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Mapping the Seafloor beneath the Bach Ice Shelf Using Airborne Gravity Data

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Introduction

The Bach Ice Shelf, located on the Antarctic Peninsula, has undergone accelerated retreat due to atmospheric and oceanic warming, leading to significant mass loss and the development of critical fractures. Its dynamics are influenced by factors such as geometry, pinning points, mass balance, and intrusions of deep warm waters (e.g., Upper Circumpolar Deep Water-UCDW), which intensify basal melting. This study maps the sub-ice seafloor using high-resolution airborne gravity data. The central hypothesis is that seafloor features control warm-water circulation, directly impacting ice stability and climate projections.

Method and/or Theory

This study uses airbone gravity data from NASA's Operation IceBridge (2011-2016) data collected using the AIRGrav system (~500 m altitude, 142 m/s speed, 70-s filter for ~5 km resolution) to map subglacial bathymetry beneath Bach Ice Shelf. Four profiles along the sheld will be modeled. The models will incorporate average density contrasts (ice: 915 kg/m³; seawater: 1028 kg/m³; bedrock: 2670 kg/m³) along with existing interpretation and constraints for the region. Results will be compared to available bathymetric models such as Bedmap2 and BedMachine.

Results and Conclusions

Preliminary processing of OIB gravity data at Bach Ice Shelf reveals morphological features in one of the profiles, indicating an average depth of ~483 m. Unpublished bathymetry (Schmidt Ocean Institute) and crustal densities were used to calibrate the 2D model, reducing uncertainties. At the eastern edge, a negative gravity anomaly suggests a subglacial channel, while two depressions (~850 m and ~704 m) and a central ridge (~351 m) indicate potential pathways to investigate Circumpolar Deep-Water intrusions. These preliminary findings underscore the role of seabed topography in influencing regional ocean circulation and reveal discrepancies when compared to existing models, highlighting the need for higher-resolution data.

The bathymetric data that will be derived from airborne gravity inversion in this study are expected to provide critical insights into ice–ocean interactions, enabling: (1) quantitative assessment of ice shelf sensitivity to changing ocean circulation patterns, and (2) improved projections of West Antarctic Ice Sheet stability. While further validation is needed, these early findings align with growing evidence that localized seabed features disproportionately affect ice-shelf stability. Our findings highlight the urgent need for multidisciplinary research in the Bellingshausen Sea sector, where accelerated glacial retreat and dynamic ocean-ice feedbacks make this region a climate crisis hotspot.