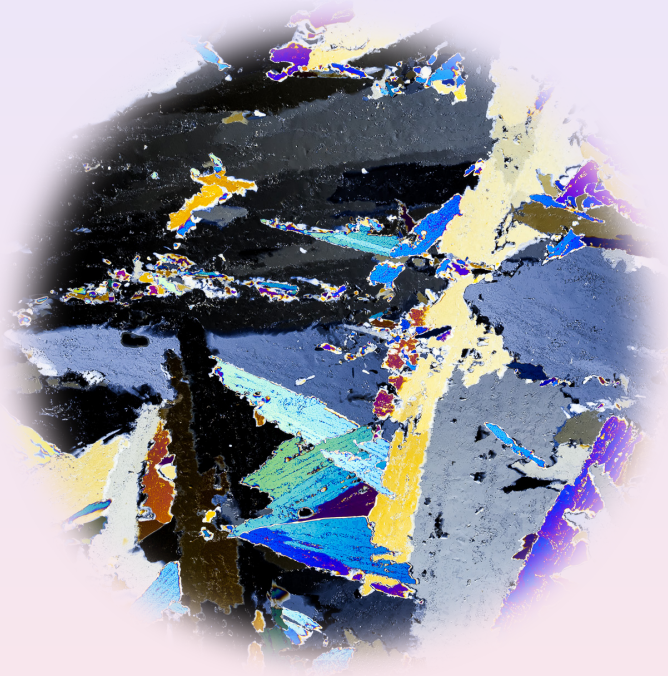
Sea-ice / ice-shelf interaction in the eastern Weddell Sea



by

Mario Hoppmann

Contributors:

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Stephan Paul
Priska Hunkeler
Olaf Boebel

International Symposium on Sea Ice in a Changing Environment,
10 - 14 March, Hobart, Australia

clic Climate and Cryosphere | WCRP World Climate Research Programme | AWI Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung | DFG-Schwerpunktprogramm 1158 Antarktis Forschung | Helmholtz Association | POLMAR Helmholtz Graduate School for Polar and Marine Research

Climate change, the Antarctic kind'a way

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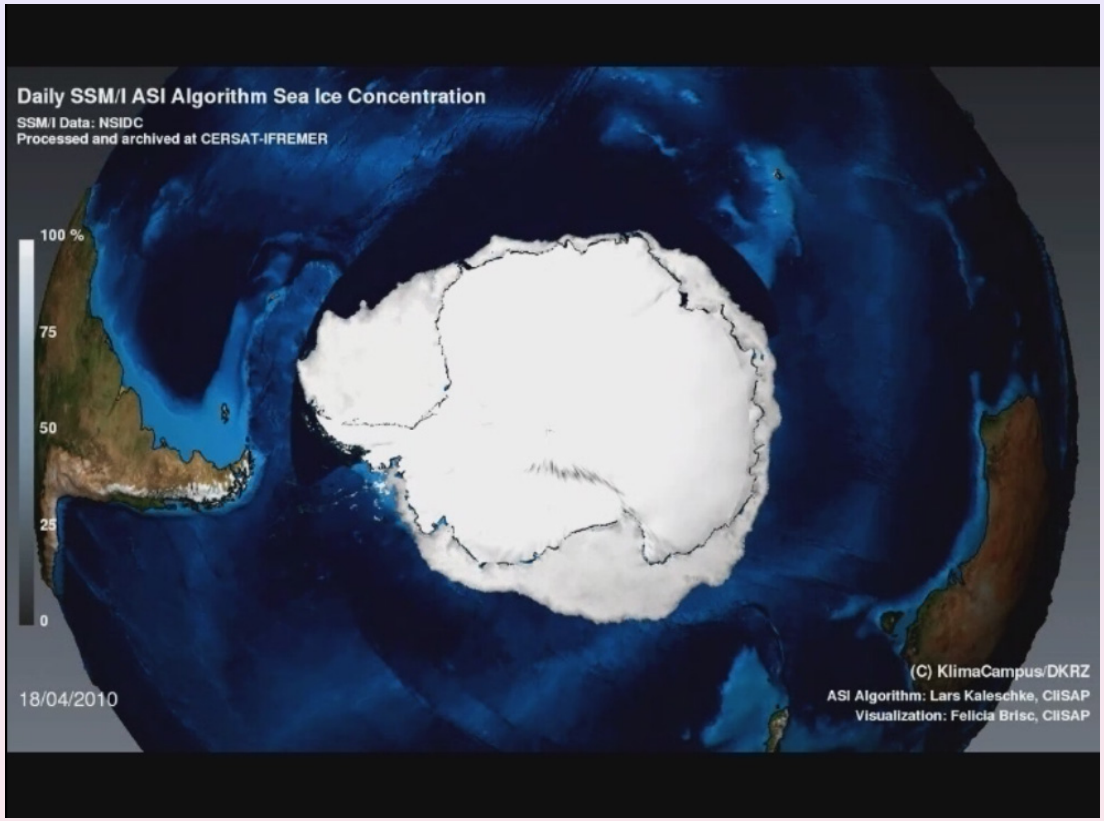

- Antarctica "behaves" strangely in a warming climate...
- We miss something!

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Ice shelf - sea ice interaction

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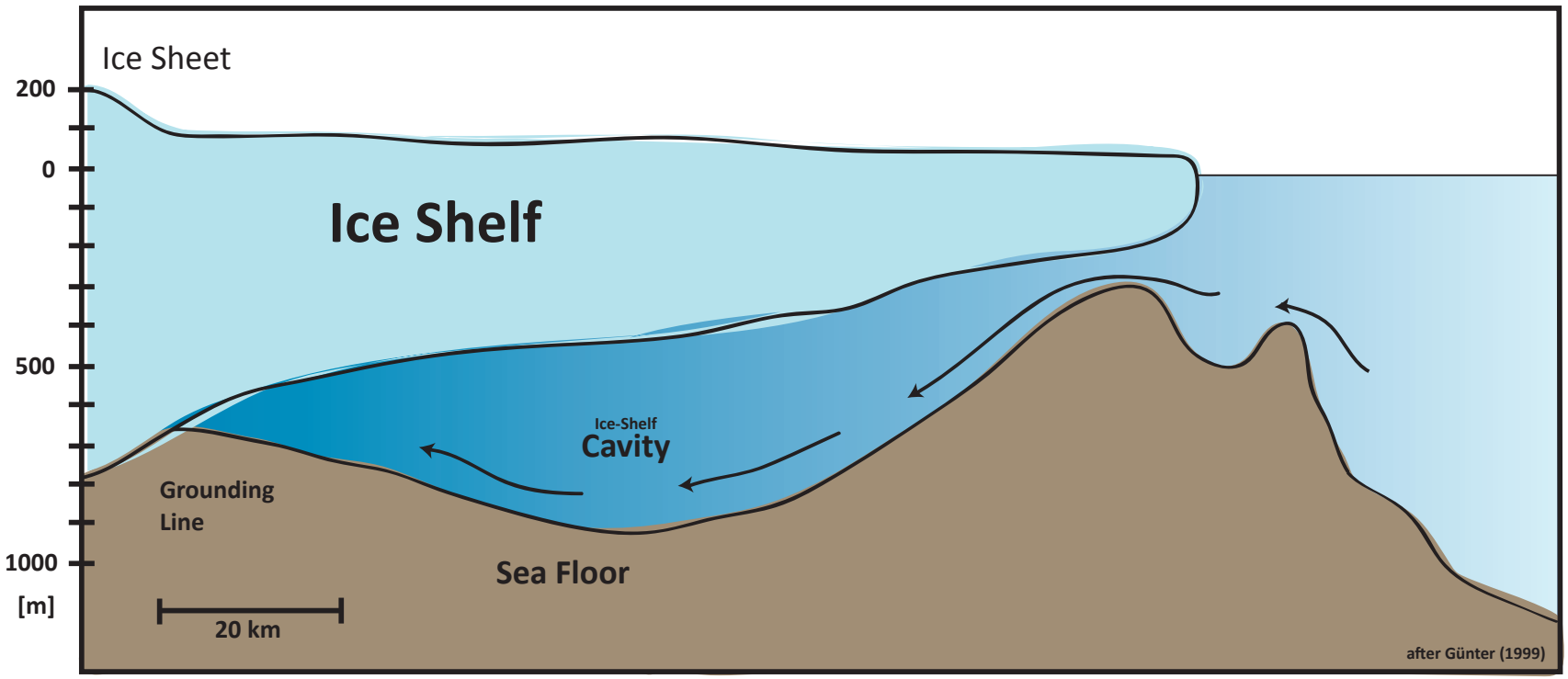

