Tunable Diode Laser Measurements of CH_2O

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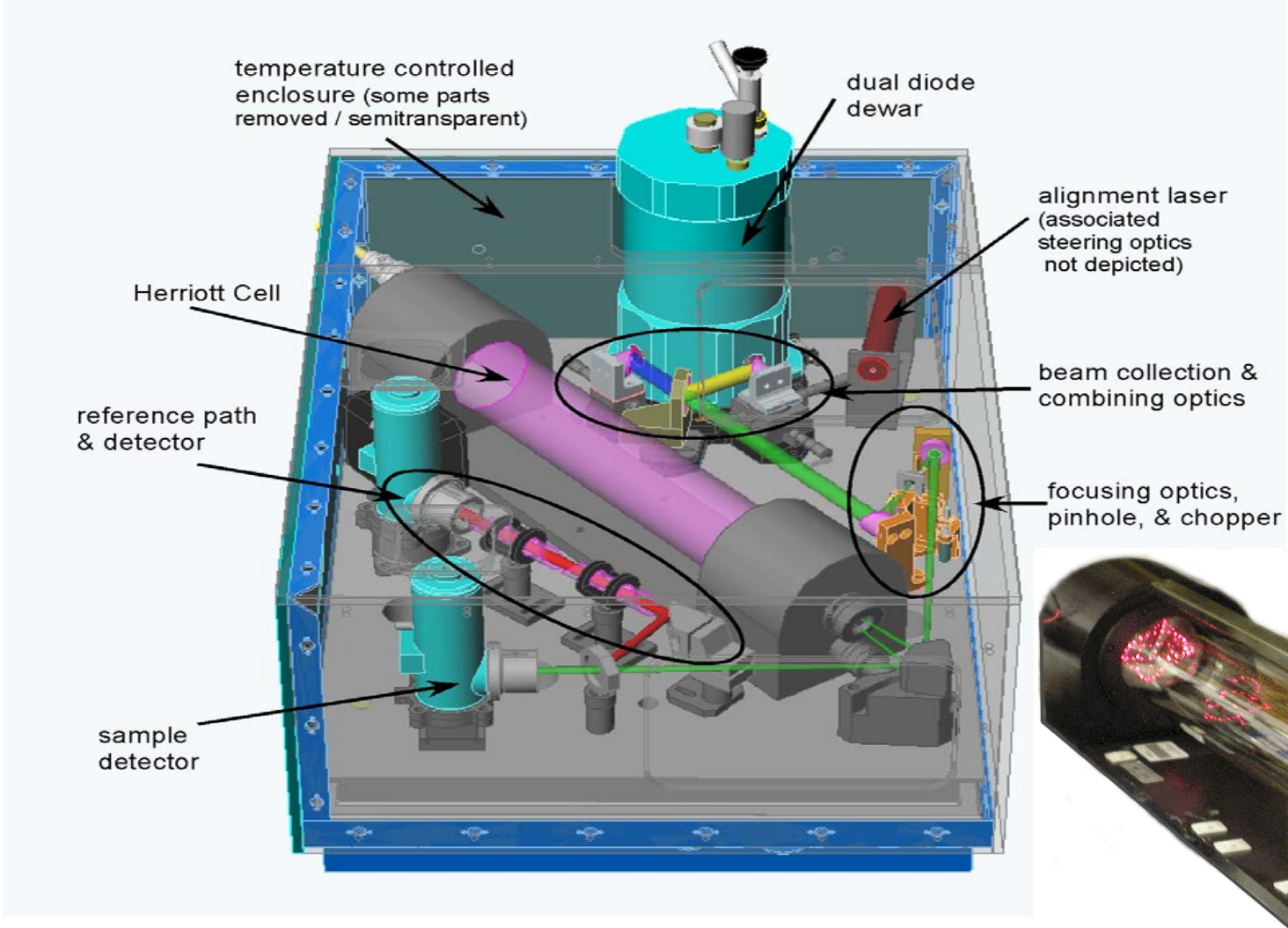
The National Center for Atmospheric Research

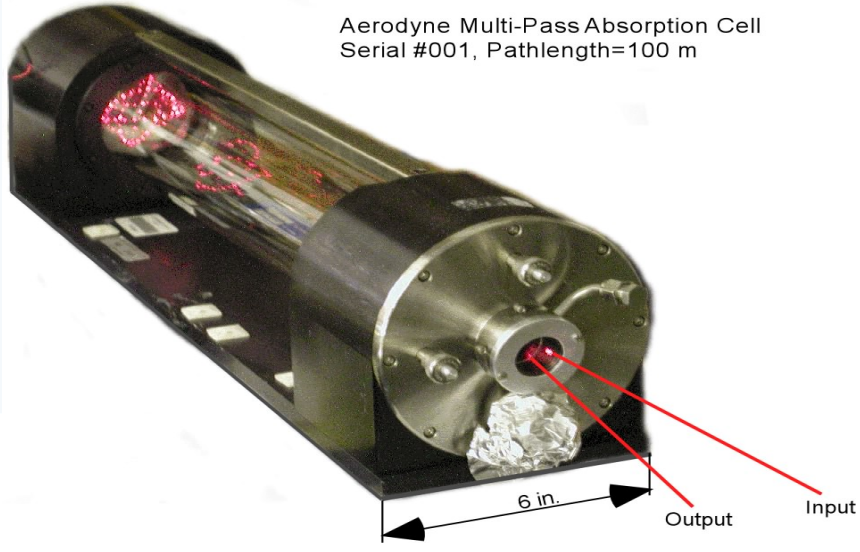
Overview

- **Tunable Diode Laser Measurements**
  Sampling, Zeroing, Calibration, Selectivity
- **Past Comparisons**
  - ■
- **INTEX-A Comparisons**
- **Convective Outflow at High Altitudes**
- **Measurements in the MBL**

