

Primary study on the characteristics of trace gases in a clean area of North China

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1. Trace gases and/or greenhouse gases

- O_3 , NO_x (NO , NO_2), SO_2 , VOC, CO_2
 O_3 - chemistry & photochemistry, health, environment...
 NO_x (NO , NO_2) - O_3 precursor
VOC - O_3 precursor, reactive gases, Secondary Organic
Aerosols, carbon cycle, climate change ...
 SO_2 - pollutant
 CO_2 - greenhouse gases
- To know their concentrations and variation trends
- To understand the quantitative inter-reactions between gases, radiation, aerosols ...

2. Experiment site - Xinglong station

- Xinglong Station: (40 ° 23'N, 117 ° 35'E, 960m)

~150 km northeast of Beijing city

a relative clean region

atmospheric background observation network
of Chinese Academy of Sciences



Lab →



3. Measured items

- Trace gases: O_3 , NO, NO_2 (NO_x), SO_2 , CO_2
- Instruments: Gas analyzer (TE comp.)
 O_3 , NO_x , SO_2 , CO_2
49C, 42CTL, 43C, 41CTL
- Calibration: ~ every 2 or 3 months

49CPS O_3 , 146C, Model 111 zero air generator

Standard gases: NO, SO_2 , CO_2



4. Data process

- All data are processed, except for:
 - thunder storm
 - no power
 - 2 hours' data after turning on the analyzer

5. Hourly concentrations of trace gases

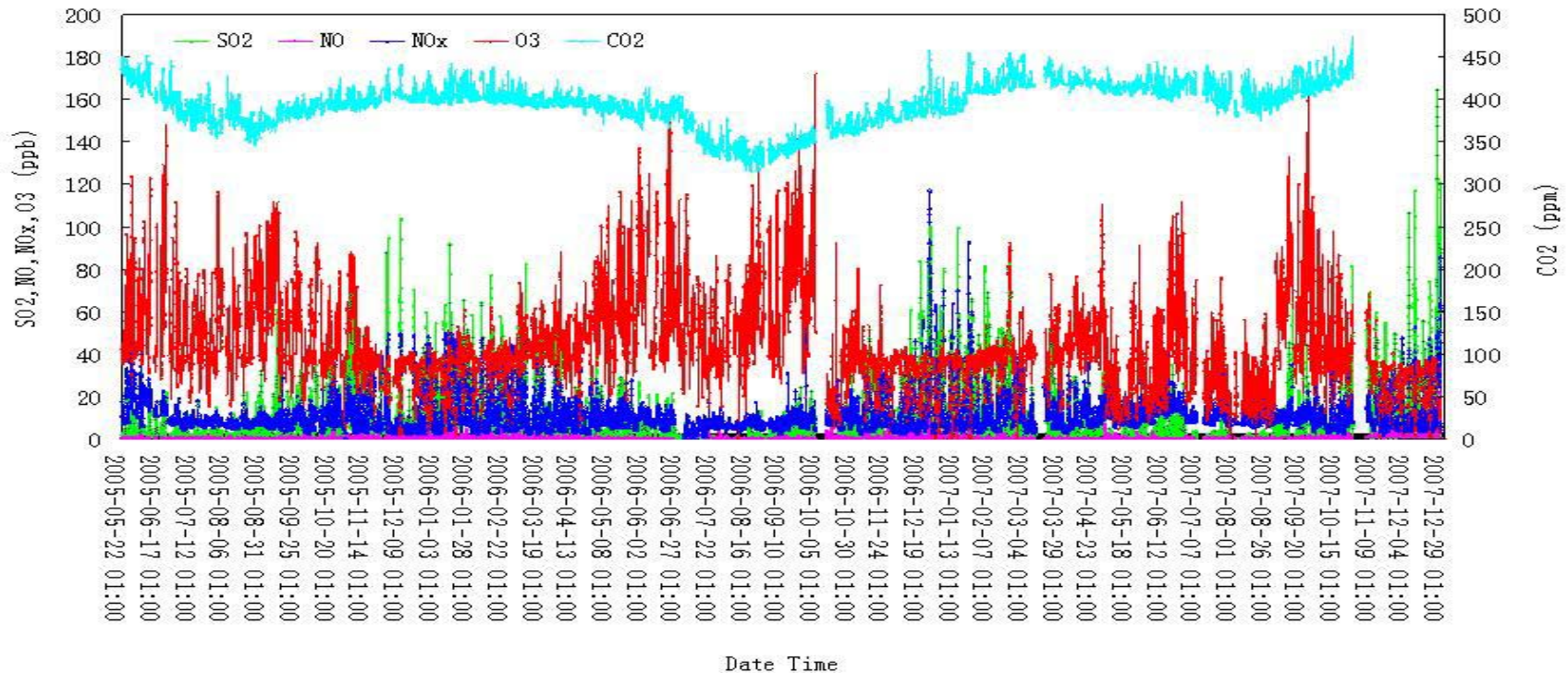


Fig. Hourly averages of trace gases from May 2005 to Dec. 2007 at XingLong station

