

Interactive comment on “Summertime tropospheric ozone variability over the Mediterranean basin observed with IASI” by C. Doche et al.

C. Doche et al.

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The authors thanks the referees for their interesting comments, which were very helpful to improve the discussion quality of the manuscript

Referee: Why do you provide the figure 1 on June-July over 1979-2012 and not over June-July-August, the summer period you study? Please check and revised if necessary.

Authors: The figure has been changed in order to include the month of August. It doesn't change the interpretation of the figure.

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Referee: Do you make your IASI validation with the WOUDC ozonesondes from coincident and collocated measurements? Could you provide more details on that? Could you suggest hypothesis to explain the negative bias around 3km and a positive bias around 10km as shown on Table 1?

Authors: The Mediterranean validation performed in this study has been done using the same coincidence criteria than the ones used in Dufour et al., 2012: $\pm 1^\circ$ and 7 hours. The following sentence have been added in the revised version of the manuscript (P13028-L14): “The same coincidence criteria ($\pm 1^\circ$ in longitude and latitude and 7 hours) as Dufour et al. (2012) have been used.” Concerning the positive bias observed at 10km and representative of the UTLS region, it has also been noticed by Dufour et al., 2012. Several hypotheses have been discussed in Dufour et al. First of all, the coarse vertical resolution of IASI observations with about one degree of freedom or less in the UTLS region does not allow one to reproduce correctly the strong ozone gradient between the troposphere and the stratosphere. Recent studies about the evaluation of the next generation of IASI satellite (IASI-NG) have shown that the improved spectral and radiometric noise of IASI-NG leads to a better vertical resolution, then reducing the bias in the UTLS region (Sellitto et al., AMT, 2013). Other hypotheses given by Dufour et al. concern the impact of spectroscopic uncertainties on ozone line intensities and possibly systematic problems in the radiative transfer. Concerning the negative bias at 3 km, it has to be compared to the estimated errors of the observations (3% versus 16%). Its significance is then questionable. The negative sign of the bias might reflect a slightly compensation effect of the positive bias reported in the UTLS region (one have to recall that the ozone retrieved in the lower and in the upper troposphere are not fully independent). This has been extensively discussed in Dufour et al., 2012 paper, we would more clearly refer the reader to this paper concerning the bias discussion. The following sentence has been added in the revised version of the manuscript (P13028-L19): “Several hypotheses (coarse vertical resolution, spectroscopic and radiative transfer uncertainties) have been discussed by Dufour et al. (2012) to explain this bias. We refer the reader to this paper for more

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details.”

Referee: P13024 L19-22 : I would suggest to add a reference and to replace by “These studies are mainly based on accurate in-situ observations – ozonesondes or MOZAIC/IAGOS vertical profiles and surface stations - (Kalabokas et al., 2013, 2008; Zbinden et al. 2013) but their specific geographic and temporal sampling provide an incomplete vertical tropospheric description over the entire basin.”

Authors: This suggestion has been taken into account in the new version of the paper.

Referee: P 13024 L24 : “Coarse”, please evaluate P 13025 L4-6 : “offer a maximum of sensitivity in the mid-troposphere with an effective vertical resolution of about 6–7km”. Please clarify what you meant by (IASI) “effective vertical resolution of about 6–7km”. Text could be improved, I am not sure “vertical resolution” is here the correct expression

Authors: In atmospheric inverse method, the vertical resolution of the retrieved profile is given by the full width of the half maximum of the averaging kernel of the profile (Rodgers, C. D.: Inverse methods for atmospheric sounding: Theory and practice, vol. 2, World Scientific Publications, Series on Atmospheric, Ocean, Planet. Phys., Singapore, 2000.). In the case of thermal infrared sounders like IASI and TES, the vertical resolution estimate ranges between 6 and 7 km. The expression “vertical resolution” is the one commonly used in inverse approaches for atmospheric sounding.

Referee: P 13025 L26 : I suggest “lower free troposphere” instead of “lower part of the free troposphere”.

Authors: This suggestion has been taken into account in the new version of the paper.

Referee: P 13026 L19-21 : “Concerning ozone, the vertical information is sufficient to study separately different atmospheric layers within the troposphere”. Suppress “atmospheric” and give something more accurate than “different” (may be 2 or 3 layers???)

