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CENTRE NATIONAL D'ÉTUDES SPATIALES

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IDS

ACTIVITY REPORT 2018

International Doris Service

International DORIS Service Activity Report 2018

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International DORIS Service

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Preface

In this volume, the International DORIS Service documents the work of the IDS components between January 2018 and December 2018. The individual reports were contributed by IDS groups in the international geodetic community who make up the permanent components of IDS.

The IDS 2018 Report describes the history, changes, activities and the progress of the IDS. The Governing Board and Central Bureau kindly thank all IDS team members who contributed to this report.

The IDS takes advantage of this publication to relay the thanks of the CNES and the IGN to all of 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_2018.pdf

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ABOUT IDS

1 INTRODUCTION

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

At present, more than 60 groups from 38 different countries participate in the IDS at various levels, including 50 groups hosting DORIS stations in 35 countries all around the globe.

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

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

2 HISTORY

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

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

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

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

In 2018, IDS organized a meeting of the Analysis Working Group on June 11 at CNES in Toulouse (France), in conjunction with the 7th Copernicus POD Quality Working Group meeting dedicated to Sentinel-3, as well a Workshop in Ponta Delgada (Azores Archipelago), Portugal, on September 24-26, as part of the 25 Years of Progress in Radar Altimetry Symposium with the Ocean Surface Topography Science Team (OSTST) meeting.

In 2019, two meetings of the Analysis Working Group are organized: first, in Munich (Germany) on April 4, then in Paris (France) on September 30 and October 1st.

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

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

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

Date	Event	Location
2014	Analysis Working Group Meeting http://ids-doris.org/report/meeting-presentations/ids-awg-03-2014.html IDS workshop http://ids-doris.org/report/meeting-presentations/ids-workshop-2014.html	Paris France Konstanz Germany
2015	Analysis Working Group Meeting http://ids-doris.org/report/meeting-presentations/ids-awg-05-2015.html Analysis Working Group Meeting http://ids-doris.org/report/meeting-presentations/ids-awg-10-2015.html	Toulouse France Greenbelt USA
2016	Analysis Working Group Meeting http://ids-doris.org/report/meeting-presentations/ids-awg-05-2016.html IDS workshop http://ids-doris.org/report/meeting-presentations/ids-workshop-2016.html	Delft The Netherlands La Rochelle France
2017	Analysis Working Group Meeting https://ids-doris.org/ids/reports-mails/meeting-presentations/ids-awg-05-2017.html	London United Kingdom
2018	Analysis Working Group Meeting http://ids-doris.org/report/meeting-presentations/ids-awg-06-2018.html IDS workshop http://ids-doris.org/report/meeting-presentations/ids-workshop-2018.html	Toulouse France Ponta Delgada Portugal

Table 2. List of IDS events organized between 2004 and 2018

IDS retreat 2018

After 15 years of activity, the IDS organized its first retreat on June 13 and 14 at Château de Mons, near the small town of Caussens, in Gascony, in the Southwest of France (country of the Musketeers and Armagnac). In addition to the members of the IDS Governing Board, eleven people including outside members of IDS such as Christian Bizouard (Observatoire de Paris), Klaus Börger (University of Bonn), Pierre Exertier (OCA), Oliver Montenbruck (DLR), Paul Poli (SHOM) were asked to work on the strengths, weaknesses, opportunities and threats of the IDS. To support the general discussions dealing with how to grow or to increase the visibility of the IDS, five subjects of special interest (possible evolution of the DORIS technology, Precise Orbit Determination, interest in ionospheric-tropospheric derived products, DORIS geocenter and pole estimations, IDS scientific goals and organization) were addressed. From the minutes of all the discussions, the IDS Governing Board will write a preliminary version of the IDS strategic plan. The next step will be consultation with the DORIS system stakeholders. Then, the first IDS strategic plan including both medium and long-term actions will be made available.

3 ORGANIZATION

The IDS organization is very similar to the other IAG Services (IGS, ILRS, IVS) and IUGG Service such as IERS (**Figure 1**).

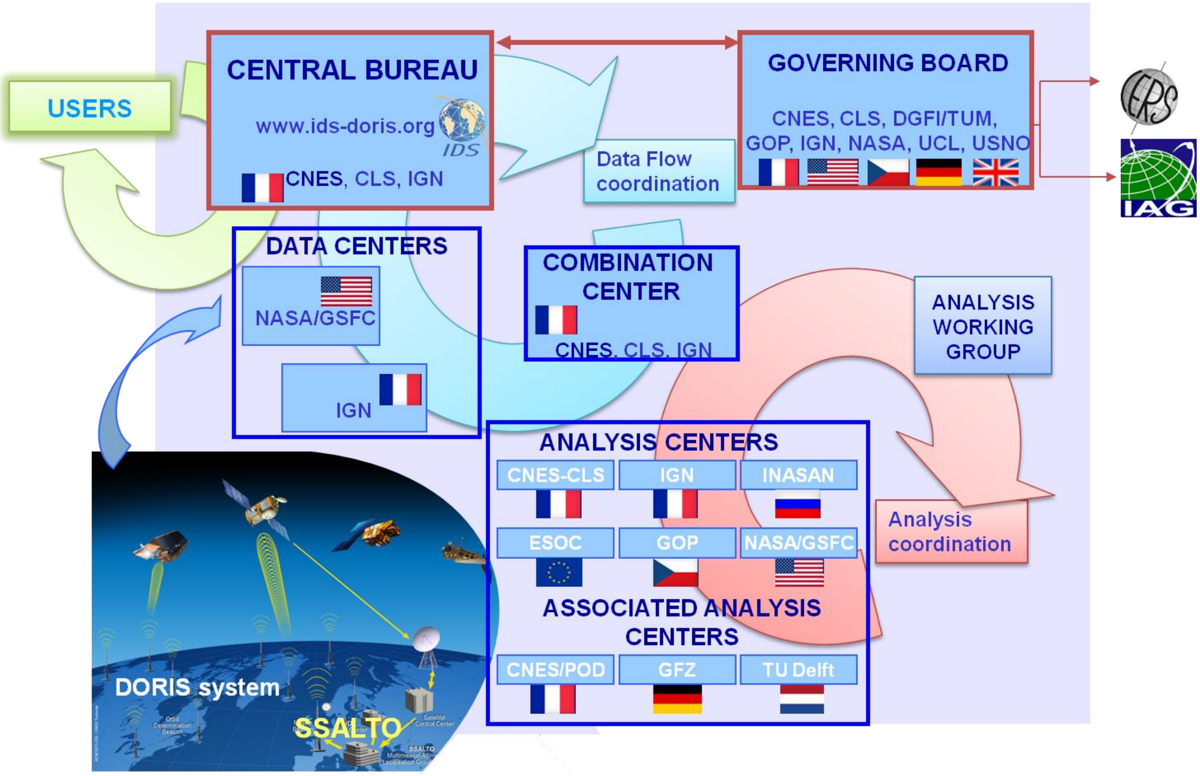


Figure 1. IDS organization

3.1 GOVERNING BOARD

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

The GB consists of eleven voting members and a number of nonvoting members. The membership is chosen to try to strike the right balance between project specialists and the general community.

The elected members have staggered four-year terms, with elections every two years. There is no limit to the number of terms that a person may serve, however he or she may serve only two terms consecutively as an elected member. 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.

The term of two posts expired at the end of 2018. The holders of these posts are: Hugues Capdeville and Jean-Michel Lemoine as tandem team of the Analysis Coordination, and Marek Ziebart as one of the Members at Large. After the elections organized in fall 2018, the new members elected by the IDS Associates for the term 2019-2022 are:

- Hugues Capdeville (CLS) and Petr Štěpánek (Geodetic Observatory Pecny) as Analysis Coordinator,
- Claudio Abbondanza (NASA/JPL) as a Member at Large.

It is important to note that Hugues Capdeville and Petr Štěpánek will share together the responsibility and the work of the Analysis Coordination. From January 1st, 2019, the tandem can be contact at ids.analysis.coordination@ids-doris.org

Because of his new responsibility within the IDS Governing Board, Petr Štěpánek resigned from his position of IAG Representative. IDS will work with the IAG to have another representative designated for 2019-2020.

The IDS congratulates the new members and would like to friendly and warmly thank Jean-Michel and Marek for their valuable contribution to the IDS.

Table 3 gives the list of GB's members since 2003, the members in office on January 1st, 2019, are indicated in bold.

3.2 REPRESENTATIVES AND DELEGATES

IDS representatives and delegates are:

IDS representatives to the IERS:

Analysis Coordinator: Hugues Capdeville (+Jean-Michel Lemoine)
Network representative: Jérôme Saunier

IDS representatives to GGOS consortium: Frank Lemoine, Laurent Soudarin

IDS representative to GGOS Bureau of Networks and Observations: Jérôme Saunier

3.3 CENTRAL BUREAU

In 2018, the IDS Central Bureau is organized as follow:

- Laurent Soudarin CLS (Director)
- Pascale Ferrage CNES
- Jérôme Saunier IGN
- Guilhem Moreaux CLS
- Pascal Willis IGN/IPGP

Position	Term	Status	Name	Affiliation	Country
Analysis coordinator	**2019-2022**	**Elected**	**Hugues Capdeville** **Petr Štěpánek**	**CLS** **Geodetic Obs. Pecny**	**France** **Czech Republic**
	2015-2018	*Elected*	*Hugues Capdeville* *Jean-Michel Lemoine*	*CLS* *CNES/GRGS*	*France*
	2013-2014	*Ext'd*	*Frank Lemoine*	*NASA/GSFC*	*USA*
	2009-2012	*E.b.GB*	*Frank Lemoine*	*NASA/GSFC*	*USA*
	2005-2008		*Frank Lemoine (subst.)*	*NASA/GSFC*	*USA*
	2003-2005		*Martine Feissel-Vernier*	*IGN/Paris Obs.*	France
Data Centers' representative	**2017-2020**	**Elected**	**Patrick Michael**	**NASA/GSFC**	**USA**
	2013-2016	*Elected*	*Carey Noll*	*NASA/GSFC*	*USA*
	2009-2012	*Elected*	*Carey Noll*	*NASA/GSFC*	*USA*
	2003-2008		Carey Noll	NASA/GSFC	USA
Analysis Centers' representative	**2017-2020**	**Elected**	**Frank Lemoine (chair)**	**NASA/GSFC**	**USA**
	2013-2016	*Elected*	*Pascal Willis (chair)*	*IGN+IPGP*	*France*
	2009-2012	*Elected*	*Pascal Willis (chair)*	*IGN+IPGP*	*France*
	2003-2008		*Pascal Willis*	*IGN+IPGP*	*France*
Member at large	**2019-2022**	**Elected**	**Claudio Abbondanza**	**NASA/JPL**	**USA**
	2015-2018	*Elected*	*Marek Ziebart*	*UCL*	*UK*
	2013-2014	*Ext'd*	*John Ries*	*Univ. Texas/CSR*	*USA*
	2009-2012	*E.b.GB*	*John Ries*	*Univ. Texas/CSR*	*USA*
	2003-2008		*John Ries*	*Univ. Texas/CSR*	*USA*
Member at large	**2017-2020**	**Elected**	**Denise Dettmering**	**DGFI/TUM**	**Germany**
	2013-2016	*Elected*	*Richard Biancale*	*CNES/GRGS*	*France*
	2009-2012	*E.b.GB*	*Pascale Ferrage*	*CNES*	*France*
	2003-2008		*Gilles Tavernier (chair)*	*CNES*	*France*
Director of the Central Bureau	**Since 2003**	**App.**	**Laurent Soudarin**	**CLS**	**France**
Combination Center representative	**Since 2013**	**App.**	**Guilhem Moreaux**	**CLS**	**France**
Network representative	**2017-2020**	**App.**	**Jérôme Saunier**	**IGN**	**France**
	2013-2016	*App.*	*Jérôme Saunier*	*IGN*	*France*
	2010-2012		*Bruno Garayt (subst.)*	*IGN*	*France*
	2009	*E.b.GB*	*Hervé Fagard*	*IGN*	*France*
	2003-2008		*Hervé Fagard*	*IGN*	*France*
DORIS system representative	**2017-2020**	**App.**	**Pascale Ferrage**	**CNES**	**France**
	2013-2016	*App.*	*Pascale Ferrage*	*CNES*	*France*
IAG representative	**2019-2020**	**App.**	**To be appointed**		
	2017-2018	*App.*	*Petr Štěpánek*	*Geodetic Obs. Pecny*	*Czech Republic*
	2013-2016	*App.*	*Michiel Otten*	*ESOC*	*Germany*
	2009-2012	*App.*	*Michiel Otten*	*ESOC*	*Germany*
	2003-2008		*Not designed*		
IERS representative	**2017-2020**	**App.**	**Brian Luzum**	**USNO**	**USA**
	2013-2016	*App.*	*Brian Luzum*	*USNO*	*USA*
	2009-2012	*App.*	*Chopo Ma*	*NASA/GSFC*	*USA*
	2003-2008		*Ron Noomen*	*TU Delft*	*Netherlands*

App. = Appointed; Elected = Elected by IDS Associates; E.b.GB = Elected by the previous Governing Board;
Ext'd = Extended term for two years linked to the set-up of the partial renewal process

Table 3. Composition of the IDS Governing Board since 2003

DORIS SYSTEM

4 THE NETWORK

Jérôme Saunier / IGN, France

4.1 GENERAL STATUS AND OPERATION

Challenged by the headwinds last year, the DORIS ground network righted the helm in 2018, which was a very active year in terms of development and enhancement.

With 57 stations (including 4 master beacons and 1 time beacon) that are spatially well distributed over the Earth's land surface, the DORIS permanent network fully meets the orbit determination requirements for satellite altimetry. Two additional DORIS stations are dedicated to IDS for other scientific applications: Wettzell (Germany) and Mangilao (Guam Island, USA) (**Figure 2**).

Notwithstanding the extensive outage of 2 stations (Santa-Cruz and Betio) and the shutdown of the 2 Russian stations (Badary and Krasnoyarsk) for regulation issues (**Figure 3**), the DORIS network provided a reliable service in 2018 with an annual mean of 88% of active sites (**Figure 4**) thanks to the resourcefulness and the combined efforts of CNES, IGN and all agencies hosting the stations: 6 failed beacons and 2 failed antennas were replaced, including Mahé restarted in November after 3-yr outage.

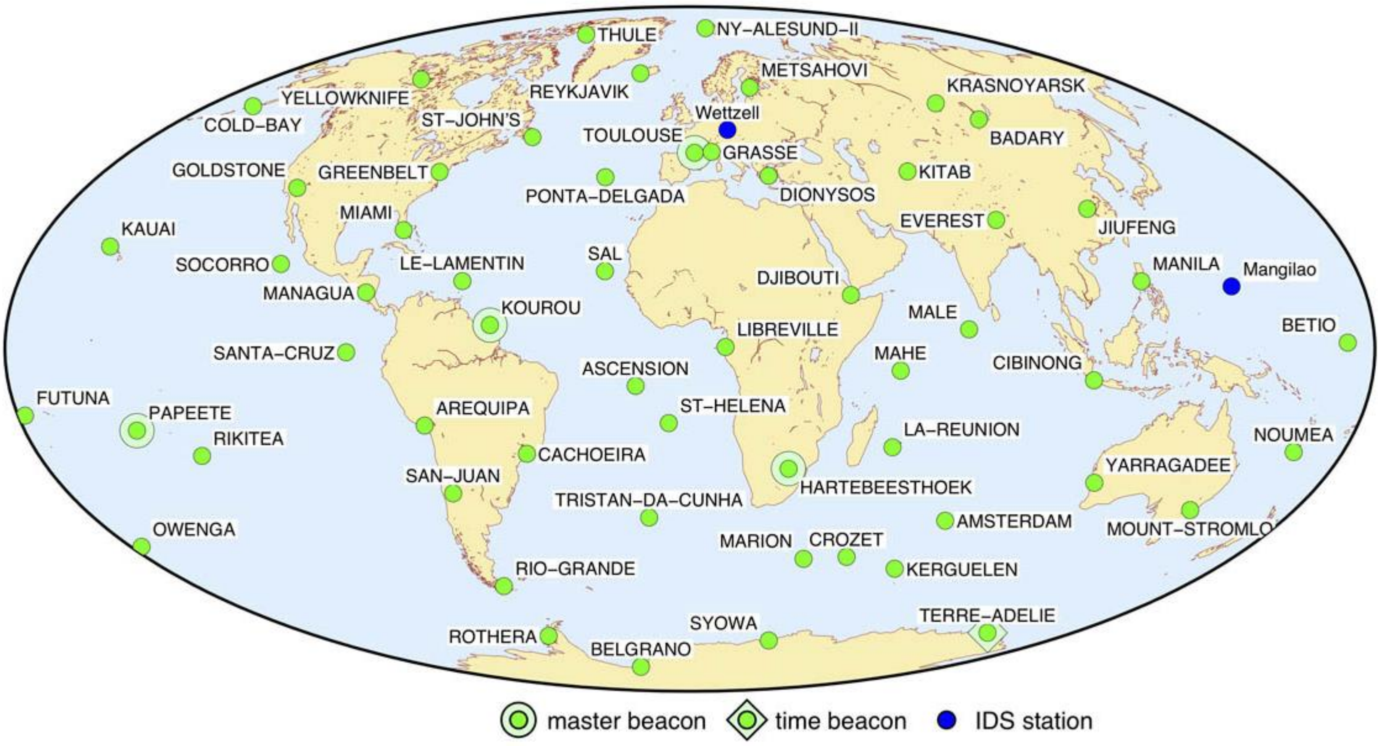


Figure 2. The DORIS permanent network

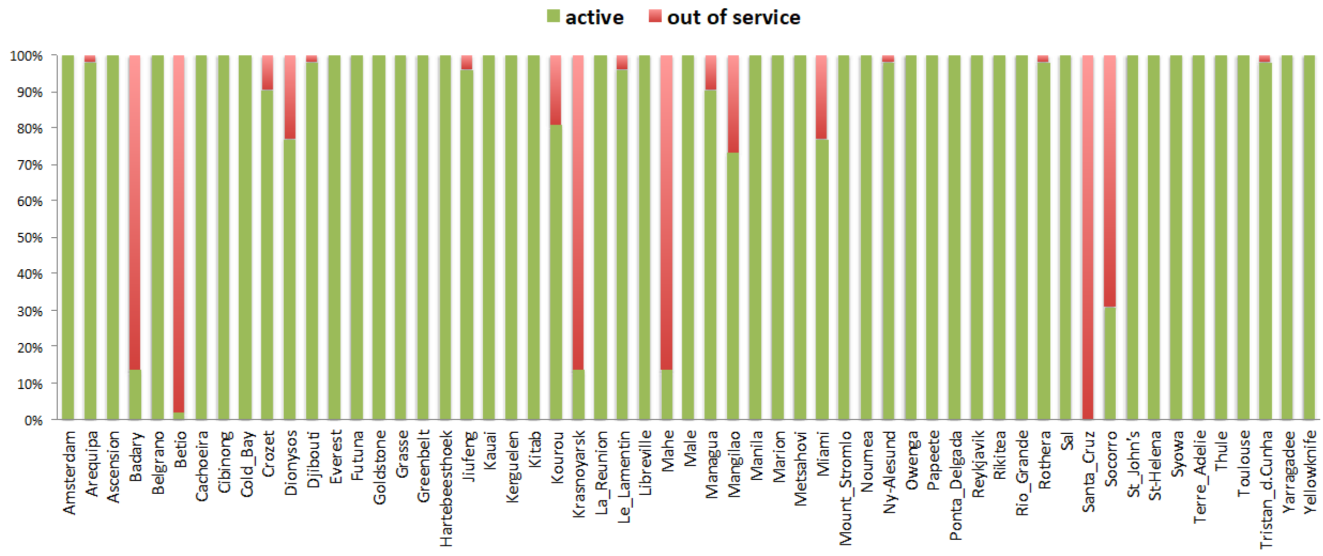


Figure 3. Network activity 2018

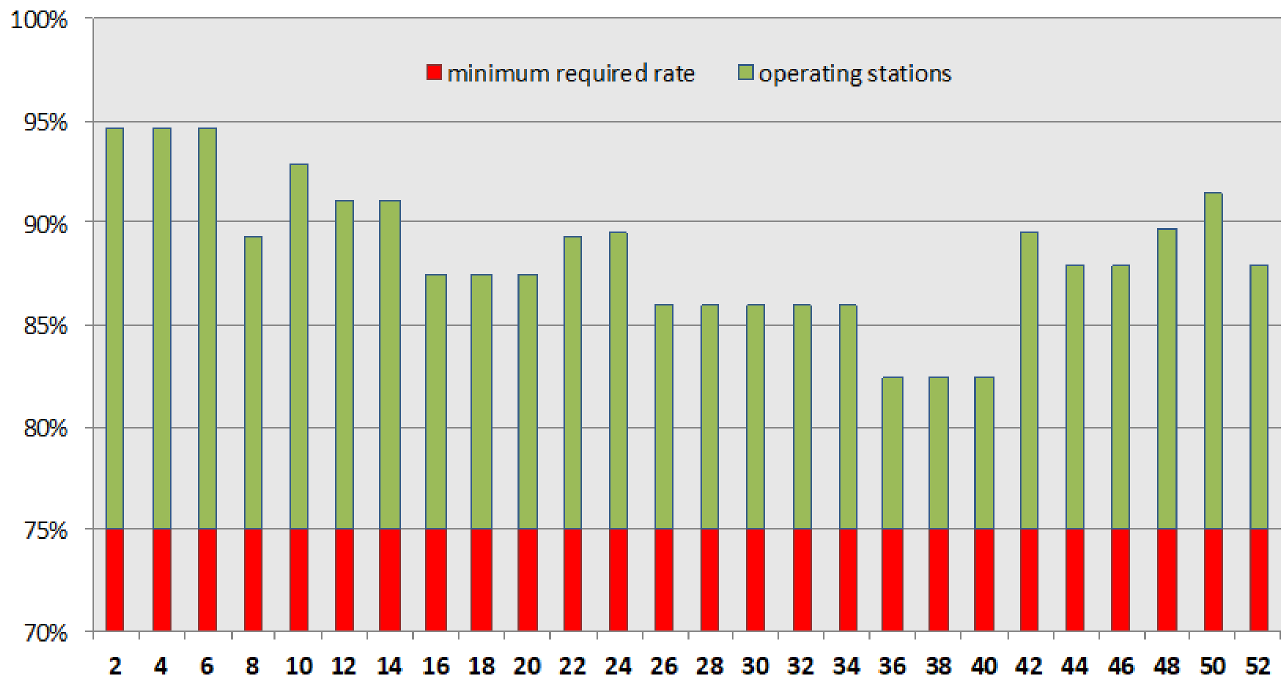


Figure 4. Network availability 2018

4.2 EVOLUTION AND DEVELOPMENT

There have been many developments and maintenance operations for the ground network in 2018. Early in the year, we moved the station at Rothera about 100 m away because of site refurbishment. In April, a new DORIS site has been set up in Guam Island, at Mangilao, close to the IGS station "GUUG" and the tide-gauge of Pago Bay (PSMSL 2130). This station will provide a significant contribution to the coverage of the western North Pacific Ocean over the Micronesia and the Mariana Trench. Then, two main events occurred in Argentina in the last semester: the restarting at Rio Grande after 2-yr outage and the station installation at San Juan. These two stations were both eagerly expected to fill the coverage gap in this area. Finally, in October, the station in Svalbard was relocated about 3 km away to be part of the new geodetic observatory Ny-Ålesund II.

Regarding the network equipment, we continued the gradual replacement of Starec ground antennae B type with C type for which standard uncertainty of the 2GHz phase center in the vertical direction was reduced from 5 mm to 1 mm to improve measurements accuracy. 25% of the network is equipped with such antennae (Starec type C). The 4th DORIS beacon generation is now in its final stage of development. Following the testing of the prototype in 2018, the manufacturer will proceed with the construction of the production models with the first delivery planned in the spring of 2019. Using a signal amplifier at the foot of the antenna, a longer distance between beacon and antenna (up to 50m vs. 15 m before) will make it easier to find suitable environment for the coming antennae installations and give the opportunity to relocate existing antennas to get better visibility.

