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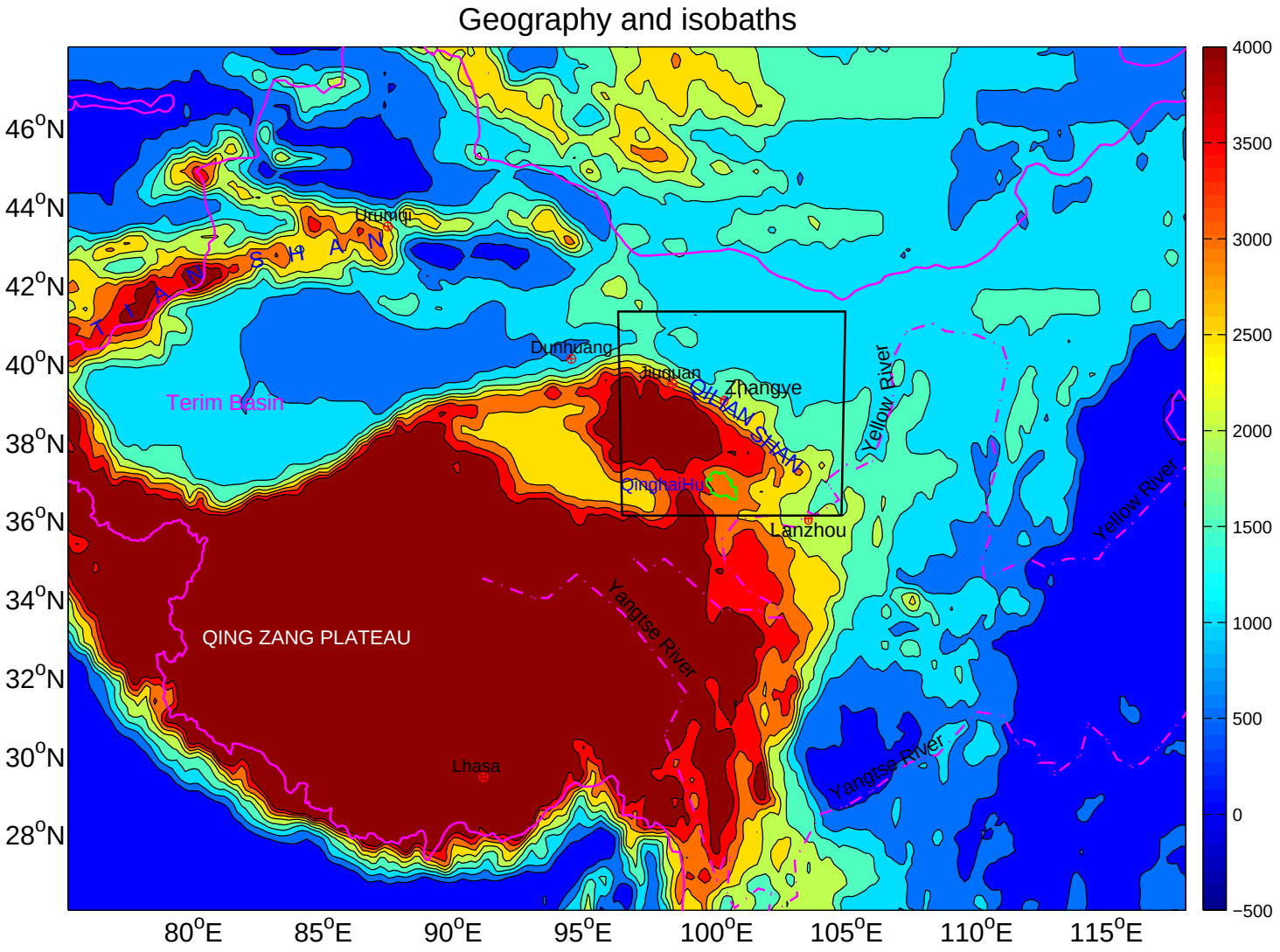
Severe Air Pollution in Lanzhou China

