Atmospheric Chemistry and Physics Discussions

Atmos. Chem. Phys. Discuss., referee comment RC2
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Comment on acp-2020-1058

Anonymous Referee #3

Referee comment on "Measured and modelled air quality trends in Italy over the period 2003–2010" by Ilaria D'Elia et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2020-1058-RC2, 2021

This paper assesses the ability of the AMS-MINNI chemistry transport model to estimate air pollutant concentrations and trends over the period 2003-2010. In my opinion these types of assessment very important for justifying the use of these types of models for estimating the possible effects of national and international legislation that influence pollutant emissions and their impacts on air quality. As the authors point out, this type of assessment is not new and cite various studies with similar assessments, both national and European. However, there is a need to carry out such an assessment for Italy, and more specifically for the AMS-MINNI model to justify the use of this model in national regulatory assessments. After an introduction describing the problems of air quality and the use of models to understand and contribute to solutions to these problems, the authors describe the air quality measurements, model simulations and statistical methods used in the assessment. The results of the assessment are presented in two sections, the first of which evaluates the ability of the AMS-MINNI model to reproduce the observed concentrations and the second section evaluates the ability of the model to reproduce the trends in the observed values for the period 2003-2010. The authors conclude that the model is fit for purpose with regards to its ability to estimate atmospheric concentrations of NO2, O3 and PM10 although some discrepancies are found, such as an underestimation of NO2 and PM10 concentrations and an overestimation of O3 concentrations at urban and suburban sites. With regards to the trends the authors classify the model performance for estimating the trends as good, although again with some discrepancies, such as an underestimation of NO2 trends for traffic stations and an underestimation of O3 trends at nearly all sites, including the estimation of trends in the opposite direction to those observed. In summary, the assessment is not novel but does provide a valuable contribution to the body of knowledge regarding the ability of air qualiy models to reproduce observed concentrations and trends of air pollutants as well as contributes to the work justifies the use of AMS-MINNI model in regulatory assessments. However there are some specific points that I highlight below, which I think the authors should address before accepting the manuscript for publication.

The most important of these regards the conclusions by the authors that the model's ability to reproduce the observed concentrations is in line with the "state of the art". This may be the case but it is not clear to the reader. With the way the analysis is presented, the reader does not get an impression of whether the model performance is good or not, other than subjective statements in the text like "model performance is quite good". I suggest that the performance indicator values are explicitly compared (e.g. in a table) with the values of Colette et al. (2011), used as a reference for this evaluation, and other studies to show that the results are in line with the state of the art.

Finally, although the level of english is suitable for understanding the manuscript's content, it could definitely be improved. I have provided below a comprehensive list of suggested changes that could improve the readability of the manuscript.

Specific comments:

Line 1: Why was this period chosen for the analysis. This should be somewhere in the Introduction or Methods section
Line 15: I suggest that throughout the manuscript the word "trend" is used instead of "slope" to avoid confusion. I suggest that "slope" is only used in the section describing the trend methodology.
Lines 29-34: This is a good concise summary of the impacts of air pollution
Line 106: The spatial representativeness of TRA and IND stations is probably a lot smaller than the model spatial resolution. Although it is always good idea to evaluate the models with all possible observations it should be made clear that it is not expected that the model can realistically simulate the concentrations well at these sites
Line 145: From the text it sounds like the finest spatial disaggregation was done at NUTS3 but from the trends maps it looks like a finer spatial aggregation was applied (e.g. to road emissions). Details of this finer spatial disaggregation should be included
Lines 161-168: I'm not sure if this paragraph is very useful. The previous paragraph says that no clear meteorological trends were found so maybe this paragraph could be removed
Line 198: I don't think that 3 indicators could be considered a comprehensive set
Line 214: AMS-MINNI performs even better. Better than what? Better than RMSE or corr (and if so, how was it evaluated?) or better than Colette 2011?
Lines 215-217: This may be true for TRA and IND sites but you would not expect this to be a problem for BKG sites
Line 232: "similar RMSE values". Similar to what? Similar to Colette 2011 or something else?
Line 238: "better". Better than what? the values are quite similar to the daily indicator
Lines 270-273: I suggest rephrase this is follows: Figure 3 shows that all STs are negative (93% significant), whereas 79% of the OTs were negative (58% significant; 21% non-significant) and 21% were positive (7% significant; 14% non-significant). (Please check my figures because I've estimated them from the figure)
Line 276: Suggest add "at BKG sites" after "values" because model performance does not look that good for TRA sites in Fig 5a
Lines 292-293: This improvement appears to be related to the increase in PM emissions for SNAP2 (maybe residential heating emissions). Does this mean that these emissions were underestimated before that year? This will obviously have an impact on the trend estimates. I think that the authors should comment on this.
Lines 366-367: Although the model skill for the trends could be considered good it is concerning that there is quite a large bias in concentrations, especially at the beginning of