2005.05-2007.12	O3	NO	NO _x	SO ₂	CO ₂
AVG	42.6	0.4	11.4	8.4	395.6
MAX	172.1	45.3	118.0	164.3	474.5

6. Daily averages of trace gases

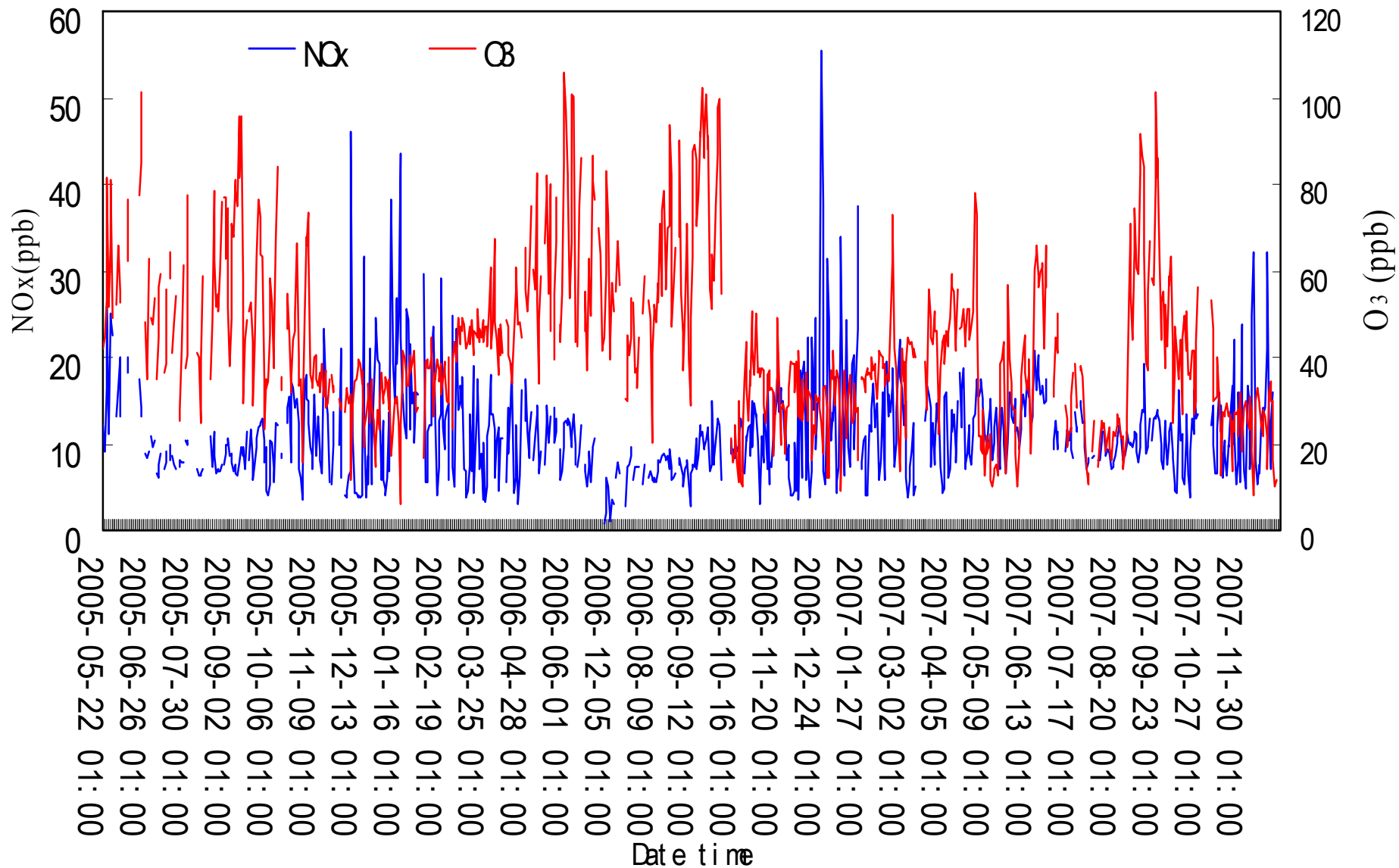


Fig. Daily averages of trace gases at Xinglong station

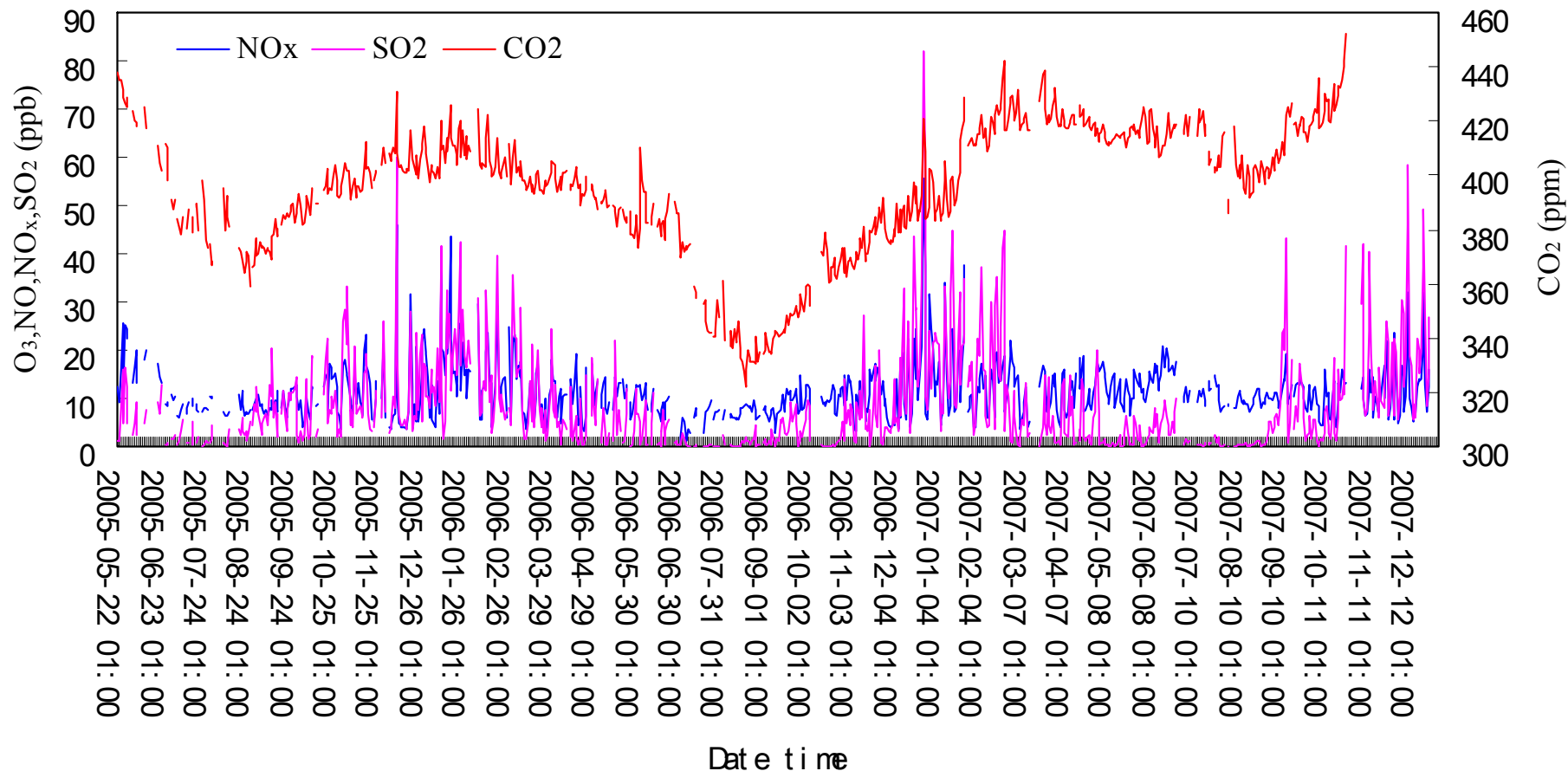


