



IUGG



IAG/AIG  
International Association  
of Geodesy

# Geodesy

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Royal Observatory of Belgium  
& UCLouvain



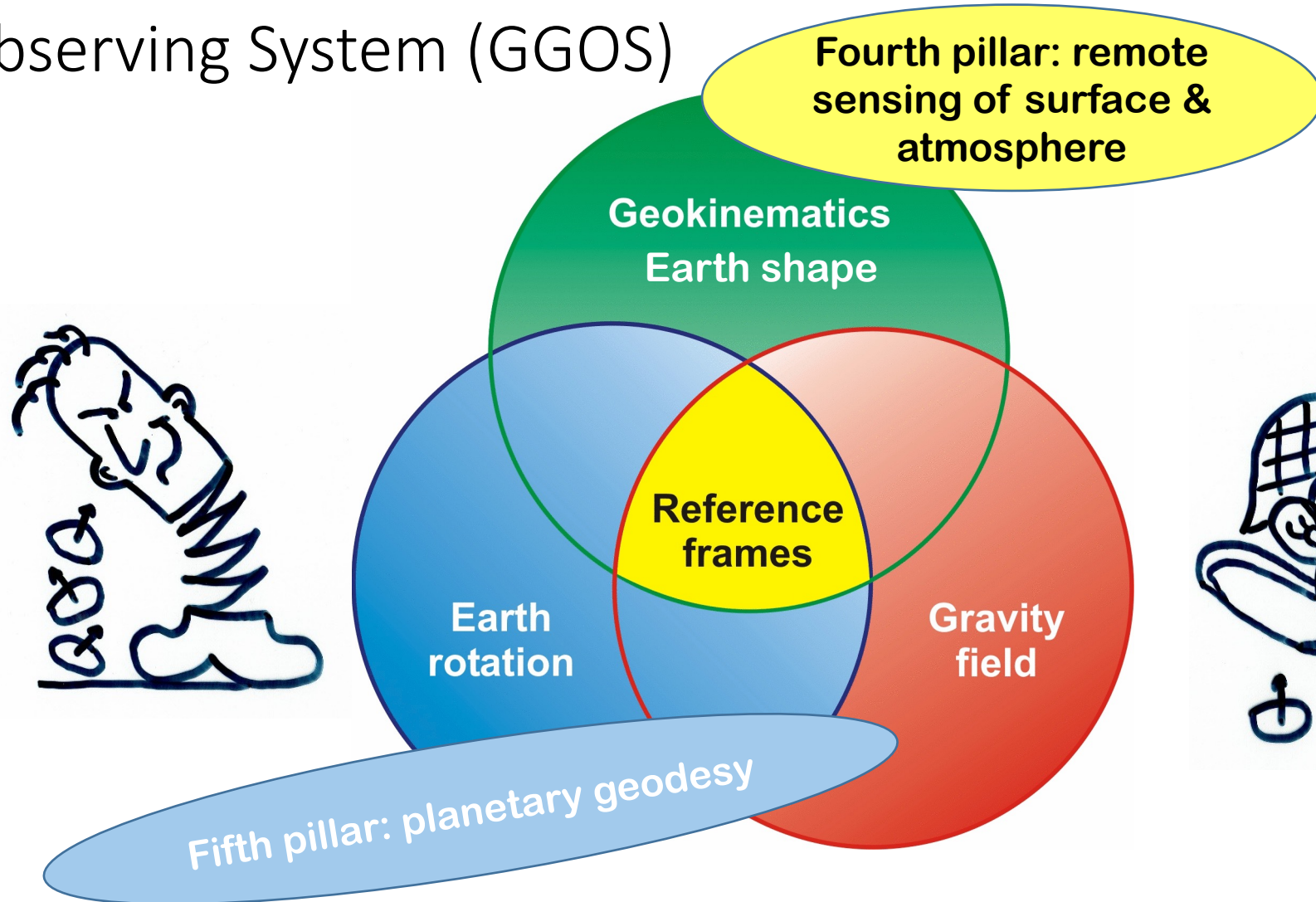
BNCGG



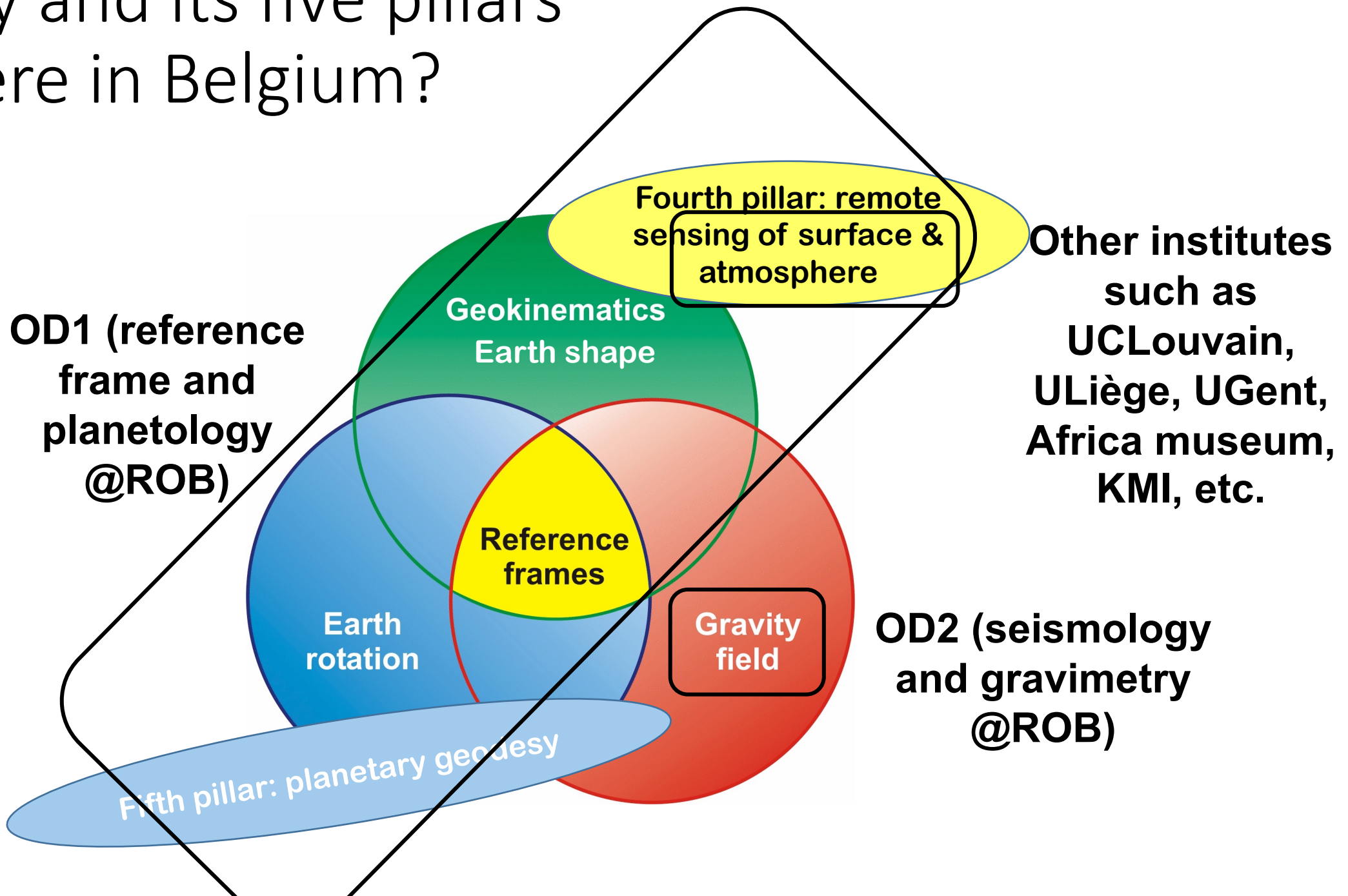
in Belgium

# Geodesy and its three pillars

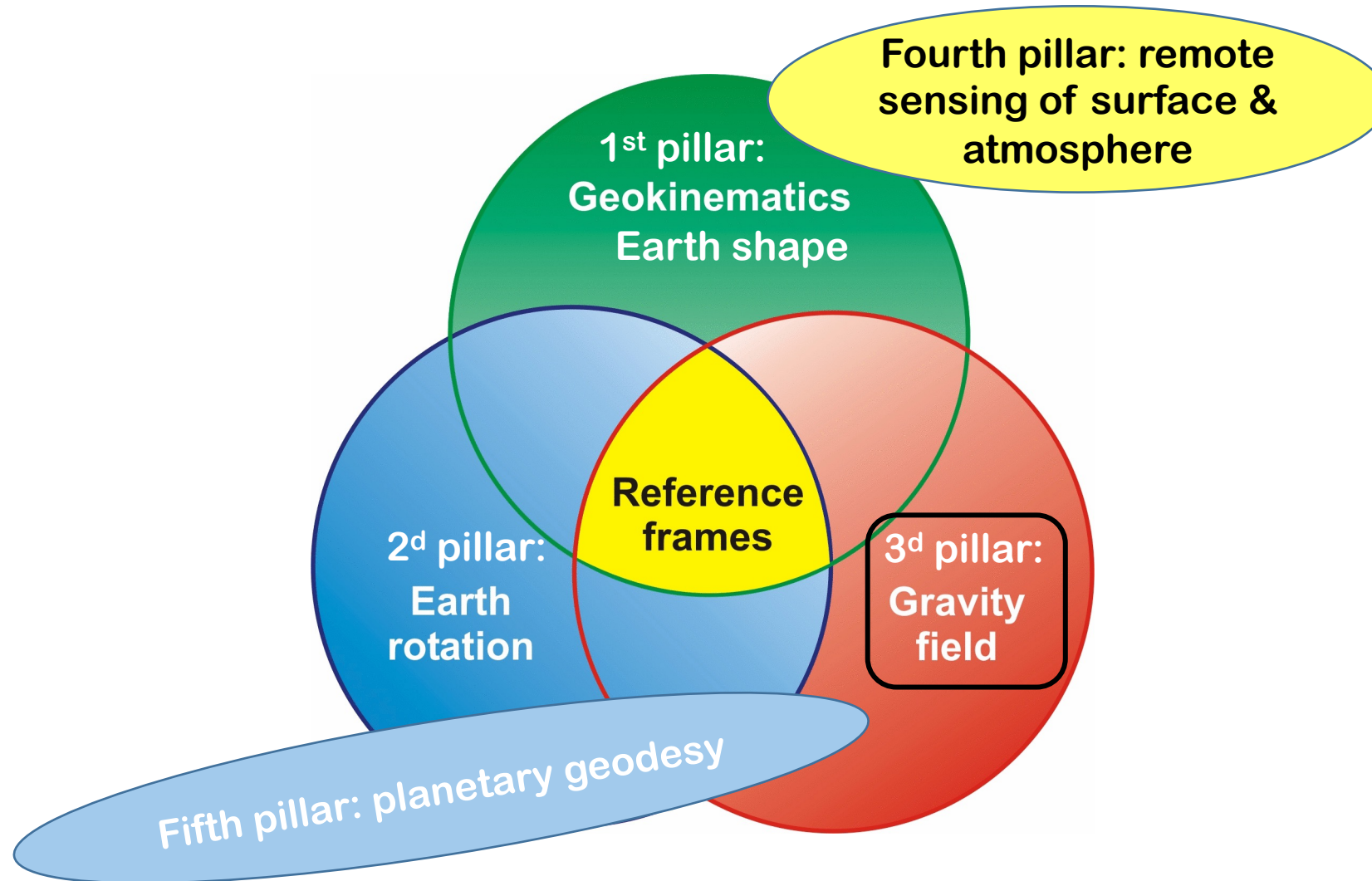
↔ The Global Geodetic Observing System (GGOS)

