SCIAMACHY Command Line Tool Software User's Manual (SUM)

SCIAMACHY Level 1b to 1c processing

SciaL1c

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Change Record

Issue	Rev.	Date	Page	Description of Change
1.0		30/01/02	all	completely new, originally provided as document PO-TN-ESA-GS-2307
6.0		10/05/06	all	re-launched as document ENV-SUM-DLR-SCIA-0071
			p.5	Introduction: Comments to de-coupling of tool from EnviView and coupling of tool to the operational software baseline. References: Upgrade of references to current actual issues
			p.6	Document overview: Totally new
			p.8	Table 3-1: Extension by measurement categories 20 through 26
			p.16	
	A	19/01/07	several	several changes in spelling and wording
	B	23/01/07	several	some minor glitches fixed
2		29/12/07	p. 5	- List for which the tool is available revised
			p. 13	- User Options GADS description revised.
			p. 55	- User Options GADS updated
			p. 18	- Tool overwrite behaviour revised
			p. 18	- Ways how to display help revised
			p. 19	- Start and stop time option handling revised
			p. 20	- Geolocation handling revised
			p. 25	- Calibration options revised
			p. 26	- Dark correction flag implemented
			p. 26	- Application of monitoring factors implemented
			p. 27	- Option to list available states in a level 1b file
			p. 28	- State selection implemented
			p. 30	- Data calibration samples revised
			p. 46	- Corrected table for radiometric sensitivity Nadir (unit + caption) - Corrected table for radiometric sensitivity Limb (unit + caption)
			p. 47	- Corrected table for radiometric sensitivity Occultation (unit + caption)
			p. 47	
	B	12/06/08	p. 27	- option description updated
			p. 28	- new options “-clearlog” added
			p. 29	- new option “-ascii” added
			p. 29	- new option “-ascii-smr” added
			p. 23	- “-ds” option behaviour revised
3		18/03/14	p. 5	- introduction revised
			p. 20	- option –cal revised
			p. N/A	- option –mfactor revised
			p. 21	- option –list revised
			p. 23	- option –state now allows multiple arguments
			p. N/A	- new –compat option
	B	28/05/15	p. N/A	- option -compat revised to reflect that -compat 5 automatically turns -compat 4.
	C	23/07/15		
4		16/04/2019	p. 23	• Added clarification that -state selects index and not ID and gave workaround to process a specific ID
			p. 5	• Updated introduction
			p. 7	• Updated references
				• Added modifications for the NetCDF4 products
			various	• Removed options no longer available
			p. 25	• Rewrote the example chapter
			p. 29	• Removed Appendices no longer needed
5		27/05/24	p. 15	• Added moon option for version 4.2

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1 Introduction

1.1 Purpose and Scope of the document

SCIAMACHY was 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. After the end of the mission several processor updates were done in phase F of the project. After phase F, SCIAMACHY is now part of the heritage program of ESA. In the FDR4ATMOS project the Level 0-1 data processor was updated to correct deficiencies in the Level 1 product and to add lunar data to Level 1b. This also required an update of the scial1c tool t version 4.2.

The extraction and application tool “SciaL1c” shall be used to transform SCIAMACHY Level 1b products into so called Level 1c products being in general geo-located, calibrated spectral radiance. Since many users had found such a tool useful for their own applications, the tool has also been designed as command-line tool in addition to the provided functionality of EnviView.

In the past this software was available in both, a command line version or embedded into the EnviView tool, allowing a case by case application supported by a graphical user interface. From a functional point of view, there was absolutely no difference between both, whereas it is obvious that the command line version is more appropriate for systematic handling of large amount of SCIAMACHY data. During ENVISAT mission, the evolution of SCIAMACHY’s calibration algorithm changed substantially the application of calibration data to spectral data in the Level 1b-1c processing step so that the EnviView tool and its sub-tools became out-of-date. For that reason, ESA decided to split the command-line tool functionality from the viewing tool EnviView and to release to the user a stand-alone version of the command-line tool SciaL1c which calibration applications are based on the processor software used in ENVISAT PDS. From that, the user shall recognize to use no longer the SciaL1c tool provided with the EnviView software package. In addition the maintenance of the EnviView software has been discontinued and all viewing functionalities are provided through the BEAT/CODA software (http://www.stcorp.nl/beat).

The operational processing software undergoes in different cycles some upgrades so that the tool SciaL1c is also subject to changes. Note that the now provided SciaL1c version (4) is designed in accordance with the operational processing baseline version [R1]. In order to avoid any incompatibilities with products generated with former Level 1b processor versions, the SciaL1c has been established downgrade-compatible so that Level 1b files generated with former versions of the IPF are not only readable but are accepted as input to produce valid Level 1c files. However, due to numerous improvements in the Level 0-1 processing, it is not recommended to use older versions of the Level 1b products.

The current SciaL1c s/w version is 4. It now takes the Level 1 netCDF format as input and generates a Level 1c product in netCDF format. For backward compatibility, ENVISAT file format reading and writing is still supported. However, not all options previously implemented are supported for the old format. Note that the switches for different product versions (i.e. 6-8) are no longer maintained and were not tested (although they might still be present). Users of these product versions should use SciaL1c version 3.2. The copying of different data sets from Level 1b

to Level 1c is also dropped if netCDF input/output (the default) is chosen, because

- All datasets are available in the Level 1b
- For netCDF, standard tools can be used to efficiently copy groups or data from one file to another file, i.e. if the need arises the user can easily copy Level 1b data to the Level 1c file.

SciaL1c 4 is available for Linux 64bit versions.[1]

This User Manual shall:

-
- Explain the general meaning of the different extraction and calibration options in order to get the user prepared for his specific tasks.
- Give examples for different command lines, which may be used as a starting point for other user specific extraction/application configurations.

This User Manual will not:

- Explain the full Level 1b processing principles, which are far beyond the scope of this document. In this case the reader is referred to the Level 0-1c ATBD [R1] .
- Explain the Level 1c netCDF format. The description is available in a separate document [R4].

[1]If a larger number of users require it and after evaluation of the effort it may also be ported to another platform on a best effort basis. DLR-IMF and ESA should be contacted in this case.

