The International DORIS Service: Current Status and Future Plans

Laurent Soudarin, Pascal Willis, Richard Biancale, Pascale Ferrage, Hugues Capdeville, Jean-Michel Lemoine, Brian Luzum, Guilhem Moreaux, Carey Noll, Michiel Otten, Jérôme Saunier, Marek Ziebart

What is the IDS?

The International DORIS Service is an IAG service created in 2003

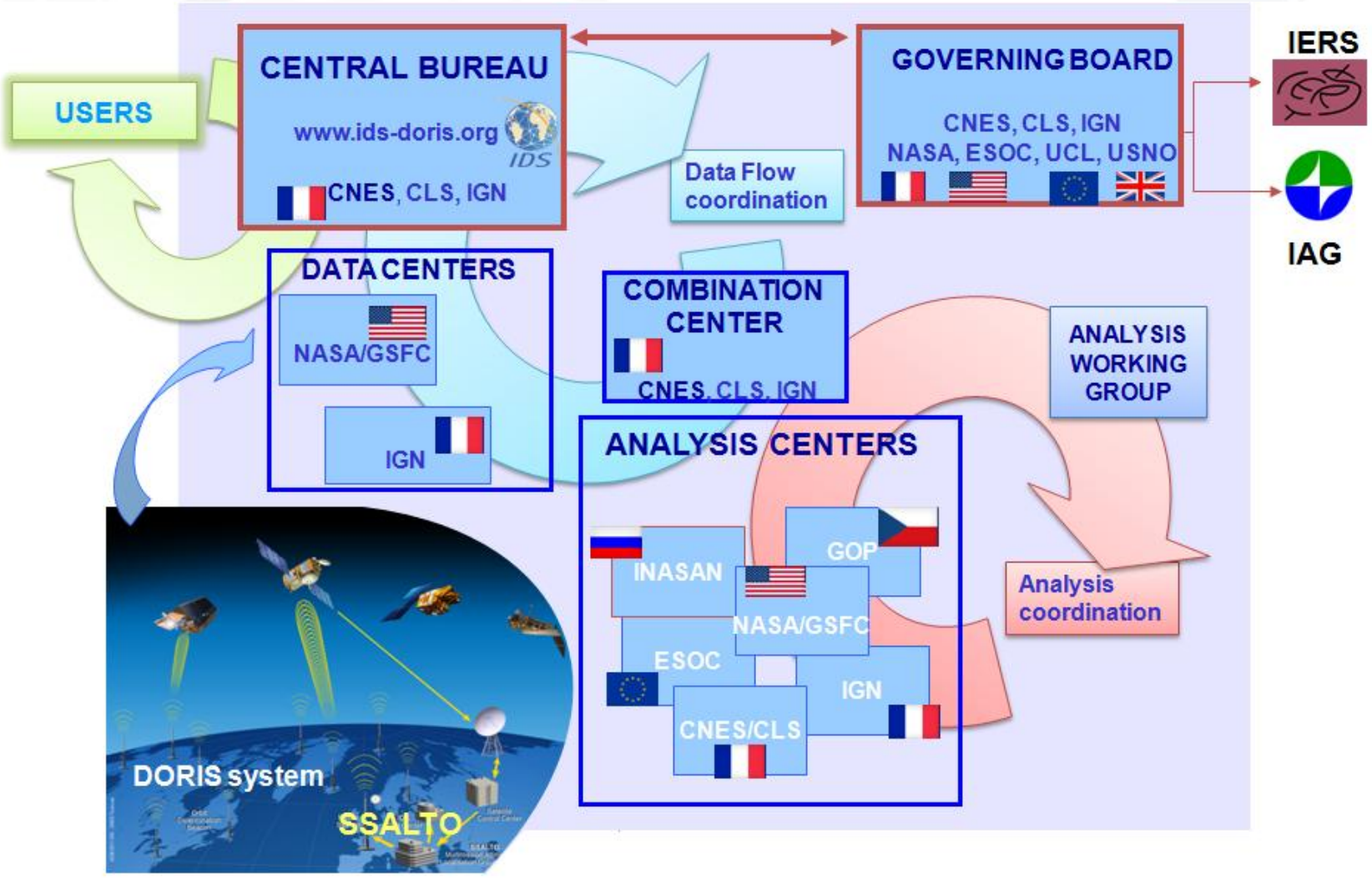
- To provide a support, through DORIS data and products, to geodetic, geophysical, and other research and operational activities
- To give access to data, derived products and informations related to the DORIS system

