International Reference Ionosphere (IRI)
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Statistical analysis of wave activity in ionosphere from 2003-2012 Digisonde observations

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Method

Basis is spectral analysis of Ne-variations at different heigts z with the 12 hr Blackman window

We can detect:

Amplitude (both relative and absolute)

Wave frequency ω

Vertical wave number $k_z = \Delta\varphi/\Delta z$

apparent vertical velocity $V_z = \omega/k_z$

We used four criteria to select wave-like disturbances.

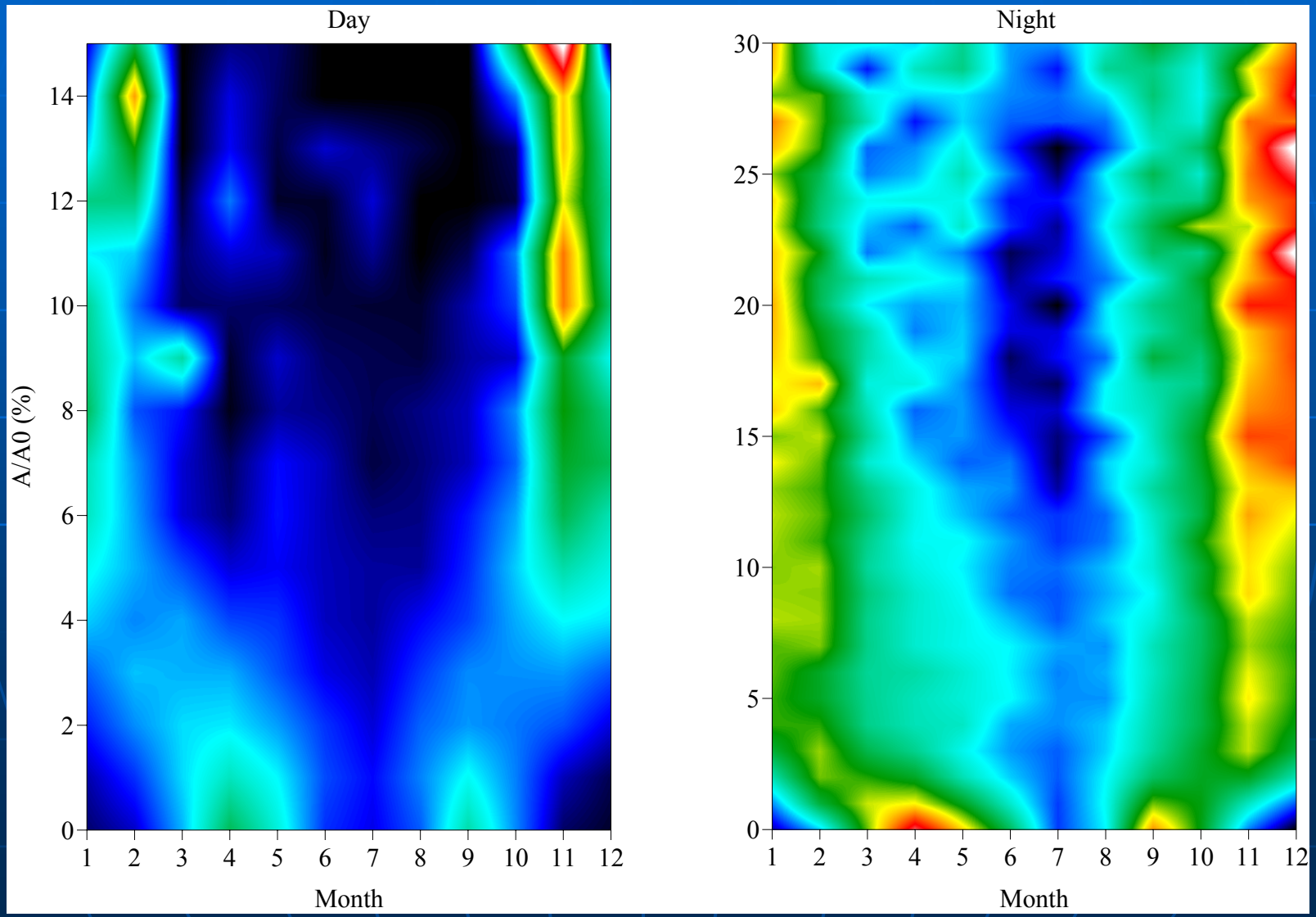
1) The local spectral maxima coincide at three heights as a minimum.

2) The amplitude of local maximum is more than 3% of zero harmonic amplitude.

