Reactive Nitrogen during TRACE-P

Yutaka Kondo
Research Center for Advanced Science and Technology
The University of Tokyo

F. Flocke, A Weinheimer, D. R. Blake, G. Sachse, M. Avery, M. Zondlo, H. Fuelberg, R. Weber, S. Sandholm, G. Chen, J. Crawford, D. Davis, D. Jacob, I. Uno, G. Carmichael, R. Talbot, H. Singh, A. Bandy, D. Thornton, TRACE-P science team

1. Chemical signatures and processes of the biomass burning plumes (Y. Kondo)
2. The role of synoptic scale transport on the distributions of reactive nitrogen and other species during TRACE-P (Y. Miyazaki)
3. Sources, distribution and partitioning of reactive nitrogen in the lower troposphere over western Pacific during TRACE-P (K. Kita)
4. Efficiency of transport of nitrogen and sulfur compounds from the Asian continent (M. Koike)

Model calculations

Box model of GIT (G. Chen, J. Crawford, D. Davis)

3-D global model of Harvard Univ. (D. Jacob)

3-D regional model of Univ. of Kyushu (I. Uno)

3-D regional model of Univ. of Iowa (G. Carmichael)

Reactive Nitrogen during TRACE-P

Yutaka Kondo
Research Center for Advanced Science and Technology

The University of Tokyo
4-6-1 Komaba, Meguro-ku, Tokyo 153-8904, Japan
kondo@atmos.rcast.u-tokyo.ac.jp

Sampling locations

Z = 2-4 km

Lat = 17-30 °N, Long < 150 °E (MA)

Lat > 30 °N, Long < 156 °E (NA)

Five-day back-trajectories of sampled air masses over

Biomass burning region (Lat < 28 °N): BB

Non-biomass burnin region (Lat > 28 °N): FF

Pacific Ocean : PO

Convection over South-East Asia was often observed.

Hot spots and high aerosol index was observed over southern China and Southeast Asia (Thailand, India).

Percentage of air masses

BB	FF	PO
MA	67.8	18.6	13.6
NA	5.7	93.6	0.7

Generally CH_3Cl is high and C_2Cl_4 is low at 17-30 °N (MA)

CH_3Cl is used as a tracer for the biomass burning impacted air

Median values of for FF air = 559 pptv pptv
Median values of C_2Cl_4 for BB air = 4.15 (+6.28, - 1.95) pptv

BB impacted air ≡ CH_3Cl > Median + central 67 % = 585 pptv
And C_2Cl_4 < 10.4 pptv

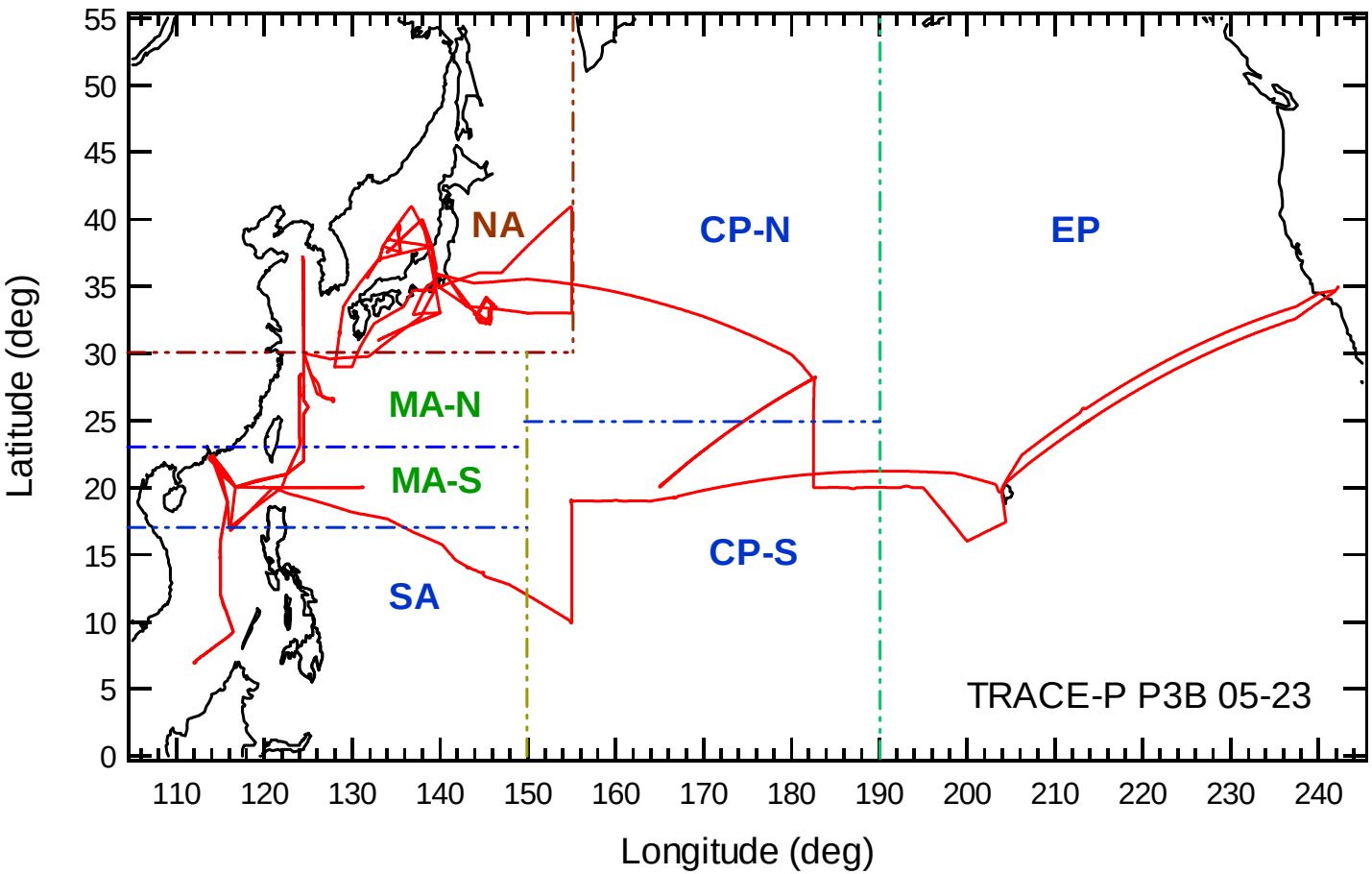
Summary

1. At latitude < 30 N and 2-4 km, biomass burning elevated levels of trace gases and aerosol.
a) O_3 by 15 ppbv,
b) CO, NOy, PAN, C_2H_6 by factors of 2-4.

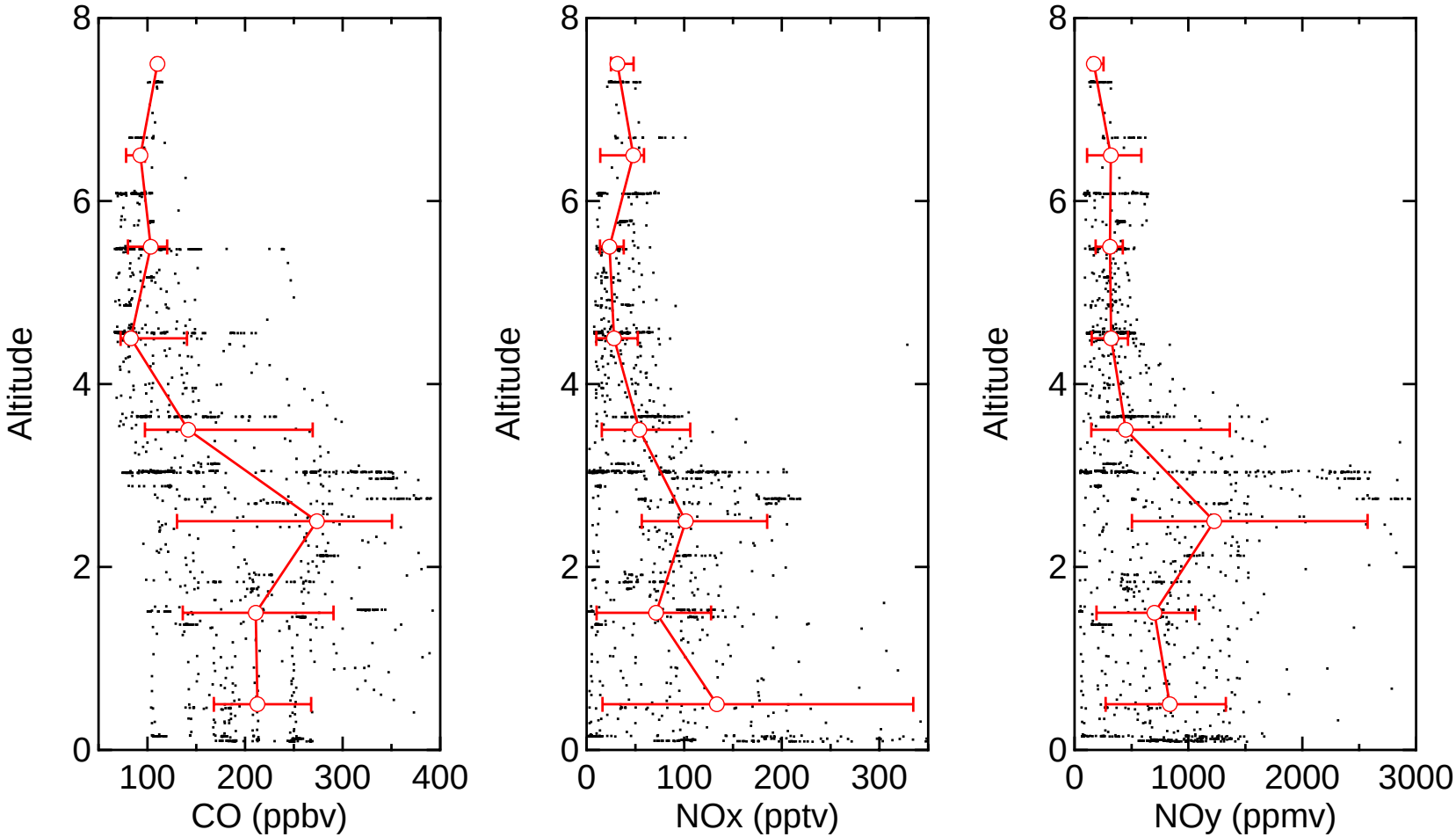
2. Net ozone production rate is negative (- 3 ppbv/day) in this layer. Although NO was high (30-40 pptv), high O_3 (70 ppbv) and H_2O (7000 ppmv) lead to a large O_3 loss.
Ozone must be produced in the boundary layer of the biomass burning region.