1.2 Documents

1.2.1 Applicable Documents

- None -

1.2.2 References

[R1] ENV-TN-DLR-SCIA-0041 Issue 8, “SCIAMACHY Level 0 to 1c Processing: Algorithm Theoretical Baseline Document”
[R2] ENV-SRN-DLR-SCIA-0078, Issue 5, “SCIAMACHY Command Line Tool SciaL1c Software Release Note”
[R3] ENV-IODD-DLR-SCIA0136, Issue 3, “SCIAMACHY Level 1 netCDF Product User Guide”
[R4] ENV-IODD-DLR-SCIA-0141, Issue 2, “SCIAMACHY Level 1c netCDF Product User Guide”

1.3 Abbreviations and Acronyms

ADS	Annotation Data Set
ASCII	American Standard Code for Information Interchange
ASM	Azimuth Scan Mirror
DOAS	Differential Optical Absorption Spectroscopy
DS	Data Set
DSD	Data Set Description
DSR	Data Set Record
ENVISAT	Environmental Satellite
EnviView	Envisat Viewing Toolbox
ESA	European Space Agency
ESM	Elevation Scan Mirror
FPN	Fixed Pattern Noise
GADS	Global Annotation Data Set
IFE	Institut für Fernerkundung der Universität Bremen
I/O DD	Input/Output Data Definition
IPF	Instrument Processing Facility
MB	Megabyte
MDS	Measurement Data Set
MDSR	Measurement Data Set Record
MPH	Main Product Header
N/A	not applicable
NRT	Near Real Time
PDS	Payload Data Segment
PMD	Polarisation Measurement Device
PPG	Pixel-to-Pixel Gain
PUG	Product User Guide
SCIAMACHY	Scanning Imaging Absorption Spectrometer for Atmospheric Chartography
SPH	Specific Product Header
SRON	Space Research Organisation of The Netherlands
SSAG	SCIAMACHY Scientific Advisory Group

1.4 Document Overview

The document is split in several chapters and one appendix, which provide some technical details about the spectral band definitions.

The document is organised as follows

- *Chapter 1* – provides an introduction including the references, abbreviations, and the document overview;
- *Chapter 2* – provides the user the general product layout and an outline of the tool;

- *Chapter 3* – introduces the handling of the tool;
- *Chapter 4* – provides some useful examples;
- *Appendix A* – is a compilation of parameter tables.

2 The general SciaL1c S/W and product layout

Since SciaL1c version 3.9.4, SCIAMACHY Level 1c products use the NetCDF4 standard format.The previous products, which have the general ENVISAT data format, can still be generated using the “-envisat” command-line option. Additional ASCII output, which was originally introduced for debugging purposes, is also possible.

What makes Level 1c products specific is that the user himself decides about their content.

The Level 1b NetCDF product is subdivided into MODE and BAND groups. PMD detector data are treated like a band. The science and PMD detector data are both organised in a BAND group which contains the matching geolocation data and other auxiliary data. The Level 1c product follows the same logic.

Following filters can be applied:

- a specific time interval;
- a certain geographical area;
- a specific measurement type (e.g. all nadir type measurements) or even a measurement category (e.g. the nadir pointing measurements are a subset of type nadir);
- a specific spectral region (i.e. clusters or bands).

In terms of data obtained from the polarisation detectors (PMD), the user can extract (in combination with filtering for time or geographical area)

- integrated PMD values (32 Hz, synchronised with science detector shortest integration time);
- fractional polarisation values.

Notes:

- The smallest extractable unit of measurement data is data of one band (cluster), which was obtained during execution of one specific instrument state and which matches the extraction criteria.
- In the remainder of this document, the options above will be referred to as extraction options as they generally select/reduce the amount of Level 1b data, being transferred to Level 1c.

Now, on top of that the user can specify how the data, obtained from the eight science detectors, shall be calibrated, choosing between

- No calibration
- Memory effect
- Leakage current
- PPG
- Spectral calibration
- Polarisation
- Radiance
- PMD sun normalisation
- Monitoring factors (m-factors). No longer needed, but can be used to process Version 7 Level 1b files
- Monitoring factors (m-factors). No longer needed, but can be used to process Version 7 Level 1b files
- All calibrations

For version 8 Level 1b products and above, the m-factor correction is done within the Level 0-1 processing: As soon as the radiometric calibration option is selected, the radiometric m-factors are *automatically* applied, because they are part of the radiometric sensitivity in the Level 1b product. The same is true for the polarisation correction, where the m-factors are also already contained. Thus the m-factor option is obsolete for Level 1b files of Version 8 or later and *must not be used.*
Any combination of extraction and calibration options is allowed, which means that the user has an enormous freedom to "design" his specific Level 1c product. However, not each of the possible combinations is meaningful, e.g. a polarisation correction can only be applied, if the spectral calibration is switched on as well.

The instrument's operational concept (states, being executed in a timeline) is as much as possible reflected by the Level 1c data structure. This means that most of the data set records (except some of those calibration relevant copies of Level 1b data sets) contain data, which belong to one state, as it was executed along the orbit.

In more detail, the first column of the three general ADS depicted by REF _Ref174180921 \h Figure 2-1, consists basically of copies of the Level 1b product ADS, but only containing those records (1 record per state) of the extracted states (for details see Annex B). In general they are automatically generated, i.e. they do not have to be specified by the user (see also option –ds section). The "States of the product" ADS is of special importance because it contains mandatory information of state details, like e.g. the cluster definition, the exact duration, integration times etc. The meaning of bits and bytes of this data set can be found in annex B of this document.

The second column of REF _Ref174180921 \h Figure 2-1 contains a so called "User Option" GADS. In this automatically generated data set, all selection criteria, the user has applied to the original Level 1b product, are summarised in order to trace his work easily and to distinguish between different Level 1c products derived from the same Level 1b input. The details of this data set can be found in Annex C of this document.

"User Option" GADS is followed by the calibration GADS, which are pure copies from the Level 1b product. The user might decide himself which of the individual calibration GADS of the 1b product he wants to copy into 1c (see recommendations further down the document). Annex B shows the details of each of the data sets, whereas their selection is described in section "-ds option".

Finally, there are in total 10 measurement data sets possible. Four measurement data sets (MDS) are reserved for nadir, limb, and occultation or monitoring cluster, i.e. science channel data.

3 General tool handling

Whenever the user wants to extract/calibrate Level 1b data, the command line version of “SciaL1c” needs to be called with the options, the user wants to apply on the input Level 1b product.

In general, the command line would look like:

```
scial1c –option_1 [option_1_argument] –option_2 [option_2_argument] …
-option_n [option_n_argument] /full/or/relative/path/to/level_1b_file
```

Options need to be separated by just a blank character from each other. If the input file is not in the same directory as the SciaL1c software, you have to specify the file including its path. The tool will then produce a Level 1c file in the current directory, having the filename:

ENV_RPRO_SCI_L1C____yyyymmddThhmmss_yyyymmddThhmmss_ooooo_01_040000_yyyymmddThhmmss.nc

See [R3] and [R4] for details. With the option “-envisat” the product name will be as it used to be:

```
<level_1b_file>.child
```

This means that the user has to type in the full product name – a very long name – only once. Additionally, the Level 1c filename still allows identifying the product, as it contains start/stop sensing times, orbit numbers etc. of the Level 1b input file. The filename elements differing from the Level 1b are:

- the product type, which is L1C (not L1B)
- the processor version string, which is the SciaL1c version
- the processing time which is the time of the Level 1b-c processing (the time of when the user did run the tool.

Generally, the user is allowed to produce more than one Level 1c file, based on the same Level 1b input. E.g. he wants to investigate the input of a specific calibration parameter onto the calibrated signal. Whenever this happens, the tool overwrites previous child files automatically. To prevent this, you may use –out option to specify output directory or incorporate the tool into a batch script which handles moving/renaming child files itself.