Ice shelf - sea ice interaction

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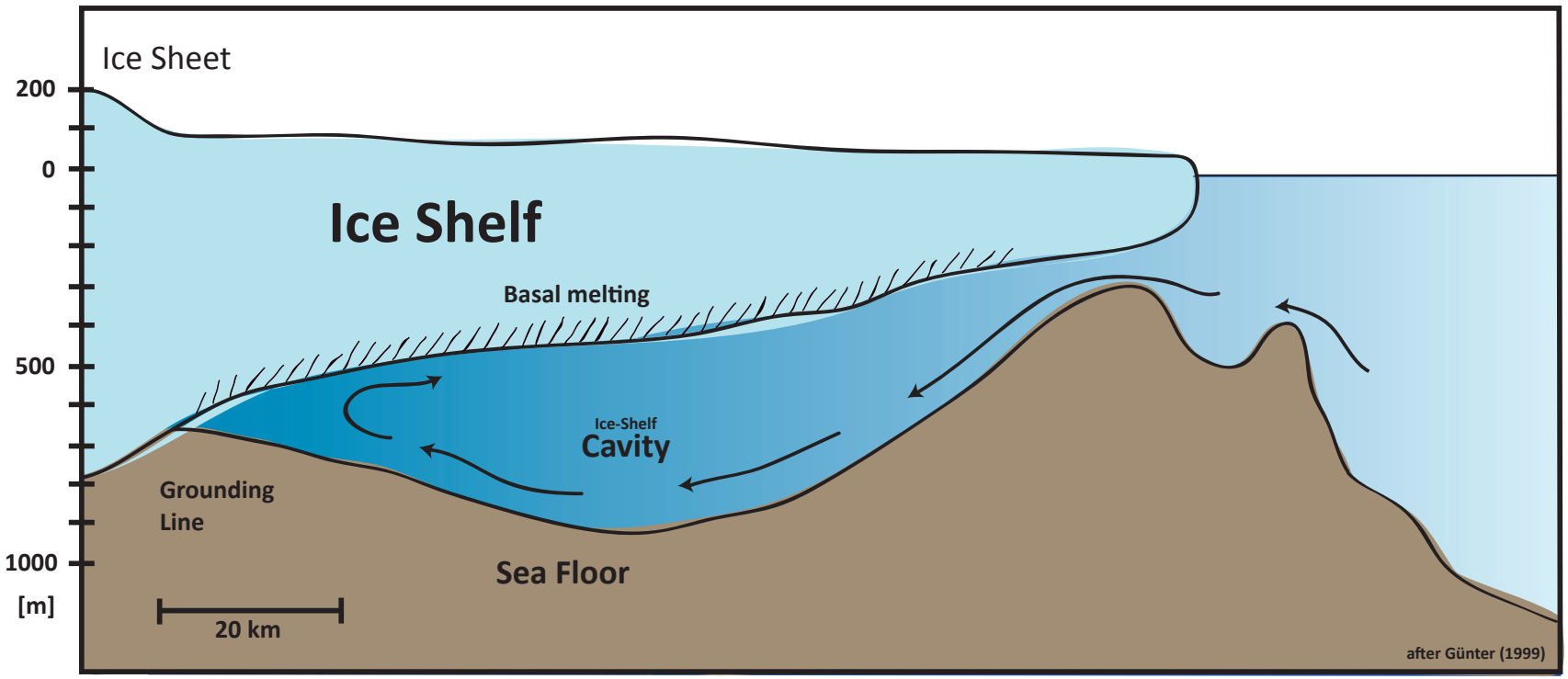

Ice shelf - sea ice interaction

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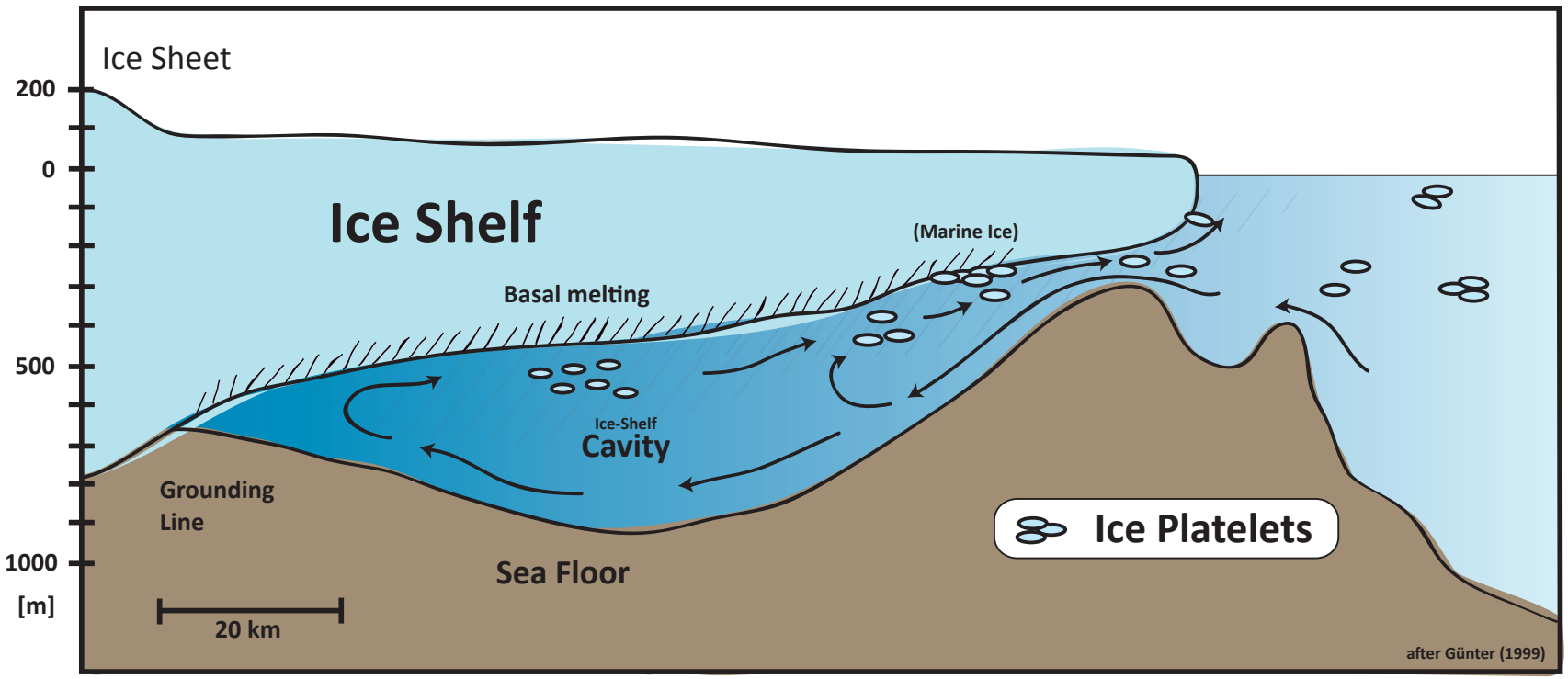

