



*Supplement of*

## **The unexpected high frequency of nocturnal surface ozone enhancement events over China: characteristics and mechanisms**

**Cheng He et al.**

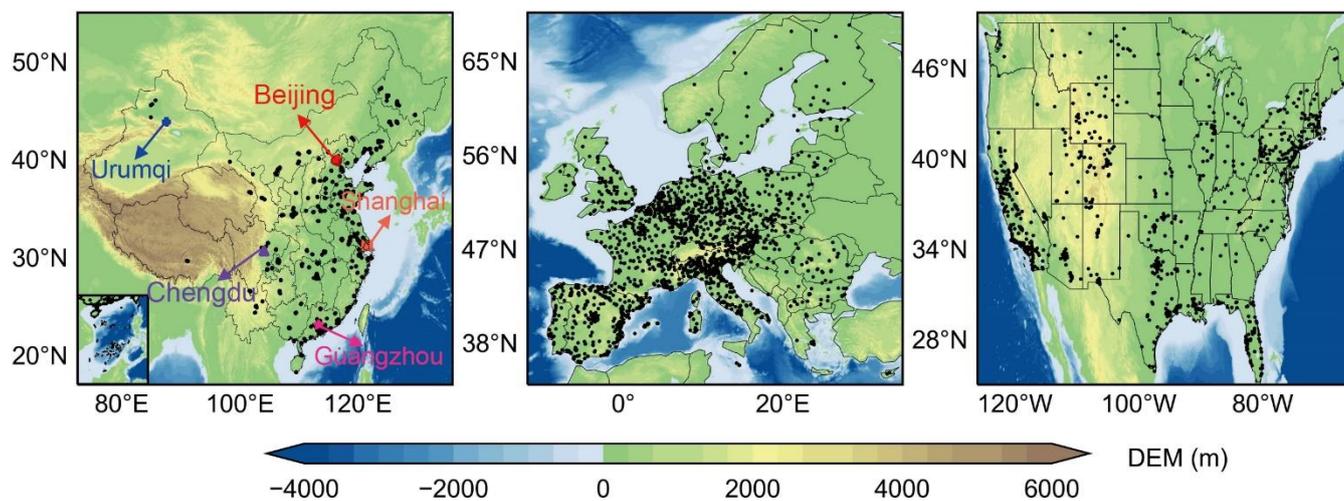
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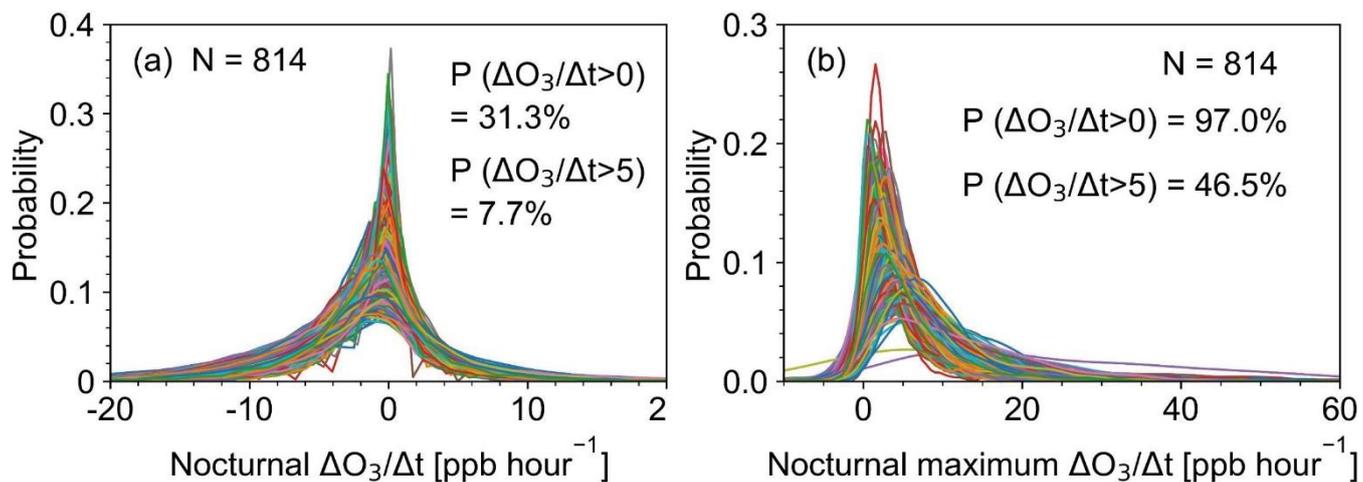
## Data quality control procedures

