We thank the referee for the valuable and thoughtful comments which helped to improve the paper. Our responses to the comments are below.

General comments

- The authors should better emphasize in the introduction why is important to perform another set of LES, which could be in fact be seen as a repeat of previous sensitivity tests of marine stratocumulus to aerosol and large-scale conditions published in the literature. The design of the set of simulations the authors perform here could also allow to compare the relative importance of changes in aerosol to that of changes in meteorology for the evolution of marine stratocumulus. Such a discussion would be very valuable, given the difficulty in making such a comparison based on observations. And therefore would worth to be included in the manuscript.

>>Response: We have added discussion in the Introduction to emphasize the significance of the present simulations: "Taken as a whole, a number of studies essentially cover the range of aerosol-cloud-precipitation interactions. No single study, however, covers the spectrum of aerosol and meteorological influences relative to a consistent base case. High-resolution LES simulations that investigate a full range of aerosol and meteorological variables are carried out in the present study. The meteorological factors investigated include SST, free-tropospheric humidity, large-scale subsidence rate, and wind speed. Diurnal variation is considered for non-precipitating as well as lightly and heavily precipitating conditions. In that sense, the present work can be viewed as a comprehensive, consistent retrospective of aerosol-MSc interactions. A second goal of the present study is to evaluate analytical formulations of cloud optical depth susceptibility to aerosol perturbations, including the Twomey, droplet dispersion, cloud thickness effects. While such analytical formulations are generally based on simplifying assumptions, they offer the advantage of concisely encapsulating complex responses. If generally applicable, analytical formulations of MSc responses to aerosol perturbations offer promise for use in large-scale models. To the extent possible, each effect is quantitatively evaluated from LES experiments to enable comparison with the analytical formulations. The present work therefore also provides an indication of the extent to which analytical formulations of cloud susceptibility to aerosol perturbations can be evaluated with LES."

- The discussion of the results should be revised, because it often is too long, not clear and sometimes leaves the impression the authors misunderstood some of the basic mechanisms driving the stratocumulus clouds (see specific comments below).

>>Response: We appreciate the care with which the referee prepared this review. The material that was not clear has been carefully revised. See responses below.

- The differentiation of the two regimes non/light drizzling and heavy drizzling leads often to confusion, as sometimes the clean case becomes non-precipitating and then it is not clear if when the authors talk about the impact of aerosol in heavy drizzling conditions they still/always refer to the clean case or not.

>>Response: The non/light drizzling and heavy drizzling cases are defined based on the surface precipitation rate. A surface precipitation rate less than 0.1 mm day^{-1} is defined as light drizzle. A precipitation rate between 0.1 and 1 mm day^{-1} is defined as moderate drizzle. Heavy drizzle is defined as a precipitation rate exceeding 1 mm day^{-1}. If the clean cloud becomes non-precipitating, for example, it is no longer referred to as drizzling.

- Drizzle evaporation in the sub-cloud layer does not always lead to a rise of the cloud base, hence a diminution of the LWP, by stabilizing the under-cloud layer and decoupling the cloud layer from the surface. Sometimes, when the cloud is only slightly drizzling the cooling of the cloud base region, via evaporation of rain drops just under the cloud base, may maintain a lower condensation level, hence a lower cloud base (Lu and Seinfeld, 2005). During daytime it can moreover partially compensate the warming of the cloud base region due to absorption of solar radiation and also prevent, or diminish the raise of the cloud base (Sandu et al. 2008). This feedback should be mentioned along with the others pathways of aerosol-drizzle-cloud interactions summarized in the introduction, and considered in the analysis of the results.

>>Response: We appreciate the referee pointing out additional physics resulting from drizzle evaporation that was not fully discussed. We have added a discussion (see responses below) for further clarification. And to clarify, we do not suggest that drizzle evaporation in the sub-cloud layer leads to a rise of the cloud base.

Specific comments

Abstract

The switching between night-day-night when the contribution of the different effects to cloud susceptibility is summarized is confusing.

