	1,654,134	18,684	336.81 GB	7.26 GB
Quaternion Files	84,039	5,927	71.74 GB	1.36 GB

Table 8. *DORIS files downloaded from the CDDIS and the cumulative total volume of files distributed.*

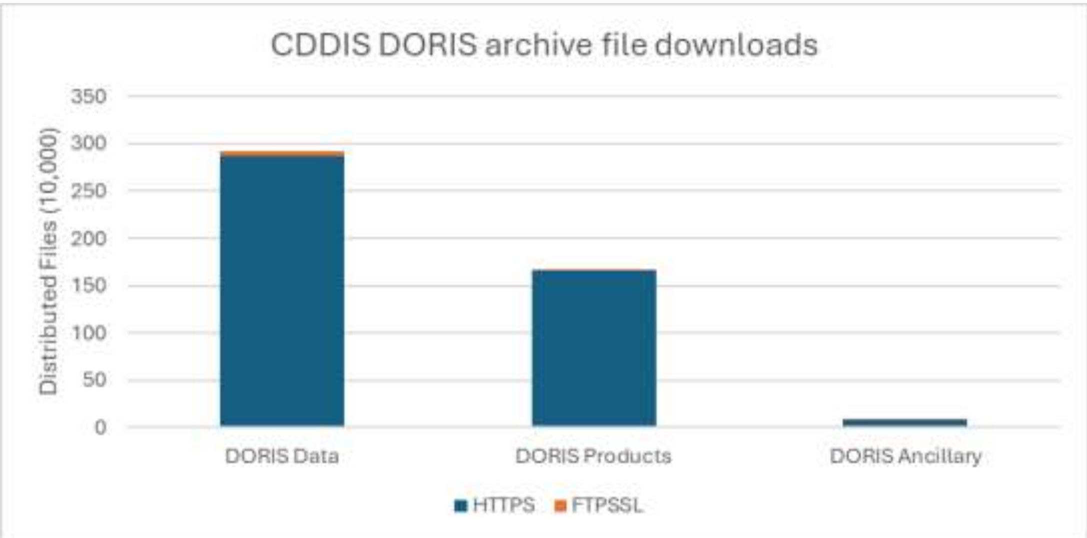


Figure 9. *Total count of files downloaded from the CDDIS DORIS archive.*

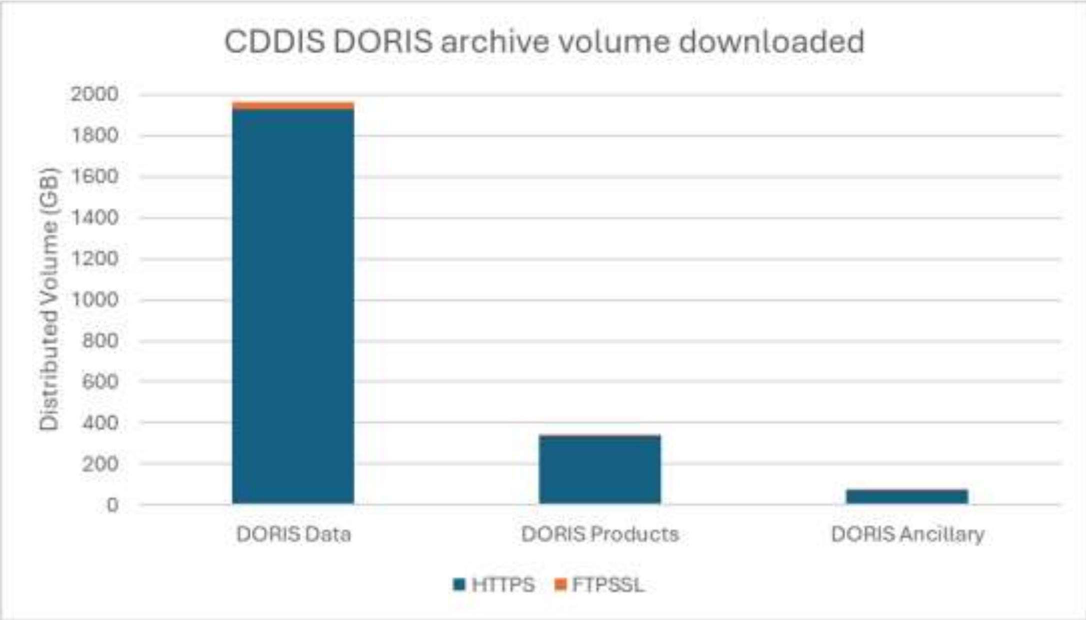


Figure 10. *Total volume of files downloaded from the CDDIS DORIS archive.*

7.3 RECENT ACTIVITIES AND DEVELOPMENTS

CDDIS recently completed its website unification in the summer of 2025 under the NASA earthdata umbrella. Additionally, content and documentation will be forthcoming in 2026. While this unification consolidated CDDIS's content under the broader NASA web infrastructure, its archive access will continue to stay the same at *https://cddis.nasa.gov/archive/*.

The CDDIS implemented a script to mirror updates made to files in its archive that are made on the IGN data center.

The CDDIS hosts data files for the Sentinel-3A and Sentinel-3B satellite.

7.4 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. The CDDIS will upgrade its ingest process to enable immediate processing of uploaded data and product files to its archive, reducing latency between the provision of data and its accessibility.

7.5 CONTACT

Anna Kelley, Software Engineer

SSAI, INC

NASA GSFC

Code 61A

Greenbelt, MD 20771

USA

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

8 IGN DATA CENTER

Jérôme Saunier / IGN, France

The IGN Data Center hosts and distributes data from the following international services: EUREF, SONEL, IGS, and IDS. The IGN Data Center has been operational since 2006. Today the IGN Data Center serves as:

- IGS Global Data Center: *igs.ign.fr*
- IGS Terrestrial Frame Combination Center: *webigs-rf.ign.fr*
- **IDS Data Center**: *doris.ign.fr*
- EUREF Permanent GNSS Network Local Data Center: *rgpdata.ign.fr*
- REGINA Data Center
- SONEL Data Center

8.1 ARCHITECTURE AND DATA ACCESS

The IGN Data Center offers:

- FTP deposit server for data and analysis centers uploads, requiring special authentication
- Free FTP anonymous access to observations data and products
- Access: *ftp://doris.ign.fr*

NB: The backup site 'doris.ensg.eu' with identical infrastructure and configuration has been permanently shut down and taken offline due to maintenance difficulties for several years, and given the improvements made to the main server doris.ign.fr.

8.2 OPERATIONAL ACTIVITIES

The IGN Data Center provides users with approximately 200 Go of DORIS-IDS data, products, metadata and information.

In 2025, regarding IDS section, the number of visits and data downloads increased compared to previous years, reaching 6634 visits, with 934 Go (2 186 448 files) of DORIS data downloaded by the users. This increase is likely due to the use of NRT RINEX data and DIODE orbits that were made available last year.

The data center operated normally throughout the year until September, when it began to show serious signs of weakness and experiencing malfunctions for two weeks. This accelerated the migration to a new independent infrastructure, which had been planned to avoid disruption caused by other services (GNSS data flow in particular). The service was back to normal in November when the migration was complete.

The interface with the IDS Central Bureau, Combination Center and Analysis Centers and continuous monitoring of data integrity, as well as any necessary corrective actions, enabled reliable provision of data and products.

8.3 MAINTENANCE AND DEVELOPMENT

The main development for 2025 was the separation of servers' infrastructure between GNSS data and DORIS data to have full projects independence and avoid mutual interferences. This migration to a new infrastructure was carried out for both the collection server (dorisdepot.ign.fr) and the distribution server (doris.ign.fr). The server architecture has not been changed, nor the user experience.

This development is intended to improve the robustness of the data center and the service provided to users of DORIS data and products over time.

8.4 CONTACT

For technical support, please use our generic email address: *ids.data.center@ign.fr*

ANALYSIS ACTIVITIES

9 ANALYSIS COORDINATION

Petr Štěpánek / Geodetic Observatory Pecný, VÚGTK, Czech Republic

9.1 INTRODUCTION

This section provides an overview of the activities of the DORIS Analysis Working Group (AWG) during 2025 and summarizes the current status of the IDS Analysis Centers and Associate Analysis Centers. Two AWG meetings were organized during the year: an online meeting held on 24 March 2025, and an in-person AWG meeting hosted in Athens on 6–7 November 2025. Both meetings focused on recent developments in DORIS data analysis, precise orbit determination, terrestrial reference frame activities, and ongoing improvements in IDS operational products and analysis strategies.

9.2 AWG ONLINE MEETING ON 24 MARCH 2025

The DORIS Analysis Working Group (AWG) online meeting held on 24 March 2025 focused on the current status of IDS Analysis Centers, improvements in DORIS data processing, and recent developments related to terrestrial reference frame updates and precise orbit determination. The meeting was organized by Petr Štěpánek and gathered experts from major international geodetic institutions and IDS analysis teams.

The first part of the meeting consisted of status reports from several IDS Analysis Centers, including GRG, GSC, GOP, IGN-IPGP, DGFI-TUM, and GFZ. These presentations summarized ongoing operational activities, software developments, and updates in DORIS data processing strategies. Particular attention was given to maintaining consistency between analysis products and improving the quality of orbit and station coordinate solutions.

An important topic of the meeting was the analysis of IDS contributions to the ITRF2020-u2024 update. Discussions focused on evaluating the consistency and long-term stability of DORIS-derived geodetic products and their role in future terrestrial reference frame realizations.

Several technical presentations addressed precise orbit determination for current satellite missions. These included processing of SWOT satellite DORIS measurements and improvements in CryoSat-2 orbit determination through the transition from legacy Doppler format 2.2 data to RINEX-based processing. The meeting highlighted ongoing efforts to modernize DORIS data handling and improve orbit accuracy for altimetry and Earth observation missions.

Overall, the meeting demonstrated continued international collaboration within the IDS community and emphasized the importance of DORIS observations for high-precision geodesy, satellite orbit determination, and maintenance of global terrestrial reference frames.

Presentation files are available on the IDS website at

https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-03-2025

9.3 AWG ON SITE MEETING IN ATHENS ON 6–7 NOVEMBER 2025

The onsite DS Analysis Working Group Meeting, held in Athens on 6–7 November 2025, focused on recent developments in DORIS data analysis, precise orbit determination (POD), and contributions to terrestrial reference frame realizations. The meeting gathered experts from international analysis centers including CNES/CLS, NASA GSFC, GOP, GFZ, DGFI-TUM, and IGN-IPGP to discuss ongoing processing improvements and future geodetic missions.

A major topic of the conference was the contribution of DORIS products to the ITRF2020 updates and the development of DPOD2020 v5.0. Several presentations addressed the evaluation of DTRF2020-u2024 solutions, reference frame consistency, and combined geodetic products aimed at improving the realization of the terrestrial reference frame.

The Analysis Centers presented status reports on their operational processing strategies, software developments, and orbit determination performance. Particular attention was given to multi-technique orbit solutions combining DORIS and SLR observations, improvements in radial orbit accuracy, and the processing of altimetry missions such as SWOT, Sentinel, Jason, and CryoSat-2.

Additional research presentations focused on advanced POD modeling, stochastic acceleration adjustments, ionospheric monitoring using near-real-time DORIS data, and the impact of satellite self-shadowing effects on orbit quality. The conference also included updates on the DORIS network status, future satellite missions, and activities of the IDS Combination Center and Clocks Working Group.

Overall, the meeting demonstrated continuous progress in DORIS-based geodetic processing and highlighted the importance of international collaboration for maintaining high-precision global reference frames and Earth observation products.

Presentation files are available on the IDS website at

https://ids-doris.org/resources/presentations/ids-meetings.html#ids-awg-11-2025

9.4 ANALYSIS CENTERS AND COMBINATION CENTER

The IDS currently consists of five Analysis Centers (ACs) and four Associate Analysis Centers (AACs), relying on eight independent software packages, as summarized in **Table 9**. Several centers routinely perform Precise Orbit Determination (POD) of DORIS satellites, often in combination with complementary space geodetic techniques such as SLR and GNSS.

The operational IDS products are regularly generated by ESA, GSC, GRG, GOP, and IGN. Among the AACs, GFZ and DGFI-TUM continue to support dedicated DORIS analysis activities, while GFZ remains under consideration for transition to full AC status. The CNES AAC also maintains its contribution through POD solution generation.

The Combination Center (CC) continues the routine production of weekly IDS SINEX combinations released every three months and coordinates analyses related to dedicated IDS campaigns. During 2025, processing activities focused on data covering the 2024.0–2025.0 interval in support of the ongoing IDS contribution to the ITRF2020 extension and related reference frame updates.

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

Table 9. *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, the year 2025 was mostly devoted to the computation of (the fourth and) fifth version(s) of the DORIS extension of the ITRF2020 for Precise Orbit Determination (DPOD2020). To understand the behavior of each of the IDS contributions to the second yearly update of the ITRF2020, the IDS CC analyzed all the single satellites solutions from the GOP, GRG, GSC and IGN solutions from 2021.0 to 2025.0. In line with that study and in collaboration with the IDS ACs, the IDS CC submitted late October to Earth, Planets and Space a paper on the DORIS contribution to ITRF2020-u2024. Once the first and second yearly updates of the ITRF2020 (ITRF2020-u2023, ITRF2020-u2024) were released, the IDS CC performed their DORIS evaluations.

10.2 IDS ROUTINE EVALUATION AND COMBINATION

At the end of 2025, the time span of the SINEX files of the IDS combined solution was 1993.0-2025.5. These files correspond to the IDS series 19 and 26 (since 2021.0), extension of the IDS contribution to the ITRF2020 (IDS 16).

As depicted by **Figure 11** and further explained by the study on the IDS AC contributions to the second yearly update of the ITRF2020, we observe larger variations of the IGN 22 scale since almost mid-2023 and a higher mean offset of the z-translation values for ESA 16.

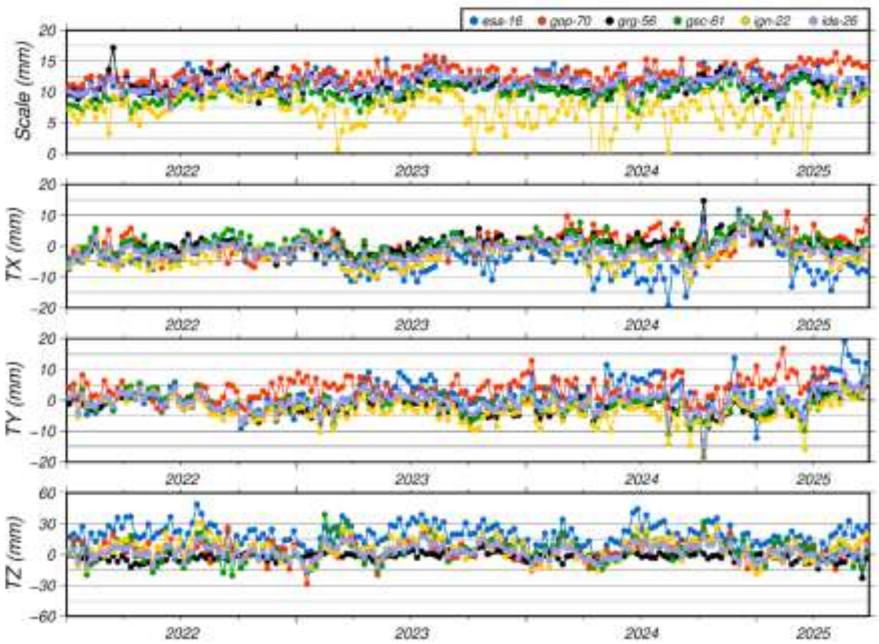


Figure 11. *Helmert parameters w.r.t. DPOD2020 version 4.1 of the IDS AC series ESA 16, GOP 70, GRG 56, GSC 61, IGN 22 and IDS 26.*

10.3 DPOD2020 VERSION 4.0

Early 2025, the IDS CC started the realization of the fourth version of the DPDO2020 based on the IDS 19/25 series from 1993.0 to 2025.0. Like version 3.0, that fourth version includes the estimation of the periodic (annual, semi-annual, first two draconitics of Jason satellites) signals from the observations since mid-2002 and for sites with at least two years and a half of observation. It also includes DORIS-only post-seismic deformation corrections for the SODA (Socorro Island) and GONC (Goldstone) stations.

Compared to the previous DPOD release (version 3.0), that fourth version includes one more year (2024) of weekly positions of the DORIS stations from the IDS 25 series. Thus, the DPOD2020 version 4.0 ground network contains 225 beacons at 90 sites (see **Figure 12**). Compared to version 3.0, there is one new site: Ulaanbaatar (Mongolia). Based on the analysis of the coordinate time series of all the stations from 1993.0 to 2025.0, compared to DPOD2020 version 3.0, we introduced 21 new discontinuities, mainly from late 2020. Note that five of the new discontinuities concern the JIWC station at Jiufeng (China).

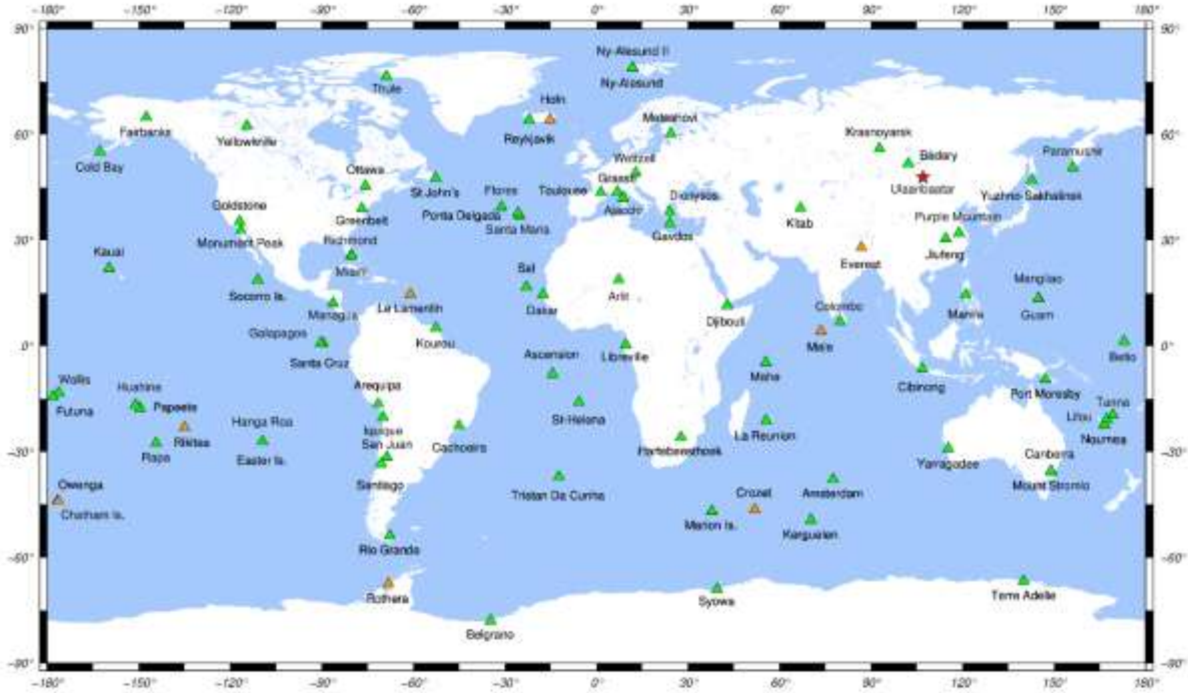


Figure 12. *DPOD2020 version 4.0 ground network. Green: sites with no new station since DPOD2020 v3.0. Orange: sites with new station(s) since DPOD2020 v3.0. Red: new site since DPOD2020 v3.0.*

With or without using seasonal station position corrections, the largest station position differences between DPOD2020 version 3.0 and version 4.0 occur at HOGC (Höfn – Iceland) and GAVC (Gavdos, Greece), two stations which were turned on during the second half of 2023 (see **Figure 13**).

For more details and results on the IDS CC evaluation of the DPOD2020 version 4.0, refer to https://ids-doris.org/documents/combinationcenter/dpod2020_04_TechnicalReport.pdf.

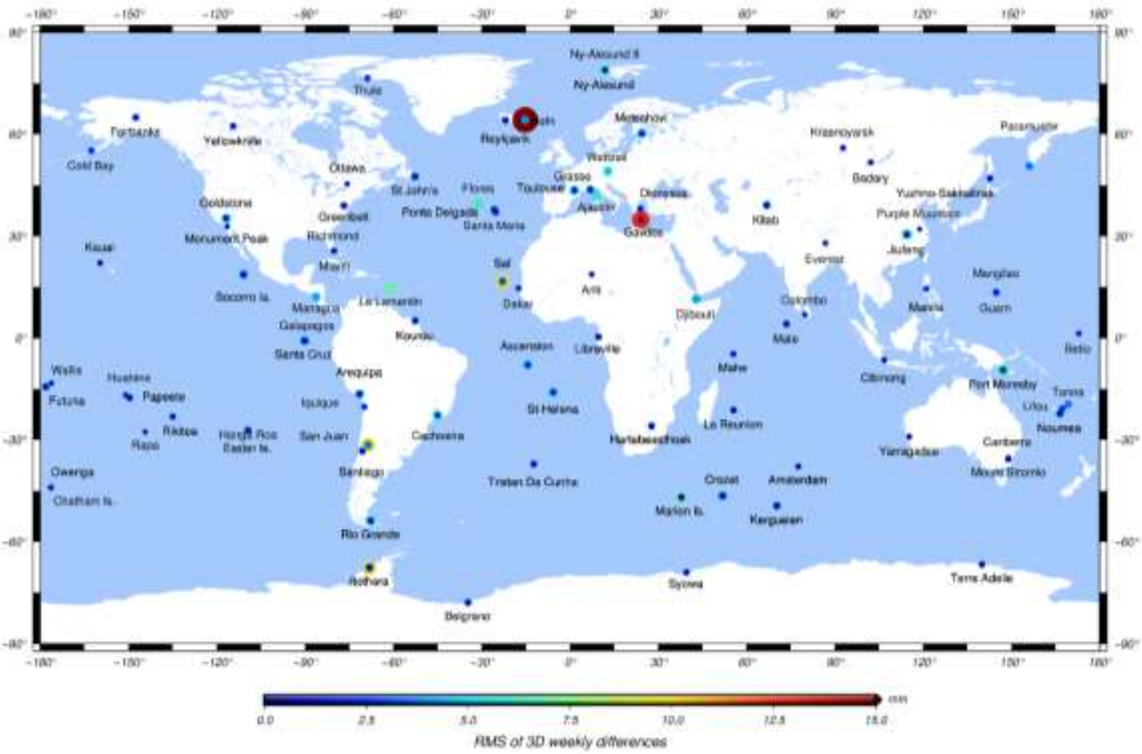


Figure 13. *RMS of the weekly 3D station position differences between DPOD2020 version 3.0 and DPOD2020 version 4.0 from 1993.0 to 2025.0.*

10.4 DPOD2020 VERSION 5.0

Mid-2025, the IDS CC initialized the realization of the fifth version of the DPDO2020. That new version differs from the previous one by the extension of the time span (1993.0-2025.5) and by the estimation of the periodic (annual, semi-annual, first two draconitics of Jason satellites) signals from the observations since mid-2002 and for sites with at least two years of observation. That fifth version also includes DORIS-only post-seismic deformation corrections for the SODA and GONC stations at, respectively, Goldstone and Socorro Island.

The elaboration of the DPOD2020 v5.0 started with the computation of a DORIS station position and velocity cumulative solution (aligned onto the ITRF2020-u2023) from the IDS 19/26 series. As depicted by **Figure 14**, in overall, from 1993.0 to 2025.5, the DORIS ground network includes 226 stations at 90 sites (one more station – KEZC @ Kerguelen – compared to DPOD2020 version 4.0).

As usual, the discontinuity and velocity constraints were deduced from the analysis of the coordinate time series of all the DORIS stations over the entire time span. The velocity constraints consist in forcing the 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). On the model of the ITRF2020, we introduced constraints on the frequency coefficients to get a unique couple (cosine and sine) of coefficients by DORIS site (i.e. all the time segments of all the stations at one site have the same coefficients). Periodic signals were only estimated for sites with more than two years (two years and a half for the older versions) of observation and with observations after mid-2002. We did not estimate periodic signals for the sites which were closed before mid-2002 because the DORIS coordinate time series are more scattered before that date due to the capability of the DORIS receivers to follow only one beacon at a time.

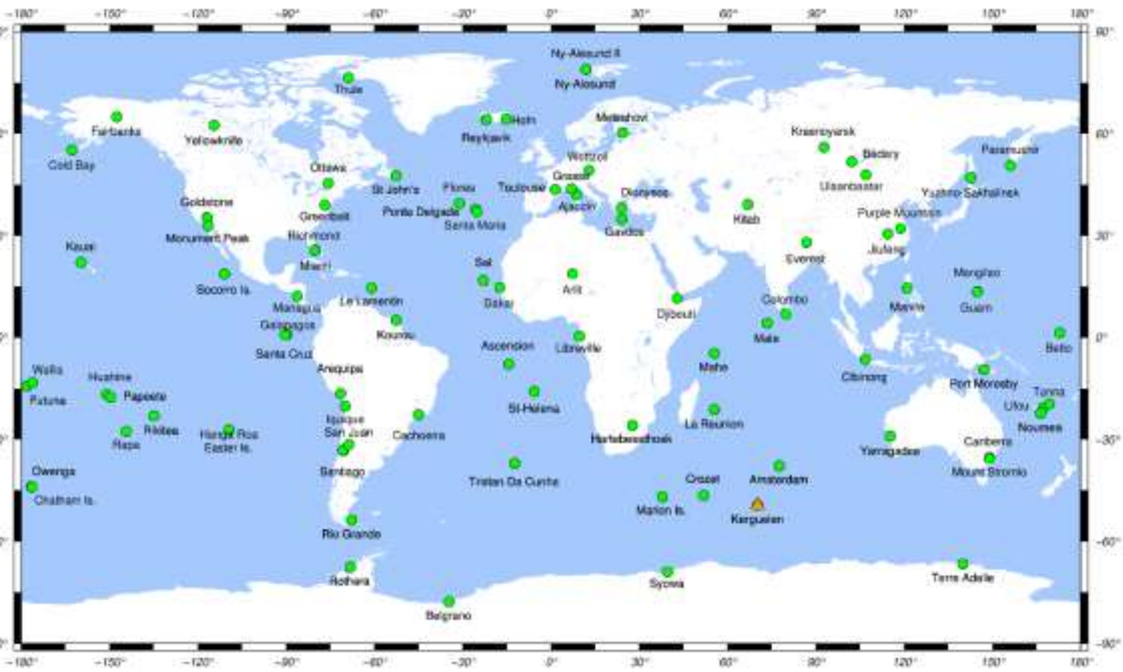


Figure 14. *DPOD2020 version 5.0 ground network. Green: sites with no new station since DPOD2020 v4.0. Orange: sites with new station(s) since DPOD2020 v4.0. Red: new sites since DPOD2020 v4.0.*

In addition to the above-mentioned velocity and frequency constraints, the DORIS-to-DORIS surveyed ties were used as constraints in the stacking of the IDS weekly solutions. From the analysis of the IDS 19/26 coordinate time series, we identified 135 discontinuities at 50 of the 90 DORIS sites between 1993.0 and 2025.5 (see **Figure 15**). Note that more than half (60) of these discontinuities have a seismic or a geophysical origin, 25 are associated with technical events (such as an antenna change, beacon or USO change), the remaining having so far unknown origins.

Since version 3.0, in addition to the SODA station at Socorro Island, the DPOD2020 solutions give also DORIS-only post-seismic corrections for the GONC station at Goldstone. These GONC post-seismic corrections are associated with the M7.1 Earthquake on 2019/07/06. The SODA and GONC post-seismic deformation corrections are delivered as XYZ corrections to be added to the linear model expressed in the DPDO2020 SINEX file and are stored in a text ASCII file.

