14.2 THE RAPID GROWTH AND DECAY OF A LOW-LATITUDE EXTRATROPICAL CYCLONE IN THE CENTRAL PACIFIC OCEAN

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1. INTRODUCTION

Between 0000 UTC 5 November and 1200 UTC 6 November 1986 an extratropical cyclone in the central Pacific Ocean underwent periods of both rapid intensification and rapid decay. The cyclone began this period of fluctuation in intensity at an unusually low latitude (~31ºN) and then progressed northward. In this paper we describe elements of the synoptic evolution of this cyclone, leaving detailed analysis of its short and furious life cycle to the oral presentation. In the subsequent synoptic description we use the operational analyses of the European Centre for Medium Range Weather Forecasts (ECMWF). These data are available on a 2.5 x 2.5 latitude/longitude grid at 17 unevenly spaced isobaric levels.

2. SYNOPTIC DESCRIPTION

At 1200 UTC 4 November 1986 a broad trough at 500 hPa was centered over the central Pacific Ocean (Fig. 1a). This feature was reflected in a similarly broad tropopause-level PV wave (Fig. 1b). Significant thermal wind advection of geostrophic vorticity was located just north of a weak trough in the sea-level pressure field (Fig. 1a).

Twelve hours later, the upper trough (Fig. 2a) and PV fields (Fig. 2b) had sharpened significantly while progressing to south of 30ºN. Intensified PVA by the thermal wind resulted in the development of a sea-level pressure minimum at ~31ºN with a central pressure of 1001 hPa.

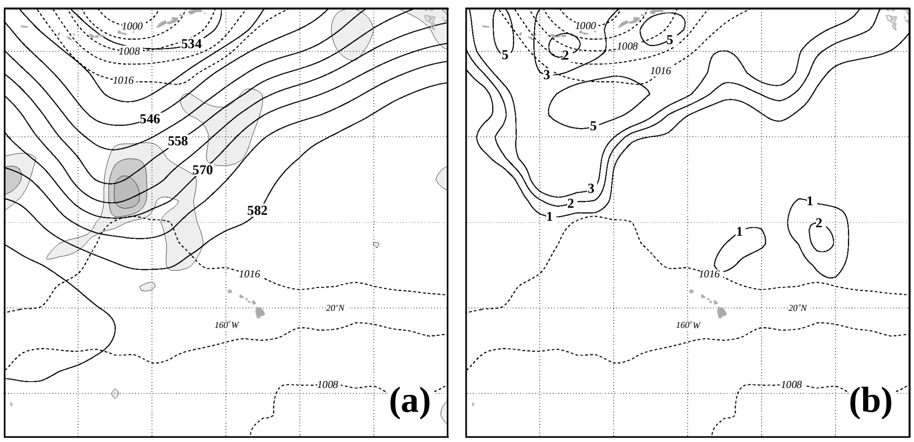

Fig. 1. (a) 500 hPa geopotential height (solid lines), sea-level pressure (dashed lines), and positive 500 hPa geostrophic vorticity advection by the 300:700 hPa thermal wind (shaded) from ECMWF analysis at 1200 UTC 4 November 1986. Geopotential height labeled in dm and contoured every 6 dm. Sea-level isobars labeled in hPa and contoured every 4 hPa to a maximum of 1016 hPa. PVA labeled in units of s^{-2} and contoured every 2 x 10^{-9} s^{-2} beginning at 1 x 10^{-9} s^{-2}. Latitude/longitude grids contoured every 10 degrees.

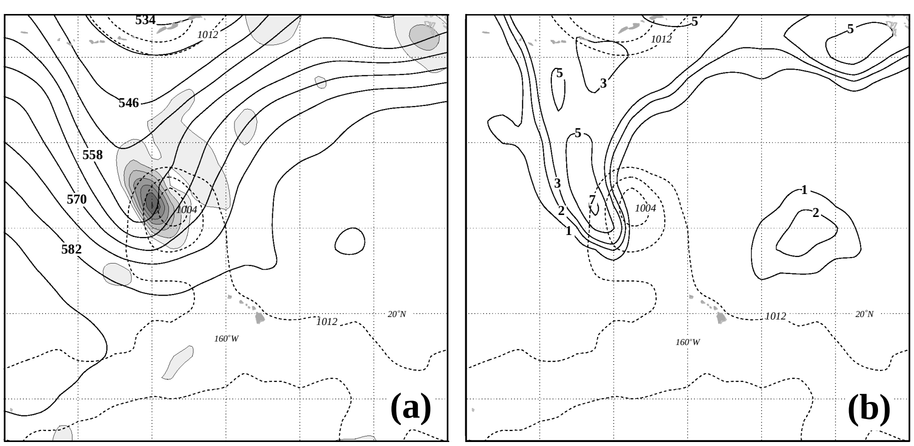

Fig. 2. (a) As for Fig. 1a except for 0000 UTC 5 November 1986 and sea-level isobars are contoured to a maximum of 1012 hPa (b) As for Fig. 1b except for 0000 UTC 5 November 1986.

