



## 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.

with CNES and IGN prior to the installation of DORIS in September 2016, making Wettzell a new GGOS core site.

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.

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.



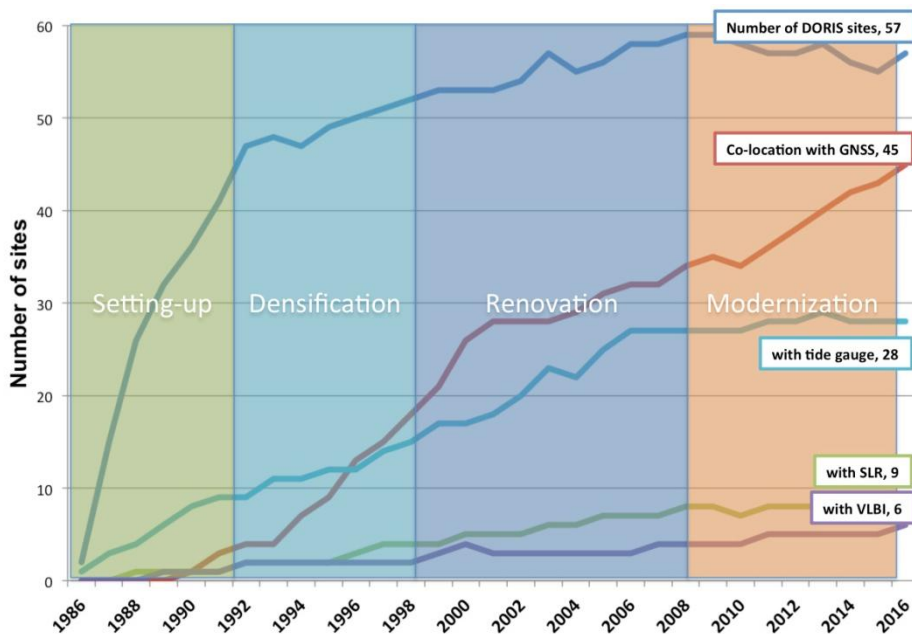
*Attentive audience at IDS Workshop 2016*

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

# Looking back over 30 years of DORIS network development

Jérôme Saunier (IGN)

The latest IDS workshop was an occasion to look back over the last 30 years since the start of the DORIS network deployment. There are four main phases in the network evolution. After the setting-up, densification and renovation phases, we are today in the modernization phase, with a number of ongoing actions to make the DORIS network even more robust and maintain the desired level of performance. They include constant monitoring, standardization of monumentation, regular assessment of performance and enhancements to equipment.

