

# Asynchronous glaciation in Eastern Siberia during the Late Quaternary

Iestyn Barr  
Queen's University Belfast  
i.barr@qub.ac.uk

## 1. Introduction

- Uncertainty has persisted about the extent and timing of former glaciation in Eastern Siberia [1, 2].
- Robust reconstructions of the region's palaeoglaciators are lacking. Chronological-constraints upon former periods of glaciation are also poor.
- Here, part of the uncertainty about the region's glacial history is addressed by mapping end moraines, compiling published dates, and using these data to reconstruct the extent of glaciers during the global Last Glacial Maximum (gLGM, c.21 ka) and earlier phases of glaciation [3].

## 2. Materials and Methods

- The distribution of moraines across Eastern Siberia was mapped from satellite images (Landsat) and DEM data (ASTER GDEM, VFP DEM) (see example in fig 1)
- This moraine record was combined with a dataset of published age-estimates ( $n = 25$ ), which constrain the timing of former glaciation. From these data the extent of former glaciation was reconstructed.

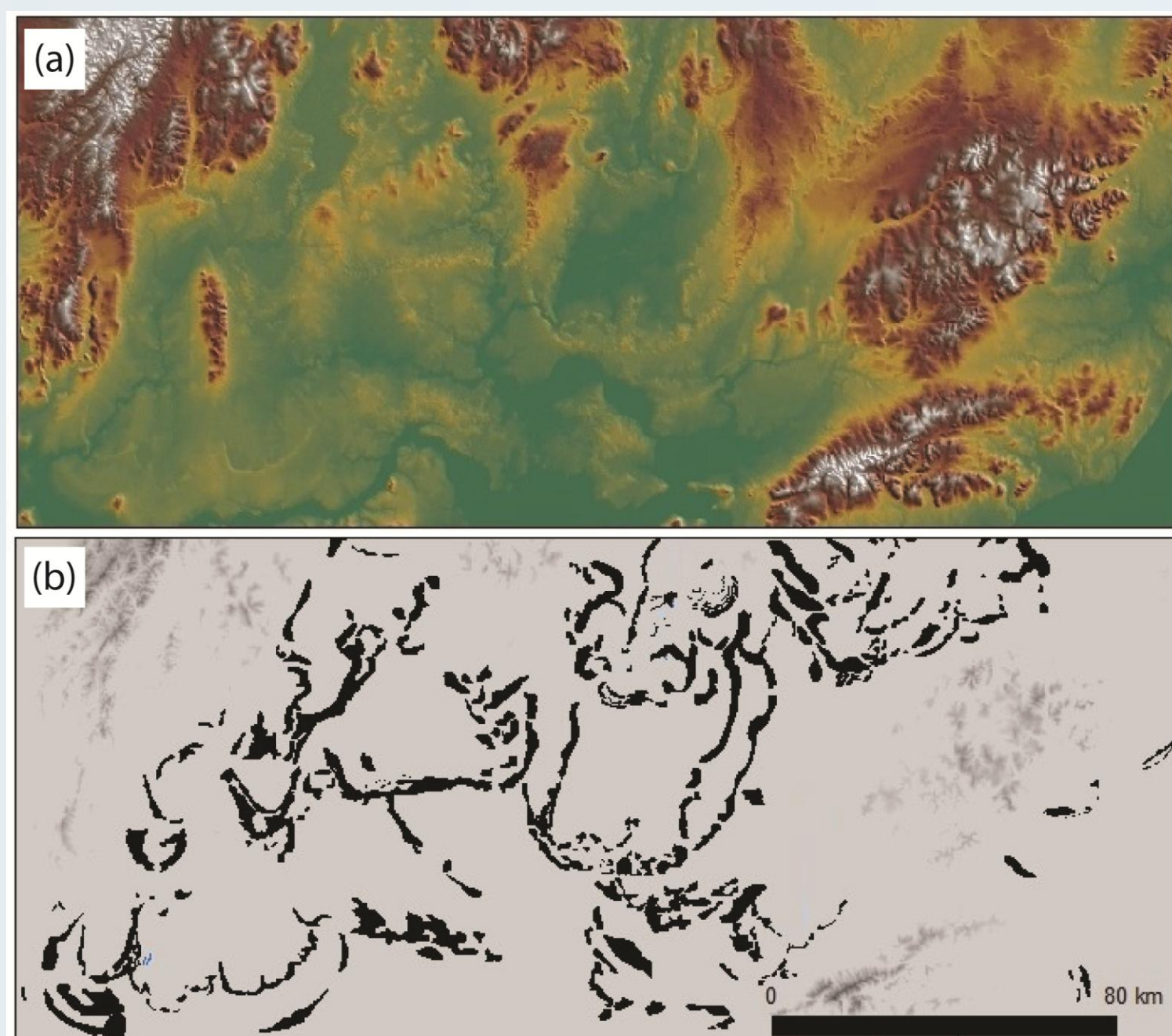


Fig. 1. End moraines upon the Chukchi Peninsula. (a) As seen in ASTER GDEM data. (b) As mapped (black polygons)

