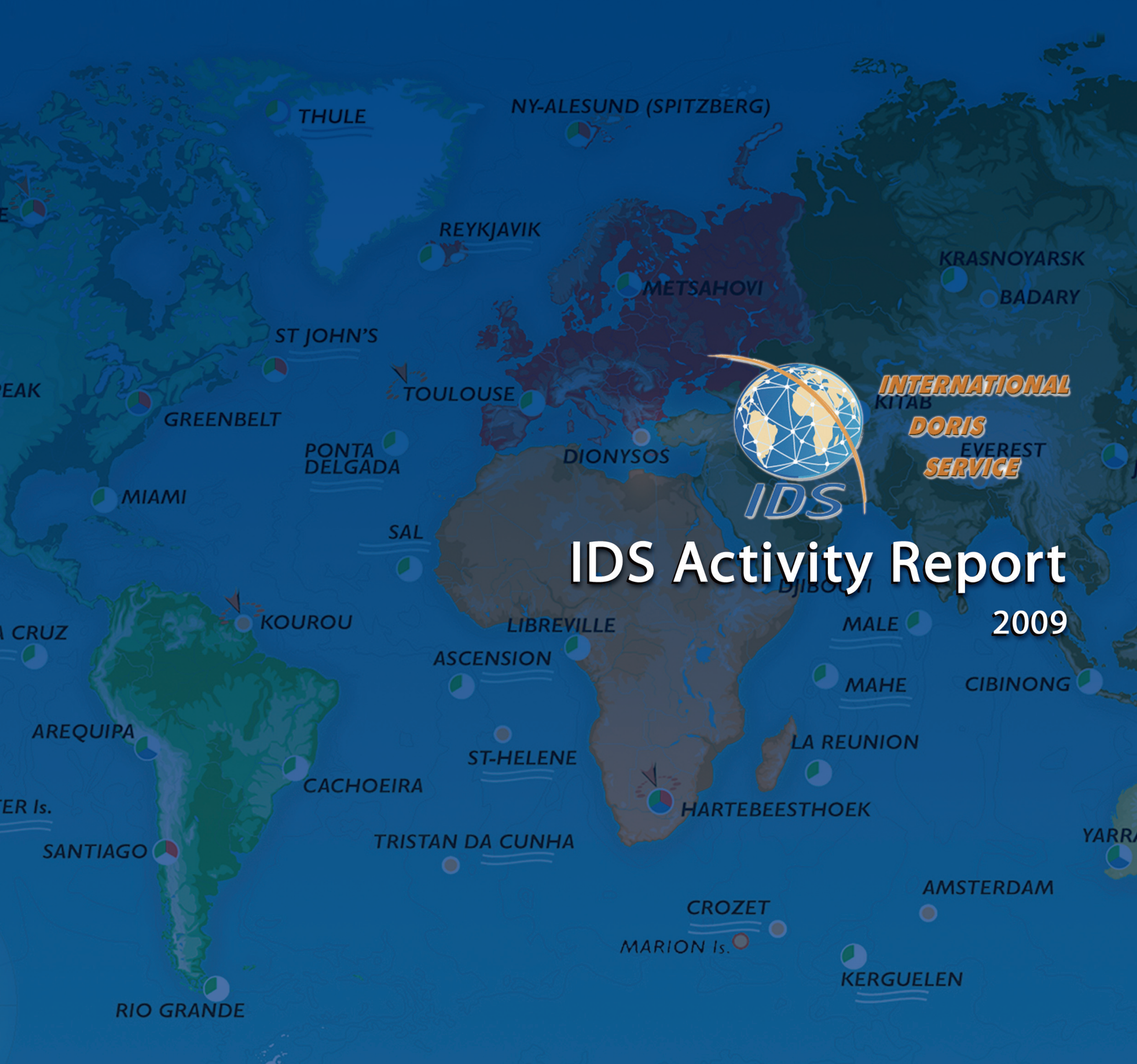

INTERNATIONAL DORIS SERVICE

IDS

IDS Activity Report

2009

INSTITUT GEOGRAPHIQUE NATIONAL

CENTRE NATIONAL D'ÉTUDES SPATIALES

The International DORIS Service

January 2009 – December 2009 report

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In this volume, the International DORIS Service documents the work of the IDS components between January 2009 and December 2009. The individual reports were contributed by IDS groups in the international geodetic community who make up the permanent components of IDS.

The IDS 2009 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 entire contents of this Report also appear on the IDS web site at

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

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IDS AND DORIS QUICK REFERENCE LIST

1. IDS web site

http://ids-doris.org/

2. Contacts

Central Bureau IDS.central.bureau@cls.fr
Governing Board IDS.governing.board@cls.fr

3. Data Centers

CDDIS: ftp://cddis.gsfc.nasa.gov/doris/
IGN: ftp://doris.ensg.ign.fr/pub/doris/

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@cls.fr

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@cls.fr

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:

> Tavernier, G.; Fagard, H.; Feissel-Vernier, M.; Le Bail, K.; Lemoine, F.; Noll, C.; Noomen, R.; Ries, J.C.; Soudarin, L.; Valette, J.J.; Willis, P. 2006. The International DORIS Service: genesis and early achievements, in DORIS Special Issue, P. Willis (Ed.), JOURNAL OF GEODESY 80(8-11):403-417, DOI: 10.1007/s00190-006-0082-4

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

http://ids-doris.org/report/publications/peer-reviewed_journals.html

9. Overview of the satellite constellation

http://www.aviso.oceanobs.com/en/doris/doris-applications/index.html

10. Sitelogs

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. 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, 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 scheduled for launch in late 2009. 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 Geophysical Union

EOP

Earth Orientation Parameters

Envisat

ENVIronmental SATellite Earth-observing satellite (ESA)

ESA

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

ESA, esa

acronyms for *ESA/ESOC* Analysis Center, Germany

ESOC

European Space Operation 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

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

geoc

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

eop

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

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

(HaiYang means 'ocean' in chinese) is a marine remote sensing satellite series planned by China in 2009 (HY-2A, 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 Géographique National, French National Geographical Institute

IGN, ign

acronyms for *IGN/IPGP* Analysis Center, France

IGS

International GNSS Service.

ILRS

International Laser Ranging System

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, 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
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).

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

sp1, sp3
Specific format for orbit ephemeris files

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

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

STPSAT1
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.

TBC
To Be Confirmed.

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 Troposphere 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 50 groups from 35 different countries participate in the IDS at various levels, including 43 groups hosting DORIS stations in 32 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.

2 DORIS SPECIAL ISSUE IN THE ADVANCES IN SPACE RESEARCH

Pascale Willis (1)

(1) IGN/IPGP, France

Following a first DORIS Special Issue in Journal of Geodesy (Springer-Verlag) in 2006 (J. Geod., 80(8-11), 406-664, 2006), a second DORIS Special Issue was started in 2009 in Advances in Space Research (Elsevier), with Pascal Willis as Guest Editor.

As previously done, a broad Call for Participation was issued through the DORISmails and also published in several Newsletters (IAG, COSPAR, …). The submission deadline was November 1, 2009. In total, 26 manuscripts were submitted through the EES Elsevier Web (http://ees.elsevier.com/asr) site before the deadline, demonstrating a large international participation. When considering only the first author of each paper, 15 institutions were involved within 7 different countries.

All major aspects of the International DORIS Service activities and of the DORIS system development were covered: IDS organization and facilities, new DORIS system development and results, characterization of clock performances using other systems (T2L2), precise orbit determination for altimetric missions and other satellites, recent improvement in data analysis from all IDS Analysis Centers (eg. atmospheric drag, detection of effects over the South Atlantic Anomaly (SAA)), comparison and combination of DORIS results in view of ITRF2008, geodetic applications for station coordinates and velocities, geocenter motion monitoring, scale of the terrestrial reference frame, atmospheric sciences (detection of ionospheric scintillation, tropospheric results for climatology), characterization of signal and noise in DORIS data measurements as well as in time series of station positions.

As last time, all manuscripts are sent to 3 independent reviewers. Papers are accepted individually and are available with a DOI on the Journal Web site (http://www.sciencedirect.com/science/journal/02731177) a few days after acceptance. Accepted papers are advertised through the DORISmails on a weekly basis and posted on the IDS Web page for peer-reviewed articles. At the end of January 2010, already 7 manuscripts were accepted. Publication of the DORIS Special Issue is expected during summer 2010.

3 HISTORY

The DORIS system was designed and developed by CNES, the French space agency, in partnership with the space geodesy research institute GRGS and France’s mapping and survey agency IGN 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 IDS. 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 (Collecte Localisation Satellites) and IGN (Institut Géographique National).

The IDS Central Bureau and the Analysis Coordinator initiated several Analysis Campaigns.

Several meetings were organized as part of the DORIS Pilot Experiment:

- DORIS Days were held in Toulouse in May 2000 (see programme and contributions in http://ids-doris.org/report/meeting-presentations/doris-days-2000.html),
- an IDS Workshop was held in Biarritz in June 2002 (see programme and contributions in http://ids-doris.org/report/meeting-presentations/ids-workshop-2002.html),
- an IDS Analysis Workshop was held in Marne La Vallée in February 2003 (see programme and contributions in http://ids-doris.org/report/meeting-presentations/ids-workshop-2003.html).

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.

- An IDS plenary meeting was held in Paris in May 2004 (see programme and contributions in http://ids-doris.org/report/meeting-presentations/ids-plenary-meeting-2004.html).

- An IDS workshop was held in Venice in March 2006 (see http://ids-doris.org/report/meeting-presentations/ids-workshop-2006.html).

- Two DORIS Analysis Working Group Meetings were held in Paris in March and June 2008 (see http://ids-doris.org/report/meeting-presentations/ids-awg-03-2008.html and http://ids-doris.org/report/meeting-presentations/ids-awg-06-2008.html).

- An IDS workshop was held in Nice in November 2008 (see http://ids-doris.org/report/meeting-presentations/ids-workshop-2008.html).

- A DORIS analysis Working Group Meetings was held in Paris in March 2009 (see http://ids-doris.org/report/meeting-presentations/ids-awg-03-2009.html)

In 2010, a Workshop will be organized on October 21-22, in Lisbon, Portugal (see http://ids-doris.org/report/meeting-presentations/ids-workshop-2010.html), and a DORIS Analysis Working Group Meeting will be held at ESOC in Darmstadt, Germany, on April 20-21.

4 ORGANIZATION

The IDS organization is very similar to the other IAG Services (IGS: International GNSS Service, ILRS: International Laser Ranging Service, IVS: International VLBI Service) and IUGG Service such as IERS (International Earth rotation and Reference system Service).

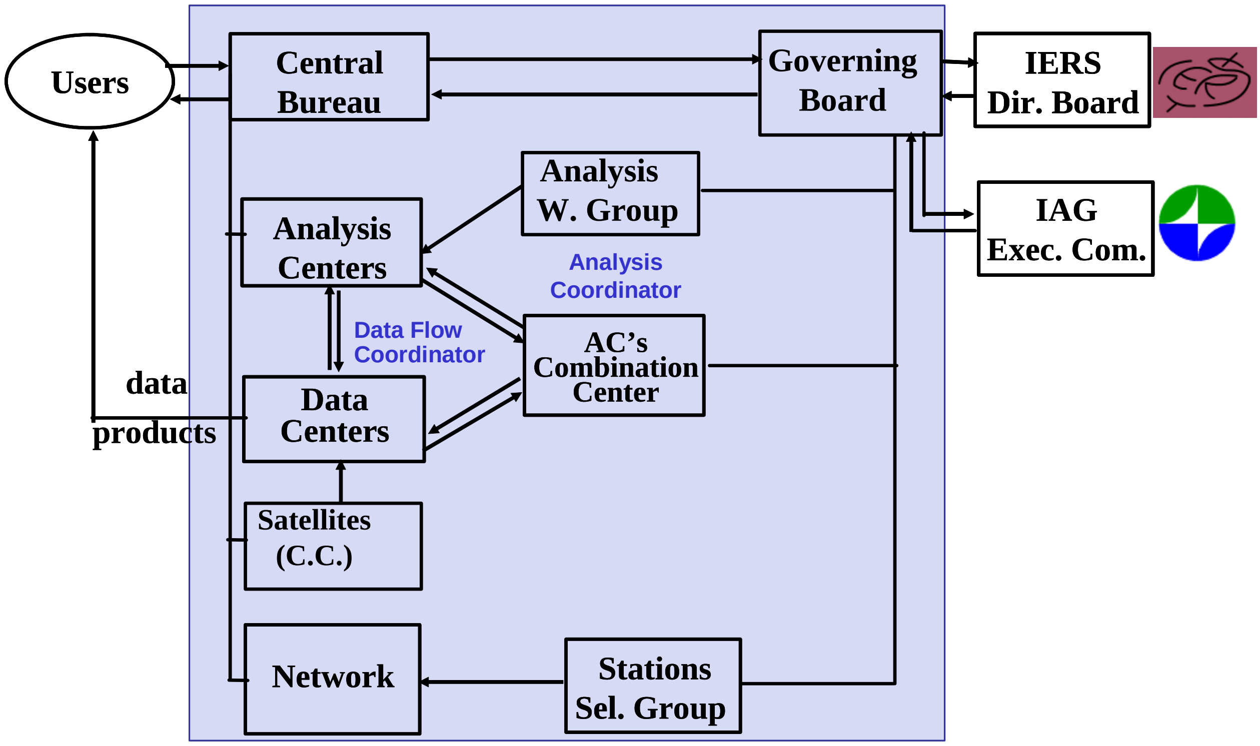

Figure 1 IDS organization

Governing Board

In December 2008, a new Governing board was elected or appointed. In 2009, the Governing Board was:

- Pascal Ferrage CNES Member at large
- Hervé Fagard IGN Network representative
- Frank Lemoine NASA GSFC Analysis Coordinator
- Chopo Ma NASA GSFC IERS Representative
- Carey Noll NASA GSFC Data Flow Coordinator
- Michiel Otten ESOC IAG Representative
- John Ries U. Texas CSR Member at large
- Laurent Soudarin CLS Director of the Central Bureau
- Pascal Willis IGN/IPGP Analysis Center Representative (Chairperson)

Following the change of activities of Herve Fagard in Fall 2009, Bruno Garayt (IGN) was elected in December 2009 as Network representative and will serve until 2012 in the IDS Governing Board as all other members. The IDS Governing Board, Central Bureau and members express their warm thanks to Hervé Fagard for his long-term and efficient involvement in the IDS and in the DORIS network installation and maintenance activity.

Central Bureau

In 2009, the Central Bureau is organized as follows :

- Laurent Soudarin CLS (Director)
- Hervé Fagard IGN
- Pascale Ferrage CNES
- Jean-Jacques Valette CLS
- Pascal Willis IGN/IPGP

For the reasons presented above, Hervé Fagard was replaced by Jérôme Saunier in December 2009.

5 THE CENTRAL BUREAU: IDS INFORMATION SYSTEM

Laurent Soudarin (1), Pascale Ferrage (2)

(1) CLS, France
(2) CNES, France

Within the IDS, the information is provided through the web and ftp sites of the Central Bureau, the Data Centers and the Analysis Coordination, depending on the kind of information. Day-to-day news of general interest are given to the DORIS community by the DORISmail service. The DORISreport and the IDS Analysis Forum mailing lists are devoted to the Analysts. This report gives an overview of the IDS information system.

5.1 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:

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

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

5.2 WEB AND FTP SITES

5.2.1 IDS WEB SITE

address : http://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” provides access to the general description of the system, and gives information about the system events 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 index, FAQs, news on the IDS and news on DORIS.

The main headings of the “IDS” section include:

- 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.
- 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: IDS documents, DORIS bibliography, meeting presentations, DORIS-related peer-reviewed publications, mail system messages, citation rules, etc.
- Contacts and links: information about related activities

The headings of the “DORIS” section include:

- 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 performance plots from the CNES MOE and POE processings

The headings of the "Analysis Coordination" section are:

- Documents: about the DORIS system's components (space segment, ground segment, stations, observations), the models used for the analysis, the products and their availability.
- 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.

This site is maintained by the Central Bureau.

In 2009, the URL of the website was changed to ids-doris.org. Users were asked to use the new address (DORISmail 624). The old address (ids.cls.fr) will be closed in the course of 2010.

