

Interactive comment on “Direct North-South synchronization of abrupt climate change recording in ice cores using beryllium 10” by G. M. Raisbeck et al.

G. M. Raisbeck et al.

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Replies are in bold

This paper is an important contribution towards understanding of the causes and dynamics of the abrupt climate changes of the last 100,000 years. It takes advantage of the fact that changes in geomagnetic and solar-wind shielding of the galactic cosmic ray flux produce globally synchronous variations in cosmogenic isotope fluxes to sediments. Thus, variations should be coherent in both hemispheres, allowing synchronization of Greenland and Antarctic ice core records of climate, as long as both ice core records also contain sufficiently-high-resolution cosmogenic isotope records. The approach is particularly significant because it avoids the uncertainty associated with the

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gas age-ice age difference, which other inter-polar synchronization efforts must S341 contend with. This is because both the climate record and the cosmogenic isotope record are stored in the ice matrix. The conclusions are mainly that both Antarctica and Greenland experience the highest temperatures simultaneously, within a stated uncertainty of about 200 years. This finding reinforces gas-based methods, that also find that temperature maxima are coeval. The authors explain well the apparent disagreement that once seemed to exist between the methods, as being primarily a matter of definition: Antarctica warms while Greenland is cold, but both peak together, and then subsequently cool together. So it is not sufficient to simply say that one hemisphere is in phase or out of phase with the other - the records have different shapes. Indeed, these unique shapes are well explained by the thermal bipolar seesaw model, as shown by the authors. One overall comment is that the Greenland Be-10 record is probably the weakest part of the paper. The authors are strongly encouraged to pursue their stated goal of a NGRIP high-resolution Be-10 record.

We agree. This has now been done

This would greatly strengthen the conclusions of this paper in addition to opening up new opportunities for synchronization of paleorecords. Of particular help in this regard would be automation of the analysis so that many thousands of samples could be run in a reasonable amount of time.

We agree and can only regret that the former director of the CSNSM evidently did not share this point of view when he decided to shut down the accelerator where these measurements were made.

A second overall comment is that the authors have perhaps brushed off too easily the problem of flux not equalling production, with possible climate-dependence of the flux. It is well known that the fluxes to polar ice sheets of Be-10 are only about one-third as much as would be expected, based on the production rate. The explanation likely is that most Be-10 enters the troposphere in mid-latitudes during spring, and precipi-

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tation removes much of it by scavenging before it can make it to the polar ice sheets. It thus seems quite possible that climate and rainfall in particular could modulate the Be-10 flux to ice sheets. However, this problem is not fatal for the approach used by the authors, because they merely compare the shapes of the Be-10 flux curves, not their absolute values. Thus the approach they use is probably robust to this effect. Nonetheless a much higher resolution and precision record from Greenland would assuage much of the doubt related to this issue, if it can be shown that the shapes of the curves are very similar.

We agree, and plan to do so in the near future

I recommend publication, with only very minor editorial changes.

Minor comment:

when the authors say "intensity" they need to specify "galactic cosmic ray intensity"

Done

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