Water plays fundamental roles in the energetics and dynamics of our atmosphere both radiatively and via latent heat transfer. Despite its 5 orders of magnitude change in concentration between the surface and mid-stratosphere, water vapor is important radiatively throughout this interval and the small amounts of condensed water in clouds dramatically alter both the short wave and long wave fluxes. The strong sensitivity of water to temperature via the Clausius-Clapeyron relation has allowed us to deduce fundamental aspects of the tropical Hadley circulation and the Brewer-Dobson circulation in the stratosphere. Water influences and is influenced by other processes in the climate system in ways that are not yet understood adequately for quantitative prediction of climatic change.

Measuring water vapor coverage at the precisions and spatial and temporal resolutions and coverage needed to understand the feedbacks is challenging. To gain understanding, the observations must reveal signatures diagnostic of the underlying physical processes. Present and planned space-borne passive sensors provide much coverage but vertical resolution well below many of the scales at which water is known to vary. Furthermore the IR and visible sensors cannot sense much below cloud top. We are developing a centimeter and millimeter-wave satellite to satellite occultation system to globally measure water vapor and its isotopes, ozone, clouds, temperature and geopotential height. The active crosslink limb sounder will provide individual water vapor profiles with precisions of 1 to 3\% with vertical resolutions of a few hundred meters or better extending from near the surface into the mesosphere. The system can both characterize and penetrate clouds with a factor of 2 or less degradation to the retrieved quantities. The system is capable of measuring ozone with similar precision and resolution from the upper troposphere into the mesosphere allowing us
to characterize the chemically and radiatively important ozone variability and trends. The system is capable of measuring the water isotopes, HDO and H2-18O, as well. These observations will provide information on the past condensation/evaporation and fractionation history of the water vapor in the upper troposphere and lower stratosphere yielding a powerful set of constraints for understanding the water concentrations it observes and evaluating and improving climate models. Using the resolution and precision of this space-borne system we will routinely measure and characterize the filamentary structure of water, ozone and temperature often observed by in-situ platforms and the "tape recorder" signature of air moving upward across the tropical tropopause. The ozone allows us to distinguish between tropospheric and stratospheric air as well as identify and characterize the regions where they are mixing. The system will characterize the somewhat mysterious apparent decadal increases in stratospheric water vapor mixing ratios with much needed 1 to 2% absolute accuracy and a global perspective needed to understand the reality and causes of the trend.

The talk will consist of a brief scientific background followed by a discussion of some of the ways in which this new observing system will improve our understanding of atmospheric moisture and ozone variability and trends.