## 3. Results and Discussion

- 8414 end moraines were mapped across the region (see fig 2a), and cluster in, and around, the region's uplands, indicating that former ice-masses were largely mountain-centred
- Reconstructions reveal that much of Eastern Siberia preserves a glaciated landscape (see figure 2b)
- During the gLGM, the total glacierised area was  $\sim 253,000 \text{ km}^2$  with a general decrease in ice extent from the SE to the N and W (see figure 2c). This estimation of total glacierised area is considerably lower than estimates derived from many published reconstructions

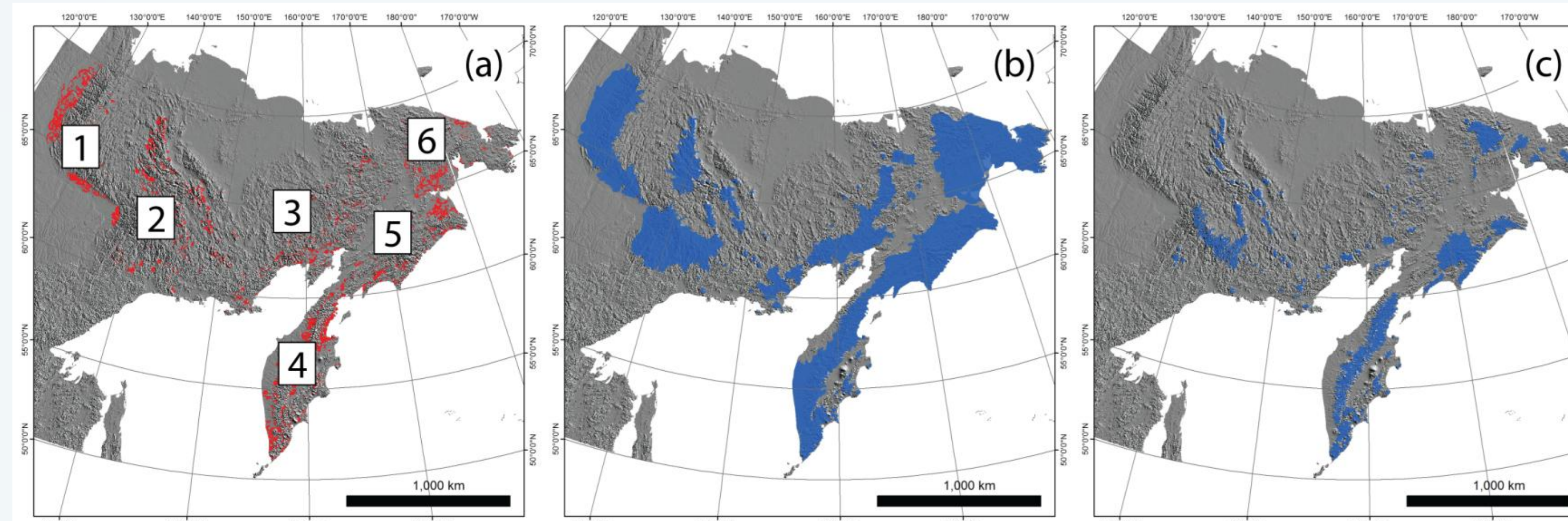


Fig. 2. (a) End moraines (red), as mapped across Eastern Siberia ( $n = 8414$ ). Numbered regions are also shown in figure 3. (b) Region lying within the limits of mapped moraines, and interpreted as reflecting the Quaternary maximum extent. (c) Reconstruction of glaciation during gLGM.

- Present understanding of ice extent across Eastern Siberia during the past  $\sim 160 \text{ ka}$  is summarised in Fig. 3.
- Though this record is incomplete (due to the scarcity of dates), it is apparent that former phases of glaciation were regionally-asynchronous.
- Glaciers attained their maximum Late Quaternary extent prior to the gLGM (MIS2).
- There is also evidence that glaciation was out-of-phase with other regions of the Northern Hemisphere (see figure 3), where the development of ice sheets restricted the advection of moisture bearing air masses to much of Eastern Siberia [4], and resulted in a significant reduction in global sea levels. Thus, moisture availability appears to have been a dominant palaeoclimatic driver of glaciation in Eastern Siberia [5].

