

Figure 1. Topographic map with the AirNow (diamond), NYSM standard sites (dot) and NYSM profiler sites (cross) used in this study. Sites are grouped into three regions: western NYS (blue circle), central NYS (red circle) and near-NYC (green circle). Details of these sites are listed in table 2 and 3.

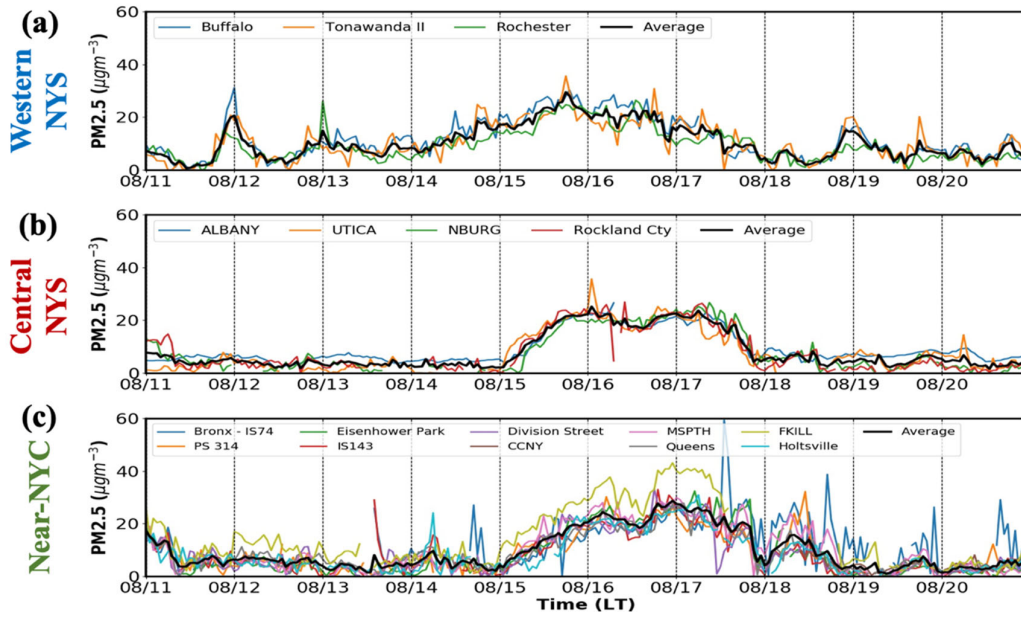


Figure 2. Timeseries of PM_{2.5} mass concentrations during Aug 11th – 20th, 2018, at AirNow air quality sites in (a) western NYS, (b) central NYS and (c) near-NYC. Thick black lines represent the regional averages of each region.

