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Atmospheric Chemistry and Physics Discussions

Interactive comment on "

The impact of temperature changes on summer time ozone and its' precursors in the Eastern Mediterranean" *by* U. Im et al.

U. Im

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REPLIES TO REVIEWER #1

We thank the reviewer for the careful reading and the valuable comments that helped improving our paper. All suggested English and typographic corrections are incorporated in the new version of the manuscript. Below we present how we are addressing the specific comments of the reviewer.

Reply to the comment on P4356, L22-23: The introductory paragraph now reads as

following: "Several meteorological variables, including temperature, precipitation and atmospheric ventilation impact on air quality (Jacob and Winner, 2009). Among these variables, temperature is shown to have the largest effect on ozone (O3) mixing ratios (Sanchez-Ccoyllo et al., 2006; Dawson et al., 2007). O3 is a product of complex non-linear interactions between nitrogen oxides (NOx) and volatile organic compounds (VOC) in the presence of sunlight (Crutzen, 1994; Seinfeld and Pandis, 1998). Depending on VOC/NOx ratios, O3 can be produced or consumed (Sillman and Samson, 1995). Temperature increases enhance biogenic emissions of isoprene and other VOCs as well as photochemical activity since most thermal atmospheric reactions show positive temperature dependence. Thus, temperature increases in the presence of sufficient NOx lead to increases in O3 levels."

Reply to the comment on P4356, L24-25: For clarity, this sentence now reads : "Observations showed that while primary pollutant levels decrease downwind, secondary pollutants like O3 are produced photochemically during transport of precursors downwind from the large agglomerations and from the surrounding regions: Europe, Balkans and the north of the Black Sea."

Reply to the comment on P4359, L16: In the revised version, the horizontal, vertical and temporal resolution of the NCEP data is now specified: "The initial and boundary conditions have been provided from the National Centers for Environmental Prediction (NCEP) on $1^{\circ} \times 1$ horizontal and 6-hour temporal resolution, with a vertical extend up to 10 mbar."

Reply to the comment on P4359, L19-20: In the revised version, the vertical extend of the model and the first layer is now clearly defined: "...with 30 vertical layers. The lowest level is 8 meters high and the domain top extends to $\sim$16 km. The model layer thickness increases from surface to the model upper boundary. PBL heights are calculated with the Meteorology-Chemistry Interface Processor (MCIP: Otte and Pleim, 2010) and PBL top is generally within the first 27 vertical layers. The 27th layer corresponds to a height of about 3 km. The remaining 3 layers are very coarse and

extend from around 3 km from surface to 16 km"

Reply to the comment on P4359, L26: Nudging has been applied to all model grids. The sentence is rewritten for clarity: "Additionally, nudging has been applied for temperature, wind and moisture parameters towards the NCEP reanalysis for all model grids. The nudging coefficients are set to 0.0003 sec-1 for each variable and forcing every 6 hours has been applied."

Reply to the comment on P4363, L6: j was defined in the same sentence (. . .PCj is the contribution of each process, j,. . .). However, this part has been simplified following the suggestions of both reviewers (see reply to reviewer #2). We have rewritten the following sentence as "In the present study, we evaluate the major atmospheric processes (i): HTRA, VTRA, DDEP, and CHEM that determine O3 mixing ratios."

Reply to the comment on P4364: As requested it is now clarified that: "only the effect of temperature changes on biogenic emissions is evaluated in this study. Potential changes in anthropogenic emissions with temperature due to evaporative VOC emissions have been neglected."

Reply to the comment on P4365: A new figure (Fig. S3) that shows the locations of the stations used in our study is incorporated in the supplementary materials.

Fig. S3. Locations of the air quality monitoring stations (The geographic coordinates of the stations are provided in Table 1). Reply to the comment on P4366, L28: This discussion has been removed based on the comments of the reviewer. Reply to the comment on P4367, L5: We thank the reviewer for carefully reading our manuscript and for pointing this typesetting error. Indeed, the order of the figures did not match the figure caption and it is now corrected. The statistical calculations have been also repeated and their correctness has been confirmed.

