The ADM Atmospheric database

Technical note TN2.4 on WP1400 (L1B study task 2 output)
Name code: AE-TN-KNMI-L1B-001

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Change log

Version	Date	Comment
0.1	31-Jan-2005	A first try.
0.2	14-Feb-2005	Updated to changed fileformat version 0.2.
1.0	03-May-2006	First release for WP1400
1.1	30-Aug-2006	Added comments from ESA, updated LITE dataset.
1.2	05-Sep-2007	Added new datasources and scenarios:
		LITE collocated with ECMWF data
1.3	12-Oct-2007	Added section 4.3 on the conversion tools needed to convert
		from KNMI ASCII to XML format as needed by the E2S.
		Added a number of new datasources and scenarios:
		CALIPSO collocated with ECMWF data
		some simpeler new test scenarios
		extended the vertical range of the database to 30 km
1.4	30-Oct-2007	added a user defined cloud type in the Clouds module.
		removed a scaling mistake in the CALIPSO backscatter data. It was off
		by a factor of 1000 because the input data used a unit of [1/km.Sr]
		while we expected [1/m.Sr].
1.5	25-Jun-2008	added 4 new scenarios needed for specific tests

known problems:

20071026 most ground parameters are not yet exported or used

20071026 see section on the conversion tool for u,v,w to hlos conversion issues

20071026 Merci profile do not reach to the new 30km upper limit

20071029 note that the scene LiteScene_A_and_EcmwfColloc_3.6km that was distributed informally 28 june 2007 did contain an error. The NWP data was stretched by a factor of 5, resulting in to low variability in especially the wind and temperature. The database version of this scene is corrected now.

Contents

1 introduction

This document describes the atmospheric scenario database which is to be used for testing the ADM Aeolus processing software chains (E2S/L0/1A/1BP/L2AP and E2S/L0/1A/1BP/L2BP/L2CP) that will be build for the ADM Aeolus mission.

It first describes the general setup of the database on the file level in section 3. Then in section 4 the filestructure itself is explained, and the software written to produce these files is described in section 5. Finally in section 6 the scenarios included in this database are described.

Note that this work, although WP1400 is closed now, is not fully completed. Several open points remain, and extensions might be added if data requests are recieved from any of the processor development teams. If this happens this document will be updated accordingly.

2 documents and acronyms

2.1 applicable documents

[AD1] Statement of Work of the Development and Production of L2B/C Aeolus data, AE-SW-ESA-GS-0117, version 1B, Sep 2004

[AD2] Level 1B detailed processing document, 521800_L1bPDPM_2.0.doc, by MDA, version Jul-31, 2006

[AD3] Test scenarios for L1B & L2B processors, Technical Note by: Alain Dabas and Ad Stoffelen (see eRoom: AEOLUS/LIBRARY_of_DOCUMENTS/ECMWF-L2B/TECH-NOTES/Task_4/TEST_CASES_FOR_L1B_L2B_050225.doc) (a name code is not yet available for this document, as far as I know).

2.2 reference documents

[RD1] System Requirements document for the WALES Earth Explorer Core Mission, EEM-FP/2001-12-560, Issue 1, rev. 0, 28-02-2002

[RD2] Evaluation of Spaceborne Differential Absorption Lidar for Water Vapour, Ozone and Carbon Dioxide (DIAL), Technical Note 2a, Review of Instrument Concept and Measurement Physics, 05-04-2001, by: M. Wirth, C. Kiemle and G. Ehret.

[RD3] Establishment of a backscatter coefficient and atmospheric database, DERA/EL/ISET/CR980139/1.0, june 1998, by: J.M. Vaughan, N.J. Geddes, Pierre H. Flamant and C. Flesia.

[RD4] LITE4ADM: On the use of LITE data for the Atmospheric Dynamics Mission - Aeolus, 2003, by: G. J. Marseille, A. Stoffelen and A. van Lammeren; KNMI, intern rapport; IR 2003-01

[RD5] KNMI, Scientific Report; WR 96-01, by W.M.F. Wauben "a new algorithm for total ozone retrieval from direct sun measurements with a filter instrument"

[RD6] Merci executive summary, Measurement Error and Correlation impact on the Atmospheric Dynamics Mission, by: Ad Stoffelen, Pierre Flamant, Måns Håkansson, Erland Källén, Gert-Jan Marseille, Jean Pailleux, Harald Schyberg, Michael Vaughan.

[RD7] Merci, Measurement Error and Correlation impact on the Atmospheric Dynamics Mission, Draft Task 3 and Task 4 report, ESA Contract Number: 15192/01/NL/MM, by: Ad Stoffelen, KNMI, Måns Håkansson, MISU, Gert-Jan Marseille, KNMI.

[RD8] Calipso4ADM, First results, informal L2B study report, by: G.J. Marseille, Ad Stoffelen, Jos de Kloe, July 2007.

2.3 literature

[LR1] Atlantic atmospheric aerosol studies 2. Compendium of airborne backscatter measurements at 10.6 μm, J. M. Vaughan et al., Journal of Geophysical Research, Vol 100, No. D1, pages 1043-1065, January 20, 1995

[LR2] McClatchey, R. A., Fenn R. W., Selby J. E., Volz F. E., and Garing J. S., Optical properties of the atmosphere. Environmental Research Paper No. 354, AFCRL-71-0279, Air Force Geophysics Lab, Bedford, MA, 1971, 85 pp.

[LR3] Lidar In-space technology experiment (LITE) measurements of sea surface directional reflectance and the link to surface wind speed, Robert T. Menzies, David M. Tratt, William H. Hunt, Applied Optics, Vol. 37, No. 24, 20 august 1998.

[LR4] Simulation of wind profiles from a space-borne Dopller wind lidar, by: G.J. Marseille and A. Stoffelen, Q.J.R. Meteorol. Soc. (2003), 129, pp.3079-3098.

2.4 acronyms

AD	applicable document (see section 2.1)
ADM	Atmospheric Dynamics Mission
ASCII	American Standard Code for Information Interchange
BRC	Basic Repeat Cycle (covering a 200 km orbit section)
CALIPSO	Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation
E2S	end-to-end simulator
ECMWF	European Center for Medium-Range Weather Forecast
ESA	European Space Agency
GENSCAT	GENeric SCATterometer software repository at KNMI
GLAS	Geoscience Laser Altimeter System (GLAS) instrument on ICESat
GRIB	GRIdded Binary (fileformat)
ICESat	Ice, Cloud, and land Elevation (ICESat) satellite
IDL	interactive data language (a commercial software package sold by CreaSo for plotting and data analyse)
KNMI	Koninklijk Nederlands Meteorologisch Instituut (Royal Dutch Meteorological Institue)
L1Bp/L2Ap/L2Bp	Level 1B/2A/2B processor
LITE	Lidar In-space Technology Experiment
LR	literature reference (see section 2.3)
MERCI	Measurement Error and Correlation Impact on ADM (ESA project)
NWP	numerical weather prediction
RD	reference document (see section 2.2)
RMA	Reference Model Atmosphere

2.5 document preparation

This document was written using the LaTeX typesetting system. Most graphics have been produced using the IDL software package.

3 database organisation

The atmospheric database for ADM will consist of a set of test scenarios. Each scenario will be written to a separate annotated ascii file, and each ascii file will be compressed using the unix/linux tool gzip to reduce the filesize before storing them (compression between 90 and 95 % is usual for these files[1]).

[1] the current database consisting of 74 scenarios has a size of 763.846.537 bytes, and can be compressed to 60.477.967 bytes, which is a compression ratio of 92%.

Each file will hold data for a fraction of an orbit, or just a single profile. The file may give profiles for each of the measurements in the BRC or just one profile to prevent duplicating identical synthetic profiles many times.

For testing a larger part of an orbit, or a complete one, several database files can be used. A tool is available at KNMI to do this[2].

If needed to test a specific scenario, or processor feature, a series of database files can be produced to describe the atmosphere along a complete orbit.

The data in the file forms a complete sequence of lat-lon positions between the specified start- and end-values for lat-lon (or just at one lat-lon, if only one profile is given).

At regular positions along this ground track (for example every 500 m) the surface and atmospheric parameters needed for the simulation are given. No gaps in the groundtrack are foreseen in the files.

The atmospheric parameters are defined by a set of vertical atmospheric profiles. The profiles may be tilted by the E2S program to match the detailed measurement geometry of the simulation that is performed, or may be kept vertical in case of simulating a calibration.

The vertical resolution of the profiles in choosen to be 125 m to match the smalled possible rangegate setting of the instrument.

The evrtical profiles will be compleet between a start-stop altitude. However, below the local orography (defined by the source of the data) the profile parameters are set to missing[3]. When the underlying original data contains intermediate regions of missing data this will be replaced by appropriate other data (like NWP data or interpolated data between the levels that are available).

The E2S simulation software may ofcourse use multiple scenarios from multiple files from this database, if that is needed to produce a result.

3.1 filename convention

The atmospheric database will be organised into multiple subdirectories, each one holding a single well defined scenario, consisting of 1 *.asc file, one atm_db_settings.txt file, and optionally several *.xml files. The directory names will be in a clear human readable form, like "LITE_and_ECMWF" or "IceSat_and_RMA".

The files inside these directories will have the date-time, lat-lon and a unique global sequence number in their names. The sequence number enables selecting the right order for simulating a larger part of an orbit. All files in all subdirectories of the database will recieve a unique sequence number, which might be used as abbreviation to identify a scenario.

Since the atmospheric database is generated independently, the exact orbit produced by the E2S simulator is not available. Therefore when using the database it is needed to replace the lat-lon (and if they are used, also date-time) information from these files by different but nearby values, generated by the simulator[4].

The deviation in lat-lon values should not be too large to prevent ending up in a different climate-zone, or above a very different landscape than expected by the scene name. Therefore it seems usefull to have the lat-lon values in the filenames.

Also the deviation in date-time should not be too large to prevent ending up in a different season, or daylight zone.

Thus the proposed filenames are of the form:

- date_time_lat_lon_number.asc

In which the lattitude and longitude are expressed as SLL_SLLL: a sign and 2 digits for latitude, and a sign and 3 digits for longitude. The sign will be expressed as the "+" character for positive, or the "-" character for negative. Latitude will have the range -90 to +90, longitude will have the range -180 to +180, both will be rounded to the nearest integer value.

The date and time are expressed as YYYYMMDD_HHMMSS (rounded to seconds), and the sequence number is expressed as CCCCCC, a 6 digit integer which should be sufficient to give all files in all directories a unique sequence number.

[2]Currently this is only used for collecting all 7 CALIPSO segments into one big scenario file.

[3]Note that some datasources also have an upper limit. For example the MERCI datafiles do not all reach the 30km altitude, but are sometimes lacking a few 100 m. Also these levels will be set to missing

[4]This may be done using the an adapted version of the conversion tool, which is discussed in section 4.3.

The files will have an extension named ".asc" which allows them to be in the same directory as the versions converted to xml (which might be given the extension ".xml"), but still be separated on the basis of their name.

An example of such a filename will be:

- 20050131_235959_+52_+005_123456.asc

The lat-lon and date-time will be representative for the midpoint of the orbit section in the file.

4 file organisation

The database files consist of two parts (see the example given in Appendix A). First a header composed of lines starting with the # character, containing a detailed description of the file organisation, and also some textual information like creation date and time, creator, origin of the data, purpose of the scenario, and a fileformat version number.

This is followed by 2 numbers giving the number of lat-lon positions in this file, and the number of levels used in the profiles.

Then for each lat-lon position atmospheric profile as well as ground level and ancillary information is given.

4.1 ground level and ancillary info

At each lat-lon position the following 13 parameters are given:

- latitude (in [deg])
- longitude (in [deg])
- orography (in [m] above sea level, so above the zero level of the geoid, not above the WGS84 reference ellipsoid[5])
- ground backscatter (in [1/sr])
- background radiance (in [W/m^2])
- albedo (as fraction between 0-1)
- land-ice mask (flag)
- year (year number including century)
- month
- day
- hour (hour UTC)
- minute
- second

[5]note that orography, just as the lat, lon, date, time fields should not be used to compare to real geolocation results from the E2S/L1BP. These parameters cannot in fact be very precise because they have different values for the different datatypes used to produce a given scenario. Therefore they should probably be replaced by the conversion tool or later, by more precise ADM orbit data. If needed, a precise ADM orbit can be inserted in this database. However, the user still should not expect a precise collocation with the profile data, simply because data along the precise orbit is not available for most of the datasources (except NWP data). For a possible workaround and more discussion about this, see section 4.3.

For each element a number of properties are given in the file header (like the unit, the number to be used as missing indicator, etc). See for a full explanation section 5.3.1.

Many files in the database have 150 profiles spaced 500 m apart (which is equivalent to a timestep of 0.074627 s) resulting in a ground track length of 75 km, or just 1 profile if the atmospheric data is not varying along the track (for example when using a constant climatological profile). Some synthetic profiles have a different number of profiles (for example to describe different backscatter ratios 5 profiles are packed in one file). For collocated LITE and ECMWF data we follow the resolution of the accumulated LITE profiles, giving 240 profiles separated by 3.6 km. For collocated CALIPSO and ECMWF data we follow the resolution of the accumulated CALIPSO profiles, giving between 667 and 1434 profiles per segment, or 5606 profiles when all segments are combined into a single scene.

4.2 profile info

At each lat-lon position a profile is given for the following 14 parameters:

- start height of this slice of the atmosphere (in [m])
- end height of this slice of the atmosphere (in [m])
- pressure (in [hPa])
- temperature (in [K])
- west-to-east (eastward) wind component (in [m/s])[6]
- south-to-north (northward) wind component (in [m/s])
- upward wind component (in [m/s])
- upward precipitation speed (in [m/s])[7]
- aerosol backscatter (in [1/(m.sr)])
- aerosol extinction (in [1/m])
- cloud backscatter (in [1/(m.sr)])
- cloud extinction (in [1/m])
- molecular backscatter (in [1/(m.sr)])[8]
- backscatter on precipitating particles (in [1/(m.sr)])

The values are defined to be the mean values in each slice except for pressure, for which the center value in the slice is used[9].

At the moment the levels are defined at regular intervals, but the file definition can accomodate irregular slices of atmosphere as well, might we need that in the future.

Current settings for the height levels are 240 steps of 125 meter thickness, making up the first 30 km of the atmosphere.

Again for each element a number of properties are given in the file header (like the unit, the number to be used for missing, etc). See for a full explanation section 5.3.1.

[6] note that this item may also hold the hlos value, in which case the south-to-north wind component will be set to missing.

[7] So this speed is negative for falling precipitation.

[8] molecular extinction can be derived directly from the molecular backscatter using the following simple formula: $\sigma_{mol} = \frac{8\pi}{3}\beta_{mol}$ (see [RD1], p.A3, or [RD3], p. 50). Note that in these references the symbol α is used for extinction

[9] in fact most data sources have a vertical resolution coarser than the 125 m used in this database, so the values are interpolated linearly to the appropriate height, and therefore the center value will be identical to the mean value in each bin. The only exception being the pressure which is linearly interpolated on the logaritm of the defined pressure points, causing the mean in a bin to be different from the center value.

4.3 conversion tools

The current ASCII fileformat, described above, is not directly suitable for use as input by the E2S simulator. The format was agreed between KNMI, ESA, DLR and Physics Solutions end 2004 for use by the DE2S and was mainly designed for easy use and human readability. For its contents all items where included that seemed usefull in the near or far future for testing, even if no datasources where at hand at that time. Some time later the E2S became available, requiring xml formatted input files which lack the possibility of using several of the items defined in the atmospheric databse.

Therefore a conversion is needed to the xml formatted input files required by the E2S.

At first a tool was written in Java by Dorit Huber for use at DLR. This tool was not distributed to the other teams interested in the data, leading to development in parallel of an alternative conversion tool in Matlab by Marie-Laure Denneulin at Météo France. Since this Matlab tool has been made available for other users, it has been included in for example the L2BP software package, and has been used to test the E2S-L1B-L2B software chain.

However, by reviewing the source code of this Matlab tool, some problems regarding the use if the database have become clear, notably:

- the geolocation used by the atmospheric database has no relation to the orbit generated by the E2S, which makes it hard to perform certain tests with this data, like ground detection and ground calibration.
- the available conversion tool does not export any data to the atmosphereGroundParameters.xml file.
- the E2S uses hlos wind as input, while the atmospheric database specifies the u,v,w wind components. A trick has been added to specify hlos in the atmospheric database as well, by setting the v component to missing. This is not sufficient when realistic wind data is needed for testing, with for example a vertical wind component. For such cases the u,v,w components need to be converted to a proper hlos, and to do so the measurement geometry is needed.

Note also that the question whether off-nadir or nadir geometry is used is related to this conversion, and not to the content of the atmospheric database.

In 2008 a new conversion tool was written in python, and distributed as part of the Chain_of_Processors package. This tool solved some problems, notably exporting data without loss of precision, by using flexible format specifiers, and creation of atmosphereGroundParameters.xml files to allow exporting ground elevation and albedo values. The geolocation and u,v,w to hlos conversion issues mentioned above have still not been solved.

A possible workaround for these problems would be the following:

- select an atmospheric database scene
- convert this atmospheric database scene to xml, accepting the wrong hlos (just copy the u component to hlos)
- define the E2S timing and orbit initialisation input parameters
- run the E2s and L1B software
- use the available matlab L1B reading routine to read the L1B product file, and extract the geolocation parameters
- use an adapted Matlab conversion tool to allow optional replacement of geolocation data by data retrieved from the L1B file
- convert again this atmospheric database scene to xml, now using the known geolocation to properly convert the wind u,v,w components to hlos.
- run the E2s and L1B software
- now it is valid to compare the input and output geolocation and winds. However, when doing this another round of horizontal interpolations is probably needed, since the ADM measurement locations are not defined on the same grid as the atmospheric profiles used as input. But since these angles vary relatively slowly from BRC to BRC this seems not a big problem.

An alternative solution would be to take the orbit initialisation and timing settings from the E2s, run a modified orbit-prediction tool, and make the predicted orbit available to the conversion tool on a fine grid to minimise any additional interpolation errors. Extra information needed as output of this orbit prediction tool would be the azimuth and the incidence angle at each rangebin and each measurement position (or on a grid fine enough to allow the use of linear interpolation to generate the exact numbers without too much loss of precision).

However, I don't have de expertise and time available at the moment to implement such a modified tool.

When only the vertical wind component w needs to be used for testing, and the exact u,v to hlos conversion is not important, only the E2S needs to be run. The incidence angle is reported in the E2S output files named $(scenario)/instrumentData/SLS_Input_BRC_***.m This may be used to convert u and w components to the los wind and then to the hlos wind, resulting in a difference between the real hlos and the u component used as hlos by the E2S.

For testcases in which u,v,w to hlos conversion is not very important, it is possible to export the surface topography (orography) directly from the atmospheric database to the atmosphereGroundParameters.xml file. If subsequently use of the DEM is switched off (this is possible), then ground related tests may be performed. However, also to make this possible the conversion tool must be adapted to be able to export data to the atmosphereGroundParameters.xml file.

Further input is needed to decide which option to explore.

Note that besides for the DE2S and E2S these database files may also be used as input for the L2BP software. A dedicated conversion tool named ConvertKnmiAscToAMD is available in the L2BP software package in directory $(L2BP_SOURCE)/AMD_file_handling. This tool converts the data to the AUX_MET files in Earth Explorer format that may be used as input for the L2B processor.

4.4 A note on the E2S extrapolation

As a user of the E2S it has been unclear to me what policy is used to extrapolate the atmospheric data, in case the vertical profile does not extend far enough up or down to cover all rangebins. Therefore I investigated this in the E2S matlab source code. The answer can be found in file:
$(E2S_Install)/matlab/SLS/SLS_InitializeAtmosphere.m
between lines 81 to 95 (for version 2.03). Here it is clearly stated that the E2S will assume:

- no extinction
- no backscatter
- no wind
- temperature 10K

Users of the E2S should be aware of this behaviour when using rangebin definitions reaching beyond the vertical range defined in the atmospheric database. This may especially happen when the data source used to build the atmospheric database scene has a different orography then the actual locations simulated by the E2S.

To circumvent this problem the Run_E2S_L1B_L2B.py script from the Chain_of_Processors has a switch which allows adding some safetylyers. When activated the lowest valid layer of the profile is duplicated and assigned an altitude of -1 km. The highest valid layer is duplicated and assigend an altitude of +40 km. This should enforce valid data for all possible range-bin definitions within the ADM-Aeolus project.

5 software

The software used to produce the database was build using the Fortran90 programming language. This enables both the use of some standard libraries needed to access meteorological information (usually stored in a format known as GRIB), and the reuse of software components written by the author and his colleagues during prior projects (on scatterometry in Eumetsat and ESA projects).

The needed functionality was strictly devided into separate modules using (as much as possible in this language) an object oriented approach of programming, i.e. defining a data structure needed for communicating with the module, and adding functions and subroutines to the module that act on this data structure.

Each module has a special fortran test program used to test the interface and the functionality of the module. For modules that produce data, also a testprogram (written in the IDL script language) was added to generate plots of the produced data, permitting visual inspection of the results. For validation also an IDL tool is available to read the generated database files and visualise them.

5.1 supporting modules

The software components written during previous projects are packed in a folder known as GENSCAT. The following modules have been reused for the current software:

- Makeoptions: an include-file for the Makefiles generated for the current combination of compiler and operating system, which enables easy portability of the software to multiple systems
- support/file: a module to administrate the fileunits used by the fortran program, and to facilitate system independent binary reading (solving the big/little endian problem)
- support/convert: a module to do conversions (for example between lat-lon and x,y,z coordinates), and provide several constants, like π.
- support/num: a module to define several numerical properties of the program, like the default integer, and real type, and the missing values (also some special functions are provided to test on the missing value)
- support/datetime: a module to handle calendar (stepping through days, months, years, producing julian day numbers) and time.
- support/random: a module to generate high quality random numbers

Two new general support modules (or objects) have been written especially for this project:

- Interpolate: this module defines a data structure to store a single one dimensional vertical profile, methods to fill this profile data structure, and to interpolate, and if needed extrapolate, to retrieve values from it. If needed, arrays of these profiles can be constructed in the main program. In section 5.2 this module is described in more detail.
- Ascii: this module defines the way in which the data is written to the asci output file. It defines an array of elements, which have properties like name, abbreviation, value, etc. And it defines methods to write the definitions to the header of the file, and to write the data to the body of the file. In section 5.3 the output by this module is described in detail.

