

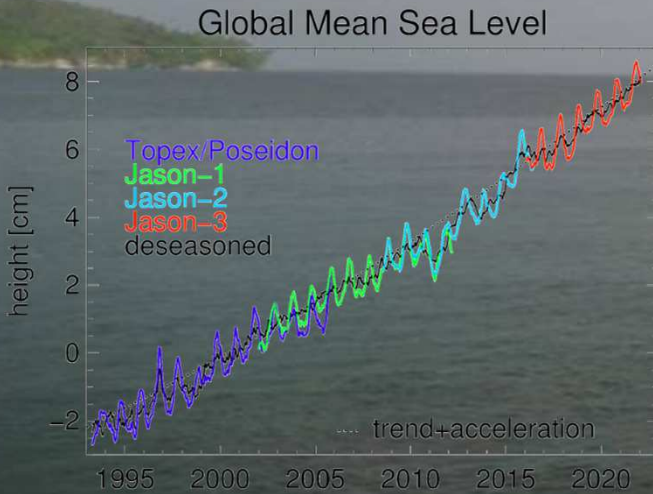
# Tide Gauge Benchmark Monitoring

Tilo Schöne, GFZ Potsdam, Chair TIGA-WG  
Members of the TIGA-WG

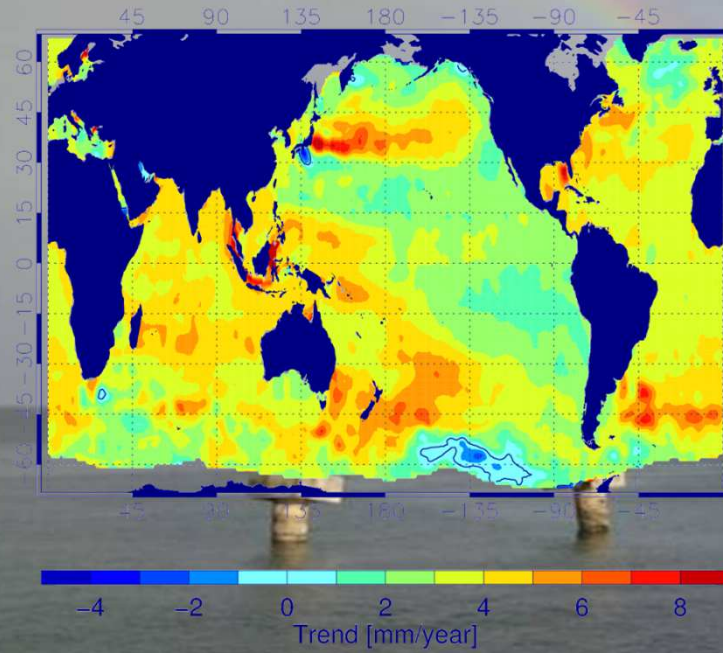




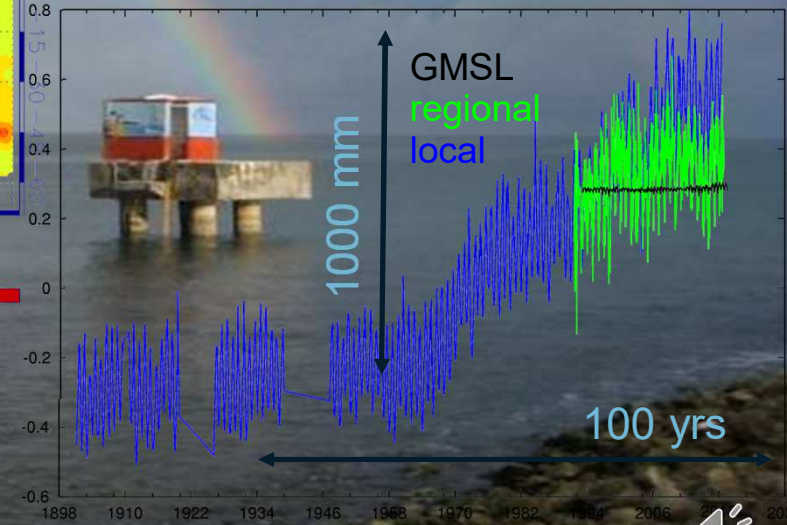
# Global Ocean



Sea Level Trend: 04/1993–02/2022



# Coastal Impact



## We aiming on providing the best possible GNSS solution for sea level research

bringing the GNSS, tide gauge and sea level community

- Work with the UNESCO/IOC (GLOSS) community to provide the reference frame for tide gauges
- Maintain a global **virtual** GNSS @ TG network
  - Promote the establishment of local ties (leveling) between GNSS and TGBMs.
  - Promote the establishment of more continuous operating GNSS stations, in particular in the southern hemisphere.
  - Provide meta information, e.g. on leveling between benchmarks or open data access
- Compute precise coordinates and velocities of GNSS stations at or near tide gauges with a significant delay to allow as many as possible stations to participate (reproX).
- Provide training to tide gauge operators through workshop. Through UNESCO/GLOSS advice station operators about the operation of GNSS @ TG stations.



## Major Accomplishments (1)

- University of La Rochelle and GFZ Potsdam processed large networks of GNSS@TG stations in IGS-repro3, which goes beyond the repro3 coverage
