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Supplement of

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

Rachel L. James et al.

Correspondence to: Rachel L. James (r.james@leeds.ac.uk) and Paul J. Connolly (paul.connolly@manchester.ac.uk)

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SECTION S1: Temperature profiles

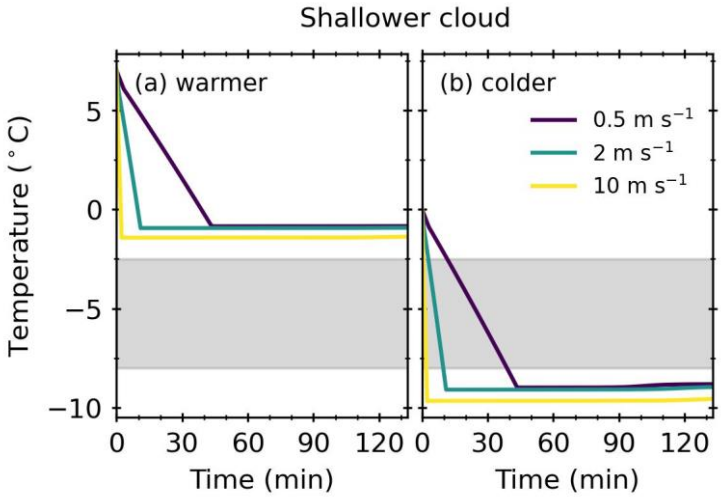

Figure S1 Temperature profiles of a shallower (1.3 km deep) cloud. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C. The grey shaded regions indicate the temperature region in which rime-splintering could be active.

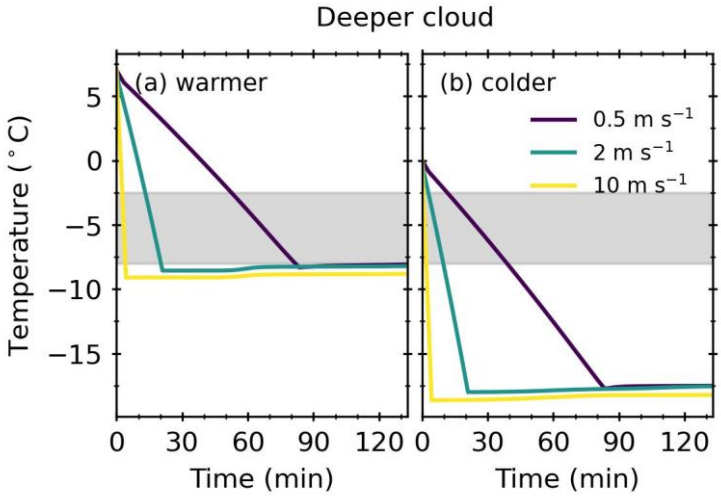

Figure S2 Temperature profiles of a deeper (2.4 km) cloud. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C. The grey shaded regions indicate the temperature region in which rime-splintering could be active.

SECTION S2: Additional figures for shallower clouds with a natural aerosol size distribution

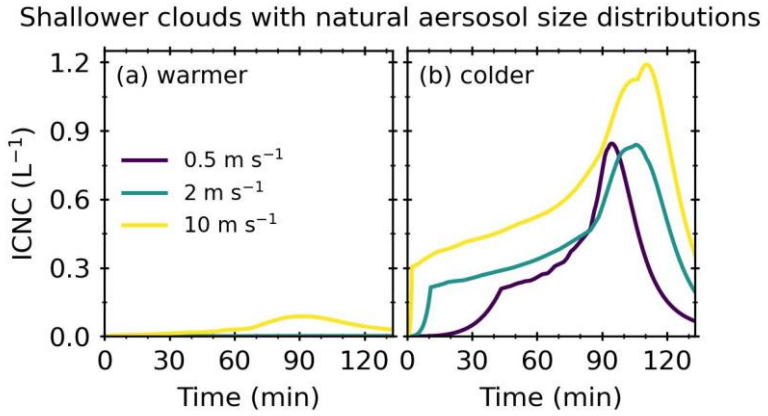

Figure S3 Control simulation ice crystal number concentrations for shallower clouds (1.3 km deep) with a natural aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

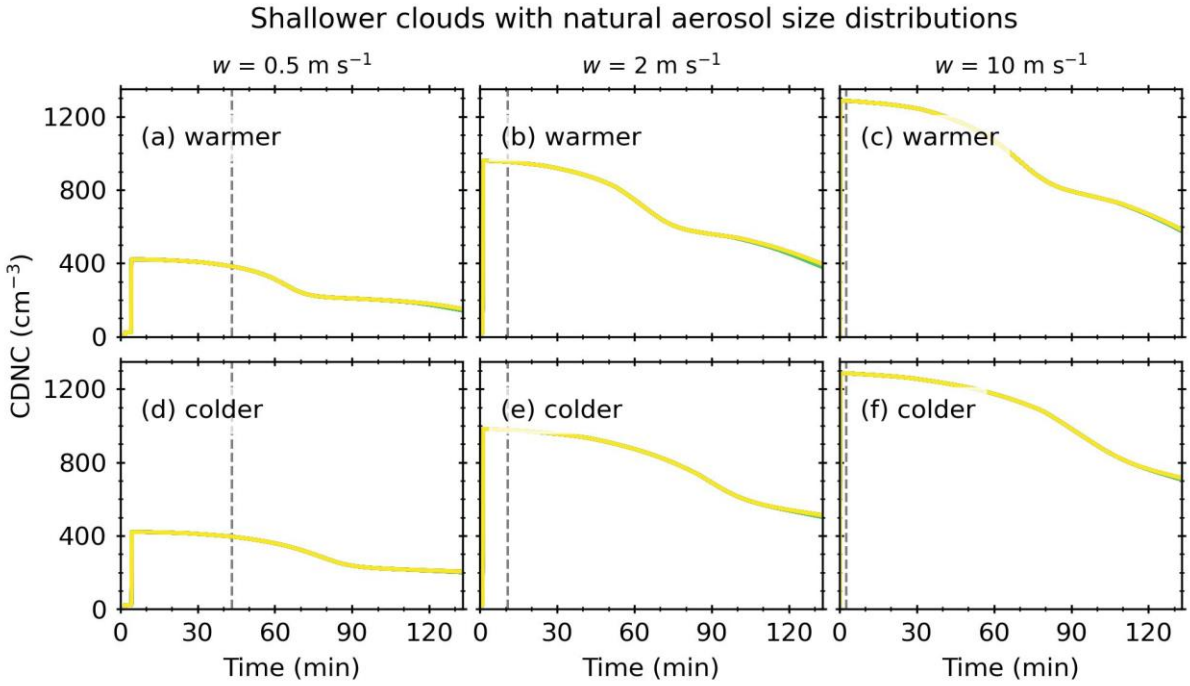

Figure S4 Cloud drop number concentrations for a shallower cloud (1.3~km deep) with a natural aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

