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ANOMALOUS WINTER WEATHER IN 1984 AND A SEABIRD IRRUPTION ALONG THE COAST OF SOUTH AFRICA

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SUMMARY

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An anomalous irruption of Southern Ocean seabirds into the coastal waters of South Africa was recorded during the winter of 1984. The irruption appears to be related to an unusual pattern in the winter climate. A stationary pair of upper level high and low pressure anomalies near Gough and Marion Islands, respectively, initiated sustained southerly surface wind anomalies across the region 35-50S, 15-30E. The large scale anomalies persisted through the winter season and provided a potential conduit for seabird movement.

INTRODUCTION

Ryan *et al.* (1989) have indicated that large numbers of seabirds, which normally occur south of 40S, appeared along the South African coast during the winter of 1984. However, evidence appeared to be insufficient to relate the irruption to specific meteorological features. Although the winter storm of 15 May 1984 was a wreck event (Ryan & Avery 1987), with extreme onshore winds and low air pressures (Jury *et al.* 1986), the fetch winds from this event could not have brought seabirds from more southerly latitudes. The purpose of this note is to highlight anomalies in the macro-scale weather which may have contributed to the irruption of Southern Ocean seabirds to the coastal waters of South Africa in mid-winter 1984.

METEOROLOGICAL EVIDENCE

Our confidence in the analyses of weather patterns over the Southern Ocean has greatly increased since 1979 with the advent of weather satellites (Hoskins *et al.* 1989). At twice daily intervals high resolution satellites profile the atmosphere's temperature, moisture, and geopotential height every 100 km or so. In addition, geostationary satellites such a METEOSAT provide information on winds using clouds at various levels as tracers. These data are then assimilated, along with the conventional data from coastal and island stations and ships, using advanced numerical models which account for the atmospheric thermo-dynamical controls and movement of weather systems. Researchers can inspect the climatological bulletins issued by the South African Weather Bureau and the Climate Analysis Center (USA) for monthly or seasonal weather anomalies and gain insights into the regional interrelationships between environmental and biological perturbations.

Coastal symptoms: winter 1984

Research on hemispheric scale weather events which induce shelf waves (low frequency elevations in sea level which regularly traverse the South African coast) and associated pulses of upwelling in the southern Benguela Current along the west coast of South Africa has identified the winter of 1984 as being anomalous (Jury *et al.* 1990). Coastal sea temperatures (from the Koeberg Nuclear Power Station located 30 km north of Cape Town) displayed sharp downward excursions through the winter of 1984 in contrast to other winters where coastal sea temperatures remain constant. Three sustained upwelling events occurred during the winter of 1984: mid June, late July and at the end of August. The events coincided with the eastward movement of large anticylonic high pressure cells, providing weather conditions conducive to the northward movement of seabirds from mid-latitudes, such as illustrated by the sequence of weather maps shown in Fig. 1. An upper level Rossby wave trough in the westerly jet stream passed over Marion Island and anticyclonic curvature of the jet stream following this wave caused a surface anticyclone of dimensions 20° latitude X 30° longitude to strengthen and move eastward. Sustained southeasterly flow was obtained over the Cape Province and adjacent ocean, and coastal sea temperatures decreased from 15°C to 10°C near Cape Town. The presence of a combined anticyclone - coastal low weather regime and consequent upwelling event in the mid-winter period is most unusual (Jury *et al.* 1990).

Macro-scale anomalies: winter 1984

Clear evidence for the unusual climate of the mid-latitudes for the winter season June-August 1984 is provided by anomalies in the upper level geopotential height and upper and lower winds taken from the diagnostics bulletin (Climate Analysis Center 1984). A positive 200 hPa (12 km level) geopotential anomaly extended 3 500 km from 65S, 0E to Cape Town as seen in Fig. 2a. A negative anomaly was located near 55S, 60E. The high-low anomaly pair resulted in a deformation of the upper jet stream structure in the mid-latitudes and a channel of upper level southerly air flow to the south of Africa. It can be noted that positive upper level geopotential anomalies occurred across most of the southern hemisphere mid-latitudes during the winter of 1984, in particular over Western Australia and New Zealand (Climate Analysis Center 1984).

Flow in the 12-km layer of the atmosphere is above the level of seabird movement. However, it is generally accepted that the mid-latitude atmosphere is dynamically driven from above (Holton 1979). It is therefore important in understanding low-level circulation systems to consider first the upper flow patterns. The upper level circulation anomaly for June-August 1984 is shown in Figure 2b. Westerly winds at the 200 hPa (12 km) level were strengthened at two mid-latitude locations: over the western South Atlantic Ocean and the South Indian Ocean. In between these accelerated regions, to the southwest of Cape Town, the jet stream weakened and underwent an anticyclonic rotation. The anticyclonic anomaly persisted through the winter of 1984 near 40S, 10E. It can be noted that the anomaly was peculiar to the South African sector of the southern hemisphere and could be partially attributable to strong easterly flow over the tropical Indian Ocean (Fig. 2b). The influence of the upper level dynamical structure on the lower level (1.5 km) circulation is reflected in Fig. 2c. Sustained southerly wind anomalies to the south of South Africa can be noted. It is likely that the sustained southerly flow across the region 35-50S, 15-30E during the winter of 1984 acted as a conduit for seabird movement and contributed to the seabird irruption noted by Ryan *et al.* (1989).

