Task 2
Data Processing Quality Control

Title: Investigation on excessive N2O concentration in the stratosphere observed on MIPAS L2 re-processed data of 8 – 13 March 2003

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Abstract

This document presents the investigation on the anomaly of excessive N2O in the stratosphere detected by Dr. Jens-Uwe Grooss (Forschungszentrum Juelich) on some MIPAS L2 re-processed data (available at D-PAC).

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1 The anomaly detection

The problem was detected by Dr. Jens-Uwe Grooss (Forschungszentrum Juelich) looking at MIPAS N2O re-processed data (available at D-PAC archive). He found that for some days the N2O concentration seems excessively high in the stratosphere, this was verified for the following days:

from March 7 18:00 to March 8 ~19:00 2003

from March 13 18:00 to March 15 4:00 2003

The anomaly can be seen in Fig.1, where the pressure level at which N2O VMR is equal to 300ppb is plotted as a function of time. The plot shows that for some days (see peaks around 8th and 15th March) this VMR level occurs at pressure lower (higher altitude) with respect to the rest of the analyzed time interval.

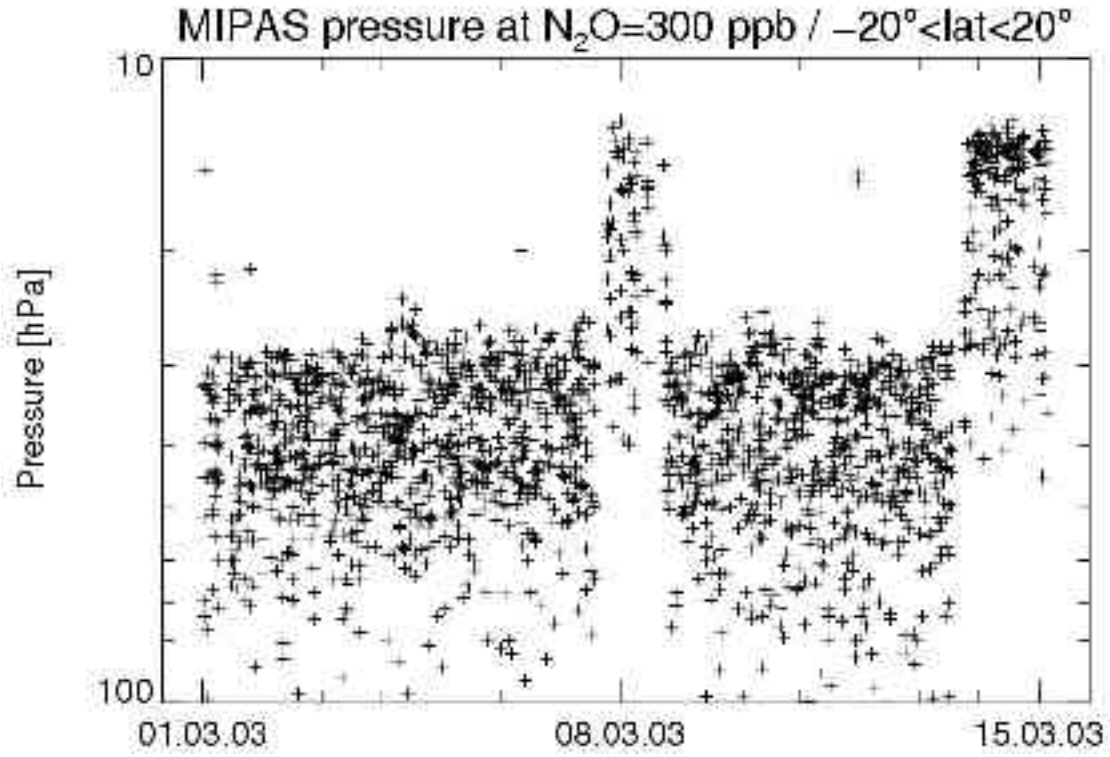

Figure 1 Pressure level at which N2O VMR is equal to 300ppb as a function of time for March 2003 MIPAS re-processed data considering the latitude range -20°<lat<20°.

