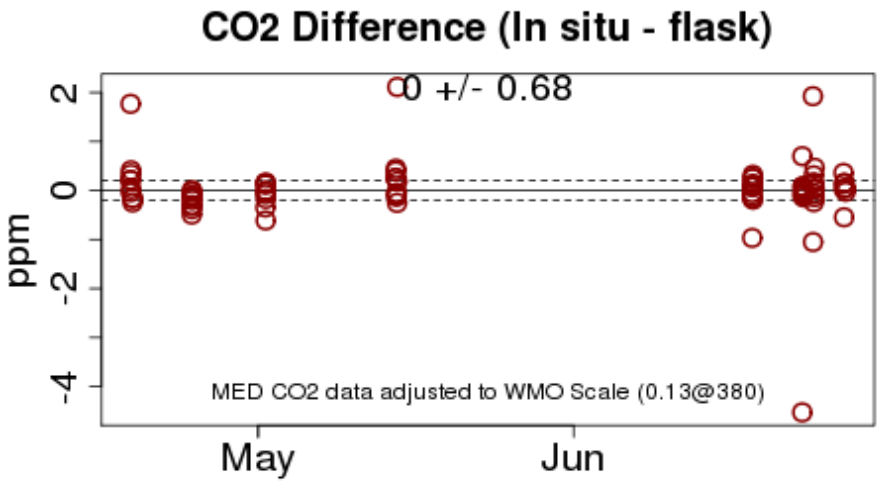
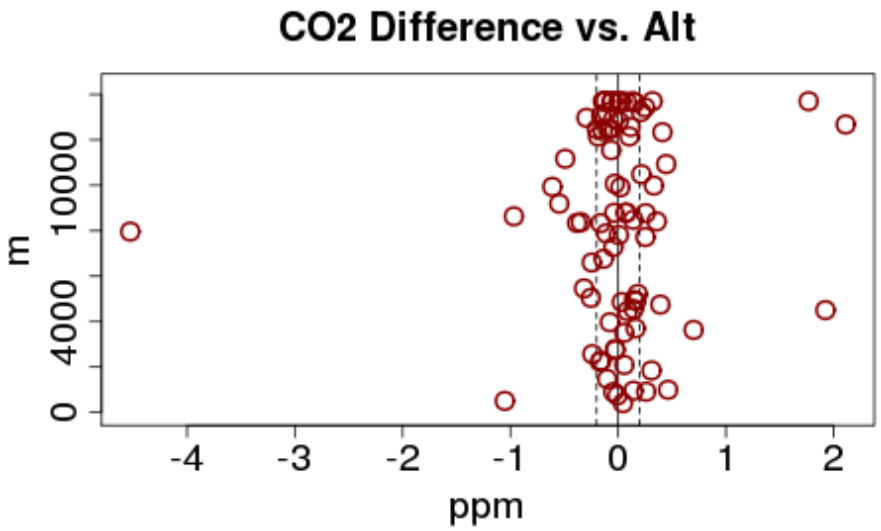
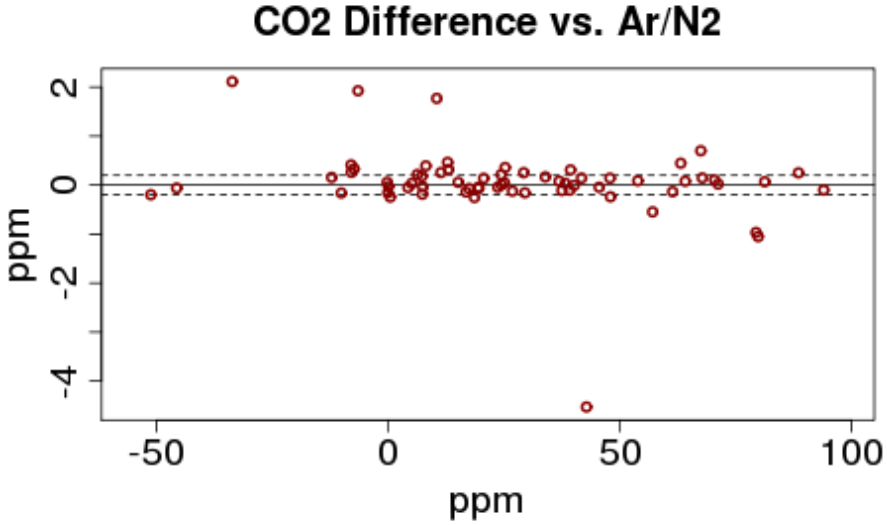
AO2 Update

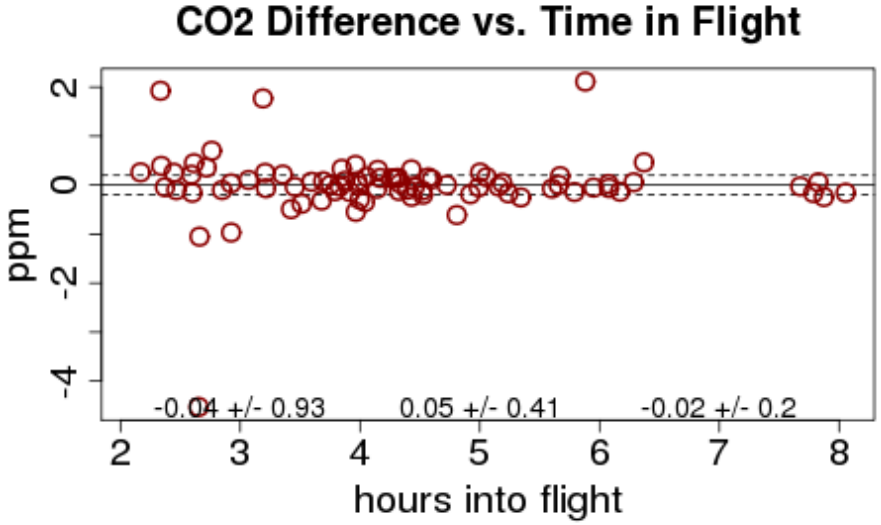
- CO_2 intercomparisons
- O_2 data features
- O_2 issues to be resolved
- Future work

START-08

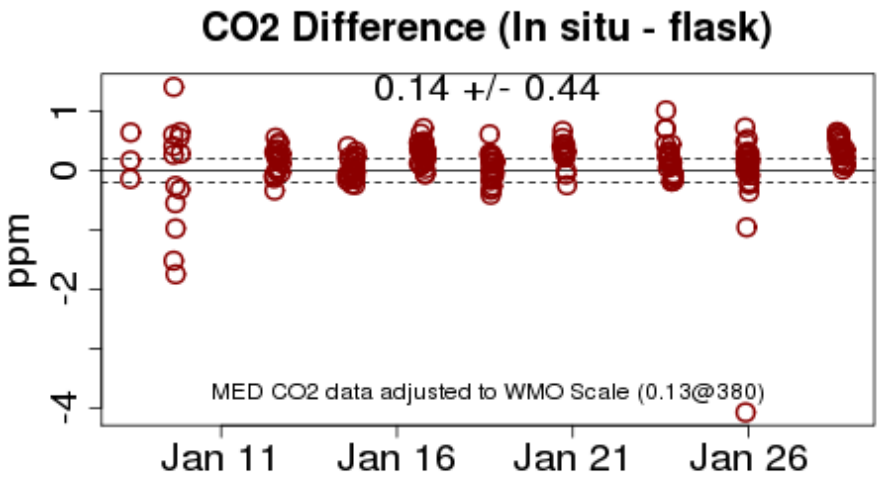

CO2 Difference (In situ - flask)
0 +/- 0.68
MED CO2 data adjusted to WMO Scale (0.13@380)
ppm
May
Jun

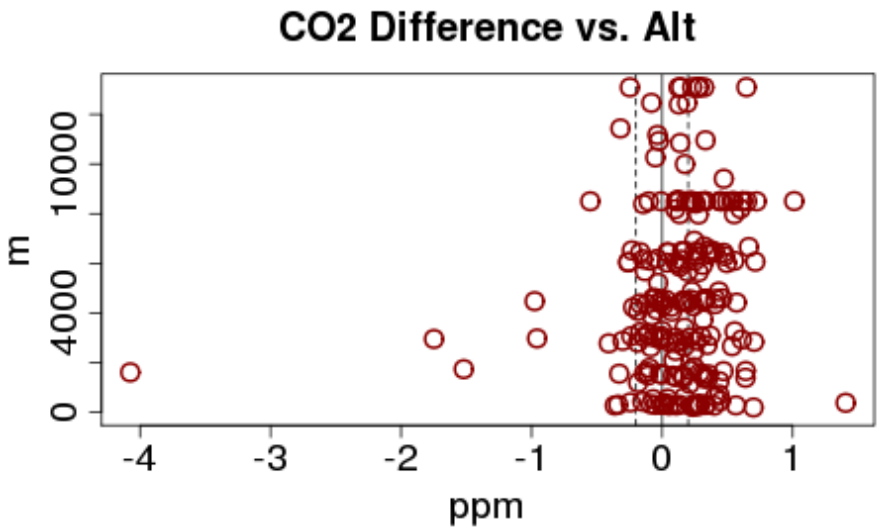

CO2 Difference vs. Alt
m
ppm

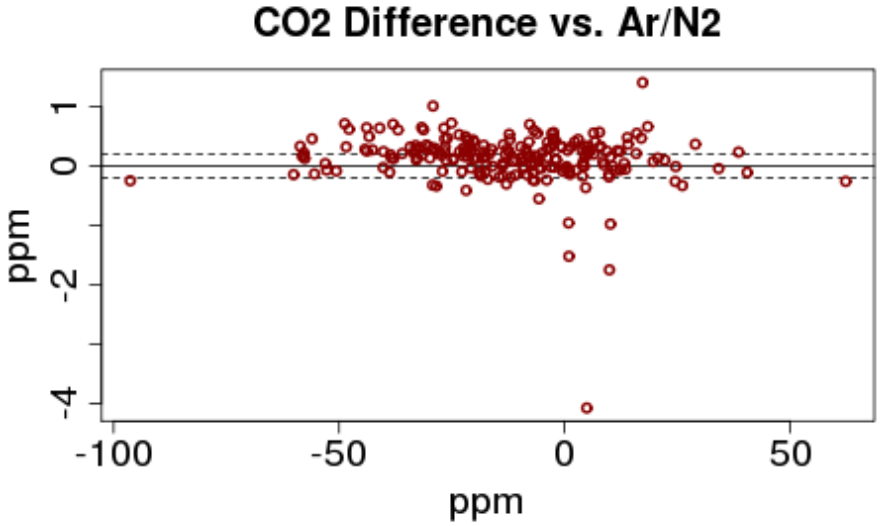

CO2 Difference vs. Ar/N2
ppm
ppm

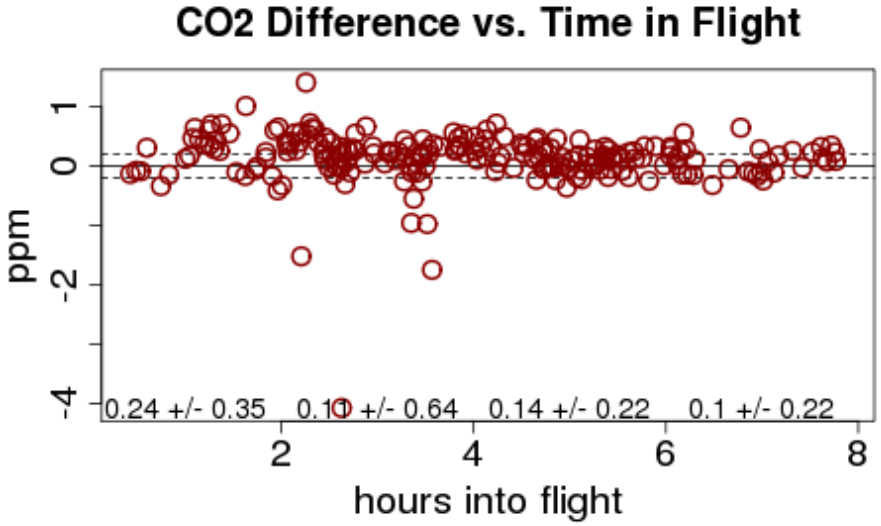

CO2 Difference vs. Time in Flight
ppm
-0.04 +/- 0.93
0.05 +/- 0.41
-0.02 +/- 0.2
hours into flight

HIPPO1

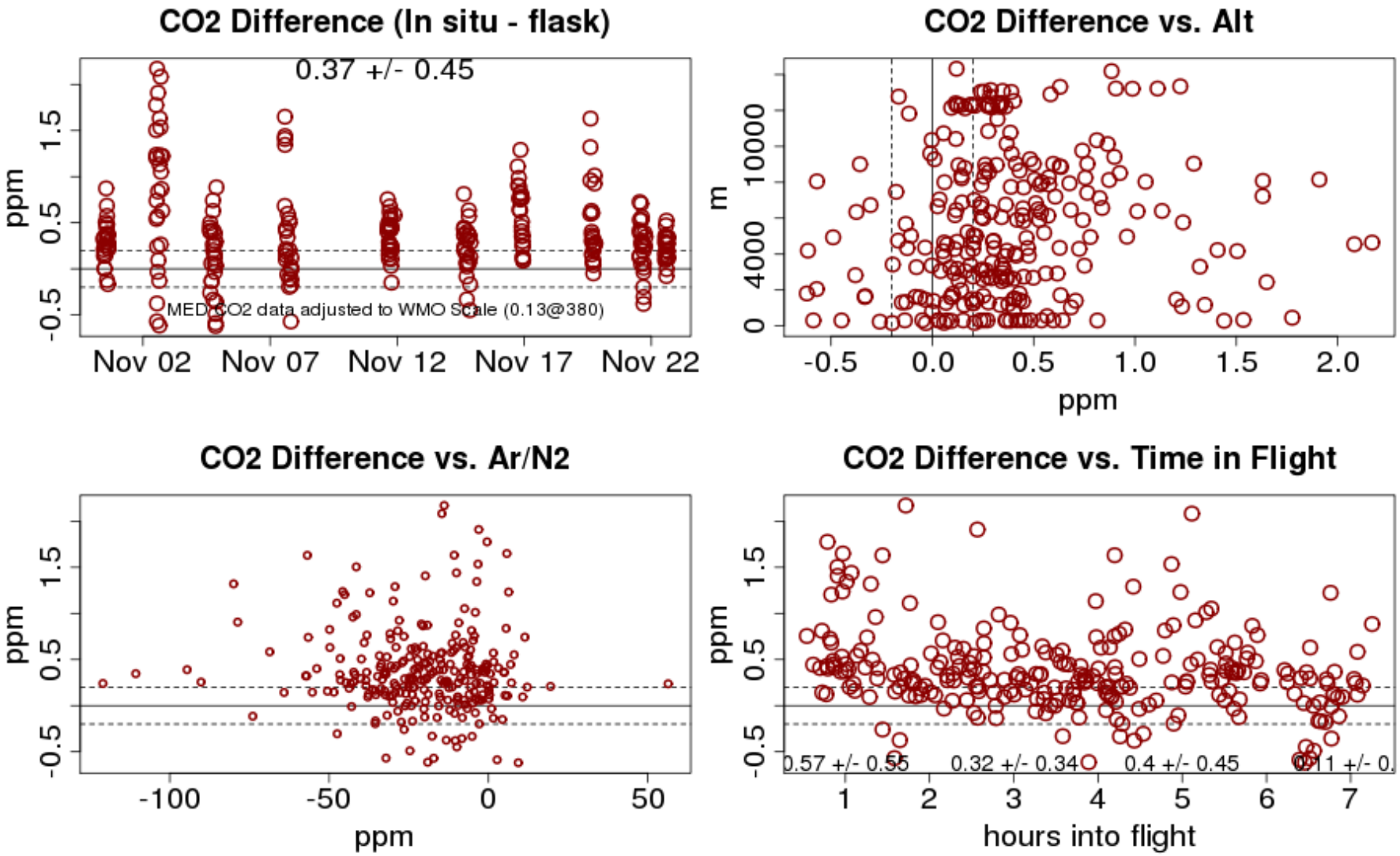

CO2 Difference (In situ - flask)
0.14 +/- 0.44
MED CO2 data adjusted to WMO Scale (0.13@380)
ppm
Jan 11
Jan 16
Jan 21
Jan 26


