Water Vapor Measurements during PAVE in the Stratospheric Middleworld: Comparison with Previous Missions and Significance for Strat Trop Exchange and Stratospheric Clouds

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Thanks to: **Eric Jensen and Mark Schoeberl, Project Scientists**

William Read, MLS team

- Motivation, Instruments, and Experimental Background
- Overall distributions of water in the middleworld
- Relationship of water to ozone
- Discussion of a mixing event
- Implications for ice clouds in the lowermost stratosphere
- Conclusions

Motivation – Why water vapor in the Lowermost Stratosphere?

- Sensitive indicator of tropospheric injection
- Radiatively Active
- Clouds MAY act as a chlorine activator
- Now have 3 different years with a reasonable (multiflight) dataset

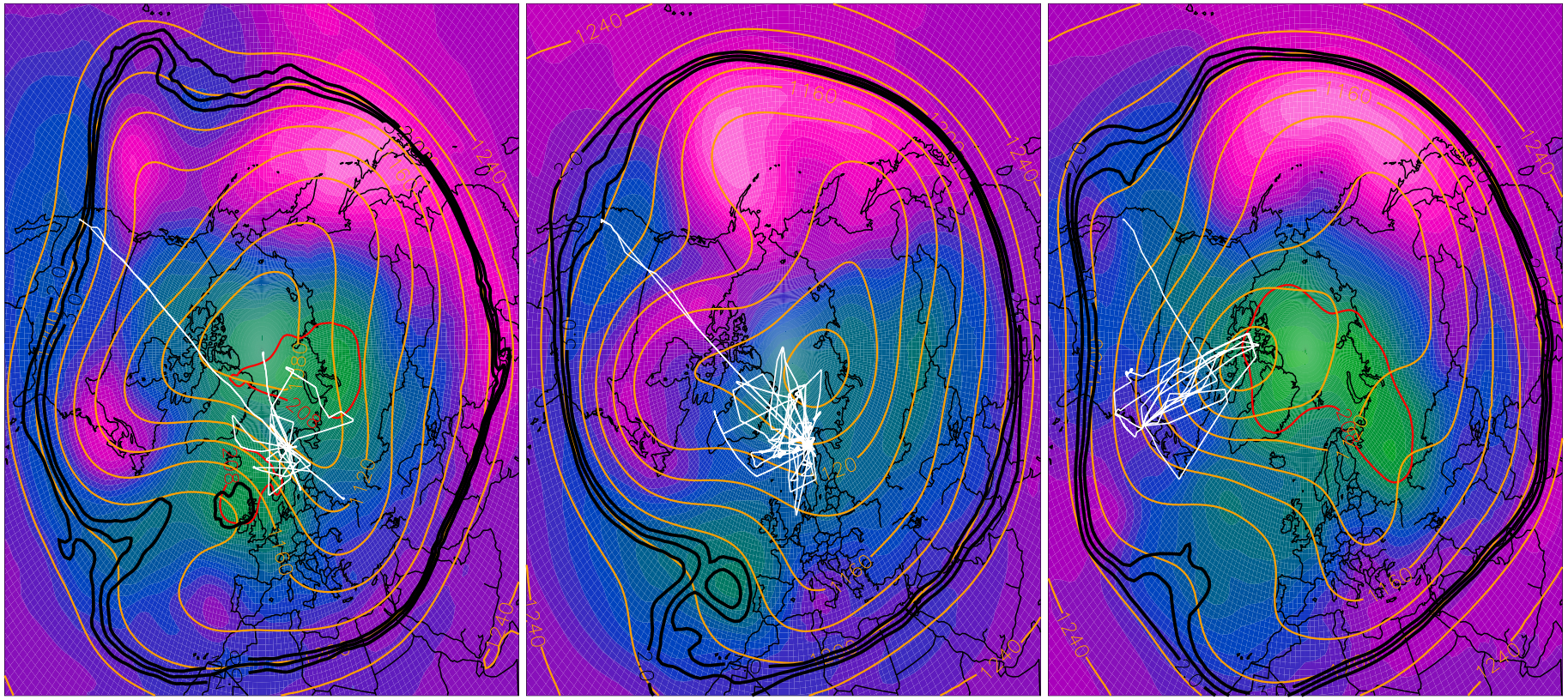
Tracer Data for PAVE

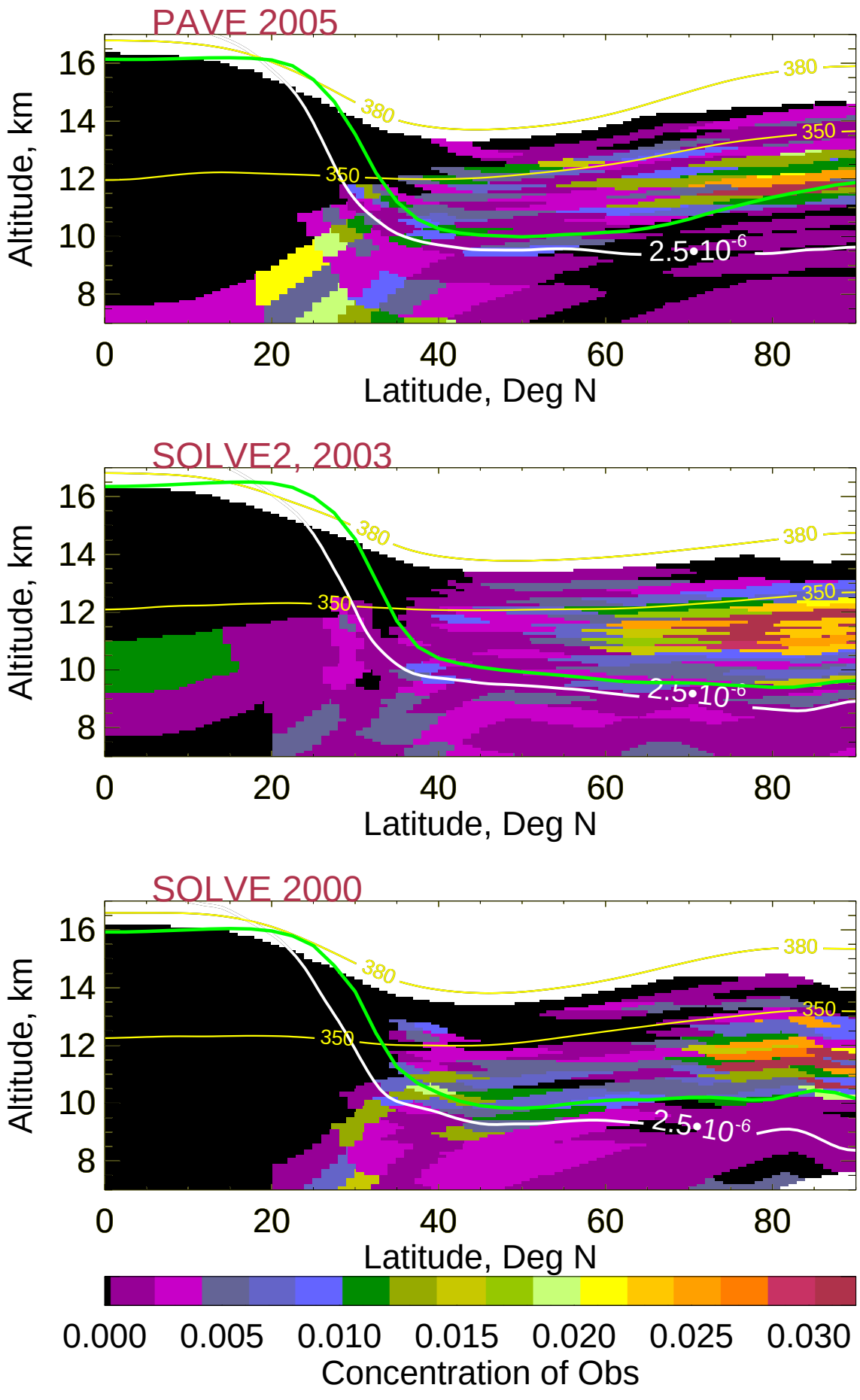
- Water Vapor (TDL 1.4 microns wavelength external path – 1 hz)
- Ozone (NO2 chemiluminescence – 1 hz)
- CO, CH4, and N2O (TDL Herriot cell 4-8 microns – 1hz)

