Earth Syst. Sci. Data Discuss.,
https://doi.org/10.5194/essd-2018-52-AC2, 2018

Open Access Earth System Science Data Discussions

Interactive comment on "A global compilation of coccolithophore calcification rates" *by* Chris J. Daniels et al.

Chris J. Daniels et al.

a.poulton@hw.ac.uk

Received and published: 25 August 2018

RC2 (Anonymous)

General comments: Daniel et al. have created a global dataset of field calcification rates by coccolithophores. This dataset will be extremely useful to the scientific community and should be published. The manuscript is well written and the figures are clear and describe the dataset well. I have a few comments and suggestions below, but overall the manuscript is in great shape and I recommend publication after minor revisions.

2.1 Authors: We thank the reviewer for their positive comments and respond to their specific comments below.

Printer-friendly version

Discussion paper

Specific comments:

Line 38: excessive “the” before “coccolithophores”

2.2 Authors: Changed.

Line 63: Biocalcification is also poorly constrained due to data limitations (e.g., satellite derived PIC only sees the surface and is tuned to capture E. hux and not other species)

2.3 Authors: This is already covered later in this section (Lns 75-94).

Line 84-86: Might want to also mention that the E hux morphotype B/C, which dominates the Southern Ocean (Charalampopoulou et al. 2016), is particularly lightly calcified and the PIC algorithm overestimates PIC in the Southern Ocean due to the unique reflectance properties of E hux B/C (see Holligan et al., 2010)

2.4 Authors: Now added to Lns 88 to 89.

Line now reads:

‘Relatively small differences in the CaCO3 content of the various E. huxleyi morphotypes (Young et al., 2003; Poulton et al., 2011; Charalampopoulou et al., 2016) can have significant impacts in terms of the satellite-retrieval of PIC concentrations (Holligan et al., 2010) and CaCO3 formation at the scale of mesoscale blooms (Poulton et al., 2013).

Reference added:

Holligan, P.M., Charalampopoulou, A., and Hutson, R: Seasonal distribution of the coccolithophore Emiliania huxleyi and of particulate inorganic carbon in the surface waters of the Scotia Sea, J. Mar. Sys., 82, 195-205, 2010.

Line 97: Unclear who “their” is referring to. Either delete it or replace it with coccolithophore”, if you are just referring to coccolithophore calcification.

2.5 Authors: Apologies, a mistake on our part. ‘Their’ is now deleted.

Line 105: Perhaps add to this citation list: two recent reviews by Balch (Annual Review in Marine Science) and Krumhardt et al. (Progress in Oceanography) – see ref list at the end of this document for complete citation.

2.6 Authors: Both now added to this section.

Ln now reads:

'. . .reviewed numerous times (see Paasche, 2002; Zondervan, 2007; Boyd et al., 2010; Raven and Crawfurd, 2012; Monteiro et al., 2016, Taylor et al., 2016' Krumhardt et al., 2017; Balch et al., 2018).'

References added:

Balch, W.M.: The ecology, biogeochemistry and optical properties of coccolithophores, Ann. Rev. Mar. Sci. 10, 71-78, 2018.

Krumhardt, K.M., Lovenduski, N.S., Iglesias-Rodriguez, M.D., and Kleypas, J.A.: Coccolithophore growth and calcification in a changing ocean, Prog. Oceanography, 159, 276-295, 2017

Line 238: There is a left open parenthesis in this sentence and it's a bit confusing. I suggest a rewrite: "From these profiles, depth-integrated values were calculated to represent euphotic zone integrated CP in which the euphotic zone is taken as either 1% (e.g. Poulton et al., 2006) or 0.1% (e.g. Balch et al., 2011) of incident irradiance in the different studies."

2.7 Authors: We agree and have changed as suggested.

Line 252: Is there an extra "of" after "surface"?

