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A Statistical Model of the Global Carbon Budget

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We propose a dynamic statistical model of the Global Carbon Budget (GCB) as represented in the annual data set made available by the Global Carbon Project (Friedlingsstein et al., 2019, Earth System Science Data 11, 1783--1838), covering the sample period 1959--2018. The model connects four main objects of interest: atmospheric CO₂ concentrations, anthropogenic CO₂ emissions, the absorption of CO₂ by the terrestrial biosphere (land sink) and by the ocean and marine biosphere (ocean sink). The model captures the global carbon budget equation, which states that emissions not absorbed by either land or ocean sinks must remain in the atmosphere and constitute a flow to the stock of atmospheric concentrations. Emissions depend on global economic activity as measured by World gross domestic product (GDP), and sink activity depends on the level of atmospheric concentrations and the Southern Oscillation Index (SOI). We use the model to determine the time series dynamics of atmospheric concentrations, to assess parameter uncertainty, to compute key variables such as the airborne fraction and sink rate, to forecast the GCB components from forecasts of World-GDP and SOI, and to conduct scenario analysis based on different possible future paths of World-GDP.