

Referee Report

Lee et al., Examination of effects of aerosol on a pyroCb and their dependence on fire intensity and aerosol perturbation using a cloud-system resolving model, submitted to Atmos. Chem. Phys., 2019

General comments

In response to comments and requested from both reviewers, the authors shortened the paper and improved the structure. After making the following minor language revisions, many of which will further decrease the length of the text, I recommend the manuscript for publication in ACP. Even after implementing these changes, I strongly recommend that the manuscript is proofread for correct English before publication. Thanks!

Specific comments

299 Please provide examples in the text of “good agreement”

29-30 “specifically focusing on how fire-produced aerosols affect this role via a modeling framework” -> “specifically focusing via a modeling framework on how fire-produced aerosols affect this role”

67 “studies to improve this understanding has been going on” -> “studies have been conducted to improve this understanding”

80 Insert "of pyroCB" after “microphysical properties”

84 “make” -> “decrease”

85 remove “smaller”

86-87 remove “or increasing aerosol”

88-89 replace “this more competition makes” with “decreasing the size of”

89 remove “smaller”

90 change “sizes of droplets” to “droplet sizes”

91 “autoconversion that is” -> “autoconversion,”

92 “for them to” -> “in which they”, “be” -> “become”

94-95 “More cloud liquid is thus available for transport to places above the freezing level by updrafts.” -> “More cloud liquid is thus available for transport by updrafts to altitudes above the freezing level.”

101 “by” -> “of”

108 “cloud typical properties” -> “cloud properties”

110 “For the simplicity of the term” -> “For simplicity”

113 “have shown” -> “showed”, “updrafts

throughout the manuscript, ex. 115: “the pyroCb development and its impacts on the UTLS” -> “pyroCb development and its impacts on the UTLS”

125 “impacts” -> “impacts on”

128 “parameterize” -> “parameterizes”

133 remove “have”

135 “cloud-particle” -> “cloud-particle and aerosol”

137 “varying with varying” -> “varying with”

137-138 “the bulk schemes in general uses” -> “bulk schemes in general use”

138-139 remove “which are not able to consider the variation of collection efficiencies and terminal velocities in reality”

139-140 “This makes the bin scheme more sophisticated than the bulk scheme.” ->

“Thus, the bin scheme is more sophisticated than the bulk scheme.”

147 “are strongly dependent” -> “is strongly dependent”

152 “are referred to as fire-driven updrafts, henceforth” -> “are henceforth referred to as fire-driven updrafts”

153-156 “Aerosol effects on clouds are initiated by an increase in aerosol concentration, which can be caused by an increase in aerosol emission at and near the surface, and dependent on how much aerosol concentration increases, or on the magnitude of an increase in aerosol concentration, i.e., aerosol perturbation” -> “Aerosol effects on clouds are initiated by an increase in aerosol concentration, which can be caused by an increase in aerosol emission at and near the surface, and dependent on how much aerosol concentration increases (aerosol perturbation)”

157 “has not been” -> “was not”

166-167 “Shortwave and longwave radiation parameterizations have been included in all simulations by adopting” -> “Shortwave and longwave radiation is parameterized by”

169 “To represent the microphysical processes” -> “To represent microphysical processes”

176 “The cloud-droplet” -> “A cloud-droplet”, “parameterization, which is based” -> “parameterization based”

177 “Arbitrary aerosol mixing states and arbitrary” -> “Arbitrary aerosol mixing states and”

190 “case is performed” -> “case was performed”

192 “the site and the pyroCb” -> “the site and pyroCb”

193 remove “between them”

198 “from Ft. Smith” -> “from the Ft. Smith”

204-205 “These tendencies are horizontally homogeneous and applied to the control run every time step by interpolation” -> “These tendencies are applied to the control run every time step by interpolation, in a horizontally homogeneous manner”

206 “lengths” -> “extents”

207 “For the simulation, the” -> “The simulation”

211-212 “simulation, at the center of the simulation domain, a fire spot with a diameter of 40 km is placed” -> “simulation, a fire spot with a diameter of 40 km is placed at the center of the simulation domain”

