Supplementary Information

Assessment of NAAPS-RA performance in Maritime Southeast Asia during CAMP^{2}Ex

Eva-Lou Edwards[1], Jeffrey S. Reid[2], Peng Xian[2], Sharon P. Burton[3], Anthony L. Cook[3], Ewan C. Crosbie[3,4], Marta A. Fenn[3,4], Richard A. Ferrare[3], Sean W. Freeman[5], John W. Hair[3], David B. Harper[3], Chris A. Hostetler[3], Claire E. Robinson[3,4], Amy Jo Scarino[3,4], Michael A. Shook[3], G. Alexander Sokolowsky[5], Susan C. van den Heever[5], Edward L. Winstead[3,4], Sarah Woods[6], Luke D. Ziemba[3], Armin Sorooshian[1,7]

[1]Department of Chemical and Environmental Engineering, University of Arizona, Tucson, AZ, 85721, USA
[2]Marine Meteorology Division, Naval Research Laboratory, Monterey, CA, 93943, USA
[3]NASA Langley Research Center, Hampton, VA, 23681, USA
[4]Science Systems and Applications, Inc., Hampton, VA, 23666, USA
[5]Department of Atmospheric Science, Colorado State University, Fort Collins, CO, 80523, USA
[6]SPEC Inc., Boulder, CO, 80301, USA
[7]Department of Hydrology and Atmospheric Sciences, University of Arizona, Tucson, AZ, 85721, USA

[*]Corresponding author: armin@arizona.edu

Contents of this file

Table S1-S8, Figures S1–S16

Table S1. Dates for each research flight (RF) based on UTC time at takeoff.

RF	Date
1	24 August 2019
2	27 August 2019
3	29 August 2019
4	30 August 2019
5	4 September 2019
6	6 September 2019
7	8 September 2019
8	13 September 2019
9	15 September 2019
10	16 September 2019
11	19 September 2019
12	21 September 2019
13	23 September 2019
14	25 September 2019
15	27 September 2019
16	29 September 2019
17	1 October 2019
18	3 October 2019
19	5 October 2019

Table S2. Summary statistics (means [standard deviations in parentheses], biases, and number of points [N]) for mixed layer heights (MLH) determined from the methods described in Section 2.5. Biases represent the deviation from the mean MLH for a given flight.

		Dropsonde							HSRL-2		
	All methods combined	Pinching of temperature and dew point temperature		Potential temperal inversion		Abrupt decrease in water vapor mixing ratio			MLH product		
RF	Mean (m)	Mean (m)	Bias (m)	Mean (m)	Bias (m)	Mean (m)	Bias (m)	N	Mean (m)	Bias (m)	N
1	559.89 (153.35)	594.43 (155.97)	34.55	728.36 (384.41)	157.24	567.93 (162.38)	8.05	15	543.77 (111.26)	-16.12	186
2	617.31 (114.54)	677.47 (217.53)	60.15	627.55 (234.19)	10.23	628.45 (240.95)	11.14	11	615.46 (103.02)	-1.85	485
3	622.84 (199.03)	549.18 (163.58)	-73.66	439.75 (40.08)	-162.74	548.11 (287.48)	-74.73	9	629.20 (197.64)	6.36	440
4	520.17 (220.51)	541.88 (119.28)	21.71	562.33 (154.05)	42.17	546.78 (157.14)	26.61	9	519.01 (223.01)	-1.15	706
5	502.41 (255.70)	484.98 (216.84)	-17.42	490.60 (216.75)	-11.81	465.80 (202.10)	-36.61	5	502.74 (256.55)	0.33	985
6	610.03 (118.34)	601.43 (60.36)	-8.60	555.63 (69.60)	-48.36	559.67 (105.57)	-50.36	9	611.89 (119.66)	1.86	518
7	511.57 (307.64)	545.45 (470.17)	33.88	395.00 (158.41)	-93.25	437.00 (192.90)	-74.57	10	513.37 (307.58)	1.81	742
8	556.41 (217.80)	396.05 (172.93)	-160.36	395.71 (172.76)	-160.69	371.43 (152.27)	-184.98	7	560.08 (217.53)	3.67	965
9	632.87 (124.56)	513.83 (161.41)	-119.04	462.45 (161.32)	-170.42	454.55 (161.46)	-178.33	11	637.81 (120.17)	4.94	1042
10	583.07 (145.44)	502.41 (216.63)	-80.65	502.88 (235.94)	-75.47	506.69 (233.82)	-71.89	17	593.43 (128.65)	10.36	374
11	590.82 (200.31)	679.07 (226.22)	88.25	592.40 (110.08)	1.58	592.40 (110.08)	1.58	5	589.08 (202.78)	-1.74	262
12	652.29 (137.59)	583.57 (97.86)	-68.72	502.73 (92.48)	-149.56	561.82 (199.26)	-90.47	11	654.84 (136.63)	2.55	1332
13	659.99 (119.77)	633.31 (251.14)	-26.68	577.18 (62.39)	-60.73	561.46 (69.43)	-85.39	15	662.46 (117.20)	2.47	1049
14	684.10 (178.46)	502.13 (183.87)	-181.97	478.29 (184.74)	-205.82	502.00 (183.66)	-182.10	7	691.20 (174.78)	7.10	562
15	501.64 (170.45)	359.45 (104.90)	-142.19	368.86 (109.31)	-116.19	372.63 (101.92)	-129.02	8	504.54 (170.50)	2.90	1069
16	485.28 (113.26)	404.54 (132.10)	-80.74	426.33 (132.50)	-52.01	401.65 (129.95)	-83.63	17	491.21 (109.85)	5.93	620
17	531.80 (124.45)	429.30 (121.45)	-102.50	436.09 (118.49)	-95.71	429.82 (119.50)	-101.98	11	534.80 (123.50)	3.00	1102
18	561.78 (203.95)	353.07 (223.69)	-208.71	308.86 (147.70)	-252.92	344.14 (215.10)	-217.64	7	572.84 (198.32)	11.06	430
19	578.07 (141.63)	567.43 (114.69)	-10.64	556.11 (115.98)	-21.95	567.22 (114.71)	-10.84	9	578.75 (136.55)	0.69	569

Table S3. Summary statistics (means [standard deviations in parentheses], biases, root mean squared errors [RMSEs], coefficients of determination [R^2], and number of points [N]) for NAAPS-RA/HSRL-2 AOT comparisons for each flight.

	HSRL-2	NAAPS-RA with NAAPS-RA RH					NAAPS-RA with dropsonde RH				
RF	**Mean**	**Mean**	**Bias**	**RMSE**	**R^2**	**N**	**Mean**	**Bias**	**RMSE**	**R^2**	**N**
1[a]	0.07 (0.01)	0.17 (0.02)	0.10	0.11	1.00	2	0.22 (0.03)	0.15	0.15	1.00	2
2	0.11 (0.04)	0.09 (0.01)	-0.03	0.04	0.76	11	0.11 (0.02)	-0.01	0.02	0.88	11
3	0.10 (0.03)	0.14 (0.02)	0.04	0.05	0.08	9	0.17 (0.03)	0.07	0.07	0.44	7
4	0.09 (0.02)	0.12 (0.01)	0.02	0.03	0.04	9	0.13 (0.02)	0.04	0.05	0.17	9
5	0.15 (0.05)	0.15 (0.02)	0.01	0.04	0.31	5	0.16 (0.02)	0.01	0.03	0.47	5
6	0.29 (0.10)	0.30 (0.09)	0.02	0.05	0.70	9	0.35 (0.10)	0.07	0.10	0.40	9
7	0.12 (0.06)	0.22 (0.02)	0.10	0.12	0.18	10	0.24 (0.02)	0.12	0.14	0.01	10
8	0.20 (0.13)	0.07 (0.01)	-0.13	0.18	0.07	7	0.07 (0.02)	-0.13	0.17	0.13	7
9	0.91 (0.24)	0.89 (0.17)	-0.02	0.24	0.08	11	0.93 (0.16)	0.02	0.25	0.06	11
10	0.34 (0.20)	0.60 (0.12)	0.26	0.33	0.04	17	0.62 (0.14)	0.28	0.36	0.01	17
11	0.17 (0.08)	0.17 (0.03)	0.00	0.06	0.17	4	0.20 (0.04)	0.03	0.07	0.08	4
12	0.22 (0.05)	0.17 (0.03)	-0.04	0.06	0.22	11	0.21 (0.05)	-0.01	0.05	0.31	11
13	0.21 (0.04)	0.13 (0.02)	-0.08	0.09	0.48	13	0.17 (0.04)	-0.04	0.05	0.42	13
14	0.15 (0.05)	0.10 (0.01)	-0.05	0.07	0.43	7	0.14 (0.03)	-0.01	0.03	0.77	7
15	0.05 (0.02)	0.06 (0.01)	0.02	0.02	0.52	8	0.07 (0.02)	0.03	0.03	0.30	8
16	0.09 (0.02)	0.08 (0.01)	-0.01	0.03	0.01	17	0.09 (0.01)	0.01	0.02	0.08	17
17	0.20 (0.10)	0.17 (0.04)	-0.03	0.09	0.23	11	0.22 (0.05)	0.02	0.08	0.35	11
18	0.17 (0.10)	0.07 (0.01)	-0.10	0.15	0.82	7	0.08 (0.01)	-0.09	0.14	0.33	7
19	0.03 (0.01)	0.02 (0.00)	-0.01	0.02	0.89	9	0.03 (0.01)	0.00	0.02	0.83	9

[a]RF1 not discussed in study because of low number of points.

Table S4. Same as Table S3, except for AOT_{ML} comparisons for each flight.

