Subject: Authors' Responses to Referee #1 Comments

Dear Referee #1,
We really appreciate your effort and valuable although critical comments regarding to manuscript No. acp-2017-1005. We accept your statement for major revision as well as recommendation to submit of revised paper to another type of journal. We have prepared completely new version of manuscript that considered most of your comments. Our answers are enclosed in supplement titled as “Authors' Responses to Referee #1 Comments.pdf”.

On behalf of all co-authors, yours faithfully, Svetlana Bičárová

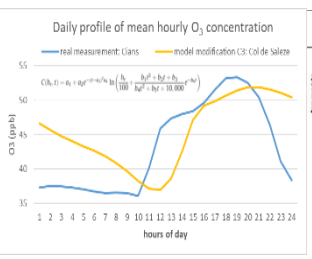
Review of Referee #1 includes comments in separate paragraphs on pages C1-C4. In the following, problems or questions with answers for each paragraph are shortly described.

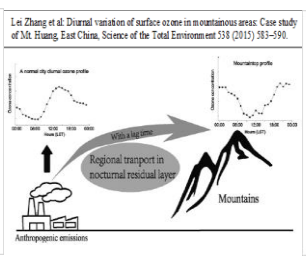
C1

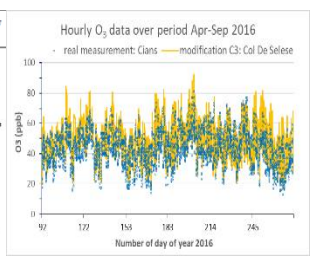
C1/Paragraph 1
Problem: Improving of the results organization, interpretation and conclusions
Answer: We considered this suggestion. Text of old version of the manuscript was almost completely changed with respect to new topic “Phytotoxic ozone dose and the role of environmental factors in ozone uptake of dwarf mountain pine” presented in the revised manuscript.
Problem: The inclusion of the French site.
Answer: We excluded the French study site. Modelling of stomatal ozone flux requires complex inputs based on real measurements and specific parameters. Database of measured input variables in Fr-Alp is not supported by measurement system focused on modelling of stomatal ozone flux. We worked with the available data that were modified. In the future, increase attention should be paid to extension of real field measurements of ozone, meteorological and environmental variables on timberline zone of mountains in Europe.

C2

C2/Paragraph 1
Problem: On-site data in FR-Alp plot (C3)
Answer: Of course, we agree that the best is to have data from one location. At one place (plot C3, Col de Salèse) were assessed ozone symptoms on Swiss pine and there were also measured ozone concentrations using passive samplers. The following data sources were used to prepare the input file for the PODy calculation.
Ozone data
- real measurement (passive samplers) on plot C3-Col de Salèse with monthly O_3 mean of 46 ppb
- real measurement (active ozone analyzer) on site Cians with relatively similar monthly O_3 mean of 43 ppb
Diurnal variability of hourly data from the Cians ozone analyzer were modified according to eq. 3 (in old version of manuscript) and then recalculated with respect to monthly mean differences. Partial steps of this modification illustrate figures below this answer.
Meteorological data
- hourly data from the nearest Isola 2000 meteorological station were used in the input file
According to the average air temperature for the period from April to September, the climate at C3-Col de Salèse (13.8 ° C) is similar to that of Isola 2000 (13.7 C).
Although collection of one-site real hourly O_3 and meteorological data at C3-Col de Salèse is serious problem, modification of available data provides rational framework for model estimation of PODy. Nevertheless, revised manuscript do not include French study site.

