Correlation analysis between terrestrial CO2 budget and teleconnection indices

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Terrestrial CO_2 budget is regulated by complicated biogeochemical processes of plant and soil, and is though to have a considerable feedback effect on the human-induced climatic warming on a long-term basis. Until now, various researches, including observation, experiment, and modeling, have been conducted to elucidate the mechanism that determines terrestrial CO_2 budget. It has focused on relationship with environmental factors such as atmospheric CO_2 level, temperature, moisture, solar radiation, etc. However, when analyzing large-scale relationship between CO_2 budget and climate, correlation with meteorological patterns (i.e. teleconnection), rather than specific factors, can provide clearer results in some cases. It has been recognized that terrestrial CO_2 budget has a significant relationship with the ENSO regime, such that huge amount of carbon is released from terrestrial ecosystems due to high temperature and drought in lower latitudes. In this study, regional terrestrial CO_2 budget was analyzed with respect to multiple teleconnection regimes. A process-based terrestrial ecosystem model, VISIT (Vegetation Integrative Simulator for Trace gases), was used to capture CO_2 budget during the period from 1901 to 2002 at 0.5 deg x 0.5 deg resolution, using an observation-based global climate data (CRU TS2.1). For the globe, latitudinal zones, and each mesh, anomaly component in the simulated carbon budget, in which seasonal cycle and linear long-term trend were removed, was correlated with representative teleconnection indices: e.g., ENSO, Arctic Oscillation (AO), Indian-Ocean Dipole mode (IOD). I found that ENSO had a dominant effect on the global scale terrestrial carbon budget anomaly, especially in high-productive South America and Southeast Asia. AO had a small effect at the global scale, but regionally, exerted a significant impact on respiratory CO_2 emission in winter over the Eurasia and North American regions. Similarly, IOD showed simulation correlations in lower latitudes. For example, when IOD index was positive, precipitation in eastern Africa tended to be higher, and terrestrial CO_2 budget indicated positive correlation through increased photosynthetic uptake. In terms of the global environmental change, these relationships are effective in investigating impacts of a change in climatic pattern. For example, when some alteration in frequency and amplitude of certain climate pattern is implied by climate model study, we can readily evaluate the impact on terrestrial CO_2 budget.