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OBSERVATIONS OF A VORTEX EMBEDDED IN A MONSOONAL FLOW

G. Holland

Head Office, Bureau of Meteorology, Melbourne

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In a data-sparse area such as the Australian region, analysts are often required to interpret instantaneous views of vortices, such as given on a satellite mosaic or radar photograph, in terms of the prevailing flow patterns without the aid of any synoptic observations in the immediate vicinity. It is not always appreciated, however, that the circulation as viewed on a satellite mosaic or radar photograph is in a frame of reference tied to the circulation. For a large slowly moving vortex this will cause negligible differences, but for a small rapidly moving vortex, literal interpretation of the circulation without accounting for the vortex movement may result in large errors.

It is the purpose of this note to briefly describe an example of a small rapidly moving vortex that was noted during the preparation of tropical cyclone case histories for the 1975-76 season in northern Australia.

On 14 March 1976 a weak tropical depression formed to the south-west of the Indonesian island of Sumba and moved eastwards under the influence of a prevailing westerly monsoon. The depression deepened into tropical cyclone Linda for a brief period on the 16th, but then rapidly decayed as it was absorbed into the circulation around an intense monsoonal low over northern Australia. The track and estimated central pressures are shown in Fig 1.

The decayed remains of Linda were observed on Darwin radar during 17 March as a well-defined though somewhat ragged vortex as is shown in Fig 2. However, synoptic observations in the near vicinity admit no such circulation, but merely a very short wave perturbation on the prevailing westerly flow with a strong cyclonic shear. This is illustrated by Figs 3, 4, and 5, which show the prevailing synoptic situation at the surface, a time cross-section of upper winds and surface observations at Darwin, and a composite of radar echo velocities (derived from movement of major echoes over the period 0430-0500 GMT) and synoptic observations around the disturbance. The radar echo velocities may be interpreted as representative of the low-level circulation (see Watanabe 1963).

A detailed analysis is not appropriate because of the varying observations presented in Fig 5. However, it is obvious that the differences are due to the motion of the vortex relative to the earth (approximately 12 m/s). In a frame of reference attached to the moving system it is seen as a closed circulation with a substantial amount of its vorticity contained in the trajectory curvature (as shown schematically by Fig 2), whereas in a frame of reference on the earth, it appears as a small perturbation with nearly all its vorticity contained in the shear of the horizontal wind (as shown in Fig 5).

REFERENCE

Watanabe, K. 1963. Vertical wind-distribution and weather echo motion (in the case of the typhoon). In *Proc. Tenth Weath. Rad. Conf., April 1963* (Am. Met. Soc.), 222-5.

