Tide Gauge Benchmark Monitoring

IGS Workshop 2022 (28.06.2022, ZOOM)

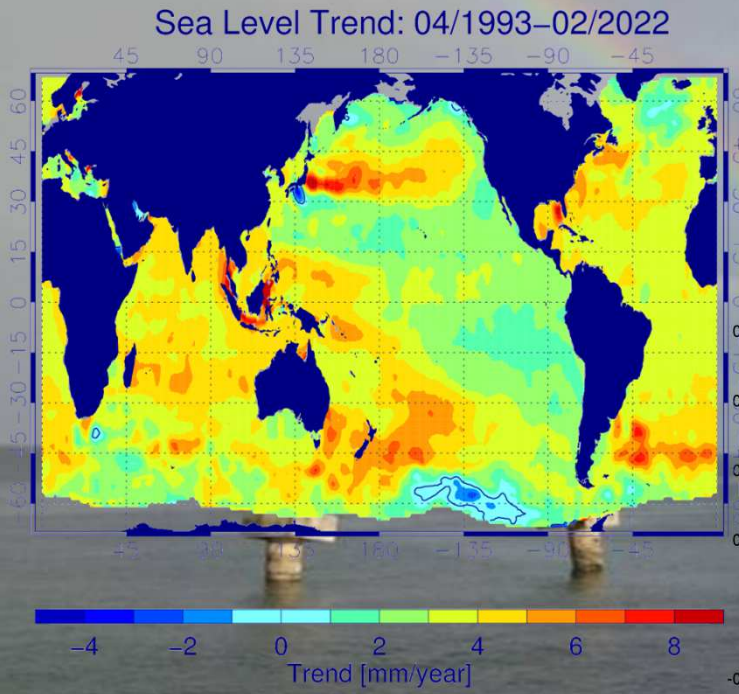
TIGA-WG AGENDA

Agenda

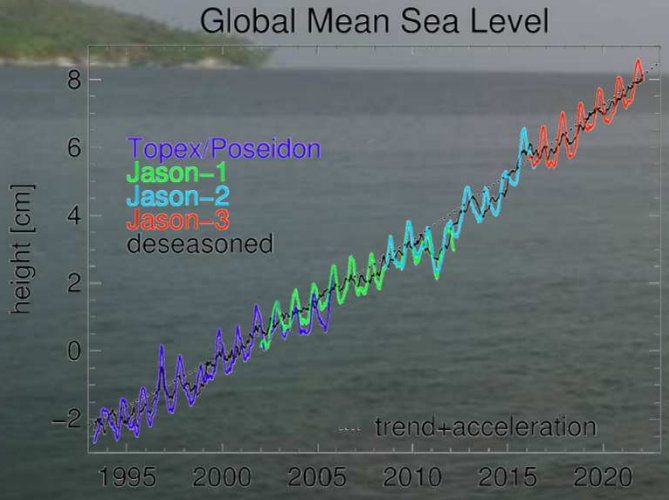
- Tilo Schöne: Introduction to the session
- Gary Mitchum: A brief history of the GLOSS, TIGA partnership
- Guy Wöppelmann: Estimates of vertical land motion at tide gauges from multiple solutions (IGS-repro3 and others)
- Benjamin Männel: Results of the GFZ‘s TIGA repro3 contribution
- Status of the TIGA Network and status of SONEL (prepared by Elizabeth Prouteau)
- ALL: Open discussion along the key technical questions

