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Influence of coordinate rotation on calculation of vertical advection

MARTINA HUNNER; LUKAS SIEBICKE; THOMAS FOKEN

University of Bayreuth, Department of Micrometeorology, Bayreuth

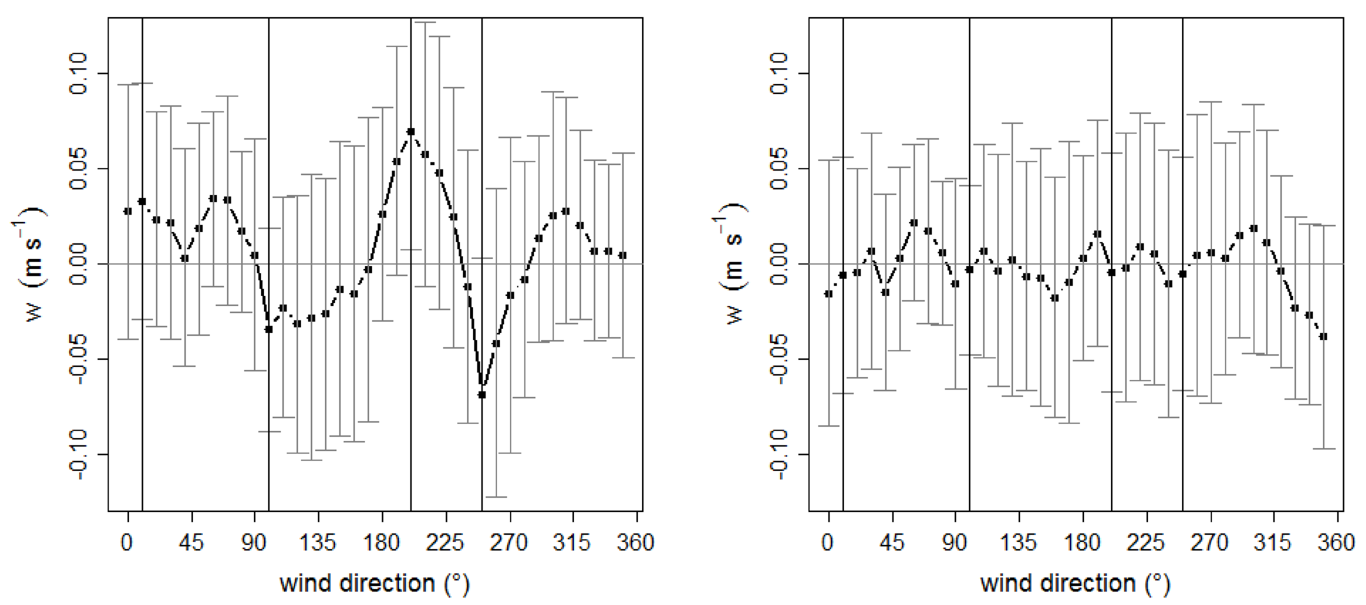
EGER

Introduction

Vertical advection, estimated by a CO_2 concentration gradient and mean vertical wind velocity, was investigated during the EGER project (ExchanGE processes in mountainous Regions) at the FLUXNET station Waldstein Weidenbrunnen in Germany. A CO_2 profile was obtained within the first intensive observation period (IOP 1, short period) in September and October 2007. Measurements of a sonic anemometer including vertical velocity are available for September 2007 to February 2008 (long period). Since values of vertical velocity are pretty small, they cause a high source of uncertainty to vertical advection calculation. To correct influences of sensor misalignment, obstacles or local topography, the planar fit coordinate rotation is carried out (Wilczak et al., 2001). The influence of time span and classification in wind sectors as well as the effect of data quality on the correction of vertical velocity and therefore on the calculation of vertical advection were tested.

