DTU esa Kema NORSK-POLARINSTITUTT British Antarctic Survey NATURAL ENVIRONMENT RESEARCH COUNCIL

P-band radar ice sounding in Antarctica

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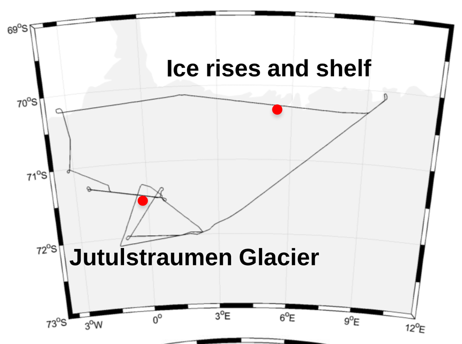
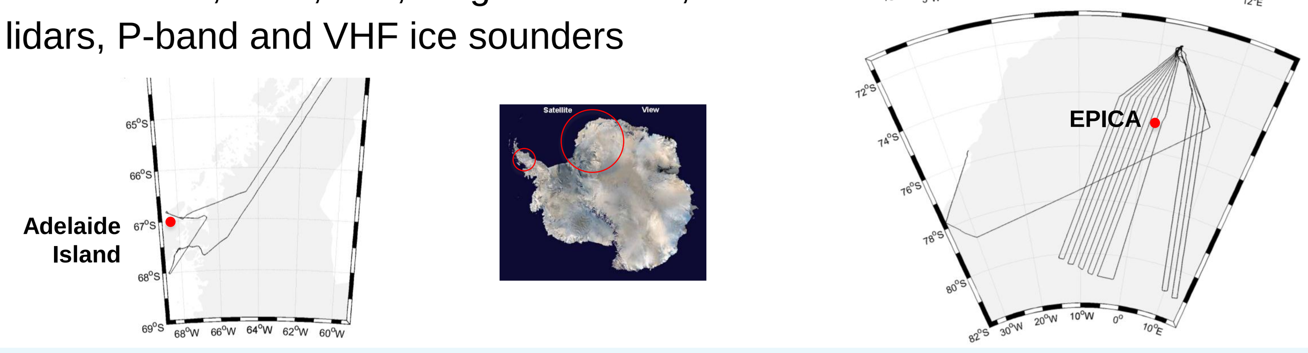
During the ICEGRAV campaign P-band radar ice sounding data were acquired in Queen Maud Land and over Adelaide Island. The objective was to assess the feasibility of space-based ice sounding and to acquire data of glaciological interest. For the campaign ESA's POLarimetric Airborne Radar Ice Sounder (POLARIS) was mounted on a Basler BT-67 of Kenn Borek Air.

ICEGRAV campaign

Time: February, 2011
Objectives: Gravity / ice sounding (primary / secondary)
Funding: National Geospatial-Intelligence Agency (NGA), ESA (POLARIS) and NASA (VHF radar)
Instruments: Gravimeters, GPS, INS, magnetometers, lidars, P-band and VHF ice sounders





Space-based ice sounding?

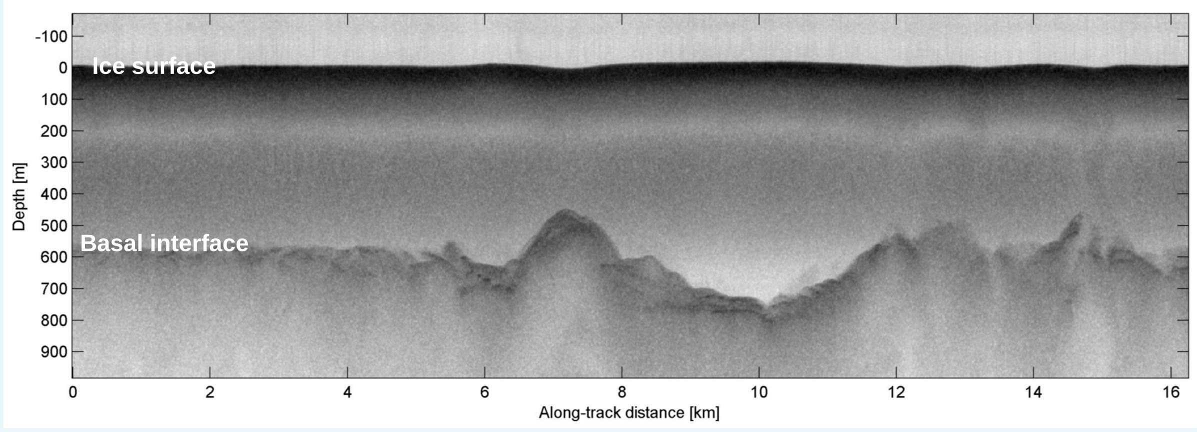
Space-based radar ice sounding of the continental ice sheets can potentially offer full coverage, uniform data quality and sampling. Due to the ITU frequency regulations, a space-based sounder must operate at P-band, i.e. at a higher frequency than normally used for sounding. POLARIS was built to assess the feasibility of space-based sounding in terms of:
1) the attenuation of P-band signals in various ice types
2) the ability to detect deep internal ice layer
3) the potential of radar polarimetry for the observation of ice anisotropy
4) the suppression of surface clutter by means of novel multi-phase center techniques.