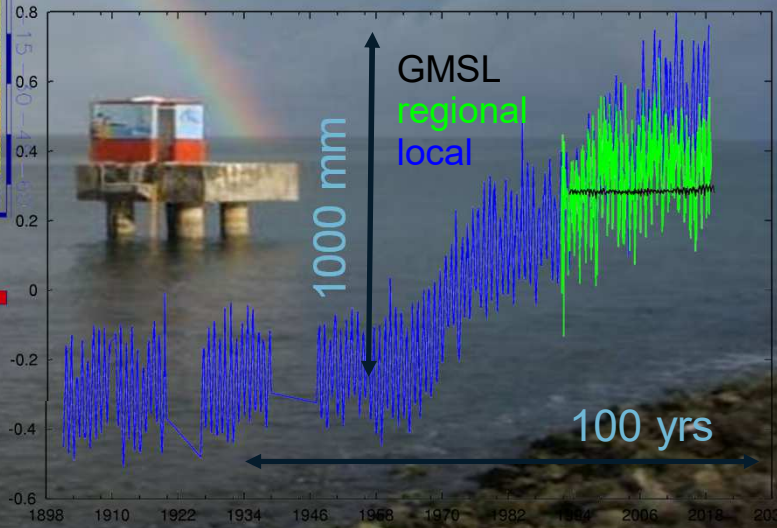
https://igs.org/igs-ws-2022/#day-2

Global Ocean



Coastal Impact





TIGA Working Group

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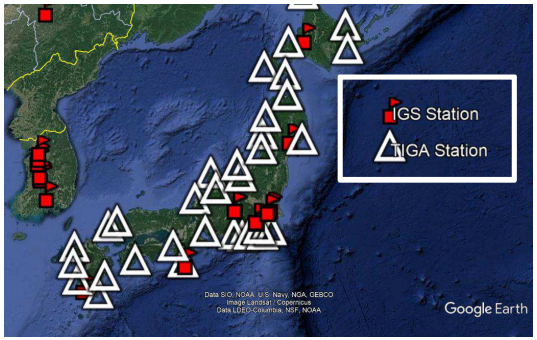
Applications of GNSS@TG

- Sea Level Research – Tide Gauges have century time series
- Altimetry calibration and stability monitoring
- World Height System Unification
  - GNSS@TideGauges are the contact between the **physical** (geoid/MSL) and **geometrical** reference (ITRF) frames
- ITRF densification
- Reference for InSAR coastal/subsidence mapping
  - Coastal hazard assessment
- Near-coastal wet tropo- and ionospheric product for altimetry



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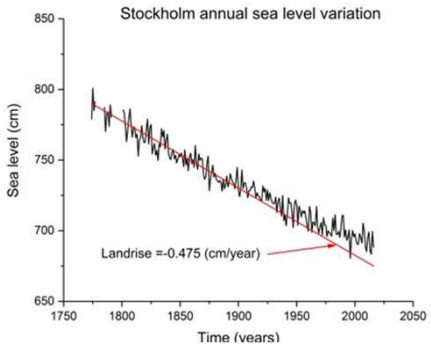
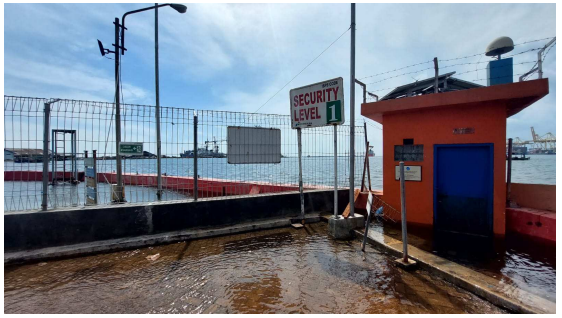
NEED of GNSS@TG

