

Fig1. LED Frequency Distribution from June to August, 2023

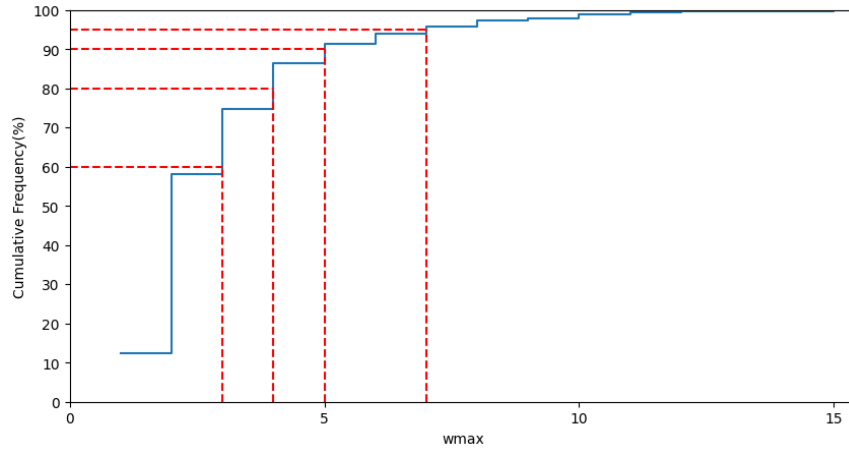


Fig2. Simulated maximum vertical velocity Frequency Distribution from June to August, 2023

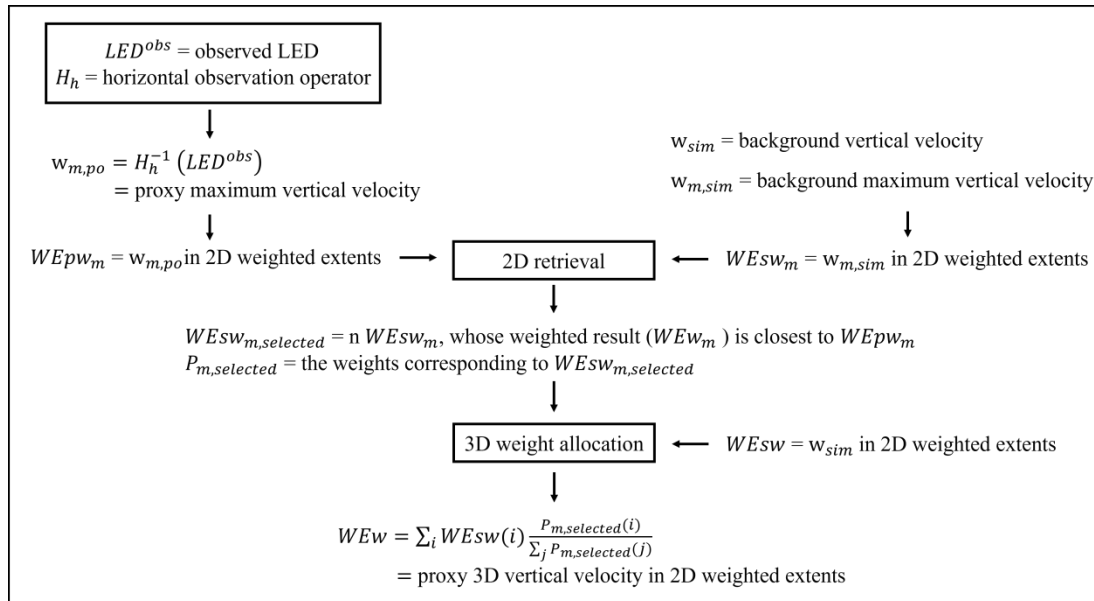


Fig3. Flow chart showing the sequence of operations performed in the Lightning data assimilation of vertical velocity.

