EuroGOOS-SONEL GNSS@TG metadata campaign

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Last update : 26 February 2021

The objective of this work done by SONEL for Puertos del Estado is to :

- **Task 3.1:** Report on European coastal sea level stations providing geocentric sea level data and vertical land movement information (easy and quick access to this information is important for scientists interested in sea level rise associated to climate change and for validation of altimetry data). Analysis of gaps and recommendations for new stations to get a better assessment of sea level rise along the coast.
  Deadline:
  - Updated list of coastal sea level stations providing geocentric sea level data and vertical land movement information 30 November 2020

A previous list of GNSS@TG for Europe included in CMEMS portal was produced by SONEL in May 2018 in the frame of the EuroGOOS Tide Gauge Task Team. In order to provide *an updated list of coastal sea level stations providing geocentric sea level data and vertical land movement*, we decided to launch a metadata and levelling information for European countries and update the status of GNSS@TG (*i.e* the GNSS co-located at tide gauge).

The idea that drive this project was to update the levelling and benchmarks information contained in the SONEL database (hereafter SDD). The missing information on the SDD is mainly on the levelling between the GNSS antenna and the Tide Gauge principal Benchmark (hereafter TGBM).

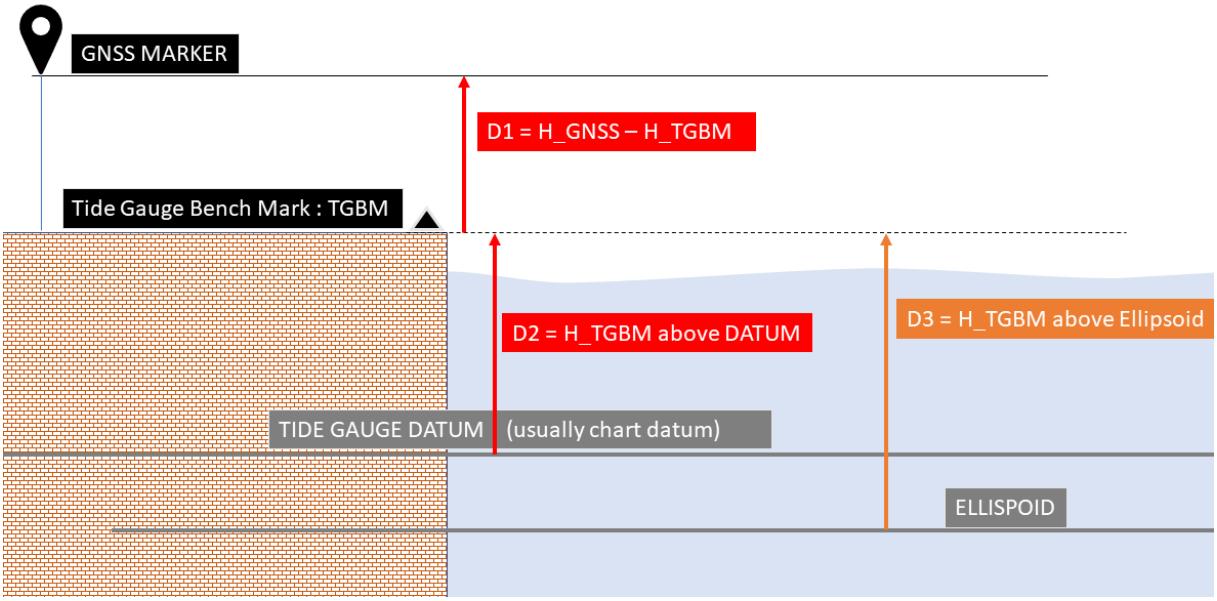


Figure 1: Schematic view of the main instruments (GNSS and TG in black) and on the quantity that needs to be filled in or update in the SDD. Namely the levelling between the GNSS marker and the TGBM **(D1)**, the vertical height of the TGBM above the Tide Gauge Datum **(D2)** and the Ellipsoidal height of the TGBM **(D3)**.

In order to get or update these information we have decided to create a European scale email campaign to ask our TG and GNSS contacts for these information.

To get a better control on this campaign and to be able to reproduce easily this type of mailing campaign we have decided to build a python package to automatically parse the SDD for existing information, create a google sheet for each country in the scope of the campaign with the basic information we need to automatically send email to our contact list.

In this document, we will present the scope of the campaign, the methodology and the criteria applied to select the Tide Gauge (TG) GNSS pairs, and the different steps of the campaign from section 1 to section 4. In section 5 we detail by countries the response we have received and show the maps of the pairs for this country

1/ Methodology used to define the scope of the campaign

[1] Selection of the SONEL database on a geographical polygon

The first step is to define a priori the countries targeted by the campaign. For this we have used a polygon to extract from the SONEL database (hereafter SDD) the relevant information. The polygon used for this campaign is shown in Figure 2. It allows to get the principal countries in Europe. The output of the extraction is a .csv file.

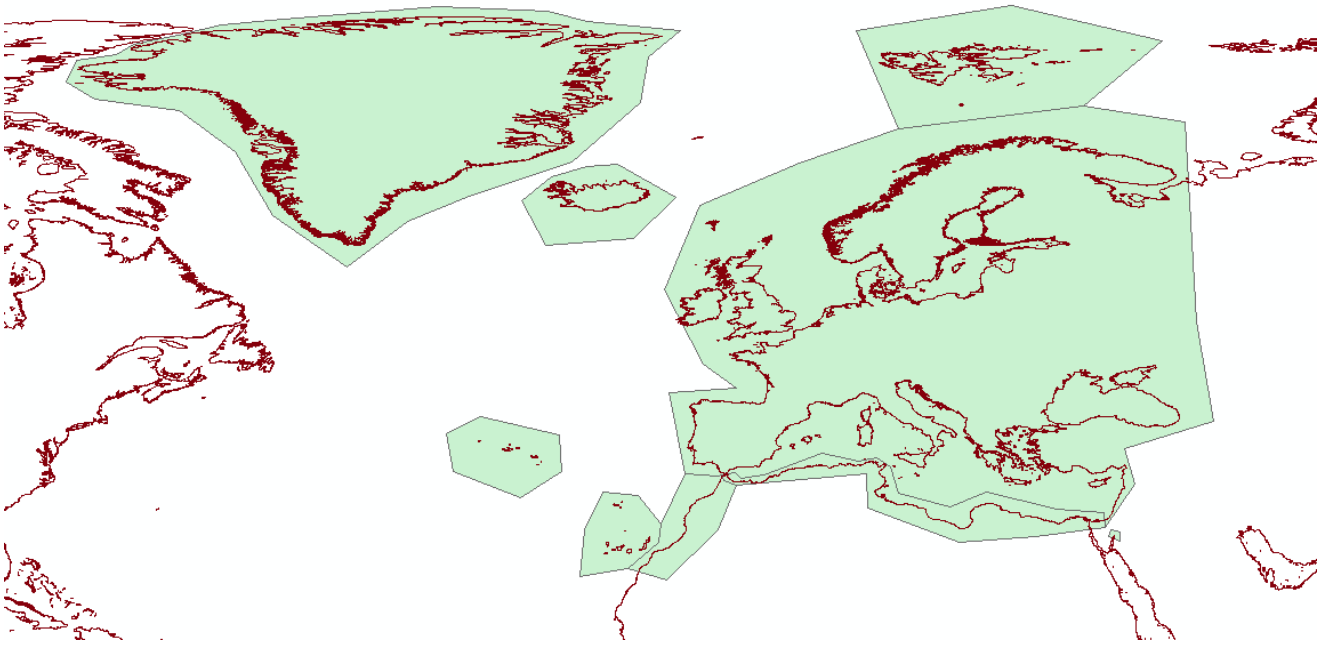


Figure 2: Polygon use for the SONEL BDD extraction

[2] Selection of the SONEL database on a distance criterion

On the extracted *.csv file* we apply a second selection based on the horizontal distance between the GNSS and the TG. In order to reduce the number of pairs (GNSS, TG) concerned with the campaign, we apply a criterion distance between the TG and the GNSS marker. For this campaign the criterion was **1 km**, meaning that we have taken into consideration only the GNSS station that are less than a km from the TG. This criteria reduce the number of pairs from 542 to 172.

The application of the two "filter" (polygon and distance) allows to obtain the **scope** of the campaign which is the **list of countries** for which we have information on the SDD that can be updated.

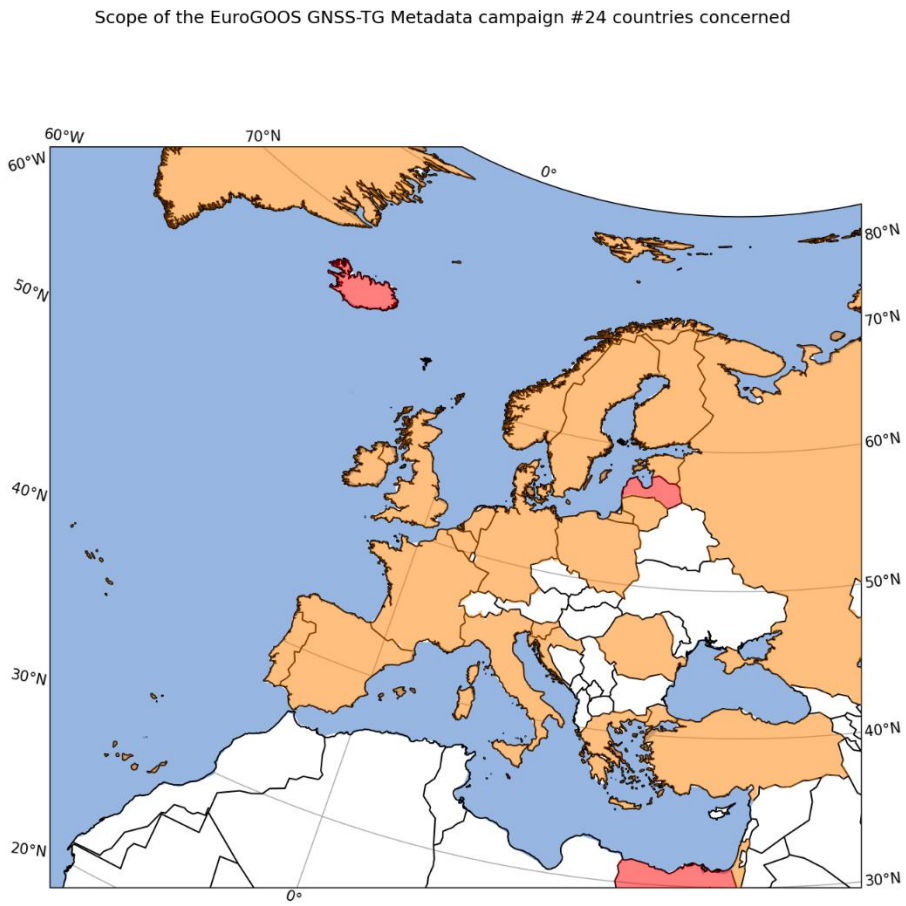


Figure 3: scope of the campaign. 24 countries are concerned with the campaign and 4 countries (in red) are within the extracting polygon but have no GNSS less than 1 km from a TG

2/ Applying a distance criterion to reduce the number of pairs

In the same way we have mapped the global scope of the campaign we can now with this criteria map at the country scale the number of pairs concerned.

