Anonymous referee #2

General Comment:

The authors have made a serious effort to address the first-round comments. The methods section is now complete, the study is positioned much better within the literature on aerosol–fog interactions over the IGP and elsewhere, the interpretation of the AAI/SSA data has been appropriately softened, and spot checks indicate that the previously flagged citation problems have been resolved. The scientific content of the responses is adequate, and no new analysis appears necessary. However, the revised manuscript still contains errors of presentation that should have been caught before resubmission, including a self-contradictory statement of a headline result and several figure cross-references left stale by the renumbering of sections.

General Response: We thank the reviewer for acknowledging the substantial improvements made in response to the first-round comments. We also appreciate the reviewer's meticulous attention to detail in identifying the remaining inconsistencies in the manuscript. In response, we have carefully rechecked the manuscript for consistency in the presentation and interpretation of the results, as well as for figure, section, and appendix cross-references following the renumbering. The contradictory statement concerning the fog-height response has been corrected, and the remaining outdated figure references have been updated. We have also undertaken additional thorough proofreading of the revised manuscript to minimize such inconsistencies in the final version.

Specific comments:

#1. The fog-height result is still stated inconsistently. The abstract says disabling absorption increases fog height by ~20%, but Line 329 states that "the absence of aerosol absorption can reduce fog height by over 20%", leaving it unclear whether absorption increases or reduces fog height. In addition, the same paragraph gives two sets of fog-top heights (240/300/210 m at Lines 321–322 versus 350/250 m at Lines 328–329) without explaining how they differ. The authors should reconcile the direction and the numbers.

Response: The results of the present study consistently show that aerosol absorption acts to limit the vertical extent of fog. When the aerosol absorption component of ARI is suppressed in the ARII-A experiment, the fog-top height increases from approximately 240 m in the Control experiment to approximately 300 m, corresponding to an increase of about 25%. Conversely, the fog-top height decreases to approximately 210 m in the

ARII-S experiment. The values of 350 m and 250 m quoted later in the same paragraph, together with the statement that the absence of aerosol absorption can reduce fog height, were inconsistent with the results shown in Fig. 9, and resulted from an oversight in the previous version of the manuscript. We thank the reviewer for carefully identifying this inconsistency, which has therefore been removed. The corresponding text has been revised to ensure consistency with both Fig. 9 and the statement in the Abstract, as follows [Ln 333-335 of the revised manuscript]

> ……..…. *Overall, ACI has a stronger influence than ARI on the growth and evolution of dense fog, corroborated by previous findings (Yan et al, 2021). Nevertheless, the increase in fog height from ~ 240 m in the Control experiment to about 300 m in the ARII-A experiment indicates that suppressing aerosol absorption can increase fog height by about 25%. This highlights the non-negligible contribution of ARI alongside the dominant role of ACI during dense fog events over the IGP.*

Correspondingly, the relevant line in the abstract has also been revised as [Ln 19-21]

> ……..…. *The results of numerical experiments reveal that disabling the aerosol absorption component of ARI nearly doubled the area affected by dense fog, increased fog height by more than 20%, and delayed fog dissipation by about two hours. ……..*

We use “more than 20%” in the abstract rather than an exact value of 25% because the diagnosed fog-top heights (~240 and ~300 m) are approximate; therefore, quoting an exact percentage would imply greater precision than is supported by the analysis.

#2. Several figure cross-references were not updated after the sections were renumbered. Lines 196–198 refer to "Fig. 2, left panel" and "Fig. 2, right panel", which appear to correspond to Figure 4 (Figure 2 is now the AAI map), and Line 176 cites Fig. A1 and A2 for the MODIS and AERONET SSA results where Figures A2 and A3 are meant. All figure and appendix references should be checked against the final numbering after revision.

Response: The manuscript has now been thoroughly checked for figure and appendix cross-references. They have now been corrected throughout the revised manuscript, including the specific instances highlighted by the reviewer, as shown below.

