

Responses to Report 3

We thank the reviewer for taking the time to catch the grammatical and minor errors.

The manuscript is improved in many aspects as compared to the previous version. However, there are still some grammatical and other minor mistakes that authors need to address before accepting it for final publication.

Line 15: change parametrization to parameterization

'parametrization' has been changed to 'parameterization'.

Line 24: change ice nucleating to ice-nucleating

'ice nucleating' has been changed to 'ice-nucleating'.

Line 30: delete 'being'

'being' has been deleted.

Line 46: change minerology to mineralogy

'minerology' has been changed to 'mineralogy'.

Line 49: the ice-nucleating sites...

It has been changed to 'the ice-nucleating sites'

Line 50: the formation

'the' has been added.

Line 53: change 'do not active' to 'do not act'

'do not active' has been changed to 'do not act'

Line 58: feldspar are particularly

'is' has been changed to 'are'.

Line 70: the mechanical breakup

'the' has been added.

Line 80: delete the from ' the future research'

'the' has been deleted.

Line 97: change falling into to fall into

'falling into' has been changed to 'fall into'.

Line 105: change large scale to large-scale

'large scale' has been changed to 'large-scale'.

Line 107: change 'projects of layer..' to project on layer....

'projects of layer' has been changed to 'project on layer'.

Line 112: remove 'as' before greater.

'as' has been removed.

Line 113: You have used secondly two times. Modify the sentences.

The first sentence has been removed.

Line 121: is included in section 3 or given in section 3

It has been changed to ‘given in section 3’.

Line 124: add space between UK’s and FAAM

A space has been added.

Line 126: change on board to onboard

‘on board’ has been changed to ‘onboard’.

Line 129: remove the full stop after ‘micrometers’

The full stop has been deleted.

Line 130: define 2D-S

It has been defined as ‘two-dimensional stereo (2D-S) Probe’.

Line 133: polarisation

The Met Office of the UK uses ‘relative depolarisation ratio’ rather than ‘relative polarisation ratio’ Please see

<https://catalogue.ceda.ac.uk/uuid/3fdd6ccdce5b4ee887536402edfe6835>.

Line 146: define MSL

It has been defined: ‘mean sea level (MSL)’.

Line 156: hundred meters

It is the British spelling.

Line 159: change ‘of several passes from the aircraft measurements’ to in several passes based on the aircraft measurements.

‘of several passes from the aircraft measurements’ has been changed to ‘in several passes based on the aircraft measurements.’

Line 163-164: This is not very clear. What is the reason behind ‘secondary ice production most likely occurred’.

This comment was also made by Reviewer 2.

‘The observation indicates that the ice concentrations were a few tens per litre at derived temperatures in cloud between 0 and -2 °C (Lloyd et al., 2020). Therefore, secondary ice production most likely occurred.’ has been changed to ‘The observation indicates that the ice concentrations were a few tens per litre at derived temperatures in cloud between 0 and -2 °C (Lloyd et al., 2020). It is impossible of course to be certain of the origin of ice particles in such clouds. The fact that the passes were made within a few hundred metres of cloud top, the concentrations of ice particles were higher than expected from typical INP measurements for the estimated cloud-top temperatures, and there was no evidence of higher concentrations of ice particles in the downdraughts suggest that secondary ice production most likely occurred..’

Line 172-175: Split this into separate sentences.

The sentences have been changed to

‘The microphysical processes of drops include condensation, evaporation, collision and coalescence, sedimentation of cloud particles, particle growth by deposition of water vapour. The processes involved with ice include primary freezing modes of deposition/condensation, contact, and immersion, and secondary freezing through the riming-splintering (the Hallett-Mossop) process

(Hallett and Mossop, 1974; Cotton et al., 1986), in the temperature range of -3 to -8 °C with a maximum at -5 °C, and the transition and interaction between different species.'

Line 175: is 'and the transition and interaction between different species' is part of the previous statement.

'and ...' has been changed to ', and ...'.