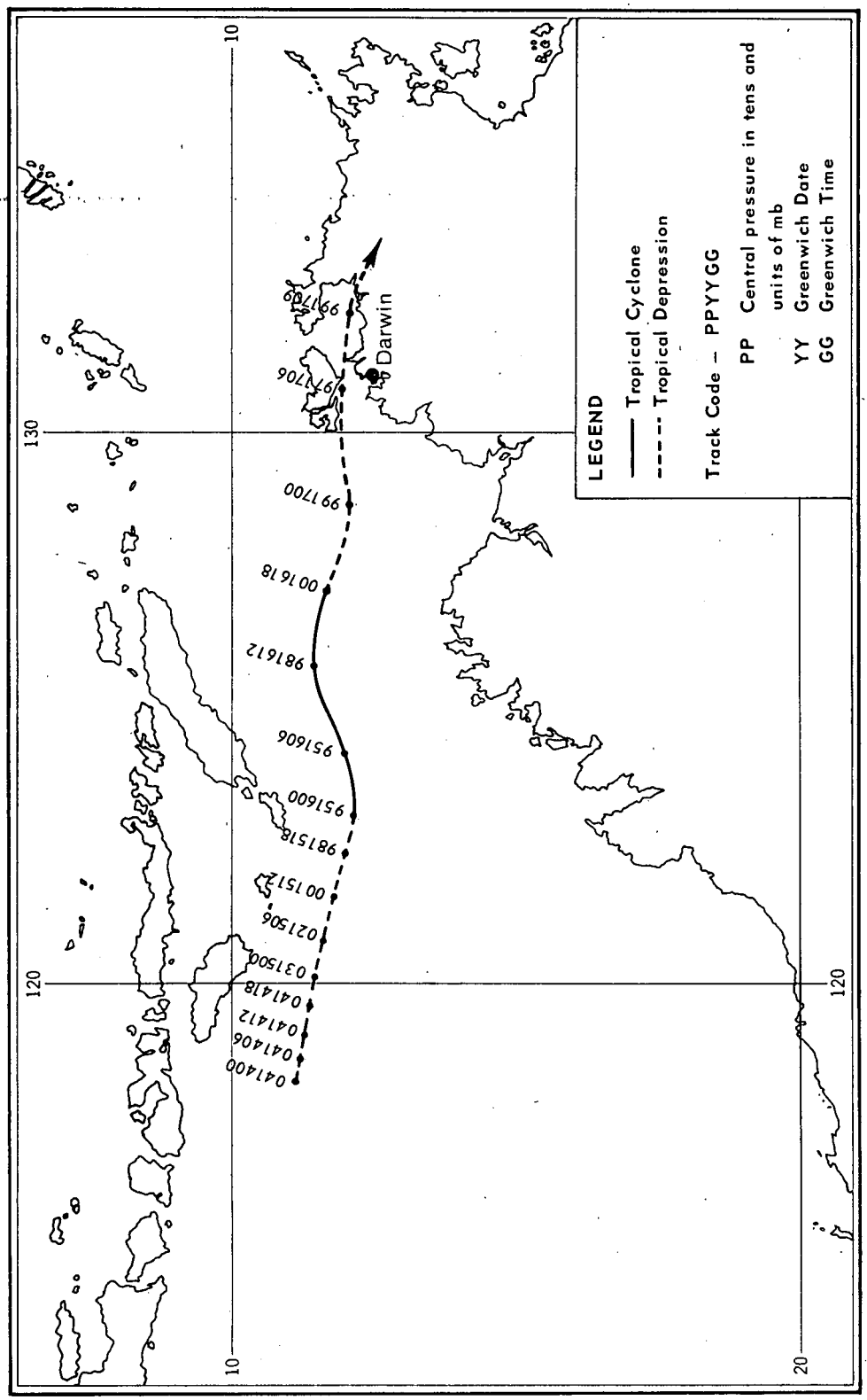
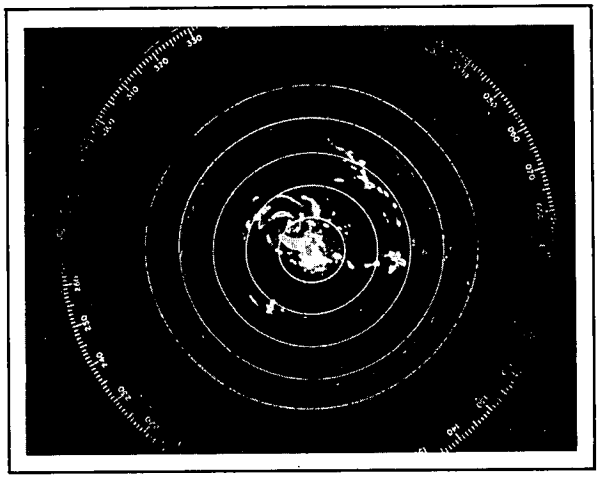
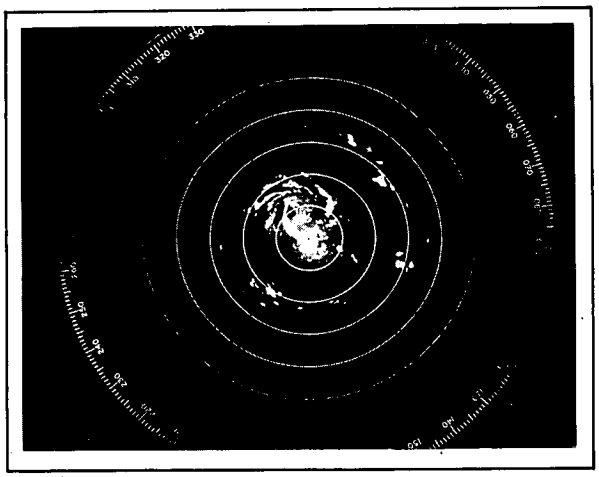


