K049
2007/08

LOGISTICS REPORT

K049: NZ ITASE
ANTARCTICA NEW ZEALAND 2007/08

Event Personnel:

Dr Nancy Bertler	Antarctic Research Centre, Victoria University of Wellington & GNS Science
Mr Matt Watson	ScanTec Limited
Mr Davie Robinson	GNS Science
Ms Julia Bull	Antarctic Research Centre, Victoria University of Wellington
Ms Rachael Rhodes	Antarctic Research Centre, Victoria University of Wellington & GNS Science

Name of compiler: Nancy Bertler   Signature of compiler: [signature]

*AIMS

The principal purpose of this year's field season was to conduct a site survey at Skinner Saddle and Gawn Ice Piedmont in the vicinity of Byrd Glacier for future ice core drilling. We accomplished a total of 185 km high resolution radar survey and identified excellent drilling locations at both sites.

The NZ ITASE programme has five objectives:

1. **ITASE-Objective**
   The focus of the New Zealand ITASE group is to provide information from the climate sensitive, low altitude, coastal sites. This will capture the climate signature of the troposphere, which represents a regional account on the Ross Sea climate. The ice core data are expected to provide a record of air temperature, snow accumulation, precipitation source, atmospheric circulation strength, storm frequency, sea ice variation, ocean productivity, and anthropogenic influences. The results will help to decide whether the Ross Sea region is currently cooling or warming with a longer-term prospective, taking low frequency climate variability (100 to 1000 year cycles) into account. Furthermore, proposed tele-connections such as the Amundsen Low-ENSO correlation [Bertler et al. 2004; Meyerson et al. 2002] or the Southern Hemisphere Annual Mode [Thompson and Solomon 2002] can be further constrained.
2. **Latitudinal Gradient Project Objective**
   The project is expected to contribute substantially to the Latitudinal Gradient Project, as it can provide a history of temperature, humidity, sea ice cover, precipitation source, atmospheric circulation, and ocean productivity along the Victoria Coast for the last 200 to 10,000 years. Furthermore, the timing and velocity of the Ross Ice Shelf retreat some 9 to 5ka years ago is still discussed controversially [Hall and Denton 2000; Steig et al. 1998; Steig et al. 2000].
3. **ANDRILL Objective**
   The ice core locations 2 and 3 (Evans Piedmont Glacier and Mt. Erebus Saddle) are in the vicinity of planned ANDRILL coring locations (Granite Harbour and Windless Bight). The ice core records will provide a high resolution climate dataset, which serves as a reference for the younger part of marine record recovered through ANDRILL.
4. **Longer-Term Mass Balance Objective**
   During the 1999/2000 season mass balance measurement devices (submergence velocity method [Hamilton and Whillans 2000; Hamilton et al. 1998]) have been deployed at Victoria Lower Glacier. The device has since been revisited. The measurements show that the glacier has a slightly negative mass balance, losing around 12-15cm thickness per year. A continuation of the measurements will allow monitoring changes in the ablation intensity of the McMurdo Dry Valleys.
5. **The Antarctic – New Zealand Connection Objective**
   New Zealand's future economic and social development, environmental sustainability, and infrastructural planning critically relies upon the accurate assessment of the impact of "global warming" in our sector of the planet. Future climate change is a result of both natural variability and anthropogenic influence. A joint programme between Victoria University, GNS Science, University of Maine, is investigating ice core records from New Zealand (Tasman Glacier and Mt. Ruapehu ice field). The comparison between our NZ and Antarctic ice core records will provide much needed data for the development of realistic regional climate models to predict NZ climate in the 21th Century [Mullan et al. 2001].

*PERSONNEL

Name	Role	Organisation	Departed Chch	Returned Chch
Nancy Bertler	PI	Victoria University / GNS Science	23/10/2007	20/12/2007
Matt Watson	Radar Expert	ScanTec	23/10/2007	27/11/2007
Davie Robinson	Field Safety Expert	GNS Science	23/10/2007	26/11/2007
Rachael Rhodes	Student	Victoria University / GNS Science	23/10/2007	07/12/2007
Julia Bull	Student	Victoria University	26/11/2007	07/12/2007
Alex Pyne	Drilling Expert	Victoria University	Transfer from K001 to K049 13/12/2007	20/12/2007

*PLANNING

- *Application process*
  The application process was efficient and well documented
- *Communications with Antarctica New Zealand staff*
  Communication with Antarctica New Zealand staff was professional, timely, and effective.
- *Pre-season information*
  The information received was timely and valuable
- *Medicals, documentation and flights to Antarctica*
  The information received was timely and valuable. However, I would like to note that there is a loophole in the information flow for the medical assessment. I would like to suggest that the PI of any field group will be informed by the medical advisor of any condition of a team member relevant to the field deployment, such as allergies etc. Furthermore, I would like to suggest adding to the medical questionnaire the question on how long the examining doctor has known the patient. This would help the medical advisor to evaluate how comprehensive the medical assessment might be.
- *Environmental Advice*
  The pre-season information received was timely and valuable
- *Other comments*
  The multi-season experience of many Antarctica NZ staff makes the planning process field deployment a professional and efficient process. However, I would like to note that also new staff, in particular in the management team, contributed to have made this year's planning and implementation a very efficient and positive experience.

*PREPARATIONS FOR THE FIELD

- *Reception and planning for your event*
  The reception was well organised, friendly and efficient. The main issues of the event were promptly discussed and organised.
- *Availability and condition of equipment received*
  Upon our arrival Scott Base staff the field support team, J.Barton and D.Mahon had staged most of our field equipment in the HFC. The equipment was in good condition and suitable for our field deployment.

- *Antarctic Field training and any specialist training*
  All team members with the exception of Rhodes conducted a refresher training, which was efficient and useful. Rhodes participated the full Antarctic field training. In addition, we conducted an additional glacier travel training. The training, carried out by Davie Robinson, was excellent and catered for the specific needs of this group. Extensive crevasse extraction training, roped skidoo-travel, and management of extreme weather conditions were an important focus of the training. All members felt that the field training was very practical, helpful, and beneficial for the team. We are grateful to E. Barnes for the concept and excellent implementation of a modulised, tailored field training programme

- *Field party equipment 'shakedown' journey*
  The equipment shakedown journey was particularly useful to identify and repair minor defects in the equipment, as well as to practise and revise traverse routines. When the team deployed to Skinner Saddle, all science and field equipment was thoroughly tested and checked.

- *Delays at Scott Base, whatever the cause*
  We deployed in general on time to and between field sites, with only minor (1 day) weather delays at our move to Gawn Ice Piedmont and from Evans Piedmont Glacier. We purposely delayed our departure from Scott base to Skinner Saddle by one day as this provided the opportunity to use the DC-3 instead of Twin Otter aircrafts. However, due to delays in the DC-3 schedule we used the Twin Otter aircrafts.

- *Safety and Risk Management processes*
  The risk management process was useful.

- *General comments about Scott Base*
  The Hillary Field Centre is a well designed, practical, and much welcome improvement for field preparations. The cage system as well as the bench space along with the excellent organisation and coordination by J. Burton and D. XXX allowed a number of groups to concurrently prepare and test their science and field equipment indoors. In addition, this provided an atmosphere for scientific exchange between groups as well as exchange of practical experience between individuals. The doors to the cages are somewhat too narrow and don't allow equipment to be transferred by trolley. The new mess and lounge area is a well implemented improvement of the living quarters.

- *Other comments*
  We would like to thank Scott Base staff for their very efficient, professional, and above and beyond support with our programme!

FIELD TRANSPORT

- *Vehicles*

➢ Skidoos and Nansen Sledge

We used two Bombardier skidoos (SWT 08 and 09) for traversing at Skinner Saddle and Gawn Ice Piedmont. These skidoos are easier to drive and to start than the older Alpine II models. Overall, the skidoos were reliable and performed well. The skidoos were well prepared and fitted with spare parts and we received professional and useful advice during field deployment via radio. A Nansen Sledge was used to carry the Ground Penetrating Radar (GPR) control units, high resolution GPS, a generator and solar panels. The sledge was in good condition and performed extremely well in both soft snow and rough terrain. Good weather conditions allowed us to conduct 150km of GPR survey lines at Skinner Saddle, while marginal weather conditions at Gawn Ice Piedmont limited our efforts to 35km. Fuel consumption of the traverse was on average 1.5L / km (or 0.66 km/L) for both skidoos together. The ratio between the front skidoo, pulling the Nansen sledge, and the trailing back skidoo was approximately 60/40%.

- *Aircraft Operations*

➢ Twin Otter

The field deployment by Twin Otter was again highly successful, efficient, and practical. In preparation for field deployment to a new site, we met with the pilots, discussed satellite images and digital elevation models of the site. The crew provided us with aircraft pallets which we pre-packed and plastic wrapped. The landing at this both sites was smooth and unproblematic. Four flights accommodated the cargo input of our deployment. The loading and unloading of the aircraft was fast and relatively easy even for heavy equipment, such as skidoos or fuel drums. At Gawn Ice Piedmont, crevasse fields undetected in our satellite images required finding an alternative landing site. The pilots were very accommodating and also created a safe zone for us by taxing across our chosen camp site before unloading. We would like to thank the crew for their professional, practical, and friendly support.

➢ HNO

Field deployment to Evans Piedmont and Victoria Lower Glacier was carried out with HNO. Both deployment and pickup of cargo and passengers was very professional, efficient, and safe. The extensive regional and local experience of R.McPhail is invaluable. We are grateful for the exceptional support by HNO.

- *Ship Operations*

We are grateful for discussions with Captain O'Hanlon of the American Tern regarding the shipment of our ice core cargo.

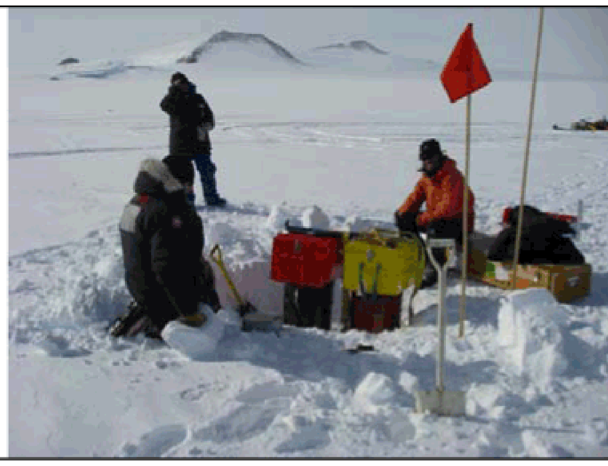
*EVENT DIARY

Date	Main Activities and Location	Other Comments
23 Oct Tue	Bertler, Watson, Robinson, Rhodes arrive at SB	
24 Oct Wed	Refresher AFT for Bertler, Watson, Robinson. Rhodes starts full AFT Starting to pull all equipment, fulfilling licence requirements	
25 Oct Thu	Test remainder of the field equipment, change set-up of polar pyramid tents, and discuss with SB Carpenter the construction of a Nansen sledge cockpit, test SB heater for polar tent	
26 Oct Fri	Testing generators and scientific equipment. However, not all radar equipment can be tested as some cargo still delayed due to delays in Kiwi-Hercules flights. We change deployment date into the field from 30 Oct to 29 Oct as the DC-3 might become available then instead of Twin Otter	
27 Oct Sat	Robinson, Bertler, Watson and Rhodes, crevasse training in HFC, team meeting on risk assessment	
28 Oct Sun	Overnight shake-down journey with linked skidoo travel and Nansen sledge set-up. Marginal weather with up to 50kts wind and temperature of around -28°C provide excellent training conditions.	

