DORIS INFRASTRUCTURE

Status and Plan after 30 years of service

EGU2020: Sharing Geoscience Online G2.1

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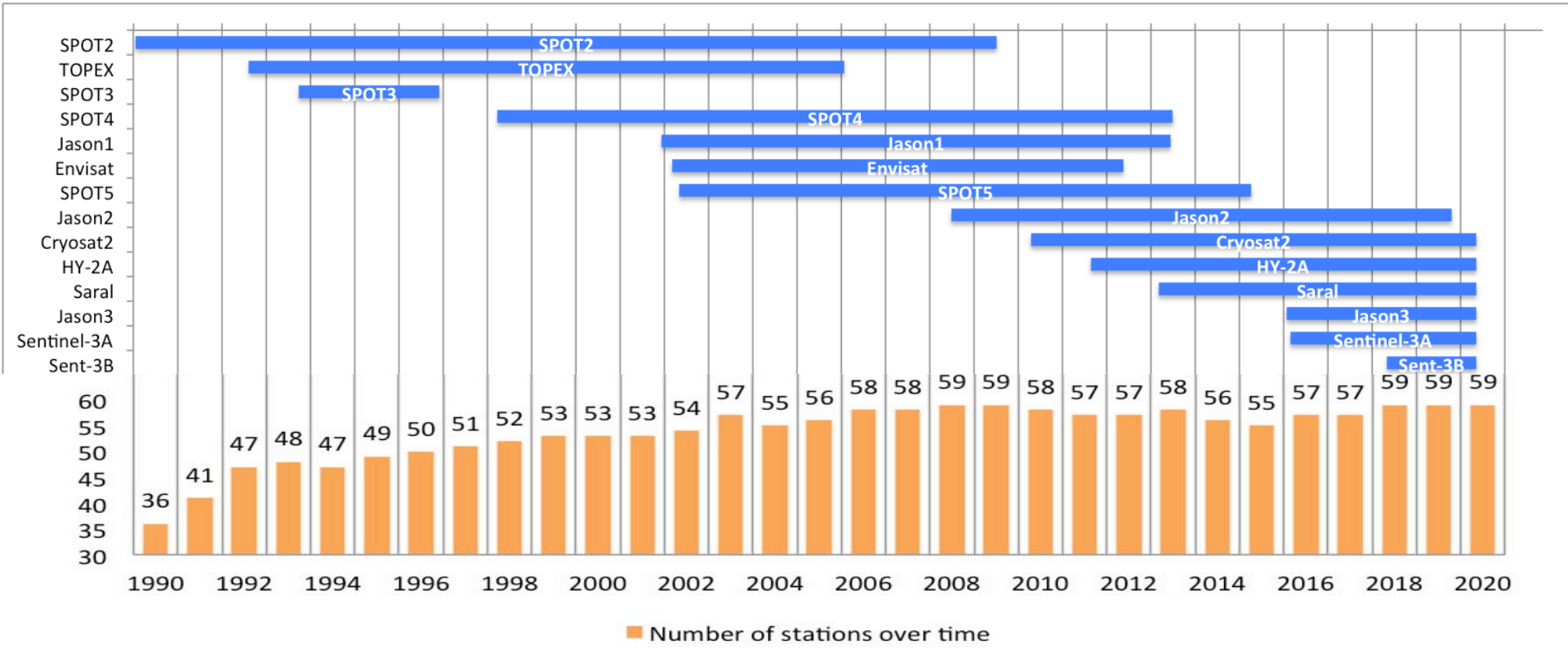
GENERAL POINTS (1/2)

A network dedicated to satellite altimetry for almost 30 years

- System fully mature since the early 2000s: 6 DORIS contributors satellites / 60 stations
- Coverage of about 90% for LEO satellites (when all DORIS stations are operating)



GENERAL POINTS (2/2)

A network built and managed by a single entity: CNES/IGN

- **Site selection criteria adjusted accordingly to the system requirements**
- **Full control of the infrastructure deployment**
- **Centralized maintenance**
- **Performance monitoring and technology development**

