COMPARISON OF SCIAMACHY OTHER PRODUCTS (AOIDs 126, 174, 427)

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ABSTRACT

Comparisons have been performed between the SCIAMACHY CO, CH_4 and H_2O columns and ground-based measurements performed at different stations. SCIAMACHY CO, CH_4 and H_2O columns show unrealistic values, orders of magnitude too high, negative values, large spread and constant values at high solar zenith angles. These errors are largely caused by calibration problems. The comparisons with ground-based measurements do not provide much additional information, given the current status the SCIAMACHY CO, CH_4 and H_2O products.

1. INTRODUCTION

From the verification of the SCIAMACHY products ([1], [2]), we have seen that the BIAS products CO, CH_4, H_2O and N_2O suffer from problems in the calibration i.e. wrong dark current correction, wrong dead and bad pixel mask and wrong wavelength calibration. As a result, the CO, CH_4, H_2O and N_2O columns show unrealistic values. The CO_2 column is zero in all the files.

Despite these non-physical values, comparisons have been done between the SCIAMACHY CO, CH_4 and H_2O columns and ground-based measurements performed at different stations. In this paper we will discuss the performed comparisons.

2. COMPARISONS

2.1 CO

Figure 1 shows a comparison of the SCIAMACHY CO vertical column density (BIAS_2_CO) versus ground-based measurements performed by direct solar observations with an IR spectrometer at St. Petersburg (upper plot) and Zvenigorod (lower plot) [3]. Daily mean values from the spectrometers are provided for the comparisons (green dots). The plotted SCIAMACHY data (version 3.51 and 3.52) are from the ground pixel closest to the measurement site, within 500 km.

In table 1 the values of the SCIAMACHY and IR-spectrometer data are given for co-located measurements together with the processor version of the SCIAMACHY data. It can be seen that half of the coincidences (indicated in red) do not deal with a real retrieval of SCIAMACHY, but with some fixed constant value.

In these three cases, where we find a fixed value, the solar zenith angle for the measurement is larger than 90° and corresponds to a measurement in the ascending part of the orbit, in contrary to the other 3 coincidences where the solar zenith angles are around 40° and which correspond to a measurement in the descending part of the orbit.

