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SATELLITE CLOUD PHOTOGRAPHS IN THE AUSTRALIAN REGION

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The vast oceanic areas surrounding Australia, from which only very isolated meteorological reports are available from island observing stations and occasional ships, have always presented a major problem to meteorologists engaged in synoptic analysis and forecasting in the Australian region. Prior to the establishment of meteorological observing stations at Heard and Macquarie Islands, and Marion, Kerguelen and Amsterdam Islands, little was known of the nature of meteorological processes operating over the Indian and Southern Oceans. Since the establishment of these island stations and the organisation of observations from whaling and expedition ships in Antarctic waters, we now have a reasonably comprehensive and accurate knowledge of the type of synoptic processes occurring over these vast oceanic regions.

However, without a reasonably adequate network of observing stations over the Indian and Southern Oceans it is not possible at any time to make a reliable synoptic analysis of these regions. Even in the Coral and Tasman Sea areas, where the network is infinately superior to that over the Indian and Southern Oceans, there remains considerable uncertainty regarding the precise location and at times the existence of synoptic features such as tropical cyclones and extra-tropical depressions.

The advent of the TIROS satellites offers an opportunity of securing cloud data from these vast oceanic areas and, although the interpretation of this data is by no means unambiguous, the fact that it is often the only available meteorological information over areas of one million square miles wants a very close examination of its utility and a maximum effort to develop the utilization of satellite neph-analyses as an aid to synoptic analysis over these regions.

