Editor Decision: Publish subject to minor revisions (Editor review) (11 Aug 2016) by Prof. Dr. Lars Kaleschke

Comments to the Author:

Dear authors,

After reading again the manuscript and your answers to the reviewers I have only three remaining minor questions before I can accept the paper:

1) Introduction:

The Arctic Ocean are taking up -66 to -199 Tg C year^{-1}, contributing 5-14% to the global ocean CO2 uptake (Bates and Mathis, 2009)

Why given with a negative sign? Should be clear that it means uptake.

→It is generally admit and recognize in the literature that a negative flux corresponds to an uptake while a positive flux corresponds to a release. We add this precision in the text.

I am not sure where the numbers (24-100 Tg C year^{-1}) in IPCC FAQ 6.1 Figure 1 (page 66) come from but they are considerably smaller.
http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter06_FINAL.pdf

→Thanks for this question. The estimation from the IPCC (24-100 Tg of C yr^{-1}) comes from McGuire et al (2009), Sensitivity of the carbon cycle in the Arctic to climate change, Ecological Monographs, 79(4), pp523-555.

In this work, they used the estimation from Bates 2006 (31-45 Tg C yr^{-1}) and from Anderson et al (1998b) (about 24 Tg C yr^{-1}). From there they estimate that the Arctic Ocean is taking up from 24 to 100 Tg C yr^{-1}. How they reach this number is not mentioned in the manuscript. The only precision is the followed (p533)

"Given the estimates of Anderson et al. (1998b) and Bates (2006), we infer that the mean annual sink for atmospheric CO_2 of the Arctic Ocean and its associated shelf seas lies between 24 and 100 Tg C/yr."

Which is not helping… In the discussion of the figure 3 (p540) from McGuire et al (2009) where the Arctic Ocean uptake is mentioned (24 to 100 Tg C yr^{-1}), they also wrote the following:

"Our review indicates that the Arctic plays an important role in the global dynamics of both CO_2 and CH_4. Top-down atmospheric analyses indicate that the Arctic is a sink for atmospheric CO_2 of between 0 and 0.8 Pg C/yr (Fig. 3), which is between 0% and 25% of the net land/ocean flux of 3.2 Pg C/yr estimated for the 1990s by the IPCC's Fourth Assessment Report (AR4; Denman et al. 2007)."

They don't specify how they reach the estimation 0-0.8 Pg of C/yr… While this number is mentioned in both the abstract and the discussion.

Therefore, I can't really answer your question as I have contradictory information coming from the referred manuscript. I could only suggest to use the most recent estimation of the atmospheric CO_2 sink for the Arctic Ocean realized by Bates and Mathis (2009), as McGuire et al (2009) is using their old estimation.

2) Figure 6 release/uptake? Not sure if I understand the direction of the fluxes. Perhaps it is reverted?

→I'm not sure to understand. The figure related to the fluxes is the figure 5, not 6. I hope the clarification of the flux unit from the previous comment will help understand the presentation of the flux data.
The manuscript read:
"The CO_2 fluxes measured at the variably snow-covered sea ice surface (Fig. 2b), ranged from 0.29 to 4.43 mmol m^{-2} d^{-1} show that growing sea ice released CO_2 to the atmosphere (Fig. 5). However, as soon as the ice started to warm up and then melt, the sea ice switched from source to sink for atmospheric CO_2 with downward fluxes from -1.3 to -2.8 mmol m^{-2} d^{-1}."
The show that a positive flux corresponds to a release of CO_2 to the atmosphere and a negative flux an uptake of atmospheric CO_2, as explained now in the introduction.

3) The emission of salts to the atmosphere can very likely be neglected in your overall budget. However, calcium carbonate has been found in firn of Talos Dome, Antarctica and thought to originate from sea ice. This is important for atmospheric chemistry and climate reconstructions from ice cores. Perhaps worthwhile to mention?

→The report of calcium carbonate in continental ice in Antarctica was, at some point, suggested to come from sea ice and based on the assumption that calcium carbonate could precipitate within sea ice. At the time, ikaite precipitation within sea ice was not formally known and/or reported in the literature.
Now the missing link will be the atmospheric export of ikaite from the sea ice cover. This is far away from my field of expertise and there is nothing in our present manuscript that could bring anything to answer that question.

Line 435 Typo: Therefore, we can assume thaT more than

→ Thx for the correction.

Best regards

Lars Kaleschke