CO2 Difference vs. Alt
m
ppm

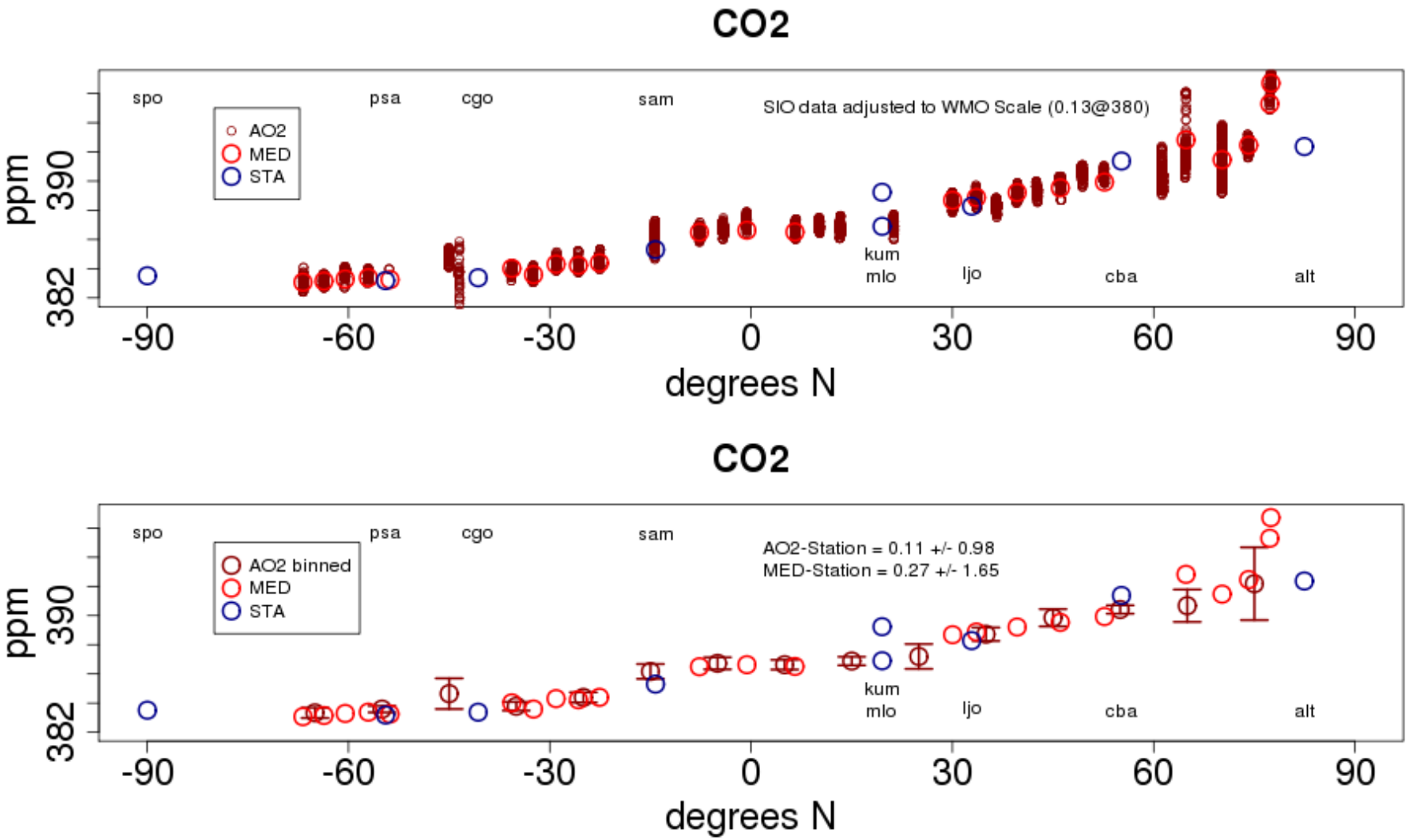

CO2 Difference vs. Ar/N2
ppm
ppm


CO2 Difference vs. Time in Flight
ppm
0.24 +/- 0.35
0.14 +/- 0.22
0.1 +/- 0.22
hours into flight

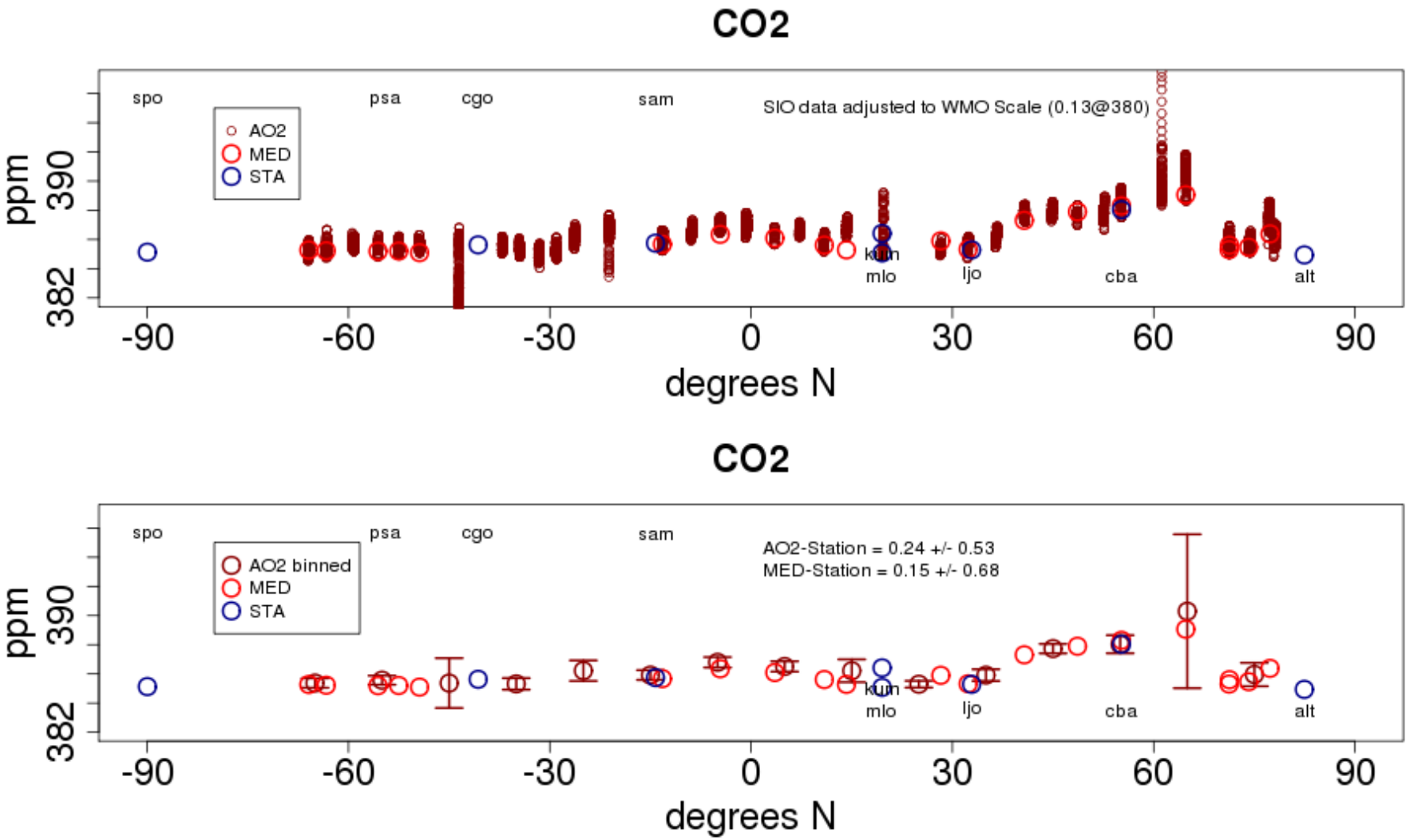
HIPPO2


CO2 Difference (In situ - flask)
0.37 +/- 0.45
MED CO2 data adjusted to WMO Scale (0.13@380)
ppm
-0.5
0.5
1.5
Nov 02
Nov 07
Nov 12
Nov 17
Nov 22
CO2 Difference vs. Alt
m
0
4000
10000
-0.5
0.0
0.5
1.0
1.5
2.0
ppm
CO2 Difference vs. Ar/N2
ppm
-0.5
0.5
1.5
-100
-50
0
50
ppm
CO2 Difference vs. Time in Flight
ppm
-0.5
0.5
1.5
0.57 +/- 0.55
0.32 +/- 0.34
0.4 +/- 0.45
0.11 +/- 0.
1
2
3
4
5
6
7
hours into flight

HIPPO1 Station Comparison

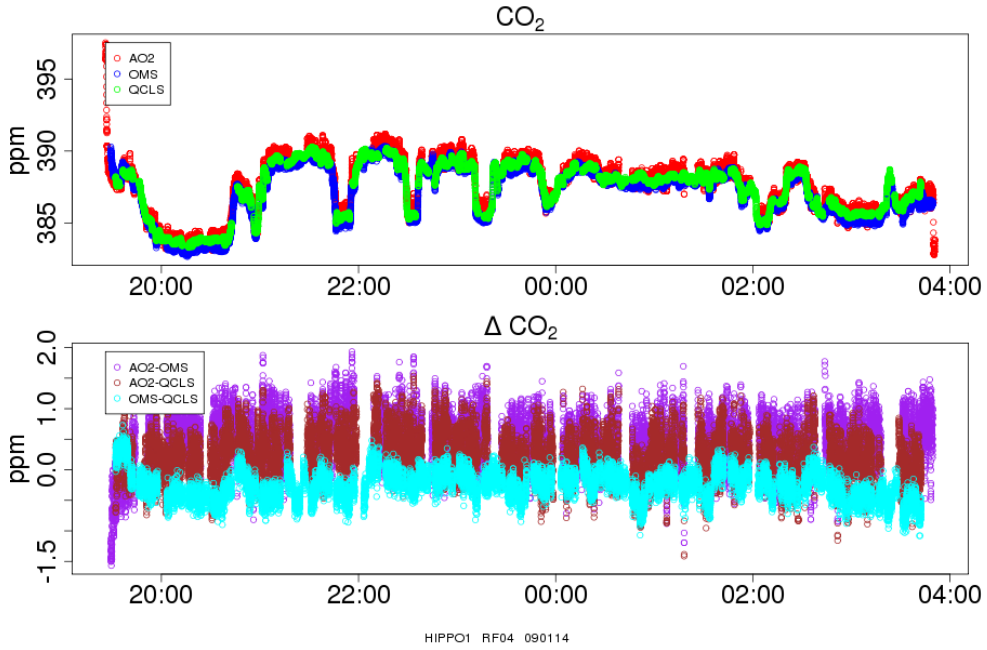


HIPPO2 Station Comparison

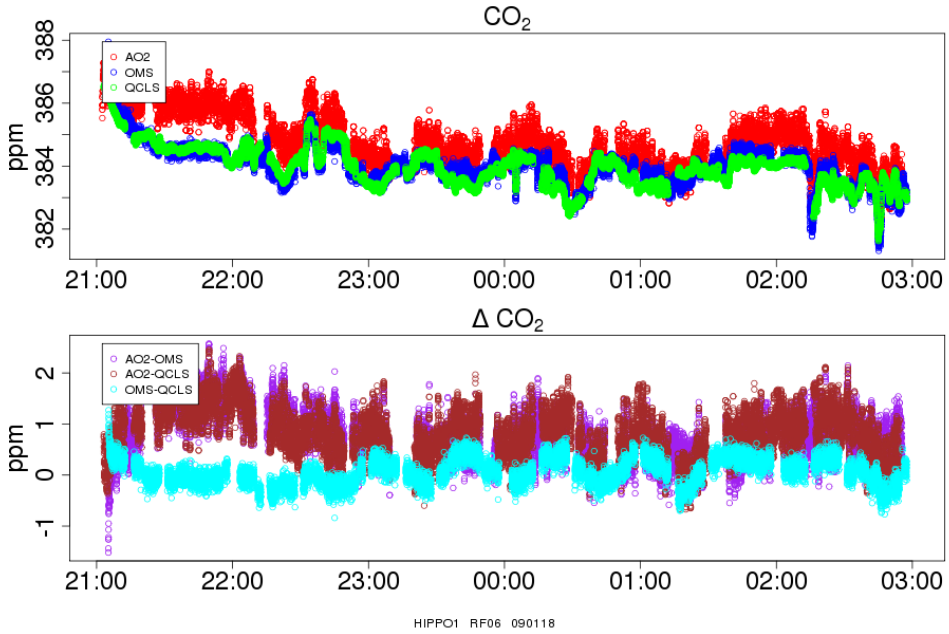


In-situ intercomparisons

HIPPO1 RF04

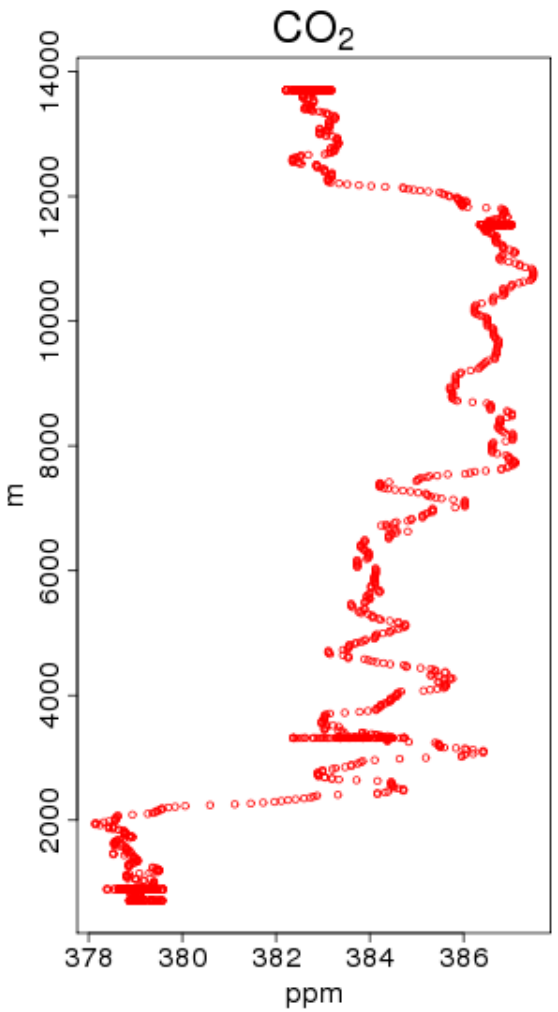


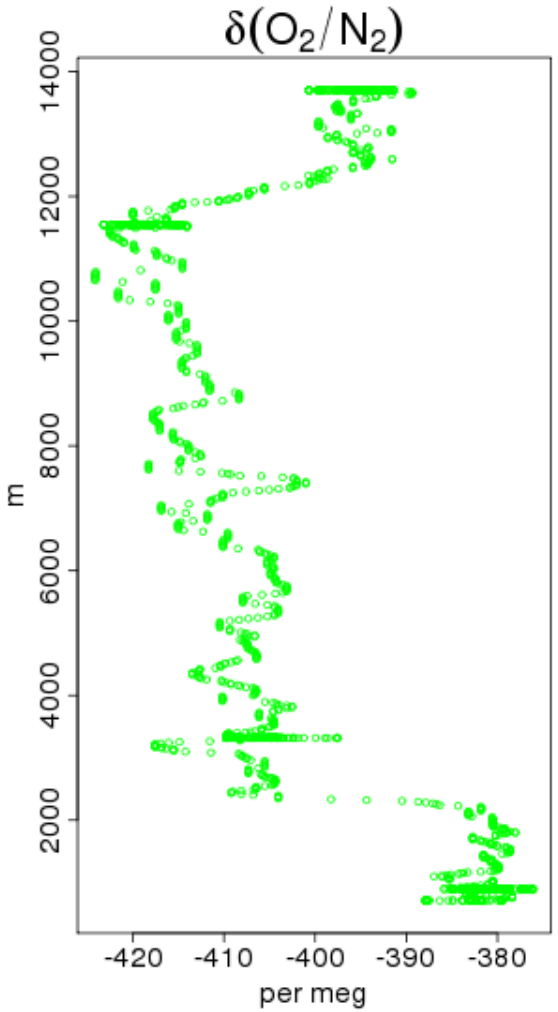
HIPPO1 RF06



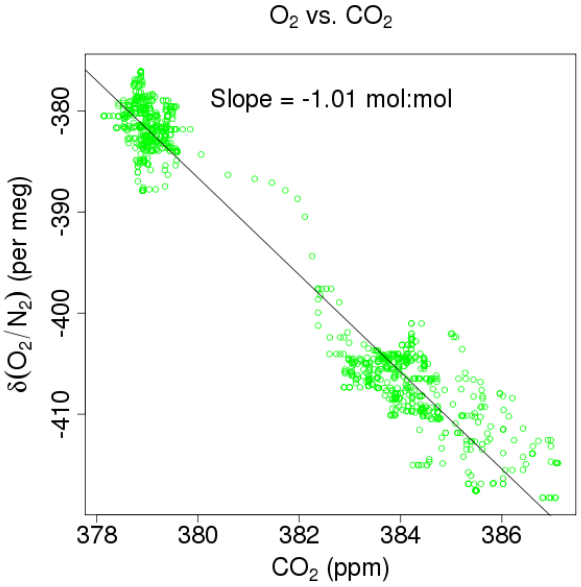
NCAR-HU Differences seem to have grown in most recent merge file