215 “the previous studies which are Trentmann et al. (2006) and Luderer et al. (2006) and adopt boreal forest emissions” -> “previous studies which adopt boreal forest emissions (Trentmann et al. (2006) and Luderer et al. (2006))”

219 “idealized and this enables” -> “idealized, enabling”

223 remove “aerosol properties that can be represented by”

235-236 “~50-70% of organic-carbon (OC) compounds, ~5-10% of black-carbon (BC) material, and ~20-45% of inorganic species” -> “~50-70% organic-carbon (OC) compounds, ~5-10% black-carbon (BC) material, and ~20-45% inorganic species”

247 Insert new paragraph after “in the control run.”

247-249 “According to Reid et al. (2005), Knobelspiessel et al. (2011), and Lee et al. (2014), it is reasonable to assume that the initial aerosol size distribution follows the unimodal lognormal distribution in fire sites. Hence, the control run adopts the unimodal lognormal distribution as an initial aerosol size distribution.” -> “The control run adopts the unimodal lognormal distribution as an initial aerosol size distribution, a reasonable

assumption in fire sites (Reid et al. (2005), Knobelspiessel et al. (2011), Lee et al. (2014))”

Throughout, e.g. 251-253 “median aerosol diameter and standard deviation of the distribution” -> “median and standard deviation aerosol diameter”

263 Insert new paragraph after “(Pruppacher and Klett, 1978).”

264 “captured” -> “capture”

268 “points” -> “point”

267, 270 “counterparts” -> “values”

279-280 “Figure 1. This field in Figure 2 represents” -> “Figure 1, representing”

Throughout, e.g. 284, including figures, “averaged” <cloud property> -> “average” <cloud property>

297 “well as” -> “well”

Throughout, including figures, anytime multiple rounds are referred to together in a row, e.g. 33,3 “the medium run and the weak run” -> “the medium and weak runs”

345 remove “or aerosol perturbation”

353, 356 “intensity” -> “intensities”

364 “corresponds” -> “correspond”

374 remove “themselves”

377 “(2018) by” -> “(2018),”

379-380 “The updraft mass flux is one of the most representative variables that are indicative of

the cloud dynamic intensity and the magnitude of convective invigoration.” -> ““The updraft mass flux is one of the most indicative variables of cloud dynamic intensity and magnitude of convective invigoration.”

381 “is” -> “was”

382-383 “17:00 GMT on August 5th and 12:00 GMT on August 6th, and 17:00 GMT on August 5th is a time around which the pyroCb starts to form” -> “17:00 GMT on August 5th, approximately when the pyroCb starts to form, and 12:00 GMT on August 6th, and 17:00 GMT on August 5th is”

385 “that” -> “which”

390-393 “Considering that the stratosphere is between the tropopause and its top that is generally ~ 50 km in altitude, the defined lower stratosphere occupies around a quarter of the total vertical extent of the stratosphere.” -> “The defined lower stratosphere occupies around a quarter of the total vertical extent of the stratosphere, the top of which is generally ~ 50 km in altitude.”

397 “the cloudy columns and that over” -> “cloudy and”

399 “in a part” -> “in the part”

410, 411 remove “those”

413 remove “or the pyroCb”

423 remove “both”

426 “as compared to that in” -> “versus”

430-433 “These averaged fluxes are over cloudy columns for the simulation period between 17:00 GMT on August 5th and 12:00 GMT on August 6th. The averaged water-vapor fluxes vary from 8.30×10^{-6} kg m⁻² s⁻¹ in the control run to 8.21×10^{-6} kg m⁻² s⁻¹ in the low-aerosol run.” -> “The averaged water-vapor fluxes over cloudy columns for the simulation period between 17:00 GMT on August 5th and 12:00 GMT on August 6th vary from 8.30×10^{-6} kg m⁻² s⁻¹ in the control run to 8.21×10^{-6} kg m⁻² s⁻¹ in the low-aerosol run.”

435 “only are” -> “are only”

436 “there are the presence of” -> “there is the presence of”

440 “cloud-ice number concentration and cloud-ice size” -> “cloud-ice number concentration and size”

442 “micron” -> μm

443-444 “The altitudes between 9 km and 13 km correspond to a part of the UTLS below the troposphere. Henceforth, the UTLS cirrus clouds mean those clouds in a part of the UTLS below the tropopause.” -> “The altitudes between 9 km and 13 km correspond to a part of the UTLS below the tropopause, and henceforth, “UTLS cirrus clouds” refer to clouds in the troposphere.”

