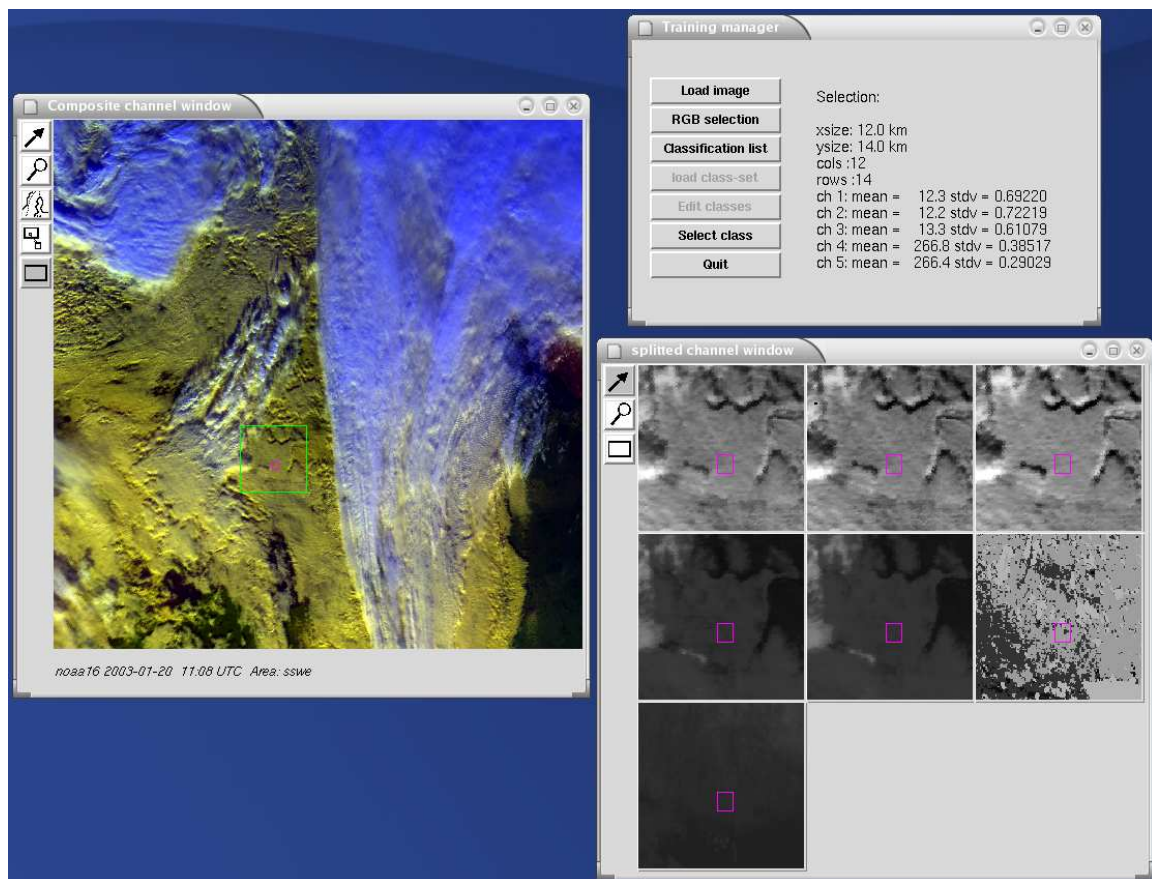


The AVHRR Interactive Training Manager

Version 2.01



*Adam Dybbroe, SMHI
Igor Giunta, MeteoSwiss
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Cover figure:

A screen dump of a training session with the Training Manager GUI. It shows the *Training manager* main dialog, the *Composite channel window* widget, and the *Splitted channel window* widget. A daytime RGB using AVHRR channels 1, 2, and 4 over southern Sweden is shown in the composite channel window.

1 Introduction

The *AVHRR interactive training manager* software (*TM tool* in the following) is an application intended for training and validation of AVHRR based cloud (and snow) analysis algorithms. Specifically it is used for the tuning and validation of the AVHRR based cloud mask and cloud type algorithms developed at SMHI in the context of the Eumetsat *Satellite Application Facility (SAF) to support Nowcasting and VSRF* and the *Ocean & Sea Ice SAF*.

With the tool the operator selects an AVHRR satellite scene and focus on a particular feature using the various image display and enhancement facilities. A target in the scene can be selected and labelled. Satellite and NWP model data are then stored together with a label corresponding to the (cloud) classification of the particular target. The classification is subjective and done by the operator visually inspecting the image data.

The application is developed in *Python* with the use of the built-in *Tkinter* interface to the image library available in the programming language *Tk/Tcl*. The application requires an installation of the Polar Platform System Software (PPS) package developed by SMHI and provided by the Nowcasting SAF.

The TM tool was originally developed under Python 1.4 in 1997-98. At that time it was dependent on the *IFUNC* image library as provided by the *Prosat* system (internal SMHI software for the operational production of AVHRR and Meteosat VIRI images). During 2001 the TM tool was totally rewritten, and made compatible with the output file formats of the PPS.

This user manual provides a short description of the software as well as a simple guidance of how to install and operate it. There is also a detailed description of the output format and how to access and read the *target-files*.

2 Applicable documents

Reference	Title	Code	Vers	Date
[AD.1.]	Product Output Format for the Polar Platform System Software Package of the SAFNWC	SAF/NWC/SMHI/SW/ICD/3	0.3.0	17/11/03
[AD.2.]	Interface Control Document for the External and Internal Interfaces for the Polar Platform System Software Package of the SAFNWC	SAF/NWC/SMHI/SW/ICD/1	0.3.0	17/11/03

3 Pre-requisites

The TM tool requires

- *ACPG* – The AVHRR Cloud Products Generation software - part of the NWCSAF PPS package. Licensed software available via <http://nwcsaf.inm.es/>.

- *ExtractNwpProfile* – Software to extract profile data from a NWP model state stored in Grib format. NWP models supported are HIRLAM and output from the ECMWF model. Available from SMHI.

ACPG requires the successful installation of a number of third party software packages. For these see the PPS manual (Thoss and Dybbroe, 2004). However, in order for the TM tool to run it is not necessary to have a full installation of ACPG available. For the purpose of the TM tool ACPG may be compiled and installed without support for the following 3rd party software packages:

- AHAMAP
- RTTOV-7
- AAPP

Example of an ACPG installation satisfying the TM tool:

```
> ./configure --without-ahamap --without-aapp --without-
    rttov --prefix=/local_disk/opt/ACPG_TRUNC --with-
    proj=/usr/local/include,/usr/local/lib --with-
    hlhdf=/local_disk/opt/HLHDF --with-
    emos=/prog/proj/SAF/Mandrake9.1/include,/prog/proj/S
    AF/Mandrake9.1/lib

> make

> make install
```

ExtractNwpProfile requires ACPG (at least as built and installed as above).

4 Installation

The building and installation of both the *ExtractNwpProfile* and the TM tool is done following the usual configure-make-make-install mantra, provided by the Gnu Autoconf tool. For online help try `./configure --help`.

