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## Two aspects of decadal ENSO variability modulating the long-term global carbon cycle

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El Niño-Southern Oscillation (ENSO) is the primary cause of interannual variations in the global carbon cycle because ENSO-driven extensive teleconnection over continents affects the terrestrial ecosystem process. ENSO is an interannual phenomenon, but it also has decadal variability. The ENSO-like SST pattern and ENSO characteristic, e.g. ENSO amplitude, change on decadal timescales. However, the influence of decadal ENSO variability on global carbon cycle has not yet been fully examined. Here we examined the impacts of decadal ENSO variability on decadal variation of terrestrial carbon flux by analyzing fully coupled pre-industrial control simulation of the Community Earth System Model 1 large ensemble (CESM1-LE). Considerable decadal variability of atmosphere-to-land carbon flux exists and this terrestrial carbon flux is mainly modulated by the tropical biosphere on decadal timescales as well as on interannual timescales. We found that there are two different pathways, which can explain about 36% of the decadal variations in terrestrial carbon flux. First, long-term climate change over tropics induced by decadal tropical Pacific SST variability regulates the terrestrial productivity and hence atmospheric CO<sub>2</sub> on decadal time scale. Second, decadal changes in asymmetric terrestrial ecosystem's response to ENSO events, resulted from decadal modulation of ENSO amplitude, generate decadal variability of terrestrial carbon flux.

**Key words:** Global Carbon Cycle, El Niño-Southern Oscillation (ENSO), Pacific Decadal Variability, ENSO asymmetry, Decadal NBP variability