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# Ice Dynamics Features and Climatic Surface Parameters in East Antarctica from Terra Nova Bay to Talos Dome and Dome C: ITASE Italian Traverses

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**Abstract -** As part of the ITASE project, the Italian Antarctic research programme undertook two overland traverses from the Terra Nova Bay Station to Talos Dome and Dome C, across a previously unknown part of the East Antarctic Ice Sheet. An analysis of the Digital Terrain Model has provided information on the ice divide location along the traverse and correlated this with bottom topography and geophysical characteristics of the bedrock. The modern western ice divide position of the Scott Coast is part of the encroachment on the Ross Ice Shelf system that could be under way since the mid-Holocene era. By examining the relationships between the snow temperature and climatic-controlling factors such as elevation and latitude, this report attempts to elucidate the climatological features in the Dome C drainage area. The analysis of snow accumulation by stakes measurements, surface morphology and surface elevation suggests that surface accumulation is strongly influenced by the local slope and katabatic wind intensity.

## INTRODUCTION

The impact of Antarctica on global climate change and the impact of global climate change on Antarctica are the focal points of a current series of international and interdisciplinary expeditions being conducted within the framework of the International TransAntarctic Scientific Expedition project (ITASE). Because of the remoteness of the continent, Antarctica is an ideal location to monitor biogeochemical cycles and local-to-global scale climate change. However, this remoteness has also prevented the collection of instrumental records, similar to those collected in the Northern Hemisphere. Such records are needed to assess Antarctica's role in and response to environmental and climate changes. The purpose of the ITASE project (Mayewski & Goodwin, 1999) is to determine the spatial variability of climatic conditions (snow accumulation, air temperature, atmospheric circulation) over the last 200-1000 years.

As a part of the ITASE project, the Italian Antarctic Programme undertook two traverses (Fig. 1) from the Terra Nova Bay Station (164°06'E 74°41'S) to Talos Dome (159°06'E, 72°48'S, 2316 m) and to Dome C (123°23'E 75°06'S, 3232 m). The scientific objectives of the traverse programme were to develop a high resolution, 3-D map documenting the last 200-1000 years of climate, atmospheric and surface conditions over the eastern Dome C drainage area.

The traverse to Talos Dome (TD) was performed from 3 to 30 November 1996, and the distance covered was about 600 km (Frezzotti et al., 1998). The traverse to Dome C (DCN) started from GPS1 on November 19, 1998 and reached Dome C on 5 January 1999 after 1300 km. The first part of the route from Terra Nova to GPS1 is crevassed and was covered during the 1997/98 expedition (Fig. 1). Along the traverse, the party carried out several tasks (drilling, glaciological and geophysical exploration, *etc*.). The first 400 km of the 1998 traverse followed the same route (up to 31Dpt) as the 1996 traverse (Frezzotti et al., 1998).

Analysis of the dynamics of the ice sheets is a first step in determining their future behaviour under conditions of a changing climate. Talos Dome and the Dome C area drain into the Ross Sea (Scott Coast and Ross Ice Shelf) and the Southern Ocean. Analysis of a Digital Terrain Model (Remy et al. 1999), bedrock topography (Lythe et al., 2000; Testut et al., 2000) and gravity and magnetic surveys along the traverse (Ferracioli et al., 2001) provide information about the influence of subglacial geology on the position of the western ice divide in the Scott drainage basin (Fig. 1).

In regions with negligible summer melting, as found throughout most of the East Antarctic plateau, and in areas for which there are no meteorological records, the mean annual air temperature at the snow

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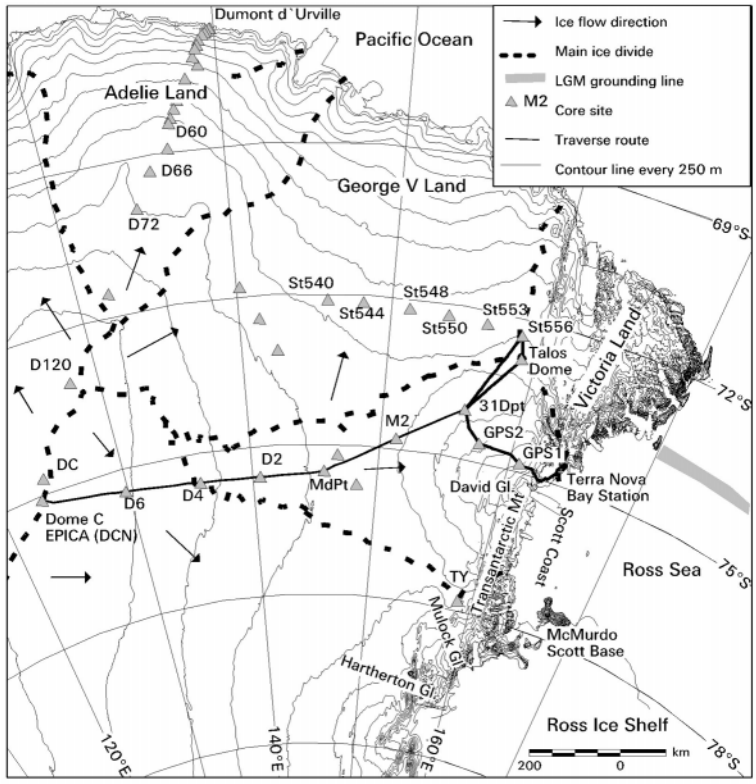


