Supplementary material for:

Intensive aerosol properties of Boreal and regional biomass burning aerosol at Mt. Bachelor Observatory: Larger and BC-dominant particles transported from Siberian wildfires

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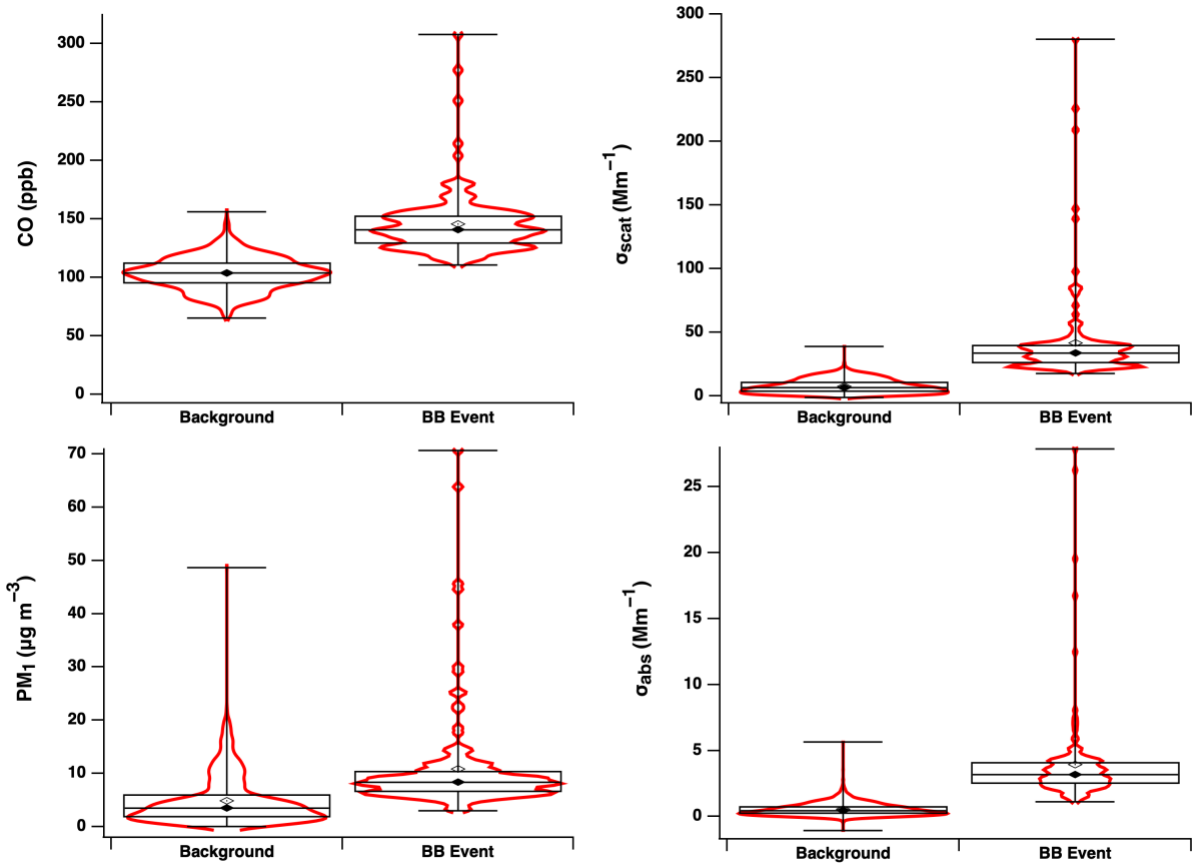

Figure S1: Combined violin and box plots of 1 hr average CO, σ_{scat}, σ_{abs}, and PM_1 for BB event and background periods for July – September 2019 at MBO. Violin plots in red show the rotated Gaussian kernel probability density, with mean shown as an open diamond and median shown as a solid diamond. Boxes in black represent upper and lower quartiles, with whiskers representing the minimum and maximum.

Table S1. Optical properties of the identified BB plumes at MBO during the summer of 2019. All enhancement ratios are obtained by taking the slope of an RMA linear regression between hourly data of the two species. Precision uncertainty and total uncertainty are provided for each value.

Date	Source fire		$\Delta\sigma_{scat}/\Delta CO$ (Mm^{-1} ppb^{-1})	$\Delta\sigma_{abs}/\Delta CO$ (Mm^{-1} ppb^{-1})	MSE (m^2 g^{-1})	MAE (m^2 g^{-1})	AAE (467-660 nm)	SAE (450-550 nm)	ω 528 nm
7/5 – 7/6	Alaska	Mean	1.29	0.10	3.71	0.30	1.27	1.64	0.93
		Precision	0.19	0.006	0.56	0.04	0.11	0.25	0.14
		Total uncertainty	0.21	0.035	0.59	0.12	0.51	0.26	0.33
7/7	Alaska	Mean	0.88	0.069	3.59	0.28	1.33	1.75	0.93
		Precision	0.13	0.004	0.54	0.04	0.12	0.26	0.14
		Total uncertainty	0.14	0.024	0.57	0.11	0.53	0.28	0.33
7/26 – 7/27	SW OR	Mean	1.25	0.13	3.83	0.41	2.55	1.94	0.91
		Precision	0.18	0.008	0.57	0.05	0.23	0.29	0.14
		Total uncertainty	0.20	0.046	0.61	0.16	1.02	0.31	0.33
7/30	SW OR	Mean	0.82	0.044	2.98	0.16	1.30	2.39	0.95
		Precision	0.11	0.003	0.45	0.02	0.12	0.36	0.14
		Total uncertainty	0.13	0.015	0.48	0.06	0.52	0.38	0.34