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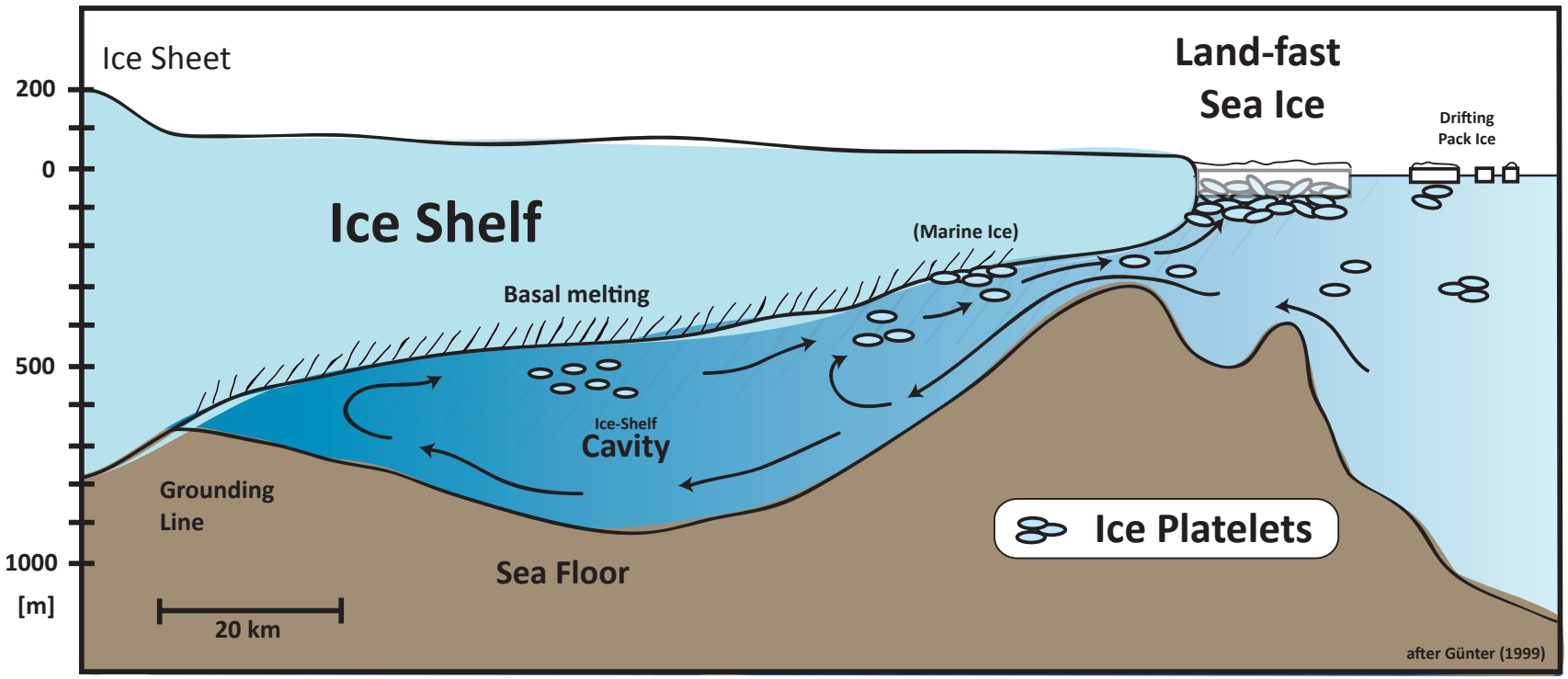
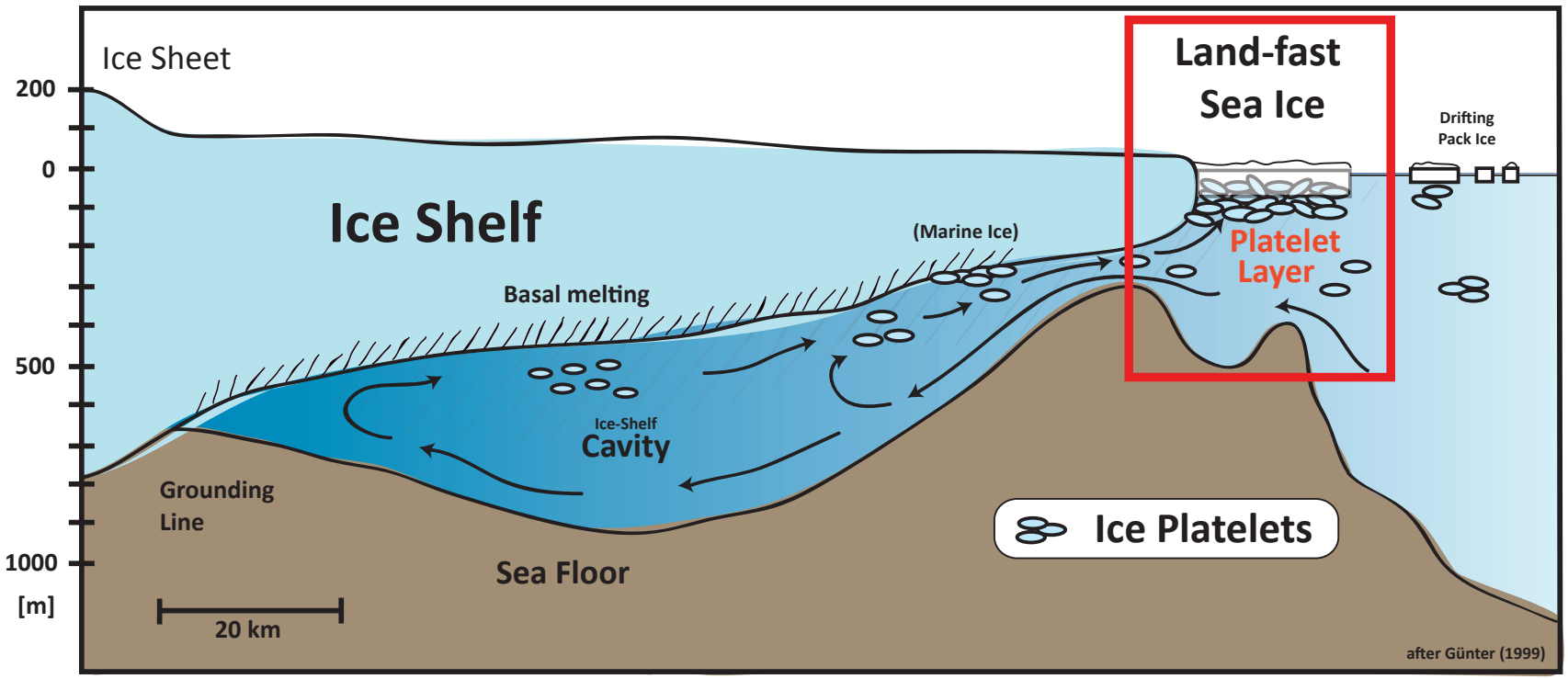


