February wind speeds at different coastal locations of Adélie Land. Note that the historic observations were taken in different years.

	Dumont d'Urville	D 10	Port Martin	Cape Denison
February 1990 wind speed[a]	—	8.1	16.0	18.3
Historic wind speed[a]	11.5	8.9	18.5	14.4
Number of years	21	8	2	2

[a] In meters per second.

speeds in excess of 30 meters per second were observed. In general, an increase in wind speed for the month of February is observed. This is typical because February is the month when a transition is made from summer to winter conditions with stronger winds during the winter months. In contrast to the present findings, historic data (table) show Port Martin having higher wind speeds in February. Hence, it is impossible to obtain conclusive evidence which area has more severe wind speeds. More data will be needed to decide for certain.

Otherwise, the climate is fairly warm for Antarctica: mean temperatures of −6.3 °C at Cape Martin, and −7.7 °C at Cape Denison are typical for the Adélie coast, and the wind hardly ever changes direction. Monthly mean "constancy" values of 0.9 are being observed.

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The katabatic wind regime near Terra Nova Bay, Antarctica

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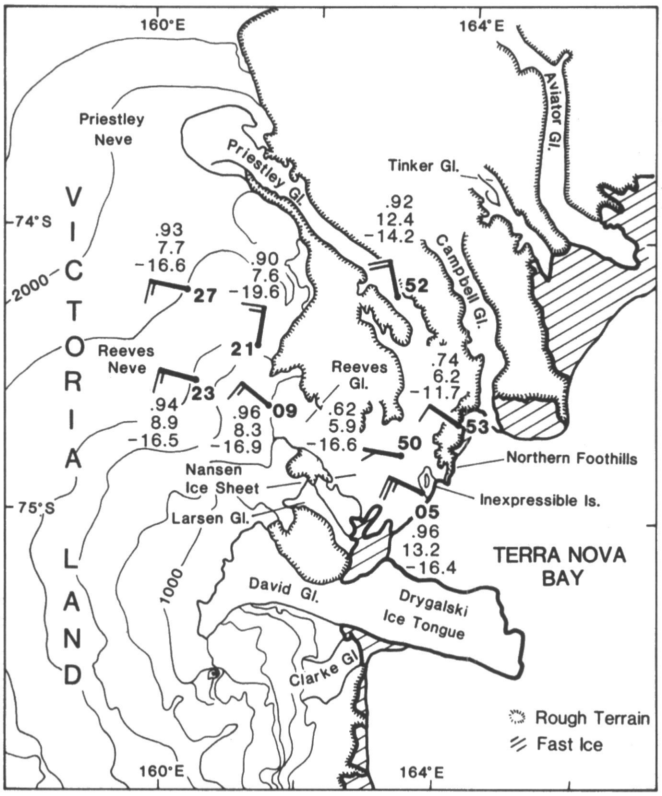
Parish and Bromwich (1987) have shown that the pattern of surface drainage currents over the antarctic continent is highly irregular. In certain portions of the continental hinterland, negatively buoyant air becomes topographically channeled into "confluence zones," enabling the katabatic winds downstream to become enhanced. The Terra Nova Bay region is one such area (Bromwich and Kurtz 1982; Bromwich 1989a; Parish and Bromwich 1989a). A comprehensive observational study of the katabatic wind regime in the vicinity of Terra Nova Bay is currently underway. Observational strategies have included surface weather data collection from automatic weather stations (Bromwich 1989a), high-resolution satellite imagery analyses (Bromwich 1989b), airborne photography (Bromwich, Parish, and Zorman 1990), and instrumental aircraft measurements (Parish and Bromwich 1989a). An automatic weather station has been operating on Inexpressible Island since 1984; four additional units were deployed at strategic locations in and around Terra Nova Bay during the 1987–1988 austral summer in support of this study. In addition, complementary automatic weather station observations have been collected by the Italian National Antarctic Research Program during this observing period. We are reporting on results from the automatic weather station network for the calendar year from February 1988 to January 1989; results for parts of this interval are presented by Bromwich and Parish (1988, 1989), Parish and Bromwich (1989b) and Bromwich et al. (1990).

The figure contains the annual results from the automatic



Annual surface winds in the Terra Nova Bay area, February 1988 to January 1989. The dots with adjacent bold numbers denote automatic weather station sites. The following variables are listed vertically near each unit: directional constancy, mean 3-meter wind speed in meters per second, and average potential temperature in degrees Celsius. The wind vectors plotted for each site give the vector-average wind and follow conventional plotting notation. Stations 50, 52, and 53 belong to the Italian National Antarctic Research Program and the remainder are U.S. deployments.

weather station array which are discussed below. Because there are extensive gaps in the observations at most sites, it is first necessary to describe how these gaps were taken into account. Stations 05 and 09 operated continuously throughout the year and their observations were used as reference time series for the coastal (50, 52, and 53) and interior (21, 23, and 27) stations, respectively, with significant measurement gaps (see table). The correction strategy for missing wind speeds at a station depended on the ratio of speed at that station to the value at the reference station when both were operating for nearly complete months. Monthly ratios were composited for the summer (October-January) and winter (February-September) periods, and then combined by weighted averaging according to seasonal duration. The reference station's annual mean speed was multiplied by the combined ratio to yield an estimate of the annual mean speed at the station with significant amounts of missing data. When necessary speeds were adjusted to a height of 3 meters above the surface by assuming a logarithmic wind speed profile and a roughness length of 0.1 millimeter (Budd, Dingle, and Radok 1966). The resultant wind direction and directional constancy values for summer and winter were taken directly from each station's available data and then combined by weighted averaging to yield annual estimates. The vector-average speed is equal to the product of the mean speed and the directional constancy. For potential temperature, the correction procedure followed that for wind speed but was based on the difference between simultaneous readings at the station and the reference location.

