Reviewer’s report

Title: A tensor product quasi-Poisson model for estimating health effects of multiple ambient pollutants on mortality

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Reviewer: Arnab Maity

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Summary

The manuscript uses a multivariate spline-smoothing approach to model the effect of multiple pollutants (SO2, NO2, and PM10) on daily mortality data. The results are compared to other models where pollutants are modeled parametrically.

Overall impression

Overall, I find the topic of the manuscript very interesting, but the overall writing leaves me disappointed. The statistical models that are used to fit the data are not clearly presented; they are a mix of mathematics (e.g., $\beta$*pollutant) and software talk (e.g., ns(Time, df=8*7)) in the same equation. There are quite a few grammatical and punctuation mistakes throughout the paper. The manuscript needs a major revision and an additional review before it can be considered for publication.

Detailed comments

My detailed comments are below.

1. It seems the mortality data is collected daily (i.e., a function of day). Are the pollutants also collected daily? I think this is true. If so, the pollutant variable in the statistical models (I) - (IV) should also have a "t" subscript.

2. The authors mention "nature cubic spline" multiple times (see, e.g., lines 2 and 5 on page 8, and line 12 on page 19). Perhaps they mean "natural cubic splines?"
3. The statistical model specifications have to be rewritten. Let's take a specific example: model (I) on page 8, lines 21 - 22 (similar comments can be made for other models). In this model:

(a) what is t and what is \( \mu_t \)?

(b) What is the term \( \text{ns(Temperature/Pressure/Humidity, df=3)} \)? Are the authors modeling the variables Temperature, Pressure and Humidity separately, each using a natural cubic spline? Or are the authors creating a new variable by dividing Temperature by Pressure and Humidity, and then modeling that new variable by natural cubic splines?

(c) It seems the pollutant variable has a coefficient \( \beta_i \). What is i? Why does pollutant variable not have a t subscript if it was collected daily?

(d) Following the previous point, why do the variables DOW and Holiday not have any coefficients? Also, it seems they too should have a t subscript along with Temperature, Pressure and Humidity.

(e) Why is the Time variable modeled with \( 8 \times 7 = 56 \) degrees of freedom while others using 3?

Perhaps the authors meant the following model (again, it is not at all clear what model is being used here; the authors must clarify this issue): Suppose \( Y_t \) denotes the daily number of deaths at day \( t \). Let the mean of \( Y_t \) given all the covariates is \( \mu_t \). Then

\[
\log(\mu_t) = \alpha_0 + \theta_1(\text{Temperature}_t) + \theta_2(\text{Pressure}_t) + \theta_3(\text{Humidity}_t) + \theta_4(t) + \alpha_1 \text{DOW}_t + \alpha_2 \text{Holiday}_t + \beta \text{Pollutant}_t,
\]

where \( \alpha_0, \alpha_1, \alpha_2 \) and \( \beta \) are unknown coefficients, and \( \theta_1(\cdot), \ldots, \theta_4(\cdot) \) and unknown smooth functions modeled by natural cubic splines.

4. Page 11, line 5: in the penalized likelihood function, the penalty term is should be \( \int \ldots \int dPM10dSO2dNO2 \), that is, all the three derivative terms are being integrated together.

5. Page 12, line 7: what is "te"? How is exactly \( \text{te(pollutant}^\text{jth})_i \) defined? The expressions of the tensor product specification is already given on page 12 (line 15). So it should be possible to give an exact specification of this term. Since the RR is calculated based on these terms, it is paramount that we clearly understand what is being done here.

6. The daily mortality data are sure to be correlated over time (days). Just running the proposed model using gam does not automatically incorporate such correlation, and may give incorrect standard errors of the parameter estimates. Thus using raw standard errors may not be the right strategy to take here. How is this issue being addressed in the proposed method?

7. There many grammatical mistakes and missing punctuation. Some example (not exhaustive) are shown below.
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