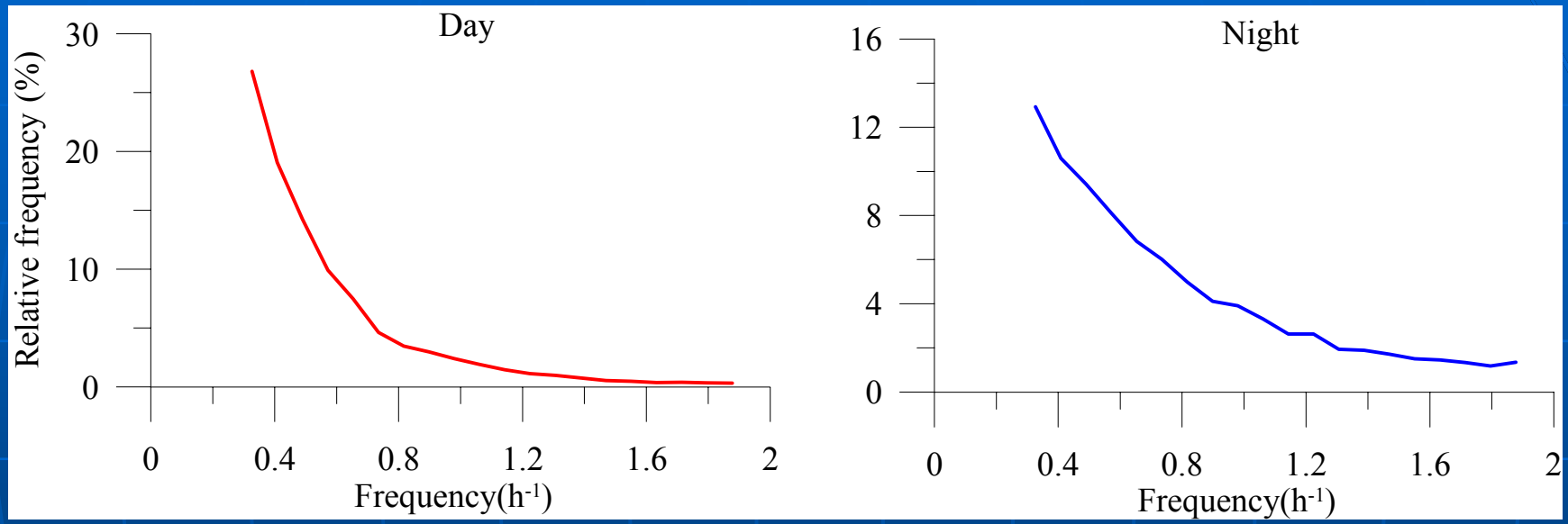
3) The amplitude of local maximum is more than 20 % greater than neighbor amplitudes.

4) The apparent vertical velocity V_z is less then 1000 km/h

Distribution of wave disturbances on months and amplitudes



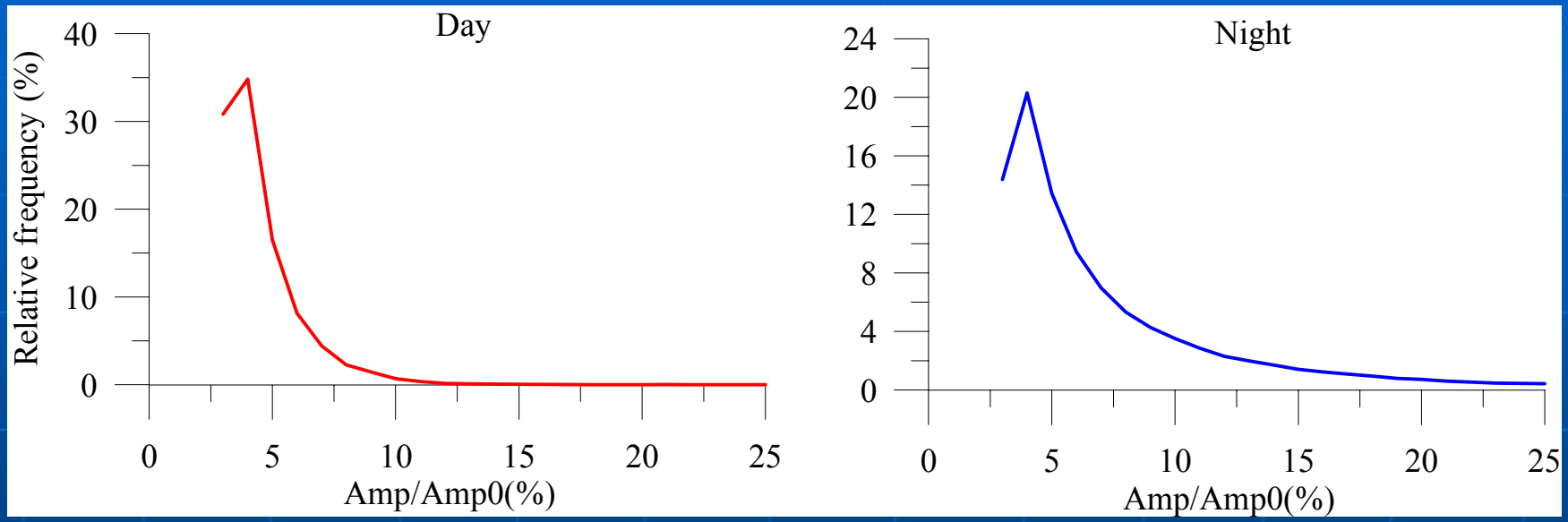
Distribution of frequencies



Relative frequency is ratio of number of disturbances with fixed frequency to total number of disturbances.

