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CENTRE NATIONAL D'ÉTUDES SPATIALES

International Doris Service

Activity Report 2013

IGN
INSTITUT NATIONAL DE L'INFORMATION GÉOGRAPHIQUE ET FORESTIÈRE

IDS

The International DORIS Service

2013 Annual Report

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Preface

In this volume, the International DORIS Service documents the work of the IDS components between January 2013 and December 2013. The individual reports were contributed by IDS groups in the international geodetic community who make up the permanent components of IDS.

The IDS 2013 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 http://ids-doris.org/documents/report/IDS_Report_2013.pdf

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IDS and DORIS quick reference list

1. **IDS website**
   http://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. **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

5. **IDS Analysis forum**
   The IDS Analysis Forum is a list for discussion of DORIS data analysis topics. To start a discussion on a specific topic, use the following address: ids.analysis.forum@ids-doris.org

6. **List of documents and links to discover the DORIS system**
   http://ids-doris.org/analysis-documents.html

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

   > Willis P., Fagard H., Ferrage P., Lemoine F.G., Noll C.E., Noomen R., Otten M., Ries J.C., Rothacher M., Soudarin L., Tavernier G., Valette J.J. (2010), The International DORIS Service, Toward maturity, Advances in Space Research, 45(12):1408-1420, DOI: 10.1016/j.asr.2009.11.018

8. **List of DORIS publications in international peer-reviewed journals**
   http://ids-doris.org/report/publications/peer-reviewed-journals.html

9. **Overview of the DORIS satellite constellation**
   http://www.aviso.altimetry.fr/en/techniques/doris/doris-applications.html

10. **Site logs**

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

11. **Virtual tour of the DORIS network with Google Earth**

Download the file at http://ids-doris.org/network/googleearth.html and visit the DORIS sites all around the world.

12. **IDS web service**

http://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.

13. **More contacts**

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

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Glossary

AC

Analysis Center

AGU

American Geophysical Union. AGU is a scientific society that aims to advance the understanding of Earth and space. AGU conducts meetings and conferences, publishes journals, books and a weekly newspaper, and sponsors a variety of educational and public information programs.

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.

ECMWF

European Centre for Medium-range Weather Forecasting

EGU

European Geosciences Union

EOP

Earth Orientation Parameters

eop

Specific format for geodetic product: time series files of 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)

EU
European Union

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

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

GGOS
Global Geodetic Observing System

GMF
Global Mapping Function

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

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 and Jason-2 was launched on June 20, 2008.

JOG
Journal Of Geodesy

JASR
Journal of Advances in Space Research

LCA, lca
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

RMS
: **Root Mean Square**

SAA
: **South Atlantic Anomaly**

SARAL
: **Satellite with ARgos and Altika**

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

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 were also conducted between ACs (orbit comparisons, single-satellite SINEX solutions for station coordinates). In 2013, 6 analysis centers reprocessed all DORIS data sets (since 1993) in order to provide weekly SINEX solutions in preparation of ITRF2013. Validation of these weekly SINEX solutions was performed by the IDS Analysis combination center.

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 1Table 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, Table 3).

In 2014, two DORIS Analysis Working Group meetings will take place, first in March, in Paris (France), then in October, in Konstanz (Germany), in conjunction with the IDS Workshop (see details at http://ids-doris.org/report/meeting-presentations/ids-workshop-2014.html).

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

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

Table 2. List of IDS events organized between 2004 and 2009

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 Rep. 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

Table 3. List of IDS events organized between 2010 and 2013

3 ORGANIZATION

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

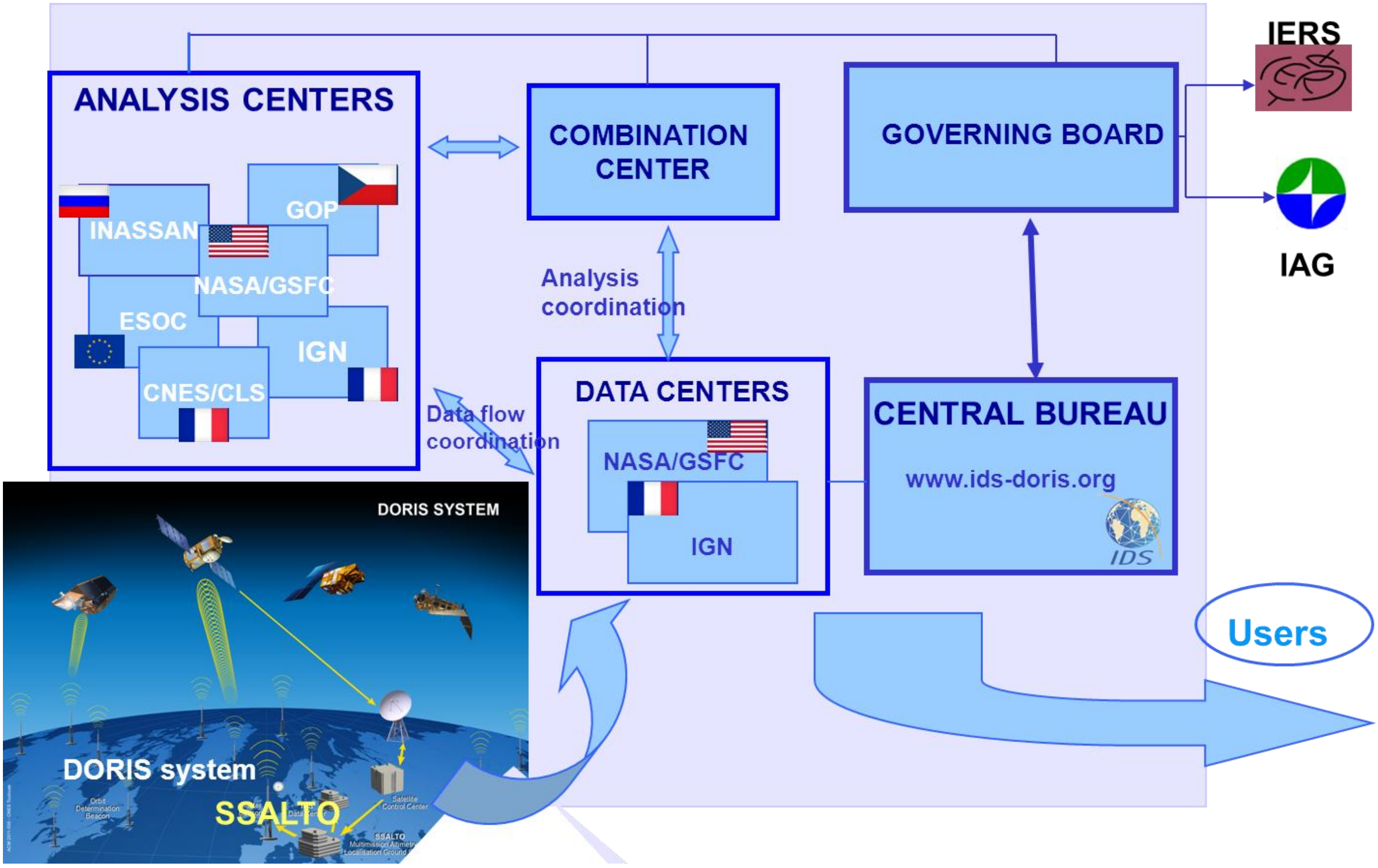


Figure 1. IDS organization

3.1 GOVERNING BOARD

In December 2012, a new Governing board was elected or appointed following the IDS terms of reference updated in 2011. **The 2013-2014 IDS Governing Board is**:

Elected Members:

Elected by the associate members

- Pascal WILLIS (IGN/IPGP) **Chairperson**
  Analysis Centers' representative

- Carey NOLL (NASA/GSFC)
  Data Centers' representative

- Richard BIANCALE (CNES/GRGS)
  Member at large

Elected by the previous Governing Board

- Frank G. LEMOINE (NASA/GSFC)
  Analysis Coordinator

- John RIES (University of Texas/CSR)
  Member at large

Appointed members:

- Pascale FERRAGE (CNES)
  DORIS System representative

- Jérôme SAUNIER (IGN)
  Network representative

- Laurent SOUDARIN (CLS)
  Director of the Central Bureau

- Guilhem MOREAUX (CLS)
  Combination Center representative

- Michiel OTTEN (ESA/ESOC)
  Representative of the IAG

- Brian LUZUM (USNO)
  Representative of the IERS

3.2 REPRESENTATIVES AND DELEGATES

IDS representative to the IAG: Pascal Willis

IDS representatives to the IERS:

Analysis Coordinator: Frank G. Lemoine
Network representative: Jérôme Saunier

IDS delegate for the GGOS Steering Committee: Pascal Willis (substitute: Frank G. Lemoine)

IDS representatives to GGOS consortium: Pascal Willis, Laurent Soudarin

3.3 CENTRAL BUREAU

In 2013, 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

4 THE CENTRAL BUREAU

Laurent Soudarin [(1)], Pascale Ferrage [(2)]

(1) CLS, France

(2) CNES, France

Like in the previous years, the Central Bureau has brought its supports to the IDS components and continued to operate the information system. We present here the main activities of 2013 and the novelties brought to the IDS web and ftp sites. Plans for 2014 are also given. An overview of the IDS information system is reminded in appendix to this report.

4.1 SUPPORT TO THE IDS COMPONENTS

The Central Bureau participated to the organization of the AWG meetings in Toulouse and Washington.

The Central Bureau worked on making available the meta-data and DORIS data of the SARAL satellite. It coordinated the actions between SAALTO and the Data Centers.

Several presentations have been made to promote the IDS activities:

AOGS, Brisbane, Australia, June 2013:

- Current status and perspectives (oral) by Willis et al.

  http://ids-doris.org/documents/report/meetings/AOGS2013_IDS_Status.pdf

IAG Scientific Assembly, Potsdam, Germany, September 2013

- The International DORIS Service (IDS) Recent developments in preparation for ITRF2013 (oral) by Willis et al.

  http://ids-doris.org/documents/report/meetings/IAG2013_IDS_PreparationForITRF2013.pdf

- IDS plot tools for time series of DORIS station positions and orbit residuals (poster) by Soudarin et al.

  http://ids-doris.org/documents/report/meetings/IAG2013_IDS_Plottool.pdf

AGU fall meeting, San Francisco, USA, December 2013

- Interactive visualization tool for station coordinates time series of DORIS and other space geodetic techniques at co-located sites (poster) by Moreaux et al.

  http://ids-doris.org/documents/report/meetings/AGU2013_IDS_Plottool.pdf

4.2 IDS WEBSITE

Address: http://ids-doris.org

The main updates of 2013 are reported hereafter.

- The presentations of the the AWG meetings held in Toulouse on April 2013 and in Washington on October 2013 have been made available:

  http://ids-doris.org/report/meeting-presentations/ids-awg-04-2013.html

  http://ids-doris.org/report/meeting-presentations/ids-awg-10-2013.html

- The activity reports for 2012 were added (IDS Activity report, report for IERS) as well as the minutes of the IDS GB meetings held in 2013:

  http://ids-doris.org/report/governing-board.html

- The list of the peer-reviewed publications related to DORIS has been enriched with 7 new references of articles published in 2013:

  http://ids-doris.org/report/publications/peer-reviewed-journals.html#2013

- The pages Sitelogs have been upgraded.

  http://ids-doris.org/network/sitelogs.html

  - The previous codes of the stations have been added in the table of the main page. In addition, the URL links have been changed. The station's name is used instead of one of the station's codes.
  - Several updated versions of site logs has been provided by IGN, (among them the site logs for Le Lamentin and Grasse), as well as more than 70 photos of station monumentations and host agency staffs. (see also http://ids-doris.org/gallery.html)

- The letter from the International Council for Science (ICSU) World Data System (WDS) accepting IDS as a Network Member has been put on line:

http://ids-doris.org/documents/report/WorldDataSystem/WDS-NetworkMember_IDS_20131010.pdf

- Links to brochures and videos about DORIS available on AVISO website have been added:

  http://ids-doris.org/analysis-documents.html#general

4.3 IDS FTP SERVER

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

The documents and files put on the IDS ftp site in 2013 are listed hereafter:

- "DORIS system definition" is a new document describing the DORIS missions, then the DORIS system in details, with its external and internal connections. It applies to the DORIS system from the DGXX generation:

  ftp://ftp.ids-doris.org/pub/ids/DORIS_System_Definition.pdf

- "Saral characteristics for DORIS calibration plan and POD processing" is a new document that describes the SARAL satellite characteristics:

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

- A note about "station equipment and impact on the frequency" which reminds the possible changes of emitting frequency in case of equipement changes for the three kinds of DORIS beacons (Orbitography, Master, and Time becons):

  ftp://ftp.ids-doris.org/pub/ids/stations/AboutStationEquipmentAndFrequency.pdf

- version #4.5 of the document describing the modelling of DORIS 2GM instruments (cleaned of any reference to Cryosat-1):

  ftp://ftp.ids-doris.org/pub/ids/satellites/DORIS_instrument_modelling_2GM.pdf

- version #5 of the document describing the DORIS satellite models implemented in CNES POE processing; it includes SARAL and updates on SPOT-5 solar panel offsets:

  ftp://ftp.ids-doris.org/pub/ids/satellites/DORISSatelliteModels.pdf)

- updated version of the DORIS internal tie file

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

- The sitelogs were all gathered in:

  ftp://ftp.ids-doris.org/pub/ids/stations/sitelogs/

4.4 FUTURE PLAN

In 2014, the Central Bureau will organise the elections for the renewal of two positions of Governing Board: Analysis Coordinator and one Member at large.

It will participate to the organisation of the IDS Workshop in Konstanz, Germany. A page compiling the necessary information will be created on the website.

A tutorial about the use of DORIS data in RINEX-like format will be proposed.

An upgraded version of the web tools to plot time series will be put online.

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

5 THE NETWORK

Jérôme Saunier

Institut National de l'Information Géographique et Forestière, France

5.1 STATUS AND PERFORMANCE

The DORIS network relies on partnerships with scientific organizations through best-effort support. This works rather well but the current economic context makes the maintenance more and more difficult.

Closure of facilities, consolidation of sites, or automation for cutting staff decided by host agencies in order to save money, force us to move out. In the end, most of the problems encountered today on the network can be summed up in one word: money!

However, we are still able to anticipate and respond in a timely way to the network events, and in parallel, we continue to carry out renovation and maintenance work in order to keep up the network performance level with the permanent objective of a better service delivered to the system.

DORIS still provided a reliable service in 2013. The joint effort of CNES, IGN and all host agencies offered outstanding network availability with an annual mean of 88 % of operating stations (Figure 2)

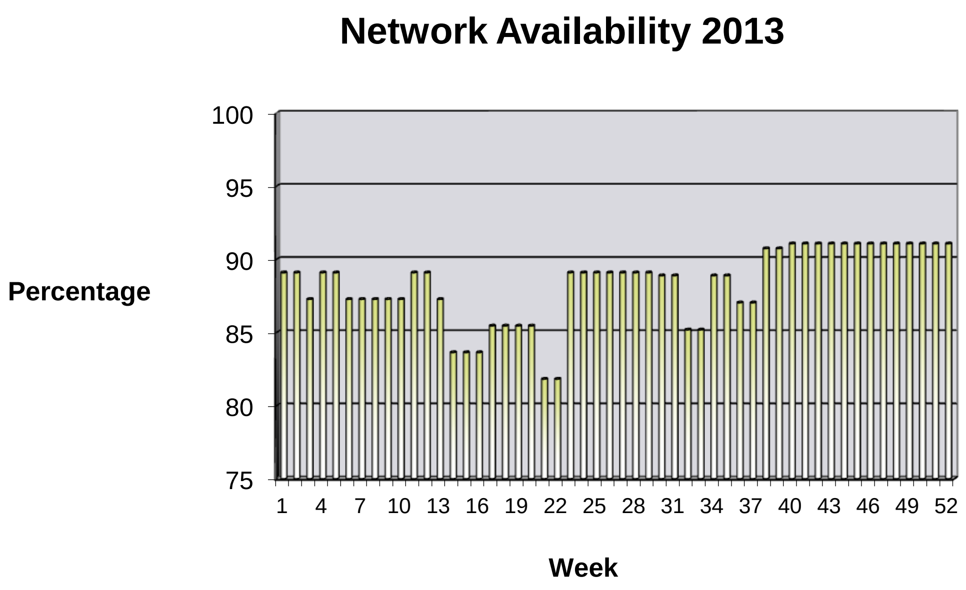


Figure 2. Network availabilty in 2013

5.2 EVOLUTION AND DEVELOPMENT

With respect to ground equipment, CNES started working on the 4th beacon generation. Designed with new electronic components and new architecture, this new beacon model aims at providing a better performance and reliability at a reduced cost. From a practical perspective, the main advantage of this beacon is the antenna cables length that will allow to install the antenna up to fifty meters from the beacon.

In view of this upcoming evolution, we asked CNES to take the opportunity to also examine a new ground antenna model but the request has been declined for budgetary reason. Nevertheless, specification and control will be strengthened in order to improve the manufacturing process of the current antenna model (Starec) and several mechanisms will be put in place to facilitate the survey.

On the field, maintenance and evolution of the network continued. The new station at “Le Lamentin” in the French West Indies (Martinique) aims at increasing the network density in this region and is the first DORIS station located on the Caribbean tectonic plate.

