

KANG-GLAC: A new UK project marrying observations and models for Kangerlussuaq Glacier, SE Greenland

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Partner Institutions: Stockholm University, Geological Society of Denmark and Greenland, ISPRA (Italy), Université Libre de Bruxelles, Memorial University (Canada), Scripps Institute of Oceanography



PROJECT GOAL: To produce coupled records of ocean-forced marine-terminating outlet glacier dynamics, and feedbacks for marine productivity and ocean circulation, over decadal to centennial time-scales in the Holocene

Here we introduce a new 3.5 year project that combines observations and numerical modelling to study Greenland Ice Sheet (GrIS) dynamics. In a 50-day research cruise on the UK's new polar research vessel, the RRS *Sir David Attenborough* (SDA) we will acquire oceanographic, biogeochemical and geological observations in Kangerlussuaq fjord and shelf, SE Greenland. These new datasets will underpin numerical modelling to determine the rates and magnitude of ice-sheet change during past warm periods (e.g. Holocene Thermal Maximum; 8-5 ka) as an analogue for future GrIS change.

RATIONALE

- Mass loss from the GrIS is one of the largest contributors to sea-level rise at present
- Greenland's marine-terminating glaciers are being affected by inflows of warm Atlantic Water
- Increased meltwater discharge alters nutrient fluxes, productivity, and biogeochemical cycling in coastal waters
- We have a limited understanding of the complex processes at ice-ocean interfaces due to a lack of observations, particularly beyond the satellite era