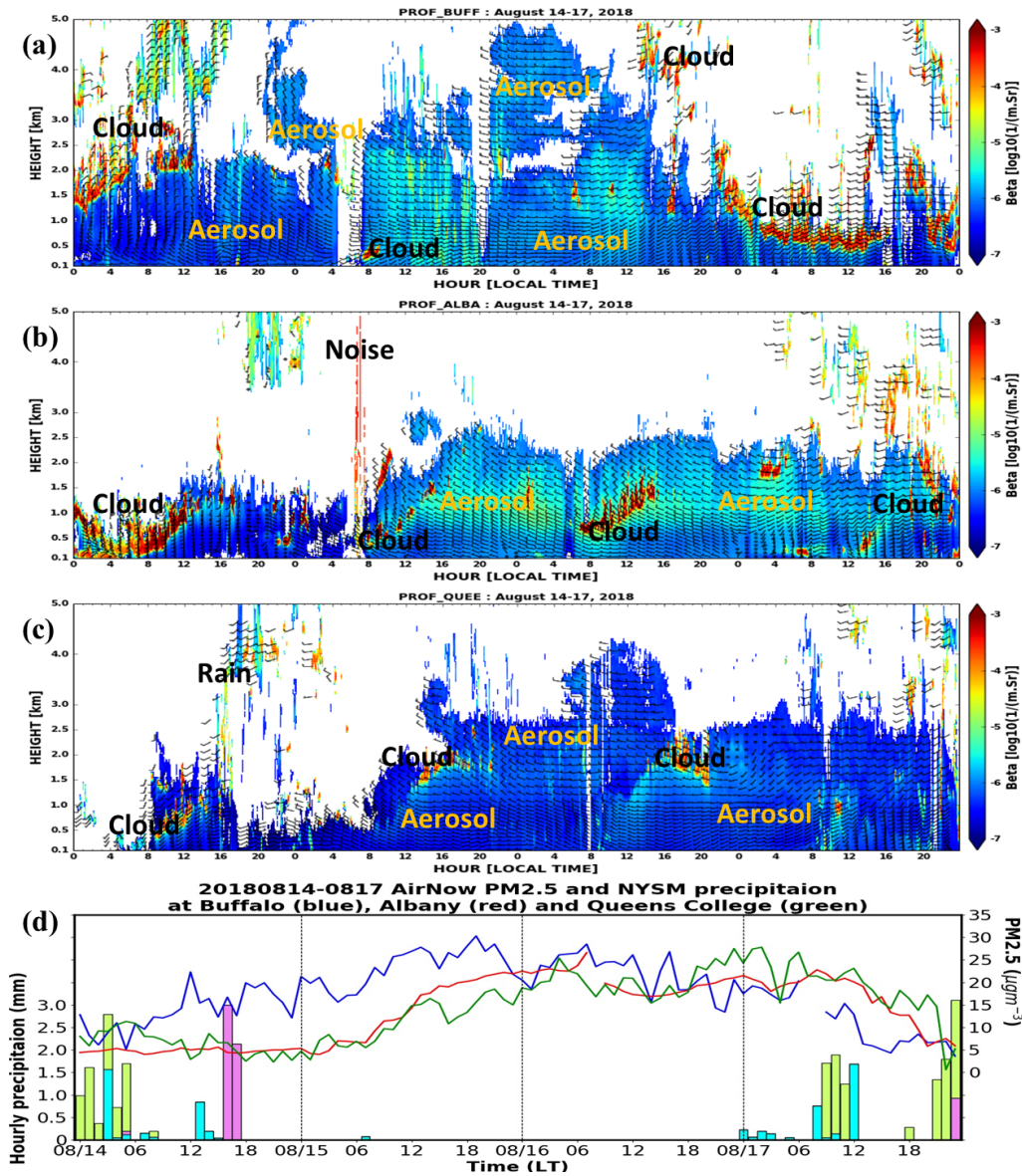


Figure 3. Vertical profiles of lidar backscattering (shaded; $\log_{10}(\text{m sr}^{-1})$) and 10-min averaged horizontal winds (barb) at the NYSM profiler sites at (a) Buffalo, (b) Albany and (c) Queens during August 14th – 17th, 2018. (d) Timeseries of PM_{2.5} concentrations (line) and precipitation (bar) at AirNow and NYSM standard sites over western NYS (blue), central NYS (red) and near-NYC (green) region, respectively.

