Verification Report OL V 5.0

SCIAMACHY Level 1b to 2 processing

ENV-VPR-QWG-SCIA-0095

Issue 2

15 June 2009

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Change Record

Issue	Date	Page	Description of Change
1	20/08/08	all	completely new
2	12/04/10	all	Adjustments for Processor Version 5

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1 Introduction

1.1 Purpose and Scope of the document

SCIAMACHY is a joint project of Germany, The Netherlands and Belgium for atmospheric measurements. SCIAMACHY has been selected by the European Space Agency (ESA) for inclusion in the list of instruments for Earth observation research for the ENVISAT polar platform, which has been launched in 2002. The SCIAMACHY programme is currently in mission under the supervision of the SCIAMACHY science team (SSAG), headed by the Principal Investigators Professor J. P. Burrows (University of Bremen, Germany), Professor I.A.A. Aben (SRON, The Netherlands) and Dr. C. Muller (BIRA, Belgium).

The Quality Working Group has been installed in 2007 to intensify the development and implementation of the Algorithm Baseline for the operational data processing system of SCIAMACHY. Current members of the QWG are the University of Bremen (IFE) (Lead), BIRA, DLR, and SRON. The expertise of KNMI is brought in via an association with SRON.

The purpose of this document is to document the goals, planning, and reporting of the verification campaign carried out in January 2009 for the Algorithm Baseline Update of the Level 1b-2 off-line data processing. The document is thought as a report to the European and national space agencies, namely European Space Agency (ESA), German Space Agency (DLR), and the Dutch counterpart (NIVR), about the verification to provide a decision baseline for the implementation and integration of the Algorithm Baseline in the operational ENVISAT ground segment.

The subject of this document is the verification of the Algorithm Baseline Update from version 4 to version 5 of the SCIAMACHY Level 1b-2 Off-line (SGP) data processing unit. In the new version of the processor, the following new products were introduced:

1. Limb cloud flagging
2. Limb BrO profiles
3. OClO slant columns
4. H_2O total columns
5. Nadir xCO total columns

Several other retrievals were improved and total columns of SO_2 and BrO were introduced.

1.2 Documents

1.2.1 Applicable Documents

Following documents are applicable for this technical note:

[A1] ENVISAT-1 Ground Segment Concept, ESA/PB-EO(94)75, Issue 5, 20 September 1994

[A2] ESA Software Engineering Standards, ESA PSS-05-0, Issue 2, Feb. 1991

[A3] ENVISAT Product Specification Volume 15, Rev. 3k

[A4] IECF Technical Description, PO-TN-ESA-GS-1142

1.3 Abbreviations and Acronyms

A list of abbreviations and acronyms which are used throughout this document is given below:

ADF	Auxiliary Data File
ADS	Annotation Data Set
AMC	Air Mass Correction
AO	Announcement of Opportunity
BIRA-IASB	Belgisch Instituut voor Ruimte-Aëronmie, Institut d'Aéronomie Spatiale de Belgique
CFI	Customer Furnished Items
CR	Change Request
DFD	Deutsches Fernerkundungsdatenzentrum (DLR)
DLR	Deutsche Forschungsanstalt für Luft- und Raumfahrt e.V.
ECMWF	European Centre for Medium Weather Forecast
ENVISAT	Environmental Satellite
EnviView	Viewing software package for ENVISAT data products
ESA	European Space Agency
GADS	Global Annotation Data Set
IMF	Institut für Methodik der Fernerkundung (DLR)
IPF	Instrument Processing Facility
IUP-UB	Institut für Umweltphysik der Universität Bremen
JAS	July-August-September
JFM	January-February-March
MDS	Measurement Data Set
MPH	Main Product Header
mrd	Mean relative difference
NCR	Non-Conformance Report
NIVR	Nederlands Instituut voor Vlugtuigontwikkeling en Ruimtevaart
NLC	Noctilucent clouds
OND	October-November-December
PDS	Payload Data Segment
PPS	Profile Per State
PSC	Polar Stratospheric Clouds

SCIAMACHY	Scanning Imaging Absorption Spectrometer for Atmospheric Chartography
SCR	Software Change Request
SGP	SCIAMACHY Ground Processor
SPR	Software Problem Report
SQWG	SCIAMACHY Quality Working Group
SRON	Netherlands Institute for Space Research
SZA	Solar Zenith Angle

1.4 Document Overview

After the introduction (this section) the general verification method is laid out (section 2). Then a short summary of processor changes follows in section 3. The following section describe the details of the verification for each processor change. These chapters are structured in the following way:

- **Introduction:** A more detailed description of the processor change
- **Involved Partners:** Point of contacts in case of questions
- **Verification Set-Up:** Description of the verification Method
- **Verification Data Set:** Description of the data sets used
- **Verification Results:** Results of the verification.

At the end of the document a short summary and conclusions are given.

2 General Verification Method

The verification has to ensure that the scientific algorithms are properly implemented. This is done by comparing the outputs of the scientific algorithm with that of the operational implementation of the algorithm. Differences between the results can be caused by a faulty implementation or by constraints in the operational processing that makes it impossible to implement the scientific algorithm one-to-one. In the latter case the deviations have to be explained and it has to be decided if they are acceptable for the operational processing. The requirements for a sufficient testing are

1. The *same* input data have to be used. This includes databases that the algorithm needs as external inputs. In case that different external inputs are used in the operational processing, because it is deemed more practical or because one cannot use the same inputs due to operational constraints, the effects of the different input has to be separated from other effects.
2. The calibration settings of the verification data has to be identical.
3. The same retrieval settings have to be used. Even if the scientific algorithm was updated since the agreement on the settings in the operational processing, the agreed settings have to be used in the verification.[1]
4. The verification data have to cover all possible instrument settings. This is usually achieved by using one complete orbit as the smallest verification data set.
5. The verification data set should cover possible seasonal dependencies.
6. If there is more than one logical branch in the algorithm (e.g. different calculation or exclusion for certain viewing geometries), the verification data set has to cover all these cases.

Note, that a special case is the direct implementation of DLR-IMF algorithms into the operational processor (this is the case for e.g. Limb retrievals). Here no independent implementation of the algorithm exists. In order to justify the implementation of these algorithms a comparison to a tested and accepted external algorithm is performed. The external algorithm is chosen on a case-by-case basis by the SQWG. Since the external might differ considerably from the operational one, requirement 3 of the above list can be relaxed or is not applicable in these cases.
A large data set of orbits had been selected originally for the verification activities with the following reasoning:

- In order to achieve on one side a good overlap with GOME measurements and on the other side to have a good overview about the seasonal dependencies, 60 orbits were selected for the verification of the SGP V. 3.0
- This data set was extended by four days taken from a period in 2006 for the verification of the SGP version 3.01, adding 49 orbits
- For the Level 2 OL processing version 4 verification orbits were added to cover the impact of the stray light correction on ozone. In addition, the verification of the changes in the AAI algorithms requests for additional special verification orbits. Also the limb product verification needed a few additional orbits with for comparisons to co-located lidar measurements.

[1] However, if it is feasible and a change has a large positive impact, one could consider a change of the settings in the operational processing. This implies a repetition of the verification with the new settings.

In order to have a representative set also for the current state of the instrument including degradation effects, the QWG decided to add 14 orbits from 2007 and 2008 to the verification data set. Together with the data sets used for the previous verifications, in total the verification set consists of 180 orbits (see Table 2.1).

Table 2.1: *Level 1b verification data set. It consists of data from the previous SGP version 4 verification data and 12 additional orbits from 2007 and 2008.*

Orbit #	Level 1b Product
2209	SCI_NL__1PPLRA20020802_093420_000057082008_00151_02209_6028.N1
2321	SCI_NL__1PPLRA20020810_051658_000059332008_00263_02321_6224.N1
2946	SCI_NL__1PPLRA20020922_211146_000059542009_00387_02946_5191.N1
3358	SCI_NL__1PPLRA20021021_155758_000059312010_00298_03358_0195.N1
3502	SCI_NL__1PPLRA20021031_172353_000060152010_00442_03502_1460.N1
4520	SCI_NL__1PSLRA20030110_201324_000060152012_00458_04520_0605.N1
4618	SCI_NL__1PPLRA20030117_163251_000059612013_00055_04618_1553.N1
4673	SCI_NL__1PPLRA20030121_124504_000059822013_00110_04673_1532.N1
4720	SCI_NL__1PSLRA20030124_193330_000059612013_00157_04720_0740.N1
4757	SCI_NL__1PSLRA20030127_093541_000059382013_00194_04757_0777.N1
4812	SCI_NL__1PPLRA20030131_054818_000059382013_00249_04812_0261.N1
4830	SCI_NL__1PSLRA20030201_115858_000060212013_00267_04830_0312.N1
4868	SCI_NL__1PSLRA20030204_034212_000059772013_00305_04868_0063.N1
4953	SCI_NL__1PSLRA20030210_021227_000059772013_00390_04953_0135.N1
4995	SCI_NL__1PSLRA20030213_003742_000060092013_00432_04995_0171.N1
5033	SCI_NL__1PSLRA20030215_162052_000059662013_00470_05033_0209.N1
5147	SCI_NL__1PSLRA20030223_152900_000059832014_00083_05147_0324.N1
5202	SCI_NL__1PSLRA20030227_114155_000060062014_00138_05202_0379.N1
5257	SCI_NL__1PSLRA20030303_075437_000060172014_00193_05257_0513.N1
5326	SCI_NL__1PSLRA20030308_033623_000059702014_00262_05326_0824.N1
5373	SCI_NL__1PSLRA20030311_102423_000059332014_00309_05373_0868.N1
5411	SCI_NL__1PSLRA20030314_020647_000060172014_00347_05411_0498.N1
5482	SCI_NL__1PSLRA20030319_010920_000059732014_00418_05482_0778.N1
5636	SCI_NL__1PSLRA20030329_192131_000059682015_00071_05636_0850.N1
5677	SCI_NL__1PSLRA20030401_160721_000059352015_00112_05677_0853.N1
5789	SCI_NL__1PPLRA20030409_115325_000059792015_00224_05789_0622.N1
5845	SCI_NL__1PSLRA20030413_094713_000059792015_00280_05845_1186.N1
5859	SCI_NL__1PSLRA20030414_091529_000059792015_00294_05859_1212.N1
5972	SCI_NL__1PSLRA20030422_064249_000059902015_00407_05972_0559.N1
6027	SCI_NL__1PSLRA20030426_025607_000059862015_00462_06027_0616.N1
6197	SCI_NL__1PSLRA20030508_000258_000056592016_00131_06197_0848.N1
6298	SCI_NL__1PSLRA20030515_012255_000056852016_00232_06298_1194.N1

Orbit #	Level 1b Product
6467	SCI_NL__1PSLRA20030526_204328_000056472016_00401_06467_1178.N1
6468	SCI_NL__1PSLRA20030526_222404_000056792016_00402_06468_1276.N1
6505	SCI_NL__1PSLRA20030529_122606_000056472016_00439_06505_1222.N1
6534	SCI_NL__1PSLRA20030531_130323_000056782016_00468_06534_1361.N1
6586	SCI_NL__1PSLRA20030604_041422_000056782017_00019_06586_1316.N1
6649	SCI_NL__1PSLRA20030608_135157_000056462017_00082_06649_1429.N1
6651	SCI_NL__1PSLRA20030608_171309_000056462017_00084_06651_1433.N1
6739	SCI_NL__1PSLRA20030614_204544_000056462017_00172_06739_1552.N1
6810	SCI_NL__1PSLRA20030619_194811_000056802017_00243_06810_0044.N1
6881	SCI_NL__1PSLRA20030624_185041_000056502017_00314_06881_0122.N1
6935	SCI_NL__1PSLRA20030628_132301_000056522017_00368_06935_0180.N1
6991	SCI_NL__1PSLRA20030702_111635_000056542017_00424_06991_0249.N1
7076	SCI_NL__1PSLRA20030708_094735_000056902018_00008_07076_0363.N1
7103	SCI_NL__1PSLRA20030710_070348_000056592018_00035_07103_0392.N1
7201	SCI_NL__1PSLRA20030717_032244_000056972018_00133_07201_0511.N1
7286	SCI_NL__1PSLRA20030723_015356_000056692018_00218_07286_0827.N1
7399	SCI_NL__1PSLRA20030730_232204_000057082018_00331_07399_0831.N1
7480	SCI_NL__1PSLRA20030805_151059_000056802018_00412_07480_0931.N1
7505	SCI_NL__1PSLRA20030807_090605_000057132018_00437_07505_0964.N1
7831	SCI_NL__1PSLRA20030830_033631_000059802019_00262_07831_1438.N1
7834	SCI_NL__1PSLRA20030830_083809_000060042019_00265_07834_1443.N1
7884	SCI_NL__1PSLRA20030902_202746_000059642019_00315_07884_1506.N1
7896	SCI_NL__1PSLRA20030903_163503_000059652019_00327_07896_1522.N1
7993	SCI_NL__1PSLRA20030910_111410_000059362019_00424_07993_1648.N1
8077	SCI_NL__1PSLRA20030916_080347_000059752020_00007_08077_1758.N1
8161	SCI_NL__1PSLRA20030922_045448_000059312020_00091_08161_1876.N1
8231	SCI_NL__1PSLRA20030927_021533_000059742020_00161_08231_2086.N1
8330	SCI_NL__1PSLRA20031004_001602_000058872020_00260_08330_2108.N1
8401	SCI_NL__1PSLRA20031008_231804_000059342020_00331_08401_2218.N1
8422	SCI_NL__1PSLRA20031010_103030_000059712020_00352_08422_2244.N1
8449	SCI_NL__1PSLRA20031012_074712_000059342020_00379_08449_2294.N1
8483	SCI_NL__1PSLRA20031014_164626_000060182020_00413_08483_2468.N1
8582	SCI_NL__1PSLRA20031021_144611_000059742021_00011_08582_2486.N1
8666	SCI_NL__1POLRA20031027_113618_000059772021_00095_08666_0114.N1
8707	SCI_NL__1POLRA20031030_082053_000059742021_00136_08707_0167.N1
8835	SCI_NL__1POLRA20031108_065742_000059342021_00264_08835_0354.N1
8877	SCI_NL__1POLRA20031111_052250_000059662021_00306_08877_0413.N1
8903	SCI_NL__1POLRA20031113_005833_000059662021_00332_08903_0457.N1
8913	SCI_NL__1POLRA20031113_174436_000059662021_00342_08913_0472.N1
9057	SCI_NL__1POLRA20031123_191039_000059832021_00486_09057_0843.N1
9127	SCI_NL__1POLRA20031128_163232_000059612022_00055_09127_0799.N1

Orbit #	Level 1b Product
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9253	SCI_NL__1POLRA20031207_114757_000059822022_00181_09253_1147.N1
9309	SCI_NL__1POLRA20031211_094209_000059612022_00237_09309_1114.N1
9336	SCI_NL__1POLRA20031213_065709_000060262022_00264_09336_1146.N1
9391	SCI_NL__1POLRA20031217_031011_000060272022_00319_09391_1331.N1
9816	SCI_NL__1POLRA20040115_194539_000059612023_00243_09816_1790.N1
9987	SCI_NL__1POLRA20040127_182730_000060002023_00414_09987_2025.N1
10584	SCI_NL__1PPLRA20040309_112444_000059692025_00009_10584_0235.N1
10597	SCI_NL__1PPLRA20040310_091242_000059332025_00022_10597_0260.N1
11382	SCI_NL__1PPLRA20040504_052223_000060032026_00306_11382_1287.N1
12521	SCI_NL__1PPLRA20040722_190912_000056432028_00443_12521_0516.N1
13328	SCI_NL__1PPLRA20040917_040756_000059922030_00248_13328_1494.N1
13560	SCI_NL__1PPLRA20041003_090641_000059522030_00480_13560_1718.N1
14226	SCI_NL__1PPLRA20041118_214525_000060282032_00144_14226_2590.N1
15049	SCI_NL__1PPLRA20050115_093838_000059912033_00466_15049_3832.N1
15783	SCI_NL__1PPLRA20050307_161743_000059952035_00198_15783_4886.N1
16884	SCI_NL__1PPLRA20050523_141702_000059962037_00297_16884_6790.N1
17574	SCI_NL__1PPLRA20050710_191429_000057092038_00486_17574_0119.N1
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20693	SCI_NL__1PPLRA20060213_163755_000059392045_00098_20693_1073.N1
21754	SCI_NL__1PPLRA20060428_193304_000060232047_00157_21754_2226.N1
22306	SCI_NL__1PPLRA20060606_090800_000056942048_00208_22306_2834.N1
22330	SCI_NL__1PPLRA20060608_012219_000056942048_00232_22330_2935.N1
22331	SCI_NL__1PPLRA20060608_030255_000057342048_00233_22331_2937.N1
22332	SCI_NL__1PPLRA20060608_044331_000056952048_00234_22332_2939.N1
22333	SCI_NL__1PPLRA20060608_062406_000057342048_00235_22333_2941.N1
22334	SCI_NL__1PPLRA20060608_080442_000056942048_00236_22334_2863.N1
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22337	SCI_NL__1PPLRA20060608_130630_000057342048_00239_22337_2866.N1
22338	SCI_NL__1PPLRA20060608_144705_000056952048_00240_22338_2867.N1
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22343	SCI_NL__1PPLRA20060608_231005_000057342048_00245_22343_2872.N1
22416	SCI_NL__1PPLRA20060614_013340_000056952048_00318_22416_2955.N1
22417	SCI_NL__1PPLRA20060614_031416_000057352048_00319_22417_2956.N1
22418	SCI_NL__1PPLRA20060614_045452_000056952048_00320_22418_2957.N1

Orbit #	Level 1b Product
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22420	SCI_NL__1PPLRA20060614_081604_000056952048_00322_22420_2959.N1
22421	SCI_NL__1PPLRA20060614_095640_000057352048_00323_22421_2960.N1
22422	SCI_NL__1PPLRA20060614_113716_000056952048_00324_22422_2961.N1
22423	SCI_NL__1PPLRA20060614_131751_000057352048_00325_22423_2962.N1
22424	SCI_NL__1PPLRA20060614_145827_000056952048_00326_22424_2963.N1
22425	SCI_NL__1PPLRA20060614_163903_000057352048_00327_22425_2964.N1
22426	SCI_NL__1PPLRA20060614_181939_000056952048_00328_22426_2965.N1
22427	SCI_NL__1PPLRA20060614_200015_000057352048_00329_22427_2966.N1
22428	SCI_NL__1PPLRA20060614_214051_000056952048_00330_22428_2967.N1
22429	SCI_NL__1PPLRA20060614_232127_000057352048_00331_22429_2968.N1
23246	SCI_NL__1PPLRA20060811_010646_000059902050_00146_23246_0835.N1
23247	SCI_NL__1PPLRA20060811_024721_000060042050_00147_23247_0836.N1
23248	SCI_NL__1PPLRA20060811_042759_000059902050_00148_23248_0837.N1
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23251	SCI_NL__1PPLRA20060811_092947_000060042050_00151_23251_0840.N1
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23258	SCI_NL__1PPLRA20060811_211402_000059902050_00158_23258_0847.N1
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24149	SCI_NL__1PPLRA20061013_030746_000059972052_00047_24149_1706.N1
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24151	SCI_NL__1PPLRA20061013_062859_000059962052_00049_24151_1708.N1
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24153	SCI_NL__1PPLRA20061013_095012_000059962052_00051_24153_1710.N1
24154	SCI_NL__1PPLRA20061013_113132_000059482052_00052_24154_1711.N1
24155	SCI_NL__1PPLRA20061013_131124_000059962052_00053_24155_1712.N1
24156	SCI_NL__1PPLRA20061013_145245_000059482052_00054_24156_1713.N1
24157	SCI_NL__1PPLRA20061013_163237_000059972052_00055_24157_1714.N1
24158	SCI_NL__1PPLRA20061013_181358_000059482052_00056_24158_1715.N1
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24160	SCI_NL__1PPLRA20061013_213511_000059482052_00058_24160_1717.N1
24356	SCI_NL__1PPLRA20061027_141120_000060242052_00254_24356_1924.N1
24874	SCI_NL__1PPLRA20061202_184137_000059912053_00271_24874_0000.N1
24992	SCI_NL__1PPLRA20061211_003228_000060022053_00389_24992_3150.N1
24993	SCI_NL__1PPLRA20061211_021315_000059912053_00390_24993_3152.N1

Orbit #	Level 1b Product
24994	SCI_NL__1PPLRA20061211_035340_000060032053_00391_24994_3154.N1
24995	SCI_NL__1PPLRA20061211_053427_000059912053_00392_24995_5760.N1
24996	SCI_NL__1PPLRA20061211_071452_000060022053_00393_24996_4469.N1
24997	SCI_NL__1PPLRA20061211_085540_000059912053_00394_24997_4657.N1
24998	SCI_NL__1PPLRA20061211_103605_000060022053_00395_24998_4778.N1
24999	SCI_NL__1PPLRA20061211_121652_000059912053_00396_24999_4902.N1
25000	SCI_NL__1PPLRA20061211_135717_000060032053_00397_25000_5000.N1
25001	SCI_NL__1PPLRA20061211_153804_000059912053_00398_25001_5034.N1
25002	SCI_NL__1PPLRA20061211_171829_000060032053_00399_25002_5136.N1
25003	SCI_NL__1PPLRA20061211_185916_000059912053_00400_25003_5236.N1
25004	SCI_NL__1PPLRA20061211_203941_000060022053_00401_25004_5761.N1
25331	SCI_NL__1PPLRA20070103_165509_000059912054_00227_25331_3320.N1
25414	SCI_NL__1PPLRA20070109_120441_000059922054_00310_25414_6224.N1
26176	SCI_NL__1PPLRA20070303_174059_000059862056_00070_26176_2621.N1
26411	SCI_NL__1PPLRA20070320_034214_000059912056_00305_26411_7214.N1
27221	SCI_NL__1PPLRA20070515_175210_000056972058_00113_27221_4648.N1
28094	SCI_NL__1PPLRA20070715_173353_000057522059_00485_28094_3011.N1
28982	SCI_NL__1PPLRA20070915_182114_000059922061_00371_28982_8151.N1
29855	SCI_NL__1PPLRA20071115_180453_000059602063_00242_29855_3284.N1
30399	SCI_NL__1PPLRA20071223_180949_000059922064_00285_30399_1787.N1
31258	SCI_NL__1PPLRA20080221_182435_000059592066_00142_31258_5349.N1
32102	SCI_NL__1PPLRA20080420_172928_000060232067_00485_32102_4119.N1
32961	SCI_NL__1PPLRA20080619_174750_000056972069_00342_32961_9057.N1
33805	SCI_NL__1PPLRA20080817_164920_000060042071_00184_33805_5238.N1
34664	SCI_NL__1PPLRA20081016_170345_000060042073_00041_34664_2255.N1

In the verification the m-factor correction will be handled in the following way:

1. M-factors will be calculated by IUP UB for all verification data using Level 1b data processed with the Level 0-1 version 7 prototype at DLR
2. They will be made available to the verifiers.
3. The selection of the proper m-factor file for a given Level 1b product has to follow ground segment rules. These rules are implemented in the latest (beta) version of the scial1c tool. It is available to the verifiers and *has to be used* for Level 1b-1c processing.
4. The m-factor correction for the off-line processed Level 2 products in the operational processor will be simulated by DLR using an external selection tool, which uses ground segment rules.

The above procedure ensures that all parties will use the same m-factor files. The complete set of m-factor files can be found in Table 2.2

Table 2.2: *M-Factor files used for generation of the Level 2 data.*

#	M-Factor File
1	SCI_MF1_AXSIFE20090128_092234_20020710_180517_20020910_180517
2	SCI_MF1_AXSIFE20090128_092234_20020810_050622_20020812_050622
3	SCI_MF1_AXSIFE20090128_092234_20020922_192001_20020924_192001
4	SCI_MF1_AXSIFE20090128_092234_20021021_154719_20021023_154719
5	SCI_MF1_AXSIFE20090128_092234_20021031_171333_20021102_171333
6	SCI_MF1_AXSIFE20090128_092234_20030110_182231_20030112_182231
7	SCI_MF1_AXSIFE20090128_092234_20030116_165325_20030118_165325
8	SCI_MF1_AXSIFE20090128_092234_20030121_123444_20030123_123444
9	SCI_MF1_AXSIFE20090128_092234_20030124_192253_20030126_192253
10	SCI_MF1_AXSIFE20090128_092234_20030127_092502_20030129_092502
11	SCI_MF1_AXSIFE20090128_092234_20030131_053758_20030202_053758
12	SCI_MF1_AXSIFE20090128_092234_20030201_114845_20030203_114845
13	SCI_MF1_AXSIFE20090128_092234_20030204_033130_20030206_033130
14	SCI_MF1_AXSIFE20090128_092234_20030210_020224_20030212_020224
15	SCI_MF1_AXSIFE20090128_092234_20030213_002733_20030215_002733
16	SCI_MF1_AXSIFE20090128_092234_20030215_161018_20030217_161018
17	SCI_MF1_AXSIFE20090128_092234_20030222_191123_20030224_191123
18	SCI_MF1_AXSIFE20090128_092234_20030226_170455_20030228_170455
19	SCI_MF1_AXSIFE20090128_092234_20030303_074426_20030305_074426
20	SCI_MF1_AXSIFE20090128_092234_20030308_032545_20030310_032545
21	SCI_MF1_AXSIFE20090128_092234_20030311_101354_20030313_101354
22	SCI_MF1_AXSIFE20090128_092234_20030314_015639_20030316_015639
23	SCI_MF1_AXSIFE20090128_092234_20030318_181646_20030320_181646
24	SCI_MF1_AXSIFE20090128_092234_20030329_173047_20030331_173047
25	SCI_MF1_AXSIFE20090128_092234_20030401_155556_20030403_155556
26	SCI_MF1_AXSIFE20090128_092234_20030409_114300_20030411_114300
27	SCI_MF1_AXSIFE20090128_092234_20030413_093632_20030415_093632
28	SCI_MF1_AXSIFE20090128_092234_20030414_090455_20030416_090455
29	SCI_MF1_AXSIFE20090128_092234_20030422_063235_20030424_063235
30	SCI_MF1_AXSIFE20090128_092234_20030426_024531_20030428_024531
31	SCI_MF1_AXSIFE20090128_092234_20030507_170455_20030509_170455
32	SCI_MF1_AXSIFE20090128_092234_20030514_164448_20030516_164448
33	SCI_MF1_AXSIFE20090128_092234_20030526_184823_20030528_184823
34	SCI_MF1_AXSIFE20090128_092234_20030528_192545_20030530_192545
35	SCI_MF1_AXSIFE20090128_092234_20030530_182231_20030601_182231
36	SCI_MF1_AXSIFE20090128_092234_20030603_193715_20030605_193715
37	SCI_MF1_AXSIFE20090128_092234_20030607_173047_20030609_173047
38	SCI_MF1_AXSIFE20090128_092234_20030608_165910_20030610_165910
39	SCI_MF1_AXSIFE20090128_092234_20030614_171040_20030616_171040