2.8 Authors: Yes, now removed.

Line 358: I'm confused about this range of global CP estimates. It is indeed highly uncertain but 8 Gt C yr-1 seems way too high. I'm not seeing this value in the references

that are cited. Another more recent reference that would be an upper end of the range would be Smith and Mackenzie, 2016 (2.1 Gt C yr-1)

2.9 Authors: We apologise for a typo in this line, 8 Gt C yr-1 should read 1.8 Gt C yr-1 (based on Berelson et al. (2007)'s range of modelled PIC export from the surface). Overall this section aims to highlight the uncertainty in current budgets and provide a simple estimate of CP from the in situ measurements (rather than provide a full overview of global CP). The 2.1 Gt C yr-1 by Smith & Mackenzie (2016) actually includes both plankton production (1.6 Gt C yr-1) and shelf benthos production (0.5 Gt C yr-1). To avoid confusion, we now give the range as 0.4 to 1.6 Gt C yr-1 (to reflect the general agreement between Balch et al. (2007), Berelson et al. (2007) and Smith & Mackenzie (2016)) for pelagic plankton production.

The line now reads:

'.. with estimates ranging from 0.4 to 1.6 Gt C yr-1 (Balch et al., 2007; Berelson et al., 2007; Smith & Mackenzie, 2016).'

Reference added:

Smith, V.S., and F.T. Mackenzie: The role of CaCO3 reactions in the contemporary oceanic CO2 cycle. Aquatic Geochemistry, 22, 153-175, 2016.

Figure 5 (and maybe elsewhere): Since coccolithophores are well known to be quite seasonal, perhaps point out that the points on the maps are not separated by season but are all measurements are included on these maps regardless of the time of year the CP measurement was taken. Due to the seasonal bias in the dataset we could almost see this as a "growing season snapshot" (?)

2.10 Authors: Indeed, with this in mind we have now added a line to the Figure 5 legend (see below) and a new line (see below) in section 3.2.1 (@ Ln 307). In terms of 'growing season snapshot', it would be tempting to agree and overplay this but the 25 year period over which the measurements have been collected warrants a very careful

consideration of such a 'snapshot'.

Line added (@ Ln 307):

'Some of this variability arises due to a lack of temporal resolution in Figure 5, where 25 years of measurements are plotted alongside one another, with a recognisable seasonal bias towards summer in both hemispheres (Section 3.1).'

Figure 5 Legend now reads:

'Global maps of (A) surface CaCO3 production (CP), and (B) euphotic zone integrated CP. Global maps superimposed on ocean bathymetry as in Fig. 1A. Note: Global maps represent all measurements and are not temporally resolved.'

Line 375: Is cell-CP really a measure of calcification per unit biomass? Cell size and organic carbon content in coccolithophores can vary between species and under changing environmental conditions (see POC-normalized growth rates in Krumhardt et al., 2016 [2017] and volume normalization in Muller et al., 2017)

2.11 Authors: Indeed, many measures of coccolithophore cell biomass (cell size, biovolume, organic content, inorganic content) do vary with environmental conditions, as well as having a natural population range (rather than a fixed value) for all species in mixed communities. None of these are routinely measured (or reported), whereas most often coccolithophore cell counts do accompany coccolithophore studies. There are also recognised difficulties in estimating cell (organic) biomass (or coccosphere biovolume) for diverse field communities (O'Brien et al., 2016) or in the case of culture-based studies from extant bacteria.

Ideally it would be good to normalise measurements of CP to community calcite (from cells, not detrital) and examine differences in growth rates (see Poulton et al., 2010); however, this has several difficulties for mixed communities in terms of weighted means and potential variability in growth rates and relative abundances (see Daniels et al., 2016). In light of these (potentially current) difficulties we have normalised to cell abun-

Printer-friendly version

Discussion paper

dance as a first order measure of (a) whether the CP rates are physiologically realistic, and (b) a (admittedly very rough) index of the relative CP rates between different communities.

Line 394: Southern Ocean E hux morphotype B/C approaches this low cell-CP (Figure 1i in Muller et al., 2015, converting from pg C cell-1 d-1 to pmol cell-1 d-1)

2.12 Authors: Good point, though we note that in this case the growth rates are relatively low (<0.1 d-1).

We have now changed Ln 394 to: 'Thus, samples in Figure 8 with a cell-CP lower than this value could be dominated by slow growing (<0.1 d-1) low-calcite morphotypes of E. huxleyi (see Müller et al., 2015) or coccolithophore species with much lower . . .'.

Reference added:

Müller, M.N., Trull, T.W., and Hallegraeff, G.M.: Differing responses of three Southern Ocean Emiliania huxleyi ecotypes to changing seawater carbonate chemistry, Mar. Ecol. Prog. Ser. 531, 81-90, 2015.

Interactive comment on Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2018-52, 2018.

Printer-friendly version

Discussion paper