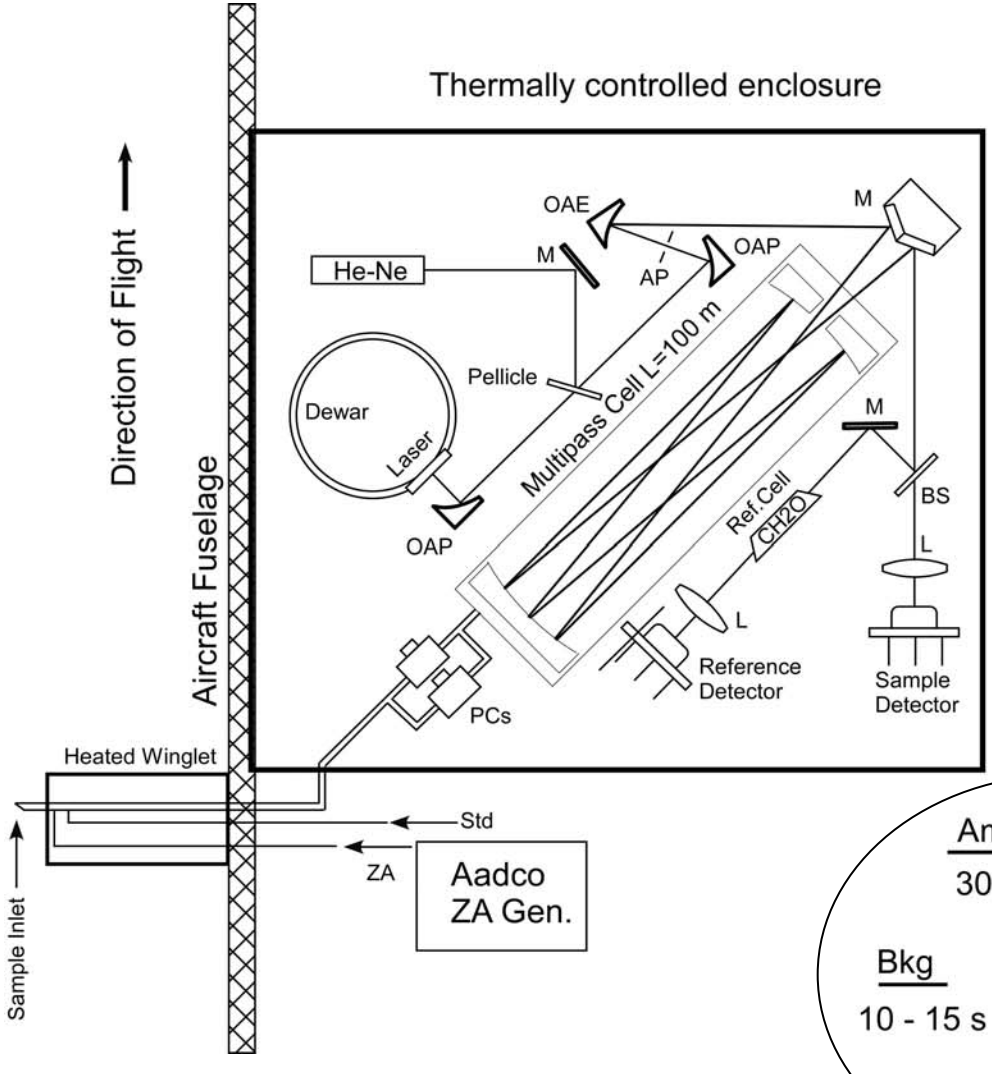
Grønland
CANADA
COMPUTER SOURCE

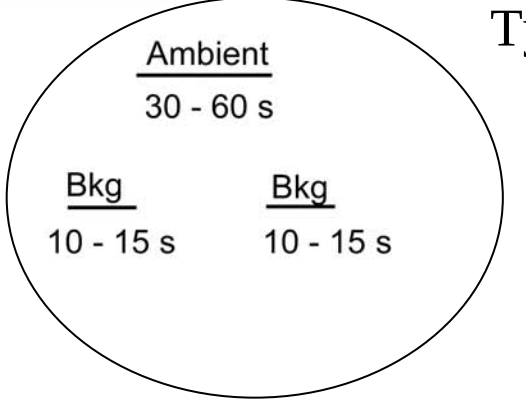
Airborne Tunable Diode Laser System





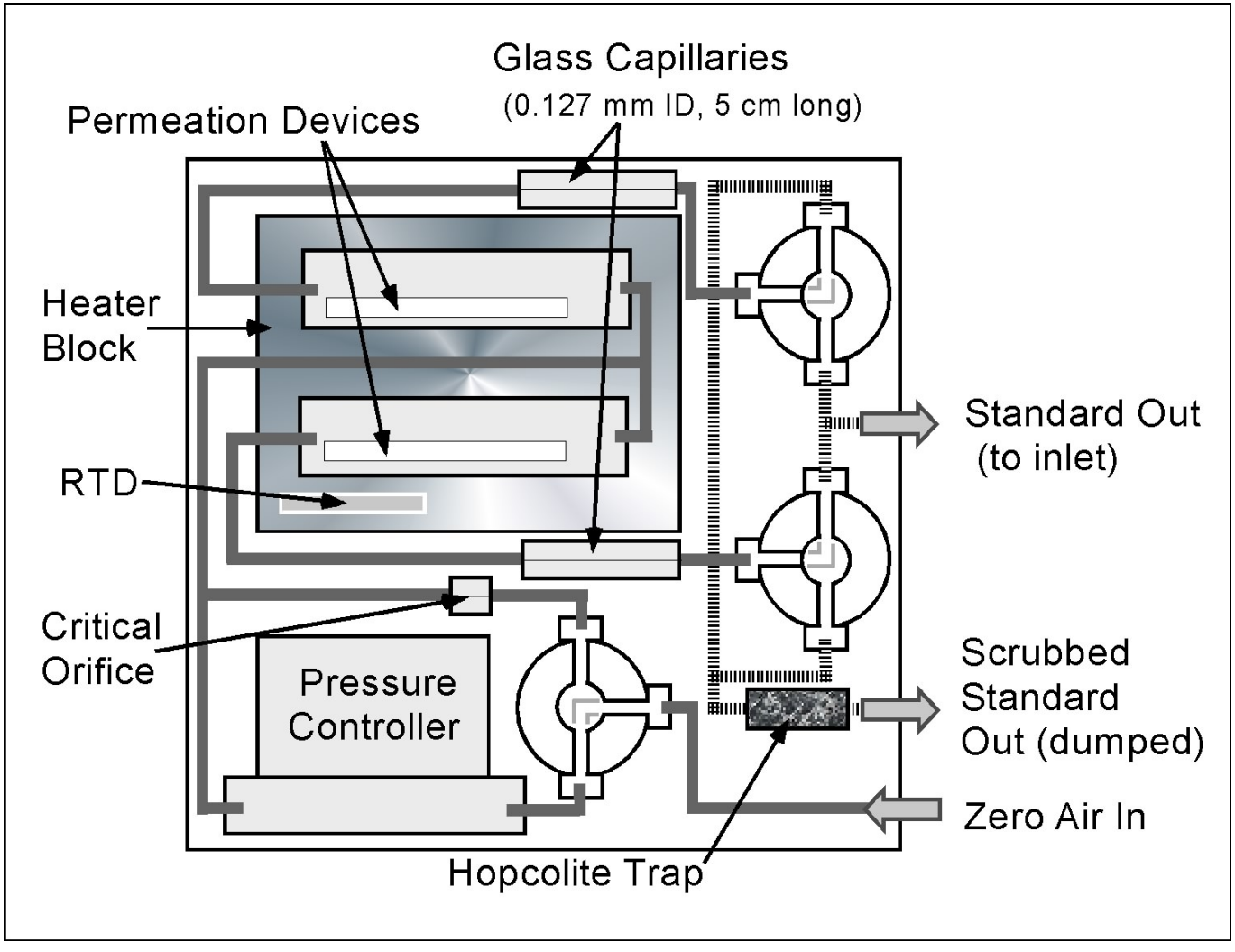
Airborne Inlet & Sampling Sequence



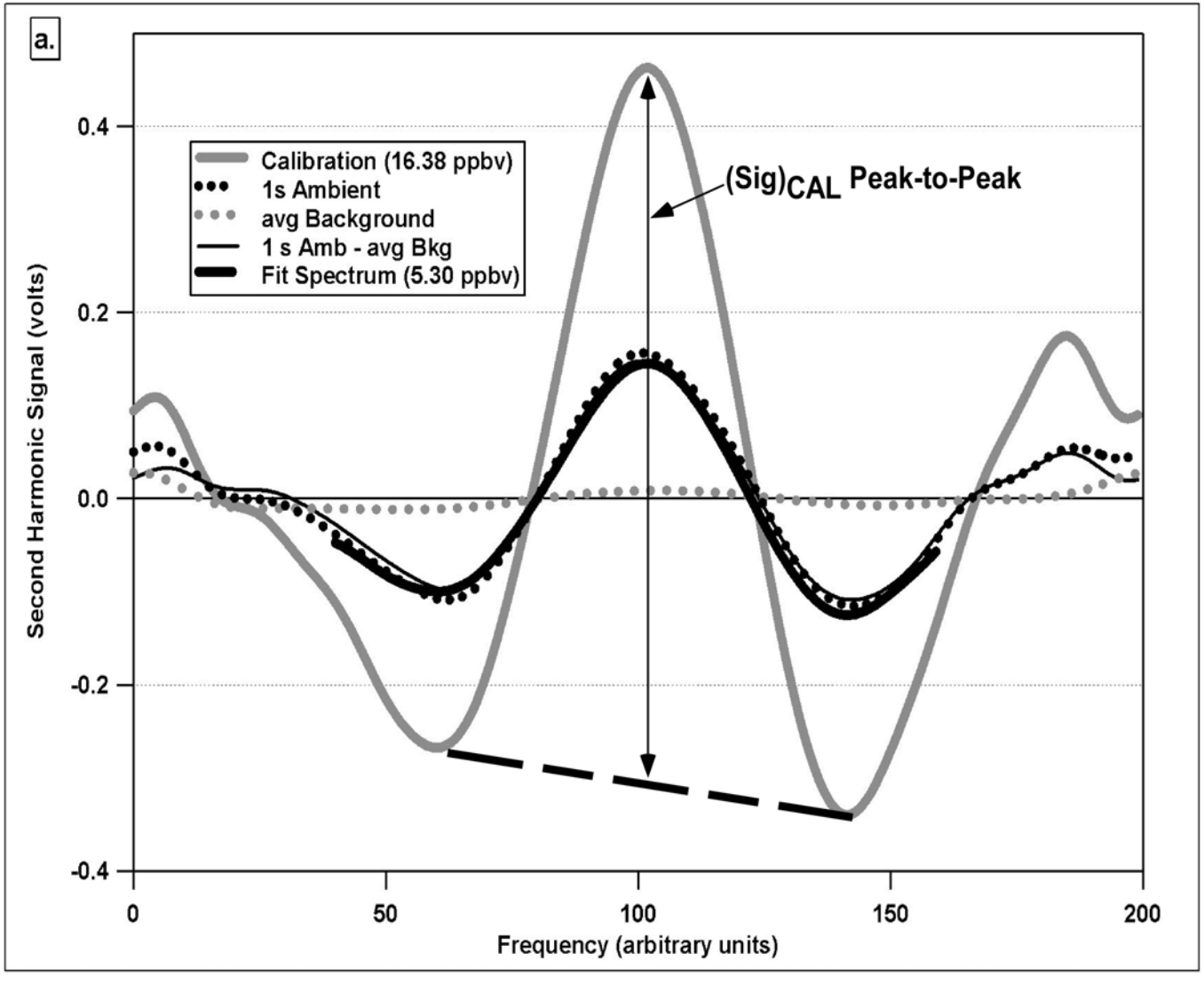


Typical Sampling Seq.

CH_2O Permeation Cal System



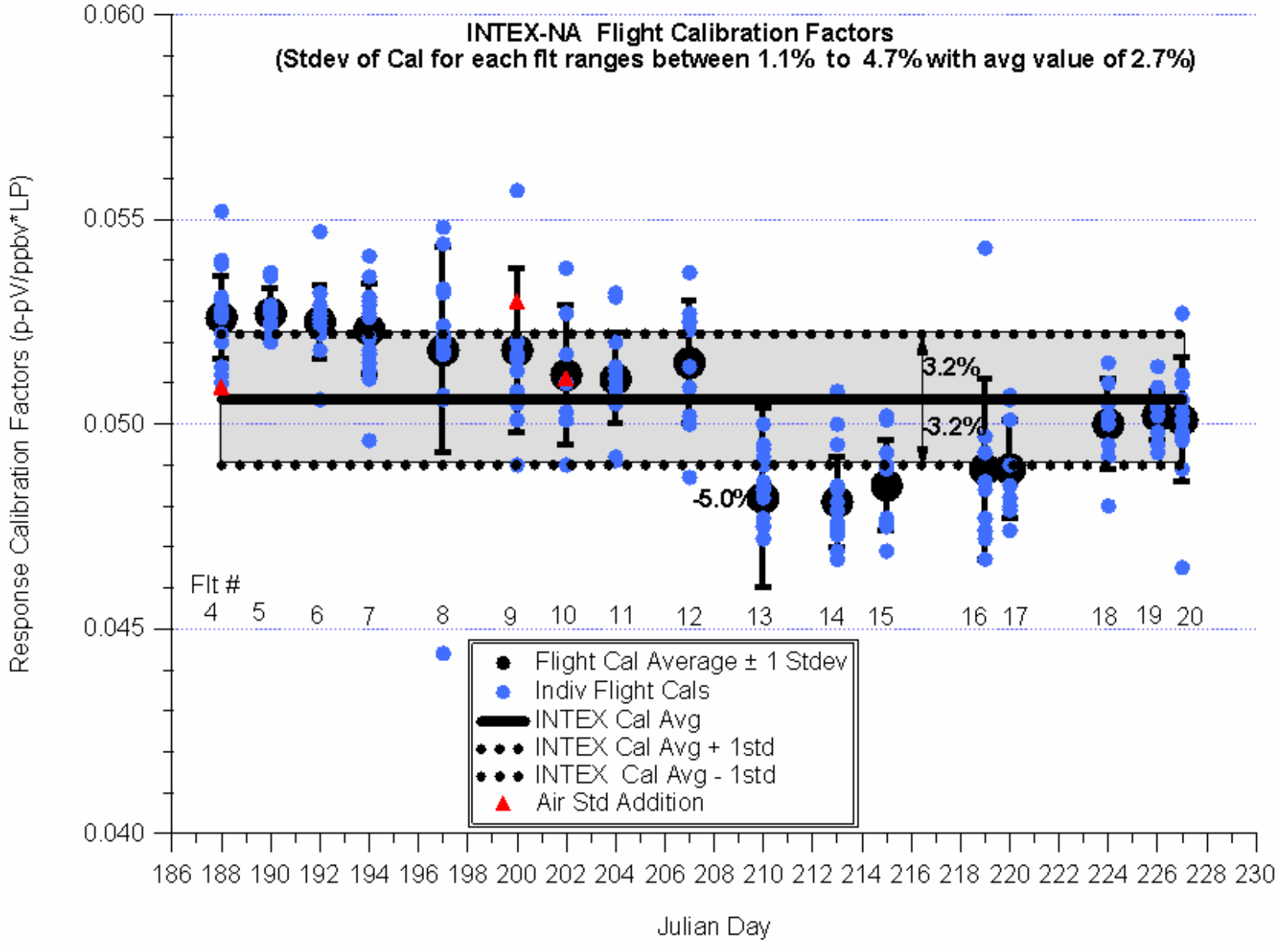
Fitting & Response Calibration Factors



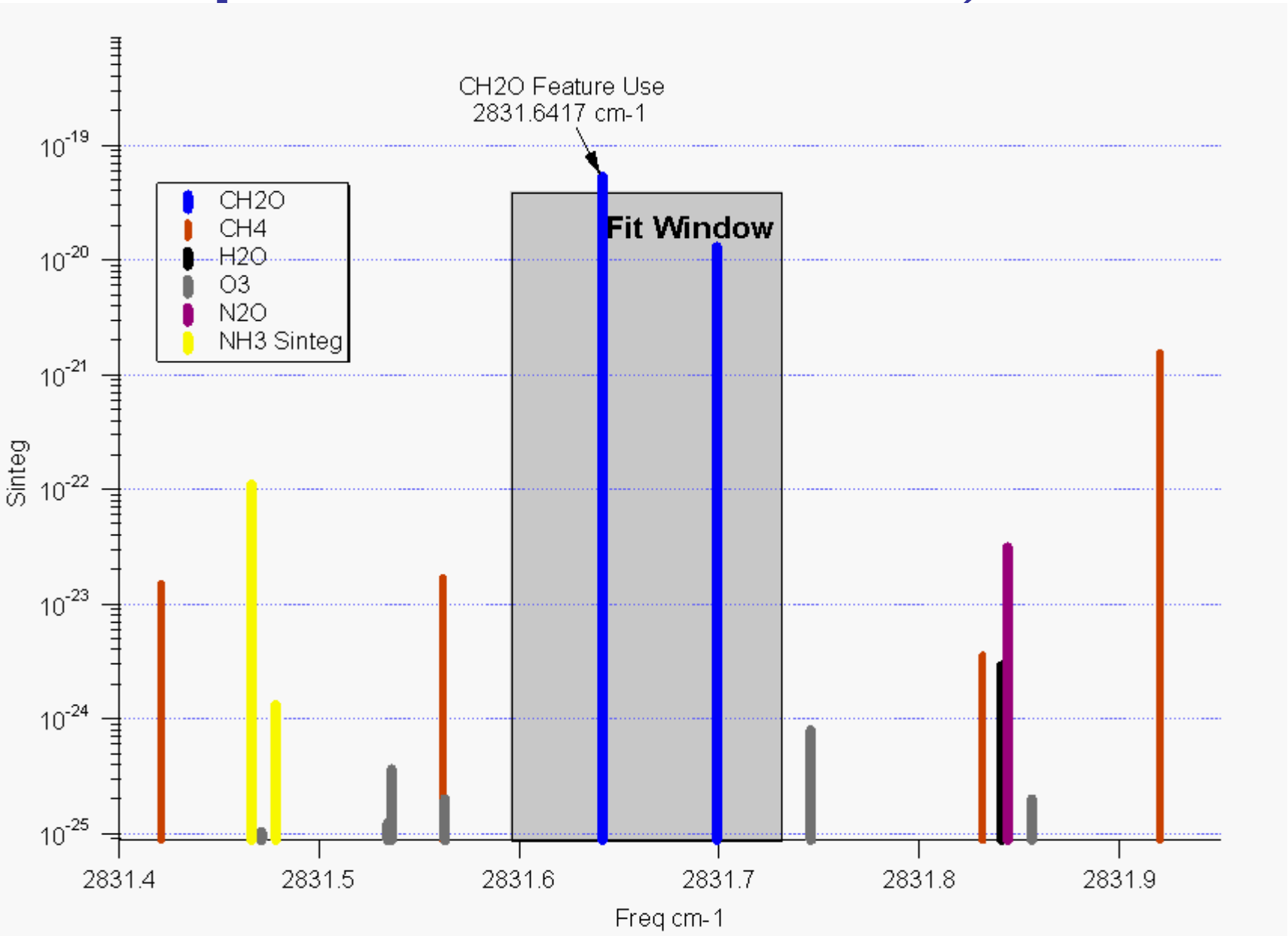
$$RCF = \frac{(Sig)_{CAL}\text{Peak-to-Peak}}{(LP)\ (Cal\ Conc)}$$