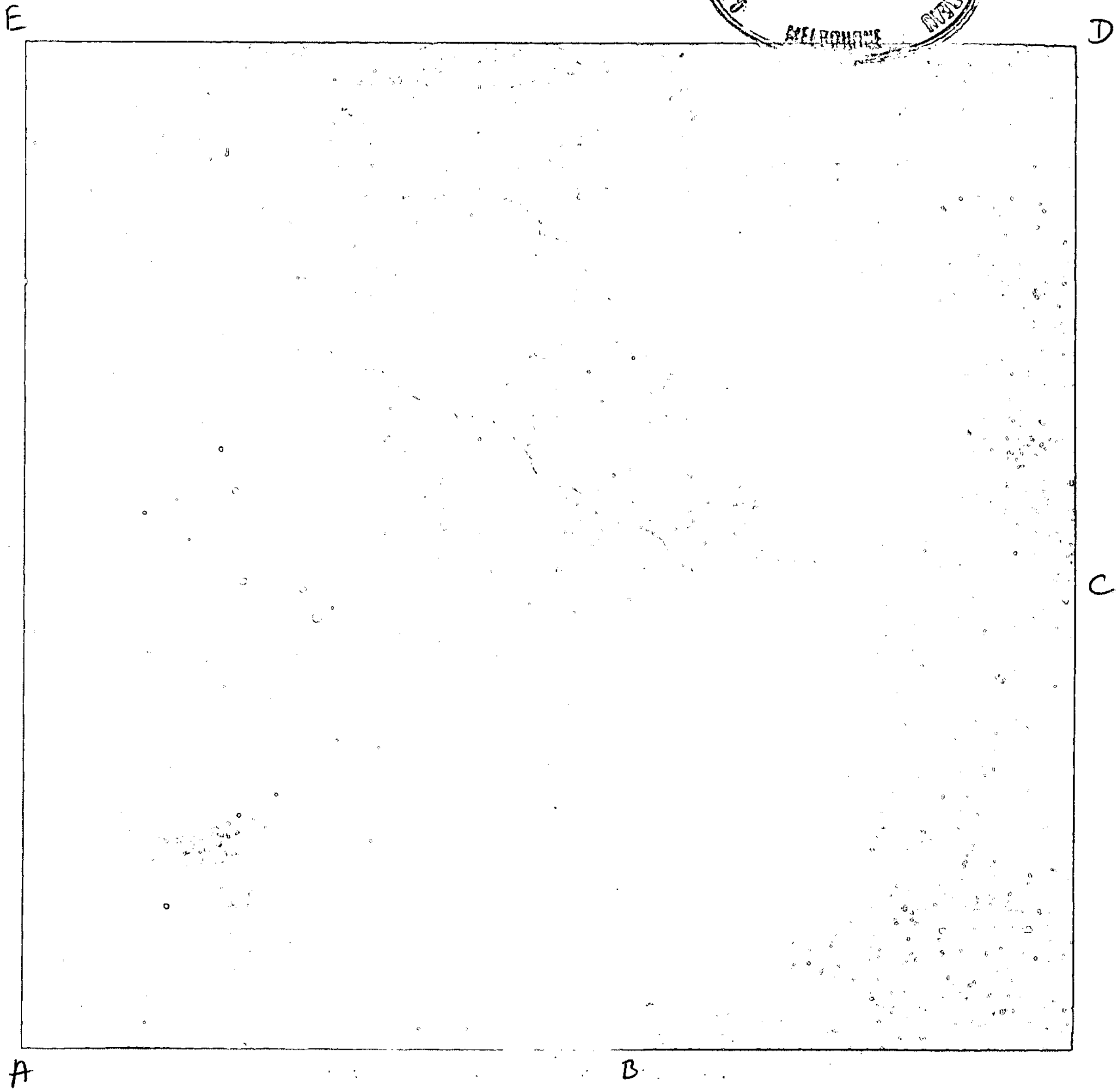

Fig. 1 Tiros I photograph taken north of New Zealand.

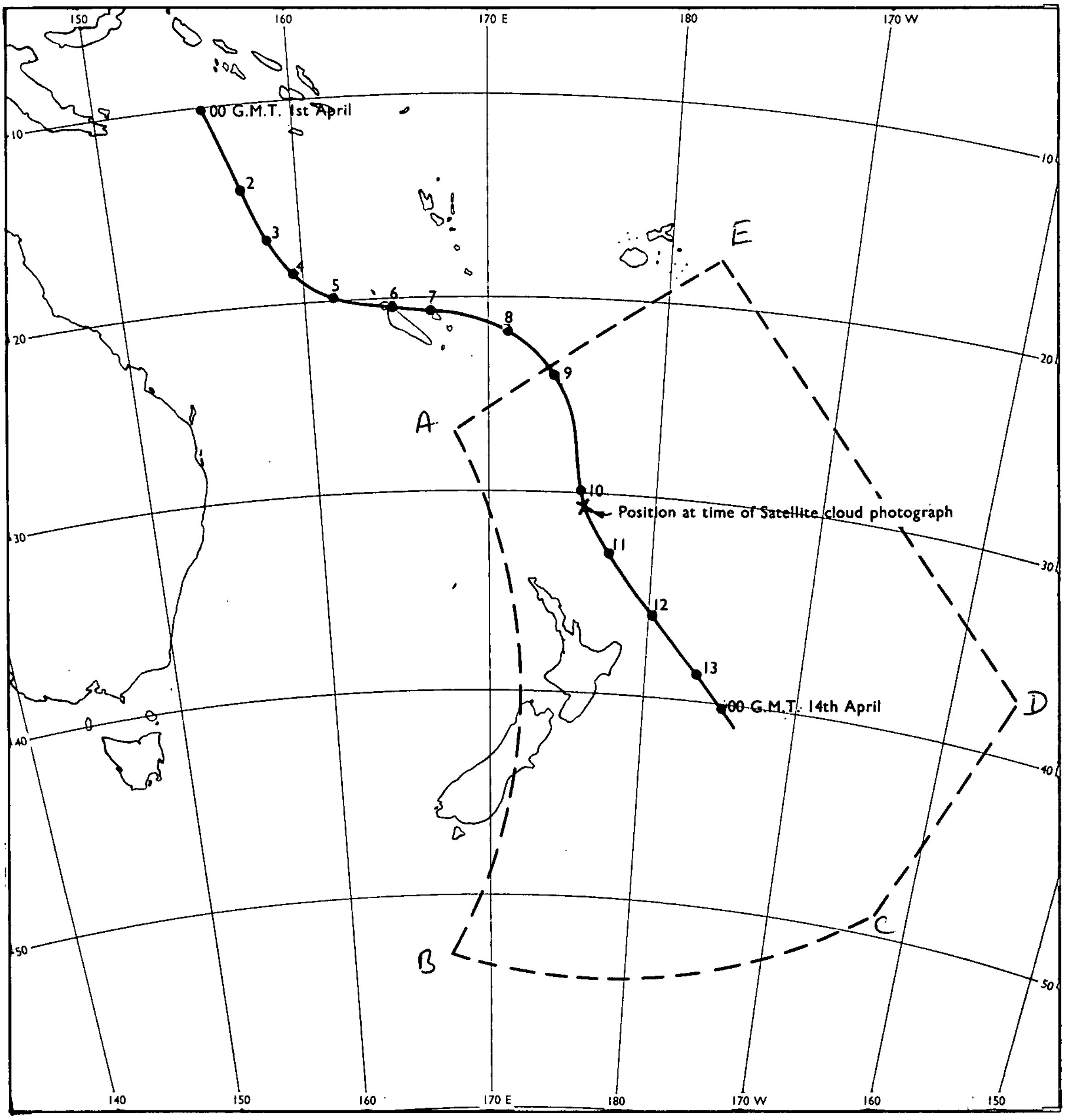

Fig. 2 Track of tropical cyclone (full line) and approximate boundary of satellite cloud photograph (broken line)