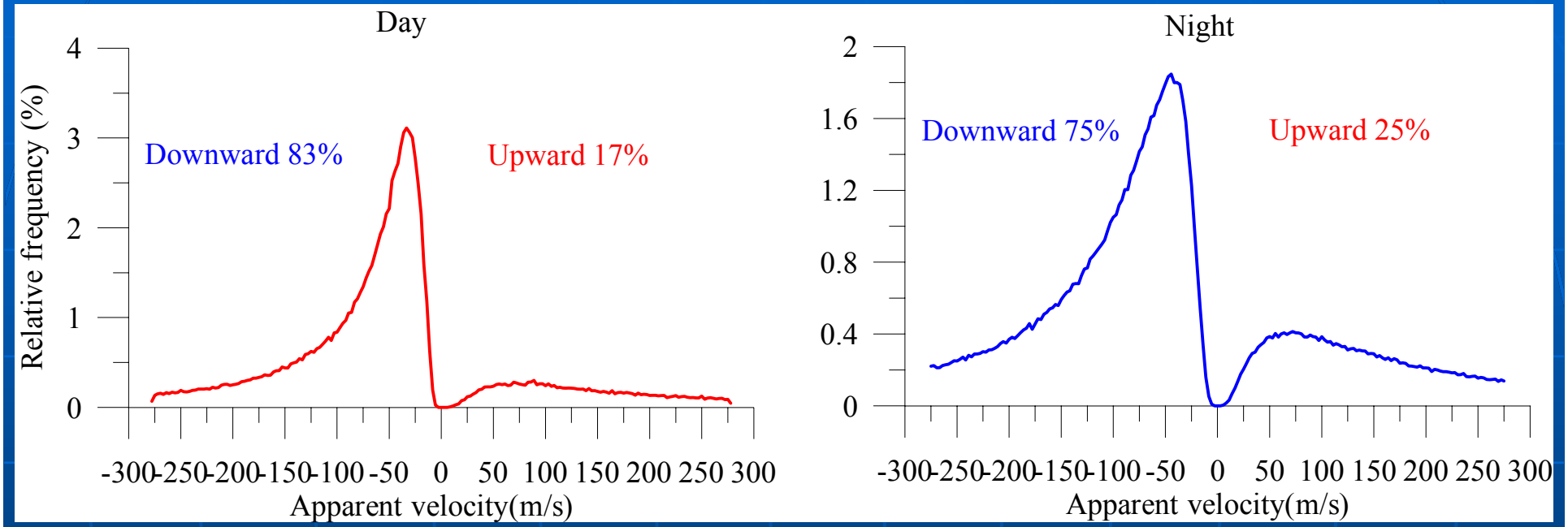
There is an exponential dependence of number of disturbances on frequency.

Distribution of relative amplitudes



Relative frequency is ratio of number of disturbances with fixed amplitude to total number of disturbances.
There are maximums at 4%