*Fig. 1* - Schematic map of Dome C drainage area. IT-ITASE 1996 and IT-ITASE 1998/99 travelling route, firn core location (IT-ITASE, Stuart & Heine, 1961; Pettré et al., 1986), main ice divide (Frezzotti et al., 2000) and Last Glacial Maximum (LGM) grounding line position.

surface is commonly estimated by assuming that it is the same as the snow temperature measured at a depth of 10-15 m. This borehole temperature provides a value for the annual surface temperature averaged over a period of a few years up to the date of measurement (Paterson, 1994). Examining the relationships between the snow temperature and climatic-controlling factors such as elevation and latitude, this report attempts to elucidate the climatological features in the Dome C drainage area.

In mass-balance studies, accurate data on accumulation and ablation are needed to reach correct conclusions. Snow precipitation is strongly affected by snowdrift, and hence an originally smooth snow cover can be redistributed into a complicated accumulation pattern. The results of snow accumulation from stake measurement and surface microrelief distributions are presented for the traverse from GPS1 to Talos Dome.

## MATERIALS AND METHODS

Surface elevation profiles along the traverse were measured by GPS (double frequency) using the GPS at the Terra Nova Station and at Dome C as references (Urbini et al., 2001). The DTM (Digital Terrain Model) was derived from European remote-sensing satellite (ERS-1) radar altimetry (Remy et al. 1999). DTM-derived topographic data with a spatial resolution of one km were used in these preliminary results. DTM has an accuracy elevation exceeding one meter over portions of East Antarctica with slope gradients of less than 0.5% (Remy et al., 1999). The topographic and slope profiles along the traverse (from the GPS1 starting point of scientific activity, about 180 km from the Terra Nova Bay Station) are shown in figure 2. A 3x3 pixel window (pixel size: 1x1 km) was used to calculate the slope at each pixel. The catchment basin was delineated by applying standard hydrological modelling tools included in the proprietary GIS ARC/info (version 7.2) to the new DTM; results are similar to those of Vaughan et al. (1999).

Twenty-five firn cores, ranging in depth from 12 m to 90 m, were drilled at eleven different sites along the traverses: TD (159°06'E, 72°48'S), ST556 (158°45'E, 72°22'S), GPS1 (160°39.55'E, 74°48.91'S), GPS2 (157°30.01'E, 74°38.65'S), 31Dpt (155°57.57'E, 74°01.52'S), M2 (151°16.16'E, 74°48.27'S), MdPt (145°49'E, 75°32'S), D2 (140°37.48'E, 75°37.33'S), D4 (135°49.89'E, 75°35.79'S), D6 (129°48.53'E, 75°26.85'S) and Dome C (123°18.75'E, 75°07.33'S). An electro-mechanical drilling system (diameter: 100 mm) was used. Firn temperature was measured at sites using ten "Pt 100 ohm at 0 °C" probes after 15-24 hour stabilisation, at 1, 3, 5, 7, 10, 13, 15, 20, 25 and 30-m depths (for boreholes deeper than 30 m) and at bottom for 12-15 m borehole depths. The tops of the holes were carefully closed with a foam rubber stopper to prevent air from flowing down the hole. The accuracy of firn temperature measurements has been estimated to be ±0.1°C.