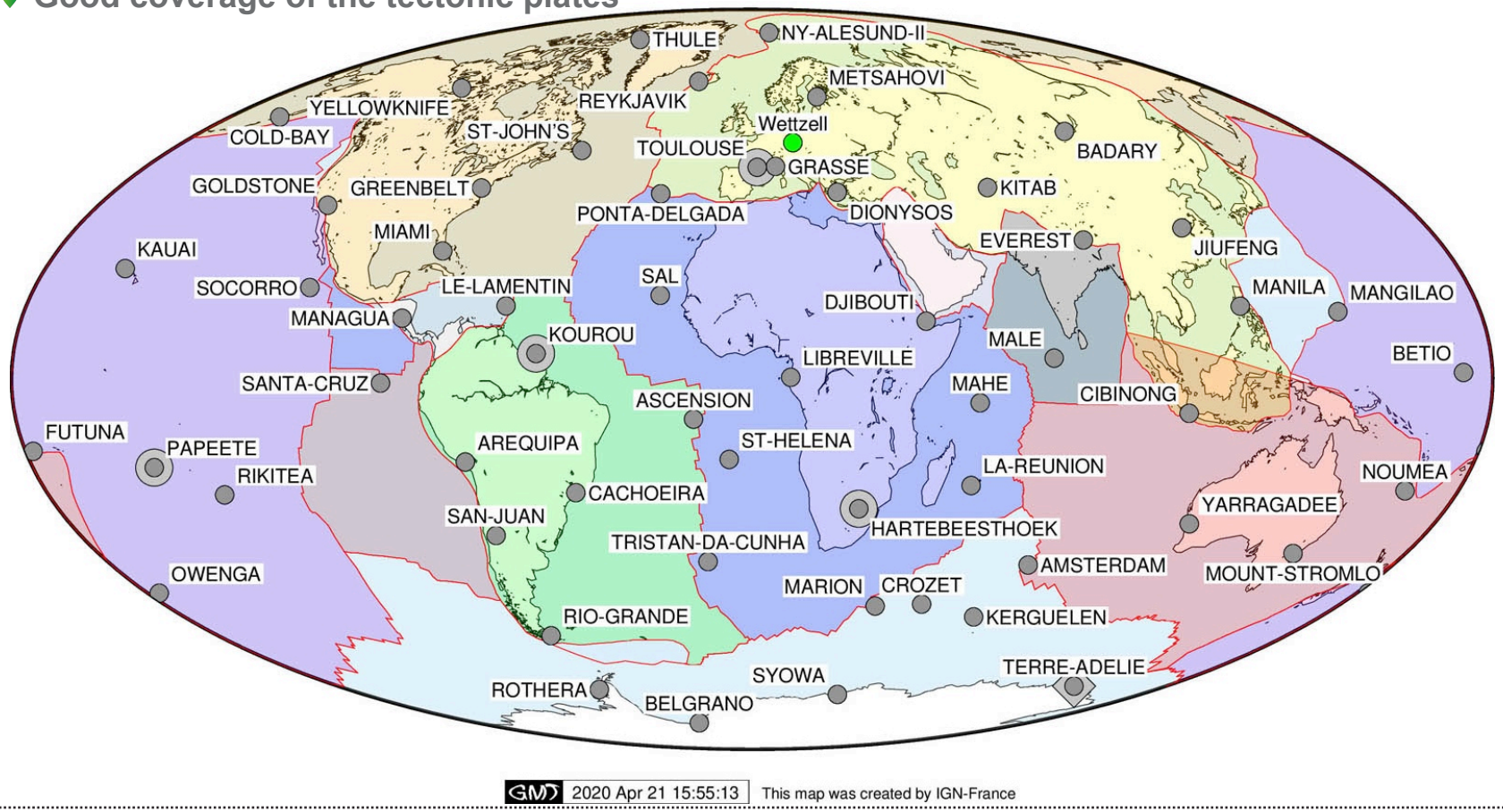
Network requirements:

- **Satellite altimetry:**
  - **ensure an almost constant visibility of at least one station by the on-board receiver**
  - **visibility of the ground stations (no obstructions above 5-10° elevation)**
- **Geodesy:**
  - **Stability of the ground stations monuments**
  - **Distribution over the tectonic plates**
  - **Co-location with other space geodetic technique and tide gauges**

STRENGTHS OF THE DORIS NETWORK (1/4)