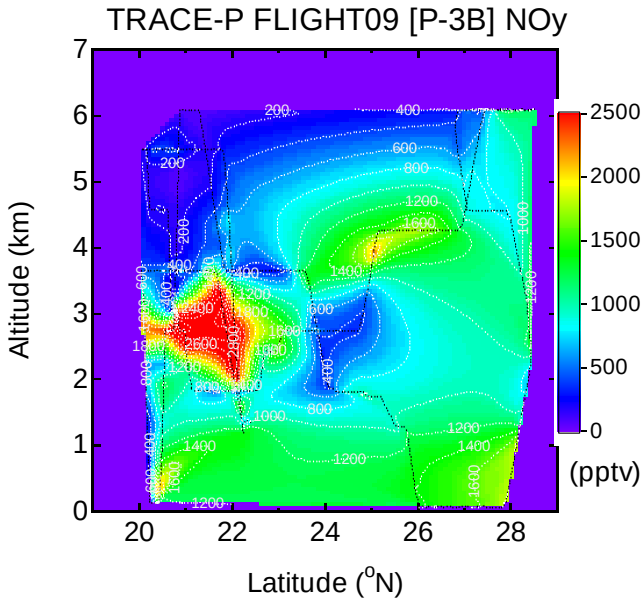
4. CO-CH_4, CO-C_2H_6, and CO-C_3H_8 correlations showed differences from those in NA (Lat > 30) air.

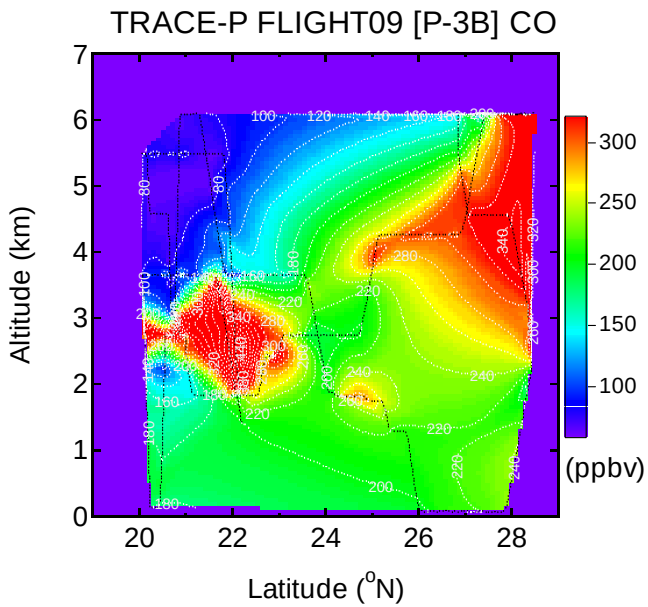
5. This air was transported as far down to 180 ° E, according to the trajectories.

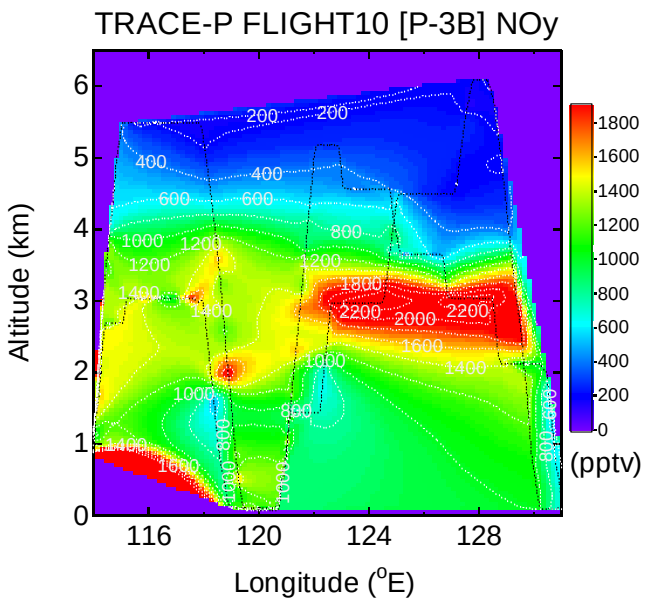

NA
CP-N
EP
MA-N
MA-S
CP-S
SA
TRACE-P P3B 05-23
Latitude (deg)
Longitude (deg)
55
50
45
40
35
30
25
20
15
10
5
0
110
120
130
140
150
160
170
180
190
200
210
220
230
240

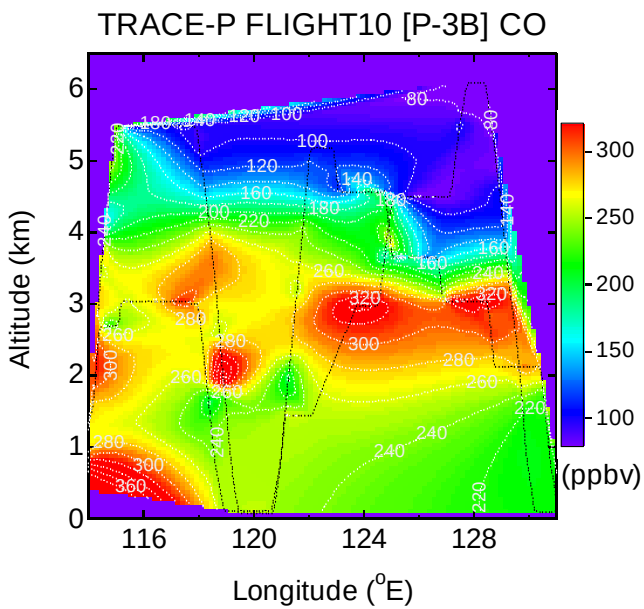
TRACE-P MAS

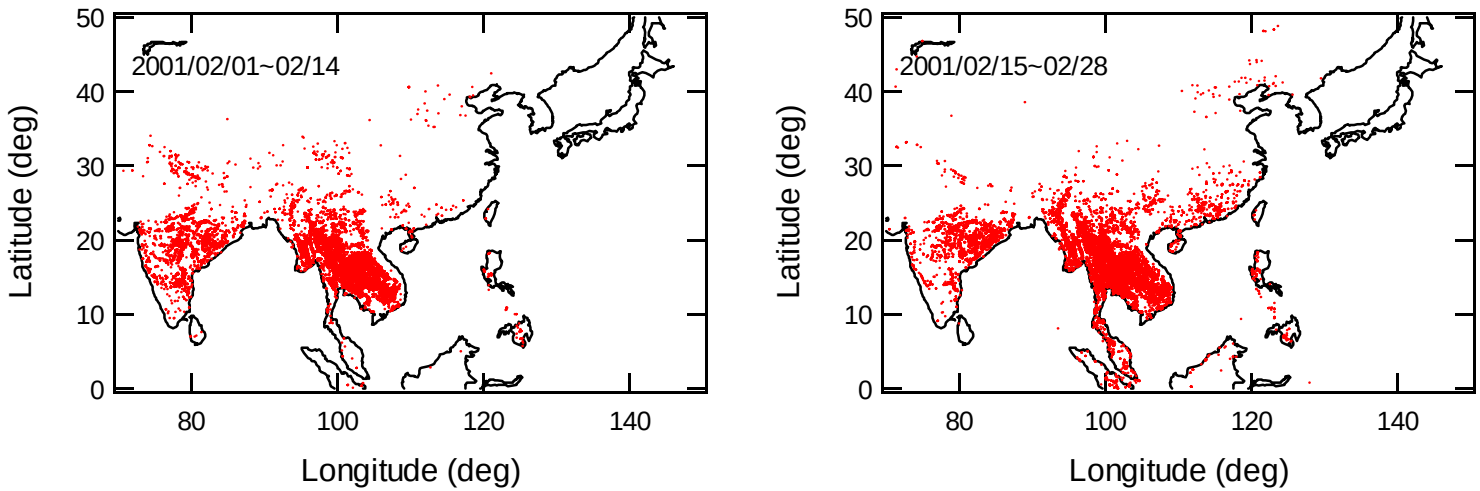

Altitude
CO (ppbv)
NOx (pptv)
NOy (ppmv)
0
2
4
6
8
100
200
300
400
1000
2000
3000

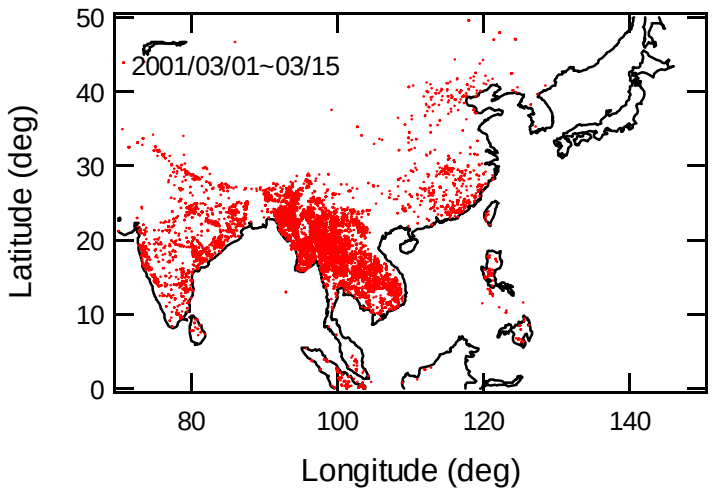

TRACE-P FLIGHT09 [P-3B] NOy
Altitude (km)
Latitude (°N)
(pptv)
0
500
1000
1500
2000
2500