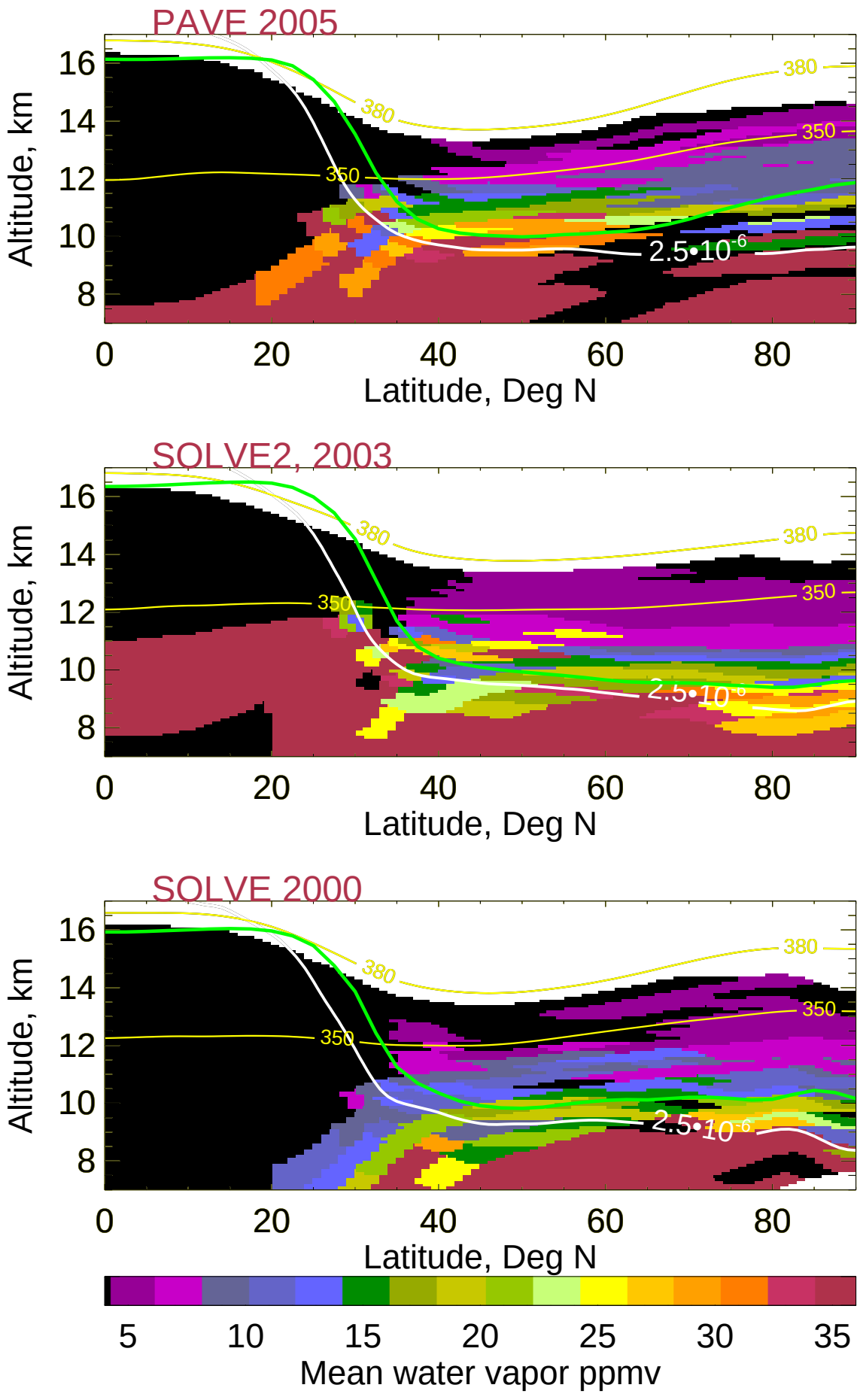
SOLVE1, 20000114-20000129

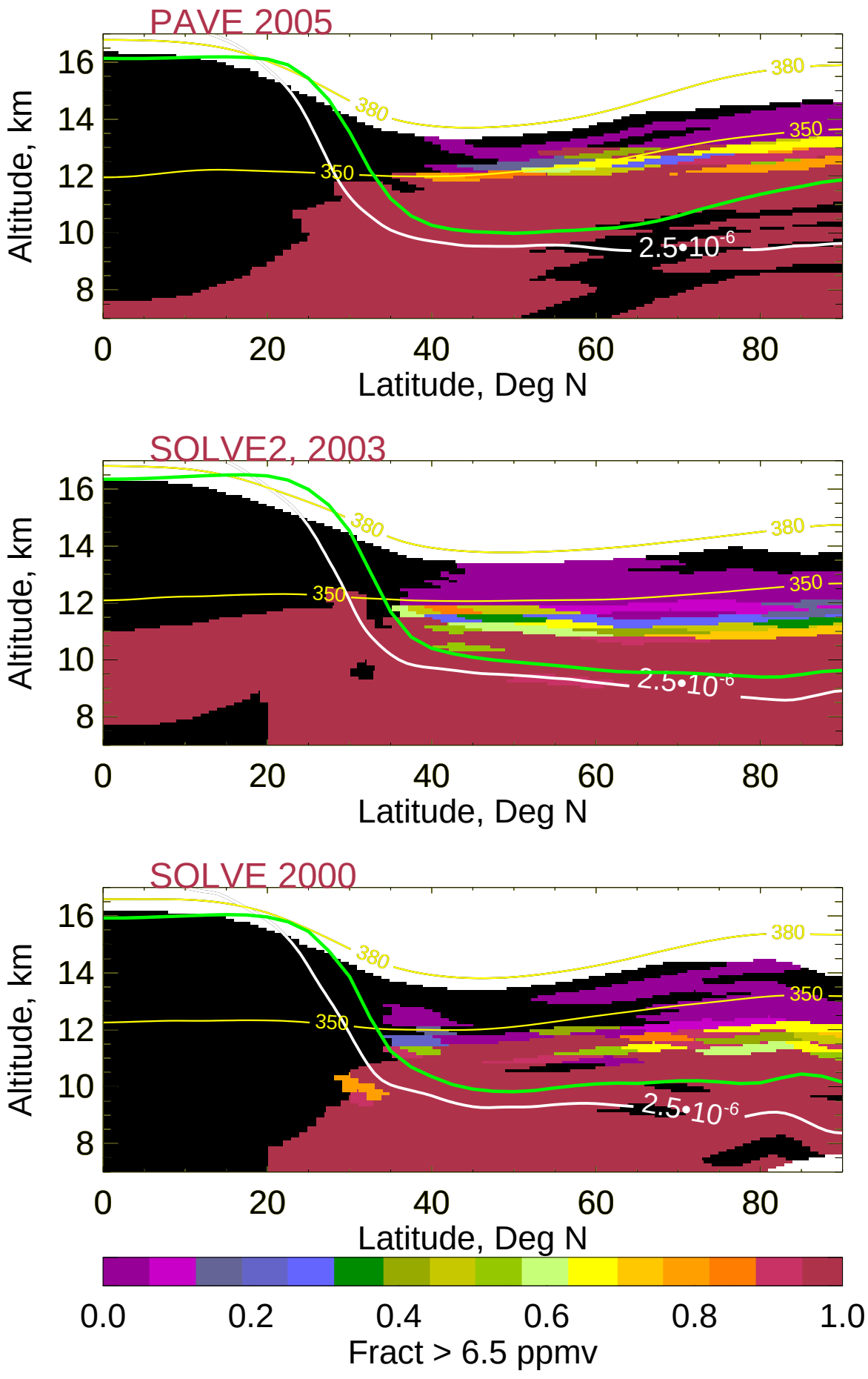
SOLVE2, 20030109-20030206

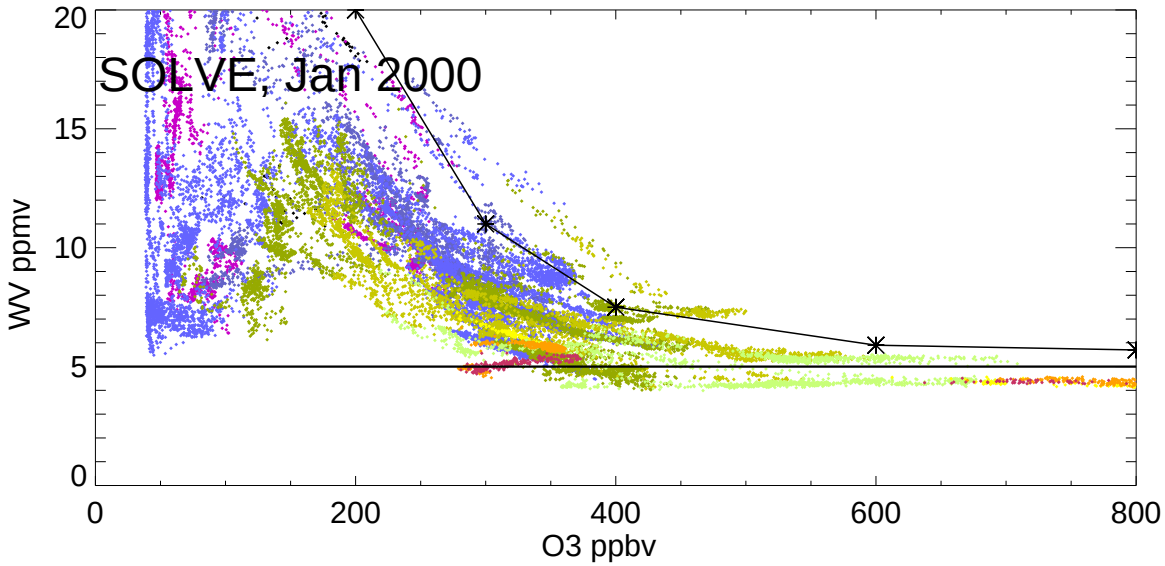
PAVE, 20050124-20050209

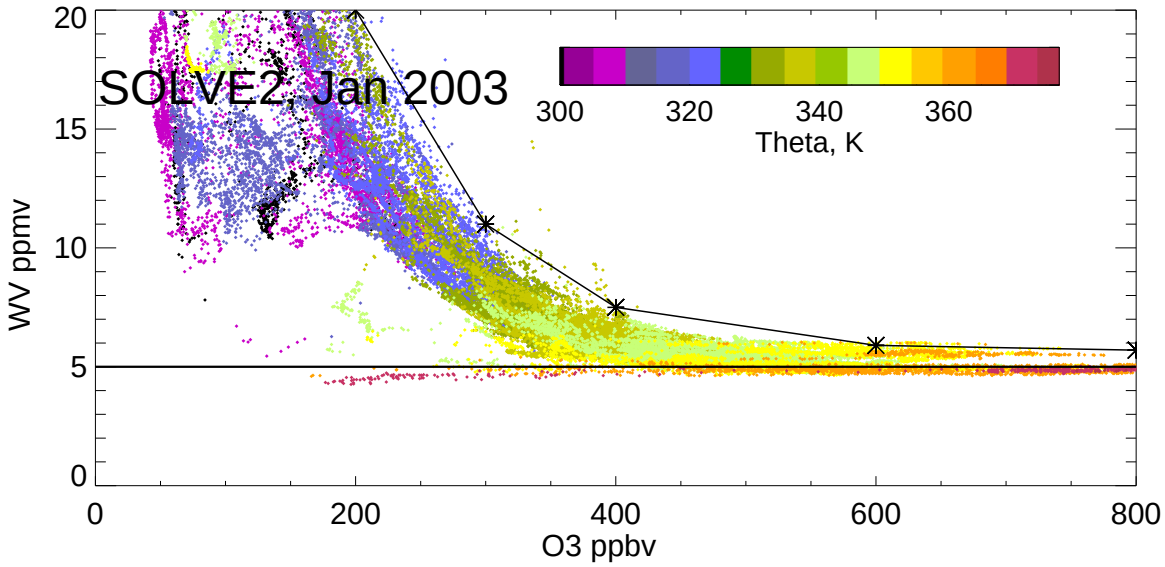


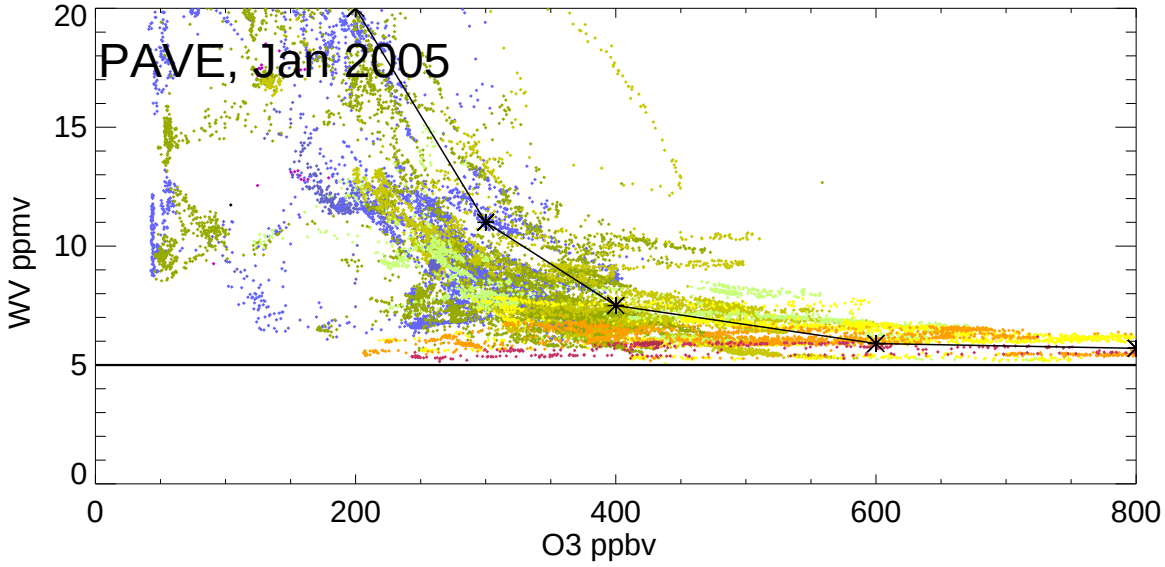

PAVE 2005
SOLVE2, 2003
SOLVE 2000
Altitude, km
16
14
12
10
8
0
20
40
60
80
Latitude, Deg N
380
350
2.5•10-6
0.000
0.005
0.010
0.015
