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# SPACEBORNE LASER FILAMENTATION: A NEW REMOTE SENSING TOOL FOR ATMOSPHERIC SPECTROSCOPY?

**Abstract**

Laser filamentation, resulting from the nonlinear propagation of intense ultra-short laser pulses in the atmosphere, has matured significantly over the last decade to become a promising tool for future space-borne lidar missions. In this technique, femtosecond laser pulses with optical power levels in the terawatt-scale propagate over long distances in the atmosphere thanks to a dynamic competition between the optical Kerr effect focusing the beam and the induced plasma effect defocusing the beam. This results in the formation of thin plasma filaments where efficient nonlinear phenomena take place, including self-phase modulation leading to the generation of a coherent supercontinuum ranging from the ultraviolet to near infrared wavelengths in the atmosphere, which could allow multispectral lidar information to be obtained using a single laser source.

In this work, we present the first proof-of-concept of space-borne laser filamentation for atmospheric remote sensing. Our results indicate that altitudes for filament formation and supercontinuum generation ranging from ground to 45 km can be reached by changing the initial pulse power, beam radius and beam curvature on board a spacecraft orbiting at a 400-km altitude. The theoretical model includes a realistic representation of the stratified atmosphere and accounts for multi-species ionization and the dependence of air density upon the molecule type and altitude profile. We demonstrate the remote generation of a white light continuum extending from 350 nm to 1.1 $\mu$m within the filament, hereby proposed as an atmospheric in-situ light source for monitoring atmospheric species on a global scale by light detection and ranging (lidar) techniques. We find that operating conditions for the proposed space-borne femtosecond lidar concept are already available with current ground-based mobile laser technology and within reach of future space laser systems.