Effects of changes in tidal mixing on the Atlantic meridional overturning circulation at the Last Glacial Maximum

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The energy source that drives abyssal circulation including Atlantic meridional overturning circulation (AMOC) comes from tidal mixing and wind stress. On present day, the input of global barotropic tidal energy is estimated to be 3.5TW and 2.3TW of this energy is dissipated by bed friction in shallow seas. The remaining 1.1TW of this energy is converted into the baroclinic internal tidal energy, and about half of this energy drives abyssal circulation. During the Last Glacial Maximum (LGM), it is pointed out that the tidal energy dissipated by bed friction decreased and the energy converted into the baroclinic tidal energy increased because the most of present-day continental shelf was converted into land by glacial sea level change. A previous research reports that total amount of increase in baroclinic tidal energy conversion rate is sensitive to the used topographic reconstruction dataset of LGM. The previous study also demonstrated that this difference in reconstruction dataset affects the regional pattern of increase of the energy conversion rate, which leads to the different response of AMOC. Although it is important to consider the change of baraclinic tidal energy conversion rate and associated changes in the vertical diffusivity, most of ocean modeling research on LGM have not taken this into account. Here, in order to investigate the effects of increase of baraclinic tidal energy conversion rate on AMOC at LGM, we performed Oceanic General Circulation Model (OGCM) simulations by using COCO. Specifically, under LGM surface boundary condition, we performed sensitivity experiment where the present-day tidal energy conversion rate is increased by some constant factors, by which we discussed the response of the glacial AMOC on the increased tidal energy input. Our OGCM results indicate that strength of AMOC increases when we applied larger baroclinic tidal energy conversion rate than the present-day value. We also did additional numerical simulations where the energy conversion rate is increased only in specific basin. The results indicates that strengthening of AMOC is very different among basins: the strength of the AMOC is affected primarily by the increase of energy conversion in Pacific Ocean and secondary by that in Southern Ocean, whereas it is not affected so much by the increase of energy conversion in Atlantic Ocean.

