



The International DORIS Service : new challenges

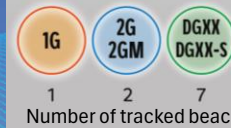
Laurent Soudarin (CLS), Frank Lemoine (NASA/GSFC),
Claude Boniface (CNES), Guilhem Moreaux (CLS),
Jérôme Saunier (IGN)

EGU General Assembly 2024, Vienna, Austria, 14–19 Apr 2024, EGU24-15590,
<https://doi.org/10.5194/egusphere-egu24-15590>, 2024.





3 generations of DORIS instruments



5 altitudes



4 orbit planes



The DORIS constellation 2023

Past missions

Spot-2	Spot-4	Spot-5
Topex	Jason-1	Jason-2
Spot-3	Envisat	HY-2A

Current missions

Cryosat-2	Sentinel-3A	Sentinel-6MF
Saral	Sentinel-3B	HY-2D
Jason-3	HY-2C	SWOT



We now have **9 active DORIS satellites!**

Challenges:

- **Every satellite is unique**, and requires special & careful treatment, for measurement and force modelling: e.g. Sentinel-6A, need to model self-shadowing; HY-2C, complicated attitude law, and no quaternions available; on SWOT, center-of-mass changes around orbit as the solar array rotates

Opportunities:

- Several current satellites have multiple tracking systems (**+SLR & GNSS**) → tri-technique processing
- The **GNSS and DORIS clocks are connected on the Sentinels** → model the rapid variations of the DORIS Ultra Stable Oscillator (USO) due to radiations, especially in the SAA area, with GNSS estimated clocks.

Next missions

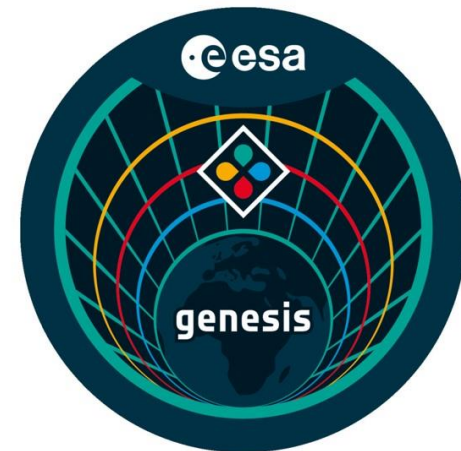


Five missions with DORIS in the next five years:

- Sentinel-3C (~2025)
- HY-2E (mid 2025)
- Sentinel-6C (Nov. 2025)
- Sentinel-3D (S3C + 2yrs)
- HY-2F (TBD)

GENESIS (2028): all four geodetic techniques on one dedicated satellite

- CNES is working with the GENESIS project and the historical manufacturer (Thales DMS) to get a DORIS DGXX-S instrument on this mission.
- Preliminary technical analysis carried out by CNES confirms that the instrument should be functionally operational at 6000km.
- The MEO altitude is a challenge (flattened Doppler, Doppler crossings, co-visibility of Master Beacons, ...) but can be addressed by adaptations of the instrument, the processing software tools, and system operations.



IDS fully supports this project and is ready to overcome these exciting challenges by promoting a close and open collaboration between the technical and scientific experts on all the components of the DORIS system and ESA GENESIS project team

DORIS system: ongoing actions



❖ **DORIS NEO**: a new onboard receiver in development (phase B in progress)

- New architecture considered
- Technological refresh with recent components and techniques

Objective: meeting the needs of future missions

❖ **Connection of beacons to atomic clocks** allowing a direct reading of the DORIS satellite oscillators

- Wettzell, Ny-Alesund and Yellowknife connected to masers (VLBI)
- in progress at Greenbelt, Hartebeesthoek, Kauai, Yarragadee

❖ **Connection of beacons to GNSS stations** to observe DORIS ground frequency behaviour

- Action getting started to connect DORIS to collocated REGINA stations (CNES/IGN GNSS network)

Network and colocations



The DORIS network has reached **60 stations**.

Co-located stations:

- 50 with at least one other IERS technique
- 29 with tide gauges.



