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Supplement of

The impact of peripheral circulation characteristics of typhoon on sustained ozone episodes over the Pearl River Delta region, China

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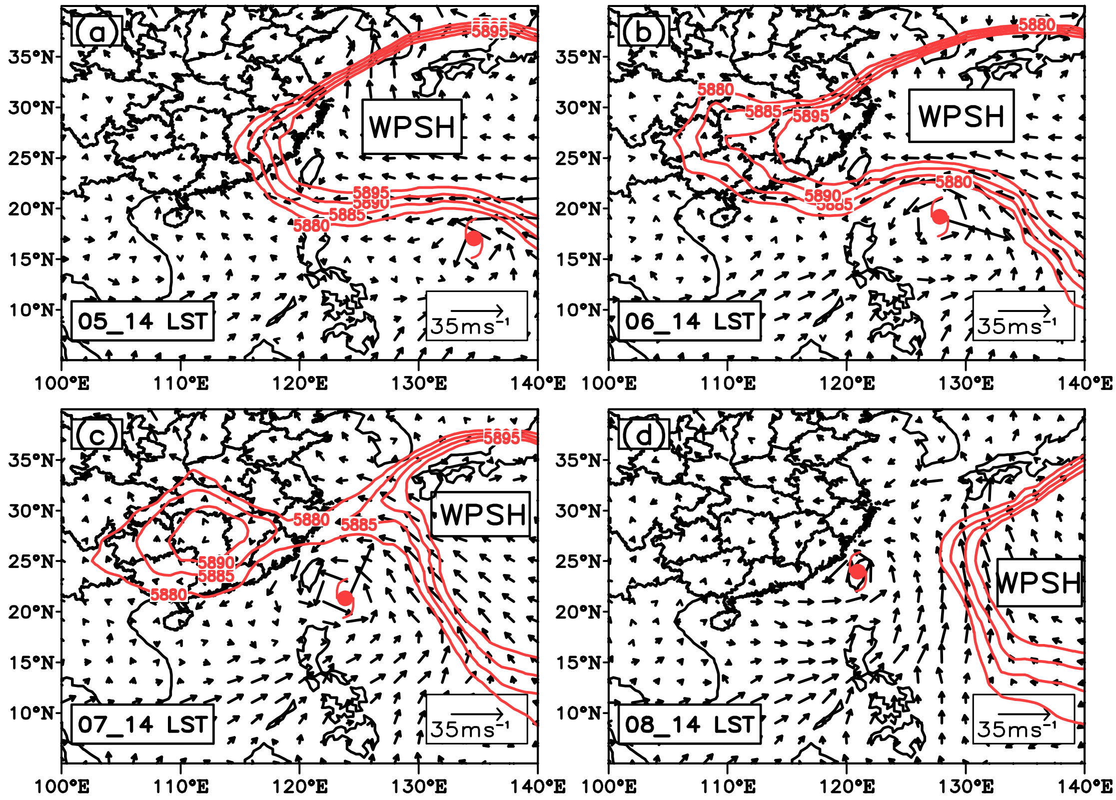

Figure S1. The 1000 hPa horizontal wind vector and the 500 hPa Geopotential height (unit: m/s) of NCEP-FNL data at 14:00 on 5 July (a), 6 July (b),7 July (c) and 8 July(d); the red typhoon signs represent the moving typhoon center and the strings WPSH represent the location of WPSH.

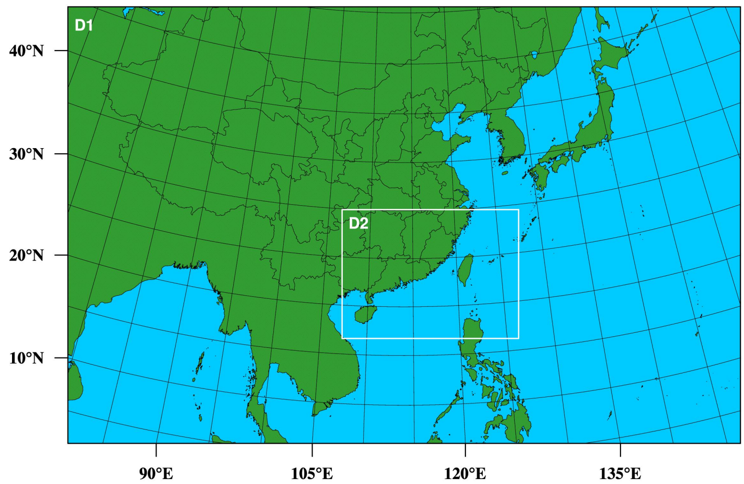

Figure S2. Map of the two nested model domains.