Line 177: One of the objectives of our study is to. Remove 'the' after freezing efficiency on 'of our study' has been added.

'the' has been deleted.

Line 178: As mentioned in the introduction ..

'As is discussed in the introduction' has been replaced by 'As mentioned in the introduction'.

Line 180: Similarly to what? This statement has no connection with the previous one.

'Similarly, the temperature where freezing begins depends on the INP types.' has been changed to 'The temperature where freezing begins depends on the INP types.'

Line 181: ... field measurements of INPs..... Replace 'the influence on cloud simulations' by 'its influence on the simulated cloud forcing in a global model.'

'the influence on cloud simulations' has been replaced by 'its influence on the simulated cloud forcing in a global model.'

Line 189: Replace 'As a result of this uncertainty by 'Considering these uncertainties'

'As a result of this uncertainty' has been replaced by 'Considering these uncertainties'

Line 194: replace model runs by tests

'model runs' has been replaced by 'tests'.

Line 194-196: This statement is not very clear. Please split into separate sentences

'The Morrison scheme has several ice freezing modes, including immersion freezing, deposition freezing as a function of supersaturation with respect to water and ice for this scheme, contact freezing, homogeneous freezing, and the secondary ice production by the HM process.' has been changed to 'The freezing modes of the Morrison scheme include immersion freezing, deposition freezing as a function of supersaturation with respect to water and ice for this scheme, contact freezing, homogeneous freezing, and the secondary ice production by the HM process.'

Line 198: The early onset examined

'The' has been added.

Line 199: The Cooper10x

'The' has been added.

Line 200: The early onset 1 &...

'The' has been added.

Line 203: Which general type of INPs?

'the Bigg scheme is for general INP types' has been changed to 'the Bigg scheme does not consider INP types'.

Line 205: the INP numbers were increased. Why a factor of 3.3, Any particular reason?

‘...by a factor 3.3 in the layer between 2 – 3 km where the dust layer was presented’ has been changed to ‘by a factor 3.3 in the layer between 2 – 3 km where the coarse mode concentrations in that dust layer were approximately 3.3 times higher than those above the layer.’

Line 206: 2-3 km

‘2 - 3 km’ has been changed to ‘2-3 km’.

Line 212: was 1 minute.

‘1 min’ has been changed to ‘1 minute’.

Line 215: water vapor mixing ratio

‘water mixing ratio’ has been changed to ‘water vapour mixing ratio’.

Line 225: a rate of about 150

‘of’ has been added.

Line 228-229: Replace ‘At 25 min, the cloud top reached about 8 km’ by ‘The cloud top had reached around 8 kilometers at 25 minutes’.

‘At 25 min, the cloud top reached about 8 km’ has been replaced by ‘The cloud top had reached around 8 km at 25 minutes’.

Line 232: Delete ‘down’

‘down’ has been deleted.

Line 246: .. with a maximum of

‘with a maximum’ has been changed to ‘with a maximum of’.

Line 251: change was identical to was identical. That of the control run...

A space has been added between ‘was’ and ‘identical’.

Line 259: high variability in the INP population

‘the’ has been added.

Figure 3: IN captions replace the comma with a full stop after ‘Figure 3’.

The comma has been replaced with a full stop.

Figure 4: In captions change ration to ratio. Also, follow the same structure of caption throughout the manuscript. e.g. (a) potential temperature and (b) mixing ratio

The caption has been changed to ‘Figure 4. Initial profiles of (a) potential temperature and (b) mixing ratio for the model simulations. Altitude is the height above mean sea level.’

Figure 13, 14: In the caption, these figures are mentioned as Figur N13, N14. In Figure 14, please mention the width of each CIP images strip. It will give an idea about the particle size.

N13 and N14 have been changed to 13 and 14, respectively.

‘The CIP image width is 960 μm .’ has been added in the caption.

Figure 4: Altitude is above mean sea level/above ground?

‘Altitude is the height above mean sea level’ has been added in the caption.

Line 263: Move ‘as plotted in Figure 7’ at the end of the statement. Remove comma after the freezing efficiency. Change wass to was.