Thanks to the REGINA network deployment (see IDS Activity Report 2011, section 5), co-locations with GNSS stepped up to forty and we carried out a lot of high precision local tie surveys during the last three years as an important contribution to ITRF2013 (Figure 3).

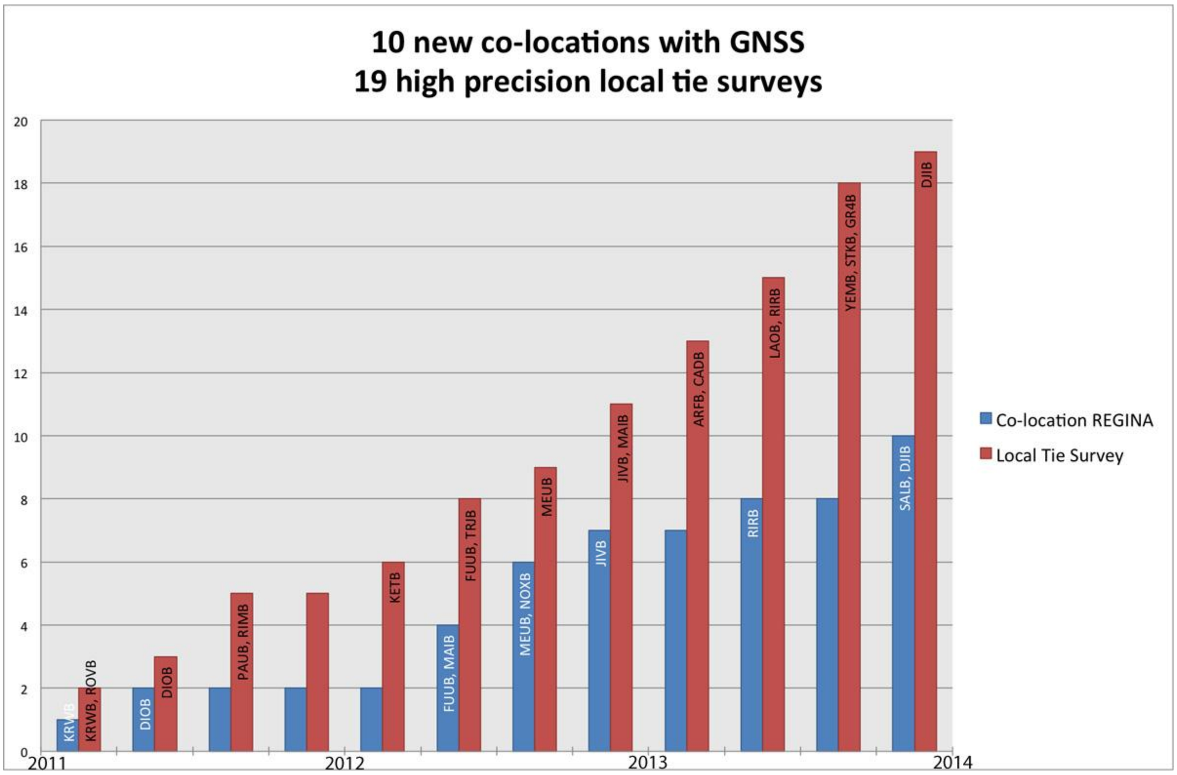


Figure 3. Co-locations with REGINA GNSS stations and local tie survey

All these tie vectors are available inside the updated sitelogs available on http://ids-doris.org/network/sitelogs.html

Grasse has been chosen as an experimental site. It is now equipped with geodetic control points in order to monitor the monumentation stability. We carried out the first observing campaign this summer.

In 2013 the following sites were visited:

- Chatham Island (NZ): reconnaissance (site going to be closed next year)
- Nicaragua: reconnaissance with a view to installing a new station
- Le Lamentin (Martinique): new station installation (Figure 4)
- Hokkaido (Japan): reconnaissance with a view to installing a new station
- St John’s (Canada): renovation (antenna raising and equipment replacement)
- Yellowknife (Canada): beacon replacement and tie survey (new REGINA station)
- Grasse (France): renovation (antenna moving) and local tie survey
- Kitab (Uzbekistan): reconnaissance with a view to moving the station
- Djibouti: local tie survey (new REGINA station)

Figure 4. New DORIS station “Le Lamentin” in Martinique, French West Indies

The map of the network (Figure 5) may change soon: four stations will move to other sites in California, Far East Russia, Florida, and Papua New Guinea.

By 2014, we hope at last to install a new station in Goldstone, California, continue with the work begun with Japan for installing a new station in Hokkaido (in place of Sakhalinsk), substitute Miami with the pair “Le Lamentin” (already installed) and Managua, and find a new suitable location for the station of Port-Moresby (site going to be closed).
Other objectives for the next year include major renovations at Syowa, Socorro, Chatham Island, Kitab and Easter Island
With regard to the IDS stations project (stations in addition to the permanent network), progress on the selected sites (Sejong, Korea + Wake, Marshall Islands) is rather slow. Therefore, we will redefine proposals for new sites at the beginning of 2014.

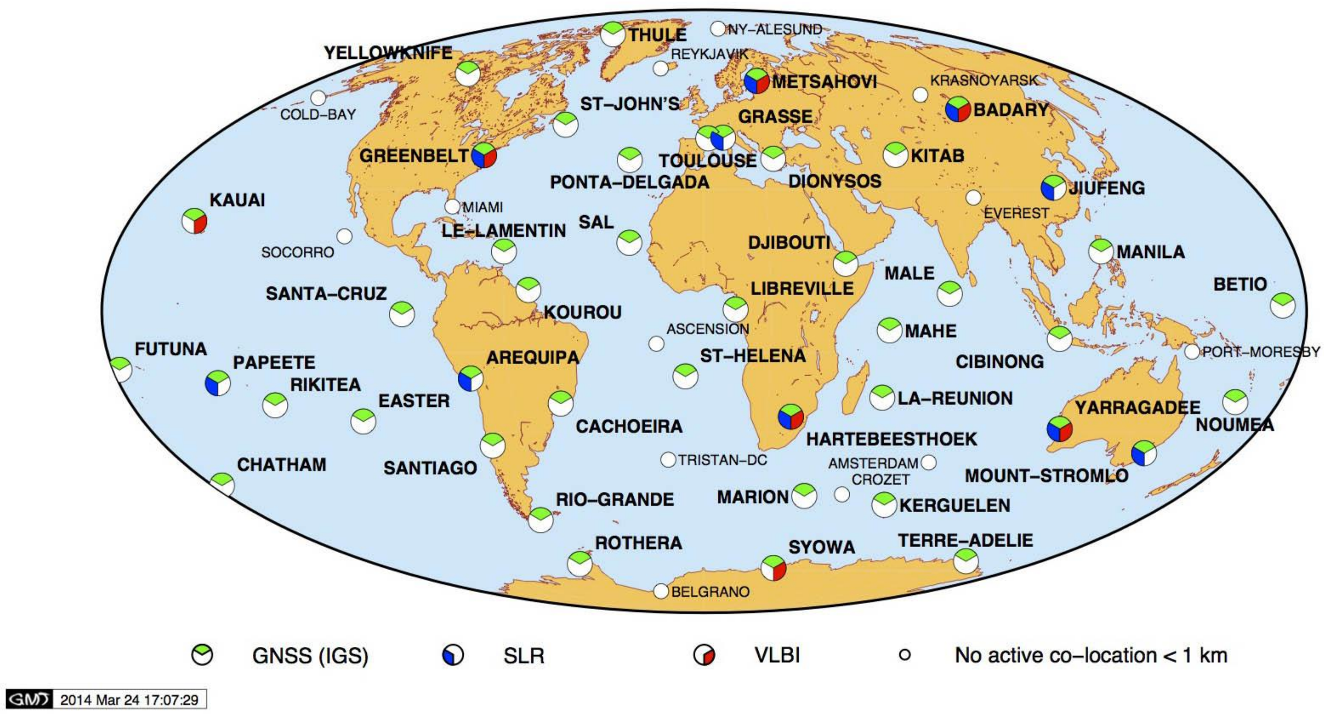


Figure 5. DORIS stations co-located with other techniques (VLBI, SLR, GNSS)

6 THE SATELLITES WITH DORIS RECEIVERS

Pascale Ferrage

CNES, France

Initially conceived for the TOPEX/Poseidon mission, the first generation receivers were flown on four satellites:

- SPOT-2, a CNES remote sensing satellite which was launched in 1990 with the first DORIS receiver for a 6-month trial experiment. SPOT-2 was de-orbited in June 2009 (maneuvers were performed in order to lower the orbit so that the spacecraft will re-enter the Earth's atmosphere within 25 years). DORIS operated for more than 19 years on-board SPOT-2, far beyond the instrument and spacecraft nominal lifetime.

- TOPEX/Poseidon, a joint venture between CNES and NASA to map ocean surface topography, was launched in 1992. While a 3-year prime mission was planned, with a 5-year store of expendables, TOPEX/Poseidon delivered an astonishing 13+ years of data from orbit: the DORIS mission ended with the second receiver failure in November 2004 whereas the ocean surface topography mapping ended in October 2005,

- SPOT-3 (CNES) was launched in 1993; the spacecraft was lost in November 1996

- SPOT-4 (CNES) was launched in 1998 and featured the first DORIS real time on-board orbit determination (DIODE). After the great success of the mission (15 years) the satellite was decommissioned in June 2013.

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

- Jason-1, the CNES/NASA TOPEX follow-on mission was launched on December 7, 2001 with a miniaturized second generation DORIS receiver. The receiver was switched on December 8. The orbit accuracy of Jason-1 has been demonstrated to be close to one cm in the radial component (*Luthcke et al. 2003; Haines et al. 2004*). At the present time, Jason-1 DORIS measurements are not used for geodesy, owing to 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*). *Jason*-1 was passivated and decommissioned on 01 July 2013, terminating the *Jason*-1 mission after 11.5 years of operations

- Envisat, the ESA mission to ensure the continuity of the data measurements of the ESA ERS satellites was launched on March 1, 2002 with a second generation DORIS receiver. In April 2012, few weeks after celebrating its tenth year of service, Envisat has stopped sending data to Earth. Esa declared the end of mission for Envisat on May 9th, 2012.

- SPOT-5 (CNES) was launched on May 4, 2002 with a miniaturized second generation DORIS receiver.

Then, a new generation DORIS receiver was developed starting in 2005. This receiver called DGXX, 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)

The following satellites have on board a DGXX receiver:

- OSTM/Jason-2 (CNES/NASA/EUMETSAT/NOAA), a TOPEX/Poseidon and Jason-1 follow-on ocean observation mission (same orbit), was launched on June 20, 2008. Jason-2 is based on the same PROTEUS platform as Jason-1, but carries the DGXX DORIS.

- Cryosat-2, the ESA mission dedicated to polar observation, was launched on April 10, 2010 with a DGXX DORIS receiver.

- HY-2A, a Chinese satellite (China Academy of Space) was launched on August 15, 2011 with a DGXX receiver.

- SARAL-AltiKA Indian-French satellite (ISRO/CNES) was launched on February 25 2013

Moreover, the satellite STPSAT1 (Plasma Physics and Space Systems Development Divisions, Naval Research Laboratory) with a CITRIS receiver to be used with the DORIS beacon network, was launched on March 9, 2007. This experiment was dedicated to global ionospheric measurements.

Figure 6 gives a summary of the satellites that provide DORIS data to the IDS data centers, as well as the evolution in time of the number of these satellites. Some of the early SPOT-2 data could not be recovered between 1990 and 1992, due to computer and data format limitations. With the exception of 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.

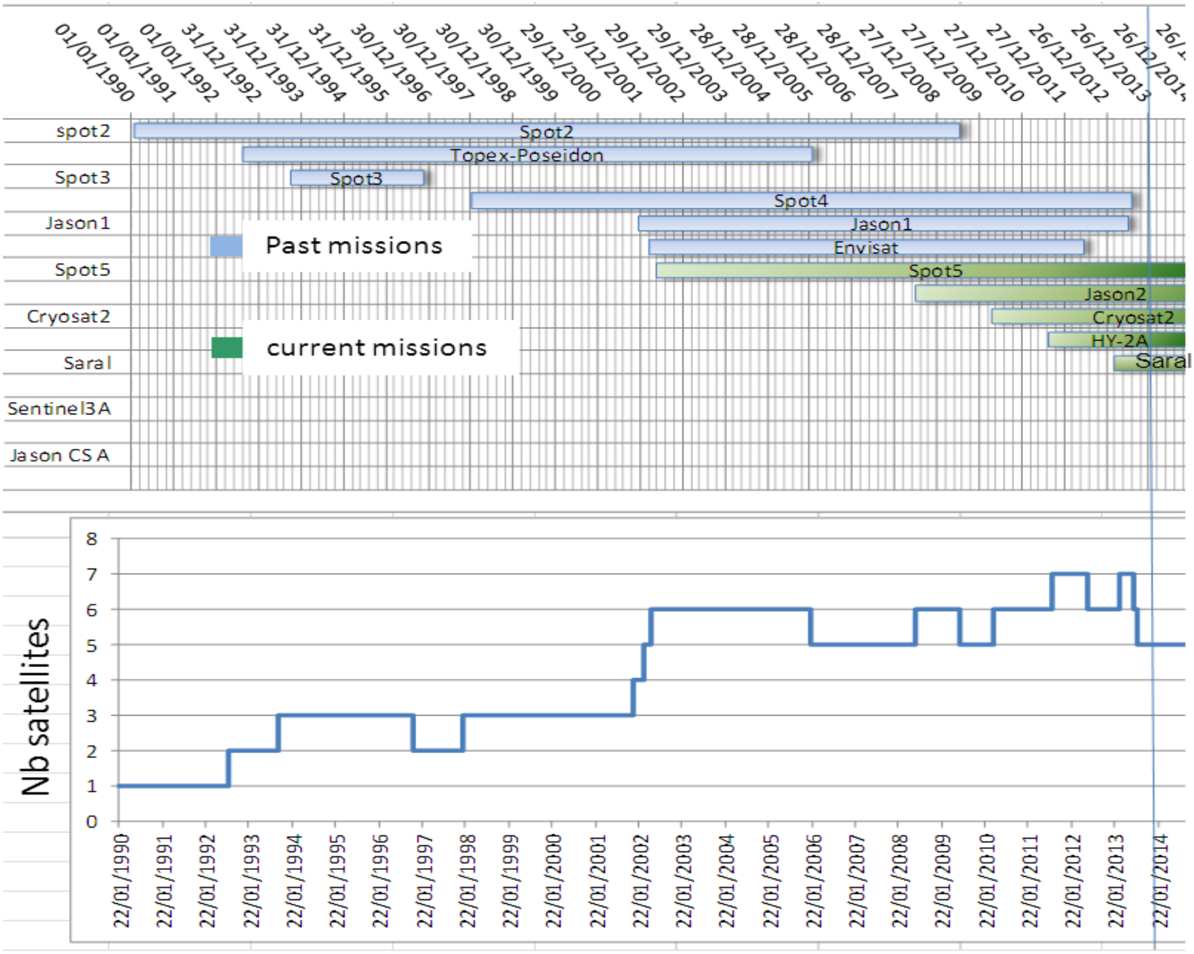


Figure 6. DORIS observations available at the IDS Data Centers (December 2013)

Some other DORIS missions are under development and should guarantee a constellation with at least 4 DORIS contributor satellites through 2030 (Figure 7):

- **SENTINEL3A** (GMES/ESA) is planned for end 2015, then **SENTINEL 3B** 12 to 30 months later.
- **Jason-3** (EUMETSAT/NOAA/CNES) is foreseen for march2015
- **Jason CS** (Eumetsat/ESA/CNES) is expected from 2020
- **SWOT** is foreseen for 2020

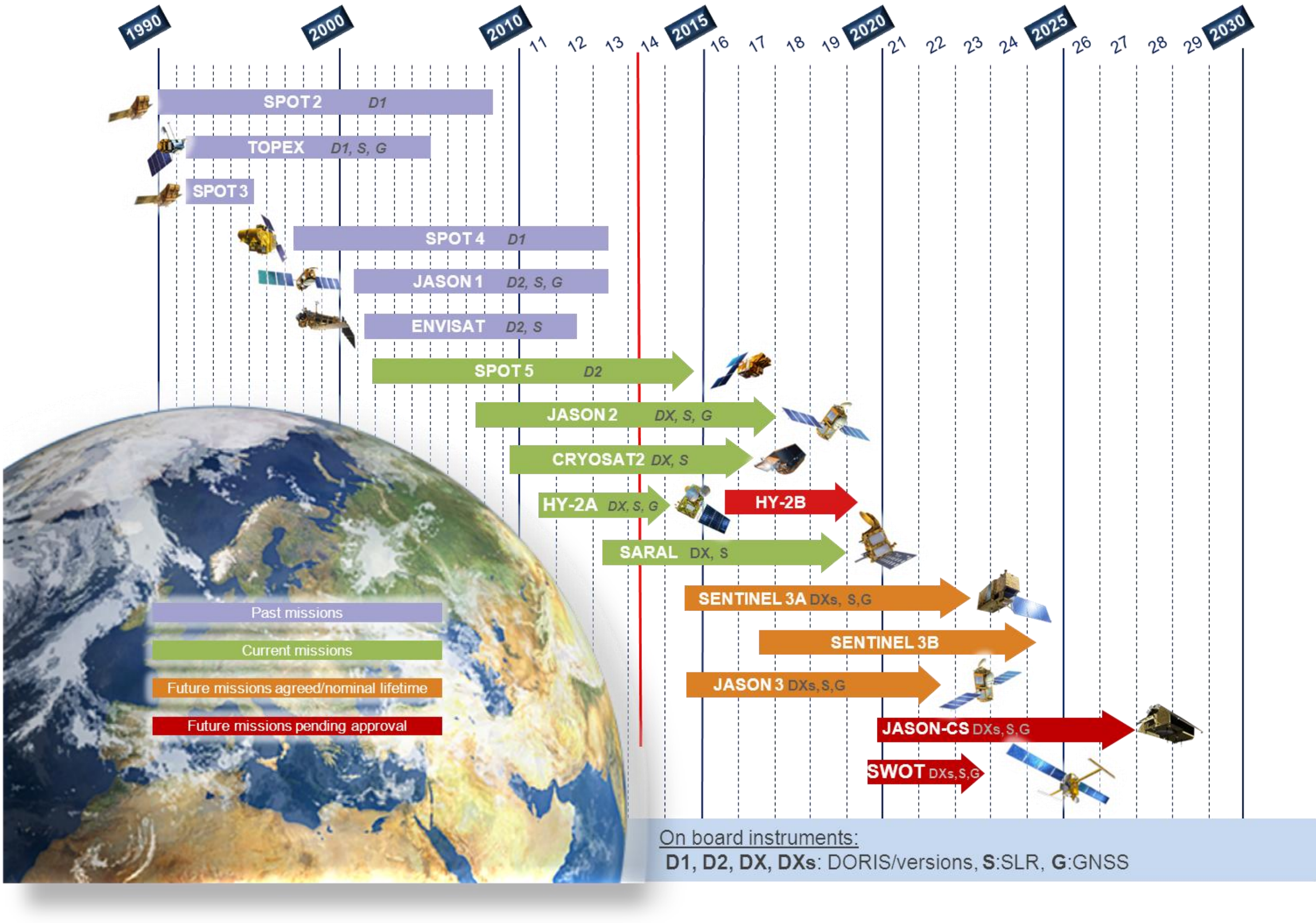


Figure 7. Current and future DORIS constellation (December 2013).