Distribution of apparent vertical velocities



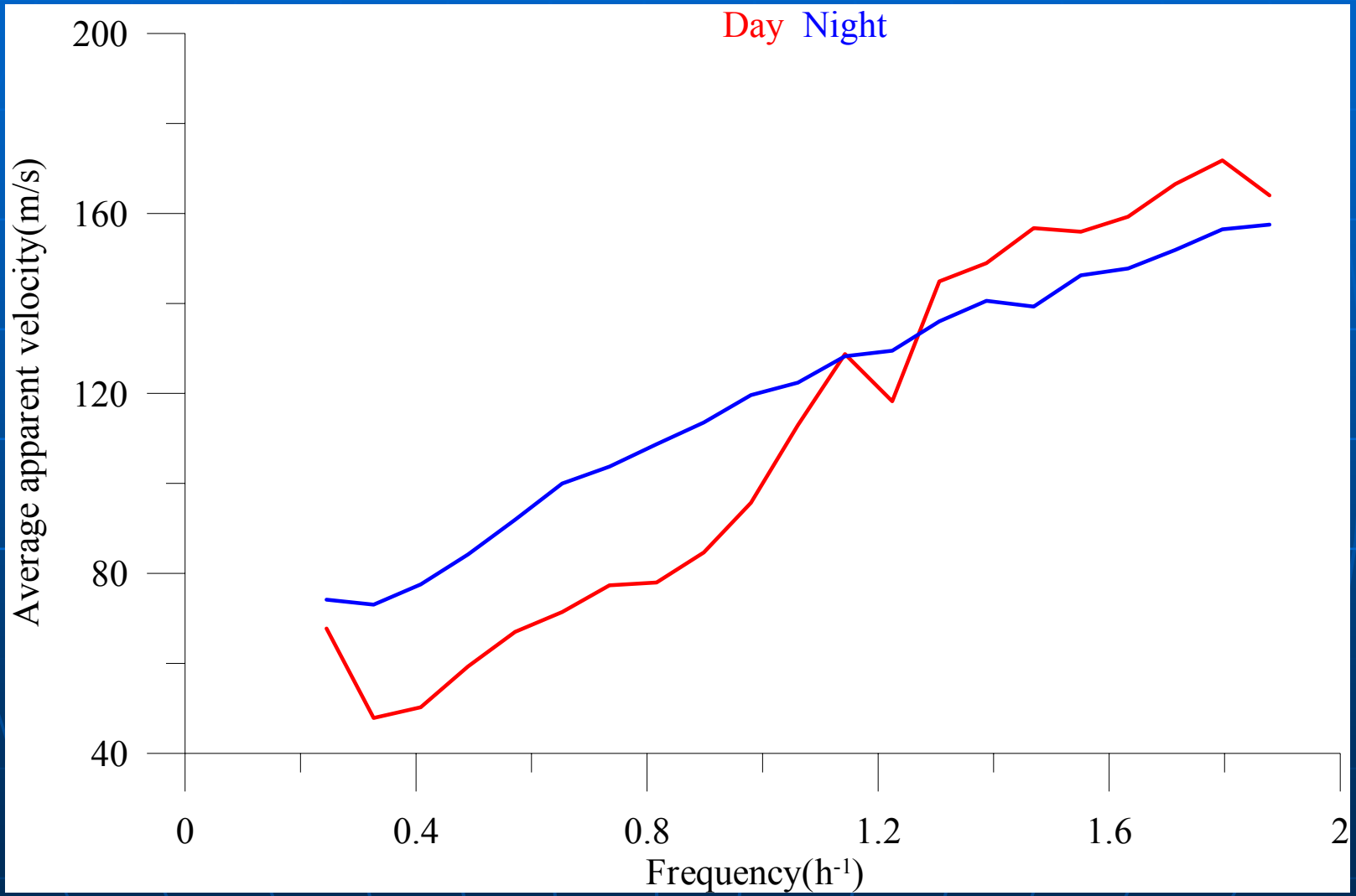
Apparent vertical velocity

Relative frequency is ratio of number of disturbances with fixed velocity to total number of disturbances.

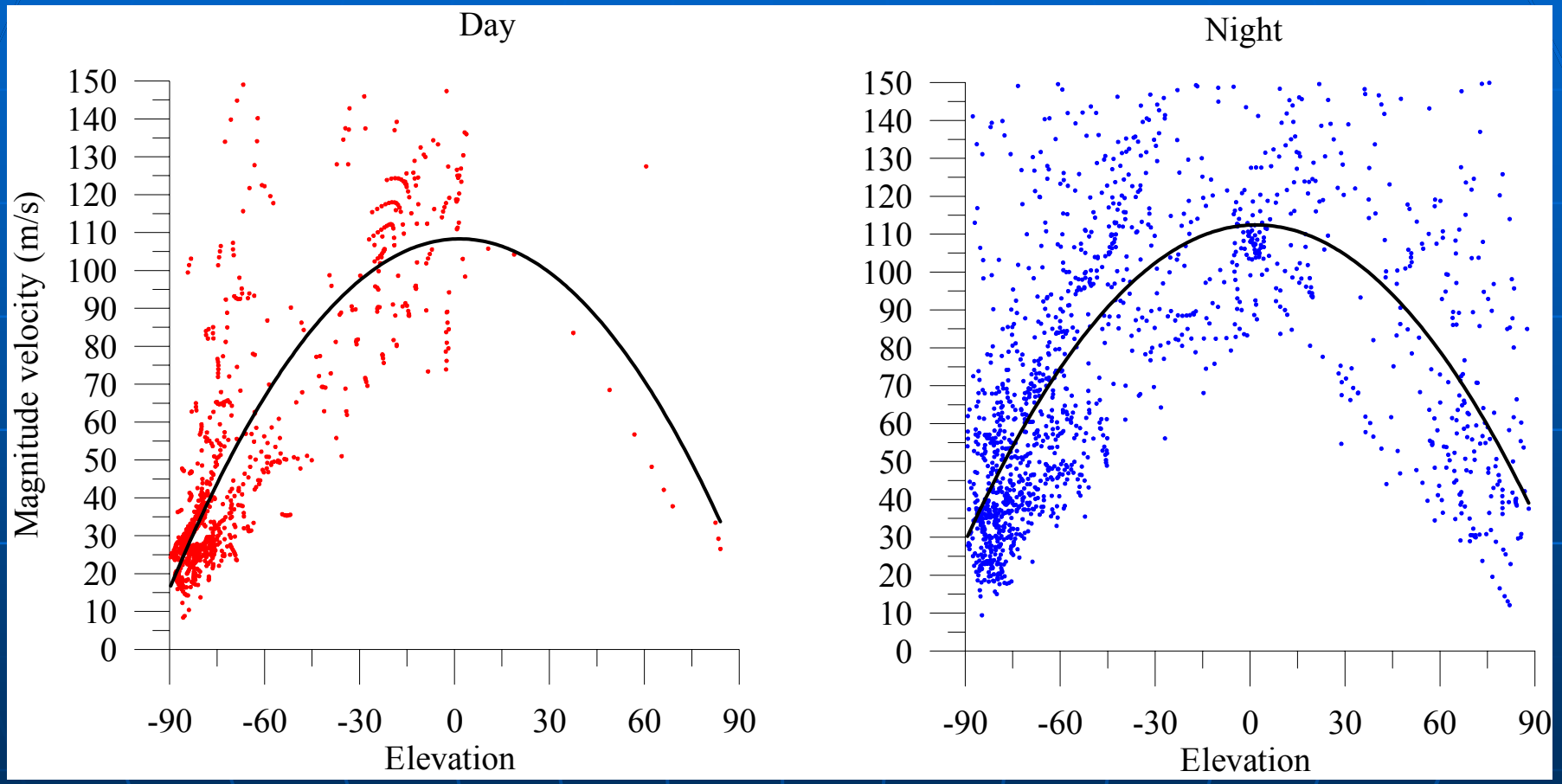
Daytime: Most probable donward velocity -33 m/s