Peter C Chu, Naval Postgraduate School

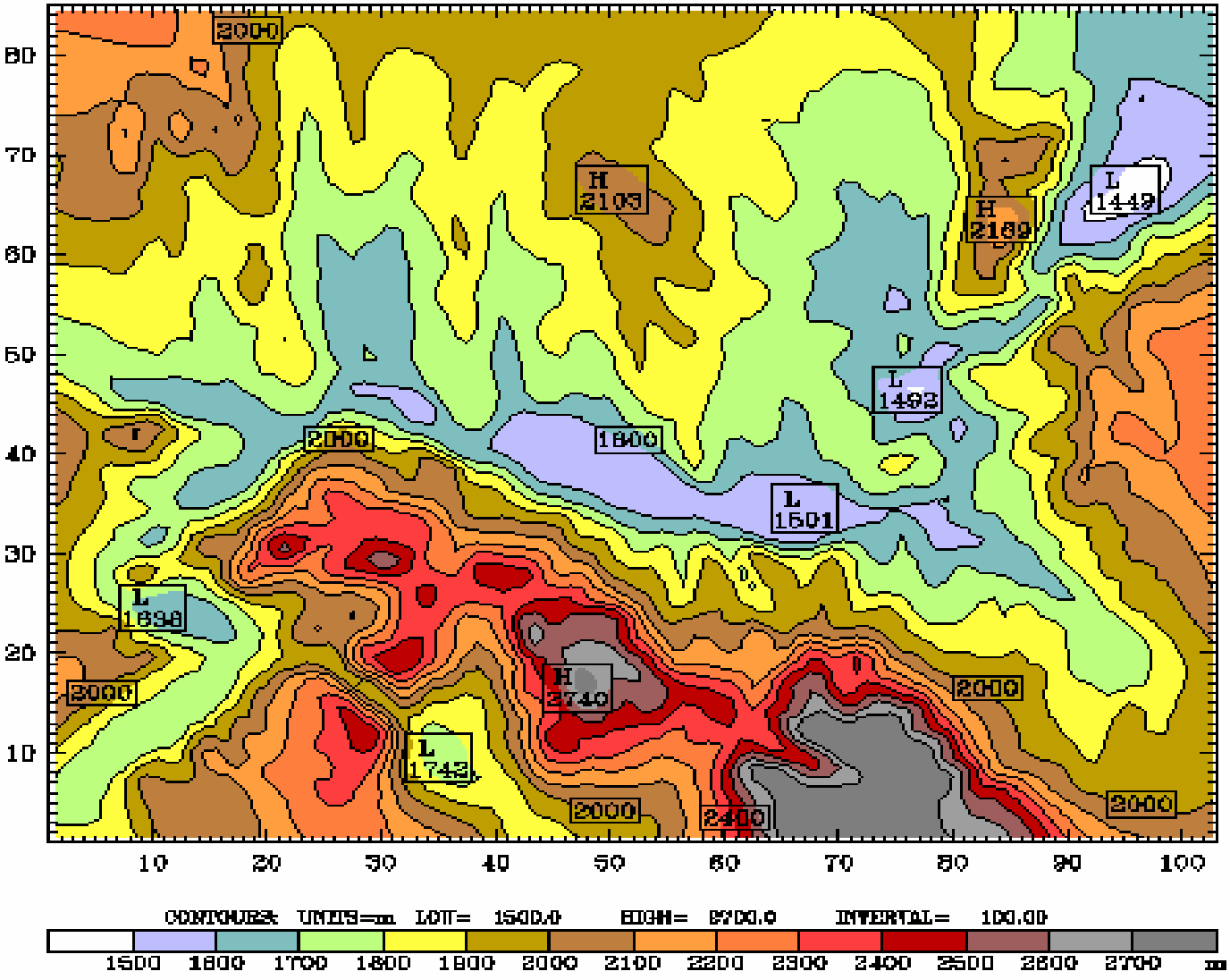
Yuchun Chen and Shihua Lu,

Institute of Cold & Arid Environment & Engineering, Chinese Academy of Sciences

Central China

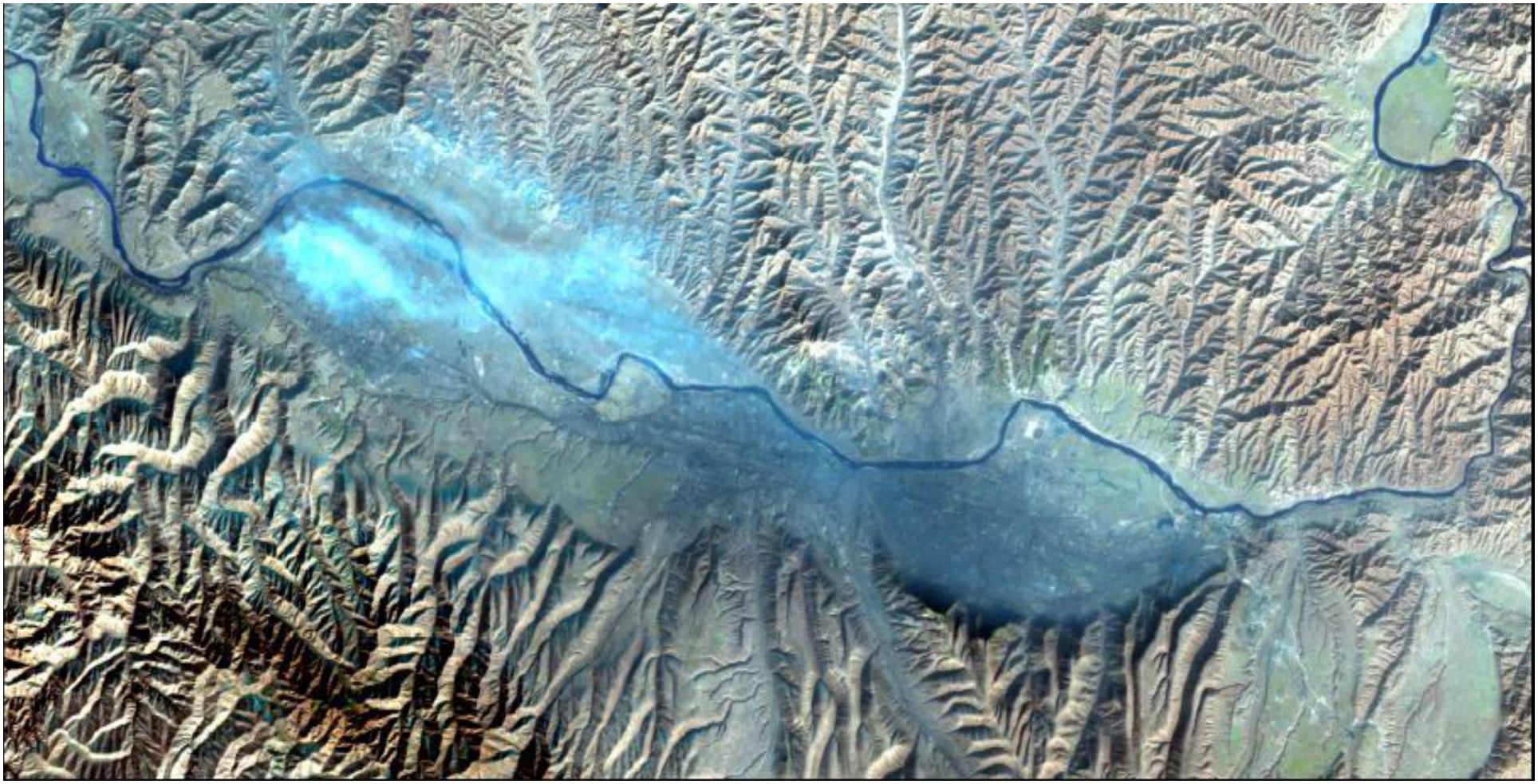


Topography around Langzhou, China



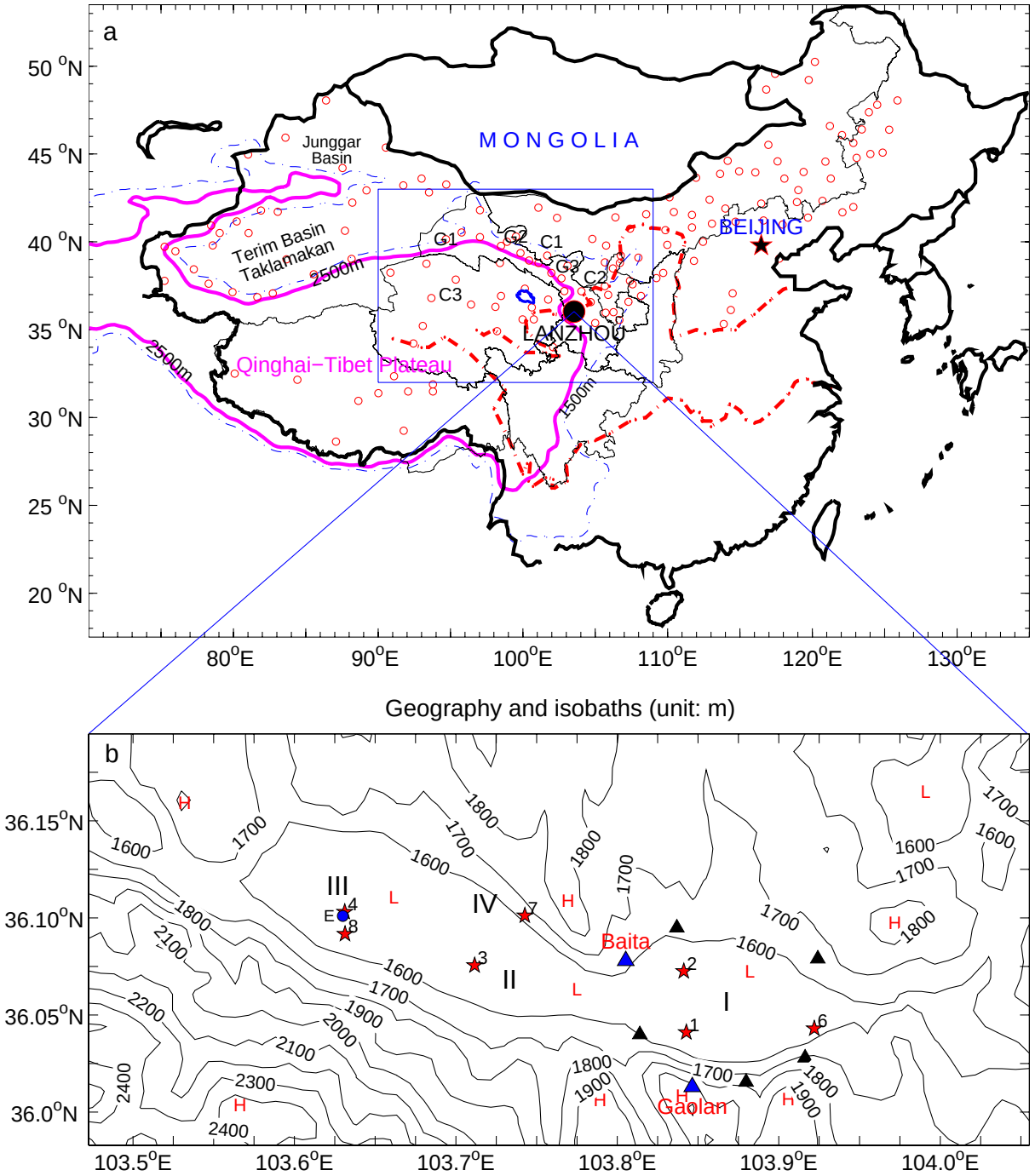
Lanzhou – One of the Most Polluted Cites in China

LANDSAT-TM imagery representing air pollution on 3 January 2001.

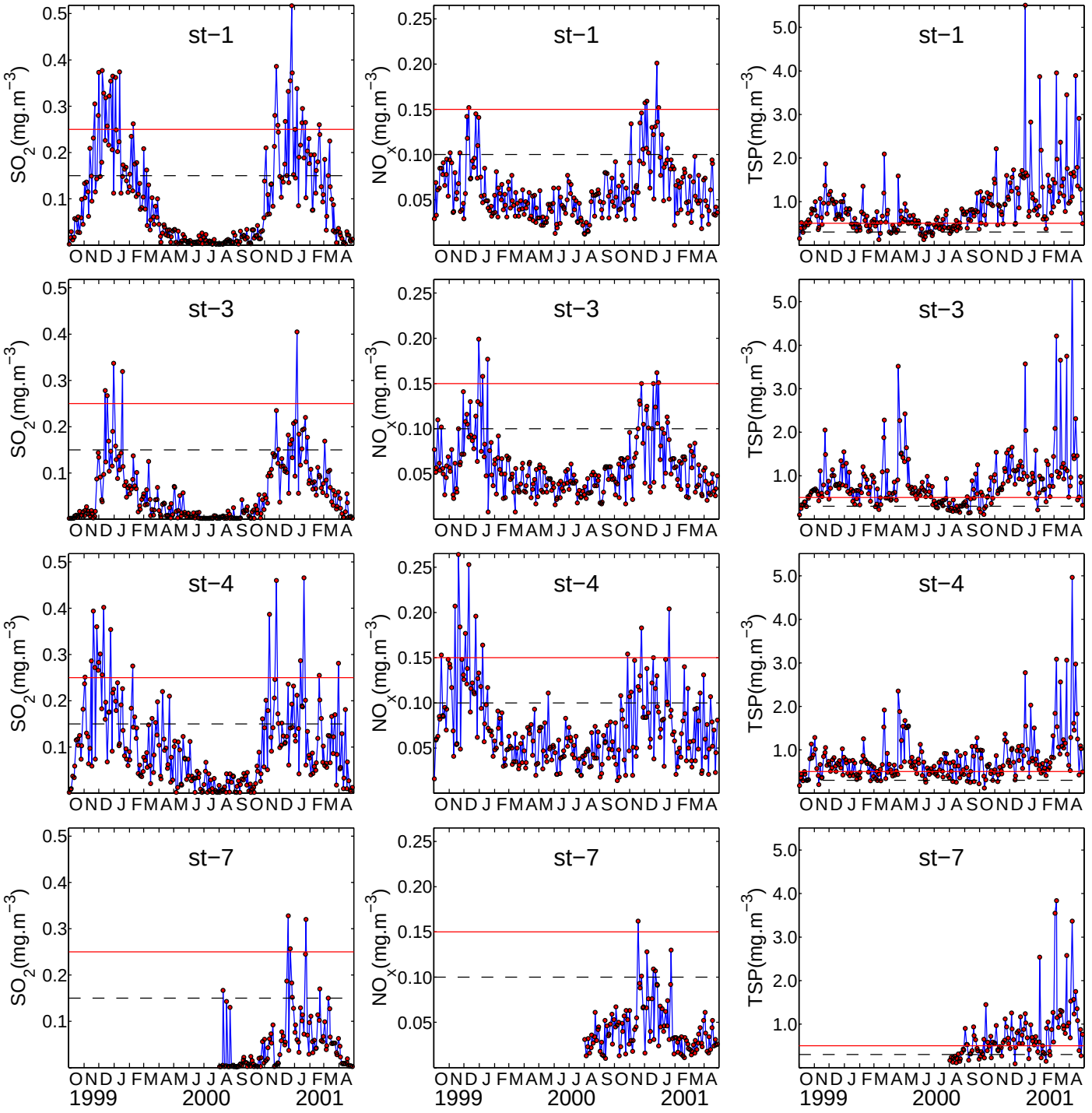


Location of observational stations and mean concentrations (mg m^{-3})

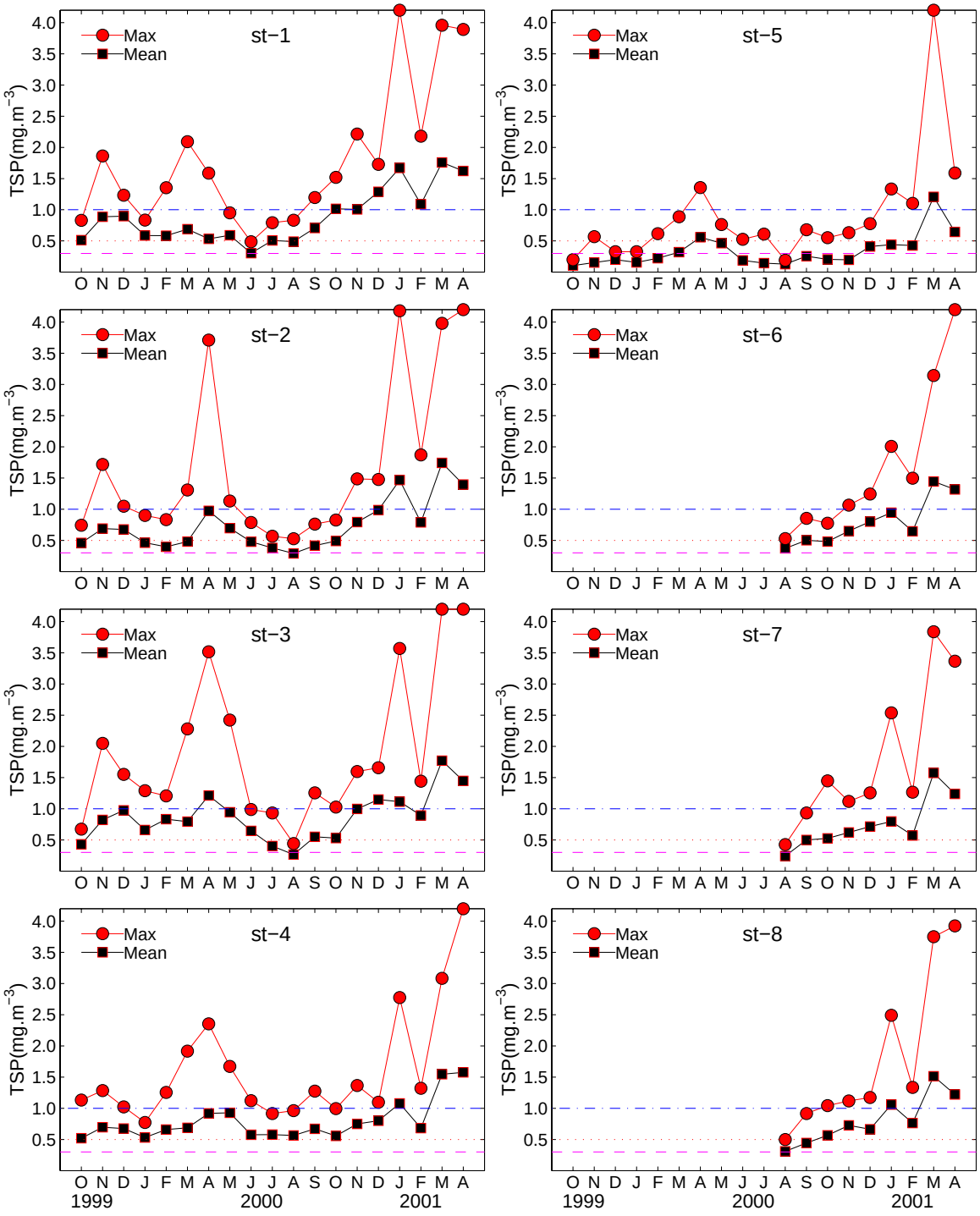
Site	Longitude E	Latitude N	Height (m)	Region	SO_2	NO_x	TSP
St-1	103.84	36.04	25	Chengguan (District-1)	0.08	0.06	0.69
St-2	103.84	36.07	11	Chengguan (District-1)	0.03	0.04	0.57
St-3	103.71	36.08	15	Qilihe (District-3)	0.05	0.05	0.74
St-4	103.63	36.10	22	Xigu (District-2)	0.08	0.06	0.68
St-5	104.09	35.84	4	Yuzhong County	0.01	0.01	0.28
St-6	103.92	36.04	19	Chengguan (District-1)	0.02	0.03	0.56
St-7	103.74	36.10	15	Anning (District-4)	0.04	0.05	0.52
St-8	103.63	36.09	4	Xigu (District-2)	0.06	0.05	0.54


a
MONGOLIA
Junggar Basin
Terim Basin
Taklamakan
2500m
Qinghai−Tibet Plateau
BEIJING
LANZHOU
G1
G2
C1
G3
C2
C3
1500m
50 °N
45 °N
40 °N
35 °N
30 °N
25 °N
20 °N
80°E
90°E
100°E
110°E
120°E
130°E
Geography and isobaths (unit: m)
b
Baita
Gaolan
I
II
III
IV
E
36.15°N
36.10°N
36.05°N
36.0°N
103.5°E
103.6°E
103.7°E
103.8°E
103.9°E
104.0°E