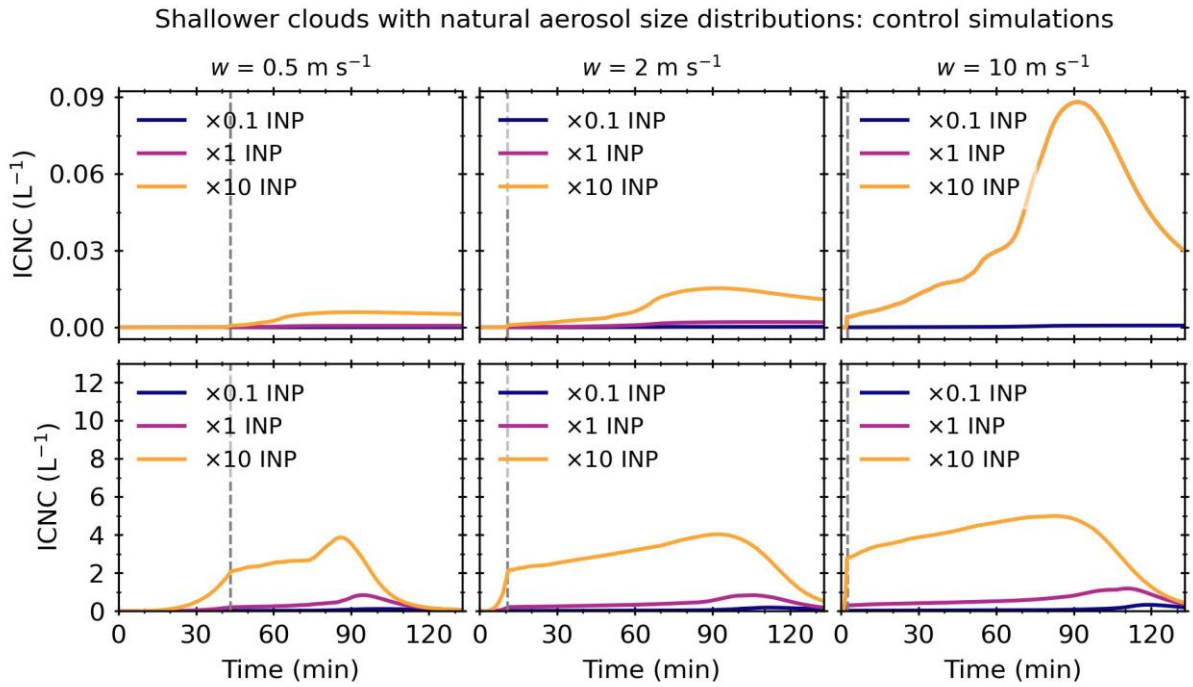

Figure S5 Ice crystal number concentrations for control simulations against simulation time for three initial INP concentrations (×0.1, ×1 and ×10) for a shallower cloud (1.3 km deep) with a natural aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud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

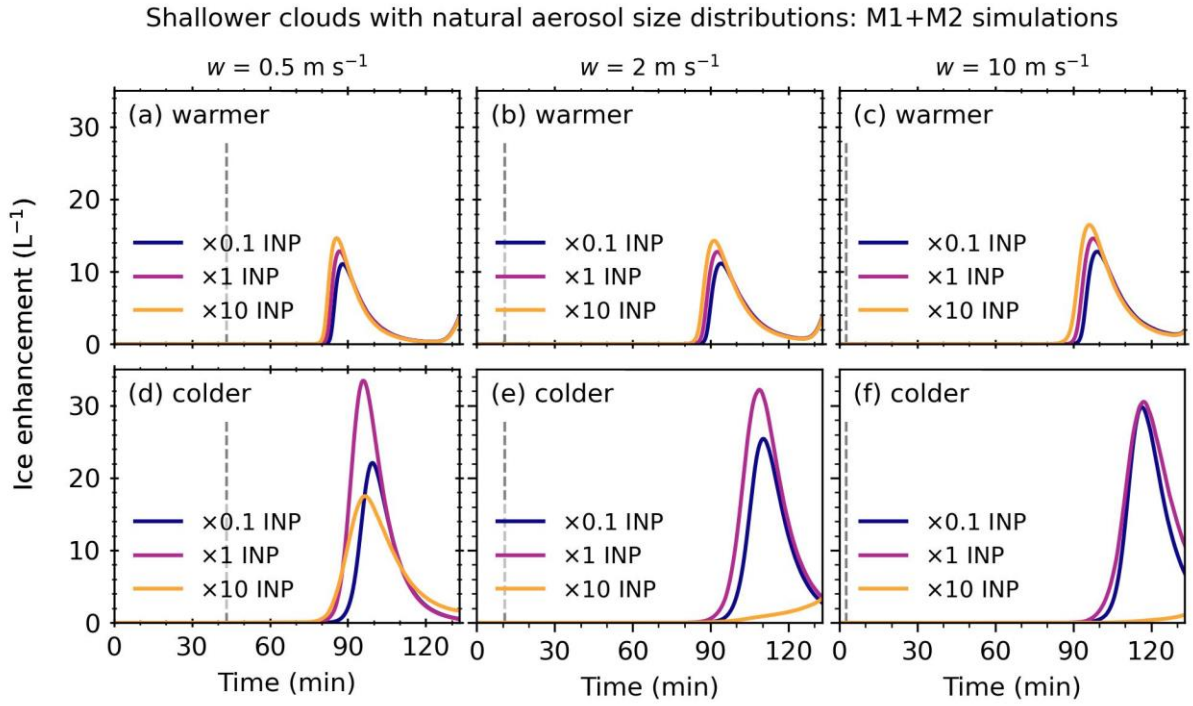

Figure S6 Mode 1 and mode 2 ice enhancement against simulation time for three INP concentrations (×0.1, ×1 and ×10) for a shallower (1.3 km deep) cloud with a natural aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

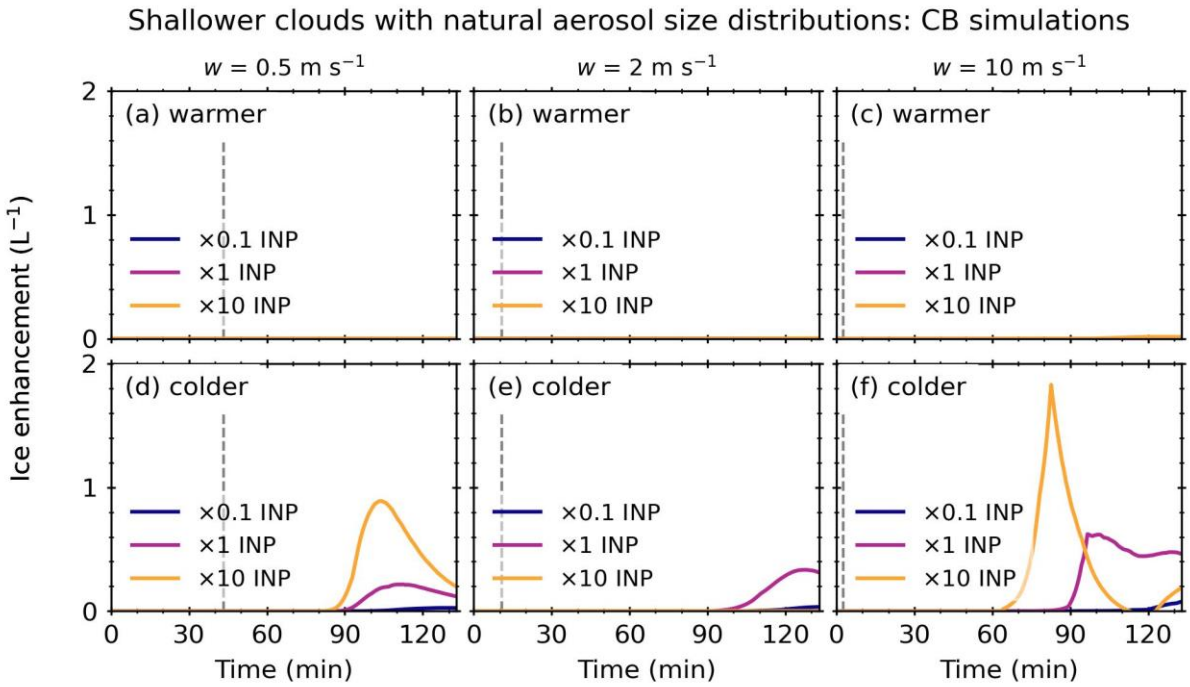

Figure S7 Ice-ice collisional breakup ice enhancement against simulation time for three INP concentrations (×0.1, ×1 and ×10) for a shallower (1.3 km deep) cloud with a natural aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

SECTION S3: Additional figures for shallower clouds with a near-city size distribution

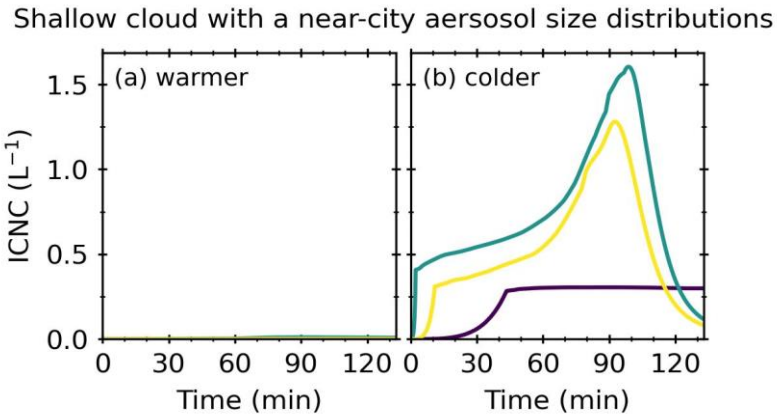

Figure S8 Control simulation ice crystal number concentrations for shallower clouds (1.3 km deep) with a natural aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