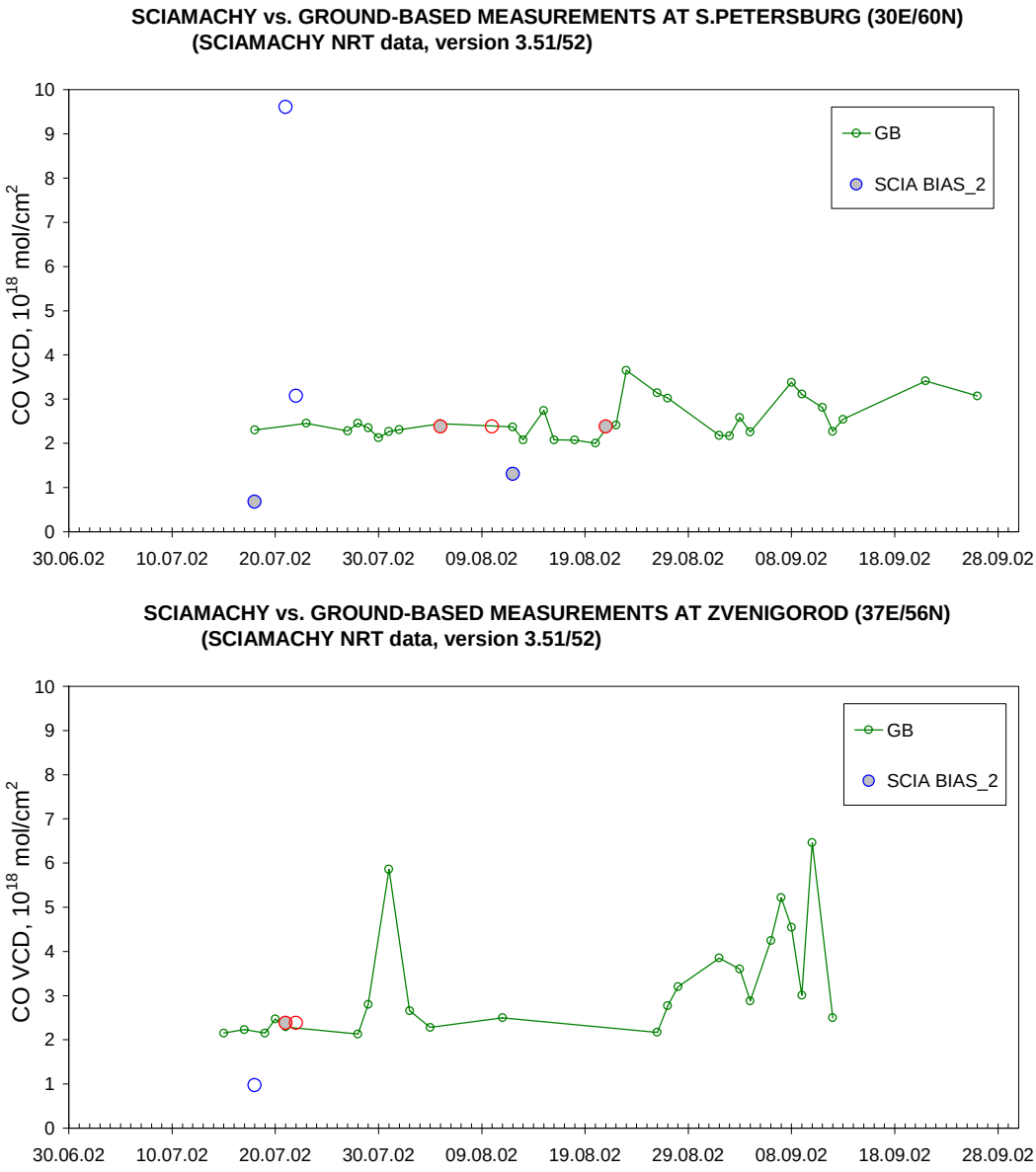

Figure 1 Comparison of SCIAMACHY CO columns with ground-based measurements from an IR spectrometer at St. Petersburg and Zvenigorod.

CO, 10^{18} mol/cm^2

STATION	DATE	G-B	BIAS_2	V_N
St.Petersburg	18.07.02	2.30	0.68	3.51
Zvenigorod	21.07.02	2.29	2.38	3.51
St.Petersburg	05.08.02	2.44	2.38	3.52
Zvenigorod	11.08.02	2.50	35.63	3.52
St.Petersburg	12.08.02	2.37	1.31	3.52
St.Petersburg	21.08.02	2.32	2.38	3.52

Table 1 Coincidences at St. Petersburg and Zvenigorod. Ground-based (G-B) and SCIAMACHY (BIAS_2) values are given together with the version number (V_N). Red numbers indicate the fixed constant values found in the product for solar zenith angles larger than 90°.

