

Reply to reviewer 2

Meteorological factors controlling low-level continental pollutant outflow across a coast

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July 31, 2014

We would like to thank the author for his/her comments on the paper.

Specific Comments

1. **The work is somewhat uneven in that much attention is paid to discuss model results, but measurements collected during ICARTT field campaign are not much used to evaluate the model. For instance, the model must be evaluated, mainly when modelling outputs are used to build the box-model structure, as the vertical extension of the boxes depends of the boundary layer depth.**

We have included a more in depth evaluation of the UM results using the ICARTT observations. Please see the response to item 4 for Reviewer 1.

2. **I do not agree with the definition of coastal outflow. A general definition must also include the horizontal advection of pollutants across a coastline within the marine boundary layer, as in the case of a cold front moving over warm water**

In the paper, the term coastal outflow is used to describe the decoupling of pollution from the surface via the formation of an internal stable boundary layer which occurs when there is horizontal transport from land to sea and the land boundary layer is deeper than the marine boundary layer (as is typically the case on non-frontal summer days). In this paper we deliberately focus on non-frontal ventilation of pollution from the boundary layer. We have included this more precise definition of coast outflow in the paper to emphasize the importance of decoupling and to clarify the distinction from ventilation associated with frontal systems. Further justification is given in item 1 of the response to Reviewer 1.

3. **Can you clarify the following sentence written in page 10858, line 5? An important aspect for this study is the diagnosis of boundary layer depth from the model. At each horizontal grid point, the boundary layer is defined by the number of turbulent mixing levels (NTML).**

We have used the UM boundary layer diagnosis of the number of turbulent mixing levels as our definition of the boundary layer depth. It is consistent with the depth of the mixed layer in neutral and convective boundary layers.

4. **Authors highlight in the abstract and in the conclusion that the Met Office Unified Model (MetUM) showed that over a 4 week period in summer 2004, horizontal ventilation of the continental boundary layer by coastal outflow was similar to the magnitude by vertical ventilation by convective and vertical advection for the whole of the eastern USA. However I did not found a clear evidence or discussion of this result in the paper.**

We have added Figure 8 which shows the 24 h running average timeseries of the

mass transport of tracer as a percentage of total mass of tracer in the domain. The figure shows that whilst the flux from land to the marine boundary layer is small the flux from land to the coastal outflow layer is large and comparable to the flux from land to the free-tropospheric layer over land. We have included this figure and text describing it in the revised paper.

5. Are your results comparable to those found by others authors coupling different regional models as WRF-Chem or WRF-CMAQ?

We are unaware of any WRF-CHEM or WRF-CMAQ studies that have analysed coastal outflow over such an extended period making a direct comparison difficult. Studies of individual outflow events (e.g. Müller et al. (2001); Dacre et al. (2007); Lee et al. (2011); Davis et al. (2012) have shown coastal outflow to be an important ventilation process but our paper demonstrates that over this 4-week summer period horizontal ventilation is comparable to vertical ventilation. Fang et al. (2009) coupled NCEP and MOZART to show, in a study of 15 US summers, that whilst the largest export events were associated with the passage of extratropical cyclones, 35% of the total export took place during high pressure situations. Their results suggest that whilst the export associated with individual convection or coastal outflow events may be small, over the whole summer period they play an important role in the ventilation of pollutants from the boundary layer. Our results demonstrate that for the 4-week summer period we studied, ventilation via coastal outflow dominated over ventilation via convection. We have included reference to the Fang et al. (2009) paper in our paper.

6. I think that it will be useful for the reader to include a figure showing the time series of the relationship between horizontal to vertical ventilation.

We have done this. Please see our response to comment 4.

References

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