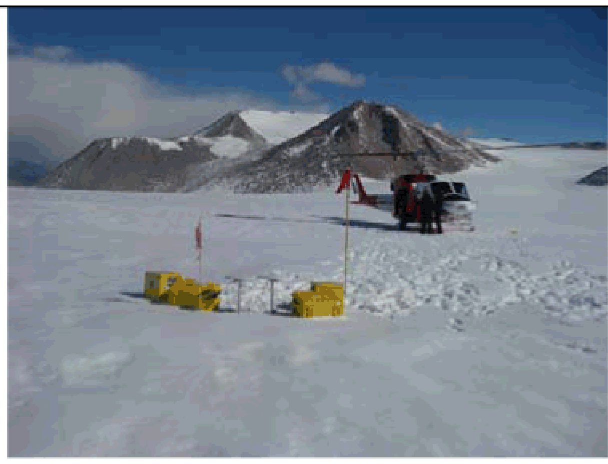
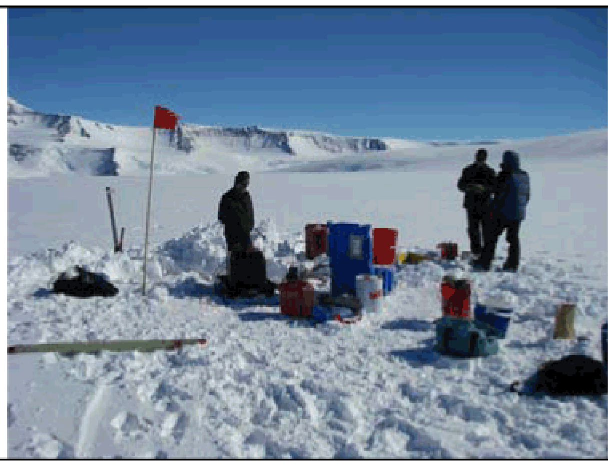
29 Oct Mon	Ground penetrating radar equipment finally arrives at Scott Base and is tested in the vicinity of Scott Base. Final packing of equipment and personal items	
30 Oct Tue	Pack cargo on aircraft pallets for Twin Otter (operating on 1800 lb per flight basis), dissemble Nansen sledge as it will not fit through Twin Otter doors, Watson and Rhodes run ground penetrating radar survey towed by Huggland around SB ski field for AFT team	
31 Oct Wed	Bertler, Watson, Robinson, Rhodes from Scott Base to Skinner Saddle. Flight time 1:15 hr; three shuttles, from 8:45am to 6.15pm. Set-up camp, secure cargo.	
01 Nov Thu	Fourth Twin Otter load arrives at 9:45am, start set-up of automatic weather station, set-up of radar equipment. First measurement shows glacier thickness at camp-site >400m.	
02 Nov Fri	Complete set-up of automatic weather station, complete crevasse training, discussing different types of anchors in variable snow conditions. Set-up of GPS base station and completion of ground penetrating radar set-up	
03 Nov Sat	Set-up of linked skidoo traverse train, sampling of surface snow, skidoo traverse in the vicinity of the camp site to ensure crevasse-free	
04 Nov Sun	1. traverse with 35MHz antennae pair produces excellent data with ice thickness exceeding 600m, good snow conditions, strong internal and bedrock reflectors, weather station is recording data. Use high resolution, kinematic GPS to map surface topography	

05 Nov Mon	2. traverse with 35MHz and 500MHz antennae pair. Higher than expected fuel consumption (0.66km / L fuel)	
06 Nov Tue	3. traverse with 35MHz antennae pair but traverse is aborted due to deteriorating weather conditions. Visibility reduces to <10m, navigation back to camp on GPS. Sample falling snow	
07 Nov Wed	Weather further deteriorates. Blowing snow, high wind speeds, poor visibility, large snow drifts. Check cargo and field equipment. New heater chimney works well with reduced flaring during wind gusts	
08 Nov Thu	Weather improves, 4. traverse and 5. traverse with 35MHz and then 500MHz antennae. Set-up shallow drill and test drilling in the vicinity of the camp	
09 Nov Fri	Weather deteriorates with poor visibility and strong winds. Postpone traverse work and start drilling but conditions deteriorate further and drilling is aborted	
10 Nov Sat	Weather conditions improve and 6. and 7. traverse are completed with 35MHz and 500MHz antennae. From data excellent drill site is identified. A total of 150km of GPR lines is achieved	
11 Nov Sun	Start dismantling traverse train and science equipment. Check weather station and dissemble GPS base station. Complete drilling to 17m depth. Good snow and firn conditions with now sign of melt	
12 Nov Mon	Move to Gawn Ice Piedmont is delayed from Monday to Tuesday. We use the extra day to conduct a series of tests with new GPR equipment and for sensitivity measurements. Preparation of four Twin Otter loads.	
13 Nov Tue	<u>Skinner Saddle to Gawn Ice Piedmont</u> Packing remaining tents and personal equipment. First Twin Otter arrives at 10am. A reconnaissance flight shows that planned camp site lies within crevasse field. We decide to land ~10km north of original site. Twin Otter pilots prepare safe-zone by taxing across the camp site before landing. Total of 4 shuttles, finished by 6pm. Help to refuel at Darwin cash before third shuttle. Set-up camp, secure cargo	

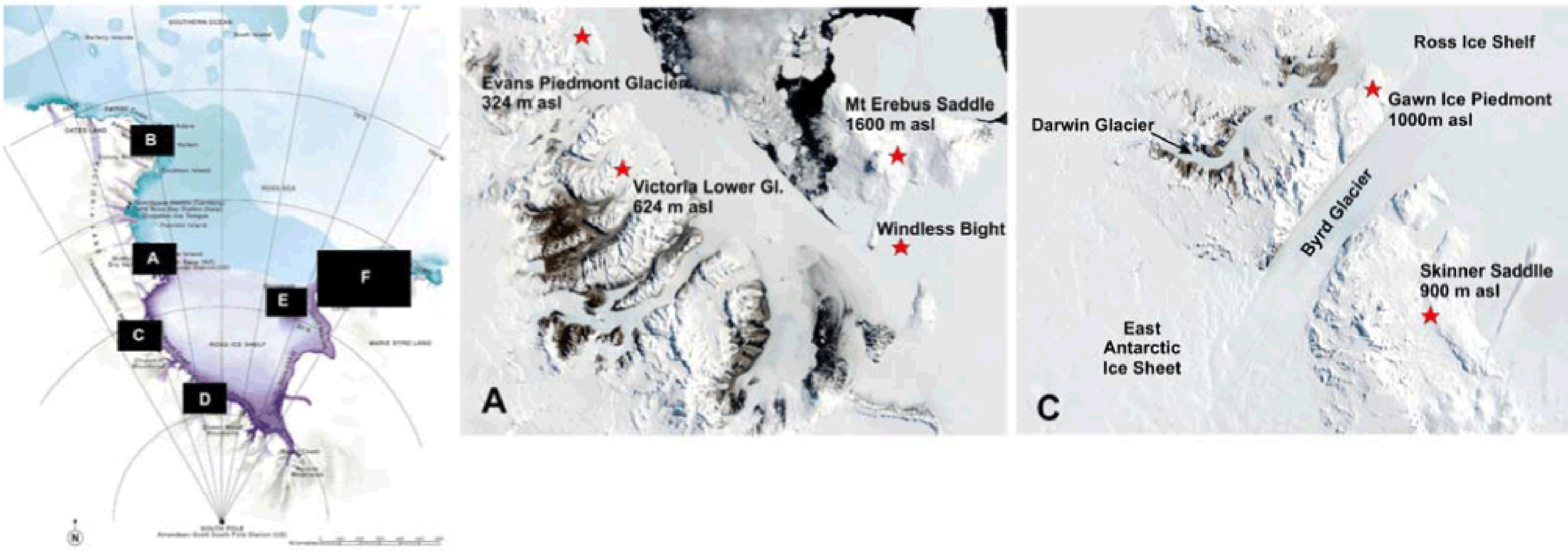
14 Nov Wed	Weather condition deteriorated over night. Start to set-up traverse train and finish camp set up, such as toilet tent. Mark runway before precipitating snow covers tracks. Weather deteriorates further. All movements are confined to camp area. Process GPS and GPR data obtained at Skinner Saddle, collect samples from falling snow in 2 hour intervals	
15 Nov	Complete traverse train set-up. However, falling snow, poor visibility prohibit traverse in this glaciological active region until late afternoon. 1. traverse with 500MHz antennae for crevasse safety. The scan shows 27 crevasses crossed during traverse. 2. traverse with 35MHz antennae shows ice thickness of 400-500m. Good snow and ice conditions with strong internal and bedrock reflectors. Weather deteriorates again. Continue collecting snow samples from falling and blowing snow	
16 Nov Fri	~ 10cm snow precipitation over night. Poor visibility and strong winds exceeding 35kts prohibit traverse work. Set-up of drilling system. Start drilling to 7m but weather deteriorates further and we abort all outside work. Installation of small computer fan in the roof of polar heaven tent proves to be effective in thermal mixing of extreme temperature gradient in the tent (hot in the top, below freezing on the floor) with an overall more homogeneous heat distribution in the tent. Continue to collect snow samples from falling and now blowing snow	
17 Nov Sat	Weather conditions deteriorate again. Blowing and falling snow, strong winds exceeding 45kts, poor visibility confines us to another day in the tents. Continue to sample falling and blowing snow.	
18 Nov Sun	Weather conditions improve but still unsuitable for traversing due to poor visibility. We continue to drill but drill arrests at 13m depth. We are unsuccessful in retrieving it. Weather conditions deteriorate again with strong winds and blowing snow and we retrieve to tents. Request 5L of glycol and 20L of ethanol to be flown in on first Twin Otter flight to attempt freeing the drill.	
19 Nov Mon	Weather conditions are poor until late evening when wind drops and visibility improves. Set-off for 3. traverse and successfully identify and scan appropriate drill site.	

20 Nov Tue	Marginal weather conditions, but 4. traverse allows high resolution grid around identified drill site. We achieved at total of 35km of high resolution radar survey lines. Then start dissembling traverse train and equipment, packing Twin Otter loads. Weather deteriorates again with blowing snow and strong winds.	
21 Nov Wed	Gawn Ice Piedmont to Scott Base Two Twin Otter aircrafts arrive at 9.45 and 10:00 respectively. Three shuttles are necessary to return all equipment and people. First flight delivers requested glycol and ethanol. Despite significant efforts we only manage to loosen the drill but not to recover it from the borehole. We case the top of the drill hole and mark the site with a flag All back at Scott Base by 6:45pm. Put tents in drying room and stow all cargo in cage and cargo yard.	
22 Nov Thu	Scott Base Drying of tents, sleeping bags. Cleaning of kitchen boxes, packing cargo, return survival bags, generators, fuel	
23 Nov Fri	Bull to come from Chch to SB but flight is cancelled. Empty drying room, start pulling equipment for Evans Piedmont Glacier deployment, continue to pack of cargo not needed for the deployment, repair Nansen sledge	
24 Nov Sat	Complete packing of cargo and continue field preparations for Evans Piedmont Glacier. Discuss with Kevin location of ice core reefer at Scott Base. Pyne designs melting tool for ice core drill. Discussion with Kevin on manufacturing the tool for drill recovery	
25 Nov Sun	Day off	
26 Nov Mon	Robinson Scott Base to Chch, Bull Chch to Scot Base. Complete field preparations for Evans Piedmont Glacier, prepare loads, Bull participates refresher AFT	
27 Nov Tue	Watson Scott Base to Chch Bertler, Rhodes, Bull Scott Base to Evans Piedmont Glacier Set-up camp, secure cargo. Film crew and accompanying AFT team arrives at site. Identify sampling site for ultra clean chemistry sampling. Excavate 4m snow pit.	

28 Nov Wed	Start sampling 4m deep snow pit, down load weather station data, various interviews with Film Crew	
29 Nov Thu	Continue to sample snow pit, carry out small repairs and maintenance work on automatic weather station. Film Crew and AFT team scheduled to leave for Scott Base but unsuitable weather conditions delay departure	
30 Nov Fri	Film Crew and AFT team leave for Scott Base Continue to sample snow pit	
01 Dec Sat	Excavate second snow pit and start sampling for geochemistry. Start measuring density and temperature at first snow pit	
02 Dec Sun	Complete first and second snow pit including geochemistry, density and temperature. Prepare double snow pit to identify and characterise snow layers and properties	
03 Dec Mon	Scheduled to return to Scott Base via Victoria Lower Glacier, but unsuitable weather conditions prohibit move. Extra day is used to excavate third snow pit	

