Validation of new H2O spectral line data using residuals analysis

J.-M. Flaud (LISA)
M. Ridolfi (UB)

Presentation at QWG 25 meeting
Firenze, 21 – 23 March 2011

Background

- As promised, Jean-Marie provided new H2O spectral line data for validation with the ORM.

Procedure for validaton

The database provided by JM is in the new HITRAN format (160 char records). In order to test the provided database we followed this approach:

1) We removed form the hitran_mipas_pf3.3 database (the most recent MIPAS database) all the H2O lines,

2) we changed the format of the lines sent by JM to the HITRAN<2001 style (100 chars)

3) we added the lines from step 2) to the database obtained from step 1).

4) we selected lines for the H2O retrieval from the database obtained at step 3. and named this line list as **"SP_V6.2_beta"**

5) In parallel we selected the lines for H2O retrieval directly from the hitran_mipas_pf_3.3 database and got the line list I call **"SP_V6.1"**

6) Finally we run the ORM_PDS_V2.0 on the 14 orbits from 14 December 2009, using alternatively **SP_V6.1 and SP_V6.2_beta** line lists. We compare average residuals in the H2O MWs from the two runs.

Note on calculation of average residuals: average residuals were computed by binning the tangent heights of the individual scans around the nominal altitudes of the NOM-OR observation mode.

Global indication of improvement

The CHI-square averaged over all (1320) the scans processed is:

- **CHI2 (SP_V6.1) = 1.34601**
- **CHI2 (SP_V6.2_beta) = 1.3455**

so, globally, the new line list improves the residuals, though not dramatically.

Now showing plots of residuals

Here we show a few example plots, the full set of plots can be visualized at the web page:

http://www.dropbox.com/gallery/18606840/1/H2O_RESIDUALS?h=93bc62

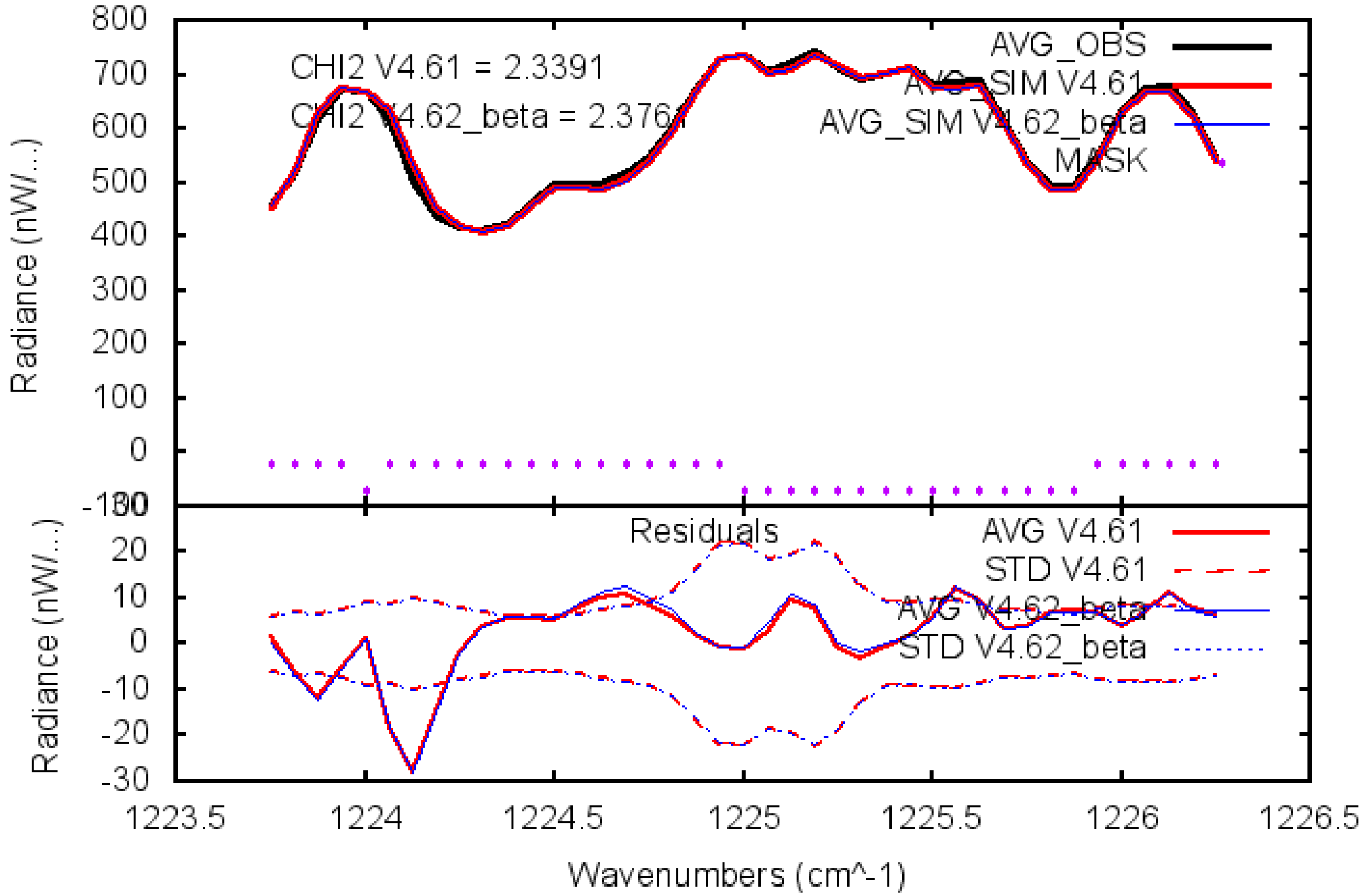
OR can be downloaded as a zip archive from the link:

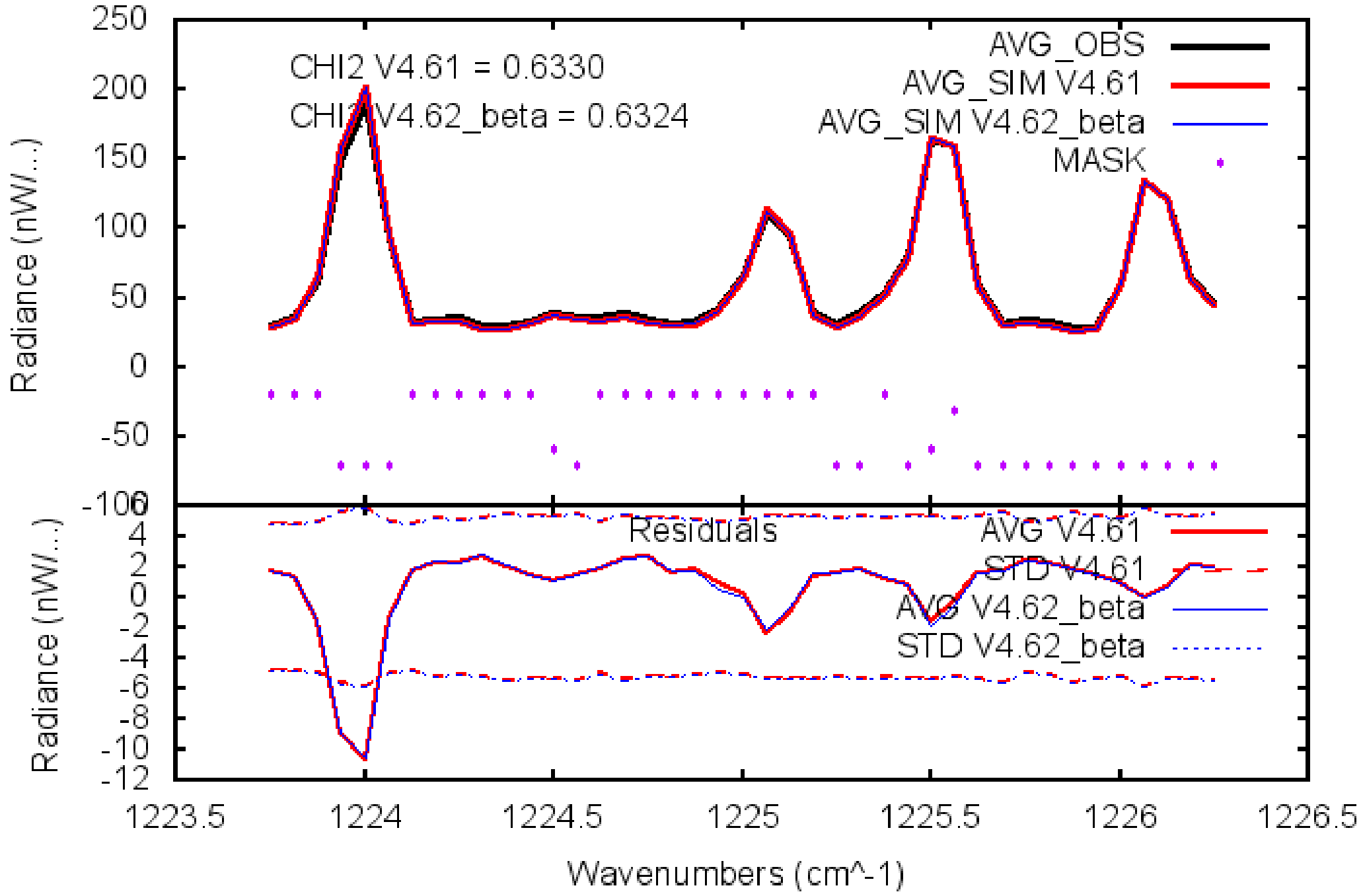
http://dl.dropbox.com/u/18606840/H2O_RESIDUALS.zip