0.020
0.025
0.030
Concentration of Obs

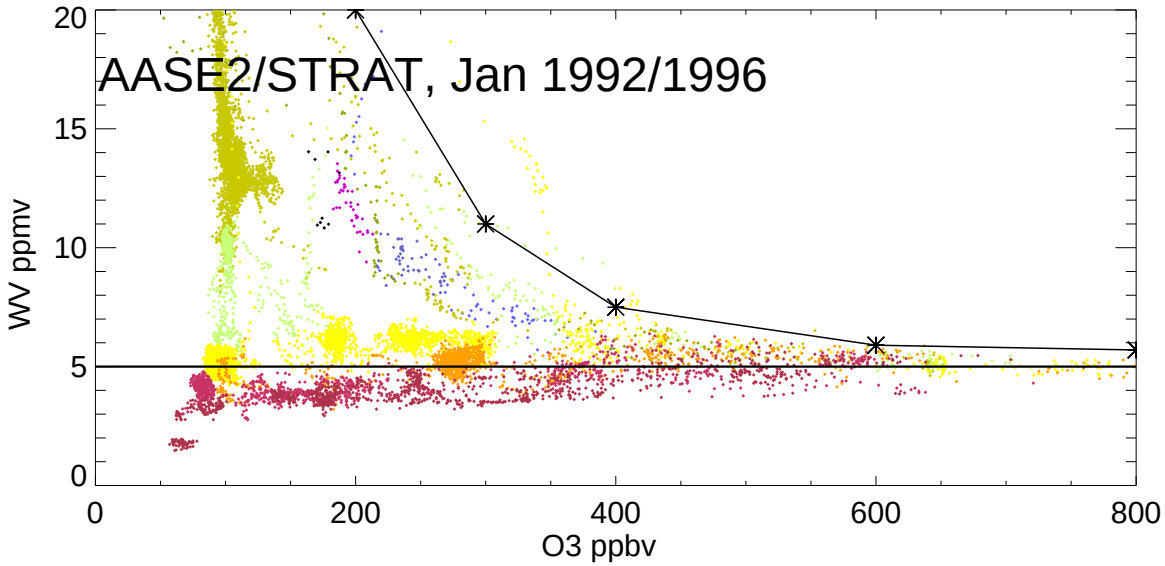

PAVE 2005
SOLVE2, 2003
SOLVE 2000
Altitude, km
16
14
12
10
8
0
20
40
60
80
Latitude, Deg N
380
350
2.5•10-6
5
10
15
20
25
30
35
Mean water vapor ppmv

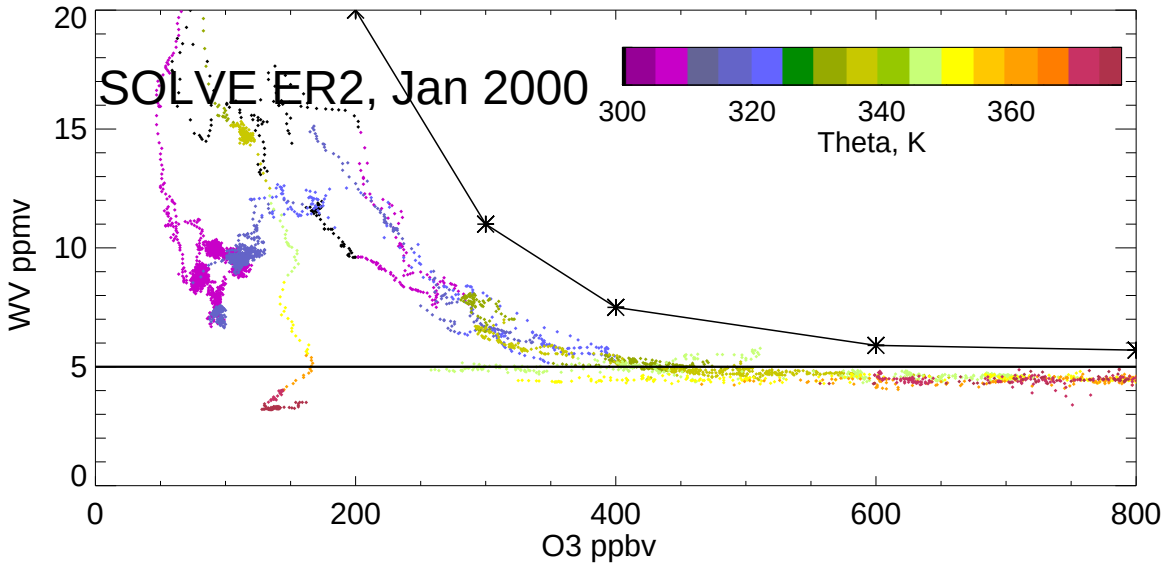

PAVE 2005
SOLVE2, 2003
SOLVE 2000
Altitude, km
16
14
12
10
8
0
20
40
60
80
Latitude, Deg N
380
350
2.5•10-6
0.0
0.2
0.4
0.6
0.8
1.0
Fract > 6.5 ppmv

