Tides and tidal mixing were stronger during the Last Glacial Maximum

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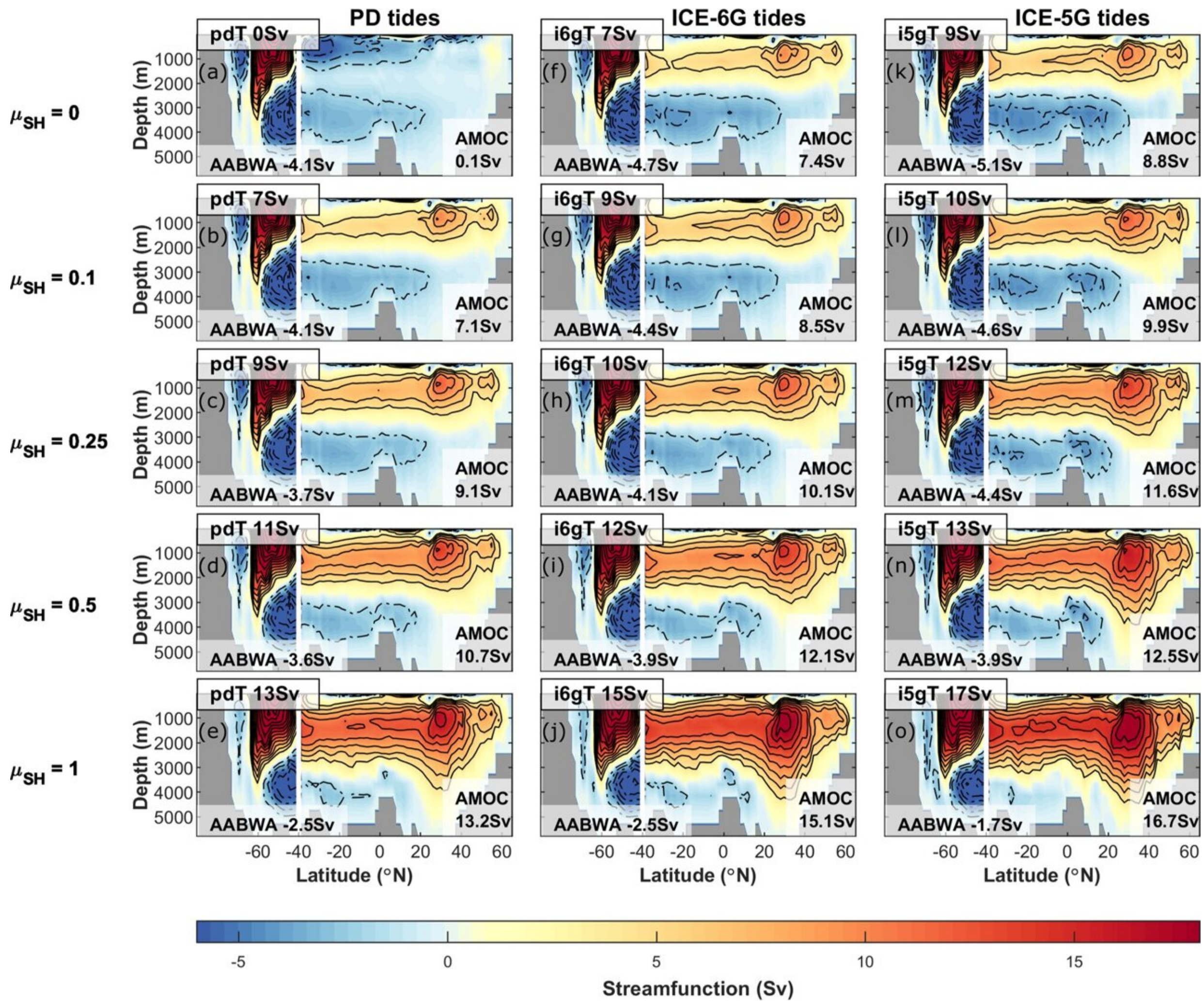

Fig. 1: Atlantic and Southern Ocean meridional overturning streamfunctions for the LGM simulation ensemble.Atlantic and Southern Ocean meridional overturning streamfunctions in Sv (1 Sv = 106 m3s−1) for the Last Glacial Maximum (LGM) simulation ensemble grouped by the tidal forcing and the μSH

term. The Southern Ocean meridional streamfunction is plotted southward of 40°S, the Atlantic meridional streamfunction northward of 40◦S. Their separation is indicated by the vertical white line at 40°S. Run names, given in the top left-hand corner for each panel, indicate the tidal dissipation case followed by the Atlantic meridional overturning streamfunction (AMOC) strength. AMOC strength at 25°N and Antarctic Bottom Water (AABW) strength in the Atlantic at 35°S are printed at the bottom of each panel. Simulations shown in panels (a)–(e) are forced with present-day (PD) global internal tide dissipation, simulations in panels (f)–(j) with LGM ICE-6G tidal dissipation, and runs shown in (k)–(o) with LGM ICE-5G tidal dissipation. Credit: DOI: 10.1038/s43247-021-00239-y

The regular and predictable ebbing and flooding of the tides may appear to not change, but new research carried out by Bangor University (UK) and Oregon State University (US) and published in the journal *Communications Earth and Environment* has demonstrated that the tides and tidal processes may have been very different during the ice ages.

During the peak of the last ice age, global temperatures were around 6°C colder than at present, and more areas of the Northern Hemisphere continents were covered in large ice sheets. The water for the ice came from the oceans, meaning that sea levels were around 120 m lower. This also caused much larger tides throughout the Atlantic Ocean.

Scientists have previously proposed that there was less mixing between layers of water, and that this held carbon in a more stagnant deep ocean, keeping it out of the atmosphere. Lower concentrations of atmospheric carbon dioxide, a greenhouse gas, contributed to the chilly climate. However, this hypothesis does not account for changes in the tides.

In the present-day ocean, tides create mixing, or "turbulence" that mixes surface and deep waters and sustains the global deep ocean overturning circulation which, in turn, influences our global climate and weather systems.

New research has shown that turbulence driven by the tides was increased during the peak of the last ice age, therefore contradicting the proposals of a quieter deep ocean.

The researchers compared climate model simulations to carbon isotope data from sediment cores and concluded that stronger tides and more turbulent mixing would have been required to create the data recorded in the sediment.

Dr. Sophie-Berenice Wilmes, an expert in Earth system dynamics at Bangor University and an author of the study, says, "These results are really exciting as they provide evidence that the tides and tidal mixing were different from present during the Last Glacial Maximum. As tidally driven ocean mixing is one of the main energy sources for the global ocean circulation and thus important for climate, this means that studies of past climate need to take into account changes in the tides."

More information: Sophie-Berenice Wilmes et al, Enhanced vertical mixing in the glacial ocean inferred from sedimentary carbon isotopes, *Communications Earth & Environment* (2021). DOI: 10.1038/s43247-021-00239-y

Provided by Bangor University