445-446 “Updrafts in the pyroCb produce supersaturation, which leads to the generation of cloud ice mass and associated cirrus clouds via deposition, the primary source of

cloud-ice mass" -> "Updrafts in the pyroCb produce supersaturation, which leads to the primary source of cloud-ice mass and associated cirrus clouds via deposition"

449 "circus" -> "cirrus"

452, 453 remove "large"

456-457 "simulations (Figure 7), and thus a negligible variation of the mass of the UTLS cirrus clouds" -> "simulations (Figure 7), and thus a negligible variation of UTLS cirrus cloud mass"

462 "The role, which is played by" -> "The role of"

464-465 "the UTLS at and above the tropopause, and in the production of the mass of the UTLS cirrus clouds is not significant for strong fire intensity" -> "the UTLS at and above the tropopause, and in the production UTLS cirrus cloud mass, is not significant for strong fire intensity"

470 "the mass of the UTLS cirrus clouds" -> "UTLS cirrus cloud mass"

478 "updrafts, produced" -> "updrafts produced"

480-481 "when the fire-generated surface heat fluxes and the fire intensity" -> "when the fire intensity and fire-generated surface heat fluxes"

485-486 "relative magnitude of aerosol-induced perturbation of latent heat to" -> "relative magnitudes of aerosol-induced perturbation of latent heat and"

500 "does vary" -> "varies"

501-503 "Hence, it can be said that percentage differences in updraft mass fluxes mean percentage differences in updraft speed with good confidence." -> "Hence, it can be said with good confidence that percentage differences in updraft mass fluxes mean percentage differences in updraft speed."

505 "run than the clean-scenario run" -> "run and clean-scenario runs"

508 and similar equations: remove "the"

517 "gets larger" -> "increases"

530 "than the" -> "than in the"

549 "the averaged LWC and the averaged CDNC" -> "the average LWC and CDNC"

550, 551 "varies" -> "decreases"

559 "reduce" -> "decreases"

566 "to increase" -> "increasing", "lowers" -> "decreases"

569 “averaged associated” -> “associated average”

575 “reduces” -> “decreases”

577 remove “size in”

578 “reduces” -> “decreases”

586 “less close to” -> “further from”

588-590 “distribution; most of aerosol activation occurs for aerosol sizes on the right-hand side of the distribution peak, here we are only concerned with the size ranges on the right-hand side.” -> “distribution. Here we are only concerned with the size ranges on the right-hand side of the distribution peak, where most of aerosol activation occurs.”

Throughout the manuscript: <cloud property>“, which is averaged” -> <cloud property>“averaged” e.g. 593 “CNDC, which is averaged” -> “CNDC averaged”

596 “to greater” -> “to a greater”

605 “thus the” -> “thus a”

618 “rates, which are averaged” -> “rates averaged”

624-629 “The averaged autoconversion rates over period 2 reduce from 3.61×10^{-6} g m⁻³ s⁻¹ in the control run with strong fire intensity to 0.93×10^{-6} g m⁻³ s⁻¹ in the weak run with weak fire intensity through 2.01×10^{-6} g m⁻³ s⁻¹ in the medium run with medium fire intensity by 74%. Those averaged autoconversion rates reduce from 4.52×10^{-6} g m⁻³ s⁻¹ in the low-aerosol run with strong fire intensity to 3.94×10^{-6} g m⁻³ s⁻¹ in the weak-low run with weak fire intensity through 4.43×10^{-6} g m⁻³ s⁻¹ in the medium-low run with medium fire intensity by 14%.” -> “The averaged autoconversion rates over period 2 decrease by 74% from 3.61×10^{-6} g m⁻³ s⁻¹ in the control run with strong fire intensity to 0.93×10^{-6} g m⁻³ s⁻¹ in the weak run with weak fire intensity through 2.01×10^{-6} g m⁻³ s⁻¹ in the medium run with medium fire intensity. Those averaged autoconversion rates decrease by 14% from 4.52×10^{-6} g m⁻³ s⁻¹ in the low-aerosol run with strong fire intensity to 3.94×10^{-6} g m⁻³ s⁻¹ in the weak-low run with weak fire intensity through 4.43×10^{-6} g m⁻³ s⁻¹ in the medium-low run with medium fire intensity.”