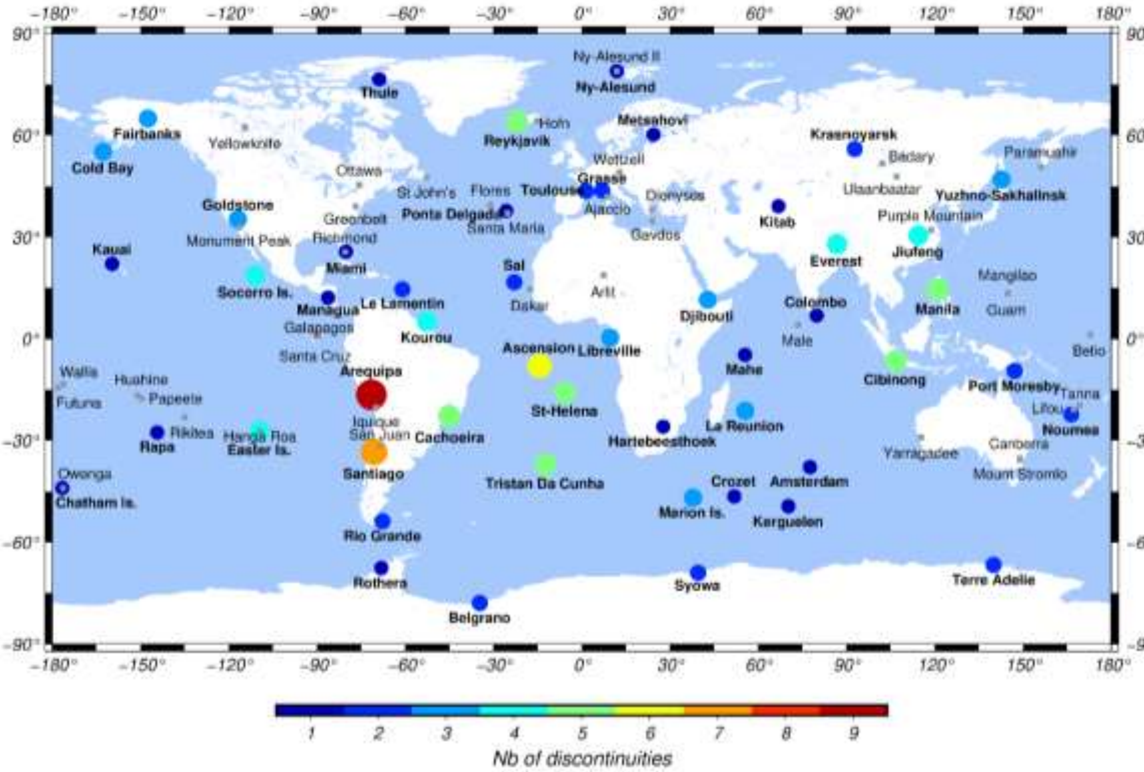


Figure 15. *Total number of discontinuities for all the DORIS sites included in DPOD2020 version 5.0. Grey squares indicate sites with no discontinuity.*

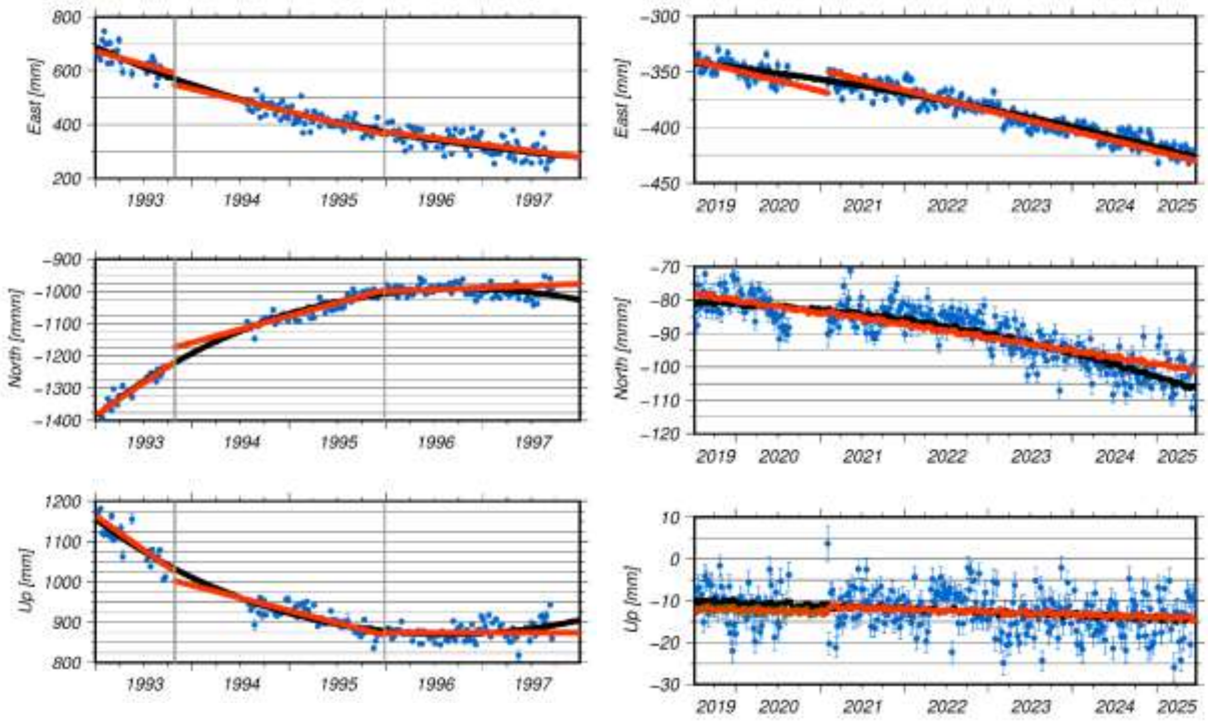


Figure 16. *Coordinate time series of the DORIS stations SODA (left) and GONC (right): IDS 19/26 series in blue, purely linear model in red and linear model with post-seismic corrections in black.*

Figure 16 displays the SODA and GONC coordinate time series from i) the ids 19/26 series, ii) the linear motion and iii) the linear motion corrected for post-seismic deformations.

Then, we started the validation of the fifth version of the DPOD2020 by computing the weekly coordinate differences with ITRF2020-u2023 (including PSD corrections) and DPOD2020 v4.0 with and without the annual and semi-annual corrections.

As indicated in **Table 10**, the median values of the 3D weekly differences between DPOD2020 v5.0 and DPOD2020 version 4.0 or ITRF2020-u2023 are smaller than, respectively, 3 and 6 millimeters. As expected, because DPDO2020 versions 4.0 and 5.0 mainly differ by six months of more observations for the later solution, we get smaller differences between these two solutions compared to DPOD2020 version 5.0 and ITRF2020-u2023. Furthermore, the use of seasonal corrections increases the differences due to the different strategies to estimate these corrections. Thus, in the case of DPOD2020 v5.0 and ITRF2020-u2023, the largest differences are located at Iquique, Lifou, and Paramushir, sites with very short time spans and for which we did not estimate periodic terms in version 5.0 as the sites were turned off before mid-2002. However, with or without using seasonal corrections, more than 85 percent of RMS of the 3D weekly position differences between DPDO2020 version 5.0 and ITRF202-u023 (resp. DPOD2020 version 4.0) are lower than 10 (resp. 5) mm.

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 DPOD2020 version 4.0. As expected due to the small differences between these two versions, from **Table 11**, we can see that DPOD2020 versions 4.0 and 5.0 give similar DORIS-to-DORIS tie residuals. In addition, we observed that eighty four 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.

More details on the internal validation of the DPOD2020 version 5.0 realized by the IDS Combination Center are available in the online technical report (see DPOD subdirectory of the IDS website).

Unit = mm	**DPOD2020 v5.0 vs DPOD2020 v4.0**		**DPOD2020 v5.0 vs ITRF2020-u2023**	
	Without periodic terms	**With periodic terms**	**Without periodic terms**	**With periodic terms**
Maximum	20.9	29.1	76.1	98.5
Mean	0.4	2.9	4.2	6.4
STD	0.7	1.5	4.1	4.3
RMS	0.8	3.3	5.9	7.8
Median	0.3	2.7	3.0	5.6

Table 10. *Statistics of the weekly station coordinate differences between DPOD2020 v5.0, DPOD2020 v4.0 and ITRF2020-u2023.*

Unit = mm	**DPDO2020 v4.0**	**DPOD2020 v5.0**
Number of ties	121	123
Number of sites	61	62
Maximum	47.6	47.3
Mean	12.9	12.9
STD	9.1	9.0
RMS	15.7	15.7
Median	10.4	10.8

Table 11. *Main statistics of the DORIS-to-DORIS tie residuals from DPOD2020 versions 4.0 and 5.0.*

10.5 DORIS EVALUATION OF THE ITRF2020-U2023 SOLUTION

Late 2024, IGN made available the first yearly update of the ITRF2020: ITRF2020-u2023. This new ITRF realization includes observations until the end of 2023. Then, early February 2024, the IDS CC performed the DORIS evaluation of that new solution. The evaluation started by extracting from the SINEX file basics information like the number of sites, the number of stations, the number of discontinuities as well as, per site, the number of distinguishable velocities (velocities which differ by more than 0.01 mm/year). The evaluation also includes the analysis of the Helmert parameter time series of the latest IDS combined series with respect to both the ITRF2020-u2023 and ITRF2020. All the results of that ITRF2002-u2023 evaluation were collected in a PowerPoint document which was shared mid-March 2025 with the IGN IERS ITRS Centre and the IDS ACs and available at https://ids-doris.org/documents/combinationcenter/ITRF2020-2023_IDSCC_eval_v3.pdf. In short, the ITRF2020-u2023 contains 215 DORIS stations at 89 sites (14 stations and 2 sites – Höfn and Hanga Roa - more than ITRF2020, see **Figure 17**) and includes new discontinuities, even before 2021.0.

We also noticed that for ITRF2020-u2023, IGN revisited the velocity equality constrains between successive stations for a few sites. These new discontinuities and velocity constraints may explain the station position differences we observed between ITRF2020 and ITRF2020-u2023. As expected due to the time expansion of the input data and to the new discontinuities, compared to ITRF2020, ITRF2020-u2023 shows smaller weekly differences with the IDS 23 series from 2021.0 to 2024.0.

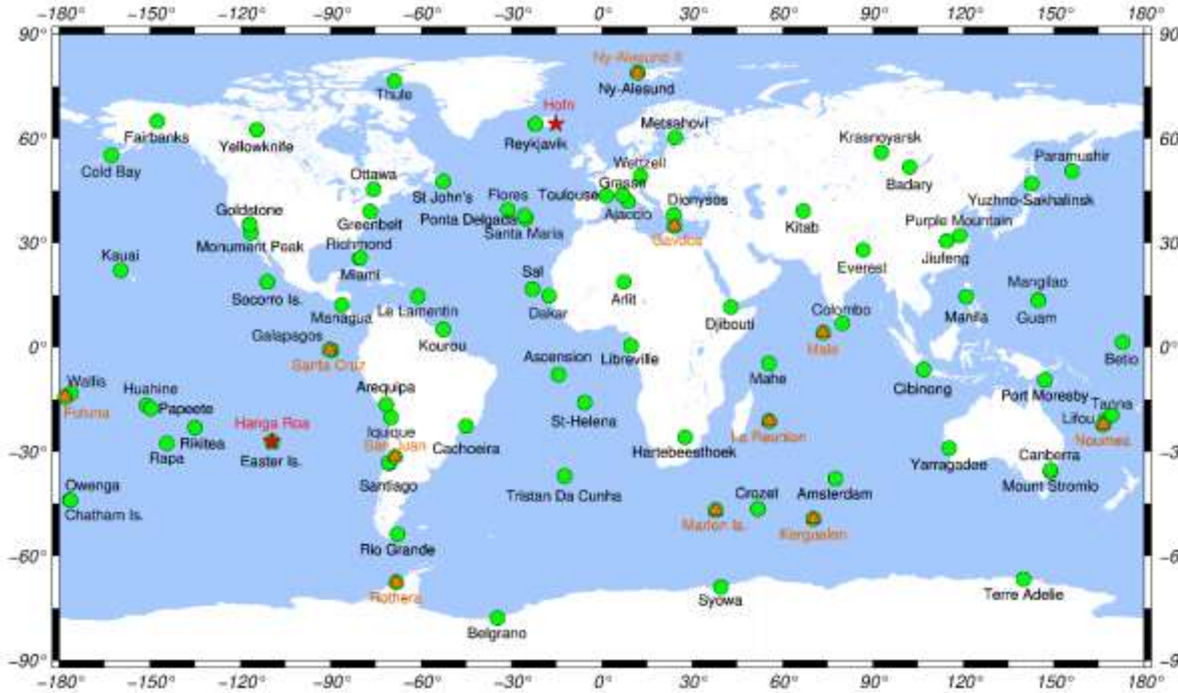


Figure 17. *ITRF2020-u2023 DORIS beacon ground network (in green: sites with no new beacon since ITRF2020; in orange: sites with new beacon since ITRF2020; in red: new sites since ITRF2020).*

10.6 DORIS EVALUATION OF THE ITRF2020-U2024 SOLUTION

Similarly to what has been done for the first ITRF2020 update, the IDS CC performed a DORIS evaluation of the second yearly update of ITRF2020: ITRF2020-u2024.

Very early, the IDS CC noticed an error in the PSD correction file in SINEX format: the vertical corrections were denoted by the H instead of the U letter. Then, within a day, the IGN IERS ITRS Centre redelivered PSD correction files. Compared to ITRF2020-u2023, that second update includes seven stations and one site (Ulaanbaatar) more (see **Figure 18**). The comparison of the time epochs of each station between ITRF2020-u2024 and the latest IDS cumulative position and velocity solution showed that ITRF2002-u2024 (like ITRF2020-u2023) gives no mean position and velocity for the DJIB station before the antenna change in 2006/06/11. Thus, the IDS CC suggested introducing for that station and that time period a new unconstrained velocity. Because ITRF2020-u2024 differs mainly from ITRF2020-u2023 by the addition of only one year of observations, the median value of the weekly station position differences between the propagation of these solutions between 1993.0 and 2024.0 (resp. between 2024.0 and 2026.0) is smaller than 1 mm (resp. 3.5 mm) 3D.

All the results of that ITRF2002-u2024 evaluation can be found in a PowerPoint document which was shared mid-October with the IGN IERS ITRS Centre and the IDS Acs and available at https://ids-doris.org/documents/combinationcenter/ITRF2020-2024_IDSCC_eval_v1.pdf.

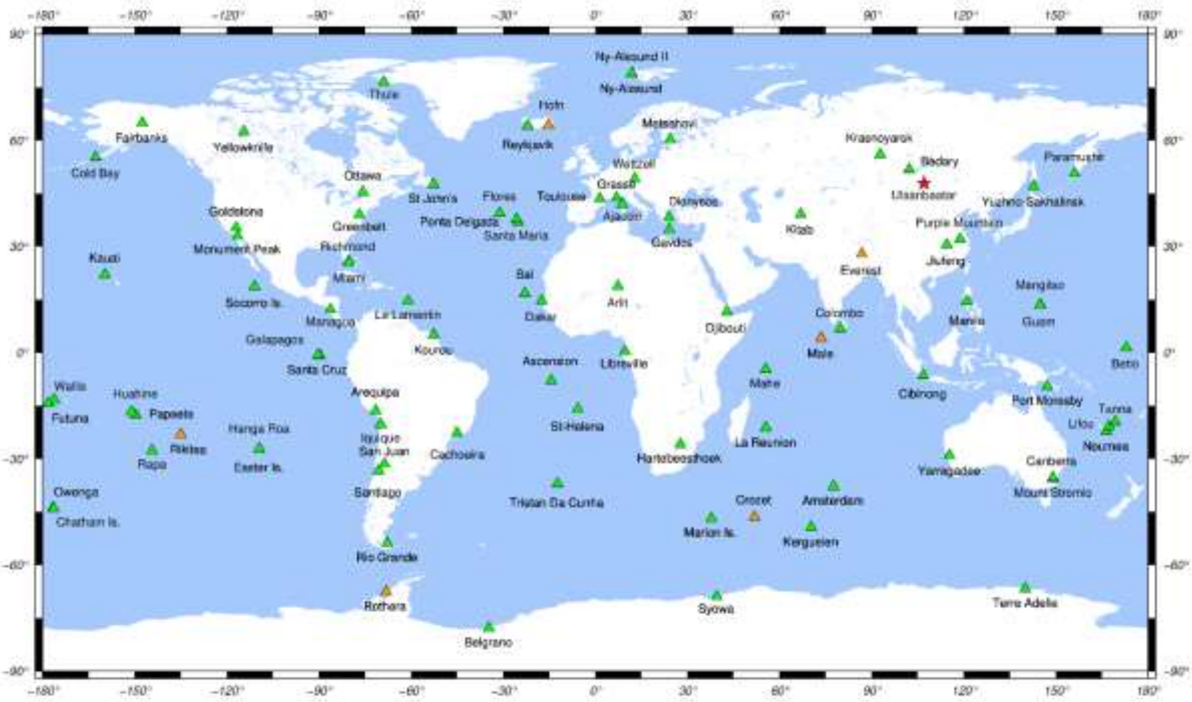


Figure 18. *ITRF2020-u2024 DORIS beacon ground network (in green: sites with no new beacon since ITRF2020-u2023; in orange: sites with new beacon since ITRF2020-u2023; in red: new site since ITRF2020-u2023).*

10.7 COMMUNICATIONS

In 2025, the IDS Combination Center joined the EGU where it had an oral presentation titled "IDS contribution to the second update of the ITRF2020" (see https://ids-doris.org/documents/report/meetings/EGU25-12833_presentation-GMoreaux.pdf).

The IDS CC also attended the IDS AWG with three oral presentations and joined the AGU Fall meeting where it had a poster on the DORIS processing improvements for the next ITRF realization (see https://ids-doris.org/documents/report/meetings/AGU2025-IDScombination-Moreaux.pdf).

With the IGN IDS AC, the IDS CC positively answered the call for participation in the IERS Technical Note on the ITRF2020 by delivering a paper on the DORIS evaluation of the 2020 realization of the ITRF.

The IDS CC also contributed with A. Kloss, J. Bogusz and A. Lenczuk to the paper titled "Assessing the evolution of position time series derived from satellite Doppler measurements", paper which was submitted to the journal "Measurement" (DOI: 10.1016/j.measurement.2026.120495).

Finally, in collaboration with the IDS ACs, the IDS CC submitted late October to Earth, Planets and Space a paper on the DORIS contribution to the second yearly update of the ITRF2020 (DOI: 10.1186/s40623-026-02459-y).

10.8 FUTURE PLANS

In 2026, 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 will realize the DORIS contribution to the third yearly update of the ITRF2020. In line with the delivery of daily LOD estimations by ESA and GOP, the IDS CC also plans to compute a new combined series including LOD. Then, the IDS CC may evaluate the first yearly update of the DTRF2020 solution from DGFI and will compute a sixth version of the DPOD2020 aligned onto the ITRF2020-u2024 solution.

11 ANALYSIS CENTRE AT EUROPEAN SPACE OPERATION CENTRE (ESOC)

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11.1 INTRODUCTION

The ESA Navigation Support Office based at ESOC in Darmstadt, Germany, plays an active role in the International DORIS Service (IDS) as an official Analysis Centre (ESA/ESOC IDS AC) mainly by providing the weekly station coordinate SINEX files used for the IDS and ITRF reference frame determination for the DORIS sites. The Office activities in 2025 concentrated on the continuous performance of its regular operations with the routine submission of its products to IDS.

11.2 IMPROVEMENTS AND ENHANCEMENTS

The Office has been developing and maintaining high-precision orbit determination models and algorithms using DORIS data alongside other techniques (GNSS, SLR, VLBI, altimetry), including:

- all DORIS satellites in the ESA contribution with Sentinel-3, Sentinel-6, Cryosat-2 as well as the other satellites equipped with DORIS receivers;
- support for Copernicus POD Service validation and independent orbit determination for Sentinel missions;
- studies on force modelling improvements (e.g. solar/Earth radiation pressure);
- improvements of the operational solution (wd16) exclusively based on the use of the DORIS RINEX files.

Furthermore, ESOC has been progressing its multi-technique solutions based on the Combination on Observation level (*Enderle et al., 2024*), including the processing of all geodetic space techniques in a single combination (GNSS, SLR, DORIS and VLBI). This development intends to also benefit the ESA Genesis mission.

11.3 MAJOR UPGRADES AND DEVELOPMENTS

11.3.1 INFRASTRUCTURE

The Office develops, maintains and operates the complex European Precise Navigation Software (EPNS) (*Zimmermann et al., 2025*) infrastructure. In 2025, the Office switched from the NAPEOS to the latest release of EPNS version 1.3 to conduct its operations.

It this context, the Office updates the databases used for the processing, including the switch to FES-2022 and the latest release of AOD1B number 7. The update of several of the macro-models used for the non-conservative force modelling was also performed.

This infrastructure relies on the Consolidated High Accuracy Multi-GNSS Processing (CHAMP) (*Gini et al., 2024*).

11.3.2 DATA

The Office processes DORIS observation data from the global beacon network and DORIS-equipped satellites and contributes its processed DORIS data to the IDS Data Centers (e.g. mirroring/ingestion via partnerships like CDDIS or IGN).

Since October 2025, the Office has been releasing through the GNSS Science Support Centre (GSSC) (*Castrillo et al., 2024*) its DORIS datasets. GSSC archives and mirrors data of all four geodetic techniques (GNSS, SLR, VLBI, DORIS) for data redundancy, long-term preservation, and global accessibility to global scientific users.

11.3.3 PRODUCTS

As part of its IDS contributions, the Navigation Support Office generates and delivers operational DORIS-based products, publicly available via their servers.

The following SINEX files, quarterly delivered, contribute to IDS combined solutions and higher-level products like DPOD (DORIS extension of ITRF for POD), supporting ITRF realizations (e.g. DPOD2020 based on ITRF2020):

- Station coordinates (DORIS beacon positions)
- Earth Orientation Parameters (EOP)

The Office also contributes its IDS weekly/monthly combinations and ITRF inputs (e.g. for ITRF2020, involving long data spans from multiple DORIS-equipped missions.

All these products are generated in the Office controlled operational environment and made accessible via HTTP/FTP on the Office's public server, as well as GSSC.

11.4 ITRF SUPPORT

All ITRF2020 recommendations are included in the ESA processing:

- New mean pole
- Up to date TVG
- Desai & Sibois HF (diurnal-subdiurnal) tidal EOP model
- Independent DORIS data selection, editing and pre-processing
- Updated SSA files for Jason and SPOT-5
- Inclusion of all data above 7 degrees with appropriate down-weighting
- Troposphere gradient estimation

The current solution (wd16) covers the period from 1993 until the end of 2025 and is automatically updated as soon as all DORIS RINEX files are available. The current processing uses a 40-day delay in the processing, ensuring that the most accurate input products are available.

11.5 FUTURE ACTIVITIES

The Navigation Support Office plans for 2026 to ensure its continuous operations with routine IDS submission, while updating its solution whenever deemed necessary. The Office endeavors to include the latest HY2-C/D satellite and investigate the possibility of including SWOT in its processing as well.

11.6 REFERENCES

Castrillo N. et al. (2024). ESA GSSC: An Open Door to GNSS Science. 9th International Colloquium on Scientific and Fundamental Aspects of GNSS, 25 - 27 September 2024, Wrocław, Poland.

Enderle W. et al. (2024). GENESIS New Combined Processing. 9th International Colloquium on Scientific and Fundamental Aspects of GNSS, 25 - 27 September 2024, Wrocław, Poland. *https://navigation-office.esa.int/attachments/83497535/1/GENESIS_New_Combined_Processing_IntColloq2024.pdf*

Gini F. et al. (2024). Advancements in Operational GNSS Processing: A Comprehensive Analysis of ESA's New Methodology. 9th International Colloquium on Scientific and Fundamental Aspects of GNSS, 25 - 27 September 2024, Wrocław, Poland. *https://navigation-office.esa.int/attachments/83497492/1/CHAMP_Gini_IntColloq_2024.pdf*

Zimmermann F. et al. (2025). Evolution of Precise Navigation Products at ESA. European Navigation Conference (ENC) 2025, Wrocław, Poland, Session on Precise Navigation Products and Galileo HAS – 21/05/2025. *https://navigation-office.esa.int/attachments/125054191/1/20250521_1630_Zimmermann_Evolution-of-Precise-Navigation-Products-at-ESA.pdf*

12 ANALYSIS CENTER OF THE GEODETIC OBSERVATORY PECNY (GOP)

Petr Štěpánek / Geodetic Observatory Pecný, Czech Republic

12.1 GENERAL DESCRIPTION

Routine processing of DORIS data has been ongoing since day 270 of 2025. Current operational solutions utilize the wd69 and wd70 standards, which were developed in parallel as evolutions of the previous wd68 standard. Notably, wd68 introduced support for the Sentinel-6, HY-2C, and HY-2D satellites, applying the measured attitude for Sentinel-6 and a nominal attitude model for the HY-2 series. Furthermore, the South Atlantic Anomaly (SAA) mitigation strategy remains active for Jason-3, Sentinel-6A, and HY-2C. This strategy optimizes orbit determination by utilizing specific stations dedicated exclusively to these satellites, managed via satellite-specific alias names for the SAA stations.

The primary distinctions between the wd69 and wd70 standards focus on the gravity field model and satellite contributions to the scale factor:

- **Gravity Field Model**: Both wd69 and wd70 adopt the updated GRGS RL05 model, upgrading from the EIGEN RL04 model used in wd68.
- **Scale Factor Contributions**: While wd69 includes contributions from all satellites, wd70 explicitly excludes Sentinel-6, Hy-2C, and Hy-2A.

Additionally, the Length of Day (LOD) parameter is fully integrated into the standard processing workflow.

12.2 LOD ESTIMATION

Regarding the determination of the Length of Day (LOD) parameter, the experiment was conducted using data spanning the period 2014.0–2021.0. The annual weighted mean exhibits variations ranging from -22 mu to 39 µs. On average, the weighted standard deviation reaches values around 83 microseconds, applying cross-track OPR (Once-Per-Revolution) amplitude constraints of 10-9 m/s2. The estimated LOD, along with its comparison to the IERS C04 model, is illustrated in **Figure 19**. The methodology and comprehensive results of this LOD estimation are currently compiled in a peer-reviewed paper, which is in the final stage of development and prepared for imminent submission.

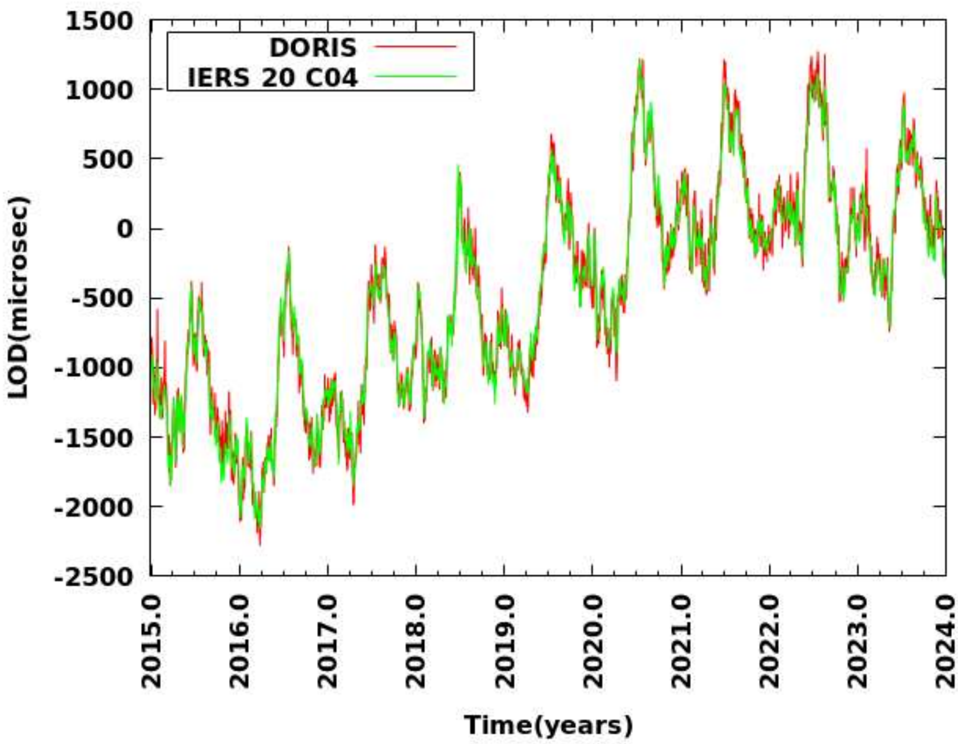

Figure 19. *LOD estimated from DORIS data compared with IERS 20 C04 model*

12.3 PROCESSING STRATEGIES FOR GEOMAGNETIC STORM (GS)

To mitigate the adverse effects of extreme space weather on satellite orbit determination, specialized processing strategies were developed and evaluated for Geomagnetic Storm (GS) days, with a particular focus on G5-category storms. During intense GS events, atmospheric drag increases significantly, causing many observations to be flagged as invalid. While this heavily reduces the overall data yield, the residuals of the remaining valid measurements show minor changes because substandard data are effectively filtered out. To address this, adjusting the atmospheric drag estimation strategy becomes essential.

Modified processing configuration was tested to optimize data retention and solution strength under these conditions, varying the drag relative constraints, residual sigma multipliers, constant residual thresholds, pass symmetry ratios, and the minimum number of observations required per pass.

Among the tested configurations, the modified strategy designated as Version 2 — especially when combined with strict pass symmetry ratio constraints — demonstrated the most significant performance improvements during G5 storm days:

- **LOD Corrections:** Modified strategy leads to a 40–80% decrease in the variance of Length of Day (LOD) corrections, while mean drifts across all satellites are reduced by approximately 60%.
- **ERP Quality and Reliability:** Modified strategy delivers the higher Earth Rotation Parameters (ERP) quality under extreme space weather conditions. On average, it yields roughly a 22% reduction in ERP bias and a 25% reduction in variability, substantially enhancing overall ERP reliability.

12.4 EXPERIMENTAL CROSS-TRACK BIAS ADJUSTMENT IN THE GOP TIME SERIES

An experimental study was carried out within the GOP time series to evaluate the impact of cross-track bias adjustments. The primary motivation for this investigation was to reduce Tz geocenter variations, a concern previously highlighted by the GRG Analysis Center (AC).

Contrary to expectations, the experimental implementation did not yield the desired improvements and instead resulted in a significant degradation of the solution stability. While the impact on the estimated Helmert translation components (Tx, Ty), the scale factor, and the pole coordinates remained negligible, the geocenter Tz component exhibited severe destabilization. In the multi-satellite solution, the standard deviation of the Tz component expanded drastically when the cross-track bias adjustment was applied.

This degradation was even more pronounced in single-satellite solutions, which experienced massive increases in both bias and standard deviation across almost all instruments, with the Hy-2C satellite showing the most significant drift.

Due to these adverse results, the current adjustment procedure cannot be operationally implemented. Moving forward, the next steps require further technical consultations with the GRG AC to verify the processing steps and to investigate whether the introduction of a priori constraints could stabilize the cross-track parameters.

13 CNES/CLS ANALYSIS CENTER (GRG)

Hugues Capdeville [(1)], Adrien Mezerette [(1)], Jean-Michel Lemoine [(2)]

[(1)] CLS, France / [(2)] CNES/GRGS, France

13.1 INTRODUCTION

CNES and CLS jointly contribute to the International DORIS Service (IDS) as an Analysis Center (GRG). DORIS data processing is carried out using the GINS/DYNAMO software package developed by CNES/GRGS.

Routine processing was maintained throughout the year 2025, with DORIS data analyzed using 3.5-day arcs for the following satellites: CryoSat-2, Saral, Jason-3, Sentinel-3A, Sentinel-3B, Sentinel-6A, HY-2C and HY-2D. Although SWOT data were routinely processed in single satellite mode, the mission is not yet included in the multi satellite solution. The GRG Analysis Center also routinely provides DORIS-only orbits for Sentinel-3A, Sentinel-3B and Sentinel-6A to the Copernicus Sentinel POD Quality Working Group (QWG).

The main activities in 2025 focused on the development of DORIS Zenith Tropospheric Delay (ZTD) products, the analysis of the impact of using GPS clock corrections as a model for the DORIS ultra-stable oscillator (USO) on station position estimation for Sentinel satellites, and the assessment of the impact of increased solar activity on Precise Orbit Determination (POD) and on the GRG IDS solutions.