>>Response: In the Abstract, the values and percentage of each effect are calculated based on nighttime conditions; while daytime values are not separately summarized in the Abstract since they are more variable with larger standard deviation, and should be viewed with more caution. However, these responses have been covered in Section 5.4. And we have re-organized the statement as follows: "Overall, the total cloud optical depth susceptibility ranges from ~0.28 to 0.53 at night; an increase in aerosol concentration enhances cloud optical depth, especially with heavier precipitation and in a more pristine environment. During the daytime, the range of magnitude for each effect is more variable owing to cloud thinning and decoupling."

Introduction

- pp 15501 L 13-19: this paragraph should be revised according to point 4 in the general comments above.

>>Response: We have added the following statement to cover other possibilities of sub-cloud drizzle evaporation and moved it to Section 5.1: "The cooling and moistening below the cloud leads to weaker turbulence intensity and inhibition of deeper mixing, and may also lower the cloud base (Lu and Seinfeld, 2005). During the daytime this can partially offset the warming of the cloud base due to absorption of solar radiation and counteract the tendency for the cloud base to rise (Sandu et al., 2008)."

- pp 15501 L 20- this paragraph is just a repeat of pathways d and e, isn't it?

>>Response: We have removed this paragraph as it did describe the pathways d and e again.

- pp 15502 - this part of the introduction would become clearer if the authors were better introducing the discussion of the sensitivity to large-scale conditions, by mentioning that the previous studies did not only explore how these clouds are affected by aerosol in certain conditions, but also how the clouds behave and respond to aerosol perturbations under different large-scale conditions. It should appear clearly for the reader that MSc depend strongly on large-scale conditions such as divergence, sst, etc, and therefore their response to aerosol perturbations may depend on the conditions governing the boundary layer.

>>Response: We have added the following statement to stress the significance of different meteorological conditions: "Meteorological conditions, such as free tropospheric humidity, large-scale divergence, and SST, have strong impacts on cloud responses to aerosol perturbations. Several previous studies (Table 1) demonstrate the extent to which clouds are affected by aerosol perturbations under different meteorological conditions."

- pp 15502 L 15-16: higher/lower divergence corresponds to shallower/deeper boundary layer and not the other way around.

>>Response: We have made the following change: " under higher (lower) D, the MBL is shallower (deeper)."

- pp 15503 first paragraph: The authors should explain here clearly what drives the diurnal cycle: during nighttime, due to the LW cooling that takes place in a thin layer at cloud top, the cloudy air from this region becomes heavier than the surrounding air, so it sinks, initiating downdrafts which are often strong enough to get to the surface. Otherwise said the LW cooling creates positive buoyancy in the cloud top region, so it enhances in-cloud TKE, hence the mixing in the boundary layer. As the boundary layer is often well mixed the cloud is supplied with moisture from the surface and it thickens despite mixing with the warmer and drier air entrained at cloud top. During daytime the absorption of solar radiation in the cloud layer partially outweighs the LW radiative cooling, but also slightly warms the cloud layer throughout its depth. Under the effect of mixing with warm air from the inversion and absorption of solar radiation, the cloud becomes slightly warmer than the undercloud layer and a thin stable layer may appear at its base. This slightly stable layer decouples the cloud from the subcloud layer. So the supply of moisture from the surface is weakened and the cloud gradually thins.

>>Response: We have revised the material to explain the diurnal variation more clearly: "During nighttime, cloud top LW cooling generates positive buoyancy in the cloud layer, which enhances in-cloud TKE and serves to mix the MBL. As the MBL is often well mixed, the cloud is supplied with moisture from the surface and becomes thicker despite the warmer and drier entrained air at cloud top. Under daytime conditions, absorption of solar radiation partially offsets the cloud top LW cooling and also warms the cloud layer throughout its depth. With the mixing of warmer entrained air and absorption of solar radiation, the cloud may become slightly warmer than the sub-cloud layer, and a thin stable layer may appear below the cloud base (Sandu et al., 2008). This stable layer could act to decouple the cloud from the sub-cloud layer, and result in a cutoff of the surface moisture supply and leads to a thinner cloud."

