Ocean Science Discussions

Ocean Sci. Discuss., author comment AC1
https://doi.org/10.5194/os-2021-45-AC1, 2021

Reply on RC1

Vadim Sivkov and Ekaterina Bubnova

Author comment on "Distribution of suspended particulate matter at the equatorial transect in the Atlantic Ocean" by Vadim Sivkov and Ekaterina Bubnova, Ocean Sci. Discuss., https://doi.org/10.5194/os-2021-45-AC1, 2021

Dear Professor McCave

Firstly, we would like to thank you again for your valuable comments, additional references, and help with English.

Secondly, we would like to answer every issue.

14-21:

(1) In the introduction the authors mention the seminal work of Biscaye and Eittreim (1977) who ascribed thick bottom nepheloid layers (BNLs) to upward mixing of SPM, but they should also mention the lateral transfer arguments of Armi (1978) and McCave (1983), the ‘separated mixed layer’ model.

(2) We added both references

(3) The works of Armi (1978) and McCave (1983) pointed out the lateral advection of SPM, which occurs due to detaching of bottom mixed layer from the slope and leads to thickening and layering of BNLs.

52-56:

(1) With so few regional measurements of particle volume by Coulter counter one might ask whether the data presented here are ‘correct’, i.e. whether contamination has been avoided…

(2) After applying the apparent densities of suspended particles from the (McCave, 1983), we obtained the estimated weight SPM concentrations at the Ioffe-2000 transect. The according changes were put at the beginning of the Results Chapter.

(3) The work of McCave (1983) contains both the partly comparable dataset of SPM

volume concentrations with a slightly wider size range (1.26—32 μm), and the apparent particle densities, that lies between 1.65 and 2.23 mg mm-3. Applying these apparent densities to our volume SPM concentrations, we got the implied weight concentrations about 0.016 to 0.35 mg L-1 (up to 0.8 mg L-1 in exceptional circumstances), which agrees with Brewer et al (1976) and Gardner et al. (2018).

174-184:

(1) The authors point to an influence of Amazon River sediments being more important than concentrations at the African end of the transect. Nevertheless, there is a marked high at the African end centred on about 800 m that the authors do not discuss and one wonders whether both might be due to internal wave activity on the upper slope.

(2) We added the lacking discussion

(3) The Ioffe-2000 transect did not reach the SPM-rich shelf waters, yet the coastal SPM source has caused a local SPM maximum at the margins of the transect at a depth of 300–900 m (up to 0.18 ppm in the west and up to 0.09 ppm in the east). It was the Amazon River that caused the more pronounced rise in SPM concentration at the western edge of transect. It is well known that the surface SPM transport from the Amazon River to the open ocean turns to the northeast alongside the coast (Gibbs, 1974). The eastern edge of the Ioffe-2000 transect is located above the gentle slope between 200 m and 2000 m named Guinea Marginal Plateau (Egloff, 1972), adjacent to the high productive Guinea shelf (Vladimirov et al., 1990; Burlakova et al., 1997). Strong currents (Mittelstaedt, 1991; Stramma et al., 2005, 2008) and implied internal wave activity, based on significant density gradients on the shelf (0–200 m) (Sarafanov et al., 2007), may provide a framework for the SPM lateral transport from the shelf along the gentle Plateau slope.

225 et seq:

(1) The authors describe the high mid water concentrations extending down to the bottom over the Sierra Leone rise to the occurrence of aggregates ballasted with Aeolian dust. The concentration zone occurs 1000 km from the coast which is well beyond the zone of coastal upwelling-driven high productivity but does fall in the region of Sahara and Sahelian dust. The authors observe that this column of high concentration occurs under the Guinea dome, a permanent thermal upwelling dome with a cyclonic associated circulation. Other examples of high concentration columns are shown by Biscaye and Eitttreim over Bermuda rise and in the Argentine basin. It seems more likely that the authors observations are related to this circulation feature.

(2) According to Sarafanov et al. (2007), the Guinea Dome cyclonic circulation within the Ioffe-2000 transect was only noticeable within the upper 300 m of the water column, so we believe that it was incomparable with the DWBC that caused the high SPM concentrations shown by Biscaye and Eittreim over Bermuda rise and in the Argentine Basin. Naturally, the circulation in the area of our observations matters, yet we suppose that the entire system of currents, including the Guinea Dome, North Equatorial Current/Countercurrent/Undercurrent and the Canary Current plays a role mostly in the SPM transport from the highly productive area of the Northwest African coast and the region of Sahara and Sahelian dust.

(3) -

286-291:

(1) The intermediate nepheloid layer (INL) downstream of the 'dam'is similar to the INL demonstrated by Tucholke and Eittreim (1974) deep western boundary current flows over the Puerto Rico Trench.

(2) We did put the additional reference in our paper.

(3) One of the most notable similar nephelometric features was described for the Puerto Rico Trench near the Navidad sill (Tucholke and Eittreim, 1974).

301-306:

(1) Lavelle (2012) has shown the effect of midocean ridges on accelerating currents along their flanks, currents which are likely to then lead to resuspension and generation of nepheloid layers.

(2) We added Lavelle (2012) in our paper.

(3) High levels of the SPM concentration were also noted above the MAR. There is the northward recirculation of rich in the SPM NADW (Sarafanov et al., 2007), which was noted both sides of the MAR at 36–40° W and 29–32° W. Another type of currents in the area is tidal currents Morozov (2018). According to Lavelle (2012), both these currents may be accelerated along the flanks of the ridge and represent a significant stirring mechanism for abyssal flow and cause the SPM concentration rise. Moreover, the axial region of the MAR including the rift zone experiences high seismicity and bears a large number of earthquake epicenters as well as the sulfide mineralization zones of various origins and bedrock zones showing strong hydrothermal imprints (Mazarovich and Sokolov, 2002); in particular in the Sierra Leone fracture zone, i.e. immediately below the Ioffe-2000 transect (see Fig. 1). Both high seismicity and strong hydrothermal activity may also be able to cause increased SPM concentrations in the bottom layer.

310-346:

(1) It would be helpful to have a figure in which some of the size distributions were illustrated - cumulative number plots for example.

(2) We thought that the most typical volume-size SPM distributions will be sufficient, but we will add the cumulative number figure as well.

(3) Additional Figure 7.

330-333:

(1) It is not clear how a large Brunt-Vaisala frequency in itself would lead to smoothing of a particle size distribution, but perhaps the authors wish to imply that there might be breaking internal wave-driven turbulence associated with frequency maxima that would promote aggregation.

(2) We paraphrased the paragraph in order to remove uncertainties.

(3) Increased shear in pycnoclines and internal wave-driven turbulence would promote aggregation and lead to a further smoothing of the size distribution (equivalent to a cumulative particle number distribution with a slope of -3) of SPM (McCave, 1984).

Additional references

Burlakova, Z. P., Eremeeva, L. V., & Morozova, A. L. (1997). Suspended matter in the estuaries of the Guinean shelf. *physical Oceanography*, 8(4), 269-283.

Stramma, L., Brandt, P., Schafstall, J., Schott, F., Fischer, J., & Körtzinger, A. (2008). Oxygen minimum zone in the North Atlantic south and east of the Cape Verde Islands. *Journal of Geophysical Research: Oceans*, *113*(C4).

Vladimirov, V. L., Bezborodov, A. A., Martynov, O. V., Ovsyanyi, E. I., & Diallo, B. (1990). Relation between the depth of visibility of a white disk and the concentration of suspended matter in shelf waters off the Republic of Guinea. *Soviet journal of physical oceanography*, *1*(6), 469-474.