Geographical distribution: very homogeneous

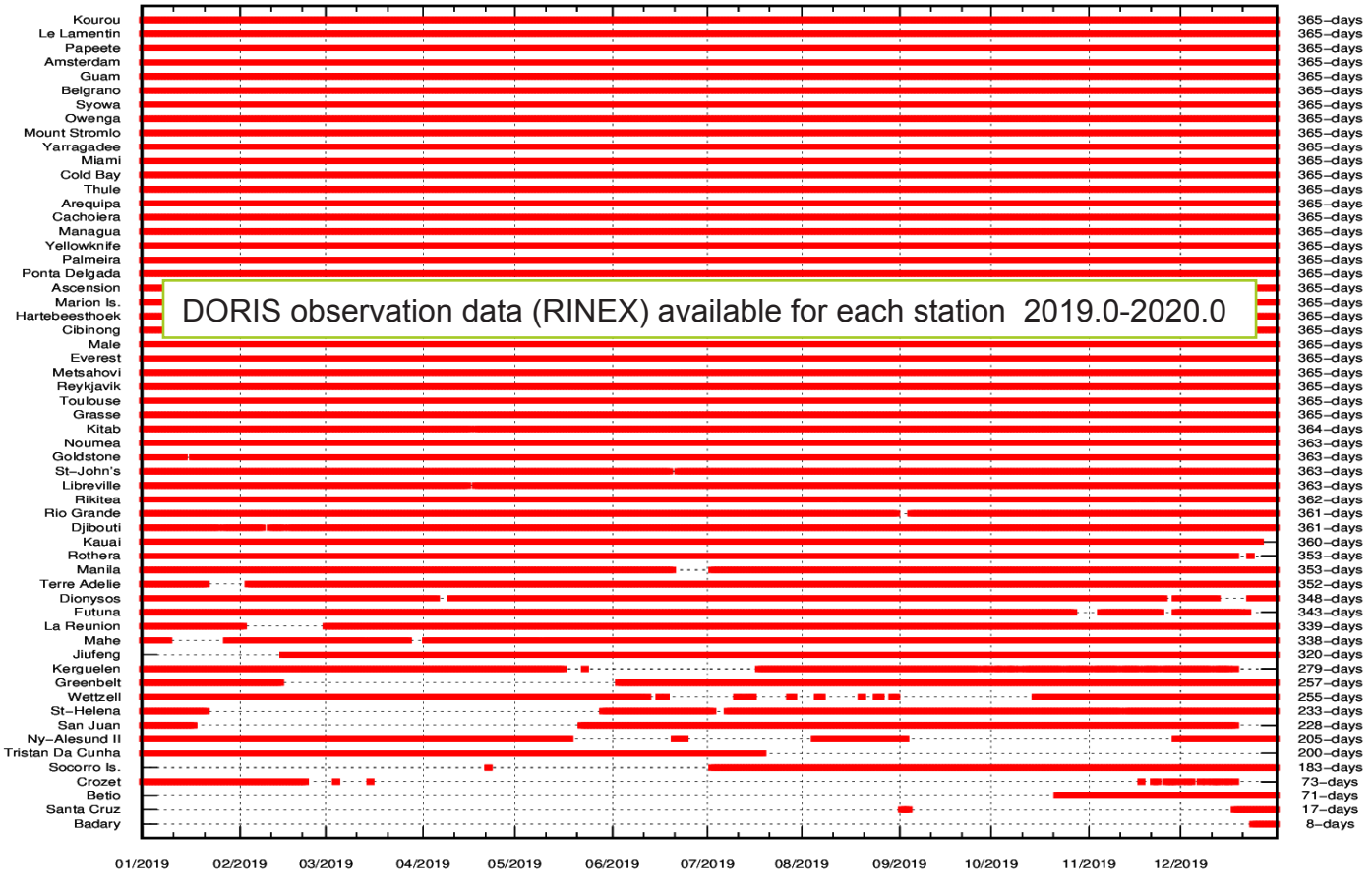
- More than half of the network located on islands or coastal areas (38 stations / 59)
- Good coverage of the tectonic plates



STRENGTHS OF THE DORIS NETWORK (2/4)

