Sudden emergence of a shallow aragonite saturation horizon in the Southern Ocean

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Motivation

Models project that with current CO_2 emission rates, the Southern Ocean surface will be undersaturated with respect to aragonite by the end of the 21st century, resulting in widespread impacts on biogeochemistry and the ocean ecosystem.

Objective

Quantify the depth of the present-day Southern Ocean aragonite saturation horizon using hydrographic and ocean carbon chemistry observations and a large ensemble of simulations from the community Earth system model to track its evolution.

Depth of aragonite saturation horizon

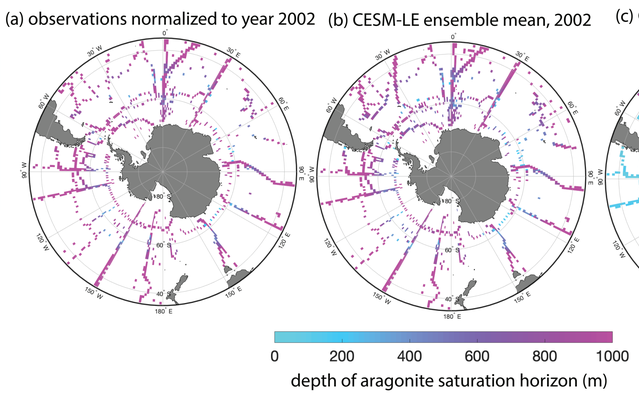

Fig. 1 | (a) Depth of the aragonite saturation horizon from GLODAPv2 bin-averaged DIC (normalized to year 2002), (b) CESM-LE in 2002, corrected for model bias using hydrographic observations and (c) CESM-LE in 2100.

Emergence of shallow aragonite saturation horizon

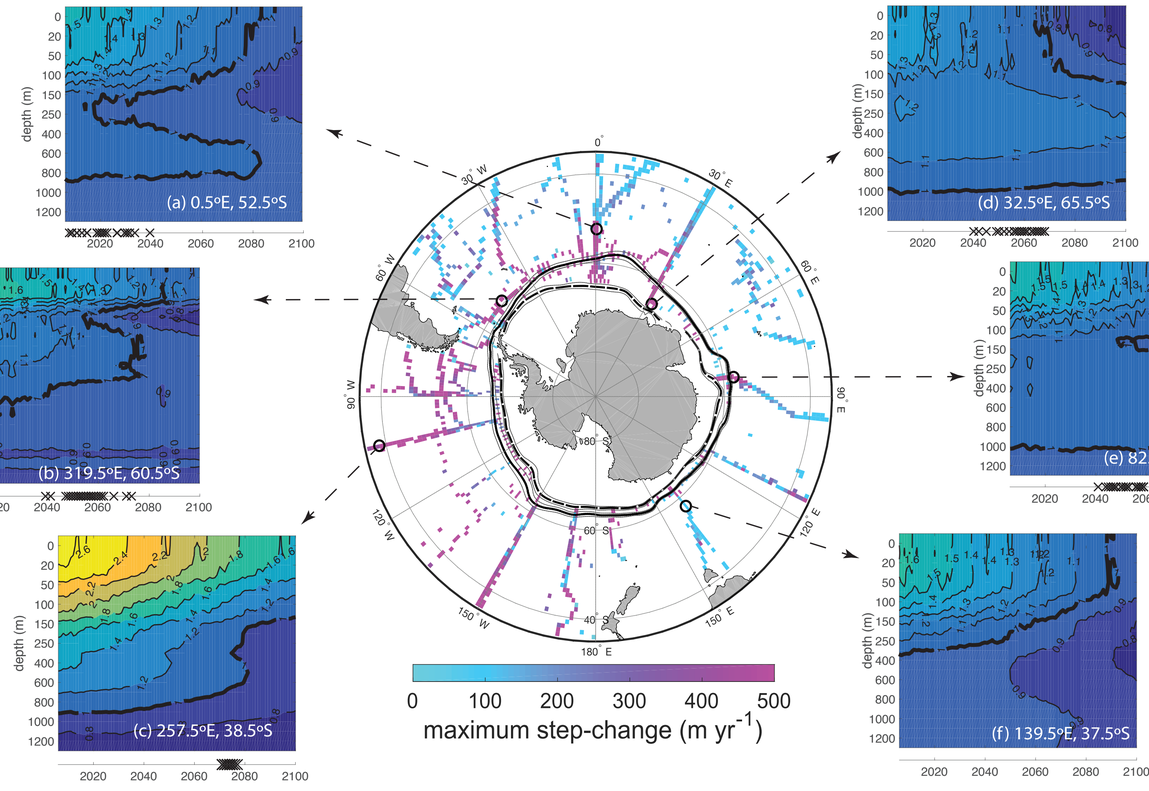

Fig. 2 | Temporal evolution of upper water column aragonite saturation state in several locations, as projected by a single ensemble member of CESM-LE (RCP8.5)

Drivers of shallow horizon

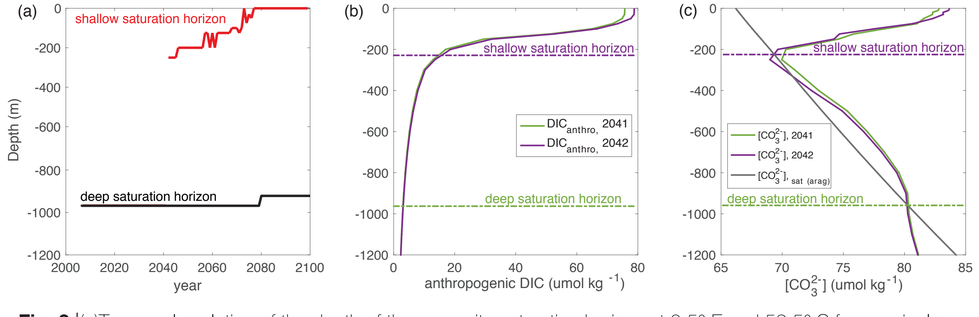

Fig. 3 |(a)Temporal evolution of the depth of the aragonite saturation horizon at 0.5° E and 53.5° S from a single CESM-LE ensemble member. (b), Vertical profiles of anthropogenic DIC concentration (µmol kg^{-1}) (c), and carbonate ion concentration (µmol kg^{-1}) along with the corresponding depth of the aragonite saturation horizon.

Conclusion

- A new, shallow aragonite saturation horizon emerges in the Southern Ocean between now and the end of the century.
- Internal climate variability may affect the year of emergence.
- The new horizon is driven by the slow accumulation of anthropogenic CO_2 in the Southern Ocean thermocline.
- The new horizon is also apparent under emission-stabilizing scenario indicating an inevitable, sudden decrease in the volume of suitable habitat for aragonitic organisms.

References

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