Report of SONEL
GLOSS Data Assembly Centre
dedicated to GNSS data @Tide Gauges

Guy Wöppelmann & Médéric Gravelle
(La Rochelle University, France)

with contributions from

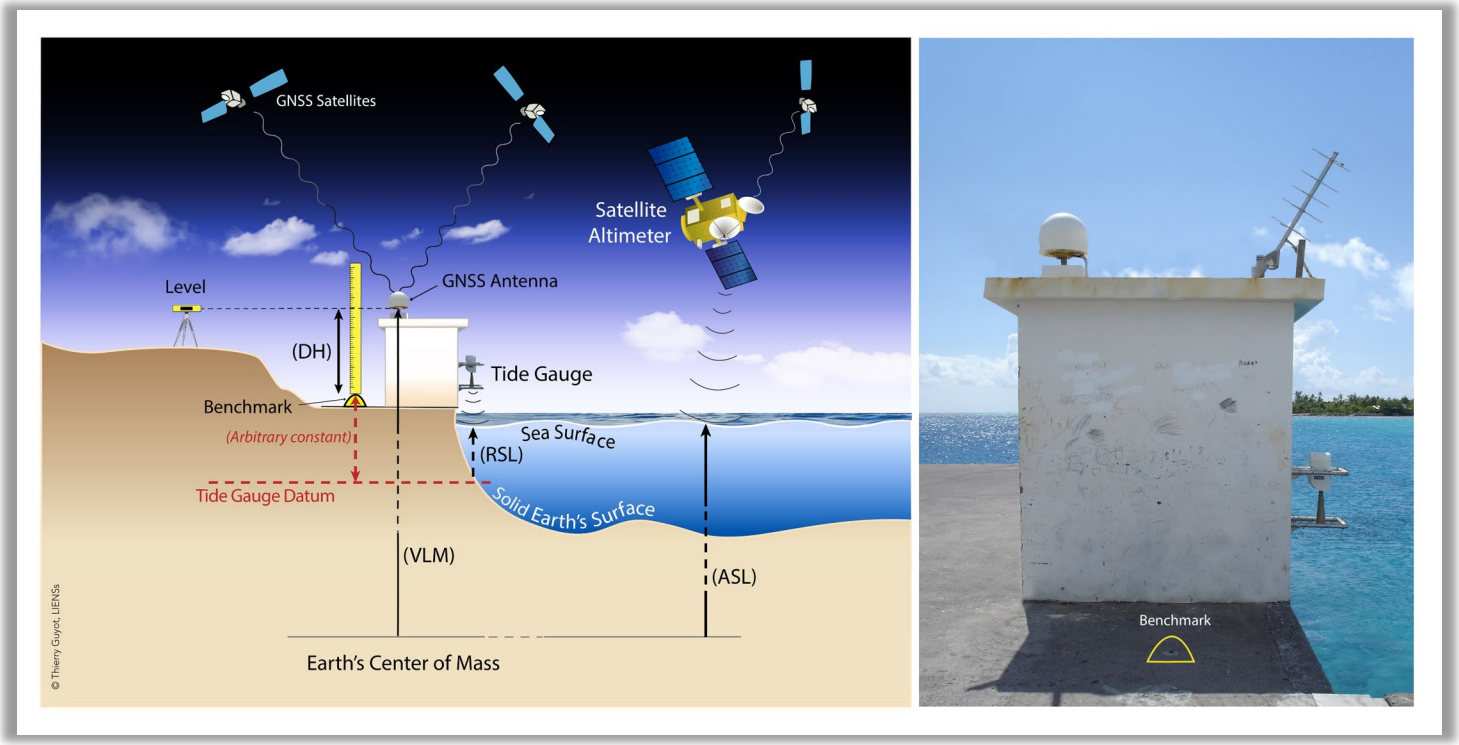
the SONEL team at LIENSs lab (GNSS + Fr TG)




(M. Guichard, S. Jeanne, A. Laval, L. Testut)

GNSS@TG: What are we talking about?

www.sonel.org



GLOSS No. 354 (Makemo)

ASL : Absolute Sea Level (geocentric)
RSL : Relative Sea Level (*wrt* to benchmark / ground)
VLM : Vertical Land Motion
DH : Difference in Height between the GNSS antenna reference point and Tide Gauge Benchmark / datum

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SONEL Data Assembly Centre in a nutshell
(the GNSS component)

www.sonel.org

Individuals directly providing raw data

IGS INTERNATIONAL GNSS SERVICE

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azti tecnalia ROSAME

1320+ stations nearby TG / 150+ agencies / 60 countries

Over 7 500 000+ daily files of raw GNSS data (a.k.a. Rinex files)

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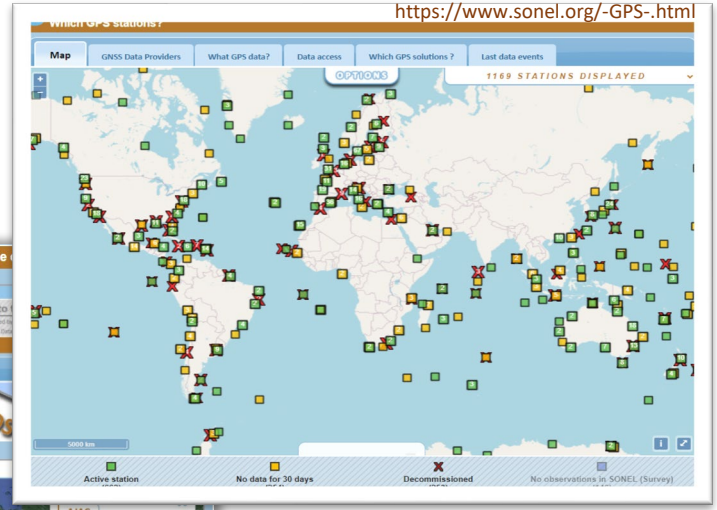
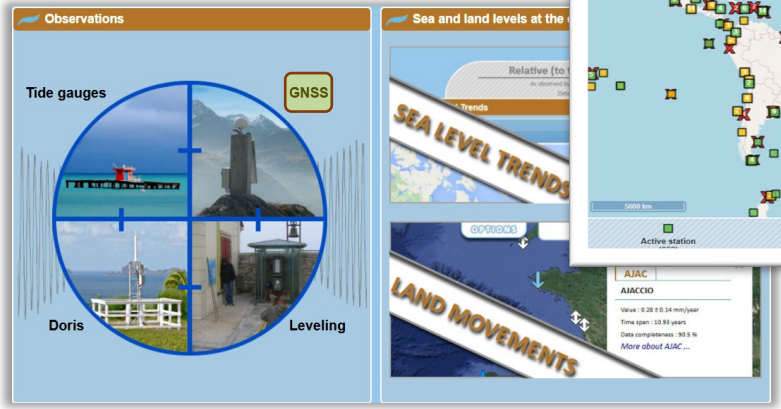
https://www.sonel.org/-GPS-.html





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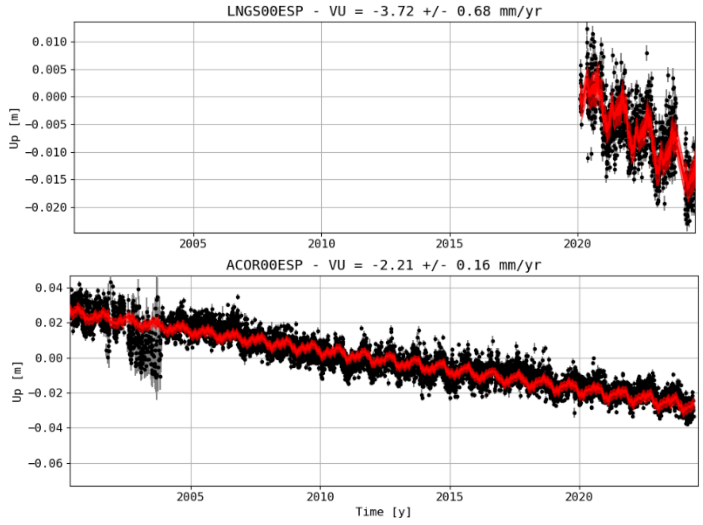
GFZ Helmholtz-Zentrum Potsdam
DGFI
uni.lu UNIVERSITÉ DU LUXEMBOURG — BLT
LIENSs — ULR
JPL Jet Propulsion Laboratory
Nevada Geodetic Laboratory

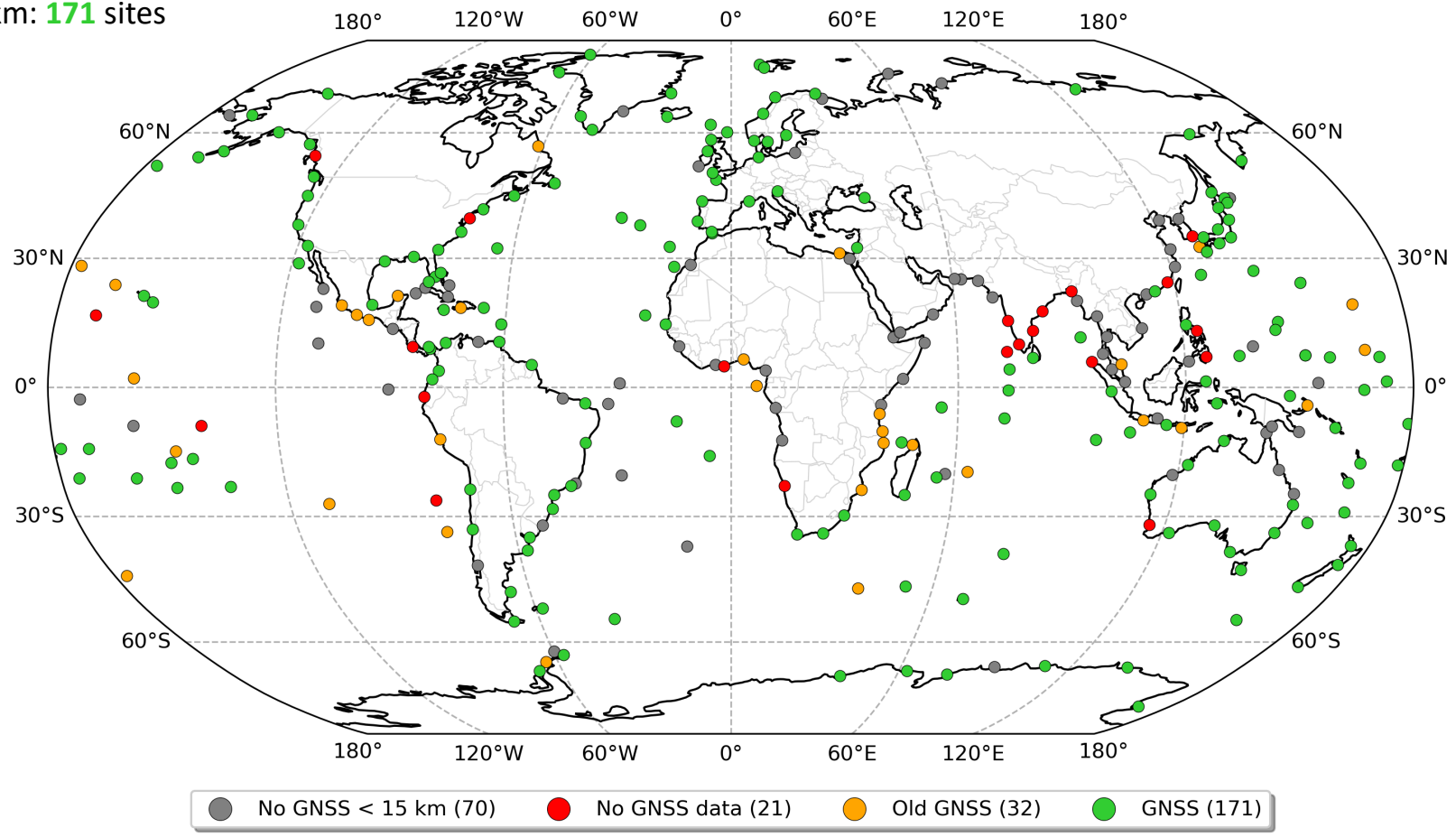
As many as 1065 stations **position time series & velocities**, depending on AC interests

USERS



SONEL Data Holdings: GLOSS core stations

Distance GNSS – TG
15 km: 171 sites



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SONEL Data Holdings: GLOSS core stations

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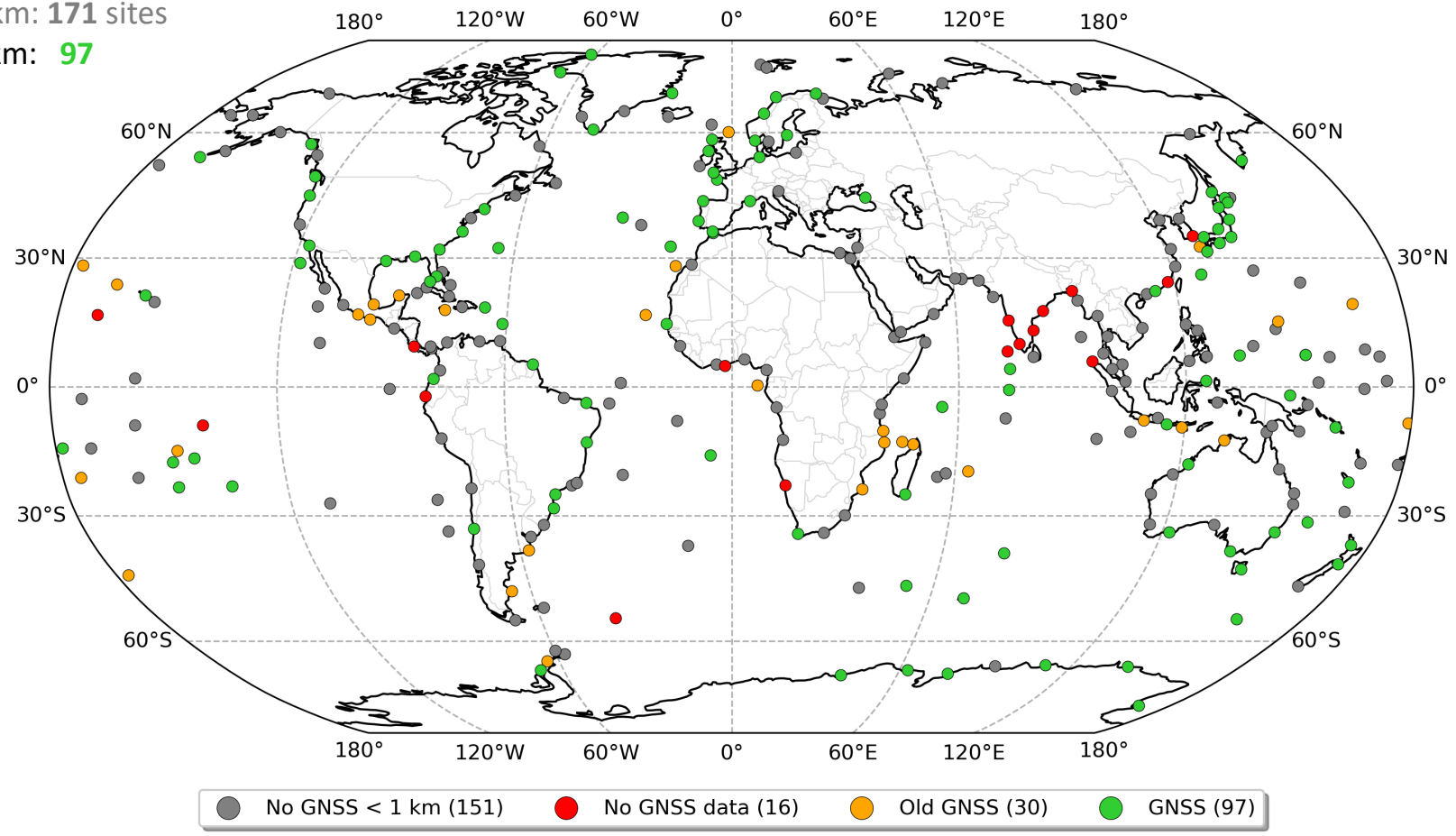