Whenever the user then later wants to trace back the differences between the two Level 1c file versions, he can still look up the CALIBRATION/CALIBRATION_OPTIONS group in the netCDF file[2], which contains a summary of all the flags he has set to derive the product. Alternatively, he can store the command line itself (see option “-b”) or analyse scial1c-main.log file that SciaL1c produced.

3.1 Option “-help” – Getting Help

Whenever questions related to syntax or options in general come up, there is some basic help on

[2] In the ENVISAT format the information is contained in the CAL_OPTIONS GADS

command line level.

1. "`scial1c`" being run without parameters, the tool displays a list of available options., i.e. short help.
2. "`scial1c –help`" or "`scial1c –help | less`" will give a general summary of all and everything, i.e. long help.
3. "`scial1c –help option_name`" will give detailed information of the requested option, only. For example: "`scial1c –help cal`" will print help for the "cal" option.

This is only a very brief help about handling the tool in general. Questions about e.g. data set records and their structures have to be referred to other documents.

3.2 Option "-out" – Specifying the Output Directory

If the result must be written into a different directory than the input was, the –out option has to be used to specify the output path. The destination directory has to exist already.

```
scial1c –option_1 [option_1_argument] … -option_n [option_n_argument]
   –out /level/1c/output/path /full/or/relative/path/to/level_1b_file
```

3.3 Option "-b" or "-batch" – Running in Batch Mode

The SciaL1c command line tool is also able to run in batch mode. This shall be possible, if the batch file option ("-b" or "-batch") is used. The batch file, which can be edited by any ASCII editor, may look like:

```
# This is a comment
# This was an empty line, or line with spaces and/or tabs
–option_1 [arg_1] … -option_n [arg_n] INPUTFILENAME1
–option_1 [arg_1] … -option_n [arg_n] INPUTFILENAME2
–option_1 [arg_1] … -option_n [arg_n] INPUTFILENAME3
–option_1 [arg_1] … -option_n [arg_n] INPUTFILENAME4
```

In this case, four different input files would be processed in a certain way, specified by the options. The input files need not to have different names, otherwise each run will overwrite previous results.

Example:

```
# Full calibration and save to the current dir
-cal all –state 2 ./l1bfile
# Exclude some calibrations and save to other dir
-cal 0,1,2,3,4,5,6 –state 2 –out /pub/sarah-millas/ l1bfile
# Process monitoring states for John
-type monitoring –out /pub/john-edwards/ l1bfile
```

The command line then simplifies to

```
scial1c –b batch.txt
```

This is a comfortable alternative to writing a script which processes several files.

3.4 Option “-starttime” & “-stoptime” – Filtering by Time

To specify a time window for Level 1b data to be selected (and may be calibrated) a start and stoptime has to be entered. The following syntax is applicable:

```
-starttime “DD-MMM-JJJJ HH:MM:SS.S[SSSSS]”
-stoptime  “DD-MMM-JJJJ HH:MM:SS.S[SSSSS]”
```

Example:

```
scial1c –cal all –starttime “02-AUG-2007 12:57:45.4” INPUTFILENAME
```

The selected times can be found back in the CALIBRATION/CALIBRATION_OPTIONS group of the Level 1c product. Make sure that selected times are covered by the product (look up the Level 1b product first with BEAT/CODA) or use –list option.

When using only this filter, basically all kinds of measurement data could be extracted. If it is combined with selecting specific clusters, nadir and limb clusters would have to be specified separately. This is due to the different cluster definitions for nadir and limb measurements. See also the command-line examples in chapter 4.

It is also important to note that date and time must be included into quotes or space must be escaped so they are treated as one argument.

3.5 Option “-topleft” & “-bottomright” – Filtering by Geo-Location

To specify Level 1b data for a geographical area of interest, the “topleft” and “bottomright” latitude and longitude coordinates have to be entered in degrees.

Longitude range: -180 to +180
Latitude range: -90 to +90

The applicable syntax, the two coordinates each separated by blanks, would be:

```
-topleft     “Latitude Longitude”
-bottomright “Latitude Longitude”
```

Example:

```
scial1c –topleft “-10 20” –bottomright “50 67” INPUTFILENAME
```

Practical advice:

1. Make sure that selected latitude and longitude values are covered by the product (look up the Level 1b product first with BEAT/CODA) or use –list option.
2. When using only this filter, basically all kinds of measurement data could be extracted. If it is combined with selecting specific clusters, nadir and limb clusters would have to be specified separately. This is due to the different cluster definitions for nadir and limb measurements. See also the command line example section in chapter 4.
3. If the right boundaries are chosen, it is possible to extract a matching pair of nadir and limb measurement. As a decision support, the simple-map view function of BEAT/CODA, when loading the Level 1b input product, shall be used to visualise (on a lat/long map) the state's corner coordinates.

It is also important to note that geo-location coordinates must be included into quotes or space must be escaped so they are treated as one argument.

3.6 Option "-type" – Working on Specific Level 1b Data Type Only

The option "-type" can be used to specify which type of Level 1b data shall be considered for Level 1b to 1c processing. One may choose between the items

- Nadir
- Limb
- Occultation
- Monitoring
- Moon
- All

The syntax to use is:

```
-type item1[,item2[,…]]
```

Items must be separated by commas.

Default: Without applying this option, the default is –type nadir, which means that in this case only Level 1b nadir data will be processed. This default will be overruled whenever option "–cat" is explicitly mentioned as well as the time or geo-location filtering is applied. In this case the default is "–type all". Note that the moon option will only work for Level 1b V.10 products, since previous versions do not contain lunar data.

Practical advice:

1. Selecting e.g. –type limb without any other options will process all data of the Level 1b limb MDS. In other words, this would effectively exclude nadir type measurements.
2. In case, -type nadir was set, there are a couple of different nadir type measurements like nadir large and small swath width but also nadir pointing measurements. If one is interested in only e.g. the pointing states, one would have to combine it with the category option (see below).
3. The option can be combined with time and geo-location options, introduced earlier.
4. "–type all" processes all Level 1b MDS data (nadir, limb, occultation and monitoring). Without any further filter to reduce the amount of data, this is quite a long way to go.
5. Option –type moon copies the lunar data from the Level1b product.

It is also very convenient to combine this option with a specific cluster (band in netCDF) in order to narrow the spectral bandwidth.

3.7 Option "-cat" – Working on Data of a Specific Measurement Category

The "-cat" option is basically a more sensible filter than the "-type".