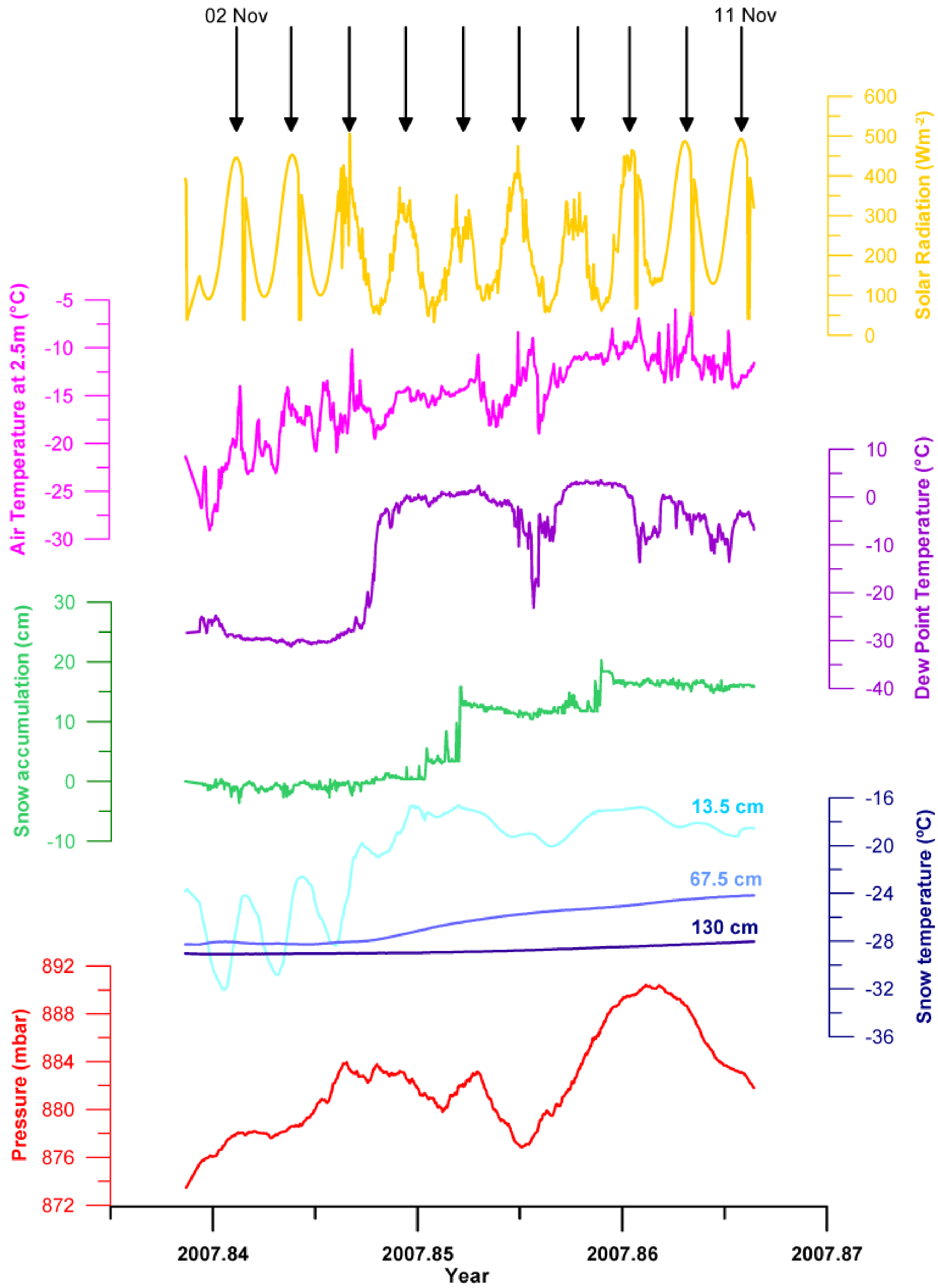
04 Dec Tue	<u>Evans Piedmont Glacier to Victoria Lower Glacier</u> Using differential GPS measuring long-term mass balance of Victoria Lower Glacier (Submergence velocity method, deployed in 1999). Dig snow pit to investigate change in snow properties due to large winter storm in previous winter. Find exceptionally large hoar crystals. Ground time 3 hours <u>Victoria Lower Glacier to Scott Base</u> Pitching tents in drying room, stow all cargo in cage and cargo yard.	
05 Dec Wed	Finish clean-up of tents, sleeping bags, kitchen and food boxes. Pack cargo.	
06 Dec Thu	Travel to Cape Evans to visit historic huts and to bring re-supplies to AHT team. Discuss with engineers manufacturing of ice core drill recovery tool.	
07 Dec Fri	Bull, Rhodes Scott Baes to Chch Scott Base engineer starts manufacturing recovery tool, pull equipment for travel to Gawn Ice Piedmont to recover ice core drill	
08 Dec Sat	Engineer completes recovery tool. Flight is scheduled for Thu 13 Dec	
10 Dec Mon	Test hotwater drill, modify to connect to recovery tool get generator, 40L glycol and 20L ethanol.	
12 Dec Wed	Flight has been delayed until PEE can be amended to allow usage of glycol and ethanol.	
13 Dec Thu	Pyne retrieves luggage from bagdrag. PEE has been amended and flight has been granted for 14 Dec	
14 Dec Fri	Successful recovery of ice core drill. We use 10L of glycol and 2L of ethanol in the process.	
18 Dec Tue	Bertler, Pyne scheduled to leave for Chch, but flight is cancelled	
19 Dec	Bertler, Pyne leave for Chch	

EVENT MAP



*WEATHER

Weather conditions during our deployment were variable. Overall we experienced favourable weather conditions at Skinner Saddle, with only two no-work days. We experienced a strong temperature shift from initially temperatures well below -30ºC to -18 ºC within a week. A total of 15cm net snow accumulation occurred during the 9 days. At Gawn Ice Piedmont weather conditions were unfavourable with only 2.5 work days out of 7 on site. Low visibility, strong winds, blowing and falling snow made traversing in this glaciological active region difficult. A total of 45cm snow accumulation occurred during our stay. At Evans Piedmont and Victoria Lower Glaciers weather conditions were very good with only one day of weather-caused delays.



Automatic weather station data from Skinner Saddle from 02 to 11 November 2007.

*ACCIDENTS, INCIDENTS OR HAZARDS

FIELD EQUIPMENT

- *Quality, suitability and performance of field clothing*

ECW Jackets: The Tiger Angel ECW jackets performed extremely well. They are comfortable, warm, relatively light weight, and shed snow extremely well. The design and black colour was also well perceived. The two-layer system is very practical and allows the jacket to be used in cold and temperate conditions alike. The hood doesn't perform in high winds as it is not ridged enough. In addition the neck is cut too narrow and the sippers can't be closed over a neck gaiter. The sippers on arms and wrists are too narrow and don't allow for fleece or lather gloves to go underneath. Overall, this is a very functional and the best performing ECW jacket our group has tested yet. The Canadian Goose jacket is similar in its feature. However, it doesn't shed the snow as well, and the artificial fur is trapping snow rather than shedding it. In addition, the inner jacket cannot be zipped out as in the case of the Tiger Angel jacket. In summary, we prefer and recommend the Tiger Angel jacket.

Windproof Trousers: The new Earth Sea and Sky windproof trousers are impractical. The cut is too high and too tight around the waist, limiting freedom of movement. However, the material shed the snow well. Overall, we preferred the Cactus windproof trousers, which we used last year and found to be practical, shed snow extremely well, provide good freedom of movement, and are very durable. All members of the group wore almost exclusively these trousers from October to January, regardless of weather conditions or work tasks. Despite the heavy use, they showed little or no sign of fatigue. Only during the coldest of days (~30ºC) during skidoo traversing in high winds were the trousers somewhat too cold. The only complaints some group members have is, that the full length sippers catch in the material as the seam is not stiffened enough. D.Robinson had a more durable version of this trouser. However, the material was less efficient in shedding snow and hence got wet at times. For this reason, we would recommend the simpler version. Together with the Tiger Angel ECW jackets, this combination offers an excellent and weather proof outer shell.

Polarfleece Jackets: The new polarfleece Earth, Sea, and Sky fleece jackets are suitable for a narrow temperature range as they are not designed to be used in a layering system. The cut of waist and arms is too narrow to allow other layers, such as a fleece shirt to be worn underneath. In addition the neck is cut too narrow to allow for a neck-gaiter to fit inside. Furthermore, the jacket has not enough pockets to keep for example batteries warm in inside pockets. Moreover, the material did not appear as durable as previously issued fleece jackets.

Fleece Shirt: The new Earth, Sea, and Sky fleece shirt did not withstand the challenges of the field deployment. In the short time we wore the shirts, the material around shoulders thinned significantly. As with the fleece jackets, the cut is too narrow to allow a layering of clothing, such as ice breaker underwear below the fleece shirt.

Windproof Jacket: The new windproof jacket was much worn by all team members. The material is durable, comfortable, lightweight and provides good freedom of movement. However, the cut is too narrow to permit layering, eg. the fleece jacket would not fit underneath the windproof jacket. Furthermore, the jacket doesn't provide a hood, a crucial feature to keep warm in windy conditions.

Carhart Salopetts: We welcome the decision to allow Carhart trousers as ECW trousers. We feel Carharts are warmer than down-ECW trousers and remain dry longer in blowing snow conditions than their blue equivalents. While they are somewhat heavier, they are also more durable.

- *Performance and design of field equipment such as tents, technical climbing equipment, kitchen gear, stoves, sleep kits and sledges*

Polar Heaven Tent: the new polar heaven greatly improved working and living conditions in the field through significantly higher insulation, stability, and functional doors. The new floor however, is extremely slippery with snow and poses a significant risk, in particular during set-up of the tent. We used old carpet from Scott Base which not only provided a safe surface, but also provided further insulation and improved ground stability over time. The new oven heaters for the polar heaven are a good addition, however they are too large and bulky to transport (240lb). Instead, we used the VUW heater, which is smaller and lighter (60lb). In addition, the VUW heater can be connected directly to a 60L fuel drum, while the SB heater requires an additional fuel container, which increases weight and bulk. The new H-shaped chimney improved the heater performance significantly during stormy conditions and/or heavy snow fall and we would like to suggest fitting SB heaters with the similar chimney top. After some very cold nights, water in the diesel fuel froze in the hose and stopped the fuel flow to the oven. Placing the hose frequently (every few days) in a hot water bath prevents the ice built-up and improves efficiency.

Sleeping bags: We used a combined system of a synthetic outer and a down inner. The combination provided excellent thermal conditions. However, the synthetic outer layer required frequent drying or else significant ice built-up occurred and subsequent melt.

- *20 person day ration box or bulk food system*

The variety and quality of food in the new bags is good and sufficient. Freeze-dry food back up for 14day additional supply is a good alternative for taking full new bags. It saves room and weight. Maybe this could replace all freeze-dry in general food bags, since freeze-dry is expensive, not much liked, and causes digestive problems for some people. Some of the items in the food boxes had gone off. E.g. most of the milk-power and nuts were not useable.

- *Condition and performance of 'wannigans'*

N.A.

- *Performance and use of generators, spill kits, alternative energy systems*

We used a 1kV, 2kV, and a 4kV generator. All generators were well serviced and functioned without problems.

- *Specialised field equipment*

We are grateful for the Nansen sledge cockpit built by the SB carpenters which provided wind protection for the ground penetrating radar operator and equipment and improved significantly work conditions and efficiency, in particular during marginal weather conditions.

We also would like to thank the SB engineer shop to built the glycol melt head designed by Alex Pyne which allowed to us to retrieve the arrested ice core drill from Gawn Ice Piedmont.

- *Other comments*

Throughout the season, Scott Base staff was exceptionally supportive, helpful, and innovative in solving problems or accommodating special requirements of our programme.

RADIO COMMUNICATIONS

- *Suitability and effectiveness of the radio and/or Iridium equipment*

The HF radio system was in poor condition, with loose wires, a broken antennae cable and an unsuitable battery charger. In discussion with the SB telecom, we rewired the radio, renewed the antennae cable and modified the charger. The batteries of the VHF and Iridium phones did not hold their charge in ambient temperature. In the field, the Iridium phone was reliably functional only when powered directly off the generator.

- *Reception/transmission conditions and suitability of radio schedule timing*

HF reception and transmission was in general good but weather dependent. VHF radio and iridium phone reception was consistently good.

- *Scott Base's general efficiency during radio schedule*

SB staff were friendly and helpful during radio communication. However, insufficient training might have been the cause for inefficiencies, miscommunication, and technical problems.

- *Other comments*

The iridium phone is a valid and practical back-up to HF radio communication. We would like to suggest activating text messaging option it is less energy demanding and cheaper than phone conversations. We used for the second year a private iridium phone to receive weather updates via text messaging. This option could also be useful to receive updates of aircraft/helo flight schedules from SB and other short messages outside the normal sched times, since the phone does not have to be switched on to store incoming messages until the phone is switched on. This could make communication initiated from SB easier and less dependent on sched times.

SCOTT BASE AND ARRIVAL HEIGHTS FACILITIES

Facility	Use
Hatherton Geoscience Laboratory	
Q-Hut study carousels	
Hillary Field Centre	We are grateful for the space allocated in the Hillary Field Centre, which we used for testing our science and field equipment as well as preparing twin otter loads
Scott Base Wet Laboratory	
Scott Base Summer Laboratory	
Arrival Heights Laboratory	
TAE Hut	
Library	

- *Additional equipment taken to Scott Base*

- *US Science facilities used*

- *Other comments*

COMPUTER FACILITIES

- *Assistance the science technicians gave with computer / IT issues*

- *Issues concerning public computer facilities in the Hatherton Laboratory*

REFUGE AND RESEARCH HUTS

Refuge/research hut name	
Overall condition	
Scale and condition of provisions	
Suitability of location	
Unnecessary equipment or rubbish/debris in the area	

- *Other comments*

*ENVIRONMENTAL IMPACT

***Sites Visited** (please fill in a box for each site visited)

Site name	Skinner Saddle
Site coordinates	80°55'54.66"S, 159°30'11.56"E, 917.5m asl
Is this site in an ASMA or ASPA? If so, which one?	No
Dates occupied (from – to)	31 Oct to 13 Nov
Total time (days /hours) at site	14 days
Maximum number of people at site (your event)	4

Total person-days (or person-hours) at site	56
Main activity undertaken	Site survey, ground penetrating radar, and shallow drilling, set-up of automatic weather station
Cumulative impacts observed	Cumulative impacts were less than minor and transitory. Impacts include exhaust fumes from skidoos, generators and polar heaven heater.
Helo landing site coordinates if not established AND marked	N.A.