631 “get greater” -> “increase”

633 “smaller” -> “lower”

635 “freezing, which is averaged” -> “freezing averaged”

640, 642 “get greater” -> “increase”

644-648 “When fire intensity is strong, the difference in freezing-related latent heat, which is averaged in cloudy areas and period 2, between the polluted-scenario run, which is the control run, and the clean-scenario run, which is the low-aerosol run,” -> “When fire intensity is strong, the difference in freezing-related latent heat averaged in cloudy areas and period 2 between the polluted-scenario run (control run) and the clean-scenario run (low-aerosol run)”

649-650 “while with weak fire intensity, that difference between the polluted-scenario run, which is the weak run, and the clean-scenario run, which is the weak-low run” -> “while with weak fire intensity, that difference between the polluted-scenario run (weak run) and the clean-scenario run (weak-low run)”

651-652 “differences, which are calculated by Equation (1),” -> “differences (calculated by Equation (1))”

653-654 “and the clean-scenario run from 9% with strong fire intensity to 83% with weak fire intensity through 51% with medium fire intensity over the period 2.” -> “and the clean-scenario run over the period 2 from 9% with strong fire intensity to 83% with weak fire intensity to 51% with medium fire intensity.”

657, 674 “deposition, which is averaged” -> “deposition averaged”

658 “period 2,” -> “period 2”

666 “transportation” -> “transport”

670 remove “as compared to those before 20:30 GMT”

673 “from” -> “starting at”

685 “in polluted-scenario” -> “in the polluted-scenario”

688 “The more mass fluxes and the more convergence” -> “The higher mass fluxes and convergence”

690 “be greater” -> “increase”

695-696 “thus, enhancing freezing, deposition, condensation, and updrafts further.” -> “thus further enhancing freezing, deposition, condensation, and updrafts.”

708, 710, 713, 727, 741 “get greater” -> “increase”

714-715 “Then, the increases in condensation, in turn, further enhance the increases in updrafts in the polluted-scenario run for each fire intensity.” -> “The increases in

condensation further enhance the increases in updrafts in the polluted-scenario run for each fire intensity.”

720 “induce” -> “induces”

752-753 “This possibility is not that unrealistic, since stronger fire likely involves more material burnt and more aerosols from it.” -> “This possibility is not that unrealistic, since stronger fires likely involve more material burned and higher aerosol emissions.”

757, 763, 778 “reduces” -> “decreases”

758 “less” -> “lower”

759-760 “For strong fire, the perturbation-related aerosol concentration is 30000
760 cm⁻³, for medium fire, it is 15000 cm⁻³, and for weak fire, it is 7500 cm⁻³.” -> “The perturbation-related aerosol concentration is 30000 cm⁻³ for strong fire, 15000 cm⁻³ for medium fire, and 7500 cm⁻³ for weak fire.”

765 “when fire-induced” -> “when the fire-induced”

772 “has the” -> “has an”

773 “run; when” -> “run, and when”

780 “with the weakening” -> “with weakening fire”

783 “whether those aerosol perturbations vary with varying fire intensity or not” -> “whether or not those aerosol perturbations vary with varying fire intensity”

791 “transport water vapor to the tropopause and above efficiently” -> “efficiently transport water vapor to the tropopause and above”

796 “gets more” -> “becomes”

810 “reduce” -> “decrease”

813 “makes” -> “results in”

814 “increase” -> “increasing”

830 “It is true that the” -> “The”

833 “transportation” -> “transport”

850 “reduce” -> “decrease”

858 “came up with” -> “generated”, “preformed” -> “performed”

861 “revised manuscript based on the reviewers’ comments and perform” -> “revised the manuscript based on the reviewers’ comments and performed”

Table 2 “Meidum-low” -> “Medium-low”

1172, 1190 "The averaged" -> "Averaged"

Figure 10 "Differences in the averaged values" -> "Differences in average values"