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Comment

***Interactive comment on “Light availability in the coastal ocean: impact on the distribution of benthic photosynthetic organisms and contribution to primary production” by J.-P. Gattuso et al.***

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General Comments: This is a very important paper, summarizing benthic primary production, a potentially critically important component of coastal ecosystems that has not received great attention in the past, especially at the basin to global scale. This manuscript provides a rigorous global analysis of the light reaching the continental shelf seafloor, a thorough compilation of light requirements and light - productivity relationships for benthic autotrophs and an analysis of the global importance of net benthic community production. Overall, this is an important contribution which will help high-

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light the potential role benthic primary production may play in coastal ecosystems.

I have two general comments that may require additional discussion and/or explanation.

1. In the Abstract, Conclusions and in the text, the authors repeatedly identify currently limited satellite data, along with biological information and improved reflectance to irradiance relationships, as a major limitation to improving estimates of benthic primary production. While better satellite data may provide some improvement, I feel that this is not the major limiting factor at present. Rather, I believe in situ measurements, at or very near the sea floor, are needed to significantly improve these estimates. This is of critical importance for evaluating sea floor light levels because particles in the benthic boundary layer (e.g. benthic nepheloid layer) may significantly reduce light fluxes at the bottom. Increased turbidity due to benthic particle resuspension and nepheloid layer formation will not be observed by satellite or secchi disc, can not be incorporated into satellite-derived and secchi disc-derived attenuation coefficient analysis and light flux estimates and may be highly variable in time. While either better satellite or better in situ data can lead to improved estimates of bottom irradiance, greatest return in improving accuracy in benthic light flux values will come from incorporating in situ observations into this analysis to provide even limited ground truth.

2. The authors choose to evaluate benthic primary production in terms of the compensation irradiance for organism growth ( $P > R$  for individual organisms) and the compensation irradiance for community metabolism ( $P > R$  for the benthic community). The later term is used as the "relevant parameter for estimating the areal extent of benthic primary producers" (line 325 and highlighted in the Abstract). While this is certainly one of many ways of evaluating the extent and role of benthic primary production in coastal ecosystems, I think that it is a very high threshold for evaluating "relevance" and that the authors should acknowledge this clearly. There are several consideration here.

Sediments are not a closed system with respect to organic carbon (OC). They receive significant amounts of OC produced in the water column and may also lose OC by grazing at the sediment surface, particle resuspension, DOC loss, etc. Generally, however, sediments are thought to import OC from the water column and heterotrophic respiration rates equivalent to 25% of the water column production rate are commonly reported for shelf areas. Since it is not possible to separate respiration by organism group (autotroph vs heterotroph) in field measurements, total community respiration (not just autotrophic community respiration) may be used which would not lead to an appropriate assessment of net benthic community production. Another way to assess the use of NCP as the threshold for relevance in a coastal ecological context is to consider the analogous situation of continental shelf waters adjacent to a river mouth that supplies nutrients and dissolved organic carbon (DOC) to those waters. The nutrients may support primary production most of which is subsequently respired. The DOC discharge also supports respiration that when added to the respiration of locally produced organic matter may exceed local primary production rates. In this hypothetical example,  $R > P$  and yet few of us would conclude that production in the river plume is not "relevant" to the shelf ecosystem. Yet that is the level used here to evaluate the "relevance" of benthic production.

Additionally, is the issue of temporal variability. It is likely that benthic and water column production vary temporally in different ways in response to external factors. It is reasonable to hypothesize that when water column biomass is largest (and probably intercepts the greatest proportion of light flux), benthic production is lowest. Alternatively, when the water column is extremely oligotrophic, benthic light flux may be greatest and, since pore water nutrients are generally available, benthic production may be highest. It is possible, therefore, that benthic production could be very important to coastal ecosystems by providing a source of OC to the community during oligotrophic periods and yet not contribute a large portion of the annual total production. This is hypothetical, of course, but again points out a limitation of using the  $P > R$  threshold as a measure of relevance.

I sympathize with the authors that there is no simple measure by which to evaluate benthic primary production in an ecological context and using a variety of measures may be best. My main point is that the authors have selected a threshold for "relevance" that is very high and could easily be misinterpreted by other readers. In reality, the coupling of pelagic and benthic systems is sufficiently dynamic and extensive in shallow coastal systems, that arbitrary separations lead to confusion. At the coastal ecosystem level, I feel that the community should be assessed in term of total productivity (water column plus benthic) relative to total respiration (water column plus benthic) and that this would provide a more meaningful measure of the state of coastal ecosystems. Most ecological models of coastal systems to date include water column production, water column respiration and benthic respiration but few include benthic production. In this context, reporting gross benthic production not just NCP would also be very helpful.

#### Specific Comments:

line 110. I am not sure this method would consistently "overestimate" the diffuse attenuation coefficient since it can not incorporate vertical variations in turbidity such as might be caused by a bottom nepheloid layer.

line 238. The authors discuss the drawbacks of using annual average images and mention seasonal variations in chlorophyll. However, in the coastal setting, there are many possible sources of temporal variability such as variations in river discharge, variations in wave height and resulting sediment resuspension, water column stratification, etc. A more representative list would be useful here.

line 249. The authors mention that among the impediments to accurate chlorophyll estimates from ocean color remote sensing is the presence of CDOM. Again, in coastal settings, many factors may impede the accuracy of remotely sensed estimates of chlorophyll. For example, on the Georgia continental shelf, the upper 2.5 mm of the sediments (approximate sea floor photic zone) generally contains as much chlorophyll

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as the entire overlying water column and yet is mostly invisible to remote sensing. It seems that this is a fundamental impediment that can not be overcome through modification of satellite algorithms.

Technical Corrections:

line 76. Define and estimate impact of "registration error"

line 94. Edit, explain or remove reference to "David" etc.

line 159. Should use a model II regression analysis since there is uncertainty in both variables.

lines 270- 275. I am not sure of the purpose of these lines since the Jahnke et al. reference explicitly relates benthic primary production to absolute light flux on a  $\text{Ein m}^{-2} \text{ hr}^{-1}$  basis (see their Figure 5).

line 323. In this section, the authors conclude that  $E_c$  growth and  $E_c$  comm are the relevant irradiance-thresholds for benthic communities - see general comment #2.

lines 644, 654 & 1000. "Richard" should be "Richards"

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