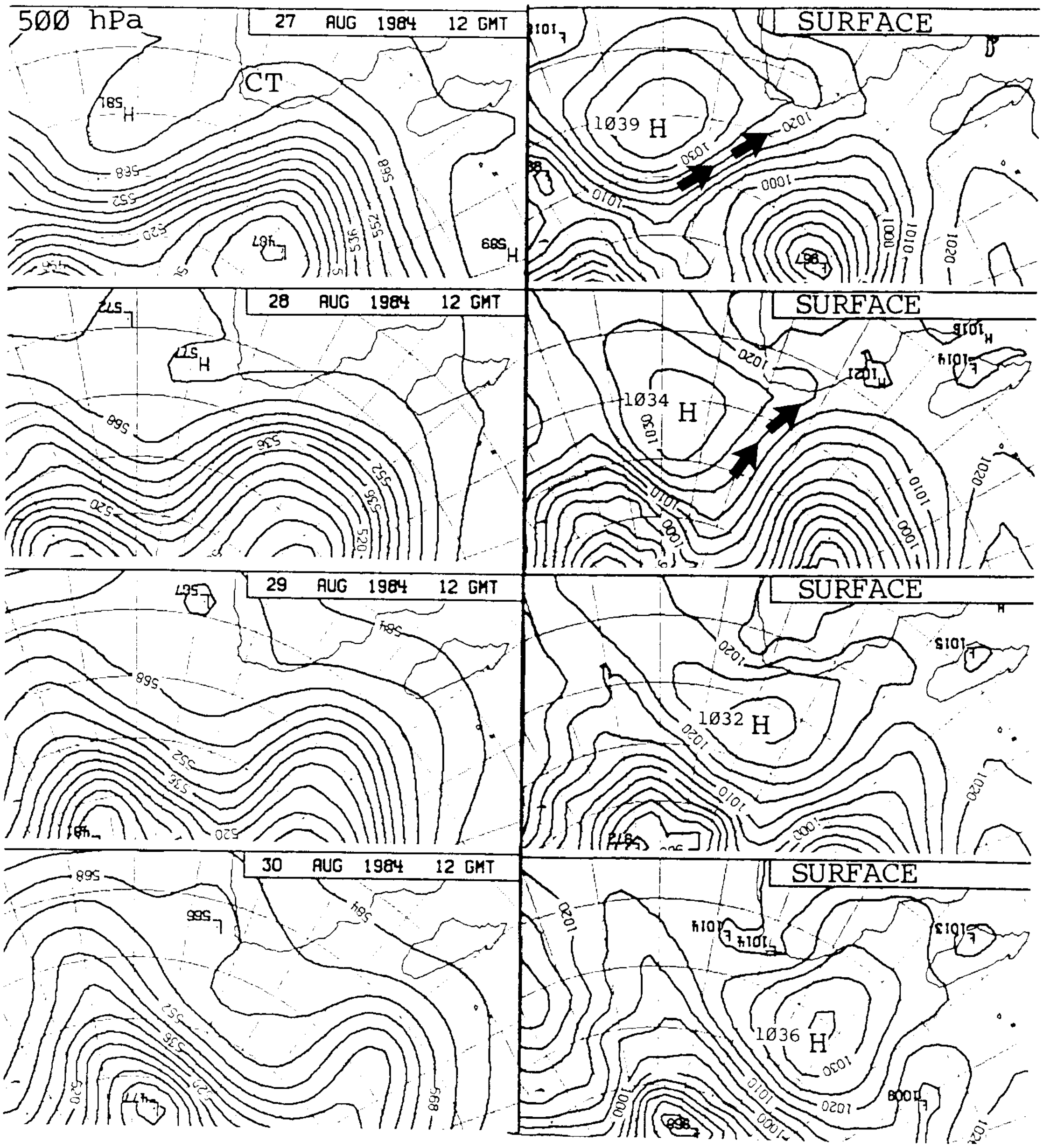

Figure 1

Weather map sequence of geopotential height at the 500 hPa, 5.5 km level (left) and surface air pressure (right) for the period 27 - 30 August 1984 (top to bottom). Southerly winds are emphasised by the arrows on the east side of the ridging high pressure cell labelled H. Cape Town is labelled CT in upper left. A polar map projection is used for Figs. 1 and 2a. Adapted from ECMWF (1984).