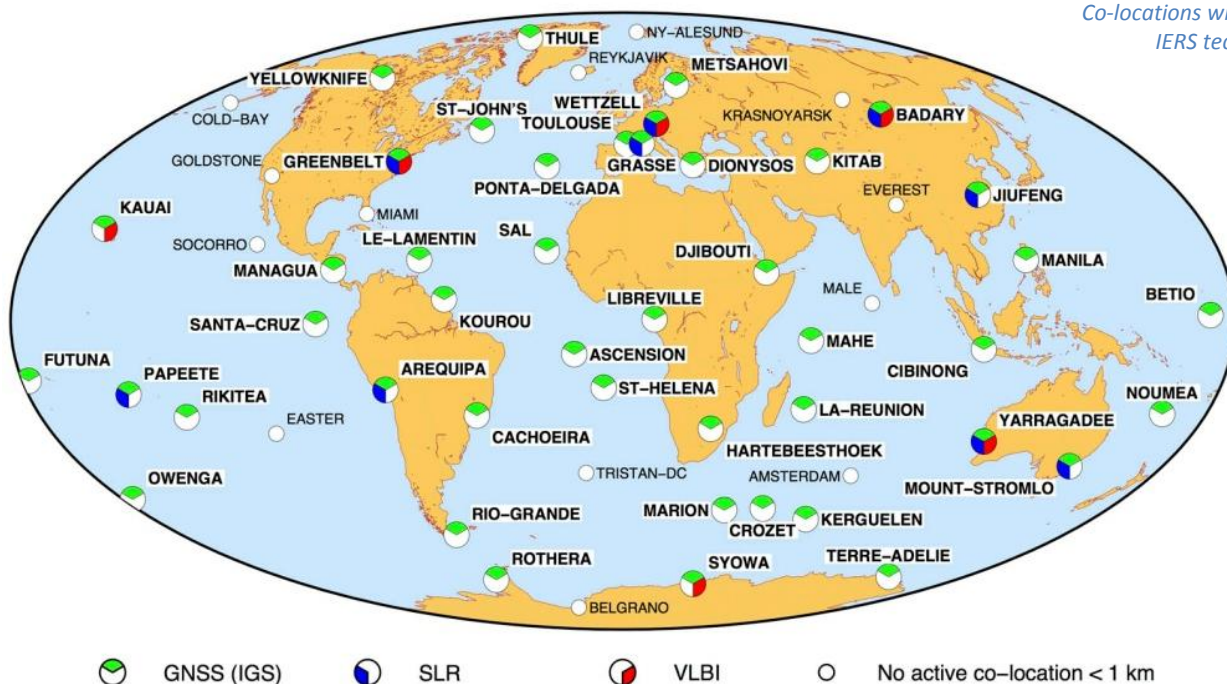


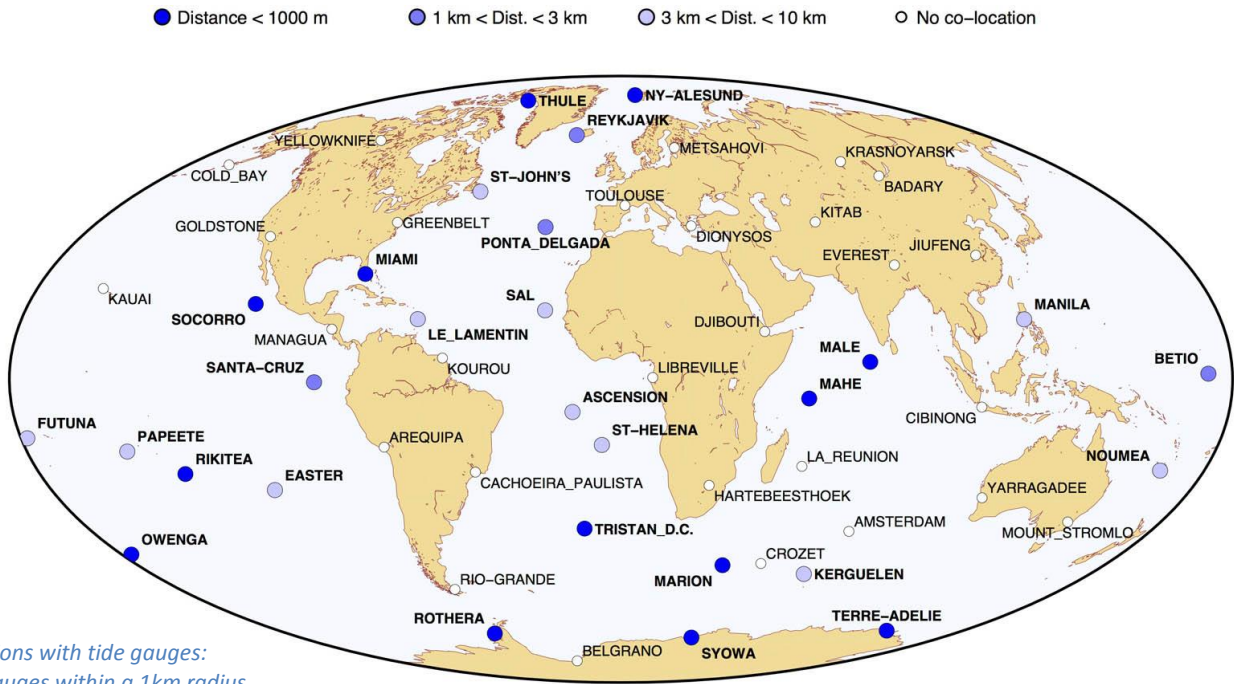
DORIS network development

At the same time, we have continuously increased the number of stations co-located with other space geodetic techniques, this being a permanent objective throughout the network's development. Today, 45 DORIS stations out of 57 are co-

located with GNSS, nine with SLR and six with VLBI, with a good North-South distribution. Wettzell (Germany) is the fourth geodetic site that includes all four techniques following the installation of DORIS last September. The other geodetic sites occu-

pied by the four techniques are Badary in Russia, Greenbelt in the USA, and Yarragadee in Australia. Co-located sites are essential for International Terrestrial Reference Frame determination.





