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Last Glacial Maximum Antarctic sea ice linked with global mean ocean temperature: evidence from PMIP3, PMIP4 and MIROC-4m simulations

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Southern Ocean sea ice and oceanic fronts are known to play an important role on the climate system, carbon cycles, bottom ocean circulation, and Antarctic ice sheet. However, many models of the previous Past-climate Model Intercomparison Project (PMIP) underestimated sea-ice extent (SIE) for the Last Glacial Maximum (LGM)(Roche et al., 2012; Marzocchi and Jensen, 2017), mainly because of surface bias (Flato et al., 2013) that may have an impact on mean ocean temperature (MOT). Indeed, recent studies further suggest an important link between Southern Ocean sea ice and mean ocean temperature (Ferrari et al., 2014; Bereiter et al., 2018 among others). Misrepresent the Antarctic sea-ice extent could highly impact deep ocean circulation, the heat transport and thus the MOT. In this study, we will stress the relationship between the distribution of Antarctic sea-ice extent and the MOT through the analysis of the PMIP3 and PMIP4 exercise and by using a set of MIROC models. To date, the latest version of MIROC improve its representation of the LGM Antarctic sea-ice extent, affecting the deep circulation and the MOT distribution (Sherriff-Tadano et al., under review).

Our results show that available PMIP4 models have an overall improvement in term of LGM sea-ice extent compared to PMIP3, associated to colder deep and bottom ocean temperature. Focusing on MIROC (4m) models, we show that models accounting for Southern Ocean sea-surface temperature (SST) bias correction reproduce an Antarctic sea-ice extent, 2D-distribution, and seasonal amplitude in good agreement with proxy-based data. Finally, using PMIP-MIROC analyze, we show that it exists a relationship between the maximum SIE and the MOT, modulated by the Antarctic intermediate and bottom waters.