#	M-Factor File
40	SCI_MF1_AXSIFE20090128_092234_20030619_193422_20030621_193422
41	SCI_MF1_AXSIFE20090128_092234_20030624_183653_20030626_183653
42	SCI_MF1_AXSIFE20090128_092234_20030627_170202_20030629_170202
43	SCI_MF1_AXSIFE20090128_092234_20030701_181646_20030703_181646
44	SCI_MF1_AXSIFE20090128_092234_20030707_182816_20030709_182816
45	SCI_MF1_AXSIFE20090128_092234_20030709_172502_20030711_172502
46	SCI_MF1_AXSIFE20090128_092234_20030716_184531_20030718_184531
47	SCI_MF1_AXSIFE20090128_092234_20030722_185700_20030724_185700
48	SCI_MF1_AXSIFE20090128_092234_20030730_180516_20030801_180516
49	SCI_MF1_AXSIFE20090128_092234_20030804_184823_20030806_184823
50	SCI_MF1_AXSIFE20090128_092234_20030806_174509_20030808_174509
51	SCI_MF1_AXSIFE20090128_092234_20030829_222357_20030831_222357
52	SCI_MF1_AXSIFE20090128_092234_20030902_165617_20030904_165617
53	SCI_MF1_AXSIFE20090128_092234_20030909_181646_20030911_181646
54	SCI_MF1_AXSIFE20090128_092234_20030915_164740_20030917_164740
55	SCI_MF1_AXSIFE20090128_092234_20030921_165910_20030923_165910
56	SCI_MF1_AXSIFE20090128_092234_20030926_174216_20030928_174216
57	SCI_MF1_AXSIFE20090128_092234_20031003_172209_20031005_172209
58	SCI_MF1_AXSIFE20090128_092234_20031008_180516_20031010_180516
59	SCI_MF1_AXSIFE20090128_092234_20031009_191415_20031011_191415
60	SCI_MF1_AXSIFE20090128_092234_20031011_181101_20031013_181101
61	SCI_MF1_AXSIFE20090128_092234_20031013_170747_20031015_170747
62	SCI_MF1_AXSIFE20090128_092234_20031020_164740_20031022_164740
63	SCI_MF1_AXSIFE20090128_092234_20031026_165910_20031028_165910
64	SCI_MF1_AXSIFE20090128_092234_20031029_170454_20031031_170454
65	SCI_MF1_AXSIFE20090128_092234_20031107_172209_20031109_172209
66	SCI_MF1_AXSIFE20090128_092234_20031110_172754_20031112_172754
67	SCI_MF1_AXSIFE20090128_092234_20031112_180516_20031114_180516
68	SCI_MF1_AXSIFE20090128_092234_20031123_171917_20031125_171917
69	SCI_MF1_AXSIFE20090128_092234_20031127_165325_20031129_165325
70	SCI_MF1_AXSIFE20090128_092234_20031130_165910_20031202_165910
71	SCI_MF1_AXSIFE20090128_092234_20031202_173631_20031204_173631
72	SCI_MF1_AXSIFE20090128_092234_20031206_185115_20031208_185115
73	SCI_MF1_AXSIFE20090128_092234_20031210_164447_20031212_164447
74	SCI_MF1_AXSIFE20090128_092234_20031212_172209_20031214_172209
75	SCI_MF1_AXSIFE20090128_092234_20031216_165617_20031218_165617
76	SCI_MF1_AXSIFE20090128_092234_20040115_193422_20040117_193422
77	SCI_MF1_AXSIFE20090128_092234_20040127_181646_20040129_181646
78	SCI_MF1_AXSIFE20090128_092234_20040308_164739_20040310_164739
79	SCI_MF1_AXSIFE20090128_092234_20040309_193714_20040311_193714
80	SCI_MF1_AXSIFE20090128_092234_20040503_172754_20040505_172754

#	M-Factor File
81	SCI_MF1_AXSIFE20090128_092234_20040722_171331_20040724_171331
82	SCI_MF1_AXSIFE20090128_092234_20040916_175346_20040918_175346
83	SCI_MF1_AXSIFE20090128_092234_20041002_193129_20041004_193129
84	SCI_MF1_AXSIFE20090128_092234_20041118_181353_20041120_181353
85	SCI_MF1_AXSIFE20090128_092234_20050114_164154_20050116_164154
86	SCI_MF1_AXSIFE20090128_092234_20050306_163901_20050308_163901
87	SCI_MF1_AXSIFE20090128_092234_20050522_175930_20050524_175930
88	SCI_MF1_AXSIFE20090128_092234_20050710_171915_20050712_171915
89	SCI_MF1_AXSIFE20090128_092234_20050912_170746_20050914_170746
90	SCI_MF1_AXSIFE20090128_092234_20051213_171623_20051215_171623
91	SCI_MF1_AXSIFE20090128_092234_20060212_165908_20060214_165908
92	SCI_MF1_AXSIFE20090128_092234_20060428_174215_20060430_174215
93	SCI_MF1_AXSIFE20090128_092234_20060605_174759_20060607_174759
94	SCI_MF1_AXSIFE20090128_092234_20060607_164445_20060609_164445
95	SCI_MF1_AXSIFE20090128_092234_20060608_175344_20060610_175344
96	SCI_MF1_AXSIFE20090128_092234_20060613_165615_20060615_165615
97	SCI_MF1_AXSIFE20090128_092234_20060614_180514_20060616_180514
98	SCI_MF1_AXSIFE20090128_092234_20060810_181351_20060812_181351
99	SCI_MF1_AXSIFE20090128_092234_20060811_174214_20060813_174214
100	SCI_MF1_AXSIFE20090128_092234_20060818_172207_20060820_172207
101	SCI_MF1_AXSIFE20090128_092234_20061012_165322_20061014_165322
102	SCI_MF1_AXSIFE20090128_092234_20061013_180221_20061015_180221
103	SCI_MF1_AXSIFE20090128_092234_20061026_175344_20061028_175344
104	SCI_MF1_AXSIFE20090128_092234_20061202_165030_20061204_165030
105	SCI_MF1_AXSIFE20090128_092234_20061210_173922_20061212_173922
106	SCI_MF1_AXSIFE20090128_092234_20061211_170745_20061213_170745
107	SCI_MF1_AXSIFE20090128_092234_20070103_164445_20070105_164445
108	SCI_MF1_AXSIFE20090128_092234_20070108_172752_20070110_172752
109	SCI_MF1_AXSIFE20090128_092234_20070303_173044_20070305_173044
110	SCI_MF1_AXSIFE20090128_092234_20070319_172752_20070321_172752
111	SCI_MF1_AXSIFE20090128_092234_20070515_173629_20070517_173629
112	SCI_MF1_AXSIFE20090128_092234_20070715_171914_20070717_171914
113	SCI_MF1_AXSIFE20090128_092234_20070915_181058_20070917_181058
114	SCI_MF1_AXSIFE20090128_092234_20071115_175343_20071117_175343
115	SCI_MF1_AXSIFE20090128_092234_20071223_175928_20071225_175928
116	SCI_MF1_AXSIFE20090128_092234_20080221_181350_20080223_181350
117	SCI_MF1_AXSIFE20090128_092234_20080420_171913_20080422_171913
118	SCI_MF1_AXSIFE20090128_092234_20080619_173336_20080621_173336
119	SCI_MF1_AXSIFE20090128_092234_20080817_163859_20080819_163859

3 Summary of Changes

The following changes are introduced with this version of the processor:

1. Cloud fraction improvements
2. Nadir SO_2 total columns for normal conditions (anthropogenic sources) and "volcanic" conditions is introduced (two MDS, one new)
3. Nadir BrO total columns are introduced.
4. Nadir OClO slant columns are introduced (new MDS)
5. Nadir H_2O total columns using AMC DOAS are introduced.
6. Nadir CO total columns.
7. Limb BrO profiles are introduced.
8. Limb cloud flags for PSC , tropospheric clouds are introduced (new MDS).
9. Handling of Limb Cloud Flagging in Ozone profile retrieval (minimum height shift in case of clouds)
10. Handling of aerosols in Ozone profile retrieval.

3.1 Summary of Tasks

Product	Dataset	Actionee	Quantities to compare
Regression Tests			
AAI/Nadir	12 orbits	G. Tilstra	Review, influence of new m-factors
O_3/Nadir	12 orbits	DLR	SCD, RMS, VCD with old Cloud fractions
NO_2/Nadir	12 orbits	DLR	SCD, RMS, VCD
Cloud Parameters	12 orbits	DLR	CFR (old), CTH, COT
NO_2/Limb	14 orbits	DLR	Number densities
Nadir			
Cloud Fractions	28 orbits	M. Hess	Cloud fractions, (compare with FRESCO)
SO_2	Stdrd	S. Hrechanyy	VCD, AMF for both types
BrO	Stdrd	BIRA	VCD, AMF
OClO	Stdrd	S. Hrechanyy	SCD, RMS
H_2O	Stdrd	M. Meringer	All entries written
xCO	Stdrd	DLR	All entries written
O_3	Stdrd	BIRA	VCD, influence of new CFR, m-factors
Limb			
O_3 Aerosol	Lidar set	A. v. Gijsel	Number densities

Product	Dataset	Actionee	Quantities to compare
test	Stdrd	K.U. Eichmann	Number densities
O_3 Cloud test	Stdrd		Number densities
BrO	Stdrd	K.U. Eichmann	Number densities, physicality of values
Cloud Products	Stdrd	M. Meringer	All entries written

All data will be made available (references and operational to all verifiers regardless of who is responsible for the comparison.

4 Task #1: Regression tests

4.1 Introduction

A number of products are not changed in the update from version 4 to version 5. However, due to the complexity of the SGP, side effects from processor changes not directly related to the unchanged products are possible. Therefore these products have to be checked.

4.2 Verification Set-Up

Goal of this verification part is to ensure that the products are unchanged. Therefore it should be enough to only test a few orbits and compare them to the results obtained during the verification of the SGP version 4. The following quantities should be compared:

1. Nadir Total Column Retrievals:
    a. SCD
    b. RMS of fit
    c. VCD
2. AAI retrieval:
    a. Reflectances used for retrievals
    b. AAI values
3. Limb profiles: Number densities as a function of height (profile values)

Since the cloud fraction derivation is also changed with this version, the Ozone verification has to be done after the verification for cloud fraction is completed

4.3 Involved Partners

DLR-IMF	*G.Lichtenberg*	Guenter.Lichtenberg@dlr.de

4.4 Verification Data

Tests will be performed on a small subset of the verification data set of typically 10 orbits. The used data sets can be found together with the verification results in the following section.

4.5 Verification Results

4.5.1 Nadir Ozone Total Columns

The first comparison will be done with old cloud fractions in order to check if the total columns have reasonable values. Note that the results can be slightly different because of the different m-factors used. The calculation is done using the OL4 data base for PMD reflectances in order to ensure that differences do not come from the updated cloud fraction algorithm. The influence of the new cloud fractions is tested separately.

Verification Data Set

As verification data set data from the so-called “stray light set” from the last verification will be taken (s. Table 4.1)

Table 4.1: *Verification set for regression test of O3*

Orbit #	Level 1b Product
3358	SCI_NL__1PPLRA20021021_155758_000059312010_00298_03358_0195.N1
4830	SCI_NL__1PSLRA20030201_115858_000060212013_00267_04830_0312.N1
8449	SCI_NL__1PSLRA20031012_074712_000059342020_00379_08449_2294.N1
9987	SCI_NL__1POLRA20040127_182730_000060002023_00414_09987_2025.N1
12521	SCI_NL__1PPLRA20040722_190912_000056432028_00443_12521_0516.N1
15783	SCI_NL__1PPLRA20050307_161743_000059952035_00198_15783_4886.N1
16884	SCI_NL__1PPLRA20050523_141702_000059962037_00297_16884_6790.N1
19811	SCI_NL__1PNPDE20051214_024739_000062162043_00218_19811_1262.N1
21754	SCI_NL__1PPLRA20060428_193304_000060232047_00157_21754_2226.N1
22306	SCI_NL__1PPLRA20060606_090800_000056942048_00208_22306_2834.N1
23361	SCI_NL__1PPLRA20060819_015541_000060042050_00261_23361_0954.N1
26411	SCI_NL__1PPLRA20070320_034214_000059912056_00305_26411_7214.N1

Verification Results

Figure 4.1 shows a scatter plot of the relative differences and the histogram of the relative differences between the OL version4 and version 5. The differences are small and can be traced back to differences in the m-factors used. Table 4.2 shows the statistical values of the comparison. The differences are not significant and the regression test was completed successfully.

Table 4.2: *Relative difference statistical values of a total of 38903 points.*

	Mean	Stdev.	Maximum	Minimum
SCD	-0.067118198	0.094502783	0.395442000	-0.034647757
RMS	0.527813040	1.036442900	5.884617200	-5.676342100
VCD	0.065822094	0.091215654	0.379223140	-0.040617760

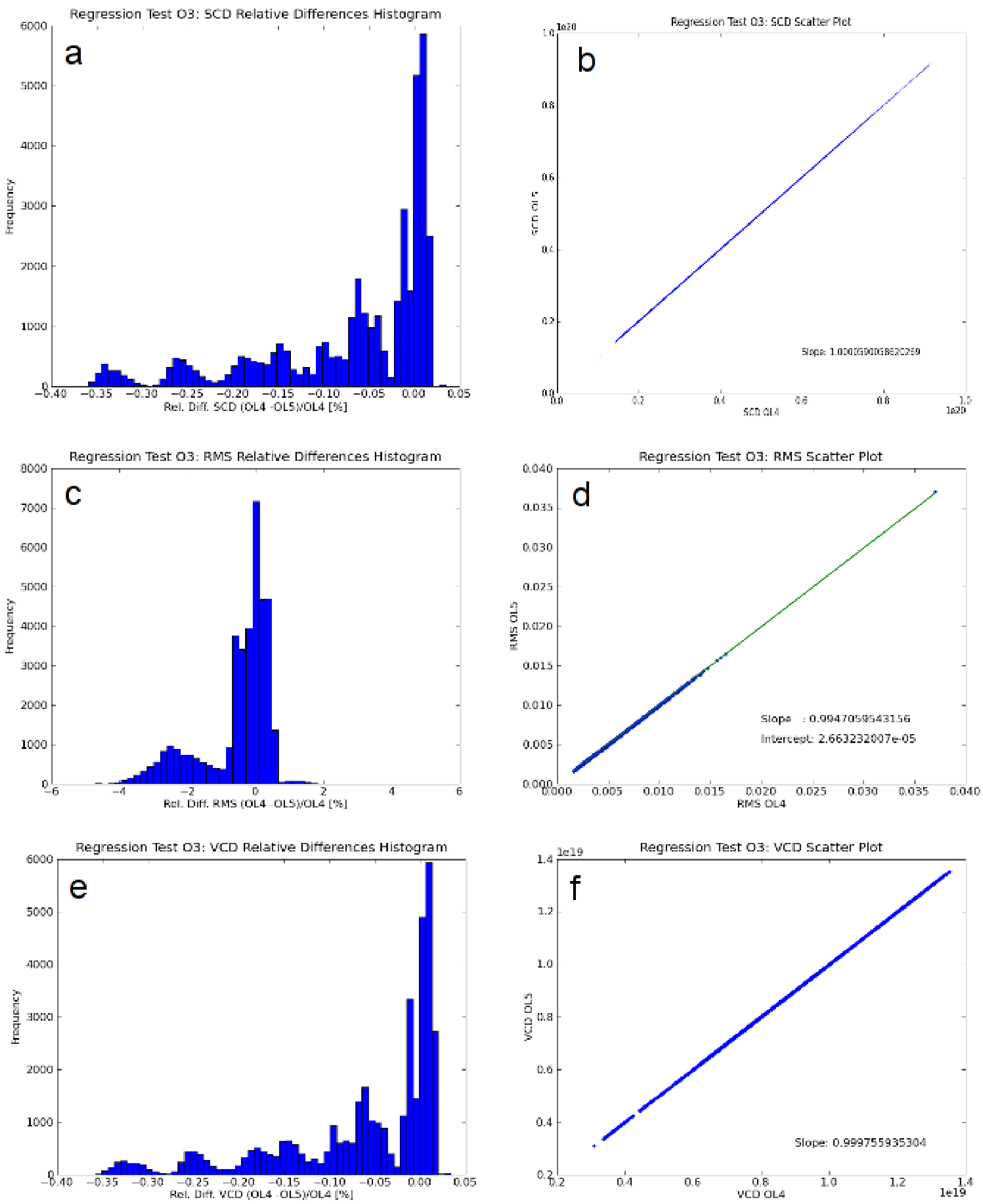

Figure 4.1: *Regression Test for nadir ozone. Shown are the relative differences in percentage between the processor versions 4 and 5. On the left histograms and on the right scatter plots of SCD (a,b), fit RMS (c,d) and VCD (e,f).*

Based on the data set of Table 2.1, comparisons between the O_3 columns provided by SGP OL V5 and the columns derived with the prototype algorithm SDOAS have been realized to make sure that the agreement is similar to the SGP OL V4 verification, the O_3 data sets have been retrieved using the new OCRA/SACURA cloud parameters, The OCRA/SACURA parameters that SDOAS ingests are extracted from the SGP OL V5 level-2 files as explained in the SGP OL V4 verification report, Figure 4.2 show the slant column, residual and vertical column comparisons, These plots are almost the same as those presented in the verification report of SGP v4 meaning that the nadir O_3 product has not been changed by the upgrade of SGP to version 5. The mean of the total column relative differences is -0.31% and the standard deviation is 0.56%.

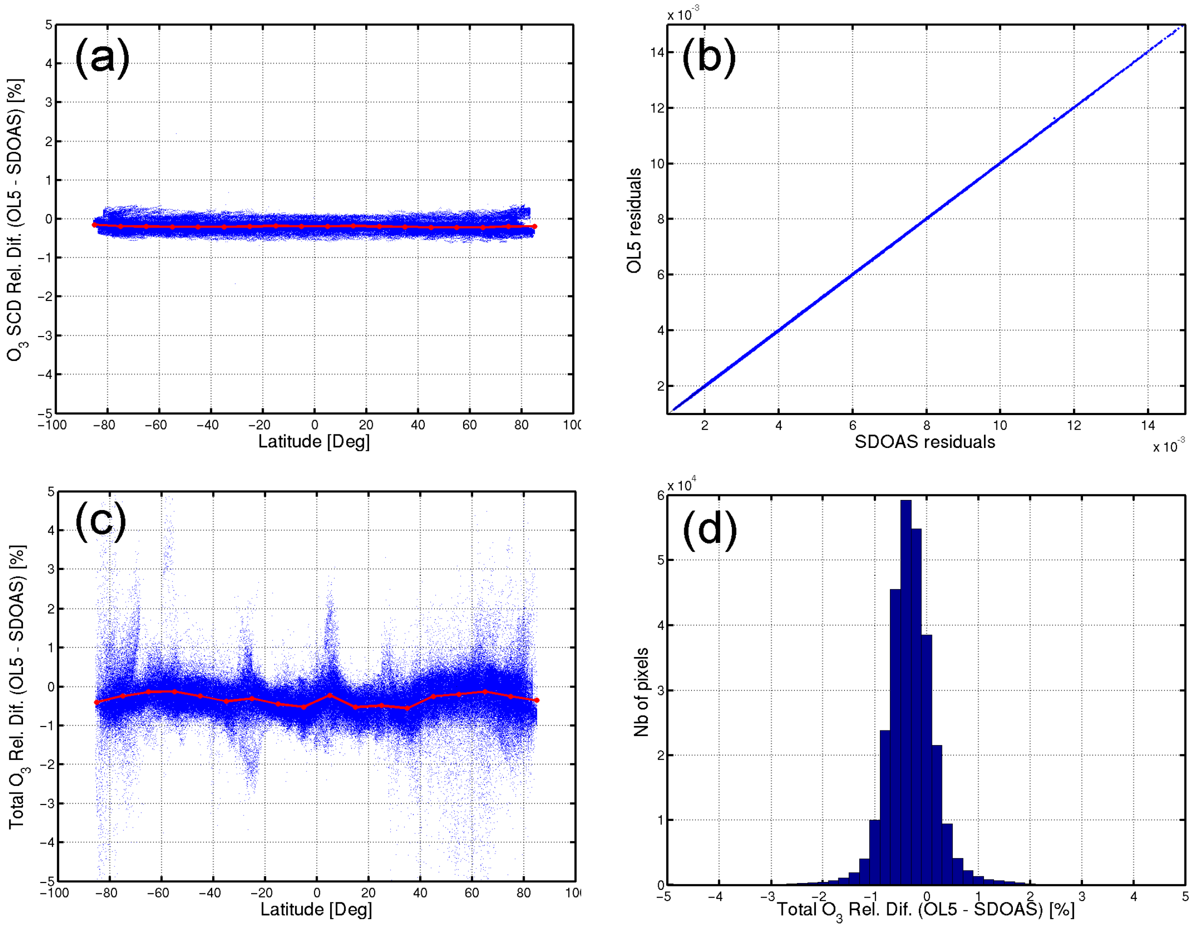

Figure 4.2: *(a) Relative differences between the O3 slant columns from SGP v5 and SDOAS for all pixels of the verification data set. The red curve represents the mean relative differences in each latitude bin. (b) Comparison of the residuals from the DOAS fit in the two algorithms (c) Relative differences between the total O3 columns from SGP 5,0 and SDOAS. The red curve represents the mean relative differences in each latitude bin. (d) Distribution of the total O3 relative differences.*

Using the prototype algorithm SDOAS, the impact of the version of the level-1 data on the total O_3 columns has been estimated using the verification data set (table2.1). Figure 4.3 shows the differences between the SDOAS ozone columns retrieved using the latest version of the level-1 data (version 7) and those derived with the level-1 v6.03 data. It clearly indicates a positive trend. Since a negative temporal trend had been highlighted in the SGP v3.01 product, the temporal stability of SGP ozone columns could be improved in this new version of the operational processor. This will have to be confirmed on a larger data set.

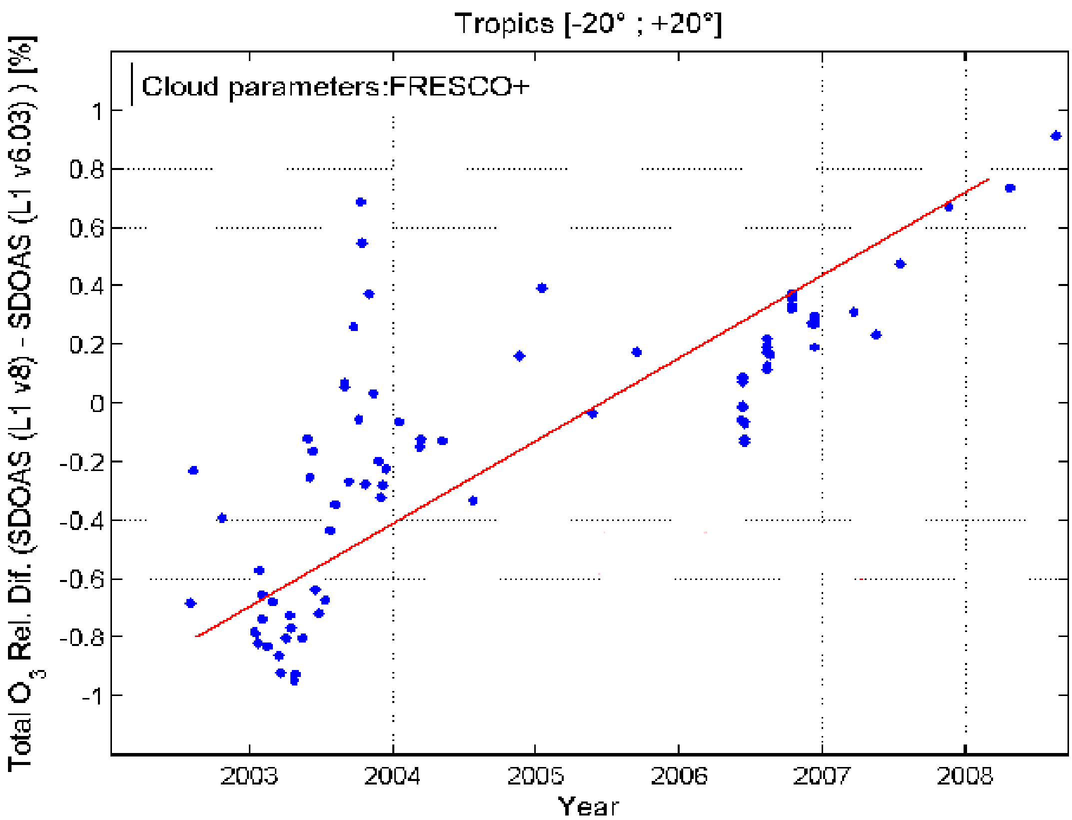

Figure 4.3: *Mean relative differences between the O_3 vertical columns retrieved with SDOAS using level-1 data version 7 and version 6.03 for all pixels of the verification data set. A slight positive temporal trend appears in the differences.*

4.5.2 Nadir NO_2 Total Columns

Verification Data Set

The same set as for Ozone will be used (s. Table 4.1)

Verification Results

The slant column and the RMS of the fit showed no differences between the two processor version as expected. The vertical column showed only differences caused by numerical effects (see Figure 4.4). Table 4.3 shows the statistics of the comparison. No significant differences were observed and the regression test can be regarded as successfully completed.

Table 4.3: *Statistical values for the relative difference of a total of 82528 points.*

	Mean	Stdev.	Maximum	Minimum
SCD	0.000000000			
RMS	0.000000000			
VCD	-5.75E-009	2.26E-007	0.000000000	-1.46E-005

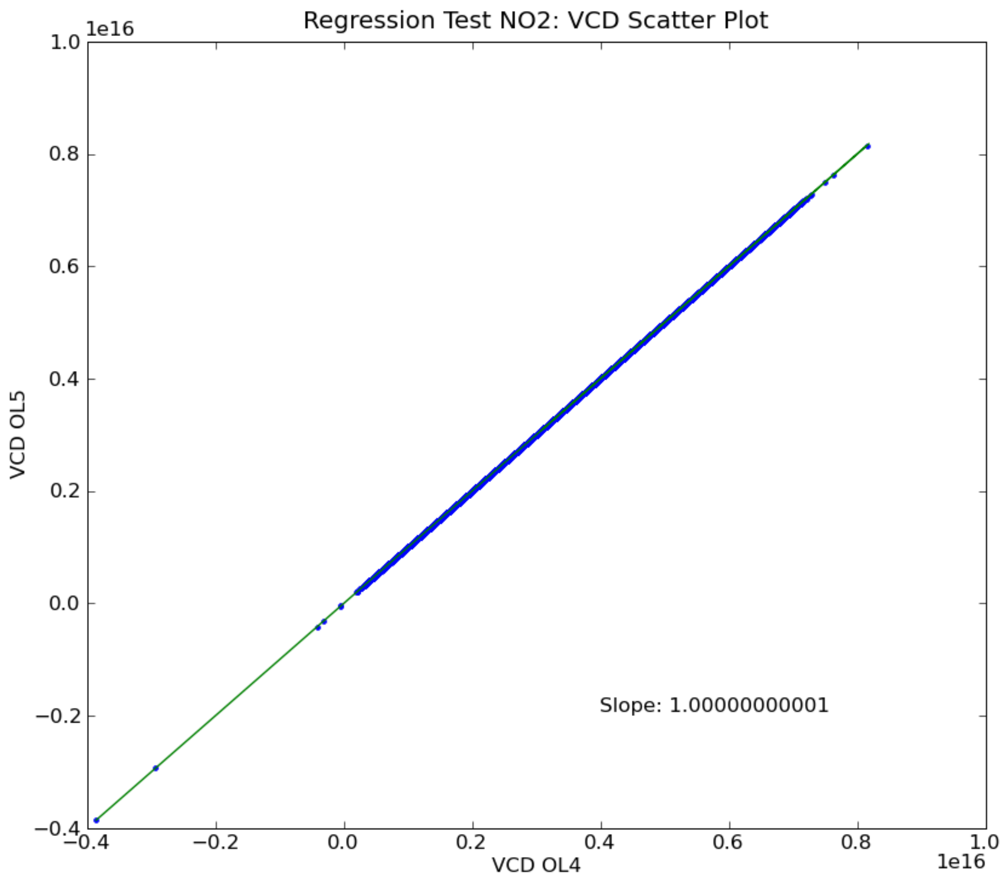

Figure 4.4: *Scatter plot of the vertical columns of both processor versions of Nadir NO2 for the regression test. The fitted slope is 1 up to the numerical precision of the output.*

Based on the data set of Table 2.1, comparisons between the NO_2 columns provided by OL v5 and the columns derived with the prototype algorithm SDOAS have been realized to make sure that the agreement is similar to the OL 4 verification, The NO_2 data sets have been retrieved using the new OCRA/SACURA cloud parameters. Figure 4.5 show the slant column, residual and vertical column comparisons. Only one orbit (#6467) leads to slant columns differences slightly larger (~-0.8x10^{15} molec/cm²). The reason for this remains unclear. However, the corresponding vertical differences are not so important, especially at high solar zenith angle due to the AMF factors. It has to be noted that this orbit was not part of the SGP v4 verification data set. The mean of the total column absolute differences is 1.46x10^{13} molec/cm² and the standard deviation is 3.2x10^{13} molec/cm². With the exception of the problematic orbit, these plots are almost the same as those presented in the verification report of SGP v4 meaning that the nadir NO_2 product has not been moved by the upgrade of SGP to version 5. Consequently, the verification for the nadir NO_2 product can be considered as successful.