Reply to the comment on P4367, L18: Indeed, the simulation-averaged ozone mixing ratio in Athens is around 50 ppb. This is now corrected in the revised manuscript as

following: "Lower O3 mixing ratios are calculated for IST ($\sim$19 ppb) than for Athens ($\sim$50 ppb) due to the O3-titration by high NOx emissions taking place in this megacity, as clearly seen in Fig.1." Reply to the comment on P4367, L27: VOC includes methane whereas NMVOC does not. We use the NMVOC emissions and mixing ratios throughout the results and discussions. We have modified the first sentence of the fourth paragraph in section 3.1. as follows: "The mean surface distributions of O3, NOx, CO and OH mixing ratios and the molar VOC/NOx ratios (calculated as the ratio of NMVOCs to NOx) are presented in Fig. 5."

Reply to the comment on P4368, L13: Regional influence means that the pollutant levels at a specific site or area originate mainly from transport from the surrounding regions than from local emissions. As explained in the manuscript, the CO/NOx ratio is an indicator of emission composition and air masses ageing. Due to the short lifetime of NOx compared to CO, lower CO/NOx ratios indicate high contribution by local emissions whereas high ratios point to important contribution of transported air masses.

Reply to the comment on P4369, L4: Indeed, throughout the text, the simulated surface mixing ratios are actually those calculated for the lowest model layer. To clarify this, the first sentence of section 2.5 is changed accordingly as following: "The model performance has been analyzed by comparing the model results for the lowest model layer with surface observations at various locations in the model domain."

Reply to the comment on P4369, L9 onwards: We agree with the reviewer that the thickness of the lowermost model layer is important for the budget analysis. This is a point that deserves being mentioned in the text for educational purposes. Therefore, we have added the following sentence: "Note however that the surface layer is rather thin (8 m) and, therefore, it is expected to be strongly affected by deposition (DDEP) and convection (VTRA) processes more than the overlaying layers. Thus, the process analysis is performed both for the surface layer alone and the entire PBL."

Reply to the comment on the PBL definition: PBL heights are calculated with the Meteorology-Chemistry Interface Processor (MCIP: Otte and Pleim, 2010) and PBL top is generally within the first 27 vertical layers of the model domain. The 27th layer corresponds to a height of about 3 km. The remaining 3 layers are very coarse and their width extends from around 3 km from surface to 16 km. We further mention in section 2.3, second paragraph: 'Note that the PBL varies spatially and temporally (hourly) as presented in Fig. S1."

Fig. S1. a) Temporal variability of domain-averaged hourly mean PBL heights and b) spatial variability of mean PBL heights averaged over the 15-day simulation period.

Reply to the comment on P4370, L2: Heights are added to Figure 6. Reply to the comment on P4370, L28: For clarity, we have re-plotted the circulation patterns and replaced Fig.7 with a new plot that shows day time circulations. The Figure caption is updated accordingly.

Reply to the comment on P4373, L21: Indeed, the first results in Fig.11. are averaged over the entire model domain. This is mentioned in the figure caption.

Reply to the comment on P4385: Table 2 caption is modified to clearly mention that the daily mean data are provided.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 4355, 2011.

