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Response of Arctic mixed-phase clouds to aerosol perturbations under different surface forcings

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1 Figures

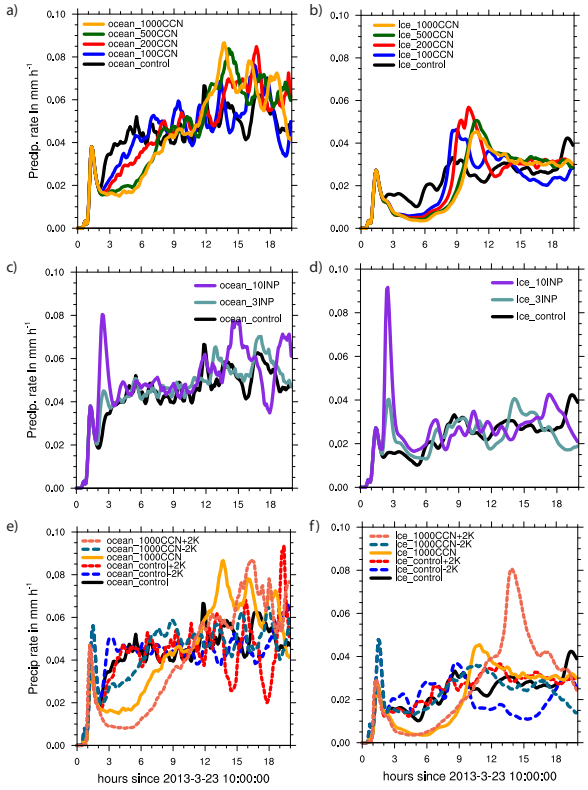

Figure S1. Mean total surface precipitation over (a) the open ocean and (b) sea ice in *control* and all CCN sensitivity simulations; (c) the open ocean and (d) sea ice in *control* and all INP sensitivity simulations, (e) the open ocean and (f) sea ice in *control* and the respective *1000CCN* simulations in their regular state and 2 K warmer and colder conditions.

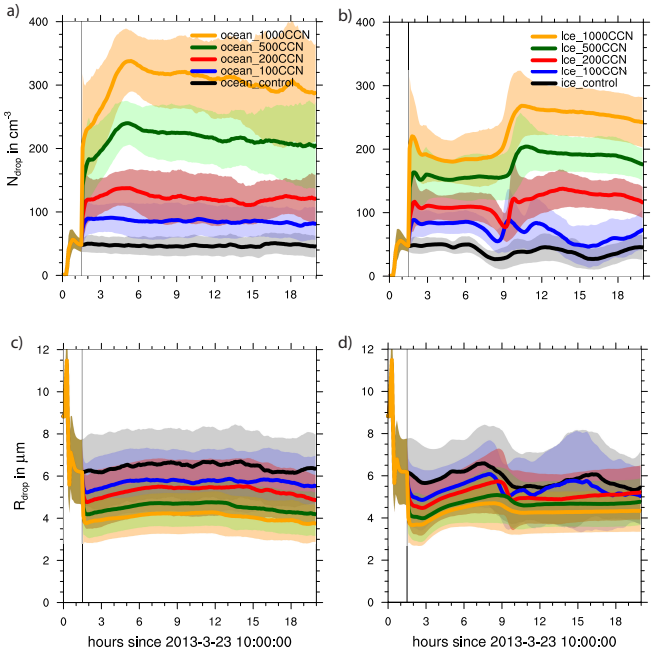

Figure S2. Domain and vertically averaged (a,b) N_{drop} and (c,d) R_{drop} over the open ocean (a,c) and sea ice (b,d) in *control* and all CCN sensitivity simulations. The solid lines depict the mean, the shadings the standard deviations. The vertical black lines indicate the CCN perturbation injections.