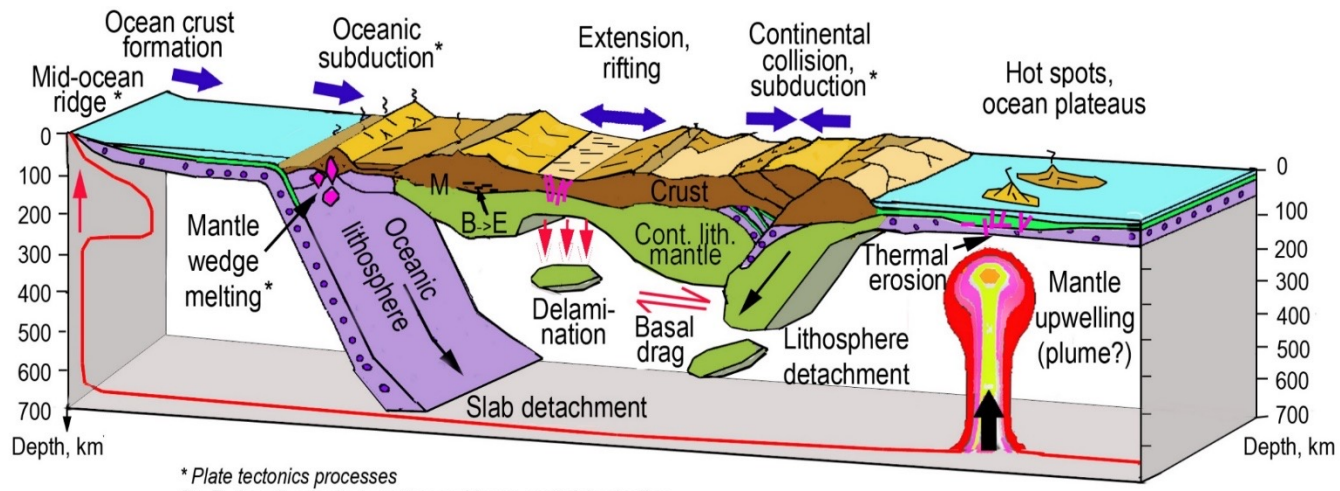


# Geodesy and its five pillars where in Belgium?

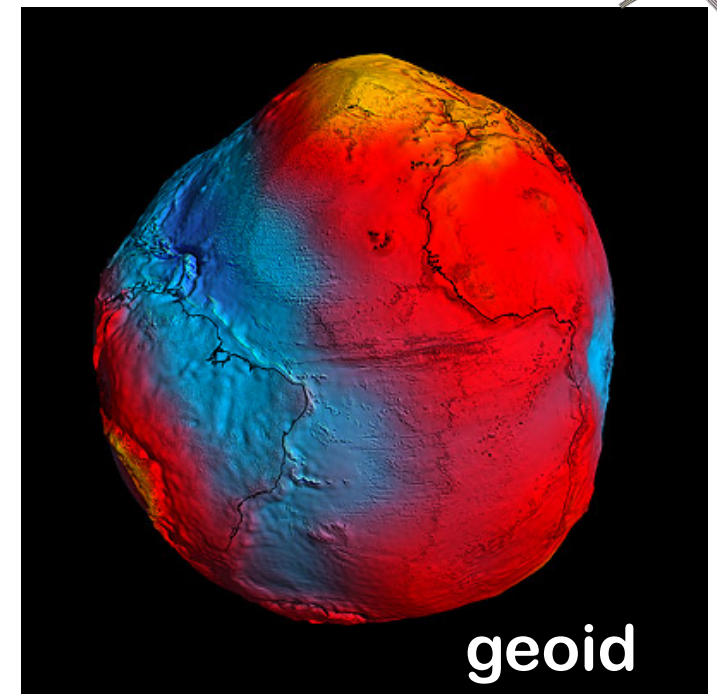
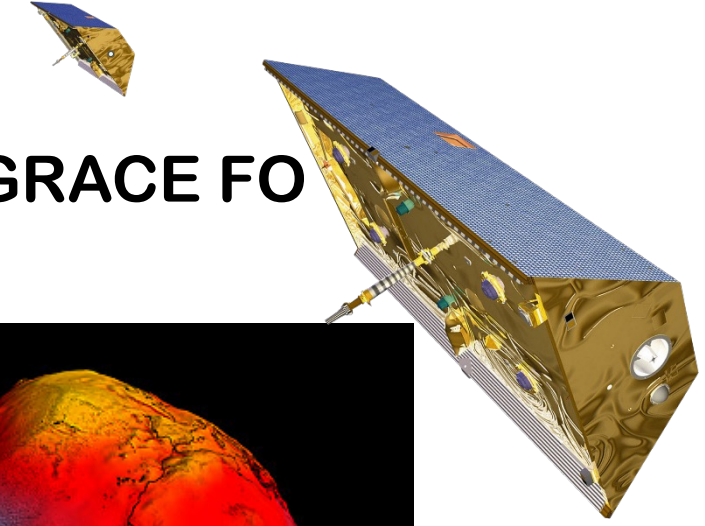


# Geodesy and its five pillars

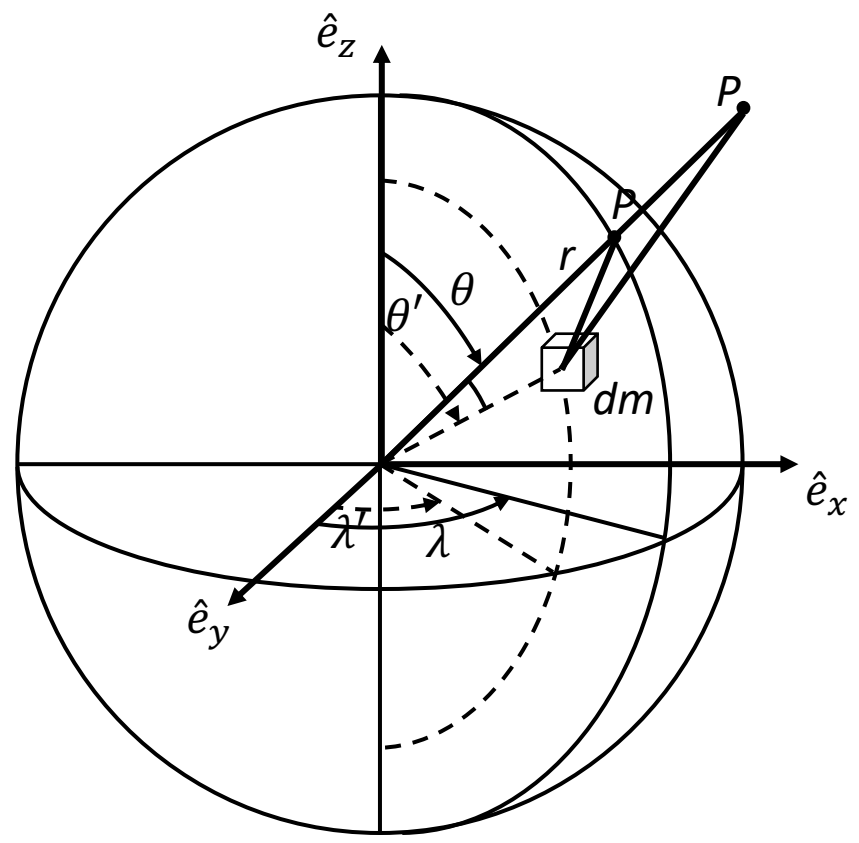




# GRACE & GRACE FO



# Global Satellites

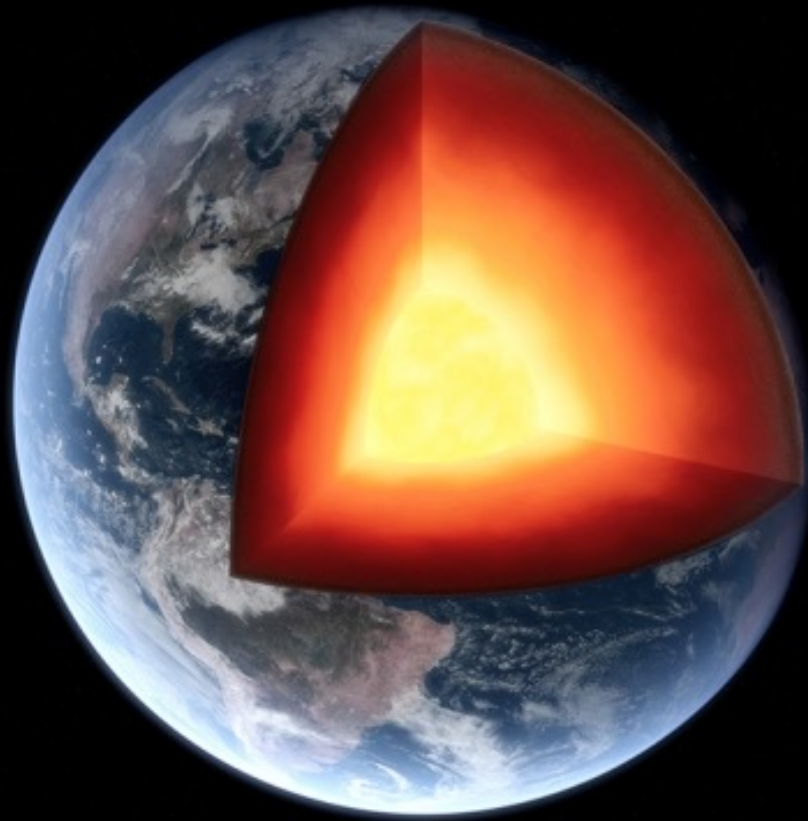
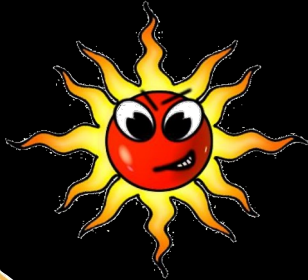


# Global Satellites

# Local Ground

Courtesy  
Michel Van  
Camp





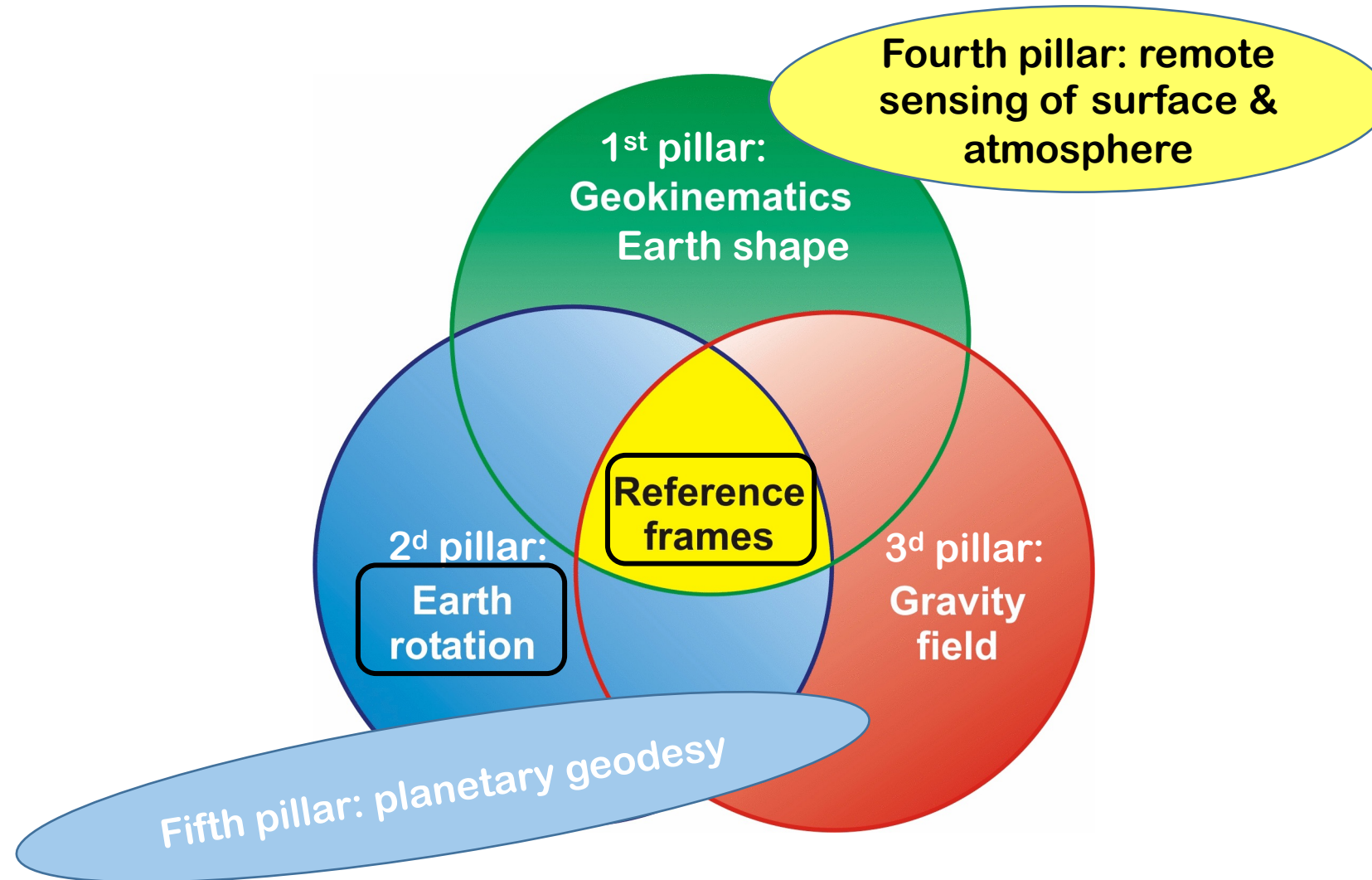
# Periodic Tides

Courtesy Michel  
Van Camp and  
Olivier de Viron

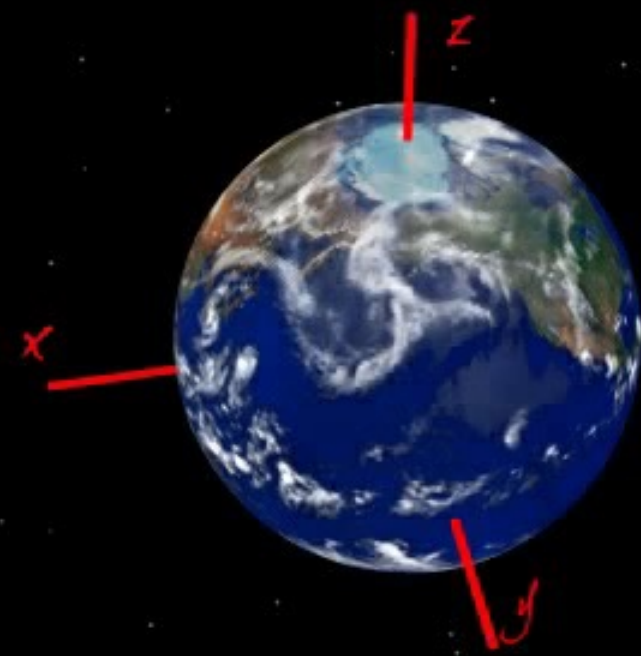
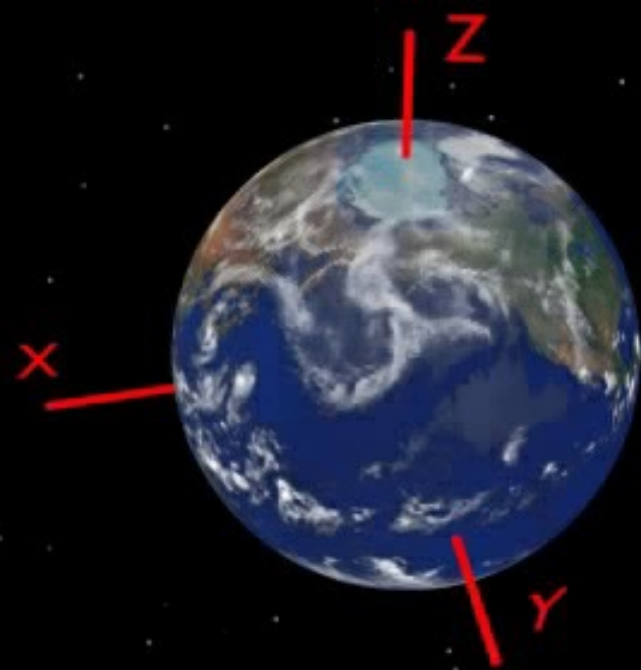