Ice shelf - sea ice interaction



Ice shelf - sea ice interaction

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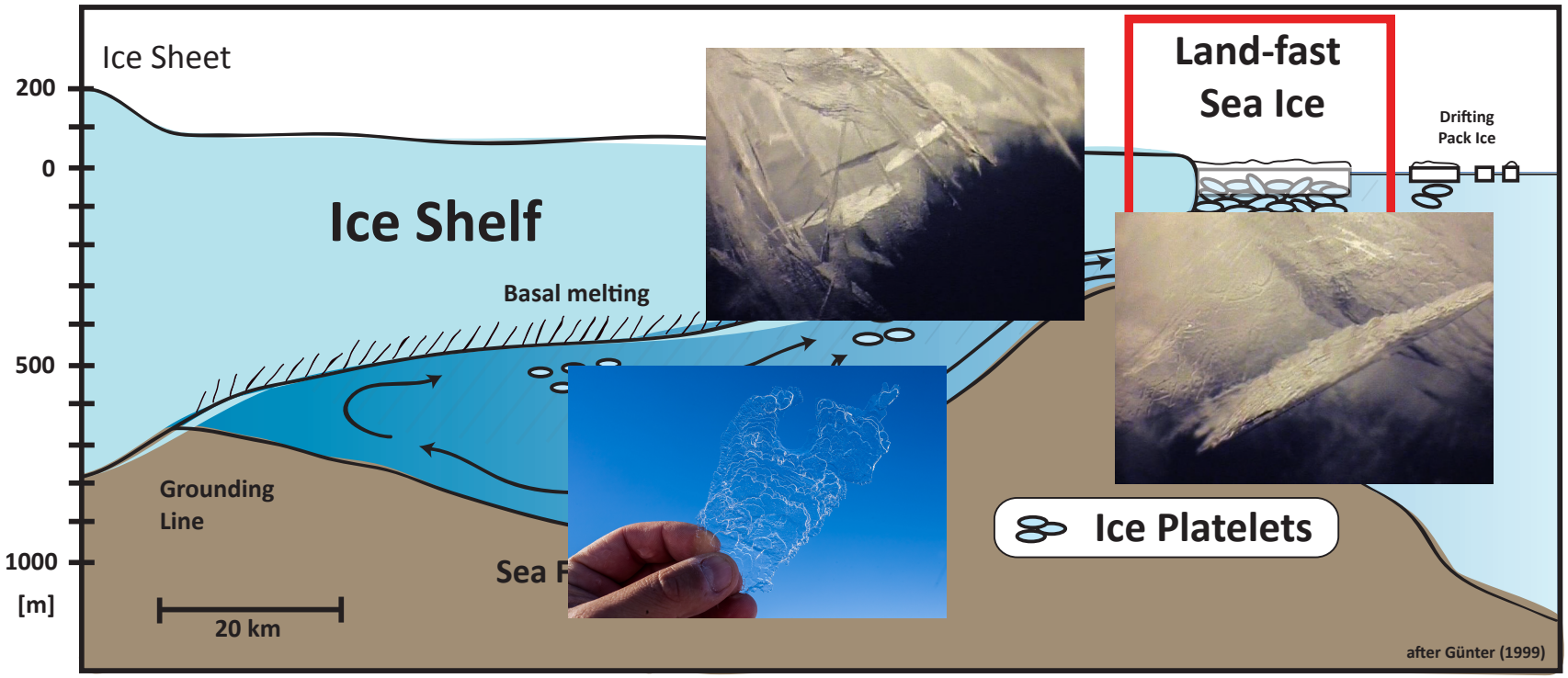

Ice shelf - sea ice interaction

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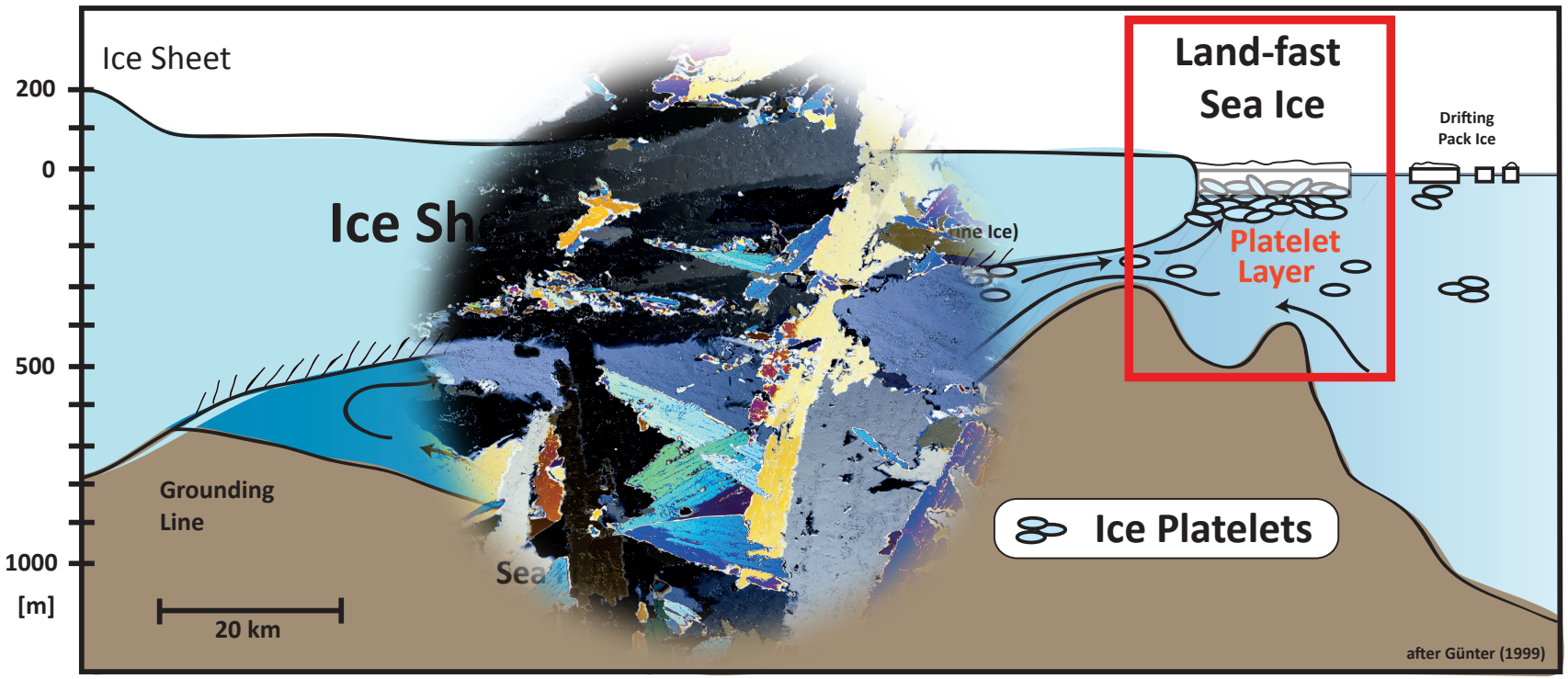

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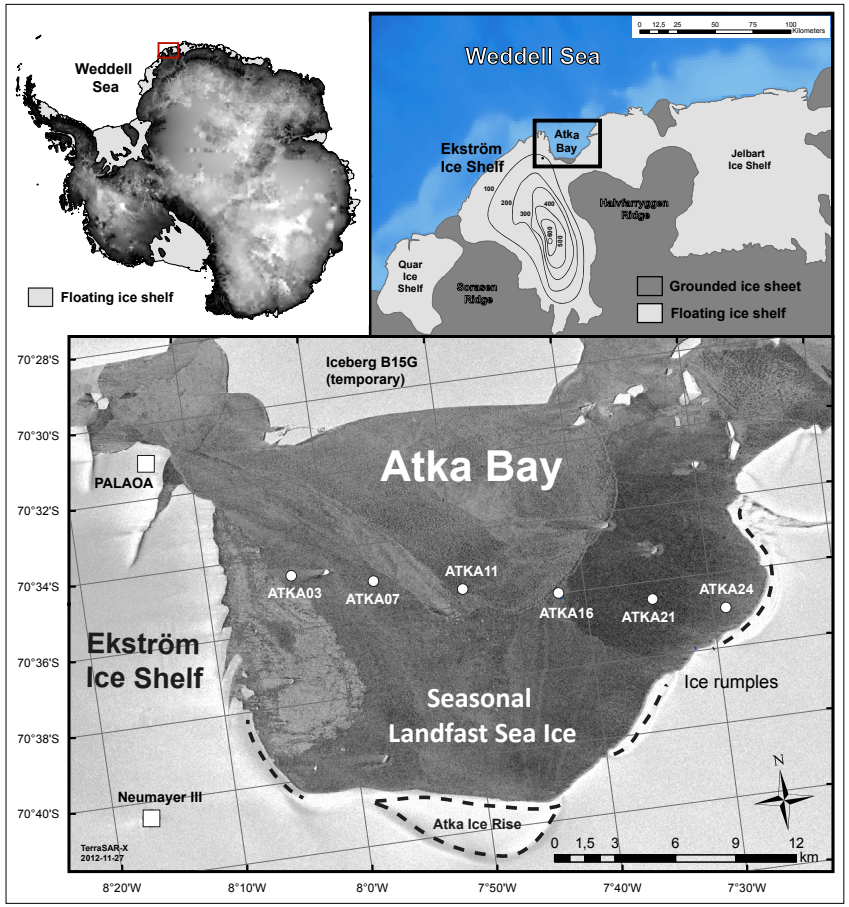
Study area: fast ice at Atka Bay, eastern Weddell Sea