IDS submits DORIS solutions to IERS and participates in GGOS

IDS products

products	content	latency	sample interval	archive locations	format	provider	missions
station coordinates	time series of station coordinates differences	quaterly	1 week	CDDIS ; IGN	stcd	IDS CC, ACs	combination
orbits	orbit ephemerides	3-4 weeks	1 min	CDDIS; IGN	sp3c	ssa (official orbits), ACs	all satellites
geocenter motion	TRF origin solution	occasionally	1 week	CDDIS ; IGN	geoc	ACs	combination
Earth Orientation Parameters	polar motion	occasionally	1 day	CDDIS ; IGN	eop	ACs	combination
ionosphere	ionospheric corrections	week	10 s	CDDIS ; IGN	iono	ssa	en1, ja1, sp2, sp4, sp5, top
reference frame	station coordinate and velocity solution	yearly	global	CDDIS ; IGN	sinex	CC	combination
SINEX	series of station coordinate solutions	quaterly	1 week	CDDIS ; IGN	sinex	IDS CC, ACs	combination

IDS organization



IDS meetings

IDS Workshop: 1 every 2 year (with OSTST meeting in Europe)

Analysis Working Group (AWG) meeting: 1 or 2 every year

2016

- AWG Meeting, Delft, The Netherlands, 26-27 May 2016
- IDS Workshop, La Rochelle, France, 31 Oct. - 1 Nov. 2016

2017

- AWG Meeting, London, UK, May (TBC)
- First IDS Retreat (TBD)

AWG meeting in Delft

IDS life: latest news

- Frank Lemoine, new Analysis Center representative has been designated as the Chair of the IDS GB for 2017-2020

- CNES/CLS will operate the Combination Center for another 4-year term

- Creation of the WG « Near Real Time data »

Objective: to implement delivery of DORIS data in NRT for assimilation in ionospheric model and other potential rapid products

Chair: Denise Dettmering (DGFI/TUM)

Analysis activities in progress

- Combination Center: Extension of the combined series contributing to ITRF2014 from Jan. 2015 to June 2016
- CC: construction of the so-called DPO2014 (DORIS extension to ITRF2014 for POD) based on DORIS combined cumulative solution

  (see poster by Moreaux et al., G41A-1006)
- Analysis Centers: implement DORIS RINEX data processing
- ACs: include Jason-3 and Sentinel-3A
- ACs: switch to ITRF2014 for IDS operational products

Analysis activities to come

- Evaluation of DTRF2014, ITRF2014 and JTRF2014

Issues to be addressed:

- DORIS scale increase in 2012 → understood

  (see poster by Capdeville et al., G41A-1005)

- Scale issues on SPOT-5 (sawtooth pattern)

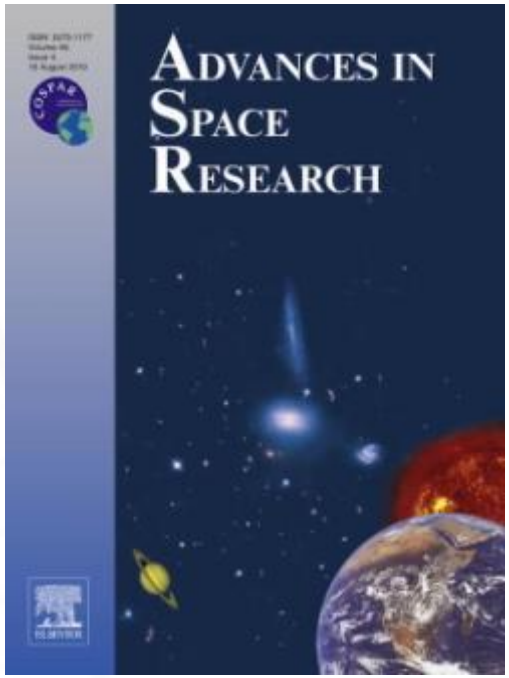
- Increase of DORIS residuals from Jan. 2013 for all missions

- Jason-2 and Jason-3 USOs: sensitivity to radiations of South-Atlantic Anomaly

- New phase law for ALCATEL ground antenna

DORIS Special Issue

« Scientific Applications of DORIS in Space Geodesy »
Advances in Space Research (Dec. 15, 2016. Volume 58, Number 12)



