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Sensitivities of Amazonian clouds to aerosols and updraft speed

Micael A. Cecchini et al.

Correspondence to: Micael A. Cecchini (micael.cecchini@gmail.com)

DSD profiles for each flight

Figures S1-4 show the individual DSD profiles for each flight considered in this study. It clearly shows the cohesiveness of the aerosol effect on the vertical structure of the warm-phase. Altitudes shown are relative to cloud base.

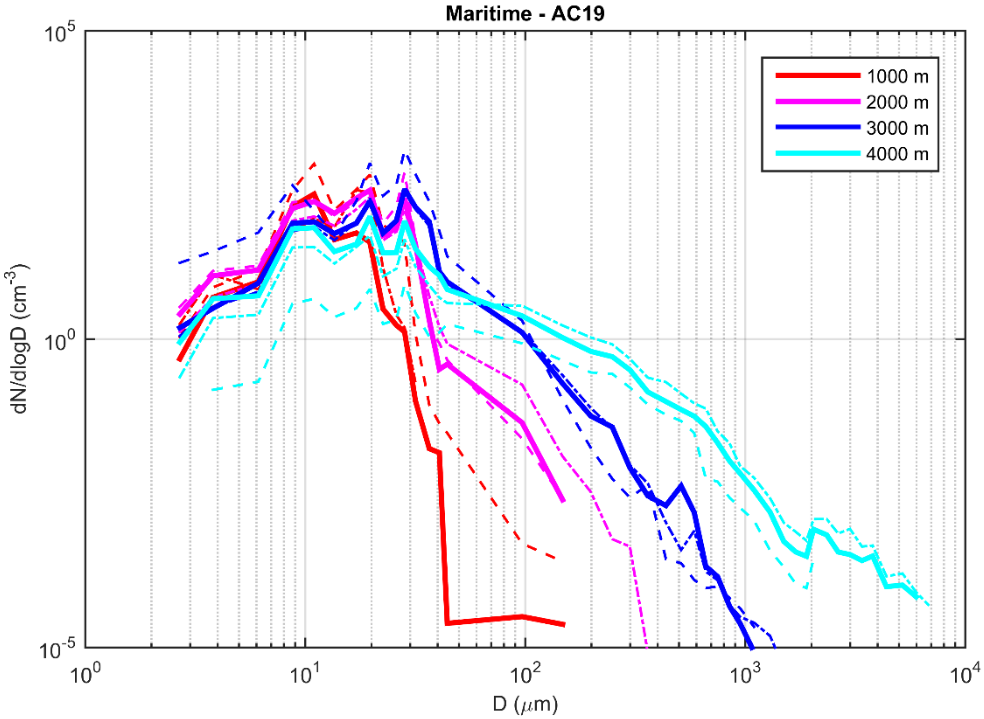

Figure S1. Droplet size distributions as function of altitude above cloud base, aerosol particle number concentration, and vertical wind speed, W, for flight AC19. Four 1000-m-thick layers are considered in the vertical, where the legends in the graphs show the respective upper limit of each one. Solid lines represent averaged DSDs for -1 m $s^{-1} \leq W \leq 1$ m s^{-1}, i.e., for relatively neutral vertical movements. Dashed lines represent averaged DSDs for the updraft regions where $W > 1$ m s^{-1}, and dot-dashed lines represent the downdrafts ($W < -1$ m s^{-1}).