	HSRL-2	NAAPS-RA with NAAPS-RA RH					NAAPS-RA with dropsonde RH				
RF	**Mean**	**Mean**	**Bias**	**RMSE**	**R^2**	**N**	**Mean**	**Bias**	**RMSE**	**R^2**	**N**
1[a]	0.02 (0.00)	0.04 (0.00)	0.02	0.02	1.00	2	0.04 (0.01)	0.02	0.02	1.00	2
2	0.04 (0.01)	0.03 (0.00)	-0.01	0.01	0.57	11	0.04 (0.00)	0.00	0.01	0.67	11
3	0.04 (0.01)	0.05 (0.00)	0.02	0.02	0.38	9	0.06 (0.01)	0.02	0.03	0.50	9
4	0.03 (0.01)	0.03 (0.00)	0.00	0.01	0.14	9	0.04 (0.01)	0.01	0.01	0.00	9
5	0.04 (0.02)	0.04 (0.01)	0.00	0.01	0.20	5	0.05 (0.01)	0.01	0.01	0.85	5
6	0.11 (0.04)	0.11 (0.04)	0.00	0.03	0.34	9	0.12 (0.03)	0.02	0.04	0.12	9
7	0.05 (0.03)	0.06 (0.01)	0.02	0.03	0.16	10	0.07 (0.02)	0.02	0.03	0.18	10
8	0.06 (0.05)	0.03 (0.00)	-0.04	0.06	0.33	7	0.03 (0.01)	-0.04	0.06	0.17	7
9	0.33 (0.07)	0.30 (0.04)	-0.03	0.05	0.74	11	0.31 (0.03)	-0.02	0.06	0.42	11
10	0.14 (0.07)	0.17 (0.03)	0.04	0.06	0.31	17	0.17 (0.03)	0.04	0.07	0.15	17
11	0.05 (0.03)	0.05 (0.01)	-0.01	0.02	0.22	4	0.05 (0.01)	0.00	0.02	0.35	4
12	0.08 (0.02)	0.07 (0.02)	-0.01	0.03	0.09	11	0.07 (0.01)	-0.01	0.02	0.01	11
13	0.08 (0.01)	0.05 (0.01)	-0.02	0.03	0.29	13	0.06 (0.01)	-0.01	0.02	0.13	13
14	0.05 (0.01)	0.05 (0.01)	-0.01	0.01	0.17	7	0.05 (0.01)	0.00	0.01	0.25	7
15	0.01 (0.01)	0.02 (0.00)	0.00	0.00	0.49	8	0.02 (0.00)	0.01	0.01	0.45	8
16	0.03 (0.01)	0.02 (0.00)	0.00	0.01	0.16	17	0.03 (0.00)	0.00	0.01	0.00	17
17	0.06 (0.02)	0.07 (0.02)	0.02	0.03	0.16	11	0.09 (0.03)	0.04	0.04	0.34	11
18	0.06 (0.05)	0.02 (0.00)	-0.04	0.06	0.00	7	0.02 (0.00)	-0.04	0.06	0.12	7
19	0.01 (0.00)	0.01 (0.00)	0.00	0.00	0.11	9	0.01 (0.00)	0.00	0.00	0.55	9

[a]RF1 not discussed in study because of low number of points.

Table S5. Same as Table S3, except for extinction comparisons from 145 – 500 m for each flight.

	HSRL-2	NAAPS-RA with NAAPS-RA RH					NAAPS-RA with dropsonde RH				
RF	**Mean (km^{-1})**	**Mean (km^{-1})**	**Bias (km^{-1})**	**RMSE (km^{-1})**	**R^2**	**N**	**Mean (km^{-1})**	**Bias (km^{-1})**	**RMSE (km^{-1})**	**R^2**	**N**
1[a]	0.03 (0.02)	0.11 (0.01)	0.07	0.07	0.90	3	0.11 (0.01)	0.07	0.08	0.03	3
2	0.07 (0.03)	0.07 (0.01)	-0.01	0.02	0.13	22	0.08 (0.01)	0.00	0.02	0.35	22
3	0.06 (0.03)	0.10 (0.01)	0.04	0.05	0.02	17	0.12 (0.02)	0.06	0.06	0.24	17
4	0.07 (0.04)	0.08 (0.01)	0.01	0.04	0.00	18	0.10 (0.02)	0.02	0.04	0.08	18
5	0.09 (0.04)	0.11 (0.02)	0.03	0.05	0.10	10	0.13 (0.03)	0.04	0.04	0.72	10
6	0.22 (0.07)	0.23 (0.07)	0.02	0.07	0.21	18	0.26 (0.07)	0.04	0.09	0.07	18
7	0.13 (0.08)	0.18 (0.02)	0.04	0.09	0.08	20	0.19 (0.05)	0.06	0.10	0.08	20
8	0.13 (0.08)	0.06 (0.01)	-0.06	0.09	0.01	13	0.07 (0.01)	-0.06	0.10	0.01	13
9	0.63 (0.18)	0.60 (0.08)	0.02	0.12	0.49	22	0.64 (0.08)	0.01	0.14	0.36	22
10	0.29 (0.14)	0.38 (0.06)	0.10	0.16	0.21	34	0.39 (0.06)	0.10	0.17	0.13	34
11	0.13 (0.07)	0.09 (0.01)	-0.03	0.06	0.29	8	0.10 (0.01)	-0.03	0.06	0.45	8
12	0.15 (0.03)	0.15 (0.04)	0.01	0.05	0.00	22	0.14 (0.02)	-0.01	0.03	0.32	22
13	0.12 (0.03)	0.10 (0.01)	-0.01	0.04	0.00	26	0.11 (0.02)	-0.01	0.03	0.05	26
14	0.09 (0.03)	0.09 (0.01)	0.00	0.03	0.21	14	0.10 (0.02)	0.01	0.02	0.55	14
15	0.04 (0.02)	0.04 (0.01)	0.01	0.02	0.39	16	0.05 (0.01)	0.01	0.02	0.31	16
16	0.08 (0.04)	0.07 (0.01)	0.00	0.03	0.04	34	0.08 (0.02)	0.01	0.04	0.00	34
17	0.13 (0.05)	0.21 (0.06)	0.09	0.11	0.16	22	0.25 (0.09)	0.11	0.13	0.27	22
18	0.15 (0.12)	0.04 (0.01)	-0.10	0.15	0.11	14	0.05 (0.01)	-0.10	0.15	0.33	14
19	0.02 (0.01)	0.02 (0.00)	-0.01	0.02	0.03	16	0.02 (0.00)	0.00	0.02	0.23	16

[a]RF1 not discussed in study because of low number of points.

Table S6. Same as Table S3, except for extinction comparisons between 500 and 1500 m for each flight.

	HSRL-2	NAAPS-RA with NAAPS-RA RH					NAAPS-RA with dropsonde RH				
RF	**Mean (km^{-1})**	**Mean (km^{-1})**	**Bias (km^{-1})**	**RMSE (km^{-1})**	**R^2**	**N**	**Mean (km^{-1})**	**Bias (km^{-1})**	**RMSE (km^{-1})**	**R^2**	**N**
1[a]	0.05 (0.02)	0.08 (0.04)	0.02	0.04	0.06	6	0.09 (0.02)	0.04	0.04	0.71	6
2	0.06 (0.04)	0.05 (0.02)	-0.03	0.04	0.46	33	0.06 (0.02)	-0.01	0.03	0.66	33
3	0.06 (0.04)	0.09 (0.03)	0.02	0.04	0.20	27	0.11 (0.04)	0.05	0.06	0.44	27
4	0.05 (0.04)	0.06 (0.02)	0.00	0.04	0.14	27	0.07 (0.03)	0.02	0.04	0.12	27
5	0.08 (0.07)	0.09 (0.03)	-0.02	0.05	0.54	15	0.09 (0.04)	0.01	0.04	0.70	15
6	0.17 (0.09)	0.19 (0.09)	-0.01	0.06	0.62	27	0.21 (0.08)	0.05	0.09	0.44	27
7	0.06 (0.07)	0.11 (0.03)	0.03	0.08	0.01	30	0.12 (0.05)	0.06	0.09	0.08	30
8	0.13 (0.12)	0.05 (0.02)	-0.09	0.14	0.07	21	0.04 (0.02)	-0.09	0.14	0.04	21
9	0.56 (0.24)	0.50 (0.16)	-0.16	0.23	0.40	33	0.50 (0.15)	-0.07	0.16	0.66	33
10	0.21 (0.17)	0.34 (0.10)	0.07	0.17	0.28	51	0.35 (0.10)	0.14	0.20	0.24	51
11	0.08 (0.04)	0.09 (0.04)	0.00	0.04	0.16	12	0.10 (0.04)	0.02	0.05	0.08	12
12	0.13 (0.06)	0.10 (0.04)	-0.05	0.08	0.02	33	0.13 (0.04)	-0.01	0.06	0.22	33
13	0.12 (0.06)	0.08 (0.03)	-0.06	0.07	0.38	39	0.11 (0.04)	-0.02	0.05	0.43	39
14	0.07 (0.03)	0.06 (0.02)	-0.02	0.04	0.28	21	0.08 (0.03)	0.01	0.03	0.31	21
15	0.03 (0.02)	0.04 (0.01)	0.01	0.02	0.35	24	0.04 (0.01)	0.02	0.02	0.06	24
16	0.05 (0.02)	0.05 (0.02)	-0.01	0.03	0.00	51	0.05 (0.02)	0.01	0.02	0.12	51
17	0.11 (0.07)	0.10 (0.05)	-0.02	0.07	0.09	33	0.13 (0.08)	0.03	0.08	0.22	33
18	0.10 (0.08)	0.04 (0.01)	-0.06	0.09	0.04	21	0.04 (0.01)	-0.05	0.09	0.06	21
19	0.02 (0.02)	0.01 (0.00)	-0.01	0.01	0.16	27	0.02 (0.01)	0.00	0.02	0.00	27

[a]RF1 not discussed in study because of low number of points.

Table S7. Same as Table S3, except for extinction comparisons above 1500 m for each flight.