Pages of the website are regularly updated:

- news about the DORIS system and IDS activities are distributed through the mailing lists are summarized on the website (http://ids-doris.org/ids-news.html, http://ids-doris.org/doris-news.html) ;
- the list of publications related to DORIS is frequently updated with the new articles published in international peer-reviewed journals (http://ids-doris.org/report/publications/peer-reviewed-journals.html) ;
- presentations in international assemblies and DORIS or IDS-related meetings are made available on the website (http://ids-doris.org/report/meeting-presentations.html) ;
- direct links are given to access new documents and/or new versions put online on the ftp site (http://ids-doris.org/analysis-documents.html) ;
- system events occurring on the DORIS system elements (with the exception of the station network) are regularly added (http://ids-doris.org/system/doris-system-events.html) ;
- etc ...

In 2009, the website was enriched with a new page dedicated to the Combination (http://ids-doris.org/analysis-combination.html). It gives the results of the combination for the IDS contribution to ITRF2008.

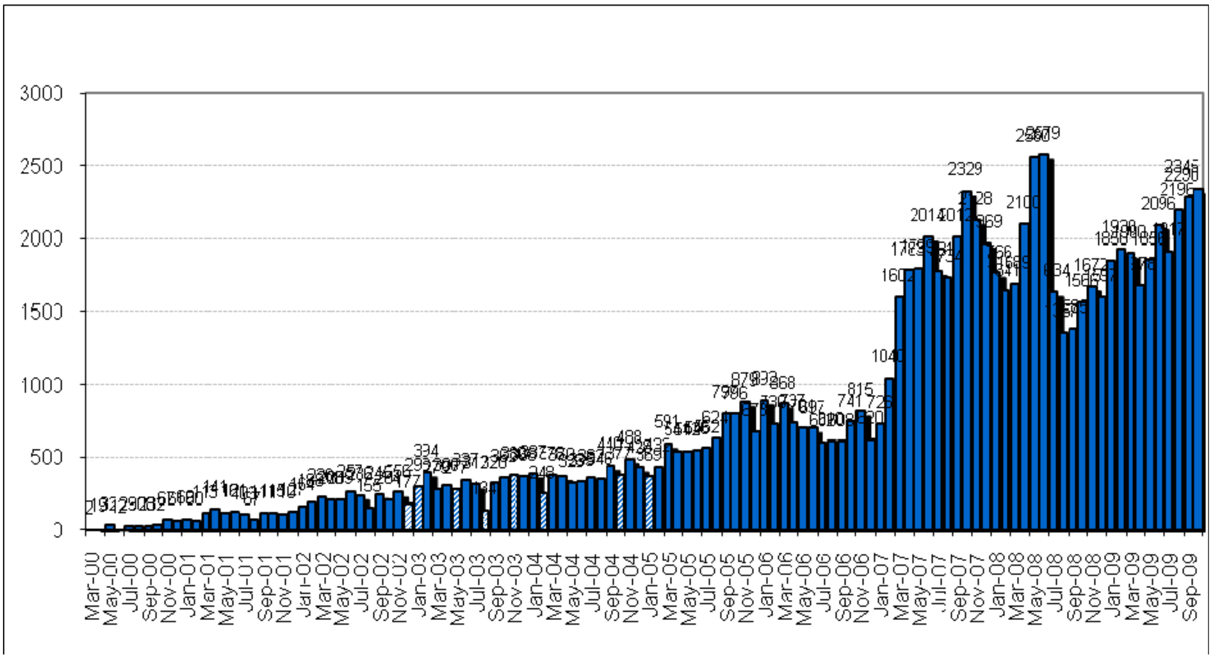

Figure 2 IDS web site number of access per month (CNES and CLS excluded)

5.2.2 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 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 DORISmails 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, instrument modelling, corrective model of DORIS/Jason-1 USO frequency, plots of the POE statistics of all the stations for each satellite;
- the stations: 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.

This 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/

By early 2010, the IDS ftp site was moved to a new server. All IDS documents are now available at ftp.ids-doris.org/pub/ids/, using the same directory structure as was found on the old IDS ftp server, ftp.cls.fr/pub/ids.

In 2009, new versions of the macromodels were put online for SPOT-2, SPOT-3, SPOT-5 and Envisat, as well as a updated version of the SAA/Jason-1 corrective model taken into account the new orbit of the satellite. The format of the satellite maneuver files provided by SSALTO for the DORIS community was changed in November 2009 to include the burn values (see the description at: ftp://ftp.ids-doris.org/pub/ids/satellites/man.readme)

5.2.3 DORIS WEB SITE

Address: http://www.aviso.oceanobs.com/en/doris/index.html

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

In 2009, the pages "DORIS Missions" and "DORIS applications" were updated with the status of current and future DORIS missions.

5.2.4 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/doris_summary.html

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/

5.3 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, IDS.analysis.forum or DORISstations. The mails of these four lists are all archived on the mailing list server of CLS. Back-up archives of the text files are also available on the Central Bureau ftp server for the DORISmails and the DORISreports.

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

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

5.3.1 DORISMAIL

e-mail: dorismail@cls.fr

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

5.3.2 DORISREPORT

e-mail : dorisreport@cls.fr

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).

The messages are 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.

5.3.3 DORIS STATIONS

e-mail : dorisstations@cls.fr

A new mailing list dorisstations@cls.fr has been opened to distribute information about station events (data gap, positioning discontinuities).

5.3.4 IDS ANALYSIS FORUM

e-mail : ids.analysis.forum@cls.fr

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.

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://ids-doris.org/analysis-discussion.html

5.3.5 OTHER MAILING LISTS

ids.central.bureau: list of the Central Bureau

ids.governing.board: list of the Governing Board ids.cbgb: common list for the Central Bureau and the Governing Board. This list is private.

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

5.4 HELP TO THE USERS

e-mail : IDS.central.bureau@cls.fr

The contact point for general information and inquiries is the IDS Central Bureau. The CB will evaluate the request and determine the appropriate contact to obtain an answer to the user's query.

5.5 FUTURE PLAN

In 2010, a new version of IDS web site will be available. It is developed with a CMS (Content Management System) which offers new capabilities for the management and the update of the site. The structure will stay the same but the system address will change. New pages will be included. A station event page will be implemented, in the same way as the system event list. It will be automatically updated from the DORISstations mails. MOE statistics will be revised. Global statistics per satellite will be included on the POE statistics page. A gallery of pictures will be set-up too.

The Central Bureau will continue to support any new ACs as they join the service.

6 THE NETWORK

Jérôme Saunier (1)

(1) IGN, France

6.1 REORGANIZATION

Hervé Fagard, IGN, responsible for the DORIS network deployment and maintenance, has changed positions in early July 2009. Therefore, the DORIS network activities, under jointly responsibility of CNES and IGN, had to be reorganized.

The international networks and services activities at IGN, including the IGS (global data center, reference frame coordination), IDS (data center and analysis), and the DORIS network activities merged into a single unit (International Networks and Services) within the Geodetic and Leveling department.

The DORIS installation and maintenance service (SIMB) is now split in two units placed respectively under the responsibility of IGN and CNES:

SIRS (Service d'Installation et de Renovation des Stations) at IGN is in charge of all the relevant geodetic activities for the maintenance of the DORIS network (new and existing stations), including frequency clearance applications, negotiation with host agencies, agreements drafting… all that in close collaboration with the CNES.

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

The persons responsible for the DORIS network are:

- Jérôme SAUNIER, IGN, SIRS manager
- Nathalie MALECHAUX, CNES, SMOS manager
- Bruno GARAYT, IGN, head of International Networks and Services unit

We want to thank Hervé for handing over to us very conscientiously and efficiently.

6.2 EVOLUTION AND DEVELOPMENT

The network is continually renovated. In order to improve stability and standardize configurations, we decided on three antenna support types:

- 2 m tower anchored on concrete pad
- 50 cm tower on load-bearing wall
- Stainless steel interface made to measure on concrete pillar

(see illustrations on this page)

Depending on the conditions at the site, the best support type and location are chosen to reduce signal obstructions and to minimize multipath effects.

Several site visits took place in 2009 in order to improve station installations and meet system requirements.

At the same time, the beacon model 3.0 deployment continued to increase network availability.

In 2009 the following stations were visited:

- Tamanrasset : reconnaissance with a view to install a new IDS station.
- Cibinong : support change and mapping of the horizon visibility mask
- Crozet : antenna and support changes and mapping of the visibility mask.
- Kuerguelen : the antenna verticality was adjusted
- La Réunion : station control
- Rikitea : tower replacement following car accident involving the DORIS monument.
- Amsterdam : support change.
- Riyadh : reconnaissance and signature of agreement to host DORIS station.
- Grasse : co-location survey.
- Krasnoyarsk : major renovation (beacon 3.0, antenna moving, support change…).
- Fairbanks : reconnaissance with a view to relocate the station to Cold Bay (Aleutian Islands chain, south-west of Kodiak).
- Papeete : the station has been upgraded in November 2009 becoming the fourth Master Beacon of the Network.

It is worth noting that Badary station, off for over 4 years (delays in customs clearance…), restarted in September!

With regard to the new IDS station in Riyadh, its installation is postponed until next year because of frequency license issues.

For now on, all beacons in the network are third generation, except Socorro (1st generation), Fairbanks and Futuna (2nd generation).

In order to facilitate maintenance and reduce time to re-activate the beacons in event of an interruption, a remote management system began to be implemented. Iridium receivers will be deployed in 2010 at twenty stations.

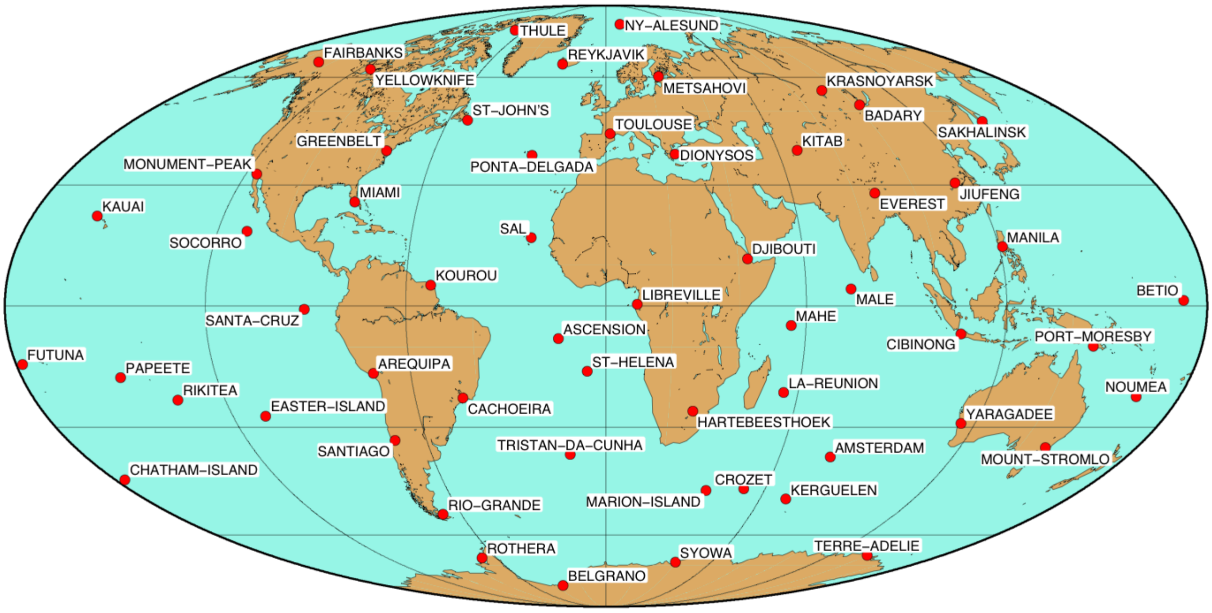

Figure 3 The permanent network - 57 stations

7 THE SATELLITES WITH DORIS RECEIVERS

Pascale Ferrage (1)

(1) 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 has been functioning more than 18 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) which was launched in 1998 and featured the first DORIS real time on-board orbit determination (DIODE).

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 Oscillators (USO) (*Willis et al. 2004*), however a correction model has recently been developed (*J.M. Lemoine and Capdeville 2006*),

- 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

- 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 provided better frequency stability while crossing SAA, and a better quality of MOE and Jason-2 useful for beacon location determination.

(3) New DIODE Navigation software (improved accuracy)

- 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.

- 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 is dedicated to global ionospheric measurements, we expect feedback soon.

Figure 4 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.

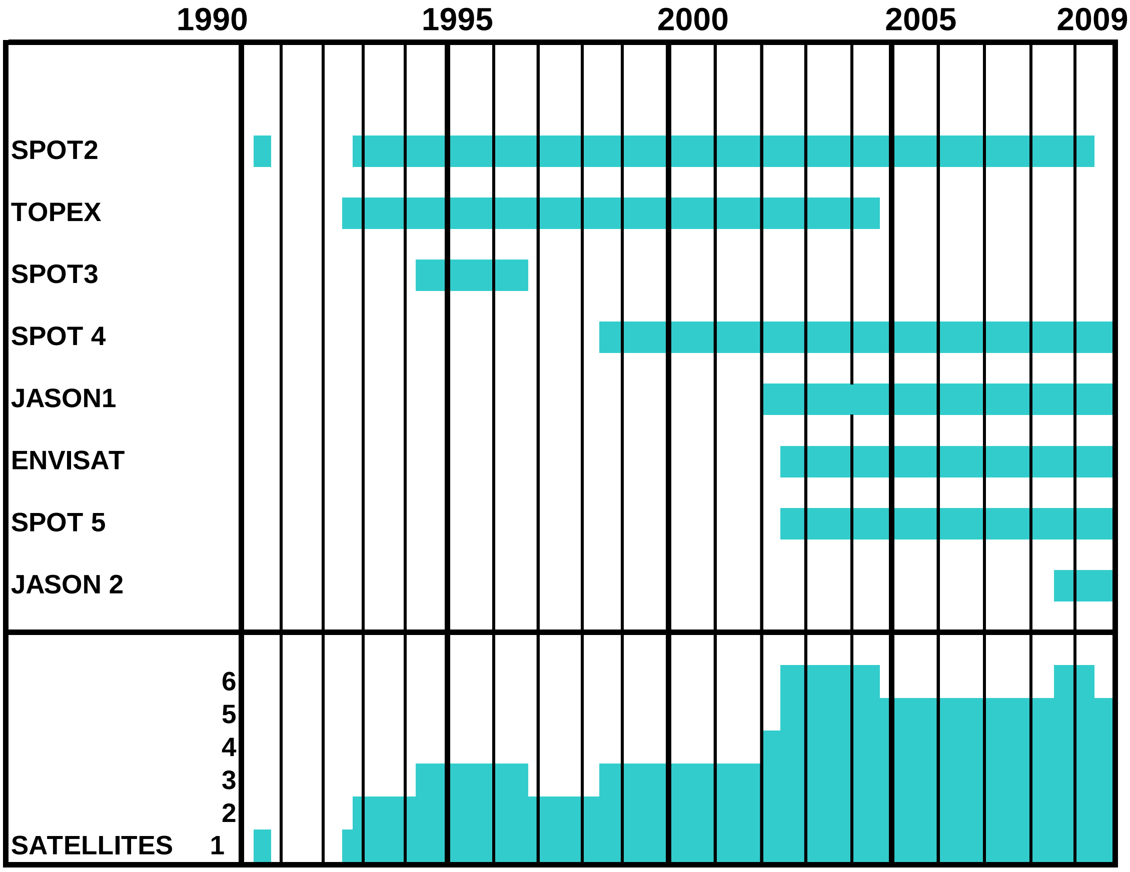

Figure 4 DORIS observations available at the IDS Data Centers (December 2009).