From GPS1 to Talos Dome, 66 accumulation aluminium stakes were set up during the 1996 expedition (Frezzotti et al., 1998) at intervals of 5 km (Fig. 1). At Talos Dome, 9 stakes were geometrically

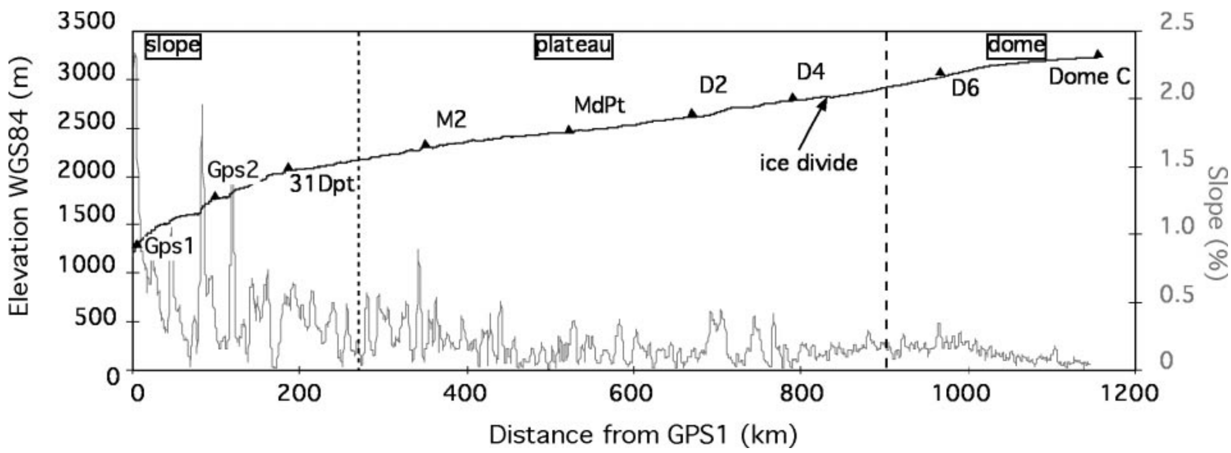


*Fig. 2* - Surface elevation (solid line) and terrain slope (grey line) along Terra Nova Bay-Dome C traverse. Core locations are indicated with triangles.

located at a distance of 8 km from the core site (TD core), following a regular octagonal scheme, and were spaced at about 5 km from each other. The height of 38 out of 66 stakes along the traverse as well as 9 stakes at Talos Dome were re-measured during the 1998 traverse, with the accuracy estimated to be ±20 mm of snow. The snow accumulation at the stakes was converted to its water equivalent by multiplying the snow density (the mean density of the snow at each stake) by the snow core depth (up to one meter), average value of 380 kg $m^{-3}$ was measured. The compaction of the snow was not taken into account when calculating the accumulation, since we were not certain whether the anchoring position of the stake was fixed or if it had changed with time. However the snow compaction has often been found to be so small that it can be neglected (Lorius, 1983).

## DISCUSSION

### CATCHMENT AREAS FROM SURFACE AND BEDROCK OBSERVATIONS

The topographic profile of the traverse indicates three sectors (Fig. 2): the slope between GPS1 and about 220 km, characterised by a step with a slope of up to 2.5%, the plateau area up to 1000 km, with a slope of up to 0.45%, and the dome area in the last 250 km with a slope of less than 0.2%. The slope profile shows very high variability along the slope and plateau area and a homogenous slope in the dome area. The surface morphology in the slope and plateau areas is correlated with the bedrock morphology, whereas in the dome area it is derived mainly from environmental conditions (wind and accumulation) and secondarily from the bedrock morphology. The ice deformation rate markedly depends upon temperature (Paterson, 1994). In addition, the difference between the plateau and dome areas may also be related to the thermal and mechanic properties of the ice (Testut et al., 2000). Satellite radar altimetry and airborne radio-echo sounding data revealed subglacial lakes and water-saturated basal sediments (Siegert & Ridley, 1998; Tabacco et al., 1998, Testut et al., 2000) in the Dome C area and in the Adventure Subglacial Trench. The low bottom yield stress would influence the ice sheet dynamics and as a result, the ice surface morphology as well (Testut et al., 2000).