13.2 DEVELOPMENT OF DORIS ZTD PRODUCTS

A major development in 2025 concerns the generation of Zenith Tropospheric Delay (ZTD) products derived from DORIS observations. In the single-satellite processing, the tropospheric delay is modeled as the sum of a hydrostatic (dry) and a wet component, mapped from zenith to the line of sight using the VMF1 mapping functions. Only the wet zenith delay parameter is estimated, while the dry component is entirely model-driven.

Contrary to GNSS processing, where ZTD parameters are typically estimated every two hours using a very large number of observations, DORIS processing relies on the concept of satellite passes of limited duration (typically range from ~8 to ~20 minutes, depending on the satellite altitude). A specific development was therefore implemented in GINS to explicitly define a DORIS pass and associate a single wet zenith delay estimate with the temporal midpoint of each pass.

Multi-satellite DORIS tropospheric products are subsequently generated by combining single-satellite solutions on an hourly basis using the DYNAMO software. The resulting ZTD time series benefit from the complementarity of the different satellite orbits, improving temporal coverage while preserving the intrinsic stability of the DORIS network.

Validation was performed through comparison with GRG GNSS ZTD solutions and with the IGS product for co-located DORIS–GNSS stations. The observed ZTD differences are typically at the millimeter level and show no significant systematic bias, demonstrating the high quality of the DORIS-derived tropospheric products. Despite the smaller number of observations compared to GNSS, DORIS ZTD products appear highly promising for long-term atmospheric monitoring, owing to the long-term stability of the DORIS ground network.

13.3 ANALYZING THE IMPACT OF GPS CLOCK AS THE MODELLED DORIS USO ON STATION POSITION ESTIMATION FOR SENTINEL SATELLITES

The DORIS Ultra-Stable Oscillators (USO) onboard Sentinel satellites are sensitive to the South Atlantic Anomaly (SAA) effect. While this sensitivity is not particularly significant for the precise orbit determination (POD) of the Sentinel-3A, Sentinel-3B, and Sentinel-6A satellites, it becomes crucial when estimating station positions. Previous studies have shown notable degradation in station position accuracy for stations located within the SAA region when using single-satellite solutions.

In 2025, the impact of modeling the DORIS ultra-stable oscillator using filtered GNSS-derived clock corrections was investigated. These corrections, provided by the CNES POD team within the framework of the IDS Working Group on Integrated Clock Correction Strategies for DORIS, are applied directly to the DORIS phase measurements at 2 GHz and 400 MHz. This approach allows a more realistic representation of onboard frequency variations, particularly during SAA crossings.

The first assessment focused on the estimated Doppler frequency bias parameters. By analyzing the master beacon station of Kourou, located within the SAA region, a clear reduction in the dispersion of the estimated frequency biases is observed when GPS clock corrections are applied (see **Figure 20**). This effect is especially pronounced for Sentinel-6A.

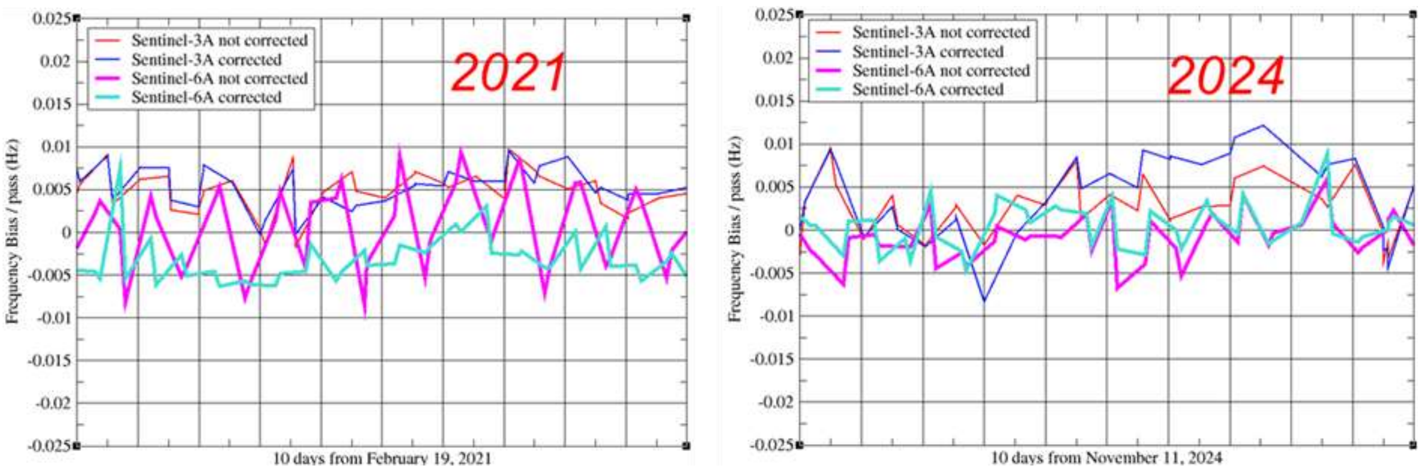

Figure 20. *Estimated frequency bias at the Kourou station, with and without GPS clock corrections.*

The impact on orbit residuals was then evaluated on a station-by-station basis. For stations located in the SAA region, the application of GPS clock corrections leads to a systematic reduction of DORIS residual RMS (see **Figure 21** and **Figure 22**, for Sentinel-6A). Although the absolute magnitude of the improvement remains moderate, the effect is spatially coherent and reproducible and confirms that GPS clock improves the consistency of DORIS observations at the measurement level.

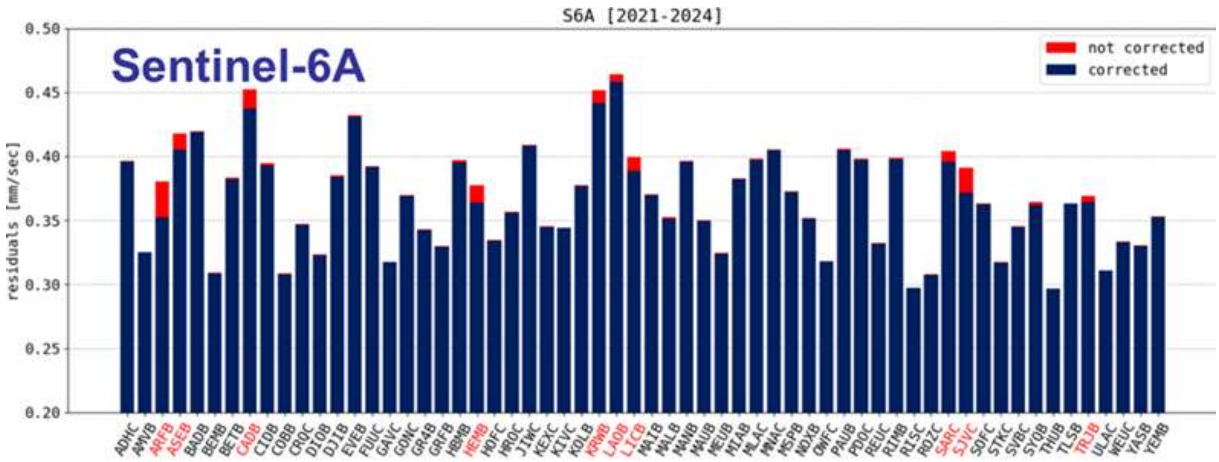

Figure 21. *Mean DORIS Doppler residuals per station for Sentinel-6A (with / without GPS clock corrections).*

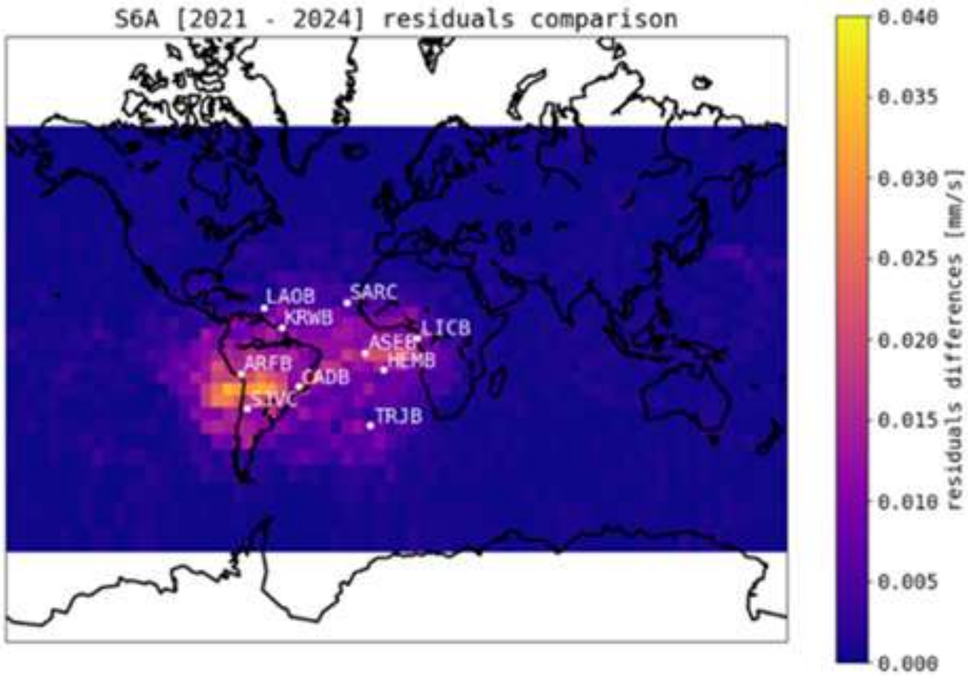

Figure 22. *Map of DORIS residual differences for Sentinel-6A highlighting SAA-affected stations.*

The most significant benefit of GPS clock corrections is observed in station position estimation. Single-satellite solutions computed with and without clock corrections for Sentinel-3A and Sentinel-6A show a clear reduction of non-physical signals in station coordinate time series when GPS clocks are applied (see **Figure 23**).

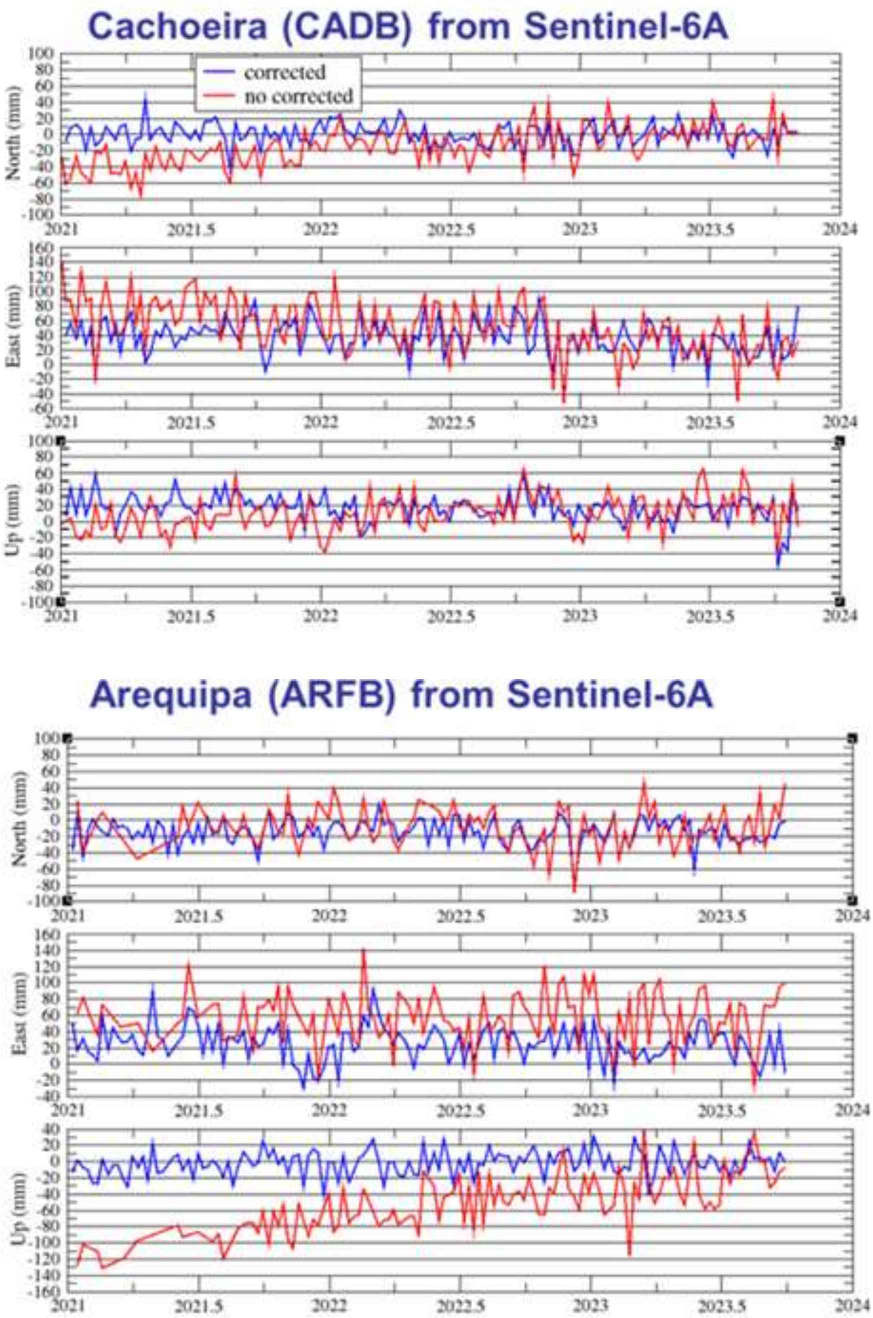

Figure 23. *Station coordinate time series for selected SAA stations (Sentinel-6A).*

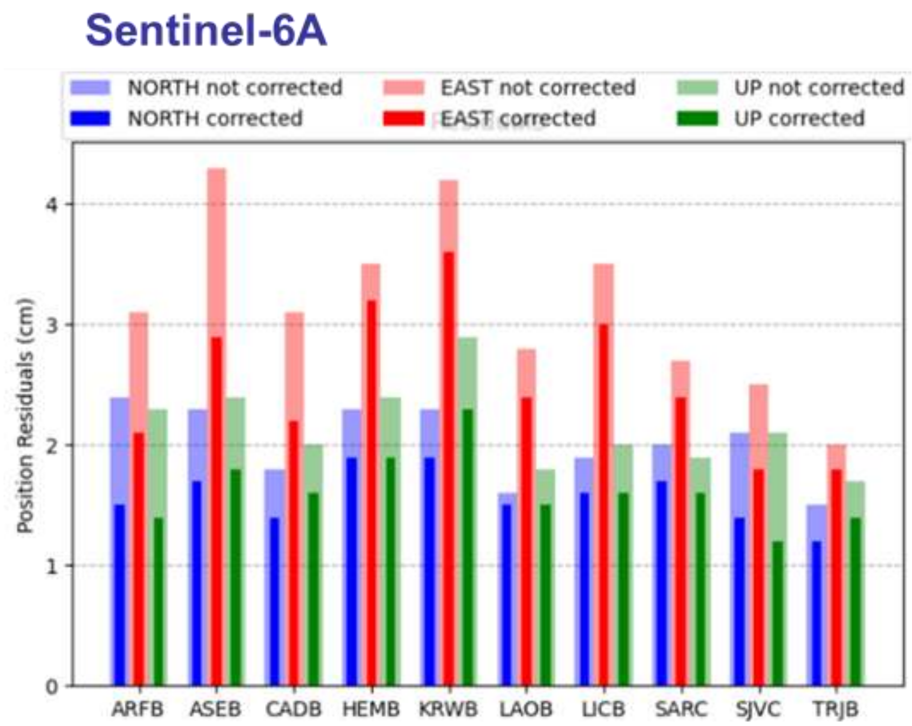

Figure 24. *Standard deviation of NEU components for SAA stations (with / without GPS clock corrections).*

After removal of long-term trends, the residual scatter of station positions is significantly reduced, particularly in the vertical component for SAA-affected stations (see **Figure 24**). This improvement is more pronounced for Sentinel-6A. Overall, these results demonstrate that GPS-derived clock corrections have a limited impact on POD performance but provide a clear and systematic improvement in DORIS station positioning, especially in regions affected by the South Atlantic Anomaly.

13.4 IMPACT OF INCREASED SOLAR ACTIVITY ON POD AND STATION POSITION ESTIMATION

The rise of solar activity starting in 2023 led to a significant increase in atmospheric density, strongly affecting low-altitude DORIS satellites. Sentinel-3A, flying at an altitude of about 800 km, shows a clear increase in empirical along-track accelerations as solar flux increases (see **Figure 25**). DORIS-only orbit quality assessments based on comparisons with external reference orbits (POE-G from CNES POD team) further confirm this behavior. For Sentinel-3A, the RMS of radial orbit differences increases during periods of high solar activity whereas Sentinel-6A shows stable agreement with external orbits, with no clear dependence on solar flux (see **Figure 26**).

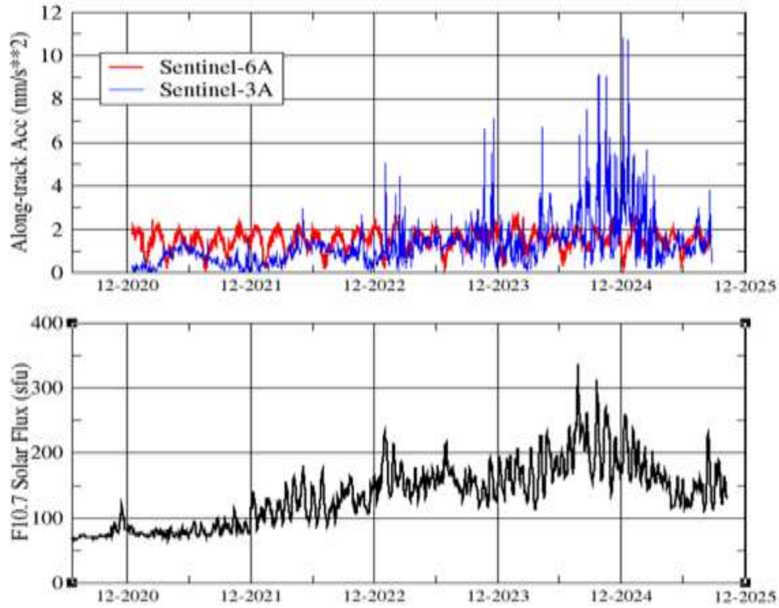

Figure 25. *Along-track OPR empirical acceleration amplitudes vs solar flux 10.7 (Sentinel-3A / Sentinel-6A).*

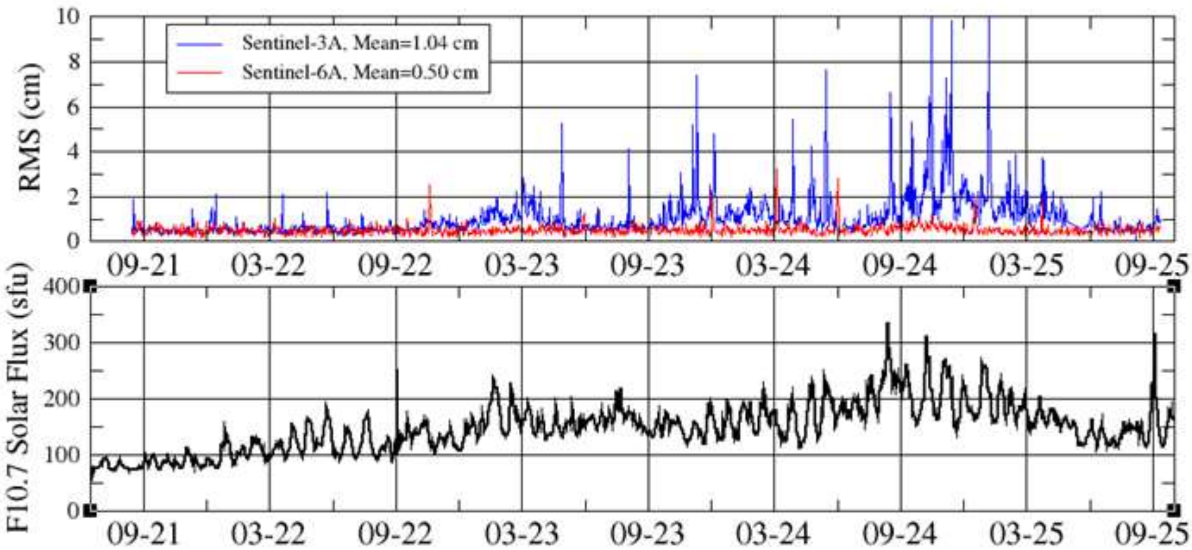

Figure 26. *RMS radial orbit differences vs solar flux 10.7 (Sentinel 3A / Sentinel-6A).*

The degradation of orbit modeling for low-altitude satellites propagates into geodetic products derived from single-satellite and multi-satellite DORIS solutions. Periods of intense solar activity are associated with increased dispersion of the scale factor and degraded station positioning performance for Sentinel-3A (see blue curve in **Figure 27**). At the multi-satellite level, the impact is partially mitigated by the contribution of higher-altitude missions, although residual signatures correlated with solar activity remain detectable.

Preliminary mitigation strategies were investigated by refining orbit parametrization, including higher-rate drag coefficient estimation and the introduction of stochastic accelerations. An experimental processing series shows improved agreement with POE-G external orbits for Sentinel-3A, as well as enhanced stability of scale factor and geocenter estimates (see **Figure 27** and **Figure 28**).

These results remain preliminary but demonstrate that advanced dynamical modeling can partially mitigate the impact of increased solar activity on DORIS-based POD and geodetic products.

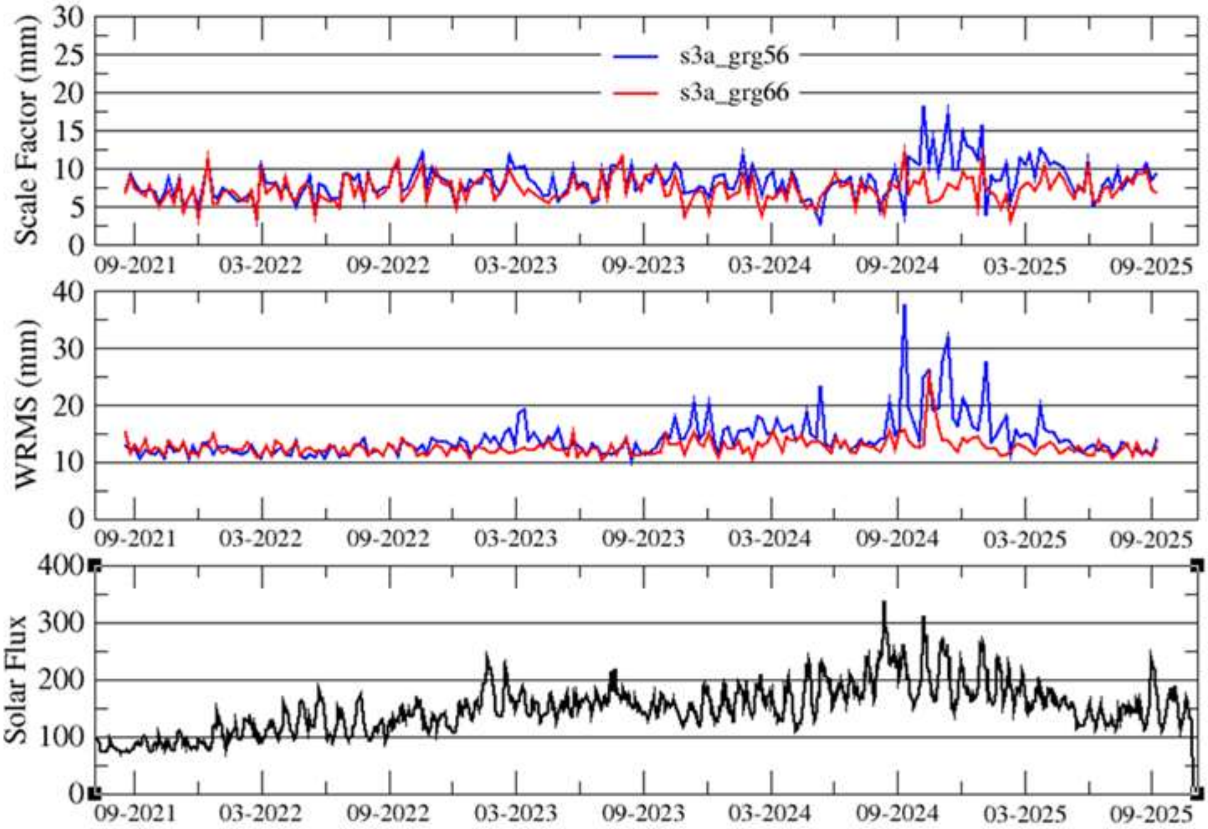

Figure 27. *Scale factor time series (Sentinel-3A) vs solar flux 10.7.*

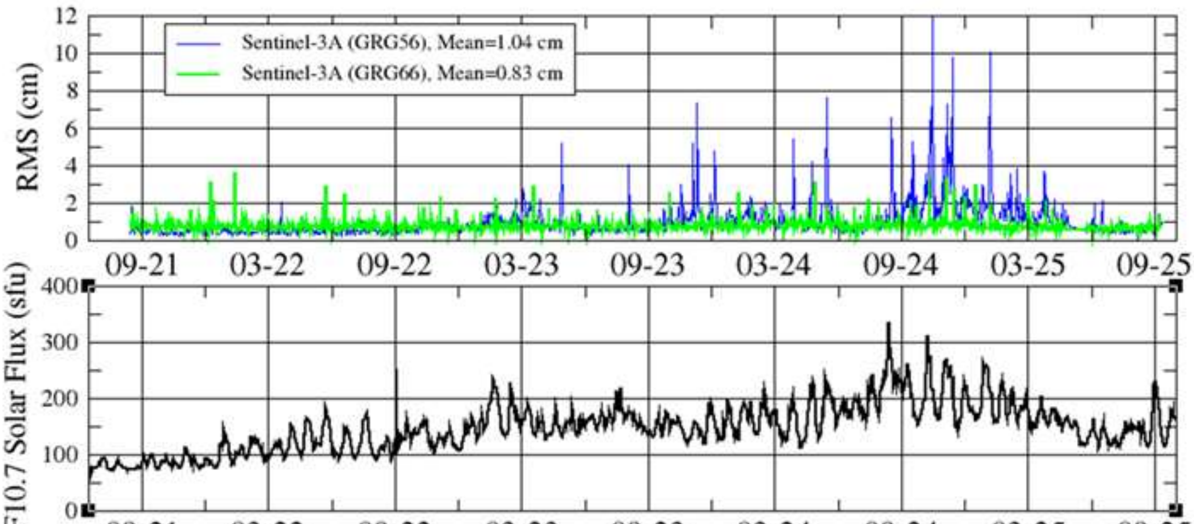

Figure 28. *RMS radial orbit differences vs solar flux 10.7 (Sentinel 3A).*

13.5 CONTRIBUTION TO IDS MEETINGS

Representatives of the GRG Analysis Center actively participated in IDS Analysis Working Group meetings and in EGU 2025. The following contributions were presented:

IDS AWG March 2025 (virtual): .

https://ids-doris.org/documents/report/AWG202503/IDSAWG202503-Capdeville-GRG.pdf

EGU 2025 May 2025 (Vienna): .

« Analyzing the Impact of GPS Clock as the modelled DORIS USO on Station Position Estimation for Sentinel Satellites” (DOI: 10.5194/egusphere-egu25-11124)

IDS AWG November 2025 (Athens): .

https://ids-doris.org/images/documents/report/AWG202511/IDSAWG202511-Capdeville-GRGreport.pdf

Additional contributions include participation in the ESA DORIS Genesis Working Group and the provision of ORBEX attitude quaternion files for HY-2C and HY-2D to the IDS community.

14 GSFC/NASA ANALYSIS CENTER (GSC)

F.G. Lemoine [(1)], D.S. Chinn [(2)], N.P. Zelensky [(2)]

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14.1 SUMMARY

The main activities of the NASA GSFC International DORIS Service (IDS) Analysis Center (AC) in 2025 consisted of (1) routine processing of DORIS data to six satellites: Cryosat-2, Jason-3, Sentinel-3A, Sentinel-3B, Sentinel-6A, and Saral; (2) delivery of the contribution to the annual update of ITRF2020-u2024 in February 2025; (3) implementing operational updates and submitting new SINEX series including gscwd60 (for the contribution to ITRF2020-u2024), and subsequently two further series gscwd61, and gscwd62; (4) in collaboration with the IDS Combination Center (Toulouse, France) and Chalmers University (Sweden), to determine a more optimum weighting of the individual satellite normal equations in the weekly combinations; (5) contributing to a IDS journal paper that describes the IDS Contribution to ITRF2020-u2024; (6) beginning to process the DORIS data to the SWOT satellite.

14.2 SINEX SERIES DESCRIPTIONS

We list in **Table 12**, the SINEX series created in 2025. All series provided weekly solutions from 2021.0 to 2025.0. The main innovation of the gscwd60 SINEX series was to update the gravity model from the GRGS_RL05 gravity model (*Lemoine J.M. et al., 2023*) to the COSTG_FSM gravity model (*Peter et al., 2022*). In addition, the low degree coefficients, C20, C21, C22, S21, S22, & C30, were replaced on a weekly basis using the SLR-based geodetic satellite solution of *Loomis et al. (2020)*. The COSTG_FSM model is developed and maintained by the Combination Service for Time-Variable Gravity Fields, a service of the International Association of Geodesy (IAG). The COSTG provides an updated gravity model on a quarterly basis that consists of a fit to GRACE-FO project solutions and other contributions. The parameterization includes mean coefficients, secular rates, and annual variations since the start of the GRACE-FO mission. The disadvantage of continuing to use the GRGS_RL05 model, is that it was determined over a finite interval of time, and degrades for precise orbit determination in extrapolation, that is when the model is applied outside the period of data that contributed to the GRGS_RL05 model. Low Earth Orbiting (LEO) satellites, like those that use DORIS, are sensitive to these types of time-variable-gravity-induced orbit errors, especially if they used a more dynamical approach to precise orbit determination (*Lemoine et al., 2026*).