18 papers grouped under five themes:
(1) ITRF2014;
(2) DORIS Ultra Stable Oscillator (USO) -- Jason2;
(3) Precise Orbit Determination;
(4) DORIS System and Network
(5) Intertechnique comparisons of DORIS Products

Guest editors:
Frank G. Lemoine (NASA/GSFC, USA)
& Ernst J.O. Schrama (T.U. Delft, The Netherlands)

DORIS in a few words

Doppler **O**rbitography and **R**adiopositioning **I**ntegrated by **S**atellite

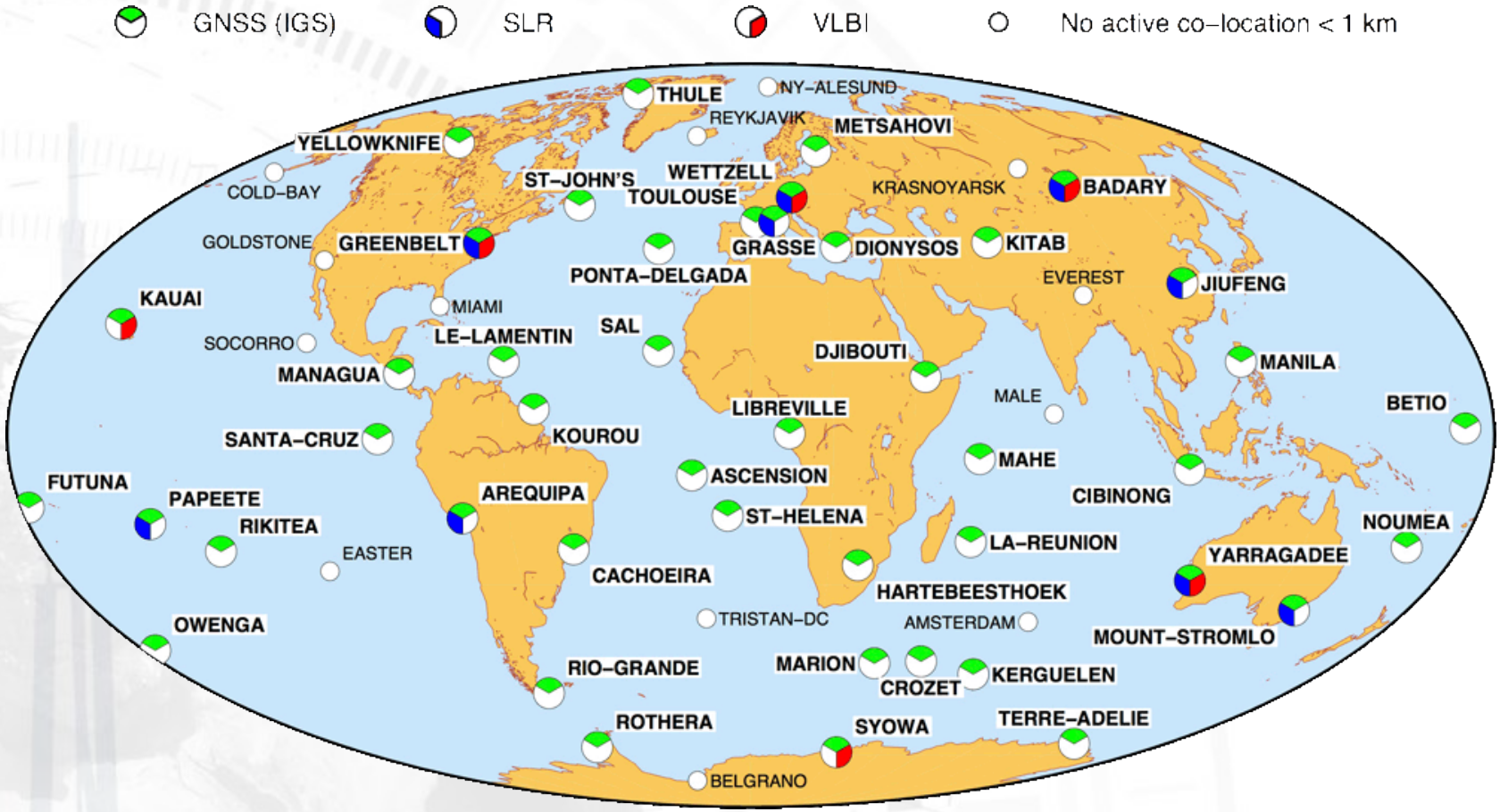
A satellite tracking system, designed for POD and high accuracy positioning