Co-location with other space geodetic techniques and with tide gauges remains a major objective for the DORIS network. In 2018, we increased the number of co-located DORIS sites with GNSS at Mangilao and Ny-Alesund II, with SLR at San Juan, with VLBI at Ny-Alesund II (**Figure 5**). All tie vectors between DORIS and the other techniques are compiled in the maintained file "DORIS_ext_ties.txt" available on the Central Bureau ftp site and on the IDS data centers.

In 2018 the following sites were visited:

- Re-location in Rothera (Antarctica)
- New site at Guam Island (USA)
- Reconnaissance in Changchun (China)
- Visit at Ponta-Delgada (Azores, Portugal)
- New site at San Juan (Argentina)
- Re-location in Ny-Ålesund (Svalbard, Norway)
- Restarting at Mahé (Seychelles)

In 2019, the overall objectives are:

- Start of the deployment of the 4th generation beacon
- Equipment replacement and local tie survey at St-John's (Canada)
- Reconnaissance in Iceland
- Restarting at Santa-Cruz (Galapagos, Ecuador)
- Restarting at Badary and Krasnoyarsk (Russia)
- New site in Changchun (China)
- Re-location at Easter Island (Chile)

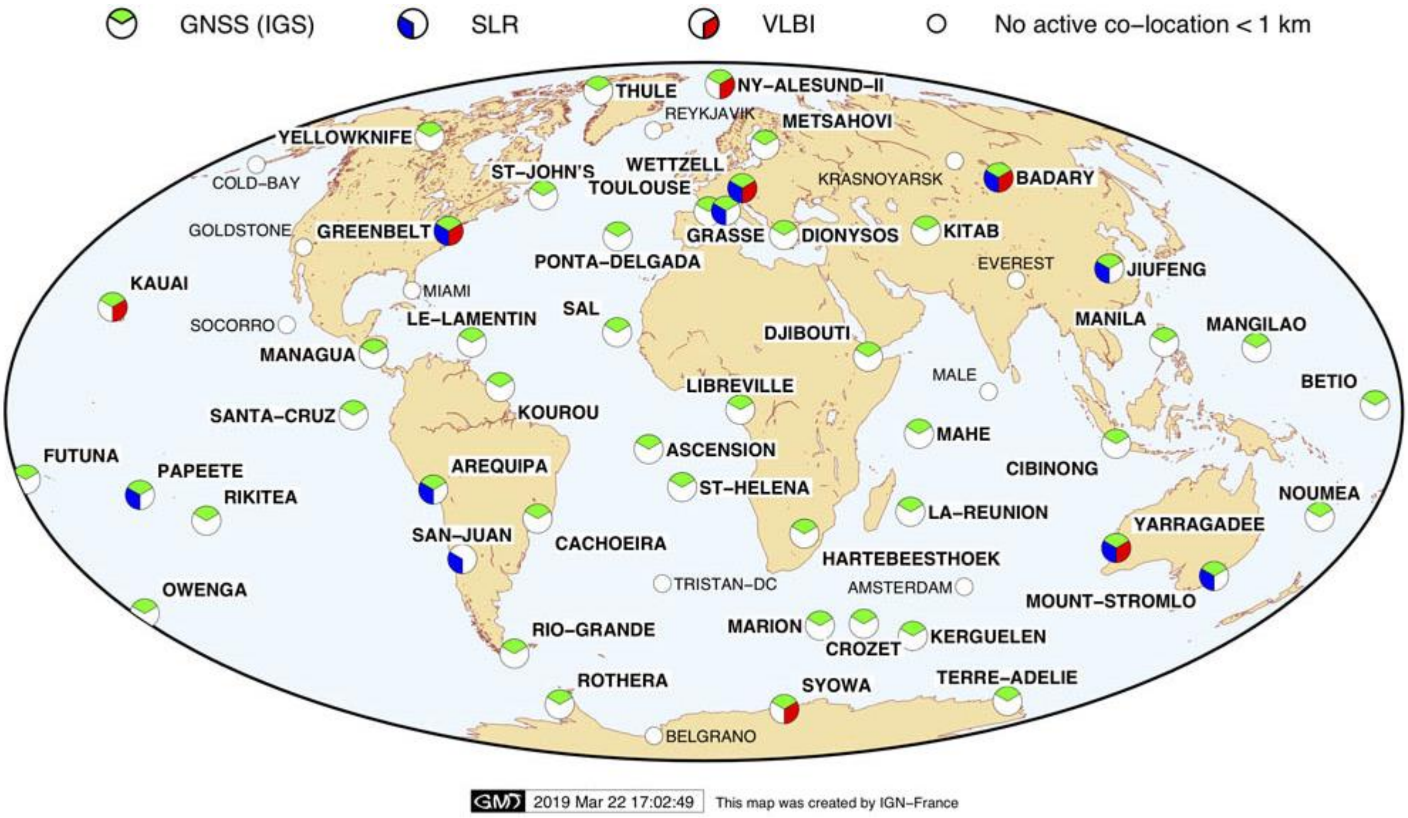


Figure 5. DORIS stations co-located with other IERS techniques

5 THE SATELLITES WITH DORIS RECEIVERS

Pascale Ferrage / CNES, France

5.1 CURRENT MISSIONS

The DORIS system was 28 years old in 2018 and its performance remains unbeatable thanks to permanent enhancements to the system and its components. Fourteen DORIS receivers have flown on various Earth observation and altimetry missions since 1990, and many future missions currently under preparation should guarantee a constellation of DORIS contributor satellites up to 2030 and beyond.

The DORIS constellation includes currently seven satellites at altitudes of 720 and 1300 km, with almost polar or TOPEX-like inclination (66 deg.).

Some of the early SPOT-2 data could not be recovered between 1990 and 1992, due to computer and data format limitations. Except for this time period, all DORIS-equipped satellites have provided continuous data to the IDS data centers. Please note the large increase in the number of DORIS satellites around mid-2002 (**Figure 6**).

Another satellite named STPSAT1 (Plasma Physics and Space Systems Development Divisions, Naval Research Laboratory) launched in March 2007 was equipped with a CITRIS receiver of the DORIS signal. This experiment was dedicated to global ionospheric measurements. Unfortunately, the CITRIS data are not available on IDS Data Centers.

Table 4 gives the list of DORIS mission contributing to IDS, and the data availability.

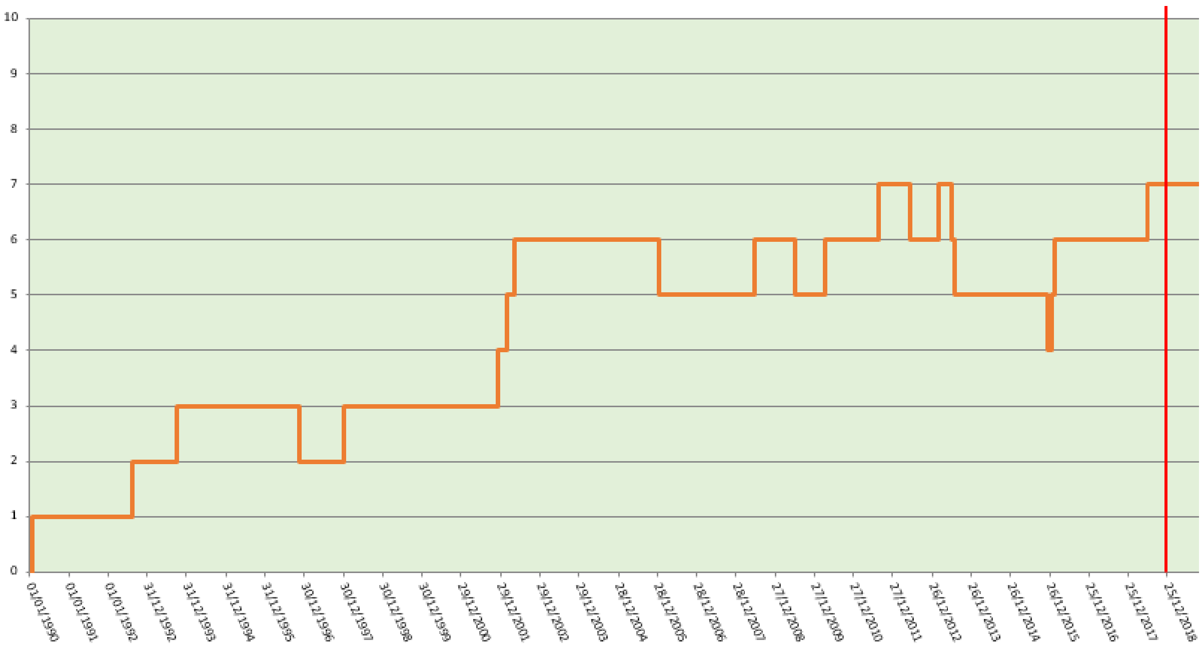


Figure 6. Number of DORIS missions contributing to IDS (December 2018)

Satellite	Start	End	Space Agency	Type	instruments
SPOT-2	31-MAR-1990 04-NOV-1992	04-JUL-1990 15-JUL-2009	CNES	Remote sensing	DG1[1]
TOPEX/Poseidon	25-SEP-1992	01-NOV-2004	NASA/CNES	Altimetry	DG1, SLR, GNSS
SPOT-3	01-FEB-1994	09-NOV-1996	CNES	Remote sensing	DG1
SPOT-4	01-MAY-1998	24-JUN-2013	CNES	Remote sensing	DG1
JASON-1[3]	15-JAN-2002	21-JUN-2013	NASA/CNES	Altimetry	DG2[2], SLR, GNSS
SPOT-5	11-JUN-2002	01-DEC-2015	CNES	Remote sensing	DG2
ENVISAT	13-JUN-2002	08-APR-2012	ESA	Altimetry, Environment	DG2, SLR
JASON-2	12-JUL-2008	PRESENT	NASA/CNES	Altimetry	DGXX[4], SLR, GNSS
CRYOSAT-2	30-MAY-2010	PRESENT	ESA	Altimetry, ice caps	DGXX, SLR
HY-2A	1-OCT-2011	PRESENT	CNSA, NSOAS	Altimetry	DGXX, SLR, GNSS
SARAL/ALTIKA	14-MAR-2013	PRESENT	CNES/ISRO	Altimetry	DGXX, SLR, GNSS
JASON-3	19-JAN-2016	PRESENT	NASA/CNES/NOAA/ Eumetsat	Altimetry	DGXX, SLR, GNSS
SENTINEL-3A	23-FEV-2016	PRESENT	GMES/ESA	Altimetry	DGXX, SLR, GNSS
SENTINEL-3B	25-APR-2018	PRESENT	GMES/ESA	Altimetry	DGXX, SLR, GNSS

Table 4. DORIS missions and data available at IDS data centers (December 2018)

(1) DG1: first DORIS receiver

(2) DG2: In the mid-nineties, CNES developed a second-generation dual channel DORIS receiver that was subsequently miniaturized:

(3) Jason-1 DORIS measurements are affected by the South Atlantic Anomaly (SAA) effect on the on-board Ultra Stable Oscillator (USO) (Willis et al. 2004), however a correction model has been developed (Lemoine and Capdeville 2006).

(4) DGXX: this new generation of DORIS receiver. It was developed starting in 2005. This receiver includes the following main new features:

1. *The simultaneous tracking capability was increased to seven beacons (from only two in the previous generation of receivers)*
2. *The new generation USO design provides better frequency stability while crossing SAA and a better quality of MOE useful for beacon location determination.*
3. *New DIODE navigation software (improved accuracy)*

5.2 FUTURE DORIS MISSIONS

With many future missions lined up, DORIS will continue contributing up to 2030 and beyond (**Figure 7**).

- **HY2-C**, **HY-2D (CNSA/NSOAS)** two Chinese missions flying DORIS are planned for end 2019 and 2020 respectively.

- **Jason-CS** will ensure continuity from Jason-3 with a first launch in 2020 (Jason-CS1/ Sentinel-6A) and 2025 (Jason-CS2 / Sentinel-6B). The Jason-CS / Sentinel satellites are part of the Copernicus program and are the result of international cooperation between **ESA**, **Eumetsat**, the **European Union**, **NOAA**, **CNES** and **NASA/JPL**.

- **SWOT** (Surface Water Ocean Topography) a joint project involving **NASA**, **CNES**, the **Canadian Space Agency** and the **UK Space Agency**, is planned for 2021.

- **Sentinel 3C** and **3D** (ESA/Copernicus) are planned for 2024 and 2025.

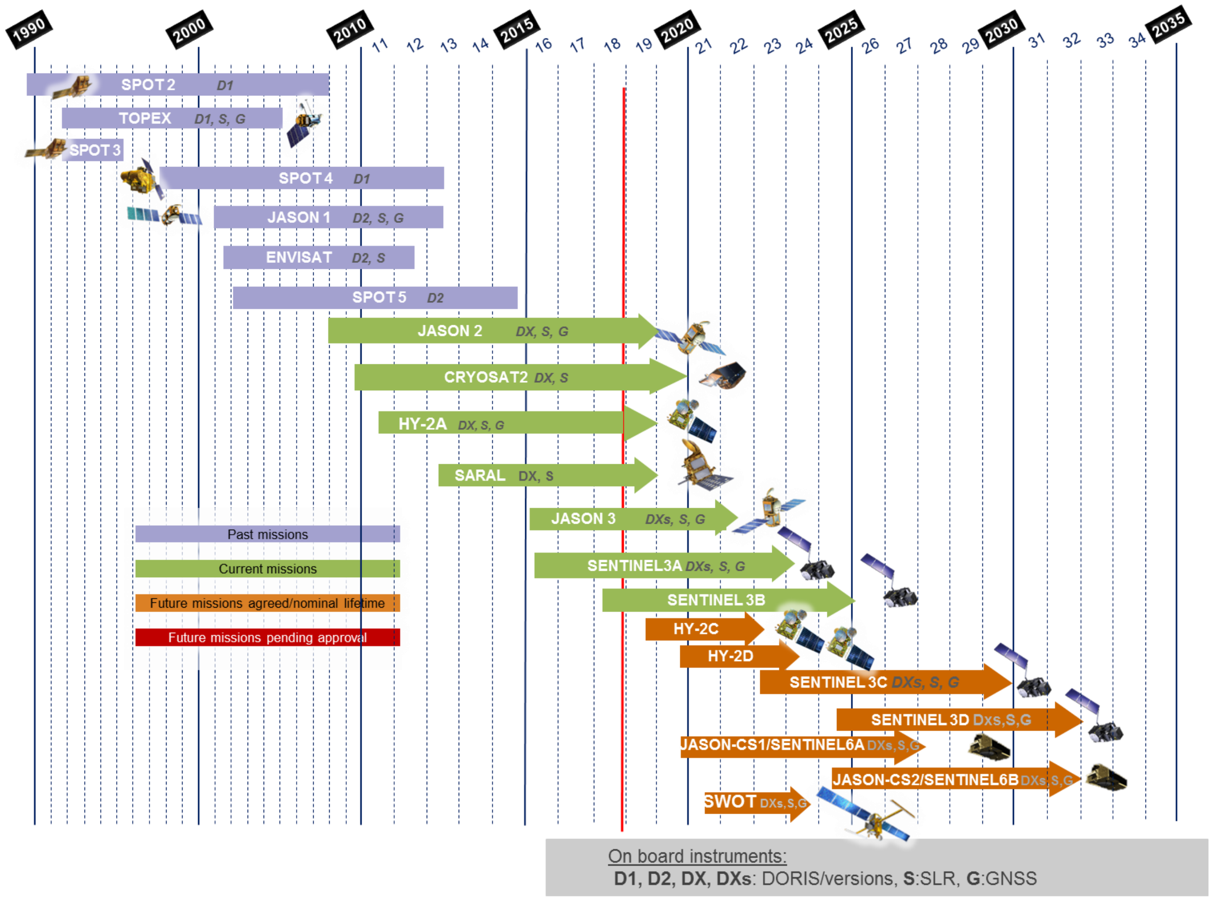


Figure 7. Current and future DORIS missions

USER SERVICE

6 CENTRAL BUREAU

Laurent Soudarin [1], Pascale Ferrage [2]
[1] CLS, France / [2] CNES, France

The Central Bureau (CB), funded by CNES and hosted at CLS, is the executive arm of the Governing Board (GB) 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 supports to the IDS components and operates the information system. This report summarizes the activities of the IDS Central Bureau during the year 2018 and forecasts activities planned for 2019. An overview of the IDS information system is reminded in appendix.

6.1 GENERAL ACTIVITIES

6.1.1 ELECTIONS FOR THE GOVERNING BOARD

In accordance with the Terms of Reference of the IDS, two positions in the IDS Governing Board became vacant at the end of 2018: the Analysis Coordinator and one Member-at-large. The CB managed the actions related to the renewal of these members for the next 4-year term 2019-2022. IDS associates were invited to nominate candidates for the two open positions. The elections were held from Dec. 1 to Dec.15, 2018.

The members elected by the IDS Associates are:

• Analysis Coordinator tandem: Hugues Capdeville (CLS, France) & Petr Štěpánek (Pecny Observatory, Czech Republic)

• Member-at-large Claudio Abbondanza (NASA/JPL, USA)

6.1.2 SERVICE DESK

Questions from users concerning IDS data and products were answered or forwarded to experts.

6.1.3 REPORTS

The CB managed the edition and publication of the IDS Activity Report 2017. It also produced the IDS contributions to IERS Annual report 2017.

6.1.4 MEETINGS

The Central Bureau participated in the organization of the AWG meeting held at CNES in Toulouse, France, on June 11, the IDS retreat on June 13 and 14 at Château de Mons, France, and the IDS Workshop in Ponta Delgada (Azores Archipelago), Portugal, on September 24 to 26. It documented the GB meetings held on these occasions. Between the meetings, the CB coordinates the work of the GB.

6.1.5 COMMUNICATION

The CB promoted the use of IDS data and products with presentations in the following meetings:

- EGU, Vienna, April: "IDS webservices for sharing data and products of the International DORIS service" (Soudarin, Ferrage).
  https://ids-doris.org/images/documents/report/publications/EGU2018-IDSwebserviceForSharingDataProducts.pdf (poster)
- IDS AWG meeting, Toulouse, June: "IDS news" (Soudarin).
  https://ids-doris.org/images/documents/report/AWG201806/IDSAWG201806-Soudarin-IDSnews.pdf (slides)
- IDS Workshop 2018, Ponta Delgada, September: "The International DORIS Service: status report" (Soudarin, Ferrage).
  https://ids-doris.org/images/documents/report/ids_workshop_2018/IDS18_s1_Soudarin_IDSstatus.pdf (slides)
- AGU, San Francisco, December: "DORIS and the International DORIS Service: Current status and planned evolution" (Lemoine, Saunier, Jayles, Ferrage, Moreaux, Soudarin)
  https://ids-doris.org/documents/report/meetings/AGU2018_IDS_CurrentStatusAndPlannedEvolution.pdf (poster)

6.1.6 NEWSLETTERS

IDS Newsletter #5 was published in September 2018. It contains the following article:

- 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)

In addition, the section "IDS life" provides information about the service.

The newsletter is distributed via email to the subscribers to the DORISmail and several identified managers and decision-makers. The issues are available for downloading on the IDS website at https://ids-doris.org/ids/reports-mails/newsletter.html.

The published newsletters and their contents are listed in **Table 5**.

Newsletter	Article title	Authors
#1 April 2016	Editorial A high performing network Two new DORIS instruments in orbit DORIS back in Goldstone DORIS contributes to the International Terrestrial Reference Frame IDS life: -GFZ first Associated Analysis Center -IDS Meetings 2016 -IDS component renewal	L. Soudarin (CLS) J. Saunier (IGN) P. Ferrage and C. Manfredi (CNES) J. Saunier (IGN) G. Moreaux (CLS) L. Soudarin (CLS)
#2 July. 2016	2015 Nepal Earthquakes moved the DORIS station on Everest by a few centimeters DORIS-VLBI compatibility tests at the Geodetic Observatory Wettzell DORIS in Managua IDS life: -IDS AWG meeting at the TU Delft -IDS Workshop La Rochelle -IDS component renewal	G. Moreaux (CLS) T. Klügel (BKG) J. Saunier (IGN) L. Soudarin (CLS)
#3 Dec. 2016	IDS held its Workshop 2016 in La Rochelle Looking back over 30 years of DORIS network development Six DORIS receivers operating in orbit and several more to come IDS life: -IDS election results -Combination Center selection	L. Soudarin (CLS) J. Saunier (IGN) P. Ferrage (CNES) L. Soudarin (CLS)
#4 Nov. 2017	Station re-location at Kitab (Uzbekistan) to get better visibility The host agency in short: UBAI DPOD2014: a new DORIS extension of ITRF2014 for Precise Orbit Determination IDS life: -Two new Associate Analysis Centers -Creation of the Working Group “NRT DORIS data” -IDS Retreat	J. Saunier (IGN) D. Fazilova, S. Ehgamberdiev (UBAI) G. Moreaux (CLS) L. Soudarin (CLS)

Newsletter	Article title	Authors
#5 Sep. 2018	DORIS stations in Polar Regions, an ongoing challenge for continuous operation Focus on Rothera on the Antarctic Peninsula	J. Saunier (IGN)
	The host agency in short: BAS	D. G. Vaughan (BAS)
	DORIS on Sentinel-3B: and now seven! Jason-2, ten years after	CNES
	IDS meetings: a time to remove the nose from the grindstone - IDS retreat - IDS Analysis Working Group meeting	G. Moreaux, L. Soudarin (CLS)
	IDS life: -IDS workshop 2018 -IDS elections -IDS activity report 2017	L. Soudarin (CLS)
#6 Feb. 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)
	The host agency in short: CIVISA	R. T. Fernandes Marques (CIVISA)
	Tribute to Richard Biancale (1952-2019)	F. Lemoine (NASA), L. Soudarin (CLS), J.-M. Lemoine (CNES), P. Ferrage (CNES), J.-P. Boy (EOST)
	IDS life: -IDS election results -Visit to the Ponta Delgada DORIS station -IDS Workshop 2018	L. Soudarin (CLS)

Table 5. Published IDS newsletters and their contents

6.2 DATA INFORMATION SERVICE

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 2018, this activity focused on:

- the delivery of Sentinel-3B's DORIS data (first data on IDS DCs in DORIS-RINEX format only with DIODE time tagging on May 1st, 2018)
- the delivery of the CNES orbits in POE-F standards (file naming, store folders, description files)
  See [ftp CDDIS or IGN] pub/doris/products/orbits/ssa/README_SP3.txt

The Central Bureau also interfaced with the Combination Center for making available the DORIS SINEX master file that contains for each DORIS station geographic positions, station IDs, type and eccentricity of the antennas. See ftp://ftp.ids-doris.org/pub/ids/stations/ids.snx

6.3 DOR-O-T, THE IDS WEB SERVICE

Address: https://ids-doris.org/webservice

Several new features were added to the IDS web service in 2018.

- Network viewer (https://apps.ids-doris.org/apps/map.html).

In addition to the DORIS network and the IGS co-located stations, it is now possible to display the boundaries of the tectonic plates (Bird, 2003), the large Earthquakes (magnitude greater or equal to 6) within a 500 km radius of the DORIS stations (source USGS), as well as the horizontal and vertical velocity vectors of the DPOD2014 solution. When the velocity vectors are showed, rates are displayed on mouse-over. Rates (North, East and Up; in mm/yr) can also been seen in the list of information linked to each station, obtained by clicking on a station. This list includes now local events, i.e., the events of the station (dates of installation, change of beacon equipment, Earthquakes in the vicinity).

- Plottools

Statistics can be updated for the displayed points over time period defined by the timeline. New additional data are proposed to be superimposed on the time series: discontinuities of position and velocity (defined by IDS CC), and number of operating satellites for each time span.

- Plottool for position residuals (https://apps.ids-doris.org/apps/dpodtool.html)

This new plottool was created to plot the position residuals (North, East, Up) of the cumulative solution derived from the routine analysis of the IDS Combination Center.