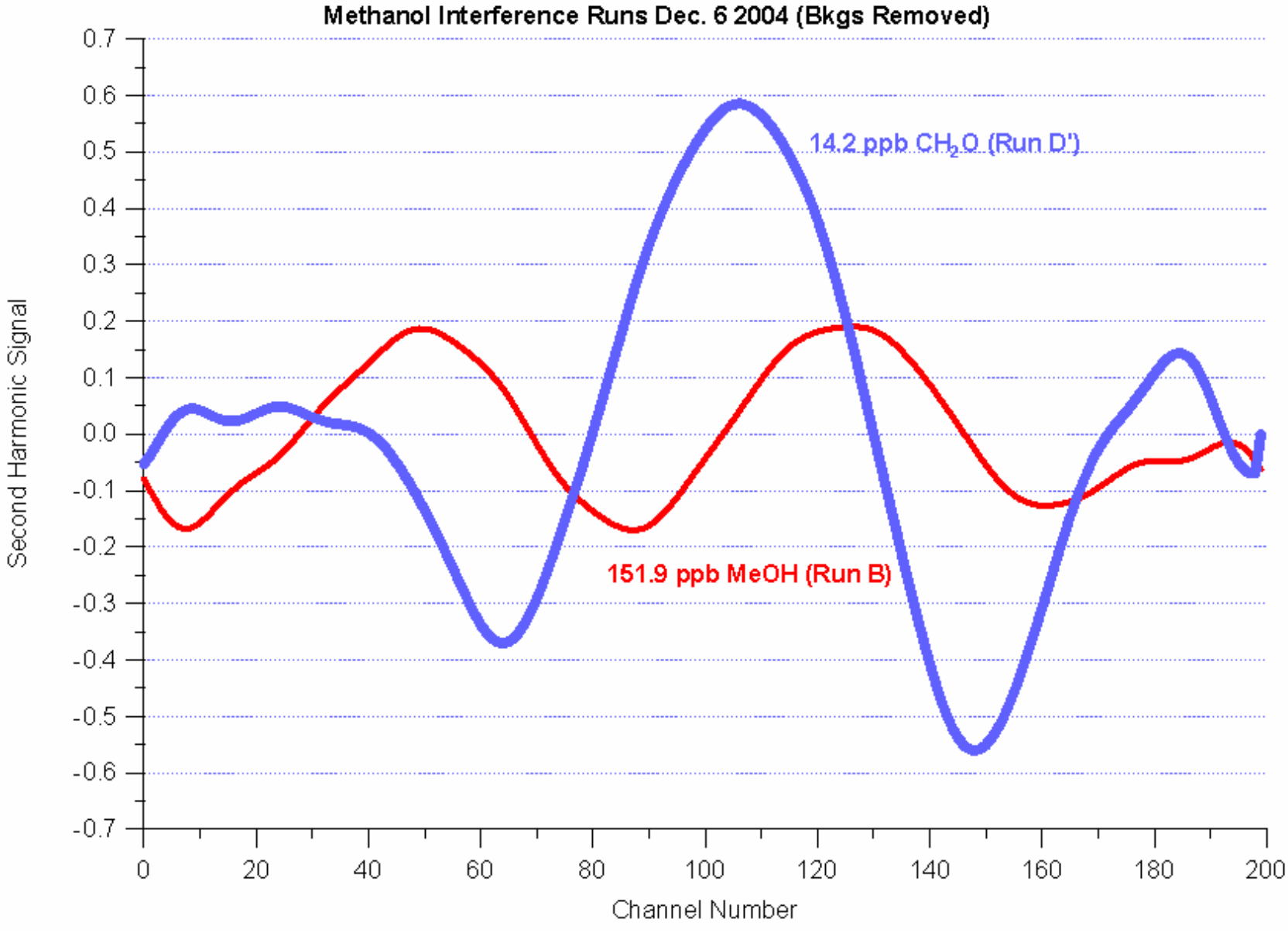
1) Electronic gain entire sys.
2) Cal stds output
3) Cal system and inlet sys surface effects
4) Pathlength
5) Mode fraction and scattered light

INTEX-A Daily Flight Calibrations



Absorption Features Near CH_2O Line

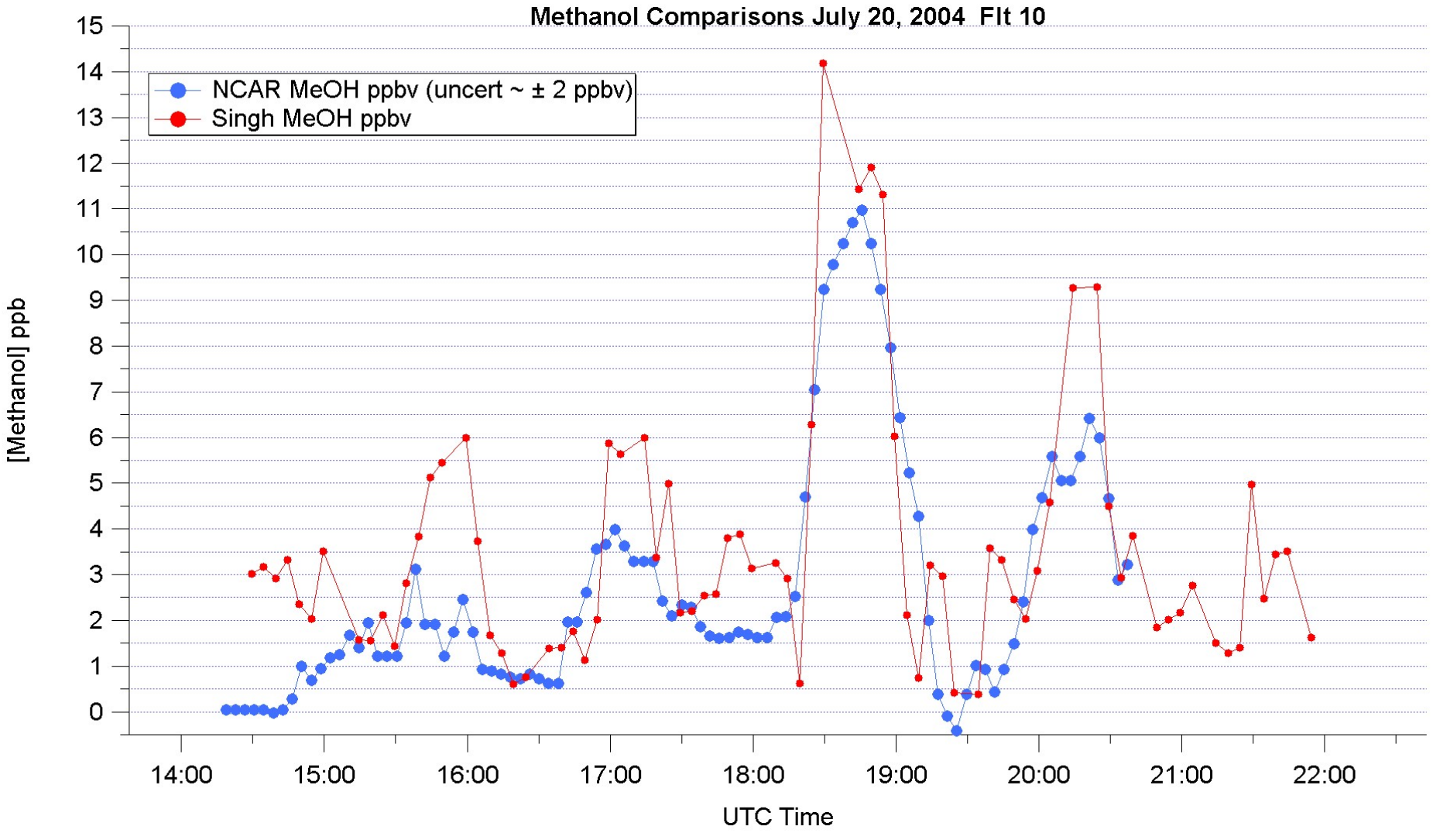



Methanol Interference Runs Dec. 6 2004 (Bkgs Removed)
14.2 ppb CH2O (Run D')
151.9 ppb MeOH (Run B)
Second Harmonic Signal
Channel Number
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
0
20
40
60
80
100
120
140
160
180
200

Results of Interference Tests

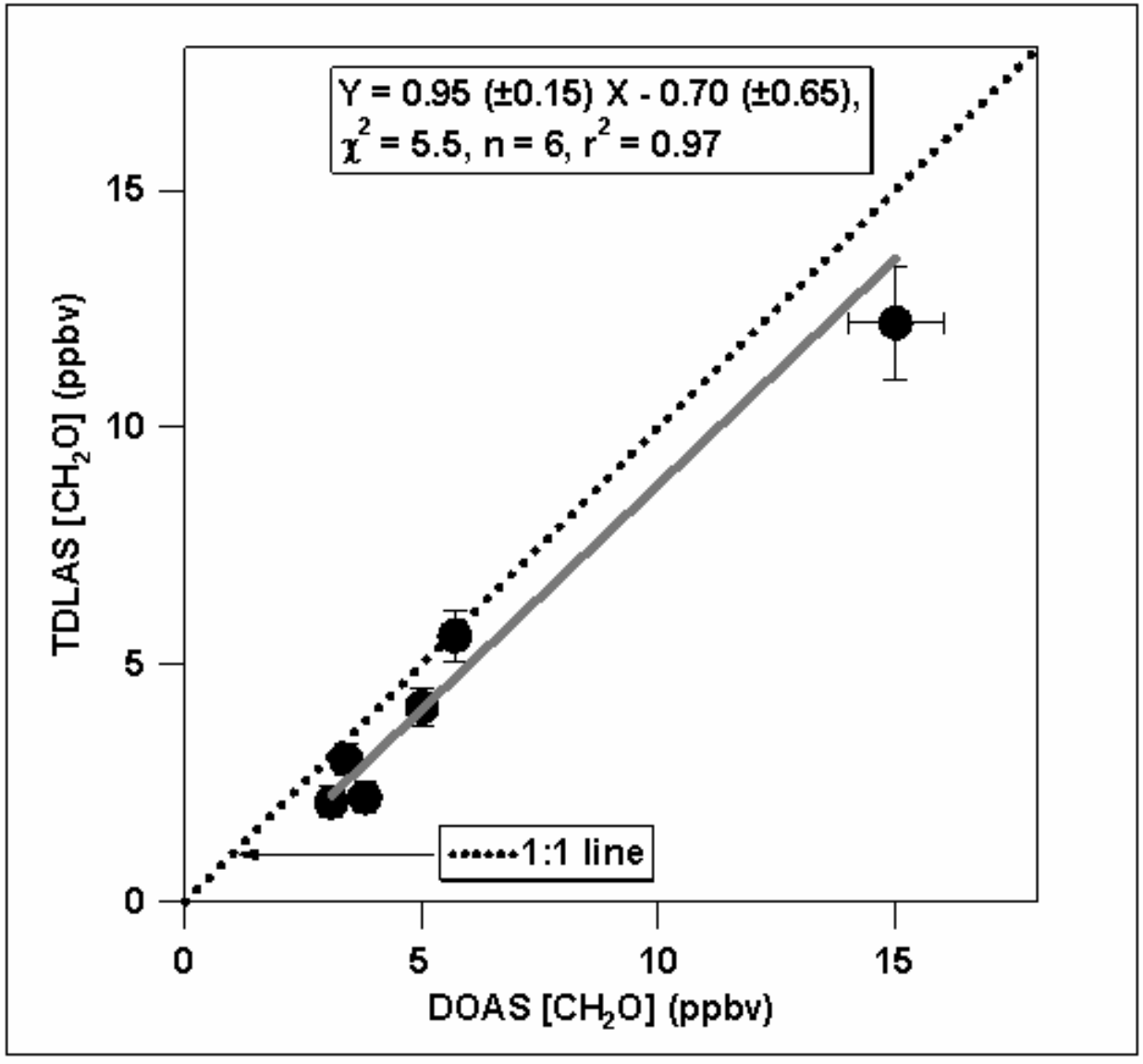
- H_2O (HDO) Line yields 0 to 4% interference for [H_2O] = 0.02 to 0.03
- Methanol yields a 0.3 to 0.4% interference for equiv. CH_2O concentrations.
- No additional interference with: ethanol, 2-propanol, acetaldehyde, propanal, butanal, i-butanal, acetone, MEK, n-butane, isoprene, benzene, i-butane, methacrolein, pentanal, hexanal

