Improving NASA GEOS atmospheric CO₂ simulations by calibrating CASA surface fluxes with an empirical sink

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Data-driven CO₂ surface fluxes (bottom) are fed into the NASA GEOS model, which transports their signal through the atmosphere (middle).

When applying the empirical sink presented here, GEOS simulations have comparable skill to flux inversion systems and can be produced in real time at high resolution.

Base surface fluxes (CQOT)
CASA-GFED terrestrial net ecosystem exchange (NEE) & biofuels, QFED biomass burning, ODIAC fossil fuels, and a year-specific version of Takahashi ocean exchange. Satellite drivers of these fluxes include AVHRR & MODIS NDVI, MODIS FRP, and VIIRS nighttime lights (see left sidebar).

However, the base fluxes underpredict the global growth rate and seasonal cycle amplitude (Figs 1 & 2).

Empirical sink (sCQOT)
A “poor man’s inversion” (Chevallier et al., 2009; Agusti-Panareda et al., 2016; Keppel-Aleks et al., 2012) — adjusts the global growth rate and seasonal cycle amplitude of NEE toward observed values.

Our approach decreases monthly heterotrophic respiration proportionally to the temperature increase from the previous month.

The adjustment draws the sCQOT fluxes in line with flux inversion products (Figs 1 & 2). When transported through the NASA GEOS model, the fluxes reproduce in situ measurements with comparable skill to CarbonTracker 2016 (CT16) fluxes (Figs 3 for an example at Mauna Loa).

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