Response of North American Terrestrial CO_2 Fluxes to Climate Variability

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North America is an important source and terrestrial sink for atmospheric carbon dioxide (CO_2). However, uncertainties on North American terrestrial CO_2 fluxes are large, including their magnitude, distribution, inter-annual variability, and trend. Given such large uncertainties, it has been extremely difficult to identify a coherent relationship between climate drivers and North American terrestrial CO_2 fluxes. Here, we analyzed atmospheric CO_2 and delta carbon-13 dioxide ($\delta^{13}CO_2$) data obtained from North America under the ESRL/GMD Greenhouse Gas Reference Network for the last two decades. Derived atmospheric CO_2 and $\delta^{13}CO_2$ anomalies indicate consistent responses of North American terrestrial CO_2 fluxes to large climate phenomena, such as El Niño and Southern Oscillation (ENSO) and the Arctic Oscillation (Figure 1). Such persistent responses, as we find, are primarily driven by the modulation of hydrological and temperature conditions associated with these large global climate phenomena. Inverse analyses of the same suite of atmospheric CO_2 observations over the last decade allowed us to further quantify the North American CO_2 flux anomalies corresponding to ENSO and the Arctic Oscillation. The derived annual anomalies of North American terrestrial CO_2 fluxes are substantial compared to the variability of anthropogenic greenhouse gas emissions over North America.

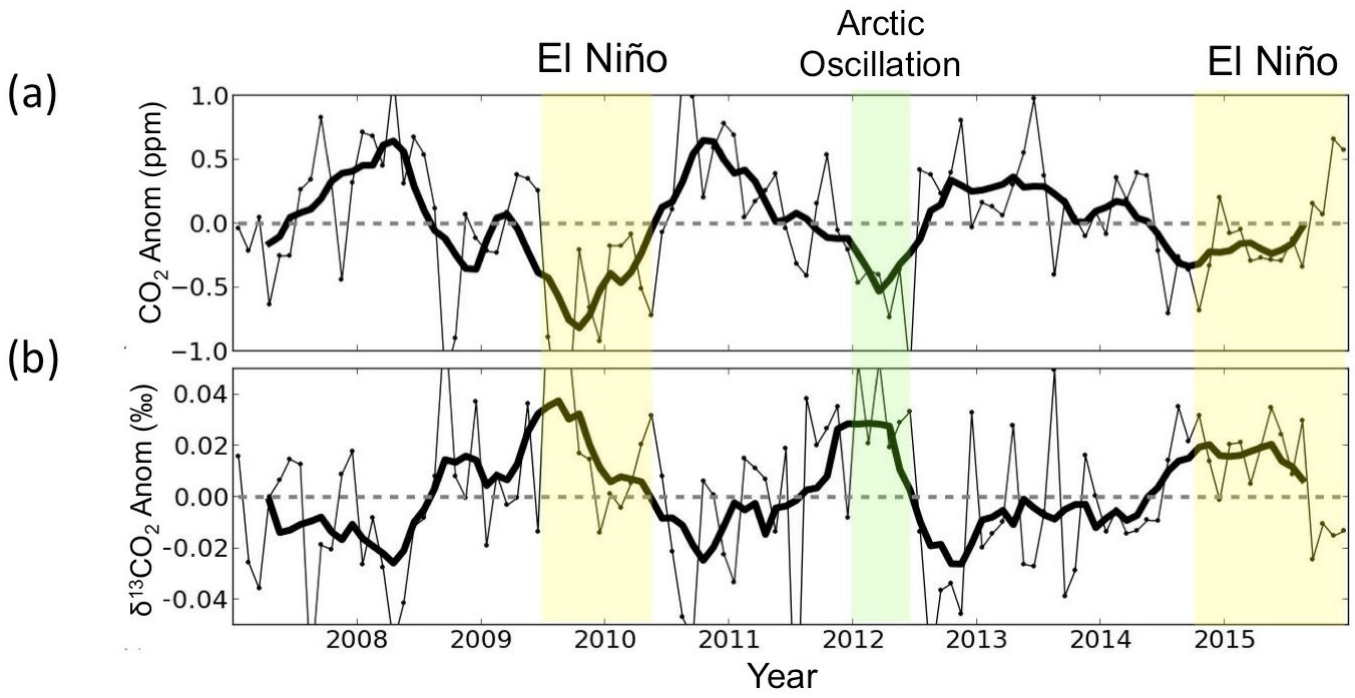

Figure 1. Monthly anomalies (thin lines) of atmospheric CO_2 and $\delta^{13}CO_2$ averaged across North American sampling sites under the ESRL/GMD Greenhouse Gas Reference Network. Thick lines indicate 6-month running averages on monthly anomalies. Yellow shading indicates El Niño periods whereas green shading indicates the period influenced by the Arctic Oscillation over the last decade.