To install *ExtractNwpProfile* one need to point to an existing installation of ACPG. Then the procedure is as in the example below:

```
> ./configure --prefix=/local_disk/opt/ExtractNwpProfile -
    -with-acpg=/local_disk/opt/ACPG_TRUNC
```

To install the TM tool:

```
> ./configure --prefix=/local_disk/opt/TrainingManager --
    with-acpg=/local_disk/opt/ACPG_TRUNC --with-
    physiography=/data/prod/SAF/ACPG/import/AUX_data/rem
    apped --with-
    profiler=/local_disk/opt/ExtractNwpProfile --
    datadir=/data/proj/saf/data/TrainingManagerData
```

5 Initialising the environment

Prior to launching the application a few environment variables need to be set:

- `SM_REGION_CONFIGURATION_FILE`: Has to point to the `region_config.cfg` file available from the ACPG. See PPS software manual.
- `SM_GRIB_CONFIGURATION_FILE`: Has to point to the `grib_config.cfg` file available from the ACPG. See PPS software manual.

It is needless to say that the regions on which target collection is going to be performed should be registered in the `region_config.cfg` file before launching the application. Likewise, the NWP model used should be configured for in the `grib_config.cfg` file.

6 Starting the Application

After setting the environment variables the application is started, from Unix, by running the python module/script `training_environment.py` like this:

```
python <install-prefix>/lib/training_environment.py
```

Then the main window pops up.

6.1 The training manager window

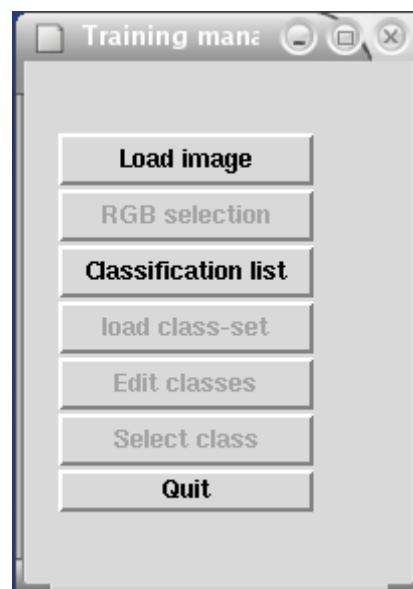


Figure 1: The training manager window, at start of application

The *training manager window* acts as the main window for the application. From here you can choose from a few options by clicking on one of the buttons. In addition the window will hold information about image data. When no image has been loaded before, that is when the application has just been launched, the *training manager window* only has three active buttons.

6.1.1 Load Image

Clicking the load image button activates a file dialog, from where you can choose a given scene from the specified (configured in the file `configure.py`) satellite archive (see section ??? for definition of areas etc.). The files you can see are remapped AVHRR files in hdf5 format according to the PPS specifications (see [AD.2.]).

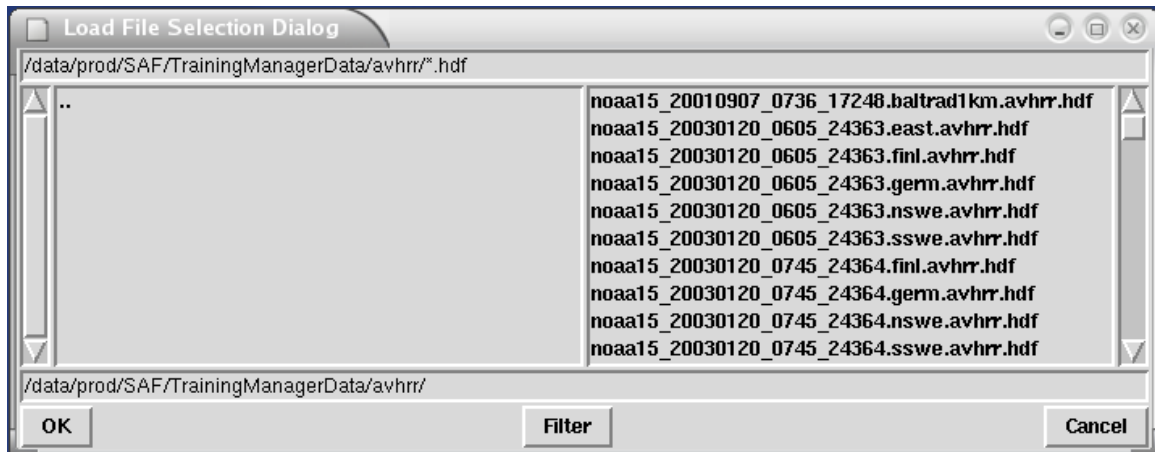


Figure 2: The Load File dialog.

6.1.2 RGB selection

Clicking the RGB selection button, when active, will provide a dialog for selecting the combination of channels to be applied in the RGB composite image. The button becomes active after the first time an image scene has been loaded.



Figure 3: RGB selection dialog.

6.1.3 Classification list

Clicking the classification list button launches a dialog listing all the target classifications available for the current training session (all users). A training session ends when the actual target data (satellite and NWP) is collected using the target metadata files.

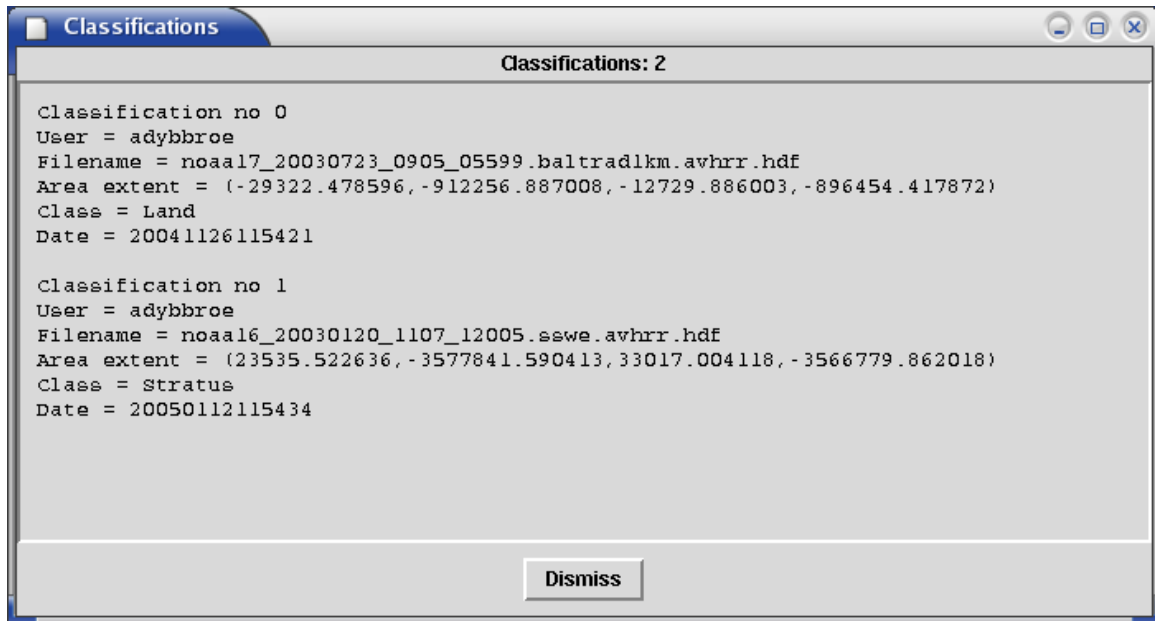


Figure 4: The *Classification list* dialog. Here two target classifications have been made, for which data have not yet been collected and stored in the training database.

6.1.4 Load class-set

It is possible to change the set of classes (and their numbering) considered for the application. By default the class set defined at SMHI in October 1998 is used (`meteo_981022.clsys`).