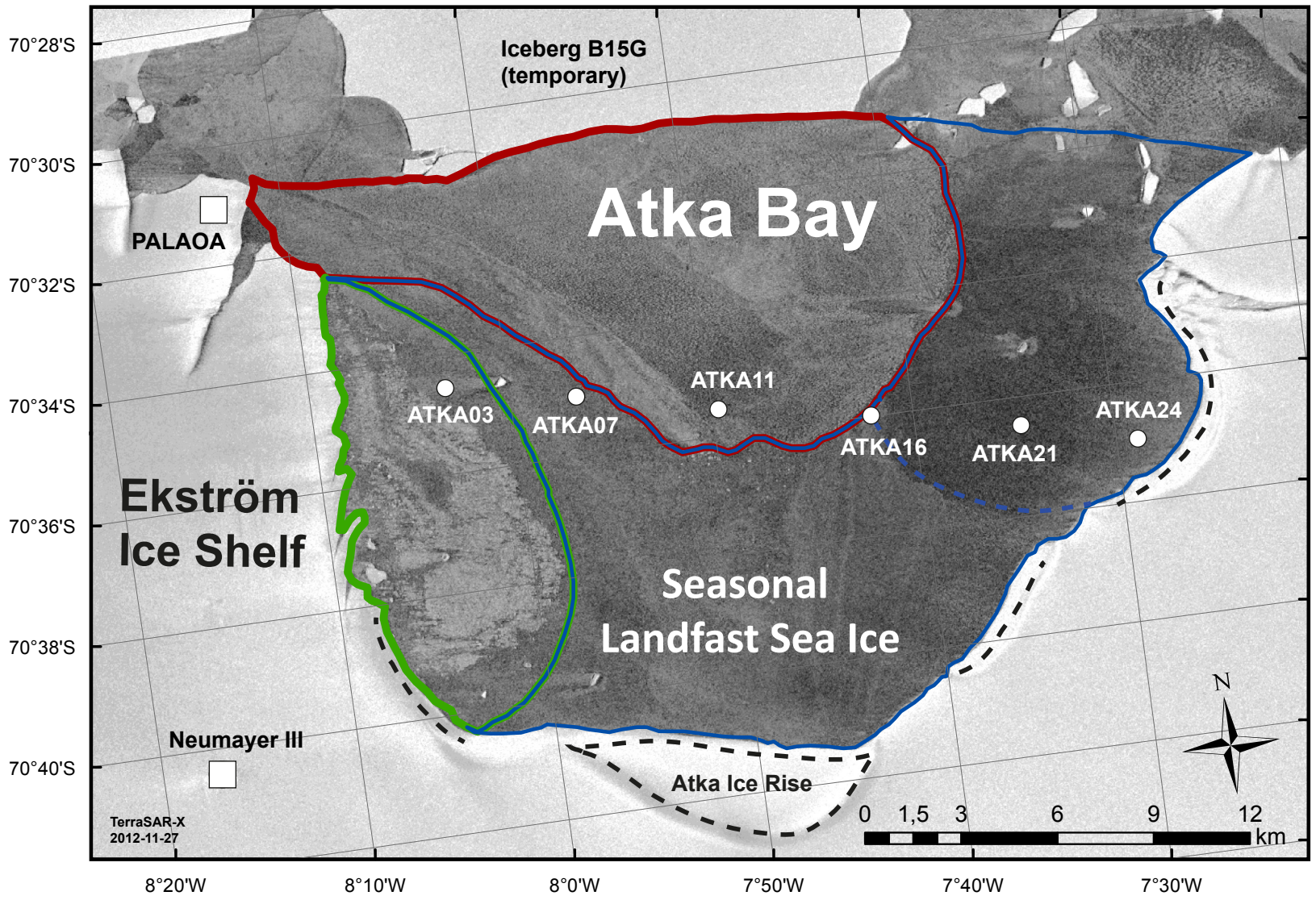


- Sea ice attached to Ekström Ice Shelf
- Near the German Antarctic station Neumayer
- Kipfstuhl (1991): Discovery of ice platelets at Atka Bay
- Günther (1999): Algal communities in platelet layers
- Fast-ice monitoring since 2010 (Antarctic Fast Ice Network)

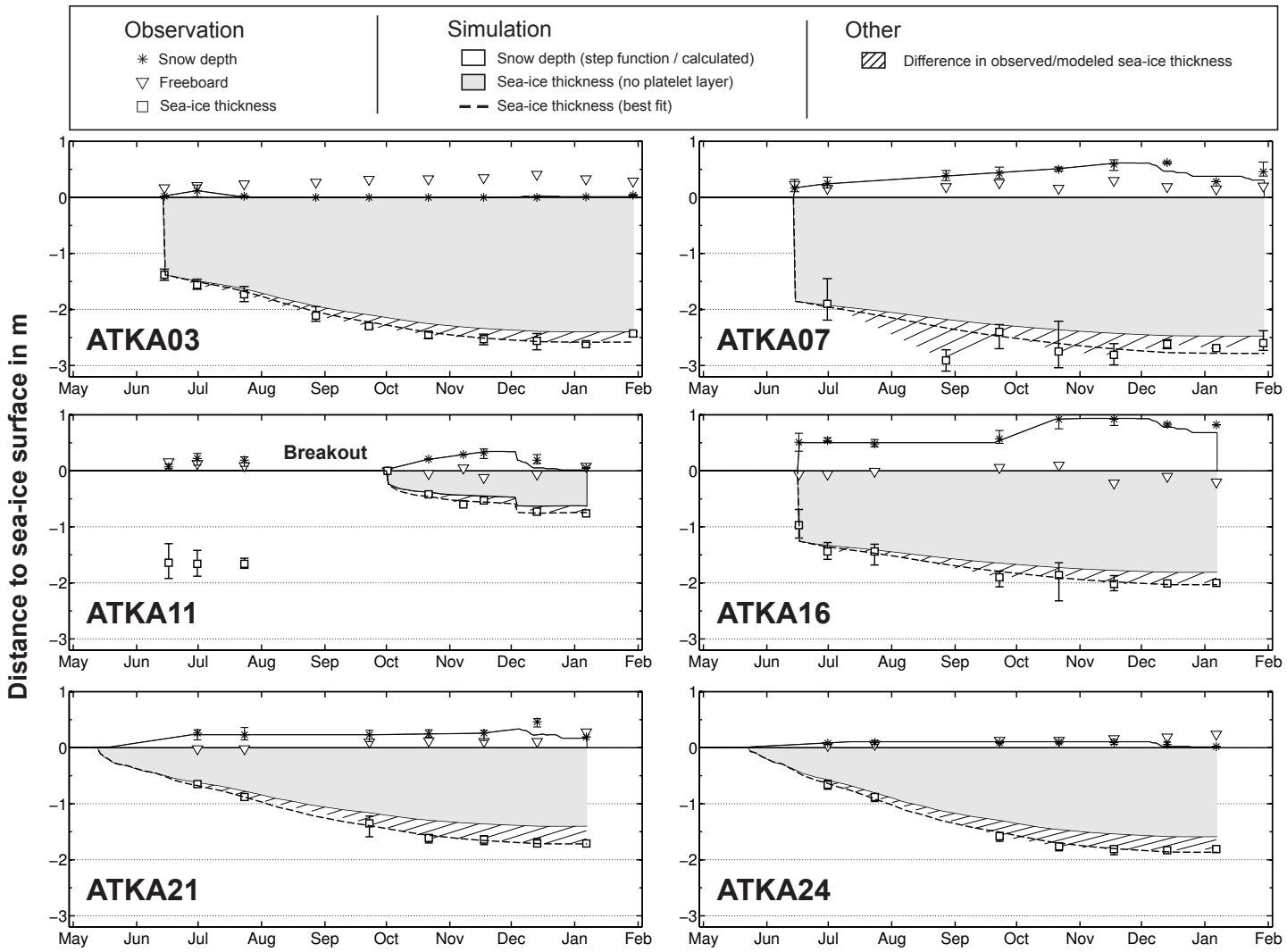
Field work

- **Drill-hole measurements**
- **Sea-ice cores**
- **Oceanographic data**
- Automated stations: **meteorology**, **eddy covariance**, spectral albedo/transmission
- Under-ice light field, albedo transects
- Electromagnetic induction sounding
- Mass balance- and snow buoys
- Snow properties, satellite remote sensing

