Observations of CO in the atmosphere of Mars With PFS onboard MarsExpress

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- CO in the atmosphere of Mars comes from photolysis of CO2

-Then is recycled through reactions involving OH

- lifetime >> mixing time

- From a theoretical point of view, CO is not expected to vary much, but…

CO observed several times from the ground in the infrared and mm, always giving a CO mixing ratio in the range:

8 (+ - 3) x 10-4

this is the accepted nominal value

Modest temporal and spatial variations however possible especially as very limited spatial resolution until now !

The SWC detector of PFS allows to observe the (1-0) infrared band of CO near 4.7 microns

Sensitive to q_{CO} and T(z)

Analysis of 63 apodized calibrated orbits (≈ 12000 individual spectra, co-added 4 by 4) ranging from January to May 2004

Focus on the 2000 - 2200 cm-1 wavenumber range

Radiative transfer code

inputs:

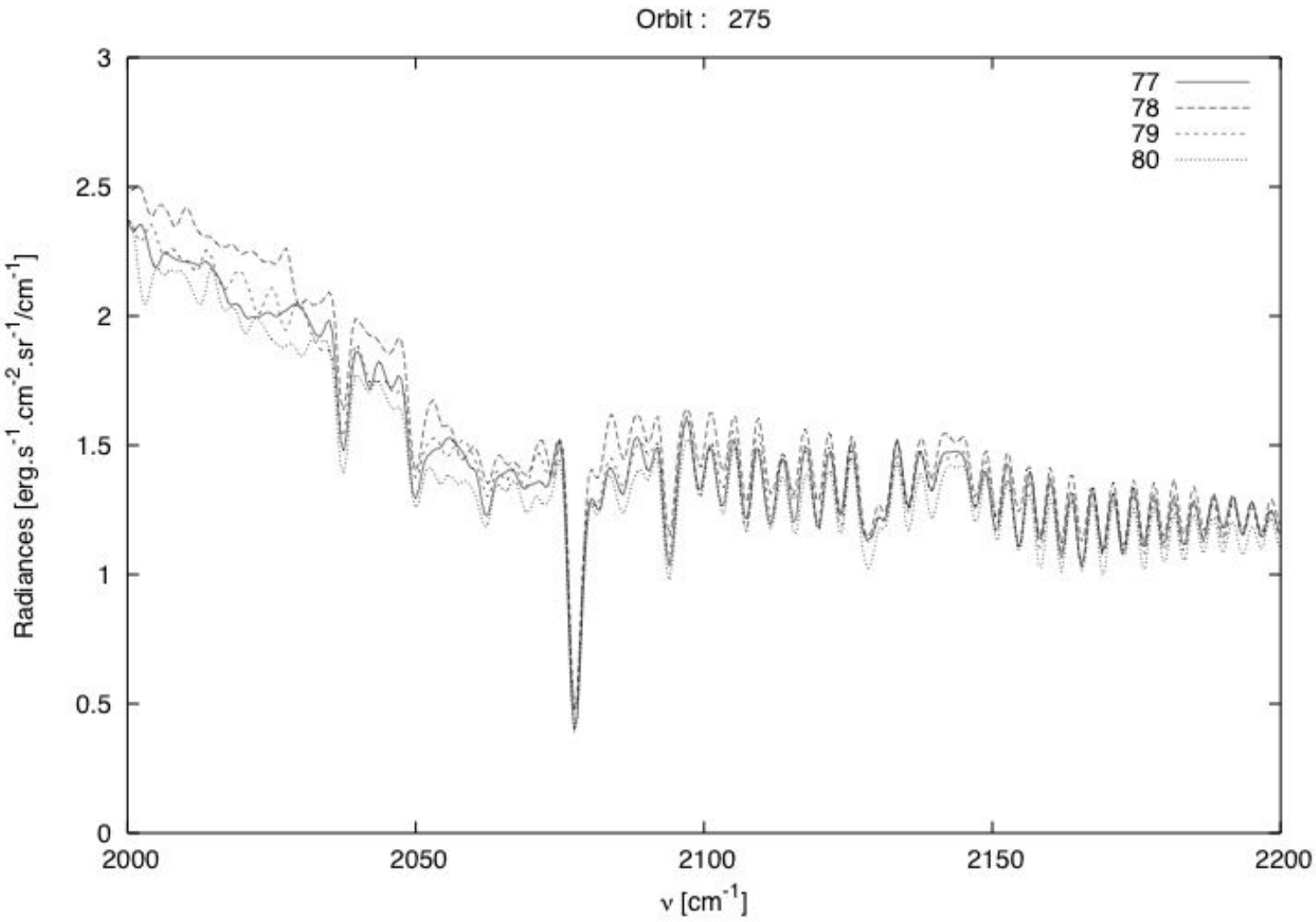
- spectroscopic data
- instrumental function
- Tsurf, Psurf
- thermal profile, either measured from LW data (Fouchet, Grassi) or from EMCD model (Forget et al.)

