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Editorial: Optical wave propagation and communication in turbulent media

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Editorial on the Research Topic
Optical wave propagation and communication in turbulent media

Optical waves are known to be degraded when they propagate in turbulent land atmosphere, marine atmosphere, ocean and tissue. Degradation in the optical wave causes changes in various received beam characteristics, which in turn results in the loss of intended performance level of the systems used in such turbulent media. Within this concept, beam spreading, beam wander, intensity fluctuations, pointing error, signal-to-noise ratio and bit-error rate performance of optical wireless communication, laser radar, imaging and similar systems used in the presence of atmospheric, marine, oceanic and tissue turbulence are being investigated.

To compensate and mitigate the degradation, and thus to improve the system performance, various techniques involving the use of aperture averaging, partially coherent source, different optical beam profiles and adaptive optics are investigated. The nature of turbulence phenomena in land atmosphere, marine atmosphere, ocean and tissue, in terms of the power spectrum, provides information on how much kinetic energy is contained in the turbulent eddies versus the spatial frequency.

Various power spectrum models valid in different media are proposed and there are still investigations to extend spectra to cover detailed physical conditions. Statistics of turbulence in weak, moderate and strong turbulence regimes and the applications of the statistics in formulating optical wave parameters are also being examined. Basic formulations are studied to cover correlations of the amplitudes, phases of the fields and additionally the correlations of the field intensities. Experimental works on the turbulence phenomena itself, the effects of turbulence on the optical wave propagation and the systems performances are indispensable part of the research in this area. In the turbulence evaluations, system configurations such as horizontal, vertical and slant paths also play important roles.

In this Research Topic some of the above mentioned and other original contributions that display new turbulence features and effects on the optical beams are covered.

In this Research Topic, paper *Mitigating the cross talk of orbital angular momentum modes in free-space optical communication by using an annular vortex beam and a focusing mirror* Cao et al. examines the probability density analysis of single orbital angular momentum (OAM) mode of an annular vortex beam with a focusing mirror in a turbulent atmosphere. The effects of different parameters on the OAM spectrum are investigated numerically. In the paper *The behavior of partially coherent twisted space-time beams in atmospheric turbulence* Hyde IV, together with a correction applied to this paper in *Corrigendum: The behavior of partially coherent twisted space-time beams in atmospheric turbulence* Hyde, the study is on how atmospheric turbulence affects twisted space-time beams, which are non-stationary random optical fields whose space and time dimensions are coupled with a stochastic twist. The paper *Combining beams in different locations for aerospace defense in a turbulent atmosphere* Liao et al. a method by arranging many high-power systems with adequate distance in a defense area is proposed and the intensity distribution and the energy irradiated on the target are studied and compared with a fixed laser system. In the paper *Multistep ahead atmospheric optical turbulence forecasting for free-space optical communication using empirical mode decomposition and LSTM-based sequence-to-sequence learning* Li et al., a hybrid multi-step prediction model for atmospheric optical turbulence is proposed by combining empirical mode decomposition, sequence-to-sequence, and long short-term memory network. The paper *Evolution of the orbital angular momentum flux density of partially coherent vortex beams in atmospheric turbulence* Zhang et al. investigates the behavior of the orbital angular momentum (OAM) flux density of partially coherent vortex (PCV) beams in atmospheric turbulence.

About the future of the field of optical wave propagation and communication in turbulent media, especially the developments in the research fields of all optical networks and internet of things are foreseen to play important roles. In this respect, searching the ways and means of reaching reliable performances of optical wireless systems in very long and extremely high data bit rate links operating in atmosphere and in underwater media seems to shape our future communication core and access networks.

Author contributions

Editorial is written by the Research Topic Editor PB.

Conflict of interest

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