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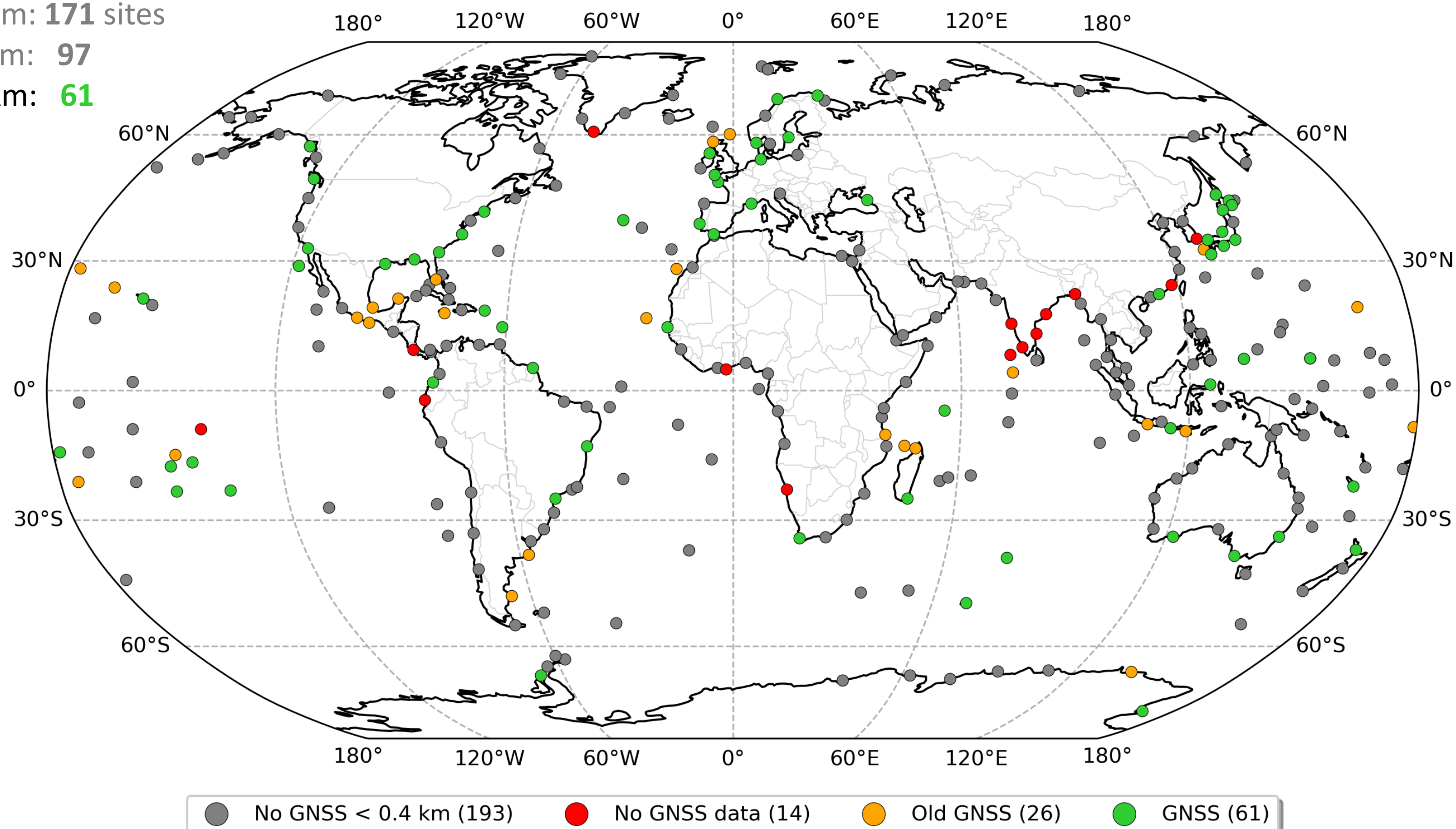

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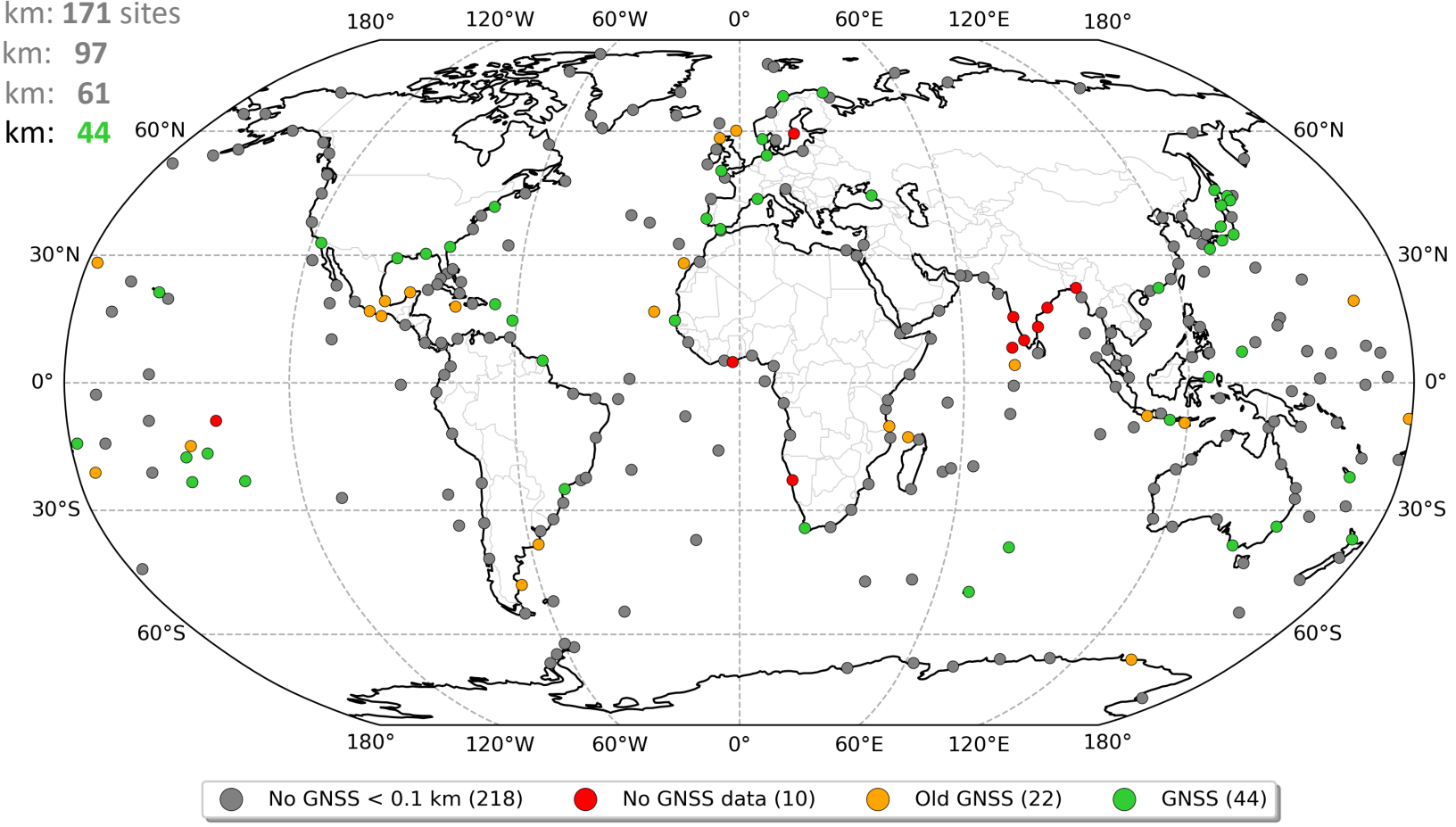

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Distance: a poor criteria (coarse proxy)

Distance GNSS – TG
15 km: **171** (59%)
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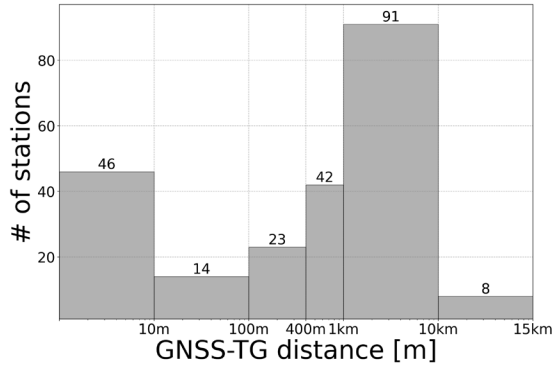
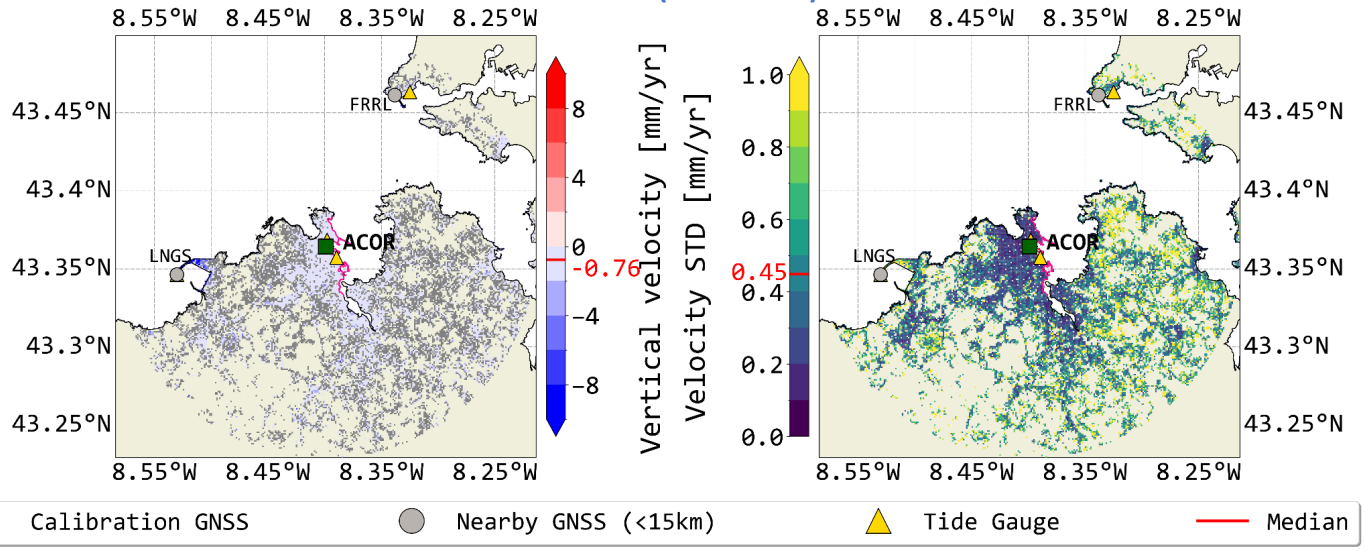


Implicit assumption : constant motion across the local area in between GNSS and TG.

Thus, the **relevant information is local VLM** :

- Local VLM can be uniform up to 10+ km
- <u>But</u> it can also show substantial differences as short as 100 m distant (e.g., pier stability)

La Coruña (GLOSS 243)



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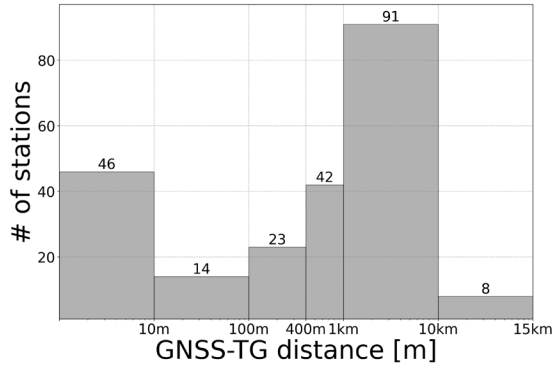

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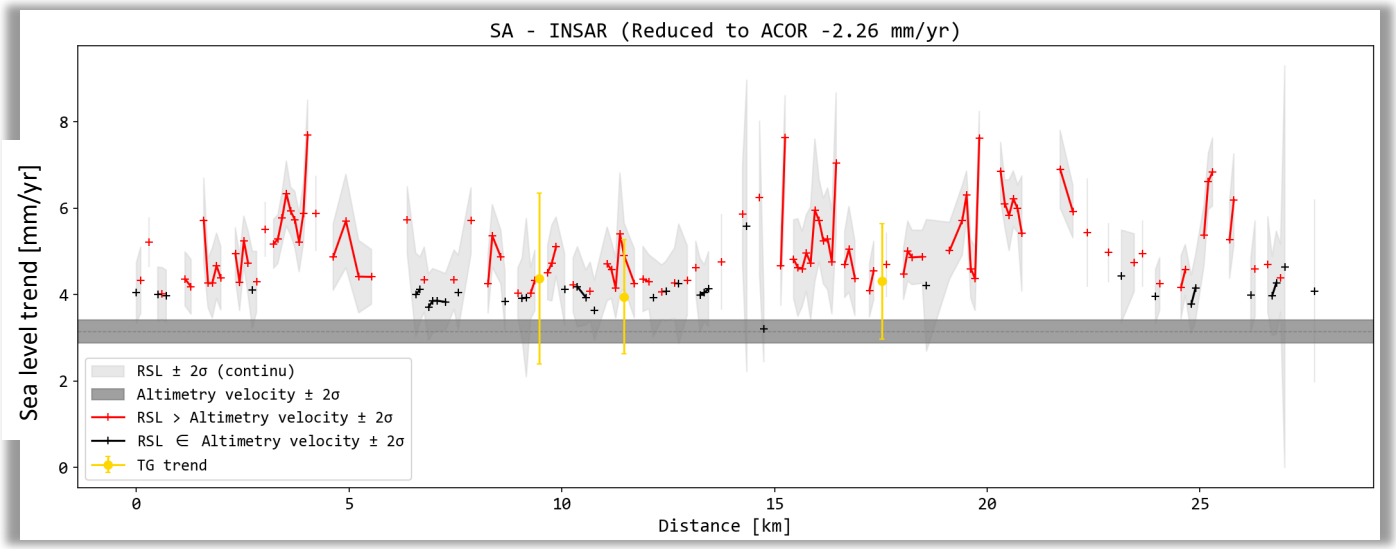

Focus on participating countries (list of Germany (1) & Ireland (2)

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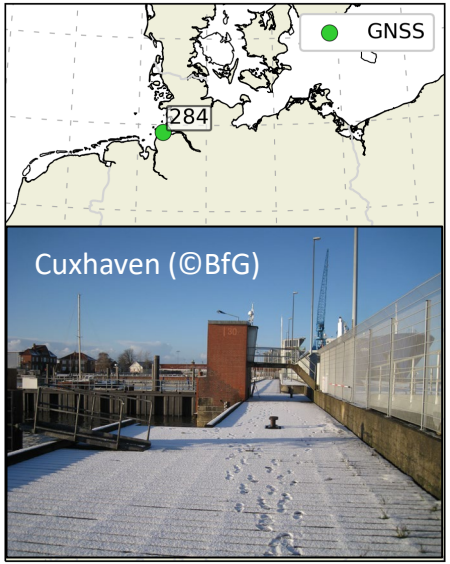
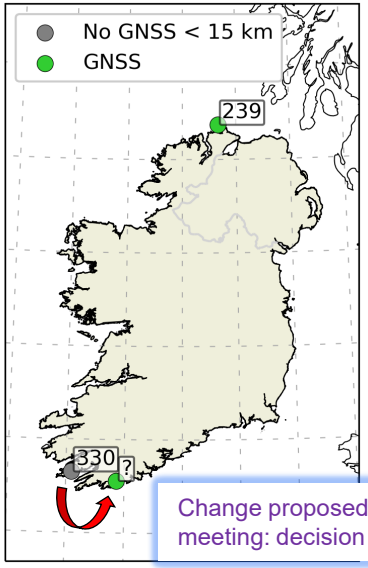
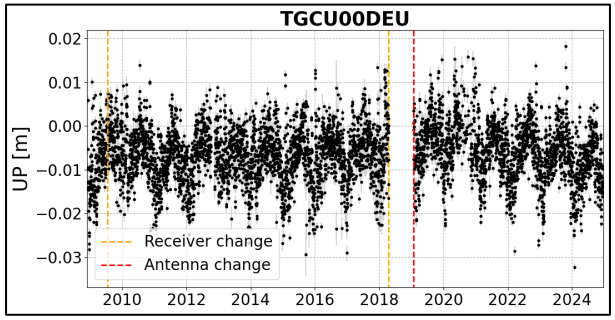
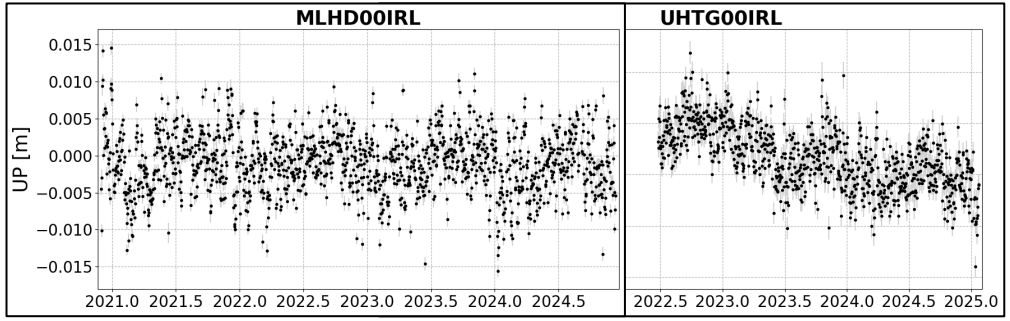




Change proposed in previous GLOSS GE meeting: decision pending (?)





