DORIS DAYS 2021

November 16,17 and 18

Introduction to DORIS for POD & Geodesy

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November 16

Session 1 – Presentation 1

What is DORIS?

In Greek mythology, Doris is a famous Oceanid, mother of the Nereids, the sea nymphs who form the procession of Poseidon, the god of the sea and oceans.

DORIS stands for

- **D**oppler **O**rbitography and **R**adiopositioning **I**ntegrated by **S**atellite
- **D**étermination d' **O**rbite et **R**adiopositionnement **I**ntégrés par **S**atellite
- **D**eterminación de **Ó**rbita y **R**adioposicionamiento **I**ntegrados por **S**atélite
- **D**eterminação de **Ó**rbita e **R**adioposição **I**ntegrado por **S**atélite

DORIS in a few words

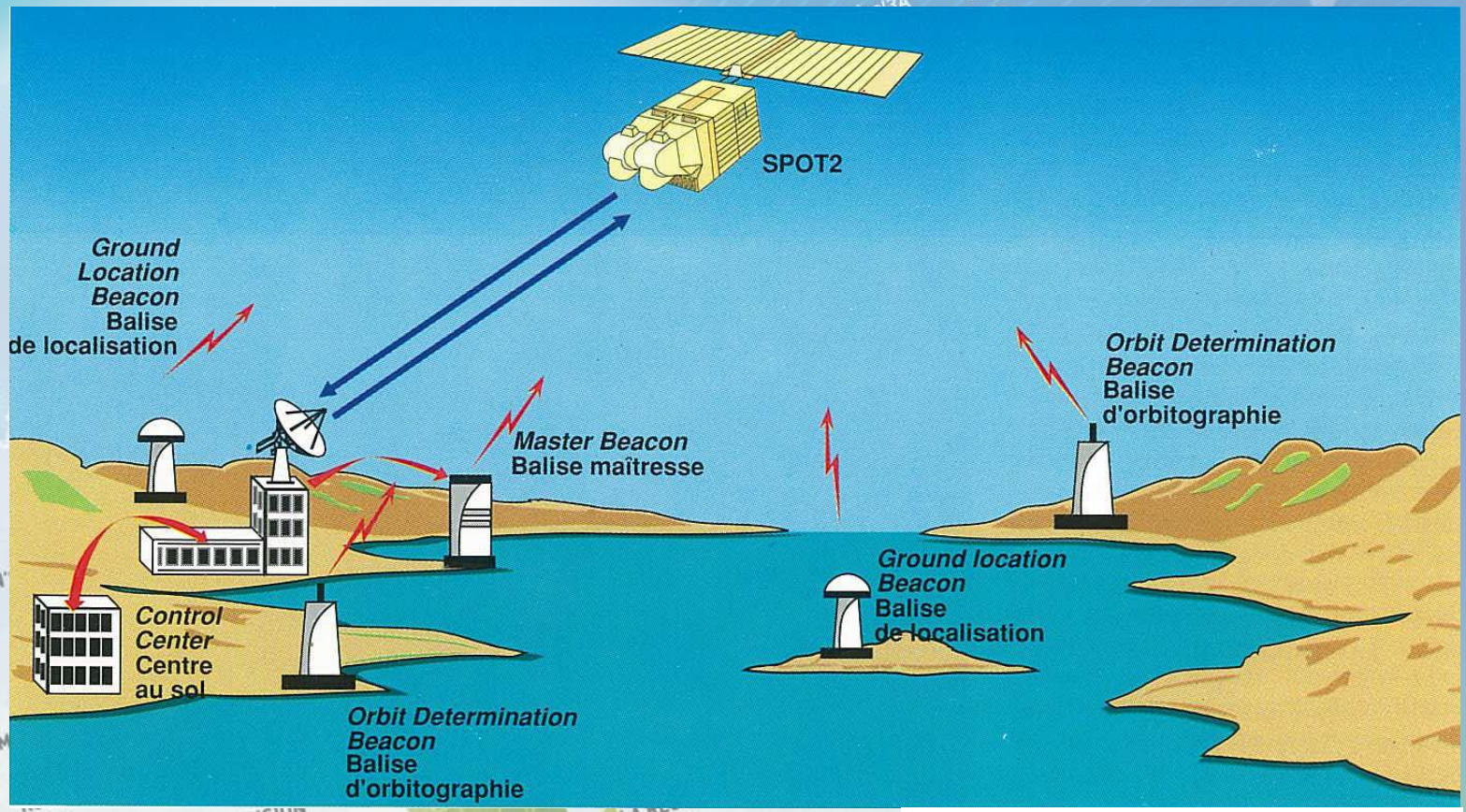
DORIS is:

- A French civil satellite tracking system designed for **Precise Orbit Determination (POD)** and high accuracy **ground positioning**
- Developed by **CNES**, the French space agency, in partnership with France's mapping and survey agency **IGN** and the space geodesy research institute **GRGS**
- Optimized for the **ocean's topography observation missions** with extreme precision, global coverage and all-weather measurements.
- An **uplift** and **centralized** system based on **Doppler** shifts measurements of RF signals transmitted by a worldwide beacons network

The DORIS system

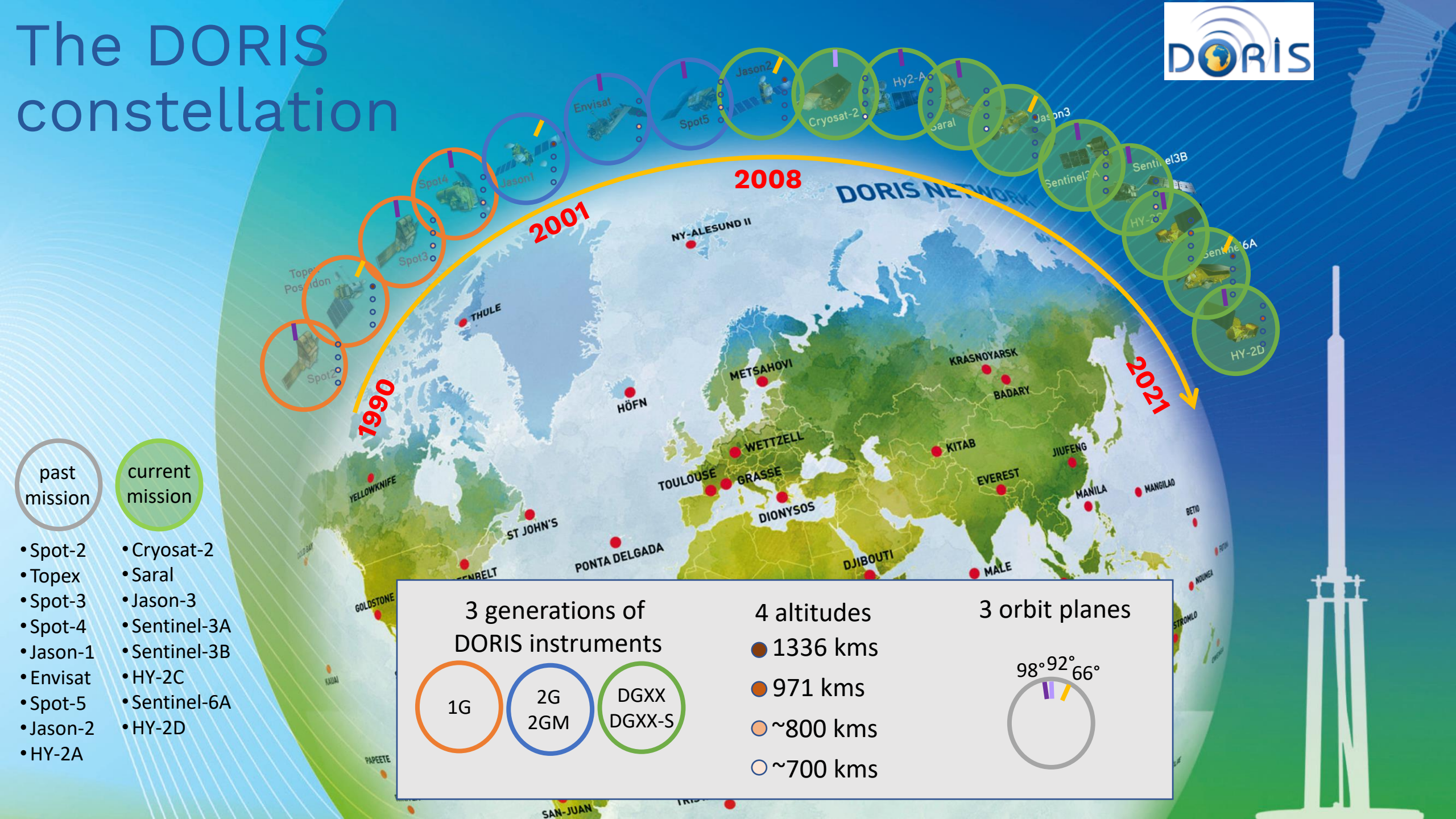
The main components of the system are:

- a **network of emitting stations** covering the globe
- the **equipment onboard the satellites** (receivers and antenna)
- a **Control Center** receiving the DORIS measurements at each satellite pass



DORIS newsletter Nov. 1990

The DORIS constellation



past mission

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

current mission

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

3 generations of DORIS instruments

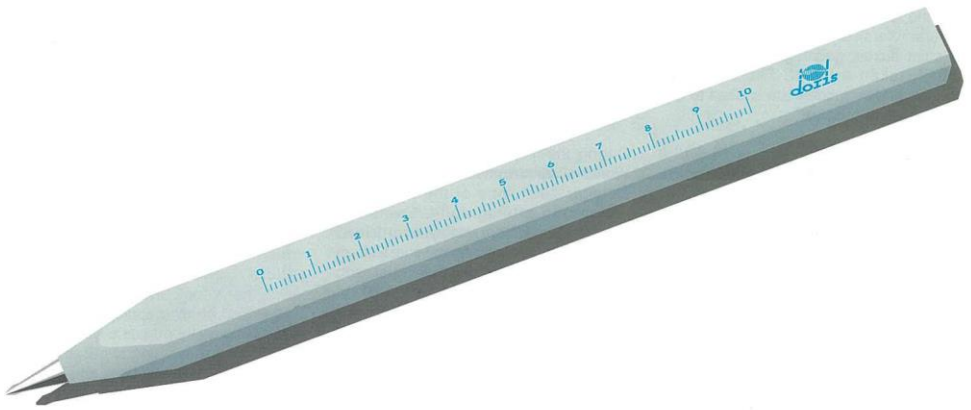
4 altitudes

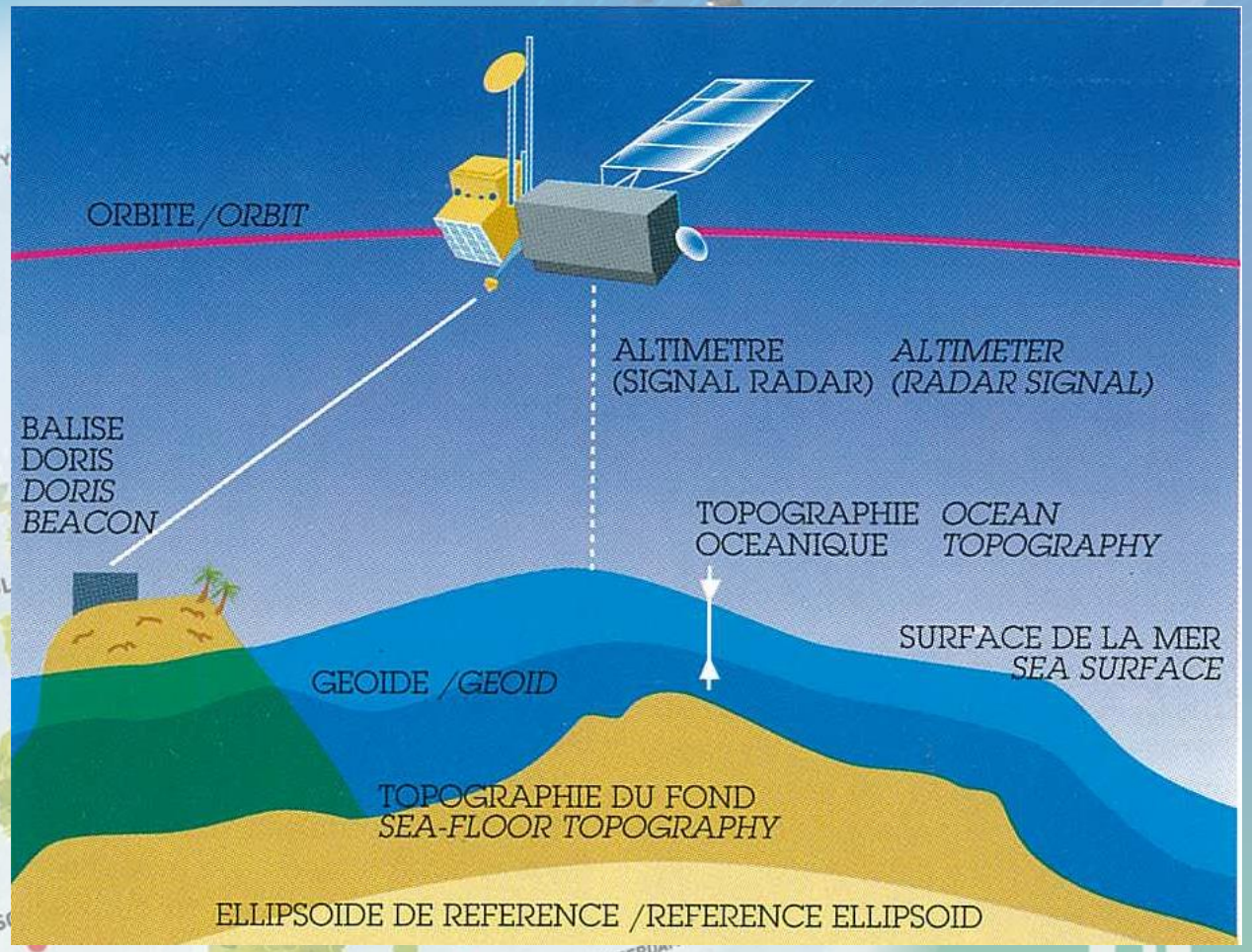
- 1336 kms
- 971 kms
- ~800 kms
- ~700 kms

3 orbit planes

DORIS for POD

- Initially designed to meet the need for very-high precision orbit determination of TOPEX/Poseidon (1992-2005)
- Objectif: orbit restitution within 10 cm.

