Yan et al. investigate the basal unit of the central Antarctic Ice Sheet, a critical yet poorly understood component of the ice-sheet system. They use new high-resolution radar data to examine the reflection and scattering properties in this region. Through Delay-Doppler analysis, they characterize two areas with different scattering properties. These results are used and discussed to determine possible englacial causes for the differences observed in these two regions, with variations in ice temperature and subglacial geology likely being responsible.

This paper is very well written, well structured, and addresses a relevant aspect of the Antarctic Ice Sheet. The basal unit is a region where complex and poorly understood processes lead to the loss of englacial layering and coherence in radar signals. Yan et al. provide a clear and comprehensive introduction to this complex topic, thoroughly describe the survey region, data, and methods, and make a valuable contribution to the field through their interpretation and critical discussion. In my opinion, this article is of high scientific quality, sheds light on a significant topic, and presents new insights, making it relevant for *The Cryosphere*.

I have two main points that need clarification and a few minor suggestions that could make the paper clearer. Once these points are addressed, I look forward to seeing this article published in *The Cryosphere*.

Main points

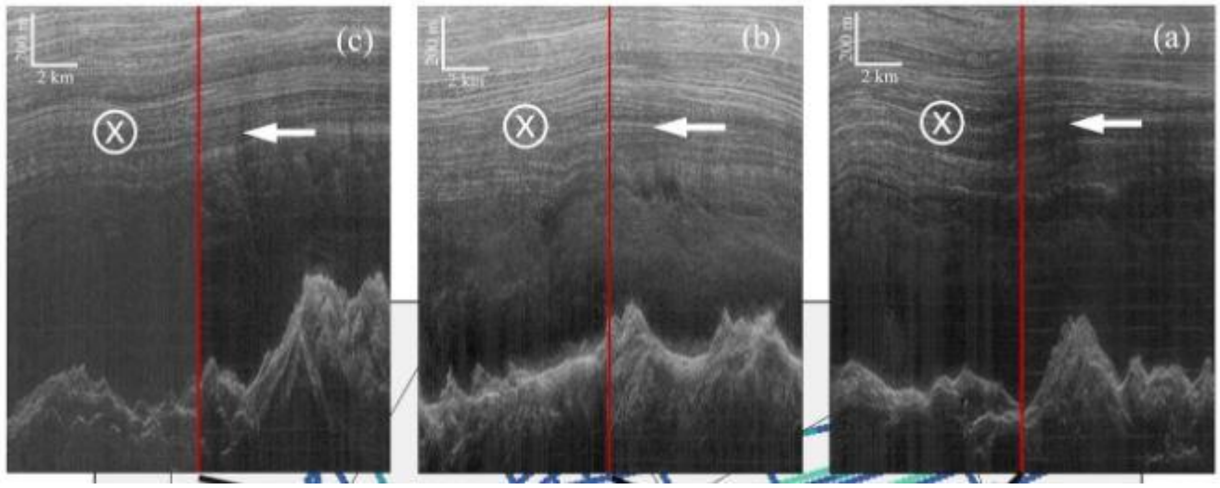
1)

L220 - 223: *“During this freeze-on process, debris may become entrained in the ice, potentially contributing to the incoherent scattering observed in IPR sounding. Given the similar radar signature, we infer that the incoherent scattering observed in the upstream portion of the COLDEX survey region may have formed through the same mechanism.”*

I would disagree with the authors' claim that the radar signature observed is "similar" to those in studies analyzing the entrainment of englacial debris. My comment is based on a purely visual comparison of the radargrams in this study (e.g., Figures 1, 3, 7) with those shown below in studies addressing entrained basal debris in the basal ice unit: Bell et al. (2011), Wrona et al. (2018), and Franke et al. (2023, 2024). When comparing the radar signatures in Figures 1, 3, or 7 of this study (where it is most visible) with those in the mentioned studies, I do not believe we are referring to the same signature. In my view, the signatures in Bell et al. (2011), Wrona et al. (2018), and Franke et al. (2023, 2024) exhibit (i) higher return power (sometimes comparable to the bed return power), (ii) are directly connected with the ice base, and (iii) are located in regions where subglacial freeze-on was modeled. I would argue that the signatures referred to in this study correspond to those seen, for example, in Figure 2 of Wrona et al. (2018) or Figure 2 of Franke et al. (2024), but located ***above*** the layer defined as sediment entrained.

