Update of KNMI HDF5 Data Format Specification, v3.8

Tiemo Mathijssen, Hans Beekhuis, Iwan Holleman, and Hans Roozekrans

KNMI Internal Report, 17 July 2019

1 Contents

2 Change notes

2.1 Change notes for version 3.8

Released 17 July 2019

- To accommodate the files delivered by the KNMI Lightning Detection Network (KLDN) changes were necessary. The changes are incorporated in this version of hdftag. These changes are documented in more detail in document: KNMI_KLDN_A06_KLiDIM_20150223. For convenience this document is added as addendum.

- To discriminate between files produced by the FLITS system and the KLDN a new source type has been defined _LAM_ (Lightning Accumulation Meteorage) So files delivered by Meteorage are tagged _LAM_ e.g. filenames conform to LGT_NL2?_LAM_*.h5 .

- New (dual polarisation) products for the radar are defined in the radar product group.

- For radar Herwijnen the radar name will read "Herwijnen"

2.2 Change notes for version 3.7

Released 4 April 2012

- With exception of RCP2011-02 the changes in this **version 3.7 are fully backwards compatible**, only additions have been made.

- RCP2011-01: On request of LVNL a change is prepared that will allow reading a radar_operational status from the metadata of the radar KNMI HDF files.

- RCP2011-02: As a consequence of RCP2011-01 the value of attribute radar_name will change slightly.
  For radar De Bilt the radar_name will read "DeBilt" (formerly De_Bilt).
  For radar Den Helder the radar_name will read "DenHelder" (formerly "Den_Helder)

- RCP2012-01-a: On request of KNMI Weather Research (KNMI/WO) the application of a clutter mask is prepared. This mask, derived from meteosat data, is applied on the dataset image1 of the radar reflectivity KNMI HDF files. A new miscellaneous type _CM_ is defined within the radar definitions.

- RCP2012-01-b: On request of KNMI Weather Research (KNMI/WO) a change is prepared to add an attribute image_cloud_mask_applied in the metadata of the radar KNMI HDF files.

2.3 Change notes for version 3.6

The following changes are introduced with respect to KNMI HDF5 ***version 3.5****:*

- The changes in this **version 3.6 are fully backwards compatible**, only additions have been made.

- A repeated group has been added for **storage of weather radar volume data**. This "scan group" and its "calibration subgroup" are introduced in section 5.8. Data from Doppler and Polarimetric radars can be stored.

- A repeated group has been added for s**torage of raw Radio-Frequency data from a lightning detection network**. This so-called "rf_data group" is introduced in section 5.10

- In the Statistics subgroup of the repeated Image group several attributes have been added for storage of derived cell properties. These attributes can amongst other things be used for storage of annotated echo tops in radar imagery

- In the repeated station group an optional dataset for storage of additional status information, i.e., number of seconds per minute that station was working optimal, has been added.

2.4 Change notes for version 3.5

The following changes are introduced with respect to KNMI HDF5 ***version 3.4****:*

The main change in this version is the extension of the KNMI HDF5 Image Format Specification beyond image data format only. The data model is extended to be able to store wind profile data, lightning localization data, and polar scan data from radar. The title of document has therefore been changed to "KNMI HDF5 Data Format Specification". In addition, a few minor changes have been applied to the data model which will not affect the current systems.

- The repeated **image group is no longer mandatory**, it will off course always be present for HDF5 files containing image data.

- Two new repeated groups have been added: **profile group and discharge group**, intended for storage of wind profile and lightning

localizations, respectively.

- The name of the **lightning group is changed to station group,** and the lightning subgroup in the image group has been removed. The naming of the tags in the station group has been changed and two tags for storage of availability information have been added.

- The **grid, point**, and **vector groups** have been deleted as they are not used.

- An "**image_datetime_valid**" tag has been added in the image group(s) for specifying the date and time that a forecast product is valid.

- The tags for the new repeated groups have been added in the overview group: **number_profile_groups** and **number_discharge_groups**. In addition, the number_lightning_groups tag has been renamed to **number_station_groups.** Finally, **number_grid_groups, number_point_groups**, and **number_vector_groups** have been removed from the overview group.

- A tag **"geo_par_pixel"** describing the geophysical parameters of the image coordinates has been added to the geographical group.