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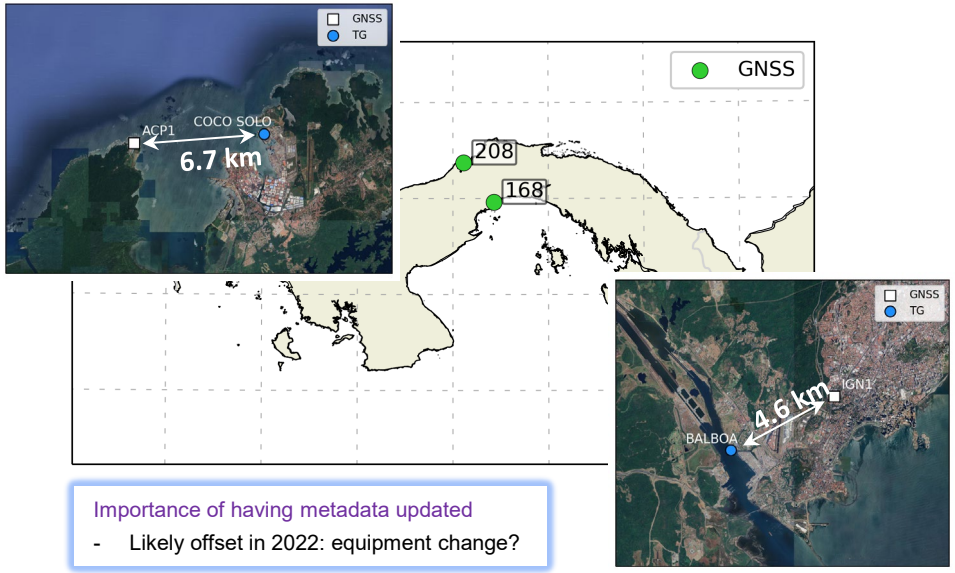
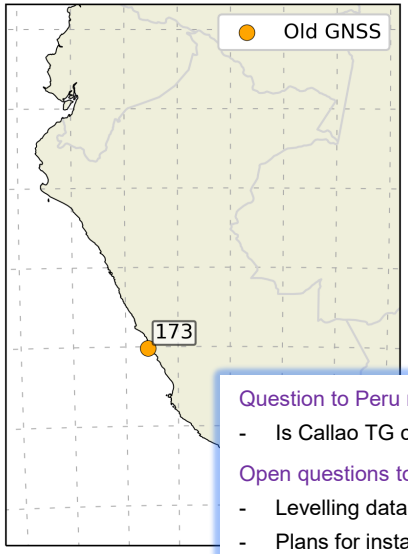
Focus on participating countries (list of 25 Feb)
Panama (2) & Peru (1)

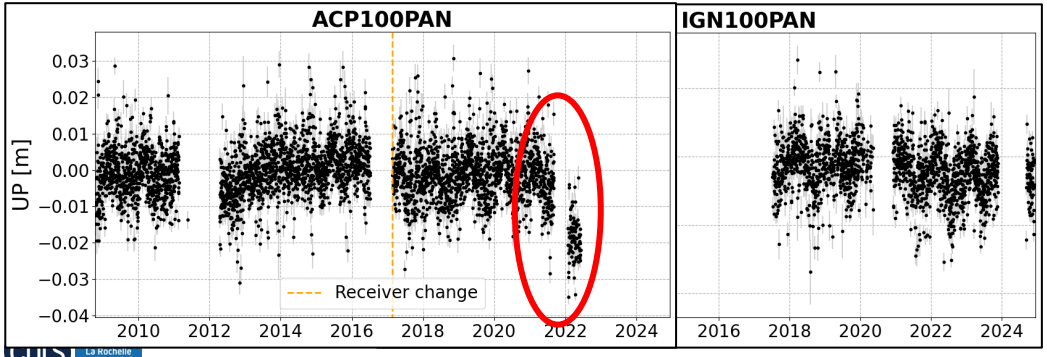


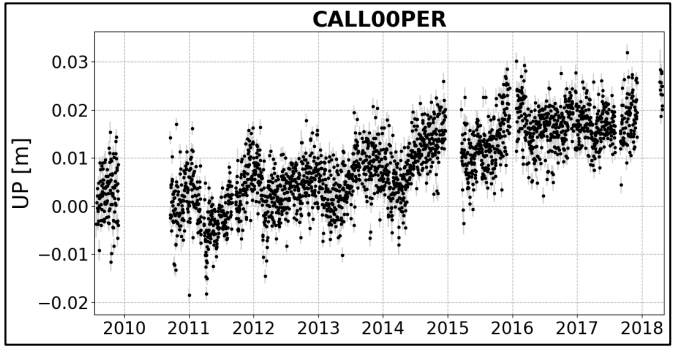
Importance of having metadata updated
- Likely offset in 2022: equipment change?



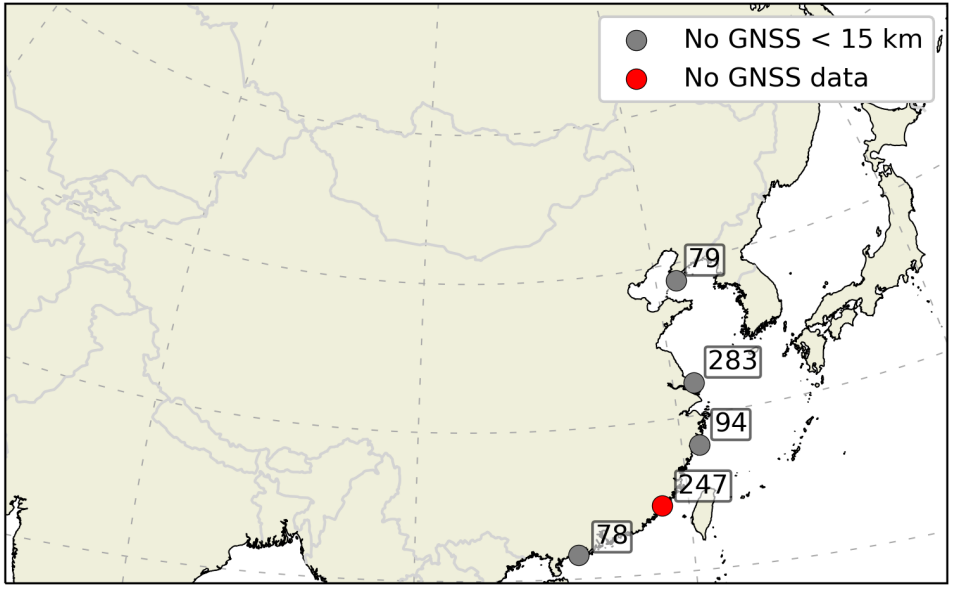
Question to Peru national Focal Point:
- Is Callao TG correctly located? (distance)

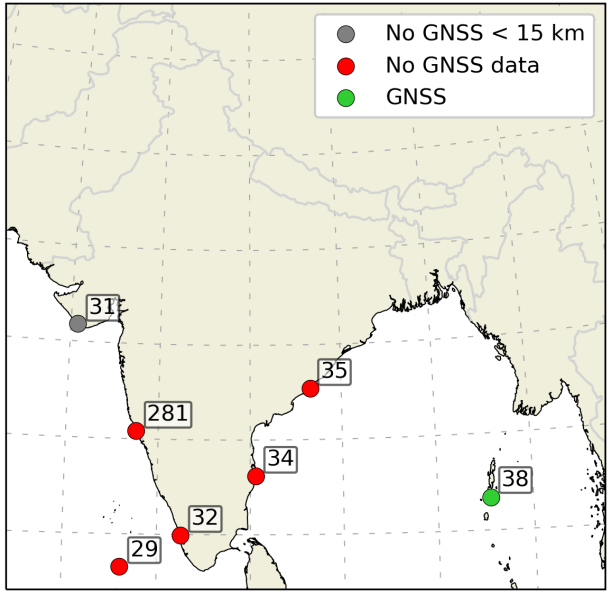
Open questions to both national Focal Points:
- Levelling data to assess local VLM (stability)?
- Plans for installing your own GNSS station?





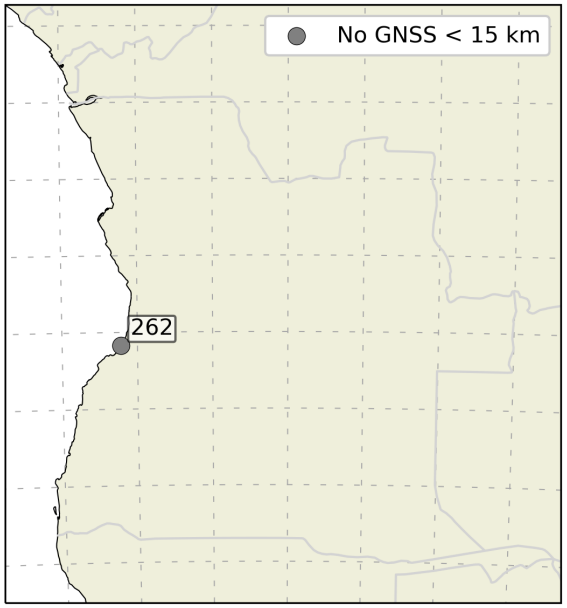
Focus on participating countries (list of 25 Feb)
China (5) & India (7)

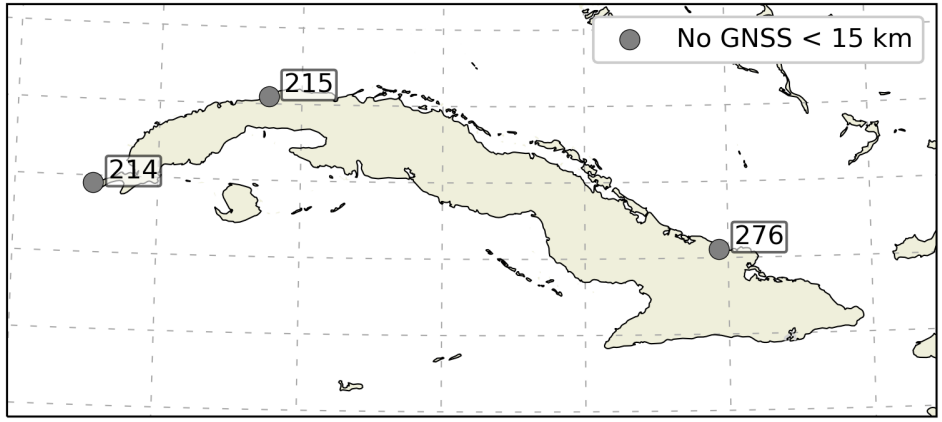




Please, reach out to me during the meeting
to examine your situation and
how we can help fulfilling GLOSS core station requirements

Focus on participating countries (list of 25 Feb)
Angola (1) & Cuba (3)





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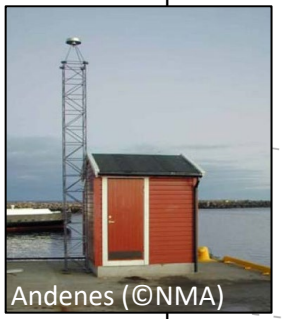
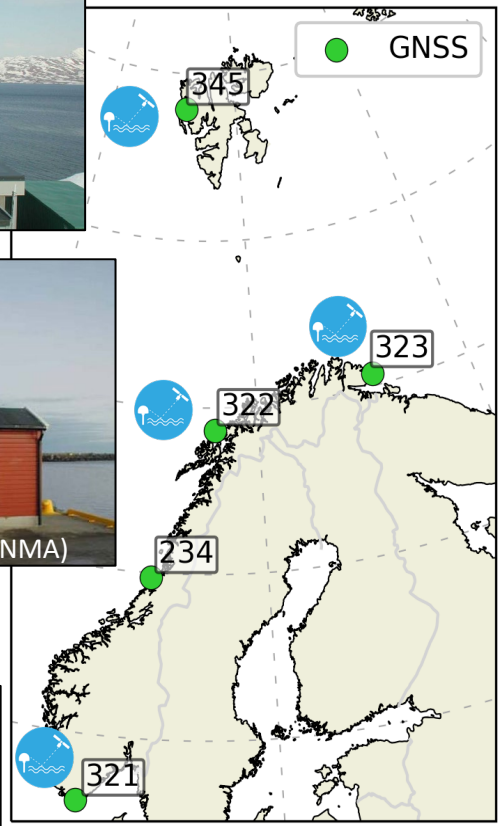
Focus on participating countries (list of 25 Feb)
Norway (5)

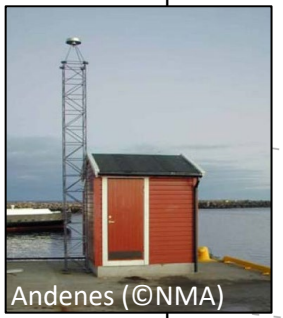




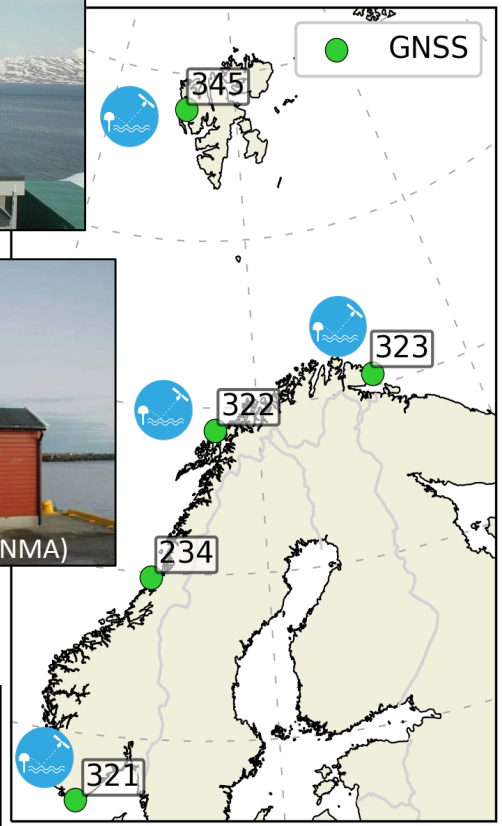
See 17th GLOSS GE meeting minutes and discussion about setting up a Working Group to keep up with advances in this area