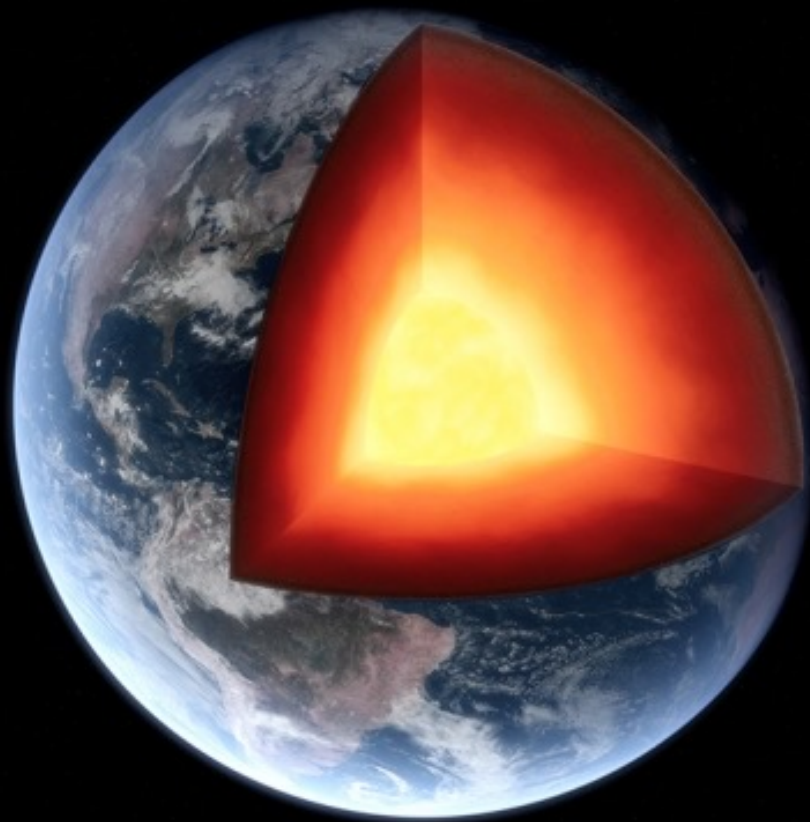
## Superconducting gravimeter

# Geodesy and its five pillars

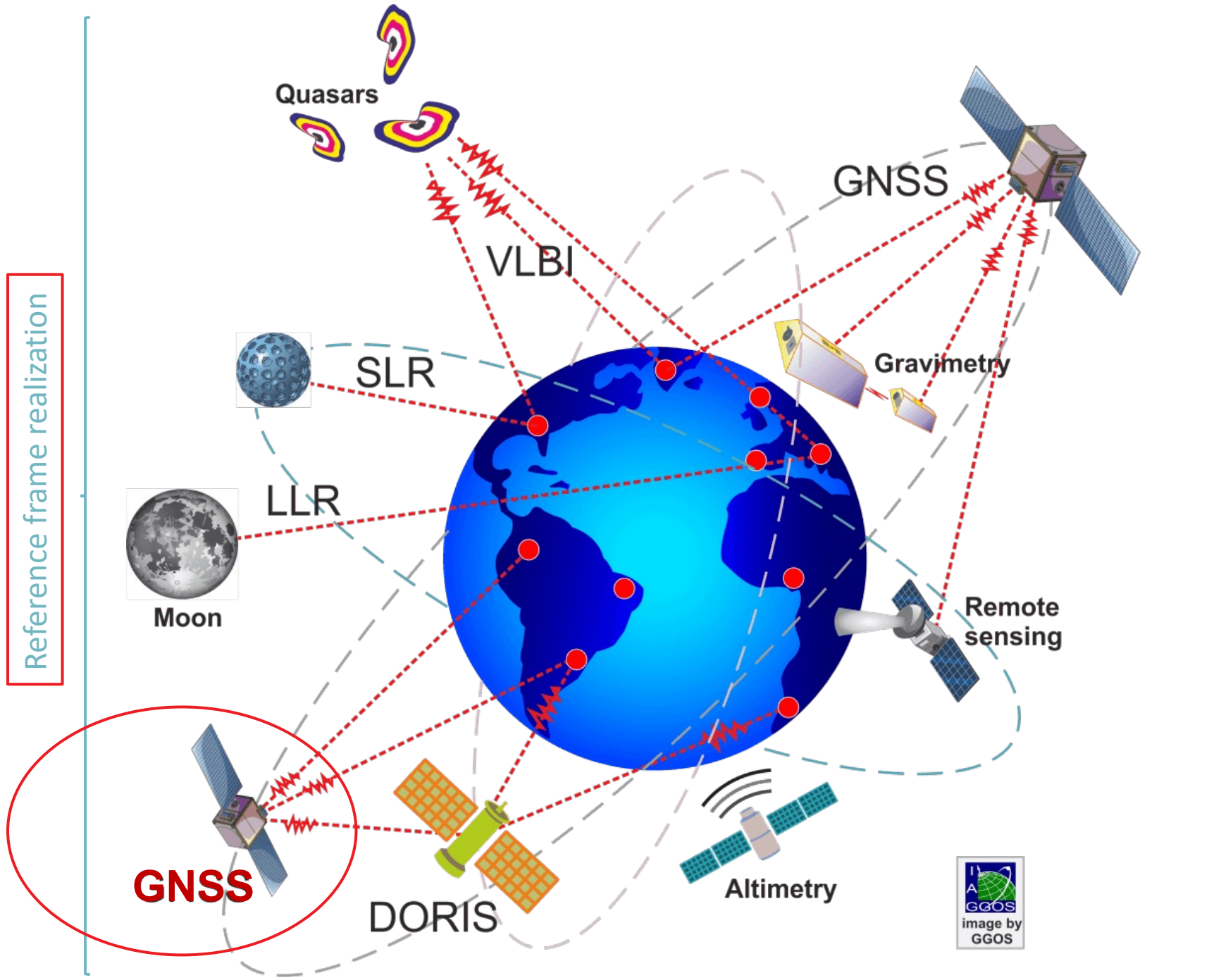








Reference frame realization

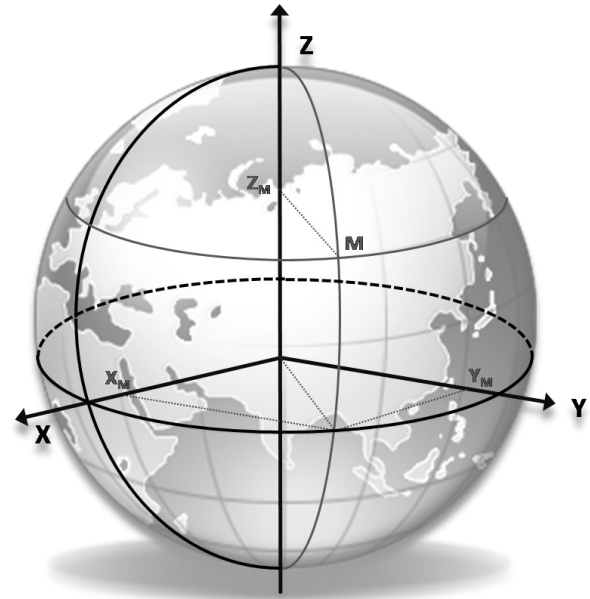
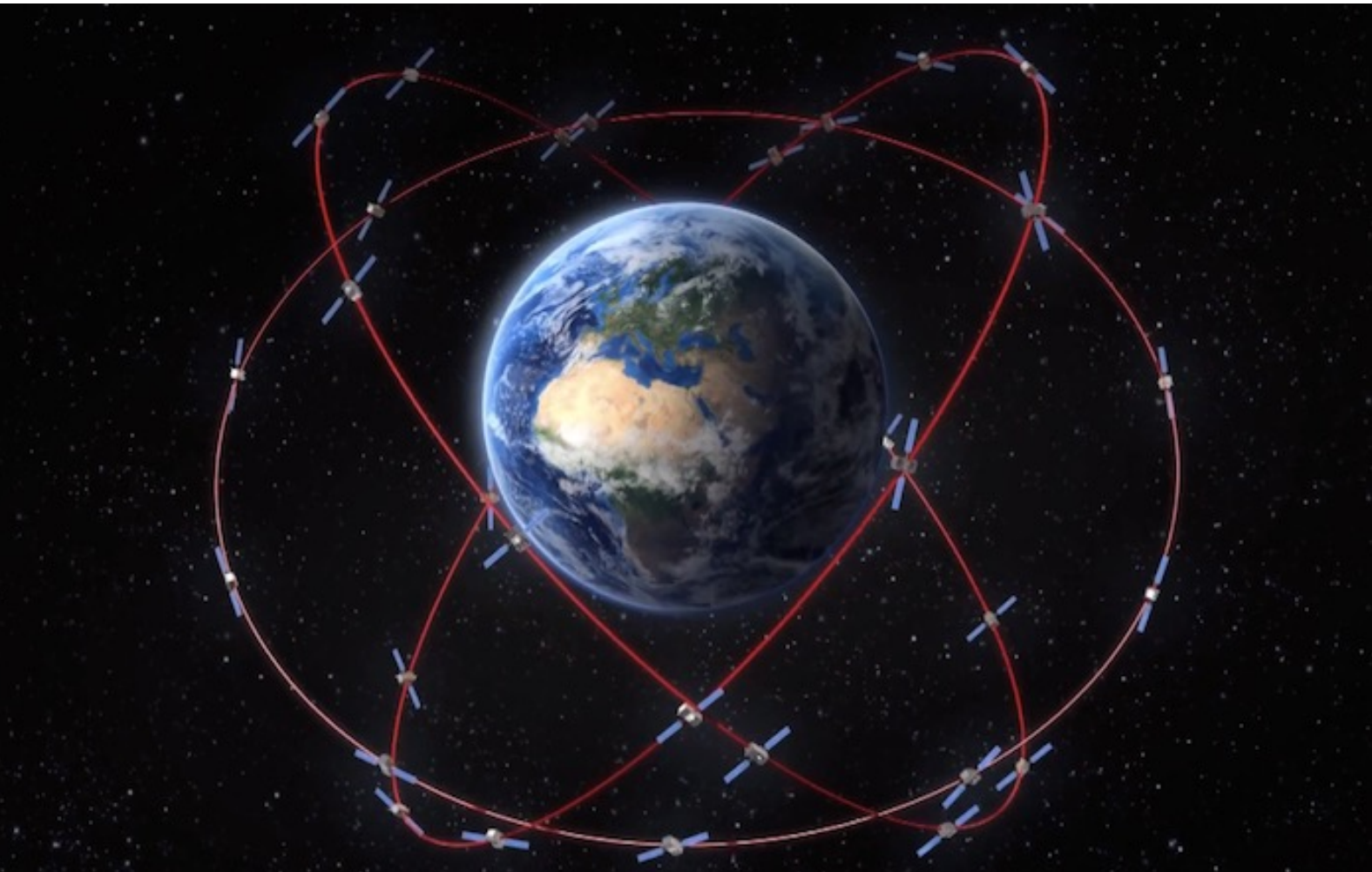


Remote sensing, gravity measurements

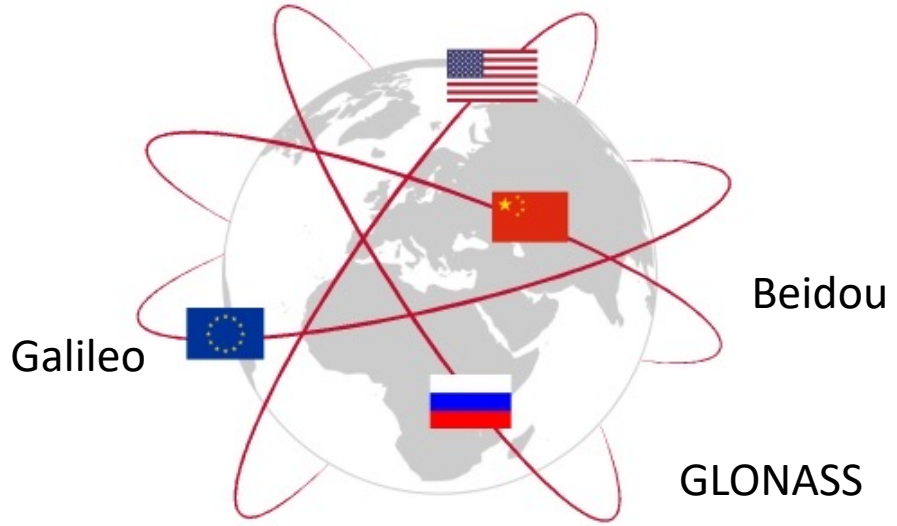
# GNSS – Global Navigation Satellite System

Integration of Belgium in international geodetic reference frames using GNSS (GPS, Glonass, Galileo, ...)

