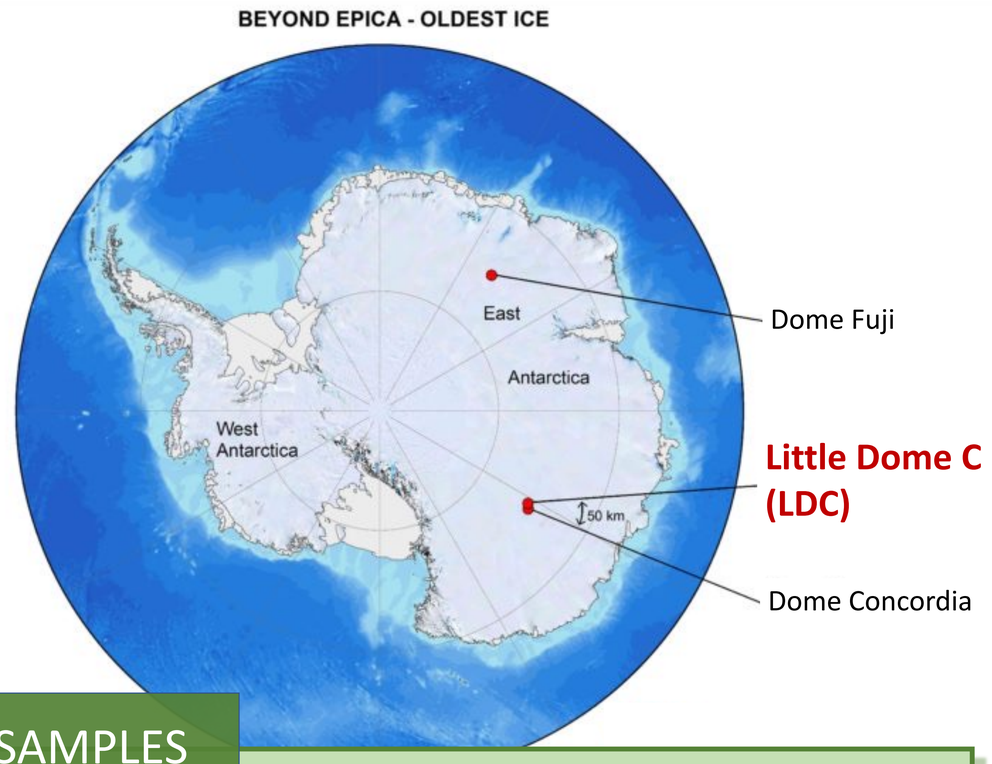
A NEW CONTINUOUS ^{10}Be RECORD FOR THE LAST 10,000 YEARS

MEASURED ON ICE CHIPS FROM A BOREHOLE IN EAST ANTARCTICA

Long Nguyen[1*] (hoang_long.nguyen@geol.lu.se), Chiara Paleari[1], Stefanie Müller[1], Marcus Christl[2], Florian Mekhaldi[1,3], Philip Gautschi[2], Robert Mulvaney[3], Julius Rix[3], Andreas Nilsson[1], Raimund Muscheler[1]

[1] Department of Geology, Faculty of Science, Lund University, Sweden
[2] Laboratory of Ion Beam Physics, ETH Zurich, Switzerland
[3] British Antarctic Survey, Cambridge, UK

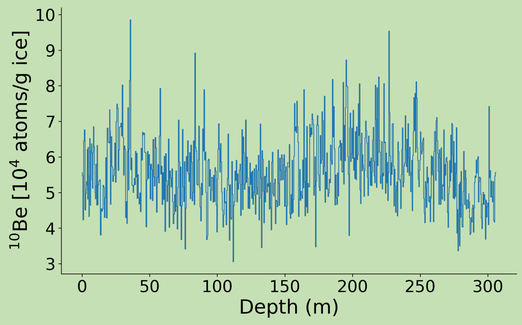


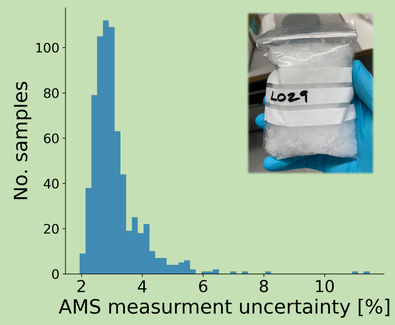
HIGHLIGHTS

- A NEW LONG-TERM ^{10}BE RECORD MEASURED ON RAPID DRILLED ICE CHIPS FROM EAST ANTARCTICA
- THE RECORD PROVIDES INSIGHTS INTO PAST CLIMATIC CONDITIONS, DEPOSITION AND SOLAR ACTIVITY
- THE RECORD HELPS TO IMPROVE SOLAR ACTIVITY AND GEOMAGNETIC FIELD INTENSITY RECONSTRUCTIONS