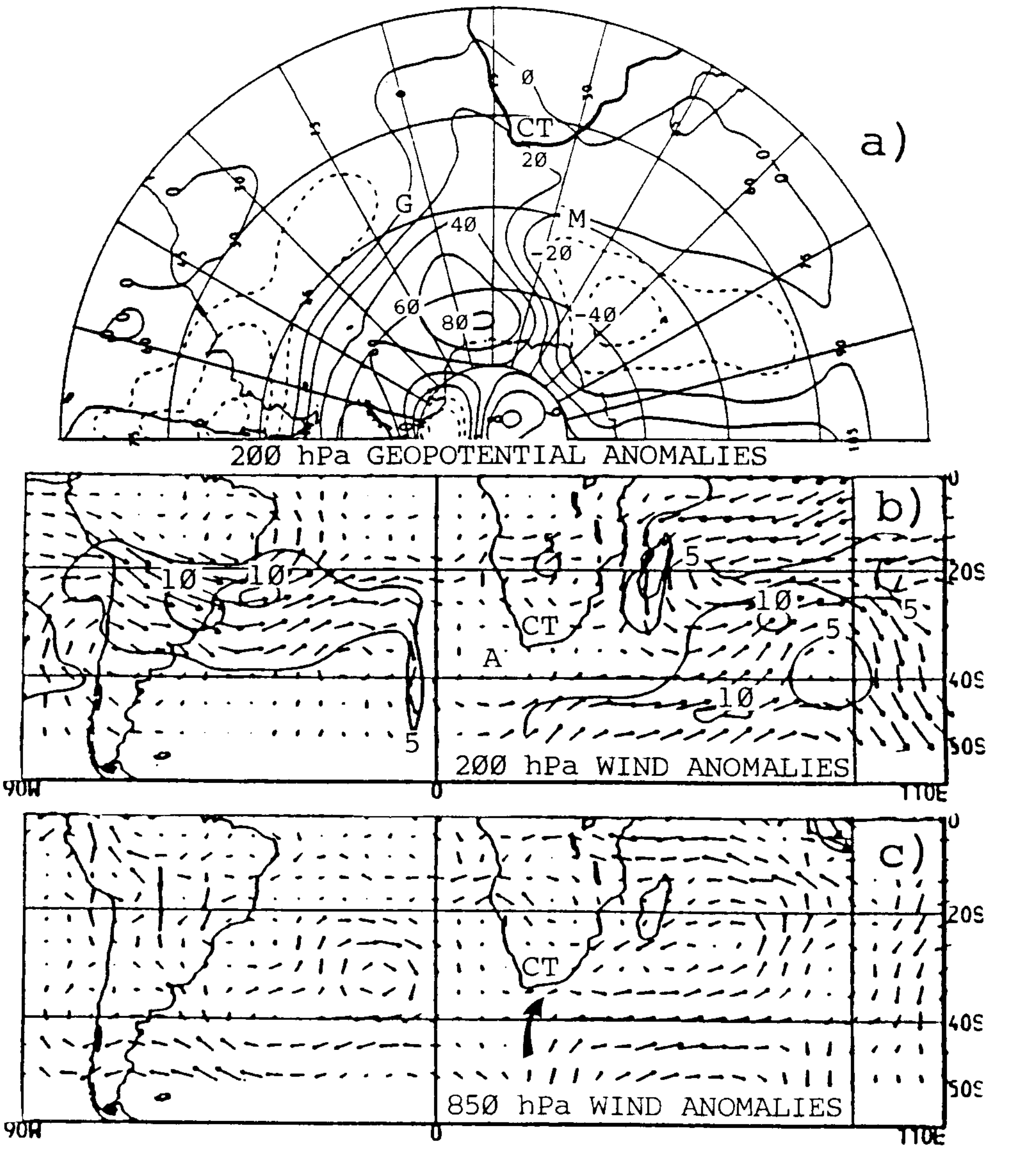

Figure 2

a) Anomalies of 200 hPa (12 km level) geopotential height for the June - August 1984 winter season. Positive values are solid, negative values are dashed. Contour interval is 20 geopotential metres. Gough (G) and Marion (M) Islands are so labelled.

b) Anomalies of 200 hPa (12 km level) wind for the June - August 1984 winter season. Vector sizes increase with speed. Isotachs are contoured at 5 m s^{-1} intervals. The anticyclonic anomaly is labelled A.

c) Anomalies of 850 hPa (1.5 km level) wind as in a). Largest vectors are 5 m s^{-1}. The seabird conduit is shown by the bold arrow. All anomalies are computed from a 1979-1983 base period. Adapted from Climate Analysis Center (1984).

SUMMARY

Meteorological evidence points to anticyclonic southerly wind events across the "roaring forties" latitude band during the winter of 1984 as a possible mechanism for a seabird irruption to the coastal waters of South Africa. The irruptions could be linked to the presence of intense anticyclones ridging eastward in mid June and late July (as indicated by the coastal sea temperature records of Jury *et al.* 1990), and at the end of August (as exemplified by the map sequence in Fig. 1). Macro-scale weather features which favoured the repetition of this event include a positive geopotential anomaly in the upper atmosphere (Fig. 2a), an associated upper level anticyclone located to the southwest of Cape Town (Fig. 2b) and a corresponding low level southerly wind anomaly which was sustained in the 15-30E, 35-50S region (Fig. 2c).

The relationships between climatic anomalies and the biological perturbation are somewhat coincidental and future research of this type could make use of regional atmospheric numerical models to simulate anomalies in weather which affect migratory species.

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