Date	Source fire		$\Delta\sigma_{scat}/\Delta CO$ (Mm^{-1} ppb^{-1})	$\Delta\sigma_{abs}/\Delta CO$ (Mm^{-1} ppb^{-1})	MSE (m^2 g^{-1})	MAE (m^2 g^{-1})	AAE (467-660 nm)	SAE (450-550 nm)	ω 528 nm
8/2	SW OR	Mean	0.50	0.049	3.38	0.33	2.33	2.17	0.93
		Precision	0.07	0.003	0.51	0.04	0.21	0.33	0.14
		Total uncertainty	0.08	0.017	0.54	0.13	0.93	0.35	0.33
8/5 – 8/7	Regional	Mean	0.54	0.061	4.51	0.51	1.34	1.91	0.90
		Precision	0.08	0.004	0.68	0.07	0.12	0.29	0.14
		Total Uncertainty	0.09	0.021	0.72	0.20	0.54	0.31	0.32
8/7 -8/8	Regional	Mean	0.42	0.042	4.63	0.47	0.97	1.87	0.91
		Precision	0.06	0.003	0.69	0.06	0.09	0.28	0.14
		Total Uncertainty	0.07	0.015	0.74	0.19	0.39	0.30	0.33
8/8	Regional	Mean	0.60	0.075	4.24	0.53	1.34	1.98	0.89
		Precision	0.08	0.005	0.64	0.07	0.12	0.30	0.13
		Total Uncertainty	0.10	0.026	0.68	0.21	0.54	0.32	0.32
8/12	Siberia	Mean	0.29	0.019	7.24	0.48	1.09	1.24	0.94
		Precision	0.04	0.001	1.09	0.06	0.10	0.19	0.14
		Total Uncertainty	0.05	0.007	1.16	0.19	0.44	0.20	0.34

Date	Source fire		$\Delta\sigma_{scat}/\Delta CO$ (Mm^{-1} ppb^{-1})	$\Delta\sigma_{abs}/\Delta CO$ (Mm^{-1} ppb^{-1})	MSE (m^2 g^{-1})	MAE (m^2 g^{-1})	AAE (467-660 nm)	SAE (450-550 nm)	ω 528 nm
8/17	Siberia	Mean	0.50	0.035	10.28	0.72	1.39	1.11	0.93
		Precision	0.07	0.002	1.54	0.09	0.13	0.17	0.14
		Total Uncertainty	0.08	0.012	1.64	0.29	0.56	0.18	0.33
8/28	Regional	Mean	1.24	0.19	3.38	0.32	1.53	2.18	0.90
		Precision	0.17	0.011	0.51	0.04	0.14	0.33	0.14
		Total Uncertainty	0.20	0.067	0.54	0.13	0.61	0.35	0.32
8/29 – 8/29	Regional	Mean	0.39	0.042	3.35	0.36	1.60	2.31	0.89
		Precision	0.05	0.003	0.50	0.05	0.14	0.35	0.13
		Total Uncertainty	0.06	0.015	0.54	0.14	0.64	0.37	0.32
9/7 – 9/8	Regional	Mean	0.76	0.11	3.70	0.55	1.78	2.27	0.88
		Precision	0.11	0.007	0.56	0.07	0.16	0.34	0.13
		Total Uncertainty	0.12	0.039	0.59	0.22	0.71	0.36	0.32

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Table S2. Log normal fit parameters generated by peak fitting of averaged SMPS size distributions performed with the standard fitting algorithm of Igor Pro analysis software [fit parameters: $x_0 = D_g$, width = 2.303· 2 log σ_g, A = 2.303·N / (π · width)] for nine BB events, as well as background periods, in August and September 2019.

Event	D_g (nm)	Width	Amplitude
SW Oregon (8/2)	156 ± 2	0.61 ± 0.02	2370 ± 50
Regional (8/5)	151 ± 2	0.64 ± 0.03	1060 ± 30
Regional (8/7)	156 ± 1	0.67 ± 0.02	1040 ± 20
Regional (8/8)	158 ± 2	0.65 ± 0.03	1080 ± 30
Siberia (8/12)	48 ± 2 231 ± 9	0.75 ± 0.04 0.94 ± 0.09	280 ± 30 350 ± 40
Siberia (8/17)	92 ± 1 278 ± 4	0.72 ± 0.02 0.52 ± 0.01	273 ± 5 245 ± 5
Regional (8/28)	151 ± 1	0.52 ± 0.01	1560 ± 20
Regional (8/29)	147 ± 1	0.55 ± 0.01	2530 ± 40
Regional (9/7)	162 ± 2	0.59 ± 0.02	1430 ± 40
Background	101 ± 1	0.76 ± 0.02	520 ± 10