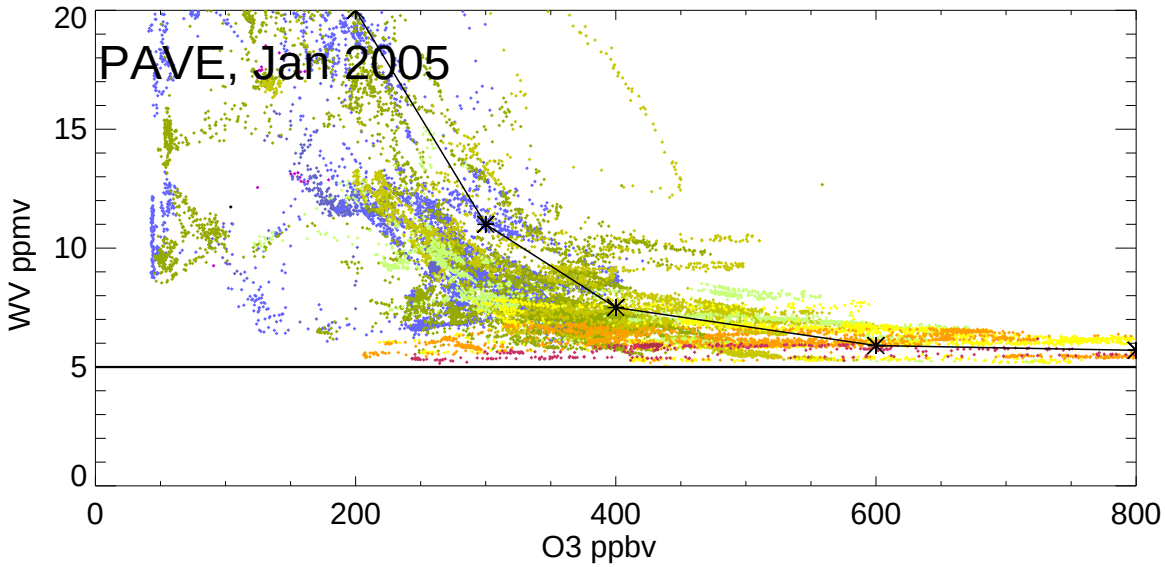

SOLVE, Jan 2000
WV ppmv
O3 ppbv
0
5
10
15
20
0
200
400
600
800

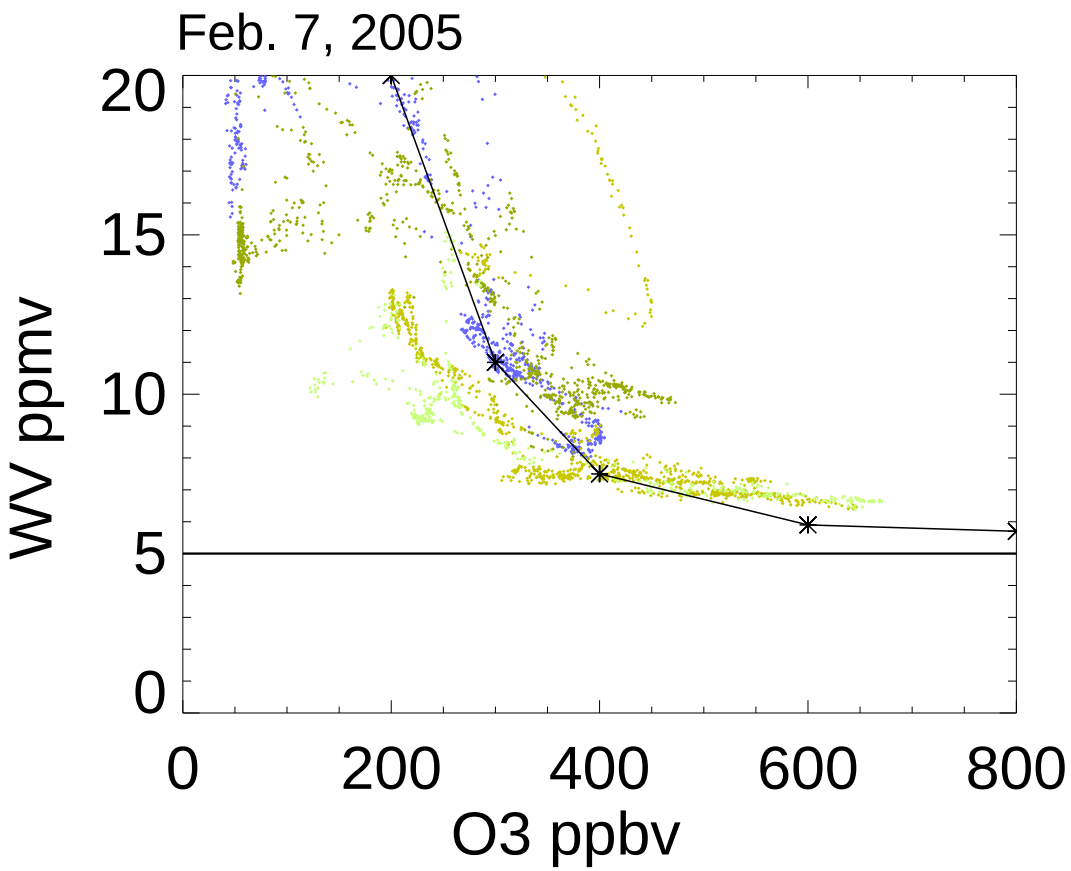

SOLVE2, Jan 2003
300
320
340
360
Theta, K
WV ppmv
O3 ppbv
0
5
10
15
20
0
200
400
600
800

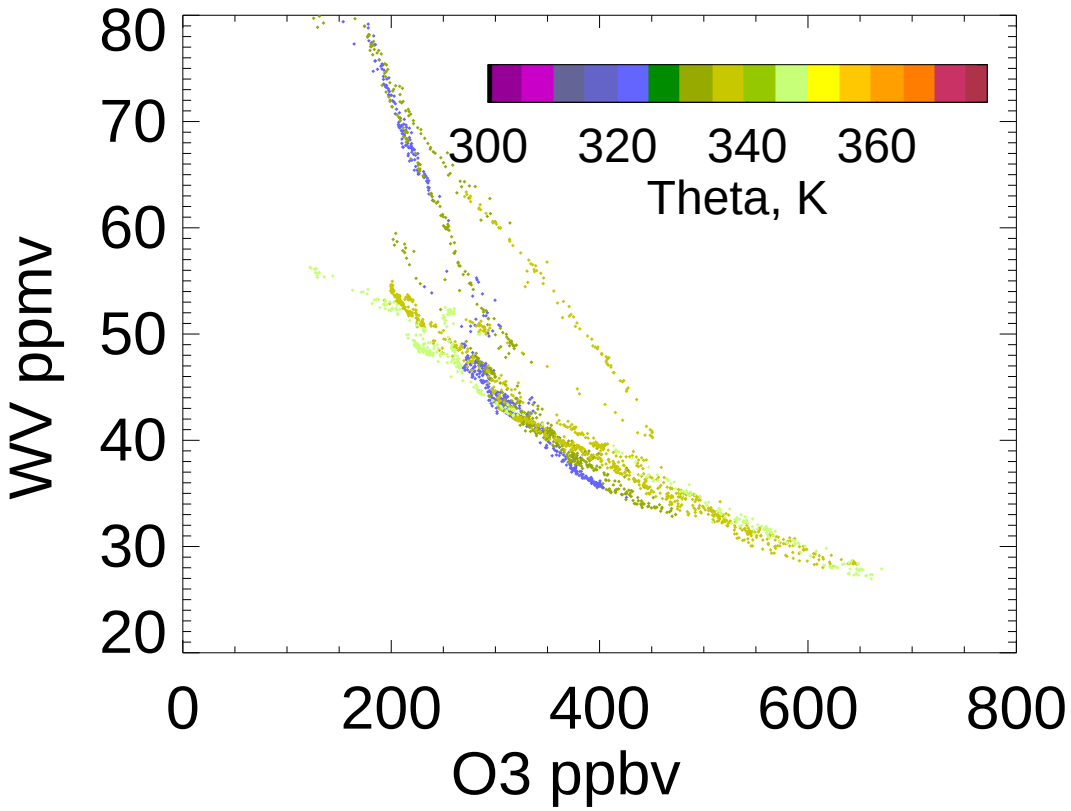

PAVE, Jan 2005
WV ppmv
O3 ppbv
0
5
10
15
20
0
200
400
600
800


AASE2/STRAT, Jan 1992/1996
WV ppmv
O3 ppbv
0
5
10
15
20
0
200
400
600
800


SOLVE ER2, Jan 2000
300
320
340
360
Theta, K
WV ppmv
O3 ppbv
0
5
10
15
20
0
200
400
600
800