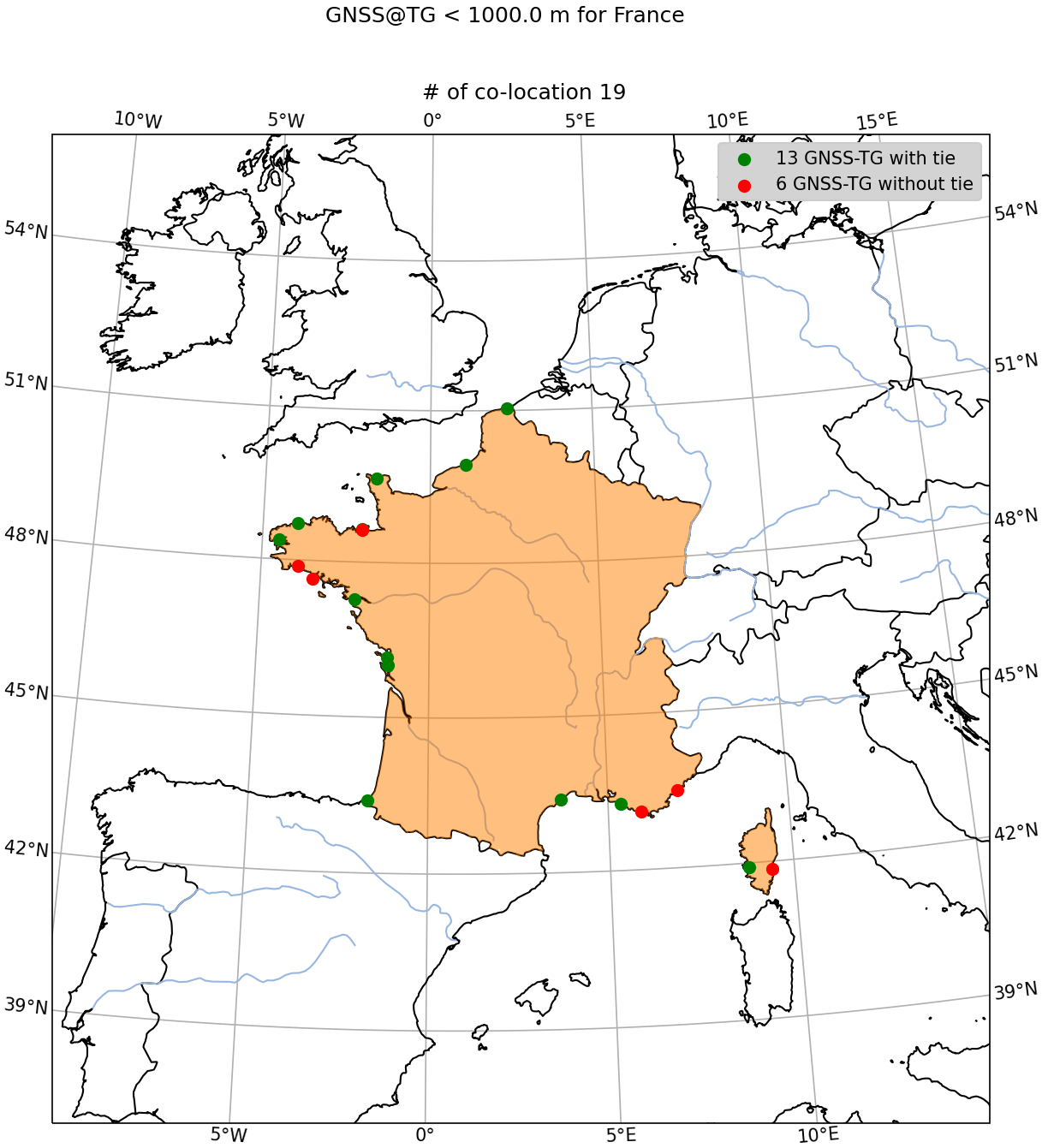


Figure 4: Example for France of the co-location GNSS@TG pairs. In green the pairs with a TIE information on the SDD and in red the pair without TIE

3/ Establishing a contact list for TG and GNSS

Once the global scope is defined we had to update our contact list. A first email campaign was launch to update our contact list for European countries. This mailing campaign allows us to identify **152 contacts** for the 24 countries on the scope of the campaign (cf. Figure 3).

4/ Launch of the campaign on 10/12/2020

On 10th of December 24 emails (1 by country) was sent to our 152 contacts, asking for the Benchmarks and levelling information of their co-located GNSS-TG pairs. A schema (cf. Figure 1), as well as a map (cf. Figure 4) were attached to the e-mail.

The main information asked were stored in a form of a google sheet that the recipient should update. The link was attached to the email (cf. Figure 5)

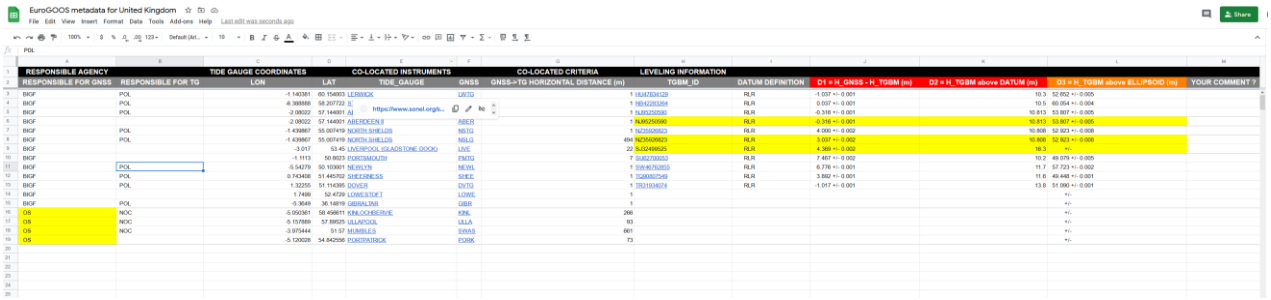


Figure 5: Example of the Google Sheet for GB

The main information asked were the 2 quantities in red in the column to be updated in priority

D1 : the levelling between the GNSS marker and the TGBM

D2 : the height of the TGBM above the local datum, and the datum definition

If the quantity D1 is not available (for example, because the levelling between the GNSS and the TG has not been performed) then contact can set D3 if they have performed a GNSS campaign above the TGBM.

5/ Status of the campaign as for today

- 24 countries were contacted via email through 152 contacts
- 172 co-located GNSS-TG pairs are concerned with the campaign
- 29 get access the google sheet

Greece : 3 co-located pairs (3 have no tie information)

* email sent to 5 contacts

→ extra email sent to mertikas@mred.tuc.gr on 14/12/2020 for the GAVDOS station

* 3 responses to email

Dr. Nikos Kalligeris (nkalligeris@noa.gr) the new responsible for the NOA tide-gauge network added to the contact list for TG

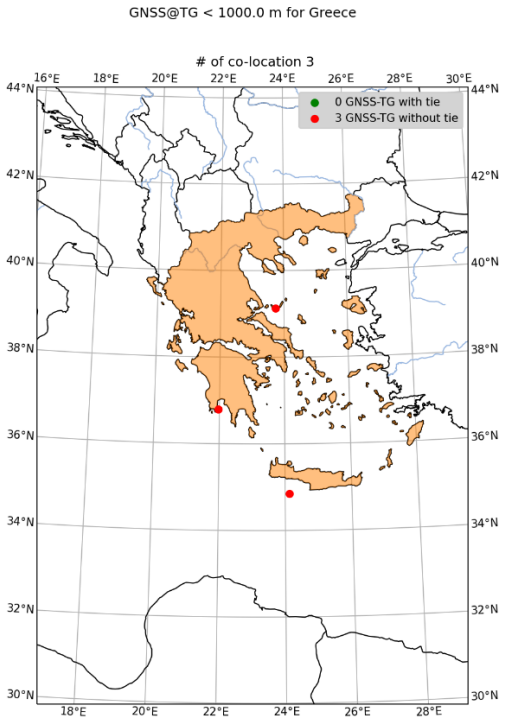
Dr. Kostas Chousianitis is the new responsible for the NOA GNSS network.

From the three stations that appear on your map only station KORO [koro - 12668M001 - Koroni, Messinia, GR] is part of the NOA (co-located) GNSS-Tide Gauge stations.

The relevant leveling information between the KORO GNSS and tide gauge has not yet been collected.
These measurements will be taken during the next maintenance visit at the station.