Nighttime: Most probable velocity -47 m/s and upward 55 m/s

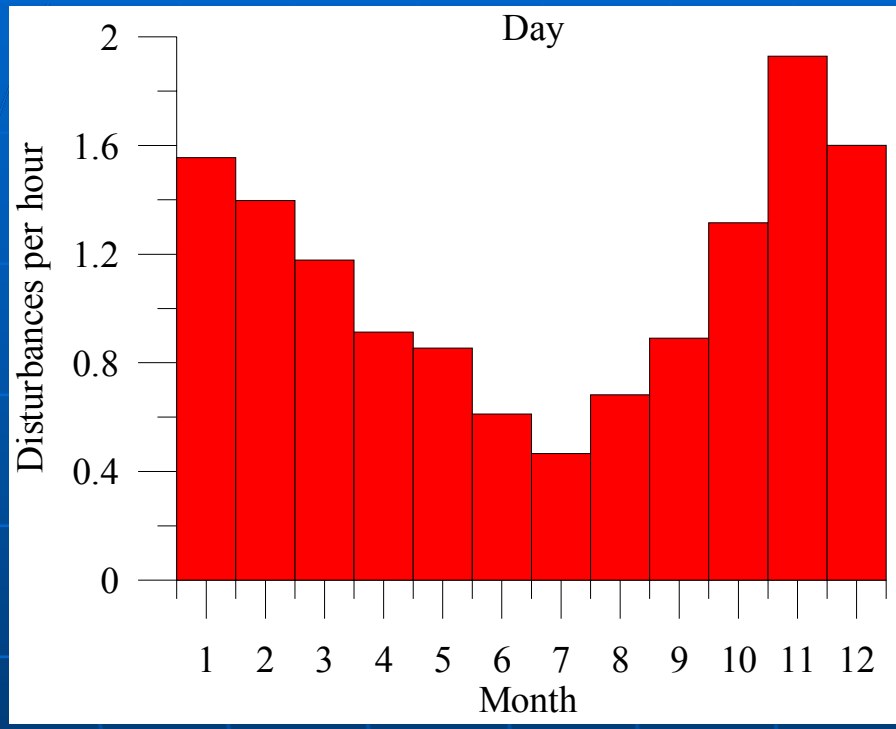
Dependence of average apparent vertical velocity on frequency