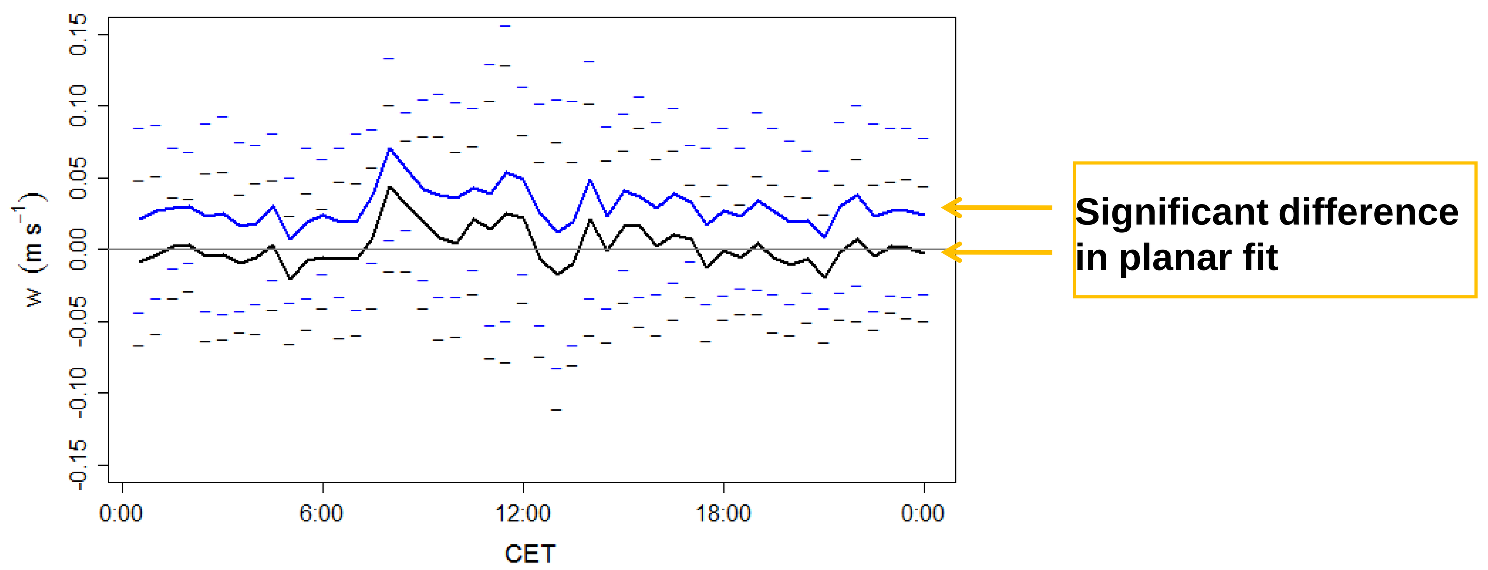
Results and Discussion

Result 1: Planar fit for several wind sectors improves the nullification of vertical wind velocity.



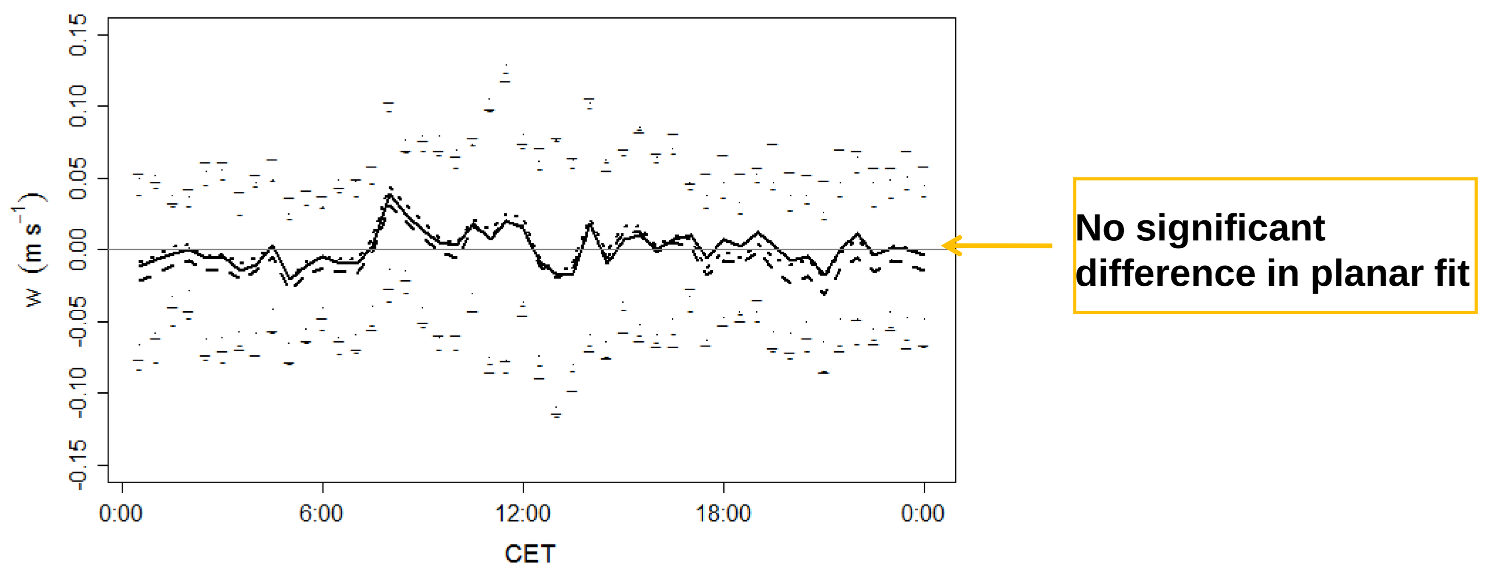
Relationship between planar fit rotated vertical wind velocity averaged over classes of 10° and wind direction. Error bars represent standard deviation. Vertical lines illustrate rotation boundaries.
Left: Rotation with all data shows a clear dependence on wind direction.
Right: After a rotation for each sector of wind direction, mean vertical velocity is distributed closer to zero..