Fig. Daily averages of trace gases at Xinglong station

2005.05-2007.12	O ₃	NO	NO _x	SO ₂	CO ₂
AVG	42.7	0.4	11.3	8.2	395.4
MAX	105.6	3.8	55.4	82.2	452.3

7. Monthly variations of trace gases

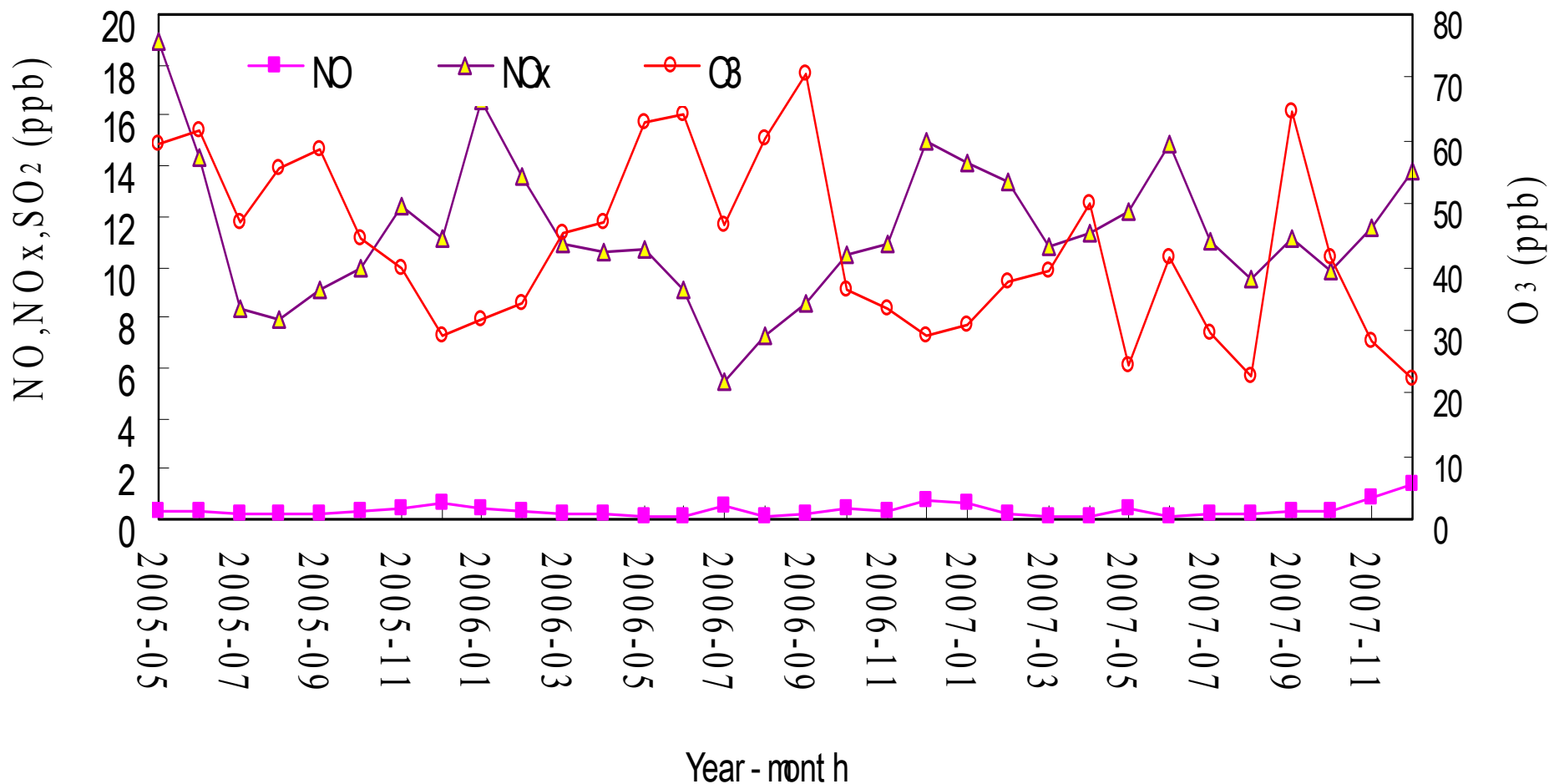