At P-band, more attenuation is expected due to volume scattering, and surface clutter suppression is imperative at satellite geometries.

POLARIS radar

- System developed by DTU for ESA
- Flown on Basler BT-67 (or Twin Otter)
- Choice of 4- or 8-element antenna
- Antenna elements developed by EPFL
- Up to 4 phase centers for clutter suppression
- Pulse compression
- Aperture synthesis (Doppler processing)
- Polarimetry (linear quad pol)
- High sensitivity (shallow / deep sounding)
- Vertical resolution ≥ 1 m in ice (85 MHz)

Jutulstraumen Glacier



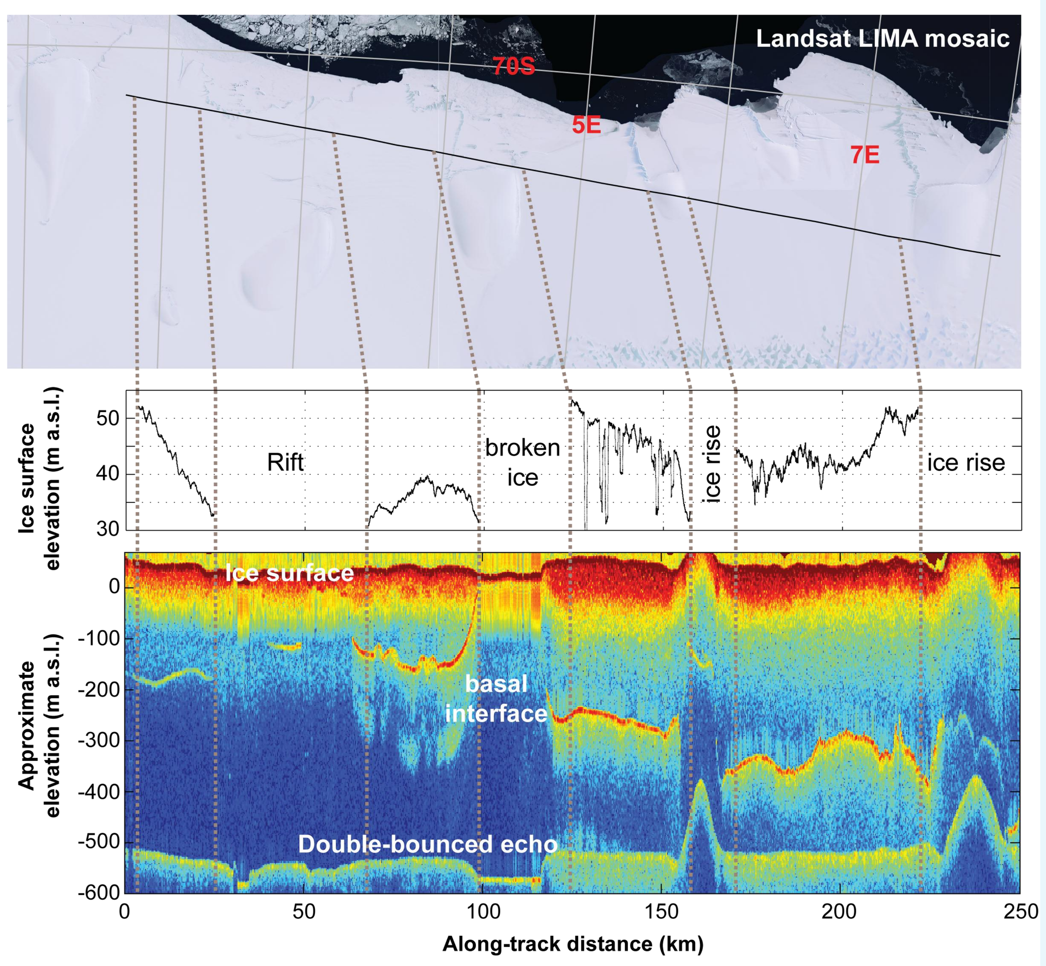
The floating tongue of the Jutulstraumen Glacier is seen in the middle of the profile. Four separate apertures are combined coherently (not yet any clutter suppression).

Ice shelf and ice rises

The anti-correlation of the surface elevation and the base elevation in hydrostatic equilibrium is disturbed, e.g. due to marine ice accretion near the shelf edge.

The basal interface is in general very bright, but the basal interface beneath the thin ice to the left is less bright than that beneath the thicker ice to the right. This suggests changes in the basal interface, ice-column properties (temperature, fabric, chemistry), or both.

The strong double bounce echo (i.e. surface-aircraft-surface) is due to a smooth surface (and a high flight altitude).



EPICA site

The EPICA site is located at 75°0.10'S, 0°4.07'E where the ice thickness is 2774 m. The EPICA ice core can serve as a reference when interpreting the POLARIS data. The profiles show internal layers enhanced by differentiating the return power (dB) in the range direction. The bedrock and internal layers can be detected. For the deep window, the bandwidth is 6 MHz, the maximum allocated for space applications.