This does not mean that the incoherent scattering detected in this study cannot originate from entrained particles, but it is not comparable to what the aforementioned studies refer to.

I leave it to the authors to decide how to address this comment and they might disagree. However, it should be clarified that—at least based on a visual comparison of the radargrams—we are not discussing the same phenomenon.



This paper: Figure 7 in Yan et al (2025; in review)

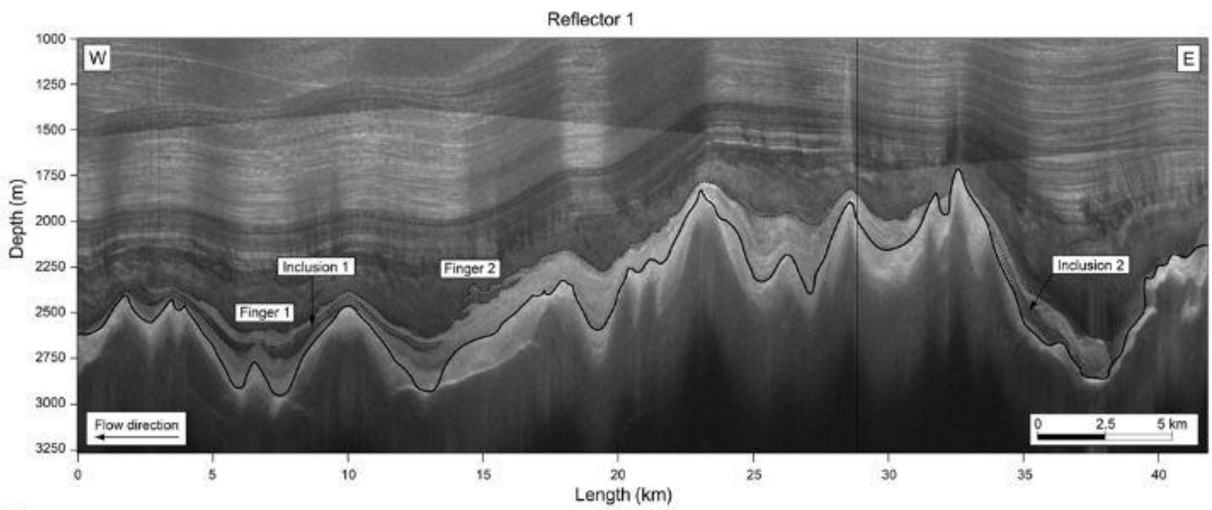


Figure 2 in Wrona et al. (2018)

