**Intergovernmental Oceanographic Commission**

*Reports of Meetings of Experts and Equivalent Bodies*

**IOC Group of Experts on the  
Global Sea Level Observing System (GLOSS)**

Eighteenth Session, Panama City, Panama

11 - 14 March 2025

**GOOS Report No. XXX**

**GCOS Report No. XXX**

**UNESCO**

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***ABSTRACT***

This report presents a summary of the topics discussed at the Eighteenth Session of the Group of Experts for the Global Sea Level Observing System (GLOSS-GE). The Group of Experts evaluated the status of the GLOSS network and programmatic activities since the last meeting of the group in 2022 (GE-GLOSS-XVII) and discussed future developments, including the updating of the GLOSS Implementation Plan, 2012.

The Group reviewed reports of the GLOSS of Data Centres and established new Working Groups and Task Teams. It tasked the GLOSS-GE Steering Committee to develop a new Implementation Plan.

Several regional and national reports were presented and reviewed. Finally, the Group reviewed present links between GLOSS and other relevant programmes and identified its own intersessional activities for 2025–2027.

Since its inception in 1988, GLOSS has provided oversight and coordination for the global and regional sea level network in support of scientific research and early warning systems. This also includes the study of vertical ground motion near tide gauges through baseline monitoring and continuous GNSS measurements.



***Note****: this report is published in electronic copy only and is available on UNESDOC, the documents database of UNESCO (*[*http://unesdoc.unesco.org*](http://unesdoc.unesco.org)*)*

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# Executive Summary / Resumen Ejecutivo

The Eighteenth Meeting of the Group of Experts on the Global Sea Level Observing System (GLOSS-GE) was held at the Radisson Panama Canal Hotel in Panama from March 11 to 14, 2025, with the support of the Panama Canal Authority and the Panama Maritime Authority.

More than 40 in-person experts and approximately 15 online participants from 30 Member States (Argentina, Belgium, Chile, Colombia, Costa Rica, Cuba, Denmark, Dominican Republic, Ecuador, Egypt, France, Germany, Guatemala, India, Ireland, Japan, Mauritius, Morocco, Nicaragua, Norway, Panama, Peru, Qatar, the Russian Federation, South Korea, Spain, the United Kingdom, the United States, Uruguay and Venezuela).

**The Group reviewed** GLOSS manuals and best practices. The group also discussed the need for a working group to review existing manuals and best practices, the creation of best practice guidelines for tidal analysis, and the establishment of a data archaeology working group.

**Additionally,** updates were provided on the University of Hawaii Sea Level Center's data management activities and the IOC Sea Level Station Monitoring Facility's real-time data portal.

**The Group** **elected** Dr (Ms) Begoña Perez (Spain) as the new chair of GLOSS-GE.

**Resumen Ejecutivo**

La Decimoctava Reunión del Grupo de Expertos sobre el Sistema Global de Observación del Nivel del Mar (GLOSS) se celebro en el Hotel Radisson Panama Canal en Panamá del 11 al 14 de marzo de 2025, con el apoyo de la Autoridad del Canal de Panama y de la Autoridad Marítima de Panama.

Participaron mas de 40 expertos presenciales y alrededor de 15 participantes en línea, de 30 estados miembros (Alemania, Argentina, Bélgica, Chile, Colombia, Corea del Sur, Costa Rica, Cuba, Dinamarca, Ecuador, Egipto, España, Estados Unidos, Federación de Rusia, Francia, Guatemala, India, Irlanda, Japon, Marruecos, Mauricio, Nicaragua, Noruega, Panama, Peru, Qatar, Reino Unido, República Dominicana, Uruguay, Venezuela).

**El Grupo revisó** los manuales y las mejores prácticas de GLOSS. También debatió la necesidad de un grupo de trabajo para revisar los manuales y las mejores prácticas existentes, la creación de directrices sobre buenas prácticas para el análisis de mareas y el establecimiento de un grupo de trabajo sobre arqueología de datos.

**Además**, se actualizaron las actividades de gestión de datos del Centro de Nivel del Mar de la Universidad de Hawái y el portal de datos en tiempo real de la Estación de Monitoreo del Nivel del Mar de la COI.

**El Grupo eligió** a la Dra. Begoña Pérez (España) como nueva presidenta de GLOSS-GE.

# ORGANIZATION OF THE SESSION

## OPENING OF THE SESSION

1. The Eigthteen session of the Global Sea Level Observing System Group of Experts (GLOSS-GE) was opened by Eng. (Mr.) Arnulfo Sanchez, Chief of Environment Division, Panama Maritime Authority. He emphasized the importance of sea level monitoring for operational maritime activities as well as for long terms studies on sea level variability and maritime planning. He welcomed all participants on behalf of the Government of Panama and declared the session open.
2. The Chairperson, Dr Gary Mitchum sent a video recorded message expressesing gratitude to Panama for hosting the meeting and apologized for not attending due to last-minute unforeseen circumstances. He noted that a key agenda item is the election of the new GLOSS chair. Dr Mitchum informed that only one nomination was received—from Spain’s Dr Begona Perez, a seasoned expert in tide gauges and sea level. Dr Mitchum endorsed her candidature strongly and handed over the floor over to her, wishing everyone a successful and enjoyable meeting.
3. The meeting began therefore with the election by acclamation of [Dr (Ms) Begona Perez (Spain)](https://oceanexpert.org/downloadFile/58301) as the new chair of GLOSS-GE for a 2-year renewable term. After her acceptance speech highlighting the importance of sea level monitoring and thanking previous chair Dr Gary Michun, the meeting continued with a round of introductions from the 55 participants (40 on-site and 15 online), representing various oceanographic institutions and national tide gauge networks from around the world.

