Referee comments 2nd iteration
Orbit related sea level errors for TOPEX altimetry at seasonal to decadal time scales
os-2017-51a version3 update

The updated paper is easier to read than the original and offers additional useful information. There are however a few more questions and remarks the authors should address for improved clarity. I recommend publication after these are addressed.

***General Comments***

- My main comment is that the authors do not explain their reasoning and assumptions for labeling their orbit error estimates derived from orbit differences as "upper bound errors". Orbit differences do not include error common to the orbits and would be better suited for estimating the lower bounds to orbit error. On page 7 l200-201 the authors say "Regional upper bound errors are guessed from the corresponding maximum RMS values over the ocean at the 1°x1° grid". This explanation is far from satisfactory. What are the assumptions made such that this will represent regional upper bound orbit error? Furthermore there is no corresponding description, including assumptions, of how "global upper bound error" is estimated. The 7mm RMS "upper bound estimate" for TOPEX global radial orbit error simply shown in Table 4 seems far too optimistic. For example, the 7mm REF-GRGS RMS difference (Tab 4) can be used as an orbit error estimate if we assume that: 1) common combined error = independent combined error = 7mm, 2) the error is shared evenly between the two orbits (orbit error = ((7**2+7**2) / 2)**(1/2) = 7). Even given all these assumptions a 7mm SLR+DORIS TOPEX realistic RMS radial error estimate seems much too optimistic, not to speak of a potentially much larger upper bound error estimate, since only 10mm radial accuracy (at best) has been achieved for the Jason-2/3 or other satellite orbits which carry the post-TOPEX advanced DORIS DGXX receiver (see for example Zelensky etal 2010 "DORIS/SLR POD modeling improvements for Jason-1 and Jason-2", or for example Zelensky etal 2016 "Towards the 1-cm SARAL orbit"). The authors may also consider mentioning the 1995 TOPEX orbit evaluation which estimated the radial error at 3 cm (Marshall etal 1995 "The temporal and spatial characteristics of TOPEX/POSEIDON radial orbit error")
  I suggest not to classify the error estimates as "upper bound". In any case the authors should include a paragraph, or better a small section, devoted to describing the methods and especially the assumptions for estimating "upper bound" or "lower bound" or "any another category" of global and regional orbit errors made using orbit differences. The description should include RMS, trend, and amplitude values since they are presented in the paper.

- Page 3 lines 81-83 summarize the main differences between the GFZ, GRGS, and GSFC orbits. I suggest including SLR/DORIS weighting combined with LRA modeling as an important orbit modeling difference. The SLR(cm) / DORIS(cm/sec) sigma weighting for (GFZ, GSFC, GRGS) are (30/.2, 10/.2, 6.7/.2).

Comparatively SLR data will have the most prominence in the GRGS solution, but which has the least sophisticated modeling of the LRA. Compared to the other solution data weightings, DORIS data will predominantly drive the GFZ orbit solution. I also suggest adding a row in Table 1 describing the empirical parameter estimation. For GSFC that would be : 1 Cd drag / 8-hours, 1 along-track & 1 cross-track OPR acceleration / 24-hours.

- Tables 4 - 5 are a summary of Figures 5-7 and are difficult to understand without first looking at Figures 5-7. However, the tables are presented first. If the presentation order is not changed, I suggest to at least identify the corresponding Figure in the Table labels. For example changing the Table 5 label "5-year trend (mm/year)" to "5-year trend variability (mm/year) (see Fig. 6)" would be very helpful. Such a clarification would be useful for all these tables. In addition I suggest putting: "Altimeter Crossover residuals" or "Altimeter Crossover differences" in the Table 3 column header label now empty, "Global" in the Table 4 empty label, "Regional maximum" in the Table 5 empty label. It is not clear if the global values are computed using only those regions where the formal sigma is smaller than the estimate. Are the RMS values shown in the tables the mean RMS values?

***<u>Specific Comments</u>***

- There must have been a mis-understanding of my question from the previous review - "Any explanation why the DORIS residuals are slightly higher for the DORIS-only orbit? One would expect a decrease in the DORIS residuals compared to the DORIS+SLR orbit DORIS residuals." . The author's response essentially said "We do not think, that the DORIS residuals of the DORIS-only orbit are necessarily smaller than those of DORIS+SLR orbit.". Yet, on page 5 l140-142 the authors write: "Among five orbits derived using DORIS observations, a slightly increased average value of DORIS RMS fits (0.04795 cm/s) is obtained for the DORIS orbit derived using only DORIS observations followed by the TBias orbit (0.04785 cm/s), while the other orbits …"
- p 4 l118 Why are GSFC orbits listed as a correction for computing the Altimeter Crossover differences? Does not each test orbit contribute for computing the test-specific Altimeter Crossover differences?
- p7 l200 "Regional upper bound errors are guessed from" -> "Regional upper bound errors are estimated from"
- p 8 l229 "mean orbit errors"? Do you mean "mean RMS orbit errors"?
- p 8 l246-247 "The global mean decadal trends (calculated over the full mission time) are mostly significant but can be further neglected, since they are two orders of magnitude smaller than the observed sea level signal over this period (~3 mm/year)." Question – does this suggest sea level trends computed over 5-years are not reliable?
- p9 l267 "The thoroughly reflection" -> "A careful consideration"
- p9 l270 "in the pre-GRACE period." -> "in the pre-GRACE period (Fig 5)."

- p13 l399 “time-invariant annual” -> “periodic annual”
- p 21-22 Why are the REF-DORIS decadal trend signs different between Tables 4 and 6?
- It is interesting most of the decadal trend REF-Test signs are positive. The values, however are very small.
- p 29 l705 “Trend” -> “Decadal trend”