We thank the reviewer for the careful reading of the manuscript and the insightful comments. Please find bellow our point-by-point replies:

General comments:

GC1. Additional analyses can be performed with regards to the transport of tracers as it is frequently used in the manuscript to explain differences. How good is the model with respect to transport, especially vertical transport?

- The transport of TM5 has been successfully evaluated many times in the past, e.g., see (Koffi et al., 2016; Krol et al., 2005; Peters et al., 2004; Williams et al., 2017). For this, we consider such analysis outside the scope of the current paper that is focused on presenting the new chemistry developments. Note that the current version of the TM5 model was recently included in a model intercomparison (Krol et al., 2018), in which vertical resolution was specifically addressed. For this, we provide references for each major release of the model that can guide the reader for further reading.
  Following, however, the reviewer's comment, brief description and references of the transport processes parameterizations in TM5 are added in Model Description (Sect. 2.1): "*The advection scheme used in TM5 is based on the slopes scheme (Russell and Lerner, 1981) and the deep and shallow cumulus convection scheme is parameterized according to Tiedtke (1989). The performance of the transport in the model has been evaluated by (Peters et al., 2004) using sulphur hexafluoride simulations and by analyzing the vertical and horizontal distribution of radon ($_{222}Rn$) to simulate the boundary layer dynamics (Koffi et al., 2016; Williams et al., 2017). More recently, global transport features, such as the transport times associated with inter-hemispheric transport, vertical mixing in the troposphere, transport to and in the stratosphere, and transport of air masses between land and ocean, were evaluated via an inter-comparison of six global transport models (Krol et al., 2018).*"

Specific Comments:

SC1. Page 4, lines 4-5: Use of 150 ppb, or any concentration level has caveats, e.g. model bias. Why not use the meteorological tropopause instead? The implications should be addressed. this?

- For this work, as we stated in the manuscript, we use the chemical tropopause level defined by a 150 ppb O_3 mixing ratio following the well-documented model intercomparison study by Stevenson et al. (2006). The use of the 150 ppb O_3 level has been used so far in numerous studies, as also with previous versions of the TM5 model, providing thus an opportunity of a direct comparison of model results with other estimates. On the other hand, the tropopause levels in a model may have various definitions, such as the temperature and the potential vorticity gradients, the altitude or the standard World Meteorological Organization definition that the lowest level above 500 hPa where the vertical temperature gradient decreases to less than or equal 2 ^oC km^{-1}.

  We agree with the reviewer that the definition of the tropopause may lead to great differences, and for this, we stated in the manuscript that the tropopause definition should always be reported when comparing modelling estimates.

  For this work, however, we prefer to keep the tropopause based on the 150 ppb O_3 mixing ratio since we here mostly focused on the differences between the different configurations of the model. However, to show the impact of the use of different tropopause levels on the calculated tropospheric budgets, we now provide the relative differences of using the 100 ppb O_3 level, i.e.:

Table 1. Tropospheric budgets of O_3 for the year 2006 in Tg(O_3) yr^{-1} and burden in Tg(O_3), using the 150 ppb O_3 mixing ratio to define tropopause level. In parenthesis the relative differences using the 100 ppb O_3 mixing ratios are also presented, calculated by reference to the 150 ppb O_3 definition of tropopause level.

Production terms	mCB05 (EBI)		mCB05 (KPP)		MOGUNTIA		Loss terms	mCB05 (EBI)		mCB05 (KPP)		MOGUNTIA	
Stratospheric inflow*	632	(10%)	429	(32%)	424	(30%)	Deposition	955	(0%)	932	(0%)	913	(0%)
Trop. chem. production	5589	(-3%)	5719	(-3%)	5709	(-3%)	Trop. chem. loss	5192	(-1%)	5216	(-1%)	5219	(-1%)
Trop. burden	385	(-8%)	384	(-8%)	375	(-8%)	Trop. lifetime (days)	22.8	(-8%)	22.8	(-8%)	22.3	(-6%)

**sum of the deposition and the tropospheric chemical loss minus the production*

Table 2. Tropospheric chemical budget of OH for the year 2006 in Tg(OH) yr^{-1}, using the 150 ppb O_3 mixing ratio to define tropopause level. In parenthesis the relative differences using the 100 ppb O_3 mixing ratios are also presented, calculated by reference to the 150 ppb O_3 definition of tropopause level.