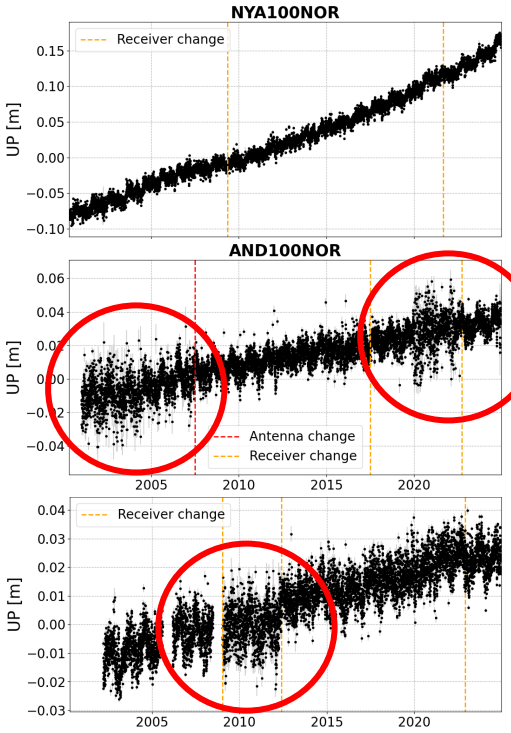
Focus on participating countries (list of 25 Feb)
Norway (5)

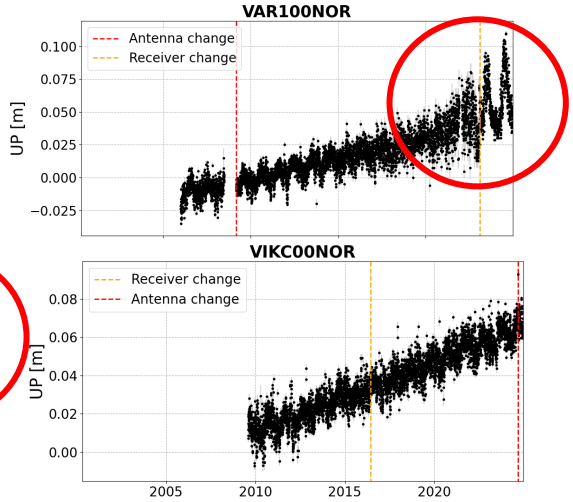

Ny Alesund (©M3G)


Andenes (©NMA)


Tregde (©NMA)





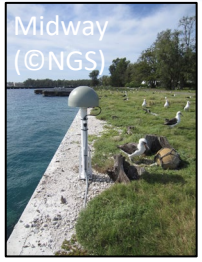


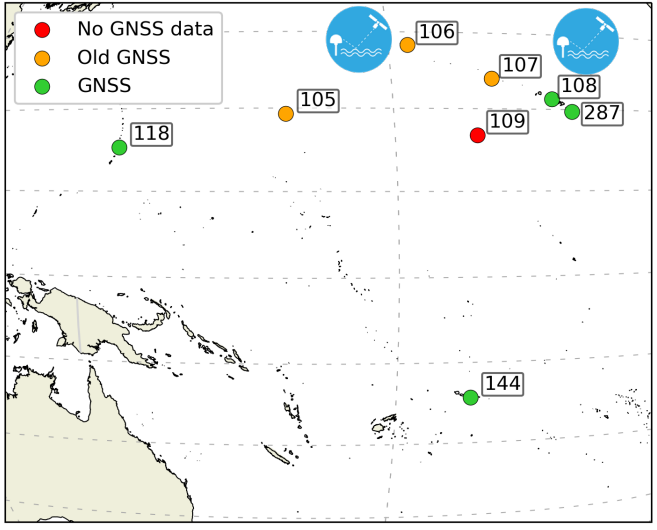
For Tide Gauge monitoring, GNSS equipment changes should be kept to the strict minimum. For instance, to address signal deterioration.

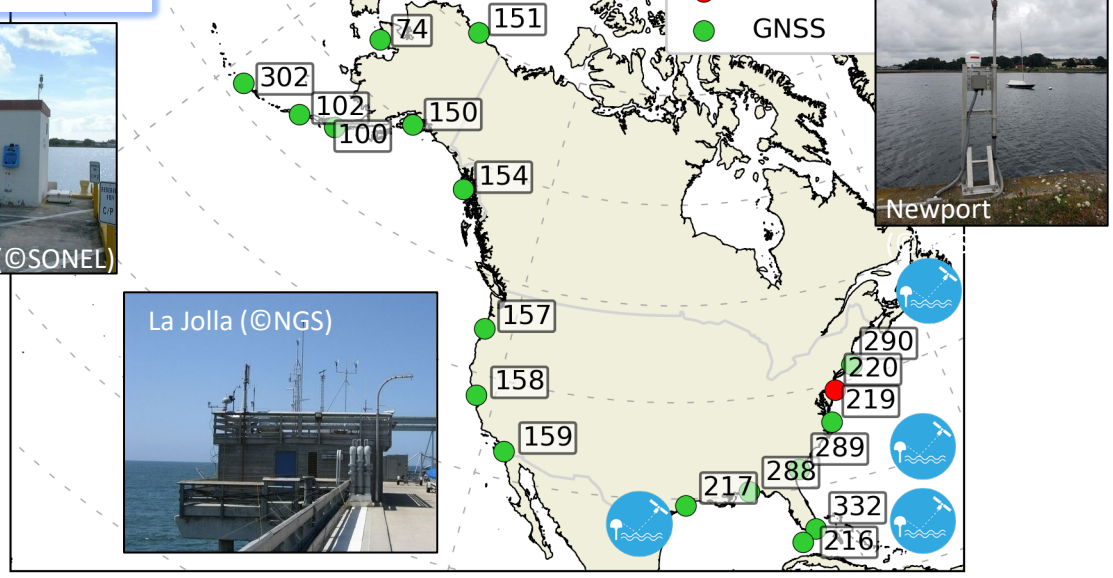
Focus on participating countries 25 Feb)

USA (26)

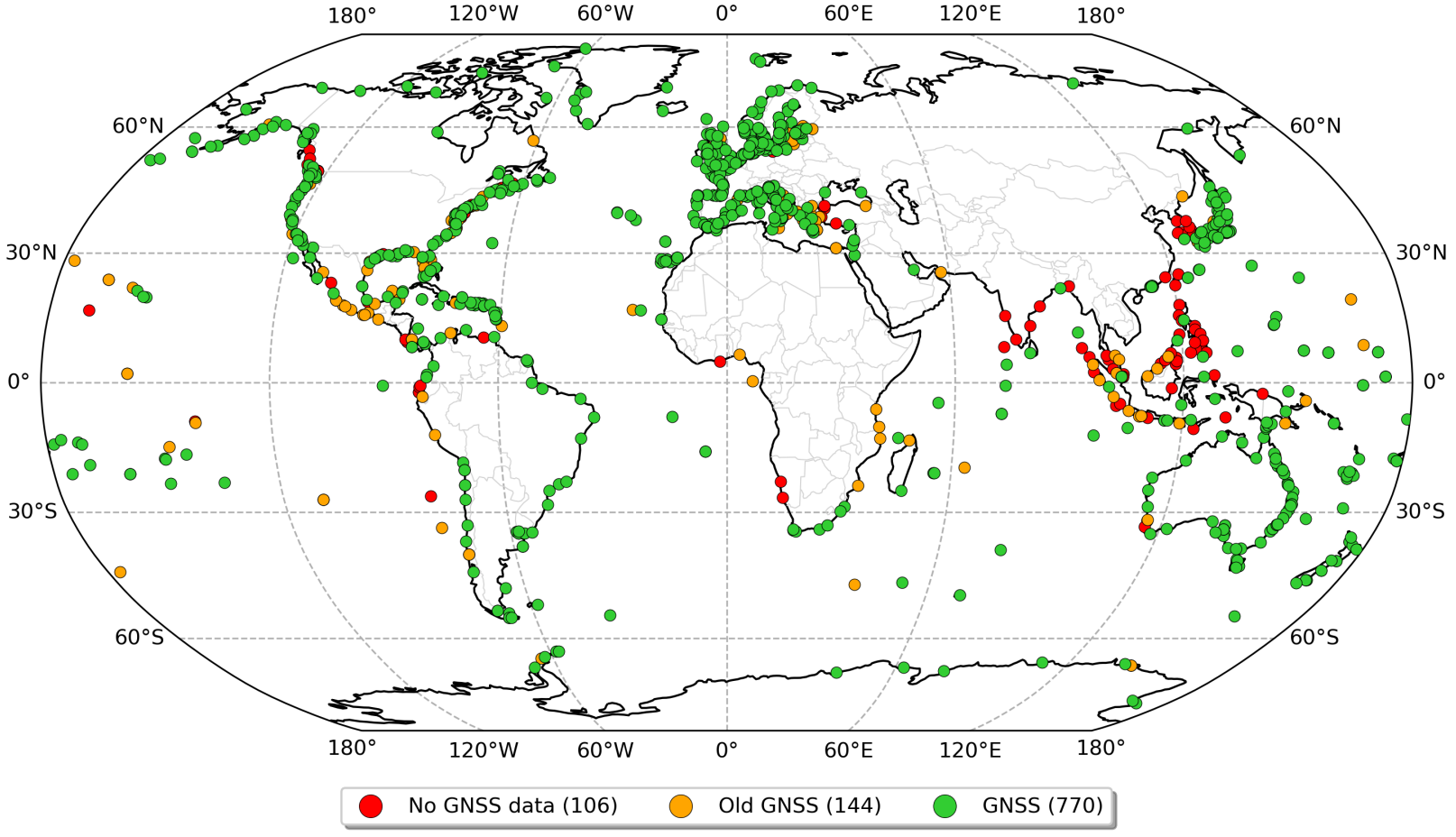
Action from SONEL to USA colleagues (NOAA and UHSLC) to examine how we can get the GNSS data from Johnston Is. (109) or Atlantic City (219)?







Overview of SONEL Data Holdings (complete)



GNSS position time series & velocities

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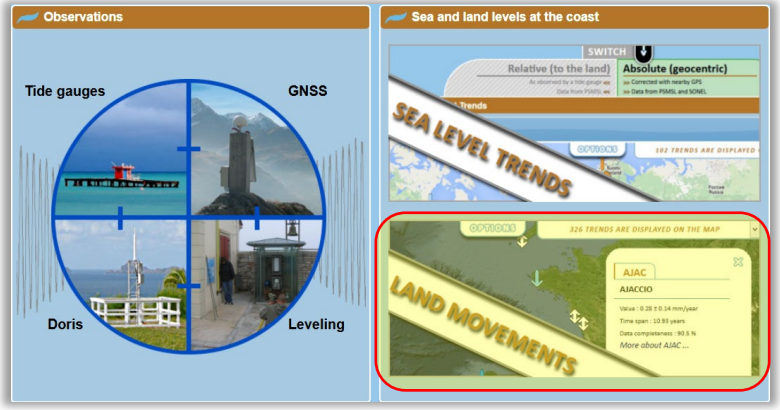

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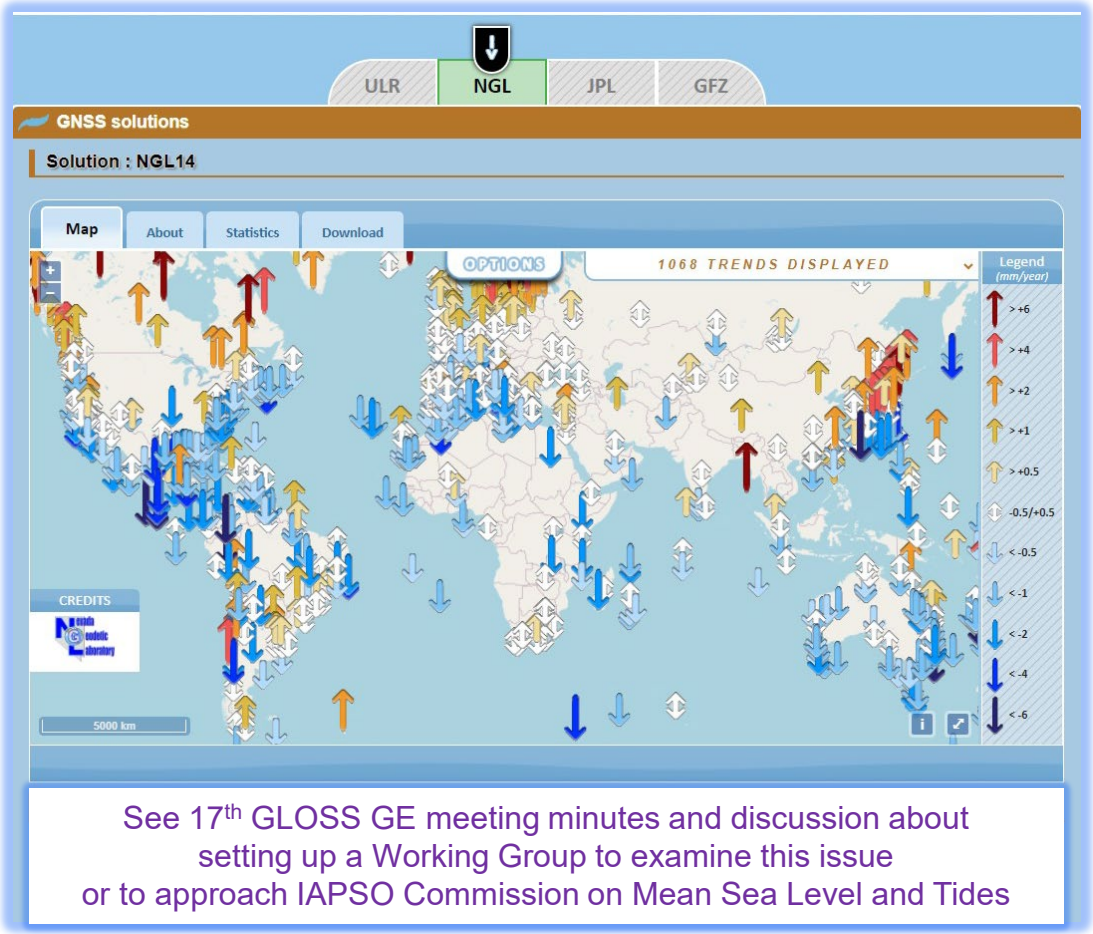


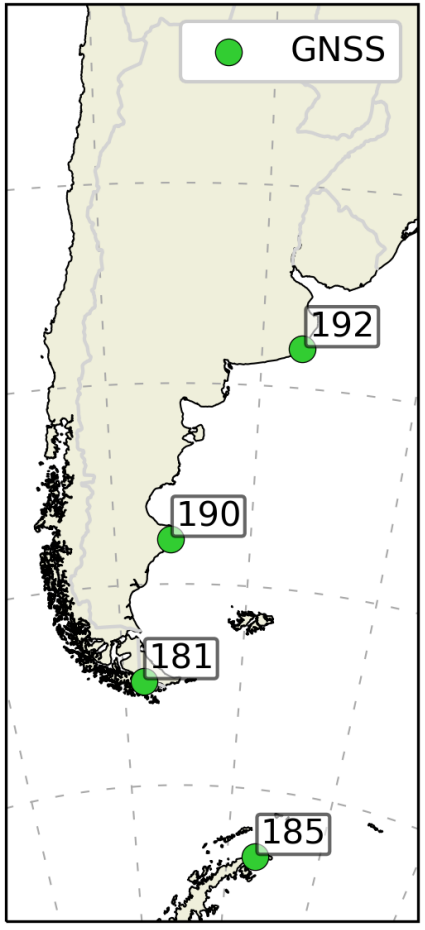
See 17th GLOSS GE meeting minutes and discussion about
setting up a Working Group to examine this issue
or to approach IAPSO Commission on Mean Sea Level and Tides