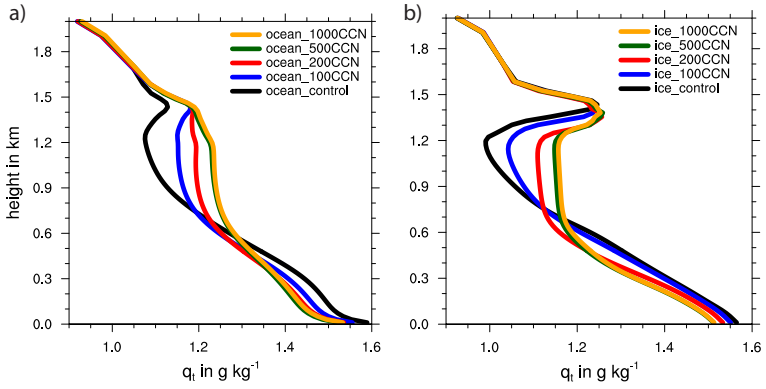

Figure S3. Average cloud total water content over the open ocean (a) and sea ice (b) in *control* and all CCN sensitivity simulations.

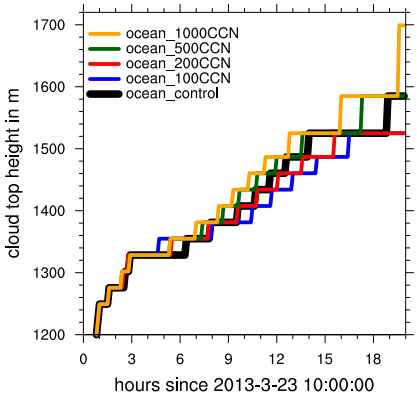

Figure S4. Cloud top of the uppermost stratiform cloud layer in *control* and all CCN sensitivity simulations over the open ocean.

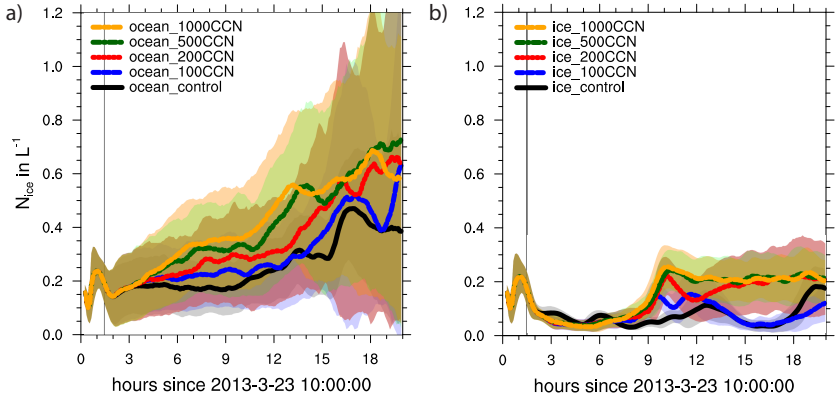

Figure S5. Domain and vertically averaged N_{ice} over the open ocean (a) and sea ice (b) in *control* and all CCN sensitivity simulations. The solid lines depict the means, the shadings the standard deviations. The vertical black lines indicate the CCN perturbation injections.

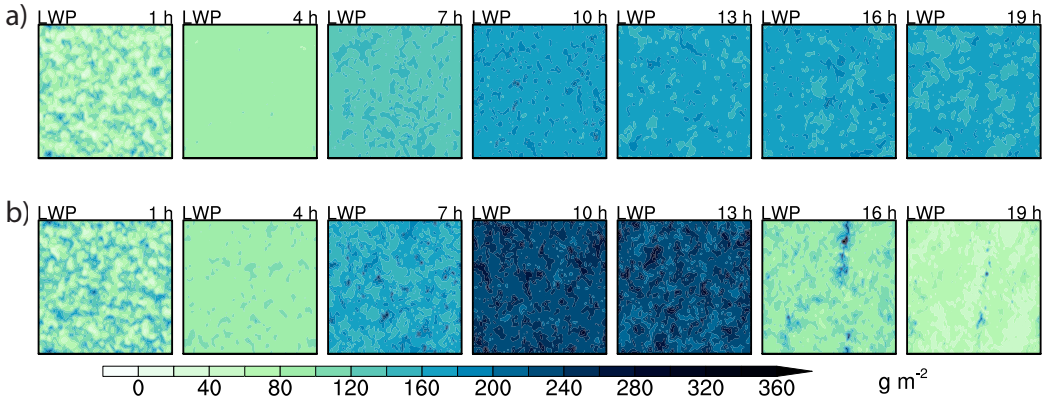

Figure S6. LWP for (a) *ice_1000CCN* and the (b) *ice_1000CCN+2K* simulation.

