

Advancing High-Resolution Monitoring of Wildfire Plume Evolution and Long-Range Smoke Dispersion

Author: Joseph F. Marino (josephmarino@unr.edu)

Mentor: Dr. Neil P. Lareau

Department of Physics, University of Nevada, Reno

Wildfires pose significant ecological and public safety risks across North America, particularly in the western United States. As climate change drives increases in wildfire frequency and severity, there is a growing need for high-quality, rapid observations of fire behavior and plume evolution. Through support from the HDRFS grant, a field-ready pickup truck has been fully outfitted as a mobile platform for wildfire data collection, including a Doppler LiDAR system and supplemental instrumentation. Previously presented under active modification, the vehicle is now fully operational and has been used extensively for wildfire monitoring and related field deployments. We present the range of applications enabled by this platform and highlight the datasets collected to date, including high-resolution LiDAR scans, radiosonde launches, GNSS measurements, and meteorological observations. The Doppler LiDAR provides detailed aerosol backscatter and line-of-sight velocity data, enabling three-dimensional reconstruction of wildfire plumes. A stabilizing mount allows the LiDAR to maintain a level orientation or be directed toward specific targets. The integrated GNSS system supplies vehicle pitch, roll, yaw, position, and velocity metadata essential for precise LiDAR scan processing. Additionally, a deployable meteorological station records wind speed and direction, temperature, humidity, barometric pressure, and solar irradiance. This mobile field platform enhances fast-response wildfire research by delivering high-resolution, multi-sensor datasets that support both operational wildfire management and scientific investigations of plume dynamics and smoke dispersion.