

**Aerological Observations made in the Typhoon KITTY  
by the Central Meteorological Observatory, Tokyo**

by

**H. Arakawa**

*Meteorological Research Institute*

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The Typhoon KITTY of Aug. 27-Sept. 2, 1949, was of great intensity, and the most destructive storm to visit Tokyo in recent years. Over 100 lives were lost as a result of the storm, and estimates of property damage run well over ¥15,000,000, 000 (about \$ 40,000,000).

On the night of Aug. 31, approaching Tokyo from the South, at the speed of ca. 50km/h, the storm centre crossed the KANTO district about 30~50 kms west of the Central Meteorological Observatory (CMO). The Typhoon KITTY was distinguished by at least the following two interesting features:

(a) The storm centre crossed the land short distance west of Tokyo, where the net of Meteorological Observation is fairly dense.

(b) It is fortunate that a good number of radiosonde and wind observations were successfully obtained from the storm area. These observations have made it possible to construct a more complete picture of the vertical structure of a typhoon in a mature stage of development than has been possible before. A radiosonde flight was made at Tokyo near the core of the typhoon.

Many papers concerning the vertical structure of the Typhoon KITTY have been published under several titles. The following note attempts to summarize the salient features of the storm, obtained from all available sources of information, as a possible contribution to future studies of typhoon structure and compare with the former picture of the vertical structure of tropical cyclones as given by E. Palmén and R. H. Simpson.

A number of regular and special radiosonde release was made at stations (CMO, Haneda Weather Central and Aerological Observatory at Tateno) under the influence of this typhoon. Radiosonde flights for the Typhoon KITTY made by the staff of CMO are:

released time and date (135th meridian civil time)	maximum height (m)
Aug. 30, 12:30	15,479
Aug. 31, 09:04	24,697
Aug. 31, 12:20	5,019
Aug. 31, 13:30	5,587
Aug. 31, 15:54	19,097

Aug. 31, 18:49

19,377.....(shortly in advance of the centre of the typhoon KITTY)

