# Relationship between intensity and duration of tropical cyclones

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Using long-term data for tropical cyclones (TC), estimates of the relationship of their characteristics are made in comparison with model considerations based on the simplest parameterizations. In particular, quantitative estimates of the relationship between the TC intensity and duration in the North-West Pacific Ocean (NWPO) with the use of the RSMC data (http://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/) for the past decades are presented.

Figure 1 shows the dependence of the TC lifetime $\tau$ on their maximum intensity $I$ (maximum $\Delta p$) in the NWPO from the RSMC data for the period 1951-2019. The TC intensity $I$ is characterized by a pressure drop $\Delta p$ at sea level between the background and the TC center similar to [1]. The TC lifetime $\tau$ is determined in days.

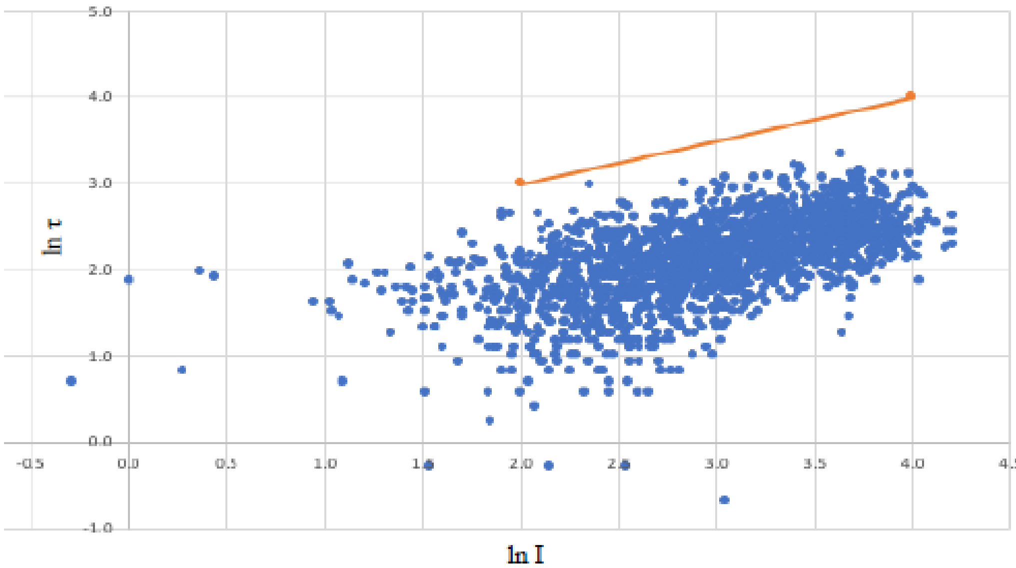


Figure 1. The dependence of the TC lifetime $\tau$ on their intensity $I$ in the NWPO from the RSMC data for the period 1951-2019.

According to Fig. 1, the relationship between $ln\ \tau$ and $ln\ I$ for 1812 analyzed TCs can be approximated by a linear dependence

$$ln\ \tau \sim k\ ln\ I \qquad (1)$$

with $k$ = 0.45 with a correlation coefficient for the corresponding linear regression $r$ = 0.58. The linear dependence (1) corresponds to a power-law dependence of $\tau$ on $I$ ($\Delta p$):

$$\tau \sim I^k\ . \qquad (1a)$$

A similar analysis was made for the relationship between the time ($\tau_i$) of TC reaching its maximum intensity $I$ ($\Delta p$), as well as between the lifetime and maximum intensity of TC that reached extratropical latitudes. In particular, for the corresponding linear regression of $ln\ \tau_i$ on $ln\ I$, according to the data for 1812 analyzed TCs in the NWPO, an exponent $k_i$ = 0.43 was obtained with a correlation coefficient $r$ = 0.43.

The results obtained are close to the estimates presented in [3] for shorter data series for the 20-year period 1970-1989 according to GTECCA. In [3] (see also [2]), the following estimates were obtained: $k$ = 0.50, $k_i$ = 0.44. The statistical results obtained can be explained using a simple model for the development of TC based on the energy balance for the kinetic energy $E_K$ with the simplest parameterizations.

The $E_K$ value increases due to the heat flux from the ocean ($F_H$):

$$\partial E_K/\partial t \sim F_H\,,$$

where $E_K \sim V^2$ with a characteristic wind speed $V$ estimated by the tangential wind speed. The value of $V^2$ for the TC is proportional to the pressure $\Delta p$ ($I$) between the center and the periphery of the TC: $\Delta p \sim V^2$. The heat flux $F_H$ can be parameterized as

$$F_H \sim C_H\, V,$$

where $C_H$ is the heat transfer coefficient, respectively. From (1) it follows

$$\partial V^2 / \partial t \sim V.$$

and the TC characteristic time $\tau$ is proportional to $V$ or

$$\tau \sim (\Delta p)^{1/2}. \qquad (2)$$

Figure 1 shows corresponding to dependence (2) straight line with slope in a good agreement with the general dependence of the lifetime on the intensity of TCs in the NWPO, estimated from the RSMC for the last 7 decades.

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**References**

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