- pp 15503 L11-12 and 21-22: the phrases: "Also, distinct..." and "The sign ..." should be rephrased.

>>Response: The phrases in question have been revised as follows: "Also, the MSc diurnal variation is distinct as a result of cloud-radiation interactions." and "Each effect is quantitatively evaluated from LES experiments to enable comparison with the analytical formulations.".

Section 2

- pp 15504 L2: ",providing a consistent..." not well phrased.

>>Response: We have rephrased the material as follows: "Analytical relationships, if shown to be valid by comparison with a more rigorous LES approach, can be effective in representing aerosol-cloud-precipitation interaction response.".

- pp 15506 L13-15: remind why the dispersion effect would lead to a warming effect.

>>Response: We have added the following statement: "…the dispersion forcing would offset the cooling from the Twomey effect as the competition for water vapor in the relatively polluted, condensation-dominated regime leads to spectral broadening and negative dispersion effect (Feingold and Siebert, 2009)."

- pp 15506 L18: The explanation of the mechanism described by Lu and Seinfeld is not clear.

>>Response: We have added the following statement to clarify the mechanism of Lu and Seinfeld (2005): "For a drizzling cloud, increasing N_a leads to spectrum narrowing (larger k) because smaller droplet suppress precipitation and lead to (1) less spectral broadening by suppressed collision-coalescence and (2) more spectral narrowing by droplet condensational growth at higher updraft velocity due to stronger TKE."

- pp 15507 L18- : The summary of Wood (2006) findings is not clear: how can more evaporation limit the moistening/cooling of the sub-cloud layer.

>>Response: This statement means that more sub-cloud evaporation limits "the moistening/cooling of the MBL resulting from precipitation suppression". With an elevated cloud base, more sub-cloud evaporation occurs. Under this condition, when surface precipitation is suppressed due to increase in aerosol number concentration, the MBL would not become as moist/cool as that with a lower cloud because more drizzle evaporation occurs below the cloud.

Section 4

- pp 15511 L4-5: Why would the cloud dissipate in summer conditions? FIRE was performed in July and all the simulations of this case with other LES show a nice diurnal cycle (Duynkerke et al. 2004, Sandu et al. 2008).

>>Response: Solar heating is likely overestimated using the Dudhia SW scheme, and consequently the daytime reduction of cloud water and precipitation would also be overestimated, as also discussed in Wang et al. (2010). Here we consider winter conditions to avoid MSc dissipation during the daytime. The sounding profile and large-scale subsidence rate used in the current study are not totally the same as those applied in Duynkerke et al. (2004) and Sandu et al. (2008). Also, in Duynkerke et al. (2004), the removal of liquid water by precipitation is not taken into account in the simulations. The direct comparison between our results and their studies may not be appropriate.

- pp 15511 L7: recent intercomparison studies lead by the GCSS modeling groups showed that 20m vertical resolution is too coarse for reproducing well the cloud top entrainment in STBLs. Models had a hard time converging even for resolutions inferior to 5m. The authors mention that differences are small when using 10m on the vertical, what about 5m? I would expect the cloud to thin and brake up much less during daytime with finer vertical resolution.

>>Response: We have also carried out the clean cloud simulation using 5 m vertical spacing for comparison and added the material to the paper. The resolution tests (20m, 10m, and 5m, figure below) show that N_d and LWP response are robust with different vertical spacing. Though N_d and LWP are higher with finer vertical resolution, the diurnal variation does not change significantly.