An uplift and centralized system based on:

- a network of emitting stations covering the globe
- onboard receivers able to track up to 7 stations simultaneously (DGXX receiver)
- a Control Center receiving the DORIS measurements at each satellite pass

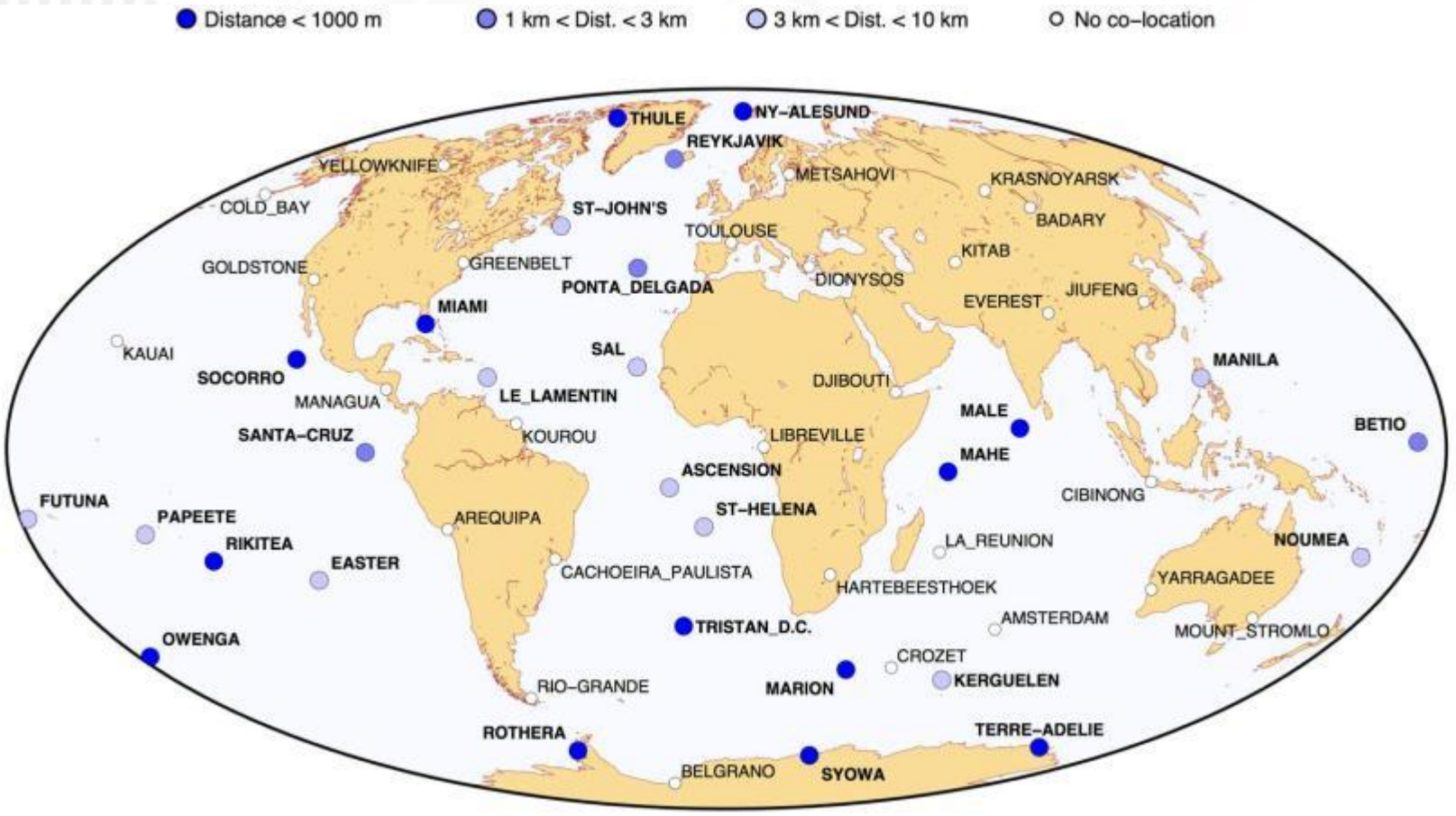
Co-locations with other IERS techniques

45 co-locations with GNSS, 9 with SLR, 6 with VLBI



Co-locations with tide gauges

28 co-locations: 13 within a 1km radius, 4 at 1-3km, 11 at 3-10km



Co-locations with VLBI

- A big challenge because of Electromagnetic Compatibility problems.
- While the VLBI system is designed to receive extreme weak signals down to –110 dBm, the DORIS beacon emits on a 2036 MHz frequency of +40 dBm
- Solutions found at Greenbelt and Wetzell with the VGOS stations after many DORIS/VLBI RF compatibility tests performed under real conditions

DORIS @ Wettzell: a good compromise

•VLBI: enough attenuation through distance and barrier
•DORIS: Operation on demand: 25% duty cycle, no effect on satellite reception
•DORIS: elevation mask around 10°: acceptable
•Co-location: excellent ties with VLBI, SLR, GNSS, SAR

Excellent collaboration between CNES/IGN and BKG to define installation requirements

DORIS antenna « WEUC » and 20m RTW

**(see presentation of Klügel et al., IDS Workshop 2016, on IDS website; also IDS Newsletter #2)*

Network evolution

- **RECENT EVENTS**
  - *Apr. 2016: **new station at Managua**, Nicaragua (near IGS station "MANA")*
  - *Jun. 2016: re-location at Kitab, Uzbekistan (major renovation to get better visibility)*
  - *Sep. 2016: **new station at Wettzell**, Germany (4th geodetic site including all four of the techniques)*
- **SHORT TERM (Next 6 Months):**
  - *San Juan, AR: **new station in place of Santiago** (3 techniques site)*
  - *Socorro, MX: restarting (equipment replacement)*
  - *Easter Island, Chile: relocating (hosting migration)*
  - *Guam, US: **new station** (near IGS station "GUUG").*