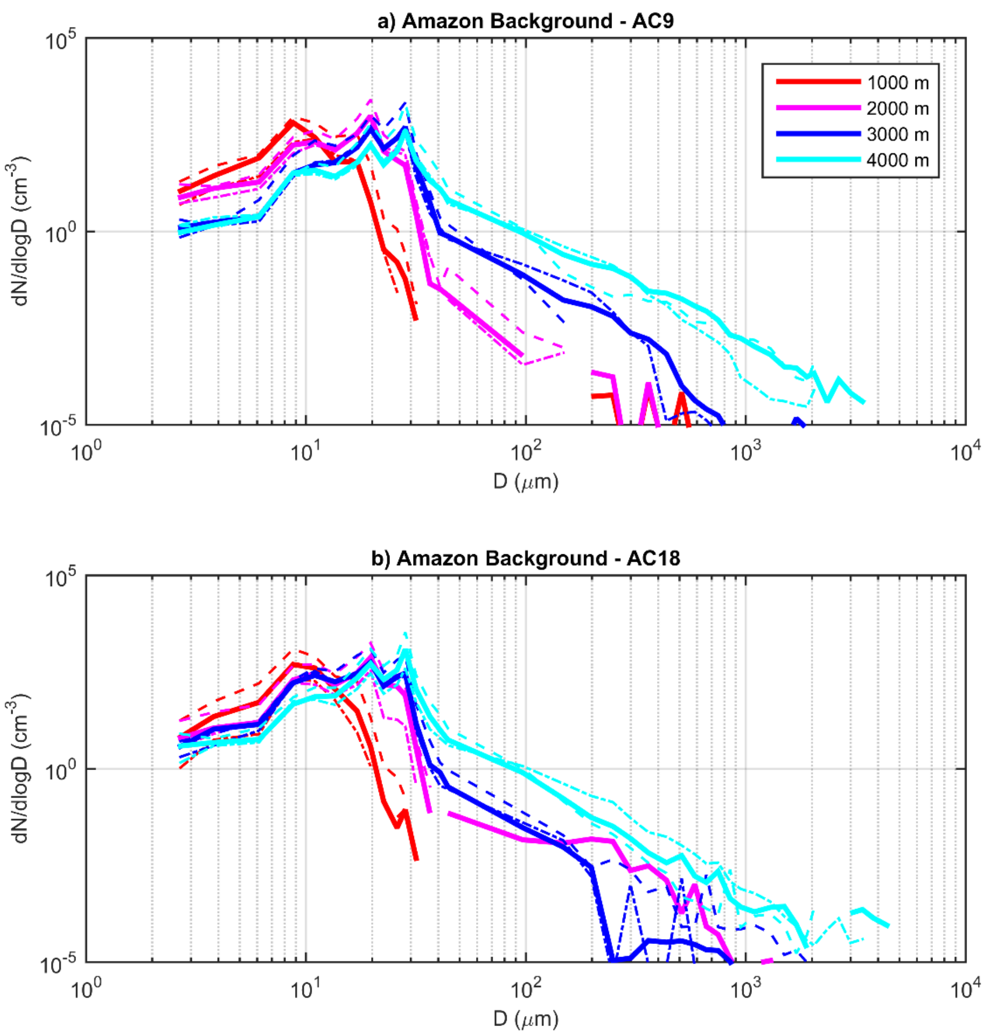

Figure S2. Droplet size distributions as function of altitude above cloud base, aerosol particle number concentration, and vertical wind speed, *W*, for flights a) AC9 and b) AC18. Four 1000-m-thick layers are considered in the vertical, where the legends in the graphs show the respective upper limit of each one. Solid lines represent averaged DSDs for -1 m $s^{-1} \leq W \leq 1$ m s^{-1}, i.e., for relatively neutral vertical movements. Dashed lines represent averaged DSDs for the updraft regions where $W > 1$ m s^{-1}, and dot-dashed lines represent the downdrafts ($W < -1$ m s^{-1}).