In early 2025 Richard Ray (NASA GSFC) published a NASA Technical Memorandum on the GOT5.5/GOT5.6 ocean tide model (*Ray, 2025*). We decided to adopt the updated ocean tide model for our modeling to address a tidal aliasing issue found in the EOP solutions for the gscwd60 SINEX series.

Series	Description	Comment
gscwd60	SINEX series for the contribution to ITRF2020-u2024. This series used the COSTG-FSM gravity model, where the low degree terms (C_{20}, C_{21}, C_{22}, S_{21}, S_{22}, & C_{30}) were replaced using the weekly SLR-based geodetic satellite solution of Loomis et al. (2020), developed in support of GRACE & GRACE-FO. (Replaces the prior gravity model: CNES_GRGS.RL05MF_COMBINED_GRACE_SLR_DORIS)	• Deliveries started 2025-03-06 to the NASA CDDIS.
gscwd61	Same as the gscwd60 SINEX series, but adopts GOT5.5/GOT5.6 ocean tide model (Ray, 2025), replacing the prior model, GOT4.10c.	• Deliveries started 2025-08-16.
gscwd62	Same as the gscwd61 SINEX series, but the satellite weights in the weekly combinations are replaced with those determined by Le Bail et al. (2025).	• Delivered started 2025-12-03. Supersedes the prior SINEX series. Will be basis of the contribution to ITRF2020-u2025.

Table 12. *GSC DORIS SINEX solutions for 2025*

In conducting analyses of the Analysis Center contributions to ITRF2020-u2024, the IDS Combination Center (Guilhem Moreaux in Toulouse, France) had identified the presence of a 14.8-day signal in the pole series (Xpole, Ypole) of Analysis Center (AC) SINEX solutions. To investigate this issue, NASA GSFC submitted single-satellite SINEX solutions from 2021 to 2024 to the IDS Combination Center. This means we created a series of SINEX files over four years for each of the six contributing satellites that we included in the multisatellite solution for gscwd60. The IDS CC was able to determine that the spurious signal in the Earth Orientation Parameters (EOP) appeared only in the contributions from the sun-synchronous satellites (Saral, Sentinel-3A, Sentinel-3B), but not in the contributions of the other satellites (Cryosat-2, Jason-3 and Sentinel-6A). This phenomenon is likely caused by tidal aliasing of the M2 signal at 14.78 days, when parameter estimates are averaged over one solar day (*Ray, R., NASA GSFC, personal communication, 2026*). A similar effect was observed with one-day estimates of station coordinates obtained from GPS processing (*Penna and Stewart, 2003*). Therefore, for this reason, we decided to update the operational series to gscwd61, adopting the new ocean tide model GOT5.5/GOT5.6 for modeling the ocean tidal geopotential, for application of ocean loading corrections, and for the application of the tidal geocenter.

The creation of the single-satellite SINEX solutions (see above) allowed us to collaborate with Karine Le Bail (Chalmers University, Sweden). K. Le Bail had been investigating anomalies in the scale derived from the VLBI contribution to ITRF2020. *Altamimi et al. (2023)* had noticed a linear trend in the VLBI scale after ~2015, towards the end of the time series. K. Le Bail had been using CATREF, the reference frame software from IGN/France for these investigations. NASA GSFC, the IDS CC agreed to collaborate on a project to use CATREF to determine more optimum weighting for each of the individual satellites. In the gscwd60 and gscwd61 solutions, the weighting is fixed to values determined for ITRF2020. We used an ad-hoc method, the relative difference in the SLR RMS of fit, to combine SLR+DORIS arcs for each satellite. With CATREF, we could obtain a more optimum set of weights using Variance Component Estimation (VCE). K. Le Bail performed the analyses and reported the results in a poster at the IAG General Assembly 2025, in Rimini, Italy (*Le Bail et al., 2025*). We list the mean weights for the prior solutions (gscwd60, gscwd61), and as well as the CATREF-determined weights in **Table 13**. The surprising result is that in a relative sense, Jason-3 and Sentinel-6A are downweighted for the "optimum" CATREF-derived weights. In addition, the best performing satellites (in a relative sense) are Cryosat-2, and Saral, followed by the Sentinel-3A & 3B satellites. The interpretation is that if the Jason-3 and S6A contributions are not downweighted, they slightly degrade the combined solution for station coordinates and Earth Orientation parameters. There are two possible explanations: (1) an unmodelled systematic error is present in the processing for these satellites; (2) the satellite inclination and higher altitude for Jason-3 and Sentinel-6A produce more DORIS satellite passes that are at lower maximum elevation, which provide a poorer geometry for the estimation of the DORIS pass-by-pass troposphere ZTD (Zenith troposphere delay) parameters. Since ZTD estimation and station height determination are correlated, this might explain the tendency to downweight the Jason-3 and Sentinel-6A data. In our processing, we use the VMF-1 (Vienna Mapping Functions 1) to model the refraction correction for DORIS data (*Böhm and Schuh, 2004*). We could upgrade to VMF-3, which is now more commonly used in the geodetic community, however the VMF-3 model has not yet been implemented in GEODYN (*Nicholas et al., 2025*). An alternative would be to use a ray-tracing approach to determine the refraction correction for DORIS data (rather than a model such as VMF-1, or VMF-3), but that would require a major revamping of the whole processing scheme for DORIS data processing. The last column in **Table 13** provides the average weights determined by excluding the DORIS stations located in the South Atlantic Anomaly (SAA) area. The DORIS satellite Ultra Stable Oscillators (USO's) are known to be perturbed by passage through the SAA area. The effect is dependent on satellite altitude (which affects the magnitude of the radiation dose), and the degree to which the satellite USO's were annealed prior to launch. Shielding of the USO in the satellite bus that might differ by satellite, and by satellite attitude mode, can also affect the USO sensitivity to radiation as a function of time.

For the gscwd62 SINEX solution, we adopted the satellite weights from *Le Bail et al. (2025)*, shown in the third column of **Table 13**. The gscwd62 SINEX solution was delivered to the IDS Data Centers (the NASA CDDIS and the IGN Data Center in France) on December 3, 2025.

Weights	Prior weights (gscwd60, gscwd61)	CATREF	CATREF w./out SAA stations
Cryosat-2	12.755	0.810	0.861
Jason-3	13.500	0.340	0.372
Saral	17.000	0.669	0.690
Sentinel-3A	13.600	0.545	0.637
Sentinel-3B	13.700	0.500	0.616
Sentinel-6A	17.400	0.446	0.469

Table 13. *Mean weights for satellite matrices in weekly solutions*

The gscwd62 solution will be the basis for the NASA GSFC IDS (DORIS) contribution to the next annual update of ITRF2020 (ITRF2020-u2025). To evaluate the gscwd62 solution, we computed the Helmert parameters of the solution with respect to DPOD2020 (Tx, Ty, Tz, and scale), as well as the 3-D WRMS (weighted root mean square) differences between the weekly station coordinate estimates and the reference solution. The WRMS (calculated from 2021-2025.75) was 7.76 mm for gscwd61, and 7.58 mm for gscwd62. So, we are able to validate a small improvement in the 3-D repeatability of the DORIS station coordinates, by adopting a more optimum set of satellite weights.

14.3 POD SUMMARY

We summarize the POD results for the gscwd62 series in **Table 14** and **Table 15** for the RMS of fit, and the empirical accelerations, respectively. The process of data cleanup and convergence always starts with doing POD with SLR+DORIS data, so we report these results here. The DORIS-only normal equations, used to create the gscwd62 SINEX series, are created afterwards in a separate step. The RMS of fit results (**Table 14**) are unremarkable. The SLR data fits are with respect to SLRF2020, and also include adjusting an SLR bias per station per arc. It is interesting to note that Jason-3 and Sentinel-6A receive approximately the same amount of SLR data each on a weekly basis, as the combined total of data per week for LAGEOS-1 and LAGEOS-2. This means the Jason-3 and Sentinel-6A satellites would make interesting testbeds to prepare multi-technique processing for the Genesis mission.

In terms of the average levels of the empirical accelerations, the performance on the different satellites is mostly satisfactory (see **Table 15**). We note that we continue to observe that Sentinel-3B has higher amplitude of the empirical accelerations than Sentinel-3A. These SLR+DORIS results for Cryosat-2 were obtained using the nominal attitude mode (as coded in GEODYN). We note there are short periods of much higher values of the empirical accelerations, typically over an arc, sometimes over several successive arcs. Some of these are associated with solar storms, which have a profound impact on the density modelling at the Cryosat-2 altitude. However, periods of non-nominal attitude may also contribute to some of these higher empirical acceleration periods for Cryosat-2.

Satellite	First Arc	Last Arc	No of Arcs	Avg. No SLR obs	Avg. No DORIS obs	Avg. SLR fit (cm)	Avg DORIS fit* (WRMS, mm/s)
Jason-3	210103	251228	297	2029	126,843	0.664	0.3589
Sentinel-6A	210103	251228	294	2018	129,976	0.609	0.3511
Sentinel-3A	210103	260101	356	673	67,587	0.713	0.3741
Sentinel-3B	210103	260101	362	665	66,533	0.724	0.3836
Cryosat-2	210103	251228	370	727	55,900	0.950	0.3779
Saral	210103	251228	274	829	82,477	0.682	0.3581
*All arcs use elevation-dependent weighting. For simplicity DORIS WRMS is rescaled by 1/0.7 to report aggregate results by satellite.							

Table 14. Average POD *RMS of fit for the gscwd62 solutions (2021-2025).*

Satellite	First Arc	Last Arc	No of Values	Along-track Average (nm/s²)	Along-track RMS (nm/s²)	Cross-track Average (nm/s²)	Cross-track RMS (nm/s²)
Cryosat-2	210103	251228	1965	4.731	6.684	2.646	3.941
Jason-3	210103	251228	1813	0.829	0.945	1.623	2.175
Sentinel-6A	210103	251228	1853	1.779	1.963	1.735	2.261
Sentinel-3A	210103	260101	1985	0.816	1.457	1.532	2.690
Sentinel-3B	210103	260101	1966	1.217	1.591	1.584	2.423
Saral	210103	251228	1876	2.643	3.948	1.159	2.248

Table 15. *Average and RMS OPR acceleration amplitudes, along-track and cross-track for the gscwd62 solutions (2021-2025).*

In terms of the average levels of the empirical accelerations, the performance on the different satellites is mostly satisfactory (see **Table 15**). We note that we continue to observe that Sentinel-3B has higher amplitude of the empirical accelerations than Sentinel-3A. These SLR+DORIS results for Cryosat-2 were obtained using the nominal attitude mode (as coded in GEODYN). We note there are short periods of much higher values of the empirical accelerations, typically over an arc, sometimes over several successive arcs. Some of these are associated with solar storms, which have a profound impact on the density modelling at the Cryosat-2 altitude. However, periods of non-nominal attitude may also contribute to some of these higher empirical acceleration periods for Cryosat-2.

14.4 OTHER ANALYSES

The DORIS satellite constellation currently consists of ten operating satellites, including Sentinel-6B, launched in November 2025. A lacuna in our operational processing is that we have not yet initiated the processing for the HY-2C, HY-2D, and SWOT satellites, launched respectively in 2020, 2021, and 2022 respectively. In order to process these satellite data, we must first implement a satellite-specific attitude module in GEODYN for these satellites. One of the complications of DORIS processing is the heterogeneity of the satellite constellation. Every satellite is unique, frequently with its own attitude algorithm, and its own set of modelling problems, either related to the measurement model or to the non-conservative force modelling. In 2025, we started to look at SWOT DORIS data, where we used the external attitude information to model the satellite attitude. We have processed one year of SLR and DORIS data to SWOT using the body quaternions, but we still need to incorporate the proper modelling for the solar arrays. We are currently working with the NASA GSFC GEODYN team to sort out the final issues on SWOT solar array modeling. Using the body quaternions and a quasi-reduced-dynamic approach to SWOT orbit determination (*adjusting empirical once-per-revolution parameters 4x per day, along-track & cross-track to the orbit*) we have obtained satisfactory fits to the SLR & DORIS data over the test period (the year 2024).

Regular project-provided external attitude information (quaternions) is not available for the HY-2C and HY-2D satellites. We note that the GRG analysis center has provided a set of quaternions for the

HY-2C & HY-2d satellites in ORBEX format, where the attitude is defined in the GINS POD software. In 2026, we will use this information to implement an attitude model for HY-2C and HY-2D.

Another activity for 2025 consisted of contributing to a journal paper that described the IDS contribution to ITRF2020-u2024. The first version of the paper (*Moreaux et al., 2025*) was submitted to Earth's Planets and Space in the 3rd quarter of 2025.

14.5 IDS-RELATED PRESENTATIONS & PAPERS FOR GSC IN 2025

Lebail K., Lemoine F., Moreaux G., Chinn D. (2025). "Strategies for combining Mono-satellite DORIS solutions", IAG Scientific Assembly 2025, Rimini, Italy, September 1-5, 2025, (poster). . *https://ntrs.nasa.gov/citations/20250008890*

Lemoine F.G., Chinn D.S., Zelensky, N.P., Yang X. (2025). "Status of DORIS processing at GSFC", 2025 IDS Analysis Working Group Meeting (Virtual), March 24, 2025. *https://ids-doris.org/documents/report/AWG202503/IDSAWG202503-Lemoine-GSC.pdf*

Moreaux G., Lemoine F., Capdeville H., Štěpánek P., Otten M., Nahmani S., Pollet A., Schreiner P. (2025). "IDS Contribution to the Second update of the ITRF2020", EGU General Assembly 2025, Vienna, Austria, 27 Apr–2 May 2025, EGU25-12833 (presentation). *https://doi.org/10.5194/egusphere-egu25-12833*

Moreaux G., Lemoine F., Capdeville H., Štěpánek P., Pollet A., Nahmani S., Otten M. (2025). "DORIS contribution to the second yearly update of ITRF2020", Earth Planets & Space, DOI: 10.1186/s40623-026-02459-y, in review. OPEN ACCESS

Moreaux G., Lemoine F., Capdeville H., Štěpánek P., Otten M., et al. (2025). "Overview of the DORIS processing improvements for the next ITRF realization", 2025 Fall Meeting of the American Geophysical Union, New Orleans, Louisiana, December 15-19, 2025 (poster). *https://ids-doris.org/documents/report/meetings/AGU2025-IDScombination-Moreaux.pdf*

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Nicholas J.B., Rowlands D.D., Luthcke S.B. et al. (2025). “The GEODYN Precision Orbit Determination Software”. ESS Open Archive, DOI: 10.22541/essoar.174051780.04684918/v1.

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15 IGN-IPGP/JPL ANALYSIS CENTER (IGN)

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This report summarizes the activities and developments undertaken by the IGN-IPGP/JPL DORIS Analysis Center during calendar year 2025. Following the reactivation of the center in 2023 and the consolidation phase achieved in 2024, the year 2025 was devoted to three closely connected objectives: maintaining sustained operational contributions to the International DORIS Service, documenting the performance of the IGN22 configuration through independent IDS Combination Center diagnostics, and extending the scientific scope of the center toward new DORIS products and new satellite configurations, especially SWOT and tropospheric parameters.

The year also marked a transition in the role of the center. In 2024, the main effort was to stabilize the GipsyX-based processing chain and prepare the IGN22 solution. In 2025, this solution became the operational reference of the center, was submitted and evaluated within the IDS framework, and served as the basis for several methodological investigations. These activities directly supported the IDS contribution to the second yearly update of ITRF2020 and strengthened the position of the center within the broader DORIS analysis community.

15.1 OPERATIONAL CONTRIBUTION AND PROCESSING STATUS

The IGN-IPGP/JPL Analysis Center maintained regular operational production throughout 2025. A major achievement of the year was the completion and operational exploitation of the full IGN22 reprocessing over 2021.0–2024.0 for the ITRF2020-u2024 update. This reprocessing became the reference dataset for several methodological studies carried out during the year and marked the transition from the 2024 consolidation phase to a fully exploited operational configuration in 2025.

In operational terms, IGN22 remained the main series during the first part of 2025, including the first quarterly contribution associated with ITRF2020-u2024, while IGN23 was introduced subsequently from 2025.25 as an updated preprocessing branch. IGN23 corresponds to a correction in the generation of the daily SINEX files, related to the improper handling of the additional 3-hour margins on both sides of the 30-hour arcs. According to the IDS Combination Center overview of operational series up to 2025.50 (*Moreaux, 2025d*), IGN22 contributed to ITRF2020-u2024 from 2021.0 onward, and SWOT observations were included in the IGN solutions from 2025:096. The same overview confirms that the center continued to provide solutions over the 2021.0–2025.50 interval within the standard IDS framework.

The IGN22 configuration itself corresponds to the fully consolidated processing strategy prepared in late 2024 and used as the operational reference in 2025. It includes corrected tropospheric a priori modeling, updated station-specific weighting parameters, improved drag-coefficient estimation adapted to solar activity, an updated gravity field series, and the implementation of the Sentinel-6A Conrad macromodel. Its improved performance relative to the previous IGN series was subsequently documented by the IDS Combination Center evaluations conducted in 2025 (*Moreaux, 2025a,* *2025d*). In this sense, the 2025 activity combined continuity of service with the operational deployment and scientific exploitation of the most advanced processing configuration developed by the center.

15.1.1 IDS COMBINATION CENTER EVALUATION OF IGN22

Following the completion of the full IGN22 reprocessing over 2021.0–2024.0, an important component of the 2025 activity was the independent evaluation of the series by the IDS Combination Center. The dedicated assessment issued in February 2025 covered the 2021.0–2025.0 interval and included 209 weekly SINEX files over a ground network of 77 stations at 61 sites. It concluded that IGN22 showed clear improvements relative to the previous IGN series in station position residuals, formal station coordinates errors, and Earth orientation parameter differences with respect to the IERS C04 series (*Moreaux, 2025a*).

The same evaluation quantified the performance of the weekly combined IGN22 series with respect to DPOD2020 v3.1. The mean WRMS of station position residuals was 6.92 mm in North, 6.94 mm in East, and 7.56 mm in Up. The Helmert parameters of IGN22 with respect to DPOD2020 v3.1 were characterized by a mean scale offset of 6.95 mm with a standard deviation of 2.57 mm, and by mean translations of −5.57 mm in Tx, −1.66 mm in Ty, and 5.98 mm in Tz. At the same time, the IDS Combination Center noted that the IGN22 scale became more scattered from the third quarter of 2023 onward and that the Tz series still exhibited a clear annual signal with an amplitude of about 6 mm. These features remained important points of attention throughout 2025.

The broader IDS Combination Center review of operational series up to 2025.50 confirmed the same overall picture. In particular, it showed that the IGN scale became more stable from the beginning of the second quarter of 2025, although with a mean offset about 3 mm higher than before, and explicitly raised the question of a possible contribution from the addition of SWOT. The same review also indicated that the formal station coordinates errors of the IGN series remained larger than those of the other analysis centers and noted that KEZC was missing from IGN22, and therefore from the corresponding IDS combined series at that stage (*Moreaux, 2025d*).

Taken together, these evaluations provided an essential external framework for interpreting the behavior of the IGN22 series in 2025. They confirmed the progress achieved with the updated processing strategy while also identifying the main issues that continued to motivate methodological investigations, especially with regard to scale behavior, formal uncertainties, and mission-dependent effects.

15.1.2 SINGLE-SATELLITE ANALYSES

As in earlier years, the center used single-satellite solutions as a key diagnostic tool to understand the behavior of the combined series. The July 2025 IDS Combination Center single-satellite evaluation of IGN22 over 2021.0–2025.0 provided a detailed breakdown by mission (*Moreaux, 2025b*). It showed that SARAL remained the most stable mission in terms of scale standard deviation, Tz behavior, and station residual WRMS, with mean residuals of 9.60 mm in North, 12.96 mm in East, and 10.73 mm in Up. By contrast, Jason-3 and Sentinel-6A exhibited the largest residual levels, with

Jason-3 at 16.12, 18.11, and 19.18 mm in North, East, and Up, respectively, and Sentinel-6A at 17.10, 17.53, and 16.99 mm.

The same evaluation also highlighted mission-dependent signatures in the Helmert parameters. CryoSat-2 exhibited a strong 480-day signal in Tz with an amplitude of about 16–17 mm and an annual signal in scale before 2023. Jason-3 showed a clear 118-day signal and an annual signal in Tz, with amplitudes of about 22 mm and 13 mm, respectively. Sentinel-3A and Sentinel-3B showed similar Tx and Ty behavior, while Sentinel-6A displayed a large-scale drift until early 2023. These results confirm that the remaining weaknesses of the combined IGN series are not random artifacts but can be traced back to specific missions and specific dynamical or observational configurations.

A complementary September 2025 evaluation of single-satellite station residuals provided further detail on the spatial structure of these effects (*Moreaux, 2025c*). After removing South Atlantic Anomaly stations and, in some cases, high-latitude stations, Jason-3 and Sentinel-6A still showed larger residuals than the other missions. The analysis also pointed to persistent large residuals at sites such as Gavdos and Wettzell, which are known to involve frequency-shift beacons, and confirmed latitude-dependent effects in the East component for several missions. These results were essential in guiding the interpretation of the combined solutions and in defining the priorities for future work.

15.1.3 DRAG MODELING AND SCALE BEHAVIOR UNDER HIGH SOLAR ACTIVITY

The revised drag-coefficient estimation strategy introduced in 2024 remained a central topic in 2025. As already noted in the 2024 report, the increase in solar activity required a more adaptive estimation of drag coefficients, based on the F10.7 solar flux index, in order to preserve the temporal stability of terrestrial reference frame parameters and station coordinates. In 2025, this modification allowed the IGN solutions to return to a level comparable to that of the other IDS analysis centers, but at the cost of increased noise in the scale, particularly for CryoSat-2. This trade-off became one of the key scientific questions to be addressed in the following year.

15.2 NEW DEVELOPMENTS OR STUDIES

During 2025, the operational activity of the center was accompanied by several developments that directly extended the research lines opened in 2024. These developments concern the weighting of DORIS observations, the first systematic exploitation of SWOT within the IGN processing chain, the structured assessment of DORIS-derived tropospheric products, and new investigations related to terrestrial reference frame behavior and future multi-satellite processing.

15.2.1 STATION-SPECIFIC WEIGHTING OF DORIS OBSERVATIONS

The station-specific weighting effort initiated in 2024 reached a mature stage in 2025. The manuscript “Weighting DORIS measurements for space geodesy” was revised during the year and is listed in the 2025 activity inventory as accepted in Advances in Space Research. The paper compares six weighting schemes, including the new IGN AC station- and antenna-dependent model selected with the Bayesian Information Criterion, and reports improvements across nearly all processed geodetic products. Pole coordinate WRMS values are reduced by up to 30% compared with uniform weighting strategies. The manuscript also states that the IGN AC weighting strategy was adopted for the version 22 release of the IDS IGN-IPGP/JPL Analysis Center. This publication therefore represents the completion of one of the major methodological developments announced in the previous reports.

15.2.2 FIRST SYSTEMATIC SWOT PROCESSING

The integration of SWOT DORIS data was one of the most visible new developments of 2025. A key technical step was the implementation, within the center processing chain, of SWOT solar-panel quaternion files provided through IDS-related exchanges. In January 2025, IDS transmitted a new set of SWOT quaternions in the JA3 format for validation by the processing chains, with the goal of replacing the previously used netCDF products if the tests were successful. This contribution was directly relevant to the center because reliable quaternion information was necessary for sustained SWOT processing with GipsyX.

The first SWOT processing results were presented at the IDS AWG meeting in March 2025. Although some initial difficulties were encountered in the auxiliary quaternion products, a substantial part of the available period could be processed successfully. In total, 228 days were processed, of which 182 provided good orbit and observation-RMS behavior. Among the processed days, 148 showed radial RMS differences below 1 cm with respect to SSALTO, while 28 were between 1 and 1.2 cm, 6 between 1.2 and 1.5 cm, and 4 between 1.5 and 2.0 cm. For the subset of solutions with radial RMS below 1.5 cm, the median differences with respect to SSALTO were 8.5 mm in the radial direction, 2.4 cm in along-track, and 1.7 cm in cross-track.

Analyses carried out in 2025 indicate that the inclusion of SWOT in the combined solutions is associated with a measurable improvement in geodetic performance. Station coordinate WRMS is reduced by about 15% in the East and Up components and by about 25% in the North component, while the XPO and YPO series improve by about 7.5%. At the same time, the scale exhibits a limited degradation of about 0.2 ppb, tentatively attributed to the onboard antenna phase center model. Taken together, these results show that SWOT is both a clear gain for the combined solutions and a source of new scientific questions for the center. They were presented at the 2025 IAG Scientific Assembly and are reported in the corresponding proceedings paper, accepted for publication subject to minor revisions.

15.2.3 DORIS TROPOSPHERIC PRODUCTS

The assessment of DORIS-derived tropospheric products, initiated in 2024, continued in 2025 and became one of the main scientific themes of the center. The study focused on the internal consistency of zenith wet delay estimates derived from the IGN-IPGP/JPL processing strategy. A comparison between solutions in which station coordinates were constrained to their a priori values and solutions in which station coordinates were estimated more freely showed that ZWD estimates are highly robust to the station-constraint strategy, with a median absolute difference of 2.86 mm and negligible global bias. Day-to-day overlap statistics further indicated median absolute inter-day differences of 3.2 mm for the constrained solution and 4.2 mm for the weaker constrained solution. Inter-satellite diagnostics showed that mono-satellite ZWD estimates are generally consistent at the millimeter-to-centimeter level, with the largest improvement obtained when the number of simultaneously visible satellites increases from two to three. At this stage, the analysis remains internal and does not yet rely on external reference products.

This work gave rise to one of the center’s direct scientific contributions to the 2025 IAG Scientific Assembly, through the proceedings paper Assessing the quality of DORIS tropospheric products: Insights from the IDS IGN-IPGP/JPL analysis center for ITRF2020-u2024, accepted for publication subject to minor revisions. More broadly, the methodological work carried out in 2025 also helped establish the scientific basis for the IDS Working Group on Tropospheric Products, whose initial scope was to be introduced at the 2026 IDS Workshop.

15.2.4 CONTRIBUTION TO TERRESTRIAL REFERENCE FRAME STUDIES

The center’s contribution to terrestrial reference frame activities in 2025 had two main components. First, the IGN22 weekly solutions contributed directly to the IDS submission for ITRF2020-u2024. Second, members of the center contributed to studies aimed at interpreting the terrestrial reference frame behavior of DORIS solutions. In this context, the paper DORIS contribution to the second yearly update of the ITRF2020, co-authored by members of the center and accepted for publication in Earth, Planets and Space subject to minor corrections, reports that over 2021.0–2025.0 the IDS 25 scale remains within ±2.5 mm with a trend of −0.10 mm/yr, that the internal consistency of station positions is better than 6 mm in North, East, and Up, and that the x- and y-pole series agree with IERS C04 at the level of about 200 µas.

In parallel, members of the center contributed in 2025 to the preparation of a dedicated study comparing the DTRF2020, ITRF2020, and JTRF2020 realizations from the perspective of the DORIS technique. Although part of the underlying analyses had already been carried out earlier, the study was consolidated and written up during 2025. Beyond the collective analysis of IDS-derived geocenter, scale, and station-position behavior, the IGN-IPGP/JPL Analysis Center had contributed an independent evaluation of the impact of the terrestrial reference frame on DORIS precise orbit determination for six satellites over 2019.0–2020.0 using GipsyX. The results showed that the differences between the tested reference frames remain very small from the point of view of Doppler residuals and orbit determination. Before Helmert correction, ITRF2020 tended to yield slightly lower RMS values in the radial, cross-track, and along-track components, although the observed differences remained limited. After removing global frame-related effects, these differences became even smaller, with no statistically significant superiority of one frame over the others, except for a slight advantage of ITRF2020 in the radial component. Overall, the study shows that the three TRF2020 realizations are highly consistent from the DORIS point of view, while supporting the use of ITRF2020 as the reference solution for future IDS products.

15.3 INTERNATIONAL COLLABORATIONS

The collaboration with JPL remained scientifically essential in 2025. As highlighted in the previous activity report, Willy Bertiger's support continued to play an important role in the refinement of the GipsyX-based DORIS processing strategy. This continuity was reflected in several major 2025 activities, including the weighting study, the SWOT developments, and the preparation of more integrated multi-satellite processing strategies. Although exchanges were temporarily affected at the beginning of the year by the consequences of the Pasadena fires, active collaboration resumed from April 2025 onward.

The interaction with the IDS Combination Center also remained central in 2025. In his role as coordinator of the IDS combination activities, Guilhem Moreaux provided several independent evaluations of the IGN solutions throughout the year. These diagnostics played an important role in guiding the center's investigations, particularly with regard to scale variability, formal station errors, mission-dependent signatures, and the interpretation of the IGN22 and IGN23 series.

The center also continued its collaboration with the team of Maria Tsakiri at NTUA. The 2026 technical proposal shows that this cooperation now extends beyond software development toward European structuring activities, including the 2025 Grow Wide proposal under the Horizon Europe WIDERA framework. Although not central to the operational IDS activity, this collaboration is relevant to the long-term strengthening of DORIS analysis capabilities in Europe and therefore deserves brief mention in the annual report.

15.4 CONTRIBUTION TO MEETINGS

The IGN-IPGP/JPL Analysis Center maintained a strong presence in the main IDS- and geodesy-related scientific meetings throughout 2025. Its direct contributions covered three complementary dimensions: reporting on the status and developments of the center, presenting new scientific results, and contributing to training and knowledge transfer within the IDS community. These activities included presentations at the DORIS Analysis Working Group, participation in EGU 2025, scientific contributions to the IAG Scientific Assembly 2025, and teaching contributions to the 2025 DORIS Days.

A first set of contributions focused on the status of the center and its ongoing methodological developments. These were presented at the DORIS Analysis Working Group in March 2025, at EGU 2025 through the contribution DORIS IGN-IPGP/JPL Analysis Center: Current status and future developments, and again at the IDS Analysis Working Group meeting in Athens in November 2025. Together, these presentations documented the evolution of the IGN processing strategy, the integration of SWOT, and the center's broader scientific directions.

A second component of the center's meeting activity concerned scientific dissemination through conference contributions more specifically focused on geodetic results. In particular, the center contributed to the IAG Scientific Assembly 2025 through presentations associated with its work on SWOT and on DORIS tropospheric products, both of which later gave rise to proceedings papers accepted for publication subject to minor revisions. Members of the center also contributed to broader IDS-related outputs, including the collective EGU 2025 contribution on the IDS participation in the second update of ITRF2020. These contributions reflect the integration of the center's work within the wider scientific dynamics of the IDS and of the geodetic community.