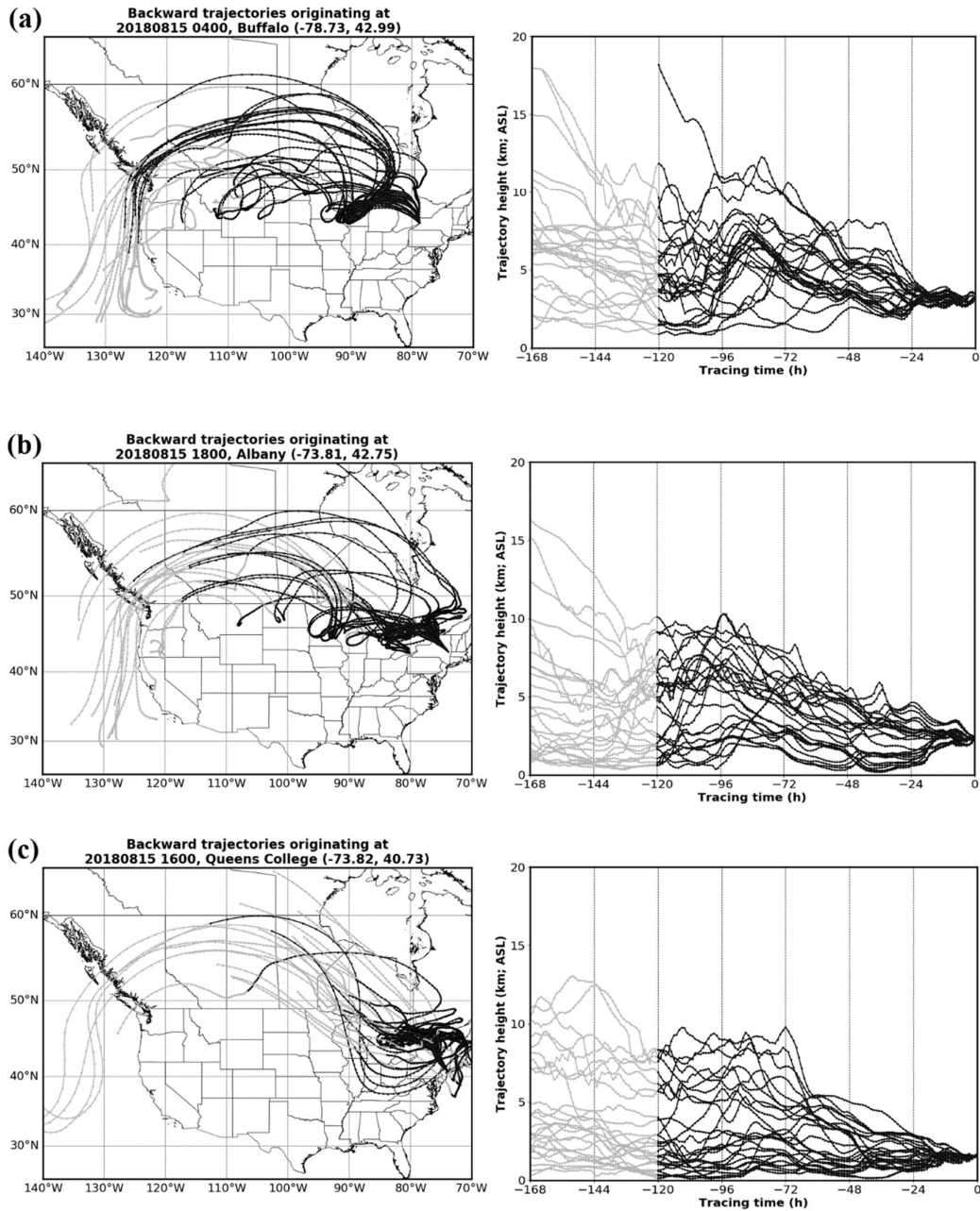


Figure 4. Seven-day ensemble backward trajectories, calculated by HYSPLIT model, originating at (a) 3000 m a.g.l. at BUFF on August 15th 0400 UTC, (b) 2000 m a.g.l. at ALBA on August 15th 1800 UTC, and (c) 1500 m a.g.l. at QUEE on August 15th 1600 UTC. The releasing height and time were determined by lidar observations at each site. Black and gray lines illustrate the trajectories during the tracing time of -120 – 0 h and -168 – -121 h, respectively.

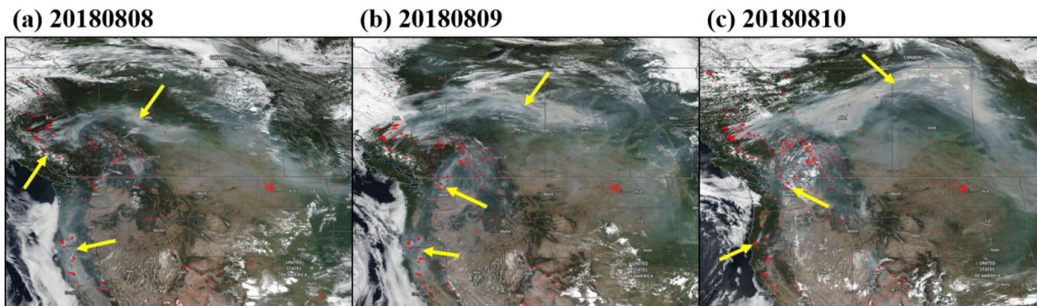


Figure 5. VIIRS true color image and fire counts on August (a) 8th, (b) 9th and (c) 10th 2018. The screenshots are taken from the NASA Earth Observing System Data and Information System (EOSDIS) Worldview (<https://worldviewearthdata.nasa.gov/>). Yellow arrows indicate the smoke plumes emitted from fire activities.