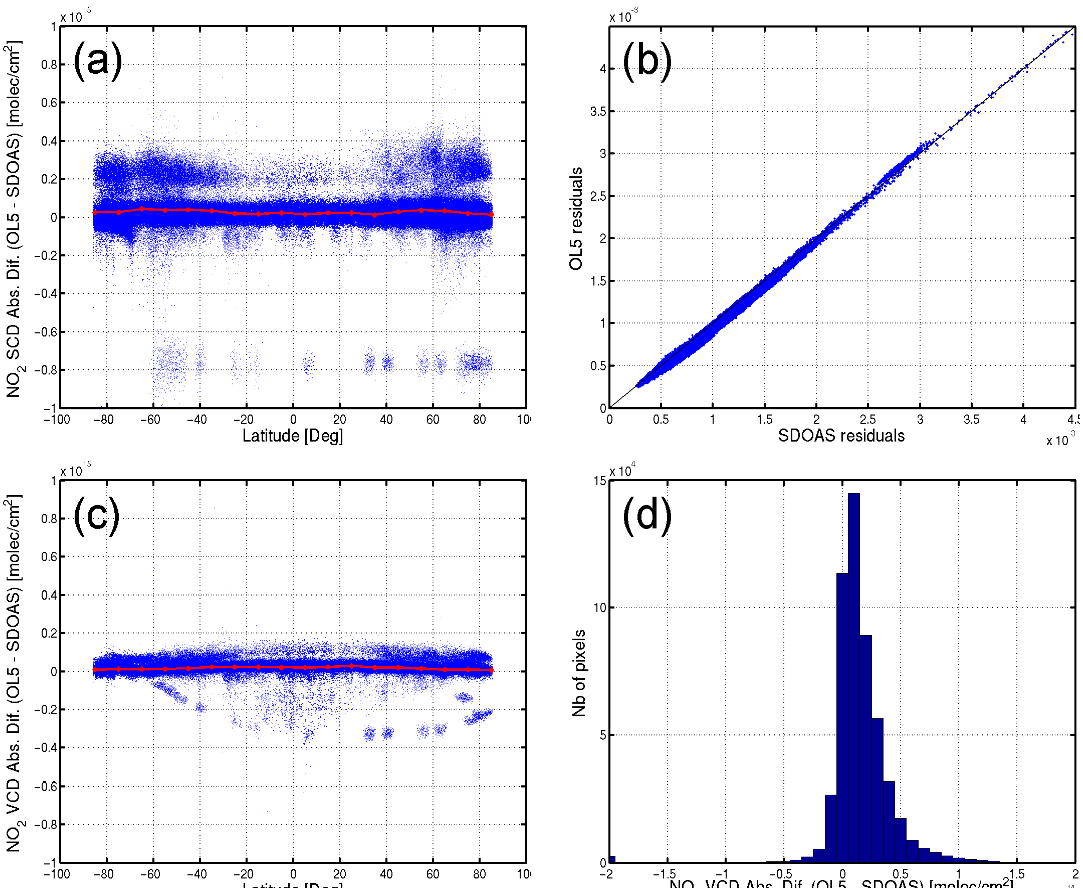

Figure 4.5: *(a) Absolute differences between the NO2 slant columns from SGP v5 and SDOAS for all pixels of the verification data set. The red curve represents the mean absolute differences in each latitude bin. (b) Comparison of the residuals from the DOAS fit in the two algorithms (c) Absolute differences between the total NO_2 columns from SGP 5,0 and SDOAS. The red curve represents the mean absolute differences in each latitude bin. (d) Distribution of the total NO_2 absolute differences.*

4.5.3 Nadir Cloud MDS

The nadir cloud MDS contains the AAI, the cloud fraction, the cloud top height and the cloud optical thickness. For all these products a regression test was made. The AAI were additionally tested against a calculation of the reference algorithm for ten orbits.

Verification Data Set

Regression test: Data from Table 4.1

Verification: Data from Table 4.5

AAI Regression Test Results

The regression test showed difference for three individual orbits. These were tracked down to a difference in the m-factors that was caused by the usage of different ADFs for the calculation. The results are summarised in Figure 4.6. Table 4.4 shows the the statistics of the comparison. The regression test was successful.

Table 4.4: *Statistics of the absolute difference of a total of 91640 points.*

	Mean	Stdev.	Maximum	Minimum
AAI Value	-0.010401493	0.000000000	0.000000000	0.000000000

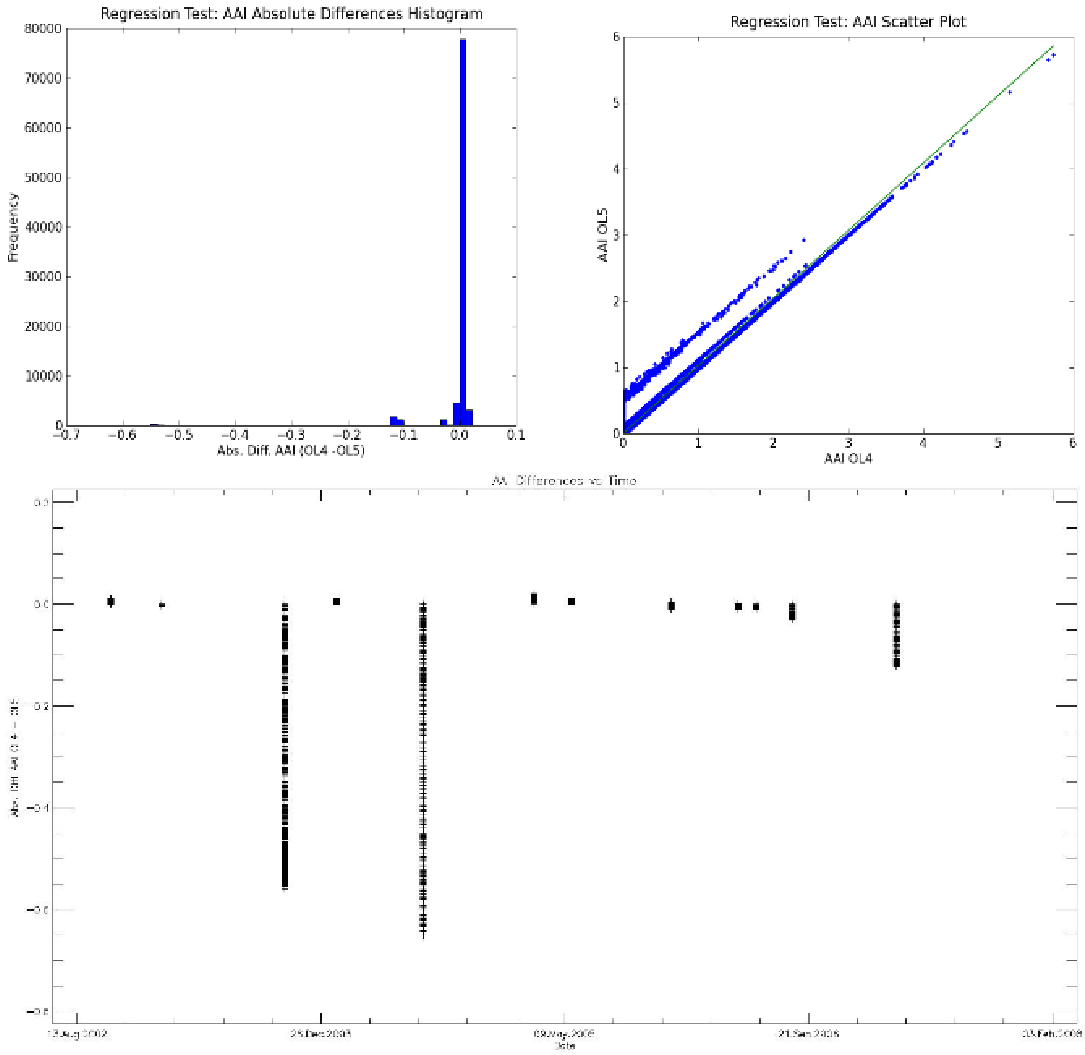

Figure 4.6: *Regression Test for AAI. Shown is the absolute difference between the processor versions 4 and 5. Top left: Histogram. Top right: Scatter plot. Bottom: Differences vs time. The differences can be explained by differences in the m-factors.*

AAI Results of comparison with reference algorithm

Verification Data set

Out of the standard set, 10 arbitrary orbits were chosen by KNMI for the comparison (see Table 4.5)

Table 4.5: *Subset of the standard set used for the verification of the AAIA.*

Orbit #	Level 1b Product
2209	SCI_NL__1PPLRA20020802_093420_000057082008_00151_02209_6028.N1
6027	SCI_NL__1PSLRA20030426_025607_000059862015_00462_06027_0616.N1
9127	SCI_NL__1POLRA20031128_163232_000059612022_00055_09127_0799.N1
11382	SCI_NL__1PPLRA20040504_052223_000060032026_00306_11382_1287.N1
15783	SCI_NL__1PPLRA20050307_161743_000059952035_00198_15783_4886.N1
18499	SCI_NL__1PPLRA20050913_100425_000060032040_00409_18499_1289.N1
22333	SCI_NL__1PPLRA20060608_062406_000057342048_00235_22333_2941.N1
26411	SCI_NL__1PPLRA20070320_034214_000059912056_00305_26411_7214.N1
31258	SCI_NL__1PPLRA20080221_182435_000059592066_00142_31258_5349.N1
32961	SCI_NL__1PPLRA20080619_174750_000056972069_00342_32961_9057.N1

Verification Results

For the comparison the residue values were compared. The positive part of these values is the AAI. The data set led to 31710 observations that were compared. The maximum of the absolute difference in residue was 0.13987 in orbit 2209. The mean value was 0.01424. Table 4.6 summarises the results per orbit:

***Table 4.6**: Comparison of reference and processor values: Number of reference values, processor values and coincidences (n_dlr, n_knmi, n_join) and the maxima of the absolute differences of the residue, albedo and topographic height.*

Orbit #	n_knmi	n_dlr	n_join	d_residue	d_albedo	d_height
2209	4419	6500	3574	0.13987	0.00550	0.00005
6027	4423	6480	3379	0.04136	0.00011	0.00005
9127	4627	6420	3544	0.08931	0.00017	0.00103
11382	4380	5900	3860	0.03320	0.00008	0.00005
15783	4961	8320	2878	0.07371	0.00020	0.00018
18499	4960	8580	2619	0.01023	0.00017	0.00005
22333	4532	7540	3228	0.03153	0.00014	0.00005
26411	4693	8320	2872	0.12257	0.00019	0.00005
31258	4942	8320	2859	0.10613	0.00019	0.00044
32961	4977	8320	2897	0.02360	0.00020	0.00005

Figure 4.7 shows a scatter plot of the residues for the reference algorithm and the SGP. The comparison shows that the reference algorithm was correctly implemented.

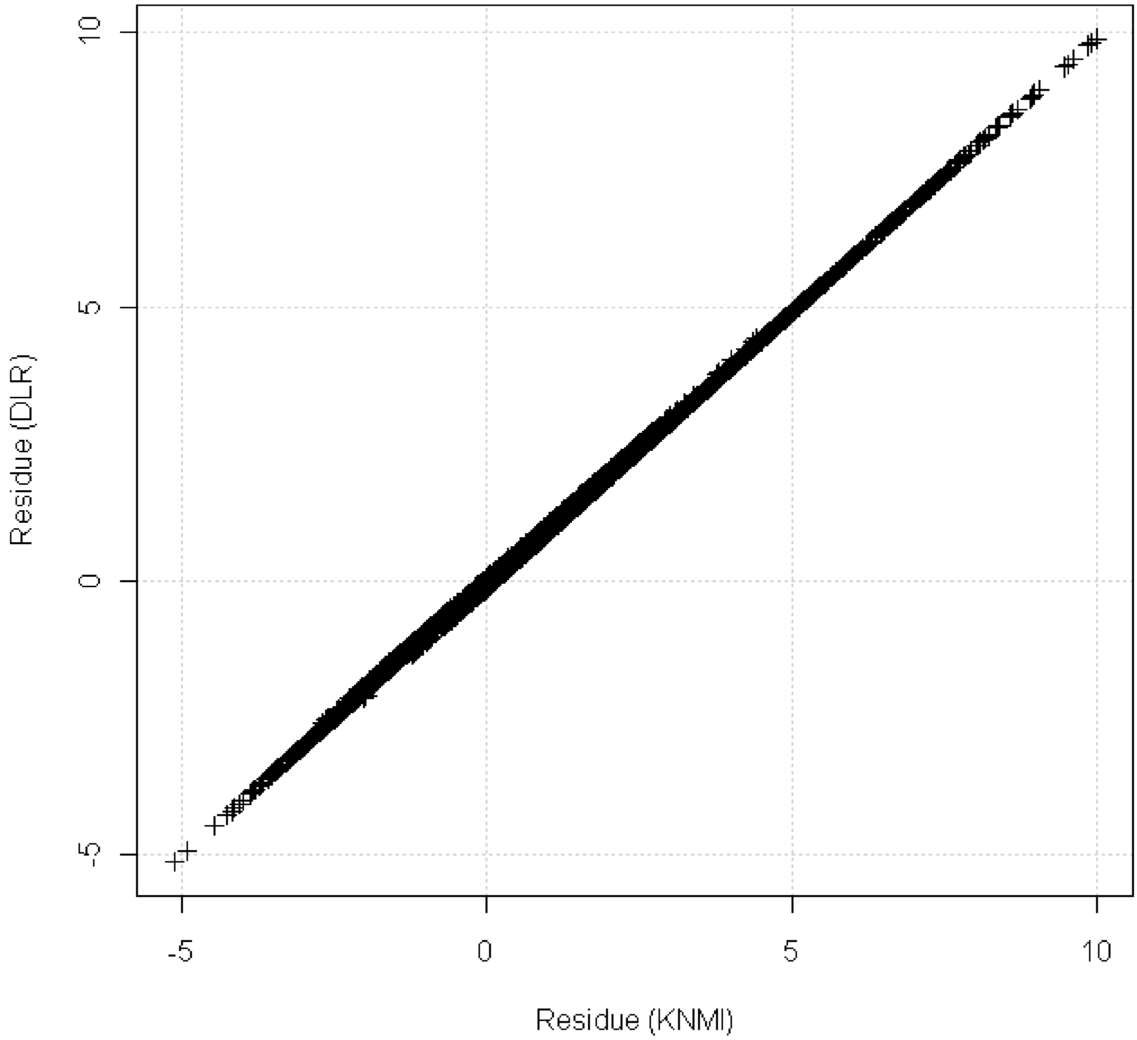

Figure 4.7: *Scatter plot of the residue values (reference values as a function of SGP values).*

Cloud Parameters

The cloud parameters showed no significant differences in the regression test as one can see in Figure 4.8. Only numerical differences are observed. The difference in the cloud fraction was 0 for all points considered. Note that new cloud fractions will be implemented and these will be validated against FRESCO (see section 5). Table 4.4 shows the statistics of the results. The regression test was successful.

Table 4.7: *Statistics of the absolute difference of a total of 91640 points.*

	Mean	Stdev.	Maximum	Minimum
Cloud Fraction	0.000000000			
COT	2.07E-011	4.44E-009	1.00E-006	-5.00E-007
CTH	-1.91E-010	2.36E-008	0.00E+000	-4.00E-006

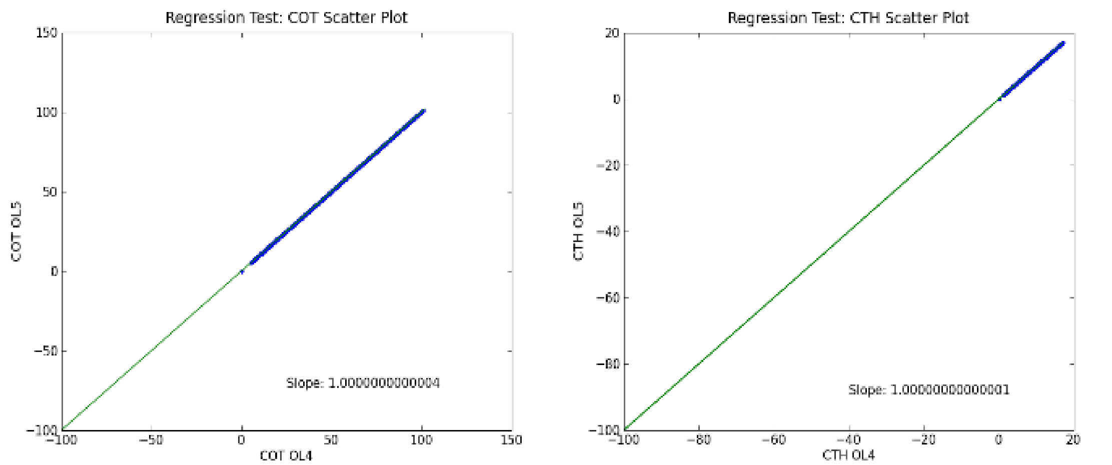

Figure 4.8: *Regression Test for cloud optical thickness (left) and cloud top height (right). The only differences found are coming from numerical effects.*

4.5.4 Limb NO_2 Profiles

Verification Data Set

For the regression test the Lidar set from the verification of the OL version 4 will be taken (see Table 4.8).

Table 4.8: *Regression Test Data for limb NO_2 profiles.*

Orbit #	Level 1b Product
2209	SCI_NL__1PPLRA20020802_093420_000057082008_00151_02209_6028.N1
2946	SCI_NL__1PPLRA20020922_211146_000059542009_00387_02946_5191.N1
3502	SCI_NL__1PPLRA20021031_172353_000060152010_00442_03502_1460.N1
4720	SCI_NL__1PSLRA20030124_193330_000059612013_00157_04720_0740.N1
4995	SCI_NL__1PSLRA20030213_003742_000060092013_00432_04995_0171.N1
5373	SCI_NL__1PSLRA20030311_102423_000059332014_00309_05373_0868.N1
5859	SCI_NL__1PSLRA20030414_091529_000059792015_00294_05859_1212.N1
6467	SCI_NL__1PSLRA20030526_204328_000056472016_00401_06467_1178.N1
6810	SCI_NL__1PSLRA20030619_194811_000056802017_00243_06810_0044.N1

Orbit #	Level 1b Product
7076	SCI_NL__1PSLRA20030708_094735_000056902018_00008_07076_0363.N1
8422	SCI_NL__1PSLRA20031010_103030_000059712020_00352_08422_2244.N1
8913	SCI_NL__1POLRA20031113_174436_000059662021_00342_08913_0472.N1
9816	SCI_NL__1POLRA20040115_194539_000059612023_00243_09816_1790.N1
10597	SCI_NL__1PPLRA20040310_091242_000059332025_00022_10597_0260.N1
13560	SCI_NL__1PPLRA20041003_090641_000059522030_00480_13560_1718.N1

Verification Results

Before the comparison, all data with limb cloud heights above the minimum standard retrieval height of 13.5 km were discarded in order to clearly separate the influence of the cloud height and possible side effects of the new implementation of the processor. After filtering 13554 points were left. The relative difference

$$R=((OL5-OL4)/OL4)\cdot 100.$$

of the values between the off-line processors version 4 and version 5 was calculated. *OL5* and *OL4* represent the values of the number densities of NO_2.

Table 4.9: *Statistics for the relative differences of a total of 13554 points.*

	Mean	Stdev.	Maximum	Minimum
Number Densities	-1.86E-007	2.30E-010	4.95E-005	-4.70E-004

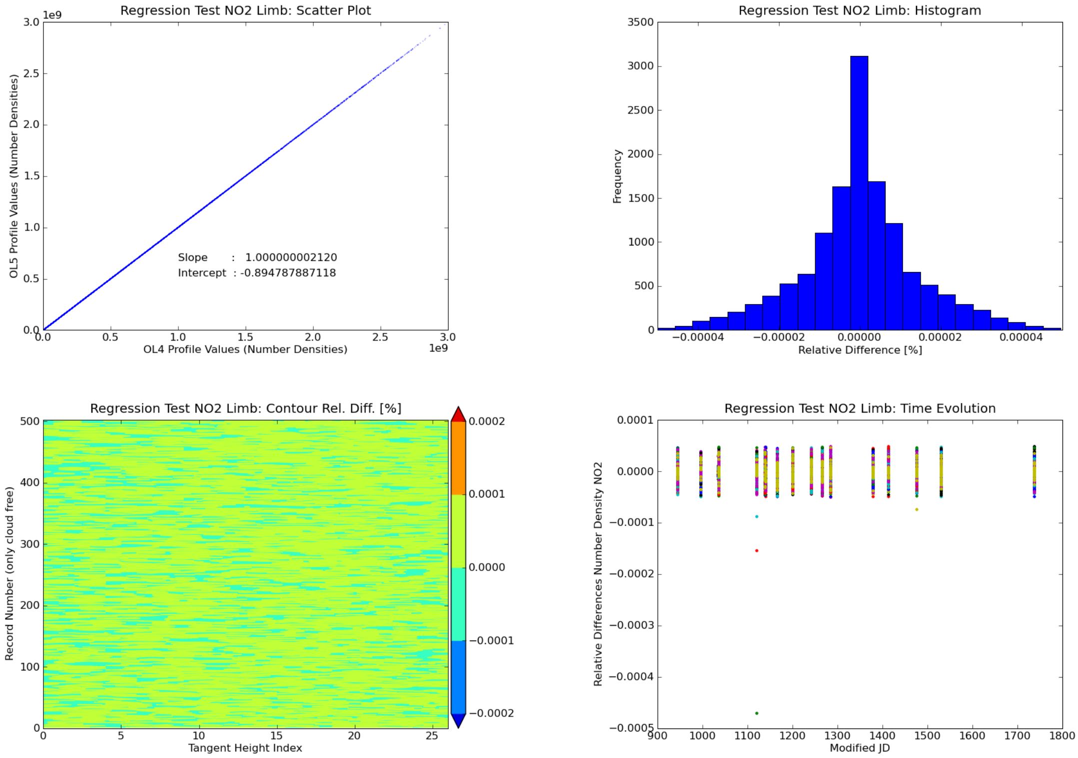

Figure 4.9: *Regression results for NO_2 limb profiles. Clockwise from top left: Scatter plot number densities OL version 4 vs. OL version 5; Histogram, time evolution and contour plot of the relative differences.*

5 Task #2: Cloud Fraction improvements

5.1 Introduction

The cloud retrieval algorithm itself was not changed, only the input data. Previous processor versions used GOME PMD data to derive scaling factors and offsets. The new implementation uses SCIAMACHY PMD data over several years to caclulate offsets and scaling factors.

5.2 Verification Set-Up

This is an internal DLR algorithm, therefore a comparison with FRESCO+ will be done to validate the results and justify the implementation. The latest FRESCO version was used.

5.3 Involved Partners

DLR-IMF	*M. Hess*	Michael.Hess@dlr.de
	M. Meringer	Markus.Meringer@dlr.de

5.4 Verification Data

Orbits from two complete days, one from summer (8.06.2006) and one from winter (11.12.2006) were chosen in order to check for seasonal effects. The data are contained in the standard verification data set (see Table 2.1).

5.5 Verification Results

Figure 5.1 shows the result of the comparison. Despite the different algorithms and input data (FRESCO uses science channel data of the Oxygen A band to determine cloud fractions) the agreement is quite good and similar to the processor version 3.01. The mean difference and standard deviation are 0.03 and 0.10. The verification can be regarded as successful. The impact of the cloud fractions on the Nadir retrievals is included in the verification of the individual trace gases (see the according sections).

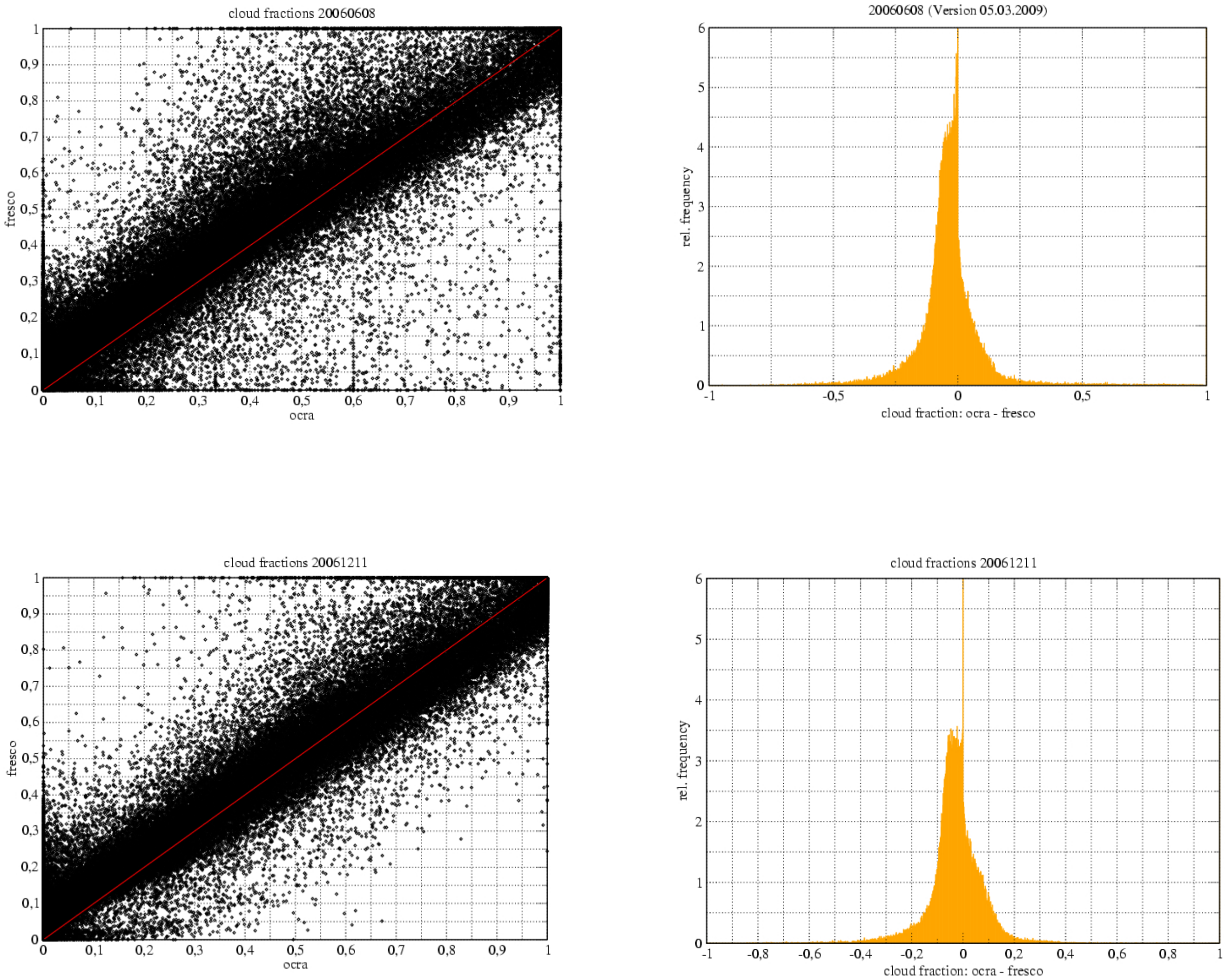

Figure 5.1: *Comparison of OCRA cloud fractions with FRESCO. Top: Data from June 8th 2006. Bottom: Data from December 11th 2006. Left: Scatter Plots (x-axis OCRA). Right: Histogram of differences (OCRA – FRESCO).*

6 Task #3: Nadir SO_2 Total columns

6.1 Introduction

In addition to the last version of the SGP, this version also contains total columns of SO_2. Since the vertical SO_2 distribution varies to a large degree between an anthropogenic scenario (pollution dominated) and a volcanic scenario, the AMF cannot be determined for both with a single climatology. In order to provide total columns for both scenarios, it was decided to introduce a new Nadir MDS into Level 2. Each product now contains one MDS for the anthropogenic (SO_2 present in the boundary layer) and one MDS for the volcanic scenario (SO_2 layer between 10 and 11 km). Both retrievals use the same, background subtracted slant column as input. The advantage of using two separate MDSs is that all information for both retrievals are contained in the product.

