Overview

The current report presents the different activities held by all components of the International DORIS Service (IDS). In a first step, we will present the current status of the DORIS system (available satellites and tracking network). In a second step, we will present the activities of the IDS Central Bureau (IDS Web site management and DORIS-related email distributions). We will then focus on the most recent activities conducted by the Analysis Centers (ACs) and the Analysis Coordination. Finally, we will present other activities related to meetings and publications.

1 DORIS system

1.1 DORIS satellites

During this report period (2012), the number of DORIS satellites has decreased to six (see Table 1).

Satellite	Start	End	Type
SPOT-2	31-MAR-90 04-NOV-92	04-JUL-90 15-JUL-09	Remote sensing
TOPEX/Poseidon	25-SEP-92	01-NOV-04	Altimetry
SPOT-3	01-FEB-94	09-NOV-96	Remote sensing
SPOT-4	01-MAY-98	–	Remote sensing
SPOT-5	11-JUN-02	–	Remote sensing
Jason-1	15-JAN-02	–	Altimetry
ENVISAT	13-JUN-02	08-APR-12	Altimetry, Environment
Jason-2	12-JUL-08	–	Altimetry
Cryosat-2	30-MAY-10	–	Altimetry
HY-2A	1-OCT-11	–	Altimetry

Table 1: DORIS data available at IDS Data Centers. As of December 2012

Just one week after celebrating its tenth year in orbit, communication with the Envisat satellite was suddenly lost on April, 8 2012. The end of the Envisat satellite operations was declared on May.

Note that in 2012, the CNES-NASA Joint Steering Group directed the Jason-1 Project to move the satellite to a geodetic orbit. Jason-1 maneuver operations were started on April 23rd, and the first operations to lower the orbit were performed on April 25th. The mission was resumed on May 7.

In the near future, several new DORIS satellites are already planned (and approved): SARAL/Altika, Sentinel-3A, Jason-3 … This should increase or at least stabilize the number of DORIS satellites in the 2013–2016 time period.

1.2 DORIS network

DORIS network still provided this year a reliable service with annual network availability mean of 89 % of operating stations. This performance is the result of the joint effort of CNES, IGN and all host agencies.

Main events of the year: Futuna and Tristan da Cunha stations back to operation after more than three years of inactivity; Mahé first station working with beacon 3.2 allowing till 80m distance between the beacon and the antenna, compared with 15m for regular cables.

With a favorable context with REGINA network deployment, it has been decided to carry out from now, as far as possible, high precision local tie surveys, with the objective of sub-millimetric tie vectors. This objective requires more means (equipment, time and transport) compared with GPS surveying method used as convenience in the past. Six co-location surveys were carried out under these terms this year.

Finally, a new set of site logs with new stations coordinates and velocities derived from DPOD and ITRF 2008 solutions and a complete updating of all information has been published on the IDS website.