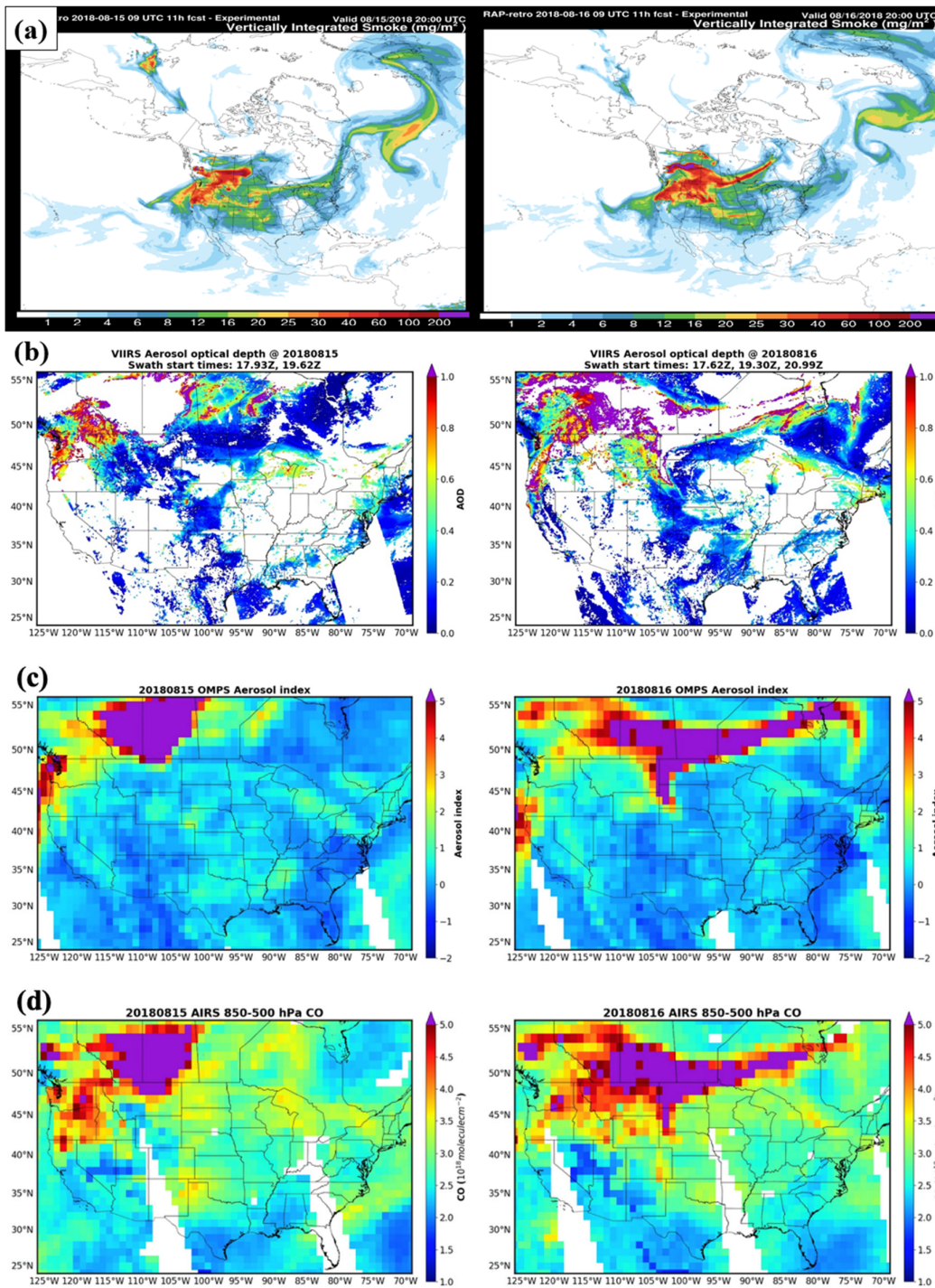


Figure 6. (a) RAP-Smoke vertical integrated smoke concentration, (b) VIIRS AOD, (c) OMPS AI and (d) AIRS column CO number concentration at 850 – 500 hPa on August 15th (left) and 16th (right), 2018.