- Results (time series) are available
  - TIGA/GFZ-repro3: doi 10.5880/GFZ.1.1.2022.001
  - SONEL ULR7: doi 10.26166/sonel\_ulr7a
- SONEL (@ University of La Rochelle)
  - acts as TIGA-WG DC and hosts TIGA-NC
  - Collects and distributes levelling ties between ARP/TGBM
  - provides an excellent service for the GLOSS, TIGA, and sea level community
  - NC provides service to keep the TIGA network up-to-date and growing



## Major Accomplishments (2)

- [www.SONEL.org](http://www.SONEL.org):
  - Integration of new levelling data (TGZ to ARP)
  - Integration of **RINEX3** files. Now also collecting RINEX3 data
  - « Last data events » tool : established at SONEL to assist the operators and users
- Corona affected our work
  - important outreach activities are missing
  - Missing input about new stations and GNSS@TG from this community
  - GLOSS GE18 meeting in November 2022 (Guy Wöppelmann)
- Support "Navi-Tech,, (China) for the installation of 5 new GNSS@TG stations (and now a few more under discussion)





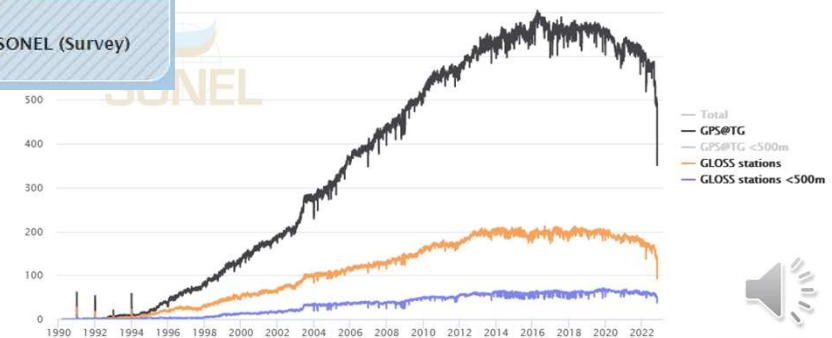
1229 Stations (12/2021)  
 1253 Stations (12/2022)

1253 GNSS@TG stations (**603** are active (49%), **278** are dormant (22%, no data within the last 30 days), and still 184 (14%) have been identified as collocated with a tide gauge but no data freely available).