	HSRL-2	NAAPS-RA with NAAPS-RA RH					NAAPS-RA with dropsonde RH				
RF	**Mean (km^{-1})**	**Mean (km^{-1})**	**Bias (km^{-1})**	**RMSE (km^{-1})**	**R^2**	**N**	**Mean (km-1)**	**Bias (km^{-1})**	**RMSE (km^{-1})**	**R^2**	**N**
1[a]	0.02 (0.01)	0.04 (0.01)	0.02	0.03	0.30	5	0.06 (0.01)	0.04	0.05	0.12	6
2	0.02 (0.01)	0.01 (0.01)	-0.01	0.01	0.38	51	0.01 (0.01)	0.00	0.01	0.31	51
3	0.01 (0.01)	0.02 (0.01)	0.00	0.01	0.05	34	0.02 (0.01)	0.01	0.01	0.18	31
4	0.01 (0.01)	0.02 (0.01)	0.00	0.01	0.19	32	0.02 (0.01)	0.00	0.01	0.05	33
5	0.02 (0.01)	0.02 (0.01)	-0.01	0.01	0.13	17	0.02 (0.02)	0.00	0.01	0.50	17
6	0.03 (0.03)	0.03 (0.03)	-0.01	0.04	0.49	40	0.04 (0.04)	0.00	0.03	0.50	40
7	0.01 (0.01)	0.03 (0.02)	0.02	0.03	0.05	40	0.03 (0.02)	0.02	0.03	0.01	41
8	0.03 (0.04)	0.01 (0.01)	-0.03	0.06	0.39	27	0.01 (0.01)	-0.02	0.04	0.44	27
9	0.10 (0.11)	0.11 (0.07)	0.00	0.11	0.22	51	0.12 (0.08)	0.02	0.11	0.21	52
10	0.03 (0.04)	0.07 (0.06)	0.04	0.08	0.11	80	0.07 (0.07)	0.05	0.08	0.14	80
11	0.02 (0.02)	0.02 (0.02)	0.00	0.02	0.55	20	0.03 (0.02)	0.01	0.02	0.55	20
12	0.03 (0.02)	0.02 (0.01)	-0.01	0.02	0.72	43	0.03 (0.03)	0.00	0.02	0.68	43
13	0.04 (0.03)	0.02 (0.01)	-0.03	0.04	0.44	42	0.03 (0.02)	-0.01	0.02	0.60	42
14	0.03 (0.03)	0.01 (0.01)	-0.02	0.04	0.49	33	0.02 (0.02)	-0.01	0.02	0.80	33
15	0.01 (0.01)	0.01 (0.01)	0.00	0.01	0.23	25	0.01 (0.01)	0.00	0.01	0.22	25
16	0.01 (0.01)	0.01 (0.01)	0.00	0.01	0.22	60	0.01 (0.01)	0.00	0.01	0.16	61
17	0.05 (0.05)	0.02 (0.01)	-0.03	0.05	0.34	35	0.02 (0.02)	-0.02	0.04	0.60	35
18	0.02 (0.02)	0.01 (0.00)	-0.01	0.02	0.02	23	0.02 (0.01)	-0.01	0.02	0.01	23
19	0.01 (0.01)	0.00 (0.00)	-0.01	0.01	0.07	18	0.01 (0.00)	0.00	0.01	0.02	18

[a]RF1 not discussed in study because of low number of points.

Table S8. Changes in summary statistics (means [standard deviations in parentheses], biases, RMSEs, and R^2) for NAAPS-RA/HSRL-2 AOT and extinction comparisons when dropsonde RHs were substituted for NAAPS-RA RHs for each flight.

	AOT				Extinction < 500 m				Extinction 500–1500 m				Extinction > 1500 m			
RF	Mean	Bias	RMSE	R^2	Mean	Bias (km^{-1})	RMSE (km^{-1})	R^2	Mean	Bias (km^{-1})	RMSE (km^{-1})	R^2	Mean	Bias (km^{-1})	RMSE (km^{-1})	R^2
1[a]	0.04 (0.04)	0.04	0.04	0.00	0.00 (0.02)	0.01	0.01	-0.87	0.01 (0.04)	0.02	0.00	0.65	0.02 (0.02)	0.03	0.02	-0.18
2	0.02 (0.03)	0.02	-0.02	0.12	0.01 (0.01)	0.01	0.00	0.23	0.01 (0.03)	0.02	-0.02	0.20	0.00 (0.01)	0.00	0.00	-0.07
3	0.03 (0.04)	0.03	0.02	0.36	0.02 (0.02)	0.01	0.01	0.22	0.02 (0.05)	0.03	0.02	0.24	0.01 (0.01)	0.00	0.00	0.13
4	0.01 (0.02)	0.01	0.01	0.13	0.02 (0.02)	0.01	0.00	0.07	0.01 (0.04)	0.02	0.00	-0.02	0.00 (0.01)	0.01	0.00	-0.14
5	0.01 (0.03)	0.01	0.00	0.17	0.02 (0.04)	0.01	0.00	0.62	0.00 (0.05)	0.03	-0.01	0.16	0.00 (0.02)	0.00	0.00	0.37
6	0.05 (0.13)	0.05	0.05	-0.29	0.03 (0.10)	0.02	0.02	-0.14	0.02 (0.12)	0.05	0.02	-0.18	0.01 (0.05)	0.02	-0.01	0.01
7	0.02 (0.02)	0.02	0.02	-0.17	0.01 (0.06)	0.01	0.01	0.00	0.01 (0.06)	0.03	0.01	0.07	0.00 (0.03)	0.00	0.00	-0.04
8	0.00 (0.02)	0.00	0.00	0.06	0.01 (0.02)	0.00	0.01	0.00	0.00 (0.03)	0.00	0.00	-0.03	0.00 (0.01)	0.01	-0.02	0.05
9	0.04 (0.23)	0.04	0.00	-0.02	0.04 (0.11)	0.00	0.02	-0.13	0.00 (0.22)	0.10	-0.07	0.26	0.01 (0.11)	0.02	-0.01	-0.01
10	0.02 (0.18)	0.02	0.03	-0.03	0.02 (0.09)	0.00	0.01	-0.08	0.01 (0.14)	0.06	0.03	-0.04	0.00 (0.10)	0.01	0.00	0.03
11	0.03 (0.05)	0.03	0.01	-0.08	0.00 (0.02)	0.00	0.00	0.16	0.01 (0.05)	0.02	0.01	-0.08	0.01 (0.03)	0.01	0.00	0.00
12	0.04 (0.06)	0.04	-0.01	0.09	-0.01 (0.05)	-0.02	-0.02	0.32	0.02 (0.06)	0.04	-0.03	0.20	0.01 (0.03)	0.01	0.00	-0.04
13	0.05 (0.04)	0.05	-0.04	-0.06	0.02 (0.02)	0.01	-0.01	0.04	0.02 (0.04)	0.04	-0.02	0.04	0.01 (0.03)	0.02	-0.02	0.17
14	0.04 (0.04)	0.04	-0.04	0.33	0.01 (0.02)	0.00	-0.01	0.34	0.02 (0.03)	0.03	-0.01	0.02	0.01 (0.02)	0.01	-0.01	0.31
15	0.01 (0.02)	0.01	0.01	-0.22	0.01 (0.02)	0.00	0.00	-0.08	0.01 (0.02)	0.01	0.01	-0.29	0.00 (0.01)	0.00	0.00	-0.01
16	0.02 (0.02)	0.02	0.00	0.08	0.02 (0.02)	0.00	0.01	-0.04	0.01 (0.03)	0.01	-0.01	0.12	0.00 (0.01)	0.00	0.00	-0.06
17	0.05 (0.06)	0.05	-0.01	0.12	0.04 (0.11)	0.02	0.02	0.11	0.04 (0.09)	0.04	0.01	0.12	0.00 (0.02)	0.01	-0.01	0.26
18	0.01 (0.02)	0.01	-0.01	-0.49	0.01 (0.01)	0.00	0.00	0.22	0.01 (0.01)	0.01	-0.01	0.02	0.00 (0.01)	0.00	0.00	0.00
19	0.01 (0.01)	0.01	0.00	-0.06	0.00 (0.00)	0.00	0.00	0.20	0.00 (0.01)	0.01	0.00	-0.16	0.00 (0.00)	0.00	-0.01	-0.05

[a]RF1 not discussed in study because of low number of points.