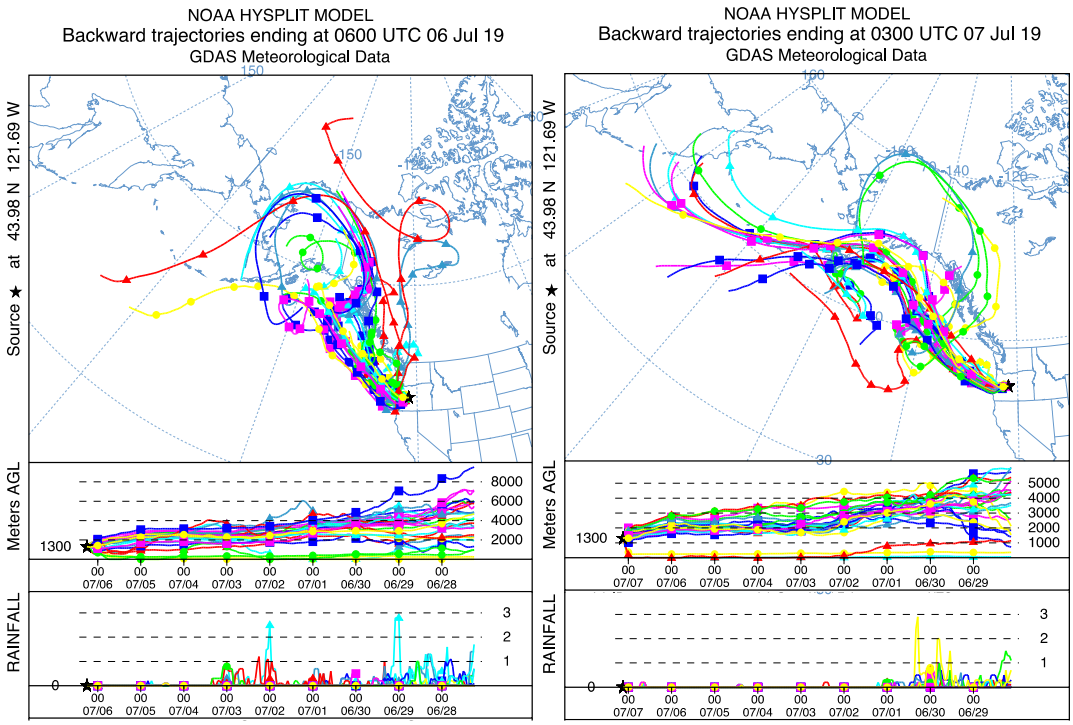

Figure S2. 10-day NOAA HYSPLIT ensemble back trajectories (1300, 1500, 1700 m AGL), rainfall (precipitation) meteorological parameter below, corresponding to the respective peaks for the first (0600 UTC July 6, 2019) and second (0300 UTC July 7, 2019) Alaskan BB events. Transport times from wildfires in the Alaskan interior to MBO were estimated to be 8-10 days.

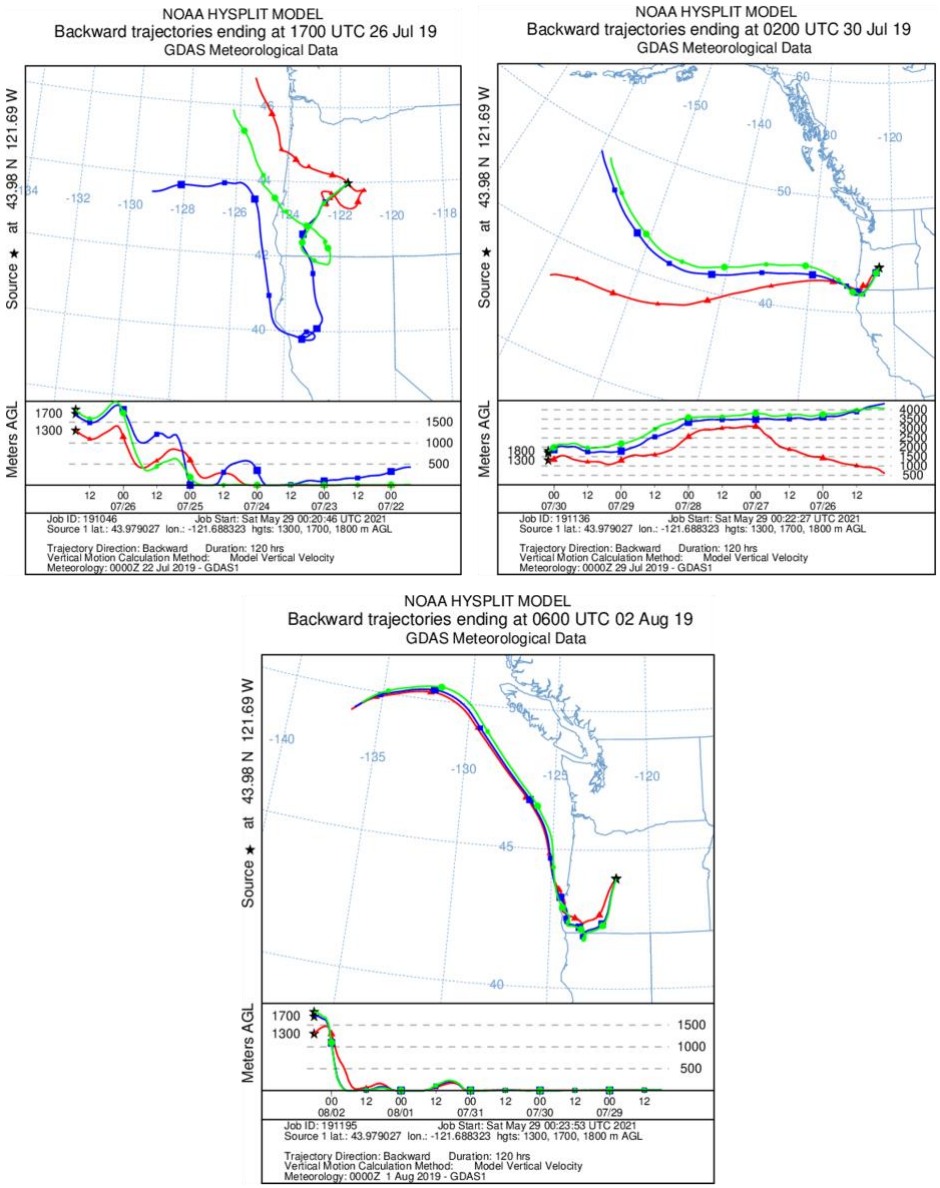

Figure S3. Five-day NOAA HYSPLIT back trajectories (1300, 1500, 1700 m AGL) corresponding to the respective peaks for the first (1700 UTC July 26, 2019), second (0200 UTC July 30, 2019), and third (0600 UTC August 2, 2019) SW OR events. Transport times from the SW OR wildfire to MBO were estimated to be 10-15 h for all events.

