

## Advances in Antarctic ice-sheet reconstructions from ice core archives

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### **Abstract**

Far-field sea level records have provided evidence that parts of the Antarctic Ice Sheet (AIS) were likely lost during the Last Interglacial (LIG) period, 116-129 thousand years ago (Kopp et al., 2009; Dutton and Lambeck, 2012; NEEM members, 2013; O'Leary et al., 2013; Dutton et al., 2015a; Dutton et al., 2015b, Yau et al., 2016). The dating, and the location, of AIS loss within the LIG however remains a difficult problem (Joughin and Alley, 2011). Sediment cores from beneath the West Antarctic Ice Sheet (WAIS) support the view that parts of the WAIS were lost within the last 1.3 million years (Scherer et al., 1998), but again the timing of the loss is unknown. And set against this, proximal ice-rafted debris evidence from marine sediment cores has been interpreted to suggest that there was no WAIS collapse in the last 250,000 years (O'Cofaigh et al., 2001) or last 1.8 million years (Hillenbrand et al., 2002). Thus near field marine and sub-ice sheet sediment core data has not provided conclusive evidence of LIG changes in the WAIS, or the wider AIS. The resultant lack of agreement and knowledge about the AIS, particularly the WAIS during the LIG, hampers our ability to calibrate models of potential AIS loss in the future.

Ice cores provide amongst the best dated proximal evidence of LIG change across the Antarctic regions (e.g. Masson-Delmotte et al., 2011; Capron et al., 2014), it is therefore helpful if we can use ice core measurements to provide constraints on the rate and timing of AIS change throughout the LIG. Bradley et al. (2012) found that it would be difficult to identify the loss of WAIS from glacio-isostatic adjustment signals in EAIS ice cores. However Steig et al. (2015) and Holloway et al. (2016) subsequently explored the atmospheric signal of WAIS loss. Here, we look at some of this recent work, and discuss whether and how AIS meltwater and/or AIS morphology changes would be recorded in Antarctic ice cores. We will focus in this talk, on the past warm LIG period.

**Keywords:** ice cores, modelling, WAIS, Last Interglacial

### **References**

- Bradley, S.L., Siddall, M., Milne, G.A., Masson-Delmotte, V., Wolff, E., (2012), Where might we find evidence of a Last Interglacial West Antarctic Ice Sheet collapse in Antarctic ice core records? *Global and Planetary Change* 88–89, 64–75.
- Capron, E., Govin, A., Stone, E.J., Masson-Delmotte, V., Mulitza, S., Otto-Bliesner, B., Rasmussen, T.L., Sime, L.C., Waelbroeck, C., Wolff, E.W., (2014), Temporal and spatial structure of multi-millennial temperature changes at high latitudes during the Last Interglacial. *Quaternary Science Reviews* 103, 116–133. doi:10.1016/j.quascirev.2014.08.018
- Dutton A., AE Carlson, AJ Long, GA Milne, PU Clark, R DeConto, BP Horton, S Rahmstorf, ME Raymo (2015a) . Sea-level rise due to polar ice-sheet mass loss during past warm periods, *Science*, 349, 153.

- Dutton A., JM Webster, D Zwartz, K Lambeck, B Wohlfarth (2015b) Tropical tales of polar ice: evidence of Last Interglacial polar ice sheet retreat recorded by fossil reefs of the granitic Seychelles islands *Quaternary Science Reviews* 107, 182-196
- Dutton, A., Lambeck, K., (2012), Ice volume and sea level during the last interglacial. *Science* (80), 337, 216–219. doi:10.1126/science.1205749
- Hillenbrand, C.D., Fütterer, D.K., Grobe, H., Frederichs, T., (2002), No evidence for Pleistocene collapse of the WAIS from sediments in the Amundsen Sea. *Geo-Mar. Lett.* 22: 51–59
- Holloway, Max D., Sime, Louise C., Singarayer, Joy S., Tindall, Julia C., Bunch, Pete, Valdes, Paul J. (2016), Antarctic last interglacial isotope peak in response to sea ice retreat not ice-sheet collapse. *Nature Communications*, 7. 9 pp. doi:10.1038/ncomms12293
- Joughin, I. and Alley, R. 2011. Stability of the WAIS in a warming world, *Nature Geo.*, 4, 506–513
- Kopp, R.E., Simons, F.J., Mitrovica, J.X., Maloof, A.C., Oppenheimer, M., (2009), Probabilistic assessment of sea level during the last interglacial stage. *Nature* 462, 863–7. doi:10.1038/nature08686
- Masson-Delmotte, V., Buiron, D., Ekaykin, A., Frezzotti, M., Galée, H., Jouzel, J., Krinner, G., Landais, A., Motoyama, H., Oerter, H., Pol, K., Pollard, D., Ritz, C., Schlosser, E., Sime, Louise C., Sodemann, H., Stenni, B., Uemura, R., Vimeux, F. (2011), A comparison of the present and last interglacial periods in six Antarctic ice cores. *Climate of the Past*, 7. 397-423. 10.5194/cp-7-397-2011
- NEEM members, (2013). Eemian interglacial reconstructed from a greenland folded ice core. *Nature* 493 (7433), 489-494.
- Ó Cofaigh, Colm; Dowdeswell, Julian A.; Pudsey, Carol J., (2001) Late Quaternary iceberg rafting along the Antarctic Peninsula continental rise and in the Weddell and Scotia Seas. *Quaternary Research*, 56 (3). 308-321. 10.1006/qres.2001.2267
- O'Leary, M. J., Hearty, P. J., Thompson, W. G., Raymo, M. E., Mitrovica, J. X., Webster, J. M., (2013). Ice sheet collapse following a prolonged period of stable sea level during the last interglacial. *Nature Geoscience* 6 (9), 796-800.
- Scherer, R. P., A. Aldahan, S. Tulaczyk, G. Possnert, H. Engelhardt, and B. Kamb. (1998), Pleistocene Collapse of the West Antarctic Ice Sheet. *Science*, 281(5373):82–85
- Steig, E. J., K. Huybers, H. A. Singh, N. J. Steiger, Q. Ding, D. M. W. Frierson, T. Popp, and J. W. C. White, (2015), Influence of West Antarctic Ice Sheet Collapse on Antarctic Surface Climate. *Geophysical Research Letters* 42(12): 4862-4868. doi: <http://dx.doi.org/10.1002/2015GL063861>.
- Yau, A. M., Bender, M. L., Robinson, A., Brook, E. J., (2016), Reconstructing the last interglacial at summit, Greenland: Insights from GISP2. *Proceedings of the National Academy of Sciences* 113 (35), 9710-9715.