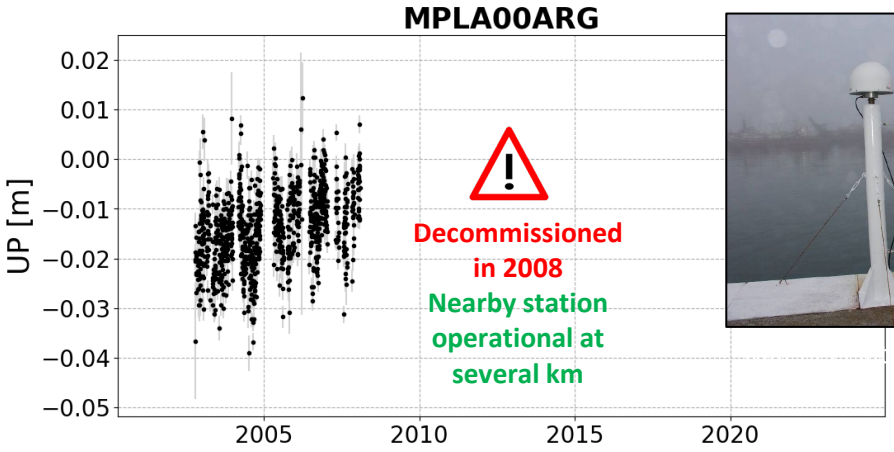
Concluding remarks

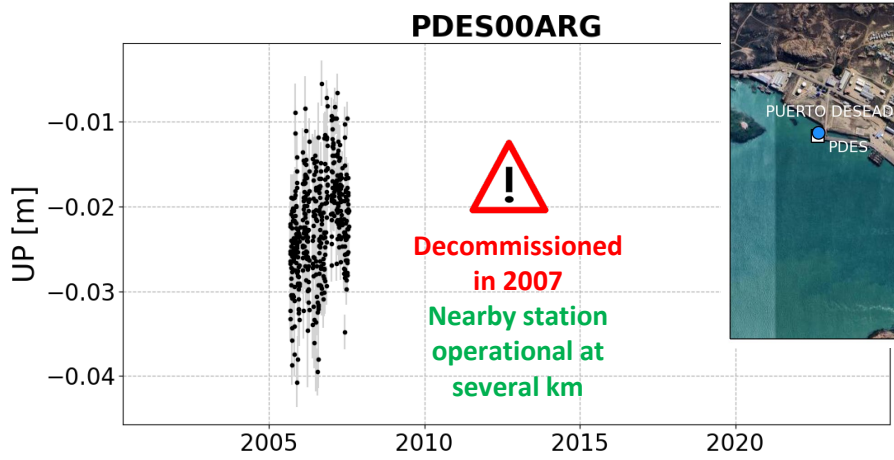
- GLOSS Core Stations : GNSS co-located at Tide Gauge
  - To monitor TG datum and bench marks stability (local vertical land motion)
  - Two possible strategies:
    - A 3rd party (agency) GNSS is located nearby (less than 1 km):
      - contact owner and ensure data availability in agreement with IOC/UNESCO policies (open and free)
      - conduct **initial levelling campaign** to link GNSS antenna reference point to Tide Gauge datum (bench mark)
      - repeat **levelling campaigns (yearly)** to assess local stability between GNSS antenna and Tide Gauge
    - Install your own GNSS station at the very Tide Gauge location (reduced costs, esp. levelling)
- GNSS-Reflectometry: new Tide Gauge technology
  - In addition to the set of available ones (radar, pressure…), best adapted for certain environments
  - See PSMSL portal on GNSS-R for mean sea levels (https://psmsl.org/data/gnssir/)
  - Stay tuned as research advances in this area (GLOSS Working Group)
- Mapping coastal subsidence with InSAR data (combined with GNSS)
  - InSAR is progressing rapidly with new satellite missions (e.g., Sentinel-1 from Copernicus)
  - High-resolution spatial view (30-100 m) with uncertainty level of less than 1 mm/year

Please, reach out to us for any supplemental information or assistance
Team e-mail: sonel@sonel.org

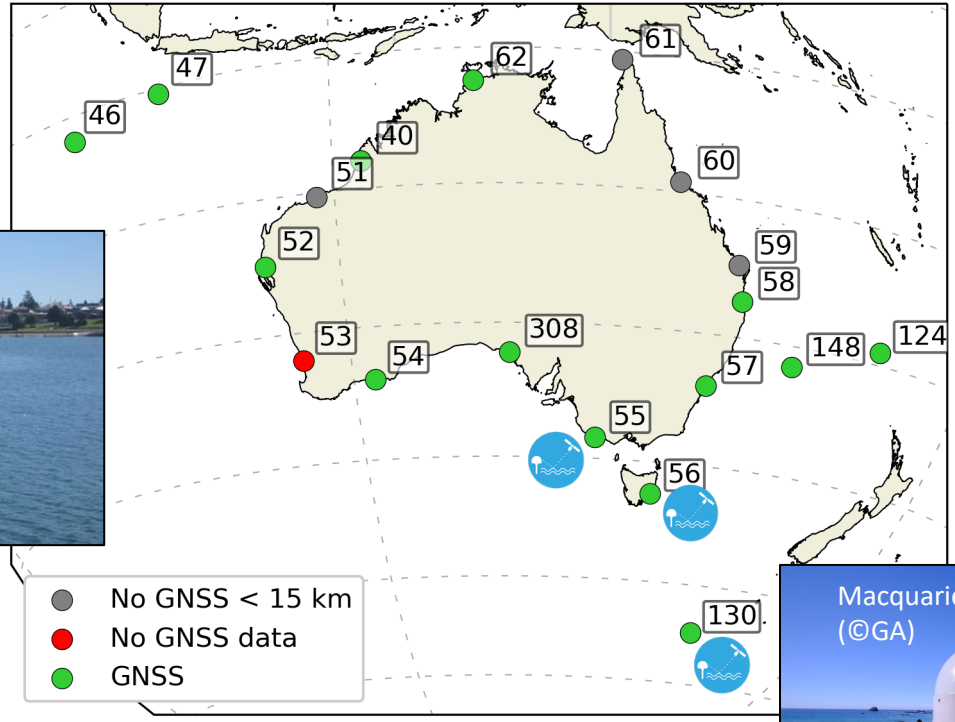
Participating Countries listed after Feb. 25th
Argentina (4)

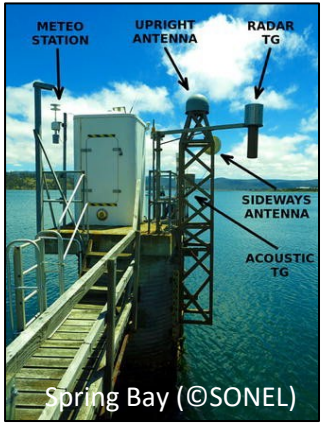






Participating Countries listed after Feb. 25th
Australia (19)

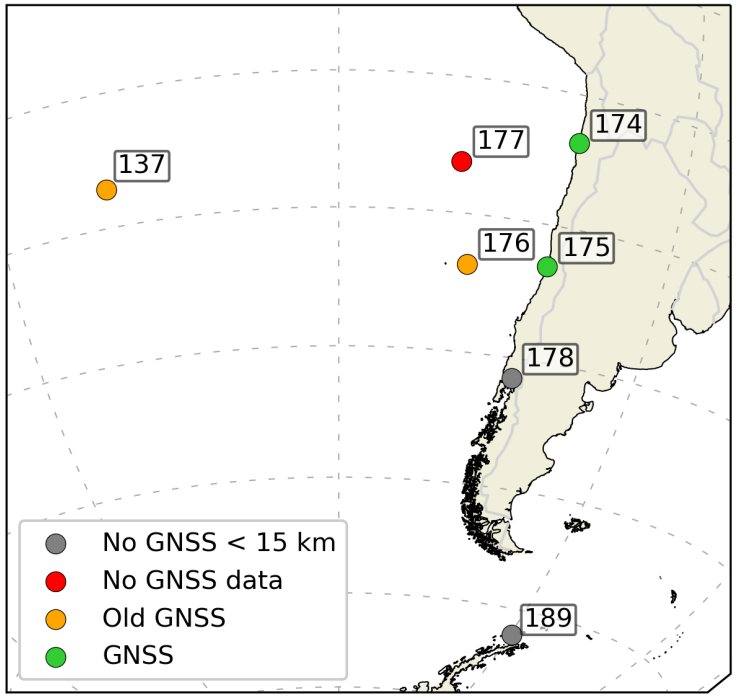




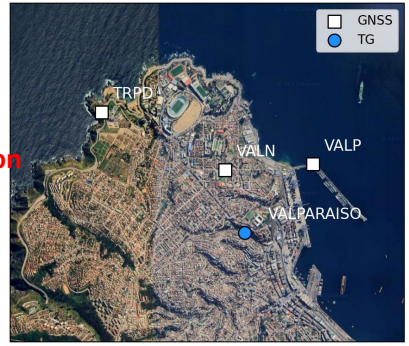
Question to Denmark national Focal Point:

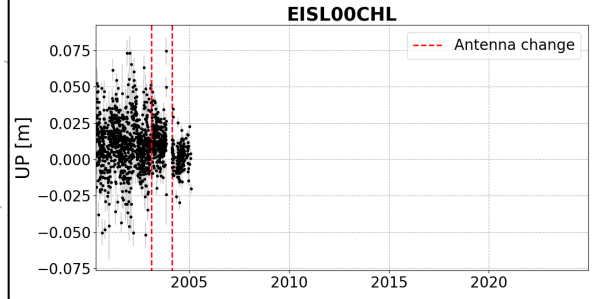
- Are there plans for a GNSS at Port Hedland (51)? Booby Is. (61)? Townsville (60)? Bundaberg (59)?

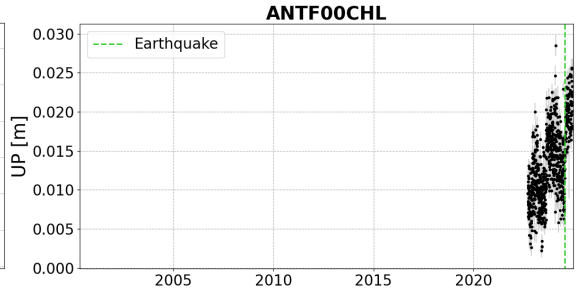
Participating Countries listed after Feb. 25th
Chile (7)

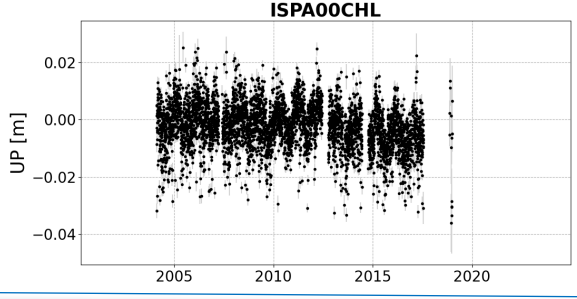


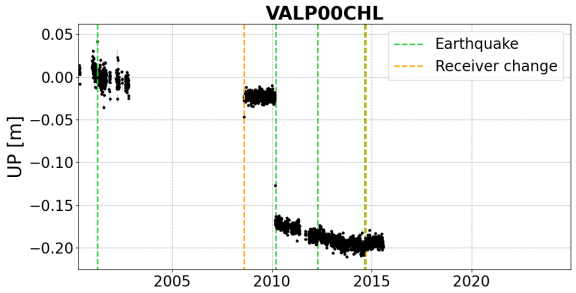
TG need for precise location











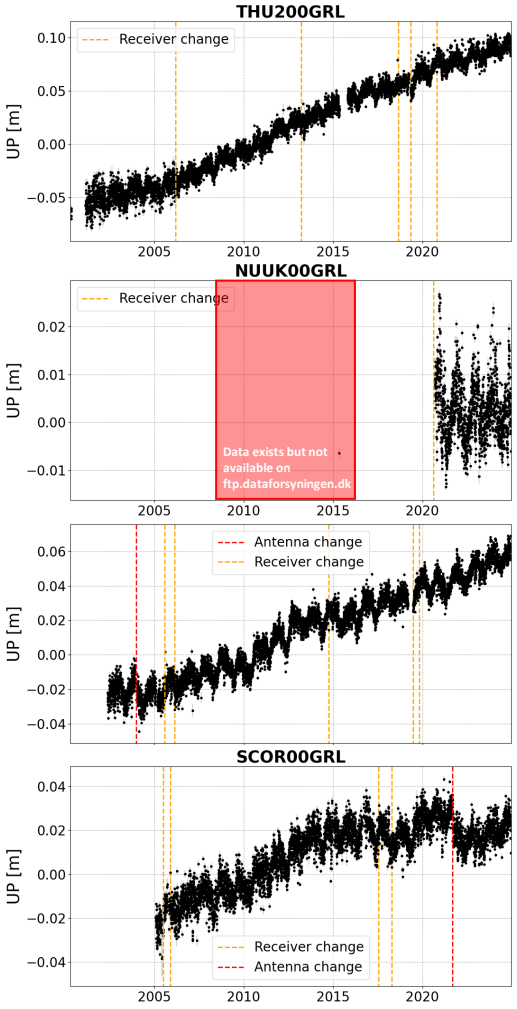
Question to Chile national Focal Point:

- Are the tide gauge locations correct for Valparaiso (175)? Isla de Pascua (137)?
- Are there plans for a GNSS at Puerto Soberania (189)? Puerto Montt (178)? Other with an ideal co-location?

Participating Countries listed after Feb. 25th
Denmark - Greenland (5)

Question to Denmark national Focal Point:

- Are there plans for a GNSS at Ammassalik (228)?



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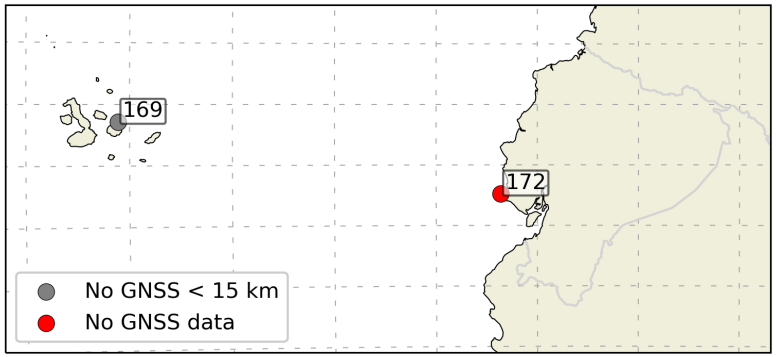
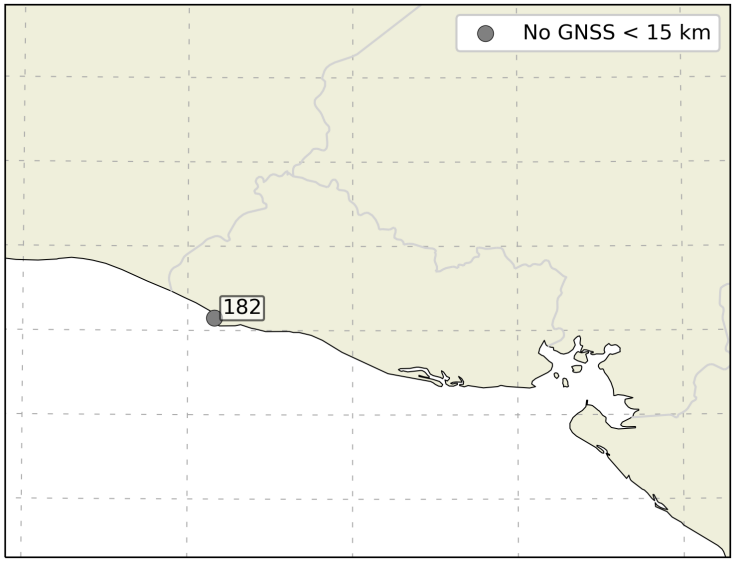
Participating Countries listed after Feb. 25th :
Ecuador (2) El Salvador (1)





Please, reach out to me during the meeting
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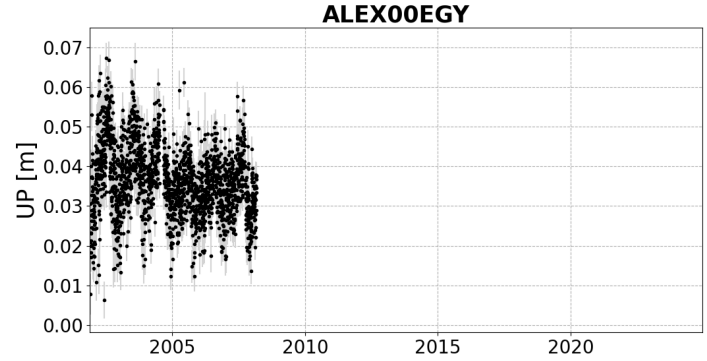
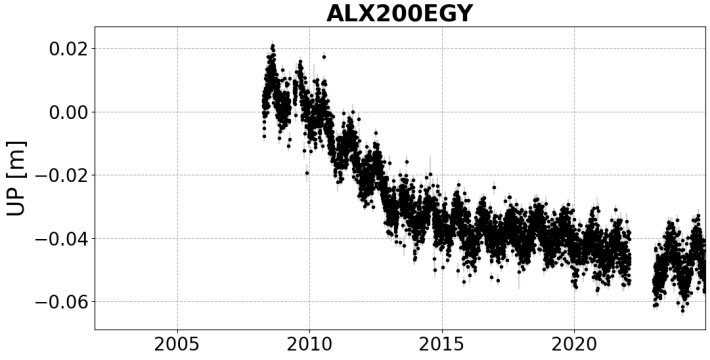
Participating Countries listed after Feb. 25th : Egypt (2)