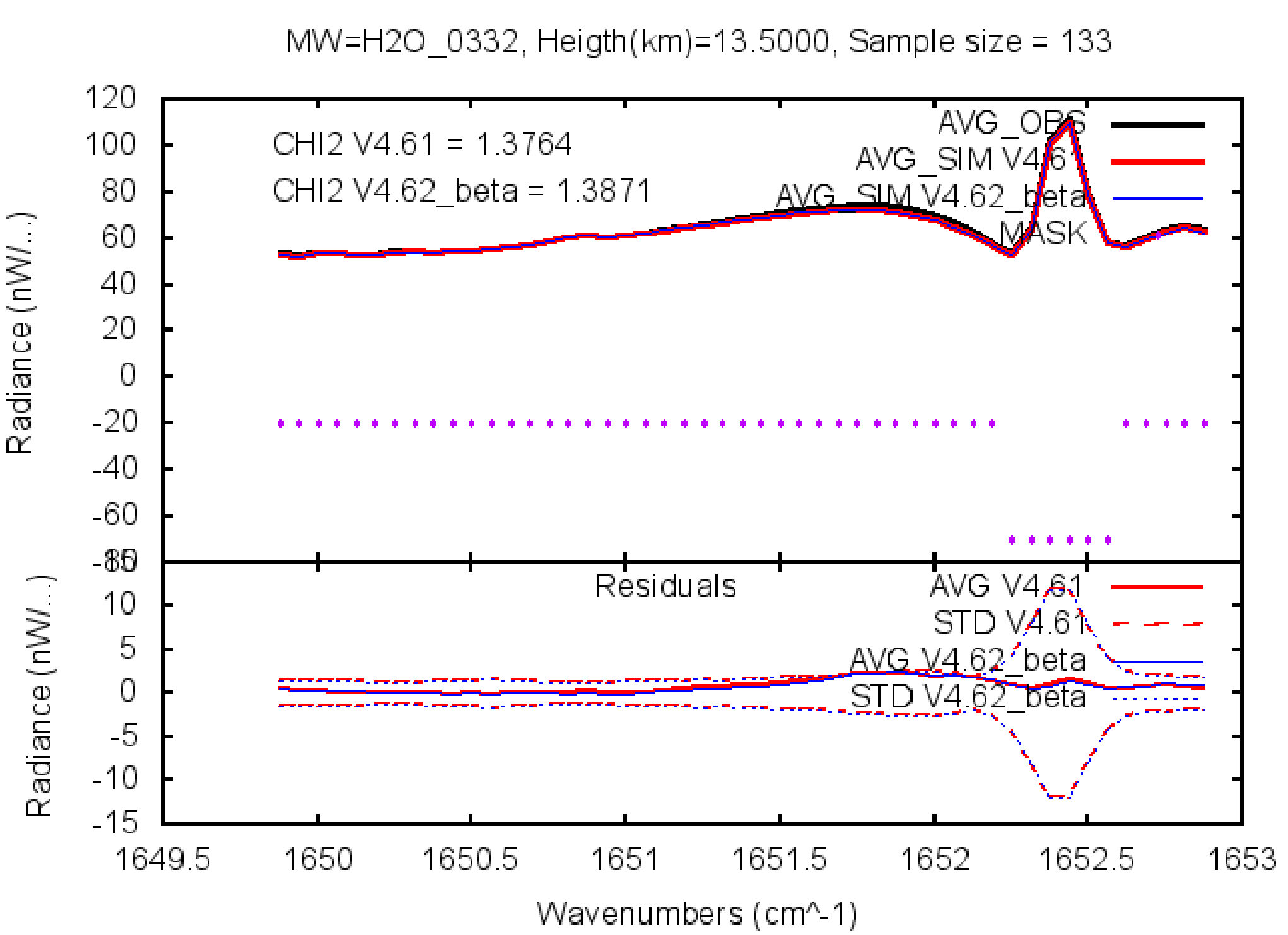
Plots caption

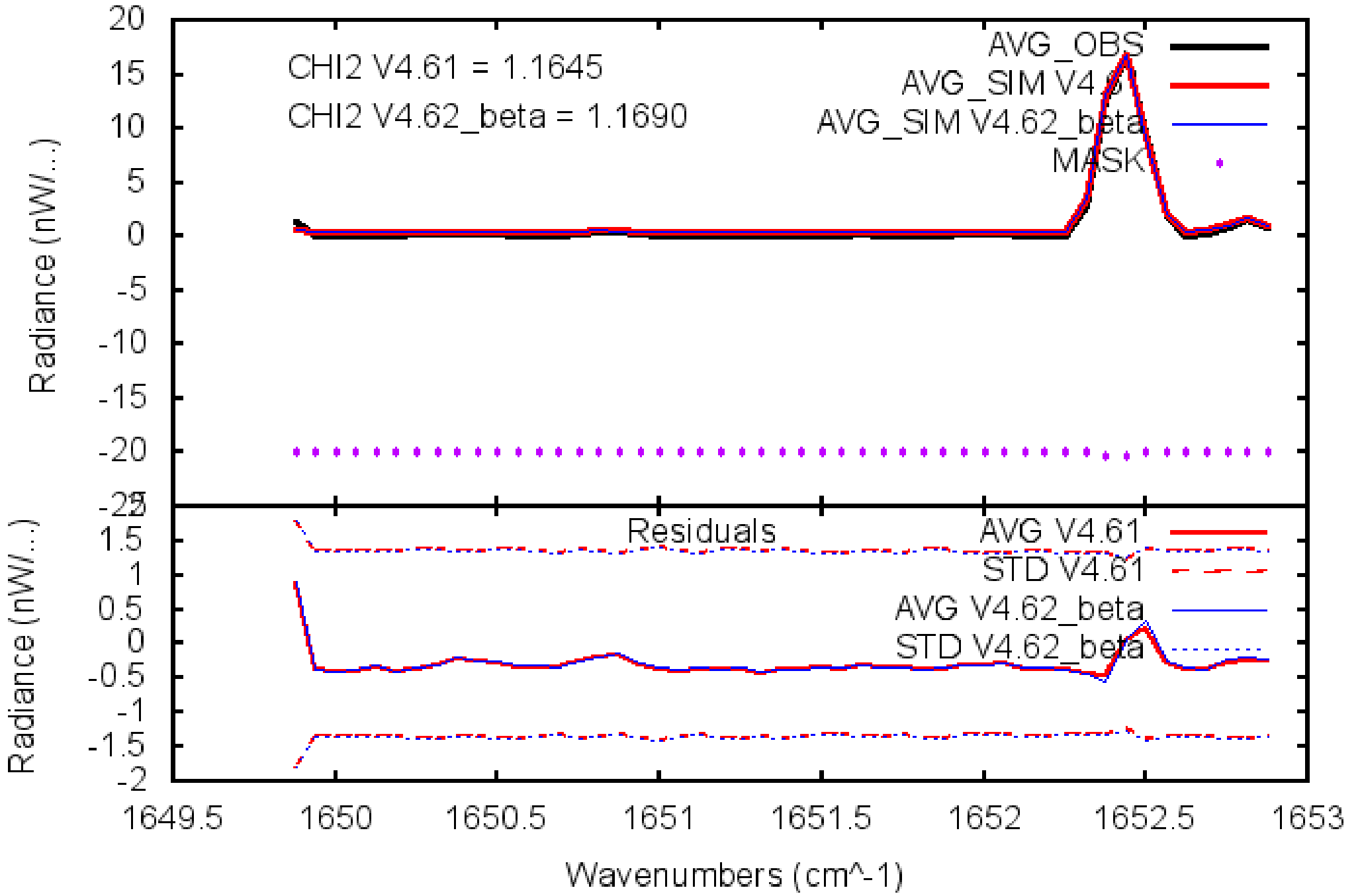
Top panel shows: the average measured spectrum (AVG_OBS, black line), the average simulated spectrum with V4.61 line list (AVG_SIM_V4.61, red line) and the average simulated spectrum with V4.62_beta line list (AVG_SIM_V4.62_beta, thinner blue line). In this plot we also show the spectral mask (pink dots) used to select the spectral points actually used for the fit. The spectral mask (*s*) originally is zero (point unused) or one (point used for the fit). For convenience here we plotted the quantity $p = s * 50 - 70$. By definition it should be either p=-70 or p=-20; however in practice also intermediate values $-70 < p < -20$ are possible due to the constant altitude binning of the averaging process that operates on limb-scans whose tangent heights change along the orbit ("floating altitude" of NOM scans used to follow the tropopause). In the top panel we also report the average partial CHI2 obtained for the selected MW and altitude, with line lists SP_V6.1 and SP_V6.2_beta.

