Lessons learned from past aerogeophysical collaborations for effectively launching new pan-Antarctic RINGS surveys[20]

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This article presents an overview of the history and challenges of airborne geophysical surveys in Antarctica, emphasising the importance of addressing data gaps, particularly in coastal regions. The article introduces the pan-Antarctic RINGS initiative, which was initiated by the Scientific Committee on Antarctic Research (SCAR) with the aim of co-ordinating and enhancing geophysical surveys in the Antarctic coastal regions.

Introduction

The five-decade history of airborne geophysical surveys in Antarctica began in the 1970s. This period saw significant

[20] The video of this presentation is available at https://youtu.be/6XY-YfPLzwg.

achievements, including the bed map of the Antarctic Ice Sheet compiled digitally for the first time in 2001 and updated in 2013. However, substantial data gaps persisted, especially in two areas, known as “poles of ignorance”, which prompted collaborative projects led by various nations to address these gaps. As of 2023, we have reasonable data of the bed topography of the Antarctic Ice Sheet, but this is not yet comprehensive (Figure 1).

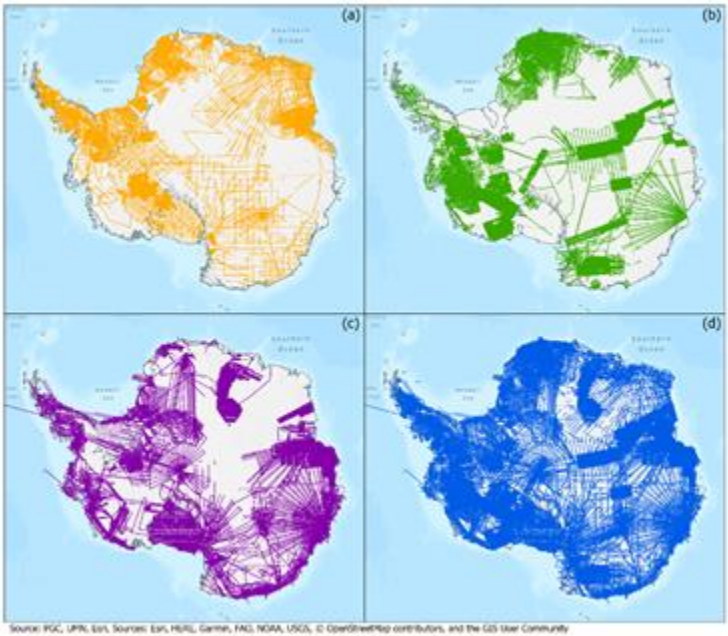

Figure 1: Radar data coverage in Antarctica (a) before 2000, (b) improvements in 2010s, (c) improvements in 2020s, and (d) as of 2023. (Credit: Fremand et al. (2023, ESSD))

Importance of Coastal Regions

Analogising the coastal regions of Antarctica as the "cork" of a wine bottle in the context of sea-level changes, whereby

we pay attention to the wine, being Antarctic ice, without paying enough attention to the "cork", i.e. the ice shelves and coastal region of the ice sheet, which is in fact loose. With the bottle being upside down, we need to pay attention to how loose the cork is and how much more loose it will become in the future. Understanding these regions is crucial for comprehending Antarctic Ice Sheet dynamics and their implications for global climate change.

Data Gaps and Challenges

Analysing data availability within 100 kilometres of the grounding line – the location where the ice-sheet ice becomes afloat, i.e. becomes an ice shelf – reveals substantial gaps, notably in Enderby Land. These data gaps are due to a lack of research stations in the area and, consequently, logistical challenges for taking measurements in the area, and are not due to lack of scientific interest. In fact, the amount of ice discharged from Enderby Land is very similar to that from Amundsen Bay, including Pine Glacier and Thwaites Glacier. Only 10 per cent of the Antarctic grounding line has radar data within 1 kilometre, emphasising the challenges in making accurate elevation estimates without adequate data.

The SCAR RINGS Initiative

To address these challenges, SCAR introduced the Antarctic RINGS initiative, aiming to create three pan-Antarctic rings: primary RING, landward RING, and seaward RING. The primary RING should go to the grounding line where ice starts to afloat; the landward ring is 10 kilometres inland, where the grounding line is expected to be in the upcoming centuries; the seaward ring is over the ice shelves and the

ocean to measure the seabed topography. Interpolating bed topography between these three rings is highly challenging, prompting us to conduct multiple profiles for each ring (Figure 2).