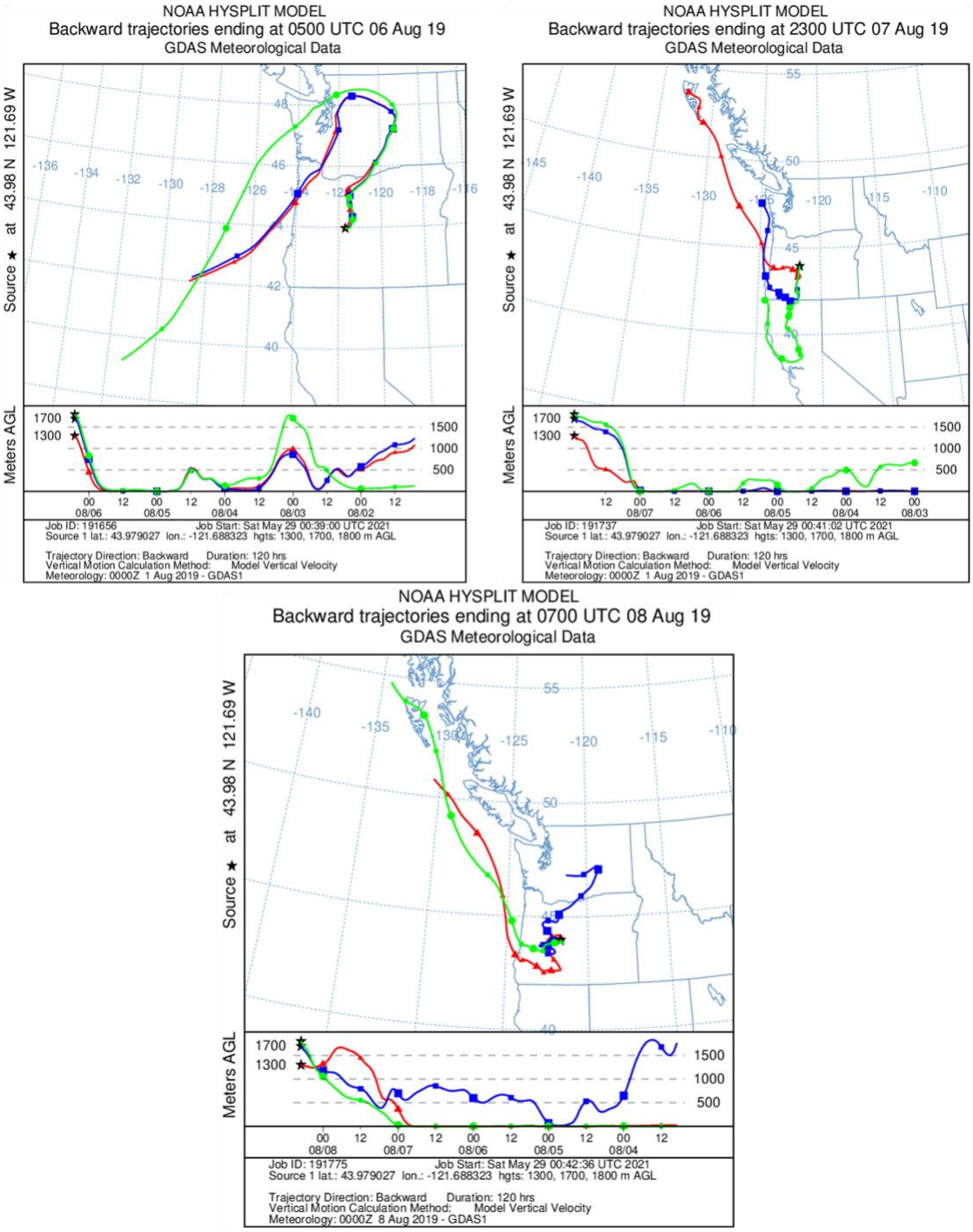

Figure S4. Five-day NOAA HYSPLIT back trajectories (1300, 1500, 1700 m AGL) corresponding to the respective peaks for the first (0500 UTC August 6, 2019), second (2300 UTC August 7, 2019), and third (0700 UTC August 8, 2019) early August regional events. Transport times to MBO were estimated to be 1-3 days.