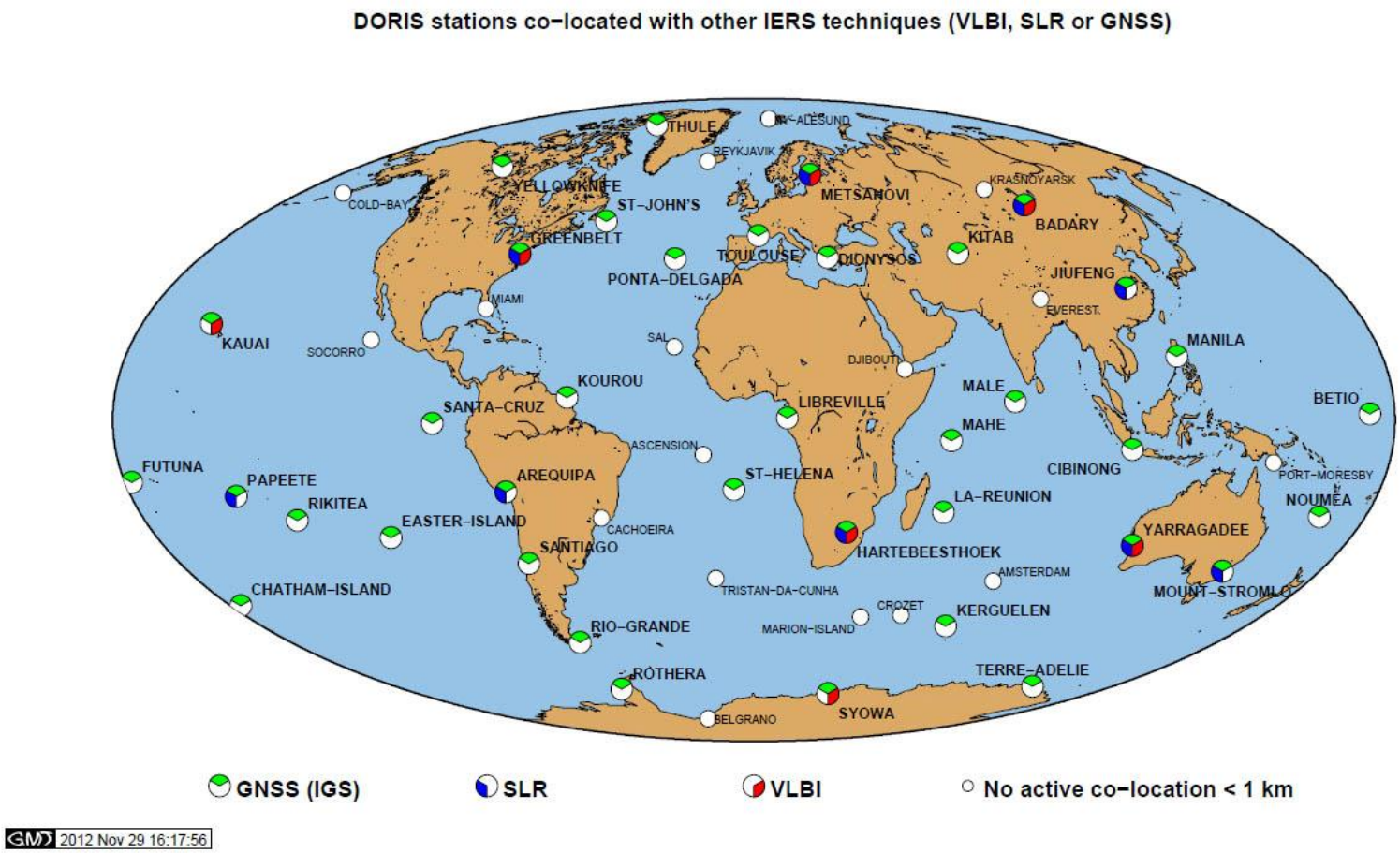

Fig. 1: The permanent DORIS network – 56 stations (as on Dec. 2012).

2 IDS Governing Board

The term of the Governing Board (GB) expired on December 31, 2012. The elections were held in the autumn 2012 in accordance with the new version of the Terms of Reference (ToR) and the procedures defined at the meeting of the Governing Board on June 1st, 2012 in Prague. Because of the set up of the GB partial renewal process with election every two years, only 3 elected positions were renewed this time: Analysis Center representative, Data Center representative, 1 member at large. The composition of the new Governing Board is given in Table 2.

Name	Institution	Country	Mandate
Richard Biancale	CNES	France	Member at large
Pascale Ferrage	CNES	France	System representative
Frank Lemoine	GSFC	USA	Analysis Coordinator
Brian Luzum	USNO	USA	IERS representative
Guilhem Moreaux	CLS	France	Combination Center representative
Carey Noll	GSFC	USA	Data flow Coordinator
Michiel Otten	ESOC	Germany	IAG representative
John Ries	U. Texas/CSR	USA	Member at large
Jérôme Saunier	IGN	France	Network representative
Laurent Soudarin	CLS	France	Director IDS Central Bureau
Pascal Willis (chair)	IGN/IPGP	France	Analysis Center representative

Table 2: Composition of the IDS Governing Board (from January 2013)

3 IDS Central Bureau

3.1 IDS Web and ftp sites

The IDS Central Bureau (CB) maintains the IDS web (http://ids-doris.org) and ftp (ftp://ftp.ids-doris.org/pub/ids) sites. The main updates of 2012 are reported hereafter.

- In February, a new set of tools, we called Plot tools, has been implemented on the IDS website to interactively build and display graphs of DORIS station coordinates time series and orbit residuals (see Section 3.3)

- The presentations of the AWG meeting held on May 31 & June 1, 2012, in Prague, Czech Republic, were put on line on a dedicated page (http://ids-doris.org/report/meeting-presentations/ids-awg-05-2012.html).