The traverse crossed the entire basin of the Scott Coast catchment area (Fig. 1) and of its largest outlet glacier (David Glacier). The drainage basin of the Scott Coast, derived from the radar altimetry DTM close to Dome C, is different from that derived by Giovinetto & Bentley (1985) on the basis of SPRI folio map series (Drewry, 1983), based on airborne radio echo-sounding, geodetic levelling and satellite systems, costant-density ballon altimetry, over-snow barometry. The new catchment area ends 300 km short of the Dome C culmination (Frezzotti et al., 2000). The first 340 km of the eastern Dome C drainage area flows into the Ross Ice Shelf and not into the Scott Coast as suggested by Giovinetto & Bentley (1985) and Drewry (1983). The ice divide between David Glacier and the Ross Ice Shelf basins, along the traverse, is a flat area (810 km from GPS1 and 340 km from DC), and the difference in elevation between the two basins is less than ten meters. The ice divide culmination of the Scott basin at 340 km from DC is located in correspondence to the Resolution Sub-glacial Highlands (Fig. 3), just a few kilometres to the east of the Adventure Subglacial Trench where thick ice (>4000 m) occurs and reaches depths below 1000 meters b.s.l (Lythe et al., 2000). The Adventure Subglacial Trench is a subglacial valley between the Resolution and Belgica Sub-glacial Highlands. These structures have an approximately

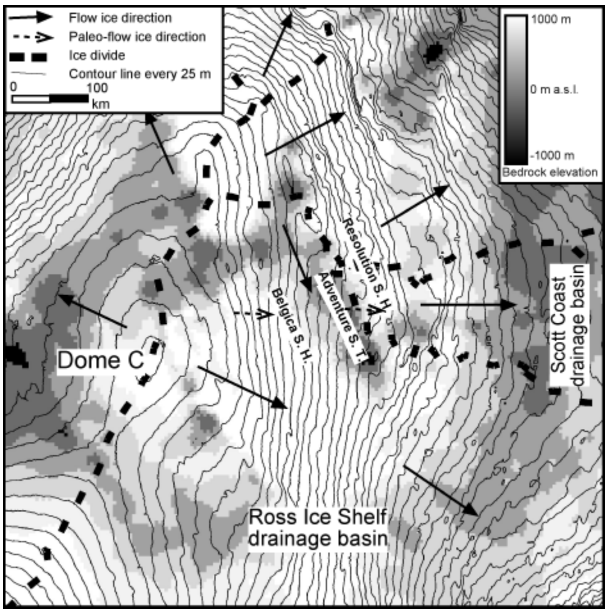


*Fig. 3* - Western Scott basin ice divide along the Terra Nova Bay-Dome C traverse. Contour line every 5 m (Rémy et al., 1999), bedrock elevation (gray image, from Lythe et al. 2000 redraw), flow direction, ice divide (Frezzotti et al., 2000) and paleo-flow direction reconstructed using re-constructions of Last Glacial Maximum flowlines (Denton & Hughes, 2000, redrawn).

NNW orientation (Ferraccioli et al., 2001), nearly 90° to the Scott basin flow direction and to the general maximum slope of this part of the ice sheet. The magnetic and gravimetric geophysical measurements performed along the traverse (Ferraccioli et al, 2001) characterised the Adventure Subglacial Trench as a sedimentary basin. Ferraccioli et al.'s (2001) crustal model pointed out that the Adventure Subglacial Trench is a narrow rift basin with a distinct Moho upwarp (about 5 km) and a low density mantel. The presence of the low density mantel at shallow depths might increase the geothermal flux of the area and therefore increase temperatures of the bottom ice. Siegert & Ridley (1998) reported that RES information along the Adventure Subglacial Trench shows a relatively bright return from the ice substratum interface that may indicate the presence of sub-glacial water in the sediment. Siegert et al. (1996) pointed out the presence of a sub-glacial lake at 135.31° E and 76.28° S in the southern part of the Adventure Subglacial Trench. The Adventure Subglacial Trench is a closed basin at 700-1000 m below sea level. It consists of the deeper part of the eastern and northern Dome C region and of the western and southern part of the Resolution Sub-glacial Highlands, where several subglacial lakes have been identified (Siegert & Ridley, 1998; Tabacco et al., 1998). Subglacial water produced in such a region may be transported by a basal hydrological system into the Adventure Subglacial Trench (the deeper area of the region), but Siegert & Ridley (1998) pointed out a lack of subglacial lake signals from RES data over this thick ice region. They conclude that subglacial water may be transported by a basal hydrological system, driven by overburden pressure, to less ice thick region of the ice sheet.

The presence of water in this region can be reconciled with independent data from maps of the basal temperature of the ice sheet (Huybrechts, 1990; Remy et al., 1996; Testut et al., 2000) that show values close or higher to the pressure melting point in the Adventure Subglacial Trench area. The thick and slow-moving interior ice sheet is generally fixed to the bedrock while the low strength of water-saturated sediment allows ice motion (Paterson, 1994).