* 2 of them access the google sheet

https://docs.google.com/spreadsheets/d/1Rlh88mB0NzivTx53Tq2oJYomALoY_MwncUnEcWUVhas/edit



Israel : 3 co-located pairs (3 have no tie information)

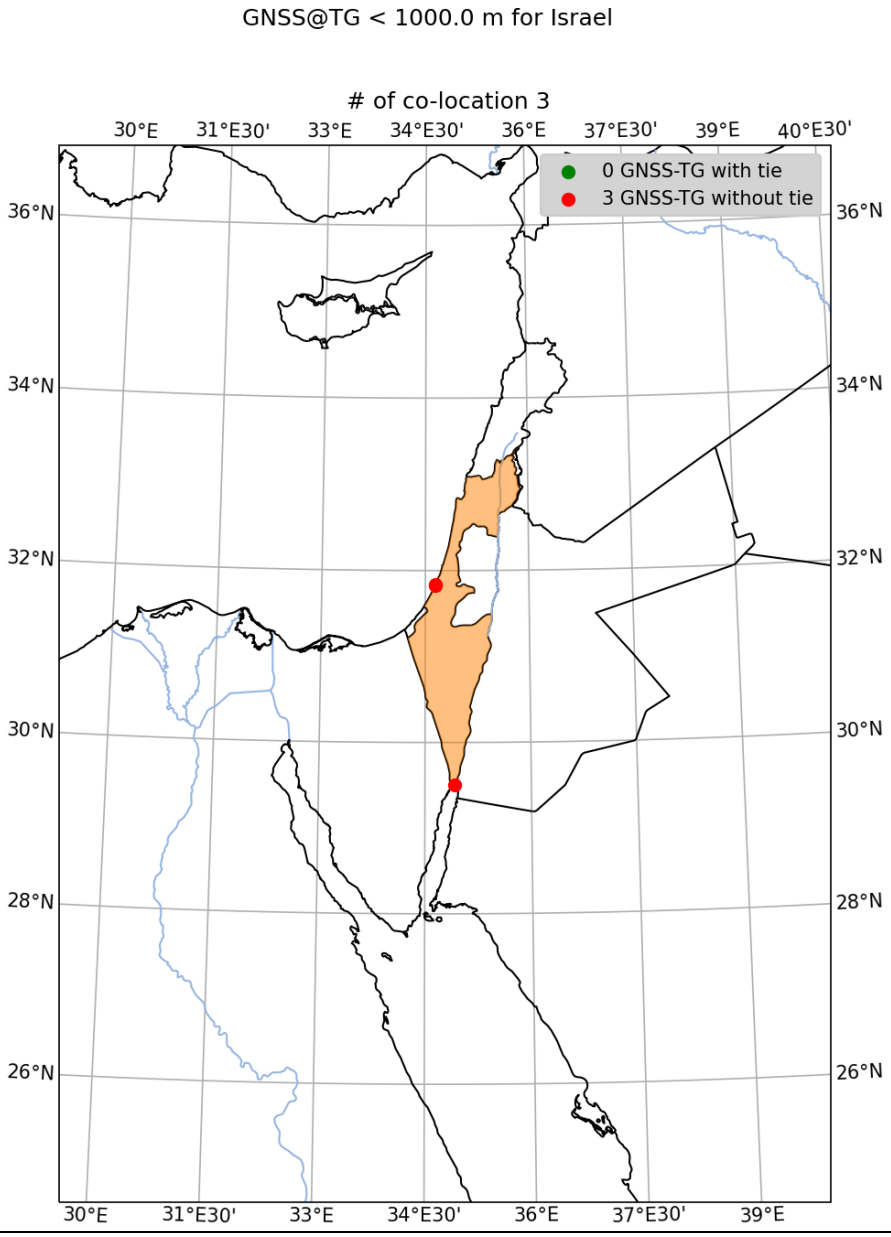
* email sent to 3 contacts

* 0 response to email

rozenblm@mapi.gov.il
Remote Server returned '550 5.1.10 RESOLVER.ADR.RecipientNotFound; Recipient not found by SMTP address lookup'

* 0 of them access the google sheet

https://docs.google.com/spreadsheets/d/1MaRg22ginZWNDCtIqx1-5RdvNoa2wI4s_Kj55t1OUug/edit



Ireland : 1 co-located pairs (1 have no tie information)

* email sent to 12 contacts

* 1 response to email

paul.hennelly@opw.ie access to the google sheet, **no update yet**. Email sent to him on 17/12/2020 for clarification for Malin Head.

* 2 of them access the google sheet

paul.hennelly@opw.ie : Some organizations use chart datum in Ireland however we at the OPW relate all our Gauges to the national Ordnance Datum "Malin Head OSGM15" .Our Primary Benchmark at the Malin Head station is PBM3 - Bolt on floor of Hut, the level of this in relation to our National Datum is 3.409m Malin Head OSGM15.The zero of the Staff gauge at the Station -3.140 m Malin Head OSGM15.

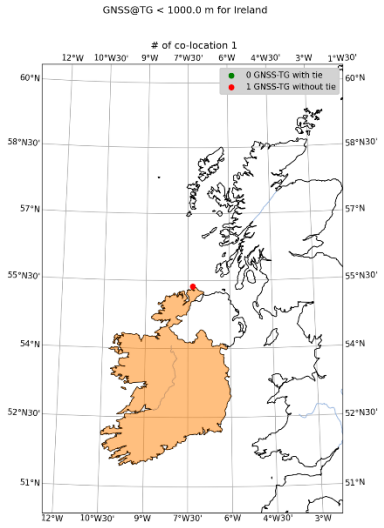
I will probably need some help in regards updating other data for this station so I will probably contact you in the new year if I need assistance.

Email (2021-0106)

NAME	LAT	LONG	ELLIP HT	ITM EAST	ITM NORTHING	LEVELLED HT
MLHD GNSS STATION	55° 22' 20.08373" N	/ 7° 20' 21.08749" W	78.602	641887.627	958566.661	21.499
PBM3 BOLT IN SHED	55° 22' 17.82560" N	7° 20' 03.38495" W	60.515	642199.994	958499.812	3.409

Katy.Fitzpatrick@osi.ie : [26/20/2021] email discussion to get the Malin head GNSS data

https://docs.google.com/spreadsheets/d/1lmDxVVCUVdqjf1ebCKE5W5rkWNYH2M_ldSs4kRzotsA/edit



Lithuania : 1 co-located pairs (0 have no tie information)

* email sent to 2 contacts

* 1 response to email

* 1 of them access the google sheet

s.plunge@aaa.am.lt : (2020-12-28) I represent Lithuanian Environmental Protection Agency. We have received request for the data (received email is pasted below). However, we are not collecting such data nor are aware who is responsible for collecting such data in Lithuania. Thus we are very sorry to inform that we are not in the possition to fullfil your request. Hopefully you can find other institution to help you.

At this page https://www.psmsl.org/data/obtaining/stations/118.php is written, so I would assume that it might be Geodetic Institute, Vilnius Gediminas Technical University. Otherwise, Klaipeda University Marine Research Institute http://apc.ku.lt/en/ might be other place to ask.

On 2021-01-06 Email sent to eimuntas.parseliunas@vgtu.lt (petras.petroskevicius@ap.vtu.lt return an error … retired ??)

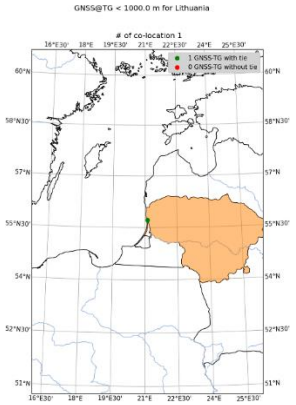
eimuntas.parseliunas@vilniustech.lt : (07/01/2021)

KLPD as tide gauge is operational, but not as GNSS station. TG responsible institution is Environmental Protection Agency, personally Ovidijus Stulpinas (ovidijus.stulpinas@aaa.am.lt).
KLAI is LitPOS station operational. My institution Vilnius technical university is responsible for it.

Reply on 15/01/2021

Send an email to ovidijus.stulpinas@aaa.am.lt [02/02/2021] to have information about the TG.

https://docs.google.com/spreadsheets/d/1_3lA8ONxrBXxDr_7y4QTfqITu1OyyYF8SthHDl8STr8/edit



Sweden : 9 co-located pairs (9 have no tie information)

* email sent to 4 contacts

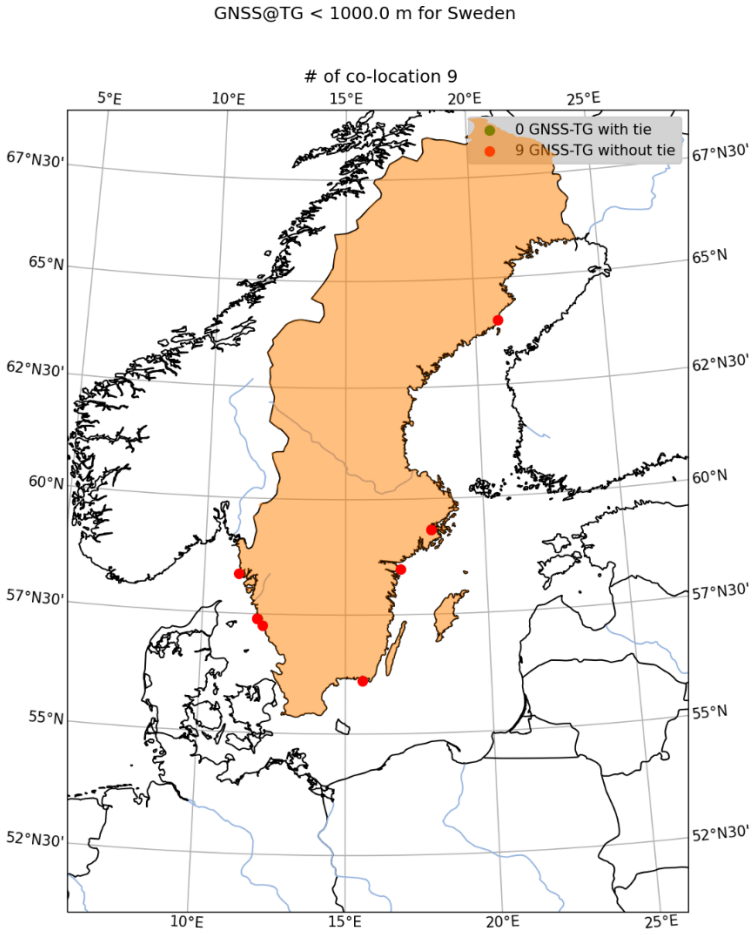
* 1 response to email

thomas.hammarklint@sjofartsverket.se will update the sheet

* 1 of them access the google sheet

thomas.hammarklint@sjofartsverket.se [02/02/2021] send excel sheet with all the information and an updated version of the scheme.