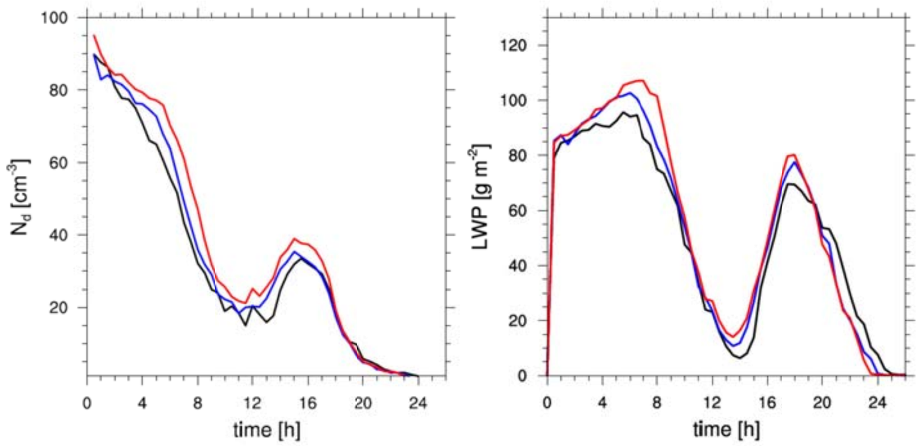

Figure. Time evolution of N_d and LWP under different vertical spacing: 20 m (black), 10 m (blue), and 5 m (red) for clean cloud.

- pp 15511 L10 : the authors are stating that the bulk properties of the cloud are similar for their big and small domain. Is this true as well about precipitation rates? Precipitation rate is generally very sensitive to the size of the domain in LES.

>>Response: The precipitation is not sensitive to the domain size considered in this study. The surface precipitation rate is similar for larger (2.5×2.5 km^2 horizontally) and smaller (1×1 km^2 horizontally) domain. A new figure on surface precipitation rate has been added in the paper for comparison.

Section 5

- pp 15512 first paragraph: The second statement is false! the TKE is enhanced by the positive buoyancy production in the cloud layer driven by the LW cooling, and not by the negative buoyancy above the cloud layer. Same for the next phrase: the surface fluxes are not increased by the enhanced TKE. The surface fluxes depend only on horizontal wind speed and the difference in temperature and resp. humidity between the surface and the air above. One of the possible explanations could be the following: given that the level of mixing is increased, the water vapor evaporated at the surface is transported more effciently towards upper levels, so the difference in qsat between the surface and the air above increases...In the following phrase: the cloud thickens during nighttime primary because the increased turbulent mixing favours the transport of moisture towards the cloud layer. The rest of this paragraph should be revised cf to the comment about the mechanisms driving the diurnal cycle made above (for the introduction).

>>Response: This paragraph has been revised as follows: "During nighttime, cloud top LW radiative cooling generates positive buoyancy in the cloud layer, which enhances TKE and mixing, destabilizing the MBL, and increasing the cloud top entrainment. Cloud-top entrainment tends to raise the cloud base by diluting the cloud with warm and dry air, but it also tends to lift cloud-top height (e.g., Randall, 1984). With stronger mixing, water vapor from the surface is transported to upper layers more efficiently, causing the difference between water vapor mixing ratio at the reference level and saturation mixing ratio at the surface to increase, and thus leading to a higher surface moisture flux. This results in a moist cloud layer, increased cloud thickness and LWP at nighttime. For the clean case (N_a =100 cm^{-3}), measurable surface precipitation begins at 5 h as LWP increases, proceeding from light drizzle (surface rain rate <0.1 mm day^{-1}) to moderate drizzle (0.1–1 mm day^{-1}) after 7 h. During the daytime, the heating due to cloud absorption of solar radiation partially offsets the cloud top LW cooling, stabilizing the MBL. Heating of the cloudy layer via SW absorption acts to thin the cloud; surface precipitation is suppressed after 12 h. Also, the MSc becomes decoupled from the sub-cloud layer as the cloud gets slightly warmer than the sub-cloud layer and a stable layer occurs at the cloud base. In the Θ_l and q_t daytime profile, it is shown that the moister and cooler surface air is not transported to the cloud layer effectively (12–14 h). And as the cloud continues to warm, the LWP decreases, attaining a minimum at ~14 h.

- pp 15512 second paragraph: Large scale divergence plays a big role in defining the cloud top height, so it is not true that the cloud top is primarily defined by the LW cooling. What do you mean by the last 2 phrases on this page?

