

Interactive comment on “Mean dynamic topography of the black sea, computed from altimetry, drifters measurements and hydrology data” by A. A. Kubryakov and S. V. Stanichny

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We want to thank You for this detailed analysis of our article. We are very pleased to view your interesting and important comments to our paper. Concerning your comments, below are our answers:

Main points

Comment: It would be better to shortly describe in introduction what we know about the Black Sea MDT (you describe it in section 2.2.4, I think it would fit better in introduction)

Response: We added a few words about Black Sea in the introduction of the paper.

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Comment: Page 703 Line 5: the time period average depends on the SLA production center. When using AVISO SLA, it corresponds to the 1993-1999 time period. Explain better why the Mean Dynamic Topography is computed/needed for the 1993-1999 time period: The Sea Level Anomalies used in this study are computed by SSALTO DUACS and they are referenced to a 1993-1999 mean profile. Therefore, to reconstruct the absolute dynamic topography, the mean dynamic topography for the same 1993-1999 time period is needed.

Response: Thank You, we transformed this part and added this information to the paper

Comment: Page 703 Line 24: add reference to Rio et al, 2011

Response: We added a link to the new Rio et al. work

Comment: Page 703 Lines 22-27: In the method by Rio et al, altimetric SLA are interpolated onto the drifters and hydrological profiles time and position. Why have you preferred stacking on the altimeter tracks? In effect, doing so, you reduce the number of in-situ measurements used for the calculation. On the other hand, you keep the full resolution of along-track altimetric data, that would be otherwise smoothed by the interpolation onto the in-situ measurements).

Response: The baroclinic Rossby radius of deformation for the Black Sea is 15-25 km. That is why, mesoscale processes plays an important role in BS circulation. This is the main reason, why we use along-track data for better detection (resolution) of the level gradients. The second reason – we use along track profile for reconstruction of the MDT by minimization of the cross-point differences without using any first approximation of the MDT (this one part of the novel approach)

Comment: Page 704 Line 11 (Eq 3): You should insist on the fact that the time period of the obtained synthetic MDT $H(r)$ depends on the time period to which the SLA used are referenced . Since you use SLA from AVISO (section 2.2.1) you get through equation

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3 a MDT representative of the 1993-1999 time period.

Response: Thank You, we included this information into article

Comment: Page 704 Lines 22-23: Explain better why in-situ measurements in the future may be used: In equation 3, the time period of the MDT is the time period to which the SLA used are referenced, whatever the time measurement of the in-situ data and the altimetry data. That is why any data may be used, also outside the period 1993-1999.

Response: Thank You, we have made corresponding corrections in the article

Comment: Page 705- section 2.2.1: you must say here that the SLA are computed relative the a 1993-1999 mean profile.

Response: Thank You, we have made corresponding corrections in the article

Comment: Page 709 Lines 1-12: In processing the dynamic heights, you neglect the steric effects occurring below 500m (the in-situ profiles extend down to 500m while you approximate the full steric effect of the Black Sea by a seasonal signal of 4 cm amplitude). Is the steric effect occurring below 500m negligible?

Response: Black sea is strong stratified basin, main seasonal changes of stratification are occurred in the upper 100 meters and strong mesoscale eddies typically disturb upper 200-400 meters. That is why, steric effect are negligible in deeper layers.

Comment: Page 709 – Results: Do you need to adjust (with a mean bias) the MDT computed from the drifters and the MDT computed from the dynamic heights before combining them? If yes: how do you proceed? If no: Are we sure that both MDT are compatible? The mean level of the MDT derived from drifters results from the minimization procedure of the Ci. The mean level of the MDT derived from the dynamic heights depends on the 500m reference depth and the computation of water balance W. How do you ensure compatibility of the both MDT mean level before combining them?

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Response: Yes, we need to adjust both along-track MDT estimates. Computed from drifters and dynamic heights along-track estimates of synthetic MDT were combined as follows: first, we add a constant to each along-track MDT estimates computed from the dynamic heights, so that they fit best mean dynamic profiles, computed from drifters. After that, weights were computed (depends on number of measurements used) for each point of each mean profile, computed from drifters and TS-measurements. After that, estimates of MDT for each point were averaged with weights (13) here k – number of point, n_{dr} – number of buoys measurements used for MDT computation in one along-track point k , n_{dyn} – the same for hydrologic data, H_{dr} and H_{dyn} is MDT estimates in point k from buoys and hydrology, respectively.

Comment: Page 709 Section 3.2.2: how many hydrological profiles are selected for computation?

Response: 771 hydrological profiles and 8245 drifter measurements were chosen for computation. After averaging it comes to synthetic estimates for 225 unique along-track points from hydrology and 755 from drifters. In section 3.2.1 number 755 corresponds to unique track points in which we have estimates of MDT. We have transformed this part (because it may lead to some misunderstanding)

Comment: Page 710: Lines 10 to 20 Description of the computed MDT: Authors mention a number of eddies by their names. Please give a geographical location (longitude, latitude) for each of them, as well as references to literature where their existence is mentioned.