https://docs.google.com/spreadsheets/d/1R01JGp6vojDldrbj8lfLIXyqThZS3lNNp4eFEUq3Lxk/edit



Slovenia : 2 co-located pairs (1 have no tie information)

* email sent to 2 contacts

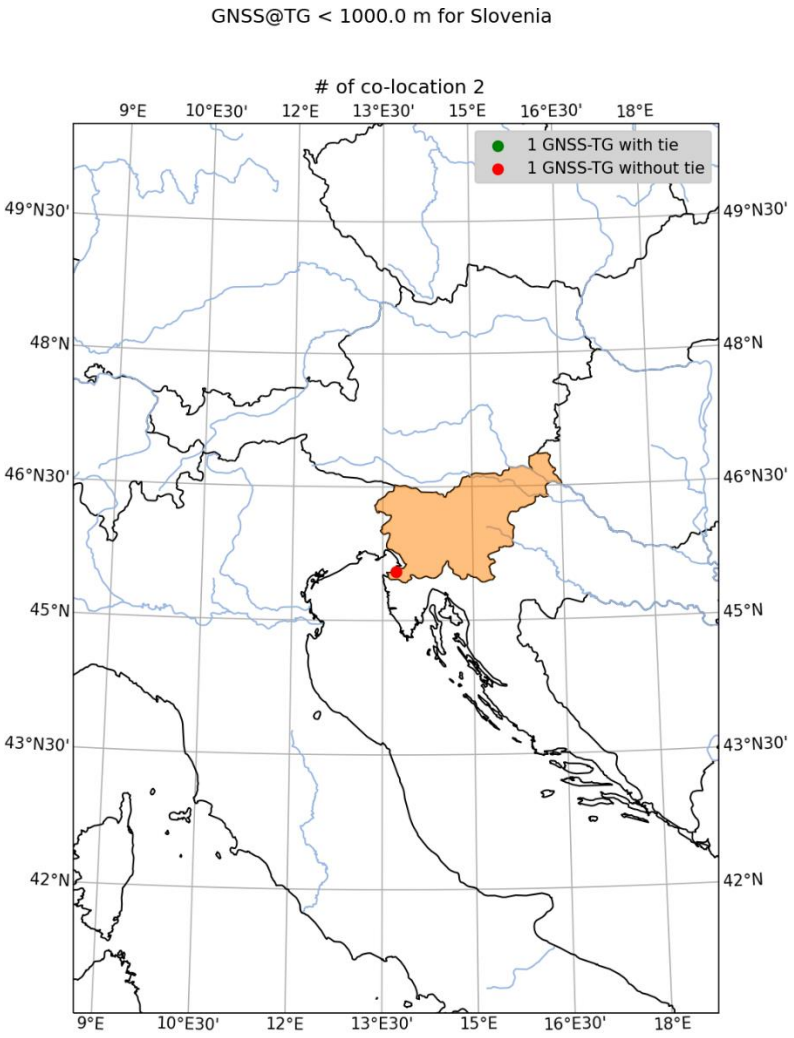
* 0 response to email

Sent email to maja.jeromel@gov.si to have clarification on the local hydrographic datum on 17/12/2020. Waiting for answer.

* 2 of them access the google sheet

https://docs.google.com/spreadsheets/d/1a2OzK9T0oVfkZUh5GRFDd1CZT-XYkLpX5sRuRFYlAOQ/edit

about Luka Koper TG : This station was active in period 1992-2005, in 2005 was moved back to current location, ~1 km away. Data set was homogenized.



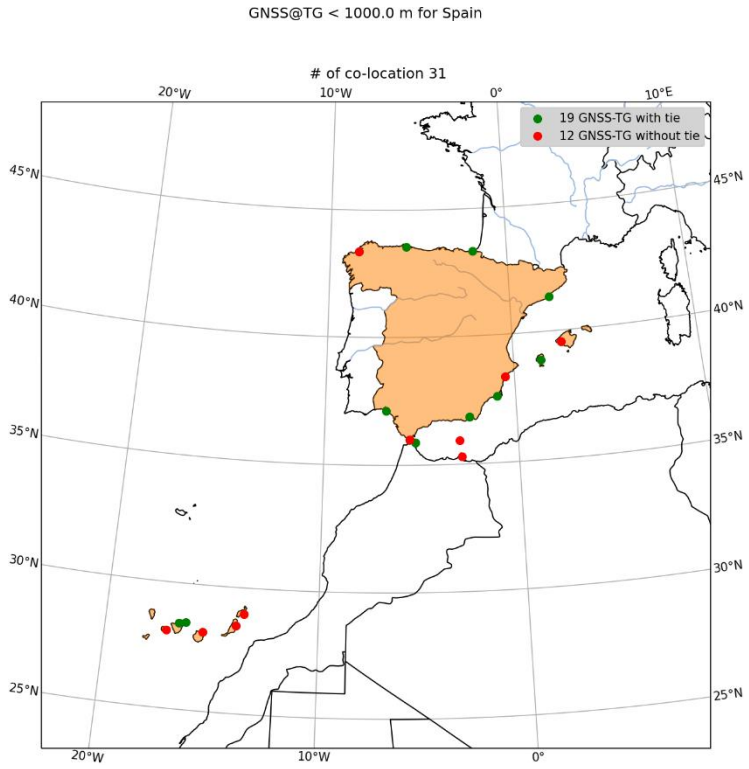
Spain : 31 co-located pairs (12 have no tie information)

* email sent to 11 contacts
* 1 response to email
* 3 of them access the google sheet

jl.iccp@gmail.com is updating the sheet

vmarting@mitma.es send a pdf (SONEL_Spain_Corrections_2020.pdf) we many corrections (mainly on TG, GNSS position) and some information on the institution hosting the instruments. **To be included in SONEL DB**

https://docs.google.com/spreadsheets/d/1cYONMZfCw37CHUxgGukqVBfZj5JaJCx1eSy_OAbKT3k/edit



Portugal : 4 co-located pairs (3 have no tie information)

* email sent to 8 contacts

isabel22@hotmail.com was remove from the list has she's not working anymore in sea level.

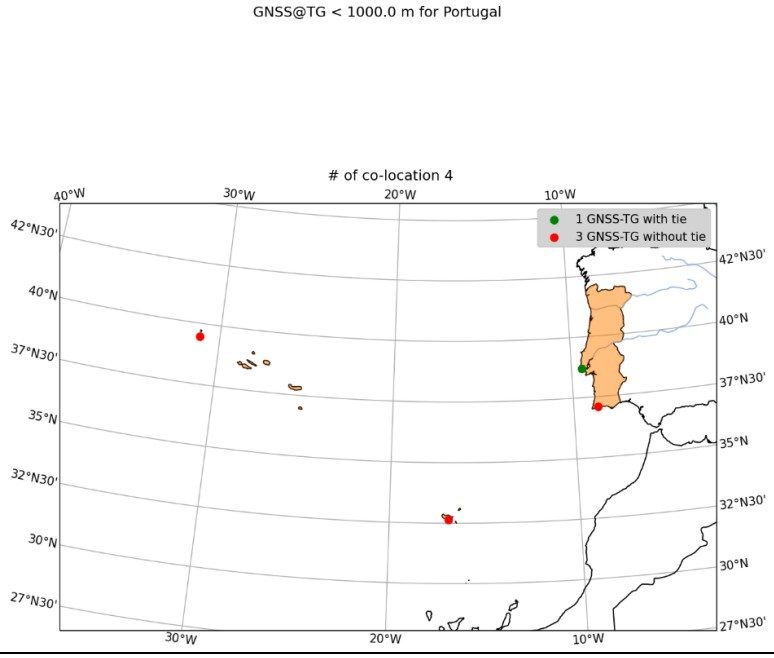
* 1 response to email

* 3 of them access the google sheet

amedeiro@dgterritorio.pt sent an excel sheet "EuroGOOS metadata for Portugal_dez2020_DGT.xlsx" with information. And leveling report for Cascais and Lagos.

Sara.Almeida@hidrografico.pt (21/01/2021) sent very clear explanation on TGZ and GNSS referencing

https://docs.google.com/spreadsheets/d/164jrha-p2lFnE3j7cfUg-qDbbGR3NeIccTcFcbFWb4A/edit



Belgium : 1 co-located pairs (1 have no tie information)

* email sent to 10 contacts

* few responses to email

pierre.voet@ngi.be We will be able to provide these data, but one crucial element is missing. To solve this, we need some extra information from the people who are responsible for the TG. As soon as we have this, we will take contact with you again.

koen.vanstaen@mow.vlaanderen.be :As owners of the tide gauge in Ostend I'm sure we can provide the necessary information. I add my colleagues in CC who will be able to assist or can be contacted for the specific information.

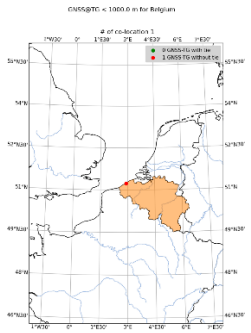
jeffrey.verbeurgt@ngi.be: (2021-01-05)

There was some confusion, due to the involvement of quite some institutions in Belgium:

- The Flemish Agency of Maritime Services, headed by Director Koen Vanstaen, is responsible for the tide gauges
- The Flemish Agency Information Flanders – Dept. Flemish Positioning System, represented by Luc Depredomme, is responsible for the GNSS antennas in Flanders (northern half of Belgium)
- The Federal Royal Observatory of Belgium – Dept. GNSS, headed by Carine Bruyninx, maintains the metadata-database of reference stations in Europe
- The Federal Mapping Agency (National Geographic Institute Belgium) – Dept. Geodesy, my employer, maintains the reference system in Belgium and performs ca. quadrennial measurements near the tide gauges by installing a GNSS antenna for several weeks near the TG's.