Ln 182-183

> …… *Additionally, SSA values retrieved from MODIS-Terra satellite data (Fig. A2) and other AERONET stations in the IGP region (Fig. A3) were also found to be below 0.95, further confirming the presence of aerosols with absorption characteristics in the region.*

Ln 203-205

> …….. *First, regions with LWP >0 were used to identify fog-affected areas (Fig. 4, left panel). To specifically distinguish areas of dense fog, this condition was further refined by using a visibility threshold < 200 meters, combined with the condition LWP > 0 (Fig. 4, right panel). ……*

Ln 336

> ***Error! Reference source not found.*** *indicates that maximum fog height typically occurs between 0800 – 1000 hours (IST). ……..*

Ln 346-347

> *A more detailed examination of such two contrasting regions (Figures A4 & A5) reveals notable differences in the vertical aerosol profiles above and below the boundary layer.*

Ln439-440

> *absorption in the UV and blue spectral range. Figure A2 displays the single scattering albedo (SSA) derived from spectral SSA retrievals with MODIS at 470 nm, averaged over the study period. Most of the region demonstrates*

Ln 443

> *2023 had very few fog-affected days. Figure A3 shows SSA values observed at three AERONET stations within the*

#3. The technical implementation of the ARII experiments is still not described well enough. The text states only that absorption, scattering, or both were "disabled in the model", without saying how this was done in the radiation scheme (for example, by modifying the aerosol optical properties). I suggest the authors add one or two sentences in Section 2.2 describing the implementation.

Response: We thank the reviewer for highlighting the need to describe the technical implementation of the ARII sensitivity experiments more explicitly. We have therefore added details in Section 2.2 of the revised manuscript explaining how the aerosol optical properties were modified [Ln 118-124 in the revised manuscript].

> *Next, three sensitivity experiments were devised to isolate the effects of aerosol radiative properties. In these runs, aerosol absorption, scattering, and both absorption and scattering were sequentially disabled in the model. The sensitivity experiments were implemented within the UKCA aerosol–radiation coupling by directly modifying the aerosol optical properties supplied to the radiation scheme. For example, in the ARII-A experiment, the aerosol absorption coefficient was set to zero for all aerosol modes, atmospheric layers, and spectral bands, thereby suppressing the radiative effect of aerosol absorption while retaining the calculated scattering properties. Importantly, this modification applies only to aerosol absorption and radiative absorption by atmospheric gases and clouds represented in the radiation scheme remains unchanged. Similarly, in the ARII-S experiment, the aerosol scattering coefficient was set to zero while retaining aerosol absorption, whereas both aerosol absorption and scattering coefficients were set to zero in the ARII experiment.*

#4. The revised text contains grammatical errors, mostly in newly added passages （e.g. "considered the dominant during fog microphysics" at Lines 60–61, the broken sentence at Lines 77–78, "vertical development fog" at Line 84, "the radiation processes in the

different processes" at Lines 258–259, "and while surface heating is enhanced" at Lines 294–295, etc.

Response: We appreciate the reviewer's detailed scrutiny in identifying these grammatical and language-related issues. The manuscript has been carefully rechecked, and the identified grammatical errors and awkward sentence constructions have been corrected throughout. The specific instances highlighted by the reviewer are addressed below. For brevity, we have not listed each individual language correction here; however, all such changes can be seen in the tracked-changes version of the revised manuscript provided with the resubmission.

Ln 60-62

……..... *While several previous studies have investigated aerosol impacts on fog, most have focused primarily on ACI, which are generally considered dominant in fog microphysics and evolution*. ……..

Ln 78-80

…….. *The influence of absorbing aerosols on fog or the relative contributions of aerosol absorption and scattering to fog evolution have not been examined in modeling studies over the IGP.* …….

Ln 83-85

……..... *The experiments have been designed to isolate the absorbing and scattering components of ARI within the same modelling framework, thereby allowing their relative roles in the temporal evolution, spatial extent, and vertical development of fog to be assessed.* ……..

Ln 265-266

…….. *A schematic for the radiation processes in the different experiments is displayed in Fig. 8.* …….

Ln 301-302

…….. *This absorption-driven heating is absent in the ARII-A experiment, while surface heating is enhanced in the ARII-S experiment.* ……