Table 3.7.1: *Coding of Measurement Categories*

Code #	Measurement Category	Function
1	Nadir	Scientific Measurement
2	Limb	Scientific Measurement
3	Nadir_pointing	Scientific Measurement
4	Solar Occultation, Scanning and Pointing at end of state	Scientific Measurement/Calibration
5	Solar Occultation, Pointing	Scientific Measurement/Calibration
6	Moon Occultation, Pointing	Scientific Measurement/Calibration
7	Moon Scanning	Scientific Measurement/Calibration
8	Sun over Diffuser, Neutral Density Filter out	Calibration
9	Sub Solar Calibration/Pointing	Calibration
10	Spectral Lamp Calibration	Calibration
11	White Lamp Calibration	Calibration
12	Dark current Calibration	Calibration, data not stored in Level 1b
13	Nadir/Elevation Mirror Calibration, Pointing using the sun	Calibration
14	Nadir/Elevation Mirror Calibration, Scanning, using the moon	Calibration
15	ADC Calibration/ Scanner Maintenance	Calibration/Maintenance, no data generated
16	Sun over Diffuser, Neutral Density Filter in	Calibration
17 (not used)	Nadir Eclipse, pointing	Scientific Measurement
18 (not used)	Nadir Eclipse, scanning	Scientific Measurement
19	White Lamp over Diffuser	Calibration/Monitoring
20	Dark_Current_calibration_HM	Calibration/Monitoring
21	NDF_Monitoring_(ND_OUT)	Monitoring
22	NDF_Monitoring_(ND_IN)	Monitoring
23	Sun_ASM_Diffuser	Calibration/Monitoring
24	Nadir_Pointing_Left	Monitoring
25	Sun_ASM_Diffuser_atmosphere	Monitoring
26	Limb_Mesosphere	Monitoring
27	Limb_Mesosphere_Thermosphere	Scientific Measurement

Each category basically comprises a group of states or even a single state. They are coded with numbers from 1 to 27.

The syntax to be used is:

```
-cat cat_1[,cat_2[,…]]
```

More than one category can be selected at once. Each category number, as specified by the table

above, needs to be separated by comma.

Data will then be written into the corresponding 1c measurement data sets, if they are available in the Level 1b product

Practical advice:

1. Selecting “-cat 5,6,7” would look for only solar, lunar occultation respectively moon scanning data.
2. Data would automatically be written to the Level 1c monitoring data set as the –type default nadir is overruled (see previous option).
3. The “-cat” option can also be combined with time or geographical filtering, but the probability of finding a granule (i.e. state) which fulfils this request, might not be too high. Therefore it is not recommended.
4. Selecting one or more clusters (see below) is always convenient.

3.8 Option “-clus”, “-nadirclus”, …, “-noclus” – Extracting Spectral Cluster

The cluster option is the most powerful tool to get data sets which just contain the spectral information of interest instead of always getting the full SCIAMACHY bandwidth.

The operational concept took advantage of the fact that within each science detector groups of pixels, all having the same exposure time, may be combined to so-called clusters. Each cluster can then be co-added on-board so that this group of pixels gets effectively a different integration time. The latter is equivalent to the ground pixel size. The smaller the integration time will be, the smaller the ground pixel, i.e. the higher the spatial resolution.

This clustering concept was introduced for two reasons. On the one side, the SCIAMACHY data rate could be regulated; on the other side spectral intervals with high scientific interest could get optimised w.r.t. their spatial resolution. In the netCDF product, cluster data are stored in groups called BAND_nn, where *nn* is a two digit number. Example: data for cluster 9 are stored in the group BAND_09, data for cluster 40 are stored in the group BAND_40. The band groups can be found as subgroups of the obsvervation modi (nadir, limb, etc). More information about the netCDF structure can be found in the product user guides [R3] and [R4].

SciaL1c supports is the selection of individual clusters, which can be addressed via an identifier in the range from 1 to 64. For details please look at annex A, where the definitions in terms of identifiers, pixel and wavelength range is laid out.

The syntax to be used is either

- `-clus 1,2,3,…,64`
- `-nadirclus 1,2,3,…,56`
- `-limbclus 1,2,3,…,40`
- `-occclus 1,2,3,…,40`
- `-monclus 1,2,3,…,40`
- `-noclus`

The different numbers of clusters reflect the fact that for the final flight states in nadir mode 56 bands or clusters are defined, while in the other modes usually 40 bands are defined. If the user gives numbers outside the valid range, no science detector data are extracted. PMD data and the standard ADS data are still extracted, but this is likely not what the user wants.

Practical advice:

Due to the fact that the cluster definition, i.e. the allocation of pixels to cluster identifiers, is different at least for nadir and limb measurements, careful usage of the above mentioned options is recommended.

1. The default of the cluster options is to select all clusters; that would be the result if no cluster is specifically selected.
2. Whenever data of one type of measurement is selected (which is having the same cluster definition for all states involved) it is sufficient to use "-clus"
3. Whenever time or geo-location filters are planned to be used together, the selected data may be of different type and therefore using different cluster definitions. In these cases it is recommended to specify something like: -starttime utc_start –stoptime utc_stop –nadircluster 5,6 –limbcluster 3. This means that whenever nadir data is found in the Level 1b product, only cluster 5 and 6 will be selected, and for limb data, cluster 3 will be taken only.
4. Cluster definitions (as given by Annex A) are written to be in agreement with the SOST definition. The option –noclus basically avoids creating cluster data related MDS at all. This may be practical for a user, who just wants to extract integrated PMD data or fractional polarisation values.

3.9 Option "-ds" – Copying Level 1b Data Sets for ENVISAT Format

This option is foreseen to select Level 1b data sets, which should appear in the Level 1c data. *It works only if the input and output product are in the old ENVISAT binary format.* For the netCDF format, standard tools can be used to copy any data set from one netCDF product to another. You may consider this option as a simple filter. The following datasets exist:

1	SUMMARY_QUALITY	20	PMD_PACKETS
2	GEOLOCATION	21	AUXILIARY_PACKETS
3	INSTRUMENT_PARAMS	22	NEW_LEAKAGE
4	LEAKAGE_CONSTANT	23	DARK_AVERAGE
5	LEAKAGE_VARIABLE	24	NEW_PPG_ETALON
6	PPG_ETALON	25	NEW_SPECTRAL_CALIBRATIO
7	SPECTRAL_BASE	26	NEW_SUN_REFERENCE
8	SPECTRAL_CALIBRATION	27	NADIR
9	SUN_REFERENCE	28	LIMB
10	POL_SENS_NADIR	29	OCCULTATION
11	POL_SENS_LIMB	30	MONITORING
12	POL_SENS_OCC	31	LEVEL_0_PRODUCT
13	RAD_SENS_NADIR	32	LEAKAGE_FILE
14	RAD_SENS_LIMB	33	PPG_ETALON_FILE
15	RAD_SENS_OCC	34	SPECTRAL_FILE
16	ERRORS_ON_KEY_DATA	35	SUN_REF_FILE

17	SLIT_FUNCTION	36	KEY_DATA_FILE
18	SMALL_AP_SLIT_FUNCTION	37	M_FACTOR_FILE
19	STATES	38	INIT_FILE
x0	CAL_OPTIONS	39	ORBIT_FILE
x1	NADIR_PMD	40	ATTITUDE_FILE
x2	LIMB_PMD		
x3	OCCULTATION_PMD		
x4	NADIR_FRAC_POL		
x5	LIMB_FRAC_POL		
x6	OCCULTATION_FRAC_POL		

The following dataset grouping acronyms exist:

A	x1, x2 and x3
B	x4, x5 and x6
C	27, 28, 29 and 30
D	31, 32, …, 40

If a user does not specify a “-ds” option, the following Level 1b data sets will appear in the 1c product: 1, 2, 6, 9, 17, 19, 1, x2, x3, x4, x5, x6, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39 and 40. This is equal to specifying “-ds 1, 2, 6, 9, 17, 19, x0, A, B, C, D” in the command-line. Note that the Level 1b measurement data sets 27 to 30 are not copied in Level 1b format into the Level 1c product.

