Testing the Community Land Model (CLM 4.5) ^{13}C isotope simulations against high resolution observations within a subalpine forest at Niwot Ridge, Colorado

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Terrestrial biosphere models are an important tool to diagnose and predict land-atmosphere exchanges of carbon and energy. This is critical in order to quantify the land-carbon feedback into the climate system. Ecological observations are extremely important in order to quantify model skill and to improve techniques in which to simulate ecosystem behavior. Recently, carbon isotope behavior has been incorporated within CLM and we test simulated ^{13}C behavior against site level observations of biomass and carbon fluxes measured at Niwot Ridge. First we 'spin-up' the model for ~2000 years to approximate site level conditions during the 21st century. Next we use tower observed meteorology along with transient atmospheric CO_2 and nitrogen deposition in order to drive the model from 1998-2013. Including the prognostic fire model within the CLM simulation provides unrealistically low biomass pools (e.g. leaf, aboveground biomass) of only 20% of the observations. The no-fire CLM simulation compares more favorably to observed present day conditions overestimating the same biomass pools on the average of 27%. The simulated seasonal cycle of the photosynthetic flux compare favorably to the flux tower observations, however the simulated ecosystem respiration is overestimated and does not capture the observed sharp increase in respiration during May. The overestimation of ecosystem respiration fluxes can likely be improved with a more accurate representation of disturbance within the simulation. During the pre-industrial period, with constant atmospheric CO_2 and nitrogen deposition, CLM predicts a photosynthetic discrimination of 20 $^{o}/_{oo}$ with biomass pools ranging from -26 to -26.5 $^{o}/_{oo}$. This compares favorably to the site level observations. Under increasing atmospheric CO_2 conditions the simulated photosynthetic discrimination increases which depletes the fast turnover pools in ^{13}C first (e.g. leaf $\delta^{13}C$ ~27 $^{o}/_{oo}$) followed by the slower turnover pools later on (e.g soil). This process leads to photosynthetic fluxes that are depleted in ^{13}C as compared to the ecosystem respiration fluxes.