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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The impact of inhomogeneous emissions and topography on ozone photochemistry in the vicinity of the Hong Kong island" *by* Yuting Wang et al.

Anonymous Referee #2

Received and published: 4 November 2020

1) The paper addresses the topic to study segregation "in order to investigate the degree to which the rates of chemical reactions between two reactive species" are modified compared to the well mixed case. This is done for 5 reactions to study a) the influence of a non-homogeneous distribution of surface sources and b) the influence of topography for a concrete case, the Hong Kong island. They apply an LES embedded in WRF for the regional flow field.

The complete topic is a next step forward if the very systematic study of Ouwersloot et al. (2011) is considered, which is cited. Therefore, the paper represents a substantial contribution to science within the scope of ACP.

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Discussion paper

2) The application of LES to study segregation is for a concrete landscape in this way is new.

3) The conclusions reached are new with respect to comparable LES studies but will be improved if some additional figures and data (in tables) are added (Remarks).

4) The methods and assumptions seem to be valid but more quantitative information should be given for any reader for better understanding of the results.

5) The interpretations and conclusions need some support by the quantitative presentation of some additional results (Remarks).

6) The authors give credit to related work and indicate their own new contribution. They may also consider: Patton, E.G. et al. (2011): Boundary Layer Meteorol. 100, 91-129. Kramm, G., Meixner, F.X. (2000): Tellus 52A and some literature noted in the remarks.

Remarks:

a) General Remarks: The presentation of segregation intensities I_S is based on the time averaging concept. This is helpful to compare also to results obtained e.g. by:

Verver, G.H.L. et al. (2000), J. Geophys. Res. 105, 3983 - 4002;

Kaser, L. et al. (2015): Geophys. Res. Letter 42, 10.894 - 10.903;

Dlugi, R. et al. (2019): ACPD, as cited; and references in 7)

for the reaction OH + RH-B, which seem to be comparable to OH + isoprene by the rate constant, and for the reacion O_3 + NO.

An LES without PBL-scheme is used, with prescribed sensible heat flux H_S , and simplified moisture flux (section 2.2).

The "inner area" has urban area, forest area and "none" (Fig.2). But "none" is sea and sea has $H_S << 220 W m^2$! Please give specific information. The mechanism to produce turbulence should be, therefore, described in detail (A table may help). Please

give also roughness properties for the sea, the urban area and the forest to explain the production of the TKE. Which term of the TKE - balance is dominant? Which processes produce TKE? Please also show wind profiles above sea, urban area, forest (hill). Are there rotating flow elements behind the hill?

What is the influence of bouyancy? You mention "convective conditions" in line 129, but does this really contribute to the TKE in your model setup? Did you specify PBL-height by Θ - or Θ_v - profile like in Ouwersloot et el. (2011)?

Please formulate a subsection on these details to inform any reader on the physics of the calculations for a better understanding.

b) In line 143-152 you give the emission rates. They are constant for all grid elements of the urban area and the forest. No heterogeneity within the areas is considered. So the scales of heterogeneity are above several hundred meters or more! In line 143 you mention "constant emissions" were used in the outer domain". But here you have sea, a harbour and emission of ships.

Please add maps like Fig.2 for emissions of NO, CO, RH-A and RH-B at the surface for a better understanding by any reader.

c) Line 234: You mention results on water vapour in Fig.1. If water vapour varies it is of direct influence on OH-production (Eq. R6).

d) Line 236: This is not "chemical equilibrium". These are stationary conditions. The ozone production is still visible for 2h and 4h! Note also you have "poluted conditions" while Ouwersloot et al.(2011) has low NO_x (or even no NO_x) conditions.

e) You mention several times that high TKE leads to higher (or high) segregation. Please present figures for each reaction to show I_S versus TKE. Also Dlugi et al.(2014), ACP14, 10333-10362 presented their findings for I_S (OH + isoprene) as function of TKE (their Fig.19).

f) For comparison with literature you may also present (for negative and positive I_S) I_S

as function of the covariance in Eq. 6to test the hypothesis that "I_S is proportional to the covariance" as mentioned by Kaser et al (2015). Dlugi et al.(2019) also presented a figure with r (your Eq. 8) as function of I_S (their Fig.9). Such results may also be added to your presentation to compare with data from literature.

g) Table 1: Dimensions are missing for all quantities.

h) Table 3: Dimensions should be shifted to the right (numbers).

i) Please give the complete notation for "VMR".

j) Fig.6: OH and RH-B: Segregation is given outside the area of emission! (also in Fig 9). How to explain positive I_S ?

h) Please replace the notion "tracer" by "chemical compounds" or "reactants" or another specific word.

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