Three Years of Stable Water Isotope Data at the Boulder Atmospheric Observatory Site: Insights Into Boundary Layer Moisture Dynamics and Atmosphere-land Surface Water Fluxes

A. Kaushik[1,2], D. Noone[1,3], M. Berkelhammer[4] and M. O'Neill[1,5]

[1]Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado, Boulder, CO 80309; 631-681-9067, E-mail: aleya.kaushik@colorado.edu
[2]University of Colorado, Department of Atmospheric and Oceanic Sciences, Boulder, CO 80309
[3]College of Earth, Ocean and Atmospheric Sciences, Oregon State University, Corvallis, OR 97331, U.S.
[4]Department of Earth and Environmental Sciences, University of Illinois, Chicago, Chicago, Illinois 60607, U.S.
[5]NOAA Earth System Research Laboratory, Global Monitoring Division, Boulder, CO 80305

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, and profiles can be exploited to improve estimates of boundary layer moistening associated with evaporation of falling precipitation and contributions from surface evapotranspiration. We present a three-year time-series of *in situ* tower-based measurements of isotopes of water vapor (δD and $\delta^{18}O$) from the Boulder Atmospheric Observatory (BAO) tall-tower site in Erie, Colorado. Vapor measurements were made at 1 Hz with a full cycle from the surface to 300 meters recorded every 80 minutes. In addition, samples were collected during precipitation events at the surface and 300m and soil cores and vegetation samples were taken weekly for soil water isotope extraction and analysis. This suite of measurements is used to constrain the hydrological balance at this semi-arid site. Results indicate that during precipitation events downdrafts are important transport pathways for upper tropospheric air containing depleted water isotopes, and evidence is seen for rain re-evaporation in the boundary layer. However, on a daily basis it is evaporative fluxes that are dominant in setting surface vapor isotope ratios and incorporation of diffusive exchange and transport from within soil is important for constraining surface evapotranspiration. This has consequences for interpreting boundary layer fluxes of all trace gases, including carbon dioxide and ozone.

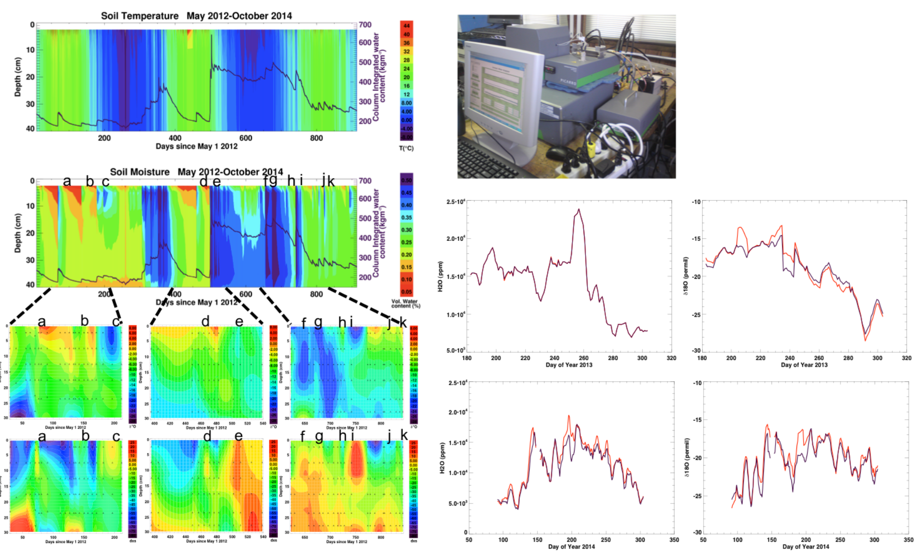

Figure 1. (left) Soil temperature & moisture May 2012-Oct 2014. Soil water isotopes show evaporation dominating fluxes. (middle) Picarro water vapor isotope analyzer set-up at BAO. (bottom) Weekly averaged water vapor and $\delta^{18}O$ at 0.5 m [solid red] and 300m [solid purple] for 2013 & 2014 summers. More enriched (less negative $\delta^{18}O$) values at the surface reflect more evaporative contribution from soil water.