Analysis of Multi-Exponential Decays in Cavity Ringdown Spectroscopy

Nick Wagner[1,2], Matt Richardson[1,2]
[1] *NOAA Earth System Research Laboratory, 325 Broadway, Boulder, CO 80305, USA*
[2] *Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, CO 80309, USA*

In cavity ringdown spectroscopy, the decay of optical power in a high finesse cavity is typically described by a single exponential, and cavity ringdown instruments are designed and operated to minimize any multi-exponential character. However, multi-exponential decays are frequently encountered in several situations: higher-order spatial modes from misalignment, non-optimal mode-matching, absorption features with spectral details that are finer than the laser spectrum, non-uniform mirror reflectivity, and co-adding of many decays. In this report, we analyze ringdown decays using a multi-exponential fit function and quantify errors arising from non-exponential decays. Specifically, we use an aerosol extinction cavity ringdown spectrometer to quantify aerosol extinction at elevated relative humidity. At 662 nm, water vapor, which has spectral features finer than laser bandwidth, interferes with the aerosol measurement. We show how a multi-exponential fit function can be used to remove this interference and to quantify errors due to misalignment.