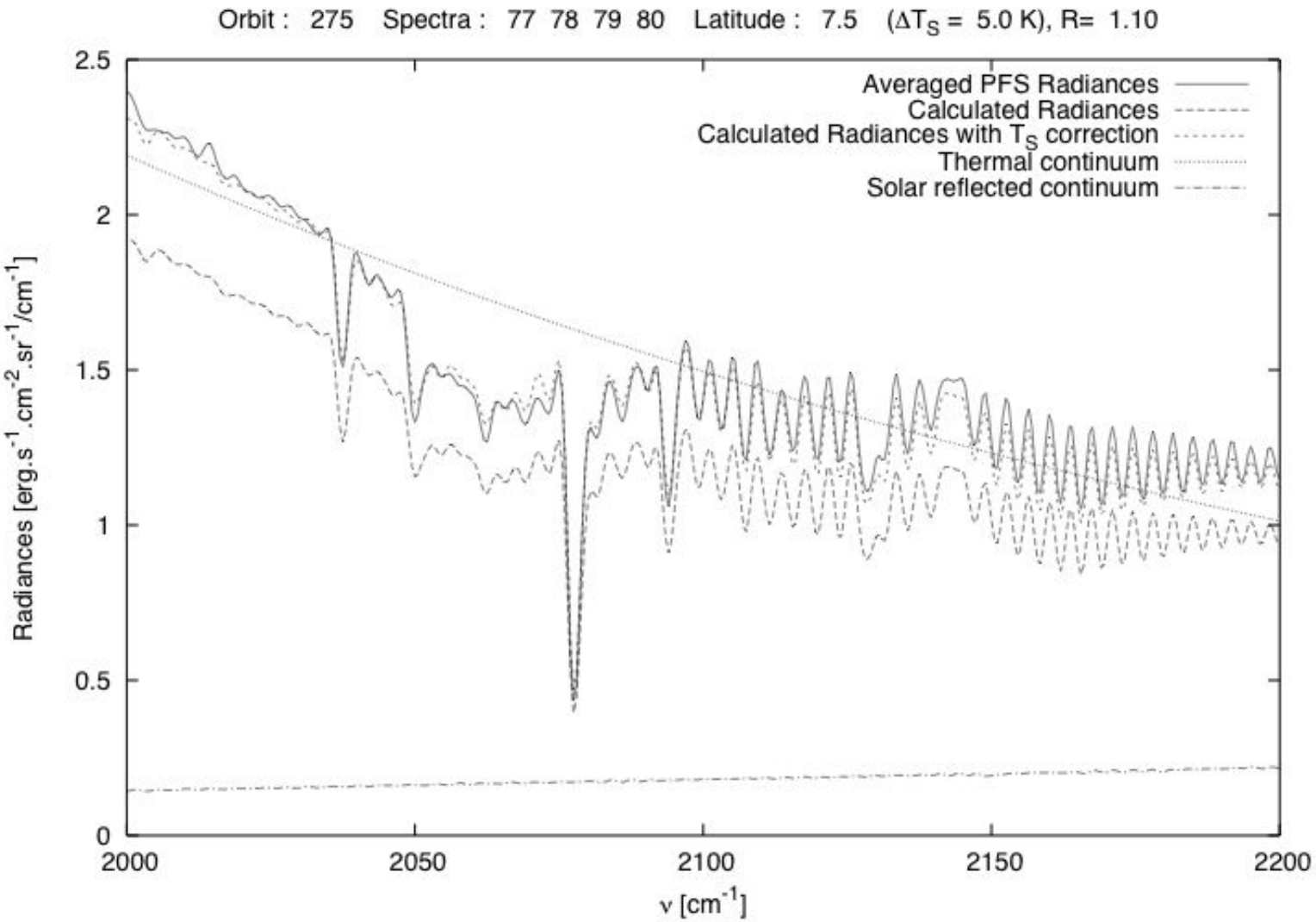
performs

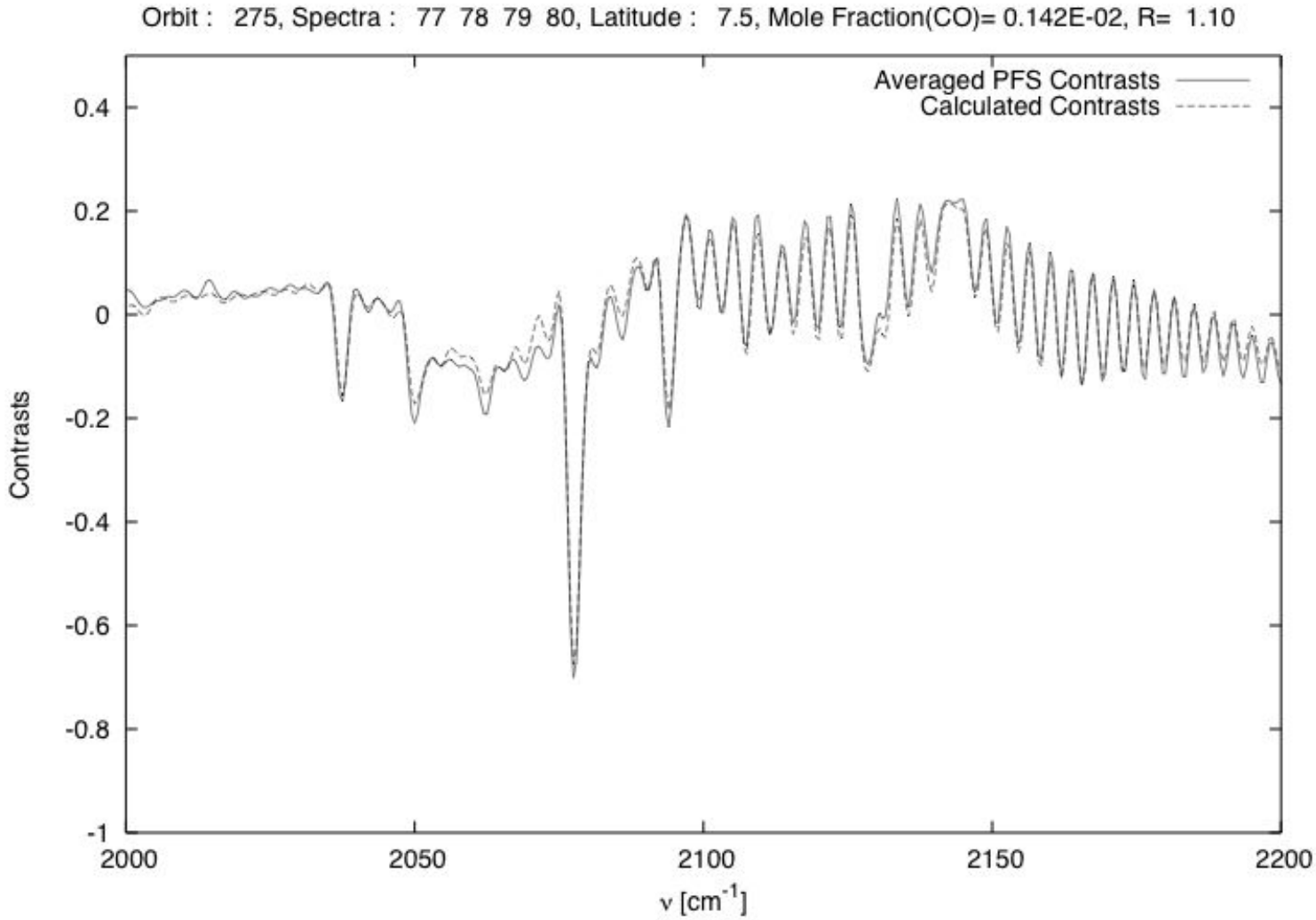
- synthetic calculations for different values of the CO mixing ratio
- least square fit