## PRACTICAL ARRANGEMENTS

1. The Technical Secretary, Mr Bernardo Aliaga, provided an overview of logistic details for the meeting. The meeting included a visit to the Panama Canal Visitor Center at the Atlantic entracnce. All documents and presentations delivered at this meeting are available from the following website: <https://oceanexpert.org/event/4663> .

## ADOPTION OF THE AGENDA AND TIMETABLE

1. The agenda was adopted as given in Annex I, avalbale also as Annex I of [Circular Letter 3022](https://oceanexpert.org/document/35457).

# REVIEW OF PROGRESS ON ACTIONS FROM GE-XVII

## REVIEW OF GLOSS MANUALS

1. The group discussed the review of [GLOSS manuals](https://oceanexpert.org/doclist/235) and best practices.
2. Andrew Matthews (Permanent Service for Mean Sea Level, PSMLS) presented the history of GLOSS manuals from the 1980s to the most recent 2016 version covering radar sensors (*Manual on Sea-level Measurements and Interpretation, Volume V: Radar Gauges*. [IOC Manuals and Guides No.14, vol. V](https://unesdoc.unesco.org/ark:/48223/pf0000246981.locale=en)) and quality control (Q*uality Control of in situ Sea Level Observations: A Review and Progress towards Automated Quality Control*, Vol. 1. [IOC Manuals and Guides No.83](https://unesdoc.unesco.org/ark:/48223/pf0000373566.locale=en)). The discussion identified several needs: updating manuals for new technologies like AI in quality control, addressing data archaeology processes, handling ancillary meteorological measurements at tide gauges, and potentially developing unified software tools for data processing. Fernando Oreiro (Argentina) suggested creating a common software repository, while Phil Thompson (University of Hawai Sea Level Center, UHSLC) noted that meteorological best practices should be left to WMO. Professor Hamouda (Egypt) emphasized the need for standardized equipment documentation and evaluation of existing infrastructure, particularly in developing countries. The group also discussed the need for guidelines on data management and distribution. A separate working group was proposed to address quality control and processing software. The conversation ended with an update on the work on IOC best practices that has been under development.
3. **The group agreed** to form a working group to identify and propose new manuals to be developed, and include them in the Implementation Plan.

## IAPSO CMSLT BEST PRACTICES

1. Mr Andrew Matthews (PSMSL) updated the group with a [presentation](https://oceanexpert.org/downloadFile/58336) on the IAPSO's initiative to create best practice guidelines for tidal analysis, which aims to provide practical guidance for the scientific community. He noted that a meeting funded by IAPSO was held in late 2023 where the group has produced initial documentation including recommended constituent sets for different data lengths and a list of available software packages in various programming languages. The document covers practical challenges such as overfitting, analyzing shallow estuaries, and dealing with nodal cycles. The group seeks additional contributions on topics including satellite data analysis, non-classical analysis techniques, AI methods, and examples of challenging tidal records to analyze.

## DATA ARCHEOLOGY

1. Mr Laurent Testut (France) [presented](https://oceanexpert.org/downloadFile/58336) on the The GLOSS Data Archaeology Working Group (DAWG) which was officially created in November 2022 during GLOSS XVII in Paris. Its mission is to rescue and preserve historical sea level data, including digitizing old tidal charts and ledgers. Mr Testut presented the group's activities, which began with a kickoff online meeting held in July 2024 with 16 participants from France, UK, Spain, US, Italy, Sweden, Netherlands, Norway, Australia. The DAWG is open to anyone interested in contributing. The group aims to establish country contacts, document best practices, and create an inventory of historical data. Key challenges discussed include data quality assessment, standardization of vertical leveling references, and proper handling of metadata. Elizabeth Bradshaw (UK, PSMSL) mentionned existing resources through Copernicus and PSMSL for data rescue projects. The immediate action item is to establish a comprehensive contact list of interested parties per country, with IOC's help in reaching out to Member States not currently participating.

