Ocean Sci. Discuss., 11, C570–C575, 2014
www.ocean-sci-discuss.net/11/C570/2014/

Ocean Science Discussions
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Interactive comment on "Evaluation of wet troposphere path delays from atmospheric reanalyses and radiometers and their impact on the altimeter sea level" *by* J.-F. Legeais et al.

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Received and published: 3 July 2014

–General comments–

The paper at hand evaluates the impact of different wet tropospheric corrections on sea level estimations from satellite altimetry measurements. The motivation for this study stems from earlier work that demonstrated the strong dependence of the sea level estimation upon this wet tropospheric correction. This paper compares three corrections: derived from microwave radiometer observations onboard the same satellites that carry the altimeters, derived from the ECMWF operational numerical weather prediction model, and derived from a global atmospheric reanalysis (namely ERA-Interim)

that spans the entire time period of the study.

Overall, the results shown here highlight different aspects of spatio-temporal impact and provide detailed insight on the added values and limitations of each of the corrections. The authors' results confirm that for optimal exploitation of satellite altimetry data improved wet tropospheric corrections are needed, ideally retrieving the high-frequency information observed by radiometers, and, in the absence of dedicated attention to carefully calibrate over long time-scales these radiometers from the space segment, tying to low-frequency information controlled by other, referenced or calibrated, sources.

Apart from one point detailed immediately hereafter, the scientific results do not appear questionable to me.

Section 3, page 1620, "This result is not expected": like the authors, I am also very surprised to see that the corrections derived from the ECMWF operational numerical weather prediction system nowadays are at best on par with ERA-Interim. Yet, the ERA-Interim system is based on a 2006 version of the ECMWF operational system at the time, so one would normally expect that by now, 8 years later, the improvements in the operational system have relegated ERA-Interim to produce wet corrections of comparatively lower quality. Past this counter-intuitive result, the paper mentions probably the explanation: section 2.1 page 1617 explains that the operational corrections are processed differently than the ones from ERA-Interim (the former is received from a third-party, the latter is computed by the authors themselves from gridded fields if I interpreted correctly the information given). I understand that the processing performed by a third-party is outside of the control of the authors' work, but it could be useful to check that the procedure employed by the third-party behaves as expected. Again, one may appreciate that this question may not be easily answered by the authors themselves: the reason why they use wet corrections corrections computed by a third-party in the first place is probably because they do not have access to the ECMWF operational 3D fields at full resolution. Consequently, this point should not delay publication

OSD
11, C570–C575, 2014

of the work, but instead serve to trigger further dicussion and investigations.

To continue past Figure 9 (which shows wet path delays) it could be instructive to pursue the work into the space of measured radiometer brightness temperatures – e.g., mapping ERA-Interim or other, more recent, global reanalyses in that space with the help of radiative transfer models, to be applied at the time and location of the radiometer observations. This could help devise a better understanding of each radiometer's behavior, possibly improve the quality control and (inter-)calibration of these. It may be possible to use current state-of-the-art GSICS-like calibration procedures to relate measurements from the old microwave radiometers to what appear as ultra-stable measurements from IASI and AIRS, using either the current microwave radiometers or simulated brightness temperatures computed from reanalysis fields as a means of information transfer.

–Specific questions–

Figure 4, and also Figure 3, top right compared to top left, is there any obvious reason why there is a stronger annual cycle in the differences with ERS(1,2) and Envisat than with TOPEX and Jason(1,2)? Could it have to do with radiometer data processing? e.g., the procedure used to remove "the biases between the radiometer measurements of the altimeter mission" (Figure 3 caption)?

Figure 4 and also Figure 3, top row, could the bowing shape in both time-series, with a maximum around year 2000, be explained by the rain assimilation problem in ERA-Interim, which yields also a bowing shape (though reversed) in terms of total column water vapor, ERA-Interim being more wet by about 1 mm over global oceans before 1991 (and from 2010 onwards) than at its driest point, about in the early 2000s? This effect can be seen in peer-reviewed material Figure 1b (though this figure shows global averages, not just over oceans) of Berrisford et al., 2011 (Atmospheric conservation properties in ERA-Interim. Q. J. R. Meteorol. Soc. 137: 1381-1399 DOI:10.1002/qj.864). Note at the time that paper was prepared ERA-Interim still as-

OSD
11, C570–C575, 2014

similated SSMI radiances over rainy areas and hence the TCWV time-series shown there hadn't fully recovered to higher levels, pre-SSMI times. I hence provide a figure, showing time-series of TCWV (and anomalies), where the effect of the jumps caused by SSMI are most visible, in the tropical oceans (defined as latitudes 20S-20N), extending until June 2014 (note the data point shown here for ERA-Interim for June 2014 is provisional): the magnitude of the relative drying, at its lowest point in about 2000, is about 2 mm. I am not sure how this would map into the sea-level alimetry time-series and whether the sign and magnitude of the effect would agree with what is shown from ERA-Interim in Figure 4.