Production terms	mCB05 (EBI)		mCB05 (KPP)		MOGUNTIA		Loss terms	mCB05 (EBI)		mCB05 (KPP)		MOGUNTIA	
$O(^1D) + H_2O$	1960	(0%)	1953	(0%)	1878	(0%)	OH + CO	1665	(-2%)	1671	(-2%)	1775	(-2%)
$NO + HO_2$	1268	(-4%)	1312	(-4%)	1426	(-4%)	$OH + CH_4$	613	(0%)	626	(0%)	644	(-1%)
$O_3 + HO_2$	560	(-1%)	566	(-1%)	561	(-1%)	$OH + O_3$	254	(-2%)	260	(-2%)	262	(-3%)
$H_2O_2 + hv$	262	(-1%)	265	(-1%)	303	(-1%)	OH + ISOP	114	(-1%)	115	(-1%)	120	(0%)
Other	203	(-2%)	201	(-2%)	120	(-1%)	Other	1606	(-1%)	1626	(-1%)	1487	(-1%)

Table 3. Global budgets of CO for the year 2006 in Tg(CO) yr^{-1} and burden in Tg(CO), using the 150 ppb O_3 mixing ratio to define tropopause level. In parenthesis the relative differences using the 100 ppb O_3 mixing ratios are also presented, calculated by reference to the 150 ppb O_3 definition of tropopause level.

Production terms	mCB05 (EBI)		mCB05 (KPP)		MOGUNTIA		Loss terms	mCB05 (EBI)		mCB05 (KPP)		MOGUNTIA	
Emissions	1097	(0%)	1097	(0%)	1097	(0%)	Deposition	98	(0%)	97	(0%)	99	(0%)
Trop. chem. production	1809	(-1%)	1818	(-1%)	1992	(-1%)	Trop. chem. loss	2840	(-6%)	2849	(-6%)	2924	(-2%)
Strat. chem. production	26	(69%)	26	(73%)	26	(65%)	Strat. chem. loss	87	(68%)	89	(69%)	90	(68%)
Atmos. burden	370	(0%)	360	(0%)	361	(0%)	Lifetime (days)	47.5	(2%)	46.2	(2%)	43.6	(3%)

SC2. Page 13, line 13. Use of different emissions are not clearly mentioned in section 2.4. Authors should justify the use of different emissions and how this impacts the changes they see in the different scenarios.