# REPORT OF GLOSS DATA CENTERS

1. Mr Phil Thompson, director of the UHSLC and associate professor in the Department of Oceanography, [presented](https://oceanexpert.org/downloadFile/58338) on the UHSLC Data Management and Updates. He noted that the center maintains two main data streams: research quality data (JASL) with one-year latency with QC including vertical stability, timing, and station metadata, contributing to PSMSL and GESLA-3 (97 of 114 countries) and and fast delivery with data one-month latency, Quality control (QC) focused on outlier detection and primarily for the GLOSS Core Network. JASL Archive Update (as of Dec 2024 the JASL Archive Metadata format changed from. dmt to machine-readable yaml and contains a total of 19,405 station-years from 691 series, with a GOSS subset:of 10,880 station-years from 254 sites.
2. UHSLC is working on modernizing their database infrastructure by migrating from ASCII to PostgreSQL (with TimescaleDB), which supports complex metadata and time series relationships. The center has added 928 station years from 157 different series since 2020, with recent updates focusing on stations in the US, Japan, Australia, and Malaysia. They are developing new tools for station monitoring and working to improve data access through ERDDAP servers. Mr Thompson presentation also highlighted increasing usage of their data, demonstrated by growing citation metrics.

Mr Andrew Matthews (PSMSL) updated the group with a [presentation](https://oceanexpert.org/downloadFile/58325) on the PSMSL which is s the global data center for long-term mean sea level data, active since 1933. Hosted by the UK’s National Oceanography Centre (NOC) and supported by the British Oceanographic Data Centre (BODC), PSMSL is a key contributor to GLOSS, IAG, IAPSO, and GGOS. Mr Matthews noted that PSMSL continues to acquire, quality control, and distribute mean sea level data, with gaps remaining in Arctic, Antarctic, Africa, and South America, especially for long-term records. From 2018–2022, PSMSL data was cited in 451 papers across 182 journals, including Nature and Geophysical Research Letters.

PSMSL hosts a growing repository of GNSS-IR sea level data (now ~350 sites). Wityh a dedicated portal: psmsl.org/data/gnssir that includes Python notebooks and metadata for programmatic access. BODC has modernized quality control software for UK tide gauge data, developed ERDDAP dashboards for real-time coastal flood monitoring and is working with PSMSL to align metadata with the upcoming GLOSS ERDDAP server.

Mr Matthews shared the initiative on Data Rescue & Citizen Science which obtained Quality-controlled historical data (1853–1903) from Liverpool Bay via Zooniverse volunteers, and was used to validate a 1902 storm surge reanalysis.

He reported that future plans of PSMSL include Future Plans: finalize ERDDAP data delivery for PSMSL and BODC, improve metadata lineage and use of permanent identifiers, expand GNSS-IR applications (e.g., near real-time, wave height) and continue historical data recovery efforts.

Mr Bart Vanhoorne and Mr Stijn Vermaere (Flanders Marine Institute VLIZ) [presented](https://oceanexpert.org/downloadFile/58339) on the IOC Sea Level Station Monitoring Facility (SLSMF) operated for IOC as part of the GLOSS program. They noted that the SLSMFcollects real-time sea level data from 1,257 stations operated by 179 institutes worldwide. The SLSMF collects data via GTS, FTP, HTTP, and BGAN, data is parsed and inserted into a central VLIZ database every minute. SLSMF delivers real-time operational status, raw data stream visualization, metadata management, Web services and APIs and a Sea Level Station Catalogue (SSC). The system includes several new features: automated quality control of data, a new API with expanded functionality launching on March 21st, 2025, and integration of DART buoy data for tsunami detection. Key developments include a daily quality control dataset that flags potentially problematic data, though this may filter out legitimate extreme events like tsunamis. The facility is working on metadata versioning, infrastructure updates, and a unified station page oriented around catalog identifiers. Discussion highlighted challenges around data transmission methods, gap management, and sensor offset handling.

Guy Wöppelmann (University of La Rochelle, France) [presented](https://oceanexpert.org/downloadFile/58363) a report of the Système d'Observation du Niveau des Eaux Littorales (SONEL). SONEL is the GLOSS Data Assembly Centre for GNSS@Tide Gauges (TG). It collects, processes, and distributes GNSS data co-located with tide gauges to monitor vertical land motion (VLM) and improve absolute sea level (ASL) measurements. Mr Wöppelmann provided an overview of GNSS (Global Navigation Satellite System) stations and their relationship with tide gauges in the GLOSS network. He explained that while there are over 1,300 stations from 150 agencies across 60 countries, only 15% of GLOSS core stations are strictly co-located with GNSS antennas, though 60% have stations within 15 kilometers. Mr Wöppelmann emphasized that distance between GNSS antennas and tide gauges is a crucial factor, as local vertical motion may not be uniform over distance. However, distance is a poor proxy for VLM accuracy—because local conditions (e.g., pier stability) can cause significant variation even within 100 m. He recommended agencies to install their own GNSS stations at tide gauges rather than relying on distant ones.

SONEL provides open access to raw GNSS data and derived products (e.g., velocities, follows IGS standards for geophysical modeling and corrections and supports InSAR integration and GNSS-Reflectometry (GNSS-R) for future tide gauge technologies. Mr Wöppelmann concluded by discussing future plans, including developing a new web portal, expanding data server capacity, and updating GNSS products more frequently through the Copernicus project.