Positions and velocities at all surface points



GPS



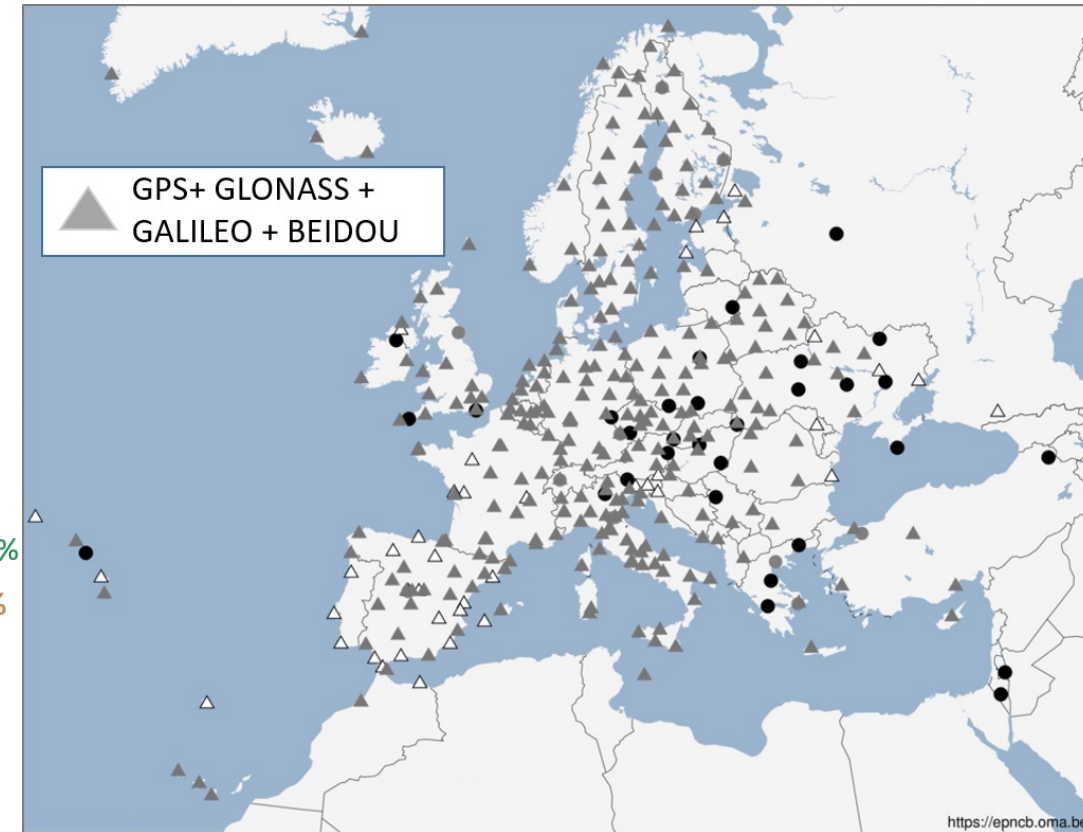
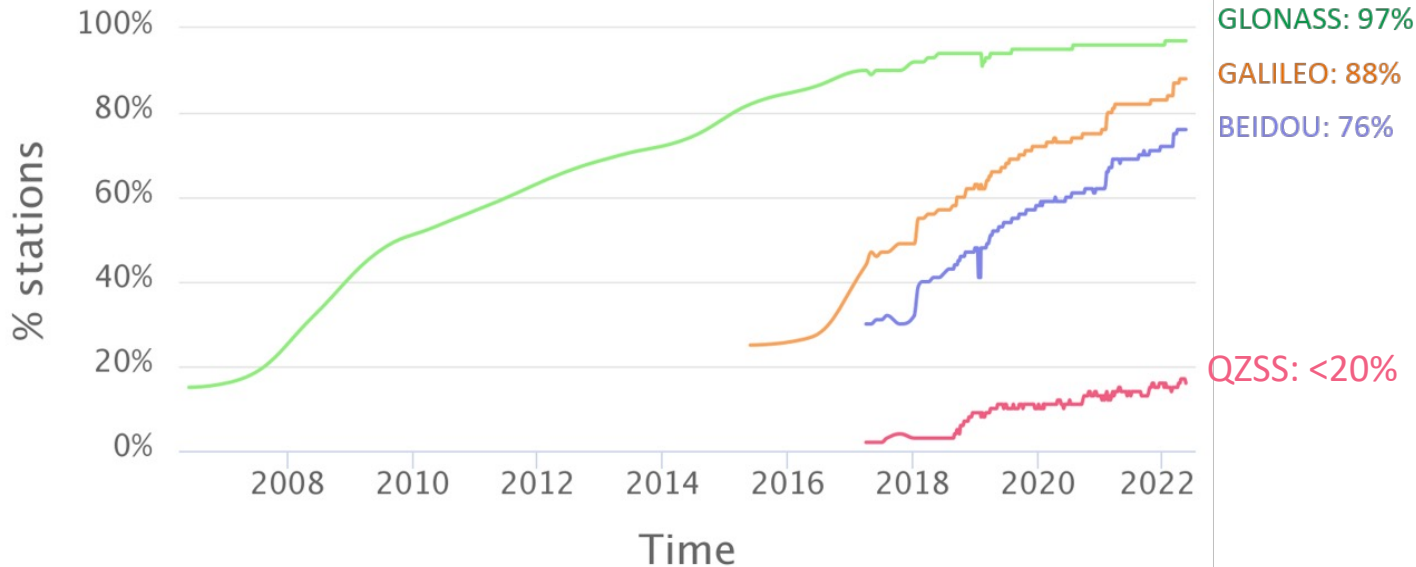
# EUREF European Reference Frame

Coordination of EUREF Permanent Network (EPN);

- ~400 stations
- continued modernization of the network

## Station Capabilities (%)

Source: EPN Central Bureau

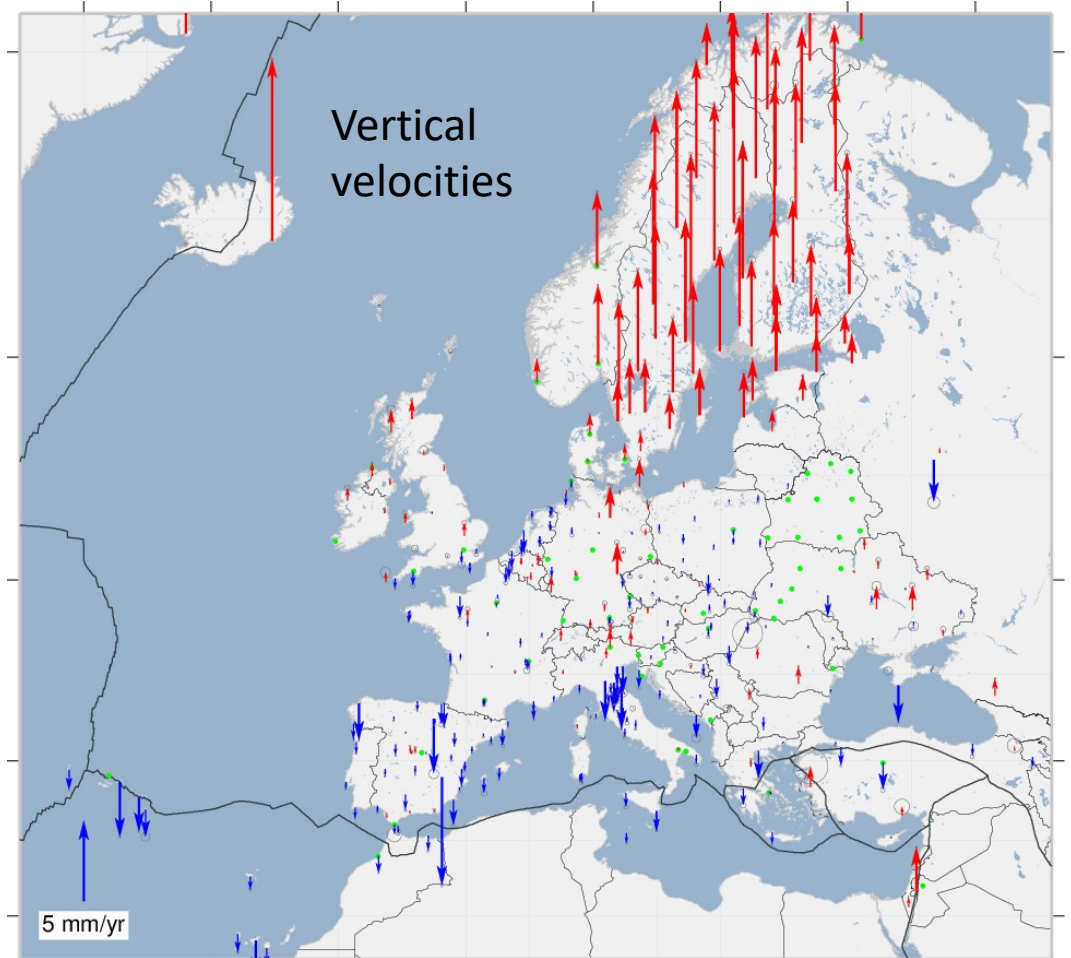
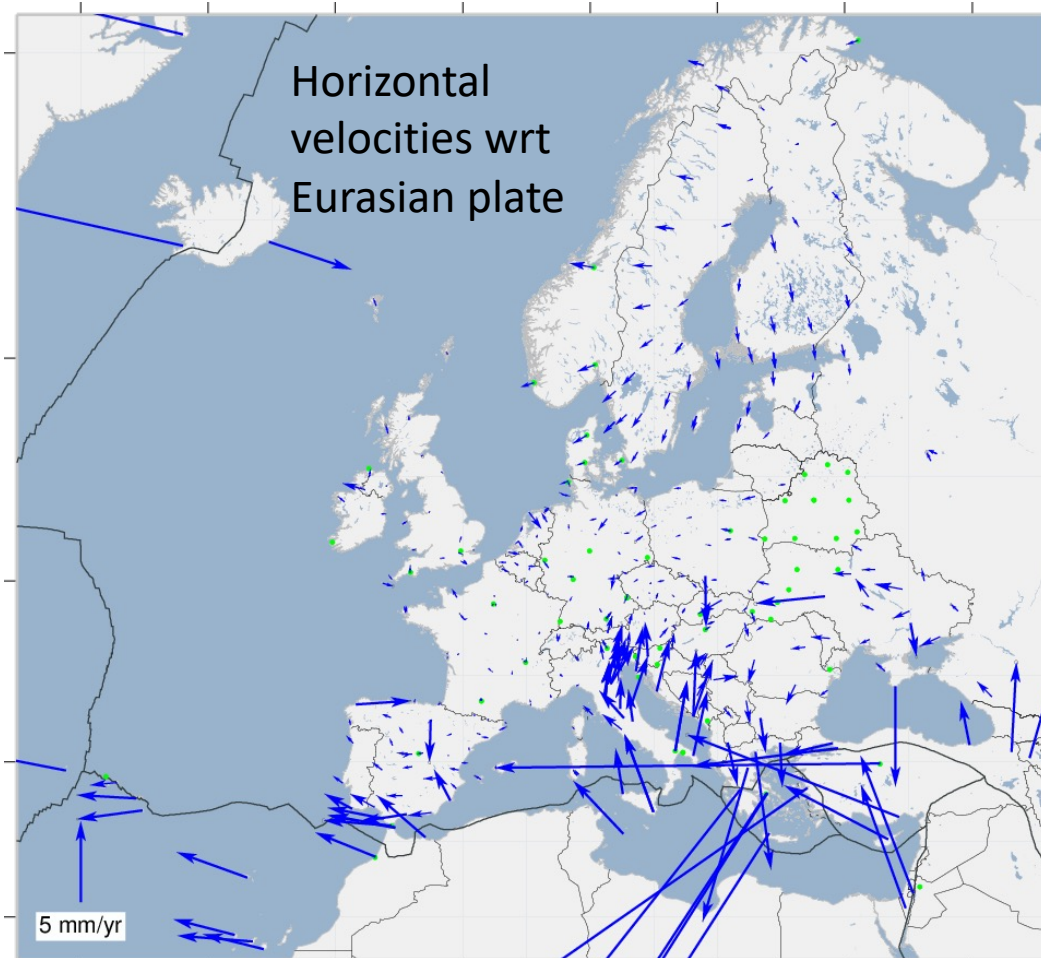


Courtesy Carine Bruyninx

See also poster entitled “Belgian contribution to the maintenance of the European coordinate reference system”