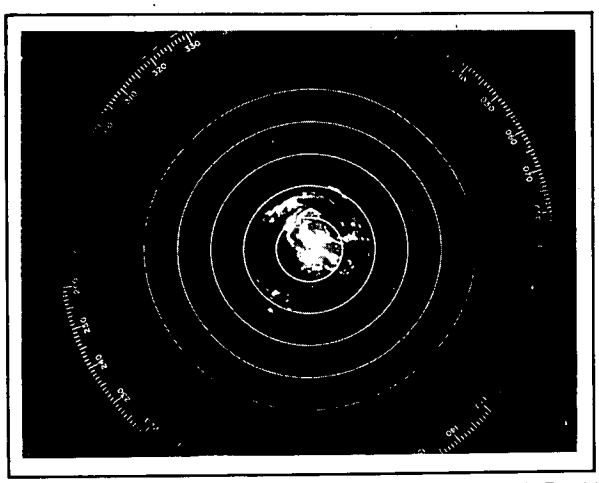
Fig 1 Track of tropical cyclone Linda, 14 March to 17 March 1976



(a)



(b)



(c)

Fig 2 Photographs from Darwin radar on 17 March 1976 at (a) 0430 GMT, (b) 0500 GMT and (c) 0600 GMT, showing passage of vortex through Clarence Straight approximately 60 km to the north. Maximum radar range 445 km.

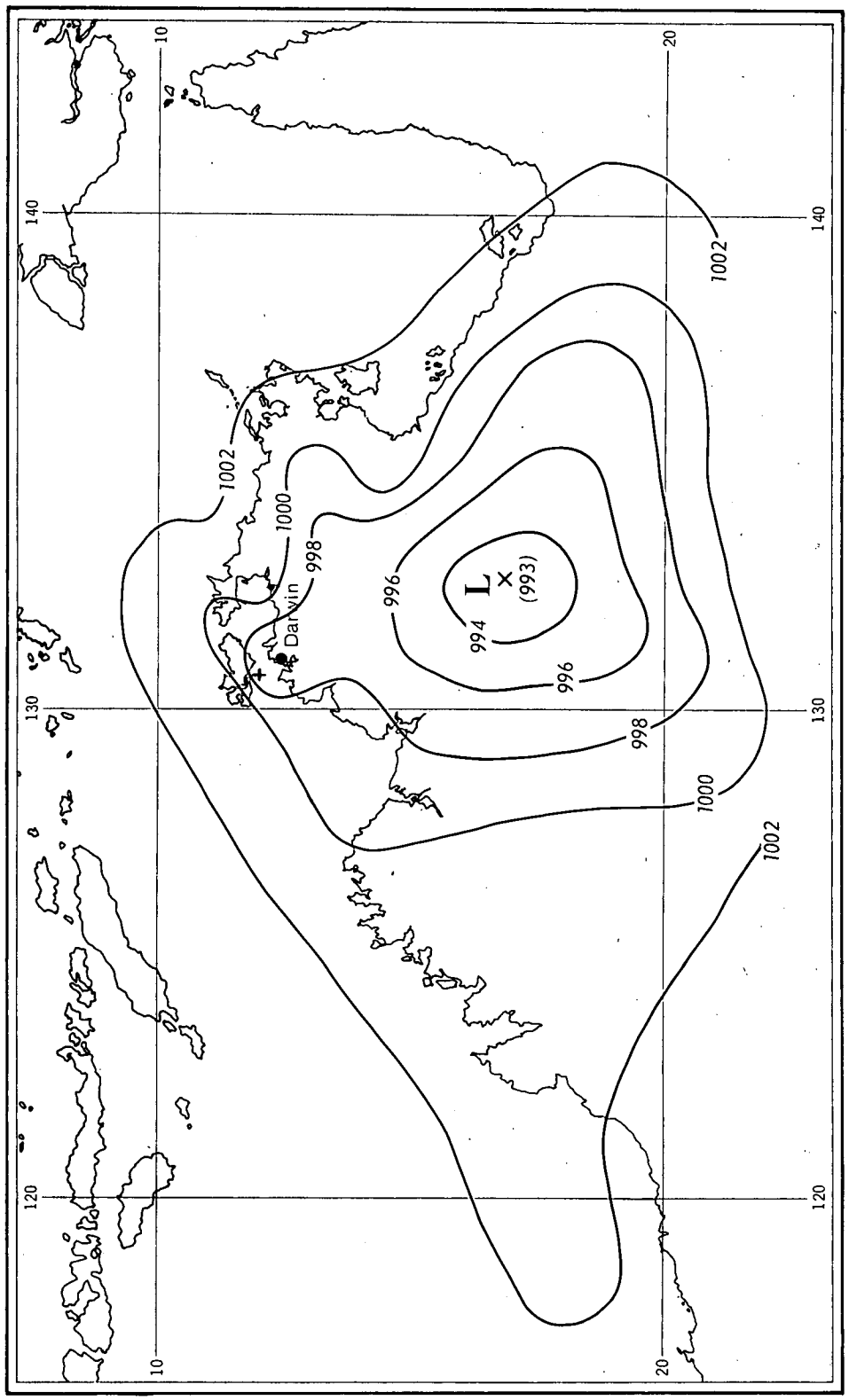


Fig 3 Prevailing surface synoptic situation over northern Australia 0530 GMT 17 March 1976. The radar centre of the vortex is indicated.

