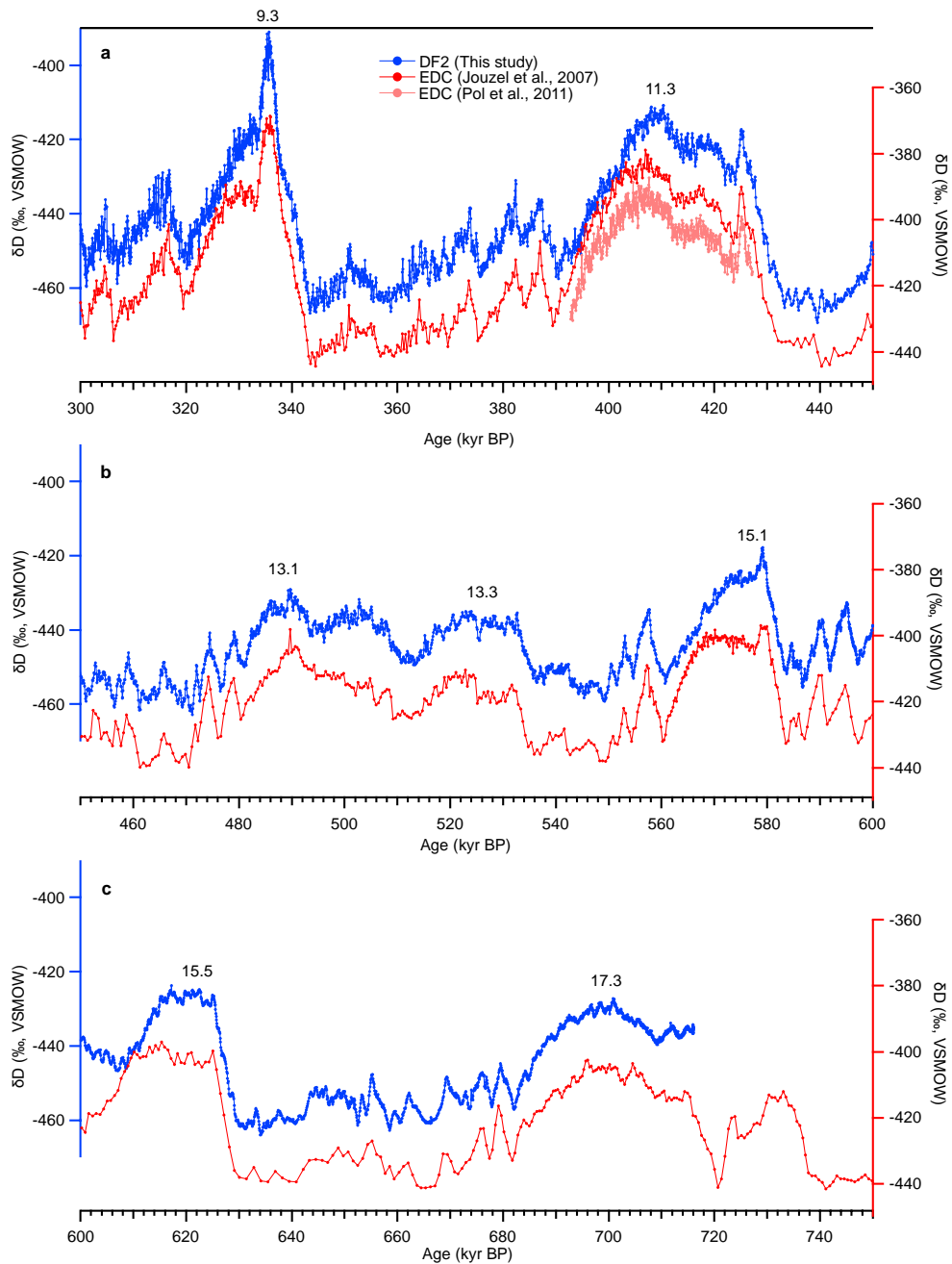


## **Supplementary Information**

**Asynchrony between Antarctic temperature and CO<sub>2</sub> associated with obliquity over the past 