# Ice thickness and massflux investigations on Shirasebreen, Dronning Maud Land, Antarctica

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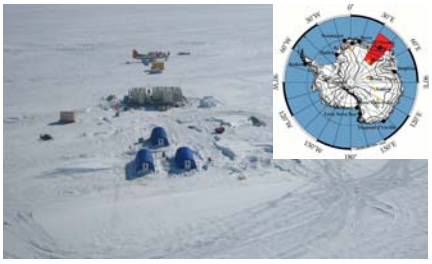

*Fig. 1: Japanese summer Station S17 and overview map of investigated area.*

## Introduction

In austral summer 2005/06 the joint Japanese German ANTSYSO (Antarctic Flight Missions at Syowa Region: Airborne Geophysical, Glaciological and Atmospheric Research in East Antarctica) project by the National Institute of Polar Research (NIPR) Tokyo and the Alfred Wegener Institute for Polar and Marine Research (AWI) Bremerhaven was started. Within ANTSYO AWI's survey aircraft *POLAR2* (see figure 2) is operated from NIPR's new established summer station S17 (see figure 1), some 20 km east of the Japanese wintering base Syowa. The first survey carried out under the frame of ANTSYO was a combined geophysical and glaciological investigation, gaining data for the subprojects WEGAS (West-East Gondwana Amalgamation and its Separation) and DISTINCT (Dronning Maud Land Ice Sheet Incorporative Task). On this poster we will focus on the ice thickness measurements derived from airborne radio echo sounding above the Shirasebreen and its catchment basin and adjacent areas only.


*Fig. 2: Geophysical instrumentation on-board of* POLAR2.

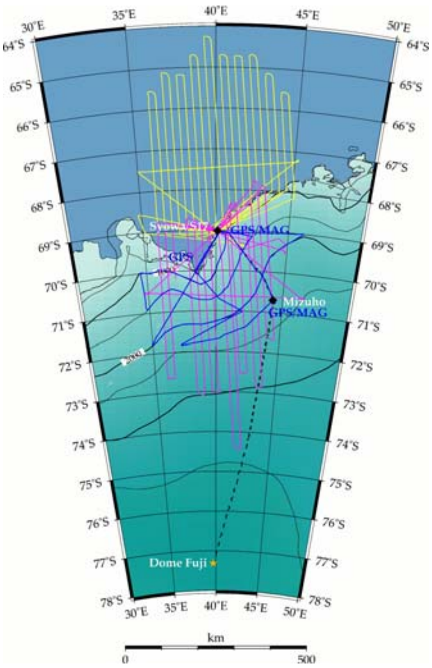


*Fig. 3: Survey flights of the ANTSYO I project: blue lines DISTINCT, yellow and purple lines WEGAS.*

## Survey set-up

For the geophysical ANTSYO flights *POLAR2* was equipped with 2 GPS receivers, a laser and a radar altimeter, a magnetometer, and a gravity meter (WEGAS flights only), respectively a radio-echo sounding (RES) system (southern WEGAS flights and DISTINCT flights). While for the three flights dedicated to DISTINCT (see blue lines in figure 3) a terrain following flight level of about 1500 ft above the ice sheet surface has been chosen, fixed flight levels were used for the WEGAS flights in order to avoid disturbances of the gravity meter. The line spacing of the WEGAS survey was 20 km. To accomplish the airborne measurements three GPS base stations and two magnetic reference stations were set-up on the ice sheet close to the camp S17, at Mizuho and at Padda island (see figure 3).

On the flights for DISTINCT the 150 MHz RES system on-board of *POLAR2* has been used in so-called toggle mode, recording two RES profiles of different vertical resolution on one flight track by toggling between a short (60 ns) and a long (600 ns) pulse. An example of the 600 ns pulse is shown in figure 4. Because the flights with the gravity meter on-board were flown at an altitude of 11000 ft the RES system on these flights has been operated in long pulse mode only. The trace separation prior to stacking is 3.4 m for the mono pulse mode at 130 kts, sample interval is 13 ns, and the vertical resolution is about 10 m for the short and 50 m for the long pulse. During the data processing traces are stacked 10 fold to improve the signal to noise ratio and to reduce the data volume.

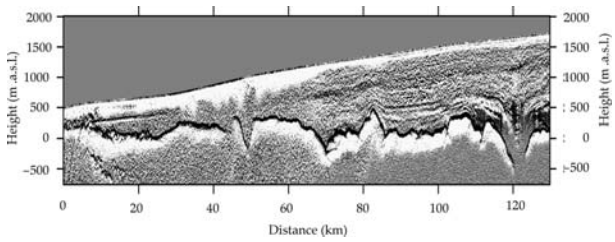


*Fig. 4: Processed and static corrected RES profile along the the centre line of Shirasebreen.*