>>Response: For the first part, we mean that at nighttime, LW radiative cooling is the dominant term as compared to the daytime when the SW radiation partially offsets the LW radiation. The sentences in question have been removed to avoid confusion. And the last 2 phrases have been revised as follows: "In the clean cloud, the drizzle evaporation below the cloud can moisten and cool the sub-cloud layer, increasing the relative humidity of the sub-cloud air, lowering the cloud lifting condensation level, hence lowering cloud base (Lu and Seinfeld, 2005). Also, the cloud-top entrainment decreases in the presence of drizzle, therefore the cloud top falls. The decreased entrainment drying/warming as well increases the MBL relative humidity and leads to a lower lifting condensation level. Therefore, more raindrops are likely to reach the surface before evaporating in the sub-cloud layer. As the surface precipitation increases during the second night, the cloud becomes optically thinner and cloud top LW cooling decreases, allowing subsidence to compress the MBL. And the cloud eventually disappears at ~24 h."

- pp 15513 L 2 - Why is N_d decreasing so much along the hours? Isn't that the reason why the cloud disappears (low nd implies high precipitation)?

>>Response: Yes, high surface precipitation leads to lower N_d. We have removed the sentence and revised as follows: "As the surface precipitation increases during the second night, the cloud becomes optically thinner and cloud top LW cooling decreases, allowing subsidence to compress the MBL. And the cloud eventually disappears at ~24 h."

- pp 15513 L6-8: not well phrased.

>>Response: This has been rephrased as follows: "Proceeding from clean to semi-polluted (N_a = 200 cm^{-3}) conditions, more numerous and smaller cloud droplets undergo less efficient collision-coalescence, which leads to a suppression of precipitation."

- pp 15513 L10-12 the reason why precipitation decreases the turbulent mixing should be better explained. See Stevens et al. 1998. Besides it should be mentioned that this is the case for nightime, during daytime, precipitation may maintained a less decoupled BL acc. to Sandu et al. 2008.

>>Response: We have revised the statement as follows: "The precipitation suppression at nighttime results in higher TKE, because in the presence of precipitation, drizzle formation leads to stabilization of the sub-cloud layer through evaporative cooling and moistening. The cooling and moistening below the cloud leads to weaker turbulence intensity and inhibition of deeper mixing, and may also lower the cloud lifting condensation level, maintaining a lower cloud base (Lu and Seinfeld, 2005). During the daytime this can partially offset the warming of the cloud base due to absorption of solar radiation and counteracts the tendency for the cloud base to rise (Sandu et al., 2008). The existence of drizzle reduces the buoyancy, stabilizes the MBL, decreases the TKE, and reduces the entrainment strength. As a result, precipitation suppression due to increased N_a increases the buoyancy fluxes and TKE, destabilizes the MBL, enhances the cloud-top entrainment, and establishing a well-mixed MBL. This is consistent with previous findings (e.g., Stevens et al., 1998; Ackerman et al., 2004; Lu and Seinfeld, 2005; Wood, 2007)."

- pp 15513 L16-19. The size of the droplets is not the only reason why there is more evaporation in the cloud base region. At cloud top absorption of SW radiation is outweighed by the much stronger LW cooling, and the cloud water content is higher.

>>Response: We thank the referee for pointing out this additional physical explanation. The rising of cloud base and falling of cloud top can be explained by thermodynamic budget responses. During the daytime, SW heating offsets the LW effect, leading to decrease in TKE and entrainment. Therefore the cloud top height becomes lower. And as the MBL gradually warms during the daytime, relative humidity decreases and results in higher cloud base. We have added the following statement: "With a stabilized MBL and decreased TKE during the daytime, the cloud top falls by 80 m due to reduced cloud top entrainment. As the MBL gradually warms with SW heating, the relative humidity in the MBL decreases, causing the cloud base to rise by 100 m."

- pp 15513 L23: sedimentation-entrainment and evaporation-entrainment feedbacks.

>>Response: We have changed the phrase accordingly.