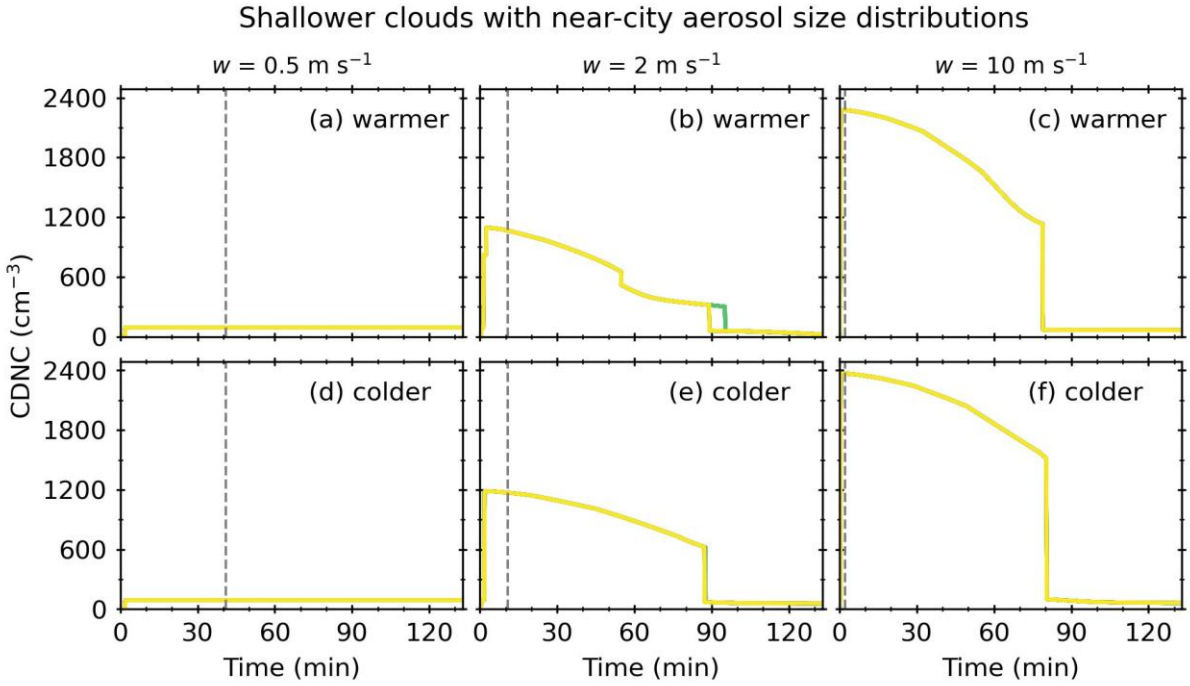

Figure S9 Cloud drop number concentrations for a shallower cloud (1.3~km deep) with a near-city aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

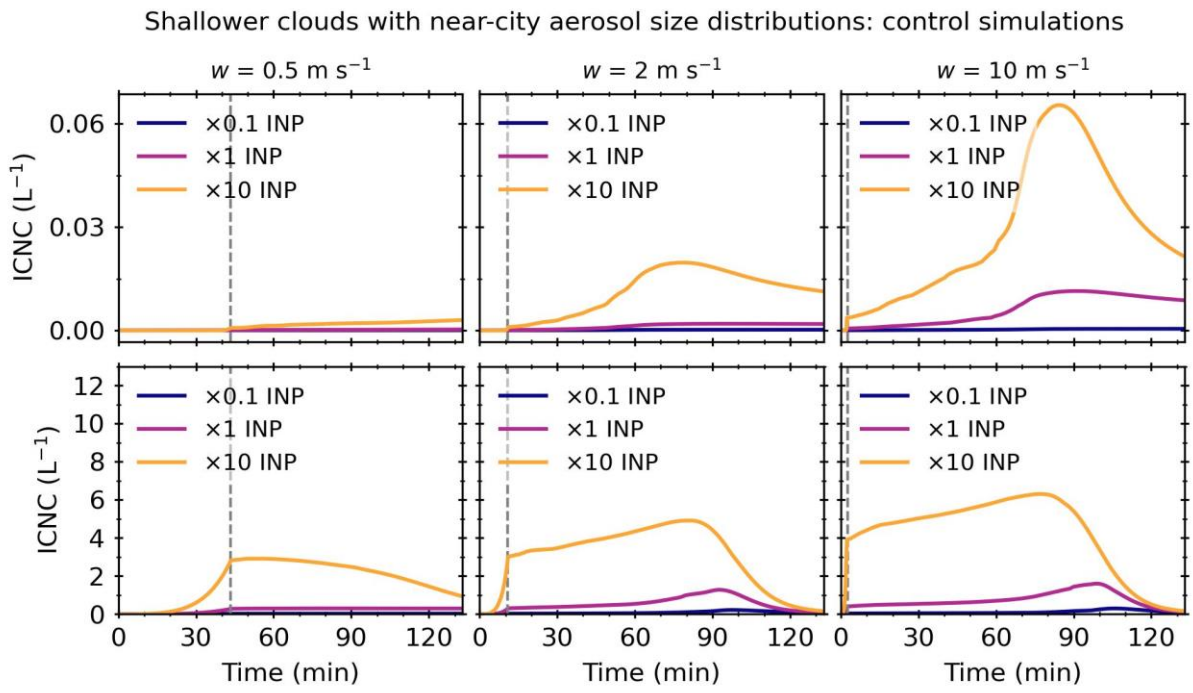

Figure S10 Ice crystal number concentrations for control simulations against simulation time for three initial INP concentrations (×0.1, ×1 and ×10) for a shallower cloud (1.3 km deep) with a near-city aerosol. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures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

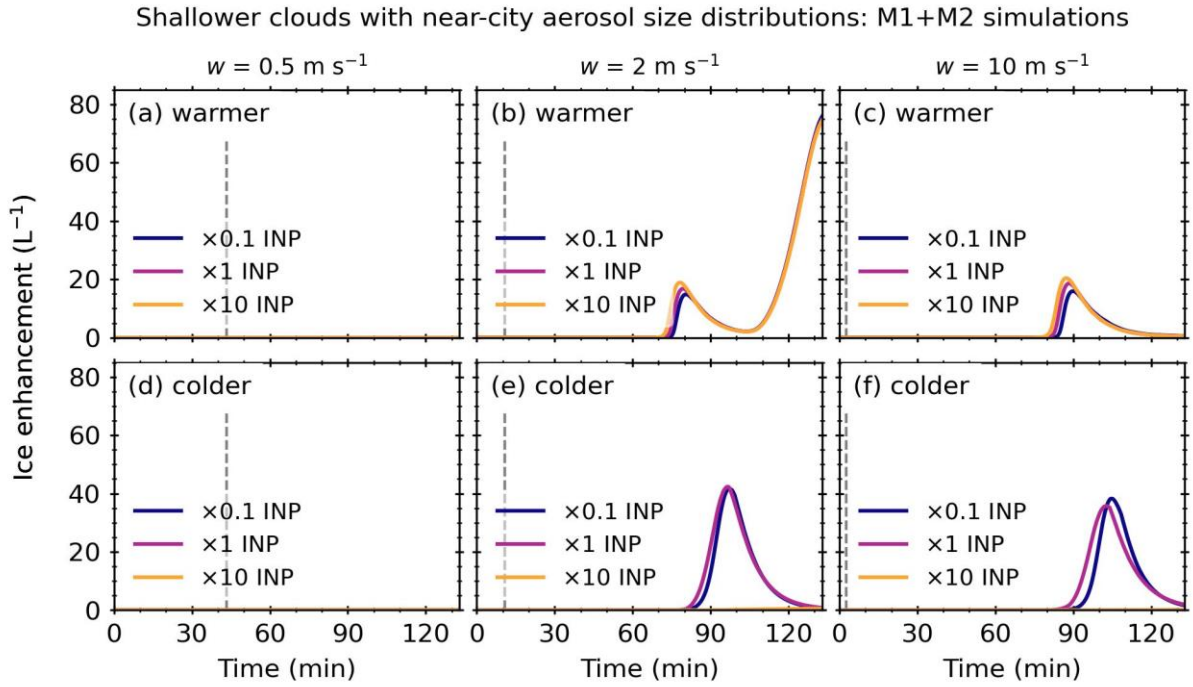

Figure S11 Mode 1 and mode 2 ice enhancement against simulation time for three INP concentrations (×0.1, ×1 and ×10) for a shallower (1.3 km deep) cloud with a near-city aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