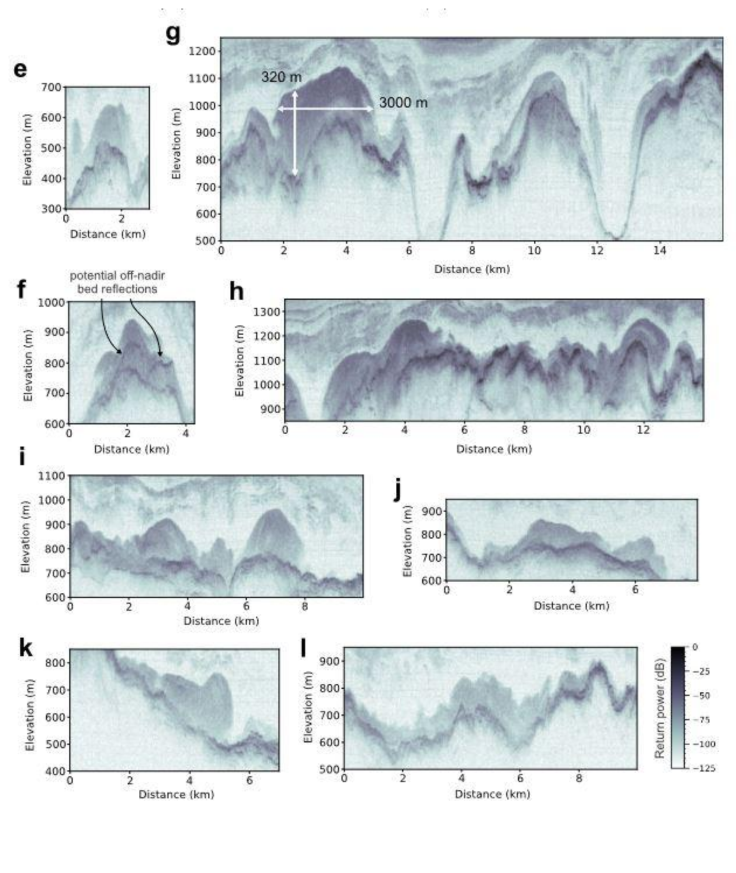
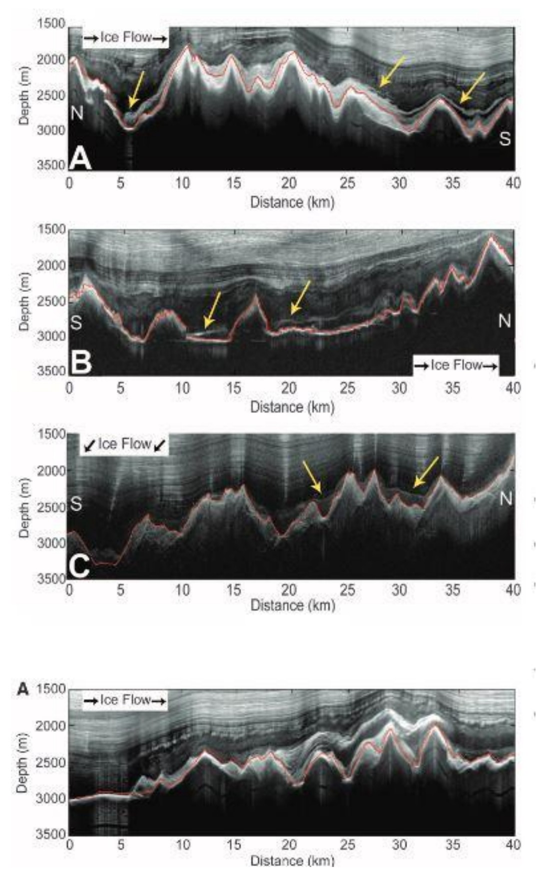
	

Figure 2 in Franke et al. (2024)	Figure 3 in Bell et al. (2011)

References

Bell, R. E., Ferraccioli, F., Creyts, T. T., Braaten, D., Corr, H., Das, I., et al. (2011). Widespread Persistent Thickening of the East Antarctic Ice Sheet by Freezing from the Base. *Science*, *331*(6024), 1592–1595. https://doi.org/10.1126/science.1200109

Wrona, T., Wolovick, M. J., Ferraccioli, F., Corr, H., Jordan, T., & Siegert, M. J. (2018). Position and variability of complex structures in the central East Antarctic Ice Sheet. *Special Publications*, *461*(1), 113–129. https://doi.org/10.1144/sp461.12

Franke, S., Gerber, T., Warren, C., Jansen, D., Eisen, O., & Dahl-Jensen, D. (2023). Investigating the Radar Response of Englacial Debris Entrained Basal Ice Units in East Antarctica Using Electromagnetic Forward Modeling. *IEEE Transactions on Geoscience and Remote Sensing*, *61*, 1–16. https://doi.org/10.1109/tgrs.2023.3277874