Results of Fitting Out Methanol

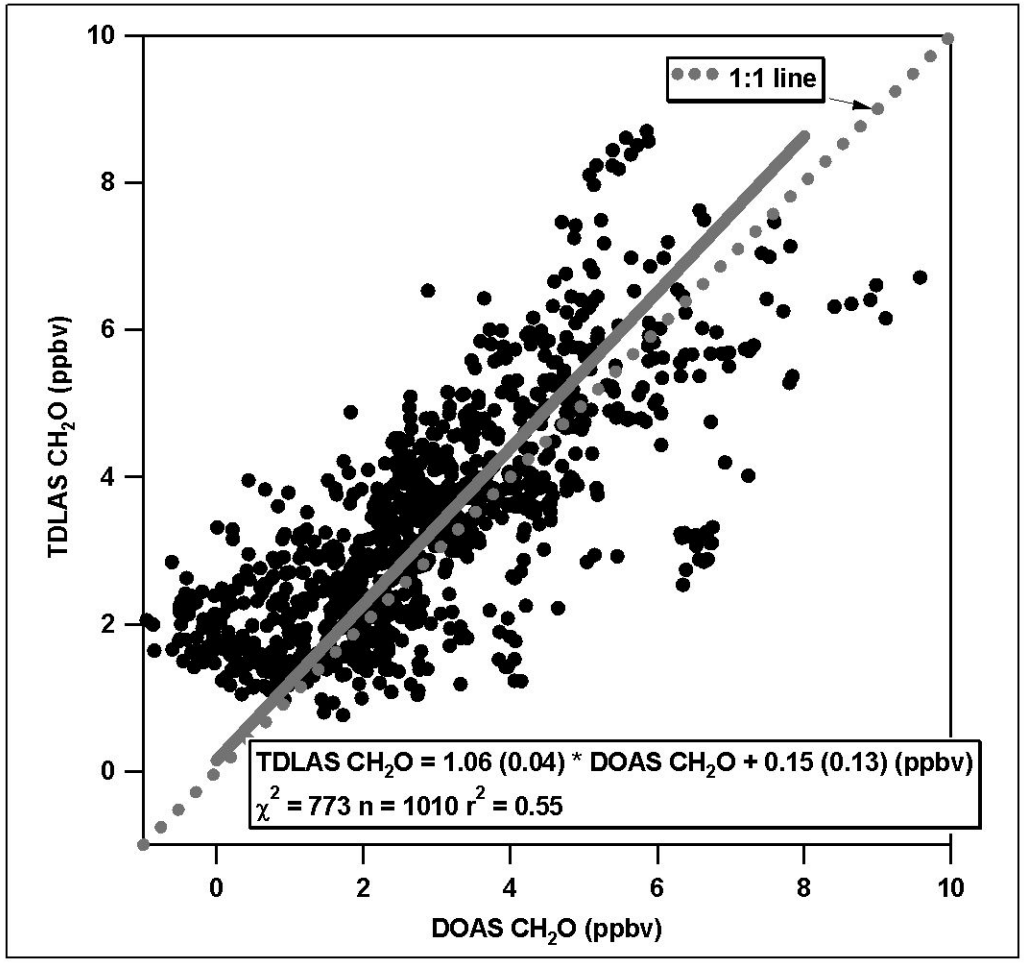


TDLAS-DOAS Comparisons Over LaPorte, Texas

TDLAS: On Electra
DOAS: Ground-Based



Comparison of NCAR TDLAS & UCLA DOAS CH_2O Measurements (Cornelia Fort During SOS 99)



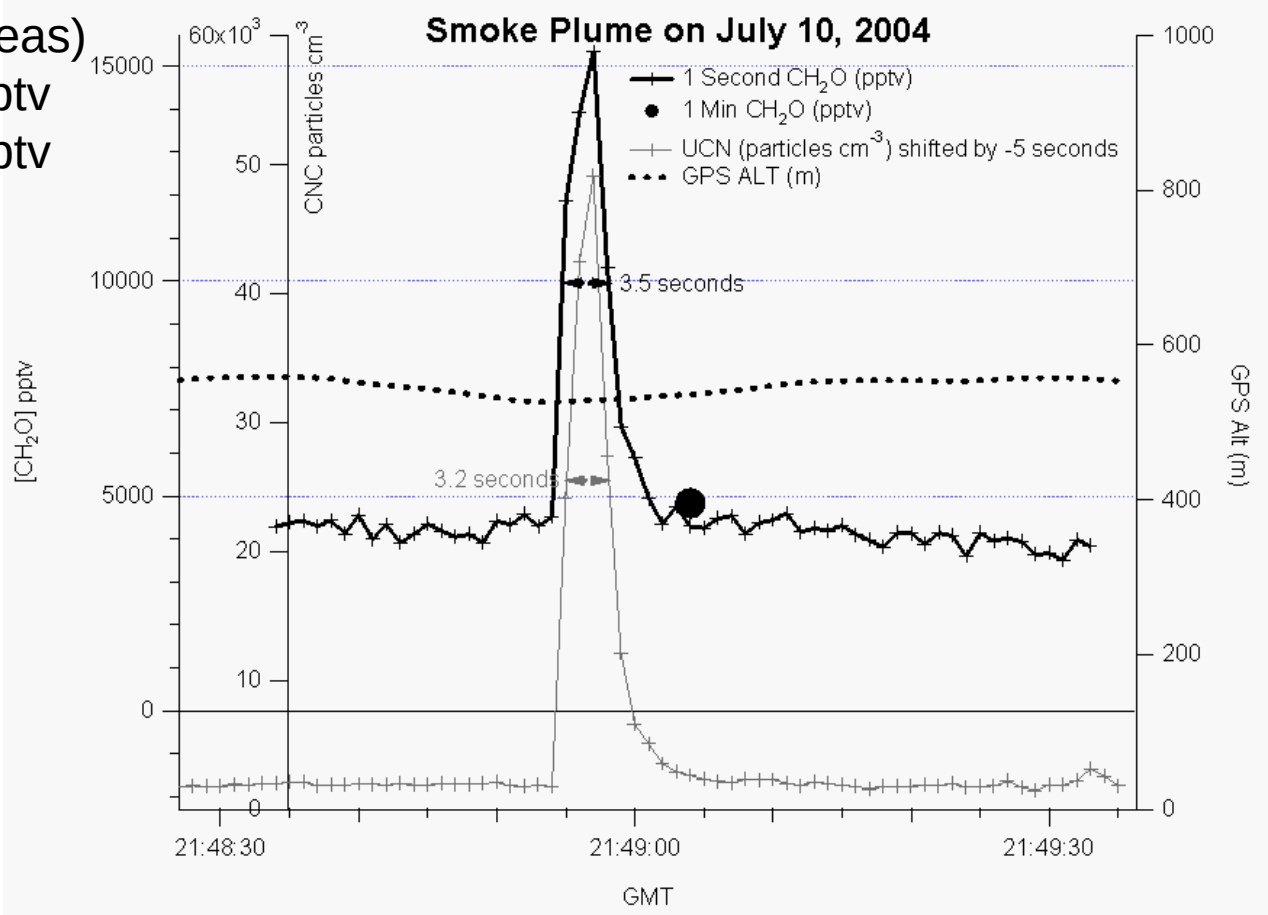
TDL Performance Characteristics

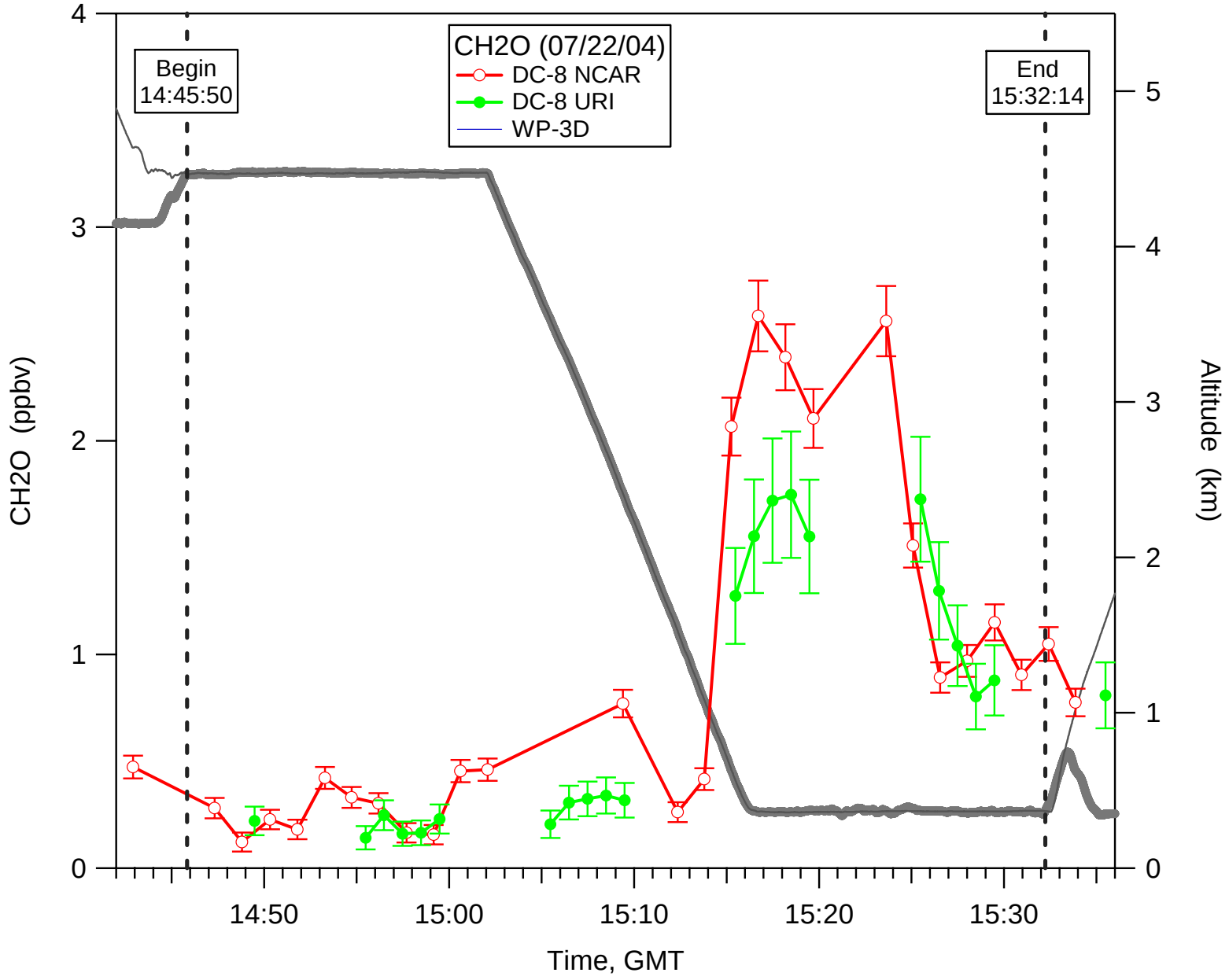
1) Data on all but 1 science flight

2) Accuracy: Better than 12%

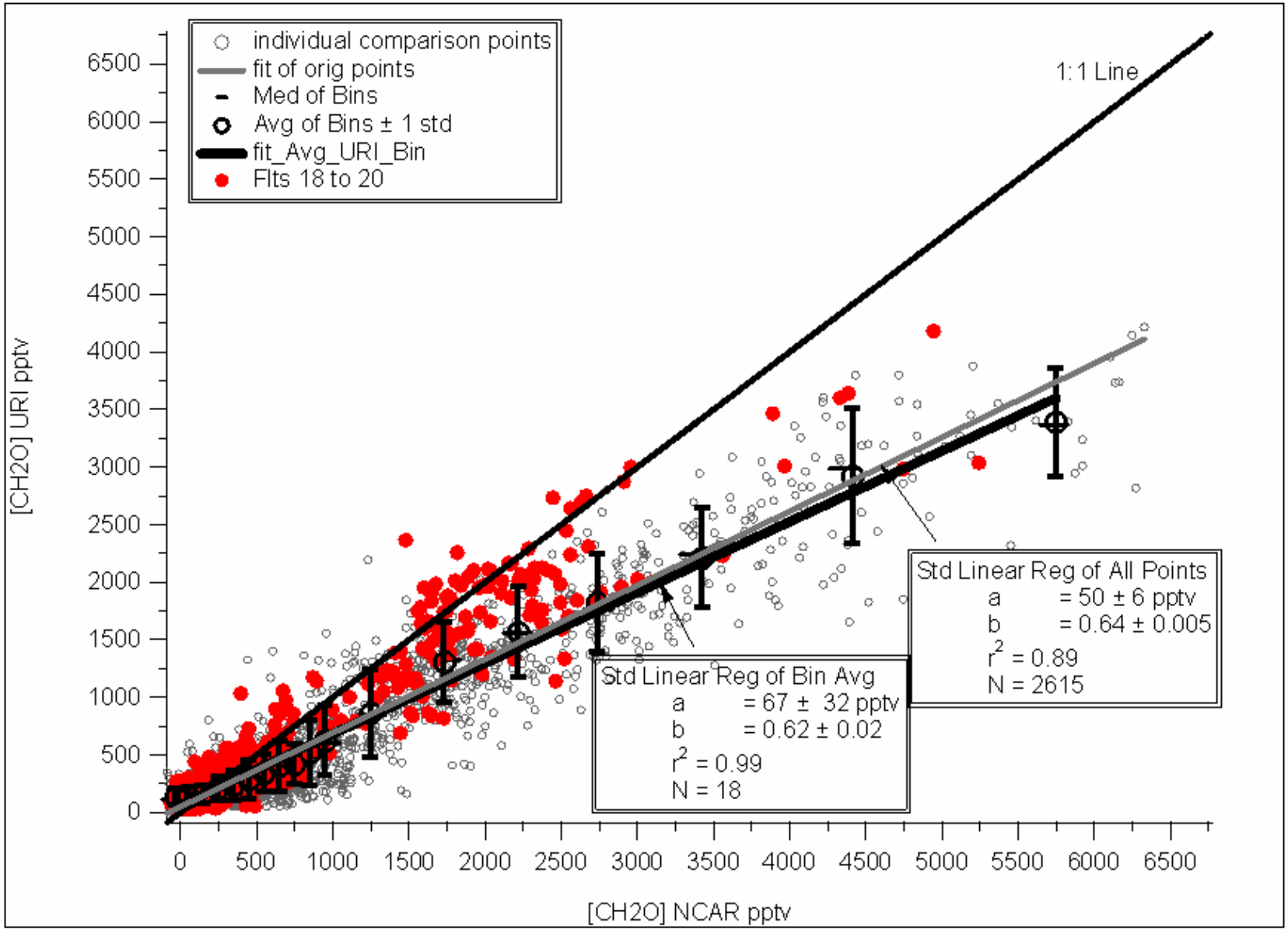
3) Upper limit to LOD (30 second meas)
   a) Before 7/31/04: ~ 70 to 80 pptv
   b) After 7/31/03 ~ 50 to 60 pptv

