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A new method for continuous measurements of trace gas fluxes under a seasonal snowpack

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The recognition that winter processes can make an important contribution to annual biogeochemical budgets has challenged the traditional view of winter as a season of suppressed activity. The importance of snow and related cryosphere processes as an ecological factor has been recognized since at least the beginning of the 20th century. However, even today many observations remain anecdotal. The omission is due not only to the misconception that there is little biological activity during this period, but also to the inherent difficulties associated with winter sampling; for instance, cold temperatures and snow cover can make sampling especially difficult and challenging in winter.

Here we provide information on a new program to measure continuous trace gas fluxes through the seasonal snowpack at Niwot Ridge, Colorado. We have developed experimental protocols for the study of snowpack trace gas concentrations and their fluxes, and applied these measurements over five winter seasons (2004-2008) for studies of CO2, nitrogen oxides (NOx = NO + NO2), N2O, O3, and volatile organic compounds (VOCs) at a high elevation alpine site in the Colorado Rocky Mountains. These results suggest that soil temperature and soil moisture are the primary controls on trace gas fluxes through snow. Moreover, simultaneous measurements of trace gas concentrations at multiple heights in the snowpack show that the gradient method based on Fick's law appears to provide excellent results and that heterogeneities within the snowpack such as ice lenses do not cause major artifacts in the calculation of trace gas fluxes.