Investigating Below-cloud Rain Evaporation and Boundary Layer Moisture Recycling by Coupling Stable Water Isotopes in Vapor and Precipitation to Raindrop Size Distributions at the Boulder Atmospheric Observatory Site

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The moisture balance of the continental boundary layer plays an important role in regulating the exchange of water and energy between the surface and the atmosphere, yet the mechanisms associated with moistening and drying are both poorly observed and modeled. Measurements of stable water isotope ratios can provide insights into air mass origins, convection dynamics and mechanisms dominating atmosphere-land surface water fluxes. Profiles can be exploited to improve estimates of boundary layer moistening associated with evaporation of falling precipitation and contributions from surface evapotranspiration. We present two years of *in situ* tower-based measurements of isotope ratios of water vapor (δD and $\delta^{18}O$) and raindrop size distributions from the Boulder Atmospheric Observatory (BAO) tall tower site in Erie, Colorado at the surface and 300m. Isotope vapor measurements were made at 1 Hz with a full cycle from the surface to 300 meters recorded every 80 minutes. In addition, water samples were collected during precipitation events at the surface and 300m. Raindrop size and velocity measurements were made continuously during precipitation events using Parsivel instruments located at the surface and 300m. Aggregate raindrop size measurements suggest that the profile shifts from smaller raindrops at 300m to larger raindrops at the surface, contrary to what is expected for rain evaporation. We use this unique suite of measurements and, in particular, exploit the differences between the surface and 300m observations on an event-by-event basis to constrain the hydrological mass balance during and after rain events, and evaluate parameterization choices for rain evaporation and moisture recycling processes in current climate models.

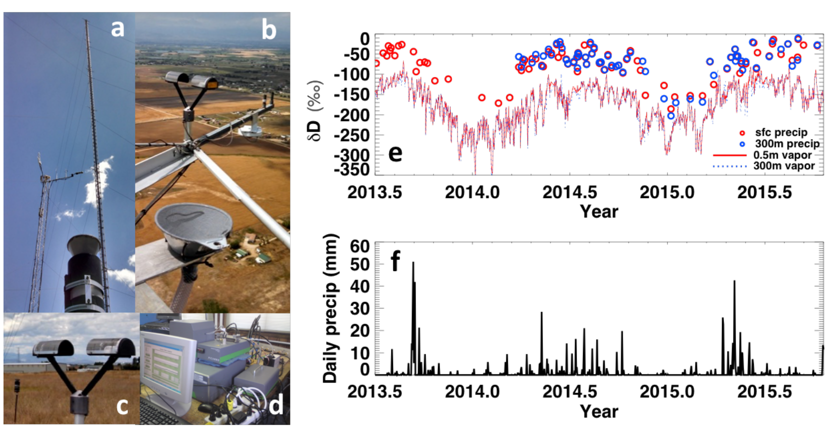

Figure 1. (a) Surface precipitation collector & University of Colorado meteorology tower at BAO site; Collector and Parsivel at (b) 300m & (c) surface; (d) Picarro water vapor isotope analyzer set-up at BAO; (e) Isotope ratios in precipitation and vapor at surface and 300m; (f) Daily total precipitation at BAO.