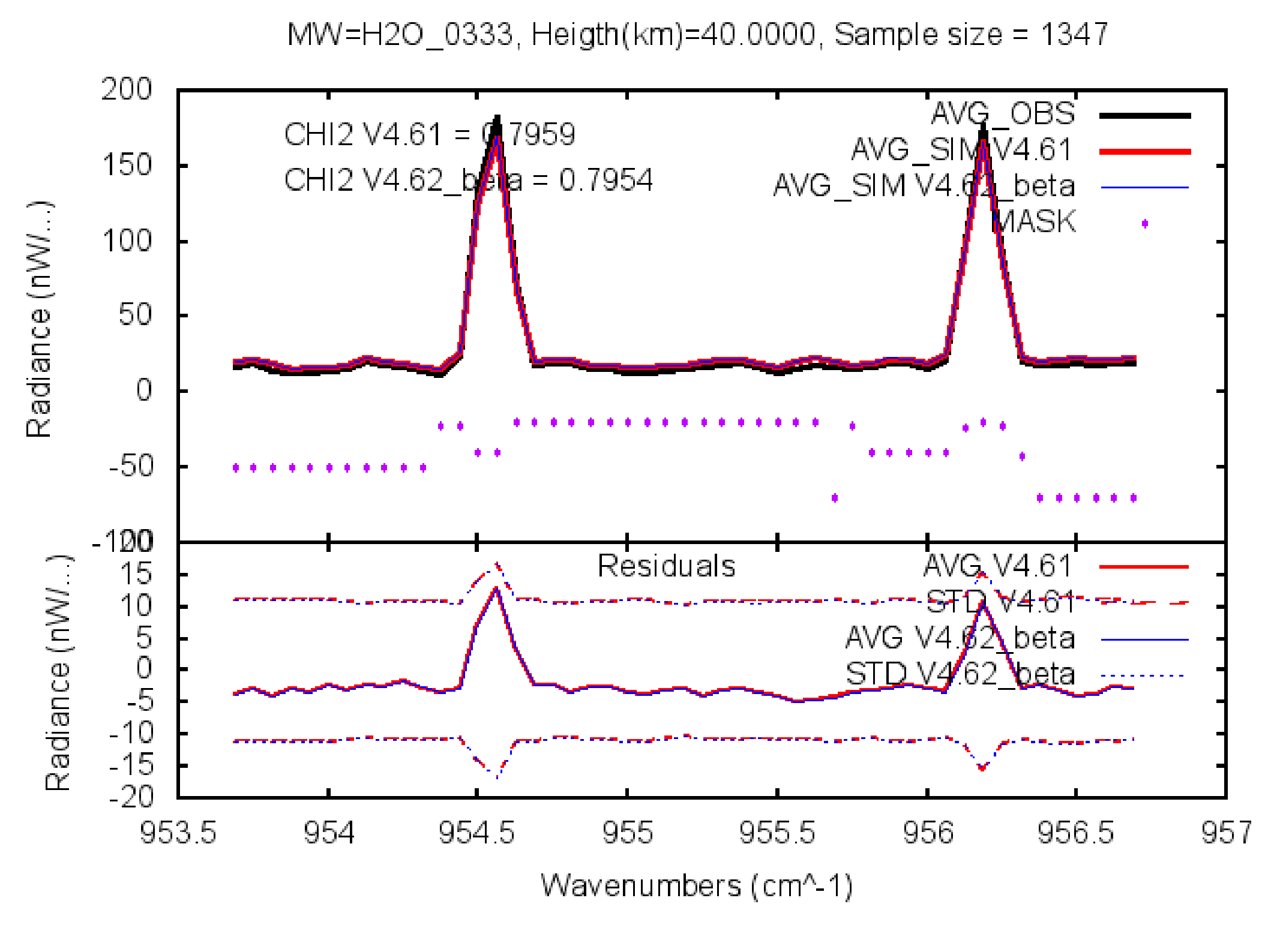
The bottom panel shows the residuals. The red thick lines refer to SP_V4.61 residuals, while blue thinner lines refer to SP_V4.62_beta residuals. Solid lines represent the average of the residuals (OBS-SIM). Dashed lines represent the standard deviation of the residuals. Spectroscopic errors should contribute as a bias, therefore they should be visible in the average of the residuals, but not in their standard deviation.

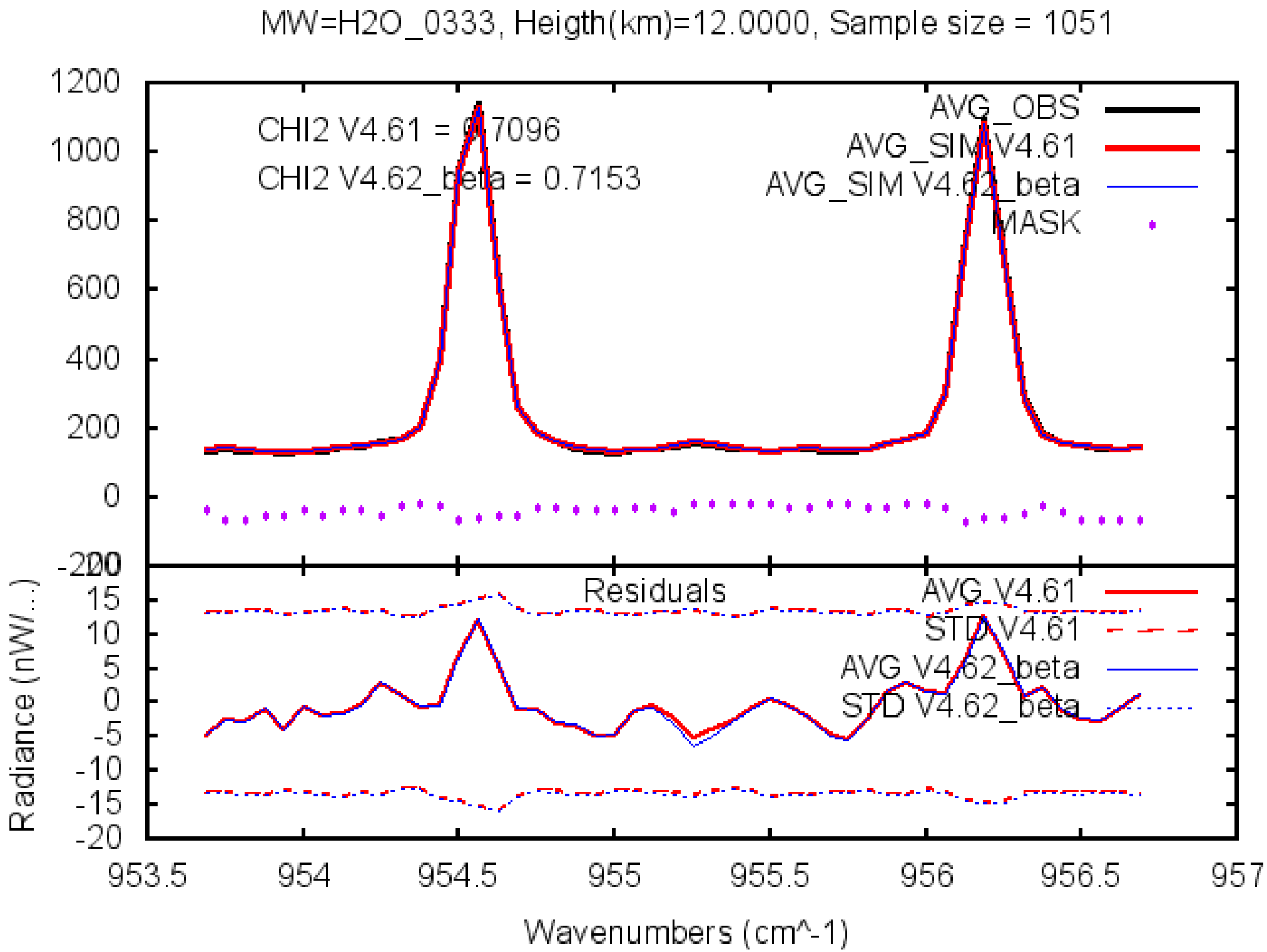

MW=H2O_0331, Heigth(km)=6.0000, Sample size = 93
CHI2 V4.61 = 2.3391
CHI2 V4.62_beta = 2.3764
AVG_OBS
AVG_SIM V4.61
AVG_SIM V4.62_beta
MASK
Radiance (nW/...)
Residuals
AVG V4.61
STD V4.61
AVG V4.62_beta
STD V4.62_beta
Radiance (nW/...)
Wavenumbers (cm^-1)
800
700
600
500
400
300
200
100
0
20
10
0
-10
-20
-30
1223.5
1224
1224.5
1225
1225.5
1226
1226.5