Daily Mean Concentration



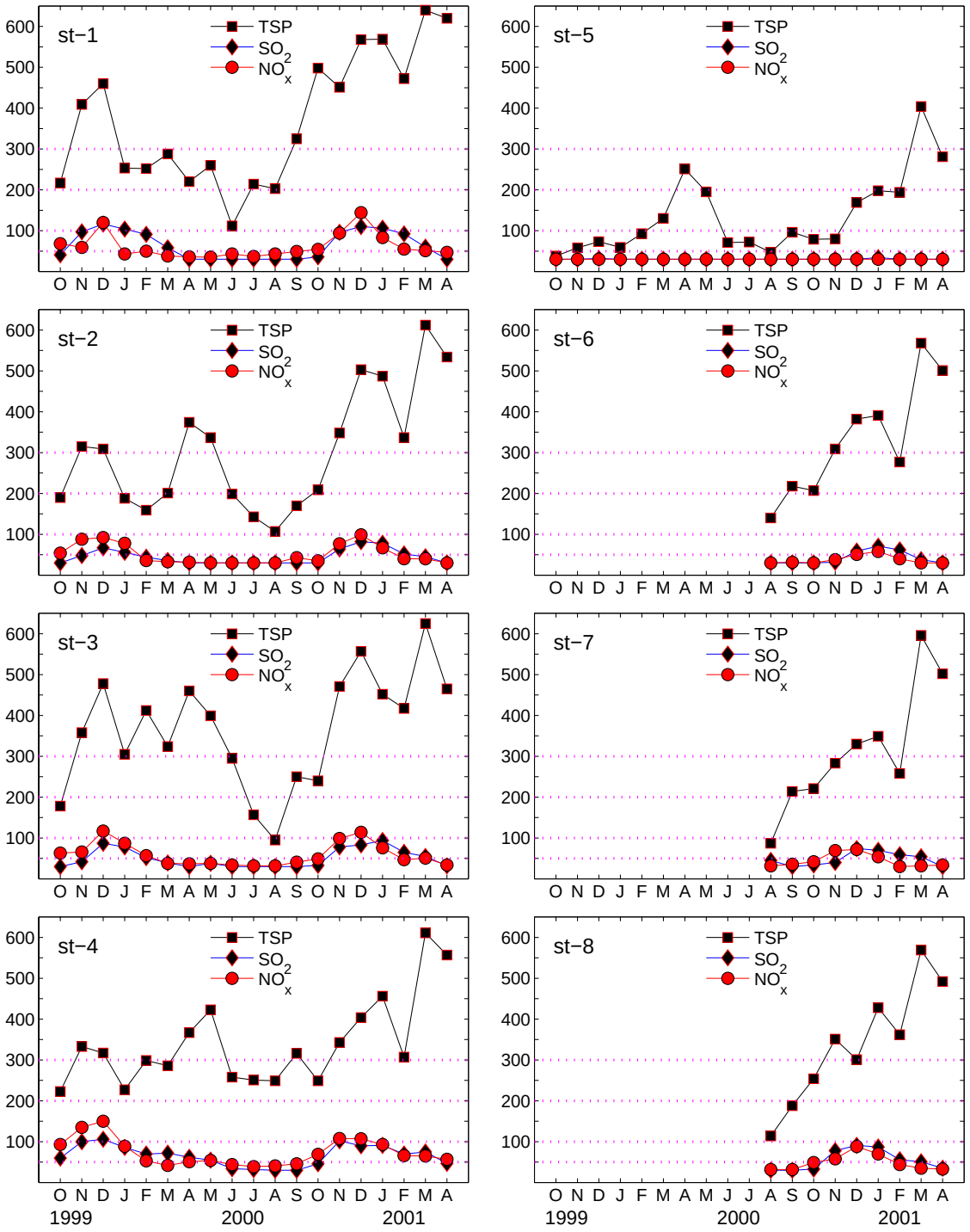
Monthly mean(■) and maximum(●) Concentrations (mg m-3) of TSP at St-1 to St-8.



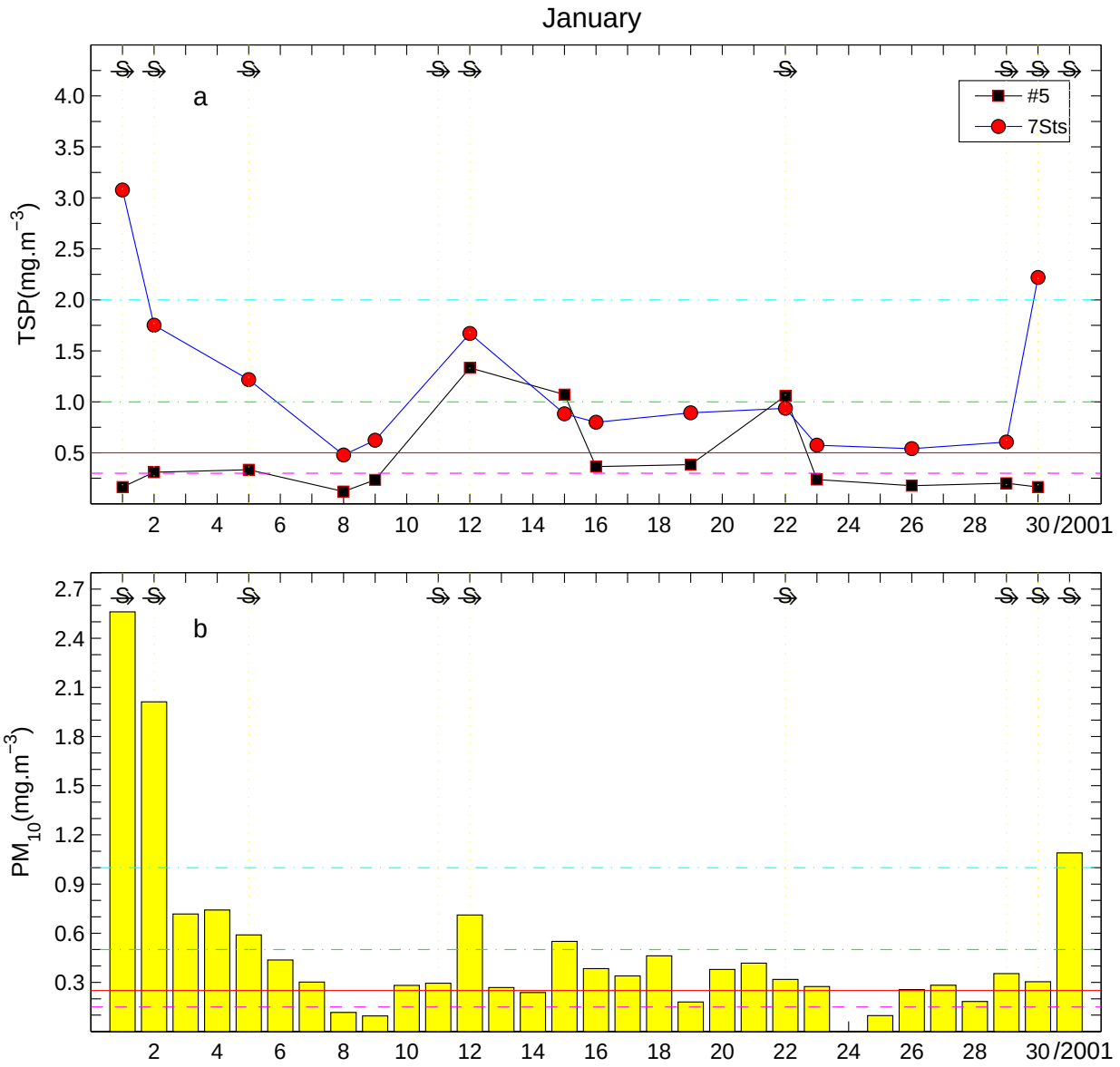
Air Quality Management

≤Air Pollution Index	Air Quality Classification		Air Quality Description and Management
< 50	I	Clean	No action is needed.
50-100	II	Good	No action is needed.
100-200	III_1 III_2	Low-level pollution	Persons should be careful in outdoor activities.
200-300	IV_1 IV_2	Mid-level pollution	Persons with existing heart or respiratory illnesses are advised to reduce physical exertion and outdoor activities.
>300	V	High-level pollution	Air pollution is severe; The general public is advised to reduce physical exertion and outdoor activities.

Monthly mean API at St-1 to St-8.



Dust Storms and (TSP, PM_{10}) in January 2001



Factors Affecting Air Quality

- Meteorological Conditions

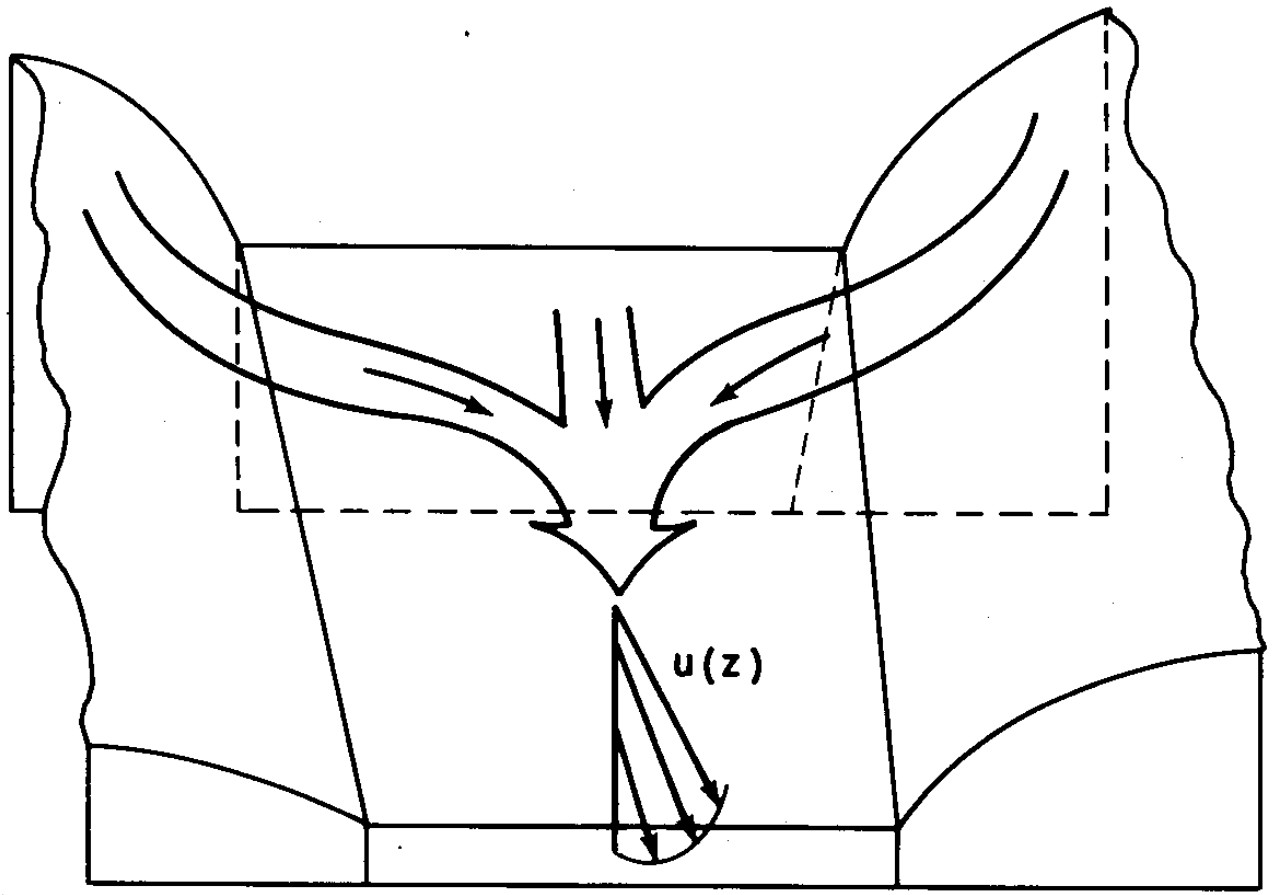
  Stable stratification especially Inversion

  Low Winds

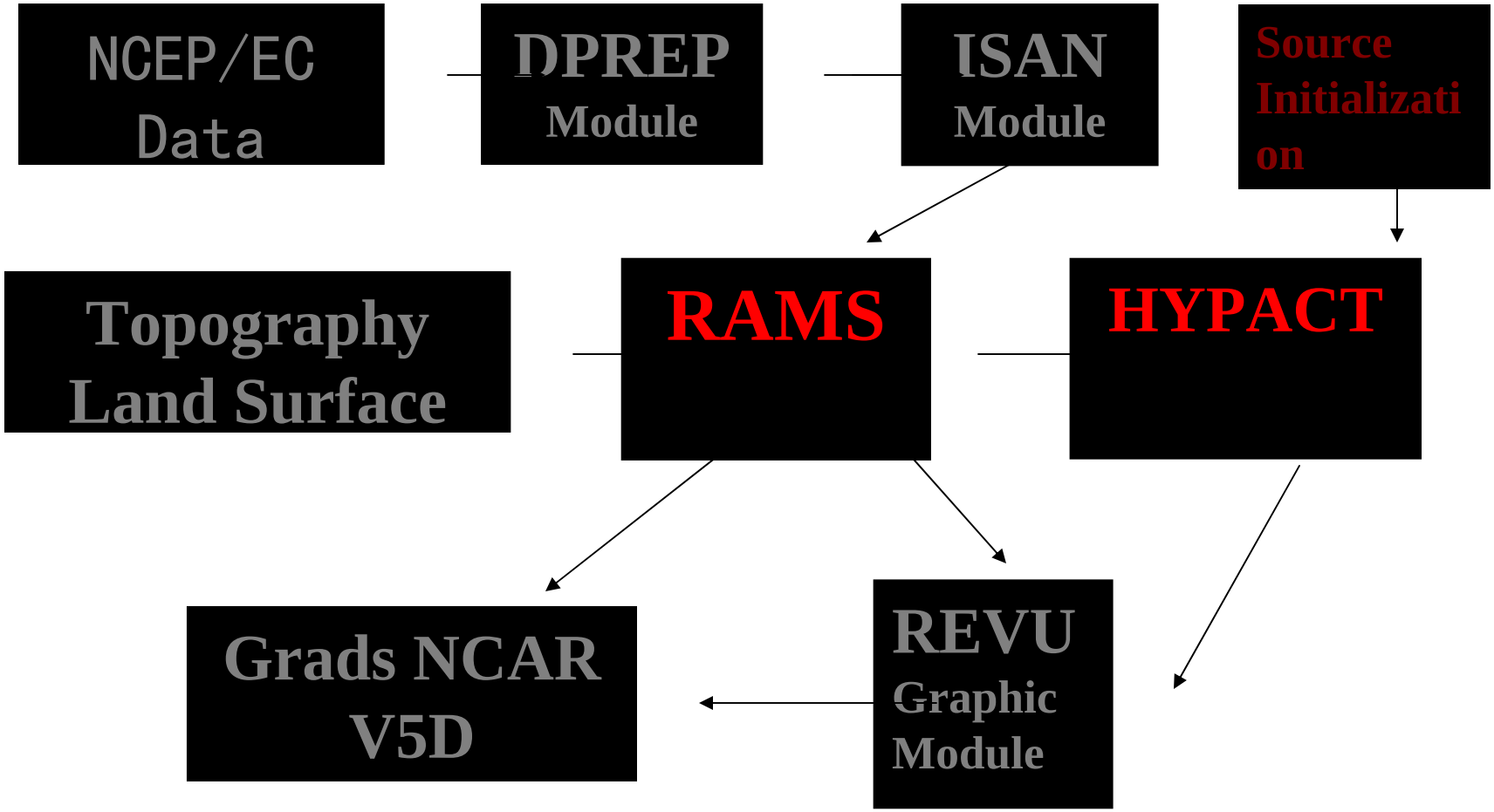
  Valley Wind

- Pollution Sources

Mountain-Valley Wind (at Night)