Also several new supporting modules have been written to handle the datasources needed for this project. Some are still to be implemented, but are kept here because they might prove to be usefull for future releases of the database. They are (in alphabetical order)

- AtmState, a module to provide climatological profiles, see section 5.4.1
- BackscatProf, a module to provide data from clean-air LITE backscatter profiles see section 5.4.2. No scenes have been defined yet that use this datasource
- CalcHeightFromP, a module to calculate the altitude for a given NWP model level, see section 5.4.3
- Calipso, a module to read the reprocessed and converted data generated for this instrument, see section 5.4.4.
- CloudRadar, [this datasource is not yet implemented] a module to provide with cloud and wind vector data from the doppler wind rader system, see section 5.4.5

- Clouds, a module to generate artificial clouds, see section 5.4.6[10].
- CollocEcmwf, a module to read collocated NWP profile data generated to match the LITE or CALIPSO data, see section 5.4.7
- DaylightCalc [not yet fully implemented], a module to calculate the solar-angle above horizon, see section 5.4.8
- GribProf, a module to read NWP GRIB files and construct vertical profiles from them, see section 5.4.9
- IceSat [this datasource is not yet implemented], see section 5.4.10
- LiteProf, a module to read raw binary LITE datafiles, see section 5.4.11
- LiteScatProf, a module to read processed LITE datafiles, providing cloud and aerosol backscatter, see section 5.4.12
- MerciProf, a module to read NWP data from datafiles constructed for the MERCI project, see section 5.4.13
- MolScat, a module to calculate the molecular backscatter profile, see section 5.4.14
- Orbit, a module to do a simple orbit calculation, used to generate artificial data for which the precise orbit details are not relevant, and cannot be copied from one of the datasources, see section 5.4.15
- RadioSonde, a module to read radio-sonde data files, see section 5.4.16
- Topo, a module to read a coarse topography file to be used for scenes that have no orography available, see section 5.4.17

5.2 vertical interpolation

The interpolation module defines a datastructure to hold an arbitrary number of datapoints against altitude to form a profile. The data may be defined on irregular intervals, and missing numbers may occur in the data. It is also possible to indicate that the values are defined in a circular domain (for example degrees for winddirection).

Some special functions are provided to get an interpolated value from the profile at a given altitude, or an integrated value between two altitude levels.

Properties can be set to define how the interpolation should be performed. Possible settings are:

- linearly
- on the log values of the data

Also it can be specified whether extrapolation downward or upward is allowed, and if so, what method should be used to extrapolate. Also limits can be set above or below which no extrapolation is performed. Possible extrapolation types are:

- no extrapolation allowed
- linear extrapolation, using the last 2 defined points
- logaritmic extrapolation, using the log values of the last 2 defined points
- copying the last defined datapoint into the undefined region
- multiplying the function $1/(1+dz^2)$ on the last defined datapoint. (which defines the Lorenzian profile used for RMA aerosol profiles above 16 km, see [RD2], p.80)

Finally some functions are available to correct the profile for a given bias, and to convert a profile given in log-values to normal values.

[10] Note that similar funcionality is also available in the E2S, by using the atmosphereCloudParameters.xml file. However, this E2S input file allows for only a single cloud layer, while this Clouds module of the atmospheric database allows for an arbitrary number of cloud layers.

Table 1: definition of the items used in the ascii module for the filecontents list

filecontents list (this list contains 2 items)						
item nr	full name	abbrev.	value	unit	format	missing value
1	max. nr of surface items	nprofiles	150	[nr]	i3	-1
2	nr of height steps in a profile	nsteps	240	[nr]	i3	-1

5.3 interface

The interface between the production of the atmospheric database, and the simulation software using this data, consists of the files used to transfer the data, and thus of the precise file definition, which is given below.

The extra conversion step to single profiles in xml format, as is needed by the E2S program, was discussed in section 4.3 above.

5.3.1 ascii module

To write the data to file the ascii module is used. This module defines an array of element properties, methods to initialise, fill, and print these definitions, and insert data into the list. If needed a separation character (usually a comma or a space) can be choosen. Further it defines methods to open and close the ascii file, write the header or the data to the file, print the definition list, or read data from the file.

When initialising a list the maximum number of elements is specified. Then for each element in the list the following properties can be defined:

- item number (determines the ordering in the list)
- full name
- abbreviation
- physical unit
- dataformat for writing
- number to be interpreted as missing data

Once a list is defined, it can be filled and filled again with data many times in a do loop, and written in the defined way on a single line to the output file. The definitions presently in use for the atmospheric database are given in section 5.3.2.

5.3.2 content

For the datafiles in fact 3 instances of this datatype are used:

- one to define the properties for the first 2 numbers in the file (number of lat-lon positions and number of height steps in the profile, see table 1).
- one to define the properties for the surface and ancillary information (see table 2).
- one to define the properties for the profile information. (see table 3).

For each list definition the item number, full name, abbreviated name, an example value, physical unit, printformat, and missing definition is given in the table.

The flags used for the land-ice mask field are given in table 4.

Table 2: definition of the items used in the ascii module for the surface list

surface list (this list contains 12 items)						
item nr	full name	abbrev.	value	unit	format	missing value
1	latitude	Lat	-37.52	[1 deg]	f8.2	999.00
2	longitude	Lon	-135.55	[1 deg]	f8.2	999.00
3	orography	orogr	8765.4	[1 m]	f6.1	-999.0
4	ground backscatter	beta_g	1.000E-05	[1/sr]	es10.3e2	-1.000E+00
5	background radiance	B	92.300	[1 W/m^2]	f6.3	-1.000
6	albedo	albedo	0.5	[fraction]	f6.3	-1.000
7	land/ice mask*	mask	0	[flag]	i1	9
8	year	CCYY	2004	[1 year]	i4	-999
9	month	MM	10	[1 month]	i2	99
10	day	DD	22	[1 day]	i2	99
10	hour	h	9	[1 h (utc)]	i2	99
11	minute	m	43	[1 min]	i2	99
12	second	s	16.40	[1 sec]	f5.2	-9.99

* the possible values for the land/ice mask are defined in table 4.

Table 3: definition of the items used in the ascii module for the profile list

profile list (this list contains 13 items)						
item nr	full name	abbrev.	value	unit	format	missing value
1	start height	hs	25875	[1 m]	i6	-9999
2	end height	he	26000	[1 m]	i6	-9999
3	pressure	p	20.3	[1 hPa]	f6.1	-999.0
4	temperature	T	215.3	[1 K]	f5.1	-99.0
5	west-to-east wind component	u	75.5	[1 m/s]	f5.1	999.0
6	south-to-north wind component	v	-49.6	[1 m/s]	f5.1	999.0
7	upward wind component	w	23.3	[1 m/s]	f5.1	999.0
8	upward precipitation speed	w_p	0.0	[1 m/s]	f5.1	999.0
9	aerosol backscatter	beta_a	3.429E-10	[1/(m.sr)]	es10.3e2	-1.000E+00
10	aerosol extinction	sigma_a	1.715E-08	[1/m]	es10.3e2	-1.000E+00
11	cloud backscatter	beta_c	0.000E+00	[1/(m.sr)]	es10.3e2	-1.000E+00
12	cloud extinction	sigma_c	0.000E+00	[1/m]	es10.3e2	-1.000E+00
13	molecular backscatter	beta_m	3.106E-07	[1/(m.sr)]	es10.3e2	-1.000E+00
14	backscatter of precipitating particles	beta_pr	0.000E+00	[1/(m.sr)]	es10.3e2	-1.000E+00

Table 4: flag table used for the land-ice mask

land-ice mask flag table	
above land	0
above sea	1
above ice	2
unknown/missing	9

Table 5: available data sources for each of the items used in the atmospheric database. (A=avialable, - = not available, NI=available but not yet implemented for this datasource, ?=in principle this should be available for this instrument, but I can't find it in the datafiles, I=does not provide this item directly but provides a necessary intermediate value to obtain this item)

	data provided by each module																		
module name	lat/lon	oro	beta_g	B	albedo	mask	date	time	P	T	u/v	w	w_p	beta_a	sigma_a	beta_c	sigma_c	beta_m	beta_pr
AtmState	A	-	-	-	-	-	A	-	A	A	-	-	-	A	I	-	-	A	-
BackScatProf	-	-	-	-	-	-	-	-	-	-	-	-	-	A	I	-	-	A	-
Calipso	A	-	NI	-	-	-	A	A	-	-	-	-	-	A*	I	A*	I	-	-
CloudRadar	-	-	-	-	-	-	NI	NI	-	-	NI	NI	?	-	-	-	-	-	-
Clouds	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	A	-	-
CollocEcmwf	NI	-	-	-	-	-	NI	NI	A	A	A	A	-	-	-	-	-	-	-
DayLightCalc	-	-	-	I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GribProf	-	A	-	-	-	A	-	-	A	A	A	A	-	I	I	-	-	-	-
IceSat	NI	-	?	-	-	-	NI	NI	-	-	-	-	-	NI	I	NI	I	-	-
LiteProf	A	A	NI	-	-	A	A	A	-	NI	-	-	-	-	-	-	-	-	-
LiteScatProf	-	-	-	-	-	-	-	-	-	-	-	-	-	A	I	A	I	-	-
MerciProf	NI	NI	-	-	-	-	NI	NI	A	A	A	A	-	I	I	-	-	-	-
MolScat	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A	-
Orbit	A	-	-	-	-	-	A	A	-	-	-	-	-	-	-	-	-	-	-
RadioSonde	A	-	-	-	-	-	A	A	A	A	A	-	-	I	I	-	-	-	-
Topo	-	A	-	-	-	A	-	-	-	-	-	-	-	-	-	-	-	-	-
Artificial	-	-	-	-	-	-	-	-	-	A	A	A	-	A	A	-	-	A	-

* note that for CALIPSO the total backscatter, so aerosol plus cloud backscatter, is given in the aerosol backscatter field. No effort has been implemented yet to separate them.

5.4 data sources (modules)

This subsection will give a list of the available data sources that can be choosen to produce scenarios. For each datasource a fortran module was written to gain access to the source (usually to read a specific filetype, or run a specific algorithm), and the input and output parameters will be specified. The main program is controlled by command-line options, which can be used to select any combination of these data sources. The complete program, in turn, is called many times with different options, by a python script in which all scenes of the database are defined. In this script the set of command-line options needed to generate each scene is defined, together with the directory name to be used for storing the resulting datafile.

An overview off all modules that are available at the moment, and what data they produce, is given in table 5.

The module CalcHeightFromP is not included in this table, because it is just a helper module for the GribProf module, and thus provides no data items on its own. LiteProf and LiteScatProf read 2 different datafiles belonging to the same data source, which is the reason why they contain a complementary set of items.

The Artificial profiles for temperature, wind u/v components and aerosol backscatter and aerosol extinction are not yet placed in a separate module. They are extremely simple and just define a constant or zero value for the whole profile (for temperature, and wind u/v components) or a constant value times another profile (as is used for the extinction[11] and the aerosol backscatter[12]) If artificial profiles become

[11] at the moment aerosol and cloud extinction is just taken to be a constant times the aerosol backscatter. To do this an aerosol backscatter to extinction ratio of $R_a = 0.02$ [1/sr], is taken from the DERA report [RD3], p. 51, in which values are mentioned between 0.017 and 0.026 (with some exceptions of 0.044 and 0.074). For clouds a different backscatter to extinction ratio R_c value may be given. Currently the fixed value of $R_a = 0.05$ [1/sr] is taken from the DERA report [RD3], p. 64.

[12] artificial backscatter is defined by the given molecular backscatter profile, and taking a given constant backscatter ratio, which may be specified on the command line (also a linear variation along track of the backscatter ratio is possible).

more complex, like when vertical gradients are needed, this will probably be placed in a separate module.

The intermediate indicator for beta_a has been put in there because the aerosol backscatter can in some conditions be determined from a humidity profile, using an empirical method[13]. [not yet implemented] Humidity is in principle available from the GribProf, MerciProf and RadioSonde modules.

The intermediate indicators for sigma_a and sigma_c are inserted for some datasources because they may be calculated from the backscatter using a constant backscatter to extinction ratio.

From this table it is easy to identify which items are still lacking a (possible) datasource. These are:

- ground backscatter (b_g)
- background radiance
- albedo
- precipitation speed (w_p)
- backscatter on precipitation.

Besides, also a datasource for retrieving an ice-mask is not yet available. One of the possibilities to estimate such a map is to use sst values from an NWP model, and apply a threshold on it (typically -1 or 0 degree Celsius).

Ground or sea surface backscatter should in principle be available from the LITE or IceSat data, but it is not yet clear how to retrieve this, since some sort of correction for incidence angle is probably needed (and for IceSat data a wavelength conversion is needed as well). In [LR3] some measurements on sea surface backscatter for 355 nm are reported. However, from these results it has become clear that the backscatter depends very strongly on the local windconditions and the presence of white-caps on the clouds. This question is especially important for calibration simulations. A technical note holding more details on this problem is being prepared by me, and will be available later this year.

As an example a level of 10^{-1} [1/sr] for sea surface backscatter is found for nadir looking geometry, and a level of 10^{-3} [1/sr] or lower for 37 degrees off-nadir looking geometry and a wind speed of 10 [m/s]. Clearly these numbers depend strongly on the local surface windspeed. At 6 [m/s] the off-nadir sea surface backscatter is already an order of magnitude smaller, 10^{-4} [1/sr], and below 4 [m/s] the number is of the scale, so below 10^{-4} [1/sr].

Once the albedo is known, calculation of the Background radiance term is possible. A datasource for albedo still needs to be found[14].

The best solution to get reliable ground/sea backscatter and albedo numbers is probably the upcoming air-campain.

A source for precipitation speed might be the doppler-cloud-radar. Finally, for backscatter on precipitation, no data source is available yet to obtain this[15].

5.4.1 AtmState

This module defines some reference atmospheric profiles for temperature, pressure, and humidity, for 3 different climate regions: arctic winter, mid-latitude winder and tropics[16]. They were taken from [RD1], page A6, and before that published in [RD2], p.85-92, in which it is said that they are produced by David Tan. David Tan in turn used[17] the AFGL "McClatchey" reference atmospheres [LR2].

Also 5 different reference profiles for aerosol backscatter are available (taken from [RD1], page A2, and before that published in [RD3], p. vii and p.28, and in [RD2], p. 79, with some minor differences in the lower decile profile only between 16.5-19.5 km).

[13] see for example [RD7], section 2.4, p.20-22

[14] albedo might be retrieved from meteosat satellite images, by taking data with approximately 37 degrees incidence angle (which form a circle on the surface). Then this data can be sorted on solar elevation and surface type, to get an idea of the typical values. Note that meteosat does not have a 355 nm channel, so some conversion to this wavelength seems needed. The amount of work involved is obviously outside the scope of the current project

[15] Maybe some cases of backscatter on precipitation can be selected from the LITE or IceSat data, but this has not yet been studied in detail

[16] other regions, like arctic summer, mid-latitude summer or US standard atmosphere could be added later from this source. They have not yet been added due to lack of time.

[17] personal communication

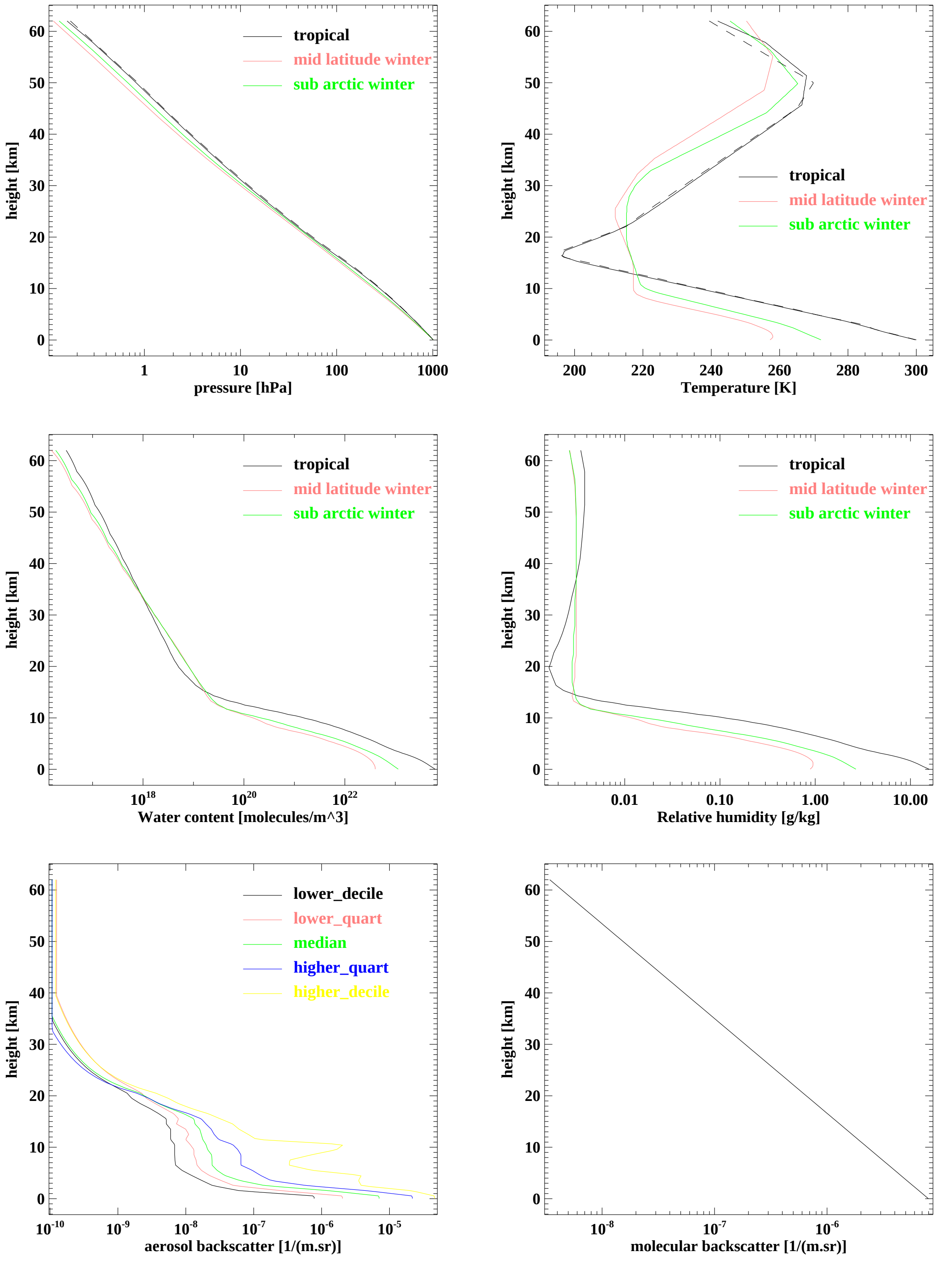


Figure 1: *Climatological profiles available in the AtmState module, based on data published in the Wales report [RD1]. For the tropical case the temperature and pressure as published by McClatchey [LR2] have been overplotted using black dashed lines to show that the dataset is indeed identical.. (except for some small interpolation artefacts).*

- lower decile[18]

[18]defined as the profile for which 10% of the measurements is smaller and 90 % of the measurements is larger

- lower quartile[19]
- median[20]
- higher quartile[21]
- higher decile[22]

This aerosol backscatter data is derived from a climatological database [LR1] of atmospheric backscatter at 10.6 micron for regions of the Atlantic during the relatively clean atmospheric period 1988-1990. This data was converted to 355 nm wavelength using the scaling law given in [LR4], page 3081, eq.4.

These above profiles are stored as datasets included in the module. Backscatter coefficients at heights in between table values are calculated by linear interpolation of log(backscatter) vs height.

If needed also a non-deterministic profile (using a random generator and a scaling law) can be generated [but this is not yet fully implemented].

Finally an empirical function is given to produce a climatological profile of the molecular backscatter (see [RD2], p. 82, or [RD3], p. 55, parameterization of DERA (Vaughan et al.)).

The module needs no other inputs than the requested height, and the choice for climate-scene or percentile[23], and returns a value for any of the above mentioned profiles and scenarios. The possible outputs are lat/lon/date, pressure, temperature, humidity, aerosol backscatter or molecular backscatter. It uses the Interpolate module to store the data and to do the actual interpolation.

Note that this function is independant of the local pressure and temperature profile, so it is less accurate than the profile provided by the MolScat module (see 5.4.14). Therefore the MolScat module is used in most scenes now, for providing molecular backscatter.

In figure 1 the data available from this datasource is shown. Note that the data used for the continuous lines was taken from the Wales report [RD1]. To be sure the data is identical to what was published by McClatchey [LR2], these latter profiles for temperature ande pressure have been overplotted with black dashed lines (for the tropical case only). Apart from some interpolation artefacts that data indeed is identical.

5.4.2 BackScatProf

This module implements reading of an ascii file containing a single profile for aerosol and molecular backscatter.

The profile was constructed taking table 3.1, page 28, Atlantic clean-air cases 1988-1990, from [RD3], DERA (Vaughan et al.), which gives backscatter values for 10.6 μm. The data was converted to 355 nm wavelength using the scaling law given in [LR4], page 3081, eq.4, and interpolated to higher resolution. Above 16 km an exponential decreasing function was assumed.

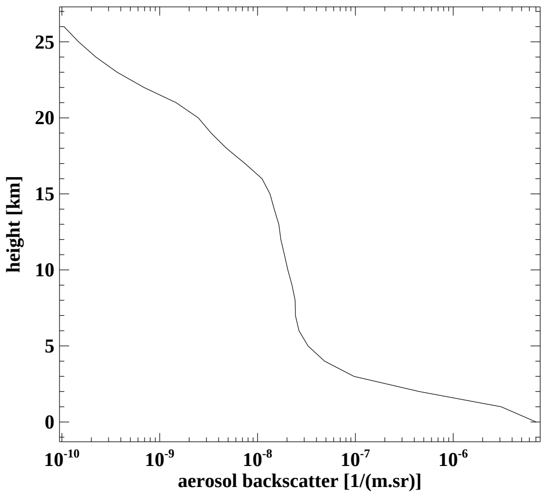
The molecular backscatter was calculated by an empirical function of altitude only (see [RD2], p. 82, or [RD3], p. 55, parameterization of DERA (Vaughan et al.)). This actually is the same profile as is made available by the MolScat module.