When clicking the *load class-set* button a dialog is launched allowing to load another class-set different from the default one. See Figure 5.

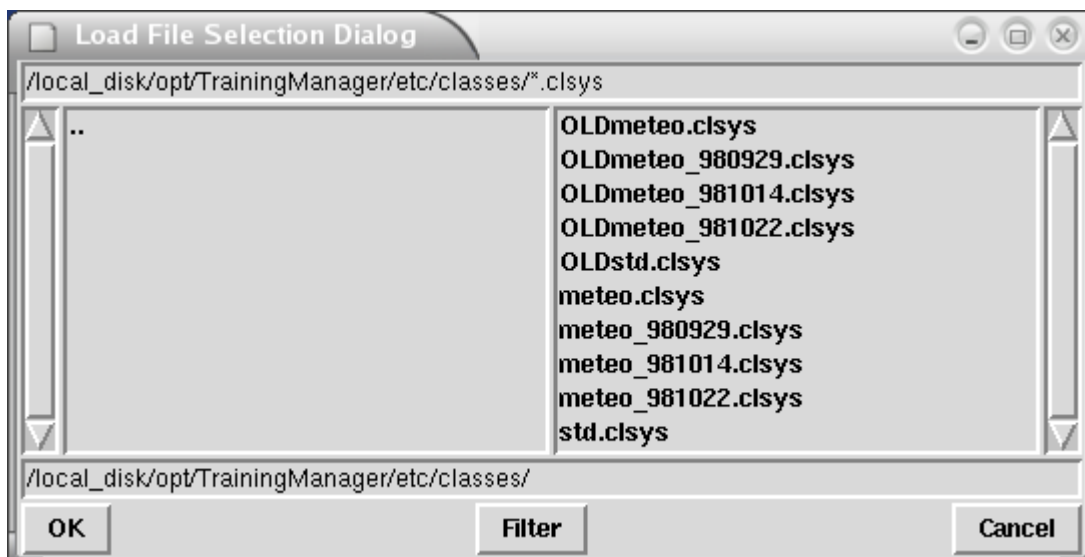


Figure 5: Dialog for loading the class-set.

Changing the class-set shall be done after careful consideration, and not something which should be done on a regular basis. Therefore it can only be done by the application administrator.

Typically a new class-set would be defined interacting with the *Edit classes* button (see below). Then the `configure.py` would be updated specifying the new class-set file instead of the previous default version, and the next time the TM tool is launched the new class-set is loaded by default. A class-set different from `meteo_981022.clsys` may e.g. be motivated if performing training with volcanic plumes, forest fires, or over terrain (or surface types) much different from the conditions over Northern Europe (for instance northern Africa). If changing/updating the class-set of October 1998, please consider adding new classes, instead of changing existing classes!

6.1.5 *Edit classes*

The current class-set may be altered clicking the *Edit classes* button. From the dialog shown in Figure 6 one is able to change both the meaning and the description of existing classes, or new classes may be added.

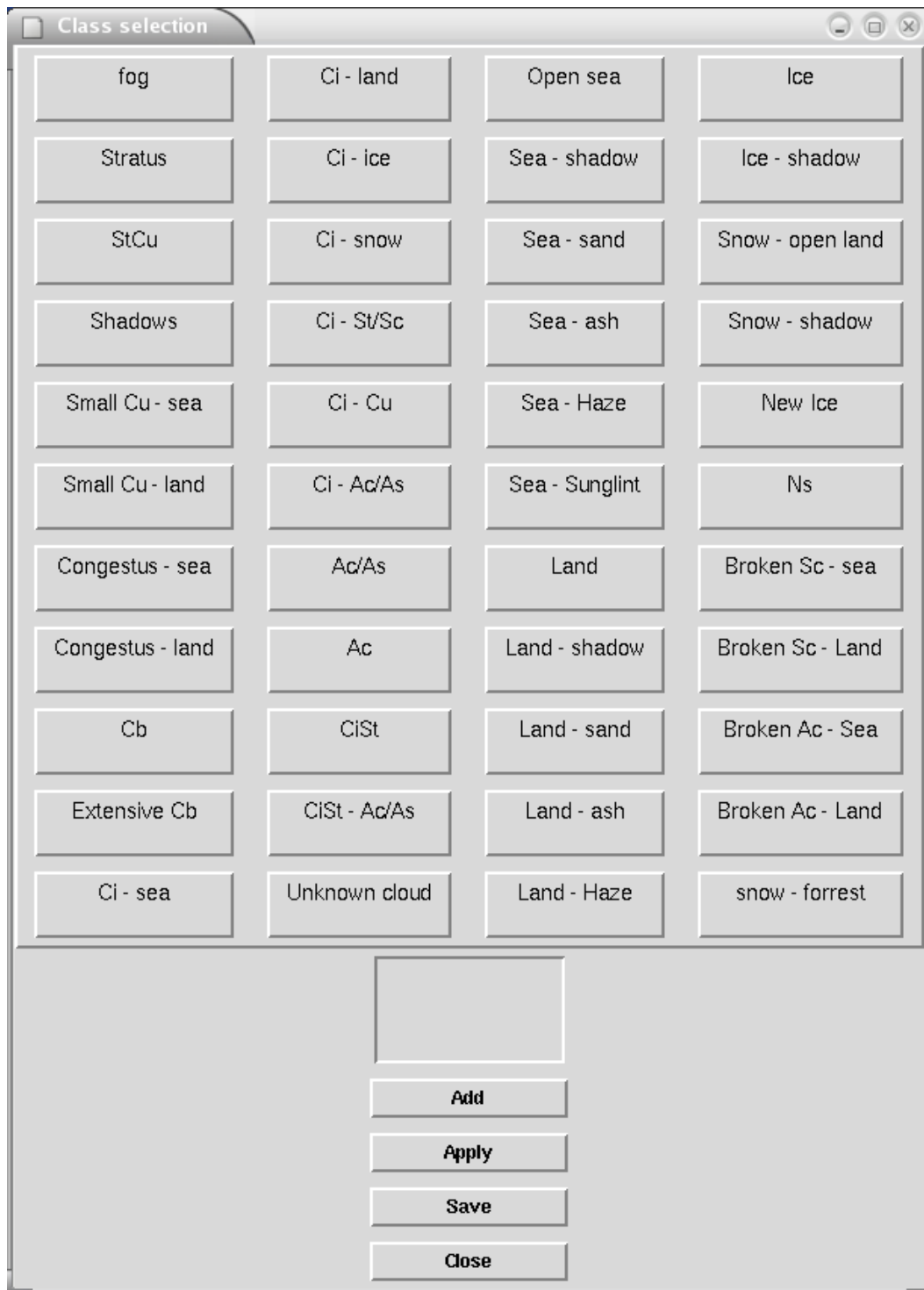


Figure 6: The *Edit classes* dialog.

Figure 7 shows the dialog when the *Add* button has been activated.

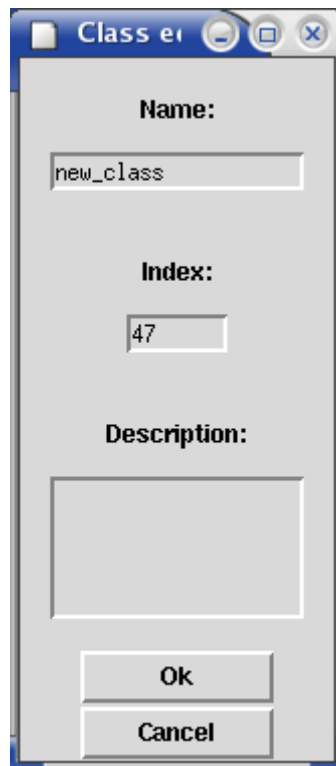


Figure 7: Adding a new class: The dialog as it appears when having clicked the *Add* button in the *Edit classes* dialog. An index number one higher than the current highest class number is suggested, and the name of the class is `new_class` until a more appropriate name is chosen.