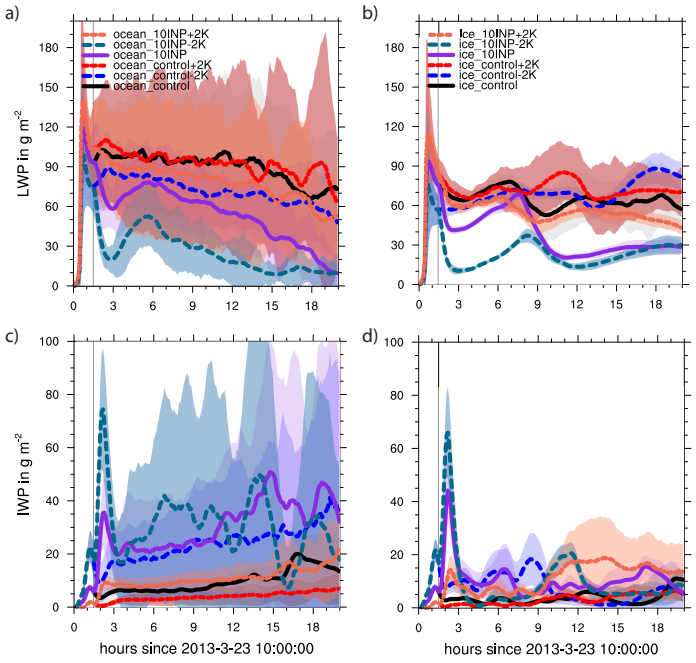

Figure S7. Domain averaged a,b) LWP and c,d) IWP over the open ocean (a,c) and sea ice (b,d) in *control* and the respective *10INP* simulations in their regular state and 2 K warmer and colder conditions. The lines depict the mean, the shadings the standard deviations. The vertical black lines indicate the INP perturbation injections.

Table S1. Averaged cloud properties ± 1 standard deviation throughout the simulated time period following the aerosol injection (hour 2-20) for all CCN and INP sensitivity simulations not listed in Table 3 over the open ocean and sea ice. Note that for net surface SW radiation we only averaged over daytime (8.5 h in total).

	ocean_100CCN	*ocean_200CCN*	*ocean_500CCN*	*ocean_3INP*	*ice_100CCN*	*ice_200CCN*	*ice_500CCN*	*ice_3INP*
Cloud mean $N_{drop}(\mathrm{cm}^{-3})$	86.5±25.5	123.8±35.3	217.4±47.8	49.2±15.3	70.0±31.0	118.1±30.4	177.0±38.3	37.8±18.3
Cloud mean R_{drop}(µm)	5.7±1.5	5.3±1.3	4.6±1.1	6.4±1.7	5.4±1.7	5.1±1.3	4.7±1.1	6.2±2.1
LWP ($\mathrm{g\,m}^{-2}$)	122.3±46.7	146.1±48.0	168.1±54.7	74.9±44.4	84.1±23.8	111.2±20.6	139.3±29.0	48.5±17.9
Cloud mean $N_{ice}(\mathrm{L}^{-1})$	0.31±0.28	0.37±0.35	0.43±0.36	0.47±0.36	0.09±0.06	0.15±0.11	0.17±0.10	0.13±0.09
Cloud mean R_{ice} (µm)	15.4±2.1	15.9±2.6	17.7±3.4	14.9±2.1	17.8±2.9	18.1±3.4	18.4±3.5	17.2±2.9
IWP ($\mathrm{g\,m}^{-2}$)	12.2±15.5	18.4±28.1	34.5±35.4	17.9±20.3	3.5±3.1	8.6±9.9	10.9±10.6	5.9±3.9
Cloud optical depth	14.5±5.2	18.6±5.7	24.8±7.5	8.1±4.4	10.6±3.0	14.7±2.3	20.1±3.7	5.4±2.1
Net surface LW ($\mathrm{W\,m}^{-2}$)	-26.5±5.8	-26.3±4.6	-22.4±4.4	-26.7±7.8	-23.8±6.6	-23.5±4.4	-20.3±4.3	-24.6±6.2
Net surface SW ($\mathrm{W\,m}^{-2}$)	15.1±11.8	13.2±11.0	11.5±10.1	19.5±14.4	20.3±16.2	18.5±15.6	16.9±14.7	25.2±18.5