Descent into Grand Forks, ND



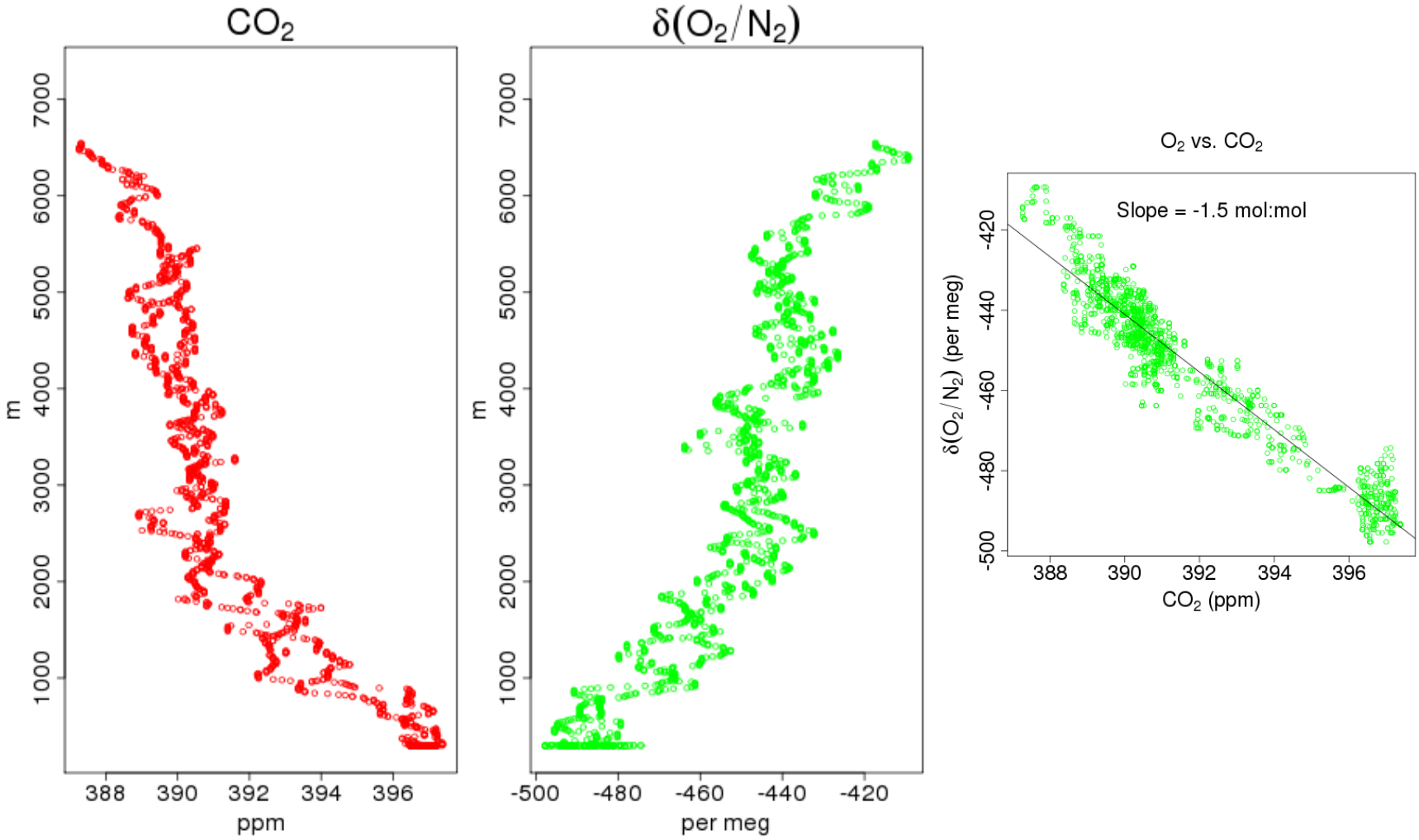


Boundary-layer transition



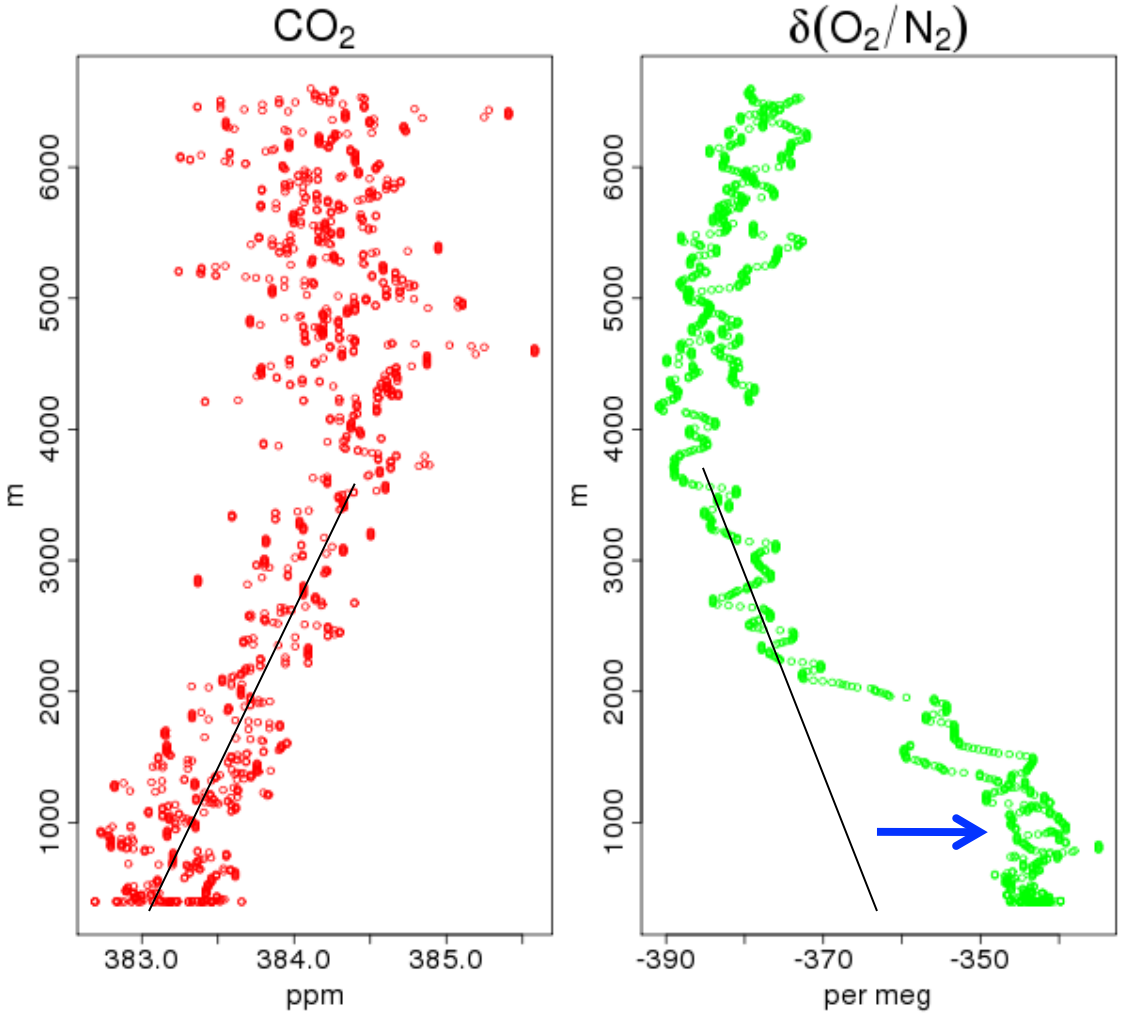
June 23, 2008 at 1600 LT

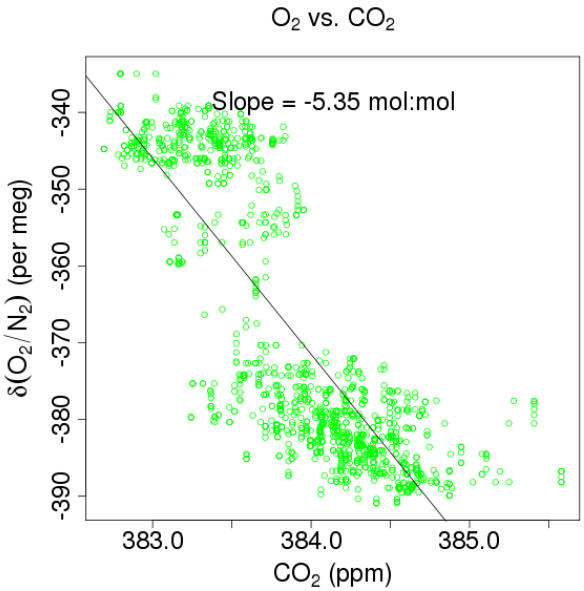
HIPPO1 AO2 Profiles at 80 N



January 12, 2009

HIPPO1 AO2 Profiles at 65 S

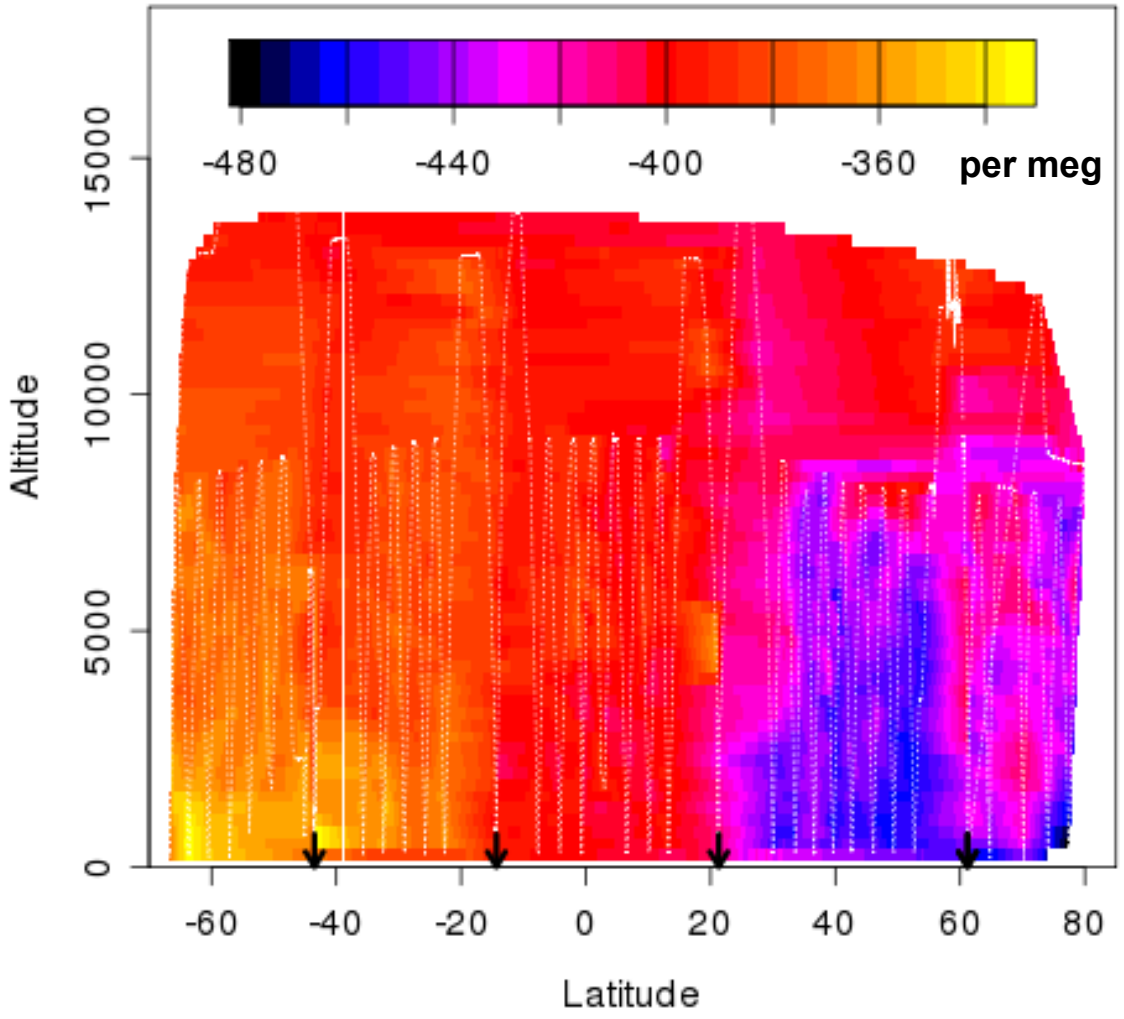




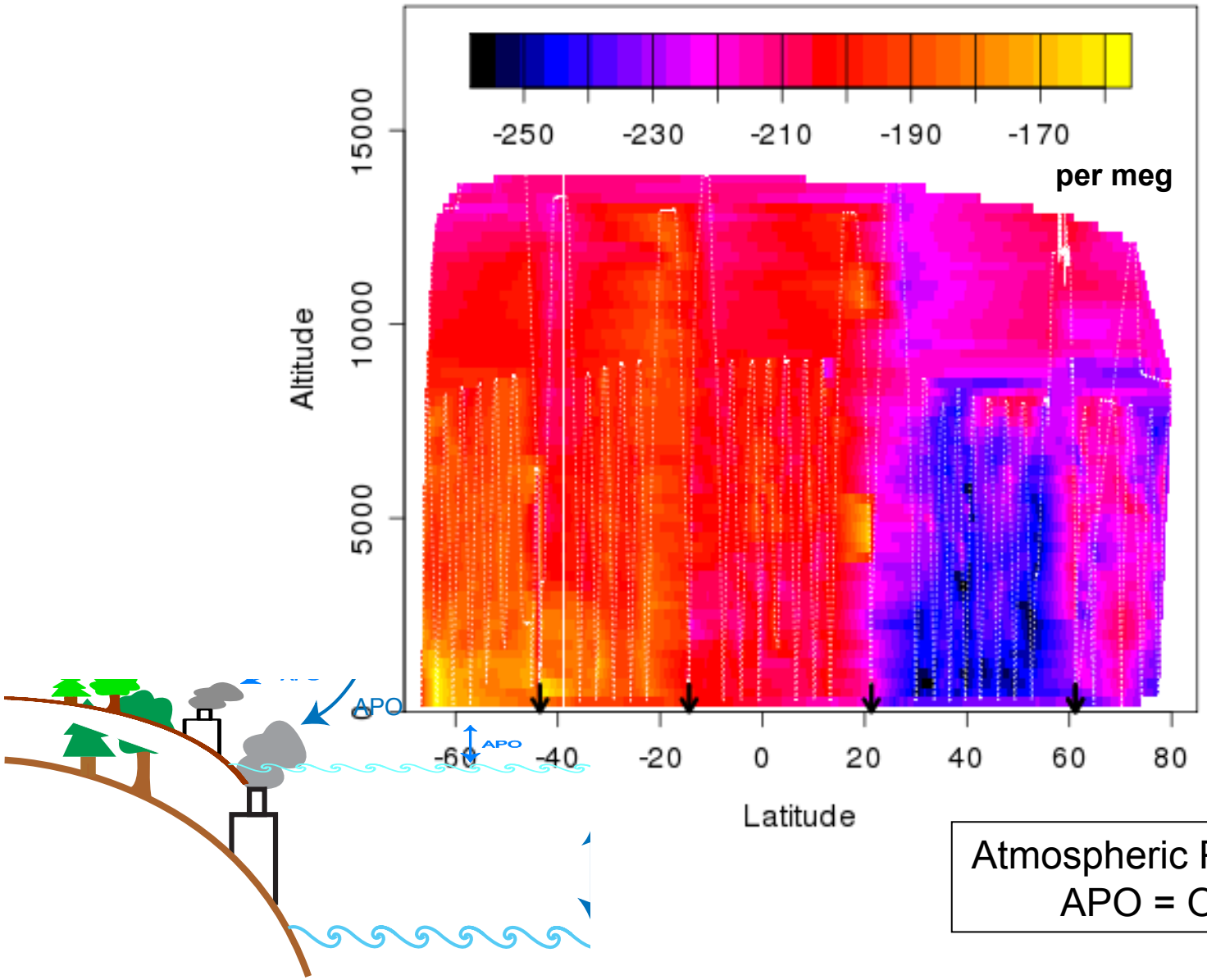
Southern Ocean
O_2 outgassing

January 20, 2009

O_2 Cross Section, January, 2009



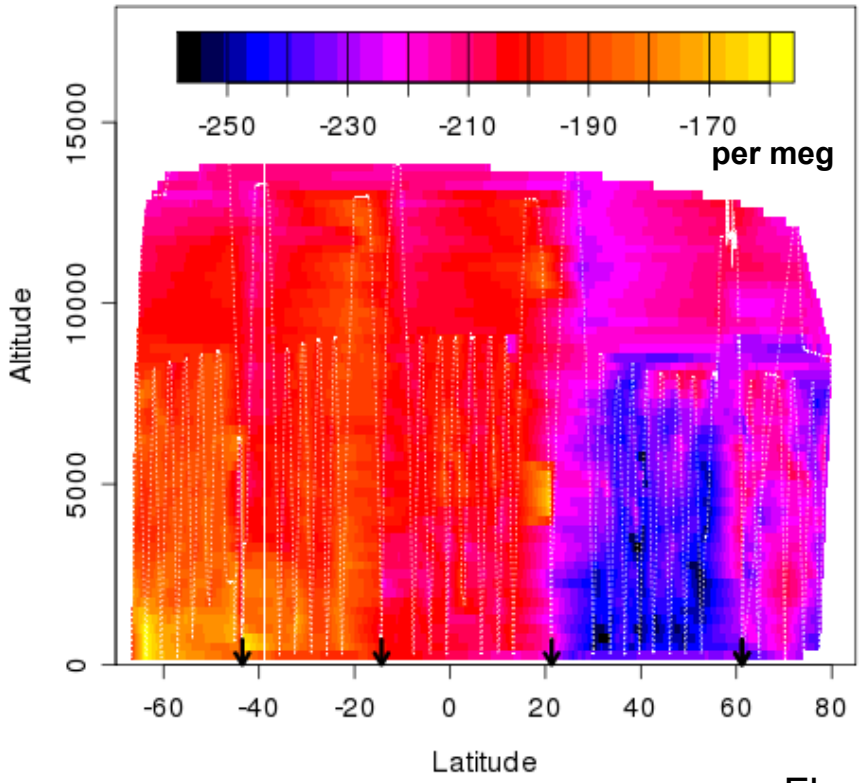
APO Cross Section, January, 2009



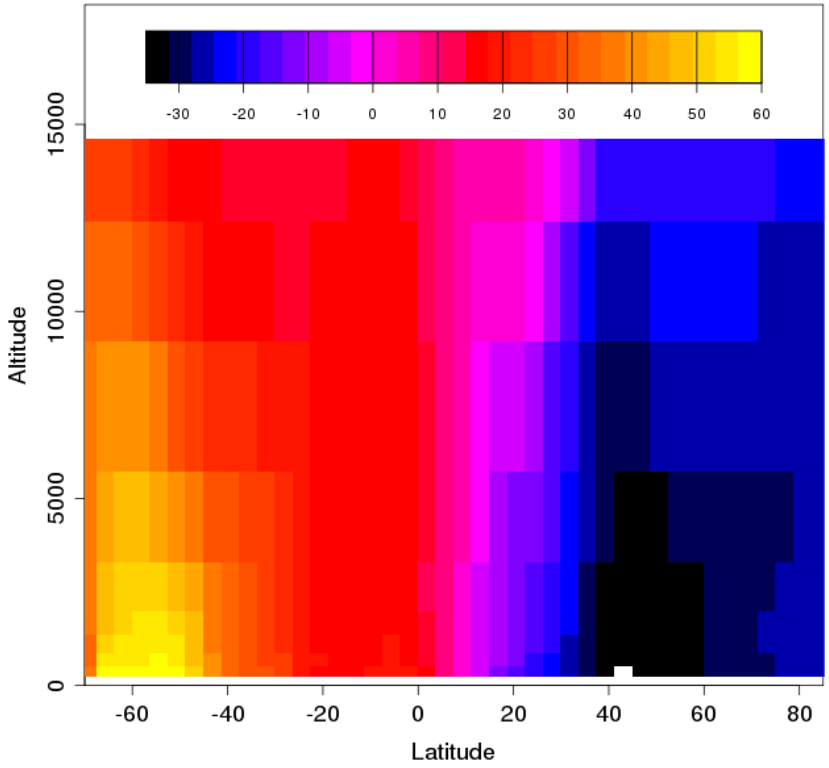
Atmospheric Potential Oxygen:
APO = O_2 + 1.1*CO_2