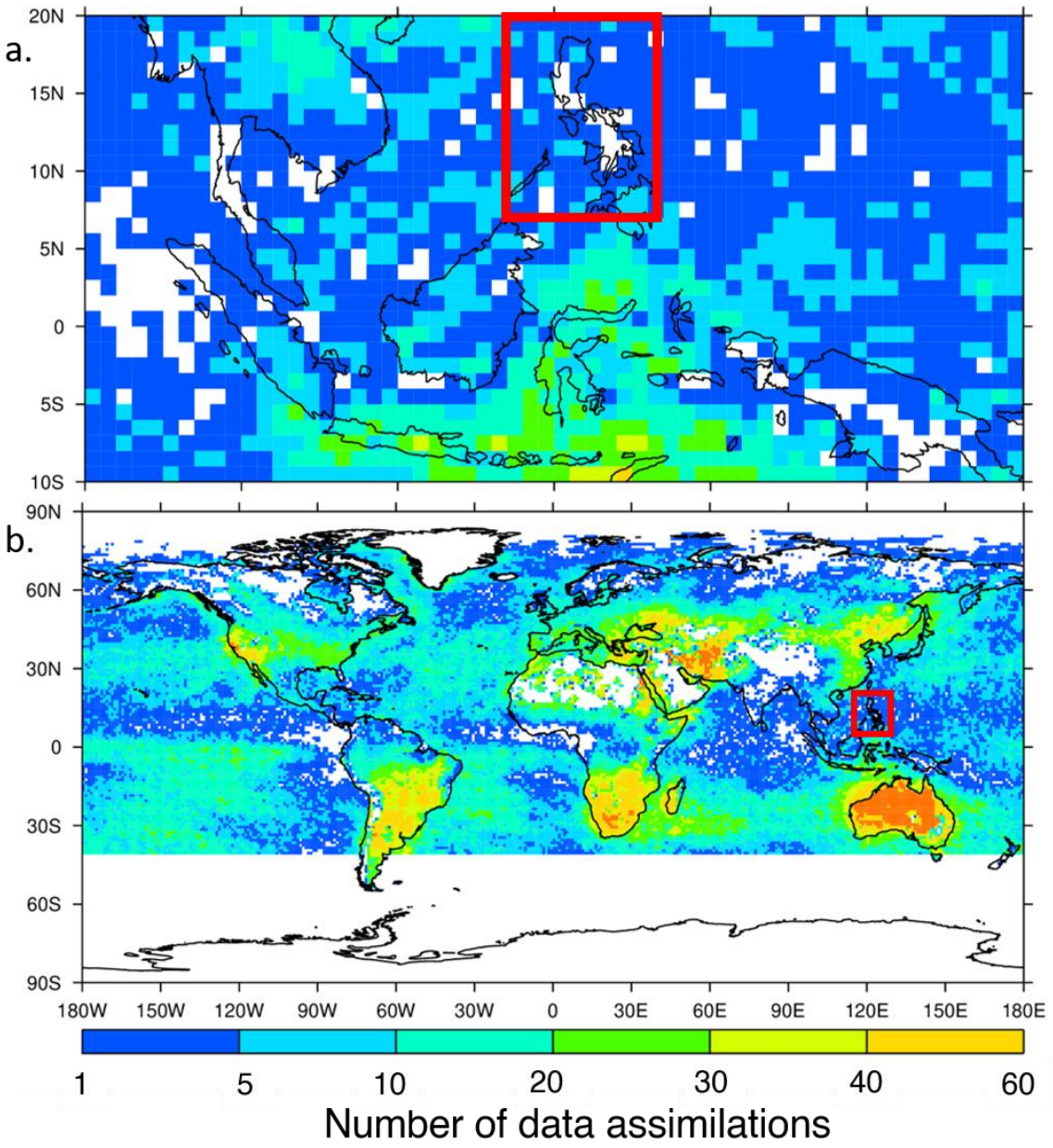

Figure S1. Total number of quality-controlled and assured MODIS AOT retrievals that were assimilated into NAAPS-RA per 1° grid during the time period relevant to the campaign (00Z 24 August 2019 – 18Z 04 October 2019) for (**a)** Southeast Asia and (**b**) the entire globe. White grids indicate there were zero data assimilations, and red rectangles indicate the region in which we evaluated NAAPS-RA performance.

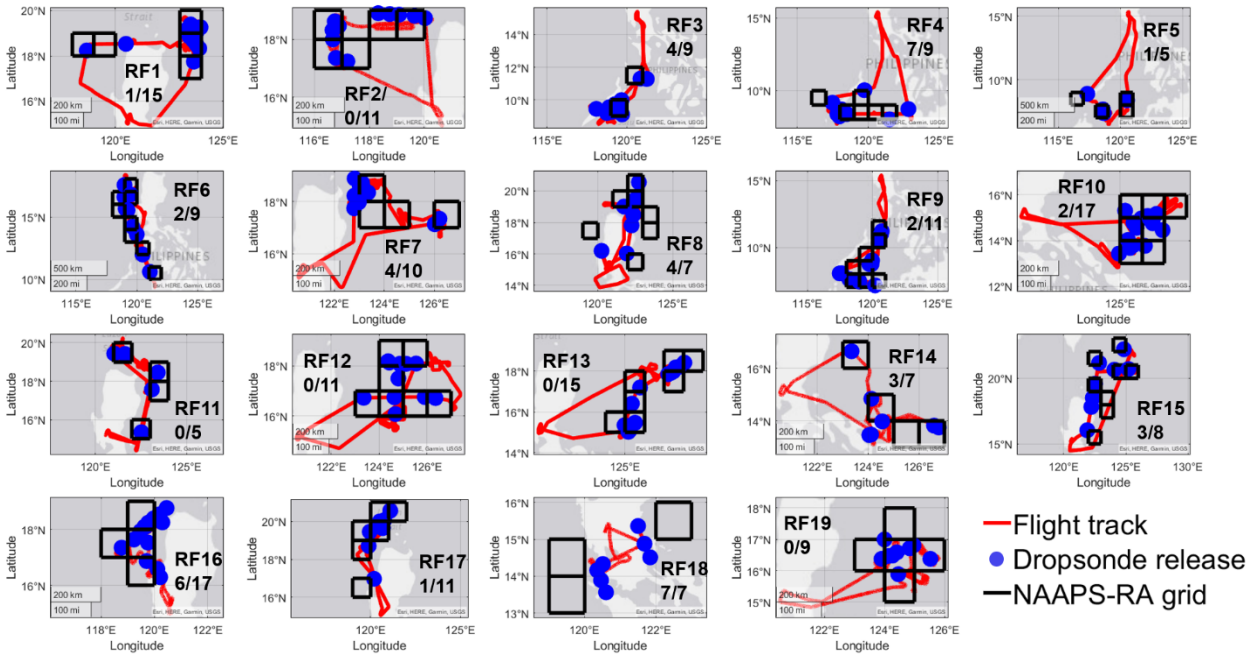

Figure S2. Flight tracks (red), dropsonde release points (blue circles), and 1° grids relevant to NAAPS-RA data (outlined with black squares). If a NAAPS-RA 1° grid does not encompass a dropsonde release point, this indicates that grid replaced an original grid that contained land at the surface. The number of replaced grids out of the total is then reported for each research flight (RF).

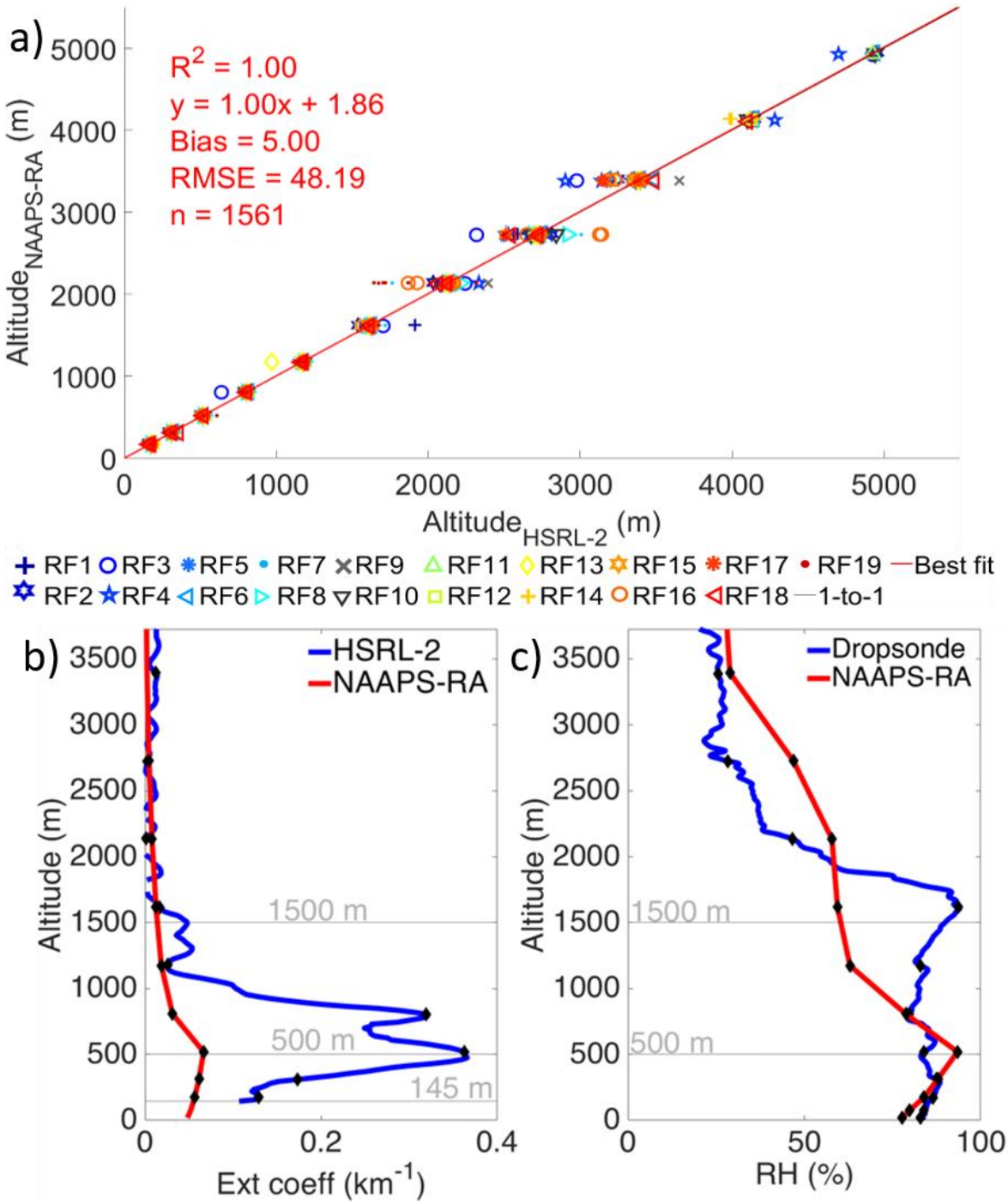

Figure S3. (**a**) Altitudes at which NAAPS-RA and HSRL-2 extinction coefficients were compared, as well as an example of (**b**) simulated (NAAPS-RA) and retrieved (HSRL-2) extinction profiles and (**c**) simulated (NAAPS-RA) and measured (dropsonde) RH profiles for a location sampled during RF8 on 13 September 2019. Horizontal lines indicate altitudes relevant to the three altitude layers discussed throughout the study: (i) 145 – 500 m (for extinction comparisons) or < 500 m (for RH comparisons), (ii) 500 – 1500 m, and (iii) >1500 m.