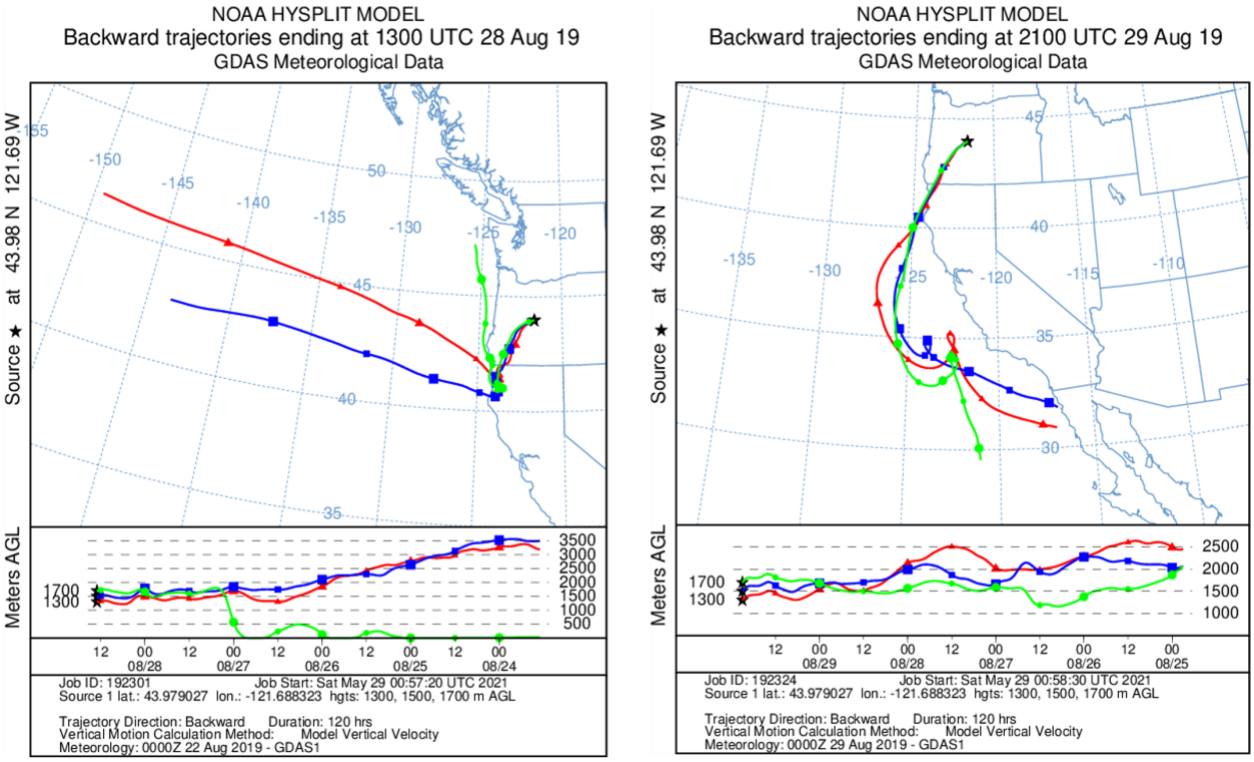

Figure S5. Five-day NOAA HYSPLIT back trajectories (1300, 1500, 1700 m AGL) corresponding to the respective peaks for the first (1300 UTC August 28, 2019) and second (2100 UTC August 29, 2019) late August regional events. Transport times to MBO were estimated to be 12-48 h.

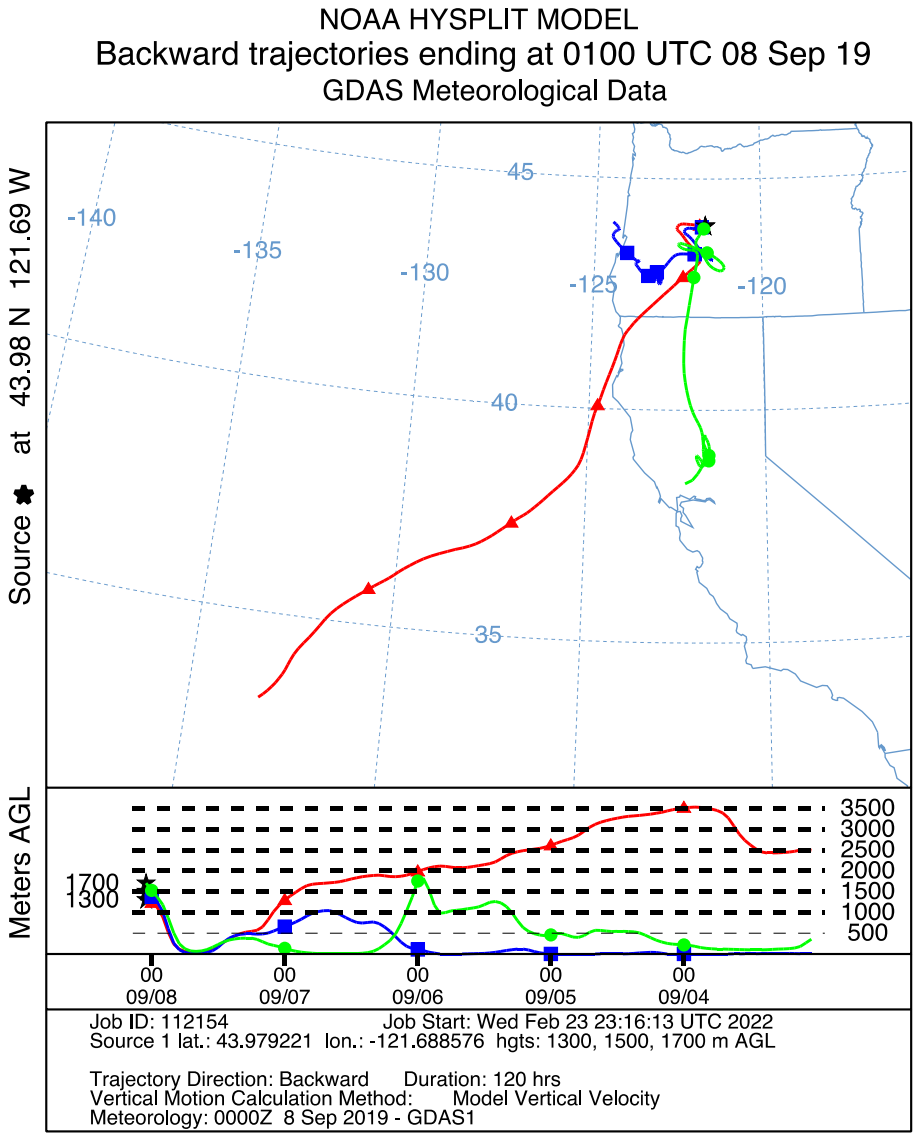

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Figure S6. Five-day NOAA HYSPLIT back trajectories (1300, 1500, 1700 m AGL) corresponding to the peak (0100 UTC September 8, 2019) of the early September regional event. Transport times to MBO were estimated to be <12-48 h.