720,000 years**

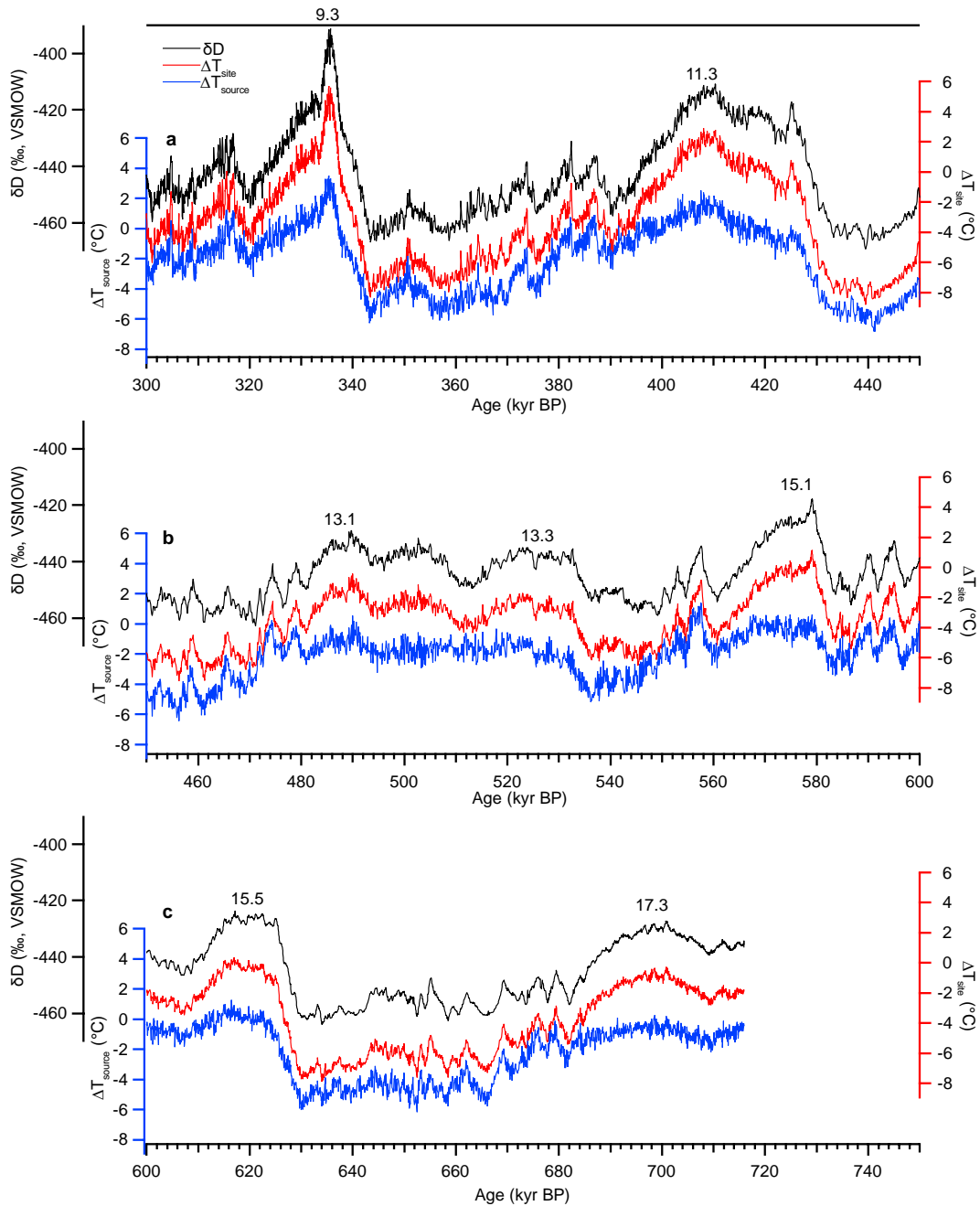
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**Supplementary Figures 1-5  
References for Supplementary Information**