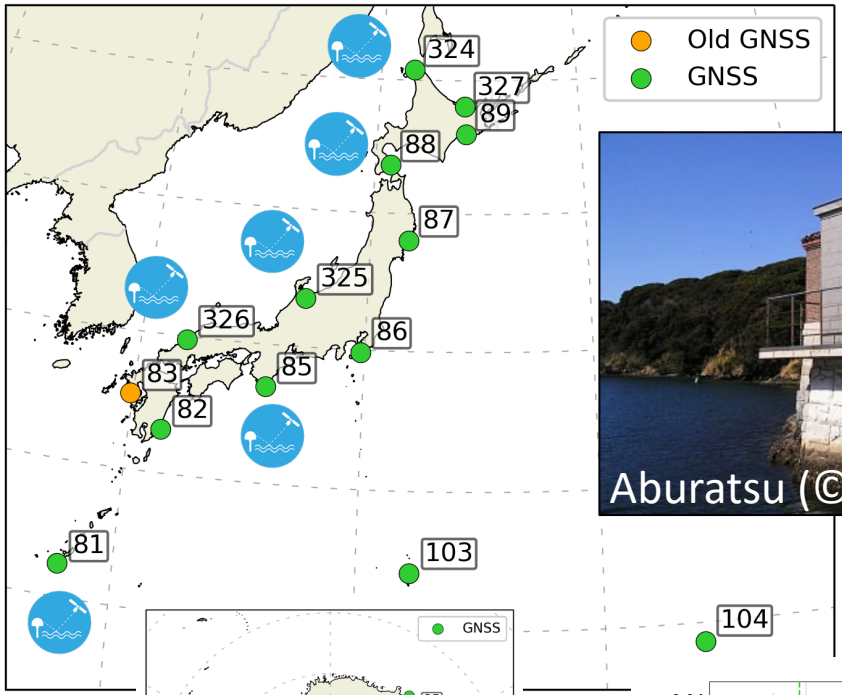


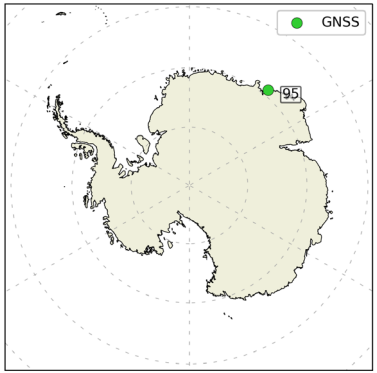


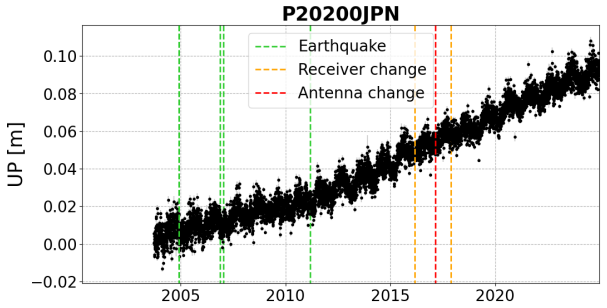
Question to Egypt national Focal Point:

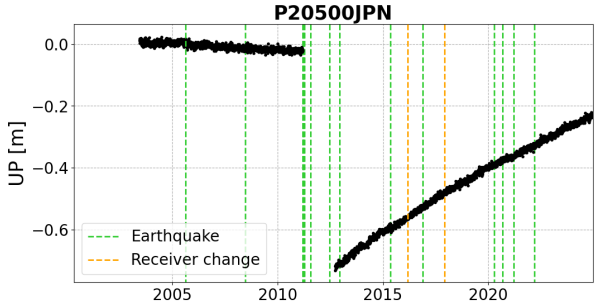
- Are there plans for a GNSS at Suez (1)?
- What about Alexandria (349) with a closer co-location?

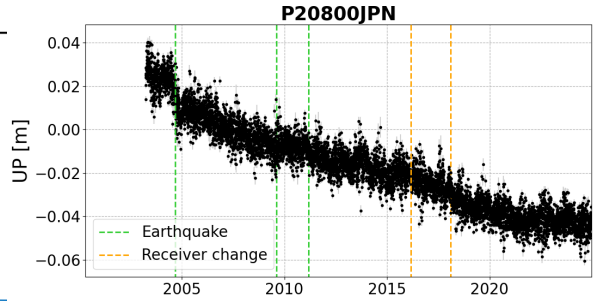
Participating Countries listed after Feb. 25th
Japan (15)

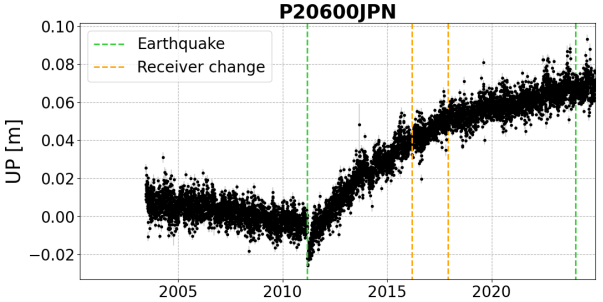






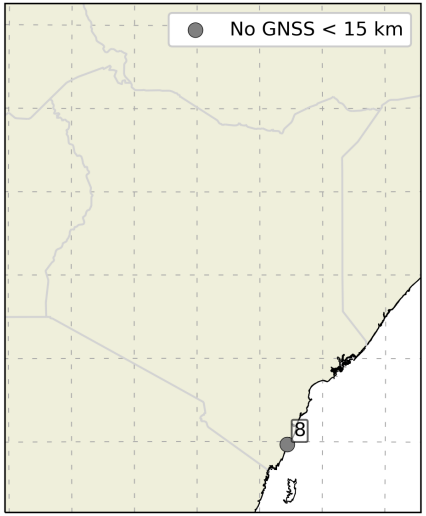




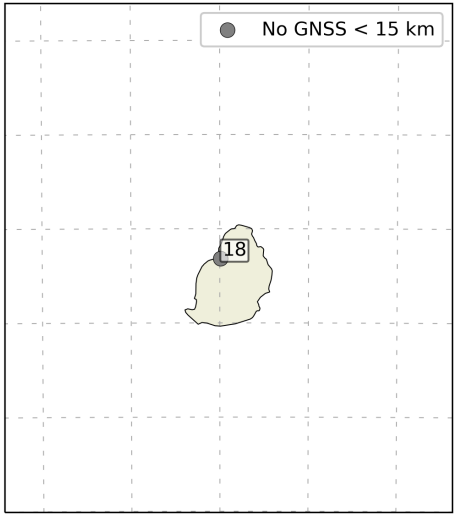


Participating Countries listed after Feb. 25th :

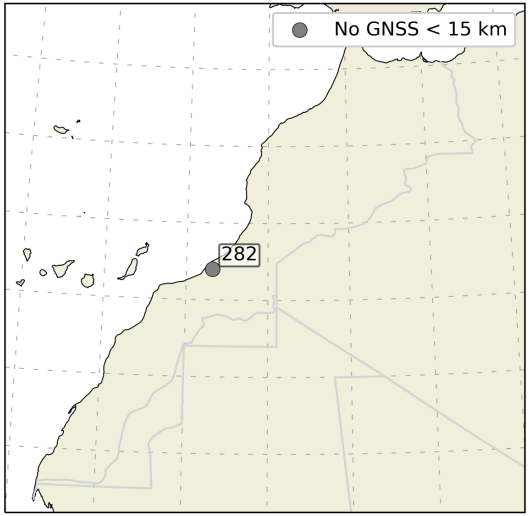
Kenya (1)



Mauritius (1)



Morocco (1)



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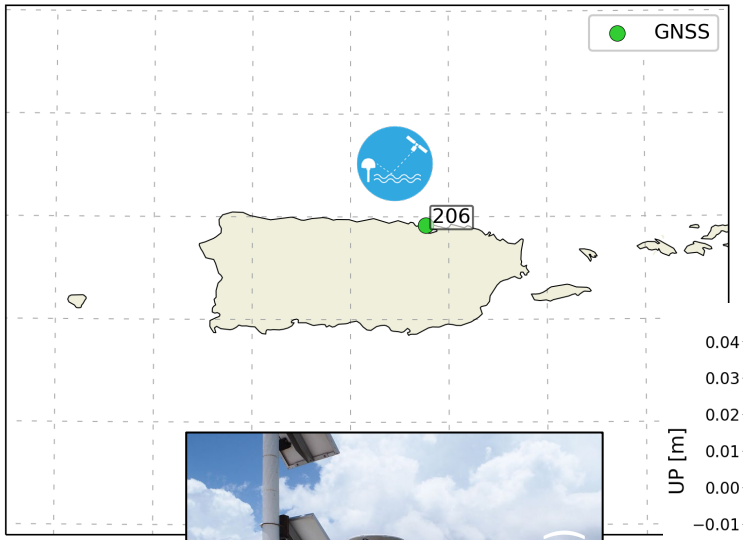
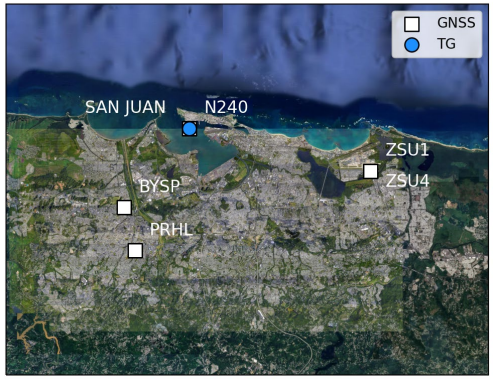
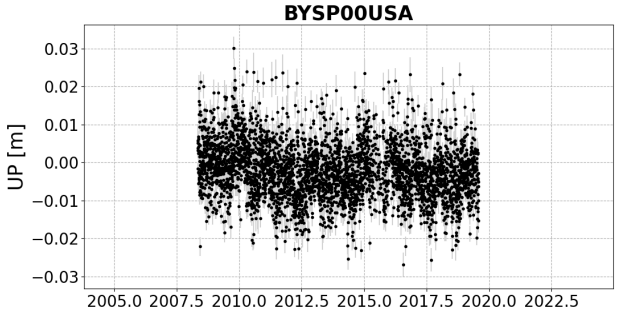
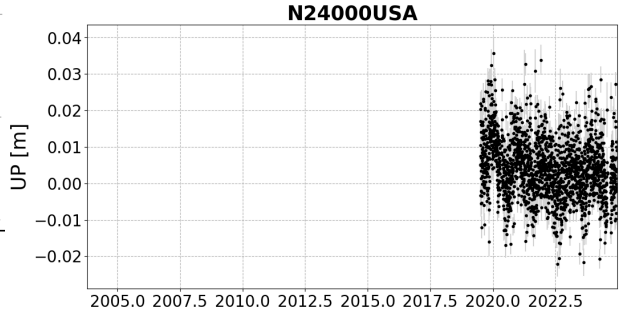
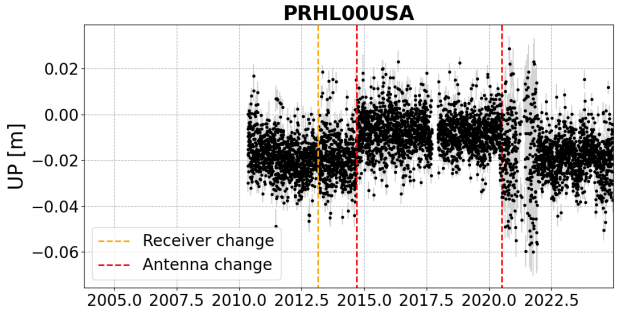
Participating Countries listed after Feb. 25th : Puerto Rico (1)

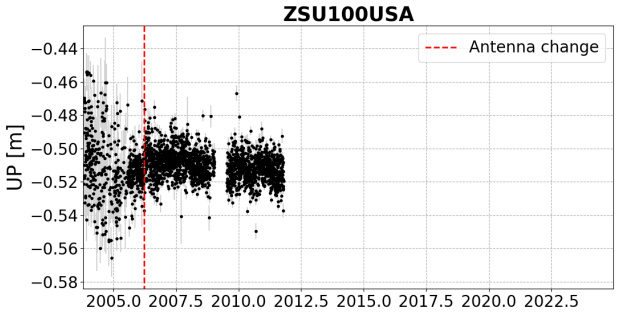


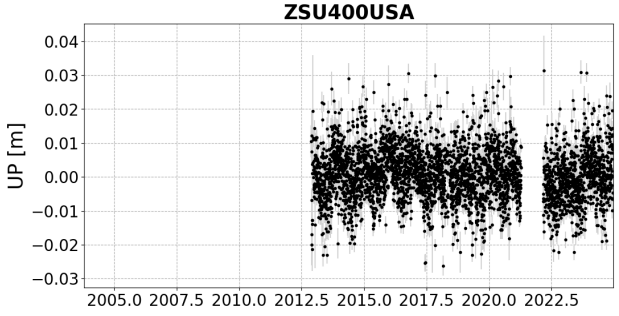




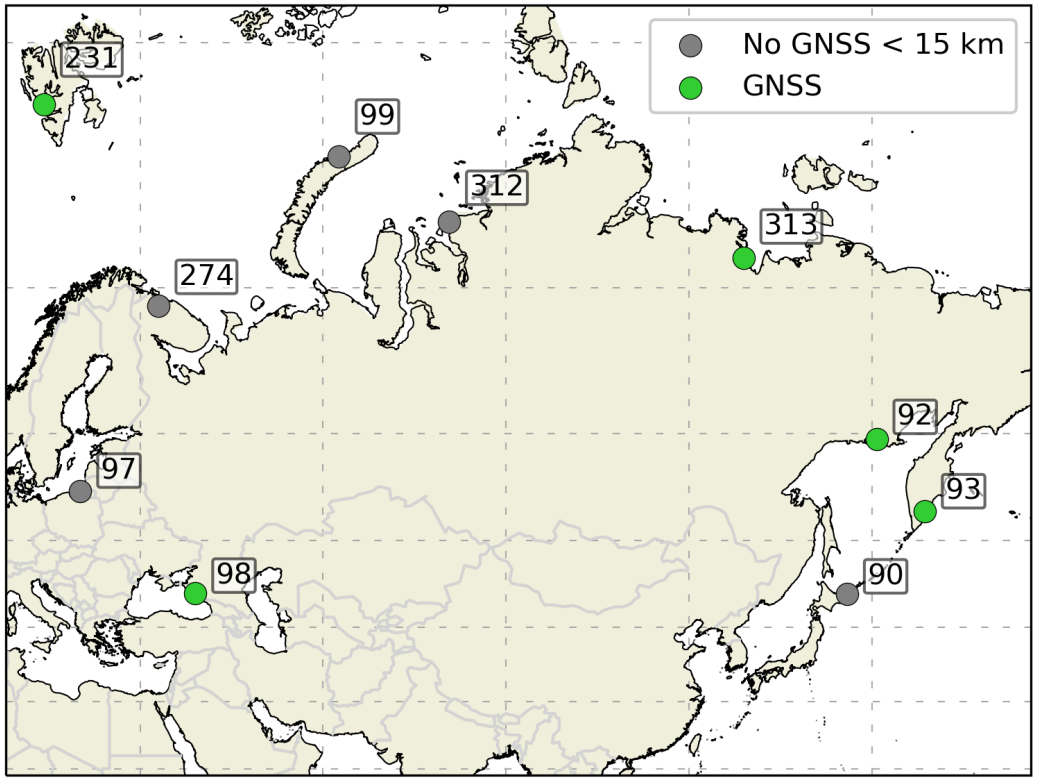


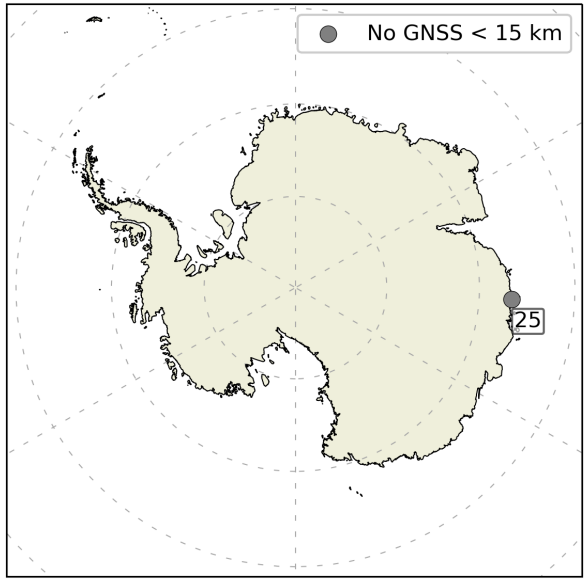






Participating Countries listed after Feb. 25th : Russian Federation (12)