- As explained in our replies to the other reviewer (RC1), we use the same emissions (and boundary conditions) for the different chemistry configurations of the model. This choice is made in order to specifically focus only on their differences between the two mechanisms in the model as explicitly presented in Sect. 3. In the manuscript we refer to the different "speciation" of the emitted volatile organic compounds (VOC) i.e. how the VOC emissions are distributed among the VOC species considered in the different chemical mechanisms: the more lumped mCB05 does not resolve all of the NMVOCs provided by the emission datasets, whereas MOGUNTIA explicitly simulates the NMVOCs (C1-4) and isoprene. To make this point clearer, however, we changed the word "speciation" with "*representation*" when we refer here to the differences between the two chemical schemes (see also our reply to SC17) and we clearly state in the manuscript that both mechanisms use the same emission datasets.
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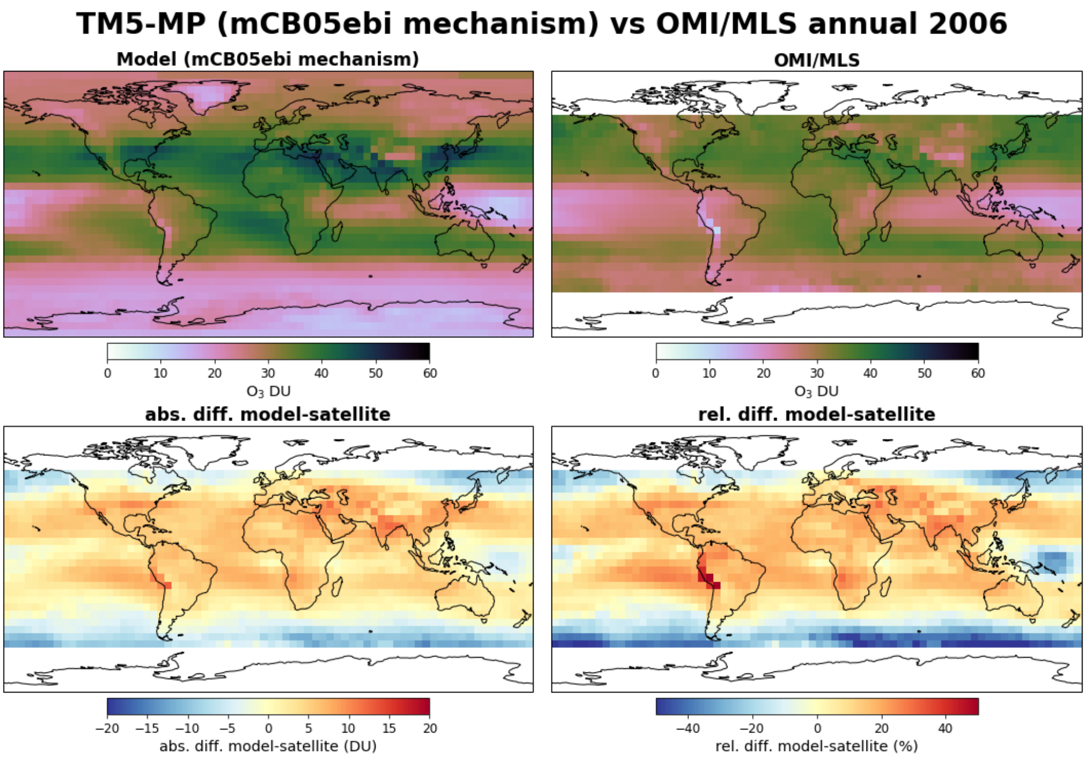
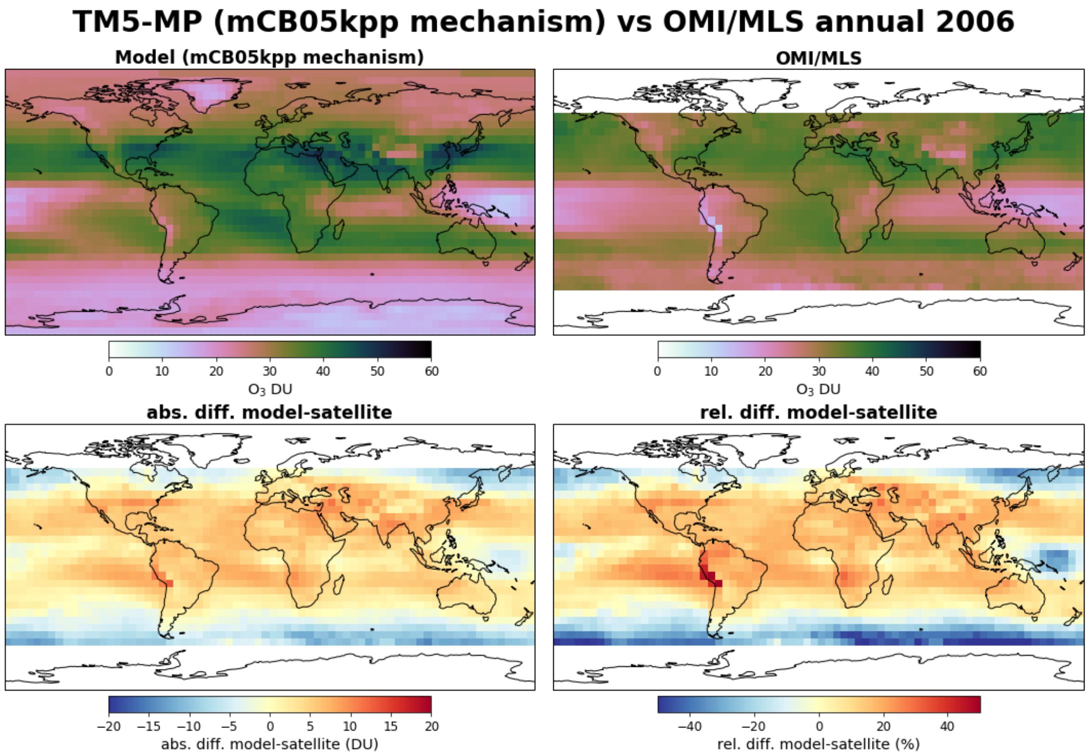
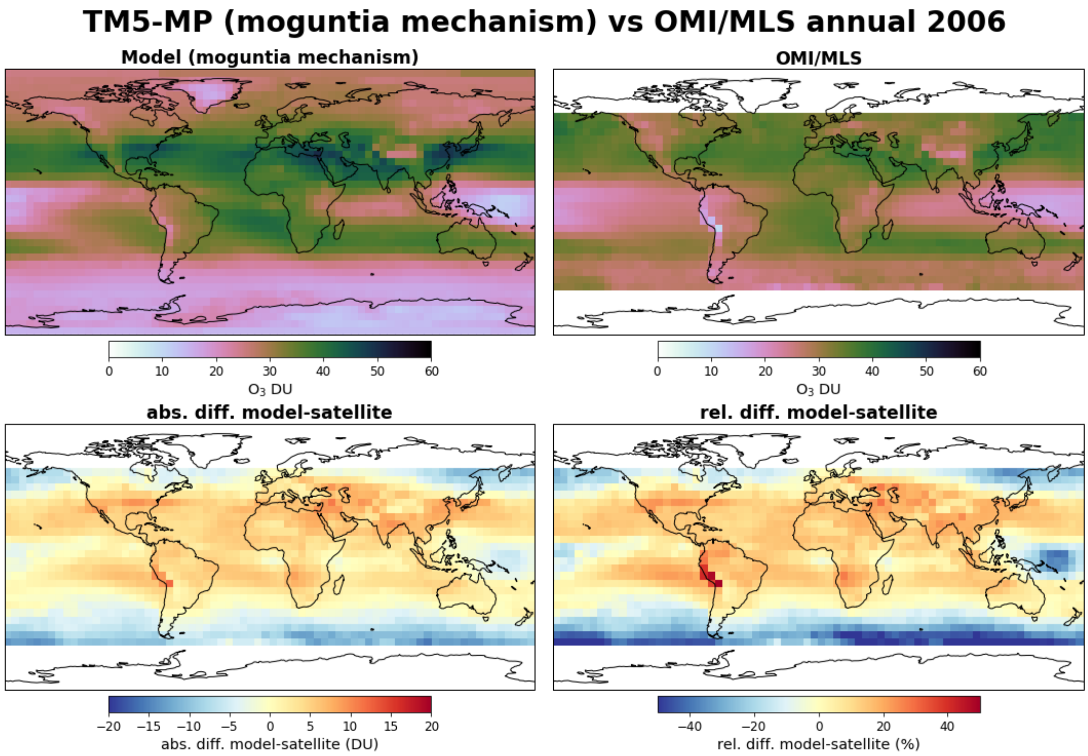
SC3. Page 20, Line 3: It would be great if the results are compared with satellites

- For this work we used two extended surface ozone observation databases and one ozonesonde database to evaluate the model and discuss the differences of the different configurations. More extended model evaluation, although always interesting, is not however expected to change the conclusions of this work, especially for the simulated tropospheric ozone mixing ratios. On the other hand, as also we refer in the summary (Sect. 6) a more dedicated comparison of the model with the MOGUNTIA configuration with *in-situ* observations and satellite retrievals is planned to be performed in the future. As an example of our work in progress, the reviewer can find bellow an evaluation of tropospheric O_3 columns (for the three configurations of this study) with the respective OMI monthly tropospheric retrievals:







Overall, it is obvious from this evaluation, that the MOGUNTIA scheme simulates better the OMI retrievals, thus leading the model in the right direction. Note, again, that we choose not to present this evaluation in this paper, since a separate paper is in progress.

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