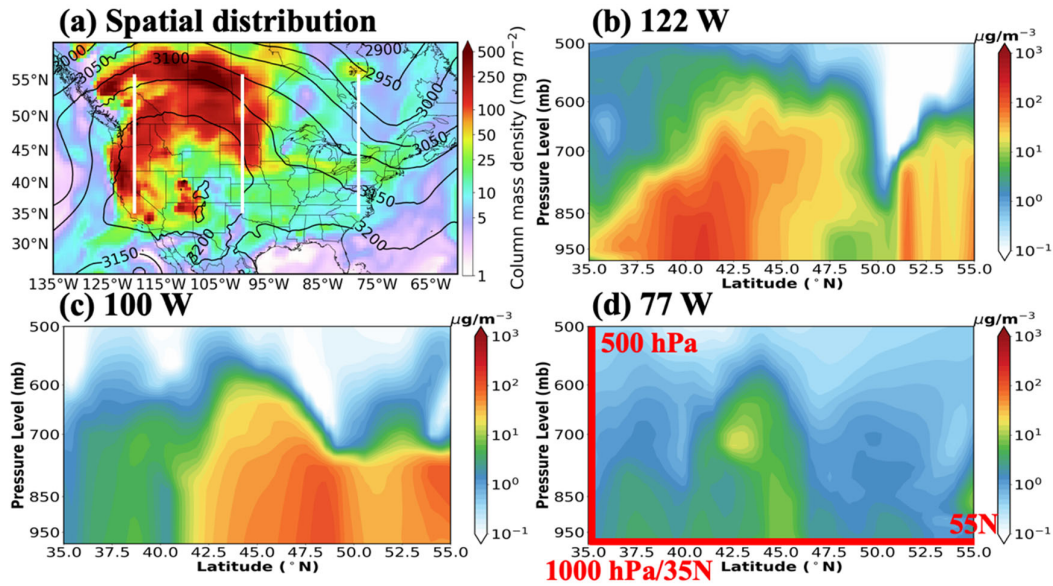


Figure 7. The (a) geopotential height at 700 hPa (contour) and spatial distribution of smoke column mass density (shaded), and meridional cross-sections of smoke mass concentrations at (b) 122W, (c) 100W and (d) 77W from MERRA-2 reanalysis on August 10th 00Z. White lines in (a) represent the location of cross-sections. Red numbers in (d) show the coordinate of the cross-sections.

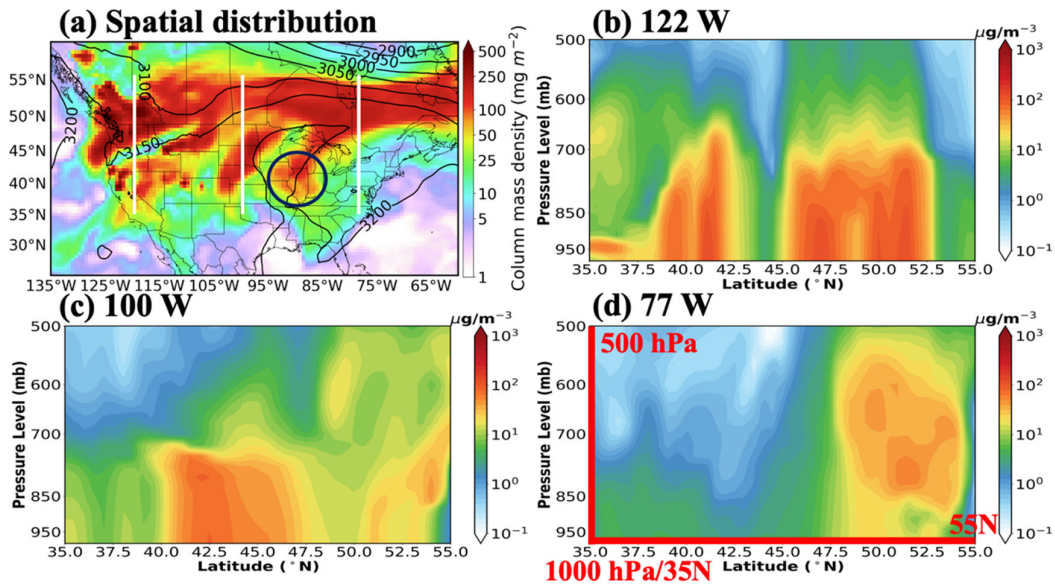


Figure 8. The (a) geopotential height at 700 hPa (contour) and spatial distribution of smoke column mass density (shaded), and meridional cross-sections of smoke mass concentrations at (b) 122W, (c) 100W and (d) 77W from MERRA-2 reanalysis on August 13th 00Z. White lines in (a) represent the location of cross-sections. The black circle in (a) indicates the dispersed smoke plume. Red numbers in (d) show the coordinate of the cross-sections.