An ozone data record ( $x_i$ ) is removed if it meets the one of the following criteria:

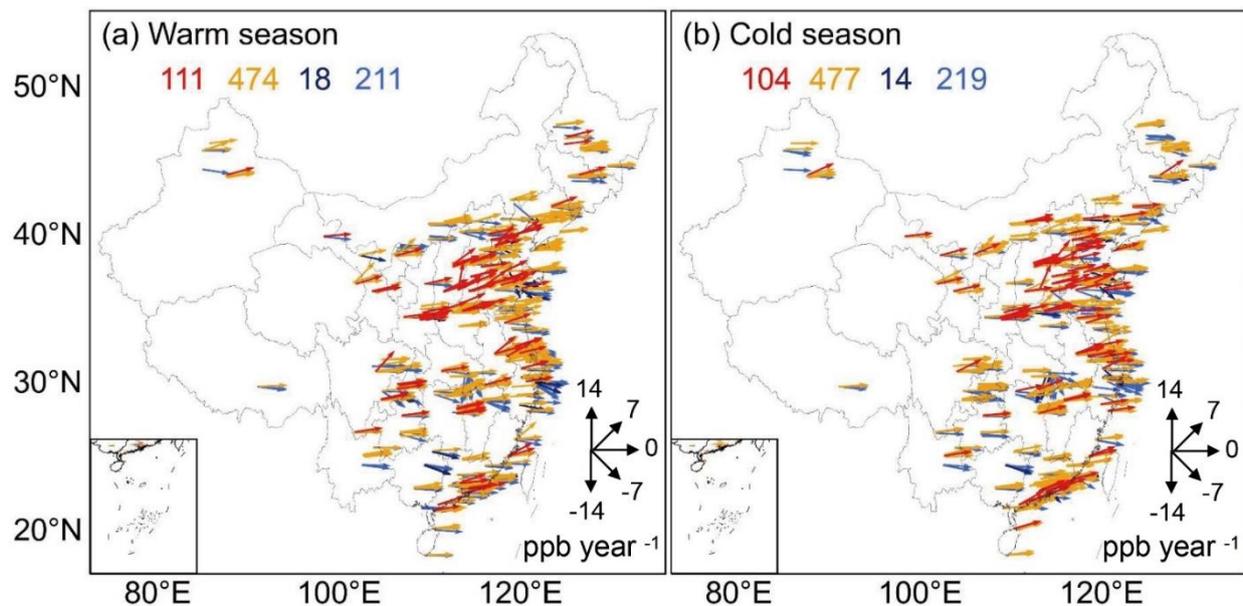
- (1) With values exceeding 500 ppbv which are highly unreliable;
- (2) With a standardize value ( $z_i = \frac{x_i - \bar{x}}{\sigma}$ , calculated for each month) large than 5;
- (3) With more than three records of the same values in any consecutive five-hour period;
- (4) If  $(x_i - x_{i-1})(x_{i+1} - x_i) > 0$  and  $(|x_i - x_{i-1}| + |x_{i+1} - x_i|) > 100$  ppbv.