The future DORIS mission are numerous and should guarantee a constellation with at least 4 DORIS contributor satellites through 2020:

CryoSat-2 (ESA): is to be launched on February 25, 2010

HY2A (China Academy of Space), is to be launched in June 2011

SARAL/ALTIKA (ISRO/CNES) is to be launched from mid 2011

SENTINEL3A (GMES/ESA) is planned for November 2012

Jason3 (EUMETSAT/NOAA/CNES) is foreseen from mid 2013

SWOT is foreseen for 2017

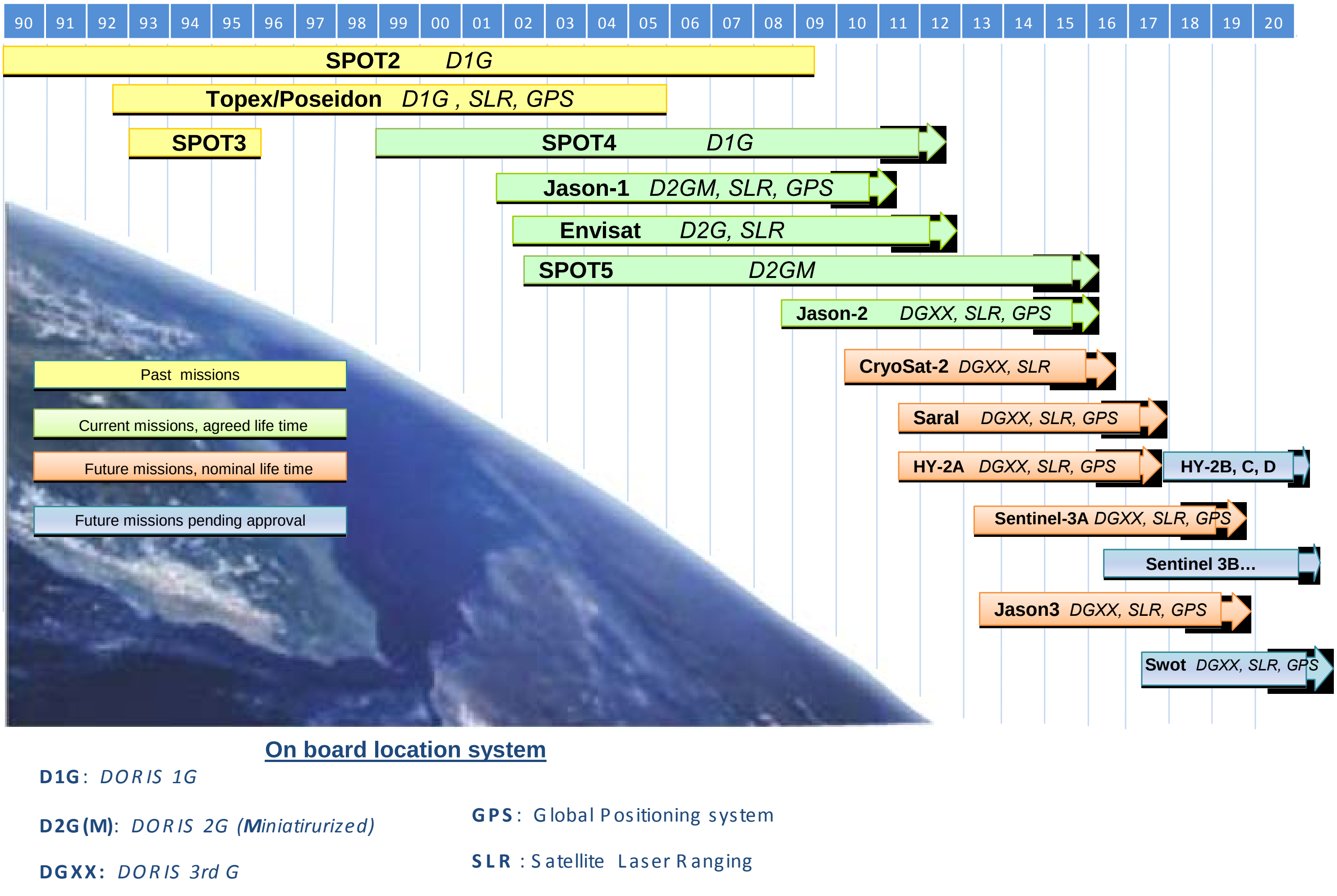

Figure 5 Current and future DORIS constellation (December 2009).

8 IDS DATA FLOW COORDINATION (2006-2008)

Carey Noll (1)

(1) NASA/GSFC, USA

8.1 INTRODUCTION

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

- Crustal Dynamics Data Information System (CDDIS), NASA GSFC, Greenbelt, MD USA
- Institut Géographique National (IGN), Saint Mandé France

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

8.2 FLOW OF IDS DATA AND PRODUCTS

The flow of data, products, and information within the IDS is analogous to what is used in the other IAG geometric services (IGS, ILRS, IVS) and is shown in Figure 8. IDS data and products are transmitted from their source to the IDS data centers. DORIS data are downloaded from the satellite at the DORIS control and processing center, SSALTO 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.

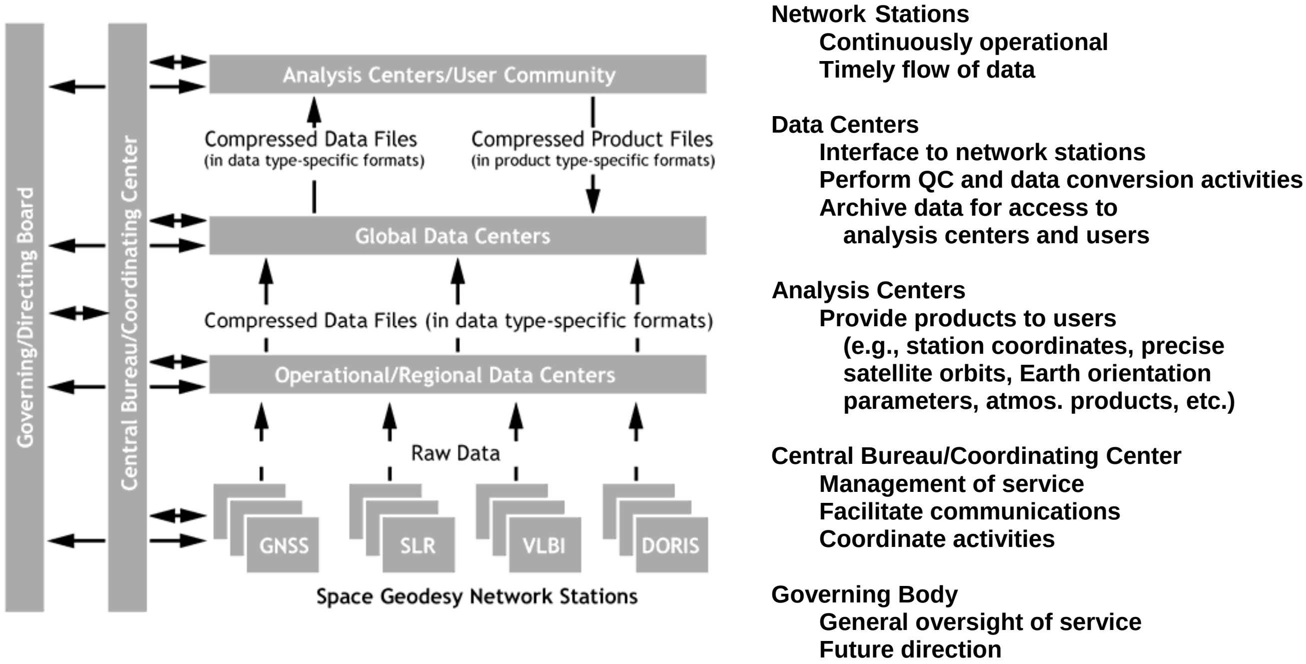

Figure 6 Routine flow of data and information for the IAG Geodetic Services

The IDS data centers use a common structure for directories and filenames that was implemented in January 2003. This structure is shown in 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 CB ftp site) with general information and data and product documentation (maintained by the IDS Central Bureau)

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

Directory	File Name	Description
Data Directories		
/doris/data/*sss*	*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/orbits/	*ccc*/*cccsssVV*.*bXXDDD*.*eYYEEE*.sp1.*LLL*.Z	Satellite orbits in SP1 format from analysis center *ccc*, satellite *sss*, solution version *VV*, start date year *XX* and day *DDD*, end date year *YY* and day *EEE*, and file version number *LLL*
/doris/products/SINEX_global/	*cccWWuVV*.snx.Z	Global SINEX solutions of station coordinates for analysis center *ccc*, year *WW*, content *u* (d=DORIS, c=multi-technique), and solution version *VV*
/doris/products/SINEX_series/	*ccc*/*cccYYDDDtuVV*.snx.Z	Time series SINEX solutions for analysis center *ccc*, starting on year *YY* and day of year *DDD*, type *t* (m=monthly, w=weekly, d=daily) solution, content *u* (d=DORIS, c=multi-technique), and solution version *VV*

/doris/products/stcd/	*cccWWtu*/*cccWWtuVV*.stcd.*aaaa*.Z	Station coordinate time series SINEX solutions for analysis center *ccc*, for year *WW*, type *t* (m=monthly, w=weekly, d=daily), content *u* (d=DORIS, c=multi-technique), solution version *VV*, for station *aaaa*
/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/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/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*.
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 1 Main Directories for IDS Data, Products, and General Information

8.3 DORIS DATA

SSALTO deposits DORIS data at 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. The IDS data centers currently archive DORIS data from five operational satellites (SPOT-4, -5, Jason-1, -2, and Envisat); data from future missions (e.g., CryoSat-2, SARAL, etc.) will also be archived within the IDS. Historic data from SPOT-2 (operations ceased in July 2009), SPOT-3, 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 2. 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). The DORIS data files are 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 of data availability after the last observation day satellite specific are shown in Table 3. The delay in data delivery to the data centers (in days by satellite) is shown in **Figure 7**.

Satellite	Time Span
TOPEX/Poseidon	25-Sep-1992 through 01-Nov-2004
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 present
SPOT-5	11-Jun-2002 through present
Jason-1	15-Jan-2002 through present
Jason-2	12-Jul-2008 through present
Envisat	13-Jun-2002 through present

Table 2 DORIS Data Holdings

Satellite	Number of Days/ Multi-Day File	Average Latency (Days)
Envisat	6	22
Jason-1	10	21
Jason-2	10	33
SPOT-2, -4, -5	9	24

Table 3 DORIS Data File Information

DORIS phase data from Jason-2 are also available in RINEX (Receiver Independent Exchange Format), version 3.0. The Jason-2 satellite includes the newer, next generation DORIS instrumentation capable of generating these 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.

8.4 DORIS PRODUCTS

IDS analysis centers use similar procedures by uploading 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, *M. Ottens.*
- Geoscience Australia (gau), *R. Govind.*
- Geodetic Observatory Pecny (gop), Czech Republic, *P. Stepanek.*
- NASA Goddard Space Flight Center (gsc) USA, *F. Lemoine, K. Le Bail*.
- Institut Géographique National/JPL (ign) France, *P. Willis.*
- INASAN (ina) Russia, *S. Kuzin.*
- CNES/CLS (lca) France, *L. Soudarin, J.M. Lemoine*.
- CNES/SOD (sod) France, *J.P. Berthias.*
- SSALTO (ssa) France*, L. Cerri*.

IDS products are archived by type of solution and analysis center. The types and sources of products available through the IDS data centers in 2005-2009 are shown in Table 4. This table also includes a list of products under evaluation from several DORIS analysis centers.

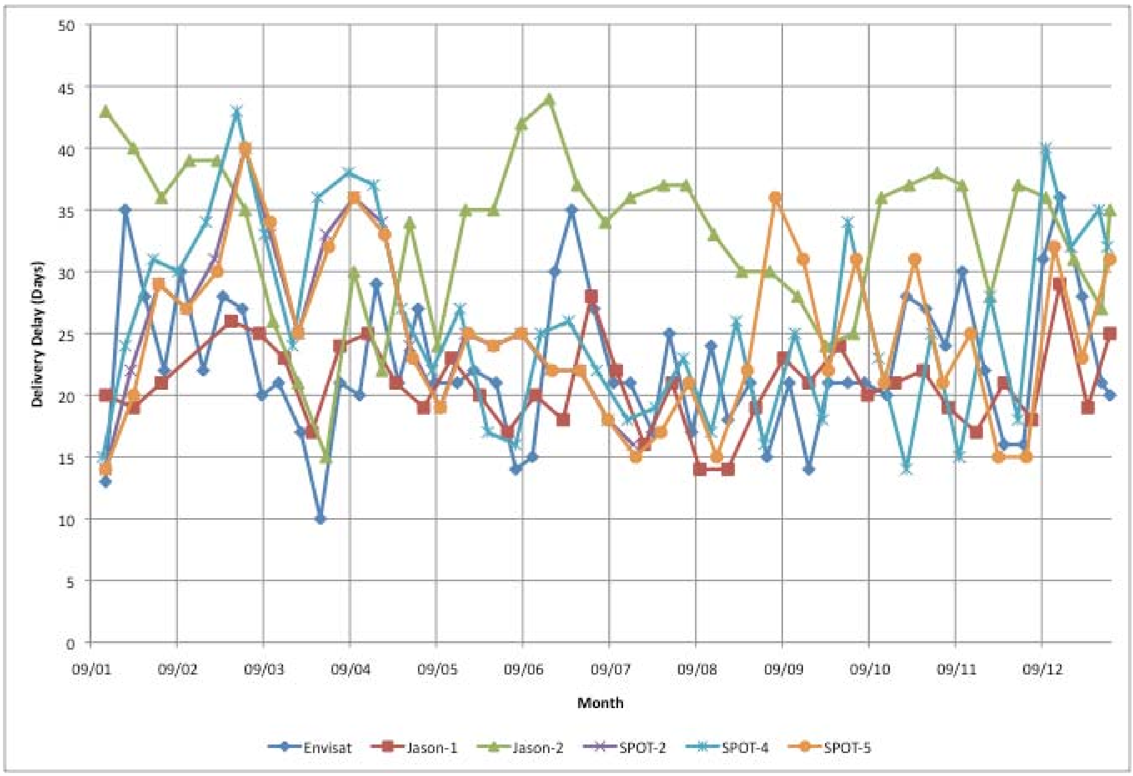

Figure 7. Latency in delivery of DORIS data to the CDDIS (all satellites, 01-12/2009)

Type of Product	ACs/Products								
	ESA	GAU	GOP	GSC	IGN	INA	LCA	SSA	SOD
Time series of SINEX solutions (*SINEX_series*)	X(W)	X(W)	X(W)	X(W)	X(W,M)	X(W,M)	X(W,M)	X(W,M)	X(W)
Global SINEX solutions (*SINEX_global*)					X		X		
Geocenter time series (*geoc*)					X	X	X		
Orbits/satellite (*orbits*)				X	X(F)	X(F)	X		
Ionosphere products/satellite (*iono*)								X	
Time series of EOP (*eop*)					X	X			
Time series of station coordinates (*stcd*)					X(W)	X(W)	X(W,M)	X(W)	

Notes: W=weekly solution
M=monthly solution
F=future contribution

Table 4 IDS Product Types and Contributing Analysis Centers

8.5 SUPPLEMENTARY DORIS INFORMATION

An additional directory structure was installed at the IDS data centers containing ancillary information for DORIS data and product usage. Files of Jason-1 and -2 satellite attitude information were made available through the IDS data centers starting in 2009. 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 for processing DORIS data to determine satellite orientation and attitude information.

8.6 FUTURE PLANS

The IDS data centers will investigate procedures to regularly compare holdings of data and products to ensure that the archives are truly identical.

9 IDS DATA CENTERS

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

(1) NASA/GSFC, USA

(2) IGN, France

9.1 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. Approximately 40 Gbytes of CDDIS disk space is devoted to the archive of DORIS data, products, and information.

During 2009, over 250 international groups downloaded over 155 Gbytes (225K files) of DORIS data, products, and information from the CDDIS.

9.1.1 CDDIS FUTURE PLANS

The CDDIS plans to be operational in a new distributed server environment by spring 2010. The structure of the DORIS data and product archive will remain unchanged in this new system configuration.

9.1.2 CDDIS CONTACT

Carey Noll, CDDIS Manager	Email:	Carey.Noll@nasa.gov
NASA GSFC	Voice:	301-614-6542
Code 690.1	Fax:	301-614-6015
Greenbelt, MD 20771	ftp:	ftp://cddis.gsfc.nasa.gov/pub/doris
USA	WWW:	http://cddis.gsfc.nasa.gov

9.2 IGN DORIS DATA CENTER

The IGN data center is handled by the geodetic and leveling department (SGN).