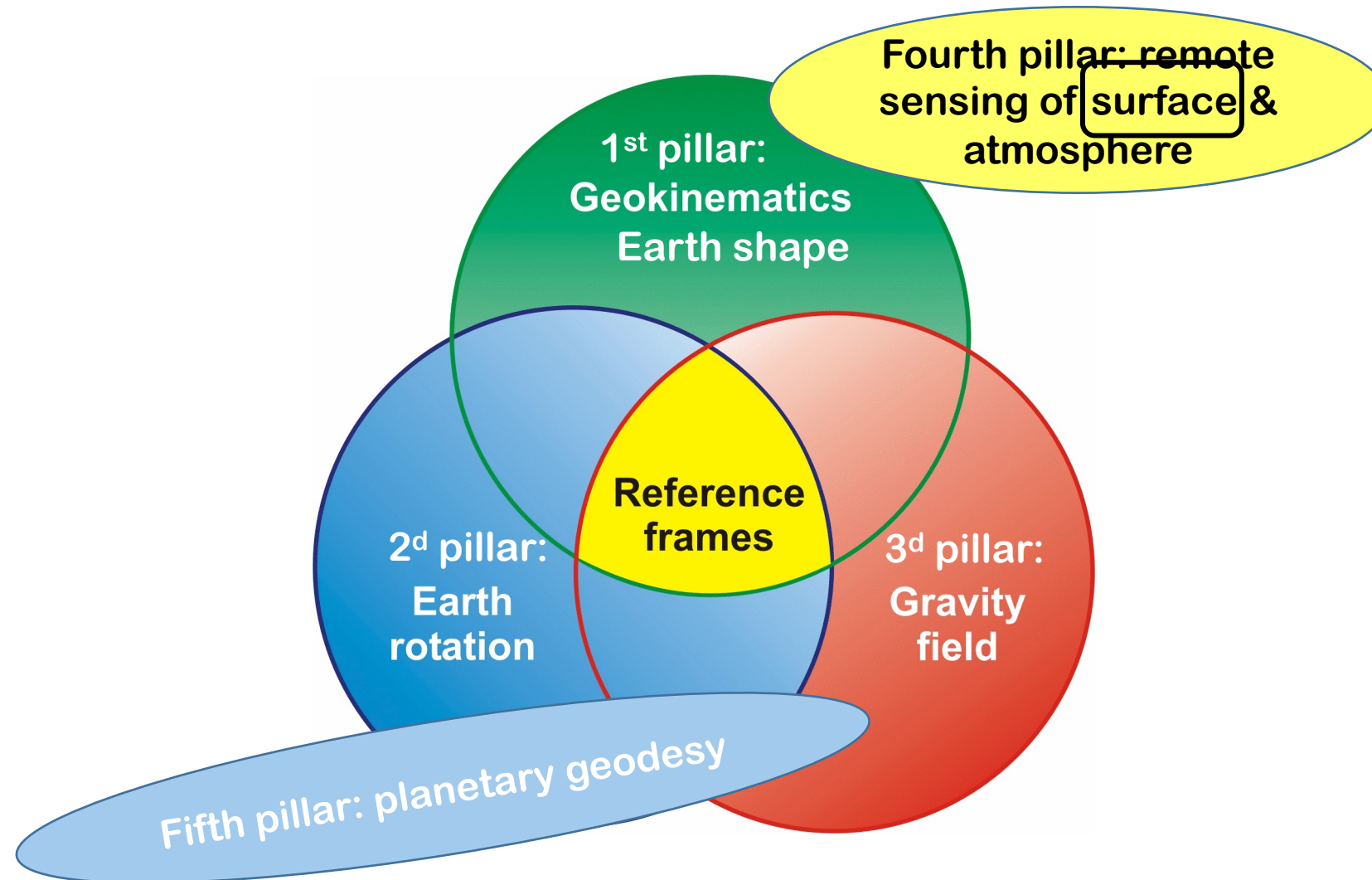
# GNSS in Europe

- Velocities of EPN (EUREF Permanent Network) stations, plate velocities



Courtesy  
Carine  
Bruyninx and  
Juliette  
Legrand

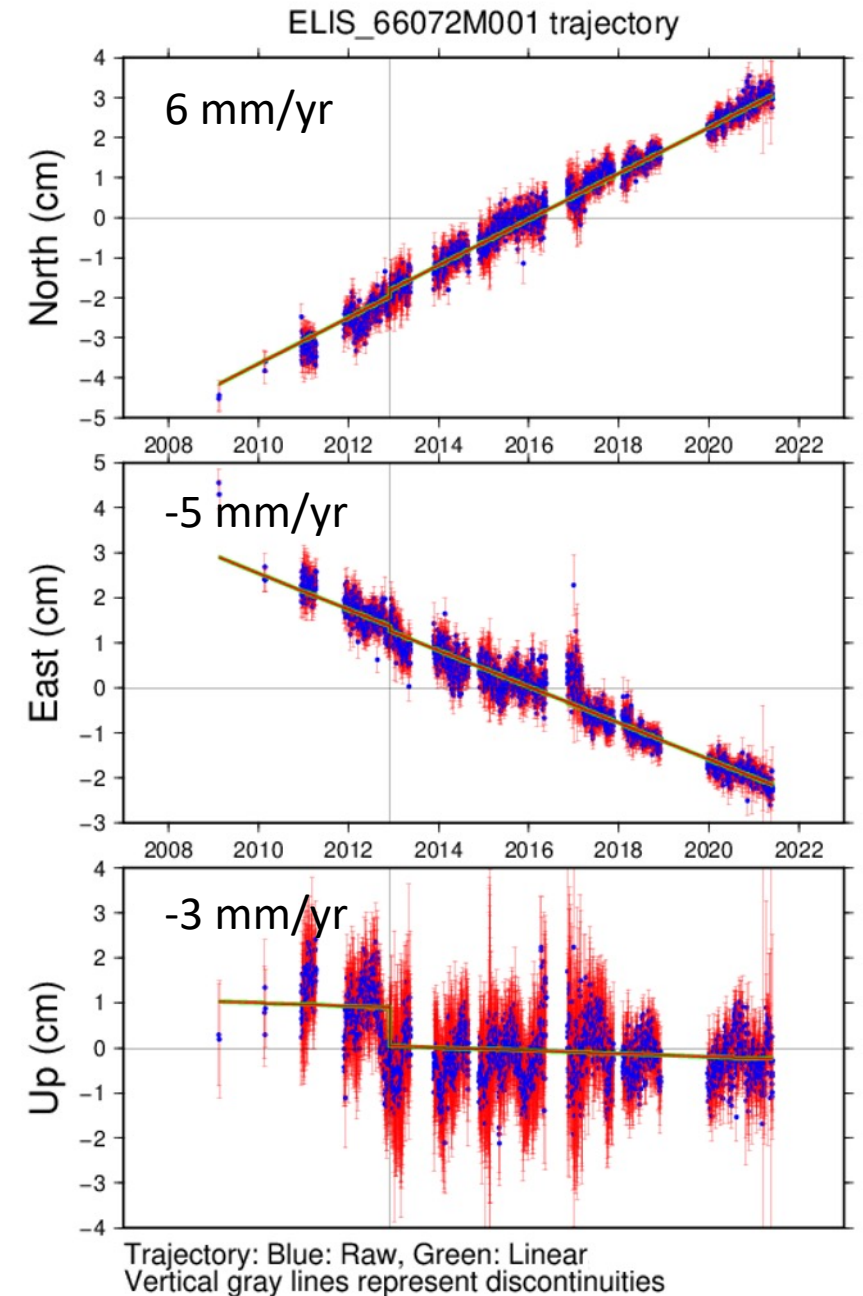
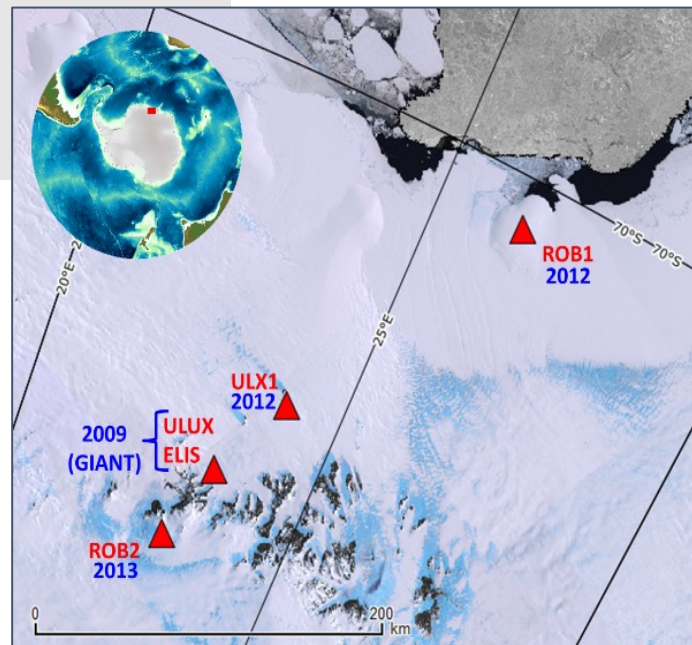
# Geodesy and its five pillars



# GNSS in Antarctica

## Antarctica deformation

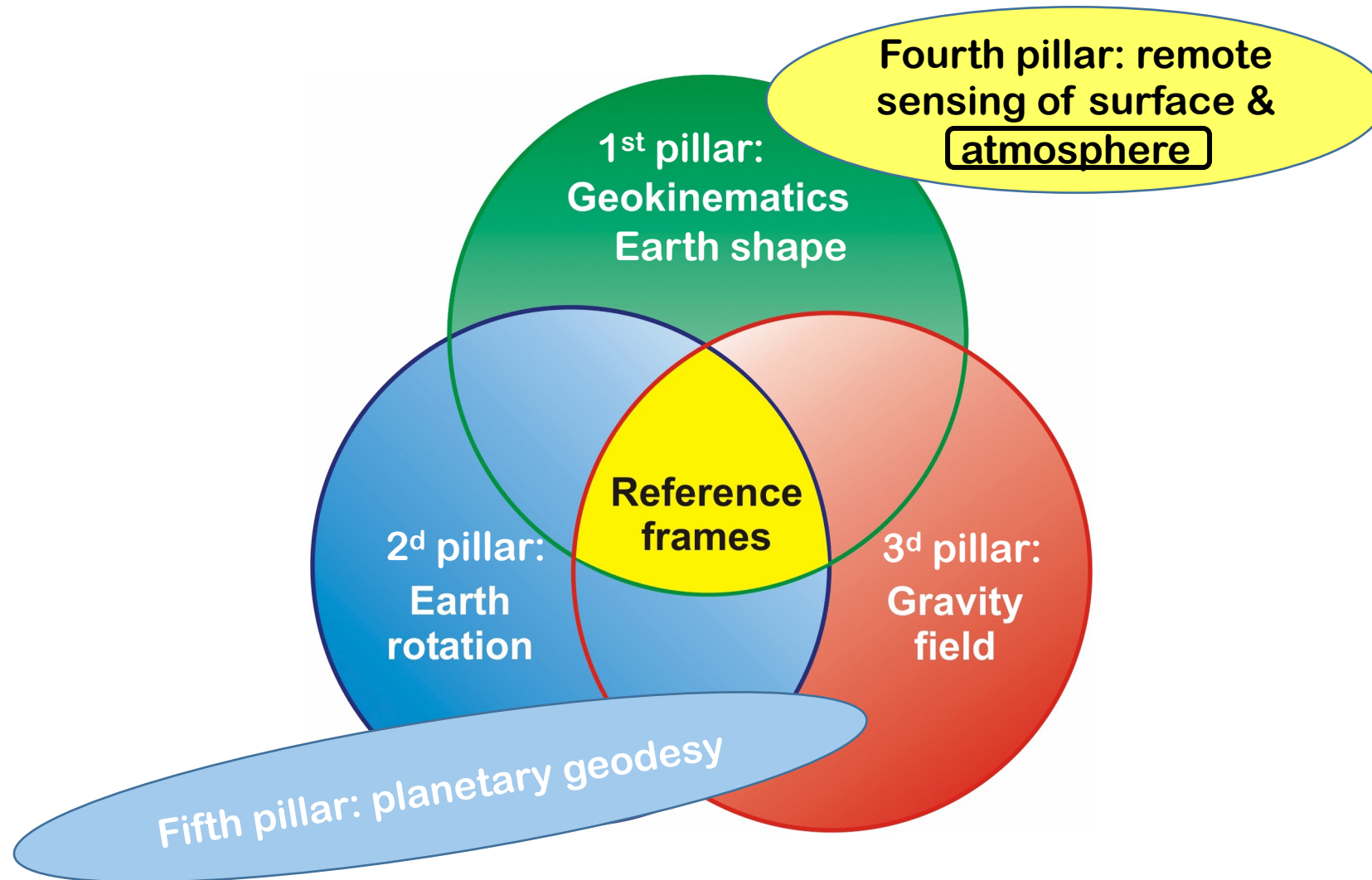
- IceCon project (BELSPO - ULB): monitor long-term mm-level deformations of the Earth's crust induced by changes of the surface ice mass
- 'Permanent' GNSS infrastructure at PEB upgraded GPS → GPS/Glonass/Galileo/Beidou



Courtesy Carine Bruyninx



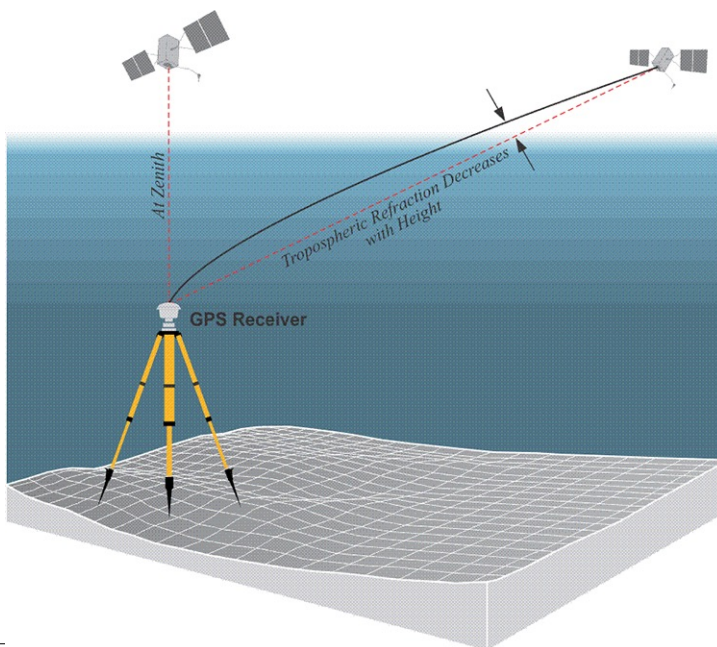
# Geodesy and its five pillars





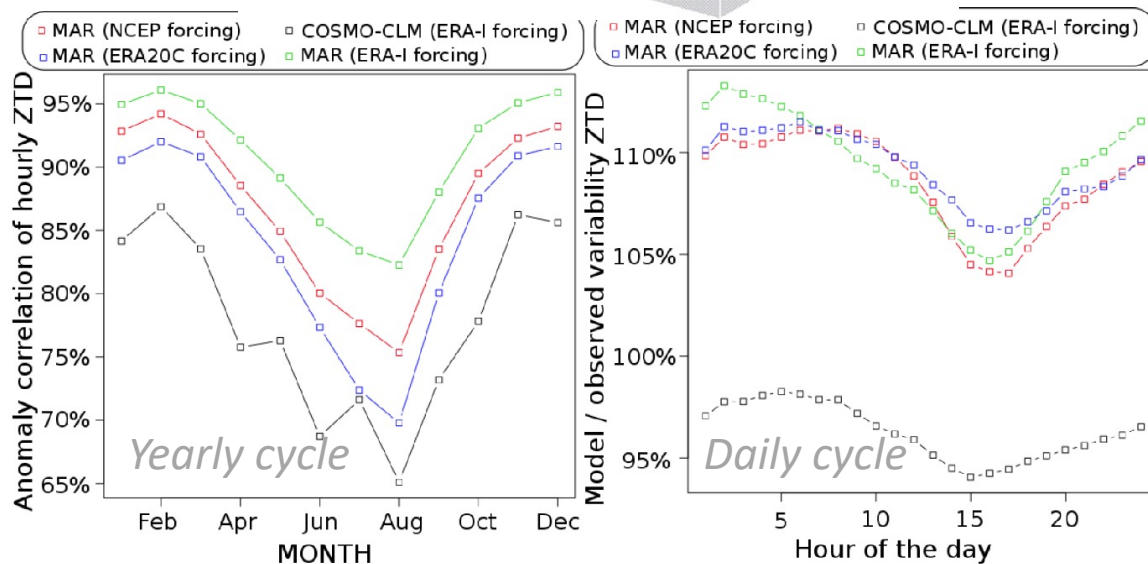
# Troposphere with GNSS

GNSS products e.g. deformations, plate velocities, ionosphere, **troposphere**



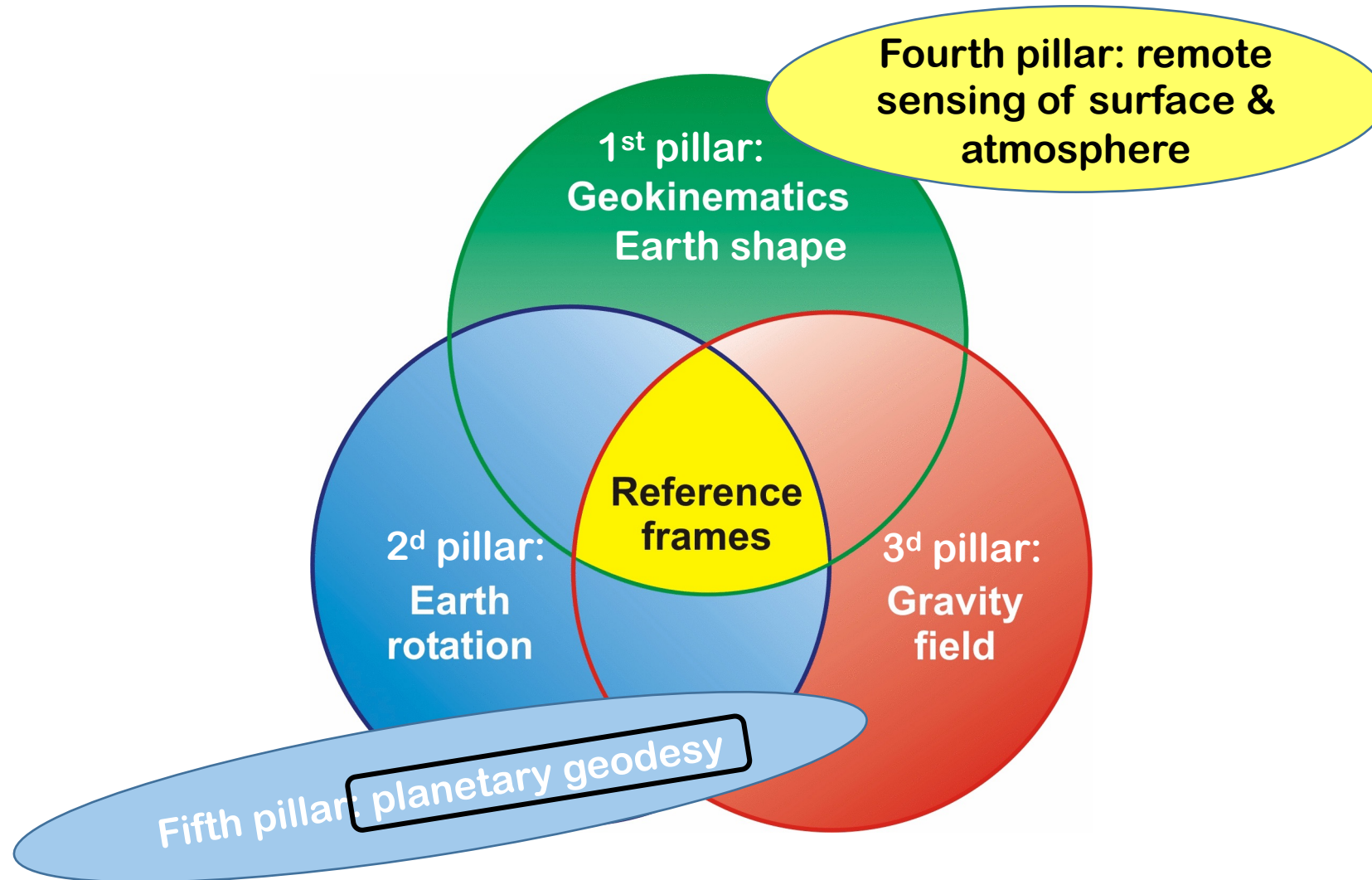
Courtesy Eric Pottiaux

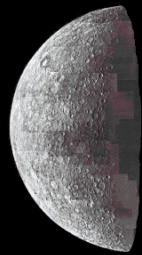
See also poster entitled “GNSS-based remote sensing of atmospheric water vapour at ROB for meteorology and climate: Status, perspectives, and challenges”



