

Detection and attribution of changes in arctic ecosystems and atmospheric CO₂ Detection and attribution of changes in arctic ecosystems and atmospheric CO₂

PATRA, Prabir^{1*} ; KOBAYASHI, Hideki¹ ; SAEKI, Tazu¹
PATRA, Prabir^{1*} ; KOBAYASHI, Hideki¹ ; SAEKI, Tazu¹

¹RIGC/JAMSTEC

¹RIGC/JAMSTEC

Atmospheric CO₂ responds to terrestrial ecosystem activity widely from sub-hourly to decadal time scales primarily due to photosynthesis, weather and climate variations. The measurements of CO₂ thus consist of source signals from anthropogenic as well as natural ecosystem activities convolved with atmospheric transport. Since the records of CO₂ concentration in ambient air at monthly or finer time resolution began in the late 1950s, the seasonal ecosystem dynamics has enhanced significantly in the recent years (Graven et al., 2013). We further analyse the relative contributions of fossil fuel emissions and atmospheric transport on the CO₂ at a greater number of surface measurement sites since the 1980s using the CCSR/NIES/FRCGC atmospheric general circulation model (AGCM)-based chemistry transport model (ACTM). Our results suggest the trends in fossil fuel emissions and transport have detectable contribution to the CO₂ seasonal cycle changes at the sites in northern tropics to mid-latitudes, and that the seasonal cycle increase in the arctic region is governed mainly by the terrestrial ecosystem.

To attribute causes for the recent changes in carbon cycle dynamics we have chosen the period of 1999-2011, which is covered by high quality process oriented ecosystem parameters from remote sensing and atmospheric CO₂ measurements at the largest network of sites for flux inversion. Our analysis suggests that the early greening by several days in the Alaskan tundra region closely correlated with the amplitude of CO₂ seasonal cycle at Point Barrow, Alaska. But no clear trend in the greening onset is detectable at semi-arid grasslands near Ulaanbaatar, Mongolia, except for the closely coupled interannual variations in greening onset time and CO₂ seasonal cycle amplitude. We estimated CO₂ fluxes from 84-regions of the globe at monthly time intervals using measurements from about 100 sites. The terrestrial CO₂ fluxes are estimated after removing the effects of fossil fuel emissions and oceanic fluxes in measured CO₂ concentrations. We find the carbon exchange of the Alaska region of our inversion is increased both for the seasonal cycle amplitude and net annual uptake over the period of 2002-2011.

Our results have large implications for developing the future and validating the present earth system models for studying climate-carbon-biosphere interactions.

キーワード: CO₂ seasonal cycle, Ecosystem phenology, Arctic environment

Keywords: CO₂ seasonal cycle, Ecosystem phenology, Arctic environment