4) Response Time : 1- 2 seconds

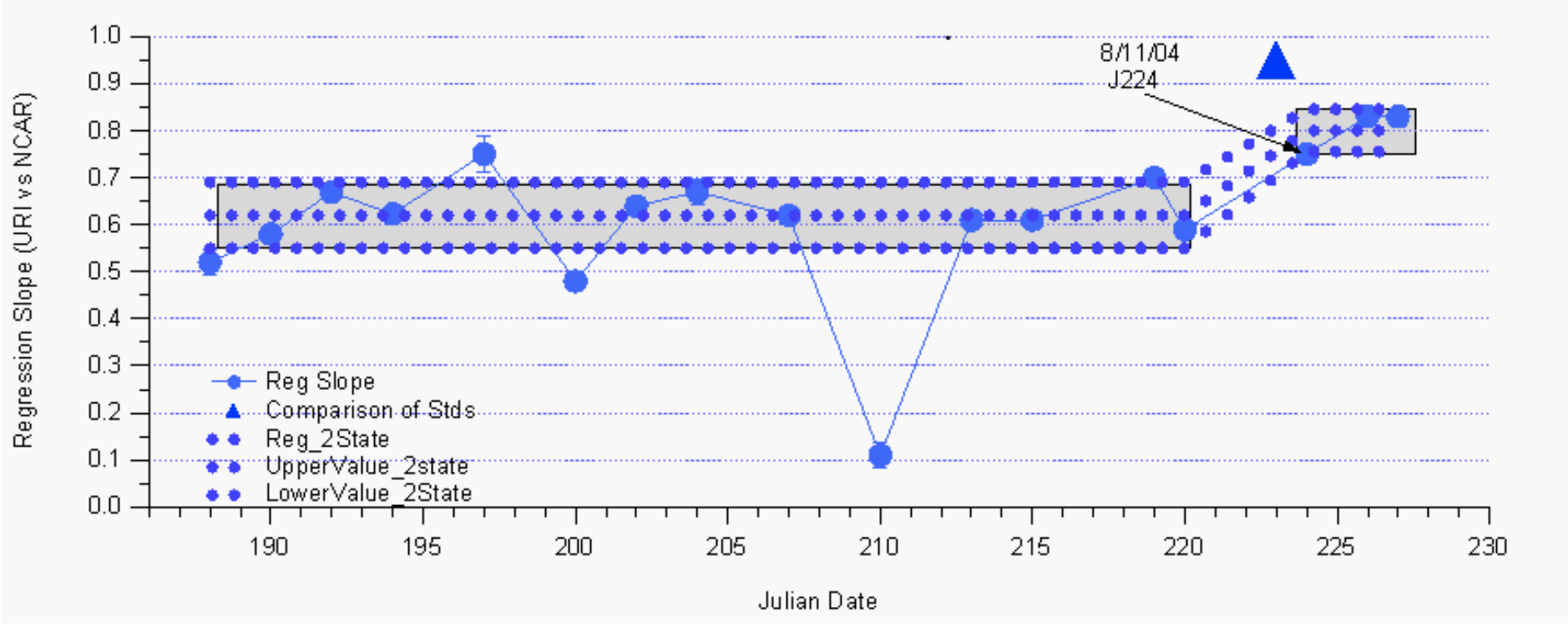



CH2O (07/22/04)
DC-8 NCAR
DC-8 URI
WP-3D
Begin
14:45:50
End
15:32:14
CH2O (ppbv)
Altitude (km)
Time, GMT
14:50
15:00
15:10
15:20
15:30
0
1
2
3
4
5

URI vs NCAR Linear Regression (normal) on 1-Min. Merged Data



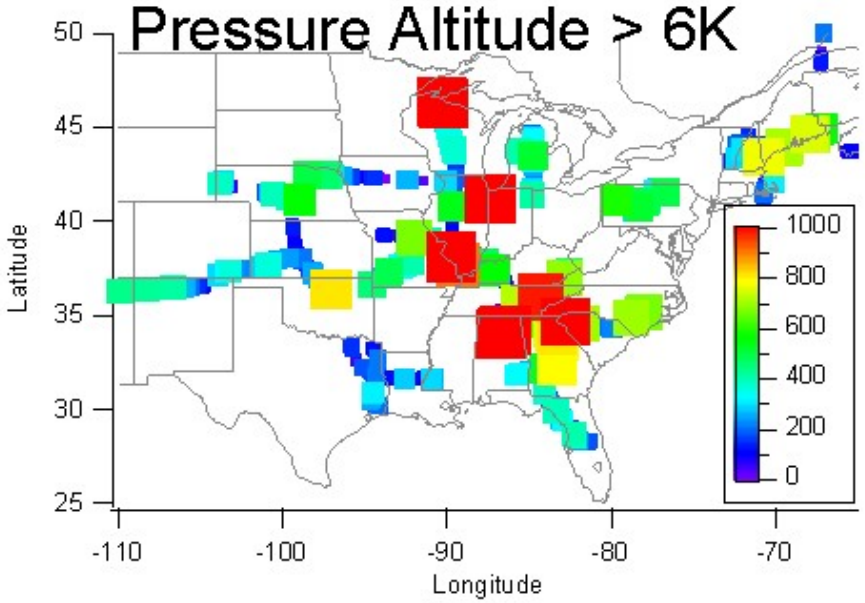
Time Dependence of Regression Slopes

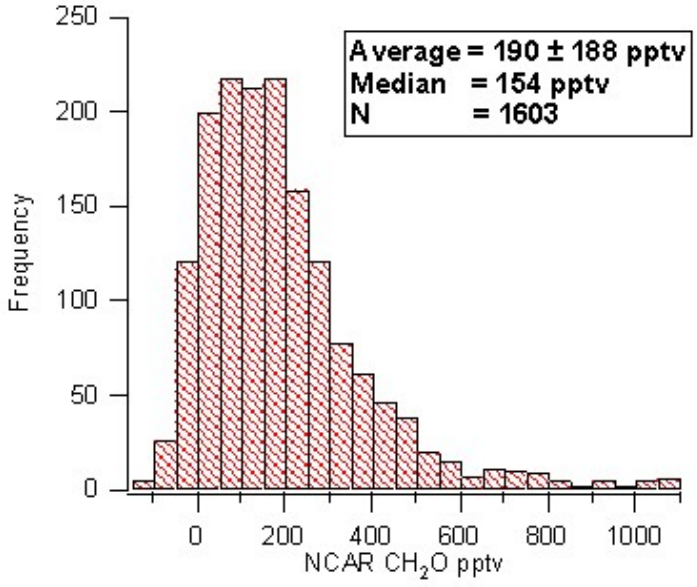


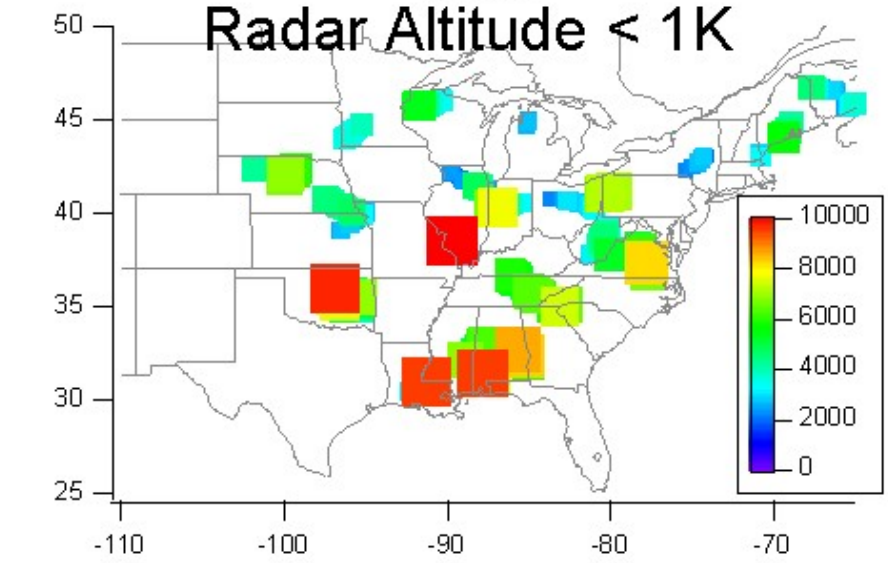
CH_2O During INTEX-NA 2004

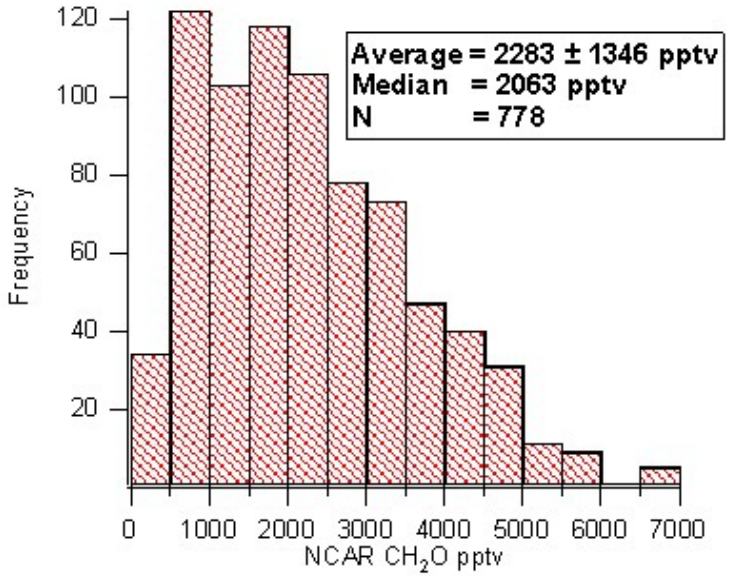
- CH_2O in the UT & Convective Outflow
- CH_2O in the MBL & Transport