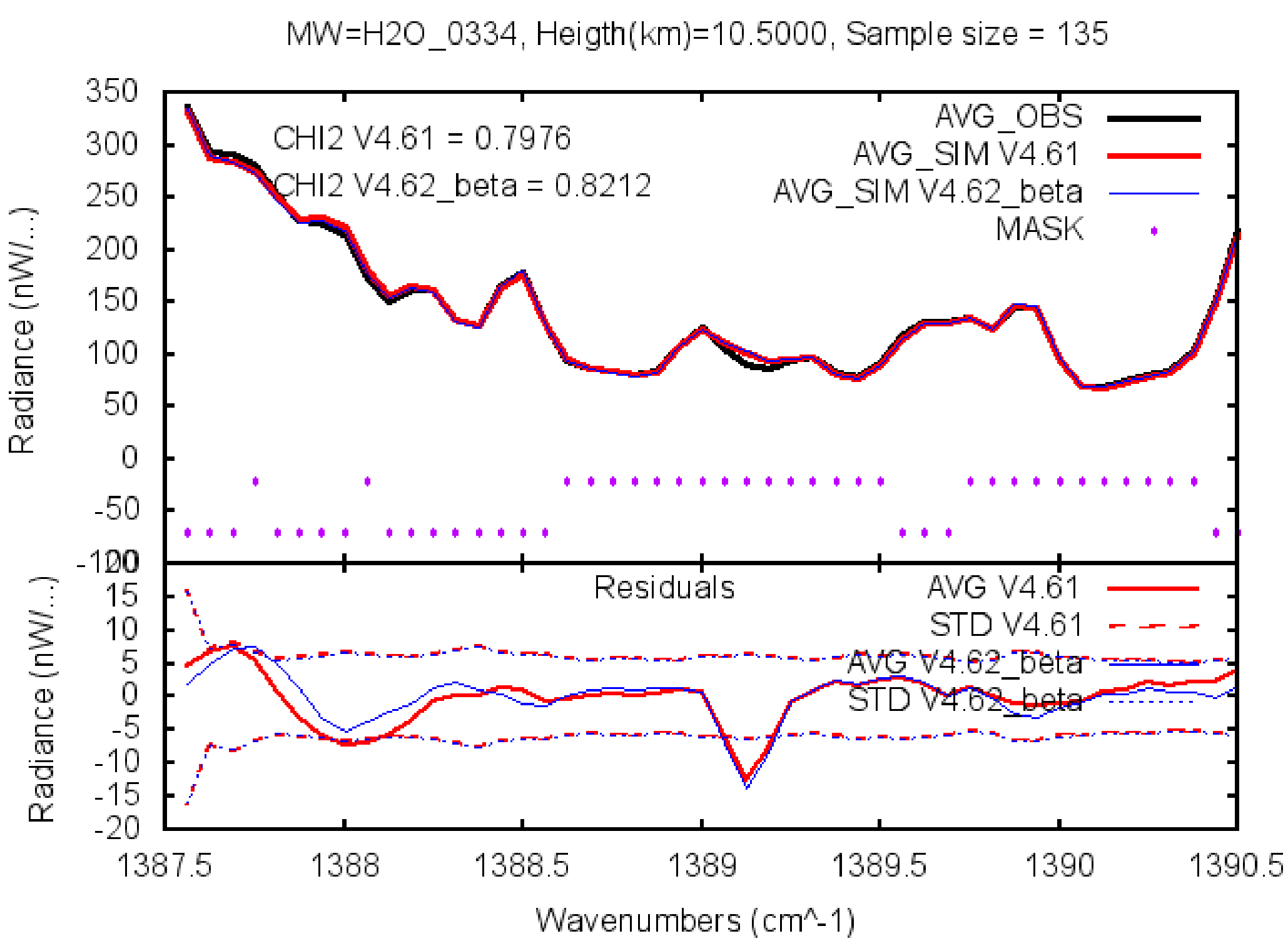

MW=H2O_0331, Heigth(km)=23.0000, Sample size = 181
CHI2 V4.61 = 0.6330
CHI2 V4.62_beta = 0.6324
AVG_OBS
AVG_SIM V4.61
AVG_SIM V4.62_beta
MASK
Residuals
AVG V4.61
STD V4.61
AVG V4.62_beta
STD V4.62_beta
Radiance (nW/...)
Radiance (nW/...)
Wavenumbers (cm^-1)
250
200
150
100
50
0
-50
-100
4
2
0
-2
-4
-6
-8
-10
-12
1223.5
1224
1224.5
1225
1225.5
1226
1226.5