outputs:

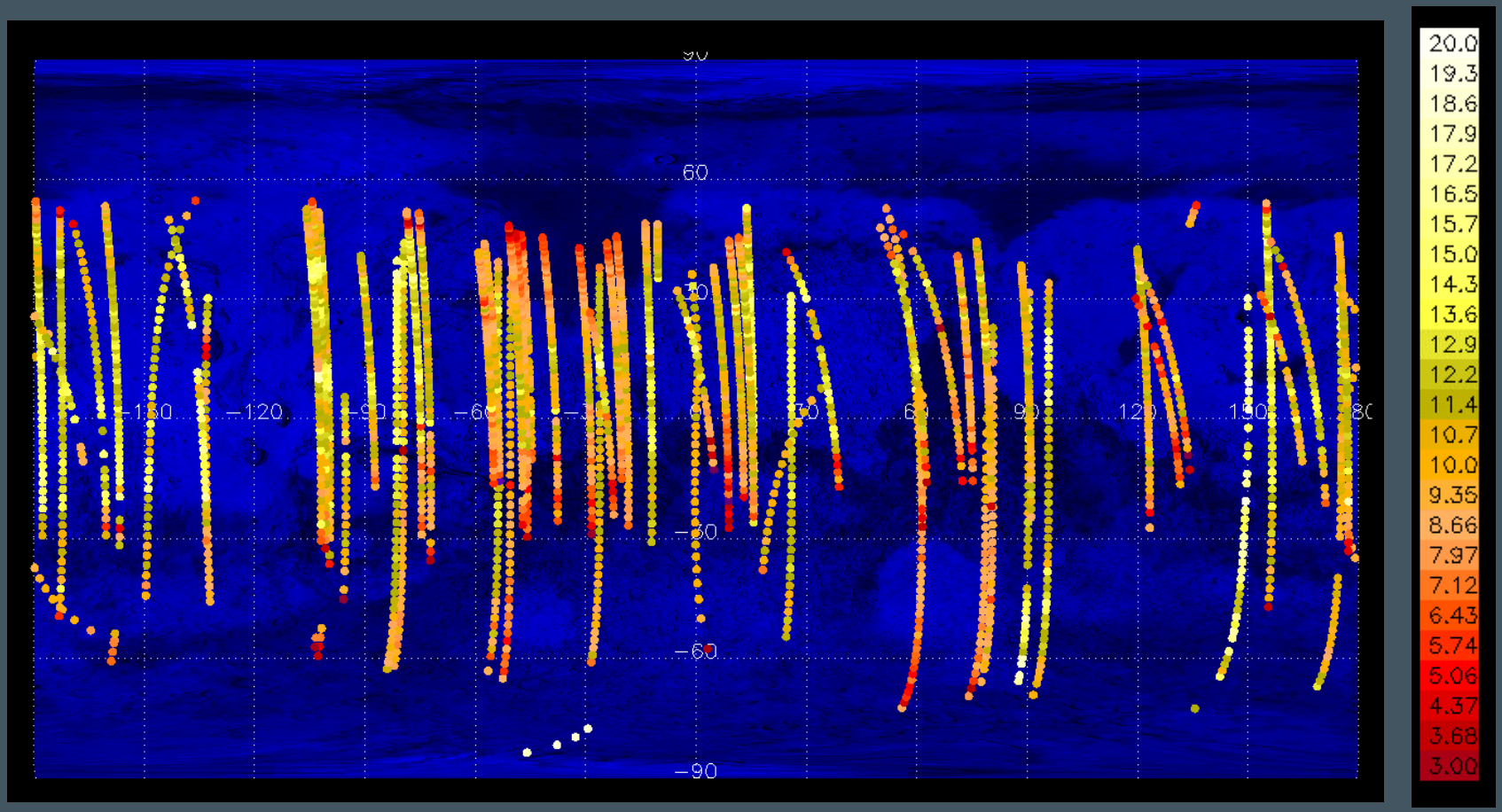
- best CO mixing ratio
- (shift in surface temperature)


Orbit : 275
77
78
79
80
Radiances [erg.s-1.cm-2.sr-1/cm-1]
ν [cm-1]
0
0.5
1
1.5
2
2.5
3
2000
2050
2100
2150
2200