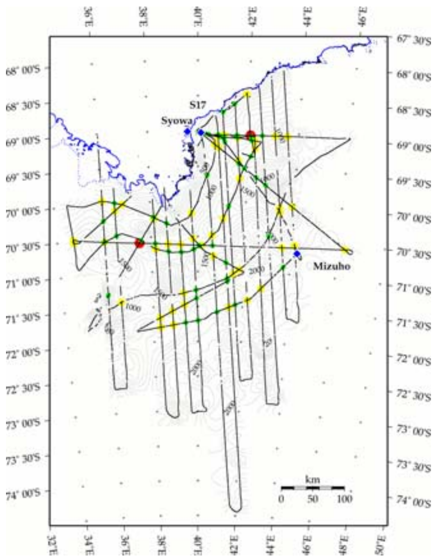


*Fig. 5: Data base of ice thickness map shown in fig. 6. The coloured dots indicate the cross-over errors, green < 30 m, yellow < 50 m, and red > 50 m. The grey contour lines show the ice thickness (s. fig. 4), line spacing in 100 m. Fig. 7 shows the associated histogram.*

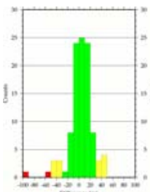

*Fig. 7: Histogram of cross-over errors in ice thickness measurements.*

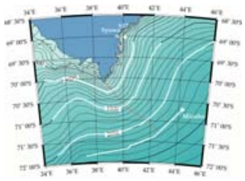

*Fig. 8: Locations of RES profiles (white lines) for DISTINCT shown in fig. 9.*

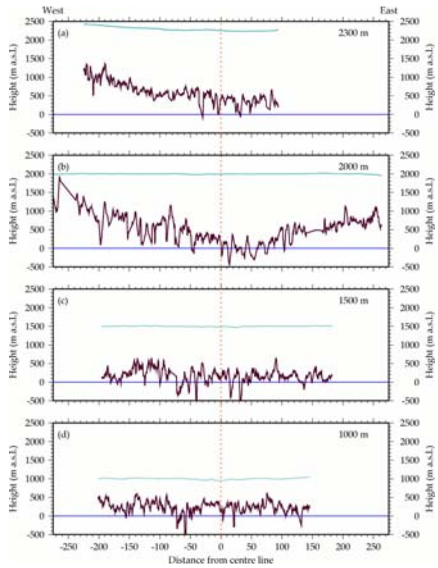


*Fig. 9: Cross sections of Shirasebreen, surface topography green, bedrock brown. The doted red line approximates the centre line of the outlet glacier, for position see fig. 8.*

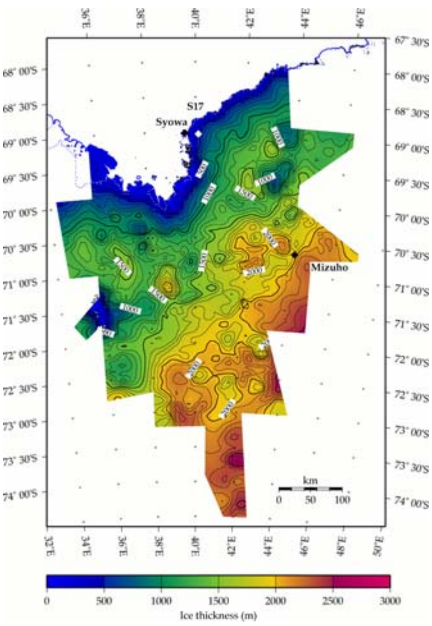


*Fig. 6: Ice thickness distribution of Shirasebreen and its catchment area. The contour line spacing is 100 m, outcrops are indicated by grey spots.*

## Results

On 12 survey flights ice thicknesses could be measured using the AWI airborne RES system, covering the catchment area over approximately 160000 $km^2$ of Shirasebreen (see figure 6) along 11000 km. The largest ice thickness has been observed at the southern end of the investigated area (42.08°E/73.72°S) with 2904 m. The mean ice thickness is about 1469 m, which is considerably less than the mean for the grounded Antarctic ice sheet (2079 m, Huybrechts et al., 2000). The ice thickness grid obtained from the combined DISTINCT and WEGAS survey is shown in figure 6. Figure 5 shows the positions of the data points and colour coded cross-over errors.

The cross-over analysis of the profiles shows that only at two points the ice thickness of intersecting profiles deviate more than 50 m from each other, while 86 % of 105 intersections reveal differences of less than 30 m (see figure 7). This is an excellent consistency.

A remarkable feature of the Shirasebreen is its missing trench. None of the four cross sections shown in figure 9 shows such depression as it is known from other outlet glaciers, e.g. the Jutulstraumen in central DML. The two northern profiles reveal a rough but over larger distances flat bedrock.

A first estimate of the mass flux of the Shirasebreen, based on surface velocities published by Pattyn and Derauw (2002), gives approximately 11 Gt $a^{-1}$ . This is less than quoted by the authors based on older, much coarser distributed ice thickness data. Assuming that this first guess based on the presented ice thickness data is correct, would denote that Shirasebreen is more or less in balance.

## Outlook

As a next step an improvement and a densification of surface velocities in the estuary of Shirasebreen will be aimed for. Another emendation will be the incorporation of previous obtained ice thickness data.

## References

Huybrecht, P., Steinhage, D., Wilhelms, F. and J. Bamber, 2000: Balance velocities and measured properties of the Antarctic ice sheet from a new compilation of gridded data for modelling. Ann. Glac. 30, pp. 52-60.

Pattyn, F. and D. Derauw, 2002: Ice-dynamic conditions of Shirase Glacier, Antarctica, inferred from ERS-SAR interferometry. J. Glac. 48 (163), pp. 559-565.