7 IDS DATA FLOW COORDINATION

Carey Noll

NASA/GSFC, USA

7.1 INTRODUCTION

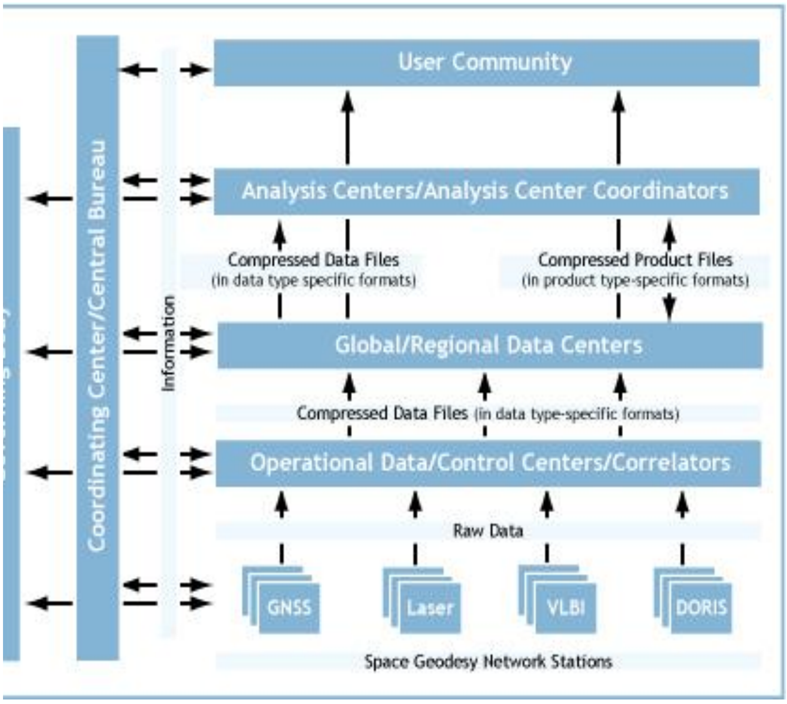
Two data centers support the archiving and access activities for the IDS:

- Crustal Dynamics Data Information System (CDDIS), NASA GSFC, Greenbelt, MD USA
- Institut National de l'Information Géographique et Forestière (IGN), Marne la Vallee 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 4 and fully described on the IDS Central Bureau website at *http://ids-doris.org/analysis-documents/struct-dc.html*. The main directories are:

- */pub/doris/data* (for all data) with subdirectories by satellite code
- */pub/doris/products* (for all products) with subdirectories by product type and analysis center
- */pub/doris/ancillary* (for supplemental information) with subdirectories by information type
- */pub/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)

The DORIS mission support ground segment group, SSALTO (Segment Sol multimissions d' ALTimétrie, d'Orbitographie et de localisation précise), 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*	*sss*data*MMM*.*LLL*.Z	DORIS data for satellite *sss*, cycle number *MMM*, and version *LLL*
	sss.files	File containing multi-day cycle filenames versus time span for satellite *sss*
/doris/data/*sss*/sum	*sss*data*MMM*.*LLL*.sum.Z	Summary of contents of DORIS data file for satellite *sss*, cycle number *MMM*, and file version number *LLL*
/doris/data/*sss*/yyyy	*sss*rx*YYDDD*.*LLL*.Z	DORIS data (RINEX format) for satellite sss, date YYDDD, version number *LLL*
/doris/data/*sss*/yyyy/sum	*sss*rx*YYDDD*.*LLL*.sum.Z	Summary of contents of DORIS data file for satellite *sss*, cycle number *MMM*, and file version number *LLL*
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/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 or SP3c 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*/qbody*YYYYMMDDHHMISS*_*yyyymmddhhmiss*.*LLL*	Spacecraft body quaternions for satellite *sss*, start date/time *YYYYMMDDHHMISS*, end date/time *yyyymmddhhmiss*, and version number *LLL*
	sss/qsolp*YYYYMMDDHHMISS*_*yyyymmddhhmiss*.*LLL*	Spacecraft solar panel angular positions for satellite *sss*, start date/time *YYYYMMDDHHMISS*, end date/time *yyyymmddhhmiss*, and version number *LLL*
/doris/cb_mirror		Mirror of IDS central bureau files

Table 4. 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 five operational satellites (CryoSat-2, HY-2A, Jason-2, SARAL, and SPOT-5); data from future missions will also be archived within the IDS. Historic data from Envisat, Jason-1 (mission ended in June 2013), SPOT-2, -3, -4 (mission ended in June 2013), 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 5. The DORIS data from all satellites are archived in multi-day (satellite dependent) files using the DORIS data format 2.1 (since January 15, 2002). This format for DORIS data files is on average two Mbytes in size (using UNIX compression). SSALTO issues an email notification through DORISReport once data are delivered to the IDS data centers. The number of days per file and average latency in 2013 of data availability after the last observation day satellite specific are shown in Table 6. The delay in data delivery to the data centers (in days by satellite) in 2013 is shown in Figure 9.

Satellite	Time Span
CryoSat-2	30-May-2010 through present
Envisat	13-Jun-2002 through 08-Apr-2012
HY-2A	01-Oct-2011 through present
Jason-1	15-Jan-2002 through 21-Jun-2013
Jason-2	12-Jul-2008 through present
SARAL	14-Mar-2013 through present
SPOT-2	31-Mar through 04-Jul-1990 04-Nov-1992 through 14-Jul-2009
SPOT-3	01-Feb-1994 through 09-Nov-1996
SPOT-4	01-May-1998 through 24-Jun-2013
TOPEX/Poseidon	25-Sep-1992 through 01-Nov-2004

Table 5. DORIS Data Holdings

	DORIS-Format Data			RINEX Data
Satellite	Number of Days/ Multi-Day File	Average Latency (Days)	Average File Size (Mb)	Average File Size (Mb)
CryoSat-2	7	24	2.7	1.6
HY-2A	7	26	3.1	1.8
Jason-1	12	26	6.1	2.5
Jason-2	11	27	6.1	2.5
SARAL	8	26	1.5	1.8
SPOT-4	10	19	3.1	1.8
SPOT-5	10	17	2.6	1.8

Table 6. Data file information

DORIS phase data from Jason-2, CryoSat-2, SARAL, and HY-2A 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 in 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 day (typically) following the end of the observation day.

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 from 2011 in DORIS V2.2 format from the Jason-1 satellite (cycles 331 through 368) were submitted to the IDS data centers in late 2012; a set of SPOT-5 data (cycles 138 through 432, 2006 through 2013) were provided in 2013. These files were submitted to the IDS data centers and archived in dedicated directories, e.g., at CDDIS:

ftp://cddis.gsfc.nasa.gov/pub/doris/campdata/ssacorrection/ja1

ftp://cddis.gsfc.nasa.gov/pub/doris/campdata/ssacorrection/sp5

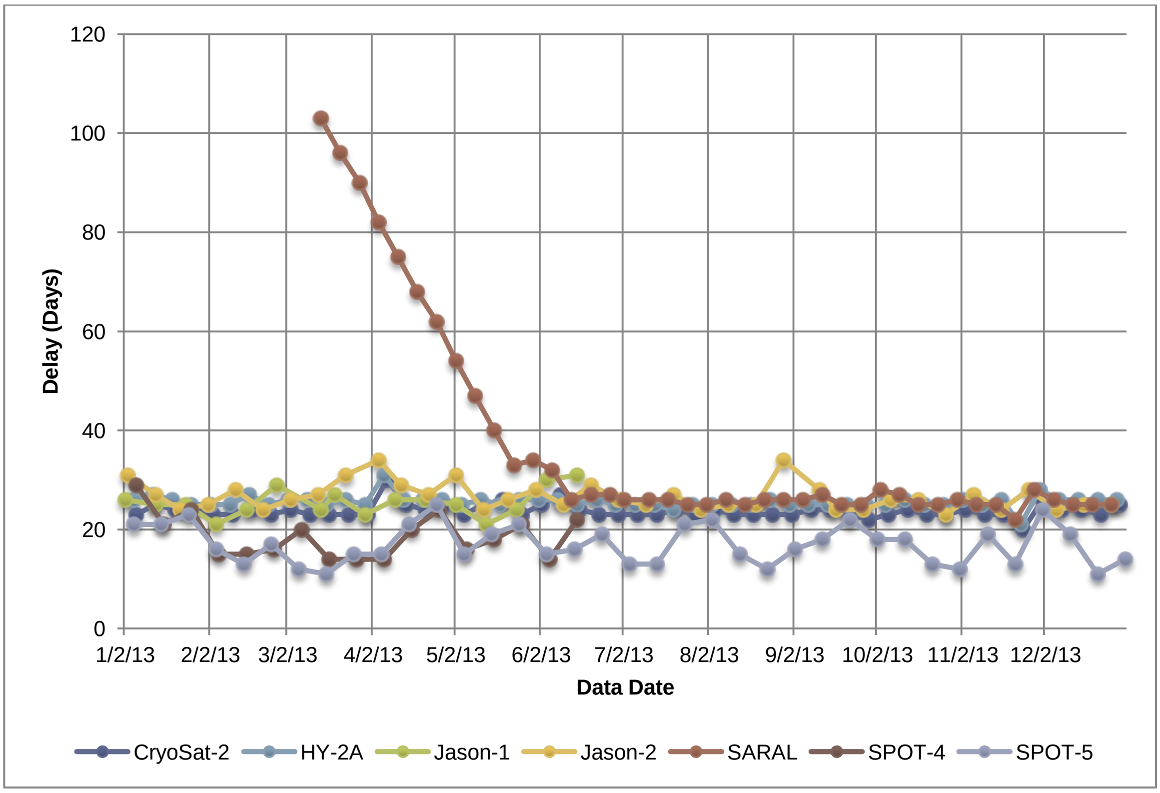


Figure 9. Delay in delivery of DORIS data to the CDDIS (all satellites, 01-12/2013)

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) France
- CNES/SOD (sod) France
- SSALTO (ssa) France

Type of Product	ACs/Products									
	ESA	GAU *	GOP	GSC	IDS	IGN	INA	LCA	SOD	SSA
Time series of SINEX solutions (*sinex_series*)	X	X	X	X	X	X	X	X	X	X
Global SINEX solutions (*sinex_global*)						X		X		
Geocenter time series (*geoc*)						X	X	X		
Orbits/satellite (*orbits*)				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
Time series of SINEX solutions (2010 campaign)		X	X	X		X	X	X		

*Note: GAU historic solution

Table 7. IDS Product Types and Contributing Analysis Centers

A solution (designated "ids") produced by the IDS combination center from the individual IDS AC solutions started production in 2012. IDS products are archived by type of solution and analysis center. The types and sources of products available through the IDS data centers in 2005-2013 are shown in Table 7. This table also includes a list of products under evaluation from several DORIS 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 SARAL 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

Carey Noll [(1)], B. Garayt [(2)]

(1) NASA/GSFC, USA

(2) IGN, France

8.1 CRUSTAL DYNAMICS DATA INFORMATION SYSTEM (CDDIS)

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:

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

The CDDIS automated software archives data submitted by SSALTO and performs minimal quality-checks (e.g., file readability, format compliance) resulting in a summary file for each data file. Software extracts metadata from all incoming DORIS data. These metadata include satellite, time span, station, and number of observations per pass. The metadata are loaded into a database and utilized to generate data holding reports on a daily basis. By the end of 2013, approximately 70 Gbytes of CDDIS disk space has been devoted to the archive of DORIS data, products, and information.

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

The CDDIS provided special, limited access space in its archive for IDS Analysis Working Group (AWG) test solutions. This area allowed AWG members to exchange SINEX and orbit files for analysis development and testing.

During 2013, user groups downloaded approximately 425 Gbytes (550K files) of DORIS data, products, and information from the CDDIS..

8.1.1 FUTURE PLANS

The CDDIS staff will continue to interface with the IDS Central Bureau (CB), SSALTO, and 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 staff is currently assessing its system hardware architecture and near-term requirements. Plans are to procure new server hardware in mid-2014 to expand on-line storage and ensure system reliability for the next few years.

The CDDIS staff will continue to interface with the IDS CB, SSALTO, and 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.

8.1.2 CONTACT

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ftp: ftp://cddis.gsfc.nasa.gov/pub/doris
WWW: http://cddis.gsfc.nasa.gov

8.2 IGN DORIS DATA CENTER

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

During year 2013, the two IGN data centers had a nominal functioning. They have been enhanced with new products, in cooperation with the IDS CD and in line with CDDIS.

8.2.1 CONTACT

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9 IDS COMBINATION

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9.1 ACTIVITY SUMMARY

IDS combination activities in 2013 were devoted to i) the pursuit of the IDS combination and the improvement of the operational chain, ii) preparation to ITRF2013 and iii) communications at EGU and AGU meetings.

9.2 IDS ROUTINE COMBINATION

The last 12 months were dedicated to the pursuit of the multi ACs weekly SINEXs combination. We remind that the IDS Combination Center also produces stations coordinates times series (in so-called STCD format) associated to the combined solution as well as for both ESA and GSC Analysis Centers.

At the end of 2013, the combined solution was available until end of first quarter of 2013. The remaining quarters of 2013 should be evaluated and combined early 2014. Different weighting strategies of ACs EOPs solutions in the combined product were tested. Based on rotations parameters criteria, these strategies were judged unsatisfactory as they add a negative impact on stations positions.

The last quarter of 2013 was also used to make to slight improvements in the evaluation and combination chains. In addition, a small bug of the EOPs projections in ITRF has been corrected and the IDS CC was involved in the elaboration of a new version of the IDS web service to interactively display Helmert parameters as output of the evaluation process.

9.3 ITRF2013 PREPARATION

To better estimate processing time which will be necessary to evaluate all the individual solutions from the ACs, early 2013, the IDS CC evaluated for each AC the longest SINEXs series in both terms of stations positions and EOPs. For example, frequency analysis of the Helmert parameters revealed some annual periodic signals in Tx and Ty for most of the ACs (Figure 10).