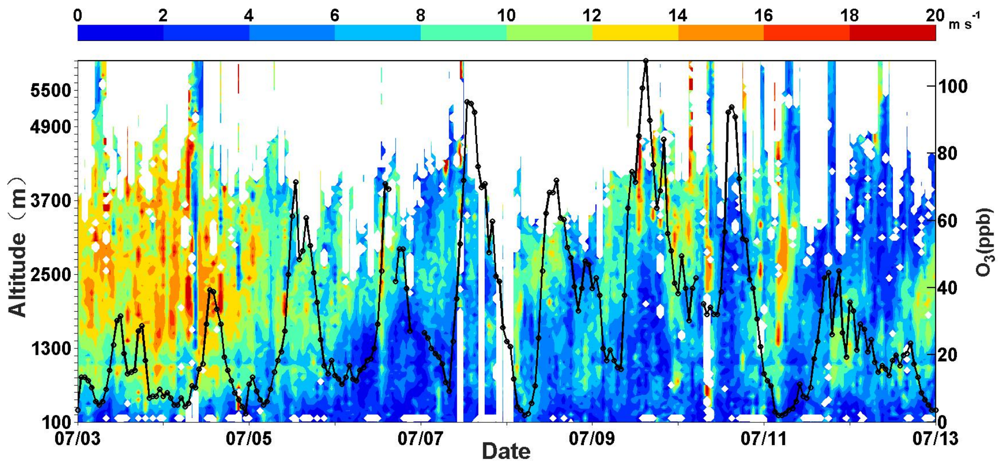

Figure S3. The profile evolution of horizontal wind speed of 59285 wind profile radar station in PRD from 3 July to 13 July; the black solid line denotes the surface ozone concentration.

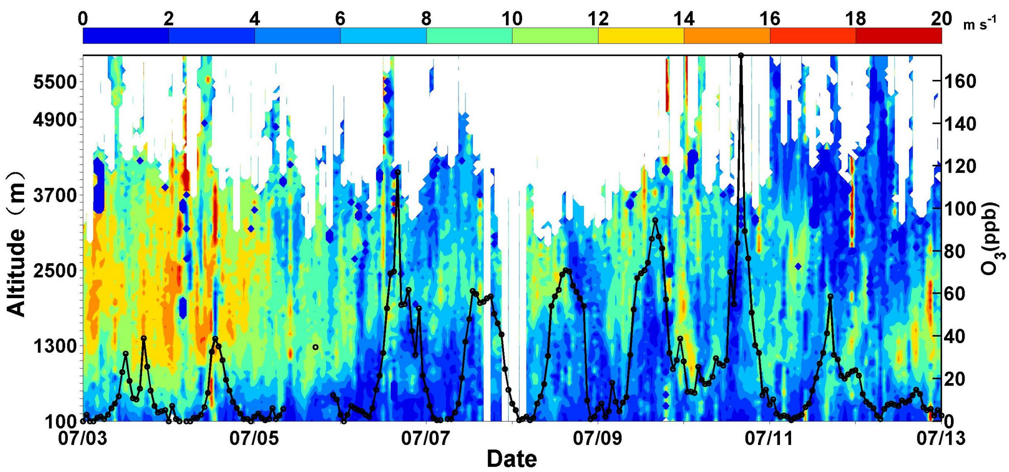

Figure S4. The profile evolution of horizontal wind speed of 59294 wind profile radar station in PRD from 3 July to 13 July;the black solid line denotes the surface ozone concentration.