Site name	Gawn Ice Piedmont
Site coordinates	80°05'58.15"S, 159°16'37.60"E, 1221.0 m asl
Is this site in an ASMA or ASPA? If so, which one?	No
Dates occupied (from – to)	13 Nov to 21 Nov, and 14 Dec
Total time (days /hours) at site	9 days and on separate visit 5 hours
Maximum number of people at site (your event)	4 and on separate visit 3
Total person-days (or person-hours) at site	36 person-days and on separate visit 15 person-hours
Main activity undertaken	Site survey, ground penetrating radar, and shallow drilling
Cumulative impacts observed	With the exception of usage of 15L of glycol and 25L of ethanol to free ice core drill, the cumulative impacts were less than minor and transitory. These additional impacts include exhaust fumes from skidoos, generators and polar heaven heater
Helo landing site coordinates if not established AND marked	N.A.

Site name	Evans Piedmont Glacier
Site coordinates	76°43'31.95"S, 162°35'18.17"E, 390.9 m asl
Is this site in an ASMA or ASPA? If so, which one?	McMurdo Dry Valleys ASMA
Dates occupied (from – to)	27 Nov to 04 Dec
Total time (days /hours) at site	8 days
Maximum number of people at site (your event)	3
Total person-days (or person-hours) at site	24 person-days
Main activity undertaken	High resolution snow pit sampling, automatic weather station maintenance, and mass balance measurements
Cumulative impacts observed	Cumulative impacts were less than minor and transitory. No generator or fuel heater were used during the field deployment
Helo landing site coordinates if not established AND marked	N.A.

Site name	Victoria Lower Glacier
Site coordinates	77°19'48.31"S, 162°31'55.29"E, 626.2 m asl
Is this site in an ASMA or ASPA? If so, which one?	McMurdo Dry Valleys ASMA
Dates occupied (from – to)	04 Dec
Total time (days /hours) at site	3 hours
Maximum number of people at site (your event)	3
Total person-days (or person-hours) at site	9 person-hours
Main activity undertaken	Mass balance measurements

Cumulative impacts observed	Cumulative impacts were less than minor and transitory. No generator or fuel heater were used during the field deployment
Helo landing site coordinates if not established AND marked	N.A.

Chemicals

Chemical name	*Site of use*	*Quantity used*	*Quantity of unused/waste chemicals returned to NZ*	*Purpose of chemical*
Ethanol	Gawn Ice Piedmont	25 L	N.A.	Retrieval of ice core drill
Glycol	Gawn Ice Piedmont	15 L	N.A.	Retrieval of ice core drill
Details of chemicals left at Scott Base (justification as to why they were left, quantity and storage location): Ethanol and glycol were provided by SB and unused quantities were returned to the engineers workshop				

Geological Material

Location		*Specimen type*	*Quantity **(kg)***
Site name	Coordinates		
Skinner Saddle	80°55'54.66"S, 159°30'11.56"E	17m of firn core and 20 snow samples	90 kg
Gawn Ice Piedmont	80°05'58.15"S, 159°16'37.60"E	14m of firn core and 50 snow samples	70 kg
Evans Piedmont Glacier	76°43'31.95"S, 162°35'18.17"E	600 snow samples	50 kg

Equipment installed/left in field

Type of equipment/marker installed	*Location (name and coordinates)*	*Number of items left in field*	*(Dimension in metres: H, W, L)*	*Estimated retrieval date*
Automatic weather station	80°55'54.66"S, 159°30'11.56"E	1	3m, 4m, 4m	After intermediate depth ice core retrieval

If equipment has been left in the field please provide a justification:

The meteorological data will be used to establish transfer functions between ice core proxies and atmospheric parameters. The AWS records temperature, wind direction and speed, humidity, snow accumulation, snow temperature and solar radiation. We will remove the AWS during the drilling season.

Please insert or append a photograph of the installation(s) (AWS, marker, stake etc) in this report.

Waste management

Location		*Approximate quantity*	*Disposal methods i.e. tidecracked, returned to SB etc*
Site name	Coordinates		
Skinner Saddle	80°55'54.66"S, 159°30'11.56"E		Urine and filtered grey-water disposed at site, all remaining waste returned to SB
Gawn Ice Piedmont	80°05'58.15"S, 159°16'37.60"E		Urine and filtered grey-water disposed at site, all remaining waste returned to SB
Evans Piedmont Glacier	76°43'31.95"S, 162°35'18.17"E		All waste returned to SB

***Differences from original Preliminary Environmental Evaluation (PEE)**
Our original PEE did not considered the use of ethanol and glycol to retrieve an arrested ice core drilling system. An application to amend our PEE permit to allow the use of ethanol and glycol was kindly granted by MFAT.

ANTARCTIC SPECIALLY PROTECTED AND MANAGED AREAS

Note that all event leaders who hold permits for entry to an ASPA need to complete a Visit Report for each ASPA entered. Please download this form from our 'Returning to New Zealand' web page or contact Miranda Huston, the Environmental Advisor.

- *New ASPA or ASMA designation to be considered:*

- *New Special Features within the McMurdo Dry Valleys ASMA to be considered:*

HISTORIC SITES

Historic site name	
General observations on site condition	

- *Other comments*

ANTARCTIC GEOGRAPHIC PLACE NAMES

Location of Feature	
Type of Feature	
Proposed Name	

DESCRIPTION OF REMOTE, RARELY USED FIELD SITES

- Weather
- Campsite suitability
- Helicopter and/or fixed wing landing site suitability
- Travel (e.g. crevasse problems, ruggedness of terrain, used/potential routes)
- Sea ice activity and suitability for travel
- Overall description of the area
- Availability of freshwater
- Suggestions for any of the above for future use of the site/area
- Any other comments you wish to provide.

K049A
2007/08

Antarctica New Zealand

IMMEDIATE SCIENCE REPORT

K049A: NZ ITASE
ANTARCTICA NEW ZEALAND 2007/08

Event Personnel:

Dr Nancy Bertler	Antarctic Research Centre, Victoria University of Wellington & GNS Science
Mr Matt Watson	ScanTec Limited
Mr Davie Robinson	GNS Science
Ms Julia Bull	Antarctic Research Centre, Victoria University of Wellington
Ms Rachael Rhodes	Antarctic Research Centre, Victoria University of Wellington & GNS Science

1 Scientific Programme

a. Context of your research

Unprecedented changes are occurring in the Earth's climate. 2005 and 1998 were the warmest two years in the instrumental global surface air temperature record since 1850. The global average surface temperature has increased, especially since about 1950 with 100-year trend (1906–2005) of 0.74°C ± 0.18°C (IPCC, 2007). Although the scientific evidence of global warming is now widely regarded as incontrovertible, predicting regional impacts is proving more problematic. Especially, conclusions of the Southern Hemisphere record are limited by the sparseness of available proxy data at present (Mann & Jones, 2003).

While meteorological records from instrumental and remote sensing data display the large intercontinental climate variability, the series are insufficient to infer trends or to understand the forcing, which renders prediction difficult (Jones et al., 1999; Mann & Jones, 2003). The long ice core records from the Antarctic interior and Greenland revolutionised our understanding of global climate and showed for the first time the occurrence of RCE (Rapid Climate Change Events) (for review e.g. Mayweski and White (2002)). To understand the drivers and consequences of climate change on timescales important to humans, a new focus of ice core work is now moving towards the acquisition of 'local' ice cores that overlap with and extend the instrumental records of the last 40 years back over the last several thousand years.

This has been a key motivation behind the US-led International Transantarctic Scientific Expedition (ITASE) of which New Zealand is a member. The NZ ITASE objective is to recover a series of ice cores from glaciers along a 14 degree latitudinal transect of the climatically sensitive Victoria Land coastline to establish the drivers and feedback mechanism of the Ross Sea climate variability (Bertler et al., 2004a; Bertler et al., 2004b; Bertler & 54 others, 2005; Bertler et al., 2005a; Bertler et al., 2005b; Patterson et al., 2005). Furthermore, the ice core records will provide a baseline for climate change in the region that will contribute to the NZ-led multinational Latitudinal Gradient Project as well as providing a reference record for the NZ-led ANDRILL objective to obtain a high-resolution sedimentary archive of Ross Ice Shelf stability.

b. Objectives

The 2008/08 field season comprised objectives at Skinner Saddle (SKS), Gawn Ice Piedmont (GIP). Evans Piedmont Glacier (EPG), and Victoria Lower Glacier (VLG).

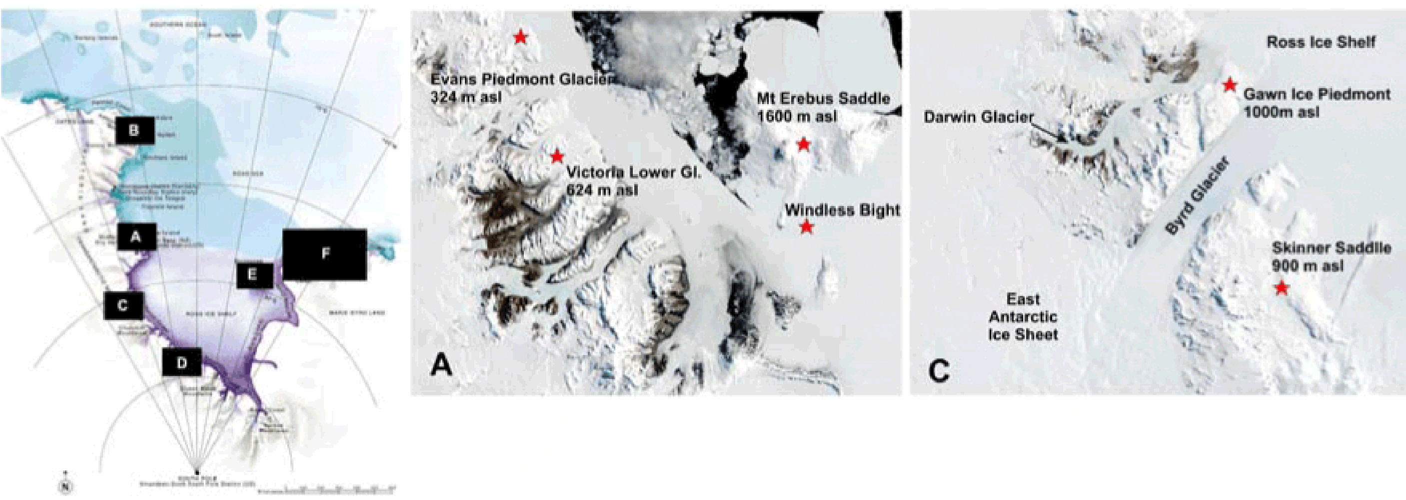


Fig. 1: Overview map of the Ross Sea region showing the location of the satellite images A and C. A) Locations of sites in the McMurdo Sound region, C) Location of sites in the Byrd / Darwin Glaciers region. Satellite images are derived from MODIS

c. Objectives

Site survey at Skinner Saddle and Gawn Ice Piedmont

Ground penetrating radar (GPR) measurements provide an image of the internal layering of a glacier and the topography of the ice-rock interface beneath. We applied low and high frequency radar pulses (8 MHz, 35 MHz, 200MHz, and 500MHz) to map the bedrock interface and internal flow structures in the glacier. Those features are identified through reflectors that result from changes in physical and chemical properties, such as dust layers or aerosol and density variations and are thought to represent isochrones (Morse et al., 1998; Vaughan et al., 1999). The choice of antenna frequency involves a trade-off between penetration depth and mapping resolution. The control units were mounted on a Nansen Sledge, pulling transmitter and transceiver antennae. The sledge also carried high precision GPS antenna, which is tied to the temporary GPS base station deployed at the SKS and GIP camps.
Traverses totaling 150km at Skinner Saddle and 35km at Gawn Ice Piedmont have been surveyed with GPR. Excellent isochrone reflections are visible from both the bedrock/glacier interface and in the top part of the profile, which will also be used to investigate geographical and chronological accumulation changes. Further post-processing will enhance the reflectors and will correct for surface topography.