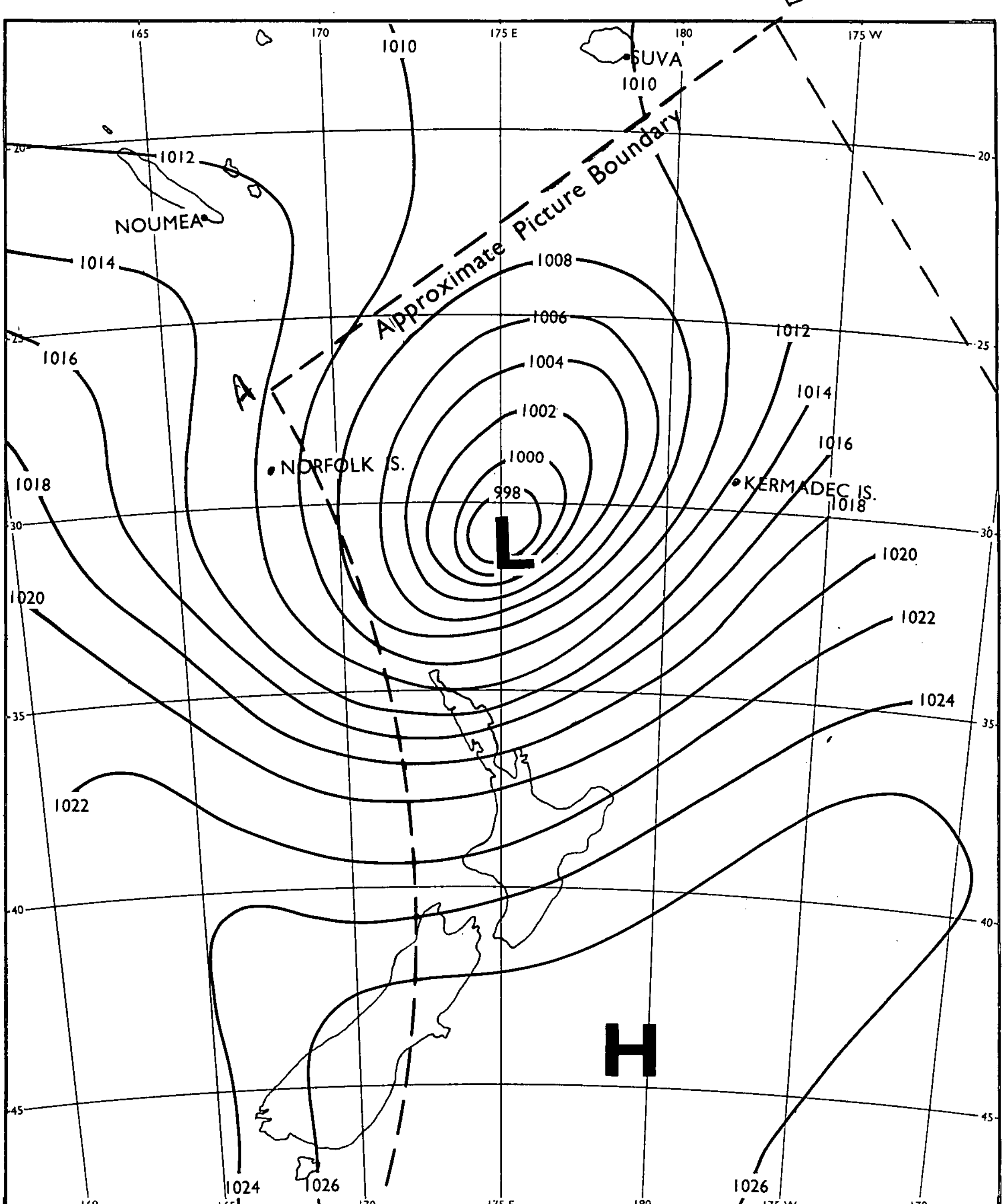

Fig. 3 M.S.L. pressure at 0200 G.M.T. on 10th April 1960
(Satellite photo taken 0300 G.M.T.)