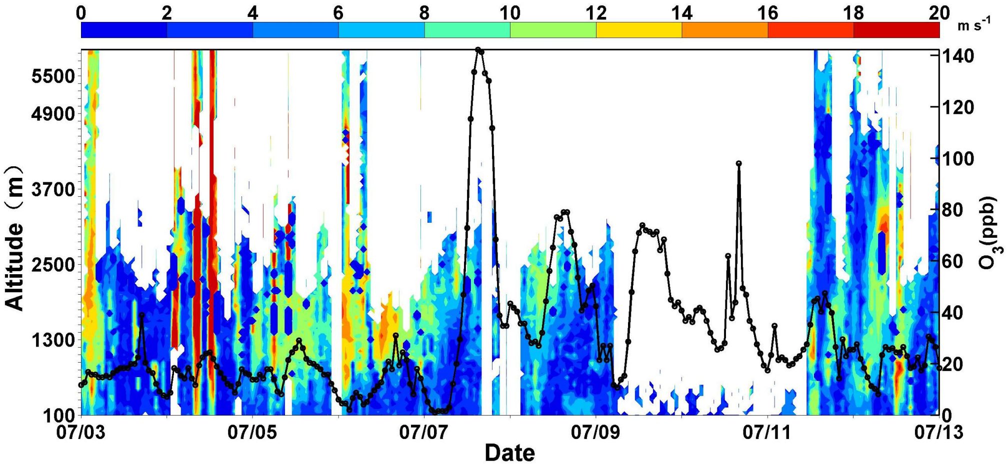

Figure S5. The profile evolution of horizontal wind speed of 59476 wind profile radar station in PRD from 3 July to 13 July; the black solid line denotes the surface ozone concentration.

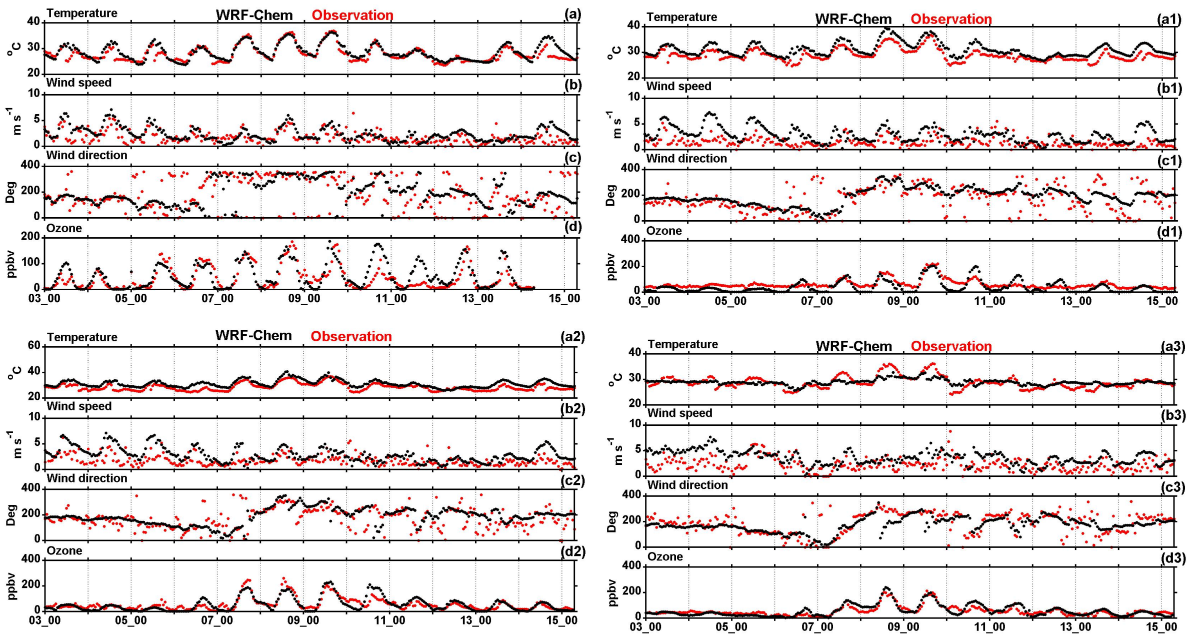

Figure S6. Comparison of measured (red dots) and simulated (black dots) data for temperatures, wind speeds, wind directions, and ozone concentrations at (a-d)Guangzhou, (a1-d1)Shenzhen, (a2-d2)Zhongshan and (a3-d3)Zhuhai.

The derivation of C_{d2} - C_{d1}:

In the numerical IPR analysis, the ozone concentration at any location at time $t+1$ follows Eq. (S1):

$$C_{t+1} = C_t + SUM_{t+1}, \quad (S1)$$

where C_{t+1} and C_t are the ozone concentrations at time $t+1$ and time t, respectively. SUM_{t+1} is the net change in contributions from all of the physical and chemical processes from time t to time $t+1$, and is shown in Eq. (S2):

$$SUM_{t+1} = ADV_{t+1} + CHEM_{t+1} + VMIX_{t+1} + CONV_{t+1}. \quad (S2)$$

As specified in Eqs. (S1) and (S2), ozone concentration is a cumulative amount. Then, according to Eq. (S1), we obtain:

$$C_{t+24} - C_t = \sum_{j=1}^{j=24} SUM_{t+j}, (t = 08:00, 09:00, ..., 20:00), \quad (S3)$$