Continental CH2O Distributions 1-Min TDLAS

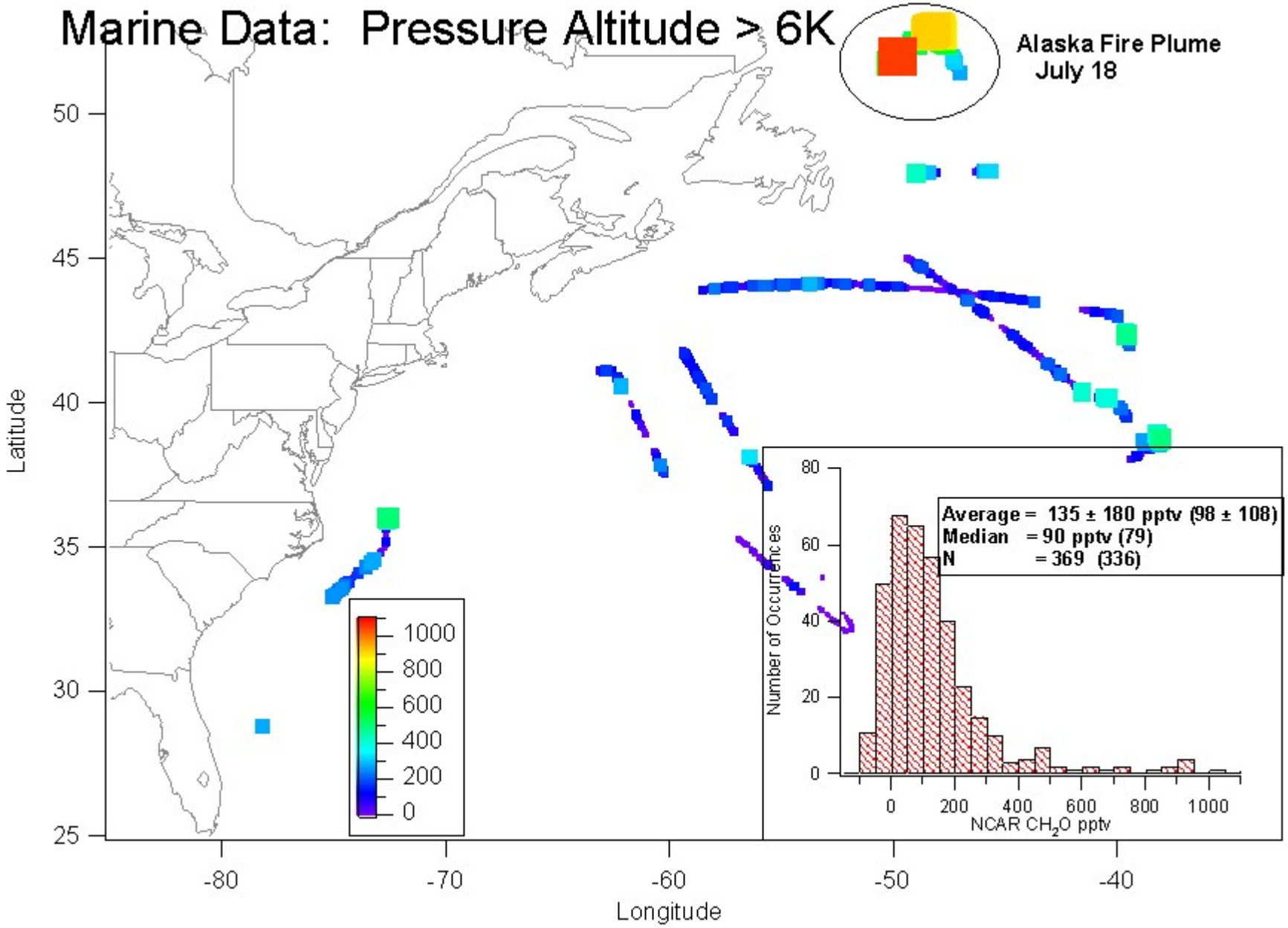




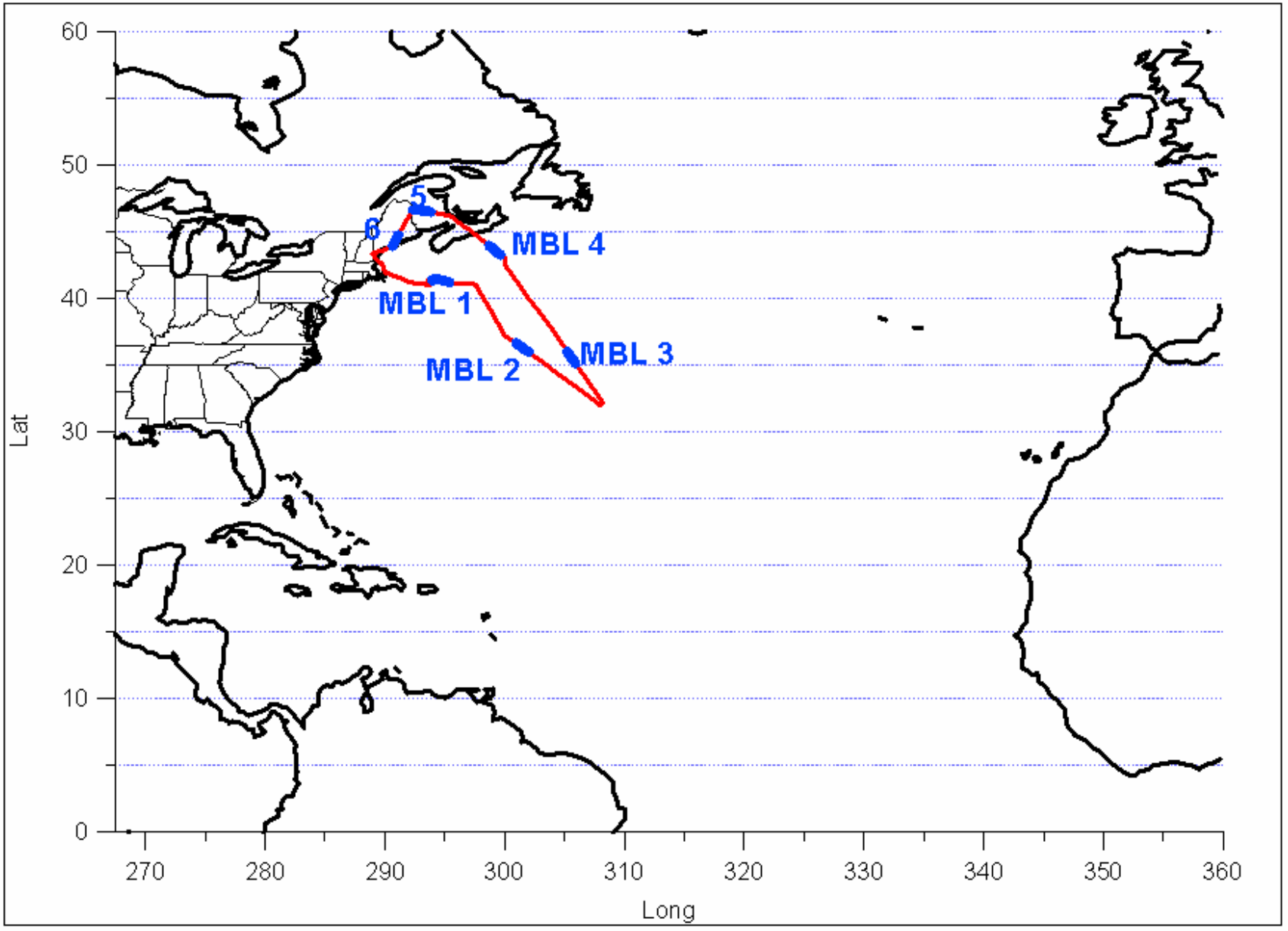


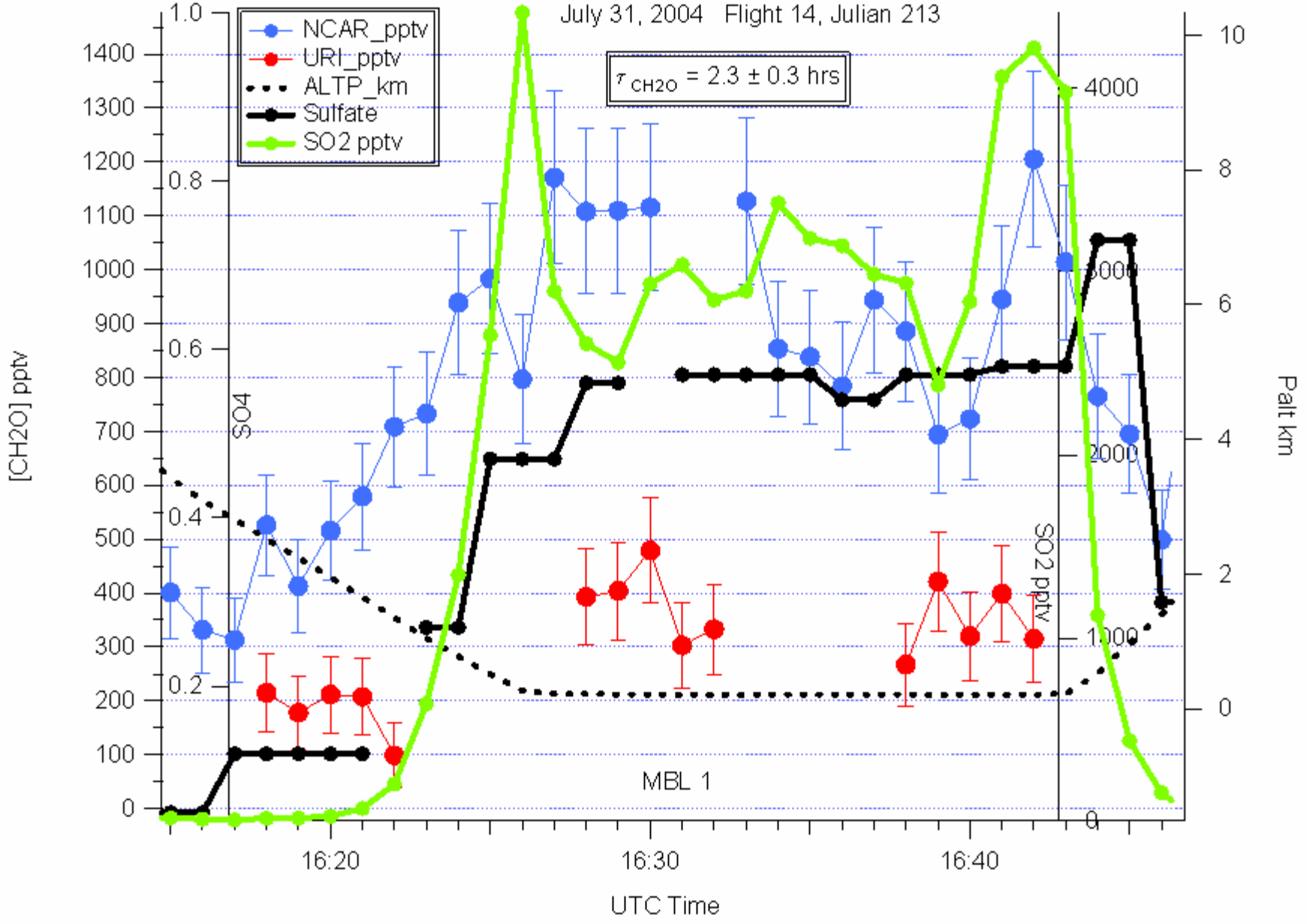


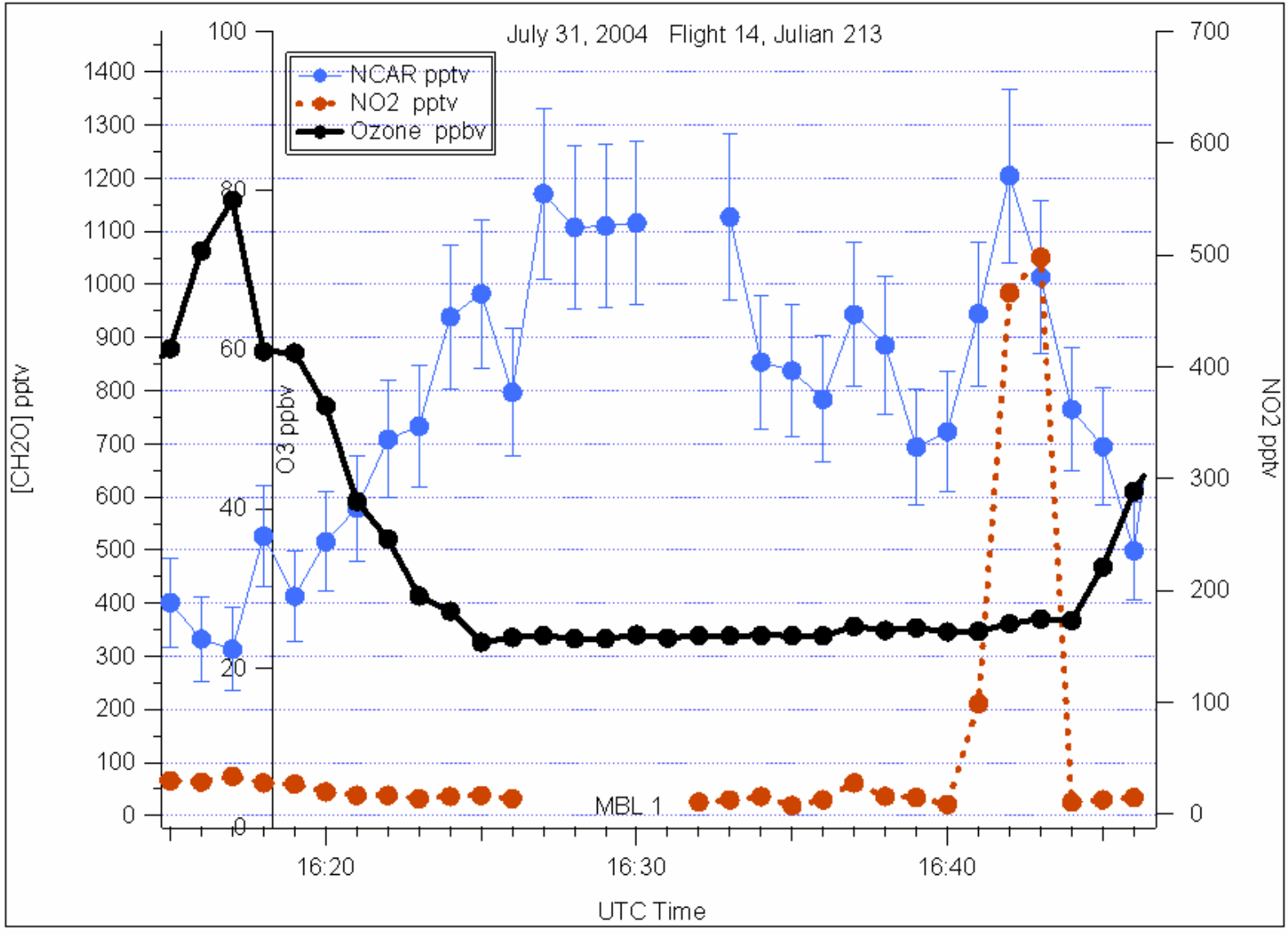
Marine CH2O Distributions 1-Min TDLAS

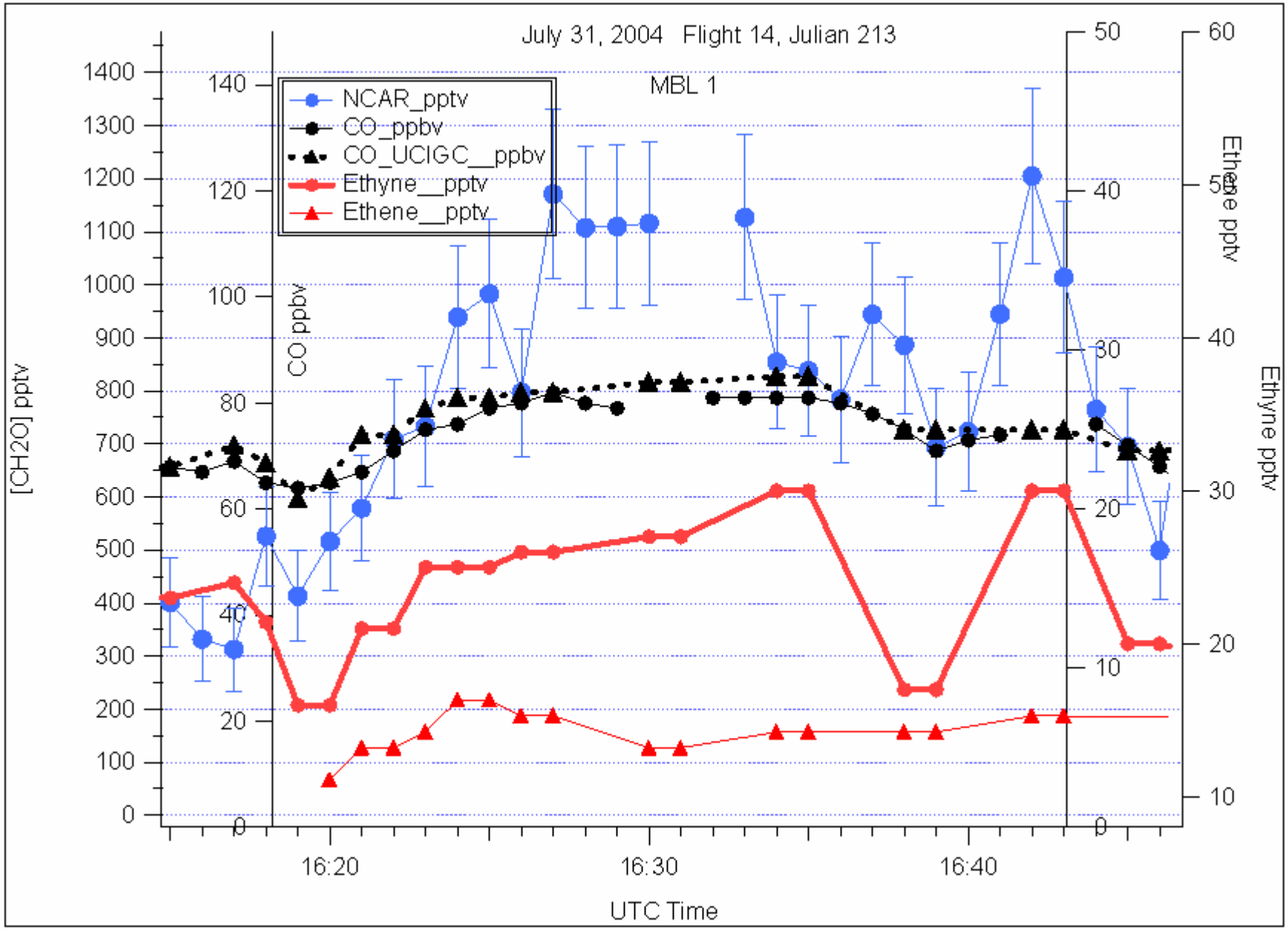


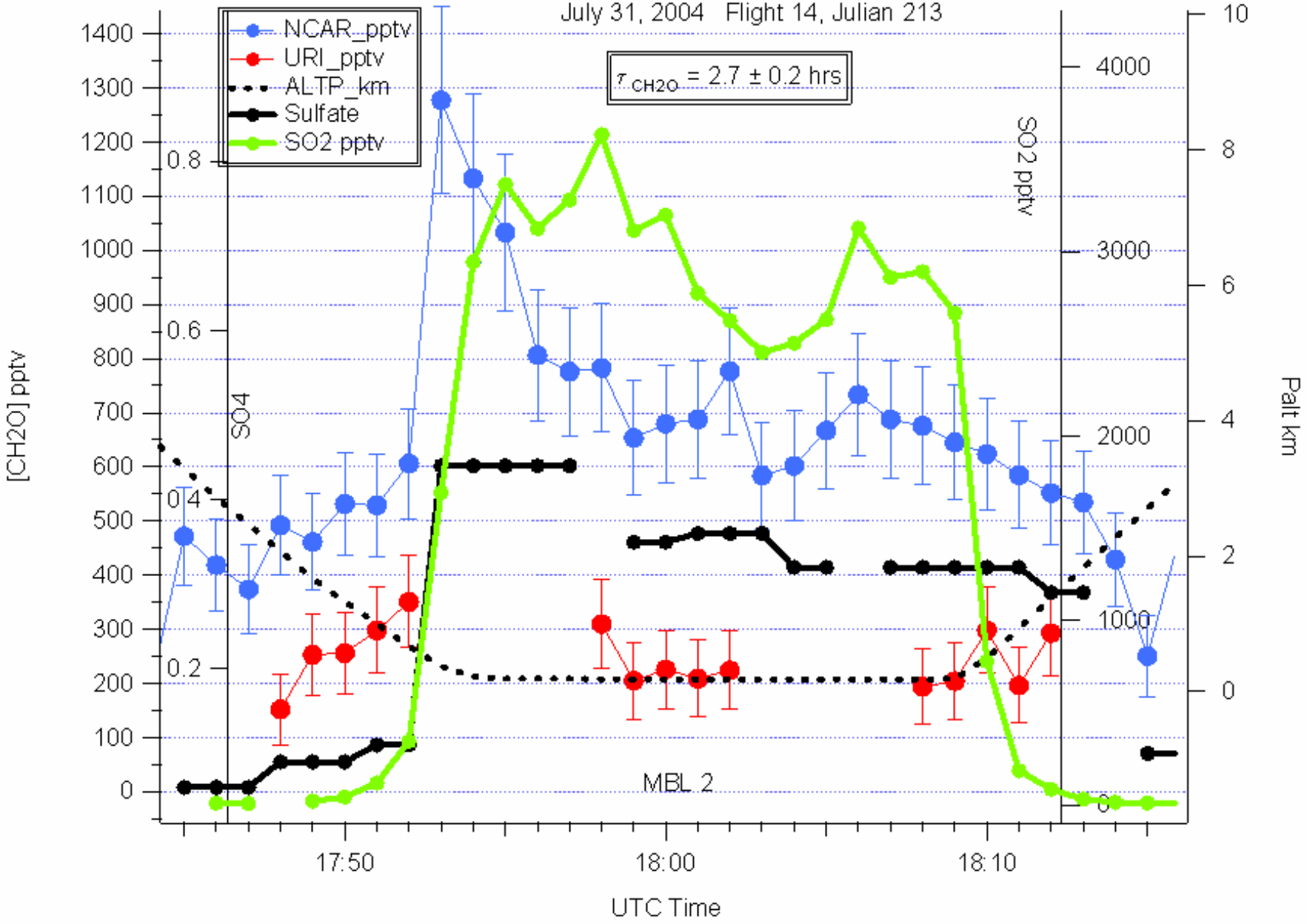
July 31, 2004 Flt 14 Julian 213

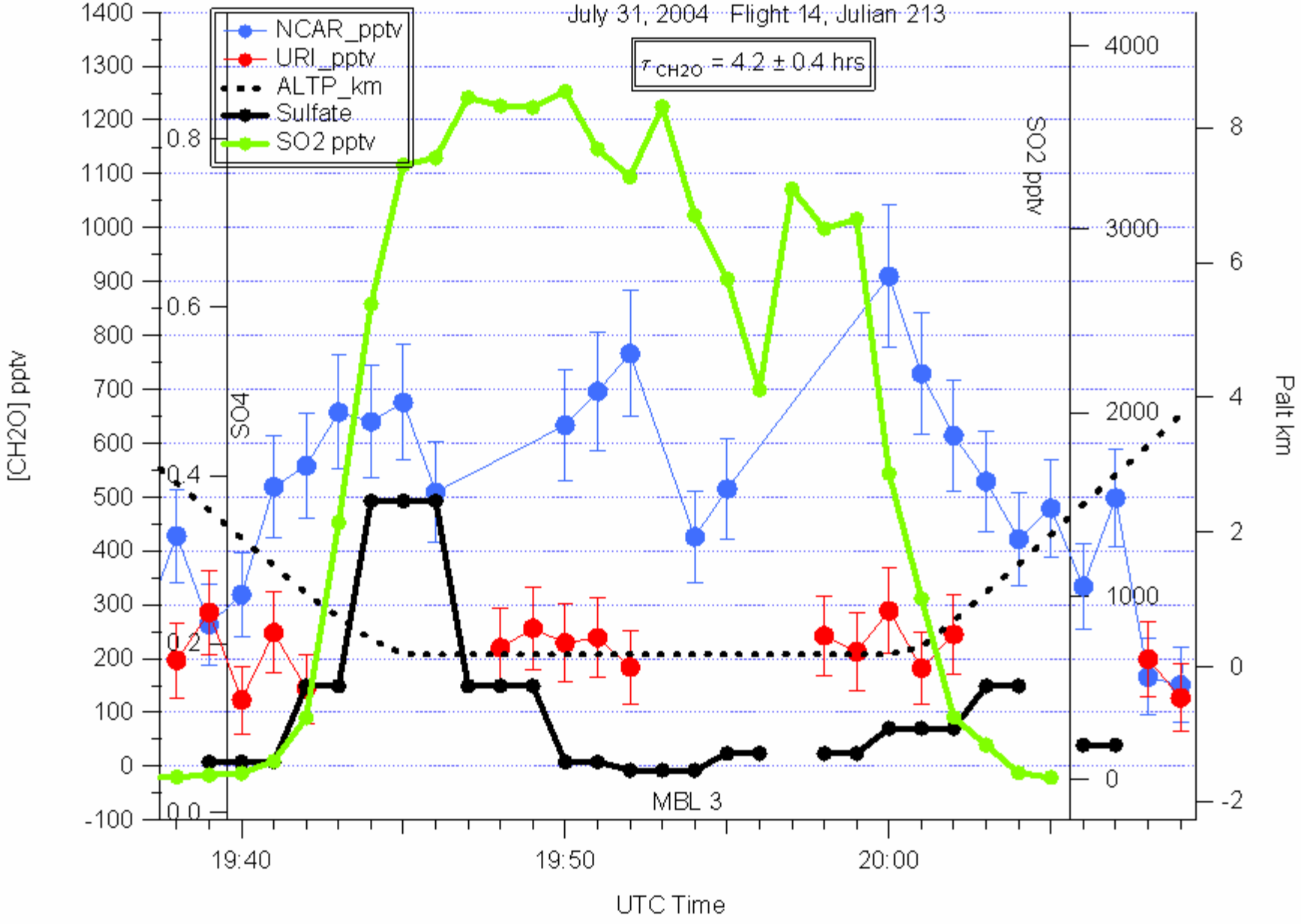


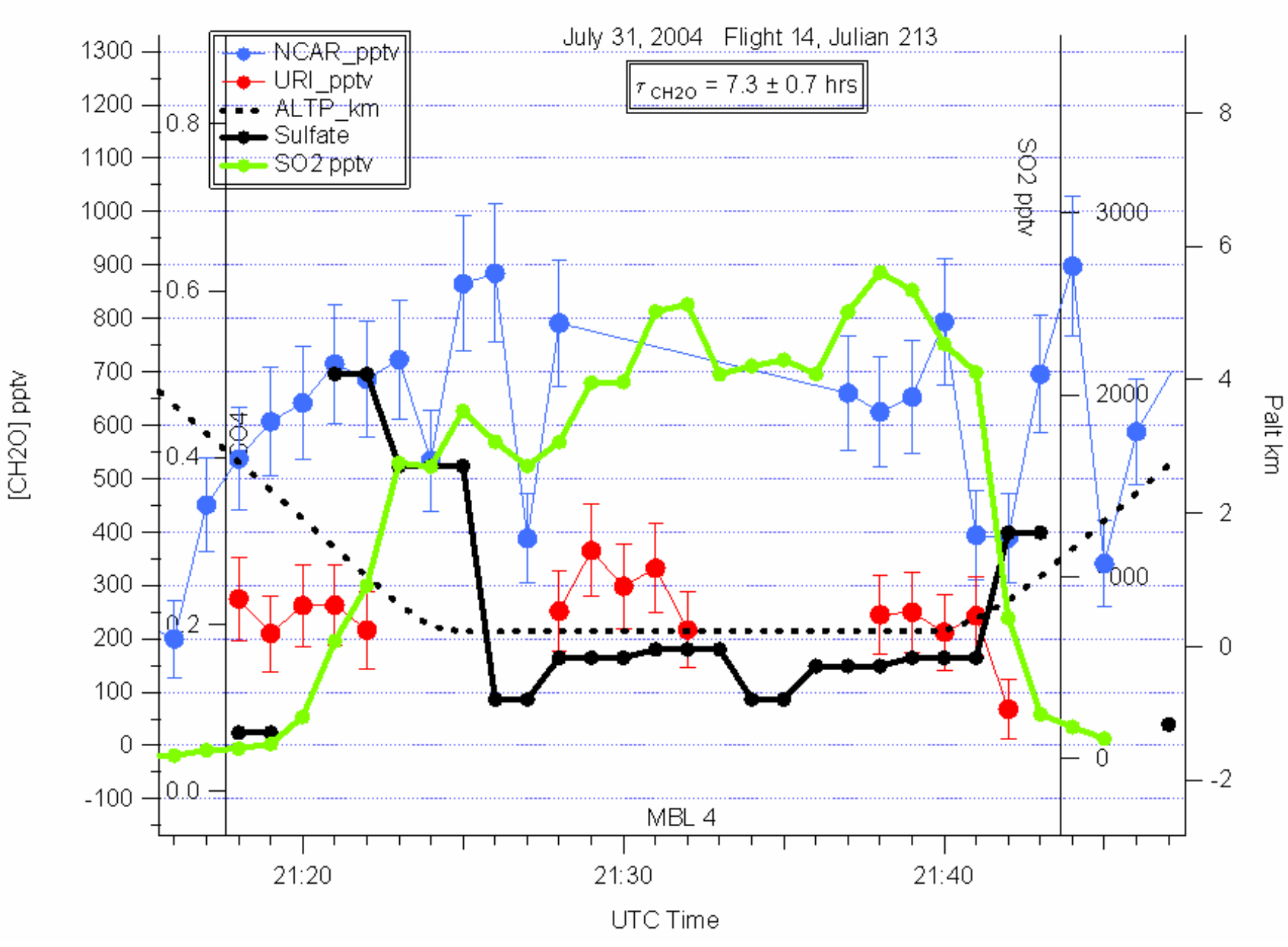

July 31, 2004 Flight 14, Julian 213
NCAR_pptv
URI_pptv
ALTP_km
Sulfate
SO2 pptv
τ_{CH2O} = 2.3 ± 0.3 hrs
[CH2O] pptv
SO4
SO2 pptv
Palt km
MBL 1
UTC Time
16:20
16:30
16:40
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
0.2
0.4
0.6
0.8
1.0
1000
2000
3000
4000
0
2
4
6
8
10

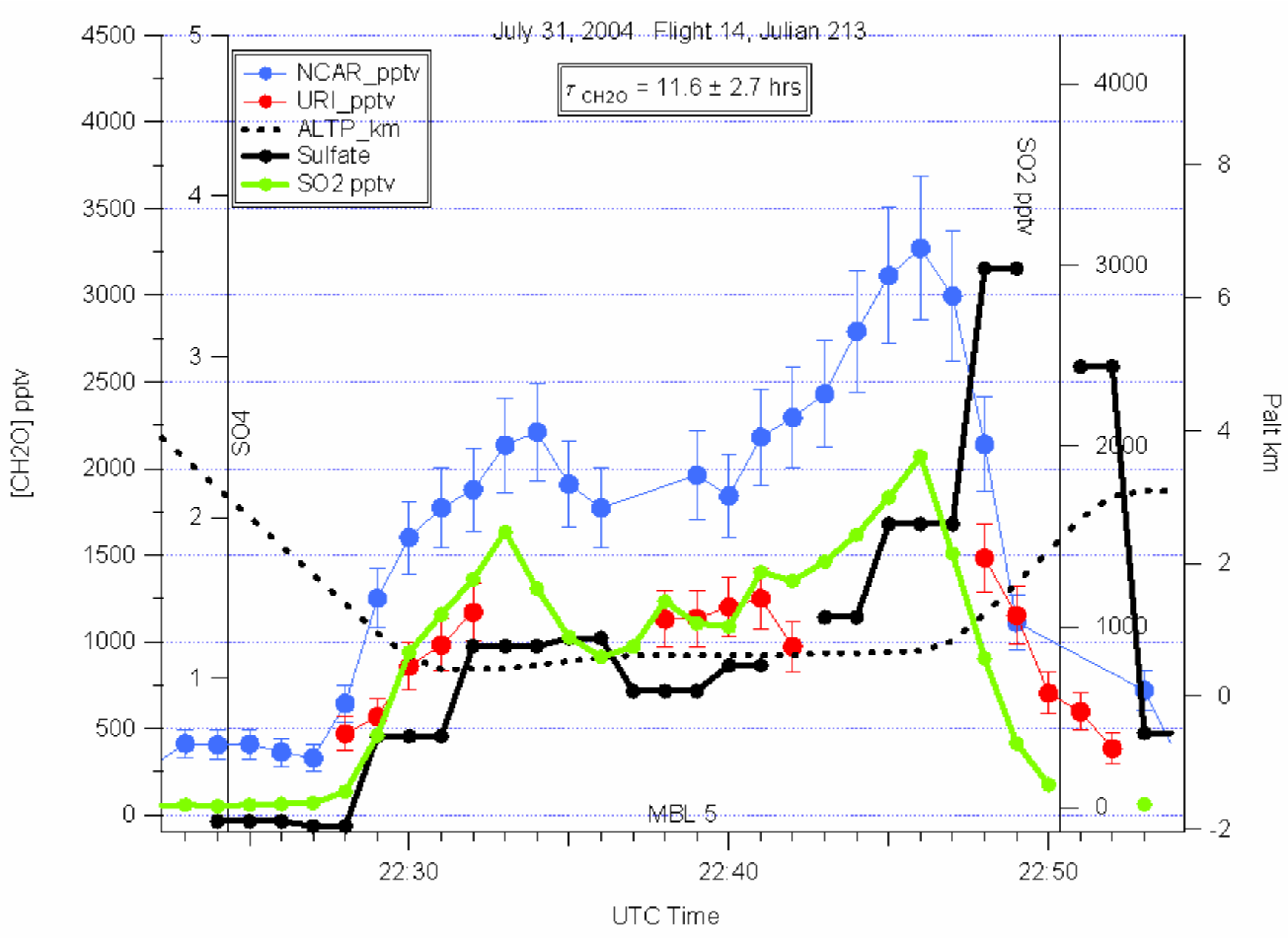

July 31, 2004 Flight 14, Julian 213
NCAR pptv
NO2 pptv
Ozone ppbv
[CH2O] pptv
O3 ppbv
NO2 pptv
MBL 1
16:20
16:30
16:40
UTC Time
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