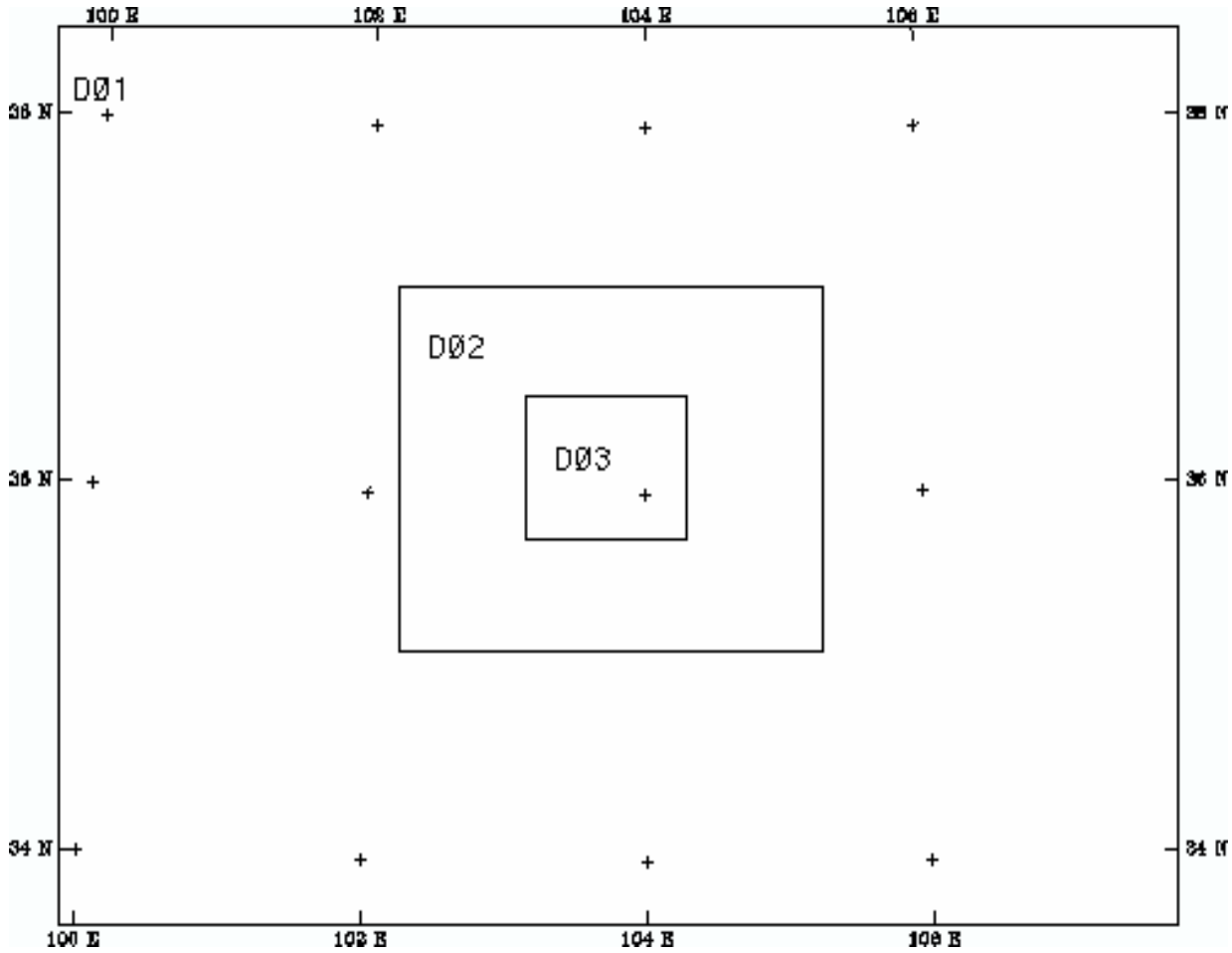
Coupled RAMS-NYPACT Model



Model Description

- Nonhydrostatic
- Multi-grid System: 9 km, 3 km, 1 km
- 23 vertical levels, to 50 hPa
- 30” - Topography data
- Assimilation of observational data
- Land surface model
- Integration area: 720 km (E-W),540 km (N-S)
  Centered at 103.8°E, 36.1°N

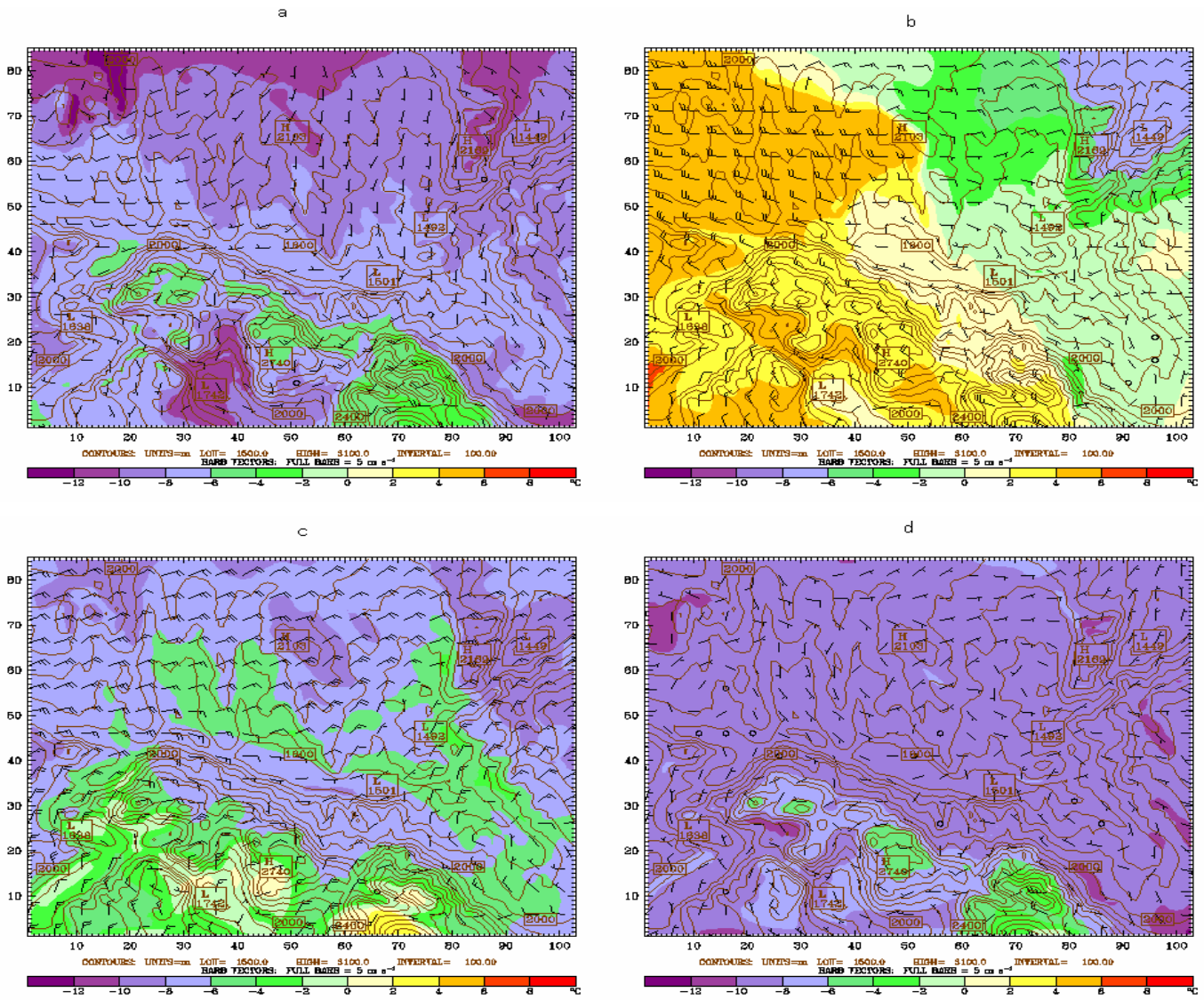
Multi-Grid System



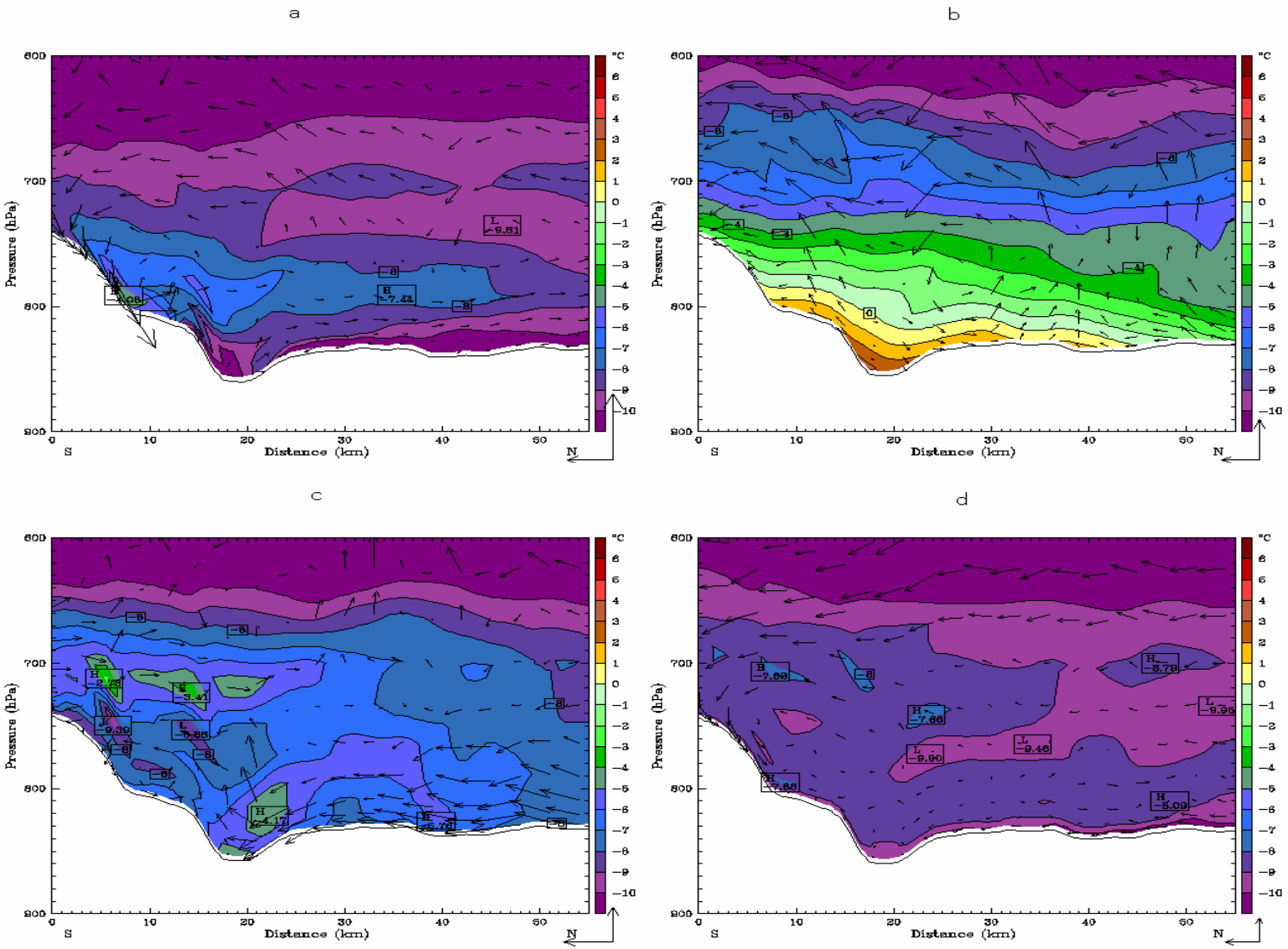
Model Integration

- Winter Simulation (Dec 2000)
- Initial Time: 08 BT, Dec 5, 2000
- Initial Conditions (NCEP Reanalysis)
- Lateral Boundary for the Largest Area (Every Six Hours, NCEP Reanalysis)
- Δt: 60 s, 30 s, 10 s