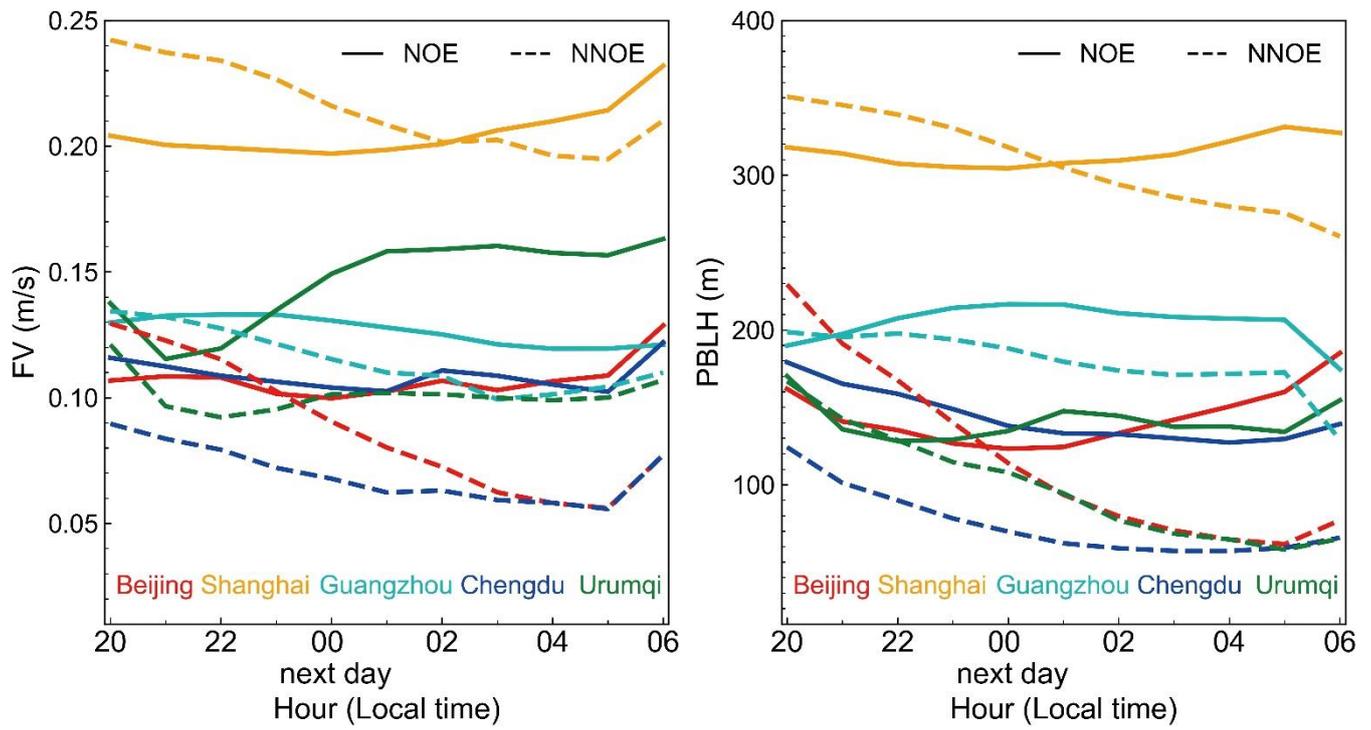
**Figure S1.** Distribution of ozone monitoring sites selected in China, US, and Europe. The red spots mark selected cities.



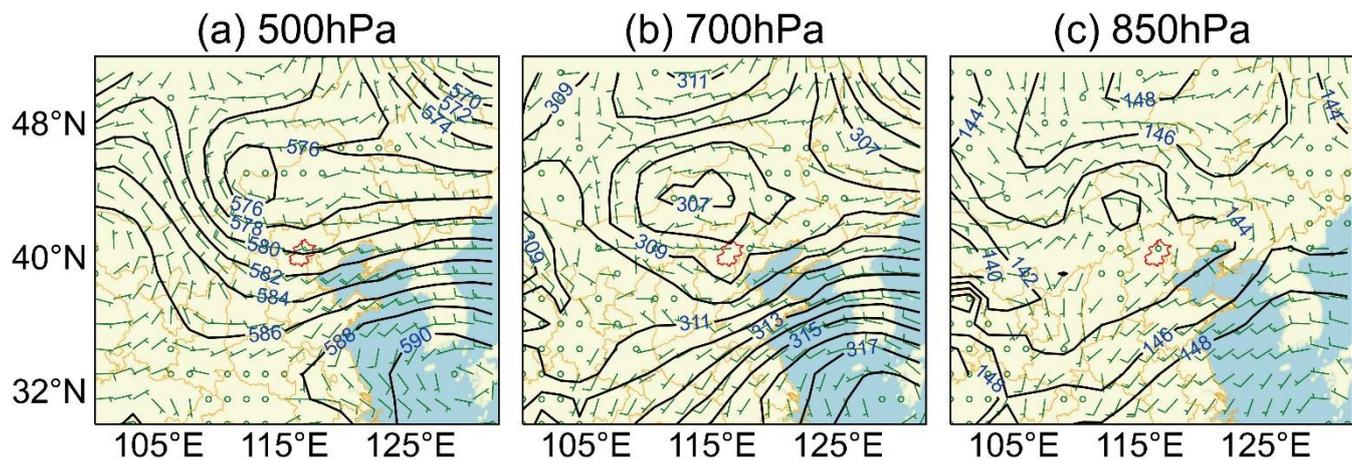
**Figure S2.** Probability density distribution of hourly (a) and daily maximum (b) nocturnal ozone fluctuation ( $\Delta O_3/\Delta t$ ) at all Chinese sites (represented by each curve) in 2014-2019.



