

# ***Interactive comment on “The Dynamical Impact of Rossby Wave Breaking upon UK PM10 Concentration” by C. P. Webber et al.***

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## **Response to the minor comments made by Anonymous Referee 2**

**1. Abstract:** Please include the probability of PM10 exceedences both for days without RWB and for those conditions most likely to lead to an episode. Also make it clear that an exceedance when there is RWB is 3 times more likely than period without RWB (it is not clear currently what is 3 times more likely than).

*The probability of exceeding a hazardous UK [PM10] threshold has been included within the abstract. Furthermore the probability of exceeding a threshold for Omega Block events has been included. These steps will help to elucidate what is three times more likely that what.*

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**2. Introduction 1):** It would be helpful to expand the description of what is meant by Rossby Wave breaking here. Start by a quick reminder of what a Rossby Wave is and then give a bit more explanation of what is meant by large scale overturning (and that it is not overturning in the vertical!). A figure similar to Figure 2 of Masato et al., 2012 would be useful to better orient the reader and also help explain the diagnostics in section 2.

*The following text has been inserted at the beginning of the paragraph beginning on P2 L33:*

*"Synoptic-scale baroclinic eddies lead to wave-like distortions of the subtropical jet and to wave-breaking regions on the poleward and equatorward sides of the jet (known as RWB) (Haynes, 2015)."*

*The following reference was included:*

*Haynes, P. H.: CRITICAL LAYERS, In Encyclopedia of Atmospheric Sciences, edited by James R. Holton, Academic Press, Oxford, 582-589, doi: <http://dx.doi.org/10.1016/B0-12-227090-8/00126-3>, 2003.*

*We feel that adding a physical representation of what RWB is, would provide the reader with greater insight into RWB and overturning than a graphical representation of the metrics used to diagnose RWB.*

*P2 L33 has been changed to read:*

*"RWB is the large scale meridional overturning of air masses in the upper troposphere"*

*P2 L47 a line has been added to explain that RWB is diagnosed as the meridional overturning of potential temperature on the 2-PVU surface.*

**3. Introduction 2):** When discussing the way that high pressure influences concentrations, is not the suppression of vertical mixing by large scale subsidence also a factor which may play a role?

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*We agree that this is an important part of how high pressure influences pollutant concentrations within the boundary layer. The following was included to explain this mechanism, on P2 L35:*

*"High pressure is directly associated with the elevation of PM10 concentration, through the suppression of vertical mixing out of the boundary layer."*

*The subsequent text on P2 L35 "This high pressure anomaly can influence" has been changed to read "This high pressure anomaly can also influence".*

**4. Section 2.1:** You state ERA-Interim data has been temporally filtered, but has it also had a running mean in longitude applied, as described in M11 and M13? If so please state this, if not explain why.

*This is the case and has been included in the final text. P4 L31:*

*"As in M13 a 15° longitudinal running-mean filter has been applied to the calculated fields for  $\bar{\theta}_{i,j,t}^n$  and  $\bar{\theta}_{i,j,t}^s$ . The longitudinal filter removes the influence of small-scale transient features on the calculation of the DB and RI indices."*

**5. Section 2.2 1):** I found the section explaining the exceedance threshold confusing. Please remove the first sentence and start the paragraph with "In this study PM10 exceedances are defined using a threshold based on the results of the European Study of Cohorts for Air Pollution effects (ESCAPE)..."

*This revision has been made, while a further alteration has been made to motivate the hazardous UK [PM10] threshold using the APHEA2 project, as opposed to the ESCAPE project. This alteration was made following a comment made by anonymous reviewer 1 (See review 2).*

*This paragraph now begins:*

*"In this study PM10 exceedances are defined using a threshold based on the results of the APHEA2 project."*

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**6. Section 2.2 2):** At the end of the paragraph replace the last part of the final sentence (after = 2.98) with: Therefore we use a threshold for daily mean [PM10] of  $29.72 \mu\text{g m}^{-3}$  or  $\log_e[\text{PM10}]=3.39$  to define an exceedance.