the time series. I think this should be looked into for future evaluations and maybe commented on here
Line 389: What does "half summer period" mean?
Lines 413-414: The phrase "For almost all Northern Italy and for all pollutants, it is possible to estimate an area with significant simulated trends." does not make sense. Surely you can estimate the area with significant trends for the entire domain!

Supplementary material:

Figure S6: What is the reason for the increase after 2006 in SNAP2 (residential biomass burning?) Is it real or just an adjustment to the estimates?
S5: These tables are very useful and complete

Technical corrections (and suggestions):

Line 14: Suggest change "regional models applications" to "regional air quality modelling"
Line 16: Suggest that the division sign (÷) should be changed for a dash. A division sign does not make sense in this context
Line 16: Suggest change "show the same magnitude" to "were of a similar magnitude"
Line 16: Suggest change "while a smaller variability is detected" to "while a smaller range of trends was found than those observed"
Lines 18-19: Suggest change "allowed to extend both the spatial coverage and the statistical significance of pollutants' concentrations trends" to "provides a greater spatial coverage and statistical significance of pollutant concentration trends"
Line 22: Remove final "s" from "concentrations" and "emissions"
Line 23: Remove final "s" from "pollutants"
Line 36: Suggest change "bringing " to "leading"
Line 37: Suggest change "measured concentrations of air pollutants" to "air pollutant concentrations"
Line 38: Suggest change "how much" to "to what degree"
Line 38: Suggest change "limitations" to "limits" and remove final s and apostrophe from "pollutants'"
Line 44: Suggest add "sources of " before "information"
Line 46: Suggest change "even if with" to "although they have"
Line 48: Suggest change "On" to "For"
Line 55: Suggest change "it is missing" to "failed to reproduce"
Line 60: Suggest change "scale (Colette et al., 2017a), they" to "scale, Colette et al. (2017a)"
Line 74: Suggest add "the studies by" before "Cattani"
Line 77: Suggest change "prevalence" to "number"
Line 78: Add comma after "trends"
Line 85: Remove final s from "concentrations"
Line 86: Suggest change "compared to meteorological and anthropogenic emissions variability" to "compared with variations in meteorology and anthropogenic emissions"
Line 89: Suggest change "where" to "in which"
Line 106: Suggest change "divided by type" to "by station type"
Line 107: Suggest change "ones divided by zone" to "sites by zone type"
Line 120: Suggest delete "in input"