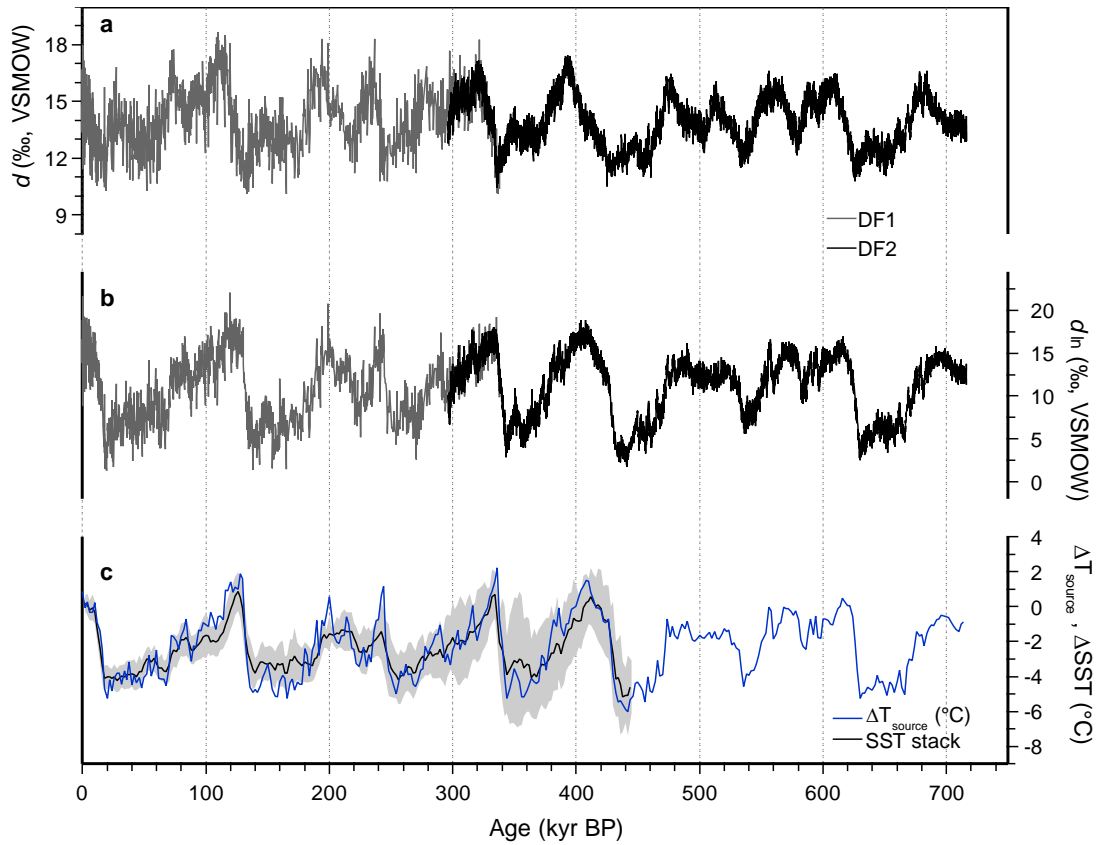
### Supplementary Figure 1. $\delta D$ records from the DF2 and EDC ice cores

The  $\delta D$  records of the DF2 (10-cm sampling, blue) and EDC cores (55-cm sampling, red)<sup>1</sup> for (a) 300-450 kyr BP, (b) 450-600 kyr BP and (c) 600-750 kyr BP. The light-red line indicates high-resolution (11-cm sampling) data<sup>2</sup> covering MIS 11 (these  $\delta D$  values are shifted by 10‰ for clarity). Numbers indicate Marine Isotope Stages. Dots represent raw data.