6.4 IDS WEBSITE

Address: https://ids-doris.org

Pages of the website are regularly updated, and new documents added:

- The presentations of the IDS Workshop 2018 were put on line.
  https://ids-doris.org/ids/reports-mails/meeting-presentations.html#ids-workshop-2018
- The presentations of the AWG meeting held at CNES in Toulouse on June 11 were put on line.
  https://ids-doris.org/ids/reports-mails/meeting-presentations.html#ids-awg-06-2018

The page of Analysis Coordination's Documents was completed with the minutes of the Analysis Working Group Meeting in Toulouse.
http://ids-doris.org/report/analysis-coordination.html

- The activity reports for 2017 (IDS Activity report, report for IERS) as well as the minutes of the IDS GB meetings held in 2018 (Toulouse, Ponta Delgada) and several presentations in meetings (IERS DB, GGOS, ...) were added on the page of the Governing Board's documents.
http://ids-doris.org/report/governing-board.html

- The list of the peer-reviewed publications related to DORIS has been enriched with new references of articles published in 2018.
http://ids-doris.org/report/publications/peer-reviewed-journals.html#2018

- Some maps were added or updated
https://ids-doris.org/doris-system/tracking-network/maps.html

Besides, the website was enriched with new pages and received some changes. The main updates of 2018 are reported hereafter.

- A new page Outreach material was created. It gathers links to the videos, leaflets and newsletters as well as some material to discover DORIS
https://ids-doris.org/ids/reports-mails/outreach-material.html

- The section "Reports & mails" has been renamed "Documentation" and one of its pages, the page "Documentation" (with the links to the pages where the documentation provided by the IDS is stored) has been renamed "Overview". So, this page is accessible through the menu by following now "IDS > Documentation > Overview", but its URL is unchanged:
https://ids-doris.org/ids/reports-mails/documentation.html
- The page "Documents related to data analysis" in the section "Analysis Coordination" has been renamed "Documents for the data analysis" and its category "General" has been modified. The URL of the page is unchanged:
https://ids-doris.org/analysis-coordination/documents-related-to-data-analysis.html

6.5 IDS FTP SERVER

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

The documents and files put on the IDS ftp site in 2018 are listed hereafter.

New files:

- Input data for HY2 Precise Orbit Determination
ftp://ftp.ids-doris.org/pub/ids/satellites/HY2_InputDataForPOD.pdf

- Jason-3 characteristics for POD processing
ftp://ftp.ids-doris.org/pub/ids/satellites/Jason-3_CharacteristicsForPODprocessing.pdf

- POE-F configuration for CNES POD
ftp://ftp.ids-doris.org/pub/ids/data/POD_configuration_POEF.pdf

Updated files:

- History files of events in ftp://ftp.ids-doris.org/pub/ids/events/
- DORIS internal ties
ftp://ftp.ids-doris.org/pub/ids/stations/DORIS_int_ties.txt
- recommended initial values of mass and center of gravity coordinates
ftp://ftp.ids-doris.org/pub/ids/satellites/MassCoGInitialValues.txt

Updated documents:

- « DORIS satellites models implemented in POE processing » with Sentinel-3B added and update on Saral and Sentinel-3A DORIS Center of Phase locations
ftp://ftp.ids-doris.org/pub/ids/satellites/DORISSatelliteModels.pdf

6.6 FUTURE PLAN

In 2019, the Central Bureau will participate in the organization of meeting of the Analysis Working Group at CNES, Paris, France, on September 30 and October 1 (https://ids-doris.org/ids/reports-mails/meeting-presentations/ids-awg-09-2019.html). It will also organize the meetings of the Governing Board scheduled in 2019.

The Central Bureau plans to improve user navigation on the website, and to work with the Data Centers to check the completeness of the data deliveries. Two IDS Newsletters will be issued in 2019.

The Central Bureau will continue to guide any new users who want to get involved in DORIS activities.

7 IDS DATA FLOW COORDINATION

Patrick Michael / NASA GSFC, USA

7.1 INTRODUCTION

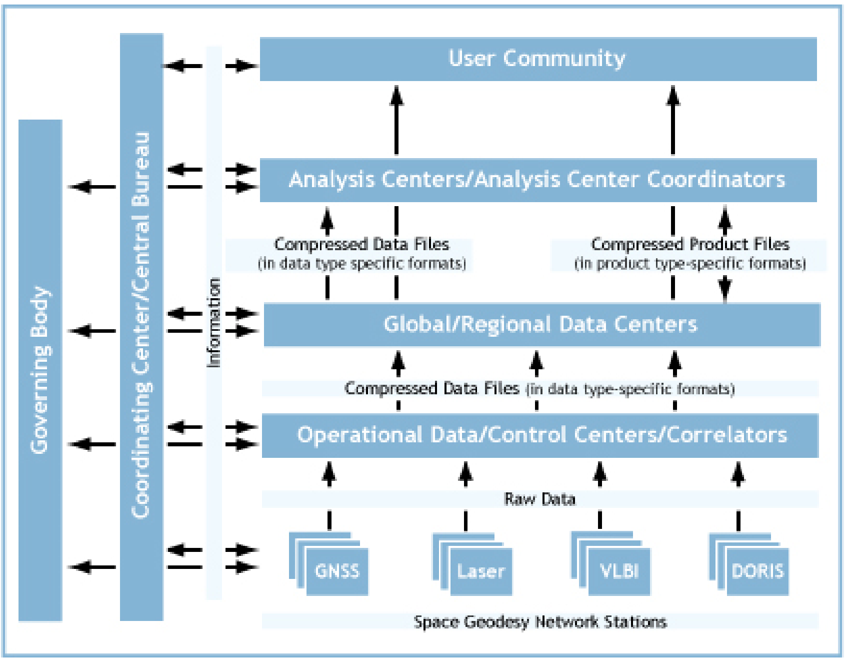
Two data centers support the archiving and access activities for the IDS:

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

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

7.2 FLOW OF IDS DATA AND PRODUCTS

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



Network Stations
- Continuously operational
- Timely flow of data

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

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

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

Governing Body
- General oversight of service
- Future direction

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

The IDS data centers use a common structure for directories and filenames that was implemented in January 2003. This structure is shown in **Table 6** and fully described on the IDS website at:

https://ids-doris.org/ids/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 campaign and satellite code
- */doris/cb_mirror* (duplicate of the IDS Central Bureau ftp site) with general information and data and product documentation (maintained by the IDS Central Bureau)
- */doris/general* (for miscellaneous information and summary files)

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

Directory	File Name	Description
Data Directories		
/doris/data/sss	sssdataMMM.LLL.Z sss.files	DORIS data for satellite sss, cycle number MMM, and version LLL File containing multi-day cycle filenames versus time span for satellite sss
/doris/data/sss/sum	sssdataMMM.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	sssrxYYDDD.LLL.Z	DORIS data (RINEX format) for satellite sss, date YYDDD, version number LLL
/doris/data/sss/yyyy/sum	sssrxYYDDD.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/qbodyYYYYMMDDHHMISS_yyyymmddhhmiss.LLL sss/qsolpYYYYMMDDHHMISS_yyyymmddhhmiss.LLL	Spacecraft body quaternions for satellite sss, year yyyy, start date/time YYYYMMDDHHMISS, end date/time yyyymmddhhmiss, and version number LLL Spacecraft solar panel angular positions for satellite sss, year yyyy, start date/time YYYYMMDDHHMISS, end date/time yyyymmddhhmiss, and version number LLL
/doris/cb_mirror		Mirror of IDS central bureau files

Table 6. Main Directories for IDS Data, Products, and General Information

7.3 DORIS DATA

SSALTO deposits DORIS data to the CDDIS and IGN servers. Software at the data centers scans these incoming data areas for new files and automatically archives the files to public disk areas using the directory structure and filenames specified by the IDS. Today, the IDS data centers archive DORIS data from seven operational satellites (CryoSat-2, HY-2A, Jason-2, Jason-3, SARAL, Sentinel-3A, and Sentinel-3B); data from future missions will also be archived within the IDS. Historic data from Envisat, Jason-1, SPOT-2, -3, -4, -5, and TOPEX/Poseidon, are also available at the data centers. A summary of DORIS data holdings at the IDS data centers is shown in **Table 7**. The DORIS data from select satellites are archived in multi-day (satellite dependent) files using the DORIS data format 1.0 (before January 2002), 2.1, or 2.2 (since June 2008). 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.

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 present	Multi-day, RINEX
Jason-1	15-Jan-2002 through 21-Jun-2013	Multi-day
Jason-2	12-Jul-2008 through present	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
SPOT-2	31-Mar through 04-Jul-1990 04-Nov-1992 through 14-Jul-2009	Multi-day
SPOT-3	01-Feb-1994 through 09-Nov-1996	Multi-day
SPOT-4	01-May-1998 through 24-Jun-2013	Multi-day
SPOT-5	11-Jun-2002 through 30-Nov-2015	Multi-day
TOPEX/Poseidon	25-Sep-1992 through 01-Nov-2004	Multi-day

Table 7. DORIS Data Holdings Summary

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

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

ftp://cddis.nasa.gov/doris/campdata/saacorrection/ja1
ftp://cddis.nasa.gov/doris/campdata/saacorrection/sp5
https://cddis.nasa.gov/archive/doris/campdata/saacorrection/ja1
https://cddis.nasa.gov/archive/doris/campdata/saacorrection/sp5

7.4 DORIS PRODUCTS

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

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

A solution (designated “ids”) produced by the IDS combination center from the individual IDS AC solutions started production in 2012. IDS products are archived by type of solution and analysis center. The types and sources of products available through the IDS data centers in 2005-2018 are shown in **Table 8**. This table also includes a list of products under evaluation from several DORIS analysis centers.

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

*Note: GAU and SOD historic solutions

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

Table 8. IDS Product Types and Contributing Analysis Centers

7.5 SUPPLEMENTARY DORIS INFORMATION

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

7.6 FUTURE PLANS

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

8 IDS DATA CENTERS

8.1 CRUSTAL DYNAMICS DATA INFORMATION SYSTEM (CDDIS)

Patrick Michael, Carey Noll / NASA GSFC, USA

8.1.1 INTRODUCTION

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

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

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

8.1.2 OPERATIONAL ACTIVITIES

At the end of 2018, the CDDIS has devoted nearly 119 GB of disk space (64GB or ~54% for DORIS data, 31GB or ~26% for DORIS products, and 23GB or ~19% for DORIS ancillary data and information) to the archive of DORIS data, products, and information. During the past year, users downloaded approximately 6100 Gbytes (3.4M files) of DORIS data, products, and information from the CDDIS.

In 2017, CDDIS developed all new software to automate the ingest of data submitted by SSALTO and in 2018 add product ingest as well. This new software is a significant improvement over the previous process and performs a full range of quality-checks and metadata extraction. The software uses these new checks and metadata to generate a summary file for each data file. All incoming DORIS data have its metadata extracted and stored in a local database. These metadata, which includes satellite, time span, station, and number of observations per pass, and are utilized to generate data holding reports on a daily basis.

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

8.1.3 RECENT ACTIVITIES AND DEVELOPMENTS

During 2017, the CDDIS developed all new software to handle the ingest of GNSS, SLR, and DORIS data and in 2018 the software was upgraded to handle products as well. This new software allows for more automated operation, much improved quality-checks, and a new metadata extraction process and storage method all leading to improved efficiency in processing incoming data. CDDIS's goal is that all incoming files are quality-checked, metadata extracted, and processed into the archive within 30 seconds of being received. A schematic diagram of the current CDDIS architecture is shown in **Figure 9**.

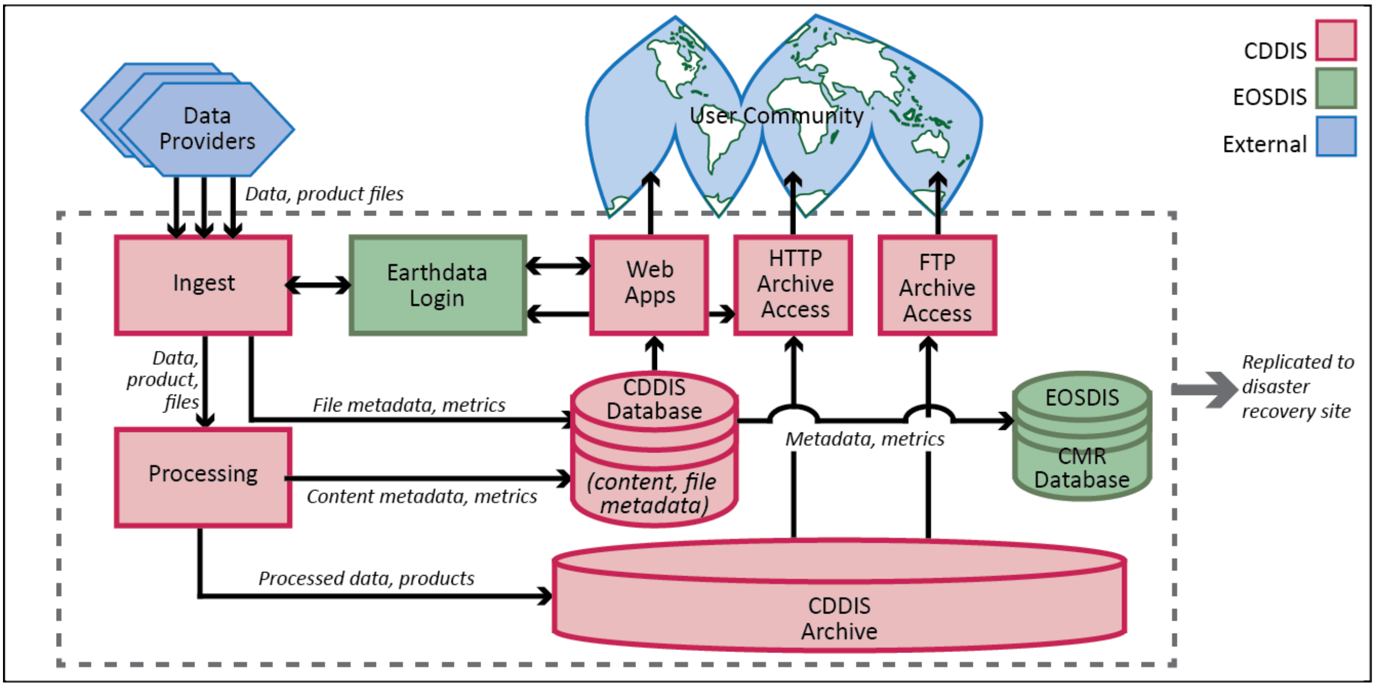


Figure 9. System architecture overview diagram for the new CDDIS facility installation within the EOSDIS infrastructure

8.1.4 FUTURE PLANS

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

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

The CDDIS continues to review and update its ingest procedures to both decrease latency of file delivery to the public archive and to continually improve quality control checks to all incoming data and products. In addition, CDDIS has made its archive fully available through https and will soon add ftp-ssl access as well.

In response to increased Information Technology (IT) security requirements from both the U.S. Government and NASA, CDDIS will be forced to remove anonymous ftp access to its archive in the fall of 2020. CDDIS strongly suggests that the science community begin moving to https or ftp-ssl to ensure that they are able to continue to download the needed data and products for their operations come fall 2020.

8.1.5 CONTACT

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WWW:	https://cddis.nasa.gov
Archive access:	ftp://cddis.nasa.gov/doris
	https://cddis.nasa.gov/archive/doris
Technical support:	support-cddis@earthdata.nasa.gov

8.2 IGN DORIS DATA CENTER

Bruno Garayt / IGN, France

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

- a FTP deposit server for data and analysis centers uploads, requiring special authentication
- a free FTP anonymous access to the observations and products
- an independent Internet links.

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

- ftp://doris.ensg.eu for the Marne-la-Vallée site
- ftp://doris.ign.fr for the Saint-Mandé site

8.2.1 CONTACT

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ANALYSIS ACTIVITIES

9 ANALYSIS COORDINATION

***Hugues Capdeville* [1]*, Jean-Michel Lemoine* [2]**
[1]*CLS, France /* [2] *CNES/GRGS, France*

9.1 INTRODUCTION

The activities of all the DORIS analysts of the past year 2018 have been dominated by taking into account the last DORIS satellites Jason-3, Sentinel-3A and Sentinel-3B for which DORIS data are only available in RINEX format, defining the best strategy to mitigate the impact of the sensitivity to the South Atlantic Anomaly (SAA) effect of DORIS Ultra Stable Oscillator (USO) and starting the preparation of the next ITRF contribution.

The last meeting of the IDS Analysis Working Group (AWG) was hosted in CNES, Toulouse, on June 11, 2018 in conjunction with a meeting of the Copernicus POD Quality Working Group. The IDS workshop 2018 was held on 24 to 26 September 2018 in Ponta Delgada (Azores Archipelago, Portugal), as part of the 25 Years of Progress in Radar Altimetry Symposium with the Ocean Surface Topography Science Team (OSTST) 2018.

The next IDS Analysis Working Group will be held in Munich (Germany) hosted by DGFI, on Thursday April 4, 2019.

9.2 ANALYSIS ACTIVITY OVERVIEW

All the IDS Analysis Centers (AC) continue the standard routinely processing by considering the last DORIS data available. The IDS includes six ACs and three “associate analysis centers” who use seven different software packages, as summarized in **Table 9**. We also note which analysis centers on a routine basis perform POD analyses of DORIS satellites using other geodetic techniques (c.f. Satellite Laser Ranging (SLR), or GNSS). The multi-technique analyses are useful since they can provide an independent assessment of DORIS system performance and allow us to validate more easily model changes and the implementation of attitude laws for the different spacecraft, in the event spacecraft external attitude information (in the form of spacecraft quaternions) is not available. The participation of the Deutsches Geodaetisches Forschungsinstitut der Technischen Universitaet Muenchen (DGFI-TUM, represented by Mathis Blossfeld) and other potential IDS ACs should continue to be encouraged.

Name	AC	AAC	Location	Contact	Software	Multi-technique
ESA	✓		Germany	Michiel Otten	NAPEOS	SLR, GNSS
GOP	✓		Czech Republic	Petr Stepanek	Bernese	
GRG	✓		France	Hugues Capdeville	GINS	SLR, GNSS
GSC	✓		USA	Frank Lemoine	GEODYN	SLR
IGN	✓		France	Pascal Willis	GIPSY	
INA	✓		Russia	Sergei Kuzin	GIPSY	
CNES		✓	France	Alexandre Couhert	Zoom	SLR, GNSS
GFZ		✓	Germany	Rolf Koenig	EPOS-OC	SLR, GNSS
TU Delft		✓	The Netherlands	Ernst Schrama	GEODYN	SLR

Table 9 . Summary of IDS Analysis Centers

9.3 STRATEGY TO MITIGATE SENSITIVITY TO THE SAA EFFECT OF DORIS USO

The behavior of the various DORIS on-board oscillators in the vicinity of the high radiation area "South Atlantic Anomaly" (SAA) has been studied. It has been shown by different ACs (and associated) that all DORIS receivers are frequency-sensitive to the crossing of the SAA, though at very different levels. For Jason-1 and SPOT-5 satellites, a corrective model has been developed and used for the realization of the ITRF2014. However, Jason-2 is also impacted, not at the same level as Jason-1 but strong enough to worsen the multi-satellite solution provided for ITRF2014 for the SAA stations. The last DORIS satellites are also impacted by the SAA effect, in particular Jason-3. Currently we have the following possibilities to mitigate the SAA effect.

For Spot-5 and Jason-1, ACs can use the DORIS2.2 data corrected by the models available at CDDIS and IGN Data Centers. Note, for Jason-1 the corrective model is also available. For Jason-2 and Jason-3, ACs can adjust at least a bias+drift by pass for SAA stations in their POD processing. We could use better corrected frequency model for Jason-2 and Jason-3 USO when Belli et al. will demonstrate their efficiency and will make them available.

We can also use the strategy to add single satellite solution affected by the SAA in the multi-satellite solution. This method was tested and adopted for Jason-1 for the ITRF2014. Before combining single satellite solution affected by SAA to the other single satellite solutions, we rename the SAA stations (and all their adjusted parameters) so these SAA stations from this single satellite do not contribute to the realization of the combined solution.

9.4 HOW DORIS CAN CONTRIBUTE TO FUTURE REALIZATIONS OF THE ITRF ORIGIN DORIS

The space-geodetic observation of geocenter motion is still in its infancy. Independent solutions have systematic differences as large as the signal level. The ITRF origin is only sensed by SLR observations of the LAGEOS-1 and 2 satellites. There are other techniques than SLR (DORIS, GPS-LEO satellites). The DORIS and GNSS tracking networks are stable and uniquely well distributed geographically and other missions than the LAGEOS satellites (other spherical satellites, Jason-2/3) which can observe geocenter motion, in both competitive and independent manner. The number of laser range normal point data for Jason-2/3 is two to three times higher than for the LAGEOS satellites.

DORIS can play a role because the tracking network is stable and well-distributed (reduces network effects). The sun-synchronous satellites should be disregarded (β'≈365 days). Solar Radiation Pressure (SRP) modeling deficiencies primarily affects the Z geocenter (TZ) derived from non-spherical satellites. The collinearity of TZ with residual SRP modeling errors can be mitigated well for Jason-like satellites since their 118-day draconitic period is not close to one solar year. So, the Jason-2/3 satellites are appealing for geodetic DORIS-based geocenter motion determination. The upcoming launches of future DORIS satellites HY-2C (inclination of 66º), Jason-CS/Sentinel-6 (66º), and SWOT (inclination of 78º), should also permit the same type of geocenter solutions.

IDS GB is evaluating formation of Working Group on the geocenter where non-IDS participation would be encouraged.

9.5 PREPARATION FOR THE NEXT ITRF

IDS ACs have to continue their preparation to the next ITRF scheduled in 2020. They must focus on the following topics.

9.5.1 IMPROVEMENT OF THE NON-CONSERVATIVE FORCE MODELLING FOR DORIS SATELLITES

The analyses associated with ITRF2014 as well as subsequent work have demonstrated that the DORIS products contain signals at distinct tidal, TOPEX/Jason-draconitic, semi-annual, and annual periods. These signals point to potential problems in force and measurement modeling, potentially associated with the tidal EOP modelling and with the modeling of non-conservative forces on some satellites. ACs must improve SRP modelling to reduce draconitics, in particular for Topex/Jasons satellites by using solar angle panels, by estimating SRP coefficient, by improving the macromodels, ...

9.5.2 DORIS RINEX DATA PROCESSING AND INTRODUCTION OF THE NEW SATELLITES IN THE IDS COMBINED SOLUTION FOR ALL ACS

The Jason-3, Sentinel-3A and Sentinel-3B satellites have to be added in the DORIS processing chain of IDS ACs. Currently, only 4 ACs (ESA, GSC, GOP and GRG) could do that because they are able to process RINEX data format. The others ACs must complete their DORIS/RINEX data processing implementation in order to take into account the data from these new satellites.

9.5.3 SCALE ISSUES ON SPOT-5 (SAWTOOTH PATTERN) / SPOT ATTITUDE

The SPOT-5-only scale clearly showed a sawtooth pattern with breaks. The discontinuities are of the order of -20 mm, so they are significant. Although no obvious cause has been found, efforts to understand these variations should continue, in particular to understand if something intrinsic to the SPOT-5 DORIS USO might be the cause.

9.5.4 ADOPT AND EVALUATE THE NEW STANDARDS/MODELS RECOMMENDED BY IERS

ACs have to implement the new linear mean pole model but not until reprocessing has started, otherwise a velocity discontinuity will be introduced into their time series. They must adopt a Time-Variable Gravity (TVG) model (using GRACE + SLR + GOCE + geophysical fluid models for full space geodetic era) compatible with the linear pole model. They are awaiting the High Frequency (diurnal-subdiurnal) tidal EOP model recommended by the IERS working group leaded by J. Gipson. They also have to use the last ocean tidal as FES2014.

10 COMBINATION CENTER

Guilhem Moreaux / CLS, France

10.1 ACTIVITY SUMMARY

In addition to the routine evaluation and combination of the IDS AC solutions, in 2018, the IDS Combination Center released the third version of the IDS cumulative position and velocity and DPOD2014 solutions and started some studies in line with the realization of the IDS contribution to the ITRF2020.

10.2 IDS ROUTINE EVALUATION AND COMBINATION

At the end of 2018, the time span of the SINEX files of the IDS combined solution was 1993.0-2018.5. These files correspond to the new IDS series 13 which differs from the previous one (ids 12) by the contribution of one IDS AC less and by the deleting of weekly AC contributions with large value of the Helmert parameters.