Franke, S., Wolovick, M., Drews, R., Jansen, D., Matsuoka, K., & Bons, P. D. (2024). Sediment Freeze-On and Transport Near the Onset of a Fast-Flowing Glacier in East Antarctica. *Geophysical Research Letters*, *51*(6). https://doi.org/10.1029/2023gl107164

2)

The authors interpret that the cause for the appearance and disappearance of incoherent scattering in the basal unit is spatial variability in englacial temperature. They mention that other processes can also contribute, but warmer ice seems to be their main interpretation, and this is also very prominent in the abstract.

I wonder how robust this is or if other mechanisms, such as equally warm/cold ice with different degrees of internal mixing could be an equally likely cause. There is not much other data or information presented in the paper (basal reflectivity, estimates on englacial attenuation, …) that would support temperature differences to be the main cause (or I did overlook them). Maybe the authors could comment on that and (if possible) strengthen this interpretation, or consider to say that other mechanisms could be equally likely in relevant parts of the paper (e.g., abstract and conclusions).

Moreover, a connection between incoherent scattering and subglacial roughness is being made. Is there also a correlation between incoherent scattering and ice thickness?

Minor points

- I hope I didn't overlook this, but the paper does not provide the specific years of the radar flights. This should be pointed out more clearly in the abstract and data and methods section.
- Would it be possible to draw the dashed lines you have in Figure 3, also in the radargrams in Figure 4?
- Figure 5: Ice thickness is reducing from right to left in the conceptual figure. From your radargrams and bed topography map it seems that ice thickness is however fairly constant and probably even thicker in your Type II boundary. Maybe this could be addressed or corrected to avoid conclusions drawn from this figure (e.g., that the Type II region has thinner ice).
- L129: *[… 2D focusing was applied following the procedure described in Peters et al. (2007), which helps correct for off-nadir scattering…]* – I believe this refers to along-track off-nair scattering and not cross-track off-nadir scattering?
- L53-58: Franke et al. (2024) could be cited here as well with regard to freeze-on of subglacial water and sediment entrainment at the onset of Jutulstraumen Glacier, but I'll leave it entirely optional for the authors because it concerns one of my own publications.
- L64: Regarding radar signatures and COF, I'd suggest to cite the work of Lilien et al. (2021) as well.
- L220: Regarding freeze-on of subglacial water, I'd suggest to cite Creyts et al. (2014) next to Wolovick et al. (2013) as well.

References

Creyts, T. T., Ferraccioli, F., Bell, R. E., Wolovick, M., Corr, H., Rose, K. C., Frearson, N., Damaske, D., Jordan, T., Braaten, D., and Finn, C.: Freezing of ridges and water networks preserves the Gamburtsev Subglacial Mountains for millions of years, Geophys Res Lett, 41, 8114–8122, https://doi.org/10.1002/2014gl061491, 2014.

Lilien, D. A., Steinhage, D., Taylor, D., Parrenin, F., Ritz, C., Mulvaney, R., Martín, C., Yan, J.-B., O'Neill, C., Frezzotti, M., Miller, H., Gogineni, P., Dahl-Jensen, D., and Eisen, O.: Brief communication: New radar constraints support presence of ice older than 1.5 Myr at Little Dome C, Cryosphere, 15, 1881–1888, https://doi.org/10.5194/tc-15-1881-2021, 2021.

Franke, S., Wolovick, M., Drews, R., Jansen, D., Matsuoka, K., and Bons, P. D.: Sediment Freeze-On and Transport Near the Onset of a Fast-Flowing Glacier in East Antarctica, Geophys. Res. Lett., 51, https://doi.org/10.1029/2023gl107164, 2024.

Thank you once more for the nice read and I hope to see this paper published soon.

Best wishes,
Steven Franke