

# REPORT OF TECHNIQUE CENTRES: INTERNATIONAL DORIS SERVICE (IDS)

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## OVERVIEW

DORIS was developed for precise orbit determination and precise positioning on Earth.

Following the inclusion of DORIS as a new technique in IERS, six groups have been participating as Analysis Centres: CNES/SOD, GRGS, and IGN in France, UT/CSR in the USA, DUT in the Netherlands and MCC in Russia. The first four groups have submitted regular results to IERS either for polar motion determination or for tracking stations coordinates and velocities. Other groups are still developing their processing capabilities. Two IERS Data Centres have been providing the scientific community with DORIS measurements for several years: NASA/CDDIS and IGN/LAREG.

In 1999, following the recent IERS reorganisation, it has been decided at the IAG General Assembly (Birmingham, UK, August 1999) to create a DORIS Pilot Experiment. Such a Pilot Experiment would give time to all groups to coordinate and improve their operationability in order to create on the long term an International DORIS Service (IDS). In the future, this scientific service would structure the DORIS community in order to provide scientific products for a broad range of potential users, starting by the IERS itself. This is done as common activity of the IERS and the IAG/CSTG (Commission of the International Association of Geodesy for the Coordination of Space Technique). This is very similar to what is done for GPS by the IGS, or for VLBI by the IVS or for SLR and LLR for the ILRS.

The Steering Committee manages the DORIS Pilot Experiment with the help of a Central Bureau responsible for the daily coordination and management: information, communication, meetings, workshops...

After two DORIS Days meetings held in 1998 and 2000, the DORIS community will meet at the first IDS Workshop in Biarritz, France, in June 2002.

Two Data Centres support DORIS data and products archiving and distribution activities for the space geodesy and geodynamics community.

The Central Bureau started a station coordinates Analysis Campaign in November 2001 and Martine Feissel-Vernier joined the Steering Committee as Analysis Coordinator.

The DORIS Station Selection Committee defines site criteria and analyses proposals for new sites. As a first experiment, Geoscience Australia installed a DORIS beacon in Antarctica in December 2001 to be operated for a few weeks.

For two years, a network renovation action has been conducted: today almost half of the stations meet the new stability requirement. In the same period, third generation beacons were developed. Deliveries and deployment started in December 2001.

A new satellite recently joined the three satellites already flying with a DORIS receiver, two other will be launched in early 2002. They carry an improved second generation DORIS receiver including two channels and DIODE navigator.

## THE INTERNATIONAL DORIS PILOT EXPERIMENT

For the DORIS Pilot Experiment an international Call for Participation has been issued in September 1999. A Steering Committee has been set up and is now composed of the following individuals:

Gilles TAVERNIER	CNES	Chairperson
Martine FEISSEL-VERNIER	Observatoire de Paris-IGN	Analysis coordinator
Frank LEMOINE	NASA/GSFC	Stations Selection Group chairperson
Carey NOLL	NASA/CDDIS	Data Flow coordinator
John RIES	University of Texas CSR	future DORIS representative to IERS
Laurent SOUDARIN	CLS	Central Bureau Web server
Pascal WILLIS	IGN-JPL	DORIS representative to IERS

CNES, CLS and IGN perform the operational tasks of the Central Bureau. A specific Web site has been created presenting the Pilot Experiment organisation, the proposals, the members of the different groups, the DORIS Mails, the Site logs, a lot of new information on the DORIS system and also links to all DORIS groups Web sites: <http://ids.cls.fr>

An IDS Workshop will be held in Biarritz on June 13 and 14, 2002, dealing with general information about the DORIS system evolutions (satellites, network...), IDS status (central bureau, stations selection group, data centres), orbits and related products, DORIS analysis results (plate motions, vertical velocities, EOP, TRF...) and the IDS analysis campaign.

Two Data Centres archive and distribute DORIS measurements and ancillary data. They will also archive and distribute products as soon as they are available, with the help of Carey NOLL (Data Flow coordinator):

NASA GSFC / CDDIS	USA	Carey Noll
IGN / LAREG	France	Edouard Gaulué

Data are currently available for 4 satellites for more than 12 years:

- SPOT2: from 31 March to 04 July 1990, from 01 February to 22 March 1992 and from 16 October 1992
- TOPEX/POSEIDON: from 25 September 1992
- SPOT3: from 01 February 1994 to 09 November 1996
- SPOT4: from 01 May 1998

Data from the recently launched JASON will be available soon.