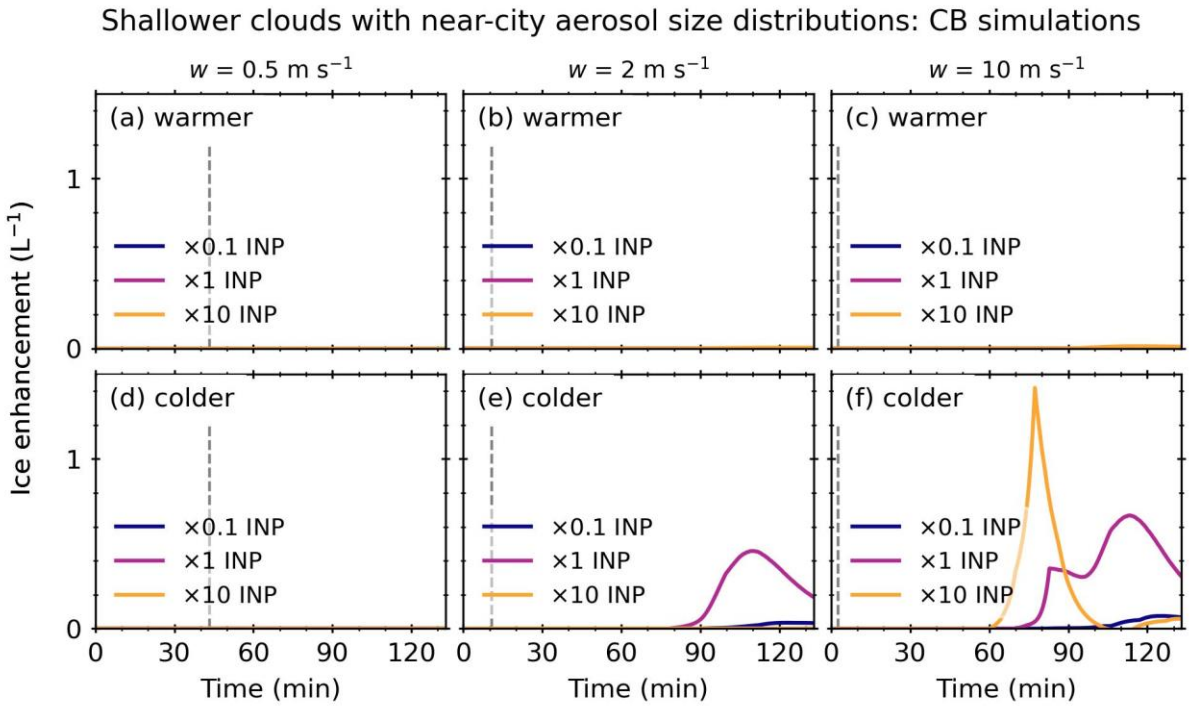

Figure S12 Ice-ice collisional breakup ice enhancement against simulation time for three INP concentrations (×0.1, ×1 and ×10) for a shallower (1.3 km deep) cloud with a natural aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

SECTION S4: Additional figures for deeper clouds with a natural aerosol size distribution

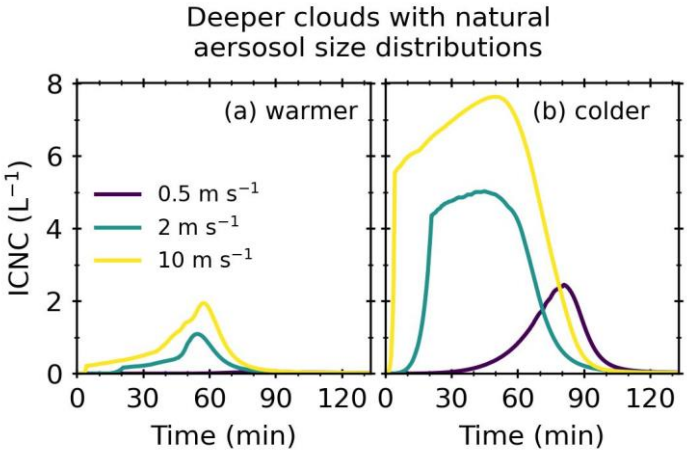

Figure S13 Control simulation ice crystal number concentrations for deeper clouds (1.3 km deep) with a natural aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

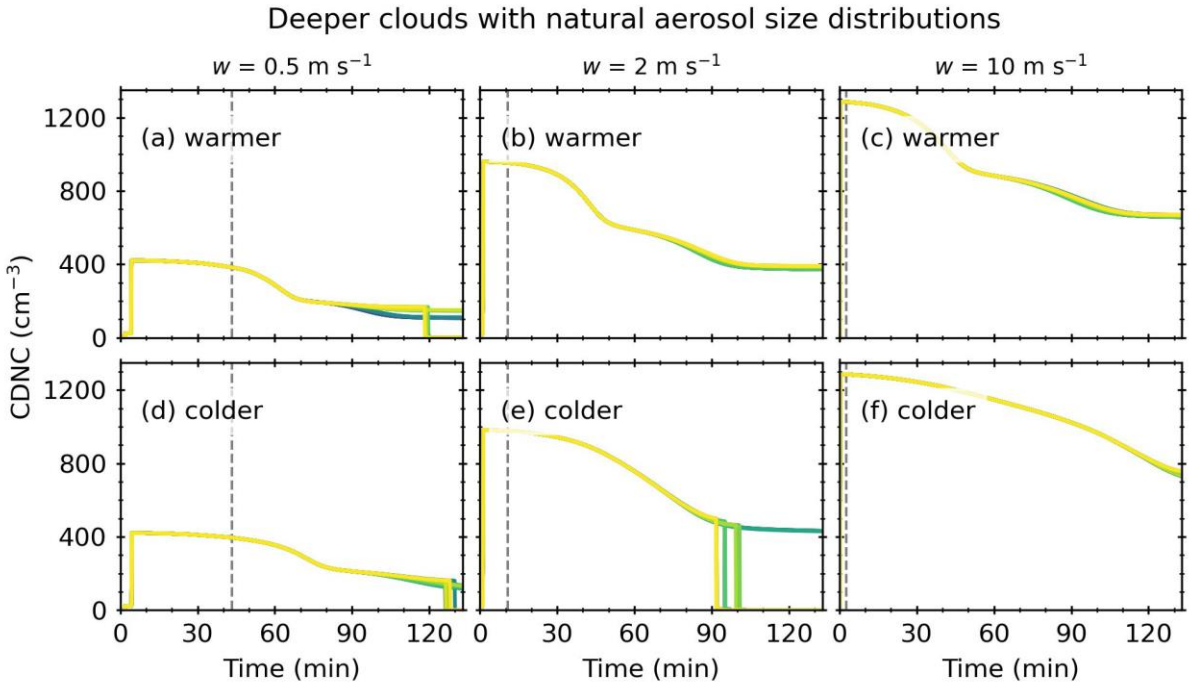

Figure S14 Cloud drop number concentrations for a deeper cloud (1.3 km deep) with a natural aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

SECTION S5: Additional figures for deeper clouds with a near-city size distribution