2 The anomaly investigation

A quality check of the data (retrieved from D-PAC L2 archive) was performed using Quadas tool, some results are presented in the following figure. In Figs 2 it is shown the N2O VMR as a function of time for 7 – 8 March 2003. The red spots in the figures show too high N2O value in the stratosphere (highlighted with blue curve) corresponding to the problem observed by the user. The start and stop of the anomaly is also clearly visible in these plots and correspond to the time reported already by the user, namely from 7th 18h UTC to 8th March 19h UTC. The anomaly does not depend on latitude and is not only restricted to low altitude, but goes up to 30 km.

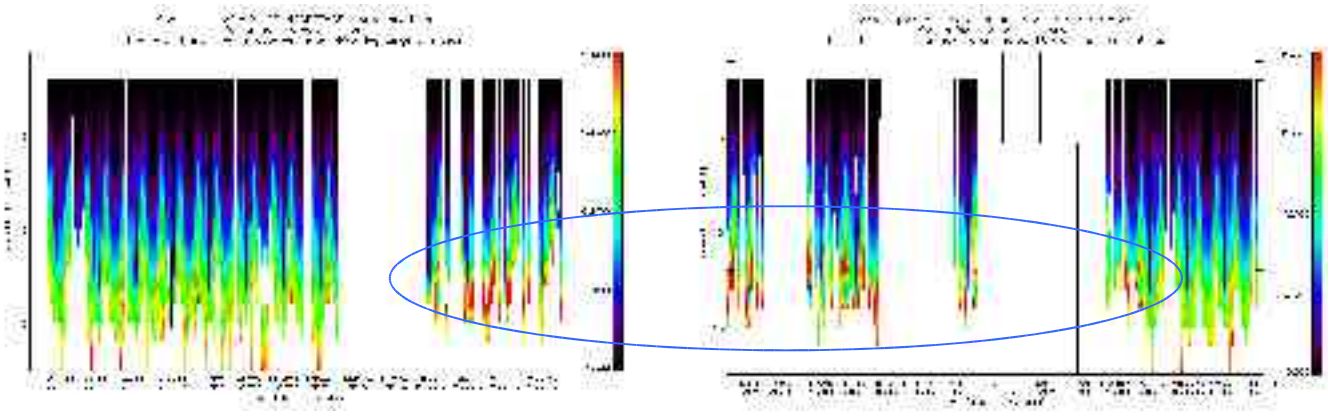

Figure 2 N2O concentration (color scale) plotted versus sweep index and time for 7 – 8 March 2003. Highlighted with blue curve are the regions with excessively high N2O (see red spot) in the stratosphere, the anomaly starts on 7th March 2003 18h UTC and stops on 8th March 2003 19h UTC.

The anomaly is not only in the N2O, but also in the other retrieved target parameters. In particular we observe that for the same period we have an excess of retrieved T, CH4 (see Fig. 3) and O3 and a deficient retrieved values for H2O, NO2 and HNO3 (see Fig. 3). Also in this case the anomaly does not depend on latitude and goes up to high altitude (around 30 km).