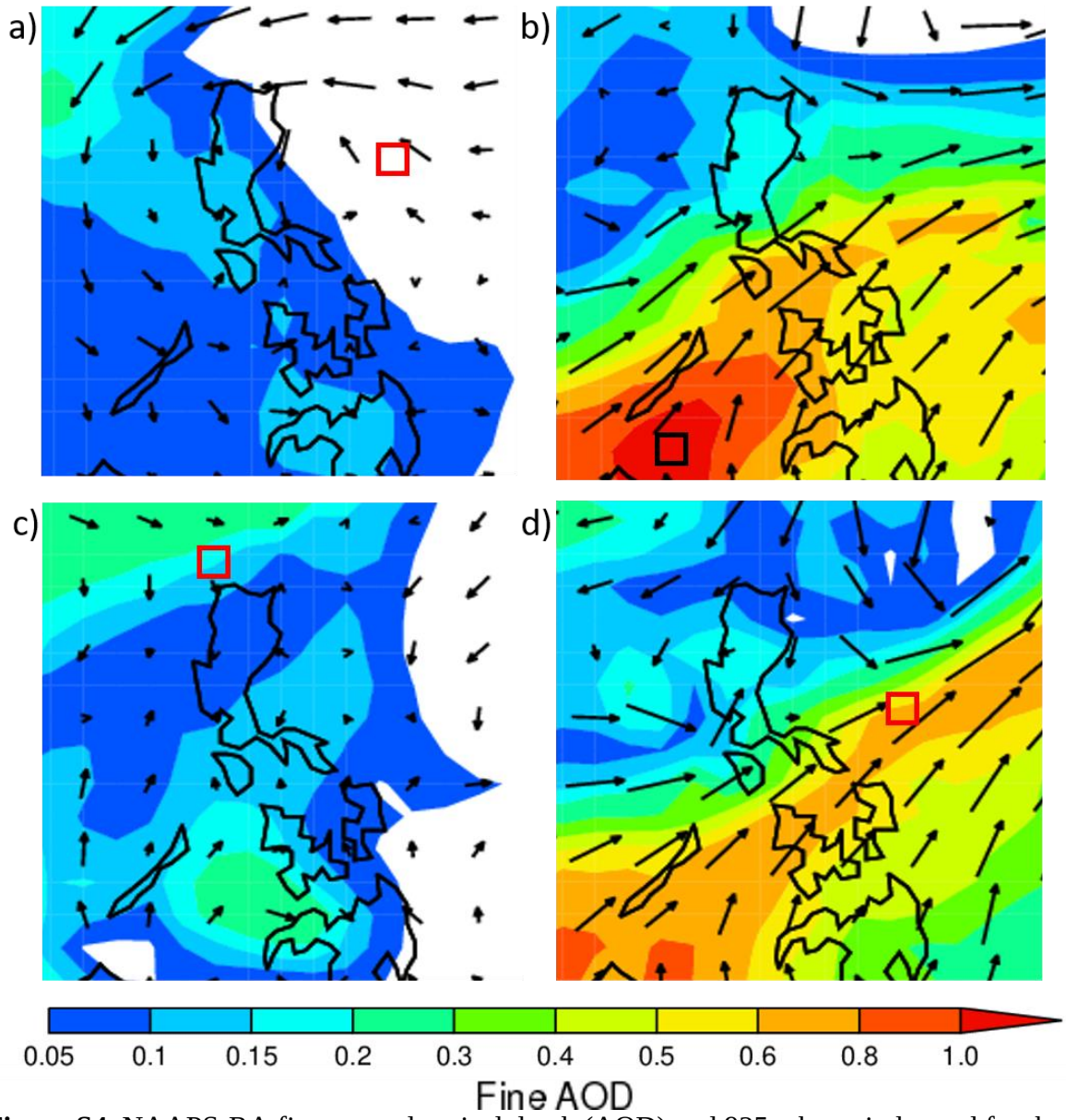

Figure S4. NAAPS-RA fine aerosol optical depth (AOD) and 925 mbar wind speed for the 6-hr periods most relevant to the (**a**) clean case study on 5 October 2019, (**b**) biomass burning smoke case study on 15 September 2019, (**c**) Asian pollution case study on 1 October 2019, and (**d**) mixed case study on 16 September 2019. White coloring indicates a fine AOD of ~0. Red squares indicate the 1° grid relevant to each case study (a black square is used for the smoke case study).

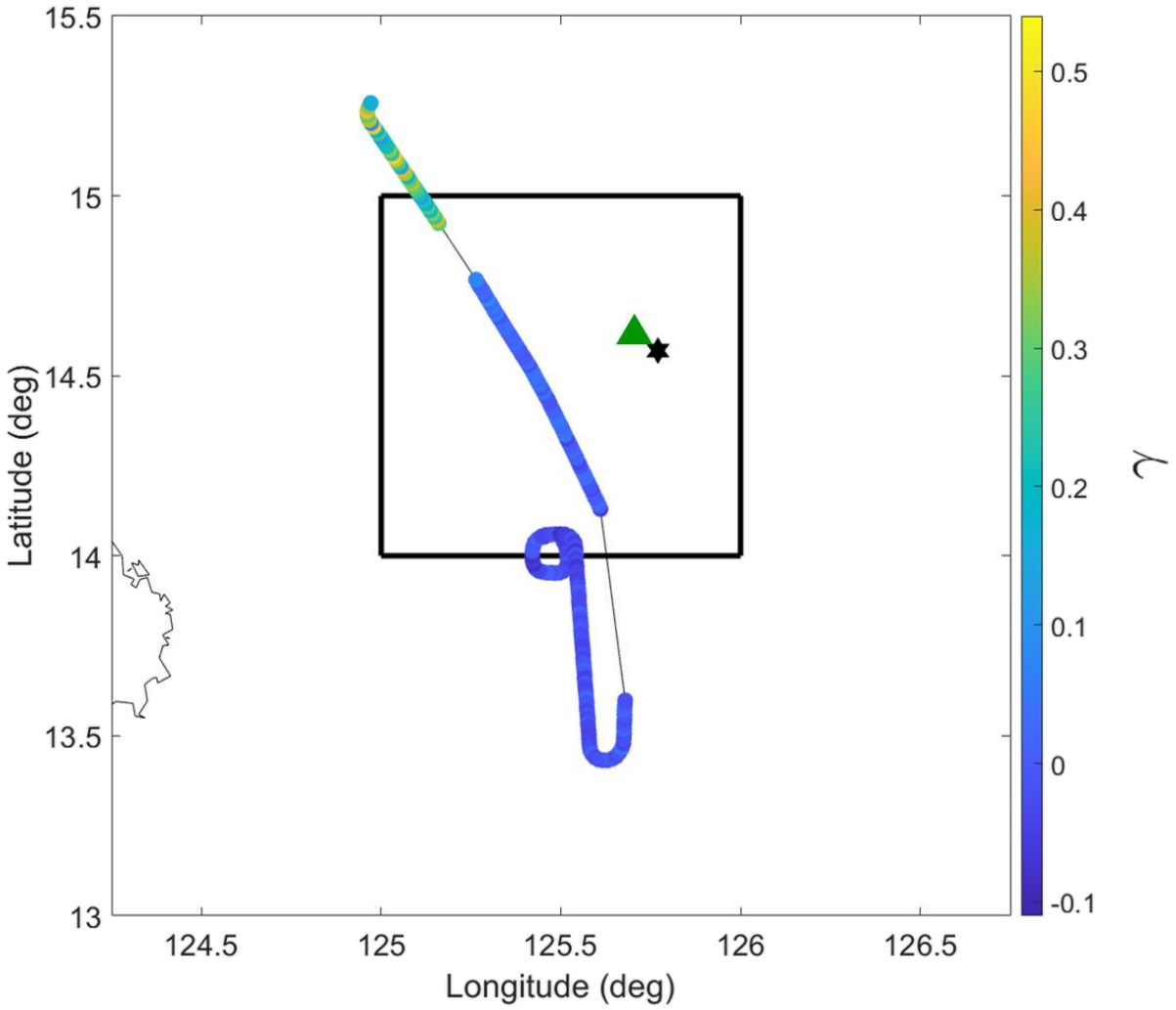

Figure S5. Flight track in the mixed layer (ML) for RF10 on 16 September 2019 colored by the hygroscopic growth parameter, γ. A thin black line indicates when data for γ were unavailable along the flight track, the green triangle denotes where vertically resolved HSRL-2 data were extracted, the black six-pointed star indicates a dropsonde release point, and the black square outlines the 1° × 1° grid relevant to the NAAPS-RA data.

