The manuscript by Dr Crosta and colleagues provides an overview of the importance of Antarctic sea ice on the global climate system and oceanographic circulation, its present and past variations and a thorough revision of marine- and ice core-based sea-ice proxies for the reconstructions of sea-ice changes. Authors begin with a well structured and justified introduction, followed by a description of the processes and consequences of the sea-ice formation and an up-to-date description of the current trends in sea-ice dynamics in the Southern Ocean. Next, authors described with great detail the main proxies for the reconstruction of sea-ice changes in the past with particular emphasis on diatom valves and the key biomarkers produced by this group of organisms. Authors also dedicate a section to other microfossil groups used in sea-ice reconstructions and to geochemical and isotopic proxies. Lastly, authors summarize our current knowledge of past sea-ice changes, list the gaps in the knowledge and propose future directions for sea ice research in the Southern Ocean.

Overall, this manuscript is organized logically and well written, making it easy to follow. The figures are of high quality and the manuscript contains a wealth of information useful for the specialized and non-specialized reader. I enjoyed and learned much reading the manuscript and recommend its publication. Next, I provide some minor points that authors may like to address:

Lines 88-90. Authors could underscore the importance of these waters fuelling primary production in lower latitudes (Sarmiento et al., 2004).

Line 112: Since diatoms are a critical proxy for sea ice reconstructions authors could include a general description of the dominant phytoplankton groups in marine ecosystems under the influence of sea ice. Two or three lines describing the distribution of the dominant groups (diatoms, *Phaeocystis*, etc.) could be useful for the non-specialized reader.

Section 3.1 (lines 269-369). Diatoms are powerful tools for sea ice reconstructions but they experience important dissolution in the water column and sediments that can introduce important bias in the interpretation of the fossil/sedimentary record. Since this is a review authors could briefly mention the limitations/problems associated with dissolution (if any).

line 314 Could authors find an alternative term/wording for “martheginal”or provide a brief description between brackets?

Lines 365-367 Could authors specify where this selective dissolution takes place? water column, surface-sediment interface? both? which one is more important?

Andrés S. Rigual Hernández

References

Sarmiento, J.L., Gruber, N., Brzezinski, M.A., Dunne, J.P., 2004. High-latitude controls of thermocline nutrients and low latitude biological productivity. Nature 427, 56-60.