Late 2018, the IDS CC initialized the routine production of EOP time series files to be delivered to the IDS Data Centers.

10.3 IDS CUMULATIVE SOLUTION

In 2017, the IDS Combination Center realized and made available (through the IDS Data Centers) the third version of the DORIS cumulative position and velocity solution. That solution is obtained by the stacking of the latest IDS combined solution from 1993.0 to the last week of the combined solution. Therefore, the cumulative solution contains only the mean positions and velocities of the DORIS stations included in the IDS combined solution. We remind that all these solutions are available in SINEX format and can be freely downloaded from the subdirectory "products/sinex_global/ids/" from the IDS Data Centers (CDDIS and IGN).

10.4 DPOD2014

In line with the realization of the third version of the DORIS cumulative solution, the IDS CC also delivered to the IDS community the third version of the DORIS extension of the ITRF2014: DPOD2014. Compared to the cumulative solution, the DPOD2014 contains the stations observed before 1993 as well as the stations turned on after the ending date of the stacking (see **Figure 10**). The DPOD2014 solution is available for download from the IDS Data Centers through the subdirectory "products/dpod/dpod2014/" in both SINEX and text formats (CDDIS and IGN).

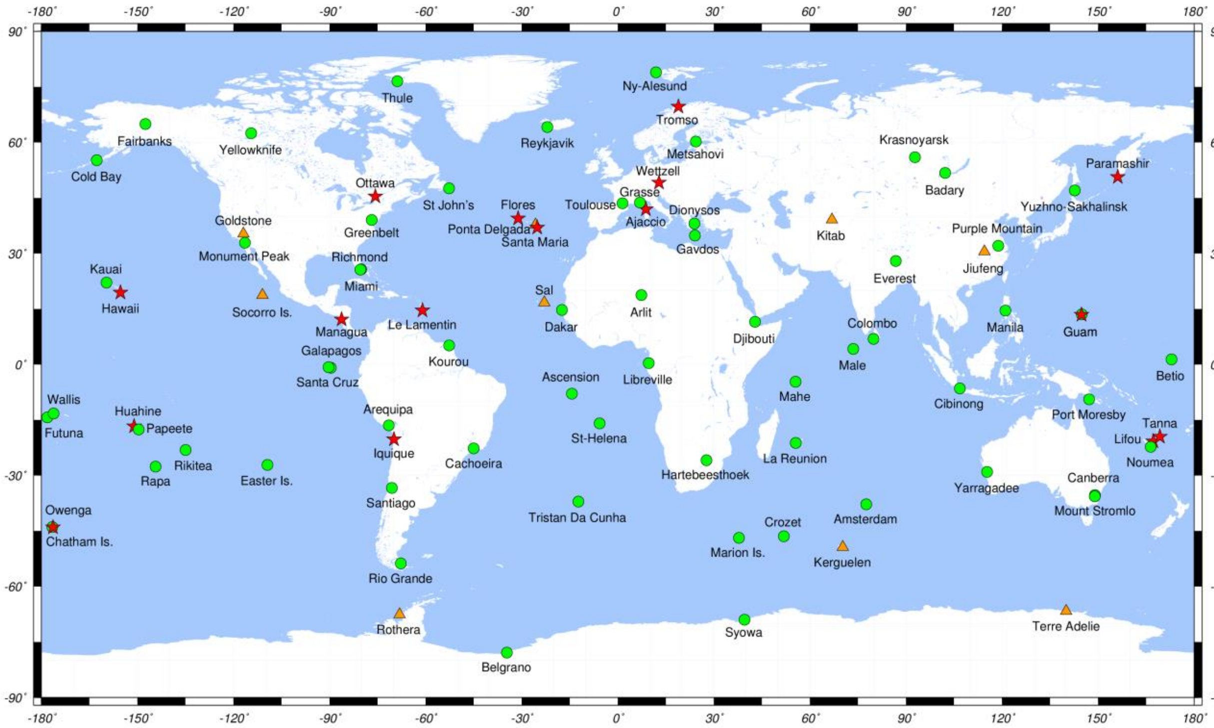

Figure 10. DORIS sites included in the version 3 of the DPOD2014 (i.e. DORIS extension of the ITRF2014). Green: ITRF2014 sites. Orange: ITRF2014 sites with new station(s) since ITRF2014. Red: sites not included in the ITRF2014.

Note that in collaboration with the IDS POD validation group lead by P. Willis from IGN, the IDS CC published in Advances in Space Research the paper titled "DPOD2014: a new DORIS extension of ITRF2014 for Precise Orbit Determination" (63-1, pp 118-138, DOI: [10.1016/j.asr.2018.08.043](https://doi.org/10.1016/j.asr.2018.08.043)). This paper, which describes how the DPOD2014 solution is realized and validated, is in open access until the end of the year 2019.

10.5 IDS CC STUDIES

In preparation to the realization of the IDS contribution to the ITRF2020, the IDS CC investigated on how to increase the station position performances over the time period 1993.0 to 2002.3 (before the start of SPOT-5). While evaluating the IDS contribution to the ITRF2014, compared to the IDS series delivered for the ITRF2008, we noticed a slight degradation (mainly on the East component) of the station position performances before the start of SPOT-5. Note that the new solution had in the same time more stations in the weekly SINEX files. First, we thought about a problem with the z-rotation but none of the tests on the contribution to that rotation had a positive impact on the station positioning. Then, we started to investigate on the first level of the processing: the preprocessing of the individual AC contributions. Using a more stringent parameterization, we were able to improve the station positioning of the new solution (ids 40) without decreasing too much the number of stations included in the weekly SINEX files (see **Figure 11**). We ended up with the same number of stations as we had with the IDS contribution to the ITRF2008.

As reported in **Table 10**, the new test series (ids 40) gives similar performances to the IDS contribution to the ITRF2008 (ids 01) excepted for the very first time period (1993.0-1994.1; before SPOT-3).

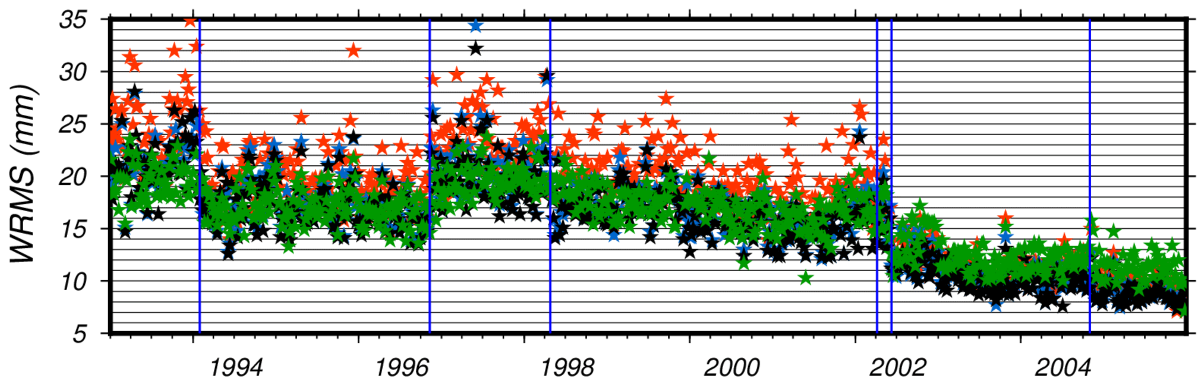

Figure 11. WRMS of the station position of the IDS 01 (green - contribution to the ITRF2008), IDS 09 (red - IDS contribution to the ITRF2014) and IDS 40 (black – test) series

Time period	Number of DORIS satellites	Series	Number of weeks	North [mm]		East [mm]		Up [mm]	
				Mean	STD	Mean	STD	Mean	STD
1993.0-1994.1	2 (SPOT-2, TOPEX)	ids 01	52	16.9	2.4	21.4	2.7	20.1	2.3
		ids 12	56	19.6	3.8	29.9	5.7	24.5	5.0
		ids 40	56	18.4	2.5	23.0	3.6	21.7	3.5
1994.1-1996.9	3 (+ SPOT-3)	ids 01	142	14.1	2.0	18.8	2.3	17.7	2.3
		ids 12	143	14.6	2.4	23.9	3.8	18.9	3.0
		ids 40	143	14.5	2.5	18.9	2.7	17.2	2.5
1996.9-1998.3	2 (- SPOT-3)	ids 01	73	16.5	2.5	21.4	2.5	20.5	2.2
		ids 12	74	18.1	4.5	28.9	4.6	23.1	4.0
		ids 40	75	17.4	3.9	21.9	3.4	20.5	3.0
1998.3-2002.3	3 (+ SPOT-4)	ids 01	192	14.8	2.4	18.8	2.4	17.1	2.4
		ids 12	204	14.8	2.8	23.3	4.1	18.4	3.0
		ids 40	204	14.4	2.3	18.1	2.8	16.3	2.3

Table 10. Statistics of the WRMS of the station position of the IDS 01 (green - contribution to the ITRF2008), IDS 09 (red - IDS contribution to the ITRF2014) and IDS 40 (black – test) series

10.6 COMMUNICATIONS

In 2018, the IDS Combination Center joined the EGU and AGU fall meetings where it presented two posters respectively titled “Intercomparison of the DORIS, GNSS, SLR, VLBI and gravimetric time series at co-located sites” and “What could be the IDS contribution to the next ITRF2020” (https://ids-doris.org/documents/report/meetings/AGU2018_IDS_ContributionToNextITRF2020.pdf).

In addition, the IDS joined the COSPAR 2018 meeting as well as the IDS Workshop (in Azores) where he presented the results of the study described in the previous section (“IDS Combined Solution: on the way to the ITRF2020”) as well as a poster on the DORIS Ponta Delgada station titled "Assets and strengths of the DORIS station at Ponta Delgada", both available on the IDS website respectively at:

- https://ids-doris.org/images/documents/report/ids_workshop_2018/IDS18_s2_Moreaux_IDSCombinedSolutionPreparationForITRF2020.pdf
- https://ids-doris.org/images/documents/report/ids_workshop_2018/IDS18_poster_Moreaux_DORISatPontaDelgada.pdf

The IDS CC also actively participated to the IDS AWG held in Toulouse and in the first IDS retreat organized in Gascony.

10.7 FUTURE PLANS

In 2019, 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 release two versions of the DORIS cumulative position and velocity solution as well as two versions of the DPOD2014 (DORIS extension of the ITRF2014). In line with the realization of the IDS contribution to the next ITRF (ITRF2020), the IDS CC will start by reviewing its single AC solution evaluation process and the combination scheme. The objectives of these reviews are to increase the station positioning and EOP performances of the forthcoming IDS combined solution, mainly for the time period before the start of SPOT-5 (1993.0-2002.3).

11 ANALYSIS CENTER OF THE GEODETIC OBSERVATORY PECNY (GOP)

Petr Štěpánek / Geodetic Observatory Pecný, Czech Republic

11.1 ROUTINE DATA PROCESSING

The data until the day 270, 2018 were processed and the corresponding weekly SINEX files were delivered to the data center. The solution standards wd50 were updated to wd51 (applying the constrained cross track harmonics in the satellite orbit model) and consequently to wd52 (including the nominal phase center offset values instead of the application of data accessories. The routine processing is still based only on the Doppler data processing, but the switch to RINEX is planned during 2019.

11.2 RINEX DATA PROCESSING

RINEX processing capabilities were fully implemented into the data processing software (modified version of Bernese GPS software 5.2). The approach is based on the split of the observation file into the RINEX to the pseudorange observations and phase observations. The pseudorange observations (for the beacons equipped with the atomic clocks) are processed separately to estimate the polynomial model of the onboard clocks. The clocks are approximated with the polynomial of 2nd degree for the time interval of 3 days. For each daily arc, the 3 days clock polynomial is estimated. The time span for the polynomial starts one day before the beginning of the arc and ends one day after the end of the arc.

The pre-estimated onboard clock model is then applied in the processing of the Doppler observations, reconstructed from the RINEX data file. Unlike the processing of Doppler data in IDS exchange format, the observations are available on both frequencies and the ionosphere-free linear combination is formed in the processing. **Table 11** and **Table 12** compare the POD accuracy, when CNES/SSALTO GNSS+DORIS orbits are used as a reference. Note, that the mean differences are similar for RINEX and for Doppler, except for along-track component for Cryosat. Standard deviation is similar for Doppler and RINEX or lower for RINEX with exception of the radial and the along-track component of Jason-2.

Satellite	**Mean w.r.t. CNES orbit** (mm)			**Std. dev. w.r.t. CNES orbit** (mm)		
	Radial	**Along**	**Out**	**Radial**	**Along**	**Out**
JASON-2	-0.2±0.6	2.5±7.0	0.1±2.4	8.5	23.7	26.5
CRYOSAT-2	0.1±0.4	2.2±2.8	-0.1±0.7	7.4	19.4	21.3
HY-2A	0.8±0.4	-5.6±6.6	-0.6±1.3	7.2	28.7	22.1
SARAL	0.1±0.3	-1.2±2.5	0.6±0.9	6.5	19.0	24.9

Table 11. GOP POD (DORIS only) comparison with the CNES/SSALTO orbits (GNSS + DORIS). Solutions are based on the Doppler exchange format data processing

Satellite	Mean w.r.t. CNES orbit (mm)			Std. dev. w.r.t. CNES orbit (mm)		
	Radial	Along	Out	Radial	Along	Out
JASON-2	-0.2±0.5	-0.9±7.6	0.2±2.4	9.2	26.8	26.3
CRYOSAT-2	0.1±0.4	12.0±4.3	-0.1±0.6	7.3	18.8	19.5
HY-2A	0.8±0.4	-2.3±6.9	-0.7±1.4	7.1	28.7	21.7
SARAL	0.1±0.3	-0.6±3.2	0.6±0.9	6.4	19.1	24.7

Table 12. GOP POD (DORIS only) comparison with the CNES/SSALTO orbits (GNSS + DORIS). Solutions are based on the RINEX data processing

11.3 INTRODUCTION OF SENTINEL-3 AND JASON-3 IN THE PROCESSING

The implementation of RINEX processing capabilities enables to start with processing of the satellites Sentinel-3A, Sentinel-3B and Jason-3. We performed a test on 3 months of data comparing the impact of these satellites to the overall combination as well as on the POD comparison campaign.

Table 13 and **Table 14** present the orbit accuracy of Sentinel-3 satellites, using CNES and ESA satellite macromodels. The CNES orbit is used as the reference. The both macromodels perform with a similar mean difference and standard deviation. The mutual mean differences of the both solutions reach less than 1 mm in all the components, while standard deviation is the highest in the along-track component (1.2 mm).

Table 15 presents the weekly station RMS with respect to DPOD 2014 (ver.1.0) and weekly repeatability WRMS. “C4(D)” is the solution using Doppler format data, the other solutions are RINEX. J3, SA and SB correspond to the inclusion of the satellites Jason-3, Sentinel-3A and Sentinel-3B, respectively. It is obvious that the addition of the Sentinel satellites improves the solution, with significant effect on the repeatability WRMS. The impact of Jason-3 is uncertain, which probably relates to the missing application of the SAA compensation strategy in the processing.

Table 16 includes the weekly mean, variations of weekly mean and standard deviation with respect to the weekly mean of the estimated pole coordinates. The IERS C04 model was used as the reference. There is a minor standard deviation reduction when including either Jason-3 or Sentinel-3. Sentinel-3 also reduced the variations of the weekly mean.

Solution	Mean w.r.t. CNES orbit (mm)			Std. dev. w.r.t. CNES orbit (mm)		
	Radial	Along	Out	Radial	Along	Out
ESA	-0.5±0.4	-15.0±3.5	-0.8±0.7	7.6	19.5	20.5
CNES	-0.2±0.4	-15.0±3.5	-0.9±0.6	7.5	19.6	20.5

Table 13. Sentinel-3A GOP POD (DORIS only) comparison with the CNES/SSALTO orbits (GNSS + DORIS). A posteriori std. dev. of the fit (D1 frequency observation of unit weight – in zenith) added in the last column

Solution	Mean w.r.t. CNES orbit (mm)			Std. dev. w.r.t. CNES orbit (mm)		
	Radial	Along	Out	Radial	Along	Out
ESA	-0.5±0.4	-11.7±4.0	-0.4±0.7	8.5	21.0	23.8
CNES	-0.2±0.4	-11.8±4.0	-0.5±0.7	8.4	21.0	23.9

Table 14. Sentinel-3B GOP POD (DORIS only) comparison with the CNES/SSALTO orbits (GNSS + DORIS). A posteriori std. dev. of the fit (D1 frequency observation of unit weight – in zenith) added in the last column.

Solution	RMS w.r.t. DPOD 2014 (mm)			Repeatability WRMS (mm)	
	Latitude	Longitude	Height	Latitude	Longitude
C4(D)	12.0	19.7	22.4	6.6	8.9
C4	12.1	20.7	22.8	6.2	8.6
C4+J3	11.1	20.1	22.1	6.4	9.0
C4+SA	11.4	23.5	22.3	5.9	7.8
C4+SB	11.1	17.6	21.4	5.8	7.6
C4+SA+SB	11.2	20.7	21.2	5.9	7.6
C7	10.4	19.3	21.1	5.9	7.8

Table 15. Weekly multi satellite solutions, RMS w.r.t DPOD 2014 and repeatability WRMS

Solution	Xp Mean (mas)	Yp Mean (mas)	Xp Std. Dev. (mas)	Yp Std. dev. (mas)
C4(D)	0.19±0.23	-0.12±0.21	0.34	0.31
C4	0.19±0.24	-0.15±0.20	0.33	0.33
C4+J3	0.13±0.30	-0.16±0.21	0.31	0.27
C4+SA	0.17±0.18	-0.12±0.17	0.28	0.31
C4+SB	0.22±0.18	-0.13±0.16	0.30	0.31
C4+SA+SB	0.20±0.15	-0.11±0.16	0.26	0.31
C7	0.12±0.21	-0.11±0.20	0.28	0.28

Table 16. Comparison of the estimated pole of rotation coordinates to IERS C04 model

Figure 12 displays the weekly single-satellite height estimates of the stations Cachoeira Paulista. There are not systematic differences for Cryosat, Saral, Hy-2A and Sentinel-3A, unlike for Sentinel-3B, Jason-2 and Jason-3. Since Jason-2 and Jason-3 are affected by SAA, a similar effect could be found also for Sentinel-3B.

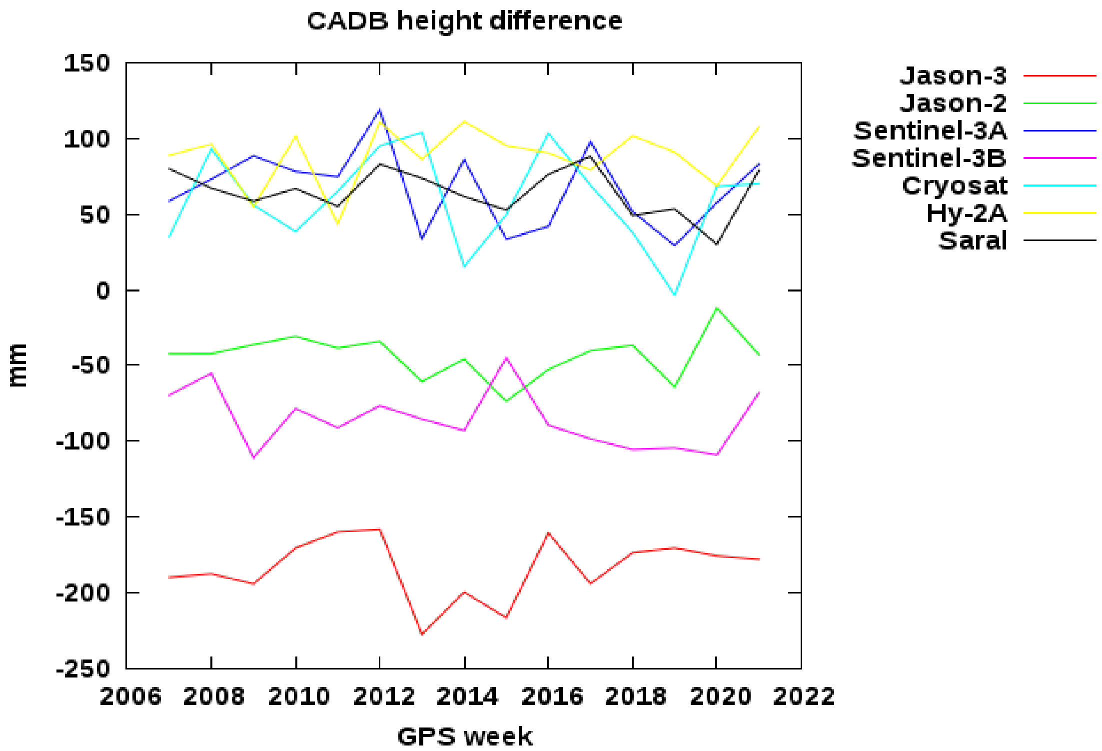

Figure 12. CADB height w.r.t. DPOD 2014 for single-satellite weekly solutions

12 CNES/CLS ANALYSIS CENTER (GRG)

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

12.1 INTRODUCTION

The CNES and CLS participate jointly to the IDS as an Analysis Center. The processing of the DORIS data is performed using the GINS/DYNAMO software package developed by the GRGS.

We continued the standard routinely processing by taking into account the data until October 2018. We analyzed the DORIS2.2 data with 3.5-day arcs and a cut-off angle of 12° by using the ITRF2014 configuration for the following satellites: Jason-2, Cryosat-2, HY-2A and Saral. The satellites Jason-3, Sentinel-3A and Sentinel-3B were added in our processing from RINEX data. The main activity during 2018 was to improve our products, as well orbits and solutions, in the frame of our contribution to the next ITRF realization.

12.2 JASON-2&3 AND SENTINEL-3A&B POD STATUS

The Sentinel-3B satellite was added in the DORIS processing chain of the CNES/CLS Analysis Center. A POD status for the Jason and Sentinel missions has been done by analyzing the orbit results obtained on the time span processing of 115 weeks (from June 2016 to August 2018). We took into account the standards and models used for our contribution to the realization of the ITRF2014, the IERS conventions and the IDS recommendations. We give in the **Table 17** the average per arc of the amplitudes of empirical acceleration in tangential and normal, DORIS and SLR RMS of the orbit residuals. For both directions (tangential and normal), the average amplitude of the empirical accelerations is less than 4.10^{-9} m/s^2, showing that the modeling of the macromodel and attitude laws is correct. The orbit residuals level of the Jason-3 (0.35 mm/s on average) and Sentinel-3A&B (0.36&0.38 mm/s), are slightly higher than Jason-2 (0.33 mm/s). For Jason-3, it can be explained by a higher sensitivity to SAA than other satellites. For Jason-2&3, there is also a ~59-day signal in the DORIS residuals.

Satellite	**DORIS RMS** (mm/s)	**SLR RMS** (cm)	**OPR amplitude average** (10^{-9} m/s^2)		**Solar radiation coefficient**
			Along-track	**Cross-track**	
JASON-2	0.329	1.8	2.4	2.2	0.97
JASON-3	0.352	1.9	1.3	2.5	0.99
SENTINEL-3A	0.362	1.4	2.3	1.9	1.00
SENTINEL-3B	0.381	1.5	1.8	2.3	1.00

Table 17. Average of DORIS and SLR RMS of fit per arc, OPR amplitude average and Solar radiation coefficient on the entire processing period data processing

The orbit residuals level of the Jason-3 (0.35 mm/s on average) and Sentinel-3A&B (0.36 and 0.38 mm/s), are slightly higher than Jason-2 (0.33 mm/s). For Jason-3, it can be explained by a higher sensitivity to SAA than other satellites. For Jason-2&3, there is also a ~59-day signal in the DORIS residuals.

The DORIS-only orbits have also been evaluated by an independent SLR measurements processing. SLR residuals on DORIS-only orbits are of a good level for Jason and Sentinel missions (see for example results for Jason-3 and Sentinel-3A). The level is comparable to the other orbits evaluated (see **Figure 13** and **Figure 14**), precise orbit DORIS+GPS of CNES POD team (for Jason-3 and Sentinel-3A), GPS-only orbit of JPL (for Jason-3) and GPS-only orbit of CPOD (Copernicus POD service) (for Sentinel -3A).