The possible utilization of satellite neph-analyses and in particular those from the TIROS satellites, falls under two main headings. Firstly, there is the use of the satellite photographs in regions where synoptic analysis can be made with a high degree of confidence or where a relatively dense network of surface cloud observing stations exists, and in these cases it is possible to determine whether the satellite cloud photographs exhibit distinctive and characteristic patterns from which synoptic features may be identified. It is also likely that these satellite cloud pictures will reveal new information regarding the cloud structure association. The second use to which the satellite cloud photographs or analyses may be put, is to employ them to assist synoptic analysis over regions from which normal observations are scanty or lacking. It is clear that it will not be possible to use satellite neph-analyses as an aid to synoptic analysis until the interpretations of the neph-analyses are reasonably unambiguous.

Fig.1 is a cloud photograph taken by TIROS I north of New Zealand at about 0300 G.M.T. on 10 April 1960. The approximate area included in the photograph is indicated by the broken line in fig.2 although some uncertainty exists regarding the exact location of this area. The mean sea level pressure pattern at the time of the photograph is shown in fig.3, a tropical cyclone being located some two hundred to three hundred nautical miles north of the north island. As shown in fig.2 this tropical cyclone originated in the New Guinea - Solomon Island area, moving as indicated in fig.2. Between 8th and 10th April the cyclone exhibited the characteristic filling and rejuvenation which frequently occurs in this area as the cyclone moves into extra tropical latitudes. Fig.1 shows the rain shield of the tropical cyclone, over the north island of New Zealand, extending to Kermadec Island and covering all the oceanic area to the southeast of the centre. Three long narrow bands of cloud extend from the rain shield, one northeast-ward towards Suva, one towards Noumea and the third between these two. This picture is substantiated by the dense overcast and widespread rain reported from stations in the north island of New Zealand, Kermadec Island and a ship in the vicinity of the centre.

At this stage of its development it appears that cooler air was finding its way into the southern, western and northwestern sectors of the cyclone, while a tongue of moist tropical air was entering the cyclone from the northeast. However, there is no suggestion of the cloud pattern corresponding to the classical polar front wave cyclone. Because of the uncertainty regarding the exact location and orientation of the picture, it is not possible to say which part of the cloud pattern corresponds with the centre of the tropical cyclone, but it appears likely that this is located on the immediate left of the point where the left hand or western band enters the rain shield. If this is so, the area immediately to the north of the centre (which is almost directly beneath the satellite) occupies the majority of the photograph. It is clear that with a more precisely located and orientated series of satellite photographs and a denser surface observing network, TIROS photographs could be valuable aids in determining the structure and life history of clouds associated with tropical cyclones. This illustration also suggests that satellite cloud photographs are likely to be valuable in detecting and tracking tropical storms and extra-tropical depressions.

Fig.4 shows a neph-analysis constructed from a series of TIROS II satellite photographs taken about 0600 G.M.T. 8th December 1960. This neph-analysis covers an area of approximately one million square miles, in which the only available normal surface observations were from Macquarie Island and the Ocean Weather Ship, U.S.S. Wilhoite. The synoptic analysis shown in fig.4 is essentially that prepared before the TIROS neph-analysis was received. Some small adjustments have been made to frontal orientation but these are of a minor character. The most distinctive on the neph-analysis are the two more or less parallel bands of overcast cloud in the region south of the southwest corner of Australia. The leading band of cloud corresponds closely with the front extending across the extreme southwest corner of the continent and off to the southeast. The second band of cloud, which is more extensive than the first, appears to be associated with another front which on the original analysis was shown somewhat further to the south than that in fig.4.

Another interesting feature of the neph-analysis is the band of cloud orientated roughly north-south along longitude 165E. On the original analysis this corresponds almost exactly to a front or trough line extending north-south between Macquarie and Campbell Islands. Another feature of interest in the triangular area of 'overcast' on longitude 150, just south of latitude 50. This cloud area was responsible for the insertion of the warm front in the vicinity during the re-analysis, but could possibly be explained more simply by formation of stratus or strato-cumulous in a northwesterly stream ahead of an advancing depression.