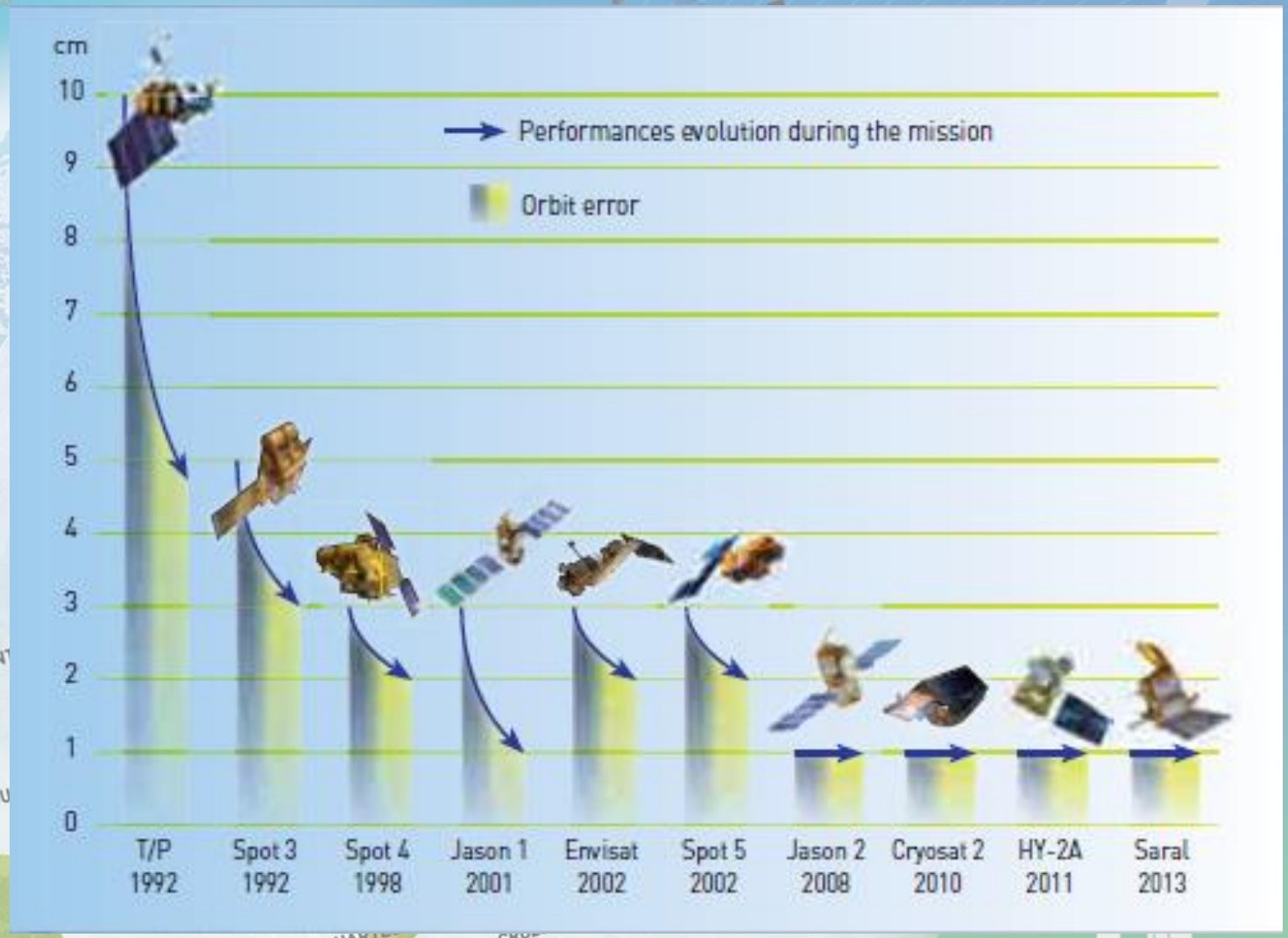




DORIS newsletter Nov. 1990

POD performances

- Objective 10-cm precision quickly met and exceeded
- From 10 cm to 2.5 cm for the satellites carrying the first two generations of instruments
- Since Jason-2, 1 cm or even better thanks to the improvements made to the whole system (on-board and ground instruments, monumentation, processing, ...)



DORIS for Geodesy

From its conception, DORIS has been designated for the precise location of the network stations.

- **1990**: the first DORIS instrument is on board **SPOT-2**