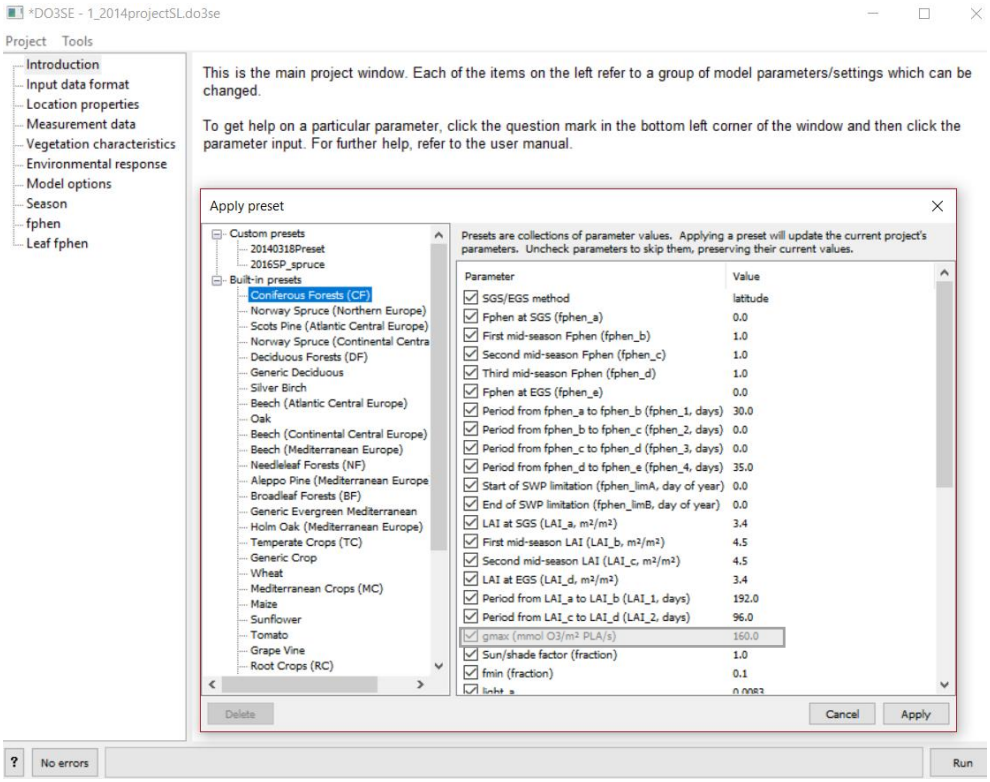






Problem: Parameterization for coniferous forest (CF)

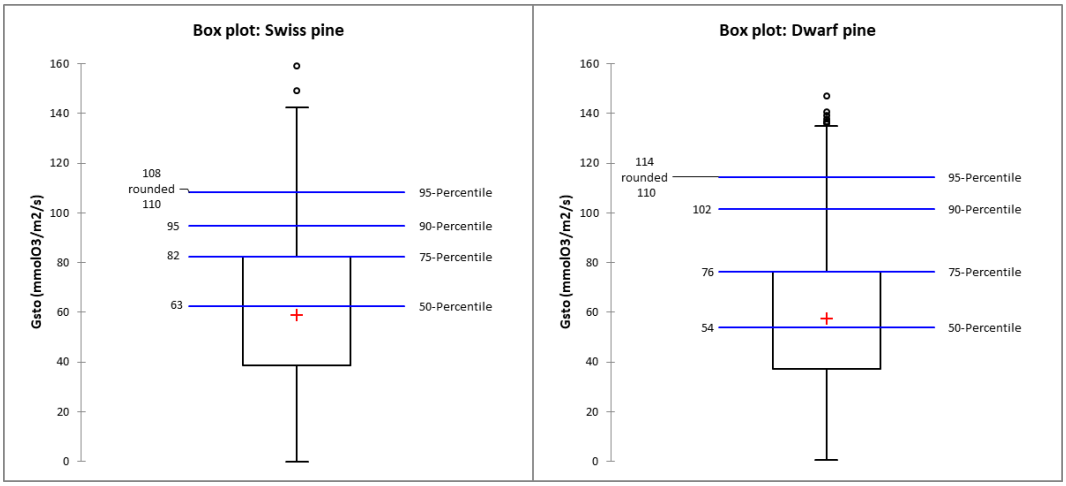
Answer: We used parameterization for coniferous forest according to built-in preset in model DO3SE (see below). List of complete parameters is included in supplement Part SI-1: Details to section: Methods DO3SE model parameterization for version (DO3SE_INTv3.0.5).