Although the interpretation of the neph-analysis for 8th December 1960 is far from being completely unambiguous, the patterns it contained added to the confidence of the analysts who had produced the oceanic analysis shown in fig.4. Without entering into a discussion as to whether the fronts shown on the chart are true fronts or trough lines, it does seem that the neph-analyses immediately to the south of the southwest point of Australia yielded valuable information for synoptic analysis and forecasting in that region. It would, however, be misleading to give the impression that all neph-analyses

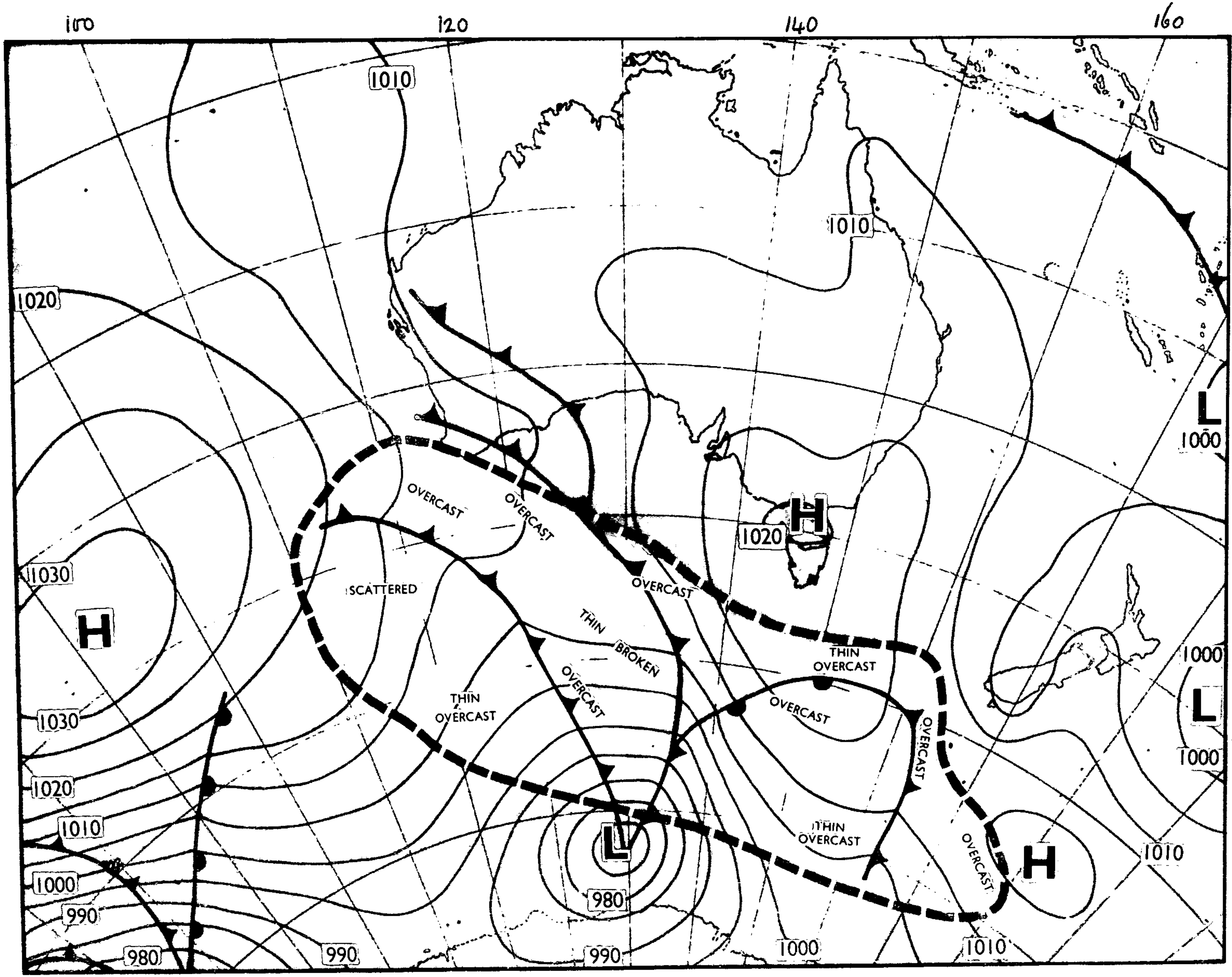

Fig. 4 Tiros II Nephanalysis and synoptic situation at 0600 G.M.T. on 8th December 1960

for oceanic areas in the vicinity of Australia have yielded equally promising information. In some cases very little significance is apparent and there seems little relationship between the neph-analysis and the synoptic pattern. However, there have been a number of cases where cloud patterns appeared to be equally significant, as in the case of 8th December 1960.

From a brief examination of TIROS I photographs and the examination of more than one hundred neph-analyses, it seems clear that a great deal of work remains to be done in determining the significance of cloud pictures and their relationship to synoptic features. However, although many uncertainties still exist in this regard, there are cases where satellite neph-analyses are of definite assistance in synoptic analysis and forecasting, particularly over large oceanic areas from which normal meteorological observations are scarce or lacking.