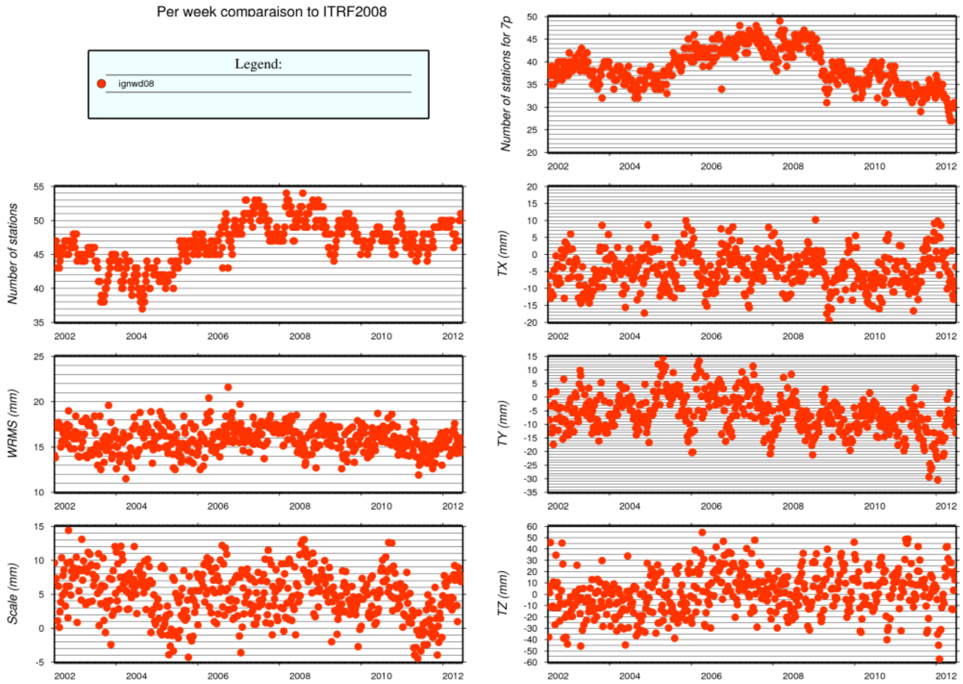

Figure 10. Helmert parameters wrt ITRF2008 of series IGN 08 over time period 2002-2012

Based on the IDS Combination Center presentation done during AGU 2012 Fall meeting, ESA and GSC started 2013 by implementing beacon frequency variations. As depicted by Figure 11 and Figure 12, the updated series ESA 07 and GSC 18 have no longer scale jumps early 2002 while DORIS data format has changed.

In the context of forthcoming ITRF2013, IDS asked all the ACs to send single satellite solutions over 1995 and 2011 for evaluation and discussions at the AWG held in Toulouse (April 2013). From the evaluation of these single satellite solutions, the Combination Center pointed out that some efforts were still remaining in order to improve HY-2A modeling which presented highest scale values wrt ITRF2008. We also bring to the attention of the ACs the presence of signals of periods of 120 and 180 days in the Tz parameter of Cryosat-2 (see for example Figure 13).

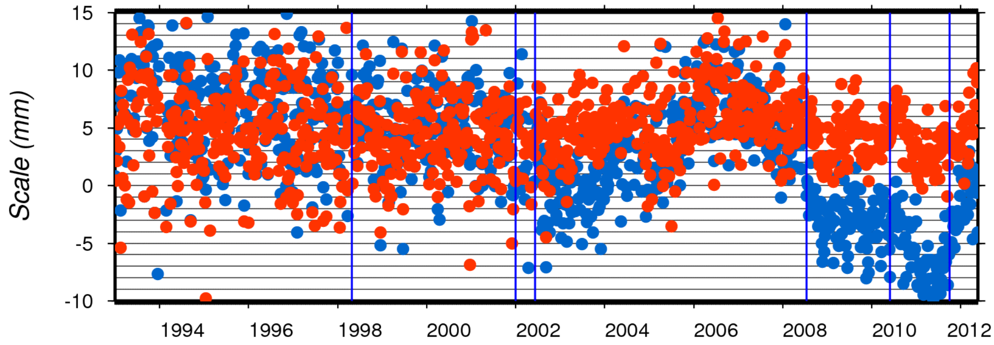

Figure 11. **Scale wrt ITRF2008 of ESA series 06 (blue) and 07 (red, 06 + beacon frequency variations)**

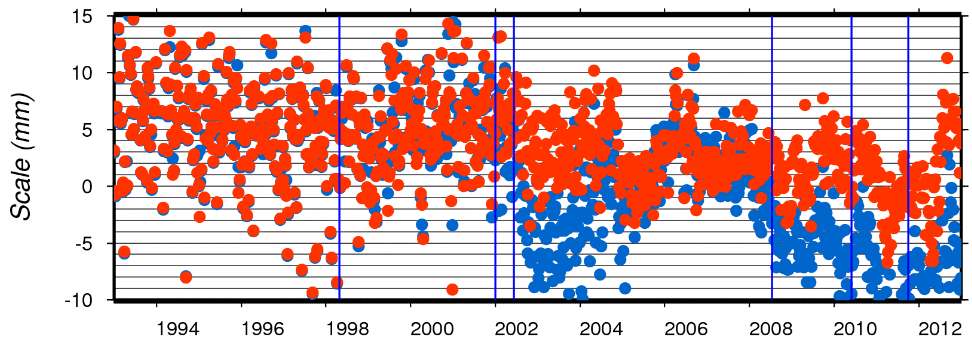

Figure 12. Scale wrt ITRF2008 of GSC series 15 (blue) and 18 (red, 15 + beacon frequency variations)

With the delivery by CNES of both Starec and Alcatel DORIS antennas phase laws, the two last quarters of 2013 were devoted to the evaluation by IDS CC of the impact of including these phase laws. Based on the evaluation of GOP, GSC and LCA tests series presented during the AWG in Washington (October 2013), and as expected, the major impact of the phase laws is on the scale (Figure 14). So far, some additional tests have to be performed in order to precisely understand the influence of these laws, notably to see any dependence with the time evolution of the network in terms of antennas type as well as any correlation with arrival of new DG-XX missions which allow more data at lower elevations. Nevertheless, due to the impact of the phase laws on the scale, all the IDS ACs agreed in Washington that those who will not use the phase law, will participate in the combination but not for the combined scale from DORIS.

In order to not consider in combined scale any contribution from all the ACs which will not use phase laws, a new version of the combination scripts has been developed and successfully tested.

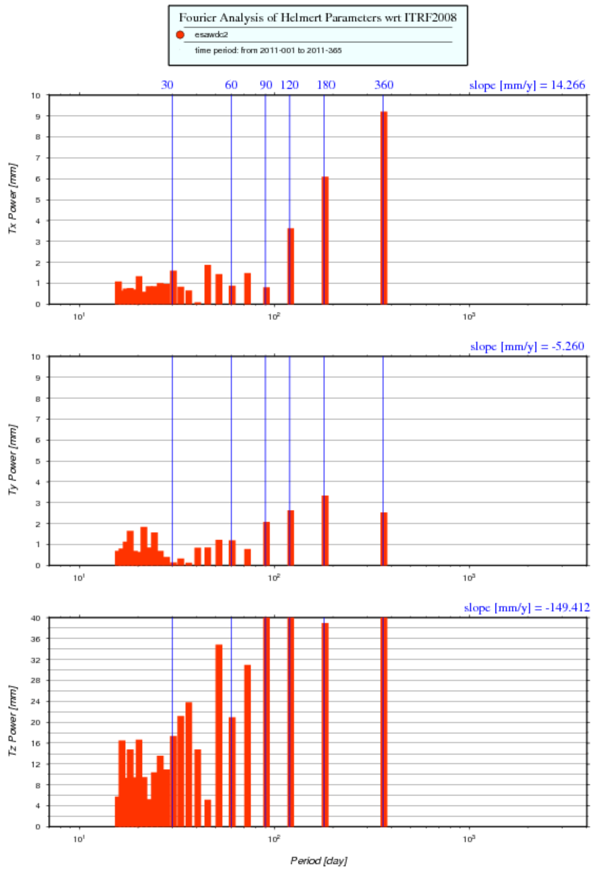

Figure 13. Frequency analysis of the Helmert translation parameters wrt ITRF2008 of Cryosat-2 solution from ESA

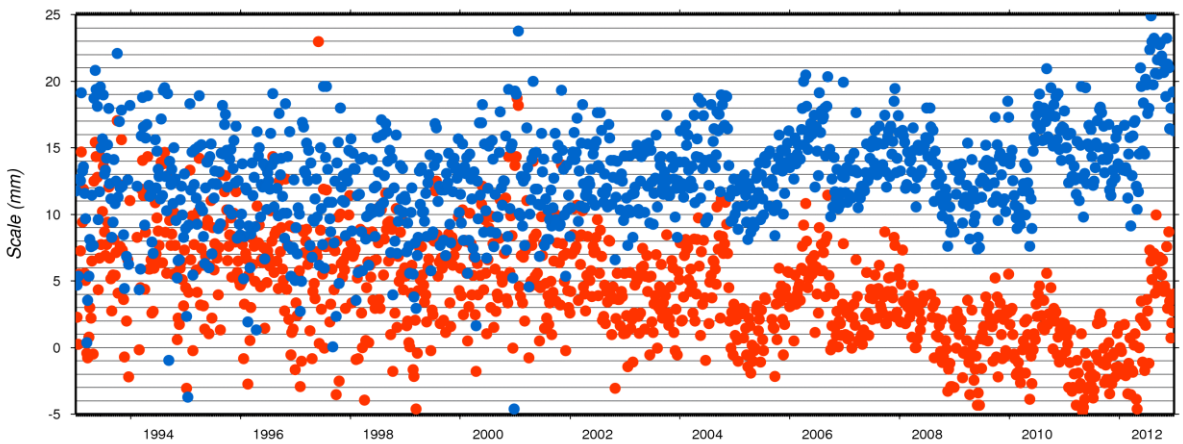

Figure 14. Scale impact of DORIS antennas phase laws as observed by GSC (red=series 20 without phase laws, blue = series 21 == series 20 + phase laws).

9.4 COMMUNICATIONS

The IDS Combination Center joined both EGU and AGU fall meetings where it presented two oral presentations respectively titled “Impact of beacon frequency changes on the DORIS contribution to ITRF2008” and “Status of DORIS contribution to ITRF2013”. An abstract on the DORIS contribution to ITRF2013 was also submitted for oral presentation at EGU 2014.

9.5 FUTURE PLANS

The activity of the IDS Combination Center in 2014 will be mainly devoted to the elaboration of the IDS contribution to ITRF2013.

10 REPORT OF THE ESA/ESOC ANALYSIS CENTER (ESA)

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10.1 INTRODUCTION

The activities in 2013 of the European Space Operation Centre focused on the generation of the ESA IDS contribution to ITRF2013. As a result of various test performed throughout the year we have generated a new ESA IDS solution (esawd10). This solution has been made available to the combination centre and after the finalization of the ITRF2013 activities will be made available on CDDIS. Further this solution will also become the new ESA routine solution for 2014 onwards.

10.2 TESTING FOR ITRF2013 AND THE NEW ESAWD10 SOLUTION

The esawd07 solution released in 2012 contained major improvements to our modeling and was our first solution covering the period from 1993 until 2012. In 2013 we have generated several further test solutions that accumulated into the final esawd10 solution. Many minor changes were made but some of the major differences came from the following changes:

- Starec and Alcatel phase law correction applied
- Inclusion of Jason-1 from 2002 until launch of Jason-2
- New SAA corrected data for Jason-1 and Spot-5 (>2006)
- Switch to EIGEN-6S2.5 model for gravity
- Proper handling of the TOPEX and SPOT-5 solar array offset angle
- Retuning of Solar radiation coefficients for all satellites based on each mission entire duration instead of selected period as done before
- Switch from NRLMSISE-90 to NRLMSISE-00 model for neutral atmosphere density calculation

This updated solution covers the entire IDS processing period from 1993 until 2014 and has been delivered to the combination centre and after the closure of the ITRF2013 activities will be made available on CDDIS.

Further we continue to participate in the combination on the observation level campaign (COL) and as part of these activities have generate a ESA solution in which we have combined all space born geodetic data (SLR, DORIS and GNSS) on the observation level for the first few months for 2013 and presented the results at the EGU.

10.3 FUTURE ACTIVITIES

The Navigation Support Office plans for 2014 to switch to processing the DORIS RINEX data for Jason-2, Cryosat-2 and HY-2A instead of the older DORIS Data Exchange Format.

11 REPORT OF THE GEODETICAL OBSERVATORY PECNY ANALYSIS CENTER (GOP)

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11.1 INTRODUCTION

The activities of GOP analysis center focused on the preparation and initiation of the DORIS data re-processing for new ITRF. The complex tests of the orbit modeling parameters were realized, with emphasis on the accuracy of the estimated station coordinates, Earth rotation pole coordinates and transformation parameters of the solution w.r.t. ITRF. Another part of work consisted in the implementation of the new standards recommended by IDS and the testing of their impact on the solution.

11.2 IMPACT OF THE ORBIT MODELING ON THE STATION COORDINATE AND ERP ESTIMATES

A complex set of the tests was performed to study impact of chosen orbit modeling options with the goal to optimize the orbit modeling for the IRTF data reprocessing. The results are published in (*Štěpánek et al. 2014*).

In a series of experiments, the DORIS data were processed with different orbit model settings. Initially, the data from the complete year 2011 were processed. At the next step, the time span was extended to 1995, 2011 and 2001-2004. A number of factors were analyzed. First, the impact of precise modeling of the non-conservative forces on geodetic parameters was compared with results obtained with an empirical-stochastic modeling approach. Second, the temporal spacing of drag scaling parameters was tested. Third, the impact of estimating once-per-revolution harmonic accelerations in cross-track direction was analyzed. And fourth, two different approaches for solar radiation pressure (SRP) handling were compared, namely adjusting SRP scaling parameter or fixing it on pre-defined values.

Our analyses confirm that the empirical-stochastic orbit modeling approach, which does not require satellite attitude information and macro models, results for most of the monitored station parameters in comparable accuracy as the dynamical model that employs precise non-conservative force modeling. However, the dynamical orbit model leads to a reduction of the RMS values for the estimated rotation pole coordinates by 17% for x-pole and 12% for y-pole.

The experiments show that adjusting atmospheric drag scaling parameters each 30 minutes is more appropriate for DORIS solutions than to handle the parameter only each two hours, when this conclusion is relevant even for the middle solar activity period. Moreover, it was shown that the adjustment of cross-track once-per-revolution empirical parameter significantly increases the RMS of the estimated Earth rotation pole coordinates. With recent data it was however not possible to confirm the previously known high annual variation in the estimated Geocenter Z-translation series as well as its mitigation by fixing the SRP parameters on pre-defined values (*Gobindass et al. 2009*).

11.3 ITRF RE-PROCESSING

The re-processing for new ITRF started in the last quarter of 2013. The modeling standards were considerably updated to come up to orbit modeling testing and to meet IDS recommendations. The major difference w.r.t. operative GOP solutions wd3X is the application of the dynamical orbital modeling, including the non-conservative force modeling and satellite attitude models application. To be consistent with IDS recommendations, additional updates regarded the gravity filed, antenna phase law, mean pole definition and application of SPOT-5 SAA corrections were built up. The differences between the new and the previous standards are summarized in Table 8.

	Solutions wd3X (old)	**Solutions wd4X (new)**
Orbit modeling	Empirical- stochastic	Dynamical
Satellite macro models	Not applied	Applied
Solar Rad. Pressure	Empirical sun-satellite 1/day	1 coeff./day
Atmosphere drag	Stochastic par. In along track each 15 min.	1 coeff./30 min.
Atmosphere density model	Not Applied	MSIS-86
Earth radiation	Not applied	CERES model
Mean pole	Constant	Quadratic term
Gravity	EIGEN-GL04C	EIGEN-6S2 (after 2002.0)
Antenna Phase law	Not applied	Applied for Starec and Alcatel
SPOT-5 SAA	Not corrected	CNES corrective model

Table 8. Summary of major differences between solution standards for current ITRF re-processing (wd4X) and the previous solutions (wd3X)

12 REPORT OF THE GSFC/NASA ANALYSIS CENTER (GSC)

Frank G. Lemoine [(1)], Nikita P. Zelensky [(2)], Karine Le Bail [(1,3)], Douglas S. Chinn [(2)], J. W. Beall [(4,1)]

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(2) SGT/NASA, USA

(3) NVI Inc., Greenbelt, Maryland, U.S.A

(4) Mission Operations and Services, Riverdale, Maryland, U.S.A

In 2013, we concentrated intensively on the preparations for the reprocessing of the DORIS data to prepare the GSC contribution to the DORIS combination for ITRF2013. In addition, we initiated the processing data to new DORIS satellites, SARAL and HY-2A, and evaluated the contribution of HY-2A as potential part of the combination for ITRF2013. In addition, we continued routine (quarterly) deliveries of SINEX files.

In 2013, we concentrated intensively on the preparations for the reprocessing of the DORIS data to prepare the GSC contribution to the DORIS combination for ITRF2013. In addition, we initiated the processing data to new DORIS satellites, SARAL and HY-2A, and evaluated the contribution of HY-2A as potential part of the combination for ITRF2013. And we continued routine (quarterly) deliveries of SINEX files.

As preparation for ITRF2013, the following modeling changes were implemented to the previous operational series (wd12).

1. New Gravity Model (Static)

   GOCO2S (*Goiginger et al. 2011*) instead EIGEN-GL04S1 (*Förste et al. 2008*)

2. New Gravity Model (Time-Varying)

   At GSFC we have developed a 5x5 time series from SLR & DORIS tracking to up to 15 satellites. We have done harmonic fits to this time series adjusting coefficients as appropriate (rates, annual, semiannual, and for C20 an 18.6 yr harmonic). This "fit" model now represents a conventional model we can apply in the DORIS processing. The C21/S21 terms are represented according to IERS 2010 conventions (*Petit and Luzum 2010*).

3. Troposphere.

- The GMF (*Boehm et al. 2006a*) mapping function is used instead of Niell.
- The Saastomoinen troposphere model is used instead of Hopfield.

- GPT is used for the *a priori* met data (no change from gscwd11, gscwd12) (*Boehm et al. 2007*)
- Only the wet troposphere delay scale factor is adjusted.

