Greenhouse gas (CO$_2$, CH$_4$) alteration in shallow ice at Larsen blue-ice area, Northern Victoria Land, East Antarctica

Giyoon Lee$^1$, Jinho Ahn$^1$, Ikumi Oyabu$^2$, Chang Hee Han$^3$, Kajal Kumar$^1$, Kenji Kawamura$^2$-$^4$-$^5$

$^1$School of Earth and Environmental Sciences, Seoul National University, Seoul, South Korea
$^2$National Institute of Polar Research, Tokyo, Japan
$^3$Department of Earth System Sciences, Yonsei University, Seoul, South Korea
$^4$Department of Polar Science, School of Multidisciplinary Sciences, The Graduate University for Advanced Studies, SOKENDAI, Tachikawa, Japan
$^5$Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Yokosuka, Japan

Correspondence to: Jinho Ahn (jinhoahn@gmail.com)

1. Introduction

To date, CO$_2$ and CH$_4$ concentrations are relatively stable for the last 800 kyr analyzing air bubbles occluded in Antarctic ice cores. CO$_2$ and CH$_4$ concentrations can be altered due to high dust contents and/or microbial activity in ice cores (Rohde et al., 2008; Lee et al., 2020).

2. Study area

Surface ice sample (a), and 2–10 m long ice cores were collected. Dust bands with gentle folding structures in the mid-to downstream part were observed, while severely folded dust bands were observed (e.g. B and Z fold) (Fig. 3b).

3. Gas analysis

• CH$_4$ and CO$_2$ concentrations were measured from Seoul National University by wet and dry extraction methods, respectively.
• CH$_4$ concentration records from the Larsen BIA area generally show an increasing trend from the subsurface to a depth of ~0.35–1.15 m. Then gradually decreases until it reaches to ~0.6 m. CO$_2$ concentration in the Larsen BIA area shows a gradual decrease from the subsurface until a depth of ~4.6 m where the concentration variation stabilizes. CO$_2$ concentration in Larsen BIA ice samples (depth < 4.6 m) is elevated compared to EDC and WAIS Divide records.

4. Pb analysis

• Pb from 1.35 m, 9.05 m depth ice of LS23 and from three 1.95 m depth ice of Larsen BIA ice cores are not significantly altered by modern aerosols.
• Pb concentration in Larsen BIA ice samples (depth < 4.6 m) is elevated and/or depleted compared to EDC and WAIS Divide records.

5. Conclusion

- Greenhouse gas (CO$_2$, CH$_4$) concentrations are altered at shallow depth of ~1.0–6.5 m of Larsen BIA. CH$_4$ concentration generally show an increasing trend from the surface to a depth of ~0.35–1.15 m. Then gradually decreases while CO$_2$ concentration shows a gradual decrease from the subsurface until a depth of ~4.6 m.
- Based on 8$^13$C–N$_2$ modern air intrusion has not caused the greenhouse gas alteration.
- Based on Pb$^{206}$, biological activity is less likely for altering the greenhouse gas concentrations in the shallow ice samples.
- Based on the Pb ice core results, greenhouse gas alteration is not related to modern aerosol intrusion.

6. References

- Hu, H. et al., 2022: 8$^13$C of CO$_2$ in a Tibetan Ice Core confirms its Chronology to the Holocene. GRL, 46, e2022GO009056.
- Lee, J. S. et al., 2009: Recent methane emissions in Greenland ice cores associated with high dust concentrations, Geochimica et Cosmochimica Acta, 75, 3963-3977.
- Lüthi D., et al., 2008: High-resolution carbon dioxide concentration record 650,000–800,000 years before present: Nature 453, 379-382.
- Masuruzzo and Hinckley, 2001. Trace metal suites in Antarctic pre-industrial ice are consistent with emissions from quiescent draining of volcanics worldwide. EPIS, 186, 33-43.
- Monnin, E. et al., 2005, Evidence for substantial accumulation rate variability in Antarctica during the Holocene, through synchronization of CO$_2$ in the Taylor Dome, Dome C and DML ice cores, EPIS, 190, 45-66.