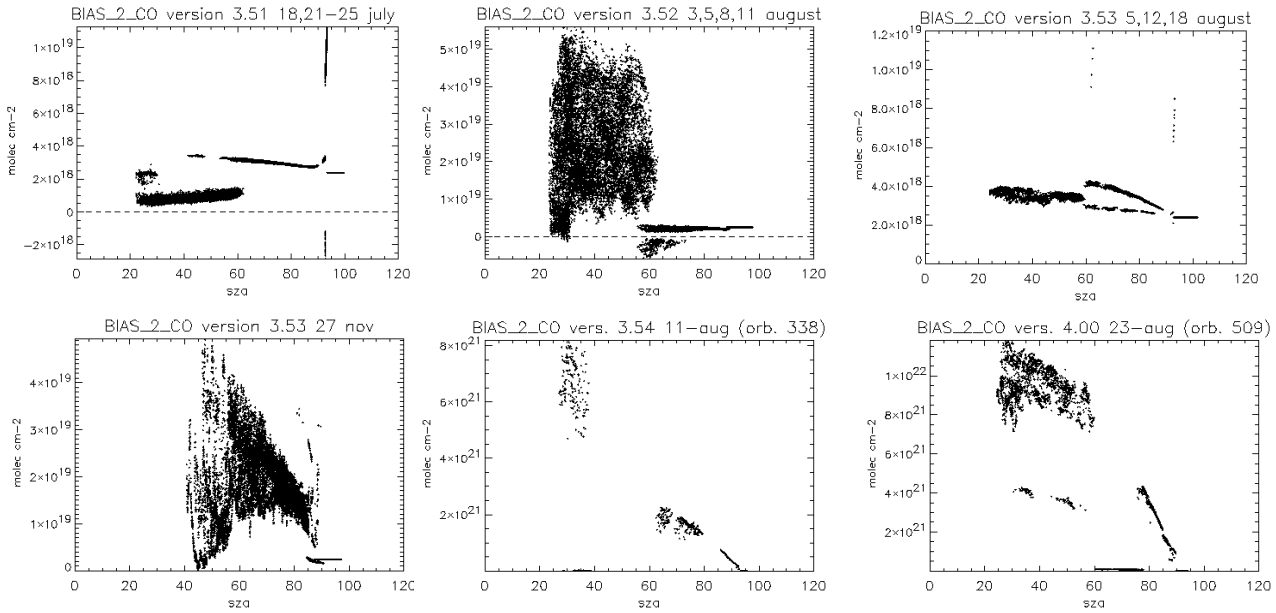

Figure 2 CO vertical column densities in molecules/cm^2 as function of solar zenith angle for different processor versions and dates.

The fixed value of 2.38E18 molecules/cm^2 agrees well with the ground-based measurements and is a realistic value for the CO vertical column density. The non-fixed values shown in Figure 1 (blue circles) seem to contradict other studies (references) showing values for CO that are orders of magnitude too large. This is due to the different processor versions and dates of the measurements used in the studies. Figure 2 shows scatter plots of the vertical column densities of CO as function of solar zenith angle for different SCIAMACHY processor versions and dates. Indeed version 3.51 (18,21 and 25 July) seems to produce values of the right order of magnitude. This is also valid for version 3.53 data for 5, 12 and 18 August while the data produced with the same version but for 27 November exhibits a large spread and is orders of magnitude too large. Also processor version 3.52 and 4.0 show this large spread and values that are orders of magnitude off.
It is clearly illustrated that the behaviour of the retrieved SCIAMACHY CO column values depends on the processor version and date. In all the versions we can also see the fixed constant values for large solar zenith angle

2.2 CH_4

Figure 3 shows a comparison of the SCIAMACHY CH_4 vertical column density (BIAS_2_CH4) with ground-based measurements performed by direct solar observations with an IR spectrometer at St. Petersburg (upper plot) and Zvenigorod (lower plot) [3]. Daily mean values from the spectrometers are provided for the comparisons (green dots). The plotted SCIAMACHY data (version 3.51 and 3.52) are from the ground pixel closest to the measurement site, within 500 km.
In table 2 the values of the SCIAMACHY and IR-spectrometer data are given for co-located measurements together with the processor version of the SCIAMACHY data.
Again it can be seen that some of the coincidences (indicated in red), corresponding to solar zenith angles larger than 90°, do not deal with a real retrieval of SCIAMACHY, but with a fixed constant value. This fixed value of 3.54E19 molecules/cm^2 agrees well with the ground-based measurements and is a realistic value for the CH_4 vertical column density.
Figure 4 illustrates that, similarly to the CO values, the measured SCIAMACHY CH_4 column values depend on the processor version and date. Some combinations of processor version and dates deliver values orders of magnitude too large, others are in the right order of magnitude. Negative values are seen in version 3.51 and 4.0.
BIAS_1_CH4 (from window 2269-2275 nm) shows similar results as BIAS_2_CH4 (from window 2360-2366 nm). Figure 5 shows one complete orbit of BIAS_1_CH4 data from 22 November 2002 (version 3.53) as function of time [4]. In the beginning of the orbit we see the constant value of 3.54E19 molecules/cm^2, further along the orbit the values rapidly increase to values in the range of 10^{21} and 10^{22} molecules/cm^2, which is orders of magnitude too large.

