Isolating and Disseminating Core Updraft Structures for the 2019 FIREX-AQ Campaign using Observations from an Airborne Doppler Lidar

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An intensive data collection period to address the impacts of wildfires on the environment as well as the role that the environment has on wildfire development was cooperatively led by NOAA and NASA during the Fire Influence on Regional to Global Environments and Air Quality (FIREX-AQ) campaign in July-August, 2019. A component of this effort was to vertically sample areas where active wildfires were reported using a micro-pulsed Doppler wind Lidar system mounted on a Twin Otter aircraft. This was accomplished by targeting different wildfires across the broader Boise, Idaho (USA) area through different sampling strategies. The relatively slow cruising speed (60-m/s) of the Twin Otter and the high vertical (62-m) and temporal resolution (10-Hz) of the micro-pulsed Doppler wind Lidar offered a unique opportunity to sample the fine structure of updrafts and plumes extended over wildfire sources. Two sampling modes were available to probe the wildfires that included a motion compensated stare at nadir and a 15 degree off nadir conically scanning velocity azimuth display (VAD) configuration. While the VAD setting allowed for the determination of the inflow/outflow structure near wildfires, the nadir pointing configuration detailed the updrafts/downdrafts embedded in the plume.

The central theme of this presentation is to illustrate and showcase an approach for isolating updrafts within the broader plume structure in order characterize not only the core strength of updrafts within the plume, but to examine the lateral entrainment properties, plume geometry, and the horizontal and vertical structure of the updrafts. Spatially isolating updrafts from the rest of the flow allows for the proper identification of the interface where lateral entrainment occurs, and therefore allows one to determine the eddies produced at the flanks of the updraft as the parcel ascends. Examining the vertical and horizontal variability of the updraft will be key when quantifying the role that lateral entrainment has on the vertical velocity profile of the updraft and the mixing characteristics across the width of the plume. The application of this method has been expanded to most flights during the campaign effort, and thus offers some insight about updrafts during different stages of development for different wildfire sources.

The application of novel techniques, such as the one described in this study, is part of a growing trend to demonstrate how isolating information that is otherwise masked can lead to a better understanding of highly dynamic conditions that often challenge models and modeling assumptions. In this example, the statistical quantification of convective sources will assist in providing a roadmap about how to treat mixing processes of a parcel with its environment during ascent, and thus will pave the way for improvements in parameterizations such as that found in mass flux components and plume rise formulations which depend, at a minimum, on the buoyancy structure, lateral entrainment, and the overall wind profile. These improvements in turn should lead to improvements in local and long range transport central to air quality modeling.