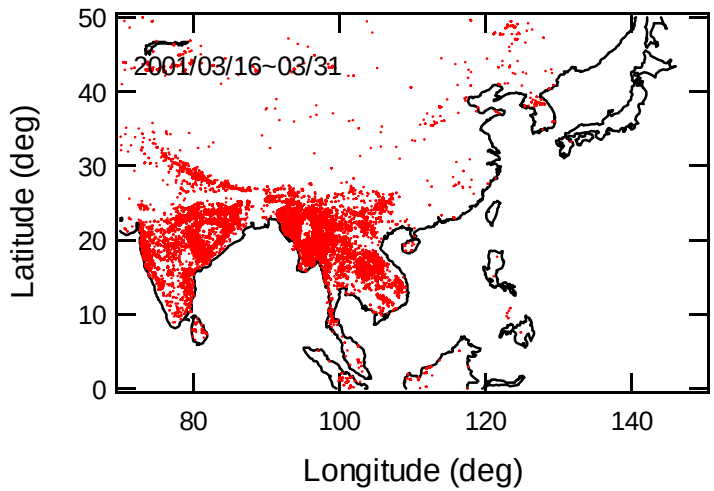

TRACE-P FLIGHT09 [P-3B] CO
Altitude (km)
Latitude (°N)
(ppbv)
100
150
200
250
300

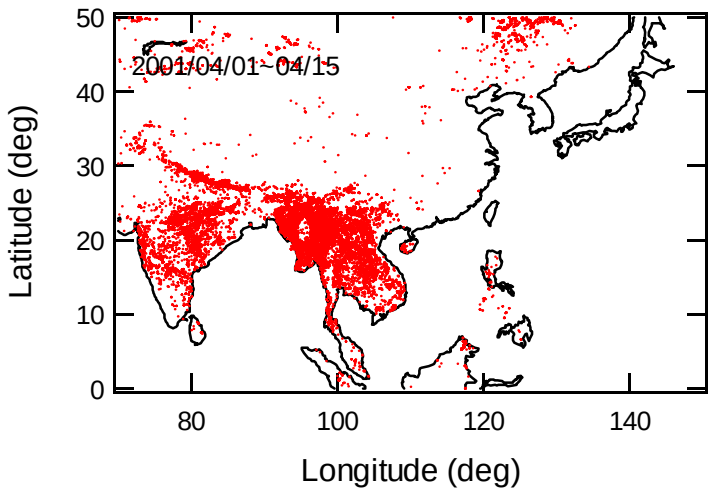

TRACE-P FLIGHT10 [P-3B] NOy
Altitude (km)
Longitude (°E)
(pptv)

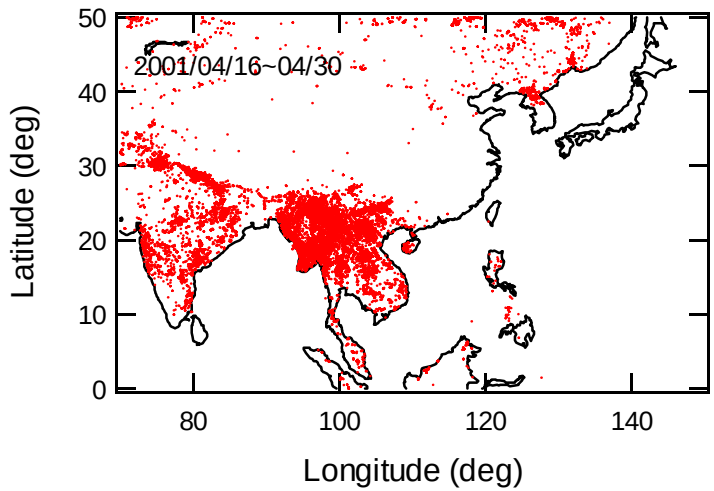

TRACE-P FLIGHT10 [P-3B] CO
Altitude (km)
Longitude (°E)
(ppbv)

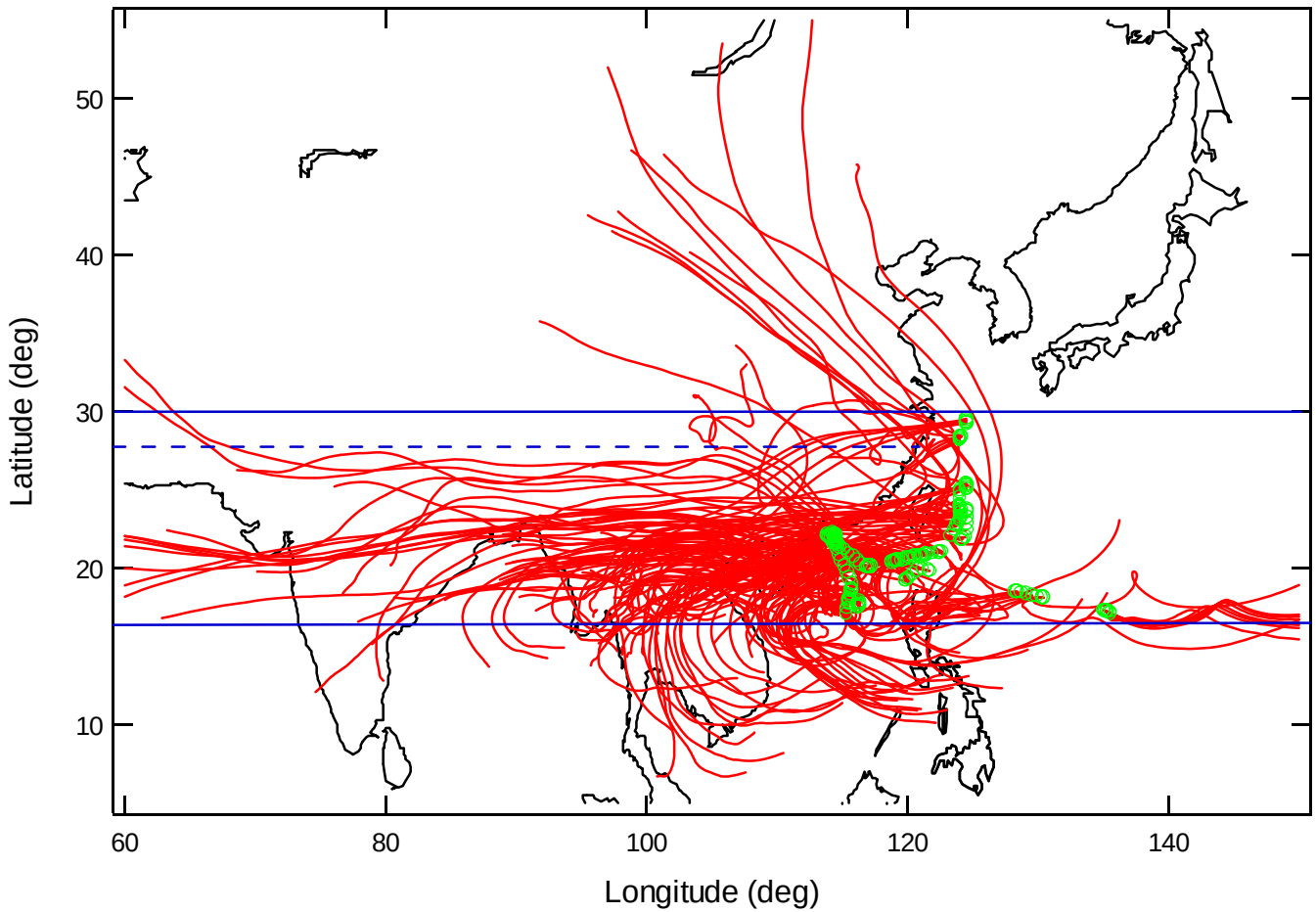

2001/02/01~02/14
2001/02/15~02/28
Latitude (deg)
Longitude (deg)
0
10
20
30
40
50
80
100
120
140

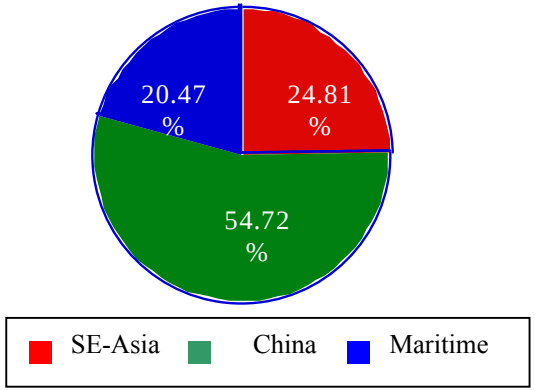

2001/03/01~03/15
Latitude (deg)
Longitude (deg)
0
10
20
30
40
50
80
100
120
140


2001/03/16~03/31
Latitude (deg)
Longitude (deg)
0
10
20
30
40
50
80
100
120
140

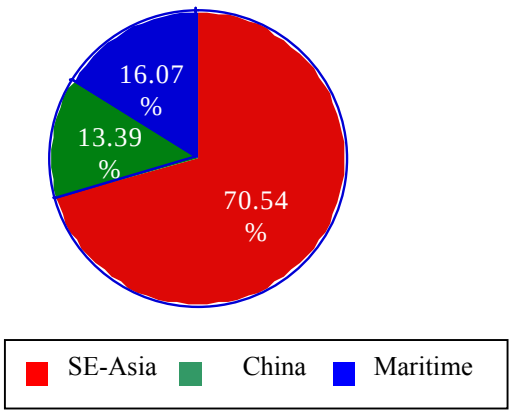

2001/04/01~04/15
Latitude (deg)
Longitude (deg)
0
10
20
30
40
50
80
100
120
140


2001/04/16~04/30
Latitude (deg)
Longitude (deg)
0
10
20
30
40
50
80
100
120
140

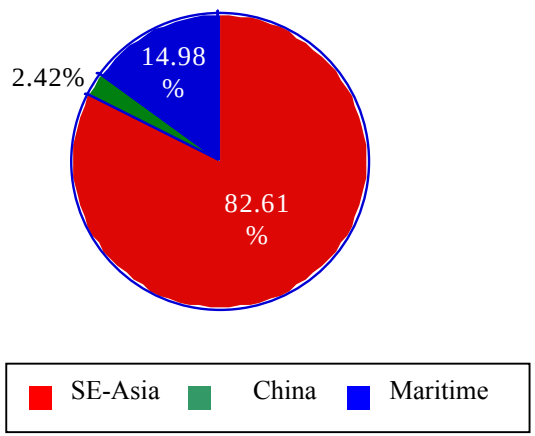

Latitude (deg)
50
40
30
20
10
60
80
100
120
140
Longitude (deg)



