

IGS Component Summary Report December 2013

Component Name: Tide Gauge Benchmark Monitoring Working Group
 Chair: Tilo Schöne, GFZ Potsdam, Germany, tschoene@gfz-potsdam.de
 Chair term expires: 12/2014
 Report prepared by: Tilo Schöne, tschoene@gfz-potsdam.de

Has the membership changed in 2013? NO

Current Membership

Name	Entity	Host Institution	Country
Guy Wöppelmann	TAC, TNC, TDC	University La Rochelle	France
Laura Sánchez	TAC	DGFI Munich	Germany
Heinz Habrich	TAC	BGK, Frankfurt	Germany
Minghai Jia		GeoScience Australia	Australia
Paul Tregoning	TAC	ANU	Australia
Zhiguo Deng	TAC	GFZ Potsdam	Germany
Daniela Thaller	Combination	BKG Frankfurt	Germany
Norman Teferle	TAC/Combination	University of Luxembourg	Luxembourg
Richard Bingley	TAC	University of Nottingham	UK
Ruth Neilan	IGS Central Bureau	ex officio	USA
Jake Griffith	IGS AC coordinator	ex officio	USA
Carey Noll	TDC	CDDIS, NASA	USA
Tilo Schöne	Chair TIGA-WG	GFZ Potsdam	Germany
Philip Woodworth	PSMSL	PSMSL, NOC, Liverpool	UK
Gary Mitchum	GLOSS GE Chair	University of South Florida	USA
Mark Merrifield	GLOSS GE (past chair)	UHSLC, Hawaii	USA
Matt King		University of Tasmania	Australia

Was the Charter updated in 2013?

- Yes, 01.01.2013, (http://adsc.gfz-potsdam.de/tiga/Charter_TIGA.html)

Summary of Activities in 2013:

Key accomplishments at a high level

- IAG Talks (2) and Poster (2)
- Reporting to UNESCO/GLOSS Group of Experts about TIGA status, Network status, and data holdings
- Reprocessing of GNSS@TG data almost completed by four groups
- Contribution to IGS repro2
- Coordination with GGOS Theme 3
- Support to UNESCO/GLOSS activities

SONEL Data Center Development

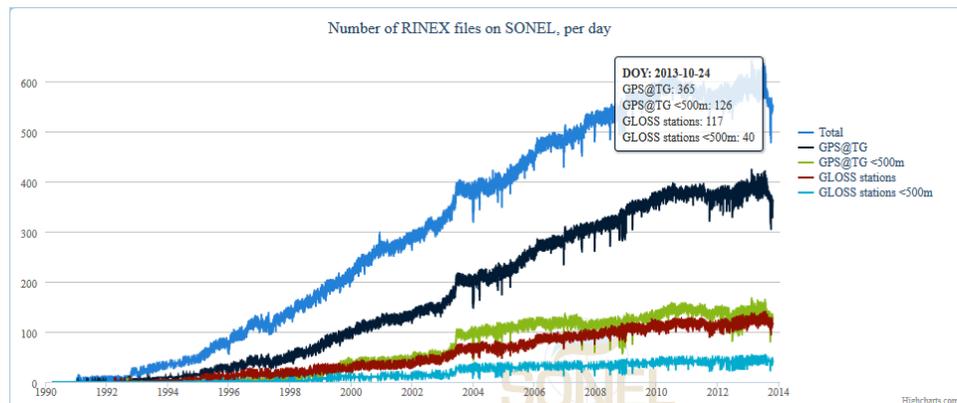
The SONEL data center (www.sonel.org) acts as a one-stop-shop for GNSS and tide gauge information related to TIGA and to GNSS@TG stations. Significant improvements have been achieved over the last year. Especially the meta data, have been significantly improved. Frequent data updates and meta data exchange with TIGA Data Center at CDDIS and tide gauge data centers (PSMSL, GLOSS) ensures up-to-date information.