- pp 15514 L3-4: the authors should perhaps note that this finding shouldn't be generalized, as it's mainly due to the fact that the clean cloud disappears. Which might be just an artifact of the model used in this study (and a result of a strong diminution of N_d in time).

>>Response: We agree that this finding should not be generalized since the clean cloud ultimately disappears. We have removed: "as suggested by Albrecht (1989)".

- pp 15514 last paragraph: this is a typical example of the confusing discussion related to the classification in non-drizzling/heavy drizzling regimes mentioned in the third general comment.

>>Response: The non/light drizzling and moderate/heavy drizzling clouds are classified according to the strength of the surface precipitation rate rather than as clean or polluted. If the clean cloud becomes non-precipitating, it is no longer referred to as drizzling. We have added the following statement in clarification: "Note that clouds are classified as non/light drizzling and moderate/heavy drizzling rather than as clean and polluted."

- pp 15515 L4-5: the authors should better explain the chain of phenomena which lead to a rise of the cloud top, filling the gaps which might not be obvious for the reader. The affirmation in the next phrase ("Also, the cloud base...) is not that trivial to make: the evolution of the LCL depends on how much the BL warms compared to how much it moistens.

>>Response: We have added the following statement: “As SST increases, the surface sensible and latent heat fluxes increase accordingly, resulting in higher θ_l and q_t in the MBL. The extent of heating exceeds the extent of moistening in terms of affecting the relative humidity, resulting in lower relative humidity under higher SST, and thus higher cloud base. The increased surface fluxes also enhance the TKE and cloud top entrainment, and therefore deepen the cloud by rising cloud top.”

- pp 15515 L13: is not the cloud who becomes stable but the thin layer at its base.

>>Response: We have removed the statement in question and covered the issue of decoupling in Sec. 5.4.4.

- pp 15515 L24: the other way around. Besides, here it might have been useful to have a look at the vertical profiles to understand in which case the BL is warmer/drier, etc.

>>Response: We have revised the statement as follows: “And the cloud reforms at ~27 h and 20 h for SST290 and SST292 polluted cases, respectively.” The vertical profiles have been plotted, and will be discussed in the response to the next comment.

- pp 15515 last paragraph: the analysis of the profiles and the entrainment rates would have perhaps allowed to better understand why the cloud is disappearing in the polluted case when the SST is increased. Otherwise the affirmation in point (2) seems unsustained.

>>Response: The vertical profiles of vertical velocity variance, total water mixing ratio, and liquid water potential temperature have been added to the paper. With increased SST, vertical velocity variance, total water mixing ratio, and liquid water potential temperature increase accordingly. And with increased SST and aerosol number concentration, the MBL becomes even warmer. The extent of heating exceeds the extent of moistening, resulting in lower relative humidity under higher SST cases; and therefore the MBL dries and the cloud disappears in the polluted case.

- pp 15516 L5: Again the surface fluxes don't increase directly because of the TKE increase (see comment concerning pp 15512 first paragraph). What probably happens is that by mixing with drier air at cloud top the BL becomes gradually drier and the difference in qsat at the surface, so the latent heat fluxes, increase.

>>Response: We have revised the statement as follows:” This enhances the TKE and leads to stronger mixing and increased cloud top entrainment. As more dry air is entrained into the cloud layer, the MBL gets drier, causing the surface latent heat flux to increase.”

- pp 15516 L6: "as well as stronger drying" and warming.

>>Response: We have added “and warming” accordingly.

- pp 15516 L10: also, no precipitation implies more mixing in the BL so the vapour from the surface is more efficiently transported towards the cloud layer.

>>Response: We have added the following:” In the QFT3 case, no precipitation indicates stronger mixing in the MBL so the vapor from the surface is transported more efficiently to the cloud layer.”

- pp 15516 L12: there is no supplementary moistening at the beginning of the simulation, i.e. the latent heat fluxes are equal. What are you referring to?

>>Response: We have removed: ”from the onset”.