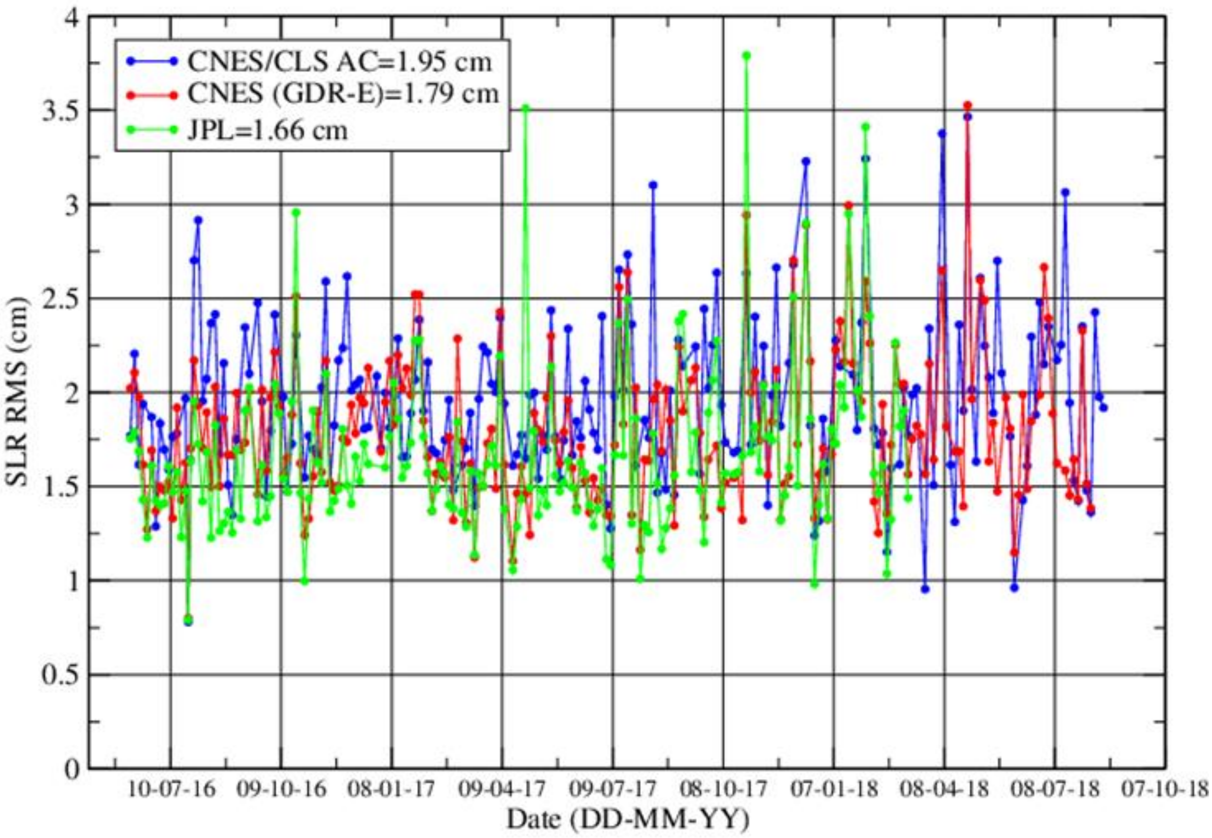

Figure 13. Independent SLR RMS of fit on Jason-3 orbits, DORIS-only orbit for CNES/CLS AC (in blue), (GPS+DORIS) orbit for POD CNES team (GDR-E) (in red) and GPS-only for JPL (in green)

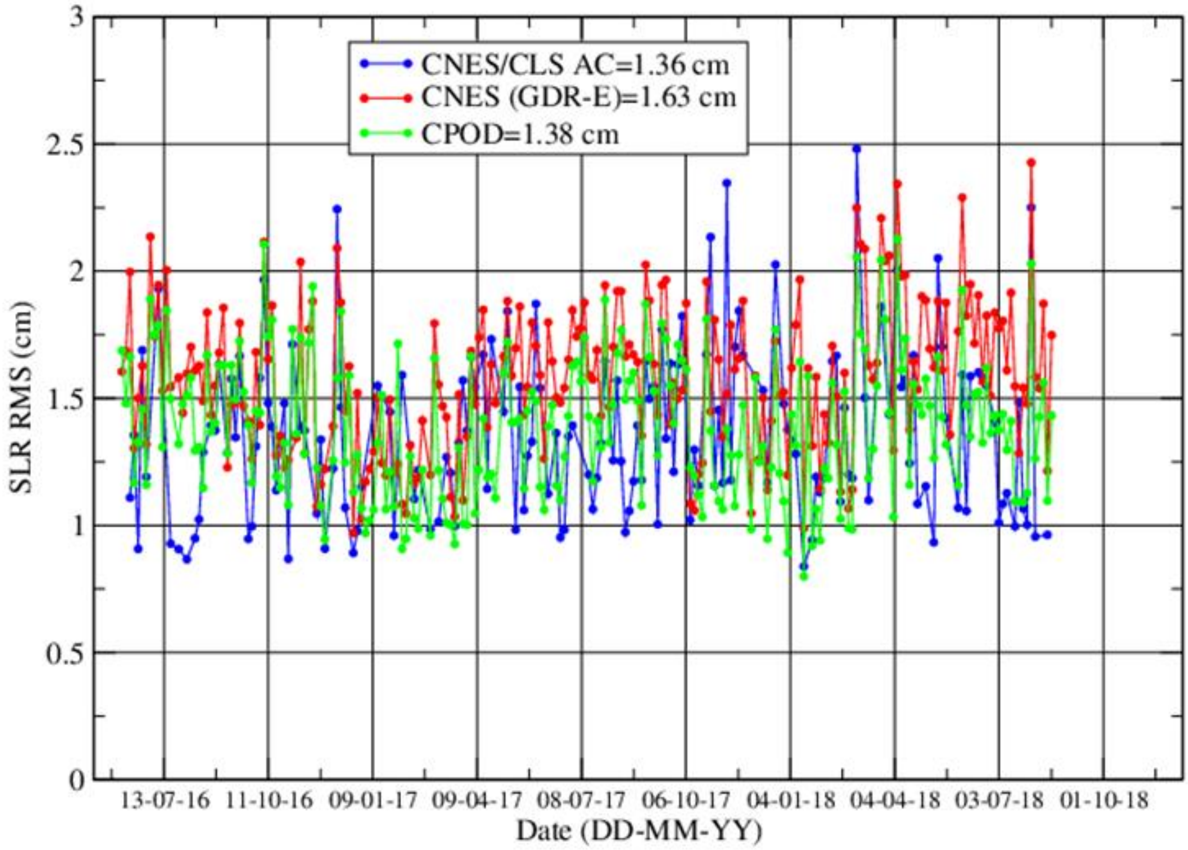

Figure 14. Independent SLR RMS of fit on Sentinel-3A orbits, DORIS-only orbit for CNES/CLS AC (in blue) et (GPS+DORIS) orbit for POD CNES team (GDR-E) (in red) and GPS-only for CPOD (in green)

We compared our Jason and Sentinel orbits with those of the CNES POD team, of JPL and of CPOD (shown in **Figure 15** for Jason-3 and in **Figure 16** for Sentinel-3A). For Jason-3, there is a good agreement between our orbits and the others but there is a tangential bias of ~ 1.3 cm which could be explained by a difference in the time tagging of the DORIS and GPS measurements. This bias is present for all GPS orbit comparisons (in blue with GDR-E obit, in red with JPL orbit and in green with our GPS-only orbit). There is also a signal at ~59 days in the average of the radial component that could come from in one part the fact that we use the nominal attitude (unlike the other teams that use measured quaternions BUS + solar panels angles) and in second part the fact they determine a reduced dynamic orbit. For Sentinel-3A, the agreement between the orbits is better but there remains a tangential bias certainly correlated to the time tagging of the measurements.

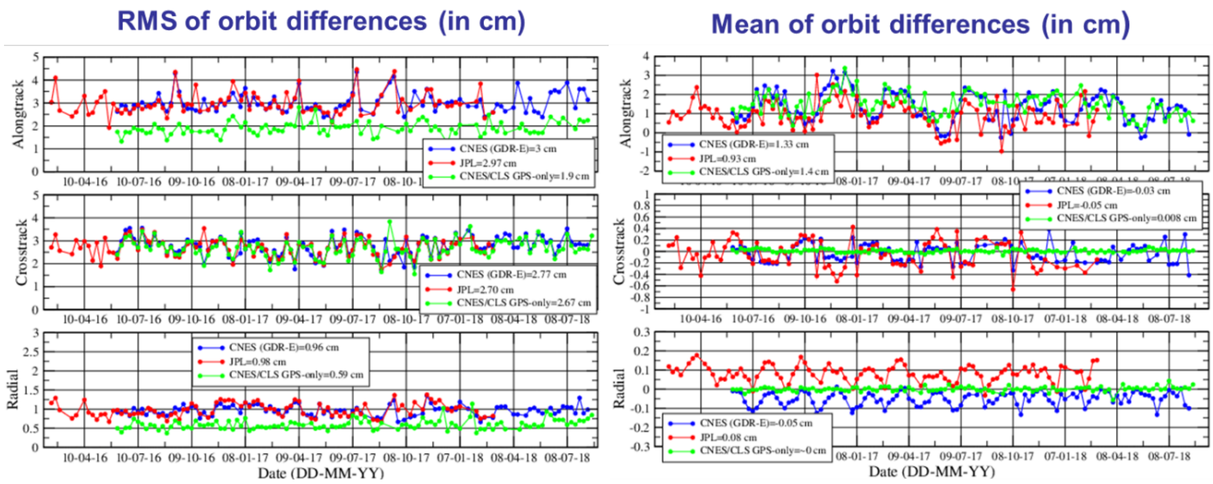

Figure 15. Jason-3 orbit differences between CNES/CLS AC and CNES POD team (in blue), and JPL (in red), and our GPS-only orbit (in green).

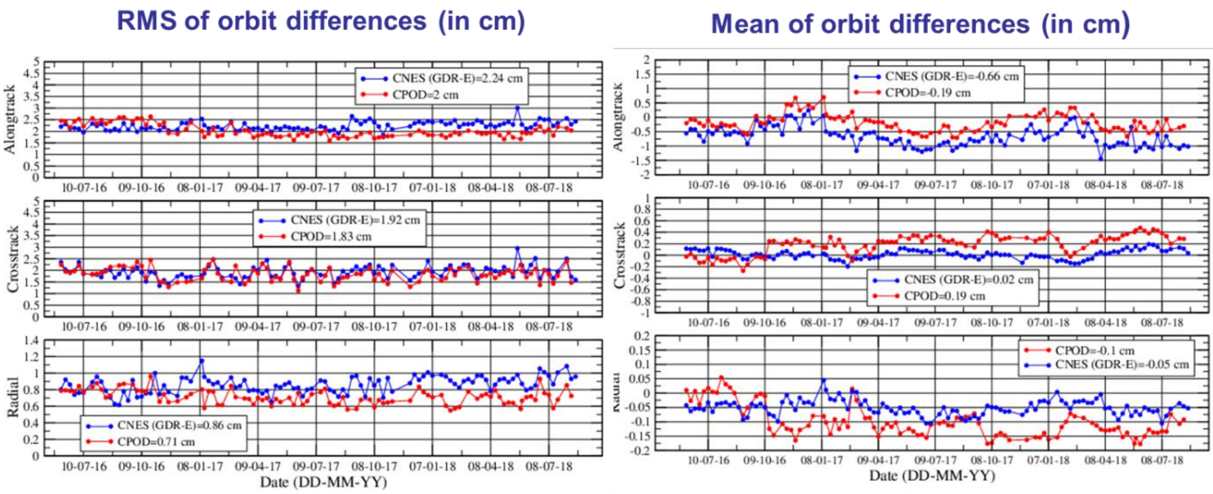

Figure 16. Sentinel-3A orbit differences between CNES/CLS AC and CNES POD team (in blue), and CPOD (in red).

The GRG orbits were also evaluated by the calculation of Sea Surface Height (SSH) difference at crossover per cycle for Jason missions. For Jason-2 (**Figure 17**), the STD and RMS of the SSH differences calculated from cycle 1 to 300 are at the same level for the CNES POD team orbit (in blue) and GRG orbit (in red). Note also that the mean values are anti-correlated. For Jason-3 (**Figure 18**), the statistical results are slightly better when we consider the CNES POD orbit (in black) and JPL orbit (in blue).

The CNES/CLS AC provides routinely the Sentinel orbit to the Sentinel-3 Copernicus POD Quality Working Group (QWG). We present here one result from the evaluation made by GMV (**Figure 19**). These results show that the DORIS-only orbit calculated with GINS is at the same level, in particular for radial component, as the other orbits which are all determined from GPS measurements.

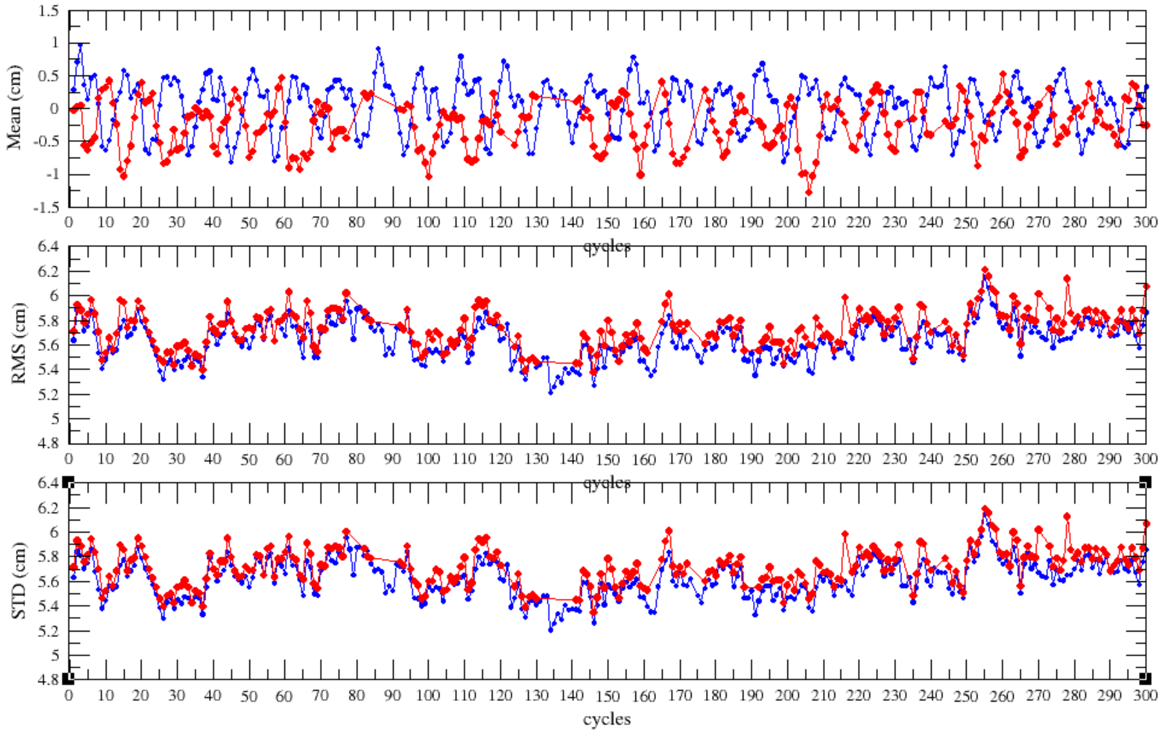

Figure 17. Jason-2 SSH difference at crossover per cycle (Mean, RMS and STD), for CNES POD orbit (in blue) and CNES/CLS orbit (in red)

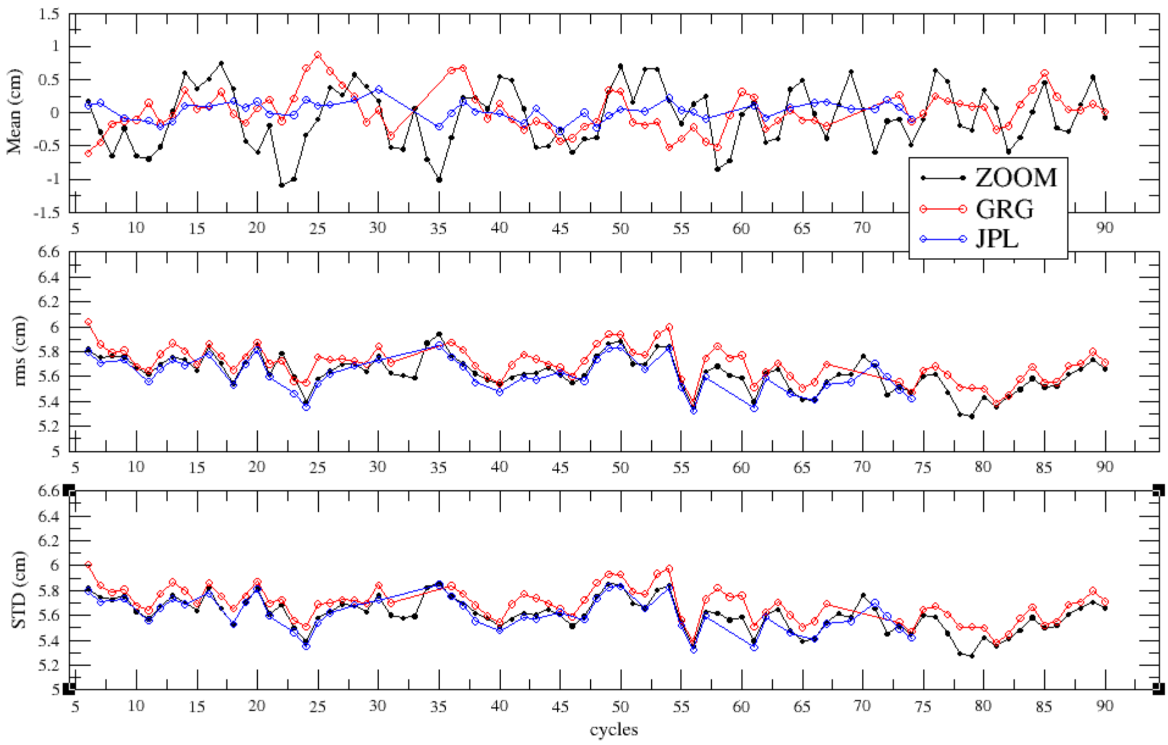

Figure 18. Jason-3 SSH difference at crossover per cycle (Mean, RMS and STD), for CNES POD orbit (in black) and CNES/CLS orbit (in red) and JPL orbit (in blue)

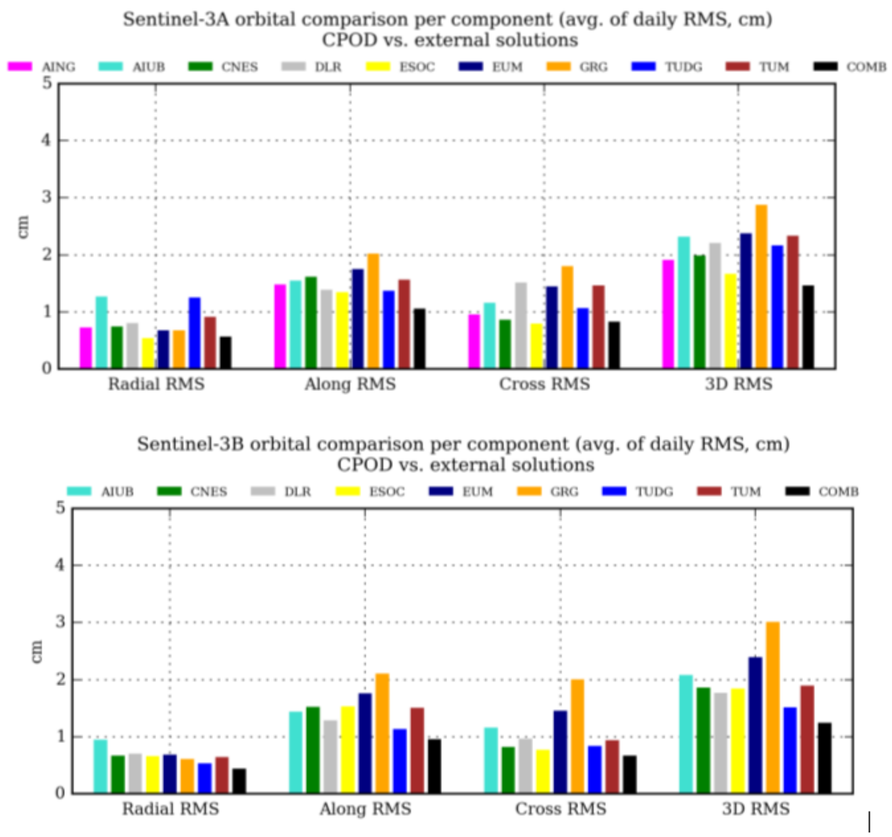

Figure 19. Sentinel-3A&B orbit comparisons per component (average of daily RMS; cm); CPOD vs. external solutions

12.3 IMPROVEMENT OF THE CNES/CLS IDS ANALYSIS CENTER SOLUTION FOR THE CONTRIBUTION TO THE NEXT ITRF

To improve our multi-satellite solution, we have created a new serie (grgwd41) with the following news:

- introduction of Jason-3 and Sentinel-3A (RINEX data) in the GRG DORIS processing
- switch to the ITRF/DPOD2014
- DORIS-only orbits processing and evaluation by SLR processing
- strategy to mitigate the SAA impact for Jason-2 and Jason-3
- on the orbit (adjusting of frequency Polynomial on SAA station per pass)
- on the positioning (renaming of SAA stations)
- remove the DORIS scale jump in 2012
- use the new position of the HY-2A Center of Mass given by the Chinese Project
- make our own pre-processing when using Doris2.2 data

We have re-processed DORIS data of all active satellites from the beginning of the Jason-2 mission (July 2008). As shown in the **Figure 20** thanks the new position of the CoM HY-2A and with our preprocessing of the Doris2.2 data, the scale jump in 2012 is removed (curve in red).

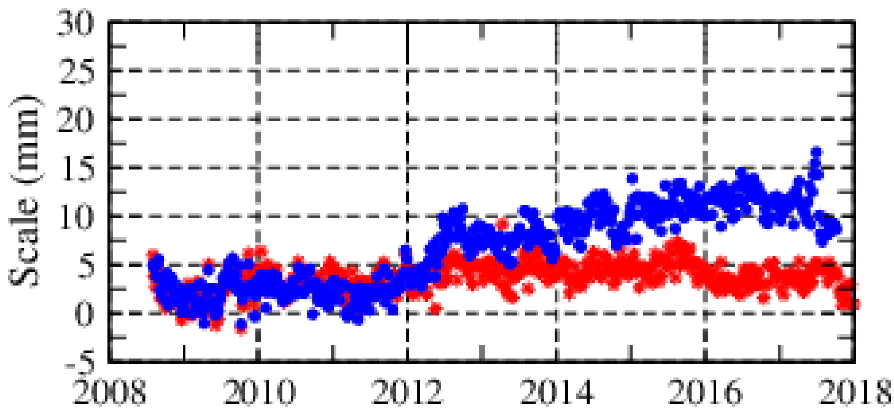

Figure 20. Multi-satellite scale factor

12.4 ANALYZE OF THE DORIS SCALE FACTOR AND GEOCENTER FROM SINGLE SATELLITE SOLUTIONS

The DORIS scale factor and geocenter is the combination of each single DORIS satellite solutions. We propose here to analyze the scale factor and geocenter of these single satellite solutions in order to improve the combined solution. Indeed, previous studies showed that single satellite solutions can have some large scale or geocenter values, such as the HY-2A scale. We have already identified a high value for Tz translation for several satellites. The SPOT-5 scale clearly showed a sawtooth pattern with breaks (discontinuities are of the order of -20 mm). The objective of this study is to analyze each single satellite solutions in terms of scale and geocenter, to try to understand and resolve the potential problem. We started the analyses with Envisat and Sentinel-3A&B which have a significantly bias in Tz translation. We determined the single satellite solutions from DORIS data available for Sentinel-3A&B and ENVISAT and we compared to DPOD2014 (computed by CATREF).