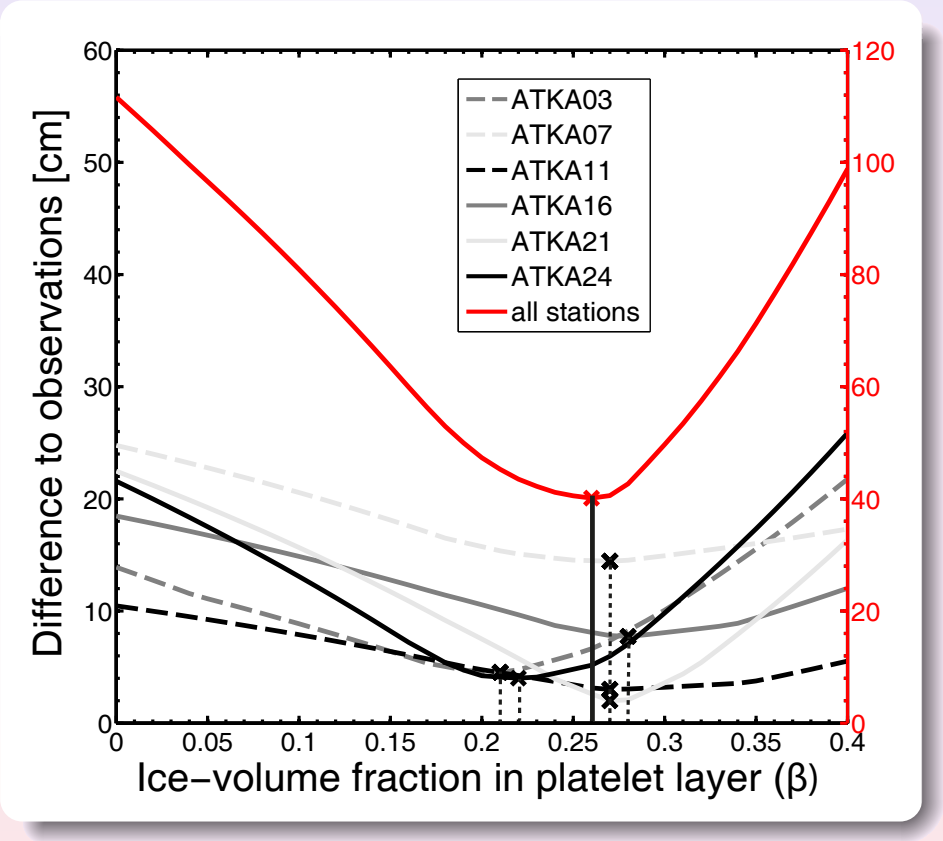
Field setting in 2012



Sea-ice thermodynamic growth



Platelet-layer ice-volume fraction

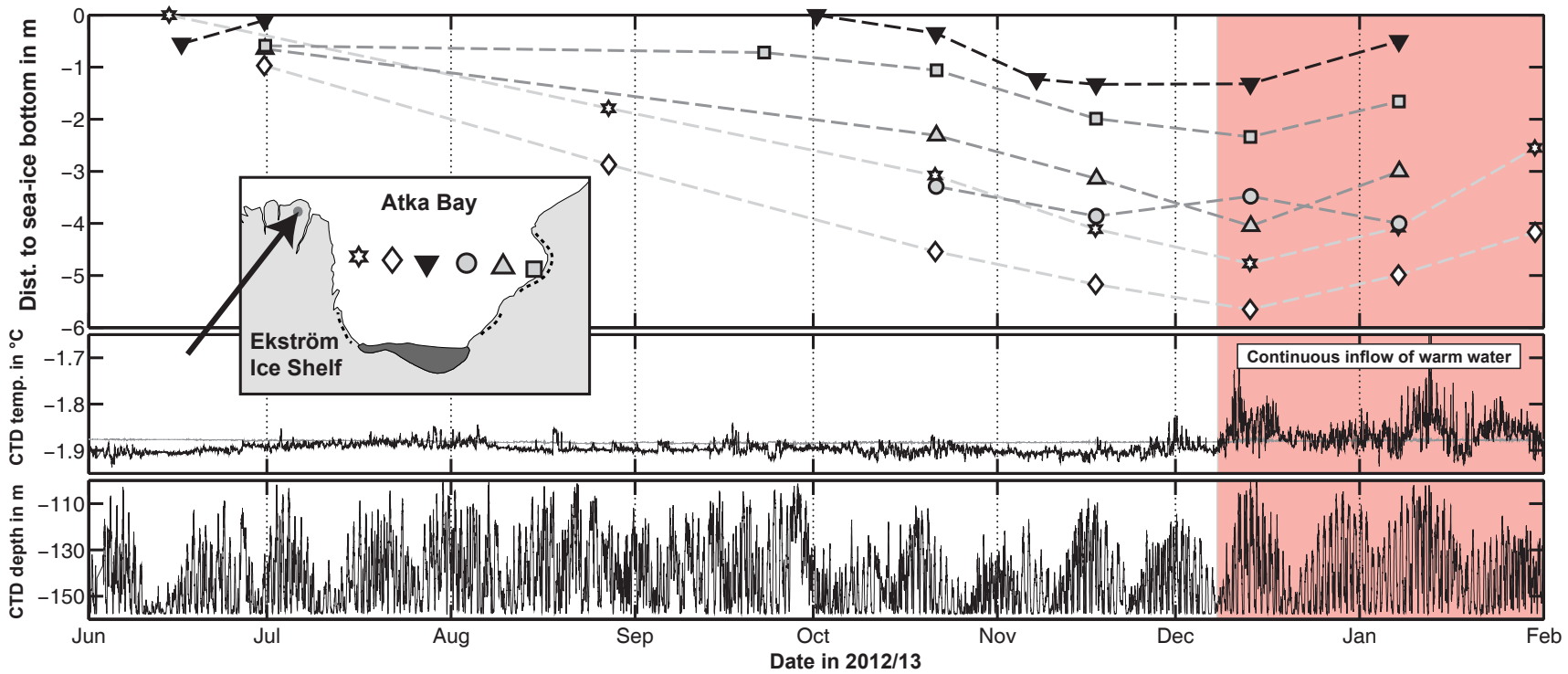


- Modification of growth rate
- **Ice-volume fraction: 0.26 (0.21 - 0.28)**
- Selected studies:

  Atka Bay:
  0.2 (Kipfstuhl 1991)
  0.46 (Günther 1999)
  0.29 - 0.43 (Hunkeler et al. submitted)

  McMurdo:
  0.25±0.07 (Gough et al. 2012)
  0.16±0.07 (Price et al. 2014)