A particular mention should be made of the 2025 DORIS Days, to which the center contributed through dedicated lectures on atmospheric effects and positioning. Beyond their immediate training value, these contributions also supported a broader capacity-building effort within the IDS community, by strengthening the transmission of expertise, fostering skills development, and contributing to the long-term resilience of the geodetic infrastructure. In that sense, the 2025 edition provided not only an excellent framework for technical dissemination and community visibility, but also a concrete contribution to the wider international objective of sustaining geodetic capacity. The associated training material is available through the IDS portal.

15.5 SCIENTIFIC OUTPUT AS OF 31 DECEMBER 2025

As of 31 December 2025, the scientific output directly related to the activities of the center included one peer-reviewed article accepted in Advances in Space Research, two proceedings papers associated with the 2025 IAG Scientific Assembly accepted for publication subject to minor revisions, one submitted collective article on the DORIS contribution to the second yearly update of ITRF2020, and one submitted study on the DTRF2020, ITRF2020, and JTRF2020 solutions for the IERS Technical Note series. Together, these outputs illustrate the close link between the center's operational activity, its methodological developments, and its contribution to broader IDS and terrestrial reference frame studies.

15.6 FUTURE DEVELOPMENTS OR STUDIES

The developments planned for 2026 follow directly from the scientific and operational results obtained in 2025. The center will continue to provide regular mono-satellite and multi-satellite solutions to the IDS Combination Center and to contribute to the next yearly update of ITRF2020. A first scientific axis concerns the one-year reprocessing for the ITRF2020-u2025 update and the continued evaluation of the impact of incorporating SWOT observations into the IGN solutions. A second axis concerns the continuation of the first length-of-day experiments initiated in late 2025, with comparison against the IERS C04 series. A third axis concerns the further development of more integrated multi-satellite processing strategies in GipsyX, together with improved handling of South Atlantic Anomaly effects. A fourth axis is the launch of the IDS Working Group on Tropospheric Products, with an initial focus on DORIS-derived ZWD estimates and on the coordinated documentation, comparison, and assessment of contributed products across participating analysis centers.

Additional priorities include a dedicated CryoSat-2 study focused on scale instability under high solar activity, continued development of daily multi-satellite processing under GipsyX, and an assessment of the impact of onboard antenna phase center offsets on DORIS-derived products. More broadly, ongoing work on the sensitivity of DORIS precise orbit determination to Earth orientation information and to tropospheric modeling choices extends the 2025 investigations in directions fully consistent with the mission of the center.

15.7 ACKNOWLEDGMENTS

The authors gratefully acknowledge the International DORIS Service (IDS), and in particular the IDS Central Bureau and the IDS Combination Center, for their continuous support and for the independent evaluations that helped guide several aspects of the center's work throughout 2025. We are especially grateful to Guilhem Moreaux for the care and consistency of the IDS Combination Center diagnostics, which proved particularly valuable in interpreting the behavior of the IGN series and in prioritizing methodological investigations. We also warmly thank Willy Bertiger for his continued support on the use and refinement of the GipsyX-based DORIS processing strategy, and Laurent Soudarin for providing the SWOT quaternion products that made their implementation in our processing chain possible. Finally, we would like to acknowledge the organizers of the 2025 DORIS Days for a particularly successful edition, which provided an excellent framework for training, technical exchange, and capacity building within the IDS community.

This project was financially supported by CNES as an application of the DORIS_CAII project.

15.8 SCIENTIFIC OUTPUT AND SUPPORTING DOCUMENTS

Pollet, A., Nahmani, S., Rebischung, P., & Bertiger, W. (2025). Weighting DORIS measurements for space geodesy. Advances in Space Research. Accepted for publication. DOI: *https://doi.org/10.1016/j.asr.2025.11.114*

Moreaux G., Lemoine F., Capdeville H., Štěpánek P., Pollet A., Nahmani S., Otten M. (2025). "DORIS contribution to the second yearly update of ITRF2020", Earth Planets & Space, DOI: 10.1186/s40623-026-02459-y, in review. OPEN ACCESS

Moreaux, G., Capdeville, H., Pollet, A., & Nahmani, S. (2025). DORIS assessment of the DTRF2020, ITRF2020 and JTRF2020 solutions. Submitted to the IERS Technical Note series.

EGU 2025

Moreaux, G., Lemoine, F., Capdeville, H., Štěpánek, P., Otten, M., Nahmani, S., Pollet, A., & Schreiner, P. (2025). IDS contribution to the second update of the ITRF2020. EGU General Assembly 2025, Vienna, Austria, 27 April–2 May 2025, EGU25-12833. DOI: *https://doi.org/10.5194/egusphere-egu25-12833*.

Pollet, A., Nahmani, S., & Bertiger, W. (2025). DORIS IGN-IPGP/JPL Analysis Center: Current status and future developments. EGU General Assembly 2025, EGU25-15635. DOI: *https://doi.org/10.5194/egusphere-egu25-15635*.

IAG Scientific Assembly 2025

Nahmani, S., Pollet, A., & Bertiger, W. I. (2025). Assessing the quality of DORIS tropospheric products: Insights from the IDS IGN-IPGP/JPL analysis center for ITRF2020-u2024. Accepted for publication, subject to minor revisions, in the proceedings of the 2025 IAG Scientific Assembly, Rimini, Italy, 1–5 September 2025.

Pollet, A., Nahmani, S., & Bertiger, W. I. (2025). First assessment of SWOT DORIS data by the IDS IGN-IPGP/JPL Analysis Center. Accepted for publication, subject to minor revisions, in the proceedings of the 2025 IAG Scientific Assembly, Rimini, Italy, 1–5 September 2025.

IDS Analysis Working Group and related IDS meetings

Nahmani, S., Pollet, A., & Bertiger, W. (2025, March 24). Status of the IGN-IPGP AC in 2025. DORIS Analysis Working Group Meeting. *https://ids-doris.org/documents/report/AWG202503/IDSAWG202503-Nahmani-IGN22solution.pdf*

Pollet, A., Nahmani, S., & Bertiger, W. (2025, March 24). SWOT first results. IDS Analysis Working Group Meeting. *https://ids-doris.org/documents/report/AWG202503/IDSAWG202503-Pollet-ProcessingSWOT.pdf*

Pollet, A., Nahmani, S., & Bertiger, W. (2025, November 6–7). Status of the IGN-IPGP/JPL Analysis Center. DORIS Analysis Working Group Meeting, Athens, Greece. *https://ids-doris.org/documents/report/AWG202511/IDSAWG202511-Pollet-IGN_IPGPstatus.pdf*

DORIS Days 2025

Nahmani, S. (2025, November 5). Atmospheric Effects. DORIS Days 2025. DOI: *https://doi.org/10.24400/312072/i05-2025.001*.

Pollet, A. (2025, November 5). Positioning. DORIS Days 2025. DOI: *https://doi.org/10.24400/312072/i05-2025.001*.

IDS Combination Center evaluations and supporting internal documents

Moreaux, G. (2025a, February 18). Evaluation of the IGN22 series by the IDS Combination Center. Internal IDS Combination Center presentation.

Moreaux, G. (2025b, July 17). IGN22 single-satellite solutions: Evaluation (Version 2.0). Internal IDS Combination Center presentation.

Moreaux, G. (2025c, September 5). IGN22 single-satellite solutions: Station position residuals and EOPs. Internal IDS Combination Center presentation.

Moreaux, G. (2025d, October 1). Evaluation of operational series up to 2025.50. Internal IDS Combination Center presentation.

16 INASAN ANALYSIS CENTER (INA)

Sergey Kuzin / Institute of Astronomy RAS, Russia

16.1 MAIN ACTIVITIES

In 2025, INASAN (ina) DORIS Analysis Center (AC) performed the activities listed hereafter:

- The orbits of six DORIS satellites were determined over a three-year time interval from 2022.0 to 2025.0;
- Calculations were performed for the Cryosat-2, Jason-3, Saral, Sentinel-3A, Sentinel-3B and Sentinel-6A satellites based on DORIS RINEX measurement processing;
- The orbit determination accuracy was assessed both by internal convergence and by comparison with orbits obtained by other DORIS data analysis centers.

16.2 MAIN MODELS

The main models and parameters used for processing are:

- Earth gravitational field - goco02s.t2.all;
- cutoff angle – 10 degrees;
- tropospheric model - GMF (Global Mapping Function);
- ionospheric correction;
- quaternions for Jason3 only;
- phase center corrections both satellite and ground stations antennas;
- de-aliasing model AOD1B RL06 by GFZ has been applied in DORIS/RINEX data processing;
- the current satellite macromodels were used for processing (https://ids-doris.org/documents/BC/satellites/DORISSatellitesModels.pdf);
- a priori stations coordinates - DPOD2020 (version 031) (Doris Precise Orbit Determination 2020).

16.3 RESULTS OF INTERNAL ORBIT COMPARISON

16.3.1 DORIS POST-FIT RESIDUALS FOR INVESTIGATED SATELLITES

Post-fit residuals for six investigated satellites are given in **Figure 29**. **Table 16** summarizes the single-satellite processing results. They show that the RMS errors in determining the radial velocity between the transmitters and receivers of the DORIS system vary within the range of 0.35 mm/s - 0.40 mm/s. These error values are very close to those obtained by other DORIS data analysis centers (*https://ids-doris.org/resources/presentations/ids-meetings.html/ids-awg-03-2025*). At the same time, **Figure 29** shows that the RMS errors of the Jason3 satellite have pronounced periodic increases in errors of about 20 percent. These "jumps" in errors are a consequence of increased errors in determining the orbits of the Jason3 satellite compared to other satellites. The source of these errors is unknown to the author at the time of writing, and additional research is needed to clarify this phenomenon.

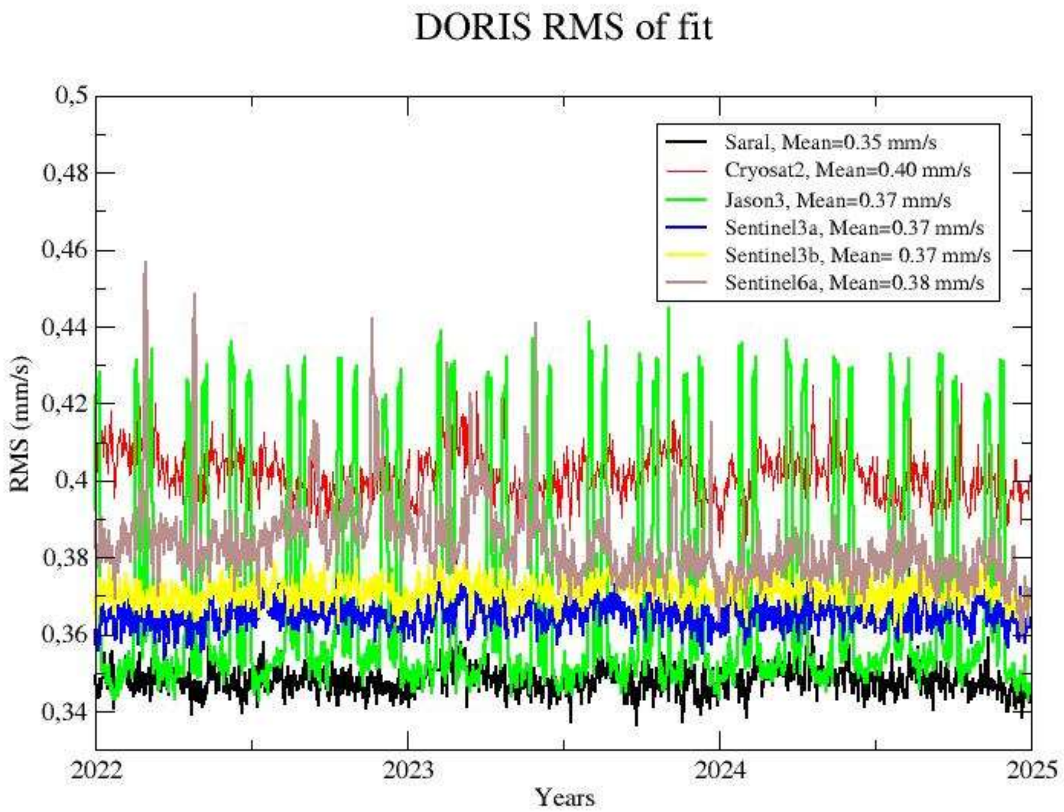

Figure 29. *DORIS RMS of fit for Saral, Cryosat2, Jason3, Sentinel3a, Sentinel3b and Sentinel6a satellites for 2022.0-2025.0.*

Satellite	Mean post-fit RMS (mm/s)
Saral	0.35±0.01
Cryosat-2	0.40±0.01
Jason-3	0.37±0.03
Sentinel-3a	0.37±0.01
Sentinel-3b	0.37±0.01
Sentinel-6a	0.38±0.01

Table 16*. Single-satellite processing results*

16.3.2 COMPARISON OF THE RMS ERRORS OF ORBITAL OVERLAP BETWEEN ADJACENT DAYS

Using the GIPSY-OASIS II software package, orbits are calculated not over a daily interval, but over a slightly extended interval of 30 hours, including a 3-hour orbit overlap with the previous day and a 3-hour overlap with the following day. This 6-hour orbit overlap allows us to evaluate the accuracy of orbital solutions. **Figure 30** shows the RMS errors of the orbit overlap for the Saral satellite over a three-year interval of 2022.0-2025.0. The errors are given in the HCL coordinate system. The HCL system is a system of rectangular coordinates whose origin is located at the satellite's center of mass and rotates with the satellite. The H coordinate is directed toward the center of the Earth, and the C coordinate is directed transversely to the satellite's motion. The direction of the C coordinate coincides with the direction of the satellite's velocity. For other studied satellites, the residual error curves have a similar nature, but with their own error values. The results of estimating the errors of orbital overlap between adjacent days for all studied satellites are presented in **Table 17**. It shows that the errors of the altitude components of orbital overlap vary within the range of 1.97 cm - 3.41 cm, the transverse components within the range of 4.90 cm - 7.71 cm, and the longitudinal components within the range of 3.19 cm - 5.26 cm. The orbital overlap errors of the longitudinal (5.26 cm) and transverse (7.71 cm) components have maximum values for the Jason3 satellite. The minimum error value in the altitude component (1.97 cm) is typical for the Saral satellite.

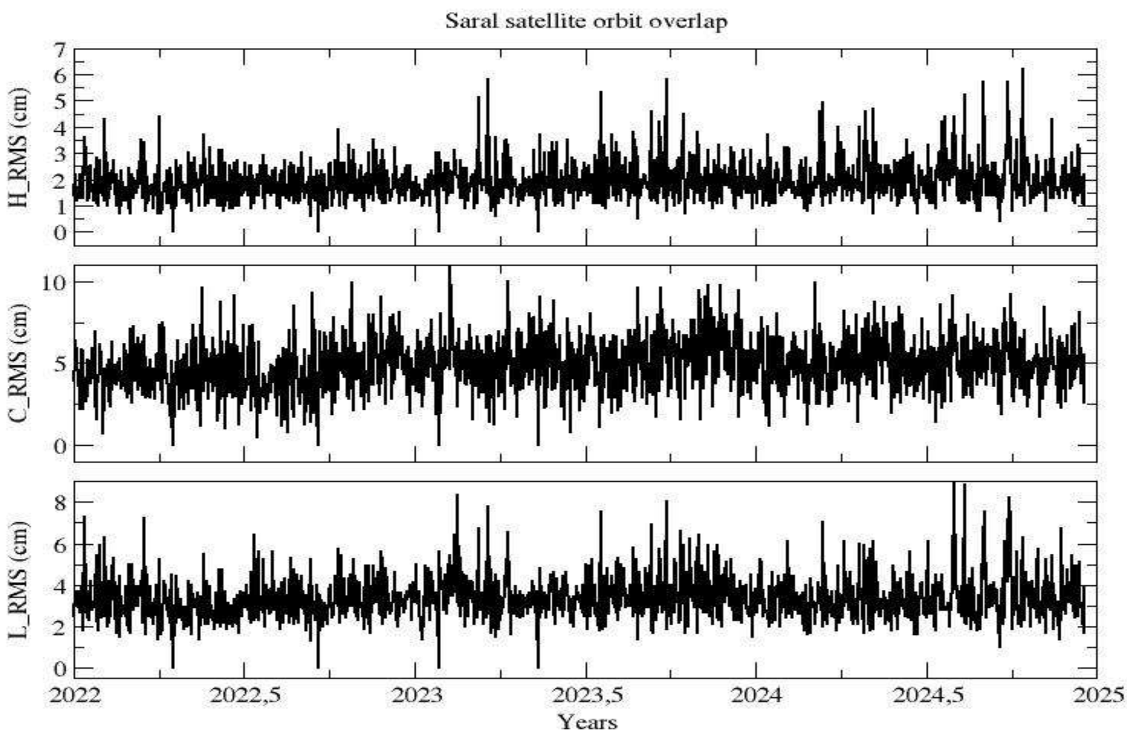

Figure 30. *RMS errors in determining the orbital overlap between adjacent days of the Saral satellite for 2022.0-2025.0.*

Satellite	RMS of fit (cm)		
	H	C	L
Cryosat-2	2.14±1.35	5.37±2.58	3.19±1.52
Jason-3	2.15±2.50	7.71±10.48	5.26±4.44
Saral	1.97±0.94	4.90±1.72	3.36±1.16
Sentinel-3a	3.41±1.70	7.24±2.79	5.15±2.01
Sentinel-3b	3.35±1.67	7.15±2.76	5.02±2.00
Sentinel-6a	3.35±1.67	7.16±2.76	5.04±2.04

***Table 17**. RMS errors of orbital overlap between adjacent days for the satellites studied for 2022.0-2025.0.*

16.4 RESULTS OF EXTERNAL COMPARISON OF ORBITS

For comparison with orbits obtained by other DORIS measurement analysis centers, the POE-F (Precise Orbit Ephemerides version F) orbits of the CNES-SSALTO/POD analysis center (France) (*ftp://ftp.ids-doris.org/pub/ids/data/POD_configuration_POEF.pdf*) were used. These orbits are supplied to users in sp3 format and are available to all interested users on the website *https://cddis.nasa.gov/archive/doris/products/orbits/ssa/*.

Currently, these orbits are "reference" orbits, obtained using the latest high-precision processing models and recommended for use and comparison by all DORIS measurement analysis centers. The orbits obtained during processing of the six aforementioned DORIS satellites were compared with the POE-F orbits over a three-year time interval from 2022.0 to 2025.0. **Figure 31** shows the comparison curves of the average daily orbit errors and the average daily orbit difference for the Saral satellite over the time interval from 2022.0 to 2025.0. The obtained values are expressed in the HCL coordinate system described in the previous section. For the other satellites under study, the comparison curves of the orbit errors and differences are similar in nature, but with their own numerical values. **Table 18** shows the numerical values of the external orbit comparison. Analysis of the obtained results shows that the average values of the altitude components of the orbit comparison errors for five satellites (Cryosat2, Saral, Sentinel3a, Sentinel3b, Sentinel6) vary within the range of 1.30 cm (Sentinel6a) - 2.55 cm (Sentinel3a, Sentinel3b). These values of the altitude component errors are at a level comparable with the errors obtained by other DORIS data analysis centers, which vary within 1-2 cm for different satellites (see the presentations from the AWG meeting in March 2025: *https://ids-doris.org/resources/presentations/ids-meetings.html/ids-awg-03-2025*). Errors of other analysis centers are also given in comparison with the POE-F orbits. The comparison errors of the transverse components vary within the range of 3.48 cm - 9.30 cm, for the longitudinal components 3.37 cm - 36.25 cm. The Jason3 satellite has increased error values (more than 3 times) compared to other satellites. The reason for this increase in errors, as noted earlier, is currently unknown to the author of the article and requires additional research. The values of simple average daily differences in orbit comparison vary within the range of -2.62 mm - 2.43 mm for altitude components, -5.76 mm - 4.13 mm for transverse components and -28.01 - 19.93 mm for longitudinal components. Moreover, the errors of the simple difference of orbit comparison for some components can significantly exceed the values of the differences themselves (more than 3 times). HY2C, HY2D and SWOT satellites are being processed in test mode.

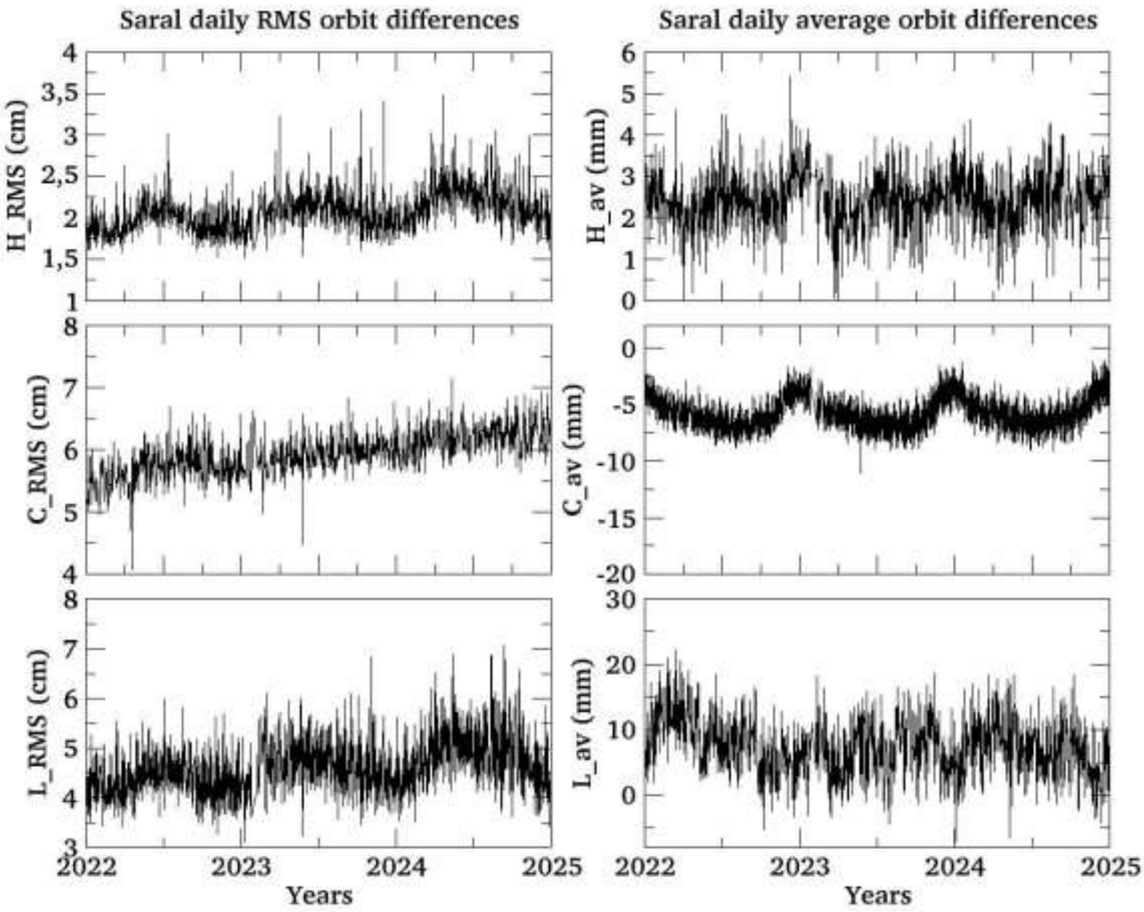

Figure 31. *Average daily errors and differences in the comparison of the Saral satellite orbits relative to the POE-F orbits for the time interval 2022.0-2025.0.*

Satellite	Residuals, cm			Daily average, mm		
	H	C	L	H	C	L
Cryosat-2	1.87±0.51	7.11±0.72	5.04±0.67	0.88±1.27	0.39±1.92	-0.28±5.40
Jason-3	9.66±15.56	9.30±11.92	36.26±59.49	-0.90±3.51	-0.28±10.93	-19.48±56.90
Saral	2.07±0.26	5.93±0.34	4.62±0.61	2.43±0.75	5.76±1.70	7.36±4.68
Sentinel-3A	2.55±0.43	6.50±0.51	5.62±0.76	2.20±1.30	3.71±2.16	19.93±7.80
Sentinel-3B	2.55±0.44	6.48±0.59	5.58±0.71	2.34±1.41	4.13±2.01	17.45±7.25
Sentinel-6A	1.30±0.20	3.48±0.77	3.37±0.50	0.56±0.74	0.96±6.93	-2.22±6.33

***Table 18**. Average daily errors and differences in the comparison of the orbits of the studied satellites relative to the POE-F orbits on the time interval 2022.0-2025.0.*

16.5 KEY FUTURE STEPS

In 2026, the INASAN DORIS Analysis Center plans to work on

- the development of a robust multi-satellite solution;
- the implementation of a new gravitational field model;
- resolving data processing issues related to the Jason-3 satellite;
- robust processing of data from the HY2C, HY2D, and SWOT satellites;
- the use of quaternions from Cryosat-2, Sentinel-3A, Sentinel-3B, and Sentinel-6A.

17 DGFI-TUM ASSOCIATE ANALYSIS CENTER

Julian Zeitlhöfler [1], Mathis Bloßfeld [1], Sergei Rudenko [1,2], and Miriam Baumgartner [1]

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[2] Present address: Geodetic Institute, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

17.1 INTRODUCTION

The activities of the DGFI-TUM Associate Analysis Center (ACC) of the International DORIS Service (IDS) included in 2025:

- Further enhancement of DOGS-OC (DGFI-TUM Orbit and Geodetic parameter estimation Software – Orbit Computation) used for precise orbit determination (POD) with SLR and DORIS observations,
- Studies on relative weighting between SLR and DORIS observations in combined POD,
- Generation and analysis of time series of SLR and DORIS station coordinates for 1992–2025 using ITRS 2020 realizations and their updates,
- Tests of ITRS 2020 realizations and their updates for POD of altimetry satellites,
- A review of Earth's mean time-variable gravity field models developed in 2000–2023 and investigation of their impact on POD of altimetry satellites (*Rudenko et al., 2026*).

17.2 FURTHER DEVELOPMENT OF THE POD SOFTWARE

In 2025, the use of the following models and improvements were carried out in DOGS-OC:

- Further improvement of processing DORIS observations,
- Progress in implementing state-of-the-art tropospheric delay modeling (e.g., Vienna Mapping Functions 3),
- Revision of atmospheric drag modeling in DOGS-OC,
- Implementation of Sentinel-3A/B platforms in the POD software,
- An update of satellite-specific information (satellite mass, maneuver and nominal attitude) for nine active DORIS satellites,
- Implementation of xTRF2020-u20XX updates in the SINEX interface.

The status of DORIS-based POD of altimetry satellite processed at DGFI-TUM is shown in **Figure 32**. The average of arc-wise observation residuals RMS values improves from the TOPEX/Poseidon mission with 0.49 mm/s to Jason-2 with 0.36 mm/s. More recent missions (Jason-3 and Sentinel-6A) have slightly larger RMS values which are most likely related to the influence of the radiation on the onboard ultra stable oscillator in the South Atlantic Anomaly region. The number of observations per arc increases by a factor of three from TOPEX/Poseidon (single-channel onboard instrument) to the missions since Jason-2 (seven channels).

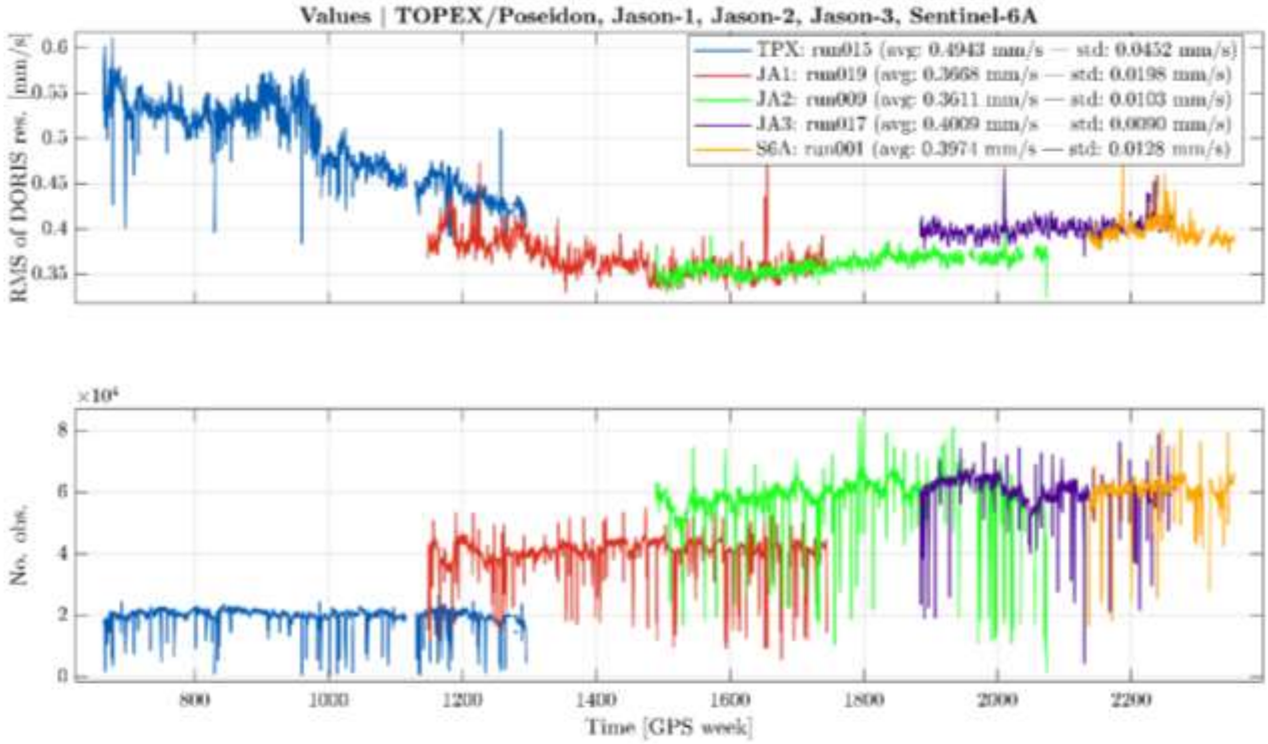

Figure 32. *RMS of observation residuals (top panel) and number of DORIS observations (bottom panel) per arc for altimetry mission computed at DGFI-TUM.*

17.3 COMPARISON OF DORIS STATION COORDINATE TIME SERIES

We have analyzed time series of DORIS station coordinates computed based on the following Terrestrial Reference Frame (TRF) realizations: DTRF2020 (*Seitz et al., 2026*), ITRF2020 (*Altamimi et al., 2023*), JTRF2020 (*Gross et al., 2023*), their first updates DTRF2020-u2023 (*Seitz et al., 2025*), ITRF2020-u2023 (*Altamimi et al., 2023*), JTRF2020-u2022 (*Gross et al., 2023*), as well as DPOD2020 (version 4.1, *Moreaux et al., 2023*). The time series were computed by applying velocities for secular TRFs (DPOD2020, DTRF2020, ITRF2020, and their updates). In addition, periodic functions based on annual and semi-annual signals in the center-of-mass (CM) frame and post-seismic deformation (PSD) corrections were applied for DPOD2020, ITRF2020, and its update. For DTRF2020 and its update, time series for CM atmospheric, oceanic, and hydrological non-tidal loading corrections available from Global Geophysical Fluids Center, as well as PSD corrections were applied. For the epoch-wise JTRF2020 and its update, daily values of station positions were used. **Figures 33, 34, 35, 36** and **37** illustrate different cases of good agreement, as well as different modeling of station coordinate time series in various TRFs. More results are provided in *Rudenko et al. (in preparation)*. The color legend is the same in all these figures and explained in **Figure 33**. The epochs colored in grey are outside the validity interval (as provided by each TRF).

