Remote-Sensing Derived Trends in Gross Primary Production Explain Increases in the CO_2 Seasonal Cycle Amplitude

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An increase in the seasonal cycle amplitude (SCA) of atmospheric carbon dioxide (CO_2) since the 1960s has been observed in the Northern Hemisphere (NH). However, dominant drivers of the amplified CO_2 seasonality are still debated. In this study, we employ satellite-based remote sensing observations to track spatial and temporal changes in global gross primary production (GPP) of different vegetation types. Then, we use a state-of-art atmospheric transport model to examine whether our bottom-up estimates of ecosystem fluxes can capture the magnitude of CO_2 SCA trends at multiple surface sites. Further, we explore dominant drivers of the observed CO_2 SCA trends across different locations of sites. To our best knowledge, this paper makes the first effort to link long-term satellite remote sensing observations with ground atmospheric CO_2 measurements across the NH to explore how terrestrial carbon fluxes shape and change spatiotemporal pattern of atmospheric CO_2.

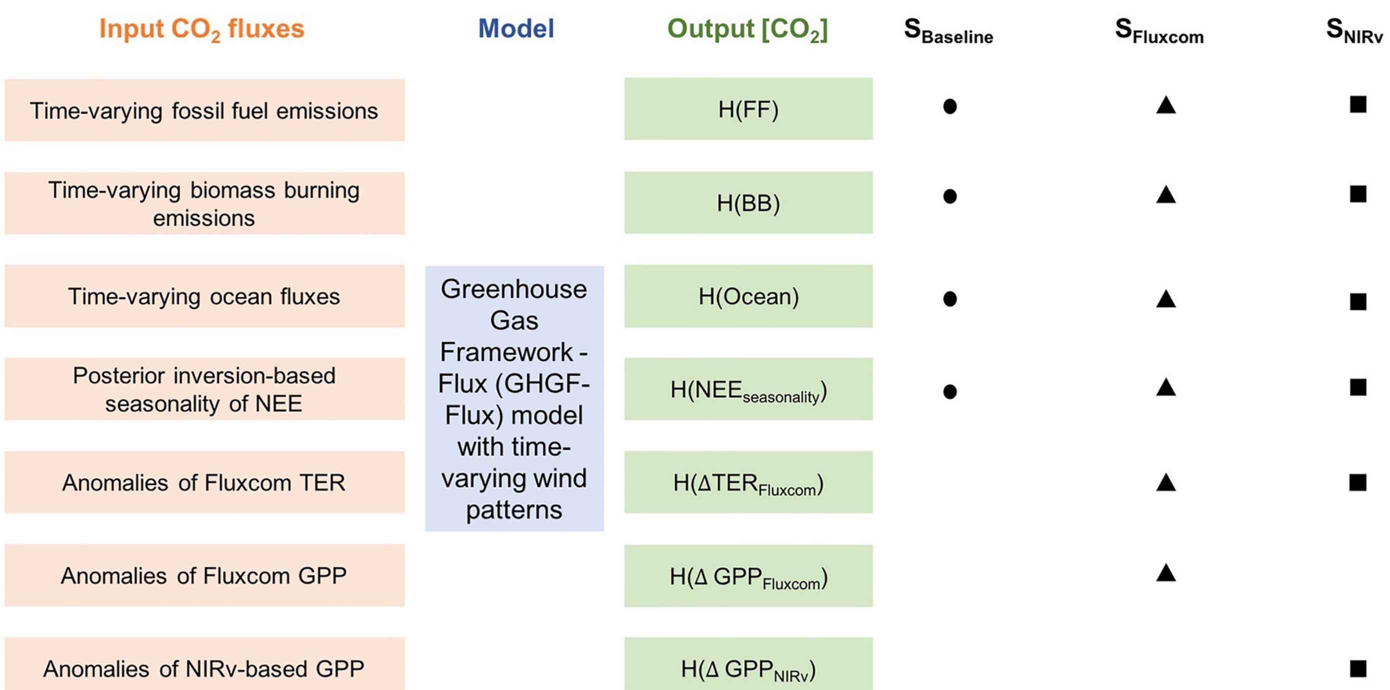

Figure 1. Diagram of the $S_{Baseline}$, $S_{Fluxcom}$, and S_{NIRv} simulations based on CO_2 fluxes from multiple sources. [CO_2] represents the atmospheric CO_2 concentrations. Mathematically, [CO_2] simulated in $S_{Baseline}$, $S_{Fluxcom}$, and S_{NIRv} can be formulated as $H(FF) + H(BB) + H(Ocean) + H(NEE_{seasonality})$, $H(FF) + H(BB) + H(Ocean) + H(NEE_{seasonality}) + H(TER_{Fluxcom}) + H(GPP_{Fluxcom})$ and $H(FF) + H(BB) + H(Ocean) + H(NEE_{seasonality}) + H(TER_{Fluxcom}) + H(GPP_{NIRv})$, where H(X) denotes the application of a forward atmospheric model to simulate CO_2 concentrations driven by fluxes X.