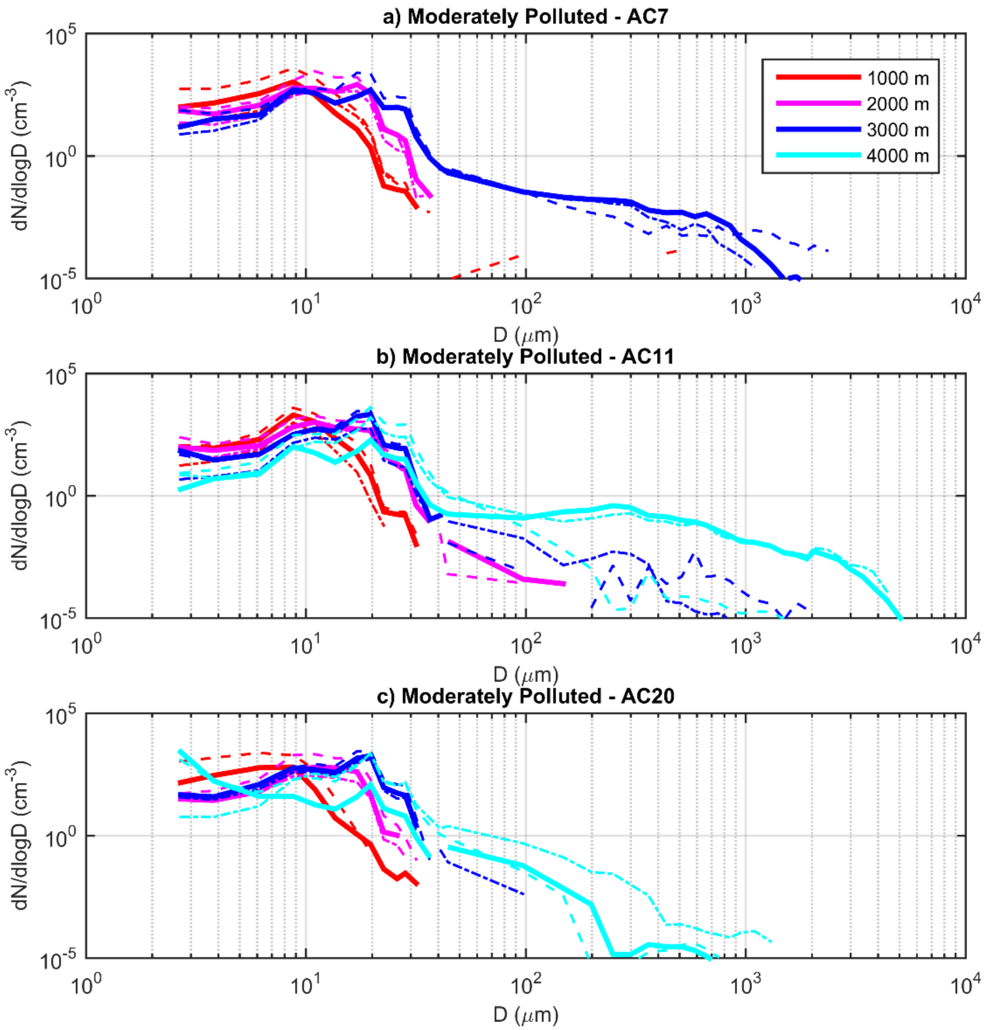

Figure S3. Droplet size distributions as function of altitude above cloud base, aerosol particle number concentration, and vertical wind speed, *W*, for flights a) AC7, b) AC11, and c) AC20. Four 1000-m-thick layers are considered in the vertical, where the legends in the graphs show the respective upper limit of each one. Solid lines represent averaged DSDs for -1 m $s^{-1} \leq W \leq 1$ m s^{-1}, i.e., for relatively neutral vertical movements. Dashed lines represent averaged DSDs for the updraft regions where $W > 1$ m s^{-1}, and dot-dashed lines represent the downdrafts ($W <$ -1 m s^{-1}).