6.1.6 Select class

When clicking the *select class* button, when active, a dialog pops up providing a large set of options corresponding to the, currently defined, possible classes to choose from. This button is not active until a target has been identified by the user, by choosing the target selection mouse mode and drawing a polygon in one of the windows. See 7.1.5 and 7.3 for further explanation.

6.1.7 Quit

Pressing the *Quit* button quits the application - without asking you to confirm the action.

7 A training session step by step

When loading an image clicking the *load image* button, two more windows will appear besides the *training manager window*. These are the *composite channel window*, and a so-called *splitted channel window*, hereafter called the *channel-split window*. The view of the application after loading the satellite scene is pictured in Figure 8.

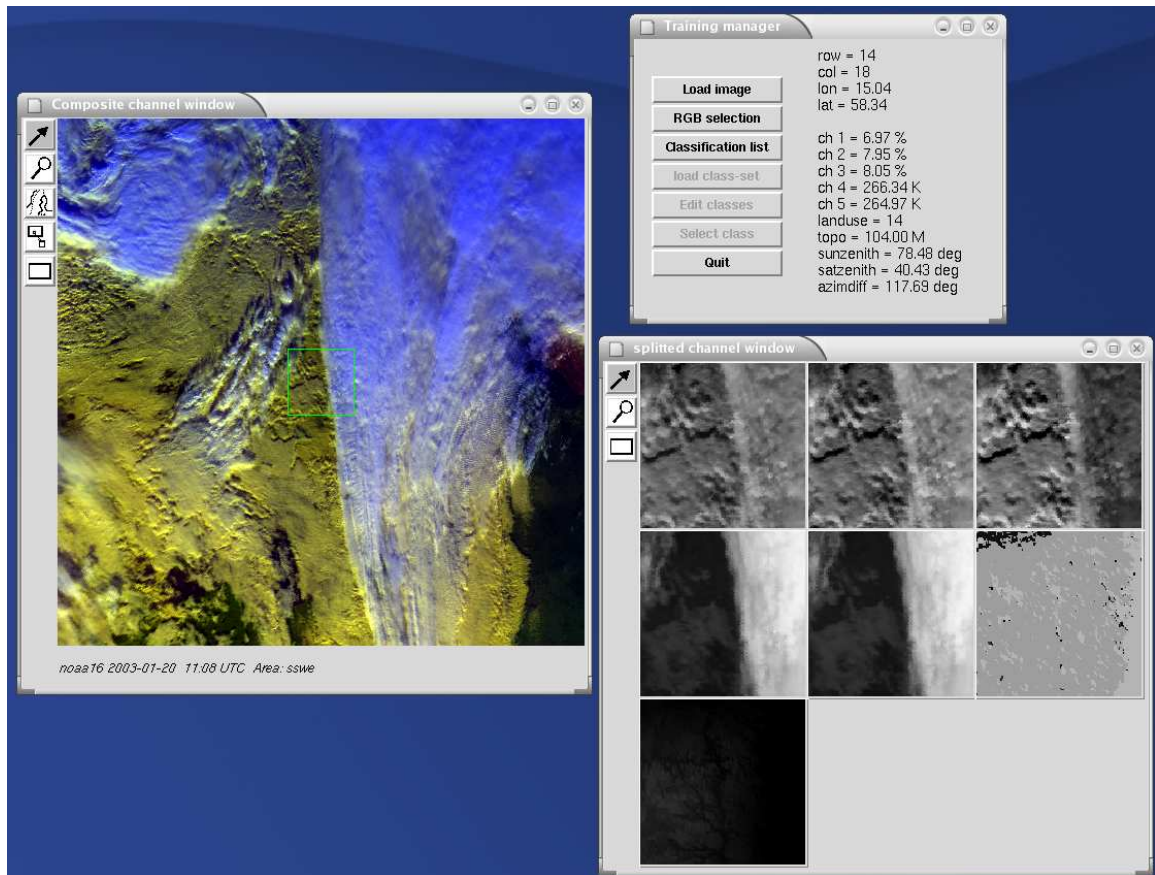


Figure 8: A snapshot of a training session, just after loading a satellite scene.

The *training manager window* now holds information on the image data, as may almost be seen from the figure, and an additional button is active - see section 6.1.2.

7.1 The composite channel window

The *composite channel window* displays, on default, a RGB image of channel 3, 4 and 5, during night-time and a RGB image composition using channel 1, 2, and 4 during daytime. The scene is classified as a night scene when having the sun elevation below 10 degrees everywhere.

In cases around sun-rise and sun-set this threshold, discriminating between day and night, may result in a somewhat awkward looking RGB image, which may cause problems with interpretation. This may be the case when the sun is above 10 degrees in only a fraction of the scene. In these situations the channel 1, 2 and 4 composite is chosen. But due to poor illumination the two short wave channels only contain little contrast compared to the IR channel, and the automatic stretching has difficulties composing the three channels properly. If the resulting image is found difficult to interpret, it is possible to re-configure the settings of the *composite channel window* by clicking the, now active, *RGB selection* button in the *training manager window*, see section 6.1.2.

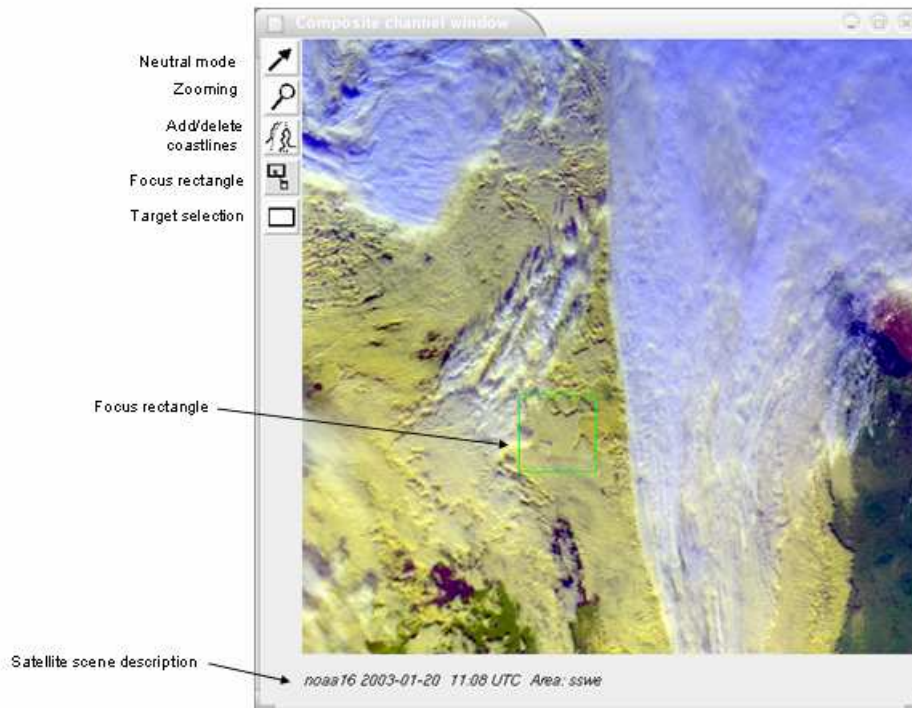


Figure 9: The composite *channel window*, with a control panel with buttons, and a label at the bottom describing date and time, satellite, and area identification. The focus mode is selected here, and the focus rectangle is shown in green

In Figure 9 a view of the composite channel window is presented. A label holding information about the date and time, satellite, and the area for which data have been processed is shown at the bottom of the window. This information is actually not displayed before the mouse pointer has been visiting the image, and the information is only updated when entering the image.