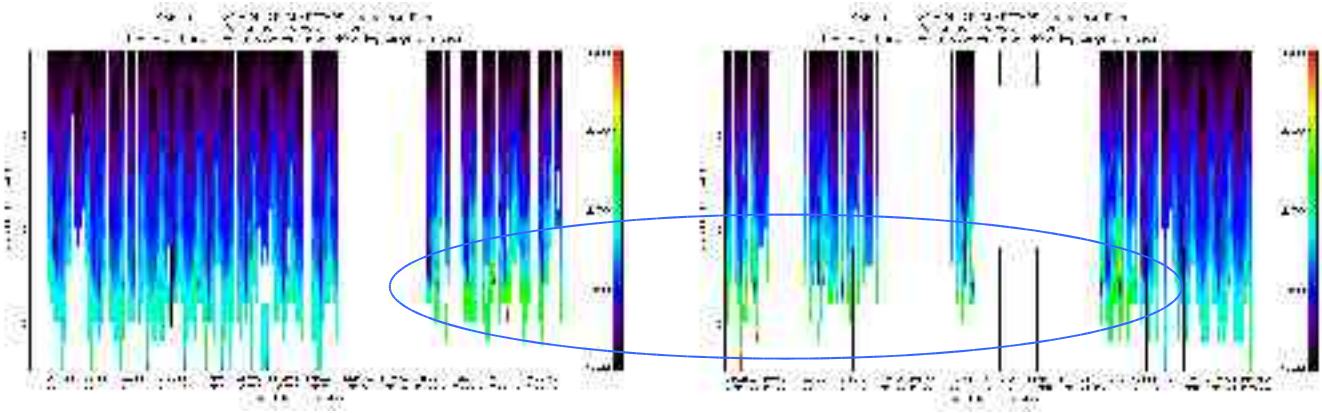

Figure 3 CH4 concentration (color scale) plotted versus sweep index and time for 7 – 8 March 2003. Highlighted with blue curve are the regions with excessively high CH4 in the same region where we observe too high N2O.

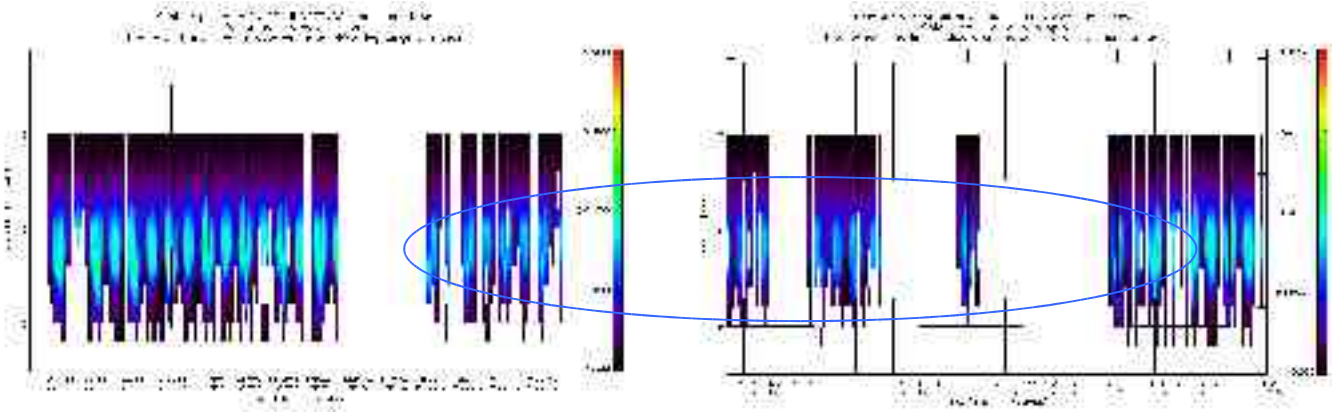

Figure 4 HNO3 concentration (color scale) plotted versus sweep index and time for 7 – 8 March 2003. Highlighted with blue curve are the regions with too low HNO3 in the same region where we observe too high N2O.

A further evidence of the anomaly is reported in Fig. 5; this plot shows the last chi-square value for all the retrieved parameters of the MIPAS L2 processing chain (e.g.: pT, H2O, O3, N2O, NO2, CH4, and HNO3). Also in this case the anomaly is manifest; see the extremely high chi-square value of the N2O retrieval (highlighted with a blue curve). The time extension of this anomalous chi-square is the same observed in the previous plot. Also in this analysis the excessive chi-square can be detected for all the retrieved parameters, even though the problem is more pronounced for p-T, O3 and N2O.