Note that the reference algorithm from A. Richter (IUP Bremen) is specifically developed for SO_2, while the SGP OL uses the SDOAS formalism. Therefore somewhat larger differences can be expected between the results.

6.1.1 Retrieval Settings

The table below summarises the retrieval settings for the SO_2 retrieval:

L0-1c settings	
Calibration	All on except radiometric calibration
SMR	A0
DOAS Settings	
Fitting Interval	315 – 327 nm
Polynomial Degree	3rd order
Absorption Cross Sections/Fitted Curves	
SO_2	Vandaele et al. (1994)
Background database	Filled during the operational processing by SGPv4
O_3	Bogumil et al.(2003), 243 K
O_3 Difference spectrum	T = 223 K, Difference $\sigma_{O3}^{243K} - \sigma_{O3}^{223K}$, shift allowed
Undersampling	Constant Undersampling Spectrum calculated by IUP-Bremen
Ring Spectrum	Vountas et al (1998)
Background Ref. Sector	180 – 220 deg (Pacific)
Empirical Functions	Eta Nadir
Offset and slope correction	Inverse Spectrum of earthshine radiance

Total Column Calculation/Profiles	
Anthropogenic	
AMF ref. Wavelength	315 nm
SO_2 Profile	Anthropogenic pollution scenario (1 DU SO2 present from surface to 1 km) (generated by IUP-Bremen)
Volcanic	
AMF ref. Wavelength	315 nm
SO_2 Profile	Volcanic scenario (10 DU SO2 present in layer between 10 and 11 km) (generated by IUP-Bremen)

6.2 Verification Set-Up

Comparison of VCD and AMF for both retrieval variants (volcanic and anthropogenic)

6.3 Involved Partners

IUP-UB	*A. Richter*	richter@iup.physik.uni-bremen.de
DLR-IMF	*S. Hrechanyy* *K. Kretschel*	serhiy.hrechanyy@dlr.de Klaus.Kretschel@dlr.de

6.4 Verification Data

See Table 2.1

6.5 Verification Results

The SO_2 slant columns have already been implemented and verified for SGPv4. For SGPv4 the offset correction data bank filled with the verification orbits only was used (for lack of more appropriate data bank). For SGPv5 it was decided to use the "best possible" data bank filled by the SGPv4 during the operational processing, on the side of the IUP-Bremen the same approach was applied. Although it was aimed to make the manner of data bank filling exactly the same as recommended by the algorithm developer IUP-Bremen, some differences in the manner of filling remained. The main one is the applied cloud fraction criterion: whereas IUP-Bremen takes all SC values from the reference sector independent on cloud parameters to build up the data bank, in SGPv5 only the values from the pixels with cloud fraction less than 50 % are taken. This will be changed for the next version of the SGP, but for the current one this fact is to a certain extent responsible for the difference between the IUP scientific processor and the SGPv5.

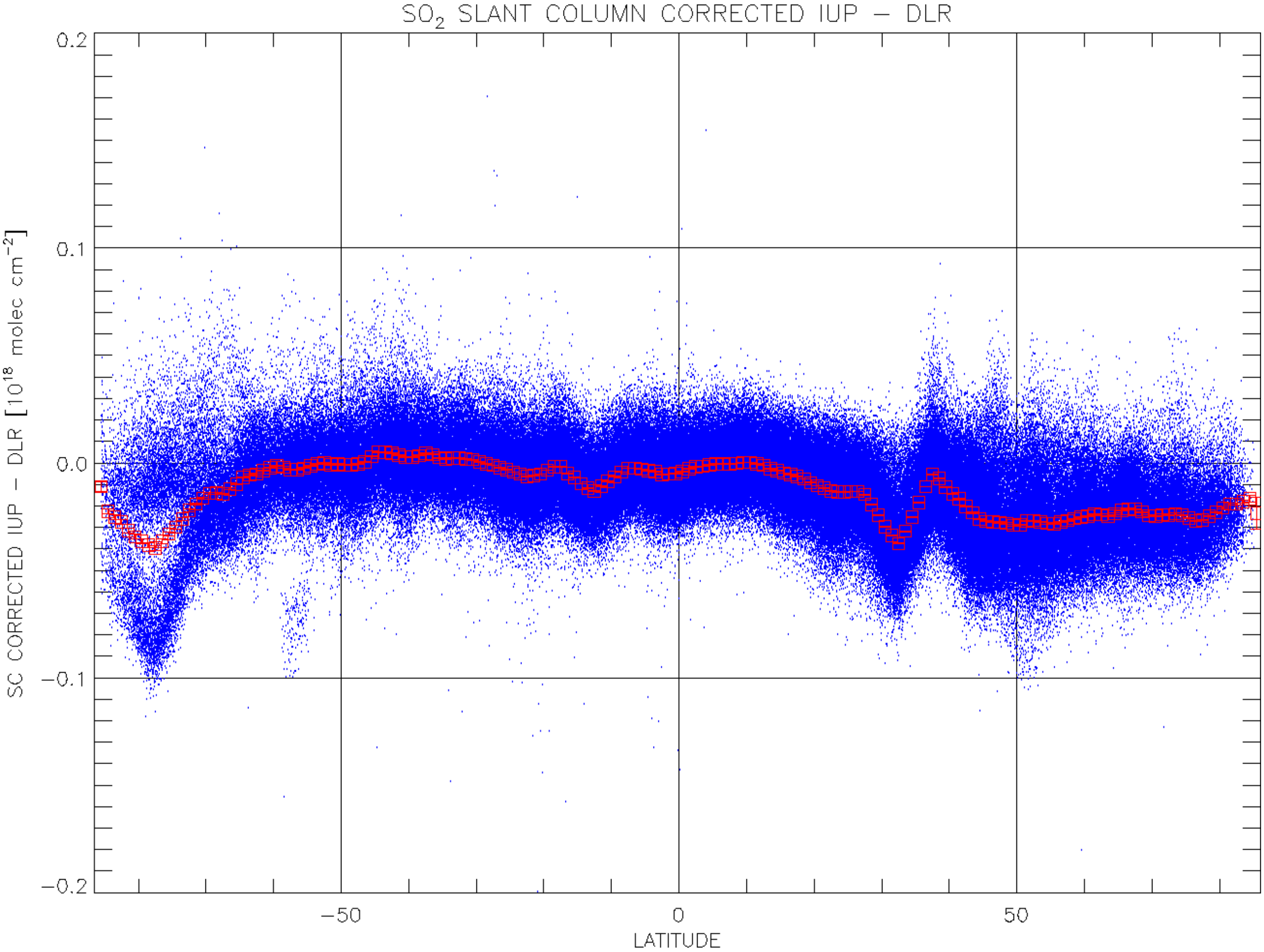

Figure 6.1: Latitudinal dependence of the absolute difference between the SO2 slant columns from the SGP and the IUP-Bremen algorithms.

Figure 6.1 shows the absolute difference between SO_2 slant columns for all pixels of the verification data set. The clear problems at some latitudinal regions (e.g. at ~ 80°S or at ~ 30°N) are probably related to above-described discrepancy in the manner of the data bank filling. The problem was revealed quite late leaving no time for its correction. This will be done in the next version of the SGP.

Figure 6.2 shows the two types of AMF used for the calculation of the “anthropogenic” SO_2 vertical columns and the “volcanic” ones.

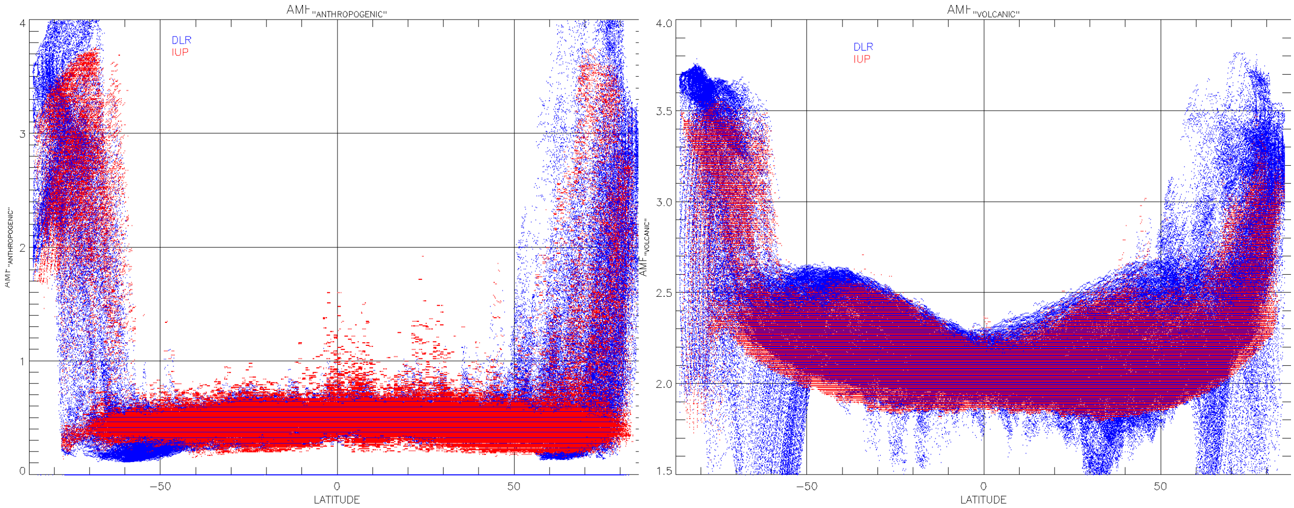

Figure 6.2: AMF used to calculate "anthropogenic" (left) and "volcanic" (right) SO2 vertical columns. AMF calculated in the IUP-Bremen algorithm shown in red; those in the SGP - in blue.

"Anthropogenic" AMF demonstrates a very good agreement between the IUP-Bremen and the SGPv5 (apart from adjacent regions with high and low albedo; the small disagreement could be related to the different albedo data bases: the GOME LER climatology of Koelemeijer is used in the IUP-Bremen algorithm, in SGPv5 the TOMS LER data base is used). "Volcanic" AMF agrees good as well apart from rare cases in tropics where SGP AMF is lower. Finally, Figure 6.3 shows the differences between vertical SO_2 columns ("anthropogenic" - left and "volcanic" - right) retrieved with the SGPv5 and the IUP-Bremen algorithm.

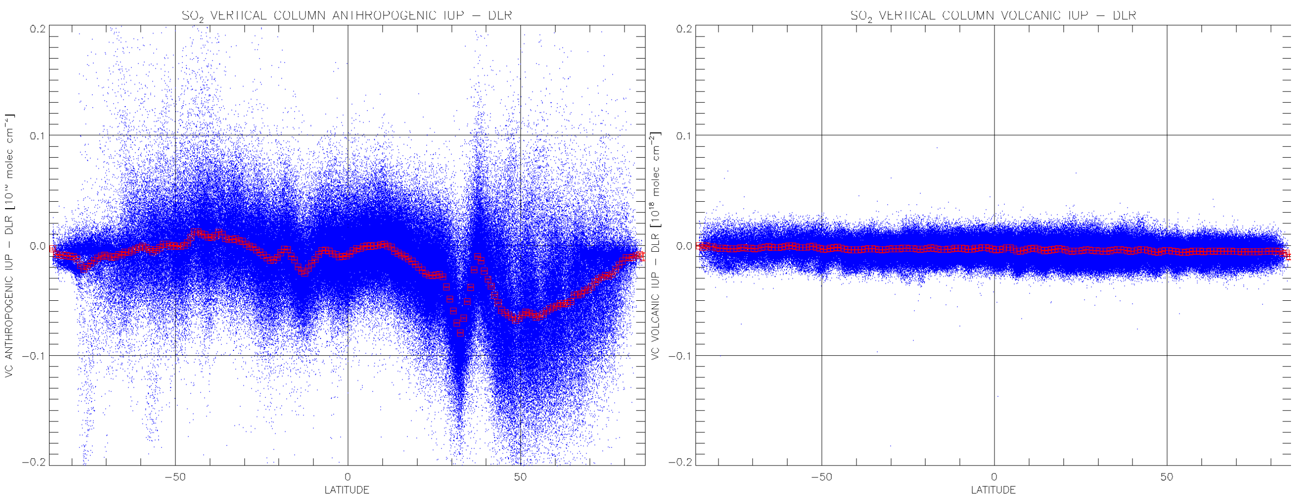

Figure 6.3: Absolute difference of vertical columns ("anthropogenic" on the left and "volcanic" on the right panels) retrieved by SGPv5 and by the prototype IUP-Bremen algorithm.

The problems in the "anthropogenic" vertical columns originate from the differences in the slant columns (see Figure 6.1). In addition, they are "amplified" by the smaller than unity "anthropogenic" AMF. In contrast, the agreement between two "volcanic" products is very

good.
Overall the mean of the absolute differences of the "anthropogenic" vertical columns is $-2.05 \cdot 10^{16}$ molec/cm^2 and the standard deviation is $4.51 \cdot 10^{16}$ molec/cm^2; for the "volcanic" vertical columns the mean of the absolute differences is $-4.85 \cdot 10^{15}$ molec/cm^2 and the standard deviation is $9.02 \cdot 10^{15}$ molec/cm^2.
Considering

- the slightly different manner of the offset correction data bank filling;
- that the reference algorithm from A. Richter (IUP Bremen) is specifically developed for SO_2, while the SGP OL uses the SDOAS formalism,

the verification can be considered as satisfactory. However, the user should be advised that in some instances unrealistic SO_2 values are retrieved by the SGP OL. They can be recognized as 5° latitude wide stripes encircled the whole globe. This problem will probably persist until the full SCIAMACHY data set will be used to build up the offset correction data bank.

7 Task #4: Nadir BrO Total Columns

7.1 Introduction

In this version of the processor the calculation of the total columns was added to the Nadir BrO product. For the calculation a climatology from BIRA is used. The reference algorithm was developed by BIRA.

7.1.1 Retrieval Settings

L0-1c settings	
Calibration	All on except radiometric calibration
SMR	A0
DOAS Settings	
Fitting Interval	336 – 351 nm
Wavelength Shift	Cross correlation according to Chance and Spurr solar line atlas
Polynomial Degree	3rd order
Absorption Cross Sections/Fitted Curves	
NO_2	Bogumil et al., Temperature = 243 K
O_3	Bogumil et al. 243 K, shifted
O_3 Difference spectrum	T = 223 K, Difference $\sigma_{O3}^{243K} - \sigma_{O3}^{223K}$, shifted
O_2 – O_2	Greenblatt et al 1990; Wavelength axis corrected by Burkholder
BrO	Fleischmann et al., T= 223 K
Ring Spectrum	Vountas et al (1998)
Empirical Functions	Eta Nadir Key data (angle = ?)
Offset and slope correction	Inverse Earthshine
Total Column Calculation: Profiles/AMF	
AMF ref. wavelength	343.5 nm
BrO Profile	Climatology based on the 3-D CTM BASCOE from BIRA (Theys 2008)
Radiative Transfer Model	LIDORT
CTH, Cloud top	SACURA
Cloud Fractions	OCRA

7.2 Verification Set-Up

In the verification the slant columns, the air mass factors and the total columns are compared for the complete verification data set.

7.3 Involved Partners

BIRA	*C. Lerot*	christophe.lerot@aeronomie.be
	M. v. Roozendael	Michel.VanRoozendael@aeronomie.be
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	K. Kretschel	Klaus.Kretschel@dlr.de

7.4 Verification Data

See Table 2.1

7.5 Verification Results

The BrO slant column product has already been implemented in SGP v4 and verified. However, we compared again the slant columns and residuals derived from SGP v5 and the prototype algorithm SDOAS. Figure 7.1 shows the slant columns absolute differences for all pixels of the verification data set. The differences are very comparable to those observed during verification of SGP v4. For a few orbits, the differences are slightly larger than for most of pixels. This phenomena, already observed during OL 4 verification, probably originates from a level-1 issue and is not related to a L1 to L2 algorithm implementation problem. Figure 7.2 shows that the quality of the fits is similar for SGP and the reference algorithm.

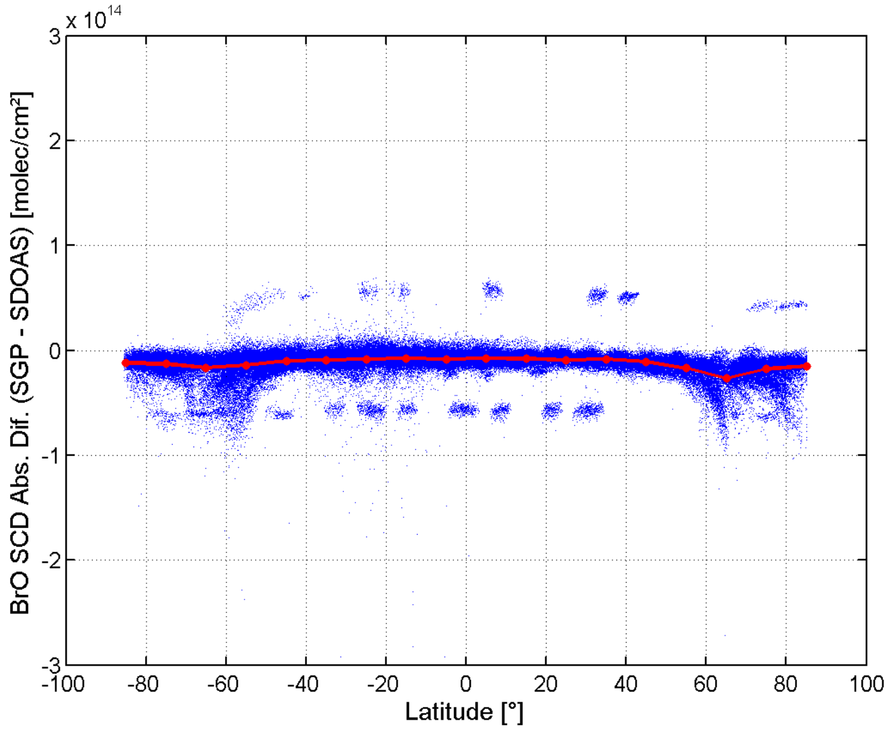

Figure 7.1: *Latitudinal dependence of the absolute differences between the BrO slant columns from the SGP and the BIRA algorithm.*

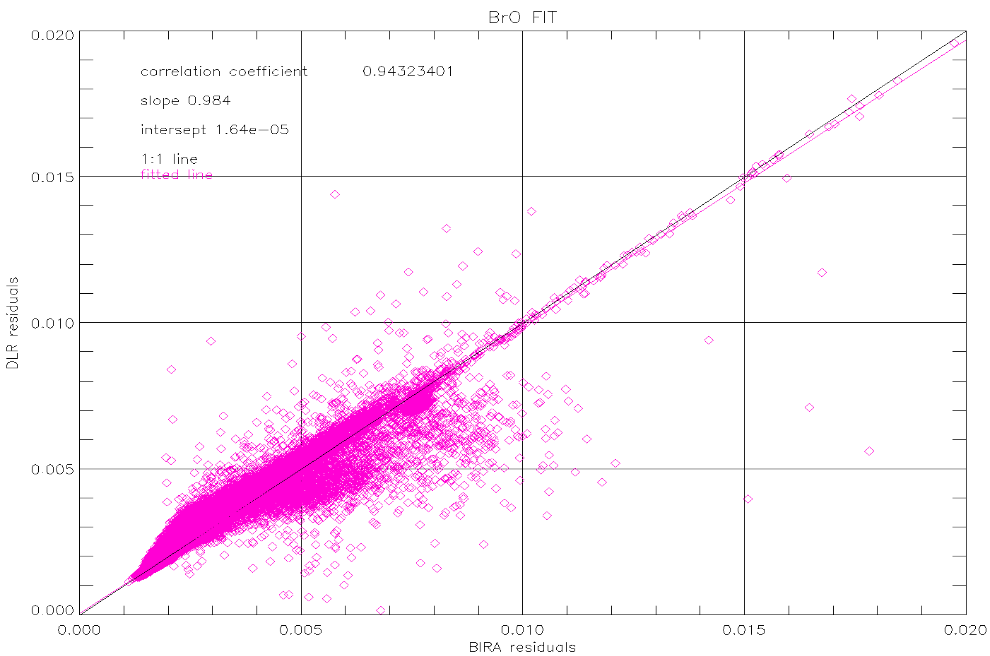

Figure 7.2: *Comparison of the SGP residuals with respect to the BIRA residuals.*

The conversion of the BrO slant columns into vertical columns is a new feature of the version 5 of SGP. It requires AMF calculation based on a BrO concentration profile climatology provided by BIRA. Figure 7.3 shows the relative differences between the AMF to ground calculated by SGP and by SDOAS. Although the SGP AMF are systematically slightly smaller than the SDOAS AMF, the overall agreement is satisfactory. The remaining bias is acceptable since it is small regarding to the accuracy of the BrO slant column retrievals, Finally, Figure 7.4 shows the differences between total BrO columns retrieved with SGP v5 and SDOAS. With the exception of the orbits for which the slant columns differences are larger due to level-1 issue, the overall agreement is very good. The mean of the absolute differences is $-2.39 \cdot 10^{12}$ molec/cm² and the standard deviation is $6.74 \cdot 10^{12}$ molec/cm². Again, the small remaining bias is acceptable as it is within the current accuracy of the method. For example, a change of the BrO reference cross-section data set would have a comparable impact on the BrO slant columns. The verification of the implementation of the BrO slant column retrieval algorithm in the operational processor is then successful.

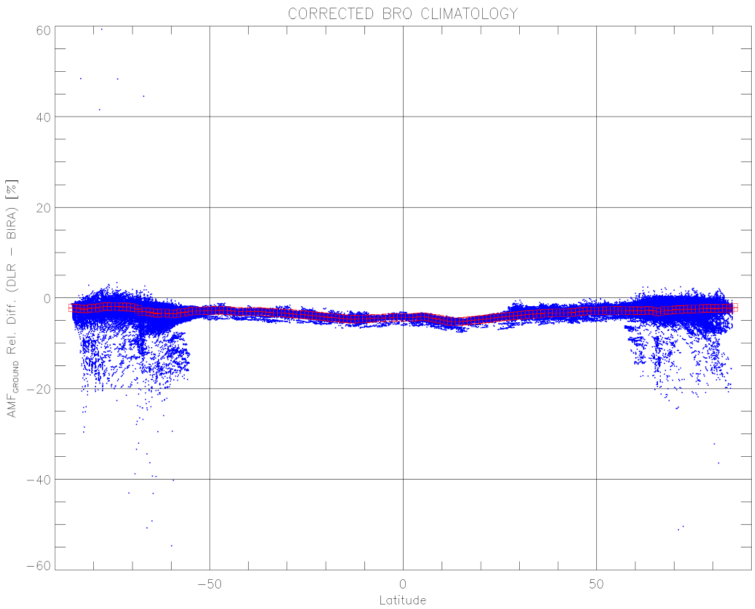

Figure 7.3: *Relative Differences of AMF to ground calculated in SGP and in the prototype algorithm SDOAS.*

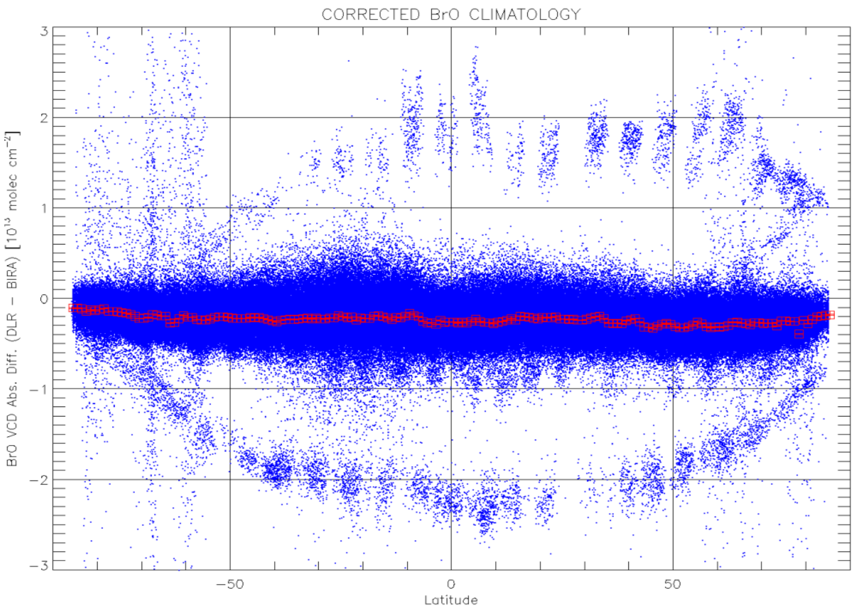

Figure 7.4: *Absolute differences of total columns retrieved in SGP v5 and in the prototype algorithm SDOAS.*

8 Task #5: Nadir OClO Slant Columns

8.1 Introduction

Originally OClO was foreseen for the version 6 of the SGP OL. But first comparisons showed acceptable results and the implementation was fast tracked. Note that the operational processor uses the SDOAS approach by BIRA while the reference algorithm was specifically developed for OClO by A. Richter IUP Bremen. Therefore, somewhat larger differences in the results can be expected.