- The presentations of the IDS Workshop and of the AWG meeting held in Venice on September 2012 have been made available (http://ids-doris.org/report/meeting-presentations/ids-workshop-2012.html)

- Several activity reports were added (IDS Activity report for 2011, 2010 and 2011 Reports for IERS) as well as the minutes of the IDS GB meetings held in 2012 (http://ids-doris.org/report/governing-board.html).

- The list of the peer-reviewed publications related to DORIS has been enriched with 6 new references of articles published in 2012 (http://ids-doris.org/report/publications/peer-reviewed-journals.html#2012). With the exception of a few number of articles, they can be accessed directly or with their DOI link.

- A new version of the site logs has been provided by IGN, with coordinates expressed in ITRF2008. They can be seen on the IDS website (http://ids-doris.org/network/sitelogs.html).

New documents and files were put on the IDS ftp site, in particular a new version of the document describing the DORIS satellite models implemented in CNES POE processing. It includes HY-2A. (ftp://ftp.ids-doris.org/pub/ids/satellites/DORISSatelliteModels.pdf)

3.2 IDS Mail system

Several types of emails are distributed by the IDS Central Bureau:
- DORISMail: general DORIS interest
- DORISReports: reports related to DORIS data and products
- AWG and IDS Analysis Forum: technical discussion between analysis centers, combination and coordination
- DORISstations: information about station events (data gap, positioning discontinuities)
Everyone is welcome to subscribe to any of these emails. See more details on http://ids-doris.org/report/mails.html.

3.3 Plot tools

The CB implemented on the IDS web site new plot tools to provide time series browsing in an interactively way (http://ids-doris.org/plot-tools.html)

This family of tools named Plot tools is composed of:

- STCD tool for station position time series (North, East, Up residuals).

- POE tool for CNES/POE statistics time series (satellite orbit residuals, amount of station measurements).

STCD tool and POE tool contain utilities for selecting sites or satellites, displaying time series, editing data, changing plot appearance, specifying scaling, downloading data, plots and graph statistics in several formats. They are

equipped with statistic tools for the calculation of mean, slope and weighted rms with respect to the slope (WRSD). Several series can be viewed and compared on the same graph. Complementary data about station and satellites events can also be displayed. A help online is available for both tools.

Station coordinates time series are generated from the STCD files provided by IDS Analysis Centers and available on the IDS Data Centers. STCD format description can be seen at:
http://ids-doris.org/documents/report/CB_STCD_format_v1.0.pdf.
Orbit performance time series are outputs of the CNES POE processing for the DORIS missions.
Satellite events are extracted from the list of the main events that occurred on the DORIS system elements with the exception of the station network.
Station events are extracted from the list of the main events that occurred on the DORIS station network (new sites, new antennae, removed sites, failures...) with information on data gaps, invalidated data...
Information about recent earthquakes are also obtained from USGS survey service and added to the station events data available for the Plot tools.

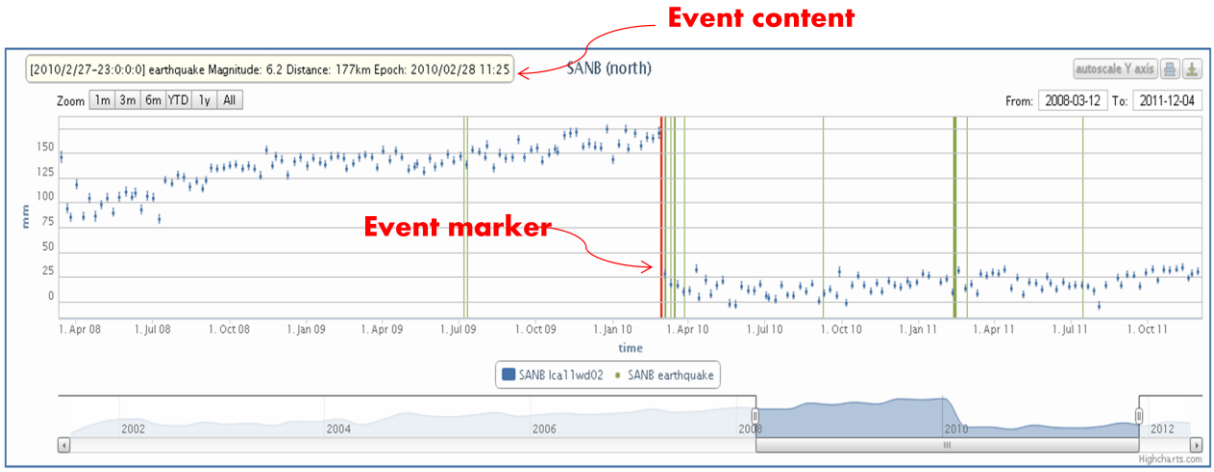

Fig. 2: Example of a position time series displayed with STCDtool: evolution of the North component of the DORIS station in Santiago with discontinuity due to the 2010 Chile Earthquake.

