



Snow Radiance Processor

Version 1.1

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COLLABORATORS

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Chapter 1

Introduction

1.1 Scope

This document is the software user manual (SUM) for the BEAM Snow Radiance Processor.

1.2 Objectives

As outlined in detail in [1], the aim of developing a BEAM Snow Radiance Processor is to undertake research and algorithm development on snow properties derived from both MERIS standalone as well as synergetic MERIS/AATSR datasets, with stated objectives:

- Cloud screening
- Ice / snow discrimination
- Snow cover determination (including the snow index);
- retrieval of
- snow temperature
- snow emissivity
- snow grain size
- snow albedo
- concentration of pollutants
- deriving recommendations for future missions

This SUM specifically describes the software developed to address all these objectives, and how to use the corresponding BEAM Snow Radiance Processor.

1.3 Reader Level

This specification is mainly written for the following audiences:

- BEAM Snow Radiance Processor users

This user manual specifications assumes that the reader is familiar with basic concepts in using the BEAM software and its integrated processors.

1.4 Acronyms and Nomenclature

1.4.1 Acronyms

- AATSR - Advanced Along-Track Scanning Radiometer
- ATBD - Algorithm Theoretical Baseline Document
- BC - Brockmann Consult
- dl - dimensionless
- ESA - European Space Agency
- FUB - Free University of Berlin
- IUP - Institute of Environmental Physics, University of Bremen
- MDSI - MERIS Difference Snow Index
- MERIS - Medium Resolution Imaging Spectrometer Instrument
- NDVI - Normalized Difference Vegetation Index
- NDSI - Normalized Difference Snow Index
- SIC - Snow/Ice/Cloud Identification Processor
- SIP - Snow/Ice Properties Processor
- SUM - Software User Manual
- VISAT - Visualization and Analysis Tool

1.4.2 Nomenclature

1.5 References

- [1] STSE SnowRadiance: Statement of Work, ESA, EOP-SM/1789, iss. 2, rev. 2, April 2008
- [2] : Kokhanovsky, A.: Retrieval algorithm of snow/ice properties. STSE SnowRadiance, SIP-ATBD, IUP, October 2009.
- [3] Preusker, R., and J. Fischer: Estimation of snow temperature and emissivity using AATSR measurements at 11um and 12um. STSE SnowRadiance, Snow Temperature ATBD, FUB, January 2010.
- [4] Krämer, U. and C. Brockmann: Using O2 Products for the Cloud Screening in the MERIS and S3 operational processing. ESA O2 Project Deliverable D6.3c, September 2009
- [5] Gomez-Chova, L., G. Camps-Valls, Calpe, J., Munoz, J., and J. Moreno: MERIS/AATSR Synergy Algorithms for Cloud Screening, Aerosol Retrieval, and Atmospheric Correction. ESRIN Contract No. 21090/07/I-LG, March 2010.

Chapter 2

Software Installation

2.1 The Snow Radiance Processor as BEAM plugin

As a BEAM plugin, the Snow Radiance Processor needs the following software to be installed in advance:

- BEAM, version 4.8

The BEAM software can be obtained from the BEAM download page (www.brockmann-consult.de/beam). Note that the Snow Radiance Processor software has been developed in the frame of BEAM 4.8. Full compatibility with older BEAM versions cannot be guaranteed, therefore, it is strongly recommended to use the Snow Radiance Processor with BEAM, version 4.8. Once newer releases of BEAM are published, the Snow Radiance software will be updated accordingly if required.

The Snow Radiance software delivery consists of several jar files: a core module, the modules of the BEAM MERIS/AATSR Synergy Toolbox and for AATSR recalibration, and adjusted BRR (Bottom of Rayleigh Reflectance) and SDR (Surface Directional Reflectance) modules, which provide additional Java classes used by the toolbox:

- beam-meris-aatsr-snowradiance-1.1.jar
- beam-meris-aatsr-synergy-aerosol-retrieval-1.1.2.jar
- beam-meris-aatsr-synergy-cloud-screening-1.1.2.jar
- beam-meris-aatsr-synergy-preprocessing-1.1.2.jar
- beam-meris-aatsr-synergy-core-1.1.2.jar
- beam-aatsr-recalibration-1.3.jar
- beam-meris-brr-2.2.1.jar
- beam-meris-sdr-2.2.1.jar

These files need to be downloaded from the BEAM plugin page:

- <http://www.brockmann-consult.de/cms/web/beam/plug-ins>

or the Snow Radiance Wiki page:

- <http://www.brockmann-consult.de/beam-wiki/display/SNOWR/Software>

The files need to be copied into the 'modules' folder of the BEAM installation. Note that existing versions of these jar files need to be replaced/overwritten. There should not be more than one jar file for each of these modules in the 'modules' folder!