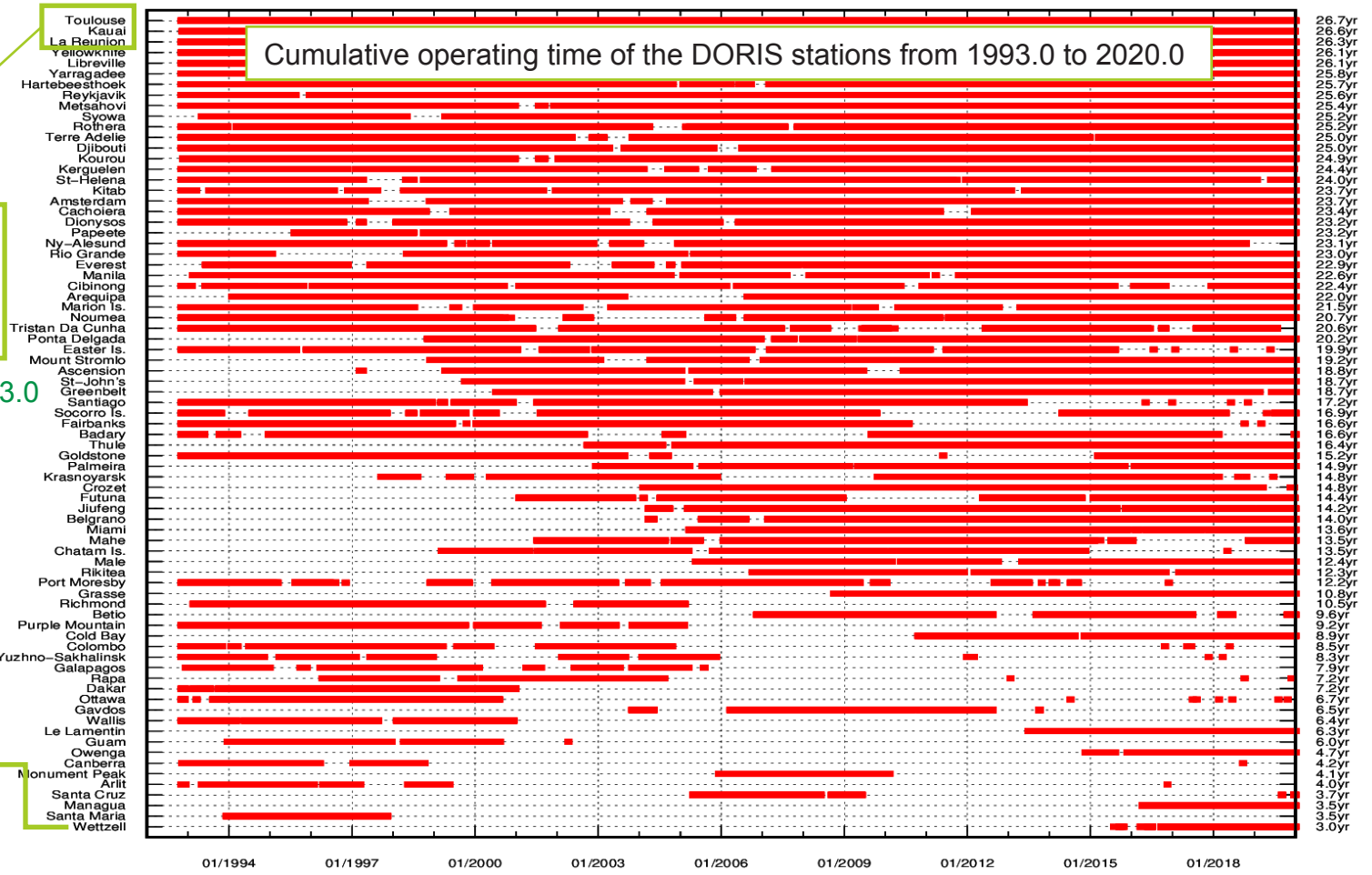
Reliability: close monitoring and maintenance by CNES/IGN

Excellent rate of active sites: maintained over 85% from 2012



STRENGTHS OF THE DORIS NETWORK (3/4)