4. Update of Ocean Tide and Loading Model: GOT4.8 instead of GOT4.7. The only change between GOT4.7 and GOT4.8 involved an update of the S2 harmonic.

5. More rigorous editing is applied at the SINEX formation level.

   We have edited stations with fewer than 250 observations in a given week, because we found in our inversion tests, these perturbed unreasonably the weekly set of estimated Helmert parameters.

6. Macromodels were updated for SPOT-2, SPOT-3. A correction was made in the modeling of Envisat. The orientation of the solar array in Envisat macromodel used for drag and albedo/IR computations was corrected over what had previously been used for ITRF2008. Also, a correction was implemented in the Envisat/UCL model, where the area specified for solar array thermal re-radiation was corrected.

7. The IERS2010 pole model, specified in the IERS 2010 standards (*Petit and Luzum 2010*) was applied; In addition the background model for C_{21} and S_{21} was applied as specified in equation 6.5 of *Petit and Luzum (2010)*.

8. More frequent drag coefficient adjustments were made as per the recommendations of the IDS AWG (Toulouse, 2013).

9. A DORIS time bias was applied for TOPEX/Poseidon data processing derived from joint analysis of the SLR+DORIS data to this satellite. This mitigates the sometimes 10's of milliseconds excursions in the DORIS time bias observed in some parts of the TOPEX mission.

10. The Starec and Alcatel DORIS antenna phase law was implemented in GEODYN and thoroughly validated.

11. In the wd21 series, in GEODYN, we directly apply the DORIS tracking point offsets (on the spacecraft) and the vertical antenna eccentricity. In the earlier series, we used the center-of-mass corrections directly from the DORIS2.2 format data. This step was necessary since the application of the DORIS antenna phase map in GEODYN would only occur if tracking point offsets at the spacecraft were computed directly in GEODYN. We thus validated first the application of the measurement offsets, and then the application of the antenna phase law.

A summary of the GSC SINEX series produced in the calendar year 2013, as a part of the ITRF2013 activities, is summarized in Table 9. **All the SINEX series discussed involved a complete reprocessing of all available data (1992-2013), each time with different sets of**

improvements. In Table 10, we summarize the RMS of fit to the various satellites for the different SINEX series. As a general rule, when we compute a new DORIS SINEX series, we always also converge a companion SLR+DORIS series of orbits, so we can verify that the changes we have implemented have not deleteriously affected the processing. Thus, we show the SLR fit of these companion orbits, and as a matter of course we intercompare the SLR+DORIS and DORIS-only orbits for those satellites that have both sets of tracking data available. We note that between the wd18 and the wd20 series, we updated the attitude model for Cryosat-2 in GEODYN. The series wd20 and wd21 use the quaternions supplied by E.J.O. Schrama (TU Delft). The use of the quaternions corrected an orientation offset that affected the earlier Cryosat-2 orbit computations.

gscwd12	Previous operational series. Continuation of ITRF2008 modeling and standards.
gscwd15	Complete new time series (1992-2012) with new modeling standards. Many updates. **DORISReport 3258 (28-Feb-2013)**
gscwd17	Internal series. Test of macromodel-related changes only (SPOT-2, SPOT-3, Envisat)
gscwd18	New complete time series (1992-2012) with macromodel updates (SPOT-2, SPOT-3, Envisat) + implementation of modeling to handle DORIS station frequency changes**. DORISReport 3426 (06-Sept-2013).**
gscwd20	Apply IERS2010 standards (pole, C_{21}, S_{21}). Add SPOT-5 SAA data (2006-2013). **DORISReport 3453 (30-Sept-2013); DORISReport 3496 (22-Nov-2013); DORISReport 3521 (28-Dec-2013)**
gscwd21	Apply DORIS COM & offsets (with attitude law or quaternions), and apply Phase Law for Alcatel and Starec antennae. **Series delivered to IDS Combination Center for evaluation (not a public series).**

Table 9. Summary of GSC SINEX Series for 2013

Satellite & Data	wd12	wd15	wd17	wd18	wd20	wd21
Envisat (slr+dor) (SLR) (DORIS)	1.272 0.494	1.289 0.492	1.162 0.492	1.165 0.492	1.146 0.502	Dor only 0.492
TOPEX (slr+dor) (SLR) (DORIS)	1.701 0.513	1.679 0.514	--	1.677 0.514	1.684 0.514	Dor only .510
Jason2 (slr+dor) (SLR) (DORIS)	1.215 0.361	1.165 0.376	--	1.159 0.375	1.167 0.375	Dor only .377
Cryosat2 (slr+dor) (SLR) (DORIS)	2.131 0.437	1.850 0.445	--	1.851 0.441	1.283 0.439	Dor only .441
SPOT-2	0.471	0.471	0.471	0.477	0.475	0.476
SPOT-4	0.456	0.465	--	0.474	0.474	0.475
SPOT-5 (2002.0-2006.0 no SAA corr.) (2006.0-2013.0 w. SAA corr.)			--	.453 .425	.453 .422	.454 .422

Table 10. Summary of RMS of fit for SLR and DORIS arcs (SLR fits, cm; DORIS fits, mm/s)

12.1 IMPACT OF IMPROVED FREQUENCY BIAS MODELING

From 2002 onward, the DORIS2.2 data files used systematically a nominal value of the beacon frequency, rather than the actual frequency. Hence, the partial derivatives in GEODYN must be updated to allow for a correction (deviation) from this nominal frequency. The change alters dramatically the scale of the series, and removes sporadic jumps in the station height for some stations. We show in Figure 15 the impact on the DORIS scale, by comparing the wd15 SINEX series (where the frequency bias correction was not applied), and the wd18 SINEX series (where the frequency bias correction was applied).

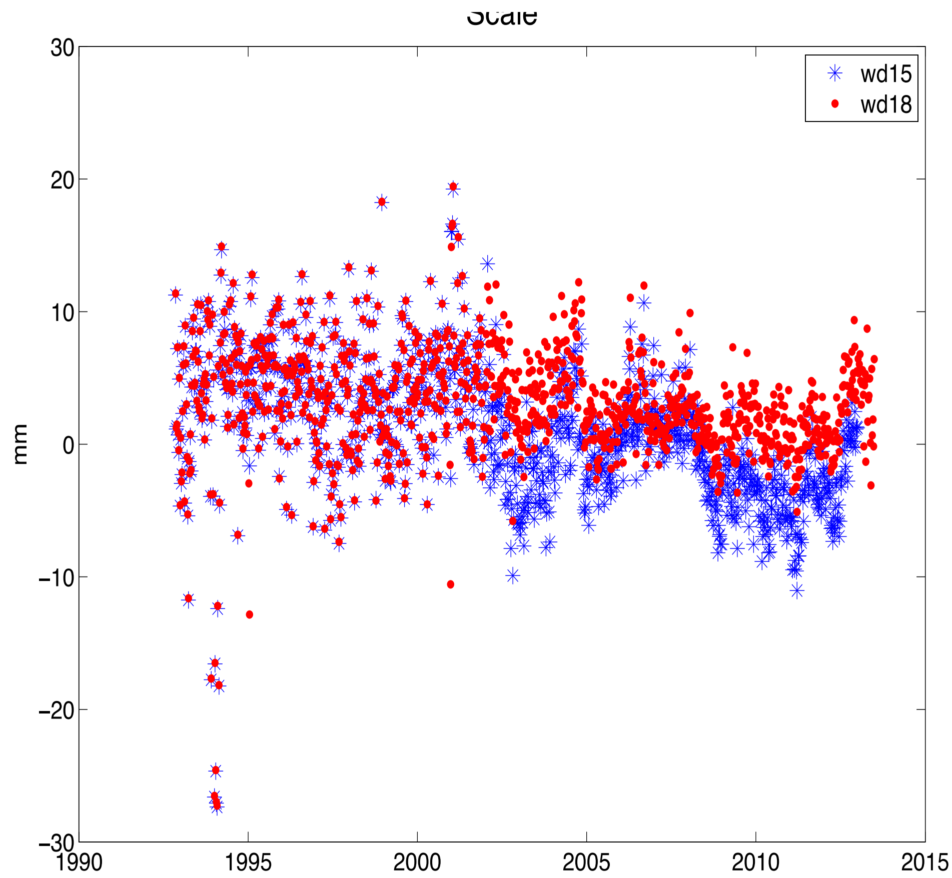

Figure 15. DORIS Scale for wrt. DPOD2008 for the GSC SINEX series wd15 (frequency bias correction to partial derivatives not applied), with wd18 (frequency bias correction to the partial derivatives are applied)

12.2 IMPROVED NON-CONSERVATIVE FORCE MODELING

We re-evaluated the performance of the non-conservative force modeling for the all the DORIS satellites, by analyzing the residual empirical accelerations (once-per-rev's) for all the DORIS satellites. The previous modeling was as described by *Le Bail et al. (2010)*, while for Envisat we used the UCL model (*Ziebart et al. 2005*; *Sibthorpe 2006*) for solar radiation pressure, together with a CNES-supplied macromodel for atmospheric drag and planetary radiation pressure. The SPOT-2, SPOT-3 performances (from the values of the empirical once-per-revolution accelerations, OPR's) were clearly outliers, and after re-tuning, the residual OPR's were reduced. For Envisat, we corrected an error in the orientation of the normal vectors of the solar array for the macromodel. The results also showed increased OPR's associated with SPOT-5 after March 2012 – which was traced to unmodeled changes in the SPOT-5 solar array pitch after March 2012. The CNES provided updated values of the SPOT-5 solar array pitch which we implemented for the wd20 and wd21 SINEX series.

As an illustration, we show in Figure 16 the daily along-track empirical acceleration amplitudes for SPOT-2 early in the mission, for the ITRF2008-derived model, and the new model. The model changes the values of two parameters, the –Y specular reflectivity and the solar array (Sun-facing) specular reflectivity. We summarize the improvements in the empirical accelerations in Table 11 for SPOT-2, and Table 12 for SPOT-3. In both cases, the new model reduces the median value of the amplitude of the along-track accelerations. High values of these empirical accelerations are indicative of solar radiation pressure mismodeling, which has previously been shown to correlate with mismodeling of geophysical parameters (e.g. *Gobinddas et al. 2009*). The tests we summarize in Table 11 and Table 12 were performed over generally quiet periods of the solar cycle. At the peak of the solar cycle (i.e. 2001-2002), the satellites at the SPOT altitude are very highly impacted by increased atmospheric drag, and the estimated values of the along-track empirical accelerations on SPOT-2 (for example) increase to as high as 7-9 x 10^{-9} m/s^2.

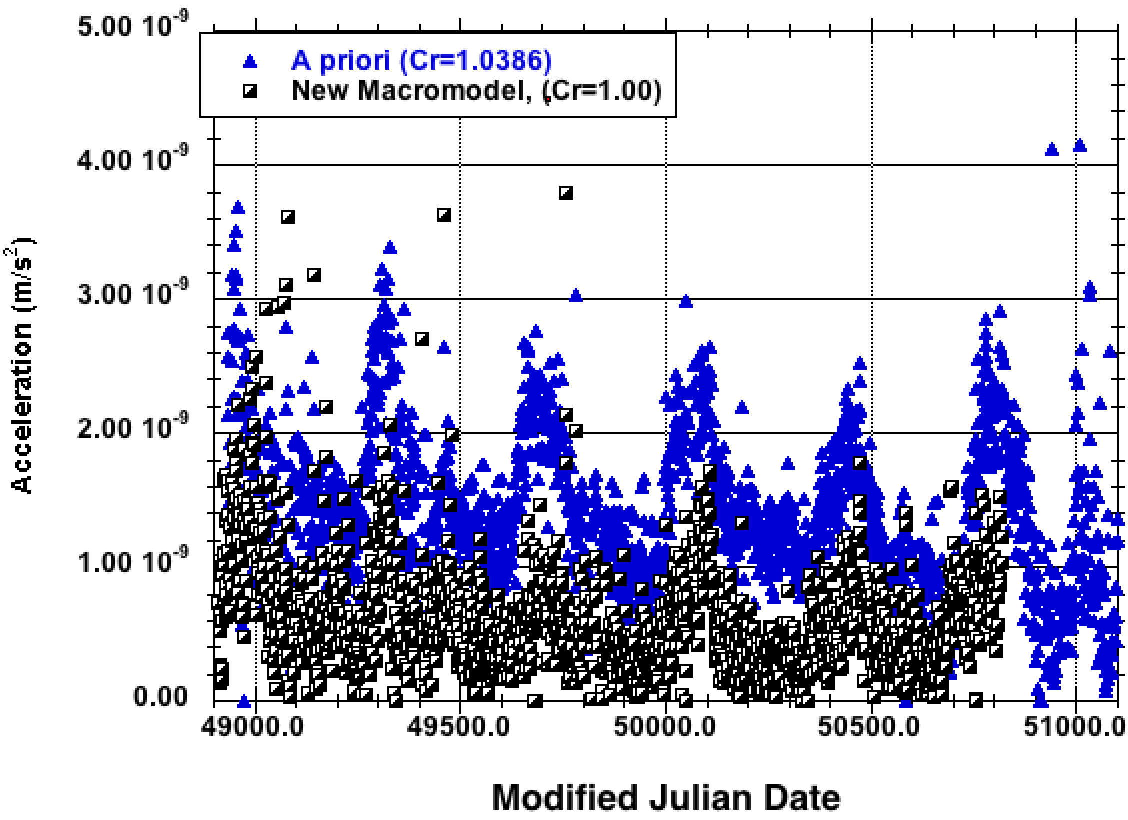

Figure 16. SPOT-2 amplitude of daily along-track once-per-rev accelerations, shown for 1992 to 1998 for the ITRF2008-derived macromodel (Le Bail et al., 2010), and the new returned macromodel. The units are m/s2.

Series	Along-track (units, 1.0e-9 m/s^2)		Cross-track (units, 1.0e-9 m/s^2)		Cr Value
	Median	**Mean**	**Median**	**Mean**	
Nominal (ITRF2008)	**1.379**	**1.552**	**2.511**	**3.011**	**1.0386**
New (for ITRF2013)	**0.548**	**0.739**	**2.701**	**3.024**	**1.00**

Table 11. SPOT-2 Macromodel Tests (1992-1997)

Series	Along-track (units, 1.0e-9 m/s^2)		Cross-track (units, 1.0e-9 m/s^2)		Cr Value
	Median	**Mean**	**Median**	**Mean**	
Nominal (ITRF2008)	**3.13**	**3.20**	**2.20**	**2.47**	**1.00**
New (for ITRF2013)	**0.586**	**0.601**	**2.151**	**2.401**	**1.00**

Table 12. SPOT-3 Macromodel Tests (1994-1996)

12.3 APPLICATION OF THE DORIS ANTENNA PHASE LAWS

At the request of the IDS Governing Board, the CNES conducted tests of models of the Starec antenna to determine the variations in the antenna phase center. A phase center variation (PCV) model was reported by C. Tourain (IDS Workshop 2012; IDS AWG Toulouse 2013). The analysis working group decided to implement the PCV modeling as a baseline in the ITRF2013 processing. The PCV corrections are elevation but not azimuthally dependent, and can vary up to 20 mm in range over a range of elevations, for the Starec antenna. For the Alcatel antenna, the CNES only provided data from a manufacturer's model. These PCV maps were implemented in the gscwd21 series, and we validated on a satellite-by-satellite basis, the application of the phase law either was neutral in terms of RMS of fit, or showed an improvement. We illustrate in Figure 17 the impact of the application of the Alcatel and Starec phase laws on the scale of the DORIS coordinate time series, wrt DPOD2008. In general there is a positive shift in scale whose magnitude is correlated with the number of Starec antenna present in the network.

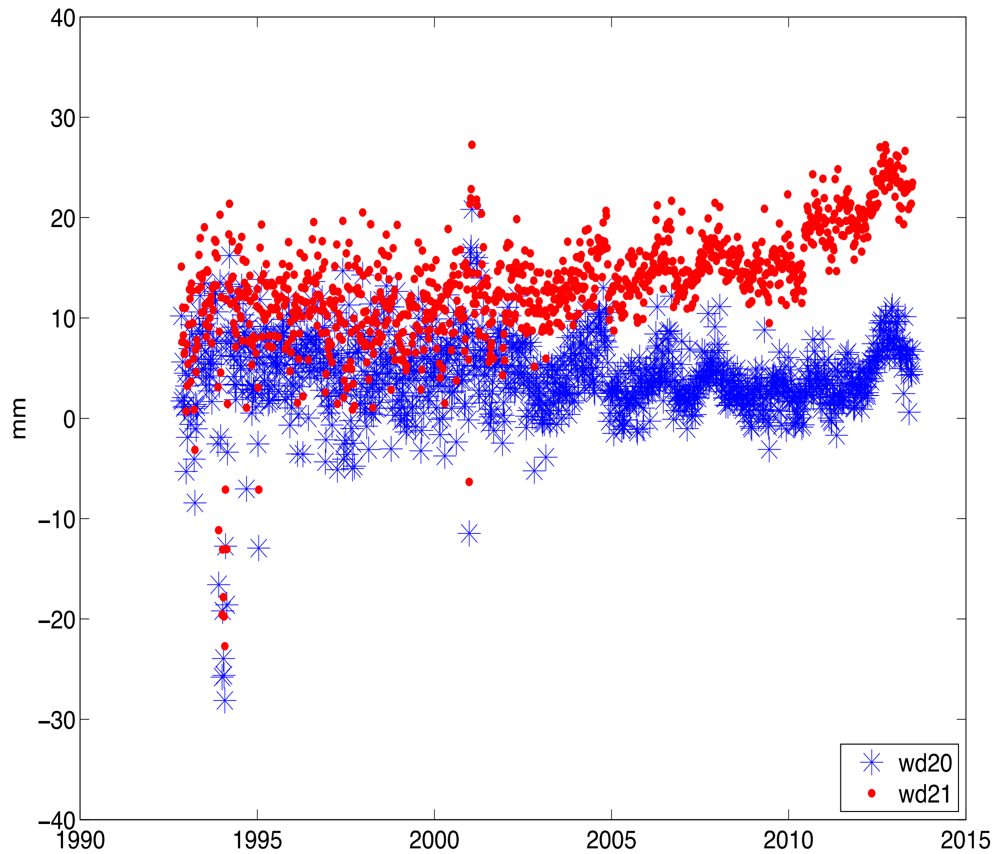

Figure 17. Scale of SINEX weekly series for GSC series gscwd20, and gscwd21, illustrating the impact of the application of the DORIS antenna phase map corrections for the Starec and Alcatel antennae. The scale is calculated w.r.t. DPOD2008 and the units are mm.