2.2 Auxiliary Data

The auxiliary data files required for the Snow Radiance Processor are all included in the jar archives described above. No additional data needs to be downloaded.

2.3 Additional Requirements

To be able to process all options properly, the MERIS/(A)ATSR Synergy Toolbox processor needs the following add-ons to be installed in BEAM (if not already done):

- MERIS L2 Auxdata module, version 1.1.1

The MERIS L2 Auxdata can be installed with the BEAM module manager. See BEAM help documentation for details (<http://www.brockmann-consult.de/beam/doc/help/visat/ModuleManager.html>).

Chapter 3

Products

The input and output products of BEAM Snow Radiance processor are:

Input:

- MERIS L1b (mandatory for all retrievals)
- AATSR L1b (mandatory for snow temperature/emissivity retrieval)

Output: The output is a 'Snowradiance L2 product' which can contain the following bands:

Quantity	Bandname	Unit
Snow temperature	snow_temperature	K
Snow emissivity	snow_emissivity	dl
Snow grain size	snow_grain_size	mm
Soot concentration	soot_concentration	ng/g
Snow albedo (15 MERIS channels)	snow_albedo_n	dl
Water vapour	water_vapour	kg/m ²
NDVI	ndvi	dl
NDSI	ndsi	dl
MDSI	mdsi	dl

Table 3.1: Regular bands

Quantity	Bandname	Unit
Snow Radiance flags	snowradiance_flags	dl
MERIS L1 flags	l1_flags_MERIS	dl
AATSR L1 confidence flags nadir	confid_flags_nadir_AATSR	dl
AATSR L1 confidence flags forward	confid_flags_fward_AATSR	dl
AATSR L1 cloud flags nadir	cloud_flags_nadir_AATSR	dl
AATSR L1 cloud flags forward	cloud_flags_fward_AATSR	dl

Table 3.2: Flag bands

From the user interface it can be specified which of these bands shall be computed and written to the output product.

The MERIS and AATSR L1 flags are simply copied from their input products, respectively. The 'Snow Radiance flags' reflect the results of the cloud/ice/snow discrimination. The coding of these flags is listed in the following table:

Name	Value	Description
F_NO_AATSR	0	pixel is outside AATSR coverage (in case of colocated product)
F_CLOUD	1	pixel was specified as cloudy
F_ICE	2	is covered with ice (AATSR NDSI criterion)
F_SNOW	4	is covered with snow (AATSR band criterion)
F_UNSPECIFIED	8	unspecified coverage (no cloud, ice or snow)

Table 3.3: Flag bands

Chapter 4

The BEAM Snow Radiance processor

The BEAM Snow Radiance processor can be invoked from the Visat 'Tools' menu as shown below.