Orbit : 275 Spectra : 77 78 79 80 Latitude : 7.5 (ΔT_S = 5.0 K), R= 1.10
Averaged PFS Radiances
Calculated Radiances
Calculated Radiances with T_S correction
Thermal continuum
Solar reflected continuum
Radiances [erg.s^-1.cm^-2.sr^-1/cm^-1]
ν [cm^-1]
2.5
2
1.5
1
0.5
0
2000
2050
2100
2150
2200


Orbit : 275, Spectra : 77 78 79 80, Latitude : 7.5, Mole Fraction(CO)= 0.142E-02, R= 1.10
Averaged PFS Contrasts
Calculated Contrasts
Contrasts
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
2000
2050
2100
2150
2200
ν [cm-1]

CO mixing ratio as a function of location

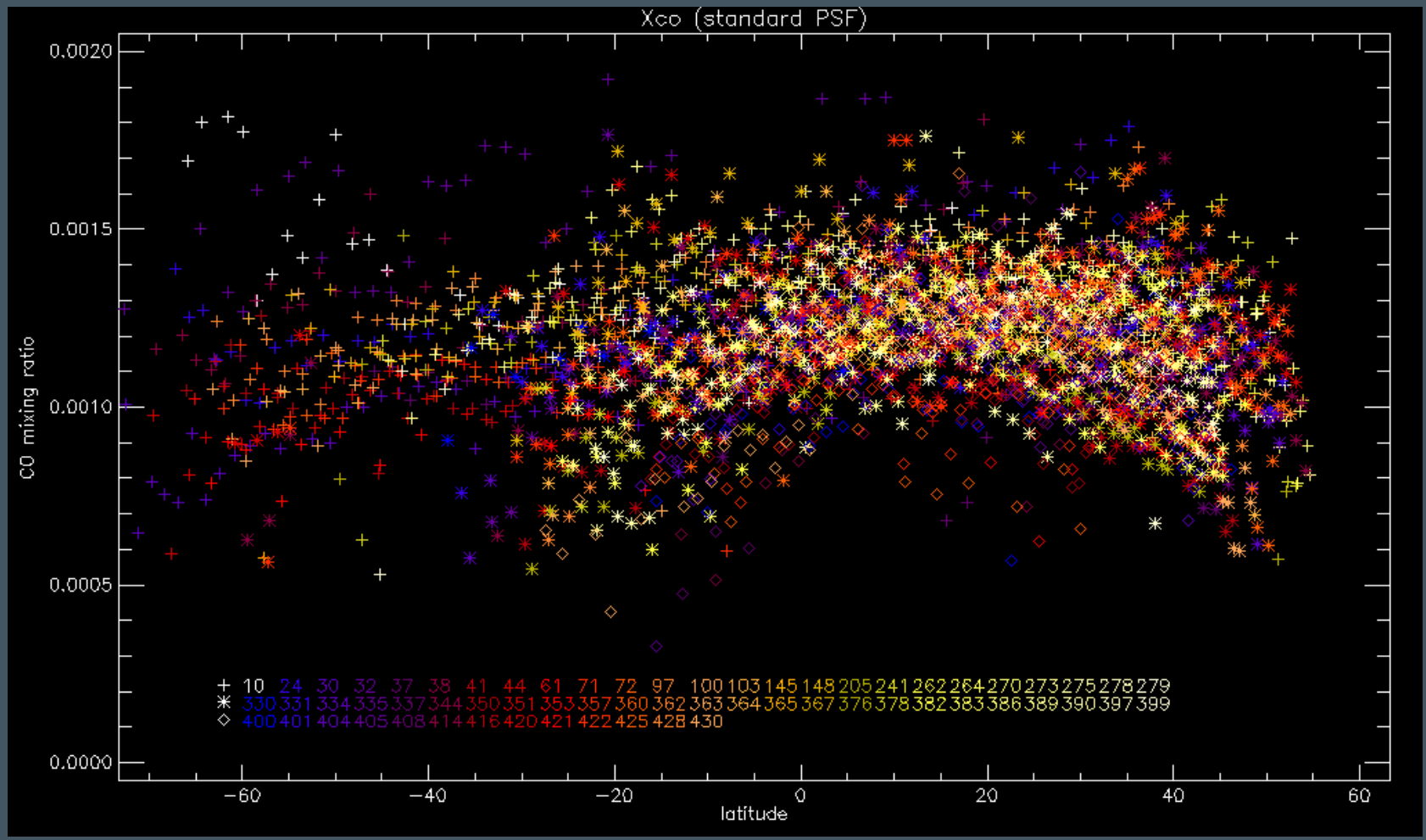


q_{CO}

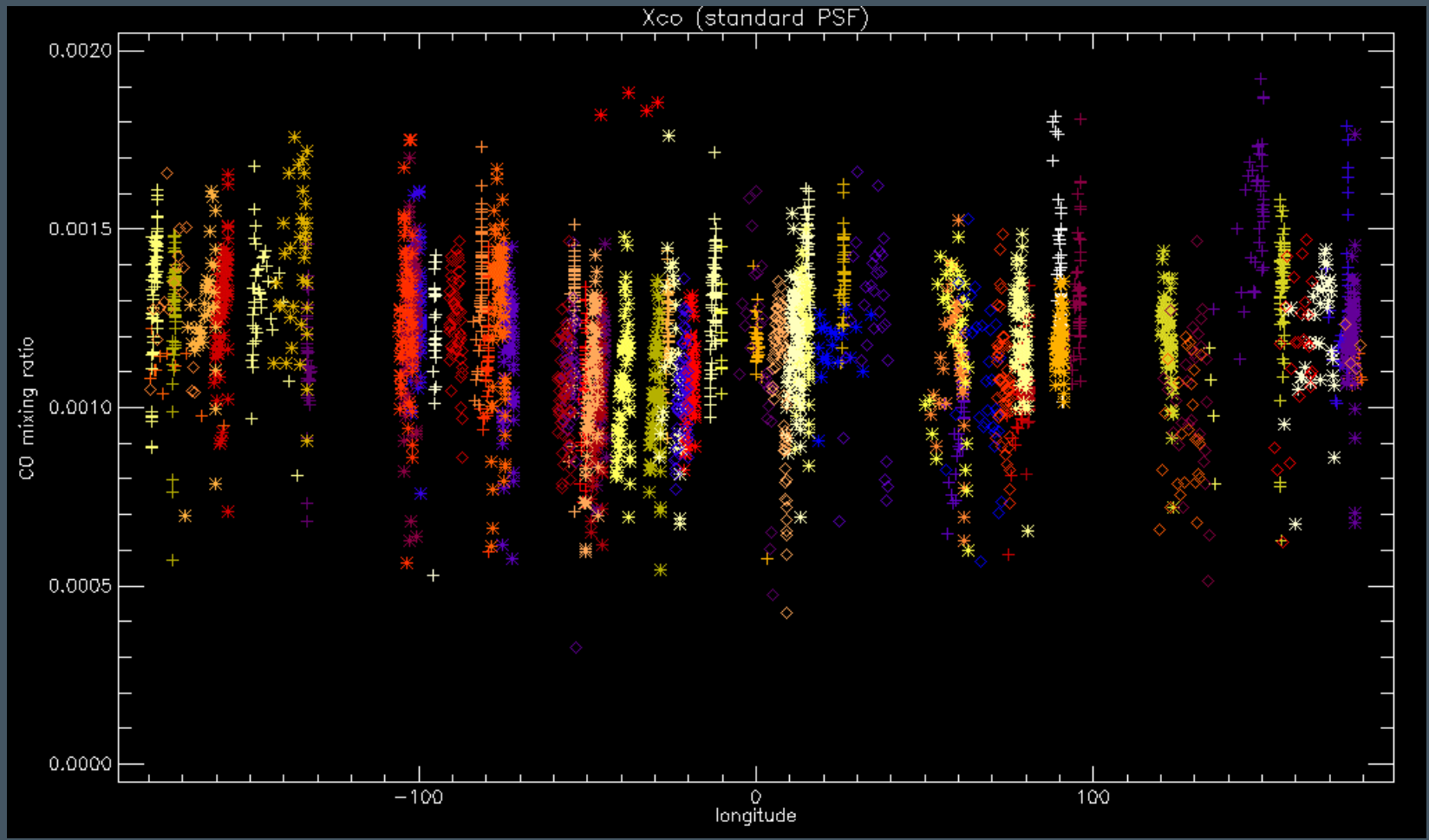
Ls ≈ 320 to 40

x 10e-4

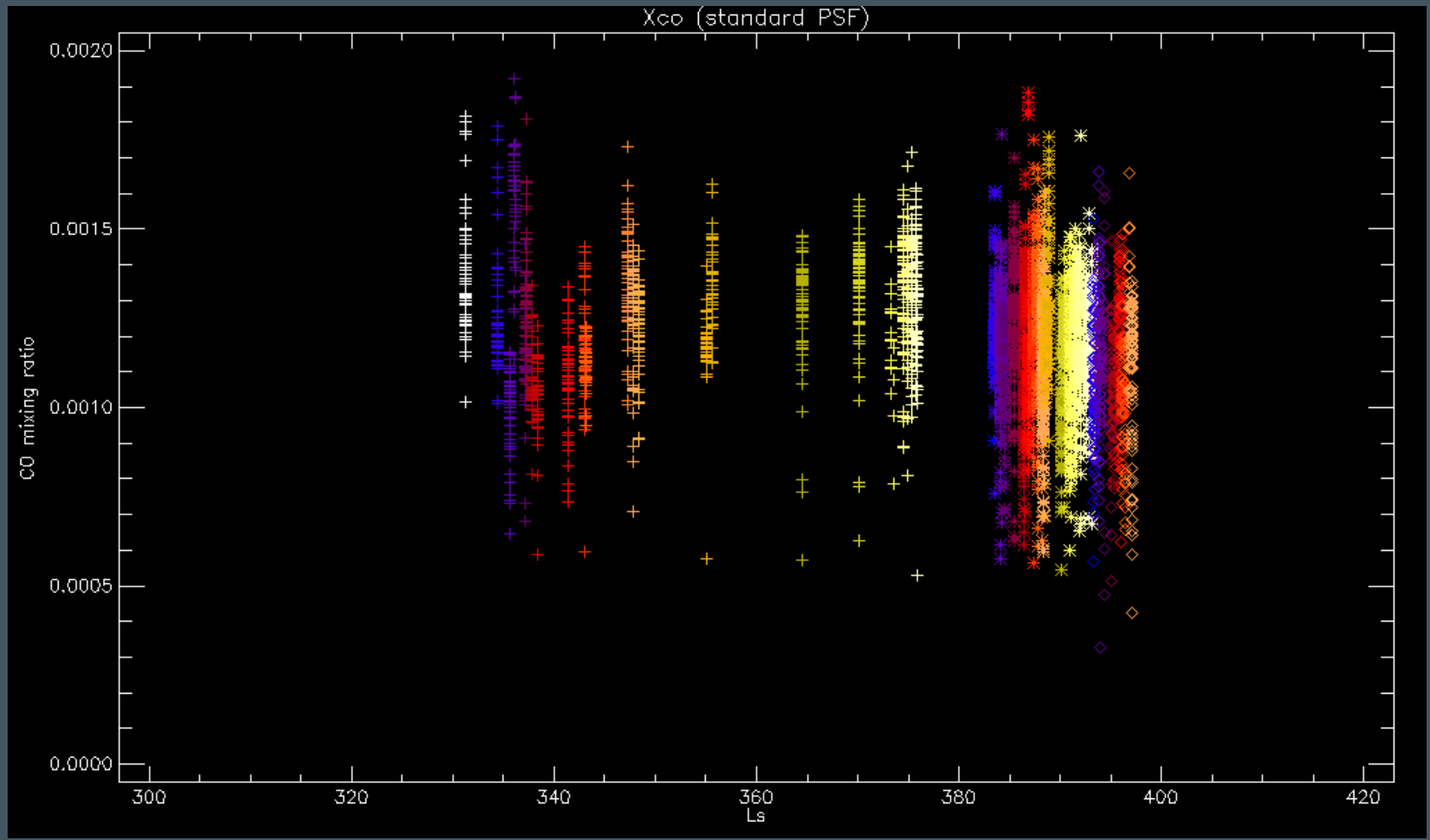
CO mixing ratio as a function of latitude