PAVE, Jan 2005
WV ppmv
O3 ppbv
0
5
10
15
20
0
200
400
600
800


Feb. 7, 2005
20
15
10
5
0
WV ppmv
0
200
400
600
800
O3 ppbv

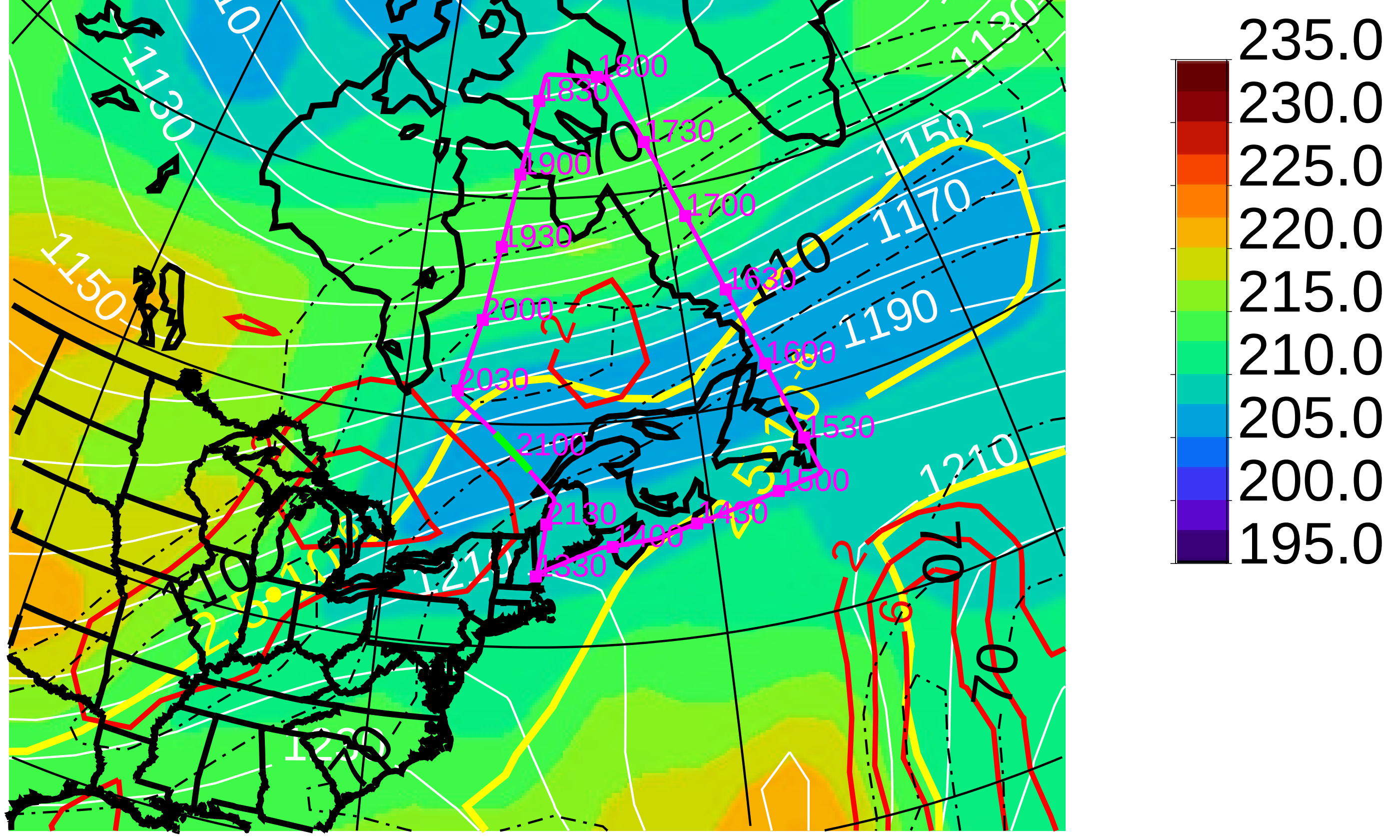

80
70
60
50
40
30
20
WV ppmv
300
320
340
360
Theta, K
0
200
400
600
