Assessment of global mean sea level from altimeters cross-calibration with in-situ measurements
(TOPEX/Poseidon, Jason-1 and Envisat)

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Summary

Measurements from space altimetric missions (TOPEX/Poseidon (T/P) and Jason-1) are believed to provide a reliable estimation of the Mean Sea Level (MSL) trend (to date 3.1 mm/year since 1993 without post glacial rebound). However, some potential drifts have been identified due to geophysical corrections, orbit solutions and the uncertainty to link the different MSL time series.

In-situ datasets (tide gauges, Temperature/Salinity (T/S) profiles) provide independent measurements of sea surface height variations, methods have been developed to assess the global MSL trend from such data. The basic idea of the data processing is that differences between in-situ and altimetric measurements should not have any drift or bias over long time scales.

First, altimetric data are compared with tide gauge measurements using 4 different tide gauge networks (GLOSS/CLIVAR, SONEL, BODC database and OPPE). Second, an innovative method using the whole set of free-drifting profiling floats of the ARGO network is used. In this case, altimetric data are compared to sea level heights computed from T/S profiles for the 2004-2008 time period.

Both in-situ datasets complement each other since the first one (tide gauges) concerns coastal areas while the second one (T/S profiles) is widespread enough to detect potential drifts in the open ocean.

Overview

Methodology

1/ SSH calculation

- The SSH reference is not the same: the Mean Sea Surface has to be removed from altimetric SSH
- Tide effects (due to the distance between 2 measurements) have to be removed from both SSHs
- Atmospheric effects have to be removed for the same reason
- Vertical movements are corrected on tide gauge measurements using vertical velocities of the Earth’s crust recorded by ground stations

2/ Colocation of altimetric and in-situ data by interpolation on the altimeter time series of the 4 closest altimetric tracks

3/ Editing of tide-gauges time series using the cross-comparison from all the altimeters in order to remove tide gauges with an abnormal behavior (jump, very strong drift)

Estimation of MSL drift

The MSL altimeter drift estimate is very weak (almost null for Jason-1 and close to 0.4 mm/yr for T/P, see fig 1). Merging both altimeter missions over the whole period, the global MSL drift becomes close to 0.3 mm/yr.

For Envisat, a negative MSL drift close to -1.2 mm/year is detected from 2002 to 2008 (fig 1). But focusing only on the end of the period (from 2004), the Enviast MSL drift is now weaker close to -1 mm/yr (fig 2). Over this period, Jason-1 and Envisat global MSL are in better agreement though a negative trend is displayed (-0.7 mm/yr for Jason-1 and -1.1 mm/yr for Envisat).

The precision of the MSL drift estimation is in the order of 0.5 mm/yr considering the longest altimeter period. It is depending on the accuracy of the collocation method between altimeter and in-situ measurements but also on the accuracy of the vertical movements correction.

Conclusion

This study aims at demonstrating the capability of these both methods to detect drift or abnormal jump in the SSH provided by altimeters. The calculation of the trend and the comparison with in-situ results can lead to assess the errors on the global MSL trend and thus estimate the absolute drift. The cross-comparison between altimeter missions is able to accurately detect the MSL relative bias. Here, we underline the drift of Envisat MSL, especially at the beginning of the time period (2002-2004). Finally, these both methods are complementary at the tide gauge one samples coastal areas with a good time resolution while the T/S has a better space sampling (open ocean) but a lower time resolution.