Network Management

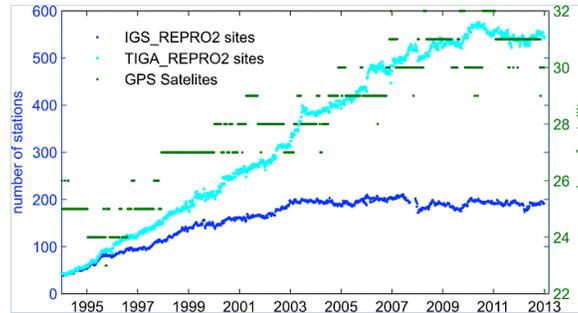
As an ongoing task, SONEL in cooperation with TIGA identifies potential new TIGA stations and encourages and assists station manager to participate. In addition, stations with data outages and/or significant data gaps are identified. Station operators are contacted to get data access.

SONEL is recognized as the GNSS and TIGA data center for UNESCO/GLOSS/IOC.



TIGA Reprocessing:

Four (4) groups are currently reprocessing TIGA and GNSS@TG data. Results can be expected by end of 2013. Two groups will contribute to IGS repro2. Nearly 800 stations are processed. In peak times, e.g. GFZ (see figure) processes up to 794 stations, 580 of them near tide gauges, numbers are similar for the other groups.

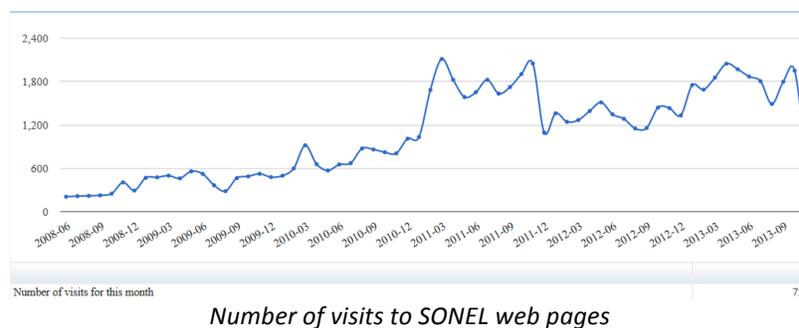


New products introduced or improvements to existing products

- Update to the IOC Sea Level Catalog (<http://www.ioc-sealevelmonitoring.org/ssc/>)
- Increase of number of available GNSS at Tide gauge station data (RINEX) and improved coverage of data holdings (data archeology)
- SONEL Data and Information Center, with e.g., tools for GNSS data management, inventory of GNSS@TideGauges, and meta data.
 - o www.sonel.org

User access and availability/outage statistics

SONEL has a constant high access to the TIGA DC web pages.



Total number of visits	19988
Number of visitors	14894
Number of viewed pages	51272
Average number of viewed pages by visit	2.57

Number of visits since 7.12.2012

(<http://www.sonel.org/-Statistiques-d-acces-.html?lang=en>)

Any problems that impacted the availability of products

- TIGA Analysis Center Issues: EUREF Reprocessing is delayed, it is unlikely, that EUREF will contribute to TIGA reprocessing
- TIGA Combination center(s): Daniela Thaller left AIUB. AIUB currently does not have the capability to provide a Bernese-based combination. Discussion with BKG ongoing.

Standards supported or maintained

In November 2013 TIGA WG was tasked to update the UNESCO GLOSS Sea Level Manual Section of GNSS installations. In addition the TIGA Working Group, with its TIGA data center and TIGA network coordinator, interacts with the GLOSS data center and maintains the repository of metadata, data and leveling information for all GNSS@TGs, including the TIGA observing stations and the GLOSS core network stations.