- pp 15517 L3: here and throughout the text when you are taking about a precipitation rate you are talking about the precipitation at the surface, right? perhaps this should be mentioned somewhere.

>>Response: Yes, “ precipitation” always refers to precipitation at surface. We have added the clarification.

- pp 15517 L11: This statement is confusing. The entrainment rate does primarily depends on the mixing in the BL, or more precisely on the cloud top radiative cooling, so on the LWP. While, the cloud top evolution depends on the balance between entrainment and subsidence.

>>Response: The vertical velocity variance (a measure of strength of turbulent mixing) increases in the DIV3 polluted case due to increase in LWP and thus cloud top radiative cooling. This statement has been removed as it is confusing.

- pp 15517 L15-20: Sometimes light precipitation which evaporates at cloud base may maintain a lower cloud base (Lu and Seinfeld, 2005).

>>Response: This comment does not seem to fit in the discussion among these statements. We have covered it in other responses corresponding to the below-cloud evaporation.

- pp 15517 L24: (1) this is true in the precipitating case only.

>>Response: We have revised the statement as follows: " (1) In the precipitating case, when *D* is decreased as compared to the Control case, the cloud thins and LWP decreases on a short time scale;"

- pp 15518 L16: LWP is higher than in what case?

>>Response: We have revised the statement as follows: "(2) when *U*, *V* are increased and N_a is increased, precipitation is suppressed and LWP is higher than that of the case with lower N_a."

- pp 15518 L21: This phrase should be reformulated as is not clear. Also, when you are saying "under these moister conditions", what are you referring to? moister than in what cases?

>>Response: We have revised the statement as follows: "This is because under these conditions (Control, DIV3 and WIND cases) in which heavier precipitation occurs, the increase in aerosol number concentration suppresses precipitation, resulting in less water loss and higher LWP."

- pp 15519 L4: The last statement would deserve more explanation. Also you might want to discuss here how the difference in LWP between the polluted and the clean clouds depends on the time of the day. Are you finding opposite behaviour during night/day like in the study of Sandu et al. 2008?

>>Response: The statement has been revised: "The time evolution of difference in LWP between polluted and clean cloud cases has the same tendency as compared to Fig. 7 of Sandu et al. (2008), with larger LWP difference under moister conditions, and vice versa. Also, during daytime conditions the LWP difference decreases, and becomes negative for all simulations after ~14 h, similar to the results in Sandu et al. (2008)."

- pp 15519 L14: Why only certain cases are used for deriving these relationships?

>>Response: It is computationally prohibitive to examine all different environmental conditions and aerosol number concentrations. Only certain key cases are used for deriving these relationships.

- pp 15519 L21: "a result of a drier atmosphere and lower supersaturation". Why is the atmosphere drier in the SST290 case?

>>Response: In the SST290 case, both surface heat and moisture fluxes increase with higher SST. The extent of warming exceeds the extent of moistening, and therefore the relative humidity is lower in SST290 case, as added in Section 5.2.1 (Effects of Higher SST). Thus, the drier atmosphere compared to the Control case results in a lower supersaturation and less CCN activation.

- pp 15522 L2-4: The phrase "Overall, though..." is not clear.

>>Response: The phrase has been removed.

- pp 15522 L13-14: It would worth mentioning that this is explained by the fact that the cloud changes the most when the change in Nd leads to a suppression of precipitation (the passage from a precipitating to a non-precipitating cloud).

>>Response: We added the following statement to explain why the total cloud susceptibility is stronger under lower N_a: “This is because when N_a increases from that of a clean background, transition from precipitating to non-precipitating cloud results in more pronounced enhancement of total cloud susceptibility.”

- pp 15524 L1-3: The phrase : "the cloud base height ..." is not clear.

>>Response: The phrase has been removed.

Conclusions

- pp 15525 L9: SW heating partially offsets the LW cooling. Mention that in his paragraph you are referring to the control case you have considered.

>>Response: We have revised the phrase as follows: “In daytime, for the Control case, SW heating partially offsets the LW cooling and thins clouds; …”.