Simulated Wind and Temperature Fields at 800 hPa on: (a) 08, (b)14, (c) 20, (d) 02 BT

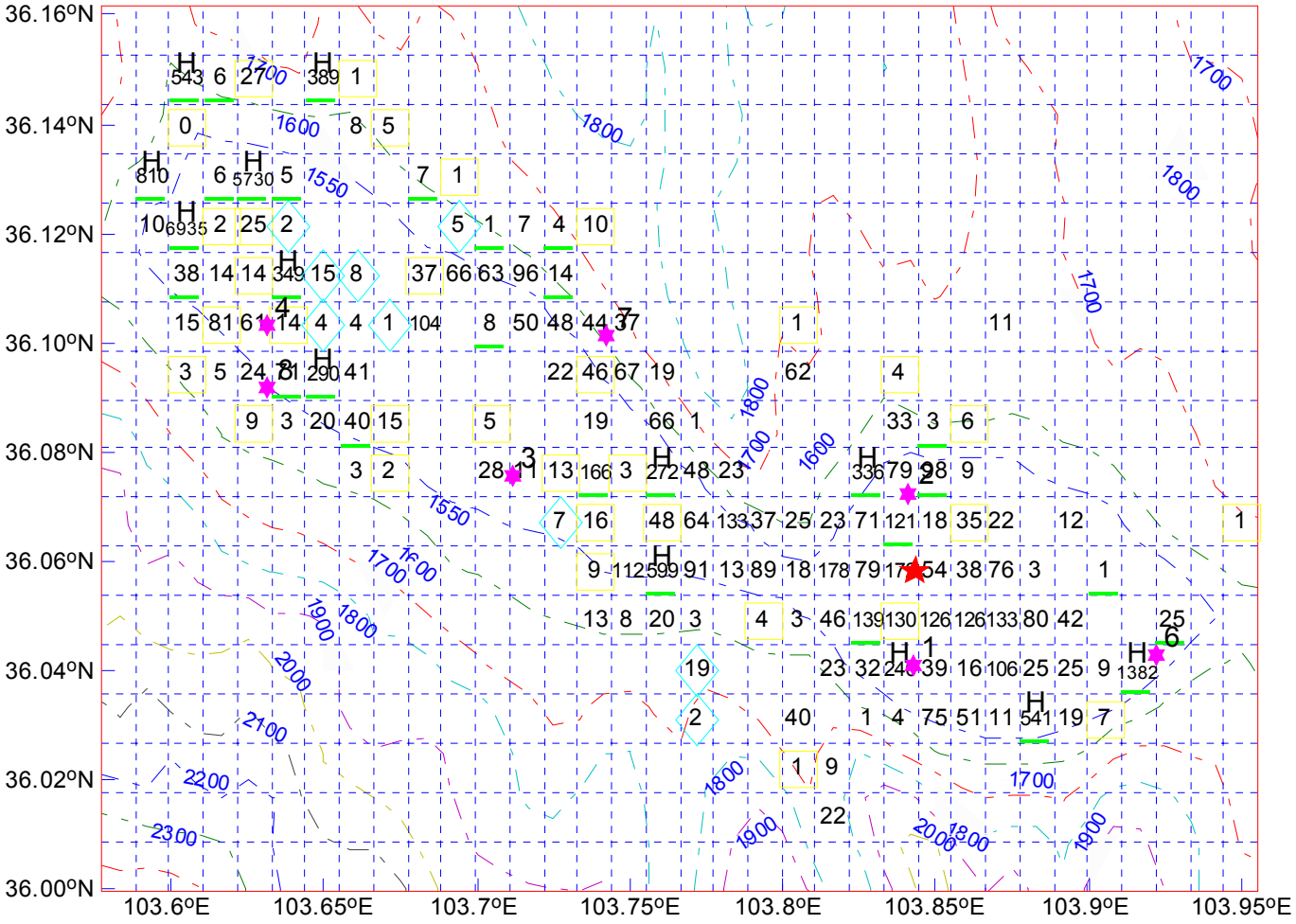


Simulated (v, w) and T in the north-south cross-section across the GaoLanShan Mountain on: (a) 08, (b)14, (c) 20, (d) 02 BT



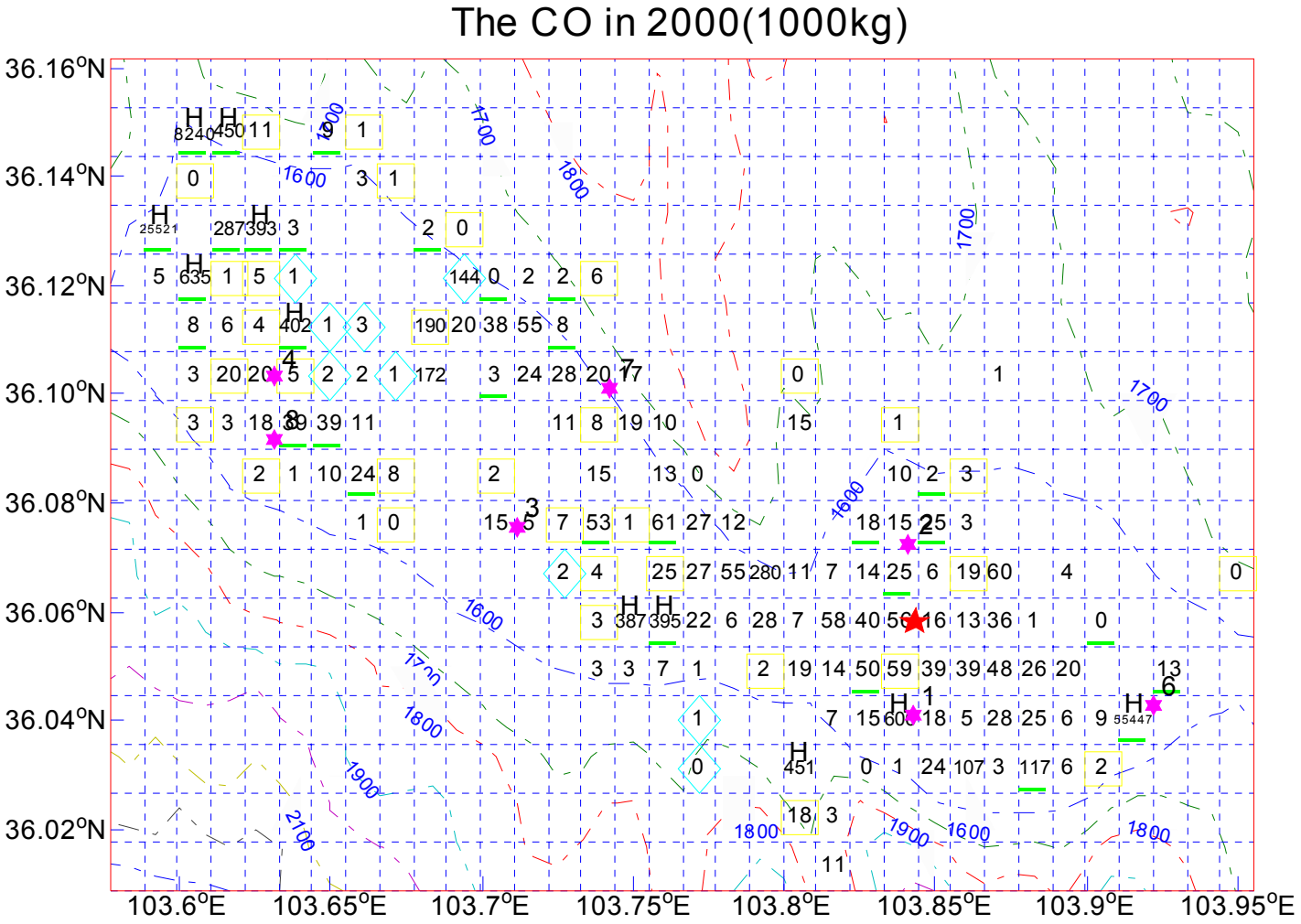
Dust Sources (1000 kg)

The Yan Chen in 2000(1000kg)



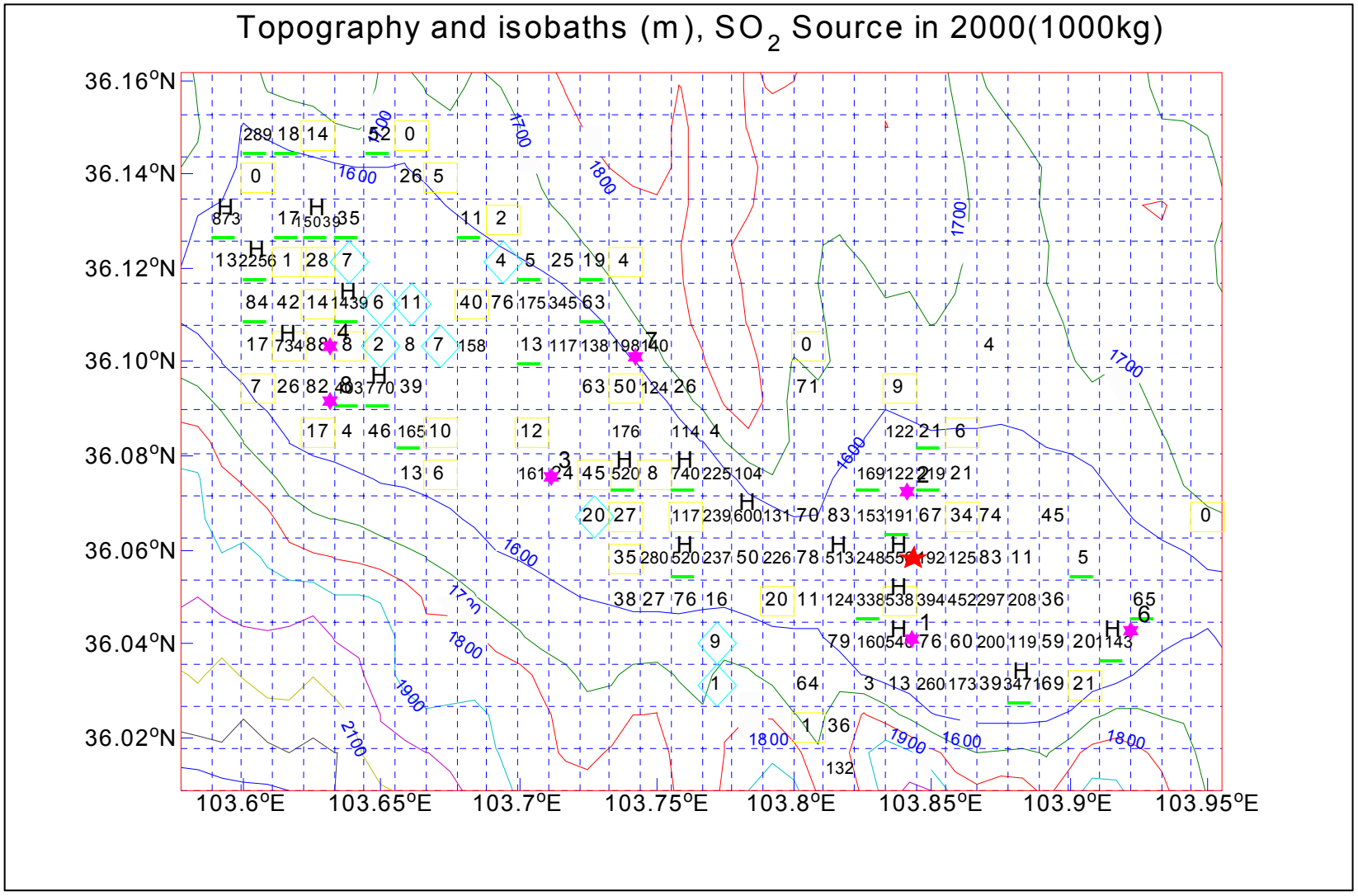
◇ Industrial ☐ Residential

CO Sources (1000 kg)



