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Interactive comment on "Sources of Fe-binding organic ligands in surface waters of the western Antarctic Peninsula" *by* Indah Ardiningsih et al.

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In this manuscript, Ardiningsih et al. report measurements of the dissolved iron (Fe) and organic ligands concentrations, as well as the ligand conditional binding strength, in the upper 600-m water along five stations in the western Antarctic Peninsula (WAP) region of the Southern Ocean, where iron limits the ocean primary production. This region shows distinct features in the dissolved Fe pattern and in the hydrographic dynamics. It also contains biological hotspots in regions close to the shelf sea, where the marine ecosystem can be directly impacted by climate change. Thus, it is important to understand the mechanisms controlling the distribution of organic ligands and dissolved Fe in the WAP. The results of this manuscript suggest that ligands in the surface water of the shelf regions are the products of ice-algal exudates and sea-ice

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melting, while ligands in the deeper shelf water are produced from sediment-related processes. In the open ocean water of the WAP region, ligand productions are likely to be related to the sea-ice melting process and to the phytoplankton bloom. Mover, the authors show that the ligands concentration in the WAP always exceeds dissolved Fe concentration. This result suggests that any additional Fe input can be stabilized in the dissolved form, thereby being bioavailable for phytoplankton. Overall, this manuscript is well written and easy to follow. However, I would like to raise some questions and suggestions regarding the title, introduction, and discussion of the manuscript, which hopefully can be considered by the authors. I would be more than happy to backdown from these questions if the authors do not agree and provide good counter-arguments.

Major questions/comments

(1) First, the title (Sources of Fe-binding organic ligands in surface waters of the western Antarctic Peninsula) and the introduction of the manuscript give me the impression that this study will use a new method/technique other than CLE-AdCSV to identify the sources of organic ligands in the WAP region. In the Introduction, the authors wrote "The application of AdCSV gives the total concentration ([Lt]) and conditional binding strength of the dissolved organic ligands but does not provide information on the identity of ligands" (line 56-57) then stated that "the sources and identities of Fe-binding ligands are still largely unknown" (line 58=59). Thus, I was excited to see what (new) methods the authors would use to pinpoint the sources of organic ligands in the WAP region, which is a very important issue to address, and I think, have not been done before. However, at the end of the Introduction, the authors wrote (line 97-100): "In order to probe sources and distributions of Fe-binding ligands along a natural gradient of Fe, the CLE-AdCSV technique was used to quantify the total concentrations and conditional stability constants of Fe-binding ligands". To be honest, I was a bit disappointed and confused at this point. As an ocean biogeochemistry modeler who does not have a strong background on measurement techniques, I do not understand how the authors can probe the sources of ligands by using the CLE-AdCSV technique, which was

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stated before that cannot be used to provide information on the identity of ligands. It turns out that, if I understood correctly, the authors used CLE-AdCSV to measure the concentration and strength of organic ligands, then they based on other hydrographic and biogeochemical features, as well as previous studies, to hypothesize/argue about the potential origins of the measured ligands. While their arguments are valid, I think it is different from measurements that directly pinpoint to ligands' origin and identity. Thus, I would suggest the authors to modify the title and introduction such that they are not misleading and reflect correctly the problems that the manuscript directly address and the methods that the authors use to achieve this goal. Again, in my mind, this is a study that measures the ligands concentration and binding strength, then suggest their potential sources, not a study that directly identify the sources of ligands.

(2) Second, in section 4.2 of the manuscript, the authors discussed at length on how a high complexation capacity of ligand and ice-melting processes can control the ocean primary productivity in the WAP region. They also discussed on the potential impact of global warming on Fe chemistry and ligand, and stated that (line 387-390): "Overall, the continued sea-ice melt and glacial retreat can be expected to increase the supply of Fe (Lannuzel et al., 2016), other micronutrients (Co, Mn, etc.), and Fe-binding ligands (Lin and Twining, 2012), but the consequences for their complexation capacity and overall bio-availability of Fe remain elusive." But what about the impact of ligand production from ice-algal exudates, sediments, and phytoplankton bloom? How will these processes change in the future under the impact of global warming? Is the ligand production from ice-algal exudates going to increase or decrease with sea-ice melting? Since these are major processes in producing ligands, I would love to see more discussion on them.

Minor comments:

Line 16: Our results indicate that organic ligands in "the" surface water. . .

Line 17: Organic ligands in "the" deeper shelf water

Line 41: Should the reference here be Henley et al., 2019?

Line 69-70: covered by sea-ice (remove with)

Line 85-86: such as glacial meltwater, sediments", and" upwelling

Line 171: hydrographic features of the WAP "was" described elsewhere

Line 173: Two distinct horizontal currents exist in the study area: The Coastal Current (CC) and the Antarctic Circumpolar (replace, by:)

Figure 3 caption: remove depth in colors denoting depth the values. . .

Line 323-326: Maybe revise this sentence to make it shorter and clearer: "Mopper et al. (2015) suggested that the absorption of solar radiation by chromophoric dissolved organic matter as part of the ligand pool which commonly produced by sea ice algae (Norman et al., 2011), leads to the photochemical transformation of these compounds."

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