- **1992-1993**: **first publications on DORIS positioning** with SPOT-2 data: positioning accuracy of 10-20 cm, then 5-7 cm after improvement of the processing strategy
- **1994**: **first contribution to ITRF** (2 groups: IGN and LEGOS/CLS)
- **1995**: measurements of **tectonic plate motion** with 3 years of data; first geodetic determination for the African plate
- **1999**: first comparison between altimetry and tide gauge and **DORIS vertical motions**

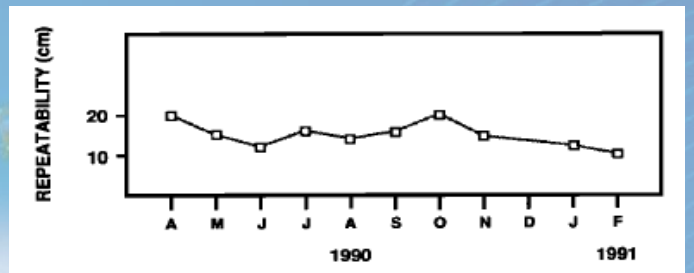
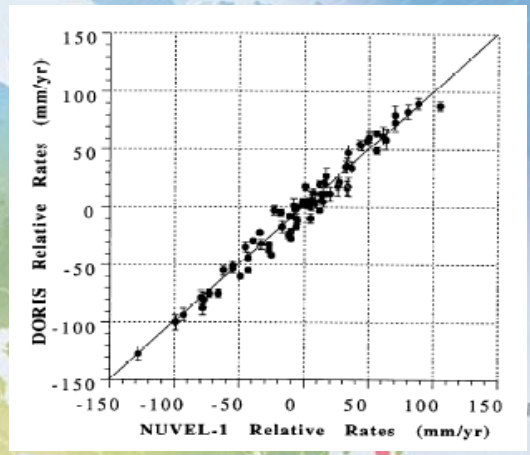
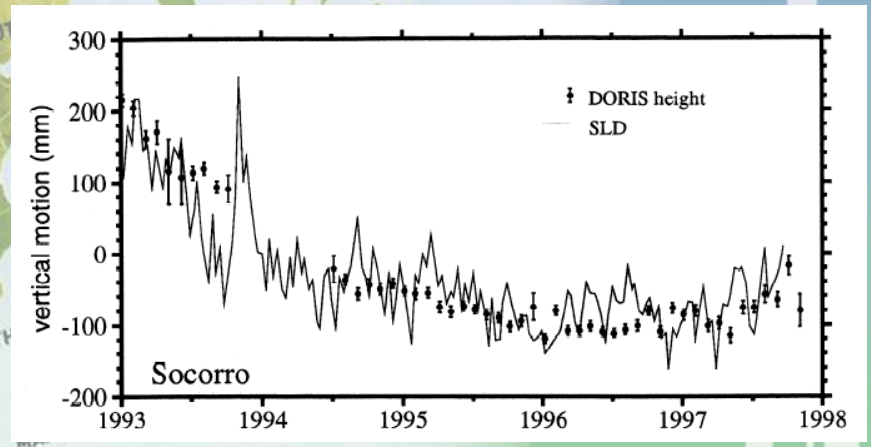