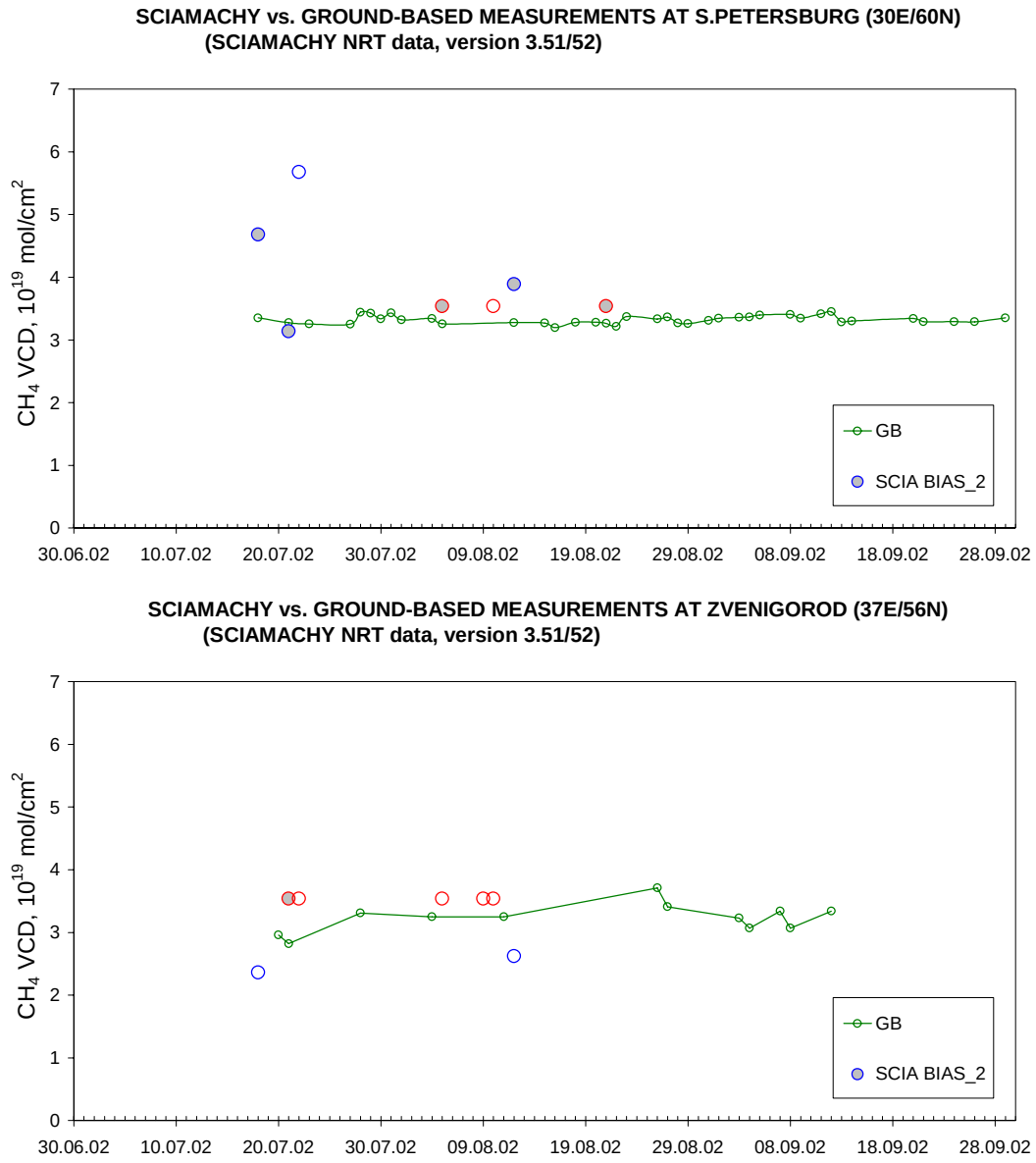

Figure 3 Comparison of SCIAMACHY CH_4 columns with ground-based measurements from an IR spectrometer at St. Petersburg and Zvenigorod.

CH_4, 10^{19} mol/cm^2

STATION	DATE	G-B	BIAS_2	V_N
St.Petersburg	18.07.02	3.35	4.68	3.51
St.Petersburg	21.07.02	3.27	3.14	3.51
Zvenigorod	21.07.02	2.82	3.54	3.51
St.Petersburg	05.08.02	3.26	3.54	3.52
Zvenigorod	11.08.02	3.25	405.31	3.52
St.Petersburg	12.08.02	3.28	3.89	3.52
St.Petersburg	21.08.02	3.26	3.54	3.52

Table 2 Coincidences at St. Petersburg and Zvenigorod. Ground-based (G-B) and SCIAMACHY (BIAS_2) values are given together with the version number (V_N). Red numbers indicate the fixed constant values found in the product for solar zenith angles larger than 90°.

