

Interactive comment on “Modeling the impact of riverine DON removal by marine bacterioplankton on primary production in the Arctic Ocean” by V. Le Fouest et al.

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We first would like to thank the referee for her/his relevant comments and suggestions. The constructive comments of the referee were very helpful to improve the quality of the manuscript. In what follows, the referee's comments are reminded in bold and italic police of character, whereas our responses are given in normal police character. Note that the line numbers mentioned in our response refer to those of the submitted version of the manuscript. New references cited in our responses are given at the end of each comment.

1. “Primary producers were divided into two groups depending on size. This is a

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bit simplistic as different groups of phytoplankton can have big impact on several key parameters independent of size; but perhaps this covers the major groups of relevance for this region”

Response #1: In the model, large phytoplankton (LP) encompass diatoms (single and chain-forming), large dinoflagellates and large nanophytoplankton cells, whereas small phytoplankton (SP) accounts for small nanophytoplankton and picophytoplankton. This simplification, even imperfect, is required to reduce the uncertainty related to the biological parameters assignment and to the resulting simulated fluxes of nitrogen. Nevertheless, it encompasses the major phytoplankton groups relevant for plankton dynamics and biogeochemistry in the Arctic waters (e.g. Li et al., 2009; Coupel et al., 2012). Moreover, size-fractionated chlorophyll is a common measurement that permits to assess the predictive ability of biological models applied to the AO (e.g. Le Fouest et al., 2013). We added a sentence in section 2.3 (page 16959, L 6) to take into account the referee's comment: “These two compartments encompass the major phytoplankton groups relevant for plankton dynamics and biogeochemistry in the Arctic waters (e.g. Li et al., 2009; Coupel et al., 2012).”

Coupel, P., Jin, H. Y., Joo, M., Horner, R., Bouvet, H. A., Sicre, M.-A., Gascard, J.-C., Chen, J. F., Garçon, V., and D. Ruiz-Pino (2012), Phytoplankton distribution in unusually low sea ice cover over the Pacific Arctic, *Biogeosciences*, 9, 4835-4850; Le Fouest, V., B. Zakardjian, H. Xie, P. Raimbault, F. Joux, and M. Babin (2013), Modeling plankton ecosystem functioning and nitrogen fluxes in the oligotrophic waters of the Beaufort Sea, Arctic Ocean: a focus on light-driven processes, *Biogeosciences*, 10, 4785-4800; Li, W. K. W., McLaughlin, F. A., Lovejoy, C., and E. C. Carmack (2009), Smallest Algae Thrive As the Arctic Ocean Freshens, *Science*, 10.1126/science.1179798.

2. “Zooplankton groups are also simplified, but probably fulfill the need in this model”

Response #2: Mesozooplankton and protozooplankton represent the main plankton consumers. However, it should be stressed that in the Western Arctic euphausi-

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ids (macrozooplankton) can play an important role on plankton dynamics and carbon fluxes (e.g. Berline et al., 2008). If not explicitly considered as a state variable for nitrogen fluxes, their effect on mesozooplankton biomass is implicitly taken into account through a quadratic mortality term of mesozooplankton (page 16972, L11).

Berline L., Spitz Y. H., Ashjian C. J., Campbell R. G., Maslowski W., and S. E. Moore (2008), Euphausiid transport in the Western Arctic Ocean, *Marine Ecology Progress Series*, 360, 163-178.

3. "In most places it seems the RIV run of the model does not even meet measured BP, and I was missing some more discussion on why that is. Is there an underestimate of DON available or something else not accounted for in the model?"

Response #3: A discussion is added to account for the referee's comment (page 16965, L 18): "In addition to the usable RDON flux into coastal ocean, autochthonous sources of DONI are important in fueling BP. Despite improved BP estimates simulated in RIV run, the rates remain within the lower range of the observations. It can result from unresolved sources of DONI within the model such as ice-edge and under ice phytoplankton blooms (Arrigo et al., 2012; Perrette et al., 2011), and from missing biological processes like mesozooplankton sloppy feeding and viral lysis."

Arrigo, K. R., Perovich, D. K., Pickart, R. S., Brown, Z. W., van Dijken, G. L., Lowry, K. E., Mills, M. M., Palmer, M. A., Balch, W. M., Bahr, F., Bates, N. R., Benitez-Nelson, C., Bowler, B., Brownlee, E., Ehn, J. K., Frey, K. E., Garley, R., Laney, S. R., Lubelczyk, L., Mathis, J., Matsuoka, A., Mitchell, B. G., Moore, G. W., Ortega-Retuerta, E., Pal, S., Polashenski, C. M., Reynolds, R. A., Schieber, B., Sosik, H. M., Stephens, M., Swift, J. H. (2012), Massive phytoplankton blooms under Arctic sea ice, *Science*, 336, 1408, doi:10.1126/science.1215065; Perrette, M., Yool, A., Quartly, G. D., and E. E. Popova (2011), Near-ubiquity of ice-edge blooms in the Arctic, *Biogeosciences*, 8, 515-524, doi:10.5194/bg-8-515-2011.

4. "The text is generally well written but with some unnecessary long and difficult sen-

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tences. For example this sentence from the Abstract: "In this study, in order to elucidate on the processes regulating the production of phytoplankton (PP) and bacterioplankton (BP) and 5 their interactions, we employ a biogeochemical model coupled to a pan-Arctic ocean-sea ice model (MITgcm) to explicitly simulate and quantify the contribution of usable dissolved organic nitrogen (DON) drained by the major circum-Arctic rivers on PP and BP in a scenario of melting sea ice (1998–2011)." In my opinion, breaking up these types of sentences into two sentences would increase the readability, but this is a matter of personal preference."

Response #4: The sentence was shortened accordingly: "In this study, we employ a biogeochemical model coupled to a pan-Arctic ocean-sea ice model (MITgcm) to elucidate on the processes regulating the production of phytoplankton (PP), bacterioplankton (BP), and their interactions. The model explicitly simulates and quantifies the contribution of usable dissolved organic nitrogen (DON) drained by the major circum-Arctic rivers on PP and BP in a scenario of melting sea ice (1998–2011)". Careful attention will be paid for too long sentences that would need to be shortened in order to improve the reading of the manuscript.

5. "P16962 L12: "The PP increase it tightly linked.." should 'it' be changed to 'is'?"

Response #5: The sentence has been corrected accordingly (page 16962, L12): "The PP increase is tightly linked to a higher bacterioplankton activity that promotes RDON recycling into nutrients usable by both phytoplankton and bacterioplankton."

Interactive comment on *Biogeosciences Discuss.*, 11, 16953, 2014.

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