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Atmospheric Chemistry and Physics Discussions

# *Interactive comment on* "Chemical and aerosol processes in the transition from closed to open cells during VOCALS-REx" *by* J. Kazil et al.

**Anonymous Referee #2**

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In this paper authors investigate effect of the aerosol emission from the ocean surface, aerosol formation from sulphuric acid and entrainment of the aerosol from above the boundary layer on the stratocumulus cloud evolution using numerical model. In particular authors are trying to answer the question if the mentioned above aerosol sources provide enough aerosol to keep open cell circulation within the marine boundary layer; with the sink of the aerosol being removal by the drizzle droplets. Numerical model (WRF/chem) is modified by authors, and the two moment aerosol MADE module is coupled with the two-moment microphysics, resulting in the scheme capable of simulating aerosol formation, aerosol growth to the CCN sizes and later used as a CCN in microphysics parametrization; and the transport/reaction of the chemical species by/with the cloud/rain water. Authors find that combined effect of the aerosol from the surface, nucleation of the aerosol from the H2SO4 and entrainment is sufficient to



maintain open cell circulation and explain in detail aerosol formation in the cloud free regions. Authors also find agreement between numerical model results and an observations for the concentration of the aerosol bigger than 120 nm. There are differences in the modelled and observed SO2 concentration, especially inside the cloud, which at this stage authors can not explain.

After reading the manuscript I have few questions authors might consider to address in revised version:

Specific comments:

a)Part where the model is described is split into main text and appendix what makes reading difficult and some information is repeated in both.

b)It's not clear from the description how exactly aerosol is activated. How number of activated CCN is related to the supersaturation (P4715L14)?

c)I'm concerned about aerosol conservation. Since microphysics keeps (redundant) information about aerosol concentration and mass (mass can be calculated by integration of the: N(r_a)r_aˆ3 over the r_a) is mass and number of the aerosol conserved in this scheme during deactivation? Or maybe conservation is ensured by varying geometric mean diameter for each mode. But in the latter case is coarse mode geometric mean diameter always bigger than accumulation mode geometric mean diameter?

d)I'm not sure authors discussed in enough details entrainment as a source of aerosol. In this paper authors state that entrainment contribution is 50% of that by the surface fluxes. However in Wang et al. 2010 apparently the contribution by entrainment was not enough to maintain boundary layer (open cell) circulation. Under what conditions aerosol from entrainment will contribute enough to keep open cell circulation?

e) And related to the previous point: is aerosol nucleation from the gas phase and entrainment (without the sea salt emission from the surface) enough to keep open cell circulation? As authors state in the article it takes time to grow nucleated aerosol to the

CCN sizes, as a result cloud may dissipate before nucleated aerosol reach CCN size.

f) In 2.2 authors state that some reactions were removed from the WRF/chem. Can these reactions affect DMS -> SO2 transition in the cloud (figure 10b and 10d) .

g)P4717,L3: It's not clear why authors decided to include removal of the nucleation mode aerosol by collision with drops, but neglected accumulation and coarse mode removal by this process.

Technical corrections:

1)Authors should consider adding "Numerical simulations" in title and abstract (first sentence) to make it clear that paper is about numerical simulations of chemical and aerosol processes.

P4688L11 Remove sentence "We introduce ...."; and change next sentence to "Results from the numerical model ...".

P4689,L15: Shouldn't authors refer Stevens et al. 2005b instead of 2005a?

P4690: Consider rewriting first paragraph starting from "Aerosol nucleation has been ...". First sentence in this paragraph is about nucleation and removal, second about emission and entrainment, third again about nucleation. It also contains concept of "aerosol surface area" I'm not familiar with and a although it was used in Tomlinson (2007) I didn't find physical meaning of it.

P.4691, L9 Sentence "Photo-, gas ..." seems to be unfinished. Maybe "It follows photo-, ... and transport will play important roles in determining aerosol properties in the MBL".

P4692,L7: Starting from "In recent years ..." to the end of the paragraph seems to be out of context in this place. Shouldn't this part be in Motivations?

P4697,L23: "Dry deposition ..", It's not clear what authors are trying to say in this sentence. It may be too technical and unnecessary.



P4698,L23: In the table 1 there is no aerosol in coarse mode, and Aitken mode aerosol is specified only in the free troposphere. Please specify it in the text too.

P4700,L16: First 2 sentences in this paragraph are difficult to understand. What is H2SO4 condensational sink? Is it a transfer of the H2SO4 from the gas phase to the water droplets? And where is sea salt emission on the figure?

P4701,L15: Maybe "... in the cloud free MBL top region". Later authors explain why SO2 within the cloud is low.

P47505,L24: Is it really true that there is more water in sizes d>40 um than in d<40 for the drizzling stratocumulus? Typically mean droplet diameter is less than 40 um.

b) It's not clear why author discuss DMS and SO2 in different sections (5.3 and 5.4), at the same time having plots on the same figure.

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