Response: We changed this part, for better understanding. To answer on your comment: Batumi anticyclone is on the south-east, Sevastopol in the north-west, west of Crimea, Bosphorous is in the south-west of the BS, Kizilirmak – south-south-east, Sakarya – south-south west, Synop and Trabzon on the south of the Black Sea; Crimean anticyclone on the north; and Kali-Akra Eddy on the north-west coast. You can see geographical distribution of these eddies in this paper: Korotaev, G., T. Oguz,

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A. Nikiforov, and C. Koblinsky: Seasonal, interannual, and mesoscale variability of the Black Sea upper layer circulation derived from altimeter data, J. Geophys. Res., 108(C4), 3122, 2003

Comment: Page 711 Lines 13: Replace “Correlation is 0.78 and 0.73 with CMDT and SMDT” with “Correlation is 0.78 and 0.73 with SMDT and CMDT”. RMS differences are around 4cm in both cases. What part of the signal variance does it represent? Dispersion around mean slopes of Figure 7 seems quite important for both SMDT and CMDT.

Response: Thank You, this is unfortunate misprint, we corrected it. As You see from the figure, amplitude excursion of dynamic level is about 0.35 m, RMS for in-situ DT in this array is 0.08 m.

Comment: Page 712: Why don't you consider only drifters in low wind conditions as you did for selecting drifters for the SMDT computation? You compute correlations on each single drifter trajectory. Do you always have long enough trajectories to get significant statistics? What is the correlation obtained for the whole trajectories dataset? What is the RMS difference expressed in percentage of the drifter variance.

Response: The main validation purpose was to analyze how good estimated altimetry velocities correspond to in-situ drifter data. That is why all buoys measurements were used. Of course, wind Ekman component will lead to reducing correlation coefficients. We should consider it when analyzing results of comparison. The length of drifter life varies from two weeks to more than year. Correlation obtained for the whole dataset is 0.69 for zonal and 0.61 for meridional. Amplitude excursion of drifter velocities is more than 1 m/s and RMS of all array is 0.177m/s

Comment: Line 21: You find regression slopes greater than 1, which means that altimeter derived velocities are greater than drifter velocities, even though drifter velocities also include the Ekman component. I would have expected the contrary (at least the contrary is usually obtained in the global ocean). How do you explain this result?

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Comment on validation datasets used. You have chosen to take an important amount of data for validation (2002-2009 and 2001-2008), almost as long as the dataset used for computation (1993-2003). Have you tested the impact of using more data for MDT computation?

Response: In fact, there is a misprint on the figure, we already mentioned it (see comment 1 <http://www.ocean-sci-discuss.net/8/C121/2011/osd-8-C121-2011.pdf>). Of course, altimetry-derived velocities is less than in-situ, cause to Ekman drift velocity. In the period used for validation there are too few new in-situ data, and there will be no considerable improvement in MDT field (in our opinion). A lot of buoy data in 1999-2003 is connected with big drifting experiment in Black Sea. After, only few buoys were launched.

Other comments:

All through the text: Replace “methodic” by “method” Lack of pronoms (the)

Page 704 Lines 20 and Page 705 Line1: replace “receive” by “retrieve”

Page 705 Line 7: Replace “All standard correction was applied” by ‘All standard corrections were applied”.

Page 705 Line 10: Replace “Obtained SLA measurements have precision about 3–4 cm, temporal resolution 10-days and spatial 7 km.” by “ Obtained SLA measurements have a precision of about 3-4 cm, a 10 days temporal resolution and a 7 km spatial resolution.”

Page 705 Line 17: Replace “depth..” by “depth.”

Page 705 Line 18: Replace “A temporal resolution” by “Temporal resolution”

Page 706 Line 2 Replace “to a depth 500m” by “to a depth of 500m”

Page 707 Line 13: Replace “project” by “projected”

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Page 707 Line 16: Replace “consisted of” by “made of”

Figure 2: Contradiction between Track number (68) and text on page 707 (track number 84)

Figure 3: Contradiction between caption (track number 84) and plot title (track number 68)

Page 708 Line Replace “Let sea level for each cross point is for track number i is l_i and for track j is l_j , Respectively” by “Let sea level for each cross point be l_{ij} for track number i and l_{ji} for track number j respectively.”

Page 709 Line 1: Inappropriate reference to Figure Page 709 Line 19: Replace “time period after 1992 year characterized” by “time period after 1993 is characterized”

Page 713: Lines 13-14 Replace “Synthetic” method allow to improve mean dynamic topography in future when there will appear new in-situ measurements.” By “The “synthetic” method allows to compute an improved MDT estimate each time new in-situ measurements are available.”

Response: Thanks a lot for your comments. They were really helpful. We have corrected all grammatical errors.

We hope that we answered all questions sufficiently complete. Thanks for the interest You show to our work.

Interactive comment on Ocean Sci. Discuss., 8, 701, 2011.