800
O3 ppbv

18 UTC on 7 February, 2005 at 196.0 mb

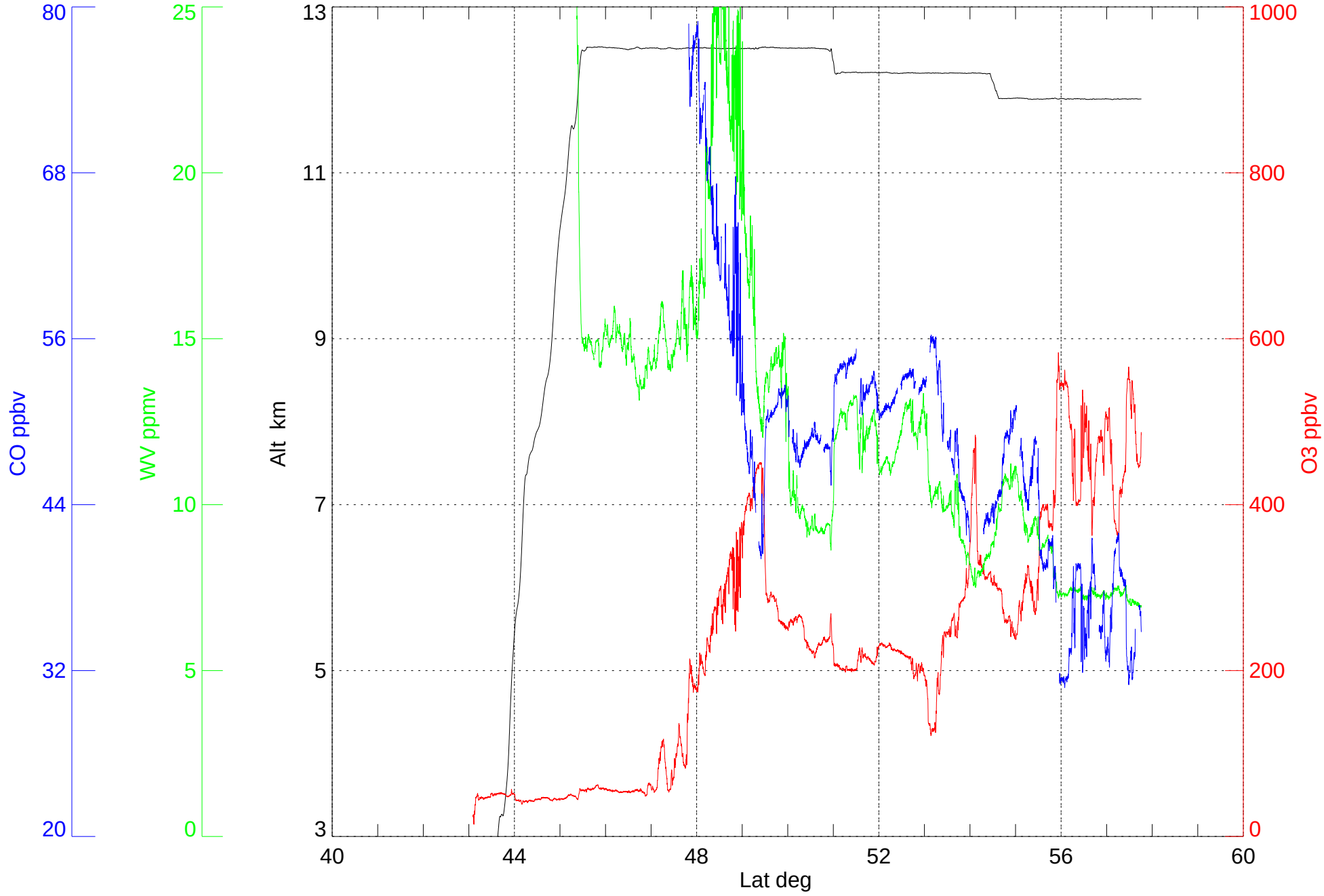
NMC, Grid: GG2%5X2%5

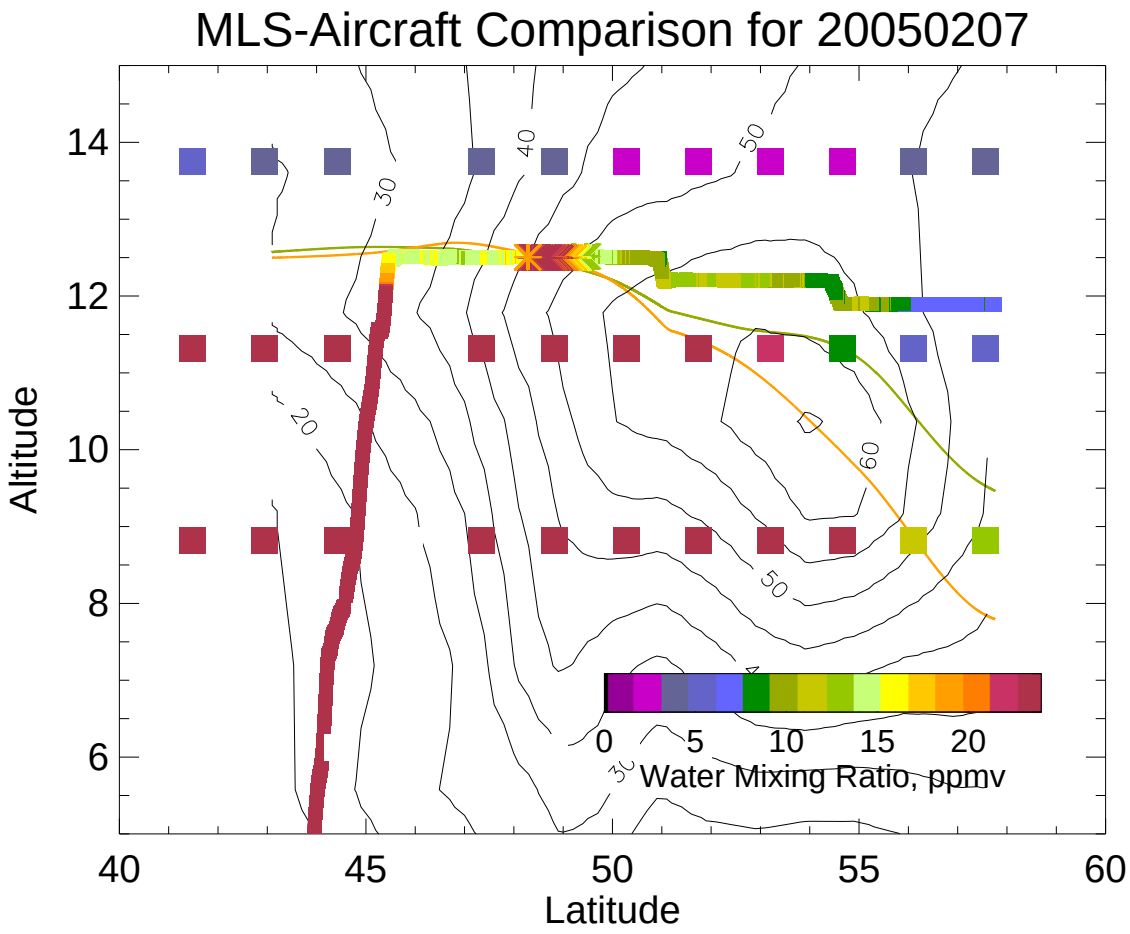
Seq: E01, Spec: SMRF62

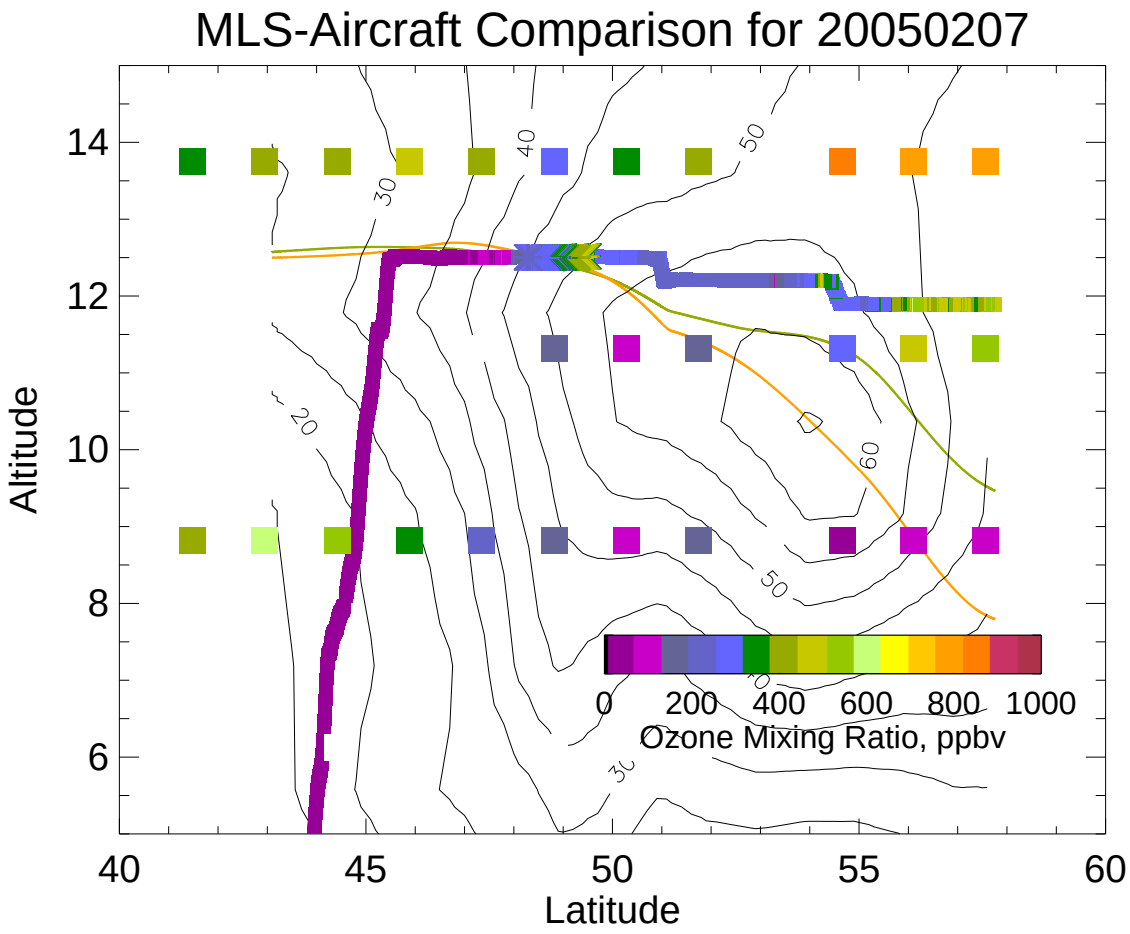
T at 39Kft (K)