4 IDS Data Centers

The IDS data flow organization remains the same. It is based on two data centers: one on the East Coast of the U.S. (CDDIS at NASA GSFC) and one in Europe (IGN in France). They are both exact mirrors of each other, and so, are able to continue on an operational basis, even if one of them is inaccessible due to a temporary failure.

These two data centers archive the DORIS data as well as the IDS products (station coordinates and velocity, geocenter motion, earth orientation parameters, ionosphere data, etc.).

The main events of the year are listed hereafter:

- Data from HY-2A launched in 2011 are now archived in the IDS Data Centers, in data format 2.1 and in RINEX version 3.0 (phase data), as it is the case for the DGXX receivers on Jason-2 and Cryosat-2.

- Taking advantage of the recent GDR-C and GDR-D orbit reprocessing campaigns, CNES POD team redelivered the Envisat measurements to the IDS. This redelivery concerns arcs 001-255 (as since arc 256 the ionospheric field is corrected) and arcs 901-907, 910 (measurements available prior to arc 001, never delivered before).

- In the fall of 2012, the IDS Analysis Working Group requested a test data set where data from stations in the South Atlantic Anomaly (SSA) were reprocessed by applying corrective models. Data from 2011 in DORIS V2.2 format from the Jason-1 satellite (cycles 331 through 368) were submitted to the IDS data centers in late 2012; a set of 2011 SPOT-5 data (cycles 322 through 358) will be provided in early 2013. These files were submitted to the IDS data centers and archived in dedicated directories.

- A solution (designated “ids”) produced by the IDS combination center from the individual IDS AC solutions started production in 2012.

5 IDS Analysis Centers

All seven analysis centers that participated in ITRF2008 continue to remain active, participating in the IDS activities, with a very important commitment in the Analysis Working Group (AWG).

Acronym	Analysis Center	Country	Software package
ESA	ESOC	Germany	NAPEOS
GAU	Geoscience Australia	Australia	GEODYN
GOP	Geodetic Observatory Pecny	Czech Rep.	Bernese
GSC	GSFC	USA	GEODYN
IGN	IGN	France	GIPSY/OASIS
INA	INASAN	Russia	GIPSY/OASIS
LCA	CNES/CLS	France	GINS/DYNAMO

Table 3: List of IDS Analysis Centers routinely participating in the analysis activities in 2012.

The IDS held AWG meetings in Prague (Czech Republic, May 31-June 1, 2012), and in Venice (Italy, September 26, 2012). The meeting in Prague was hosted by the Czech Office for Surveying, Mapping, and Cadastre (COSMC), while the AWG meeting in Venice took place at the conclusion of the bi-annual DORIS workshop which was associated with the NASA ESA conference on satellite altimetry. At both meetings, the overarching concern was the planning for the data reprocessing to take place for the next ITRF. It is anticipated that the IERS will release a call for submissions in early 2013, with submission of the final SINEX files by the technique centers in early 2014. This would require the IDS ACs to finish their reprocessing of most of the 20-years of DORIS data by the end of 2013. Therefore, the decision on the models to use and what improvements to make in the modeling standards and analysis procedures were constant themes in both meetings.
The Prague AWG included 15 participants from the CNES, GFZ, GOP, GSFC, IGN, IPGP, LCA and the University of Luxembourg. The primary issues discussed included:
(1) A review of the first orbit determination results with HY-2A;
(2) A report on the ground calibration of the Starec DORIS antennae;
(3) Updates on the SAA models for SPOT-5 and Jason-1;
(4) A presentation of the results of a comparison campaign between the analysis centers for orbits and the values of the empirical accelerations;
(5) A review of the effect of atmospheric loading and its impact on geodetic data, and a discussion of a call to DORIS analysis centers to participate in an IERS analysis campaign to apply atmospheric loading at the observation level.