Sept. 1, 01:50

16,902

Sept. 1, 11:00

22,036

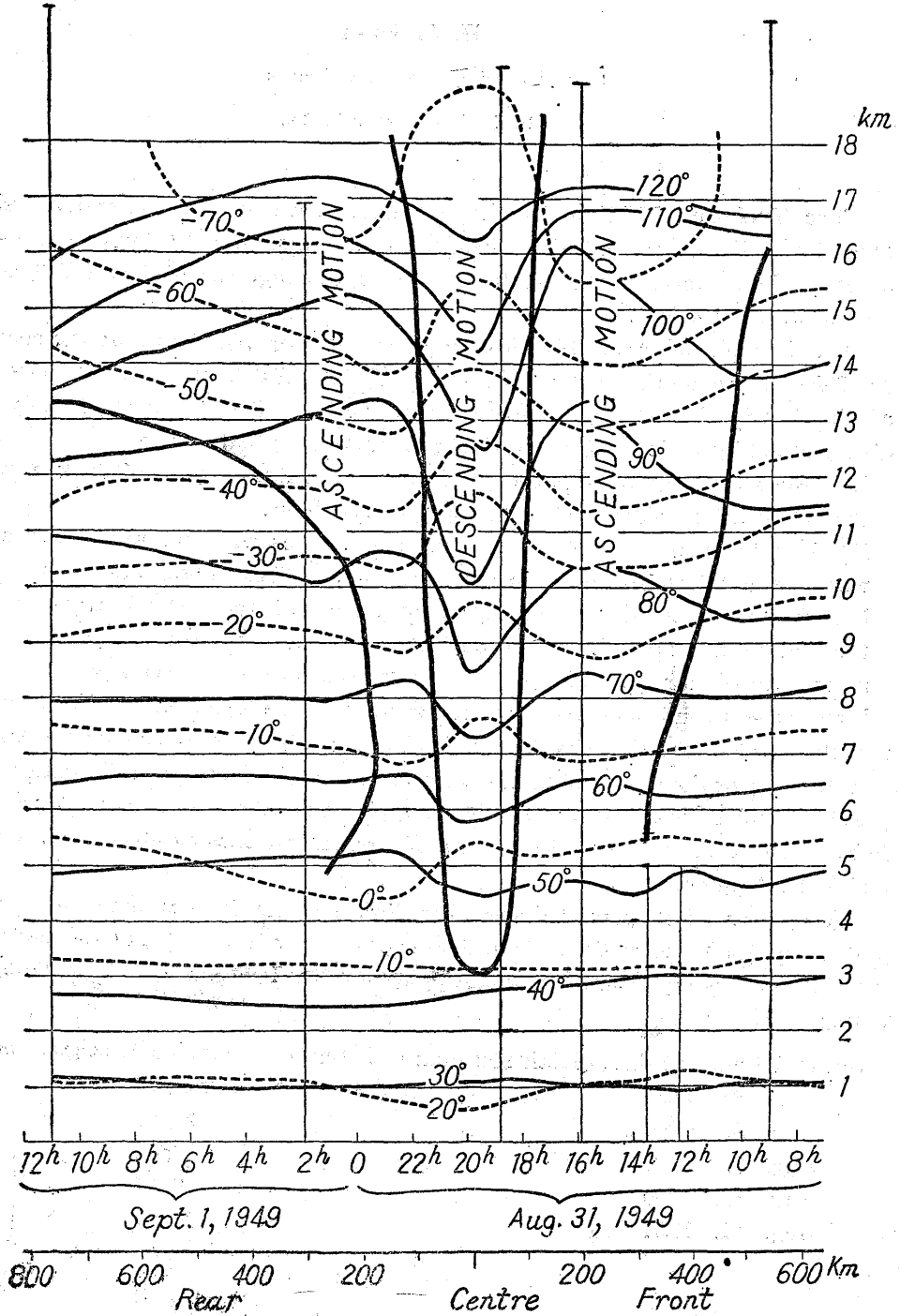


Fig. 1 Time cross section through the Typhoon KITTY.



Fig. 1 is the time cross section showing the distribution of temperature (dotted line) and potential temperature (full line). It would appear that the core of the storm is decidedly warmer, specially at higher levels, than the air columns at 200kms in the front and 300kms in the rear from the centre. And it would also appear that core of the storm is decidedly higher in potential temperature, especially at higher levels. These two features are quite similar with the PALMÉN's cross section, which shows that there is a marked descending motion in the free atmosphere in the very core of the storm. It would appear that the storm region in the front and the rear of the storm is decidedly colder both in air temperature and potential temperature, especially at higher levels, than the air columns at great distance from the centre. The very heavy lines with considerable slope show the boundary surfaces separating two regions of ascending and descending air currents. This is quite different from Dr. PALMÉN's cross section. In stormy region of any tropical storm in a mature stage of development there must be an intense ascending motion, which results the dynamical cooling and the uprush of the isentropic surface. So the vertical structure given for the Typhoon KITTY seems to be more trustworthy than the PALMÉN's cross-section for the Miami-New Orleans hurricane of September 17-21, 1947.

If we suppose that the time cross-section of the typhoon KITTY takes over the role of the *spatial* meridional cross-section of the typhoon KITTY we can conclude some important results. In view of the importance of baroclinity for the dynamics of typhoon, the present author intends to evaluate the variation of the circulation with time  $\frac{dC}{dt} = - \int \frac{dp}{\rho}$ , where  $\rho$  is the density,  $p$  the atmospheric pressure. In order to compute the intensity of the circulation acceleration in the cross section of the typhoon KITTY, one might choose a convenient path of integration consisting of two principal isobars  $p$  and  $p_{-100}$  and two vertical lines  $a$ , and  $a_{+1}$  connecting these isobars indicating the released times for two successive soundings. From the hydrostatic equation, it follows that  $-\frac{dp}{\rho} = g dz = d\psi$ , where  $g$  is the acceleration of gravity,  $z$  the height, and  $\psi$  the geopotential. Integration along the isobars gives zero. Along two verticals, the height differences between two successive principal isobars may be integrated so that

$$\frac{dC}{dt} = \psi \begin{matrix} p_{i-100} & p_{i-100} \\ -\psi & \\ p_{i+1} & p_{i+1} \end{matrix}$$

See: V. BJERKNES, J. BJERKNES, H. SOLBERG u. T. BERGERON, 1933: Physikalische Hydrodynamik, Berlin, Springer, § 41 (3' A).

To evaluate the circulation acceleration, the data including heights of isobaric surfaces for each 100 mb interval from the original soundings are tabulated in Fig. 2, and the isobars for every 100 mb (full lines) and the lines indicating the released times (thin vertical lines) may be drawn in the cross-section of the Typhoon

KITTY. The evaluated height differences are also tabulated in Fig.2. The circulation accelerations are written for each square in metres (geometrical height) instead of dynamic metres (geopotential). Two heavy lines with considerable slope are the axes of low pressure. The descending motion in the core and the ascending motion in the storm region, must receive a retardation owing to the evaluated circulation acceleration, while the original baroclinity loses its intensity. Thus the descending motion in the core and the ascending motion in the storm region are of dynamic origin, other than the circulation acceleration.

The isobaric curves of Fig.2 show clearly that the pressure minimum is progressively decreased with increasing altitude in the troposphere. Above 12~13km, such tendency continues so that the maximum of pressure appears over the region of minimum pressure in the lower layers.

The forward displacement of the pressure minimum at greater heights found by R.H. SIMPSON for the Florida hurricane of October, 1946 seems to be real, while the statistical investigations for extra-tropical cyclones suggest almost reversal model.

#### *References*

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