- The **"DISPLAY_ORIGIN"** subtags to the HDF5 images in the overview, image, classification groups has been changed from mandatory to only mandatory for images with an unusual orientation.

- A few tags describing the characteristics of a polar radar scan have been added to the **radar subgroup** of the image group.

- A **profile group** with contents has been added which is intended for storage of profile data from weather radar, sodar, and profiler. It can be extended for profiles from radiosonde and models.

- A **discharge group** with contents has been added which is intended for storage of time series of localizations from lightning detection systems.

- Two tags, one for storage of limited availability information and one for adjustment information, have been added to the **radar group.**

2.5 Change notes for version 3.4

The following changes are introduced with respect to KNMI HDF5 ***version 3.2****:*

- **The naming convention of repeated groups**. The change is that potential repeated groups **always** get a number at the end of the group name. In contrary to the definition in version 3.2, now the group name ends with 1 in case there is only one group included in the file (e.g. image1 instead of image). This is only valid for groups that are allowed to be repeated (image, visualisation, satellite, radar, lightning, classification, grid, point, and vector).
- **The implementation of calibration tables**. If the values in a calibration table are linear calibrated then not all pixel values need to be included in the table. When The minimum and maximum values of linear range(s) are stated the values in between can be calculated by interpolation.
  This convention may save a lot of table space (e.g. in case of 16-bit pixel values).
  An example:

  Old table:

Integer value	Calibrated value
0.0	-50.0
1.0	-49.5
2.0	-49.0
…	…
251.0	75.5
252.0	76.0
253.0	76.5
254.0	77.0

  New table:

Integer value	Calibrated value
0.0	-50.0
255.0	77.5

- **Tables in HDF5 can only contain elements of the same data type**. This means that annotation/classification tables may contain only strings. So, also the pixel values must be written as strings.
- **The names of two attributes in the Overview group have been changed:**
  Old name (version 3.2):
  KNMIhdf5_version_number

KNMI_hdf_url

New name (version 3.3 and later):

hdftag_version_number

hdftag_url

The following changes are introduced with respect to KNMI HDF5 ***version 3.3****:*

- **In the Overview group:** “number_xxx_groups” tags are only mandatory in case the value is larger than 0. In previous version these groups were mandatory in any case.
- **Definition of order of geo_product_corners** (in Geographic group). The first corner is always the southwest corner . Then northwest, northeast and southeast. In earlier versions it was defined as lowerleft, upperleft, etc.
- **HDF5 file naming convention.** The timestamp convention was not defined in earlier versions (the convention that is specified in chapter 7 is not applicable in file names). In chapter 8 the timestamp convention as used within KNMI is described.

3 KNMI HDF5 implementation

In this document the HDF5 Data format as implemented within KNMI is described. Some more specific background information is given.

3.1 What is HDF?

HDF (Hierarchical Data Format) is a multi-object file format for sharing scientific data in a distributed environment. HDF is developed by the National Center for Supercomputing Applications (NCSA) in the USA. An important feature of HDF files is that the files are self-describing. The aim of HDF is to make files, containing e.g. image data, self-contained. By grouping related pieces of information together and forcing a certain structure of the file, it will be easy for other users to make use of the data in the files. Self-contained also means that all meta-data associated with the dataset and/or needed for further processing of the dataset is included in the file. Another attractive feature of HDF is the "free" availability of software libraries to handle HDF files. Libraries are developed by NCSA for different operating systems (Unix, Linux, Windows). More general information on HDF can be found on: www.hdfgroup.org.

3.2 Versions

The implementation of the file format described in this document is based on HDF version 5.0 (HDF5). KNMI has based its definition of HDF5 on the MEOS-HDF format of Kongsberg Spacetec. MEOS (Multi-mission Earth Observation System) is Kongsberg Spacetec's line of systems for earth observation satellites ground stations. Spacetec is the builder of KNMI's Omnivoor/Beelden image database system.

For users of the KNMI HDF5 files the following HDF5 utilities are most useful: "h5view" and "h5dump". These utilities (and many others) can be downloaded from: www.hdfgroup.org/HDF5.

