Scintillation theory for very long and intermediate paths. Comparison with experiments.

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The theory of wave parameters fluctuations in a turbulent media was mainly developed about 40 years ago. In recent set of experiments fluctuations of the intensity were measured for the different path lengths (up to 150 km) and different optical wavelengths. Intensity fluctuations may be caused by two different effects: random focusing-defocusing (only this mechanism works in the case of plane wave) and random beam wandering. Filtering of the experimental data allowed separation of these two effects and comparison of the results of these experiments with the theoretical results for the weak, strong, and intermediate fluctuations of a plane wave. We derived an interpolation formula which connects the range of weak fluctuations and the asymptotic regime for the range of saturated fluctuations. To determine the level of optical turbulence for experimental conditions, C_n^2, we used both statistical data and numerical weather model WRF. These two estimates agree well to each other. On the base of these data we performed calculations of the fluctuations of intensity and intensity correlation functions for the conditions in which experiments were conducted. Because all experiments were conducted in the range of saturated fluctuations, the results for the relative intensity variance were almost independent of estimates of C_n^2. We found that they are in the excellent agreement with the existing theory. We found that measurements of intensity fluctuations for long paths cannot be used for estimates of C_n^2, which are necessary for most applications, which depend on phase fluctuations. The measurements of variance of angle of arrival performed by Hartmann sensor would be much more useful.