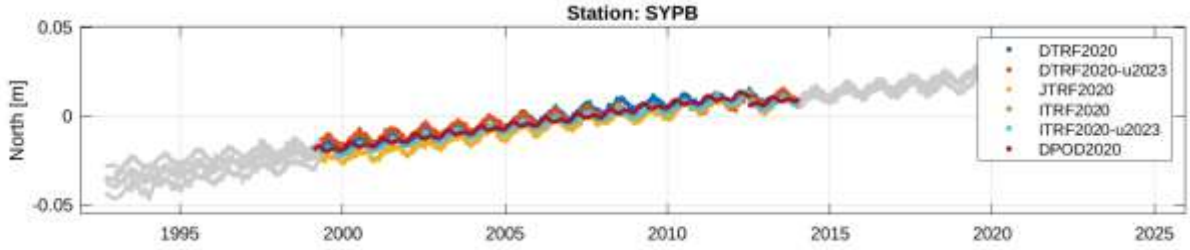

***Figure 33**. North component of the coordinate time series of DORIS station SYPB (Syowa, Antarctica).*

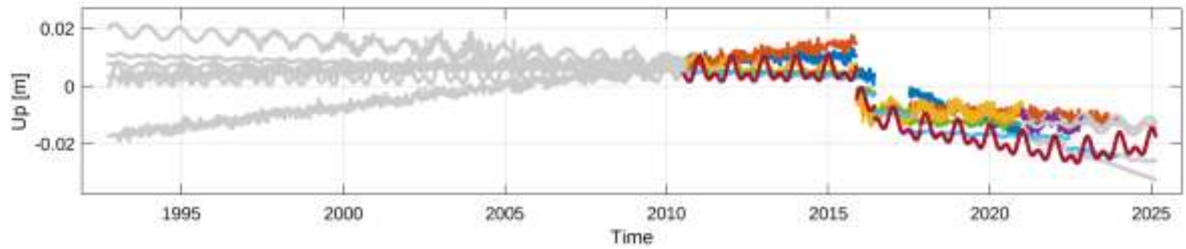

***Figure 34.** Up component of the coordinate time series of DORIS station ASEB (Ascension, United Kingdom, South Atlantic Ocean) – an example of station subsidence.*

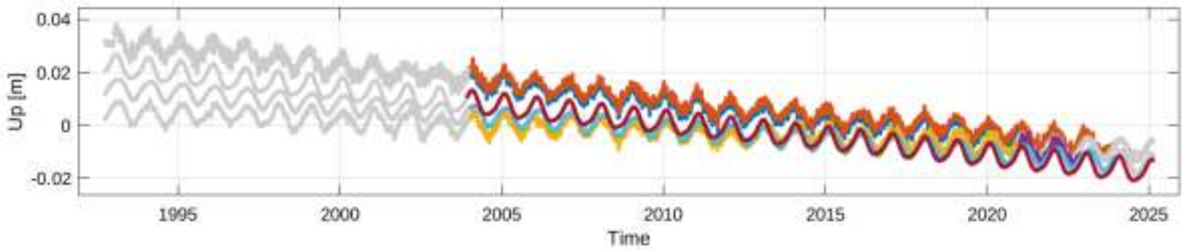

***Figure 35.** Up component of the coordinate time series of DORIS station YASB (Yarragadee, Australia) – an example of slightly different vertical velocities between the TRFs.*

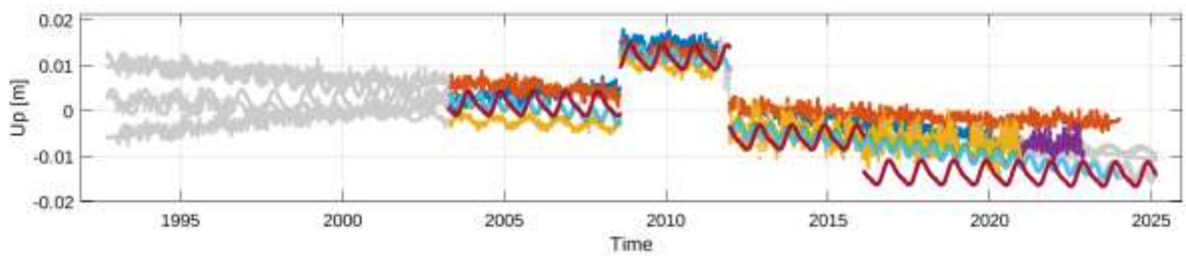

***Figure 36.** Up component of the coordinate time series of DORIS station HEMB (St. Helena, United Kingdom, South Atlantic Ocean) – an example of a position shift in station coordinates time series.*

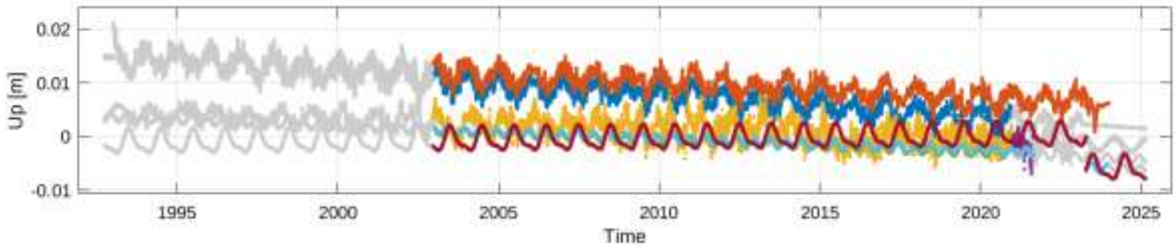

Figure 37. *Up component of the coordinate time series of DORIS station KOLB (Kauai, Hawaii, USA) – an example of slightly different, shifted Up components between different TRFs.*

17.4 COMBINED POD OF JASON-3 USING SLR AND DORIS

The Genesis mission, to be launched in 2028, aims to collocate DORIS, GNSS, SLR, and VLBI on a single satellite platform (*Delva et al., 2023*). To validate multi-technique POD prior to the launch, the Jason-3 satellite, which carries DORIS, GPS, and SLR instruments (*NASA et al., 2025*), is used as a testbed. A combination at observation level is performed to determine an optimal relative weighting scheme of SLR and DORIS observations and parameter configurations. The derived solution was validated through internal and external validation, including orbit parameters, stochastic analysis, orbit overlaps, and comparisons with independent reference orbits from CNES, JPL, and GSFC. In total, around 1.5 years of the Jason-3 mission were analyzed (*Baumgartner, 2025*).

After different weighting tests, the optimal solution in terms of minimal deviation from the reference orbits was achieved by using technique-specific a priori standard deviations of systematic errors of 0.2 mm/s for DORIS and 5 cm for SLR as a weighting setup. This setup yields a radial standard deviation of 11.4 mm, a mean of −7.2 mm, and a median of −6.7 mm in their differences relative to the JPL orbit. Residual statistics confirm the consistency of the combined solution. The RMS, not considering elevation-based weighting, of SLR residuals is 14.2 ± 1.2 mm, and DORIS residuals are 0.40 ± 0.003 mm/s. Single-technique solutions show similar RMS values of observation residuals (DORIS-only: 0.402 mm/s, SLR-only: 12.3 ± 1.4 mm).

Estimated physical parameters are consistent with expected satellite dynamics. For the derived combined orbit, e.g. the Earth albedo coefficient is 1.0060 ± 0.0024, and the atmospheric drag coefficient is 0.6357 ± 0.5346. Empirical accelerations remain within ±1 nm/s^2, confirming the realism of the physical modeling.

External orbit validations against CNES, JPL, and GSFC orbits confirm the improvement throughout the analysis period. **Figure 38** shows the orbit differences of a selected 14-day time span with respect to the SSA orbit. Compared to SSA, the DGFI-TUM combined orbit solution shows a radial standard deviation of 0.74 cm, a mean of 0.01 cm, and a median of –0.01 cm. In comparison, reference orbit differences among independent agencies range from 0.45 cm to 0.71 cm in the radial direction.

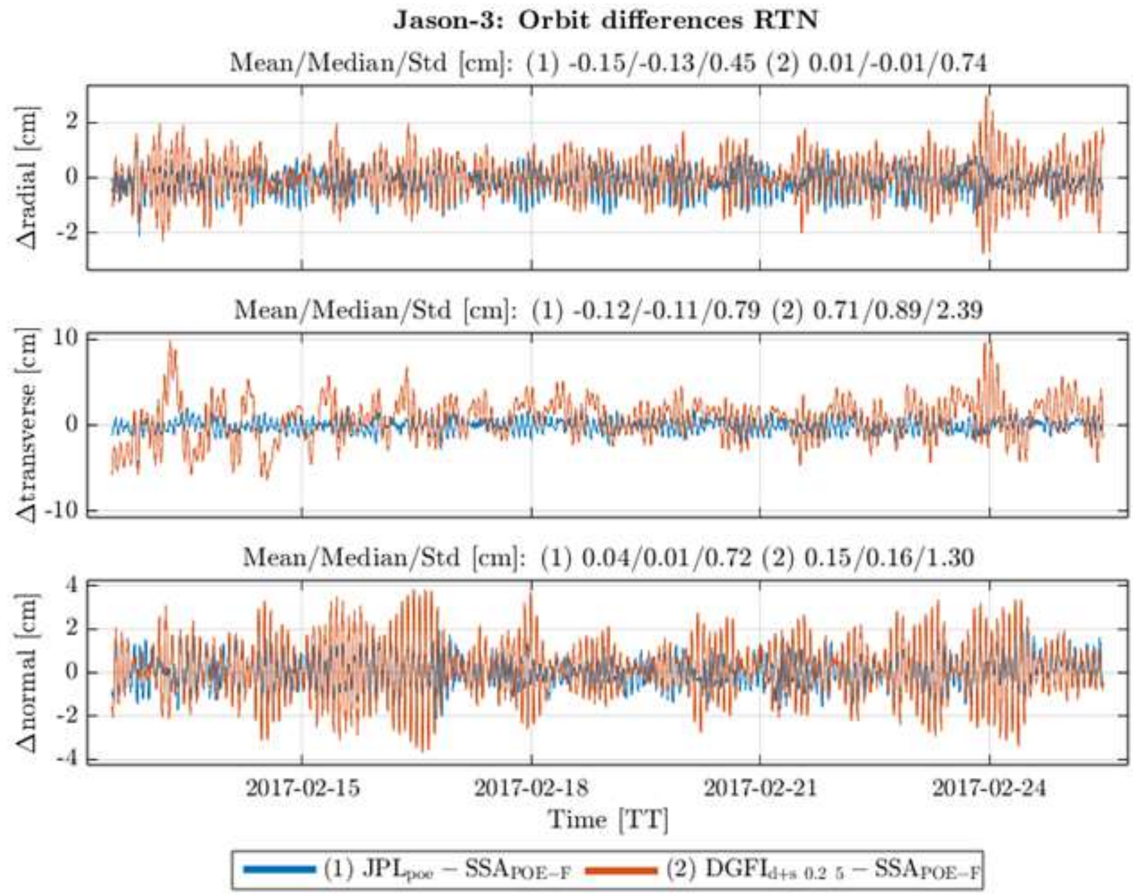

Figure 38. *Orbit differences of the DGFI-TUM and JPL solutions w.r.t. the SSA POE-F solution.*

Overall, the results show a reduction in the RMS of orbit differences relative to external orbits and provide a basis for future analyses, with a focus on longer time spans, estimation of station positions and Earth orientation parameters, and the application of the derived setup to other satellites.

The DGFI-TUM IDS AAC actively contributed to the ESA Genesis GSET Working Groups on ITRF & Combination (WG 1) and SLR (WG 5). In future, it is planned to analyze simulated DORIS observations to Genesis with DOGS.

In the framework of co-location in space studies performed at DGFI-TUM in 2025, a new approach of combining satellite orbits at the normal equation level of the Gauß-Markov model is currently developed.

17.5 PRESENTATIONS

More results can be found in the following presentations:

Baumgartner, M., Zeitlhöfler, J., & Bloßfeld, M. (2026) Multi-Technique POD Solution for Jason-3 developed at DGFI-TUM. IAG Symposium Reference Frames for Applications in Geosciences (REFAG2026). Zenodo. https://doi.org/10.5281/zenodo.18875769

Rudenko S., Bloßfeld M., Seitz M., Zeitlhöfler J. (2025) Comparison of time series of DORIS and SLR station coordinates of ITRS 2020 realizations and their updates and their impact on POD of altimetry satellites. IDS Analysis Working Group Meeting, Athens, Greece. https://ids-doris.org/ documents/report/AWG202511/IDSAWG202511-Rudenko-DORIS_SLR_TimeSeriesComparison.pdf

Seitz M., Bloßfeld M., Angermann D., Rudenko S., Zeitlhöfler J., Seitz F. (2025) DTRF2020-u2023 and first steps towards DTRF2020-u2024. IDS Analysis Working Group Meeting, Athens, Greece. https://ids-doris.org/images/documents/report/AWG202511/IDSAWG202511-Zeitlhöfler-DTRF2020-u2023.pdf

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Moreaux G., Lemoine F.G., Zelensky N.P., Moyard J., Couhert A. (2023). DPOD2020: a DORIS extension of the ITRF2020 for Precise Orbit Determination, Advances in Space Research, 72(11):4625-4650, https://doi.org/10.1016/j.asr.2023.10.006

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Rudenko S., Bloßfeld M., Seitz M., Zeitlhöfler J. A comparison of time series of DORIS and SLR station coordinates of ITRS 2020 realizations and their updates and their impact on POD of altimetry satellites (in preparation).

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18 GFZ ASSOCIATE ANALYSIS CENTER

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18.1 INTRODUCTION

In 2025, the Associate Analysis Center (AAC) at GFZ Helmholtz Centre for Geosciences continued its activities within the International DORIS Service (IDS), focusing on precise orbit determination (POD), improvements in observation modeling, and contributions to the realization of the terrestrial reference frame.

A major activity during the year was the preparation of the GFZ AAC for a potential transition towards a fully operational IDS Analysis Center (AC). In this context, an orbit technical note describing the GFZ processing strategy, modeling standards, and orbit products was submitted to the IDS Combination Center (IDS CC). This documentation provides the basis for evaluating the GFZ solutions within the IDS combination process and supports the further integration of GFZ products into the IDS operational infrastructure.

Several technical developments were implemented to further improve the processing chain. These included improvements in the dynamic modeling of satellites, the integration of spacecraft attitude information for the SWOT mission, and the implementation of preprocessing procedures for DORIS observations using external clock solutions.

In addition, GFZ contributed SINEX solutions to the ongoing update of the ITRF2020-u2025 realization within the IDS framework. So far, the submitted solutions have been included in the combination without weighting. The latest submission is currently under evaluation and may be included in the combination with weighting for the first time.

Close collaboration with the IDS Combination Center also led to the clarification of inconsistencies in the interpretation of delivered SINEX products, allowing the GFZ solutions to be interpreted and processed correctly within the IDS combination chain.

18.2 SENTINEL-6A (MF) MACRO MODEL EVALUATION

To improve the dynamic modeling of the Sentinel-6A (MF) satellite, a new macro-model representation of the spacecraft was implemented within the EPOS-OC (*Neumayer et al., 2024*) precise orbit determination framework. In order to evaluate potential improvements in the modeling of non-gravitational forces, orbit solutions were generated using the GFZ in-house macro-model and the macro model by Conrad (*Conrad et al., 2022*) and compared in terms of orbital fit statistics and external orbit comparisons to the CPOD combined solution (*Fernández et al., 2024*). The results of the orbital fit are shown in **Table 19**, indicating a slightly better RMS of the SLR residuals for the Conrad macro model; however, changes are in the sub millimeter range. Furthermore, the results for the orbital comparison, given in **Table 20**, show a minor degradation for the Conrad model, especially in the radial and along-track component, whereby it performs better in the cross-track component.

		GFZ		Conrad	
		mean	RMS	mean	RMS
SLR	[cm]	0.0041	0.8552	0.0166	0.8268
DORIS	[mm/s]	0.0000	0.3817	0.0000	0.3828

Table 19. *Orbital fit of DORIS and SLR residuals for Sentinel-6A (MF) (mean and RMS)*

	GFZ		**Conrad**	
	Mean [cm]	RMS [cm]	mean [cm]	RMS [cm]
Radial	0.26	0.69	0.26	0.73
Cross-track	-0.30	1.42	-0.29	1.33
Along-track	0.03	1.87	0.06	1.95

Table 20. *Orbital comparison to the CPOD combined solution (mean and RMS*

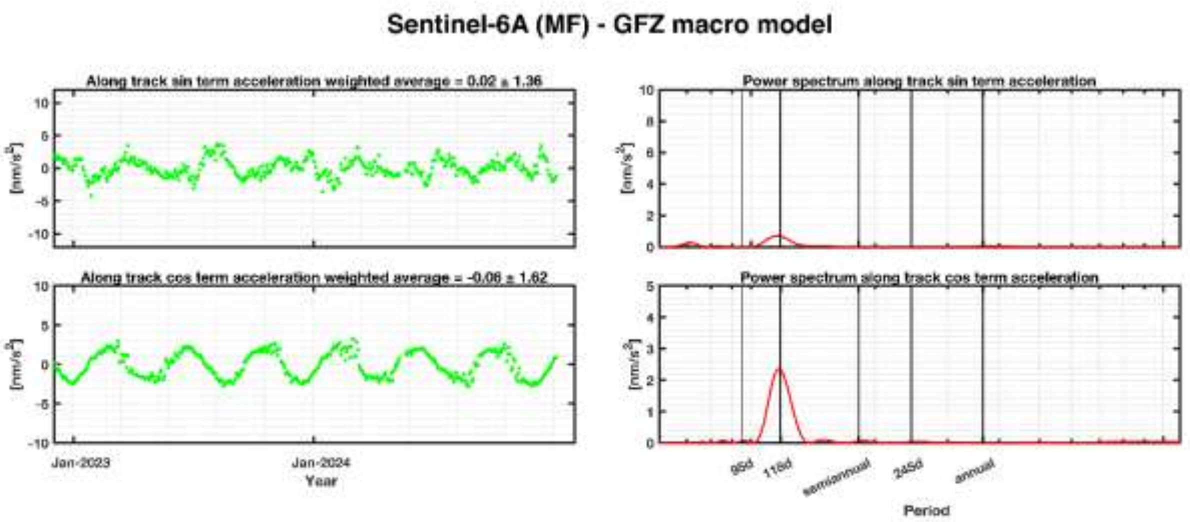

Figure 39. *Empirically estimated along-track accelerations (left) and corresponding power spectrum (right) for the GFZ macro model.*

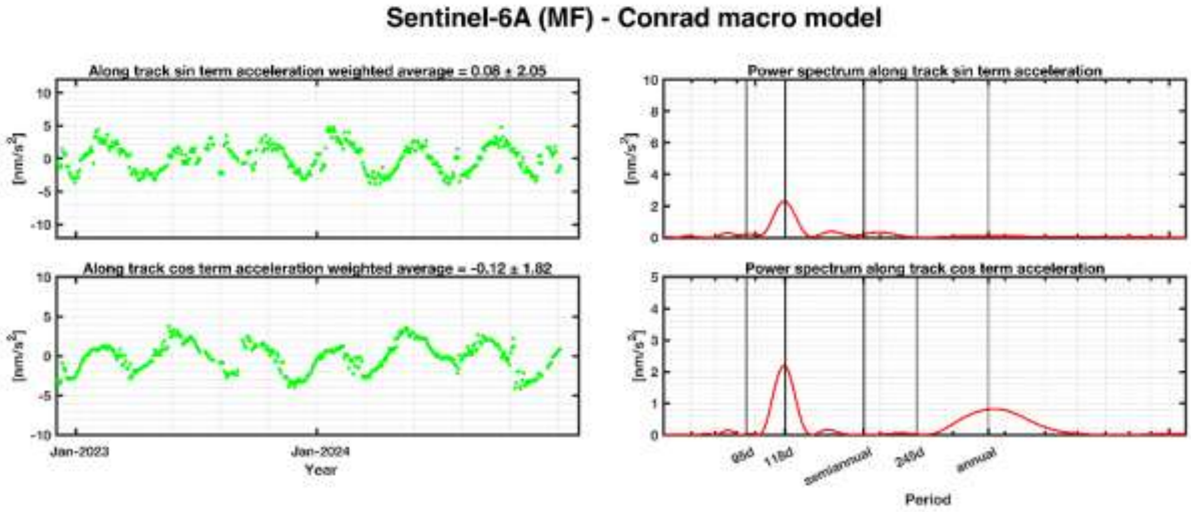

Figure 40. *Empirically estimated along-track accelerations (left) and corresponding power spectrum (right) for the Conrad macro model*

For the GFZ macro model, a reduction in the amplitudes of empirically estimated accelerations could be observed. **Figure 39** and **Figure 40** show the empirically estimated accelerations in along-track and their power spectrum. It can be seen that the GFZ model demonstrates a significant reduction of the signal at 118 days in the sine term, as well as a reduction in the standard deviation of the accelerations from 2.05 to 1.36 nm/s^2. In the cosine term, the GFZ model shows no annual signal in contrast to the Conrad model; the signal at 118 days shows a comparable amplitude.

Therefore, as the orbit analysis did not show distinct improvements, and the analysis of empirically estimated accelerations suggests a more accurate representation of the satellite geometry and its interaction with non-gravitational perturbations for the GFZ model, it was kept as the model used in the processing chain.

18.3 IMPLEMENTATION OF SWOT ATTITUDE DATA

For the SWOT mission, spacecraft attitude information in the form of quaternion time series was provided. In 2025, these quaternion data were implemented in the GFZ POD processing chain.

The quaternion data describe the spacecraft orientation with high temporal resolution and allow a consistent transformation between spacecraft-fixed and inertial reference frames within the observation modeling. The quaternion information provided is now used operationally in the GFZ processing setup for both the satellite body and the solar panel orientation.

The implementation improves the consistency of the observation modeling by accounting for the time-dependent spacecraft attitude in the orbit determination process.

18.4 DORIS CLOCK CORRECTION PREPROCESSING

Within the activities of the IDS Working Group “Integrated Clock Correction Strategies for DORIS”, a preprocessing procedure for DORIS observations was implemented at GFZ. This approach enables the correction of original DORIS RINEX observation files using externally provided clock solutions prior to the orbit determination, thereby also enabling the possibility to provide corrected observation data to the broad community.

The impact of this preprocessing was investigated by analyzing systematics in the post-fit residuals geographically, as well as the resulting orbit accuracy and its influence on the estimated terrestrial reference frame (TRF) parameters. At this stage, the analysis indicates a significant improvement in the systematics of the post-fit residual (see **Figure 41**). Improvements for orbit and TRF accuracy are still under further investigation.

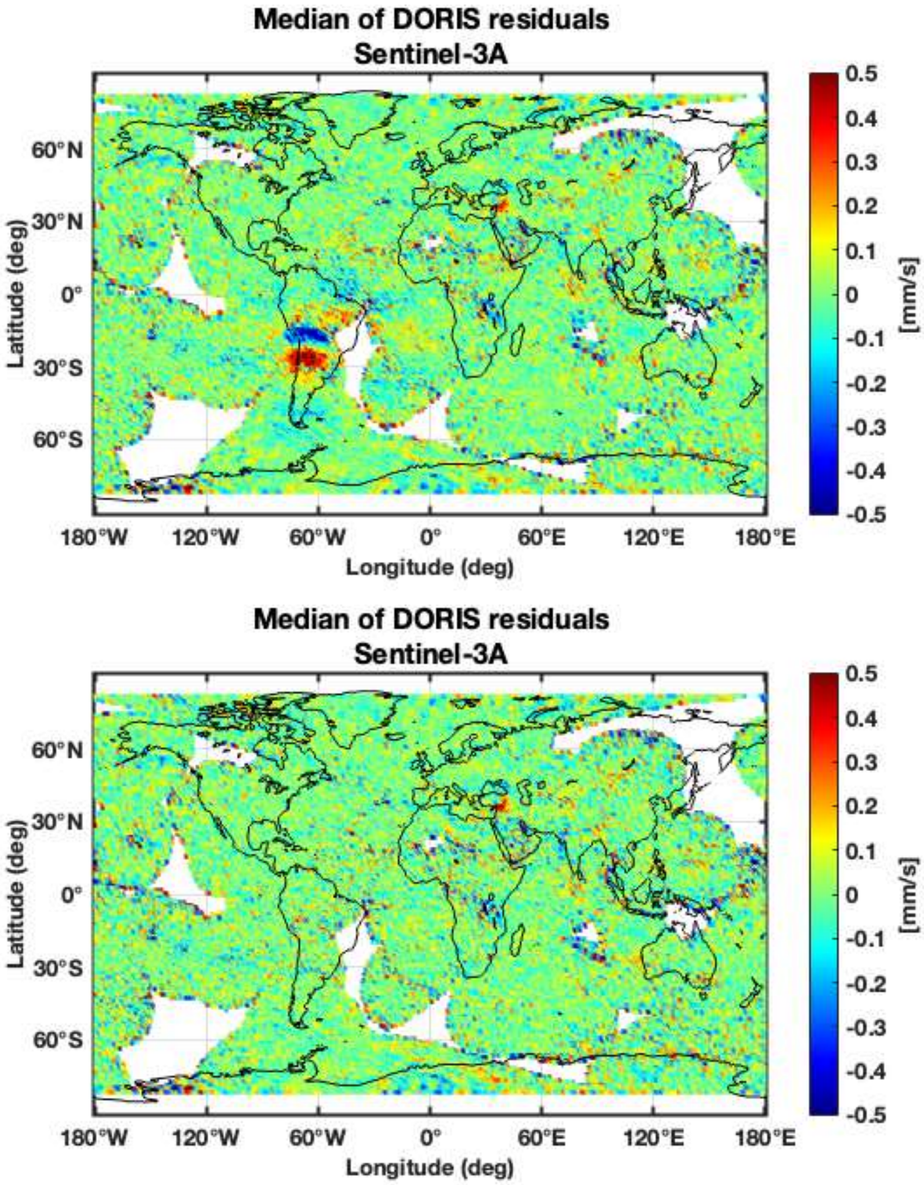

Figure 41. *Geographical distribution of the median DORIS residuals for Sentinel-3A without (top) and with (bottom) clock corrections applied.*

18.5 CONTRIBUTION TO IDS COMBINATION AND SINEX CONSISTENCY

During the integration of GFZ solutions into the IDS combination process, inconsistencies in the interpretation of delivered SINEX files were identified. These issues were investigated in close collaboration with the IDS-CC, and an adapted way of providing the solutions in the SINEX format has been implemented, which resolves the previously identified issues.

The SINEX solutions provided by GFZ can now be interpreted correctly by the IDS CC, allowing the corresponding solutions to be included in the combination process without ambiguity.

In addition, GFZ provided single- and multi-satellite solutions contributing to the ongoing update of the ITRF2020 realization within the IDS framework. So far, the solutions have been included in the combination with zero weight; the new solution for the ITRF2020-u2025 update is currently under evaluation.

18.6 PRESENTATIONS

Schreiner P, Reinhold A (2025) Status Report of the IDS AAC at GFZ. IDS AWG meeting 2025. Online, March 24, 2025. https://ids-doris.org/documents/report/AWG202503/IDSAWG202503-Schreiner-GFZ.pdf

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19 TU DELFT ASSOCIATE ANALYSIS CENTER

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19.1 INTRODUCTION

In 2025, we reprocessed CryoSat-2 data up to October 2025 using the methodology described in *Schrama (2017)* and *Schrama and Visser (2024)*. This approach employs IDS format 2.2 together with laser tracking data. The only time-dependent TVG correction applied in this analysis is derived from the AOD1B model. The main findings are presented in the following subsections, followed by an interpretation of the results.

19.2 RESULTS

The dataset used is not based on the DORIS/RINEX format, but instead on IDS format 2.2, combined with beacon coordinates from the latest DPOD 2020 release. The resulting Doppler and laser residuals are shown in **Figure 42**. The top panel presents the DORIS residuals, with an average RMS of 0.3884 mm/s, while the bottom panel shows the SLR residuals, with an average of 0.854 cm.