Figure 7, over the Hudson Bay and Antarctic ice shelf sea-ice margins, do we see here indications of radiometer corrections suffering from sea-ice contamination?

–Minor points, possibly requiring minor text changes–

Page 1617, line 5 "should not be affected by jumps": should be *less* affected by jumps (There are several reasons why one would still expect 'jumps' in reanalyses: in the presence of model bias, the introduction (or removal) of unbiased observations in the assimilation will necessarily introduce jumps. The next question of course is about the magnitude of these jumps.)

The last paragraph of section 3.2 would benefit from some clarification (partial re-writing with more substantial facts would help support the statements).

Page 1629, maybe replace "the number of precipitate water content (PWC) retrievals from SSM/I satellites is not taken into account properly and the ERA Interim atmosphere becomes too dry" by "the greater the number of total column water vapor retrievals from SSM/I satellites, the greater the drying induced by the analysis increments. This results in the atmosphere being represented in ERA-Interim as more dry"

The paper by Cazenave et al. (2009) is available on the web at the following URL http://www.oceanobs09.net/proceedings/pp/2A3-Cazenave-OceanObs09.pp.11.pdf

OSD
11, C570–C575, 2014

(last accessed 3 July 2014)

Interactive comment on Ocean Sci. Discuss., 11, 1613, 2014.

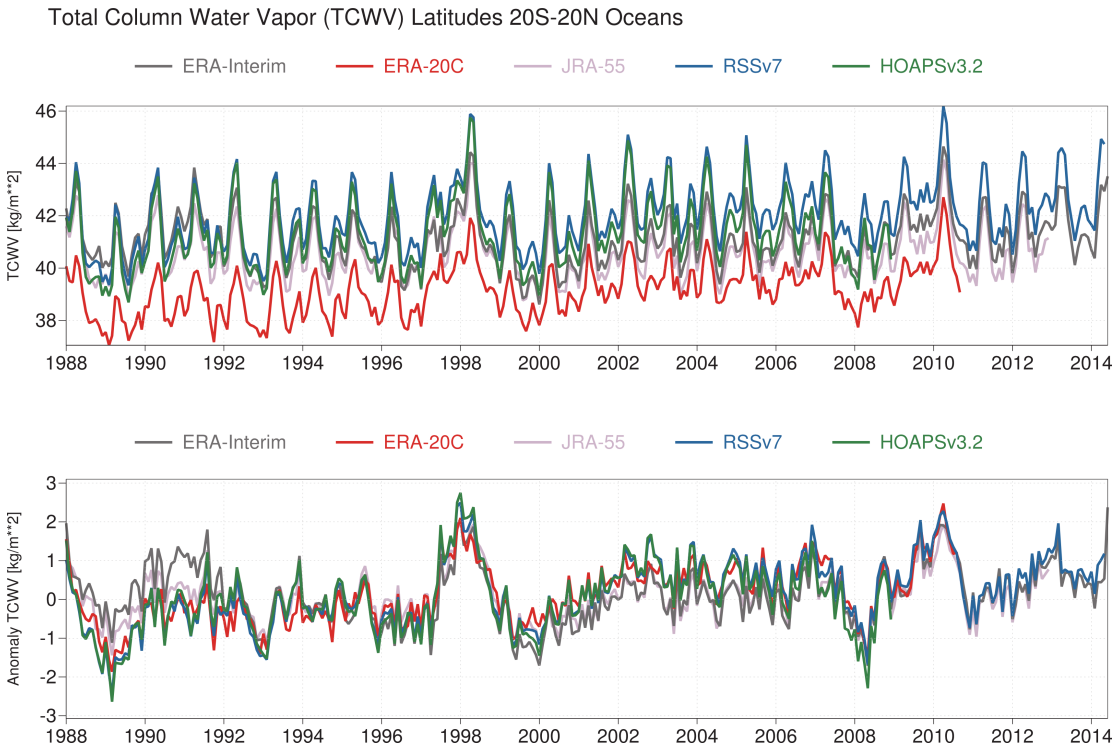

Fig. 1. Time-series of total column water vapor from different products over tropical oceans (bottom plot shows anomalies)

OSD
11, C570–C575, 2014