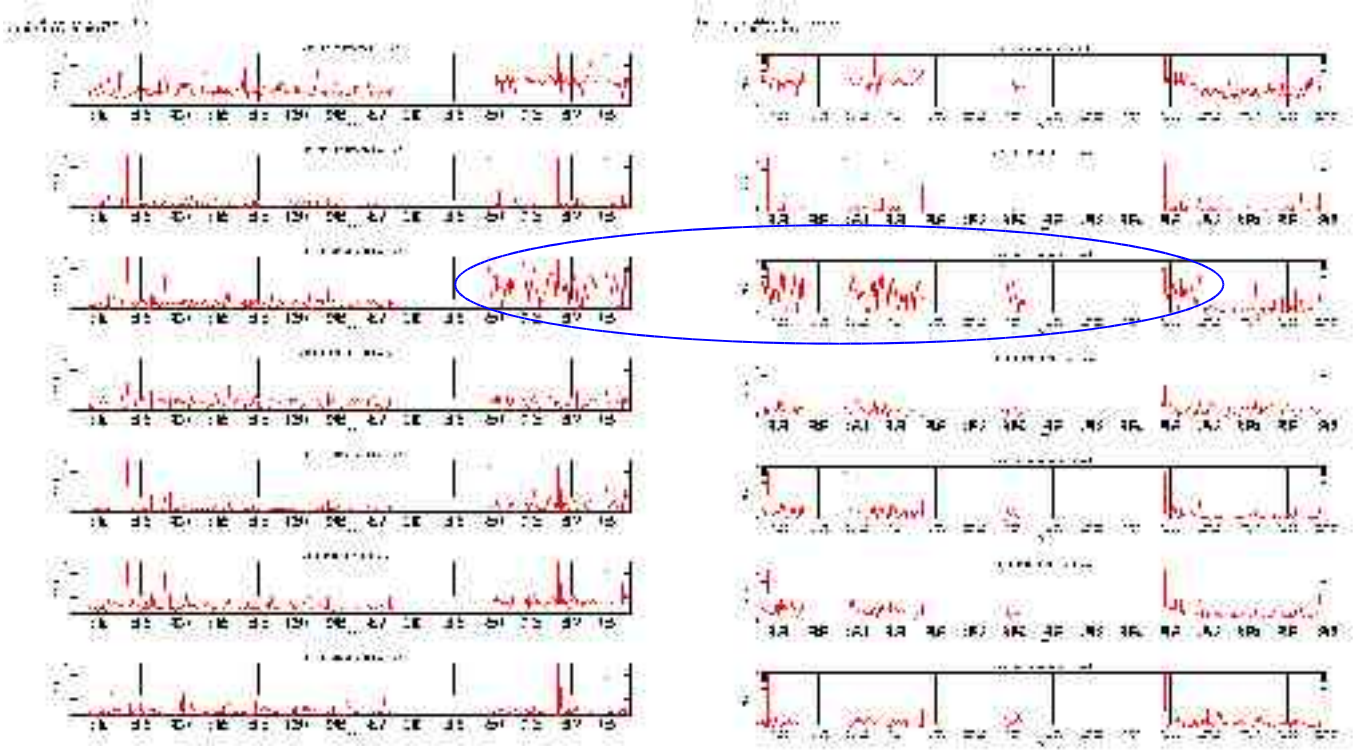

Figure 5 Last chi-square values for 7th and 8th March 2003 MIPAS L2 data. This value is plotted as a function of time for all the retrieved L2 parameters, e.g.: (starting from the top) pT, H2O, N2O, HNO3, CH4, O3, NO2. Highlighted with the blue curve is the anomalous high chi-square for N2O retrieval, for the same period all the chi-square (in particular p-T and O3) seem really high.

