We appreciate the thoughtful and helpful comments on our manuscript. Please find our reply below. The comments and questions from the reviewer are given in black color and our answers are given in blue color.

(1) One of them is enhancing the vertical biomass mixing into the euphotic zone so that sustains the primary production. Another way is by vertical mixing diluting the biomass so that reducing the productivity. The latter process seems to not be well discussed in the current version of the manuscript.

We agree. Both mechanisms (i.e. pumping up nutrients & dilution of biomass out of euphotic zone) play a significant role in modulating the tidal response of productivity. However, the impact of tidal mixing on phytoplankton biomass distribution resulting in a lower productivity has only been explored in the discussion of the negatively responding southern North Sea (line 385- 392 in the submitted version) and while discussing the impact of the spring neap cycle (see Fig.10g and Fig.10c and in the respective discussions line 516- 530). Our discussion in the submitted version is indeed a bit too brief and we will further expand the discussion in the revised version to hopefully clarify the involved processes.

In the following the mechanism is exemplarily further explored corresponding to Fig.10g and Fig.10c. During spring tide (depicted by high values in black line), increased mixing results in less phytoplankton biomass in the upper layer and more biomass in the lower layer. Enhanced vertical mixing during spring tide dilute the phytoplankton cells in the upper layer and redistribute them more evenly in the whole water column, thereby reducing productivity. For Fig.6, we also supplemented a plot below, which shows the time evolution of vertical distribution of phytoplankton biomass at the representative point in *neg.SNS* (the same grid cell plotted in Fig.6 a,b,c,d). It shows that the tidal mixing smoothed the vertical gradient of phytoplankton biomass; in contrast, in the non-tidal scenario, the phytoplankton biomass tends shows higher concentrations in the upper layer.

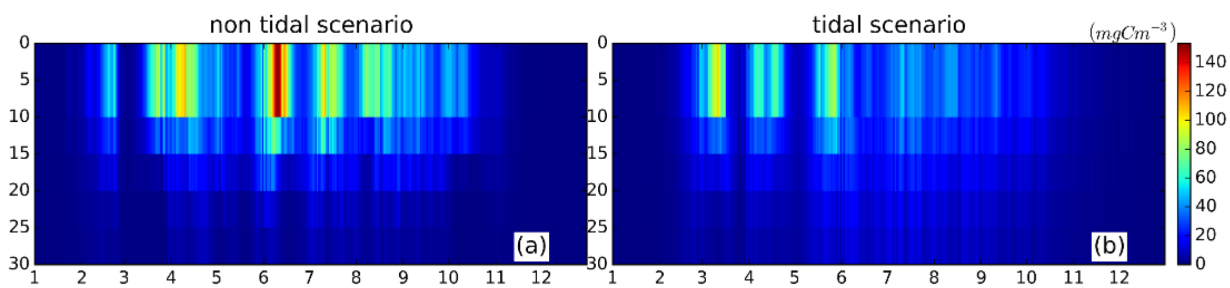

Figure R1: Time series of averaged (1990-2015) biomass vertical profiles in the representative grid cell of subdomain *neg,SNS*.

We will further expand the discussion in the revised version to hopefully clarify the involved processes.

(2) A point of view as a modeler, I am somehow confused with the meaning of the spatial resolution 6' x 10' (line 91) because a) no unit associated with, and b) it is not the comment way we are using.

The model uses a spherical coordinates. To make this more clear we change the sentence into "The model was formulated on a staggered Arakawa-C grid using spherical coordinates, with a spatial resolution of 6′ in latitude and 10′ in longitude.

(3) Line 138, "southern coast" is not clear to understand

Yes, we agree that this term is ambiguous. In the updated version, we change it as 'European continental coast

(4) Between line 197-204, authors divided the North Sea into three subdomains by tidal forcing, and then further separate it with positive net primary production and negative one. After, authors separate the southern North Sea into EC and outside of EC, separate the northern North Sea into NT and the deeper area. Those of sentences are not clear until figure 4 is mentioned. Please make it clear.

Yes, we agree that this is somewhat unclear. In a revised version of the manuscript we will make the logic of sub-area division more clear and reconstruct the paragraph: "The pre-division of the area into subdomains is based on a combination of geographic location, bathymetry and the local responses of NPP to tidal forcing (increase, decrease). First, SNS and NNS were divided by the 65 m isobath. In the SNS, areas with positive and negative NPP response to tides were separated. The negatively responding area in the SNS was further geographically divided into the English Channel (*EC*, south of 52°N) and an area along the continental coast (*neg.SNS*). In the NNS, the area of the Norwegian Trench (*NT*) was separated, which was characterized by a water depth deeper than 200 m. The remaining region of the NNS was further divided based on the response of NPP to tidal forcing. The area along the eastern British coast (*BC*) showing elevated NPP in response to tides was separated from the negative responding area in the middle of NNS (*deep NNS*). In the east of the NNS, an area with mild increase of NPP was identified (*low-sen. NNS*)."

