

Recent Increase in Seasonal Amplitudes of CO₂ and δ¹³CO₂ Over Canada and Their Implications

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High precision CO₂ and δ¹³CO₂ measurements of flask samples were carried out by Environment Canada for Alert, NU (82°27'N, 62°31'W,) and Fraserdale, ON (49°53'N, 81°34'W) during the period of 1998 – 2010 and 2003-2010, respectively. Alert (World Meteorological Organization/Global Atmosphere Watch site) is a Northern Hemisphere background site, whereas Fraserdale is a representative site of boreal forest in Eastern Canada. A digital filtering approach was applied to the discrete signals of flask CO₂ and δ¹³CO₂ measurements. Seasonal amplitudes (SA) have been obtained in both CO₂ and δ¹³CO₂, based on photosynthesis dominant and respiration dominant processes. The results are comparable with those by two other previously published curve-fitting methods. The SA mean values of CO₂ and δ¹³CO₂ are ~ 16.2ppm and ~ 0.8 ‰ at the background site and ~ 21.8ppm and ~ 1.1‰ at the boreal forest site, respectively, for the period of 2003-2009. Increases in SAs of CO₂ and δ¹³CO₂ were observed at both sites during the period. Although the size of the increase is different between the two sites, the mean relative increase rates for CO₂ and δ¹³CO₂ are similar, ranging between 2-3 % /yr, suggesting that the terrestrial biosphere in the Northern mid-high latitudes was working more actively during the period of 2003 through 2009, in comparison with the previous years (see Figures below). The ratio of [the mean increased CO₂]/[the mean increased δ¹³CO₂] at Alert is obviously different from that at Fraserdale, inferring that the dominant sources causing the increases of SAs at the two sites could be different. Further analysis shows that the observed variations in SA of CO₂ and δ¹³C at the boreal forest site are correlated with summer/fall (May – October) temperatures as well as winter/spring (November – April) precipitation, indicating possible regional climate response of terrestrial biosphere carbon cycle.

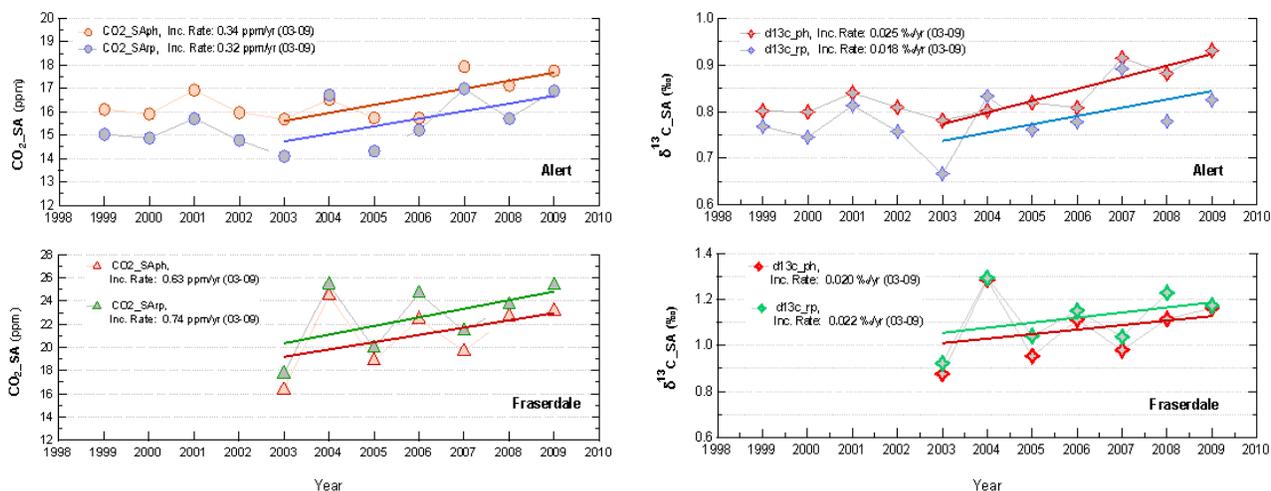


Figure 1. Seasonal amplitude of CO₂ (left) and δ¹³CO₂ (right) at Alert (top) from 1998 -2009 and Fraserdale (bottom) from 2003 to 2009.