10.5194/esd-12-871-2021

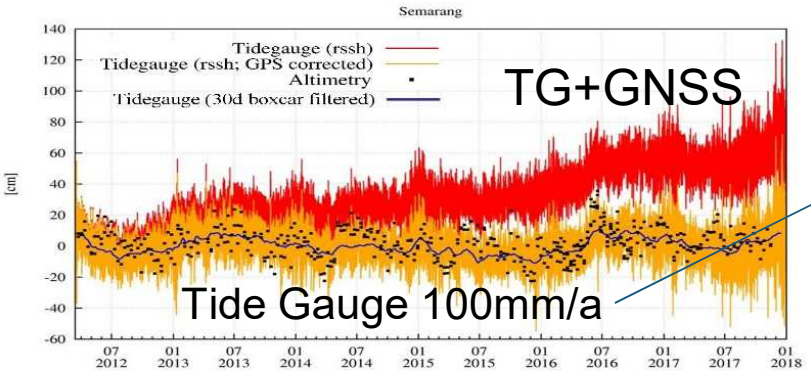


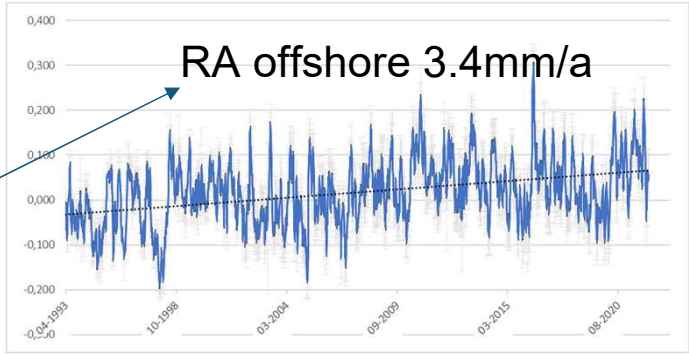
- Tide Gauges measure against their TGZ (which may change over time)
- Two close gauges may give opposite signals due to local effects
- Tide gauges might be moved (e.g., harbour constructions)
- GNSS provide the connection to the geometrically stable reference frame and other techniques (e.g., InSAR)

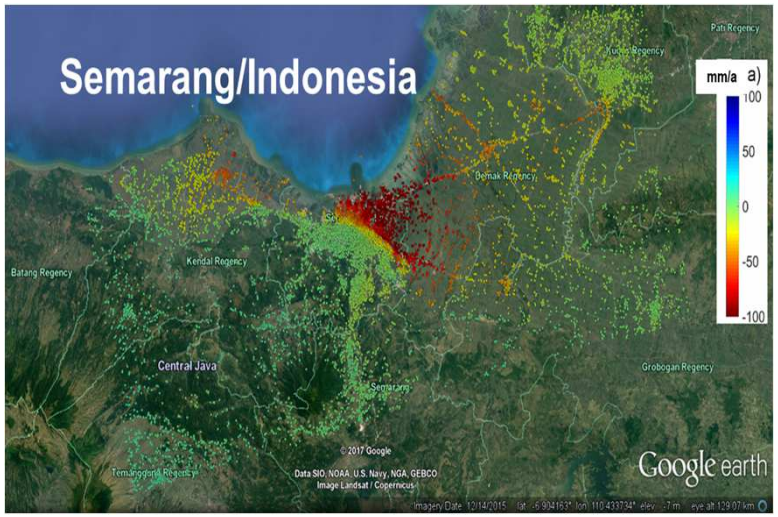


Tide Gauges – Where Sea Level Rise matters!

TIGA Subsidence







Geocentric SLR is only part of the problem!

Several coastal cities have a higher hazard potential due to subsidence

GNSS-controlled tide gauges and InSAR services are indispensable

The relative SL matters too!

TIGA-WG CHARTER

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

bringing the GNSS, tide gauge and sea level community together

- 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 (e.g., IGS repro campaigns).
- Provide training to tide gauge operators through workshop. Through UNESCO/GLOSS advice station operators about the operation of GNSS @ TG stations.

