We would like to thank the reviewer for the constructive comments and valuable suggestions. We address below all the issues (blue text) and specify where the manuscript has been updated accordingly.

Anonymous Referee #2

RC1: 'Comment on acp-2020-1058'

Received and published: 28 January 2021

This manuscript analyses and discusses both observed and simulated trends of three air pollutants (PM10, NO_2 and ozone) in Italy over an 8-year period. I have somewhat mixed feelings on the manuscript. On one hand, the paper is clearly written and well organized, and it appears to be scientifically sound. On the other hand, the paper is not particularly original, and it is unlikely to attract a wide scientific interest. I have three major points that the authors should address before I can recommend accepting this paper for publication.

First, since this paper deals with air pollution trends, I am concerned with the rather short time period (2003-2010) covered in the analysis. This is a very short time periods considering potentially large year-to-year variability in meteorological conditions affecting air pollutant concentrations. The authors mention (section 2.3) that the national emission inventory covers the period 1990 to 2015, and it is difficult to see what would limit running the model simulations for a longer period as well. Concerning emission data, I understand that there might be fewer stations with sufficient data coverage prior to 2003, but why not to look at the trends until 2015?

We agree with the reviewer that the period investigated could be longer but this does not influence the value of the results shown here. Several studies have already published observed trend studies on periods shorter than 10 years and we list here few examples:

- *Zhai et al., 2019, Fine particulate matter (PM2.5) trends in China, 2013–2018: separating contributions from anthropogenic emissions and meteorology, ACP, 19, 11031-11041 where the authors affirm that "Trend analyses use only those sites with at least 70 % data coverage for each of the 6 years from 2013 to 2018";*
- *Dufour et al., 2018. Lower tropospheric ozone over the North China Plain: variability and trends revealed by IASI satellite observations for 2008–2016, ACP, 18, 16439–16459.*
- *Sheng et al., 2018. 2010–2016 methane trends over Canada, the United States, and Mexico observed by the GOSAT satellite: contributions from different source sectors, ACP,18, 12257–12267, where it is said that "We use 7 years (2010–2016) of methane column observations from the Greenhouse Gases Observing Satellite (GOSAT) to examine trends in atmospheric methane concentrations over North America and infer trends in emissions".*

Nevertheless, we are aware that an analysis of longer time series would strengthen our findings. To overcome the issue of the number of year availability, in applying the chosen method a more stringent criterion was adopted with respect to other studies, i.e. only stations with valid data covering the 100% of the investigated years were taken into account (for a total of 8 years), whereas a less stringent criterion is generally adopted in other studies (as for example, 75% is set in Colette et al., ACP, (2011), corresponding in some cases to 8 years).

In addition, the choice of the period to investigate in this first study of observed and modelled trends over Italy was also determined by the availability of coherent model results that have the same model setup for the years 2003 to 2010. More specifically, in the following years, AMS-MINNI simulations adopted a different setup (spatial domain, chemical mechanism, boundary conditions), that clearly affects time series homogeneity.

We have added the following text in the Data and Methods section to explain why this period was chosen (Line 103-111 of the revised version of the manuscript):

"The threshold of 100% of the investigated years is a more stringent criterion with respect to other studies, generally adopting a less stringent criterion (e.g. 75% is set in Colette et al. (2011), corresponding in same cases to 8 years). Our choice guarantees that the trend analysis is always based on an 8-year period, which can be considered quite robust. Indeed, several studies are available in literature, presenting trend analysis over similar or shorter periods (Zhai et al., 2019; Dufour et al., 2018; Sheng et al., 2018). Of course, data covering a longer period would strengthen our findings. Anyway, in this first study over Italy, the choice of the period to investigate was determined by the availability of coherent model results that have the same model setup for the years 2003 to 2010. More specifically, in the following years, AMS-MINNI simulations adopted a different setup (spatial domain, chemical mechanism, boundary conditions), that clearly affects time series homogeneity."

Second, the authors should explain more explicitly what is the scientific purpose of this paper. Evaluating the trends of air pollutants, as stated on line 81, does not really mean anything. After reading the paper, it seems that this paper is mostly about model evaluation, more specifically about the capability of the model AMS-MINNI in simulating air pollutant trends in Italy. It remains somewhat unclear whether the authors want to say anything about the actual air pollution trends over the considered time periods, based on either modeled or simulated data or some combination of these two.

The paper is focused on the evaluation of the capability of the model to capture measured trends but it also point out the strengths and the weaknesses of CTMs in reproducing simultaneously the trends of three pollutants of major concern for human health in Italy and Europe. We think that presenting how reliable is a model to build multi-pollutant time trends is an important prove of CTM capabilities in assessing air quality and supporting air quality plans, especially for models regularly used in national regulatory assessments, as requested by the Air Quality and National Emission Ceilings directives but also for other scientific studies. Indeed, our analysis demonstrates the good agreement between modelled and observed trends and the added value of the model outcomes to provide coverage and information also in parts of the territory where observations are completely absent or observed time trends turn out to be statistically not significant. We have added the following text to better clarify this point:

Introduction, Line 82-85 of the revised version of the manuscript:

"The evaluation of CTM capabilities to reproduce the trends of pollutants increases the reliability of their application in assessing air quality and supporting air quality plans, especially for models regularly used in national regulatory assessments, as requested by Air Quality (EC, 2008) and National Emission Ceilings (EC, 2016) directives but also for other scientific studies."

Conclusions, Line 429-431 of the revised version of the manuscript:

"The evaluation of the AMS-MINNI capability to reproduce the trends of pollutants increases the reliability of its application in assessing air quality and supporting air quality plans, especially for its use in national regulatory assessments."

Third, in order to attract more readers, the authors should at least shortly discuss the applicability of this paper to other part of the world, and in simulating the temporal variability of other important air pollutant than the three ones considered in this work.

The methodology applied in the present paper to obtain a synoptic picture of the concerned air quality trends is widely recognized in literature (as underlined throughout the manuscript) and can be extended to other part of the world.

The results shown here may be a reference for other studies in complex geographical conditions such as the Italian territory, that represents an interesting environmental framework due to its complex orography resulting in peculiar meteorological conditions, the great variety of natural and anthropogenic contexts, and the presence of the Po Valley, a well-known air pollution hot spot. For the first time on the entire Italy, different O_3 metrics were considered in analysing both observed and modelled trends, being O_3 a particular significant pollutant in the Mediterranean area.

We have added this short discussion in the Conclusion section underlying also the importance of analysing other air pollutants (Line 438-442 of the revised version of the manuscript)

"The present analysis may be applied to other pollutants, especially substances of potential concerns for health (e.g. PM2.5). Moreover, it can be considered a reference for other studies in complex geographical conditions such as the Italian territory, that represents an interesting environmental framework, due to its complex orography, resulting in peculiar meteorological conditions, the great variety of natural and anthropogenic contexts, and the presence of the Po Valley, a well-known air pollution hot spot."