# STATUS OF GLOSS CORE NETWORK

1. Mr Andrew Matthews (PSMSL) updated the group with the group with a [presentation](https://oceanexpert.org/downloadFile/58320) showing the status of GLOSS stations across different data centers. The GLOSS Core Network (GCN) was initially defined in 1990 with 307 sites. It has been periodically updated, with the latest additions made in 2019. The network currently has 294 sites, with 107 sites providing data to all streams and 84 having GNSS data. The latest list of GCN stations is available from the [GLOSS Implementation Plan](GLOSS%20Implementation%20Plan) 2012, plus 4 sites on Pacific islands added in GE XVI (Busan, 2019). The status of the network is monitored via PSMSL.org. The analysis focuses on whether a site is installed and providing data to any data center, not necessarily in real-time. The last date of data submission to each center is used to assess activity. A best guess based on data since 2018 is a s follows:

* No installation ever: 6 sites
* No current installation: 52 sites
* Not quality controlled: 34 sites (only in VLIZ / UHSLC Fast)
* Not datum controlled: 8 sites (in PSMSL, but not RLR)
* Missing from one or more data centres: 87 sites
* Working: 107 sites (84 have GNSS too)

1. The group then discussed next steps for the GCN based on Mr Matthews presentation. Key action items include data centers double-checking their information to understand why some stations are not being updated, and potentially redefining network requirements as part of the Implementation Plan. The group clarified that while the GCN is a fixed set of stations defined in the implementation plan, any station meeting GLOSS standards can receive a GLOSS ID and contribute data even if not part of the core network.

# NATIONAL SEA LEVEL ACTIVITIES - PRESENTATION OF A SELECT SET OF NATIONAL REPORTS

1. Written national reports were delivered by [Argentina](https://oceanexpert.org/downloadFile/58303), [Australia](https://oceanexpert.org/downloadFile/58385), [Chile](https://oceanexpert.org/downloadFile/58326), [Cuba](https://oceanexpert.org/downloadFile/58359), [Denmark](https://oceanexpert.org/downloadFile/58361) [Ecuador](https://oceanexpert.org/downloadFile/58311), [Egypt](https://oceanexpert.org/downloadFile/58390), [France](https://oceanexpert.org/downloadFile/58226), [Germany](https://oceanexpert.org/downloadFile/58324), [India](https://oceanexpert.org/downloadFile/58317), [Japan](https://oceanexpert.org/downloadFile/58307), [Kenya](https://oceanexpert.org/downloadFile/58328), [Morocco](https://oceanexpert.org/downloadFile/58308), [Norway](https://oceanexpert.org/downloadFile/58318), [Panama](https://oceanexpert.org/downloadFile/58358), [Peru](https://oceanexpert.org/downloadFile/58331), [Russian Federation](https://oceanexpert.org/downloadFile/58306), [Spain](https://oceanexpert.org/downloadFile/58314), [Sweeden](https://oceanexpert.org/downloadFile/57971), [United Kindom](https://oceanexpert.org/downloadFile/58315) and [United States](https://oceanexpert.org/downloadFile/58330). Powerpoint presentations were delivered by [Argentina](https://oceanexpert.org/downloadFile/60101), [Chile](https://oceanexpert.org/downloadFile/60102), [China](https://oceanexpert.org/downloadFile/58316), [Denmark](https://oceanexpert.org/downloadFile/58385), [Dominican Republic](https://oceanexpert.org/downloadFile/58395), [Egypt](https://oceanexpert.org/downloadFile/58392), [France](https://oceanexpert.org/downloadFile/58397), [Germany](https://oceanexpert.org/downloadFile/58343), [India](https://oceanexpert.org/downloadFile/58396), [Ireland](https://oceanexpert.org/downloadFile/58387), [Japan](https://oceanexpert.org/downloadFile/58344), [Morocco](https://oceanexpert.org/downloadFile/58345), [Norway](https://oceanexpert.org/downloadFile/60103), [Russian Federation](https://oceanexpert.org/downloadFile/58346), [Spain](https://oceanexpert.org/downloadFile/58364), [Sweeden](https://oceanexpert.org/downloadFile/58391) and [United Kingdom](https://oceanexpert.org/downloadFile/58347).
2. China reports 70 tide stations with 6 GLOSS core stations, showing accelerated sea level rise along their coast. Denmark operates 80 tide gauges with 8 co-located GNSS stations, while in Greenland they are testing GNSS reflectometry as an alternative to traditional tide gauges due to challenges with sea ice. Egypt emphasizes urgent concerns about sea level rise impacts on the Nile Delta, reporting a 5cm per year increase over the last decade. Germany maintains about 160 stations along the North Sea coast and has discovered historical tide gauge data from the 1940s from various European countries. Ireland operates 19 active tide gauge stations with real-time data sharing capabilities, including three GLOSS stations, and has recently experienced significant storm surges, particularly during Storm Aeon in January.
3. Japan Meteorological Agency manages 70 tide gauge stations and uses radio wave type tsunami meters, with data collected through a satellite system and shared with 5-minute latency. Morocco monitors sea levels through two bodies (Meteorological Agency and Harbors Authority) and recently recorded storm surges in Casablanca and tsunami effects from the 2023 Turkey earthquake. The Norwegian Mapping Authority operates 25 tide gauge stations including 5 GLOSS stations, has installed 4 new radar gauge stations since the last meeting, and is conducting a comparative study of different sensor types. Russia reports maintaining 180 active tide gauge stations across 13 seas through Roshydromet's regional centers.
4. Spain's sea level monitoring networks are operated by different institutions. Puertos del Estado operates 41 stations with radar sensors, measuring sea level, waves, and atmospheric data, with 10 stations co-located with GNSS receivers. The National Research Council runs 11 stations including 3 GLOSS network stations, while the National Geographic Institute operates 17 stations including the country's oldest tide gauge in Alicante. The Spanish Hydrographic Office has recently deployed new low-cost sensors in small ports, and there are ongoing efforts across institutions to assess vertical land movement and relative sea level rise through GNSS co-location and leveling campaigns.
5. 18. The Swedish Sea level network consists of 60 stations delivering one-minute data. The network features real-time quality control, open API access, and radar gauge sensors protected by wells due to ice conditions. The longest time series dates back to 1774 in Stockholm, 93% of which are digitized. Recent upgrades funded by the EU included sensor duplication and leveling to the Baltic Sea datum 2000. The data shows land uplift of approximately 0.5cm per year in Stockholm, with sea level rise accelerating since the 1980s to about 3mm per year. The network shares data openly through various services including Copernicus and AMMONET. Future developments include implementing S-100 standards to integrate sea level and current information with navigation systems through the Baltic SIENA Project.

