The authors thank the reviewer for their comments on the revised manuscript. In the following the reviewers' comments appear in black with the authors' responses in blue.

In this paper, the authors examine the connections among air stagnation, PM2.5 and O3 concentrations, and various dynamical indices related to the synoptic scale circulation over Europe. They demonstrate that the synoptic/large-scale circulation can explain >50% of the variability of monthly variability of stagnation and pollutant concentrations. Overall, the manuscript is well-written, and I appreciate the work the authors have already done responsive to the reviewers' requests from the discussion stage. I have a handful of comments and questions, mainly about the MLR methodology and the robustness of results to different timescales.

Major comments:

• I hypothesize that several of the dynamical indices examined herein are correlated. While you address multicollinearity using VIFs (Lines 184-187), have you tested the sensitivity of your selected predictors (Figure 7) by using a more conservative VIF under 5? Could restricting the VIF threshold create a more parsimonious model?

We have tested the sensitivity of the model using different VIFs. The models are very similar in each case. Using a VIF of 2 (the most restrictive value we tested), and considering the leading six predictors selected by the model in each region and season, a total of only 11 out of the 120 predictors (considering all regions and seasons) in the European model with a VIF of 5 are removed for being too highly correlated with other predictors. This will not have a large impact on the model as used for our purpose. Indeed, the model using a VIF of 2 has skill (R2) at most 0.03 less than the model using a VIF of 5. To highlight this in the article, we have added the sentence "Using a more restrictive threshold of 2.0 for the VIF does not change the conclusions drawn from the results presented in this article." (Lines 186-187).

• Have you accounted for long-term secular trends in the data in your MLR approach? I expect that variables related to the ASI and those related to your dynamical various indices have changed over the ~40 year period and these changes might impact your results.

We have not accounted for trends in the MLR directly by removing trends in the various variables or anything similar. As there is no single way to detrend, and given that we would need to decide how to detrend each variable, we chose not to as this could add additional uncertainty to the model interpretation. Furthermore, detrending may not be particularly useful here, because long-term trends in the dynamical fields (block/RWB/ridges/etc) are overall small, or at least smaller than internal variations (or than interannual variability).

We have tested how the model performs during different time periods within the reanalysis period (using fewer years to fit the model) and the skill does not show any large change for the different periods. This can also be seen by comparing the model skill for the Horton ASI across the whole period (Figure 6) with the skill when calculating using only 16 years of data (Figure 9) where no large difference is observed.

• Figure 5 and corresponding discussion: Are the "extreme ozone days" and "extreme PM2.5 days" defined for each season or using all seasons? I am specifically trying to make sense of the very small impact of BI and RI on ozone for winter and wondering if this finding is simply an artifact of ozone's pronounced seasonal cycle.

The extreme pollutant days are defined for each season separately to take into account the seasonal cycle of the pollutants. We have made this clear in the text (Lines 281-282). We would not expect blocks to be related to high ozone days in winter as weather conditions during such events favor ozone reduction (Ordóñez et al. 2017). On the other hand, subtropical ridges have been shown to have a moderate impact on ozone concentrations in winter (Ordóñez et al. 2017) in agreement with the presented results.

• Given that the EU's air quality directives are based on a mixture of hourly/daily (e.g., O3) and annual thresholds, have you considered the impact of the dynamical features of interest on *daily* pollutant concentrations rather than the monthly mean values you currently use (Lines 483-484)? If your results and overall conclusions not robust to the choice of daily versus monthly data, does this imply something about what controls PM2.5 and O3 (and stagnation) variability on daily versus longer timescales?

The stepwise model results cannot be compared to daily data as we are considering the monthly variability of the pollutants (and dynamical indices, many of which are binary fields on daily scales). However, we consider the impact of blocks and ridges on daily pollutant concentrations in section 3.3 (and Figure 5), where we show that there is a clear influence of both blocks and ridges on pollutant concentrations. This supports that the signals we report on monthly mean concentrations stem from daily anomalies in the pollutants linked to atmospheric circulation in a similar fashion as on monthly scales. Therefore, monthly values largely result from the recurrence of daily anomalies in the month, which in turn depends on the monthly frequency of occurrence of those dynamical features.

Minor comments

• Line 180: typo "skilful"

Changed

• Figure 4: letters (a)-(e) are more difficult to read than on the rest of your figures

We have made the text larger here.

• You state that the ridge index is defined south of 50˚N (55˚N in summer); this is shown in Figure 2b. Why are there values for ASI defined north of 50˚N in the RI plots of Figure 8a, d?

The field shown is the air stagnation index, composited on days defined as having ridges, blocking, or Rossby wave breaking, and hence spans all latitudes. This has been made clearer in the text (added "and are shown in Figure 8" at Line 453).

References:

C. Ordóñez et al.: Regional responses of surface ozone in Europe to the location of high-latitude blocks and subtropical ridges. Atmos. Chem. Phys., 17, 3111–3131, 2017