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Exploring the interior of East and West Antarctica with airborne geophysics

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Antarctica plays a pivotal role in the global climate and geodynamic system. However, due to its remoteness and inaccessibility Antarctic exploration presents a variety of logistic and technological challenges. Airborne geophysical techniques represent a cost-effective way of obtaining coverage over large and remote areas of Antarctica and has significant potential for interdisciplinary geosciences studies, ranging from glaciology, solid earth geophysics, geology and environmental research. Consequently the international community remain very active in aerogeophysical research and exploration over the Antarctic and are continuously expanding their capabilities. The British Antarctic Survey (BAS) owns two airborne geophysical platforms: a ski-equipped Twin Otter and Dash-7. The Twin Otter features an in-house radar system (PASIN), an L&R air-sea gravimeter and Scintrex Cs magnetometers installed in fixed wing configuration. In addition, single point laser altimeter and radar altimeters are installed for ice surface the measurement and multiple GPS navigation systems are used for positioning. The Dash-7 platform has the same potential-field set-up but currently lacks a radar system, although a new feasibility project is underway to develop one, in particular for possible future collaborative Arctic work. Magnetic base stations and GPS base stations are installed on the ground in the survey area to monitor magnetic diurnal variations and for GPS-post processing. The radar equipment installed in the Twin Otter is a 150 Mhz system that has recently sounded ice 4800 m thick (to our knowledge the thickest ice imaged in Antarctica so far), while also providing a unique view of englacial stratigraphy, basal morphology and subglacial hydrology. The gravity system measures Free-Air gravity anomalies with a spatial resolution of ca 15 km and accuracies of 2-3 mGal. Such characteristics enable us to study major geological features, including major sedimentary basins, magmatic arcs, rift basins and to assess crustal thickness and structure. The magnetic system enables us to study volcanic provinces, delineate major sedimentary basins and terranes and maps major faults concealed beneath the ice sheets. In recent years our airborne geophysical activities have shifted from the traditional areas surveyed by BAS in the Antarctic Peninsula towards more remote interior areas. In 2008-09 we contributed to a flagship project of the International Polar Year in the interior of East Antarctica in the Dome A region (AGAP), site of the Kunlun Chinese station, and a candidate area for future deep ice core drilling. The region is also of large international interest as it is underlain by the Gamburtsev Subglacial Mountains , the least understood mountain range on Earth and yet a key nucleation site for the formation of the East Antarctic Ice Sheet. Huge logistic challenges were overcome to perform this survey, that could not have been achieved without pooling resources from 6 different countries. A variety of aircraft were used to support the campaign and deploy the fuel in two remote field camps on the2 sides of the Dome. For the survey we used two Twin Otters, one equipped by BAS, and the other by the US Antarctic programme. This approach proved very effective and in total 120,000 line km of new data were acquired. The high altitude and extreme cold temperatures required significant equipment modifications. The results include unprecedented views of the subglacial topography and lithosphere in the region as well as new data to study englacial structures and processes. Our most recent 2010-11 campaign included a survey over the Institute and Moeller Ice streams in West Antarctica that had not been explored since the 70's.