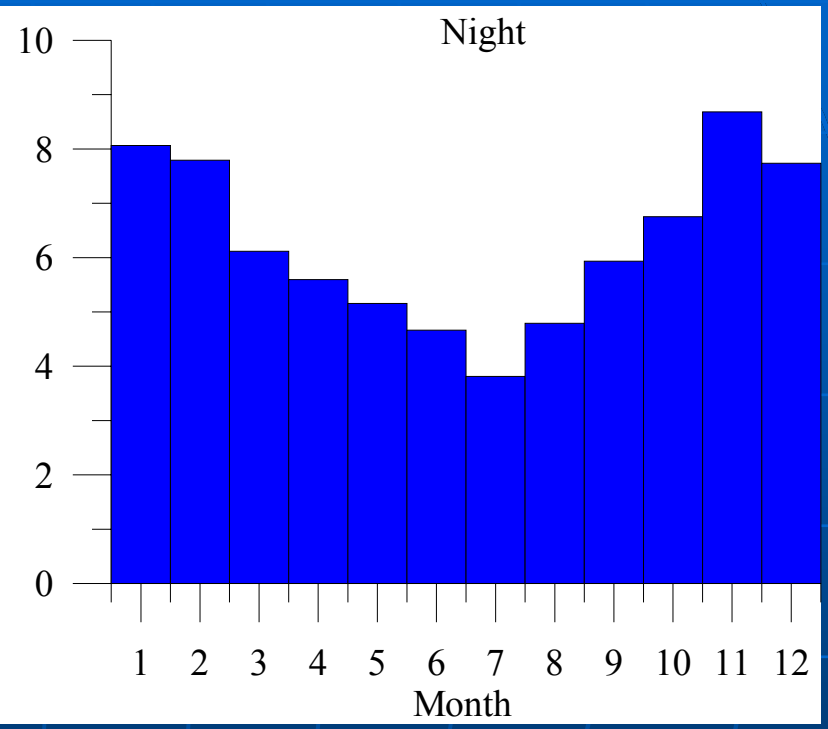


Dependence of TID magnitude velocity on elevation

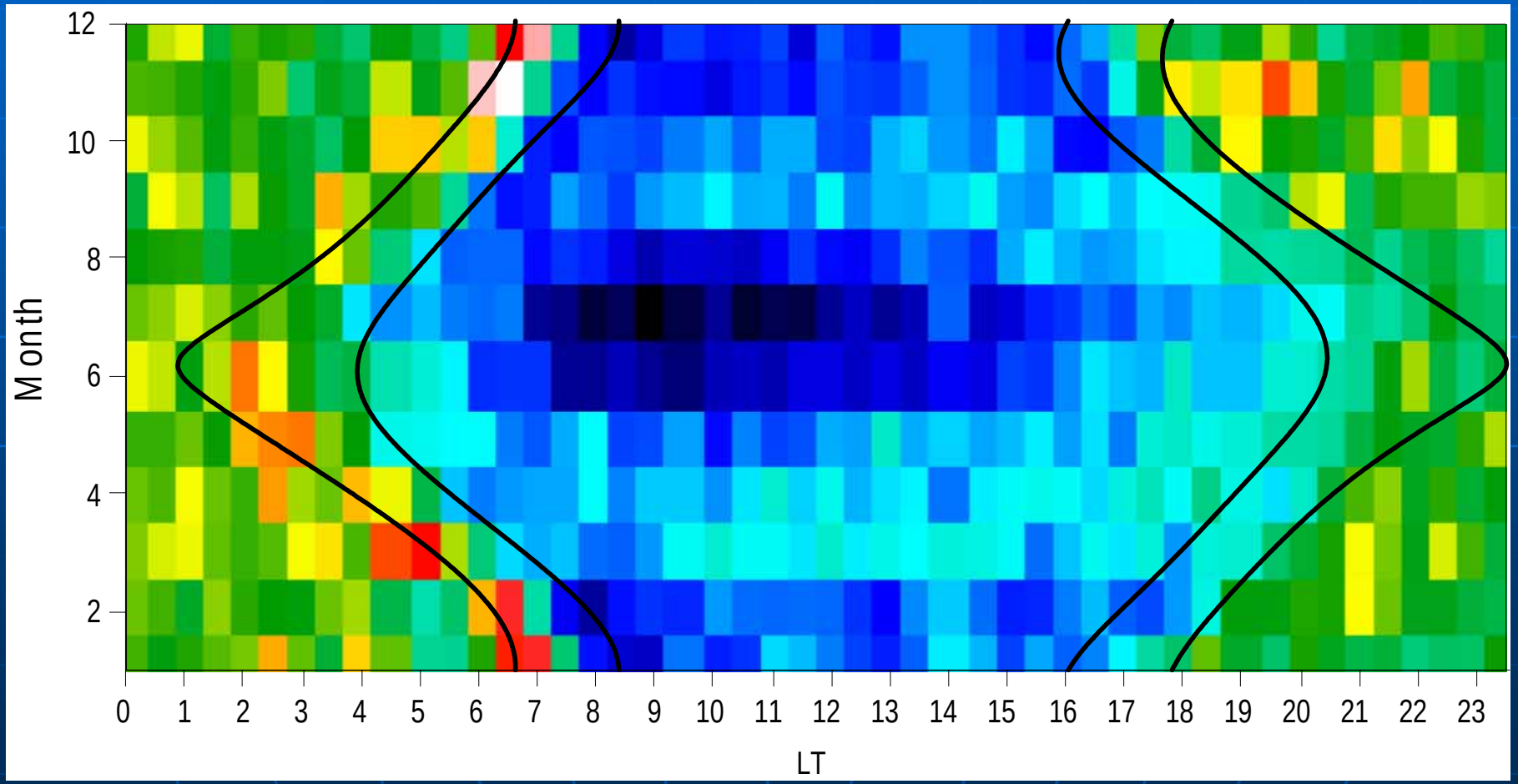


Distribution of wave disturbances on months