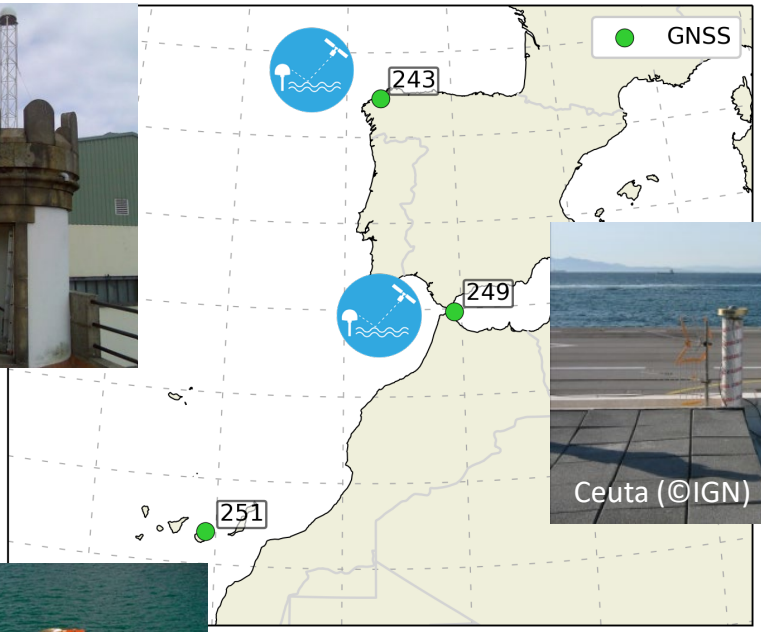


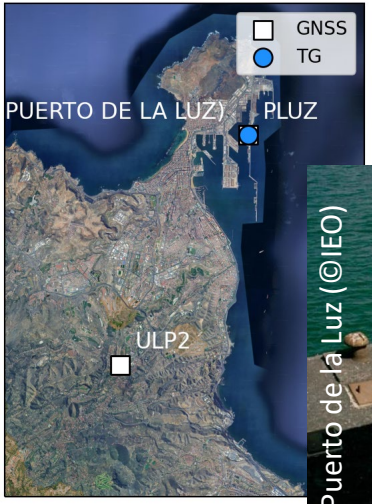
Question to Russia national Focal Point:

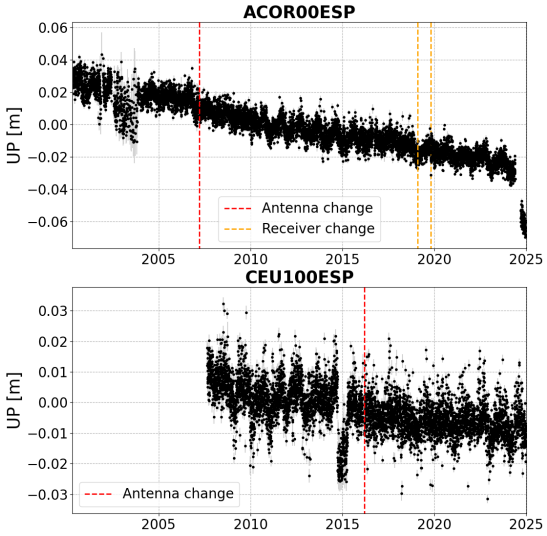
- Are there plans for a GNSS at Mirny (25)? Kaliningrad (97)? Murmansk (274)? Russkaya Gavan (99)? Dikson (312)? Provideniya (309)? Yuzhno Kurilsk (90)?

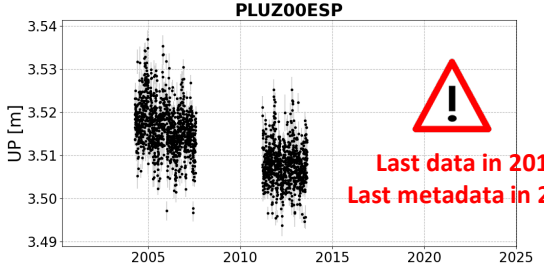
No GNSS data since May 2022

Participating Countries listed after Feb. 25th : Spain (3)

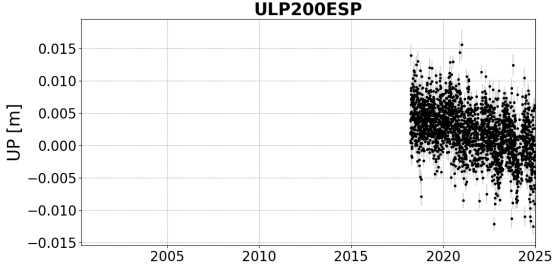




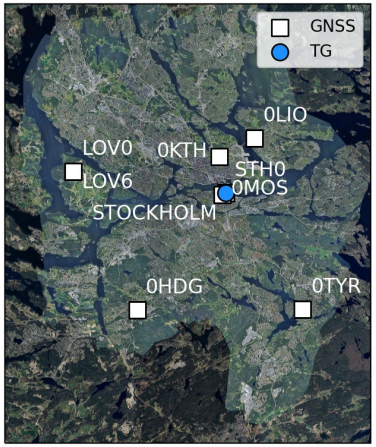


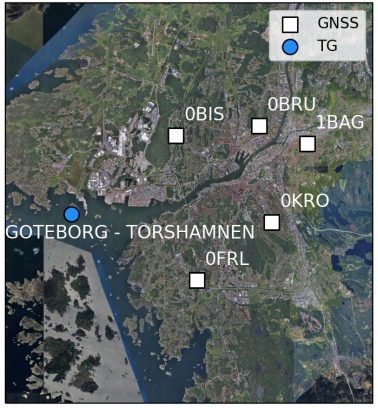


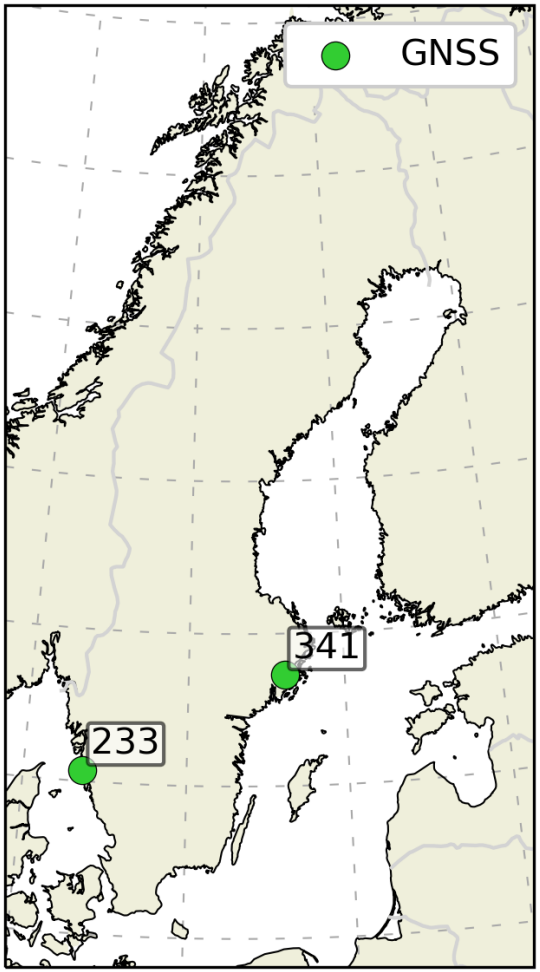
Last data in 2013
Last metadata in 2004



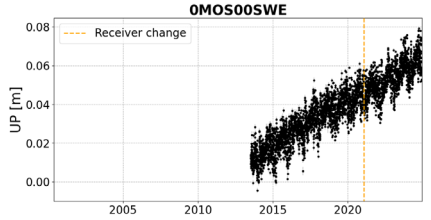
Participating Countries listed after Feb. 25th : Sweden (2)

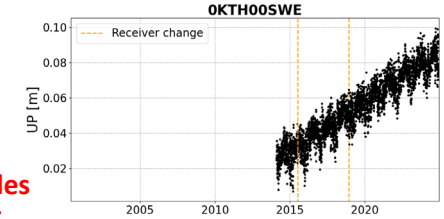


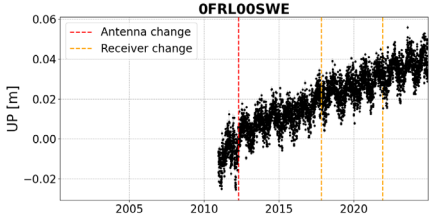


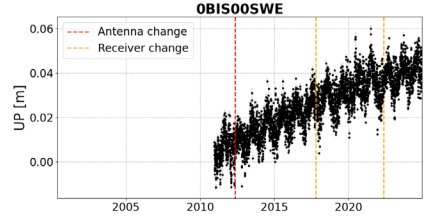


No metadata files for non-EPOS stations

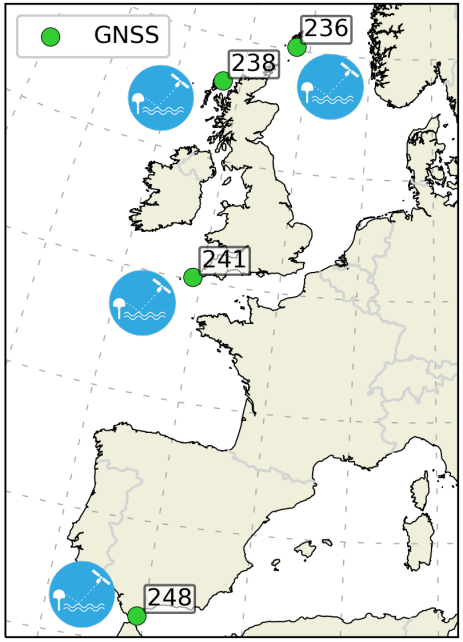


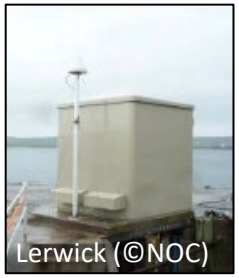




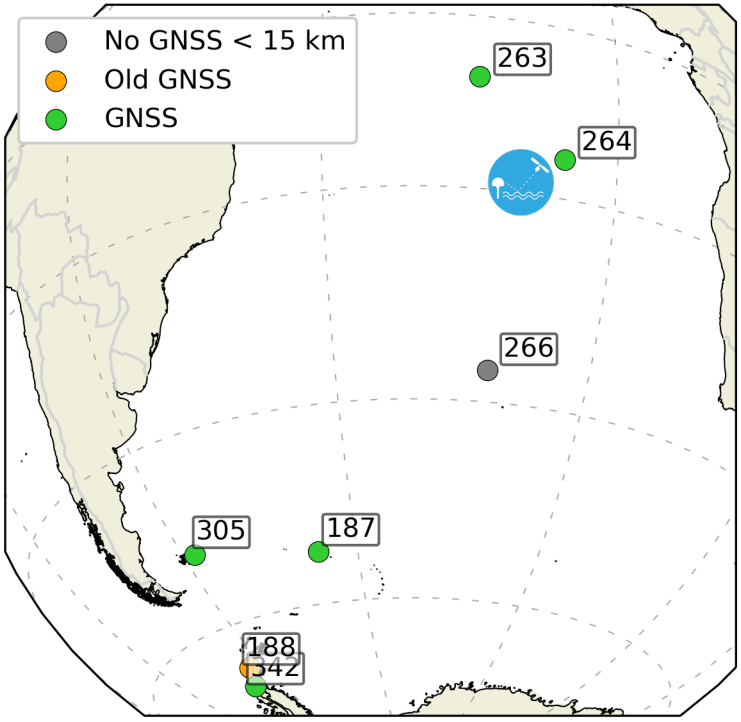


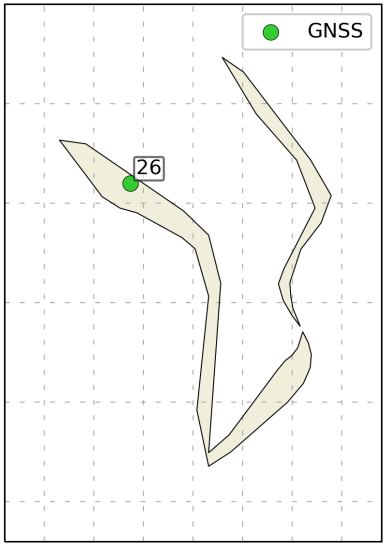
Participating Countries listed after Feb. 25th : UK (13)



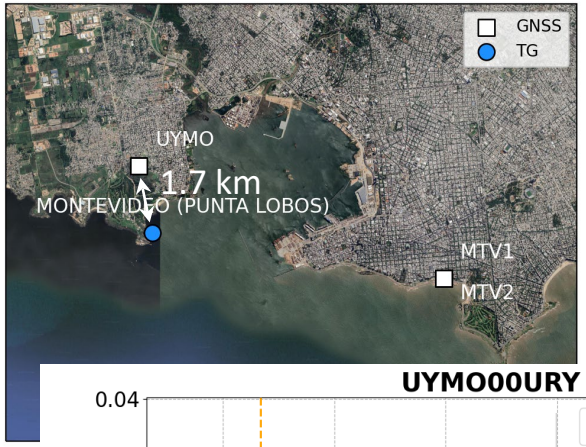


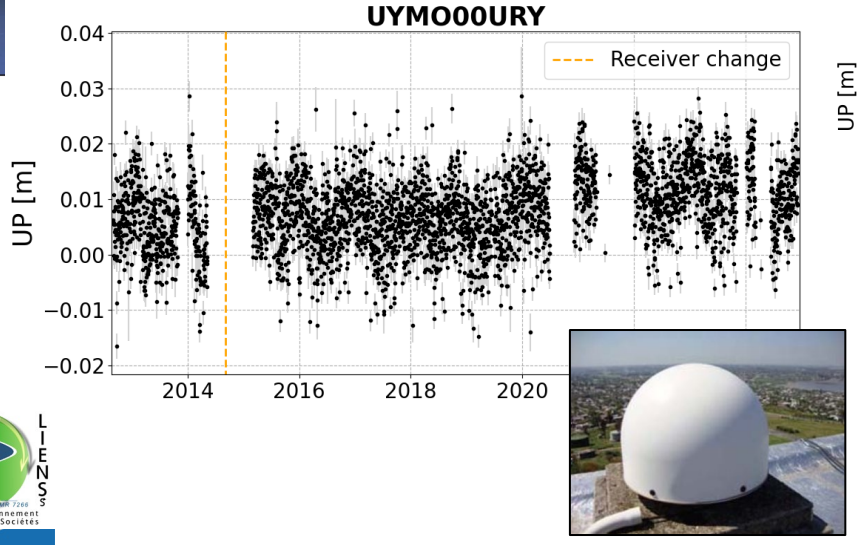
Decomissioned in 2015 and 2022, respectively