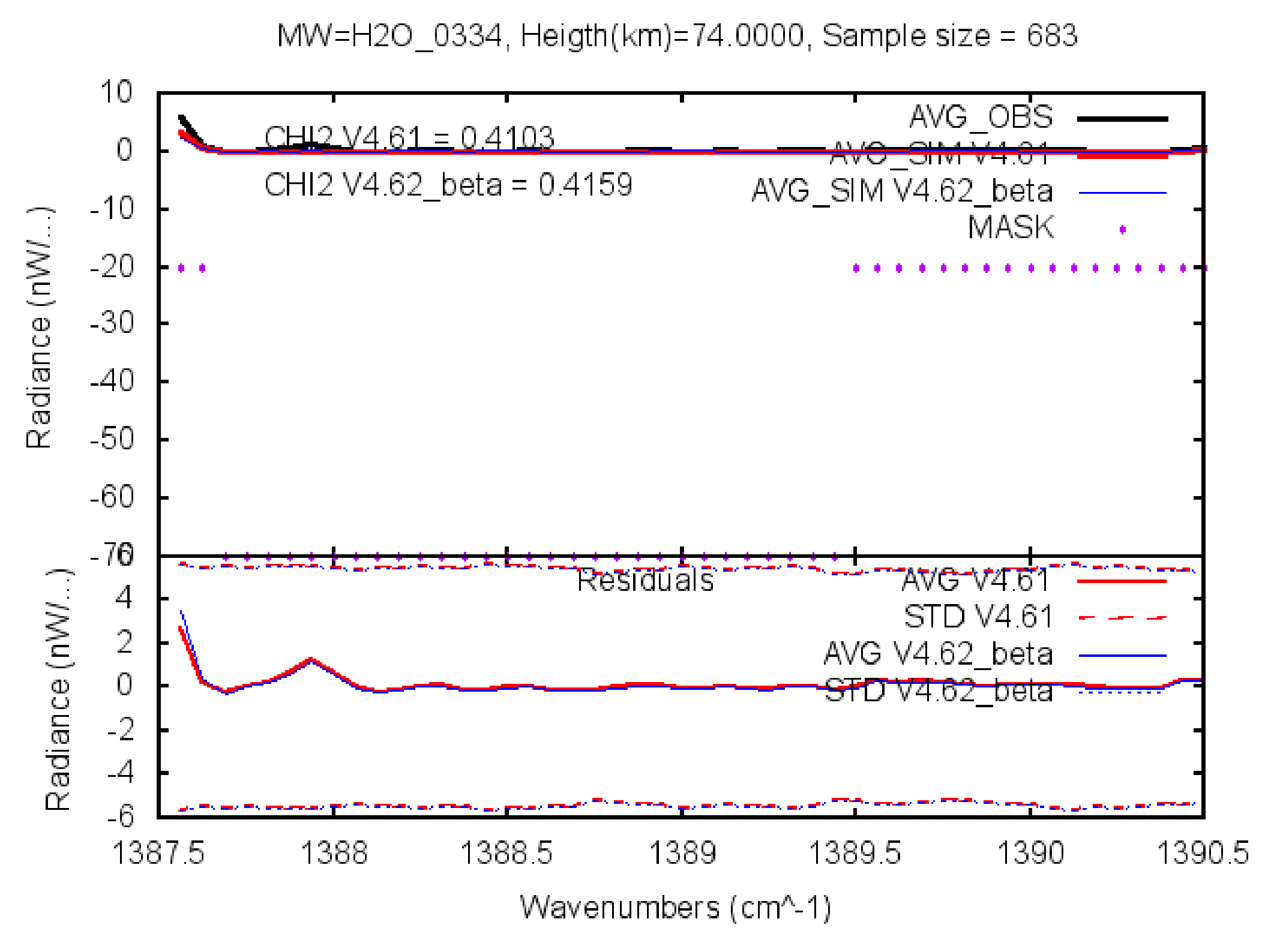

MW=H2O_0332, Heigth(km)=13.5000, Sample size = 133
CHI2 V4.61 = 1.3764
CHI2 V4.62_beta = 1.3871
AVG_OBS
AVG_SIM V4.61
AVG_SIM V4.62_beta
MASK
Radiance (nW/...)
120
100
80
60
40
20
0
-20
-40
-60
Residuals
AVG V4.61
STD V4.61
AVG V4.62_beta
STD V4.62_beta
10
5
0
-5
-10
-15
1649.5
1650
1650.5
1651
1651.5
1652
1652.5
1653
Wavenumbers (cm^-1)