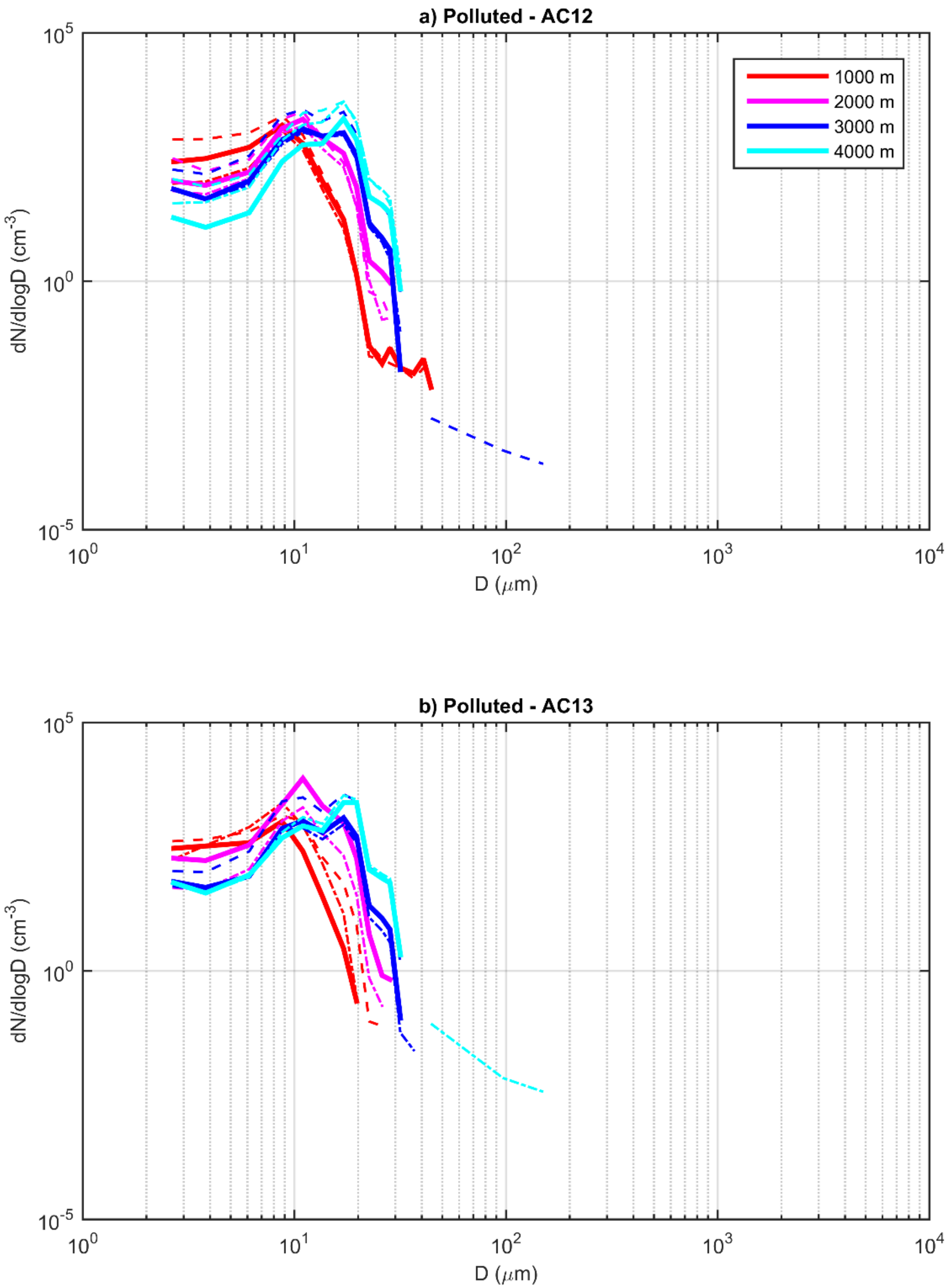

Figure S4. Droplet size distributions as function of altitude above cloud base, aerosol particle number concentration, and vertical wind speed, *W*, for flights a) AC12 and b) AC13. Four 1000-m-thick layers are considered in the vertical, where the legends in the graphs show the respective upper limit of each one. Solid lines represent averaged DSDs for -1 m s^{-1} ≤ W ≤ 1 m s^{-1}, i.e., for relatively neutral vertical movements. Dashed lines represent averaged DSDs for the updraft regions where W > 1 m s^{-1}, and dot-dashed lines represent the downdrafts (W < -1 m s^{-1}).

Sensitivities for individual intervals

By fixing two dimensions in the 3D matrices and varying the third, we can obtain individual sensitivities in the form of the Equation 1 in the manuscript. As an example, we can fix both *w* and *H* and obtain the sensitivities of DSD parameters to varying N_a. By using the natural logarithm scale and applying a linear fit, we obtain the sensitivity as the angular coefficient and the R^2 parameter is a measure of the significance of the relation. By calculating every possible combination, we obtain Tables S1-15 shown below. The amount of 1 Hz data for each sensitivity are shown in Tables S16-18.

w (m s^{-1}) \ *H* (m)	**200**	**500**	**950**	**1625**	**2637.5**	**4156.25**
0.5	-0.11 R^2 = 0.85	-0.27 R^2 = 0.96	-0.25 R^2 = 0.99	-0.23 R^2 = 0.94	-0.38 R^2 = 0.97	-0.47 R^2 = 0.71
1	-0.13 R^2 = 0.84	-0.26 R^2 = 0.93	-0.30 R^2 = 0.99	-0.18 R^2 = 0.86	-0.25 R^2 = 1.00	-0.26 R^2 = 0.96
2	-0.16 R^2 = 0.79	-0.26 R^2 = 0.98	-0.28 R^2 = 0.91	-0.17 R^2 = 0.64	-0.31 R^2 = 0.98	-0.16 R^2 = 0.53
4	-0.18 R^2 = 0.82	-0.28 R^2 = 0.95	-0.25 R^2 = 0.96	-0.25 R^2 = 0.95	-0.31 R^2 = 0.95	-0.28 R^2 = 0.99
8	-	-	-	-	-0.26 R^2 = 0.80	-0.33 R^2 = 0.98

Table S1. sensitivities of D_{eff} to N_a - $S_{D_{eff}}(N_a) = \left.\frac{\partial lnD_{eff}}{\partial lnN_a}\right|_{w,H}$. Intervals upper limits are highlighted in bold letters.

