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Transient atmosphere-ocean-carbon simulations through the Penultimate Deglaciation and Last Interglacial

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The Penultimate Deglaciation saw climatic warming from a glacial state into the Last Interglacial, which saw warmer-than-preindustrial temperatures and extreme northern hemisphere monsoons. Here a fast, intermediate-complexity 3D dynamic atmosphere-ocean model is used to study the Atlantic Meridional Overturning Circulation (AMOC), Indian and Southeast Asian Summer Monsoons and the carbon cycle during the Penultimate Deglaciation and Last Interglacial in steady state and transient simulations between 140,000 and 122,000 years before present. We find two weak phases of AMOC, the second longer than the first. Indian Summer Monsoon starts in a weak state and reaches a maximum around 127,000 years ago (where northern summer insolation is at a maximum) before declining. The Southeast Asian Monsoon displays smaller changes and an earlier peak. The timing of AMOC collapse and recovery is strongly affected by choice of freshwater forcing timeseries. Sensitivity experiments where individual forcings are varied, find that the timing of AMOC recovery is further influenced by precession, and by ice sheet retreat independent of meltwater flux. Indian monsoon strengthening is mainly driven by precession, with further contribution from CO_2, obliquity and the timing of AMOC recovery. Transient simulations find later warming compared to steady state experiments. Experiments with freely evolving CO_2 fail to replicate ice core-inferred deglacial CO_2 increase.