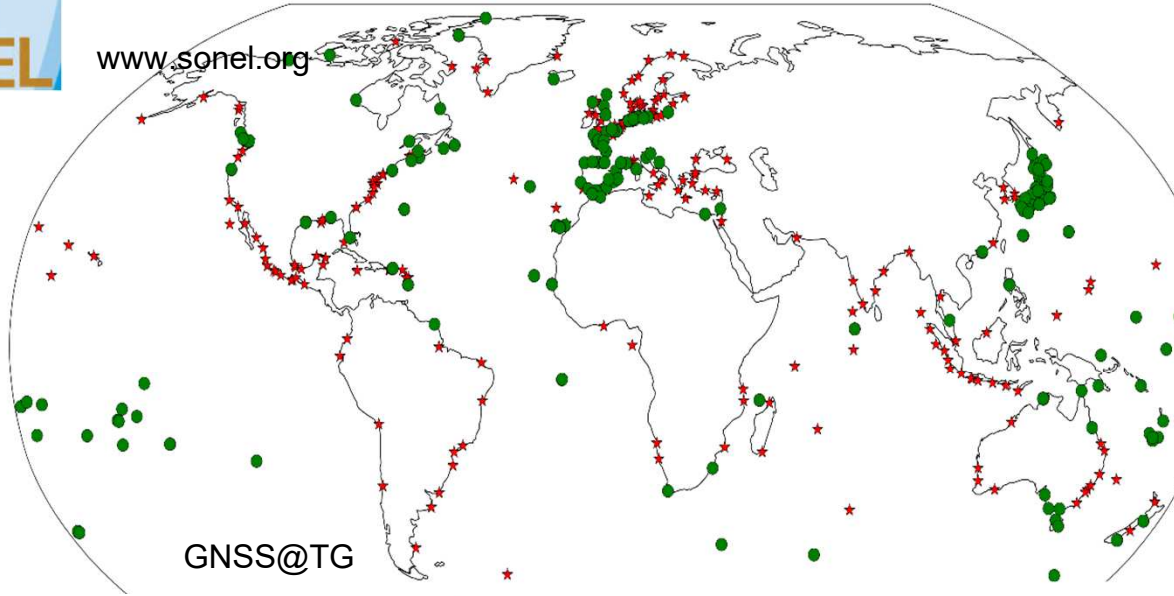
www.sonel.org

Number of RINEX files on SONEL, per day





www.sonel.org



Precise levelling Thule GNSS marker Domes 43001M002 to Aanderaa WLR7 sensor pressure inlet														
Year	Instrument	Thule GNSS marker Domes 43001M002	From	To	From	To	From	To	From	To	From	To	From	To
2013	TCA		-1,6711	-0,6712	-3,0880	-4,2280	-0,9656	-7,3872	-0,0850	-25,0691	201309066	201409015	1514	
2014	TCA		-1,6711	-0,6714	-3,0875	-4,2274	-0,9624	-7,3860	-0,0850	-25,0708	201409015	201509012	1514	
2015	TCA		-1,6711	-0,6714	-3,0875	-4,2287	-0,9636	-7,3866	-0,0850	-25,0703	201509013	201609002	1397	
2016	WLR7		-1,6710	-0,6712	-3,0880	-4,2281	-0,9644	-7,3879	-0,0850	-25,0746	201607001	201709002	1397	
2017	TCA		-1,6710	-0,6703	-3,0881	-4,2268	-0,9657	-7,3879	-0,0850	-25,0748	201709002	201809025	1397	
2018	TCA		-1,6711	-0,6716	-3,0879	-4,2287	-0,9660	-7,3810	-0,0850	-25,0693	201809025	201909006	1514	
2019	T816		-1,6715	-0,6722	-3,0881	-4,2284	-0,9675	-7,3868	-0,0850	-25,0675	201909006	202009004	1514	
2020	GNSS					-17,6238	-7,3860	-0,0850	-25,0649	202009004			1514	

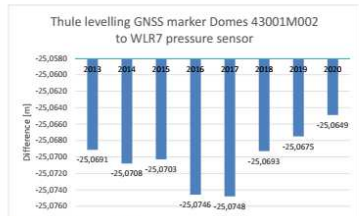


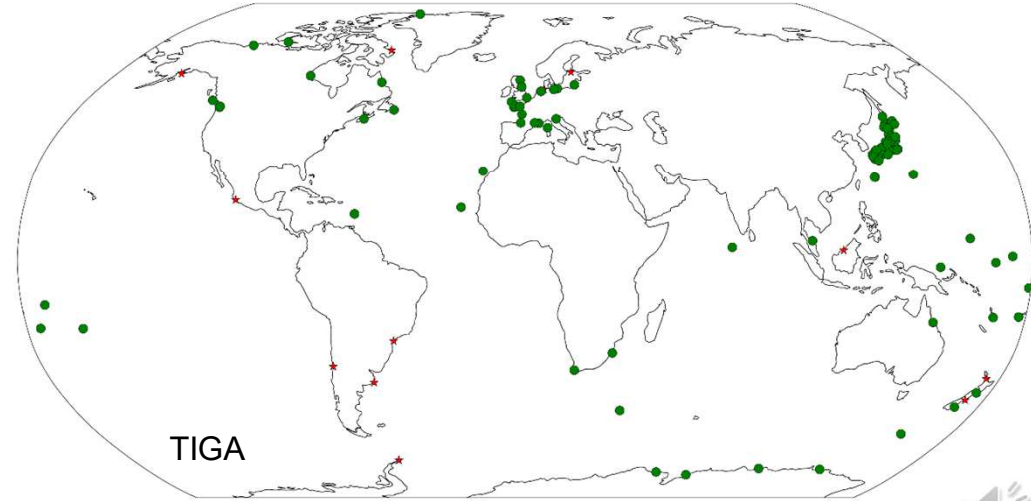
Figure 7 Height differences Thule

The changes in pressure sensor position is likely a combination of debris-buildup in the well and subsidence of the pier/concrete block where the Datum point is placed.

