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On the Intensification and Recurvature of Tropical Cyclone Tracy (1974)

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1. Introduction

On Christmas Eve, 1974, Tropical Cyclone Tracy made landfall at Darwin, Australia, with tragic loss of life and property. The event is part of the meteorological folklore. The current study uses objective analyses from the NCEP re-analysis project, and the Bureau of Meteorology's operational Tropical Cyclone Limited Area Prediction System, TC-LAPS (Davidson and Weber, 2000), to investigate Tracy's motion and intensity change during the 2 days prior to landfall. The numerical system operates on two meshes, which are one-way nested. The outer grid is at 0.75^0 resolution, covers the approximate domain 55S - 25N, 65E - 180E and is used to forecast the large-scale environment. The inner grid is at 0.15^0 resolution and is initialised using sophisticated vortex specification and initialisation.

2. Observed and Forecast Circulation Features

Although the Tracy circulation is understandably not well-depicted in the original analyses, forecasts using the NCEP data and TC-LAPS show remarkable skill at predicting the large scale environment and the storm's behavior. Figure 1 shows observed and forecast track and central pressure information commencing 1100UTC, 22 December 1974.

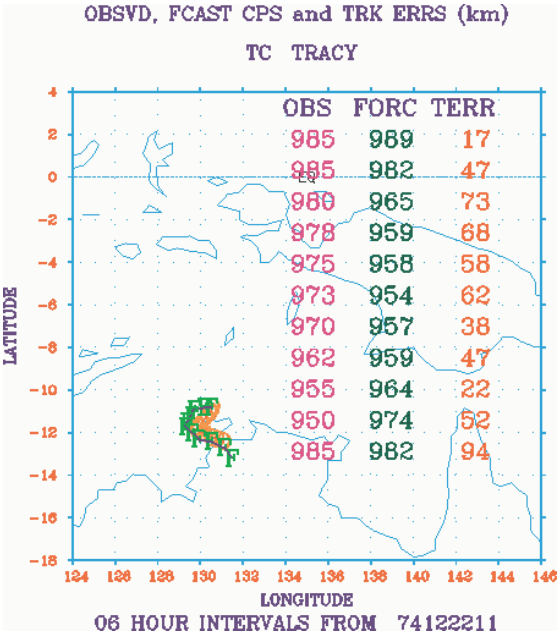

Figure 1. Tracks and central pressures

The hair-pin recurvature and landfall at Darwin are extremely well forecast. The predicted intensification occurs earlier than observed but is still rather encouraging. Figure 2 shows the 850 hPa initial condition and 48 hour forecast.

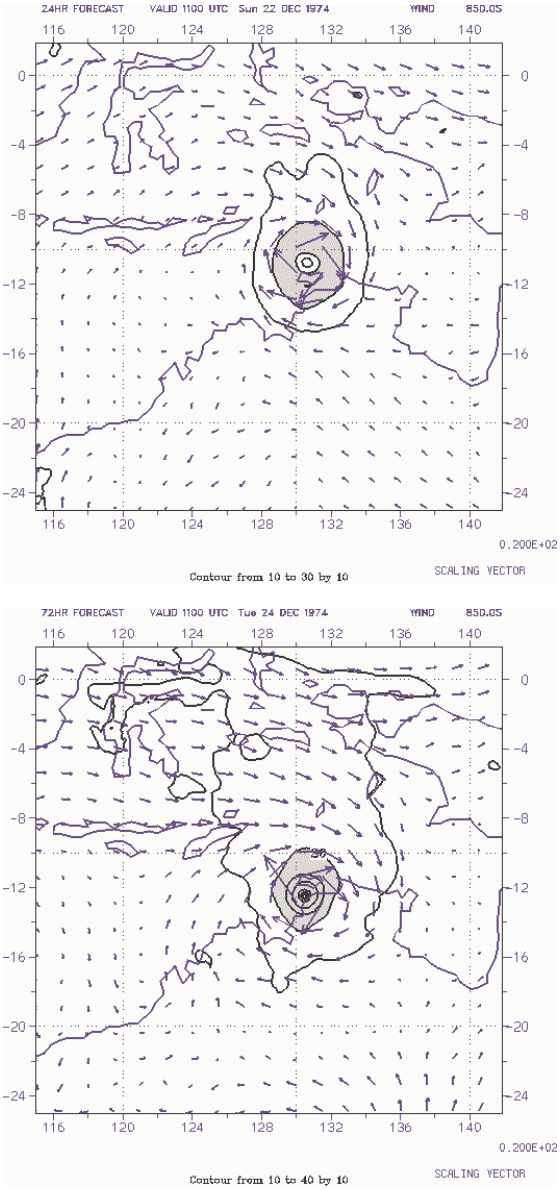

Figure 2. Initial and 48 hour forecast 850 hPa wind fields valid 1100UTC 22 and 24 December 1974.

Of note are (i) the intensification, which commences just prior to recurvature, and (ii) the strengthening in the westerly monsoon flow over Indonesia during the period of the forecast. This strengthening (i) coincides with the onset of the monsoon, (ii) alters Tracy's

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environmental steering to an easterly, and (iii) is mostly independent of Tracy's intensification (see later). Figure 3 shows the 200 hPa initial condition and 48 hour forecast from the inner grid.