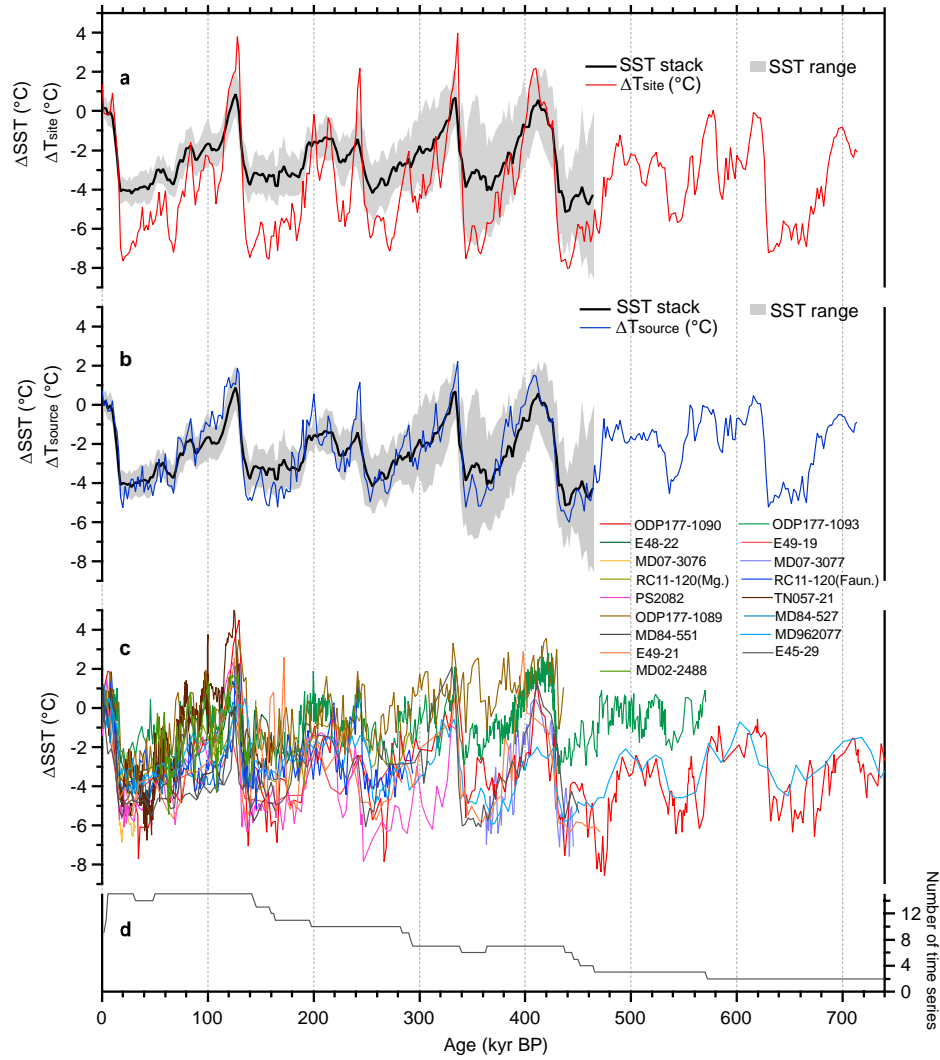
**Supplementary Figure 2. Enlarged profiles of the  $\delta D$ ,  $\Delta T_{\text{site}}$  and  $\Delta T_{\text{source}}$  records from the DF2 core**

Records of  $\delta D$  (black),  $\Delta T_{\text{site}}$  (red) and  $\Delta T_{\text{source}}$  (blue) from the DF2 core for (a) 300-450 kyr BP, (b) 450-600 kyr BP and (c) 600-750 kyr BP. Numbers indicate Marine Isotope Stages.