Preliminary APO comparison

HIPPO1 APO Observations



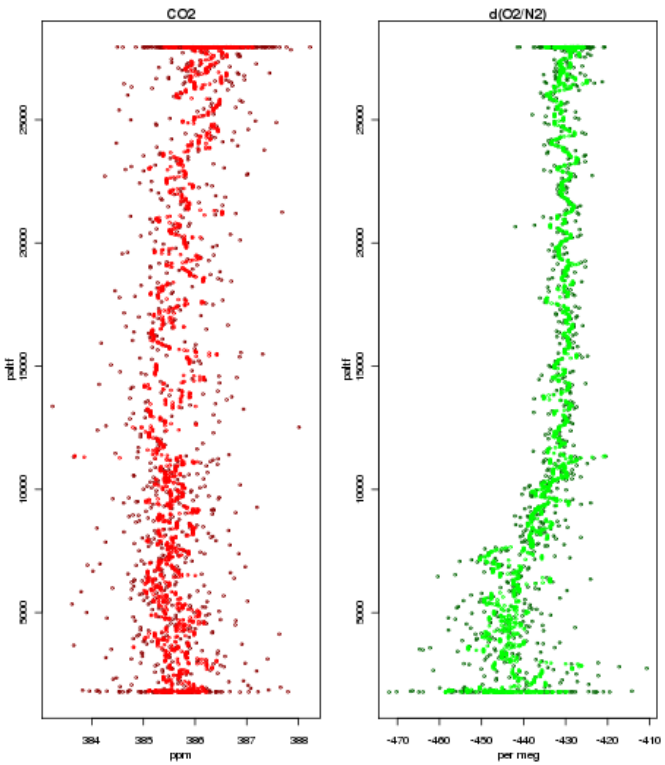
January Mean APO from Climatological fluxes in TM3



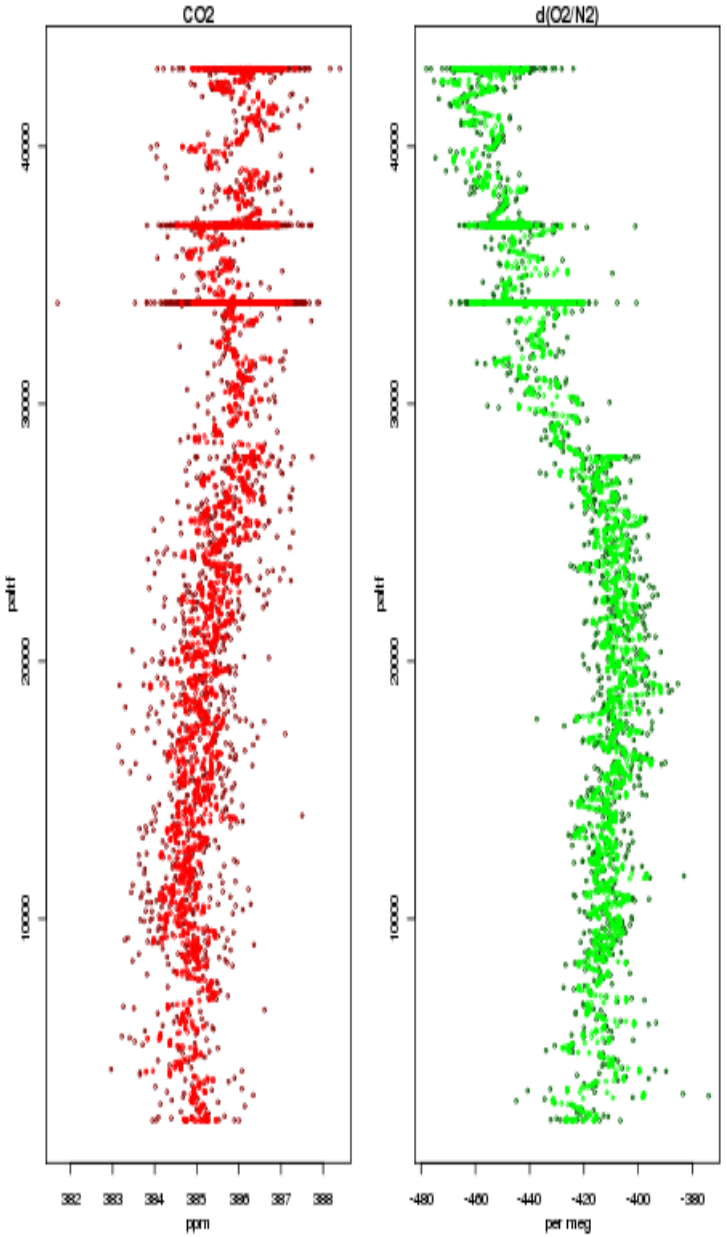
Fluxes:

Mean ocean O_2: Gruber et al., 2001
Seasonal ocean O_2 and N_2: Garcia and Keeling, 2001
Mean ocean N_2: Gloor et al., 2001
Seasonal + mean ocean CO_2: Takahashi et al., 2009
Fossil-fuel CO_2 and O_2: CDIAC

HIPPO2 and HIPPO3 AO2 Profiles at 67 S

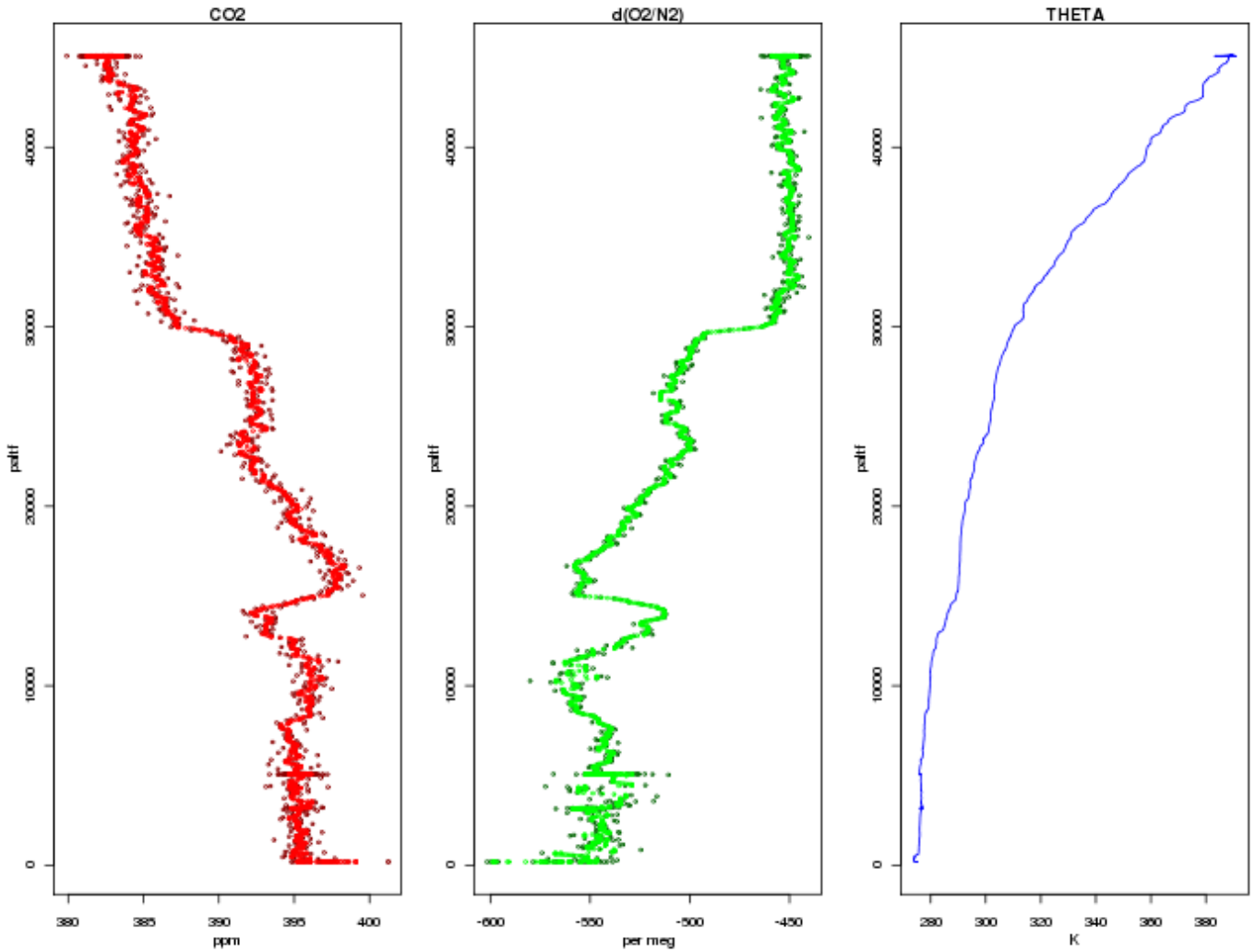


November 2009

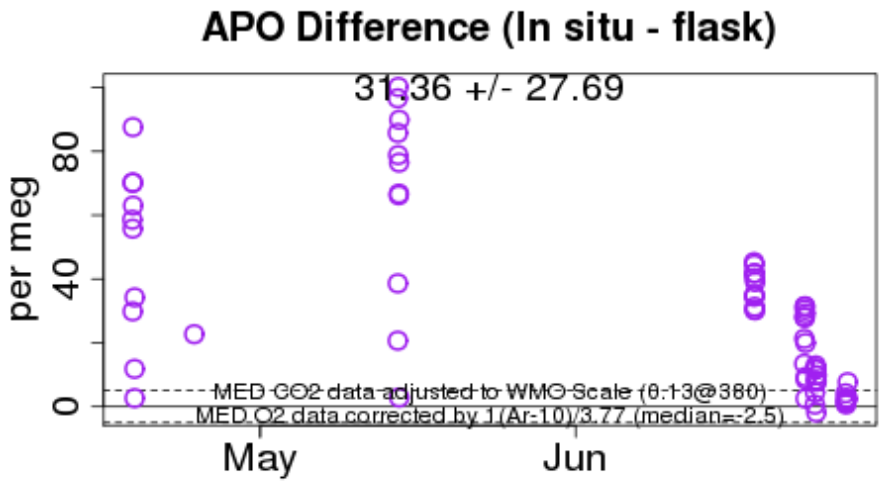


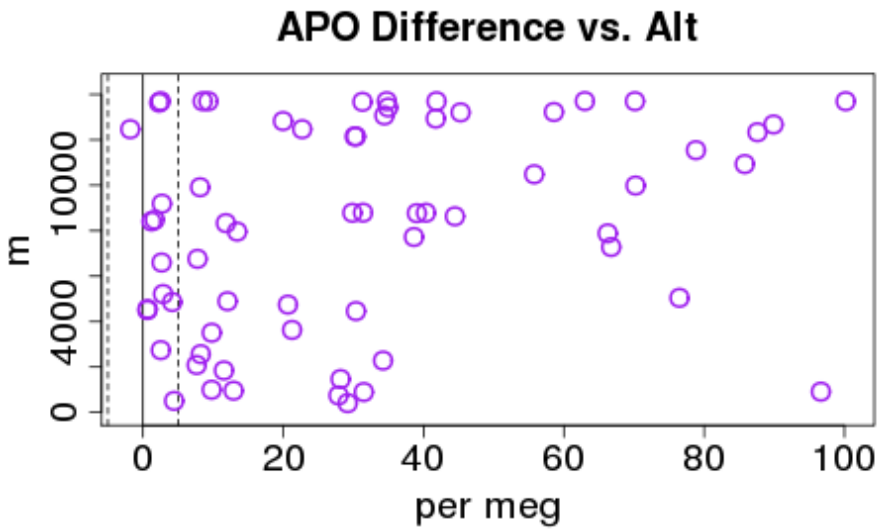
April 2010

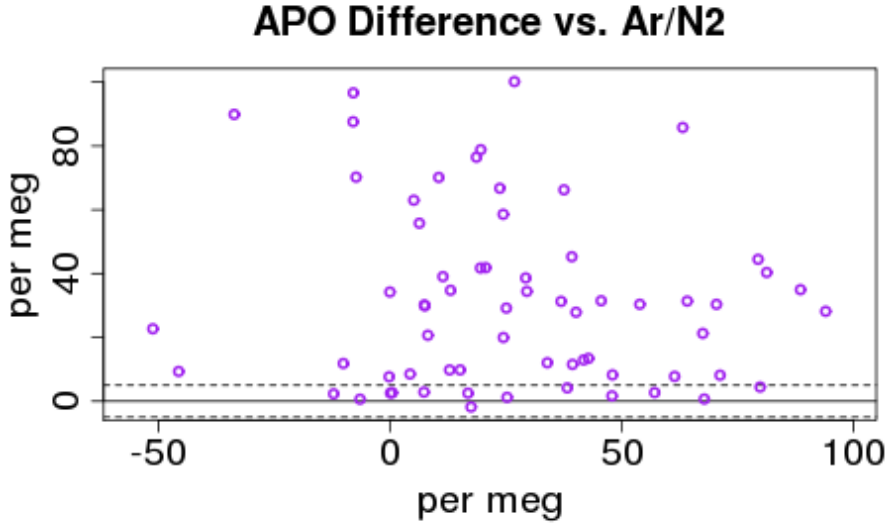
HIPPO 3 AO2 Profiles at 65 N

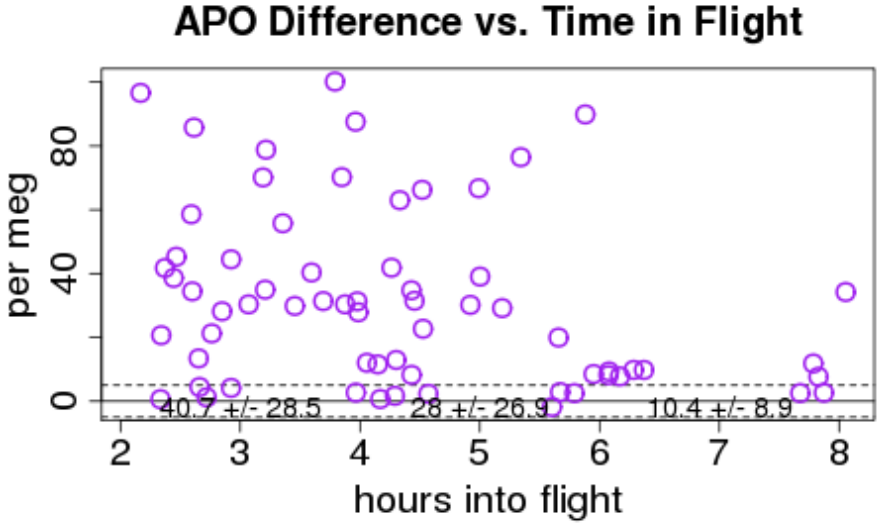


START-08

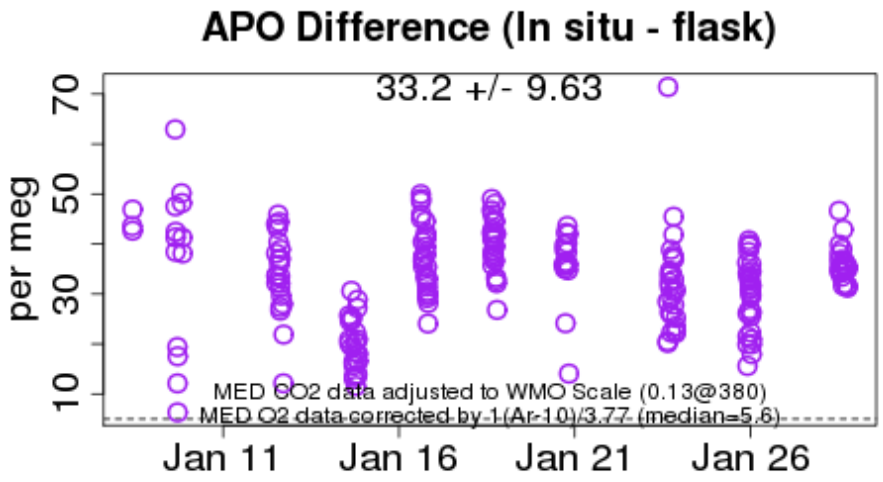

APO Difference (In situ - flask)
31.36 +/- 27.69
per meg
0
40
80
MED CO2 data adjusted to WMO Scale (0.13@380)
MED O2 data corrected by 1(Ar-10)/3.77 (median=-2.5)
May
Jun