Fig. Monthly variations of trace gases concentration at Xi ngLong station

- NO con. is very low

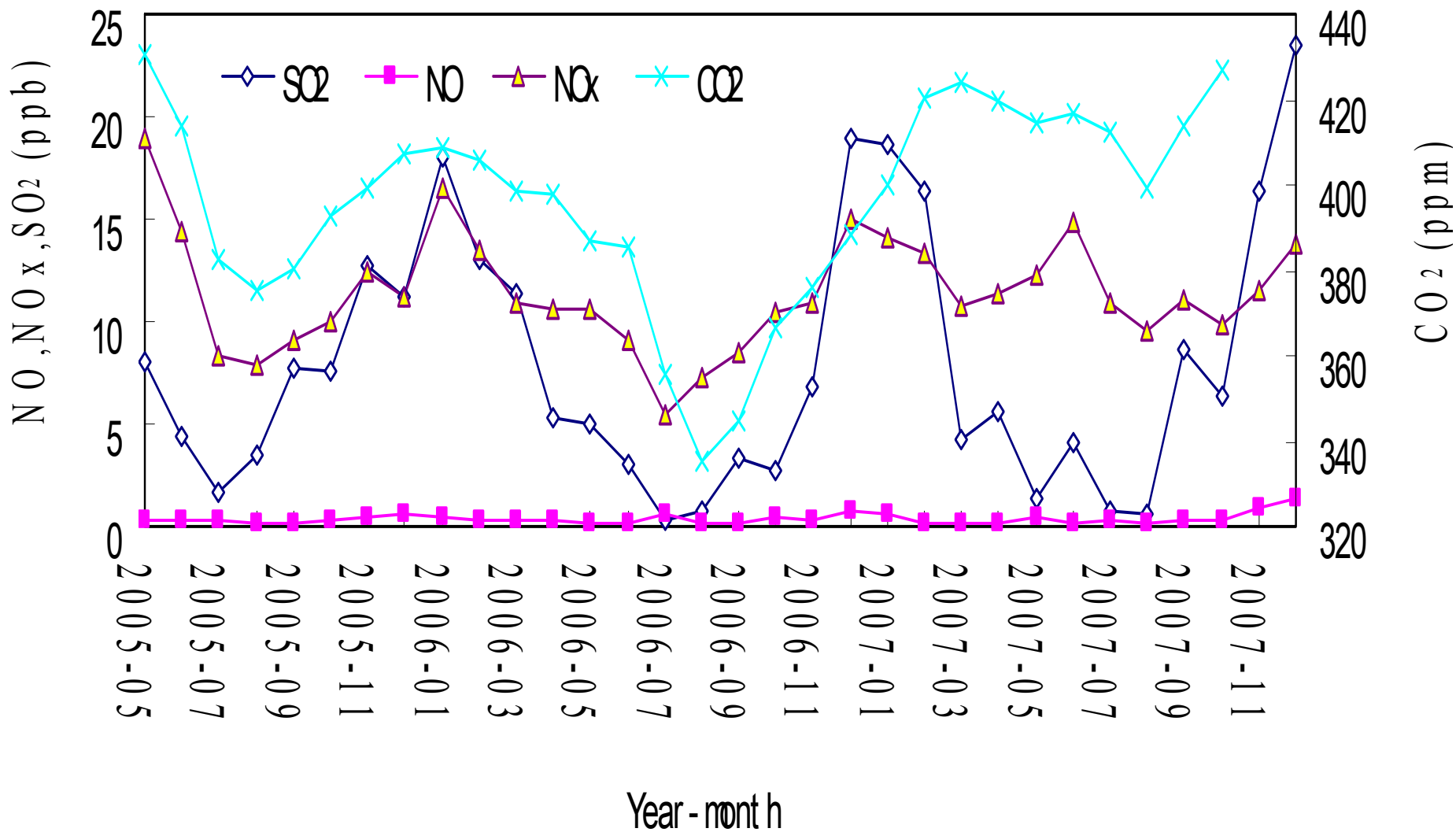


Fig. Monthly variations of trace gases concentration at XingLong station

- All trace gases showed an evident seasonal variations
- Better air quality – summer season