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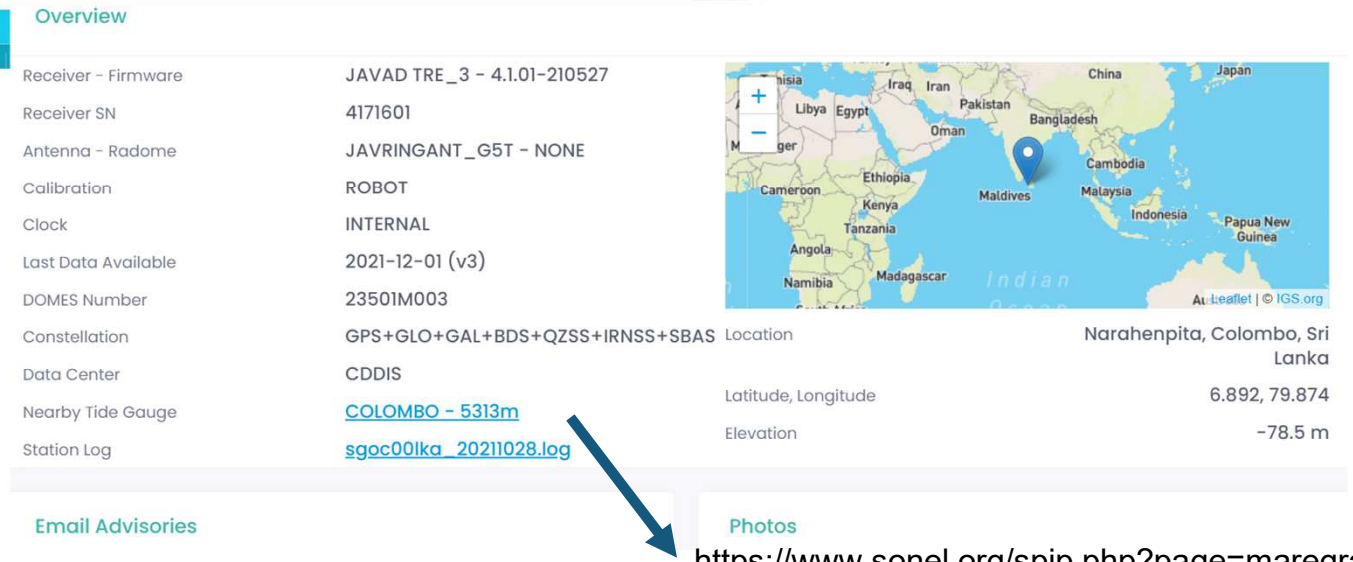
Progress (from AM Meeting 12/2021)

- Contributions by ULR and GFZ with dedicated repro3 solutions, UoL in 2022
- www.SONEL.org:
  - Integration of new levelling data (TGZ to ARP)
  - Integration of **RINEX3** files. Now collecting RINEX3 data for 566 (out of 900) stations.
  - « Last data events » tool : a table is automatically updated when :
    - a new station in added to SONEL database
    - a new sitelog has been recovered
    - a large amount of data has been downloaded out of the daily process
- Corona affected your work
  - important outreach activities are missing
  - Missing input about new stations and GNSS@TG from this community

Interface IGS SONEL/PSMSL

Ways have been establish for seamless integration of collocated tide gauges information between IGS (*www.igs.org*), SONEL (*www.sonel.org*) and PSMSL



https://www.sonel.org/spip.php?page=maregraphe&idStation=1994

Key technical items to be discussed by WG

- Review the status (coverage) of repro3 contribution, requirements of the Sea Level community on the IGS-TIGA products
- TIGA-repro3
  - GFZ-TIGA-repro3 is not included in the official release of IGS (only the AC version)
  - Setup a combination product after UoL is ready with repro3
- Discuss ways to improve the situation with leveling TGBM/ARP
- Impact of multi-GNSS combinations on long-term homogeneity of the vertical of GPS-only time series (req. sub-mm/a) at tide gauges

https://igs.org/igs-ws-2022/#day-2

Key Questions

Relevant pre-reading for TIGA

- IOC manuals on Sea Level (IOC Manuals and Guides No. 14: Volumes I–V, No. 83: Volume I): https://gloss-sealevel.org/library/manuals-guides
- IGS CORS Guidelines
- IGS Data Center Guidelines
- Review the Service of (the TIGA Data Center) www.sonel.org
  - Leveling information: https://www.sonel.org/-Stability-of-the-datums-.html?lang=e
  - GNSS@TG network: https://www.sonel.org/-GPS-.html?lang=en
  - Suggesting new station: https://www.sonel.org/spip.php?page=part_cgpstg
  - Access to time series: (e.g.) https://www.sonel.org/spip.php?page=gps&idStation=639
- Review the usefulness of the tide gauge related information at https://igs.org/network/ (e.g., https://igs.org/imaps/station.php?id=COCO00AUS)