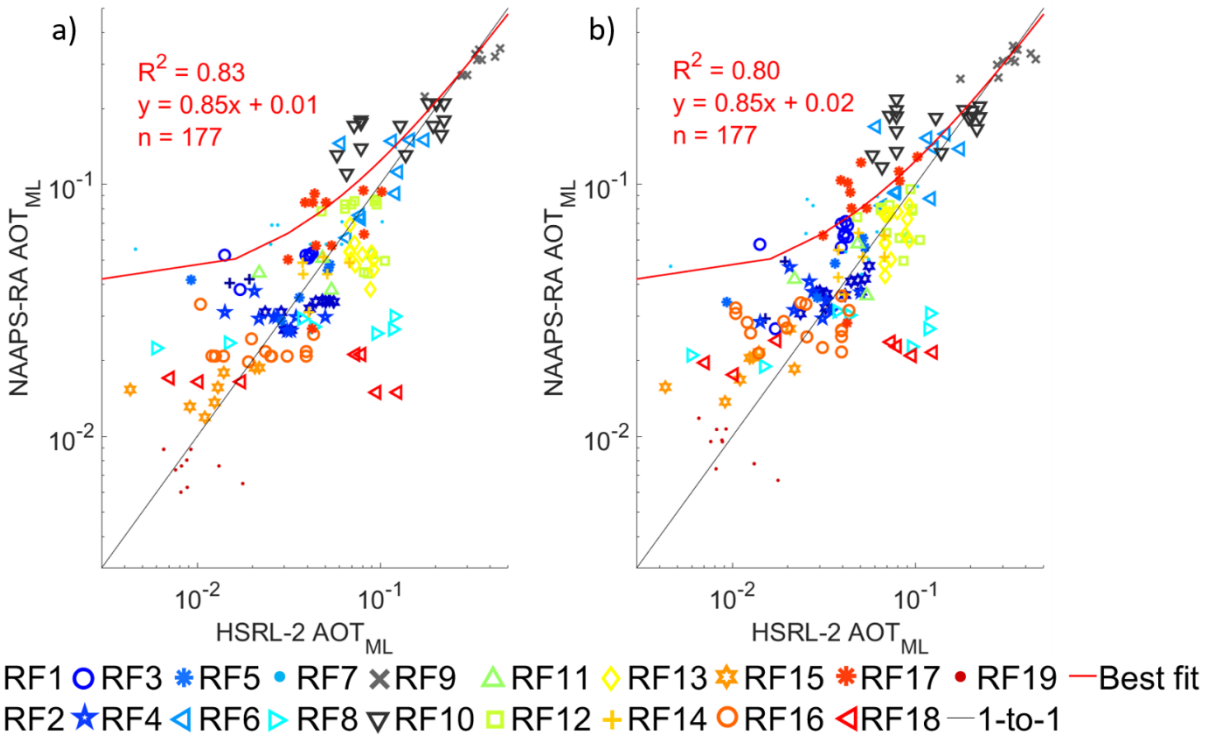

Figure S6. Comparison between simulated (NAAPS-RA) and retrieved (HSRL-2) mixed-layer AOT (AOT_{ML}) when NAAPS-RA extinction coefficients were calculated using RHs from (**a**) NAAPS-RA and (**b**) dropsonde data.

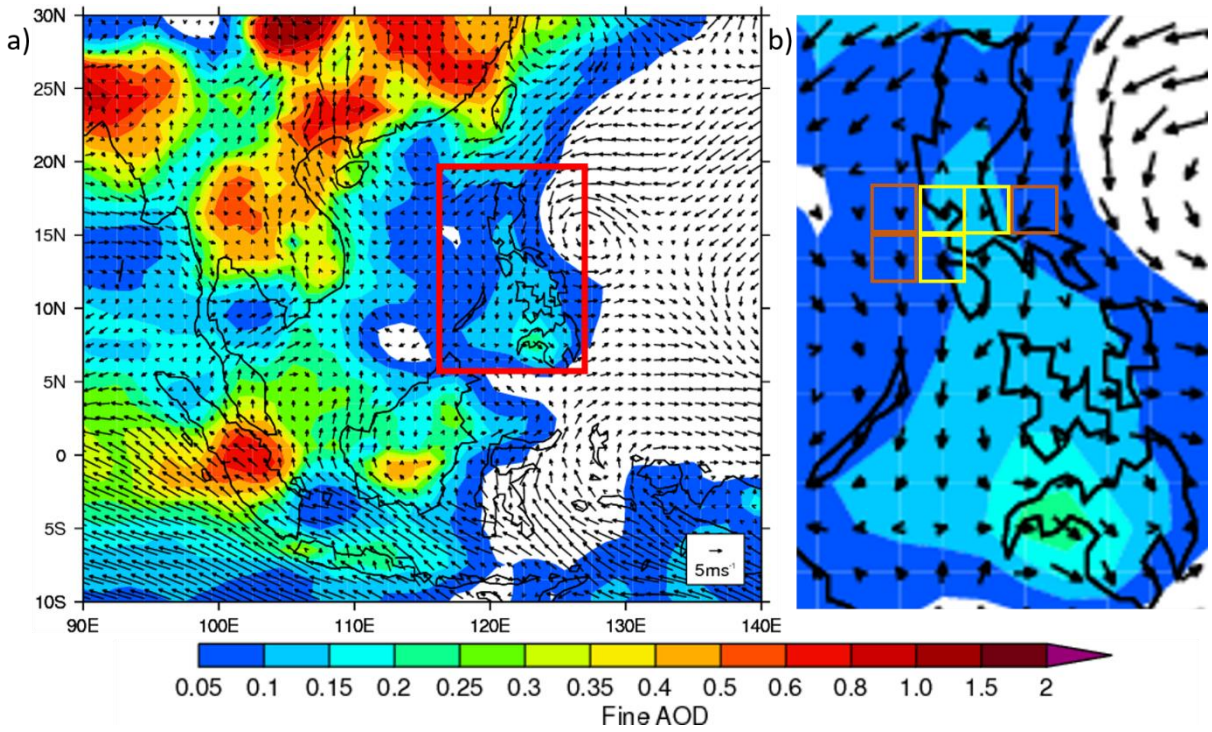

Figure S7. NAAPS-RA fine AOD and 925 mbar wind speed from 21Z – 03Z on 03 – 04 October 2019 (times corresponding to RF18) for (**a**) East and Southeast Asia (the Philippines is outlined with a red rectangle) and (**b**) the Philippines. Replacement NAAPS-RA grids are indicated by magenta squares, and the original grids are indicated by yellow squares.

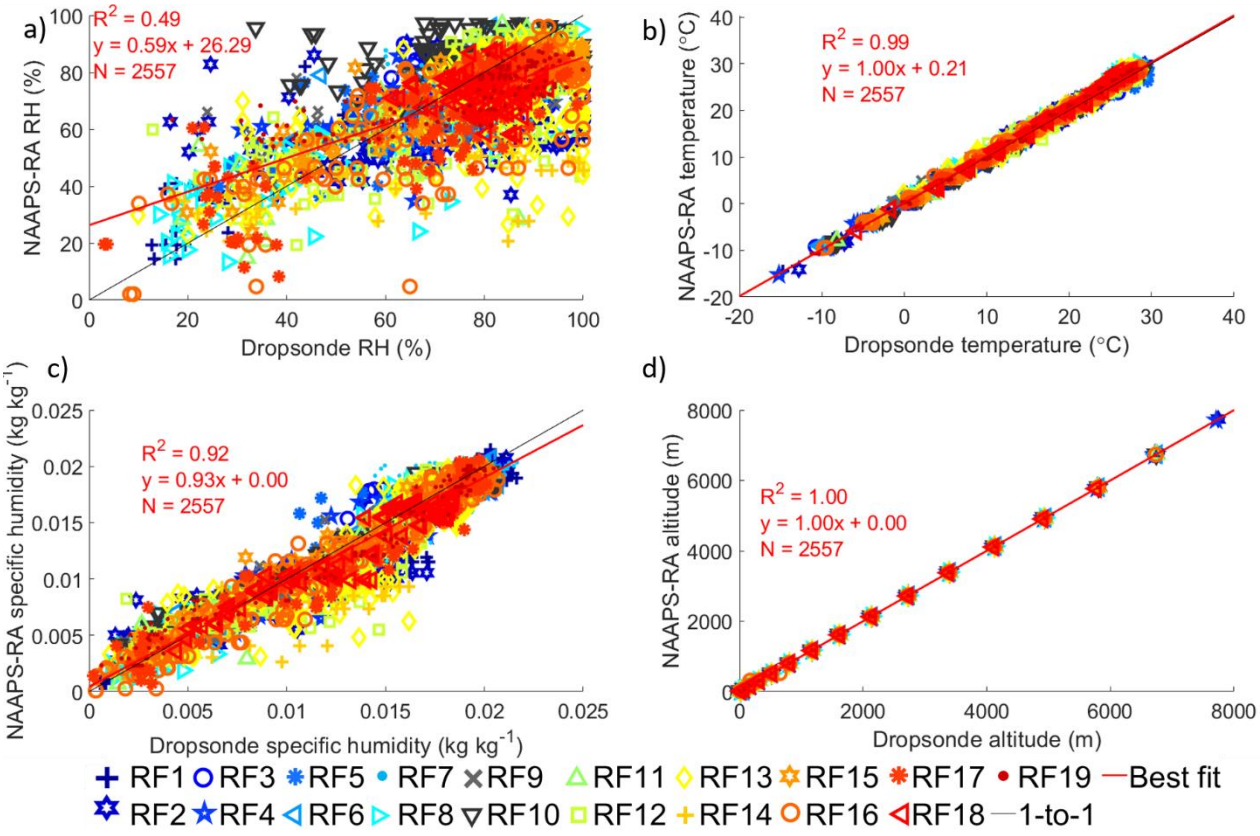

Figure S8. Comparisons between simulated (NAAPS-RA) and measured (dropsonde) **(a)** RH, (**b**) temperature, (**c**) specific humidity, and (**d**) the altitudes at which comparisons were made.