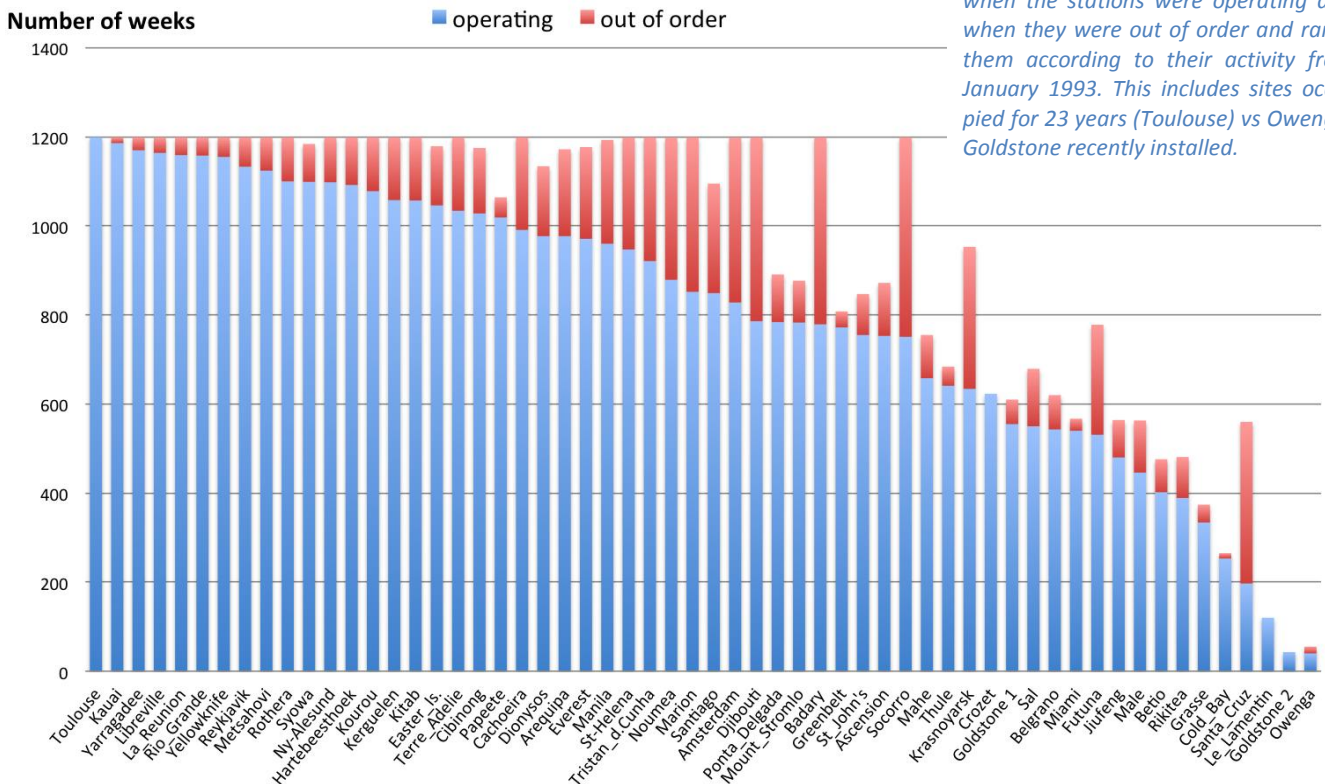
Co-locations with tide gauges:  
 13 tide gauges within a 1km radius,  
 4 at 1-3km, 11 at 3-10km

Another major objective for the DORIS network is to co-locate with tide gauges. About half (28) of the current stations are located on islands or in coastal areas close to tide gauges so as to contribute to the estimation of vertical land motion and monitoring of sea level. Co-location surveys have been car-

ried out on each co-located site, in most cases (75%) by the IGN, following installation or maintenance operations. A full review of the survey reports since 1988 has revealed a gradual improvement in the determination of tie vectors, but only half of them have been determined to millimeter accuracy.

Finally, network reliability and performance have always been optimal thanks to a skilled maintenance service, which routinely overcomes the challenges of operating in remote areas. The network availability rate for 2016 should remain close to 90%.

### DORIS network activity from January 1993



This plot shows the number of weeks when the stations were operating and when they were out of order and ranks them according to their activity from January 1993. This includes sites occupied for 23 years (Toulouse) vs Owenga, Goldstone recently installed.

# Six DORIS receivers operating in orbit and several more to come

Pascale Ferrage (CNES)

The DORIS system is 26 years old and its performance remains unbeatable thanks to permanent enhancements to the system and its components. Thirteen DORIS receivers have flown on various Earth observation and altimetry missions since 1990, and many future missions currently under preparation should guarantee a constellation of DORIS contributor satellites up to 2030 and beyond. There follows a brief overview of current and future missions.