As shown in **Figure 21**, there is a high bias in Tz translation (~ 6 cm) for Sentinel solutions. The Tz bias could be related to a wrong position in the cross-track direction for DORIS receiver phase center (CoP) or for Center of gravity (CoG). So, we have estimated the distance between the satellite CoG and the DORIS CoP for Sentinel-3 and we obtain a Cross-track offsets of 2 cm (see **Table 18**). Then, we processed DORIS data by taking into account the new position of DORIS phase center from June 2016 to August 2018 for Sentinel-3A and from June to August 2018 for Sentinel-3B. The orbit differences are very small in the three components and DORIS RMS of fit are very slightly lower. When the estimated CoP is applied, the Tz bias vanishes and the solution is more consistent with the ITRF-DPOD2014 (**Figure 22**).

We have also estimated the distance between the satellite CoG and the DORIS CoP for ENVISAT and we found a Cross-track offsets of 2.5 cm. As for Sentinels solutions, when the CoP estimated is used, the Tz bias vanishes and the solution is more consistent with the ITRF-DPOD2014 (**Figure 23**).

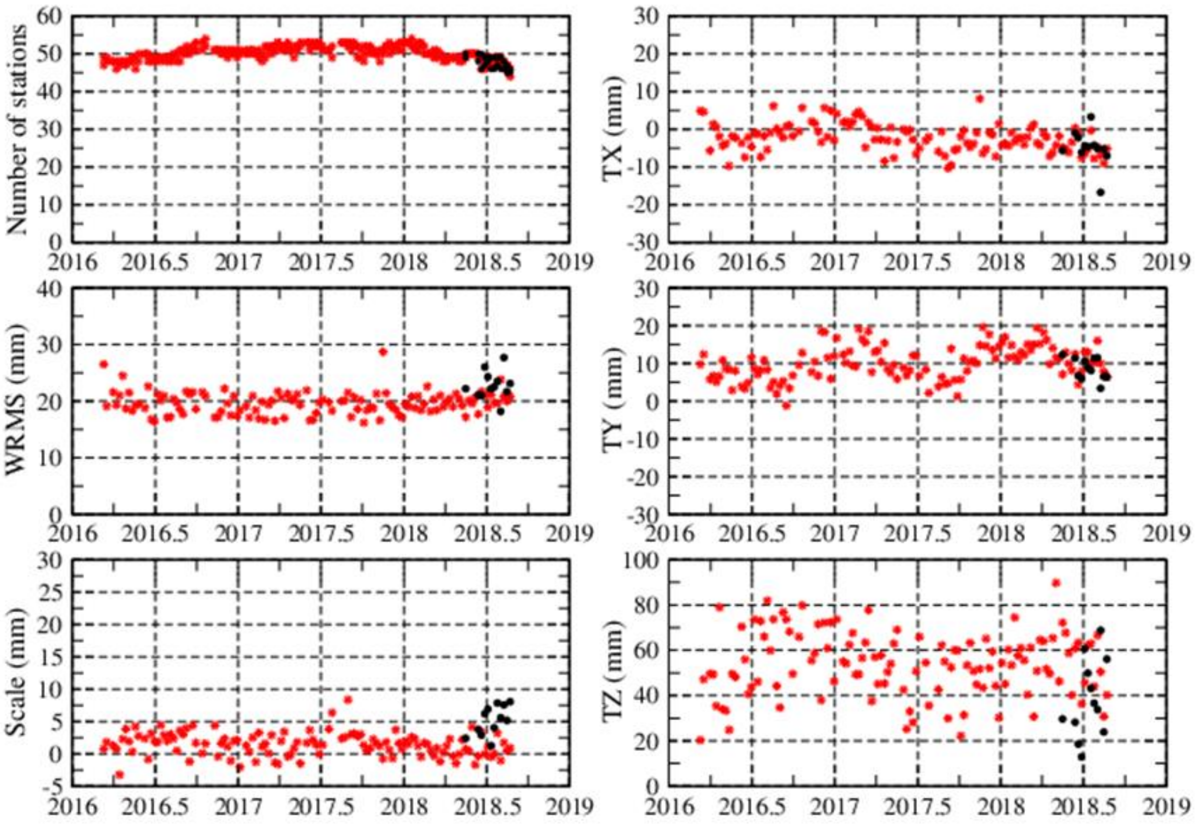

Figure 21. Scale factor and geocenter from single satellites solutions Sentinel-3A (in red) et Sentinel-3B (in black)

Component	Original value (m)	Estimated value (m)	Offset (cm)
X (along-track)	+1.570	+1.570	no
Y (cross-track)	+0.073	+0.093	+2
Z (radial)	+0.760	+07.60	~0.1

Table 18. DORIS CoP for Sentinel-3A

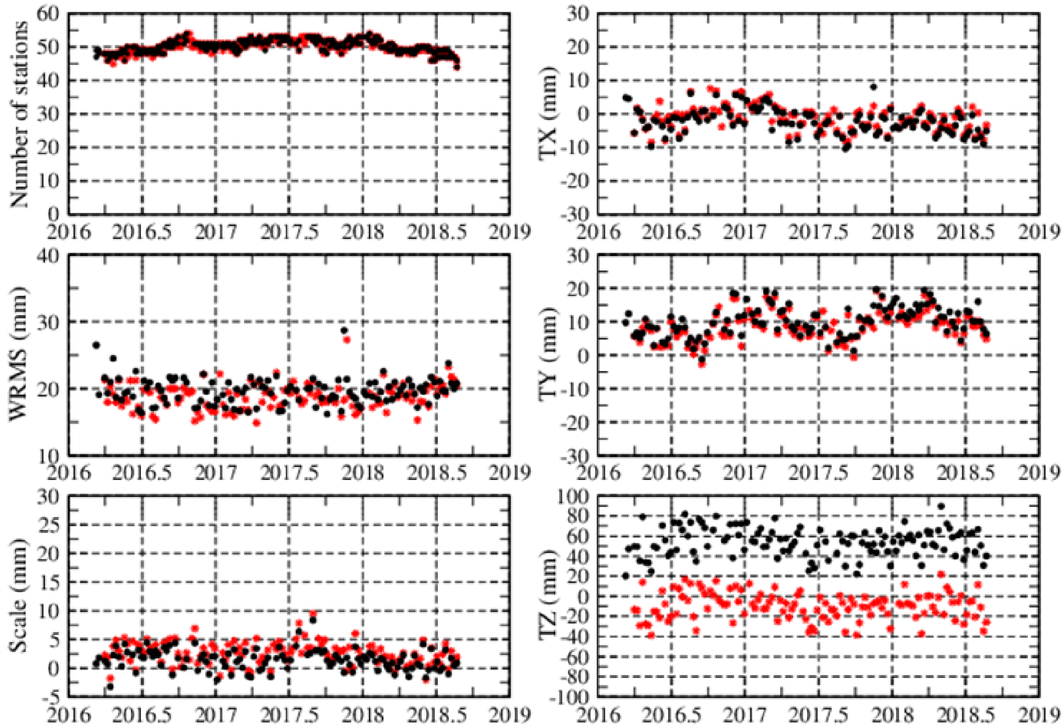

Figure 22. Scale factor and geocenter for Sentinel-3A solution before and after correction of CoP position (in black and red respectively)

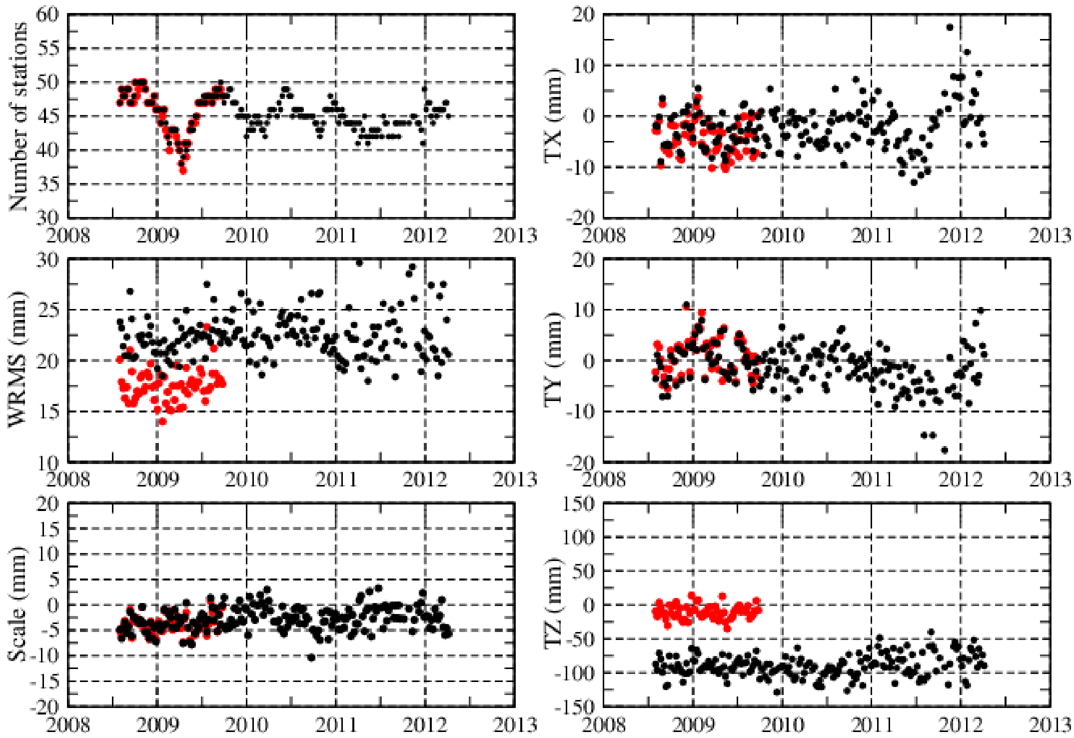

Figure 23. Scale factor and geocenter for ENVISAT solution before and after correction of CoP position (in black and red respectively)

12.5 CONTRIBUTION TO IDS MEETINGS

The Analysis Center's representatives participated in 2018 to the AWG meeting in Toulouse in conjunction with Copernicus POD Quality Working Group in June. They also participate to the EGU in Vienna and OSTST/IDS Workshop in Ponta Delgada. They presented the following works:

AWG (Toulouse)

- GRG AC status report

https://ids-doris.org/images/documents/report/AWG201806/IDSAWG201806-Capdeville-GRG_StatusReport.pdf

- Analyze of the DORIS Scale Factor and Geocenter from single satellite solutions

https://ids-doris.org/images/documents/report/AWG201806/IDSAWG201806-Capdeville-SingleSatelliteSolutions.pdf

EGU (Vienna)

- Analyze of the DORIS scale factor and geocenter from single satellite solutions

OSTST (Ponta Delgada)

- Precise Orbit Determination status on Jason-2&3 and Sentinel-3A&B by CNES/CLS IDS Analysis Center

https://meetings.aviso.altimetry.fr/fileadmin/user_upload/POD_05_Capdeville.pdf

IDS Workshop (Ponta Delgada)

- Improvement of the CNES/CLS IDS Analysis Center solution for the contribution to the next ITRF

https://ids-doris.org/images/documents/report/ids_workshop_2018/IDS18_s2_Capdeville_ImprovementGRGsolutionForNextITRF.pdf

13 GSFC/NASA ANALYSIS CENTER (GSC)

F.G. Lemoine [(1)], D.S. Chinn [(2)], N.P. Zelensky [(2)], Alexandre Belli [(3)], Karine Le Bail [(4)]
[(1)] NASA GSFC, USA / [(2)] SGT Inc. @ NASA GSFC, USA / [(3)] USRA, NASA Postdoctoral Program @ NASA, USA / [(4)] NVI Inc. @ NASA GSFC, USA

The GSC Analysis Center carried out the following activities in 2018:

(1) Submitted two solutions to the IDS data centers that were updates to previous SINEX series (gscwd31, gscwd32).

(2) Begin testing a new version of GEODYN (gscwd32) and begin a complete reprocessing of DORIS data in view of the preparations for the next ITRF.

(3) Begin to review the models that we will need to update for the ITRF2020 reprocessing.

13.1 SUBMISSION OF OPERATIONAL SOLUTIONS

The SINEX series developed since the completion of ITRF2014 are listed in **Table 19**. The gscwd31 and gscwd32 series were updated and delivered in 2018.

Series	Dates	Description
gscwd28	2008/195 – 2016/360	Modeling improvements for Jason-2 (Use of Solar array quaternions in addition to body quaternions)
gscwd29	2008/020 – 2017/176	wd29 = wd28 + DPOD2014 as a priori
gscwd30	2016/010 – 2017/176	wd30 = wd29 + Jason-3 (no special handling for SAA stations)
gscwd31	2016/003 – 2018/188	wd31 = wd30 + Jason-3 (special handling for SAA stations)
gscwd32	2016/003 – 2018/188	wd32 = wd31 + new version of GEODYN + apply new HY2A offset.

Table 19. Description of GSC SINEX Series

The gscwd32 series represented a test of the new HY-2A offset as well as a new version of GEODYN (1802). The new version of GEODYN completely changed the way DORIS-related biases (range-rate and troposphere) were handled in the program. Previously, in an approximation that was meant to save time, the biases were estimated internally and then eliminated on an iteration-by-iteration basis. The idea of this approximation was to reduce execution time. However, the cost of the approximation was inordinate complexity when it came to tracing problems (i.e. debugging) when problems arose. This feature was eliminated, and the explicit estimation of biases was introduced. The purpose was to make maintenance of GEODYN easier. This meant that the normal equation for the least squares solution became much larger, and runtimes increased. To mitigate this problem, a feature was introduced from the GPS processing that allowed the block-by-block estimation of biases, reducing the rank of the normal matrix.

Additional changes in this new version of GEODYN (version 1802) included small fixes to the modeling of modeling of tidal variations in Earth orientation (tidal EOP), and in the modeling of Earth tides. The previous modeling of tidal EOP (which was used in the ITRF2014 processing) was not fully in agreement with the IERS2010 standards. In fact, our NASA GSFC colleague, Richard Ray determined that were missing some constituents and some anomalous terms in the setups. After the “cleanup” (a joint effort between Richard Ray @ NASA GSFC, and Jake Griffiths, former IGS Analysis Coordinator now at the U.S. Navy Research Laboratory), the tidal EOP modeling in GEODYN was made fully compatible with the IERS2010 standards. A memorandum documenting the current implementation is available upon request. We now await further updates from the IERS working group on tidal EOP modeling to determine what model should be implemented for the ITRF2020 reprocessing.

In **Figure 24**, we illustrate the scale from our recent SINEX solutions. The change in scale from wd29 to wd31 reflects the introduction of Jason-3; the change in scale from wd31 to wd32 reflects the incorporation of the new HY-2A offset (c.f. DORISMAIL 1092, “HY-2A POD Instrument Location Updates”, by Alexandre Couhert, 07-Dec-2017).

We also evaluated the WRMS of three series (w.r.t. DPOD2014), and found that over the test periods (time periods as shown in **Figure 24**) the WRMS was 7.7 mm for wd29, 9.2 mm for wd31, and 9.7 mm for wd32. The slight increase for wd32 was a bit disconcerting. After some investigation, we found that the new software to introduce explicit DORIS-system bias estimation sometimes inadvertently truncated the start and the end of passes. So, it was probably the smaller number of observations and the slight worsening of the observational geometry that slightly degraded the WRMS. In the work for the next ITRF, we plan to reprocess all the data and remove all the explicit deletes of data that we have used up until now (e.g. from ITRF2008, ITRF2014) and completely re-edit the data with respect to DPOD2014 and other updated geophysical standards. Thus, we don’t think this particular artifact is a serious concern.

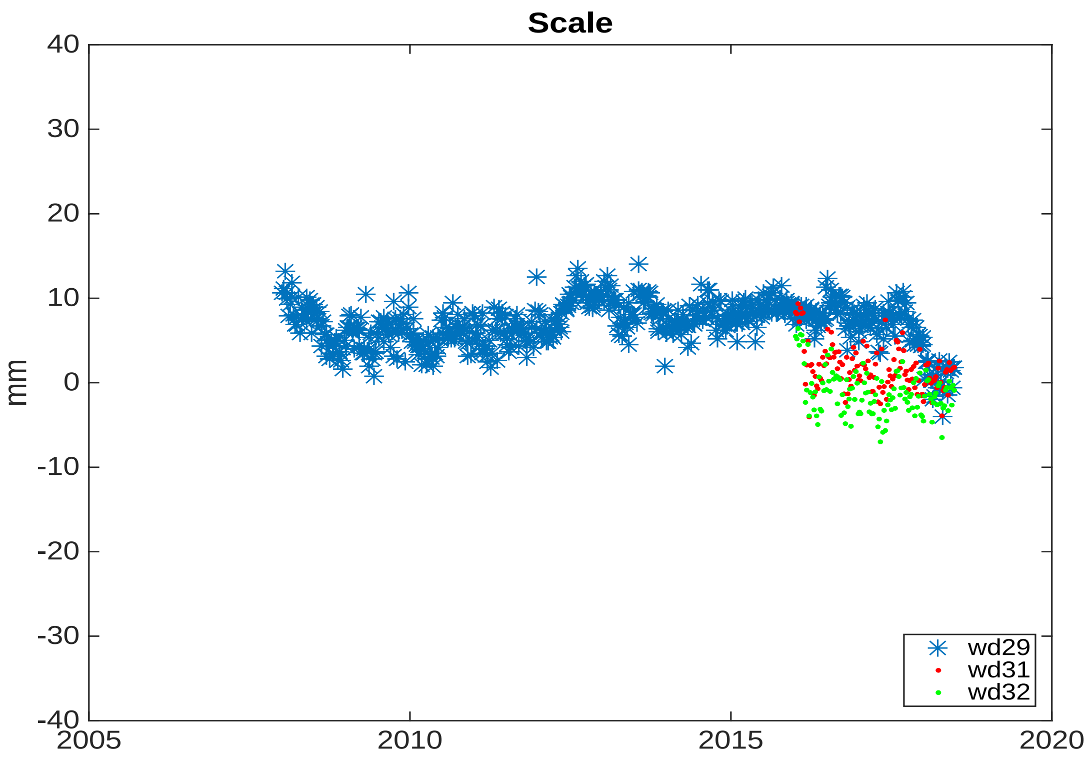

Figure 24. DORIS system scale for gsc solutions with respect to DPOD2014

13.2 PREPARATIONS FOR THE ITRF2020 REPROCESSING

Table 20 summarizes the status of work underway for the reprocessing of the DORIS data for ITRF2020 and the items that were accomplished in 2018, and the work items that remain open and will need to be completed in 2019. Postdoc Alexandre Belli (University Space Research Association, USRA, NASA Postdoctoral program at NASA GSFC) and Nikita Zelensky are testing a new USO model for Jason-2 which we plan to include in the DORIS ITRF2020 reprocessing. GOCO05S is a new a priori background model for the Earth's geopotential that we have evaluated. It is developed by the GOCO consortium led by the University of Graz (Austria) and is based on GRACE, GOCE, and other satellite data from 2003-2014. It includes both a static model, as well as secular and annual terms. A disadvantage is that it makes no provision for modeling the geopotential outside the data period (2003-2014), and in addition smooths through large earthquake-introduced discontinuities (i.e. Tohoku, 2011, Sumatra/Andaman, 2004). Nikita Zelensky has tested the implementation of the ITRF2014 linear mean pole. We see an improvement in the residuals for the TOPEX, Jason-1, and Jason-2 POD as reflected in the tests presented for the OSTST meeting in Ponta Delgada, Portugal (September 2018).

Item	Description	Status
1	Adopt new background gravity model (GOCO05S)	done
2	Adopt VMF1 for DORIS satellite processing (instead of GMF/GPT used for ITRF2014)	done
3	Adopt new offset for HY-2A (c.f. DORISMAIL 1092, 07-DEC-2017)	Tested with gscwd32
4	Adopt new Atmosphere-Ocean-Dealiasing (AOD) models for background time-variable gravity processing (use products developed from GRACE FO project, made available by the GFZ). (same models as for RL06 processing of GRACE FO)	done
5	Adopt and implement ITRF2014 linear mean pole.	done
6	Adopt new (2017) Alcatel phase law for DORIS antennae	TBC
7	Reprocess all DORIS data for current satellites with new background models, new GEODYN versions, and newly regenerated deletes.	In progress
8	Test USO models for Jason-2 & Jason-3 based on results from T2L2	In progress
9	Further improve non-conservative force modeling for DORIS satellites	In progress
10	Adopt new IERS model for diurnal/sub-diurnal tidally-driven variations in Earth rotation	After EGU2019
11	Switch to RINEX processing for all RINEX-compatible DORIS Satellites.	TBC
12	Add new satellites (Sentinel-3A, 3B)	TBC

Table 20. Status of Modeling in preparation for the ITRF2020 re-processing

14 IGN/JPL ANALYSIS CENTER (IGN)

Pascal Willis [1,2]
[1] IGN, France / [2] IPGP, France

14.1 CONTEXT

The Institut Géographique National uses the GIPSY/OASIS software package (developed by the Jet Propulsion Laboratory, Caltech, USA) to generate all DORIS products for geodetic and geophysical applications. In 2018, IGN used the most recent versions (GOA 6.3 and successive development versions). This software package is installed on both sites at IGN in Saint-Mandé and at IPGP in Tolbiac. While data are processed on a regular basis, DORIS results were only submitted at specific intervals (every 3 months, as requested by the IDS Analysis Coordinator). New solutions are submitted simultaneously to both IGN and NASA/CDDIS data centers. In 2018, the continuation of the solution submitted for the ITRF2014 contribution (ignwd15) was performed. In parallel, new developments were done with the new GipsyX software package from JPL for processing DORIS Doppler and RINEX data, processing DORIS data from RINEX files for Jason-2 and SPOT5 satellites.

14.2 PRODUCTS DELIVERED IN 2018

The latest delivered IGN weekly time series is still ignwd15 (in free-network) (**Table 21**). This solution is used by the IDS combination center to derive the IDS combined products. The ignwd15 solution is the one used by the IDS Combination Center in preparation of ITRF2014 (same analysis options). Doppler data from all DORIS satellites were used, except for Jason-1 because of the South Atlantic Anomaly effect. For SPOT5, corrected data were used, as provided by Hughes Capdeville. Following problems found when trying to process the DORIS data expressed in the new RINEX format (providing pseudoranges and phases instead of integrated Doppler), the newest satellites Jason-3 and Sentinel-3 could not be used in the IGN solution in 2018.

As the IDS Combination Center now provides the IGN solution after projection and transformation into ITRF2014, as well as all derived geodetic products, only the DORIS free-network solution is now provided to IDS. Due to the lack of time, no new combined IGN solution was computed for long-term positions and velocities of DORIS ground stations, as we plan to use the future regular DPOD2014 realizations to transform and align our weekly solution with the future GipsyX software package, still under development.

In 2018, the new DPOD2014 solutions and now generated by Guilhem Moreaux (CLS). We set up a validation group to perform some basic verifications (availability of results for all stations, tests of performances for POD applications, comparisons with previous solutions, ...). This evaluation group includes: Hanane Ait Lakbir (CNES), Alexandre Couhert (CNES), Frank Lemoine (NASA/GSFC), Guilhem Moreaux (CLS), Pascal Willis (IGN-IPGP, chair), Nikita Zelensky (SGT). In 2018, one official new release of DPOD2014 was validated and then released through a DORISMail.

Product	Latest version	Update	Data span	Number of files
Weekly SINEX - free-network	ignwd15	Weekly	1993.0-2019.0	1356
STCD	none	Weekly	1993.0-2014.7	0
Geocenter	none	Weekly	1993.0-2014.7	0
EOPs	none	Weekly	1993.0-2014.7	0

Table 21. IGN products delivered at the IDS data centers until the end 2018. As of May 16, 2019.

14.3 MAJOR IMPROVEMENTS IN 2018

Major difference from previous ignwd15 weekly solution concerns:

- the use of phase law correction (however, the correction for the Alcatel antennas is only based on data provided by the manufacturer and not yet data from anechoid chamber observations),
- the use of the GRGS gravity field model (EIGEN-6S, using 2 successive realization) including time variations,
- use of VMF-1 mapping function and,
- only at the end of the time series, estimation of horizontal tropospheric gradients (since January 2014).