13 REPORT OF THE IGN/JPL ANALYSIS CENTER (IGN)

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13.1 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 2013, IGN used the most recent versions (GOA 6.2 and successive development versions). This software package is installed on both sites at IGN in Saint-Mandé and at IPGP in Tolbiac. In 2013, all DORIS results were generated to IDS by the IPGP site. Computations are done routinely on a daily basis using a crontab command launching several scripts successively, first checking for new DORIS data availability. New solutions are then submitted simultaneously to both IGN and NASA/CDDIS data centers. Internal validation is done after the facts using an internal Web site available at IPGP, eventually leading to a few resubmissions of weekly SINEX solutions. In 2013, tests were conducted between an older 32-bit computer and a newly bought 64-bit computer purchased by IPGP. While routine processing continued as in 2012, new studies were also launched in preparation of ITRF2013. Only test solutions (orbit and single-satellite SINEX solutions) were submitted at the end of 2013 in view of ITRF2013.

13.2 PRODUCTS DELIVERED IN 2013

The latest delivered IGN weekly time series is still ignwd08 (in free-network). However, in parallel, another set of weekly solutions (ignwd10, projected from ignwd08 and later transformed into ITRF2008), were also submitted simultaneously. This is the solution that was used in preparation of ITRF2008 and available for combined solutions IDS-1, IDS-2 and IDS-3. It is the one still used by the IDS Combination Center. Models and strategy estimation remain unchanged but new SINEX solutions were generated every week (on average), usually 1 day after data delivery for the last satellite. Furthermore, new satellites have been incorporated in the solutions (Jason-2). However, solutions, including the more recent Chinese HY-2A satellite and Indian saral/AltiKa satellite, were computed for internal tests but not yet submitted. Following the delivery of the ignwd10 solution, all derived products were also updated every week to be compatible with ITRF2008. Newly resubmitted Envisat data were reprocessed for internal tests but are not part of the current results at the end of 2012. A significant improvement was obtained when using the new data from CNES (more numerous and profiting from a better time tagging procedure).

Products relying on ITRF2005 were discontinued in 2011, while products relying on ITRF2008 keep being submitted every week (see Table 13). However, in December a failure of the older 32-bit computer stopped the delivery of the routine products presented above. Taken into account the importance of the preparation of ITRF2013, these igwd08 and igwd10 series were stopped then. It is expected to start delivery of new DORIS products in early 2014. Due to lately detected problem, weekly sinex files for ignwd10 were not submitted in 2013.

Product	Latest version	Update	Data span	Number of files
Weekly SINEX - free-network - in ITRF2008 - summary files	 ignwd08 ignwd10 ignwd08	 Weekly Weekly Weekly	 1993.0-2012.9 1993.0-2012.0 1993.0-2012.9	 1088 1044 1088
STCD	ign11d01	Weekly	1993.0-2012.9	169
Geocenter	ign11d01	Weekly	1993.0-2012.9	1
EOPs	ign11d01	Weekly	1993.0-2012.9	1

Table 13. IGN products delivered at the IDS data centers in 2013. As of January 31, 2014

Besides these IDS products, several IGN results were also provided to the Analysis Coordinator for test purposes: satellite orbits in sp3 format, weekly SINEX solution by satellites, multi-satellites weekly SINEX solutions with or without Jason-2 data, satellites orbits for all satellites. These tests were conducted in view of the preparation of ITRF2013.

Comparisons of DORIS-derived tropospheric zenith delays were also performed towards GPS PPP solutions, including DORIS results since January 1993. For test purposes, VMF-1 mapping function was also used during all recent CONT campaigns leading to tropospheric comparisons toward VLBI and GPS estimates (*Bock et al., under review*). Systematic comparisons of horizontal tropospheric gradients were also generated with regards to GPS PPP solutions provided by Jet Propulsion Laboratory for the International GPS Service (*Willis et al., 2014*).

In 2013, new work was conducted toward the realization of a new DPOD2008 solution (terrestrial reference frame for precise orbit determination derived from ITRF2008), for which several updates were delivered and are still available at the following Web site: http://www.ipgp.fr/~willis/DPOD2008/ . Version 1.13 is available at the end of 2013, including all possible DORIS stations (*Willis et al., in press*).

While no new velocity field solution was provided in 2013, a regional study was done for geodetic and geophysical consideration in Africa (*Saria et al., 2013*), within the scope of the AFREF project. The same is also true for the Gavdos calibration site for satellite altimeter calibration purposes (*Willis et al., 2013*).

13.3 MAJOR IMPROVEMENTS IN 2013

No major improvement was done for the ignwd08 solution, except the use of the newest satellites HY-2A and Saral/Alti-Ka (*Willis et al., in press*). Major improvements were considered for the next solutions that will be delivered in early 2014 for ITRF2013 submission. Previous improvements done in 2011 include:

- use of the more recent GGM03S gravity field (still without taking into account seasonal variations)
- rescaling of the solar radiation pressure models using an empirical coefficient determined using a large DORIS data set for each satellite. This mitigates errors in the Z-geocenter at periods of 118 days and 1 year and also improve vertical component of high latitude stations.
- hourly estimation of drag coefficient for lower DORIS satellites at 800 km. This avoids problem related to high geomagnetic activity (geomagnetic storm and maximum of 11-year solar cycle around 2001).

13.4 NEW DEVELOPMENTS

New developments in view of the future ITRF2013 solution have been conducted in 2013: using more recent gravity field (EIGEN6S2 and GOCO02S), or better a priori for station positions (DPOD2008 version 1.13). New developments were also realized in order to use more recent tropospheric mapping function and ZTD a priori (GPT and GPT2) but will not appear yet in the new solution. Observations at lower elevation (7 degrees instead of 10 degrees) will now be used in conjunction with the most recent VMF-1 mapping function. A sign error was also found when providing time series of geocenter coordinates. Previous series already available at CDDIS will not be corrected. However, the next time series will be properly corrected.

14 REPORT OF THE INASAN ANALYSIS CENTER (INA)

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14.1 INTRODUCTION

In 2013, INASAN (ina) DORIS Analysis Center continued routine processing DORIS data using GIPSY-OASIS II software developed by JPL with DORIS part of GIPSY developed by IGN/JPL. Table 14 shows current products delivered by INASAN to the IDS.

Product	Latest version	Span
Sinex weekly free-network solutions	inawd07	1993.0 - 2013.8
Geocenter time series	ina10wd01	1993.0 - 2013.8
EOP time series	ina10wd01	1993.0 - 2013.8
STCD time series	ina12wd01	1993.0 - 2012.8

Table 14. INASAN products provided to the IDS (February 2014).

The files with the product description can be found at:

1) sinex series

ftp://cddis.gsfc.nasa.gov/pub/doris/products/sinex_series/inawd/inawd07.snx.dsc

2) geocenter

ftp://cddis.gsfc.nasa.gov/pub/doris/products/geoc/ina10wd01.geoc.dsc

3) EOP-series

ftp://cddis.gsfc.nasa.gov/pub/doris/products/eop/ina10wd01.eop.dsc

4) STCD-series

ftp://cddis.gsfc.nasa.gov/pub/doris/products/stcd/ina.stcd.readme

14.2 SOFTWARE UPDATE AND ANALYSIS RESULTS DESCRIPTIONS

During 2013 the GIPSY-OASIS software had some updates and currently we use 6.2 Linux version. All these updates mainly connected with the processing GNSS measurements and bugs fixed from previously used 6.1.2 release. There were no any improvements in the models and processing strategies for DORIS data. The all models and processing strategies are identical to those reported in IDS_Report_2011.pdf.

INA AC took part in the single-satellite IDS Analysis campaigns (Spot-2, Spot-3, TOPEX satellites for 1995 and Envisat, Spot-4-5, Cryosat-2, Jason-2 satellites for 2011). The evaluation results of these campaigns wrt ITRF2008 can be found in *Moreaux et al. (2013)*.

Estimated annual geocenter variations for 1993.0-2013.8 were derived by least squares method and evaluated as 5.4±0.2 mm, 4.3±1.3 mm, 2.9±1.1 mm for X, Y and Z components, respectively (respect to ITRF2005, more exactly respect to ign09d02 - global Doris solution). The same values obtained for the IGN geocenter time series for the time period 1993.0-2013.8 are 4.7±0.2 mm, 4.5±1.8 mm, 1.6±0.6 mm for X, Y and Z components.

15 REPORT OF THE CNES/CLS ANALYSIS CENTER (LCA)

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15.1 INTRODUCTION

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

The main activity during 2013 was the contribution to the next release of the International Terrestrial Reference Frame planned in 2014 (ITRF2013). The first step was to prepare the ITRF processing context by the definition of the models and standards. Secondly, we started to process two decades of DORIS data (1993-2013). In 2013, we also worked on the SAA corrective model for Jason-1 and developed the SAA corrective model for SPOT-5.

15.2 PREPARATION TO ITRF2013

To adopt the standards for ITRF2013 and to improve our processing some changes were brought to the set of models and in the GINS software.

Concerning the gravitational forces, the main changes are:

- Geopotential: EIGEN-6S2 (with derive terms)
- Ocean tides: FES2012
- Atmospheric gravity: 3hr ERA-interim / ECMWF up to degree 50
  (Atmospheric tides: none; considered through the ECMWF atmospheric data)
- Non tidal oceanic gravity: TUGO R12 up to degree 50
- Third body: JPL DE421 *(IERS conventions 2010)*

For the geometry we use now:

- Troposphere: GPT2/VMF1 + one gradient per station in North & East directions
- Ocean loading: FES2012
- Tidal atmospheric loading: S1/S2 Ray&Ponte *(IERS conventions 2010, ITRF2013 recom.)*

One recommendation of the IDS Analysis Coordinator is to use for ITRF 2013 the phase law for ALCATEL antennas given by CNES. This phase law has been implemented in GINS and has been used for our ITRF processing.

A study has been realized to reduce the Along-track and Cross-track OPR amplitudes for Spots satellites, Jason-1 and Envisat. This led to change SRP values for theses satellites.

For Cryosat-2, we applied the CNES 7-plate macromodel with a SRP value which has been estimated over a sufficiently long period.

A correction has been brought in the GINS software to take into account the last changes (beginning in 2012) of the orientation of solar panel for Spot-5 (GINS version used is the 13-2d2).

We added Jason-1 with SAA corrected data in the multi-satellite solution for a period defined at the last AWG (see below). For Spot-5, we used SAA-corrected data since January 2006.

15.3 DATA PROCESSING AND PRODUCTS DELIVERED TO IDS

15.3.1 STANDARD ROUTINELY PROCESSING

In 2013, we continued to routinely provide the lcawd32 series by delivering to the IDS Combination Center the multi-satellite solutions (lcawd32 SINEX) and orbits files in sp3c at the IDS Data Centers for each DORIS mission since their beginning, including Jason-1. These are DORIS+SLR mixed orbits for ENVISAT, Topex/Poseidon, Cryosat-2, HY-2A and the two Jason satellites, and DORIS-only orbits for the SPOT satellites. The generic name of these series is lca02.sp3.

Coordinates time series of each station expressed in ITRF2008 are available in STCD format and as GIF plots at IDS Data Centers. They also can be seen with the web tool of the IDS at http://ids-doris.org/webservice/client/stcdtool.html. They are updated approximately every 3 months.

Description files can be found at CDDIS (ftp://cddis.gsfc.nasa.gov/) and IGN (ftp://doris.ensg.ign.fr/). For the data analysis summary, see in particular pub/doris/products/sinex_series/lcawd/lcawd30.snx.dsc

15.3.2 ITRF PROCESSING

In 2013, a complete reprocessing started to contribute to the 2013 ITRF. We processed DORIS data from 1993 to 2011. The Table 15 gives the DORIS data used and the satellite combination for the different periods.

Period	Topex	Spot2	Spot3	Spot4	Spot5	Envisat	Jason1	Jason2	Cryosat2	Satellite combination
1993/01-1994/01	x	x								s2t
1994/02-1996/10	x	x	x							s2s3t
1996/11-1998/04	x	x								s2t
1998/05-2001/12	x	x		x						s2s4t
2002/01-2004/10	x	x		x	x	x				s2s4s5teJc
2004/11-2008/06		x		x	x	x	x			s2s4s5eJcj
2008/07-2010/05		x		x	x	x		x		s2s4s5eJc
2010/06-2012/04				x	x	x		x	x	s4s5eJc
2012/04-2013/06				x	x	x		x	x	s4s5Jc
2013/06-2013/12				x	x	x		x	x	s5Jc

(s2/3/4/5 = SPOT-2/3/4/5, t = Topex, e = Envisat, J = Jason-2, c = Cryosat-2, j = Jason-1)

Table 15. Multi-satellite combination used for IDS solutions

Note, for Jason-1 we compute new data set including SAA model correction from end of TOPEX (Nov. 2004) to start of Jason-2 (July 2008). For SPOT5, since January 2006 we consider new data set including SAA model correction.

The IDS Combination Center has done a first analysis of our multi-satellite solution lcawd40. On the Figure 18 the results of the comparison to the ITRF 2008 obtained with CATREF software. In addition of the usual results (WRMS, scale, Translations Tx, Ty, Tz, …) the percentage of STAREC Antenna stations used to calculate the 7 Helmert parameters is given.

The first result interesting in this figure is to see the bias on the scale compared to ITRF2008 which is explained by the application of the phase law.

The periodic long term signal of 18,6 years on the translations Tx and Tz is clearly reduced with the lcawd40 solution.

On Figure 18 we see the different time periods corresponding to the change of satellite number in the constellation (vertical blue lines). We distinguish in particular two periods, before and after 2002 (introduction of the 2G instruments with Spot-5, Envisat and Jason-1).

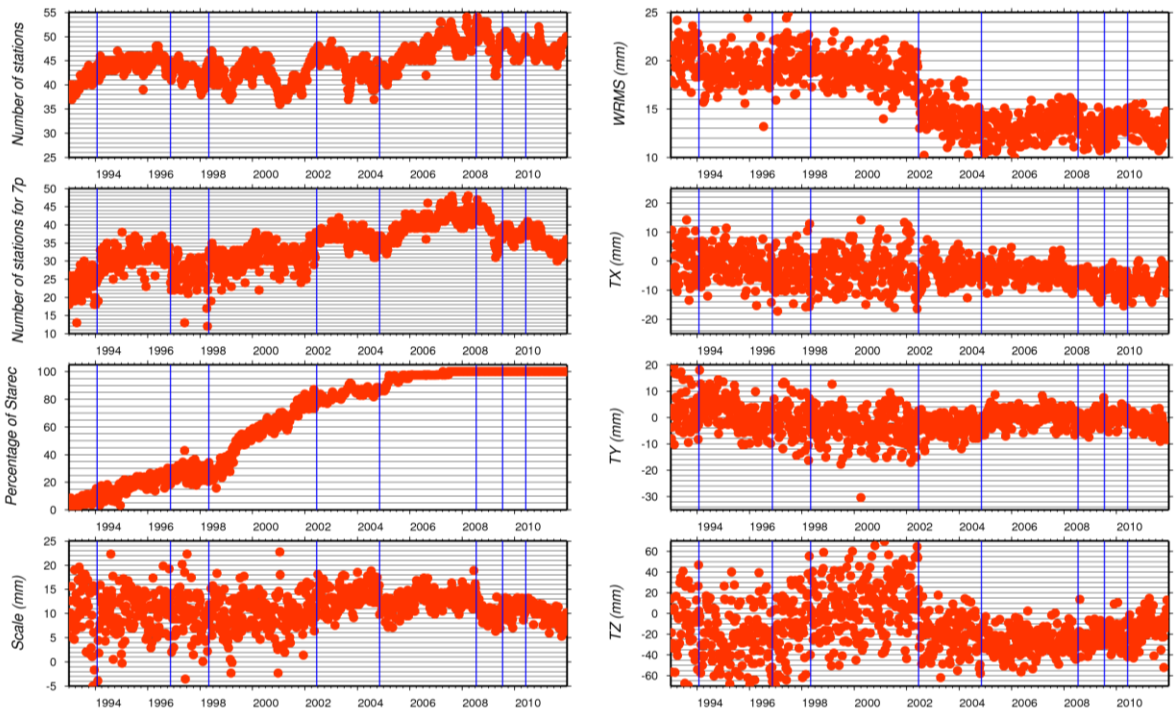

Figure 18. Helmert parameters (Geocenter and Scale) estimated by the IDS Combination Center with LCA solution lcawd40

15.4 SAA CORRECTING MODELS

In the context of the forthcoming ITRF 2013, the LCA AC had to deliver the corrected measurements by the SAA models for Jason-1 and Spot-5 during the period defined at the last AWG at Toulouse and Washington.