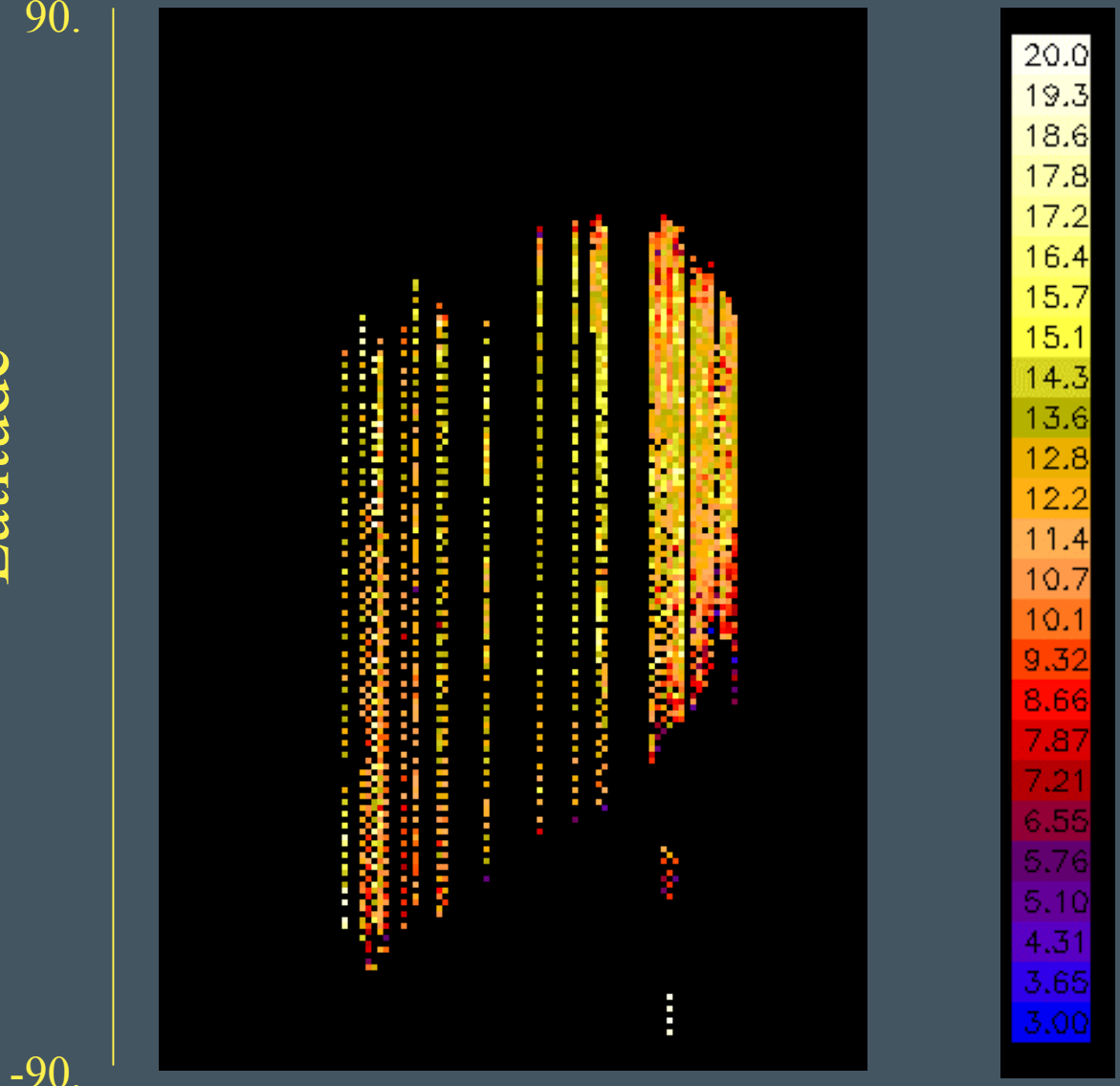


CO mixing ratio as a function of longitude

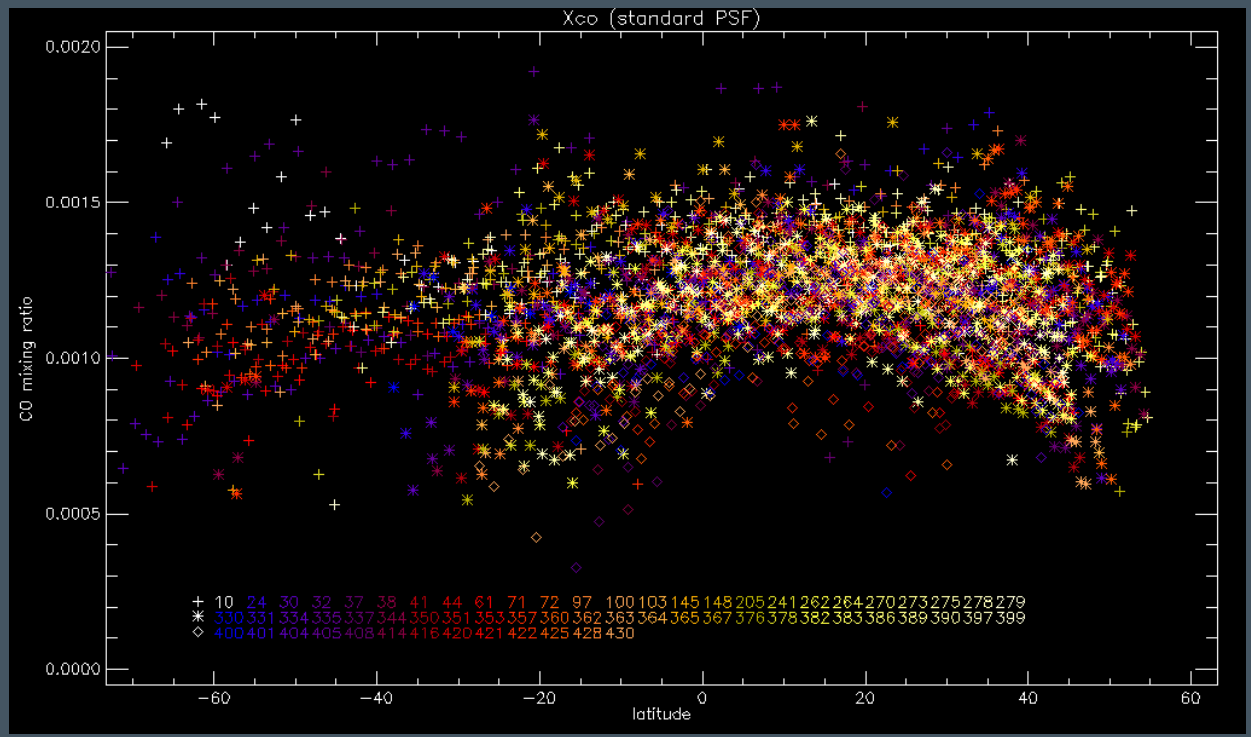


CO mixing ratio as a function of Ls




90.
Latitude
-90.
300.
420.
L_S
20.0
19.3
18.6
17.8
17.2
16.4
15.7
15.1
14.3
13.6
12.8
12.2
11.4
10.7
10.1
9.32
8.66
7.87
7.21
6.55
