Supplement of

A bin microphysics parcel model investigation of secondary ice formation in an idealised shallow convective cloud

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SECTION S1: Temperature profiles

**Figure S1** Temperature profiles of a shallower (1.3 km deep) cloud. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C. The grey shaded regions indicate the temperature region in which rime-splintering could be active.

**Figure S2** Temperature profiles of a deeper (2.4 km) cloud. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C. The grey shaded regions indicate the temperature region in which rime-splintering could be active.
SECTION S2: Additional figures for shallower clouds with a natural aerosol size distribution

**Figure S3** Control simulation ice crystal number concentrations for shallower clouds (1.3 km deep) with a natural aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

**Figure S4** Cloud drop number concentrations for a shallower cloud (1.3–km deep) with a natural aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.
Figure S5 Ice crystal number concentrations for control simulations against simulation time for three initial INP concentrations ($\times 0.1$, $\times 1$ and $\times 10$) for a shallower cloud (1.3 km deep) with a natural aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

Figure S6 Mode 1 and mode 2 ice enhancement against simulation time for three INP concentrations ($\times 0.1$, $\times 1$ and $\times 10$) for a shallower (1.3 km deep) cloud with a natural aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.
Figure S7 Ice-ice collisional breakup ice enhancement against simulation time for three INP concentrations ($\times 0.1$, $\times 1$ and $\times 10$) for a shallower (1.3 km deep) cloud with a natural aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.
**SECTION S3:** Additional figures for shallower clouds with a near-city size distribution

![Shallow cloud with a near-city aerosol size distributions](image)

**Figure S8** Control simulation ice crystal number concentrations for shallower clouds (1.3 km deep) with a natural aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

![Shallow clouds with near-city aerosol size distributions](image)

**Figure S9** Cloud drop number concentrations for a shallower cloud (1.3~km deep) with a near-city aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.
Figure S10 Ice crystal number concentrations for control simulations against simulation time for three initial INP concentrations (×0.1, ×1 and ×10) for a shallower cloud (1.3 km deep) with a near-city aerosol. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

Figure S11 Mode 1 and mode 2 ice enhancement against simulation time for three INP concentrations (×0.1, ×1 and ×10) for a shallower (1.3 km deep) cloud with a near-city aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.
Figure S12 Ice-ice collisional breakup ice enhancement against simulation time for three INP concentrations (×0.1, ×1 and ×10) for a shallower (1.3 km deep) cloud with a natural aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.
SECTION S4: Additional figures for deeper clouds with a natural aerosol size distribution

**Figure S13** Control simulation ice crystal number concentrations for deeper clouds (1.3 km deep) with a natural aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

**Figure S14** Cloud drop number concentrations for a deeper cloud (1.3 km deep) with a natural aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.
SECTION S5: Additional figures for deeper clouds with a near-city size distribution

Figure S15 Control simulation ice crystal number concentrations for deeper clouds (2.4 km deep) with a near-city aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

Figure S16 Cloud drop number concentrations for a deeper cloud (2.4 km deep) with a near-city aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.
**SECTION S6:** Particle and ice size distribution contour plots

**Figure S17** Contour plot showing the particle size distribution as a function of simulation time for shallower clouds (1.3 km deep) with natural aerosol size distributions. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.
Figure S18 Contour plot showing the particle size distribution as a function of simulation time for shallower clouds (1.3 km deep) with near-city aerosol size distributions. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.
Figure S19 Contour plot showing the particle size distribution as a function of simulation time for deeper clouds (2.4 km deep) with natural aerosol size distributions. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.
Figure S20 Contour plot showing the particle size distribution as a function of simulation time for deeper clouds (2.4 km deep) with natural aerosol size distributions. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.
SECTION S7: Ice particle aspect ratio figures

**Figure S21** Ice particle aspect ratio for a shallower cloud (1.3 km deep) with a natural aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

**Figure S22** Ice particle aspect ratio for a shallower cloud (1.3 km deep) with a near-city aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.
Figure S23 Ice particle aspect ratio for a deeper cloud (2.4 km deep) with a natural aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

Figure S24 Ice particle aspect ratio for a deeper cloud (2.4 km deep) with a near-city aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.
**SECTION S8:** Liquid and ice water contents

**Figure S25** Liquid water content for a shallower cloud (1.3 km deep) with a natural aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C. These simulations were extended past the 133.3 min runtime, indicated by a grey dashed line, to demonstrate the effects of the Wegener-Bergeron Findeisen process.
Figure S26: Ice water content for a shallower cloud (1.3 km deep) with a natural aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C. These simulations were extended past the 133.3 min runtime, indicated by a grey dashed line, to demonstrate the effects of the Wegener-Bergeron Findeisen process.