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Comment

Interactive comment on “Coccolithophore surface distributions in the North Atlantic and their modulation of the air-sea flux of CO₂ from 10 years of satellite Earth observation data” by J. D. Shutler et al.

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Received and published: 14 July 2012

Shutler et al (2010) developed an algorithm to improve the climatology of coccolithophores in shelf seas and coastal zones, using spectral properties of suspended calcite to investigate their frequency and distribution. The present paper extends the use of this approach over the North Atlantic Ocean to investigate the occurrence of coccolithophore blooms, determine their surface areas from April to August over a period of 10 years and correlate these numbers with ENSO and NOA events. The authors also estimate standing stocks of CaCO₃ and the modulating effect of surface calcite

C2439

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Discussion Paper



production on dissolved pCO₂ and the air-seawater CO₂ flux. The generalisation of the impact of coccolithophore calcification on the pCO₂ air-sea gradient to the entire basin based on remote sensing is a step for the understanding of inorganic C dynamics in the context of Global Change.

The present study is interesting even if it is restrained to open ocean, excluding shallow areas, like the North Sea and the Biscay shelf. The area covered by coccolithophore blooms is estimated to be $47.4 \pm 11.9 \cdot 10^5 \text{ km}^2/\text{yr}$ and the discarded Biscay bloom investigated by Shutler et al. (2010) represents $\sim 17 \cdot 10^5 \text{ km}^2$, which is 1/3 of the present estimate. Since the developed algorithm is shown to also capture shelf coccolithophore blooms, why restrain the coverage to the open ocean and not include shallow blooms?

Specific comments: 1) It is now accepted that water leaving radiance is proportional to the seawater concentration of suspended calcite and more precisely to surface densities of detached coccoliths and not only coccolithophore cells (Balch et al. 2005). The coccolith-to-coccolithophore ratio is highly variable and increases towards the end of the bloom (Holligan et al. 1993). Reducing the estimate of CaCO₃ standing stocks to a layer depth of 20m, a life span of 30 days, a coccolithophore concentration of 2000 cells/ml leading to a PIC concentration of 65 mg/m³, is probably the weakest part of the manuscript. The determination of CaCO₃ standing stocks could benefit from the 2-band approach that Balch et al. (2005) (used with MODIS images), with the added value of providing also the organic carbon estimates.

2) Holligan et al. (1993) also suggest that the duration of the bloom averages 30-40 days and that it disappears from satellite images over 1 or 2 weeks, too rapid for the sinking of individual particles and little indication for lateral dispersion. Some other reports indicate shorter or longer periods of high reflectance associated to coccolithophores. The approach A + BY is probably, depending of the time frequency of satellite snapshots, suitable for determining and study the life span of the different features and their dispersion. Can such a study be incorporated to the present study?

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3) Takahashi's climatology that relies upon in situ measurements probably already accounts for the effect of calcification on pCO₂ in some areas and needs to be modulated in the text.

4) As suggested by A.V. Borges in his previous comment, the effect of coccolithophore blooms on pCO₂ and the dissolved inorganic carbon system has been documented in the cited papers (Harlay et al. 2010, 2011 and Suykens et al. 2010). Previous studies by Purdie and Finch (1994) or Buitenhuis et al. (1996), for example, have also illustrated the potential reduction by calcification of the air-sea gradient in pCO₂, based on in situ measurements. The reference to these papers should be made in the discussion.

Minor comments: Are (NASA, 2010; L12p5827) and (NOAA, 2011) some bibliographic references? If yes, they are not listed in the reference list.

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Interactive comment on Biogeosciences Discuss., 9, 5823, 2012.

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9, C2439–C2442, 2012

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C2442