# GLOSS DATA ACCESS AND STATUS REPORTING

1. Mr Phil Thompson, director of the UHSLC and associate professor in the Department of Oceanography offered a [presentation](https://oceanexpert.org/downloadFile/58340) outlining efforts to modernize and simplify access to GLOSS data.
2. The motivation for this initiative is that the current GLOSS data system is confusing and outdated. Users struggle to identify the right dataset for their needs and locate where the data is hosted. In light of this the GLOSS-GE Data Centers are looking into how to improve data accessibility.
3. Goals and next step are to reorganize and reclassify data, to unify metadata and use controlled, standardized language, replace vague terms like “delayed mode” with clear quality levels, ensure unique time series across all data streams, link data resolution and quality control (QC) levels to specific applications and communicate this to users and to create a Unified Data Portal.
4. The unified Data portal will use linked ERDDAP servers at each data center as the backend. It will develop a centralized front-end (led by VLIZ), allow integration into existing websites (e.g., NOC) and make the data center hosting invisible to the end user.
5. **The group agreed** to have a regular brief report on the status of the ongoing work on the Unified Data Portal.

# UN DECADE OF OCEAN SCIENCE FOR SUSTAINABLE DEVELOPMENT

1. Mr Bernardo Aliaga, Technical Secretary GLOSS, presented an update on the [UN Ocean Decade](https://www.unesco.org/en/decades/ocean-decade) initiative (2021-2030), explaining that while it doesn't provide direct funding, it offers endorsements that can help secure national funding. Mr Glenn Noland (Ireland) suggested submitting the Unified Data Portal as a potential Ocean Decade project.

# GLOSS IMPLEMENTATION PLAN

1. This tem was briefly introduced by Chair Begonna Perez. She recalled that at the GLOSS-XVII session (2023) the Group of Experts had agreed to request the Chair to continue the update of the [GLOSS Implementation Plan (2012)](https://unesdoc.unesco.org/ark:/48223/pf0000217832.locale=en) with the aim to submit a first draft to the Steering Committee at its next meeting. This was not possible for unforeseen circumstances and therefore the Steering Committee proposes to allow more time for the drafting and complete an initial draft for an online review of GLOSS Focal Points within 2025.
2. **The Group agreed** to task the Steering Committee to complete a first draft of the new Implementation Plan to be distributed by the secretariat to GLOSS focal points for comments.
3. **The Group agreed** to review and update GLOSS-GE Terms of Reference given the dissolution of JCOMM.

# LINKAGES BETWEEN GLOSS AND OTHER PROGRAMMES AND BODIES

## TWCWG

1. Mr Chris Jones from the UK Hydrographic Office [presented an overview of the International Hydrographic Organization (IHO) Tides, Water Levels and Surface Currents Working Group (TWCWG)](https://oceanexpert.org/downloadFile/58412). He described the role, structure, and current initiatives of the IHO and its TWCWG, with a focus on collaboration with GLOSS and the development of standards for tides, water levels, and currents. He reported that IHO is an intergovernmental organization promoting uniform hydrographic practices and nautical charting, that was established in 1921 and is composed by 100 Member States. IHO coordinates hydrographic offices globally and develops standards and best practices.
2. TWCWG focuses on technical coordination related to tides, water levels, currents and vertical datums, with significant overlap with GLOSS activities. Key initiatives include developing standards for electronic navigation products (S-104 for water levels and S-111 for surface currents), maintaining a standard constituent list, and working on vertical reference frames. Mr Jones emphasized the importance of collaboration between TWCWG and GLOSS to avoid duplication of efforts, particularly in areas like metadata standards and mean sea level monitoring. GLOSS is represented in TWCWG.

