Observation of O_3 flux in red pine forest

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The emission and absorption of trace gases at the biosphere affects to atmospheric chemistry, and thus it makes influence with potential indirect effects on carbon cycle and climate (Ollinger *et al.*, 2002). We constructed and tested O_3 and NO_x flux measurement system with the gradient method at a meteorological tower in red pine forest (Site Code: FJY) in the autumn of 2014 and 2015. We also measured CO_2 flux at the same meteorological tower for validation of the system by comparison with CO_2 flux determined by the eddy covariance method.
The heights of the forest canopy and the meteorological tower were about 25 m and 32 m. Concentrations of O_3, NO_x and CO_2 were measured at two heights (26 m and 32 m in 2014, 26 m and 34 m in 2015) above the canopy by an ultraviolet absorption O_3 analyzer (Thermo: 49C), a chemiluminescence NO_x analyzer (Thermo: 42iTL) and an infrared absorption CO_2 analyzer (Licor: LI-820). The O_3 instrument was calibrated before the observation, and the NO_x and the CO_2 instruments were calibrated every three weeks at the observation site. The air was sampled every 300 seconds from each two vertical heights and supplied to the analytical instruments through PFA tube. Concentration of CO_2 was also measured by an infrared absorption CO_2 analyzer (Licor: LI-6262) at 26.5 m to determine CO_2 fluxes by the eddy covariance method. Wind speed and wind direction were measured at 26.5 m and they were used to obtain fluxes by the gradient and eddy covariance methods.
The CO_2 fluxes in the day time (9:00-16:00) in the autumn of 2014 were observed with the gradient and the eddy covariance method as -9.0±7.3 mmol m^{-2} s^{-1} and -8.6±6.5 mmol m^{-2} s^{-1}, respectively. The CO_2 flux obtained by the gradient method was slightly lower and more scattered than CO_2 flux obtained by the eddy covariance method; however these values reasonably agreed. We made sure the flux observation system with gradient method worked properly.
The observed O_3 concentrations at the two heights differed significantly; however the observed NO_x concentrations at the two heights were similar and there were no significant differences, which indicated that it was difficult to obtain NOx fluxes with gradient method in the red pine forest.
The primary result indicated that O_3 deposition in the red pine forest in the day time (9:00-16:00) were -1.1±1.5 nmol m^{-2} s^{-1} in autumn 2014, and -1.9±2.5 nmol m^{-2} s^{-1} and 0.9±2.6 nmol m^{-2} s^{-1} in autumn and winter 2015. The O_3 deposition in winter was smaller than in autumn, which was a similar trend with literature (Fares et al., 2010).
References:
Ollinger *et.al.*, 2002, *Global Change Biology* **8**, 545-562.
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