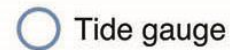
GNSS (IGS)



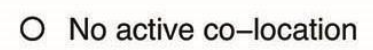
SLR



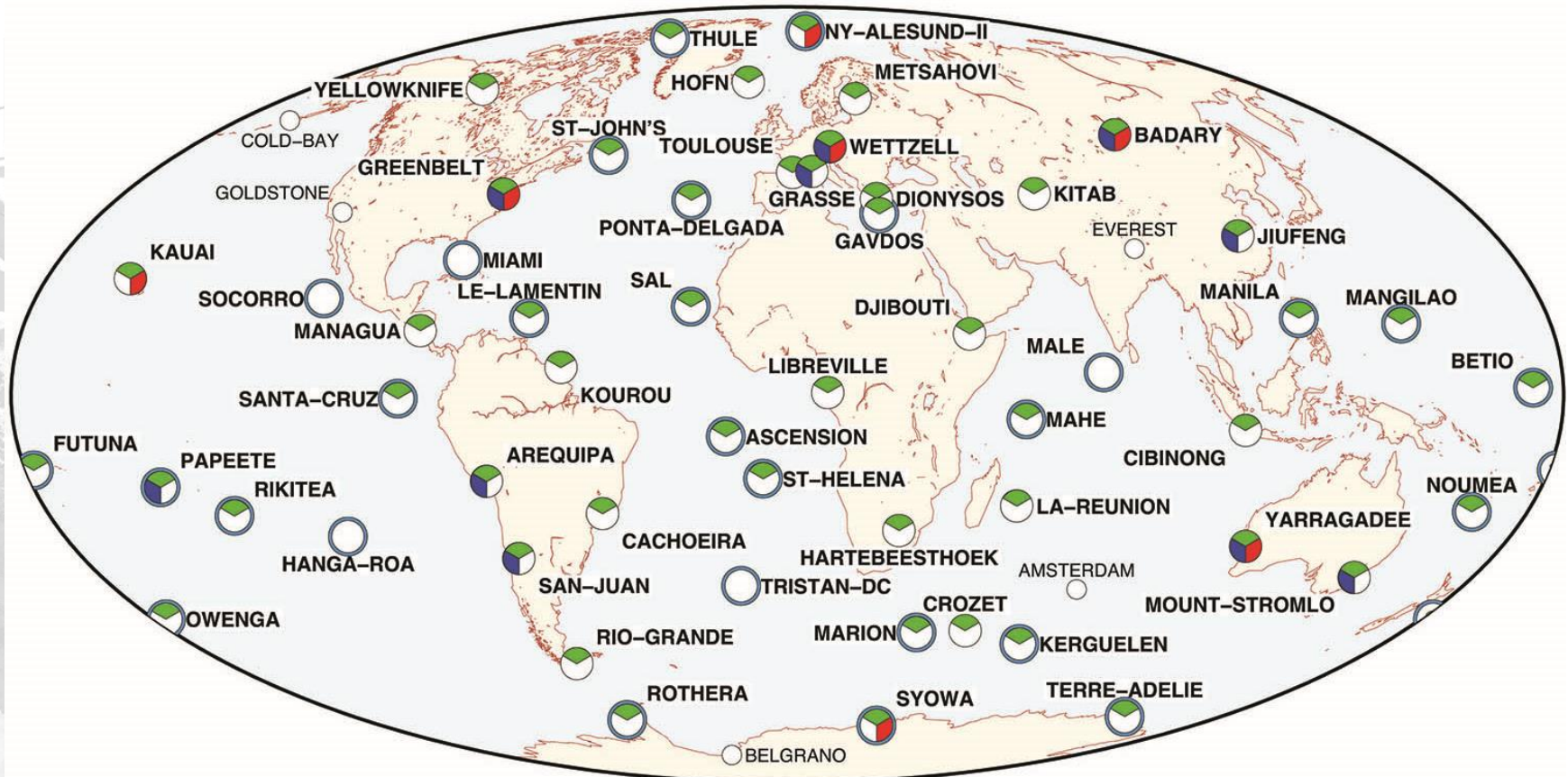
VLBI



Tide gauge



No active co-location



Network: contributing to POD and Geodesy



Maintaining a high level of service

- Network **reliability**: annual mean of **89% of active sites** over the year 2023
- Long time series: half of the network stations have more than 22 years of activity
- Balanced distribution of stations: filling gaps in coverage left by station closures
- Challenge: difficult geopolitical context / remoteness of certain stations

New equipment deployment improving network robustness and reliability

- **4th generation beacon** (deployment started in 2019)
 - **62% of the network** stations already equipped
- **Starec C antenna** (deployment started in 2014) :
 - **47% of the network** stations already equipped