Table S2. Averaged cloud properties ±1 standard deviation throughout the simulated time period following the aerosol injection (hour 2-20) for all temperature sensitivity simulations over the open ocean. Note that for net surface SW radiation we only averaged over daytime (8.5 h in total).

	ocean_control+2K	*ocean_control-2K*	*ocean_1000CCN+2K*	*ocean_1000CCN-2K*	*ocean_10INP+2K*	*ocean_10INP-2K*
Cloud mean $N_{drop}(\mathrm{cm}^{-3})$	47.0±15.4	54.0±14.1	246.3±96.4	280.2±107.4	48.0±15.8	56.8±16.2
Cloud mean R_{drop}(µm)	6.6±1.7	6.2±1.5	4.8±1.2	4.0±1.0	6.5±1.7	5.4±1.2
LWP ($\mathrm{g\,m}^{-2}$)	92.5±63.9	71.7±27.7	221.1±80.7	97.6±38.9	77.9±50.6	24.0±21.8
Cloud mean $N_{ice}(\mathrm{L}^{-1})$	0.11±0.09	0.49±0.45	0.18±0.14	0.70±0.62	0.36±0.28	1.58±1.61
Cloud mean R_{ice} (µm)	16.5±2.1	15.7±2.5	17.6±3.6	15.7±2.6	14.8±2.1	12.8±2.5
IWP ($\mathrm{g\,m}^{-2}$)	4.4±3.6	24.4±28.8	10.5±8.8	34.6±36.2	11.5±7.7	31.2±43.3
Cloud optical depth	9.7±5.9	7.9±2.8	32.1±12.1	17.2±7.3	8.3±4.8	3.0±2.5
Net surface LW ($\mathrm{W\,m}^{-2}$)	-25.6±4.2	-25.5±5.7	-23.5±5.7	-27.1±8.6	-25.9±4.5	-56.6±22.7
Net surface SW ($\mathrm{W\,m}^{-2}$)	19.1±14.0	19.2±14.4	10.7±9.5	12.4±10.1	19.4±14.2	23.0±17.4

Table S3. Averaged cloud properties ±1 standard deviation throughout the simulated time period following the aerosol injection (hour 2-20) for all temperature sensitivity simulations over sea ice. Note that for net surface SW radiation we only averaged over daytime (8.5 h in total).

	ice_control+2K	*ice_control-2K*	*ice_1000CCN+2K*	*ice_1000CCN-2K*	*ice_10INP+2K*	*ice_10INP-2K*
Cloud mean $N_{drop}(\mathrm{cm}^{-3})$	49.7±18.3	54.9±12.2	191.5±97.0	254.6±53.8	52.8±12.9	35.2±14.6
Cloud mean R_{drop}(µm)	6.0±1.7	6.1±1.5	4.9±1.4	3.9±0.9	6.2±1.6	6.3±2.0
LWP ($\mathrm{g\,m}^{-2}$)	72.1±19.8	70.0±11.5	149.0±66.7	94.2±17.3	55.4±8.3	22.1±8.4
Cloud mean $N_{ice}(\mathrm{L}^{-1})$	0.07±0.05	0.19±0.13	0.08±0.04	0.24±0.18	0.24±0.16	0.43±0.45
Cloud mean R_{ice} (µm)	18.4±2.9	16.6±2.7	19.5±4.3	17.6± 3.1	16.5±2.9	14.2±2.0
IWP ($\mathrm{g\,m}^{-2}$)	3.3±2.6	7.4±7.5	6.0±5.8	13.9±13.8	12.0±10.6	9.4±11.8
Cloud optical depth	8.1±2.3	7.9±1.3	21.1±10.2	16.7±2.9	6.2±0.9	2.5±0.9
Net surface LW ($\mathrm{W\,m}^{-2}$)	-20.0±2.6	-20.8±2.7	-20.1±4.9	-22.8±3.5	-21.9±3.7	-44.1±16.7
Net surface SW ($\mathrm{W\,m}^{-2}$)	24.4±18.7	24.2±19.0	17.3±13.4	17.4±15.0	25.1±18.9	31.8±23.8