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Discussions

Interactive comment on "Coccolithophore surface distributions in the North Atlantic and their modulation of the air-sea flux of CO_2 from 10 years of satellite Earth observation data" *by* J. D. Shutler et al.

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Shutler et al (2010) developped 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

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$11.9 105 km^2/yr and the discarded Biscay bloom investigated by Shutler et al. (2010) represents $\sim$17 105 km^2, which is 1/3 of the present estimate. Since the developped 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/m^3, 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 provinig 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?

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 paper 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.

Refs: Balch, Gordon, Bowler, Drapeau & Booth. 2005. Calcium carbonate measurements in the surface global ocean based on Moderate-Resolution Imaging Spectroradiometer data. Journal of Geophysical Research 10 (C07001), doi:10.1029/2004JC002560.

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Purdie & Finch. 1994. The impact of a coccolithophorid bloom on dissolved carbon dioxide in sea water enclosures in a Norwegian fjord. Sarsia 79, 379-387.

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