Polar Lows: Statistical relationship between size and duration

Mokhov I.I.[1,2], Poroshenko A.G.[1]

[1]A.M. Obukhov Institute of Atmospheric Physics RAS

[2]Lomonosov Moscow State University

mokhov@ifaran.ru

Statistical estimates of the relationship between the characteristic sizes (R) and the lifetime (τ) of polar mesocyclones (Polar Lows, PL) were obtained according to STARS data (Sea Surface Temperature and Altimeter Synergy for Improved Forecasting of Polar Lows) for the period 2002-2010 [1] (see also [2]). STARS data, based on satellite infrared images obtained using the AVHRR (Advanced Very-High-Resolution Radiometer) instrument, characterize PL parameters over the Norwegian and Barents Seas with hourly resolution.

Figure 1 (a,b) shows characteristic PL maximum and mean size R [km] in dependence on PL duration τ [hours]: $R = R$max (a), $R = R$mean (b). In Fig. 1, different branches can be distinguished for the relationship between the characteristic size and duration of PLs. In particular, it is possible to highlight the features of PLs with $R \leq 200$ km and with $R > 200$ km. Nonlinear features are displayed for the largest PLs in dependence on their duration.
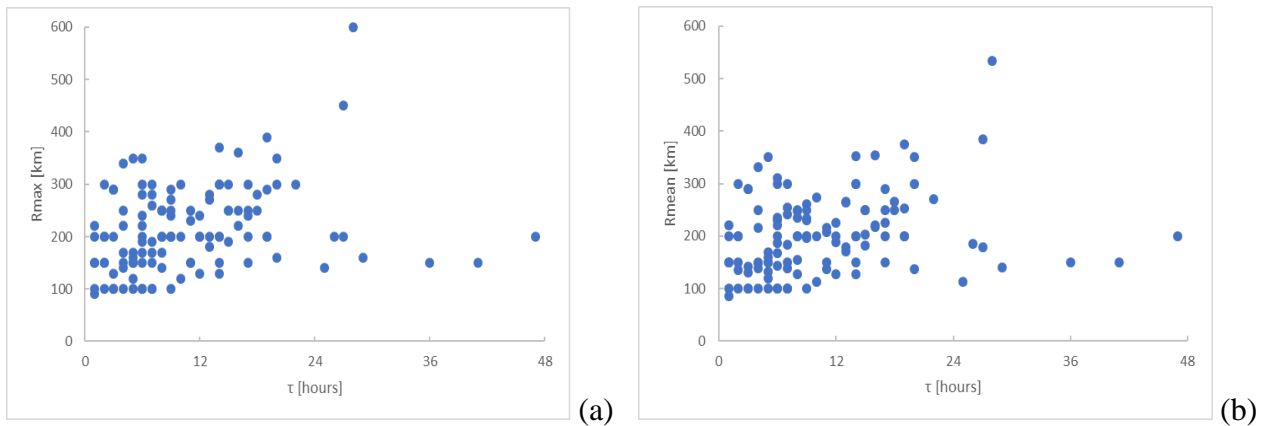

(a)   (b)

Fig. 1. Characteristic PL maximum and mean size R [km] as a function of PL duration τ [hours]: $R=R$max (a), $R=R$mean (b).

Figure 2 (a,b) characterizes PL size R [km] (> 200 km) in dependence on PL duration τ [hours] on logarithmic scales: (a) $ln\,R$max vs ln τ, (b) $ln\,R$mean vs $ln\,\tau$. Linear regressions $ln\,R$max $= a + k_M\,ln\,\tau$ and $ln\,R$mean $= b + k_m\,ln\,\tau$ (lines in Fig. 2) correspond to the dependences Rmax $\sim \tau^{k_M}$, Rmean $\sim \tau^{k_M}$. Blue lines in Fig. 2 (a, b) characterize the linear regressions for all analyzed PLs with $R > 200$ km, red lines correspond to PL with $\tau > 12$ hours, green lines correspond to PL with $\tau > 18$ hours.
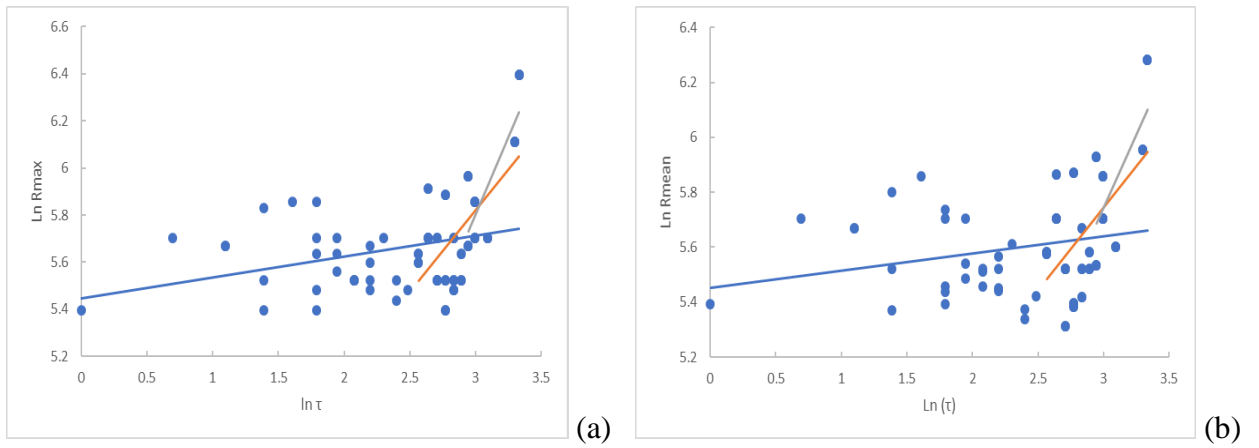
Fig. 2. Characteristic PL size R [km] (> 200 km) in dependence on PL duration τ [hours] :
(a) $ln\ R$max vs $ln\ \tau$, (b) $ln\ R$mean vs $ln\ \tau$.

Table 1 presents the estimates of k_M and k_m with their standard deviations, as well as the correlation coefficients r for the corresponding linear regressions $ln\ R$ on $ln\ \tau$.

Table 1. Estimates of k_M and k_m with their standard deviations for the corresponding linear regressions $ln\ R$ on $ln\ \tau$ (in brackets: correlation coefficients r)

$R > 200$ km	k_M (r)	k_m (r)
$\tau > 6$ hours	0.09±0.04 (0.32)	0.06±0.04 (0.23)
$\tau > 12$ hours	0.69±0.19 (0.64)	0.60±0.20 (0.55)
$\tau > 18$ hours	1.30±0.43 (0.80)	1.07±0.50 (0.69)

The most statistically significant estimates of k_M and k_m were obtained for longer lived PLs (with k_m about 0.6 and k_M about 0.7 for PLs with $\tau > 12$ hours and with k_m about 1.1 and k_M about 1.3 for PLs with $\tau > 18$ hours).

References

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