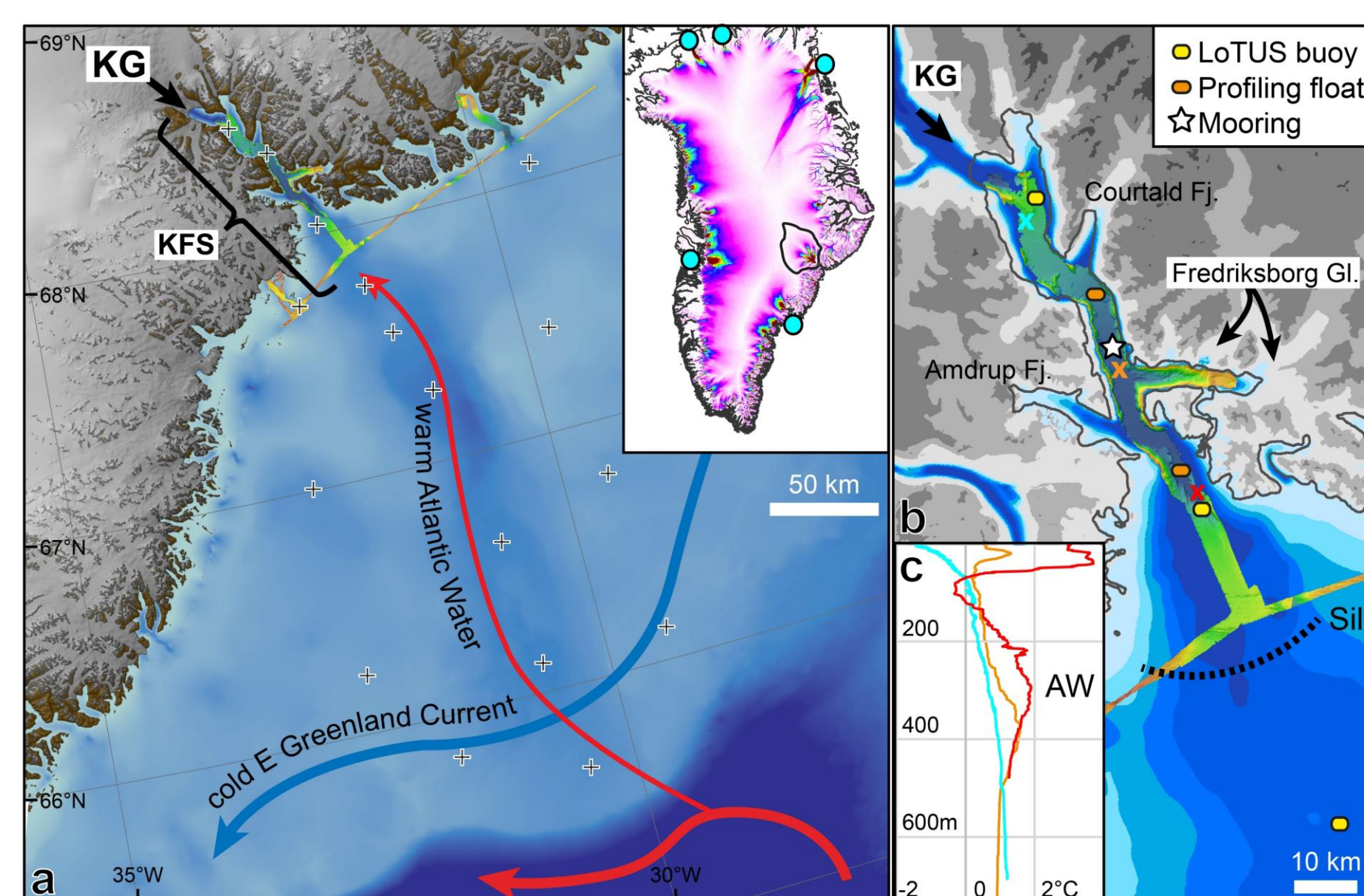


Figure 1a. Kangerlussuaq fjord and shelf with Atlantic Water (AW) flowing into the fjord. Inset shows Kangerlussuaq drainage basin that delivers ~5% of GrIS discharge to the ocean. The glacier retreated 5 km in 2005 and another 6 km in 2016-18 to the cusp of an overdeepened basin. It is now primed for further retreat. **b.** Bathymetry and suggested instrument locations. **c.** CTD profiles from 2004 and 2016 showing AW inflow getting deeper along the fjord.