During 2009, the international network and services operational activities at IGN have been reorganized. The IGS (global data center, Reference Frame coordination from 01/2010), the IDS (data center and analysis, operated by IGN/SGN in cooperation with P. Willis IGN/DT), the ITRF database management and local tie survey, the EUREF analysis center and the IGN DORIS network activities have been merged into a unit (International Network and Services) within the Geodetic and Levelling department. This reorganization was motivated by the search of a valuable synergy between different techniques at different level of activities (from the network to the analysis) which might be benefit to the IDS, working closely with the analysis centers, and contributing to the setting up by the international community of a geodetic infrastructure of the highest quality in terms of monuments, observation conditions, enhanced with the collocation with other fundamental geodetic space techniques as required by AIG for GGOS.

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

- a FTP deposit server for data and analysis centers uploads, requiring special authentication
- a free FTP anonymous access to the observations and products
- fully 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

The IGN plans to develop a dedicated web site for the IDS Data Center.

9.2.1 CONTACT

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10 IDS ANALYSIS COORDINATION

Frank Lemoine (1)

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10.1 ANALYSIS COORDINATION

The DORIS Community was extremely active in 2009. The primary activities in 2009 concerned the management of the submissions from seven analysis centers, and for the first time the construction of a technique-level combination for DORIS in view of an ITRF submission. In the course of 2009, three technique-level combinations were created, each incorporating a further level of improvements. The final activities concerned the preparation of a journal paper, submitted to the DORIS special issue of the Adv. In Space Research (Valette et al., 2010).

Seven analysis centers made submissions including including the European Space Operations Center (ESOC), the Geodetic Observatory Pecny (GOP), Geoscience Australia (GAU), the NASA Goddard Space Flight Center (GSC), the Institut Géographique National (IGN), the Institute of Astronomy, Russian Academy of Sciences (INASAN, named as INA), and CNES/CLS (named as LCA). The ACs used five different software packages to process the DORIS data from 1992 to 2008, including NAPEOS (ESA), Bernese (GOP), GEODYN (GAU, GSC), GIPSY/OASIS (IGN, INASAN), and GINS (LCA). The various submissions, and description of the IDS combinations are presented in Table 5.

The first IDS combination (IDS-1) was prepared in February 2009, based on complete submissions from 1993-2009 from three analysis centers (LCA, IGN & ESA), and partial submissions from the other analysis centers. The results were discussed at the DORIS Analysis Working Group (AWG) meeting in Paris, France (23-24 March 2009). At the meeting Yaya and Valette (2009) showed that the horizontal residuals (east and north) of the IDS-1 combination peaked at 20-35 mm in late 2001 and early 2002 and that this was attributed to the high solar flux in that period of time. For example the filtered F10.7 flux (averaged over 3 solar rotations) ranged between 200 and 250 s.f.u. for nearly the entire time period. Following the presentation of these results, LCA and GSC modified their solutions. LCA adjusted drag coefficients once per 2 hrs for 2001-2002, and GSC adjusted drag coefficients once per two hrs for the entire time series and once per hr for the period 2001-2002. We note that ESA already

adjusted drag coefficients frequently (once per 2.4 hrs), IGN once/hr for the low satellites. GOP adjusted stochastic parameters every 15 minutes along-track – so that this quasi-reduced dynamic approach naturally accommodated the increased drag in 2001-2002. We note that Gobinddass et al. (2010) discuss the issue of drag modeling for the DORIS satellites and its impact on the ITRF computations, and recommended to the AWG the adjustment of more frequent cd's.

A second issue concerned the scale offset in the station coordinate solutions for the GAU and GSC solutions, which was traced to the use of the Goad and Goodman (1974) troposphere mapping function in the GEODYN. The GSC and GAU reprocessed their entire submissions with the Niell (1996) mapping function, and this removed the bias in the scale of their coordinate solutions with respect to ITRF2005 and the other solutions.

Another important issue in the construction of the combination was the criteria for how the combination should be designed. A preliminary solution (IDS-2) was constructed with the updated solutions from LCA, GAU and GSC. In addition, the processing for the GOP solution was extended back to 1993. Based on an analysis of the frequency content of the geocenter and scale time series for the individual solutions, a separate geocenter was estimated for LCA and INA, whereas the other AC solutions contributed to the geocenter of the combination. The concern was to avoid large amplitude oscillations in the geocenter at either the annual period or at the period of 118-days (beta-prime period for TOPEX/Poseidon) since they are signatures of solar radiation pressure mismodeling (Gobinddass et al., 2009). The amplitude of the signals at the annual and 118-day periods is shown in Table 6 the individual AC series and the IDS combinations. The final IDS combination (IDS-3) was a simultaneous solution for both stations and Earth orientation parameters, as described in Table 5.

Iterations	**SINEX Series & changes**	**Combination Strategy**			**Ref. System Problem**
		Parameters	**Weigths**	**EOPs**	
IDS-1 (Feb. 09)	gopwd31 (1998.0-2008.0) inawd06 (1997.0-2008.8) lcawd20 (1993.0-2008.8) ignwd08 (1993.0-2008.8) gauwd06 (2003.0-2008.8) esawd03 (1993-2008.0) gscwd06 (2003.0-2008.8)	Geocenter : IC(3) for all series Scale: GAU, GSC estimated, IC for others	var. factor no deweight	no	Scale offset (gau & gsc) high residuals : 2002 solar activity
IDS-2 (May. 09)	Same as above except : gopwd31 : 1993.0-2008.0 lcawd21 : 1h Cd(1) (2002) gauwd08 : new tropo, 2h Cd(1) ,2002.0-2003.0 gscwd10 : new tropo +2h Cd(1) , 1992.8-2003.0	Geocenter : INA, LCA estimated IC for other series Scale : IC for others	deweight: INA : 4 LCA : 2	no	Periodic signals TZ: 118 & 365 days Scale : 365 days
IDS-3 (Aug., 09)	Same as above except: lcawd24 : SRP(2) fixed	Geocenter and Scale: GAU, INA, LCA estimated IC for ESA, GOP, GSC, IGN (validation step for all series with 5 cm residual threshold)	var. factor no deweight	yes	-

Cd(1) Satellite drag coefficient estimated per 2 hours or higher during Sept.2001-March2002
SRP(2) Solar Radiation Pressure fixed to avoid TZ periodic signals a 118 days and 1 year
IC(3) Internal Constraints

Table 5 Summary of IDS Combinations

Weekly series	TZ (mm)		Scale (mm)
	118 days	1 year	1 year
Per AC solutions			
esawd03(IDS-3)	2.4	7.0	0.9
gauwd08 (IDS-3)	3.4	13.0	0.2
gopwd31 (IDS-3)	3.0	5.1	1.2
gscwd10 (IDS-3)	4.9	5.7	0.2
ignwd08 (IDS-3)	3.2	3.0	1.1
inawd06 (IDS-3)	11.0	28.3	2.5
lcawd21 (IDS-2)	11.7	12.7	1.8
lcawd24 (IDS-3)	12.2	7.9	1.7
IDS solutions			
IDS-1	5.7	9.6	1.4
IDS-2	2.7	5.0	1.1
IDS-3	2.7	3.6	0.9

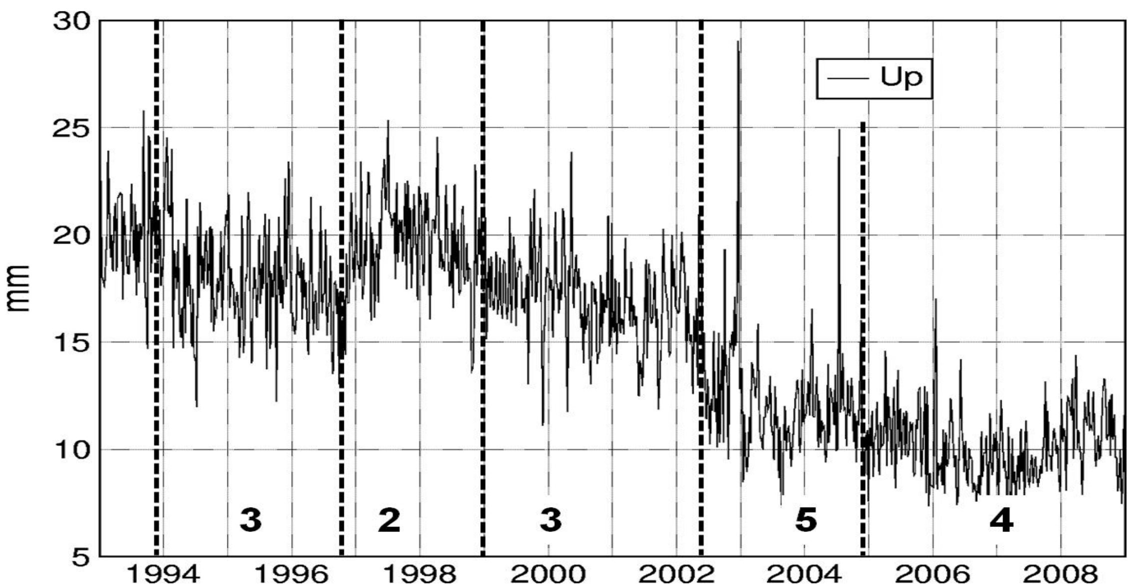
Table 6 Observed amplitudes at 118 and 365 days in the DORIS-derived geocenter and scale time series

In terms of coordination of models, all the analysis centers that contributed to the IDS Combinations, have achieved a remarkable level of convergence in the force and measurement modeling. This convergence was the result of discussions during the Analysis Working Group (AWG) meetings in 2008 and 2009. Orbit comparisons between analysis centers, all the ACs were shown to be at the same level of precision orbit determination performance. For example the majority of the ACs adopted the DPOD2005 set of station coordinates, which was built on ITRF2005, and developed to support Precision Orbit Determination for DORIS satellites (Willis et al., 2009). All the ACs used GRACE-derived gravity models; five of the seven analysis centers applied atmospheric gravity derived from NCEP or ECMWF; six of the seven analysis centers used modern ocean tide models such as FES2004 (Lyard et al., 2006) or the GOT models (Ray, 1999, updated). Given the importance of radiation pressure and drag modeling on the scale behavior of the coordinate solutions, in the future we must continue to strive to improve the radiation modeling for the DORIS satellites, and mitigate the effects of atmospheric drag-induced error on station coordinate and EOP solutions. This may be accomplished by encouraging all the ACs to adopt tuned macromodels, or to implement specialized radiation pressure models for all the satellites (e.g. Ziebart et al., 2005; Sibthorpe, 2006), if such models can be made available. For the modeling and parameterization of atmospheric drag, it would be desirable to adjust drags more frequently for the low satellites, and to experiment with new atmospheric drag models, for example those derived using GRACE and CHAMP accelerometer data, or other models such as Bowman et al. (2008), that rely on solar flux proxies other than the standard F10.7.

The modeling of the troposphere for DORIS remains an issue and is directly related to the scale of the DORIS solutions. In terms of troposphere modeling though, only three of the ACs used the IERS-recommended GMF mapping function (Boehm et al., 2006), and two of the ACs used the older Niell

(1996) mapping function.   It is important to encourage all the ACs to upgrade to the most modern mapping functions, and to experiment with other improvements, such as for example, the application of tropospheric gradients rather than the estimation of a single troposphere scaling parameter.

We summarize the positioning quality of the IDS-3 combination in **Figure 8**. We show the WRMS for the weekly solutions in the Vertical, East, and North components, with the vertical bars on the charts designating the number of satellites available. It is notable that the vertical component shows a consistent improvement from 1993 to 2002 even prior to the availability of five or more satellites in 2002. This is doubtless the consequence of the campaign to improve the station stability as described in Fagard (2006). The East component has the higher WRMS, and this is not surprising given the predominantly polar-orbit geometry of the DORIS satellite constellation. We see an increase in the North component of the WRMS in late 2001-early 2002, even though the number of satellites has remained the same. The 81-day F10.7 flux peaks at nearly the same time, indicating that drag modeling on the low satellites deleteriously affects the positioning, especially in this time period. It is highly encouraging that the north WRMS is below 1 cm after 2004. In the future we may look forward to the contributions of new satellites such as Jason-2 which will improve the observing geometry, and due to their seven channel DGXX receiver, make available much more data for DORIS positioning and EOP determination.



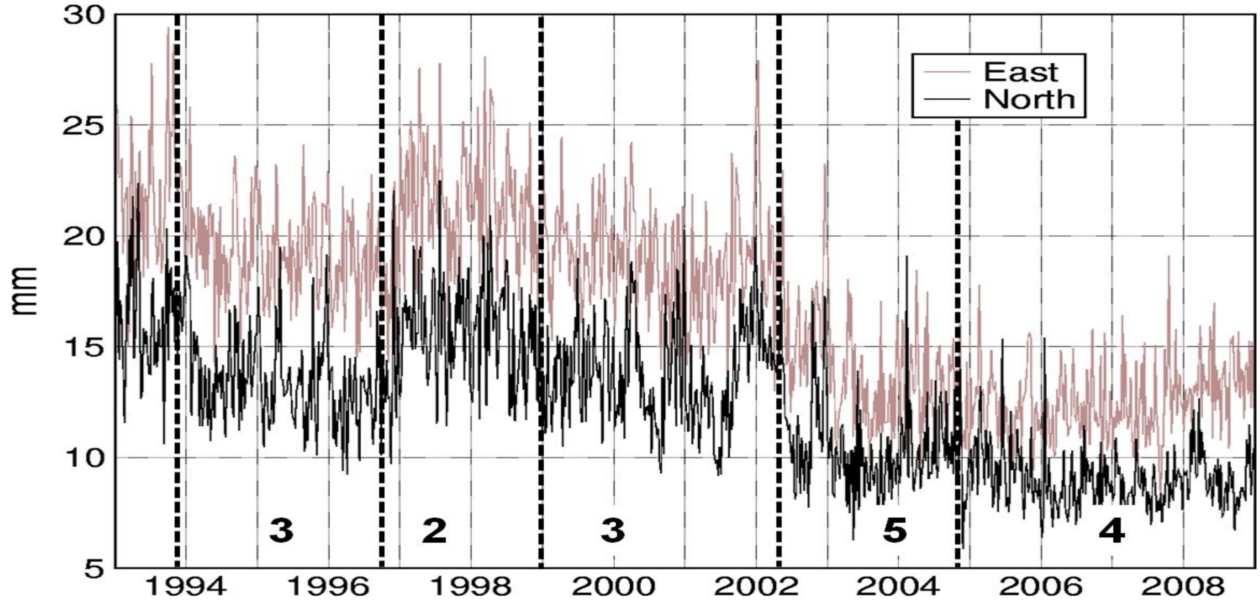


Figure 8 WRMS of the stations residuals for the IDS-3 weekly solutions. The dashed vertical bars delineate the periods when the number of DORIS satellites available for positioning changed (shown in bold at the bottom of each figure). From Valette et al. (2010).

In addition to the modeling improvements that have been already described, the IDS faces the challenge of working towards becoming an operational service, which will mean more of the analysis centers will need to become make routine deliveries of SINEX solutions. Other important challenges include adding new satellites such as Jason-2, Cryosat-2, and Saral/Altika to the routine weekly analyses, and validating their contributions to DORIS station coordinate and EOP solutions.

11 IDS COMBINATION

Jean Jacques Valette (1)

(1) CLS, France

11.1 ACTIVITY SUMMARY

IDS combination activities in 2009 were mainly focused on the validation of long term SINEX series and on the IDS contribution to ITRF2008. For the first time, the International DORIS Service has computed a technique level combination. An article was submitted to the DORIS special issue of the Advances in Space Research and a poster was presented at the AGU Fall meeting in San Francisco.

11.2 AC CONTRIBUTION

In 2009, eight Analysis Centers participated in the DORIS measurements processing as listed in Table 7. A new candidate Analysis Center in 2009 was the University of Newcastle. Five different software packages are used including NAPEOS (ESA), Bernese (GOP), GEODYN (GAU, GSC), GIPSY/OASIS (IGN, INASAN), and GINS (LCA). This software diversity is a real progress for the IDS and was then particularly helpful for the preparation of a contribution to the IERS call for participation for the realization of ITRF2008 that was published in November 2008.