ICE CHIP SAMPLES

- The samples were obtained through the Rapid Access Isotope Drill Project (RAID) during 2017-2018.
- The project used a novel rapid drill method[1], which recovered 461 m of ice in 104 hours.
- More than 1000 ice chip samples were obtained, each covers around 43 cm depth and weights about 45 g.
- 699 samples have been prepared and measured with Accelerator mass spectrometry (AMS)
- We observed insignificant temporal mixing between consecutive samples (evaluated to be less than 5 years).
- **Refer to Nguyen et al.[2] for details of the sample preparation, measurement and evaluation.**

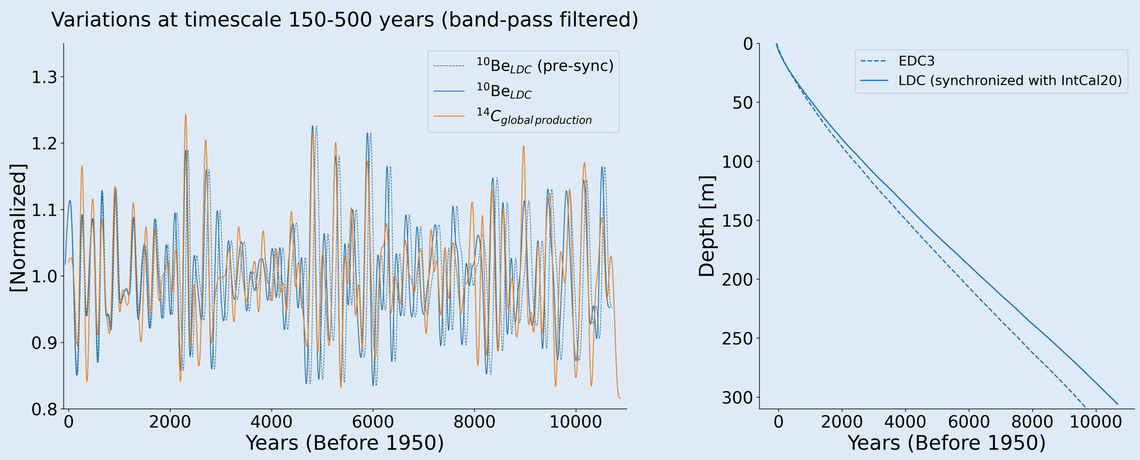




(Nguyen et al. 2021)

INSIGHTS FROM THE NEW 10BE RECORD

1. Dating of the LDC ice samples

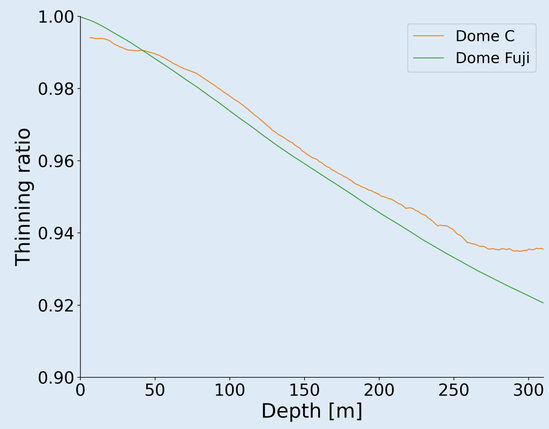


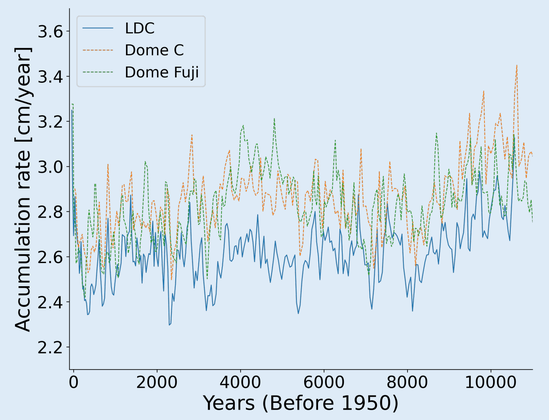
Method: Age of the ice samples was first estimated based on the EDC3 ice core chronology[3,4]. The variations on a timescale between 150-500 years of the ^{10}Be concentrations and ^{14}C production rates (inferred from IntCal20[5]) are dominated by common signals from solar activity variations (left figure). We synchronized the common signals to derive an improved time scale for the LDC samples. Please refer to Adolphi et al.[6] for details on the synchronization method.