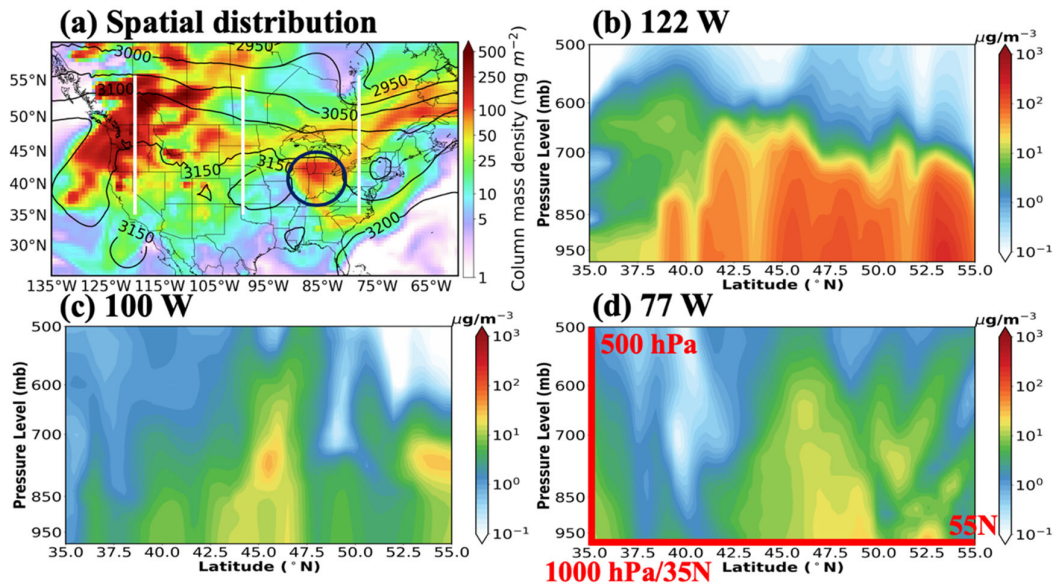


Figure 9. The (a) geopotential height at 700 hPa (contour) and spatial distribution of smoke column mass density (shaded), and meridional cross-sections of smoke mass concentrations at (b) 122W, (c) 100W and (d) 77W from MERRA-2 reanalysis on August 15th 00Z. White lines in (a) represent the location of cross-sections. The black circle in (a) indicates the dispersed smoke plume. Red numbers in (d) show the coordinate of the cross-sections.

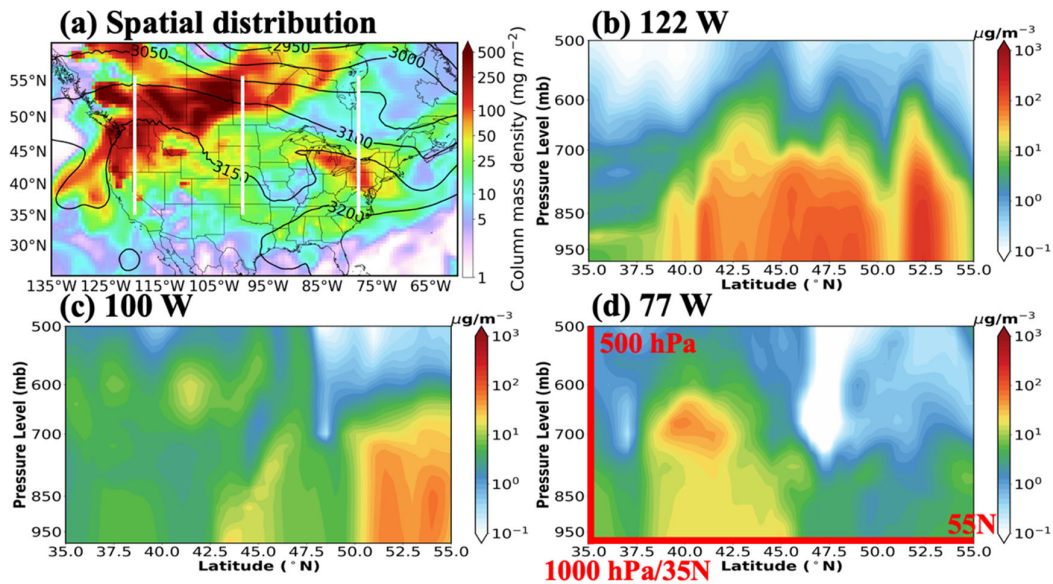


Figure 10. The (a) geopotential height at 700 hPa (contour) and spatial distribution of smoke column mass density (shaded), and meridional cross-sections of smoke mass concentrations at (b) 122W, (c) 100W and (d) 77W from MERRA-2 reanalysis on August 16th 00Z. White lines in (a) represent the location of cross-sections. Red numbers in (d) show the coordinate of the cross-sections.