Line 120: Suggest change "RAMS, orographic" to "RAMS and orographic"
Line 125: Add space befoe "km" (Horizontal resolution of RAMS) and befoe "m" (Vertical resolution)
Line 153: Suggest change "tendency" to "trends"
Line 175: Suggest remove "before time trend estimates"
Line 177: Suggest remove "statistical"
Line 177: Suggest change "it does not care about" to "it is not sensitive to"
Line 177: Suggest change "works" to "studies"
Line 181: Suggest change "not significant" to "non-significant" throughout the manuscript
Line 181: Suggest change "simulations analyses" to "modelled estimates"
Line 183: Suggest remove "all the"
Line 183: Suggest change "divided in" to "separated into"
Line 188: Suggest change "AMS-MINNI capability" to "capability of AMS-MINNI"
Lines 193-194: Suggest change "being this metric" to "this metric being"
Lines 194-195: Suggest change "Anyway, in addition to daily values and concerning only O3 evaluation" to "For O3, in addition to daily values"
Line 201: I think "indices" would be more correct than "indexes"
Line 203: Suggest change "time trends" to "temporal trends" throughout the manuscript
Line 205: Suggest remove "being them"
Line 206: Suggest change "concerning" to "for"
Line 206: Suggest change "for zone" to "by zone type"
Line 212: Suggest change "in detail" to "specifically"
Line 221: Suggest change "as commonly in" to "which is common for"
Line 221: Suggest change "models. This is highlighted by" to "models, as shown by"
Line 222: Suggest change "Anyway, in this case the" to "However,"
Line 225: Suggest change "Saharan dust contribution" to "The contribution of Saharan dust"
Lines 226-228: Suggest rewrite as “As far as MB and corr are concerned, simulated PM10 concentrations are overall in agreement with observations, with values ranging from -12.8 to -3.9 μg m-3 and from 0.453 to 0.630, respectively.”
Line 231: Suggest change "More in detail, considering results at" to "More specifically, for"
Line 232: Suggest change "skills" to "values"
Lines 232-233: Suggest change "Similarly to NO2 performance" to "Similarly to the performance for NO2"
Line 233: Suggest change "the MB in reproducing O3 levels changes" to "the MB of O3 concentrations changes"
Line 233: Suggest add "the" before "spatial"
Line 235: Suggest change "plays as O3 sink" to "acts as an O3 sink"
Line 237: Suggest change "to daily one" to "to that for daily concentrations"
Line 238: Suggest change "globally" to "generally"
Lines 238-241: Suggest rewite as "With respect to daily values, correlation for MDA8 (0.712 - 0.853) is globally better, as is MB (lower absolute values). With regards to RMSE (24.4 - 25.1 μg m-3) the values are worse at BKG stations and slightly better at IND and TRA sites."
Line 243: Suggest change "expected if compared to daily ones, due to" to "expected when compared with daily values for"
Line 246: Suggest change "turns out to perform quite well being the results" to "performs quite well, with the results being"
Lines 246-247: Suggest change "the state of the art of air quality model performances" to "the performances of state of the art of air quality models"
Line 247: Suggest change "concerning" to "when considering"
Lines 250-251: Suggest change "to make a comparison between observed trends (OT) and simulated trends (ST)" "to compare observed trends (OT) and simulated trends (ST)"
Line 255: Suggest remove "synthetically"
Lines 257-258: Suggest change "the time series of observed and simulated monthly average concentration values, detailing model performance in the considered multiannual

period" to "the time series of observed and simulated monthly average concentrations (averaged over all stations for each station type)"
Line 260: Suggest change "the map of the simulated" to "maps of simulated"
Line 260: Suggest insert "the" before "spatial"
Lines 260-261: Suggest change "split up according to station type" to "by station type"
Line 264: Suggest remove "description"
Line 269: Suggest change "show" to "have"
Line 274: Suggest change "better reproduces monthly values" to "reproduces monthly values better"
Line 278: Suggest change "worsen" to "is worse"
Line 278: Suggest change "usually" to "mostly"
Line 280: Suggest change "also in some portion of the territory" "in parts of the domain"
Line 282: Suggest move "better" to after "slopes"
Line 282: Suggest change "performances decline" to "is worse"
Lines 282-284: Suggest rewrite as "The map of the simulated slopes not only has a wider coverage but also shows a greater area with significant trends compared with observations."
Line 287: Suggest change "proven also" to "shown"
Line 288: Suggest change "show" to "have"
Lines 289-290: Suggest move "statistically significant" to before "observed"
Lines 290-291: Suggest change "reaches a percentage of 84% but decreases to 44% when simulated data are taken into account" to "is 84% compared with only 44% for the ST"
Line 292: Suggest change "slightly improving" to "improving slightly"
Line 294: Suggest change "in many" to "at many"
Line 295: Suggest remove "slightly". It is too subjective
Line 296: Suggest remove "represented"
Line 296: Suggest change "depicting" to "", which show"
Line 297: Suggest change "if compared to" to "when compared with"
Line 297: Suggest change "also for PM10 the simulated statistically significant trends" to "the simulated statistically significant trends for PM10"
Lines 298-299: I don't understant the statement of poor coverage by the model when the model covers the entire country. I assume this should say observations
Line 299: Should "Centre" not be "Central"?
Line 299: Suggest change "where anyway the model shows" to "where the model estimates"
Line 300: Suggest change "ST" to "trends"
Line 306: Suggest change "Apr/Sep" to "Apr-Sep" throughout manuscript
Line 308: Suggest change "on" to "for"
Lines 308-309: Suggest rewite as "The number of stations with increasing and decreasing trends and their significance depends on the metric used (Table 2 and Fig. 11)."
Line 309: Change "trend" to "trends"
Line 309: Suggest change "observed" to "the observed"
Line 310: Suggest change first "trends" to "datasets"
Line 310: Suggest change "show" to "have"
Line 314: Suggest change "shows" to "has"
Line 319: Suggest change "in observed trend than simulated ones." to "for observed trends than for those simulated."
Line 320: Suggest change "a wide area of significant simulated trend" to "a large area of significant simulated trends"
Line 321: Suggest rewrite "with no significant ST covering especially the North-Eastern area." as "with an area of non-significant ST in the North-Eastern area"
Line 322: Suggest change "where a higher sample is available" to "for which there are more stations available"
Line 322: Suggest change "the simulated trend" to "the model"
Line 323: Suggest change "observed trend where positive" to "observed positive trends"