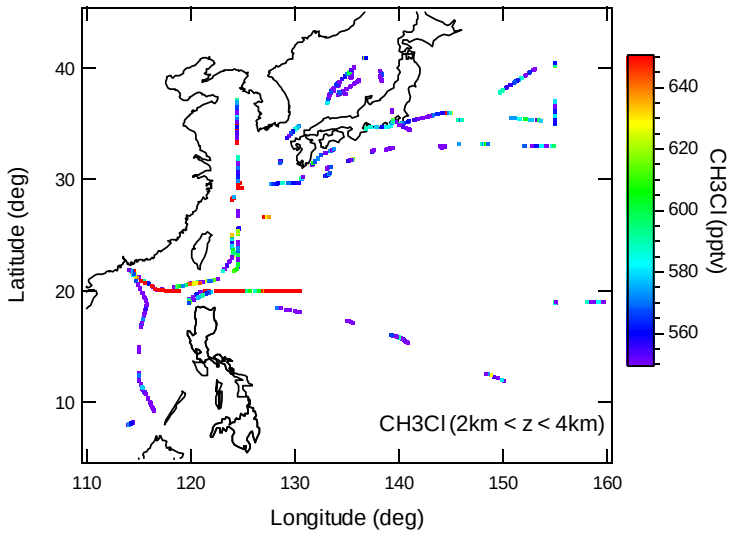
0-2km

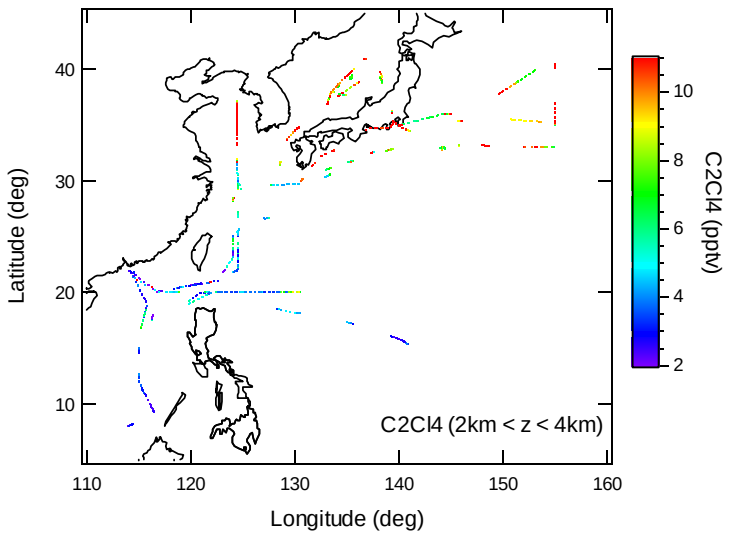


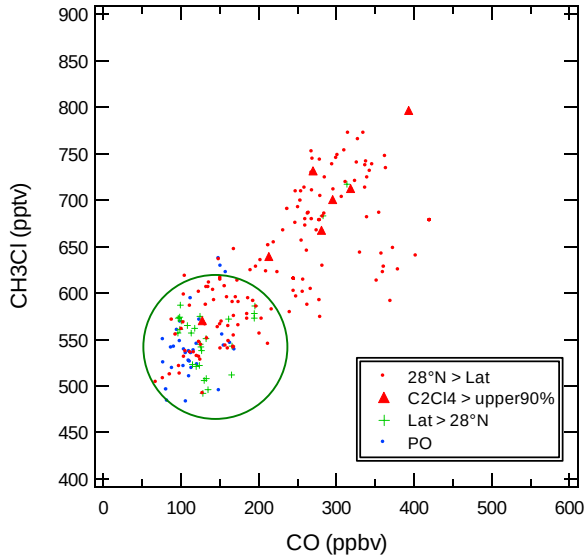
2-4km

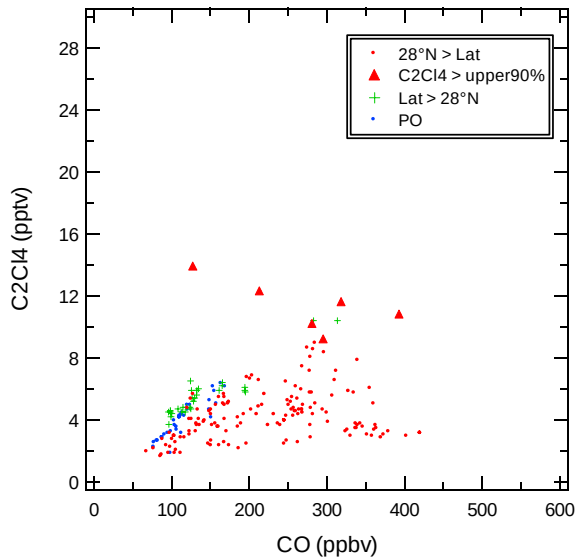


4km-


CH3Cl (2km < z < 4km)
Latitude (deg)
Longitude (deg)
CH3Cl (pptv)
40
30
20
10
110
120
130
140
150
160
640
620
600
580
560

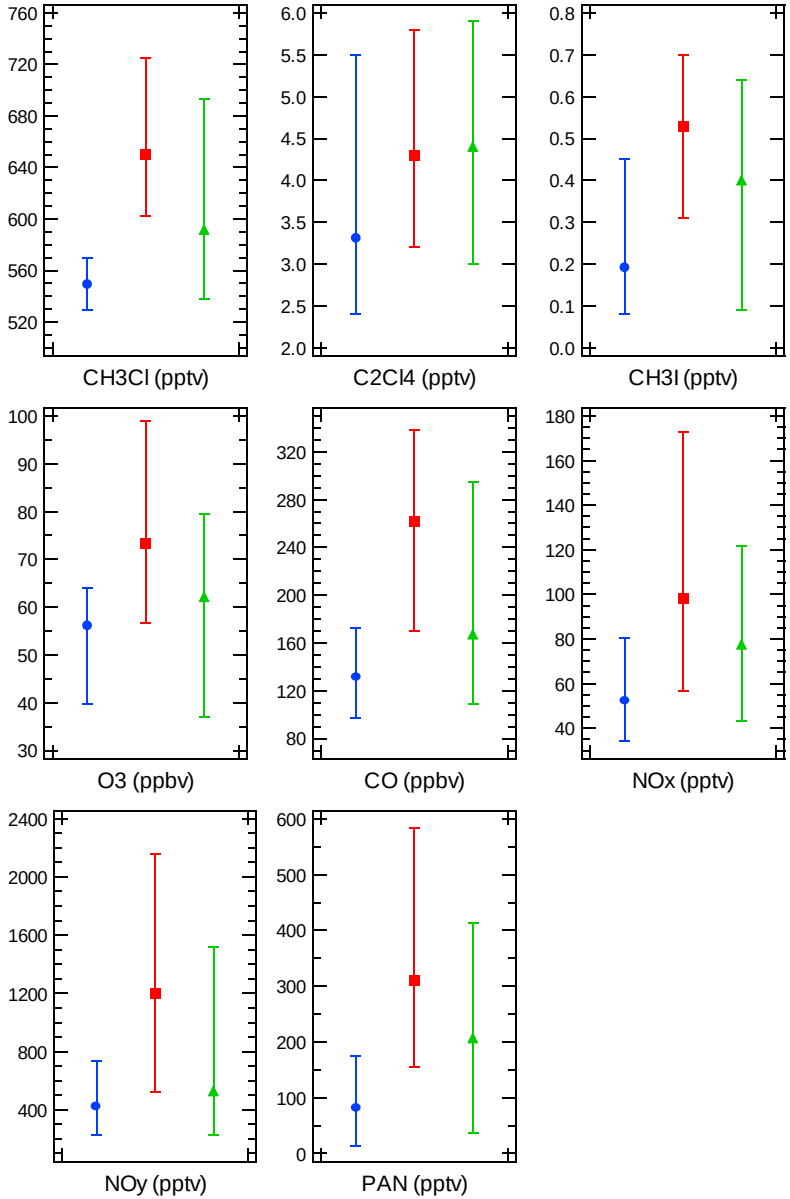

C2Cl4 (2km < z < 4km)
Latitude (deg)
Longitude (deg)
C2Cl4 (pptv)
40
30
20
10
110
120
130
140
150
160
10
8
6
4
2