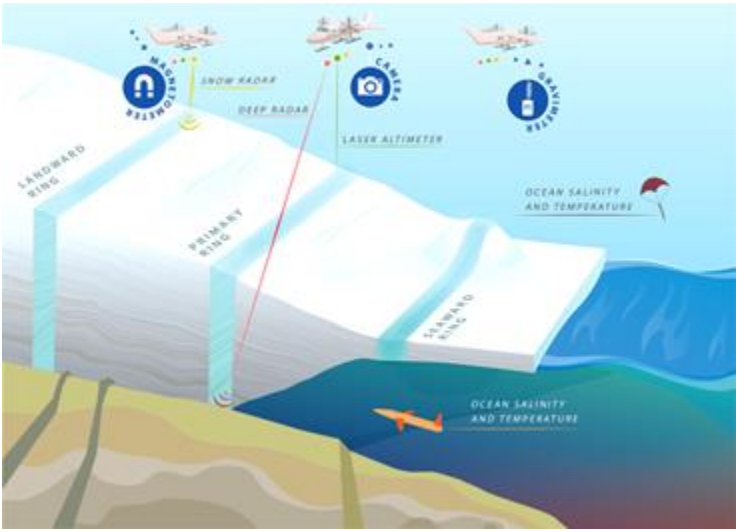

Figure 2: Three rings of observation. (Credit: Hasan Abbas (GRID-Arendal) and RINGS Action Group)

RINGS surveys can serve as multidisciplinary platforms, incorporating instruments such as deep sounding radar, gravimeters, microwave radiators, magnetometers, laser altimeters, and cameras. The RINGS project emphasises the inter-connected systems and complex processes involving the atmosphere, ocean, cryosphere, and geology.

Established in 2021, the SCAR Action Group RINGS has seen doubled membership and aims to co-ordinate surveys in advance to ensure comprehensive data coverage. Recommendations have been discussed in the ATCM meeting

in Helsinki, underscoring the importance of RINGS surveys in the context of sea-level rise.

Successful Geophysical Missions and Technologies

The key factor of successful geophysical missions is international collaboration. No national Antarctic programme is capable of conducting the flights all around Antarctica alone, so the idea is to develop multiple regional projects, co-ordinating them from the outset to avoid any data gaps. One way to do this is the use of multiple research stations, which is already working properly but with challenges of different layers of communication and management between stations (Figure 3).

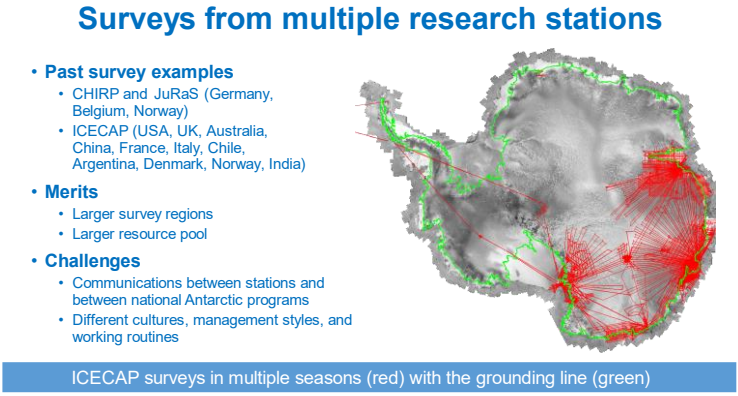

Figure 3: ICECAP survey from multiple research stations. (Credit: Authors)

Other ways are to establish remote field camps in strategic locations to reduce the “air commute”, or to deploy aircraft from outside Antarctica. All the options here discussed require the use of fixed wings, but employing helicopters,

even from vessels where there are no other facilities in the vicinity, and drones is very useful.

Conclusion

The RINGS goal is to co-ordinate the work and collection of data in advance rather than patching the data together afterwards.

Collaboration with COMNAP's airborne facilities and science education facilitation groups is deemed crucial for the success of the RINGS initiative.