(5). Line 219 – 226 also makes confuse to me. It looks like the authors want to further discuss the described impact on/before line 218. The descriptions, however, didn't well expound. For example, the definition of stratification is defined by the vertical seawater temperature difference reaching to 0.5 deg-C; however, why 0.5 deg-C is using here didn't explain. Also, how the averaged MLD can be used to measure the depth of stratification needs to be stated.

In coastal and shelf seas, stable stratification with lighter water above heavier water emerges as a consequence of an increase in buoyancy from surface heating and/or freshwater input counteracting mixing processes (from tides, waves, winds). Once stratification establishes, the water column form a layer, which separated the upper surface mixed layer from the deep water and acts as a barrier that dampens vertical mixing and exchange of materials. Except for regions of fresh water influence (ROFI) the dominant reason for stratification is surface heating, which has a strong seasonal cycle in the North Sea resulting in seasonal stratification pattern (Schrum et al., 2003). That is why we use the temperature difference to identify the depth of the surface mixed layer (MLD) to quantify the stratification. The difference of temperature reaching 0.5 ℃ between surface and layers below is a criterion we have chosen to identify the onset of stratification and mixed layer depth. The same method has also been used in many other studies (Gong et al., 2014; Karl and Lukas, 1996; Lefèvre et al., 1994;

Richardson et al., 2002; Sharples et al., 2006). This will be clarified in a revised version of the manuscript.

(6). Line 229 – 237 and line 280 needs to well describe.

Lines 229-237 will be rewritten as : " The onset of the spring bloom, the establishment of stratification and sufficient light conditions were estimated in days of the year for each grid point for each simulation year; subsequently the percentage of years with advanced and/or delayed responses to tidal forcing were estimated for each grid point. The increase/decrease of winter zooplankton and peak amplitude of spring bloom after applying tidal forcing, were also recorded for each grid cell for each year. Subsequently, we obtained the spatial pattern of percentage of years with 1) higher amplitude of the spring bloom, 2) later onset of the spring bloom, 3) later onset of stratification, 4) deeper mixed layer depth, 5) later occurrence of sufficient light conditions for building phytoplankton biomass, and 6) higher concentration of winter zooplankton in response to tidal forcing (tidal scenario vs. non-tidal scenario)."

Line 280 will be rewritten as: "In addition to tidal forcing, atmospheric forcing and bathymetry modulates stratification (Van Leeuwen et al., 2015) and productivity pattern (Daewel and Schrum, 2017); consequently tidal impacts on stratification and hence primary production are subject to spatial-temporal variability."

Reference

Daewel, U. and Schrum, C.: Low-frequency variability in North Sea and Baltic Sea identified through simulations with the 3-D coupled physical-biogeochemical model ECOSMO, Earth Syst. Dyn., 8(3), 801–815, doi:10.5194/esd-8-801-2017, 2017.

Gong, X., Shi, J. and Gao, H.: Modeling seasonal variations of subsurface chlorophyll maximum in South China Sea, J. Ocean Univ. China, 13(4), 561–571, doi:10.1007/s11802-014-2060-4, 2014.

Karl, D. M. and Lukas, R.: The Hawaii Ocean Time-series (HOT) program: Background, rationale and field implementation, Deep Sea Res. Part II Top. Stud. Oceanogr., doi:10.1016/0967-0645(96)00005-7, 1996.

Van Leeuwen, S., Tett, P., Mills, D. and Van Der Molen, J.: Stratified and nonstratified areas in the North Sea: Long-term variability and biological and policy implications, J. Geophys. Res. C Ocean., 120(7), 4670–4686, doi:10.1002/2014JC010485, 2015.

Lefèvre, D., Bentley, T. L., Robinson, C., Blight, S. P. and Williams, P. J. l. B.: The temperature response of gross and net community production and respiration in time-varying assemblages of temperate marine micro-plankton, J. Exp. Mar. Bio. Ecol., doi:10.1016/0022-0981(94)90005-1, 1994.

Richardson, A. J., Pfaff, M. C., Field, J. G., Silulwane, N. F. and Shillington, F. A.: Identifying characteristic chlorophyll a profiles in the coastal domain using an artificial neural network, J. Plankton Res., 24(12), 1289–1303, doi:10.1093/plankt/24.12.1289, 2002.

Schrum, C., Siegismund, F. and John, M. S.: Decadal variations in the stratification and circulation patterns of the North Sea. Are the 1990s unusual?, ICES Mar. Sci. Symp., 2003.

Sharples, J., Ross, O. N., Scott, B. E., Greenstreet, S. P. R. and Fraser, H.: Inter-annual variability in the timing of stratification and the spring bloom in the North-western North Sea, Cont. Shelf Res., 26(6), 733–751, doi:10.1016/j.csr.2006.01.011, 2006.