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Gap-filling of VOC flux data for deriving annual budgets: Case study at a mountain meadow

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Although the biosphere is currently thought to be the main source for atmospheric volatile organic compounds (VOCs) longer time series of VOC measurements are barely available and the accuracy VOC modeling approaches still suffers from a lack of flux measurement data. However, long-term VOC flux data sets could provide a way to improve the quality of modeling approaches and make a first step towards a better VOC quantification.
We used VOC flux data of methanol, acetone, acetaldehyde and the monoterpenes, which were measured by means of a proton transfer reaction - mass spectrometer PTR-MS utilising the disjunct eddy covariance method (vDEC) above an intensively managed mountain grassland in Stubai Valley (Austria), to compare the performance of four different gap filling approaches and to get complete annual time series of the VOCs for the years 2009 and 2011.
Assuming a zero flux from the grassland during the winter period, when the meadow is usually covered by snow, the average cumulative VOC fluxes above the grassland show with 103 $mg\ C\ m^{-2}$ in the year 2009 and 464 $mg\ C\ m^{-2}$ in the year 2011 a high inter-annual variability. The gap filling using the filling method which performs best on the data introduced mean errors of 20 $mg\ C\ m^{-2}$ in 2009 and 13 $mg\ C\ m^{-2}$ in 2011. Methanol was with average cumulative emission fluxes of 375 $mg\ C\ m^{-2}$ and 442 $mg\ C\ m^{-2}$ during the year 2009 the main compound contributing to the VOC balance during both years. The cumulative fluxes of methanol using the four different gap-filling approaches agreed within a range smaller than 7 percent in 2009 and 2 percent in 2011. During the first year (2009) the cumulative deposition fluxes of monoterpenes (on average 317 $mg\ C\ m^{-2}$) turned out to have also a big influence on the overall VOC balance (its cumulative flux variation depending on the used gap filling method was less than 10 percent). All other compounds showed fluxes which were below 10 percent of the methanol emission flux in 2009 while flux contribution of the non-methanol compounds was less than 5 percent of the total budget in 2011.