Pre-Reading Material

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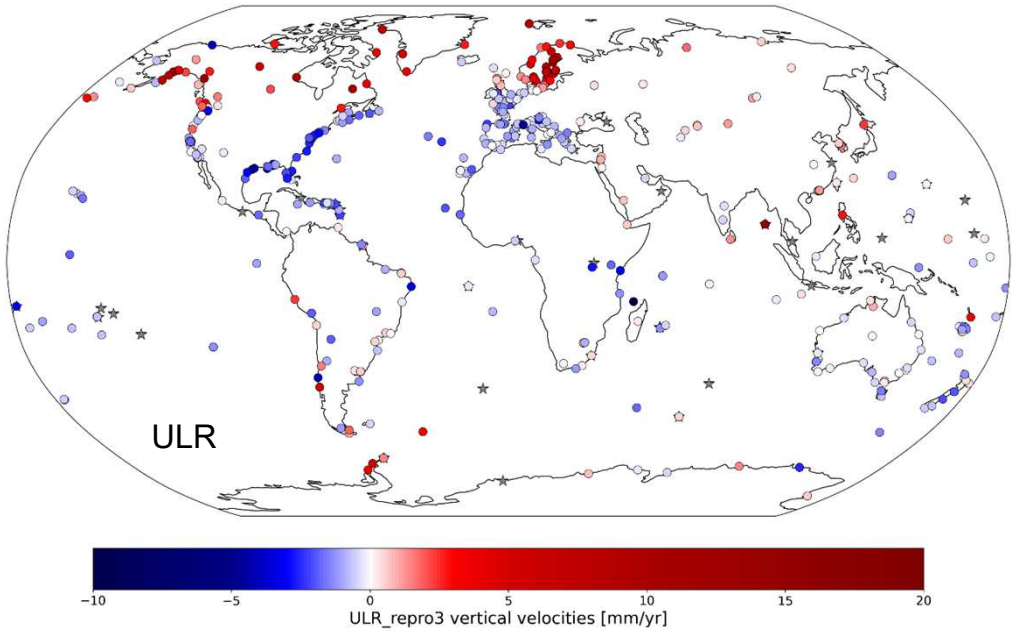
Key Questions