- pp 15525 L21: "Also, the entrainment dries the air". The entrainment does not dry the air, the mixing of dry air entrained at cloud top with the cloudy air leads to a drying of the BL. In this paragraph you are referring to the impact of the large-scale conditions on the cloud in the clean case, or in both clean and polluted cases? It would worth mentioning.

>>Response: We have revised the statement as follows: ”Also, the mixing of dry air entrained at cloud top with the cloudy air leads to drying of the MBL.” In this paragraph, the impact of the large-scale conditions on the cloud has been revised as the follows: ”For both clean and polluted conditions, under higher SST, drier free-troposphere, or stronger large scale divergence rate, the clouds become thinner than in the corresponding Control case, and surface precipitation decreases in clean clouds.”

- pp 15526 L12: The phrase: "The drier the environment, ..." is not clear.

>>Response: The statement has been revised as follows: “For non/light drizzling cases (SST290 and QFT3), the magnitude of $\Delta(\ln H)/\Delta(\ln N_a)$ is smaller; the same trend as in the other effects.”

- pp 15526 L15: Sometimes when you are talking about "cloud susceptibility" it's not clear if you mean the total cloud susceptibility, or the LWP, the optical thickness, etc susceptibility to aerosol perturbations. It would worth being more careful when using this formulation throughout the manuscript.

>>Response: We mean the cloud optical thickness susceptibility, or the total cloud susceptibility, to aerosol perturbation. This has been clarified in the revision.

- I think it would be very valuable to add at the end of the conclusions a few lines reminding what have we learned from all these sensitivity experiments, what is the take home message of this study, or in general of all the LES studies performed so far that focused on MSc-aerosol interactions.

>>Response: We thank the referee for this excellent suggestion. The following has been added in the conclusions: “From the comprehensive and systematic evaluation of the impact of aerosol, precipitation and large-scale environmental conditions on the evolution of MSc, it is shown that MSc is sensitive to aerosol perturbation under clean background, and to the important environmental conditions considered. Also, the total cloud susceptibility to aerosol perturbation is larger under heavier drizzling clouds and cleaner environment. Among the Twomey, droplet dispersion, and cloud thickness effects which contribute to the total cloud susceptibility, the Twomey effect dominates, the droplet dispersion effect plays a minor role, and the cloud thickness effect acts either to enhance or counter the Twomey effect, depending on precipitation strength and cloud base height. Moreover, the good agreement on total cloud susceptibility between analytical expression and LES simulation suggests that the analytical formulation may be effective in representing the

complex aerosol-cloud-precipitation interactions and is useful in quantifying the cloud responses to aerosol perturbations."

Figures

- For all figures where dashed lines are used: these lines are hardly distinguishable from full lines. Perhaps using dotts instead of dashes is a better option.

>>Response: All the figures have been re-plotted with short-dashed lines.

- Fig. 3: how come the boundary layer stabilizes so much during daytime despite of the very weak rain? is the SW heating realistic, isn't it overestimated?

>>Response: It seems that the SW heating is overestimated with the Dudhia SW radiation scheme, making the MBL overheated and too stable. The Dudhia SW scheme does not account for solar absorption above the model top. In the future, we intend to apply a different scheme to avoid the overestimation. We have added the following statement in Sec. 5.1: "It is noted, however, that the solar heating is likely overestimated with the Dudhia SW radiation scheme and leads to overly reduced daytime cloud water."

- Fig. 4: the title is misleading, these are not all cloud properties. For all the figures of this type it would be worth adding the cloud cover.

>>Response: The title has been revised: "Time evolution of clean (N_a = 100 cm^{-3}, black), semi-polluted (N_a =200 cm^{-3}, blue), and polluted (N_a =1000 cm^{-3}, red) clouds (2.5×2.5 km^2 horizontal domain)". And concerning the cloud cover (or, cloud fraction), it is plotted.

The following new reference has been added in the revised manuscript:

Randall, D. A.: Stratocumulus cloud deepening through entrainment, Tellus, 36, 446–457, 1984.