2. Reconstruction of the accumulation rate at LDC

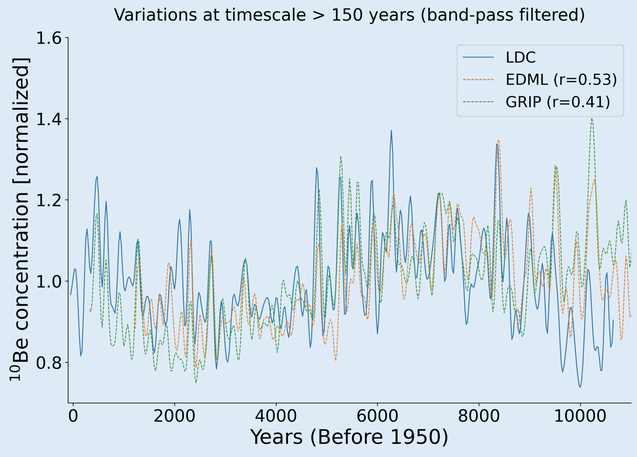
Method: The accumulation rate at LDC was estimated from the depth-age relationship (resulting from the dating the ice samples) assuming the same ice thinning function as for the Dome C ice core[4].

Results: The accumulation rates at LDC are mainly within 2.4 - 2.9 cm/year, which are lower than at Dome C and Dome Fuji[4,7], during the Holocene. Long-term variations in the accumulation rates can be observed. There was a decrease in the accumulation rates from 10,000 to 8000 year BP at all of the sites. These variations could potentially affect the deposition process of ^{10}Be in the past.

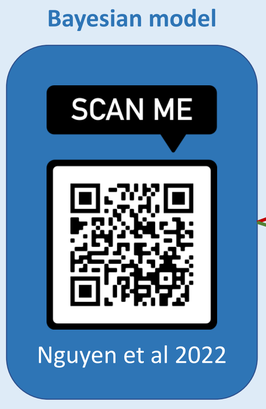




3. Imprints of solar activity and the geomagnetic field reconstructed by a novel Bayesian method

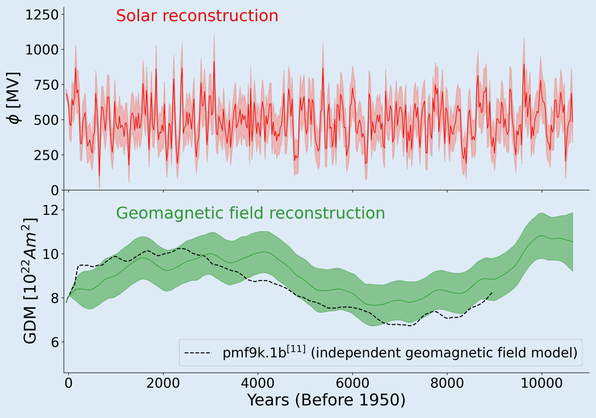


^{10}Be data



Centennial variations

Millennial variations



Long-term changes in the LDC ^{10}Be concentrations correlate with ^{10}Be concentrations of the GRIP ice core [8] and of the EDML ice core [9] due to the influences of solar activity and geomagnetic field which are dominant on long-term timescales. Some disagreements (e.g. around 2000, 8000 and 10,000 years BP) suggest local differences in climatic processes and conditions at these sites.

We have developed a statistical method[10] that allows us to separate and reconstruct solar activity & the geomagnetic field intensity from ^{10}Be records. The separation is based on distinctive variations of these two processes which are integrated into a Bayesian model. Our method reduces the dependence of solar reconstructions on independent geomagnetic field models to eliminate the geomagnetic field influence on ^{10}Be records. Therefore, the method also eliminates the uncertainties associated with those geomagnetic field models and, at the same time, provides an independent geomagnetic field reconstructions based on ^{10}Be.

4. References

1. Rix et al., J. Glaciol. 65:288–298 (2019)
2. Nguyen et al., Results in Geochemistry 5: 100012 (2021)
3. Parrenin et al., Clim. Past 3:485–497 (2007a)
4. Veres et al., Clim. Past 9:1733-1748 (2013)
5. Reimer et al., Radiocarbon 62:725–757 (2020)
6. Adolphi et al., Clim. Past 12:15–30 (2016)
7. Parrenin et al., Clim. Past 3:243–259 (2007b)
8. Vonmoos et al., Geophys Res Sp Phys 111:A10105 (2006)
9. Steinhilber et al., PNAS 109:5967–5971 (2012)
10. Nguyen et al., Earth Planets Space 74:130 (2022)
11. Nilsson et al., Geophys J Int 198:229–248 (2014)