This default setting is defined for a Level 1c user, who is preparing for his Level 2 processing in the old format. Therefore those annotation data sets, which are mandatory for that purpose (see above) will extracted by default. It presumes that the user does not need other calibration relevant GADS.

Whenever default behaviour should be modified, the “-ds” option must be explicitly given in the command-line. The syntax for the command is:

```
-ds set1[,set2[,…]]
```

Alternatively, help on this command line option can be ordered via

```
scial1c –help ds | less
```

Please note that for unknown datasets a filename is copied automatically into the Level 1c product.

Practical advice:

1. Whenever the –ds option is activated, the default (see above) will no longer be extracted automatically. This means that each data set, which shall go into the Level 1c product, needs explicit mentioning.
2. The option may be most interesting for a Level 1 user who is investigating the quality of the various calibration/correction parameters (or their impact on Level 2 retrieval) and who is

working with the ENVISAT format.

3.10 Option “-pmd” – Extracting Integrated PMD Data

In case the user chooses ENVISAT product format as output, with the option -pmd PMD values are written to the output. The netCDF format *always* contains the PMD values.

The command syntax is as simple as

```
-pmd
```

Practical advice:

1. In case of monitoring states, no integrated PMD data are available. Be aware of this when setting the extraction options.

3.11 Option “-fracpol” – Extracting Fractional Polarisation Values

In case the user chooses ENVISAT product format as output, with the option -fracpol polarisation fractions are written to the output. The netCDF format *always* contains the polarisation fractions.

The command syntax is as simple as

```
-fracpol
```

Practical advice:

1. In case of monitoring states, no integrated PMD data are available. Be aware of this when setting the extraction options.

3.12 Option “-cal” and “-allcal” – Calibrating the Data

In this section the different corrections and calibrations, which can be applied to SCIAMACHY science detector data, will be described. Principally one can choose to apply:

0 - Memory effect
1 - Leakage current
2 - pixel to pixel gain (ppg)
3 – This option is obsolete and has no effect[3]
4 - Straylight
5 - Spectral calibration
6 - Polarisation
7 - Radiance
8 - PMD sun normalisation
all - Apply all calibrations

The syntax to be used is

```
-cal option1[,option2[,…]]
```

[3] The etalon correction is contained in the m-factor correction

```
-cal all
-allcal
```

The purpose is to let the user decide about which calibrations/corrections to apply. This option is very helpful, as it allows to analyse step by step the “quality” of the corrections to be applied. Therefore one might want to compare the same Level 1b input under different configurations of the calibration options, to learn about the absolute value of correction first and secondly to see the influence on a Level 2 product, which is based on differently calibrated Level 1c data (see examples section).

Practical advice

1. The default of the calibration options is set to *no calibration*. Therefore it is important to specify the calibration steps to be applied.
2. Calibrations 0 to 4 are all wavelength independent, while calibrations 6 and 7 are dependent on wavelength. This means they cannot be applied without a wavelength calibration being applied before.
3. Monitoring states cannot be calibrated for polarisation (because the Level 1b processor does not calculate fractional polarisation values for monitoring states). Therefore SciaL1c automatically skips polarisation correction for monitoring states and logs this into a log file.
4. Radiance calibration for monitoring measurements is not supported for the same reason
5. Some combinations of calibration options do not make sense and the tool will give out an error and a warning. One example is the application of the polarisation correction for limb: this correction needs the radiometric calibration and thus the option 7 must also be given.

Please note that option 3 (etalon) is no longer needed since Level 1b products version 8.0 and above already incorporate m-factor with etalon corrections. Should a user still need to use it (for previous Level 1b product versions), SciaL1c version 3.2 with the special –compat option should be be used.

3.13 Option “-darkflag” – Dark correction

By default the tool uses Limb measurements for the dark correction of Limb data. However, scientists might prefer to use the information from the leakage GADS for this purpose. To allow switching between Limb measurements and the dark corrections in the leakage GADS, this option was implemented.

The command syntax is as simple as

```
-darkflag <LIMB|GADS> next step.
```

1.

3.14 Option “-list” – Show States wrt Command line

Option –list in combination with all other possible options allows users to see, which states exist or will be processed should a user start SciaL1c processing. A state description can be found at the SOST web page (currently at http://atmos.caf.dlr.de/projects/scops/).

- If no other command-line options are present, -list displays ALL states that exist in the Level 1b product.

- In combination with other command-line options, -list shows states as if SciaL1c has been run.
- No output child file is generated

