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Interactive comment on "Weak and intense katabatic winds: impacts on turbulent characteristics in the stable boundary layer and CO_2 transport" *by* Jon A. Arrillaga et al.

Anonymous Referee #1

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REVIEW

Title: Weak and intense katabatic winds: impacts on turbulent characteristics in the stable boundary layer and CO2 transport Authors: Jon A. Arrillaga, Carlos Yagüe, Carlos Román-Cascón, Mariano Sastre, Gregorio Maqueda, and Jordi Vilà-Guerau de Arellano Manuscript: acp-2018-944 Journal: Atmospheric Chemistry and Physics (ACP)

General Assessment:

The paper by Arrillaga et al. focuses on the study of the katabatic flows on a relatively flat area 2-km away from the steep slopes of the Guadarrama Mountain Range (Spain).

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Discussion paper

Authors discuss weak, moderate and intense katabatic events. The manuscript also examines a horizontal CO_2 transport driven by the katabatic advection.

Judgement:

I think that obtained results may be useful for further understanding of the katabatic flows and manuscript is suitable for publication in the ACP, however not before a major revision. I recommend acceptance with major revisions although most of the comments are not that major and related to lack of clarity. My specific comments are listed below.

Revision issues:

Although it is appropriate to refer readers to other papers for the details of the field campaign and instrumentations, more info is needed in this paper than is currently provided (see my remarks detailed below).

Data (post) processing. Data processing is only briefly mentioned (p. 5). More info is needed in this paper for the details of the turbulent flux measurements than is currently provided. A reader (in order to acknowledge the results) would want to know: 1) how the filtering was done (block average, high-pass, other?), 2) what data-quality control checks were used, 3) how the wind stress (or momentum flux, friction velocity) was computed in Fig. 11? Based only on the longitudinal (or downstream) $\langle u'w' \rangle$ wind stress component or both longitudinal and lateral (or crosswind) $\langle v'w' \rangle$ stress components? Why?

Large errors in the measurement of the turbulent fluxes can result from relatively small errors in the alignment of a sonic anemometer due to the cross contamination of velocities (i.e. fluctuations in the longitudinal wind speed components appear as vertical velocity fluctuations, and vice versa). To avoid these errors rotation of the anemometers' axes is needed to place the measured wind components in a streamline coordinate system. The most common method is a double rotation of the anemometer coordinate system to compute the longitudinal, lateral, and vertical velocity components (Kaimal and Finnigan, 1994, section 6.6). Was this done?

Since the sonic anemometer measures the so-called 'sonic' virtual temperature (which is close to the virtual temperature) the moisture correction in the sonic anemometer signal is necessary to obtain the correct value of temperature itself and sensible heat flux (e.g. Kaimal and Finnigan, 1994). Authors reported the sensible heat flux (Figure 9). To value the present results the authors should either show that the moisture corrections and their impact on the results are small, or (if otherwise) apply moisture corrections to the sonic temperature following Schotanus et al. (1983) based on the data collected by the Campbell fast-response open path infrared gas analyzer listed in Table 1.

Authors say nothing about the Webb correction (also referred as WPL or Webb effect after the paper by Webb et al. [1980]). This correction must be taken into account when the turbulent fluxes of minor constituents such as carbon dioxide or, in some cases, water vapor are measured (Webb et al. 1980).

In a slope-following coordinate system, the horizontal (along the slope) heat (buoyancy) flux contributes to the net buoyancy term and, therefore, the Monin-Obukhov stability parameter z/L (see page 11 and Fig.10) contains this additional term (e.g., see Grachev et al. 2016, their Eq. (3) and references therein). Authors say nothing about this issue for calculation z/L which is very important point for katabatic flows.

Minor and editorial/technical comments:

Page 5, Line 8. Replace COˆ2 by CO_2.

Page 11, Line 28. I suggest to provide a definition of the Monin-Obukhov stability parameter (z/L) and the bulk Richardson number (R_B) for a layman reader.

Page 12, Lines 2-9. I would like also to see here a discussion on difficulties and controversy of interpretation associated with the critical Richardson number (e.g., Grachev et al. 2013 and references therein).

References: Replace 'Boundary Layer Meteorol.' by 'Boundary-Layer Meteorol.' (dash is missed).

Page 19, Line 1. Please correct Silvana's name: Di Sabatino S. instead Sabatino, S. D.

Page 20, Line 9. Please correct reference Pardyjak et al. as follows: Pardyjak E.R., Fernando H.J.S., Hunt J.C.R, Grachev A.A., Anderson J.A. (2009) A case study of the development of nocturnal slope flows in a wide open valley and associated air quality implications. Meteorologische Zeitschrift, 18(1), 85–100. DOI: 10.1127/0941-2948/2009/362

Included references:

Grachev A.A., Andreas E.L, Fairall C.W., Guest P.S., Persson P.O.G. (2013) The critical Richardson number and limits of applicability of local similarity theory in the stable boundary layer. Boundary-Layer Meteorol. 147(1): 51–82. DOI: 10.1007/s10546-012-9771-0

Kaimal J.C., Finnigan J.J. (1994) Atmospheric Boundary Layer Flows: Their Structure and Measurements. Oxford University Press, New York and Oxford, 289 pp

Schotanus P., Nieuwstadt F.T.M., De Bruin H.A.R. (1983) Temperature measurement with a sonic anemometer and its application to heat and moisture fluxes. Boundary-Layer Meteorol. 26(1): 81–93. DOI: 10.1007/BF00164332

Webb E.K., Pearman G.I., Leuning R. (1980) Correction of flux measurements for density effects due to heat and water vapour transfer. Q. J. R. Meteorol. Soc. 106(447): 85–100. DOI: 10.1002/qj.49710644707

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