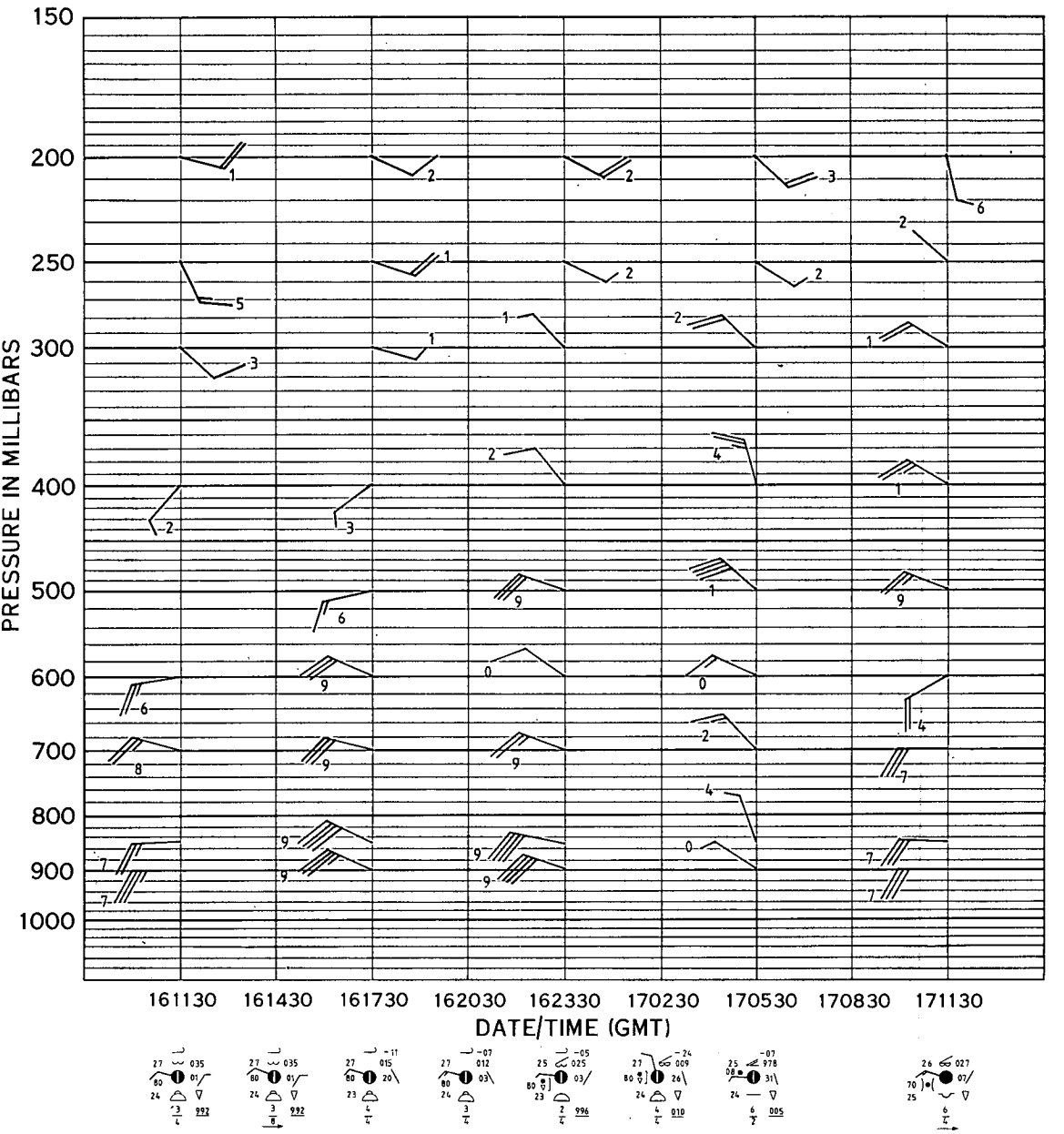


Fig 4 Time cross section of upper winds at Darwin from 1130 GMT 16 March to 1130 GMT 17 March 1976. The vortex passed approximately 60 km to the north between 0530 and 0600 GMT.

