Catastrophic ice sheet collapse and future sea levels: Lessons from the last interglacial

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There is now growing evidence that the land-based ice-sheets of the West Antarctic and Greenland underwent catastrophic collapse during previous warm interglacial periods, inducing rapid rises in sea levels. Compared to the full range of glacial to interglacial transitions of typically 100 m to 130 m, the likely future increase in sea level is relatively small, of the order of ~3 m to 6 m. However with many coastal cities being subject to inundation with even modest sea level rises, constraining the critical thresholds for greenhouse-driven collapse of the terrestrial based ice-sheets is of paramount importance.

In order to provide new constraints on this problem we have undertaken a study of the southern-most known occurrence of Last Interglacial coral reefs that occur along the southern coastlines of Australia. These reefs flourished during the warmest period of the Last Interglacial with temperatures similar to those predicted for 2100 from Greenhouse warming. A new locality has been discovered at a latitude of 34^{o} S, in a small embayment (Foul Bay) that is ~15 km north of Cape Leeuwin in Leeuwin-Naturaliste block of southwest Western Australia. The reef consists mainly of *Goniastrea* sp. together with lenses containing abundant gastropods (*Turbo* sp.) and opercula, and rare bivalves. The main reef occurs at a height of 3-4 m above present-day sea level with a smaller subsidiary reef at ~0 to 1 m. Very precise U-Th MC-ICPMS dating of multiple sub-samples of *in situ* coral indicates a narrow range of ages from ~128 ka to 125 ka. This shows that during the first part of the Last Interglacial, both warmer conditions and higher sea levels prevailed, approximately coincident with the maximum in Northern Hemisphere summer insolation. This points to the Greenland icesheet being a significant contributor to the higher sea levels during the Last Interglacial whereas today the maximum summer insolation is in the Southern Hemisphere. Thus with further greenhouse warming effecting global temperatures the West Antarctic icesheet is argued to be most susceptible to catastrophic collapse although an important role for the Greenland icesheet cannot be discounted. Regardless, there is an imperative to reduce greenhouse emissions to minimise the magnitude of future increases in sea levels.

^{14}C variability in two late Holocene stalagmites and the implications for climate forcing mechanisms

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Putative links between late Holocene climate variability and solar output remain controversial and are difficult to demonstrate unequivocally. Here we show that temporal changes in initial ^{14}C activity in calcite deposited in two late-Holocene stalagmites (from Attahöhle, Sauerland, Germany and Grotte de Clamouse, S.E. France) vary synchronously with changes in atmospheric ^{14}C production during the critical time interval between 2.7 and 2.2 kyr. B.P. Atmospheric ^{14}C production changes were computed using the atmospheric (tree-ring) ^{14}C dataset and a multi-box carbon-cycle model. The new 'wiggle-matched' ^{14}C data for these late-Holocene stalagmites provide independent support for their U-series chronology, and eliminate the need for chronological 'tuning' as in published $\delta^{18}O$-atmospheric ^{14}C comparisons. In stalagmite CL26 from Grotte de Clamouse, the carbon isotope systematics ($\delta^{13}C$ and ^{14}C) undergo a significant perturbation at 2.4 ka. Prior to 2.4 ka the initial ^{14}C in the stalagmite tracks that of the atmosphere, implying open-system behaviour, but after 2.4 ka the initial ^{14}C activity correlates strongly with $\delta^{13}C$, apparently reflecting a more closed-system behaviour. Monte Carlo simulations that involve the generation of synthetic $\delta^{18}O$ time-series datasets were used to evaluate the statistical robustness of correlations between atmospheric ^{14}C production and stalagmite $\delta^{18}O$. The study highlights the utility of time-series ^{14}C measurements in stalagmites as a means to interpret correctly their oxygen and carbon isotope variability.