8.1.1 Retrieval Settings

L0-1c settings	
Calibration	All on except radiometric calibration
SMR	A0
DOAS Settings	
Fitting Interval	365 – 389 nm
Polynomial Degree	4th order
Absorption Cross Sections/Fitted Curves	
NO_2	Bogumil et al., T= 223 K
O_4	Hermans (1999)
OClO	Krominga (2003)
Ring	Vountas (1998)
Undersampling	Constant Undersampling Spectrum calculated by IUP-Bremen
Empirical Functions	Eta Nadir, "Magic Ratio (ratio of cloudy and cloud free measuremen) calculated by IUP-Bremen"
Offset and slope correction	Inverse Earthshine

8.2 Verification Set-Up

The slant column and the residual of fit will be compared. Note that physically meaningful results are only expected in polar regions.

8.3 Involved Partners

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8.4 Verification Data

See Table 2.1

8.5 Verification Results

Before reporting OClO verification results it's necessary to underline certain specialities of this product. OClO is much less abundant than O3 (5-6 orders of magnitude) or NO2 (2-3 orders of magnitude). OClO measurement results are much more noisier than those of O3 or NO2: whereas mean absolute deviation of O3 SC from one orbit equals roughly 20-30 % of its mean values (at NO2 it can reach 60-65 %), in case of OClO measurements this value reaches several hundred percent. Comparison of two such noisy products will certainly lead to much higher relative differences and to a significantly worse correlation between them than in case of O3 and NO2.

Average OClO values calculated by IUP and the OL version 5 as a function of SZA are shown on Figure 8.1. It can be seen that significant OClO is only present at SZA > 90° for two reasons: a) rapid photolysis of OClO and b) limitation of chlorine activation to the vortex which is situated at high latitudes. The lengths of the error bars reveals as well how noisy the product is at high SZA. At lower SZA there is an obvious offset between two data sets. Both of them, however, retrieve negative OClO values, which have to be considered as unphysical.

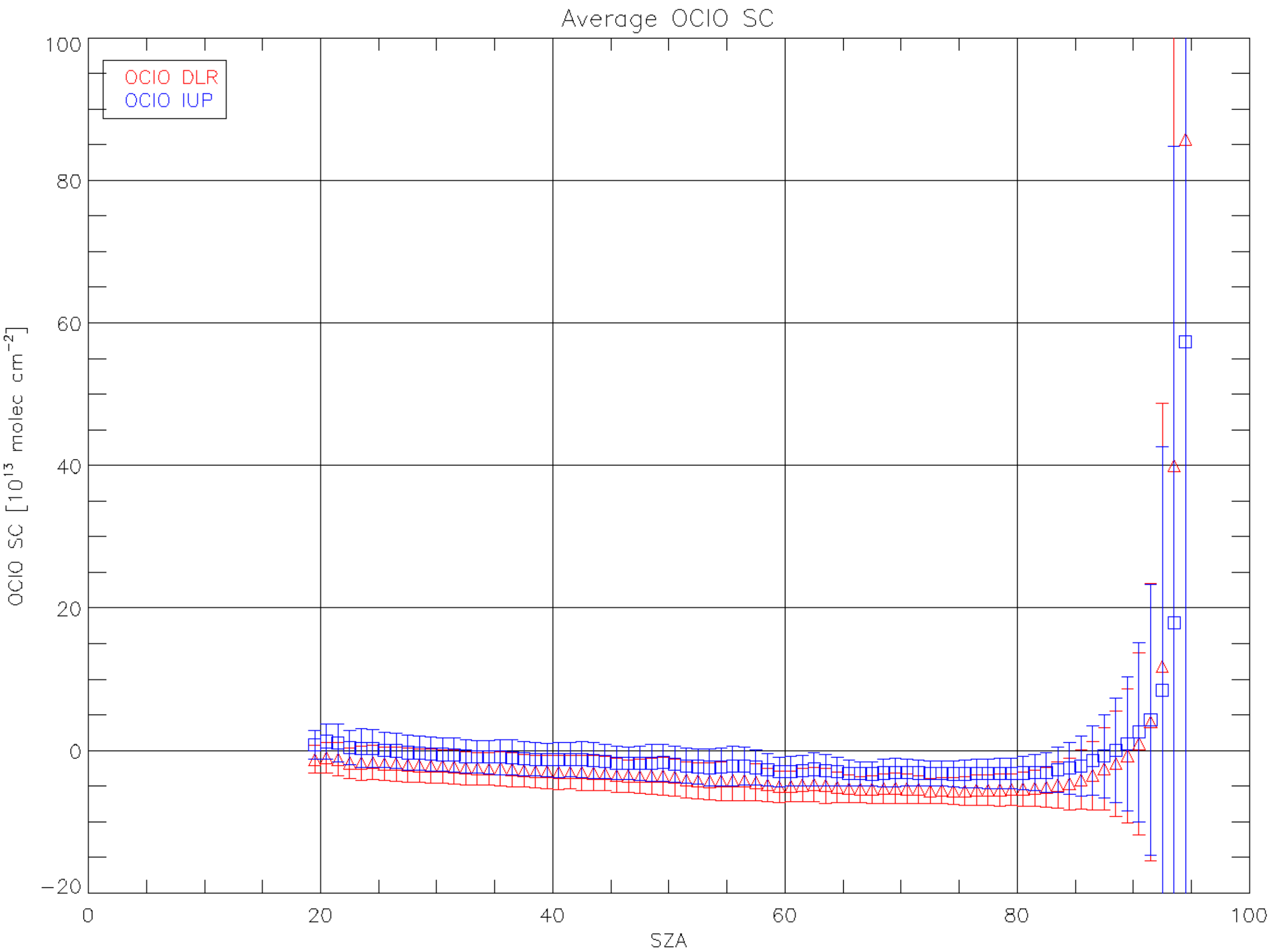

Figure 8.1: *OClO slant column values (red: Processor, blue: reference algorithm) as a function of SZA.*

Figure 8.2 (top) shows a scatter plot of OClO values retrieved by the IUP scientific algorithm and by the OL version 5. Since OClO is present in darkness only as briefly described above, corresponding OClO values (SZA > 90°) are chosen for the plot. OClO values at very high SZA (> 93°) were not taken into consideration because noise at that SZA is extremely high, making them unusable. It can be seen that the slope is slightly flatter (0.87) than the 1:1 line.

The histogram of the relative differences between OClO of IUP and the OL version 5 is shown on the bottom of Figure 8.2. For this histogram the same OClO values were chosen (90° < SZA < 93°). This histogram reveals that the mean difference between two versions of OClO is 6.3% (this number, however, is quite variable, its standard deviation is 50.7%).

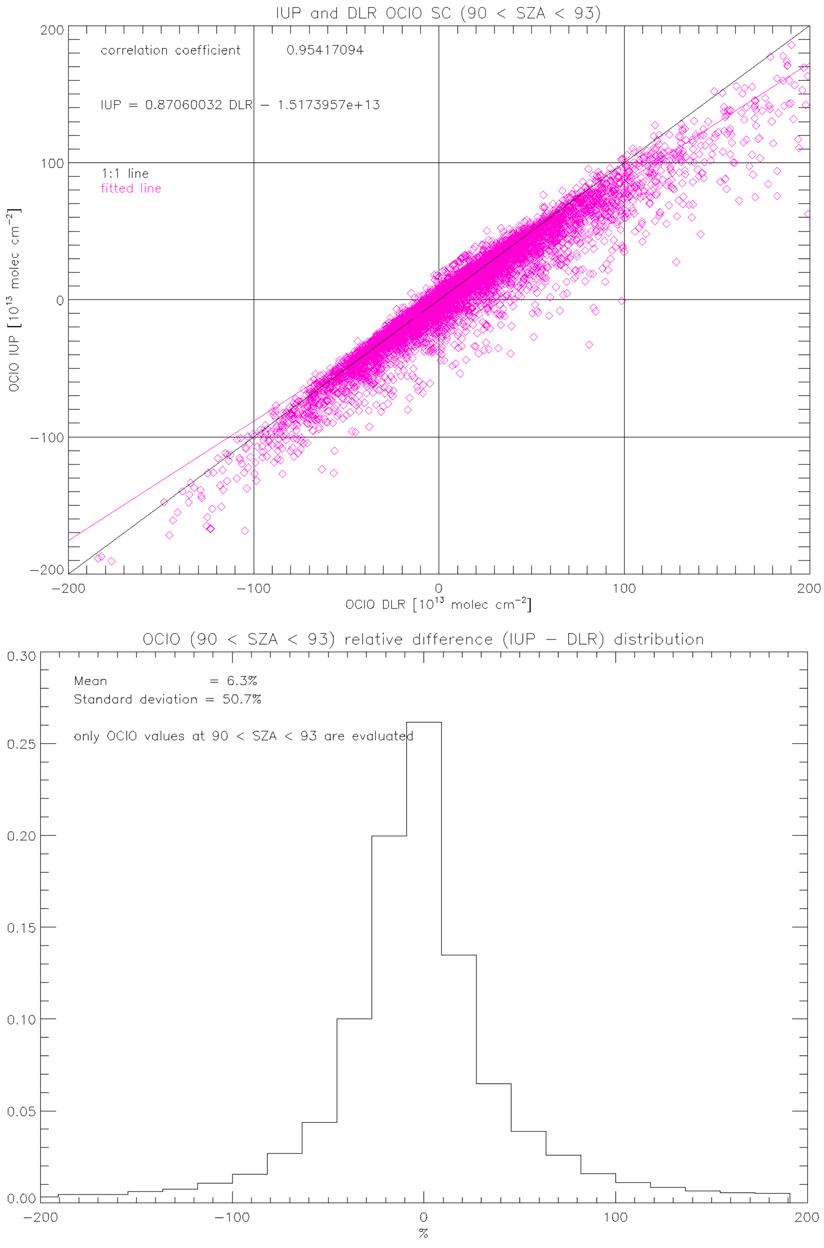

Figure 8.2: *Scatter plot (top) and Histogram (bottom) of the slant columns in the relevant region between 90 and 93 degree SZA.*

Comparison of RMS from both fits is shown in Figure 8.3. RMS from IUP OClO fit are slightly (12.4 % on average) lower.

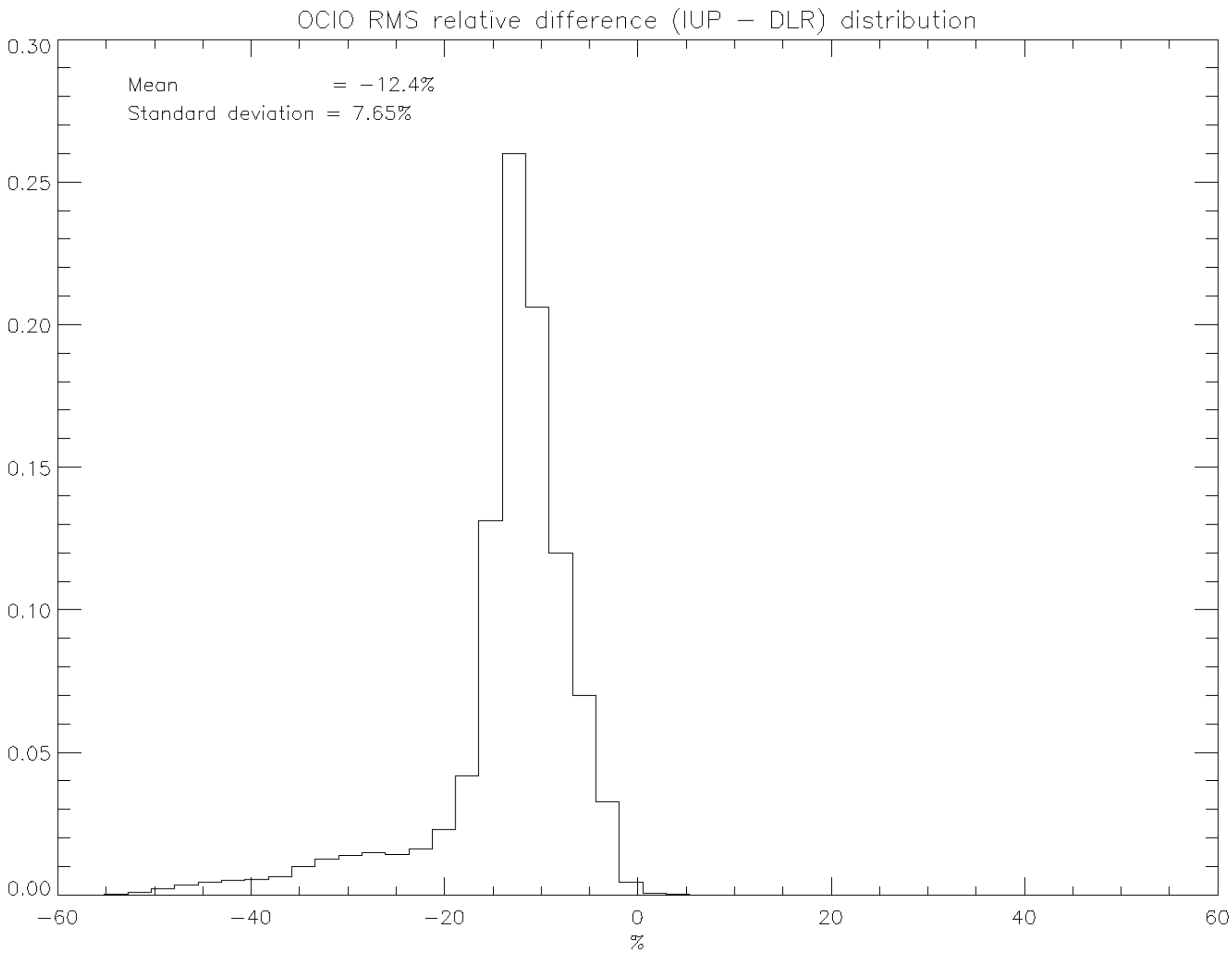

Figure 8.3: *Histogram of the relative differences of the RMS fit values for the reference and the SGP algorithm.*

In summary, the agreement between the OL OClO column product and the IUP Bremen scientific product is not excellent, but considering the large variability in each of the two products, the differences appear acceptable at this point.

9 Task #6: Nadir H_2O Total Columns

9.1 Introduction

This product is newly introduced to the Level 2 processing. Contrary to the other Nadir trace gas products in the UV/VIS it uses a direct retrieval (AMC DOAS) developed by S. Noël IUP Bremen. The source code of this retrieval was delivered to IMF and was directly implemented into the processor.

9.1.1 Retrieval Settings

L0-1c settings	
Calibration	Memory Effect, Leakage, Wavelength
SMR	A0
DOAS Settings	
Fitting Interval	688 – 700 nm
Total Column Calculation/Profiles	
AMC-DOAS retrieval code developed by IUP-Bremen is used without any changes in this version of the processor. All retrieval settings used there remained untouched in this way.	

9.2 Verification Set-Up

The total column, the total column error and the AMF correction factor will be compared for the verification data set.

9.3 Involved Partners

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DLR-IMF	*M. Meringer*	*Markus.Meringer@dlr.de*

9.4 Verification Data

See Table 2.1

9.5 Verification Results

The verification set comprises a total of 180 orbits. Reference data for 179 orbits was delivered by IUP. 177 of the 180 verification orbits were processed by the SGP without failure. Orbits 7399 and 22429 failed due to latitude >90°, another one (22343) due to corrupt L1b data. The 177 orbits with the test data are a subset of the 179 orbits with reference data. Within the 177 orbits a total of 1241587 records were identified by corresponding start times.

9.5.1 Results by records

For each of these 1241587 identified records three relevant entries were compared:

- VCD: vertical column density (in g/cm^2),
- ERRVCD: error in the VCD,
- AMFGRD: originally the AMF to ground; in case of AMC-DOAS this field is used for the AMF correction factor (AMC).

All values for both, reference and test data, were computed with fixed Doppler shift of 0.01nm at 500nm.

The absolute difference in VCD has a maximum of 0.036, occurring in orbit 7831.The mean in the absolute difference is 0.0009. The number of records with absolute difference in VCD < 0.001 is 1011500 (81.5%); < 0.01: 1226987 records (98.8%). The relative absolute difference | VCD(IUP) – VCD(DLR)| / VCD(IUP) is at most 0.065, occurring in orbit 07884; the mean is 0.00135. The number of records with relative absolute difference < 0.001 is 851025 (68.5%); <0.01: 1216318 records (98.0%). Figure 9.1 shows a plot of VCD for test vs. reference data, Figure 9.2 shows the relative differences vs. orbit.

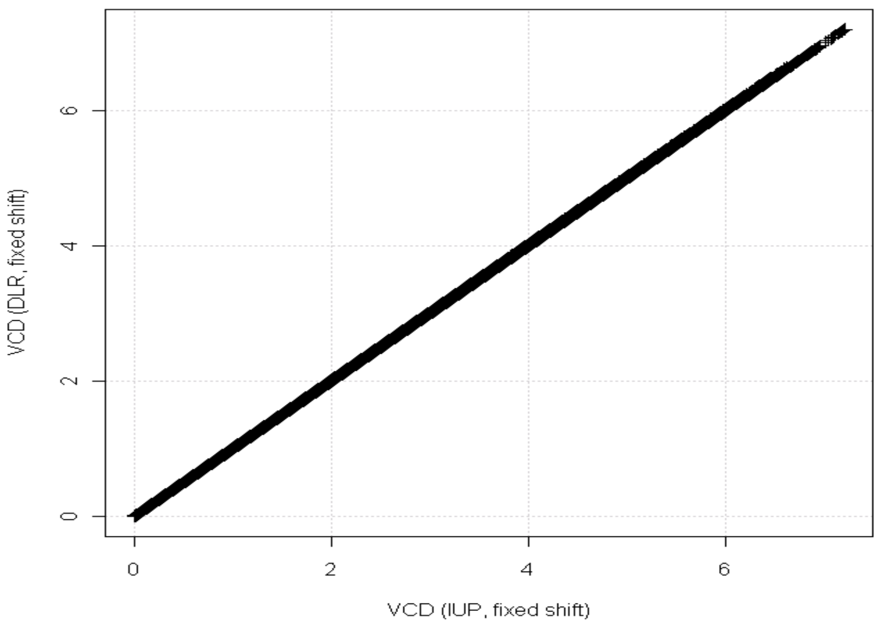

Figure 9.1: *Scatter plot of total columns of water.*

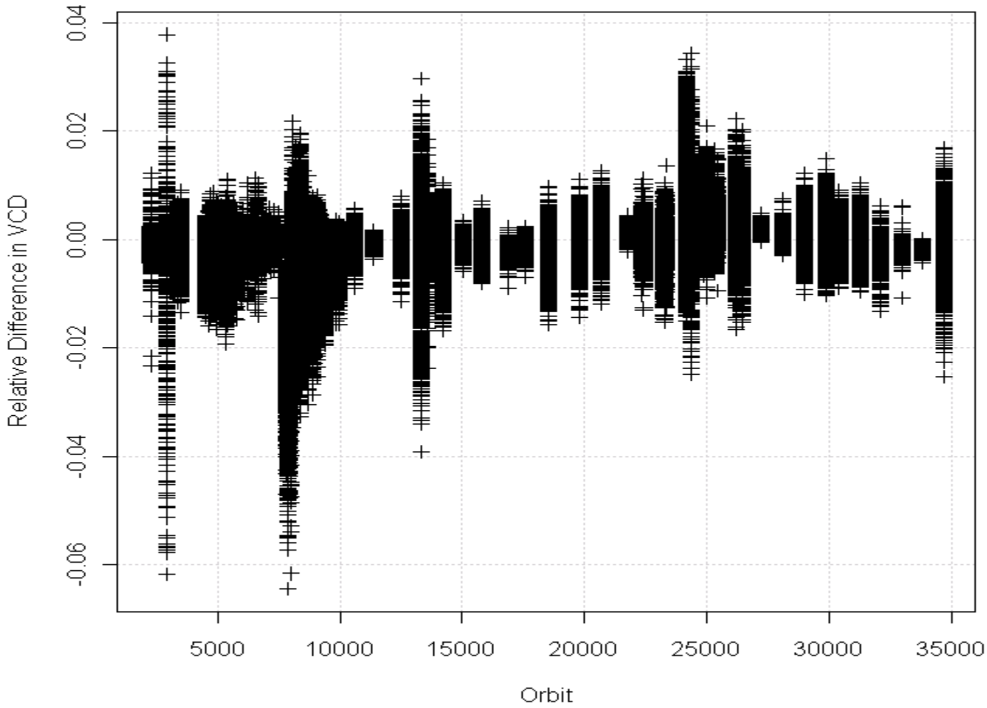

Figure 9.2: *Relative Difference of the total columns of water vapour as a function of orbit.*

Next we examined absolute differences between test and reference data in ERRVCD. The absolute difference has a maximum of 0.003, occurring in orbit 7993, and a mean of 0.0003. The number of records with absolute difference <0.001 is 1228314 (98.9%).

The absolute difference between test and reference data in AMFGRD is at most 0.003, occurring in state 7993; the mean is 0.0003. The number of records with absolute difference <0.001 is 1208119 (97.3%). The individual results per orbit can be found in Appendix A.

The operational implementation of the retrieval and the reference algorithm differ in the handling of the Doppler shift. The operational retrieval uses a fixed value while the reference algorithm in the meantime uses the Doppler shift given in the Level 1b file. Figure 9.3 shows the effect of using a fixed Doppler shift instead of the variable one for the reference algorithm. Since it is well within the error of the retrieval, it was decided to use the fixed Doppler shift for this version of the SGP. For the verification results from the reference algorithm with a fixed shift were used.

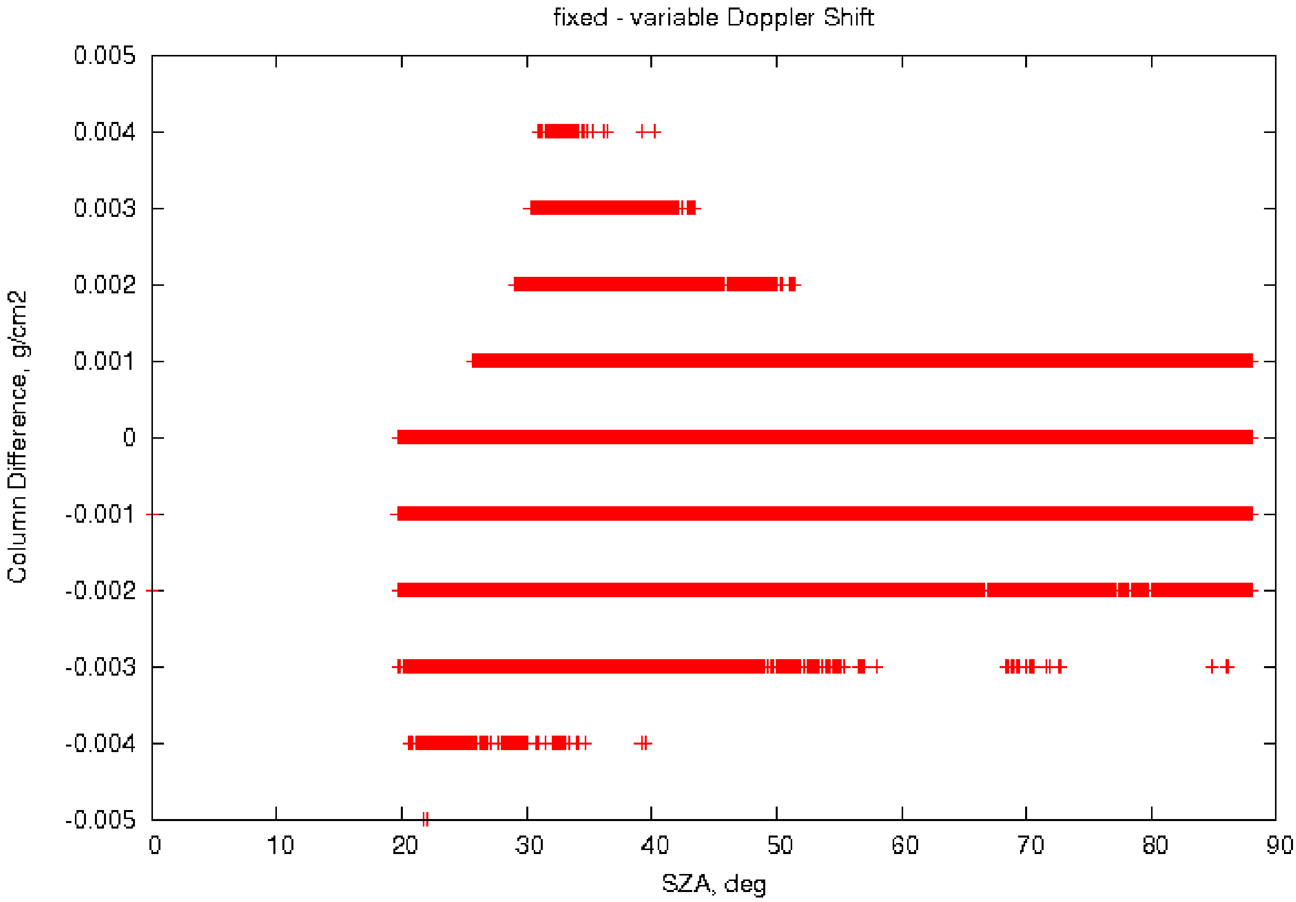

Figure 9.3: *Effect of using a fixed Doppler shift instead of a variable one in the water vapour retrieval.*

10 Task #7: Nadir CO Total Columns

10.1 Introduction

The CO retrieval uses the BIRRA code developed by F. Schreier ,DLR-IMF. It uses a non-linear least square method to directly fit the radiances. The result of the retrieval are correction factors to an initial value from climatology. Correction factors for CO, CH_4 and H_2O are simultaneously retrieved. The product contains the correction factors, the resulting columns from the multiplication of the correction factors with the starting values and a "CH_4 corrected" value of the total CO column. The underlying assumption for the latter is that CH_4 is homogeneously distributed compared to CO. The division of the correction factor for CO by the correction factor for CH_4 corrects grosso modo for remaining instrument effects, clouds in the FoV etc. The most likely use case for the CO retrieved values are averages over a larger data set (e.g. monthly means).

10.2 Verification Set-Up

Note that the DBPM has considerable influence on the retrieved results. A comparison with the operational mask is difficult, because first *all* Level 1b data have to be processed with SciCal. This is out of scope for the verification. However, tests on a small data set showed that the CO retrieval with the new DBPM gives reasonable results. However, this has to be confirmed on a larger data set. The DBPM used for the verification corresponds to the mask used in the Level 0-1 version 6.03 data. This mask is not optimal for the CO retrieval.

Note that the reference code is developed independently from the operational processor. Although the code was transferred to the operational processor, some differences can be expected because of different input auxiliary data, especially topography data bases. The verification is done for all datapoints without applying flagging. An evaluation of the quality of the data will be done separately from the verification, when all DBPM and calibration data are available.