Stability: very long time series: between 20y and 30y of data for 37 stations



Toulouse: 26.7yr
Kauai: 26.6yr
La Réunion: 26.3yr

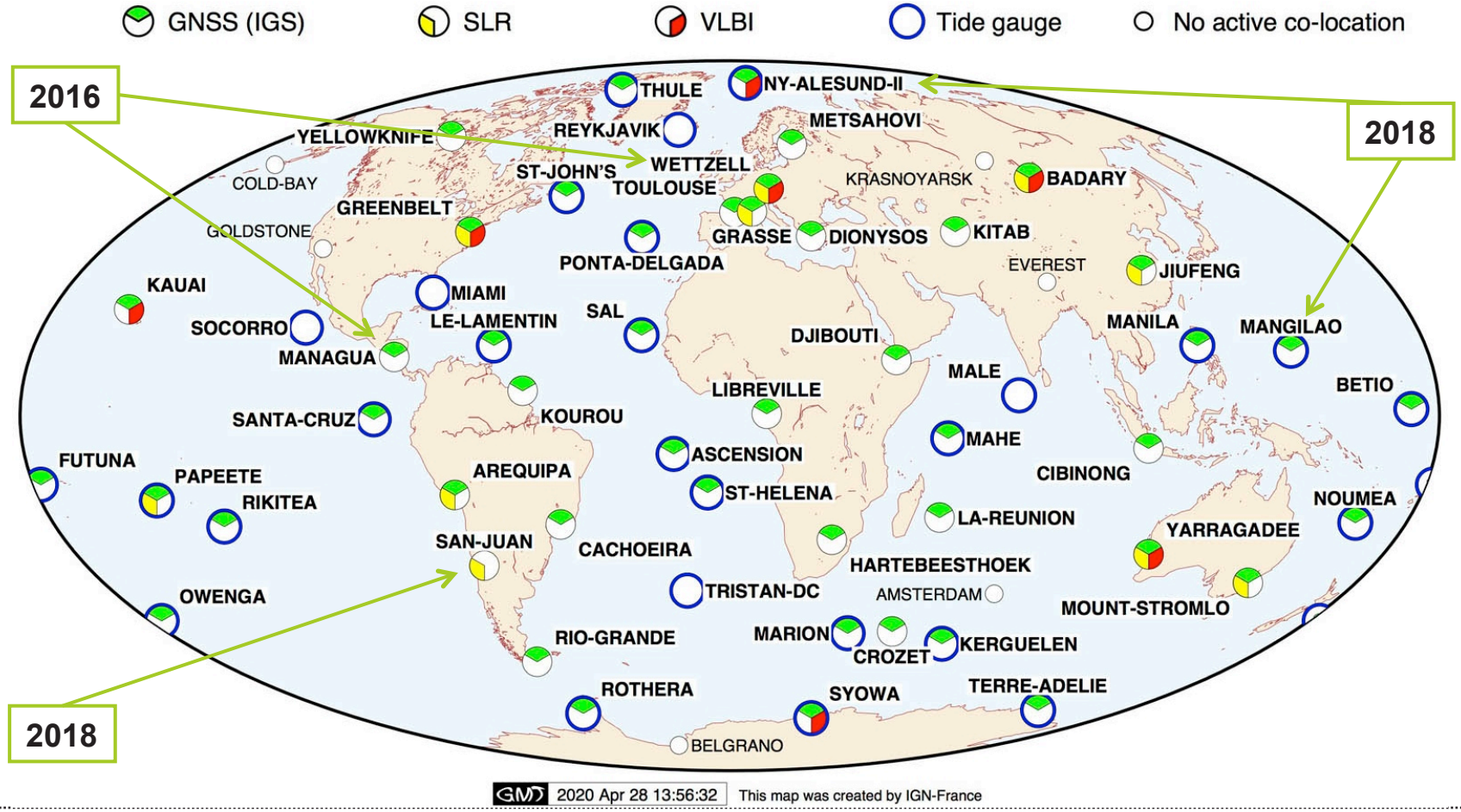
+ 3yr from 1990.1 to 1993.0

Wettzell:
4 techniques site
from 09/2016

STRENGTHS OF THE DORIS NETWORK (4/4)

Co-location: with other IERS techniques and tide gauges

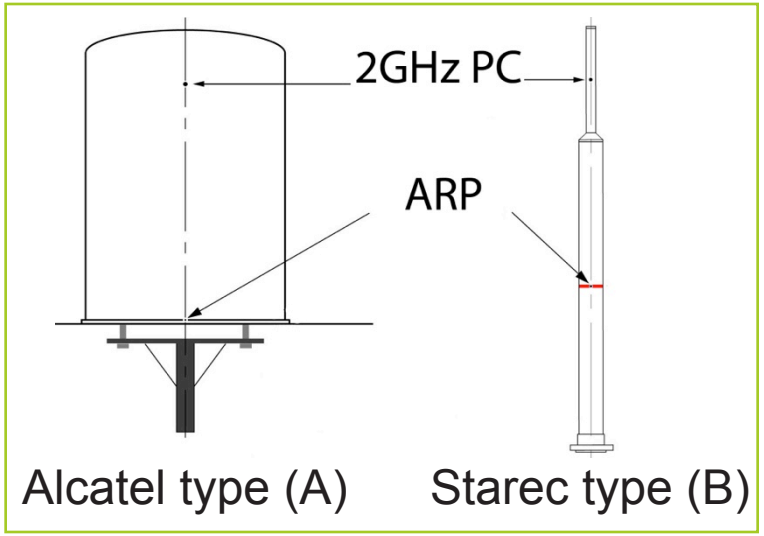
Continuous effort to co-locate DORIS: 5 new sites with co-location in the past 4yrs



HARDWARE IMPROVEMENTS: ANTENNAE

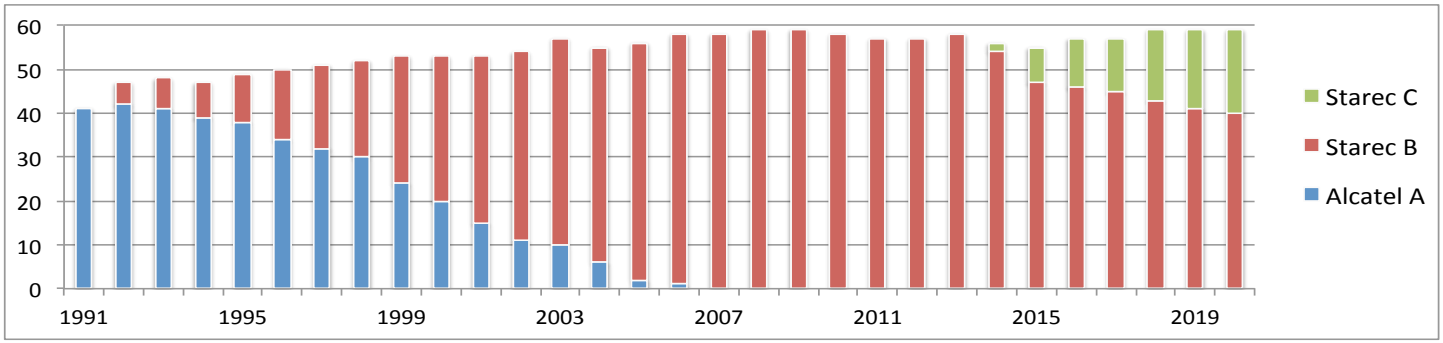
1992-2006: gradual replacement of Alcatel antennae with Starec antennae