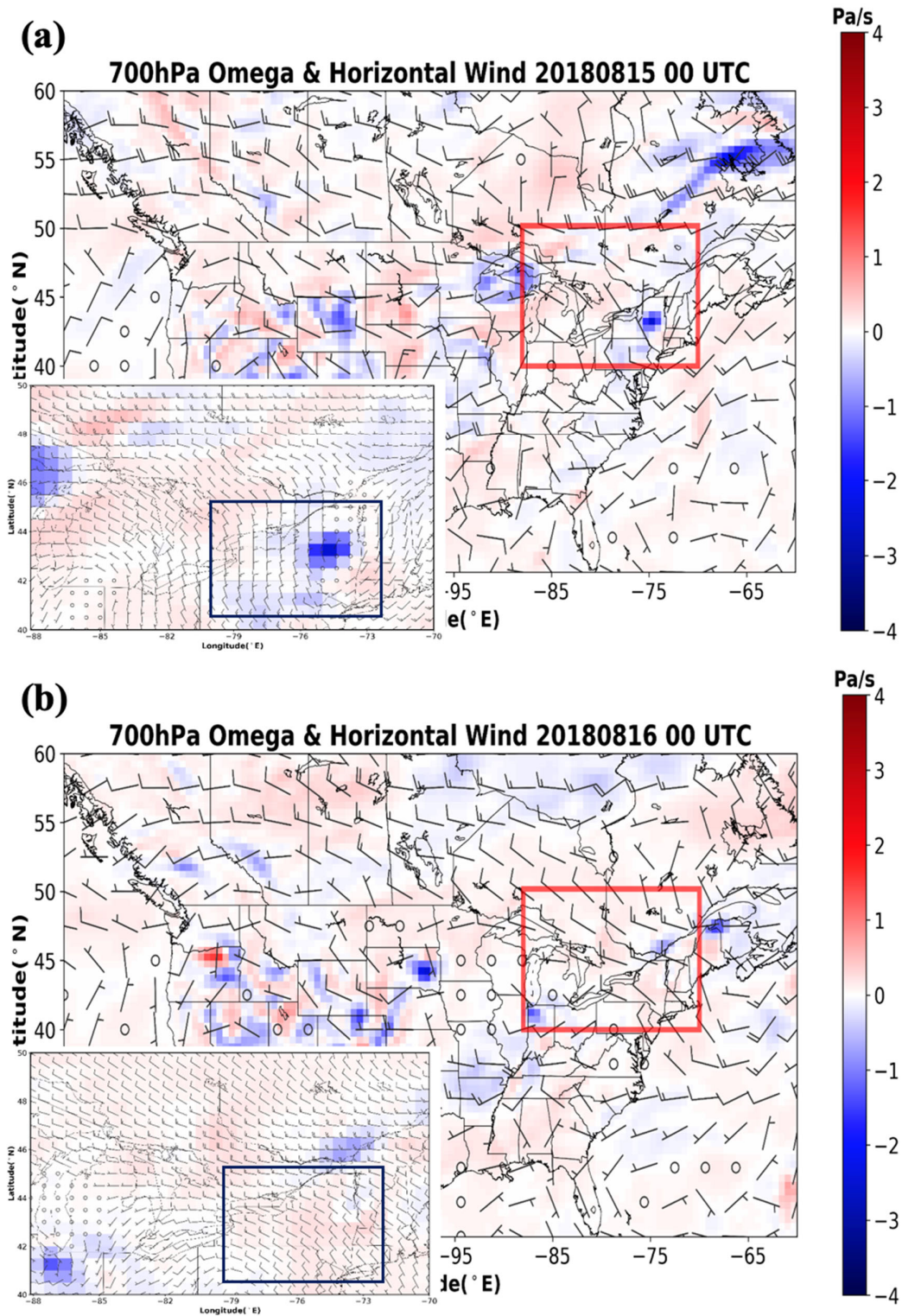


Figure 11. The 700 hPa vertical velocity (shaded) and horizontal wind (barbs) from HRRR analysis on (a) August 15th and (b) 16th. Red boxes are shown as the left bottom panels. Blue boxes represent the location of NYS.