*In the sentence beginning: "The tri-site", the dependent clause following "2.98," has been removed. The suggested sentence has been added, with the minor alteration that  $\log_e[\text{PM10}]$  is replaced by  $\ln[\text{PM10}]$ . This alteration is made following the suggestion from anonymous reviewer 1 (See review 7) and has been made throughout the entire text.*

**7. Section 2.2 3):** It would also be useful to put this threshold in context by comparing to EU air quality standards and the UK DAQI for example.

*The EU legal threshold, which is also applicable in the UK has been mentioned on P5 L61. The text reads:*

*"For comparison, the European legal daily mean UK [PM10] threshold is currently set at  $50 \mu\text{g m}^{-3}$  and must not be exceeded more than 35 times a year (European Union, 2008)."*

*One reference was subsequently added:*

*Council of the European Union and Parliament of the European Union (2008). Directive 2008/50/EC of the European Parliament and of the Council.*

**8. Section 3.3:** The sentence starting: "Fig 4 illustrates" that lead to UK PM10 exceedance the following day is unclear. Is the PM10 exceedance one day after the MSLP anomaly (2 days after the RWB event) or one day after the RWB event? Please clarify. If it is the former, please give more information on why a lag between PMSL and PM10 was used.

*The 1 day lag that exists between RWB and MSLP, also exists between RWB and UK [PM10]. The sentence has been altered to clarify this important point.*

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*"the following day" has been replaced by "the day following RWB".*

**9. Section 3.4 1):** Please include a new paragraph after paragraph 2 to introduce the CDFs here. Describe Figure 5, focussing first on the blue and black lines. Then move on to the importance of persistence. It might even be useful to have 2 separate subsections for these.

*A paragraph was added to introduce the concept of CDFs and specifically what Fig. 5 illustrates, P8 L81:*

*"To illustrate the probability of exceeding a UK Midlands [PM10] threshold, Fig. 5 illustrates four cumulative distribution function (CDF) plots. The CDFs in Fig. 5 present the probability of exceeding any  $\ln[PM10]$  value, for three subset [PM10] datasets. The first dataset (blue in Fig. 5), relates to days where no RWB of any type was detected within the region of RWB influence for that RWB subset. The black line in Fig. 5 represents days where RWB of the subset being analysed has occurred, following a day of no RWB (defined as onset RWB events). The red line represents continuous RWB events where RWB of the subset being analysed has followed a day of RWB of any type."*

*Text from "Northeast Atlantic/ European RWB..." on P8 L85 to "within a region of influence (red)" on P9 L91 has been removed.*

**10. Section 3.4 2):** This analysis only covers events with persistence of 1 day. Have longer periods of persistence been considered or are there too few of these for statistical significance.

*Due to the spatial constraint placed upon RWB in this study, events with a persistence of longer than 1 day, for instance 5 days (as in Masato et al., 2013), are too infrequent to generate statistically significant results.*

**11. Section 5.2:** Would it be appropriate to present the figures from the other observations sites as supplementary material.

*Supplementary material has been added, which looks at the correlation between*

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*[PM10] at the three UK Midlands air quality monitoring sites. The tri-site super site [PM10] is representative of all sites. Therefore an extension of the work undertaken for all of the subsites, we feel, is not included.*

## 12. Technical Corrections

*The below listed corrections have been made to the text*

**12.1 P5, L59** *followed -> follows*

**12.2 P7, L49** *Subsequently -> This ensures that*

**12.3 P8, L71** *prevalent -> favourable*

**12.4 P9, L11** *Subsequently -> Therefore*

**12.5 P9, L11** *Is pre-determined from -> depends upon*

**12.6 Missing Reference:** *Buchholz et al., 2010 has been inserted within the references list*

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