By 1200 UTC 5 November (Fig. 3), the 500 hPa flow was nearly cut off (Fig. 3a) above the intensified surface cyclone which had deepened to 981 hPa. Coincident with this intensification was the development of a treble-clef shape to the upper tropospheric PV, shown by Martin (1998) to be a signature of a warm occluded thermal structure in the underlying troposphere. During this 24 h period of rapid development, during which the sea-level pressure minimum deepened 35 hPa, the surface cyclone was nearly stationary.

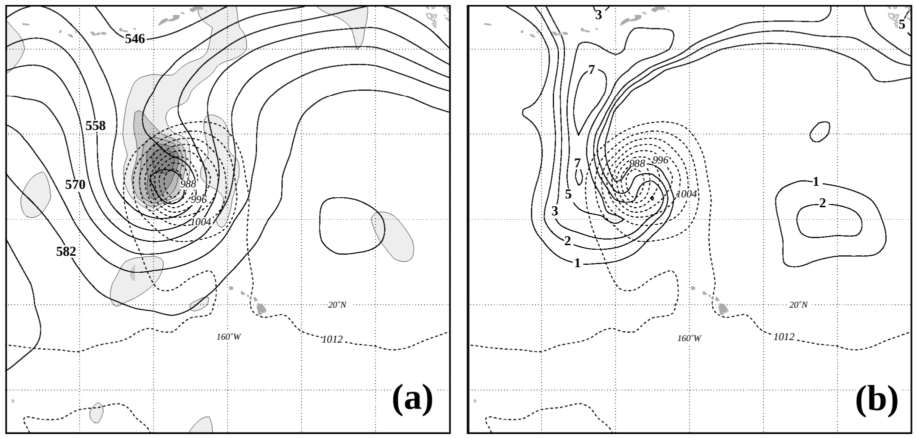

Fig. 3. (a) As for Fig. 2a except for 1200 UTC 5 November 1986. (b) As for Fig. 2b except for 1200 UTC 5 November 1986.

Between 1200 UTC 5 November and 0000 UTC 6 November, the cyclone of interest moved directly northward, maintaining its sea-level pressure minimum, while the 500 hPa cyclone became further cutoff and the tropopause-level PV wave crested and broke. A significant reduction in the magnitude of the tropopause-level PV accompanied this wave breaking (not shown).

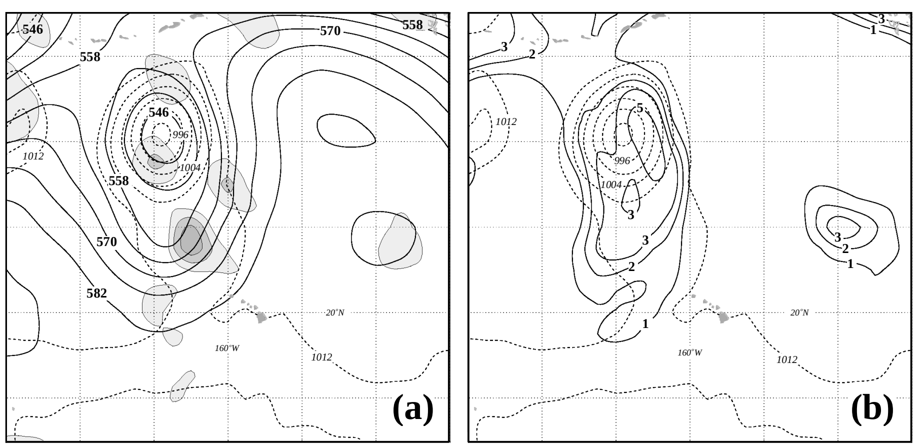

Fig. 4. (a) As for Fig. 2a except for 1200 UTC 6 November 1986. (b) As for Fig. 2b except for 1200 UTC 6 November 1986.

By 1200 UTC 6 November the surface cyclone had moved further northward (to 40º N) and its sea-level pressure minimum had filled to 991 hPa, an increase of 11 hPa in 12 h (Fig. 4a). This filling rate falls just below the threshold value adopted by Martin et al. (2001) in their examination of rapid surface cyclolysis. Also evident in Fig. 4a is the absence of any significant synoptic-scale forcing for ascent in the vicinity of the surface cyclone. The storm was equivalent barotropic by this time as evidenced by the concentric nature of the sea-level isobars and the 500 hPa geopotential height lines. Continued erosion of the tropopause-level PV characterized this 12 h period of surface cyclolysis (Fig. 4b).

3. MODEL SIMULATIONS

In our efforts to diagnose the life cycle of this particular cyclone we have simulated it using version 3.3 of the Pennsylvania State University/NCAR MM5 (Grell et al. 1994). We the used the output from the simulation to perform a piecewise PV inversion diagnosis of this event. In the presentation we will discuss the physical processes involved in producing the unusually rapid growth and decay of this cyclone.

REFERENCES

Grell, G. A., J. Dudhia, and D. R. Stauffer, 1994: A description of the Fifth-Generation Penn State/NCAR Mesoscale Model (MM5).

NCAR Technical Note, NCAR/TN-398+STR, 117 pp.

Martin, J. E., 1998: The structure and evolution of a continental winter cyclone. Part I: Frontal structure and the classical occlusion process. *Mon. Wea. Rev*., **126**, 303-328.

______, R. D Grauman, and N. Marsili, 2001: Surface cyclolysis in the North Pacific Ocean. Part I: A synoptic climatology. *Mon. Wea. Rev.,* **129**, 748-765.