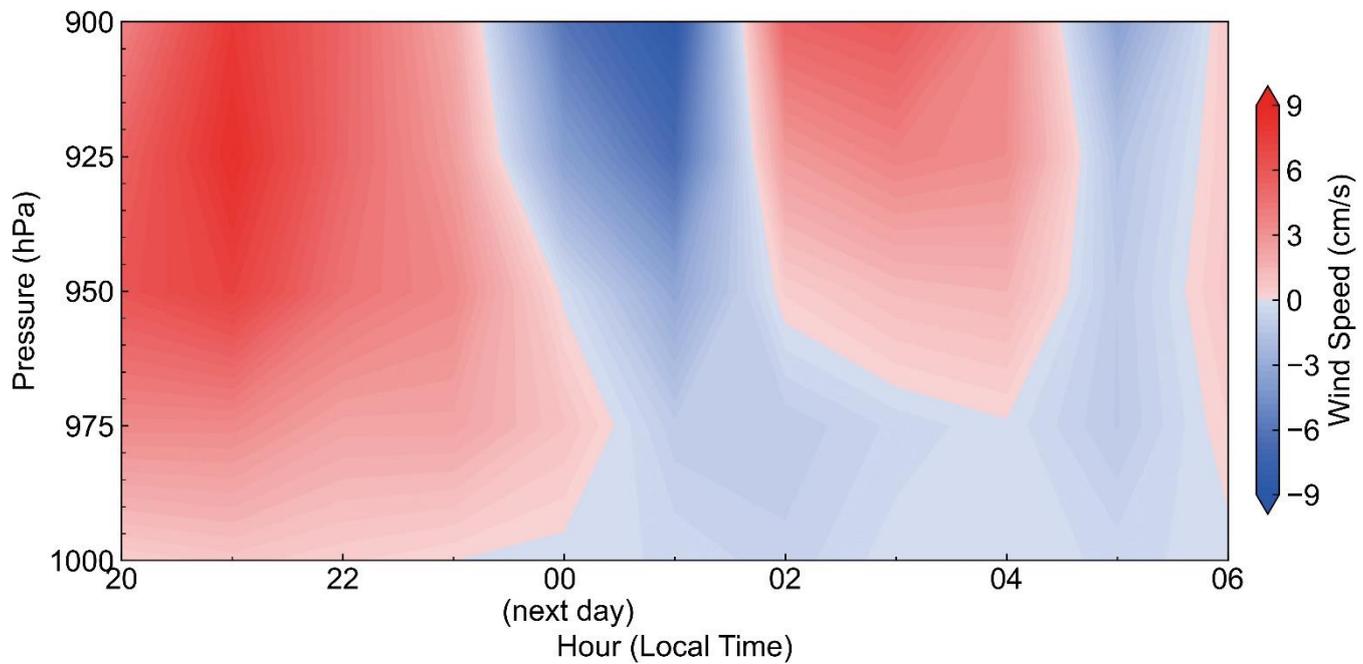
**Figure S3.** Trends of the peak ozone concentration in NOE events from 2014-2019 in the (a) warm season (April-September) and (b) cold season (October-March). Both directions and colors of the vectors in figures indicate the frequency change rates of the concentration in unit of  $\text{ppb year}^{-1}$ , the deep red and blue colors indicate trends with  $p < 0.05$ . The number of sites with positive trend ( $p < 0.05$  and  $P \geq 0.05$ ) and negative trend ( $p < 0.05$  and  $P \geq 0.05$ ) are shown inset.