N_a (cm^{-3}) \ *H* (m)	**200**	**500**	**950**	**1625**	**2637.5**	**4156.25**
500	0.020 R^2 = 0.63	0.049 R^2 = 0.61	0.048 R^2 = 0.90	-0.018 R^2 = 0.034	0.032 R^2 = 0.77	-
1000	0.018 R^2 = 0.17	0.031 R^2 = 0.57	0.0072 R^2 = 0.029	0.046 R^2 = 0.71	0.0032 R^2 = 0.0040	0.0034 R^2 = 0.0010
3000	0.031 R^2 = 0.90	0.044 R^2 = 0.69	-	-0.011 R^2 = 0.055	0.13 R^2 = 0.93	0.18 R^2 = 0.72
4500	-0.085 R^2 = 0.97	0.013 R^2 = 0.57	0.046 R^2 = 0.62	-0.0063 R^2 = 0.23	0.021 R^2 = 0.44	0.024 R^2 = 0.48

Table S2. sensitivities of D_{eff} to *w* - $\boldsymbol{S_{D_{eff}}(w)} = \left.\frac{\partial \boldsymbol{lnD_{eff}}}{\partial \boldsymbol{lnw}}\right|_{\boldsymbol{N_a,H}}$. Intervals upper limits are highlighted in bold letters.

N_a (cm^{-3}) \ w (m s^{-1})	**0.5**	**1**	**2**	**4**	**8**
500	0.33 R^2 = 0.98	0.27 R^2 = 0.92	0.31 R^2 = 0.85	0.32 R^2 = 0.92	-
1000	0.35 R^2 = 0.98	0.32 R^2 = 0.99	0.30 R^2 = 0.95	0.32 R^2 =1.00	0.41 R^2 = 0.94
3000	0.14 R^2 = 0.62	0.23 R^2 = 0.90	0.28 R^2 = 0.96	0.26 R^2 = 0.97	0.27 R^2 = 0.96
4500	0.19 R^2 = 0.95	0.24 R^2 = 0.98	0.24 R^2 = 0.99	0.26 R^2 = 0.97	-

Table S3. sensitivities of D_{eff} to H - $\boldsymbol{S_{D_{eff}}(H)} = \left.\frac{\partial ln D_{eff}}{\partial ln H}\right|_{N_a,w}$. Intervals upper limits are highlighted in bold letters.

w (m s^{-1}) \ H (m)	**200**	**500**	**950**	**1625**	**2637.5**	**4156.25**
0.5	0.69 R^2 = 0.97	0.75 R^2 = 0.82	1.23 R^2 = 0.89	0.64 R^2 = 0.86	-0.069 R^2 = 0.011	1.24 R^2 = 0.83
1	0.67 R^2 = 0.90	0.79 R^2 = 0.87	0.90 R^2 = 1.00	0.87 R^2 = 0.88	0.70 R^2 = 1.00	1.11 R^2 = 0.95
2	0.72 R^2 = 0.84	0.89 R^2 = 0.98	1.049 R^2 = 0.94	0.87 R^2 = 0.92	0.90 R^2 = 0.92	1.40 R^2 = 0.96
4	0.54 R^2 = 0.62	0.85 R^2 = 0.95	0.79 R^2 = 0.99	0.49 R^2 = 0.37	0.72 R^2 = 0.92	1.22 R^2 = 0.98
8	-	-	-	-	0.94 R^2 = 1.00	0.83 R^2 = 0.98

Table S4. sensitivities of N_d to N_a - $\boldsymbol{S_{N_d}(N_a)} = \left.\frac{\partial ln N_d}{\partial ln N_a}\right|_{w,H}$. Intervals upper limits are highlighted in bold letters.

N_a (cm^{-3}) \ H (m)	**200**	**500**	**950**	**1625**	**2637.5**	**4156.25**
500	0.57 R^2 = 1.00	0.46 R^2 = 0.89	0.86 R^2 = 0.97	-0.12 R^2 = 0.070	0.40 R^2 = 0.76	-
1000	0.45 R^2 = 0.91	0.44 R^2 = 0.99	0.34 R^2 = 0.47	0.32 R^2 = 0.89	0.29 R^2 = 0.91	0.64 R^2 = 0.89
3000	0.61 R^2 = 0.94	0.85 R^2 = 0.96	-	0.37 R^2 = 0.82	0.39 R^2 = 0.95	0.65 R^2 = 0.92
4500	0.24 R^2 = 0.91	0.30 R^2 = 0.89	0.41 R^2 = 0.67	-0.37 R^2 = 0.46	1.034 R^2 = 0.70	0.38 R^2 = 0.90

Table S5. sensitivities of N_d to w - $\boldsymbol{S_{N_d}(w)} = \left.\frac{\partial ln N_d}{\partial ln w}\right|_{N_a,H}$. Intervals upper limits are highlighted in bold letters.