3.3 Tag naming

All information placed within an HDF5 file can be stored and retrieved by a named tag. Tag names should be unambiguous and self-explanatory. In general, tags should be lower case with the underscore character used as the word spacer. Use of abbreviations is common when naming tags. However, KNMI and Spacetec suggest that abbreviations only are used when it can be used unambiguously and when it's quite obvious what it stands for. E.g. "clong" could be used to represent "centre longitude", but we suggest that "center_longitude" is used instead.

3.4 Purpose of KNMI HDF5 Data Format

The purpose of the KNMI HDF5 Data Format is to store the (image) data in a platform independent and self-contained way. The HDF5 Data Format as described in this document is implemented in the image data infrastructure of KNMI (BIK) for all EUMETSAT and NOAA satellite data, weather radar data, and lightning image data. This document is distributed to users of KNMI HDF5 data files to enable them to process the data.

4 Overview

The layout of the HDF5 files is similar to a directory structure in a file system. A folder, or divider, similar to a directory name, is used as a placeholder for information that is logically grouped together. The presence or absence of fields gives information on what can be done with the file. A minimum required set of tags and groups must be present in each KNMI HDF5 file.

Groups	Subgroups
overview **(M)**	
geographic **(M)**	
	map_projection
image **(R)**	
	calibration
	statistics
	satellite
	radar
profile **(R)**	
scan **(R)**	
	calibration
discharge **(R)**	
rf_data **(R)**	
visualisation **(R)**	
satellite **(R)**	
	sensor
radar **(R)**	
station **(R)**	
classification **(R)**	
	calibration

M These groups are **mandatory**
R These groups can be **repeated**

4.1 Mandatory groups

The following groups are the minimal required content of the KNMI HDF5 files.

Overview group

This group provides an overview of the dataset. It contains references, identifiers, a quicklook and fields describing the content of the file.

Geographic group

All information about the geographic reference of the dataset is placed in this group. This includes map projection and parameters used in this operation.

4.2 Repeated groups

All other groups are optional. This implies these groups will be only included in case it is relevant or applicable to the type of data. These optional groups are called repeated groups, where a repetition of zero indicates the absence of a group. The **Overview** group contains fields stating the number of repeated groups present in the HDF5 file. The names of the groups will be numbered as follows: **group name*n*** where **group name** is the name of the group, and ***n*** is the group number. Numbering starts at 1 and runs until the number of groups as stated in the overview group.

Image group

This group forms the core of a HDF5 image file. It contains most relevant image information. The image data (pixel values) itself and metadata about the image are placed in this group. There can be more than one image group in one HDF5 file. In the KNMI HDF5 implementation the following rules for the storage of multiple image-layers are defined:

- One HDF5 file can only contain multiple images (2D arrays) in case these images all have the same **geographical** properties (spatial resolution, area coverage and map projection). This implies that the images, stored in **one** HDF5 file, **all** have an **equal** number of pixel columns and rows.

- One Image group can only contain multiple

images (2D arrays) in case these images all have the same **product_name** (so, the subgroups, calibration, etc. applies to all images in this image group). This only makes sense for animations (timed sequences of images).

For the moment KNMI does not have plans to store time series of images in one HDF5 file and this technical note does not describe the HDF5 implementation for the storage of time series.

The KNMI implementation implies that in case more than one image-layer is stored in one HDF5 file (e.g. all AVHRR channel images), each image-layer is stored in a separate (repeated) Image group. The storage of image-layers in the image_data tag is implemented following the NCSA standards as described in the document "HDF5 Image and Palette" (see: https://support.hdfgroup.org/ftp/HDF5)

Each Image group contains a Calibration subgroup that contains all relevant metadata in relation to the calibration of the pixel values of the image(s), stored in the group. The transformation of (binary) pixel values to real geophysical values is described here.

Profile group

This repeated group is intended for storage of vertical profiles from e.g. weather radars, sodars, or profilers, and it can be extended from radiosonde observations of model profiles. The values of a variable at the different levels/heights in a profile are stored in a datasets. Different datasets are proposed for several variables and additional datasets can be included. The only mandatory dataset is the one described the geometric height of the vertical levels in the profile.