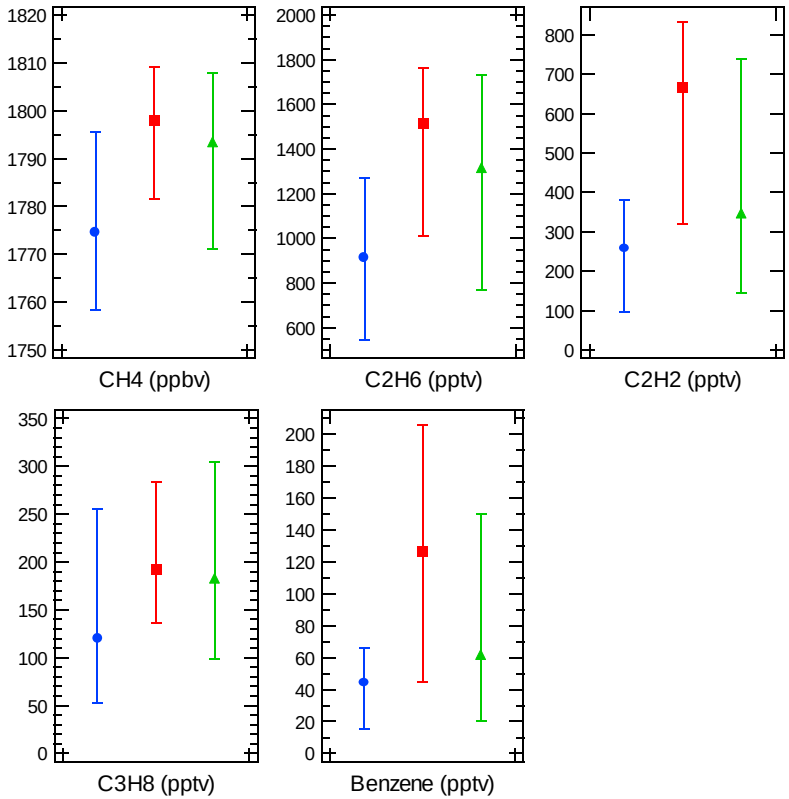
C2Cl4 > median + central90%
4.10 4.90

2 km < z < 4 km



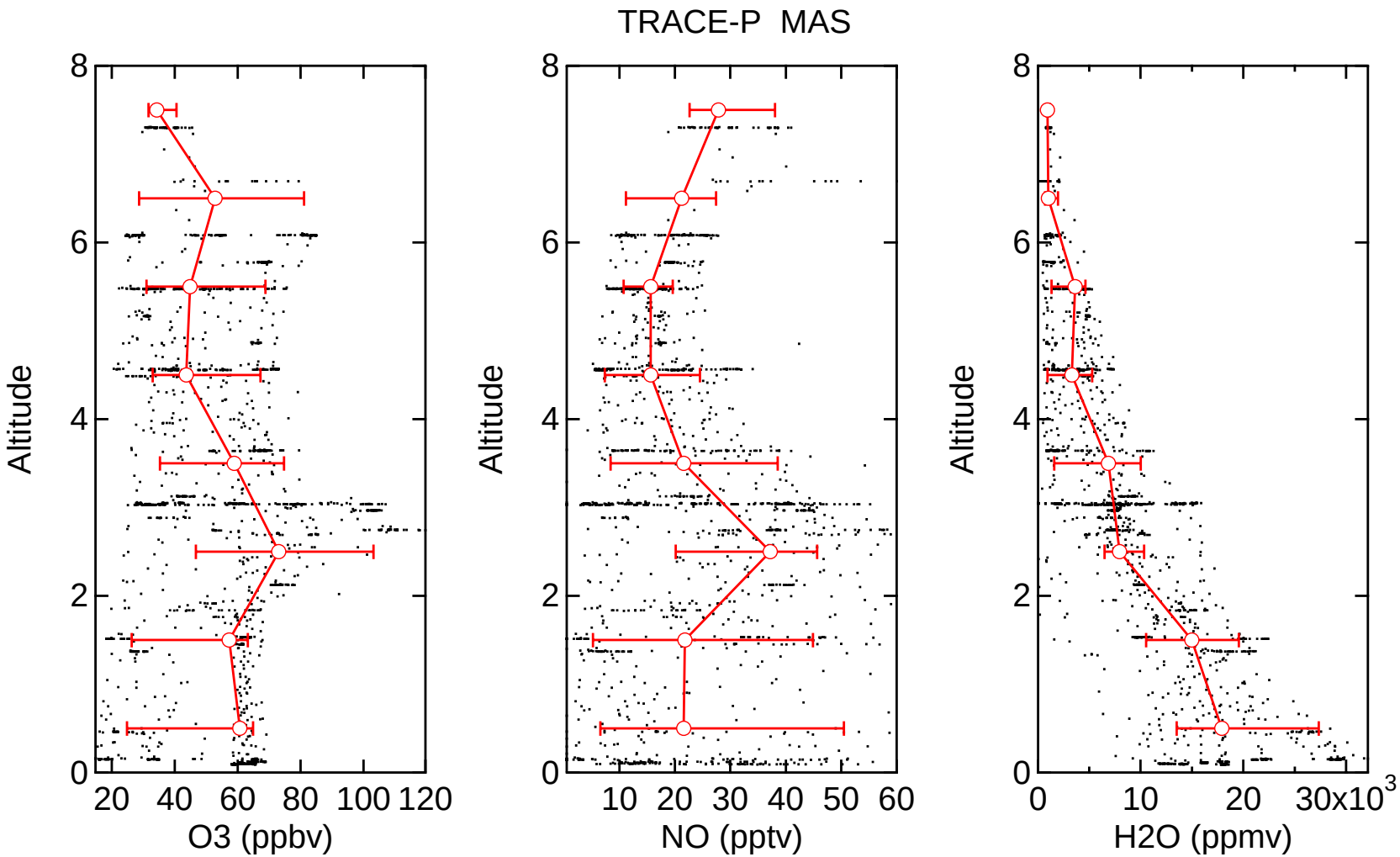
Background (Lat < 28°N, CH_3Cl < 578 pptv)
Lat < 28°N (CH3Cl, C2Cl4)
All