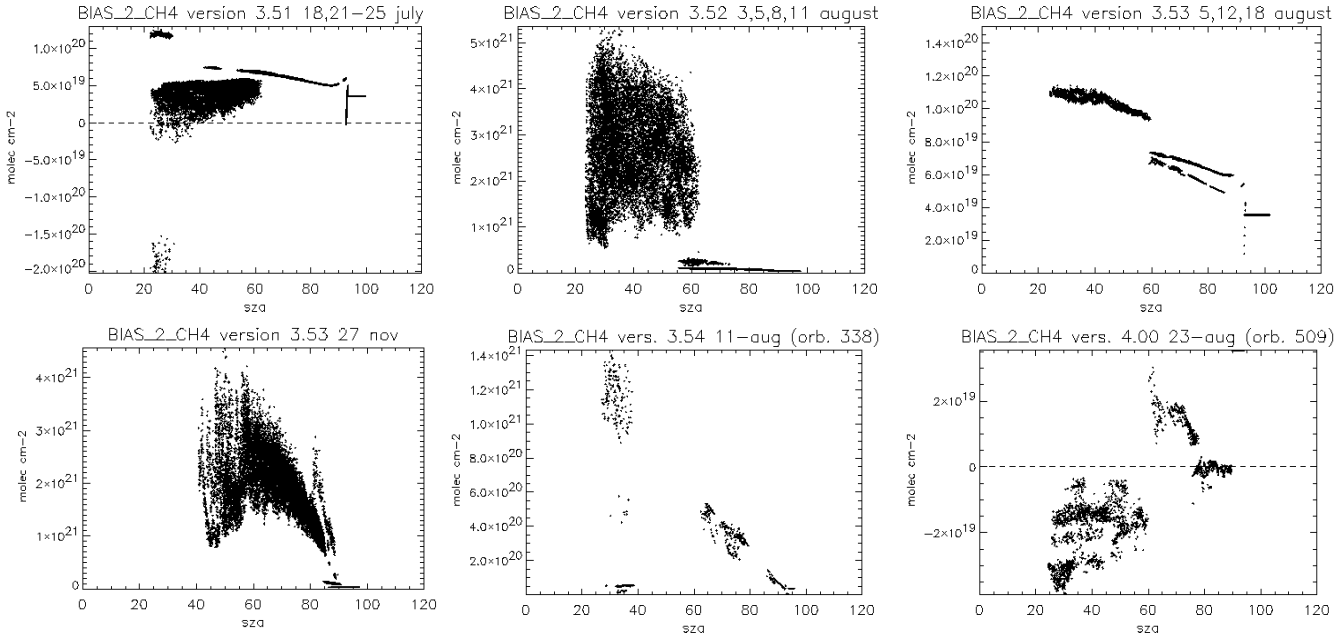

Figure 4 CH_4 vertical column densities in molecules/cm^2 as function of solar zenith angle for different processor versions and dates.

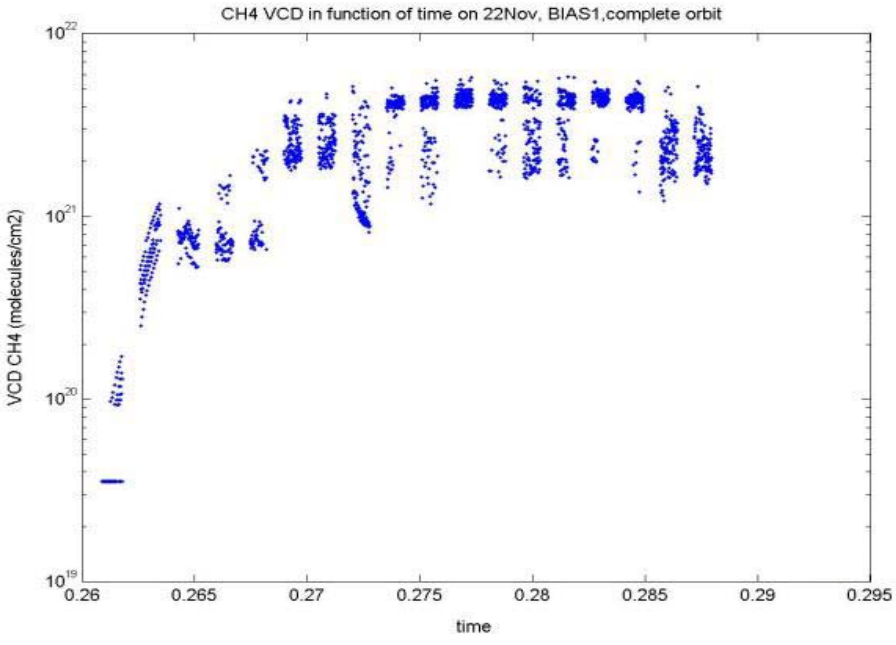

Figure 5 BIAS_1_CH4 vertical column densities in molecules/cm^2 for one orbit on 22 November 2002 as function of time.

