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## ***Interactive comment on “Countergradient heat flux observations during the evening transition period” by E. Blay-Carreras et al.***

**E. Blay-Carreras et al.**

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Firstly, we would like to thank the editor his favorable review. His remarks will surely improve the discussion of this study. Below we answer all his comments.

Referee 2 comments

Due to the lack of response from several nominated second reviewers, I have had to intervene in the interest of time. I have read through the script and agree with reviewer 1 that it is well written and structured. I would ask you to heed each of reviewer 1's comments on the observational side. In addition, from the modeling side I would consider: Relating your delayed transition idea to the 'demixing' idea of Nieuwstadt and Brost 1986. Are the two related?

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To our opinion, despite demixing and the countergradient effect presented at the manuscript coexist during the afternoon transition, both processes are not necessarily related.

The presented investigation is compatible with the existence of a neutral layer, above the stable surface layer, where, due to entrainment, turbulence may still exist (demixing process) (Nieuwstadt and Brost 1986, Grimmond et al. 2002, Pino et al. 2006a). The last upward movement can be accelerated in the upper part of the boundary layer due to the presence of the demixing process making possible a stronger descent of warm air introduced from the free atmosphere. The idea of having vertical movement in the upper part of the BL when the lower part becomes stable does not disagree with the idea of the last eddy movement and it has been presented also by Sorbjan (1997), although he did not relate the movements in the entrainment zone with the ground.

In spite the idea of demixing has been widely accepted, recently Darbieu et al. (2014) have shown, by using LES and aircraft observations that during the afternoon transition turbulence (TKE and variances) decreases earlier at the upper levels of the boundary layer. If this result is also true during the evening transition, it seems that demixing, if it exists, cannot be also attributed to entrainment. We have extended the previous paragraph dealing with this subject in the introduction in the new version of the manuscript.

There are several existing parametrizations in weather and climate models that use counter-gradient mixing (e.g. Lock et al 2000, Holtslag and Boville 1993). Can you relate your observational results to these parametrizations?

The papers mentioned by the editor introduce a nonlocal term in the parameterization of the vertical diffusion in the atmospheric boundary layer to account with convective situations where the heat flux can be counter to the local potential temperature gradient (positive heat flux and positive gradient of potential temperature). In these cases turbulence is produced by nonlocal transport, by eddies of the size of the boundary layer. This mainly occurs at the upper part of the boundary layer, just below the entrainment

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zone and far from the surface layer.

On the contrary, the countergradient dynamics analyzed in the manuscript is produced at the evening transition near the ground. In this case, during several tenths of minutes coexist negative heat fluxes with a negative gradient of the potential temperature. Moreover, the temporal duration is really short.

We include a comment in the manuscript about the similarities and discrepancies between the countergradient concept used in weather and climate models and the one presented in our research.

Darbieu, C.; F. Lohou, M. Lothon, F. Couvreux, D. Pino, P. Durand, E. Blay, and J. Vilà: Evolution of the turbulence during the afternoon transition of the convective boundary layer: a spectral analysis. 21st Symposium on Boundary Layer and Turbulence, 8-13 June 2014. Leeds (UK).

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Interactive comment on Atmos. Chem. Phys. Discuss., 14, 7711, 2014.

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