GNSS@TG

★ No tie - GNSS@TG < 1km ● Tie

Finn Bo Madsen/DTU  
Levelling info for Greenland ☺

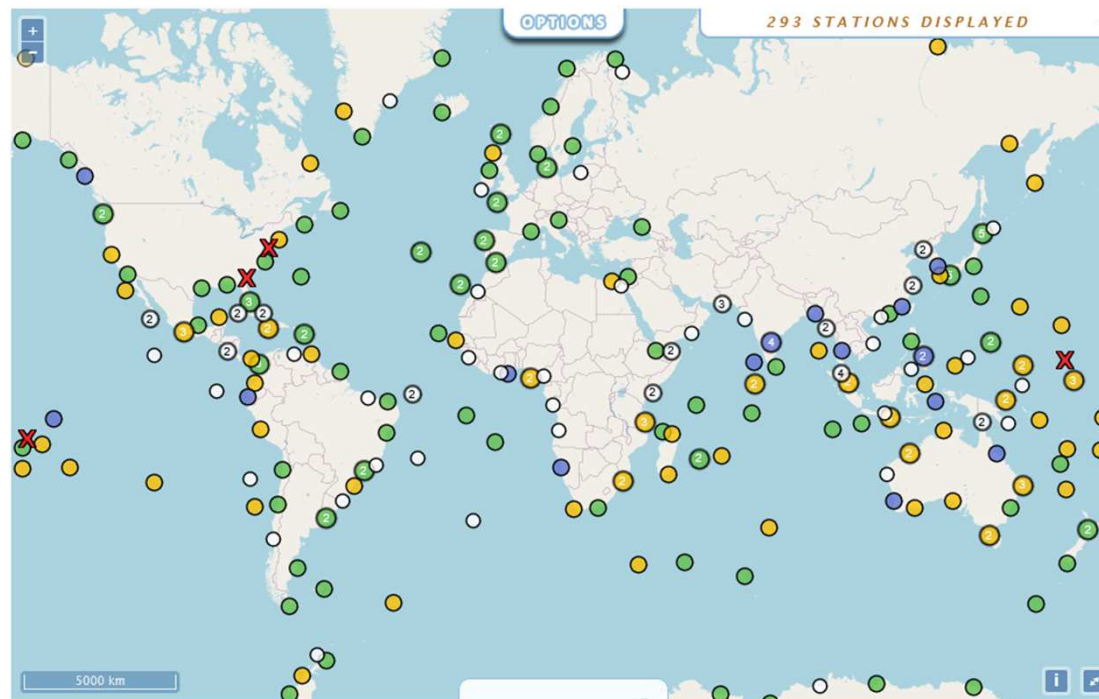


★ No tie - GNSS@TG < 1km ● Tie



**200** GLOSS stations  
co-located or nearby  
a GNSS stations (68%)

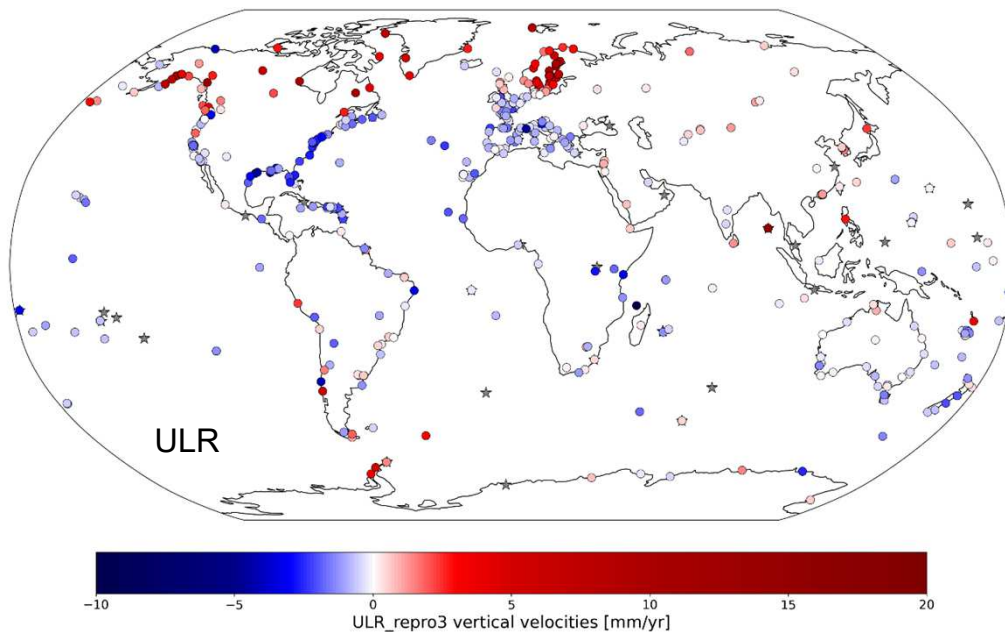
- 113 with active GNSS (136 in 2019)
- 87 dormant GNSS (55 in 2019)