The location of the Scott Coast western ice divide coincides (Fig. 3) with a NNW high of bedrock (Belgica sub-glacial Highlands) and the change of flow direction system into the Ross Ice Shelf follows the NNW sediment-filled basin (Adventure Subglacial Trench) incised in a steep-sided valley (Resolution and Belgica sub-glacial Highlands). This observation corroborates the suggestion by Bell et al. (1998) that ice dynamics in the interior of ice sheet are strongly modulated by subglacial geology. Joughin et al. (1999) pointed out that the tributaries of the West Antarctic ice stream are guided by and contained within subglacial valleys, and only rarely does ice flow across a ridge between valleys.

Reconstruction of the Last Glacial Maximum (LGM) ice flowlines for the drainage of Dome C to the Ross Sea suggest that the Ross Sea embayment was largely filled with a low-surface-profile, marine-based ice sheet (*e.g.* Bentley, 1999, Denton & Hughes, 2000). The upper portions of the outlet glaciers close to the TransAntarctic Mountain (David, Reeves, Priestley, Hatherton etc.) thickened 35-100 m, whereas their lower portions near the Ross Sea thickened up to about 1000 m (Denton et al., 1989; Orombelli et al. 1990; Bentley, 1999). This pattern of thickening has been attributed to the presence of extensive grounded ice in the Ross Sea, when the grounding line extended almost to Coulman Island (Licht et al., 1996; Shipp et al. 1999), and to the decrease of precipitation in the interior of the ice sheet (Alley & Whillans, 1984; Denton & Hughes, 2000). During the Last Glacial Maximum, the outlet glaciers draining off of the Scott Coast could have presented a steeper profile from the inner part of the TransAntarctic Mountain to the grounding line than the Ross Ice Shelf outlet glaciers (Mulock, Hatherton), where the grounding line moved up to 800 km in a northerly direction to the present position. On the basis of re-constructions of Last Glacial Maximum flowlines (Denton et al., 1989; Denton & Hughes, 2000) the Scott Coast outlet glaciers appear to have been more expanded in the drainage basin than at the present time, so the Scott Coast system basin during the Last Glacial Maximum could be extended up to Dome C.

Field and satellite observations have established that substantial changes are occurring in West Antarctica, particularly in the area where sediments and sub-glacial water occur (Joughin et al., 1999). Examination of drainage networks inferred by mosaics of RADARSAT SAR images (Jesek, 1999) and DTM highlights a pattern that could be correlated with the ongoing capture of the Scott Coast drainage system by the Ross Ice Shelf system. We suggest that the modern western ice divide position of the Scott Coast is part of the encroachment of the Ross Ice Shelf system that has been under way since the mid-Holocene era. The encroachment of the Ross Ice Shelf on the Scott Coast systems could be guided by:

- effects of an increase of slope profile of the Ross Ice Shelf outlet glaciers and therefore a discharge following the retreat of the grounding line in the Ross Sea during the Holocene era;
- NNW-SSE direction of subglacial topography (Adventure Subglacial Trench) which is coincident with Ross Ice Shelf flowlines and nearly 90° to the Scott Coast basin flow direction;
- presence of water-saturated sediment in the Adventure Subglacial Trench floor that allows ice motion along SSE direction .