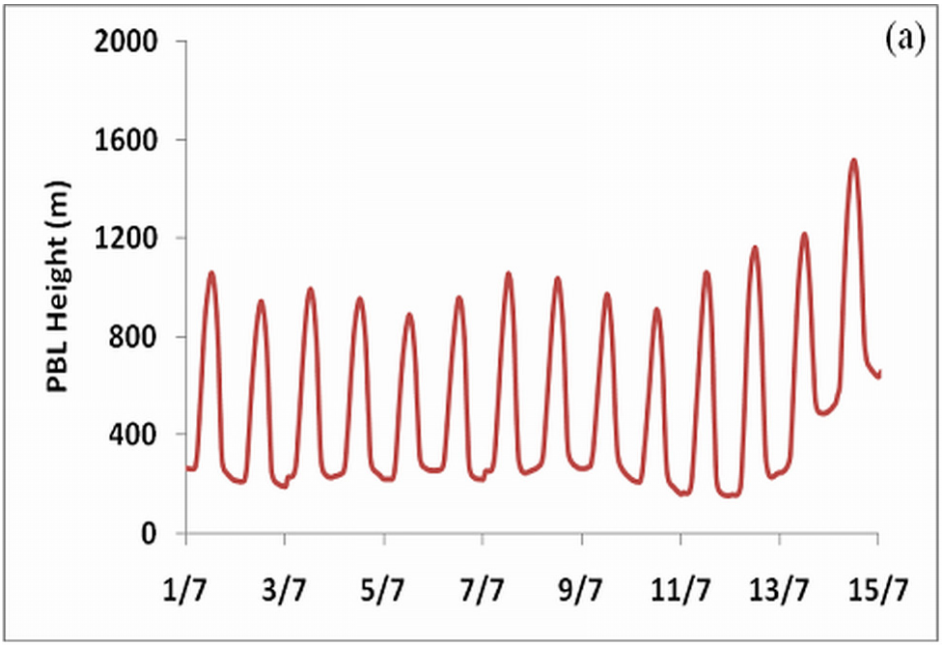

Fig. 1. Fig.S1a

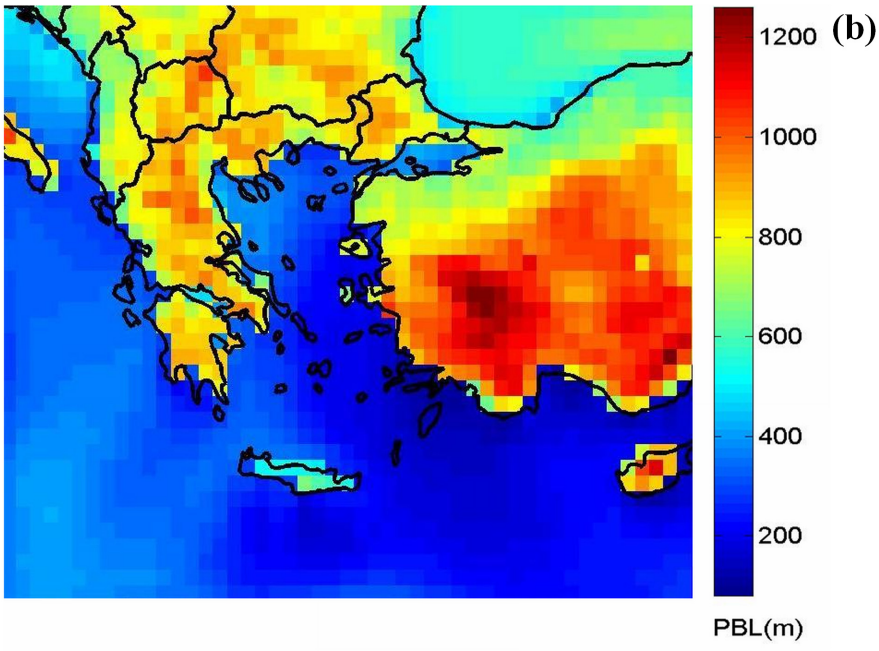

Fig. 2. Fig.S1b

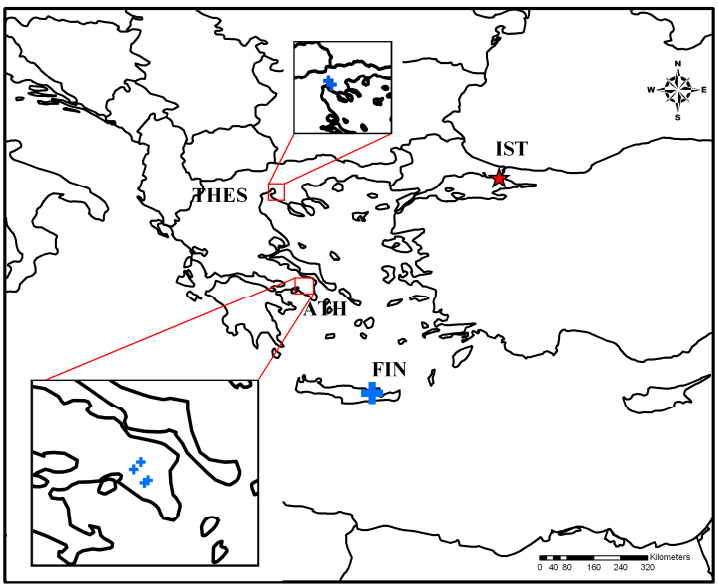

