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اللجنة الدولية الحكومية لعلوم المحيطات
政府间海洋学委员会

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Subject: IOC contribution to the theme "Sea-level rise and its impacts" – 21st meeting UN Open-ended Informal Consultative Process on Oceans and the Law of the Sea, 22-26 June 2020

Dear Mr Mathias,

Referring to your letter LOS/SGR/2020/1/IGO of 16 December 2019, I am pleased to offer the following contribution:

Sea level is a fundamental parameter in the sciences of oceanography, geophysics and climate change. Changes in observed sea level occur across a wide spectrum from seconds and minutes (wind waves, earthquakes, tsunami), hours to days (tides, storm surges), years (seasonal cycles, El Niño), through to long term changes due to climate change and the slow vertical land movements which are still occurring following the last ice age. Knowledge of sea level gradients is essential for understanding the ocean circulation. Sea level data are of great practical importance to coastal populations in applications such as flood defence and navigation.

The IOC's GLOSS program has been serving climate science and other missions as well, for 35 years now. In the early years, the primary mission was the development of a global network of tide gauges that was capable of serving the needs of climate scientists and geodesists, and the sole GLOSS data center was the Permanent Service for Mean Sea Level (PSMSL). From the beginning, however, the GLOSS mission included a substantial capacity building effort, and in the years since the GLOSS mission has greatly expanded to include, amongst other things, tsunami warning and the support of satellite altimetry. Additional data centers have been added, including the University of Hawaii Sea Level Center (UHSLC) and the Système d'Observation du Niveau des Eaux Littorales (SONEL).

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From the beginning, GLOSS has been focused on delivering data rather than doing science and that is still true today. The group supports the science but has never been a research program. The GLOSS Group of Experts, which oversees the activities of GLOSS, is comprised of data originators, data managers, and active scientists of all types, including climate scientists. The inclusion of climate researchers in this group has always been an essential part of the structure and serves to ensure that the data collection and management activities remain highly relevant to climate studies.

The PSMSL focuses on stewarding long monthly mean tide gauge records. The UHSLC provides high quality hourly and daily tide gauge records and SONEL provides research quality vertical land motion rates from continuous GNSS receivers located near to tide gauges.

The PSMSL predates the GLOSS program by many years, but GLOSS was largely created to encourage and improve the monthly mean sea level time series that are held at the PSMSL, and these holdings have improved substantially as a result. Given the focus on monthly mean sea level data, which is mostly a reflection of what was possible in the years preceding the beginning of GLOSS, these data are mostly used for studies of seasonal and longer variability. This focus includes the study of global mean sea level rise based on various methods that were essentially simple averaging of the global tide gauge dataset. Such studies date back at least 50 years and all depend on the PSMSL dataset. In more recent years, a number of more complicated analyses, collectively referred to as sea level reconstructions, have been developed. None of these methods would be possible without the PSMSL dataset that is supported by the GLOSS program.

As GLOSS developed the need for collecting, quality-controlling, and providing higher frequency data (i.e., hourly and daily values) became apparent. The initial desire from the GLOSS community to collect the higher frequency data was a very practical one. It is very difficult to quality control monthly mean sea level data if one does not have access to the higher frequency data. But soon after the beginning of the GLOSS program the advent of satellite altimeters and a new mission began. Because of the nearly global coverage afforded by the altimeters, this was obviously the best way to measure global mean sea level change because the large volume redistribution signals, ENSO for example, cancel and allow us to isolate the volume change signal. At the same time, though, the global mean sea level estimate derived from the satellite altimeters is very complex, and admits errors of many sorts. This was recognized early in the GLOSS years and methods were developed to use the high frequency in situ sea level data to provide ground truth for the altimeters. The UHSLC took on the task of providing these data in a timely manner in order to carry out this new GLOSS mission. In essence, the venerable tide gauge network provided the underpinning for the satellite estimates of global mean sea level change.

With a few years experience comparing the tide gauge data to the satellite altimetry data it became apparent that vertical land motion at the individual tide gauges was a problem. In fact, this was determined to be the leading source of error in deciding whether the satellite altimeter data could be considered drift-free, or stable. GLOSS took the lead on addressing this problem, creating the TIGA program that was specifically charged with using continuous GPS measurements to estimate vertical land motions at the tide gauge locations. This eventually led to the opening of another GLOSS data center, SONEL, which was charged with collecting, processing, and distributing these data and products. It should be noted, too, that having these vertical land motion estimates near to many tide gauges have also been exploited in re-analyses of the long-term tide gauge dataset.

The preceding has focused on the GLOSS contribution to sea level rise studies, but the climate change impact of a high quality tide gauge network goes far beyond that. Climate change results in sea level change, which is more than just global mean sea level rise. Ice melt patterns result in regional sea level fingerprints. Ocean-atmosphere dynamics change with warming and again sea level changes regionally. Storm surges can become more or less frequent depending on location. These regional changes and the long-term modulation of relatively high frequency events cannot easily be captured by satellite altimeters, but the global tide gauge network, guided by GLOSS, can.

IOC has estimated conservatively that for 2017 alone more than 200 scientific publications are based on sea level data provided by the GLOSS data centers.

Reference:

Global Sea-Level Observing System (GLOSS) Implementation Plan – 2012. UNESCO/IOC, 41pp. 2012. (IOC Technical Series No.100) (English)
[https://unesdoc.unesco.org/ark:/48223/pf0000217832.locale=en]

I trust the above is of use and IOC and the GLOSS program stands ready to contribute further.

Yours sincerely,

Vladimir Ryabinin
Executive Secretary