

Englacial stratigraphy in Ellsworth Subglacial Highlands, West Antarctica

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Problem

The effort at achieving continent-wide coverage of englacial ice sheet layers (i.e. AntArchitecture), is limited by a lack of data in the critical regions between the Amundsen and Weddell Sea, i.e. the upper reach of Pine Island Glacier (PIG), Rutford and Institute Ice Stream (RIS and IIS, respectively).

Aims

1. To constrain past regional ice flow using new radar data collected by Centro de Estudios Científicos (CECs) in Ellsworth Subglacial Highlands (ESH).
2. To map key Internal Reflection Horizons (IRHs) across the region and determine their likely ages.

Methods

- 155 Mhz central freq. radar surveys were undertaken in 2006 and 2014 (Fig. 1).
- IRHs traced by regionally tracking clear layer packages (Fig. 2)
- IRHs tied to existing work^[1,2] at 2 crossover points (Fig. 1).
- Age ranges are estimated using a 1-D age depth model^[3] assuming a range of 0.153 to 0.2 (m a^{-1} ice-equivalent) accumulation rates.

Results

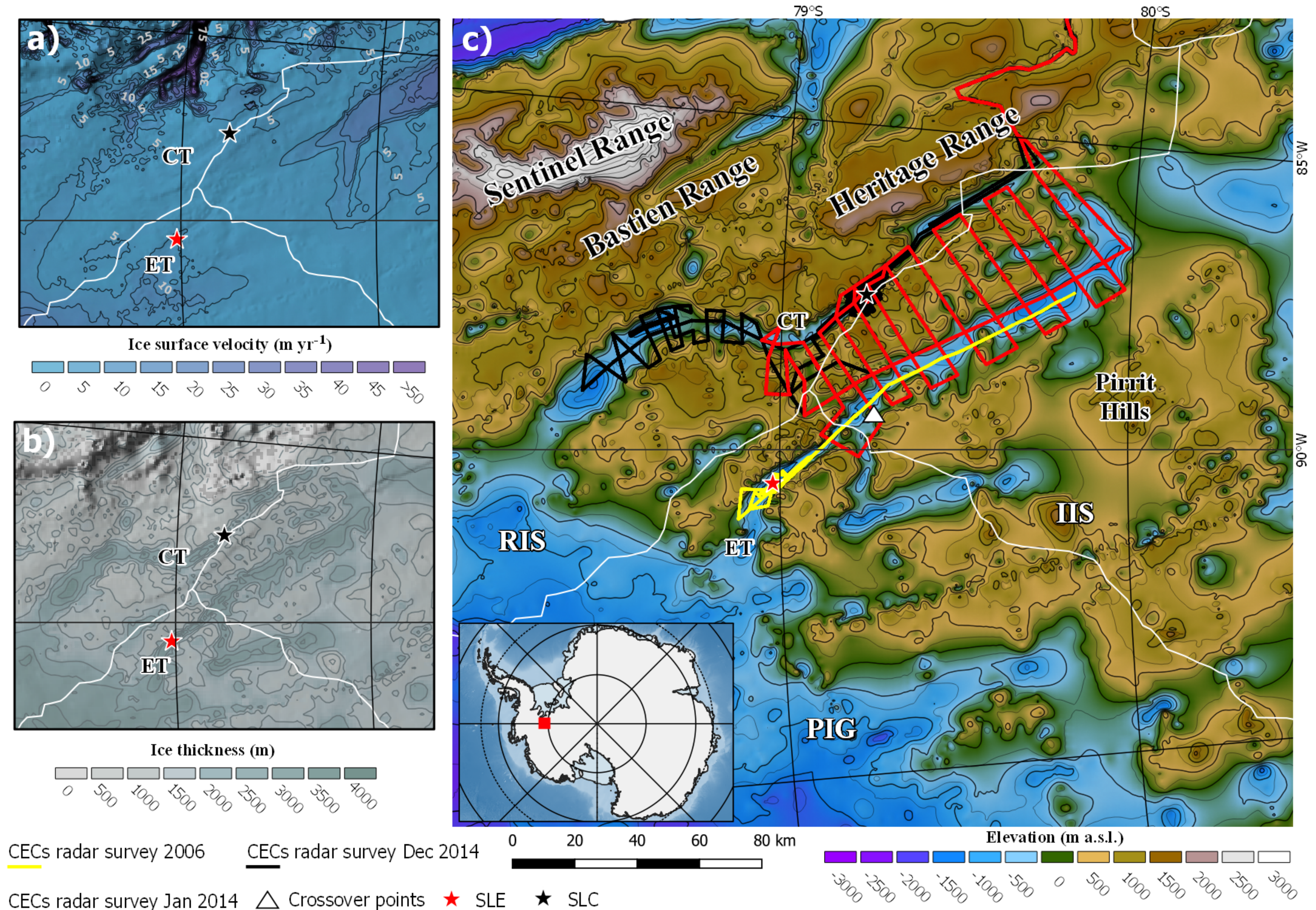
1. We mapped 6 number of IRHs across the region. All layers are deeper within CECs Trough (CT) and Ellsworth Trough (ET) and shallower in the alpine regions between CT and ET.
2. We find that the oldest traced IRH is from the Early Holocene (8.0 - 8.6 ka) (Fig. 2 and Fig. 3).
3. The ability to trace layers regionally to this date suggests ice flow has been relatively stable since the deposition of IRH 6.
4. Above Subglacial Lake CECs (SLC - Fig. 1 and Fig. 2) the ice layers are not significantly deformed suggesting potentially stable conditions throughout the Holocene.