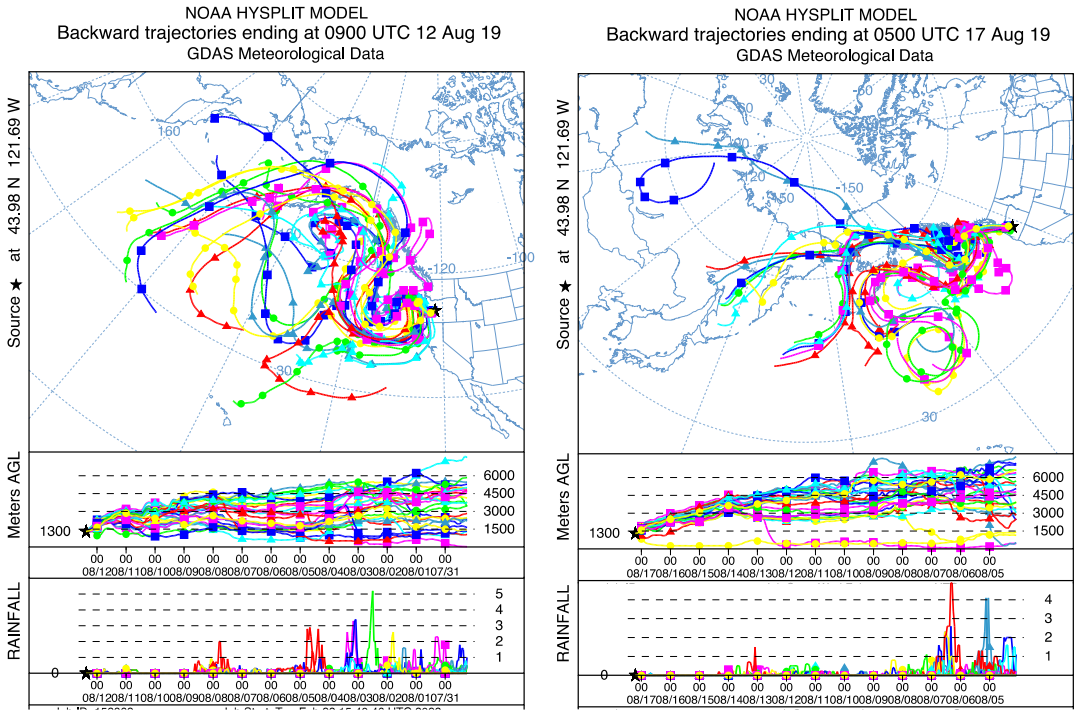

Figure S7. 14-day NOAA HYSPLIT ensemble back trajectories (1300, 1500, 1700 m AGL), with rainfall (precipitation) meteorological parameter below, corresponding to the respective peaks for the first (0900 UTC August 12, 2019) and second (0500 UTC August 17, 2019) Siberian events. Transport times to MBO were estimated to be >14 days.

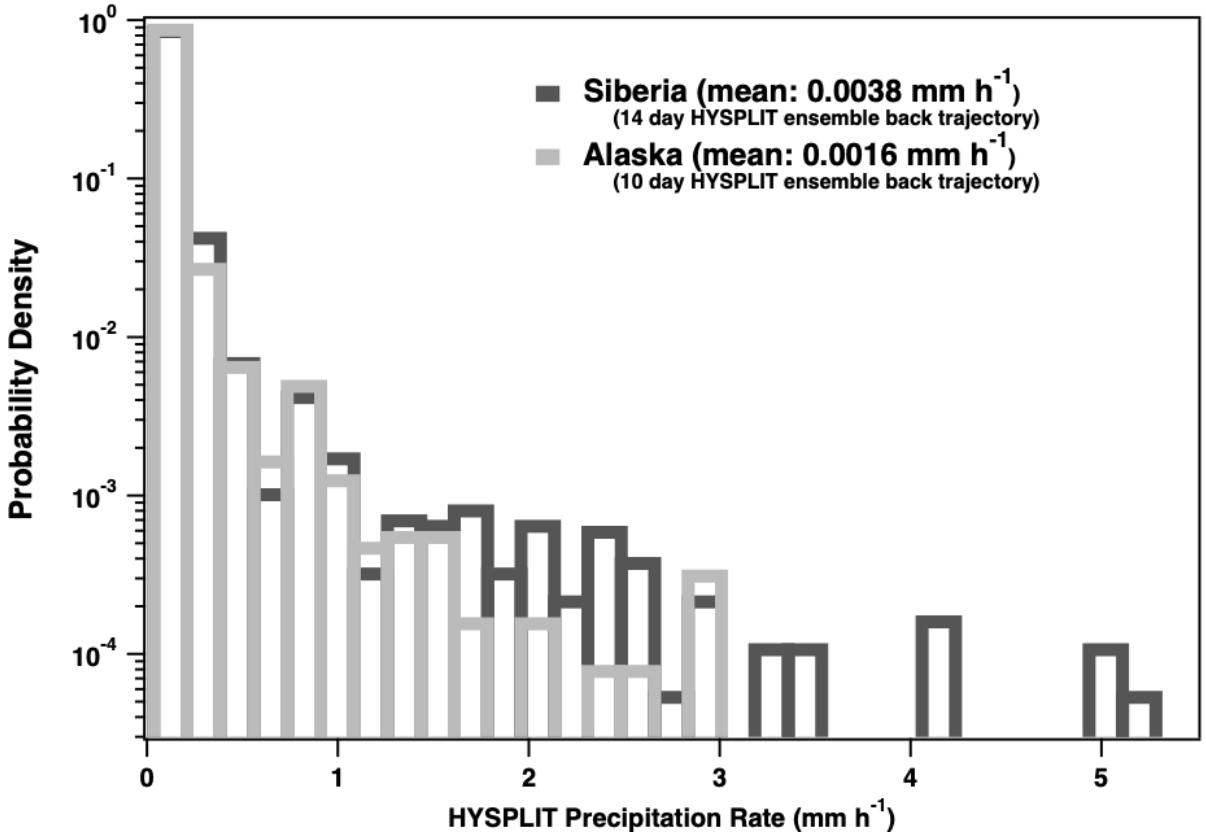

Figure S8. Probability density of precipitation rates (mm h^{-1}) from NOAA HYSPLIT ensemble back trajectories for Alaska (10 days) and Siberia (14 days) BB events observed July and August 2019 at MBO.