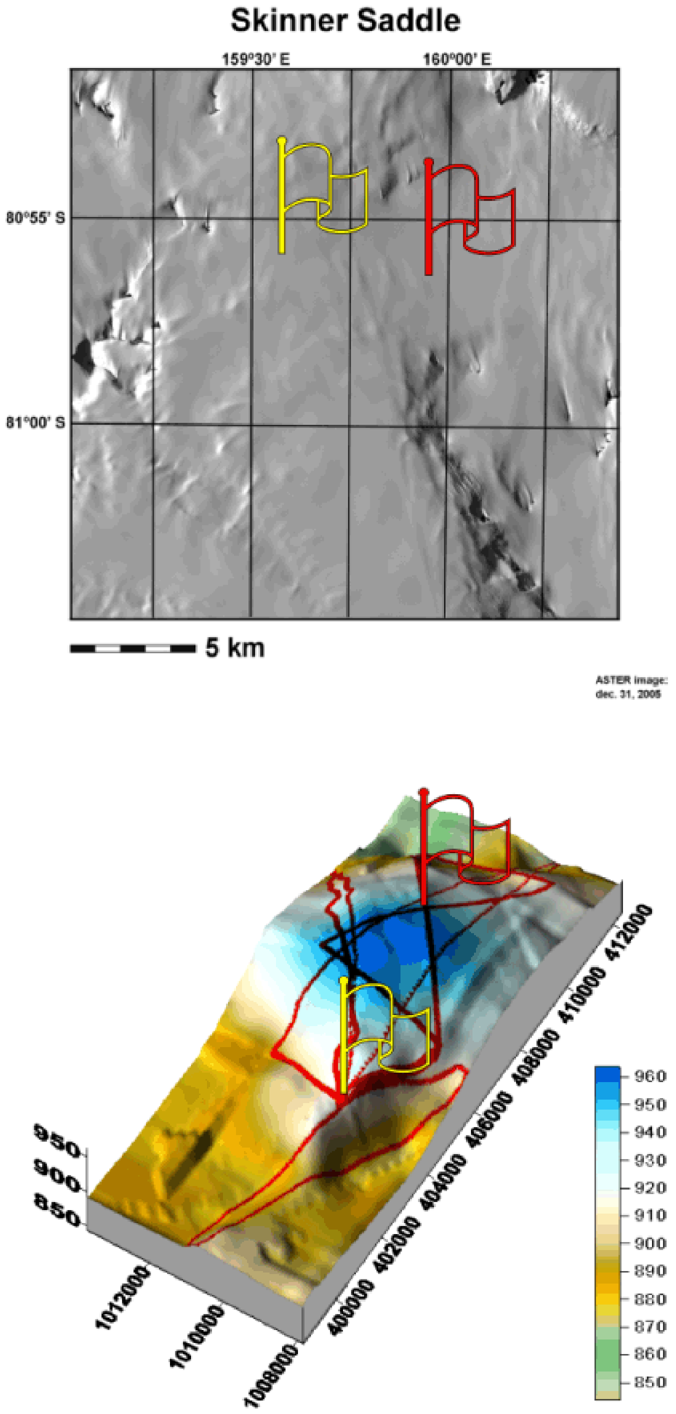


Fig. 2 A) ASTER satellite image of Skinner Saddle and vicinity. See Figure 1 for overview. Image from 31 October 2005. Yellow flag indicates location of camp, red flag indicates proposed drilling location. **B)** Digital elevation model. X/Y/Z grid in UTM 58 map units. Red lines indicate location of ground penetrating radar survey lines

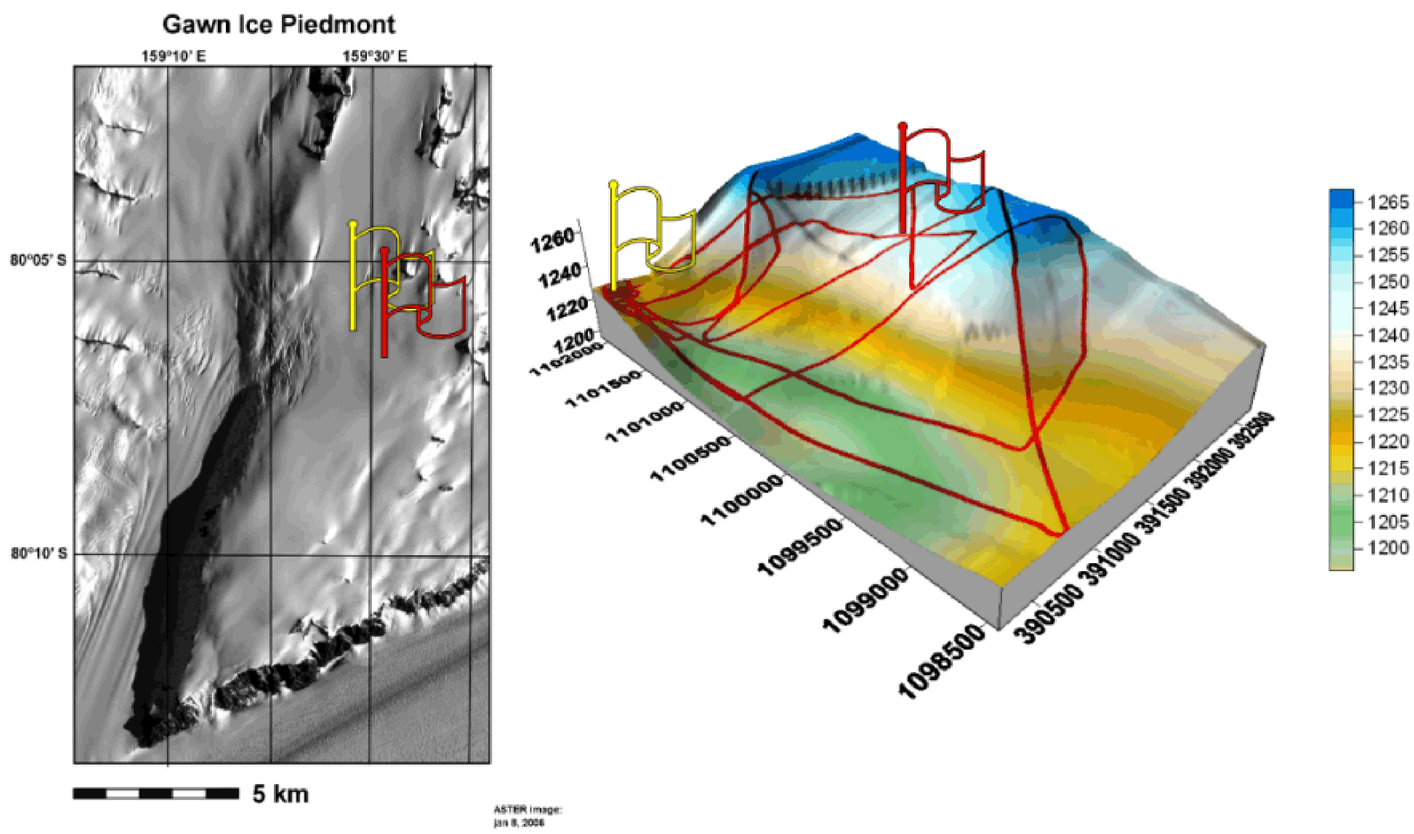


Fig. 3 A) ASTER satellite image of Gawn Ice Piedmont and vicinity. See Figure 1 for overview. Image from 08 January 2004. Yellow flag indicates location of camp, red flag indicates proposed drilling location. **B)** Digital elevation model. X/Y/Z grid in UTM 58 map units. Red lines indicate location of ground penetrating radar survey lines

Drilling of shallow firn cores at Skinner Saddle and Gawn Ice Piedmont

As part of the site reconnaissance we drilled a 17m and 13m deep firn core at SKS and GIP, respectively. The drilling system was kindly provided by the Alfred Wegener Institute. The initial data set from these cores allow us to calculate annual accumulation and establish transfer functions with meteorological data to establish the quality and sensitivity of the ice.

Fig.4: Firn core drilling at GIP

Automatic weather station set-up, maintenance, and data retrieval

In 2004/05 we deployed an automatic weather station on EPG. The data permit the calculation of transfer functions between ice core proxies and meteorological parameters, such as temperature, precipitation, meso-scale atmospheric circulation pattern, katabatic winds, and seasonality of snow accumulation. In addition a new snow accumulation sensor and high precision snow temperature probes allow us to monitor snow accumulation rates, the potential influence of snow loss through sublimation, wind erosion or melt, and the quality of preservation of the meteorological signal in the snow. Furthermore, the data allow us to estimate the uncertainty of re-analysis data (NCEP/NCAR and ERA-40 data) in the region. In addition we set-up a new automatic weather station at Skinner Saddle for the interpretation for our planned ice cores from Skinner Saddle and Gawn Ice Piedmont.

Fig.5: Automatic weather station at EPG (left image) and newly set-up weather station at SKS (right image)

Submergence Velocity Measurements at Victoria Lower and Evans Piedmont Glacier

The response time of a glacier to changes in accumulation or ablation is dependent on the size and thickness of the ice mass. In general, the response time of cold-based glaciers is positively correlated with the size of its ice mass, leading to long response times in Antarctica. For glaciers in the McMurdo Dry Valleys, with lengths on average of 5-10km and flow rates of 1 to 3 m/a, the response times are thought to range from 1,500a to 15,000a (Chinn, 1987; Chinn, 1998). Consequently, annual variations in surface elevation may only reflect changes in loss rates. As a result surface measurements of mass balance are difficult to interpret in terms of long-term mass balance (Hamilton & Whillans, 2000). This is especially the case in places like the McMurdo Dry Valleys where mass loss is thought to be predominately due to sublimation at ice cliffs and glacier surface caused by wind and solar radiation (Chinn, 1987; Chinn, 1998).

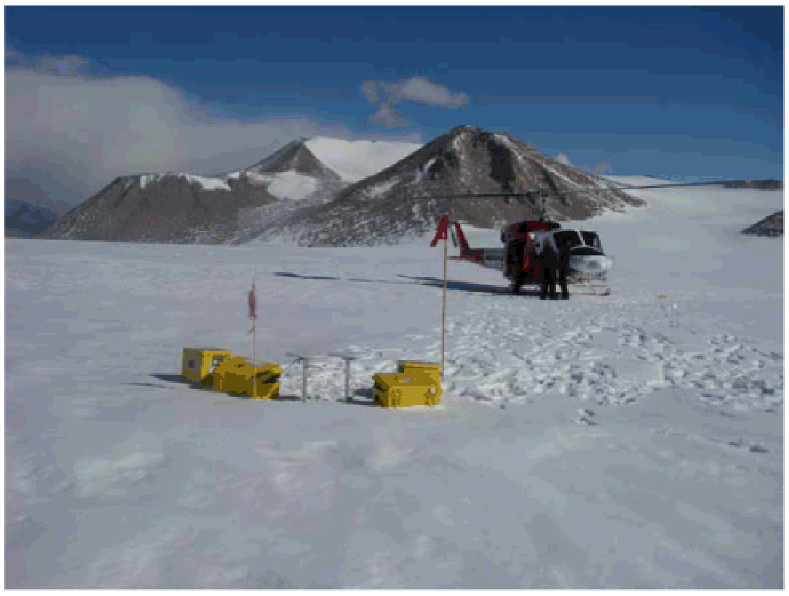


Fig.6: Submergence Velocity Measurements at VLG

For Victoria Lower Glacier (VLG), two mass balance measurements are available in the literature for 1983 and 1991 based on ice cliff characteristics and the motion of the glacier snout (Chinn, 1998). The measurements indicate that VLG was advancing 1.24m/a into Victoria Valley during this time period. However, the small number of observations (2) and the cliff's sensitivity to sublimation (contemporary surface ablation) result in a high uncertainty of longer term mass balance. To determine the longer-term mass balance of the glaciers, unaffected by annual surface variations, three 'coffee-can' or 'submergence velocity' devices (Hamilton et al., 1998; Hamilton & Whillans, 2000) were deployed at Victoria Lower Glacier in 1999/2000 and two at Evans Piedmont Glacier in 2004/05. These are annually re-measured to monitor mass balance changes.

d. Methodology

Ground Penetrating Radar

For mapping glacier flow structures and the glacier-bedrock interface a 'GSSI SIR 3000 and GSSI SIR 10 A were used with a maximum time window of 8,000 and 10,000 ns, respectively. A 35MHz antennae-pair (Bistatic Radarteam SE-40), a 200MHz antennae-pair, and a single 500MHz antenna are pulled by a Nansen Sledge, which carries the control units. A Trimble 5700 differential, kinematic GPS, provides absolute positioning of the GPR data and allows survey of the glacier surface topography. GPR and GPS measurements are taken in kinematic mode.

Fig.7: Photo showing Nansen sledge carrying GPR and crevasse rescue equipment

Submergence Velocity Measurements at Victoria Lower and Evans Piedmont Glaciers

During the 1999/2000 season three submergence velocity devices (Hamilton & Whillans, 2000) for mass balance measurements in the McMurdo Dry Valleys were installed. During the 2004/2005 season two submergence velocity devices have also been installed at EPG. This method is used to determine mass balance by comparing vertical velocity of a marker in firn or ice with long-term, average snow accumulation rates. The movement of the marker is the result of three motions: firn compaction, gravitational glacial flow, and changes in mass balance.

High precision GPS measurements are used to determine absolute position of the tracking point during subsequent years. Trimble 5700 base station and rover unit were used to measure the absolute position of the tracking point of the mass balance devices.