In figure 2 the data available from this datasource is shown.

The module uses the Interpolate module to store the data. The only needed input is the filename, and the requested altitude, the outputs are aerosol or molecular backscatter.

This module is not yet used by any test scene, and since the provided data (apart from interpolation artefacts) is identical to what is available in the AtmState module (as I only learned much later), it will probably never be used (and may be removed entirely in a next update of this database).

[19] defined as the profile for which 25% of the measurements is smaller and 75 % of the measurements is larger
[20] defined as the profile for which 50% of the measurements is smaller and 50 % of the measurements is larger
[21] defined as the profile for which 75% of the measurements is smaller and 25 % of the measurements is larger
[22] defined as the profile for which 90% of the measurements is smaller and 10 % of the measurements is larger
[23] Note that the main program does not yet have a commandline switch to choose which percentile to use. At the moment all RMA scenes use the median aerosol profile



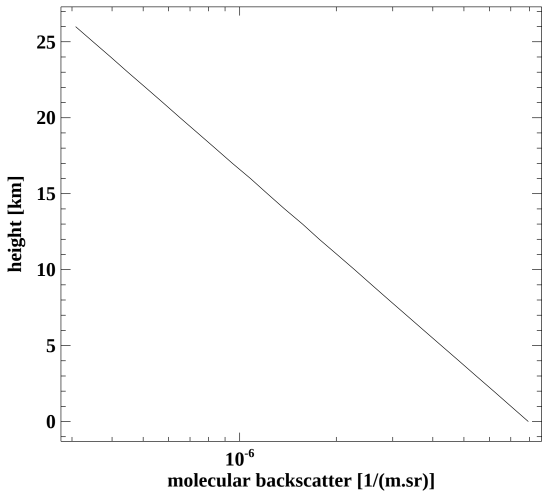


Figure 2: *Backscatter for aerosols and molecules available in the BackScatProf module.*

5.4.3 CalcHeightFromP

This module is used to calculate the altitude for given NWP model levels. These levels are usually defined as pressure levels[24]. From the pressure, the temperature and the humidity profiles the geopotential can be calculated. This geopotential can then be converted to altitude when the surface value of the geopotential is given. To do this accurately the latitude must be provided which makes it possible to approximate the local gravitational accelleration constant.

The needed inputs are latitude, and profiles for temperature, humidity, pressure, and the surface value for the geopotential. The output is the altitude for the requested model levels.

5.4.4 CALIPSO

This module provides access to datafiles holding CALIPSO data inverted to total backscatter and converted to 355 nm. These steps have been performed by G.J. Marseille (see: [RD8]). First particle backscatter is retrieved from attenuated backscatter at 532 nm. Then the result is converted to 355 nm using a scaling law. Note that the result includes both aerosol and cloud scattering, no effort has been implemented yet at KNMI to separate the two. The input for this module is either a filename for the datafile to be used, or a segment number (between 1 and 7). Seven segments have been selected for now for addition to the database, which together form about half an orbit of data.

After selecting a segment or giving an input file, all profiles in the input file are stored in memory using the Interpolate module. Data can be retrieved after giving the profile number within the segment.

Then, the following data is available: lat, lon, date, time, total backscatter, at a given altitude.

In figure 3 an example of the particle backscatter at 355 nm as retrieved by the iterative scheme proposed by G.J. Marseille.

The defined segments are:

1 polar, north of Russia.

2 mid-lattitude, eastern Europe

3 sub-tropical, North Africa, Meditteranian

4 tropical, Africa, south of Sahara

5 tropical, central Africa

[24]the pressure in turn can usually be calculated by using the surface pressure, the level number and a table of fixed coefficients a_n and b_n, using a formula like $p = a_n + b_n * p_s$ (this example is for the NWP model used by ECMWF, see http://www.ecmwf.int/research/ifsdocs/CY28r1/index.html, part III, section 2.2.1 on vertical discretisation)

6 sub-tropicalocean, west of South Africa

7 mid-lattitude, ocean south-west of South Africa

Clearly still some problems do exists below clouds, due to the very low signal levels found there, but this should not be a problem when using the data, since also for ADM almost no signal should be generated in this area. Also the inversion to backscatter produced sometimes unphysical negative values in the upper layers. These have been set to zero, and produce the white spots in the upper half of figure 3. These zero values should have no effect on the simulation results, and will be averaged out when the typical ADM rangebin size of 2 km is used.

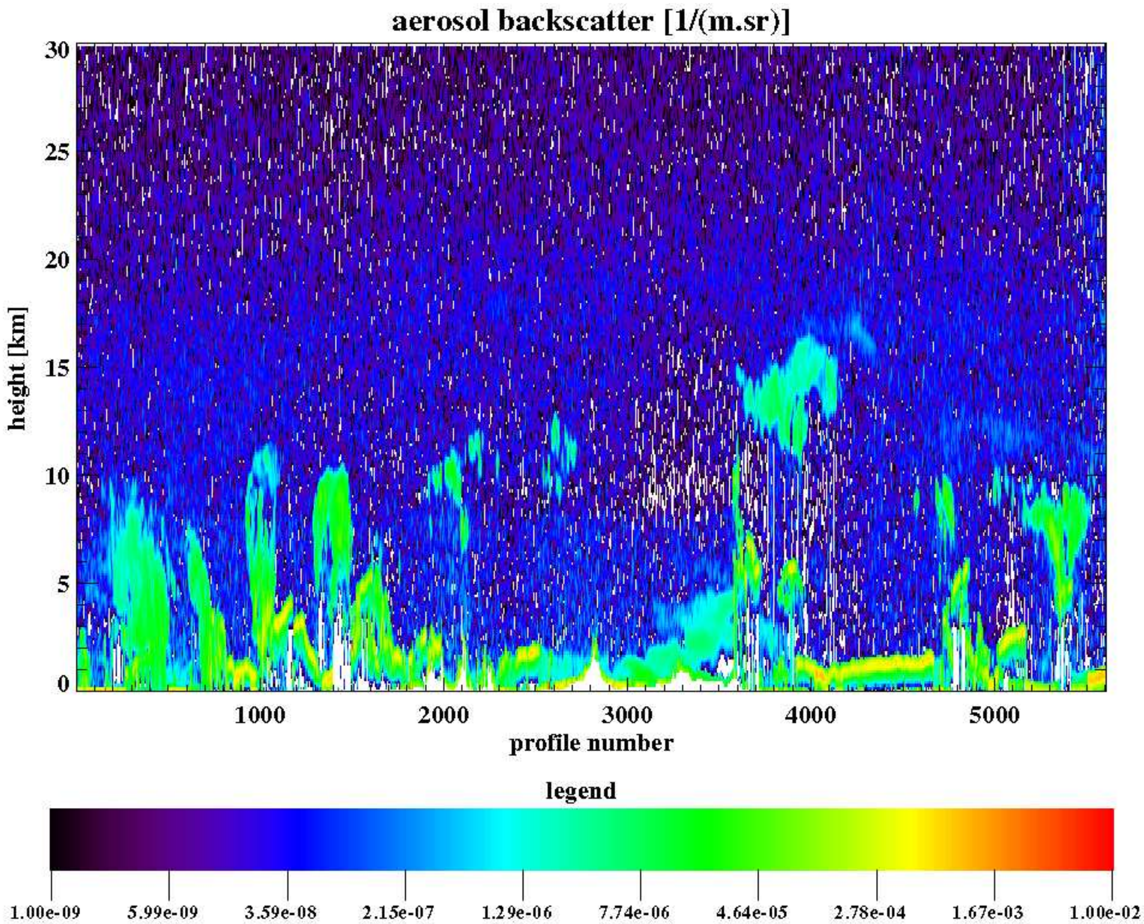


Figure 3: *Example of the CALIPSO particle backscatter at 355 nm for all 7 segments as retrieved by the iterative scheme proposed by G.J. Marseille.*

5.4.5 CloudRadar

This module will use cloud doppler radar information to produce a realistic variability in the wind components. This module is still to be implemented, and this section will be used to document that implementation.

5.4.6 Clouds

To be able to include clouds in the climatological reference scenarios given in section 5.4.1 a module was constructed to define a number of different cloud types (with given properties) at any altitude.

The module uses the cloud types defined in table 6.

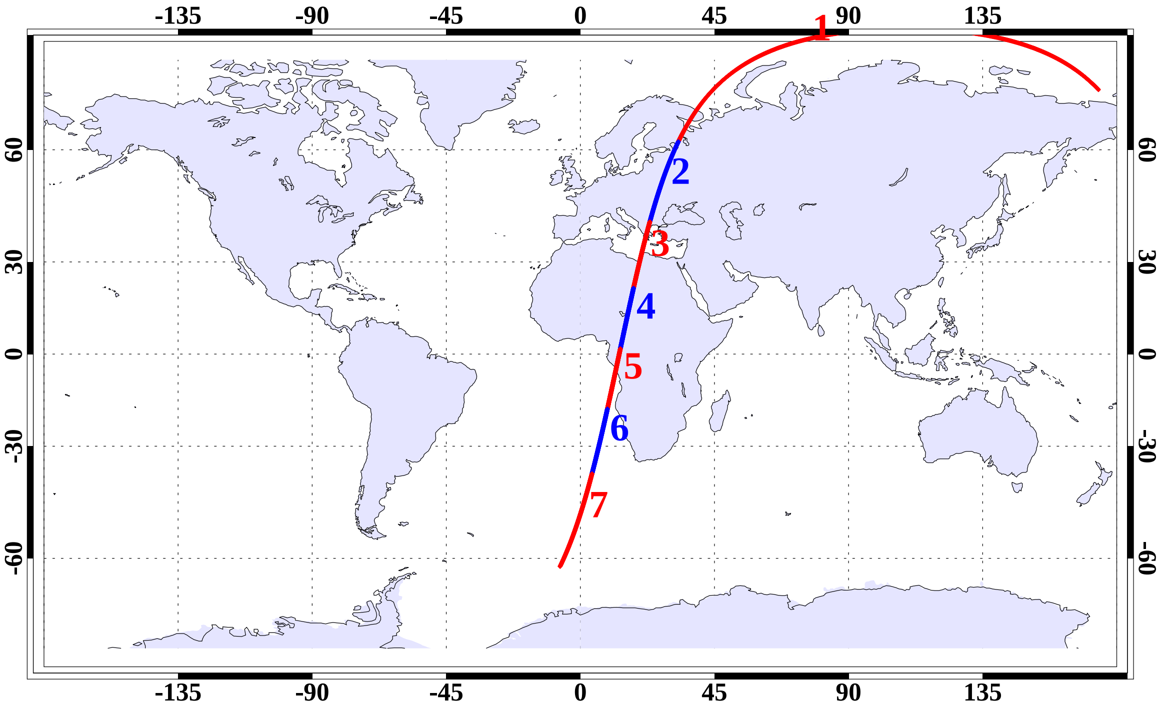


Figure 4: *Locations of the Calipso backscatter shown in figure 3.*

Most properties for these clouds types were taken from [RD3], p.64. The numbers for typical thickness for fair weather cumulus, altostratus and cirrus are taken from [RD2], p. 82. The numbers for typical thickness for altostratus and (subvisible) cirrus are also given in [RD1], p. A3.[25]

Additional to the above defined fixed cloud types, a free user defined cloud type is available. Any altitude, thickness, backscatter and extinction value can be used for this type.

In addition to the above properties, also a cloudcover between 0 and 1 can be defined. When the value is below 1 a random number is used to switch each defined cloud on or off resulting in the requested coverage. Ofcourse this is only usefull if multiple profiles are generated. [this needs some more testing].

Once the desired clouds are defined, the full cloud backscatter and cloud extinction profiles are available (using the interpolate module) and the values can be requested at any altitude.

[25] Note that [RD2], p. 82, gives different numbers for the properties of cirrus clouds: backscatter $= 1.6 \times 10^{-4}$ 1/(m.sr) and extinction $= 2.3 \times 10^{-3}$ 1/m, both numbers are about 11 times higher than the ones given in [RD3], p.64 and [RD1], p. A3. I suspect this is a typing mistake in [RD2], because the values for FWC and AltoStratus clouds are identical in [RD2], table E.2, p.82, and [RD3], table 5.2, p.64. Only the cirrus case differs.

Table 6: available artificial clouds defined in the Clouds module and their properties

name	lowest occurrence	highest occurrence	typical thickness	backscatter	extinction
fair weather cumulus cloud	2.2 km	10 km	250 m	6.0×10^{-4} 1/(m.sr)	1.2×10^{-2} 1/m
stratus cloud	200 m	700 m		5.0×10^{-3} 1/(m.sr)	9.0×10^{-2} 1/m
altostratus cloud	2 km	4.5 km	0.5 km	1.0×10^{-3} 1/(m.sr)	1.8×10^{-2} 1/m
cumulonumbus cloud	2 km	4 km		1.0×10^{-2} 1/(m.sr)	1.8×10^{-1} 1/m
cirrus cloud	8 km	16 km	1 km	1.4×10^{-5} 1/(m.sr)	2.0×10^{-4} 1/m
polar stratospheric cloud	16 km	30 km		3.0×10^{-7} 1/(m.sr)	6.0×10^{-6} 1/m
user defined cloud	any	any	any	user defined	user defined

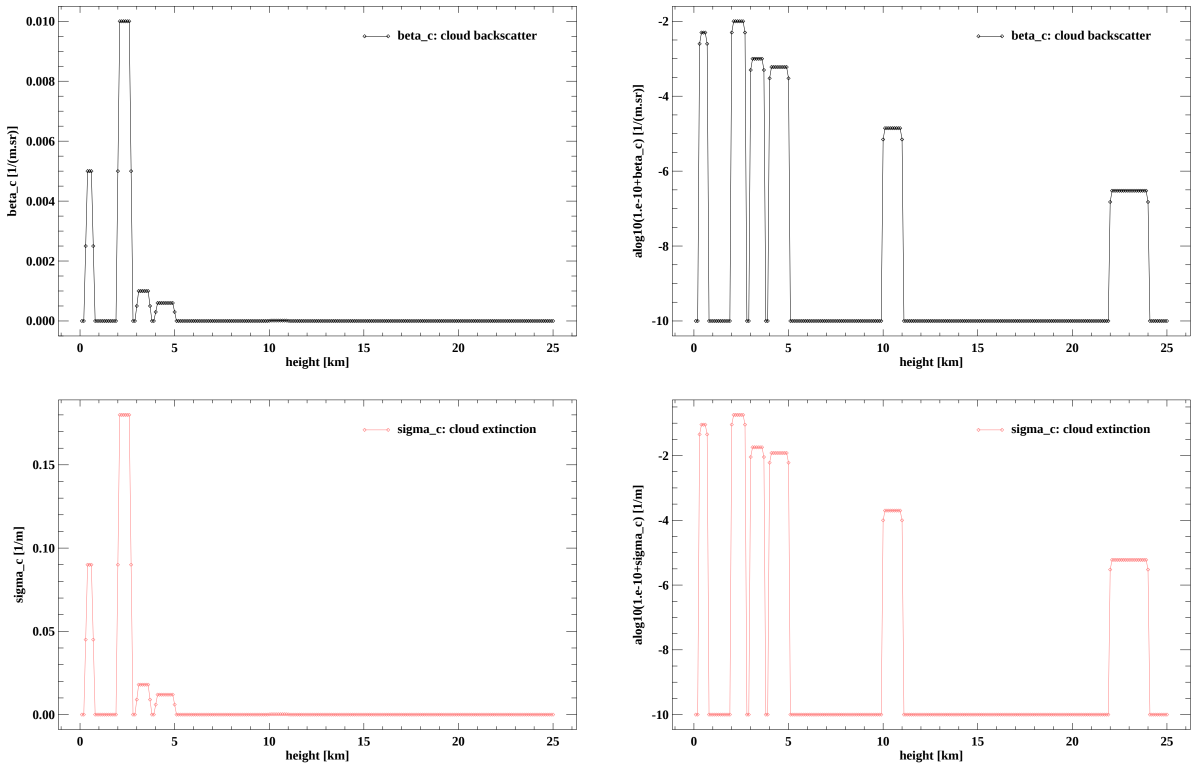


Figure 5: *An example of backscatter and extinction profiles provided by the Clouds module. The left 2 plots are in linear scale, the right 2 plots use a logarithmic y-axis. Note that the number of different cloud types in this scene seems somewhat unrealistic, and is only ment to demonstrate the functionality of this module.*

For convenience the cloud boundaries will probably be choosen to match the level boundaries used for the profile definition. This cloud definition is independent of the actual rangegate definition. The cloud boundaries may also be choosen to be in between the points used by the profile definition, in which case the actual profile point will be interpolated between the cloud properties and the no cloud case just above or just below.

When requesting data from the module, the only needed input is altitude. The possible outputs are cloud backscatter and extinction.

An example of a backscatter and extinction profile defined by a set of clouds in this way is shown in figure 5. The 6 clouds used in this example are:

- stratus cloud, between 300 and 700 m
- cumulo nimbus cloud, between 2 and 2.7 km
- alto stratus cloud, between 3 and 3.7 km
- fair weather cumulus cloud, between 4 and 5 km
- cirrus cloud, between 10 and 11 km
- polar stratospheric cloud, between 22 and 24 km

all with a cloudcover of 8/8.

Note that the E2S software has its own input file for synthetic cloud definition. See also footnote [10] on page 13 about this E2S functionality. This is totally independent of what is in this database! Cloud layers defined in this database are added onto the aerosol backscatter and extinction profiles before being read by the E2S. This is handled by the ascii-to-xml conversion tool (see section 4.3), which allows selection of aerosol only, cloud only, both or neither.

5.4.7 CollocEcmwf

This module provides access to datafiles holding collocated ECMWF model profile data. These have been produced at the actual time and location of the LITE and CALIPSO profiles available in this database. For LITE collocation the ERA-40 model was used, since this is the best quality NWP data available to us for 1994. For CALIPSO collocation the operational ECMWF model was used.

The input for this module is either a filename for the datafile to be used, a scene letter as defined by the LiteScatProf module in section 5.4.12 or a segment number as defined by the Calipso module in section 5.4.4.

After selecting a file, scene or segment all profiles in the input file are stored in memory using the Interpolate module. Data can be retrieved after giving the profile number within the segment This assumes the ordering and locations of the profiles in the collocated file matches with the profiles and locations in the LITE/CALIPSO datafile. This is safe because the collocated files have been constructed to fullfill this condition.

Then, given the altitude (if needed) the following data is available: p, T, u, v, w. Examples of temperature, wind u-component, wind-shear and cloud-cover collocated to the CALIPSO data all 7 segments are given in Figures 6, 7. Additionally, windshear and cloud cover from the ECMWF model collocated to the CALIPSO data from segment 1 has been plotted and is given in figures 8 and 9. Note that these last 2 parameters are not available in the atmospheric database.

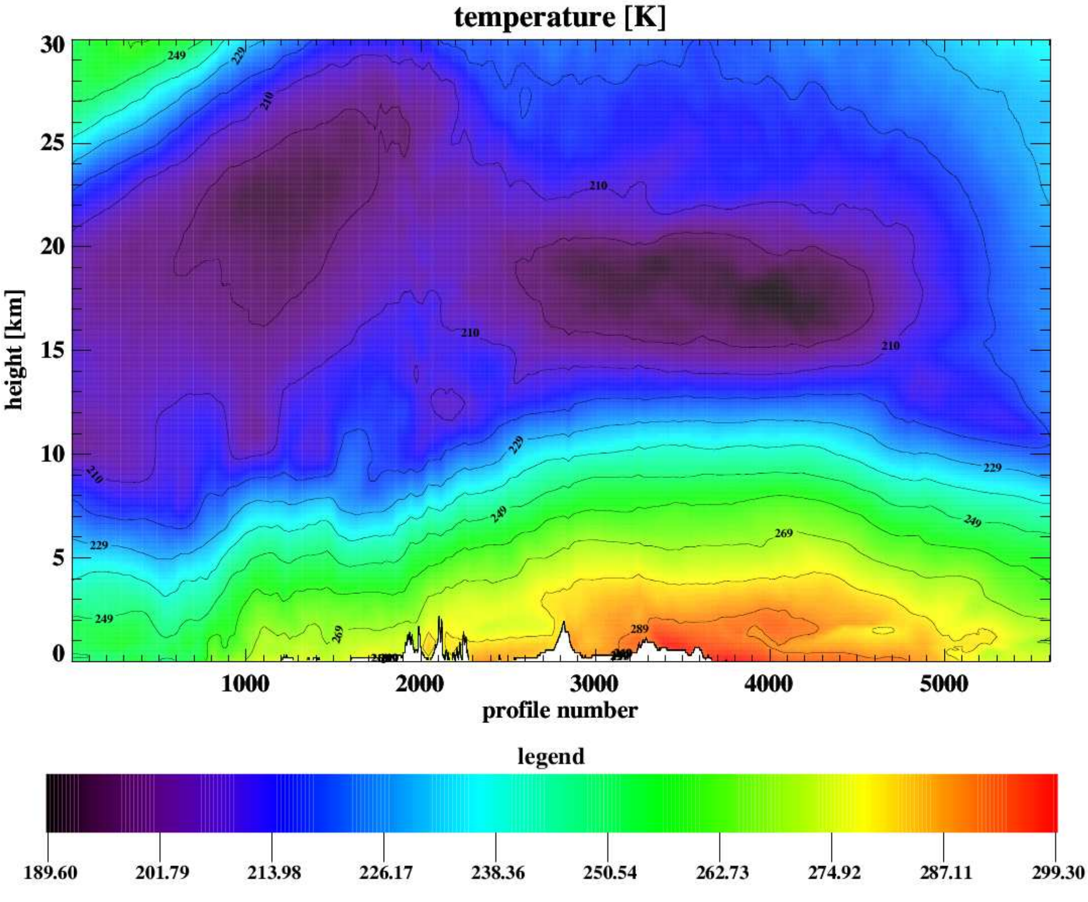


Figure 6: *Example of the temperature collocated to segment 1 to 7 of CALIPSO data as provided by the CollocEcmwf module*