References

- [1] Ashmore et al. (2020). Englacial Architecture and Age-Depth Constraints Across the West Antarctic Ice Sheet. <https://doi.org/10.1029/2019GL086663>.
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- [3] Dansgaard & Johnsen (1969). A flow model and a time scale for the ice core from Camp Century, Greenland. <https://doi.org/10.3189/S0022143000031208>.
- [4] Mouginot et al. (2019). Continent-Wide, Interferometric SAR Phase, Mapping of Antarctic Ice Velocity. <https://doi.org/10.1029/2019GL083826>.
- [5] Napoleoni et al. (2020). Subglacial lakes and hydrology across the Ellsworth Subglacial Highlands, West Antarctica. <https://doi.org/10.5194/tc-14-4507-2020>.
- [6] Slater et al. (2018). A new digital elevation model of Antarctica derived from CryoSat-2 altimetry. <https://doi.org/10.5194/tc-12-1551-2018>.

Ice Penetrating Radar surveys

Figure 1. Ellsworth Subglacial Highlands. a) Ice surface velocity and contour lines every 5 m yr^{-1} [4]. b) Ice thickness from DEMESH v1^[5] and Cryosat-2^[6]. Contour lines every 500 m. c) Bed topography^[5] and new radar surveys and contour lines every 500 m. CT: CECs Trough; ET: Ellsworth Trough. White lines: ice catchment boundaries from the SCAR Antarctic Digital Database (<https://www.add.scar.org/>). Projection: Antarctic Polar Stereographic (EPSG:3031).



Internal Reflection Horizons (IRHs)

Figure 2. Example of a radargram showing the package of IRHs traced across the region. The geometry of IRHs suggest an undisputed ice flow above SLC.

