

Interactive comment on “Short Commentary on Marine Productivity at Arctic Shelf Breaks: Upwelling, Advection and Vertical Mixing” by Achim Randelhoff and Arild Sundfjord

Anonymous Referee #3

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Review Comments for “Short Commentary on Marine Productivity at Arctic Shelf Breaks: Upwelling, Advection and Vertical Mixing”

This short commentary manuscript brings up a hot and important topic on how wind-driven upwelling, in conjunction with dramatic sea ice loss, may affect ocean productivity on the vast Arctic continental shelves. The authors argued that “shelf break upwelling is likely not a universal but rather a regional, albeit recurring feature of the new Arctic.” I do agree with the authors that regional geographic, atmospheric, oceanographic, and sea ice conditions must be taken into account when assessing pan-arctic upwelling phenomena and their impacts on upper ocean nutrient supply and primary

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production processes. Nonetheless, the authors can better justify their arguments and greatly improve the paper by providing more concrete data analysis and evidence, particularly in the northern Barents Sea shelf where the authors claim upwelling may function differently from other Arctic shelf systems.

Other comments:

Figure 1: The illustrations are too vague and lack important geographic and hydrographic features. In the left panel, I would suggest the following changes: (1) add latitudinal circles and longitudinal lines, (2) use a better color map to illustrate bathymetry (or at least supplement a color bar for the grayscale), (3) draw general surface and bottom circulation patterns.

In section “Many interconnected phenomena”: The authors tried to explain different physical mechanisms that drive upwelling and other physical processes that interact with upwelling. I am uncomfortable that the authors did not attempt to put their discussion in the context of rich literature in upwelling. There is not a single citation in the section, which is unusual.

In section “Drivers of marine productivity vary across the Arctic Ocean”: The authors should provide observational evidence when claiming Beaufort Gyre region is “one of most nutrient-depleted regions of the world ocean”.

Figure 2: Please mark corresponding transect in Fig 1 left panel. Why not plotting temperature, salinity and density fields in this transect all together so that readers can better interpret Atlantic and Arctic water masses, vertical mixing, thermal or haline stratification? How many CTD profiles were casted along this transect? Please mark the CTD cast locations. What were the wind conditions during this transect sampling? I think wind diagnosis would be critical in answering whether or not vertical mixing was caused by upwelling.

Figure 3: This is not an effective way to illustrate wind patterns. Did black dots repre-

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sent speeds of east wind component? So only those with 3 m/s or more were showed in the figure? How often were the wind measured? The author stated “only 2% of all summer days through the last 30 years can be considered upwelling-favorable”, but what’s the sample size in total? It didn’t look to me that 30-year wind measurements were included in the analysis given this few data points. To demonstrate seasonal differences in wind patterns and highlight the summer season, a plot of four wind roses that aggregate seasonal wind measurements might be more informative and illustrative.

In section “Summertime upwelling north of Svalbard?”, the argument is unconvincing without showing results from mooring or ship-based hydrographic measurements. Personal communication is not sufficient.

In section “Climate Change and the Future of Arctic Marine Productivity”, I think another relevant point is the changing phytoplankton abundance and species composition in response to changing hydrography and nutrients. I would suggest the authors to briefly touch on this point. Two examples are: 1) Li, W. K. W., F. A. McLaughlin, C. Lovejoy, and E. C. Carmack (2009), Smallest algae thrive as the Arctic Ocean freshens, *Science*, 326, 539; 2) Li, W. K. W., E. C. Carmack, F. A. McLaughlin, R. J. Nelson, and W. J. Williams (2013), Space-for-time substitution in predicting the state of picoplankton and nanoplankton in a changing Arctic Ocean, *J. Geophys. Res. Ocean.*, 118(10), 5750–5759.

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