There are eleven candidate Analysis Centres willing to process DORIS measurements:

AUSLIG	Australia	Ramesh Govind
CNES	France	Jean-Paul Berthias
CSR the Univ. of Texas	USA	John Ries
ESA ESOC Darmstadt	Germany	John Dow
Geod. Observ. Pecny	Czech Rep.	Jan Kostecky
IAA St Petersburg	Russia	George Krasinsky
IGN LAREG	France	Pascal Willis
INASAN Moscow	Russia	Suriya Tatevian
LEGOS / CLS	France	Jean-François Crétaux
Royal Observ. of Belgium	Belgium	René Warnant
University of Newcastle	UK	Phil Moore

The IDS Central Bureau initiated in November 2001 an Analysis Campaign that originally focused only on sets of station coordinates derived from the June 2001 observations of the Spot2, Spot4 and Topex/Poseidon satellites.

The main objectives of the campaign are as follows:

- Check the level of consistency of results obtained using different software packages
- Identify and analyse possible systematic discrepancies
- Study the possibility of defining time series of sets of station coordinates as an IDS product
- Initiate the process of combining DORIS results into unified IDS products.

Responses were received from six Analysis Centres, while three other expressed interest to participate at a later time. The content of the responses was larger than expected, in several ways: the data span covers several years, as compared to the single month requested, and the products span not only sets of stations coordinates, but also times series of the Earth's orientation parameters and of the geocentre location and orbits.

Martine Feissel-Vernier joined the Steering Committee as Analysis Coordinator.

In order to extend the comparison capabilities, a number of colleagues accepted to participate in their field of expertise. To date, the following analysts have accepted to participate:

Sets of station coordinates:

- L. Soudarin, J.-J. Valette, CLS and Z. Altamimi, IGN

Satellite orbits:

- H. Boomkamp, ESA

EOP time series:

- D. Gambis, IERS Earth Orientation Centre
- J. Ray, IERS Rapid Service/Prediction Centre
- M. Rothacher, IERS Analysis Coordinator

The Stations Selection Group chaired by Frank LEMOINE includes scientists involved in various applications such as geodesy, geophysics, altimeter calibration, tide gauges, ITRF collocation and a representative of the DORIS Stations Installation and Maintenance Service (IGN/SIMB): Eric CALAIS, Chuck DE METS, Herve FAGARD, Ramesh GOVIND, Bruce HAINES, Kristine LARSON, Seth STEIN, Simon WILLIAMS.

The group defined site criteria taking DORIS site constraints into account and prepared a Station Response Form which was sent to candidate sites.

Currently complete (i.e. Site Survey Forms and Documentation available) proposals are:

- |   |                        |                             |
|---|------------------------|-----------------------------|
| 1. Wousi, New Hebrides  | form, photo            | Contact: Stéphane Calmant   |
| 2. Wettzell, Germany  | form                   | Contact: Wolfgang Schlüter  |
| 3. Chile (TIGO)   | form, e-mail           | Contact: Wolfgang Schlüter  |
| 4. O'Higgins, Antarctica  | form                   | Contact: Wolfgang Schlüter  |
| 5. Czech Republic   | form, various pictures | Contact: Jan Kostelecky     |
| 6. Brussels   | form, e-mail, photos   | Contact: René Warnant       |
| 7. San Fernando, Spain  | form                   | Contact: Jose Martin Davila |
| 8. Gavdos, Crete  | form                   | Contact: Stelios Mertikas   |
| 9. AUSLIG<br>Cape York, Northern Australia<br>Burnie, Tasmania<br>Lambert, Antarctica | email                  | Contact: Ramesh Govind      |
| 10. Svetloe, Russia   | form, photos           | Contact: Zinovy Malkin      |

Incomplete proposals:

- |                        |                 |                               |
|------------------------|-----------------|-------------------------------|
| 1. Iran                | e-mail, picture | Contact: Faramarz Nilforousan |
| 2. Northwestern India. |                 | Contact: Vinod Gaur.          |

During the 12th December 2001 to 5th February 2002 period, Geoscience Australia (formerly Australian Surveying and Land Information Group, AUSLIG) deployed a DORIS beacon on the Sorsdal Glacier, which is located in the vicinity of the Davis Station (68°S-78°E), Australian Antarctic Territory. It is the first site selected for the IDS DORIS Pilot Experiment (see a short report at [http://www.jason.oceanobs.com/html/applications/ice/doris\\_sorsdal\\_uk.html](http://www.jason.oceanobs.com/html/applications/ice/doris_sorsdal_uk.html)).