Fig. 3. Fig.S3

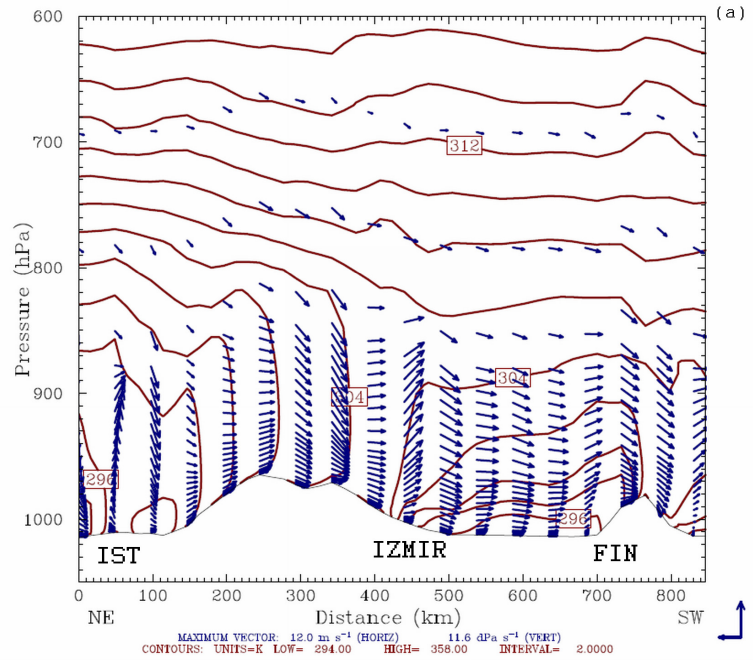

Fig. 4. Fig.7a

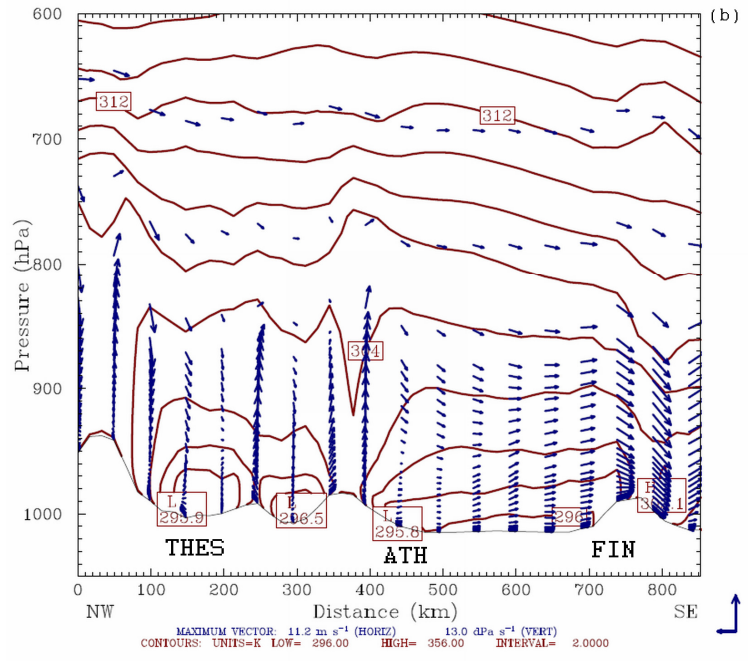

Fig. 5. Fig.7b