Note: several IAG WGs on atmosphere small structures, troposphere, climate with GNSS

# Geodesy and its five pillars





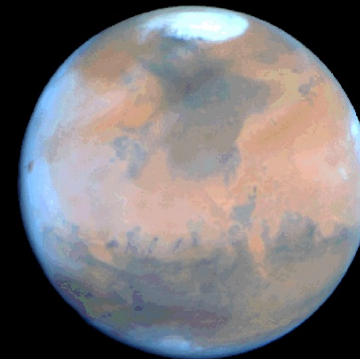
The Moon



Venus

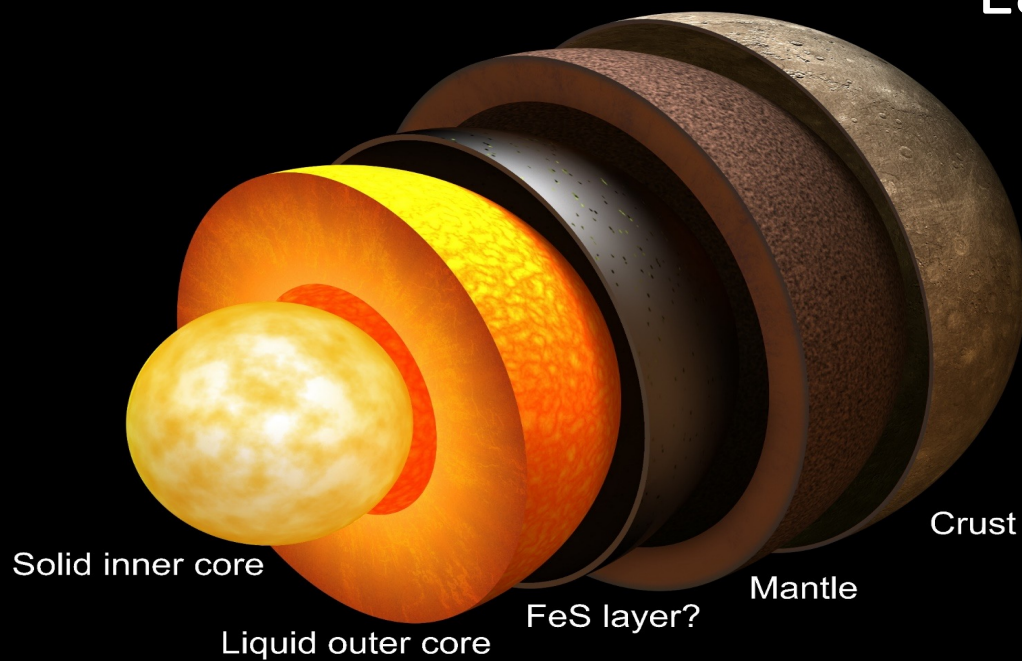


Earth



Mars

Mercury



Solid inner core

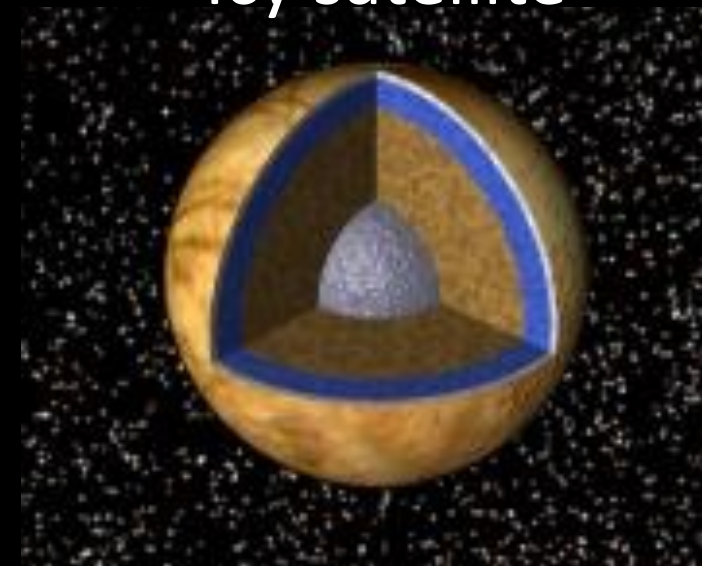
Liquid outer core

FeS layer?

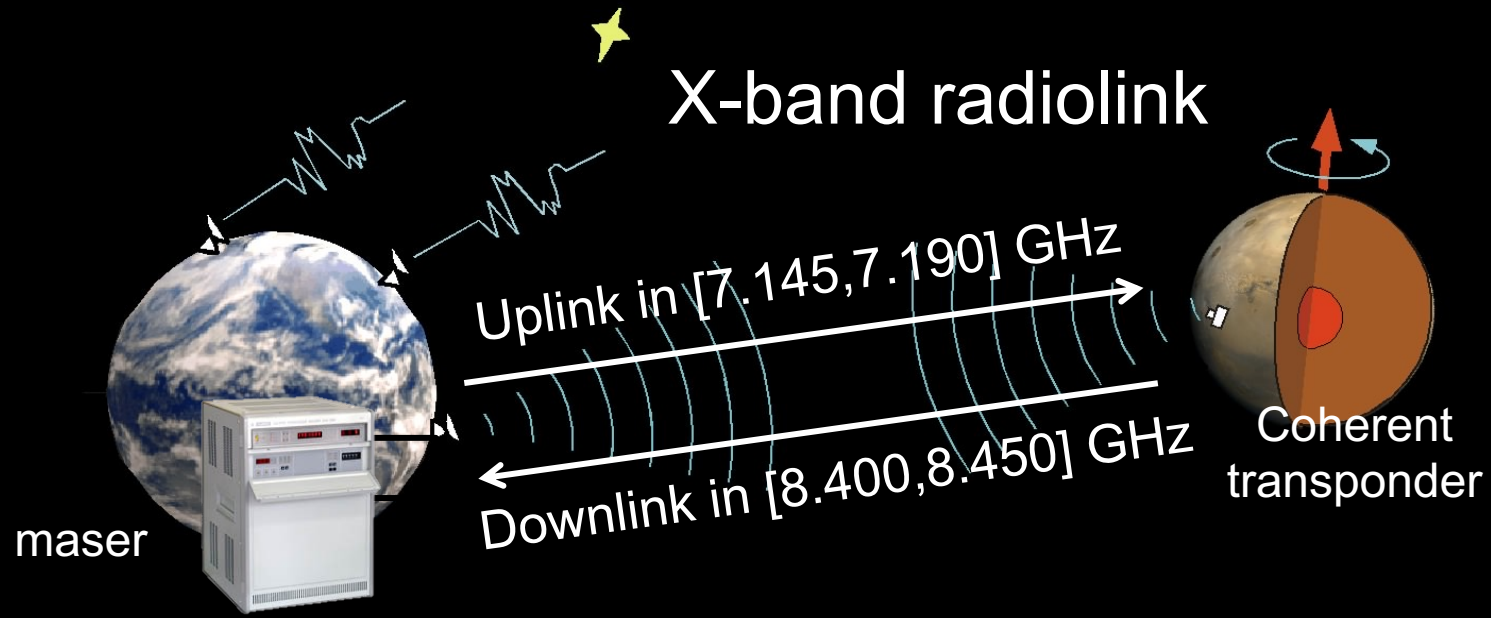
Mantle

Crust

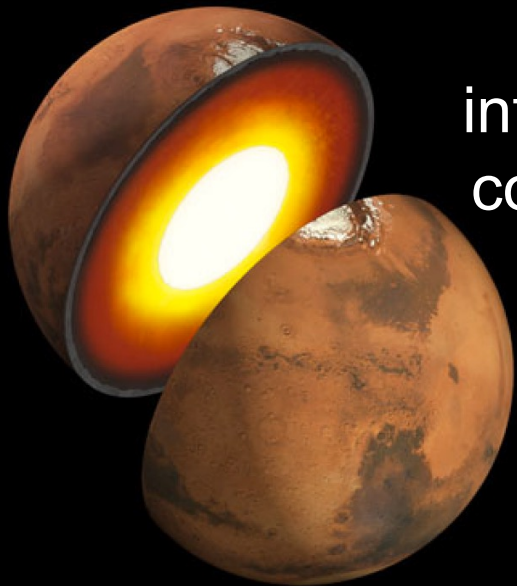
Icy satellite



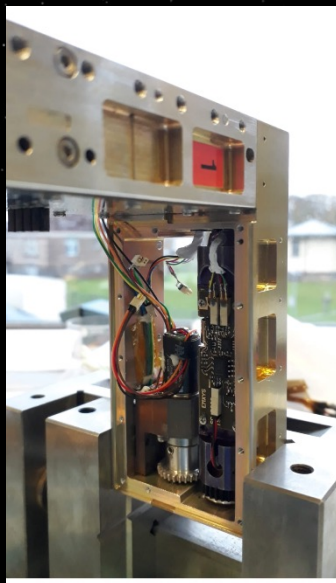
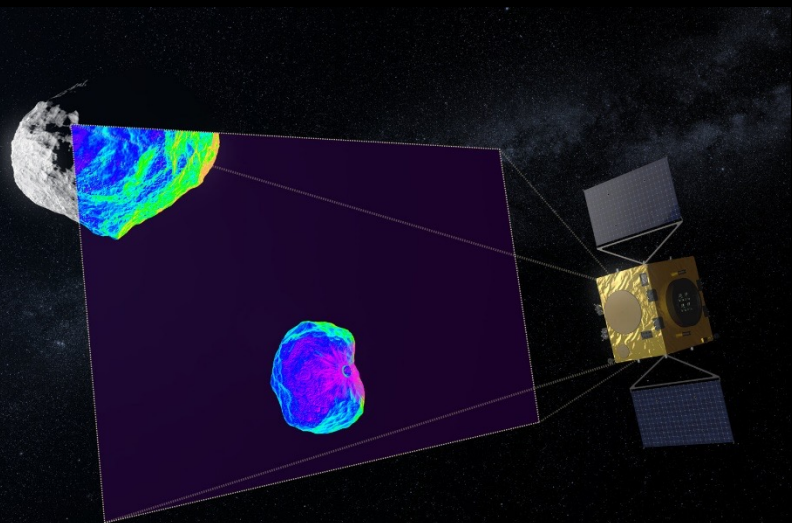
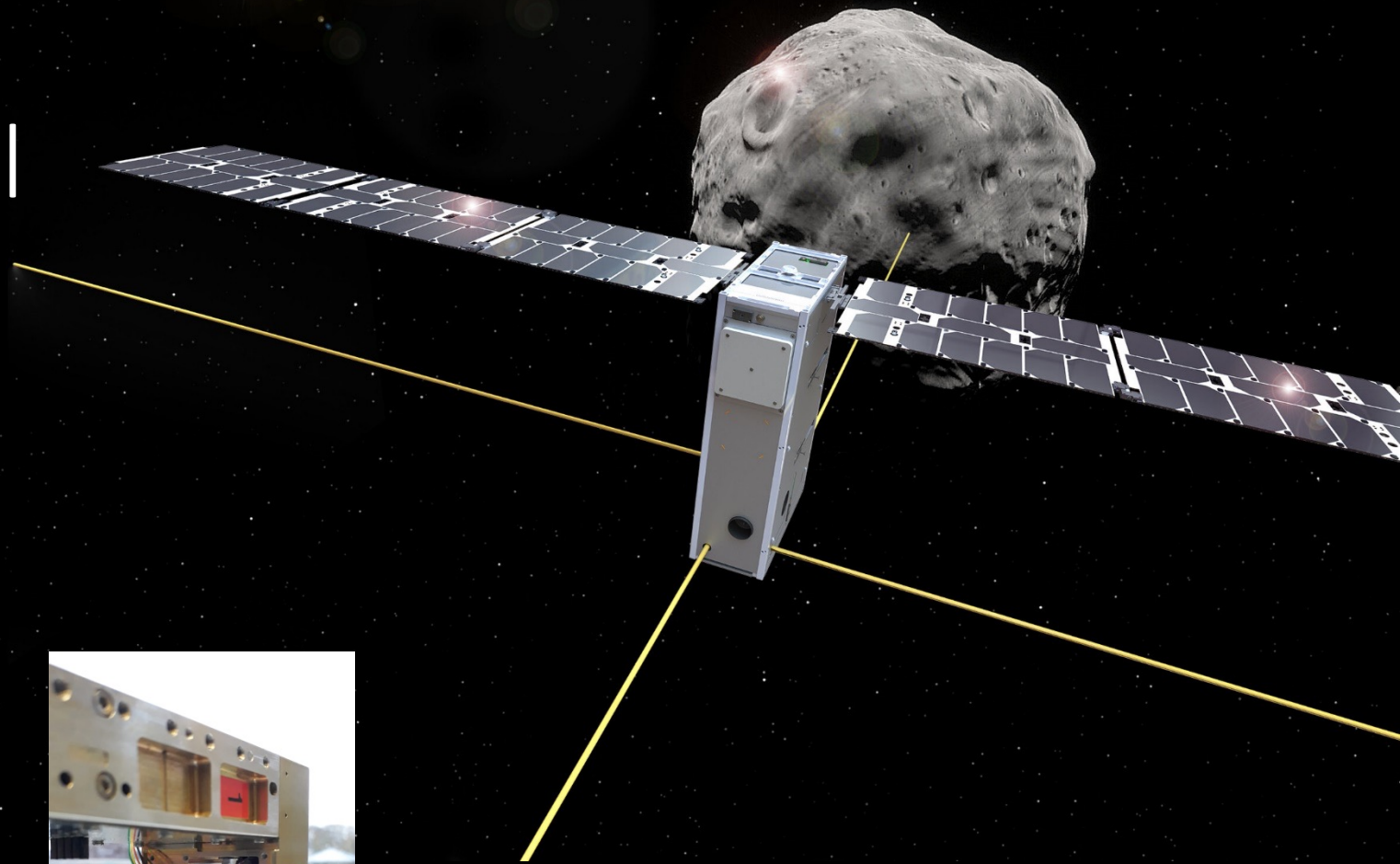
# Instrument LaRa (Lander Radioscience)