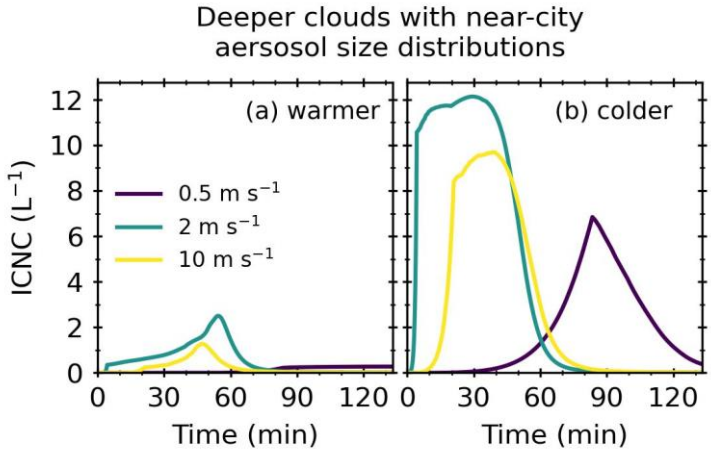

Figure S15 Control simulation ice crystal number concentrations for deeper clouds (2.4 km deep) with a near-city aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

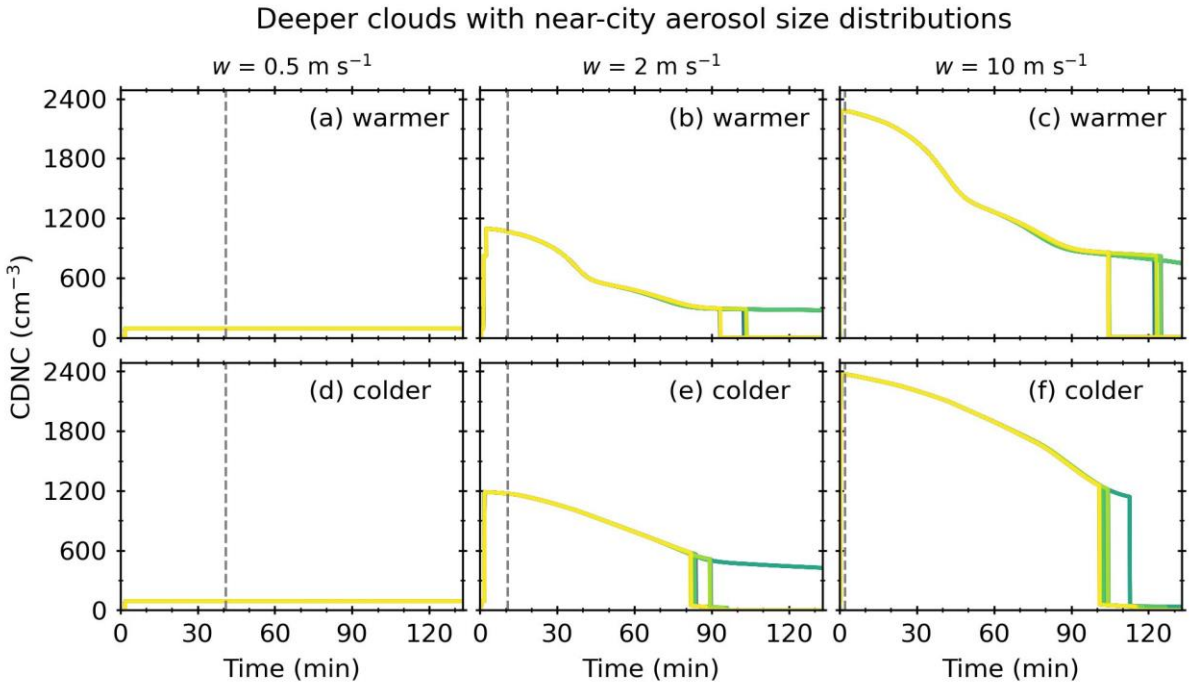

Figure S16 Cloud drop number concentrations for a deeper cloud (2.4 km deep) with a near-city aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

SECTION S6: Particle and ice size distribution contour plots

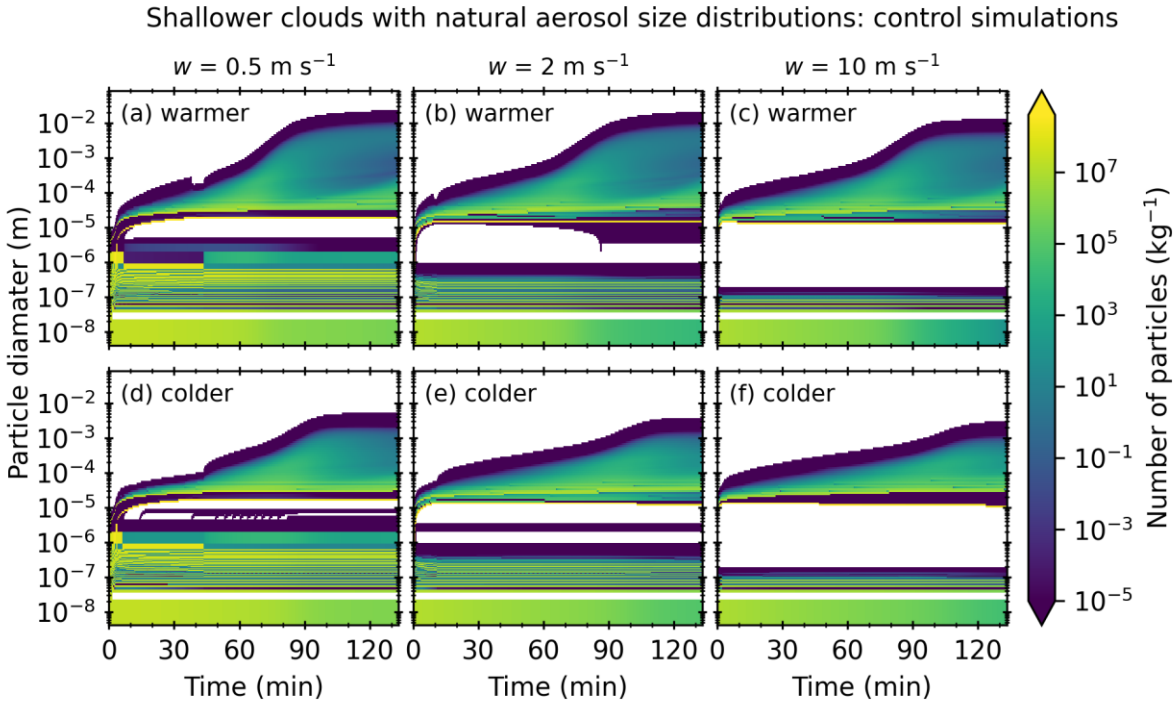

Figure S17 Contour plot showing the particle size distribution as a function of simulation time for shallower clouds (1.3 km deep) with natural aerosol size distributions. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