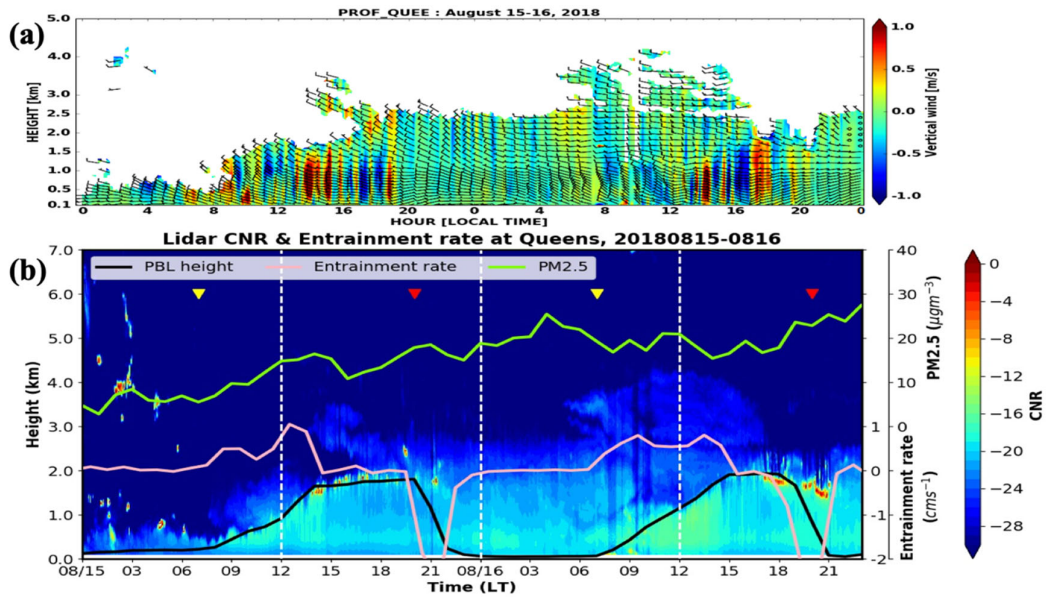


Figure 12. Temporal variations of the (a) 10-min averaged lidar vertical winds (shaded) and horizontal winds (barbs), and (b) lidar CNR (shaded), BL height (black line), entrainment rate (pink line) and PM_{2.5} mass concentration (green line) in the near-NYC region on August 15th – 16th, 2018. In (a), positive and negative values represent vertical updraft and downdrafts, respectively. Wind barbs are displayed every 40 minutes to avoid congestion. In (b), the yellow and red triangles near the top of the figure indicate the times of sunrise and sunset, respectively.

Dataset	Version/Level	Spatial resolution	Temporal resolution	Data source
Satellite observations				
VIIRS	V1/L3	6 km	Daily	NOAA CLASS ¹
OMPS	V2.1/L3	0.5° x 0.5°	Daily	NASA EARTHDATA ²
AIRS	V6/L3	1° x 1°	Daily	NASA EARTHDATA
Model products				
HRRR	V3	3 km	Hourly	NCEP Products Inventory ³
RAP-Smoke	Experimental	13.5 km	Hourly	RAP-Smoke Model Fields ⁴
MERRA-2	V5.12.4	0.5° x 0.625°	3-hourly	NASA EARTHDATA
In-situ measurements				
AirNow	L1	Site	Hourly	Air Data ⁵
NYSM	L0	Site	5 min	NYS Mesonet ⁶

Table 1. Summary of data sources. Links for data sources:

¹ <https://www.bou.class.noaa.gov/saa/products/welcome>

² <https://earthdata.nasa.gov/>

³ <https://www.nco.ncep.noaa.gov/pmb/products/hrrr/>

⁴ <https://rapidrefresh.noaa.gov/RAPsmoke/>

⁵ <https://www.epa.gov/outdoor-air-quality-data>

⁶ <http://www.nysmesonet.org/data/requestdata>

Label	Name	Id number	Location (Lat, Lon)	Region
1	Buffalo	360290005	42.88, -78.81	Western NYS
2	Tonawanda II	360291014	43.00, -78.90	Western NYS
3	Rochester*	360551007	43.15, -77.55	Western NYS
4	Albany*	360010005	42.64, -73.75	Central NYS
5	UTICA	360652001	43.10, -75.22	Central NYS
6	NBURG	360710002	41.50, -74.01	Central NYS
7	Rockland Cty	360870005	41.18, -74.03	Central NYS
8	Bronx - IS74	360050112	40.81, -73.89	Near-NYC
9	PS 314	360470052	40.64, -74.02	Near-NYC
10	Eisenhower Park	360590005	40.74, -73.59	Near-NYC
11	IS143	360610115	40.85, -73.93	Near-NYC
12	Division Street	360610134	40.71, -73.99	Near-NYC
13	CCNY	360610135	40.82, -73.95	Near-NYC
14	MSPTH	360810120	40.73, -73.89	Near-NYC
15	Queens*	360810124	40.74, -73.82	Near-NYC
16	FKILL	360850111	40.58, -74.20	Near-NYC
17	Holtsville	361030009	40.83, -73.06	Near-NYC

Table 2. List of AirNow air quality sites in NYS used in this study. Site labels are referred to fig. 1. Sites using Federal Equivalence Method (FEM) are marked with asterisks.

Type	Label	Name	Location (Lat, Lon)	Region
Standard site	BUFF	Buffalo	43.00, -78.76	Western NYS
	VOOR	Voorheesville	42.65, -73.98	Central NYS
	QUEE	Queens	40.73, -73.82	Near-NYC
Profiler site	BUFF	Buffalo	43.00, -78.79	Western NYS
	WEBS	Webster	43.26, -77.41	Western NYS
	ALBA	Albany	42.75, -73.81	Central NYS
	REDH	Red Hook	42.00, -73.88	Central NYS
	QUEE	Queens	40.73, -73.82	Near-NYC
	WANT	Wantagh	40.65, -73.51	Near-NYC

Table 3. List of NYSM sites used in this study. Site labels are referred to fig. 1.