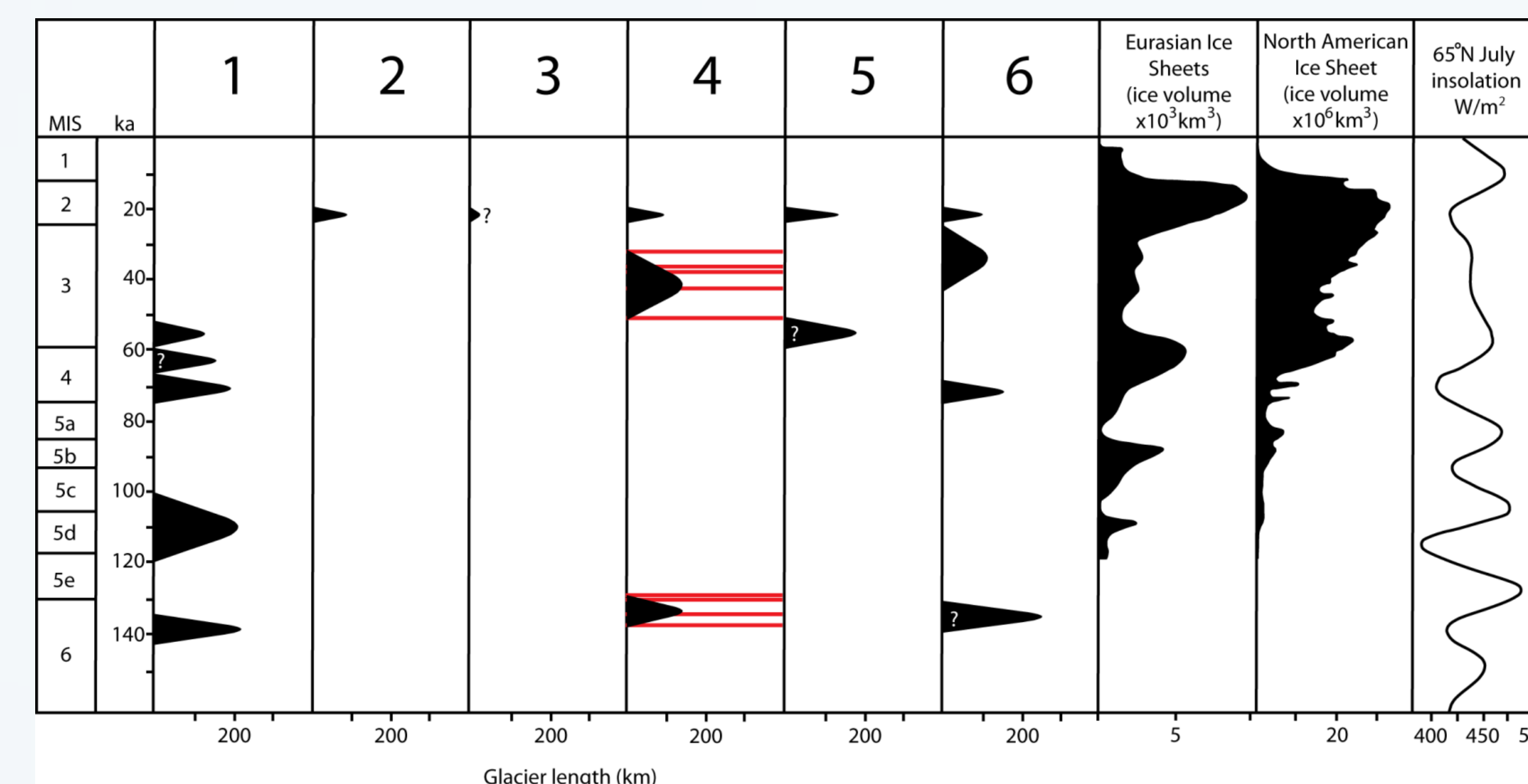


Fig. 3. Variations in the extent of glaciers in different regions of Far NE Russia over the past 160 ka (numbered regions are shown in fig 2). Glacier length is estimated from the moraine record, and published age-estimates are used to chronologically constrain former ice-margin positions. The '?' symbol denotes phases of glaciation lacking chronological-control. Horizontal red lines correspond to inferred periods of iceberg discharge into the North Pacific and Sea of Okhotsk [6, 7]. Also shown are curves depicting modelled volumes of the Eurasian (Scandinavian, British and Barents-Kara) and North American Ice Sheets. This comparison emphasises how the timing of former glaciation in Eastern Siberia appears out-of-phase with much of the northern Hemisphere.

## 4. Conclusions

- Much of the Eastern Siberia preserves a glaciated landscape.
- During the gLGM, glaciers rarely extended  $>50 \text{ km}$
- The timing of former glaciation appears to have been regionally-asynchronous, and out-of-phase with glaciations elsewhere in the Northern Hemisphere
- In most (if not all) regions, glaciers attained their maximum Late Quaternary extent prior to the gLGM, likely due to combined climatic and topographic controls.

## 5. Future Work

- There is a need for further systematic dating of glacial deposits
- The geomorphological reconstructions presented here might be verified through numerical modelling
- Onshore data might be better linked to offshore IRD records from the North Pacific and Sea of Okhotsk

## References

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