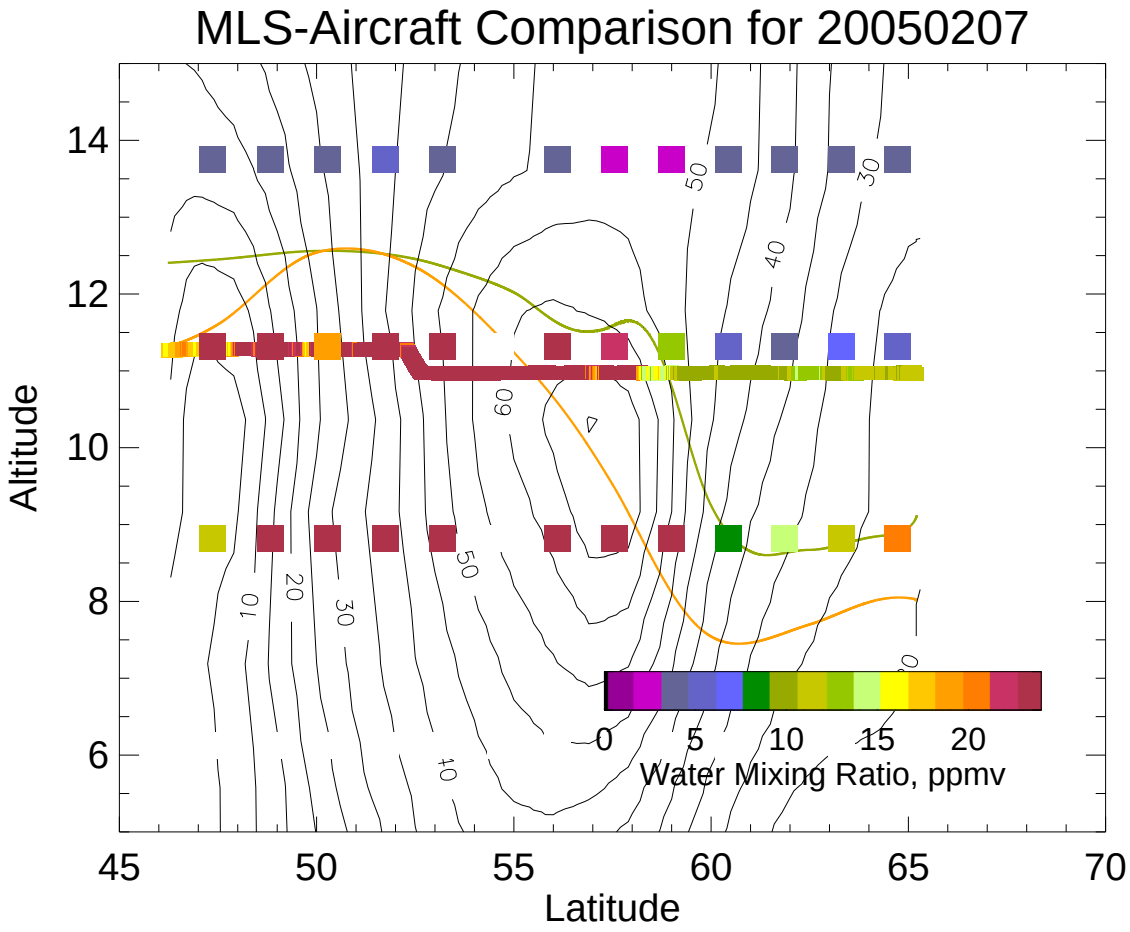


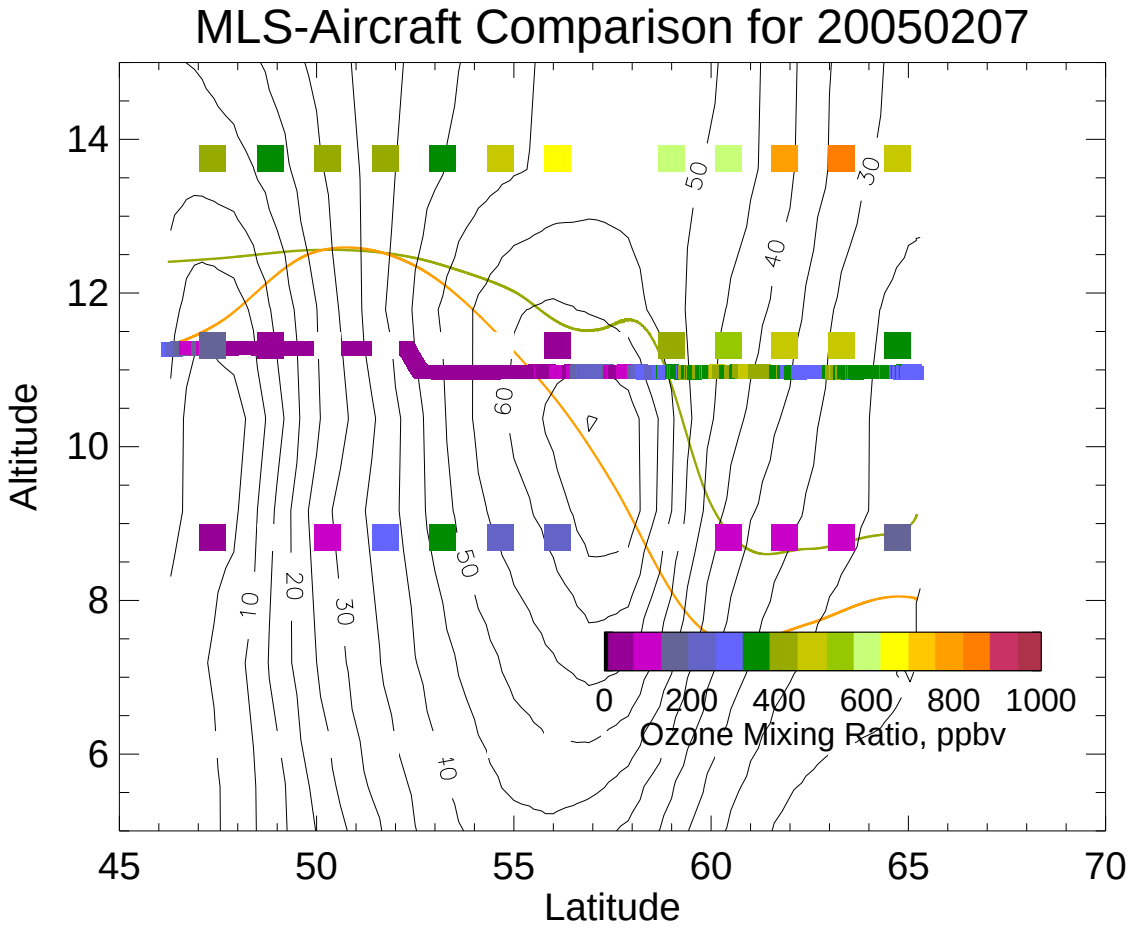
Z (dam) Trop (EPV=2.5) Ascent (2 mb/hr) WIND (kts)


20050207 (70200 - 79000)
CO ppbv
80
68
56
44
32
20
WV ppmv
25
20
15
10
5
0
Alt km
13
11
9
7
5
3
O3 ppbv
1000
800
600
400
200
0
40
44
48
52
56
60
Lat deg
Sun Sep 18 00:39:59 UTC 2005


MLS-Aircraft Comparison for 20050207
Altitude
Latitude
Water Mixing Ratio, ppmv
0
5
10
15
20
14
12
10
8
6
40
45
50
55
60


MLS-Aircraft Comparison for 20050207
Altitude
Latitude
Ozone Mixing Ratio, ppbv
0
200
400
600
800
1000
14
12
10
8
6
40
45
50
55
60

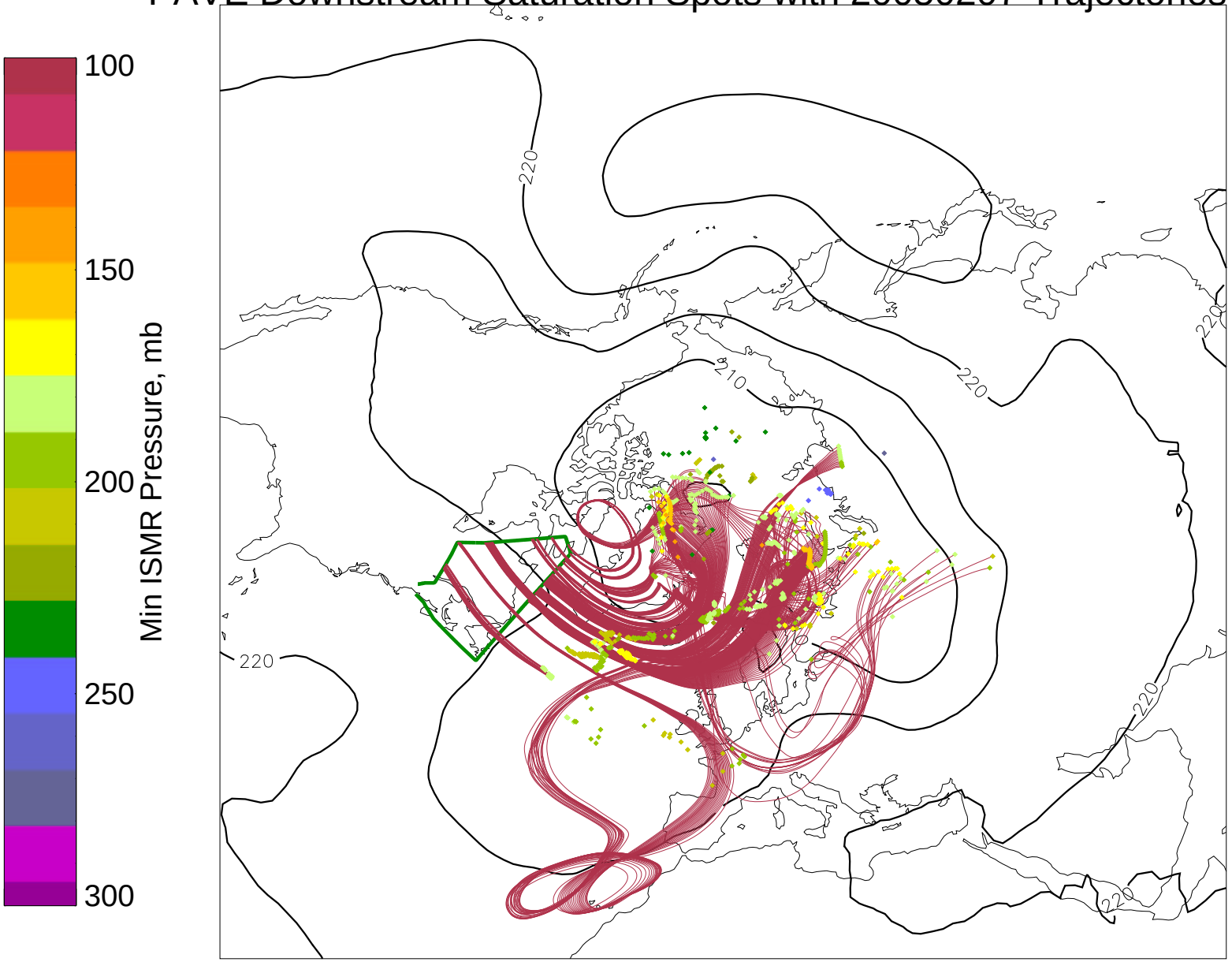

MLS-Aircraft Comparison for 20050207
Altitude
Latitude
Water Mixing Ratio, ppmv
0
5
10
15
20
45
50
55
60
65
70
6
8
10
12
14