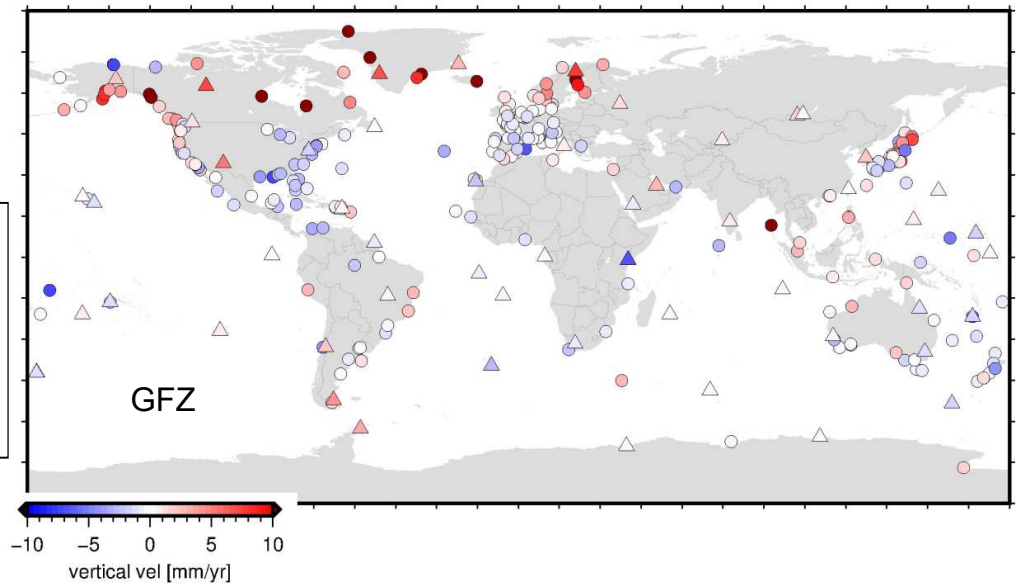
TIGA repro3 contribution



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

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



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Key Questions

TIGA - SONEL Levelling

www.sonel.org

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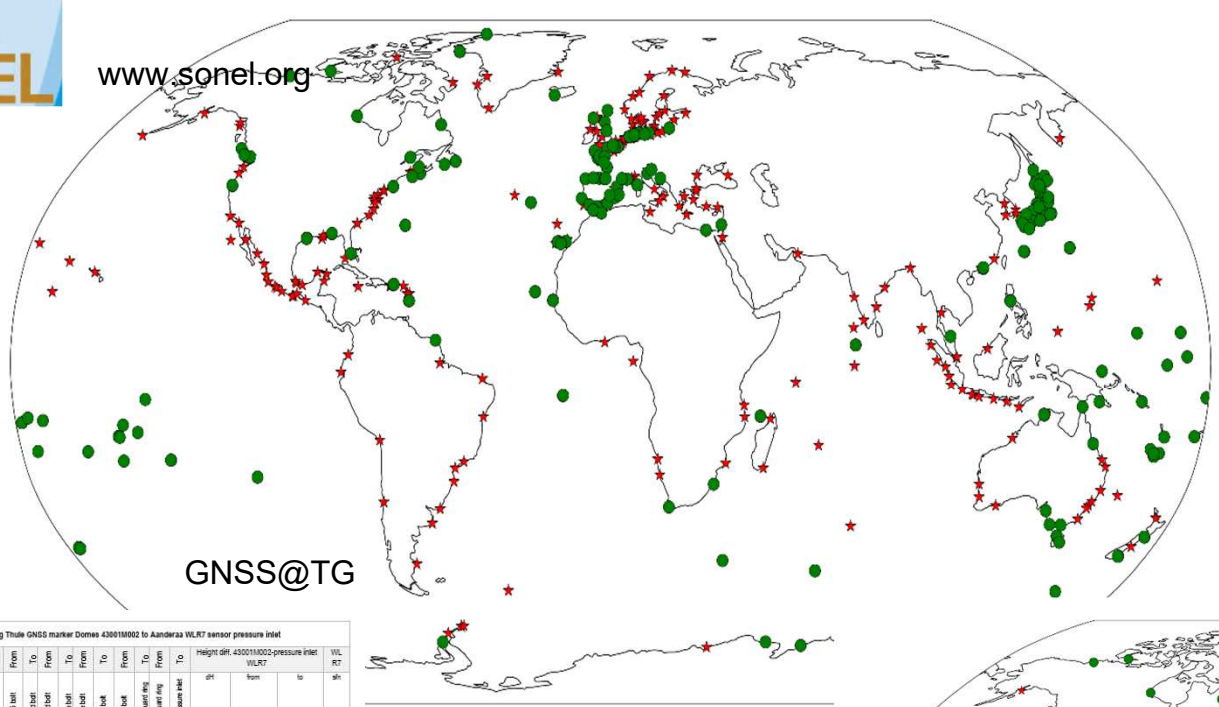


GNSS@TG

Precise levelling Thule GNSS marker Domes 43001M002 to Aanderaa WLR7 sensor pressure inlet