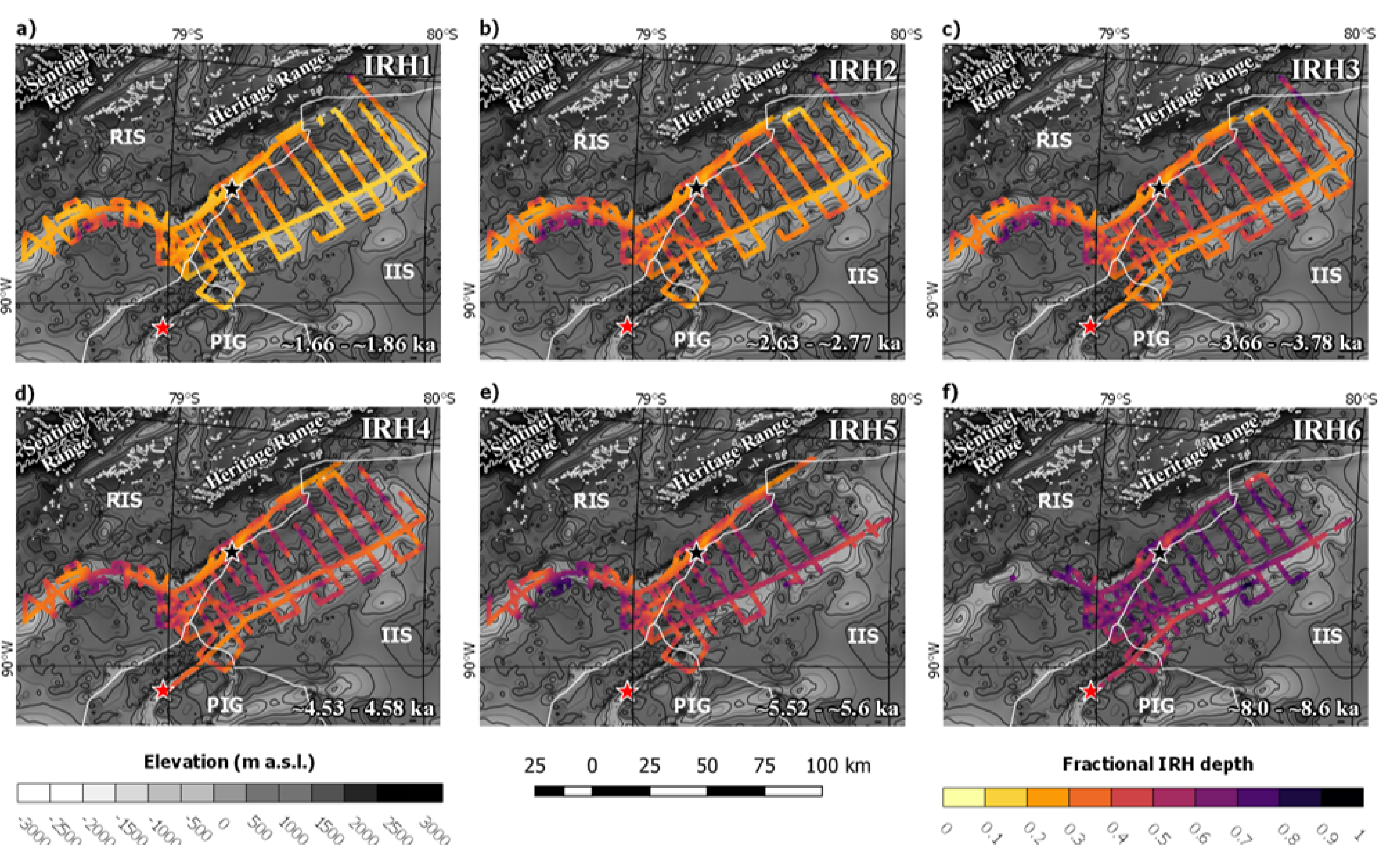
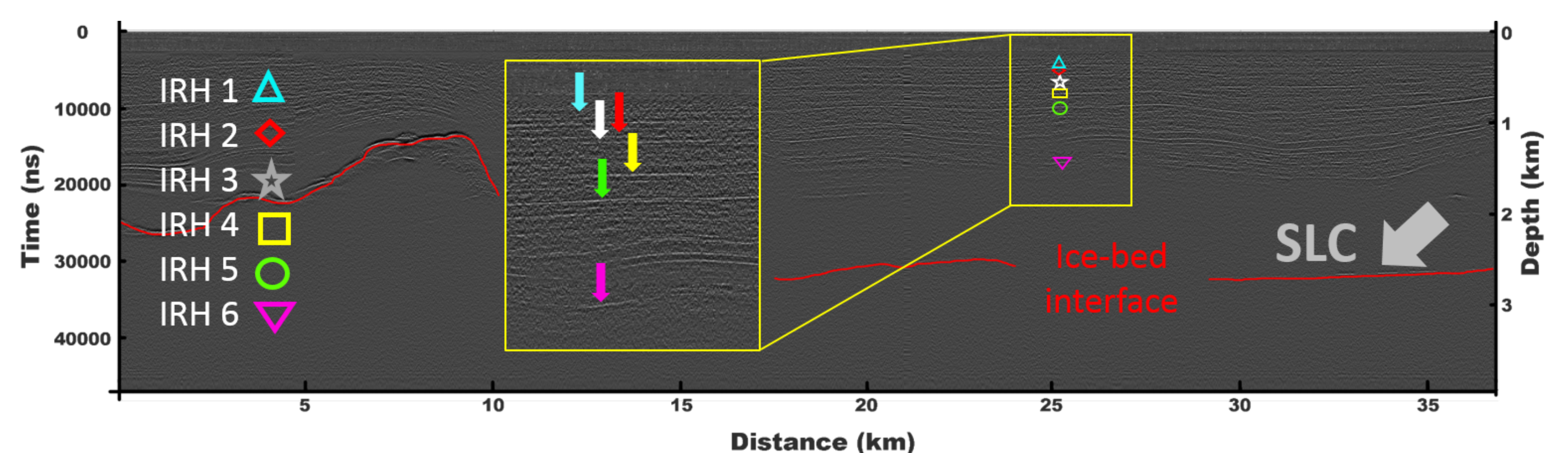


Figure 3. Spatial distribution of IRHs depth normalised by the total ice thickness, i.e. fractional ice thickness. The ice divide is shown in white (<https://www.add.scar.org/>) and the estimated range of ages is indicated in the lower right corner in each panel (a-f).