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Interactive comment on "CO_2 and CH_4 in sea ice from a subarctic fjord" *by* O. Crabeck et al.

Anonymous Referee #2

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General Comments: The authors describe a series of four ice stations over the course of one week during which they measured 18O in water, CH4, CO2 and other ice properties. This study found persistent CO2 under-saturation (with respect to atmospheric equilibrium) and CH4 over-saturation in first-year sea-ice, indicating that the latter is a sink for atmospheric CO2 and source of CH4, once the ice melts. Although the timeframe over which the study was conducted is limited (1 week), it provides a very thorough analysis and unique insight into CO2 and CH4 dynamics in sea-ice. Specifically, the comprehensive understanding of sea-ice dynamics inferred from 18O profiles, gas content, N2, Ar etc. allows a thorough discussion of the distribution of CO2 and CH4. I have some specific comments which probably amount to minor revision, but have no hesitation in recommending a revised manuscript for publication in BG.

Specific Comments: 1) p.4049, line 7: Spelling "areas"

2) p.4052, line 23: Please define "b" in "b/bulk ice volume"

3) p. 4053, line 3: Please define "hi" in equation 1.

4) p.4054,line 17: "1013 atm" - Please correct the units or insert decimal point. I'm pretty sure this should be micro-atm, not atm.

5) p. 4056, line 16: Please define "Sice". This is obviously sea-ice salinity, but has not been defined previously. Also, in Figure 2&6 this is marked as Si. It may be better to use "Sice" everywhere. Also, salinity is untiles (Figure 2&6).

6) p.4063, line 17: Spelling "Weisenburg"

7) p.4064,line 5: Spelling "rises"

8) p.4064, lines 4-10: The authors seem to attribute CH4 accumulation just below the sea-ice to advected sedimentary sources. They go on to mention riverine inputs, but the emphasis appears to be on the former. I would say that riverine inputs are more likely to be the dominant factor here for two reasons: a) The study area is fairly enclosed. Advective processes may therefore be limited to tidal exchange. What was the tidal range over the study period? This might give at least a relative indication of exchange. b) Fluvial inputs are much closer (geographically) and the CH4 maxima in the overlying sea-ice also coincide with salinity minima which have been atributed to freshwater input (section 5.2).

9) p.4066, lines 17-21: The authors suggest that CH4 bubbles may have been trapped in the growing sea-ice following their release from the seafloor. This may also explain why they are near the top of the sea-ice. I would expect the maximum methanogenesis to occur in the autumn, following the maximum POC flux from the surface to the seafloor. As sea-ice begins to grow in the autumn, the effluxing CH4 bubbles would be captured near the top of the ice (since it grows from below). On the other hand, if the seasonal sediment source is so strong in autumn, I would expect at least some CH4 to still be coming out in Spring. This doesn't seem to be the case (Figure 2; albeit

depth-profiles only reach 9 m and the seafloor is at 45 m). Shakhova et al. did show CH4 bubble trapping in sea-ice, but they also measured 2000+ nmol/L CH4 in the water column, not 17, as here! I think it's much more likely that CH4 concentration in the forming sea-ice led to the formation of CH4 bubbles as the authors explain earlier and that CH4 came from the riverine source.

10) Figure 7: The color/symbols for 13 Mar and 15 Mar. are mixed up. Please swap the color or symbols to match legend.

Interactive comment on Biogeosciences Discuss., 11, 4047, 2014.