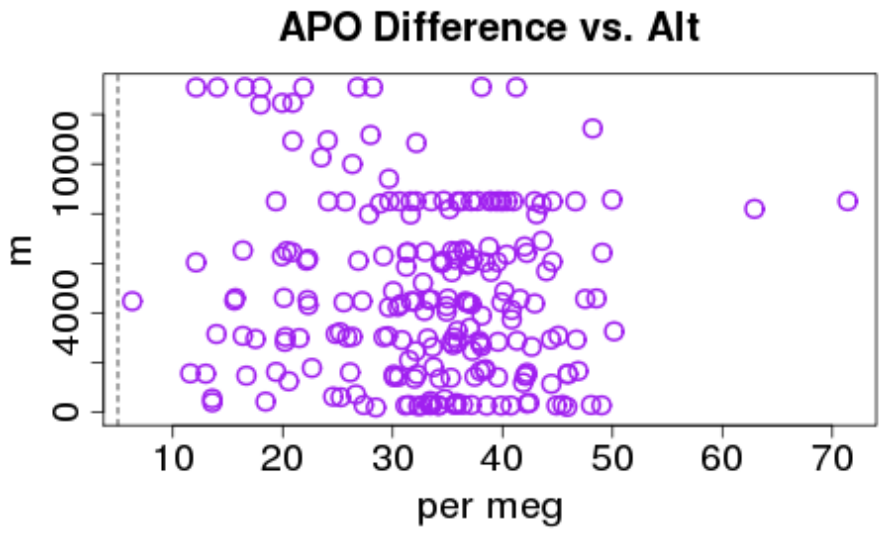

APO Difference vs. Alt
m
0
4000
10000
0
20
40
60
80
100
per meg

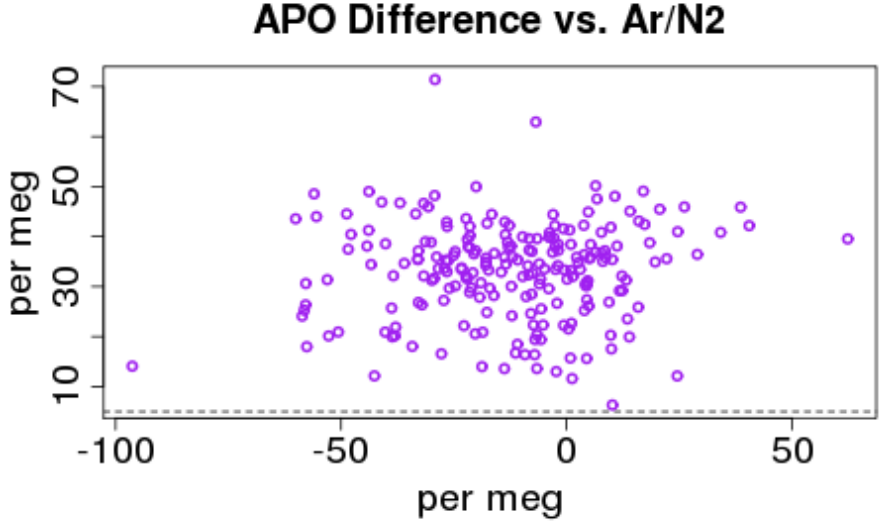

APO Difference vs. Ar/N2
per meg
0
40
80
-50
0
50
100
per meg

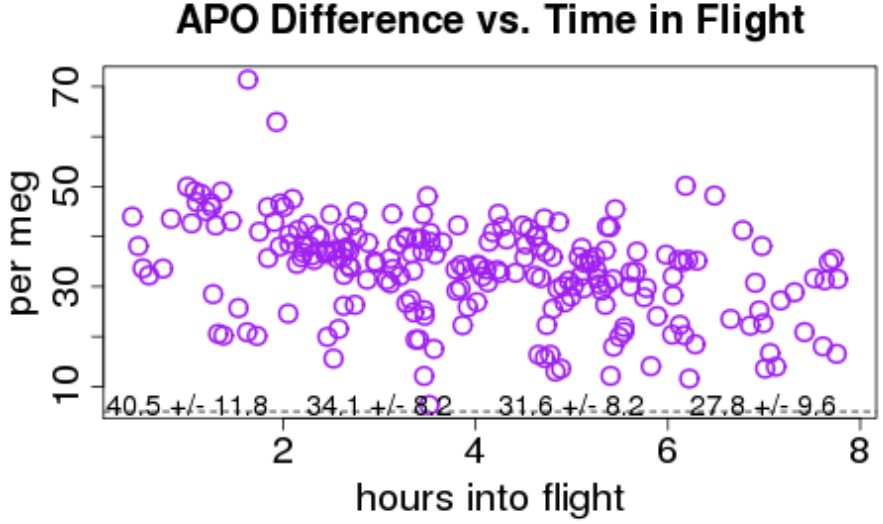

APO Difference vs. Time in Flight
per meg
0
40
80
40.7 +/- 28.5
28 +/- 26.9
10.4 +/- 8.9
2
3
4
5
6
7
8
hours into flight

HIPPO1

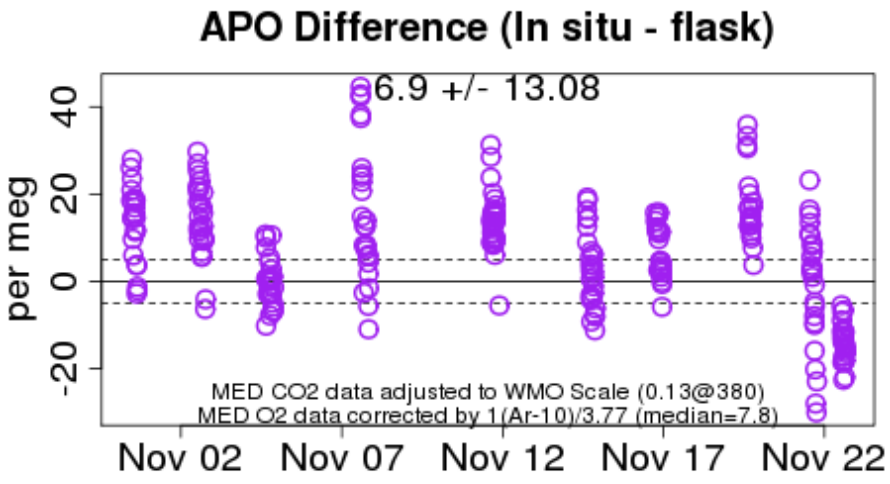

APO Difference (In situ - flask)
33.2 +/- 9.63
per meg
10
30
50
70
MED CO2 data adjusted to WMO Scale (0.13@380)
MED O2 data corrected by 1(Ar-10)/3.77 (median=5.6)
Jan 11
Jan 16
Jan 21
Jan 26

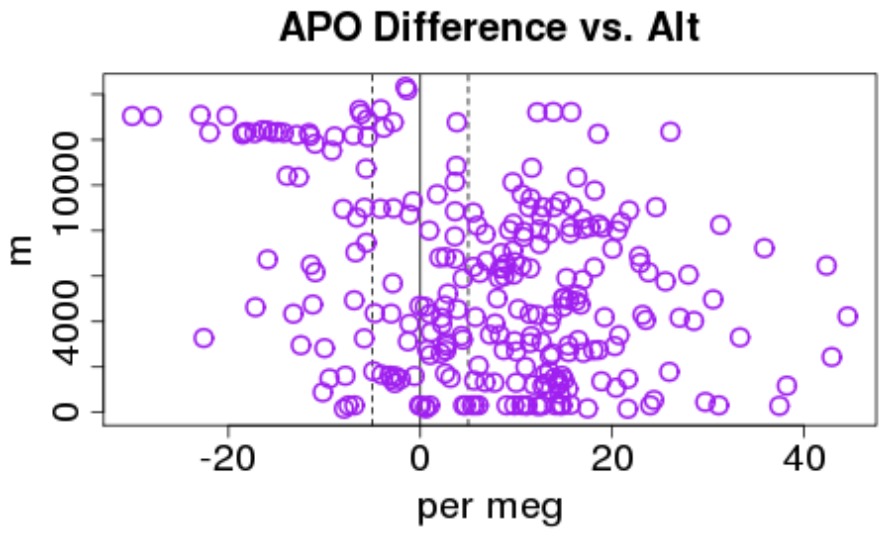

APO Difference vs. Alt
m
0
4000
10000
10
20
30
40
50
60
70
per meg

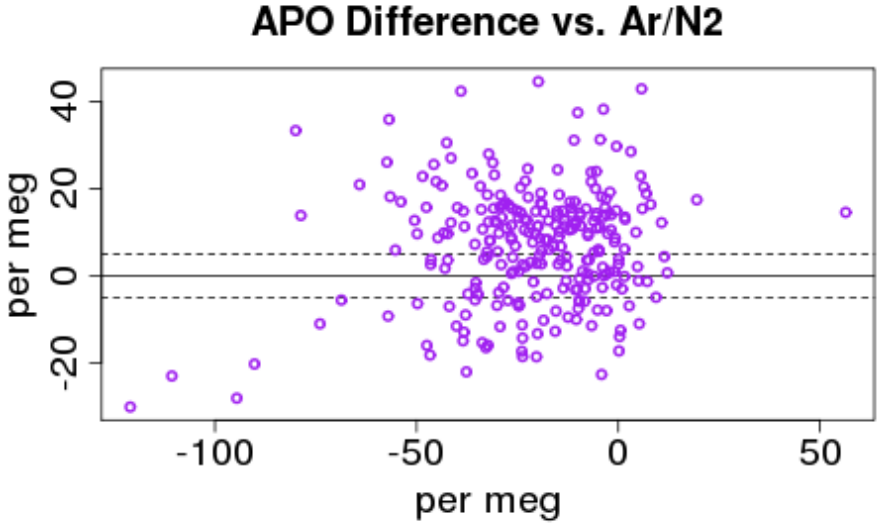

APO Difference vs. Ar/N2
per meg
10
30
50
70
-100
-50
0
50
per meg

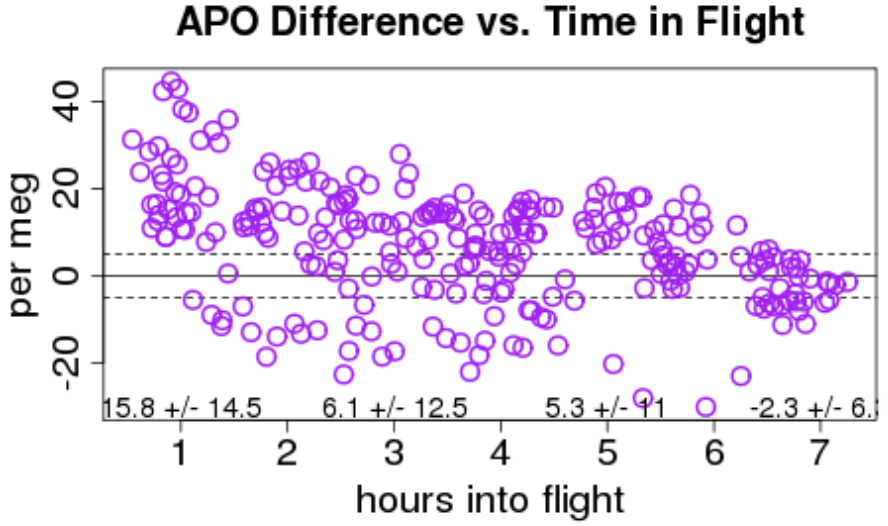

APO Difference vs. Time in Flight
per meg
10
30
50
70
40.5 +/- 11.8
34.1 +/- 8.2
31.6 +/- 8.2
27.8 +/- 9.6
2
4
6
8
hours into flight

HIPPO2

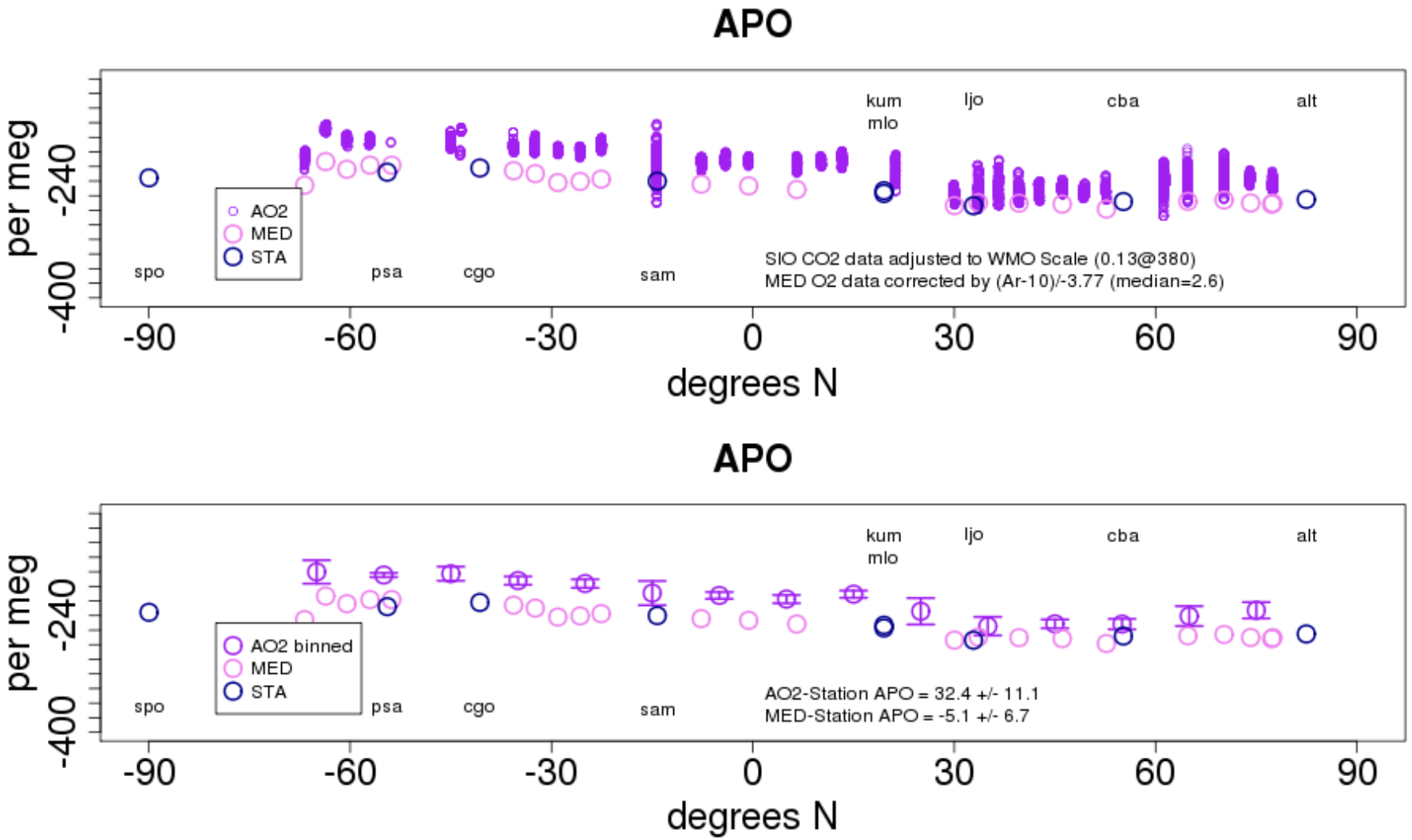

APO Difference (In situ - flask)
6.9 +/- 13.08
per meg
40
20
0
-20
MED CO2 data adjusted to WMO Scale (0.13@380)
MED O2 data corrected by 1(Ar-10)/3.77 (median=7.8)
Nov 02
Nov 07
Nov 12
Nov 17
Nov 22