Analysis Center	**Acronym**	**Contact & Reference**
ESA/ESOC, Germany European Space Agency/European Space Operations Center	ESA	Michiel Otten
Geoscience Australia (with support of GSFC)	GAU	Ramesh Govind
Geodetic Observatory Pecny, Czech Republic	GOP	Petr Stepanek
GSFC, USA NASA Goddard Space Flight Center	GSC	Frank Lemoine Karine Le Bail Douglas Chinn
IGN/IPGP, France Institut Géographique National (IGN)/ Institut de Physique du Globe de Paris (IPGP)	IGN	Pascal Willis Marie-Line Gobinddass
Institute of Astronomy, Russian Academy of Sciences (INASAN), Russia	INA	Sergey Kuzin Surya Tatevian,

CNES/CLS, France (LEGOS/CLS before 2008) Centre National d'Etudes Spatiales (CNES) Laboratoire d'Etudes en Géophysique Océanographie Spatiale (LEGOS) Collecte Localisation Satellites (CLS)	LCA	Laurent Soudarin Jean-Michel Lemoine Hugues Capdeville
University of Newcastle, UK	NCL	Philip Moore

Table 7 IDS analysis centers

11.3 CONTRIBUTION TO ITRF2008

All of the above listed ACs except the University of Newcastle participated to the IDS combination process for ITRF2008. The data from six DORIS satellites, TOPEX/Poseidon, SPOT-2, SPOT-3, SPOT-4, SPOT-5, and Envisat were processed and all the analysis centers produced weekly SINEX files in either variance-covariance or normal equation format. The CATREF software from LAREG/IGN was used to process the weekly AC solutions. Three iterations of an IDS global weekly combination were completed. Between them, the ACs improved their analysis strategies and submitted updated solutions to eliminate troposphere-derived biases in the solution scale or to reduce drag-related degradations in station positioning, and to refine the estimation strategy to improve the combination geocenter solution. The successive strategies are detailed in Table 5 *Summary of IDS Combinations* of the previous chapter (analysis coordination). One can appreciate the high level of involvement and reactivity of the ACs.

11.4 COMBINATION RESULTS

The final IDS-3 combination includes solutions for 130 DORIS stations on 67 different sites of which 35 have occupations over 16 years (1993.0-2009.0). The IDS-3 combination has an internal position consistency (WRMS) that is 15-20 mm before 2002 and 8 to 10 mm after 2002, when four or five satellites contribute to the weekly solutions (see Figure 9). The comparison to ITRF2005 in station position shows an agreement of 6 to 8 mm RMS in horizontal and 10.3 in height. The RMS comparison to ITRF2005 in station velocity is at 1.8 mm/yr on the East component, to 1.2 mm/yr in North component and 1.6 mm/yr in height.

The EOP from the IDS-3 combination was compared with the IERS EOP05C04 series and the RMS agreement was 0.24 mas and 0.35 mas for the X and Y components of polar motion.

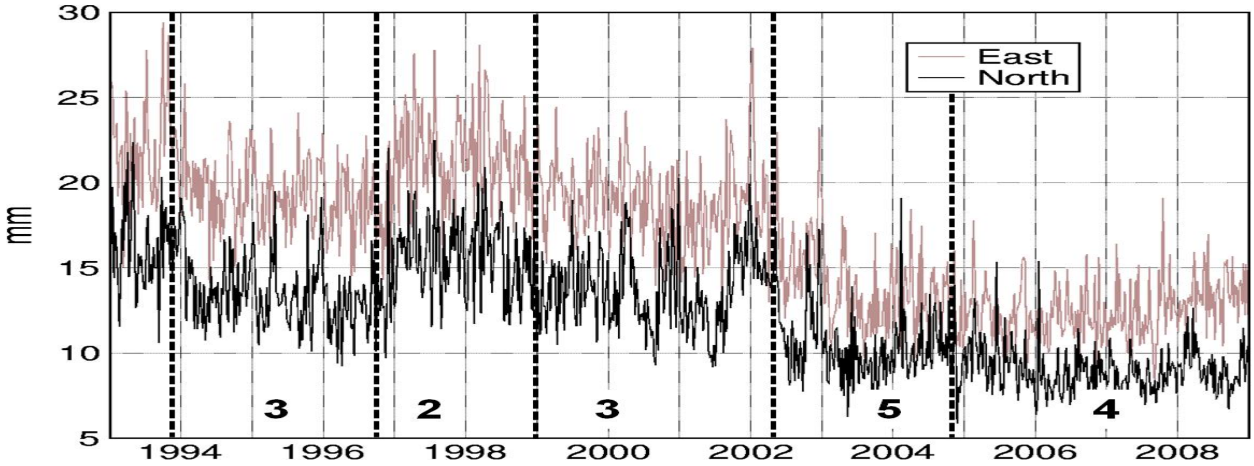


Figure 9 IDS-3 weekly solutions WRMS of the stations residuals, figures indicate the number of satellites used

The IDS-3 weekly combined series is also compared to ITRF2005 for external validation in the following figure. TX and TY remains most of the time within 20 mm in both cases. After 2002, when there are more than 3 satellites contributing, a clear annual signal is visible with an amplitude of 3.0 mm for TX and 3.5 mm for TY. The translation parameter TZ has a more complex behaviour. Its amplitude variation range reaches ± 80 mm and several signals are apparent. A periodic signal dominates at about 10-11 years with a 21 mm amplitude. One can note that a TZ maximum is seen around 2002 which coincides with the solar maximum activity in the 11 years solar cycle. At 1 year but also at 2 years period, a 6 mm signal exists and may be explained by geophysical signals affecting the Earth reference geocenter TZ component, as well as residual solar radiation pressure mismodelling in the constituent AC solutions for IDS-3.

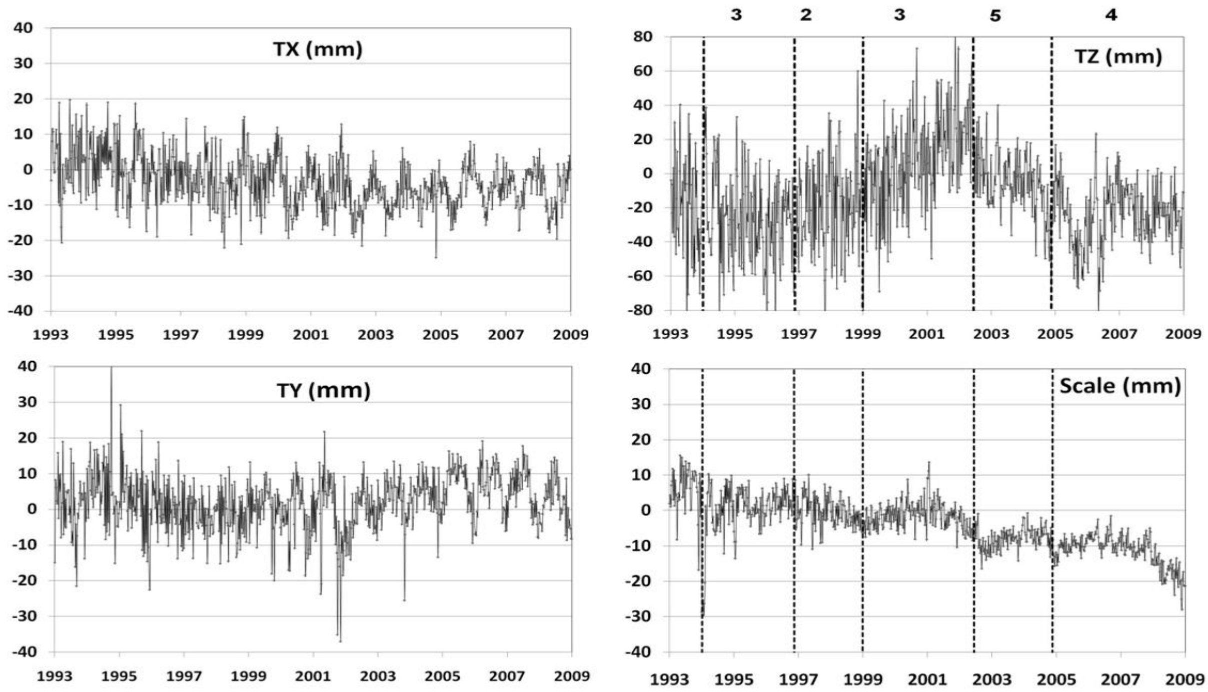


Figure 10 IDS-3 translation and scale parameters with respect to ITRF2005, dashes correspond to satellite constellation changes, upper right figures to the number of satellites

11.5 FUTURE COMBINATIONS

The current IDS processing did not include data from Jason-2, launched in June 2008. Jason-2 offers the possibility of significant improvements due to its seven channel DORIS receiver. The new receiver, which also provides dual-frequency phase observations comparable to GPS signals, on any given day delivers as much data as all the other DORIS satellites combined .

Having successfully faced the challenge of developing a group technique contribution to ITRF2008, the IDS now looks forward to developing routine delivery of weekly combinations of SINEX solutions from its member analysis centers. The experience developed in the course of the development of IDS-3 will be an invaluable precursor to the initiation of this operational service.

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

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12.1 INTRODUCTION.

After the successful delivery of the European Space Operation Centre solution (esawd03) for the ITRF-2008 combination the Navigation Support Office IDS activities in 2009 have been mainly focused on improving and harmonizing our orbit processing strategy.

These improvements have resulted in the generation of fully consistent orbit solutions for the DORIS equipped missions Envisat, Jason-1 and Jason-2 covering for all three spacecrafts the entire mission duration up to 2010.

Further a new ESA IDS solution (esawd04) is being prepared that will incorporate these improvements and harmonization efforts and will also include the Jason-2 mission.

12.2 HOMOGENEOUS ORBIT PROCESSING AND ESAWD04

ESOC has been harmonizing its orbit processing strategy for all the different Altimeter missions: ERS-1/2, Envisat, Jason-1 and Jason-2. This means that beside all the missions are processed with the same software package (NAPEOS) also the standards and models that are used for these missions are as identical as possible. The main difference between the various missions comes now only from the various tracking techniques used by these missions, e.g., SLR+Altimetry for ERS-1/2 versus SLR+DORIS+GPS for Jason-1/2.

The figure below shows the orbit difference between the latest ESOC orbit solution for Envisat and the CNES precise orbit solution (POE).

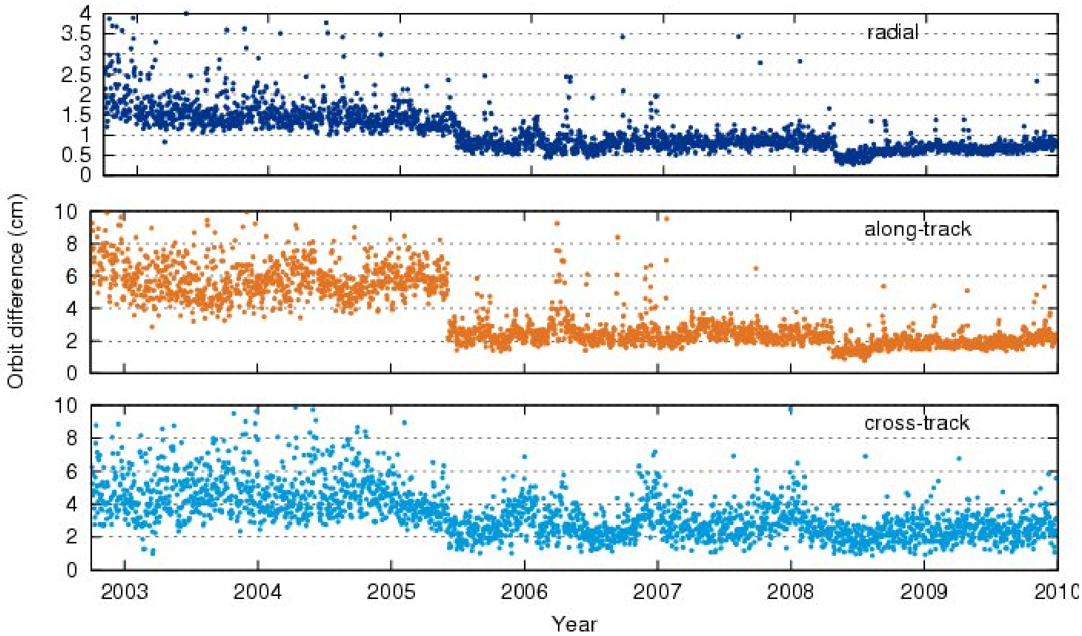

Figure 11 Daily rms orbit differences (in cm) for Envisat between ESOC and CNES**.**

The jumps in the orbit difference (mid 2005 and early 2008) are caused by changes in the CNES orbit processing strategy i.e., in mid 2005 CNES switched from the GDR-A processing standards to the GDR-B standards and in early 2008 switched to the GDR-C standards for the Envisat processing.

These new standards are also adopted for the new IDS processing strategy at the Navigation Support Office. A new release of the ESOC time series esawd04 is expected to be available in the second quarter of 2010. Besides a more homogenous processing strategy for all the missions this new time series will also include the Jason-2 missions which was only included for testing purposes in the ITRF-2008 submission. This new solution will cover the period from 1993 until the end of 2009.

Future Activities

The Navigation Support Office plans for 2010 to start routine weekly SINEX delivery to the IDS. Further, we will keep on supporting the various satellite altimeter missions with a DORIS instrument onboard by providing precise orbit solutions for validation and calibration purposes. In addition, we are participating in the combination on the observation level campaign and as part of these activities will generate a new ESA IDS test solution which will use not only the DORIS data but also will make use of all available SLR data for the missions that are equipped with and SLR retroreflector.

13 REPORT OF THE GEOSCIENCE AUSTRALIA ANALYSIS CENTER (GAU)

Ramesh GOVIND (1)

(1) Geoscience Australia . Canberra, Australia.

The main DORIS analysis activity during 2009 was to contribute to the IDS submission to the construction of the ITRF2008 and to contribute to the Advances in Space Research DORIS Special Issue. In this regard, the tasks undertaken were DORIS data processing between 2000 and mid-2009, a comparison of orbit trajectories with the Goddard Space Center (GSFC) DORIS Analysis Center, a comparison of DORIS determined orbit trajectories with SLR data and the provision of multi-satellite SINEX solutions to the IDS Combination Center. The IDS analysis activity at Geoscience Australia is undertaken in collaboration with the GSFC Analysis Center. Two papers were prepared for publication in the Advances in Space Research, DORIS Special Issue. Govind et al. (2010a) has been accepted for publication. At the time of writing, Govind et al. (2010b) was submitted and reviewed and is being revised.

The Geoscience Australia contribution to ITRF2008 comprised SINEX solutions from four satellites; SPOT-2, SPOT-4, SPOT-5 and Envisat. The Envisat SLR data has also been processed and reported in Govind et al. (2010b). Jason-2 DORIS and SLR data for the period 2008-07-13 to 2009-12-31 has been processed for orbit determination.

The computation standards, using the NASA/GSFC Geodyn0812/Solve software suite are described in ftp://ftp.ids-doris.org/pub/ids/combinations/ITRF2008-IDS/gauwd06.snx.dsc, ftp://ftp.ids-doris.org/pub/ids/centers/Template_analysis_summary.xls and Govind et al., 2010a and 2010b.

The weekly SINEX submissions to the IDS Combination Center continue as a routine analysis activity.

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

Petr Stepanek (1)

(1). Geodesy Observatory Pecný, Research Institute of Geodesy, Czech Republic

14.1 INTRODUCTION

The DORIS data processing at Geodetic Observatory Pecný (GOP) follows a GPS-like approach, realized by specifically modified version of Bernese GPS software. The analytical center had started to operate at the testing level; its status has changed at the end of 2007, when GOP was accepted as an operational analysis center. Criteria of the acceptance, prepared by IDS, were based on a comparison of the estimated network from 2005 and the estimated orbits in January 2005. These GOP testing results showed comparable precision of the GOP and the other analysis centers. The delivery of the official products (SINEX files) started in 2008, when the period 1998.0-2008.0 was processed.