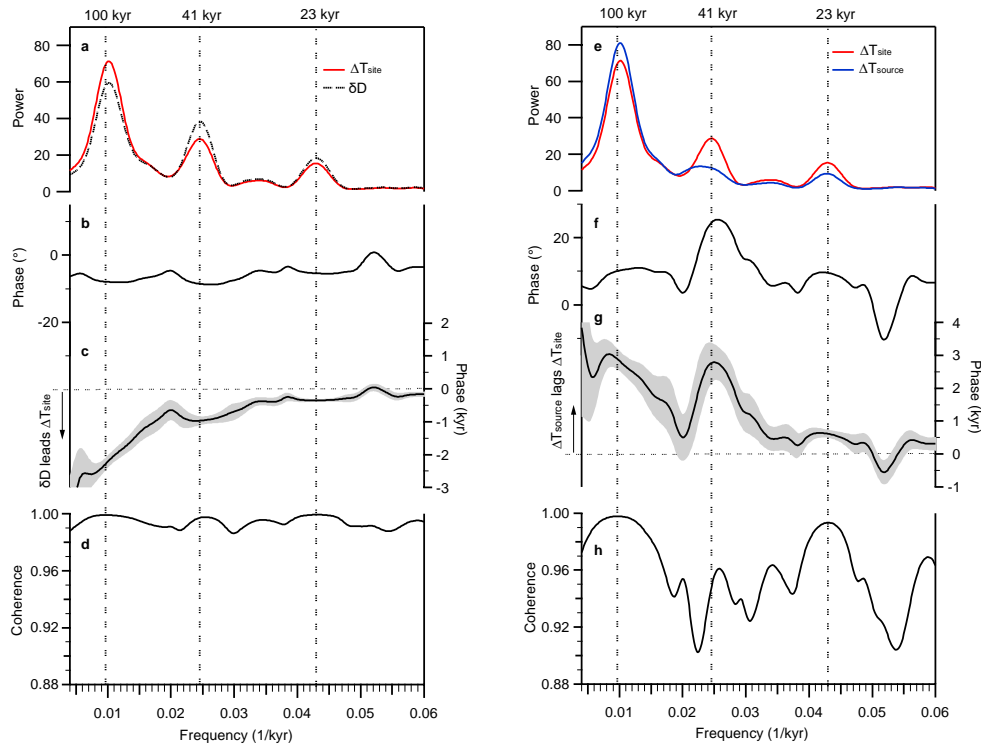
**Supplementary Figure 3. Deuterium excess and  $\Delta T_{\text{source}}$  records from the DF1 and DF2 ice cores**

(a) The  $d$  record using the traditional linear definition<sup>3</sup> of the DF1 (grey) and DF2 (black). (b) Same as (a), but for the logarithmic definition of  $d$ ,  $d \ln$ . (c) DF  $\Delta T_{\text{source}}$  record (blue) shown with the stacked SST record (black) with its uncertainty interval (area shaded grey).



**Supplementary Figure 4. DF  $\Delta T_{source}$  and SST records from the moisture source region**

(a)  $\Delta T_{site}$  (red) record from the DF cores. The black line indicates the stacked SST record from the moisture source region with its uncertainty interval (area shaded grey). Data were resampled at a 2-kyr interval. (b) Same as (a), but for the  $\Delta T_{source}$  (blue) record from the DF cores. (c) Individual SST records used to produce the stacked SST record (Methods). (d) Number of SST data series.



**Supplementary Figure 5. Cross-spectral analyses of  $\Delta T_{\text{site}}$  vs.  $\delta D$  and  $\Delta T_{\text{site}}$  vs.  $\Delta T_{\text{source}}$**   
**(a)** Power spectrum of  $\Delta T_{\text{site}}$  (red) and  $\delta D$  (black dotted). **(b)** Phase shown in units of degrees. **(c)** Same as **(a)** but shown using units of kyr. Negative values indicate that  $\delta D$  leads  $\Delta T_{\text{site}}$ . **(d)** Coherence between  $\Delta T_{\text{site}}$  and  $\delta D$ . **(e)-(h)**, same as **(a)-(d)** but for  $\Delta T_{\text{site}}$  (red) and  $\Delta T_{\text{source}}$  (blue). Positive values indicate that  $\Delta T_{\text{source}}$  lags  $\Delta T_{\text{site}}$ . The spectral analyses were conducted using 100-yr resampled data.

### Supplementary References

1. Jouzel, J. *et al.* Orbital and Millennial Antarctic Climate Variability over the Past 800,000 Years. *Science* **317**, 793-796, doi:10.1126/science.1141038 (2007).
2. Pol, K. *et al.* Links between MIS 11 millennial to sub-millennial climate variability and long term trends as revealed by new high resolution EPICA Dome C deuterium data - A comparison with the Holocene. *Climate of the Past*, **7**, 437-450, doi:10.5194/cp-7-437-2011 (2011).
3. Dansgaard, W. Stable isotopes in precipitation. *Tellus*, **16**, 436-468 (1964).