‘as plotted in Figure 7’ has been moved at the end of the statement. The comma after the

freezing efficiency has been deleted. 'wass' has been changed to 'was'.

Line 278: replace 'similar concentrations of the primary and the secondary ice production to the observations made in some passes' by 'total ice concentration observed in some passes'
'similar concentrations of the primary and the secondary ice production to the observations made in some passes' has been replaced by 'total ice concentration observed in some passes'.

Line 287: Replace 'a sensitivity and the control' by 'the sensitivity tests and the control'
'a sensitivity and the control' has been replaced by 'the sensitivity tests and the control'.

Line 289: full stop after 'between the two runs'
A full stop has been added.

Line 291: replace 'and the maximum was' by 'reaching a maximum concentration of about'
'and the maximum was' has been replaced by 'reaching a maximum concentration of about'.

Line 295: Don you mean cloud water mixing ratio. Please clarify
'cloud mixing ratio' has been changed to ' cloud water mixing ratio'.

Line 304-306. Please clarify this statement. It is not clear what the authors want to say here.
"while it was downwards in the control run the axis in the control run went down after 38 min" has been changed to "However, a decrease in the concentration occurred after about 37 min with the minimum being above 8 km."

Line 310: change mixing ration to mixing ratio
'ration' has been changed to 'ratio'.

Line 323: further increased
It has been corrected.

Line 324-325: Rewrite the statement. more/less can be written as more (less). Replace higher temperature with higher temperatures.

'There were more/less increases in the lower/upper levels when using the DeMott scheme (Demott) because of the slope of DeMott curve, i.e., more IN at higher temperature.' has been changed to 'There were more (less) increases in the lower (upper) levels when using the DeMott scheme (Demott) because of the slope of the the DeMott curve, i.e., more IN at higher temperatures.'

Line 327: there was a slight increase at the upper levels
It has been changed to 'there was a slight increase'.

Line 332: secondary ice in the concentration
'secondary ice in concentration of several tens per litre' has been changed to 'secondary ice in concentrations of several tens per litre'.

Line 344: by modified you mean by increasing. Please clarify. Why 3.3?
It has been changed to 'we increased the INP number to drop number ratio by a factor of 3.3 in the Paukert scheme'.

Line 346: that dust alone as a source of INPs was

‘dust alone as a source of INPs was not enough to produce the secondary ice concentrations similar to the observations in this case.’ has been changed to ‘dust alone as a source of INPs was not enough to produce secondary ice concentrations that were similar to the observations in this case.’

Line 349: freezing rate and onset temperature of what?

It has been changed to “the freezing rate and onset temperature in the Morrison scheme affect”.

Line 350: delete the from ‘impact of the cloud’

‘the’ has been deleted.

Line 361: change updraght to updraft.

‘updraught’ is the British spelling. Authors tend to use it.

Line 383-384: delete ‘down’

‘down’ has been deleted.

Line 422: Need a full stop after updraughts and downdraughts. What is the Knight mechanism?

A full stop has been added. The Knight mechanism is mentioned in the first sentence of the paragraph. To make it clearer, “The Knight mechanism” has been changed to “ The Knight mechanism (Knight, 2012).”

Line 423: delete the before ‘similar temperature range’

‘the’ has been deleted.

Line 427: The recent development

‘Recent development’ has been changed to ‘The recent development’

Line 442: the mountainous regions

‘mountainous regions’ has been changed to ‘the mountainous regions’.

Line 447: replace ‘to follow’ by following

‘to follow’ has been changed to ‘following’

Line 452: goes to the correct height

‘the’ has been added.

Line 465: remove ‘the’ before ‘observed’.

‘the observed’ has been changed to ‘observed’,

Line 473: at a higher altitude

It has been changed to ‘at a higher altitude’.

Line 487: delete ‘the’ before ‘the cloud microphysics’. Remove full stop before (Field et al.)

‘the’ has been deleted. The full stop has been deleted as well.