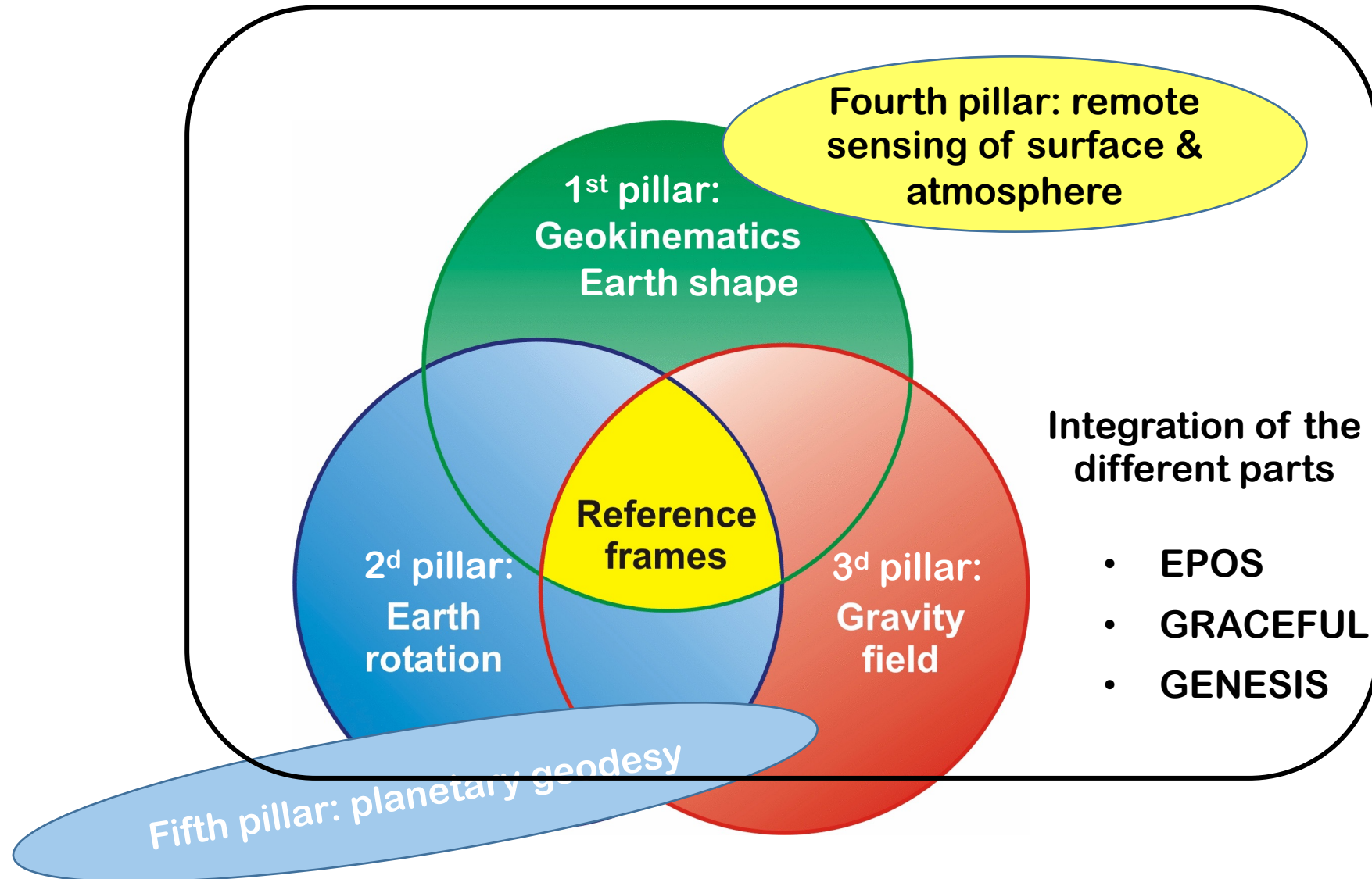
Objective:  
interior of Mars,  
core properties



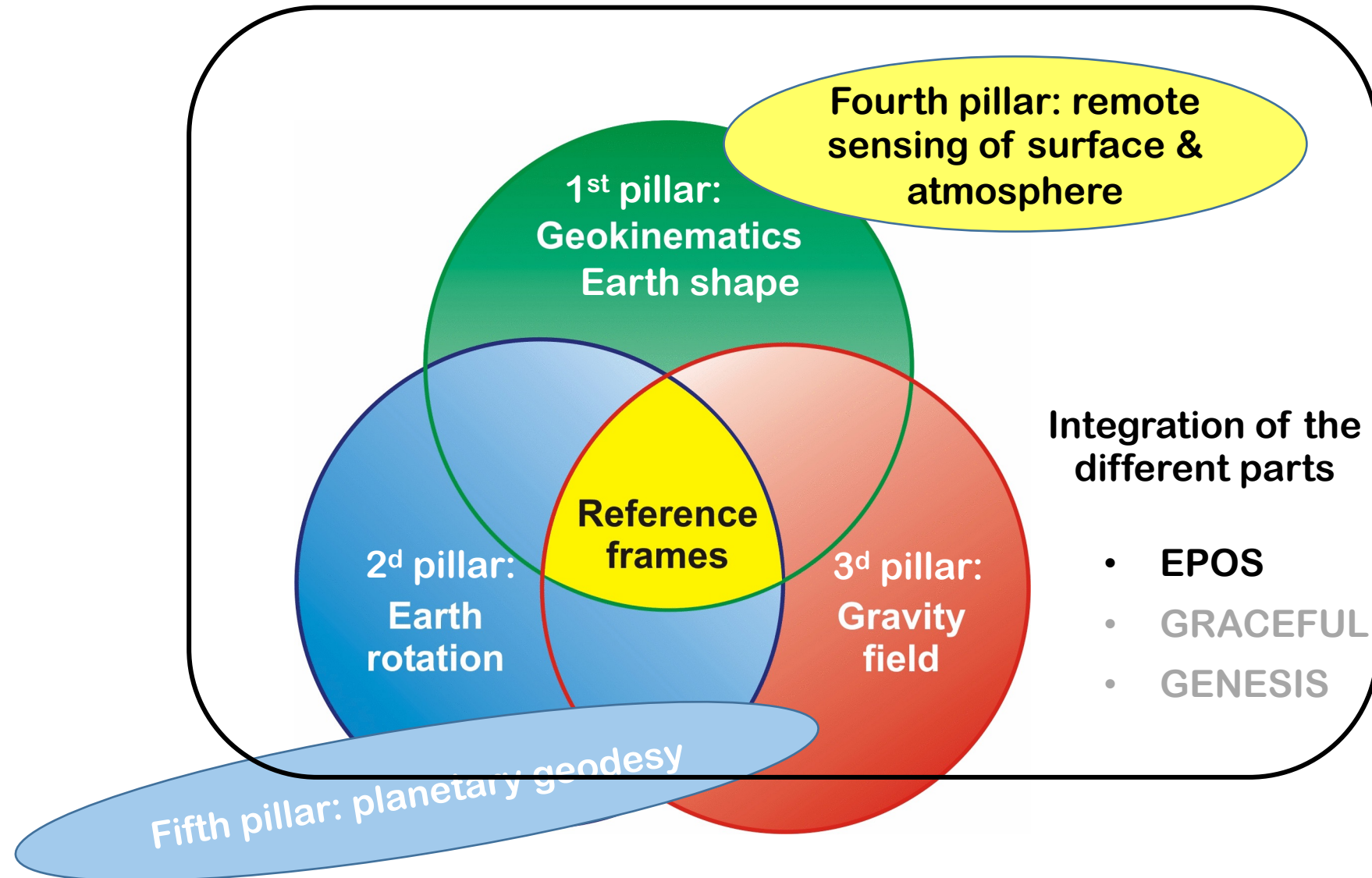
# Instrument GRASS (GRAvimeter for Small Solar System bodies) + IR camera



# Geodesy and its five pillars



# Geodesy and its five pillars

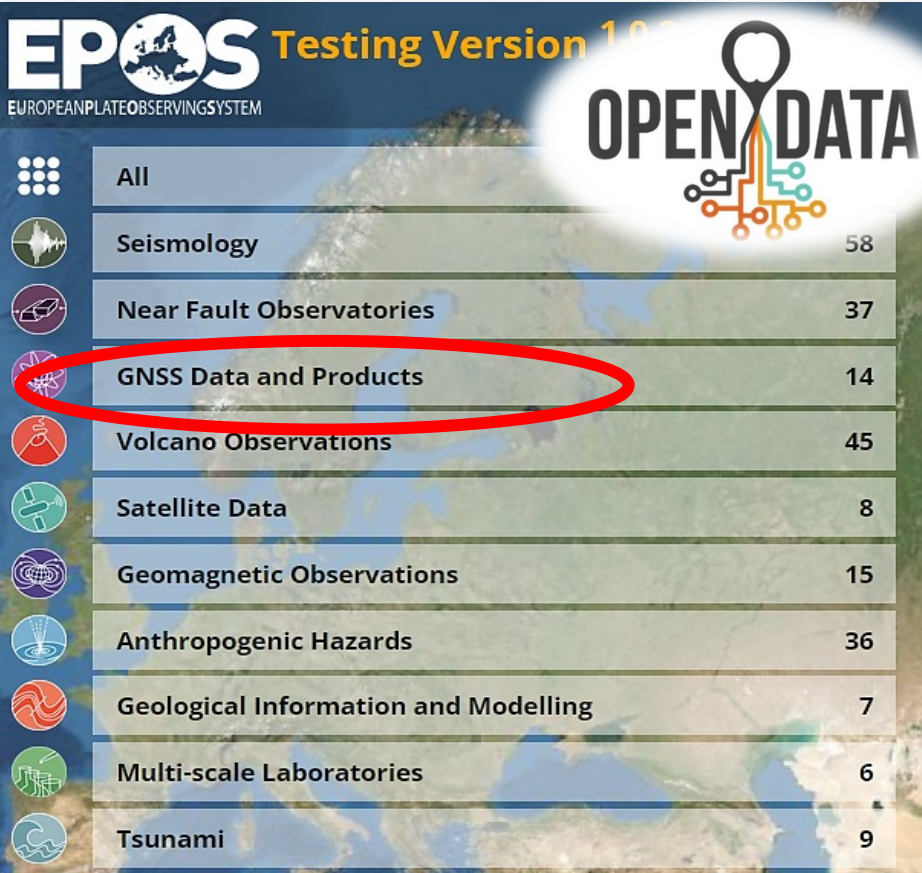




# GNSS – EPOS

European Plate Observing System (EPOS): New European Research Infrastructure in support of Solid Earth Research

- Sustainability of scientific services
- Open data - multidisciplinary
- Goal: 3000 GNSS stations for solid earth science
- Application and extension of EUREF services to EPOS
- MoU between EPOS and EUREF



The screenshot shows the EPOS website interface. At the top left is the EPOS logo with the text 'EUROPEAN PLATE OBSERVING SYSTEM'. To the right is the text 'Testing Version 1.0' and the 'OPEN DATA' logo. Below the header is a list of data categories with corresponding icons and counts. The 'GNSS Data and Products' category is circled in red.