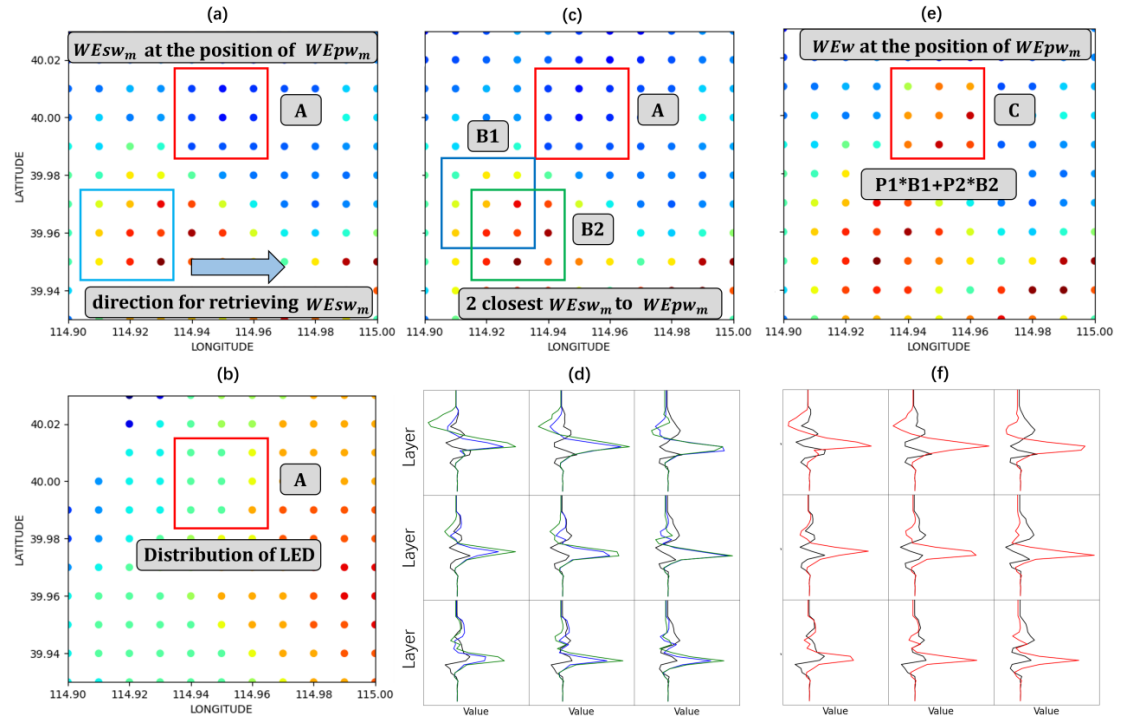


Fig4. Flow chart showing the sequence of operations to obtain the horizontal weights through lightning assimilation and transfer the weights to vertical velocity profile. (a), (c), and (e) show the distribution of maximum vertical velocity, (b) shows the LED distribution, and (d) displays the vertical velocity profiles at the positions of A (black), B1 (blue), and B2 (green). (f) presents the vertical velocity profiles at the positions of A (black) and C (red).