N_a (cm^{-3}) \ w (m s^{-1})	**0.5**	**1**	**2**	**4**	**8**
500	0.20 R^2 = 0.11	-0.29 R^2 = 0.97	-0.084 R^2 = 0.20	-0.094 R^2 = 0.080	-
1000	-0.24 R^2 = 0.36	-0.21 R^2 = 0.24	-0.22 R^2 = 0.21	-0.26 R^2 = 0.54	-0.15 R^2 = 0.64
3000	-0.11 R^2 = 0.97	-0.14 R^2 = 0.26	-0.22 R^2 = 0.94	-0.32 R^2 = 0.89	-0.26 R^2 = 0.85
4500	-0.26 R^2 = 0.094	0.068 R^2 = 0.14	0.075 R^2 = 0.056	0.081 R^2 = 0.022	-

Table S6. sensitivities of N_d to H - $\boldsymbol{S_{N_d}(H)} = \left.\frac{\partial ln N_d}{\partial ln H}\right|_{N_a,w}$. Intervals upper limits are highlighted in bold letters.

w (m s^{-1}) \ H (m)	**200**	**500**	**950**	**1625**	**2637.5**	**4156.25**
0.5	0.30 R^2 = 0.97	-0.11 R^2 = 0.070	0.48 R^2 = 0.66	-0.022 R^2 = 0.013	-1.11 R^2 = 0.82	0.058 R^2 = 0.0052
1	0.24 R^2 = 0.40	-0.030 R^2 = 0.0072	0.055 R^2 = 0.42	0.43 R^2 = 0.50	0.024 R^2 = 0.12	0.62 R^2 = 0.90
2	0.22 R^2 = 0.26	0.021 R^2 = 0.019	0.23 R^2 = 0.21	0.41 R^2 = 0.34	-0.043 R^2 = 0.097	0.60 R^2 = 0.41
4	0.032 R^2 = 0.0033	-0.025 R^2 = 0.0067	0.015 R^2 = 0.054	-0.42 R^2 = 0.25	-0.12 R^2 = 0.29	0.20 R^2 = 0.98
8	-	-	-	-	0.15 R^2 = 0.17	-0.20 R^2 = 0.90

Table S7. sensitivities of *LWC* to N_a - $\boldsymbol{S_{LWC}(N_a)} = \left.\frac{\partial lnLWC}{\partial lnN_a}\right|_{w,H}$. Intervals upper limits are highlighted in bold letters.

N_a (cm^{-3}) \ H (m)	**200**	**500**	**950**	**1625**	**2637.5**	**4156.25**
500	0.62 R^2 = 1.00	0.60 R^2 = 0.85	1.024 R^2 = 0.98	0.060 R^2 = 0.0047	0.34 R^2 = 0.91	-
1000	0.50 R^2 = 0.87	0.42 R^2 = 0.90	0.37 R^2 = 0.43	0.42 R^2 = 0.88	0.31 R^2 = 0.85	0.69 R^2 = 0.75
3000	0.70 R^2 = 0.97	0.94 R^2 = 0.94	-	0.33 R^2 = 0.72	0.70 R^2 = 0.96	0.89 R^2 = 0.87
4500	0.10 R^2 = 0.44	0.33 R^2 = 0.84	0.53 R^2 = 0.70	-0.47 R^2 = 0.64	1.00 R^2 = 0.66	0.42 R^2 = 0.81

Table S8. sensitivities of *LWC* to w - $\boldsymbol{S_{LWC}(w)} = \left.\frac{\partial lnLWC}{\partial lnw}\right|_{N_a,H}$. Intervals upper limits are highlighted in bold letters.