2.3 H_2O

The SCIAMACHY processor retrieves H_2O vertical column densities from 3 different windows. For processor version 3.53 and the period from 25 October to 10 November 2002 we found the following:

- *BIAS_2_H2O from channel 8 2360-2366 nm*: all values are negative. This is the same in older versions. Version 4.0 gives positive values but orders of magnitude too high.
- *BIAS_1_H2O from channel 8 2269-2275 nm:* values between 0 and 3 x 10^5 kg/m^2; 1% of the pixels have negative values, not counting the measurements with solar zenith angle > 85°.
- *BIAS_0_H2O from channel 7 2031-2038 nm:* some non-physical values, large spread, small errors (negative errors for negative values), many 'realistic' values around 10-20 kg/m^2, 0.1% of the pixels have negative values.

The findings for BIAS_0_H2O are illustrated in figure 6, which is a scatter plot of the H_2O vertical column density as function of solar zenith angle. You can see many realistic values between 0 and 40 kg/m^2. Furthermore a small dependency of the H2O column on solar zenith angle can be seen which is expected since the higher H_2O values in the tropics usually correspond to lower solar zenith angles.

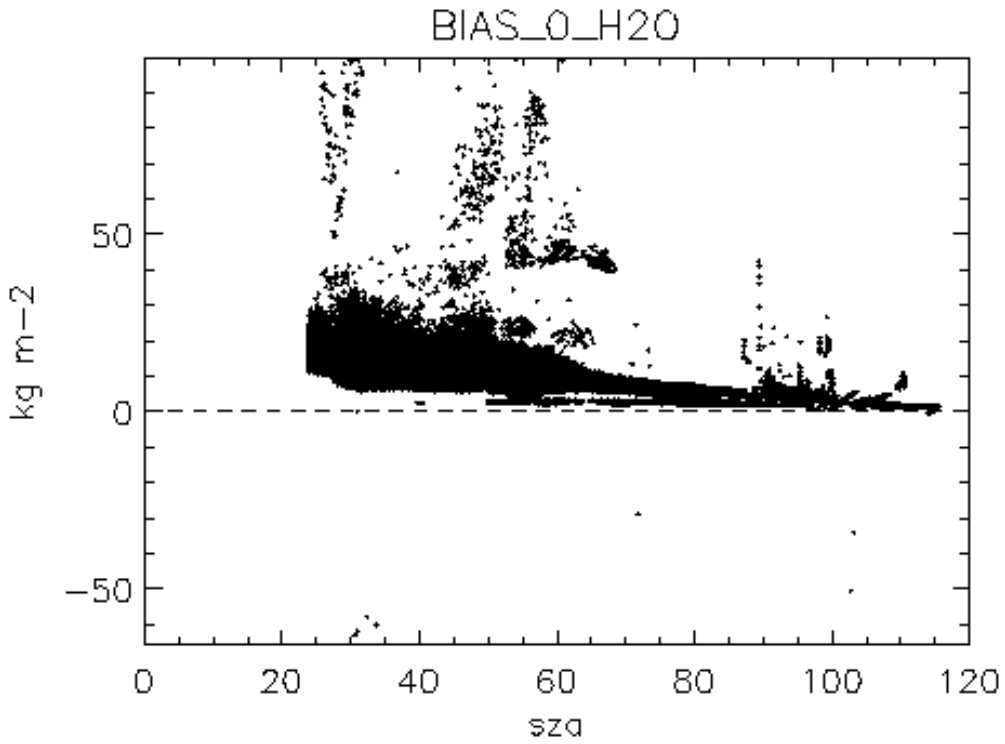

Figure 6 BIAS_0_H2O vertical column densities in kg/m^2 as function of solar zenith angle for processor version 3.53, period 25 October-10 November 2002.

Figure 7 shows a comparison of the SCIAMACHY H_2O vertical column density versus ground-based measurements performed by direct solar observations with an IR spectrometer at Issyk-Kul [3]. Daily mean values from the spectrometers are provided for the comparisons (green dots). The plotted SCIAMACHY data (version 3.53) are from the ground pixel closest to the measurement site, within 500 km.
In table 3 the values for the SCIAMACHY and IR-spectrometer data are given for co-located measurements together with the processor version of the SCIAMACHY data.
Figure 8 shows comparisons between SCIAMACHY H_2O vertical column density and integrated water vapour columns from radiosondes at De Bilt and Legionowo. All pixels within 300 km of the ground-based stations on the same day are plotted and a large spread can be seen in these pixels for a specific day. The pixel closest to the ground based station is indicated with a blue star and shows that this pixel does not always give the best agreement with the SCIAMACHY measurement. The SCIAMACHY co-locations with De Bilt are all from processor version 3.53 and those for Legionowo are from version 3.51 (18 July 2002), 3.52 (11 August 2002) and 3.53 (30 October-27 November 2002).