5.76
5.10
4.31
3.65
3.00
q_{CO}
x 10e-4

Variation with latitude, around Ls = 0 °, if confirmed, could be consistent with seasonal behavior of CO_2, leading to depletion of CO relative to CO_2 at higher latitudes, due to sublimation of CO_2



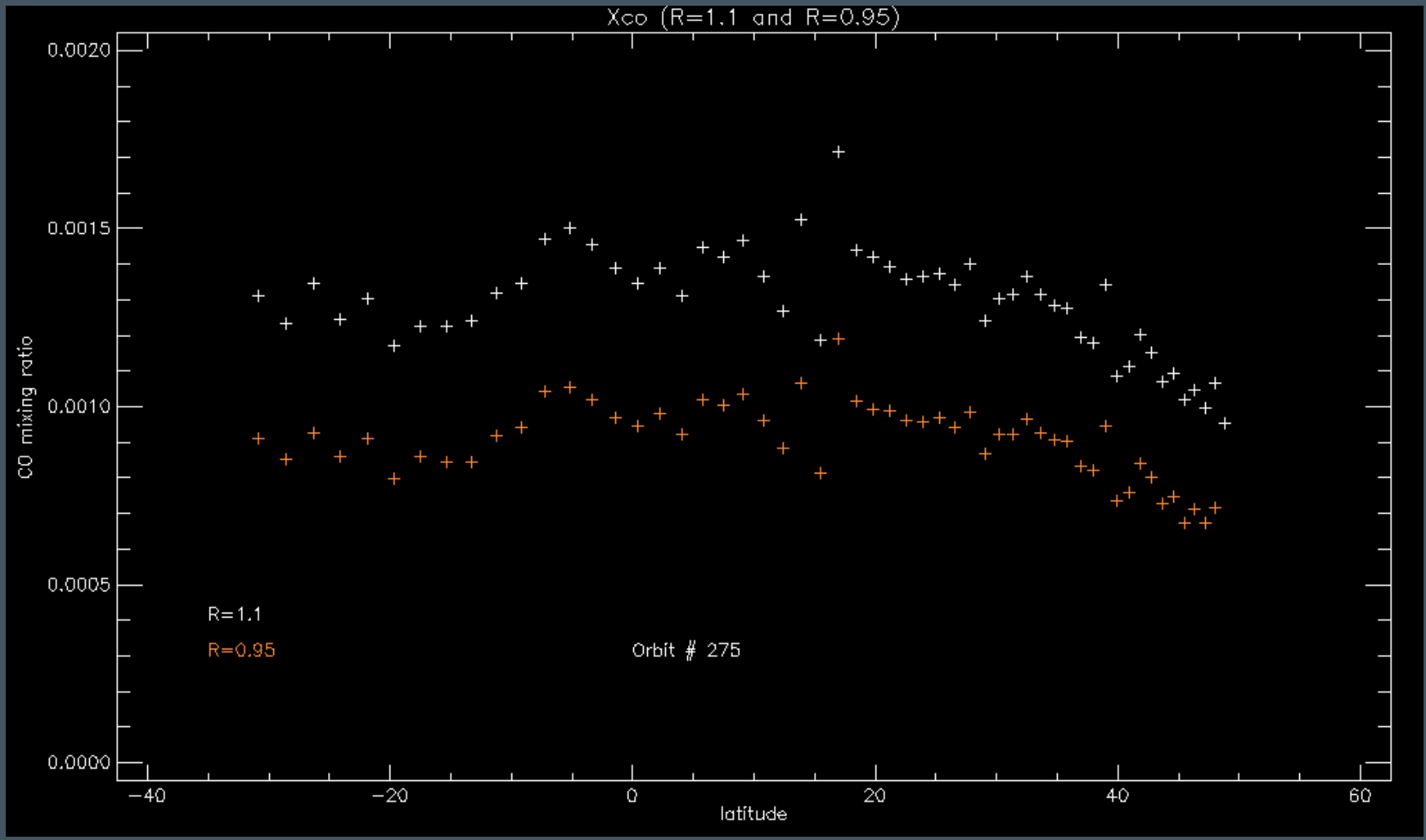
Conclusions:

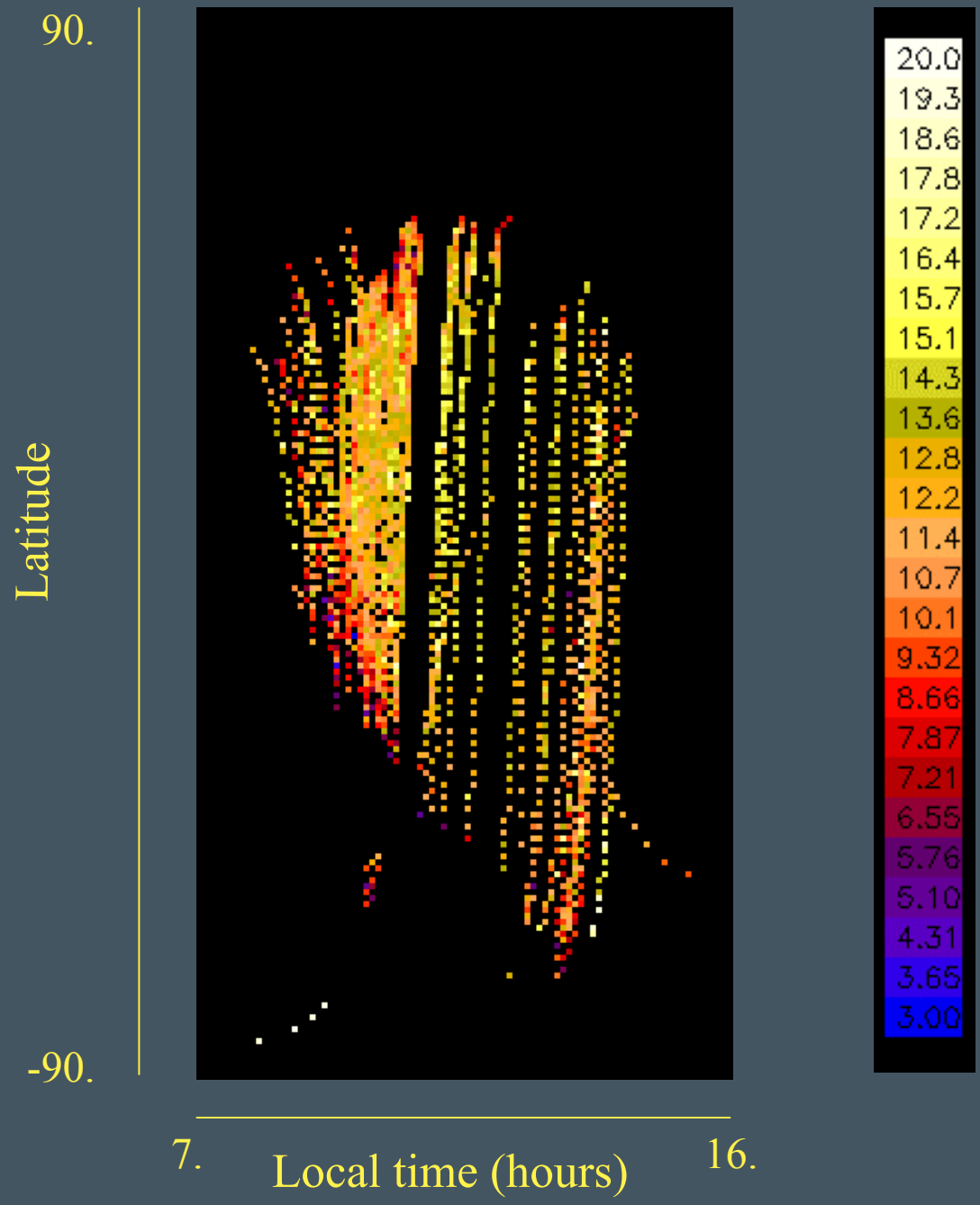
- q_{CO} values higher than expected !
  (around 12 x 10e-4 on average)
  --> needs confirmation

- possible decrease with latitude for latitudes over 20 degrees (seasonal effect ?)

Next steps:

- work with the instrumental team on the calibration issue to definitely assess absolute values of q_{CO}
- process more data to fill the gaps in longitude, Ls, local time…
- use systematic observed T(z) profiles as input
- improve the quality of our q_{CO} distribution with latitude


Xco (R=1.1 and R=0.95)
0.0020
0.0015
0.0010
0.0005
0.0000
CO mixing ratio
R=1.1
R=0.95
Orbit # 275
−40
−20
0
20
40
60
latitude


90.
Latitude
-90.
7.
Local time (hours)
16.
20.0
19.3
18.6
17.8
17.2
16.4
15.7
15.1
14.3
13.6
12.8
12.2
11.4
10.7
10.1
9.32
8.66
7.87
7.21
6.55
5.76
5.10
4.31
3.65
3.00
qCO
x 10e-4