Meetings participated in or organized

- Invited presentation about TIGA status during the IAG 150 Anniversary General Assembly. Several posters
- ESA/ESTEC Meeting GOCE+ HSU - Height System Unification with GOCE
<http://www.goceplushsu.eu/gpweb/gc-cont.php?p=56>
- GLOSS GE Reporting about TIGA status (Schöne) and SONEL Repository (Wöppelmann, Prouteau)
http://ioc-unesco.org/components/com_oe/oe.php?task=viewDocFilesPopup&docID=12010
http://ioc-unesco.org/components/com_oe/oe.php?task=viewDocFilesPopup&docID=12007
http://ioc-unesco.org/index.php?option=com_oe&task=viewDocumentRecord&docID=11937

Publications

- King, M.A., M. Keshin, P.L. Whitehouse, I.D. Thomas, G.A. Milne and R.E.M. Riva: Regional biases in absolute sea level estimates from tide gauge data due to residual unmodeled vertical land movement. *Geophysical Research Letters*, 39: L14604
doi:10.1029/2012GL052348.
- Schöne, T., R. Bingley, Z. Deng, J. Griffiths, H. Habrich, A. Hunegnaw, M. Jia, M. King, M. Merrifield, G. Mitchum, R. Neilan, C. Noll, E. Prouteau, L. Sánchez, N. Teferle, D. Thaller, P. Tregoning, P. Woodworth, G. Wöppelmann: The Tide Gauge Benchmark Monitoring Project, in Dach and Jean (eds.): *Technical Report 2012*, International GNSS Service, pp. 189-194, University of Berne,
ftp://igs.org/pub/resource/pubs/2012_techreport.pdf
- Schöne, T.: GNSS at Tide Gauges, German Climate Observing Systems. Inventory report on the Global Climate Observing System (GCOS). Self-published by DWD, Offenbach a. M., 130 pages.
- Rudenko, S.; Schön, N.; Uhlemann, M.; Gendt, G.: Reprocessed height time series for GPS stations. *Solid Earth*, 4, 1, 23-41, 2013
- Olivares, G. and F.N. Teferle, A Bayesian Monte Carlo Markov Chain Method for Parameter Estimation of Fractional Differenced Gaussian Processes. *IEEE Transactions on Signal Processing*, 2013. 61(9): p. 2405-2412.
- Sánchez L.: Towards a vertical datum standardisation under the umbrella of Global Geodetic Observing System. *Journal of Geodetic Science*, 2(4): 325-342, DOI:10.2478/v10156-012-0002-x, 2013
- Santamaría-Gómez, A., Bouin, M-N., Collilieux, X., Wöppelmann, G.: Time-Correlated GPS Noise Dependency on Data Time Period. *International Association of Geodesy Symposia*, Volume 138, Pages 119-124. 2013
- Santamaría-Gómez, A., Bouin, M-N., Wöppelmann, G.: Improved GPS data analysis strategy for tide gauge benchmark monitoring. *International Association of Geodesy Symposia*, Volume 136, 2012, Pages 11-18. 2012

Poster presentations

- Deng, Z., G. Gendt, T. Schöne: Status of the tide Gauge data reprocessing at GFZ, International Association of Geodesy Scientific Assembly, 150th Anniversary of the IAG, Potsdam, 1.-6. Sep.2013

Gravelle, M., A. Santamaria-Gomez, M. Guichard, E. Prouteau, P. Tiphaneau, G. Wöppelmann: Statistics on the dedicated GPS at tide gauge reanalysis of ULR for 1994-2012; European Geosciences Union (EGU) 2013, Vienna, Austria; April 19, 2013.

Hunegnaw, A., F.N. Teferle, R.M. Bingley, and D.N. Hansen, Status of Reprocessing and Combinations of TIGA Analysis Center Solutions at BLT, in IAG Scientific Assembly 2013, IAG 150 Years, 1-6 September, Potsdam, Germany, 2013.

Illigner, J., I. Sofian, H.Z. Abidin, T. Schöne: Coastal Sea Level Monitoring in Indonesia – A multi-purpose network, International Association of Geodesy Scientific Assembly, 150th Anniversary of the IAG, Potsdam, 1.-6. Sep.2013

Olivares, G. and F.N. Teferle, A Bayesian Monte Carlo Markov Chain Method for the Statistical Analysis of Geodetic Time Series, in IAG Scientific Assembly 2013, IAG 150 Years, 1-6 September, Potsdam, Germany, 2013.