The rate of thickness change H, can then be calculated using (Hamilton et al., 1998):

$$\dot{H} = \frac{\dot{b}_m}{\rho} + \dot{z} + \vec{\alpha} \bullet \vec{u}$$

H= rate of thickness change (myr^{-1})

b_m= accumulation rate ($Mgm^{-2}yr^{-1}$)

ρ= density at marker depth (Mgm^{-3})

z= vertical component of ice velocity(myr^{-1})

α= surface slope (radians)

u= horizontal velocity (myr^{-1} with azimuth)

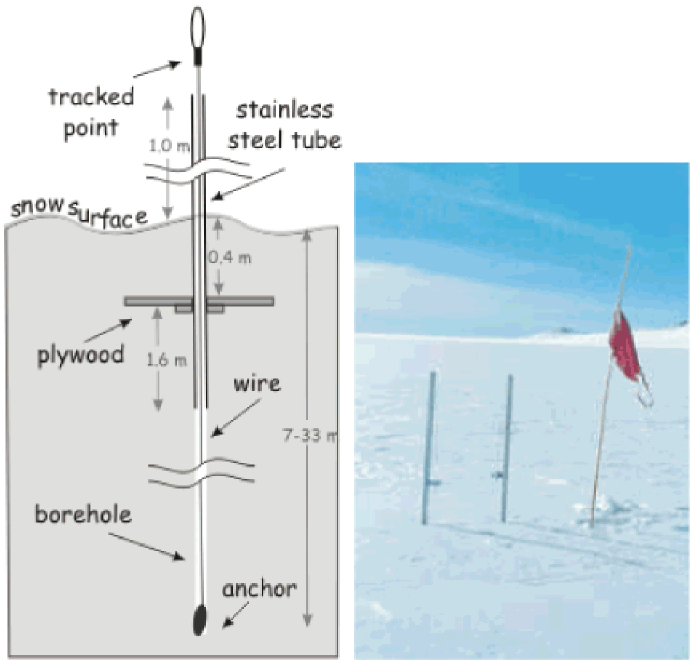


Fig.8 Cartoon of the 'coffee can' submergence mass balance device (modified after Hamilton and Whillans 2000)and picture of coffee can device deployed at Victoria Lower Glacier.

Shallow Firn Core Analysis

The following parameters will be measured on the obtained firn cores and snow samples:

Oxygen and Hydrogen Isotope Ratio

Oxygen isotope ratios are measured using a CO_2 dual-inlet system coupled to a Micromass Isoprime mass spectrometer at GNS Science. The sample is measured in the presence of a standard CO_2 gas. Sample duplicates and standard measurements showed a precision of ±0.08‰. Samples are analysed for stable hydrogen isotope radios δD via Cr reduction with a continuous Helium flow Eurovector elemental analyser coupled to a Micromass Isoprime mass spectrometer. Sample duplicates and standard measurements showed a precision of ±0.6‰.

Major Cations, Anions, and Methylsulfonate

Major ion concentrations are measured for cations (Na, K, Mg, Ca, NH_3) using a Dionex™ Ion Chromatograph with Dionex CS12 column and 20 mM methanesulfonic acid eluent. Anion concentrations (Cl, NO_3, SO_4) are measured with a Dionex AS11 column, 6.0 mM NaOH eluent. For both measurements a 0.25 mL sample loop is used. Methylsulfonate (MS) content is measured using a Dionex AS11 column with 0.1 mM NaOH eluent and a 1.60 mL sample loop

Trace Elements and Cations

Samples are analysed for trace elements and cations (Al, Ca, Cu, Fe, K, Mg, Mn, Na, P, S, Si, Sr, and Zn) using a Perkin-Elmer Optima 3000 XL axial inductively coupled plasma optical emission spectroscopy with a CETAC ultrasonic nebuliser (ICP-OES-USN at UMaine) and a Finnigan Thermo inductively coupled plasma mass spectrometer (ICP-MS at VUW) for all other trace elements and selected isotopic ratios.

Dust concentration and mineralogy

500cm^3 volume of snow/ice is filtered through Whatman quantative 2.5µm ashless filter paper. The filter is burnt in a Vulcan A-550 furnace at 500°C for 24 hours. The residue is weight with a AG204 Mettler Toledo analytical balance, and reweighed after 24hours to check for moisture absorbance during cooling. Mineralogy is determined by mounting the dust samples in glycerol gelatine for examination under an optical particles found in the dust are analysed in a JEOL 733 Electron Microprobe at VUW.

e. Results and discussions

Ground Penetrating Radar (GPR)

Traverses totaling 150km at Skinner Saddle and 35km at Gawn Ice Piedmont have been surveyed with GPR. The measurements allowed us to identify an excellent drilling location at Skinner Saddle with smooth bedrock topography and a glacier thickness exceeding 600m at the proposed drilling location. Excellent isochrone reflections are visible throughout the profile to below 150m, which will also be used to investigate geographical and chronological accumulation changes. The region at Gawn Ice Piedmont is glaciologically more active (see Figure 9) and marginal weather conditions limited our ability to a more comprehensive survey, as achieved at Skinner Saddle. However, we identified a suitable drilling site with a undisturbed depth of at least 300m, which is deeper than the target depth of 200m for this site. Further post-processing will enhance the reflectors and will correct for surface topography.

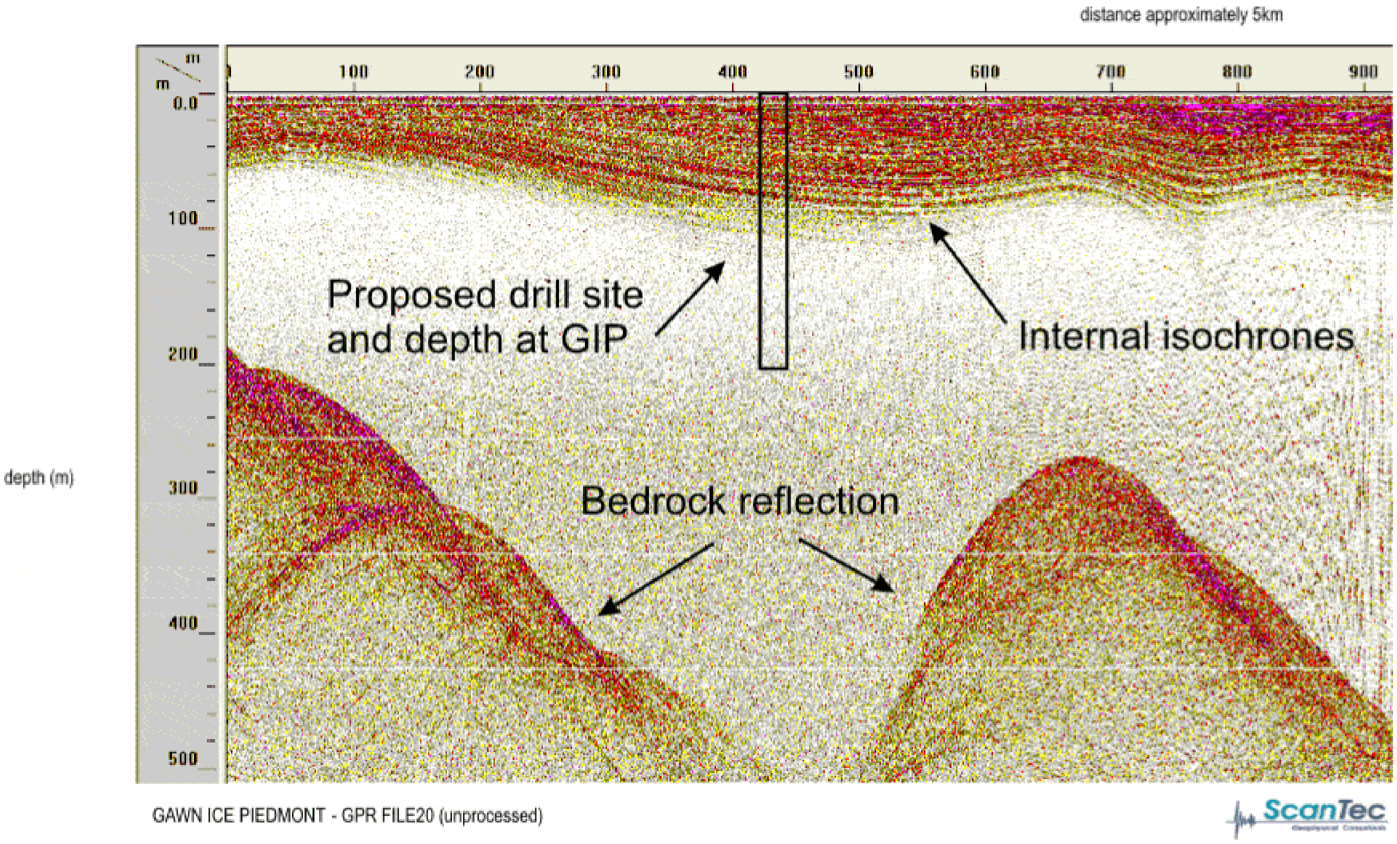


Fig.9 Unprocessed ground penetrating radar profile from GIP showing proposed drill site in the centre of the image.

These images are used to create 3D model of bedrock topography (Fig.10) and/or individual isochrones to establish ice flow direction and shear stresses as well as geographical and temporal snow accumulation changes. This allows a comprehensive assessment of the suitability of the proposed drill site.

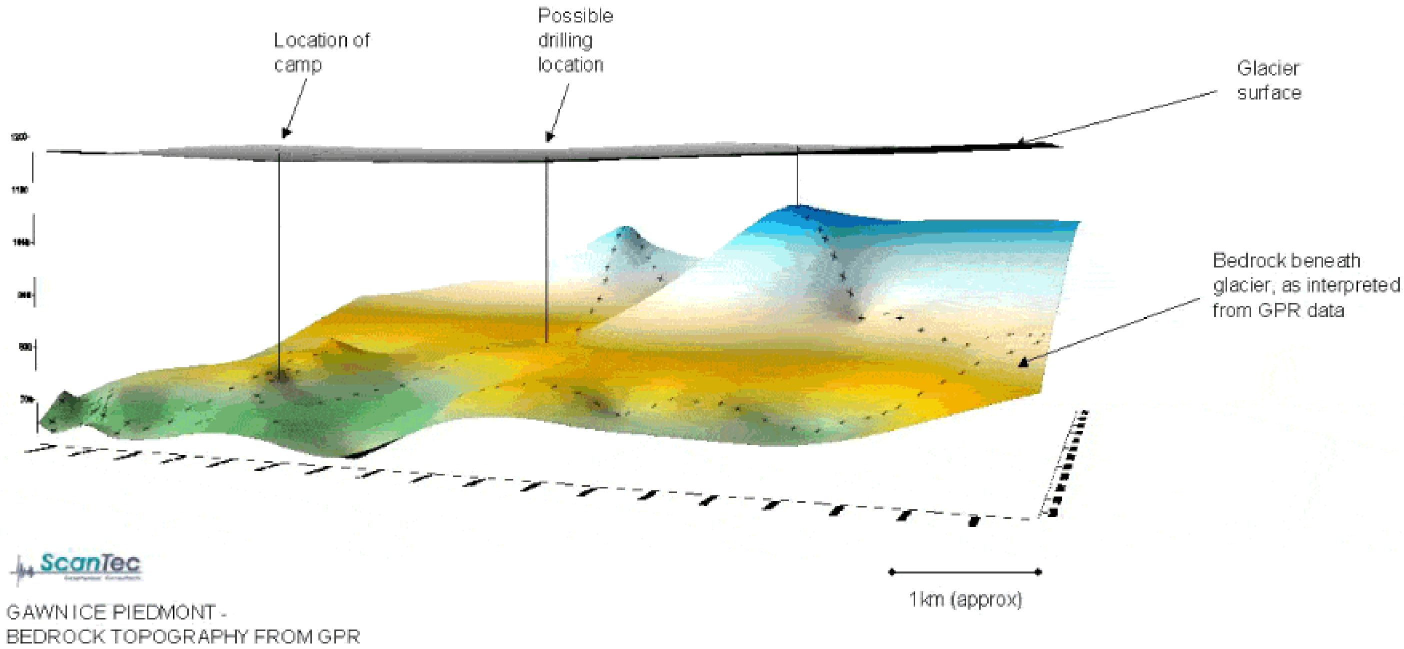
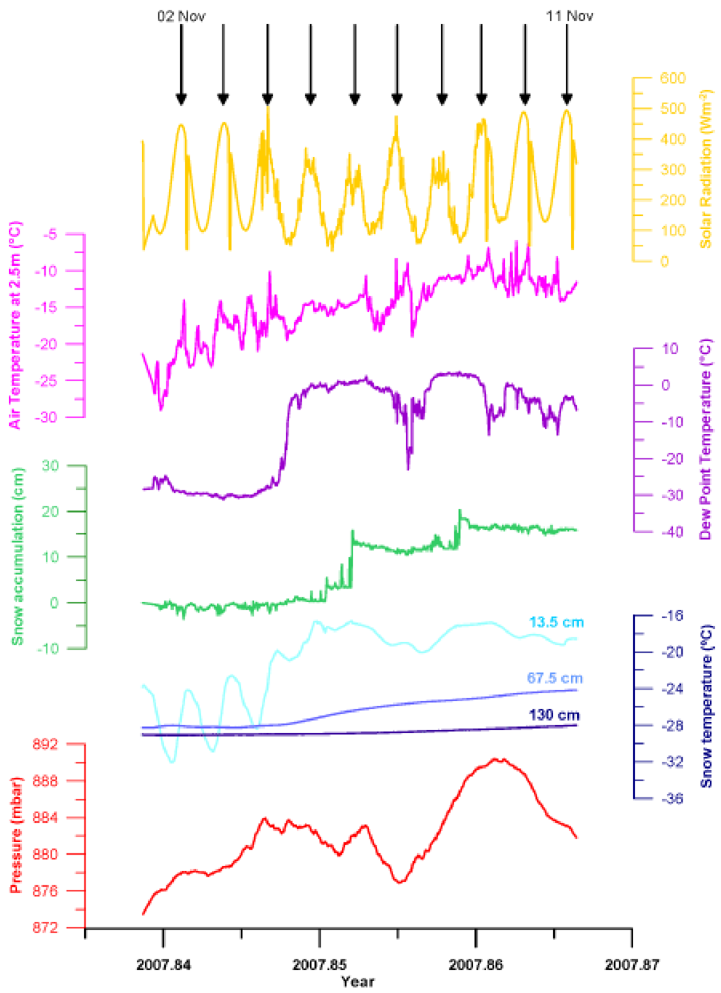


Fig.10 Calculated bedrock topography at GIP showing proposed drill site in the centre of the image.