0
20
40
60
80
100
0
100
200
300
400
500
600
700

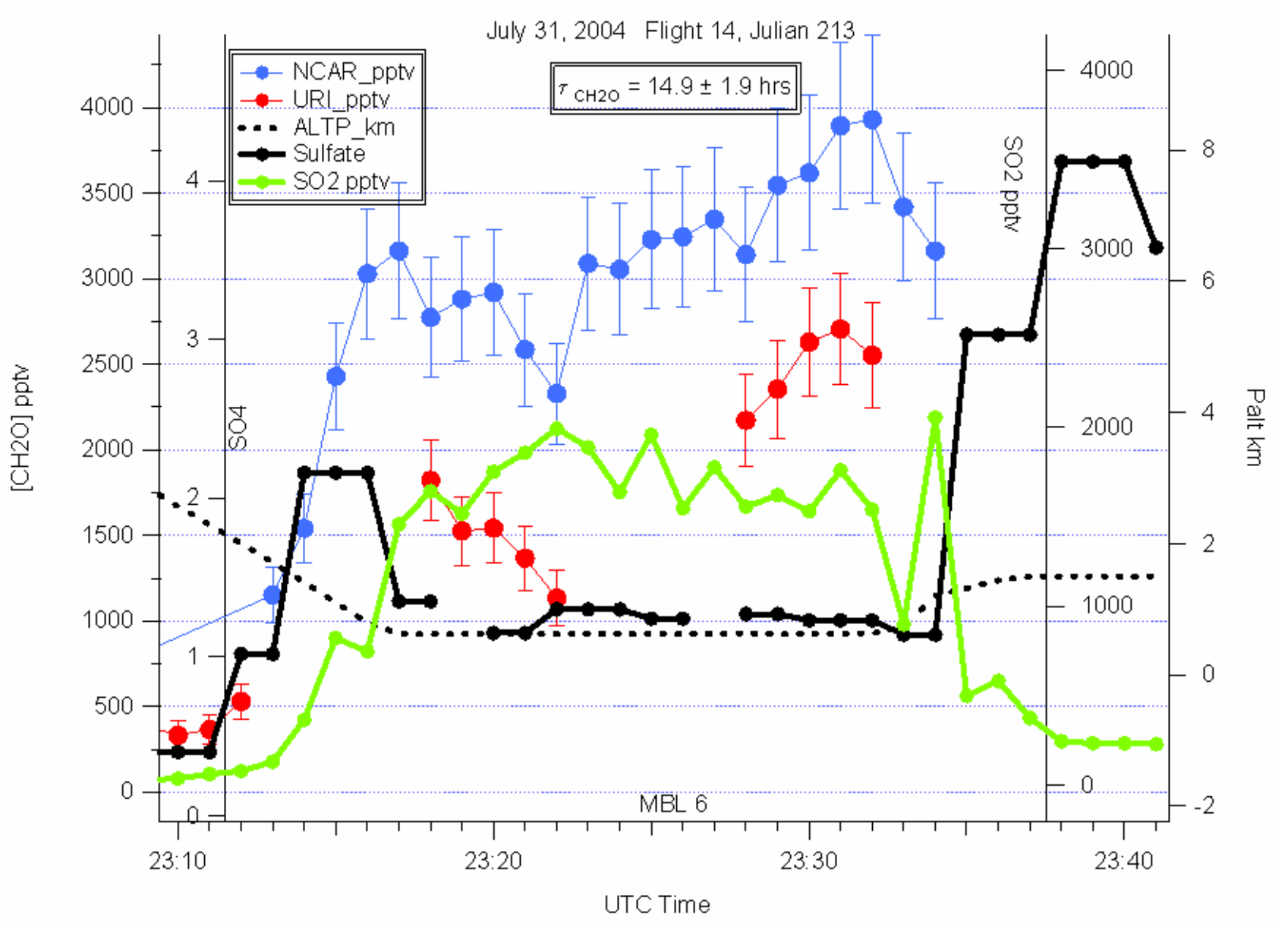

July 31, 2004 Flight 14, Julian 213
MBL 1
NCAR_pptv
CO_ppbv
CO_UCIGC__ppbv
Ethyne__pptv
Ethene__pptv
[CH2O] pptv
CO ppbv
Ethene pptv
Ethyne pptv
UTC Time
16:20
16:30
16:40
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
20
40
60
80
100
120
140
10
20
30
40
50
60


July 31, 2004 Flight 14, Julian 213
NCAR_pptv
URI_pptv
ALTP_km
Sulfate
SO2 pptv
τ_{CH2O} = 2.7 ± 0.2 hrs
[CH2O] pptv
SO4
SO2 pptv
Palt km
MBL 2
UTC Time
17:50
18:00
18:10
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
0.8
0.6
0.4
0.2
4000
3000
2000
1000
0
10
8
6
4
2
0


July 31, 2004 Flight 14, Julian 213
τ_{CH2O} = 4.2 ± 0.4 hrs
NCAR_pptv
URI_pptv
ALTP_km
Sulfate
SO2 pptv
[CH2O] pptv
SO4
SO2 pptv
Palt km
MBL 3
UTC Time
19:40
19:50
20:00
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
-100
0.8
0.6
0.4
0.2
0.0
4000
3000
2000
1000
0
8
6
4
2
0
-2