- Different design: compact / helical antenna
- Better measurement accuracy



2014: key development: Antenna C type

- Same design as Starec B but with consolidated specifications: the uncertainty of the vertical location of the 2GHz phase center is reduced from 5 mm to 1-2 mm
- 19 stations equipped => <u>one third of the network with Starec-C</u>



HARDWARE IMPROVEMENTS: BEACONS

4 generations of beacons (transmitter)

- 1990-1995-2001-2019: 4 generations of beacons have been developed improving each time reliability and performance

2019: 4th generation beacon deployment

- The 4th generation beacon has been manufactured with up-to-date electronics allowing reliable operation through 2033
- A signal amplifier at the foot of the antenna allows a larger distance (50 m instead of only 15 m) between beacon and antenna, providing better options for antenna placement
- Deployment started in June 2019: already 7 stations equipped

Foot of the antenna

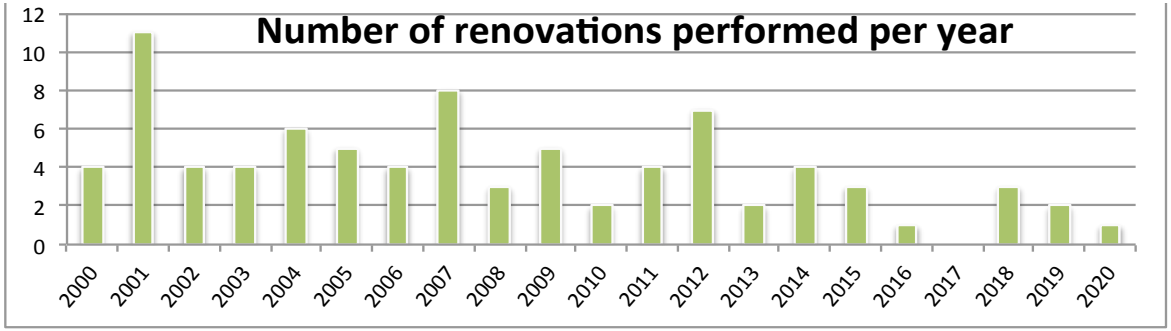
4th generation beacon

Antenna cables: 50 m long

INFRASTRUCTURE IMPROVEMENTS

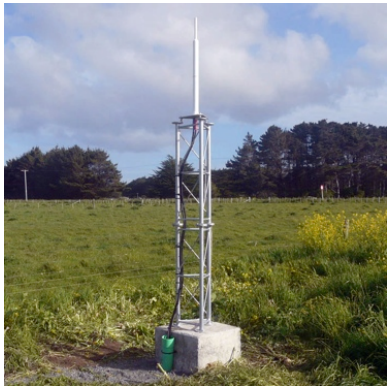
Continuous renovation of the network stations to improve data quality

- About 4 sites renovated per year in average since 2000 with objective of improving performance



Monument stability has steadily improved

- Specifying 3 standard monuments compliant with the DORIS system requirements in 2009
- The 3 standard monuments are compliant with the GGOS stability goal 0.1 mm/y (Saunier, 2016)



INSTALLATION SPECIFICATIONS

Standardizing installations (since 2007)

- **Any new installation or renovation must comply with technical specifications drawn up by CNES and IGN according to system requirements and geodesy needs**
- **Each new installation is evaluated in terms of performance and compliance with the specifications (CLS/CNES/IGN working group meeting on a quarterly basis)**

Requirements for the installation at co-located sites:

- **Spacing between instruments:**
  - **in the order of a couple hundred meters in order to achieve the required measuring accuracy of the local tie survey (IGN experience)**
- **DORIS / VLBI compatibility:**
  - **4 successive RF compatibility tests were performed at Greenbelt (2014), Wettzell (2015-2016), French Polynesia (2017), Ny-Alesund (2018) by CNES/IGN and local partners**
  - **Common conclusion: minimum distance between DORIS and VLBI antennas should be ≥ 300 m**
  - **Also mutual shielding by buildings or topography and placing DORIS "higher in elevation" than VLBI is advantageous**

STATION PERFORMANCE: RESULTS (1/3)

Improved station configuration at Kitab (Uzb.): KIUB > KIVC (2016-06-15)

