Review of Kelly-Gerreyn et al. "Benthic biomass spectra in shelf and deep-sea sediments"

The manuscript by Kelly-Gerreyn et al. describes a study on the relation between body size and biomass of benthos in three contrasting deep-sea locations. For each location, a comprehensive data set was acquired on the spectrum of abundance and biomass in each size class (i.e. the Benthic-Biomass-Size-Spectrum). Each BBSS was fitted with a relatively simple mass balance model for each size class, originally developed by Peters (1983), in which the processes ingestion, respiration and mortality are allowed to scale allometrically with body size. All size classes share a common resource: sedimentary detritus. In the fitting procedure, the model parameters are estimated to optimally reproduce the observed BBSS. The trend of an increasing biomass with is captured by the model fits. The paper is well-written and contains unique data on the BBSS of deep-sea ecosystems. Although the allometric model is not novel, its application to deep-sea benthos is and therefore the manuscript is of interest for Biogeosciences. However, there are a number of major and minor points that need to be addressed before I can recommend the manuscript to be accepted for Biogeosciences.

Major points:

1. The main research question is whether the general trend of increasing total biomass with larger size classes can be reproduced with an allometric model. The model captures this trend reasonably well. In the original model of Peters (1983) however, this trend is reversed (i.e. more biomass in the smaller size classes). Since the model structure and assumption of allometric scaling is the same, I would like to see a more thorough discussion of what controls the slope. The authors make a start at the beginning of the discussion, from which it appears that their model can fit different slopes by changing the strength of the allometric scaling of one or more metabolic processes (ingestion, respiration or mortality). However, the metabolic theory of ecology (MTE) (and also Peters in his original model) essentially assumes that allometric scaling is essentially invariant for metabolic processes. How do the authors reconcile this? (see also remark 8 related to the paper by McClain et al. 2012).
2. Although the model describes the overall trend fairly well, the data show however clear peaks in the BBSS (especially FG and OM). Yet, the authors seem to ignore these peaks in their paper and claim that the data “suggest a continuous increasing distribution of biomass across the size classes studied” (pg 920, ln 17-18). Why did the authors not test whether the data are better fitted with a bi- or trimodal distribution? Since the model cannot reproduce such peaks in the BBSS, it seems premature to conclude that the model accurately fits the data.
3. The authors indicate that the model parameters cannot be fitted uniquely because the fitting procedure returns quite large ranges for the ‘optimal’ parameter values. I agree here, but would like to know which parameters are correlated so that it becomes clear which empirical data are missing (and need to be collected in the future) to uniquely identify the model parameters.
4. It is unclear to me how the authors perceive the role of Foraminifera in the model. On pg 908, ln 20-25 and pg 910, ln 19 it seems that they claim that Foraminifera are (like bacteria) not included in the model because they belong to a size class that is not considered in the study. Yet, the lower sieve size that was used for meiofauna collection (0.45 um) does retain deep-sea foraminifera (Moodley et al. 2002), so the BBSS misses the biomass of the foraminifera. At the same time, the ludox extraction method is known to under-sample foraminifera.
5. The specific degradation rate of the organic matter is difficult to assess from the ranges that are given on pg 919-920, but it is clear that the annual flux is higher than the carbon stock. This implies a turnover rate of organic matter utilised by fauna of >1 $yr^{-1}$. This value is highly unlikely for sedimentary organic matter in the deep sea (Middelburg 1989, Rothman and Forney 2007),

even when considering that benthic fauna feeds on relatively fresh material only. A discussion on this aspect is needed, in particular because the authors suggest that their model may be used to study seasonality (pg 920 ln 15-16).

6. The authors miss two relevant papers on metabolic scaling of respiration of deep-sea fauna. Mahaut et al. (1995) describes allometric relations for shallow and deep-sea benthic fauna. Another key paper that is missing is that of McClain et al. (2012), who presents one of the most extensive data sets on respiration by deep-sea fauna. Amongst others, they find that respiration decreases stronger with body size than growth/production, which seems to contrast with the parameter values in Table 3/5.
7. What is also missing is reference to and comparison with relevant studies on the food web structure at the respective sites. Pg 920, ln 4 “unfortunately, we have no suitable data to compare these values to”. However, the paper by Billett et al. 2006 (which is cited earlier on) for OM and the papers by Gontikaki and co-authors for the FSC (Gontikaki et al. 2011a, Gontikaki et al. 2011b, Gontikaki et al. 2011c) give relevant information on the food webs of the study areas.
8. Finally, I would like to see a figure with fluxes through the different comps at each station. The authors show that biomass may increase per size class, but C fluxes may show an inverted trend because of the higher metabolic activity.

Minor points:

- Will the data be made publicly available through an online database (e.g. Pangaea)?
- pg 902, ln 14-15, unclear sentence
- pg 905, ln14, It would be useful to give the size classes here.
- pg 905, ln 26: Is ref Wilde et al. 1986 the same as De Wilde et al. 1986, two line up?
- pg 909, ln 25-26: “lost *from* the system”
- pg 917,ln 6-9: these two sentences seem to have the same message
- pg 935, Table 2. I presume that all the exponents should have a “-“ sign? For example, the geometric mean of size class 5 should be $8.4 \times 10^{-7}$ instead of $8.4 \times 10^{7}$.
- pg 938, Table 5. Caption says “Scaling parameters…”, but I presume that only the values for *b* are given here.
- Pg 939, Fig 1, the location “OM” seems to be on-land?

# References

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