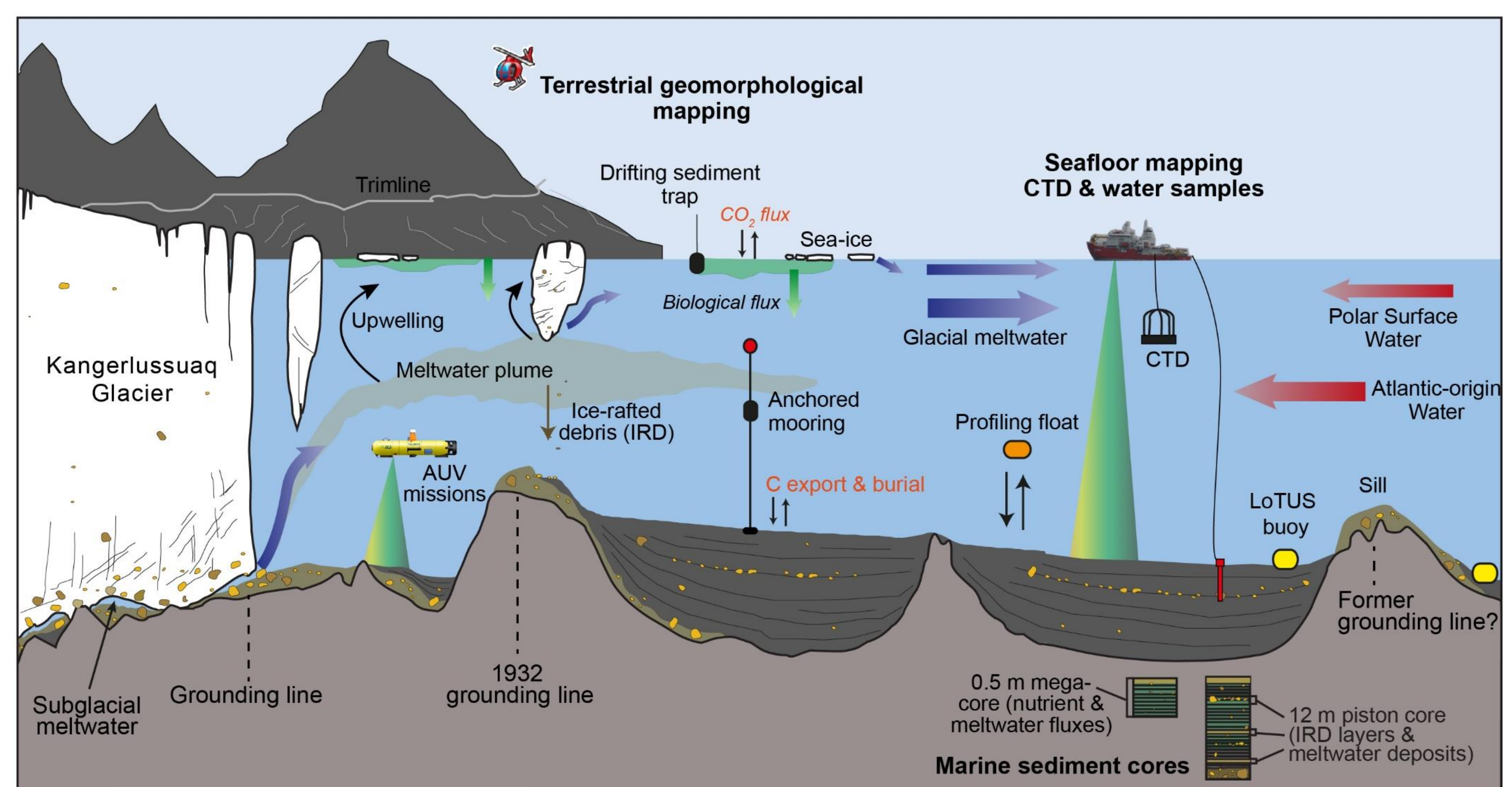
Figure 3 (right). Schematic of marine fieldwork on RRS *Sir David Attenborough*, scheduled for July-August 2024

PROJECT STRUCTURE

- WP1, Oceanography** aims to determine the circulation patterns and dynamics of warm-water incursions and glacial freshwater fluxes
- WP2, Holocene glaciology and oceanography** aims to reconstruct Holocene MTOG dynamics (ice extent, thickness, calving/melt/sedimentation rates) and ocean temperatures
- WP3, Biological and Biogeochemical Processes** aims to understand and quantify the processes and feedbacks affecting Holocene to modern C/nutrient cycling and burial in seafloor sediments
- WP4, Data-constrained modelling of GrIS** aims to assess the rate and magnitude of Holocene GrIS change as an analogue for the future



Figure 2. We will use new capabilities of the RRS SDA to maximise data collection including its moonpool (coring), workboat (Gavia AUV and CTDs), and launching helicopters



MODELLING THE GREENLAND ICE SHEET

- Generate isotope-enabled simulations from HadCM3 and WRF climate models; use an emulator to generate GrIS Holocene ice-sheet configurations
- Refine GrIS shapes using Glacial Systems Model (GSM) which is constrained by geological datasets and run for last 2 glacial cycles (Tarasov et al., 2012)
- Recalibrate the GSM using observations from KANG-GLAC and partner sites at Jakobshavn, Petermann, Helheim glaciers and interrogate phasing of Holocene environmental change (WPs 2+3) and ice-sheet response