Fig. 6. Monthly repeatability in absolute positioning (whole DORIS network considered)

Cazenave, Valette, Boucher (1992)



Soudarin and Cazenave (1995)



What DORIS can observe to characterize the geodetic properties of Earth

- ❖ Tectonic plate parameters [*Kraszewska et al., 2018*]
- ❖ Horizontal and vertical velocities of the stations [*Moreaux et al., 2016*]
- ❖ Glacial Isostatic Adjustment [*King et al., 2010*]
- ❖ Long-time series of station positions, records of events affecting the DORIS stations such as:
  - -Earthquakes (eg Gorkha Earthquake recorded at Everest's station [*Moreaux et al., 2019*]),
  - -present day ice melt of nearby glaciers (eg uplift acceleration in Thule, Greenland [*Moreaux et al., 2019*]),
  - -volcanic activity (eg deflation of the Mt. Evermannn volcano observed at Socorro [*Briole et al., 2009*])
  - -subsidences (eg slow subsidence of the Tahiti island [*Fadil et al. 2011*]), …
- ❖ Contribution to the realization of the ITRF [*Moreaux et al., 2016*]
- ❖ Geocenter motion [*Couhert et al., 2018*] and Scale of the TRF [*Štěpánek and Filler, 2018*]
- ❖ Earth Pole coordinates and estimation of LOD [*Štěpánek et al., 2018*]
- ❖ Precise orbits for altimeter missions contributing to determination of the Mean Sea Level [*Rudenko et al., 2019*]
- ❑ Contour of the SAA at the altitude of Spot and Jason [*Capdeville et al., 2016*]
- ❑ Vertical Total Electron Content of the Earth's ionosphere [*Dettmering et al., 2014*]
- ❑ Detection of scintillations (eg CITRIS project (2007-2009) [*Siefring et al., 2011*]
- ❑ Thermosphere perturbations during severe geomagnetic conditions [*Willis et al., 2005*]
- ❑ Long time-series of tropospheric delays and precipitable water [*Bock et al., 2014*]

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** for ITRF realizations.