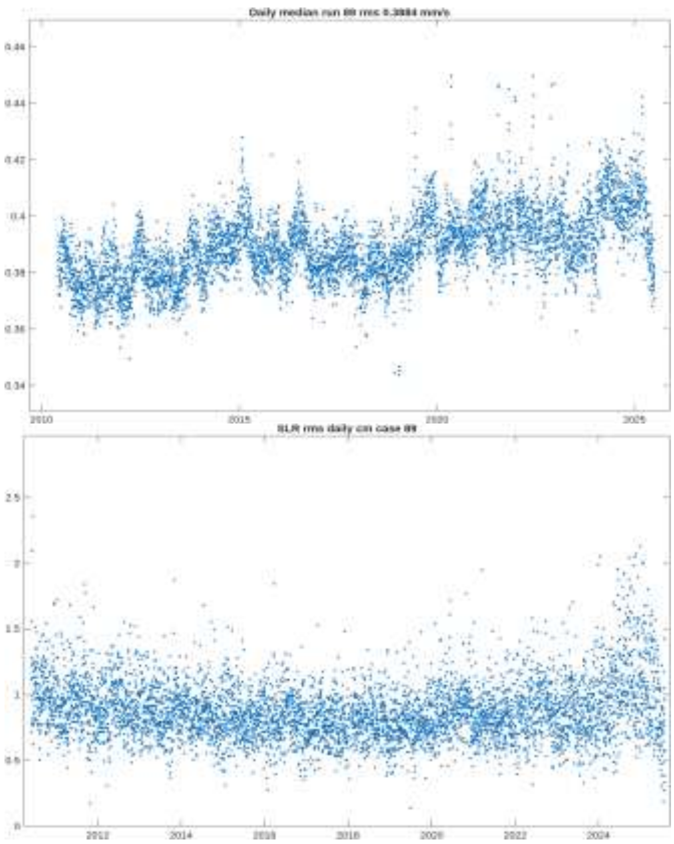

Figure 42. *Mean daily tracking residuals for DORIS (top) and SLR (bottom).*

The probability density functions (PDFs) of both time series are presented in **Figure 43**. The top panel shows the histogram of the daily estimated rms values of the DORIS residuals, the bottom panel shows it for the laser residuals, the rms values are 0.3884 mm/s and 0.854cm respectively. The distributions exhibit slight skewness and a tendency toward outliers. It should therefore be noted that statistical measures of the tracking data are influenced by the specific editing and preprocessing steps applied in this POD implementation.

During the POD process, empirical accelerations are estimated to account for components of the spacecraft's dynamical behavior that are not fully captured by the applied force models. For further details, see *Schrama and Visser (2024)*. In this report the time-variable gravity (TVG) model is based solely on the AOD1B implementation.

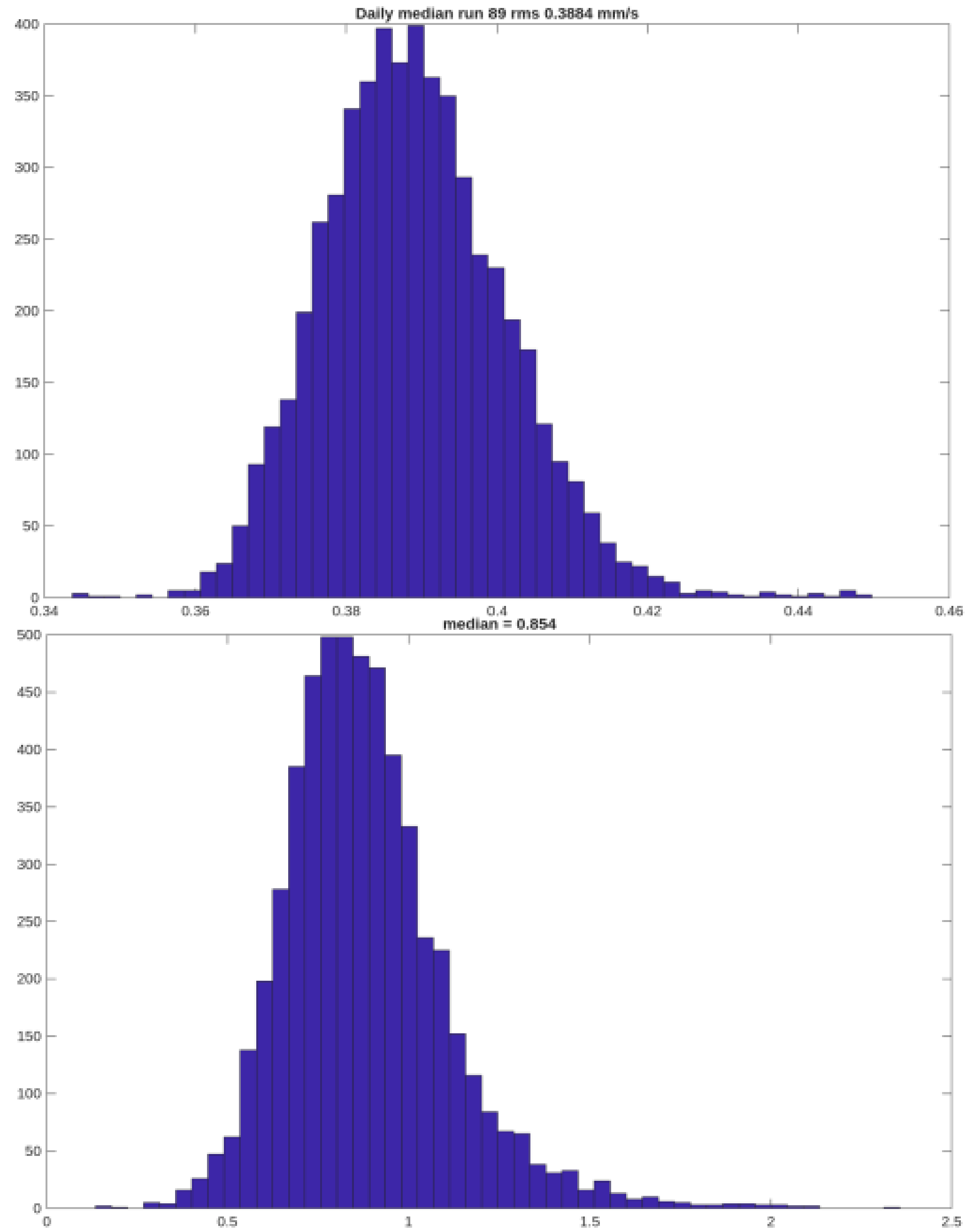

Figure 43. *Daily estimated rms values of the residuals for DORIS (top) and for SLR (bottom).*

Figure 44 shows the cosine and sine components of the along-track empirical accelerations, with average magnitudes of 1.80 and 1.35 nm/s², respectively. A slight increase in these accelerations is observed from 2022 onward, coinciding with the onset of solar cycle 25.

Between 2016 and 2022 - during the relatively quiet period between the maximum of solar cycle 24 (around 2014) and the expected maximum of cycle 25 (around 2025) - solar activity was low. This resulted in fewer solar events and a more stable thermosphere, leading to reduced variability in the satellite's dynamical environment.

The lowest panel of **Figure 44** shows the β-angle of the satellite, defined here as the angle between the Earth–Sun vector and the normal to the orbital plane. Using this angle, an empirical model can be constructed for both the cosine and sine components of the along-track accelerations. For details see *Schrama and Visser (2024)*. The model (shown in red) captures the overall trend well; however, deviations increase near solar cycle maxima.

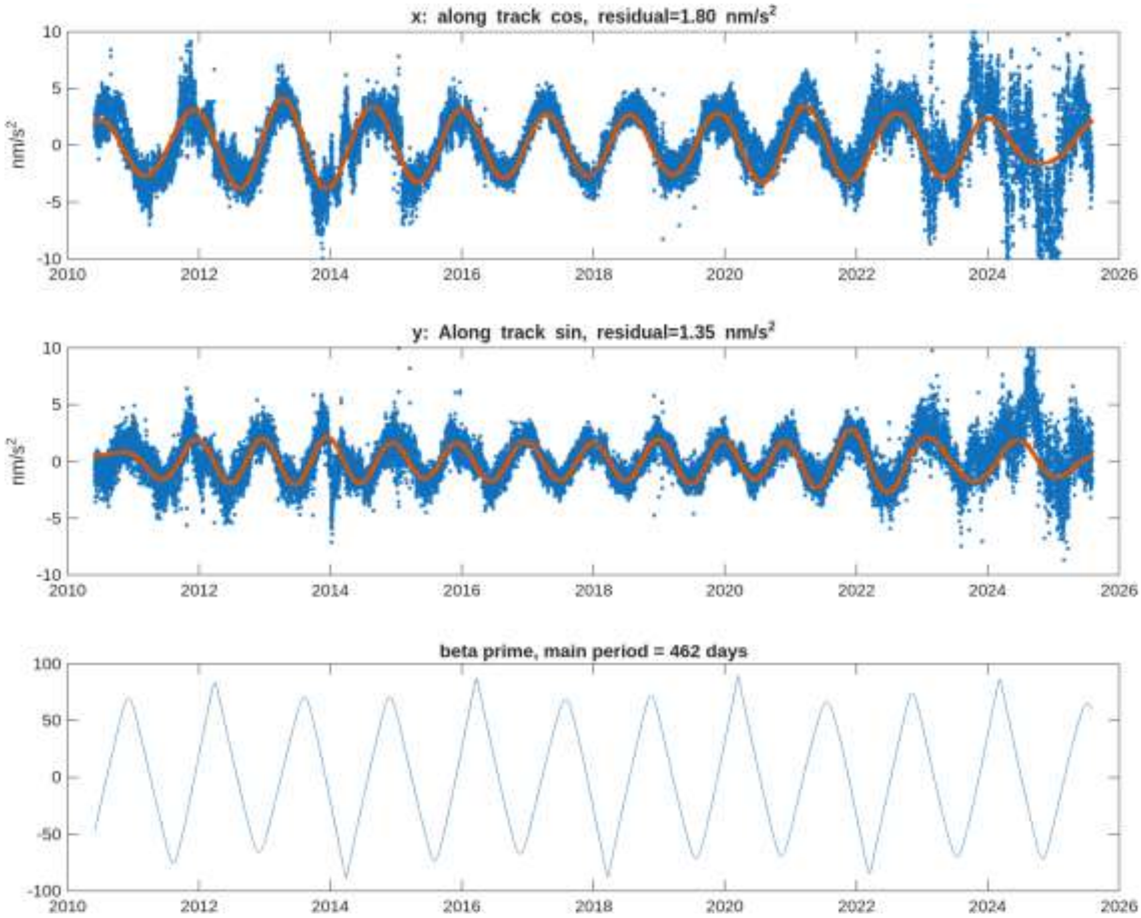

Figure 44. *Cosine (top) and sine (center) components of the along-track empirical accelerations, and β-angle of the satellite (bottom).*

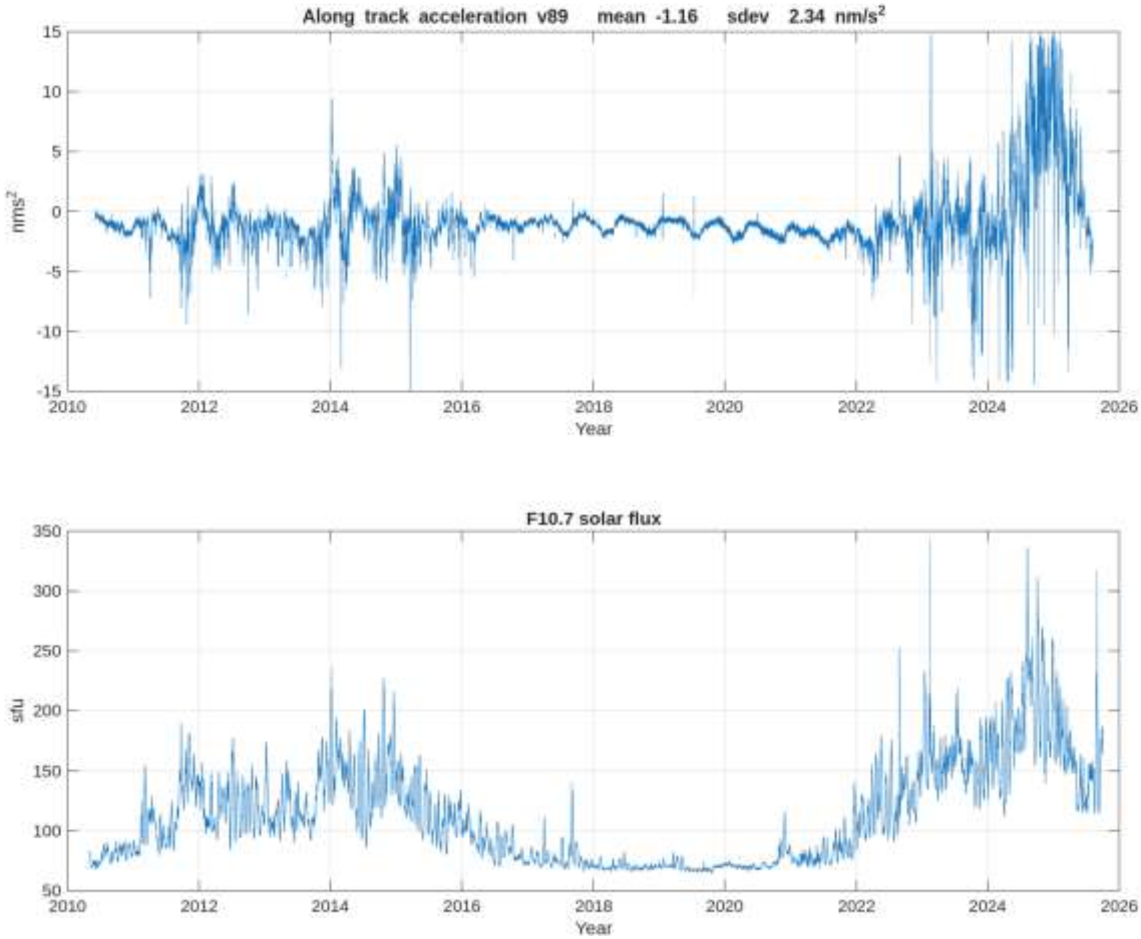

Figure 45. *Along-track empirical acceleration bias (top) and F10.7 solar flux index (bottom).*

Figure 45 presents the along-track empirical acceleration bias and its relation to solar activity. The top panel shows the temporal evolution of the bias term, while the bottom panel displays the F10.7 solar flux index. The results indicate that this bias is strongly influenced by limitations in the thermospheric density model, particularly its inability to accurately capture short-term solar-driven variability affecting the thermosphere.

As a final step in the analysis, the derived orbits are compared with external POE and Navigator solutions provided by CNES. Over the full analysis period (2010–2025), the radial differences relative to the CNES precise orbit ephemerides (POE), available via the ESA Cal/Val server, show an average daily RMS of 0.71 cm. In comparison with the real-time navigator orbits, a post-2012 software update yields an RMS difference of 3.39 cm.

19.3 OUTLOOK

In future work, we aim to further investigate the trends observed in the tracking statistics. In particular, the apparent increase in DORIS tracking residuals will be examined in more detail, with the goal of quantifying its impact on overall orbit quality.

19.4 REFERENCES

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Schrama E.J.O., Visser P.N.A.M. (2024) Choices for temporal gravity field modeling for precision orbit determination of CryoSat-2, Advances in Space Research, Volume 73, Issue 1, 2024, Pages 31-41, ISSN 0273-1177, DOI: 10.1016/j.asr.2023.11.034.

20 WORKING GROUP "NEAR REAL-TIME DORIS IONOSPHERIC APPLICATIONS"

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Philippe Yaya / CLS, France

20.1 WORKING GROUP ACTIVITIES IN 2025

The IDS Near-Real-Time (NRT) DORIS Ionospheric Applications Working Group aims to assess the requirements and benefits of NRT DORIS data dissemination, to develop standard procedures for NRT DORIS data analysis, to promote the use of NRT DORIS data in ionospheric research, and to identify potential users and further application areas. Its main objective is to bridge the gap between NRT DORIS and other geodetic observation techniques for ionospheric studies, and to exploit NRT DORIS data together with other ground- and space-based geodetic measurements in support of near-real-time and real-time ionospheric monitoring and modeling.

In 2025, the working group held two virtual meetings, in July and November, to coordinate ongoing activities and recent developments. In addition, regular exchanges with the IDS Central Bureau (CB) were maintained through online meetings held every three months. The main activities in 2025 included the transition from legacy NRT orbits to extrapolated orbits for NRT DORIS ionospheric analysis, the release of a DORIS differential slant total electron content (dSTEC) product, the use of NRT DORIS data in the official IGS global TEC map combination, and initial studies on the use of DORIS data for ionospheric irregularity monitoring.

20.2 EXTRAPOLATED ORBITS IN DORIS DATA ANALYSIS

To provide a complete orbit data set for NRT applications, a new extrapolated-orbit solution has been introduced. These orbits are derived from SSALTO MOE products and are generated for all ten current DORIS missions: CryoSat-2, HY-2C, HY-2D, Jason-3, SARAL, SWOT, Sentinel-3A, Sentinel-3B, Sentinel-6A, and Sentinel-6B. Accordingly, the NRT DORIS processing for ionospheric applications has been adapted from the legacy NRT orbits to the new extrapolated orbits. **Figure 46** and **Figure 47** illustrate the impact of this change on DORIS dSTEC retrieval and on the validation of global TEC maps. The results demonstrate a good overall consistency between the dSTEC estimates obtained from the two orbit types. The differences are centered around zero and do not reveal any evident systematic bias. The close agreement between both solutions and the high correlation indicates that the use of extrapolated rather than legacy NRT orbits has only a minor effect on dSTEC retrieval. Likewise, the RMS values obtained for the six global TEC maps with extrapolated orbits agree well with those based on the legacy NRT orbits, while for most products they are even slightly lower over the full evaluation period. Since March 2026, the extrapolated orbits have been used in the CAS processing chain for NRT DORIS ionospheric products and related analyses.

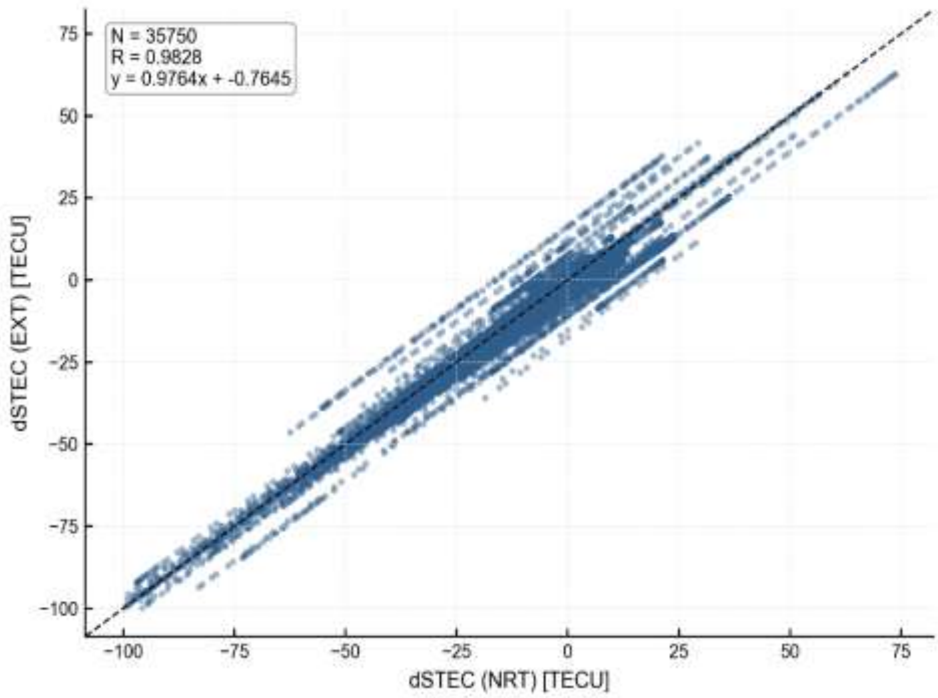

Figure 46. *Comparison of DORIS dSTEC derived from legacy NRT orbit products and the new extrapolated orbits.*

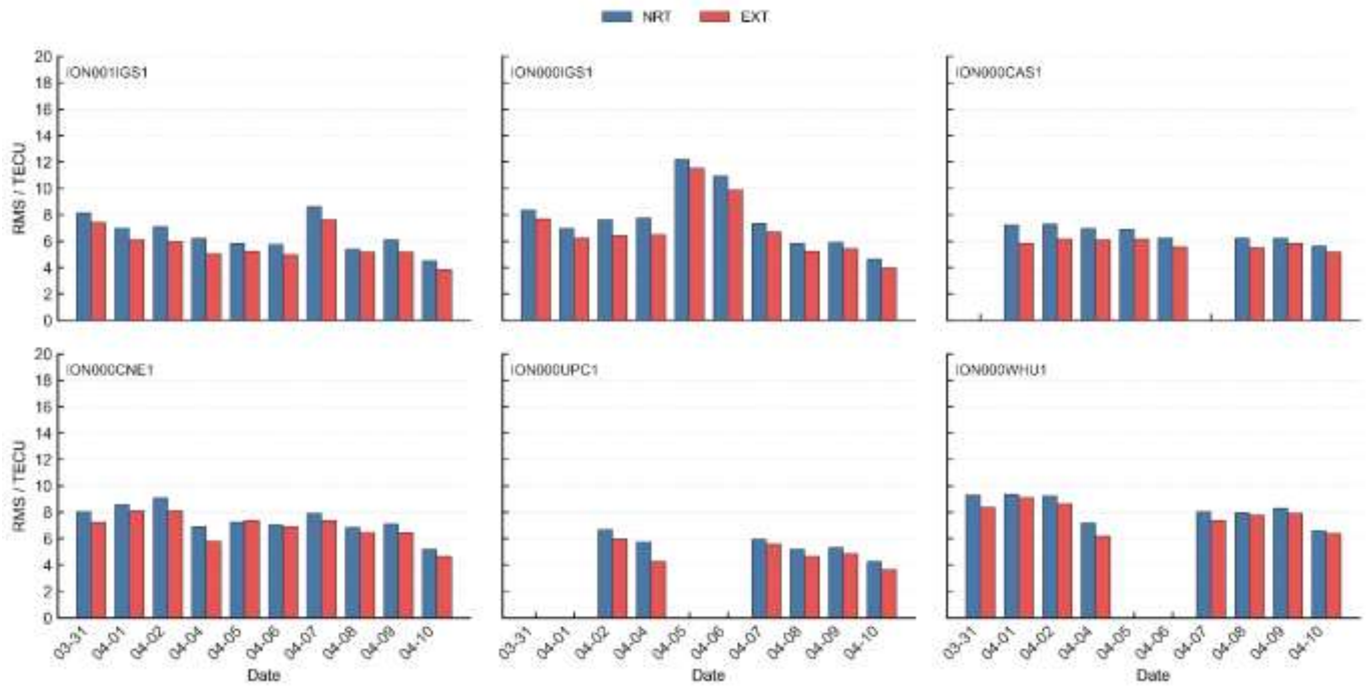

Figure 47. *DORIS-based validation results for global TEC maps obtained with legacy NRT orbits and extrapolated orbits.*

20.3 NRT DORIS DSTEC PRODUCT

The DORIS dSTEC product provides slant TEC observations derived from dual-frequency DORIS measurements collected by low-Earth-orbit (LEO) satellites. The product is generated and maintained by the CAS and is intended for global ionospheric research and related scientific applications. The DORIS-dSTEC observable represents the change in slant TEC along a continuous DORIS observation arc with respect to a selected reference epoch within the arc. Through epoch differencing, instrumental biases and other slowly varying errors are largely removed, making the product well suited for studies of ionospheric variability. The generated DORIS dSTEC product has been validated against independent ionospheric observables, including ground-based GNSS dSTEC, Jason-3 altimetry derived TEC, and IGS global TEC maps. As shown in **Figure 48**, each panel compares the daily mean standard deviation derived from GNSS-dSTEC (horizontal axis) with the corresponding value derived from DORIS-dSTEC (vertical axis) for an individual RT-GIM product. The solid blue line represents the regression fit, while the dashed gray line indicates the one-to-one reference. The strong correlations obtained, in particular for the combined global TEC maps, confirm the high level of consistency between the independent DORIS-dSTEC and GNSS-dSTEC based validations.

The derived DORIS-dSTEC product files are publicly accessible from the CAS data center at *https://data.bdsmart.cn/pub/product/iono/doris/dstec/*.

Further information on the product is provided on the IDS webpage at *https://ids-doris.org/data-products/tables-of-data-products/product-doris-dstec.html* (DOI: 10.24400/312072/i01-2026.001).

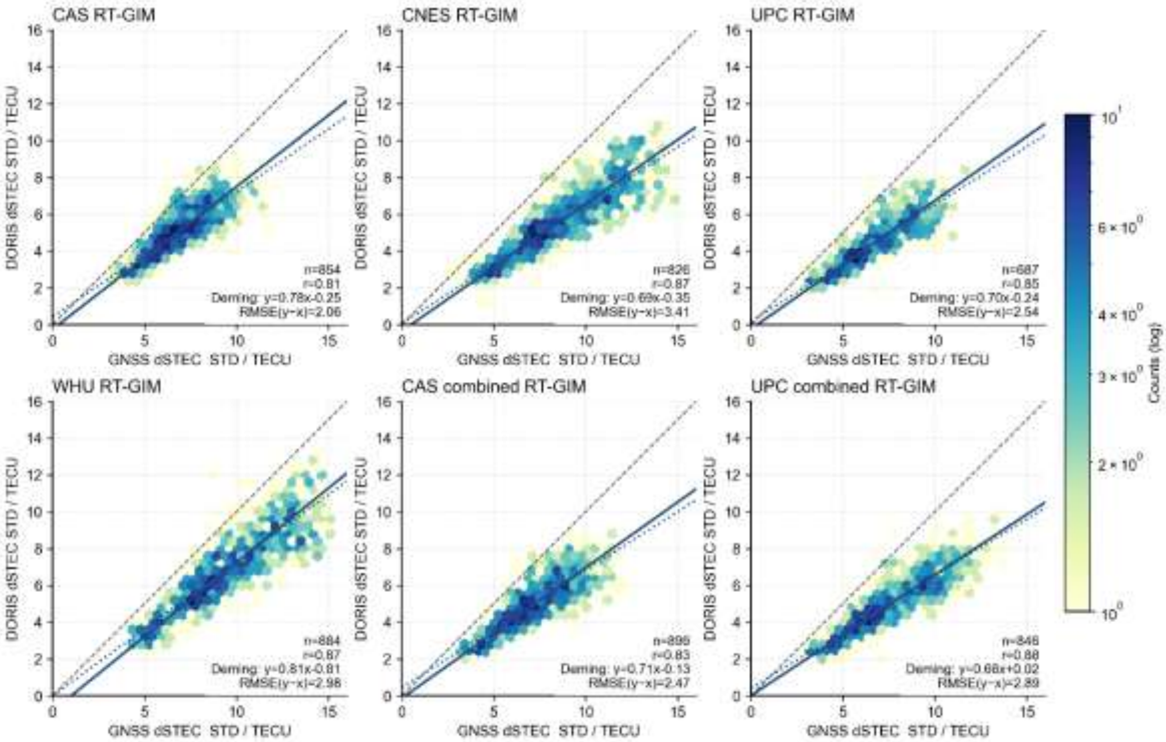

Figure 48. *Consistency analysis between DORIS- and GNSS-dSTEC assessments for different global TEC maps over the 2022-2024 period.*

20.4 DORIS BASED GLOBAL TEC MAP COMBINATION

Independent ionospheric observations are valuable not only for validation, but also for the weighting of global TEC maps. Compared with GNSS itself, the DORIS system provides complementary ionospheric observations with global coverage. DORIS offers two particular advantages for global ionospheric mapping. First, the global DORIS beacon network is more evenly distributed over continental and oceanic regions than the ground-based GNSS network, resulting in a more balanced geographic sampling. Second, the large frequency ratio of the dual-frequency DORIS observations increases the sensitivity to ionospheric delay and reduces the relative impact of measurement noise compared with standard dual-frequency GNSS combinations. Based on the DORIS-dSTEC information, a new weighting method has been developed for the official IGS global TEC map combination. **Figure 49** compares the normalized weights of the different global TEC maps obtained with the legacy GNSS-dSTEC weighting approach and the newly proposed DORIS-dSTEC-based approach. The more balanced weighting pattern highlights the benefit of including DORIS constraints for mitigating regional bias and improving the robustness of the combined solution, particularly in areas with sparse GNSS coverage or enhanced ionospheric variability. Public release of the DORIS-enhanced combined global TEC maps is expected by mid-2026.

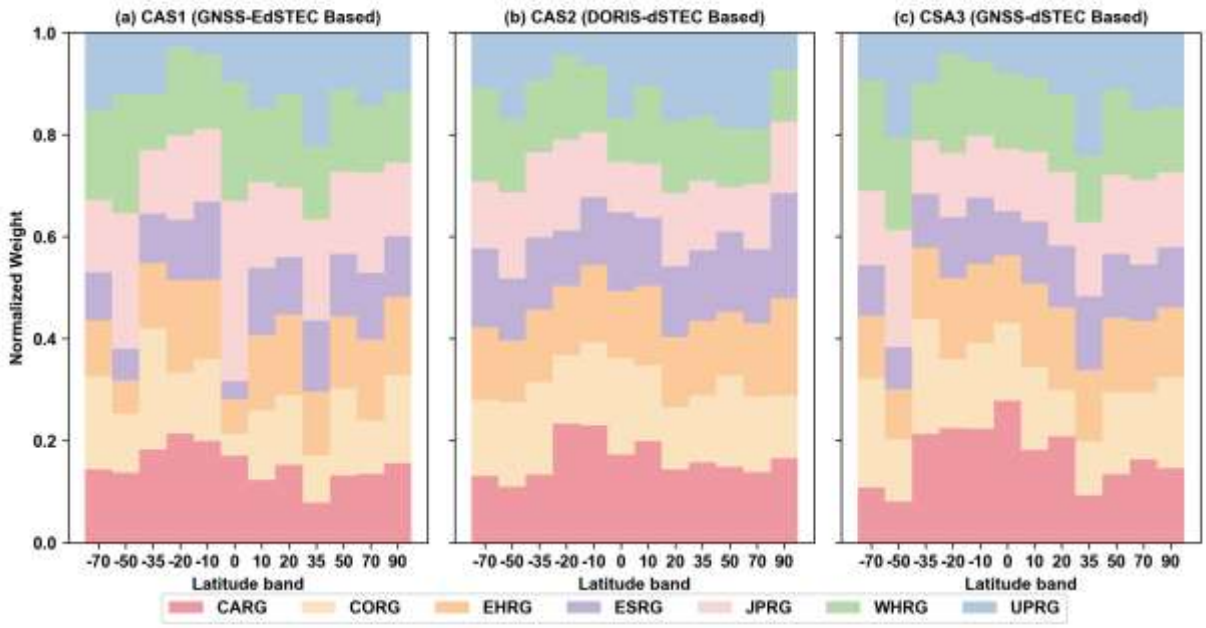

Figure 49. *Normalized weights of different global TEC maps obtained with the legacy GNSS-dSTEC weighting method and the proposed DORIS-dSTEC-based weighting method.*

20.5 DORIS DATA FOR IONOSPHERIC IRREGULARITY ANALYSIS

Considering the high precision of dual-frequency DORIS carrier-phase observations, the research team at China University of Mining and Technology (CUMT) has proposed a method for deriving an ionospheric irregularity indicator, denoted RODTI, from DORIS measurements. By applying a cycle-slip detection method tailored to the DORIS system, together with a low-elevation data screening strategy, the quality of the observations derived was significantly improved. To account for the amplitude difference between DORIS-based RODTI and ground-based GNSS ROTI, caused mainly by the much larger frequency ratio of DORIS compared with GPS, an amplitude correction method was developed using ROTI as a reference. After correction, the global correlation coefficient between RODTI and GPS-based ROTI exceeded 0.75, while the daily mean error remained within 0.03-0.05 TECU/min. As illustrated in **Figure 50**, RODTI shows a consistent temporal response with ROTI during severe geomagnetic storm conditions, demonstrating that the DORIS system can provide a useful complement to existing GNSS monitoring networks. This offers a new data source for the development of a globally coordinated ionospheric irregularity monitoring capability, particularly in regions with sparse observations such as oceans and polar areas.