The inspection of the affected L2 products shows that in most of the cases (not always) they were already flagged in the MPH with PRODUCT_ERR=1 (see Fig.6); this means that an error was already detected in the product by the processor and the reliability of these results is not guaranteed. This flag can be set to one due to several sources of quality degradation. A first check was performed on the SPH and SUMMARY_QUALITY_ADS fields in order to seek the root cause of this flag. No clues were found in these fields. Finally it was observed that this product error flag is coming from the input L1 data, indeed when this flag is set to 1 in the L1 product it is automatically reported in the corresponding L2 (see Fig. 7).

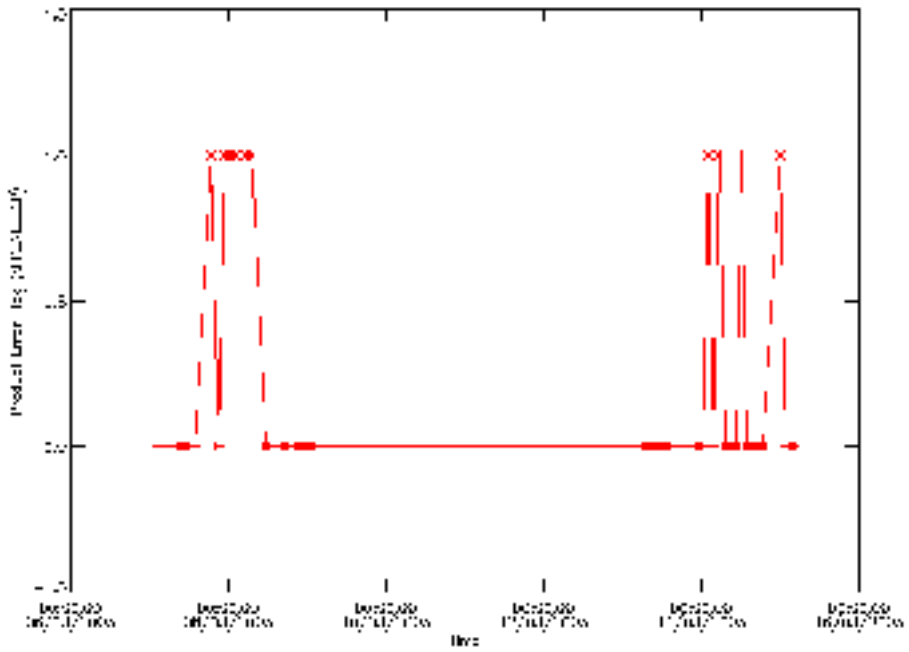

Figure 6 Product error flag (in the MPH) for MIPAS L2 data of March 2003. The products with error flag set to one correspond to the time of the anomaly reported in Fig.1.

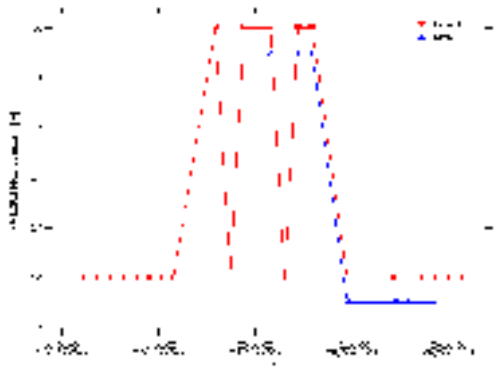

Figure 7 Product error flag (in the MPH) for MIPAS L2 compared to L1 data of 8th March 2003, The comparison shows that the product error flag present in the L2 is coming from a quality degradation of the corresponding L1 product.

The problem is now to understand the reason of the L1 product error. The corresponding L1 data were downloaded from D-PAC center, and inspected for scientific issues using Quadas tool. The investigation shows that these products are highly corrupted; in particular a high number of corrupted observations in the bands A, AB and B can be seen in the spectra (see Fig. 7 – 8), while in the band C and D the corrupted observations are less frequent. Owing to this large occurrence of corruptions the product error flag was set to 1 in the L1 MPH.