C2/Paragraph 2

Problem: Maximal stomatal conductance Gmax for Swis pine 110 mmolO_3 m^{-2} PLA s^{-1}. Is it true or false?

Answer: Next box plots illustrate Quantiles estimation of measured values of stomatal conductance Gsto SK–HT region. In this study we defined 95-Percentil as maximal stomatal conductance Gmax. After rounding it is value of 110 mmolO_3 m^{-2} PLA s^{-1} for both Swiss pine and dwarf mountain pine. Median or 50-Percentile is substantially lower, values between 50 and 60 mmolO_3 m^{-2} PLA s^{-1} do not correspond at all with median value of 125 mmolO_3 m^{-2} PLA s^{-1} for Norway spruce (Continental Central Europe). Norway spruce median value 125 mmolO_3 m^{-2} PLA s^{-1} reffered e.g. in Körner et al. (1979), Dixon et al. (1995), Emberson et al. (2000), Zweifel et al. (2000, 2001, 2002) was derived from range of values between 87 and 140 mmolO_3 m^{-2} PLA s^{-1}. This range is probably related to variability of Gmax values.



C2/Paragraph 3

Problem: The validity of ozone-induced injury data

Answer: The visible ozone symptoms assessment was carried out by the national experts of ICP Forests, Expert Panel on Ambient Air Quality, who was trained at intercalibration courses on visible ozone symptoms. Variation of

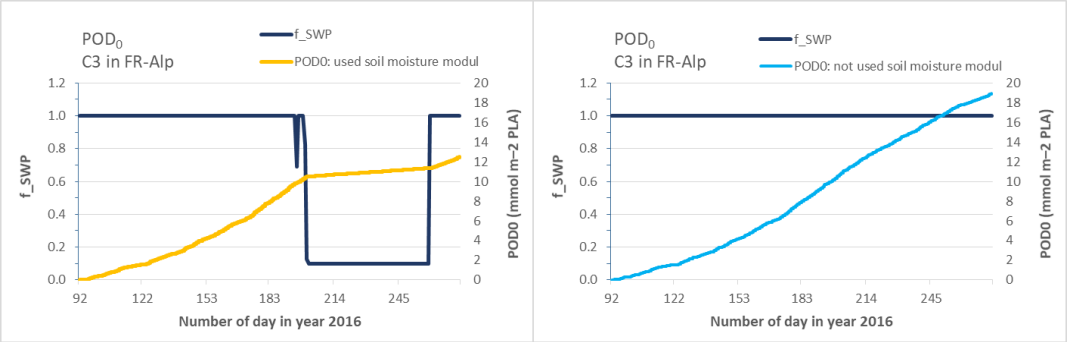
surveyors was not assessed. Fig. 6 (new version) depicts POD0 in different altitudes (A, B, C) and percentage of visual O3 symptoms on needles of different age (C+1, C+2) of dwarf mountain pine in SK–HT mountain environment. An example of O_3-induced injury observed on needles of dwarf mountain pine in the High Tatra Mountains you may see on the picture below. On the picture you can see ozone injury combined with sucking insect.

C+1 **C+2**

C2/Paragraph 4

Problem: The POD0 for FR-Alp (12.5 mmol O_3 m^{-2} PLA) and SWP

Answer: Yes, that's why it's so low because the stomatal flow has been reduced (limited) by drought. The plants respond to the lack of water in the soil by closing the stomata, which also prevents O_3 molecules from penetrating into the cells. In the dry period, therefore, the accumulated stomatal flux value stagnates. POD0 values could be higher (approximately 20 mmol O3 m^{-2}) with sufficient saturation of soil with water (see figure below this answer).



Problem: Line 260 (old version): statistical test

Answer: No, we did not test the difference statistically. Sentence in Line 260 was reformulated in paragraph 4.4 Visible ozone injury (new version).