15.4.1 JASON1 SAA MODEL

First, for Jason-1, we looked the positive impact of the integration of the Jason-1 corrected by the SAA model on the multi-satellite positioning. Then, we proposed a strategy to add Jason-1 in the multi-satellite solution by renaming SAA station parameters (positions and troposphere). We proposed the period from end of TOPEX (Nov. 2004) to start of Jason-2 (July 2008).

In 2013, the use of maps of energetic particles obtained by the dosimeter CARMEN on-board of Jason-2 has been investigated to improve the SAA model. The first work was to define the energy band the most correlate with the one of SAA Jason-1. The next step will be to use this map to determine the model parameters (planned in 2014).

15.4.2 SPOT5 SAA MODEL

Collaboration was initiated with Petr Stepanek (GOP) to elaborate and evaluate the final SAA model for Spot-5. Some SAA maps at the altitude of SPOT-5 (830 kms) have been performed. The map (see Figure 19) which has been determined with DORIS data from 2009 to 2011 has been used to estimate the parameters of the model.

We also showed the positive impact on the orbit and on the positioning of the Spot-5 SAA corrected model.

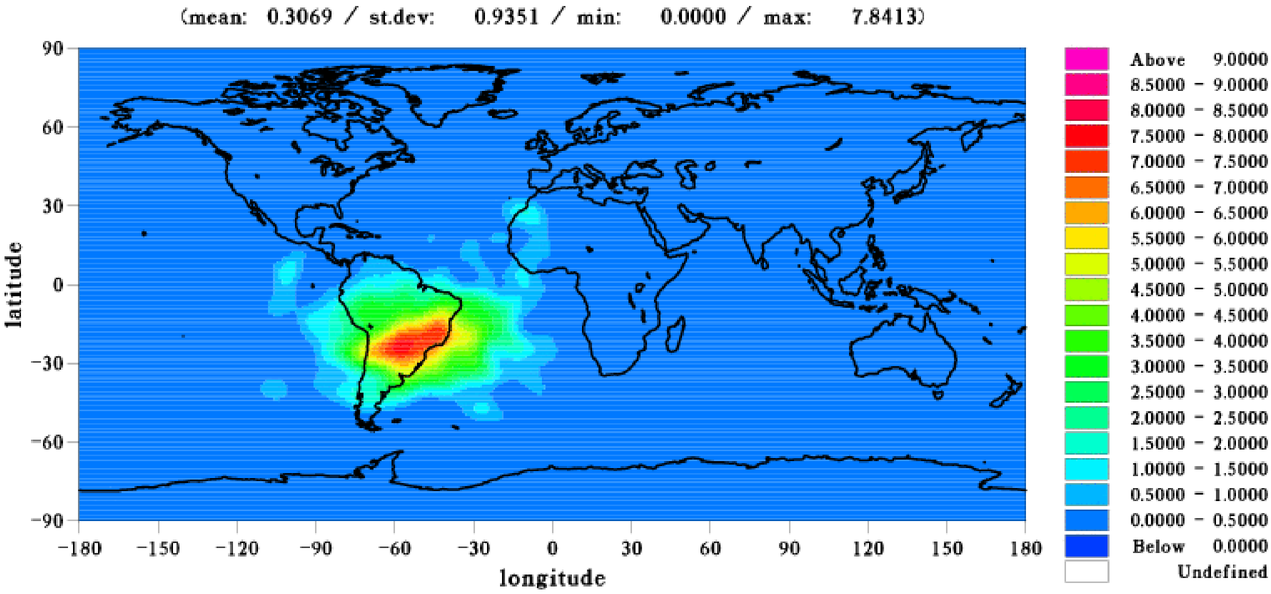

Figure 19. Spot-5 SAA map (1° x 1°)

15.4.3 DELIVERING SAA-CORRECTED DORIS2.2 MEASUREMENTS

First, it is recalled that the corrective model for Jason-1 DORIS Doppler data is available on the CB ftp site under:

ftp://ftp.ids-doris.org/pub/ids/satellites/CORRECTIVE_MODEL_JASON1

The Jason-1 doris2.2 data files corrected by the SAA model from cycle number 104 to 241 (from 2004/11/01 to 2008/07/31) are available on the ftp data centers:

ftp://cddis.gsfc.nasa.gov/pub/doris/campdata/saacorrection/ja1

ftp://doris.ign.fr/pub/doris/campdata/saacorrection/ja1

as well as ftp://doris.ensg.eu/pub/doris/campdata/saacorrection/ja1

The name of files is ja1dataCCC.saa.Z (CCC for the cycle number).

The Spot-5 doris2.2 data files corrected by the SAA model from cycle number 138 to 432 (from 2005/12/27 to 2014/01/09) are available on the ftp data centers:

ftp://cddis.gsfc.nasa.gov/pub/doris/campdata/saacorrection/sp5/

ftp://doris.ign.fr/pub/doris/campdata/saacorrection/sp5

as well as ftp://doris.ensg.eu/pub/doris/campdata/saacorrection/sp5

The name of files is sp5dataCCC.saa.Z (CCC for the Arc(cycle) number).

15.5 CONTRIBUTION TO IDS AWG MEETINGS

The Analysis Center's representatives participated in 2013 to the AWG meetings in Toulouse and Washington. They presented the following works:

AWG Toulouse

- LCA Analyses Center Updates
  http://ids-doris.org/images/documents/report/AWG201304/IDSAWG1304-Soudarin-LCA-StatusReport.pdf

- SAA corrective model for Jason-1 and for Spot-5
  http://ids-doris.org/images/documents/report/AWG201304/IDSAWG1304-Capdeville-SAAmodelJason1Spot5.pdf

AWG Washington

- ITRF 2013 Status for LCA AC
  http://ids-doris.org/images/documents/report/AWG201310/IDSAWG1310-Soudarin-LCAStatusReport.pdf

- LCA Cryosat-2 macromodel tests
  http://ids-doris.org/images/documents/report/AWG201310/IDSAWG1310-Soudarin-MacromodelAssessmentCryosat2.pdf

- Model Assessment
  http://ids-doris.org/images/documents/report/AWG201310/IDSAWG13telecon-LCA-ModelsAssessment.pdf

- Plan for delivery schedule for LCA AC
  http://ids-doris.org/images/documents/report/AWG201310/IDSAWG1310-Soudarin-LCAPlans.pdf

16 DORIS-RELATED ACTIVITIES AT GFZ

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16.1 INTRODUCTION

The activities performed at GFZ in 2013 related to DORIS data processing included further updates of GFZ's EPOS-OC software used for Precise Orbit Determination (POD) of DORIS satellites, tests of new time variable geopotential models developed by GFZ and CNES/GRGS, a test of the new Envisat DORIS 2.2 data set delivered by CNES on May 16, 2012, computation and detailed analysis of precise orbits of TOPEX/Poseidon (1992-2005) and Envisat (2002-2012), and preparations for Jason-1 and Jason-2 POD.

16.2 SOFTWARE UPDATES

The following updates of the EPOS-OC software and input files used for POD of DORIS satellites were performed:

- A most complete list of occupations of SLR, DORIS, PRARE and Doppler stations that tracked GEOSAT (1985-1990), ERS1 (1991-1996), ERS-2 (1995-2011), Envisat (2002-2012) and TOPEX (1992-2005) was generated and used to generate a new version of ocean and atmospheric loading files (1985-2013).

- A computer program to transform Envisat, Jason-1 and Jason-2 mass and center-of-mass corrections from the CNES to the EPOS-OC format was written.

- The Jason-1 macro-model implementation in the EPOS-OC software was verified.

- A script to compute non-overlapping SP3 files on the basis of overlapping ones was prepared.

- The EPOSIN software used for the generation of the EPOS-OC input files for altimetry satellite POD was adopted to Linux.

- A test on using a geocenter motion model for Envisat POD was performed.

- A test on estimating solar radiation scaling factor for Envisat POD was done.

16.3 PRECISE ORBITS OF DORIS SATELLITES - TESTS OF TIME VARIABLE GEOPOTENTIAL MODELS

Precise orbits of TOPEX/Poseidon (September 23, 1992 to October 8, 2005) and Envisat (April 12, 2002 to April 8, 2012) were computed in the ITRF2008 reference frame using SLR and DORIS measurements and the models based mainly on the IERS Conventions 2010, but six different geopotential models: stationary models EIGEN-GL04S and EIGEN-6S_stat, and four time variable geopotential models - EIGEN-6S_correct, EIGEN-6S2, EIGEN-6S2A and EIGEN-6S2B. The results of the influence of time variable geopotential models on precise orbits of altimetry satellites, global and regional mean sea level trends are included in the paper (*Rudenko et al. 2014*). The best among these orbit solutions computed using the EIGEN-6S2 geopotential model are made available via anonymous ftp at

ftp://ftp.gfz-potsdam.de/pub/home/kg/orbit/SLCCI/TOPX/VER6_CCI05/ for TOPEX/Poseidon

and

ftp://ftp.gfz-potsdam.de/pub/home/kg/orbit/SLCCI/ENVI/VER6_CCI14/ for Envisat.

A description of these orbit solutions is available also as file

ftp://ftp.gfz-potsdam.de/pub/home/kg/orbit/SLCCI/Readme_GFZ_SLCCI_orbits

The RMS fits of SLR and DORIS measurements per arc obtained for TOPEX/Poseidon VER6 orbit computed using the EIGEN-6S2 geopotential model are shown in Figure 20.

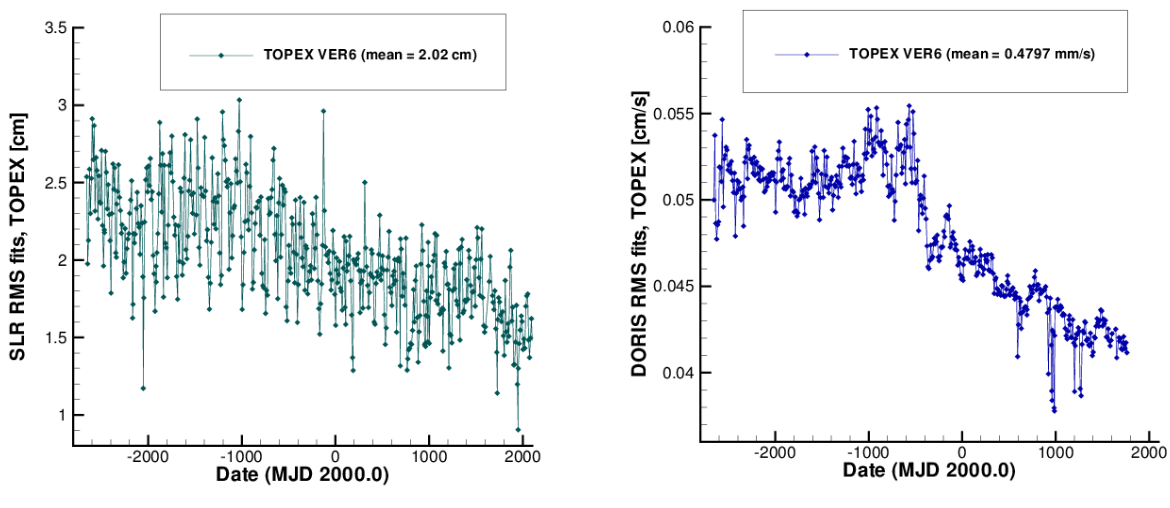

Figure 20. RMS fits of SLR (left) and DORIS (right) measurements per arc for TOPEX/Poseidon VER6 orbit from September 23, 1992 till October 8, 2005.

16.4 TEST OF THE NEW ENVISAT DORIS 2.2 DATA SET

A test of the Envisat DORIS 2.2 data set delivered by CNES on May 16, 2012 for arcs 001-255 and 901-907, 910 covering the time interval from April 10, 2002 till May 8, 2007 was performed. Precise orbits of Envisat were computed in the ITRF2008 terrestrial reference frame using the models based mainly on the IERS Conventions (2010), but using two different data sets of Envisat DORIS data: the old one and the new one. The results show, that the SLR RMS fits increased by 0.2 mm (1.6%) from 1.28 to 1.30 cm (Figure 21, left) and DORIS RMS fits increased by 0.012 mm/s (2.8%) from 0.4316 to 0.4436 mm/s (Figure 21, right), when using the new DORIS data set. At the same time, the mean number of DORIS observations accepted increased by 0.23% only from 44652 to 44754 (Figure 22). The single-satellite altimetry crossover analysis however shows that the average value of the RMS of crossover differences decreased by about 0.2% from 6.025 cm to 6.012 cm. At the same time the average value of the mean of crossover differences increased by about 1.9% from 0.365 cm to 0.372 cm. In summary the new DORIS 2.2 data set does not seem to bring a clear improvement in orbit quality.

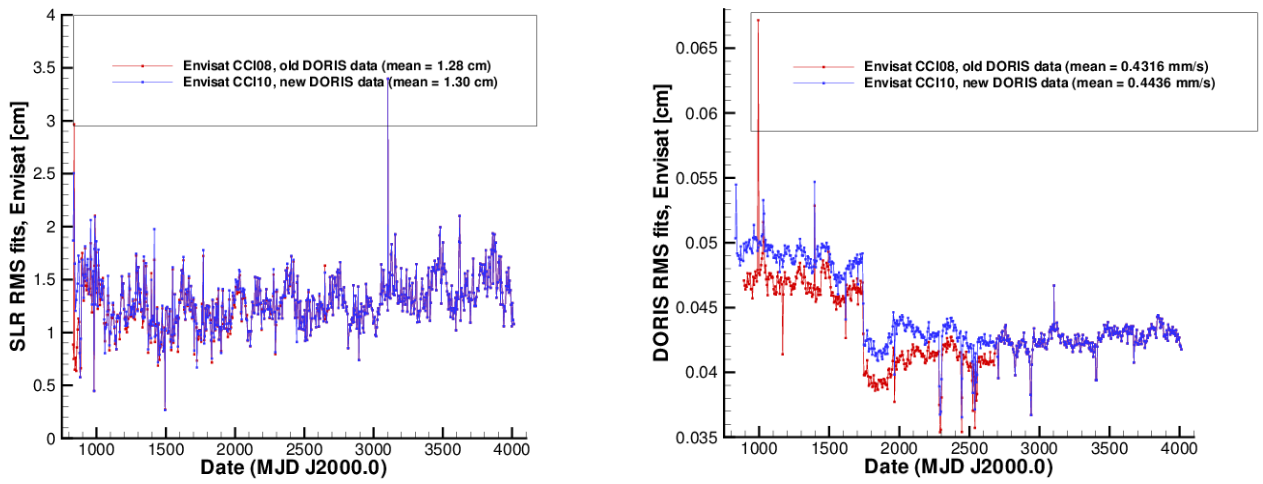

Figure 21. The RMS fits of SLR (left) and DORIS (right) measurements per arc obtained using the old and new DORIS data sets for Envisat.

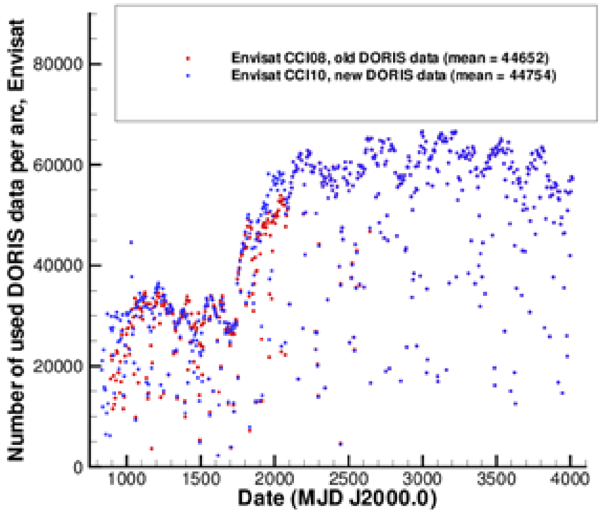

Figure 22. The number of DORIS measurements accepted per arc for the Envisat CCI08 orbit computed using the old DORIS data set and for the CCI10 orbit derived using the new DORIS data set.

16.5 FUTURE PLANS

It is planned to complete the Jason-1 and Jason-2 specific models and to implement models for Cryosat-2 and SARAL/Altika missions and to compute precise orbits of these satellites.

16.6 ACKNOWLEDGMENTS

These activities were partly supported by the European Space Agency within the Climate Change Initiative Sea Level Project and by the German Research Foundation (DFG) within the project "Consistent Estimate of Ultra-High Resolution Earth Surface Gravity Data (UHR-GravDat)".

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18 PUBLICATIONS (2013)

Here is below the list of DORIS publications in international peer-reviewed journals for 2013.

