Detection and attribution of regional CO2 concentration anomalies using surface observations

Abstract

In this study, observed episodes of CO2 concentrations at eight Northern Hemisphere (NH) sites from 1993 to 2012 were analyzed. Five-day back trajectories were calculated for a potential source contribution function (PSCF) analysis. A normalized weight factor related to the occurrence of the episodes was applied to derive more reasonable CO2 elevations and sequestrations. Weighted elevated (△CO2(W_E)) and sequestered (△CO2(W_S)) CO2 episodes had large spatial discrepancies due to the differentiation of strength and patterns of CO2 emissions/sinks in different regions. The most significant enhancement in CO2 episodes was observed at Asian sites: △CO2(W_E) increased by approximately 56% at an annual rate of ~4% yr−1 from 1995 to 2010 at Waliguan (WLG) and by approximately 39% (~3% yr−1) from 1997 to 2012 at Yonagunijima (YON). According to the PSCF analysis, these increases are largely attributed to the rapid increase in emissions in China. However, △CO2(W_S) was also enhanced by 34.4% with a growth rate of 2.3% yr−1 at WLG from 1995 to 2010 and ~26.2% (1.7% yr−1) at YON from 1997 to 2012. Both △CO2(W_E) and △CO2(W_S) showed decreasing or relatively flat trends at Monte Cimone and Schauinsland, indicating reductions in emissions and sinks in central Europe. The different intensities/trends in emissions and sinks observed at different sites in the NH show that estimating future CO2 levels is a complex problem. Atmospheric inverse and process-based ecosystem models should use more regional input data at high temporal and spatial resolutions for future carbon flux estimations.