where C_t and C_{t+24} are the ozone concentrations at the corresponding time on two adjacent days. For example, if C_t is the ozone concentration at 8:00 in the morning on a certain day, C_{t+24} represents the ozone concentration at 8:00 in the next morning. SUM_{t+j} is the sum of the contributions from all of the physical and chemical processes at the corresponding time over the time slots. For example, when t is 08:00, SUM_{08+1} indicates the SUM at 9:00 in the morning, and SUM_{08+24} indicates the SUM at 8:00 in the next morning. To give the daytime average ozone concentration difference of two adjacent days, we use 08:00 and 20:00 as the daytime and nighttime boundaries to reprocess the hourly data into a half-day average. If the daytime average ozone concentrations for two adjacent days are denoted as C_{d1} and C_{d2}, the difference between the daytime average ozone concentrations on two adjacent days can be further expressed by three continuous contribution terms from 09:00 on the first day (d1) to 20:00 on the second day (d2):

$$C_{d2} - C_{d1} = \frac{1}{N}\sum_{t1=09}^{t1=20}(t1-8)\cdot SUM_{t1} + \sum_{t2=21}^{t2=08} SUM_{t2} + \frac{1}{N}\sum_{t3=09}^{t3=20}(21-t3)\cdot SUM_{t3}\ , \quad (S4)$$

where C_{d2} and C_{d1} are the daytime average ozone concentrations on two adjacent days.

According to Eq. (S2) , Eq. (S4) can be further decomposed into the following form:

$$\begin{aligned} C_{d2} - C_{d1} = &\frac{1}{N}\sum_{t1=09}^{t1=20}(t1-8)\cdot CHEM_{t1} + \sum_{t2=21}^{t2=08} CHEM_{t2} + \frac{1}{N}\sum_{t3=09}^{t3=20}(21-t3)\cdot CHEM_{t3} \\ &+ \frac{1}{N}\sum_{t1=09}^{t1=20}(t1-8)\cdot VMIX_{t1} + \sum_{t2=21}^{t2=08} VMIX_{t2} + \frac{1}{N}\sum_{t3=09}^{t3=20}(21-t3)\cdot VMIX_{t3} \\ &+ \frac{1}{N}\sum_{t1=09}^{t1=20}(t1-8)\cdot CONV_{t1} + \sum_{t2=21}^{t2=08} CONV_{t2} + \frac{1}{N}\sum_{t3=09}^{t3=20}(21-t3)\cdot CONV_{t3} \\ &+ \frac{1}{N}\sum_{t1=09}^{t1=20}(t1-8)\cdot ADV_{t1} + \sum_{t2=21}^{t2=08} ADV_{t2} + \frac{1}{N}\sum_{t3=09}^{t3=20}(21-t3)\cdot ADV_{t3}\ . \end{aligned} \quad (S5)$$

The decomposed items are respectively denoted as:

$$TOTAL\_SUM\_CHEM = \frac{1}{N}\sum_{t1=09}^{t1=20}(t1-8)\cdot CHEM_{t1} + \sum_{t2=21}^{t2=08} CHEM_{t2} + \frac{1}{N}\sum_{t3=09}^{t3=20}(21-t3)\cdot CHEM_{t3}\ ,$$

$$TOTAL\_SUM\_VMIX = \frac{1}{N}\sum_{t1=09}^{t1=20}(t1-8)\cdot VMIX_{t1} + \sum_{t2=21}^{t2=08} VMIX_{t2} + \frac{1}{N}\sum_{t3=09}^{t3=20}(21-t3)\cdot VMIX_{t3}\ ,$$

$$TOTAL\_SUM\_CONV = \frac{1}{N}\sum_{t1=09}^{t1=20}(t1-8)\cdot CONV_{t1} + \sum_{t2=21}^{t2=08} CONV_{t2} + \frac{1}{N}\sum_{t3=09}^{t3=20}(21-t3)\cdot CONV_{t3}\ ,$$

$$TOTAL\_SUM\_ADV = \frac{1}{N}\sum_{t1=09}^{t1=20}(t1-8)\cdot ADV_{t1} + \sum_{t2=21}^{t2=08} ADV_{t2} + \frac{1}{N}\sum_{t3=09}^{t3=20}(21-t3)\cdot ADV_{t3}\ .$$

Equation (S5) shows that the daytime average ozone concentration difference of two adjacent days is determined by TOTAL_SUM_CHEM, TOTAL_SUM_VMIX, TOTAL_SUM_CONV and TOTAL_SUM_ADV.