SOIL, WATER, AND CLIMATE
MS DEFENSE SEMINAR

Tracing the Source and Transport of Atmospheric Water Vapor Using Stable Isotope Techniques

by

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Abstract:

The stable isotopes of hydrogen and oxygen in water can be used as environmental tracers of the hydrological and climate systems. The isotope ratios ($^{18}O/^{16}O$, $^{2}H/^{1}H$) of water are uniquely altered by biological and physical environmental processes, making them useful tracers of the origin and transport of water throughout the atmosphere and biosphere. Technological advancements have been made that allow continuous measurements of $\delta^{18}O$ and $\delta^{2}H$ in the vapor phase, and have simplified the isotope analysis of liquid water. The objectives of this thesis were two-fold: (1) to address a methodological problem that has prevented the use of isotope ratio infrared spectroscopy (IRIS) analyzers in the isotope analysis of water extracted from plant and soil samples, and (2) utilize tall tower measurements of $\delta^{18}O$ and $\delta^{2}H$ to develop a landscape-scale understanding of the mechanisms that control isotope variations in water vapor over a range of temporal scales. The correction procedure developed for the isotope analysis of plant and soil waters using an IRIS analyzer was found to greatly reduce the erroneous isotope values, resulting in a viable alternative to the traditional method of isotope ratio mass spectrometry (IRMS) for the isotope analysis of plant and soil waters. The observed temporal variations in $\delta^{18}O$, $\delta^{2}H$, and deuterium-excess, *d*, in water vapor resulted from a combination of local and distant biophysical processes, including boundary layer dynamics, seasonal changes in evapotranspiration (ET), and Rayleigh rainout processes. The use of these new measurements of $\delta^{18}O$ and $\delta^{2}H$ in the vapor phase, along with models and satellite observations will provide new information on the transport and recycling of water vapor in the atmosphere, and ultimately help diagnose changes in the atmospheric water cycle in response to climate change and land use change.