Water Vapor Isotope Ratio Measurements at NOAA/GMD Sites to Constrain the Isotope-enabled Community Earth System Model.

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Understanding the water cycle and its role in the earth system is vital for predicting the potential hydroclimatic changes brought about by global warming. Although making observations of water vapor and precipitation are central to any scientific analysis of the atmospheric component of the water cycle, they often times cannot completely constrain the actual mechanistic and environmental processes that are controlling water in the atmosphere. This is particularly true when using global climate and earth system models, as there is the potential to get the right water vapor or precipitation amounts for the wrong reasons, thus adding uncertainty to any forecast or projection using those models. This uncertainty can be lessened, and the physics of the atmospheric hydrologic cycle better understood, if one uses isotope ratios. The amount of hydrogen and oxygen isotopes in water relative to a standard can be used to infer information such as the temperature during evaporation, which can then be used to determine if a model is simulating the correct environmental conditions in clouds and at the air/surface interface.

In order to help advance the use of water isotopes in constraining the hydrologic cycle, spectrometers have been installed in numerous locations around the world, including the NOAA/GMD sites at Summit, Greenland and Mauna Loa, HI, as well as locally at Niwot Ridge and Erie, CO. These spectrometers can take measurements of water (H_2O, HDO, and $H_2{}^{18}O$) every 15 seconds, and have provided high-frequency time series for the past several years. Along with these new observations, a new version of the NCAR Community Earth System Model version 1.2 (CESM1.2) has been developed which directly simulates isotopes in the hydrologic cycle. Simulations from this model are compared to the observational data, and are used to identify and quantify issues in the model itself. This knowledge can then be used to improve the model, particularly in terms of the hydrology, and ultimately result in a more physically realistic and accurate modeling system.

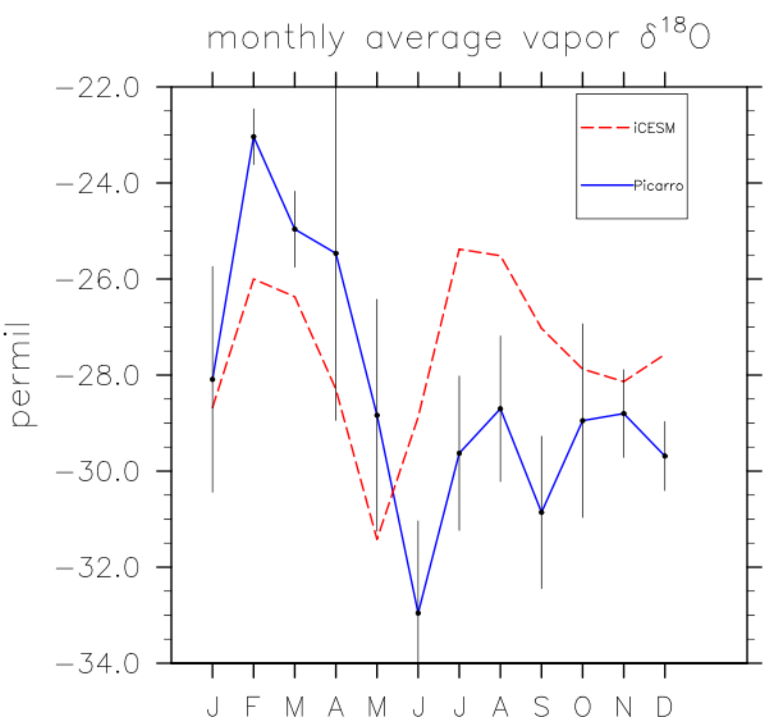

Figure 1. Monthly average $\delta^{18}O$ values as measured in Mauna Loa, HI (blue solid line) from October 2010 to August 2013. The vertical black lines represent +/- one standard error. The monthly average $\delta^{18}O$ values from CESM are also included (red dashed line).