10.3 Involved Partners

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10.4 Verification Data

See Table 2.1

10.5 Verification Results

Figure 10.1 shows the comparison of all CO values. It can be seen that the agreement between reference algorithm (also called "prototype" hereafter) and the operational algorithm is not very good. Investigations showed that the main reason are differences in the used topography database. As the total column of CO is defined as

$$CO_{VCD} = \alpha_{CO} \cdot CO_{VCD}^{reference}$$

a different topography and thus ground height has the following effects:

1. The reference value is different between prototype and operational processor
2. The iterative fit leads to a different convergence state vector

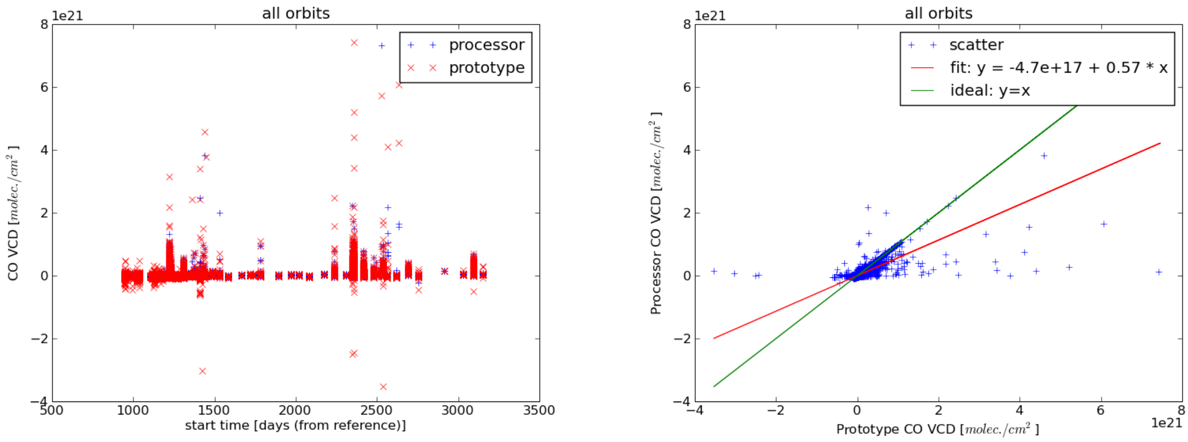

Figure 10.1: *Comparison of reference algorithm ("prototype") and processor for all data. Left: Total column values vs. time. Right: Scatter plot. In the linear fit of the scatter plot the errors of the values are not taken into account.*

In order to check if the operational implementation is correct, two ground pixels were calculated using the same ground height values (circumventing the normal operational topography database). The two ground pixels were in the Sahara and the Himalaya. If the height is the dominant factor for the differences one expects nearly no difference in the comparison of the Sahara pixel, since the topography is essentially flat. The Himalaya ground pixel should show large differences. As can be seen in Figure 10.2 this is indeed the case.

Additional effects that can lead to deviations between the BIRRA prototype and the implemented algorithm are

- Retrievals that have not converged could have gone through numerical unstable phases during iterations.
- Retrievals over sea generally lead to very small numbers causing also a numerical problem.

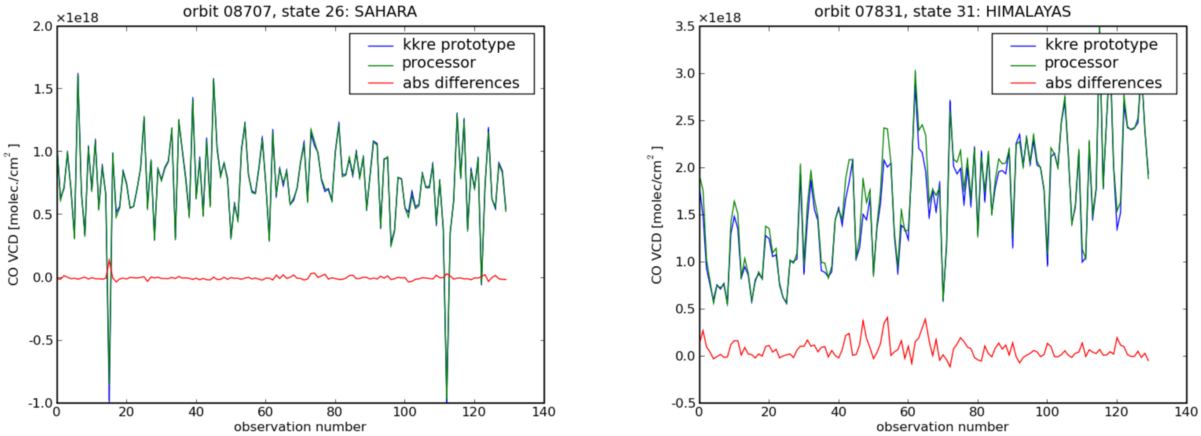

Figure 10.2: *Example for the effect of different topography databases in the prototype and the operational processor. Left: Sahara ground pixel with flat topogrphy. Right: Himalayas. The agreement for a flat topography is very good (lower, red curve).*

A comparison of CO values filtering out retrievals that did not converge already shows better results. The remaining differences are mainly due to the different topography. If one additionally filters out unphysical CO values, CO values with high error and observations over sea (these are the values most likely to be used for scientifc investigations), the comparison improves further. Scatter plots for these two cases are shown in Figure 10.3. Considering the inherent difficulties of the retrieval, the verification can be considered as successful.

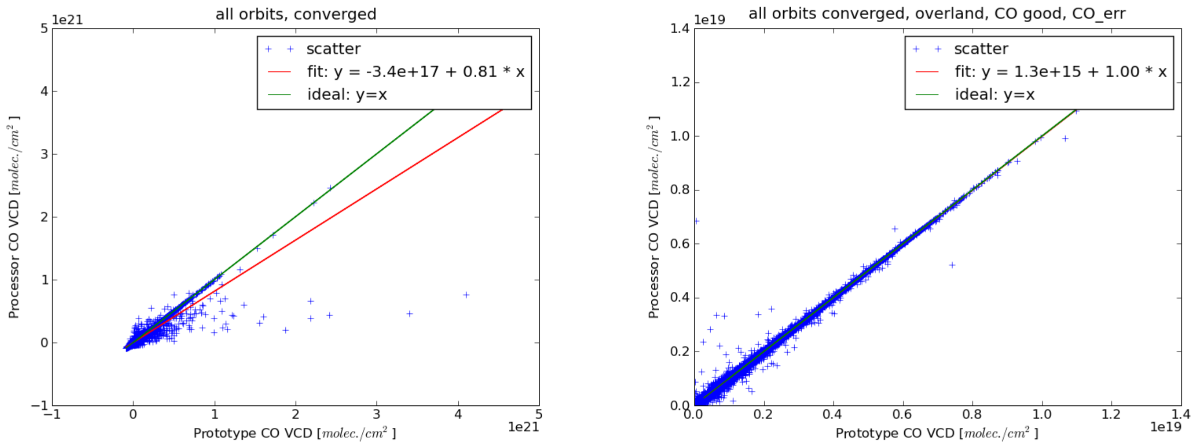

Figure 10.3: *Left: Scatter plot of CO values filtering out values where the retrieval did not converge. Right: Scatter plot only showing "useful" (see text) values. Remaining differences are caused by differences in the topography.*

11 Task #9: Limb BrO Profiles

11.1 Introduction

The BrO profiles are a completely new limb product. They will be retrieved with the same retrieval software as the other SCIAMACHY profiles with adjustments for BrO.

11.2 Verification Set-Up

Since no independent comparison data are available, only the "physicality" of values will be checked, i.e. it will be checked that the values are in a reasonable range. A thorough quality check has to be performed within the validation campaign and/or with the re-processed data set.. Note that the comparison is done with an external algorithm which is similar, but not identical to the operational algorithm. Therefore the external algorithm only serves as a justification for the implementation settings. Somewhat larger differences than for the direct implementation of an external algorithm can be expected.

11.3 Involved Partners

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11.4 Verification Data

See Table 2.1

11.5 Verification Results

The comparison of the new BrO limb profiles in SGP OL V5 has been done with the IUP BrO V3.2 retrieval model from A. Rozanov, which has the following features:

- Forward model: SCIATRAN 2.1, multiple scattering mode
- Spectral region: 338 - 356.2 nm, surface albedo: 0.3, pressure and temperature: ECMWF database
- Weighting functions type: single scattering
- Atmospheric species in the forward model: BrO, NO2, O3, O4
- A priori information for BrO is based on MIPAS observations
- Retrieved Atmospheric species: BrO, NO2, O
- Reference tangent height number: 13 (36 km), Tangent heights selected for the retrieval: 5 - 12 (10 - 33 km)

- Polynomial order: 1, correction spectra: tilt, ring, I0-correction for ozone cross sections, eta-function accounting for the scan mirror angle dependence; spectral smoothing: none
- A priori uncertainty: mimimum of 25 pptV and $4x10^7$ molecule/cm3
- Additional regularization: Tikhonov smoothing (smoothing parameter linearly decreases with altitude from 5.6 at 26 km to 0 at 10 km), both NO2 and O3 profiles are smoothed as well
- Signal to Noise Ratio: estimated from spectra, correlation length: 1.5 km
- Solution method: Optimal Estimation; iterative scheme: Gauss-Newton
- Pointing correction is not needed any more (since V6.03 of Level 1 dataset)

The IUP retrieved profiles were calculated for one profile per state (PPS). That means if possible, the spectra for the different azimuth angles of one state were added to minimize noise. Depending on the wavelength range (channel) this might have been done already onboard. The comparison was performed using one PPS. The SGP OL V5 results were thus averaged over one state. As the retrieval grids differ in both algorithms, the IUP profiles were interpolated to the coarser SGP OL V5 grid.

The SGP OL V5 profiles were retrieved as vertical column densities, while the IUP values are calculated as number densities [mol/cm3]. This was taken into account by converting the SGP OL V5 VCDs to number densities. This leads to an "uncommon" altitude grid between approximatively 18 and 32 km.

For the verification 3615 states has been used, that is about 150 orbits. The mean difference between both retrievals is below 20% between 20 and 28 km, below 40% above and below. The scatter of this mean is more than 40%. Taking into account that the retrieval of such low number densities is very sensitive to noise and other systematic errors, the observed differences are very well acceptable. Figure 11.1 shows the relative difference of the two retrievals.

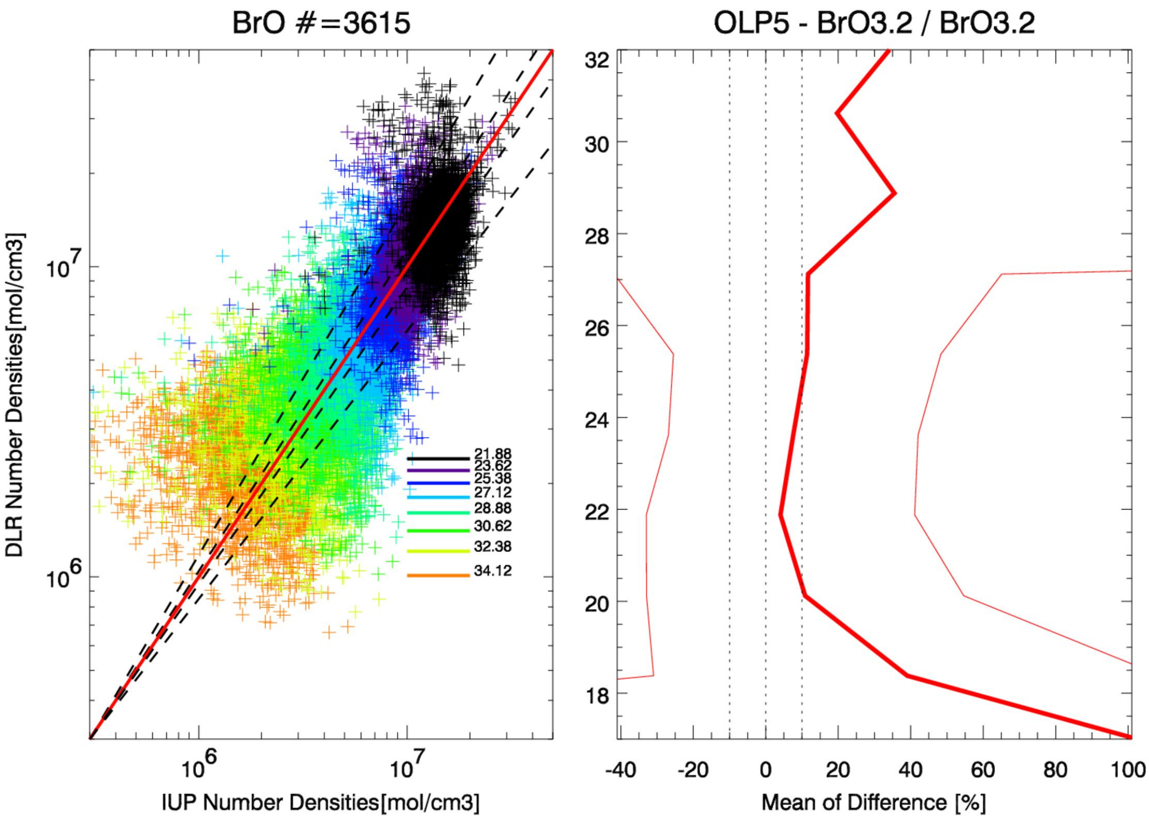

Figure 11.1: *Scatter plot of number densities [mol/cm³] for 8 different tangent heights between 21.8 and 34.1 km (left) and mean of the difference between the two retrievals and the single standard deviation (right). The relative difference is SGP OL V5-BrO3.2/BrO3.2 [%].*

12 Task #10: Limb Cloud Flagging

12.1 Introduction

A new product to indicate the presence of clouds in limb measurements was introduced. Flags for normal clouds, ice clouds, and PSCs and the corresponding colour ratio indices and cloud top heights were derived with this algorithm.

12.1.1 Retrieval Settings

L0-1c settings	
Calibration	Full, no mf
SMR	D0
Normal Clouds	
Spectral Window	750-751 nm/1088-1092 nm
PSC	
Spectral Window	750-751 nm/1088-1092 nm
Ice Clouds	
Spectral Window	1550-1553.2 nm/1630-1634 nm

12.2 Verification Set-Up

Comparison of all calculated product entries (FLAG_WCL, MAXVAL_WCL, MAXHEIGHT_WCL, MAXHEIGHTIDX_WCL, FLAG_ICL, MAXVAL_ICL, MAXHEIGHT_ICL, MAXHEIGHTIDX_ICL, FLAG_PSC, MAXVAL_PSC, MAXHEIGHT_PSC, MAXHEIGHTIDX_PSC)

12.3 Involved Partners

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12.4 Verification Data

See Table 2.1

12.5 Verification Results

The verification set comprises a total of 180 orbits. Reference data for 168 orbits was delivered by IUP. 178 of the 180 verification orbits were processed by SGP_L12_OL without failure. One orbit (22343) failed due to corrupt L1b data, another one (34664) due to missing m-factor file. The intersection of the 168 reference and the 178 test orbits comprises 166 orbits. Within these orbits a total of 14266 records were identified by corresponding start times.

12.5.1 Results by records

For each of these 14266 identified records all relevant entries in the limb cloud MDS were compared:

- FLAG: cloud flag,
- MAXVAL: maximum value of the color index ratio,
- MAXHEIGHT: tangent height (in km) where MAXVAL is found and
- MAXHEIGHTIDX: index of MAXHEIGHT

each for three different cloud types

- WCL: normal water clouds,
- ICL: ice clouds and
- PSC: polar stratospheric clouds.

For a few record differences in cloud flags were found:

- WCL: 55 records (0.4%),
- ICL: 25 records (0.2%),
- PSC: 0 (0%).

A more detailed picture deliver the cross tables below. For each combination of values (0,1,2,3) for the cloud flag in the reference (IUP) and the test (DLR) data the number of records with that combination is given.

WCL flag		DLR			
		0	1	2	3
IUP	0	863	1	0	30
	1	6	9647	5	0
	2	4	8	3551	1
	3	0	0	0	150

ICL flag		DLR			
		0	1	2	3
IUP	0	10385	12	2	0
	1	6	2956	0	0
	2	0	1	900	0
	3	0	4	0	0

PSC flag		DLR	
		0	1
IUP	0	14147	0
	1	0	119

Next we examined absolute differences in MAXVAL for the three cloud types. For WCL the maximum in the absolute difference is 2.53, occurring in orbit 2909. The mean of the absolute differences is 0.0044. The number of records with absolute difference < 0.001 is 3151 (22.1%); <0.01: 14226 records (99.7%); <0.1: 14227 records (99.7%); <1: 14256 records (99.9%).

Figure 12.1 shows a plot of MAXVAL for the test vs. the reference data and Figure 12.2depicts the difference MAXVAL(IUP) - MAXVAL(DLR) vs. orbit number.

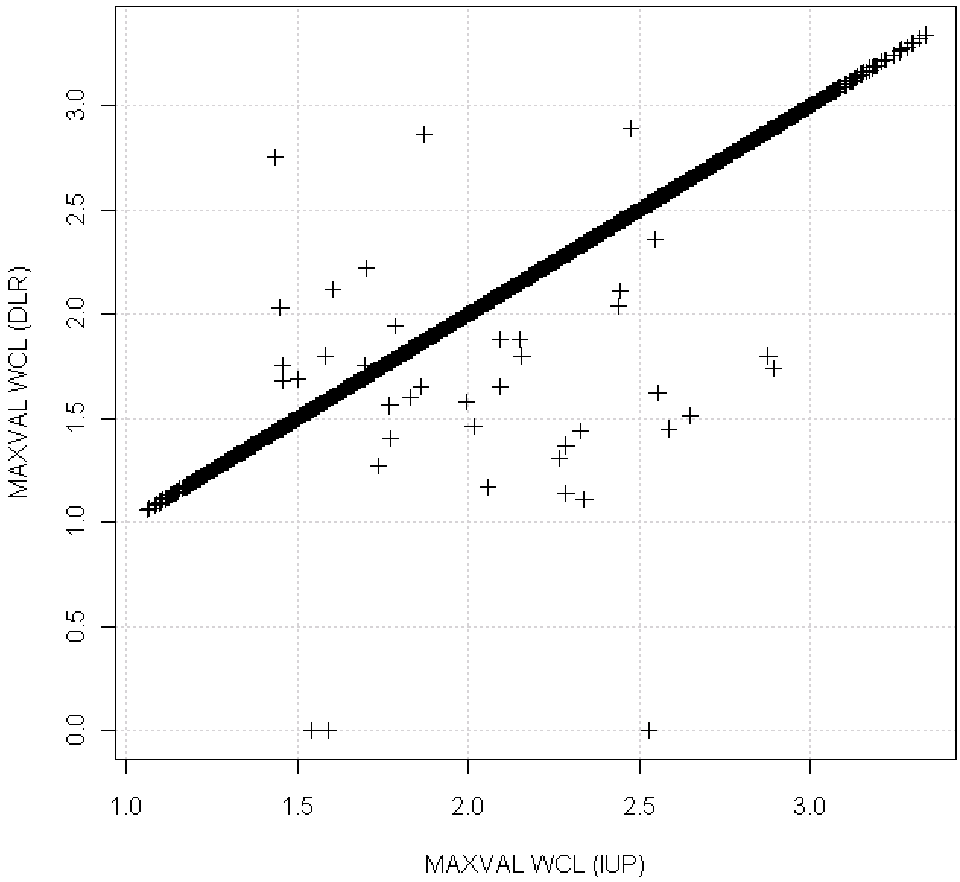

Figure 12.1: *Scatter plot for MAXVAL water clouds.*

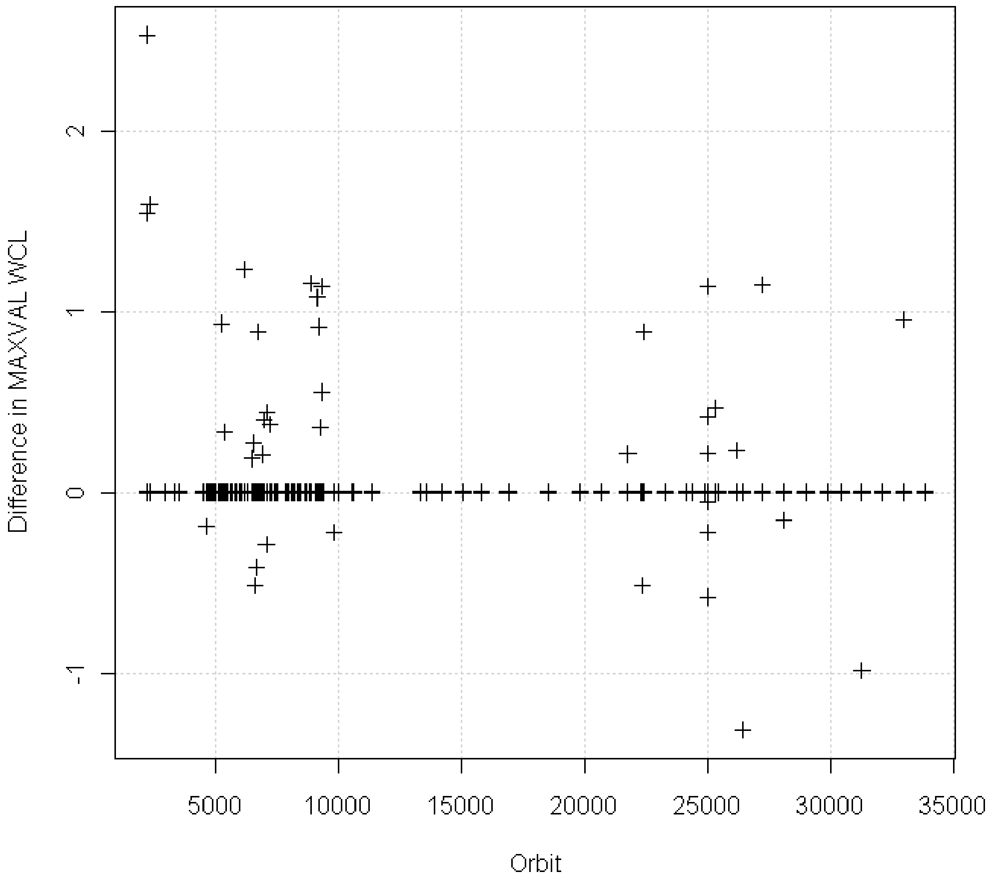

Figure 12.2: *Difference for MAXVAL water clouds between reference and SGP as a function of orbit.*

For ICL the absolute difference in MAXVAL between reference and test data has a maximum of 103.52, occurring in orbit 28094. The mean of these absolute differences is 0.0261. The number of records with absolute difference <0.001 is 2827 (19.8%); <0.01: 14215 records (99.6%); <0.1: 14238 records (99.8%); <1: 14254 records (99.9%).

For PSC the absolute difference in MAXVAL between reference and test data has a maximum of 0.005, occurring in orbit 7834. The mean of these absolute differences is 0.00002. The number of records with absolute difference <0.001 is 14173 (99.3%).

Parameter MAXHEIGHT was verified analogously. Absolute differences in MAXHEIGHT for WCL were at most 19.71, occurring in orbit 6881. The mean of the absolute differences is 0.0131. The number of records with absolute difference <0.01 is 14057 (98.5%); <0.1: 14233 records (99.8%); <1: 14236 records (99.8%).

Figure 12.3 shows a plot of MAXHEIGHT for the test vs. the reference data, Figure 12.4 depicts the difference MAXHEIGHT(IUP) - MAXHEIGHT(DLR) vs. orbit number.

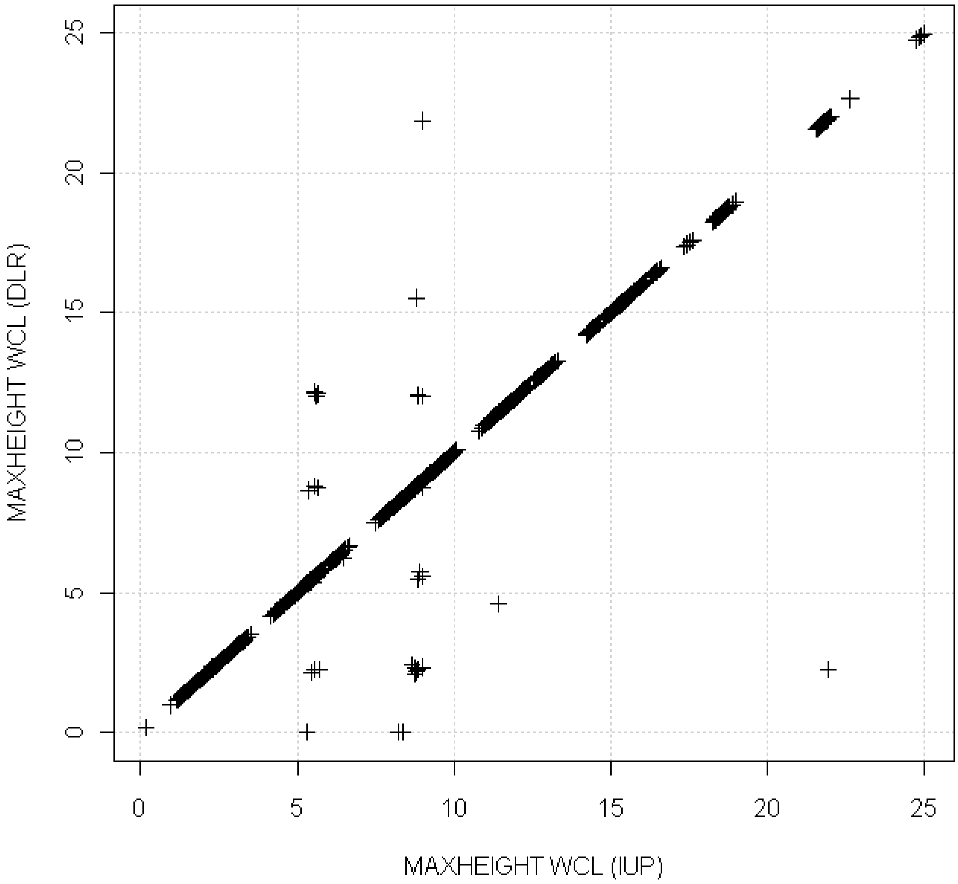

Figure 12.3: *Scatter plot of maximum heights for water clouds.*

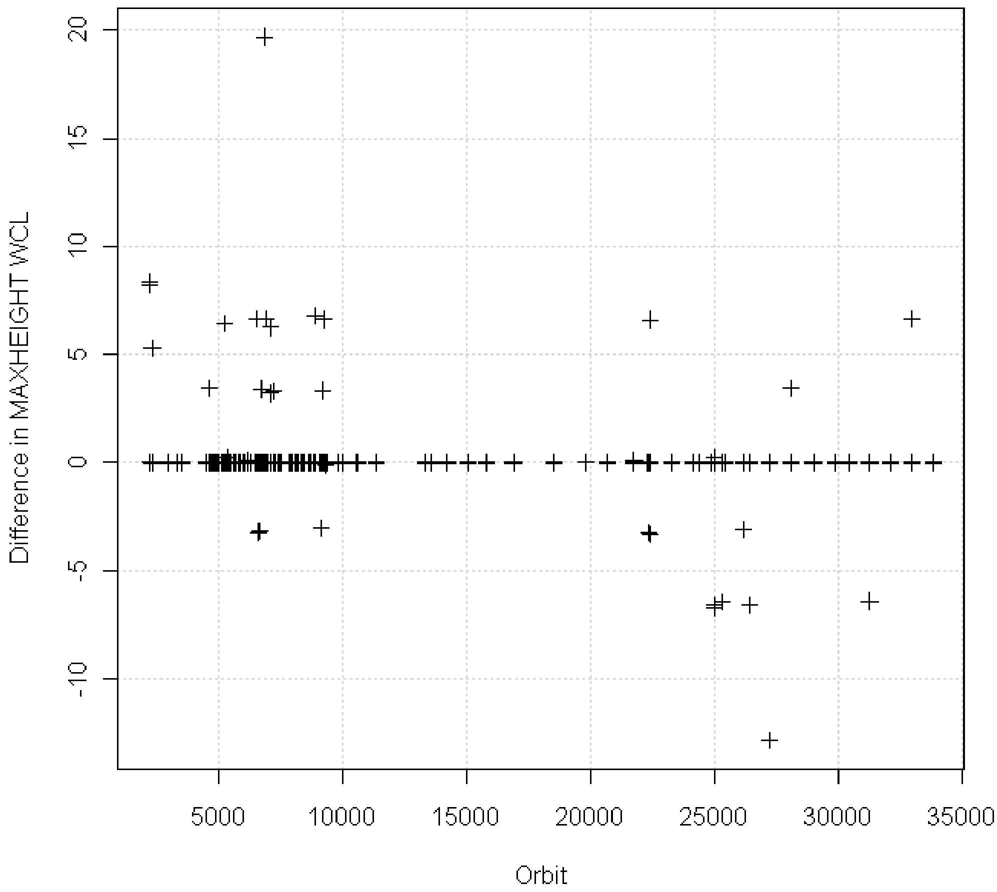

Figure 12.4: *Difference in maximum height parameter vs orbit.*

For ICL the absolute difference in MAXHEIGHT between reference and test data has a maximum of 19.83, occurring in orbit 4618. The mean of these absolute differences is 0.0161. The number of records with absolute difference <0.01 is 14051 (98.5%); <0.1: 14231 records (99.8%); <1: 14233 records (99.8%).