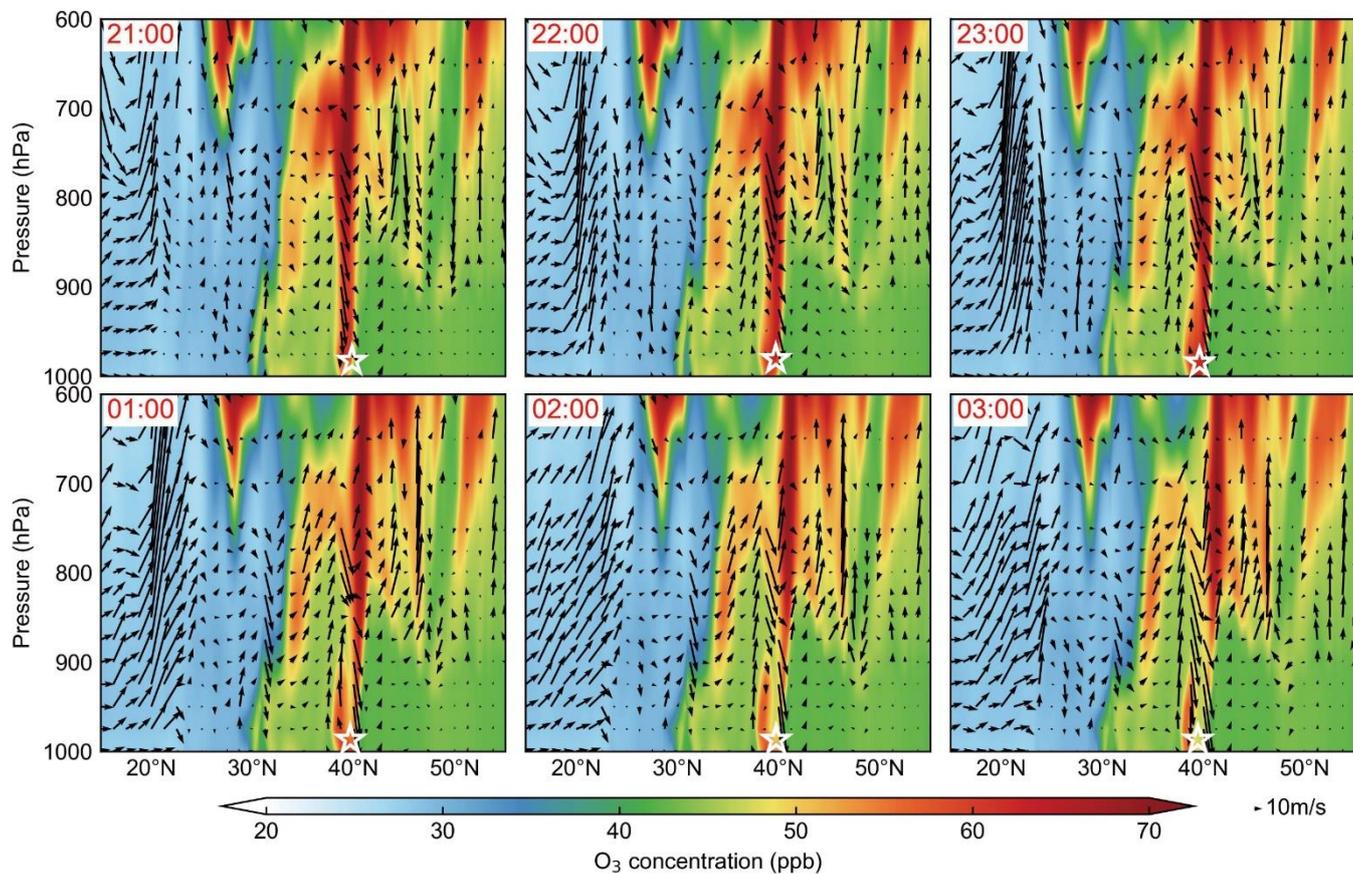
**Figure S4.** Same as Figure 6 (a) and (c) but for the absolute values.