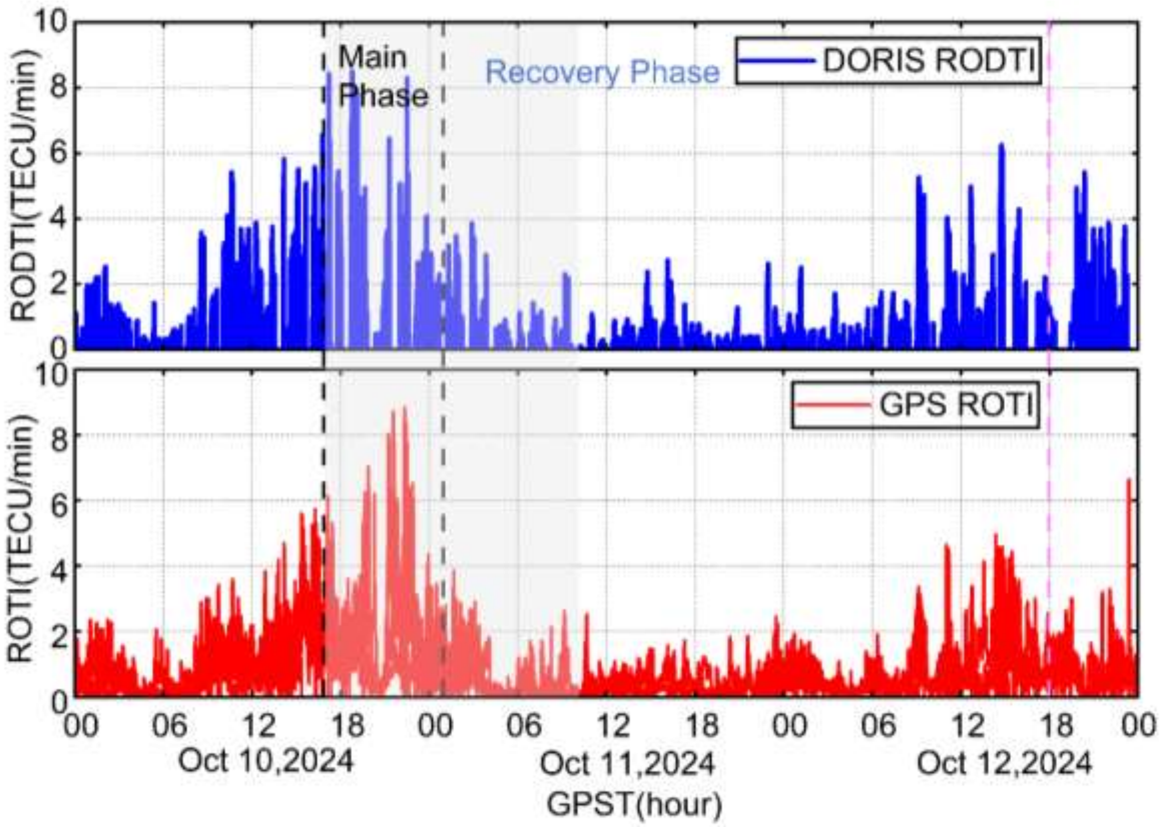

Figure 50. *Comparison of GNSS-ROTI and DORIS-RODTI time series during a severe geomagnetic storm event.*

20.6 REFERENCES

Liu, A., Wang, N., Dettmering, D., Li, Z., Schmidt, M., Yuan, H. (2023). Using DORIS data for validating real-time GNSS ionosphere maps. In New Results from DORIS for Science and Society, E.J.O. Schrama and D. Dettmering (Eds.), ADVANCES IN SPACE RESEARCH, 72(1):115-128, DOI: 10.1016/j.asr.2023.01.050

Wang, N., Lei, D., & Liu, A. (2025). NRT DORIS Data for Global Ionospheric Irregularity Monitoring. DORIS Analysis Working Group Meeting, Athens, Greece, 6-7 November 2025 *https://ids-doris.org/images/documents/report/AWG202511/IDSAWG202511-Wang-DORIS-NRT.pdf*

Wang, N., Li, Z., Krankowski, A., Hernández-Pajares, M. (2025). Near Real-Time DORIS data for IGS Global Ionospheric Maps Combination. AOSWA 2025, Haikou Nov 10-12.

Li, A., Wang, N., Li, Z., Liu, A., Li, Y., Wang, L., & Liu, B. (2026). Real-time versus postprocessing IGS combined global TEC maps: examined by Jason-3 altimetry and DORIS observations, GPS Solutions, 30(61), DOI : 10.1007/s10291-026-02022-y

21 WORKING GROUP "INTEGRATED CLOCK CORRECTION STRATEGIES FOR DORIS"

Patrick Schreiner / GFZ Helmholtz Centre for Geosciences, Oberpfaffenhofen, Germany

21.1 INTRODUCTION

Following its establishment in 2024, the Working Group continued its activities in 2025 with a stronger focus on the quantitative assessment and practical implementation of integrated clock correction strategies for DORIS. The main objective remained the mitigation of systematic effects — particularly those related to the South Atlantic Anomaly (SAA) — through the consistent use of external clock information and improved modelling approaches.

The first working group meeting was held in February 2025, featuring Hugh Evans (ESA) as a guest speaker. He presented radiation monitor data relevant to assessing the impact of the radiation environment on satellite clocks. These datasets, which are directly linked to radiation-induced perturbations of the Ultra-Stable Oscillator (USO), were subsequently made available to the working group and now form an important basis for ongoing analyses.

In May 2025, the interim results of the working group were presented at the Copernicus Quality Working Group (QWG) meeting in Potsdam as a joint contribution by CNES/CLS, GET Université de Toulouse, GFZ, and PosiTim (*Schreiner et al., 2025*). The presentation consolidated findings on the impact of external clock corrections and radiation-related effects on DORIS observations and orbit determination.

A second working group meeting took place in October 2025. Among other contributions, Mara Guaini (TUM/DTU) presented results from her master's thesis, entitled "Correlation of Sentinel-3A Clock with the Radiation Environment", providing further evidence of the relationship between radiation conditions and clock behavior.

The status and progress of the working group were also presented at the IDS Analysis Working Group meeting in November 2025 in Athens (*Schreiner, 2025*). In addition, two dedicated coordination meetings were held with the IDS Central Bureau to report on progress and discuss future directions.

On the technical side, significant progress was achieved in the development and application of external clock correction strategies. The IDS Network Team continued its efforts on the co-location of DORIS beacons with GNSS receivers within the REGINA network. The increasing number of co-located stations enables the use of GNSS-derived clock corrections for data calibration and as external information on the actual DORIS beacon frequency within the data processing.

At GFZ, a dedicated software tool was developed to apply GNSS-based clock corrections directly to standard DORIS observation files. This includes both time tag corrections and phase measurement adjustments. The long-term objective is to provide the DORIS community with corrected observation datasets that can be directly used in standard processing chains without additional implementation effort. First results demonstrate promising improvements, particularly in the reduction of systematic patterns in DORIS residuals.

The working group also agreed to prepare a joint contribution for the IAG Symposium Reference Frames for Applications in Geosciences (REFAG 2026). The resulting poster, focusing on integrated clock correction strategies and their impact on geodetic products, attracted considerable interest from the community (*Mezerette et al., 2026*).

Overall, 2025 marked the transition from conceptual discussions toward coordinated analysis, data integration, and the development of practical tools, laying the groundwork for future operational clock products and improved DORIS processing standards.

21.2 MEMBERS

Chair

- Patrick **Schreiner** (GFZ, Germany)

Members

- Hugues **Capdeville** (CLS, France)
- Alexandre **Couhert** (CNES, France)
- Bingbing **Duan** (TUM, Germany)
- Théo **Gravalon** (CLS, France)
- Barath Krishna **Gunasekaran** (TUM, Germany)
- Urs **Hugentobler** (TUM, Germany)
- Frank **Lemoine** (NASA GSFC, USA)
- Jean-Michel **Lemoine** (CNES, France)
- Flavien **Mercier** (CNES, France)
- John **Moyard** (CNES, France)
- Heike **Peter** (PosiTim, Germany)
- Anton **Reinhold** (GFZ, Germany)
- Petr **Štěpánek** (GOP, Czech Republic)
- Nikita **Zelensky** (NASA UMD, USA)

Copernicus POD Service Manager who offers cooperation as a potential provider of Sentinel clock product: Carlos **Fernández Martín** (GMV, Spain)

21.3 PRESENTATIONS

Mezerette A, Capdeville H, Gravalon T, Lemoine JM, Moyard J, Mercier F, Couhert A, Moreaux G, Schreiner P, Reinhold A, Guaini M, Gunasekaran B, Hugentobler U, Fernández Martín C (2026) Progress on DORIS Clock Correction Strategies from the IDS Working Group. IAG Symposium Reference Frames for Applications in Geosciences (REFAG2026) (Munich, Germany 2026)

Schreiner P, Reinhold A, Peter H, Gravalon T, Couhert A, Moyar J, Mercier F (2025) IDS WG "Integrated Clock Correction Strategies for DORIS" – Status and first results. 14th Copernicus POD QWG meeting (Potsdam, Germany 2025).

Schreiner P (2025) IDS WG "Integrated Clock Correction Strategies for DORIS" – Status and first results. IDS AWG meeting 2025. Athen, November 7, 2025. *https://ids-doris.org/documents/report/AWG202511/IDSAWG202511-Schreiner-WGClocksStatus.pdf*

APPENDIX

22 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/ and ftps://gdc.cddis.eosdis.nasa.gov/doris/data
   IGN: ftp://doris.ign.fr

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

5. **IDS web service**
   https://ids-doris.org/webservice
   DOR-O-T (for DORis Online Tools) 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/resources/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/resources/presentations/ids-meetings.html

10. List of documents and links to discover the DORIS system

https://ids-doris.org/resources/technical-documents.html

11. List of DORIS publications in international peer-reviewed journals

https://ids-doris.org/resources/articles/doris-bibliography.html

12. Overview of the DORIS system

https://cnes.fr/en/projects/doris (page under construction)

13. Overview of the DORIS satellite constellation

https://ids-doris.org/missions-system/missions.html

14. Site logs

DORIS stations description forms and pictures from the DORIS installation and maintenance department: https://ids-doris.org/network-stations/sites.html

15. Virtual tour of the DORIS network with Google Earth

Download the file at https://ids-doris.org/network-stations/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/resources/ids-publications/newsletter.html

18. Photo Gallery

https://ids-doris.org/ids/gallery.html

19. More contacts

For particular requests, you may also contact the following people:

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IGN Data Center

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23 IDS INFORMATION SYSTEM

23.1 WHAT AND WHERE

The Central Bureau (CB) produces/stores/maintains basic information on the DORIS system, including various standard models (satellites, receivers, signal, reference frames, etc.). Data are available at the IDS website (https://ids-doris.org) and an ftp site (ftp://ftp.ids-doris.org/pub/ids) at CLS. Note that most of the files available at the ftp site can be seen at https://ids-doris.org/documents/BC/ too.

The Data Centers (DC) store observational data and products.

A description of the data structure and formats is available at:

https://ids-doris.org/data-products/data-structure-and-formats.html

23.2 WEB AND FTP SITES

23.2.1 IDS WEB SITE

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

The IDS web site is maintained by the Central Bureau. The website structure was revised in 2024 and implemented in 2025.

23.2.2 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)

23.2.3 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 the following:

- 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/data-products/data-structure-and-formats.html).

Note that most of the files available at the ftp site can be seen at https://ids-doris.org/documents/BC/ too.

The IDS ftp site is maintained by the Central Bureau.

23.2.4 DORIS WEB SITE

The DORIS pages are no longer hosted on the Aviso website. Once updated, you will be able to find them on the CNES website (https://cnes.fr/en/projects/doris).

23.2.5 DATA CENTERS' FTP AND WEB SITES

Data and products are stored at the CDDIS and IGN Data Centers. The contain is described in the document "IDS data structure and formats" (https://ids-doris.org/data-products/data-structure-and-formats.html).

CDDIS:

- archive of DORIS data and products are accessible through authenticated https at https://cddis.nasa.gov/archive/doris/, and via other methods.
- email address for contacts and questions: support-cddis [at] earthdata.nasa.gov

IGN:

- archive of DORIS data and products are accessible through an ftp site at ftp://doris.ign.fr/pub/doris/
- email address for contacts and questions: ids.data.center [at] ign.fr

23.3 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: https://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.

23.3.1 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 IDS webserver in text format (https://ids-doris.org/documents/BC/dorismail/) with an FTP back-up archive (ftp://ftp.ids-doris.org/pub/ids/dorismail/)

23.3.2 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 IDS webserver in text format (https://ids-doris.org/documents/BC/dorisreport/) with an FTP back-up archive (ftp://ftp.ids-doris.org/pub/ids/dorisreport/)

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

23.3.3 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 IDS webserver in text format (https://ids-doris.org/documents/BC/dorisstations/) with an FTP back-up archive (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.

23.3.4 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.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

23.4 HELP TO THE USERS

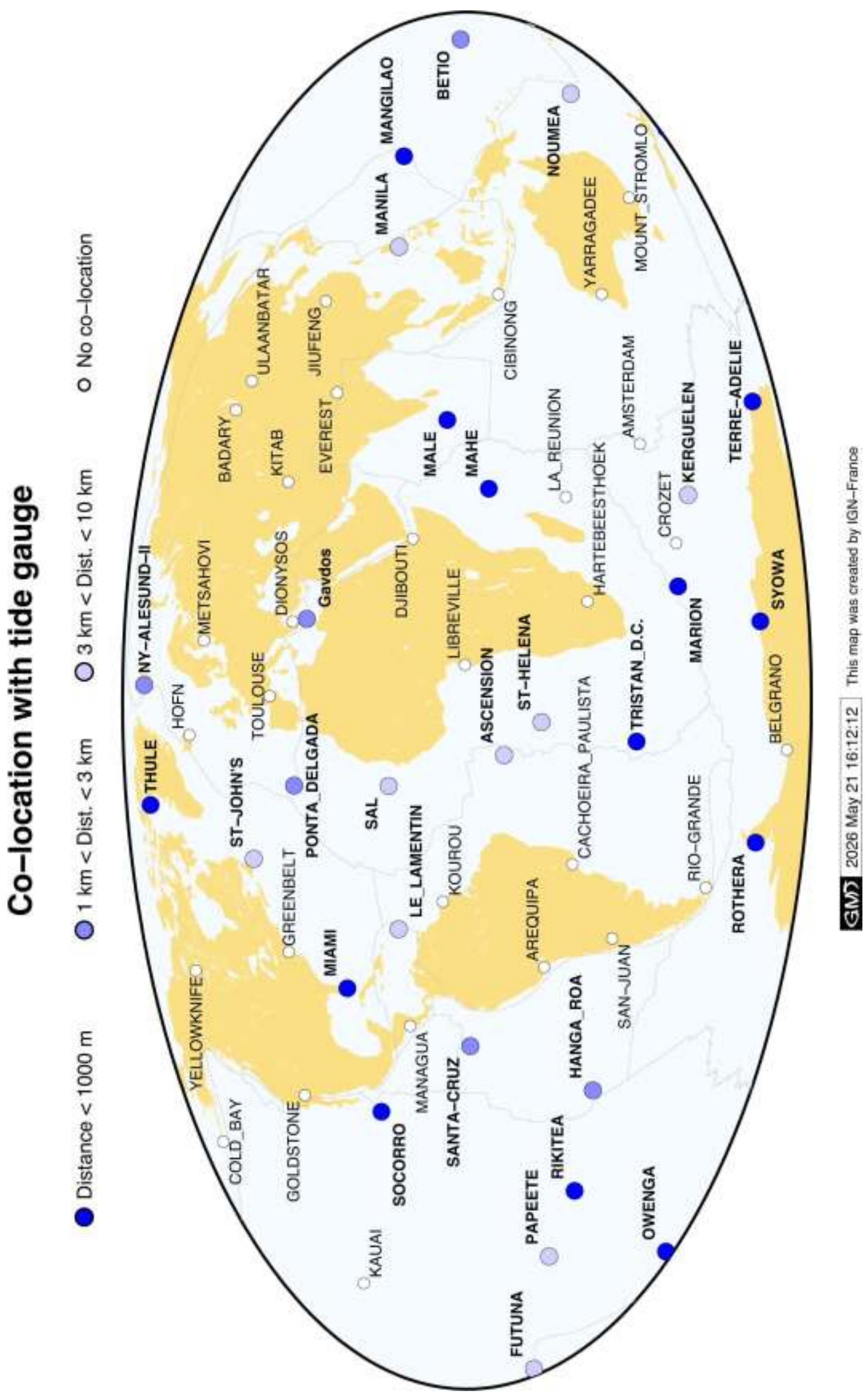
e-mail : ids.central.bureau@ids-doris.org

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.

24 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, https://www.sonel.org). 29 DORIS stations are co-located with tide gauge:

DORIS Name	Long	Lat	Country	Start date	Distance (m)	GLOSS id	PSMSL id
ASCENSION	-14.33	-7.92	UK (SOUTH ATLANTIC)	28/02/1997	6500	263	1831
BETIO	172.92	1.35	KIRIBATI	22/10/2006	1600	113	1804
FUTUNA	-178.12	-14.31	FRANCE (POLYNESIA)	18/10/2011	4400	353	2244
GAVDOS	24.11	34.84	GREECE (CRETE)	25/09/2023	2000	------	------
HANGA ROA	-109.43	-27.16	CHILE (EASTER ISLAND)	13/04/2023	2580	137	1272
KERGUELEN	70.26	-49.35	FRANCE (TAAF)	05/04/1993	3300	23	1849
LE LAMENTIN	-61.00	14.60	FRANCE (MARTINIQUE)	29/06/2013	7000	338	1942
MAHE	55.53	-4.68	SEYCHELLES	20/06/2001	300	339	1846
MALE	73.53	4.20	MALDIVES	15/01/2005	500	28	1753
MANILA	121.03	14.53	PHILIPPINES	26/02/2003	9700	73	145
MANGILAO	144.80	13.43	USA (GUAM IS.)	12/04/2018	830	------	2130
MARION ISLAND	37.86	-46.88	SOUTH AFRICA	01/01/1990	410	20	------
MIAMI	-80.17	25.73	USA (FLORIDA)	10/02/2005	180	332	1858
NOUMEA	166.42	-22.24	FRANCE (CALEDONIA)	27/01/2005	7000	123	2134
NY-ALESUND II	11.83	78.93	NORWAY (SVALBARD)	19/10/2018	2500	345	1421
OWENGA	-176.37	-44.02	NEW ZEALAND (CHATHAM IS.)	20/01/2014	80	------	------
PAPEETE	-149.61	-17.58	FRANCE (POLYNESIA)	27/07/1995	7000	140	1397
PONTA DELGADA	-25.66	37.75	PORTUGAL (AZORES)	02/11/1998	1500	245	258
RIKITEA	-134.97	-23.13	FRANCE (POLYNESIA)	23/09/2006	800	138	1253
ROTHERA	-68.13	-67.57	UK (ANTARCTICA)	01/03/2003	170	342	1931
SAL	-22.98	16.78	CAPE VERDE	15/12/2002	5700	329	1914
SANTA CRUZ	-90.30	-0.75	ECUADOR	01/04/2005	1600	------	1472
SOCORRO	-110.95	18.73	MEXICO	09/06/1989	580	162	1821
ST-HELENA	-5.67	-15.94	UK (SOUTH ATLANTIC)	01/06/1989	5900	264	1845
ST. JOHN'S	-52.68	47.40	CANADA (TERRE-NEUVE)	27/09/1999	3600	223	393
SYOWA	39.58	-69.01	JAPAN (ANTARCTICA)	10/02/1993	1000	95	1396
TERRE ADELIE	140.00	-66.67	FRANCE (ANTARCTICA)	01/02/1997	500	131	2231
THULE	-68.83	76.54	DENMARK (GREENLAND)	28/09/2002	450	343	------
TRISTAN DA CUNHA	-12.31	-37.07	UK (SOUTH ATLANTIC)	10/06/1986	120	266	------



Co–location with tide gauge
Distance < 1000 m
1 km < Dist. < 3 km
3 km < Dist. < 10 km
No co–location
THULE
NY–ALESUND–II
HOFN
YELLOWKNIFE
COLD_BAY
METSAHOVI
ST–JOHN'S
TOULOUSE
GREENBELT
GOLDSTONE
PONTA_DELGADA
DIONYSOS
Gavdos
BADARY
ULAANBATAR
KITAB
EVEREST
JIUFENG
MIAMI
SAL
SOCORRO
MANAGUA
LE_LAMENTIN
KOUROU
DJIBOUTI
MALE
MANILA
MANGILAO
KAUAI
SANTA–CRUZ
LIBREVILLE
ASCENSION
MAHE
CIBINONG
BETIO
AREQUIPA
ST–HELENA
LA_REUNION
NOUMEA
PAPEETE
RIKITEA
HANGA_ROA
CACHOEIRA_PAULISTA
HARTEBEESTHOEK
YARRAGADEE
SAN–JUAN
TRISTAN_D.C.
AMSTERDAM
MOUNT_STROMLO
FUTUNA
RIO–GRANDE
MARION
CROZET
KERGUELEN
OWENGA
BELGRANO
SYOWA
TERRE–ADELIE
ROTHERA
GMT 2026 May 21 16:12:12
This map was created by IGN–France

25 DORIS STATIONS / HOST AGENCIES

The local teams who look after the DORIS stations make a major contribution to the high quality of the DORIS network constantly improving 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 (KMS)	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	Wallis-et-Futuna, FRANCE
Gavdos	Technical University of Crete (TUC)	Chania, Crete, GREECE
Goldstone	Goldstone Deep Space Communications Complex (GDSCC), NASA	Fort Irwin, California, U.S.A.
Grasse	Observatoire de la Côte d'Azur (OCA)	Grasse, FRANCE
Greenbelt	Goddard Geophysical and Astronomical Observatory (GGAO), NASA	Greenbelt, Maryland, U.S.A.

Station name	Host agency	City, Country
Hanga Roa	Universidad de Chile (UdC)	Santiago, CHILE
Hartebeesthoek	HartRAO, South African National Space Agency (SANSA)	Hartebeesthoek, Pretoria, SOUTH AFRICA
Höfn	National Land Survey of Iceland Landmælingar Islands (LMI)	Akranes, ICELAND
Jiufeng	Innovation Academy for Precision Measurement Science and Technology (APM)	Wuhan, Hubei, CHINA
Kanpur	Indian Institute of Technology Kanpur (IITK)	Kanpur, Uttar Pradesh, INDIA
Kauai	Kokee Park Geophysical Observatory (KPGO), NASA	Kauai Island, Hawaii, 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), CNES	Kourou, French Guyana, FRANCE
La Réunion	Observatoire Volcanologique du Piton de La Fournaise (IPGP)	Ile de la Réunion, Indian Ocean, FRANCE
Le Lamentin	Météo-France	Martinique, French West Indies, FRANCE
Libreville	ESA Tracking Station	N'Koltang, GABON
Mahé	Seychelles Meteorological Authority (SMA)	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, Micronesia, U.S.A.
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

Station name	Host agency	City, Country
Nouméa	Direction des Infrastructures, de la Topographie et des Transports Terrestres (DI3T)	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 Island, French Polynesia, FRANCE
Ponta Delgada	CIVISA / IVAR Universidade dos Açores	Ponta Delgada, Azores, PORTUGAL
Rikitea	Météo-France	Gambier Islands, French Polynesia, 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, Newfoundland, 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
Ulaanbaatar	Institute of Astronomy and Geophysics of Mongolian Academy of Science (IAG-MAS)	Ulaanbaatar, MONGOLIA

Station name	Host agency	City, Country
Wettzell	Geodetic Observatory Wettzell (BKG)	Bad Kötzting, GERMANY
Yarragadee	Yarragadee Geodetic Observatory, Geoscience Australia (GA)	Yarragadee, Western Australia, AUSTRALIA
Yellowknife	Natural Resources Canada (NRCan)	Yellowknife, North-West Territories, CANADA

26 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/resources/ids-publications/newsletter.html (follow Resources > IDS publications > 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 #12 (December 2025)

- On a mission from DORIS in the Himalayas (J. Saunier, IGN)
- The host agency in short: Everest (F. Steffanoni, EvK2CNR)
- Sentinel-6B: DORIS is on (C. Manfredi, CNES)
- IDS was in Athens (L. Soudarin, CLS)
- IDS life

IDS Newsletter #11 (December 2024)

- Contribution of DORIS to Global Ionospheric Scintillation Mapping (M. Cherrier and P. Yaya, CLS)
- DORIS application for the gravity field (A. Löcher, University of Bonn)
- DORIS back in Rapa Nui (J. Saunier, IGN)
- The host agency in short: Hanga Roa (E. Santibáñez, PRS)
- IDS life & DORIS news

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

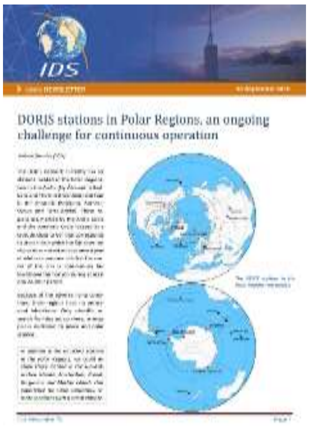
IDS Newsletter #7 (January 2020)

[DORIS in Latin America: more sun, more warmth, and more rhythm](#) (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)



[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

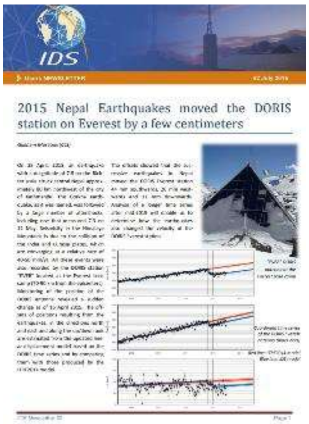
IDS Newsletter #3 (December 2016)


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)


IDS

2015 Nepal Earthquakes moved the DORIS station on Everest by a few centimeters

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

<u>IDS Newsletter #1</u> <u>(April 2016)</u>


IDS

Editorial

A high performing network

[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](#)

27 BIBLIOGRAPHY

A full list of articles related to DORIS published in international peer-reviewed journals since 1985 is available on the IDS website at https://ids-doris.org/resources/articles/doris-bibliography.html (follow Resources > Articles > DORIS bibliography)

The following list compiles the articles published in 2025:

Kotulak, K.; Wang, N.; Krankowski, A.; Li, Z.; Flisek, P.; Froń, A.; Liu, A.; Zakharenkova, I.; Cherniak, I.; Liu, L.; Yuan, Y.; Huo, X., 2025. 'ARTEMIS: Advanced Methodology Development for Real-Time Multi-Constellation (BDS, Galileo and GPS) Ionosphere Services' Project Real-Time Ionospheric Services—Efficiency and Implementation, *REMOTE SENSING*, 17(3):350, DOI : 10.3390/rs17030350

Löcher, A.; Kusche, J.; Nie, Y., 2025. A 40-year record of the Earth's time-variable gravity field from SLR and DORIS, *ADVANCES IN SPACE RESEARCH*, 76(3):1281-1291, DOI : 10.1016/j.asr.2025.05.089

28 GLOSSARY

AAC

Associate Analysis Center

AC

Analysis Center

AGU

American Geophysical Union.

AIR-CAS

Aerospace Information Research Institute under the **Chinese Academy of Sciences**

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

DGFI-TUM

Deutsches Geodätisches Forschungsinstitut (German Geodetic Research Institute) is a research institute of the **Technical University of Munich**.

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.

DORIS 1b

Format of the DORIS preprocessed data (versions DORIS 1.0, DORIS 2.1, DORIS 2.2)

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 for space projects for 17 European countries.

ESA, esa

acronyms for *ESA/ESOC* Analysis Center, Germany

ESOC

European Space Operations Centre (ESA, Germany)

EUMETSAT

EUropean organization 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, POE-F, POE-G

standards of the successive CNES/SOD POD configurations defined for the Geophysical Data Records (GDRs) altimetry products and applied for the DORIS satellites

geoc

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

eop

Specific format for geodetic products: 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); The following Poseidon are: Poseidon-2 (Jason-1), Poseidon-3 (Jason-2), Poseidon-3B (Jason-3), Poseidon-4 (Setinel-6A), Poseidon -3C (Swot).

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. It was launched on November 21, 2020.

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 satellite 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). It was launched on December 16, 2022.

TAI

International Atomic Time (abbreviated TAI, from its French name *temps atomique international*)

TOPEX/Poseidon

Altimetric satellite (NASA/CNES).

TU Delft

Delft University of Technology

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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Studio Graphique CNES, 2026-159

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)**.