For ICL the absolute difference in MAXHEIGHT between reference and test data has a maximum of 0.01, occurring in orbit 8161. The mean of these absolute differences is 0.000006. The number of records with absolute difference <0.01 is 14265 (almost 100%).

The MAXHEIGHTIDX is an even more significant parameter to prove the correctness of the SGP implementation of the cloud detection algorithm, because it is not depending on (probably different) methods for calculating tangent heights. Only for a few records differences in MAXHEIGHTIDX were found:

- WCL: 30 (0.002%),
- ICL: 33 (0.002%),
- PSC: 0 (0%).

Cross tables of these indices show a more detailed picture:

MAXHEIGHT-IDX WCL		DLR									
		0	2	3	4	5	6	7	8	9	10
IUP	2	0	1	0	0	0	0	0	0	0	0
	3	0	0	2920	0	0	0	0	0	0	0
	4	1	0	3	2637	3	4	0	0	0	0
	5	2	0	7	3	4175	3	1	0	1	0
	6	0	0	0	1	0	2805	0	0	0	0
	7	0	0	0	0	0	0	1514	0	0	0
	8	0	0	0	0	0	0	0	141	0	0
	9	0	0	1	0	0	0	0	0	39	0
	10	0	0	0	0	0	0	0	0	0	4

MAXHEIGHT-IDX ICL		DLR								
		0	3	4	5	6	7	8	9	10
IUP	3	0	2928	1	1	0	0	0	0	0
	4	1	3	2273	1	4	0	0	1	0
	5	2	8	0	3652	2	1	1	0	0
	6	0	0	3	0	2779	0	0	0	0
	7	0	0	1	1	1	1692	0	0	0
	8	0	0	0	0	0	0	344	0	0
	9	0	1	0	0	0	0	0	334	0
	10	0	0	0	0	0	0	0	0	231

MAXHEIGHTIDX PSC		DLR				
		0	7	8	9	10
IUP	0	14147	0	0	0	0
	7	0	51	0	0	0
	8	0	0	36	0	0
	9	0	0	0	27	0
	10	0	0	0	0	5

13 Task #11: Limb Ozone Profile Improvements

13.1 Introduction

Improvements:

- Inclusion of Aerosols ("LOWTRAN")

• Use of limb cloud coverage and height information

13.2 Verification Set-Up

13.3 Involved Partners

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13.4 Verification Data

See Table 2.1

13.5 Verification Results

13.5.1 Aerosols

To extend the detection height range towards the troposphere, the effect of aerosols and clouds have to be taken into account in the forward model and the retrieval. The simple LOWTRAN aerosol model was chosen as a starting point for improvement of the forward model and was implemented in both the scientific and SGP OL V5 model. The cloud flagging algorithm SCODA was implemented to avoid retrieval inside of clouds. Level 2 data of 176 orbits (about 4000 states) from 2002 to 2008 were processed for verification. SGP OL V5 O3 is retrieved with 4 profiles per state (PPS). IUP data (STRATOZONE 2.2 and SCIATRAN 2.3) was used for comparison that only has 1 PPS due to use of UV channel 2 spectra. So for comparison purposes SGP OL V5 data was degraded to 1 PPS. The SGP OL V5 profiles were retrieved as vertical column densities, while the IUP values are calculated as number densities [mol/cm3]. This was taken into account by converting the SGP OL V5 VCDs to number densities. This leads to an “uncommon” altitude grid between approximatively 18 and 40 km. The IUP dataset was interpolated to this grid. These two reduced dataset were then used for the validation (VALID; A. v. Gijsel).

Figure 13.1 shows the mean differences between SGP OL V5 and STO2.2 when using aerosols in the forward model and without. The differences are basically the same for these two cases. The influence of a background aerosol is in general small. The agreement between the two models is slightly better in the lower stratosphere when using aerosols in the forward model. Larger differences below 20 km needs to be further analyzed but are possibly due to the influence of clouds, that are used in the SGP OL V5 but not in STO2.2 for these comparisons.

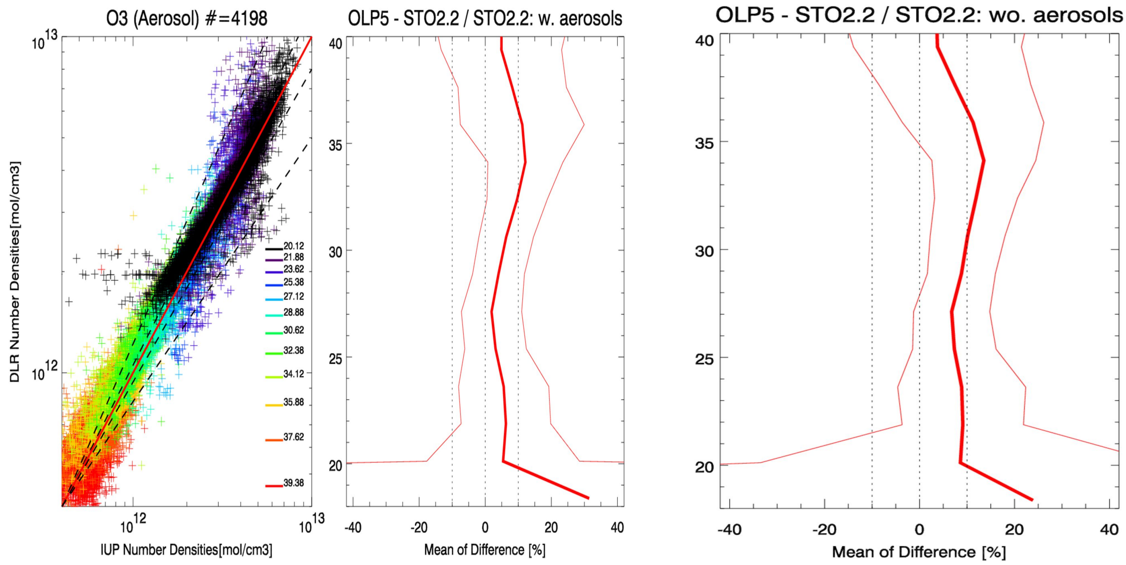

Figure 13.1: *Scatter plot of number densities [mol/cm³] for 8 different tangent heights between 21.8 and 34.1 km (left) and mean of the difference between the two retrievals and the single standard deviation (middle) using aerosols and without aerosols (right). The relative difference is SGP OL V5-ST2.2/STO2.2 [%].*

Figure 13.2 gives an overview of the validation effort with VALID. The work has been done by A. v. Gijsel (RIVM). The first part was the test of the influence of the aerosol model in the SGP OL V5 model. In both retrieval datasets also the cloud flagging algorithm was used. The agreement for both versions is in general good. A slight increase at 30 km can be seen for the aerosol case. The differences are a bit larger for aerosols in the lower stratosphere below 22 km.

If the differences are checked for different geolocations, the general improvement when using aerosols in the retrieval is substantial for all regions (see Fig. 13.3). For these comparisons only partially cloudy scenes were used, which are 2/3 of all the measurements used. There is an offset of about 5-15% in tropical region and about 3% for mid-latitudes.

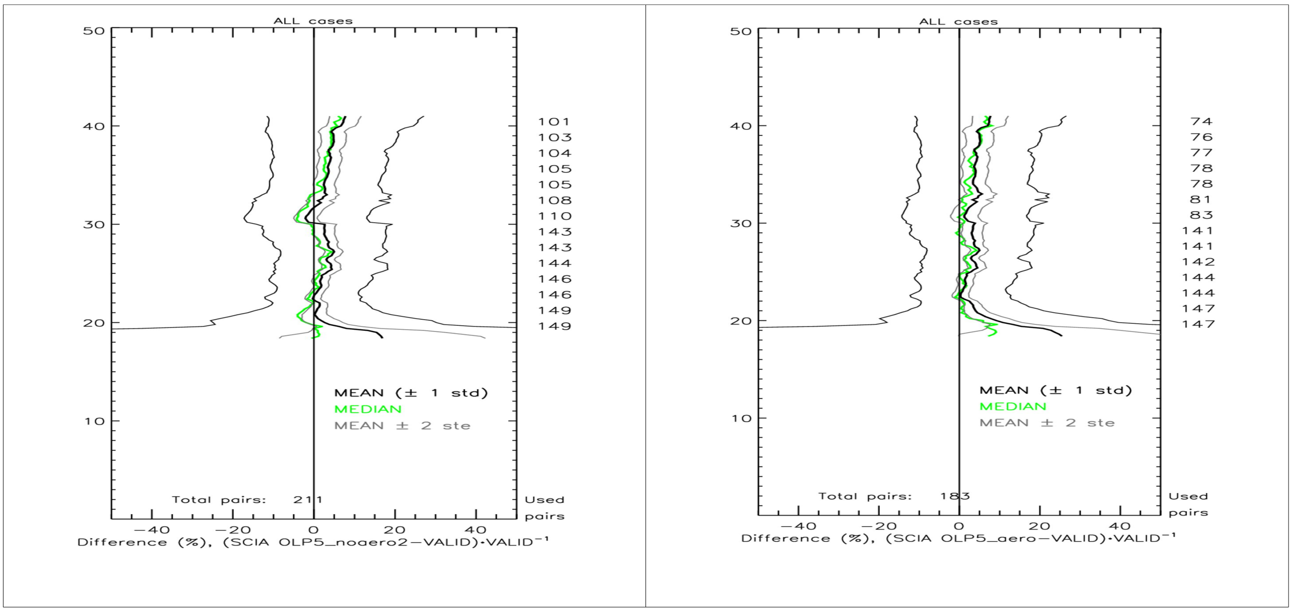

Figure 13.2: *Validation with the VALID dataset (LIDAR, sondes, microwave) (A. v. Gijsel). The left figure show the mean for the retrieval without aerosols, the right figure with aerosols.*

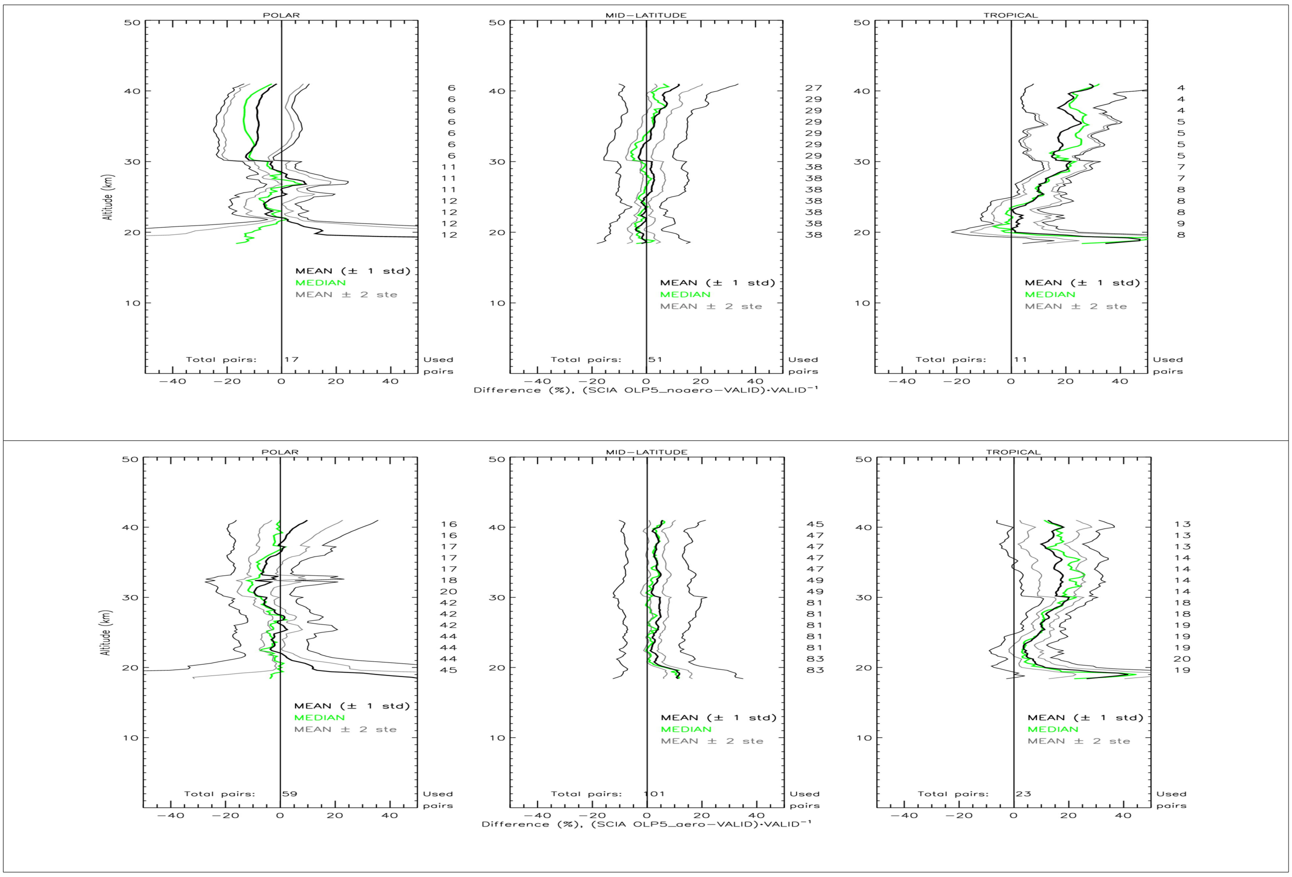

Figure 13.3: *Validation with the VALID dataset (LIDAR, sondes, microwave) (A. v. Gijsel). The upper figures show the mean for the retrieval without aerosols, the lower figures with aerosols. These figures were divided by geolocation. (left: polar, middle: mid-latitude, right: tropical)*

13.5.2 The effect of clouds for the retrieval of trace gases

The effect of taking care of clouds in the retrieval have been shown by model studies (Sonkaew et al., 2009). From this study it was concluded that it is better to omit retrieval inside the cloud and to start the retrieval above. Using the limb cloud detection SCODA for the ozone retrieval STO2.2 the effect is substantial below 20 km and can be neglected above. This is shown in Fig. 13.4. The differences can be higher than -40% for tangent heights below 15 km. But even in the cloud free case one find differences up to 20% that needs to further analysed.

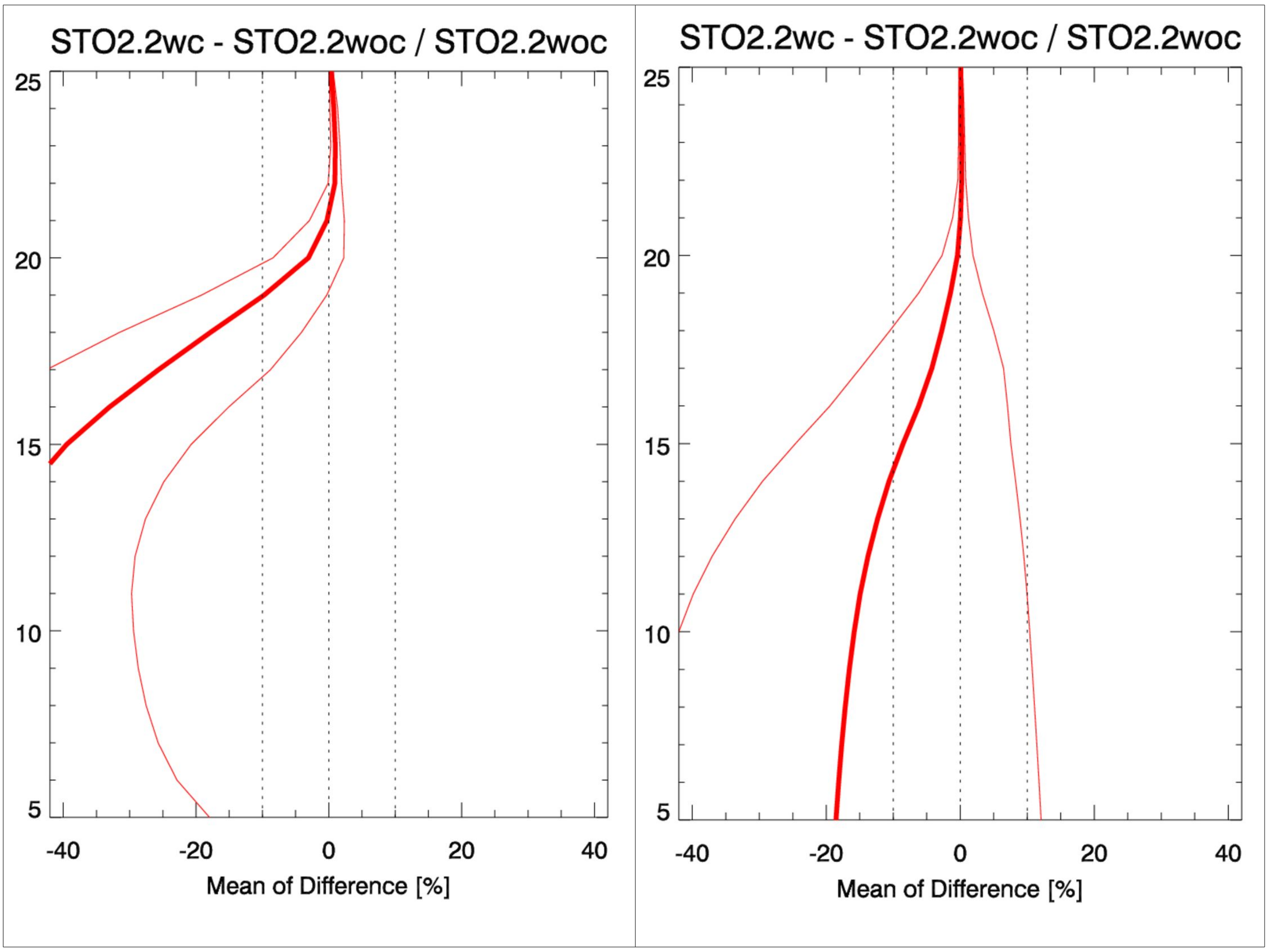

Figure 13.4: *Mean of the difference between the two retrievals and the single standard deviation (left) using full cloudy pixel and without clouds (right) in the tropical region. The relative difference is STO2.2wc-STO2.2woc/STO2.2woc [%].*

As the SGP5.0 is not optimized towards the lower stratosphere below 20 km, a comparison with the IUP algorithm can only show that clouds are not interfering retrievals above 20 km. This is shown in Fig. 13.5. The overall agreement is good. Differences are below 10%, except for the height of 34 km, where the maximum in differences of about 12 % occur. The scatter of differences is in the order of 15%. Fig. 13.6 show validation for fully cloudy scenes as seen by the different instruments. The agreement with sondes is good.

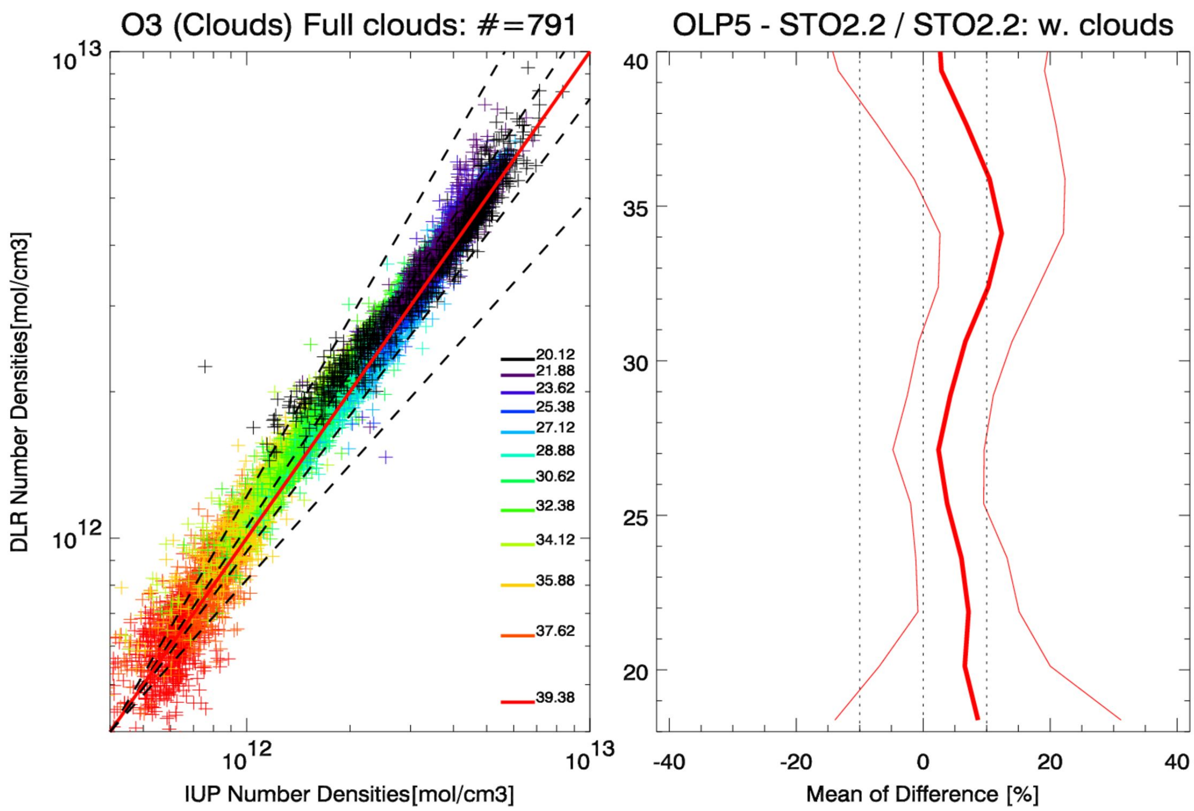

Figure 13.5: *Scatter plot of number densities [mol/cm³] for 12 different tangent heights between 20.1 and 39.4 km (left) and mean of the difference between the two retrievals and the single standard deviation (right) for a cloudy scenario (CF=2). The relative difference is SGP OL V5-ST2.2/STO2.2 [%].*

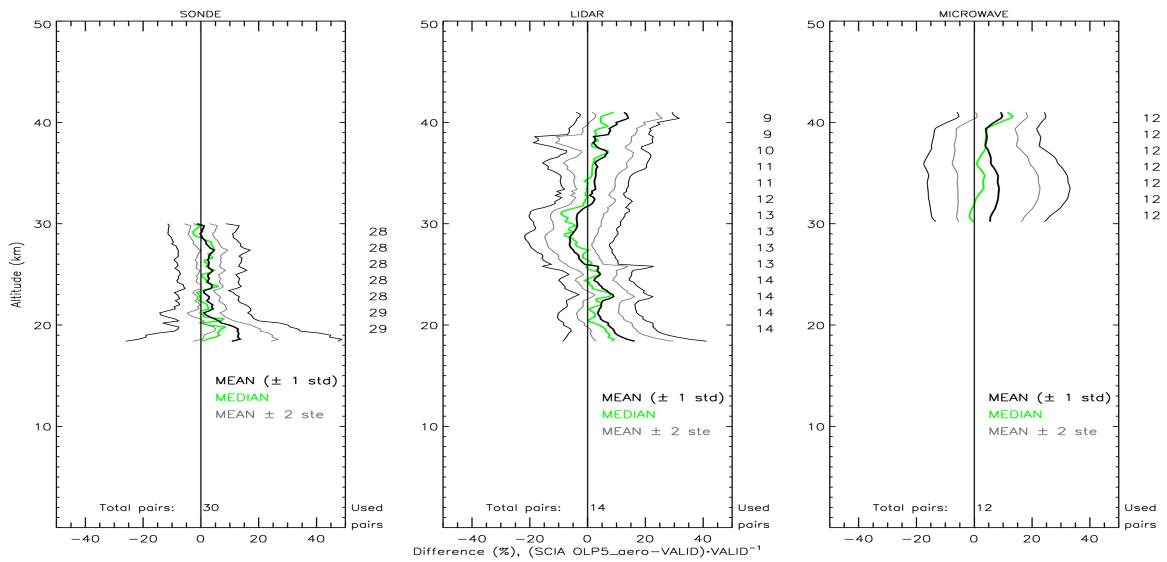

Figure 13.6: *Validation with the VALID dataset (sondes, LIDAR, sondes, microwave) (A. v. Gijsel). The figures show cases of fully cloudy scenes identified by SCIAMACHY.*

14 Summary and Conclusions

In version 5 of the SGP several new products were introduced and existing products were extended. The growing number of products leads to a growing complexity of the processor. In order to guarantee proper implementation, additional to the usual verification of new or changed algorithms, regression tests were introduced. In the regression test, unchanged products from the previous processor version are compared to the - supposedly unchanged - products from the current SGP version. Additional effects of m-factors and/or cloud fractions were also tested. Regression test were made for

- Total Column of Ozone
- Total Column of NO_2
- AAI
- Cloud optical thickness and height
- NO_2 profiles

All tests were successful. New products tested were

- Total columns of BrO
- Total columns of SO_2
- Total columns of H_2O
- Slant columns of OClO
- Total columns of CO
- Profiles of BrO
- Limb cloud flags

Additionally cloud recognition was introduced into profile retrievals, an aerosol model was introduced into the Ozone profile retrieval and the cloud fraction calculation is done on the basis of an updated reflectance database. All verifications of the changes and new products were successful.