8. Trace gas variations in different years

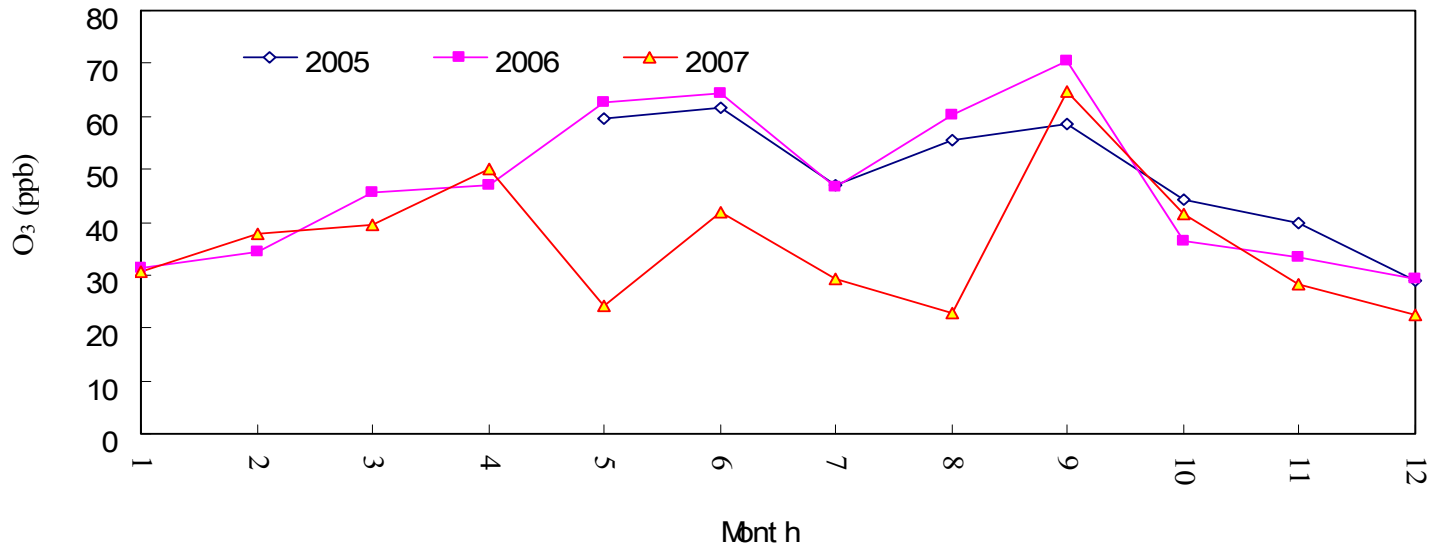


Fig. Monthly variations of trace gases concentration at Xi ngLong station

O₃ AVG

46.9 -2006

36.1 -2007

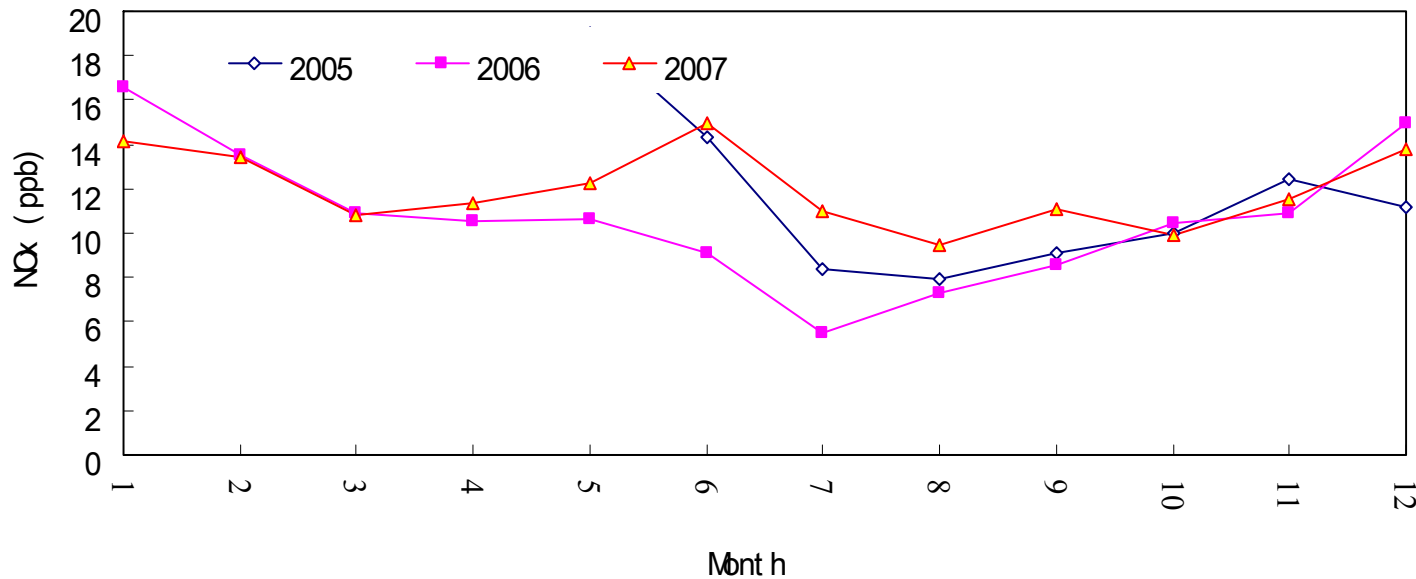


Fig. Monthly variations of trace gases concentration at Xi ngLong station

NO_x AVG

10.8 -2006

12.0 -2007

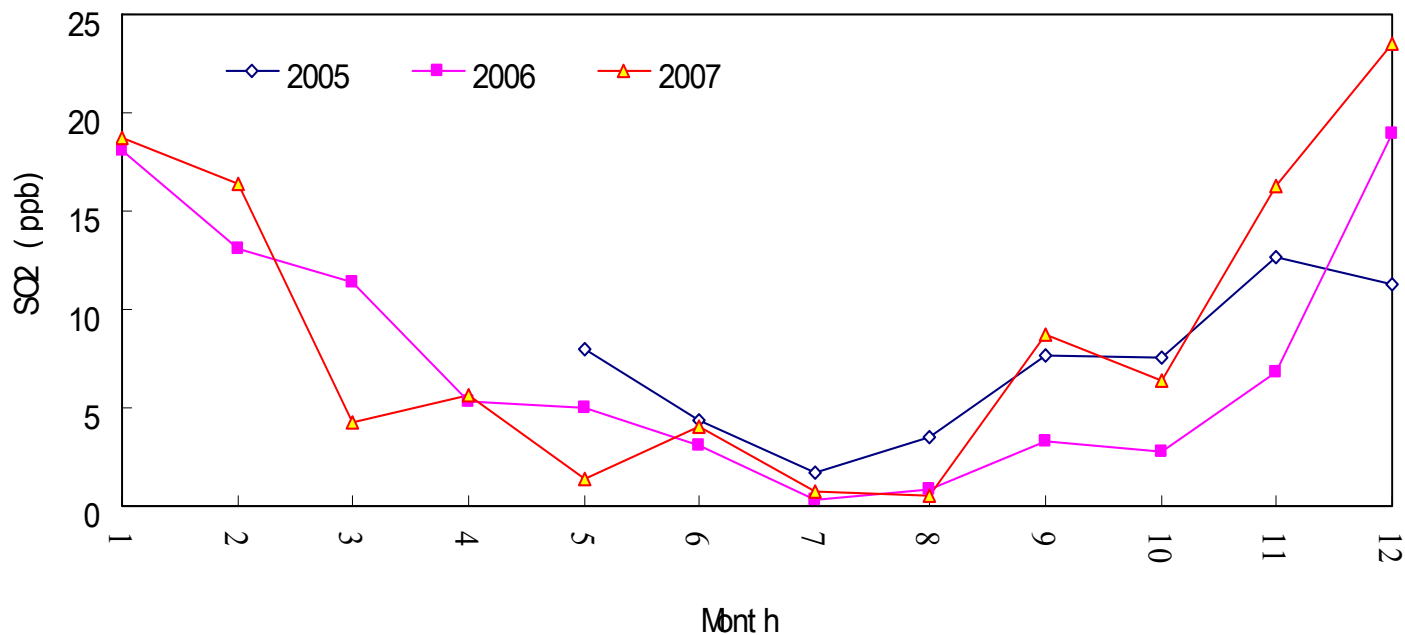


Fig. Monthly variations of trace gases concentration at XingLong station

SO₂ AVG