14.4 NEW DEVELOPMENTS

New developments are mostly related to modification of the new GipsyX software package from JPL. All satellite macromodels were added for all DORIS satellites, including the most recent ones. For test purposes, we tried to analyze DORIS/RINEX data from Jason2 and SPOT5 satellite. This should allow processing for both old and new DORIS data. To obtain reliable results and automate procedures, we processed a full year of data for both satellites (2014). For SPOT5 DORIS data, we processed Doppler data either starting from the Doppler data files (time-corrected by CNES) and compared the results with Doppler data generated using the phase measurements available in the new RINEX format (without any time correction). In the second case, we did not apply any correction to the time tagging nor to the measurement but modeled the satellite clock effect in the GipsyX software, using proper mathematical models. A peer-reviewed article is in preparation and will discuss these aspects, as well as use of this new software package for other geodetic techniques (GPS, GLONASS, Beidou, Galileo Satellite Laser Ranging). Results were close in terms of orbit comparison (2cm in radial component). For Jason2, we used the raw DORIS phase provided in the new RINEX data files and processed it as phase data. Time tagging was not corrected a priori, nor phase measurement. Comparison between the Jason-2 orbits obtained using the DORIS phase data and the orbit obtained independently using GPS data showed a 1.1 cm agreement. These two tests validated the reading of the new DORIS/RINEX format as well as the implementation of the DORIS phase and the derived DORIS Doppler models in GipsyX.

14.5 REFERENCES

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Willis P., Bertiger, W., IGN Analysis Center Update, DORIS Analysis Working Group (AWG) meeting, Munich, Germany, 4 April 2019, oral presentation.
https://ids-doris.org/documents/report/AWG201904/IDSAWG201904-Willis-IGN_StatusReport.pdf

15 INASAN ANALYSIS CENTER (INA)

Sergey Kuzin / INASAN, Russia

15.1 INTRODUCTION

In 2018, INASAN (ina) DORIS Analysis Center (AC) continued routine processing DORIS data using GIPSY-OASIS II software package (v. 6.4, developed by JPL). The processing strategy and the used models stayed the same as for the ITRF2014 preparation. There were no done any strategy, software package and models modifications during 2018. Currently INA AC processes DORIS data in DORIS 2.2 format for CRYOSAT2, HY2A, JASON2 and SARAL satellites. **Table 22** shows current products delivered by INASAN to the IDS.

15.2 ANALYSIS RESULTS DESCRIPTION: MAIN SCIENTIFIC RESULTS OBTAINED IN 2018

Table 23 gives statistical information of the current INASAN (inawd10) and IDS combined solution (idswd13) contribution to IDS. The epoch for the comparison is the mean value over the whole time period. From the Analysis Coordinator graphs (https://apps.ids-doris.org/apps/7ptool.html) we can see considerable scale rise (three times more compared with the usual mean value) beginning from April 5, 2017 until July 5, 2017. This increasing is also present in IGN Analysis Center scale time series (INA and IGN ACs use the same software package). While for the other ACs this scale rise is absent. The reason of that scale increase is currently unknown.

Table 24 displays the statistical information about inawd10 and idswd13 EOP time series. The standard deviation (std) for the X-pole and Y-pole components of the current INA eop series has about the same values (0.53 and 0.51 mas, correspondently).

It should be mentioned that numbers in the **Table 23** and **Table 24** were obtained by Dr. G.Moreaux using CATREF software package (http://apps.ids-doris.org/apps).

Product	Latest version	Span
SINEX weekly (free-network solutions)	inawd10	1993.0 – 2018.8
Geocenter time series	ina18wd01	1993.0 - 2018.8
EOP time series	ina18wd01	1993.0 - 2018.8

Table 22. INASAN SINEX series delivered to the IDS (February 2018).

AC series (time interval)	WRMS (mm)	Scale (mm)	Tx (mm)	Ty (mm)	Tz (mm)	Scale rate (mm/yr)	Tx rate (mm/yr)	Ty rate (mm/yr)	Tz rate (mm/yr)
idswd13 (1993.0 - 2018.5)	8.40 ±1.03	12.46 ±2.57	0.76 ±3.10	-5.41 ±3.22	-12.40 ±12.73	-0.03	0.55	0.27	-5.38
inawd10 (1993.0 - 2018.5)	14.17 ±2.17	16.02 ±5.22	1.98 ±5.91	-11.60 ±6.39	-13.84 ±19.94	1.62	0.54	0.07	-9.82

Table 23. Comparative statistical characteristics (mean values) of the INA analysis center (inawd10) and IDS combined solution (idswd13) contribution to IDS wrt ITRF2014

Solution	Span	X-pole			X-pole			LOD		
		mean (mas)	std (mas)	trend (mas/y)	mean (mas)	std (mas)	trend (mas/y)	mean (mas)	std (mas)	trend (mas/y)
idswd13	1993.0-2018.5	0.04	0.41	0.01	-0.01	0.39	-0.00	-	-	-
Inawd10	1993.0-2018.5	-0.03	0.53	0.00	0.04	0.51	0.00	-0.02	0.34	-0.00

Table 24. INA AC and combined idswd13 Earth Orientation Parameters Residuals wrt IERS C04.

Solution	X-component		Y-component		Z-component		Span
	A, mm	φ, deg.	A, mm	φ, deg.	A, mm	φ, deg.	
inawd10	3.1±0.1	173±6	4.1±0.1	39±5	3.1±0.7	151±24	1993.0 - 2018.8

Table 25. Annual geocenter motion estimations from weekly ina17wd time series wrt ITRF2008

Table 25 represents amplitudes and phases for the annual components of the geocenter motion for the 1993.0 - 2018.8 time period obtained from the transformation free-network inawd10 series to DPOD2008. In order to estimate amplitudes, periods and phases of geocenter variations with a least square estimation procedure we used CNES software package FAMOUS (Frequency Analysis Mapping On Unusual Sampling) developed by F. Mignard, OCA/CNRS (Obs. de la Cote d'Azur Cassiop/Centre National de la Recherche Scientifique, ftp://ftp.obs-nice.fr/pub/mignard/Famous). The amplitudes A and phases ϕ are modeled by $A\cos(\omega t + \phi)$, ω – angular frequency. The evaluated amplitudes of the annual oscillations are 3.1±0.1 mm and 4.1±0.1 mm for X and Y components, respectively, and 3.1±0.7 mm for Z component. The phase estimates of the annual signal relative to January 1 for ina18wd geocenter time series are 173±6 and 39±5 degrees for X and Y components, respectively, and 151±24 degrees for Z component.

15.3 DEVELOPMENT INASAN'S SOFTWARE PACKAGE FOR DORIS RINEX DATA PROCESSING

In 2011 development of a new software package for SLR data processing has been started at the Institute of Astronomy RAS (GeoIS software package). The general process successfully finished in 2015 [1]. This software package allows to process SLR data from geodetic spherical satellites both for LEO (like Starlette) and MEO (Lageos and Etalon). We plan to prepare this software for routine processing based on ILRS processing requirements and standards.

GeoIS includes not only SLR-processing module but also the universal module for orbits' predictions which includes a state-of-art set of perturbing forces:

- possible to choose any Earth gravity field model (in ICGEM format);
- tides: solid Earth, ocean (several certain models like FES2004, EOT11a, CSR 3.0), pole, atmospheric;
- non-tidal motions in atmosphere and ocean using AOD1B product [2];
- direct and indirect radiation pressure, Earth albedo;
- atmospheric drag including modeling of winds in upper atmosphere with HWM07 model [3].

Considering current progress, it was decided to develop additional modules (in general) for processing DORIS data in RINEX format to estimate (improve) satellite orbits, stations positions, Earth Rotation Parameters and Gravity Field (including geocenter position). To reach this goal several tasks need to be solved/implemented:

1. implement possibility to use DORIS data in RINEX format and initial orbits in SP3 format;
2. processing of huge amount of input data: for SLR we usually process no more than 20000 normal points per 7-days interval, for DORIS processing this amount reaches 120000 per 1-day interval;
3. implement calculation of "observed minus computed" for DORIS measurements;
4. developing a new procedure for calculating non-conservative forces taking into account complex shape and attitude of satellites;
5. working with quaternions for Jason-2/3 satellites;
6. implement possibility for taking into account positions of phase centers both for beacons and satellites;
7. estimating station biases on each pass;
8. implement estimation of troposphere delays;
9. taking into account maneuvers of satellites (like, yaw-flip, yaw-steering etc.);
10. some other items which lead to sufficient changes in current software 's architecture and its logic.

By the end of 2018 almost all tasks have been finished. The first step to check the software performances is improving satellite orbits.

On the first stage orbit prediction modules has been checked to verify new algorithms for atmosphere drag and radiation pressure calculations. We use orbits from CNES (GDR-E standard) as ideal orbits and compare calculated/estimated ones with this data. Processing interval is 1 day, for

Jan 2th, 2017. **Figure 25** displays differences between CNES and our orbits for CRYOSAT-2 and JASON-3 satellites in local orbital reference frame on the first (i.e. pure prediction) and last iteration.

From these results it is obvious that the orbit modeling and improving works stable, but we still have differences up to 20 cm. Moreover, these differences have purely periodical variations. It means software need to be improved in terms of modeling of acting forces. In addition, an investigation should be performed to find the most accurate orbit parameterization for each satellite (in terms of number of estimated ballistic coefficients Cd, 1CPR terms of empirical accelerations, probably more complete mode of Earth albedo and indirect Solar radiation). But in general, these results could be considered satisfactory.

Next stage of validation – long-term processing. We used data for first 3 months of 2017. Only orbit-related parameters were estimated. **Figure 26** presents RMS residuals for the processed time interval for four satellites: CRYOSAT-2, HY-2A, JASON-3 and Sentinel-3A. Based on these results we conclude that the accuracy is good but not enough to be comparable to other DORIS processing centers.

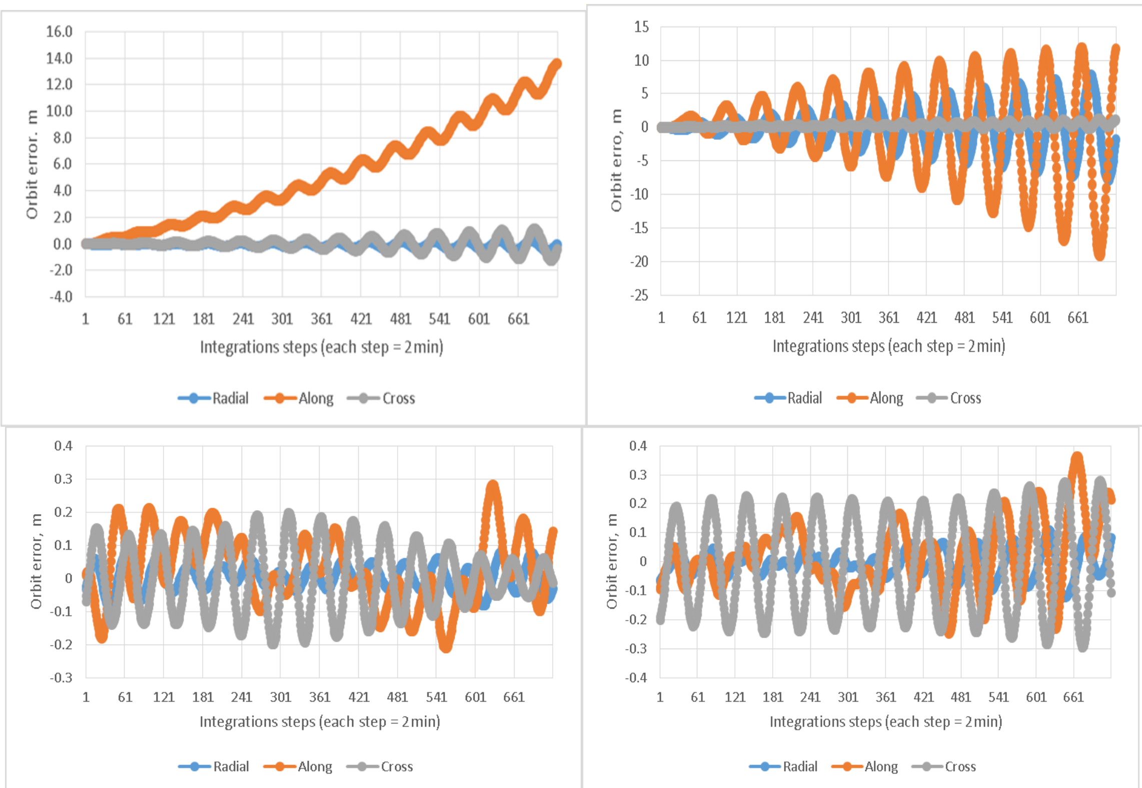

Figure 25. Orbit errors obtained by comparing GeoIS's calculated/estimated orbits with CNES results: CRYOSAT-2 first iteration – top left, CRYOSAT-2 last iteration – bottom left, JASON-3 first iteration – top right, JASON-3 last iteration – bottom right.

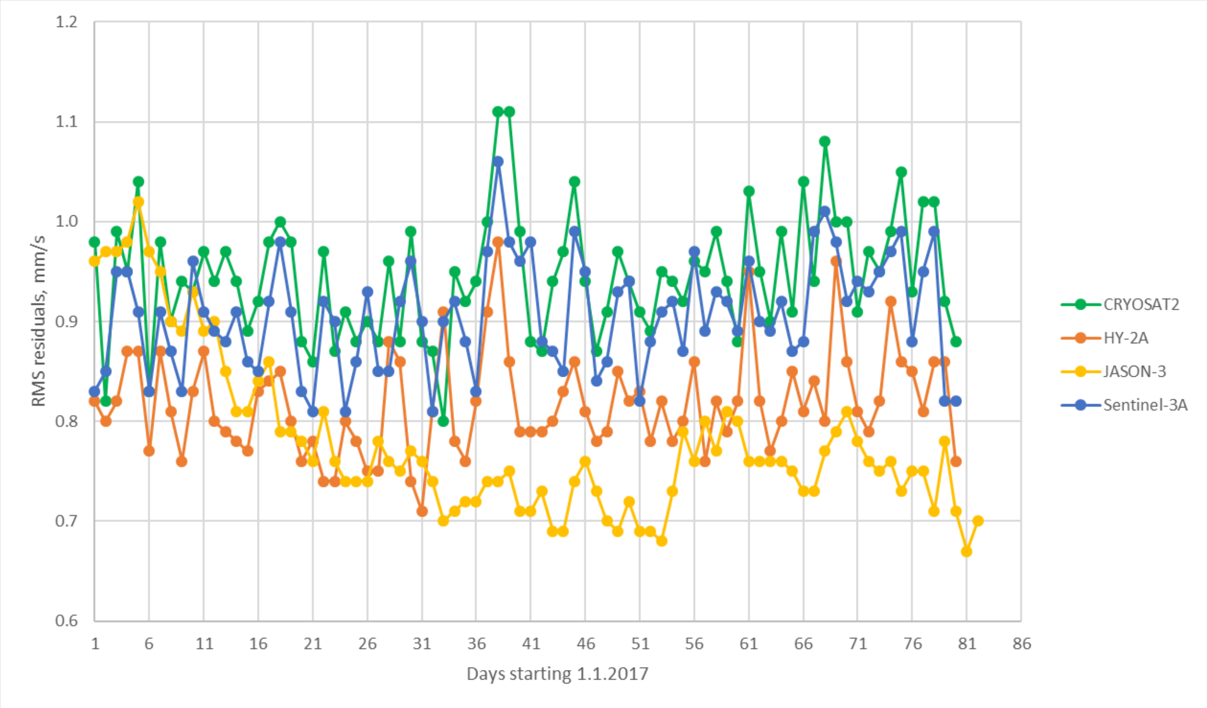

Figure 26. RMS residuals obtained for DORIS satellites on each 1-day interval for 3 months processing

15.4 CONCLUSIONS

Based on the presented results we conclude software works stable, but some additional improvements/investigations should be done (it is planned for 2019):

1. implementing of a priory attitude for JASON-2/3 satellites to fill gaps of quaternions;
2. implementing estimation of tropospheric delays for stations;
3. improving of non-conservative forces modeling/parametrization;
4. estimating of other mentioned parameters (like stations positons etc.);
5. export results to SINEX.

15.5 REFERENCES:

Ebauer K.V., 2017. Development of a software package for determination of geodynamic parameters from combined processing of SLR data from LAGEOS and LEO, *GEODESY AND GEODYNAMICS*, 8(3): 213-220, DOI: 10.1016/j.geog.2017.03.004.

Flechtner F., Dobslaw H., Fagiolini E., AOD1B Product Description Document for Product Release 05. Potsdam, 2014.

Drob D.P., Emmert J.T., Crowley G., Picone J.M., Shepherd G.G., Skinner W., Hays P., Niciejewski R.J., Larsen M., She C.Y., et al., 2008. An Empirical Model of the Earth's Horizontal Wind Field: HWM07, *JOURNAL OF GEOPHYSICAL RESEARCH*, 113, A12, DOI:10.1029/2008JA013541.

16 GFZ ASSOCIATED ANALYSIS CENTER

Rolf König, Anton Reinhold / Helmholtz Centre Potsdam - GFZ, Oberpfaffenhofen, Germany

16.1 INTRODUCTION

The activities performed at GFZ in 2018 comprised steps towards estimating station coordinates and velocities, and Earth Rotation Parameters (ERP) from DORIS and SLR observations to the altimetry satellites ENVISAT, JASON-1 and JASON-2. Also, the residuals of Precise Orbit Determination (POD) of these missions were analyzed for their systematic and stochastic characteristics. In addition, the usage of RINEX formatted DORIS observations was implemented in our POD software EPOSOC.

16.2 REFERENCE FRAME FROM DORIS AND SLR WITH ENVISAT, JASON-1 AND JASON-2

One of the objectives of this analysis was to answer the question if the orbit can serve as a global tie between DORIS and SLR that can transfer the datum from one technique to the other. For this we relied on readily available precise orbits of 7-day arc lengths from DORIS and SLR observations from and to ENVISAT, JASON-1 and JASON-2. From the converged orbit solutions, station coordinates and velocities and ERPs were set free to arrive at normal equations (NEQ) per arc and per satellite. The NEQs were accumulated to global NEQs per satellite which can be solved for the DORIS and SLR coordinates based on the very weak inherent datum. The rotational freedom of the solution however leaves coordinate displacements in the order of 20 m (see **Figure 27**). If the SLR station coordinates (the SLR stations are those to the right with sequence numbers larger 70) are endowed with No-Net-Rotation (NNR) conditions (the Helmert conditions for rotation), the displacements of the SLR station coordinates drop down drastically, but not those of the DORIS stations (see **Figure 28**). This means that the orbit does not serve as global tie in this case.

16.3 CHARACTERISTICS OF DORIS RESIDUALS FROM ENVISAT, JASON-1 AND JASON-2

From the highly precise orbits of ENIVISAT, JASON-1 and JASON-2 we analyzed the systematic and stochastic properties of the residuals. The idea is to make use of these properties for improved orbit and parameter estimation. **Figure 29** shows at the example of ENVISAT the standard deviations of the residuals per 3-degree bins dependent on azimuth and elevation. The pattern has a con-centric structure, that means that the observations can be weighted dependent on elevation.

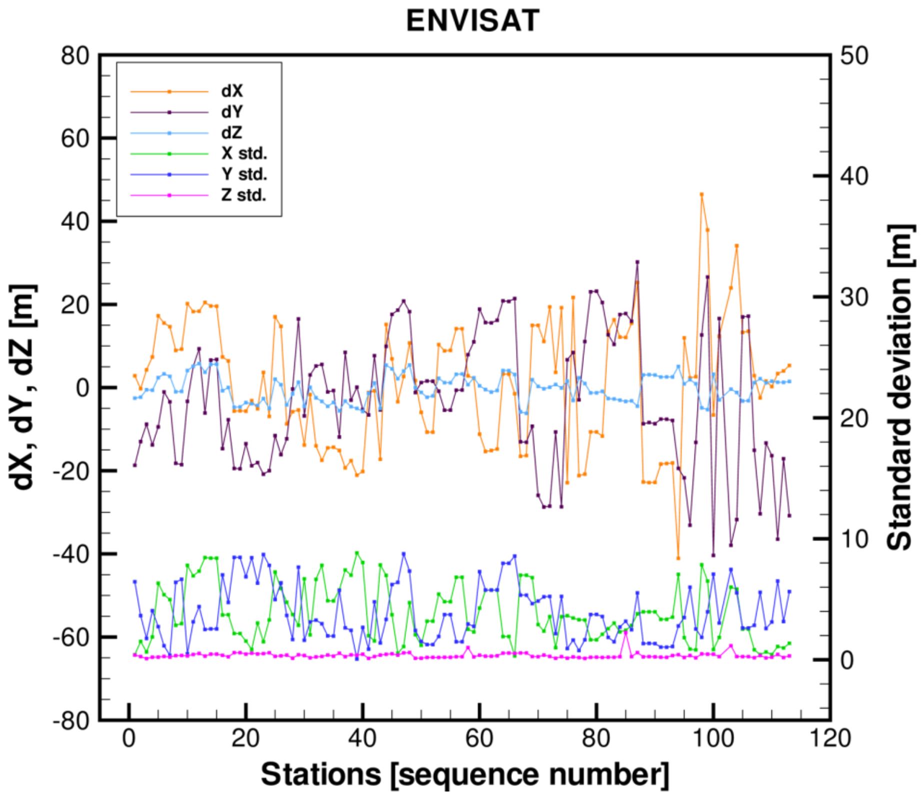

Figure 27. Station displacements without constraints

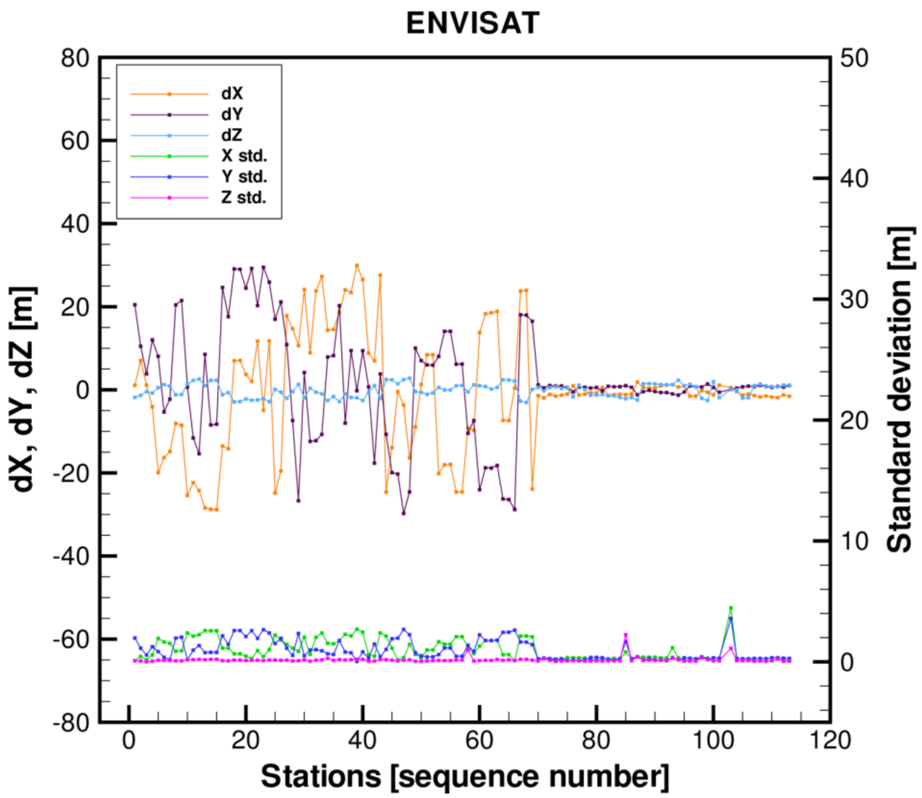

Figure 28. Station displacements with NNR conditions

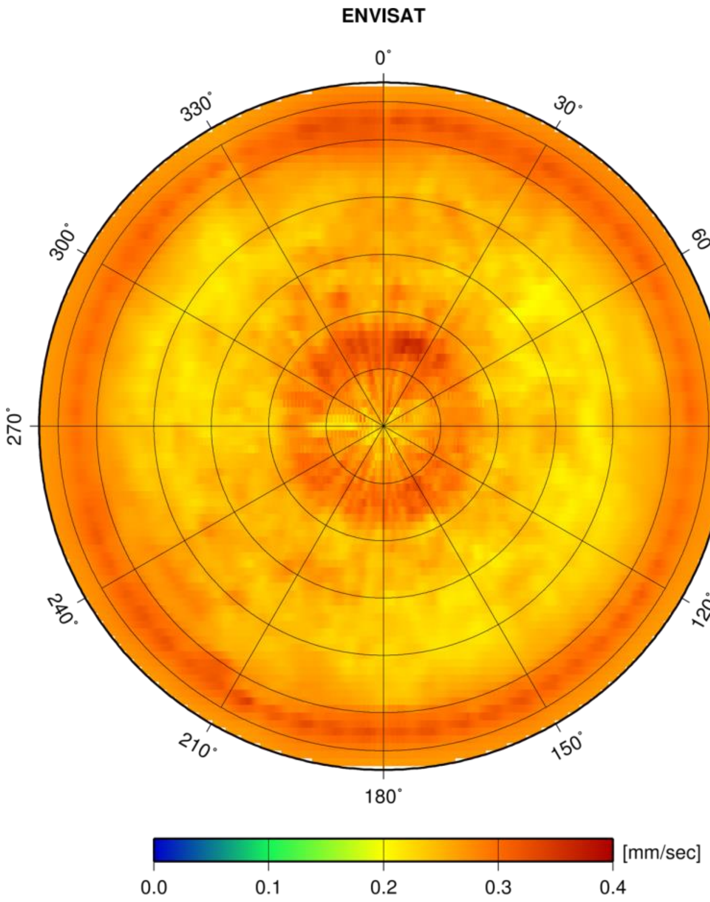

Figure 29. Standard deviations of residuals

16.4 TRANSITION TO RINEX

For POD of the newest altimetry missions like Sentinel-3 we started to adopt the RINEX format for Doppler observations in our orbit determination software EPOS-OC. We use the CNES routines to read the DORIS RINEX files and to get the data in GINS format, from where we transform them into our EPOS-OC internal format. In order to increase the accuracy of the POD we estimate the frequency biases for each DORIS ground station and each processing arc in a first step and correct the Doppler observations before further processing. Also, we optimized the threshold for the screening of the Doppler observations to efficiently eliminate outliers. For validation we reprocessed JASON-2 arcs for 2013 with new RINEX data. The results are compiled in terms of orbital fits and in **Figure 30**. The old Doppler data represented by the green line have been screened for outliers already. The blue line shows the results of using the RINEX observations as is, and the red line after applying the tailored outlier elimination