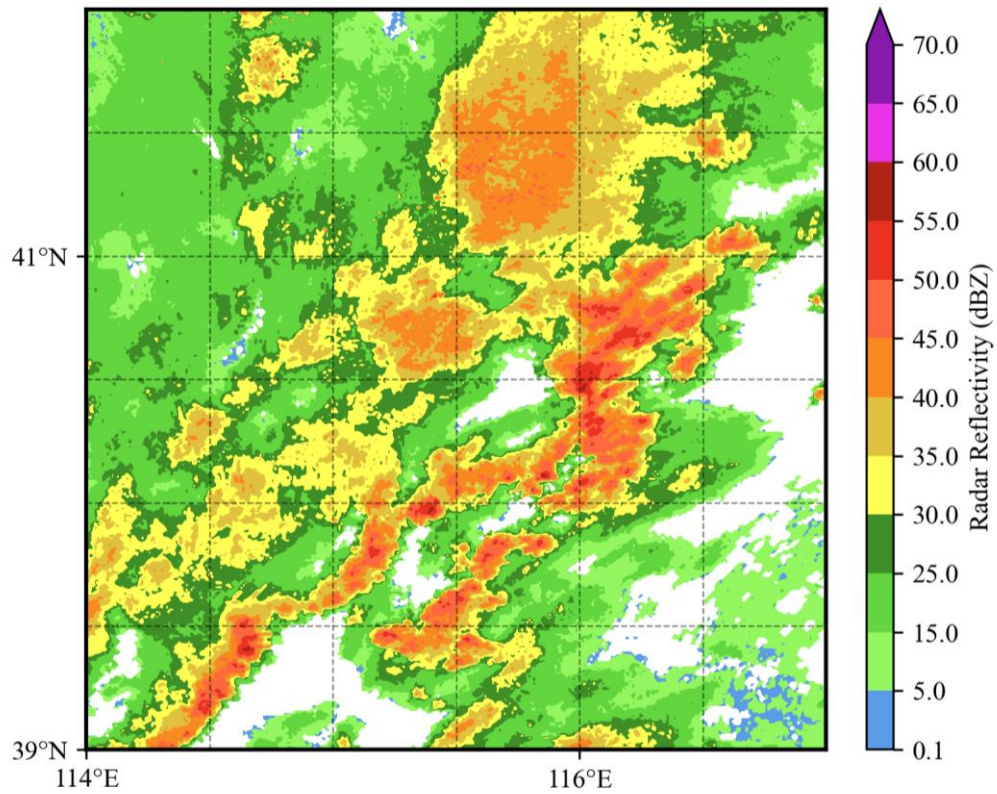


Fig5. Radar combination reflectivity at 18:00 on August 20, 2023

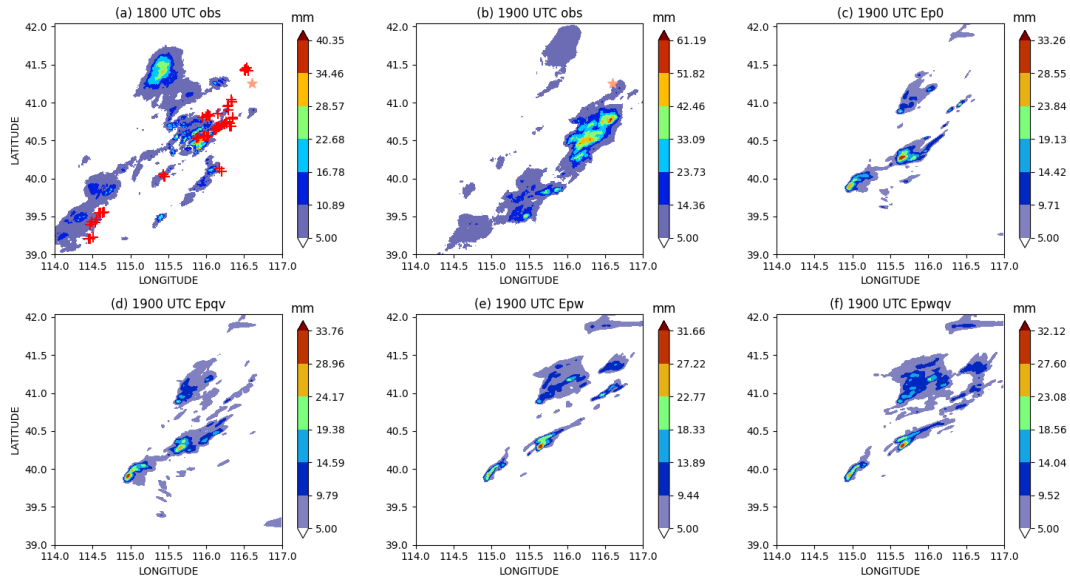


Fig6. (a) Precipitation observation between 1700 UTC and 1800 UTC, with lightning occurrences (red plus signs) and wind profiler radar location (orange star); (b) Precipitation observation between 1800 UTC and 1900 UTC. (c-f) Forecast results at 1900 UTC for Ep0, Epw, Epqv, and Epwqv.

Table1. Table relationship between LED and maximum vertical velocity and water vapor mixing ratio

LED	W_{LEDmax}	QV_{LEDmax}
1	3	0.1
2-7	6	0.13
8-10	9	0.17
11-15	12	0.2

Table2. Experiment design for assimilation settings and the corresponding TS score

Experiment	Assimilation Settings	TS Score
Ep0	No Assimilation	0.04
Epw	Assimilate vertical velocity	0.17
Epqv	Assimilate RH	0.05
Epwqv	Assimilate vertical velocity and RH	0.46