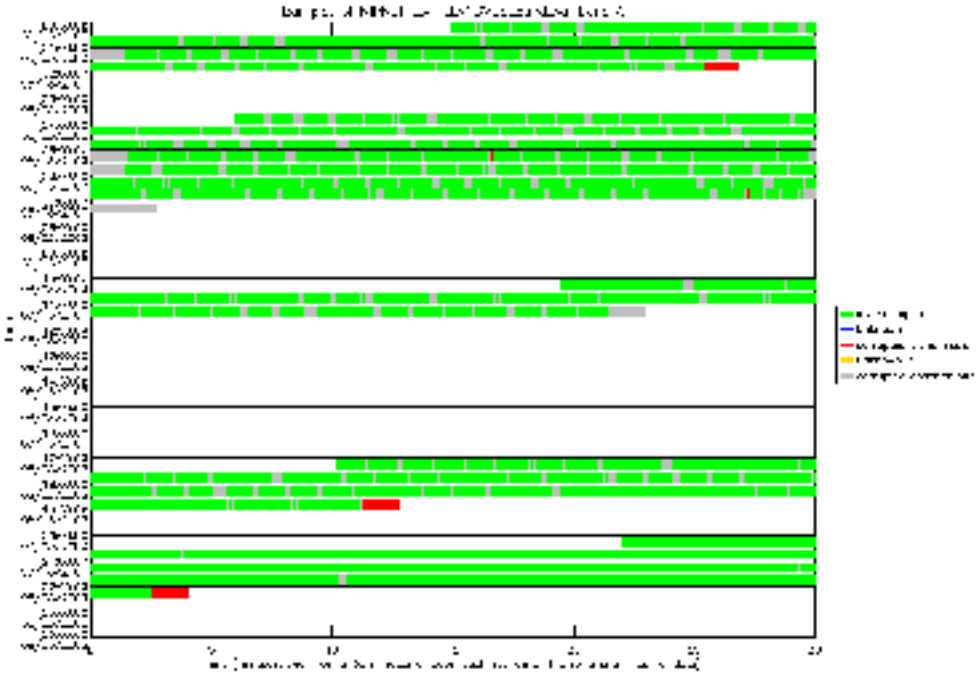

Figure 8 Band A validity flag for MIPAS L1 products of 8th March 2003 as a function of UTC.

