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Diurnal Observations of Wildfires Boundary Layer Dynamics and Aerosol Plume Convection using Stereo-Imaging Techniques

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Wildfires have posed increasing risks to human health and loss of life and property. Observations of wildfire remain limited, particularly the plume variables such as injection height and wind velocity critical to assessing wildfire impacts. Lack of adequate spatiotemporal coverage and measurement accuracy hinder predictability and initialization needed by weather and chemical transport models. The new observations from the emerging stereo wind and aerosol imaging techniques with LEO-GEO and GEO-GEO satellites offer an unprecedented opportunity to study wildfire dynamics and evolution processes in great detail. The diurnal coverage of the GEO-GEO winds stereo products (Carr et al., 2020, 2019, 2018) and the daytime coverage (and detail) of GEO multi-angle aerosol products (Limbacher et al., 2021; In Prep) can capture and further our understanding of intense wildfire dynamics (e.g., pyroCb), planetary boundary layer (PBL) variations, and direction of aerosol loadings. Using two new satellite-based stereoscopic tracking algorithms, we compare stereo observations directly with the Coupled WRF-CMAQ simulations (Zou et al., 2019) to diagnose the modeled plume injection height and wind velocity, and aerosol properties (Friberg et al., 2021; In Prep). The validated LEO-GEO winds and height algorithm provides plume dynamics data with an accuracy of 200 m vertical resolution for plume height and 0.5 m/s for plume speed. Using these stereo algorithms, we can determine if fire plumes stay within or shoot above PBL, which plays a critical role in plume transport and air quality. From the GEO-based observations of dynamic wildfire aerosol loading dispersion, height, and winds, we can track wildfire development at a sub-hourly frequency and capture extreme and/or rare events such as pyroCb that often occur in a short period of time and are largely missed by LEO satellites.

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