Result 2: Planar fit coefficients should be estimated over a long time period to ensure a dataset that covers all wind directions. However the dataset must not be too long due to changing general weather conditions.



Mean daily course of vertical wind velocity with long period (blue) and short period (black) planar fit, both applied to the short period of IOP 1. Error bars indicate standard deviation.
High positive values of vertical wind velocity can be seen with the long period planar fit, which is not representative for the short period of IOP 1.

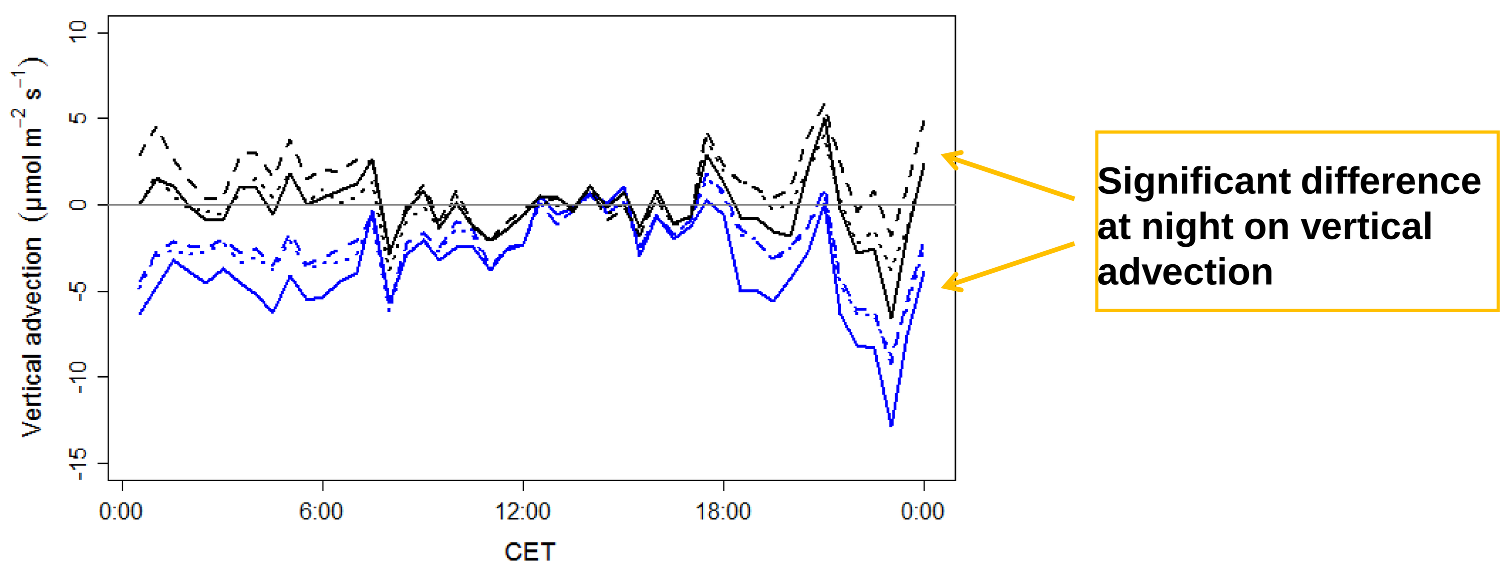
Result 3: Data collection according to data quality has no significant influence on planar fit.