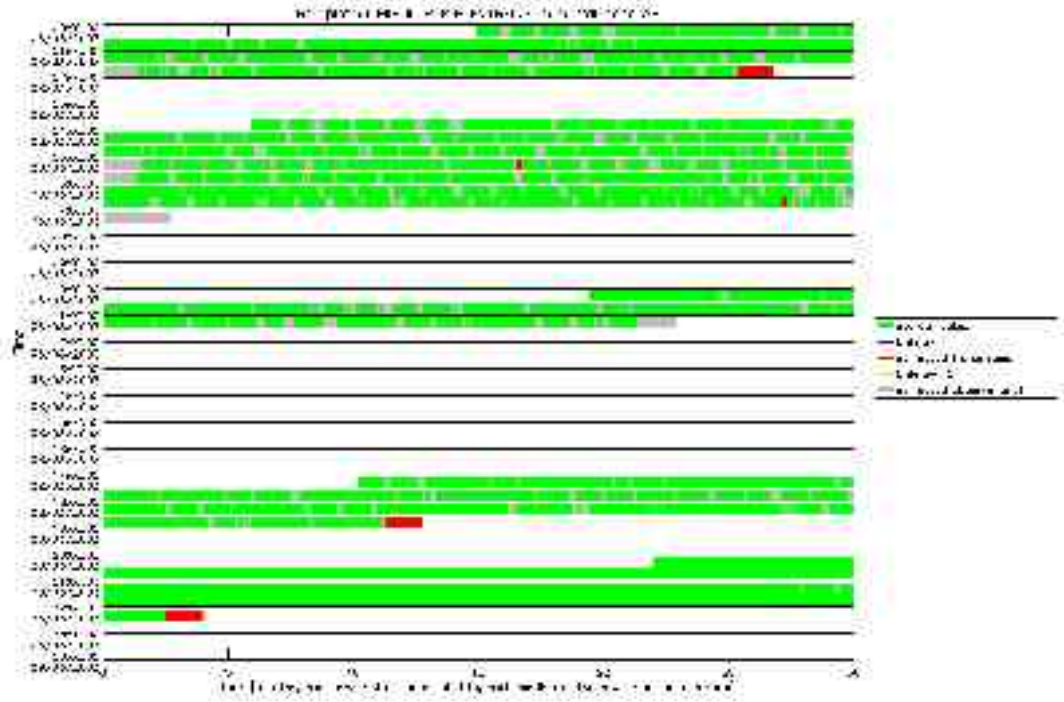

Figure 9 Band AB validity flag for MIPAS L1 products of 8th March 2003 as a function of UTC.

Finally it was noted that the used dynamic ADFs (MIP_CS1_AX, MIP_CG1_AX, MIP_CO1_AX) in the corrupted L1 products are not correct, this can be the root cause of

the retrieval problem. Indeed looking at the figure 8 we observe an anomaly in the usage of MIP_CS1_AX ADF as a function of time for days 7 – 8 March 2003 (note that for MIP_CO1 and MIP_CG! The situation is the same). In the time of the N2O anomaly an obsolete ADF was suddenly used by the processor (see creation date of June 2002!).

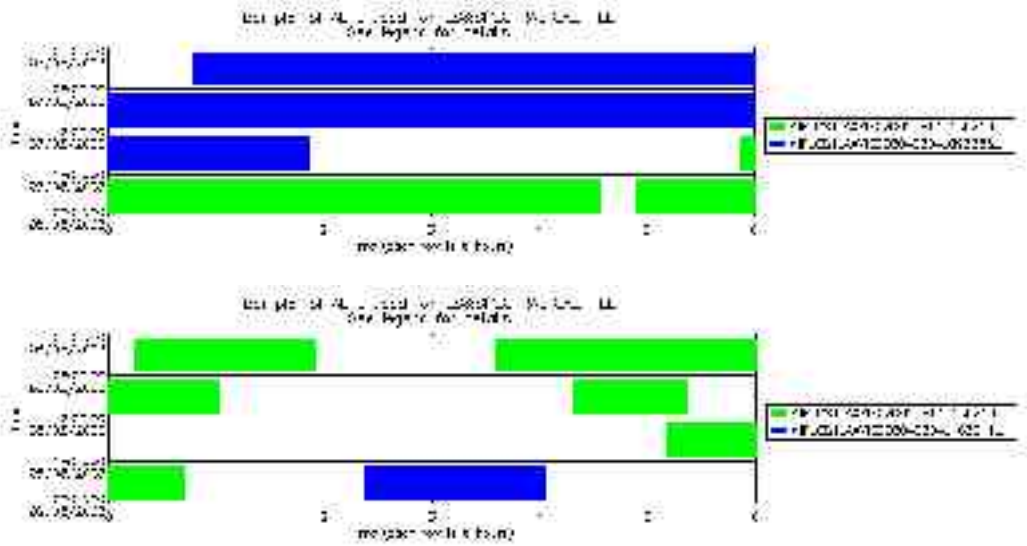

Figure 10 MIP_CS1_AX usage in the L1 processing of 7 – 8 March measurement, note that also for the other L1 dynamic ADF the situation is the same.

The inspection of the historic ADF database solves finally the mystery. The following files were found for MIP_CS1_AX in the time period we are considering (see START and STOP validity highlighted in red):

MIP_CS1_AXVIEC20040304_093656_20030227_233850_20030307_135112

MIP_CS1_AXVIEC20040304_103211_20030308_174500_20030313_132614

MIP_CS1_AXVIEC20040304_094656_20030311_084402_20030313_132614

MIP_CS1_AXVIEC20040304_104208_20030319_125512_20030326_013026

It is evident that in the ADFs database there are two validity gaps (note that for the other dynamic ADF the situation is the same); these gaps are shown in the table below.