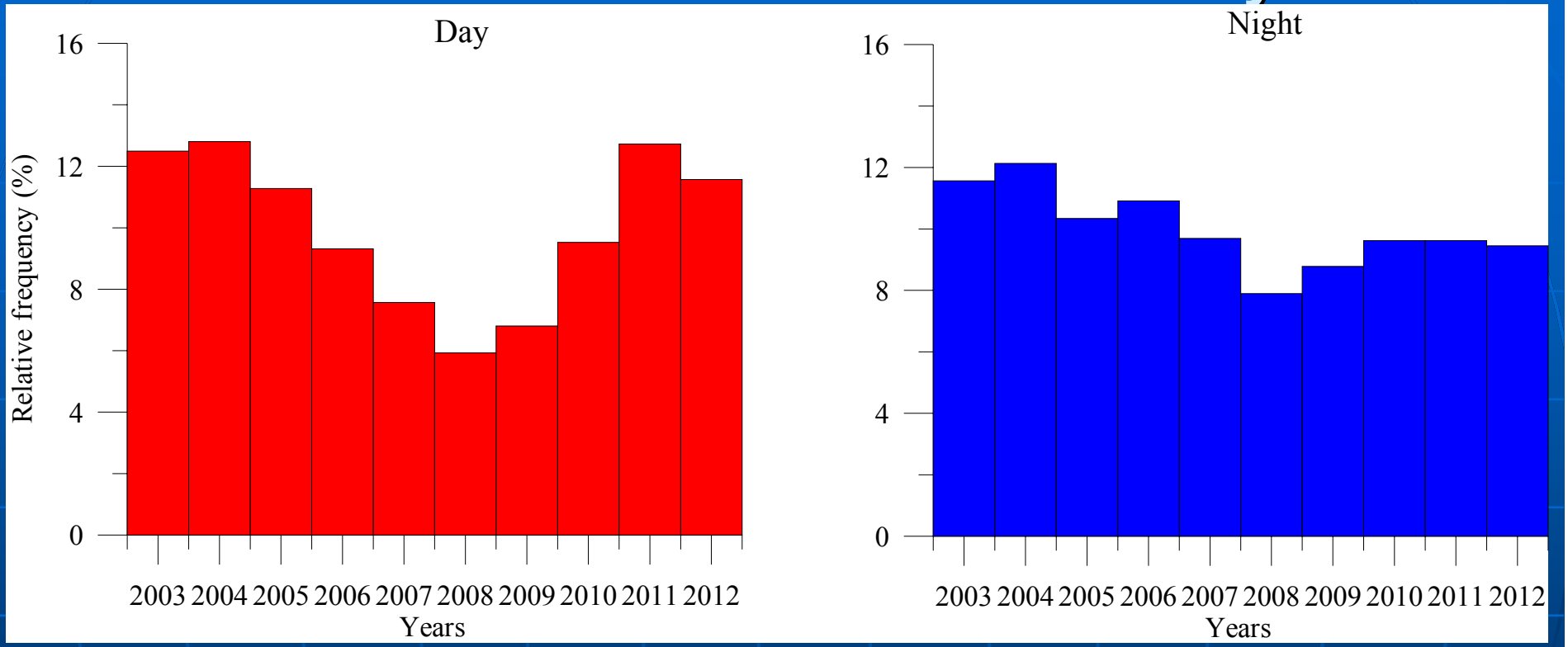




Distribution of wave disturbances on months and LT



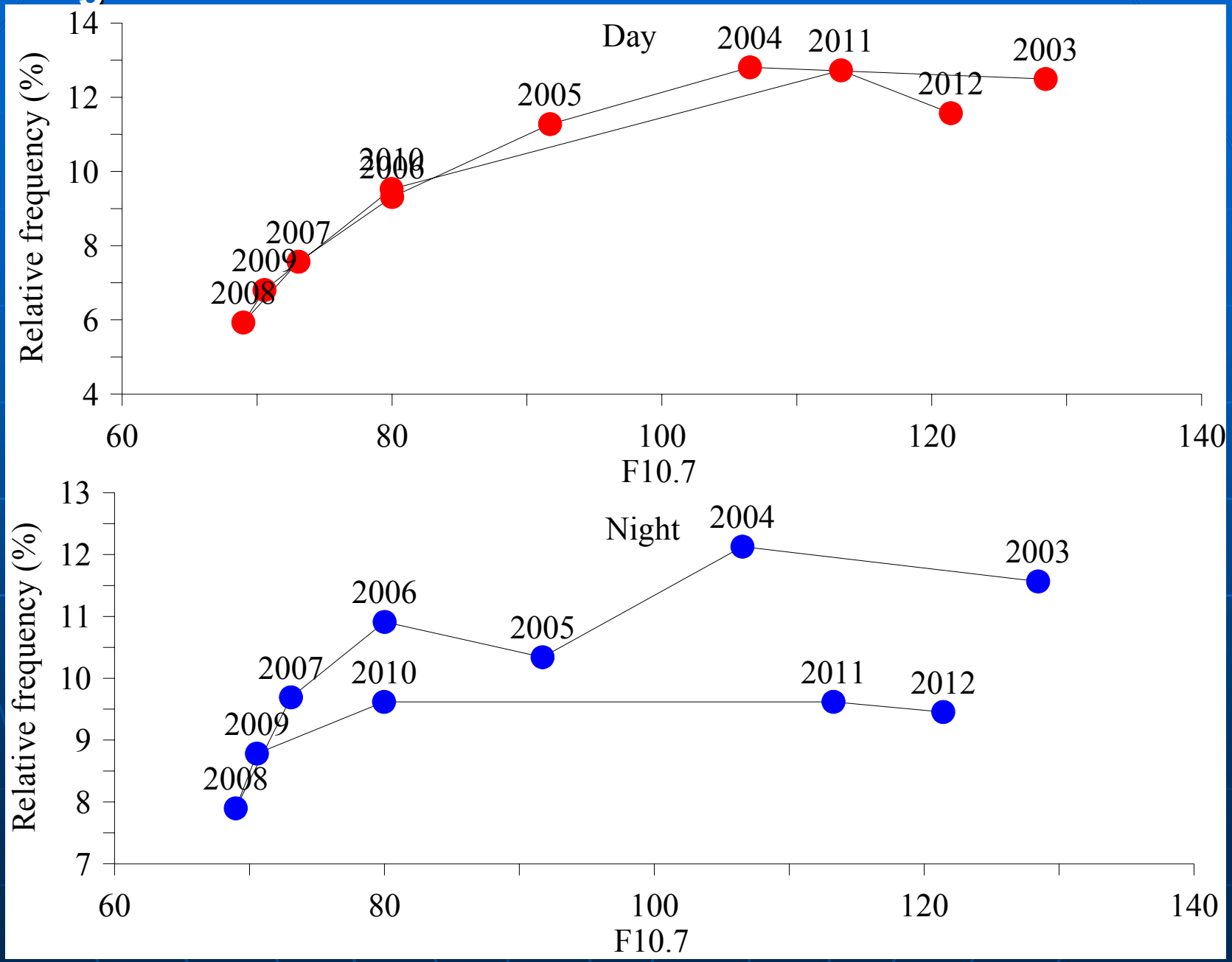
Distribution of wave disturbances on years