## Current on-orbit constellation

Today, six satellites equipped with a DORIS receiver are contributing to IDS.

### **OSTM/JASON-2**

#### **(CNES/NASA/EUMETSAT/NOAA)**

The TOPEX/Poseidon and Jason-1 follow-on ocean observation mission was launched in June 2008. Jason-2 is flying the first 7-channel DGXX DORIS receiver allowing it to simultaneously track seven beacons. It also features a

new-generation USO offering better frequency stability while crossing the South Atlantic Anomaly. The satellite uses LRA and GPS as tracking systems. It is in the T/P-Jason orbit, i.e. non-sun-synchronous, 1336 km, 66° inclination.

**Cryosat-2**, an **ESA** satellite with a nominal lifetime of 3.5 years, was launched in April 2010. It is flying a DGXX DORIS receiver + LRA. This altimetry satellite dedicated to polar observation is designed to determine variations in the thickness of the Earth's continental ice sheets and marine ice cover, and to test the prediction of thinning Arctic ice due to global warming. It is on a non-sun-synchronous orbit with an inclination of 92° at an altitude of 717 km.

**HY-2A (CNSA/NSOAS)**, was launched in August 2011. It is flying a DGXX DORIS receiver + LRA + GPS. HY-2A is part of the Chinese marine remote sensing satellite series (HY-2A to HY-2D). It is flying on a 973-kilometer orbit at an inclination of 99°.

### **SARAL (joint ISRO/CNES mission**

with a nominal lifetime of five years) was launched in February 2013. It is flying a DGXX DORIS receiver + LRA. The SARAL mission has been an essential component of the altimetry constellation from 2013

onwards, re-occupying the long-term ERS and Envisat ground track (35 days, 800 km, 98.55°). SARAL/AltiKa is also providing the first demonstration of Ka-band altimeter capabilities for high-resolution along-track applications able to be used for coastal and inland water measurements among others, and which will be further developed for the future SWOT mission.

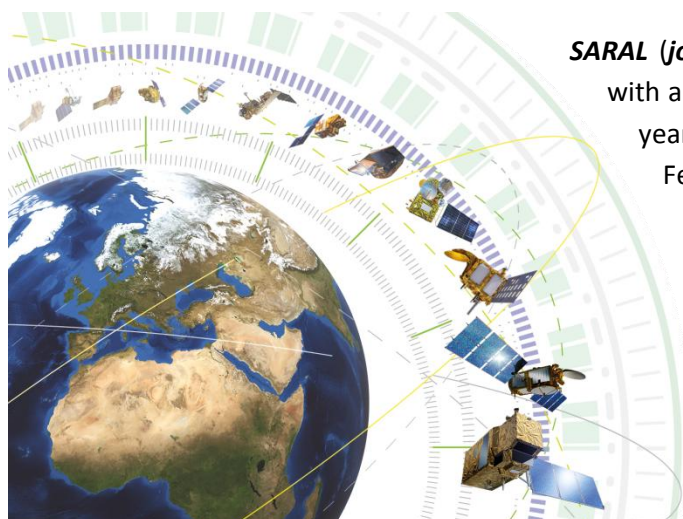
### **OSTM/Jason3**

#### **(CNES/NASA/EUMETSAT/NOAA)**

was launched on January 17, 2016. It is flying a DGXX-S DORIS receiver + LRA + GPS. Following on from TOPEX/Poseidon, Jason-1 and Jason-2, the Jason-3 satellite extends the high-precision ocean altimetry data record to support climate monitoring, operational oceanography and seasonal forecasting. Its orbit is the T/P-Jason orbit, i.e. non-sun-synchronous, 1336 km, 66° inclination.

### **Sentinel-3A (ESA/Copernicus)**

was launched on February 2016. It is flying a DGXX-S DORIS receiver + LRA + GPS. The Sentinel-3 satellite is part of the Copernicus program, a joint ESA-European Union project. Dedicated to Earth monitoring and operational oceanography, Sentinel-3A is on a slightly different orbit from the ERS, Envisat and SARAL orbit, though it is quite close (27 days, 814.5 km, 98.65°).



### Future DORIS missions

With many future missions lined up, DORIS will continue contributing up to 2030 and beyond.