## FIRN TEMPERATURES

The snow temperature measured at a depth of 10 or 15 m gives a fairly close approximation to the mean annual "surface temperature" in the dry snow, and is also close to the mean annual "screen air temperature" (Loewe, 1970). At a depth of 10-15 m, the amplitude of the annual temperature wave at the snow surface is reduced to approximately 5% of its surface value, i.e., typically 0.75°C for coastal stations and 1.75°C on the plateau (van den Broeke et al., 1999). Figure 4 shows the firn temperature depth profiles, where it is possible to observe that the maximum of winter's "cold wave" is at 5 m and that the amplitude of the seasonal fluctuations decreases with a depth down to 15 m. Temperature measurements at the 1 m depth show the beginning of the summer "warm wave" and the 10 m temperature is slightly offset by the "winter wave" by a few decimals of a degree, according to the site and season when measured (spring-summer). In Figure 5, the firn temperatures at a depth of 10-15 m collected during this traverse and the previous one (Stuart & Heine, 1961; Pettré et al., 1986) have been plotted against elevation. The correlation of temperature with surface elevation appears to be strong in the same traverse or sector (Terra Nova Bay-Dome C, TNB-DC; Dumont d'Urville-Dome C, DdU-DC; George Land, GL). The decrease in temperature with elevation shows a near-dry-adiabatic lapse rate (1.0°C 100 $m^{-1}$) with good correlation ($R^2$ = 0.98) along TNB-DC traverse. The lapse rate is close to the rates observed along DdU-DC (1.1°C 100 $m^{-1}$, $R^2$ = 0.96) and Wilkes Land (0.96°C 100 $m^{-1}$, $R^2$ = 0.88; Goodwin, 1988). These data are quite different from the sub-adiabatic lapse rate (0.5°C 100 $m^{-1}$) calculated by Stenni et al. (2000) using 10 m core temperatures and by Vitale & Tomasi (1994) using meteorological radiosounding (0.55-0.62°C 100 $m^{-1}$) for the mountain areas of Victoria Land. Fortuin & Oerlemans (1990) used a data set of 927 firn temperatures at a 10 m depth to demonstrate that mean annual surface temperatures at elevations above 1500 m on the East Antarctic plateau are controlled largely by elevation and latitude (85% of the variance explained). However, the lapse rate along Terra Nova-Dome C and Dumont d'Urville - Dome C showed distinctly less inclined slopes respect to that proposed (1.45 °C 100 $m^{-1}$) by Fortuin & Oerlemans (1990). Analysis of Figure 5 shows that the sites of D120 and DC (along the DdU-DC traverse) follow the lapse rate line of the TNB-DC traverse. These two sites are in an area of the dome which does not drain into the Adélie Coast, whereas the other points of DdU-DC traverse are inside the Adélie Coast drainage area (Fig 1). Analysis of core temperatures collected between the elevation of 2315 m and 2365 m (TY, TD, D66) at a distance of 150-280 km from the coast show a latitude gradient of about 0.5°C $deg^{-1}$ latitude.

Figure 5 shows the spatial variability in the local climate to be unrelated to altitude (MdPt cooler; D6 warmer). Probably no single process accounts entirely for the firn temperature patterns. However, we suspect that the interplay of katabatic winds and the winter

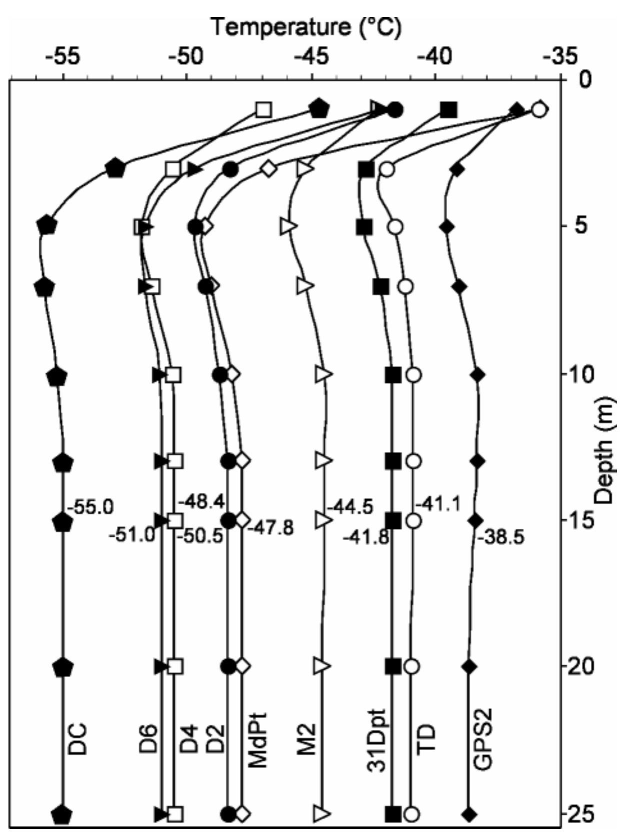


*Fig. 4* - Borehole temperature-depth profiles.