Authors: The sentences will be replaced by (P13026-L19): “Concerning ozone, between 3 and 4 pieces of information are available for the overall profile depending on

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the thermal conditions. In the troposphere, up to 1.5 degrees of freedom are observed in favourable thermal conditions. In particular, Dufour et al. (2010) have shown the ability to capture separately the variability of ozone at the lower and the upper troposphere in summer conditions, making possible air quality studies in largely polluted region”.

Referee: P 13028 L23-26 : “Due to the vertical sensitivity and resolution of IASI, the 10km level is used to describe the variability of ozone at the upper troposphere and lower stratosphere whereas the 3km level for the lower to middle troposphere. Ozone concentrations retrieved at 3km capture the ozone concentration and variability roughly from 2 to 8 km and retrievals at 10 km are sensitive to ozone changes approximately between 5 km and 14km”. Condense, it will be clearer, this is important is the frame of your study.

Authors: The sentences will be rephrased like this (P13028-L23): “Due to the coarse vertical resolution of IASI, ozone concentrations retrieved at 3 km describe the ozone concentration and variability roughly from 2 to 8 km and ozone concentrations retrieved at 10 km the ozone concentration and variability from 5 to 14 km.”

Referee: P13029 L10-11 : “A land/sea mask has been applied to calculate the averages only over the Mediterranean sea.” Could you explain more, it is not clear enough. . . You did not exclude land from your study. Furthermore the Fig 2a shows white areas on some continental regions that the caption does not describe. Could you explain and provide also a short information on that on Fig2a.

Authors: The land/sea mask has been applied on IASI dataset in order to calculate the ozone averages just over the sea, where the measurement is not perturbed by land emissivity patterns which may lead to systematic ozone overestimation, in particular over the Northern Africa (sand emissivity). For figures, this mask has been kept just over this area which is the most affected by this phenomenon.

Referee: P13029 L15-17 : May be add the number of layers relevant to the 0-14km you are studying?

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Referee: P13030 L11-12 : Better to specify in the title your study is on the summer variability, may be replace by “Ozone spatio-temporal variability in summer from IASI on a 2007-2012 period“?

Authors: This suggestion has been included in the new version of the manuscript.

Referee: P13030 L 22-26: I suggest to condense and replace may be by : “At this altitude over the basin, a steep horizontal west/east ozone gradient is observed, with greater concentrations eastward of 15E (by about 20ppbv) than westward”.

Authors: This suggestion has been included in the new version of the manuscript.

Referee: Figure 3a : Please change the ppm into ppb in order to be consistent with your text.

Authors: This suggestion has been included in the new version of the manuscript.

Referee: P13031 L 20-21 : “This comparison shows that the ozone concentrations retrieved from IASI at 3 km and at 10 km”. I can find out the 3km ozone concentrations on that figure 3.

Authors: This comparison shows that the ozone concentrations retrieved from IASI at 3 km (Fig2a) and at 10 km (Fig3a)...

Referee: P13032 L2-5 : Better to suppress “origin of” and replace by “the mixed stratospheric-tropospheric characteristics of air masses at this pressure level.“ Revised the following sentence also.

Authors: This suggestion has been included in the new version of the manuscript.

Referee: Figure 4 : Please provide an Y axis scaled to the minimum and maximum and not only between [62-70ppb]. Same for fig 5,6,7 and on fig 7 provide ppb instead of ppm. P 13034 L 7 : Please keep constant the ozone units : it is sometime ppm, ppb and ppbv.

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Authors: This suggestion has been included in the new version of the manuscript.

Referee: Take into account and refer to a study submitted recently to acpd “Summer-time tropospheric ozone assessment over the Mediterranean region using the thermal infrared IASI/MetOp sounder and the WRF-Chem Model” by Safieddine et al, Atmos. Chem. Phys. Discuss., 14, 12377–12408, 2014.

Authors: The reference has been inserted in the conclusion. The last sentence has been change into: “Recently, \cite{safieddine14} investigated this point using IASI ozone observations and regional WRF-CHEM simulations.”

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 13021, 2014.

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