APO Difference vs. Alt
m
10000
4000
0
-20
0
20
40
per meg

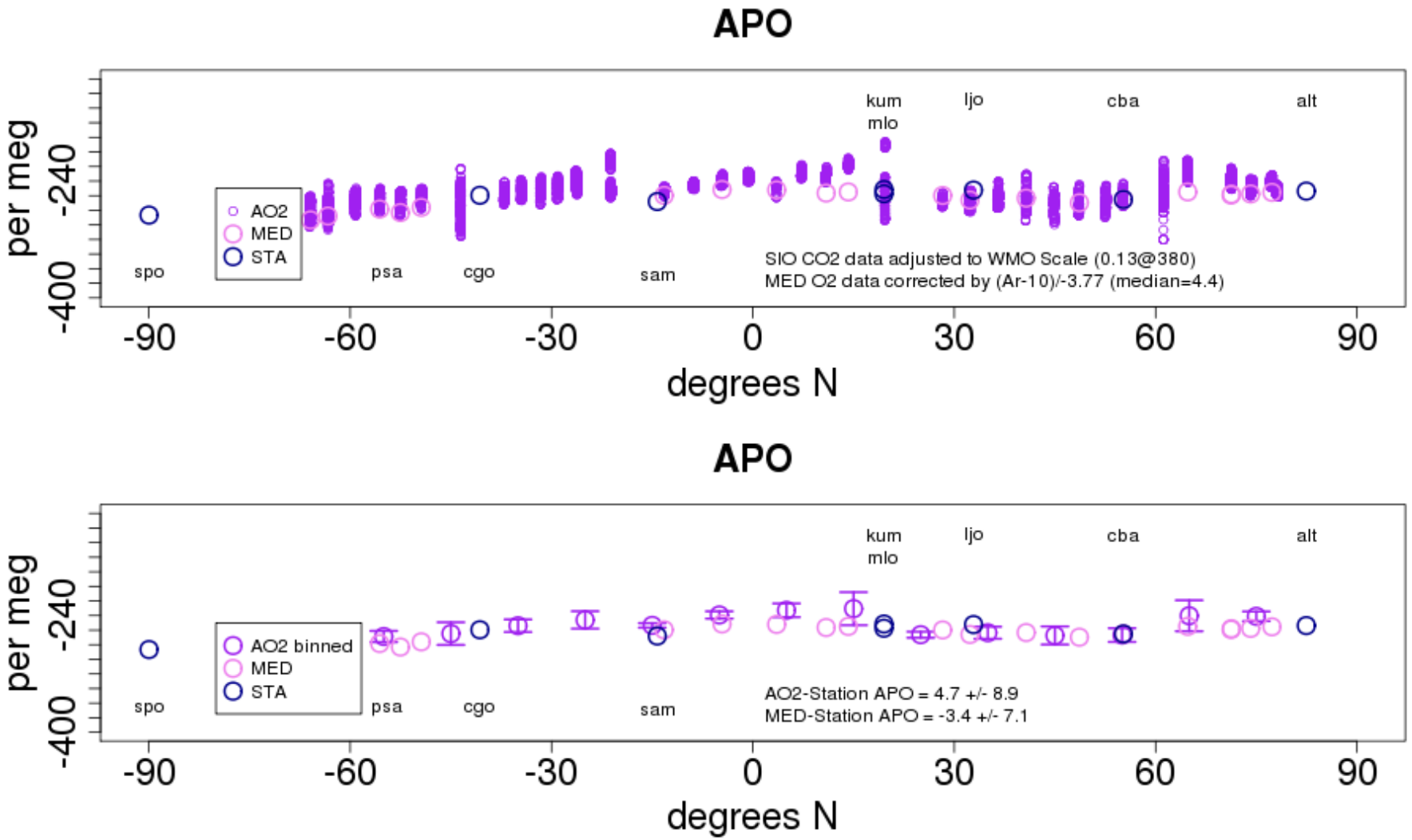

APO Difference vs. Ar/N2
per meg
40
20
0
-20
-100
-50
0
50
per meg


APO Difference vs. Time in Flight
per meg
40
20
0
-20
15.8 +/- 14.5
6.1 +/- 12.5
5.3 +/- 11
-2.3 +/- 6.
1
2
3
4
5
6
7
hours into flight

HIPPO1 Station Comparison

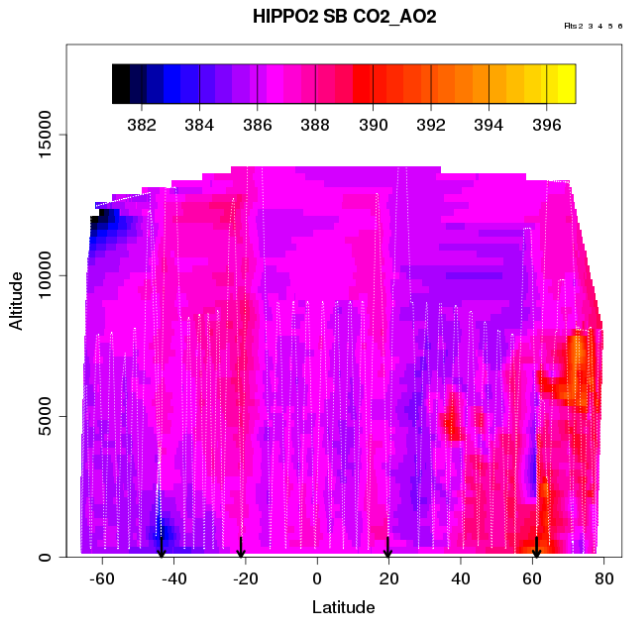


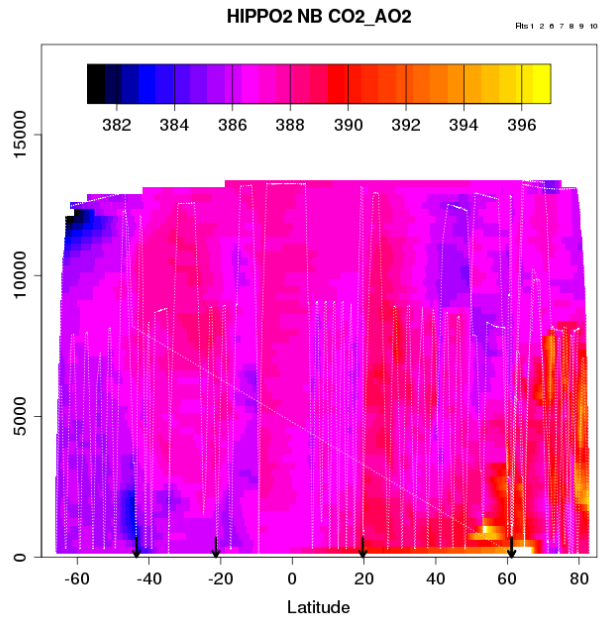
HIPPO2 Station Comparison

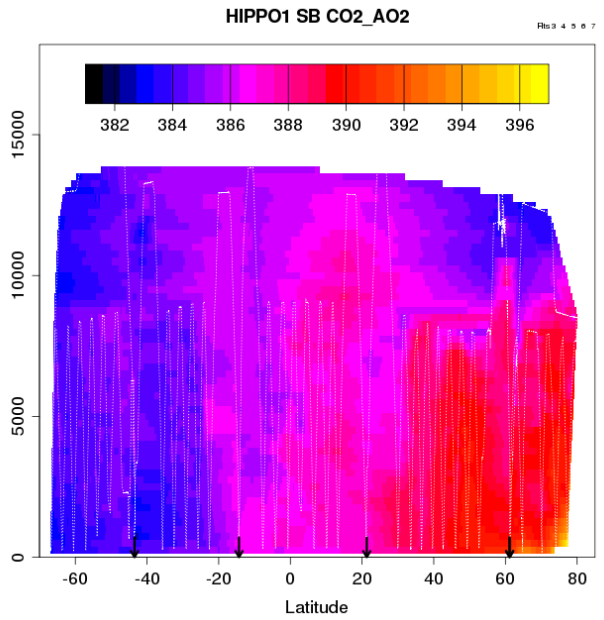


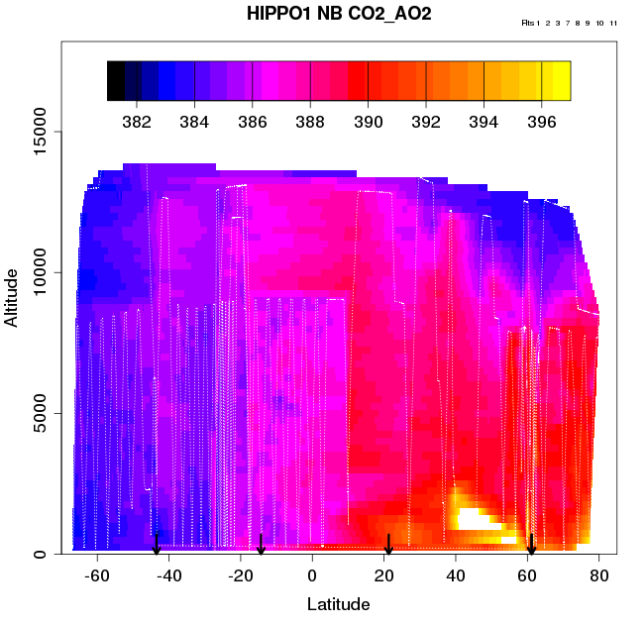
Data Summary

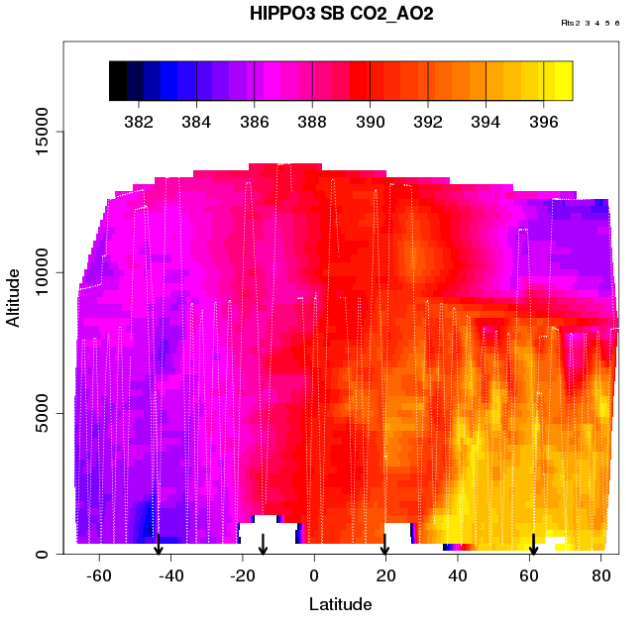
- HIPPO1 CO_2 scale offsets still exist, and some within flight calibration anomalies still to be resolved
- HIPPO2 CO_2 differences still to be investigated
- Inlet-humidity effect on O_2 requires more data-mining and possibly laboratory research
- As an intermediate step, may report 2 versions of O2 data, with one adjusted to MEDUSA values

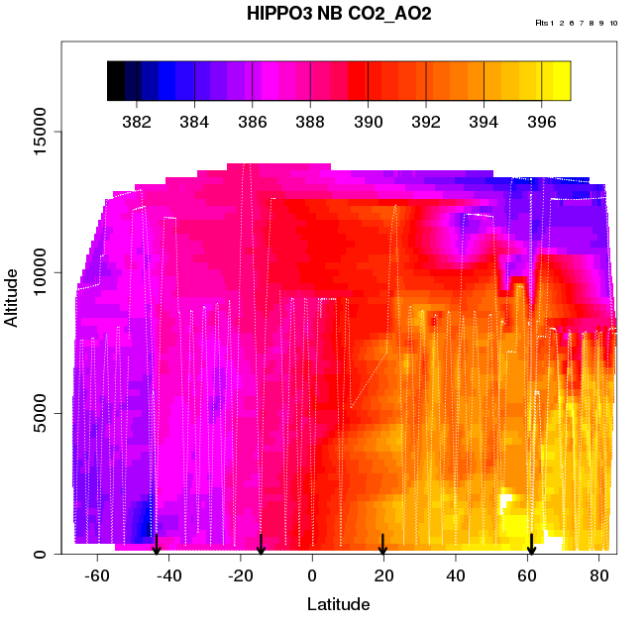

HIPPO2 SB CO2_AO2
382 384 386 388 390 392 394 396
Altitude
0 5000 10000 15000
-60 -40 -20 0 20 40 60 80
Latitude


HIPPO2 NB CO2_AO2
382 384 386 388 390 392 394 396
0 5000 10000 15000
-60 -40 -20 0 20 40 60 80
Latitude

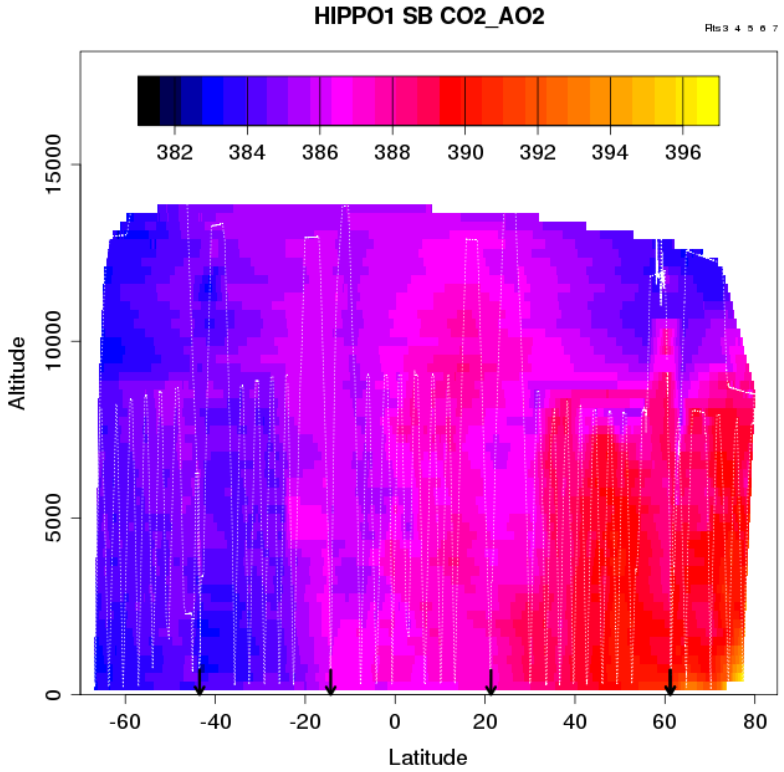

HIPPO1 SB CO2_AO2
382 384 386 388 390 392 394 396
0 5000 10000 15000
-60 -40 -20 0 20 40 60 80
Latitude

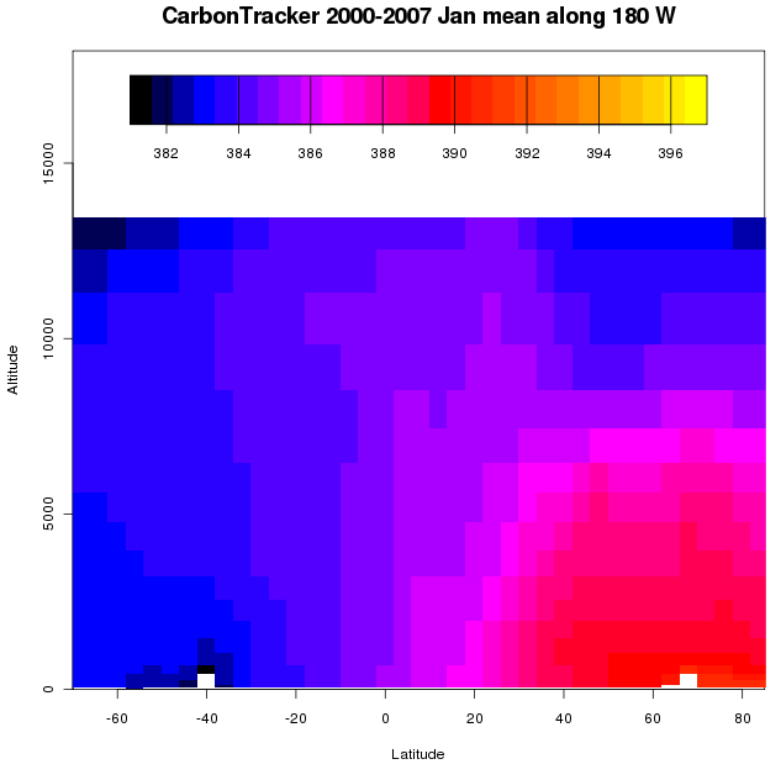

HIPPO1 NB CO2_AO2
382 384 386 388 390 392 394 396
Altitude
0 5000 10000 15000
-60 -40 -20 0 20 40 60 80
Latitude