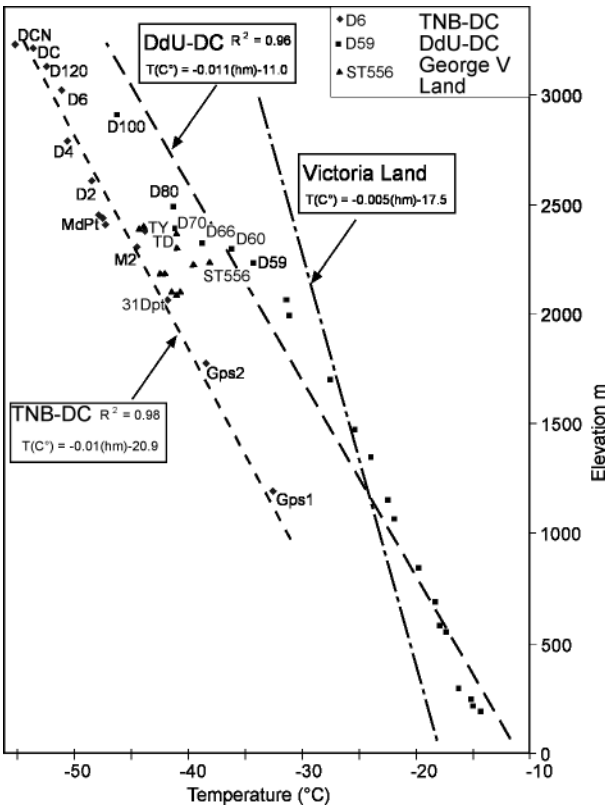


*Fig. 5* - Temperatures at the 10-15 m depth in firn as a function of ice sheet elevation. The line shows the linear regression of the data collected during this traverse and previous ones in the area (Stuart & Heine, 1961; Pettré et al., 1986) and the lapse rate of Victoria Land from Stenni et al. (2000).

temperature inversion driven by the local and regional morphology (slope, convex or concave surface) and surface albedo (glazed surface, sastrugi, *etc.*) is very important. The analysis of 10 m temperatures collected by Stuart & Heine (1961) along George V Land shows an increase in temperature from West to East along the contour 2100-2200 m (St540 –42.3 °C; St544 –41.5°C; St548 –41.0; St550 –40.9°C; St553 –39.6 °C; St556 -38.1 °C) for sites at the same latitude (around 71°S). Moreover a change in the lapse rate at the ice divide of Talos Dome (TD, St556) could be observed as well as at the break slope along DdU-DC (D72, D66, D60). Although the distance between the TD-St556 and D72-D60 cores are approximately 50 km and 123 km with an elevation difference of about 70 m and 100 m respectively, a 2.9°C and 5.9 °C difference in borehole temperature was recorded respectively at a depth of 10-15 m. The super adiabatic lapse rate (4.1-5.9°C 100 $m^{-1}$) calculated between TD-St556 and D72-D60 suggests that physical processes cannot be parameterised entirely by elevation and latitude, as noted by Waddington & Morse (1994) at Taylor Dome. The difference in core temperature at TD-St556 agrees with the isotopic composition difference observed between the two sites (Stenni et al., 2002). The Authors pointed out that the two sites are on the same distillation line of a cooling air mass moving inland to the Antarctic plateau from the ocean, with a temperature drop at the Talos Dome ice divide (Stenni et al., 2002). St556 lies along the gentle slope (0.15% or 1.5 m $km^{-1}$) of the ice divide between TD and the Southern Ocean. The higher accumulation rate (20%) at St556 than TD (Stenni et al., 2002) and the difference in isotopic composition seems to suggest a greater role in the observed temperature difference of warm-air intrusion and storms from the Southern Ocean in respect to widespread adiabatic heating of katabatic winds (Wendler & Kodama, 1985; Clarke et al, 1987). The colder temperature at Talos Dome could also be explained by a higher frequency of calm conditions with a strong inversion during the winter season, while wind turbulence mixes the inversion layer on the northern flank of Talos Dome at St556.

## STAKE MEASUREMENT

The accumulation/ablation pattern resulting from the stake measurement from GPS1 to Talos Dome showed large spatial variability over short distance, ranging from 196 to -13 kg $m^{-2}$ $a^{-1}$, with an average of 90 kg $m^{-2}$ $a^{-1}$ along the traverse and ranging from 112 to 50 kg $m^{-2}$ $a^{-1}$ at Talos Dome, with an average value of 86 kg $m^{-2}$ $a^{-1}$ (Fig. 6). The Talos Dome average value represents the annual accumulation (1996-98) at the TD site, in agreement with the accumulation value (80.5 kg $m^{-2}$ $a^{-1}$) found by core analysis for the long-term (779 years) mean accumulation rate (Stenni et al., 2002). The snow surface is irregular and changes due to redistribution processes. Surface morphology (sastrugi, snow pits, etc.) is slowly levelled by deflation and re-deposition resulting in slow filling of depressions and erosion of surface heights. At Talos Dome the range of stake measurements agree with the sastrugi heights (up to 20 cm) and suggests that the annual local noise in snow accumulation could be ± 30 kg $m^{-2}$ $a^{-1}$, which constitutes about 35 % of the average annual accumulation (Stenni et al., 2002). The record of stake measurements shows that accumulation variability decreases inland, up to 31Dpt. Stenni et al. (2000) pointed out that the accumulation-rate distribution for northern Victoria Land shows a sharp decrease from the coast (260 kg $m^{-2}$ $a^{-1}$) to the margin of Antarctic Plateau (159 kg $m^{-2}$ $a^{-1}$). On the contrary, a decrease in accumulation is evident from GPS2 to GPS1, this change in accumulation is caused by increasing wind scouring due to wind channelling in the vicinity of the David and Reeves outlet glaciers valley (Bromwich et al., 1990). Frezzotti et al. (2002) pointed out that between GPS1 and 31Dpt the surface is characterised by a steep slope up to 2.5%, and by erosional (wind crust) and redistribution microreliefs (sastrugi). The analysis of stake measurements,