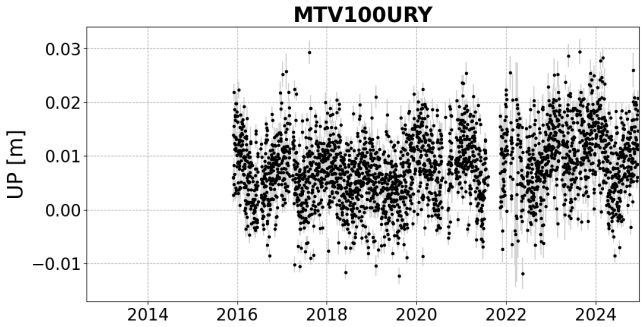


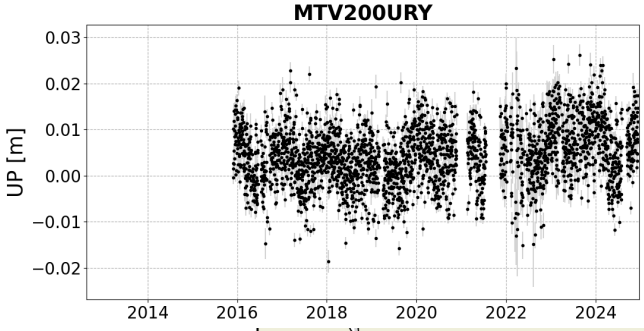


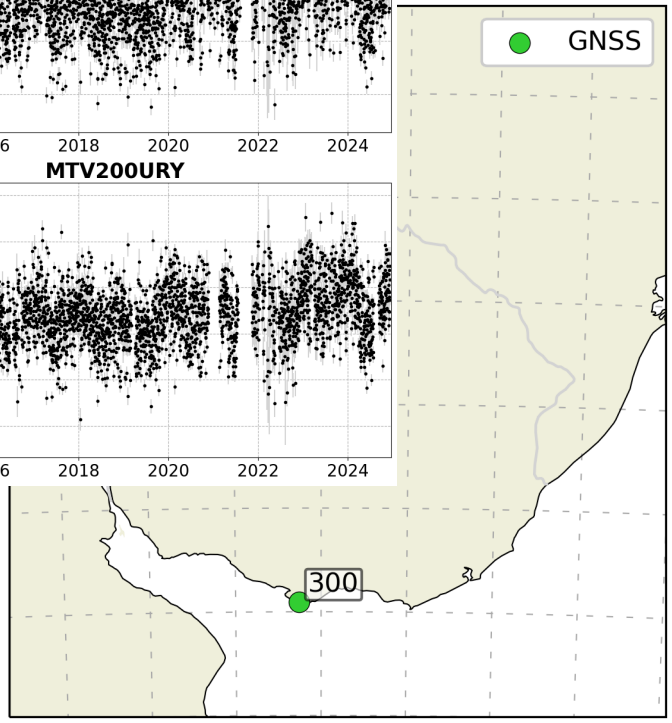
Participating Countries listed after Feb. 25th : Uruguay (1)



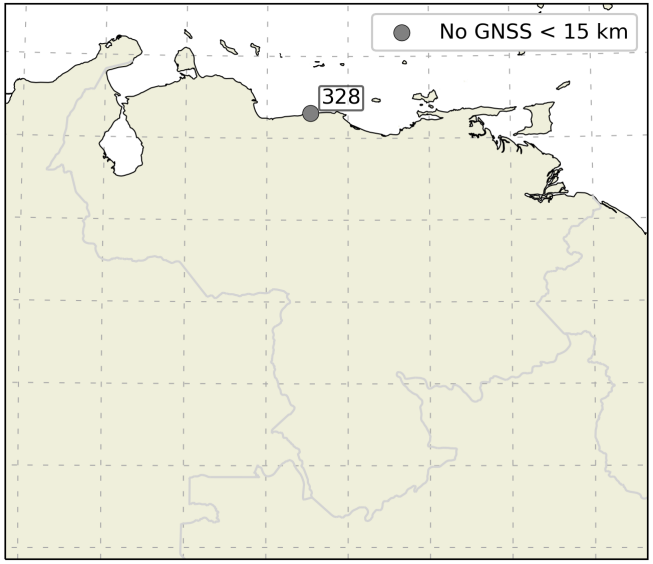








Participating Countries listed after Feb. 25th : Venezuela (1)



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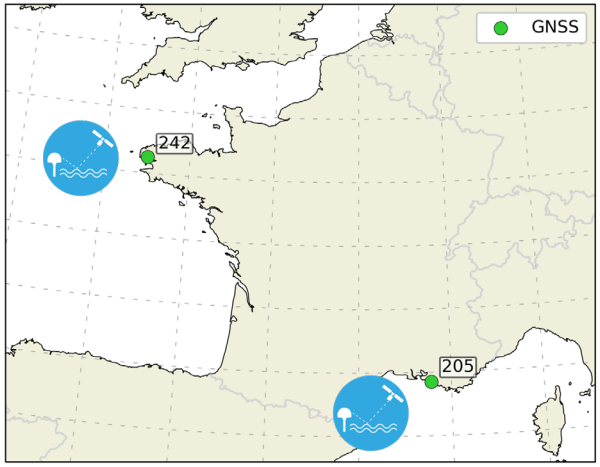
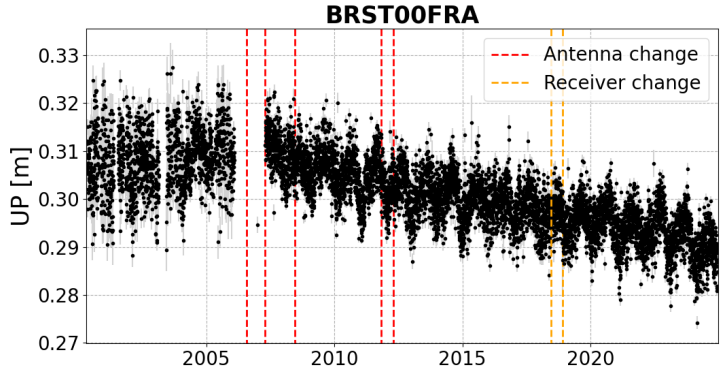
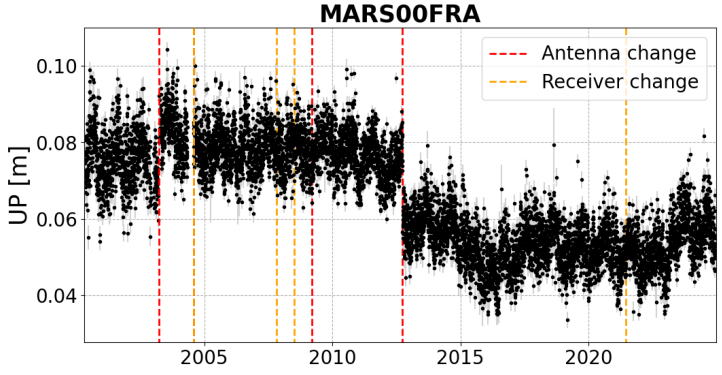
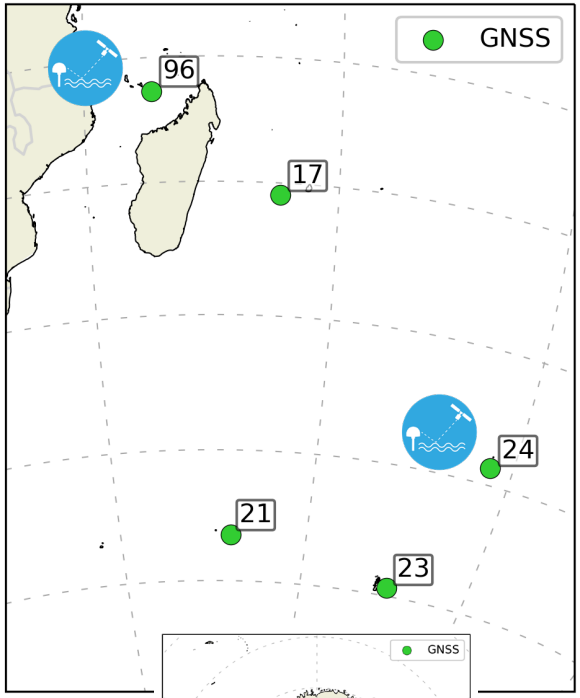
Focus on participating countries: France (19)



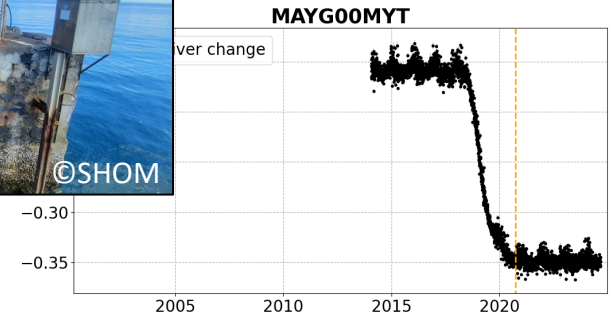


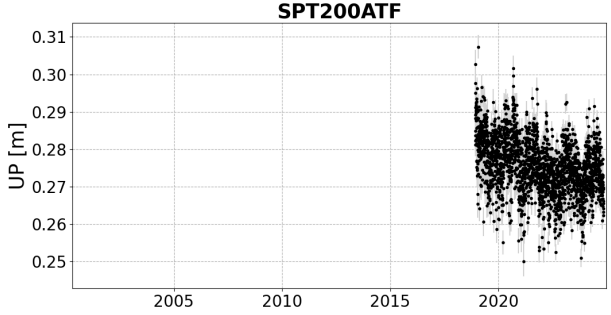


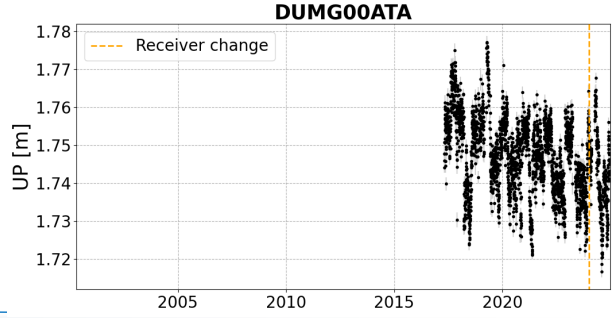
Focus on participating countries: France (19)



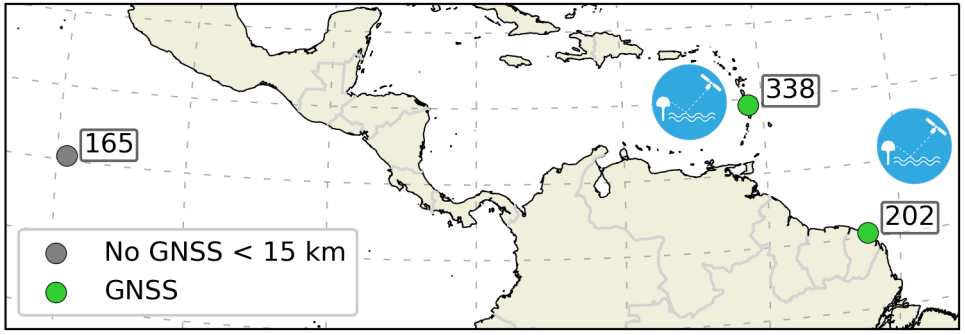
Station destroyed in 2024 by cyclone Chido

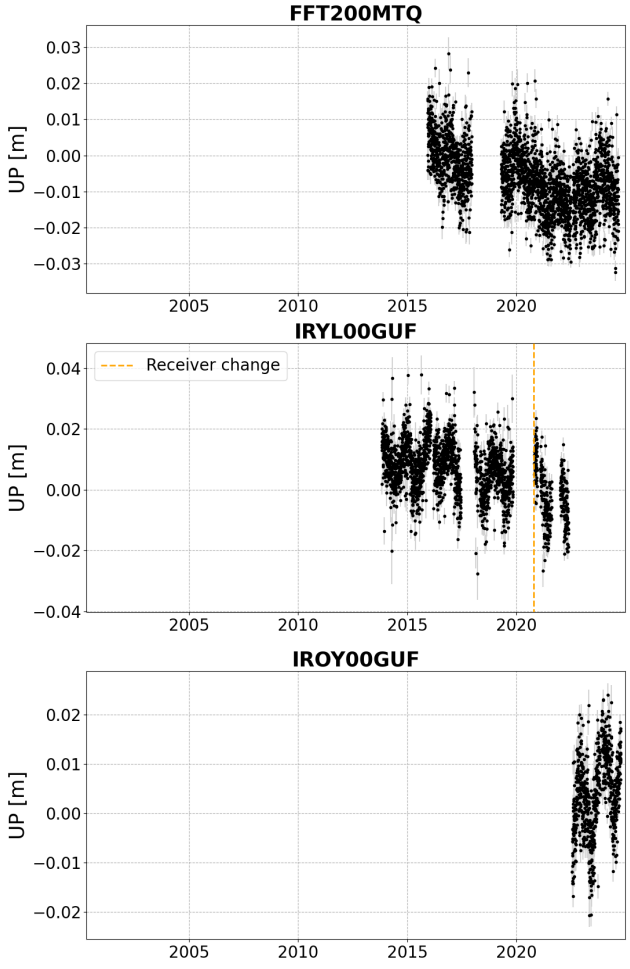




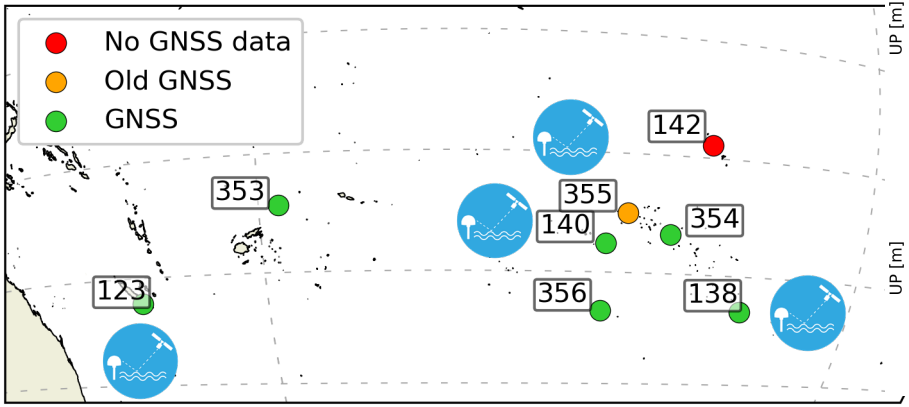


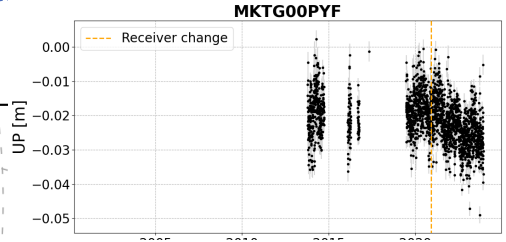
Focus on participating countries: France (19)

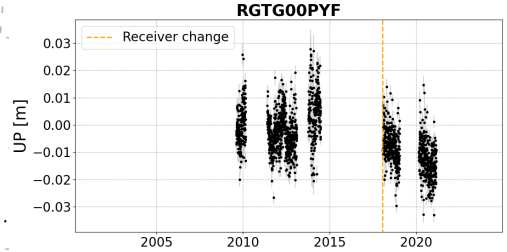


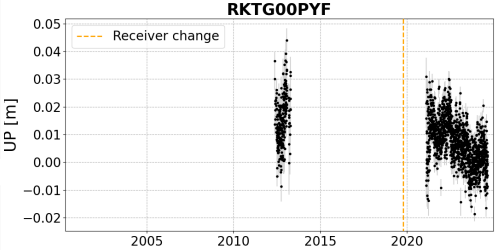


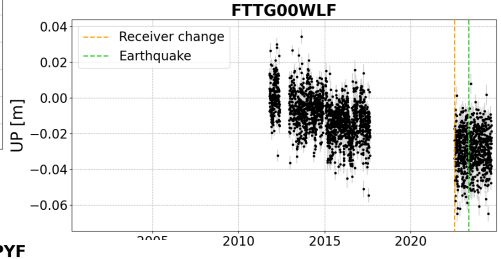
Focus on participating countries: France (19)

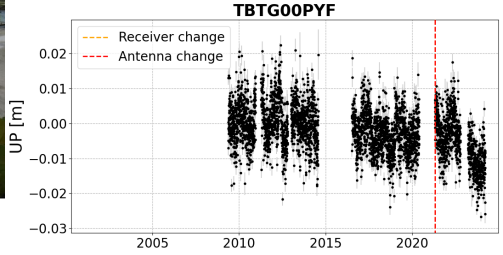












Challenges of maintaining non-telemetered stations