- **LONGER TERM:**
  - *Katherine, AS: **new station in place of Port-Moresby** (3 techniques site)*
  - *Ny-Ålesund, Spitzberg, NO: relocating to the new geodetic observatory (4 techniques site)*
  - *Changchun, CN: **new station in place of Yuzhno-Sakhalinsk** (3 techniques site)*
  - *Reykjavik, IS: relocating (site closure)*
  - *Tahiti, FR: **new 4 techniques site** under construction*

Developments in progress

- **4G beacon**

New electronic (with up to-date components)

Antenna cables allowing to install it up to 50m from the beacon

Initial deployment could start mid 2019

- **Radio frequency characterization of ALCATEL ground antenna** (1st generation, now fully removed)

Five Alcatel ground antenna have been characterized at CNES

A new phase law (*) have been defined, significantly different from the phase law defined in the IDS documentation

→ To be tested by IDS ACs

(see presentation of Manfredi et al., IDS Workshop 2016, on IDS website)

6 DORIS receivers operating in orbit

6 DORIS missions in flight with DGXX(S) receiver (7 channels)

- SENTINEL3A (ESA): 814km, 98.65° — February 16, 2016 → 2023 (+LR)
- JASON3 (NASA/CNES): 1336km, 66° — January 17, 2016 → 2021 (+LR)
- SARAL (CNES/ISRO): 800km, 98.5° — February 2013 → 2018 (+LR)
- HY2-A (CNSA, NSOAS): 960km, 99° — August 2011 → as long as possible (+LRA+GPS)
- CRYOSAT-2 (ESA): 717 km, 92° — April 2010 → end 2017 (+ LRA)
- JASON2 (NASA/CNES): 1336 km, 66° — June 2008 → 2017 (+LRA+GPS)

Several more to come

- SENTINEL3B (ESA) , 3C, 3D — 2018, 2020, 2025 (7 years + 3)
- HY2-C, 2-D (CNSA, NSOAS) — 2019, 2020 (3 years)

  HY-2 E, F, G, H To be confirmed — *2024*
- JASON-CS1/SENTINEL6A (Eumetsat/NOAA) — 2020 (7 years)

  Jason-CS2/SENTINEL6B — *2025 (7 years)*
- SWOT (NASA/CNES) : 970km, 78° — post 2021 (3 years)

- E-GRASP/Eratosthenes : an improved version of the proposal will be submitted to the new ESA/ Earth Explorer-9 call in 2017