Problem: Outliers on Figure 5 (old version)

Answer: The outliers seem to be values of the dwarf mountain pine from SK – HT. It could be result of intra-species differences in sensitivity or differences in micro site conditions.

C2-C3/Paragraph 5

Problem: Comparison of POD0 between regions is inconsistent

Answer: Yes, we agree that the PODy values for the processing of available data (see C2 / Paragraph1) are not completely accurate. But these results were analyzed in more detail in the discussion (Line 295-303 in old version). Assessment of visible ozone injury was carried out after the end of the considered season (accumulation period from April to September). Text of manuscript was modified with respect to new topic.

C3

C3/Paragraph 1

Problem: Line 305 (old version): non-essential SWP

Answer: This term follows the previous sentence in Line 304 (old version). This paragraph was changed in paragraph 4.2 Response of stomatal conductance to environmental factors (new version).

C3/Paragraph 2

Problem: Line 325 (old version): difference of visual ozone injury in natural conditions

Answer: We accepted this comment, the text was changed in new version.

C3/Paragraph 3

Problem: Grammatical errors

Answer: We accept this comment. English is not our native language. Upon completion of the professional discussion, the text will be sent to a professional linguistic correction.

C3/Paragraph 4
Problem: Long title
Answer: We accepted this comment and title in revised version is changed with respect to new topic.

C3/Paragraph 5
Problem: Line 104 (old version): AOT40 formulation
Answer: AOT40 ozone metric was excluded in the revised manuscript.

C3/Paragraph 6
Problem: Line 106-114 (old version): Missing formula and definition
Answer: Missing formula and definition was added in the revised manuscript in paragraph 3 Methods 3.1. Ozone metrics.

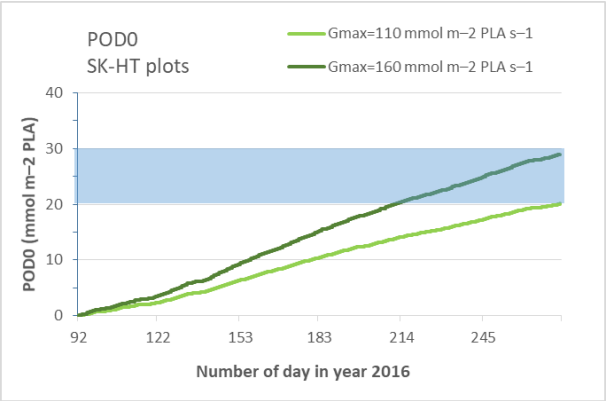
C4

C4/Paragraph 1
Problem: Line 305 (old version): SWC and phenology in the Mediterranean area
Answer: We focused on evaluating SWP (soil water potential), because we had real field measurements in addition to model results. We did not measure SWC (volumetric soil water content). The function fphen is set to 1 because we deal with coniferous trees which, from a phenological point of view, do not have so large changes in the needle compared to the deciduous trees during the growing season. It was used ftemp instead of fphen, as was recommended in Mills et al. (2017).
Problem: Line 116-121 (old version): moving to section “Discussion”
Answer: We accepted this recommendation
Problem: PAR
Answer: PAR was not measured directly, the model calculated the PAR and derived function f_light on the basis of measured global sunlight data. Response of stomatal conductance to PAR is depicted in Fig. 4. (new version).

C4/Paragraph 2
Question: For the SWP, did you follow the Part X: Sampling and Analysis of Soil protocol (ICP Forests manual) for field campaigns to measure Field Capacity and Wilting Point?
Answer: Yes, we partially followed the methodology of ICP Forest Manual (part X), as the Pedological characterisation and detailed soil profile description at our plots was complemented by sampling according to genetic horizons and a detailed soil classification was based on the World Reference Base for Soil Resources (IUSS Working Group WRB, 2015). Final soil type of each site was displayed in Table 1 in manuscript.
Besides, at all research localities we continuously monitored soil water (matrix) potential (SWP, MPa) at three fixed depths and in three different soil profiles to catch hydropedological variability of each site (methodology fully in line with ICP Forests Manual, part IX Meteorological measurements). Detail analyses and laboratory determining of pF retention curves (wilting point and field capacity) were not the objectives of this study. But manufacturer of sensors for SWP measurements (Gypsum blocks) declare the limit value of -1,5 MPa as wilting point, when the soil water becomes unavailable for forest trees.