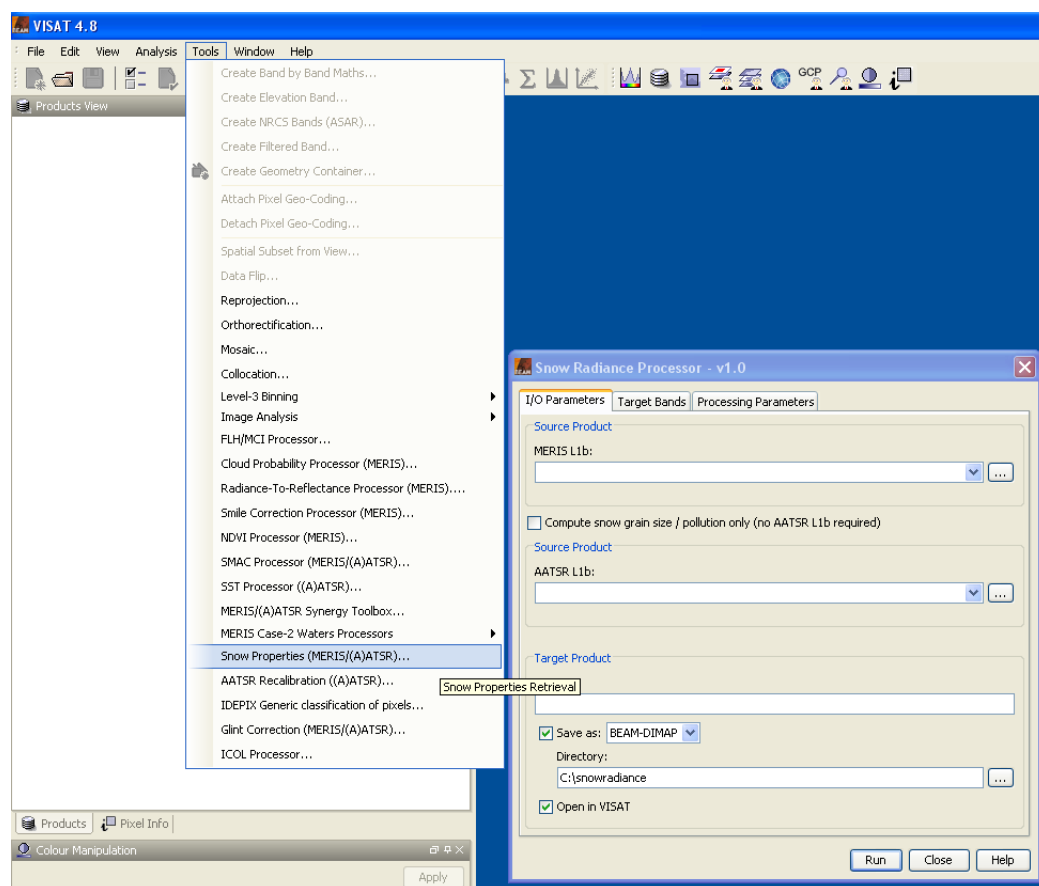


Figure 4.1: The Snow Radiance processor in BEAM Visat

The GUI for the Snow Radiance processor consists of three tab panes

- I/O Parameters
- Target Bands
- Processing Parameters

which will be described below.

4.1 I/O Parameters

The Snow Radiance processor needs as input a MERIS and an (A)ATSR L1b product to derive all the quantities listed in the previous chapter. For the derival of only snow grain size, snow albedo and soot content, an (A)ATSR L1b product is not required.

4.1.1 I/O Parameters Tab Pane

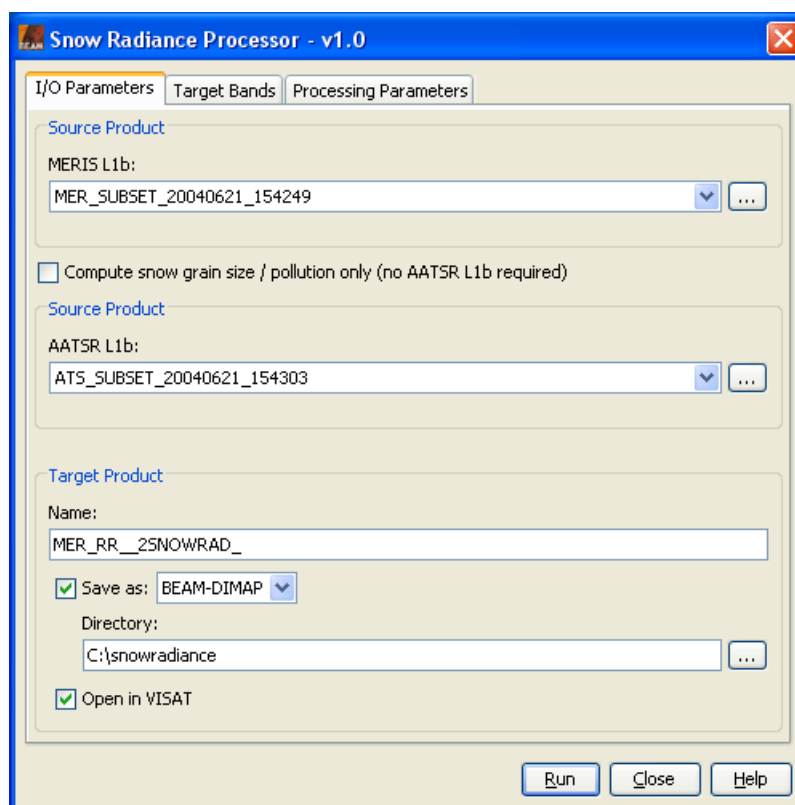


Figure 4.2: Snow Radiance processor: I/O Parameters Tab Pane

This tab pane consists of the following components:

- MERIS source product file: Select the source product file by either typing the product path into the text filed or by pressing the file selection button to invoke a standard file dialog. This source product must be a standard MERIS L1b product.
- Checkbox 'Compute snow grain size / pollution only (no AATSR L1b required)': If this checkbox is selected, only snow grain size, snow albedo and soot content will be computed. The text field to select an AATSR L1b product (see below) will be hidden (Figure 4.3).
- AATSR source product file: Select the source product file by either typing the product path into the text filed or by pressing the file selection button to invoke a standard file dialog. This source product must be a standard AATSR L1b product.
- Target product file: Select the target product file by either typing the product path into the text filed or by pressing the file selection button to invoke a standard file dialog.
- Target product format and target directory:

- 'Save as': If this checkbox is selected, the output product will be saved to disk.
- Target product format: Select one of the available output product formats.
- Select the target product directory by either typing the product path into the text field or by pressing the file selection button to invoke a standard file dialog.
- 'Open in Visat': If this checkbox is selected, the output product is opened in Visat after successful processing.

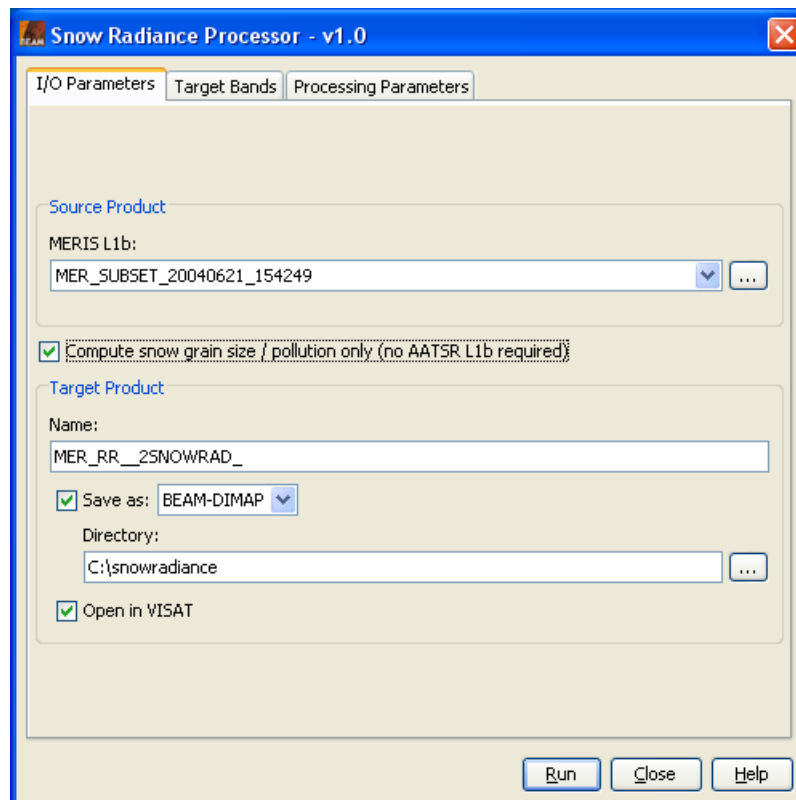


Figure 4.3: Snow Radiance processor: I/O Parameters Tab Pane in case no AATSR product shall be used

4.1.2 Control Buttons

From the 'I/O Parameters' tab pane, the following control buttons can be accessed:

- 'Run': If this button is clicked, the processor will start the computations.
- 'Close': If this button is clicked, the 'MERIS/(A)ATSR Synergy Toolbox' dialog is closed.
- 'Help': If this button is clicked, this manual is displayed as online help.