A secure future up to 2030+

On board instruments:

D1, D2, DX, DXs: DORIS/versions, **S**:SLR, **G**:GNSS

Summary

- DORIS system working since 1990

Now: 6 satellites, 57 ground stations, 45 co-locations with othet IERS techniques

Future: several more satellites to come up to 2030+, 4G beacon in development

- International DORIS Service since 2003

Now: 6 analysis centers, 2 data centers, 1 combination center, CB, GB, AWG

2013-2015: contribution to ITRF2014

2016: 18 papers for DORIS special issue

Plan for 2017:

DORIS/RINEX format, ITRF2014-related issues to address, USO's sensitivy to SAA…

And beyond:

WG on NRT data

IDS retreat 2017 to prepare the future

Contact: ids.central.bureau@ids-doris.org

IDS Newsletters

http://ids-doris.org/report/newsletter.html

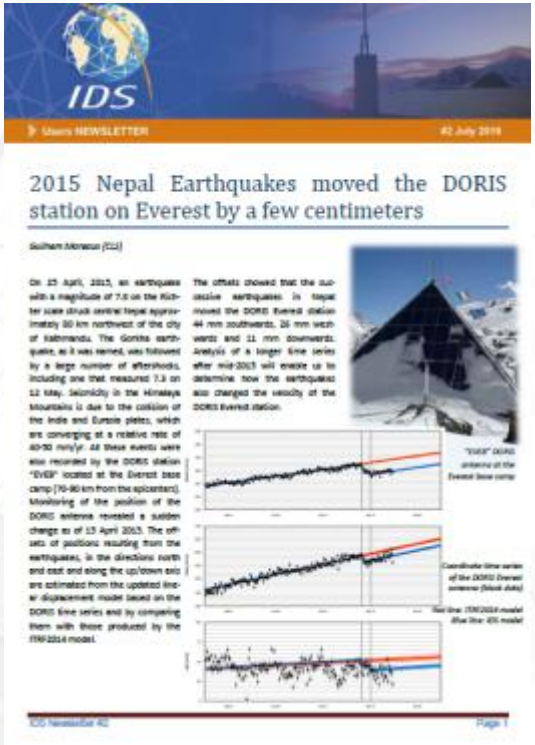
IDS

Users NEWSLETTER

Editorial

A high performing network

#1 April 2016



IDS

Users NEWSLETTER

2015 Nepal Earthquakes moved the DORIS station on Everest by a few centimeters

#2 July 2016

IDS

Users NEWSLETTER

#3 December 2016

IDS held its Workshop 2016 in La Rochelle

Laurent Soudarin (CLS)

The IDS Workshop 2016 was held in La Rochelle, France, on October 31 and November 1, in conjunction with a SAR Altimetry Workshop and the 2016 Ocean Surface Topography Science Team meeting. About 50 people participated in the Workshop. The program was divided into four sessions, during which 24 contributions were presented. The PDF versions are available on the IDS website for viewing or downloading.

The second session focused on Precise Orbit Determination (POD) and orbit modeling. It covered items such as the potential sensitivity to radiation of the DORIS oscillators on Jason-3 and Sentinel-3A, the time-tagging method for DORIS measurements in RINEX data files, and the development of DPOD2014, the new version of the DORIS-oriented Terrestrial Reference Frame for POD.

Attentive audience at IDS Workshop 2016

The third session was devoted to the recent completion of the International Terrestrial Reference Frame (ITRF2014), which provided the opportunity to look back on DORIS's contribution and address the issues raised during and after its development. Zuheir Altamimi, Head of the ITRS Center, reviewed the main DORIS results of the ITRF2014 analysis, while other speakers presented assessments of the uses of ITRF2014 for orbit determination.

The last session was an open forum on research activities and new applications. The DORIS-DIODE navigator's onboard computation of Earth Pole coordinates was highlighted. These promising results could benefit the IERS Rapid Service. DORIS observations were also shown to provide significant input for ionosphere modeling with a higher temporal resolution. The need for near real time DORIS data for operational ionospheric mapping and prediction processing was expressed. The message was clearly received by IDS, which proposed the creation of a "Near real time data" working group.