- Antenna relocation to improve visibility
- Equipment replacement (Starec B > Starec C)
- New antenna monument complying with current geodetic requirements

Renovation →

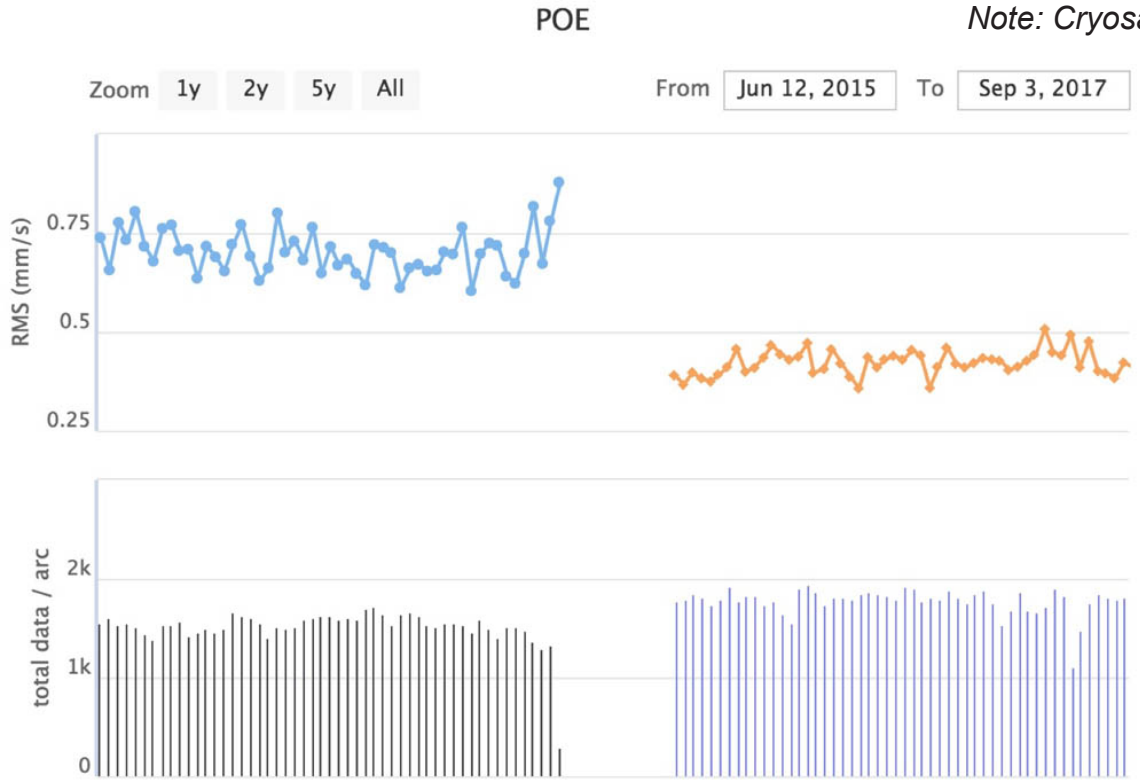
➢ **See IDS Newsletter #4**: ids-doris.org/images/documents/newsletters/IDS-Newsletter4.pdf

STATION PERFORMANCE: RESULTS (2/3)

Improved station configuration at Kitab (Uzb.): KIUB > KIVC (2016-06-15)

- **POE residuals was reduced from 0.70 mm/s to 0.42 mm/s**
- **Total measurements increased**