Seasonal evolution of platelet-layer thickness



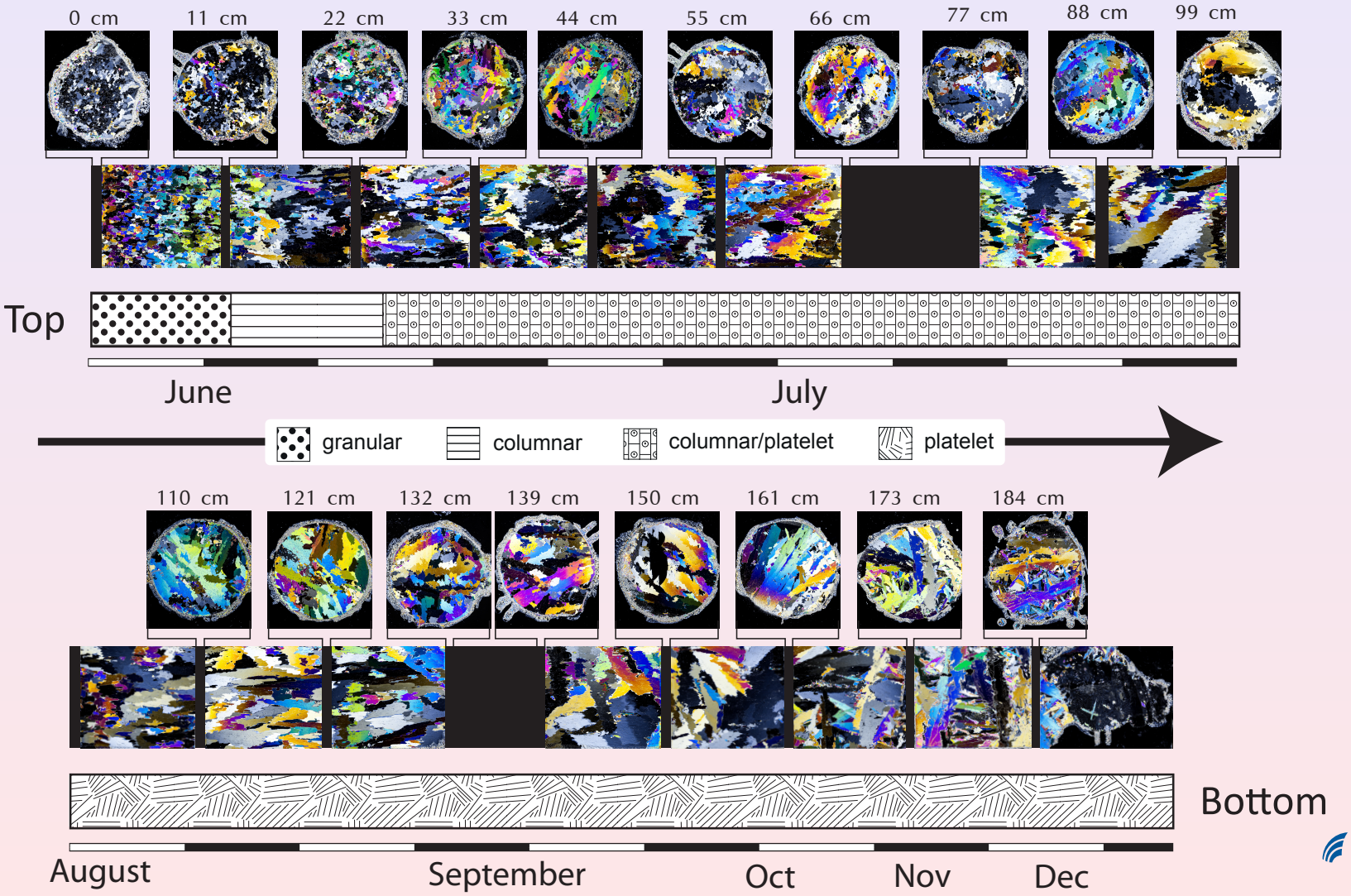
- First platelet accumulations in June.
- Maximum thickness of platelet layer in December.
- Thinning due to warmer water entering Atka Bay.
- Minimal fast-ice bottom melt due to shielding effect.

Episodic Accumulation

Rising ice platelets (4x), courtesy of Ilse v. Opzeeland

- Episodic events of high ice-platelet flux from depth.
- Low continuous flux.
- Platelets already relatively large.
- Main mechanisms: **platelet advection** and/or growth below solid sea ice?

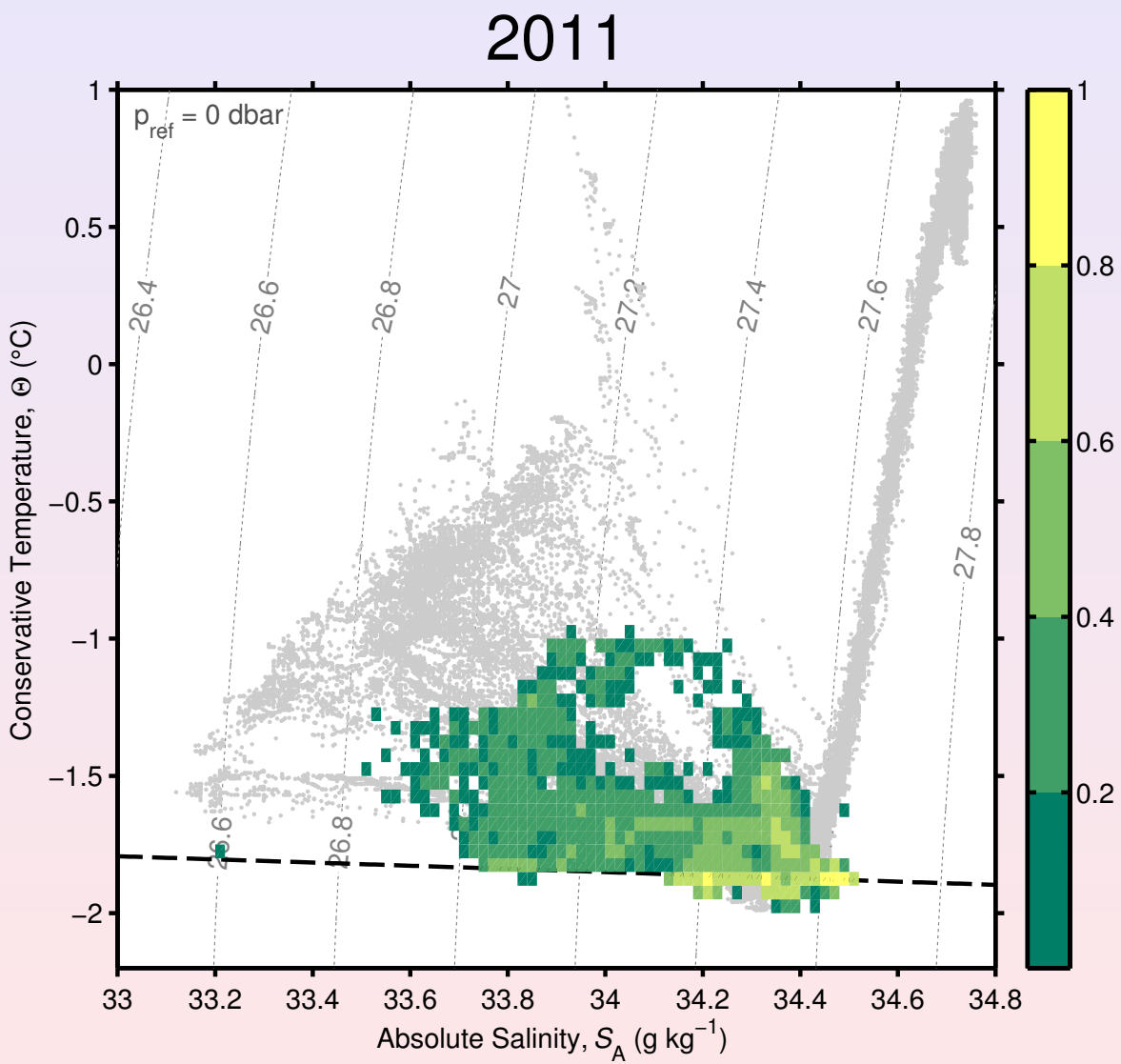
Sea-ice structure



Main findings

- Platelets accumulate between June and December in episodic events.
- Average platelet layer thickness 4m, measured maximum 10m.
- Solid volume fraction of 0.26.
- Modified crystal structure in 80 % of the cores.
- No fast-ice bottom melt due to shielding effect.
- Less flooding due to additional buoyancy.
- Ice shelf-ocean interaction contributes up to 50 % to solid+loose sea-ice mass.
- Appr. 20 % of Ekström Ice Shelf annual basal melt volume accumulates below Atka Bay fast ice as ice platelets.