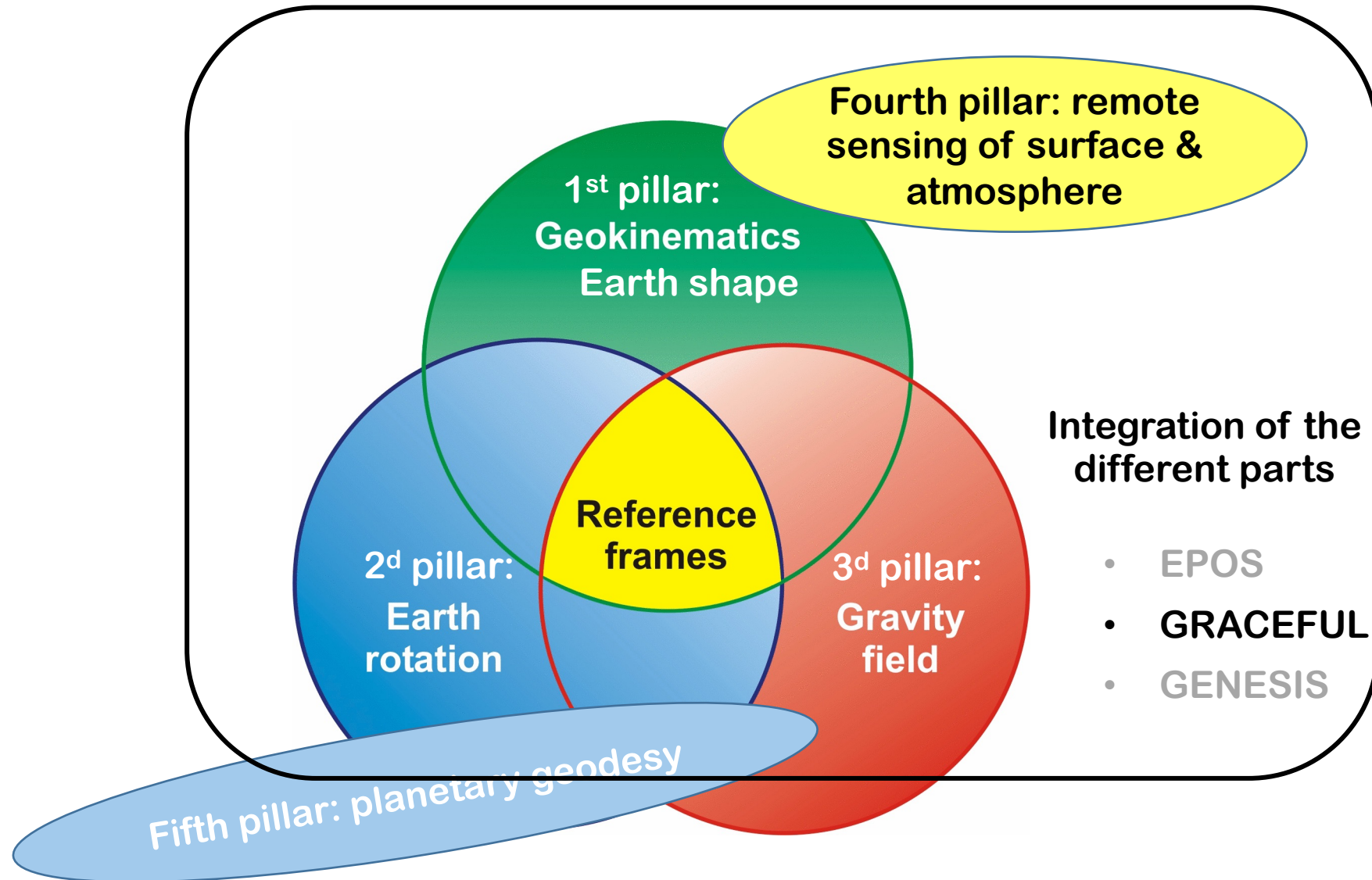
Category	Count
All	
Seismology	58
Near Fault Observatories	37
GNSS Data and Products	14
Volcano Observations	45
Satellite Data	8
Geomagnetic Observations	15
Anthropogenic Hazards	36
Geological Information and Modelling	7
Multi-scale Laboratories	6
Tsunami	9

Courtesy Carine Bruyninx

See also poster entitled “Belgian GNSS contribution to the European Plate Observing System”



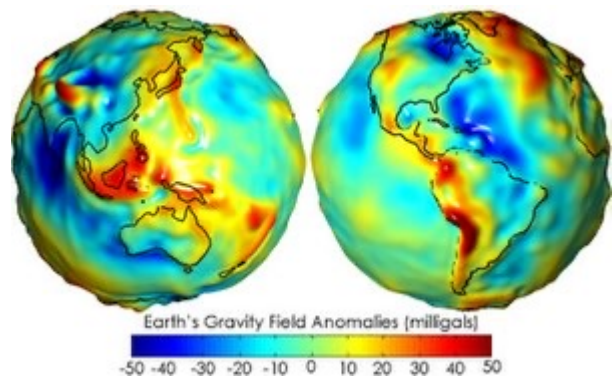
# Geodesy and its five pillars



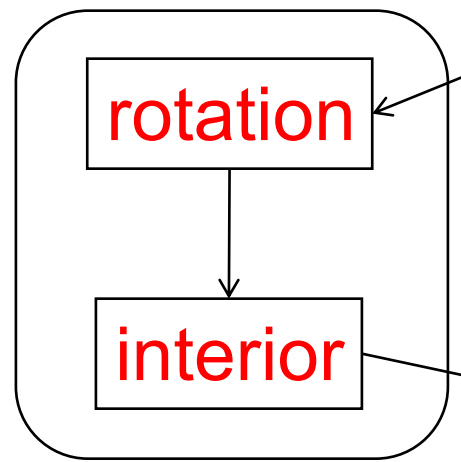
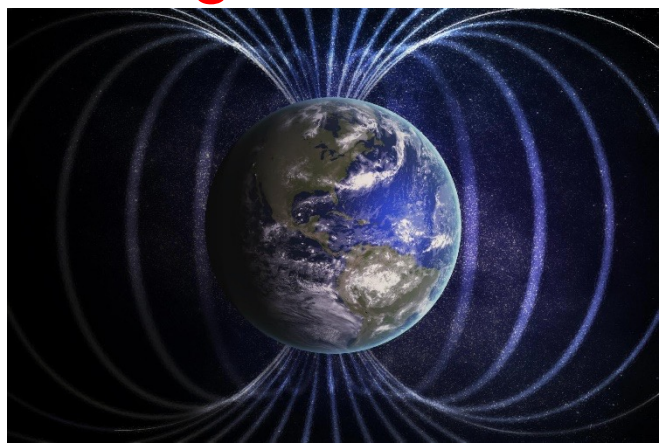
# Challenge for Earth interior

– synergy with other disciplines of IUGG

+ Gravity field



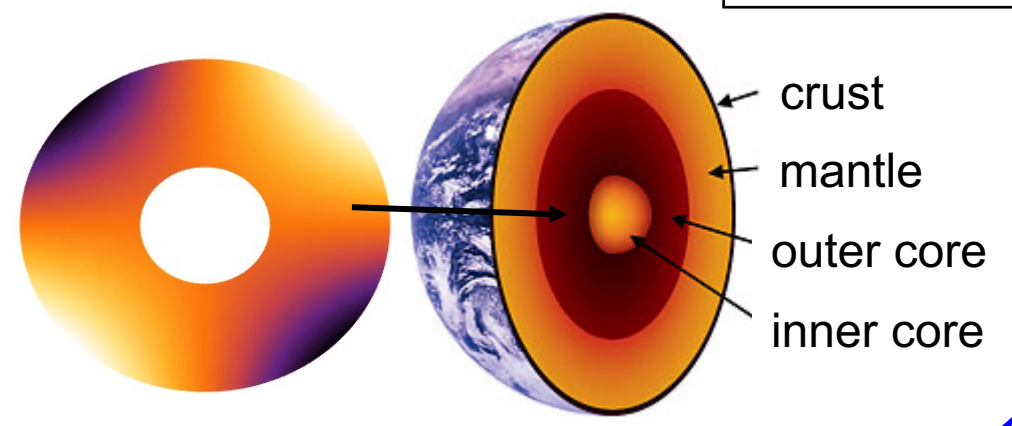
+ Magnetic field



Earth rotation observation

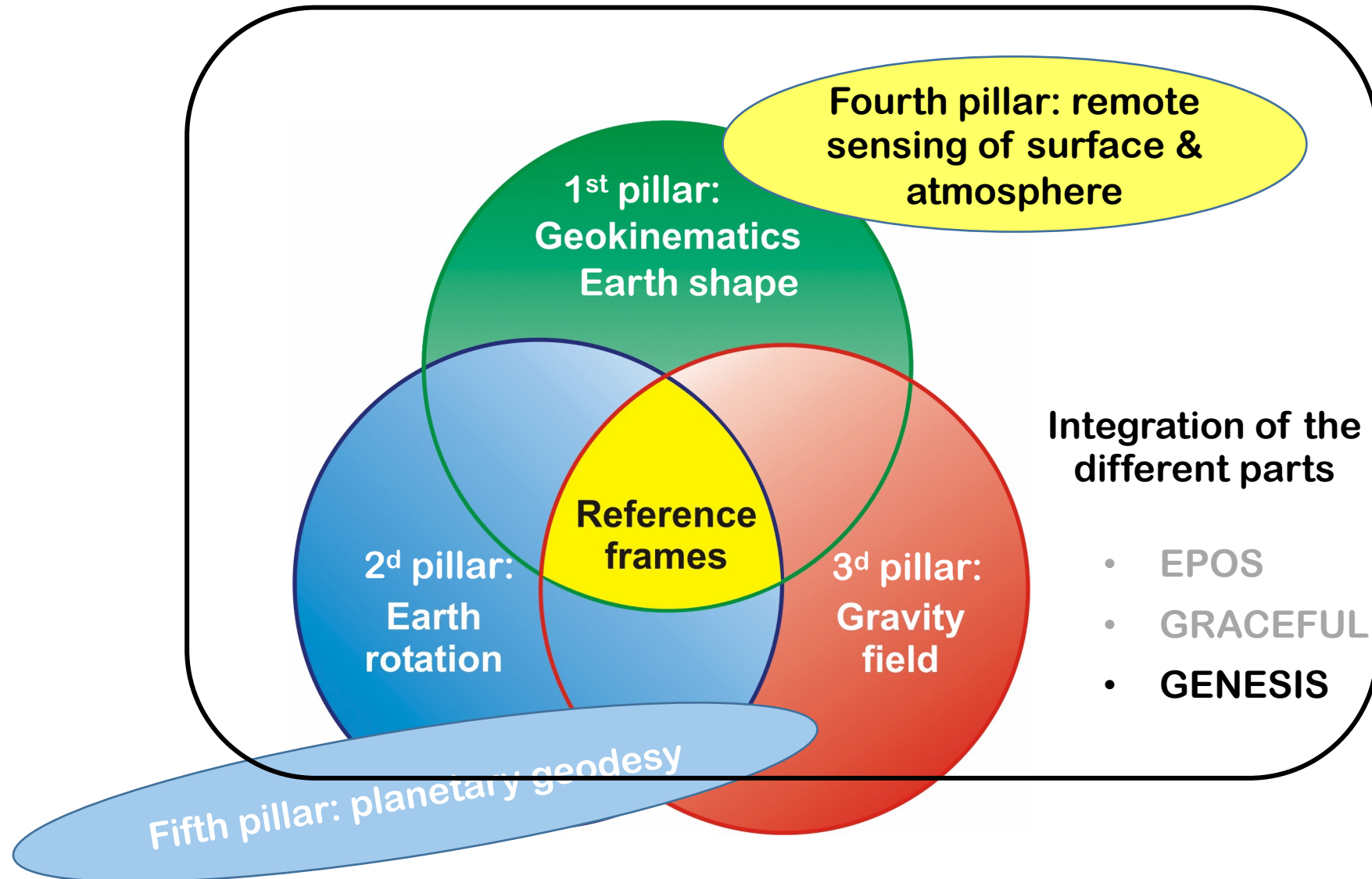
Earth rotation (and orientation) model/prediction

liquid core information  
Core-mantle coupling mechanisms



*ERC GRACEFUL*

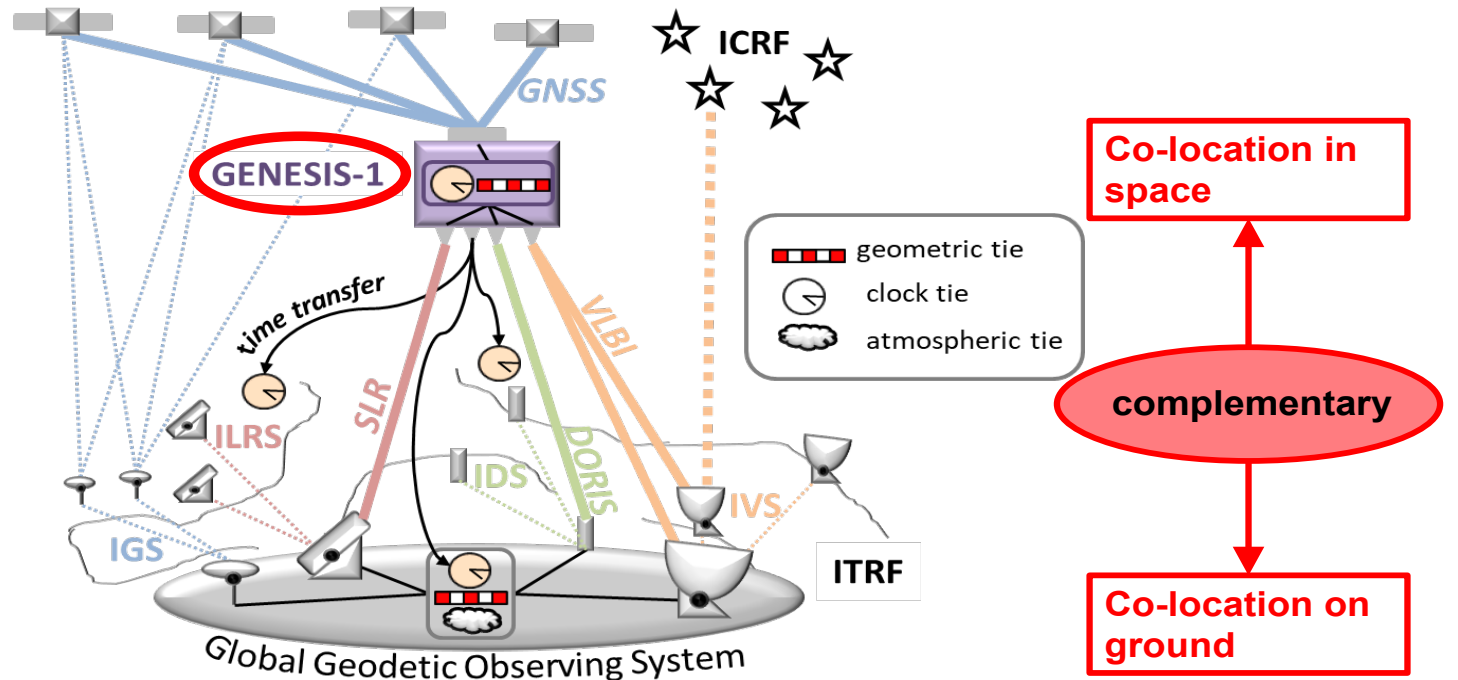
# Geodesy and its five pillars





United Nations resolution on sustainable development (A/RES/69/266): **improving and homogenizing time and space references on Earth (at the 1 mm and 0.1 mm/y)**  
 Also recommended by the Global Geodetic Observing Systems (GGOS) of the International Association of Geodesy (IAG).

### Goal of GENESIS-1: Unification of Space and Time Reference Systems



- Combining and co-locating, on one satellite platform, the full set of fundamental space-time geodetic systems.
- Relevant for many scientific and societal endeavors.



GNSS satellites

Quasars

**VT objective:**

- (1)** GENESIS satellite orbit is determined by GNSS Receiver without absolute position and orientation information
- (2)** GS local link
- (3)** Include VLBI Transmitter mimicking quasars on GENESIS satellite and observing it during **(4)** VLBI intensive sessions
- (5)** Analyze intensive sessions observing VT and quasars; and determine the absolute position and orientation of GENESIS satellite.