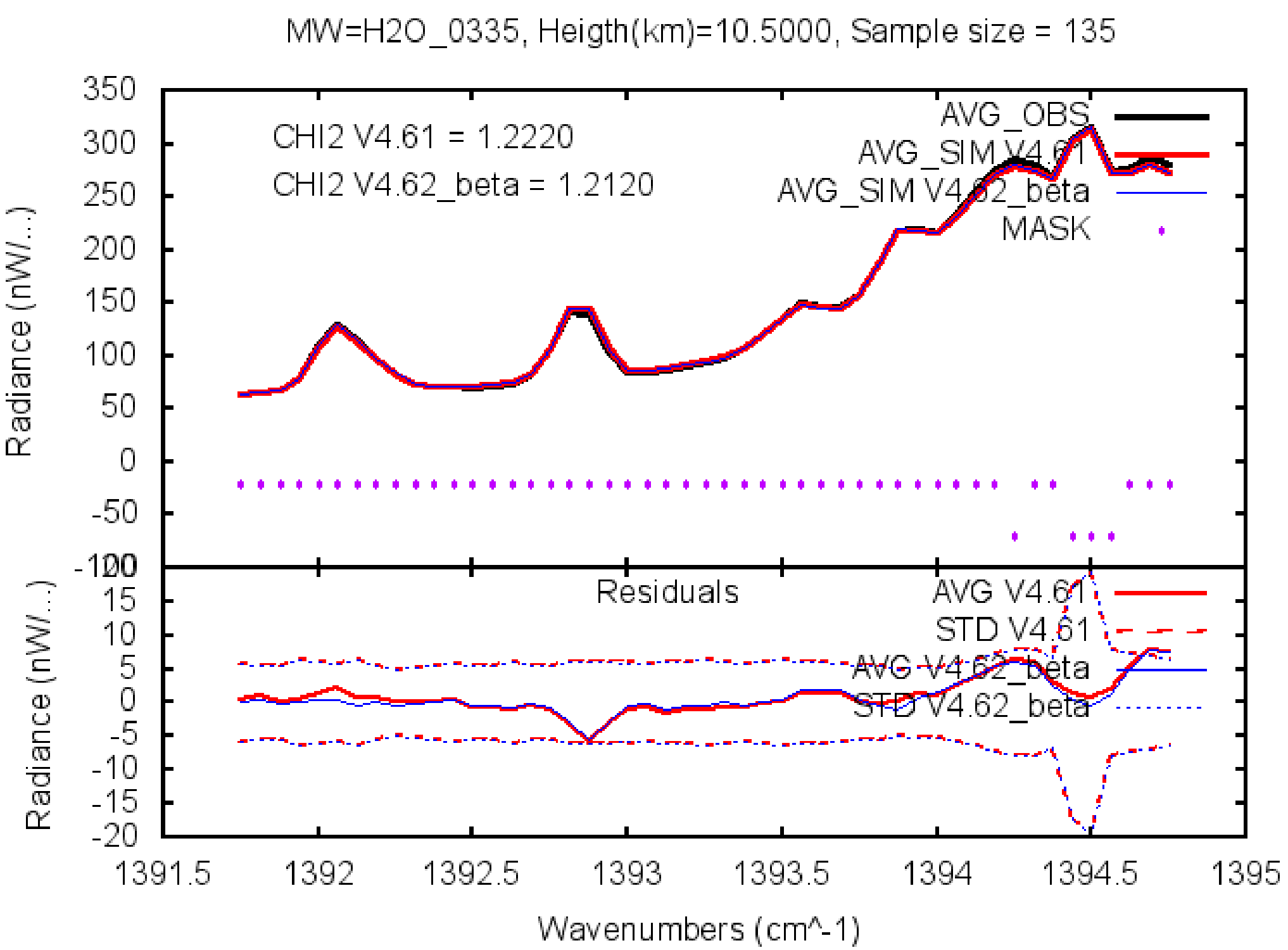

MW=H2O_0332, Heigth(km)=62.0000, Sample size = 1330
CHI2 V4.61 = 1.1645
CHI2 V4.62_beta = 1.1690
AVG_OBS
AVG_SIM V4.61
AVG_SIM V4.62_beta
MASK
Radiance (nW/...)
Residuals
AVG V4.61
STD V4.61
AVG V4.62_beta
STD V4.62_beta
Radiance (nW/...)
Wavenumbers (cm^-1)

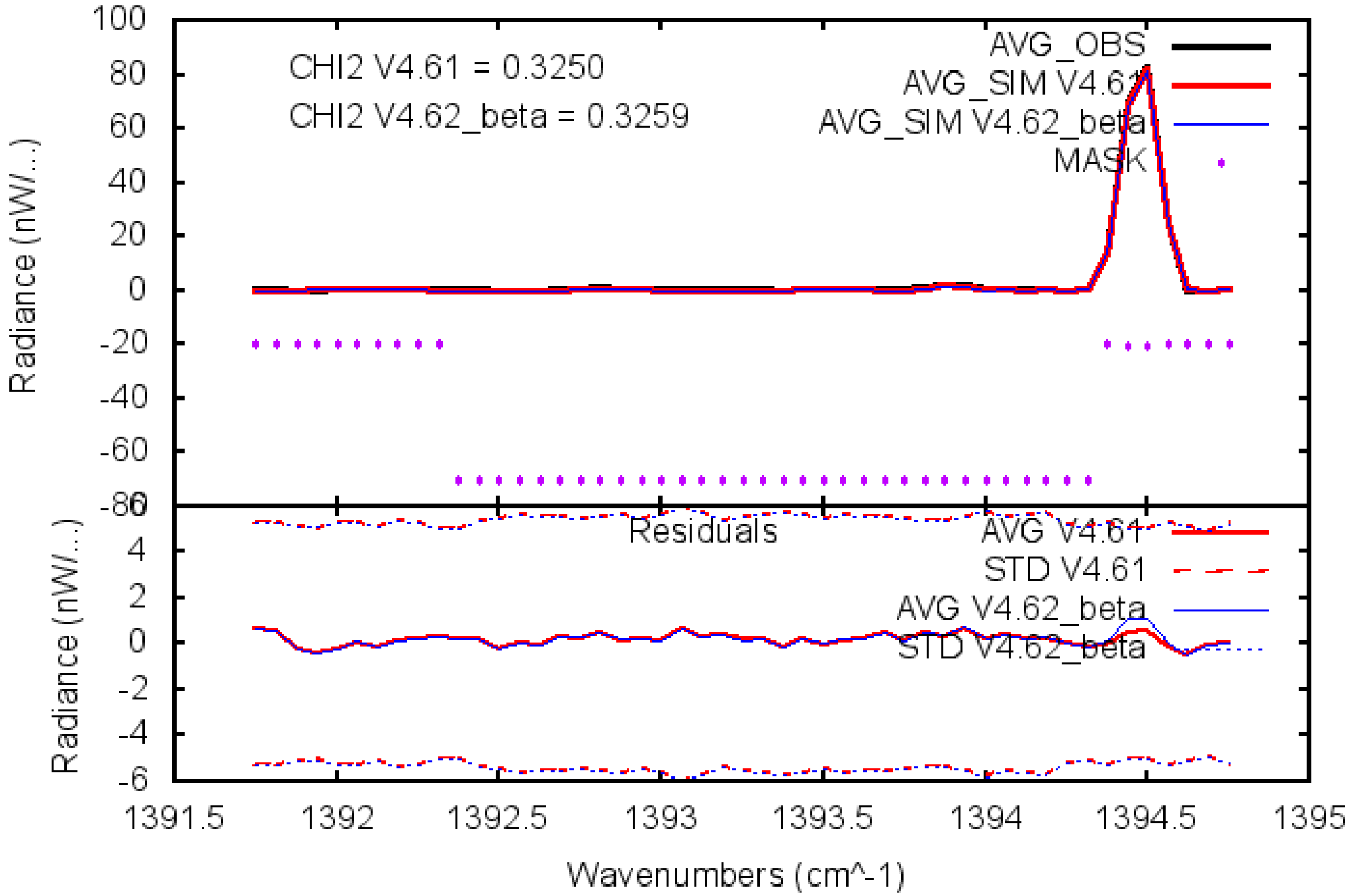

MW=H2O_0333, Heigth(km)=40.0000, Sample size = 1347
CHI2 V4.61 = 0.7959
CHI2 V4.62_beta = 0.7954
AVG_OBS
AVG_SIM V4.61
AVG_SIM V4.62_beta
MASK
Radiance (nW/...)
Residuals
AVG V4.61
STD V4.61
AVG V4.62_beta
STD V4.62_beta
Wavenumbers (cm^-1)


MW=H2O_0333, Heigth(km)=12.0000, Sample size = 1051
CHI2 V4.61 = 0.7096
CHI2 V4.62_beta = 0.7153
AVG_OBS
AVG_SIM V4.61
AVG_SIM V4.62_beta
MASK
Residuals
AVG V4.61
STD V4.61
AVG V4.62_beta
STD V4.62_beta
Radiance (nW/...)
Wavenumbers (cm^-1)
1200
1000
800
600
400
200
0
-200
15
10
5
0
-5
-10
-15
-20
953.5
954
954.5
955
955.5
956
956.5
957


MW=H2O_0334, Heigth(km)=10.5000, Sample size = 135
CHI2 V4.61 = 0.7976
CHI2 V4.62_beta = 0.8212
AVG_OBS
AVG_SIM V4.61
AVG_SIM V4.62_beta
MASK
Radiance (nW/...)
Residuals
AVG V4.61
STD V4.61
AVG V4.62_beta
STD V4.62_beta
Radiance (nW/...)
Wavenumbers (cm^-1)
350
300
250
200
150
100
50
0
-50
-100
20
15
10
5
0
-5
-10
-15
-20
1387.5
1388
1388.5
1389
1389.5
1390
1390.5