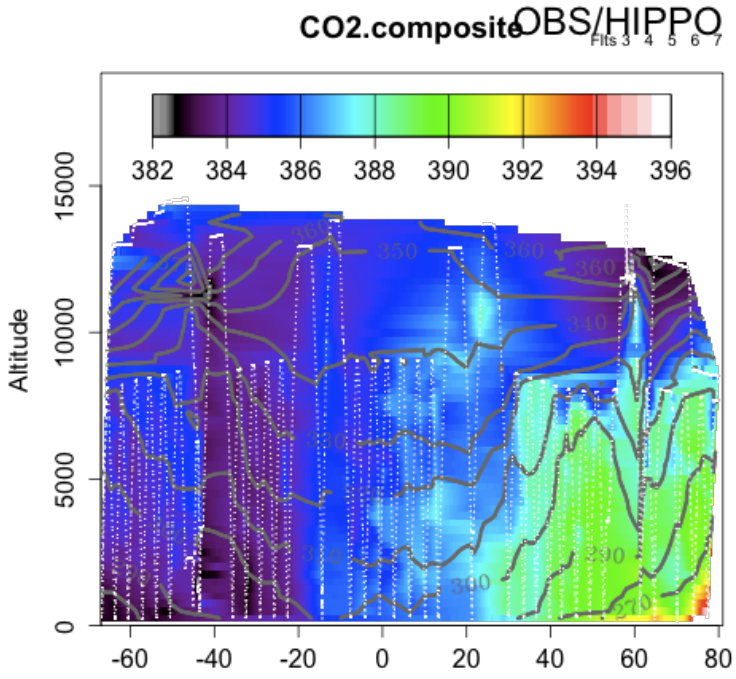

HIPPO3 SB CO2_AO2
382 384 386 388 390 392 394 396
Altitude
0 5000 10000 15000
-60 -40 -20 0 20 40 60 80
Latitude

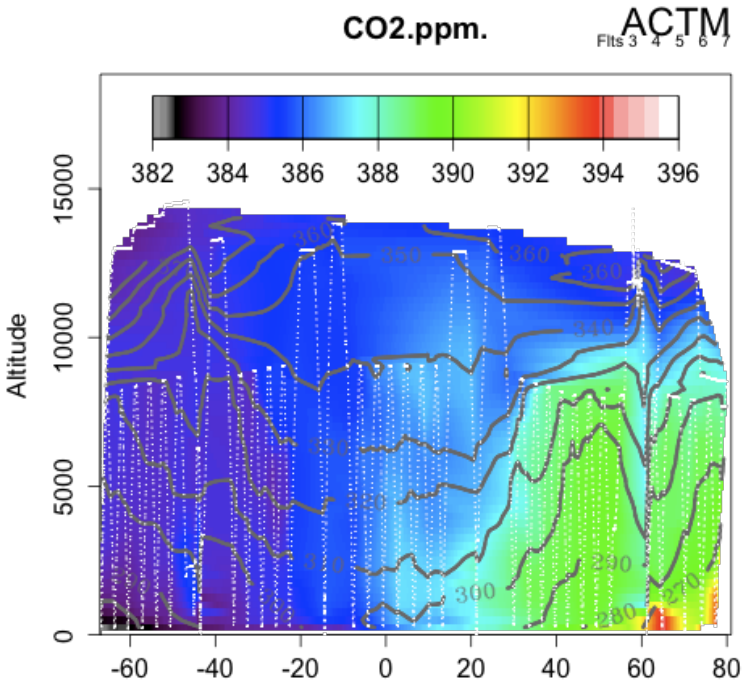

HIPPO3 NB CO2_AO2
382 384 386 388 390 392 394 396
Altitude
0 5000 10000 15000
-60 -40 -20 0 20 40 60 80
Latitude

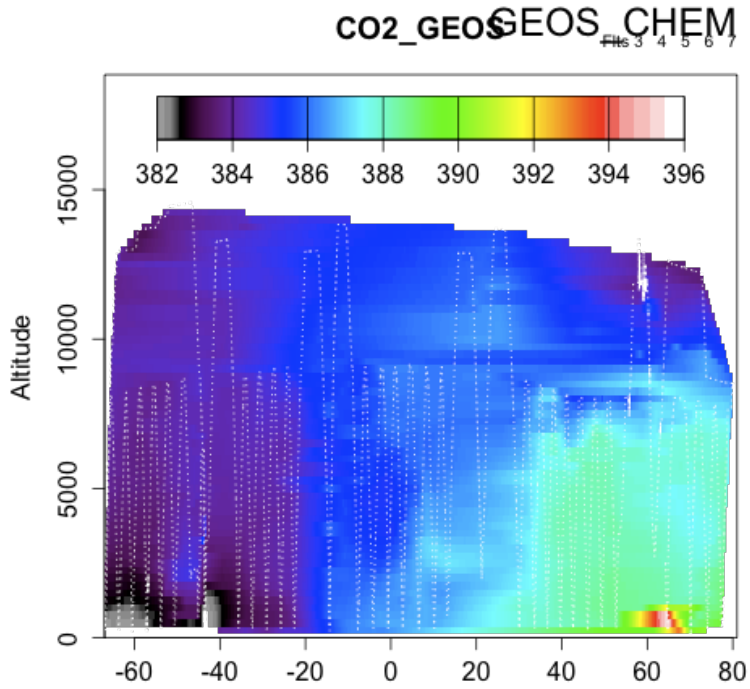
CarbonTracker Comparisons

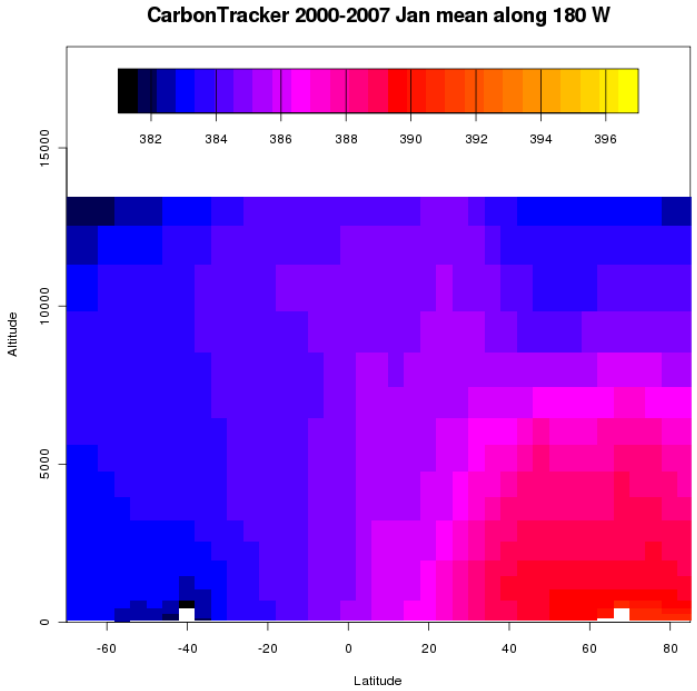





CO2.composite
OBS/HIPPO
Flts 3 4 5 6 7
382 384 386 388 390 392 394 396
Altitude
0 5000 10000 15000
-60 -40 -20 0 20 40 60 80


CO2.ppm.
ACTM
Flts 3 4 5 6 7
382 384 386 388 390 392 394 396
Altitude
0 5000 10000 15000
-60 -40 -20 0 20 40 60 80

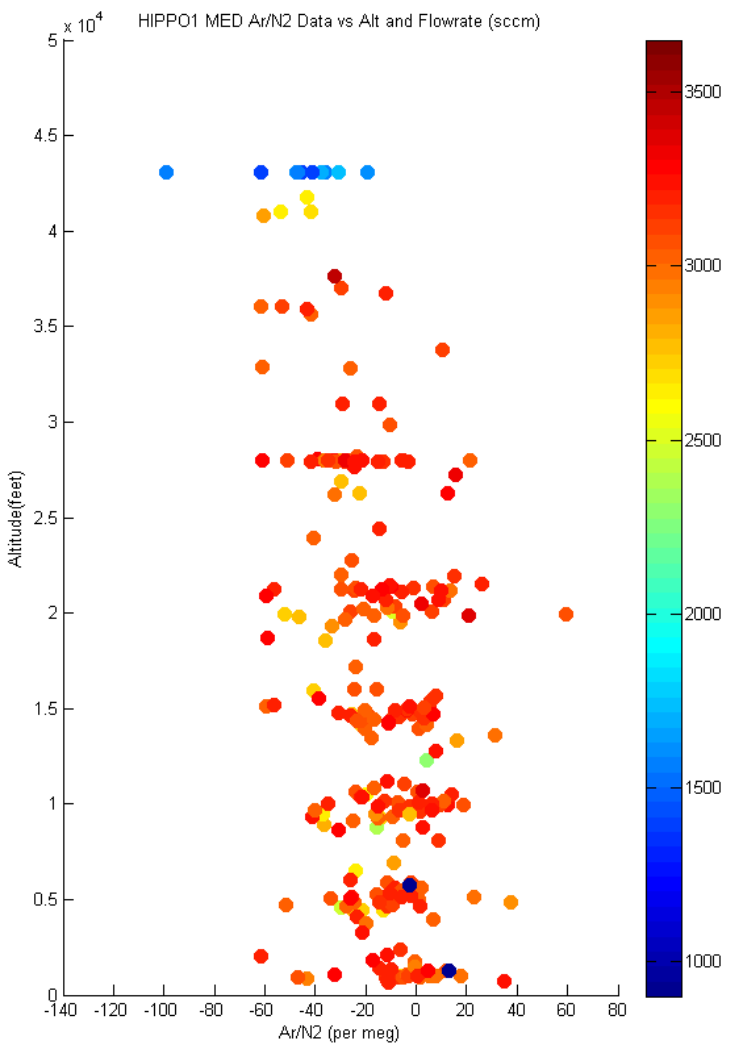

CO2_GEOS
GEOS_CHEM
Flts 3 4 5 6 7
382 384 386 388 390 392 394 396
Altitude
0 5000 10000 15000
-60 -40 -20 0 20 40 60 80

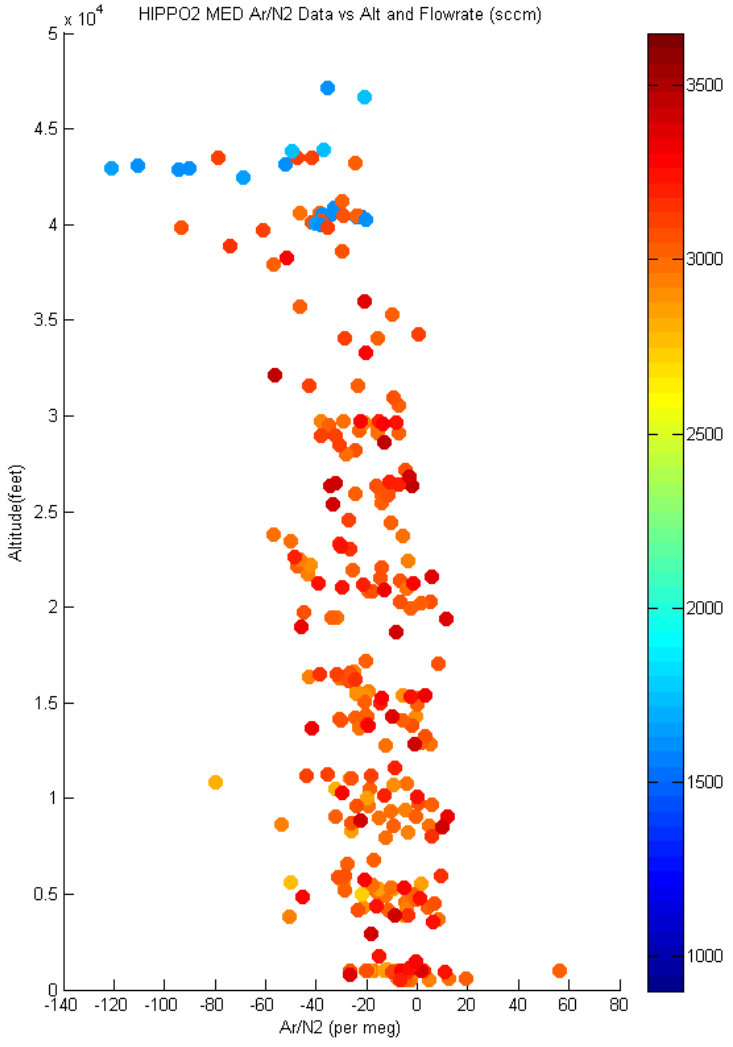

CarbonTracker 2000-2007 Jan mean along 180 W
382 384 386 388 390 392 394 396
Altitude
0 5000 10000 15000
-60 -40 -20 0 20 40 60 80
Latitude

Future work

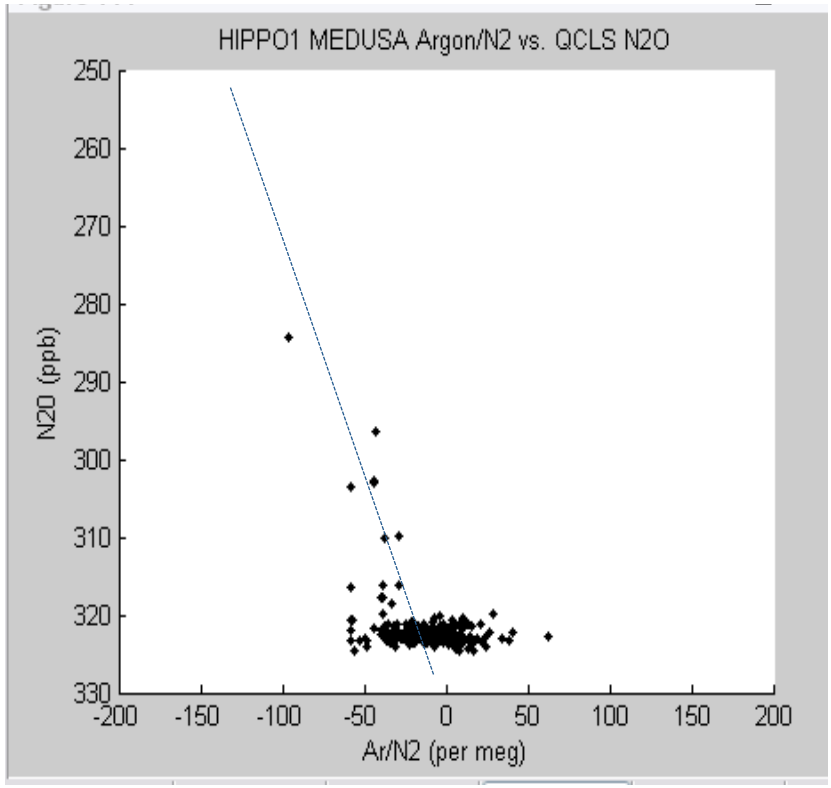
- More CO_2 and O_2 intercomparions
- More O_2 humidity-effect investigations
- Paper on AO2 instrument
- Paper(s) on stratospheric and tropospheric O_2 gradients and model comparisons
- Analyses of large-scale CO_2 gradients and model comparisons