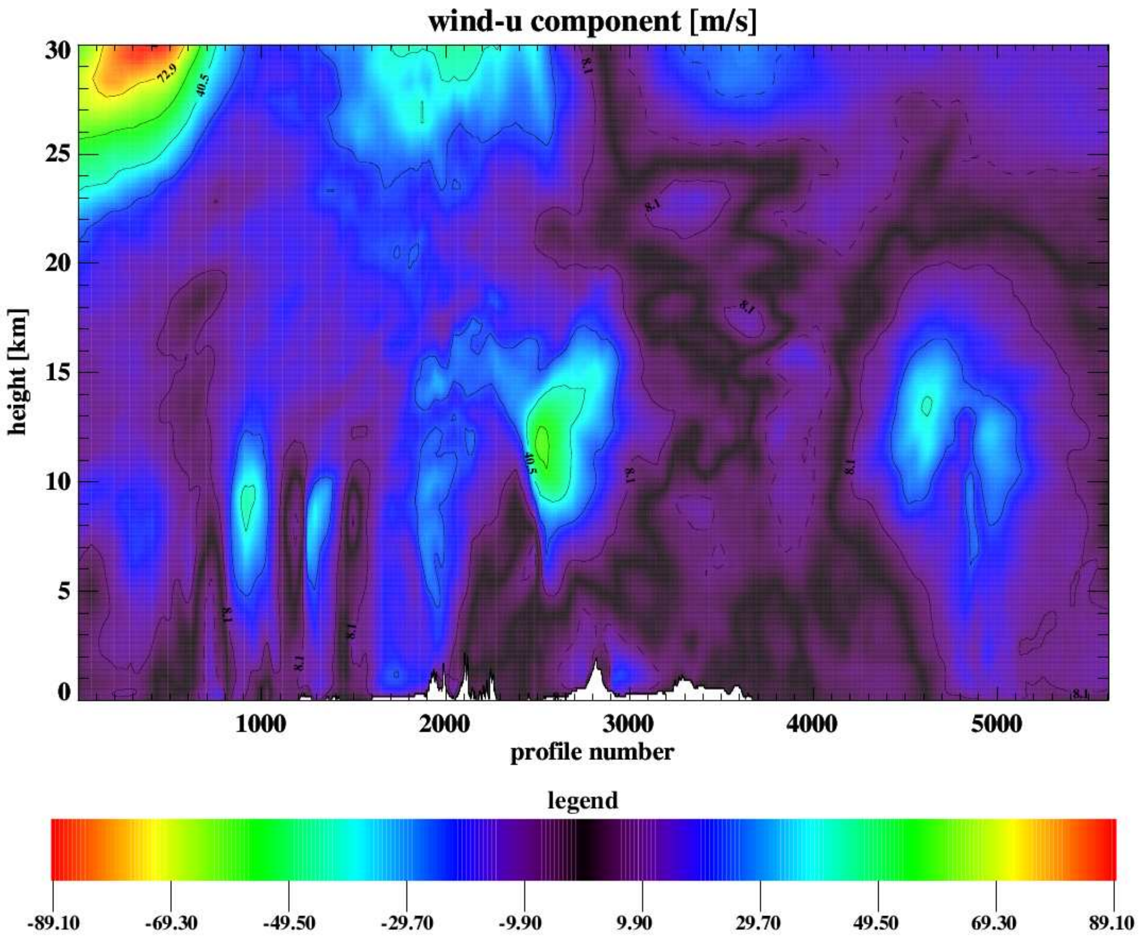


Figure 7: *Example of the wind u-component collocated to segments 1 to 7 of CALIPSO data as provided by the CollocEcmwf module*

5.4.8 DaylightCalc

This module was intended to estimate the angle of the sun above the horizon, to be able to estimate the background radiance. This only makes sense if the precise orbit is available, which is not the case when producing scenes for the atmospheric database. Therefore this calculation will probably not be used, but rather the value will be calculated inside the E2S using the available EE_CFI library routines. Note also that for this reason no further effort has been put in the implementation of this routine, which is not complete yet.

5.4.9 GribProf

This profile uses the GRIB module from the existing genscat module collection to read NWP model data from GRIB files for a given parameter. These fields usually hold global data, but for better memory efficiency a lat-lon region can be defined which is of interest. If this option is used only the data inside this region is stored in memory.

The GribProf module uses this to typically read 60 global fields for ERA-40 (or 91 global fields for the operational model) for temperature, humidity, and the requested parameter, and a few global fields for surface properties like surface pressure, and surface geopotential. So 182 fields need to be loaded to obtain a single profile for ERA-40! (or 275 global fields for the operational model). From each of these fields a single number on the requested lat-lon position is extracted (using horizontal interpolation), and these numbers are put to gether to form a vertical profile (using the Interpolate module to store the data).

The GRIB module also implements a caching mechanism to hold the relevant data into memory, to

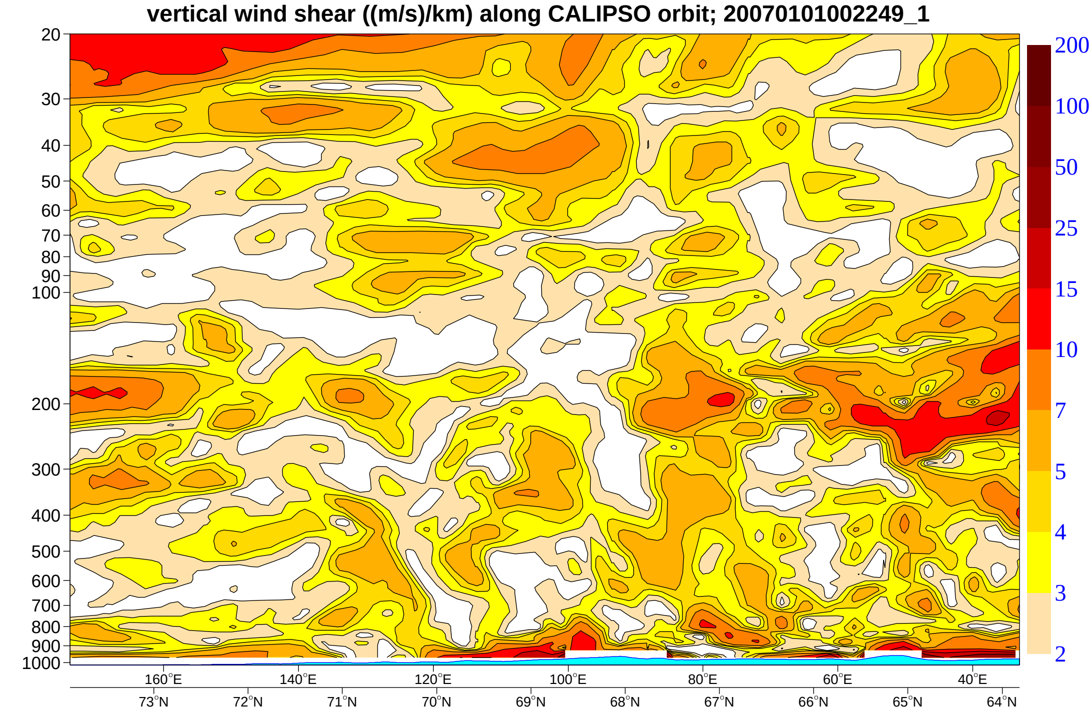


Figure 8: *Example of the wind shear present in the model data collocated to segment 1 of CALIPSO data. Note that windshear is not an item directly available through this database, although it can be calculated from the u,v,w profiles.*

prevent reading all this data again when a nearby profile is requested in a next call.

The NWP data typically is provided on model levels, which are at variable altitudes for the ECMWF model (depending on the local orography and surface pressure). The altitude for these levels for a given lat-lon position can be calculated using the CalcHeightFromP module (see 5.4.3).

Implemented data sources that are made available by this module are pressure, temperature, humidity, cloud-liquid/ice-water-content, cloudcover, wind u,v,w components, orography and land-ice mask (all from the ECMWF ERA40 or Operational NWP model). An example of a profile produced by this method is given in figure 10.

The interface to this module takes as input the filename or list of filenames) holding the NWP data, the requested parameter to be retrieved, and the lat,lon and date,time for which a profile is needed. When a profile is defined it takes just the altitude as input and gives the vertically interpolated value as output. This module is not yet used for defining a test scene in the database.

5.4.10 IceSat

This module will use information from the GLAS instrument on the IceSat satellite to produce realistic aerosol backscatter and extinction profiles in the higher lattitude regions.

GLAS has a 1064 nm laser channel for surface altimetry and dense cloud heights, and a 532 nm lidar channel for the vertical distribution of clouds and aerosols. The data therefore needs rescaling to the 355 nm wavelength used by Aeolus. For this the scaling law given in [LR4], page 3081, eq.4 will be used.

[this module is still to be implemented, and not yet in use]

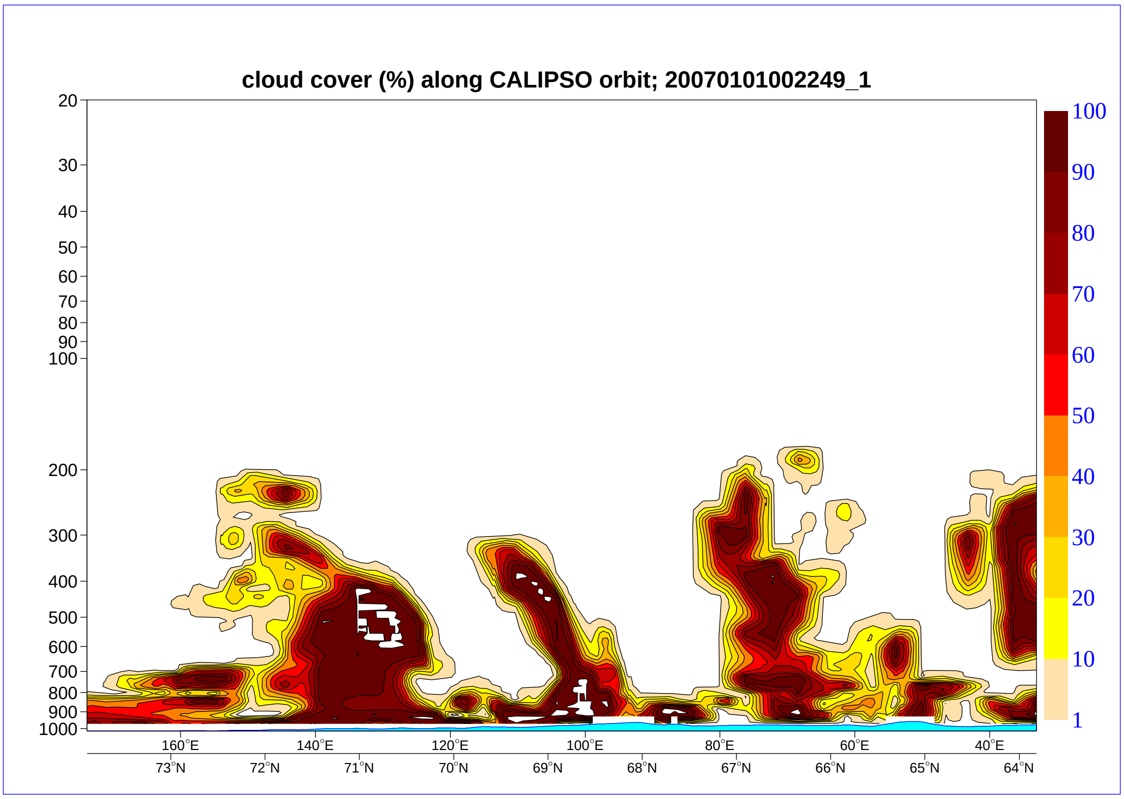


Figure 9: *Example of the cloudcover present in the model data collocated to segment 1 of CALIPSO data. Note that cloudcover is not an item directly available through this database.*

5.4.11 LiteProf

The LiteProf module provides access to datafiles containing raw LITE photoncount profiles for the 355 nm laser. Although this can not directly be used in this project, the files are still needed because they also contain the metadata like date,time and lat,lon, which is missing in the inverted LITE data files (see section 5.4.12). A final important element is that this file defines which profiles are missing and which are present.

The input for this module is the filename containing this raw LITE data. After giving the requested profile number, the possible metadata outputs are lat, lon, date, time, and landseaflag. Also a temperature profile is available in this dataset (taken from an NWP model), which is stored using the Interpolate module.

Some properties of this raw LITE data are(see: [RD4], page 4)

- LITE profile separation is 740 m.
- LITE Field-of-View (FOV) is 240 m.
- LITE vertical resolution is originally 15m, upto 40km, but this is reduced to 150m before determining aerosol/cloud backscatter.
- one scene usually contains 1200 profiles, resulting in a length of almost 900 km.

It should be possible to derive ground/sea-surface backscatter data from this data source, but I don't yet know how [I have not yet found the time to look into this.].

5.4.12 LiteScatProf

This module provides access to datafiles holding LITE data inverted to aerosol and cloud backscatter. This is done by the program written by G.J. Marseille for the Lite4ADM project (see: [RD4]). This method

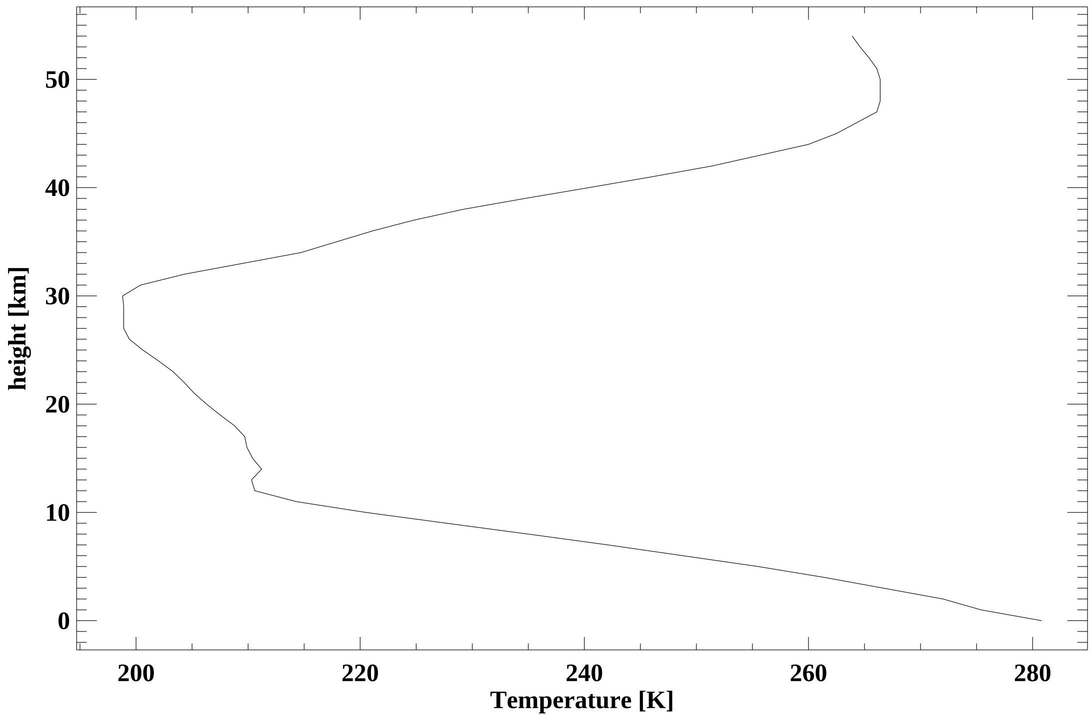


Figure 10: *An example of a temperature profile provided by the GribProf module (model is ERA40, date 1-1-2000, using a forecast step of 6h based on the analysis of 0h, using location: lat = 54.2 deg, lon = 5.7 deg.)*

combines the backscatter for all 3 available laser wavelengths in the LITE experiment, and uses a method of minimisation of a costfunction, to solve the lidar equation for the 3 wavelengths simultaneously. This gives the aerosol backscatter and the backscatter ratio profiles. Additionally a calibration on the upper part of the atmosphere, assuming a backscatterratio of 1 and a horizontal smoothing was done. This removes the horizontal striping effect which is an unphysical artefact of this retrieval scheme.

LITE vertical resolution is originally 15 m, upto 40 km, but this is reduced to 150 m before doing this inversion to reduce the noise, and increase photon-statistics in the data. For the same reason 5 along track profiles are accumulated before doing the inversion, resulting in a horizontal resolution of about 3.5 km.

The input for this module may be the filename holding this retrieved data. However, to simplify working with it several interesting files have been selected and assigned a scene letter (A to K, and S), which may also be used as input.

The defined scenes are:

A: location: over Indonesia, date: 19940910, time between 20:00:04 and 20:02:03, contains: a cirrus layer around 15 km, and aerosol layers below 3 km

B: location: over Indonesia, date: 19940910, time between 20:02:04 and 20:04:03, contains: aerosol layers below 4 km.

C: location: before the coast of Birma, date: 19940912, time between 19:44:06 and 19:46:06, tropical convective clouds upto 15 km.

D: location: South America, over the Andes, date: 19940914, time between 07:48:06 and 07:50:06, contains: mountains upto 5 km, and a cloud layer above it around 11 km.

E: location: pacific ocean, near the galapagos islands, date 19940915, time between 07:32:02 and 07:34:02, contains: several high (15 km) and lower (2 km, 6-7 km) cloud layers

F: location: pacific ocean, near the galapagos islands, date 19940915, time between 07:34:02 and 07:36:02, contains: a low stratus cloud layer between 1-2 km.

G: location: over Australia, date: 19940917, time between 16:18:08 and 16:20:08, contains: aerosol layers upto 7-8 km (and some desert dust?).

H: location: North Sea, 19940917, time between: 20:20:56 and 20:22:04, contains: a low stratus cloud layer between 2-3 km.

I: location: over Turkey, Israel (or Libanon?), and Jordan, date: 19940917, time between 20:28:04 and 20:30:04, contains: a broken cloud layer around 6 km, and some scattered lower clouds between 2-3 km.

J: location: over Arabia, date 19940917, time between 20:32:04 and 20:34:04, contains: a clear case of desert dust upto 5 km.

K: location: over Arabia, date 19940917, time between 20:34:04 and 20:36:04, contains: a clear case of desert dust upto 5 km, partially overed by a cloud layer at 6 km..

S: location: over the Sahara, date 19940912, time between 00:14:00 and 00:16:00, contains: desert dust layers below 3 km.

In figure 11 the locations of these selected scenes are indicated.

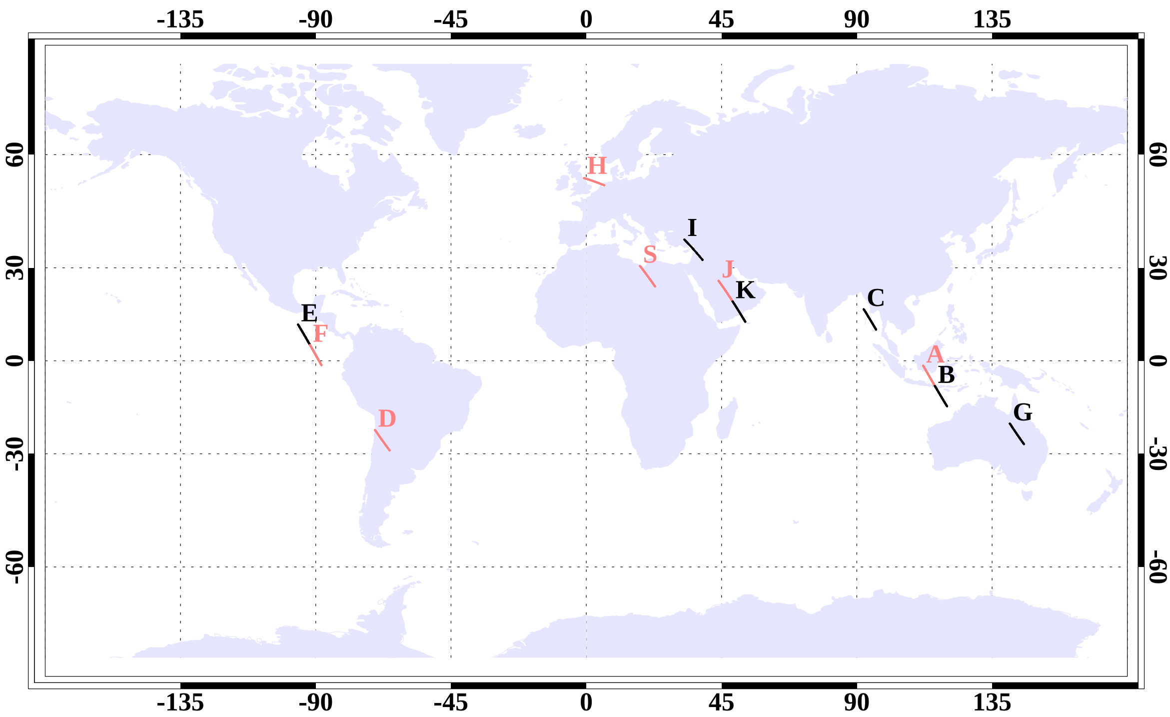


Figure 11: *Locations of the selected LITE scenes. The red/black coloring is introduced to be able to tell the difference between 2 adjacent scenes.*

In figure 12 an example is shown of the actual data available for scene D. Clearly the orography and the cloud layer above the mountains can be seen. The cloud detection is not perfect, since their shadow is clearly visible in the aerosol backscatter data. This cloud detection was implemented by selecting a number of clean profiles by hand, and using this (with an increment) as threshold to discriminate between aerosol and aerosol+cloud backscatter cases. However, note that a perfect separation of aerosols and clouds will never be possible for LITE data, because aerosol and molecular backscatter have not been measured independently. Also some some artefacts of the retrieval scheme are still visible especially inside the clouds.