**Sentinel 3B, Sentinel 3C and 3D (ESA/Copernicus)** are under development, and expected for end 2017, 2020 and 2025.

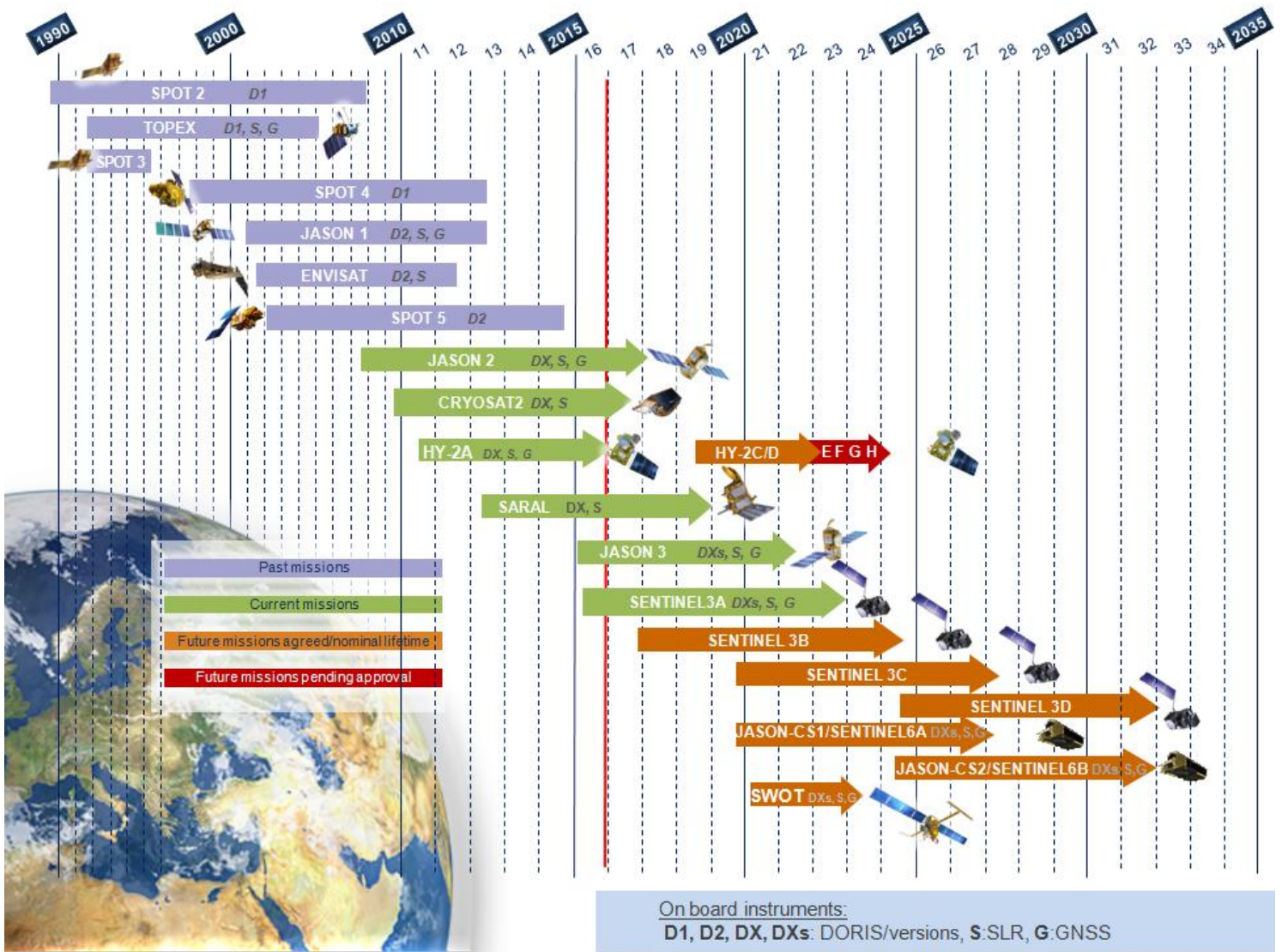
**SWOT** (Surface Water Ocean Topography) a joint project involving **NASA, CNES, the Canadian Space Agency and the UK Space Agency**, is planned for 2021.

**Jason-CS** will ensure continuity from Jason-3 with a first launch in 2020 (Jason-CS1/ Sentinel-6A) and 2025 (Jason-CS2 / Sentinel-6B). The Jason-CS / Sentinel satellites are part of the Copernicus program and are the result of international cooperation between **ESA, Eumetsat, the European Union, NOAA, CNES and NASA/JPL**.