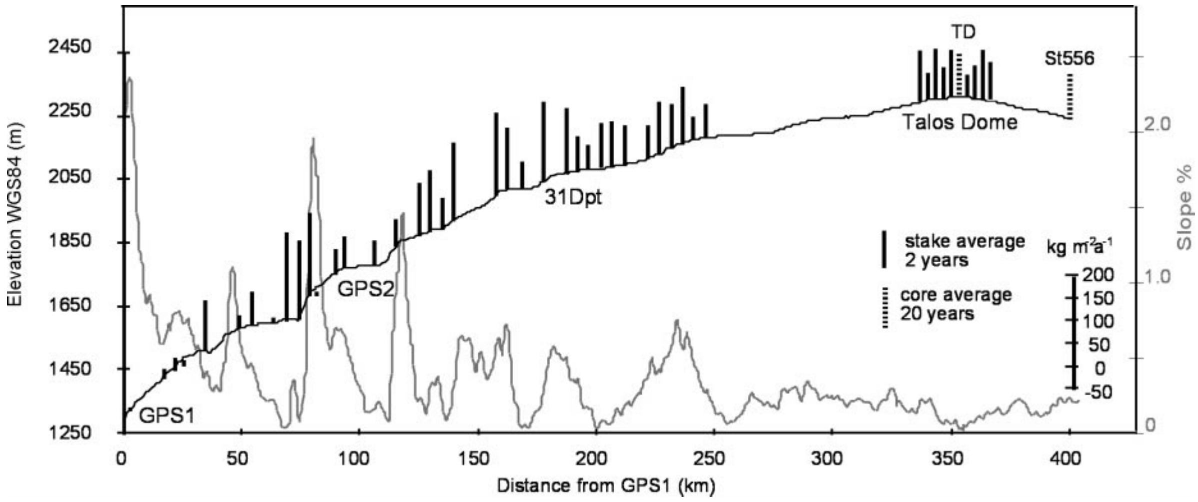


*Fig. 6* - Surface mass balance, elevation (solid line) and slope (grey line) along the GPS1-Talos Dome traverse. Surface mass balance is expressed as bars on a cross-sectional profile of the ice sheet. Positive values have been plotted on the ice sheet surface and negative values below the surface. Dash bars at TD and ST556 sites show snow accumulation from firn core analysis (Stenni et al., 2002).

surface morphology (wind crust, sastrugi, dunes, etc.) and surface elevation between GPS1 and Talos Dome suggested that surface accumulation appears to be strongly influenced by the redistribution of snow due to katabatic wind intensity drawn by the regional and local slope. Frezzotti et al. (2002) pointed out that the wind crusts are present in a wide area of the ice sheet (wide glazed surface ) where the slope is higher than 0.25° (0.4 % or 4 m $km^{-1}$). The surface mass balance of this wide glazed surface is nil or slightly negative. Observations along the TNB-DC traverse show that the interaction of surface wind and subtle variations (>2 m $km^{-1}$) of surface slope in the wind direction has a considerable impact on the spatial distribution of snow at short and long spatial scales (Frezzotti et al., 2002).

## CONCLUSION

This study correlated the surface dynamics with bottom topography and geophysical characteristics of the bedrock and the modern evolution of the eastern Dome C catchment area. The modern western ice divide position of the Scott Coast is part of the encroachment on the Ross Ice Shelf system that could be under way since the mid-Holocene era. Analysis of core temperature with elevation shows a near-dry-adiabatic lapse rate with good correlation along TNB-DC traverse. The lapse rate is close to the rates observed along DdU-DC and Wilkes Land. The super adiabatic lapse rate calculated between TD-St556 and D72-D60 suggests that physical processes cannot be parameterised entirely by elevation and latitude. Snow accumulation along the traverse shows a large spatial variation due to wind scoring. Surface slope, in the wind direction, has a considerable impact on the spatial distribution of snow at short and long spatial scales.

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