Automatic Weather Station Data from Skinner Saddle and Evans Piedmont Glacier



The automatic weather station at SKS is operational since 01 Nov 2007. The recorded data for pressure, solar irradiation, air temperature, snow temperature, dew point, and snow accumulation for the time period of our deployment at SKS are shown in Fig.11.

Fig.11: SKS automatic weather station data for 01 to 11 Nov 2007

Our weather station at EPG has been operational since October 2004. The current data set is shown in Fig. 12. The lack of data during winter 2005 is due to a technical failure.

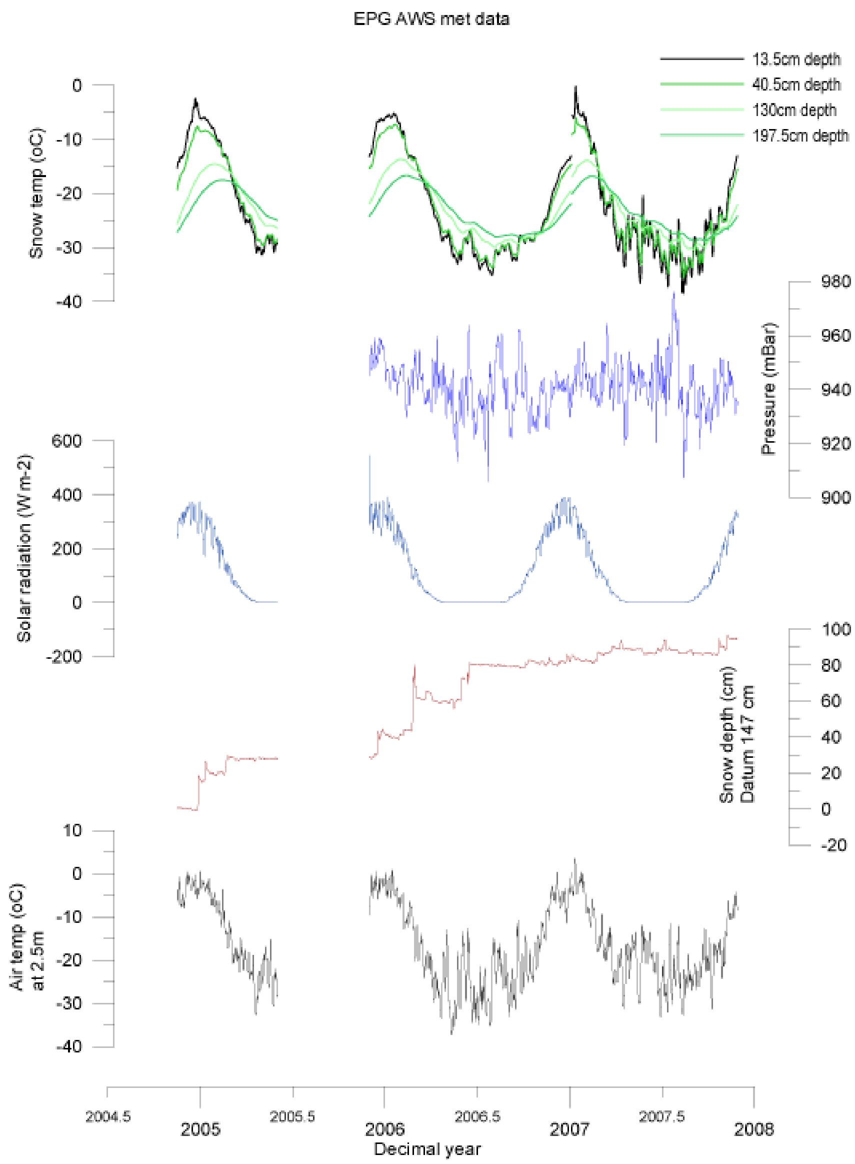


Fig.12: EPG automatic weather station data for Nov 2005 to Dec 2007

Physical snow properties at Victoria Lower Glacier

A shallow snow pit was investigated at VLG while we waited for our GPS mass balance measurements to be completed. The large seasonal temperature changes characteristic for this area produces some of the largest hoar (or cup) crystals on the planet.

Fig. 13: Cup crystals from Victoria Lower Glacier

f. How this research fits in with future work being planned

Our preceding research – Holocene Climate History from Coastal Ice – has identified the value of the specific characteristics of ice core records from coastal, low altitude sites (Bertler et al., 2004a; Bertler et al., 2004b; Bertler & 54 others, 2005; Bertler et al., 2005a; Bertler et al., 2005b; Mayewski et al., 2005; Patterson et al., 2005; Bertler et al., 2006a; Bertler et al., 2006b) and showed how tropical phenomena, such as ENSO have a significant influence on the Ross Sea Region. In contrast to Antarctica's interior, which is influenced by temperature inversion and climatic cooling of the stratosphere, the coastal sites are dominated by cyclonic activity, and hence by the climate of the lower troposphere (King & Turner, 1997). As a result, coastal sites are especially climate sensitive and show potential to archive local, rapid climate change events that are subdued or lost in the 'global' inland ice core records, such as Vostok. The reconnaissance work successfully identified two suitable drilling locations to provide such data.

g. Contributions from visiting foreign scientists

We are grateful for the loan of the Alfred Wegener Institute (Germany) shallow firn drill. Futhermore, Prof. P. Kyle (USA) is providing 8 shallow firn cores from Mt Erebus, complementing our intermediate depth ice core from Mt Erebus Saddle. This will allow us to investigate in collaboration with Prof. P. Kyle volcanic history of Mt Erebus over the last hundred years or so.

2 Publications

AGSC Committee Members and others, (in review). "State of the Antarctic and Southern Ocean climate System (SASOCS)." Reviews of Geophysics.

Alloway, B. V., D. J. Lowe, et al. (2007). "Towards a climate event stratigraphy for New Zealand over the past 30,000 years." Journal of Quaternary Science **22**(1): 9-35.

Bertler, N. A. N. and U. Morgenstern (in review). Climate Swings and Roundabouts - Cold Comfort. NZ Geoscience into the 21st Century. I. Graham and B. Hayward. Wellington

3 Acknowledgments

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IMMEDIATE SCIENCE REPORT

K049 B: NZ- ITASE Climate Variability along the Victoria Land Coast – Trace element chemistry of Antarctic snow
ANTARCTICA NEW ZEALAND 2007/08

Event Personnel:

Ms J. Bull	Antarctic Research Centre, Victoria University of Wellington
Dr N. Bertler	Antarctic Research Centre, Victoria University of Wellington
Ms R. Rhodes	Antarctic Research Centre, Victoria University of Wellington

1 Scientific Programme

a. Context of research

To date, aerosol deposited trace element records have been poorly utilised in ice core research. They can however provide important tracers or proxies of atmospheric (e.g. regional circulation, moisture transport and precipitation) and oceanic (sea-ice extent and variability) processes. In conjunction with more traditional ice core analyses (isotopic and major ion variations), new knowledge of their past variability will allow an improved understanding of the Ross Sea climate system. This has the potential to provide information that can be related to the larger Antarctic atmospheric circulation systems; the El Nino Southern Oscillation (ENSO) [1], Southern Annular Mode (SAM) [2] and to a lesser degree the Antarctic Circumpolar Wave [1] , whose relative importance remain controversial.

For this purpose, two coastal sampling sites have been chosen with variable climatic and sea ice cover influences. Whitehall Glacier, Northern Victoria Land coast was sampled in 2006/07 and provides an area of frequent and intense cyclonic activity due to its proximity to the Southern Ocean and Antarctic low pressure belt [1, 3]. This will be used in comparison of the predominantly katabatic controlled climate of Evans Piedmont Glacier that has been sampled in the most recent 2007/08 season [4].

This work contributes to the Antarctica NZ Scientific Strategy in the following sections:

- ***1C-1 What does the detailed (annual –decadal) regional climate record from ice-cores along Victoria Land Coast over the last 10,000 years tell us about patterns of climate behaviour in the region and linkages with the Southern Hemisphere climate patterns?*** [5]
  This project seeks to understand the relationship between atmospheric circulation and aerosol deposition in the recent instrumental record with the potential to extrapolate it back further into the ice core record.

- ***2C -1 – What drives natural seasonal and inter-annual variability in coastal ecosystems in the Ross Sea?*** [5]
  Southern Ocean Research and Antarctic Ecosystems Research all require a greater understanding of the climatic context conducted due to ecosystem dependency on climatic conditions.

b. Objectives

1. Clean snow sampling at Evans Piedmont Glacier

A primary objective of 2007/08 field season was to sample a high resolution snow record of the last decade, with emphasis on ultra-cleanliness, as concentration levels of trace elements in polar snow and ice are in the parts per trillion (ppt) to parts per quadrillion (ppq) range [6].

2. Automatic Weather Station data retrieval, Evans Piedmont Glacier

An automatic weather station (AWS) was installed by K049 in 2004/05 near the previous drill site and current sampling site. This data is important in establishing transfer functions between temporal variations in snow chemistry and meteorological parameters in order to quantitatively establish the use of trace elements as a climatic proxy.

c. Methodology

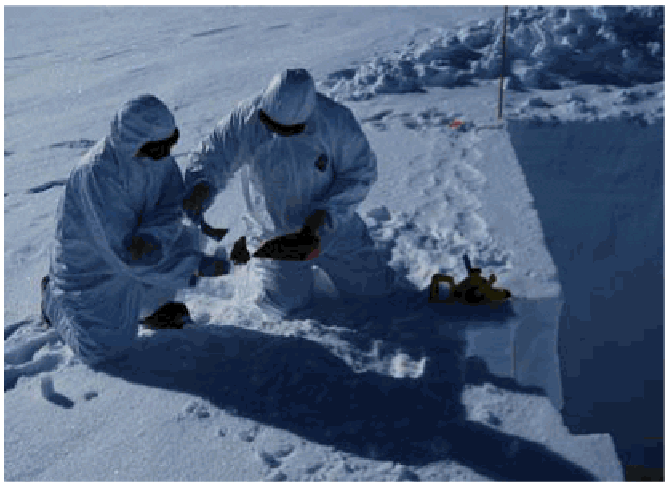


Figure 1: Snow sampling using clean procedure

Snow sampling

A 4m deep snow profile was sampled at 1cm resolution using ultra clean snow sampling methodology in order to maximise the array of potential measurable trace elements. These will include Al, As, Ba, Be, Cr, Co, Fe, Li, Mn, P, Rb, Sr, Ti, U, V, Zn. Isotopic ($\delta^{18}O$ and δD) and major ion composition will also be measured.

All sampling vials, 60ml Nalgene HDPE (high density polythene), were pre-cleaned following the procedure of Osterberg et al [6]. Preparation includes soaking in 5% trace metal-grade HNO3 for 1 week, triple rinse in DI (deionised, 18 MΩ) water and again soaked in DI H2O. Sampling equipment was triple rinsed, soaked for 4 weeks and triple rinsed again in DI water.

The sampling surface was pre-cleaned using a clean metal spade and the removal of at least 20cm horizontally immediately prior to sampling with a ceramic (ZrO) knife. 1cm thick samples were cut horizontally across the snow into a HDPE tray and transferred into vials. Tyvek clean suits, facemasks and dust free polyethylene gloves were worn to prevent sample contamination from personnel.

Snow profiling

Density and temperature profiling was conducted at 5cm resolution once sampling was complete and the surface was freshly cut back. Cylinders of known volume were hammered into the fresh surface, filled, extracted and weighed to determine precise density measurements.

Physical description notes of crystal structure and the location of hoar horizons are used to provide a preliminary chronology. This was taken both during and after sampling, with the upper section constructed into a thin wall to determine these more clearly (Fig 3.) Stable isotope and chemical species characterised by seasonal changes (e.g. sea salt species Na, Sr) will be used to confirm this chronology.

Automatic weather station (AWS)

Wind speed and direction, air temperature, snow accumulation and temperature, barometric pressure, humidity, and solar radiation are recorded (Fig.2).