14.2 BASIC PROCESSING AND ANALYSIS

Standard DORIS data processing at GOP is based on a computation of weekly free-network solutions. The data from periods 1993.0-1998.0 and 2008.0-2009.0 were processed in 2009 and corresponding SINEX files were delivered to IDS. SINEX files related to the weekly solutions from the entire period from1993.0 to 2009.0 are now available at the IDS data centers, and also include detailed description of the solution options, parameters and models. Analysis of the estimated parameters show that the WRMS is comparable with the solutions of other Analysis centers (ACs). Translation parameters between GOP solutions and ITRF2005 are varying with higher amplitude then these derived from the other ACs. Values of Z-translation are highly correlated with 10-year cycle of solar activity and the behavior of X- and Y-translation includes a main semiannual signal, in contrary to other ACs where the annual signal dominates. A most probable source of these results is the currently used reduced-dynamical orbit model, where a modeling of the non-conservative forces is substituted by estimation of empirical and stochastic parameters. Scale values doesn't show any significant overall bias or slope in the respect of ITRF2005. A bias around -6.5 mm after 2004.9 is more or less observed by all the analysis centers.

14.3 EXPERIMENTS, ANALYSES, INVESTIGATIONS

Analyses of the change of the scale at the end of 2004 lead to somewhat surprising conclusions. Terminaton of the TOPEX/Poseidon (T/P) DORIS data production is probably not the source of the problem. Tests proved that the scale derived from the multi-satellite solutions with and without inclusion of T/P data does not differ significantly in the period before the T/P data termination. The Envisat scale decreased by about 11-13 mm during onboard software update, which does not entirely describe the effect of approximately 10 mm change of the combined scale at the end of 2004. The rest is probably caused by the SPOT-5 scale change around GPS weeks 1298-1299 (from November 21st to December 4th), which has currently not a simple explanation.

The Zenith Troposphere Delay (ZTD) estimated from single-satellite DORIS solutions was compared with the ZTD estimated from GNSS observations (IGS PPP product) . The basic motivation was to check the quality of DORIS troposphere estimates and find a possible inter-technique bias. The data used for the ZTD comparisons span the period 2006.0-2009.0. The mean DORIS-GNSS ZTD bias ranges from -2 to -6 mm, depending on the satellite and the analysis strategy. A significant offset was found between ZTD from ascending and descending satellite passes, which was identified for all the stations of the network. The average offset between ascending and descending ZTD DORIS-GNSS differences is with about 11 mm (max. around 20 mm for some of equatorial stations) similar.

The comparisons of the ZTD values estimated with DORIS and with GNSS show large differences between SPOT-5 and the other satellites for three stations in South America. A high bias was found also in the station height, derived from single-satellite solutions, where differences between SPOT-5 solution and average of the other single-satellite solutions reach the following values: Cachoeira Paulista (-105 mm), Arequipa (-42 mm) and Santiago (-36 mm). The horizontal positions show the largest absolute differences (from 30 to 45 mm) for the same stations and in addition for Kourou. The location of the most biased stations offers the hypothesis, that the SPOT-5 observations are significantly affected by the South Atlantic Anomaly (SAA). The possible SAA effect is much smaller than in the case of Jason-1 and does not lead to overall degradation of the SPOT-5 data, but the effect on the estimation of the above mentioned stations coordinates is far from being negligible.

The post fit observation residuals were analyzed with respect to the length of the observation count interval. A simple empirical model of observation error was applied, when the observation noise was explained as a combination of two uncorrelated processes, where the first one σ_1 is independent (Phase measurement noise), the second one σ_2 dependent on the measurement count interval (Oscillator noise). The standard deviation σ_2 is between 0.225 and 0.257 mm/s for all satellites except SPOT-2, where σ_2 is 0.307 mm/s. On the other hand, σ_1 is lower in the case of SPOT-2 (2.57 mm) than for the other satellites (2.77-3.16 mm). The noise component that is independent on the length of the count interval dominates the observations of all satellites except SPOT-2. Note that the difference in the length between the chained and unchained SPOT-2 observations is only 1 second (3 seconds for the other satellites) and the numerical stability of the two noise components computation is then reduced.

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

Frank G. Lemoine(1), Nikita P. Zelensky(2), Karine Le Bail(1), Douglas S. Chinn(2)

(1) GSFC/NASA, USA

(2) SGT/NASA, USA

15.1 GSC ANALYSIS CENTER CONTRIBUTION TO ITRF2008

The GSC analysis center completed the processing of all DORIS data from November 1992 to December 2008, and prepared SINEX files for submission as part of the IDS Combination for ITRF2008. The GSC SINEX submissions are in normal equation format. Submissions were prepared for 839 weeks and were based on DORIS data from SPOT-2, TOPEX/Poseidon, SPOT-3, SPOT-4, SPOT-5 and Envisat. The submissions included a preliminary SINEX series, gscwd08, submitted in February 2009, and a final series, gscwd10, submitted in April 2009. The data were processed with the NASA GSFC Orbit Determination and Geodetic Parameter estimation program (GEODYN), and the companion program, SOLVE, to combine and reduce the weekly normal equations. The orbit modeling is described in Le Bail et al. (2010), and is based on the most up-to-date modeling standards. These include the EIGEN-GL04S1 gravity model, the GOT4.7 ocean tide model used for the dynamical ocean tide modeling as well as the geometric corrections for ocean loading (Ray, 1999; Ray et al., 2009), IERS standards for the precession, nutation, and solid Earth tides (McCarthy and Petit, 2003). The orbit parameterization included approximately seven day arcs, except for weeks when there were orbital maneuvers or data loses. As described in Le Bail et al. (2010), extensive efforts were made to refine the radiation pressure modeling for the DORIS satellites, specifically Envisat, and the SPOT satellites. For Envisat we use the University College London, radiation pressure model (Ziebart et al., 2005; Sibthorpe, 2006) which reduces the median along-track accelerations from 3.75 x 10^{-9} m/s^2 to 0.99 x 10^{-9} m/s^2 when the UCL model is used in lieu of a macromodel. For the SPOT satellites, a radiation reflectivity coefficient was adjusted and/or individual macromodel parameters were adjusted.

As part of the validation of the ITRF2008 delivery, we have evaluated orbit overlaps, both internally for DORIS-only orbits, and externally between DORIS-only and SLR & DORIS orbits for TOPEX/Poseidon and Envisat. For the SPOT and Envisat satellites we obtain median RMS orbit overlaps of 0.8-0.9 cm radially, 1.7 to 2.3 cm along-track, and 2.1 to 3.4 cm cross-track (these are based on orbit overlaps that extend for 12 hrs at the endpoints of the arcs, where there are no data gaps or maneuvers). The RMS orbit differences between the DORIS-only and SLR+DORIS orbits for Envisat are 1.1 cm radially, 6.4 cm along-track, and 3.7 cm cross-track. These orbit differences are characterized by mean along-track offsets due to time biases in the Envisat DORIS system of ± 5-10 μsecs. For TOPEX/Poseidon, the DORIS-only vs SLR/DORIS RMS orbit differences are 1.0 cm radially, 5.4 cm along-track and 6.8 cm cross-track.

The analysis of the gscwd08 series showed a significant offset in the scale of the derived coordinates compared to the other DORIS SINEX series and with respect to ITRF2005. This was traced eventually to the application of the Goad and Goodman (1974) mapping function in the reduction of the DORIS data. When a more modern mapping function was applied (c.f. Niell, 1996), the offset w.r.t. ITRF2005 and the other DORIS solutions was eliminated (Valette et al., 2010; Le Bail et al., 2010). The more recent GMF troposphere mapping function (Boehm et al., 2006) was not available in GEODYN in time to perform the DORIS data reductions for ITRF2008. It has since been incorporated and this mapping function implementation is currently being validated. A further distinction between the gscwd08 submission and the final gscwd10 submission concerned the drag parameterization for the lower orbiting SPOT and Envisat satellites. Analysis by Yaya and Valette (2009) showed a clear degradation in the positioning quality and the RMS of fit around the solar maximum in 2001-2002 for the preliminary DORIS combination, IDS-1. Thus, whereas typically six-hr drag coefficients (cd's) were adjusted in gscwd08 for the low satellites, in gscwd10 two-hr drag coefficients (cd's) were adjusted uniformly throughout the time series, except for 2001-2002, where 1-hr cd's were adjusted.

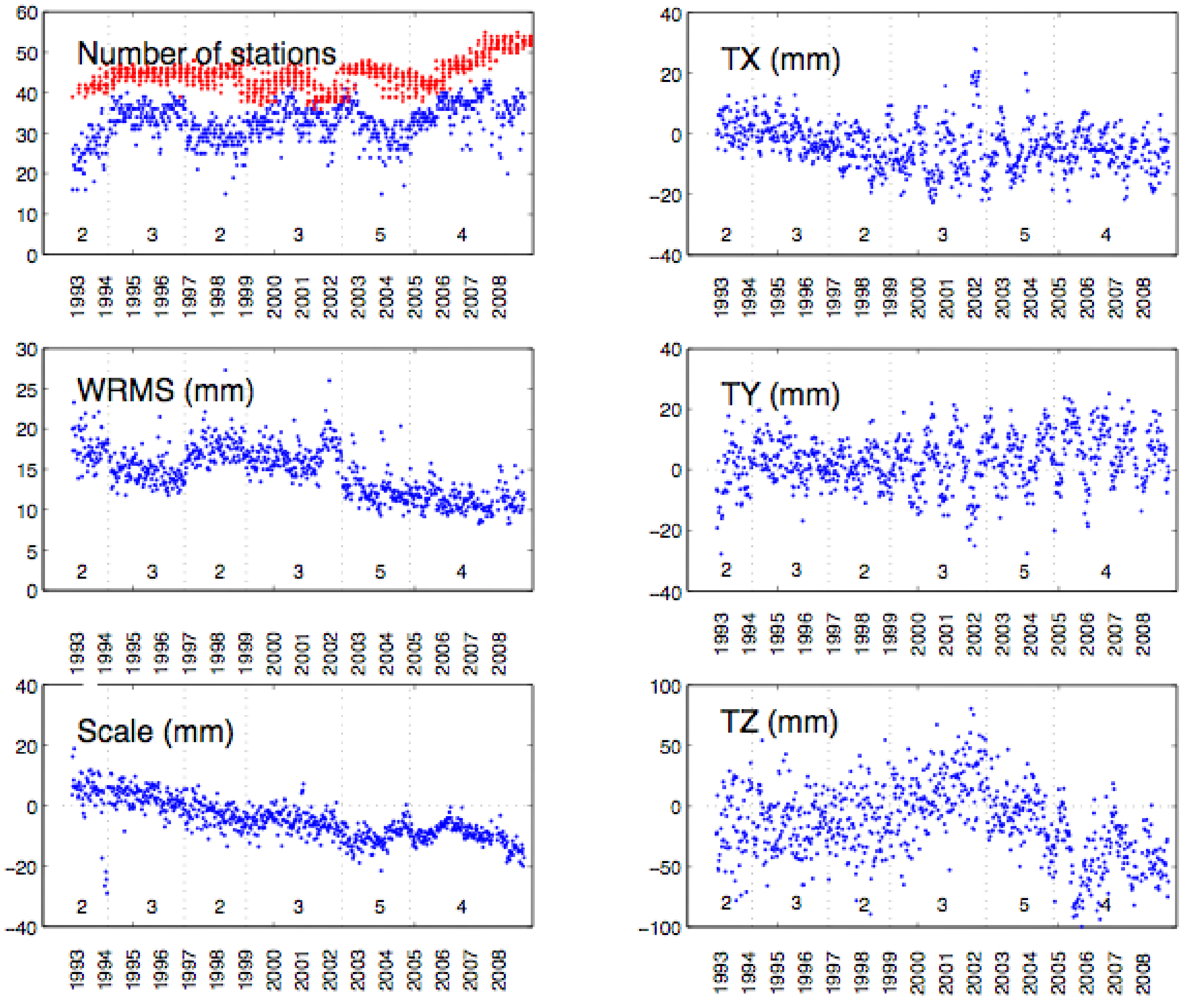

Figure 12 Analysis of the gscwd10 solution by CATREF showing the WRMS, scale, and geocenter parameters (TX, TY, TZ). The number of stations included in the submission is shown in red, whereas in blue is shown the number of stations accepted as contributing to the IDS combination.

15.2 RECOMPUTATION OF THE ORBIT SERIES FOR TOPEX/POSEIDON, JASON-1

In 2009, we recomputed the entire orbit series for TOPEX/Poseidon (1992 to 2005) and Jason-1 (2002-2009) using updated sets of orbit standards (designated std0905). These recomputations used both SLR and DORIS data, as well as the latest modeling standards, as described in Lemoine et al. (2010). As a summary of the orbit quality improvement we show in Table 8, the improvement in the SLR, DORIS fits for the TOPEX orbits from the GDR (described in Marshall et al., 1995), the ITRF2005-based orbits of Beckley et al. (2007), and the latest orbits that reflect further refinements. The latest refinements include the application of the updated troposphere mapping function as described in the previous section, and updates to the SLR and DORIS coordinates (Ries, 2008; Willis et al., 2009), as well as other improvements. For a subsample of the orbits, the independent altimeter crossover RMS of fit is reduced from 5.625 cm with the GDR, to 5.508 cm with the current generation of orbits. The RMS of fit to the SLR data is reduced from 2.21 cm with the GDR orbits to 1.84 cm with the Beckley et al. (2007) and 1.79 cm with the new orbits (designated std0905).

TOPEX SLR/DORIS orbits (Cycles 1-364)	DORIS RMS (mm/s)	SLR RMS (cm)	SLR mean (cm)	Xover RMS (cm)
GDR *(Marshall et al., 1995)*	0.5348	2.21	0.323	5.625
ITRF2005 *(Beckley et al., 2007)*	0.5104	1.84	0.323	----
Std0905 – (New 2009 Series)	0.5104	1.79	0.386	5.508

Table 8 Evaluation of the new TOPEX/Poseidon SLR/DORIS orbits

For Jason-1, we found that we had to globally downweight the DORIS data w.r.t the SLR data from 2 mm/s to 3 mm/s, in addition to further downweighting the DORIS stations in the vicinity of the South Atlantic Anomaly (SAA). This was necessary to reduce the impact of the drift in the Z component of the combined SLR & DORIS orbits w.r.t. independent SLR & Altimeter Crossover orbits. The drift for the first DORIS USO, in particular, is more severe than for the second DORIS USO, which was used after Jason-1 cycle 90. This issue is discussed in detail by Zelensky et al. (2010).

15.3 JASON-2 ORBIT ANALYSES

As part of the activities as a member of the Precision Orbit Determination (POD) team for Jason-2, we have analyzed the SLR and DORIS data for Jason-2, and compared extensively the resultant orbits with those of other analysis centers (Cerri et al., 2010; Zelensky et al., 2010). We have computed orbits for Jason-2 for cycles 1-30 using different techniques (dynamic and reduced-dynamic) and computed the independent altimeter crossover fits. What is interesting is that the DORIS-only orbits from Jason-2 (both dynamic and reduced-dynamic) have excellent (independent) SLR and Altimeter crossover fits. Also, the reduced-dynamic DORIS-only orbits, have altimeter crossover fits that are superior (lower) to the dynamic SLR+DORIS orbits (see Table 9) and have achieved 1-cm radial orbit accuracy (Zelensky et al., 2010).

In **Figure 13** we show the radial orbit differences between the NASA GSFC orbits, and those of the CNES GDRC, and between the NASA GSFC reduced-dynamic orbits and the JPL GPS-based reduced dynamic orbits. The most important result is that the radial orbit differences per cycle are less than 1.5 cm RMS and in fact are below 1.0 cm RMS for most of the sets of orbit differences. We note that the two sets of reduced-dynamic orbits agree radially at the level of 0.7 cm RMS. In addition, we see a strong beta-prime dependent signature in some of the orbit differences. Even for the reduced-dynamic orbits which show the best agreement of about 0.7 cm (**Figure 13**), spectral analysis at geographically registered locations of these orbit differences reveals the largest signal has the 118-day beta-prime period, further emphasizing the need to improve solar radiation pressure modeling (see **Figure 14**).