- ✘ 5 decommissioned GNSS (6 in 2019)
- 19 nearby GNSS, but data not available (22)
- 69 with no nearby GNSS identified in SONEL (71) using NGL database



<https://www.sonel.org/-GLOSS,81-.html>





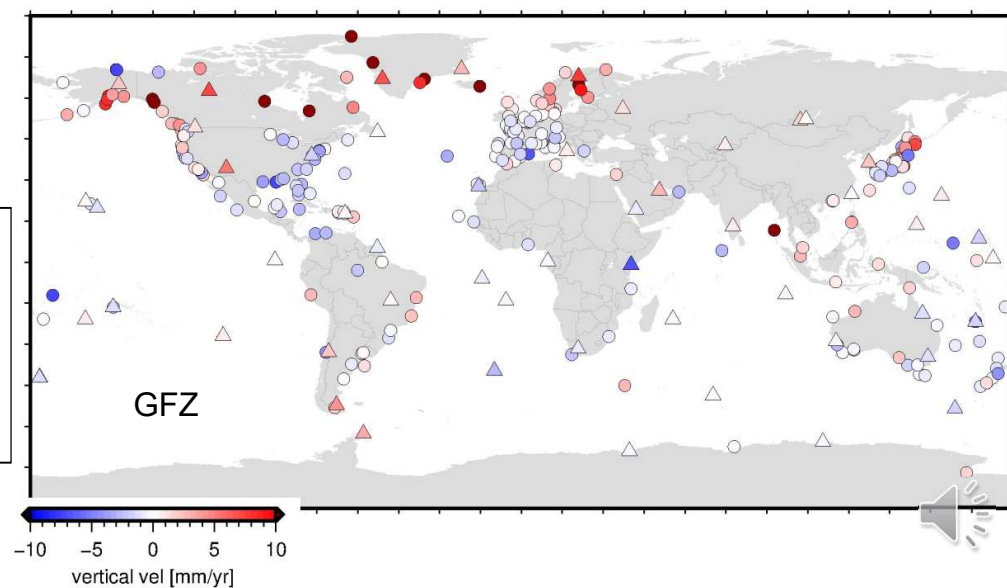


Network of **601** stations over the period [2000-2020],  
**554** « robust » velocities (**468** GNSS@TG velocities)