7.4 - 2006

8.9 - 2007

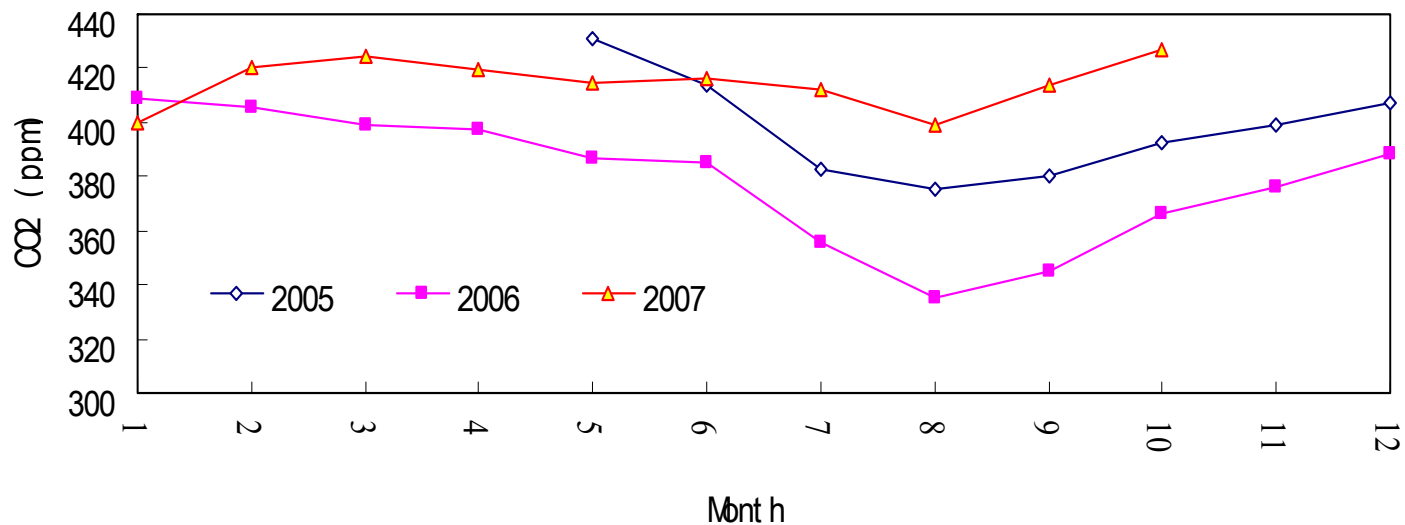


Fig. Monthly variations of trace gases concentration at XingLong station

CO₂ AVG

379.1-

2006

414.8-

2007

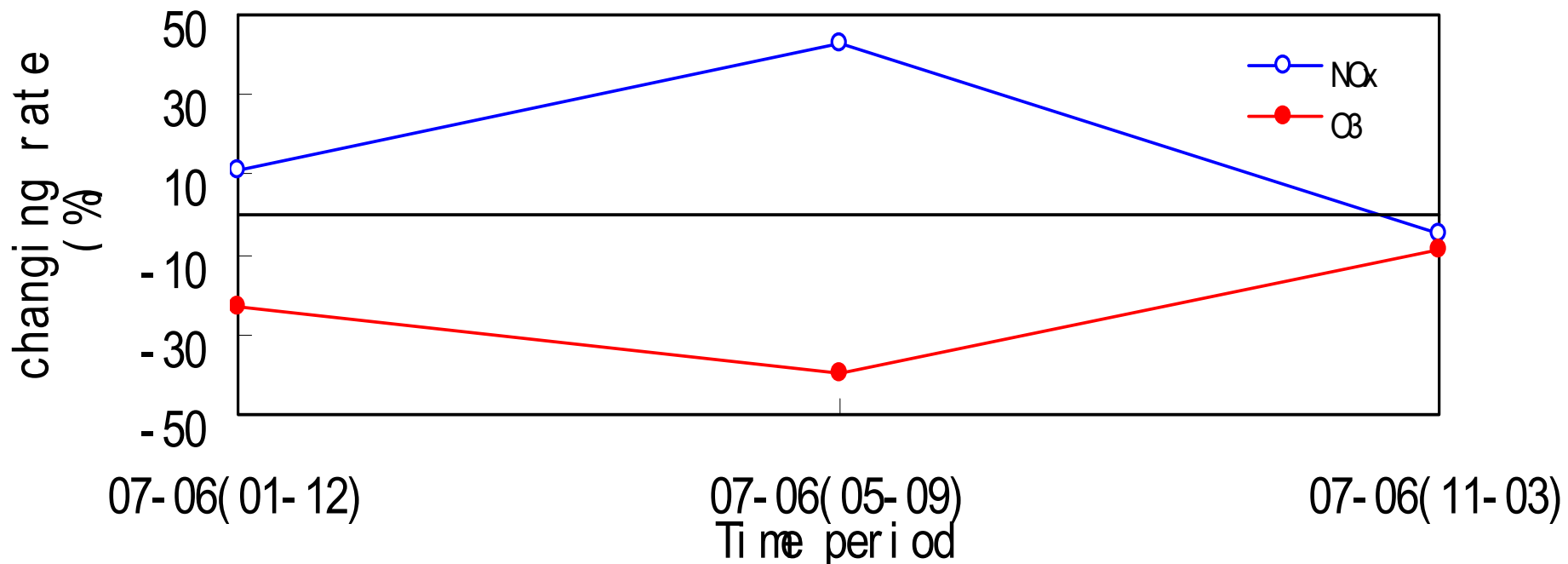


Fig. Changing rates of O₃ and NO_x at different time period between 2006 and 2007

Changing rate (%)	01-12	05-09	11-03
O ₃	-	-	-
NO _x	+	+	-

- The relation between O₃ and NO_x is complicated, other factors such as VOC, UV, and aerosols should be considered.