## OCG

1. Ms Emma Heslop from the Global Ocean Observing System (GOOS) [presented an overview of the Observation Coordination Group (OCG)](https://oceanexpert.org/downloadFile/58394) and its work with GLOSS. She explained that OCG works across GOOS networks to develop frameworks, strengthen implementation, and set standards, with current focus areas including data management, requirements gathering, and network health metrics. Ms Heslop highlighted ongoing initiatives including work on ERDDAP federation across data centers, the cross-network data implementation strategy, and collaboration with IODE on data infrastructure. The group discussed future priorities including improving metadata standards, unique IDs, and strengthening regional collaboration through GOOS Regional Alliances (GRAs), particularly for developing regions. The next [OCG-16](https://goosocean.org/event/4656) meeting in Brest (7 – 10 Apr 2025) will provide an opportunity to advance these initiatives with GLOSS representatives in attendance. Chair Begonna Perez informed the Group that Ms Elizabeth Bradshaw (PSMSL, UK) has joined the OCG Task Team on Data Management Elizabeth Bradshaw on behalf of GLOSS.

## TSUNAMI

1. Mr Bernardo Aliaga, Head Tsunami Resilience Section of IOC [presented](https://oceanexpert.org/downloadFile/58413) the historical development of the IOC's tsunami program, which began with initial developments by United States in 1948 and expanded significantly after the 2004 Indian Ocean tsunami when systems were established in the Caribbean, Mediterranean, and northeastern Atlantic regions and Indian Ocean. The current system includes 12 Tsunami Service Providers ([TSPs](https://www.ioc.unesco.org/en/global-tsunami-early-warning-and-mitigation-programme)) worldwide, though challenges remain as demonstrated by incidents in Chile (2010), Indonesia (2018), and Tonga (2022). He indicated that while GLOSS initially focused on the establishment of a high-quality, well-designed in situ sea level observing network to support a broad research and operational user base, including oceanographic and climate research communities, it began supporting tsunami warning systems in 2012, with the University of Hawaii Sea Level Center and VLIZ playing key roles in establishing sea level monitoring networks and real-time reporting facilities. Mr Aliaga noted that the current challenge for the tsunami programme is to detect tsunamis within 10 minutes of generation.

## PUERTO RICO SEISMIC NETWORK

1. Mr Victor Huerfano, Puerto Rico Seismic Network (PRSN) [presented](https://oceanexpert.org/downloadFile/58341) their monitoring system, which includes 30 tide gauges, tsunami cameras, and 145 accelerometers, with the capability to provide alerts within 5 minutes as required by law. Mr Huerfano also highlighted Puerto Rico's leadership in the Tsunami Ready program with 47 recognized communities and described their historical experience with tsunamis, including a devastating 7.3 magnitude earthquake and 6-meter tsunami a century ago.

# INTERSESSIONAL ACTIONS FOR GLOSS-GE 2025–2026

1. The discussion about the intersessional actions for the GLOSS-GE, was organised on three break-out working groups:

* Data Archeology (led by Laurent Testut)
* New technologies sensors including GNSS-IR /Reflectometry (led by Phil Thompson)
* Quality Control and Data Processing (led by Begoña Perez)

1. Data Archaeology
2. Mr Laurent Testut reported on the results fo this WG which purpose is to focus on historical sea level data with the following objectives:

* Identify and catalogue existing historical sea level data.
* Develop and promote best practices for data archaeology.
* Facilitate tools and methodologies for data recovery and digitization.
* Encourage international cooperation in digitization efforts.
* Support funding initiatives for data archaeology.
* Integrate digitized data into GLOSS public repositories.

1. **The Group agreed to** the proposed Actions:

* Establish a regionally balanced Working Group.
* Seek IOC support to engage participants from underrepresented regions (India, Russia, South America, Africa, Asia).
* Appoint a lead and co-lead for the Group.
* Finalize the Terms of Reference for the Working Group.
* Clarify any formal procedures for WG creation.

1. Mr Testut note the following expected deliverables:

* A comprehensive inventory of historical sea level data.
* A best practices guide for data archaeology.
* A technical report on tools and workflows.
* A report to GLOSS-GE.
* A repository of publications and outreach materials on the GLOSS website.
* A directory of relevant contacts.
* Contributions to data rescue proposal development.