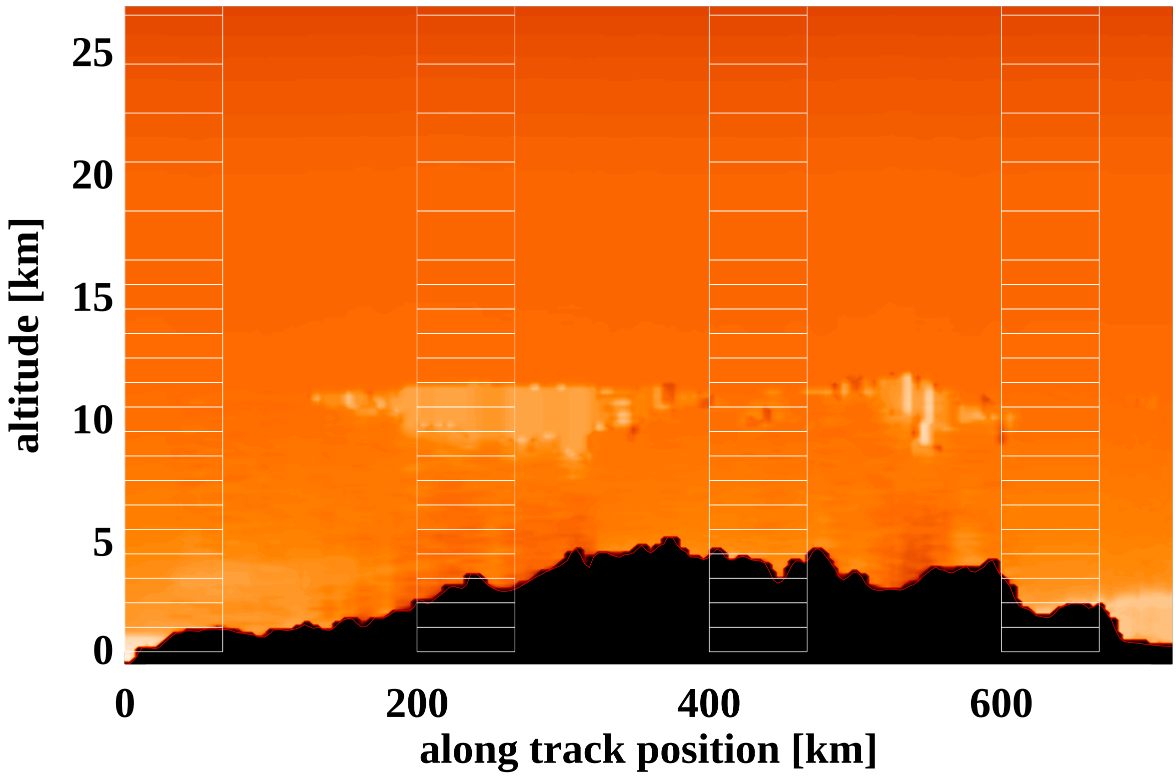


Figure 12: *Example of retrieved backscatter for LITE scene D (aerosol only, cloud backscatter has been mostly removed) Overplotted in white are the boxes typically used for accumulating the Aeolus data (1 or 2 km high, 50 km long, repeated every 200 km). Clearly the cloud detection is not perfect, since their shadow is clearly visible in the aerosol backscatter. The colors denote 10log of the aerosol backscatter values between -13.3 (dark-red) upto -4.3 (white). The overplotted orange line is the orography as read from the LITE datafiles.*

After selecting a scene, all profiles in this scene are stored in memory using the Interpolate module. Data can be retrieved after giving the profile number within the scene, or after giving an offset distance from a given start profile number (in this latter case horizontal interpolation is used if necessary).

Then, given the altitude (if needed) the following data is available: lat, lon, date, time, land-sea-mask, orography, aerosol and cloud backscatter values.

5.4.13 MerciProf

The Merci profile module provides access to a set of atmospheric database files produced for the MERCI project, and obtained from Gert-Jan Marseille.

The data was retrieved from the ECMWF MARS archive for simulations needed to study the error correlations of the wind observations by the ADM-Aeolus mission (see [RD6]), and written in one large datafile. An example of the available data (pressure, temperature, wind u,v,w components and relative humidity) is given in figure 13. Note that this set of profiles does not form an orbit, but is rather a random collection of interesting profiles from different locations at different dates and times. It does, however, give a good feeling of the variability and magnitudes present in the different quantities.

This module reads this collection of profiles and stores them using the Interpolate module. Then, after giving the profile number (within the file), and the altitude, the following parameters are avilable: pressure, temperature, the 3 wind components u, v and w, humidity, cloudcover, cloud liquid water content, and cloud ice water content.

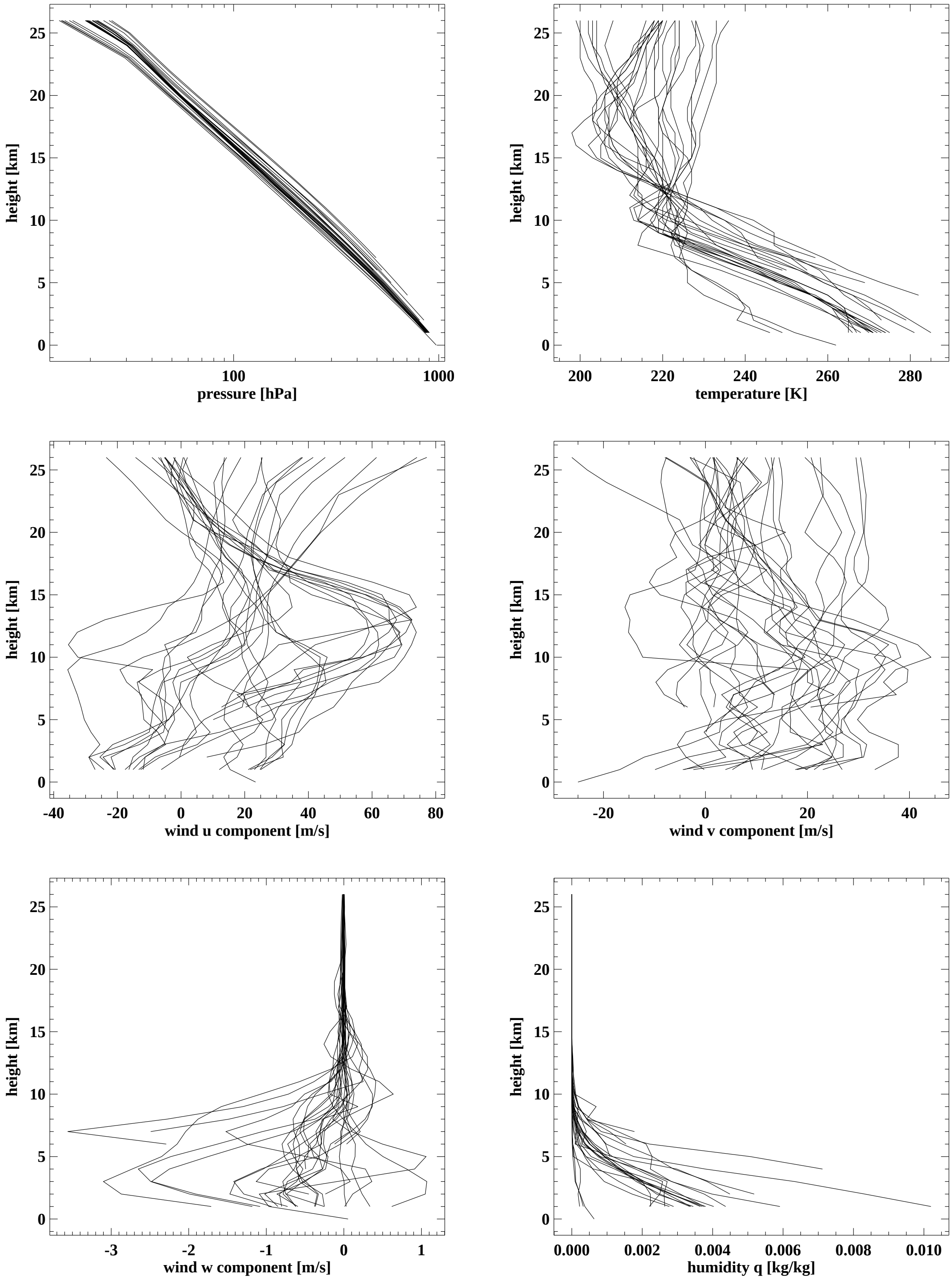


Figure 13: *Example of profiles from the Merci dataset, made available by the MerciProf module.*

5.4.14 MolScat

This module implements a method published by W.M.F. Wauben to calculate the molecular extinction for a given pressure, temperature and wavelength (see [RD5]).

The module takes pressure, and temperature as input, and directly calculates the molecular extinction from it. For convenience another function was added to convert this extinction directly to molecular backscatter, using $\beta_m = 3\sigma_m/(8\pi)$ (see also footnote [8] on page 9).

Three example profiles calculated with this module are shown in figure 14. The pressure and temperature profiles used as input where taken from the RMA profiles, see section 5.4.1 figure 1 (upper two panels). As reference also the climatological molecular backscatter is shown (blue line), see section 5.4.1 figure 1 (lower right panel).

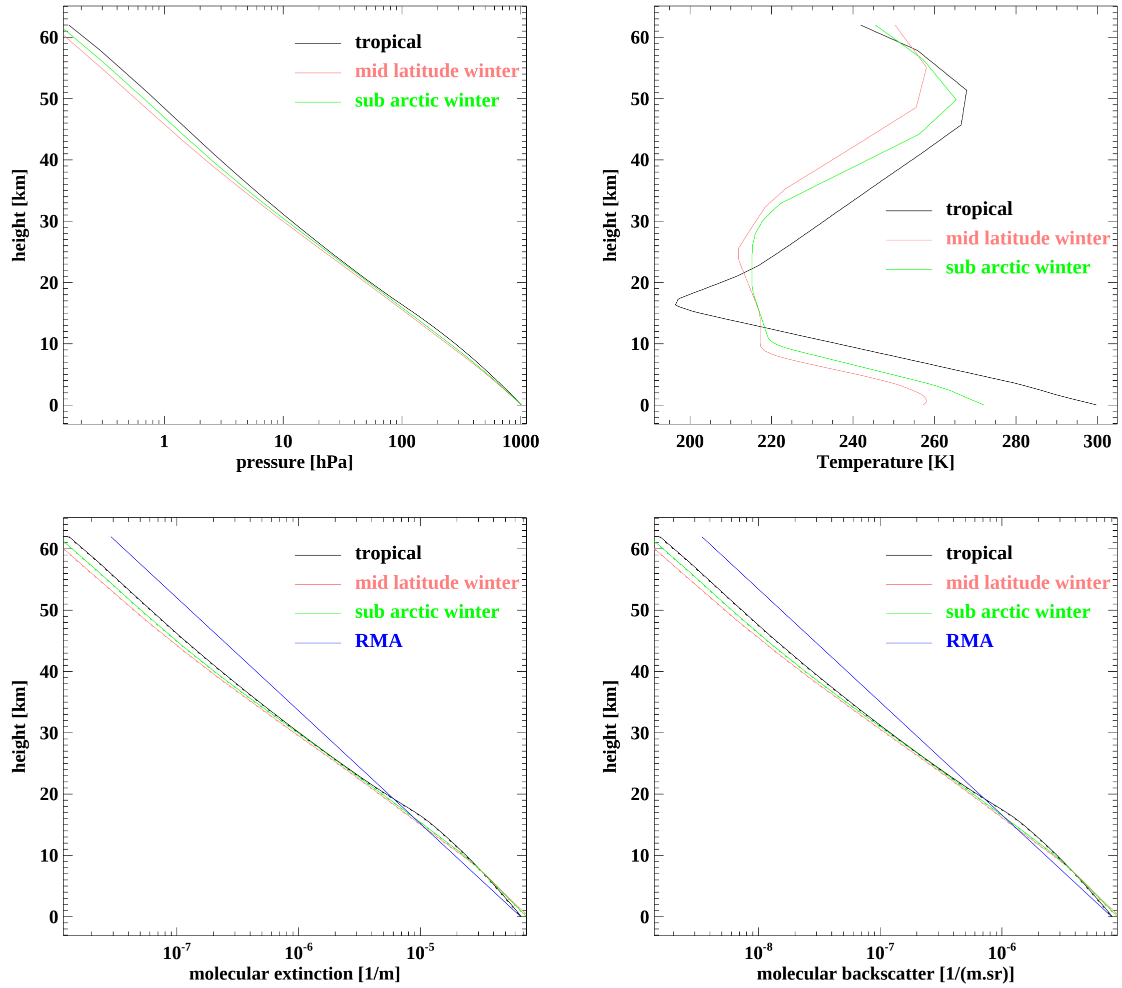


Figure 14: *Example of profiles from the MolScat module.*

A slightly different calculation for molecular backscatter has been in use by the L2A project team from Météo France. To allow this team to use the database as well, this different calculation has been added as well to the database. The results for this parametrisation has also been added in figure 14 for the 3 RMA profiles, with dashed lines. They are so similar that the lines are barely distinghuishable. The different between both methods is only 1.56 % (Météo France method gives slightly smaller values), and is probably caused by some rounding of the parameter values used in the parametrisation.

5.4.15 Orbit

A module to do a simple orbit calculation, by giving the orbit inclination angle and the satellite ground speed, and assuming a circular orbit and a spherical earth. It is initialised by giving starting lat-lon position and timestep. A method is provided to request a new satellite position, which is shifted at every call by the distance corresponding to the given timestep. An example of an orbit generated with this module is given in figure 15. The conversion tools, needed to produce xml input files for the E2S, should replace these lat,lon numbers by their own more precise orbit calculation (see section 4.3 for a discussion of these tools).

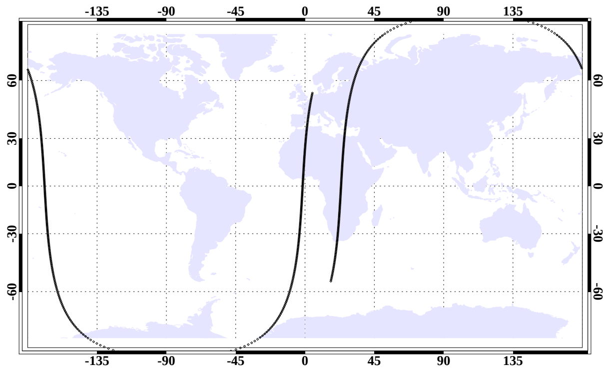


Figure 15: *Example of a simple orbit produced by the Orbit module.*

This is not intended to be a precise orbit calculation ! It is just a way of generating lat-lon pairs for cases in which no orbit and date-time information is available (for example for the several artificial test profiles).

5.4.16 Radio Sonde

This module reads the Radio Sonde datafiles available for the measurements in De Bilt[26].

The input for the module is the name of the file containing this data, which is then stored using the Interpolate module.

After giving the wanted altitude, the following parameters are available: pressure, temperature, (Not yet implemented: humidity, dewpoint temperature), wind direction and wind speed.

A general problem with this datatype is that the balloon often does not reach the altitude of 30 km, which we need for our database (see figure 16). Missing sections of the profile are replaced by the highest available valid datapoint for all parameters except for the pressure, which is logarithmically decreased starting from the highest available point. If data is requested below the lowest available valid datapoint then the missing data is replaced by the lowest available valid datapoint for all profiles, except for pressure which is logarithmically increased below the lowest available datapoint.

The large deviation between the lowest black point in the profiles of temperature, wind speed and direction, and the green extrapolated point is due to the boundary layer. This causes large gradients between the altitude of 1 km and the ground (lowest reported values are at about 4 m above see level). When a value at an altitude of 0 m is requested, the module returns with the value at 4 m, which generally has a much lower windspeed, which may have a rotated wind direction, and which may have a very different temperature than what is reported at 1 km.

Replacing missing data with a constant value has the advantage that it is clear where the real data stops. If NWP or other data would be placed here, this might be confusing during later use.

Note that some profiles seem to have missing data halfway the profile as well for some (but not all) parameters. To prevent problems caused by this, files are selected by hand that don't have this problem. If needed an interpolation can be done here as well between the parts of the profile that do contain valid data.

5.4.17 Topo

This module implements the reading of a binary topography file ETOPO5.DOS, downloaded from:
http://www.ngdc.noaa.gov/mgg/global/relief/ETOPO5/TOPO/ETOPO5/

This free downloadable file defines the earth topography at a resolution of 5 minutes (although in some data deficient regions the actual resolution is just 1 degree). It defines the elevation for each tile in whole

[26]Only De Bilt radiosonde has been implemented for now. Other locations would have been too time-consuming since different file reading code would be needed for that.

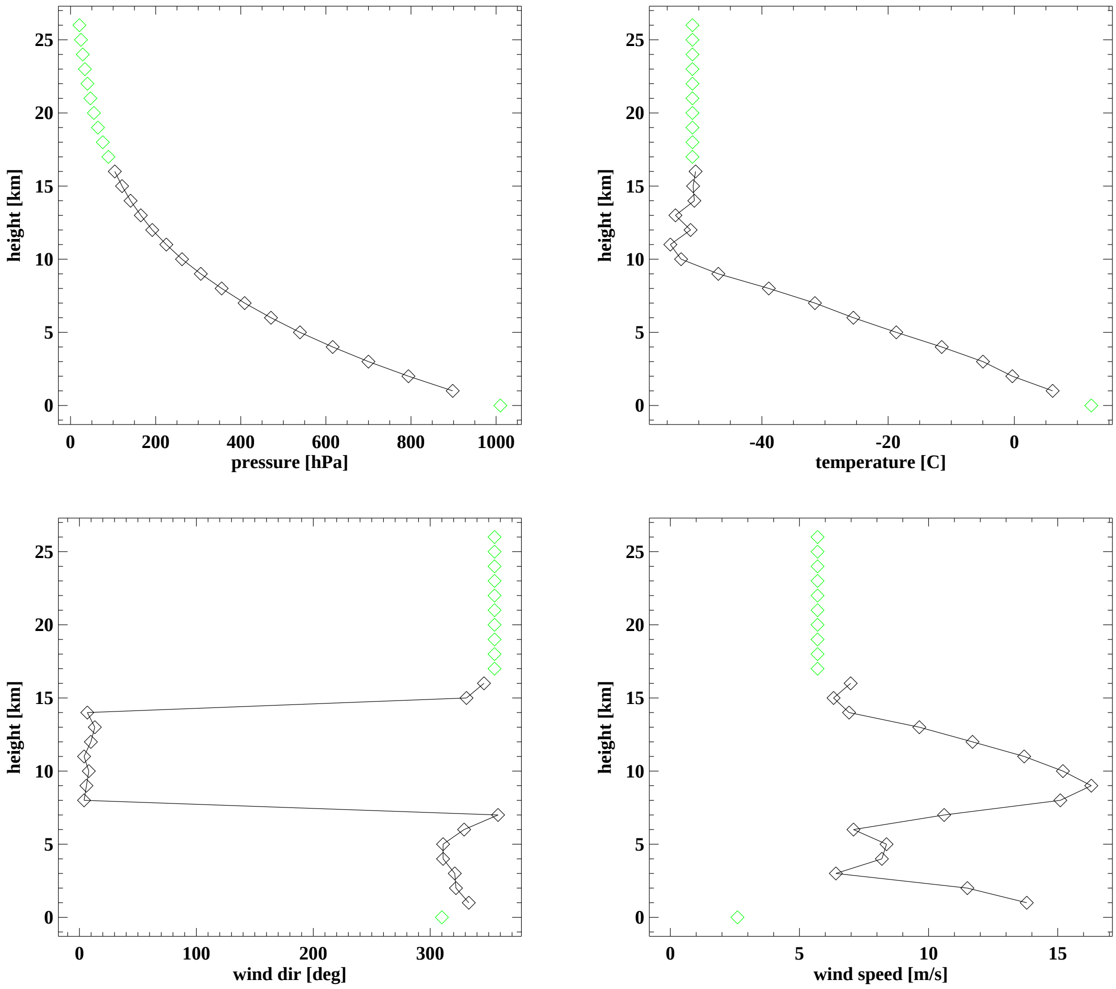


Figure 16: *Example of radiosonde profiles for pressure, temperature, wind direction and windspeed. Missing data (indicated by the green symbols) is replaced by the highest or lowest available value (or for a logarithmically decreasing/increasing function for pressure).*

meters. At sea this file defines the depth of the sea-floor, so by screening for negative values, it provides a land-sea-mask as well.

The reason for using this file for the moment, is the relative modest size of this file (18 MB) which makes it much easier to handle than the full resolution GTOPO030 topographic data with a resolution of 30 arc seconds (or ca. 1 km), which was proposed first for usage by the final processor, or than the ACEv1 DEM model that is selected now, see [AD2] section 4.9, ground detection (p.9).

There are no plans at the moment to upgrade the resolution of the model. The reason is that exact lat/lon/date/time information is not available when the atmospheric database is generated, only after running the E2S this is the case. Therefore the user should replace the ground levels with the DEM result from the E2S if high accuracy is desired[27]. Replacing the GTOPO02 model by the GTOPO05 model would therefore not increase the database accuracy.

The module accepts a lat-lon pair and returns an elevation for that location (or at sea a negative elevation for the sea floor). It does not store the file in memory, but uses the direct access option of fortran to directly read the appropriate values from the file, without having to read it all in memory. Then the necessary interpolation is done to retrieve the topography at the requested lat,lon.

[27]Note that the E2S does have an option to switch off using the DEM, and import the orography from the atmosphereGroundParameters.xml input file. however, the L1B cannot handle this and will probably use the DEM anyway to process the data. So it probably is not a good idea to use this option.

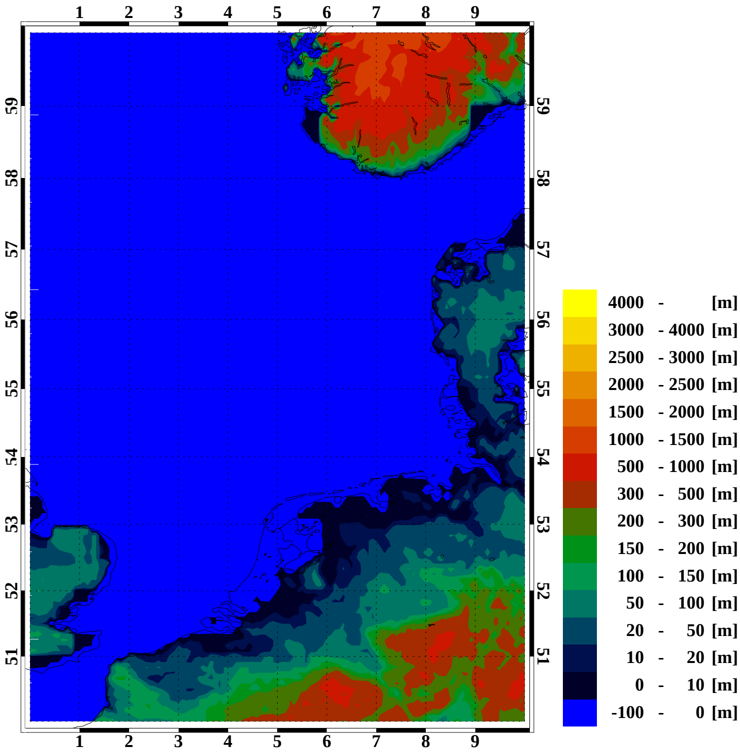


Figure 17: *Example of topography data for the region around the North Sea, as available from the Topo module. The actual coastline is overplotted using a black line.*

An example of this data is given in figure 17. Clearly the land-sea mask produced by assuming all levels below zero are sea is not very accurate. However, for simulation purposes this is not relevant, so this dataset seems good enough for this purpose.