N_a (cm^{-3}) \ w (m s^{-1})	**0.5**	**1**	**2**	**4**	**8**
500	1.14 $R^2 = 0.83$	0.27 $R^2 = 0.45$	0.74 $R^2 = 0.62$	0.80 $R^2 = 0.84$	-
1000	0.73 $R^2 = 0.92$	0.69 $R^2 = 0.90$	0.65 $R^2 = 0.65$	0.71 $R^2 = 0.92$	1.062 $R^2 = 0.79$
3000	0.51 $R^2 = 0.61$	0.58 $R^2 = 0.76$	0.64 $R^2 = 0.95$	0.48 $R^2 = 0.92$	0.52 $R^2 = 0.86$
4500	0.36 $R^2 = 0.16$	0.77 $R^2 = 0.98$	0.70 $R^2 = 0.83$	0.76 $R^2 = 0.62$	-

Table S9. sensitivities of *LWC* to *H* - $\boldsymbol{S_{LWC}(H) = \left.\frac{\partial lnLWC}{\partial lnH}\right|_{N_a,w}}$. Intervals upper limits are highlighted in bold letters.

w (m s^{-1}) \ H (m)	**200**	**500**	**950**	**1625**	**2637.5**	**4156.25**
0.5	-0.25 $R^2 = 0.50$	0.20 $R^2 = 0.50$	0.51 $R^2 = 0.70$	0.43 $R^2 = 0.74$	0.53 $R^2 = 0.87$	0.54 $R^2 = 0.40$
1	-0.33 $R^2 = 0.76$	0.12 $R^2 = 0.17$	0.62 $R^2 = 0.87$	0.37 $R^2 = 0.87$	0.37 $R^2 = 62$	0.74 $R^2 = 0.86$
2	-0.42 $R^2 = 0.93$	0.11 $R^2 = 0.28$	0.40 $R^2 = 0.91$	0.40 $R^2 = 0.66$	0.51 $R^2 = 0.86$	0.069 $R^2 = 0.13$
4	-0.54 $R^2 = 0.97$	-0.15 $R^2 = 0.39$	0.062 $R^2 = 0.20$	0.29 $R^2 = 0.36$	0.56 $R^2 = 0.88$	0.14 $R^2 = 0.18$
8	-	-	-	-	0.52 $R^2 = 0.99$	0.090 $R^2 = 0.93$

Table S10. sensitivities of *Λ* to N_a - $\boldsymbol{S_{\Lambda}(N_a) = \left.\frac{\partial ln\Lambda}{\partial lnN_a}\right|_{w,H}}$. Intervals upper limits are highlighted in bold letters.

N_a (cm^{-3}) \ H (m)	**200**	**500**	**950**	**1625**	**2637.5**	**4156.25**
500	0.35 R^2 =0.98	0.35 R^2 = 0.65	0.41 R^2 = 0.66	0.049 R^2 = 0.14	-0.090 R^2 = 0.98	-
1000	0.061 R^2 = 0.24	0.0043 R^2 = 0.0037	-0.062 R^2 = 0.11	0.19 R^2 = 0.67	-0.11 R^2 = 0.75	0.24 R^2 = 0.82
3000	-0.062 R^2 = 0.31	0.13 R^2 = 0.55	-	0.015 R^2 = 0.045	-0.14 R^2 = 0.83	-0.15 R^2 = 0.42
4500	-0.0064 R^2 = 0.13	-0.11 R^2 = 0.91	-0.097 R^2 = 0.82	-0.18 R^2 = 0.23	0.0068 R^2 = 0.0089	0.049 R^2 = 0.56

Table S11. sensitivities of Λ to w - $\boldsymbol{S_\Lambda(w)} = \left.\frac{\partial ln\Lambda}{\partial ln w}\right|_{N_a,H}$. Intervals upper limits are highlighted in bold letters.

N_a (cm^{-3}) \ w (m s^{-1})	**0.5**	**1**	**2**	**4**	**8**
500	-0.75 R^2 = 0.96	-0.84 R^2 = 0.94	-0.94 R^2 = 0.98	-1.11 R^2 = 0.97	-
1000	-0.61 R^2 = 0.98	-0.63 R^2 = 0.96	-0.47 R^2 = 0.87	-0.54 R^2 = 0.86	-0.25 R^2 = 0.073
3000	-0.10 R^2 = 0.088	-0.17 R^2 = 0.48	-0.25 R^2 = 0.54	-0.21 R^2 = 0.34	-0.26 R^2 = 0.38
4500	-0.17 R^2 = 0.47	-0.15 R^2 = 0.43	-0.15 R^2 = 0.50	-0.14 R^2 = 0.62	-

Table S12. sensitivities of Λ to H - $\boldsymbol{S_\Lambda(H)} = \left.\frac{\partial ln\Lambda}{\partial ln H}\right|_{N_a,w}$. Intervals upper limits are highlighted in bold letters.