1. The Secretariat clarified that Working Groups terms of reference and membership should be renewed at each GLOSS-GE sessions, with chairs serving two-year terms renewable once.
2. Sensor Performance & GNSS-IR
3. Phil YThompcon reported that this intra-session WG gathered ~20 participants to explore the use of GNSS-IR (Global Navigation Satellite System – Interferometric Reflectometry) and broader sensor performance issues in sea level monitoring. A quick survey revealed limited direct experience with GNSS-IR, highlighting the need to bring in external expertise.
4. GNSS-IR (Global Navigation Satellite System – Interferometric Reflectometry) is increasingly recognized as a valuable complementary technique to traditional tide gauges in sea level monitoring. Its strength lies in its ability to operate effectively in locations where conventional methods may be impractical or unavailable, offering a flexible alternative for expanding observational coverage.
5. While GNSS-IR is not yet positioned to replace traditional tide gauges, it provides unique insights into sea level variations, particularly in challenging environments. Researchers have identified two primary approaches to processing GNSS-IR data: the spectral method, as employed by the Permanent Service for Mean Sea Level (PSMSL), and the least squares/Kalman filtering method, which offers a dynamic framework for interpreting signal reflections. Together, these approaches underscore GNSS-IR’s potential to enhance sea level monitoring networks, especially when integrated thoughtfully alongside established techniques.
6. **The Group agreed** on the following actions

* Establish a permanent WG or Task Force on GNSS-IR and sensor performance.
* Create subgroups on:
  + - GNSS-IR
    - Low-cost sensors
    - Sensor comparison best practices
* Draft a proposal for WG structure and circulate it within the Steering Group.
* Encourage participation via a shared Google document.
* Explore low-cost GNSS alternatives, such as mobile-based solutions.

Quality Control, Data Processing, and Data Management

1. Begoña Perez reported that participants from various countries expressed a shared commitment to improving sea level data quality and management, highlighting several key priorities. Foremost among these was the need for standardization, with calls for clear methodologies, detailed checklists, and a unified data processing chain to ensure consistency across institutions. The importance of quality control (QC) was also emphasized, with participants advocating for both automatic and manual approaches that are traceable and reproducible.
2. 45. Another critical area was Metadata, where contributors stressed the necessity of embedding QC Metadata and thorough documentation at every stage of data handling. However, capacity gaps were noted, as some countries lack the manpower or technical resources to perform regular QC and data processing. To address this, there were suggestions to enhance performance monitoring, including tracking data completeness, update frequency, and other network metrics. Finally, participants underscored the value of knowledge sharing, calling for improved communication and collaboration across countries to exchange QC practices and tools more effectively.
3. Considering the current landscape and challenges including available resources from IOC-UNESCO and NOAA and contributions from national institutions, data centers, and international programs, as well as the need for continuous improvement, testing and implementing AI techniques, and regular updates to practices:
4. **The Group recommended** to:

* Establish a permanent Working Group within GLOSS focused on QC, processing, and data management.
* Create Subgroups for specific topics (e.g., metadata, algorithms, unified processing).
* Invite External Experts to contribute at national/regional levels.
* Improve Communication between national providers and data centers.
* Conduct Regular Surveys to assess national capabilities and data processing status.
* Ensure QC Metadata is part of the required metadata for each time series.
* Develop Network Performance Metrics and display them on the GLOSS website.
* Advance Toward a Unified Processing Chain to support a single GLOSS data access point.

1. For the immediate period **the Group agreed** to:

* Define terms of reference and membership of a WG on Quality Control, Data Processing, and Data Management
* Review and update existing manuals and public code.
* Compile challenging time series for AI training.
* Provide standardized, open-access code for computing monthly mean sea levels.
* Conduct benchmark tests to evaluate different QC and processing standards.

The team considered the idea of having a workshop focused on a specific topic of importance for GLOSS, potentially on instrumentation and technology. They also discussed the possibility of having the next GLOSS-GE sessions meeting back-to-back with a scientific workshop.

# GLOSS CHAIR ELECTION

1. **The Group elected** by acclamation of [Dr (Ms) Begona Perez (Spain)](https://oceanexpert.org/downloadFile/58301) as the new chair of GLOSS-GE for a 2-year renewable term.

# ANY OTHER BUSINESS

1. No other subjects were discussed.

# DATE AND PLACE OF THE NEXT SESSION

1. The Group discussed dates and venue for the next meeting of the group of experts. La Rochelle, France and Lima, Peru were proposed as potential locations for GLOSS-GE-XIX, in 2027.
2. . **The Group agreed to meet** in March or April 2027, if possible back to back with the IHO meeting, avoiding the week of the 4th to 9th of April, **and requested** the Steering Commmitee and the Secretariat to discuss with France and Peru on the venue and specific dates,

# CLOSURE

1. The group expressed gratitude to the local hosts in Panama for the successful meeting. The translators were also praised for their work. Mr Jorge Rodrigues (Panama GLOSS National Focal Point) expressed his appreciation for the meeting held in Panama and his commitment to the cause of monitoring sea levels. The meeting ended with a sense of accomplishment and anticipation for future collaborations.
2. The meeting closed at 12:00 local time on 14 March 2025.