At both AWG meetings, updates were presented on the ground antenna calibration of the Starec antenna. The reports, presented by Cédric Tourain (CNES) showed that based on actual measurements of multiple Starec antennae in an anechoic chamber, the actual 2 GHz phase center differed from the phase center stipulated in the documentation by 17 mm. In addition the phase law – or

phase variation vs. elevation was measured and also compared with manufacturer specifications. All previous DORIS analyses have used the old specification of the phase center and have not applied a phase law. The implications of this drastic change are unclear – and it seems that testing is required by the DORIS analysis centers. Although the DORIS scale did not contribute to the ITRF2008, a discrepancy of 17 mm (~3ppb) was not observed between DORIS and the other geodetic techniques.

6 IDS Combination

IDS combination activities in 2012 were devoted to i) the pursuit of the IDS combination and the improvement of the operational chain, ii) preliminary studies for ITRF2013, and iii) the analysis of first series including HY-2A.

6.1 Routine combination

The main evolution in 2012 of both the evaluation and combination chains concerns the inclusion of EOPs. Therefore, every three months, in addition to stations positions, IDS Combination Center evaluates single EOPs series from Analysis Centers (X and Y pole as well as LOD). EOPs are evaluated with respect to 2 criteria: a) differences between DORIS EOPs and IERS C04 series and b) in terms of EOPs formal errors.
The last quarter of 2012 was also devoted to the elaboration of a stacking chain to produce mean station positions and velocities over a time period. Some validation tests still remain, especially to check that internal ties are correctly handled.

6.2 Preliminary studies for ITRF2013

In preparation to the next ITRF (2013), the most complete time series provided by each Analysis Center were evaluated. The objectives of this exercise were to functionally test the new evaluation and combination chains with data before 2008, to size memory and CPU for ITRF2013 and to give first feedbacks to all the Analysis Centers.
Analysis of DORIS stations positions time series from IDS combined solution over time period 2000-2012 has revealed discontinuities not linked with geophysical phenomenon, but correlated with beacons frequency shifts. Indeed, some DORIS Analysis Centers did not handle properly the frequency offsets between the actual frequency of the transmitted signal at 2GHz by the beacons and its nominal value (2.03625 GHZ). The error, which resulted from using

standard station frequency value, was corrected by modifying the partial derivatives for bias estimation. This error mostly affected the estimated station height, introducing discontinuities in some of the Analysis Center solutions, which were consequently propagated into the combined solution as well as in the ITRF2008. This problem is now solved and consequently should affect neither the IDS combination, nor the future ITRF2013 solution.

6.3 First HY-2A analyses

At the end of 2012, 3 Analysis Centers (ESA, GOP and LCA) delivered multi satellites solutions including HY-2A. HY-2A which was launched on August 15th 2011 is the third DORIS satellite with the new DGXX DORIS receiver onboard (after Jason-2 and Cryosat-2). The analyses of these new series shown that adding HY-2A has no major impact on the series in terms of transformation parameters as well as on EOPs.

6.4 Future Plans

The activity of the IDS Combination Center in 2013 will be mainly devoted to the elaboration of the DORIS contribution to the next ITRF.

7 Meetings

In 2012, the IDS organized a DORIS Analysis Working Group (AWG) meeting in Prague, Czech Republic, on May 31 and June 1st, as well as the IDS Workshop and a second AWG meeting held in Venice in September.
All the presentations from the meetings are made available by the Central Bureau on the IDS website at:
http://ids-doris.org/report/meeting-presentations/ids-awg-05-2012.html
http://ids-doris.org/report/meeting-presentations/ids-workshop-2012.html
http://ids-doris.org/report/meeting-presentations/ids-awg-09-2012.html

8 Publications

IDS published a 2011 activity report that was broadly distributed to all DORIS participants and relevant services (see http://ids-doris.org/report/governing-board.html#activity).

All DORIS related articles published in international peer-reviewed journals are available on the IDS Web site http://ids-doris.org/report/publications/peer-reviewed-journals.html.

Conclusions

In conclusion, the DORIS community had a productive year in 2012. The IDS has started several validation studies in preparation for ITRF2013, involving the Analysis Centers and the Combination Center. A few problems were detected and most of them are now solved. Improvements in the accuracy of the DORIS-derived geodetic products are expected for the future combined solution, at least for the polar motion determination and also most probably for station positioning.

The IDS noted with regret the demise of Envisat in April 2012, after 10 years of operation (since March 2002). This means that the DORIS operational combination relies on four satellites (SPOT-4, SPOT-5, Jason-2, and Cryosat-2) after April 2012, pending the assessment of the utility of the HY-2A DORIS data. However, several new satellites equipped with DGXX instruments should be launched in the near future, starting with SARAL in 2013.

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