9. The interaction between hourly O₃, NO_x and UV

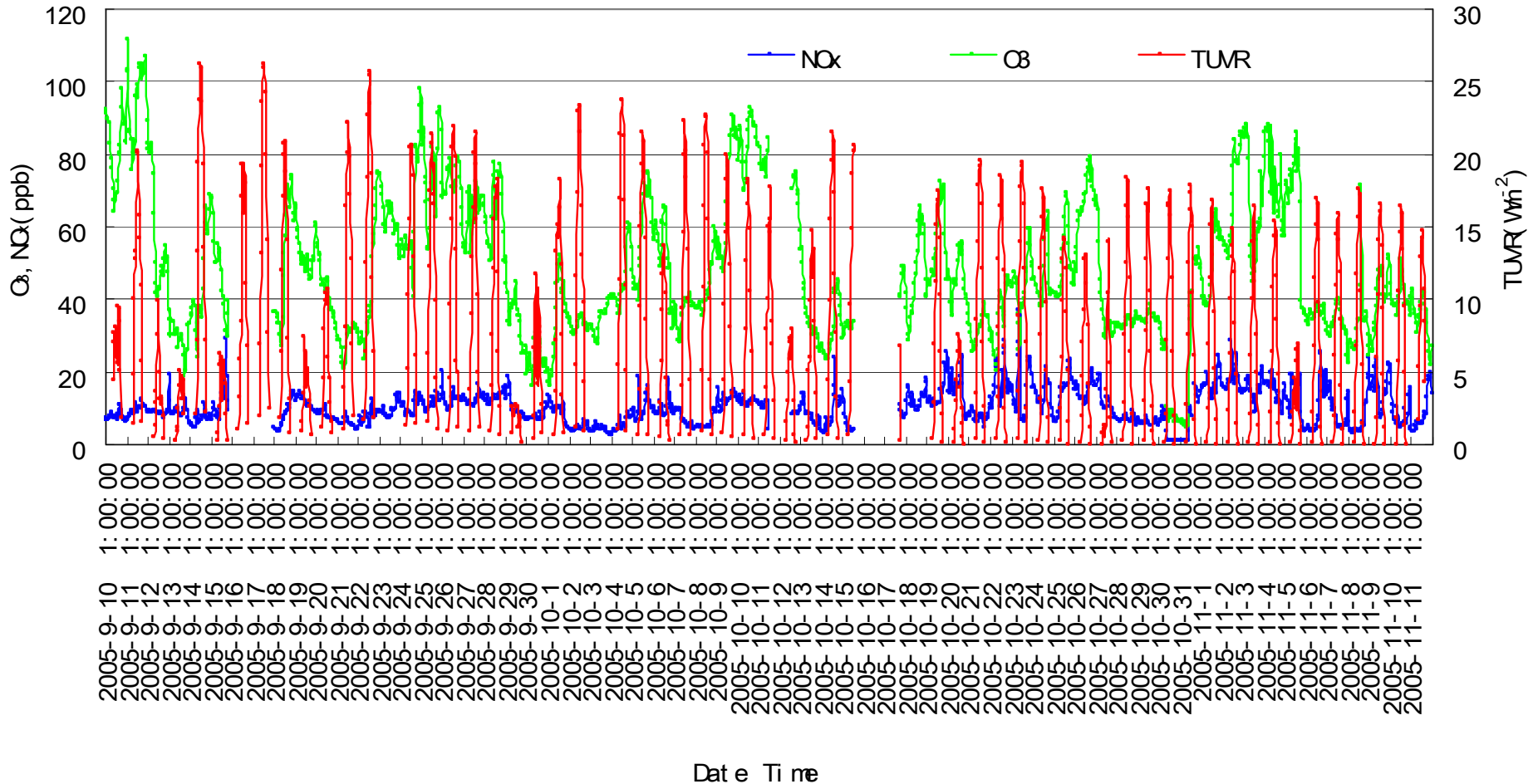


Fig. 2 Hourly variation of trace gas concentration and UV during Sep. 10 to Nov. 11 at Xinglong station

UV energy is an important triggering energy for O₃ photochemistry

10. An empirical model for analyzing the relation between O_3 and its affecting factors

(Energy conservation- UV is attenuated by gases and aerosols...)

$$e^{-k_3 n_3 m} = B_1 e^{-k_1 n_1 m} + B_2 e^{-k_2 n_2 m} + B_3 e^{-k_4 w m} + B_4 e^{-H_d/H_Q} + B_5 H_{uv} + B_0$$

O_3 NO NO_2 photochemical scattering UV

(Bai J.H. et al. An empirical correlation between surface O_3 and its factors, Atmos. Environ. 2005, 39, 4419-4423)

