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Isotopic signals of a warmer climate in Antarctica

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Ice cores may provide informative analogues for global warming. For example, MIS 5e (Marine Isotope Stage 5e) is a period that appears to have been warmer than present-day in Antarctica, and perhaps globally. It is essential that we understand how such warmings may imprint themselves on the Antarctic stable water isotope ice-core records used to study these periods. We present a set of experiments from a newly isotopical enabled model to allow us to to determine the isotopic signal of a warmer climate on Antarctic regions and specific core sites. Our experiments use a CO2-forced warming of the magnitude expected during the next 100 years.

We find that the temporal isotope against surface temperature gradient is uncertain and low for unforced inter-annual climate variability. The gradient is higher and the temperature explains a larger proportion of the isotope variance for a forced warming event. Spatially, there is almost no correlation between the temporal gradients for the unforced and forced fits. From these results, it does not appear that we can tell much about the forced warming temporal gradient from the correlation between 20 year long series of temperature and isotope records.

In Antarctica, the temporal gradient from the forced warming event, where large regions are averaged together, is generally very low. For both the forced and unforced fits using precipitation weighted surface temperature gives gradients generally 40-50% larger than those from the standard unweighted surface temperature. These differences are due to changes in the covariance between temperature and precipitation over the course of the forced warming. Bandpass filtering shows that the majority of the present-day biasing difference is due to high frequency synoptic time-scale covariance between surface temperature and precipitation, with some additional seasonal

covariance biasing over inland East Antarctica. Over the forced warming, the difference in biasing (that causes the 40-50% increase in gradient when using the weighted temperature) is mainly due to changes in the lower-frequency seasonal covariance. Changes in the higher frequency synoptic covariance during the warming also have some effect, particularly in coastal regions.

There are strong discrepancies between the present-day spatial and temporal isotope against temperature gradients. As an example, the temporal gradient (unweighted temperature) for Dome C for our forced warming is about one half of the East Antarctic spatial gradient. Thus the ice-core isotope record of the MIS 5e could be indicating a much higher warming than has so far been postulated.