Complete information about the activities of the Stations Selection Group are available on its web page which can be found on the IDS web site or directly at the following address: <http://phys-geophys.colorado.edu/~kristine/doris.html>

*DORIS NETWORK*

As in the past years, the DORIS network has been very stable (see figure 1). The installation and maintenance activities are realised by the IGN/SIMB.



Figure 1. The DORIS Network

In order to reach new accuracy goals for JASON 1 and ENVISAT, it was decided to improve the long-term stability of the antennas when necessary.

This network renovation action started in 2000 with the stations of Cibinong, Djibouti, Hartebeesthoek and Metsahovi. Two new stations were installed in Greenbelt, replacing Ottawa (antenna on a concrete pillar instead of a high building) and in Futuna (antenna on an iron tube + concrete), replacing Wallis. Several new local ties with other geodetic techniques were measured and transmitted to the IERS Central Bureau. 11 stations were renovated in 2001: Rio Grande, Easter Island, Santiago, Amsterdam, Kerguelen, Kitab, Ponta Delgada, Yellowknife, Arequipa, Noumea and Chatham, and one new station was installed at Mahe, Seychelles. Several other renovations are under way. Almost half of the stations (21 "excellent" and 4 "good", out of 54 stations in total) meet the new stability requirement, to be compared with 1 out of 6 two years ago.

It was also decided to develop third generation beacons to improve DORIS system accuracy and capacity, with possible frequency shift avoiding jamming by nearby stations, higher transmitted power, a modulated 2 GHz channel and possible remote control through a telephone line or an Argos terminal. Such a beacon has already been installed in Toulouse (master beacon). Other upgrades are planned in 2002, such as in the French Southern Indian Ocean territories.

Sites logs have been created by the SIMB for all DORIS sites and are available at the IGN Web site (<http://www.ign.fr/fr/PI/activites/geodesie/DORIS/stations-en.html>). This includes information concerning the changes in the DORIS ground equipment (antenna, beacon...) and also precise local ties with other precise space technique of the IERS. Among the existing 54 stations of the DORIS network, 35 are collocated with other techniques: 34 with 12 SLR (of which 6 permanent SLR) and 13 with VLBI (of which 7 permanent VLBI). The 4 techniques are collocated on 6 sites.

Collocation with tide gauges is also important for altimetry missions: 17 DORIS stations are less than 10 km from a GLOSS tide gauge and new sites will be selected in order to increase this number.

#### *DORIS CONTROL CENTRE*

SSALTO, the new DORIS and altimetry multimission Control Centre is operational since December 2000. Thanks to its links with the Control Centres of the different satellites fitted out with a DORIS receiver, it is able to collect DORIS measurements, preprocess and send them to the DORIS Data Centres as well as ancillary data such as manoeuvres, attitude, meteorological data.

SSALTO also produces preliminary and precise orbits, which will be sent to the Data Centres as soon as a format is adopted. The AVISO component will ensure archiving.

#### *DORIS SATELLITE CONSTELLATION*

First generation receivers equipped four satellites: SPOT 2 (launched in 1990), TOPEX/POSEIDON (launched in 1992), SPOT 3 (1993-1996) and SPOT 4 (launched in 1998).

Second generation DORIS receivers have a dual channel capability, allowing multiple stations positioning in the same area, an improved accuracy and a real autonomy thanks to DIODE navigator: self start, self programming and real time on-board orbit determination.

One satellite carrying such a receiver has been recently launched:

- JASON 1 was launched December 7, 2001, the DORIS receiver was switched on December 8 and automatically started without any command from the ground thanks to DIODE. The orbit accuracy is already on the TOPEX/POSEIDON level and should reach the aimed at radial centimetre level. The real time on-board radial accuracy is 9 to 16 centimetres RMS

Two other satellites carrying such a receiver will be launched soon:

- ENVISAT in February/March 2002
- SPOT 5 in April/May 2002

New satellites will be launched in the future, such as CRYOSAT (ESA), JASON-2 or Pleiade (SPOT follow-on).

Furthermore, in its proposal CNES has offered receivers for possible new missions. The number of available DORIS satellites has been a limiting factor in the accuracy of the DORIS results for IERS (stations positions and velocities), polar motion, for a long time. This situation should improve in the near future thanks to the three new satellites in space, but it is important to go on increasing the number of satellites.