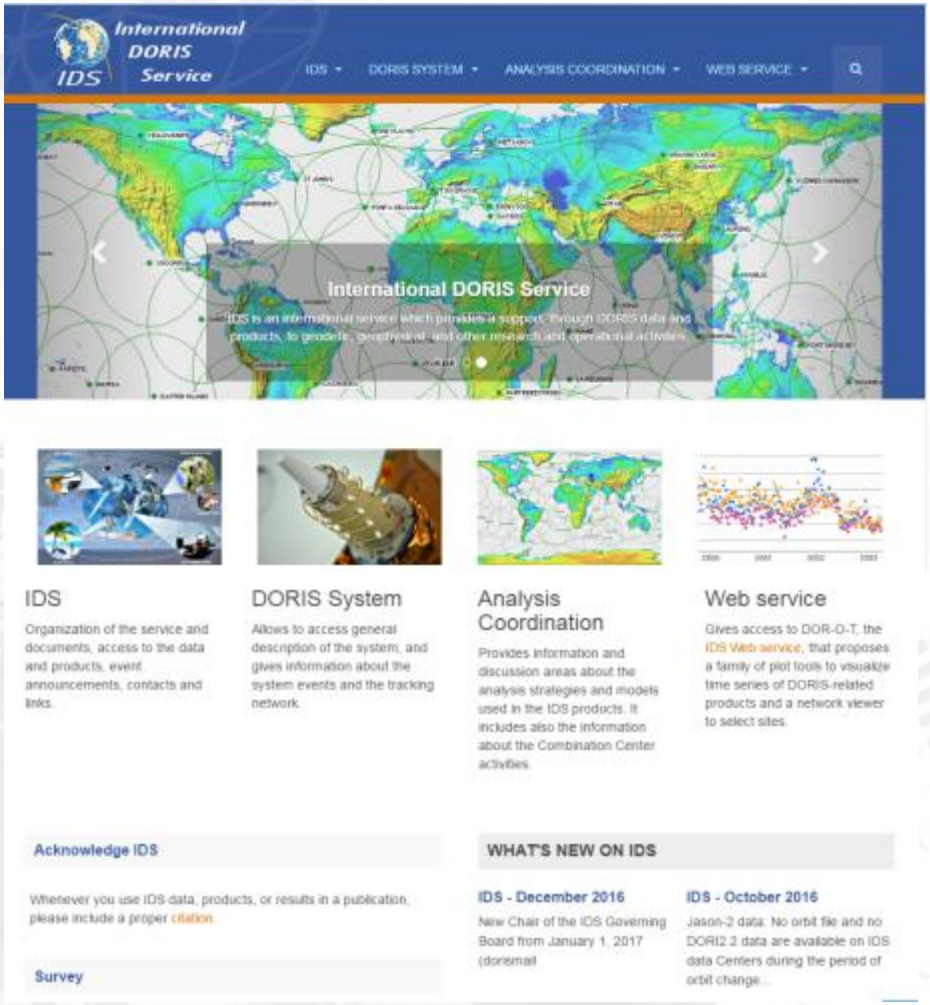
Pascal Willis, Chair of the Governing Board, closed the Workshop with a final presentation in which he reviewed IDS achievements and mapped out options for the future.

The objective of the first session was to present the status and developments in the DORIS network and constellation, whose main features are reported in this issue. Thomas Klügel from BKG presented the VLBI-DORIS compatibility tests performed at the Geodetic Observatory Wettzell with CNES and IGN prior to the installation of DORIS in September 2016, making Wettzell a new GGOS core site.