Prouteau, E., M. Gravelle, M. Guichard, G. Wöppelmann: GNSS@TG from SONEL: GLOSS Core Network status overview; PSMSL 80th anniversary workshop & XIIIth GLOSS GE 2013, Liverpool, UK, October 28-November 1, 2013.

Teferle, F.N., A. Hunegnaw, F. Ahmed, D. Sidorov, S.D.P. Williams, P.R. Foden, and P.L. Woodworth, Potential Contributions to Geoscience from GNSS Observations of the King Edward Point Geodetic Observatory, South Georgia, South Atlantic Ocean, IAG Scientific Assembly 2013, IAG 150 Years, 1-6 September, Potsdam, Germany, 2013.

Teferle, F.N., A. Hunegnaw, F. Ahmed, P.L. Woodworth, P.R. Foden, and S.D.P. Williams, The King Edward Point Geodetic Observatory in Support of Sea Level Research, PSMSL 80th Anniversary Workshop on Sea Level Science, 28-29 October, Liverpool, UK, 2013.

Teferle, F.N., S.W. White, P.R. Foden, R. Strachan, L.P. Whittamore, P.L. Woodworth, S.D.P. Williams, A. Hunegnaw, and F. Ahmed, Installation and First Evaluation of the King Edward Point Geodetic Observatory, South Georgia, in The Scotia Arc: Geodynamic Evolution and Global Implications, 14-15 May, Granada, Spain, 2013.

2014 Plan

- Finish TIGA reprocessing with 4 contributions, develop and evaluate a TIGA combined products
- Provide a product to the user community based on the most recent reprocessing, with
 - o mean rate per TOS with reliable error estimate
 - o time series of the weekly vertical coordinates with scaled formal errors
- Work with GLOSS on the improvement of the GLOSS/GCOS network situation
- Maintain and expand the current inventory of GNSS @ TG stations at www.sonel.org
- Encourage station operators through GLOSS to provide regular leveling between benchmarks
- Develop with GLOSS formalisms for documentation of leveling information
- Setup a data base for station discontinuities (IGS SINEX discontinuity file for non-IGS TIGA stations)
- Support GGOS, in particular Theme 1 (“WHS”) and Theme 3 (“Sea Level”)
- Work with the altimetry community to provide a data set for tide gauge calibration sites

CHARTER Tide Gauge Benchmark Monitoring - Working Group

Sea level change is of great concern. For decades to centuries the sea level has been measured using tide gauges. However, gauges only constitute a local datum, affected not only by climate but also by local land changes. Space geodetic techniques are the only viable tool to establish the necessary global reference frame for constraining sea level records to a common global datum. Providing this frame facilitates the distinction between the relative and absolute sea level changes by accounting for the vertical uplift of the station, and is, therefore, an important contribution to climate changes studies.

The IGS Tide Gauge Benchmark Monitoring - Working Group (TIGA-WG) is providing the service to analyze GNSS data from stations directly at or near tide gauges (TG) on a preferably continuous basis. TIGA is recognized by the Global Sea Level Observing System (GLOSS) to provide position and vertical rates for GLOSS tide gauges and is an important contribution of the IGS to the goals of the Global Geodetic Observing System (GGOS), the Global Climate Observing System (GCOS) and the World Climate Research Programme (WCRP).

The primary product of TIGA is weekly sets of coordinates, velocities, and accuracy estimates for monitoring vertical motions of Tide Gauge Benchmarks (TGBM). The product is made public to support and encourage other applications, e.g. sea level studies. The service may further contribute to the calibration of satellite altimeters, other oceanographic applications or the establishment of a World Height System.