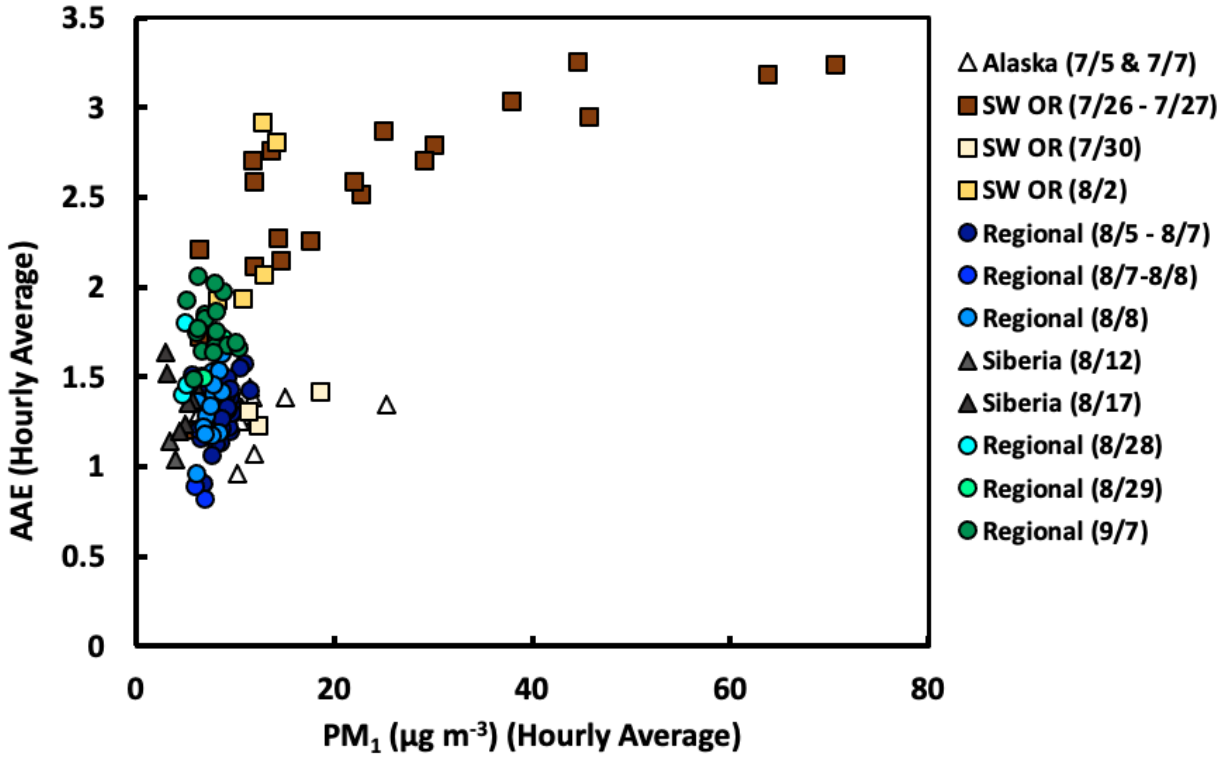

Figure S9. 1 hr average AAE values and 1 hr average PM_1 concentrations plotted for all BB events July – September 2019 observed at MBO. AAE describes particle composition with larger values indicating greater BrC content. BB events are colored by source, with Boreal (Alaska, Siberia) shown as triangles in shades of grey, SW OR shown as squares in shades of brown, and Regional shown as circles in shades of blue to green.