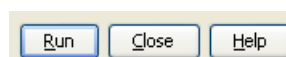


Figure 4.4: Synergy Toolbox: control buttons

4.2 Target Bands

The user interface for the quantities to be computed and written to the target product consists of two lists of check boxes (Figure 4.5):

- Snow properties
- Complementary quantities

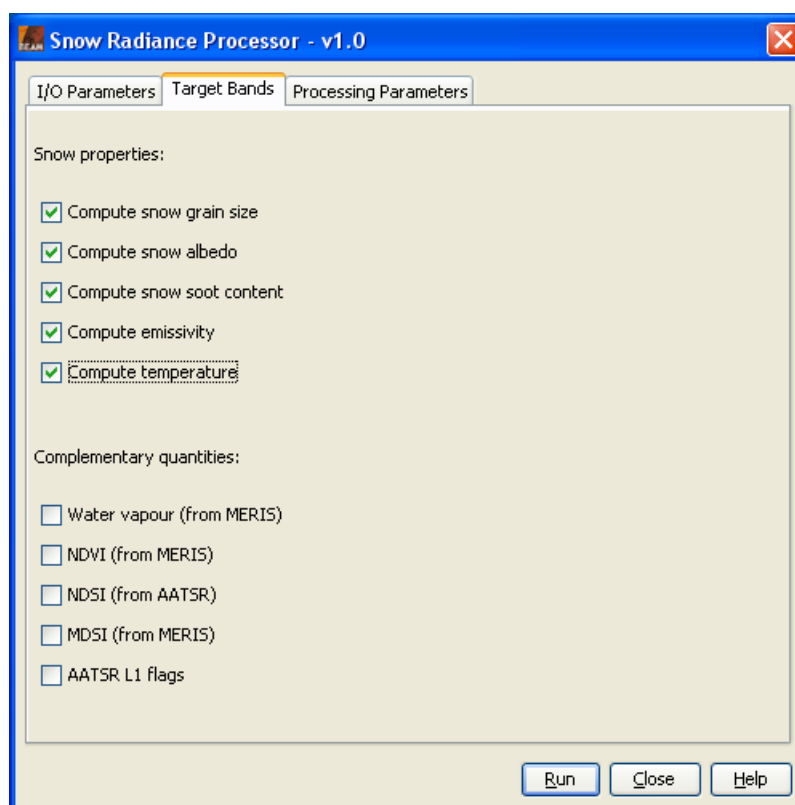


Figure 4.5: Snow Radiance processor: Target Bands Tab Pane

The snow properties which can be selected are:

- 'Compute snow grain size': If this checkbox is selected, the snow grain size will be computed and written as single band to the target product.
- 'Compute snow albedo': If this checkbox is selected, the snow albedo will be computed and written as single band to the target product.
- 'Compute snow soot content': If this checkbox is selected, the snow soot content will be computed and written as single band to the target product.
- 'Compute emissivity': If this checkbox is selected, the emissivity will be computed and written as single band to the target product. This option is enabled only if both MERIS and AATSR products were given as inputs.
- 'Compute temperature': If this checkbox is selected, the snow temperature will be computed and written as single band to the target product. This option is enabled only if both MERIS and AATSR products were given as inputs.

The complementary quantities which can be selected are:

- 'Water vapour (from MERIS)': If this checkbox is selected, the water vapour derived from the MERIS product will be written as single band to the target product.
- 'NDVI (from MERIS)': If this checkbox is selected, the NDVI derived from the MERIS product will be written as single band to the target product.
- 'NDSI (from AATSR)': If this checkbox is selected, the NDSI derived from the AATSR product will be written as single band to the target product. This option is enabled only if both MERIS and AATSR products were given as inputs.
- 'MDSI (from MERIS)': If this checkbox is selected, the MDSI derived from the MERIS product will be written as single band to the target product.
- 'AATSR L1 flags': If this checkbox is selected, the AATSR L1 flags taken from the AATSR product will be written as single band to the target product. This option is enabled only if both MERIS and AATSR products were given as inputs.

4.3 Processing Parameters

From the Processing Parameters tab pane, the parameters to apply and tune the cloud and snow masks can be specified.