* 1 of them access the google sheet

https://docs.google.com/spreadsheets/d/19zkcgTDZ0TSbenvytToZTylSE51DAJwEHRjU38P4JQU/edit



Russian Federation : 1 co-located pairs (1 have no tie information)

* email sent to 5 contacts

Delivery has failed to these recipients or groups:

Alexander V. Frolov (afrolov@mecom.ru)
The email address you entered couldn't be found. Please check the recipient's email address and try to resend the message. If the problem continues, please contact your email admin.

* 1 response to email

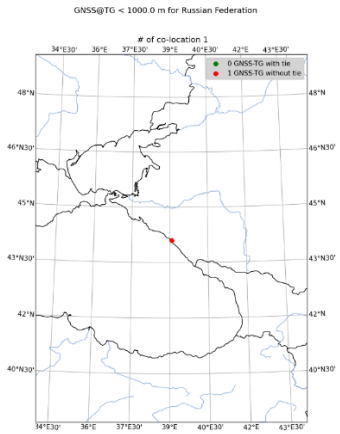
opnikitin@mail.ru (Oleg Nitikin): On this issue, I asked the head of the hydrometeorological office in the city of Tuapse. According to the response received, the Leica stationary GPS receiver was previously installed on the roof of the hydrometeorological office by Smartnet Russia for other purposes not related to sea level measurements. The distance from the GPS receiver to the sea level meter (tide gauge) is 1.3 km. Mutual geodetic referencing was not performed. Exchange of e-mail on 22/12/2020 with Oleg, asking information on GPS contact and TG status.

[26.2.2021] : About the tide gauge in the city of Tuapse. It worked at the end of the pier in the port of Tuapse. However, due to the fact that the pier has a new owner, the tide gauge was moved to a new position from the end of the pier to the place near its beginning. A levelling was made from the BM 3816. It has a height 4,475 m above zero in the National Baltic system of 1977.

A change in the antenna position of the GPS receiver was happened due to major overhaul of the hydrometeorological office from July to September 2019. All the equipment was dismantled.

* 0 of them access the google sheet

https://docs.google.com/spreadsheets/d/1uEZRvyFAIslsgBOpvpTnDqn6cqST6Uu_czizjGutmH4/edit



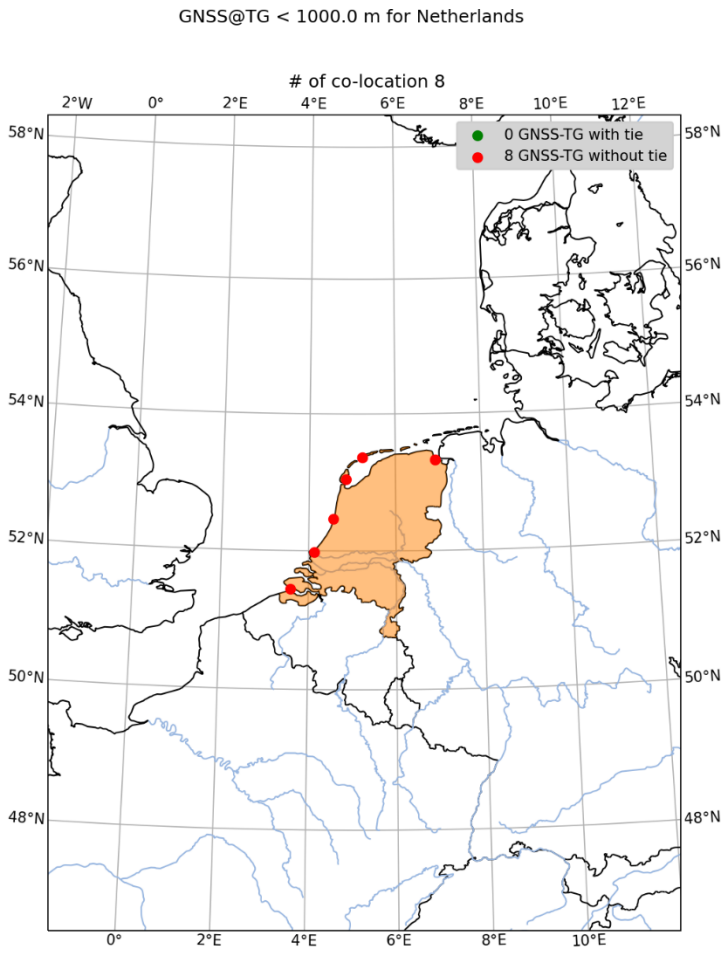
Netherlands : 8 co-located pairs (8 have no tie information)

* no email sent because Mederic is already in contact and waiting for the information

* 0 response to email

* 0 of them access the google sheet

https://docs.google.com/spreadsheets/d/1GoRvK_Xo0w18Y9Mm19mEum06rVltmsVBLPS7KoVsld8/edit



Denmark : 5 co-located pairs (5 have no tie information)

* No email sent to 5 contacts (Mederic already in contact)
* 0 response to email
* 0 of them access the google sheet

https://docs.google.com/spreadsheets/d/1YLHAM2iu6UPJXUCBHx6VnnpkVxL7FCLW-_HM4fktvCc/edit

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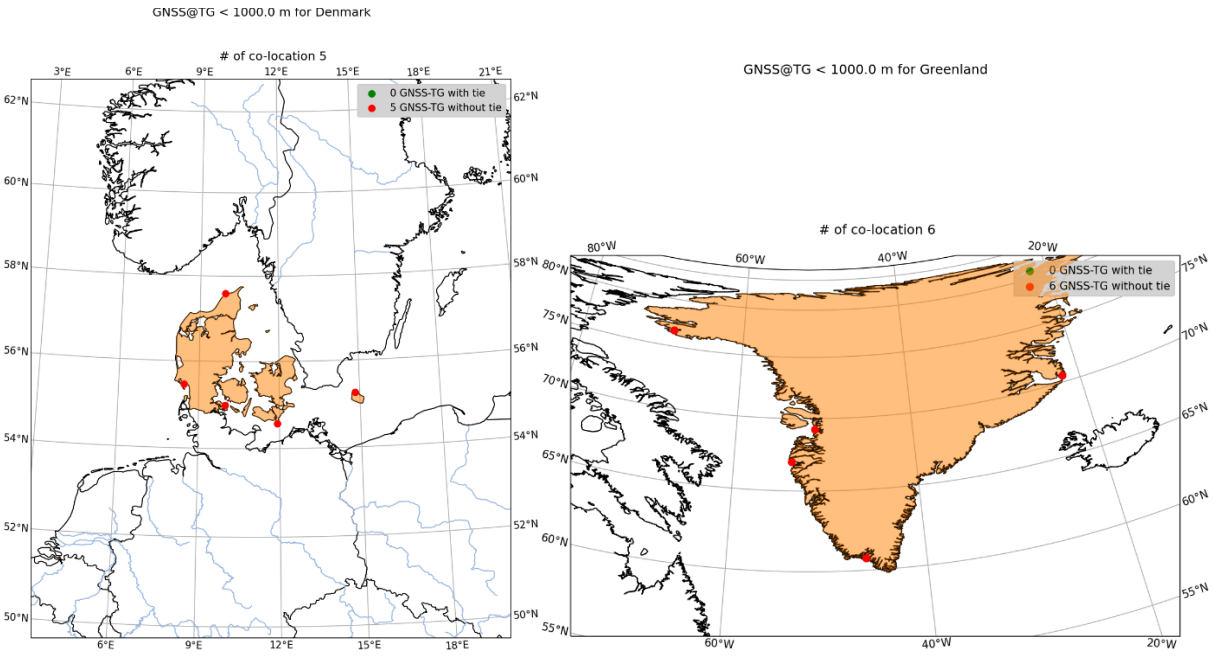
Greenland : 6 co-located pairs (6 have no tie information)

* email sent to 3 contacts
* 0 response to email
* 0 of them access the google sheet

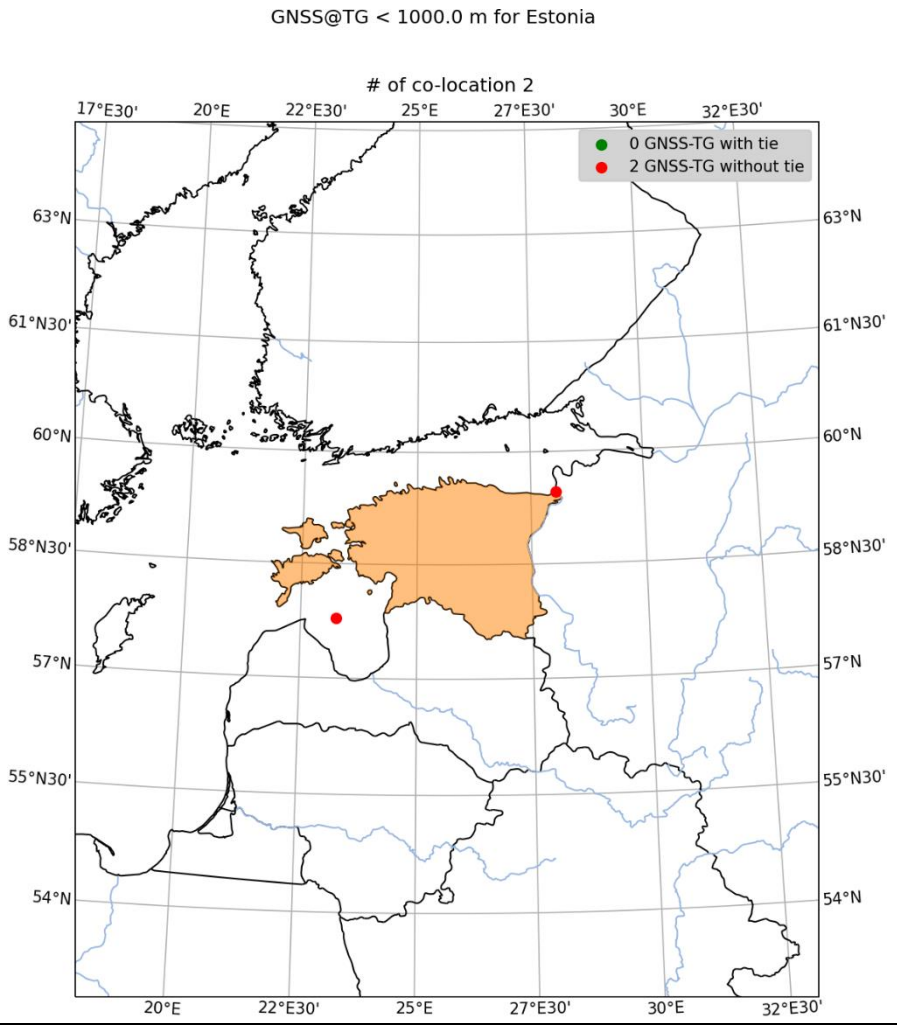
https://docs.google.com/spreadsheets/d/1DyPAOnwIjRu_IWC_UgawRZ4p5LtpfWfe6CiYyMtzlfk/edit



