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Ocean Science Discussions

Interactive comment on "A new assessment of global mean sea level from altimeters highlights a reduction of global trend from 2005 to 2008" *by* M. Ablain et al.

M. Ablain et al.

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General comments

The main originality of this paper is an exhaustive description of the altimeter errors impacting the MSL. Studies about this subject have been already performed (Nerem et al., 2001; Fernandes et al, 2006). But reprocessed GDRs and updated geophysical corrections are now available, which justifies a new assessment. In addition, another important issue of the paper is the statistical approach to estimate the error with a confidence interval. Finally, this new assessment of the global budget error allows

us to demonstrate that the recent sea level change (1 mm/yr since 2005) is not due to errors from altimetry measurements. In order to better demonstrate that the new information presented in the paper are useful, we propose a new release to take into account all your remarks.

Specific comments

Line 1-2 on page 33: You can not conclude that sea level change is accelerating on basis of the differences between the rate observed from tide gauges (1.7 mm/yr) and the rate observed from satellite altimetry which comes to around 3.4 mm/yr. First you should demonstrate that you exclude spatial sampling differences of the sea level signal which are very significant for this problem. Ablain et al have not shown this, in fact, nobody has shown this, the MSL accelerating claim is misleading and easily misunderstood.

We agree with your remark. We removed this sentence in the introduction of the new release.

Line 12-15 on page 33: The activities of Remko Scharroo (which you cite in this article) have indicated that you can combine Envisat and GFO. Perhaps you should better explain what good confidence really means.

Envisat and to a lesser extent GFO, could be useful to better take into account the MSL evolution in high latitudes. But the MSL provided by these both missions is not as accurate as Jason-1 or T/P one. Firstly, GFO is not a mission really dedicated to the MSL studies: orbit performances and the stability of radiometer correction are the main source of uncertainty. Concerning Envisat, a SSH drift is observed in 2003, probably in relationship with an USO anomaly. In addition, GDR products have not been processed in the same ground software version. It is thus another source of

OSD

6, S78–S85, 2009

uncertainty to calculate the MSL trend accurately. As the impact of not taking into account high latitudes data is weak on the global MSL trend, we finally preferred not using data from these both missions to estimate the global MSL trend.

Line 16-21 on page 33: It would be very appropriate here to mention that several papers already discuss this issue these tests, where are the references?
We agree with your remark. We add in the new introduction the following references:
- Nerem, R.S., and G.T. Mitchum, Observations of Sea Level Change from Satellite Altimetry, in /Sea Level Rise: History and Consequences/, edited by B.C. Douglas, M.S. Kearney, and S.P. Leatherman, pp. 121-163, Academic Press, 2001a.
- Nerem, R.S., and G.T. Mitchum, Sea Level Change, in /Satellite Altimetry and Earth Sciences: A Handbook of Techniques and Applications/, edited by L. Fu, and A. Cazenave, pp. 329-349, Academic Press, 2001b.
- Fernandes, M. J.; Barbosa, S.; Lázaro, C. Impact of Altimeter Data Processing on Sea Level Studies. Sensors 2006, 6, 131-163.
These modificatiosn are in the new release.

Line 2 on page 34: perhaps rectangular should be replaced by spherical?
I think "rectangular grids" is the appropriate word.

Line 24 on page 34: CGM02C should read GGM02C.
It is corrected in the paper.

OSD
6, S78–S85, 2009

Line 7 -9 on page 35: This conclusion is rather basic (you find it in many textbooks), but it is perhaps also too basic. GIA is a signal with a spatial structure, you can't just assign a global constant for this correction. Did you re-compute the MSL rate with the help of a GIA model, or did you just assign the 0.3 mm/yr correction to the graph?
Indeed, GIA is a signal with a spatial structure. But the global impact is a constant (-0.3 mm/yr, Peltier, 2004). Then it is correct to just assign the 0.3 mm/yr correction.

Line 24-27 on page 38: What is the reason to exclude the possibility of a geophysical feature affecting the hemispherical difference?
We improved this section in the new realease. Indeed physical processes can explained the hemispheric trend differences. But it also clear that new reference frame (ITRF2005) change significantly these trends in the same order as the observed signal. Then, the inconsistency observed between each hemispheric trend can legitimately be considered as an source of uncertainty.

Line 4-6 on page 39: Did you exclude the possibility that the ionospheric correction S2 might be to blame for this effect? (Ascending and descending tracks occur at different solar times)
Cal/Val studies performed since the beginning of T/P and Jason-1, have shown the good stability of altimeter parameters. As the Jason-1 and T/P ionospheric correction is directly deduced from the altimeter range differences between Ku and C bands, we can exclude a potential drift provided by this correction (separating ascending and descending tracks also). It should probably not the case using a model as for Envisat where the S-Band is not available anymore since 2008.