4.3.1 Processing Parameters Tab Pane

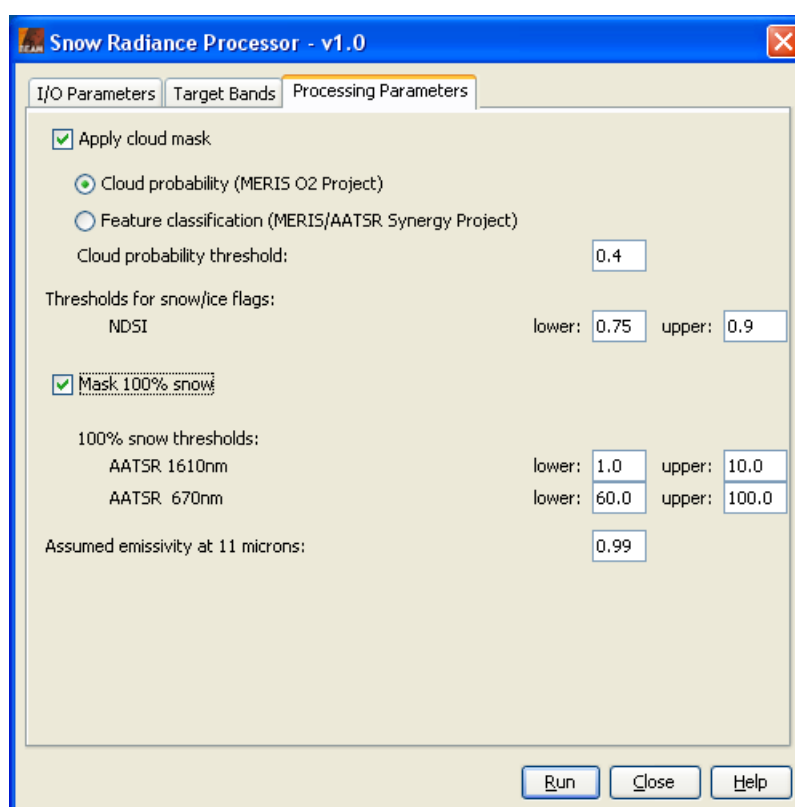


Figure 4.6: Snow Radiance processor: Processing Parameters Tab Pane

This tab pane consists of the following components:

- Checkbox 'Apply cloud mask': If this checkbox is selected, a cloud mask (as specified below) will be applied, which means that pixels classified as cloudy will not be considered for snow properties retrieval.

- Radio button 'Cloud probability (MERIS O2 Project)': If this radio button is selected, the cloud mask will be computed with the algorithms developed within the MERIS O2 Project, which are based on a cloud probability approach (see [4]). This radio button is enabled only if the 'Apply cloud mask' checkbox is selected.
- Radio button 'Feature classification (MERIS/AATSR Synergy Project)': If this radio button is selected, the cloud mask will be computed with the algorithms developed within the MERIS/AATSR Synergy Project, which are based on a feature classification approach (see [5]). This radio button is enabled only if the 'Apply cloud mask' checkbox is selected.
- Text field 'Cloud probability threshold': In this text field, a cloud probability threshold can be set if the cloud mask shall be computed with the cloud probability approach. Range is [0,1], default value is 0.4. This text field is enabled only if the 'Apply cloud mask' checkbox and the Radio button 'Cloud probability (MERIS O2 Project)' are selected.
- Text fields 'Thresholds for snow/ice flags': In these text fields, NDSI lower and upper thresholds for the snow and ice flag computation can be set. Lower default value is 0.75, upper default value is 0.9.
- Checkbox 'Mask 100% snow': If this checkbox is selected, a '100% snow' mask will be applied as specified in ATBDs ([2], [3]).
- Text fields '100% snow thresholds' for AATSR 1610nm: In these text fields, lower and upper thresholds for AATSR reflectance at 1610nm for the usage in the '100% snow' mask algorithm can be set. Lower default value is 1.0, upper default value is 10.0. These text fields are enabled only if the 'Mask 100% snow' checkbox is selected.
- Text fields '100% snow thresholds' for AATSR 670nm: In these text fields, lower and upper thresholds for AATSR reflectance at 670nm for the usage in the '100% snow' mask algorithm can be set. Lower default value is 60.0, upper default value is 100.0. These text fields are enabled only if the 'Mask 100% snow' checkbox is selected.
- Text field 'Assumed emissivity at 11 microns': In this text field, a value for the assumed emissivity at 11 microns can be set. Range is [0,1], default value is 0.99. This text field is enabled only if the 'Apply cloud mask' checkbox and the Radio button 'Cloud probability (MERIS O2 Project)' are selected.

4.4 Processing from command line

Since the Snow Radiance processor makes use of the BEAM graph processing framework, it can be used also as a command line tool outside BEAM-VISAT. The graph processing is invoked by the command

- `${BEAM-INSTALL-DIR}/bin/gpt`

To obtain general help on the graph processing, use the command

- `${BEAM-INSTALL-DIR}/bin/gpt -h`

Specific help on the Snow Radiance processor can be obtained with

- `${BEAM-INSTALL-DIR}/bin/gpt -h SnowRadiance.Master`

In this case, information on the usage and a list of all available parameters are given.