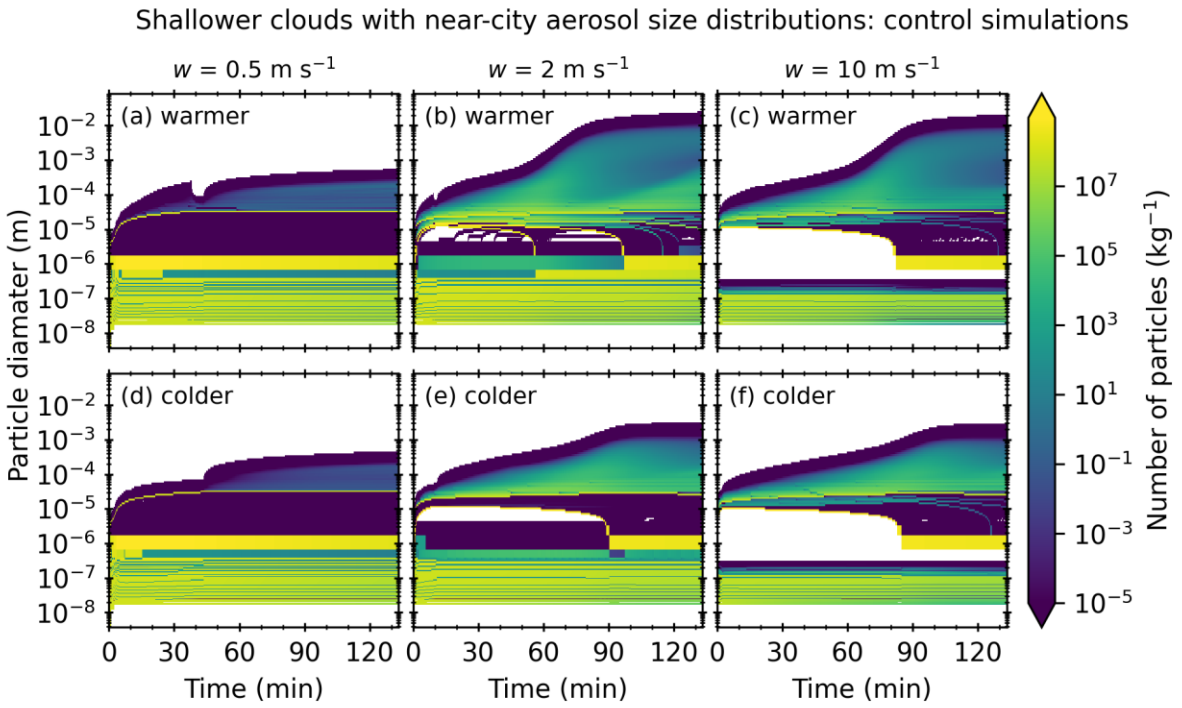

Figure S18 Contour plot showing the particle size distribution as a function of simulation time for shallower clouds (1.3 km deep) with near-city aerosol size distributions. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

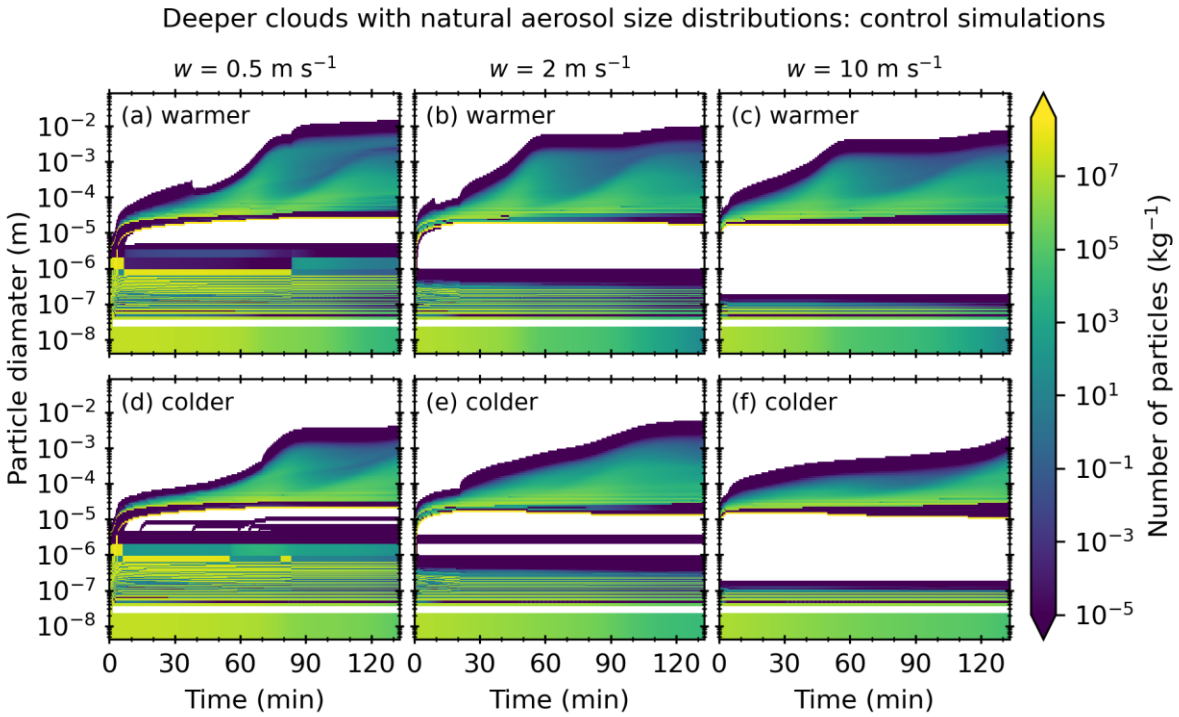

Figure S19 Contour plot showing the particle size distribution as a function of simulation time for deeper clouds (2.4 km deep) with natural aerosol size distributions. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

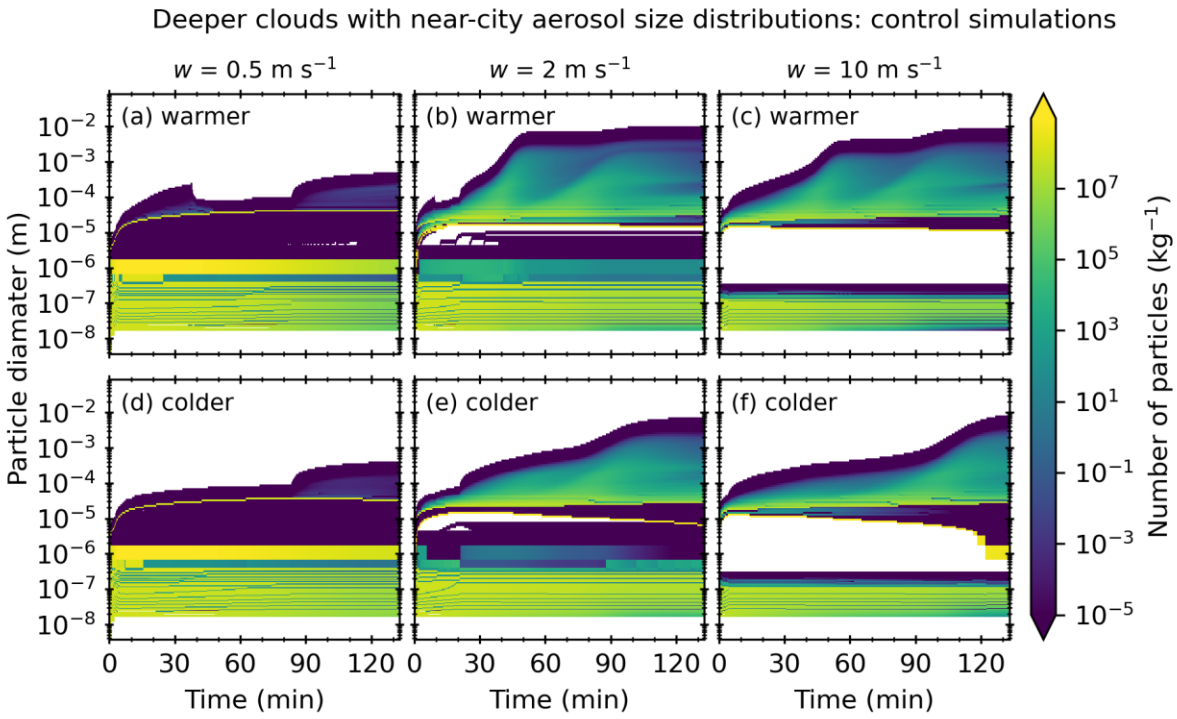

Figure S20 Contour plot showing the particle size distribution as a function of simulation time for deeper clouds (2.4 km deep) with natural aerosol size distributions. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