The complete list is available on the IDS website:
http://ids-doris.org/report/publications/peer-reviewed-journals.html#2013

Cerri, L.; Lemoine, J.M.; Mercier, F.; Zelensky, N.P.; Lemoine, F.G., 2013. DORIS-based point mascons for the long term stability of precise orbit solutions, ADVANCES IN SPACE RESEARCH, 52(3):466-476, DOI: 10.1016/j.asr.2013.03.023

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APPENDIX 1: THE IDS INFORMATION SYSTEM

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 site

AC: the Analysis Coordinator webpages on the CB web site

The baseline storage rules are as follows:

DC store observational data and products + formats and analysis descriptions.

CB produces/stores/maintains basic information on the DORIS system, including various standard models (satellites, receivers, signal, reference frames, etc). .

AC refers to CB and DC information on the data and modelling, and generates/stores analyses of the products.

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

1. the responsibility on their content and updating,
2. the easiness of user access.

Data-directed software is stored and maintained at the CB, analysis-directed software is stored/maintained, or made accessible through the AC webpages.

To avoid information inconsistencies, duplication is minimized. Logical links and cross referencing between the three types of information centers is systematically used.

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

http://www.ids-doris.org/analysis-documents/struct-dc.html

2. WEB AND FTP SITES

2.1 IDS WEB SITE

address: http://ids-doris.org (or http://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 three 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.

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 and Products: information and data center organization, access information to the IDS Data Centers and to the Central Bureau ftp site.
- Document: a link to this regularly-visited page of the Analysis Coordination
- Meetings: calendars of the meetings organized by IDS or relevant for IDS, as well as links to calendars of other international services and organizations.
- Reports and Mails: documents of the IDS components, DORIS bibliography including DORIS-related peer-reviewed publications and citation rules, meeting presentations, mail system messages, etc.
- Contacts and links: IDS contacts, directory, list of websites related to IDS activities
- Gallery (photo albums from local teams and IDS meetings).

The headings of the “DORIS system” part are:

- Official website: a description of the DORIS system on the AVISO web site
- Network: Site logs, station coordinate time series, maps, network on Google Earth
- System monitoring: DORIS system events file, station events file, station performance plots from the CNES MOE and POE processings, list of events impacting the data, list of earthquakes close to DORIS sites.
- Plot tools: STCD tool, POE tool

The headings of the “Analysis Coordination” part are:

- Presentation: a brief description of this section
- Documents: about the DORIS system’s components (space segment, ground segment, stations, observations), the models used for the analysis, the products and their availability. A direct access to this regularly-visited page is also given in the “IDS” part.
- DORIS related events: history of the workshops, meetings, analysis campaigns...
- Discussion: archive of the discussions before the opening of the forum
- Software: a couple of software provided by the Analysis Coordinator.

DORIS and IDS news as well as site updates are accessible from the Home page. Important news is displayed in the new 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” (http://ids-doris.org/doris-news.html) and “What’s new on IDS” (http://ids-doris.org/ids-news.html). The history of the updates of the website is given in “Site updates” (http://ids-doris.org/site-updates.html).

The IDS web site is maintained by the Central Bureau.

2.2 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 documents available concern:

- the centers: presentation and analysis strategy of the ACs;

- the DORIS data: format description 1.0,2.1, 2.2, and RINEX, POE configuration for GDRB and GDRC altimetry products from Jason-1 and Envisat, on-board programming and POE pre-processing history;

- the dorimails and dorisreports: archive of the messages in text format, and indexes;

- the products: format of eop, geoc, iono, snx, sp1, sp3, stcd;

- the satellites: macromodels, nominal attitude model, center of mass and center of gravity history, maneuver history (including burn values), instrument modelling, corrective model of DORIS/Jason-1 USO frequency, plots of the POE statistics of all the stations for each satellite;

- the stations: sitelogs, ties, seismic events around the DORIS station network, ITRF2000, antennas description, beacon RF characteristics, information about the frequency shifts of the 3rd generation beacon, IDS recommendations for ITRF2005, Jason and Spot-4 visibility, station events, plots of the POE statistics of all the satellites for each station, document about the interface specification between the DORIS Network beacons and the onboard instrument;

- the combinations: analysis results from Analysis Coordination's combination center (internal validation of each individual Analysis Center time series, weekly combination), IDS combination for the DORIS contribution to ITRF2008.

- ancillary data such as bus quaternions and solar panel angles of Jason-1 and Jason-2

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.ign.fr/pub/doris/cb_mirror/

2.3 DORIS WEB SITE

address: http://www.aviso.altimetry.fr/en/techniques/doris.html (new URL)

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.

2.4 DATA CENTERS' 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.

Address of the CDDIS web site: http://cddis.gsfc.nasa.gov

Address of the CDDIS ftp site: ftp://cddis.gsfc.nasa.gov/pub/doris/

Address of the IGN ftp site: ftp://doris.ensg.ign.fr/pub/doris/

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, DORISstations or IDS.analysis.forum. 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.

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/

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 people.

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.

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

3.4 IDS ANALYSIS FORUM

e-mail : ids.analysis.forum@ids-doris.org

In order to share in the present, and secure for the future, information, questions and answers on the problems encountered in the DORIS data analysis, the Analysis Coordinator with the support of the Central Bureau initiated the IDS Analysis Forum. This a list for discussion of DORIS data analysis topics (stations, satellites, DORIS instruments, data, analysis, orbits, EOP, products) moderated by the Analysis Coordination.

The messages are all archived on the mailing list server of CLS at the following address:

http://lists.ids-doris.org/sympa/arc/ids.analysis.forum

Previous to the creation of forum, the Analysis Coordinator has collected 68 messages of conversion between analysts in an archive that can be viewed at http://www.ids-doris.org/analysis-discussion.html

3.5 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: common list for the Central Bureau and the Governing Board. This list is private.

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

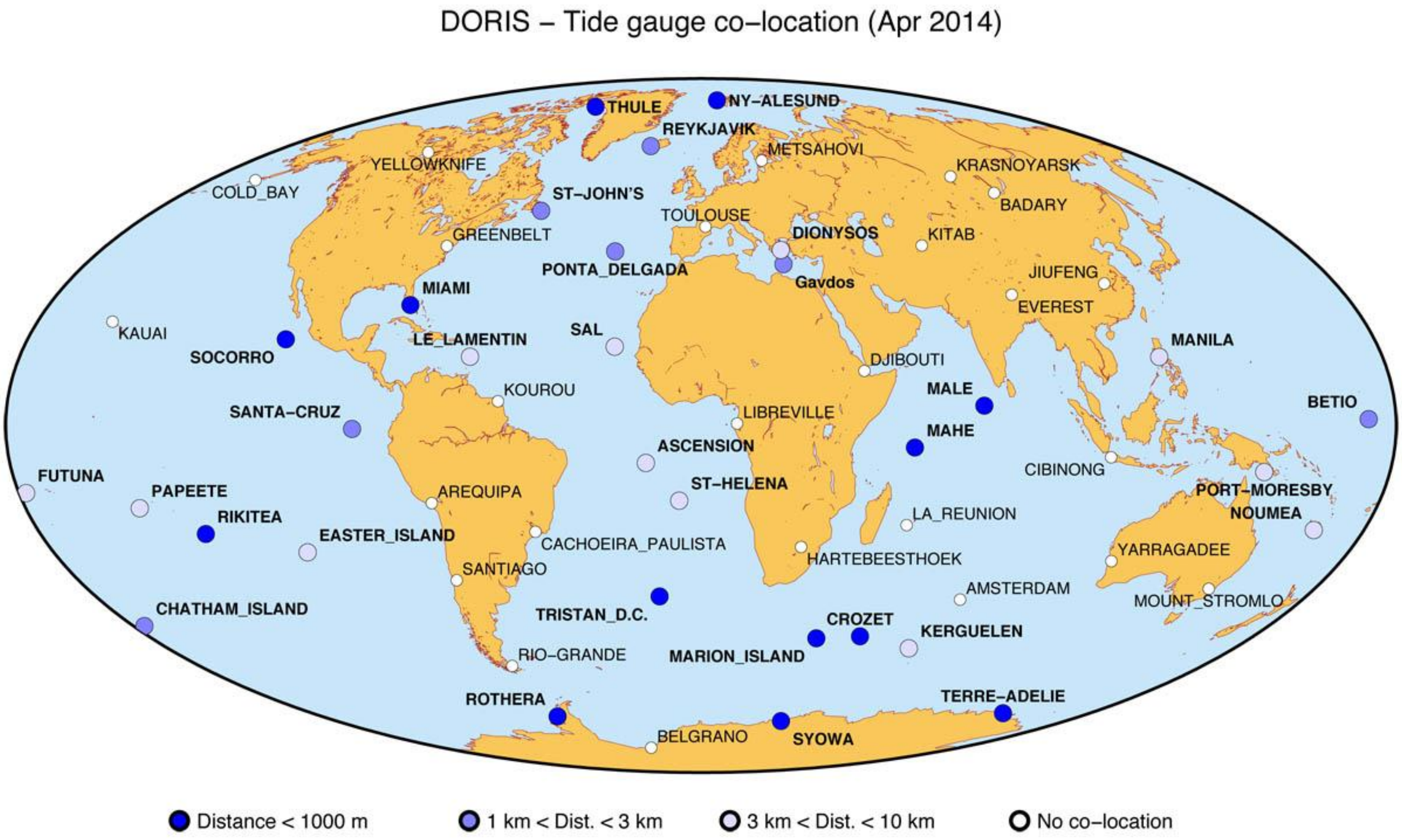
4. HELP TO THE USERS

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.

APPENDIX 2: DORIS STATIONS COLOCATION WITH TIDE GAUGES

The figure and the table 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	28/02/97	6500	263	402001
BETIO	172.92	1.35	KIRIBATI	22/10/06	1600	113	730009
CHATHAM ISL.	-176.57	-43.96	NEW ZEALAND	28/02/99	1200	128	------
CROZET ISL.	51.85	-46.43	FRANCE	21/12/03	850	21	433001
EASTER ISL.	-109.38	-27.15	CHILI	17/11/88	7000	137	810003
FUTUNA	-178.12	-14.31	FRANCE (POLYNESIA)	18/10/11	4400		
KERGUELEN	70.26	-49.35	FRANCE	28/01/87	3300	23	434001
LE LAMENTIN	-61.00	14.60	FRANCE (MARTINIQUE)	29/06/13	7000	338	1942
MAHE	55.53	-4.68	SEYCHELLES	20/06/01	300	273	442007
MALE	73.53	4.20	MALDIVES	15/01/05	500	28	454011
MANILA	121.03	14.53	PHILIPPINE	26/02/03	9700	73	145
MARION ISL.	37.86	-46.88	SOUTH AFRICA	15/05/87	1000	20	------
MIAMI	-80.17	25.73	USA	10/02/05	180	---	960001
NOUMEA	166.41	-22.27	FRANCE (CALEDONIA)	20/10/87	3600	123	740001
NY-ALESUND	11.93	78.93	NORWAY (SPITZBERG)	13/09/87	600	345	1421
PAPEETE	-149.61	-17.58	FRANCE (POLYNESIA)	27/07/95	7000	140	780011
PONTA DELGADA	-25.66	37.75	PORTUGAL (AZORES)	02/11/98	1500	245	36002
PORT MORESBY	146.18	-9.43	PAPUA NEW GUINEA	29/03/88	6000	---	670012
REYKJAVIK	-21.99	64.15	ICELAND	04/07/90	2500	229	10001
RIKITEA	-134.97	-23.13	FRANCE (POLYNESIA)	23/09/06	800	138	808001
ROTHERA	-68.1	-67.6	UK (ANTARCTICA)	01/03/05	100	342	1931
SAL	-22.98	16.78	CAPE VERDE	15/12/02	7000	329	380021
SANTA CRUZ	-90.30	-0.75	ECUADOR	01/04/05	1600		845031
SOCORRO	-110.95	18.73	MEXICO	09/06/89	400	162	830062
ST-HELENA	-5.67	-15.94	UK	01/06/89	4000	264	425001
ST. JOHN'S	-52.68	47.40	CANADA	27/09/99	4000	223	970121
SYOWA	39.58	-69.01	JAPAN (ANTARCTICA)	10/02/93	1000	95	A--041
TERRE ADELIE	140.00	-66.67	FRANCE (ANTARCTICA)	05/02/87	500	131	------
THULE	-68.83	76.54	DENMARK (GREENLAND)	28/09/02	300	---	------
TRISTAN DA CUNHA	-12.31	-37.07	UK	10/06/86	2000	266	------

APPENDIX 3: 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	Universidad Nacional de San Agustin (UNSA)	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	Republic of KIRIBATI
Cachoeira Paulista	Instituto Nacional de Pesquisas Espaciais (INPE)	Cachoeira Paulista, BRAZIL
Chatham Island	MetService	Chatham Island, NEW ZEALAND
Cibinong	BAKOSURTANAL	Cibinong , INDONESIA
Cold Bay	National Weather Service (NOAA)	Cold Bay, Alaska, USA
	US Coast Guard Navigation Center (NAVCEN)	Alexandria, Virginia, USA
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

Station name	Host agency	City, Country
Easter Island	SSC Chile S.A.	Santiago, CHILI
Everest	Comitato Ev-K2-CNR	Bergamo, ITALY
Futuna	Météo-France	Malae, Wallis-et-Futuna, FRANCE
Grasse	Observatoire de la Côte d'Azur (OCA)	Grasse, FRANCE
Gavdos	Technical University of Crete (TUC)	Chania, Crete, GREECE
Greenbelt	NASA / GSFC / GGAO	Greenbelt, Maryland, USA
Hartebeesthoek	HartRAO, South African National Space Agency (SANSA)	Hartebeesthoek, SOUTHAFRICA
Jiufeng	Institute of Geodesy and Geophysics (IGG)	Wuhan, CHINA
Kauai	Kokee Park Geophysical Observatory (KPGO)	Kauai Island, Hawaï, USA
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, FRANCE
Libreville	ESA Tracking Station	N'Koltang, GABON
Mahé	Seychelles National Meteorological Services	Mahé Island, Republic of SEYCHELLES
Male	Maldives Department of Meteorology	Male, Republic of MALDIVES
Manille	National Mapping and Ressource Information Authority (NAMRIA)	Republic of the PHILIPPINES
Marion	Antartica & Islands Department of Environmental Affairs(DEA)	Marion Island Base, SOUTH AFRICA
Metsahovi	Finnish Geodetic Institute (FGI)	Masala, FINLAND

Station name	Host agency	City, Country
Miami	Rosenstiel School of Marine and Atmospheric Science (RSMAS)	Rickenbacker Causeway, Florida, USA
Mount Stromlo	SLR Observatory, Geoscience Australia (GA)	Mount Stromlo, AUSTRALIA
Nouméa	Direction des Infrastructures, de la Topographie et des Transports Terrestres	Nouméa, NEW CALEDONIA
Ny-Alesund	Institut Polaire Paul Emile Victor (IPEV) Geodesiobservatoriet (Statens Kartverk)	Base Charles Rabot, Ny-Ålesund, NORWAY
Papeete	Observatoire Géodésique de Tahiti (UPF)	Fa'a, Tahiti, Polynésie Française, FRANCE
Ponta Delgada	Universidade dos Açores	Ponta Delgada, Azores, PORTUGAL
Port Moresby	National Mapping Bureau (DLPP)	Port-Moresby, PAPUA NEW GUINEA
Reykjavik	Landmælingar Islands (LMI)	Reykjavik, ICELAND
Rikitea	Météo-France	Archipel des Gambier, Polynésie Française, FRANCE
Rio Grande	Estación Astronómica de Rio Grande (EARG)	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
Santiago	Santiago Satellite Station SSC Chile S.A.	Peldehue, Colina, CHILI
Santa Cruz	Charles Darwin Foundation (AISBL)	Santa Cruz Island, Galápagos, ECUADOR
Socorro	Instituto Nacional de Estadística y Geografía (INEGI) Secretaría de Marina Armada (SEMAR)	Aguascalientes, MEXICO Socorro Island, MEXICO
St John's	Geomagnetic Observatory , Natural Resources Canada (NRCan)	St. John's, CANADA
St-Helena	Meteorological Station	St Helena Island, South Atlantic Ocean, 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

Station name	Host agency	City, Country
Tristan da Cunha	Telecommunications Department of TDC	Tristan da Cunha Island, South Atlantic Ocean, UK
Yarragadee	MOBLAS 5 SLR Station, Geoscience Australia (GA)	Yarragadee, AUSTRALIA
Yellowknife	Natural Resources Canada (NR Can)	Yellowknife, CANADA

INTERNATIONAL DORIS SERVICE

IDS

www.ids-doris.org

DORIS

IDS 2013

Contacts

Governing Board

Chairperson: Pascal Willis (IGN/IPGP) willis@ipgp.jussieu.fr

Central Bureau

Laurent Soudarin (CLS) laurent.soudarin@cls.fr

DORIS System

Pascale Ferrage (CNES) pascale.ferrage@cnes.fr

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IPGP INSTITUT DE PHYSIQUE DU GLOBE DE PARIS
CLS COLLECTE LOCALISATION SATELLITES
NASA
IGN INSTITUT NATIONAL DE L'INFORMATION GÉOGRAPHIQUE ET FORESTIÈRE
cnes
esa
VUGTK
CDDIS Crustal Dynamics Data Information System
INSTITUTE OF ASTRONOMY RUSSIAN ACADEMY OF SCIENCES
CSR