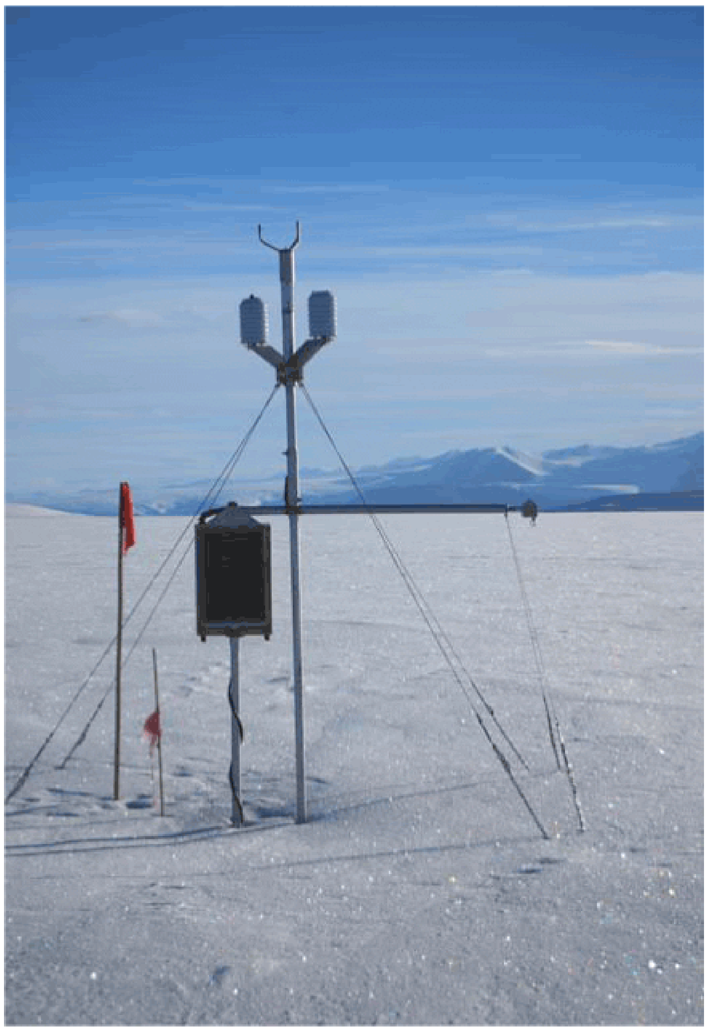


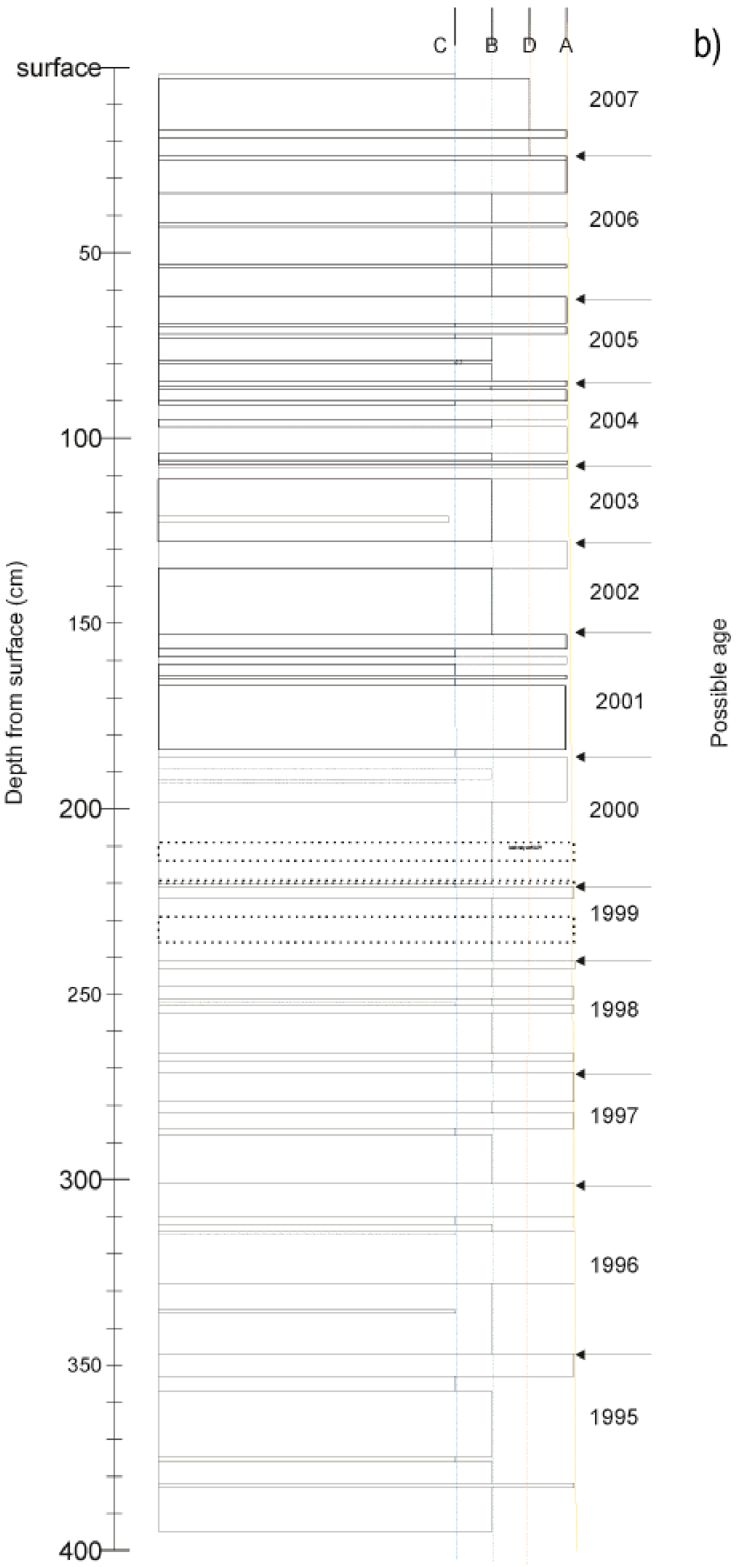
Figure 2: AWS at Evans Piedmont Glacier

d. Results and discussions

Snow profile

The presence of summer hoar horizons and changes in density suggests that the 4m pit represents 13 years of accumulation.

a)



b)

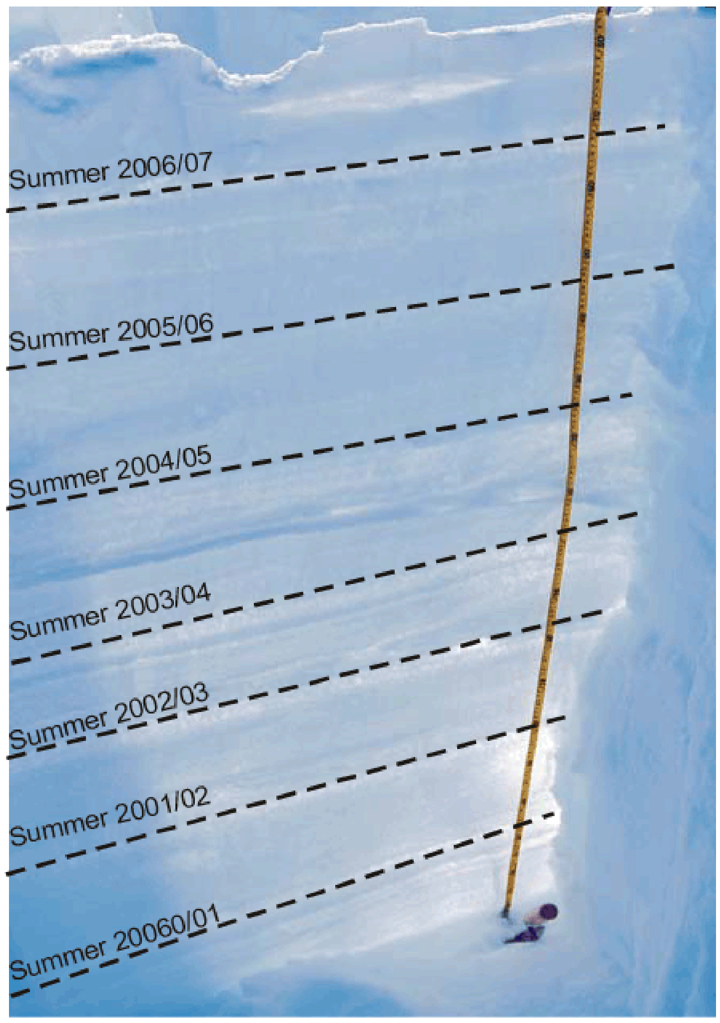


Figure 3: Snow profiling at Evans Piedmont Glacier; a) Density and observations used to locate hoar horizons (A), fresh un-compacted snow (D), normal density snow (B) and ice/ hard layers (C); b) Stratigraphy of upper 2m section of the pit.

AWS

The weather station has recorded data from the 15th Nov 2004 through to collection on the 3/12/2007. A problem with storage limits prevented continual data throughout 2005, but this was addressed by K049 during 2005/06 season. The record from Nov 2004 to Dec 2007 for air temperature, snow depth (i.e. accumulation changes), solar radiation, pressure and snow temperature is shown below (Fig. 4).

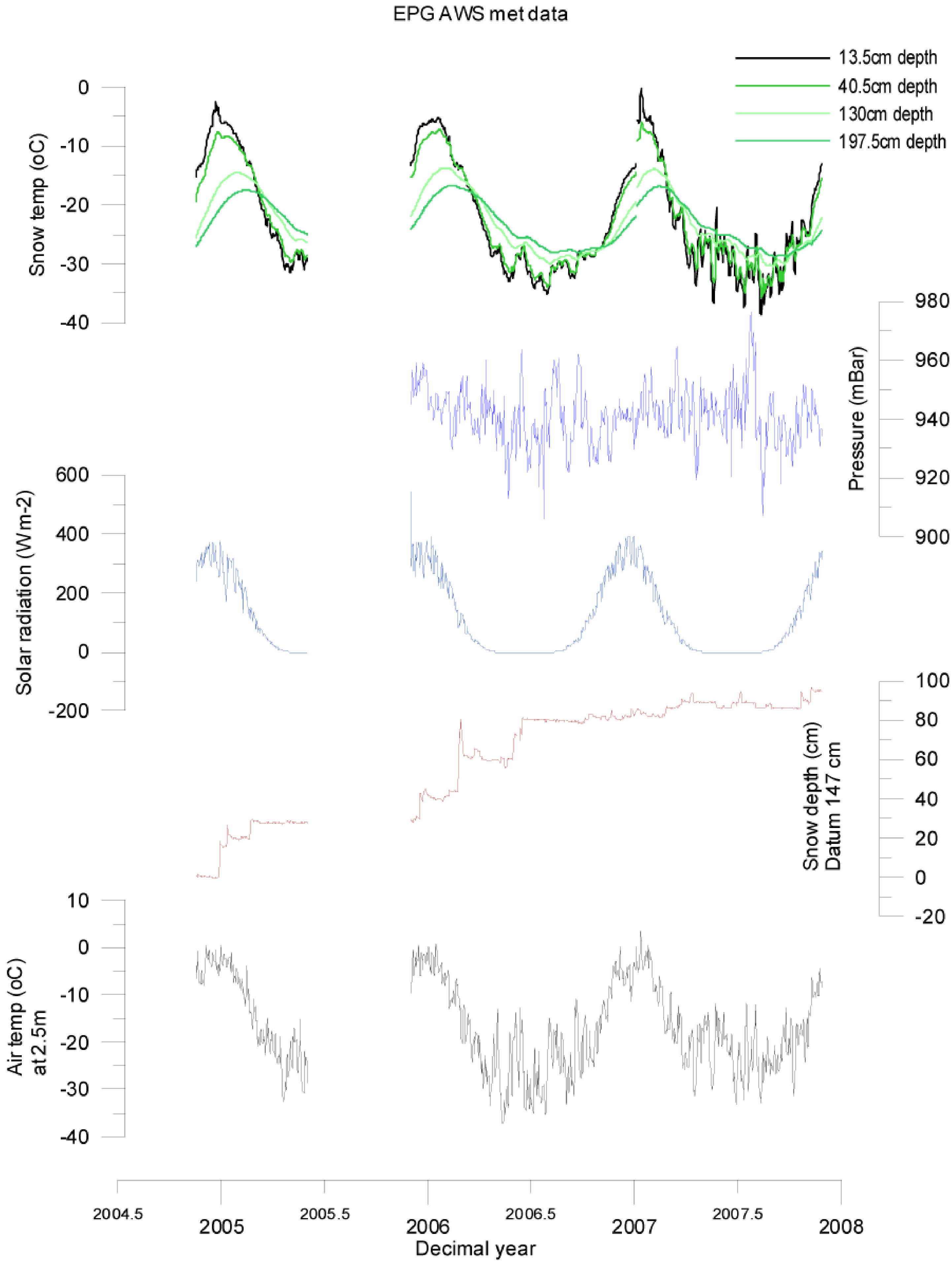


Figure 4: Meteorological data collected at Evans Piedmont Glacier.

e. How this research fits in with future work being planned;

This data will contribute to the NZ ITASE current research – Holocene Climate History from Coastal Ice - by providing new knowledge on the seasonal pattern of aerosol deposited trace elements in snow. The investigation will include determining the patterns of seasonal aerosol concentrations and their sources and sinks through correlation with both site specific meteorological data and regional re-analysis data. This will assist in the interpretation of deeper ice core trace element records and our understanding of the Ross Sea tropospheric circulation system in the past.

2 Acknowledgments

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