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Canopy flow measurements on the upwind vs. downwind side of a forested ridge

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At forest sites in complex terrain, knowledge of the canopy flow behaviour and of the degree of its decoupling from the flow aloft is necessary for assessing the contribution of advection to the CO2 budget and for analysis of the eddy flux footprint. The Experimental Ecological Study Site Bily Kriz in the Czech Republic is situated near the top of a mountain ridge forested by a young Norway spruce plantation. Flow directions across the ridge (along the slope) strongly prevail at the site. From the standard single-point eddy covariance measurements above the canopy, however, it is often not clear whether the canopy flow is of the same or opposite direction. During an experimental campaign at Bily Kriz, vertical profiles of the flow velocity in the canopy were measured by sonic anemometers. Differences in the flow characteristics as recorded when the site was on the upwind vs. downwind side of the ridge are investigated here.

Typical downwind cases are characterized by a low wind speed above the canopy and by relatively higher friction velocity than in the upwind cases. This is explained by the upslope-directed hydrodynamic pressure gradient and by the large wind shear behind the ridge top. Recirculation, if observed, usually develops only in the canopy. In the downwind cases, the magnitude of the (negative) skewness of the vertical velocity component in the canopy is lower, and similarly, the magnitude of the (negative) correlation coefficient of the streamwise and vertical velocity component is lower than in the upwind cases. This indicates that on the upwind side of the ridge, sweeps penetrate deeper in the canopy, and the downward transport of momentum into the canopy is more efficient. At night, the lower-canopy flow is often decoupled from above, and it is directed either downslope or upslope.