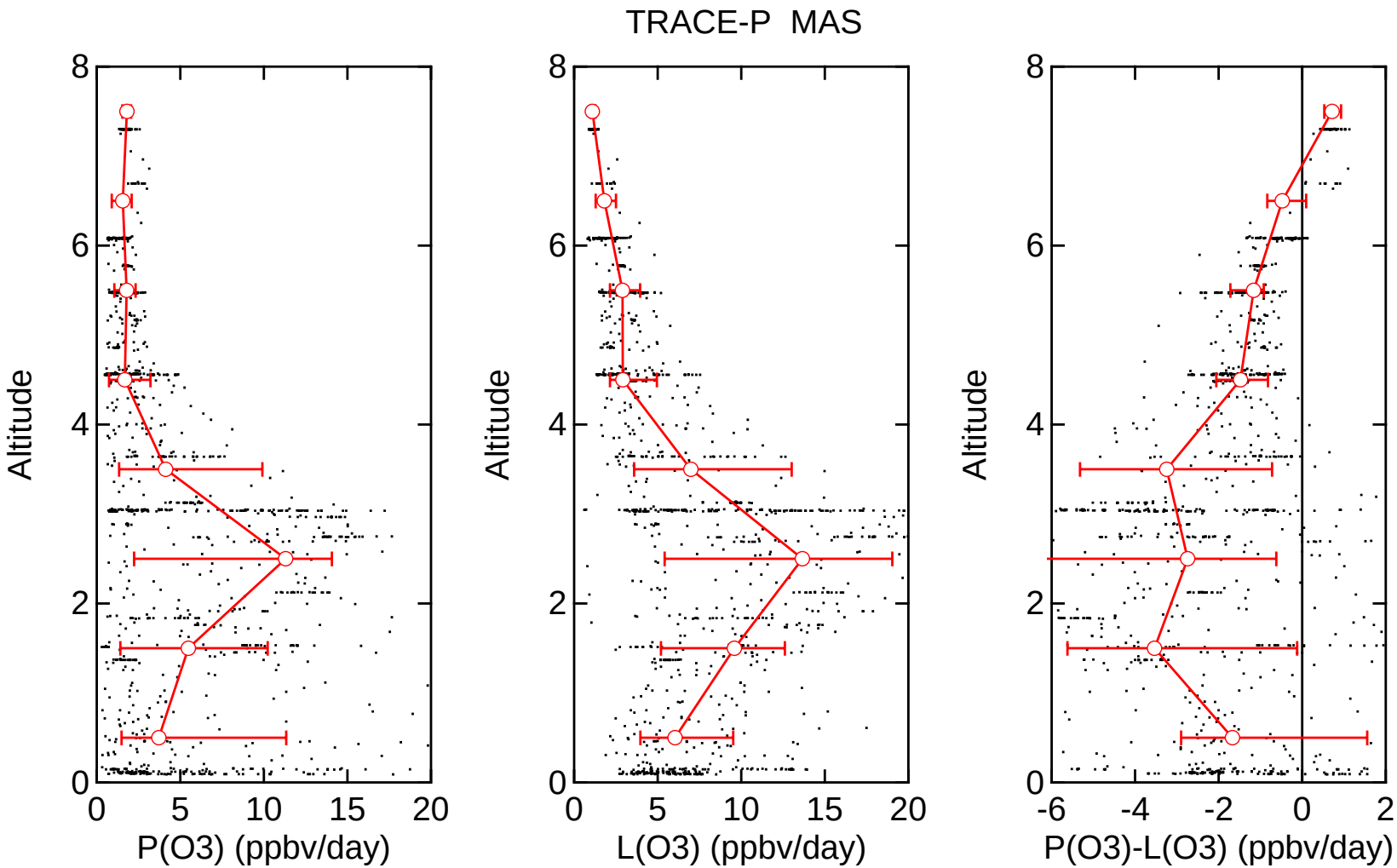
Observation altitude
2km < z < 4km

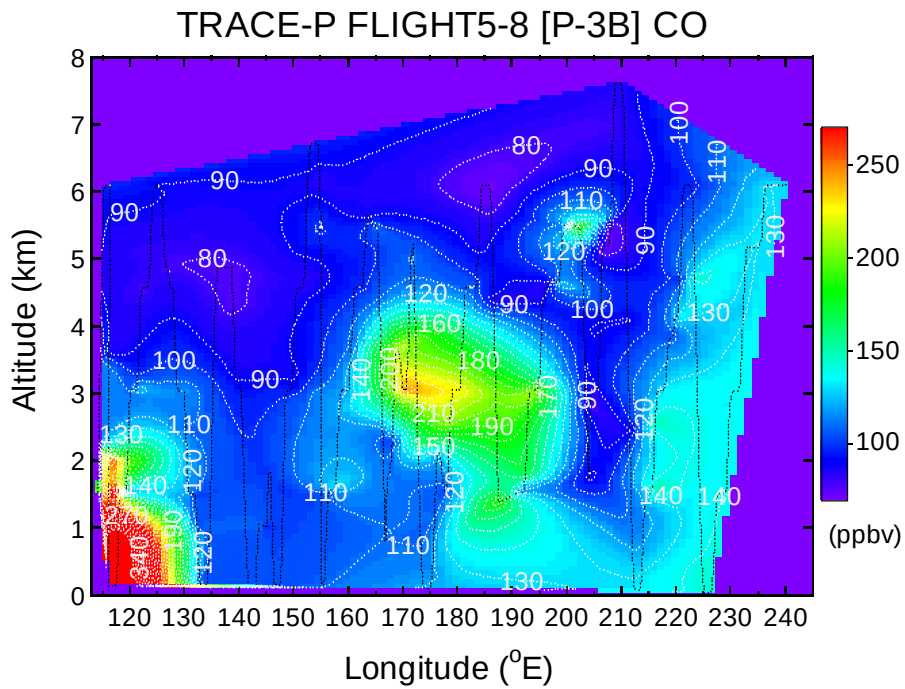


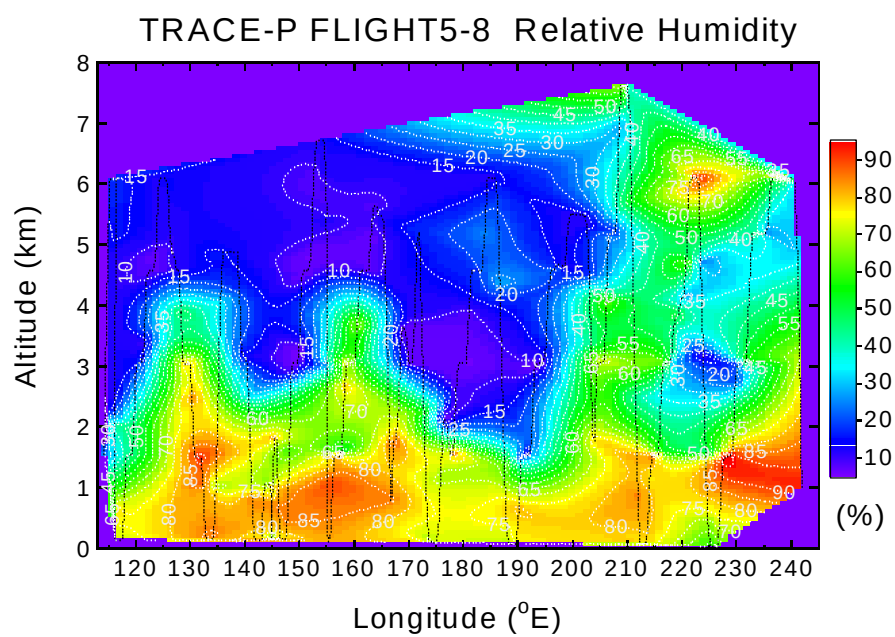
Background (Lat < 28°N, CH_3Cl < 578 pptv)
Lat < 28°N (CH3Cl, C2Cl4)
All

Observation altitude
2km < z < 4km


TRACE-P MAS
Altitude
O3 (ppbv)
NO (pptv)
H2O (ppmv)
0
2
4
6
8
20 40 60 80 100 120
10 20 30 40 50 60
0 10 20 30x10^3


TRACE-P MAS
Altitude
P(O3) (ppbv/day)
L(O3) (ppbv/day)
P(O3)-L(O3) (ppbv/day)
0
2
4
6
8
0
5
10
15
20
-6
-4
-2
0
2

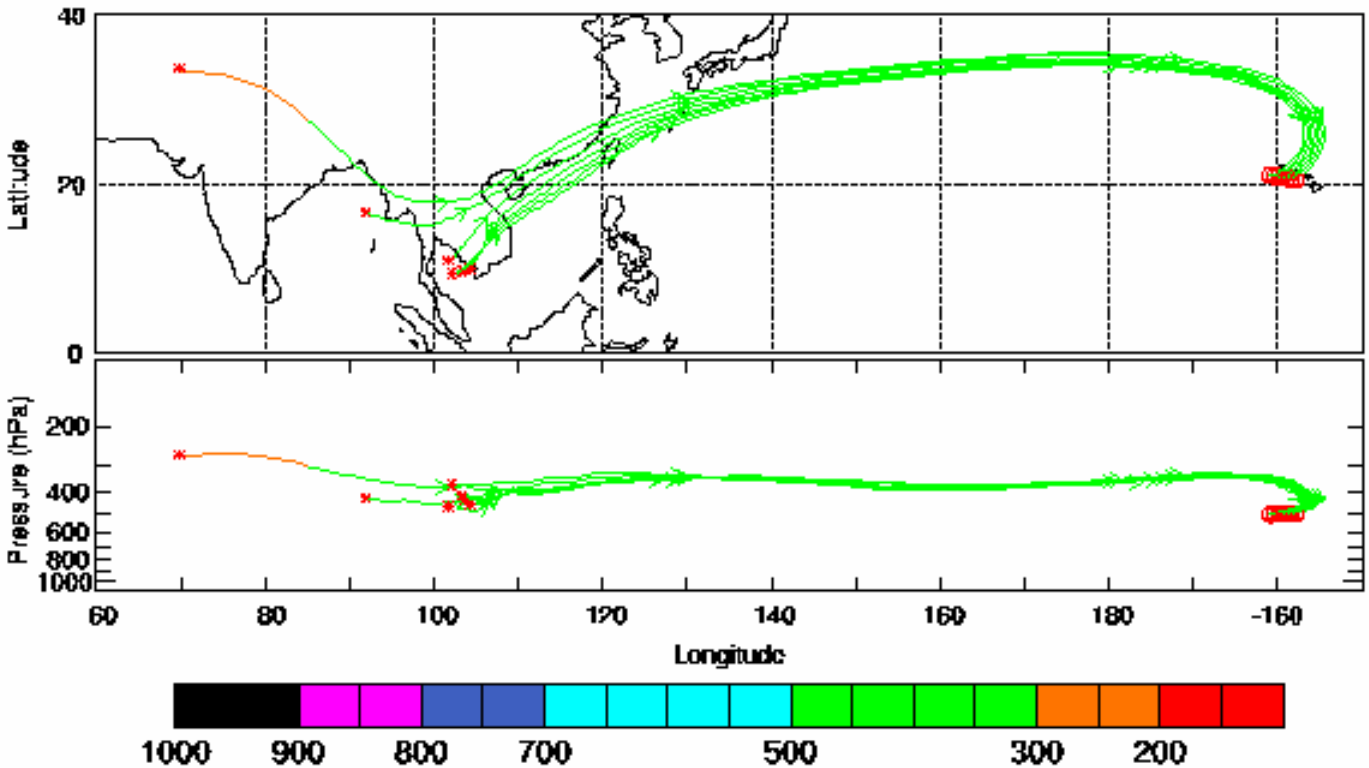

TRACE-P FLIGHT5-8 [P-3B] CO
Altitude (km)
Longitude (°E)
(ppbv)


TRACE-P FLIGHT5-8 Relative Humidity
Altitude (km)
Longitude (°E)
(%)