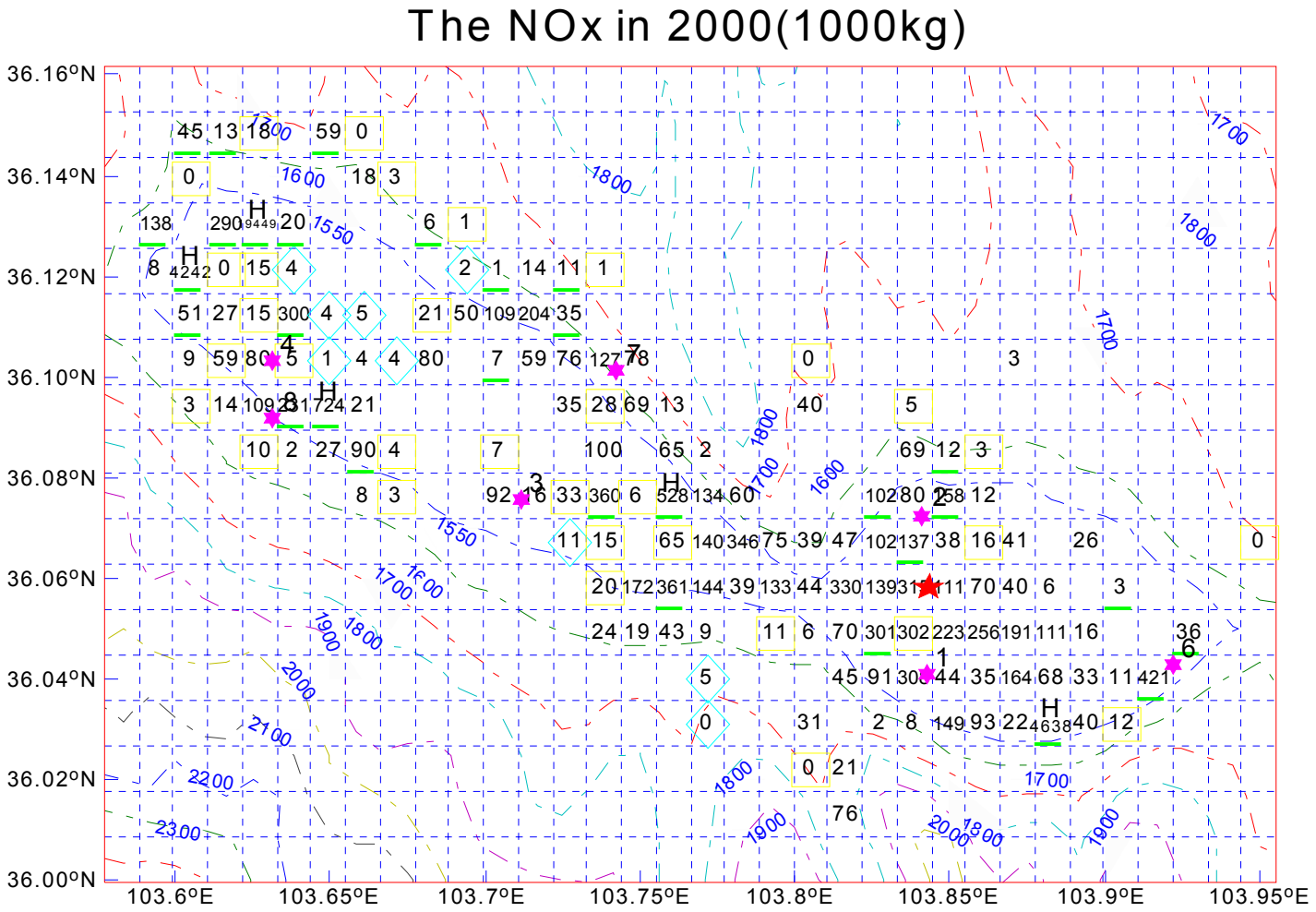
◇ Industrial ☐ Residential

SO_2 –Sources in 2000 (1000kg)



◇ Industrial　　□ Residential

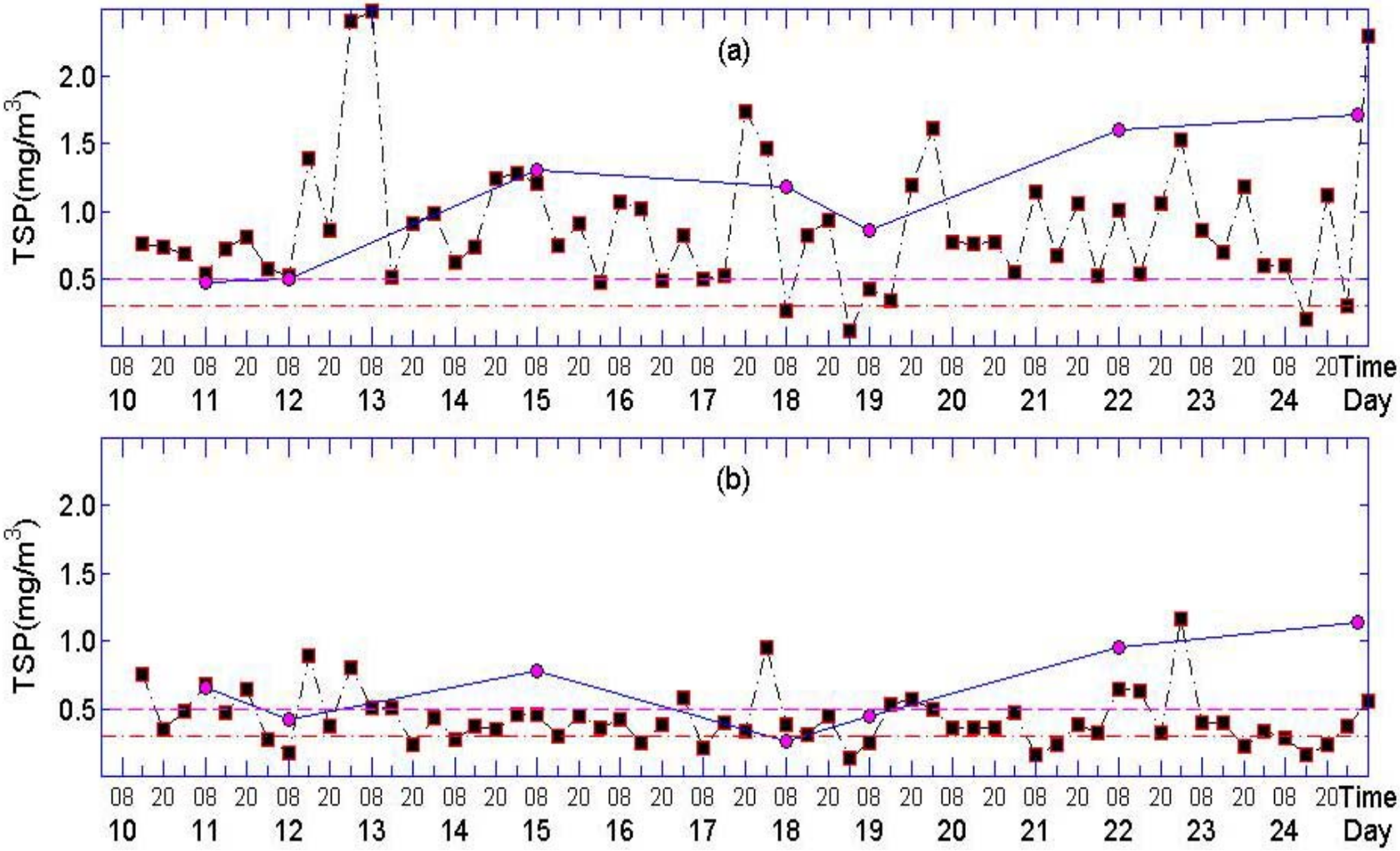
NO_x Sources in 2000 (1000 kg)



◇ Industrial □ Residential

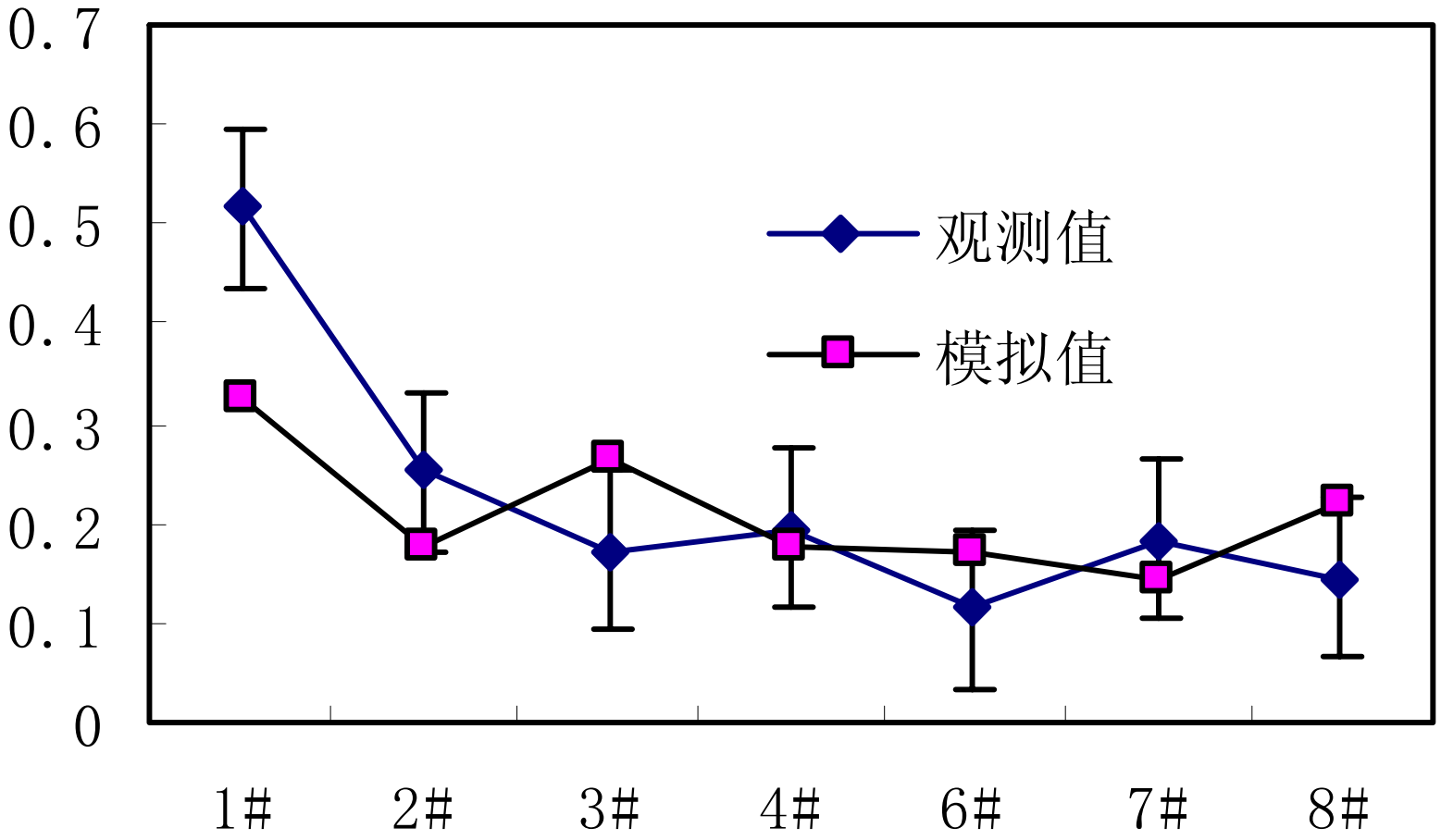
TSP Concentration at Sta-1 and Sta-8

Simulated (dashed), Observed (Solid)



