

EGU2020-3950

<https://doi.org/10.5194/egusphere-egu2020-3950>

EGU General Assembly 2020

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Limitation by iron and manganese on phytoplankton communities in the Drake Passage.□

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The Southern Ocean (SO) accounts for over 40% of anthropogenically derived CO₂ uptake. It is the world's largest High-Nutrient Low-Chlorophyll (HNLC) region and the scarcity of trace metals such as iron (Fe) drives phytoplankton composition and biomass build up. Besides Fe, manganese (Mn) is the second most abundant trace metal since it is present in the thylakoids. As dissolved manganese (dMn) concentrations in the Atlantic sector of the SO are very low (0.04 nM), phytoplankton growth may not only be limited by Fe but also by Mn availability, a theory previously described by Martin et al. (1990). However, mechanistic studies investigating the effects of multiple trace metals limiting or co-limiting on growth and photosynthesis are lacking. This study focuses on the identification of the Fe-Mn co-limitation of natural phytoplankton assemblages to elucidate the impact of different Fe and Mn additions on species composition. To this end, two shipboard Fe-Mn addition bottle incubation experiments were conducted during the 'RV Polarstern' expedition PS97 in the Western and Eastern Drake Passage (DP) in 2016. This study highlights the importance of Mn in the otherwise Fe-limited Drake Passage. From microscopy samples, the addition of Fe and Mn together triggered the highest abundance of the genus *Fragilariopsis sp.* in the Western DP. In the Eastern DP, the nanophytoplankton fraction, detected by flow cytometry, reached the highest abundance only when both trace elements were provided, confirmed by highest chlorophyll-*a* build up. Moreover, the distinct response of Mn depletion relative to the Fe depletion support the findings that Fe and Mn do not substitute to each other. This experimental study highlights that both trace elements act as drivers of the ecology across the Drake Passage.

How to cite: Balaguer, J., Koch, F., and Trimborn, S.: Limitation by iron and manganese on phytoplankton communities in the Drake Passage.□, EGU General Assembly 2020, Online, 4–8 May 2020, EGU2020-3950, <https://doi.org/10.5194/egusphere-egu2020-3950>, 2020