Estonia : 2 co-located pairs (2 have no tie information)

* email sent to 2 contacts
* xx response to email
* 0 of them access the google sheet

https://docs.google.com/spreadsheets/d/1gCO8kAnsu9gXNYwlJdJfoR5t0fVQIgwcWQQXDNfo8PA/edit



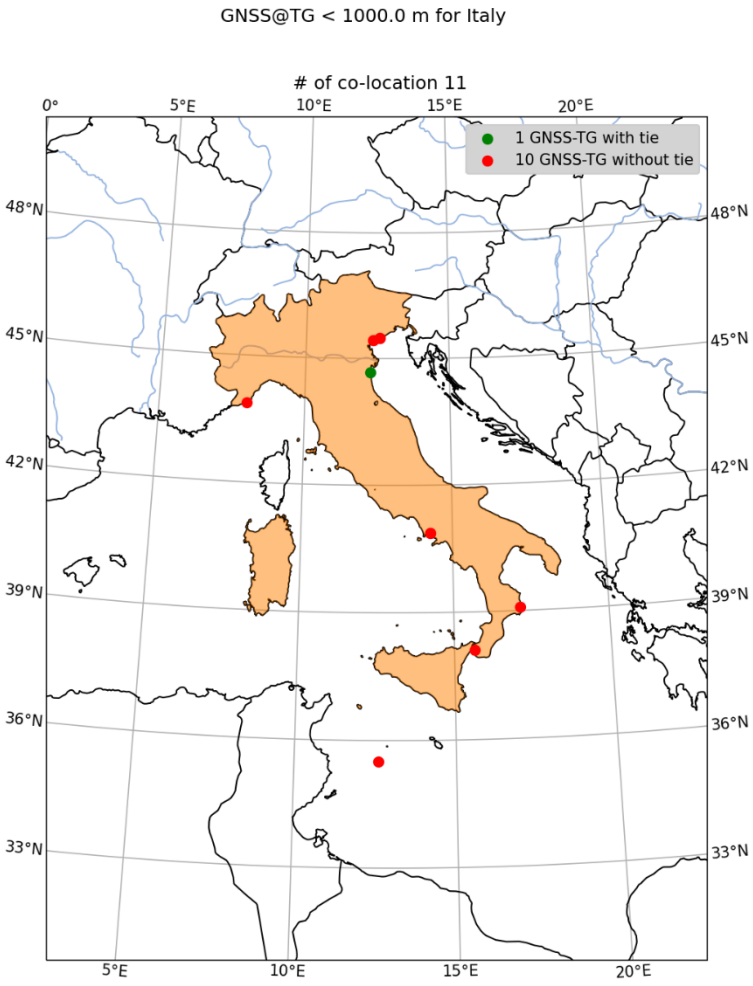
Italy : 11 co-located pairs (10 have no tie information)

* email sent to 15 contacts

* xx response to email

* 5 of them access the google sheet

https://docs.google.com/spreadsheets/d/19vJ8mm9sBos5RiMLjJOvL4jEqdX-hyPS1L949D__-PU/edit



France : 19 co-located pairs (6 have no tie information)

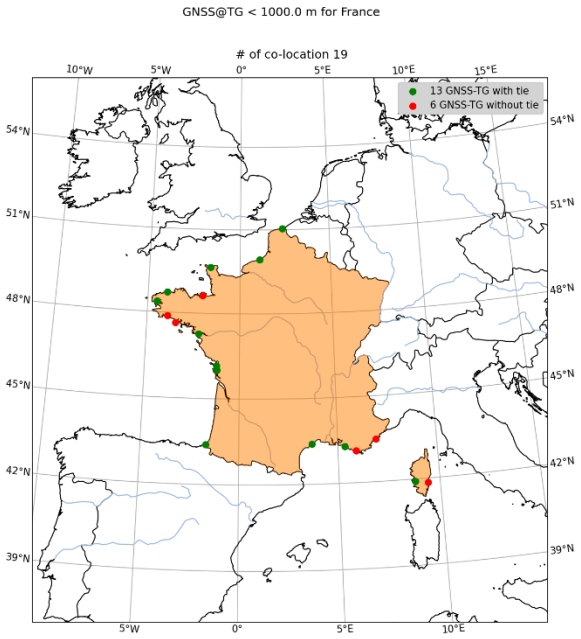
* email sent to 9 contacts

* 1 response to email

* 3 of them access the google sheet

Claire.fraboul@shom.fr : (email 2021-01-06) new ellipsoidal Estimation for some stations

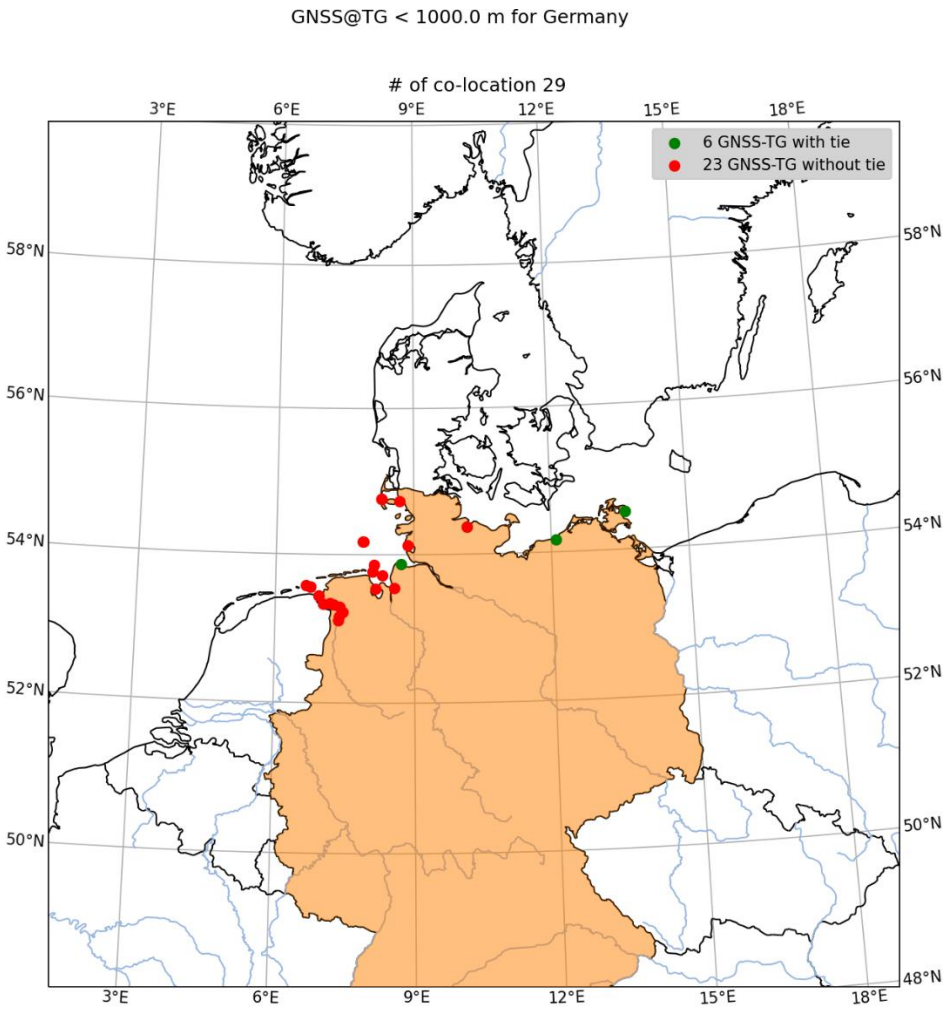
https://docs.google.com/spreadsheets/d/1_awwM-kcVPHxdgar1SLC1fANcejlH2NH_ckiAmUat54/edit



Germany : 29 co-located pairs (23 have no tie information)

* email sent to 5 contacts
* xx response to email
* 3 of them access the google sheet

https://docs.google.com/spreadsheets/d/11Ry4IgCy4Jjlr9W1VhEjq86YMNt8nUMPSbttU2Q6dnY/edit



Finland : 1 co-located pairs (1 have no tie information)