Stations renovation improving the system performance

- Enhancing stations performance through antenna relocation, equipment upgrade, installation complying with the system requirements
- **Planned renovations:**
 - Le Lamentin, French West Indies (May 2024)
 - Cachoeira Paulista, Brazil (Sept. 2024)
 - Everest, Nepal (autumn 2024)

Goldstone



Network: ongoing development and outlook



Network densification

- **Objective = 70 stations** (+10)
- Improvement factor for the ITRF realizations and others scientific products
- Densification while improving geographic coverage, co-location and network robustness
- Challenge: oceans cover 70% of the Planet's surface!
- **New sites**:
 - Easter Island, Chile (Apr. 2023)
 - Gavdos, Greece (Sep. 2023)
 - Katherine, Australia (Jun. 2024)
 - Ulaanbaatar, Mongolia (Jul. 2024)
 - Kānpur, India (Nov. 2024) (IDS site!)
 - Changchun, China (2025?)
 - Tahiti, French Polynesia (2026?)



Easter Island (Hanga Roa)

Network station co-locations

- Continuing effort to co-locate DORIS with other techniques: Katherine, Kanpur, Tahiti
- **Performing local tie surveys** on the occasion of on-site operations to contribute to ITRF combination
- Challenge: RF compatibility with VLBI requiring 300m distance between instruments with no inter-visibility
- Objective: Preparing DORIS to GENESIS: co-location in space + on ground

IDS Analysis Activities



ITRF2020 extension (See G. Moreaux's presentation in session G2.2 Mon, 15 Apr, 16:30–16:40 Room G2)

June 2023: IERS call for ITRF2020 update

March 2024: the IDS Combination Center provides two time series covering 2021.0 - 2024.0.

A challenge

- 3 years of series provided by the Analysis Centers and combine by the Combination Center
- adding three satellites vs ITRF2020: HY-2C, HY-2D and Sentinel-6A

A motivation

Six contributing groups: **ESA, GOP, GRG, GSC** (contribution to ITRF2020) + **IGN, GFZ**

DPOD2020 v2.0

Cumulative solution based on ITRF2020 used as dynamic reference frame for DORIS POD.

Data span: 1993.0-2023.0

First version of the DPOD with DORIS only post-seismic and seasonal corrections

New Working Groups



Working Group « **NRT ionospheric application** » setup in progress

Near-Real-Time DORIS data = DORIS RINEX +
DIODE orbits with 3-hr latency

Positive use of Jason-3 DORIS NRT data to weight
the GNSS contribution of RT GPS Ionosphere
Models demonstrated by WG “NRT data”

Additional **NRT data will be made available for
Sentinel-3A, Sentinel-3B, Sentinel-6A, Saral, SWOT**

Objectives of the new WG can be:

- **Focus on applications in the ionosphere**
- **Promote the usage of NRT DORIS data** for
different applications, for example diagnosing
scintillations (*)

Chair: Ningbo Wang (AIR/CAS)

Working Group « **Integrated Clock Correction Strategies for DORIS** »

**Objective: to address the issue of DORIS clocks,
exploiting clock co-locations both in space and
on ground.**

In space: to correct DORIS clock inaccuracies with
clock corrections derived from GNSS data when
both techniques are connected to the same USO
(Ultra-Stable Oscillator)

Data: .clk files of Sentinel-3A&B, Sentinel-6A

On ground: to achieve a highly accurate
knowledge of the station frequency by making
use of ground-based clock co-location

Data: observation of DORIS frequency behaviour
by GNSS REGINA stations (*initiated action*)

**Chair: Patrick, Schreiner (GFZ) with members
from CNES, CLS, TUM, GFZ, GOP, PosiTim, GMV**

*See M.Cherrier's poster "Contribution of DORIS System to Global Ionospheric Scintillation Mapping" (ST4.4, Friday 19)

Next IDS events



Meeting of the Analysis Working Group

June 4 & 6, virtual

The agenda is limited to ACs, AACs, WGs and CC activities and innovations.