7.1.1 Neutral mode

When examining the image the cursor can be in four different modes. When in the neutral mode, by selecting the arrow button (using the left mouse button), the mouse pointer becomes an arrow. In this mode pixel information bound to the position of the mouse pointer in the image is displayed in the *training manager window*, but no other action is bound to the mouse buttons.

7.1.2 Zooming

Zooming in the image can be accomplished by selecting the button with the magnifying glass. The mouse pointer now becomes a cross, and by clicking the left mouse button you will zoom in, and to zoom out again you should click the right mouse button. The middle mouse button is here reserved for moving the image around in the window, which may be necessary when zooming. To move the image in the direction of the upper left corner one should hold down the middle button while moving the mouse pointer towards the lower right corner. You are actually moving the window around while the image is fixed.

7.1.3 Adding and removing coastlines

Coast lines and political boundaries can be added as an overlay to the image by selecting the central button on the control panel, again using the left mouse button of course. A file dialog pops up and one may select between a number of standard overlays. You should of course choose the one corresponding to the image (check the area identification tag in the label at the bottom of the window). The overlay can be deleted by clicking the right mouse button on the coastlines button.

7.1.4 Focusing

By choosing the focus button in the control panel the mouse pointer becomes an "eye" and one can now choose an area of interest in the image by clicking the left mouse button. A rectangle appears centred around the "eye", and the content of the *channel-split window* now corresponds to this sub area. See Figure 8.

In a usual training session the user will select the focus option and select an interesting area, and then go to the *channel-split window* and select the training target area from there.

7.1.5 Target selection

The last button in the control panel is for target selection. When choosing this, the mouse pointer becomes a black dot. By pressing the left mouse button and holding it down while dragging a rectangular shaped polygon will define the target area, on which a training sample can be defined. Releasing the mouse button finishes the action, and the training manager window now holds statistics on the spectral content of the selected area. Also an additional button is now active, namely the *class selection* button. In Figure 8 the application view after target selection is pictured.

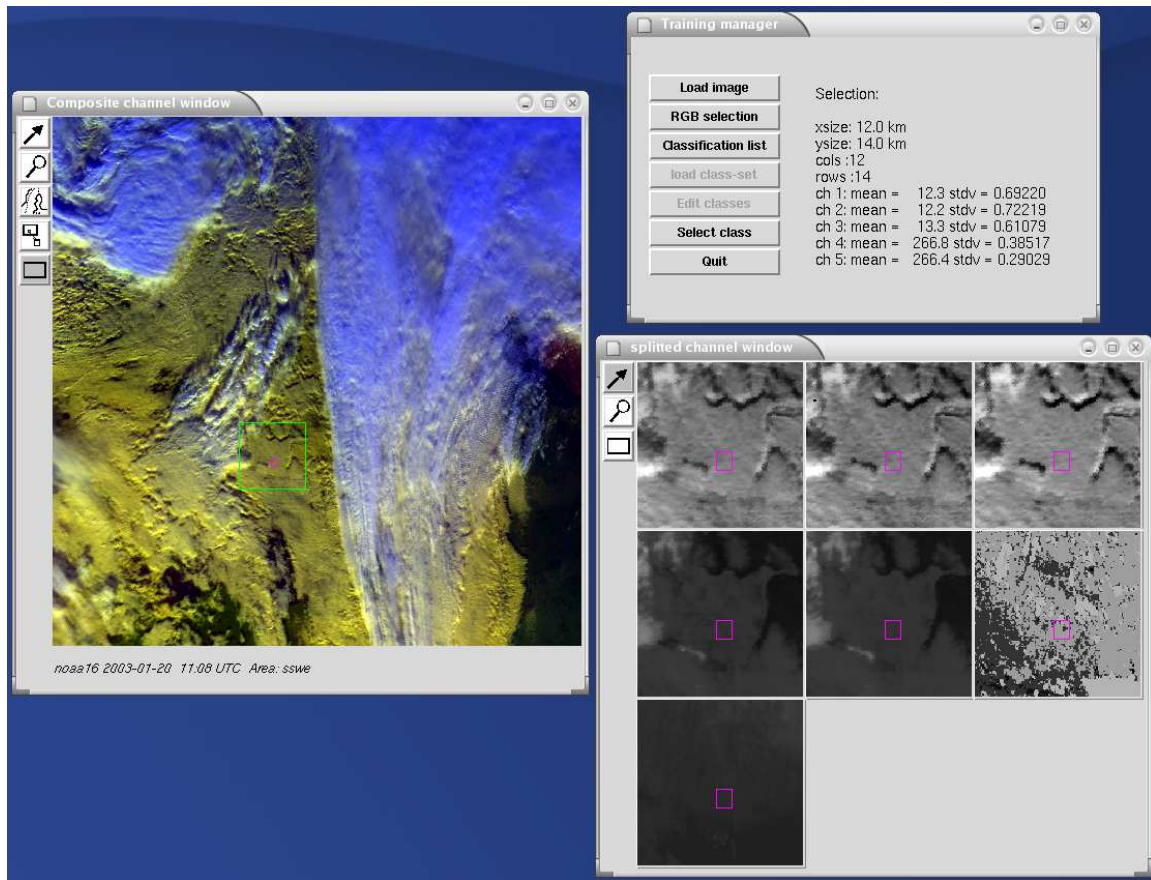


Figure 10: The application view after applying focusing and then target selection in the composite channel window. The training manager window now shows one more active button, namely the *select class* button.

Further details on the target selection procedure can be found below.

7.2 The channel-split window

The *channel-split window* consists of 7 smaller *single channel windows*¹. Starting from upper left corner and going right row by row the layers/windows contain AVHRR channel 1, channel 2, channel 3 (3a or 3b), channel 4, channel 5, land use map, and a topography map. The values displayed in the training manager window, as shown in Figure 11, are K for the three IR channels, and the two short wave channels represent the reflectance, not normalised by the sun elevation, and given in percent. The land use map is extracted from the Global 1km USGS Land Cover Characterization (GLCC) database (see <http://edcwww.cr.usgs.gov/>), and we have applied the 24 classes *USGS Land Use/Land Cover Scheme*. Here class 16 corresponds to *water* (sea/lakes).

The topography data are taken from the Global 30 Arc-Second Elevation Dataset (GTOPO30) from USGS (see <http://edcwww.cr.usgs.gov/>). The elevation is given in meters above mean sea level.

¹ The application can be re-configured so that e.g. one or both the ancillary data layers are not included, and similar more additional layers can be added if available.