5.5 main program

All the above described modules are combined into a single main executable, named make_atm_db_profiles. This program uses command-line switches to select the data source to use (and the files to be read), for each of the needed values for the database.

An example of one call of the main fortran program looks likes this:
./make_atm_db_profiles -p RMA -t RMA -aer RMA -mol RMA -uv Zero -w Zero -rma tropics -ow settings -of filename -count 2

This program in turn is executed many times to generate all scenes needed for the atmospheric database. A single call creates a single database file. This list of calls, with all needed command-line switch settings, is defined in a python script named make_atm_database.py, in order to allow easy recreation of all scenes, in case something in one of the datasources, or in the output fileformat, has to be changed, or if a bug in one of the datasources is detected and solved.

The full python script, which was used to create all scenarios, is given in appendix C,

Optionally, after creating all the ascii files for all scenarios, they can be converted to the xml format suitable for input in the E2S program. This is done by using an updated version of the Matlab tool ConvertTxtScenarioToXML() originally written by Marie-Laure Denneulin[28] This tool creates a new xml file for each of the profiles in the ascii file, so for files with 150 profiles, 150 different xml files will be generated. This leads to an large amount of disk usage, which is the reason that the xml files are no longer distributed with this database. In stead the conversion tool is made available, which is also usefull for other

[28] revision 1.2, 11 Oct. 2007. A copy of this tool is available in the L2BP software package in directory Matlab_Tools/CREATIONDATA/ or in the eRoom.

reasons (see the discussion in section 4.3 about this tool).

5.6 Combination tool

For certain types of tests it is desirable to create larger orbit sections as input for a simulation. A little tool has been developed which allows combining arbitrary atmospheric database files into a single new scenario. Note that for larger orbit sections an estimate of the center lat-lon/date-time values is not very usefull anymore. Therefore no effort has been spend on implementing this, and a new filename convention has been used for combined files. A file containing combined scenarios is simply called: combined_scenes.asc. and placed in its own directory, with a descriptive name like for example Calipso_Segments_1_to_7_and_EcmwfColloc. The scenarios used to produce the combined scenario are written to a little text file named: scenariolist.txt Using this file the original scenarios used to build the combined scenario can be found, and the atm_db_settings.txt can be inspected to see which datasources and settings wehere used to create the scenario.

6 scenarios

This section will describe the scenarios currently present in the atmospheric database, and the criteria used for choosing them.

The following criteria have been used for contructing scenarios for the atmospheric database:

- to test the available data sources (cases 1-23, 36-37) (see section: 6.1)
- to test Dorit's conversion tool (all cases) (see section 6.2)
- to test specific algorithms in the E2S tool (no cases yet) (see section 6.3)
- to test specific algorithms in the L1B processor (no cases yet) (see section 6.4)
- to test specific algorithms in the L2A processor (case 78) (see section 6.5)
- to test specific algorithms in the L2B processor (cases 24-35,38-77) (see section 6.6)

A summary of all scenarios available in the database, and the sources used to construct them is given in table 7.

Sources for P/T are:

- RMAS = RMA sub-arctic winter
- RMAW = RMA mid-latitude winter
- RMAT = RMA tropical
- TGRAD = RMA mid-latitude winter, but with an increasing constant offset in temperature added to each subsequent profile.
- ECMWF = from collocation with ECMWF model data
- MERCI = from the MERCI database

Sources for u/v are:

- 0/20/80 = windcomponents set to 0/20/80 m/s
- Sonde = Radio sonde
- Hgrad = artificial horizontal gradient with fixed steps from profile to profile
- Vgrad = artificial vertical gradient with fixed steps from layer to layer
- ECMWF = from collocation with ECMWF model data
- MERCI = from the MERCI database

Table 7: Available scenarios in the atmospheric database, and the datasources used for each scene. For explanation of the acronyms and for more details on the scenarios see text.

	data sources used by each scene						
scene name	count	P/T	u/v	beta_a	beta_c	sigma_c	beta_m
default_test	1	RMAW	0	RMAM	-	-	calc
single_RMA_profile_tropics	2	RMAT	0	RMAM	-	-	par
single_RMA_profile_midlat_winter	3	RMAW	0	RMAM	-	-	par
single_RMA_profile_subarctic_winter	4	RMAS	0	RMAM	-	-	par
MERCI_profile_1	5	MERCI	0	RMAM	-	-	calc
single_RMA_subarctic_winter_and_PSC	6	RMAS	0	RMAM	PSC	PSC	par
single_RMA_midlat_winter_and_cumulonimbus	7	RMAW	0	RMAM	CB	CB	par
single_RMA_midlat_winter_and_altostratus	8	RMAW	0	RMAM	AS	AS	par
single_RMA_midlat_winter_and_stratus	9	RMAW	0	RMAM	S	S	par
single_RMA_midlat_winter_and_fwc and	10	RMAW	0	RMAM	FWC	FWC	par
single_RMA_midlat_winter_and_cirrus	11	RMAW	0	RMAM	C	C	par
LiteScene_A_and_RMA	12	RMAT	0	LA	LA	calc	calc
LiteScene_B_and_RMA	13	RMAT	0	LB	LB	calc	calc
LiteScene_C_and_RMA	14	RMAT	0	LC	LC	calc	calc
LiteScene_D_and_RMA	15	RMAW	0	LD	LD	calc	calc
LiteScene_E_and_RMA	16	RMAT	0	LE	LE	calc	calc
LiteScene_F_and_RMA	17	RMAT	0	LF	LF	calc	calc
LiteScene_G_and_RMA	18	RMAT	0	LG	LG	calc	calc
LiteScene_H_and_RMA	19	RMAW	0	LH	LH	calc	calc
LiteScene_I_and_RMA	20	RMAT	0	LI	LI	calc	calc
LiteScene_J_and_RMA	21	RMAT	0	LJ	LJ	calc	calc
LiteScene_K_and_RMA	22	RMAT	0	LK	LK	calc	calc
LiteScene_S_and_RMA	23	RMAT	0	LS	LS	calc	calc
TestScenario_1.1_u00	24	RMAW	0	ratio	-	-	calc
TestScenario_1.1_u20	25	RMAW	20	ratio	-	-	calc
TestScenario_1.1_u80	26	RMAW	80	ratio	-	-	calc
TestScenario_1.2_u00	27	TGRAD	0	ratio	-	-	calc
TestScenario_1.2_u20	28	TGRAD	20	ratio	-	-	calc
TestScenario_1.2_u80	29	TGRAD	80	ratio	-	-	calc
TestScenario_2.1_rho1.0	30	RMAW	Hgrad	ratio	-	-	calc
TestScenario_2.1_rho2.0	31	RMAW	Hgrad	ratio	-	-	calc
TestScenario_2.1_rho5.0	32	RMAW	Hgrad	ratio	-	-	calc
TestScenario_2.2_rho1.0	33	RMAW	Vgrad	ratio	-	-	calc
TestScenario_2.2_rho2.0	34	RMAW	Vgrad	ratio	-	-	calc
TestScenario_2.2_rho5.0	35	RMAW	Vgrad	ratio	-	-	calc
RadioSonde_and_RMA	36	RMAW	Sonde	RMAM	-	-	calc
LiteScene_H_and_RadioSonde	37	RMAW	Sonde	LH	LH	calc	calc
RMA_pt_Calc_Mol_midlat_winter	38	RMAW	0	RMAM	-	-	calc
RMA_pt_Calc_Mol_midlat_winter_and_altostratus	39	RMAW	0	RMAM	AS	AS	calc
RMA_pt_Calc_Mol_midlat_winter_and_cirrus	40	RMAW	0	RMAM	C	C	calc
LiteScene_A_and_RMA_3.6km	41	RMAT	0	LA	LA	calc	calc
LiteScene_B_and_RMA_3.6km	42	RMAT	0	LB	LB	calc	calc
LiteScene_C_and_RMA_3.6km	43	RMAT	0	LC	LC	calc	calc
LiteScene_D_and_RMA_3.6km	44	RMAW	0	LD	LD	calc	calc
LiteScene_E_and_RMA_3.6km	45	RMAT	0	LE	LE	calc	calc
LiteScene_F_and_RMA_3.6km	46	RMAT	0	LF	LF	calc	calc
LiteScene_G_and_RMA_3.6km	47	RMAT	0	LG	LG	calc	calc
LiteScene_H_and_RMA_3.6km	48	RMAW	0	LH	LH	calc	calc
LiteScene_I_and_RMA_3.6km	49	RMAT	0	LI	LI	calc	calc
LiteScene_J_and_RMA_3.6km	50	RMAT	0	LJ	LJ	calc	calc
LiteScene_K_and_RMA_3.6km	51	RMAT	0	LK	LK	calc	calc
LiteScene_S_and_RMA_3.6km	52	RMAT	0	LS	LS	calc	calc

Table 7: continued table:

	data sources used by each scene						
scene name	count	P/T	u/v	beta_a	beta_c	sigma_c	beta_m
LiteScene_A_and_EcmwfColloc_3.6km	53	ECMWF	ECMWF	LA	LA	calc	calc
LiteScene_B_and_EcmwfColloc_3.6km	54	ECMWF	ECMWF	LB	LB	calc	calc
LiteScene_C_and_EcmwfColloc_3.6km	55	ECMWF	ECMWF	LC	LC	calc	calc
LiteScene_D_and_EcmwfColloc_3.6km	56	ECMWF	ECMWF	LD	LD	calc	calc
LiteScene_E_and_EcmwfColloc_3.6km	57	ECMWF	ECMWF	LE	LE	calc	calc
LiteScene_F_and_EcmwfColloc_3.6km	58	ECMWF	ECMWF	LF	LF	calc	calc
LiteScene_G_and_EcmwfColloc_3.6km	59	ECMWF	ECMWF	LG	LG	calc	calc
LiteScene_H_and_EcmwfColloc_3.6km	60	ECMWF	ECMWF	LH	LH	calc	calc
LiteScene_I_and_EcmwfColloc_3.6km	61	ECMWF	ECMWF	LI	LI	calc	calc
LiteScene_J_and_EcmwfColloc_3.6km	62	ECMWF	ECMWF	LJ	LJ	calc	calc
LiteScene_K_and_EcmwfColloc_3.6km	63	ECMWF	ECMWF	LK	LK	calc	calc
LiteScene_S_and_EcmwfColloc_3.6km	64	ECMWF	ECMWF	LS	LS	calc	calc
AllZeros	65	RMAW	0	-	-	-	-
MoleculesOnly	66	RMAW	0	-	-	-	calc
Calipso_Segment1_and_RMA	67	RMAS	0	CAL1	-	-	calc
Calipso_Segment1_and_EcmwfColloc	68	ECMWF	ECMWF	CAL1	-	-	calc
Calipso_Segment2_and_EcmwfColloc	69	ECMWF	ECMWF	CAL2	-	-	calc
Calipso_Segment3_and_EcmwfColloc	70	ECMWF	ECMWF	CAL3	-	-	calc
Calipso_Segment4_and_EcmwfColloc	71	ECMWF	ECMWF	CAL4	-	-	calc
Calipso_Segment5_and_EcmwfColloc	72	ECMWF	ECMWF	CAL5	-	-	calc
Calipso_Segment6_and_EcmwfColloc	73	ECMWF	ECMWF	CAL6	-	-	calc
Calipso_Segment7_and_EcmwfColloc	74	ECMWF	ECMWF	CAL7	-	-	calc
MoleculesOnlyAnd2Clouds	75	RMAW	0	0	Ci	Ci	calc
MERCI_profile_2_uvw	76	MERCI	MERCI	RMAM	-	-	calc
MERCI_profile_50_uvw	77	MERCI	MERCI	RMAM	-	-	calc
single_RMA_profile_midlat_winter_MF	78	RMAW	0	RMAM	-	-	calc_mf
Calipso_Segments_1to7_and_EcmwfColloc	68-74	ECMWF	ECMWF	CAL1-CAL7	0	0	calc

Sources for beta_a are:

- RMAM = RMA median
- LA...LS = LITE scene A ...LITE Scene S
- ratio = calculate aerosol backscatter from molecular backscatter using a constant backscatter ratio profile
- CAL1-CAL7 = CALIPSO segment 1 to 7

Sources for beta_c are:

- PCS = synthetic polar stratospheric cloud
- CB = synthetic cumulonimbus
- AS = synthetic altostratus
- S = synthetic stratus
- FWC = synthetic fair weather cumulus
- C = synthetic cumulus
- Ci = synthetic cirrus
- LA...LS = LITE scene A ...LITE Scene S

Sources for sigma_c are:

- PCS = synthetic polar stratospheric cloud
- CB = synthetic cumulonimbus
- AS = synthetic altostratus
- S = synthetic stratus
- FWC = synthetic fair weather cumulus
- C = synthetic cirrus
- Ci = synthetic cirrus
- calc = calculated from backscatter using a simple constant backscatter to extinction ratio of 0.02 [1/Sr].

Sources for beta_m are:

- par = parametrised profile,
- calc = calculated from p and T
- calc_mf = calculated from p and T using MF parametrisation

Aerosol extinction is calculated from aerosol backscatter in all cases using a simple constant backscatter to extinction ratio of 0.02 [1/Sr]. Cloud extinction is calculated from cloud backscatter in most cases using a simple constant backscatter to extinction ratio of 0.05 [1/Sr], except when it is defined explicitely using the Clouds module.

6.1 selected scenarios to test the implemented data sources

Selected scenarios:

- test for the default settings of the main program. This results in 1 file in the directory named: default_test
- test for the RMA profiles defined by the AtmState module. This results in 3 files in the directories named: single_RMA_profile_tropics, single_RMA_profile_midlat_winter and single_RMA_profile_subarctic_winter. Note that all 3 climate zones use the median aerosol backscatter RMA profile.
- test for the Merci datafile, read by the MerciProf module. This results in 1 file in the directory named: MERCI_profile_1
- test for synthetic cloud generation, defined by the Clouds module. This results in 6 files (one for each defined cloud type) in the directories named: single_RMA_subarctic_winter_and_PSC, single_RMA_midlat_winter_and_cumulonimbus, single_RMA_midlat_winter_and_altostratus, single_RMA_midlat_winter_and_stratus, single_RMA_midlat_winter_and_fwc and single_RMA_midlat_winter_and_cirrus.
- test for the selected LITE scenes A-K+S, available through the LiteProf and LiteScatProf modules. This results in 12 files in the directories named: LiteScene_A_and_RMA, LiteScene_B_and_RMA, LiteScene_C_and_RMA, LiteScene_D_and_RMA, LiteScene_E_and_RMA, LiteScene_F_and_RMA, LiteScene_G_and_RMA, LiteScene_H_and_RMA, LiteScene_I_and_RMA, LiteScene_J_and_RMA, LiteScene_K_and_RMA and LiteScene_S_and_RMA.
- test for use of radio sonde data, available through the RadioSonde module. This results in 1 file in the directory named: RadioSonde_and_RMA
- test for collocating LITE above the North Sea and radio sonde data at De Bilt. This results in 1 file in the directory named: LiteScene_H_and_RadioSonde
- test for use of CALIPSO data, combined with RMA profiles. This results in 1 file in the directory named: Calipso_Segment1_and_RMA
- (more to follow)

6.2 selected scenarios to test the conversion tools

No scenarios have been especially selected to test these tools. Dorit's Java tool was applied to version 1.0 of this database. Marie-Laure's matlab tool was applied to version 1.1 of this database. A few problems regarding handling of missing numbers were found in this matlab tool, which lead to an update. The updated matlab tool was applied to versions 1.2-1.4 of this database.

6.3 selected scenarios to test the E2S tool

selected scenarios:

- no requests for data have been recieved.

Note that all scenarios selected for use by the L0/1A/1B and L2A/2B/2C tests need to pass this stage as well. This way it was found that the E2S cannot handle the missing numbers as defined by this database. As a consequence the conversion tool needed to generate the xml files needed by the E2S as input was adapted to skip all levels containing missing data.

6.4 selected scenarios for L0/L1A/L1B processor tests

selected scenarios:

- no requests for data have been recieved.

Note that all scenarios selected for use by the L2A/2B/2C tests need to pass this stage as well. Scenarios that should be tested with the L1BP (taken from Herbert Nett's email of 07-02-2005) include:

- cases of variable earth surface reflectance (test of ground echo detection/validation, end-to-end calibration). This is not yet added to the database due to lack of time. See also footnote [14] on page 17 To enable this the conversion tool needs updating, see the discussion in section 4.3 on this subject.
- cases of large/low winds (are available in the Merci data, but not yet added to the database), high/low aerosol loads in layer immediately above surface (ground echo processing/validation) (are available in several of the LITE scenes)
- variable thickness of atmospheric layer in height bin containing the ground echo (is available in the LITE data scene D which has strongly varying orography)
- nadir viewing geometries (end-to-end/response calibration) Note that the viewing geometry is not defined in this database, but enters the simulation through the conversion tool. This test should be constructed using data from the database combined with proper E2S input settings) Possible a usefull scenario to be used here is one with a linearly increasing ground surface.
- systematic and random type variations in profile data (p, T, aerosol) in target atmospheres for end-to-end calibrations. A systematic variation is several profiles has already been implemented (for example horizontal or vertical gradients in the wind u component). Adding random varyation is simple, but we need to define the variability of each parameter to be able to choose a realistic variation. This is not yet done. It might be easier to do this outside the database, in the conversion tool/matlab maybe, since for good statistics this will be repeated many times, and it seems not very practical to let the database grow by a huge amount because of this)

6.5 selected scenarios for L2A processor tests

selected scenarios:

- single_RMA_profile_midlat_winter_MF: RMA mid latitude winter profiles for pressure temperature, median RMA profile for aerosol backscatter, Météo France parametrisation for molecular backscatter

6.6 selected scenarios for L2B processor tests

The needed test scenarios for the L2B processor are described in [AD3].

selected scenarios:

- Scenario 1.1: a single set of vertical profiles of pressure and temperature from RMA. Constant wind-speed (3 cases for hlos=0,20 or 80 m/s). A constant backscatter ratio profile, varied horizontally from 1 to 1.2 by increments of 0.05 (5 values). This results in 3 files in the directories named: TestScenario_1.1_u00, TestScenario_1.1_u20 and TestScenario_1.1_u80.
- Scenario 1.2: same as scenario 1.1, but now a horizontal linear gradient is added to T. The gradient is varies from 0 K to 10 K by increments of 2.5 K (so 5 different gradients). This results in 3 files in the directories named: TestScenario_1.2_u00, TestScenario_1.2_u20 and TestScenario_1.2_u80.
- Scenario 2.1: pressure and temperature are taken homogeneous in the horizontal, and are taken from the RMA. The wind profile is vertically constant, and varies linearly in horizontal direction. The hlos wind component is varied from -75 to +74 m/s, and incremented with 1 m/s for every next profile. The backscatter ratio is vertically constant and varied. Values for backscatter ratio of 1, 2 and 5 are used at the moment, this results in 3 files in the directories named: TestScenario_2.1_rho1.0, TestScenario_2.1_rho2.0 and TestScenario_2.1_rho5.0.

- Scenario 2.2: pressure and temperature are taken homogeneous in the horizontal, and are taken from the RMA. The hlos wind component profile is horizontally homogeneous, and varies linearly with height. A surface value of 5 m/s and a gradient of 4 m/s per km is used at the moment. The backscatter ratio is vertically constant and varied Values for backscatter ratio of 1, 2 and 5 are used at the moment, this results in 3 files in the directories named: TestScenario_2.2_rho1.0, TestScenario_2.2_rho2.0 and TestScenario_2.2_rho5.0.
- RMA pressure and temperature and aerosol RMA profiles, using the midlat_winter scenario, combined with calculated molecular backscatter and extinction (from p,T). The result is written to directory: RMA_pt_Calc_Mol_midlat_winter
- RMA pressure and temperature and aerosol RMA profiles, using the midlat_winter scenario, combined with calculated molecular backscatter and extinction (from p,T), and a synthetic altostratus cloud layer. The result is written to directory: RMA_pt_Calc_Mol_midlat_winter_and_altostratus
- RMA pressure and temperature and aerosol RMA profiles, using the midlat_winter scenario, combined with calculated molecular backscatter and extinction (from p,T), and a synthetic cirrus cloud layer. The result is written to directory: RMA_pt_Calc_Mol_midlat_winter_and_cirrus
- LiteScene scenes A-S at the original 3.6 km processing step, combined with RMA profiles. The files are written in directories named: LiteScene_*_and_RMA_3.6km
- LiteScene scenes A-S at the original 3.6 km processing step, collocated with ECMWF ERA-40 data. The files are written in directories named: LiteScene_*_and_EcmwfColloc_3.6km
- a test scene without any atmosphere. No wind, no aerosol and no molecular backscatter. The result is written to directory: AllZeros
- a test scene with a totally clean atmosphere. No wind, no aerosol no clouds, only molecular backscatter. The result is written to directory: MoleculesOnly
- CALIPSO data collocated with the operational ECMWF NWP model. The files are written in directories named: Calipso_Segment*_and_EcmwfColloc
- a test scene with a totally clean atmosphere. No wind, no aerosol only molecular backscatter, and two artifical cloudlayers. The result is written to directory: MoleculesOnlyAnd2Clouds
- All 7 CALIPSO segments combined in a single scenario, collocated with the operational ECMWF NWP model. The result is written to directory: Calipso_Segments_1to7_and_EcmwfColloc
- the MoleculesOnlyAnd2Clouds scenario, for testing the L2BP optical properties code
- MERCI_profile_2_uvw and MERCI_profile_50_uvw to enable defining tests 5-27 from TN3.1

The other requests have not yet been added, since an alternative matlab program is available to produce these simple synthetic scenes, without need for database input. If needed they will be added at request later.