Goals and Objectives

1. Maintain a global virtual continuous GNSS @ TG network
 - Select a set of tide gauges equipped with GNSS, with a long and reliable history, useful for both sea level change studies, and e.g. satellite altimeter calibrations. IGS network operation standards should be applied.
 - Promote the establishment of more continuous operating GNSS stations, in particular in the southern hemisphere.
 - Promote the establishment of local ties (leveling) between GNSS and TGBMs.
 - Provide meta information, e.g. on leveling between benchmarks or data access.
 - Provide training to tide gauge operators through workshops, encourage station operators to provide necessary metadata. Through GLOSS advice station operators about the operation of continuous GNSS @ TG stations.
2. 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. Provide a combined solution as the TIGA official product.
3. Study the impacts of corrections and new models on the GNSS processing of the vertical. Encourage other groups to establish, e.g. nearby absolute gravity sites.
4. Provide advice to new applications.

Organizational Structure

The Working Group is utilizing the existing infrastructure of the IGS as much as possible without disrupting standard activities. The processing of GNSS data is performed outside the IGS operational activities, but

may be carried out by existing IGS AC's. A number of TIGA Analysis Centers (TAC) provides weekly solutions using the IGS processing standards. The TIGA network will additionally include non-IGS stations (TIGA Observing Stations, TOS) meeting the IGS network requirements and are collocated with the tide gauges. The time lag for providing GNSS data will be less stringent compared to standard IGS operations, to allow also remote stations to participate. IGS, other IAG Services or Groups, GLOSS and the PSMSL may propose and advice on the inclusion of additional TOS stations. The TIGA Product will be generated by TIGA Combination Centers (TCC). The network maintenance and interaction with TOS operators is supported by the TIGA Network Coordinator (TNC), closely related to the support of the TIGA Data Centers (TDC).

Current Membership:

- Ruth Neilan, IGS Central Bureau, Director (ex officio)
- Jake Griffith, AC coordinator (ex officio)
- Tilo Schöne (Deutsches GeoForschungsZentrum, Germany) (chair of TIGA-WG)
- Philip Woodworth (PSMSL, UK)
- Gary Mitchum (University of South Florida, USA) (Chair GLOSS Group of Experts)
- Mark Merrifield (UHSLC, USA)
- Heinz Habrich (Bundesamt für Kartographie und Geodäsie, Germany (Analysis Coordinator of EUREF Permanent Network)) [TAC ETG]
- Laura Sánchez (Deutsches Geodätisches Forschungsinstitut, Germany) [TAC DGF]
- Guy Wöppelmann (University La Rochelle, France) [TAC ULR, TDC]
- Carey Noll (CDDIS NASA, USA) [TDC]
- Zhiguo Deng (Deutsches GeoForschungsZentrum, Germany) [TAC GFT]
- Daniela Thaller (University of Bern, Switzerland) [TCC]
- Richard Bingley (University of Nottingham, UK) [TAC BLT]
- Norman Teferle (University of Luxembourg, Luxembourg) [TAC BLT]
- Elizabeth Prouteau (University La Rochelle, France) [TNC]
- Addisu Hunegnaw (University of Luxembourg, Luxembourg) [TCC]
- Paul Tregoning (Australian National University, Australia)
- Minghai Jia (Geoscience Australia, Australia)
- Matt King (University of Tasmania, Australia)

Workplan 2013-2014

- Provide a product based on the most recent reprocessing, with
 - mean rate per TOS with reliable error estimate
 - time series of the vertical with scaled formal errors
 - full SINEX combined product
- Work with GLOSS on the improvement of the network situation
- Maintain and expand the current inventory of GNSS @ TG stations at www.sonel.org
- Encourage station operators through GLOSS to provide regular leveling between benchmarks
- Develop with GLOSS formalisms for documentation of leveling information
- Setup a data base for station discontinuities (IGS SINEX discontinuity file for non-IGS TIGA stations)
- Study the effect of applying atmospheric loading correction to GNSS on the measurement level in the tide gauge / sea level context
- Support GGOS, in particular Theme 1 ("WHS") and Theme 3 ("Sea Level")
- Work with the altimetry community to provide a data set for tide gauge calibration sites
- Contribute to the IERS Working Group on Site Coordinate Time Series Format