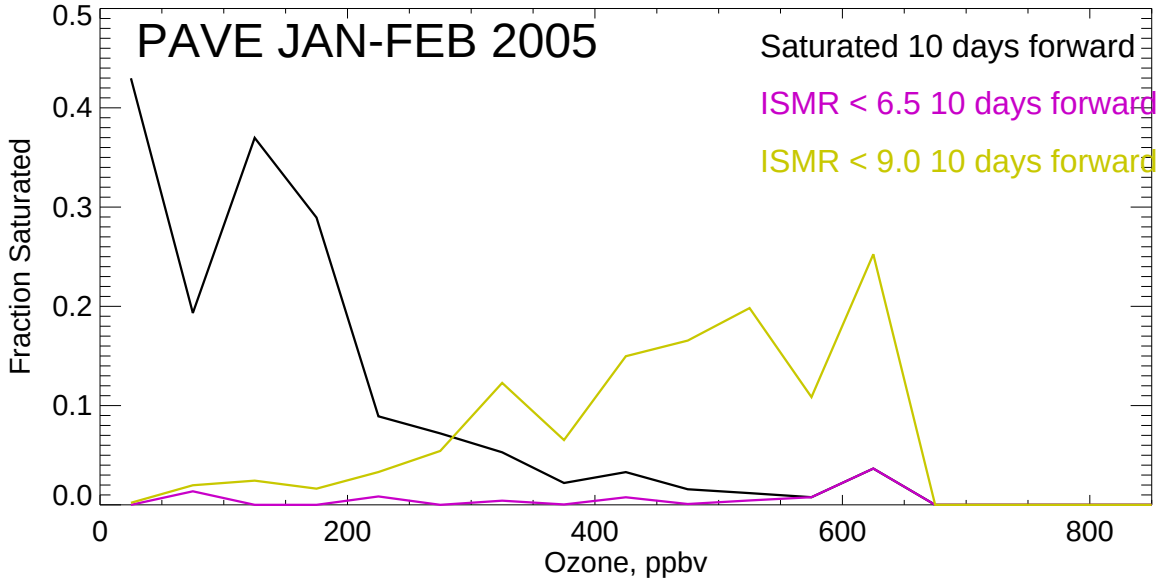

MLS-Aircraft Comparison for 20050207
Altitude
Latitude
Ozone Mixing Ratio, ppbv
0
200
400
600
800
1000
45
50
55
60
65
70
6
8
10
12
14

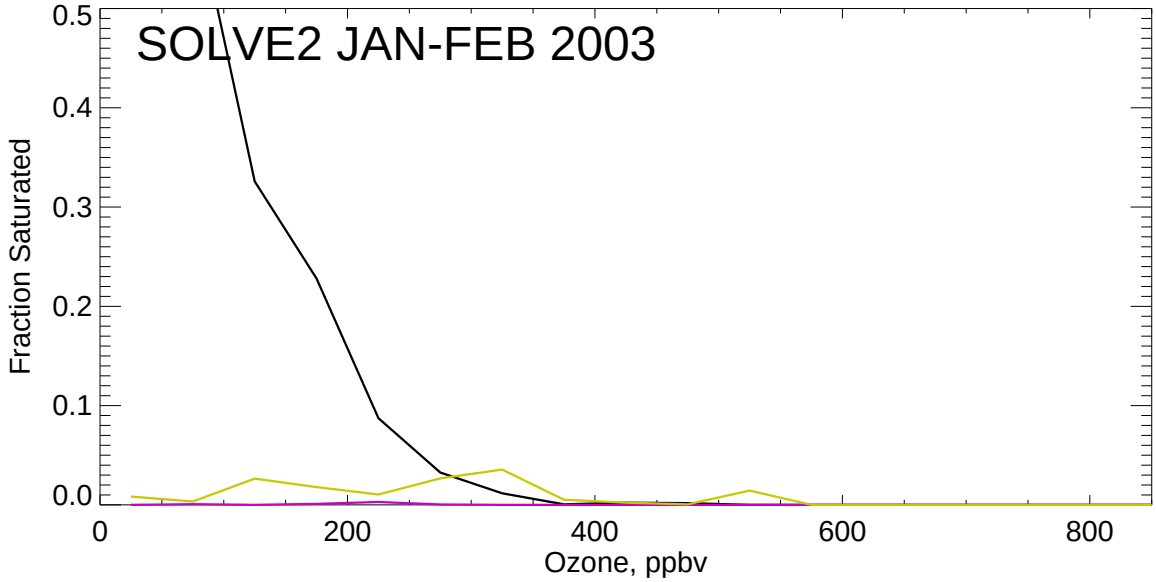
Saturated Conditions in the Middleworld

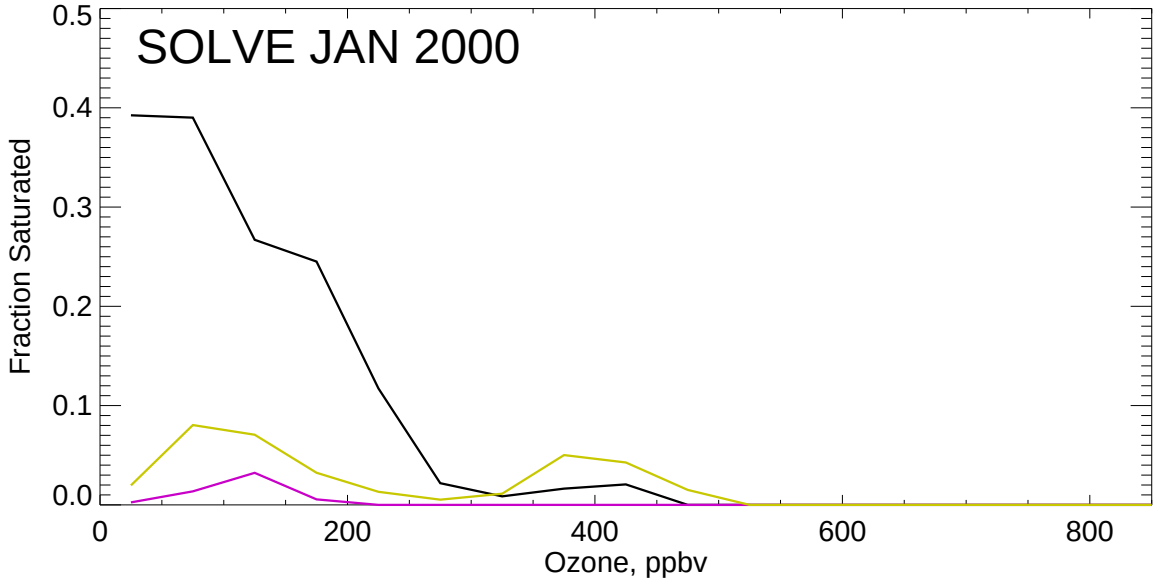
- 10 day forward kinematic trajectories using NCEP GDAS analyses
- Evaluate minimum ice SMR along the trajectories
- PDFS of ice saturation conditions as a function of ozone

PAVE Downstream Saturation Spots with 20050207 Trajectories




PAVE JAN-FEB 2005
Saturated 10 days forward
ISMR < 6.5 10 days forward
ISMR < 9.0 10 days forward
Fraction Saturated
0.0
0.1
0.2
0.3
0.4
0.5
0
200
400
600
800
Ozone, ppbv


SOLVE2 JAN-FEB 2003
Fraction Saturated
0.0
0.1
0.2
0.3
0.4
0.5
0
200
400
600
800
Ozone, ppbv


SOLVE JAN 2000
Fraction Saturated
0.0
0.1
0.2
0.3
0.4
0.5
0
200
400
600
800
Ozone, ppbv

Summary and Conclusions

- Have 3 different years of midwinter hi resolution water vapor (also ozone, CO, N2O, and CH4).
- DC-8 is able to provide coverage of most of the stratospheric middleworld up to 350K.
- Preliminary water data shows significant number of cases of water above 6.5 ppmv at values of ozone up to 600 ppbv and thetas up to 370K
- DC-8 data in general shows higher values of water at middleworld ozone values than ER-2 data from AASE2, STRAT, and SOLVE.
- Examples of clear mixing line in both water vapor in CO to ozone values of 450 ppbv.
- Water data suggests that 3-4% of parcels with ozone of 400-600ppbv cloud experience clouds in midwinter 2005.
- This is due mostly to cold winter temperatures in 2005, but partly due to enhanced water relative to previous missions.