Orbit solution	DORIS (mm/s)	SLR (cm)	Crossover (cm) cycles 1-16, 18,19
GSFC dynamic doris	0.3637	1.997	5.517
GSFC dynamic slr+doris	0.3557	1.220	5.512
CNES dynamic slr+doris+gps	---	1.147	5.523
GSFC RD doris	0.3529	1.808	5.496
GSFC RD slr+doris	0.3550	1.170	5.460
JPL RD gps	---	1.250	5.362

Table 9: Jason-2 orbit performance residual summary cycles 1-30

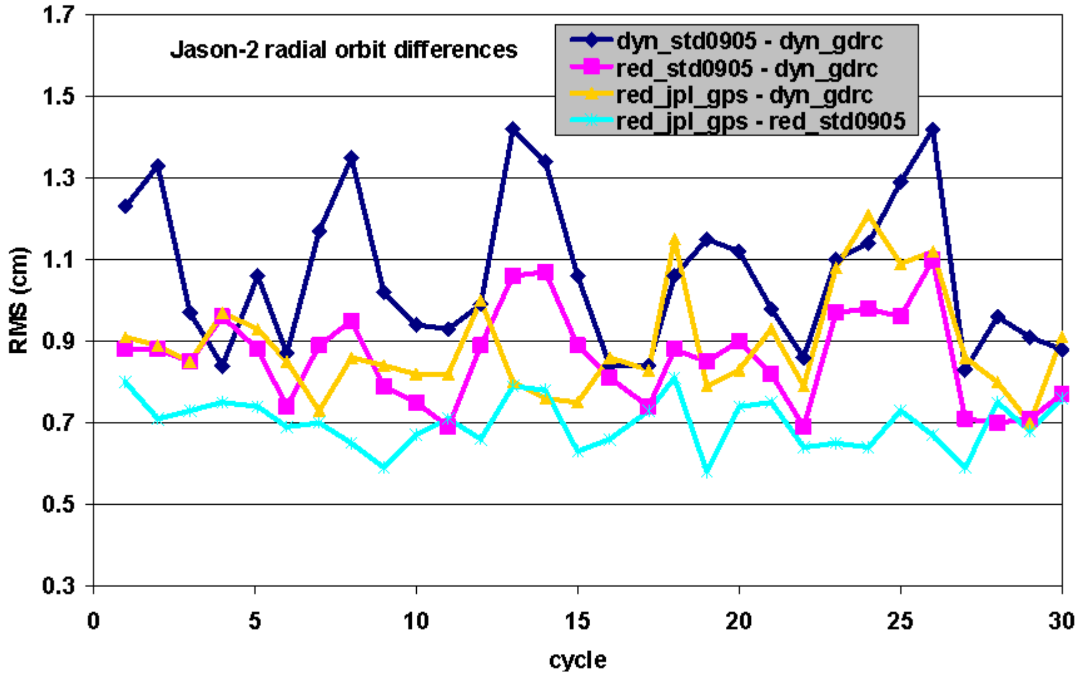

Figure 13 : Jason-2 radial orbit differences for NASA GSFC SLR/DORIS orbits (dynamic & reduced-dynamic), CNES GDRC (dynamic) and JPL GPS (reduced-dynamic).

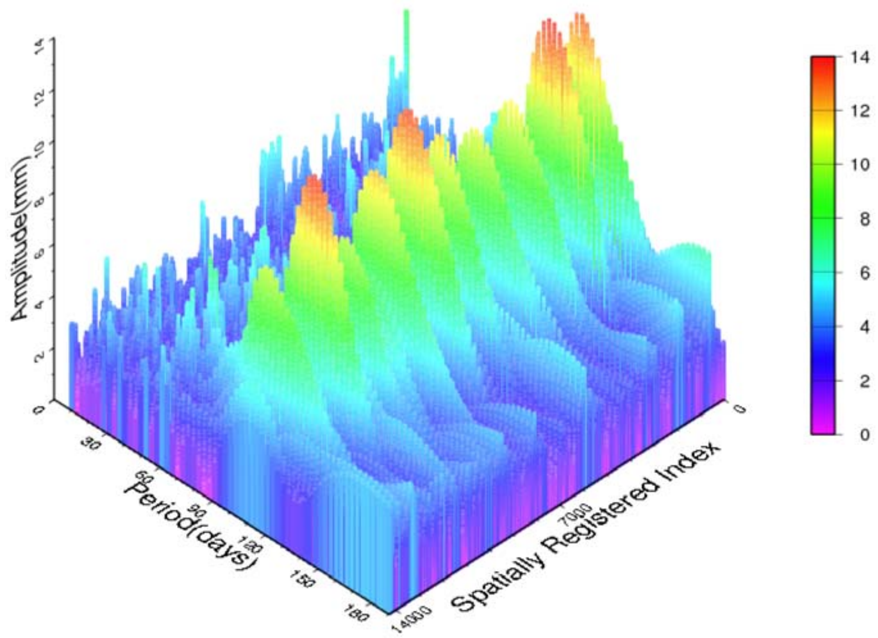

Figure 14 Jason-2 JPL GPS - STD0905 reduced-dynamic radial differences cycles 1-40 spectral analysis spatially registered points. Each spatially registered location should contain 40 orbit difference points which are sampled every 10-days.

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

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16.1 CONTEXT

The IGN is uses the GIPSY/OASIS (GOA) software package (version 5.0) to generate all possible DORIS products for geodetic and geophysical applications. Computations are done automatically at the new IPGP location in Paris (Tolbiac, Paris Rive Gauche). This is done automatically using a cron command (Linux environment). New DORIS data are downloaded once a day from the IDS data centers and processed within the next few hours. New solutions are automatically sent out to both DORIS data centers (IGN and CDDIS). Internal validations of the results are done using an internal Web site at IPGP. In order to test a future data processing at IGN, during several months the same procedures were also installed successfully at Saint-Mandé without delivering any products to avoid any duplication. It is planned to transfer the IGN data center in Saint-Mandé in 2010, using the future 5.1 version of the GIPSY/OASIS software package.

16.2 PRODUCTS DELIVERED IN 2009

The latest station coordinate delivered in 2009 is the ignwd08 (in free-network). This is the solution that was used for the preparation of the ITRF2008 (through IDS-1, IDS-2, IDS-3 combinations). This solution is regularly updated every week.

A combined solution (positions and velocities computed for all stations since 1993.0) was also derived in 2009, leading to 2 solutions available in SINEX format at the IDS data centers:

- ign09d01 for the free-network solution without using any geodetic local ties,
- ign09d02 for the solution using all available geodetic local tie information (with proper covariance information) between successive occupations of DORIS antennas at the same site, projected and expressed in ITRF2005.

All weekly free-network solutions (ignwd08) are the transformed into ITRF2005 using this internal cumulative solution (ign09d02) leading to a new time series also provided to IDS data centers in SINEX (ignwd09) and in STCD format (ign09wd01). Other parameters (TRF scale, geocenter, and EOP time series = ign09d01) are also provided at the IDS data centers. See following Table for details.

Product	Latest version	Update	Data span	files
Weekly SINEX				
-free-network	ignwd08	Weekly	1993.00 – 2009.95	883
-in ITRF2005	ignwd09	Weekly	1993.00 – 2009.95	880
- summary files	ignwd08	Weekly	1993.00 – 2009.95	884
STCD	ign09wd01	Weekly	1993.00 – 2009.95	151
Geocenter	ign09wd01	Weekly	1993.00 – 2009.95	1
EOP	ign09wd01	Weekly	1993.00 – 2009.95	1
Cumulative solution				
-free-network	ign09wd01	1 per year	1993.00 – 2009.95	1
-in ITRF2005	ign09wd02	1 per year	1993.00 – 2009.95	1

Table 10 IGN products delivered at IDS data centers in 2009. As of January 28, 2010

Satellite orbits were also provided in sp3 format to the Analysis Coordinator for test purposes. In parallel, 1993.0 to 2009.0 tropospheric results (zenith tropospheric delays) were also computed but were not (yet) delivered.

16.3 MAJOR IMPROVEMENTS

Comparing to the earlier ignwd05 weekly solution, the ignwd08 benefits from the following recent improvements :

- use of more recent GGM03S gravity field
- rescaling a the solar radiation pressure models using an empirical coefficient determined using a large data set for each satellite. See details in Gobinddass et al., J. Geod., 2009 and Gobinddass et al., Adv. Space Res., 2009. This avoids problem in Z-geocenter time series as well as in vertical component of the high-latitude stations at 118 days and 1 year

- More frequent estimation of the drag coefficient (every 1 hour) for the lowest satellites (SPOTs and Envisat). See details in Gobinddass et al., Adv. Space Res., submitted. This avoids problems during high geomagnetic activities, such as geomagnetic storms or around 11-year solar maximum
- Use of GMF mapping function for tropospheric correction

More details for this ignwd08 time series and derived products can be obtained in Willis et al., Adv. Space Res., 2010 and Willis et al., IAG Symp., 2010. This solution was used in the preparation of ITRF2008. However, until now, the more recent Jason-2 data were not used in this solution.

17 REPORT OF THE INASAN ANALYSIS CENTER (INA)

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17.1 INTRODUCTION

In 2006-2008, INASAN (ina) DORIS Analysis Center (AC) continued its activity as a member of the International DORIS Service (IDS). The processing of the DORIS data is performed using the GIPSY/OASIS II software (Linux version 4.03) developed by JPL.

In the computation all available satellites data, except Jason-1 (because of the SAA effect) and SPOT-4 only for 1998 (systematic errors in the Z-geocenter) on the moment of measurements were used. The following table summarizes current products delivered by INASAN to the IDS.

Product	**Latest version**	**Span**
SINEX weekly free-network	inawd03	1992.8 - 2009.0
Geocenter	na05wd01	1992.8 - 2009.0
EOP-series	ina07wd01	1992.8 - 2009.0
STCD-series	ina07wd01	1993.0 – 2007.6

Table 11 List of INASAN products provided to the IDS (February 2009)

The files of the products description can be found at:

1) SINEX series

ftp://cddis.gsfc.nasa.gov/doris/products/SINEX_series/inawd/inawd03.snx.dsc

2) geocenter

ftp://cddis.gsfc.nasa.gov/doris/products/geoc/ina05wd01.geoc.dsc

3) EOP-series

ftp://cddis.gsfc.nasa.gov/doris/products/eop/ina07wd01.eop.dsc

4) STCD-series

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

17.2 PRODUCT AND ANALYSIS RESULTS DESCRIPTIONS.

As a basis of all products, the weekly free-network solutions, obtained after merging daily free-network solutions, have been used. Each SINEX weekly file contains station coordinates and EOP. After the transformation of free-network solutions into a well-defined reference frame (ITRF2005), the standard deviations of the station coordinates were estimated at the level 0.5-4.0 cm, depending on the number of satellites used in the solution. The RMS of the X-pole and Y-pole was estimated as 2.83 mas and 1.70 mas, respectively, over 2000-2004 regarding to IERS C04 solution (*D.Gambis, M.Sail, T.Carlucci "Combination of Polar motion parameters series obtained from DORIS",IDS workshop, Venice, 13-15 March 2006).*

Estimated annual geocenter variations for 1993.0-2009.0 were derived by least squares method and evaluated as 6.7±0.2 mm, 5.4±0.1 mm, 28.9±1.1 mm, for X, Y and Z components, respectively (respect to ITRF2005). For the same time period annual geocenter variations of the IGN/JPL DORIS Analysis Center are 6.8±0.2 mm, 6.8±0.1 mm, 27.7±0.8 mm, for X, Y and Z components. Compare to the SLR solution, obtained for the same period, the estimated X and Y components of geocenter variations have slightly higher amplitudes and Z component is considerably higher.

DORIS inter-center orbit comparisons tests (*F.Lemoine et al*., http://ids-doris.org/report/meeting-presentations/ids-awg-03-2008.html) showed significant differences of *ina* orbits (reaching about 12 cm in along-track direction) compare to another Analysis Centers (especially compare to IGN/JPL AC using the same software GIPSY/OASIS II).

After applying the new satellites macromodels this problem was successfully resolved with overall inter-center orbit consistency at the level 1-2 cm for all directions.

In reply of Action Items List from March 2008 IDS Working Group Meeting in Paris INA AC realized test of SAA model for Jason-1 for two short periods: 2002 (days 15-33) and 2005 (days 2-36). There are no significant improvements from the use of SAA model for weekly positioning solutions for 2002 results, compare to IGN07d02. WRMS were almost the same for each station components. Another result we can see for 2005 period. By the use of SAA model WRMS of stations positions decreases about 2 times, but these results are valid only for the one-month data and subsequent investigations are needed.

The main work for 2006-2008 was connected with preparation and reprocessing DORIS data for all active period of DORIS mission 1993-2008. These reprocessing results will be used as contribution to ITRF2008 solution. INA reprocessed all DORIS data for 1997.0 - 2009.0 (except Jason-1 and SPOT-4 only for 1998) and submitted its solutions to the IDS for including in the combined IDS solution. The first preliminary results derived at the IDS Combination Center are promising can be found at http://ids-doris.org/analysis-combination.html

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

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(2) CNES/GRGS Groupe de Recherche en Géodésie Spatiale, France

18.1 INTRODUCTION

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

The Analysis Center also contributes to the combination activity of the GRGS, which uses the GINS/DYNAMO software package to process observations of the astro-geodetic techniques DORIS, GPS, SLR and VLBI, and to perform the global combination of the geodetic parameters at the observation level.

18.2 DATA PROCESSING

The 2009 activities for IDS were mainly devoted to complete the processing of the whole set of DORIS data for 1993-2008. Series of weekly free-network solutions for station coordinates and pole parameters were derived from this processing and delivered to the IDS in view of the DORIS combination for the ITRF2008 realization.

The routine processing was suspended in 2008 to focus on the contribution for ITRF2008. It has been started again in late 2009, including Jason-2 data. Deliveries to IDS will be resumed early 2010.

18.3 PRODUCTS DELIVERED TO IDS

18.3.1 WEEKLY SINEX SERIES

Three series were provided to the IDS for ITRF2008. Each submission is an improved version of the previous one.

lcawd20:

This series is based on the processing of SPOT-2, SPOT-3, SPOT-4, SPOT-5, Topex and Envisat data from January,3rd 1993 to January,3rd 2009

It may be considered as an homogeneous series since the same strategy and the same models are applied for the whole processed period, except that:

1) -before Dec 9th 2001 (until week 1143), dry and wet *a priori* ZTD are derived from the DORIS meteorological data

-from Dec 9th 2001 (from week 1144), dry and wet *a priori* ZTD are interpolated from 6-hour grids derived from ECMWF meteorological model.

2) -before July 1st 2000 (until week 1068), the albedo and IR flux are obtained from grids of mean monthly values.

-from July 1st 2000 (from week 1069), albedo and IR flux values are interpolated from 6-hour grids obtained from the ECMWF.

lcawd21:

The approach used for this series is similar to the one of series lcawd20 with the following difference:

- the atmospheric loading correction is removed from the station coordinate solutions

- SPOT-2 and SPOT-4 data of the period 2001/09-2002/03 (GPS weeks 1130- 1160) are processed with a different strategy regarding the estimation of the air drag coefficients in order to improve the results during the maximum solar activity period: 1 coef/1 hour instead of 1 coef/4 hours

lcawd24:

This third version is the series that was used in the final IDS combination IDS-3. The difference with lcawd21 is the following:

- Solar Radiation Pressure coefficients (SRP) are kept fixed to mean values while the matrices are reduced: 0.98 for Topex, 1.15 for SPOT-2, 1.15 for SPOT-3, 1.16 for SPOT-4, 1.17 for SPOT-5, 1.29 for Envisat

18.3.2 ORBITS

Orbits were delivered to the IDS Data Centers in sp1 format. For Envisat, Topex/Poseidon, and Jason-2, satellite laser ranging (SLR) data are also used for the orbit determination. These are then DORIS+SLR mixed orbits.

