Interactive comment on “Impact of snow cover on CO2 dynamics in Antarctic pack ice” by N.-X. Geilfus et al.

Anonymous Referee #2

Received and published: 27 August 2014

The paper by Geilfus et al "Impact of snow cover on CO2 dynamics in Antarctic pack ice" describes measurements on two pack ice sites. The measurements improve the general understanding of CO2 dynamics in pack ice under different conditions. The data gained under difficult experimental conditions are doubtlessly a useful piece in the complex puzzle to understand the physical, chemical and biological evolution of pack ice. As such, the paper reports valuable data, with methods well described. However, the experimental design to determine the effect of the snow cover is methodologically rather incomplete. I also missed quantitative measurements of the properties of the cover (as stratigraphy, density, specific surface area, thermal conductivity). As thermal conductivity strongly depends not only on density but also on structural properties, the heat flux could be even equal on both sites, a fact which probably can not be fixed anymore. Concerning the statistical comparison of the key figure 8, I question if any statistically significant conclusion can be drawn from these data. What seems to be clear is that the Liège site has a smaller flux, but this could as well be an effect of the different ice properties. I consider the paper a valuable report, but clearly not a paper which elucidates the effects of snow cover on CO2 dynamics.

→*Indeed we did not provide any information regarding the snow cover (snow thickness excepted). Unfortunately, this is not something we can change for this present manuscript. Therefore, and as suggested by other reviewer, we have changed the title of the manuscript as the manuscript is not a general study of the impact of snow cover on CO_2 dynamics in sea ice, but more a paper on the impact of the physical properties of the ice cover on the inorganic carbon dynamics. We would however like to underline that the temperature profiles largely differ between both locations indeed suggesting that, globally, the thicker snow at Liège results in a warmer more isothermal ice, hence that the heat fluxes probably differ between the two sites. Accordingly, the two locations react differently to the atmospheric forcing, even if they globally tell a similar story in terms of inorganic carbon dynamics.*

Point-by-point comments p 3266 l 5: To validate such conclusions, detailed measurements of snow permeability would be necessary!

→*P3266 L5 reads: ‘The impact of snow on the CO_2 exchanges between sea ice and the atmosphere has previously been discussed by Nomura et al., [2010b]; these authors suggested that a snow cover thicker than 9 cm could prevent any CO_2 exchanges between the ice and the atmosphere, and that melting snow can act as a physical barrier to CO_2 fluxes.’*

We agree that a single thickness value is probably irrelevant and that it all depends on the snow properties, including its permeability. However, this information was not given by us, but found in the manuscript of Nomura et al (2010). Indeed, our findings indicate that these authors statement is most probably not universal and strongly depends on the detailed snow structure and properties.

p 3267 l 1 "maximum homogeneity" : which type of measurements quantified this property? The description of snow depth does not really support this statement.

→*The choice of both sampling site was conducted based on a maximum homogeneity of the surface properties within each site. This was indeed not clear in the manuscript, and we have now modified the text accordingly:*

"Sampling was conducted at two distinct sites based on: (i) homogeneity of the surface properties within each site, to reduce within-site spatial variability; (ii) the contrast in ice and snow properties between the two chosen sites; and (iii) maximum distance from the ship (0.8 km and 1.1 km), to prevent sample contamination. Each site was 100x60 m and subdivided into small work sub-areas approximately 5m x 5m. The 25 m^2 sub-areas were located adjacent to each other to minimize spatial variability [Lewis et al., 2011]."

p 3268 l 9: "precision of +- 0.1" relative, absolute, unit?

→*Units for salinity measurements have been a long subject of debate amongst oceanographers. Present day recommendation is to consider it as a mere ratio, i.e. with no units. The precision is "absolute value"*

p 3270 l 13 How was this additional steel tube made airtight? How was the additional volume taken into account in the calculations?

→*The additional steel tube is surrounded by a rubber seal at its contact with the chamber. At the contact with the ice, the tube is screwed into the ice surface, making the contact airtight. The volume of snow in the chamber is off course taken into account in the calculation, as mentioned in the manuscript.*

General comments on Figures

The size of symbols and lettering is close to illegible when the paper is printed (fortunately, there is a digital version...)

→*We will increase the size of the symbols and lettering for all the figures. Thanks.*

Interactive comment on The Cryosphere Discuss., 8, 3263, 2014.