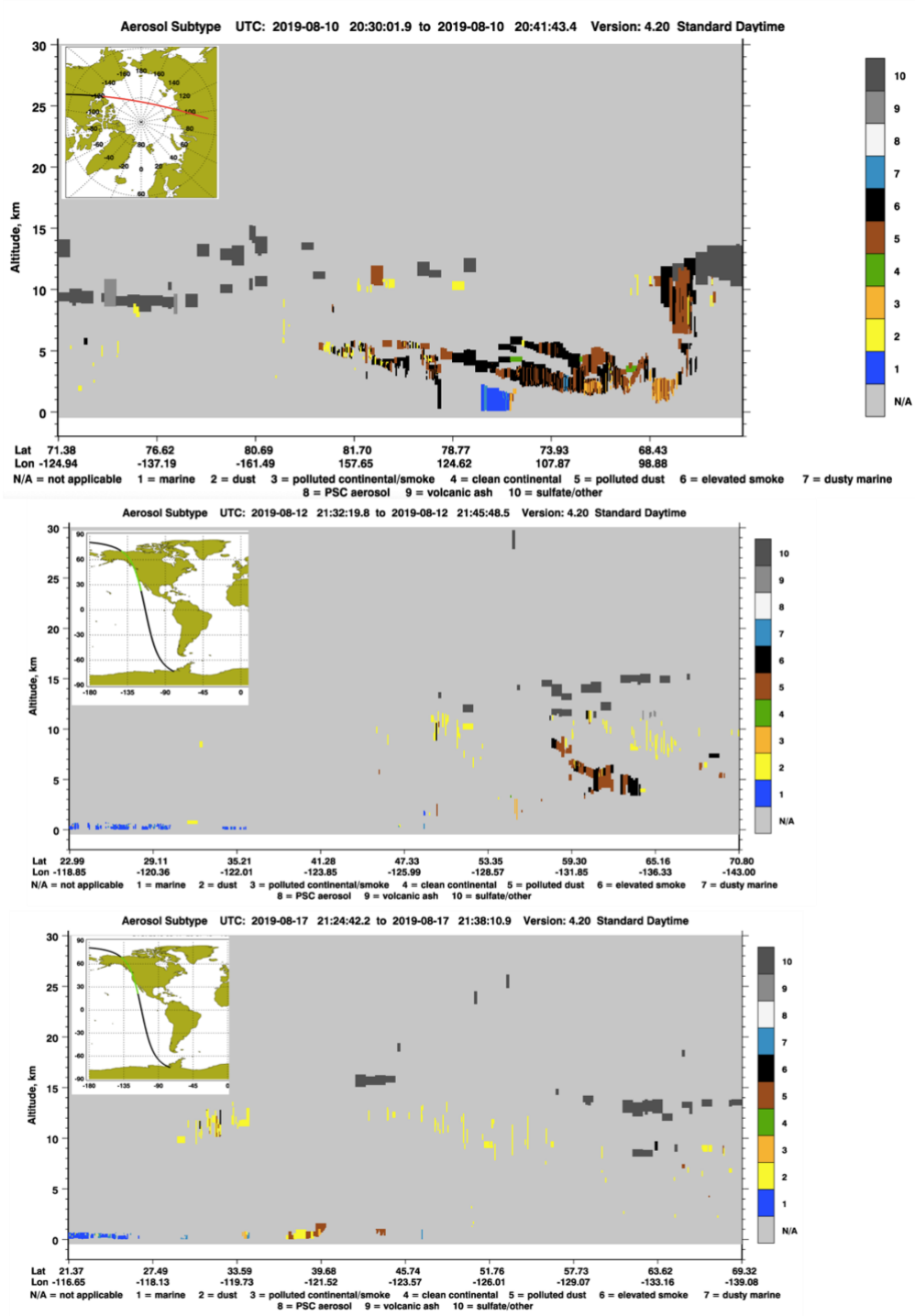

Figure S10. (top) August 10, (middle) August 12, (bottom) August 17NASA CALIPSO satellite transects documenting the transport of August 2019 Siberian Boreal Forest fires to the western US.

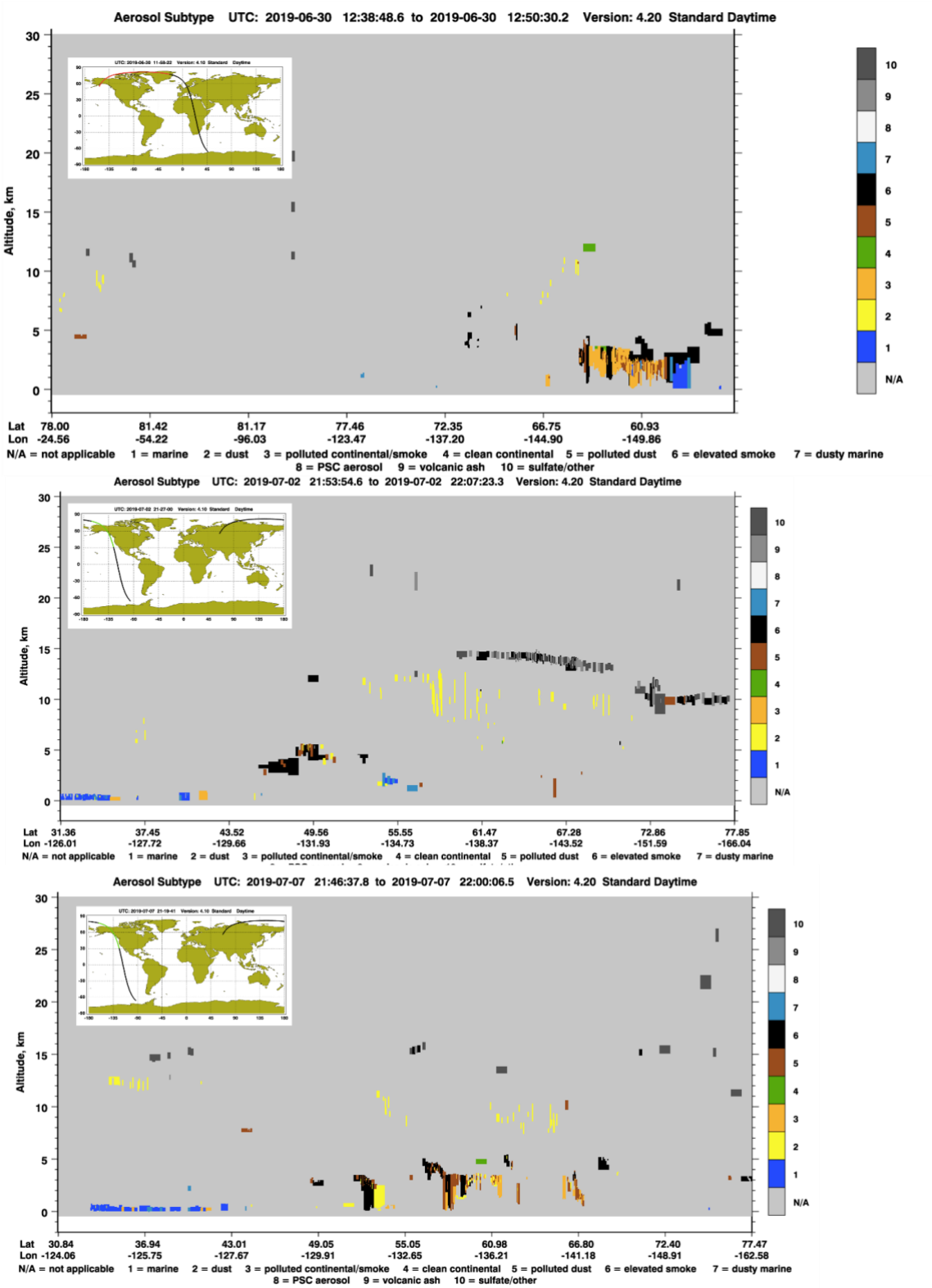

Figure S11. (top) June 30, (middle) July 2, and (bottom) July 7 NASA CALIPSO satellite transects documenting the transport of June/July 2019 Alaskan Boreal Forest fires to the western US.