Lines 323-324: Suggest rewrite "when significant decreasing OT are calculated the model shows a good agreement, even though with a lower variability range than observations." as "the model has a good agreement with the significant decreasing OT, although with a lower variability"
Lines 324-325: Suggest rewrite "are different areas, especially in the" to "are some areas, especially in"
Line 326: Suggest change "or without significant OT" to "or the OT is not significant"
Lines 328-329: Suggest rewrite as "Our analysis shows that AMS-MINNI is capable of reproducing observed trends albeit with some differences between the pollutants studied."
Lines 329-333: Suggest rewrite as "Although a quantitative analysis of the influence of variations in emissions and meteorology on concentration trends, we present a preliminary qualitative attempt to compare the temporal concentration trends to variation in emissions, having already observed (see Section 2.4) that there is no clear tendency in the meteorology."
Line 334: Suggest rewrite as "The nitrogen oxides (NOX) that are most relevant for air pollution (namely NO and NO2) are mostly emitted….."
Line 337: Suggest change "being" to "since"
Line 337: Suggest add "are" before "directly"
Line 339: Suggest remove "absolute values of"
Line 339: Suggest change "reproduces adequately" to "adequately reproduces"
Line 340: Add "a" before "national"
Line 340: Suggest change "showing robustness in potential support to" to "demonstrating its potential for supporting"
Line 342: Suggest change "decreasing tendency of concentrations measured" to "decreasing concentrations trends observed"
Line 343: Suggest change "or producing concentrations not fully responsive to correct trends" to "or the model is not responding correctly to the changes in emissions"
Lines 344-345: Suggest change "model capacity in capturing high gradients in concentration features" to "model's ability to capture large concentration gradients"
Line 345: Suggest change "model failure in catching positive slopes" to "failure of the model to capture the positive trends"
Line 346: Suggest change "exhibiting" to "with"
Line 347: Suggest change "by" to "in"
Line 348: Suggest change "points out" to "shows"
Line 349: Suggest change "sites exhibiting not significant OT" to "sites that have non-significant OT"
Line 351: Suggest change "simulated concentrations show no significant or decreasing trends" to "simulated trends are not significant or decreasing"
Line 351: Suggest change "like this happens in" to "similar occurs in"
Line 352: Suggest change "where positive slopes occur, being they obtained only from measurement analysis." to "with positive OT."
Line 353: Suggest change "are found" to "is observed"
Line 355: Suggest change "showing" to "with"
Lines 355-356: Suggest change "it is confirmed" to "these results suggest"
Line 358: Suggest remove "reductions"
Lines 359-360: Suggest change "chemical precursors (NOX, SOX, NH3, NMVOC) reactions." to "reactions of chemical precursors (NOX, SOX, NH3, NMVOC)."
Line 361: Suggest remove "quantitatively"
Line 361: Suggest change "on sites" to "on the site"
Line 364: Suggest change "of not significant trend illustrated in" to "of non-significant trends shown in"
Line 366: Suggest change "emission" to "emissions"
Line 369: Suggest change "on" to "for"
Line 370: Suggest remove "totally"
Line 373: Suggest change "emission and concentration time trends" to " temporal trends of emissions and concentrations"