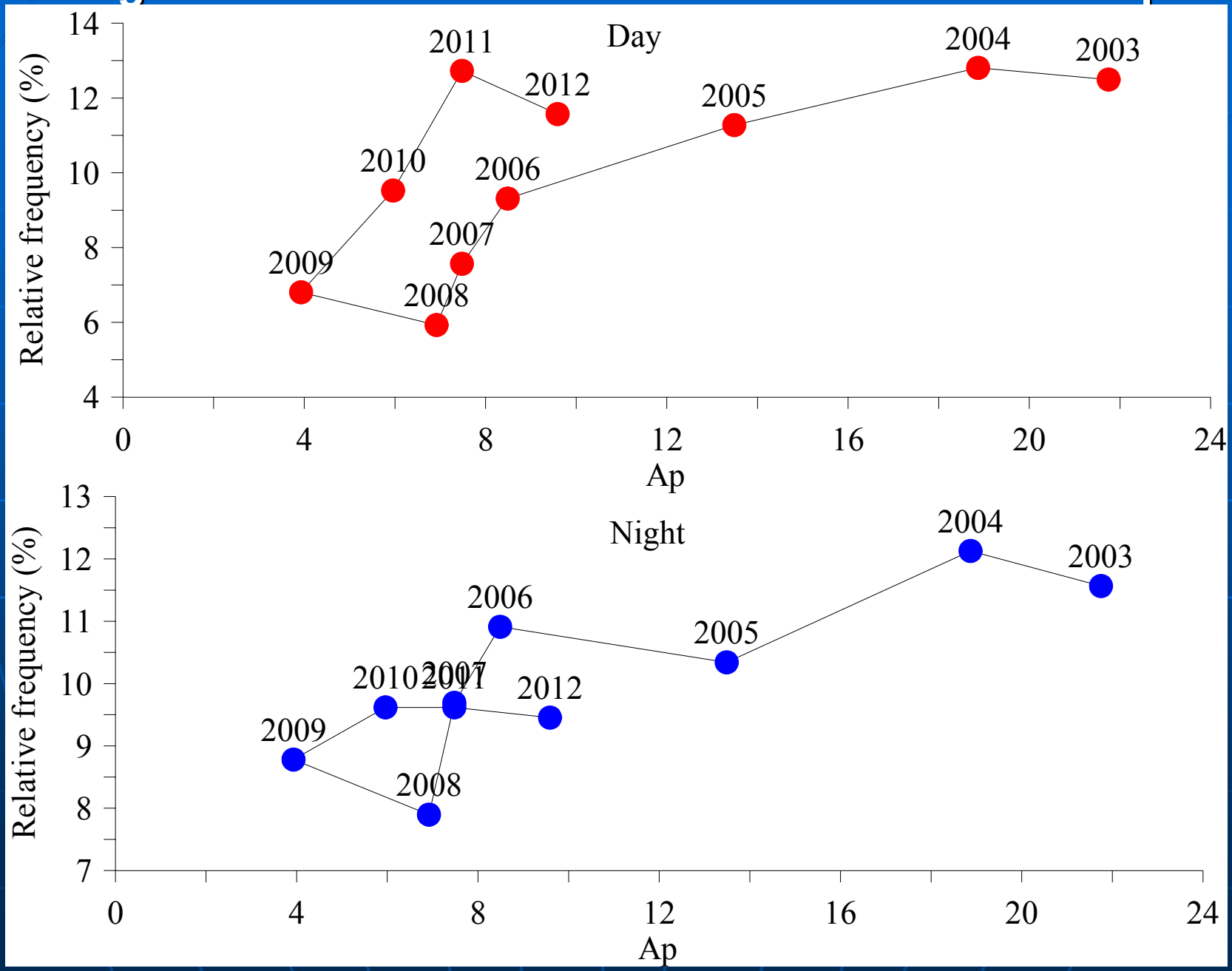
Relative frequency is ratio of number of disturbances at fixed year to total number of disturbances

For the daytime, ionospheric activity levels tend to diminish with decreasing solar activity. For the nighttime, this dependence is much weaker.

Regressions number of wave disturbances on F10.7



Regressions number of wave disturbances on Ap



The main empirical findings

- Apparent vertical velocity increases with frequency. Most likely, the reason is common with dependence of TID magnitude velocity on elevation.
- The most of TID have downward phase velocity, suggesting that the TID sources are below the observed area.
- Seasonal behavior of Number of Wave-like disturbances agrees with seasonal pattern of NmF2 Variability for TID periods (< 6 hrs).
- Number of Wave-like disturbances shows two branches of solar/geomagnetic activity dependence for 23rd and 24th solar cycles.