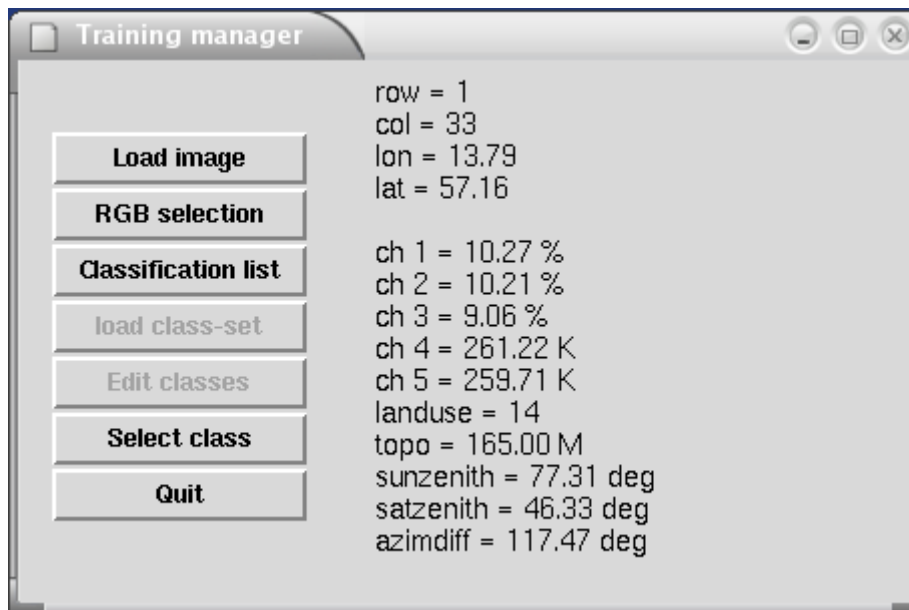


Figure 11: The training manager window when image data has been loaded. Information on pixel data is displayed to the right of the button-array

The control panel is, except for the lack of the button for the adding and removing of coast lines, equal to that of the composite channel window. But there exists some additional options, concerning image display, bound to the mouse buttons. See below.

7.2.1 Contrast stretching a layer

A simple linear stretch can be applied to a single channel/layer by clicking the left mouse button when the mouse pointer is in the image and is in neutral mode. This is, however, done already on default when loading an image. Returning to the default contrast stretch can be accomplished by clicking the right mouse button.

If the linear stretch according to the above is found insufficient a more elaborate procedure is possible. If one holds down the middle mouse button while moving it horizontally the offset of the applied linear stretch is changed. Moving towards the right increases the offset. Moving vertically changes the slope of the LUT, so that moving the mouse pointer upwards will increase the slope. Be aware that once the mouse button is pressed, one can, and will often need to, move it far away out of the actual image. One might move the mouse e.g. both to the right and upwards and at the same time altering both contrast and brightness.

7.3 The target selection procedure

Once an interesting area in the image has been identified the target selection mode is chosen, and a rectangle is drawn as described in section 7.1.5. Now, click the active *select class* button in the *training manager window* to get a *class selection* dialog as shown in Figure 12. When the mouse is being moved over a button it then becomes highlighted, and a short explanatory text is shown in the frame below.

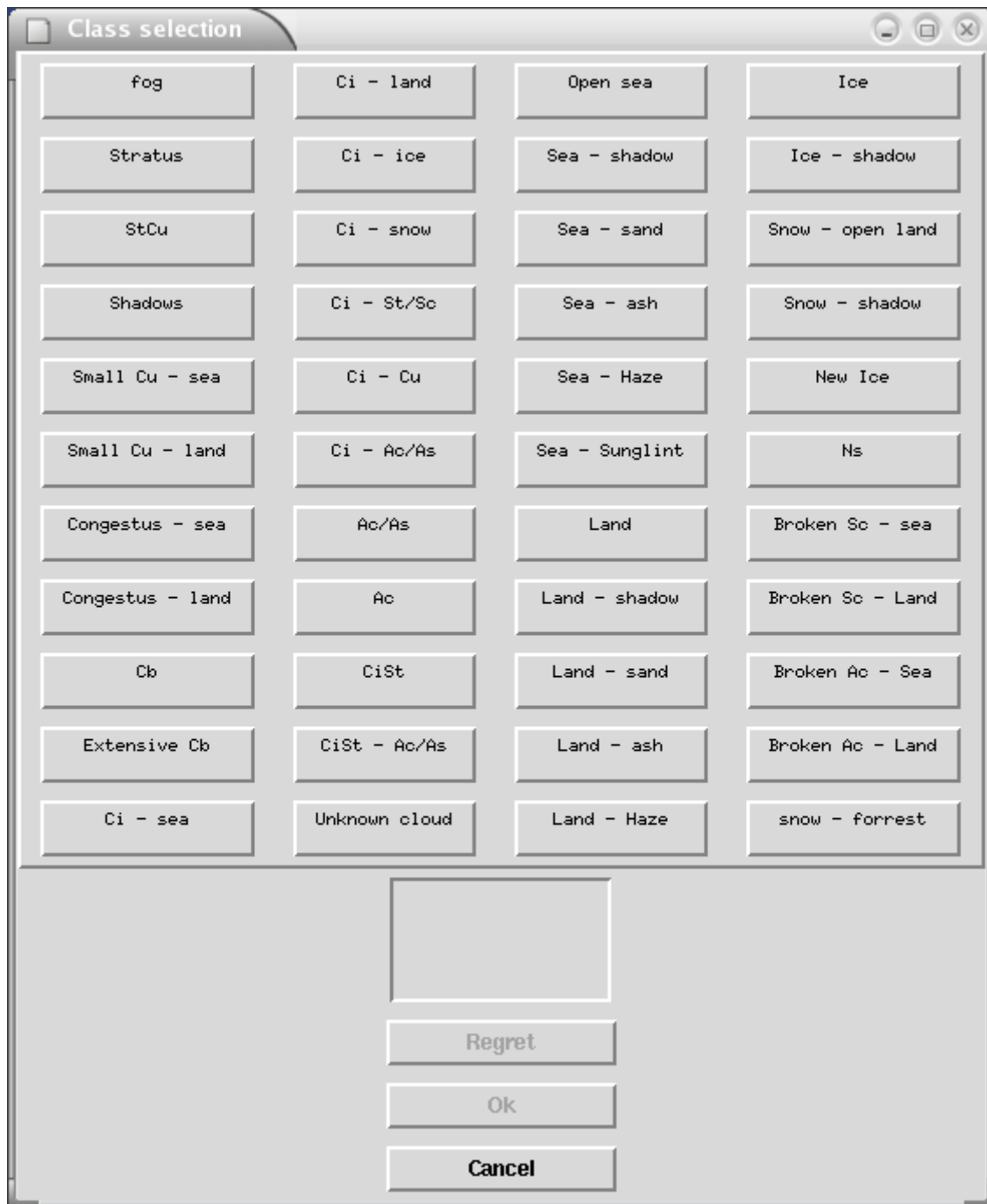


Figure 12: The class selection dialog with the possible class selection options. Only the cancel button is active since no class has been selected yet.