Simulated and Observed

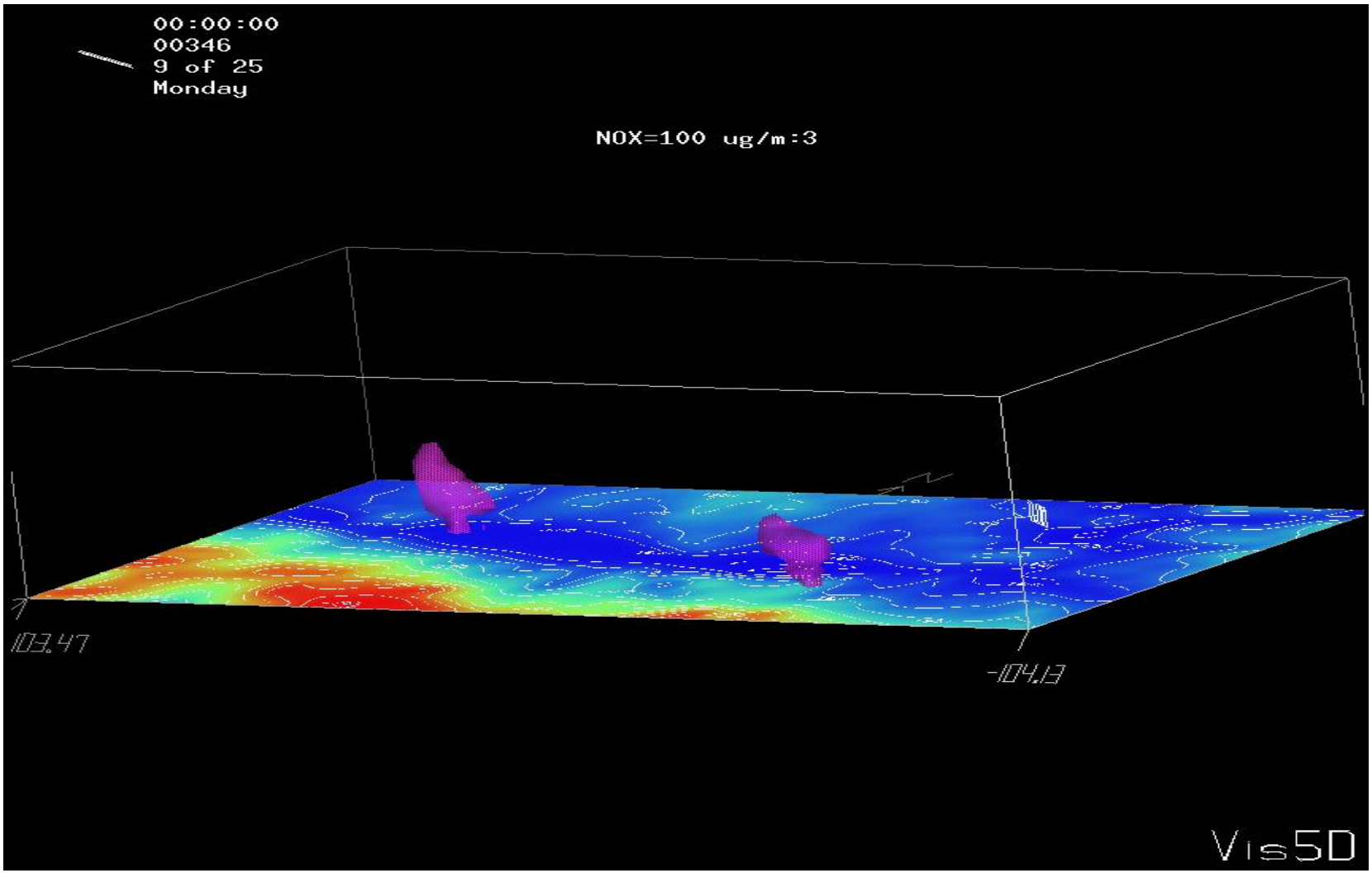
SO_2 Concentration (mg/m^3) on December 25, 2000



Simulated (□), Observed (◇)