Appendix A

Below follows a part of an example data file. The default_test scenario has been taken as example. The lines starting with # are the header. Followed by a single line with 2 numbers. This is followed by 1 block, consisting of 1 line of ancillary data and 240 lines defining the profile on this location.

```
# file format version number: 0.2
# scene description: default_test
# creation date and time: 20080215 11:21
# creator: Jos de Kloe (KNMI)
# purpose: for testing of the fileformat only
# origin of atmospheric data: RMA mid_latitude_winter (climatology)
# origin of backscatter data: RMA (climatology, median)
#
# line definition 1: nr of profiles and nr of height steps per profile
# nr. of items:   2
# items: nprofiles, nsteps
# unit: nr, nr
# format: (i4,1x,i3)
# missing values:   -1,  -1
# separator character: ','
#
# nr of profiles in this track:   1
#
# line definition 2: surface and ancillary information
# nr. of items:  13
# items: Lat, Lon, orogr, beta_g, B, albedo, mask, CCYY, MM, DD, h, m, s
# unit: 1 deg, 1 deg, 1 m, 1/sr, 1 W/m^2, fraction, flag, 1 year, 1 month, 1 day, 1 h (utc), 1 mi
# format: (f8.2,1x,f8.2,1x,f6.1,1x,es10.3e2,1x,f6.3,1x,f6.3,1x,i1,1x,i4,1x,i2,1x,i2,1x,i2,1x,i2,1
# missing values:   999.00,   999.00, -999.0, -1.000E+00, -1.000, -1.000, 9, -999, 99, 99, 99, 99
# separator character: ','
#
# nr of bins in this profile:  240
#
# line definition 3: profile definition
# nr. of items:  14
# items: hs, he, p, T, u, v, w, w_p, beta_a, sigma_a, beta_c, sigma_c, beta_m, beta_pr
# unit: 1 m, 1 m, 1 hPa, 1 K, 1 m/s, 1 m/s, 1 m/s, 1 m/s, 1/(m.sr), 1/m, 1/(m.sr), 1/m, 1/(m.sr),
# format: (i6,1x,i6,1x,f6.1,1x,f5.1,1x,f5.1,1x,f5.1,1x,f5.1,1x,f5.1,1x,es10.3e2,1x,es10.3e2,1x,es
# missing values:  -9999,  -9999, -999.0, -99.0, 999.0, 999.0, 999.0, 999.0, -1.000E+00, -1.000E+
# separator character: ','
#
   1,240
   55.00,    5.00,   0.0, 1.000E-05,92.300, 0.200,1,2005, 1,31, 9,15,17.18
     0,   125,1005.1,271.9,  0.0,  0.0,  0.0,  0.0, 7.036E-06, 3.518E-04, 0.000E+00, 0.000E+00, 8
   125,   250, 989.8,271.4,  0.0,  0.0,  0.0,  0.0, 7.036E-06, 3.518E-04, 0.000E+00, 0.000E+00, 8
   250,   375, 974.3,271.0,  0.0,  0.0,  0.0,  0.0, 7.036E-06, 3.518E-04, 0.000E+00, 0.000E+00, 8
   375,   500, 959.0,270.5,  0.0,  0.0,  0.0,  0.0, 7.036E-06, 3.518E-04, 0.000E+00, 0.000E+00, 8
   500,   625, 943.7,270.1,  0.0,  0.0,  0.0,  0.0, 6.348E-06, 3.174E-04, 0.000E+00, 0.000E+00, 8
... (230 lines deleted) ...
 29375, 29500,  11.7,217.3,  0.0,  0.0,  0.0,  0.0, 1.978E-10, 9.889E-09, 0.000E+00, 0.000E+00, 1
 29500, 29625,  11.5,217.4,  0.0,  0.0,  0.0,  0.0, 1.946E-10, 9.732E-09, 0.000E+00, 0.000E+00, 1
 29625, 29750,  11.3,217.5,  0.0,  0.0,  0.0,  0.0, 1.917E-10, 9.586E-09, 0.000E+00, 0.000E+00, 1
 29750, 29875,  11.1,217.6,  0.0,  0.0,  0.0,  0.0, 1.888E-10, 9.441E-09, 0.000E+00, 0.000E+00, 1
 29875, 30000,  10.8,217.7,  0.0,  0.0,  0.0,  0.0, 1.860E-10, 9.299E-09, 0.000E+00, 0.000E+00, 1
```

Appendix B

Below followes a list of the changes in the fileformat for the atmospheric database files.

6.7 additions for version 0.2

File format differences between version 0.1 and version 0.2, implemented 11-02-2005.
The following items were added to the file header:

- a fileformat version number
- creation date
- creator
- purpose
- origin of atmospheric data
- origin of backscatter data

The following item was added to the profile description:

- backscatter on falling/precipitating particles

Appendix C

```
#!/usr/bin/env python
#-------------------------------------------------
#  #[ documentation

#
# construct a directory tree for the ADM atmospheric database
# and run the make_atm_db_profiles program in all directories
# as often as needed, with proper options, to construct the
# actual database files.
#
# Jos de Kloe, created:     21-Jan-2005
#              last change: 25-Jun-2008
#-------------------------------------------------

#  #]
#  #[ imported modules
import os                  # operating system
import time                # for access to current date and time
#  #]
#  #[ Global INPUT settings

False = 0
True  = 1

# set some directories for the different scenarios
AtmDBdir = "../atm_database/"

# setup the list of scenarios using the python dictionary datatype,
# so each scenario number is associated with a name,
# and the experiment options used to create the scenario

name    = 0 # some constants to make the use of this dictionary
options = 1 # data structure more explicit
purpose = 2
oad     = 3 # (=origin of atmospheric data)
obsd    = 4 # (=origin of backscatter data)

# some sets of options packed together
UVW_ZERO     = "-uv Zero -w Zero "
RMA_options  = "-p RMA -t RMA -aer RMA -mol RMA "+UVW_ZERO
# corrected version for Alain, no with calculated beta_mol to make it consistent
# with the p and T profiles in the scene
RMA_pt_Calc_Mol_options  = "-p RMA -t RMA -aer RMA -mol calc "+UVW_ZERO

# some artificial cloud definitions
FWC_Cloud          = "-ArtCloud fwc           3000 1000 100 "
Stratus_Cloud      = "-ArtCloud stratus        500  125 100 "
AltoStratus_Cloud  = "-ArtCloud altostratus   2500  500 100 "
CumuloNimbus_Cloud = "-ArtCloud cumulonimbus  2500 1500 100 "
Cirrus_Cloud       = "-ArtCloud cirrus       12000 2000 100 "
PSC_Cloud          = "-ArtCloud psc          20000 2000 100 "

# some Lite settings
```

```
Lite_options      = "-lldt Lite -orolsm Lite -aer Lite -css Lite -ces simple -nprofiles 1601 -mo
                     "-uhlos -uhgrad 50.0 0.0 "
#                     "-lldt Lite "      + \ # specify source for latlon, date and time
#                     "-orolsm Lite "    + \ # specify source for orography and land-sea mask
#                     "-aer Lite "       + \ # specify source for aerosol backscatter profiles
#                     "-css Lite "       + \ # specify cloud backscatter source
#                     "-ces simple "     + \ # specify cloud extinction source
#                     "-nprofiles 1601 " + \ # specify the nr of profiles to be generated
# 1601 profiles of 0.5 km should give 800 km of data, enough for 4 BRC's
#                     "-mol calc "          # specify source for molecular backscatter profiles
#                     "-uhlos -uhgrad 50.0 0.0" gives a constant hlos wind of 50 m/s everywhere
Lite_options2     = Lite_options + " -LiteStartProfNr 1 -LiteDontInterpolate -nprofiles 240"
# this settings should give un-interpolated values on the original 3.6 km lite grid produced
# by Gert-Jan for the full track section (840 km, so 4 BRC's).

#------------------------------------------------------------------------------------------
# scenario
#  number          name                         options
#------------------------------------------------------------------------------------------
Scenario = \
         {   1:("default_test",                            # name
                "-ow defaultsettings ",                    # options
                "for testing of the fileformat only",      # purpose
                "RMA mid_latitude_winter (climatology)",   # origin of atmospheric data
                "RMA (climatology, median)"),              # origin of backscatter data
             # RMA tests
             2:("single_RMA_profile_tropics",
                RMA_options+" -rma tropics ",
                "for testing L2B calibration",
                "RMA tropics (climatology)",
                "RMA (climatology, median)"),
             3:("single_RMA_profile_midlat_winter",
                RMA_options+" -rma midlat ",
                "for testing L2B calibration",
                "RMA mid_latitude_winter (climatology)",
                "RMA (climatology, median)"),
             4:("single_RMA_profile_subarctic_winter",
                RMA_options+" -rma subarctic ",
                "for testing L2B calibration",
                "RMA subarctic_winter (climatology)",
                "RMA (climatology, median)"),
             # MERCI data test
             5:("MERCI_profile_1",
                "-p MERCI -t MERCI -MerciProfNr 1 ",
                "test using the MERCI profile database",
                "ECMWF operational NWP model for lat/lon/date/time of ...(to be filled)...",
                "RMA (climatology, median)"),
             # Synthetic cloud tests
             6:("single_RMA_subarctic_winter_and_PSC",
                RMA_options+ " -rma subarctic "+PSC_Cloud,
                "test of simulated polar stratospheric cloud (PSC) type",
                "RMA subarctic_winter (climatology)",
                "RMA (climatology, median)"),
             7:("single_RMA_midlat_winter_and_cumulonimbus",
                RMA_options+ " -rma midlat "+CumuloNimbus_Cloud,
```

```
        "test of simulated cumulonimbus cloud type",
        "RMA mid_latitude_winter (climatology)",
        "RMA (climatology, median)"),
     8:("single_RMA_midlat_winter_and_altostratus",
        RMA_options+ " -rma midlat "+AltoStratus_Cloud,
        "test of simulated altostratus cloud type",
        "RMA mid_latitude_winter (climatology)",
        "RMA (climatology, median)"),
     9:("single_RMA_midlat_winter_and_stratus",
        RMA_options+ " -rma midlat "+Stratus_Cloud,
        "test of simulated stratus cloud type",
        "RMA mid_latitude_winter (climatology)",
        "ob"),
    10:("single_RMA_midlat_winter_and_fwc",
        RMA_options+ " -rma midlat "+FWC_Cloud,
        "test of simulated fair weather cumulus cloud (FWC) type",
        "RMA mid_latitude_winter (climatology)",
        "RMA (climatology, median)"),
    11:("single_RMA_midlat_winter_and_cirrus",
        RMA_options+ " -rma midlat "+Cirrus_Cloud,
        "test of simulated cirrus cloud type",
        "RMA mid_latitude_winter (climatology)",
        "RMA (climatology, median)"),
     # Lite scene tests
    12:("LiteScene_A_and_RMA_0.5km",Lite_options+"-LiteScene A -rma tropics ",
        "test for Lite data with cirrus at 15km and aer. layers below 3 km with 0.5km ste
        "RMA tropics (climatology)",
        "Lite Scene A"),
    13:("LiteScene_B_and_RMA_0.5km",Lite_options+"-LiteScene B -rma tropics ",
        "test for Lite data with aerosols below 4 km with 0.5km step",
        "RMA tropics (climatology)",
        "Lite Scene B"),
    14:("LiteScene_C_and_RMA_0.5km",Lite_options+"-LiteScene C -rma tropics ",
        "test for Lite data in tropical convective situation with 0.5km step",
        "RMA tropics (climatology)",
        "Lite Scene C"),
    15:("LiteScene_D_and_RMA_0.5km",Lite_options+"-LiteScene D ",
        "test for Lite data with clouds above mountains with 0.5km step",
        "RMA mid_latitude_winter (climatology)",
        "Lite Scene D"),
    16:("LiteScene_E_and_RMA_0.5km",Lite_options+"-LiteScene E -rma tropics ",
        "test for Lite data with several cloud layers with 0.5km step",
        "RMA tropics (climatology)",
        "Lite Scene E"),
    17:("LiteScene_F_and_RMA_0.5km",Lite_options+"-LiteScene F -rma tropics ",
        "test for Lite data with stratus layer below 2 km with 0.5km step",
        "RMA tropics (climatology)",
        "Lite Scene F"),
    18:("LiteScene_G_and_RMA_0.5km",Lite_options+"-LiteScene G -rma tropics ",
        "test for Lite data with some aerosol layers below 5 km with 0.5km step",
        "RMA tropics (climatology)",
        "Lite Scene G"),
    19:("LiteScene_H_and_RMA_0.5km",Lite_options+"-LiteScene H -nprofiles 801 ",
        "test for Lite data with stratus layer below 3 km with 0.5km step",
        "RMA mid_latitude_winter (climatology)",
```

