Propagation of Ultrashort, Intense Laser Pulses Through the Atmosphere

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Abstract: The propagation of ultra-short (~100 fs), intense (~10–100 TW/cm²) laser pulses in the atmosphere is rich in nonlinear physics and may have a broad range of applications from remote sensing of chemical and biological agents, induced electrical discharges, and directed energy applications. Experiments using terawatt pulses with durations less than a picosecond demonstrate the formation and long-distance propagation of plasma and optical filaments, white light generation, and the emission of far out-of-band secondary radiation. Controlling the propagation of these laser pulses over long atmospheric paths is scientifically and technologically challenging. In this talk, we discuss the various physical mechanisms governing the atmospheric propagation of ultrashort laser pulses and report on several theoretical, computational, and experimental studies carried out by the Naval Research Laboratory (NRL). These studies include recent experiments demonstrating extended channeling through very strong atmospheric turbulence enabled by nonlinear self-focusing of laser pulses in air. In addition, we discuss theoretical considerations for increasing the laser power that can propagated through the atmosphere.

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Short Bio: Dr. Peñano is the Head of the Directed Energy Physics Branch in the Plasma Physics Division of the Naval Research Laboratory. His research interests include: high-energy and high-intensity laser physics; atmospheric propagation of high-energy and ultra-short pulse lasers, interactions of intense ultra-short lasers with dielectric materials, and laser plasma physics. His recent work involves the modeling of intense laser propagation through the atmosphere and its applications. He received his Ph.D. in Plasma Physics from the University of California, Los Angeles in 1998 and was a National Research Council Fellow at the Naval Research Laboratory before joining NRL’s Plasma Physics Division in 2000.