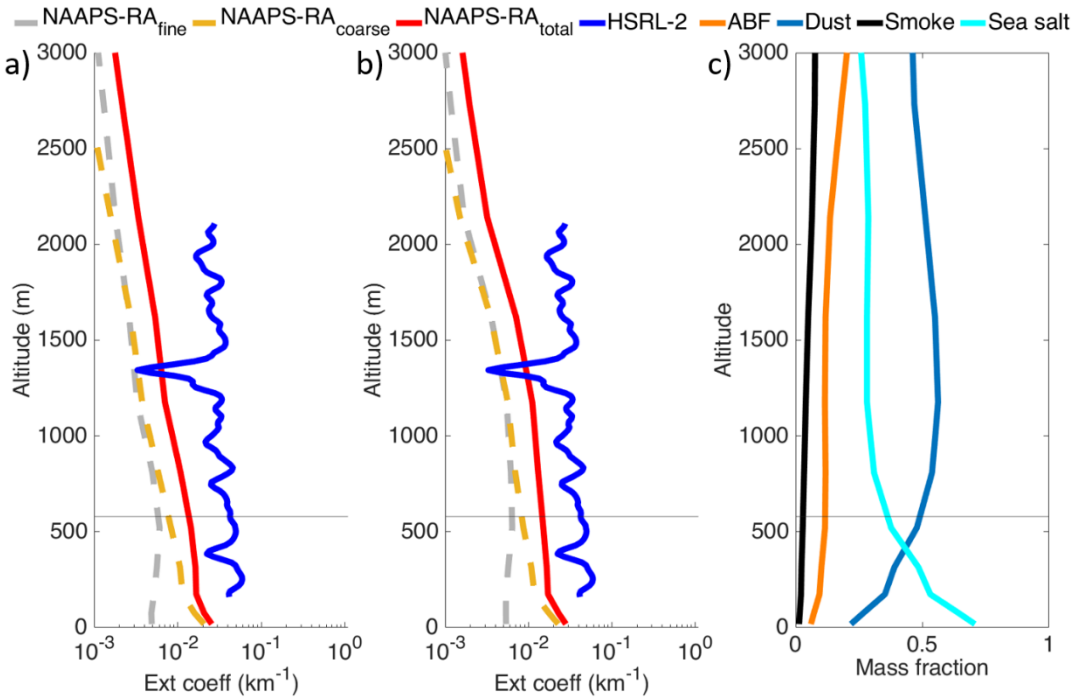

Figure S9. Retrieved total extinction profiles (HSRL-2) and simulated (NAAPS-RA) fine, coarse, and total extinction profiles when simulated values were calculated with (**a**) NAAPS-RA RH and (**b**) dropsonde RH values, as well as (**c**) simulated mass fraction profiles of the four aerosol species for the clean case study (RF19) on 5 October 2019. Black horizontal lines denote the MLH.

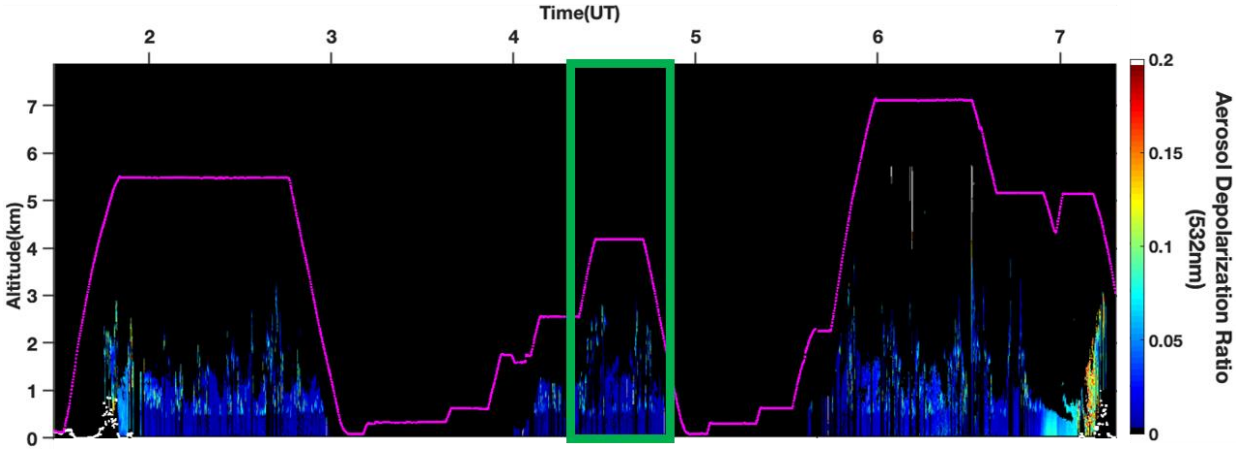

Figure S10. HSRL-2 532 nm particle depolarization ratios for the flight relevant to the clean case study (RF19 on 5 October 2019). The green rectangle indicates the period during which the HSRL-2 made retrievals within the 1° grid chosen for this case study. Clouds are not cleared from this image, and water clouds show as very small patches of elevated particulate depolarization. The aerosol has low particulate depolarization.

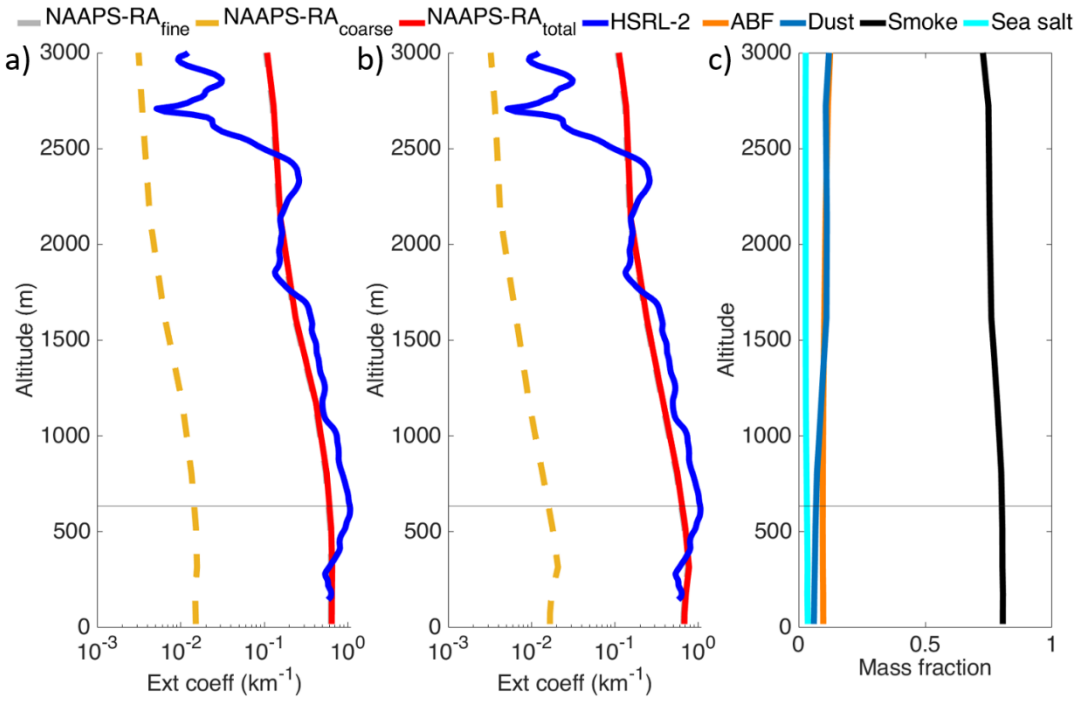

Figure S11. Same as Fig. S9, except for the biomass burning smoke case study (RF9) on 15 September 2019. Dashed silver lines for NAAPS-RA fine extinction are difficult to see as they are directly below the red lines for NAAPS-RA total extinction.

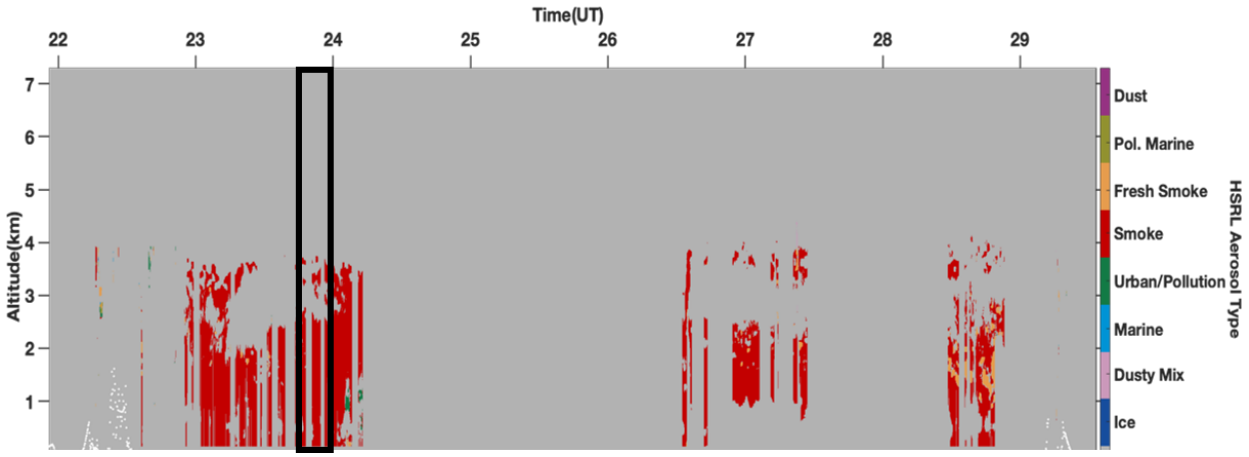

Figure S12. HSRL-2 aerosol types derived from the method described in Burton et al. (2013) for the flight relevant to the biomass burning smoke case study (RF9 on 15 September 2019). The black rectangle indicates the period during which the HSRL-2 made retrievals within the 1° grid chosen for this case study.