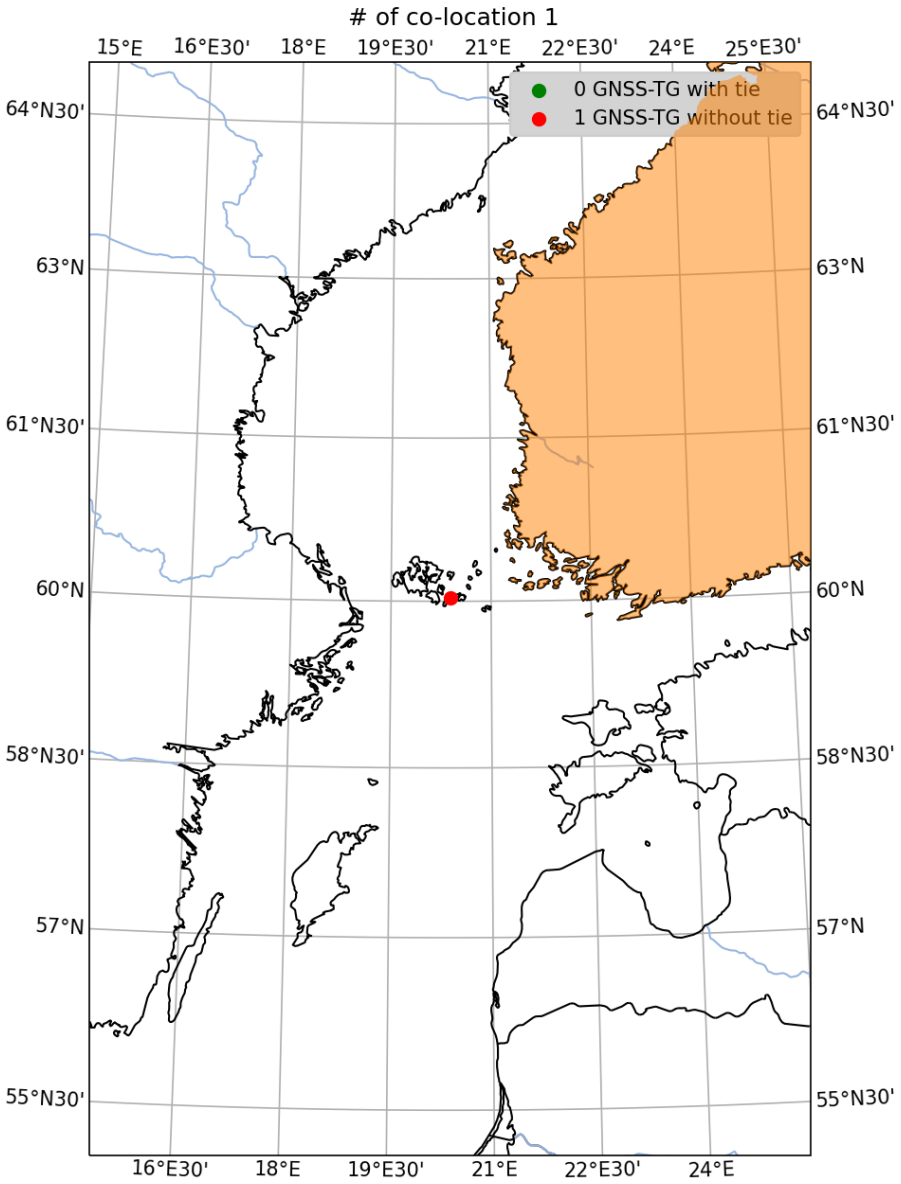
* email sent to 4 contacts

* xx response to email

* 0 of them access the google sheet

https://docs.google.com/spreadsheets/d/1jVh5-_wGmEDmJPZm4xKFwuuZS7iZWyM3khwKrOs6ocA/edit

GNSS@TG < 1000.0 m for Finland



Norway : 6 co-located pairs (6 have no tie information)

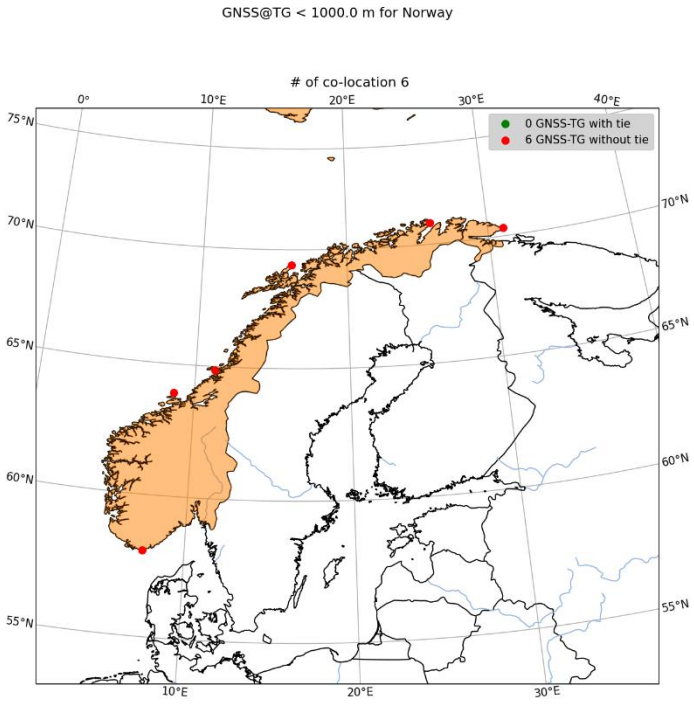
* email sent to 5 contacts

* 1 response to email

* 2 of them access the google sheet

https://docs.google.com/spreadsheets/d/1aNvVYn5ODkl-G_emxz17MSc78G3P4-VeWH2c1ckng_w/edit

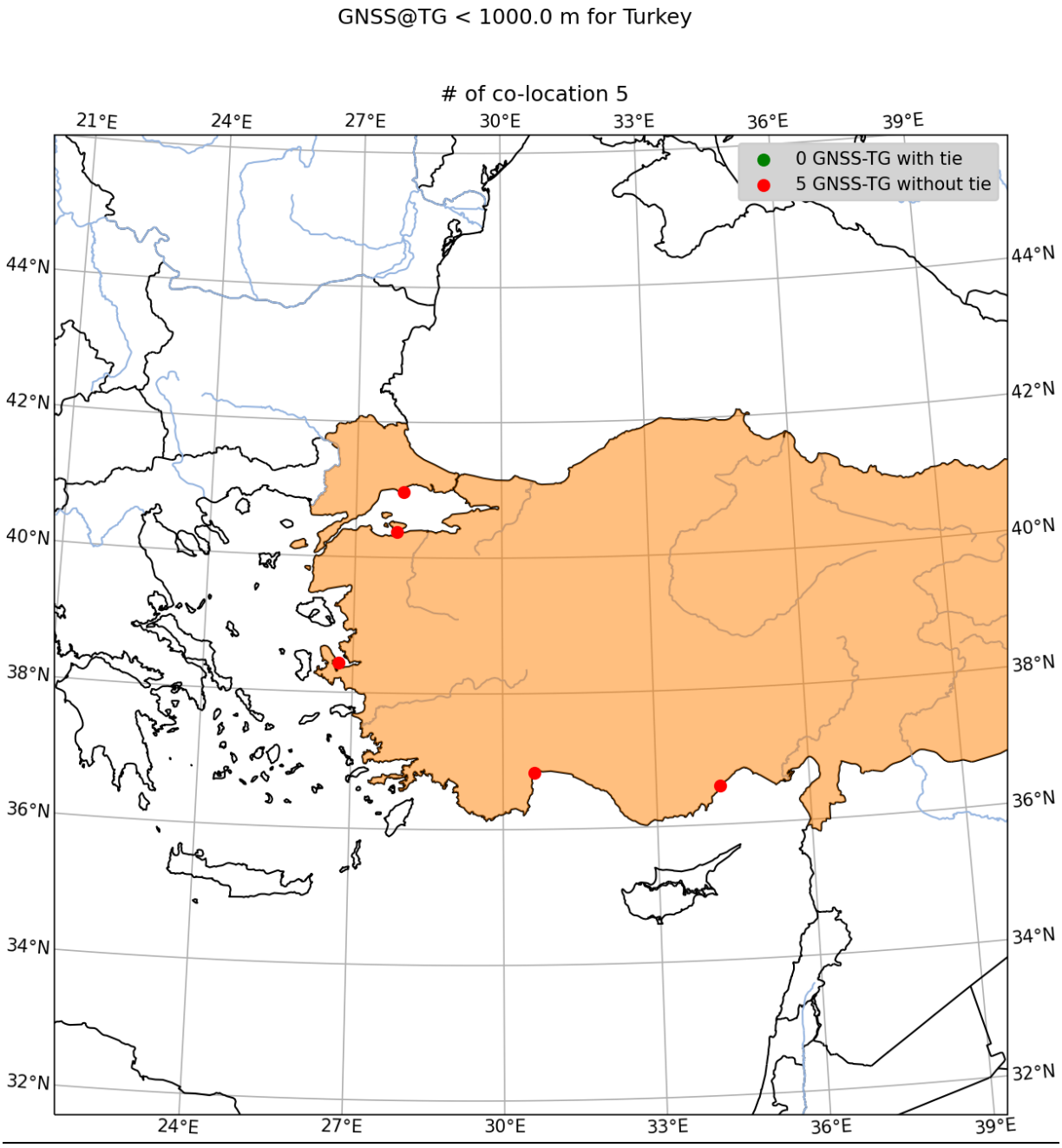
oda.ravndal@kartverket.no : (14/01/2021) complete the google sheet and sent references for the sonel pages, and a photo of the new GNSS installed in Bergen (reply on 15/01/2021). Mederic in contact with them to collect RINEW for the new Bergen station.



Turkey : 5 co-located pairs (5 have no tie information)

* email sent to 3 contacts
* 0 response to email
* 0 of them access the google sheet

https://docs.google.com/spreadsheets/d/1z7dBkGWC4cMjztpIjvHDZpF8_JdfgL7uFp61mPPzkfs/edit



United Kingdom : 17 co-located pairs (9 have no tie information)

* email sent to 16 contacts

* fews response to email

Christopher.jones@ukho.gov.uk : cannot access, granted free-login access on 20.12

Cooper, Rhys M. <rcooper@bgs.ac.uk> : I confirm BGS doesn't have anything to add to this.

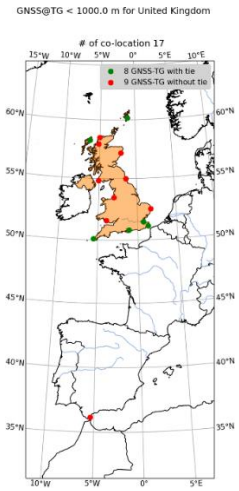
Richard.Bingley@nottingham.ac.uk : I have checked the spreadsheet for the levelling information for NEWL, PMTG, DVTG, SHEE, NSTG, ABER, SWTG and LWTG.
I have updated the spreadsheet with levelling information for LIVE and NSLG (and ABER with respect to ABERDEEN II).
As confirmed previously:
- I have no levelling information for LOWE and GIBR.
- Both I and the Ordnance Survey have no levelling information for their OSNet stations of KINL, PORK, SWAS and ULLA.

sdwil@noc.ac.uk : We might have the information for GIBR I have asked my colleagues if they have it - no response so far.

