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# High-altitude Airborne Remote Sensing of Wildfire Emissions

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A number of recent studies suggests that significant improvements in air-quality from environmental regulations might be lost as emissions from wildfires fires become dominant in certain regions, such as the Western United States, offsetting the decrease in anthropogenic emissions. Smoke from landscape fires is a significant air pollution source, that directly and indirectly affects both air quality and climate. As the size and frequency of landscape fires and their potential effects on climate and human populations grow, a more comprehensive understanding of the fundamental coupling of meteorology, fire dynamics, and biomass burning emissions becomes essential. There is a critical need for high-resolution observational constraints from remote sensing measurements on end-to-end fire processes. Smoke plume height, in particular, is an important factor for local and regional air quality modeling. Pollutant emissions, if injected at higher elevations, are likely to be transported out of the local burn site by prevailing winds and can thus affect air quality for both nearby and remote populated areas in the downwind direction.

We will focus on remote sensing observations of fire energetics, smoke plume heights, and smoke properties from NASA's ER-2 high-altitude research aircraft and discuss links between in-situ smoke characterization and large-scale satellite observations. Specifically, we will introduce the joint NASA/NOAA Fire Influence on Regional to Global Environments and Air Quality (FIREX-AQ) Field Campaign that took place in the Western United States in the summer of 2019 to evaluate effects of North American fires on air-quality and climate. The remote sensing package on the ER-2 consisted of seven instruments that provided large-scale, high-resolution observations of effective fire temperature, plume rise, and characteristics of emitted gaseous and particulate pollutants. We will describe hyperspectral, lidar, and multi-angle, spectropolarimetric remote sensing data collected during the campaign, present innovative data analysis approaches, and discuss latest scientific results regarding smoke evolution during the Williams Flats Fire in Washington and the Sheridan Fire in Arizona in comparison with near-coincident ground-based and satellite observations. The presentation will outline requirements on combined advanced remote sensing techniques for connecting fire energetics, plume rise, and downwind smoke properties for improving parametrizations in air-quality models.

**Keywords**: smoke, plume heihjt, AirMSPI, CPL, eMAS, AVIRIS

**References**

[1] Warneke, C., et al. (2023), Fire Influence on Regional to Global Environments and Air Quality (FIREX-AQ), Journal of Geophysical Research, doi:10.1029/2022JD037758
[2] Peterson, D. A., et al.(2022), Measurements from inside a Thunderstorm Driven by Wildfire: The 2019 FIREX-AQ Field Experiment. Bull. Amer. Meteor. Soc., 103, E2140–E2167, https://doi.org/10.1175/BAMS-D-21-0049.1
[3] Brodrick P. G, D. R. Thompson, M. J. Garay, D. M. Giles, B. N. Holben, and O. V. Kalashnikova (2022), Simultaneous characterization of wildfire smoke and surface properties with imaging spectroscopy during the FIREX-AA field campaign, Journal of Geophysical Research, 127(7):e2021JD034905. doi: 10.1029/2021JD034905, 2022
[4] Midzak N., J. E. Yorks, J. Zhang, J. A. Limbacher, M.J. Garay, and O. V. Kalashnikova (2022), Constrained retrievals of aerosol optical properties using combined lidar and imager measurements during the FIREX-AQ campaign, Frontiers in Remote Sensing, Front., Volume 3, https://doi.org/10.3389/frsen.2022.818605