Year	Instrument	From Thn3 bolt	To Alt bolt	From Alt bolt	To Thn5 bolt	From Thn5 bolt	To Fund bolt	From Fund bolt	To Blue bolt	From Blue bolt	To Wt bolt	From Wt bolt	To WLR7 guard ring	From WLR guard ring	To WLR pressure inlet	Height diff. 43001M002-pressure inlet WLR7 dH	from	to	WLR7 sln
2013	TCA	-1,6711	-5,6712	-3,0980	-6,2260	-0,9506	-7,3672	-0,0850	-25,0691	2013/09/06	2014/09/15	1514							
2014	TCA	-1,6711	-5,6714	-3,0975	-6,2274	-0,9524	-7,3660	-0,0850	-25,0708	2014/09/15	2015/09/12	1514							
2015	TCA	-1,6711	-5,6714	-3,0979	-6,2257	-0,9536	-7,3656	-0,0850	-25,0703	2015/09/13	2015/10/02	1397							
2016	Wild T2	-1,6710	-5,6712	-3,0990	-6,2261	-0,9544	-7,3679	-0,0850	-25,0746	2016/07/01	2017/10/02	1397							
2017	TCA	-1,6710	-5,6703	-3,0981	-6,2268	-0,9557	-7,3679	-0,0850	-25,0748	2017/10/02	2018/09/25	1397							
2018	TCA	-1,6711	-5,6716	-3,0979	-6,2267	-0,9560	-7,3610	-0,0850	-25,0693	2018/09/26	2019/09/06	1514							
2019	TS16	-1,6715	-5,6722	-3,0981	-6,2264	-0,9575	-7,3568	-0,0850	-25,0675	2019/09/06	2020/09/04	1514							
2020	GNSS					-17,6239	-7,3560	-0,0850	-25,0649	2020/09/04		1514							

Table 2 Height differences in Thule [m]

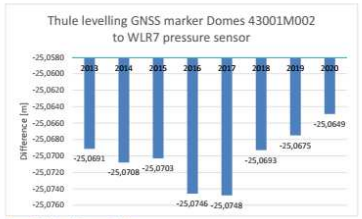
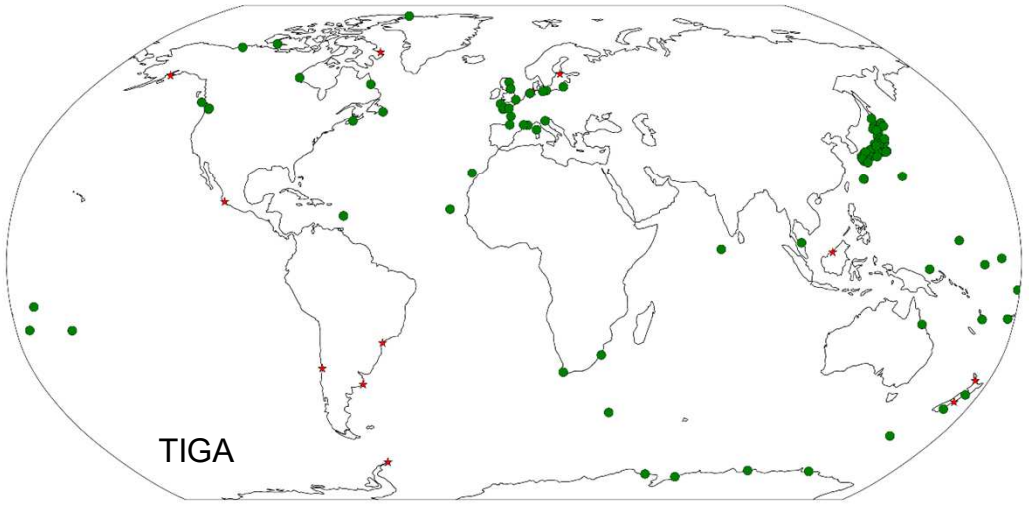


Figure 7 Height differences Thule

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.

