Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2017-1014-RC2, 2018

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Phenomenology of summer ozone episodes over the Madrid Metropolitan Area, central Spain" *by* Xavier Querol et al.

Anonymous Referee #2

Received and published: 8 February 2018

The study aimed to explore if changes in nucleation of ultrafine particles and high surface ozone levels in urban areas could be related to the atmospheric dynamics changes over the European region at highest ozone risk. The content and the methodology are consistent and this study reports valuable conclusions based on experimental investigation by means of simultaneous vertical profiles of concentrations for both pollutants and meteorological parameters using balloons.

However, the conclusions can be improved (other than ozone levels are low with thick PBL and high wind speed) and some parts are really heavy going and need to be reformulated. In general, the English language can be improved and some parts need

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to be reformulated in a simpler way. The entire paper needs to be (deeply) reorganized (i.e. section Results & Discussions & Materials and Methods) and shortened. The term "altitude" must be correctly used, i.e. use "altitude" for a.g.l. (for vertical profiles) and "elevation" for a.s.l. Please, revise all figures and manuscript.

Abstract - Line 34: "high O3 level" or "ground-level O3"

Introduction - The state-of-the-art is consistent, however for a non-European scientist; the references are limited to Spain instead of Western Mediterranean region. The state-of-the-art must be documented e.g. including an overview of ozone impacts (Ochoa-Hueso et al., 2017, EnPo) and I found different studies (Lelieveld et al., 2002_Science; Kalabokas et al., 2008_ Atm Env; Giannakopoulos et al., 2009_Global&Planetary Change; Velchev et al., 2011_ACP; Sicard et al., 2013_Atm Env).

Particulate matter and tropospheric ozone are the most threatening air pollutants in cities (EEA, 2015). More than 75% of the urban population is exposed to levels exceeding WHO guidelines for PM2.5, PM10 an surface O3 (EEA, 2015).

Line 66: "implemented" by? Line 70: add a reference. Line 73: add an example for "easy to identify". Lines 76-77, add a reference, what are the climatic and geographical characteristics leading to high ozone levels? In summer, the western part of the Mediterranean basin is dominated by anti-cyclonic subsidence (Hadley circulation + Azores), high pressure, low winds and strong insolation and thus atmospheric stability favoring photochemical production of ozone (Kalabokas et al., 2008; Giannakopoulos et al., 2009; Velchev et al., 2011; Sicard et al., 2013) and emissions of biogenic VOCs (Giannakopoulos et al., 2009). Line 90: add a value and a reference for "peaks O3 concentrations". The ozone control measures are effective at rural sites while ozone levels are rising in cities (Paoletti et al., 2014_EnPo; Sicard et al., 2013_Atm Env). Line 99: NO titration, add a reference. What is the situation in Spain as compared to other European countries such as France and Italy? Line 101: the reduction in NOx

and VOC emissions within the EU started in the early 1990s (not late). Line 107: the urban areas are characterized by "VOC-limited" conditions, and a reduction in NOx emission increases the O3 formation. Lines 112-116: too many references and auto-citation, the state-of-the-art need to be enlarged (e.g. Italy, France, Portugal) and add a comparison + quantification of the spatio-temporal changes for surface ozone levels. Lines 124-127: to be reformulated. Line 128: what are the scenarios? Line 139: “low pre-existing. . .”, please explain. Line 142: add the period of the study.

Materials & methods - The experimental protocol and methodology are consistent, well described. Even if this section is important, it can be shortened, e.g. lines 165-190: move to section “Discussion” and need to be shortened. Line 195: “highest levels of O3”, how much? Line 218: “very good results”, please quantify (e.g. r^2) this statement.

Results – Please avoid describing Figures (e.g. 260-262, 318-320), this is really heavy. Lines 249-253: move to section “Materials & Methods”. Line 254: what is the correlation coefficient between NO2 and ozone? Lines 271-272: move to section “Discussion”. Lines 260-264: move to section “Materials & Methods”. Lines 271-272: move to section “Discussion”. Line 344: “high hourly O3 concentrations. . .”Lines 345-348: move to section “Discussion”. Lines 353-414: long section, boring, need to be shortened.

Discussion – Line 425: “the surface O3 concentration”. Line 441: “biogenic VOICs”, please specify the source (e.g. isoprene). Lines 459-464: move to section “Results”. Line 468: titration by NO. Lines 487-495: to be reformulated, unclear. Lines 500-505: typical diurnal ozone concentrations, well documented in the literature, not innovative for ACP. Lines 506-5014: move to section “Results”. Lines 518-519: confusing compared to line 560, need to be reformulated. Lines 538-541: move to section “Results”.

At high elevation, changes in the background tropospheric ozone can be attributed to to i) hemispheric background concentrations, in part due to the reduction in NOx emissions; ii) the exchange between the free troposphere and the boundary layer and iii) the stratospheric inputs (Chevalier et al., 2007_ACP, Kulkarni et al., 2011; Lefohn et

al., 2012_Atm Env; Sicard et al., 2016_Env Research). The “stratospheric inputs” need to be discussed in this section, as well as exchanged between the lower stratosphere and free troposphere.

Conclusions – Line 587-588: climate change might reduce the benefits of the ozone control strategies. This can be discussed e.g. climate change and the measures and policies in North America or Asia will need to be considered into future ozone policies in Europe for ozone mitigation (Lefohn and Cooper, 2015_Atmo Env; Sicard et al., 2017_ACP). Line 612: a statement of ACP Special Issues (Lamarque et al., 2013_ACP and Young et al. 2013_ACP) with respect to the ACCMIP models can be done, or the validation of ACCMIP ozone simulations using sonde throughout the free troposphere and lower stratosphere for both seasonal and year-to-year variations of ozone (Kazuyuki Miyazaki and Kevin Bowman, 2017_ACP).

Grammatical suggestions and typos

Lines 69, 88: PM 10 and 2.5 in subscript Line 86: Monks et al., 2015 rather than 2014. Line 133: to be reformulated as “recorded in July” (a simpler way) Line 142: why did you put (and UFP) with brackets? Line 188: Gómez-Moreno (hyphen) Some acronyms need to be defined e.g. lines 206, 215, 236 Line 206: 19 or 20 July, to be checked Line 442: “through the” (space) Line 444: remove all the text given in parentheses (really heavy) Line 475: McKendry and Lundgren (instead of “et al.”) Line 601: add a reference

Tables & Figures – There are too many figures, it would be necessary to select the most informative figures (5-6 maximum) and move the other to SI. Please, change “altitude” as “elevation” in Figures and Tables when necessary. Figures 7-10-11 can be joined. Too many Figures seem similar and not useful. Figure 1: put units (m) on X- and Y-axis and “elevation (a.s.l). Figure 3: how is possible to read variations of values, I don’t see the units for each parameter (e.g. T, RH), please add a second Y-axis with units. Figure 4: blurred. Figure 13: units on Y-axis. Table 1: add the station “El Retiro” and define

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the acronyms in caption (RH, Temp., UFP. . .). Table 2: m (a.g.l).

References - Kulmala et al., 2000 (Line 702), Millán & Artíñano, 1992 (Line 725) & Skrabalova et al., 2015 are missing. Line 766: Pujadas et al., the year is missing (2000) Line 781: “et al.,” please supply the full author list. Please, read the advices in the guidelines for authors for the “list of references” (e.g. publication year, lines 787, 702) and consider a chronological order for the same author e.g. Millán.

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