**ANNEX I**

AGENDA

1. ORGANIZATION OF THE SESSION
   1. OPENING OF THE SESSION
   2. PRACTICAL ARRANGEMENTS
   3. ADOPTION OF THE AGENDA AND TIMETABLE
2. REVIEW OF PROGRESS ON ACTIONS FROM GE-XVII
   1. REVIEW OF GLOSS MANUALS
   2. IAPSO CMSLT BEST PRACTICES
   3. DATA ARCHEOLOGY
3. REPORT OF GLOSS DATA CENTERS
4. STATUS OF GLOSS CORE NETWORK
5. NATIONAL SEA LEVEL ACTIVITIES - PRESENTATION OF A SELECT SET OF NATIONAL REPORTS
6. GLOSS DATA ACCESS AND STATUS REPORTING
7. UN OCEAN DECADE
8. GLOSS IMPLEMENTATION PLAN
9. LINKAGES BETWEEN GLOSS AND OTHER PROGRAMMES AND BODIES
   1. TWCWG
   2. OCG
   3. TSUNAMI
   4. PUERTO RICO SEISMIC NETWORK
10. INTERSESSIONAL ACTIONS FOR GLOSS-GE 2025–2026
11. GLOSS CHAIR ELECTION
12. ANY OTHER BUSINESS
13. DATE AND PLACE OF THE NEXT SESSION
14. CLOSURE

ANNEX II

RECOMMENDATIONS

The Eighteenth Session of the Group of Experts for the Global Sea Level Observing System (GLOSS-GE) meeting was hosted in Panama from March 11 to 14, 2025

**The Group agreed** to review and update GLOSS-GE Terms of Reference given the dissolution of JCOMM.

**The Group agreed** to task the Steering Committee to complete a first draft of the new Implementation Plan to be distributed by the secretariat to GLOSS focal points for comments.

**The Group agreed** to form a working group to identify and propose new manuals to be developed and include them in the Implementation Plan.

**The group agreed** to have a regular brief report on the status of the ongoing work on the Unified Data Portal.

**The Group agreed** to establish three Working Groups:

**Working Group on Sea Level Data Archaeology**

**Working Group on** **on Quality Control, Data Processing, and Data Management**

**Working Group on GNSS-IR (Global Navigation Satellite System – Interferometric Reflectometry) and sensor performance**

**The group instructed** the Steering Committee to develop Terms of Reference for the above Working Groups **and requested** the Secretariat to invite Member States to appoint experts to these Working Groups through the GLOSS-GE Focal Points.

**The group expressed its appreciation** to the Government of Panama for hosting the GLOSS-GE-XVIII session.

**The Group agreed** to meet in March or April 2027, if possible back to back with the IHO meeting, avoiding the week of the 4th to 9th of April, and requested the Steering Commmitee and the Secretariat to discuss with France and Peru on the venue and specific dates,

**The Group elected** by acclamation of [Dr (Ms) Begona Perez (Spain)](https://oceanexpert.org/downloadFile/58301) as the new chair of GLOSS-GE for a 2-year renewable term.

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ANNEX III

**Eighteenth Session of the Group of Experts for the Global Sea Level Observing System (GLOSS-GE XVIII)**

11-14 March 2025

ANNEX VI

**LIST OF PARTICIPANTS**

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ANNEX IV

**LIST OF ACRONYMS**

|  |
| --- |
| BODC British Oceanographic Data Centre (UK)  BSH Bundesamt für Seeschifffahrt und Hydrographie (Federal Maritime and Hydrographic Agency, Germany)  GCN GLOSS Core Network  GCOS Global Climate Observing System (WMO–ICSU–IOC–UNEP)  GE Group of Experts  GFZ GeoForschungsZentrum (Germany)  GLOSS Global Sea Level Observing System  GNSS Global Navigation Satellite System  GOOS Global Ocean Observing System (WMO–ICSU–IOC–UNEP)  GPRS General Packet Radio Service  GPS Global Positioning System  ICSEM International Commission for the Scientific Exploration of the Mediterranean Sea  IHO International Hydrographic Organization  IOC Intergovernmental Oceanographic Commission (UNESCO)  JCOMM Joint Commission for Oceanography and Marine Meteorology (WMO–IOC)  JCOMMOPS JCOMM Observations Programme Support Centre  JMA Japan Meteorological Agency  NGDC National Geophysical Data Center (NOAA)  NOAA National Oceanic and Atmospheric Administration (USA)  PRSN Puerto Rico Seismic Network  PSMSL Permanent Service for Mean Sea Level (UK)  QC Quality control  SHOM Service Hydrographique et Océanographique de la Marine (France)  SLSMF Sea Level Station Monitoring Facility  SONEL Système d'Observation du Niveau des Eaux Littorales (France)  TWLWG Tidal and Water Level Working Group (IHO)  UHSLC University of Hawaii Sea Level Center  UNESCO United Nations Educational, Scientific and Cultural Organization  VLIZ Vlaams Instituut voor de Zee/Flanders Marine Institute (Belgium)  WDC World Data Centre (ICSU)  WG Working Group  WMO World Meteorological Organization |