OSD
6, S78–S85, 2009

Interactive Comment

Line 13-14 on page 39: could you please explain how you come to this 0.1 to 0.15 mm/yr

In the section dedicated to the orbit error, we highlight 2 sources of uncertainty. The first one depends on orbit solution applied leading to an uncertainty close to 0.1 mm/yr on the global MSL trend. The second one is linked to incoherence between ascending and descending MSL trends. But assuming it is only a problem of orbit centring, its impact is probably weak after averaging ascending and descending passes. Finally, the sum of these two uncertainties leads to an error between this 0.1 and 0.15 mm/yr.

Line 16-17 on page 39: This issue was already studied by Chambers D.P, Hayes S.A., Ries J.C., Urban T.J., New TOPEX sea state bias models and their effect on global mean sea level, JGR Oceans, Volume 108, Issue 10, 15 October 2003.

The main objective of this section is not to describe the absolute value of the SSH bias to link together each MSL time data series (TOPEX A / TOPEX-B and TOPEX / Jason-1) but is to evaluate the uncertainty of this bias. Indeed, SSB models significantly impact these SSH biases (we have indeed to discuss the Chambers et al. [JGR, 2003]). For instance and as described in the paper (section 2), using the BM4 model from M-GDR products, the SSH bias between TOPEX-A and TOPEX-B is close to 0.5 cm while using a no-parametric model (Gaspard and Labroue, 2002), the SSH bias becomes 1.17 cm. We tried to better describe this part on the new release of the paper.

Line 27+28 in page 39 and line 1+2 on page 40: But what is now new with this conclusion, what is different compared to the work of Chambers et al 2003?

The main objective of this section is to described the SSH bias uncertainty to link together each MSL time data series: Jason-1+ TOPEX and TOPEX-A+TOPEX-B.

OSD

6, S78–S85, 2009

The work of Chambers et al 2003, concentrates on the impact of the SSB on the SSH bias. But the SSB is not the only source of uncertainty to estimate the SSH bias. It is also due to the instrumental altimeter noise between two altimeters or the oceanic variability between TOPEX-A and TOPEX-B since both time data series are not overlapped. We are going to clarify this item in the paper.

Line 11 page 40: Is the 1.6 m/s/yr correct? are these units right?
It is a mistake: good unit is cm/s/yr. It is corrected in the paper.

Line 20-22 on page 40: your total error is twice as large as the value we see from Steve Nerem's activity.
The total contribution of errors listed in this paper can be calculated differently: - The sum of each error gives a total value close to 0.9 mm/yr, it's indeed twice as large as the value we see from Steve Nerem's activity. But it is a pessimistic value, since errors can be correlated.
- From a classic way, the quadratic sum of each error leads to a value close to 0.45 mm/yr in the same order as Nerem one. This basic method do not allows to take into account the correlation between each error, the no-linearity of the MSL evolution. In addition, the confidence interval of the total error is unknown.
- It is the reason why in this paper, we use a more realist statistical approach (inverse formalism). It allows us to calculate a realist error around 0.6 mm/yr with a confidence interval of 90%. This new budget error is an interesting new conclusion in the paper.
As this part is probably a little confused in the paper, we detailed in the new release.

Line 14 on page 41: replace "Altimeter MSL drift" by "the instrumental drift of the

OSD
6, S78–S85, 2009

Interactive Comment

altimeter system"
The comparison between altimeter and tide gauges data allows us to estimate the potential MSL drift of the whole altimeter system (instrumental drift, orbit, geophysical correction, 133;), and not only the instrumental drift. Then, the sentence "Altimeter MSL drift" seems well adapted.

Line 25-27 on page 42: How is it possible that a difference measurement of about 7cm rms can be used to conclude that an altimeter drift is of the order of a few tenth mm/yr. This issue should be explained. There should be a lot of ocean dynamics in this signal.
The standard deviation of SSH differences is in average close to 7 cm for one tide gauge After filtering out these 2 differences over 2 months, the differences decrease between 3 to 4 cm RMS in average. Now, considering all the tide data series, the RMS differences are significantly reduced. This allows us to estimate to detect drift of the order of a few tenth mm/yr since the adjustment formal error is lower than 0.3 mm/yr as mentioned in the paper. This remark highlights also the importance of using an large tide gauges network.

Line 1+2 on page 43: You should mention that it is assumed that the use of long time series reduces the impact of the uncertainty on the trend estimation. This is an assumption based on statistics.
P.43 l1+2: sentence "The use of long data time series lead to reduce the impact of this uncertainty on the trend estimation." replaced by "Statistic monitoring computed through this method work on the assumption that the use of long data time series reduces the impact of this uncertainty on the trend estimation."

OSD
6, S78–S85, 2009

Page 47: What load love numbers were used in the ocean tide loading computation?
We are not sure to well understand the question. It might be in relationship with a mistake which occurred in the table 1 page 47 in the "ocean tide and load tide" rows. This mistake is now corrected.

Figure 5 on page 53: is the offset between the curves deliberate?
The offset is indeed deliberate in order to display clearly each curve.

Interactive comment on Ocean Sci. Discuss., 6, 31, 2009.