The sp1 series version 03 (ja203,en103, sp203, sp303, sp403, sp503, top03 for Jason-2, Envisat, SPOT-2, SPOT-3, SPOT-4, SPOT-5 and Topex/Poseidon) was made available early 2009. It derives from the complete processing 1993-2008 for ITRF2008

18.3.3 OTHER ACTIVITY: DORIS/JASON-1 CORRECTIVE MODEL

The LCA Analysis Center is in charge of the maintenance of the DORIS/Jason-1 corrective model. The latest DORIS data collected over 2009 have been used to evaluate the evolution parameters of the model (amplitude, memory effect). The data set includes now the Jason-2 data and we also put the period of the tandem flight Jason-1/Jason-2 (15/07/2008 - 21/01/2009) to account. The evaluation results showed that it was not necessary to change the parameters. However, an upgraded version was performed to take into account the new orbit of the satellite. The model is on line at :

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

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20 PUBLICATIONS (2009)

Here is below the list of DORIS publications in international peer-reviewed journals for 2009

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The complete list is available on the IDS web site: http://ids-doris.org/report/publications/peer-reviewed_journals.html

Amalvict, M.; Willis, P.; Wöppelmann, G.; Ivins, E.R.; Bouin, M.N.; Testut, L.; Hinderer, J., 2009. Isostatic stability of the East Antarctic station Dumont d'Urville from long-term geodetic observations and geophysical models, Polar Res., 28(2), 193-202, DOI: 10.1111/j.1751-8369.2008.00091.x

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Siefring, C.L.; Bernhardt, P.A.; Roddy, P.A.; Hunton, D.E., 2009.Comparisons of equatorial irregularities measurements from C/NOFS: TEC using CERTO and CITRIS with in-situ plasma density, Geophys. Res.Lett., 36, art. L00C08, DOI: 10.1029/2009GL038985

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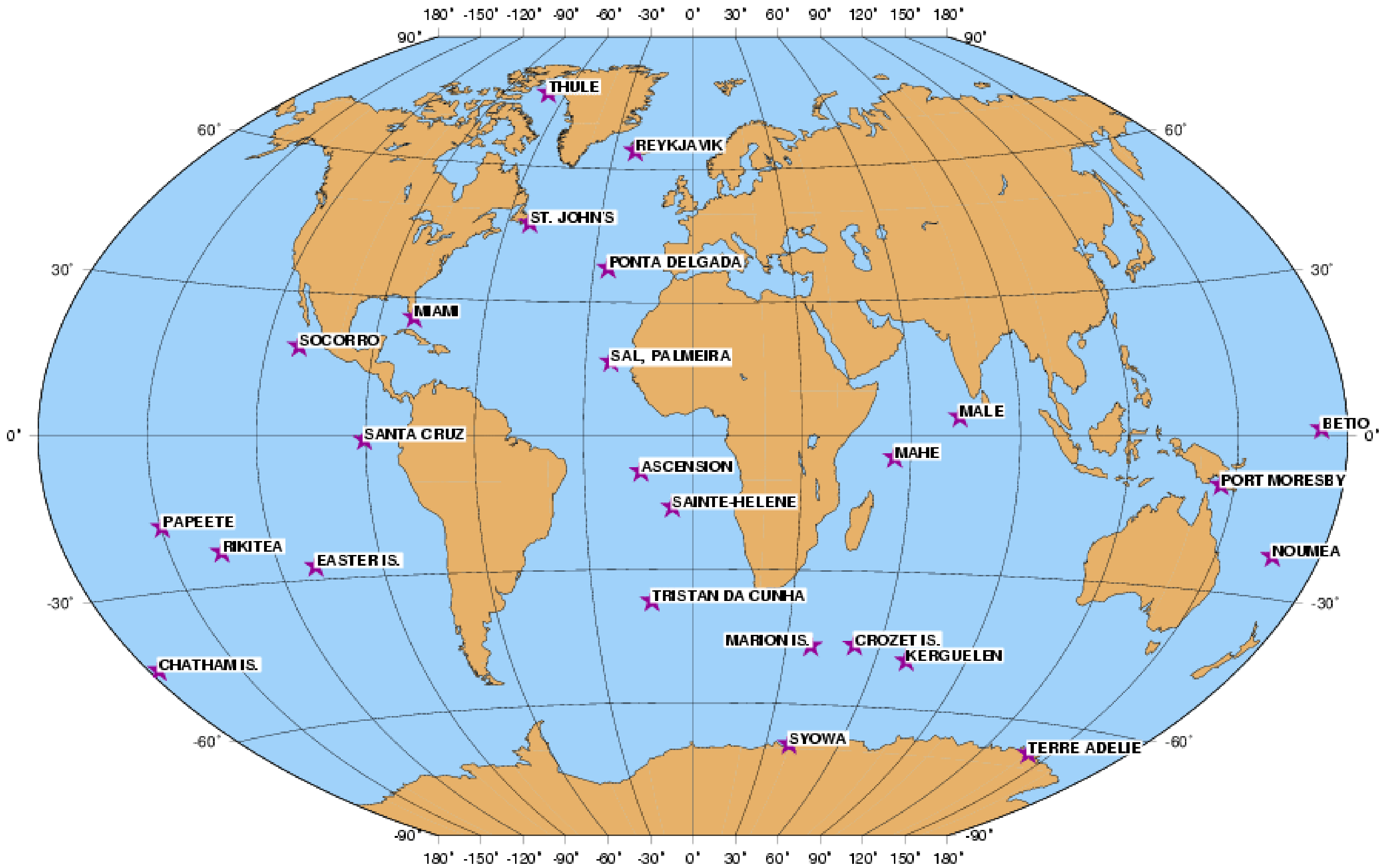
APPENDIX 1: DORIS STATIONS COLOCATION WITH TIDE GAUGES

The table and the figure below are courtesy provided by the « Système d'Observation du Niveau des Eaux Littorales » (SONEL, Université de La Rochelle, France). They are regularly updated at the following address : http://www.sonel.org/stations/cgps/survey/survey.doris.html



DORIS Name	Longitude	Latitude	Country	Start date	Distance	GLOSS id	PSMSL id
ASCENSION	-14.33	-7.92	UK	1997-02-28	6500	263	402001
BETIO	172.92	1.35	KIRIBATI	2006-10-22	1600	113	730009
CHATHAM ISLAND	-176.57	-43.96	NEW ZEALAND	1999-02-28	1200	128	------
COLOMBO	79.87	6.89	SRI LANKA	1991-06-06	5000	033	520001
CROZET ISLAND	51.85	-46.43	FRANCE	2003-12-21	850	21	433001
EASTER ISLAND	-109.38	-27.15	CHILI	1988-11-17	7000	137	810003
KERGUELEN	70.26	-49.35	FRANCE	1987-01-28	3300	023	434001
MAHE	55.53	-4.68	SEYCHELLES	2001-06-20	300	273	442007
MALE	73.53	4.20	MALDIVES	2005-01-15	500	28	454011
MARION ISLAND	37.86	-46.88	SOUTH AFRICA	1987-05-15	1000	020	------
MIAMI	-80.17	25.73	USA	2005-02-10	180	---	960001
NOUMEA	166.41	-22.27	FRANCE (CALEDONIA)	1987-10-20	3600	123	740001
PAPEETE	-149.61	-17.58	FRANCE (POLYNESIA)	1995-07-27	7000	140	780011
PONTA DELGADA	-25.66	37.75	PORTUGAL (AZORES)	1998-11-02	1500	245	36002
PORT MORESBY	146.18	-9.43	PAPUA NEW GUINEA	1988-03-29	6000	---	670012
REYKJAVIK	-21.99	64.15	ICELAND	1990-07-04	2500	229	010001
RIKITEA	-134.97	-23.13	FRANCE (POLYNESIA)	2006-09-23	800	138	808001
SAINTE-HELENE	-5.67	-15.94	UK	1989-06-01	4000	264	425001
SAL	-22.98	16.78	CAPE VERDE	2002-12-15	7000	329	380021
SANTA CRUZ	-90.30	-0.75	ECUADOR	2005-04-01	1600		845031
SOCORRO	-110.95	18.73	MEXICO	1989-06-09	400	162	830062
ST. JOHN'S	-52.68	47.40	CANADA	1999-09-27	4000	223	970121
SYOWA	39.58	-69.01	JAPAN (ANTARCTICA)	1993-02-10	1000	095	A--041
TERRE ADELIE	140.00	-66.67	FRANCE (ANTARCTICA)	1987-02-05	500	131	------
THULE	-68.83	76.54	DENMARK (GREENLAND)	2002-09-28	300	---	------
TRISTAN DA CUNHA	-12.31	-37.07	UK	1986-06-10	2000	266	------

APPENDIX 2 : DORIS STATIONS / HOST AGENCIES

Station name	contact	Institute	City, Country
Amsterdam	INSU, Labo de géophysique :geophysic team IPEV: Christine David, Dominique Fleury	Laboratoire de Géophysique	FRANCE
Arequipa	Dr Milton Talavera, Raul Yanyachi		Arequipa, PERU
Ascension	Caroline Yon	ESA Telemetry & Tracking Station Cable & Wireless SA	Ascension island, SOUTH ATLANTIC OCEAN
Badary	Roman Sergeev, Segey Smolentsev, Sergey Kuzin	Badary observatory of the Institute of Applied Astronomy Russian Academy of Sciences	village Badary, RUSSIA
Belgrano	Sergio Marenssi, Andrés F. Zakrajsek	Instituto Antártico Argentino	Buenos aires ARGENTINA
Betio	Moreti Tibiriano, Bob Twilley	Kiribati Meteorological Service	KIRIBATI, Australia
Cachoeira Paulista	Nelson Correa	Instituto Nacional de Pesquisas Espaciais (INPE)	Cachoeira Paulista, BRESIL
Chatham Island	Gwenyth Kingsbury	MetService	NEW ZEALAND
Cibinong	Cecep Subarya	Bakosurtanal	Cibinong , INDONESIA
Cold Bay	Sella Giovani	National Geodetic Survey NOAA	Silver Spring USA
Cold Bay	Gene Schlechte	USCG Navigation Center	alexandria, USA
Crozet	INSU, Labo de géophysique :geophysic team IPEV: Christine David, Dominique Fleury	Laboratoire de Géophysique	FRANCE
Dionysos	Jordan Galanis, Demitris Paradissis	National Technical University Of Athens	Zografou GREECE
Djibouti	Mohamed Kassim	Observatoire d'Arta	Arta, REPUBLIQUE DE DJIBOUTI
Easter Island Santiago	Martin Arluciaga, Tapia Miguel	Centro De Estudios Espaciales Universidad de Chile	Santiago, CHILI
Everest	Gain Petro Verza	Comitato Ev-K^2-CNR	Bergamo, ITALY
Fairbanks	Lance Seman	Command and Data Acquisition Station	Fairbanks, USA
Futuna	Francis Gallois	IRD	Nouméa NOUVELLE CALEDONIE
GRASSE	Etienne SAMAIN, Francis Pierron	Observatoire de la Côte d'Azur Grasse	Grasse, FRANCE
Gavdos	Stelios Mertikas	Laboratory of Geodesy & Geomatics Engineering	Chania Crete, GREECE
Greenbelt	Mike Perry	NASA / GSFC	USA
Hartebeesthoek	Tiaan Strydom, Carlos de Oliviera	CSIR	Pretoria South AFRICA
Jiufeng	Zheng Shaohuai	Institute of Geodesy and Geophysics	Wuhan, CHINA

Station name	contact	Institute	City, Country
Kauai	Marc Evangelista, ronald Curtis	Kokee Park Geophysical Observatory	Kauai, USA
Kerguelen	INSU, Labo de géophysique :geophysic team IPEV: Christine David, Dominique Fleury	Laboratoire de Géophysique	FRANCE
Kitab	Shubhrat Ehgamberdiev	Ulugh Beg Astronomical Institute	Tashkent, UZBEKISTAN
	Dilbar Fazilova	Kitab Latitude Station, Astronomical Observatory	Kitab, UZBEKISTAN
Kourou	M. GEHIND, Pascal GELOTO, Patrick Hoyau	Centre Spatial Guyanais	Kourou, FRENCH GUYANA
Krasnoyarsk	Vasily Panko, Andrei Aleshechkin, Segey Kuzin	Siberian Federal University	Krasnoyarsk, RUSSIA
La Réunion	Philippe Kowalski, Andrea DIMURO, C. Philipope, F. lauret, P. Boissier	Observatoire Volcanologique du Piton de La Fournaise	LA REUNION
Libreville	Pierre Clauzel	Station Ariane	Libreville, GABON
Mahe	Patrick Alcindor, Pillay Selvan	Ministry of environment and transportDivision of policy, planning & services	Mahe, SEYCHELLES
Male	The Director	Department of Meteorology	Male, REPUBLIQUE DES MALDIVES
Manille	Lorelei E. Peralta, V. N. Panfga, R. Villanueva	National Mapping and Ressources Information Authority (Namria)	PHILIPPINES
Marion Island	Ludvig Combrinck, Henry Valentine	HartRAO Space Geodesy Programme	Krugersdorp, SOUTH AFRICA
	Henry Valentine	Antartica & Island Dept of Environmental Affair & tourism	Cape town, SOUTH AFRICA
Metsahovi	Markku Poutanen	Finnish Geodetic Institute	Masala, FINLAND
Miami	Tim Dixon, Kim Outerbridge, Batu Osmanoglu &Yan Jiang	RSMAS	Rickenbacker Causeway, USA
Monument Peak	Ted Doroski, R. Sebeny	NASA SLR Tracking Station	Mt. Laguna, USA
Mount Stromlo	Ramesh Govind	Earth Monitoring Group	Canberra AUSTRALIA
Nouméa	Laurent Dubois	DITTT/ST/BGN	Nouméa, NOUVELLE CALEDONIE
	Michel DEVAUX, Francis Gallois	CENTRE IRD	Nouméa NOUVELLE CALEDONIE
Ny-Alesund	Leif Morten Tangen	Statens Kartverk	Alesund, NORWAY
Papeete	Jean Pierre Barriot, Y. Vote, L. Mercier, Y. Verschelle	Université de la Polynésie Française (UPF) Observatoire Géodésique de Tahiti (OGT)	Tahiti , FRENCH POLYNESIA

Station name	contact	Institute	City, Country
Ponta Delgada	Luisia Magalhaes	Direcçao de Serviços de Cartografia e Informaçao Geografica	Azores, PORTUGAL
	Teresa Ferreira , A. N. Trota, J. Okada, Rita MM Rodrigues	Universidade dos Açores	Azores, PORTUGAL
Port Moresby	Samuel Kodawara, Robert Moludobu, Robert Rosa	Surveyor General	PAPOUASIE NOUVELLE GUINEE
Reykjavik	Thorarinn Sigursson, Valsson Gouomundur	Landmælingar Islands	ICELAND
Rikitea	Yves Gregoris	Meteo-France	France, Polynésie Française
Rio Grande	Jose Luis Hormaechea	Estacion Astronomica Rio Grande	ARGENTINA
Riyadh	Nasr Al-Sahhaf	KACST	Riyadh, SAOUDI ARABIA
Rothera	Mike Pinnock	British Antarctic Survey	Cambridge, UK
Sal	Francisco Evora	Instituto Nacional de Meteorologia e Geofisica	Sal, CAP VERT
Sakhalinsk	Victor Kaistrenko	Institute of Marine Geology and Geophysics Russian Academy of Sciences	Yuzhno-Sakhalinsk, RUSSIA
Santa Cruz	Carlos Palacios	Charles Darwin Foundation (AISBL)	Galapagos, ECUADOR
Socorro	Francisco Hansen, Guido Alejandro, Gasca Moncayo , J Guillermo, F. Gonzalez	INEGI	MEXICO
St John's	Mario Bérubé	Natural Resources Canada Geodetic Survey Division	Ontario, CANADA
St John's	Gordon NEARY	Neary's Consulting	New-Foundland , CANADA
St-Helena	Marcos	Meteorological Station	St Helena, SOUTH ATLANTIC OCEAN
Syowa	Kazuo Shibuya , Akira-Kadokura	National Institute of Polar Research,	Tokio JAPAN
Terre Adélie	INSU, Labo de géophysique :geophysic teamIPEV: Christine David, Dominique Fleury	INSU-Laboratoire de Geophysique	FRANCE
Thule	Finn Bo Madsen	DNSC	Cppenhaguen DANEMARK
	Michael Kongstedt, M. S Pedersen	NS Comm Greenland Contractors	Pituffik DENMARK
Tristan	David Morley	Telecommunications Department	Tristan da Cunha, SOUTH ATLANTIC OCEAN
	M. FODEN	“Technologie” Development Proudman Oceanographic Laboratory	Liverpool, UK

Station name	contact	Institute	City, Country
Yaragadee	Carman Randall, vinces Noyes, Peter Bargewell, Brian Rubery, Jack Paff & Peter Thomas.	Australian Space Office	AUSTRALIA
	Johnston	Geoscience Australia (GA)	AUSTRALIA
Yellowknife	Georges Jensen, Ross Ashlie	NR Can	Yellowknife CANADA
Yuzhno-Sakhalinsk	Victor Kaistrenko	Institute of Marine Geology & Geophysics	Yuzhno-Sakhalinsk, RUSSIA

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