Automatic weather stations with significant amounts of missing data between February 1988 and January 1989

Site	Months with more than 80 percent of possible observations
21	February, August–January
23	July–January
27	February–May
50	February, March, October–January
52	February, November–January
53	March, November, December

The speed readings at site 09 after 1800 universal coordinated time 14 October 1988 were multiplied by a factor of 2.12. The average speed at this site dropped abruptly at this time in relation to the surrounding locations, but the regional speed variations were preserved. This change must have arisen because of a malfunction of the wind-speed sensor, but was consistent enough over subsequent months to justify the preliminary correction factor established from regional October readings before and after the change.

The figure displays the wind and temperature fields resulting from the above manipulations. A remarkable feature of the wind regime associated with Reeves Glacier is the extreme persistence (stations 05, 09, 21, 23, and 27). All these automatic weather station records reveal a directional constancy (ratio of the vector resultant speed to the mean speed), of at least 0.90, indicating nearly unidirectional flow. Station 52 shows a similar situation for Priestley Glacier. Topography is a predominant factor in shaping these airflows. Note that convergence into the head of Reeves Glacier is indicated, especially by the orientations of the annual resultant wind directions at stations 23 and 21; this facet of the wind regime closely matches the time-averaged streamlines in Bromwich et al. (1990). The resultant direction at station 52 is parallel to the orientation of the northern valley wall of Priestley Glacier just upwind of the site.

The strongest winds in the area are found at Inexpressible Island where the annual resultant wind speed at 3-meter height is 12.7 meters per second (13.2×0.96); the corresponding 10-meter value is 14.2 meters per second. The latter approaches the values measured at the extraordinary katabatic wind sites (Schwerdtfeger 1984) of Port Martin (16.9 meters per second) and Cape Denison (19.0 meters per second) in Adélie Land (Parish 1988), and is significantly stronger than resultant speeds at coastal sites prone to ordinary katabatic winds (<10 meters per second). Katabatic winds nearly as intense as at Inexpressible Island are found in the narrow confines of the steeply sided Priestley Glacier at station 52. No large spatial variation in resultant speeds can be seen above Reeves Glacier, and the values are comparable to those characterizing ordinary coastal katabatic winds. There appears to be a rapid acceleration of the flow as it enters Reeves Glacier (see also Parish and Bromwich 1989a). In part, this is due to the increasingly steep ice slopes but also to the aforementioned convergence at the head of the glacier. Station 50 on the Nansen Ice Sheet is located just north of the typical northern edge of the katabatic stream issuing from Reeves Glacier but at times experiences intense blasts of katabatic air. This explains the comparatively low mean speeds and rather variable directions, but with a resultant direction that points toward the glacier. Station 53 is situated on the eastern side of the mountainous Northern Foothills. Katabatic winds from Priestley Glacier, and to a lesser extent from Reeves Glacier, affect this location (compare Bromwich and Parish 1989), and lead to moderate mean winds, somewhat variable wind directions, and a resultant direction that generally points toward Priestley Glacier. The wind records from stations 05, 50, and 53 reflect the sharp speed decrease at the northern boundary of the katabatic jet from Reeves Glacier.

Potential temperatures are also entered in the figure. This variable corrects for the different elevations at which the air temperature measurements are taken, and a constant value arises when air descends and is compressively heated in a dry adiabatic fashion. The spatial distribution of potential temperatures reflects the atmospheric dynamics governing the airflows. Values at stations 27, 23, 09, and 05 suggest that the air converging into and blowing down Reeves Glacier moves dry adiabatically along the surface. There is little surface evidence for the abrupt drop in potential temperature at 175 meters above the surface encountered near the head of Reeves Glacier during successive aircraft missions in November 1987 (Parish and Bromwich 1989a). If this aircraft result is generally applicable, then convergence at the head of the glacier is primarily manifested above the surface via deepening and overall acceleration of the katabatic layer. The origin and fate of the potentially colder surface air moving southward past station 21 into the head of Reeves Glacier have yet to be identified. The potential temperature at station 50 is close to that of the katabatic stream down Reeves Glacier and arises because of the combined influence of unidirectional katabatic wind events and the generally light, variable winds at other times. The potential temperature of the Priestley Glacier airstream (station 52) is significantly warmer than that of the Reeves Glacier wind, indicating that the former is positively buoyant in relation to the latter. This buoyancy contrast, together with the differing topographic obstacles, probably explains why the katabatic airstream from Reeves Glacier airstream descends directly to Terra Nova Bay, while the Priestley Glacier exhibits complex behavior beyond the elbow bend in the glacier (compare Bromwich 1989b). The comparatively warm potential temperature at station 53 arises because of the combined impact of katabatic winds from Priestley Glacier and the maritime influence of Terra Nova Bay. The 4.7 °C potential temperature contrast between stations 05 and 53 illustrates the conclusion of Bromwich (1989a) that the airstream from Reeves Glacier is a source of cold boundary layer air for the southwestern Ross Sea.

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