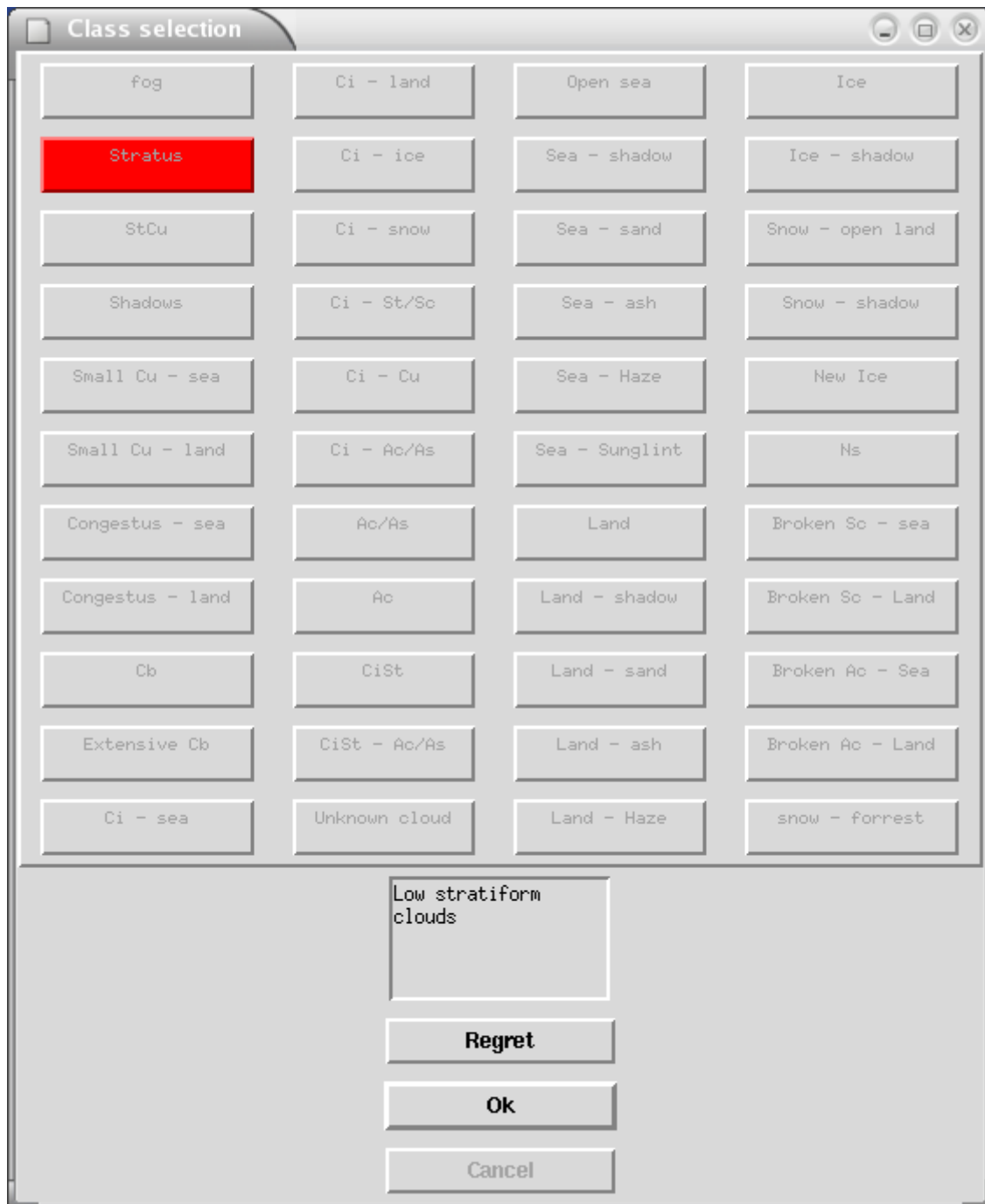


Figure 13: The class selection dialog after having selected a class. The selected class button is now red and a corresponding short explanatory text is shown in the frame below. Now only the *Regret* and *Ok* buttons are active.

Once the class has been selected by clicking the right button, the particular button becomes red (see Figure 13) and all the others are becoming inactive. Now, the two other of the three buttons at the bottom of the dialog is active. These are the *regret* and *ok* buttons. Pressing the *regret* button will delete the newly written target-metadata-file, and the selection of a new training target can start all over again.

Clicking the *ok* button closes the dialog leaving the newly created training target-metadata-file as it is.

8 The training target metadata files

Training data selected by the user during the interactive sessions are stored into light metadata files. Within

```
<install-prefix>/etc/batchjobs.dat
```

each training target appears as file-block containing the AVHRR-filename, the geographical parameters and the classification chosen by the user (provided with the absolute processing time in seconds). The format is python-friendly and the information can easier be consulted from its twin file:

```
<install-prefix>/etc/ascii_batchjobs.dat
```

Here below an example of one target block:

```
CLASSIFICATION [
USER: adybbroe
FILENAME:
/data/proj/saf/data/TrainingManagerData/avhrr/noaa16_20050115_1124_22
251.sswe.avhrr.hdf
AREAEXTENT:          (172770.090538,-3610829.244734,185412.065846,-
3598977.392882)
CLASS: Open sea
PROCTIME: 1105908414.586356
]
```

These target metadata files are automatically updated at the end of each target selection procedure.

9 Data collection

Once the target information from the user has been gathered, the next step consists in collecting all necessary input data and to insert them into the database. The module

```
<source-prefix>/util/process_batchjobs.py
```

reads the metadata file, locates and extracts the correspondent satellite (AVHRR, sun-sat angles), physiography and model data.

Input data should reside within following dedicated folders:

```
<data-dir>/avhrr/
```

```
<data-dir>/angles/
```

```
<physiography-dir>/
```

```
<data-dir>/nwpl/
```

<data-dir>/nwp2/

<data-dir>/nwp3/

The optional folder for nwp-files let the freedom of using different sources (such as archived and real-time data) with different priorities.

The data are then written into database files, namely into separated target-class files:

<installation-dir>/database/tbd_<class>.hdf

At the end of this processing the original metadata file is cleaned and ready for new target selection sessions (one copy of it will be saved into date-referenced file).

9.1 Training target file format

The whole training database is a directory containing one single database file for each training selection class (tdb_Land.hdf, tdb_Opensea.hdf,). Internally they are hierarchically structured into nested GROUPs, where the training target file occupies the lowest file-unit:

Date → Satellite → observer → processing time → training target files

The result of a usual one-day classification activity is therefore distributed into several database files, the exact insert location of which depends on the satellite and observer ID.

The training target file is itself organized in a header containing area and satellite angle parameters, one NWP data group and 7 datasets for AVHRR and auxiliary data:

9.1.1 Training target ATTRIBUTE "header":

Mapping, satellite geometry and further definition data are packed into the header-unit.

Type	Description	Content	Ref
H5T_COMPOUND [DATATYPE]	Area and satellite angle parameters	List of target definition parameters	9.1.1.1

9.1.1.1

Parameter	Type	Remarks
observer	string	
target_type	string	
target_des	string	Target class description
tle1	string	
tle2	string	
satellite	string	

Pcs_id	string	
Pcs_def	string	
origin_areaid	string	
target_code	integer	
time_1970	integer	
nl	integer	Number of vertical levels
lon_0	float	
lat_0	float	
lat_ts	float	
Area_extent	float[4]	
center_angles	float[4]	sun-zenith, sat-zenith, sun-sat azimuth difference

9.1.2 Training target GROUP "hirlam"

NWP data are stored into this node.

Comment: The name *hirlam* is here somewhat misleading, but kept for historical reasoning. It is possible, and very likely, that other type of model data (e.g. from ECMWF) will be stored here instead of data from the HIRLAM model. The name should rather have been something like *nwp* or *model*.