IDS is a component of **GGOS**

IDS is a member of the **ICSU WDS** network

IAG = International Association of Geodesy

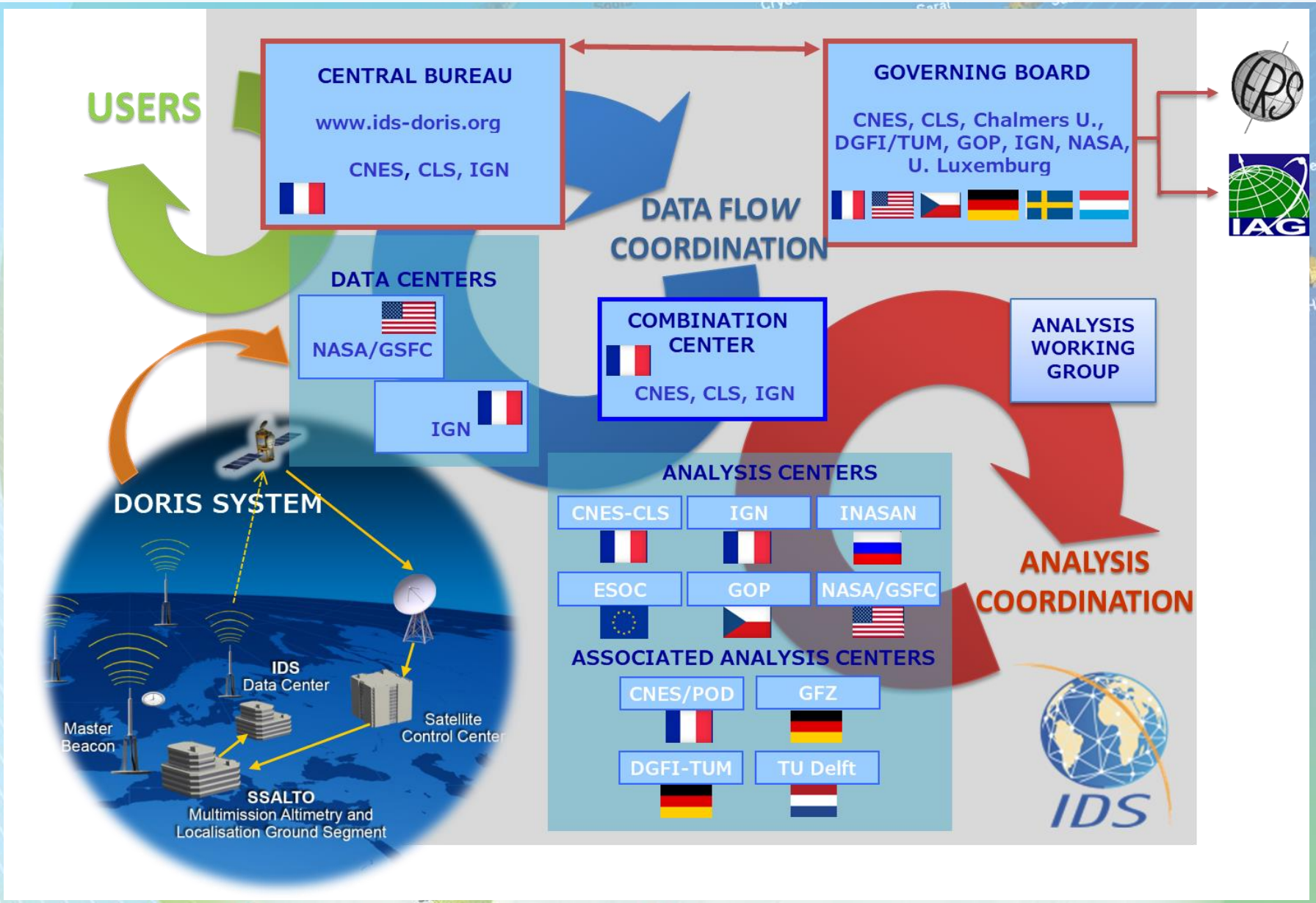
IERS = International Earth Rotation and Reference Systems Service

GGOS = Global Geodetic Observing System

WDS = World Data System

ICSU = International Council for Science

IDS organization



IDS life

• Meetings

IDS Workshop:

1 every 2 year (with Ocean Surface Topography Science Team (OSTST) meeting in Europe)

→next: IDS workshop, Venice, Italy, 21-23 March 2022

Analysis Working Group (AWG) meeting:

1 or 2 every year

Currently: virtual meetings

• Publications

Annual activity reports

- Content:

About IDS / DORIS system / User service / Analysis Activities

- Available on IDS web site

Newsletters

- Articles about:

project news / the network / Analysis results / IDS life

- Distributed by email

and available on IDS web site

Key points

The DORIS system has been working since 1990

- A performing system for POD and observation of geodetic variables of the Earth
- Current constellation: 8 satellites

International DORIS Service since 2003

- Mission: provide a support, through DORIS data and products, to geodetic, geophysical, and other research and operational activities
- Perspectives: grow the community, lower barriers to entry, technology evolutions …