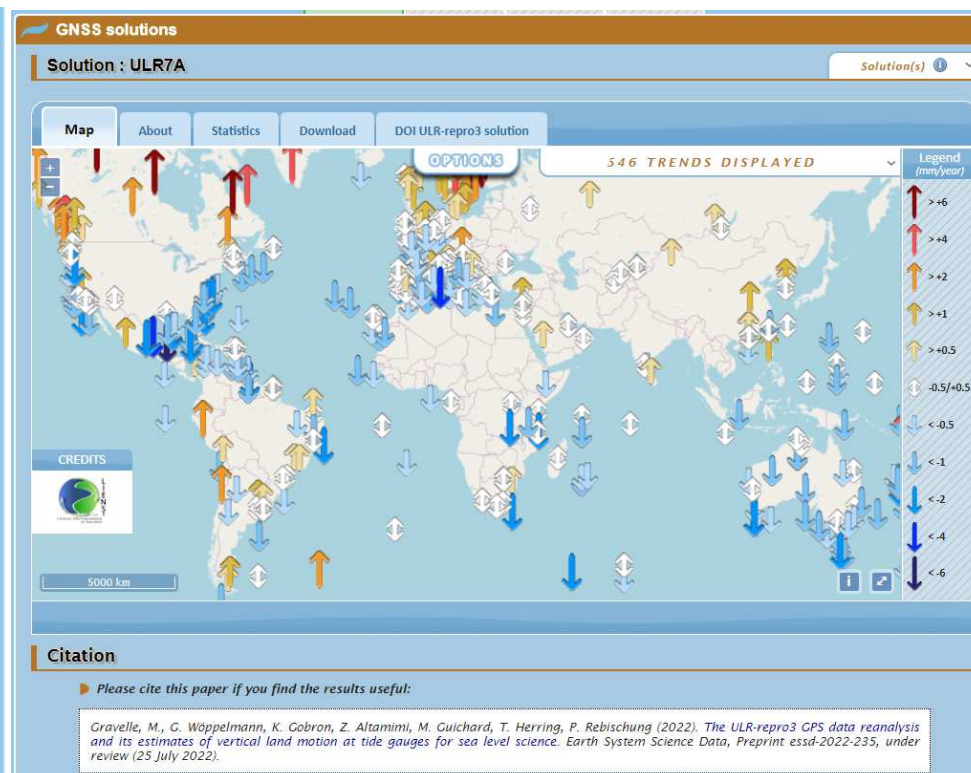
- do we have sufficient network coverage
- can we increase the number of contributing stations (and how)
- are there any other AC/AAC/groups which may contribute
- how can we come to a combined products of all (non)repro3 solutions
- Multi-GNSS ; RINEX2/3

## TIGA repro3 contribution

Network of **341** stations (**101** TIGA and **153** GNSS@TG stations + 66 IGS14 core stations) [1994-2020]



# Providing vertical land motion @TG through SONEL



## Discussion Highlights at the June IGS Meeting

- Understanding sea level change and coastal hazards requires a stable reference frame and GNSS@TideGauge time series
- Community appreciates SONEs capability for displaying time series from different solutions/ACs
  - more efforts are needed to (study and) explain differences between solutions at a specific site
- Can we provide better service to non-IGS users, non-GNSS experts?
  - comparison of solutions
  - combination of TIGA-repro3 (GFT and UoL are not in the IGS-repro3 solution)
  - Outreach at sea level conferences



## Emerging Ideas (1) from the IGS2022 meeting

- Work with GLOSS-GE to get feedback for the QoS, define more stations, and connect to the TG community
- Work with IAPSO/CMSLT (President: Gary Mitchum)
  - to define and (later) provide a better service to non-expert GNSS users of time series and trends (what are and why we have different solutions and results)
  - analyze the impact in respect the sea level change estimates
  - Develop a test strategy for time series of GNSS@TG
  - CMSLT plans establishing a working group on GPS/GNSS datums, which will provide an excellent forum to get both communities together



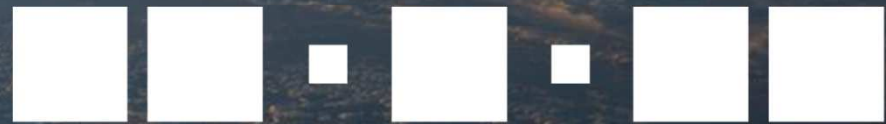
## Emerging Ideas (2) from the IGS2022 meeting

- Develop a “How-to” for the IHO-TWCWG (action item from last GLOSS-GE)
- Guidelines for TIGA-labeled stations should be renewed
  - beyond the IGS CORS Guidelines, reflecting the way of the ARP to the TGZ
  - IOC manuals on Sea Level (IOC Manuals and Guides No. 14: Volumes I–V), esp. IV

## Recommendations

- Non-expert community needs guidelines for the understanding of jumps, drifts, non-concruent GNSS time series from individual solutions





IGS

INTERNATIONAL  
GNSS SERVICE

**Thank You!**

**Contact:**

Tilo Schöne

[tschoene@gfz-potsdam.de](mailto:tschoene@gfz-potsdam.de)