Note: Cryosat2 plots (similar results from other DORIS satellites

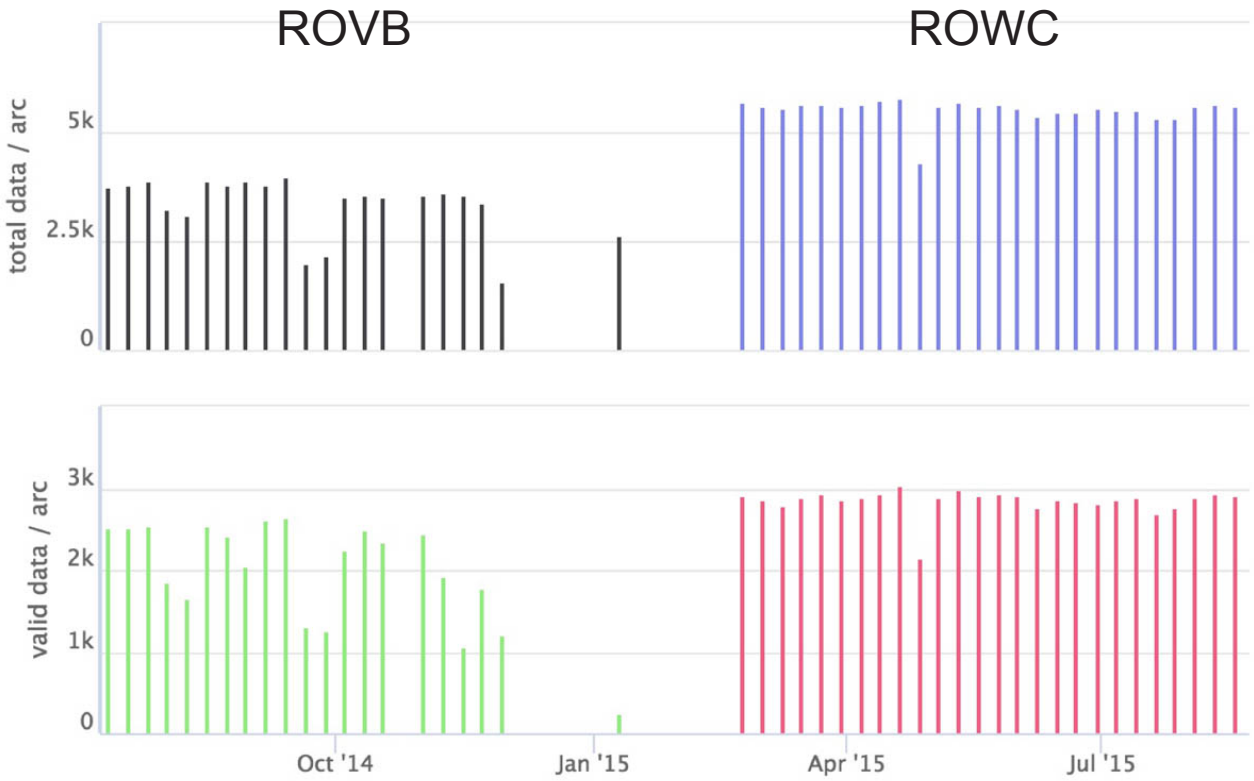


Name	statistics
RMS cryosat2 KIUB	mean: 0.70 mm/s start: 2015/06/13 end: 2016/06/12
total measurements cryosat2 KIUB	mean: 1514.94 data/arc start: 2015/06/13 end: 2016/06/12
valid measurements cryosat2 KIUB	mean: 1097.51 data/arc start: 2015/06/13 end: 2016/06/12
RMS cryosat2 KIVC	mean: 0.42 mm/s start: 2016/09/11 end: 2017/09/02
total measurements cryosat2 KIVC	mean: 1781.48 data/arc start: 2016/09/11 end: 2017/09/02
valid measurements cryosat2 KIVC	mean: 1190.33 data/arc start: 2016/09/11 end: 2017/09/02

STATION PERFORMANCE: RESULTS (3/3)

Antenna replacement at Rothera: ROVB > ROWC (2015-03-15)

- **total and valid measurements from Cryosat-2 increased after antenna replacement**
- **similar results from Jason-2** (total measurements ROVB: 4285 data/arc / ROWC: 8275 data/arc)



Name	statistics
RMS cryosat2 ROVB	mean: 0.40 mm/s start: 2014/07/12 end: 2015/01/10
total measurements cryosat2 ROVB	mean: 3345.43 data/arc start: 2014/07/12 end: 2015/01/10
valid measurements cryosat2 ROVB	mean: 1983.76 data/arc start: 2014/07/12 end: 2015/01/10
RMS cryosat2 ROWC	mean: 0.41 mm/s start: 2015/02/21 end: 2015/08/16
total measurements cryosat2 ROWC	mean: 5527.69 data/arc start: 2015/02/21 end: 2015/08/16
valid measurements cryosat2 ROWC	mean: 2851.19 data/arc start: 2015/02/21 end: 2015/08/16

MAIN CHALLENGES FOR THE COMING YEARS

Maintaining a high level of reliability and availability of the network stations

- **Notwithstanding the current sanitary crisis and local economic difficulties**

Continuing of the new equipment deployment

- **Starec C antenna**
- **4th generation beacon**

Monument stability monitoring

- **GGOS goal: 0.1mm/year**
- **Equipping sites with control points and targets to carry out monitoring surveys**
- **Installing devices such as tiltmeter or Geocube sensor (IGN GNSS tech)**

Ongoing discussions following the IDS Retreat (June 2018):

- **Make the network more robust by adding stations in critical areas (about 10)**
- **Connect DORIS beacons to GNSS at co-located sites?**
- **Sub-network of atomic orbitography beacons?**
- **Combined DORIS-GNSS on-board receiver: currently under study at CNES**

THANK YOU FOR YOUR ATTENTION

Visit the IDS website: ids-doris.org

- Network viewer
- Time series of station positions
- Documentation
- Newsletters

Sentinel-3