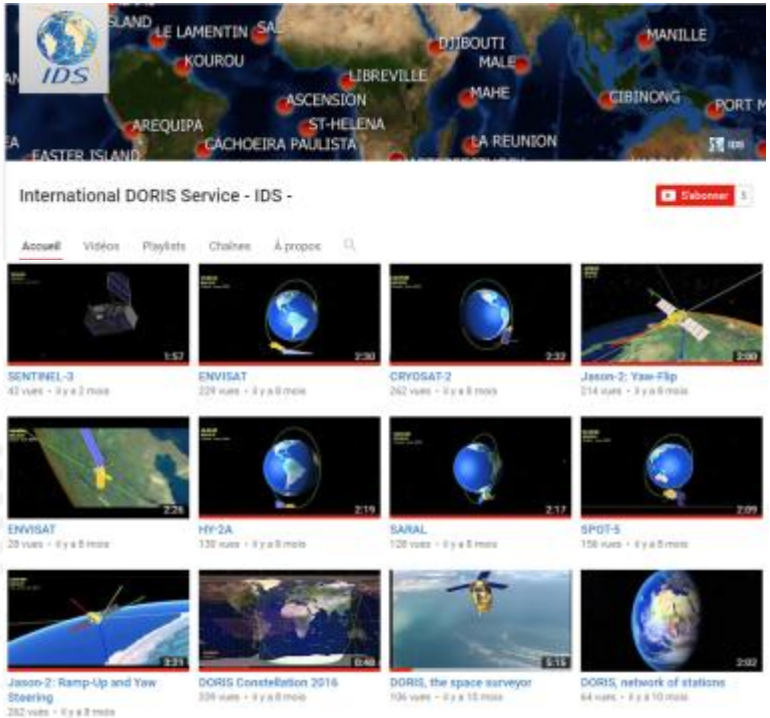
IDS Newsletter #3 Page 1

#3 December 2016

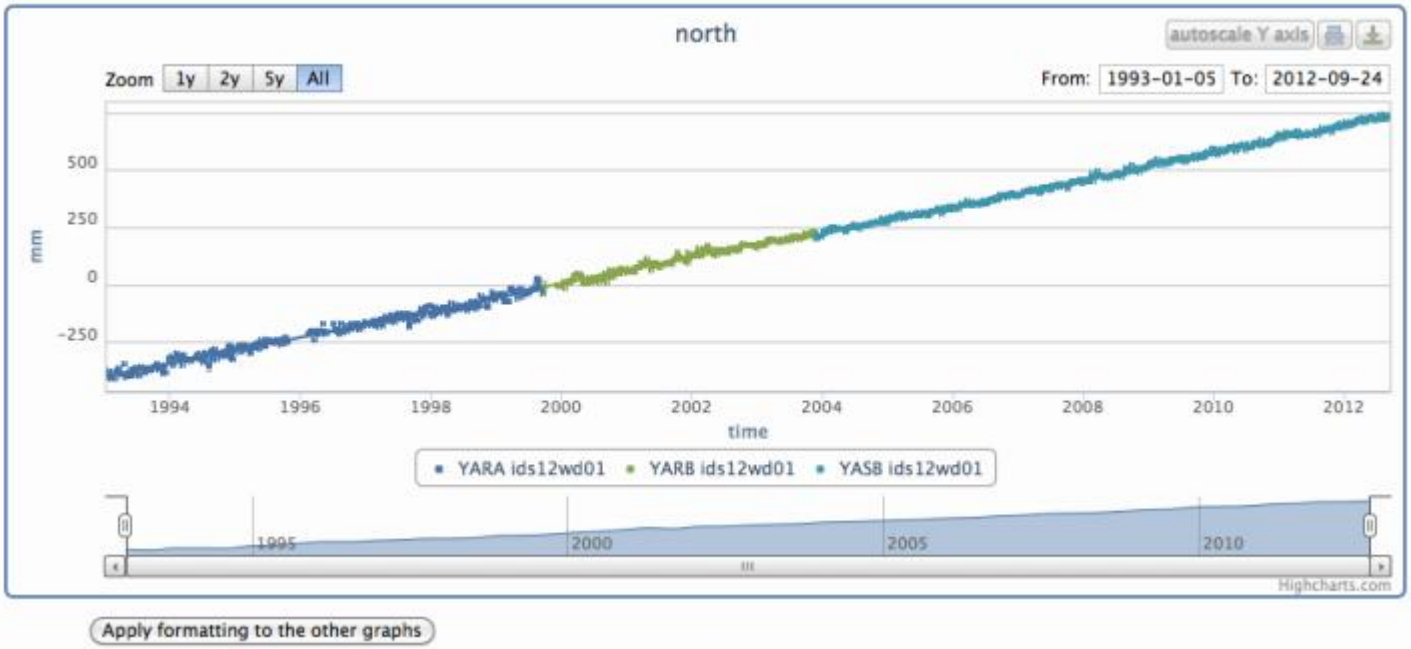
IDS web site
http://ids-doris/org



NEW: YouTube channel



IDS webservice
http://ids-doris.org/webservice

To visualize time series of DORIS-derived products

- Station positions
- Orbit residuals
- EOP
- Combination parameters (TRF scale and translations, position RMS…)