Airborne Geophysics Research Capabilities of the British Antarctic Survey Twin Otter Aircraft

The British Antarctic Survey has a Twin Otter aircraft with a certified fit of airborne geophysics instrumentation.

The Twin Otter aircraft is a very adaptable platform used the world over as a 'bush' aircraft. Its twin turbo-prop engines and 'Short Take off and Landing' (STOL) capability allow it to be operated from small, remote unpaved airfields. The addition of skis or tundra tyres also allows operation on snow and from remote camps.

The aircraft can be operated single pilot and a long range fuel tank is also available. Double cargo doors provide good access for installing instrument racks.

In general the aircraft works in the Antarctic from October through to March each year. Outside the Antarctic season the aircraft is available in the Northern hemisphere.

Aircraft Operations	
Range	1000 km, increased with long range tank depending on configuration.
Airspeed	Cruise 65 m/s. Data collection 60m/s.
Complement	Pilot + maximum 4 mission operators / scientists.
Altitudes	<30m to 5000m. Unpressurized but with oxygen fit for pilots and operators.

The instrument suite includes ice penetrating radar, gravimeter, magnetometers and laser scanner. The systems are all synchronised by a distributed GPS NMEA and 1pps signal. Real time data is reviewed and the systems controlled from a central command console or via tablet computer. The survey network system lets multiple operators view and use the equipment installed on the aircraft, though normally standard missions are flown by one pilot and one operator.

Installations are flexible allowing for tailored missions for gravity, radar, magnetics or hyperspectral missions or any combinations of the systems. Hard points in the wings allow for mounting of 8 radar antenna and instrumentation. Pods can be fitted at the wing tips for the magnetometer installation.

The floor hatch opening can accommodate a laser range finder or scanning laser which can be used for measuring ice floe topography and ice surface. The required GPS and attitude measurements to support this are available from a Leica and Novatel based with built in system redundancy. A digital SLR camera can also be fitted to provide visual references for the data sets. A hyperspectral suite of imaging equipment can be utilised in the camera bay for a wide range of survey applications such as geology or vegetation studies. The camera bay can also be utilised to drop airborne deployable
sensors and towed sensor arrays such as low frequency radars.

Further details of the instrumentation are given overleaf.

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GPS Positioning	The survey aircraft employs two GPS logging at 10Hz. This provides a true dual redundant system utilising two dissimilar GPS receivers, mitigating against drop outs due to firmware coding errors . A Leica GPS 500 provides the primary GPS and a Novatel DL-V3 provides the system redundancy.
GPS NMEA and 1pps distribution	GPS NMEA and one pulse per second (1pps) is distributed to all systems to provide synchronisation of all the data and formation of coherent data sets.
Inertial Measurement Unit (IMU)	Aircraft attitude and inertial information is provided by an IMAR FSAS inertial unit (been a non ITAR controlled system it can be more readily used in foreign countries). The IMU data is logged to a Novatel Span receiver.
Magnetometer	The Twin Otter is configured for fixed wing magnetometer operation. The aircraft modifications include inboard positioned wingtip fuel pumps, pod boom hard points and demagnetised airframe to maximise magnetic data collection. Sintrex CS3 sensors are used due to their high sensitivity, high cycling rates, excellent gradient tolerance, fast response and low susceptibility to the electromagnetic interference.
Airborne Geophysical Information System (AGIS)	The AGIS data logging system is used to log the magnetometer data at a frequency of 10Hz with a sensitivity of 1 pico Tesla, radar altimeter data and fluxgate magnetometer is also logged. AGIS also provides pilot guidance information.
Radar Altimeters	Data are recorded from the aircraft's radar altimeter fitted in the tail section at 10Hz. These have a range of around 800-1000m and a wider beam compared to the laser altimeter.
Fluxgate Magnetometer	A Billingsley TFM100G2 fluxgate magnetometer is mounted in the tail of the aircraft. This provides corrections for magnetometer data.
Laser Altimeter	A Riegl LD90-3800VHS-FLP Laser Altimeter is fitted in the floor camera hatch. Returns up to 700m over snow are possible depending on the surface reflections. A repetition frequencies up to 2 kHz can be achieved giving an along track measurement every 3cm with an accuracy up to 5cm.
Ice Penetrating Radar	The ice penetrating radar is a coherent two pulse radar with an output of 4 KW radar at 150 MHz. The radar is capable of imaging ice to depths of 5km with an along track resolution of 10 cm before processing and a depth resolution of 8 metres.
Visible Near Infrared Hyperspectral	The CASI-1500 is a visible near infrared (VNIR) sensor which offers a 1500 pixels across its field of view, allowing imaging of a vast area with a single pass, or achieve spatial resolutions as high as 25 cm. The sensor samples at 14 bits, with sampling across 100 spectral bands at 15 nm intervals across a 365 and 1050 nm range.
Short-Wave Infrared Hyperspectral	The SASI-600 is a short-wave infrared (SWIR) sensor which offers a 600 pixels across its field of view, allowing imaging of a vast area with a single pass. The sensor samples at 14 bits, with sampling across 288 programmable spectral bands across 950 to 2450nm .
Thermal Infrared Hyperspectral	The TASI-600 is a thermal infrared sensor which offers a 600 pixels across its field of view, allowing imaging of a vast area with a single pass. The sensor samples at 14 bits, with sampling across 32 spectral bands across 8 to 11.5µm .
Gravimeter	Aerogravity measurements are acquired with a modified LaCoste and Romberg air/sea gravimeter. Crossover analysis indicates the free-anomaly field is accurate to ~5 mGals for wavelengths greater than 10 km.
AHRS	A secondary aircraft attitude reference is available from the aircrafts Litef LCR92 attitude and heading reference system.
Sony HD cockpit cam	A cockpit installed camera provides high definition video and a forward view for the operator when located in the cabin.
Canon 7D	A downward pointing DSLR in the camera bay provides synchronised high resolution surface imagery.

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