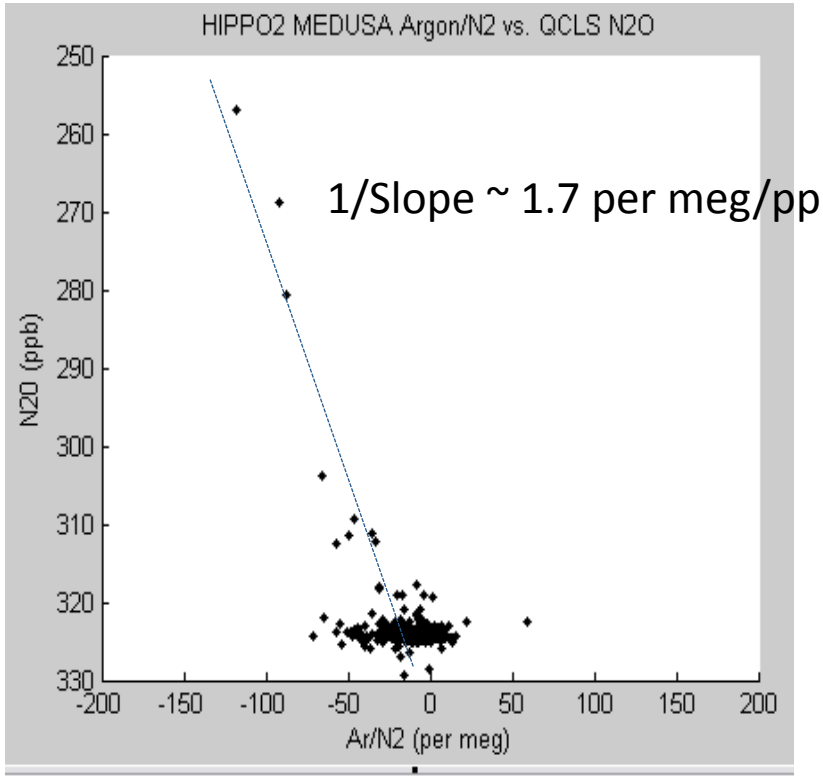
$\delta(Ar/N_2)$ versus elevation





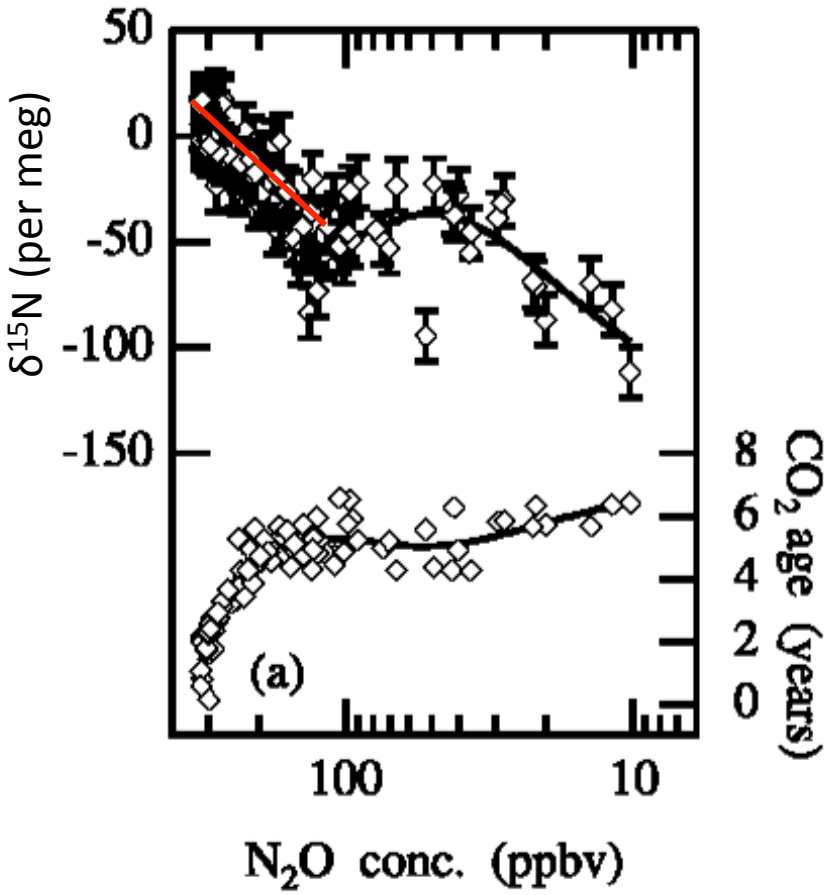
$\delta(Ar/N_2)$ versus N_2O





1/Slope ~ 1.7 per meg/ppb

Comparison to Ishidoya et al., 2008 GRL Vol. 35



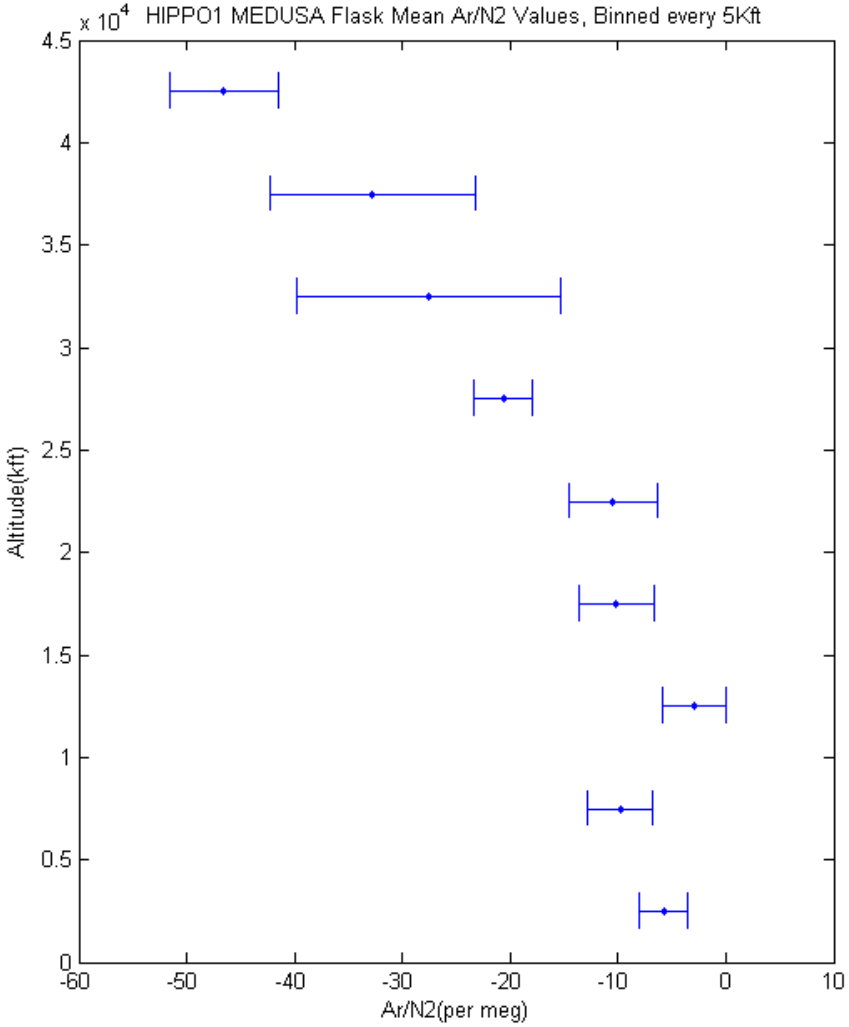
$\delta = A + B \log (N_2O)$
B = 105 per meg

At N_2O = 300 ppb, yields:
slope = 0.15 per meg/ppb

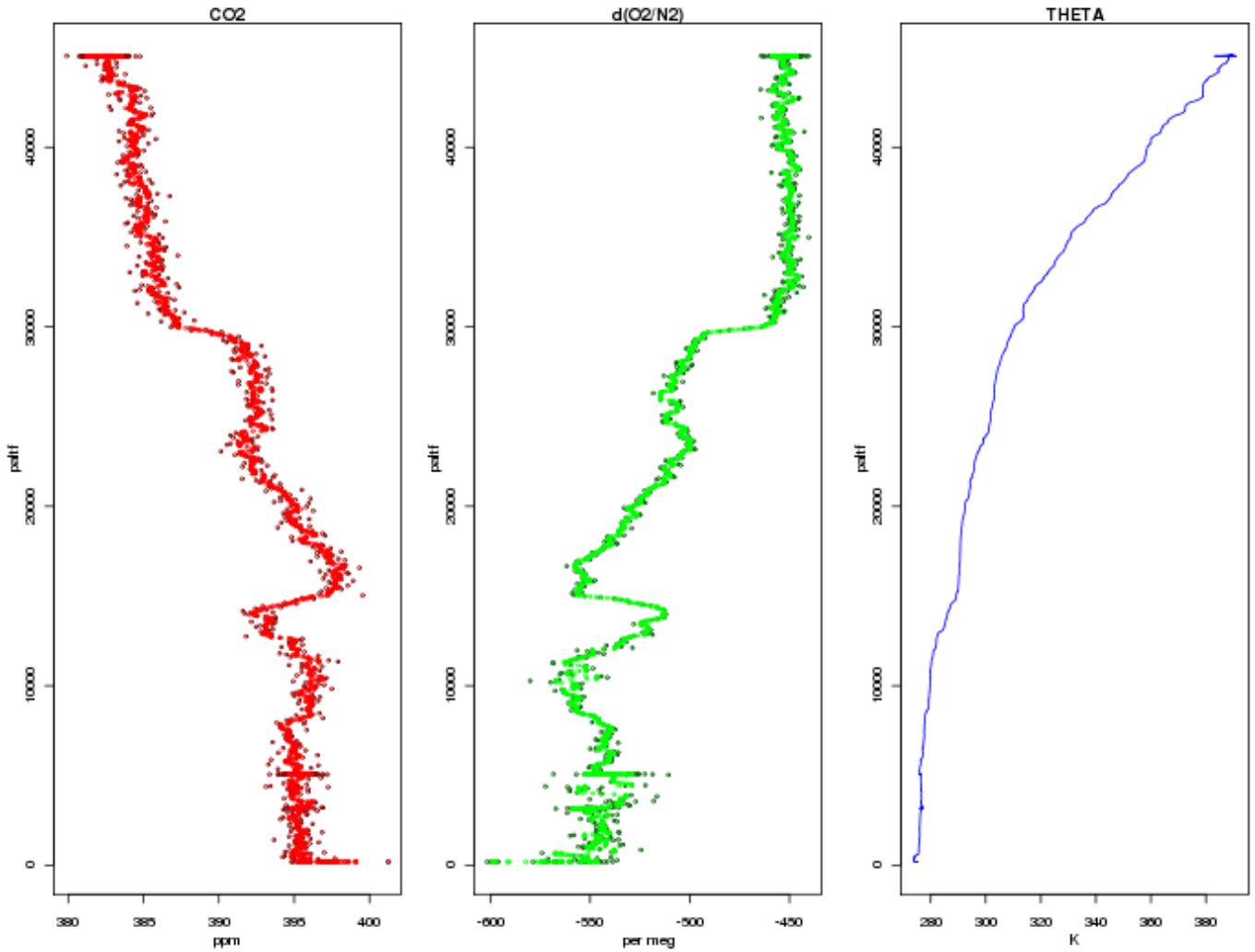
HIPPO on equivalent basis*:
1.7/12 = 0.14 per meg/ppb

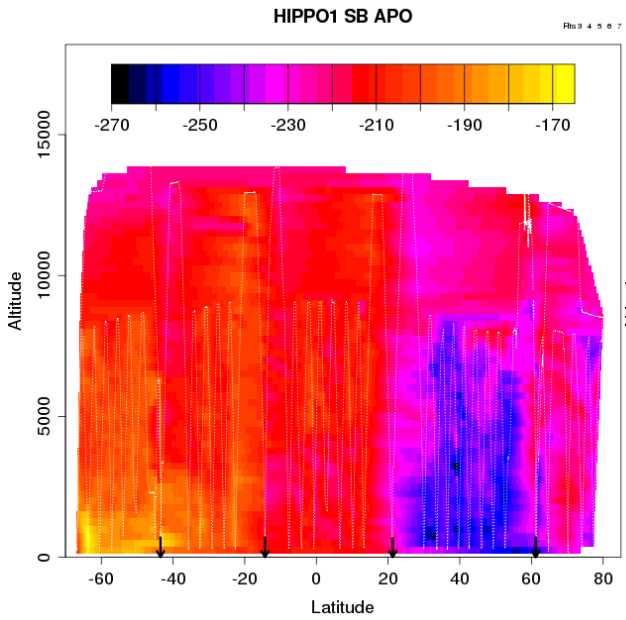
*Uses gravimetric scaling
$\Delta\delta^{15}N = \Delta\delta(Ar/N_2)/12$

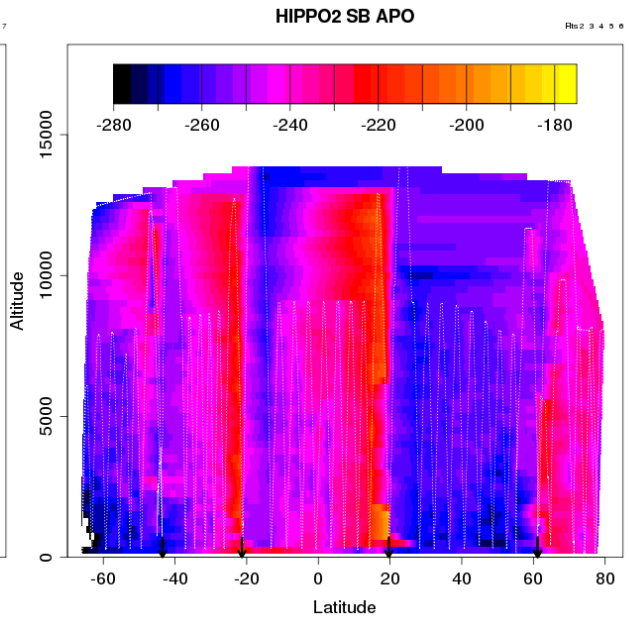
HIPPO1 Ar/N_2 Data

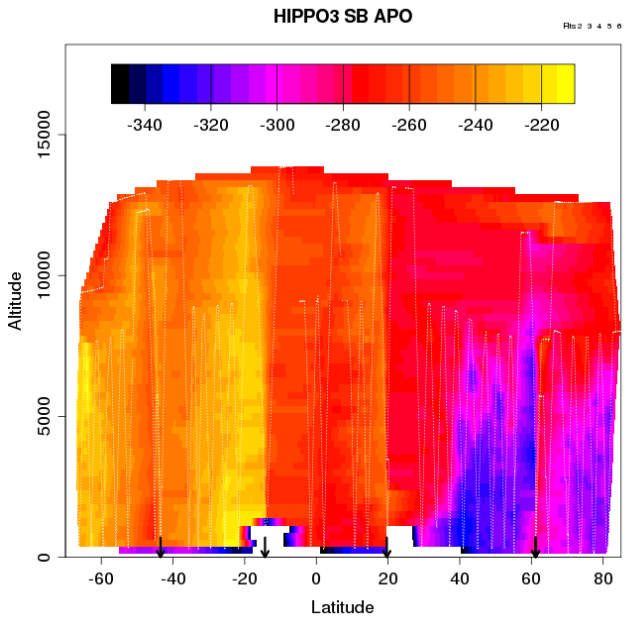


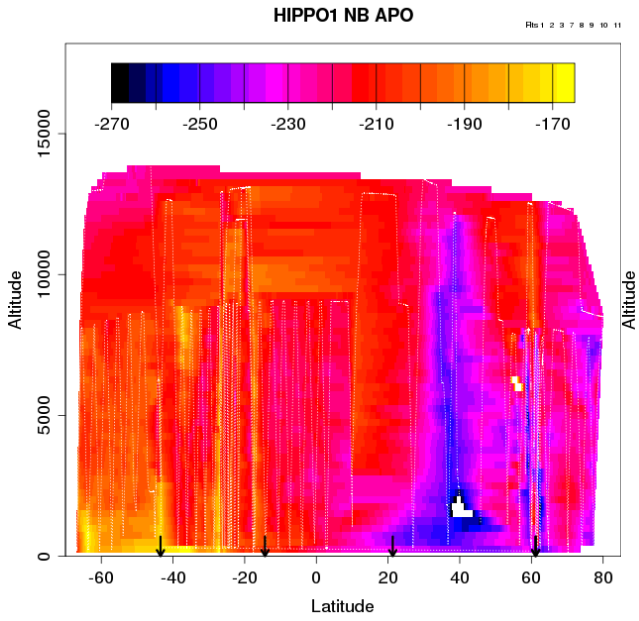
HIPPO 3 AO2 Profiles at 65 N

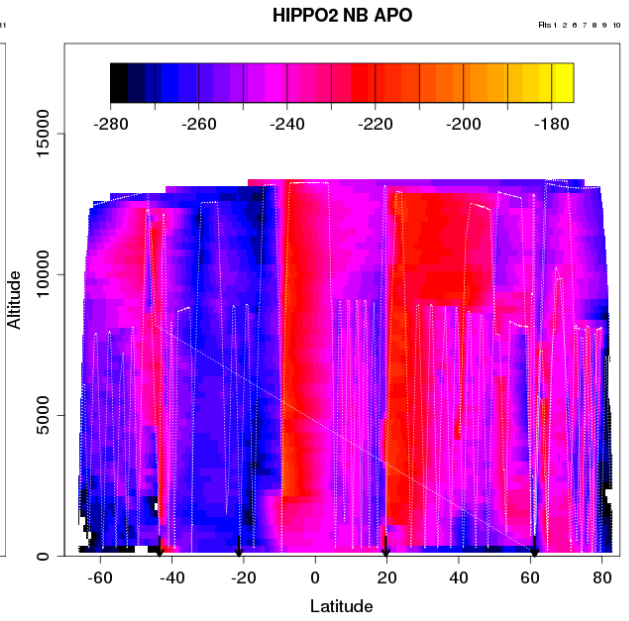


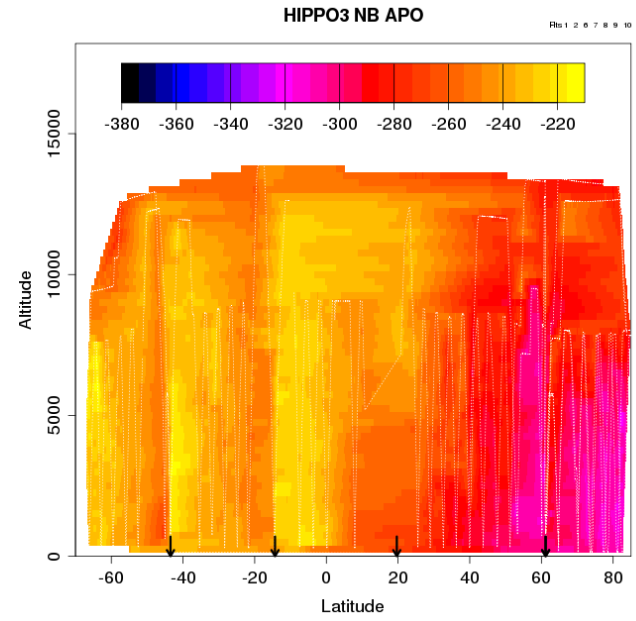

HIPPO1 SB APO
-270 -250 -230 -210 -190 -170
Altitude
0 5000 10000 15000
-60 -40 -20 0 20 40 60 80
Latitude


HIPPO2 SB APO
-280 -260 -240 -220 -200 -180
Altitude
0 5000 10000 15000
-60 -40 -20 0 20 40 60 80
Latitude


HIPPO3 SB APO
-340 -320 -300 -280 -260 -240 -220
Altitude
0 5000 10000 15000
-60 -40 -20 0 20 40 60 80
Latitude


HIPPO1 NB APO
-270 -250 -230 -210 -190 -170
Altitude
0 5000 10000 15000
-60 -40 -20 0 20 40 60 80
Latitude


HIPPO2 NB APO
-280 -260 -240 -220 -200 -180
Altitude
0 5000 10000 15000
-60 -40 -20 0 20 40 60 80
Latitude


HIPPO3 NB APO
-380 -360 -340 -320 -300 -280 -260 -240 -220
Altitude
0 5000 10000 15000
-60 -40 -20 0 20 40 60 80
Latitude