HOW AEROSOLS INFLUENCE THE OPTICAL WIRELESS COMMUNICATION LINKS

The ever-increasing demand for faster internet demands may cause regime shift from existing Radio Frequency technology to higher bandwidth light-based telecommunication systems like optical wireless communication, where more data can be transmitted with lesser power. Optical pulses propagating through the atmosphere experience scattering and absorption losses imparted by gas molecules and aerosols and intensity fluctuations induced by atmospheric turbulence . Moreover, they are subjected to an increase in their pulse widths, as different wavelength components travel at different velocities. This leads to interference (overlapping of pulses) and sets a maximum limit to the reliable data transfer rate. While the absorption and scattering losses can be easily modelled and compensated, it is difficult to model the turbulent fluctuations.

A recent study using balloon and satellite observations along with radiative transfer computations show that, over and above these losses, aerosol-induced atmospheric heating leads to an additional broadening in optical pulses by modifying the turbulent fluctuations. A higher absorption of solar radiation by aerosols can lead to more pulse broadening. Narrow pulses, due to their wider frequency spectra, are more vulnerable to such aerosol effects while the broader pulses are more resilient. This enhanced pulse broadening due to aerosols will reduce the anticipated performance and ultimately set limits on improving the efficiency of terrestrial as well as ground-to-satellite links.

Reference: K. Sunilkumar, N. Anand, S. K. Satheesh, K. Krishna Moorthy, G. Ilavazhagan, Enhanced optical pulse broadening in free-space optical links due to the radiative effects of atmospheric aerosols, Optics Express, 2021, https://doi.org/10.1364/OE.409794

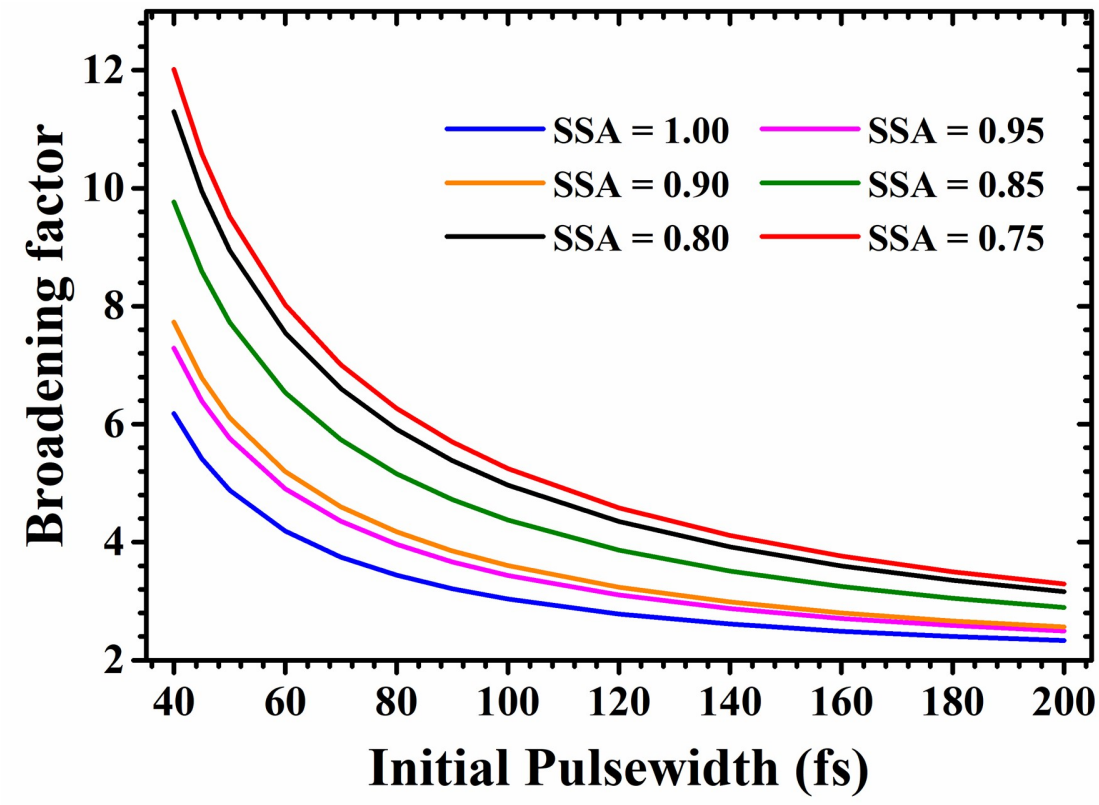

Fig. Variation in optical pulse broadening factor (ratio of received to input pulse widths) for different initial pulse widths and aerosol single scattering albedo (SSA). SSA is a ratio of absorption by the aerosol to the sum of absorption and scattering.