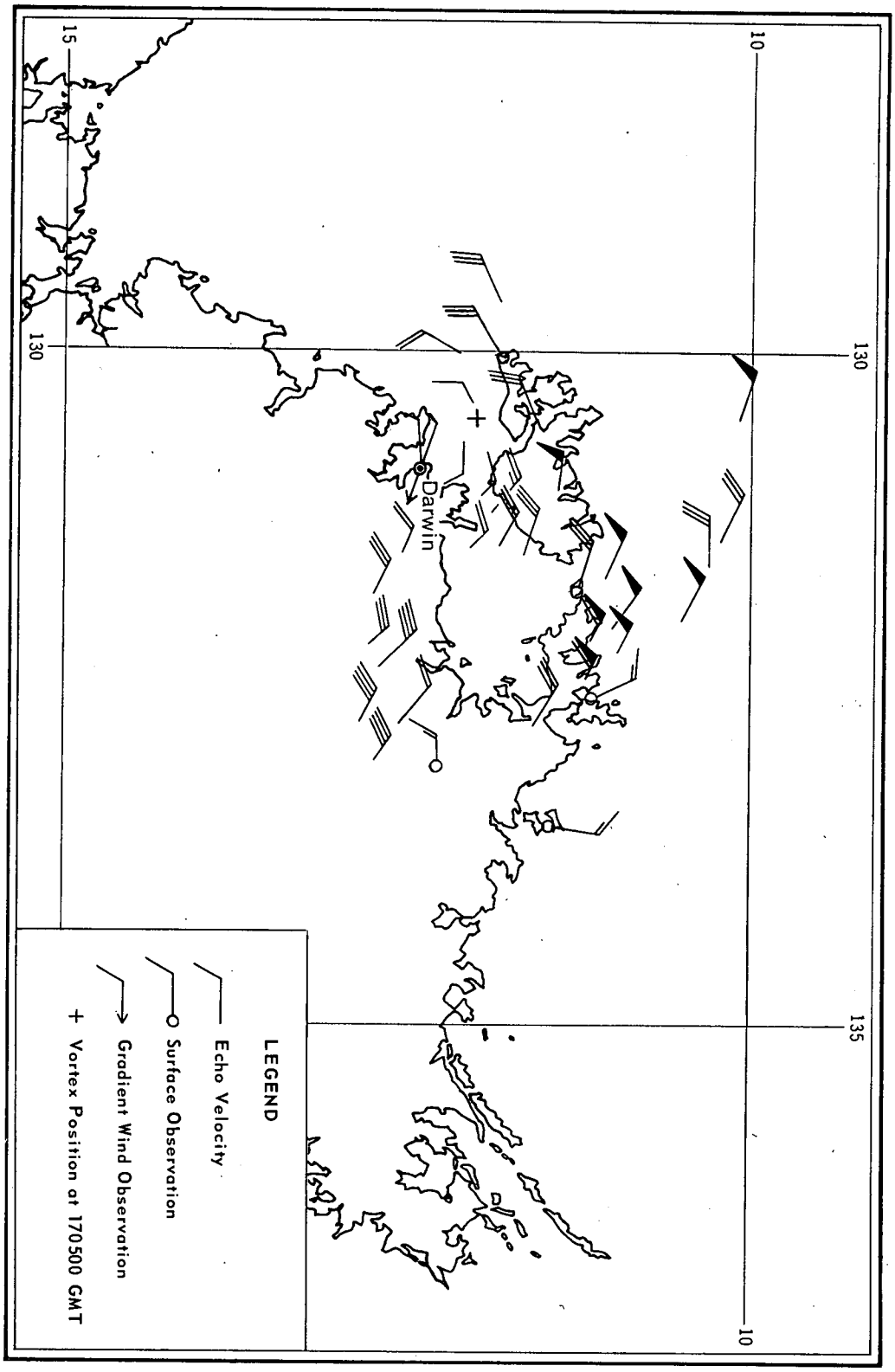


Fig 5 Composite of wind observations at 0530 GMT and radar echo velocities from 0430 to 0500 GMT on 17 March 1976. The vortex position at 0500 GMT is also shown.