2.019 Development, evaluation and application of a modified micrometeorological gradient method for estimating gaseous dry deposition over forest canopies.

Early Career Scientist

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Abstract:

A modified micrometeorological gradient method (MGM) was developed for estimating gaseous dry deposition velocity (V_d) over forest canopies. Differed from existing micrometeorological gradient methods, such as the aerodynamic gradient method (AGM) and the modified Bowen-Ratio method (MBR) which make use of concentration gradients above the canopy top, the new method uses concentration gradients between a level above and a level below the canopy top, taking advantage of relatively large gradients between these levels due to significant pollutant uptake at top layers of the canopy. The new method was validated using 10-year flux data collected at the Harvard Forest site and produced $V_d(O_3)$ values close to the eddy-covariance measurements during daytime, although slightly overestimated the measurements at night.

The new method was further applied to a five-year gradient data collected at a forest in southern Ontario to estimate $V_d(O_3)$ and $V_d(SO_2)$ and produced very reasonable diurnal and seasonal patterns compared to historical and literature flux data. The mean (median) $V_d(O_3)$ and $V_d(SO_2)$ was 0.35 (0.27) and 0.59 (0.54) cm s^{-1}, respectively at this forest. Detailed analysis of the flux data produced by this method suggests that snow surface became an effective sink for SO_2 but inhibited the O_3 deposition in winter. Canopy wetness increased the non-stomatal uptake of O_3 while decreasing the stomatal uptake, which also applied to SO_2, but additional factors such as surface acidity also played an important role on the overall uptake. Flux data at this forest produced by this new method were then used to evaluate and improve the dry deposition algorithms currently used in North America.