SECTION S7: Ice particle aspect ratio figures

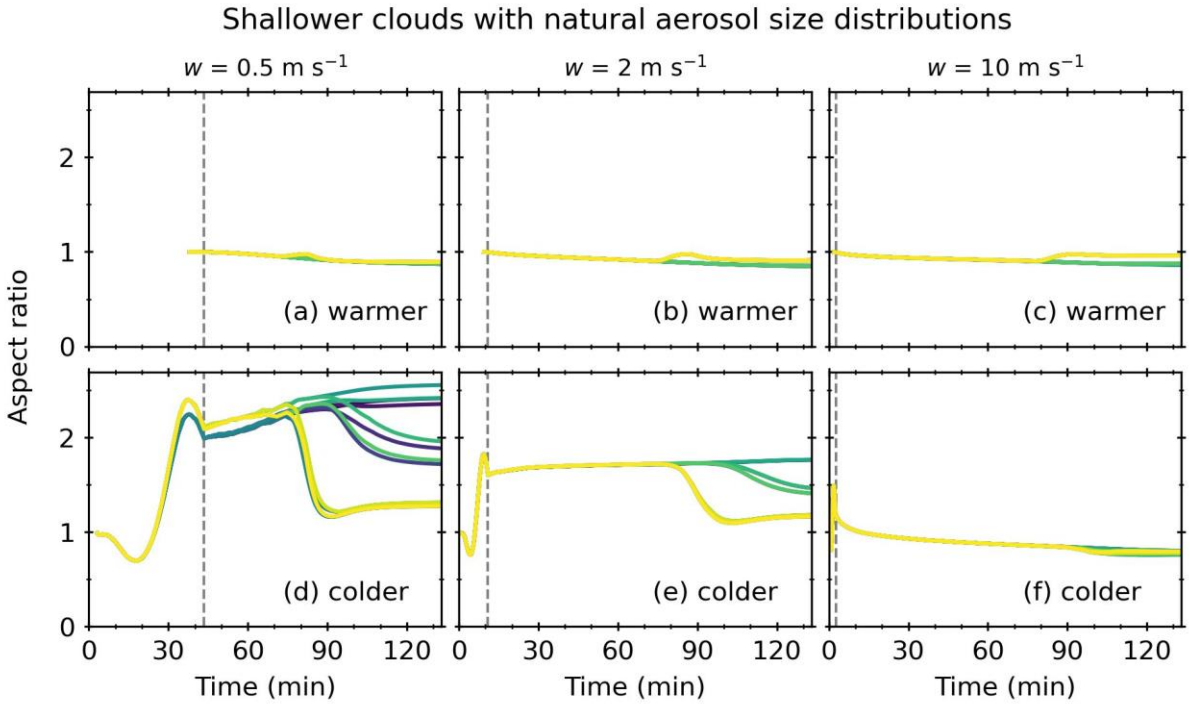

Figure S21 Ice particle aspect ratio for a shallower cloud (1.3 km deep) with a natural aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

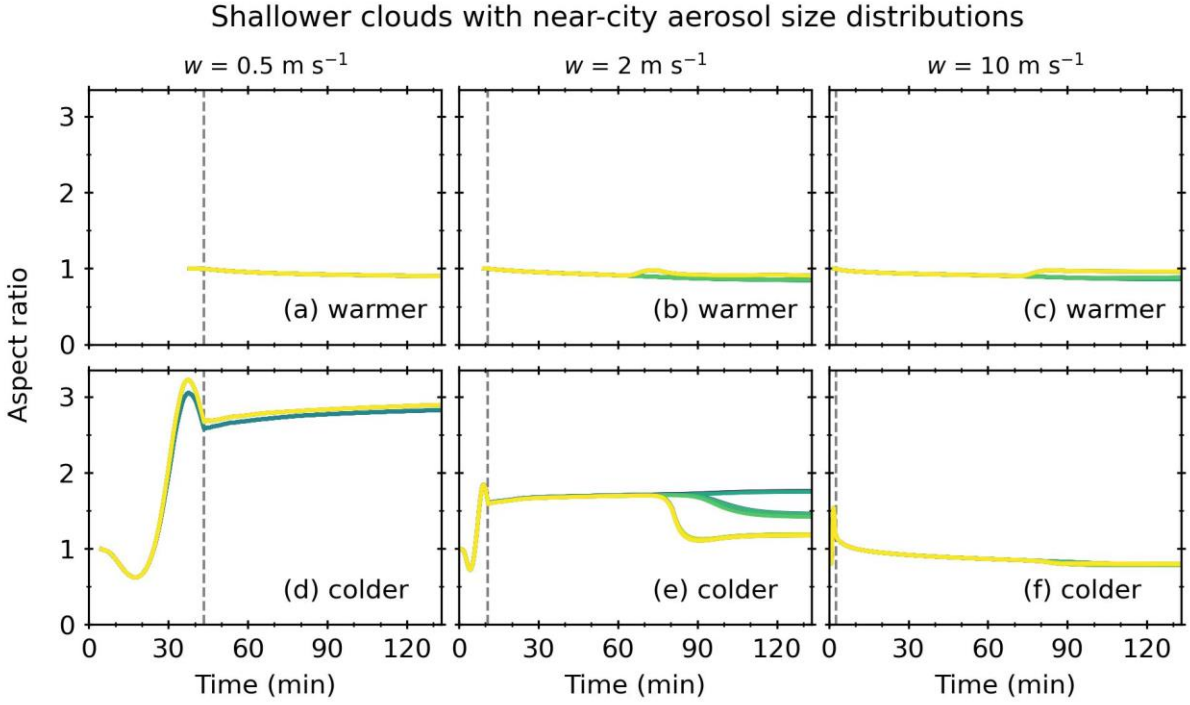

Figure S22 Ice particle aspect ratio for a shallower cloud (1.3 km deep) with a near-city aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

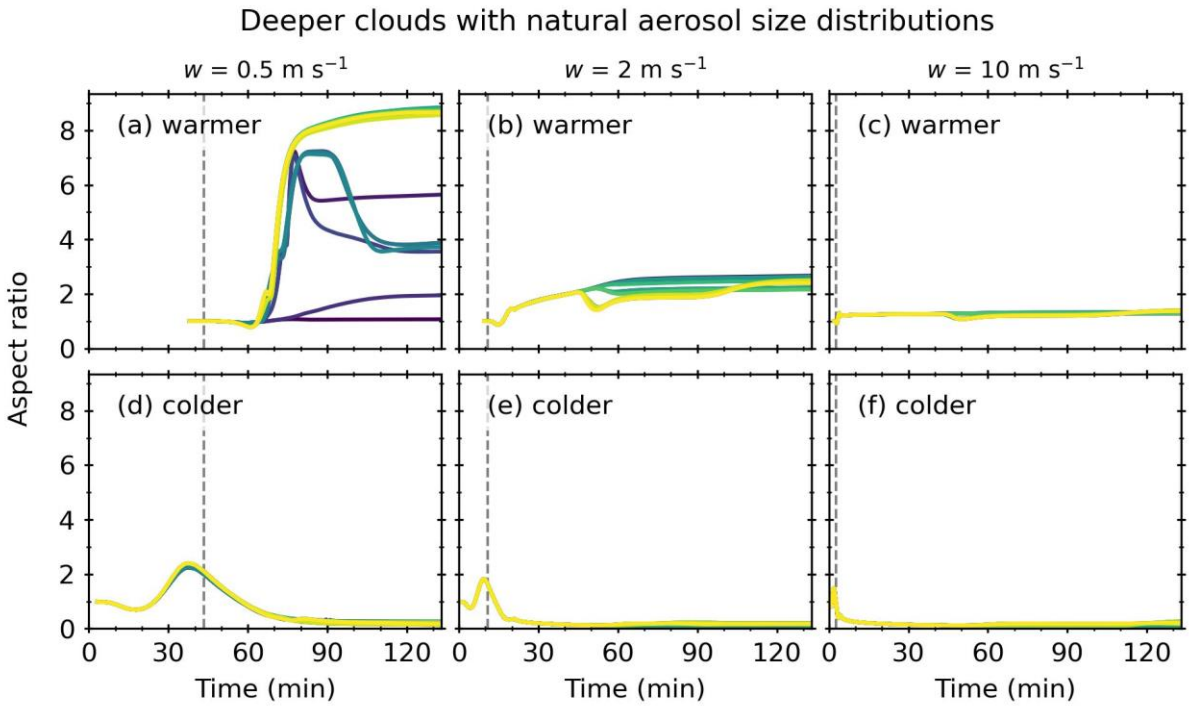

Figure S23 Ice particle aspect ratio for a deeper cloud (2.4 km deep) with a natural aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

