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Combined impact of shifts in Southern Ocean westerlies and Antarctic sea ice during LGM on atmospheric CO_2

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A significant influence of changes in the westerly winds over the Southern Ocean was proposed as a mechanism to explain a large portion of the glacial atmospheric pCO$_2$ drawdown (Toggweiler et al., 2006). However, additional modelling studies with Earth System Models of Intermediate Complexity do not confirm the size and sometimes even the sign of the impact of southern hemispheric winds on the glacial pCO$_2$ as suggested by Toggweiler (Menviel et al., 2008; Tschumi et al., 2008, d'Orgeville et al., 2010).

We here add to this discussion and explore the potential contribution of changes in the latitudinal position of the winds on Southern Ocean physics and the carbon cycle by using a state-of-the-art ocean general circulation model (MITgcm) in a spatial resolution increasing in the Southern Ocean (2° longitude; northern hemisphere: 2° latitude; southern hemisphere: 2°cos(α)). We discuss how the change in carbon cycling is related to the upwelling strength and pattern in the Southern Ocean and how they depend on the changing wind fields and/or the sea ice coverage.

While the previous studies explored the impact of the westlies starting from present day or pre-industrial background conditions, we here perform simulations from LGM background climate. Ocean surface conditions are for reasons of consistency taken from output of the COSMOS Earth System model for a pre-industrial control and two LGM runs (Zhang et al., in preparation). Additionally, a northwards shift (by 10°) of the westerly wind belt as proposed by Toggweiler is investigated.

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