Mean daily course of vertical wind velocity during IOP 1. Error bars represent standard deviation.
Planar fit was carried out with all data (continuous line), with data filtered according to neutral stratification (dashed line) and with quality assessed data according to Foken et al., 2004 (dotted line).

Conclusion for vertical advection

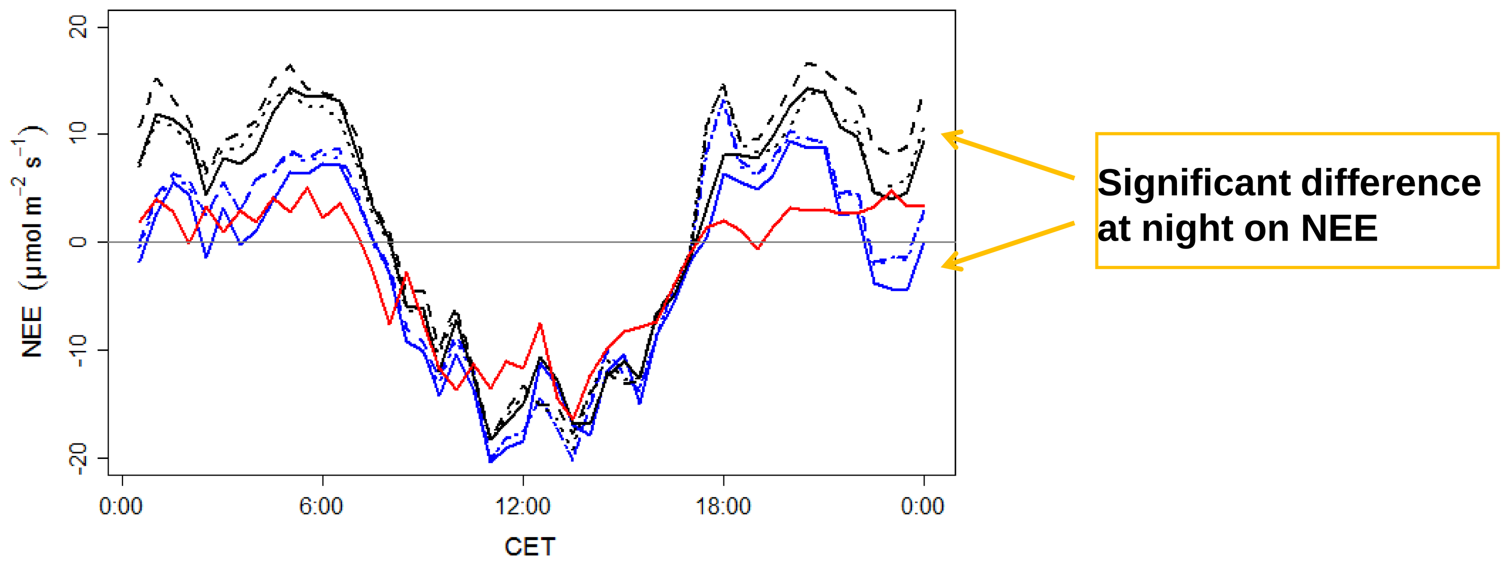
The choice of the planar fit method has great influence on vertical advection.



Mean daily course of vertical advection, obtained with the long period (blue) and the short period (black) planar fit. Continuous lines stand for planar fit with all data, dashed lines for planar fit with neutral stratification and dotted lines with quality criterion.

Conclusion for NEE

Vertical and horizontal advection do not compensate each other, due to the same sign and thus show important contribution to net ecosystem exchange, depending on the planar fit method.



Mean daily course of NEE obtained with the long period (blue) and the short period (black) planar fit. Continuous lines stand for planar fit with all data, dashed lines for planar fit with neutral stratification and dotted lines with quality criterion. The red line represents NEE without advection.

Contact: martina.hunner@stmail.uni-bayreuth.de
www.bayceer.uni-bayreuth.de/mm

References:
Foken, T. et al., 2004. Post-field data quality control. In: Lee X. et al. Handbook of Micrometeorology: A Guide for surface flux measurement and analysis. Kluwer, Dordrecht, 181-208.
Wilczak, J. et al., 2001. Sonic anemometer tilt correction algorithms. Boundary-Layer Meteorology, 99: 127–150.

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