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Evaluation of Turbulent Fluxes on a mountain slope

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Studies about turbulent exchanges, momentum and mass transfer and energy balance on mountain slopes allow a better comprehension of the interactions between soil and atmosphere in complex orography. In addition, if long periods of observations are considered, the evolution of energy and mass fluxes can be derived. This is useful for model delicate ecosystems such as in the highlands. Furthermore, the study on carbon dioxide fluxes can be related to the increase of greenhouse gas.
The eddy-covariance technique has some critical points: one of the most important is related to the relative uncertainty in the fluxes estimation when there are bad weather or low-wind and nocturnal conditions.

Our aim is divided into two parts: in the first one, the meandering was explored. In the second part, we compared two approaches, the planar fit and the double rotation techniques for the computation of turbulent fluxes.

Because of the high number of low-wind speed conditions (LWS), we investigated the "meandering": in LWS conditions, wind speed components and scalars such as temperature can show oscillations visible in the auto-correlation function of the signals. In these cases, turbulent fluxes estimation may be difficult. We analysed 11 months of data collected at 10 Hz, considering a 1-hour time scale, with the identification of surface-layer parameters. Meandering phenomenon was explored following the works of Mortarini et al. (2013, 2015). We evaluated also the impact of clear-sky conditions on our data. We observed the validity of the formula for spectral analysis proposed in the aforementioned papers in most part of the analysed hours. Meandering conditions occur in 305 hours over more than 8000, especially during winter and night, although there are diurnal episodes. Meteorological conditions seem to play some role on the local phenomena because, although no certain relationship between stability and meandering parameters was found, the sky was cloudy in most part of meandering hours.
In the second part, 30-minutes turbulent fluxes (sensible heat flux, latent heat flux and mass fluxes of water vapour and carbon dioxide) were determined using planar fit and double rotation techniques and the eddy-covariance technique use was tested for our site having a slope of about 26°. Then, computation of the energy balance was done. We made comparisons between estimated and measured data and considerations on sensible and latent heat fluxes, then energy and mass fluxes and net radiation were computed also at the daily scale.
We found that anemometer rotations improve robustness of computation and the difference between planar fit and double rotation is not so high in fluxes computations. Planar fit seems to give more reliable values. Considering the ground flux, G, we obtained a better approximation of energy balance. In particular, the computation of the energy balance ratio (EBR) showed that in general the balance is better during the daytime, while the seasons in which the energy balance is nearer to closure are summer and autumn.

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