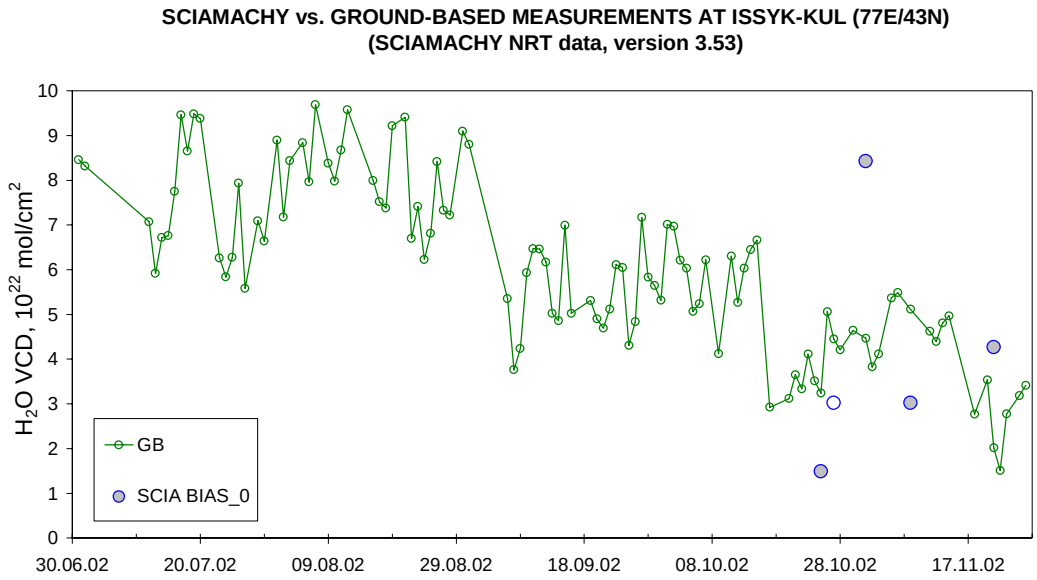

Figure 7 Comparison of SCIAMACHY H_2O columns with ground-based measurements from an IR spectrometer at Issyk-Kul.

H_2O, 10^{22} mol/cm^2

STATION	DATE	G-B	BIAS_0	V_N
Issyk-Kul	25.10.02	3.24	1.49	3.53
Issyk-Kul	01.11.02	4.47	8.43	3.53
Issyk-Kul	08.11.02	5.12	3.02	3.53
Issyk-Kul	21.11.02	2.02	4.27	3.53

Table 3 Coincidences at Issik-Kul. Ground-based (G-B) and SCIAMACHY (BIAS_0) values are given together with the version number (V_N).

It should be noted that H_2O is highly variable in space and therefore when comparing different measurements strict collocation criteria need to be set. The simple comparisons performed here need to be combined with dynamical analyses to identify the airmasses of the satellite and ground based measurement. Furthermore radiosondes are less accurate in the stratosphere and the sensitivity of the SCIAMACHY measurement for the tropospheric water vapour amount needs to be investigated to determine the suitability of using integrated radiosonde measurements for the validation of the SCIAMACHY data.

3 CONCLUSIONS

In this paper we have shown that SCIAMACHY column amounts of CO, CH_4 and H_2O show non-physical values, depending on processor version and dates orders of magnitude too high, negative values, large spread and constant values at high solar zenith angles. The poor quality of these products is largely caused by calibration errors, i.e. wrong dark current correction, wrong dead and bad pixel mask, wrong wavelength calibration, no correction for loss of transmission due to ice ([1]).
Given the current status of the CO, CH_4 and H_2O products, the comparisons with ground-based measurements do not give much additional information.
BrO, OClO, SO_2 and H_2CO columns have not been addressed in this paper since these products have not been distributed to all cal/val PI's yet.
To conclude we would like to state that scientific retrievals of CH_4 and H_2O from SCIAMACHY Level 1 data yield physically consistent values, which suggest that the here reported problems can be understood and fixed in the near future.

