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Using the phenomenon of backscattering enhancement for lidar sounding of a turbulence as a mathematical problem

M I Fortus and **A S Gurvich**
A M Obukhov Institute of Atmospheric Physics - RAS, Russia

The phenomenon of backscattering enhancement (BSE) lies in the fact that the intensity of radiation scattered exactly backward at the source point exceeds that of radiation scattered by the same obstacle in the absence of turbulence. The enhancement is due to the fact that radiation scattered exactly backward has propagated twice through the same turbulent inhomogeneities of the refractive index. The BSE coefficient $\mathbf{K}^E$ found from measurements is a ratio of the mean intensity of radiation scattered exactly backward by a small obstacle in a turbulent medium to the mean intensity scattered at a small angle to this direction. The BSE coefficient is a function of $\boldsymbol{L}$ (t*he* distance between the lidar and the center of the scattering volume $\mathbf{K}^{(E)}= \mathbf{K}^{(E)}(L)$) and is correlated with the turbulent structural parameter $\mathbf{C}n^2(r)$ (where ^{r} is the coordinate along the sounding laser beam) by the Volterra ill-posed integral equation of the first kind, $\int^1_0 Cn^2 (L.\xi).\kappa er(L, \xi)d\xi = const\ (\boldsymbol{K}^{(E)}(L)\text{-}1)$, $0 \le L \le L_{max}$ where ^{ker} $(L\ .\ \xi)$ is the kernel of the integral equation and const is a known as constant. The BSE coefficient inevitably contains noises which are to be filtered out, otherwise even the presence of the lowest noises will lead to inadmissibly large distortions in solving the ill-posed equation (**A**). A matrix equation, which is a discrete analogy of the Volterra equation $\mathbf{A}\ .\ \mathbf{X} = \mathbf{Y}$, is considered. (^{A} is an ill-posed triangle matrix on the order of **Q,** ^{X} and ^{Y} are the ^{Q}-dimensional vectors, ^{Y} being the measured value containing noises). It is supposed that the components of the vectors ^{X} and ^{Y} are the positive random variables mutually independent and identically distributed with mean values equal to one and variances equal to one too. The problem of statistical filtration of noises is considered for the class of $\mathbf{C}\mathbf{n}^2$ solutions describing a sharp transfer to high turbulence. The procedure of filtering noises, which makes it possible to estimate the transition zone, is proposed and the intensity is estimated.

Biography

M I Fortus has completed her PhD from the Institute of Atmospheric Physics - RAS. She is the Senior Staff Scientist at this institute. She has published more than 40 papers in reputed journals.

mfortus@ya.ru

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