

MODELLING OF FLUCTUATIONS OF REFRACTIVE INDEX OF ATMOSPHERE

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Propagation of powerful ultra-short pulses in an air is accompanied by the phenomenon of filamentation. Casual fluctuations of refractive index of an atmosphere initiate the small-scale self-focusing. As result it is formed a few of filaments which are located in a plane of cross-section of a beam and begin on different distances from the aperture of the laser system. Thus, at numerical researches of filamentation process of the powerful ultra-short pulses in an atmosphere it is necessary adequate reproduction of fluctuations of refractive index.

For description of influence of the fluctuation of refractive index the phase screen model in which the spectrum of spatial fluctuations of refractive index of an atmosphere is given by the modified Karman spectrum is used.

Influence of an atmosphere turbulence results in casual change of a phase of a wave. The phase screen for simulating the influence of turbulence, has been developed with use of a method of sliding summation [1, 2] in which two-dimensional spectrum of spatial fluctuations of a refraction index can be expressed as:

$$F_n(k_x, k_y, k_z) = 0.33 C_n^2 (k^2 + k_0^2)^{-11/6} \exp(-k^2 / k_m^2), \quad (1)$$

where, k_x, k_y, k_z -is a coordinates in a frequency space; $k_0 = 2\pi/l_0$ and $k_m = 5.95 l_0$ - the minimal and maximal frequency of fluctuations; L_0 , and l_0 - external and internal dimensions of turbulence respectively, and C_n^2 - the structural characteristic of a refraction index of an atmosphere. The spectral density of phase fluctuations on the δ -correlated screen:

$$F_\varphi(k_x, k_y) = 2\pi k_0^2 \Delta z F_n(k_x, k_y, 0) \quad (2)$$

The model of atmospheric turbulence constructed by the specified method describes well the influence of small-scale inhomogeneity on the phase fluctuation of radiation. These fluctuations cause dynamic small-scale self-focusing of a beam which results in formation of multi-fillamentation. The size of maximal inhomogeneity which influence is displayed on the phase screen is limited to the sizes of the screen itself. This circumstance limits an opportunity of the account of influence of the large-scale inhomogeneity of refractive index on a phase of a beam. The increase in the sizes of the screen causes increase in computing resources. On the other hand large-scale inhomogeneity acts on a beam as on a single whole, causing fluctuation of the beam in space. Therefore at research of small-scale self-focusing of a beam it is possible to not take into account large inhomogeneity with the sizes exceeding the size of a beam twice. Taking into account the mentioned above, the algorithm of modelling of phase fluctuations of intensity in a turbulent atmosphere has been developed.

In figure the phase taper values of a radiation field behind the phase screen are presented. Such a phase taper corresponds to passage of an optical path in length of 10m. The parameters used were: structural constant $C_{n2} = 5.0 \cdot 10^{-14} \text{ m}^{-2/3}$, external scale of turbulence $L = 1M$, and internal scale $l = 0.001M$. X and Y lines - numbers of spatial cells with step of 0.0003 m. Z axis - the size of a phase taper in radians. Apparently from the figure the large-scale perturbation of refractive index have led to the general positive phase taper on which small-scale fluctuations are imposed. Here on x/y plane the lines of equal phase tapers are shown. More dark lines correspond to smaller phase tapers.