The command syntax is as simple as

```
-list
```

Below you will find different examples of SciaL1c –list output, where you can observe how program output changes:

```
$ ./bin/scial1c -list l1bfile

SciaL1c version 4.0 based on L0-1 9+ (N1 + nc). Compiled on 2019-04-09 11:23:23

NetCDF input detected
Reading STATES group
NetCDF level-1b filename:
ENV_RPRO_SCI_L1B____20031019T172934_20031019T191022_08555_01_090100_20181101T111325.nc
Number of states in the product is 92.
Reading calibration data.
index  1 id 63 cat 12 dur  480 oph 0.234 date 19-OCT-2003 17:29:34.270624 no MDS
index  2 id 67 cat 12 dur 1280 oph 0.244 date 19-OCT-2003 17:30:07.829216 no MDS
index  9 id  8 cat 12 dur  640 oph 0.298 date 19-OCT-2003 17:35:55.739356 no MDS
index 10 id 26 cat 12 dur  480 oph 0.305 date 19-OCT-2003 17:36:39.297947 no MDS
index 11 id 46 cat 12 dur  160 oph 0.309 date 19-OCT-2003 17:37:12.856539 no MDS
index 12 id 63 cat 12 dur  480 oph 0.313 date 19-OCT-2003 17:37:26.411226 no MDS
index 13 id 67 cat 12 dur 1280 oph 0.322 date 19-OCT-2003 17:37:59.969818 no MDS
index 79 id 65 cat 15 dur  320 oph 0 date 01-JAN-2000 00:00:00.000000 no MDS
index 80 id  8 cat 12 dur  640 oph 0.127 date 19-OCT-2003 18:59:19.778175 no MDS
index 81 id 26 cat 12 dur  480 oph 0.134 date 19-OCT-2003 19:00:03.340673 no MDS
index 82 id 46 cat 12 dur  160 oph 0.138 date 19-OCT-2003 19:00:36.895358 no MDS
index 83 id 63 cat 12 dur  480 oph 0.142 date 19-OCT-2003 19:00:50.457858 no MDS
index 84 id 67 cat 12 dur 1280 oph 0.151 date 19-OCT-2003 19:01:24.012544 no MDS
index 89 id  8 cat 12 dur  640 oph 0.217 date 19-OCT-2003 19:08:21.825023 no MDS
index 90 id 26 cat 12 dur  480 oph 0.224 date 19-OCT-2003 19:09:05.383615 no MDS
index 91 id 46 cat 12 dur  160 oph 0.228 date 19-OCT-2003 19:09:38.942207 no MDS
index 92 id 63 cat 12 dur  480 oph 0.231 date 19-OCT-2003 19:09:52.496894 no MDS
index 25 id  1 cat  1 dur 1280 oph 0.486 date 19-OCT-2003 17:54:28.172895
index 27 id  2 cat  1 dur 1280 oph 0.509 date 19-OCT-2003 17:56:47.602576
[...]



$ ./bin/scial1c -list -cal all l1bfile

SciaL1c version 4.0 based on L0-1 9+ (N1 + nc). Compiled on 2019-04-09 11:23:23

NetCDF input detected
Reading STATES group
NetCDF level-1b filename:
ENV_RPRO_SCI_L1B____20031019T172934_20031019T191022_08555_01_090100_20181101T111325.nc
Number of states in the product is 92.
Reading calibration data.
index 25 id  1 cat  1 dur 1280 oph 0.486 date 19-OCT-2003 17:54:28.172895
index 27 id  2 cat  1 dur 1280 oph 0.509 date 19-OCT-2003 17:56:47.602576
index 29 id  3 cat  1 dur 1280 oph 0.532 date 19-OCT-2003 17:59:07.036163
index 31 id  4 cat  1 dur 1040 oph 0.554 date 19-OCT-2003 18:01:26.473656
index 33 id  4 cat  1 dur 1040 oph 0.575 date 19-OCT-2003 18:03:30.899431
index 35 id  5 cat  1 dur 1040 oph 0.595 date 19-OCT-2003 18:05:35.333019
index 37 id  6 cat  1 dur 1040 oph 0.616 date 19-OCT-2003 18:07:39.758794
index 39 id  6 cat  1 dur 1040 oph 0.637 date 19-OCT-2003 18:09:44.188476
```

```
index 41 id  6 cat  1 dur 1040 oph 0.657 date 19-OCT-2003 18:11:48.622063
[...]
```

```
$ ./bin/scial1c -list -type limb l1bfile

SciaL1c version 4.0 based on L0-1 9+ (N1 + nc). Compiled on 2019-04-09 11:23:23

NetCDF input detected
Reading STATES group
NetCDF level-1b filename:
ENV_RPRO_SCI_L1B____20031019T172934_20031019T191022_08555_01_090100_20181101T111325.nc
Number of states in the product is 92.
Reading calibration data.
index  3 id 27 cat 26 dur  647 oph 0.255 date 19-OCT-2003 17:31:31.508900
index  4 id 27 cat 26 dur  647 oph 0.262 date 19-OCT-2003 17:32:15.567491
index  5 id 27 cat 26 dur  647 oph 0.269 date 19-OCT-2003 17:32:59.629989
index  6 id 27 cat 26 dur  647 oph 0.277 date 19-OCT-2003 17:33:43.688581
index  7 id 27 cat 26 dur  647 oph 0.284 date 19-OCT-2003 17:34:27.747172
index  8 id 27 cat 26 dur  647 oph 0.291 date 19-OCT-2003 17:35:11.805764
index 14 id 28 cat  2 dur  836 oph 0.377 date 19-OCT-2003 17:43:42.657302
index 15 id 28 cat  2 dur  836 oph 0.386 date 19-OCT-2003 17:44:38.524486
index 16 id 28 cat  2 dur  836 oph 0.395 date 19-OCT-2003 17:45:34.399484
index 17 id 28 cat  2 dur  836 oph 0.405 date 19-OCT-2003 17:46:30.266668
index 21 id 29 cat  2 dur  836 oph 0.447 date 19-OCT-2003 17:50:44.813531
index 22 id 29 cat  2 dur  836 oph 0.456 date 19-OCT-2003 17:51:40.684622
index 23 id 29 cat  2 dur  836 oph 0.465 date 19-OCT-2003 17:52:36.555713
index 24 id 29 cat  2 dur  836 oph 0.475 date 19-OCT-2003 17:53:32.422898
index 26 id 30 cat  2 dur  836 oph 0.498 date 19-OCT-2003 17:55:51.860391
index 28 id 30 cat  2 dur  836 oph 0.521 date 19-OCT-2003 17:58:11.293978
index 30 id 31 cat  2 dur  836 oph 0.544 date 19-OCT-2003 18:00:30.727565

[...]
```

3.15 Option “-state” – Process Selected States

This option allows users to select one or more states for processing. To get a list of available states in Level 1b file, use –list option. The number returned by –list is actually STATE index, stored inside the Level 1b file plus one. The index is not to be confused with the STATE ID: The ID signifies an instrument configuration, while the index just shows the sequential number of the state in the product.

The command syntax is as simple as

```
-state NUM1[,[,…]]
```

Currently there is no separate option to extract a state according to ID. If one wants to filter for a state ID, under Linux or Unix variants, the following construct could be used for processing, e.g. process only state ID 6:

```
scial1c -state `scial1c -list <file> |grep -F "id  6 " | awk -vORS=,
'{print $2}' | sed 's/,$/\n/'` <file>
```

The part enclosed in `` (note the direction of the quotes) extracts the indices of the requested state IDs from the listing and produces a comma separated list that is then used to process the file.

Replace “id 6 “ with the ID number you are interested in. Note that the blanks are intentional!. See Section 4.2 for a more detailed explanation.

3.16 Option “-clearlog” – Clear SciaL1c Log

This option tells the program to clear SciaL1c log file (which is scial1c-main.log) before starting processing.

The command syntax is as simple as

```
-clearlog
```

3.17 Option “-ascii” – Dump Level 1c into ASCII File

This option tells SciaL1c to dump each processed Level 1c state into an ASCII file. This is a highly experimental option and no guarantee and warranty are provided.

For every state a text file with a .dat extension is generated.

The command syntax is

```
-ascii FILENAME_PREFIX
```

3.18 Option “-ascii-smr” – Dump SMR Vector into ASCII File

With this option SciaL1c writes Sun Mean Reference (SMR) spectrum with id D0 after m-factor calibration into a text file. It is useful for comparison of the correct application of m-factors to SMR spectrum.

The command syntax is as simple as

```
-ascii-smr FILENAME
```

3.19 Option “-envisat” – Generate Level 1c in ENVISAT binary format instead of NetCDF

This option tells SciaL1c to generate the old, binary product in ENVISAT format with MPH and SPH instead of the NetCDF product.

The command syntax is

```
-envisat
```

4 Command line examples

In this chapter some typical command-line examples will be discussed. They may be used as a starting point for user's own configurations of the SciaL1c command line tool. Below, names in '<>' have to be replaced with actual file names.