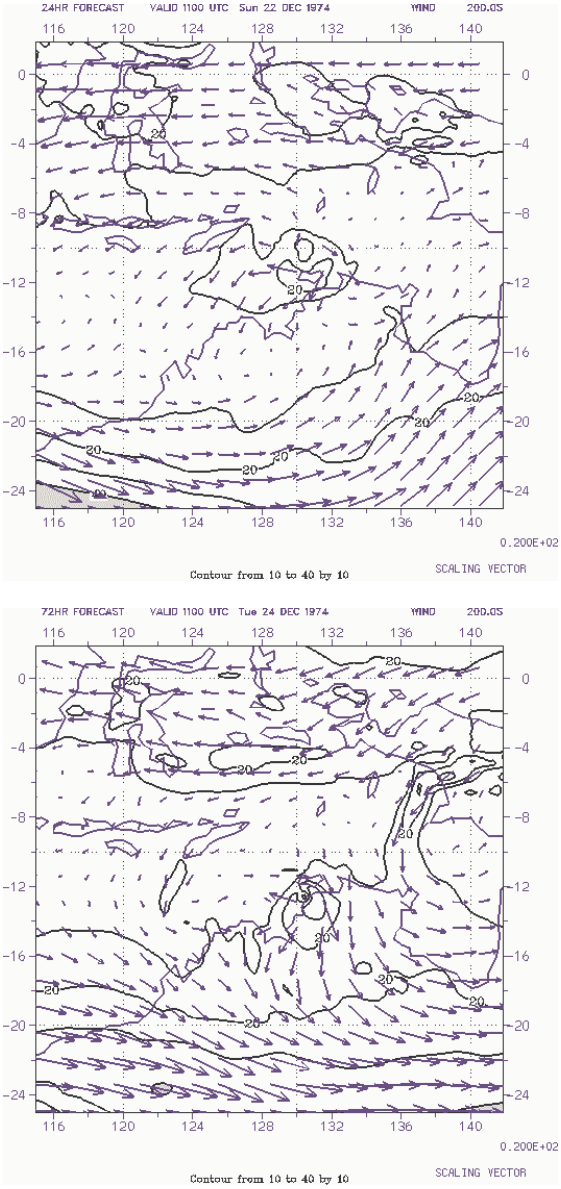

Figure 3. Initial and 48 hour forecast 200 hPa wind fields valid 1100UTC 22 and 24 December 1974.

Of note are (i) the equatorward re-location of the upper ridge (with implied reduction in environmental shear), (ii) the development of a weak environmental trough which overlays Tracy's low level circulation, and (iii) the connection between the storm outflow and the mid-latitude westerlies. These environmental circulation changes, which provide very favorable conditions for intensification, are almost identical with those described by Davidson and Kar (2002) during rapid tropical cyclone intensification.
Figure 4 shows the 850 hPa 48 hour forecast from the coarse outer grid and without vortex specification.

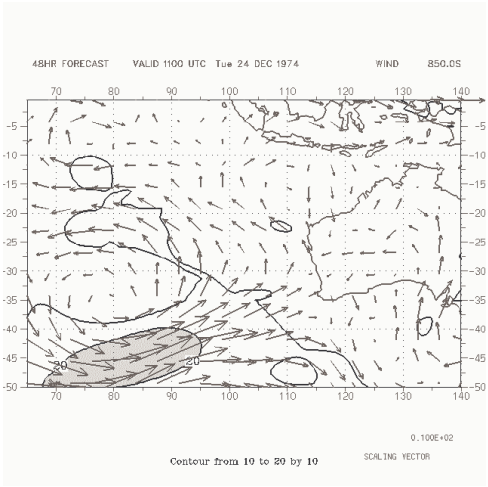

Figure 4. 48 hour forecast 850 hPa wind field valid 1100UTC 24 December 1974.

Of note are : (i) the absence of the Tracy circulation in the forecast, (ii) the acceleration of the monsoon westerly flow over Indonesia, even without a realistic depiction of the Tracy circulation, and (iii) indications of a trough-ridge-trough wave train extending from high latitudes over the Indian Ocean to just south of Java, We propose that this at least modulates the timing and intensity of the monsoon onset.

3. Conclusion

Tracy's landfall at Darwin coincided with the onset of the Australian monsoon. As the monsoon westerlies developed over Indonesia, the storm changed its direction of motion under the influence of the developing monsoon flow. We propose that onset was triggered via an eastward and equatorward propagating wave train at lower and upper levels, which originated from high latitudes. The effect of this process was to establish a weak monsoon structure, which was amplified by local convective processes. Intensification commenced just prior to recurvature and was associated with an upper tropospheric flow transition. During this time, rapid and large scale flow changes: (i) resulted in an equatorward movement of the upper ridge and a reduction in environmental wind shear, (ii) directly influenced the development of Tracy's upper vortex via downstream development of a weak environmental trough, which overlay the low-level circulation, and (iii) provided a connection between the storm outflow and the midlatitude westerlies to form an extended outflow channel.

References

Davidson, N.E. and S.K. Kar, 2002: Upper tropospheric flow transitions during rapid tropical cyclone intensification. *Quart. J. Roy. Met. Soc*., **128**, (in press).

Davidson, N.E. and H.C. Weber, 2000 : The BMRC high resolution tropical cyclone prediction system : TC-LAPS. *Mon. Wea. Rev*., **128,** 1245-1265