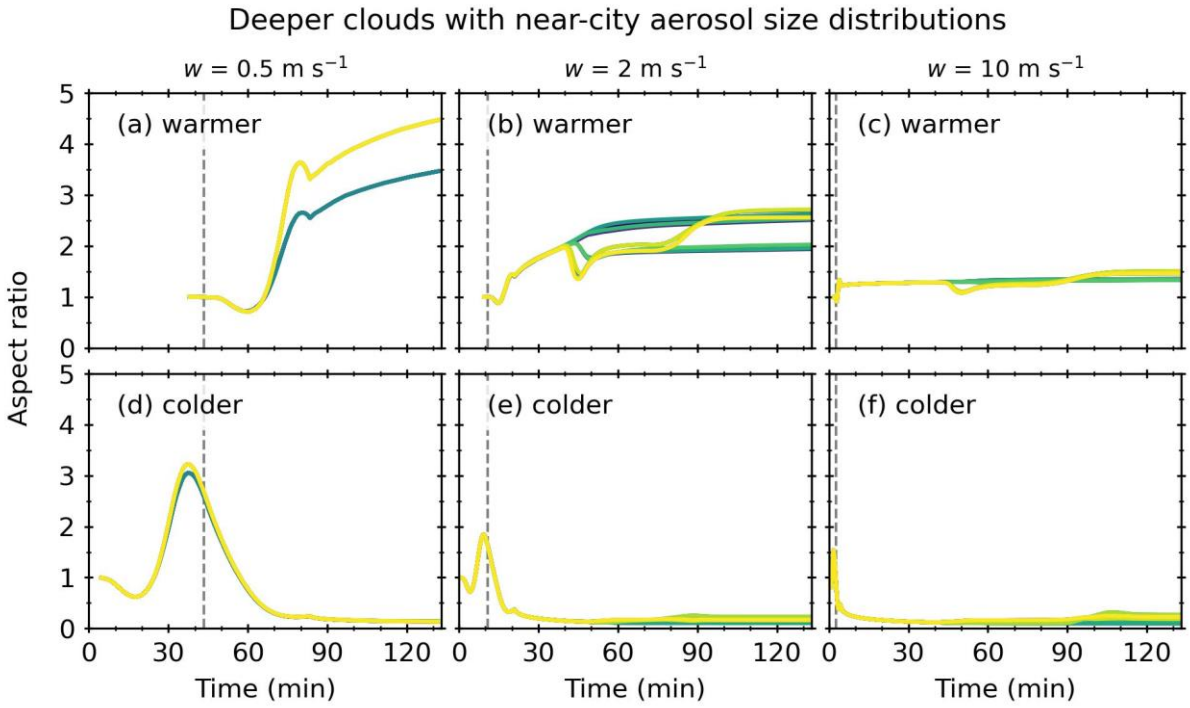

Figure S24 Ice particle aspect ratio for a deeper cloud (2.4 km deep) with a near-city aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C.

SECTION S8: Liquid and ice water contents

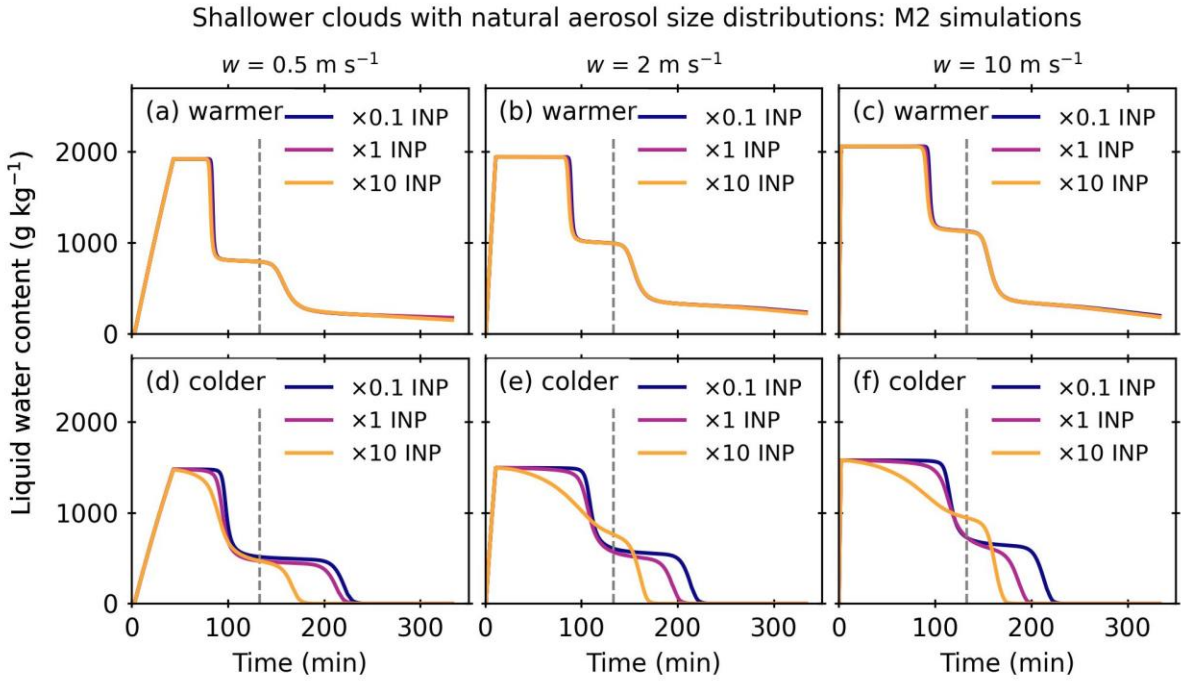

Figure S25 Liquid water content for a shallower cloud (1.3 km deep) with a natural aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C. These simulations were extended past the 133.3 min runtime, indicated by a grey dashed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

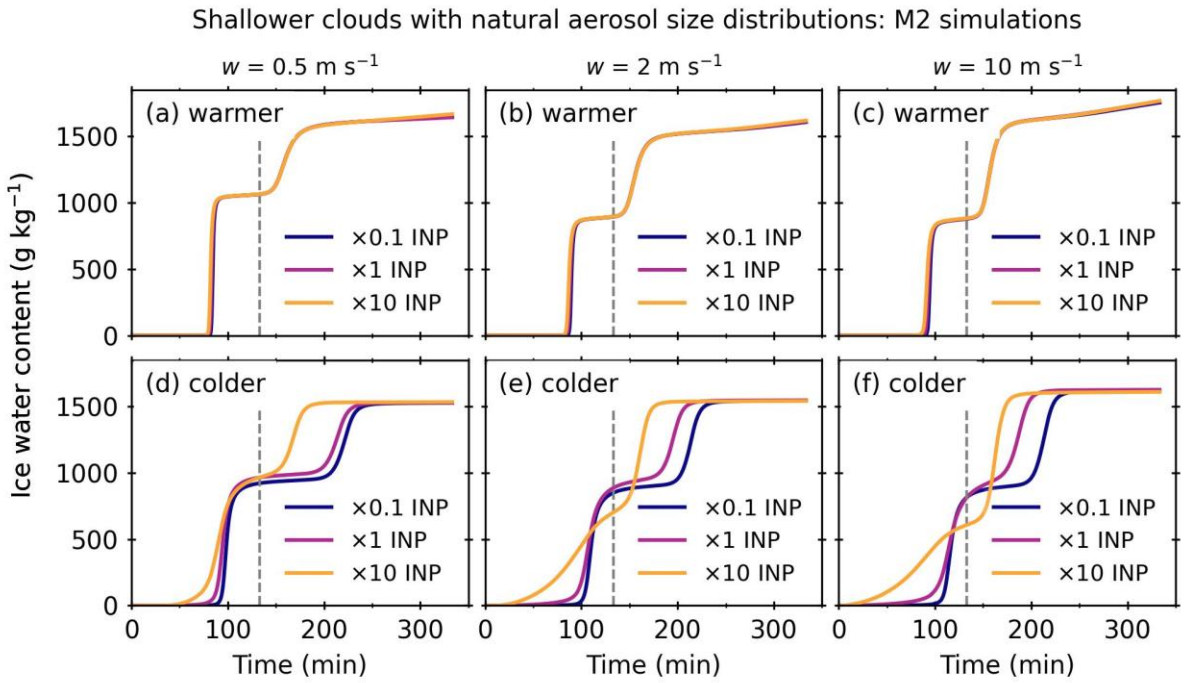

Figure S26 Ice water content for a shallower cloud (1.3 km deep) with a natural aerosol size distribution. Warmer refers to cloud base temperatures of 7 °C, and colder refers to cloud base temperatures of 0 °C. These simulations were extended past the 133.3 min runtime, indicated by a grey dashed line,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