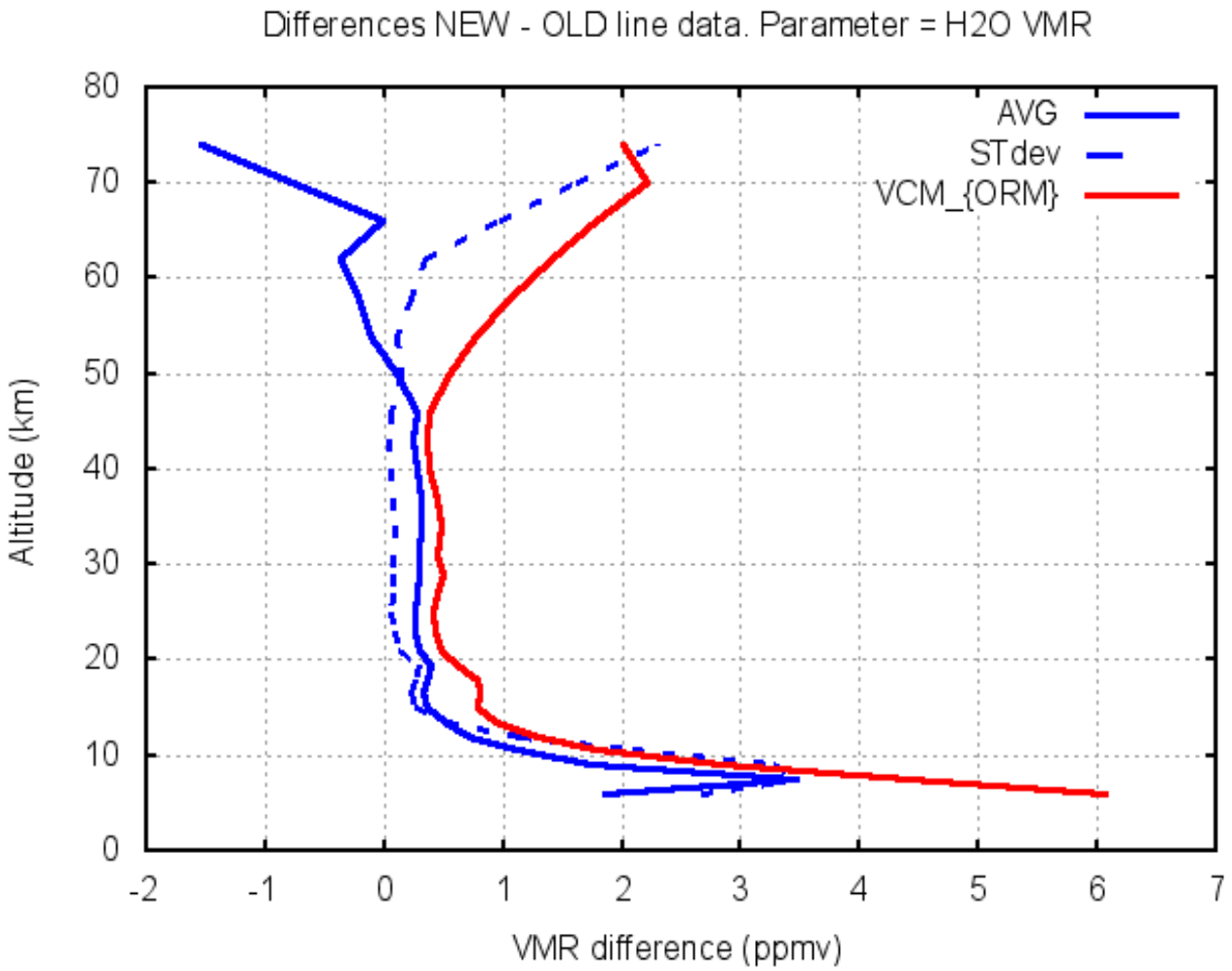

MW=H2O_0334, Heigth(km)=74.0000, Sample size = 683
CHI2 V4.61 = 0.4103
CHI2 V4.62_beta = 0.4159
AVG_OBS
AVG_SIM V4.61
AVG_SIM V4.62_beta
MASK
Radiance (nW/...)
Residuals
AVG V4.61
STD V4.61
AVG V4.62_beta
STD V4.62_beta
Radiance (nW/...)
Wavenumbers (cm^-1)
10
0
-10
-20
-30
-40
-50
-60
-70
4
2
0
-2
-4
-6
1387.5
1388
1388.5
1389
1389.5
1390
1390.5


MW=H2O_0335, Heigth(km)=10.5000, Sample size = 135
CHI2 V4.61 = 1.2220
CHI2 V4.62_beta = 1.2120
AVG_OBS
AVG_SIM V4.61
AVG_SIM V4.62_beta
MASK
Radiance (nW/...)
Residuals
AVG V4.61
STD V4.61
AVG V4.62_beta
STD V4.62_beta
Radiance (nW/...)
Wavenumbers (cm^-1)
350
300
250
200
150
100
50
0
-50
-100
15
10
5
0
-5
-10
-15
-20
1391.5
1392
1392.5
1393
1393.5
1394
1394.5
1395


MW=H2O_0335, Heigth(km)=58.0000, Sample size = 400
CHI2 V4.61 = 0.3250
CHI2 V4.62_beta = 0.3259
AVG_OBS
AVG_SIM V4.61
AVG_SIM V4.62_beta
MASK
Radiance (nW/...)
Residuals
AVG V4.61
STD V4.61
AVG V4.62_beta
STD V4.62_beta
Radiance (nW/...)
Wavenumbers (cm^-1)
100
80
60
40
20
0
-20
-40
-60
-80
6
4
2
0
-2
-4
-6
1391.5
1392
1392.5
1393
1393.5
1394
1394.5
1395

Profile differences due to changed spectroscopic line database

Retrieved profile differences are relevant only for H2O VMR. Differences in p,T and other species are much smaller (more than one order of magnitude) than the noise error. Average (solid blue) and standard deviation (dashed blue) of the H2O VMR differences are shown in the plot below along with the noise error predicted by the VCM calculated by the ORM (solid red).



Conclusions

- The new H2O line data do not have a spectacular impact on the residuals, therefore it is difficult to assess their accuracy on the basis of residuals analysis.
- The H2O VMRs retrieved with the new and the old line data systematically differ up to about 20% at the top of MIPAS NOM scan range.
- Therefore the new H2O line data should be included in the next release of the MIPAS database (if considered more accurate than the previous data, on the basis of considerations independent of the residuals analysis shown here.)