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Challenges and opportunities of quantifying local CO2 advection at a mountain forest in the Alps

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Mountain forests, which play an important role in the mitigation of anthropogenic CO_2 emissions are supposed to be heavily affected by climatic changes and extremes. Efforts towards the understanding of the physiological processes regulating mountain forest carbon and water fluxes are crucial to correctly manage and protect these key ecosystems. However, among the challenges in micrometeorological flux measurements in complex terrain, the unaccounted presence of advective CO_2 fluxes has the potential to bias the daily and longer-term CO_2 exchange estimates towards unrealistic net uptake, a bias that urgently needs to be accounted for in order to reduce uncertainties related to role of mountain forests in the global carbon cycle. On the other hand, given the typical local bi-directional wind system in mountains, information on advective flows at these sites could be easier to detect compared to other terrains. We present the results of a CO_2 advection experiment conducted at a European larch site in Northern Italy (2100 m asl). The setup consisted of: the main eddy covariance flux tower (20 m), a sub-canopy eddy covariance flux system (2 m), a home-assembled system for measuring CO_2 concentrations at three heights on the four sides of a 40 x 40 m control volume, composed by a solenoid valve system, multiple sampling inlets and a gas analyzer, and three automatic chambers measuring bare soil respiration (two chambers) and the net ecosystem CO_2 exchange from the vegetated forest floor (one chamber). Results show that: i) advection is a not-negligible fraction of the total net ecosystem CO_2 exchange of this forest, ii) coupling measurements of above and below canopy eddy covariance in mountain forest sites could emerge essential for detecting/estimating the unaccounted CO_2 flux