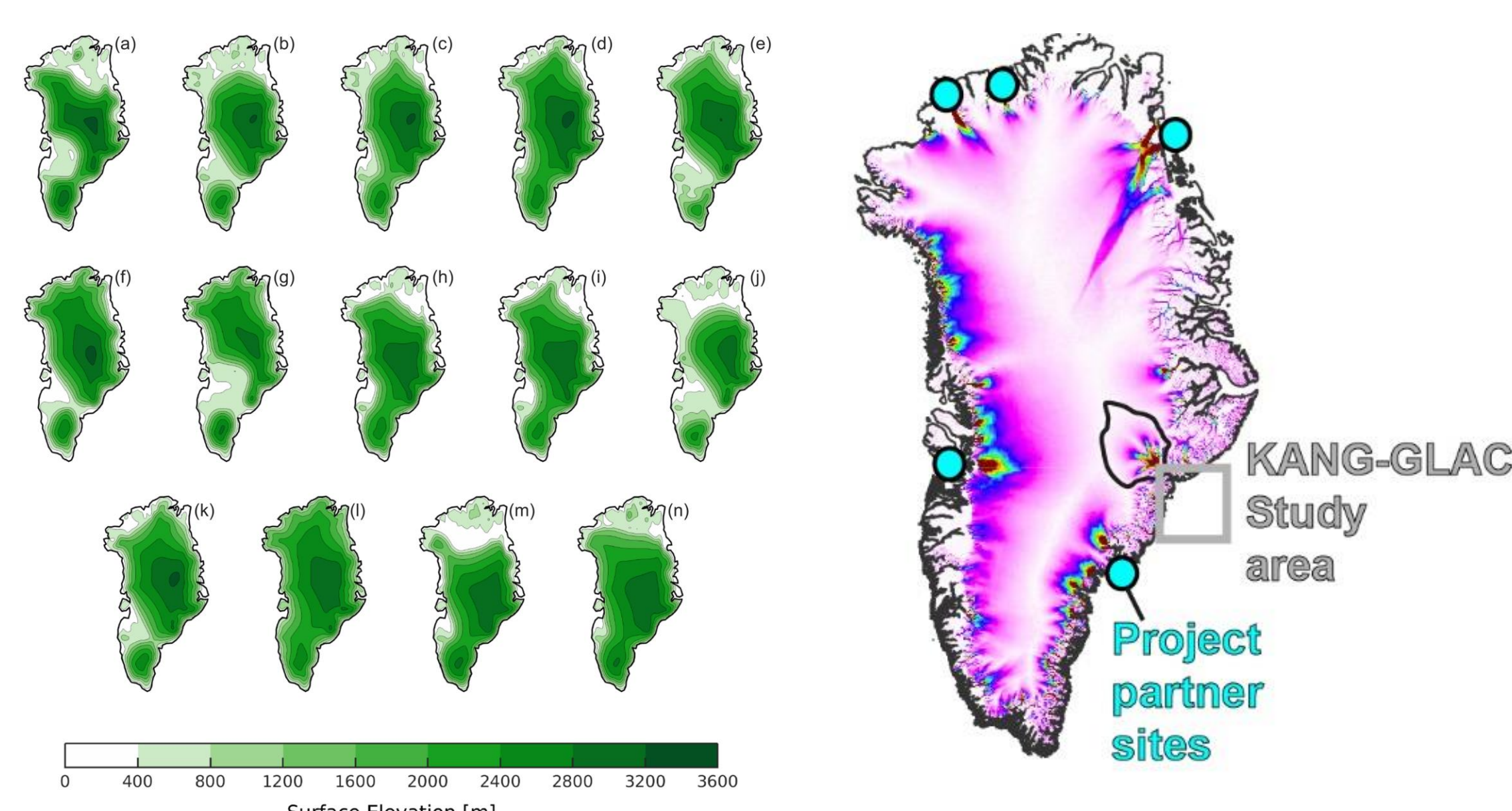


Figure 4. Example of simulated GrIS shapes for the Last Interglacial 129-116 ka (left; Domingo et al., 2020) and KANG-GLAC study area and partner sites available to constrain glaciological models

AN OPPORTUNITY IN 2023-24?

- 5 international cruises to Greenland in summer 2023 and 2024 (US, Canada, Switzerland, Sweden, UK)
- Study areas all around Greenland: South, North, NW and SE
- Is this an opportunity to coordinate sampling and measurements (CTDs, currents, nutrients?) for a holistic view of Greenland fjords in 2023/24?