**Two pathways of decadal ENSO variability in modulating long-term global carbon cycle**

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**Introduction**

The El Niño–Southern Oscillation (ENSO) drives interannual global carbon cycle variability by affecting terrestrial ecosystem via atmospheric teleconnection. The ENSO-like SST pattern has significant decadal variability and the ENSO characteristic changes on decadal time scales. It is expected from the strong relation between ENSO and global carbon cycle on interannual timescales that such decadal behaviors of ENSO naturally modulate the global carbon cycle on decadal timescales.

Study Purpose: how and how much decadal ENSO variability affects global carbon cycle on decadal time scales?  
Data: CESM1-LE, Long-term fully coupled control simulation under pre-industrial condition

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**Pathway 1: Decadal tropical Pacific SST variability**

**On interannual time scale**

**[El Nino years]**  
Warm & Dry  
Reduced net productivity  
Carbon release to ATM

**[La Nina years]**  
Cold & Wet  
Increased net productivity  
Carbon uptake from ATM

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**Pathway 2: ENSO asymmetry & decadal ENSO amplitude modulation**

**Asymmetric terrestrial carbon flux due to ENSO asymmetry**

Residual NBP effects can be reflected to the mean state.

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**Summary**

There are two pathways, which can explain about 36% of the decadal variations in global carbon cycle.  
First, climate change induced by decadal ENSO-like SST variability regulate terrestrial productivity on decadal time scale.  
Second, decadal changes in asymmetric terrestrial biosphere’s response to ENSO, resulted from decadal ENSO amplitude modulation, generate decadal variability of carbon flux.