4.1 Data Types

As mentioned above, the default is *not* to apply any calibrations and extract only nadir type data. Thus, if one wants to extract all nadir data and calibrate them, the user should issue the command-line

```
scial1c -cal all <l1bfile>
```

For other data types the type option *must* be given, e.g.

```
scial1c -type limb -cal all <l1bfile>
```

to extract and process limb states or

```
scial1c -type all -cal all <l1bfile>
```

to extract all files

4.2 Extract Only Certain State IDs

There is no option to extract states with an ID. However, one can use linux standard programs and design a command that will extract only states with a certain ID (see also Section 3.15). The command line is

```
scial1c -state `scial1c -list <l1bfile> | grep -F "id  6 " | awk
-vORS=, '{print $2}' | sed 's/,$/\n/'` <l1bfile>
```

Note that this was only tested on a few files/state ID. The blanks in the grep statement are intentional. The command should be typed without the line break above. The command works as follows:

1. Everything that is enclosed in the inverted quotes (``) after the state option extracts the indices for the state ID. The direction of the quotes is important
2. The part until the first pipe ('|') extracts a listing of all states.
3. The grep command filters for the state ID (6 in the above case); only the listing lines with state ID 6 are going through the filter. Important: for single digit state numbers you need *2 spaces* after 'id' and before the number, i.e. "id□□6□". For double digit numbers the string is

"id□61□"

4. The *awk* call generates a comma separated list of the state indices corresponding to the state ID
5. The *sed* command at the end removes the last comma and inserts a line feed at the end.

Using this construct, you should put the state option at the very end of your options to SciaL1c. Make sure that you use the same Level 1b within the quotes and outside the quotes. The command was tested on bash, csh, tcsh and zsh.

4.3 Extracting different Bands/Clusters for different Data Types

The cluster options enable the user to extract different clusters (or bands) for different data types. For example, if you want to extract band 29 for nadir, band 30 for limb and band 31 for occultation, you type

```
./scial1c -type all -nadirclus 29 -limbclus 30 -occclus 31 <l1bfile>
```

Note that you need the type option, otherwise only nadir cluster would be extracted.

4.4 Sensitivity Studies

Sensitivity studies can be done by incrementally apply calibration options, process the data further and compare the results. A batch file would be most suitable to do this. If you define a batch file as

```
# batch file for incrementally calibrate
-out nocal <l1bfile>
-cal 0 -out mecnl_cal <l1bfile>
-cal 0,1 -out dark_cal <l1bfile>
-cal 0,1,2 -out ppg_cal <l1bfile>
-cal 0,1,2,4 -out stray_cal <l1bfile>
-cal 0,1,2,4,5 -out wvl_cal <l1bfile>
-cal 0,1,2,4,5,6 -out pol_cal <l1bfile>
-cal 0,1,2,4,5,6,7 -out rad_cal <l1bfile>
```

and then run

```
scial1c -b <batchfile>
```

one will generate incrementally calibrated Level 1c files in the named directories. Note that the *directories have to exist before running scial1c.* Scial1c does not create directories and will throw an error if it cannot fined the target directory. This is done after the file is processed on trying to write the file. The calibration option 3 is missing on purpose; it is obsolete for version 9 Level 1b

products.

A Parameter Table

Annex A Table	Content
A.1	Cluster definition nadir
A.2	Cluster definition limb

A.1 Nadir Cluster/Band Definition

Cluster ID Ch.1	Start Pixel	End Pixel	Length	Min Wvl.	Max Wvl.	Description	Cluster Index	Cluster Identifier	Start Pixel
0	0	4	5			Blinded Pixel	1	0	0
1	5	196	192	213,29	239,88	straylight	2	1	5
2	197	551	355	240,00	281,90	virtual channel 1a	3	2	197
3	552	747	196	282,01	303,54	virtual channel 1b	4	3	552
4	748	841	94	303,65	313,92	overlap region, PMD 1	5	4	748
	842	1018	177	314,03	333,80	unused pixel			
5	1019	1023	5			Blinded Pixel	6	5	1019

Cluster ID Ch. 2	Start Pixel	End Pixel	Length	Min Wvl.	Max Wvl.	Description	Cluster Index	Cluster Identifier	Start Pixel
0	0	4	5			Blinded Pixel	7	0	1024
	5	75	71	411,63	404,07	unused pixel			
1	76	189	114	403,96	391,87	overlap region 2b	8	1	1100
2	190	853	664	391,76	320,14	UV DOAS, PMD 1	9	2	1214
3	854	947	94	320,02	309,43	overlap region 2a, UV DOA	S, PMD1 0 1	3	1878
	948	1018	71	309,31	301,18	unused pixel			
4	1019	1023	5			Blinded Pixel	11	4	2043

Cluster ID Ch.3	Start Pixel	End Pixel	Length	Min Wvl.	Max Wvl.	Description	Cluster Index	Cluster Identifier	Start Pixel
0	0	9	10			Blinded Pixel	12	0	2048
	10	32	23	386,09	391,63	unused pixel			
1	33	82	50	391,88	404,10	overlap region	13	1	2081
2	83	162	80	404,34	423,73		14	2	2131
3	163	598	436	423,97	526,96	VIS DOAS,	15	3	2211

Cluster ID Ch.3	Start Pixel	End Pixel	Length	Min Wvl.	Max Wvl.	Description	Cluster Index	Cluster Identifier	Start Pixel
						PMD 2			
4	599	673	75	527,20	544,56		16	4	2647
5	674	760	87	544,80	565,08	AE	17	5	2722
6	761	895	135	565,31	597,28		18	6	2809
7	896	929	34	597,52	605,48	overlap region	19	7	2944
	930	1018	89	605,72	627,17	unused pixel			
8	1019	1023	5			Blinded Pixel	20	8	3067

Cluster ID Ch.3	Start Pixel	End Pixel	Length	Min Wvl.	Max Wvl.	Description	Cluster Index	Cluster Identifier	Start Pixel
0	0	4	5			Blinded Pixel	21	0	3072
	5	9	5	596,48	597,38	unused pixel			
1	10	45	36	597,60	605,43	overlap region	22	1	3082
2	46	77	32	605,65	612,53		23	2	3118
3	78	612	535	612,75	725,99	PMD 3, AE	24	3	3150
4	613	746	134	726,19	753,77		25	4	3685
5	747	852	106	753,98	775,92	O2(A)	26	5	3819
6	853	918	66	776,13	789,85	overlap region	27	6	3925
	919	1018	100	790,06	811,25	unused pixel			
7	1019	1023	5			Blinded Pixel	28	7	4091

Cluster ID Ch.5	Start Pixel	End Pixel	Length	Min Wvl.	Max Wvl.	Description	Cluster Index	Cluster Identifier	Start Pixel
0	0	4	5			Blinded Pixel	29	0	4096
	5	9	5	774,73	775,94	unused pixel			
1	10	55	46	776,24	789,74	overlap region	30	1	4106
2	56	83	28	790,04	798,06		31	2	4152
3	84	608	525	798,35	946,62	PMD 4/7, AE	32	3	4180
4	609	766	158	946,90	990,40		33	4	4705
5	767	1000	234	990,68	1056,25	overlap region, (AE)	34	5	4863
	1001	1018	18	1056,53	1061,40	unused			

Cluster ID Ch.5	Start Pixel	End Pixel	Length	Min Wvl.	Max Wvl.	Description	Cluster Index	Cluster Identifier	Start Pixel
						pixel			
6	1019	1023	5			Blinded Pixel	35	6	5115