C4/Paragraph 3
Problem: Line 134 (old version): Integration time for passive samplers
Answer: Biweekly or monthly period; O3 concentration data from passive samplers are not included in the revised manuscript.

C4/Paragraph 4
Problem: Line 293 (old version): High difference of POD0 when used preset a measured-based value Gmax
Answer: As illustrated in the figure below as well as Tab. 3 in the revised manuscript, the difference in POD0 is reasonable for the difference in Gmax.



C4/Paragraph 5
Problem: Line 295 (old version): lower ozone uptake
Answer: This is explained also in Conclusions (Line 295–345 in old version)
Problem: Line 308-309 (old version): reference
Answer: The text is related to the reference given below in Line 312 (Zeppel et al., 2013). Paragraph 309-312 (old version) was amended.

C4/Paragraph 6
Problem: PODy and passive samplers
Answer: Please see C2/Paragraph 1

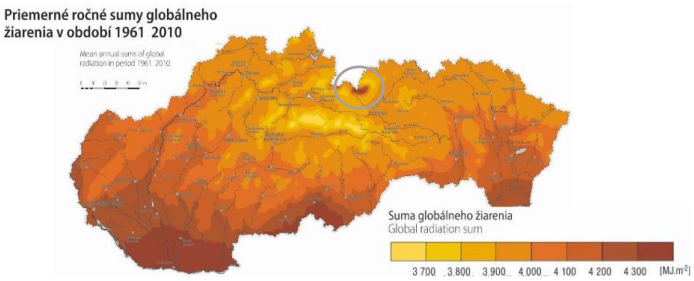
C4/Paragraph 7
Problem: PODy, SWC and Y
Answer: In this work we have analyzed the SWP (as described C4/Paragraph 2). We considered the recommended reference in the revised manuscript.

C4/Paragraph 8
Problem: Line 90 (old version): missing reference
Answer: "Visible leaf injury on particularly sensitive species is one of the O3 air pollution symptoms (Benham et al. 2010." However, this sentence is not in a new version of manuscript anymore.

Benham, S. E., Broadmeadow, M. S. J., Schaub, M., Calatayud, V., & Bussotti, F. (2010). Using commercial tree nurseries to monitor visible ozone injury-An evaluation. Forest Ecology and Management, 260(10), 1824–1831. https://doi.org/10.1016/j.foreco.2010.08.

C4/Paragraph 9
Problem: Improving of Figures and Tables
Answer: Figures and Tables were modified in new version.
Problem: Global radiation
Answer: The annual sum of global radiation is one of the basic climatic characteristics, commonly used also in the Climate Atlas of Slovakia (2015). Spatial distribution of the average annual sum of global radiation in the reference long-term period 1961-1990 illustrates the map below. Sums of global radiation in the High Tatra Mts. (circle on map) correspond to the measurements in the SK-HT plots in 2016. A new CMP10 Pyranometer Kipp and Zonen was used at plots A, B, C.

SK–HT	Global radiation R (kW m^{-2}) Sum (Apr-Sept 2016)	Global radiation R (MJ m^{-2} Sum (Apr-Sept 2016)
A	863	3,107
B1	587	2,112
B2	707	2,534
C1	750	2,700
C2	543	1,954
D	798	2,876



Problem:Table 4: SWP – (not) acceptable agreement
Answer: Yes, for the SWP value the relative difference seems to be high, but for calculating Gsto and PODy is an important function fSWP and there were no differences. An emphasis on this important circumstance is given at the end of Line 236 (old version) ... with respect to fSWP (Table 4). We changed the formulation of this sentence in the revised version of the manuscript.