July 31, 2004 Flight 14, Julian 213
τ_{CH2O} = 7.3 ± 0.7 hrs
NCAR_pptv
URI_pptv
ALTP_km
Sulfate
SO2 pptv
[CH2O] pptv
SO4
SO2 pptv
Palt km
MBL 4
21:20
21:30
21:40
UTC Time


July 31, 2004 Flight 14, Julian 213
τ CH2O = 11.6 ± 2.7 hrs
NCAR_pptv
URI_pptv
ALTP_km
Sulfate
SO2 pptv
[CH2O] pptv
SO4
SO2 pptv
Palt km
MBL 5
UTC Time
22:30
22:40
22:50
4500
4000
3500
3000
2500
2000
1500
1000
500
0
5
4
3
2
1
4000
3000
2000
1000
0
8
6
4
2
0
-2


July 31, 2004 Flight 14, Julian 213
NCAR_pptv
URI_pptv
ALTP_km
Sulfate
SO2 pptv
τ_{CH2O} = 14.9 ± 1.9 hrs
[CH2O] pptv
SO4
SO2 pptv
Palt km
MBL 6
UTC Time
23:10
23:20
23:30
23:40
0
500
1000
1500
2000
2500
3000
3500
4000
1
2
3
4
6
8
-2

Topics for Papers

- CH_2O in the UT & Convective Outflow
- CH_2O in the MBL & Transport
- CH_2O Distributions Over the U.S.
- Effects of Fires
- Measurement-Model Relationships
- CH_2O & Tracer Correlations
- Relationship of CH_2O with methanol and clouds/aerosols (Alaska fire plume)