P3 B_FLIGHT_6_FL_LEG_04

TRACE-P 5-DAY BACKWARD TRAJECTORIES

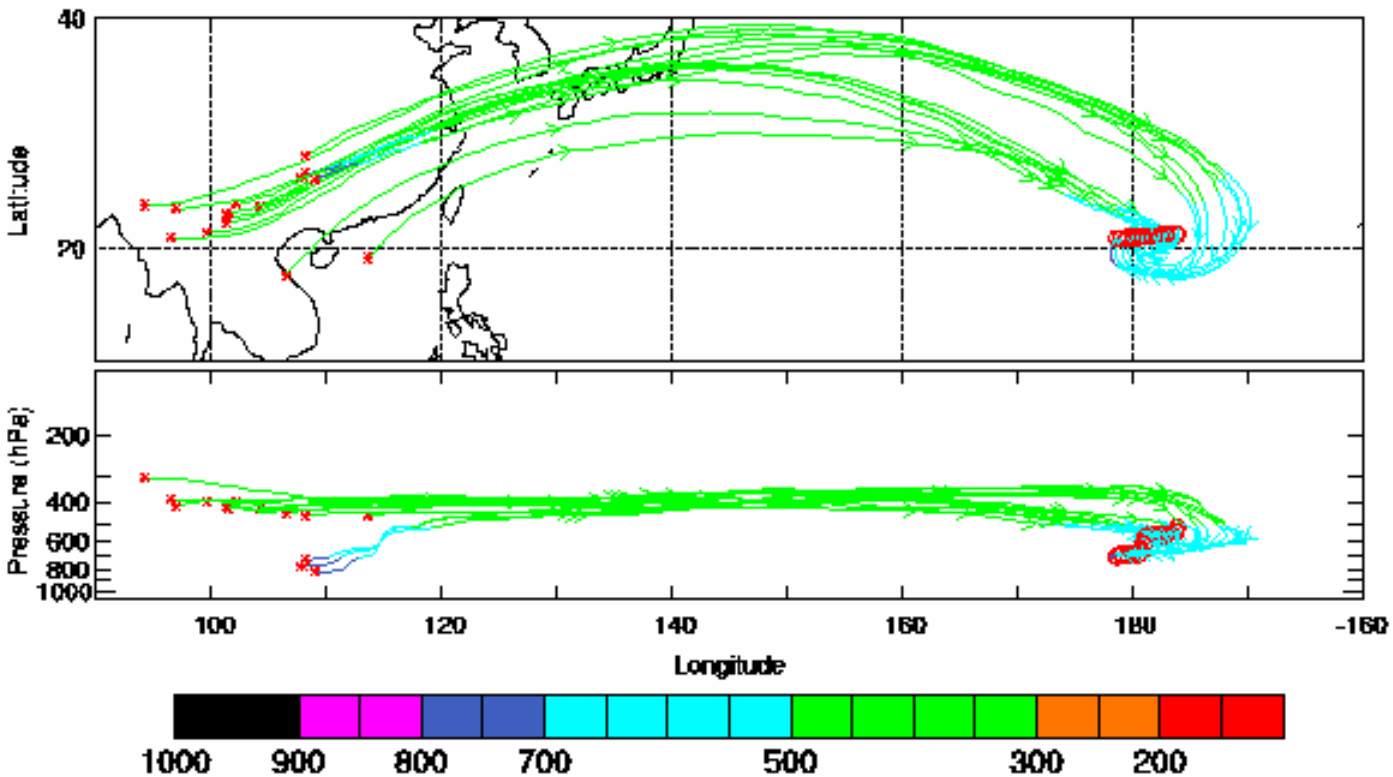
2001 FEB 28 00Z

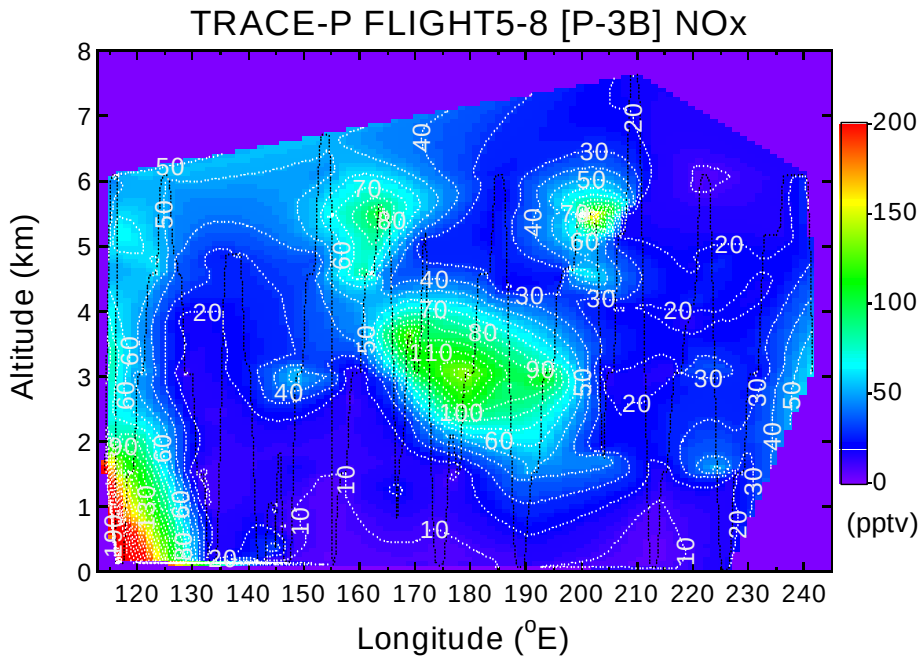


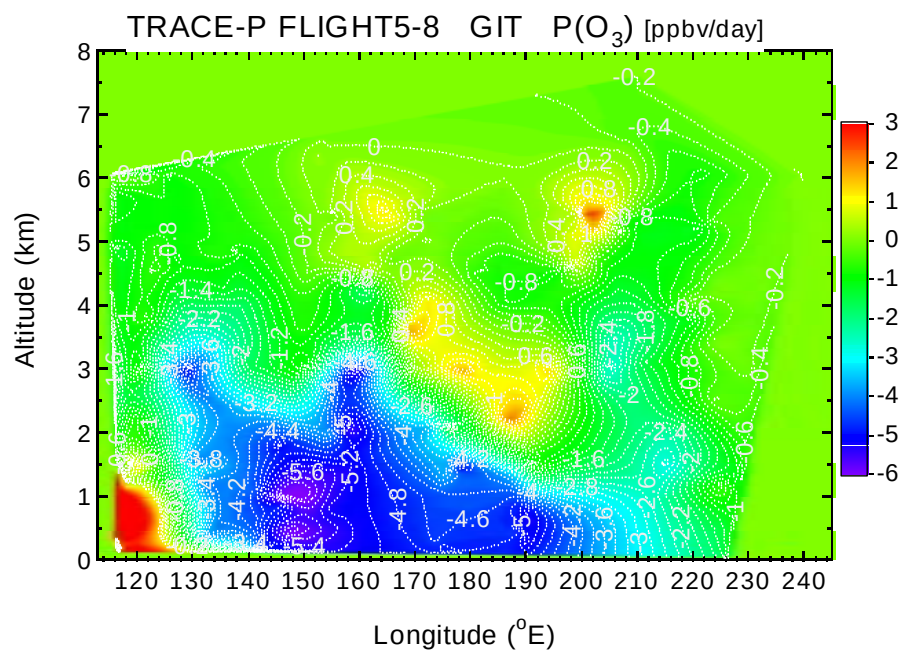
P3-B FLIGHT 6 FL LEG 11

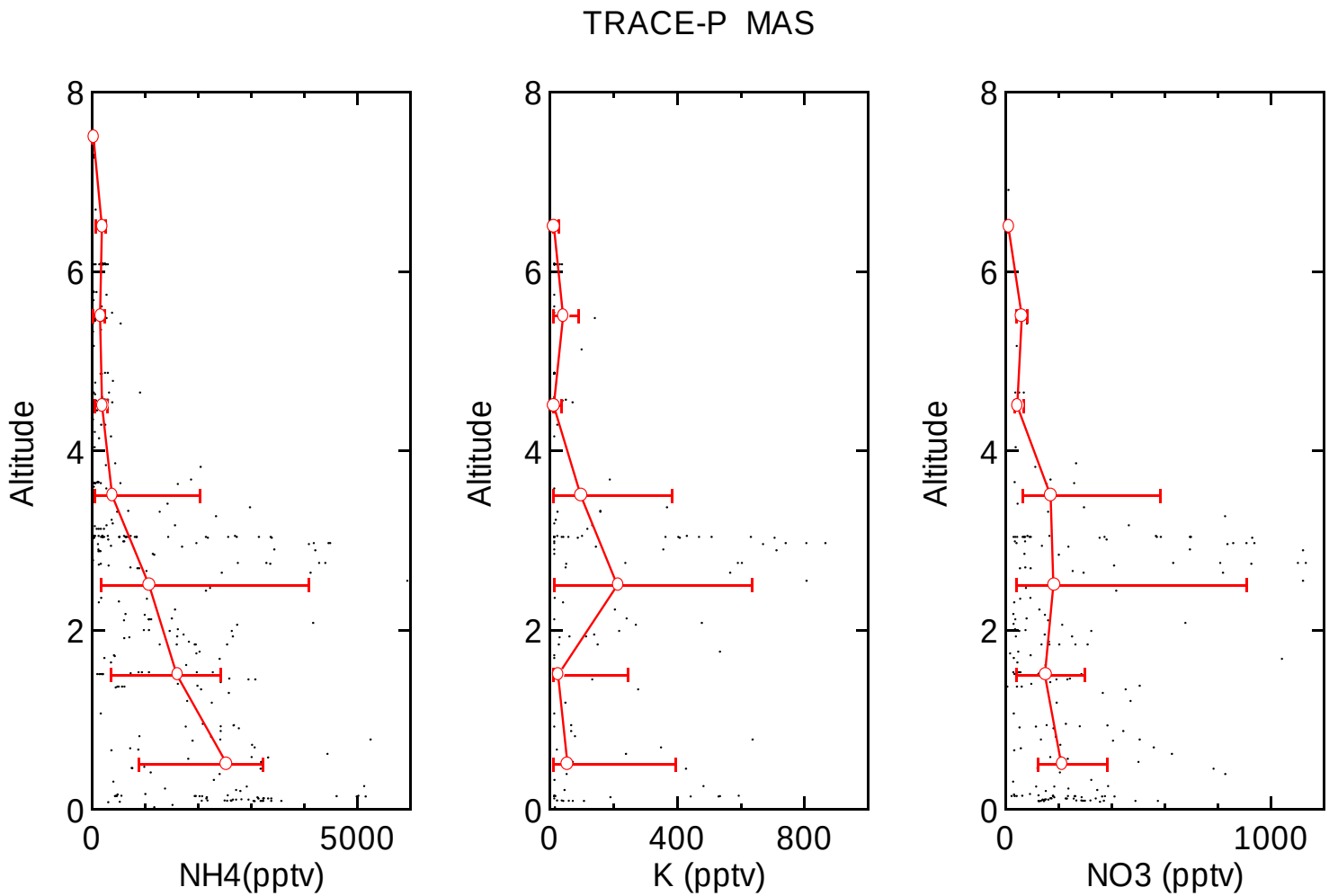
TRACE-P 5-DAY BACKWARD TRAJECTORIES

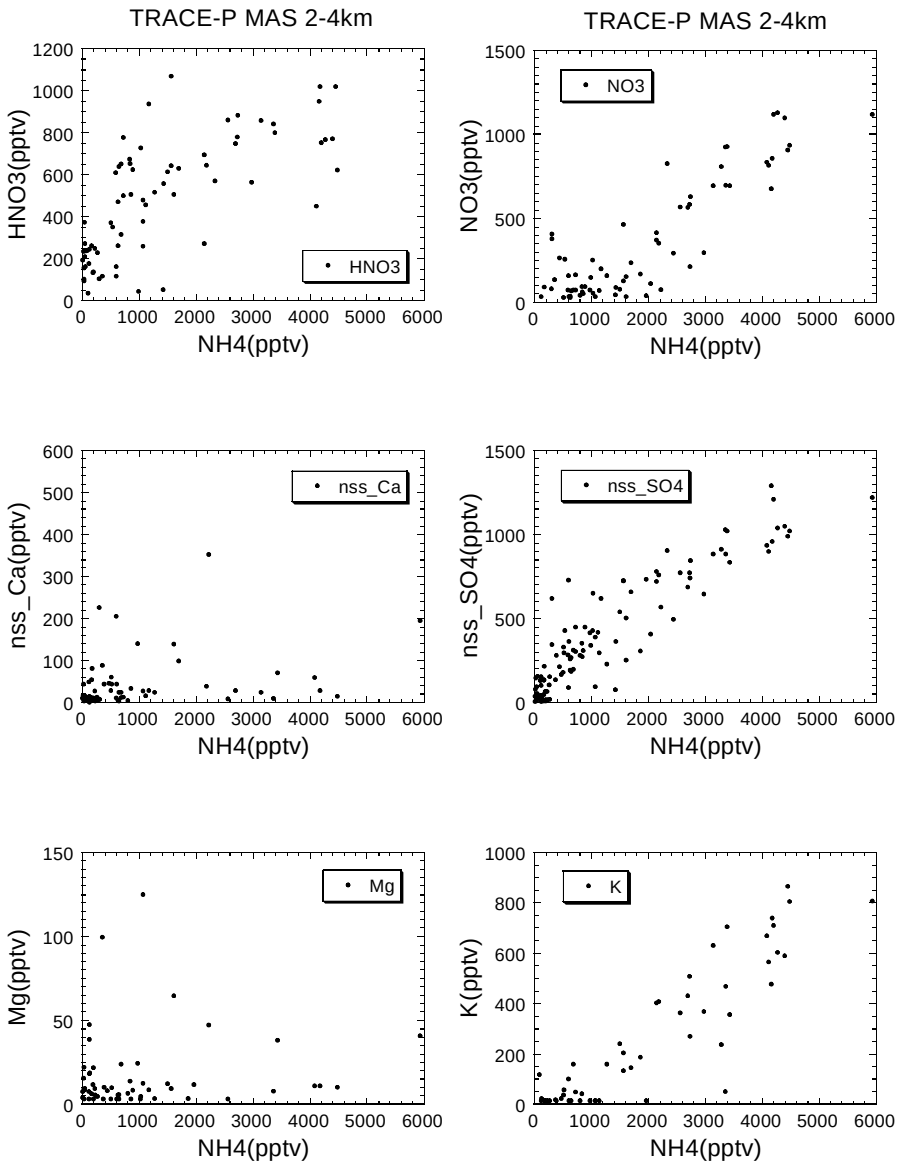
2001 FEB 28 00Z



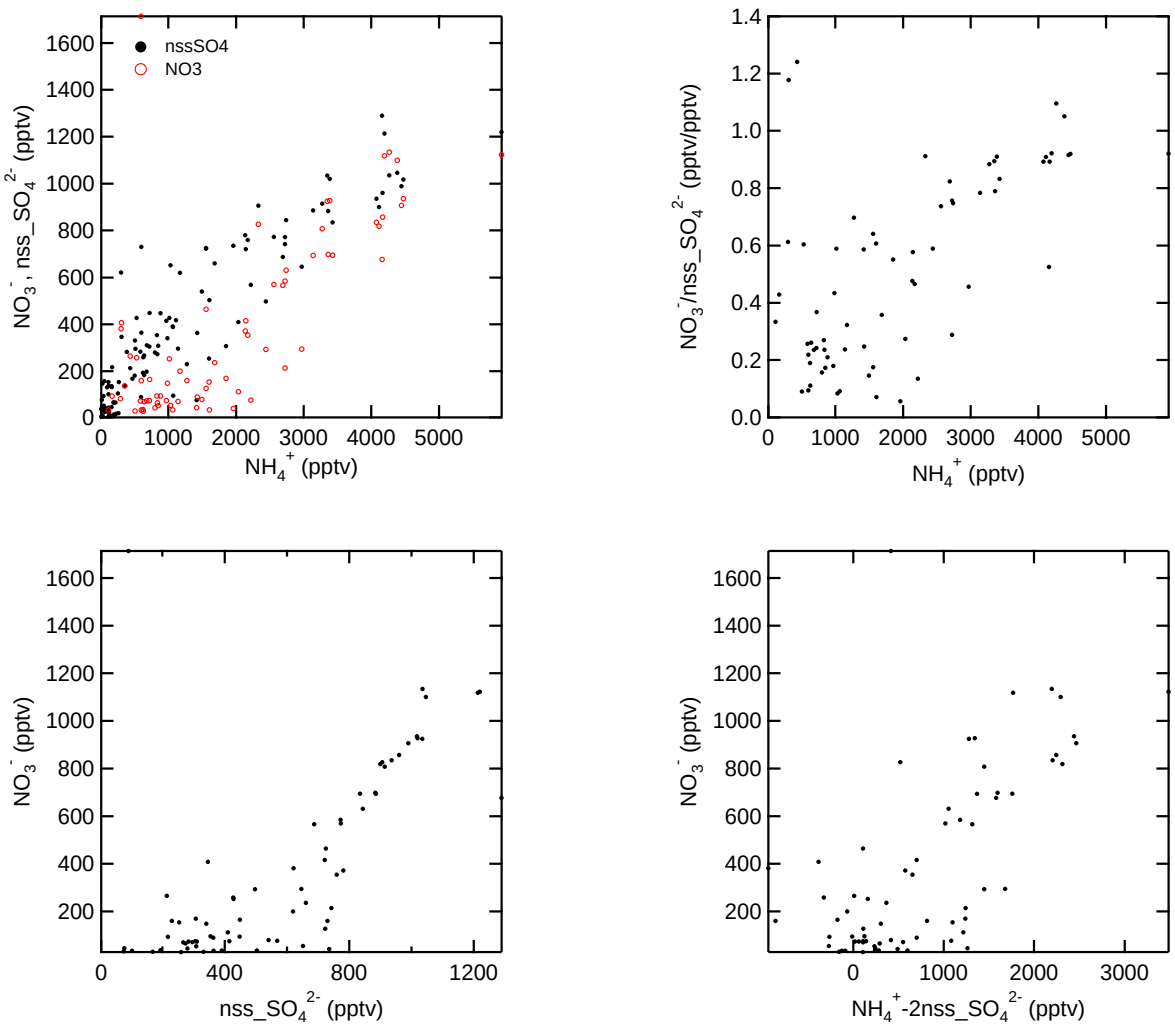

TRACE-P FLIGHT5-8 [P-3B] NOx
Altitude (km)
Longitude (°E)
(pptv)

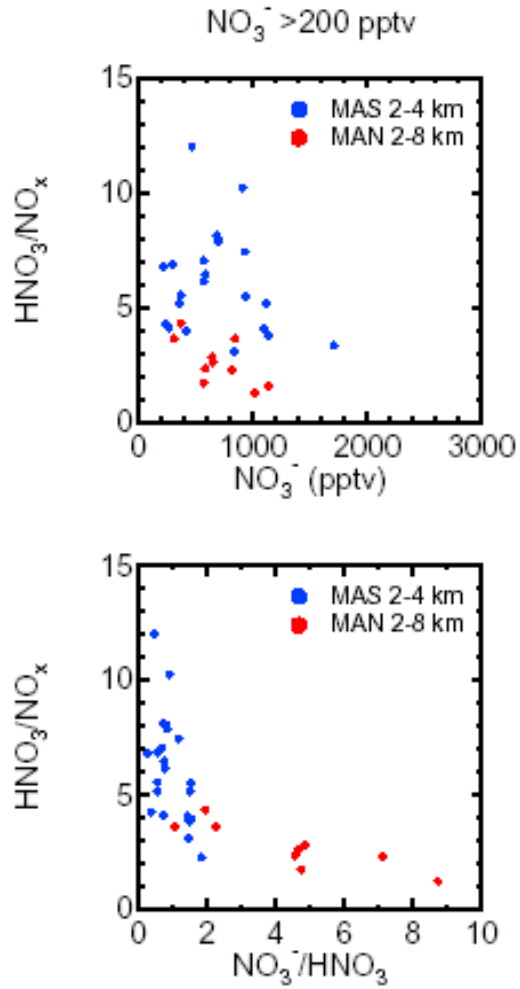

TRACE-P FLIGHT5-8 GIT P(O3) [ppbv/day]
Altitude (km)
Longitude (°E)


TRACE-P MAS
Altitude
NH4(pptv)
K (pptv)
NO3 (pptv)
0
2
4
6
8
0
5000
400
800
1000


TRACE-P MAS 2-4km
HNO3(pptv)
NH4(pptv)
HNO3
TRACE-P MAS 2-4km
NO3(pptv)
NH4(pptv)
NO3
nss_Ca(pptv)
NH4(pptv)
nss_Ca
nss_SO4(pptv)
NH4(pptv)
nss_SO4
Mg(pptv)
NH4(pptv)
Mg
K(pptv)
NH4(pptv)
K

TRACE-P MAS, 2-4 km




NO3- >200 pptv
MAS 2-4 km
MAN 2-8 km
HNO3/NOx
NO3- (pptv)
0
1000
2000
3000
0
5
10
15
MAS 2-4 km
MAN 2-8 km
HNO3/NOx
NO3-/HNO3
0
2
4
6
8
10
0
5
10
15