Cluster ID Ch. 6	Start Pixel	End Pixel	Length	Min Wvl.	Max Wvl.	Description	Cluster Index	Cluster Identifier	Start Pixel
0	0	9	10			Blinded Pixel	36	0	5120
	10	23	14	979,55	990,03	unused pixel			
1	24	106	83	990,84	1056,23	overlap region	37	1	5144
2	107	334	228	1057,02	1233,24		38	2	5227
3	335	360	26	1234,01	1253,14	AE	39	3	5455
4	361	538	178	1253,90	1388,96		40	4	5481
5	539	566	28	1389,72	1410,36	Water Vapour	41	5	5659
6	567	745	179	1411,12	1548,51		42	6	5687
7	746	899	154	1549,30	1670,70	Water/Ice cloud & PMD 5	43	7	5866
8	900	930	31	1671,51	1695,84		44	8	6020
9	931	944	14	1696,65	1707,26	add. Water/Ice cloud	45	9	6051
10	945	996	52	1708,08	1750,09		46	10	6065
	997	1013	17	1750,92	1764,24	unused pixel			
11	1014	1023	10			Blinded Pixel	47	11	6134

Cluster ID Ch. 7	Start Pixel	End Pixel	Length	Min Wvl.	Max Wvl.	Description	Cluster Index	Cluster Identifier	Start Pixel
0	0	9	10			Blinded Pixel	48	0	6144
	10	47	38	1935,55	1939,88	unused pixel			
1	48	292	245	1939,99	1967,79		49	1	6192
2	293	440	148	1967,90	1984,05	CO2	50	2	6437
3	441	882	442	1984,15	2029,89		51	3	6585
4	883	987	105	2029,99	2040,19	CO2, H2O	52	4	7027
	988	1013	26	2040,29	2042,70	unused pixel			
5	1014	1023	10			Blinded	53	5	7158

Cluster ID Ch. 7	Start Pixel	End Pixel	Length	Min Wvl.	Max Wvl.	Description	Cluster Index	Cluster Identifier	Start Pixel
						Pixel			

Cluster ID Ch. 8	Start Pixel	End Pixel	Length	Min Wvl.	Max Wvl.	Description	Cluster Index	Cluster Identifier	Start Pixel
0	0	9	10			Blinded Pixel	54	0	7168
1	10	1013	1004	2260,61	2384,49	PMD 6, Ch. 8, unused pixel	55	1	7178
2	1014	1023	10			Blinded Pixel	56	2	8182

Table A.1: *Cluster definitions for Nadir measurements.*

A.2 Limb Cluster/Band Definition

Cluster ID Ch.1	Start Pixel	End Pixel	Length	Min Wvl.	Max Wvl.	Description	Cluster Index	Cluster Identifier	Start Pixel
0	0	4	5			Blinded Pixel	1	0	0
1	5	196	192	213,29	239,88	straylight	2	1	5
2	197	551	355	240,00	281,90	virtual channel 1a	3	2	197
3	552	841	290	282,01	313,92	virtual channel 1b	4	3	552
4	842	1018	177	314,03	333,80	unused pixel	5	4	842
5	1019	1023	5			Blinded Pixel	6	5	1019

Cluster ID Ch.2	Start Pixel	End Pixel	Length	Min Wvl.	Max Wvl.	Description	Cluster Index	Cluster Identifier	Start Pixel
0	0	4	5			Blinded Pixel	7	0	1024
1	5	75	71	411,63	404,07	unused pixel	8	1	1029
2	76	853	778	403,96	320,14	virtual channel 2b	9	2	1100
3	854	947	94	320,02	309,43	virtual channel 2a	10	3	1878
4	948	1018	71	309,31	301,18	unused pixel	11	4	1972
5	1019	1023	5			Blinded Pixel	12	5	2043

Cluster ID Ch.3	Start Pixel	End Pixel	Length	Min Wvl.	Max Wvl.	Description	Cluster Index	Cluster Identifier	Start Pixel
0	0	9	10			Blinded Pixel	13	0	2048
1	10	32	23	386,09	391,63	unused pixel	14	1	2058
2	33	929	897	391,88	605,48	Channel 3 (main part)	15	2	2081
3	930	1018	89	605,72	627,17	unused pixel	16	3	2978
4	1019	1023	5			Blinded Pixel	17	4	3067

Cluster ID Ch.4	Start Pixel	End Pixel	Length	Min Wvl.	Max Wvl.	Description	Cluster Index	Cluster Identifier	Start Pixel
0	0	4	5			Blinded Pixel	18	0	3072
1	5	9	5	596,48	597,38	unused pixel	19	1	3077
2	10	918	909	597,60	789,85	Channel 4 (main part)	20	2	3082
3	919	1018	100	790,06	811,25	unused pixel	21	3	3991
4	1019	1023	5			Blinded Pixel	22	4	4091

Cluster ID Ch.5	Start Pixel	End Pixel	Length	Min Wvl.	Max Wvl.	Description	Cluster Index	Cluster Identifier	Start Pixel
0	0	4	5			Blinded Pixel	23	0	4096
1	5	9	5	774,73	775,94	unused pixel	24	1	4101
2	10	1000	991	776,24	1056,25	Channel 5 (main part)	25	2	4106
3	1001	1018	18	1056,53	1061,40	unused pixel	26	3	5097
4	1019	1023	5			Blinded Pixel	27	4	5115

Cluster ID Ch.6	Start Pixel	End Pixel	Length	Min Wvl.	Max Wvl.	Description	Cluster Index	Cluster Identifier	Start Pixel
0	0	9	10			Blinded Pixel	28	0	5120
1	10	23	14	979,55	990,03	unused pixel	29	1	5130

Cluster ID Ch.6	Start Pixel	End Pixel	Length	Min Wvl.	Max Wvl.	Description	Cluster Index	Cluster Identifier	Start Pixel
2	24	996	973	990,84	1750,09	Channel 6/6+ (main part)	30	2	5144
3	997	1013	17	1750,92	1764,24	unused pixel	31	3	6117
4	1014	1023	10			Blinded Pixel	32	4	6134

Cluster ID Ch.7	Start Pixel	End Pixel	Length	Min Wvl.	Max Wvl.	Description	Cluster Index	Cluster Identifier	Start Pixel
0	0	9	10			Blinded Pixel	33	0	6144
1	10	47	38	1935,55	1939,88	unused pixel	34	1	6154
2	48	987	940	1939,99	2040,19	Channel 7 (main part)	35	2	6192
3	988	1013	26	2040,29	2042,70	unused pixel	36	3	7132
4	1014	1023	10			Blinded Pixel	37	4	7158

Cluster ID Ch.8	Start Pixel	End Pixel	Length	Min Wvl.	Max Wvl.	Description	Cluster Index	Cluster Identifier	Start Pixel
0	0	9	10			Blinded Pixel	38	0	7168
1	10	1013	1004	2260,61	2384,49	Channel 8	39	1	7178
2	1014	1023	10			Blinded Pixel	40	2	8182

Table A.2: *Cluster definitions for Limb measurements.*