Appendix

A Detailed results for H_2O verification

Finally we show a table that reports above described results per orbit. The row header is composed of date and orbit number. The next four columns show the number records in the reference and the test data, and the intersection, i.e. obtained by joining records via the start time. Column ref_tot shows the number of records before removing those with SZA>88 or AMC<0.8. Columns ref, test and join show numbers of records with SZA≤88 and AMC≥0.8 for the reference set, the test set and the joined set. The last three columns show the maximum absolute difference in VCD, VCDERR and AMFGRD (=AMC) per state.

date_orbit	number of records				maximum absolute difference		
	ref_tot	ref	test	join	VCD	ERRVCD	AMC
20020802_02209	9120	5582	5577	5577	0.002	0.002	0.001
20020810_02321	9040	5977	5969	5969	0.002	0.002	0.001
20020922_02946	7920	5995	5989	5989	0.002	0.001	0.001
20021021_03358	8560	6706	6698	6698	0.002	0.002	0.001
20021031_03502	8560	7085	7084	7084	0.002	0.001	0.001
20030110_04520	8400	6027	6020	6020	0.002	0.002	0.001
20030117_04618	8720	6524	6519	6519	0.002	0.001	0.001
20030121_04673	7820	5404	5401	5401	0.002	0.002	0.001
20030124_04720	8720	5711	5707	5707	0.001	0.002	0.001
20030127_04757	8400	7026	7021	7021	0.002	0.001	0.001
20030131_04812	8400	6555	6549	6549	0.002	0.002	0.001
20030201_04830	8480	6290	6286	6286	0.001	0.002	0.001
20030204_04868	3920	2178	2172	2172	0.002	0.002	0.001
20030210_04953	8480	6846	6837	6837	0.001	0.002	0.001
20030213_04995	8320	5704	5699	5699	0.001	0.002	0.001
20030215_05033	7800	5989	5984	5984	0.001	0.001	0.001
20030223_05147	8480	7080	7079	7079	0.002	0.001	0.001
20030227_05202	8640	6276	6270	6270	0.002	0.002	0.001
20030303_05257	8480	6759	6756	6756	0.001	0.002	0.001
20030308_05326	8640	6163	6159	6159	0.001	0.002	0.001
20030311_05373	8480	6322	6315	6315	0.001	0.002	0.001
20030314_05411	8400	6490	6486	6486	0.001	0.002	0.001
20030319_05482	8560	6712	6709	6709	0.002	0.002	0.001
20030329_05636	8640	6630	6627	6627	0.001	0.002	0.001
20030401_05677	8400	6677	6670	6670	0.001	0.002	0.001
20030409_05789	8160	6496	6480	6480	0.010	0.002	0.002
20030413_05845	8000	5995	5990	5990	0.001	0.002	0.001
20030414_05859	8000	6588	6586	6586	0.001	0.001	0.001
20030422_05972	7640	5966	5958	5958	0.002	0.002	0.001
20030426_06027	8160	5302	5299	5299	0.003	0.002	0.001
20030508_06197	8200	6088	6081	6081	0.002	0.002	0.001
20030515_06298	7320	5021	5015	5014	0.001	0.002	0.001
20030526_06467	8720	6253	6251	6250	0.001	0.001	0.001
20030526_06468	8160	6047	6038	6038	0.001	0.002	0.001

date_orbit	number of records				maximum absolute difference		
	ref_tot	ref	test	join	VCD	ERRVCD	AMC
20020802_02209	9120	5582	5577	5577	0.002	0.002	0.001
20030529_06505	8720	6591	6582	6582	0.001	0.002	0.001
20030531_06534	8160	6495	6490	6490	0.001	0.002	0.001
20030604_06586	8160	5374	5371	5371	0.001	0.002	0.001
20030608_06649	8720	5106	5101	5101	0.001	0.002	0.001
20030608_06651	8720	6213	6210	6210	0.001	0.001	0.001
20030614_06739	8720	6104	6101	6101	0.001	0.001	0.001
20030619_06810	8160	6037	6034	6034	0.001	0.001	0.001
20030624_06881	8720	6049	6042	6042	0.001	0.001	0.001
20030628_06935	8460	5991	5987	5987	0.001	0.002	0.001
20030702_06991	8720	6769	6764	6764	0.001	0.001	0.001
20030708_07076	8160	6336	6327	6327	0.001	0.001	0.001
20030710_07103	8720	6605	6598	6598	0.001	0.001	0.001
20030717_07201	8160	5818	5811	5811	0.001	0.001	0.001
20030723_07286	8200	5864	5860	5860	0.001	0.002	0.001
20030805_07480	8200	5356	5346	5346	0.001	0.001	0.001
20030807_07505	8160	6972	6971	6971	0.001	0.001	0.001
20030830_07831	7640	5614	5590	5590	0.036	0.002	0.003
20030830_07834	8720	6759	6739	6739	0.032	0.002	0.003
20030902_07884	8740	6472	6457	6457	0.032	0.002	0.003
20030903_07896	8720	6083	6058	6058	0.034	0.002	0.003
20030910_07993	8160	6168	6142	6142	0.035	0.003	0.003
20030916_08077	8240	6477	6470	6470	0.002	0.001	0.001
20030922_08161	8240	6716	6706	6706	0.002	0.001	0.001
20030927_08231	8560	6682	6676	6676	0.002	0.002	0.001
20031004_08330	8320	6558	6554	6554	0.002	0.002	0.001
20031008_08401	8480	6503	6502	6501	0.002	0.001	0.001
20031010_08422	8320	6579	6576	6576	0.002	0.001	0.001
20031012_08449	8480	6307	6304	6304	0.002	0.002	0.001
20031014_08483	8480	6513	6503	6502	0.002	0.001	0.001
20031021_08582	8920	6461	6451	6451	0.002	0.001	0.001
20031027_08666	8920	7058	7050	7050	0.002	0.001	0.001
20031030_08707	8500	6428	6424	6423	0.003	0.001	0.001
20031108_08835	8500	6907	6900	6900	0.002	0.002	0.001
20031111_08877	8920	6765	6753	6753	0.003	0.002	0.001
20031113_08903	8920	6926	6909	6909	0.003	0.002	0.001
20031113_08913	8680	6660	6655	6655	0.003	0.001	0.001
20031123_09057	8180	6630	6620	6620	0.003	0.002	0.001
20031128_09127	8500	6987	6984	6984	0.003	0.002	0.001
20031201_09168	8920	6701	6691	6690	0.003	0.002	0.001
20031203_09189	8500	6355	6343	6343	0.003	0.001	0.001
20031207_09253	8420	5853	5845	5845	0.003	0.001	0.001
20031211_09309	8500	6847	6847	6847	0.003	0.001	0.001
20031213_09336	8420	6698	6694	6694	0.003	0.002	0.001
20031217_09391	8920	6261	6247	6247	0.003	0.001	0.001
20040115_09816	8500	5782	5773	5772	0.002	0.001	0.001
20040127_09987	8440	6586	6582	6582	0.002	0.002	0.001
20040309_10584	8420	6548	6544	6543	0.002	0.002	0.001

date_orbit	number of records				maximum absolute difference		
	ref_tot	ref	test	join	VCD	ERRVCD	AMC
20020802_02209	9120	5582	5577	5577	0.002	0.002	0.001
20040310_10597	9000	7386	7382	7382	0.002	0.001	0.001
20040504_11382	7700	5301	5292	5292	0.002	0.001	0.001
20040722_12521	14860	7863	7851	7851	0.002	0.001	0.001
20040917_13328	14040	8295	8291	8291	0.002	0.001	0.001
20041003_13560	14040	8312	8308	8308	0.001	0.001	0.001
20041118_14226	14300	7668	7655	7655	0.002	0.001	0.001
20050115_15049	14300	8672	8670	8670	0.002	0.001	0.001
20050307_15783	14040	8755	8751	8751	0.002	0.001	0.001
20050523_16884	14040	7685	7678	7678	0.003	0.001	0.001
20050710_17574	14040	8355	8350	8350	0.002	0.001	0.001
20050913_18499	14040	8161	8156	8156	0.002	0.001	0.001
20051214_19811	12220	6646	6640	6640	0.001	0.001	0.001
20060213_20693	14300	8643	8638	8638	0.002	0.001	0.001
20060428_21754	14300	8037	8033	8033	0.002	0.001	0.001
20060606_22306	12480	7716	7710	7710	0.001	0.001	0.001
20060608_22330	12480	5735	5729	5728	0.001	0.001	0.001
20060608_22331	12480	5155	5150	5150	0.001	0.001	0.001
20060608_22332	12480	6547	6542	6542	0.001	0.001	0.001
20060608_22333	12480	6966	6964	6964	0.001	0.001	0.001
20060608_22334	12480	6884	6884	6884	0.001	0.001	0.001
20060608_22335	12480	6315	6310	6310	0.001	0.001	0.001
20060608_22336	12480	6082	6072	6072	0.001	0.001	0.001
20060608_22337	12480	6400	6399	6399	0.001	0.001	0.001
20060608_22338	11960	5998	5994	5994	0.001	0.001	0.001
20060608_22339	13000	6117	6110	6110	0.001	0.001	0.001
20060608_22340	12740	7217	7213	7213	0.001	0.001	0.001
20060608_22341	13000	6615	6609	6609	0.001	0.002	0.001
20060608_22342	13000	6642	6638	6638	0.001	0.001	0.001
20060614_22416	13520	5739	5726	5726	0.001	0.001	0.001
20060614_22417	14300	7129	7121	7121	0.001	0.001	0.001
20060614_22418	14040	7070	7061	7061	0.001	0.001	0.001
20060614_22419	13780	7655	7648	7647	0.001	0.001	0.001
20060614_22420	14040	8199	8195	8195	0.001	0.001	0.001
20060614_22421	14300	7595	7586	7586	0.001	0.001	0.001
20060614_22422	14040	7621	7613	7613	0.001	0.001	0.001
20060614_22423	14300	7037	7029	7029	0.001	0.001	0.001
20060614_22424	14040	7141	7139	7139	0.001	0.001	0.001
20060614_22425	14300	7566	7560	7560	0.001	0.001	0.001
20060614_22426	14040	7682	7664	7664	0.001	0.001	0.001
20060614_22427	14300	7638	7634	7634	0.001	0.001	0.001
20060614_22428	14040	8098	8094	8094	0.001	0.001	0.001
20060811_23246	14300	6138	6128	6128	0.001	0.001	0.001
20060811_23247	14040	7450	7443	7443	0.001	0.001	0.001
20060811_23248	13780	7227	7218	7218	0.001	0.002	0.001
20060811_23249	13520	6581	6572	6571	0.001	0.001	0.001
20060811_23250	14300	8607	8602	8602	0.001	0.001	0.001
20060811_23251	14040	8291	8278	8278	0.001	0.001	0.001

date_orbit	number of records				maximum absolute difference		
	ref_tot	ref	test	join	VCD	ERRVCD	AMC
20020802_02209	9120	5582	5577	5577	0.002	0.002	0.001
20060811_23252	13780	7456	7448	7447	0.001	0.001	0.001
20060811_23253	14040	8409	8403	8402	0.001	0.001	0.001
20060811_23254	14300	7258	7250	7250	0.001	0.001	0.001
20060811_23255	14040	8261	8257	8256	0.001	0.001	0.001
20060811_23256	14300	7076	7062	7062	0.001	0.001	0.001
20060811_23257	14040	7995	7985	7984	0.001	0.001	0.001
20060811_23258	14300	7636	7626	7625	0.001	0.001	0.001
20060819_23361	14040	8316	8312	8312	0.001	0.001	0.001
20061013_24149	14040	8793	8788	8788	0.004	0.001	0.001
20061013_24150	14300	8513	8509	8509	0.004	0.001	0.001
20061013_24151	14040	8831	8829	8829	0.004	0.001	0.001
20061013_24152	14300	8560	8558	8558	0.004	0.001	0.001
20061013_24153	14040	8607	8599	8599	0.004	0.001	0.001
20061013_24154	14300	7520	7515	7515	0.004	0.001	0.001
20061013_24155	14040	7882	7878	7878	0.004	0.001	0.001
20061013_24156	14300	8275	8270	8270	0.004	0.001	0.001
20061013_24157	14040	8172	8168	8167	0.004	0.001	0.001
20061013_24158	14300	8551	8548	8548	0.004	0.001	0.001
20061013_24159	14040	7905	7902	7902	0.004	0.001	0.001
20061013_24160	14300	8323	8321	8320	0.005	0.001	0.001
20061027_24356	14300	8674	8672	8672	0.002	0.001	0.001
20061202_24874	13780	6641	6633	6633	0.003	0.001	0.001
20061211_24992	14040	8411	8405	8405	0.003	0.001	0.001
20061211_24993	14040	8198	8188	8188	0.003	0.001	0.001
20061211_24994	14040	8140	8138	8138	0.003	0.001	0.001
20061211_24995	14300	8739	8734	8734	0.003	0.001	0.001
20061211_24996	14040	8887	8885	8885	0.003	0.001	0.001
20061211_24997	14300	7776	7773	7773	0.003	0.001	0.001
20061211_24998	14040	8297	8295	8295	0.003	0.001	0.001
20061211_24999	14300	7556	7551	7551	0.003	0.001	0.001
20061211_25000	14040	8740	8736	8736	0.003	0.001	0.001
20061211_25001	14300	9121	9115	9115	0.003	0.001	0.001
20061211_25002	14040	9063	9057	9057	0.003	0.001	0.001
20061211_25003	14300	7049	7040	7040	0.003	0.001	0.001
20061211_25004	14040	7638	7629	7629	0.003	0.001	0.001
20070103_25331	14040	7235	7221	7221	0.003	0.001	0.001
20070109_25414	14040	8282	8280	8280	0.003	0.001	0.001
20070303_26176	13780	7332	7328	7328	0.003	0.001	0.001
20070320_26411	13780	8347	8344	8344	0.003	0.001	0.001
20070515_27221	14300	7411	7406	7406	0.004	0.001	0.001
20070715_28094	14300	7429	7422	7422	0.002	0.001	0.001
20070915_28982	14300	8668	8666	8666	0.002	0.001	0.001
20071115_29855	14040	7801	7797	7797	0.002	0.001	0.001
20071223_30399	14040	6992	6973	6973	0.001	0.001	0.001
20080221_31258	14040	8569	8562	8562	0.001	0.001	0.001
20080420_32102	14040	7265	7263	7263	0.003	0.002	0.001
20080619_32961	14560	7788	7775	7775	0.003	0.002	0.001

date_orbit	number of records				maximum absolute difference		
	ref_tot	ref	test	join	VCD	ERRVCD	AMC
20020802_02209	9120	5582	5577	5577	0.002	0.002	0.001
20080817_33805	14040	7739	7729	7729	0.002	0.002	0.001
20081016_34664	11440	7967	7966	7965	0.002	0.001	0

B Results per orbit for Limb Cloud Verification

We show a table that reports above described results per orbit. The row header is composed of date and orbit number. The next three columns show the number records in the reference and the test data, and the intersection, i.e. obtained by joining records via the start time. Following three columns give the number or records with differences in flags for WCL, ICL and PSC, respectively. The next columns show the maximum absolute difference in MAXVAL for each of the cloud types, followed by the maximum absolute difference in MAXHEIGHT. The last three columns offer the maximum absolute difference in MAXHEIGTIDX for each cloud type

date_orbit	num. of records			num. of diff. in FLAG			max. abs. diff. in MAXVAL			max. abs. diff. in MAXHEIGHT			max. abs. diff. in MAXHEIGHTIDX		
	ref	test	join	WCL	ICL	PSC	WCL	ICL	PSC	WCL	ICL	PSC	WCL	ICL	PSC
20020802_02209	92	87	82	2	0	0	2.530	1.267	0.000	8.37	8.37	0.00	5	5	0
20020810_02321	92	86	81	1	0	0	1.589	1.082	0.000	5.31	5.31	0.00	4	4	0
20020922_02946	92	84	80	1	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20021021_03358	92	85	80	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20021031_03502	92	85	80	1	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030110_04520	94	88	84	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030117_04618	93	87	84	0	1	0	0.189	0.175	0.000	3.44	19.83	0.00	1	6	0
20030121_04673	83	84	79	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030124_04720	92	84	82	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030127_04757	92	86	83	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030131_04812	90	88	83	1	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030201_04830	90	88	83	0	0	0	0.005	0.005	0.000	0.00	0.01	0.00	0	0	0
20030204_04868	63	56	56	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030210_04953	92	86	83	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030213_04995	95	90	86	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030215_05033	95	90	86	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030223_05147	92	86	83	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030227_05202	91	88	83	1	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030303_05257	94	87	84	1	0	0	0.933	0.074	0.004	6.45	6.45	0.00	2	2	0
20030308_05326	91	88	82	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030311_05373	93	88	84	1	1	0	0.333	0.147	0.000	0.21	0.21	0.00	0	0	0
20030314_05411	95	92	87	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030319_05482	94	88	84	3	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030329_05636	95	89	85	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030401_05677	91	84	81	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030409_05789	92	84	81	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030413_05845	94	88	86	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030414_05859	95	88	87	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0

date_orbit	num. of records			num. of diff. in FLAG			max. abs. diff. in MAXVAL			max. abs. diff. in MAXHEIGHT			max. abs. diff. in MAXHEIGHTIDX		
	ref	test	join	WCL	ICL	PSC	WCL	ICL	PSC	WCL	ICL	PSC	WCL	ICL	PSC
20030422_05972	92	85	81	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030426_06027	92	86	82	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030508_06197	96	91	87	1	0	0	1.229	0.010	0.000	0.10	3.35	0.00	0	1	0
20030515_06298	90	84	82	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030526_06467	92	88	84	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030526_06468	92	88	84	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030529_06505	96	92	88	0	1	0	0.186	0.157	0.000	0.06	0.06	0.00	0	0	0
20030531_06534	92	88	84	0	0	0	0.270	0.079	0.000	6.65	0.10	0.00	2	0	0
20030604_06586	92	88	84	1	0	0	0.517	0.162	0.000	3.21	6.51	0.00	1	2	0
20030608_06649	92	84	84	0	1	0	0.416	0.074	0.000	3.15	3.15	0.00	1	1	0
20030608_06651	92	88	84	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030614_06739	96	88	88	1	0	0	0.887	0.085	0.000	3.41	6.67	0.00	1	2	0
20030619_06810	92	88	84	1	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030624_06881	92	88	84	0	0	0	0.005	0.005	0.000	19.71	0.01	0.00	6	0	0
20030628_06935	96	92	88	0	0	0	0.210	0.006	0.000	6.64	6.51	0.00	2	2	0
20030702_06991	92	88	84	1	0	0	0.401	0.095	0.000	0.04	0.04	0.00	0	0	0
20030708_07076	92	88	84	0	0	0	0.292	0.059	0.000	3.20	6.64	0.00	1	2	0
20030710_07103	96	91	87	0	1	0	0.442	0.108	0.000	6.26	6.26	0.00	2	2	0
20030717_07201	88	83	79	0	0	0	0.374	0.083	0.000	3.33	6.65	0.00	1	2	0
20030723_07286	96	90	86	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030730_07399	60	86	50	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030805_07480	96	89	85	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030807_07505	92	85	81	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030830_07831	92	85	82	0	0	0	0.005	0.005	0.001	0.01	3.30	0.00	0	1	0
20030830_07834	95	89	85	0	0	0	0.005	0.005	0.005	0.01	0.01	0.00	0	0	0
20030902_07884	99	92	88	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20030903_07896	95	89	85	0	0	0	0.005	0.005	0.005	0.01	0.01	0.00	0	0	0
20030910_07993	95	88	84	0	0	0	0.005	0.005	0.005	0.01	0.01	0.00	0	0	0
20030916_08077	95	88	84	0	0	0	0.005	0.005	0.005	0.01	0.01	0.00	0	0	0
20030922_08161	95	88	84	0	0	0	0.005	0.005	0.004	0.01	0.01	0.01	0	0	0
20030927_08231	92	84	81	0	1	0	0.005	0.005	0.005	0.01	0.01	0.00	0	0	0
20031004_08330	92	84	81	0	0	0	0.005	0.005	0.004	0.01	6.60	0.00	0	2	0
20031008_08401	45	85	35	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20031010_08422	91	84	80	0	0	0	0.005	0.005	0.004	0.01	0.01	0.00	0	0	0
20031012_08449	95	89	85	0	0	0	0.005	0.005	0.005	0.01	0.01	0.00	0	0	0
20031027_08666	98	88	87	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20031030_08707	99	92	88	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20031108_08835	99	92	88	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20031111_08877	98	88	87	1	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20031113_08903	98	88	87	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20031113_08913	92	88	84	1	2	0	1.153	0.140	0.000	6.81	6.81	0.00	2	2	0
20031123_09057	100	93	89	0	1	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20031128_09127	99	92	89	1	0	0	1.077	0.043	0.000	3.05	3.05	0.00	1	1	0
20031201_09168	97	88	87	1	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20031203_09189	99	92	89	1	0	0	0.916	0.051	0.000	3.34	3.34	0.00	1	1	0
20031207_09253	99	92	89	0	0	0	0.357	0.028	0.000	6.62	6.61	0.00	2	2	0
20031211_09309	99	92	89	1	1	0	1.136	0.050	0.000	0.03	0.03	0.00	0	0	0
20031213_09336	99	92	89	0	0	0	0.555	0.038	0.000	0.08	0.08	0.00	0	0	0

date_orbit	num. of records			num. of diff. in FLAG			max. abs. diff. in MAXVAL			max. abs. diff. in MAXHEIGHT			max. abs. diff. in MAXHEIGHTIDX		
	ref	test	join	WCL	ICL	PSC	WCL	ICL	PSC	WCL	ICL	PSC	WCL	ICL	PSC
20031217_09391	98	89	88	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20040115_09816	99	92	89	1	2	0	0.222	0.200	0.000	0.04	0.04	0.00	0	0	0
20040127_09987	92	85	82	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20040309_10584	99	89	87	1	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20040310_10597	97	89	88	0	0	0	0.005	0.006	0.000	0.01	0.01	0.00	0	0	0
20040504_11382	100	89	89	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20040917_13328	98	88	87	0	0	0	0.005	0.005	0.002	0.01	0.01	0.00	0	0	0
20041003_13560	102	92	91	0	0	0	0.005	0.005	0.002	0.01	0.01	0.00	0	0	0
20041118_14226	99	89	88	1	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20050115_15049	96	89	88	0	1	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20050307_15783	101	90	89	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20050523_16884	101	94	91	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20050913_18499	102	92	91	0	0	0	0.005	0.005	0.005	0.01	0.01	0.01	0	0	0
20051214_19811	28	61	28	0	0	0	0.004	0.005	0.000	0.00	0.00	0.00	0	0	0
20060213_20693	95	89	88	1	0	0	0.005	0.005	0.003	0.01	0.01	0.00	0	0	0
20060428_21754	100	91	91	0	0	0	0.211	0.187	0.000	0.07	0.07	0.00	0	0	0
20060606_22306	101	94	91	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060608_22330	101	94	91	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060608_22332	101	94	91	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060608_22333	101	94	91	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060608_22334	97	90	87	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060608_22335	101	94	91	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060608_22336	101	94	91	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060608_22337	101	94	91	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060608_22338	101	94	91	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060608_22339	101	94	91	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060608_22340	99	92	91	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060608_22341	100	96	92	0	0	0	0.516	0.018	0.000	3.25	6.50	0.00	1	2	0
20060608_22342	101	94	91	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060614_22416	101	94	91	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060614_22417	100	90	90	1	0	0	0.005	0.005	0.000	3.30	0.01	0.00	1	0	0
20060614_22418	101	94	91	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060614_22419	100	90	90	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060614_22420	101	94	91	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060614_22421	100	90	90	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060614_22422	101	94	91	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060614_22424	101	94	91	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060614_22425	100	90	90	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060614_22426	96	92	88	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060614_22427	100	92	92	3	0	0	0.889	0.032	0.000	6.61	6.61	0.00	2	2	0
20060614_22428	101	94	91	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060614_22429	68	90	58	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060811_23246	99	89	88	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060811_23247	101	92	90	0	0	0	0.005	0.005	0.002	0.01	0.01	0.01	0	0	0
20060811_23248	99	89	88	0	0	0	0.005	0.005	0.001	0.01	0.01	0.00	0	0	0
20060811_23249	101	92	90	0	0	0	0.005	0.005	0.005	0.01	0.01	0.00	0	0	0
20060811_23252	99	89	88	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060811_23253	97	88	86	0	0	0	0.005	0.005	0.005	0.01	0.01	0.00	0	0	0

date_orbit	num. of records			num. of diff. in FLAG			max. abs. diff. in MAXVAL			max. abs. diff. in MAXHEIGHT			max. abs. diff. in MAXHEIGHTIDX		
	ref	test	join	WCL	ICL	PSC	WCL	ICL	PSC	WCL	ICL	PSC	WCL	ICL	PSC
20060811_23255	101	92	90	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060811_23256	99	92	91	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20060811_23257	101	94	91	0	0	0	0.005	0.005	0.002	0.01	0.01	0.00	0	0	0
20061013_24149	102	92	91	0	0	0	0.005	0.005	0.003	0.01	0.01	0.00	0	0	0
20061013_24150	99	89	88	0	0	0	0.005	0.005	0.001	0.01	0.01	0.00	0	0	0
20061013_24151	102	92	91	0	1	0	0.005	0.005	0.003	0.01	0.01	0.00	0	0	0
20061013_24152	99	89	88	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20061013_24153	98	92	91	1	0	0	0.005	0.006	0.000	0.01	0.01	0.00	0	0	0
20061013_24154	99	89	88	1	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20061013_24155	102	92	91	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20061013_24156	99	89	88	0	0	0	0.005	0.005	0.003	0.01	0.01	0.00	0	0	0
20061013_24157	102	92	91	1	0	0	0.005	0.005	0.004	0.01	0.01	0.00	0	0	0
20061013_24158	100	92	92	0	0	0	0.005	0.005	0.003	0.01	0.01	0.01	0	0	0
20061013_24159	102	93	91	0	0	0	0.005	0.005	0.005	0.01	0.01	0.01	0	0	0
20061013_24160	99	89	88	0	0	0	0.005	0.005	0.005	0.01	0.01	0.01	0	0	0
20061027_24356	99	89	88	1	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20061202_24874	99	88	88	0	0	0	0.005	0.005	0.000	0.01	9.88	0.00	0	3	0
20061211_24992	102	93	92	3	1	0	0.220	0.206	0.000	0.02	0.02	0.00	0	0	0
20061211_24993	98	89	88	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20061211_24994	98	89	88	1	0	0	1.137	0.079	0.000	0.06	0.06	0.00	0	0	0
20061211_24995	98	89	88	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20061211_24996	102	93	92	1	1	0	0.052	0.017	0.000	6.73	6.73	0.00	2	2	0
20061211_24997	98	89	88	1	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20061211_24998	102	93	92	0	0	0	0.213	0.008	0.000	6.59	6.59	0.00	2	2	0
20061211_24999	98	89	88	1	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20061211_25001	98	89	88	1	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20061211_25002	97	92	89	0	0	0	0.580	0.062	0.000	0.24	0.24	0.00	0	0	0
20061211_25003	99	89	88	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20061211_25004	102	93	92	1	1	0	0.414	0.199	0.000	0.01	3.23	0.00	0	1	0
20070103_25331	98	88	88	1	0	0	0.468	0.005	0.000	6.44	6.69	0.00	2	2	0
20070109_25414	100	90	89	0	0	0	0.005	0.005	0.000	0.01	0.01	0.00	0	0	0
20070303_26176	98	88	88	1	0	0	0.232	0.083	0.000	3.10	3.10	0.00	1	1	0
20070320_26411	102	92	91	1	0	0	1.317	0.057	0.000	6.59	6.66	0.00	2	2	0
20070515_27221	100	92	92	2	1	0	1.146	0.106	0.000	12.87	9.55	0.00	4	3	0
20070715_28094	100	92	92	0	1	0	0.155	103.520	0.000	3.42	6.66	0.00	1	2	0
20070915_28982	100	90	89	0	0	0	0.005	36.190	0.000	0.01	0.01	0.00	0	0	0
20071115_29855	102	93	91	0	0	0	0.005	5.700	0.000	0.01	0.01	0.00	0	0	0
20071223_30399	99	88	88	0	3	0	0.006	0.005	0.000	0.01	0.01	0.00	0	0	0
20080221_31258	101	93	91	3	2	0	0.990	0.270	0.000	6.41	16.25	0.00	2	5	0
20080420_32102	96	90	86	0	0	0	0.005	0.920	0.000	0.01	0.01	0.00	0	0	0
20080619_32961	92	88	84	1	1	0	0.956	59.600	0.000	6.66	6.66	0.00	2	2	0
20080817_33805	101	93	90	2	0	0	0.005	70.060	0.005	0.01	0.01	0.00	0	0	0