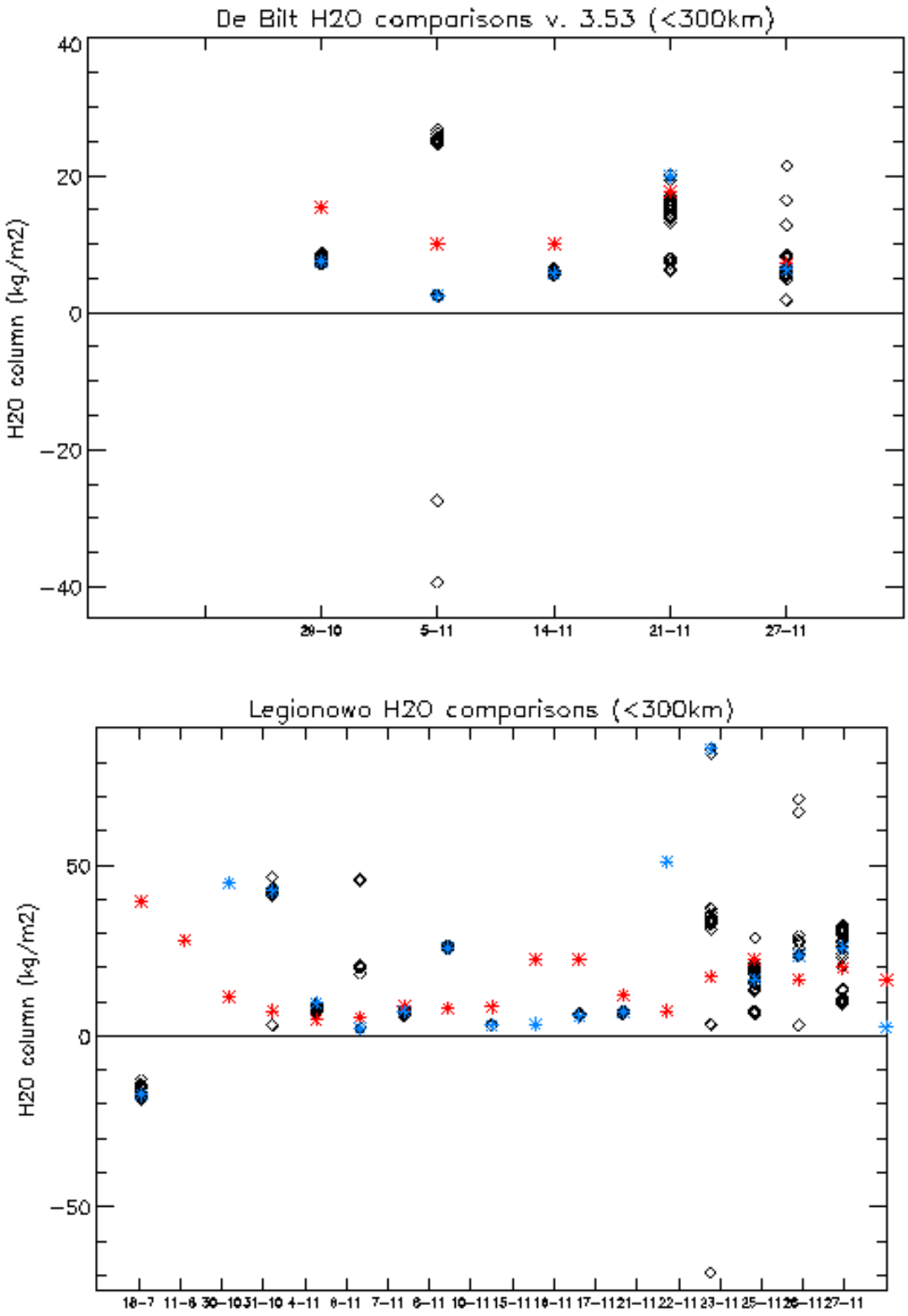

Figure 8 Intercomparisons of SCIAMACHY H_2O vertical column densities integrated radiosondes at collocated ground based stations at De Bilt (52.1 N; 5.18E) and Legionowo (52.2 N; 20.6 E). Red stars are the values from the integrated radiosondes. Black squares are the SCIAMACHY measurements within 300 km of the stations. Blue stars denote the SCIAMACHY pixels closest to the ground based station.

ACKNOWLEDGEMENTS

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4. REFERENCES

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