11. CO₂ long-term variation (1994-2007)

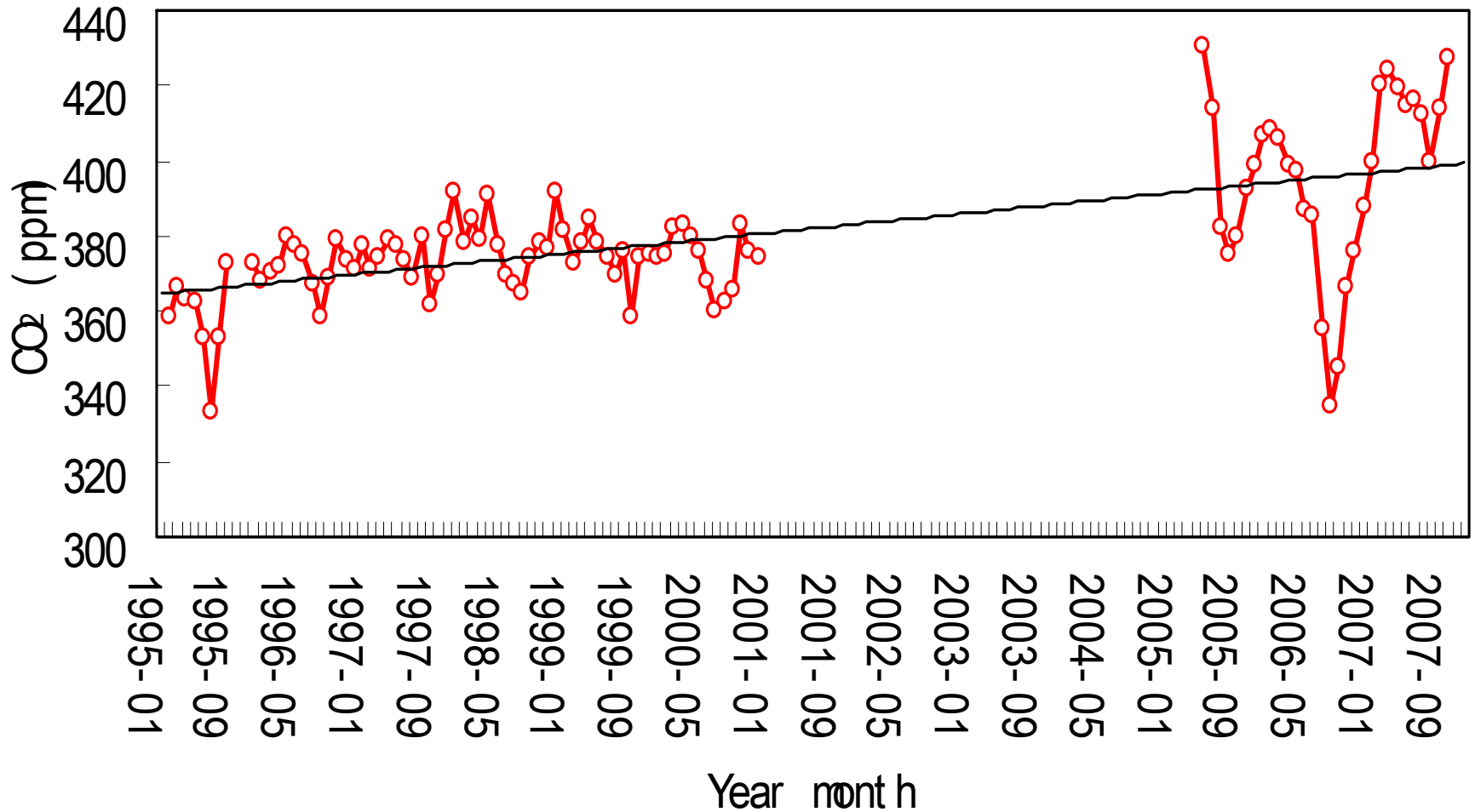


Fig. Monthly averages of CO₂ at Xinglong station

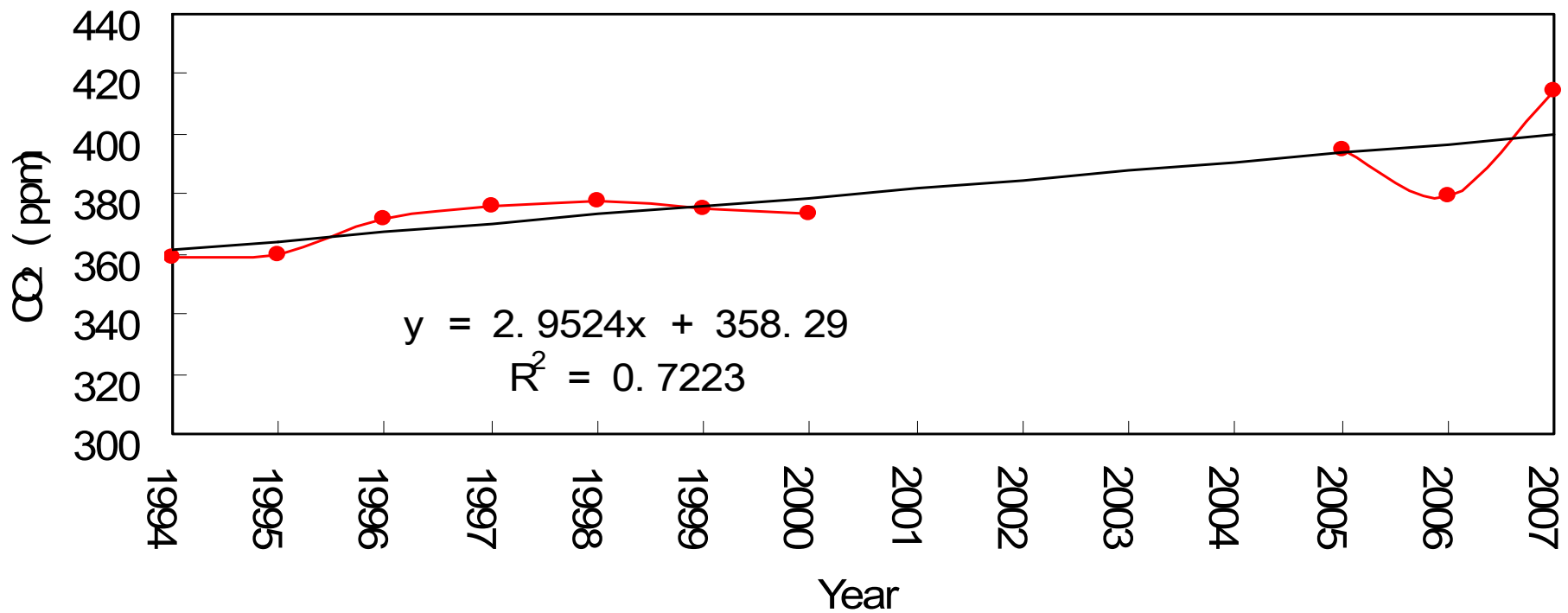


Fig. Yearly averages of CO₂ at XingLong Station

Time Period	Incr. amou. /year (ppm)	Incr. rate /year (%)	Analyzing method
1994-2000	2.91	0.81	Flask, GC
1994-2007	2.95	0.82	Gas Analyzer (2005-2007)

- **Main measurements at Xinglong Station**

1) Solar radiation: Spectral solar radiation (UV, Visible, NIR),
direct, diffuse, global radiation

2) Trace gas: surface O₃, NO_x (NO, NO₂), SO₂, CO₂, CO

3) Aerosol: PM2.5, Black carbon

4) Meteorological parameters: T, e, P, wind



Thanks!

Welcome to visit Xinglong station!