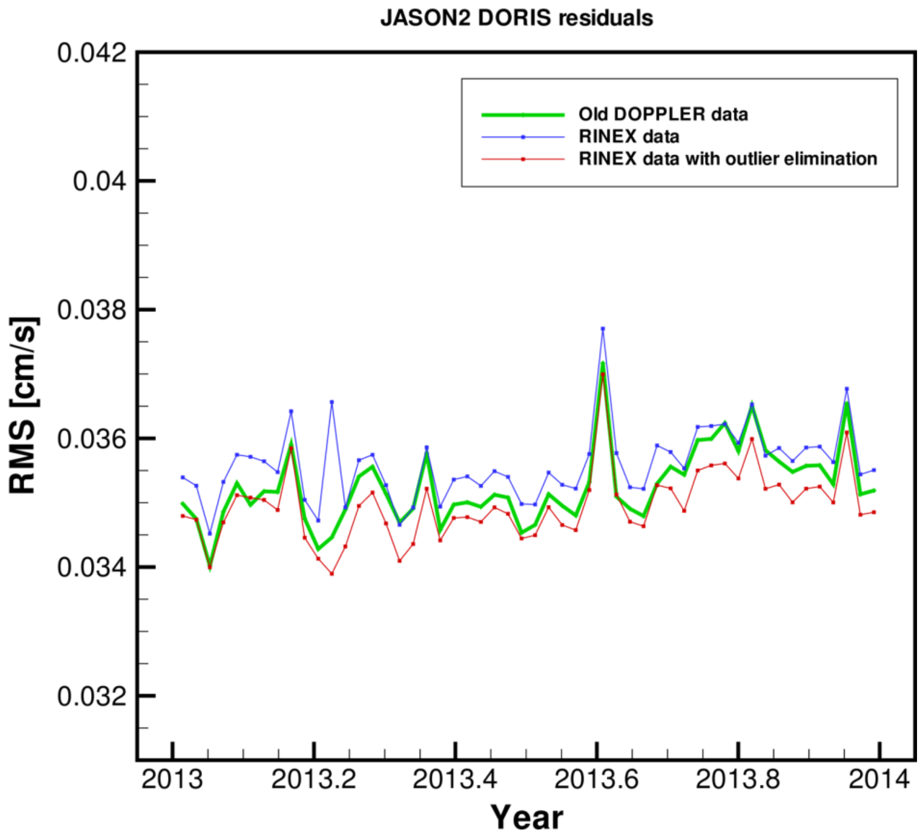

Figure 30. POD of old Doppler vs. new RINEX observations

16.5 PRESENTATIONS AND REFERENCES

- Reinhold A., Koenig R.: Development of stochastic modeling for DORIS simulations in GGOS-SIM. IDS Analysis Working Group Meeting, Toulouse, France, June 11, 2018 https://ids-doris.org/images/documents/report/AWG201806/IDSAWG201806-Reinhold-SimulationsGGOS_SIM.pdf
- Koenig R., Reinhold A., Glaser, S., Neumayer K.H.: Station Positions and Earth Rotation Parameters from JASON-1, JASON-2, and ENVISAT. International DORIS Service (IDS) Workshop, Ponta Delgada, Portugal, September 24-26, 2018 https://ids-doris.org/images/documents/report/ids_workshop_2018/IDS18_s2_Koenig_StationPositionsEOPfromJ1J2Env.pdf
- Koenig R., Reinhold A., Dobslaw H., Esselborn S., Neumayer K.H., Dill, R.: On the Effect of Non-tidal Atmospheric Loading on Altimetry Orbits. Ocean Surface Topography Science Team (OSTST) Meeting, Ponta Delgada, Portugal, September 27-28, 2018 https://meetings.aviso.altimetry.fr/fileadmin/user_upload/POD_09_Koenig.pdf
- Reinhold A., Koenig R., Glaser S., Neumayer, K.H.: DORIS observations to JASON-1, JASON-2, and ENVISAT for the determination of the global reference frame (in German). Geodetic Week, Frankfurt am Main, Germany, October 16, 2018

17 WORKING GROUP "NRT DORIS DATA"

Denise Dettmering / DGFI-TUM, Germany

The general objective of this working group is a thorough assessment on benefits, requirements and prospects of DORIS data with improved data latency with a focus on applications in ionospheric research. In 2018, two main topics has been handled by members of the Working Group, namely (1) the validation of real-time global ionospheric maps by DORIS data sets and (2) the usage of DORIS data in near real-time ionospheric modeling. More information can be found below. Based on the present experiences and in line with some of the recommendations from the IDS retreat in June 2018, currently, CNES is studying a potential extension of its services in order to allow the ground segment to export the DORIS measurements in near real-time to the users.

17.1 VALIDATION OF REAL-TIME GLOBAL IONOSPHERIC MAPS BY DORIS DATA SETS

As an extension of DORIS applications in GNSS community, the relative slant total electron content (dsTEC) extracted from DORIS DGXX data have been applied to validate the quality of different ionospheric models (e.g. real-time global ionospheric maps). DORIS dsTEC exhibit a good consistency with GPS dsTEC at the level of 0.2-0.5 TECu, which is a sufficiently promising result because most ionospheric models are generated with GPS/GNSS technique. While the consistency between DORIS- and GNSS-derived ionospheric information requires to be further checked with more DORIS DGXX data, increasing contributions from DORIS are foreseen for independent assessments of ionospheric models or high-precision ionospheric modeling.

Reference: *Wang N and Li Z. Consistency of DORIS and GPS Assessments for the Real-time Global Ionospheric Maps. IDS Workshop, 24-29 September 2018, Ponta Delgada, Portugal.* https://ids-doris.org/images/documents/report/ids_workshop_2018/IDS18_s4_Ningbo_ConsistencyDORISandGPSforRTionoMaps.pdf

17.2 USING DORIS DATA IN NEAR REAL-TIME IONOSPHERIC MODELING

Today, the most important input observations for near real-time ionospheric modeling are terrestrial GNSS observations due to their spatio-temporal resolution and real-time availability. However, large data gaps exist due to the inhomogeneous distribution of the GNSS observation sites, especially over the oceans. DORIS can mitigate the data gap problem and improve the accuracy and reliability of ionospheric maps. However, data derived from the DORIS system is currently provided with a latency of several days –too late for rewarding an inclusion in (near) real-time ionospheric models.
Using real DORIS data with different (simulated) latencies, the contribution of NRT DORIS data to ionosphere modeling has now been studied for the first time. Based on a Kalman filter approach with multiple filters running in parallel for different observations types (e.g., GNSS, DORIS) with different updating periods, it has been shown that DORIS data with latencies larger than one day(current standard) has no influence on the results at all, whereas 1 hour old data sets can help to improve the modeling significantly by up to 50% (depending on the data distribution with respect to the GNSS data coverage).

Reference: *Erdogan E., Dettmering D., Schmidt M., Goss A. The impact of low-latency DORIS data on near real-time VTEC modeling. IDS Workshop, 24-29 September 2018, Ponta Delgada, Portugal.* https://ids-doris.org/images/documents/report/ids_workshop_2018/IDS18_s4_Dettmering_ImpactLowLatencyDORISdataOnNRT-VTECmodeling.pdf

APPENDIX

18 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: ftp://cddis.gsfc.nasa.gov/doris/
   IGN: ftp://doris.ensg.eu and ftp://doris.ign.fr

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

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

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

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

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

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

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

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

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

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

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

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

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

16. **IDS video channel**
    Videos of the DORIS-equipped satellites in orbit
    https://www.youtube.com/channel/UCiz6QkabRioCP6uEjkKtMKg

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

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

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

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19 IDS INFORMATION SYSTEM

19.1 WHAT AND WHERE

IDS has three data/information centers:

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

The baseline storage rules are as follows:

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

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

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

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

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

19.2 WEB AND FTP SITES

19.2.1 IDS WEB SITE

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

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

It is composed of four parts:

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

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

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

The main headings of the "IDS" parts are:

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

The headings of the "DORIS system" part are:

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

The headings of the "Analysis Coordination" part are:

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

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

The IDS web site is maintained by the Central Bureau.

19.2.2 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)

19.2.3 IDS FTP SERVER

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

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

The main directories are :

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

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

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

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

19.2.4 DORIS WEB SITE

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

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

19.2.5 DATA CENTERS' FTP AND WEB SITES

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

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

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

19.3 THE MAIL SYSTEM

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

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

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

19.3.1 DORISMAIL

e-mail: dorismail@ids-doris.org

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

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

The messages are moderated by the Central Bureau.

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

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

19.3.2 DORISREPORT

e-mail : dorisreport@ids-doris.org

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

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

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

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

19.3.3 DORISSTATIONS

e-mail : dorisstations@ids-doris.org

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

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

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

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

19.3.4 OTHER MAILING LISTS

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

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

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

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

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

19.4 HELP TO THE USERS

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

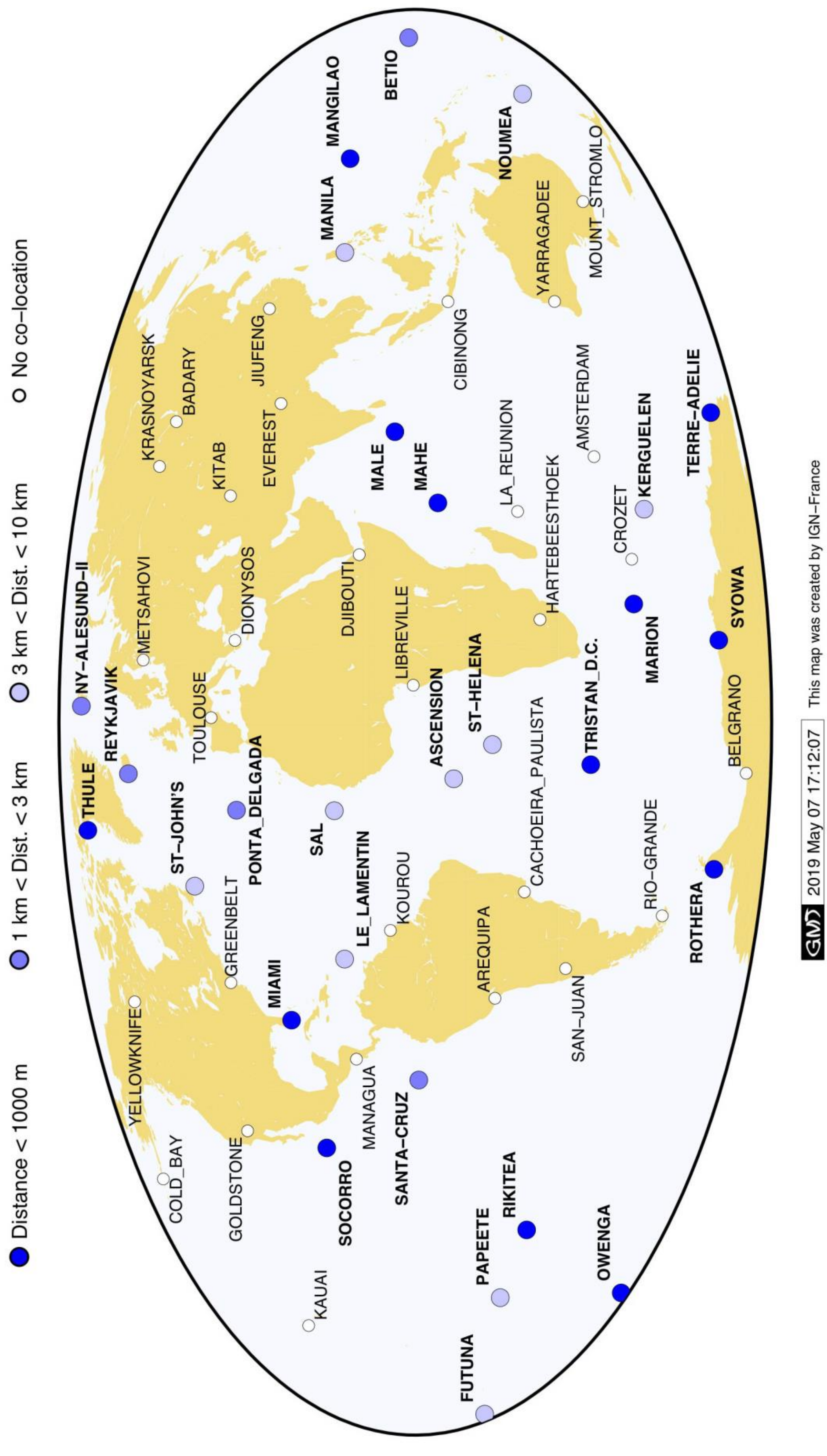
The contact point for every information requirement is the Central Bureau. It will find a solution to respond to user’s need. A list of contact points has been defined for internal use depending on the kind of questions.

20 DORIS STATIONS / CO-LOCATION WITH TIDE GAUGES

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

DORIS Name	Long	Lat	Country	Start date	Distance (m)	GLOSS Id	PSMSL Id
ASCENSION	-14.33	-7.92	UK (SOUTH ATLANTIC)	28/02/97	6500	263	1831
BETIO	172.92	1.35	KIRIBATI	22/10/06	1600	113	1804
FUTUNA	-178.12	-14.31	FRANCE (POLYNESIA)	18/10/11	4400	------	2244
KERGUELEN	70.26	-49.35	FRANCE (TAAF)	05/04/93	3300	23	1849
LE LAMENTIN	-61.00	14.60	FRANCE (MARTINIQUE)	29/06/13	7000	338	1942
MAHE	55.53	-4.68	SEYCHELLES	20/06/01	300	339	1846
MALE	73.53	4.20	MALDIVES	15/01/05	500	28	1753
MANILA	121.03	14.53	PHILIPPINES	26/02/03	9700	73	145
MANGILAO	144.80	13.43	USA (GUAM IS.)	12/04/18	830	------	2130
MARION ISLAND	37.86	-46.88	SOUTH AFRICA	01/01/90	410	20	------
MIAMI	-80.17	25.73	USA (FLORIDA)	10/02/05	180	332	1858
NOUMEA	166.42	-22.24	FRANCE (CALEDONIA)	27/01/05	7000	123	2134
NY-ALESUND II	11.83	78.93	NORWAY (SVALBARD)	19/10/18	2500	345	1421
OWENGA	-176.37	-44.02	NEW ZEALAND (CHATHAM IS.)	20/01/14	80	------	------
PAPEETE	-149.61	-17.58	FRANCE (POLYNESIA)	27/07/95	7000	140	1397
PONTA DELGADA	-25.66	37.75	PORTUGAL (AZORES)	02/11/98	1500	245	258
REYKJAVIK	-21.99	64.15	ICELAND	04/07/90	1570	229	638
RIKITEA	-134.97	-23.13	FRANCE (POLYNESIA)	23/09/06	800	138	1253
ROTHERA	-68.1	-67.6	UK (ANTARCTICA)	01/03/03	100	342	1931
SAL	-22.98	16.78	CAPE VERDE	15/12/02	5700	329	1914
SANTA CRUZ	-90.30	-0.75	ECUADOR	01/04/05	1600	------	1472
SOCORRO	-110.95	18.73	MEXICO	09/06/89	400	162	1821
ST-HELENA	-5.67	-15.94	UK (SOUTH ATLANTIC)	01/06/89	5900	264	1845
ST. JOHN'S	-52.68	47.40	CANADA (TERRE-NEUVE)	27/09/99	3600	223	393
SYOWA	39.58	-69.01	JAPAN (ANTARCTICA)	10/02/93	1000	95	1396
TERRE ADELIE	140.00	-66.67	FRANCE (ANTARCTICA)	01/02/97	500	131	------
THULE	-68.83	76.54	DENMARK (GREENLAND)	28/09/02	450	------	------
TRISTAN DA CUNHA	-12.31	-37.07	UK (SOUTH ATLANTIC)	10/06/86	120	266	------

Co–location with tide gauge



21 DORIS STATIONS / HOST AGENCIES

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

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

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

Station name	Host agency	City, Country
Hartebeesthoek	HartRAO, South African National Space Agency (SANSA)	Hartebeesthoek, SOUTH AFRICA
Jiufeng	Institute of Geodesy and Geophysics (IGG)	Wuhan, CHINA
Kauai	Kokee Park Geophysical Observatory (KPGO)	Kauai Island, Hawaï, U.S.A.
Kerguelen	Institut Polaire Paul Emile Victor (IPEV)	Base de Port-aux-Français, archipel de Kerguelen, Sub-Antarctica, FRANCE
Kitab	Ulugh Beg Astronomical Institute (UBAI)	Kitab, UZBEKISTAN
Kourou	Centre Spatial Guyanais (CSG)	Kourou, FRENCH GUYANA
Krasnoyarsk	Siberian Federal University (SibFU)	Krasnoyarsk, RUSSIA
La Réunion	Observatoire Volcanologique du Piton de La Fournaise (IPGP)	Ile de la Réunion, FRANCE
Le Lamentin	Météo-France	Martinique, French West Indies, FRANCE
Libreville	ESA Tracking Station	N'Koltang, GABON
Mahé	Seychelles Meteorological Authority	Mahé Island, Republic of SEYCHELLES
Male	Maldives Department of Meteorology	Male, Republic of MALDIVES
Managua	Instituto Nicaragüense de Estudios Territoriales (INETER)	Managua, NICARAGUA
Mangilao	University of Guam (UoG)	Guam Island, USA
Manila	National Mapping and Ressource Information Authority (NAMRIA)	Manila, 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)	Rickenbacker Causeway, Florida, U.S.A.
Mount Stromlo	Mount Stromlo Observatory, Geoscience Australia (GA)	Mount Stromlo, Canberra, AUSTRALIA
Nouméa	Direction des Infrastructures, de la Topographie et des Transports Terrestres	Nouméa, NEW CALEDONIA
Ny-Ålesund II	Institut Polaire Paul Emile Victor (IPEV) Kartverket (Norwegian Mapping Authority)	Ny-Ålesund, Svalbard, NORWAY
Owenga	Land Information New Zealand (LINZ)	Chatham Island, NEW ZEALAND
Papeete	Observatoire Géodésique de Tahiti, Université de la Polynésie Française (UPF)	Fa'a, Tahiti, Polynésie Française, FRANCE

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

22 GLOSSARY

AC

Analysis Center

AGU

American Geophysical Union.

AVISO

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

AWG

Analysis Working Group

CB

Central Bureau

CDDIS

Crustal Dynamics Data Information System

CLS

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

CNES

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

CNRS

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

CryoSat-2

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

CSR

Center for Space Research, the University of Texas

CSTG

Coordination of Space Technique in Geodesy

DC

Data Center

DGXX

DORIS receiver name (3rd Generation)

DIODE

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

DORIS

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

DPOD

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

ECMWF

European Centre for Medium-range Weather Forecasting

EGU

European Geosciences Union

EOP

Earth Orientation Parameters

Envisat

ENVIronmental SATellite Earth-observing satellite (ESA)

ESA

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

ESA, esa

acronyms for *ESA/ESOC* Analysis Center, Germany

ESOC

European Space Operations Centre (ESA, Germany)

EUMETSAT

EUropean organisation for the exploitation of METeorological SATellites

GAU, gau

acronyms for the *Geoscience Australia* Analysis Center, Australia

GB

Governing Board

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

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

geoc

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

eop

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

GFZ

GeoForschungsZentrum, German Research Centre for Geosciences

GGOS

Global Geodetic Observing System

GNSS

Global Navigation Satellite System

GLONASS

Global Navigation Satellite System (Russian system)

GOP, gop

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

GRG, grg

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

GRGS

Groupe de Recherche de Géodésie Spatiale

GSC, gsc

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

GSFC

Goddard Space Flight Center (NASA).

HY-2

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

IAG

International Association of Geodesy

IDS

International DORIS Service

IERS

International Earth rotation and Reference systems Service

IGN

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

IGN, ign

acronyms for *IGN/IPGP* Analysis Center, France

IGS

International GNSS Service

ILRS

International Laser Ranging Service

INA, ina

acronyms for the *INASAN* Analysis Center, Russia

INASAN

Institute of Astronomy, Russian Academy of Sciences

IPGP

Institut de Physique du Globe de Paris

ISRO

Indian Space Research Organization

ITRF

International Terrestrial Reference Frame

IUGG

International Union of Geodesy and Geophysics

IVS

International VLBI Service for Geodesy and Astrometry

Jason

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

JOG

Journal Of Geodesy

JASR

Journal of Advances in Space Research

LCA, lca

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

LEGOS

Laboratoire d'Etudes en Géodésie et Océanographie Spatiales, France

LRA

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

MOE

Medium Orbit Ephemeris.

NASA

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

NCEP

National Center for Environmental Prediction (NOAA).

NLC, ncl

acronyms for *University of Newcastle* Analysis Center, UK

NOAA

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

OSTST

Ocean Surface Topography Science Team

POD

Precise Orbit Determination

POE

Precise Orbit Ephemeris

Poseidon

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

RINEX/DORIS

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

SAA

South Atlantic Anomaly

SARAL

Satellite with ARgos and Altika

Sentinel-3

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

SINEX

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

SIRS

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

SLR

Satellite Laser Ranging

SMOS

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

snx see SINEX

SOD

Service d'Orbitographie DORIS, CNES DORIS orbitography service

SPOT

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

sp1, sp3

Specific format for orbit ephemeris files

SSALTO

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

STCD

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

STPSAT

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

SWOT

Surface Water Ocean Topography. Name of a future CNES/NASA satellite mission.

TOPEX/Poseidon

Altimetric satellite (NASA/CNES).

USO

Ultra-Stable Oscillator

UTC

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

VLBI

Very Long Baseline Interferometry.

ZTD

Zenith Tropospheric Delay

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

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