Geodetic Enquiries GeodeticEnquiries@os.uk : some new information on the GNSS under the responsibility for OS

* 3 of them access the google sheet

https://docs.google.com/spreadsheets/d/1oNT7rDhbHUjRGzPGMjpcsC-v1P8Z5GLbE3xEmPL6dFk/edit



Croatia : 2 co-located pairs (1 have no tie information)

* email sent to 6 contacts

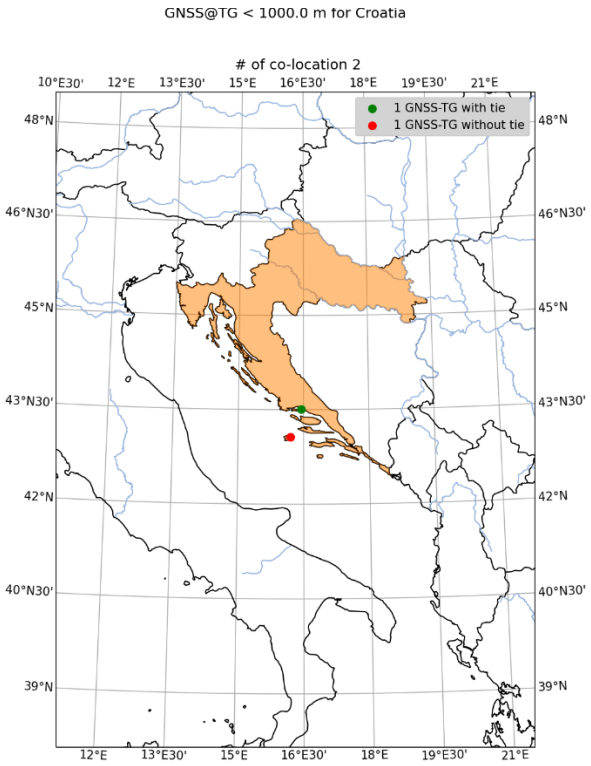
* 1 response to email

Hrvoje Mihanovic hrvoje.mihanovic@izor.hr :

Regarding SPLT CGPS collocated with TG the best info can be obtained from Srdjan and Marko, from the Hydrographic Institute of the Republic of Croatia. I used to work with them in the past and I was also co-responsible for those data, but they should have more fresh information. As for Vis, I guess this comes from the fact that two devices were located at nearby location but in different periods. I believe there used to be a tide gauge in Vis (not anymore), and probably some other institution had a campaign with CGPS during different period? I don't think Hydrographic Institute ever had them collocated.

* 0 of them access the google sheet

https://docs.google.com/spreadsheets/d/1Mu4P_5_eP3MIjYSW8eA5jY42JGohSANfvSsWJSlU9jw/edit



6/ Status map of the update as for today (date of the report)

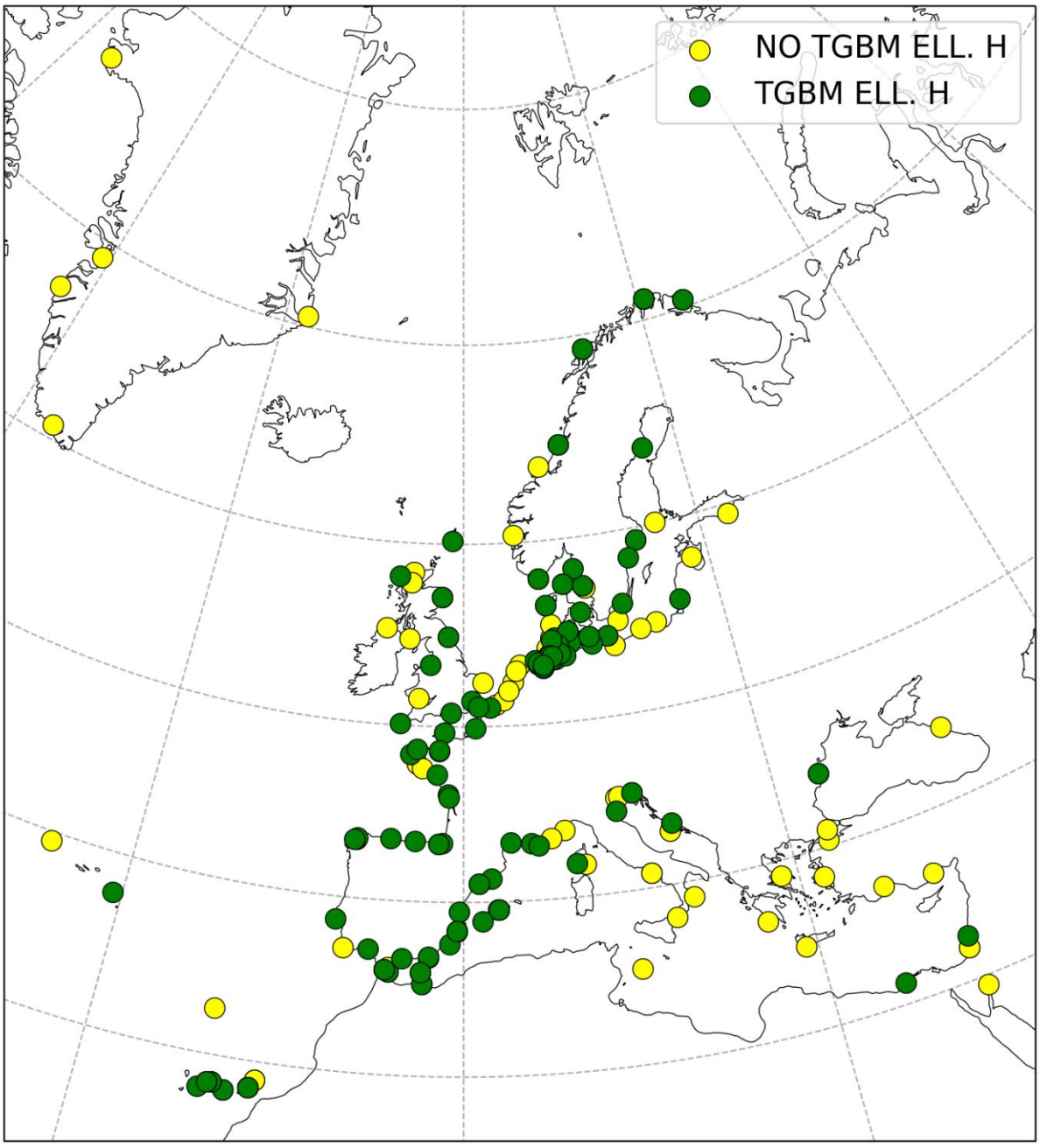


Figure 6: Map of the TG for which we have a Ellipsoidal Height estimation of the primary TGBM (in green) and the one where it is missing (yellow)

7/ Appendix A : Email sent to the 24 countries (example for GB)

Dear Tide Gauge, GNSS operators,

You have been identified as a key contact for your country either because you are involved in sea/water level measurements with Tide Gauges (TG) or GNSS stations (GNSS).

We would really appreciate if you could provide ***by the end of this month*** new or updated information to the SONEL data assembly center (see context a the bottom of this message).

This metadata campaign deals with the update of the levelling and metadata information between GNSS and TG that are ***less than 1 km apart***.

We have attached a map with the GNSS-TG pair less than 1 km apart for your country with in red those pairs without any levelling information yet.

In priority we need updated information about height and levelling between GNSS and TG primary benchmarks (TGBM and GNSS marker, see diagram attached)

To help you identify the information we are missing and the one we already have, we have set an online Google SpreadSheet below

https://docs.google.com/spreadsheets/d/1oNT7rDhbHUjRGzPGMjpcsC-v1P8Z5GLbE3xEmPL6dFk/edit

On this spreadsheet the columns you can update :
-> the names of the agencies responsible for TG and/or GNSS
-> the coordinates of the tide gauge station, and the horizontal distance between the GNSS and TG
-> the TGBM_ID and the local/national datum information. When no local datum information are provided we have used the PSMSL RLR reference (https://www.psmsl.org/data/obtaining/rlr.php)
-> D1 (the levelling between the GNSS marker and the TGBM, see diagram attached)
-> D2 (the height of the TGBM above the datum) and/or D3 (see diagram attached)
-> if a new GNSS station near the TG exists you can insert a row
-> feel free to add any comment at the end of the row in the comment column

Any additional levelling information (pictures, local map, reports, ...) is welcome.

Thank you for helping us to improve our knowledge about the status of the tide gauge network in Europe

Don't hesitate to contact us for more information by replying to this email or to forward this email to persons who can provide us these information

Many thanks for your help,
The SONEL team

CONTEXT OF THE CAMPAIGN:

The role of Global Navigation Satellite Systems (GNSS) has been recognized of high importance by the sea level science community. Sea level measurements at the coast are usually made with tide gauges, which measure changes in sea level relative to the land. To account for the influence of land movement on tide gauges records, it is recommended to pair them with GNSS permanent stations to measure the elevation of the land surface relative to the center of Earth, and to tie the GNSS antenna reference to the main benchmark of the closest tide gauge (TGBM).

Collecting, archiving and disseminating these ties and other type of metadata (images, ...) at the global scale is an important task of the SONEL GNSS data assembly center (www.sonel.org) of the international Global Sea Level Observing System (GLOSS program). GLOSS was established by the Intergovernmental Oceanographic Commission (IOC) of UNESCO in 1985 to establish a well-designed, high-quality in situ sea level observing network and provide oversight and coordination for global and regional sea level networks.

The EuroGOOS Tide Gauge Task Team coordinates since 2015 the European network of tide gauge platforms, as a densification of GLOSS in the region, aiming at the integration of tide gauges in European initiatives and to identify relevant products required by diverse sea level data users. Long-term mean sea level studies are one of the key objectives of these platforms, for which colocation with GNSS reference stations is encouraged