Ongoing work: Oceanography



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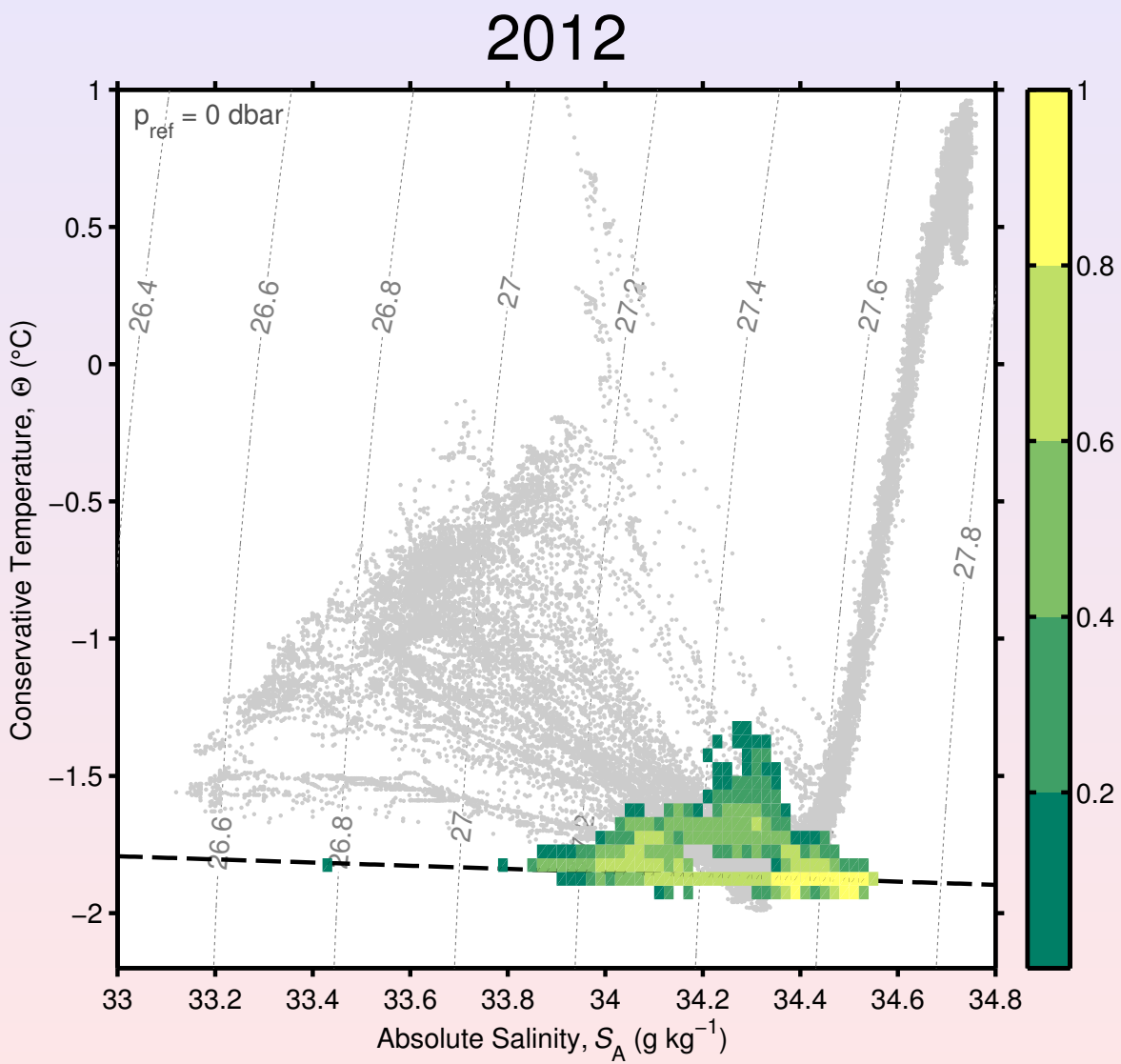

Ongoing work: Multi-frequency EM induction sounding

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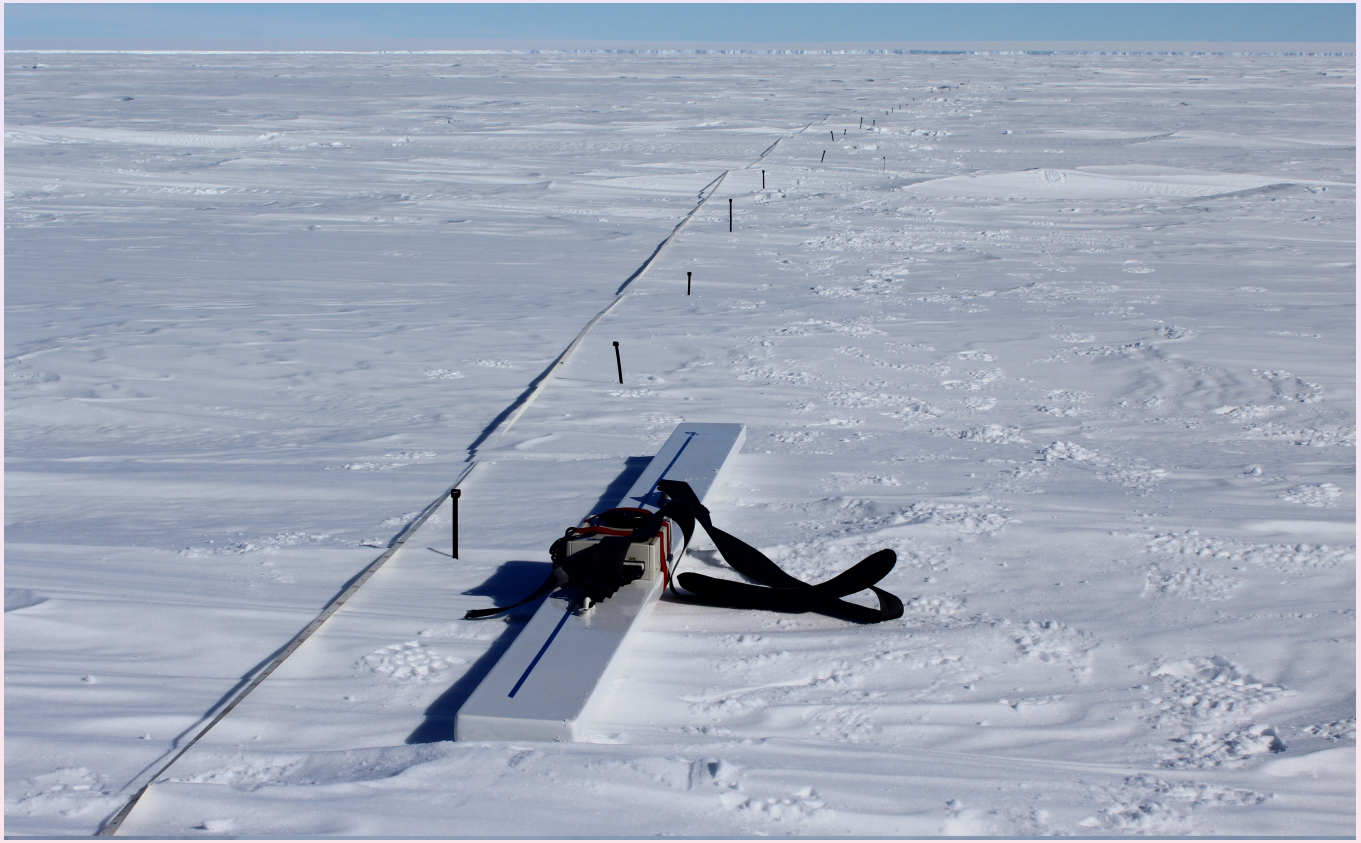

Conclusion

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Wake up! Take-home messages!

1. Sub ice-shelf processes heavily influence sea-ice properties in the eastern Weddell Sea.
2. Fast ice is an accessible indicator of ice-shelf melt processes, which become increasingly important.
3. More monitoring sites and improved methods are needed to establish this link.

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Gough, A. J., Mahoney, A. R., Langhorne, P. J., Williams, M. J. M., Robinson, N. J. & Haskell, T. G. (2012), 'Signatures of supercooling: McMurdo Sound platelet ice', *Journal of Glaciology* **58**(207), 38–50.

Günther, S. (1999), Jahreszeitliche Entwicklung von Festeis-Lebensgemeinschaften und ihrer Umwelt, PhD thesis, Universität Bremen.

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Kipfstuhl, J. (1991), 'On the formation of underwater ice and the growth and energy budget of the sea ice in Atka Bay, Antarctica (mostly in German)', *Reports on Polar and Marine Research* **85**, 88p.

Price, D., Rack, W., Langhorne, P. J., Haas, C., Leonard, G. & Barnsdale, K. (2014), 'The sub-ice platelet layer and its influence on freeboard to thickness conversion of Antarctic sea ice', *The Cryosphere Discuss.* **8**(1), 999–1022.