w (m s^{-1}) \ H (m)	**200**	**500**	**950**	**1625**	**2637.5**	**4156.25**
0.5	0.17 R^2 = 0.81	0.013 R^2 = 0.014	-0.17 R^2 = 0.45	-0.12 R^2 = 0.66	-0.097 R^2 = 0.56	-0.097 R^2 = 0.36
1	0.21 R^2 = 0.93	0.066 R^2 = 0.21	-0.19 R^2 = 0.75	-0.11 R^2 = 0.80	-0.080 R^2 = 38	-0.24 R^2 = 0.77
2	0.30 R^2 = 0.95	0.027 R^2 = 0.068	-0.12 R^2 = 0.98	-0.14 R^2 = 0.50	-0.14 R^2 = 0.72	0.036 R^2 = 0.090
4	0.44 R^2 = 1.00	0.091 R^2 = 0.24	0.0092 R^2 = 0.018	-0.072 R^2 = 0.12	-0.17 R^2 = 0.70	0.0031 R^2 = 0.0012
8	-	-	-	-	-0.18 R^2 = 0.94	0.16 R^2 = 0.95

Table S13. sensitivities of ε to N_a - $\boldsymbol{S_\varepsilon(N_a) = \frac{\partial ln\varepsilon}{\partial lnN_a}\Big|_{w,H}}$. Intervals upper limits are highlighted in bold letters.

N_a (cm^{-3}) \ H (m)	**200**	**500**	**950**	**1625**	**2637.5**	**4156.25**
500	-0.29 R^2 =0.95	-0.11 R^2 = 0.60	-0.19 R^2 = 0.80	0.015 R^2 = 0.057	0.063 R^2 = 1.00	-
1000	-0.080 R^2 = 0.41	-0.016 R^2 = 0.71	0.076 R^2 = 0.34	-0.12 R^2 = 0.78	0.049 R^2 = 0.53	-0.14 R^2 = 0.86
3000	0.037 R^2 = 0.31	-0.17 R^2 = 0.76	-	0.00013 R^2 = 0.000024	0.0024 R^2 = 0.0019	-0.035 R^2 = 0.22
4500	0.027 R^2 = 0.51	0.037 R^2 = 0.61	0.024 R^2 = 0.53	0.018 R^2 = 0.30	-0.025 R^2 = 0.27	-0.023 R^2 = 0.28

Table S14. sensitivities of ε to w - $\boldsymbol{S_\varepsilon(w) = \frac{\partial ln\varepsilon}{\partial lnw}\Big|_{N_a,H}}$. Intervals upper limits are highlighted in bold letters.

N_a (cm^{-3}) \ w (m s^{-1})	**0.5**	**1**	**2**	**4**	**8**
500	0.22 R^2 = 0.85	0.30 R^2 = 0.73	0.36 R^2 = 0.94	0.48 R^2 = 0.99	-
1000	0.15 R^2 = 0.79	0.16 R^2 = 0.82	0.094 R^2 = 0.63	0.16 R^2 = 0.74	-0.16 R^2 = 0.084
3000	0.0066 R^2 = 0.0045	0.0093 R^2 = 0.030	0.017 R^2 = 0.046	0.028 R^2 = 0.032	0.010 R^2 = 0.0024
4500	-0.022 R^2 = 0.062	-0.037 R^2 = 0.20	-0.036 R^2 = 0.17	-0.046 R^2 = 0.29	-

Table S15. sensitivities of ε to H - $\boldsymbol{S_{\varepsilon}(H)} = \left.\frac{\partial ln\varepsilon}{\partial lnH}\right|_{N_a,w}$. Intervals upper limits are highlighted in bold letters.

w (m s^{-1}) \ H (m)	**200**	**500**	**950**	**1625**	**2637.5**	**4156.25**
0.5	289	89	21	32	36	45
1	247	82	20	24	22	45
2	223	87	26	34	28	49
4	111	47	30	37	29	38
8	0	0	0	0	18	27

Table S16. number of 1 Hz DSD data for the sensitivities to N_a.

N_a (cm^{-3}) \ H (m)	**200**	**500**	**950**	**1625**	**2637.5**	**4156.25**
500	259	84	28	27	11	0
1000	234	84	38	40	56	81
3000	265	91	0	61	43	75
4500	125	55	25	16	23	44

Table S17. number of 1 Hz DSD data for the sensitivities to w.

N_a (cm^{-3}) \ w (m s^{-1})	**0.5**	**1**	**2**	**4**	**8**
500	169	119	90	35	0
1000	137	136	146	94	20
3000	142	100	138	110	51
4500	64	85	73	53	0

Table S18. number of 1 Hz DSD data for the sensitivities to H.