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    # should actually be: mid_latitude_summer, but I don't have data for that
    "Lite Scene H"),
20:("LiteScene_I_and_RMA_0.5km",Lite_options+"-LiteScene I -rma tropics ",
    "test for Lite data with broken cloud layer at 6 km with 0.5km step",
    "RMA tropics (climatology)",
    "Lite Scene I"),
21:("LiteScene_J_and_RMA_0.5km",Lite_options+"-LiteScene J -rma tropics ",
    "test for Lite data with desert dust upto 5 km with 0.5km step",
    "RMA tropics (climatology)",
    "Lite Scene J"),
22:("LiteScene_K_and_RMA_0.5km",Lite_options+"-LiteScene K -rma tropics ",
    "test for Lite data with desert dust and some clouds with 0.5km step",
    "RMA tropics (climatology)",
    "Lite Scene K"),
23:("LiteScene_S_and_RMA_0.5km",Lite_options+"-LiteScene S -rma tropics",
    "test for Lite data with more desert dust with 0.5km step",
    "RMA tropics (climatology)",
    "Lite Scene S"),
 # set of Test scenarios
24:("TestScenario_1.1_u00"," -aer const_ratio -abr 1.0 0.05 -nprofiles 5 "+\
    " -uhgrad 0.0 0.0 -uhlos ",
    "testscenario 1.1 with u=hlos=0 as defined in the TN by A. Dabas and A. Stoffelen
    "RMA mid_latitude_winter (climatology)",
    "calculated assuming a given backscatter ratio"),
25:("TestScenario_1.1_u20"," -aer const_ratio -abr 1.0 0.05 -nprofiles 5 "+\
    " -uhgrad 20.0 0.0 -uhlos ",
    "testscenario 1.1 with u=hlos=20 as defined in the TN by A. Dabas and A. Stoffele
    "RMA mid_latitude_winter (climatology)",
    "calculated assuming a given backscatter ratio"),
26:("TestScenario_1.1_u80"," -aer const_ratio -abr 1.0 0.05 -nprofiles 5 "+\
    " -uhgrad 80.0 0.0 -uhlos ",
    "testscenario 1.1 with u=hlos=80 as defined in the TN by A. Dabas and A. Stoffele
    "RMA mid_latitude_winter (climatology)",
    "calculated assuming a given backscatter ratio"),
27:("TestScenario_1.2_u00"," -aer const_ratio -abr 1.02 0.0 -thg 0.0 2.5 "+\
    "-nprofiles 5 -uhgrad 0.0 0.0 -uhlos ",
    "testscenario 1.2 as defined in the TN by A. Dabas and A. Stoffelen",
    "RMA mid_latitude_winter (climatology)",
    "calculated assuming a given backscatter ratio"),
28:("TestScenario_1.2_u20"," -aer const_ratio -abr 1.02 0.0 -thg 0.0 2.5 "+\
    "-nprofiles 5 -uhgrad 20.0 0.0 -uhlos ",
    "testscenario 1.2 as defined in the TN by A. Dabas and A. Stoffelen",
    "RMA mid_latitude_winter (climatology)",
    "calculated assuming a given backscatter ratio"),
29:("TestScenario_1.2_u80"," -aer const_ratio -abr 1.02 0.0 -thg 0.0 2.5 "+\
    "-nprofiles 5 -uhgrad 80.0 0.0 -uhlos ",
    "testscenario 1.2 as defined in the TN by A. Dabas and A. Stoffelen",
    "RMA mid_latitude_winter (climatology)",
    "calculated assuming a given backscatter ratio"),
30:("TestScenario_2.1_rho1.0"," -aer const_ratio -abr 1.0 0.0 "+\
    "-nprofiles 150 -uhgrad -75.0 1.0 -uhlos ",
    "testscenario 2.1 as defined in the TN by A. Dabas and A. Stoffelen",
    "RMA mid_latitude_winter (climatology)",
    "calculated assuming a given backscatter ratio"),
31:("TestScenario_2.1_rho2.0"," -aer const_ratio -abr 2.0 0.0 "+\
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                "-nprofiles 150 -uhgrad -75.0 1.0 -uhlos ",
                "testscenario 2.1 as defined in the TN by A. Dabas and A. Stoffelen",
                "RMA mid_latitude_winter (climatology)",
                "calculated assuming a given backscatter ratio"),
            32:("TestScenario_2.1_rho5.0"," -aer const_ratio -abr 5.0 0.0 "+\
                "-nprofiles 150 -uhgrad -75.0 1.0 -uhlos ",
                "testscenario 2.1 as defined in the TN by A. Dabas and A. Stoffelen",
                "RMA mid_latitude_winter (climatology)",
                "calculated assuming a given backscatter ratio"),
            33:("TestScenario_2.2_rho1.0"," -aer const_ratio -abr 1.0 0.0 "+\
                "-nprofiles 1 -uvgrad 5.0 0.004 -uhlos ",
                "testscenario 2.2 as defined in the TN by A. Dabas and A. Stoffelen",
                "RMA mid_latitude_winter (climatology)",
                "calculated assuming a given backscatter ratio"),
            34:("TestScenario_2.2_rho2.0"," -aer const_ratio -abr 2.0 0.0 "+\
                "-nprofiles 1 -uvgrad 5.0 0.004 -uhlos ",
                "testscenario 2.2 as defined in the TN by A. Dabas and A. Stoffelen",
                "RMA mid_latitude_winter (climatology)",
                "calculated assuming a given backscatter ratio"),
            35:("TestScenario_2.2_rho5.0"," -aer const_ratio -abr 5.0 0.0 "+\
                "-nprofiles 1 -uvgrad 5.0 0.004 -uhlos ",
                "testscenario 2.2 as defined in the TN by A. Dabas and A. Stoffelen",
                "RMA mid_latitude_winter (climatology)",
                "calculated assuming a given backscatter ratio"),
             # radiosonde test  [1st testfile: radio_sonde_2005040412.vv0
             #                   2nd testfile: radio_sonde_2004081712.vv0]
            36:("RadioSonde_and_RMA"," -aer RMA -mol calc -rsfn radio_sonde_2004081712.vv0 "+\
                "-p RS -t RS -uv RS ",
                "test for using RadioSonde data for P,T,u,v",
                "RadioSonde testfile",
                "RMA climatological profiles"),
            # combine Lite scene H and the RadioSonde profile at almost the same time/lat/lon
            37:("LiteScene_H_and_RadioSonde",Lite_options+"-LiteScene H -nprofiles 801 "+\
                "-rsfn radio_sonde_1994091718.dat -p RS -t RS -uv RS ",
#                "-rsfn radio_sonde_1994091800.dat -p RS -t RS -uv RS ",
                "Lite data with stratus layer below 3 km combined with RadioSonde data",
                "RadioSonde at 19940917 18h GMT",
                "Lite Scene H dated 19940917 20.20h GMT"),
            # adapted version of scene 3
            38:("RMA_pt_Calc_Mol_midlat_winter",
                RMA_pt_Calc_Mol_options+" -rma midlat ",
                "For testing E2S/L1/L2 processing chain",
                "p,T from RMA mid_latitude_winter (climatology), beta_mol calculated",
                "RMA (climatology, median)"),
             # adapted version of scene 8
            39:("RMA_pt_Calc_Mol_midlat_winter_and_altostratus",
                RMA_pt_Calc_Mol_options+ " -rma midlat "+AltoStratus_Cloud,
                "For testing E2S/L1/L2 processing chain with a cloud layer",
                "p,T from RMA mid_latitude_winter (climatology), beta_mol calculated",
                "RMA (climatology, median)"),
            # adapted version of scene 11
            40:("RMA_pt_Calc_Mol_midlat_winter_and_cirrus",
                RMA_pt_Calc_Mol_options+ " -rma midlat "+Cirrus_Cloud,
                "For testing E2S/L1/L2 processing chain with a cirrus cloud layer",
                "p,T from RMA mid_latitude_winter (climatology), beta_mol calculated",
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    "RMA (climatology, median)"),
# adapted version of scene 12
41:("LiteScene_A_and_RMA_3.6km",
    Lite_options2+ " -LiteScene A -rma tropics -LiteStartProfNr 1 -LiteDontInterpolat
    "test for Lite data with cirrus at 15km and aer. layers below 3 km with 3.6km ste
    "p,T from RMA tropics (climatology), beta_mol calculated",
    "Lite Scene A"),
# adapted version of scene 13
42:("LiteScene_B_and_RMA_3.6km",
    Lite_options2+ " -LiteScene B -rma tropics ",
    "test for Lite data with aerosols below 4 km with 3.6km step",
    "p,T from RMA tropics (climatology), beta_mol calculated",
    "Lite Scene B"),
# adapted version of scene 14
43:("LiteScene_C_and_RMA_3.6km",
    Lite_options2+ " -LiteScene C -rma tropics -nprofiles 239 ",
    "test for Lite data in tropical convective situation with 3.6km step",
    "a first realistic scenario to be used with the E2S/L1B/L2B chain of processors",
    "p,T from RMA tropics (climatology), beta_mol calculated",
    "Lite Scene C"),
# adapted version of scene 15
44:("LiteScene_D_and_RMA_3.6km",
    Lite_options2+ " -LiteScene D -rma midlat ",
    "test for Lite data with clouds above mountains with 3.6km step",
    "p,T from RMA tropics (climatology), beta_mol calculated",
    "Lite Scene D"),
# adapted version of scene 16
45:("LiteScene_E_and_RMA_3.6km",
    Lite_options2+ " -LiteScene E -rma tropics ",
    "test for Lite data with several cloud layers with 3.6km step",
    "p,T from RMA tropics (climatology), beta_mol calculated",
    "Lite Scene E"),
# adapted version of scene 17
46:("LiteScene_F_and_RMA_3.6km",
    Lite_options2+ " -LiteScene F -rma tropics ",
    "test for Lite data with stratus layer below 2 km with 3.6km step",
    "p,T from RMA tropics (climatology), beta_mol calculated",
    "Lite Scene F"),
# adapted version of scene 18
47:("LiteScene_G_and_RMA_3.6km",
    Lite_options2+ " -LiteScene G -rma tropics ",
    "test for Lite data with some aerosol layers below 5 km with 3.6km step",
    "p,T from RMA tropics (climatology), beta_mol calculated",
    "Lite Scene G"),
# adapted version of scene 19
48:("LiteScene_H_and_RMA_3.6km",
    Lite_options2+ " -LiteScene H -rma midlat -nprofiles 120 ",
    "test for Lite data with stratus layer below 3 km with 3.6km step",
    "p,T from RMA tropics (climatology), beta_mol calculated",
    "Lite Scene H"),
# adapted version of scene 20
49:("LiteScene_I_and_RMA_3.6km",
    Lite_options2+ " -LiteScene I -rma tropics ",
    "test for Lite data with broken cloud layer at 6 km with 3.6km step",
    "p,T from RMA tropics (climatology), beta_mol calculated",
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    "Lite Scene I"),
# adapted version of scene 21
50:("LiteScene_J_and_RMA_3.6km",
    Lite_options2+ " -LiteScene J -rma tropics ",
    "test for Lite data with desert dust upto 5 km with 3.6km step",
    "p,T from RMA tropics (climatology), beta_mol calculated",
    "Lite Scene J"),
# adapted version of scene 22
51:("LiteScene_K_and_RMA_3.6km",
    Lite_options2+ " -LiteScene K -rma tropics -nprofiles 239 ",
    "test for Lite data with desert dust and some clouds with 3.6km step",
    "p,T from RMA tropics (climatology), beta_mol calculated",
    "Lite Scene K"),
# adapted version of scene 17
52:("LiteScene_S_and_RMA_3.6km",
    Lite_options2+ " -LiteScene S -rma tropics ",
    "test for Lite data with more desert dust with 3.6km step",
    "p,T from RMA tropics (climatology), beta_mol calculated",
    "Lite Scene S"),
# adapted version of scene 41
53:("LiteScene_A_and_EcmwfColloc_3.6km",
    "-lldt Lite -orolsm Lite -aer Lite -css Lite -ces simple -mol calc "+\
    "-LiteStartProfNr 1 -LiteDontInterpolate -nprofiles 240 "+\
    "-LiteScene A -LiteStartProfNr 1 -LiteDontInterpolate "+\
    "-p CollocEcmwf -t CollocEcmwf -uv CollocEcmwf -w CollocEcmwf ",
    "Lite data with cirrus at 15km and aer. layers below 3 km collocated with ECMWF d
    "p,T from ECMWF (ERA40), beta_mol calculated",
    "Lite Scene A"),
# adapted version of scene 42
54:("LiteScene_B_and_EcmwfColloc_3.6km",
    "-lldt Lite -orolsm Lite -aer Lite -css Lite -ces simple -mol calc "+\
    "-LiteStartProfNr 1 -LiteDontInterpolate -nprofiles 240 "+\
    "-LiteScene B -LiteStartProfNr 1 -LiteDontInterpolate "+\
    "-p CollocEcmwf -t CollocEcmwf -uv CollocEcmwf -w CollocEcmwf ",
    "Lite data with aerosols below 4 km collocated with ECMWF data, with 3.6km step",
    "p,T from ECMWF (ERA40), beta_mol calculated",
    "Lite Scene B"),
# adapted version of scene 43
55:("LiteScene_C_and_EcmwfColloc_3.6km",
    "-lldt Lite -orolsm Lite -aer Lite -css Lite -ces simple -mol calc "+\
    "-LiteStartProfNr 1 -LiteDontInterpolate -nprofiles 239 "+\
    "-LiteScene C -LiteStartProfNr 1 -LiteDontInterpolate "+\
    "-p CollocEcmwf -t CollocEcmwf -uv CollocEcmwf -w CollocEcmwf ",
    "Lite data with tropical convective clouds collocated with ECMWF data, with 3.6km
    "p,T from ECMWF (ERA40), beta_mol calculated",
    "Lite Scene C"),
# adapted version of scene 44
56:("LiteScene_D_and_EcmwfColloc_3.6km",
    "-lldt Lite -orolsm Lite -aer Lite -css Lite -ces simple -mol calc "+\
    "-LiteStartProfNr 1 -LiteDontInterpolate -nprofiles 240 "+\
    "-LiteScene D -LiteStartProfNr 1 -LiteDontInterpolate "+\
    "-p CollocEcmwf -t CollocEcmwf -uv CollocEcmwf -w CollocEcmwf ",
    "Lite data with some high clouds above mountains collocated with ECMWF data, with
    "p,T from ECMWF (ERA40), beta_mol calculated",
    "Lite Scene D"),
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# adapted version of scene 45
57:("LiteScene_E_and_EcmwfColloc_3.6km",
    "-lldt Lite -orolsm Lite -aer Lite -css Lite -ces simple -mol calc "+\
    "-LiteStartProfNr 1 -LiteDontInterpolate -nprofiles 240 "+\
    "-LiteScene E -LiteStartProfNr 1 -LiteDontInterpolate "+\
    "-p CollocEcmwf -t CollocEcmwf -uv CollocEcmwf -w CollocEcmwf ",
    "Lite data with several cloud layers collocated with ECMWF data, with 3.6km step"
    "p,T from ECMWF (ERA40), beta_mol calculated",
    "Lite Scene E"),
# adapted version of scene 46
58:("LiteScene_F_and_EcmwfColloc_3.6km",
    "-lldt Lite -orolsm Lite -aer Lite -css Lite -ces simple -mol calc "+\
    "-LiteStartProfNr 1 -LiteDontInterpolate -nprofiles 240 "+\
    "-LiteScene F -LiteStartProfNr 1 -LiteDontInterpolate "+\
    "-p CollocEcmwf -t CollocEcmwf -uv CollocEcmwf -w CollocEcmwf ",
    "Lite data with low cloud layer collocated with ECMWF data, with 3.6km step",
    "p,T from ECMWF (ERA40), beta_mol calculated",
    "Lite Scene F"),
# adapted version of scene 47
59:("LiteScene_G_and_EcmwfColloc_3.6km",
    "-lldt Lite -orolsm Lite -aer Lite -css Lite -ces simple -mol calc "+\
    "-LiteStartProfNr 1 -LiteDontInterpolate -nprofiles 240 "+\
    "-LiteScene G -LiteStartProfNr 1 -LiteDontInterpolate "+\
    "-p CollocEcmwf -t CollocEcmwf -uv CollocEcmwf -w CollocEcmwf ",
    "Lite data with low aerosol layers collocated with ECMWF data, with 3.6km step",
    "p,T from ECMWF (ERA40), beta_mol calculated",
    "Lite Scene G"),
# adapted version of scene 48
60:("LiteScene_H_and_EcmwfColloc_3.6km",
    "-lldt Lite -orolsm Lite -aer Lite -css Lite -ces simple -mol calc "+\
    "-LiteStartProfNr 1 -LiteDontInterpolate -nprofiles 120 "+\
    "-LiteScene H -LiteStartProfNr 1 -LiteDontInterpolate "+\
    "-p CollocEcmwf -t CollocEcmwf -uv CollocEcmwf -w CollocEcmwf ",
    "Lite data with low cloud layer collocated with ECMWF data, with 3.6km step",
    "p,T from ECMWF (ERA40), beta_mol calculated",
    "Lite Scene H"),
# adapted version of scene 49
61:("LiteScene_I_and_EcmwfColloc_3.6km",
    "-lldt Lite -orolsm Lite -aer Lite -css Lite -ces simple -mol calc "+\
    "-LiteStartProfNr 1 -LiteDontInterpolate -nprofiles 240 "+\
    "-LiteScene I -LiteStartProfNr 1 -LiteDontInterpolate "+\
    "-p CollocEcmwf -t CollocEcmwf -uv CollocEcmwf -w CollocEcmwf ",
    "Lite data with broken cloud layers collocated with ECMWF data, with 3.6km step",
    "p,T from ECMWF (ERA40), beta_mol calculated",
    "Lite Scene I"),
# adapted version of scene 50
62:("LiteScene_J_and_EcmwfColloc_3.6km",
    "-lldt Lite -orolsm Lite -aer Lite -css Lite -ces simple -mol calc "+\
    "-LiteStartProfNr 1 -LiteDontInterpolate -nprofiles 240 "+\
    "-LiteScene J -LiteStartProfNr 1 -LiteDontInterpolate "+\
    "-p CollocEcmwf -t CollocEcmwf -uv CollocEcmwf -w CollocEcmwf ",
    "Lite data with a thick desert dust layer collocated with ECMWF data, with 3.6km
    "p,T from ECMWF (ERA40), beta_mol calculated",
    "Lite Scene J"),
# adapted version of scene 51
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63:("LiteScene_K_and_EcmwfColloc_3.6km",
    "-lldt Lite -orolsm Lite -aer Lite -css Lite -ces simple -mol calc "+\
    "-LiteStartProfNr 1 -LiteDontInterpolate -nprofiles 239 "+\
    "-LiteScene K -LiteStartProfNr 1 -LiteDontInterpolate "+\
    "-p CollocEcmwf -t CollocEcmwf -uv CollocEcmwf -w CollocEcmwf ",
    "Lite data with a desert dust layer and a cloudlayer on top collocated with ECMWF
    "p,T from ECMWF (ERA40), beta_mol calculated",
    "Lite Scene K"),
# adapted version of scene 52
64:("LiteScene_S_and_EcmwfColloc_3.6km",
    "-lldt Lite -orolsm Lite -aer Lite -css Lite -ces simple -mol calc "+\
    "-LiteStartProfNr 1 -LiteDontInterpolate -nprofiles 240 "+\
    "-LiteScene S -LiteStartProfNr 1 -LiteDontInterpolate "+\
    "-p CollocEcmwf -t CollocEcmwf -uv CollocEcmwf -w CollocEcmwf ",
    "Lite data with a desert dust layer collocated with ECMWF data, with 3.6km step",
    "p,T from ECMWF (ERA40), beta_mol calculated",
    "Lite Scene S"),
# set everything to zero, so there is NO atmosphere in this case
65:("AllZeros"," -aer Zero -mol Zero -nprofiles 1 "+\
    " -uv Zero -w Zero -uhlos ",
    "testscenario with u=hlos=0, no aerosols and no clouds",
    "RMA mid_latitude_winter (climatology)",
    "Set to zero for both aerosols and molecules (so we have no atmosphere here...)")
# set everything to zero except for molecular scattering
66:("MoleculesOnly"," -aer Zero -mol calc -nprofiles 1 "+\
    " -uv Zero -w Zero -uhlos ",
    "testscenario with u=hlos=0, no aerosols and no clouds",
    "RMA mid_latitude_winter (climatology)",
    "Set to zero for aerosols"),
# a first test using Calipso data, using the first 100 profiles of segment 1
67:("Calipso_Segment1_and_RMA",
    "-lldt Calipso -orolsm elev -aer Calipso -mol calc "+\
    "-nprofiles 100 -CalipsoSegment 1 "+\
    "-p RMA -t RMA -rma subarctic -uv Zero -w Zero ",
    "Calipso data combined with tropical RMA p,T data, with 3.3km step",
    "p,T from RMA (tropical), beta_mol calculated",
    "Calipso Segment 1"),
# Calipso segment 1, collocated with operational ECMWF data
68:("Calipso_Segment1_and_EcmwfColloc",
    "-lldt Calipso -orolsm elev -aer Calipso -mol calc "+\
    "-nprofiles 1434 -CalipsoSegment 1 "+\
    "-p CollocEcmwf -t CollocEcmwf -uv CollocEcmwf -w CollocEcmwf ",
    "Calipso data collocated with ECMWF data, with 3.3km step",
    "p,T from ECMWF(operational model), beta_mol calculated",
    "Calipso Segment 1"),
# Calipso segment 2, collocated with operational ECMWF data
69:("Calipso_Segment2_and_EcmwfColloc",
    "-lldt Calipso -orolsm elev -aer Calipso -mol calc "+\
    "-nprofiles 684 -CalipsoSegment 2 "+\
    "-p CollocEcmwf -t CollocEcmwf -uv CollocEcmwf -w CollocEcmwf ",
    "Calipso data collocated with ECMWF data, with 3.3km step",
    "p,T from ECMWF(operational model), beta_mol calculated",
    "Calipso Segment 2"),
# Calipso segment 3, collocated with operational ECMWF data
70:("Calipso_Segment3_and_EcmwfColloc",
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    "-lldt Calipso -orolsm elev -aer Calipso -mol calc "+\
    "-nprofiles 671 -CalipsoSegment 3 "+\
    "-p CollocEcmwf -t CollocEcmwf -uv CollocEcmwf -w CollocEcmwf ",
    "Calipso data collocated with ECMWF data, with 3.3km step",
    "p,T from ECMWF(operational model), beta_mol calculated",
    "Calipso Segment 3"),
# Calipso segment 4, collocated with operational ECMWF data
71:("Calipso_Segment4_and_EcmwfColloc",
    "-lldt Calipso -orolsm elev -aer Calipso -mol calc "+\
    "-nprofiles 667 -CalipsoSegment 4 "+\
    "-p CollocEcmwf -t CollocEcmwf -uv CollocEcmwf -w CollocEcmwf ",
    "Calipso data collocated with ECMWF data, with 3.3km step",
    "p,T from ECMWF(operational model), beta_mol calculated",
    "Calipso Segment 4"),
# Calipso segment 5, collocated with operational ECMWF data
72:("Calipso_Segment5_and_EcmwfColloc",
    "-lldt Calipso -orolsm elev -aer Calipso -mol calc "+\
    "-nprofiles 668 -CalipsoSegment 5 "+\
    "-p CollocEcmwf -t CollocEcmwf -uv CollocEcmwf -w CollocEcmwf ",
    "Calipso data collocated with ECMWF data, with 3.3km step",
    "p,T from ECMWF(operational model), beta_mol calculated",
    "Calipso Segment 5"),
# Calipso segment 6, collocated with operational ECMWF data
73:("Calipso_Segment6_and_EcmwfColloc",
    "-lldt Calipso -orolsm elev -aer Calipso -mol calc "+\
    "-nprofiles 672 -CalipsoSegment 6 "+\
    "-p CollocEcmwf -t CollocEcmwf -uv CollocEcmwf -w CollocEcmwf ",
    "Calipso data collocated with ECMWF data, with 3.3km step",
    "p,T from ECMWF(operational model), beta_mol calculated",
    "Calipso Segment 6"),
# Calipso segment 7, collocated with operational ECMWF data
74:("Calipso_Segment7_and_EcmwfColloc",
    "-lldt Calipso -orolsm elev -aer Calipso -mol calc "+\
    "-nprofiles 810 -CalipsoSegment 7 "+\
    "-p CollocEcmwf -t CollocEcmwf -uv CollocEcmwf -w CollocEcmwf ",
    "Calipso data collocated with ECMWF data, with 3.3km step",
    "p,T from ECMWF(operational model), beta_mol calculated",
    "Calipso Segment 7"),
# Copy of 66, molecular scattering only, with 2 cloud layers added
75:("MoleculesOnlyAnd2Clouds"," -aer Zero -mol calc -nprofiles 1 "+\
    " -uv Zero -w Zero -uhlos -ArtCloud cirrus 8500 1000 100 -ArtCloud cirrus 12500 2
    "testscenario with u=hlos=0, no aerosols and 2 cloud layers",
    "RMA mid_latitude_winter (climatology). 2 cloud layers added",
    "Set to zero for aerosols."),
 # MERCI data using u,v,w as well, high surface wind
76:("MERCI_profile_2_uvw",
    "-p MERCI -t MERCI -uv MERCI -w MERCI -MerciProfNr 2 ",
    "u,v,w retrieved from the MERCI profile database",
    "ECMWF operational NWP model for lat/lon/date/time of ...(to be filled)...",
    "RMA (climatology, median)"),
 # MERCI data using u,v,w as well, low surface wind
77:("MERCI_profile_50_uvw",
    "-p MERCI -t MERCI -uv MERCI -w MERCI -MerciProfNr 50 ",
    "u,v,w retrieved from the MERCI profile database",
    "ECMWF operational NWP model for lat/lon/date/time of ...(to be filled)...",
```

```
                "RMA (climatology, median)"),
            # copy of nr. 3, but now with MF parametrization for Mol scatter
            78:("single_RMA_profile_midlat_winter_MF",
                RMA_options+" -rma midlat -mol calcmf ",
                "for reproducing data used by L2A tests",
                "RMA mid_latitude_winter (climatology)",
                "RMA (climatology, median)"),

         }



#------------------------------------------------------------------------------------------
#Scenario.append(007:("single_RMA_midlat_winter_and_cumulonimbus",\
#                      RMA_options+ " -rma midlat "+CumuloNimbus_Cloud) )

# run all scenarios
#First = 1
First = 78
#Last  = 67
Last  = 78
ScenariosToRun = range(First,Last+1)
#ScenariosToRun = [1,2,3,4,5]
# beware: 012 means octal 12, so 8+2 = 10 !!!

MakeCombineScenes = 0 # 1=true; 0=false

# run only a selected scenario
#ScenariosToRun = [ 12, 16, 17, 19, 21] # Lite scenes: AEFHJ
# ScenariosToRun = [ 24,25,26,27,28,29 ]
#ScenariosToRun = [ 33,34,35 ]
#ScenariosToRun = [ 23 ]

ExpDir = "../bin/"

#  #]
#--------------------------------------------------
# subroutines and functions:
#--------------------------------------------------
def EnsureDirExists(Dir):
    #  #[ if directory does not exist, create it
    if (not os.path.exists(Dir)):
        print "creating directory: "+Dir
        os.mkdir(Dir)
    else:
        print "directory already exists: "+Dir
    # ensure all users have write and read access to this directory
    # (needed to be able to convert to xml with the matlab tool
    # running from within the matlab account ....)
    # (the leading zero indicated octal numbers are used!)
    os.chmod(Dir,0777)
    #  #]
def EnsureFileIsReadable(File):
    #  #[ ensure all users have read access to this file
    # (the leading zero indicated octal numbers are used!)
```

```
    os.chmod(File,0744)
    #  #]
#-------------------------------------------------
# main program
#-------------------------------------------------
EnsureDirExists(AtmDBdir)
for scene in ScenariosToRun:
    #  #[ make the directory (if needed)
    OutpDir = AtmDBdir+Scenario[scene][name]+'/'
    os.environ['ADM_ATM_DB_OUTPUT_DIR']  = OutpDir
    EnsureDirExists(OutpDir)
    #  #]
    #  #[ handle the filename
    filename        = "default_filename.asc"

    # retrieve the current date and time as a string
    # and make it available as environment variable
    os.environ["CurrentDateTime"]  = \
             time.strftime("%Y%m%d %H:%M",time.gmtime(time.time()))
    #  #]
    #  #[ setup the experiment
    os.environ["ADM_scene_description"]     = Scenario[scene][name]
    os.environ["ADM_purpose"]               = Scenario[scene][purpose]
    os.environ["ADM_origin_of_atm_data"]    = Scenario[scene][oad]
    os.environ["ADM_origin_of_backsc_data"] = Scenario[scene][obsd]

    ExpOptions      = Scenario[scene][options]+" -ow settings -of "+filename
    ExpOptions      = ExpOptions + " -count %i" % (scene)
    Executable      = "./make_atm_db_profiles "+ExpOptions
    os.chdir(ExpDir)
    #  #]
    #  #[ execute the fortran program
    print "executing  experiment: "+Executable
    err = os.system(Executable)
    if (err != 0):
        print "os.system() command ended with an error !"
        os._exit(1)
    #  #]
    #  #[ rename the produced file
    # now rename the output file using the name that is present in filename.txt
    fd = open(OutpDir+"filename.txt",'r')
    new_filename = fd.readline()
    # remove the leading space and tailing newline character
    # that seems to be present in this string ...
    new_filename = new_filename.strip(" \n")
    print "new_filename = ["+new_filename+"]"
    fd.close()
    os.rename(OutpDir+filename,OutpDir+new_filename)

    # delete the temporary file: filename.txt
    os.remove(OutpDir+"filename.txt")

    EnsureFileIsReadable(OutpDir+new_filename)
    EnsureFileIsReadable(OutpDir+"atm_db_settings.txt")
    #  #]
```

```
#  #[ create combined scenarios
if (MakeCombineScenes):
    # just one for now, as a test

    Executable = "./combine_scenes"
    filename   = "combined_scenes.asc"
    CombinedSceneName  = "Calipso_Segments_1to7_and_EcmwfColloc"
    OriginalSceneNames = ["Calipso_Segment1_and_EcmwfColloc", \
                          "Calipso_Segment2_and_EcmwfColloc", \
                          "Calipso_Segment3_and_EcmwfColloc", \
                          "Calipso_Segment4_and_EcmwfColloc", \
                          "Calipso_Segment5_and_EcmwfColloc", \
                          "Calipso_Segment6_and_EcmwfColloc", \
                          "Calipso_Segment7_and_EcmwfColloc"]

    os.chdir(ExpDir)
    Command = Executable+" "+CombinedSceneName+" "+\
              " ".join(["%s" % name for name in OriginalSceneNames])
    print "executing  experiment: "+Command
    err = os.system(Command)
    if (err != 0):
        print "os.system() command ended with an error !"
        os._exit(1)

    # create new directory [if needed]
    OutpDir = AtmDBdir+CombinedSceneName+'/'
    EnsureDirExists(OutpDir)

    # move file no new directory
    print "moving file: "+ExpDir+filename+" to "+OutpDir+filename
    os.rename(ExpDir+filename,OutpDir+filename)
    EnsureFileIsReadable(OutpDir+filename)

    # create scenariolist.txt file
    fd = open(OutpDir+"scenariolist.txt",'w')
    for file in OriginalSceneNames:
        fd.write(file+"\n")
    fd.close()
    EnsureFileIsReadable(OutpDir+"scenariolist.txt")
    #  #]

# stop here (for testing purposes)
#os._exit(1)

#  #[ asterisk check
print "--------------------"
print "Done producing the profiles"
print "now checking if any of the files have an asterisk character in it"
print "which indicates problems with the formatting ......"
print "--------------------"

# as fast hack to test for problems in the formats
os.system("grep -l \* "+AtmDBdir+"*/*.asc")
```

```
print "--------------------"
print "finished asterisk check"
print "--------------------"
#  #]
#---------------------------------------------------
# END OF SCRIPT

#---------------------------------------------------
```