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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The influence of synoptic weather regimes on UK air quality: regional model studies of tropospheric column NO_2" *by* R. J. Pope et al.

Anonymous Referee #2

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This paper describes the use of a meteorological classification with satellite retrievals to explore the effect of synoptic systems on air quality and to evaluate how well these relationships are reproduced in a regional air quality model. The manuscript builds on earlier published work using classification approaches, adding to it through (1) new model-observation comparisons, and (2) novel use of idealised tracers to diagnose the governing processes. The results are interesting and valuable, demonstrating that the model can capture the influence of synoptic variability on column NO2 concentrations, and this will be of interest to ACP readers. The paper is well written and presented and the results are clearly illustrated with selected figures.

A weakness of the study is that it doesn't fully achieve its stated aim to "determine the controlling factors" in the relationship between column NO2 and synoptic meteorology. This isn't a major failing, but the paper is less useful than it would otherwise be. The idealised tracer approach hasn't been fully exploited to quantify the influence of transport or to provide a more critical test of lifetimes from the observations. This would require a small amount of additional analysis, but I believe it would add substantial value to the study. My other comments are relatively minor and are outlined below.

General comments:

What is the lifetime of NO2 in the model, and how does this compare with the idealised tracer analysis? If the relevant model fluxes have not been diagnosed it should still be possible to estimate the mean lifetime from the regional tropospheric abundance and emissions. Does the tracer analysis provide any new insight into how modeled and observed NO2 lifetimes differ? What are the implications of this for removal processes, for the magnitude of emissions, or for the balance between transport and chemistry processes? This would allow a stronger and more quantitative statement than the current one "showing that transport is an important factor..." (which is true, but not very informative).

The "best fit" lifetimes of 6h in summer and 12h in winter are identified based on Fig 9. However, marking off the fraction of pixels for modeled NO2 in Figure 8 under each season/condition would provide verification of this and might allow assessment of equivalent tracer lifetimes intermediate between those modeled.

Section 4.2: How do the NO2 emissions in the model vary by season, and how much does this contribute to the observed seasonal column differences? Greater wintertime emissions will contribute to greater absolute anomalies even without differences in NO2 lifetime.

It would be helpful to provide a brief assessment of the likely meteorological biases in the analysis given that both cloud cover and tropopause height are strongly influenced

by the synoptic system. How is the stratospheric contribution to the NO2 column removed, and how might this influence the comparison between cyclonic and anticyclonic conditions? In addition, the chemical lifetime of NO2 will differ under the different synoptic conditions, and this is likely to exaggerate the contrast between cyclonic and anticyclonic conditions that is currently attributed to transport. How much effect is this likely to have?

Standard statistical metrics are discounted in section 4.2 as providing only a partial evaluation, but in combination these approaches remain powerful. Supplementing the new approaches with these conventional metrics (demonstrating their weaknesses if necessary) would comfort any readers suspicious about why the normal statistics are not used.

The description of the clustering approach (p.18587) isn't clear. The term "cluster" suggests distinct groupings, but the text suggests that this is just done for all positive and all negative anomalies to give two values of phi. Please clarify this description. How sensitive is the approach taken here to different choices of the significance criterion?

Minor Comments:

Brackets or slashes are used to denote alternatives in a number of places, e.g., "cyclonic (anticyclonic) conditions..." in the abstract (lines 1-2). This shorthand is difficult for the reader to follow and should be replaced by the full text to provide a slightly more wordy (but much clearer) description. The main occurrences are: p.18578,l.1-2, p.18579,l.20-21, p.18586,l.6-7 and l.19-20.

p.18583,l.17: "....will dominate" - some justification needed here.

p.18580, l.8: remove "manage to"

Figure 9: Please choose a different color scale, as the most interesting contrasts are between the 6h and 12h tracers which are both colored green.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 18577, 2015.