Decadal Trends in ^{18}O of Atmospheric CO_2

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The stable oxygen isotope ^{18}O is unique to isotope ecology in that it links the hydrosphere to the carbon cycle. Since land biosphere fluxes are the dominant influences on the ^{18}O of atmospheric CO_2, particularly on shorter times scales, analysis of atmospheric ^{18}O trends can provide useful insight into the terrestrial carbon cycle. The isotopic values imprinted by leaf water and soil water exchanges with CO_2 out-compete those from ocean exchange, fossil fuel and biomass burning, and stratospheric reactions. The opposing isotopic imprints of photosynthesis and ecosystem respiration therefore control the majority of atmospheric ^{18}O concentration. The resulting seasonal cycle in ^{18}O data of peaks during early summer, when photosynthesis dominates, and lows during early winter, when respiration dominates, has been clearly established. However, the reasons for the interannual variability of atmospheric ^{18}O remain unknown. Studies have shown that the size and isotopic value of the "retrodiffusion" flux- the CO_2 that enters and exits leaves without being fixed by photosynthesis- is a function of stomatal conductance, which is affected by the relative humidity in the surrounding atmosphere. We observe that data from numerous global sites shows a global decadal oscillation in ^{18}O, suggesting a climatological forcing. We compare decadal trends in ^{18}O with the climate oscillations, the 11-year solar cycle, as well as relative humidity records, examining correlations and proposing associated mechanisms. Understanding the decadal patterns in atmospheric ^{18}O of CO_2 will shed light on global terrestrial carbon fluxes and the carbon-water interaction on decadal time scales, potentially helping to scale human versus natural impacts on this coupled system.

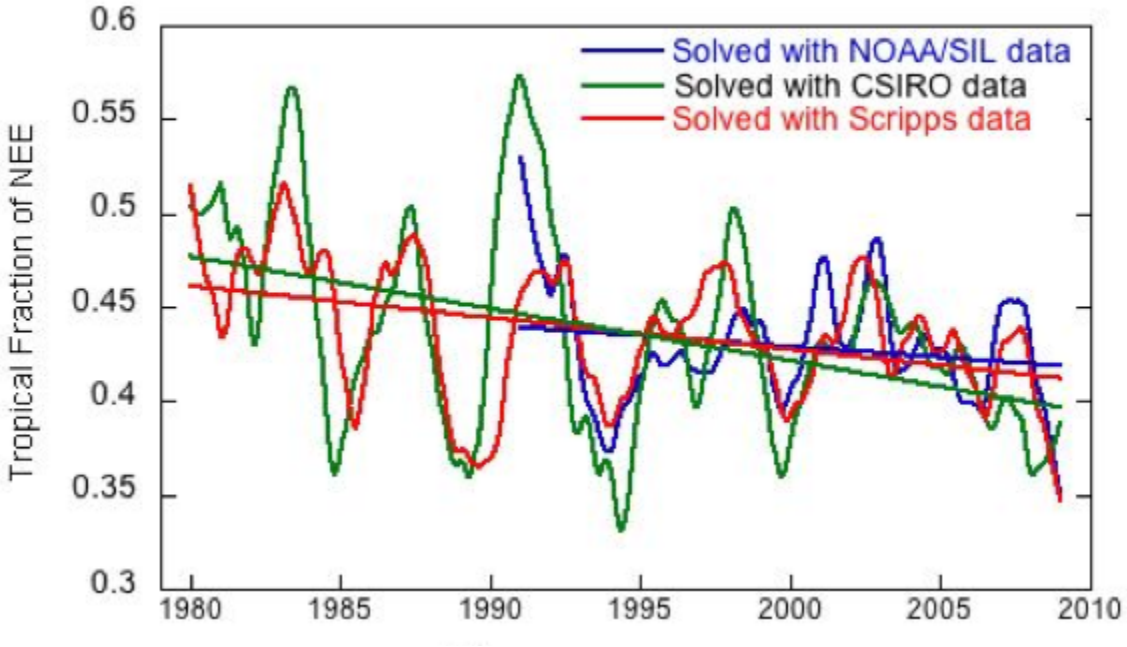

Figure 1. Modeled tropical fraction of Net Ecosystem Exchange (NEE) over 30 years, using isotope data from NOAA/INSTAAR Stable Isotope Lab, Commonwealth Scientific and Industrial Research Organization (CSIRO), and Scripps Institute of Oceanography.