→ If you want to attend, contact ids.analysis.coordination@ids-doris.org

or ids.central.bureau@ids-doris.org

IDS workshop 2024

September 5 and 6, 2024

Venue: Le Corum in [Montpellier, France](#)

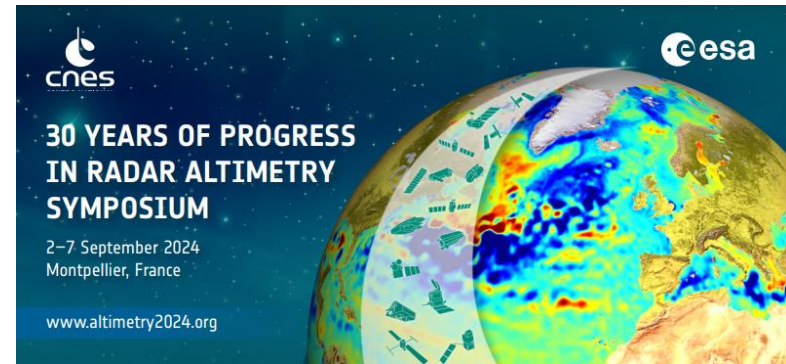
Organized as part of the "30 Years of Progress in Radar Altimetry" Symposium (ESA, CNES)

Topics: DORIS network and constellation / IDS processing and Terrestrial Reference Frame /

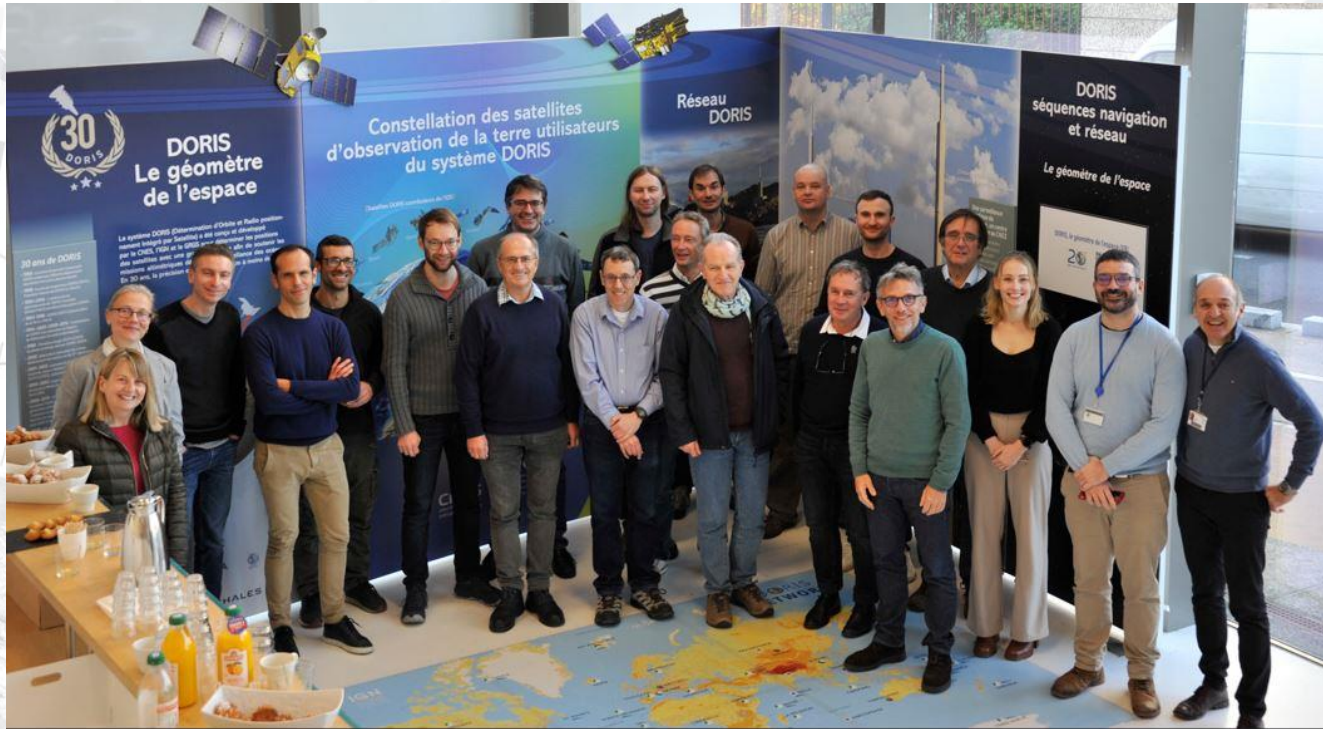
POD and modelling / Research activities and new applications.

→ The agenda is currently being drawn up

→ Logistical details: <https://www.altimetry2024.org/> (or via <https://ids-doris.org>)



Come and join the IDS community!



IDS Analysis Working Group Meeting,
Sainte Mandé, France; Nov 28-29, 2023



Flash here to visit
the IDS website

Contacts for more information

IDS Central Bureau: ids.central.bureau@ids-doris.org