Table 1 Start and stop time of ADF validity gaps.

START	STOP
2003-03-07 13:51:12	2003-03-08 17:45:00
2003-03-13 13:26:14	2003-03-19 12:55:11

Taking into account the unavailability intervals (see Tab. 2) still remain two validity gaps in the ADFs and this gaps correspond exactly to the time extension of the N2O anomaly (see Fig.11). The operational processor did not find any ADF available for this time interval and took a set of very old ADF (from commissioning phase!) which have stop validity at end of mission, namely:

MIP_CG1_AXVIEC20020618_160011_20020619_060000_20501231_235959

MIP_CO1_AXVIEC20020618_155622_20020619_060000_20501231_235959

MIP_CS1_AXVIEC20020614_160210_20020615_060000_20501231_235959

As results we had a weird spectra calibration, with a problem in the products retrieval, such as the N2O problem detected by the user.

Table 2 Start and stop time of MIPAS unavailability

START	STOP
2003-03-07 13:51:12	2003-03-07 17:52:00
2003-03-08 11:22:25	2003-03-08 17:45:00
2003-03-13 13:26:14	2003-03-13 18:05:00
2003-03-15 04:21:08	2003-03-19 12:55:12

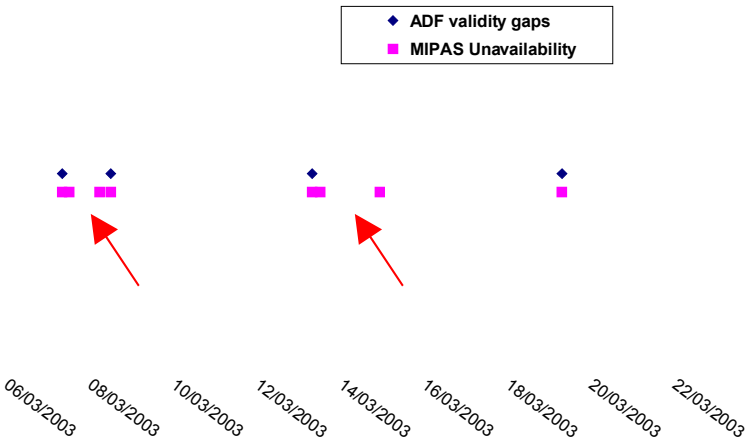

Figure 11 ADF validity gaps and MIPAS unavailability. With red arrows are highlighted the validity gaps where the N2O anomaly appears.

3 Conclusion

The investigation on the anomaly of excessive N2O value in the stratosphere shows that:

- The anomaly affects L2 MIPAS data processed OFL (with software version 4.61, 4.62) and available at D-PAC archive.
- The anomaly is observed for the following mission interval:
  - from March 7 18:00 to March 8 19:00 2003
  - from March 13 18:00 to March 15 4:00 2003
- The anomaly is not latitude dependent and is observed also at high altitude (up to 30km).
- The anomaly affects all the retrieved species with different feature:
  - An excessive retrieved VMR for N2O, CH4 and O3
  - A deficient retrieved VMR for H2O, NO2 and HNO3
- An excessive chi-square value is detected in correspondence to this anomaly for all the retrieved species, in particular for N2O, p-T and O3.
- Most of the L2 products affected by this anomaly have product error flag set to 1 in the MPH. This flag came from the corresponding L1 products used as input.
- The used L1 products show many corrupted observations in the band A, AB and B, while bands C and D are less affected by corruption
- The cause of the anomaly is the usage of wrong ADFs. The problem was that in the ADF database for the re-processing of FR MIPAS mission there was a gap in the ADF validity, in particular for the time period of the N2O anomaly the L1 processor did not find any available ADF, then it used a very old set (taken from commissioning phase!) with a resulting wrong spectra calibration. This finally causes the anomalous retrieval.