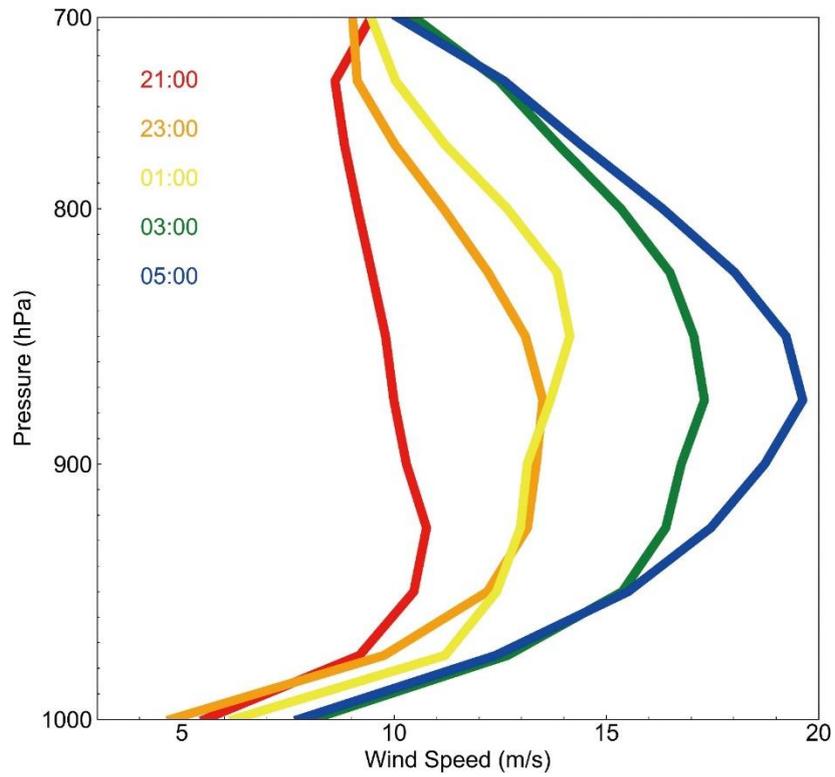
**Figure S5.** Geopotential height and wind field at (a) 500hPa, (b) 700 hPa, (c) 850hPa at 23:00 LT on July 29, 2015. The red area shows the location of Beijing.



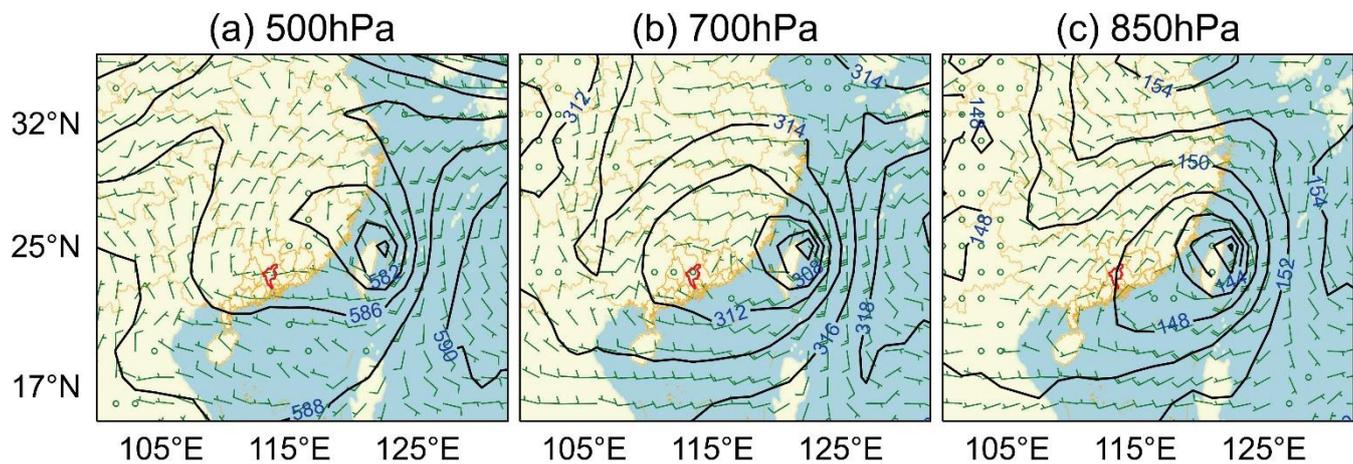
**Figure S6.** Evolution of vertical velocity over Beijing (116.5°E, 40°N) on July 29-30, 2015 in a NOE event.



**Figure S7.** Latitude-altitude cross-section of ozone (shaded) and wind fields of meridional (south-north) and vertical wind (scale by  $10^3$ ) (arrows) at the longitude of 116.5°E in a Beijing NOE event on August 26-27, 2017. The star marks the location of Beijing.



**Figure S8.** Vertical variations of nocturnal wind profiles in Beijing NOE event on August 26-27, 2017, induced by low-level jets.



**Figure S9.** Geopotential height and wind field at (a) 500hPa, (b) 700 hPa, (c) 850hPa at 21:00 LT on September 21, 2014. The red area shows the location of Guangzhou.