ENSO, DRAUGHT AND INTERANNUAL CO_2 VARIABILITY

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ABSTRACT

The interannual variability of atmospheric CO_2 growth rate shows remarkable correlation with the El Niño Southern Oscillation (ENSO). Here we present results from mechanistically based terrestrial carbon cycle model VEgetation-Global-Atmosphere-Soil (VEGAS) and the Hamburg Ocean Carbon Cycle Model (HAMOCC), both forced by observed climate fields such as precipitation and temperature. Land is found to contribute to most of the interannual variability with a magnitude of about 5 Pg y^{-1} and the simulated land-atmosphere flux shows a correlation of 0.59 with the CO_2 growth rate observed at Mauna Loa from 1965 to 2000. Ocean-atmosphere flux varies by about 1 Pg y y^{-1}, and is largely out of phase with land flux. On land, much of the change comes from the tropical regions such as the Amazon and Indonesia where ENSO related climate anomalies are in the same direction across much of the tropics. The sub-continental variations over North America and Eurasia are comparable to the tropics but the total interannual variability is about 1 Pg y^{-1} due to the cancellation from the sub-regions. This has implication for flux measurement network distribution. The tropical dominance also results from a `conspiracy' between climate and plant/soil physiology, as precipitation and temperature changes drive opposite changes in net primary production (NPP) and heterotrophic respiration (R$_h$), both contributing to land-atmosphere flux changes in the same direction. However, NPP contributes to about 3/4 of the total tropical interannaul variation and the rest is from heterotrophic respiration, thus precipitation appears to be a more important factor than temperature on the interannual time scales as tropical wet and dry regimes control vegetation growth. Fire, largely driven by drought, also contributes significantly to the interannual CO_2 variability at a rate of about 1 Pg y^{-1}. The robust variability in tropical fluxes agrees well with atmospheric inverse modeling results. Even over North America and Eurasia, where ENSO teleconnection is less robust. We will also discuss the linkage between 1998-2002 drought and CO_2.