★ No tie - GNSS@TG < 1km ● Tie

Finn Bo Madsen/DTU
Levelling info for Greenland ☺



TIGA

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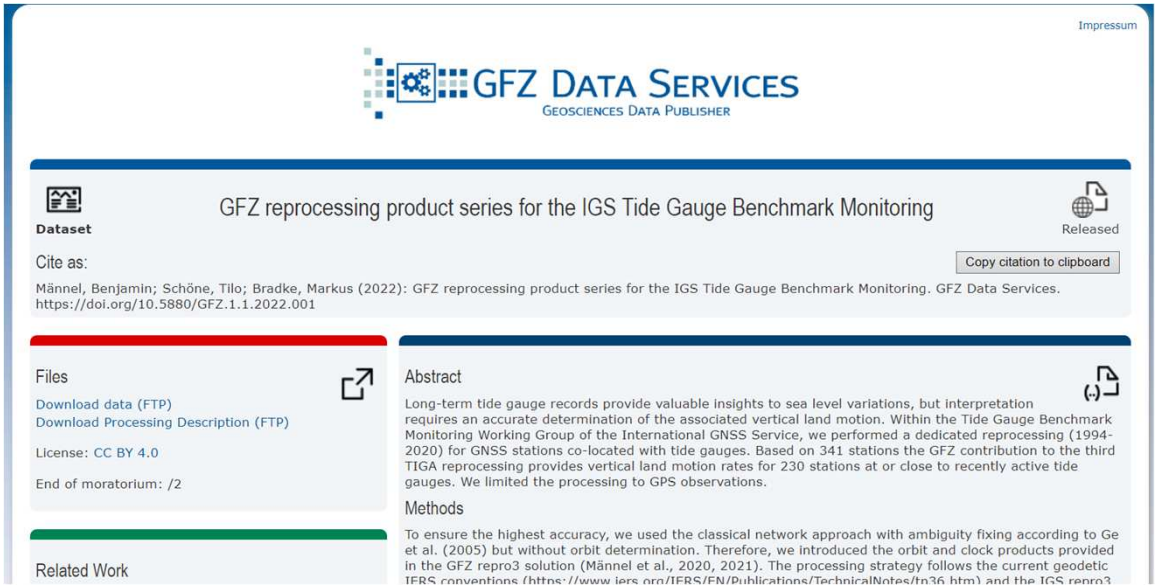
Key Questions

DOI

- GGOS Working Group **Digital Object Identifiers (DOIs) for Geodetic Data Sets**
  - https://ggos.org/about/org/co/dois-geodetic-data-sets/
- Also of value for TIGA solutions, e.g., https://doi.org/10.5880/GFZ.1.1.2022.001



- Should we consider also to apply DOI(s) for the Time Series available trough SONEL

TIGA-WG plan@2022

TIGA Working Group

- Integration of GFT & ULR solution in SONEL
- UoL repro3 solution based on CODE orbits & integration into SONEL
- Time Series Analysis at tide gauges
- Outreach to GLOSS-GE and sea level community
- Work towards more levelling ties
- How-to-tie: Manual for ***Tides, Water Level and Currents Working Group of IHO***

- Most GNSS@TG are legacy receiver of the TG community delivering GPS signals only

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Thank You!

Contact:

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Special thanks to UNAVCO for the help in the session

Working Group Members Review

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Minghai Jia		*GeoScience Australia*	*Australia*
Norman Teferle	TAC/TCC	University of Luxembourg	Luxembourg
Allison Craddock	IGS Central Bureau	ex officio	USA
Tom Herring	IGS AC coordinator(s)	ex officio	USA
Michael Moore			Australia
Carey Noll	***TDC***	*CDDIS, NASA*	*USA*
Tilo Schöne	Chair	GFZ Potsdam	Germany
Simon Williams	PSMSL	PSMSL, NOC Liverpool	UK
Gary Mitchum	GLOSS GE (current chair).	University of South Florida	USA
Mark Merrifield	*GLOSS GE (past chair)*	*UHSLC, Hawaii*	*USA*
Matt King		University of Tasmania	Australia
Benjamin Männel	TAC	GFZ Potsdam	Germany
Elizabeth Prouteau	TNC	University La Rochelle	France
Médéric Gravelle	TAC/TDC	University La Rochelle	France
Daniala Thaller		BKG	Germany

TIGA Membership