**HY2-C, HY-2D (CNSA/NSOAS)** two Chinese missions flying DORIS planned for 2019 and 2020 respectively. A further four missions (HY2-E, -F, -G and -H) are pending approval and planned from 2024.

### Dedicated geodetic mission projects

Aiming at improving the TRF to a precision of 1 mm and a stability of .1 mm/yr and homogenizing TRF/CRF/EOP, the **GRASP** and **E-GRASP/Eratoshtenes** mission proposals were not selected in the NASA/Earth Venture Mission-2 and ESA/Earth Explorer-9 calls respectively. However and because ESA did select no mission at all, an improved version of the E-GRASP/Eratoshtenes proposal will be submitted to the new ESA/EE9 call in 2017.



## IDS election results

The Governing Board meeting held after the workshop in La Rochelle provided the opportunity to confirm the results of the IDS fall 2016 elections. Three new members were elected by the IDS Associates to sit on the Governing Board from January 2017 to December 2020.

Frank Lemoine (NASA/GSFC) will succeed Pascal Willis (IGN+IPGP) as the Analysis Centers' representative. Carey Noll (NASA/GSFC), who had been serving as the Data Centers' representative since 2003, has been replaced by Patrick Michael, CDDIS Deputy Manager. Denise Dettmering (DGFI/TUM) will take the seat of Richard Biancale (CNES/GRGS) as a member-at-large. Welcome to our new members!

In November, the Board elected Frank Lemoine to serve as the Chairman for the next four years from January 1st, 2017. Congratulations to him for this new duty.

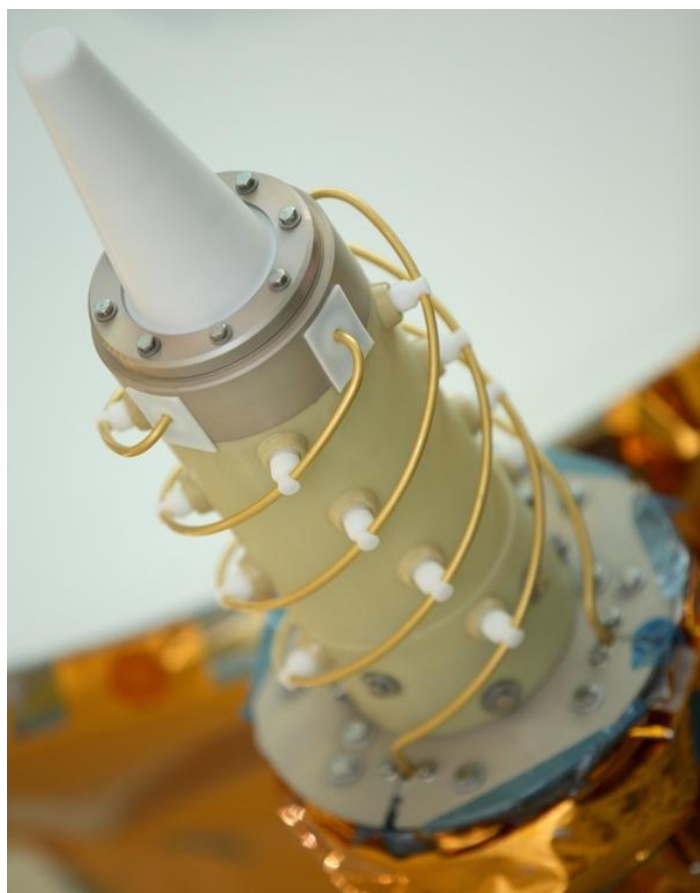
The IDS also gratefully thanks Pascal for his efficient service at the head of the Board over the last 8 years.



*Pascal Willis (left) and Frank Lemoine (right) at the IDS Workshop 2016*

## Combination Center selection

The call for proposals for the successor to the current Combination Center closed on October 15. Only one proposal was submitted, that of CNES/CLS which applied to continue the activities of the Combination Center. The GB has accepted the application and selected CNES/CLS to operate the IDS Combination Center for a further four-year period starting on January 1, 2017. Guilhem Moreaux remains the Combination Center representative on the GB.



*The DORIS on-board antenna*

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## IDS Newsletter

### IDS

11 rue Hermès  
Parc Technologique du Canal  
31520 Ramonville Saint-Agne, France

**Publication director: P. Ferrage**

**Editor-in-Chief: L. Soudarin**

**Contributors to this issue: P. Ferrage, J. Saunier,  
L. Soudarin**

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