Line 373: Suggest change "complex generation chain" to "complex photochemistry"
Lines 375-376: Suggest rewrite as "This is particularly important in Mediterranean áreas, which are susceptible to ozone-related impacts (De Marco et al., 2019) due to climatological conditions that are more favourable for O3 formation"
Line 377: Suggest change "gradient" to "trend"
Lines 377-379: Suggest rewite "considered, so not modifying the national scale ratio between the two, which is the main driver of the chemical equilibrium in the generation of O3 (Seinfeld and Pandis, 1998; Sillman, 1999)." to "considered, thus there has been little change in the ratio between them, which is the main driver of the chemical equilibrium for O3 formation (Seinfeld and Pandis, 1998; Sillman, 1999).
Line 380: Suggest change "spot densely populated with" to "spot, densely populated and with"
Line 382: Suggest change "in some scattered stations:" to "for some stations:"
Line 384: Suggest change "precursors'" to "precursor"
Line 385: Suggest change "could be additional causes of" to "could lead to"
Line 385: Suggest change "were already noticed in" to "can be found in the"
Line 387: Suggest change "all over" to "throughout"
Line 388: Suggest change "even if on" to "although with"
Line 390: Suggest change "among" to "between"
Line 391: Suggest remove "the" before "AMS"
Line 393: Suggest change "values" to "estimates"
Line 395: Suggest change "in" to "of"
Line 396: Suggest change "on" to "for"
Line 398: Suggest add "the" before "literature"
Line 399: Suggest change "of regional models applications" to "art for regional model applications"
Line 399: Suggest change "turned out to be" to "are"
Line 400: Suggest change "and the same behaviour of most of the regional models" to "and a similar behaviour to that of most regional models"
Line 404: Suggest remove "out"
Lines 407-407: Suggest change "Concerning PM10, the reason for this discrepancy" to "The reason for the discrepancy for PM10"
Line 407: Suggest change "PM10 modelled" to "modelled PM10"
Line 408: Suggest change "O3 results" to "The results for O3"
Line 408: Suggest add "data" after "network"
Line 409: Suggest change "catching" to "capturing"
Line 411: Suggest change "variability description were illustrated" to "variability are illustrated"
Line 411: Suggest change "maps generated for all" to "maps for"
Line 412: Suggest change "wider significant area for" to "larger area for significant"
Line 412: Suggest change "to observed ones" to "with theose observed"
Line 412: Suggest change "higher" with "larger"
Line 413: Suggest change "lower" for "smaller"
Lines 414-415: Suggest change "PM10 significant modelled trends" to "significant modelled PM10 trends"
Line 415: Suggest change "it is possible to catch some" to "there are"
Line 415: Suggest change "simulated significant trends" to "significant simulated trends"
Lines 415-416: Suggest change "where no observed data are present at all." to "where there are no observations."
Line 416: Suggest change "More in detail, it is worth" to "It is also worth"
Line 417: Suggest change "due to the absence of significant observed trends" to "due to a sparse or absent monitoring network"
Line 419: Suggest change "meteorology" to "meteorological"
Line 420: Suggest remove last s from "emissions"
Line 421: Suggest remove last s from pollutants
Line 425: Suggest change "widening" to "increasing"

Line 426: Suggest change "turned out to be better for" to "is best"
Line 475: Suggest change "elaborations" to "calculations"
Line 806: Suggest remove "as a percentage" (Figure 1)
Line 806: Suggest move "from 2003 to 2010" to before "relative"
Line 814: Suggest change "in the period" to "for the period" (Figure 2)
Lines 817-818: Suggest change both instances of "dashed" to "hashed" (Figure 3 and for all similar figures)
Line 822: Suggest change "dash" to "dashed" (Figure 4 and for all similar figures)
Line 823: Suggest change "stations" to "station" (and in all similar figures)
Line 828: Suggest change "lilac square" to "pink square" since I think pink is more well known than lilac
Lines 861-862: Suggest change "for different O3 observed and simulated metrics" to "for different observed and simulated metrics for O3"

Supplementary material:

Figure S5: Suggest change "Emission trend" to "Emission time series" since these are not trends (and for figures S6 and S7)
Figure S8: Suggest add "Annual" before "Temperature" (also applies to subsequent figures)
S4 (p10): Suggest change "are reported in the" to "calculated according to the"
S5.1: Suggest change "all over the Italian territory." to "for the entire Italian territory." (also applies to the subsequent tables)