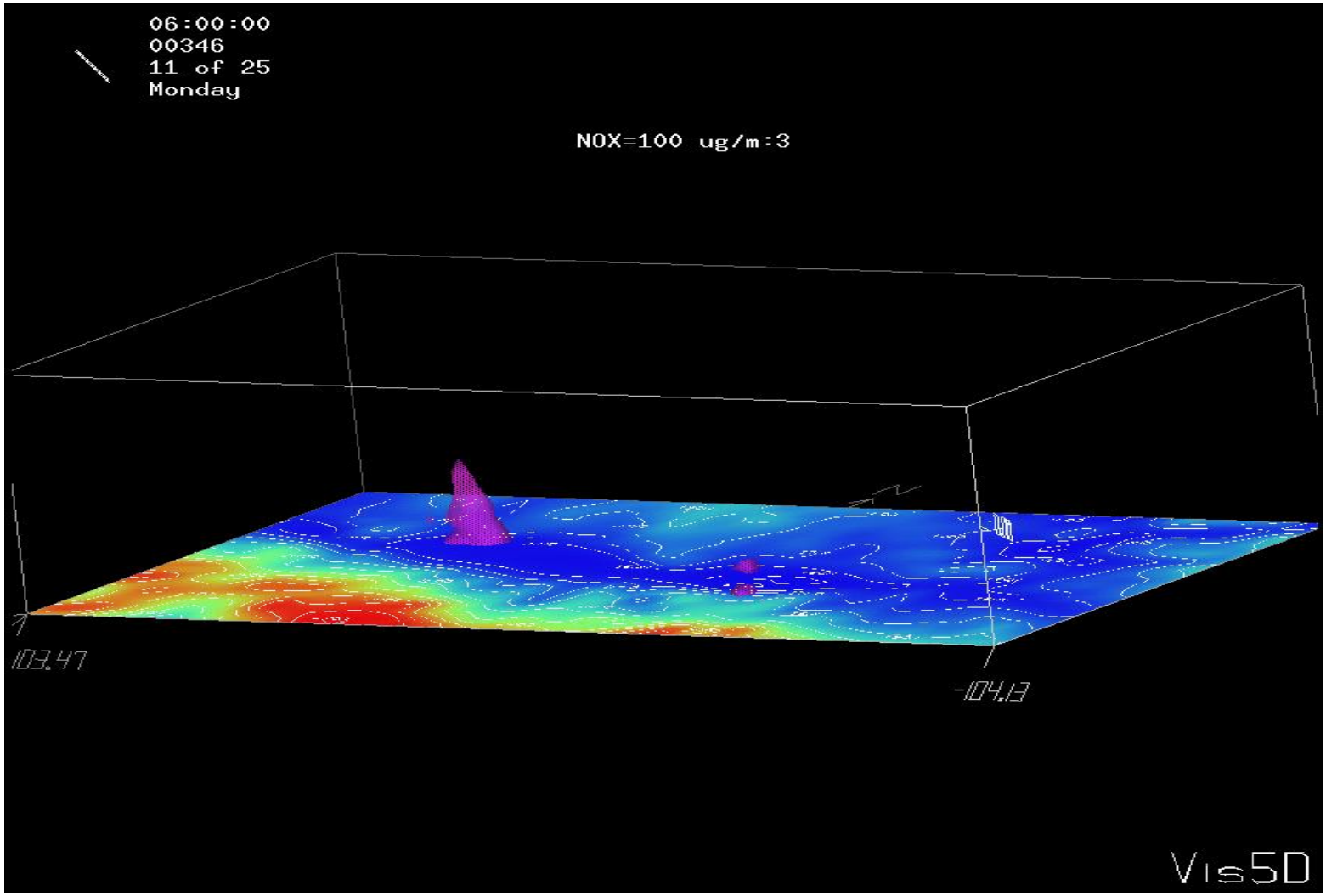
NO_x

07h Dec 11, 2000



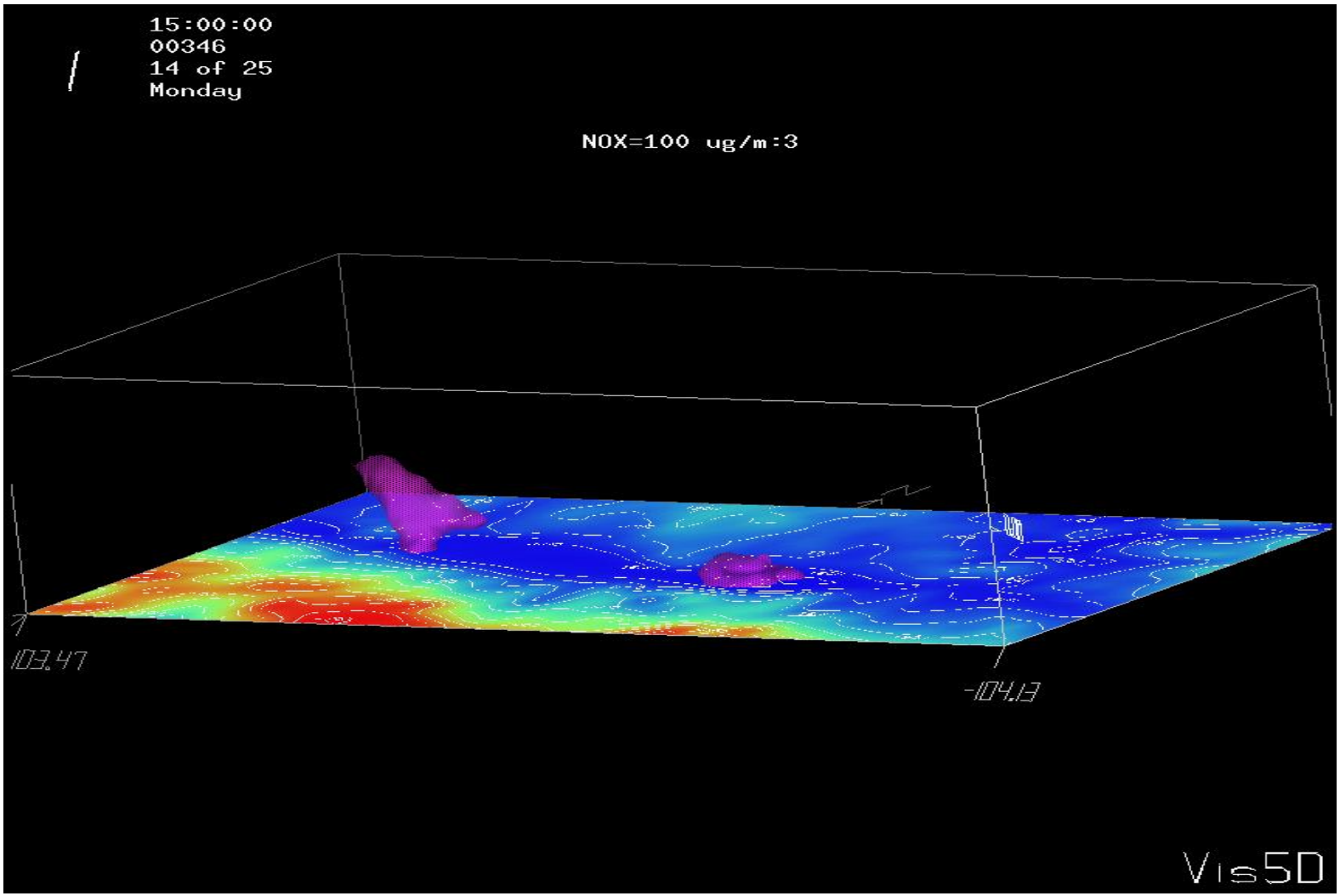
NO_x

13 h, Dec 11, 2000



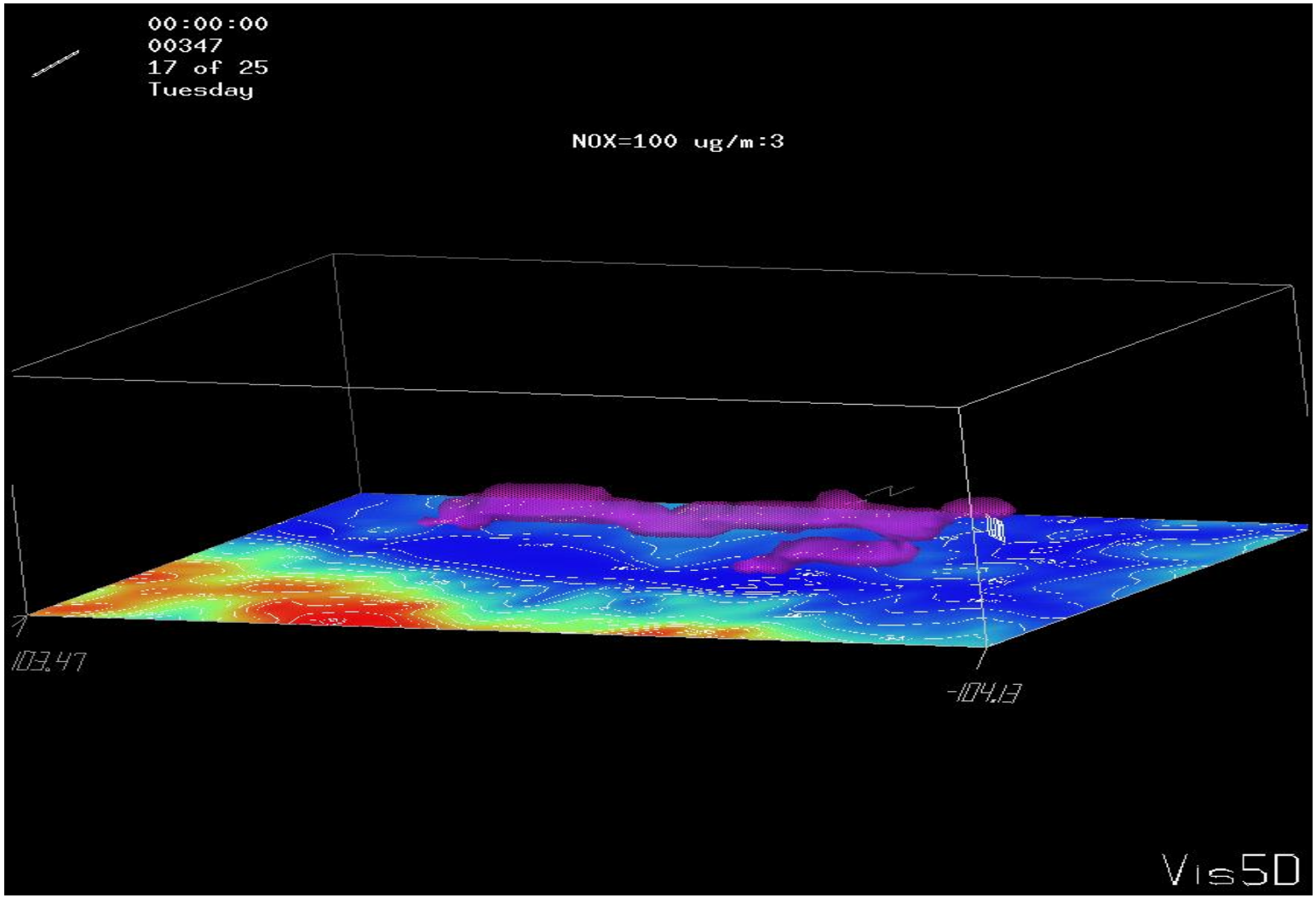
NO_x

22h, Dec 11, 2000



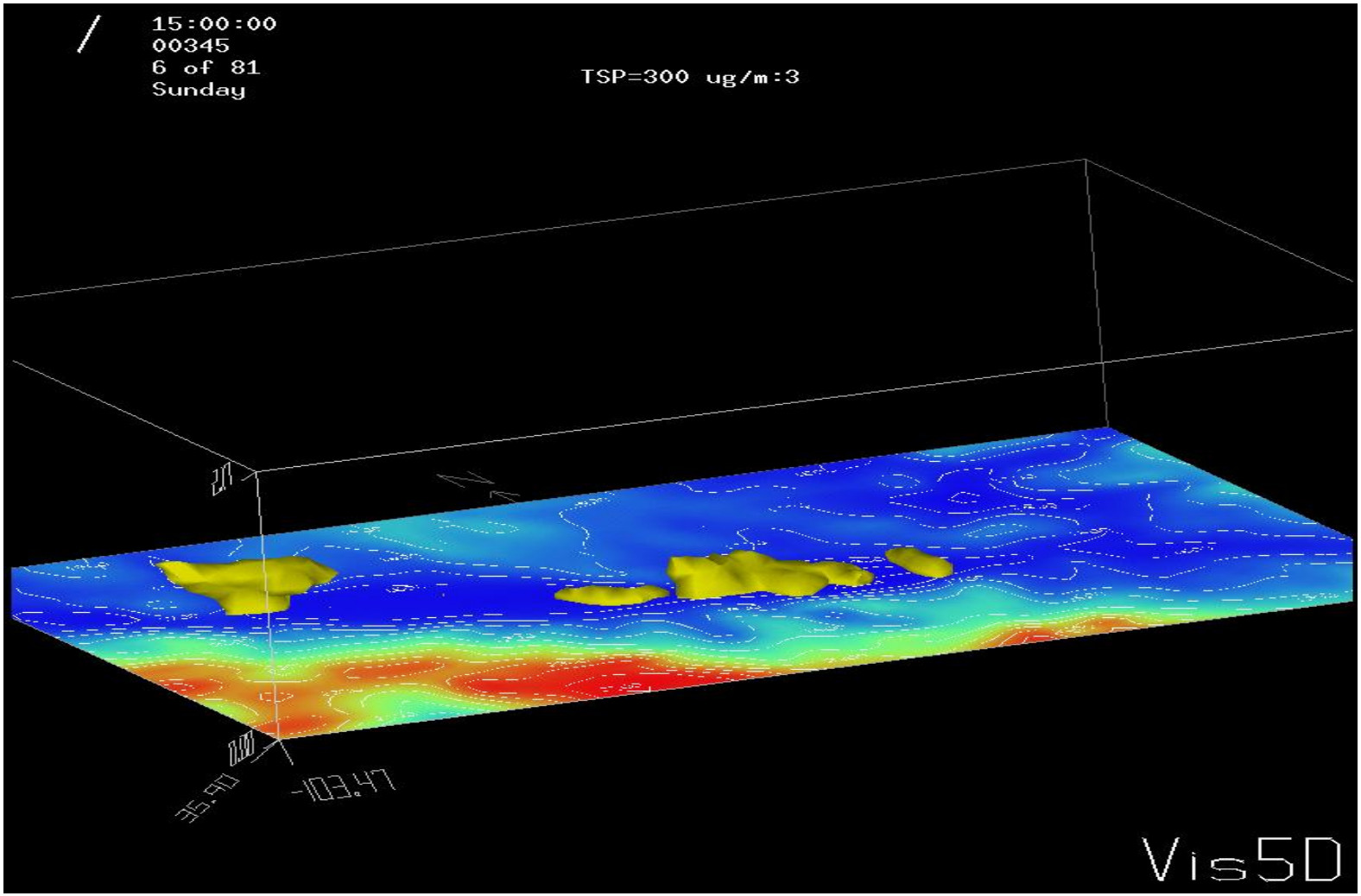
NO_x

07h, Dec 12, 2000



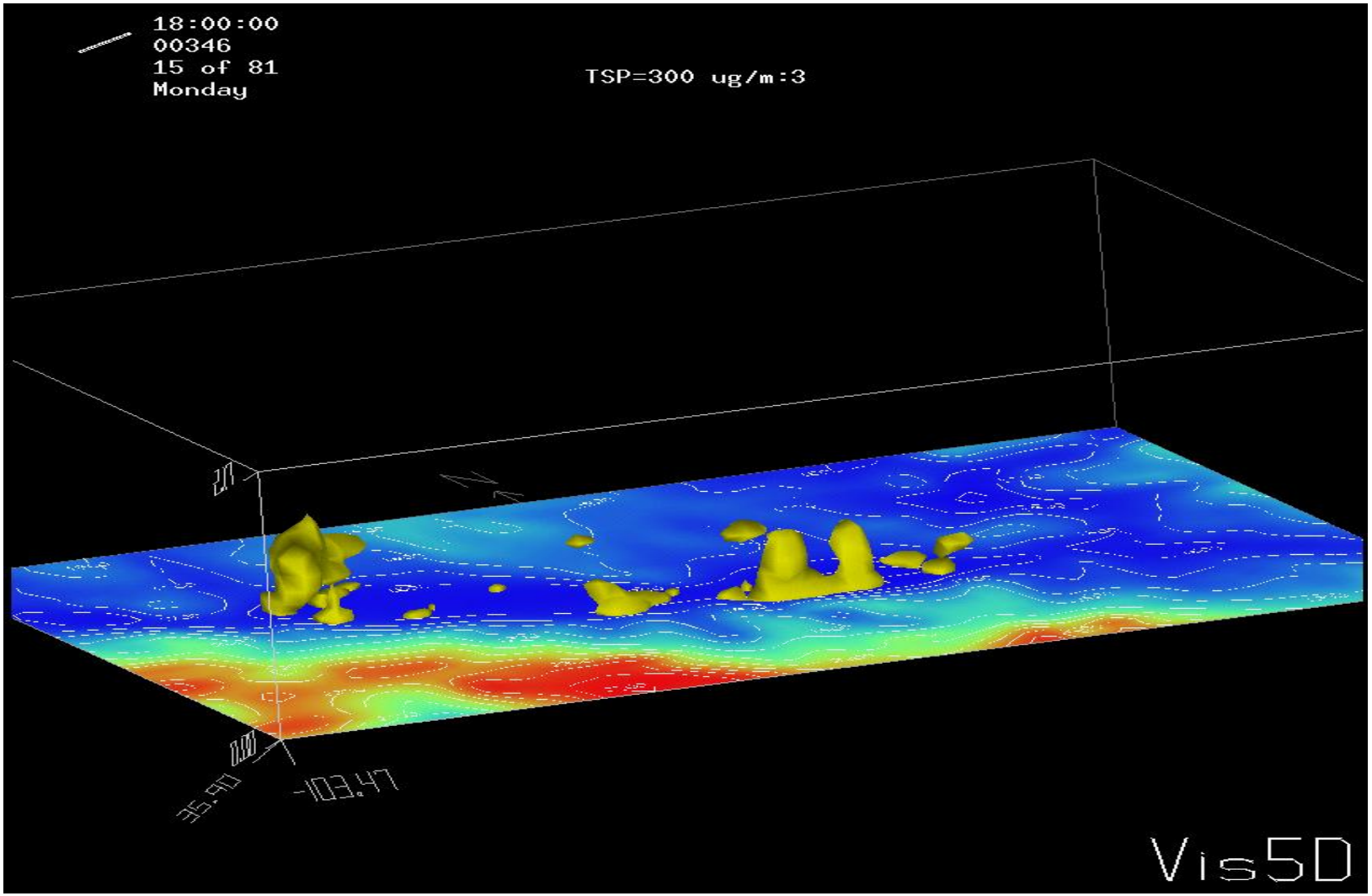
TSP

13h, Dec 11, 2000



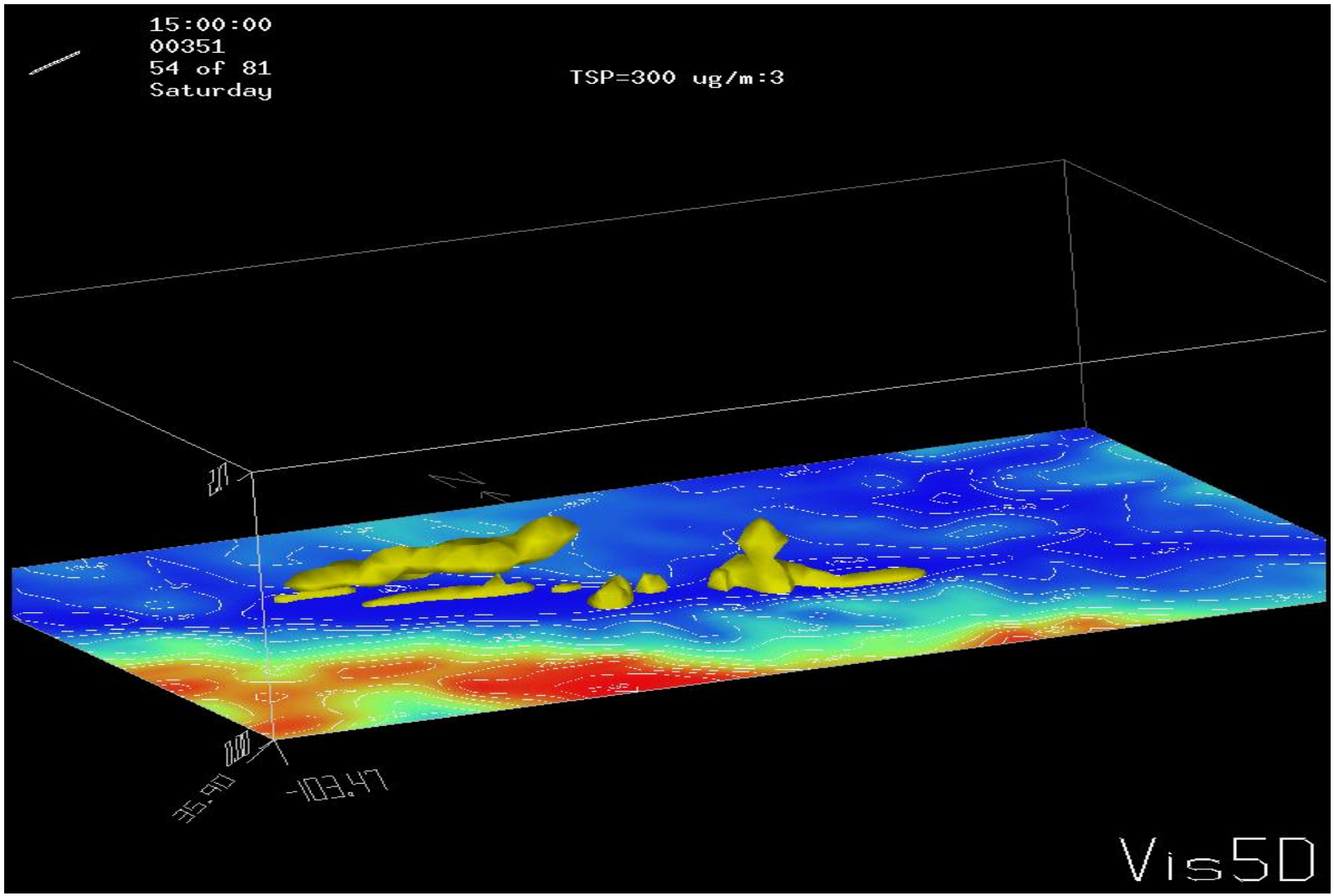
TSP

01h, Dec 12, 2000



TSP

22h, Dec 16, 2000



Conclusions

- Severe air pollution is caused by heavy pollution sources
- Meteorological conditions take important roles:
  - Inversion (Stable Stratification)
  - Valley Winds
- RAMS-HYPACT simulates the transport of the pollutants.