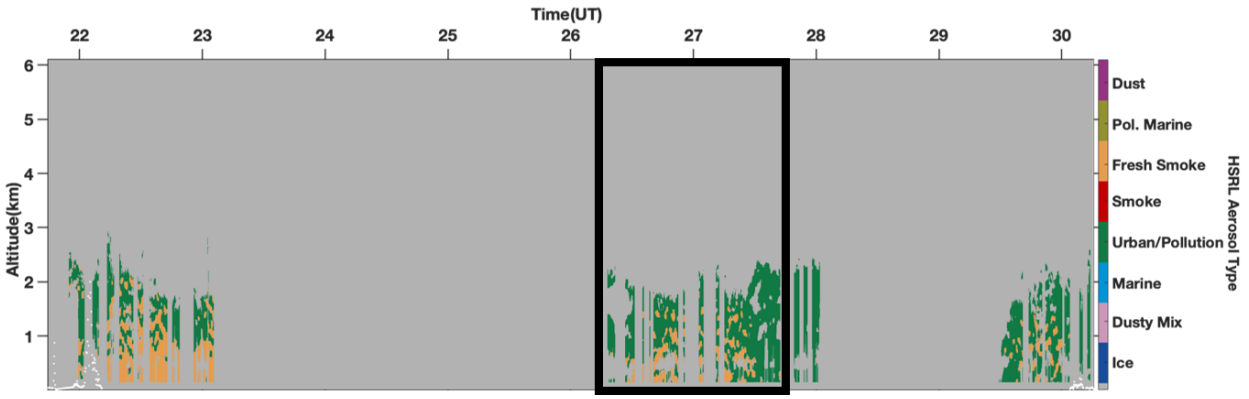

Figure S13. Same as Fig. S12, except for the flight relevant to the Asian pollution case study (RF17 on 1 October 2019).

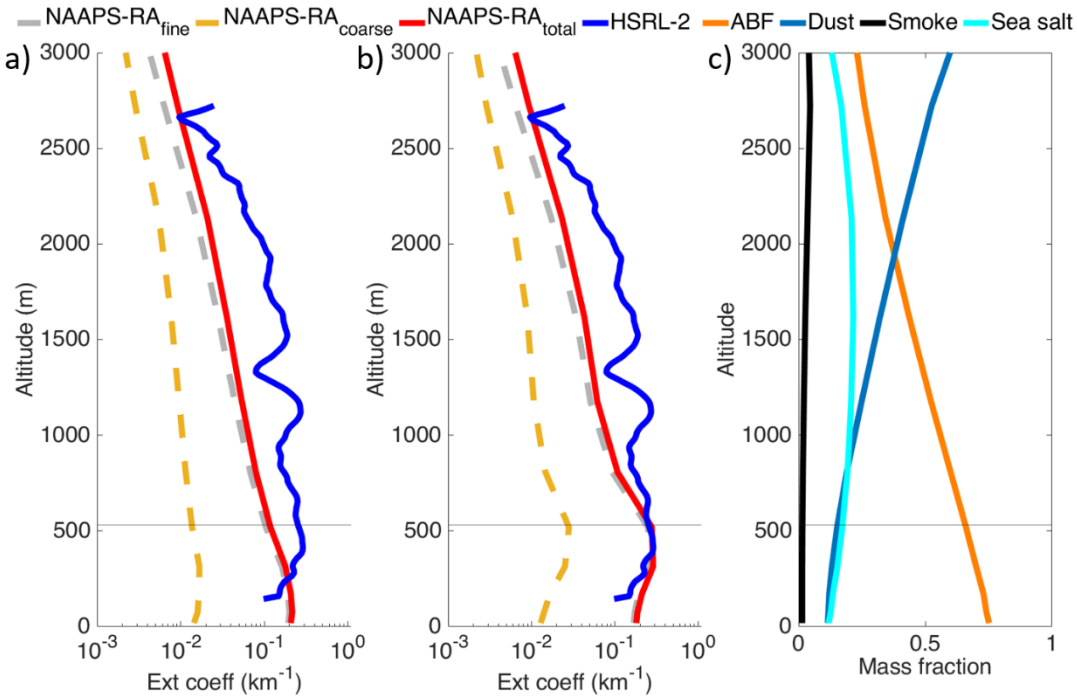

Figure S14. Same as Fig. S9, except for the Asian pollution case study (RF17) on 1 October 2019.

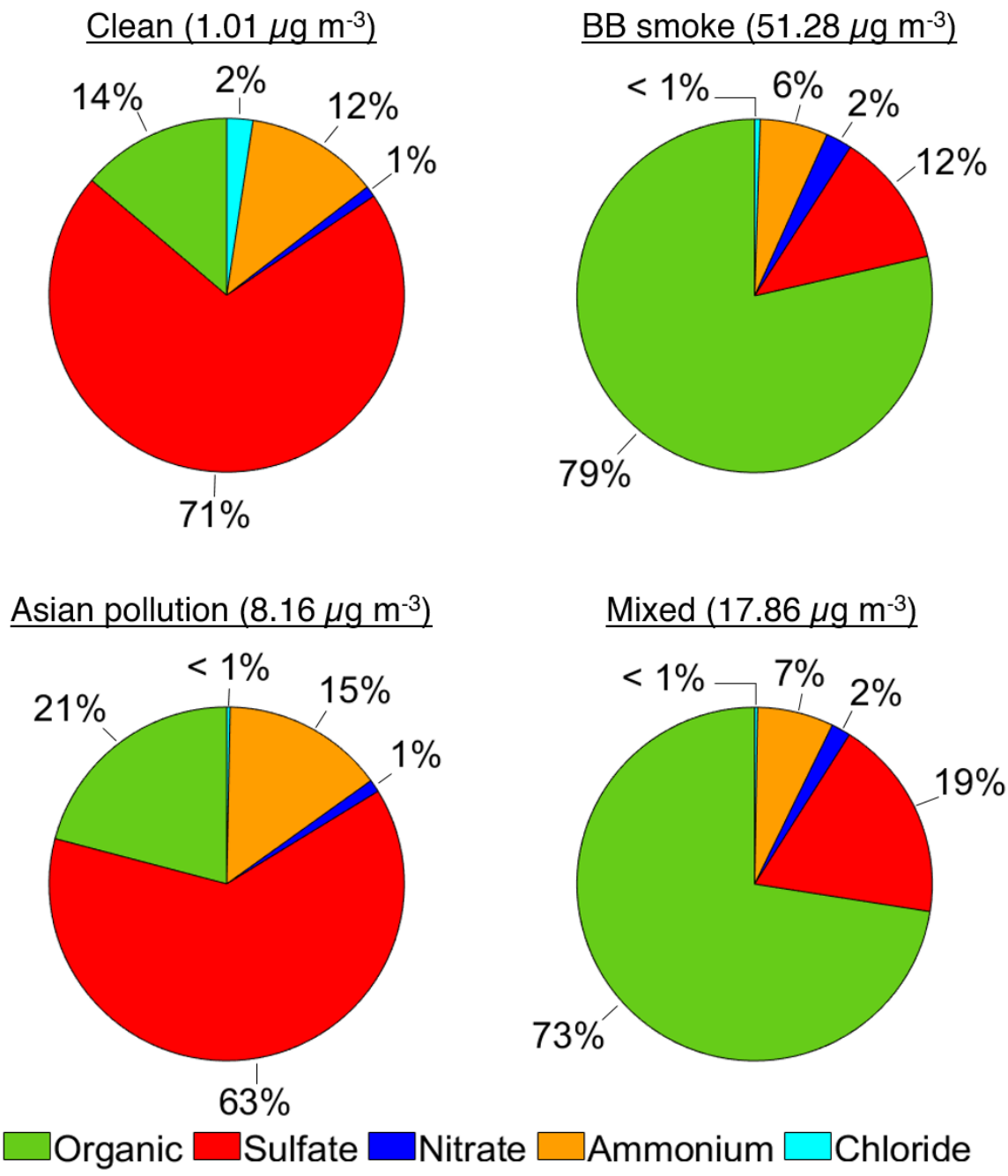

Figure S15. Fine-mode (< 600 nm) aerosol composition in the ML based on AMS measurements for each case study. Mean total fine mass concentrations are provided above each pie chart. "BB" stands for biomass burning.

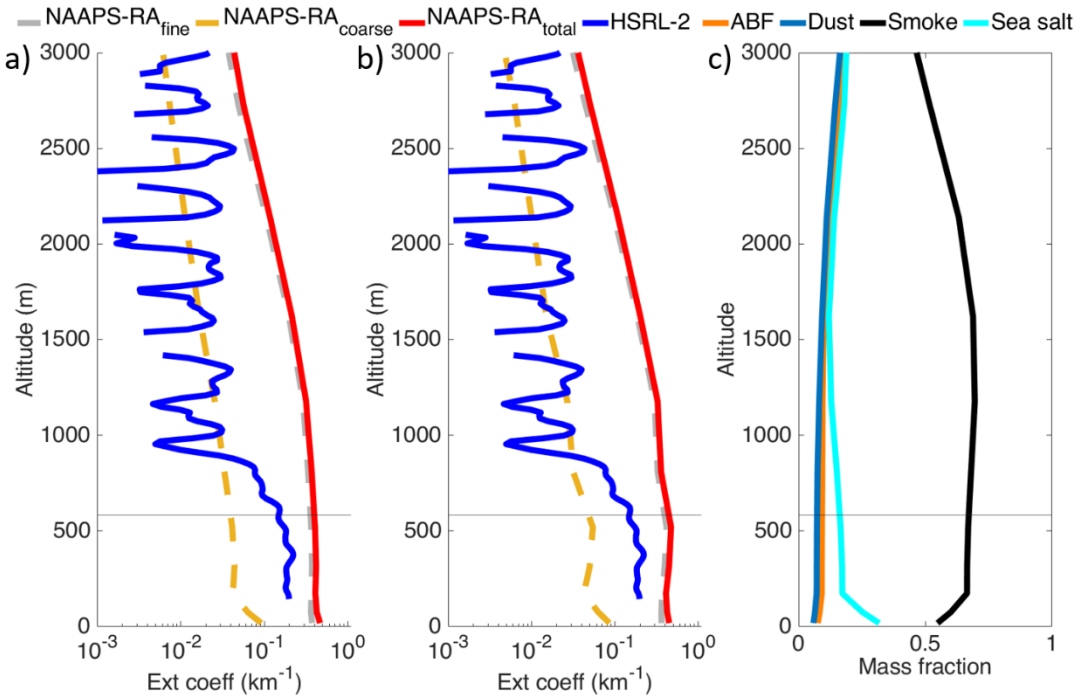

Figure S16. Same as Fig. S9, except for the mixed case study on 16 September 2019.