Type	Name	Description	Content	Ref
ATTRIBUTE	header	<i>NWP cell parameter</i>	<i>Scalar parameters</i> "header"	9.1.3.1
DATASET	prof0 prof1 prof2 prof3	<i>NWP-profiles</i> 0: pressure 1:geopotential height 2:temperature 3: relative humidity	<i>vertical profiles:</i> - DATA float array -"info"	9.1.4.1

9.1.3 Training target Hirlam H5T_COMPOUND "header"

9.1.3.1

Parameter	Type	Remarks
-----------	------	---------

projection	string	
center	string	WMO code for current NWP model
ana_time	string	
flen	integer	
nlon	integer	
nlat	integer	
nprof	integer	
latitude	float	
longitude	float	
dlambda	float	
dtheta	float	
alonw	float	
alats	float	
splon	float	
splat	float	
pg	float	
gg	float	
tg	float	
t2m	float	
rh2m	float	
wspeed	float	
wdir	float	
snow_depth	float	
land_cover	float	

9.1.4 Training target Hirlam profile ATTRIBUTE "info"

9.1.4.1

Type	Description	Content	Ref
H5T_COMPOUND	<i>NWP profile</i>	<i>List of profile definition</i>	<i>9.1.4.2</i>

[DATATYPE]	<i>characteristics</i>	<i>parameters</i>	
------------	------------------------	-------------------	--

9.1.4.2

Parameter	Type	Remarks
profile	String	
element_size	Integer	
element_type	Integer	
nl	integer	number levels

9.1.5 Training target DATASET “layer0”... “layer6”

These DATASET are used for storing radiometric and physiography data.

Type	Name	Description	Content	Ref
DATASET	layer0 layer1 layer2 layer3 layer4	<i>AVHRR-data</i> 0: channel 1 1: channel 2 2: channel 3A/3B 3: channel 4 4: channel 5	<i>channel data</i> <i>(reflectance/temperature</i> <i>data</i> <i>depending on channel)²</i> - DATA integer array -“info”	9.1.5.1
DATASET	layer5 layer6	<i>Auxiliary data</i> 5: topography 6:land-mask	<i>Elevation[m] or</i> <i>surface type data[code]</i> - DATA integer array -“info”	9.1.6.1

9.1.5.1 Training target DATASET “layer0”... “layer4”

AVHRR data from channel 1 to 5 are stored into separated DATASET called layers. Each one of them is structured as following.

² NB: true values of reflectance [%] (channels 1,2,3A) and brightness temperature [K] (channels 3B,4,5) are calibrated with gain and intercept parameter of the “info” ATTRIBUTE

9.1.5.1.1

Type	Description	Content	Ref
H5T_COMPOUND [DATATYPE]	<i>AVHRR channel characteristics</i>	<i>List of channel parameters</i>	9.1.5.1.2

9.1.5.1.2

Parameter	Type	Remarks
layer	string	"AVHRR 1" ... "AVHRR 5"
element_size	Integer	
element_type	Integer	
nr	integer	
np	integer	
gain	Float	Calibration gain
intercept	Float	Calibration offset

9.1.5.2 Training target DATASET "layer5", "layer6"

A similar layer-structure is used for storing auxiliary data, such as topography and land-mask.

9.1.5.2.1

Type	Description	Content	Ref
H5T_COMPOUND [DATATYPE]	<i>Field characteristics</i>	<i>List of fields parameters</i>	9.1.5.2.2

9.1.5.2.2

Parameter	Type	Remarks
layer	string	"TOPOGRAPHY" or "LANDUSE"
element_size	Integer	
element_type	Integer	
nr	integer	
np	integer	

gain	Float	1 (fictitious channel)
intercept	Float	0 (fictitious channel)

10 Reading the training data from Python

The python module `'training_db.py'` defines classes and implements methods for managing training database files, using the specific hdf-interface `'training_formathdf'`.

Following python instructions read one training database file, i.e. assign to the object `'tbd'` the content of all training target files which share the same user selected classification:

```
>> import training_db  
>> tdb= training_db.get_training_db(<training database file>)
```

Single training target files can then be accessed by using the method `'getTrainingFile(<training target file name>')`. Next example shows how to extract one training target of the selection class Snow in open land conditions:

```
>> tdb= training_db.get_training_db('tdb_Snow-openland.hdf')  
>> target_names=tdb.getTrainingFileNames()  
>> training_target_file=tdb.getTrainingFile(target_names[0])
```

The content (the attributes) of the object `'training_target_file'` reflects the same data hierarchy of the input hdf-file (see section 9.1). Following sparse examples can thus be easily deduced from the training target file format.

Satellite and sun angle data:

```
>> training_target_file.header.center_angles[0..3]
```

NWP relative humidity at 2m:

```
>> training_target_file.hirlam.header.rh2m
```

Profile NWP-temperature, level 20:

```
>> training_target_file.hirlam.prof[2].data[19]
```

AVHRR-channel 4 temperatures, with correspondent calibration coefficients:

```
>> training_target_file.layers[3].data  
>> training_target_file.layers[3].info.gain  
>> training_target_file.layers[3].info.intercept
```

Topography data:

```
>> training_target_file.layers[5].data
```

11 Frequently Asked Questions

11.1 GUI

I am finished in collecting training targets on one AVHRR image and I want to start again with a new one. By closing the composite channel window however, I am prevented to do anything else. What is going wrong?

For loading a new image into the composite channel window do **not** close the Window, but simply select a new file from the “Load Image” button of the Training Manager Window.

11.2 NWP-model

How do I find out which model has been used for the training data-base?

This indication (as WMO-code) is reported within the hdf-target database file: *nwp-header/center parameter*.

In Python:

```
>> training_target_file.hirlam.header.center
```

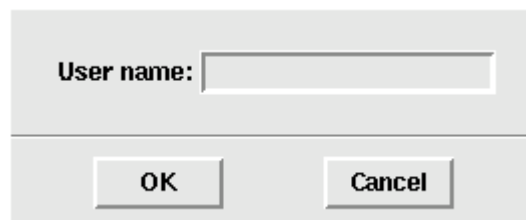
11.3 Selection Classes

I want to edit a new selection class, but the “Edit Class-Set” button on the Training Manager Window is not active. How do I do?

Firstly the permissions of Application Administrator must be set, adding your user-id to the administrators list within the file [installation-dir]/lib/security.py. Then follow §6.1.4.

11.4 User not authorized

When starting the application I am prompted for a username:



When providing my username (e.g. “adybbroe”) and clicking the “ok” button I get the dialog:



I seem not to be registered as an authorized user for the application. What do I need to do in order to be able to run the application?



If you are not an authorized user then have the administrator add your username to the file `security.py` under `<install-root>/lib`.

References

- Dybbroe, A., Karlsson, K.-G. and Thoss, A., 2005a. NWCSAF AVHRR cloud detection and analysis using dynamic thresholds and radiative transfer modelling - part one: Algorithm description, *J. Appl. Meteor.*, Vol. 44, No. 1, pp. 39-54.
- Dybbroe, A., Karlsson, K.-G. and Thoss, A., 2005b. NWCSAF AVHRR cloud detection and analysis using dynamic thresholds and radiative transfer modelling - part two: Tuning and validation, *J. Appl. Meteor.* Vol. 44, No. 1, pp. 55-71.
- Thoss, A., and Dybbroe, A., (2004) Scientific User Manual for the AVHRR/AMSU cloud and precipitation products of the NWCSAF. Available at <http://nwcsaf.inm.es>. Code = SAF-NWC-IOP-SMHIPPS-SW-SUM-2_v1.0.0. pp 89.