Scan group

This repeated group is intended for storage of raw scan data (“volume data”) of weather radars. Each scan group can be used to store all radar data and corresponding metadata collected at a certain elevation. The raw scan data must be sorted such that the first ray of the scan always starts at zero azimuth. An indicator to the ray where the raw scan originally started is stored in the metadata.

Discharge group

This repeated group is intended for storage of the time series of the localizations observed by a lightning detection system. The time series of each parameter detected by the system is stored as an array in a dataset. The data and time of each discharge event (localization) are given as a time offset in seconds against a reference data and time which is stored in this group as well. The time offset is stored in a dataset of doubles to allow for storage of a high accuracy time offset (microsec.) over a daily period.

RF_data group

This repeated group is intended for storage of the time series of the raw Radio-Frequency (RF) data from a lightning detection network. The time series of each parameter detected by the RF antennas of the system is stored as an array in a dataset. The data and time of each RF event are given as a time offset in seconds against a reference data and time which is stored in this group as well. The time offset is stored in a dataset of doubles to allow for storage of a high accuracy time offset (microsec.) over a daily period.

Visualisation group

In this group a colour palette is stored (following the NCSA specs; There can be more Visualisation groups in one HDF5 file.

Satellite group

In this group, all relevant information regarding the satellite is placed. This includes the position of the satellite at the time of data capturing. Orbit prediction data are included here. Also descriptions of the on-board instruments/sensors can be placed here (e.g.spectral bands related to channels, etc.). If data of more than one satellite is included in the HDF5 file then more Satellite groups will be included in the file.

Radar group

Idem as satellite group for (weather) radar systems.

Station group

Idem as satellite group for general observation systems, e.g., lightning detection stations.

Classification group

If automatic classification has been done, results from this process can be placed here. E.g. land/sea/cloud masks. There can be more Classification groups in one HDF5 file. This group is currently used for storage of geographical overlays for satellite images.

5 Description of KNMI HDF5 Data Format

In the HDF5 structure, besides groups, two other data types can be recognised: datasets and attributes. Datasets are meant for storage of the real image data and metadata entities larger than 16Kb. Attributes belong to a group or a dataset and are meant for storage of small entities of metadata. In the following tag description it is defined for each tag whether it is a dataset or an attribute (*in the D/A column).*

5.1 Compression of datasets

HDF5 offers the possibility to perform a lossless compression on all datasets. The compression is performed using the “zlib” library. The zlib library is a free, general-purpose lossless data-compression library for use on virtually any computer hardware and operating system (for information see: https://www.gzip.org/). The compression level is specified by an integer between 1 and 9 (inclusive) where 1 results in the fastest compression while 9 results in the best compression ratio. The default value is 6 being an optimum between speed and compression ratio. Upon extraction of datasets from a HDF5 file, the decompression is handled automatically by the HDF5 library. Compression should be performed to all datasets in the KNMI HDF5 format.

5.2 Data types

The Type column defines the data type of the field. This is one of Int, Long, Float, Double, String, Table and Image for integer, long integer, floating point number, floating point number with double precision, text, tables and images, respectively. The physical size occupied on storage by the given field is not a concern for this document. The underlying software hides this fact from the user. When reading a float value from the HDF file, the retrieved value will be in the native float format on the target computer, regardless of where the file was originally created.

5.3 Mandatory and optional fields

The issue of mandatory and optional fields in the file is not straightforward. A general HDF browser will be able to read data from the file no matter which fields are required (mandatory) and which are optional. This will also be the case for browsers (viewers) which understand the structure of KNMI HDF5 files. For example, if an image is map projected, the map projection group must be present and contains a set of fields, which are required in that context. If the image is not map projected, the map projection group does not have to be present.

Explanation of M/O column:

M= Mandatory field. This flag is used to indicate whether this field is either required for further processing using HDF5 libraries or required by the Omnivoor/Beelden database and processing system. All fields, having an M attached, should be included in the KNMI HDF5 tag. If not, the field is not applicable to the type of image data set stored in the file or the group (in which the field is included) is optional and not present in the HDF5 file.

O= Optional field. This flag indicates fields that are included in the tag for the purpose of the user, to provide background information or to help the user.

5.4 Overview group

This group provides an overview of the dataset. It contains references, identifiers, a representative quicklook of the image data and fields describing the content of the file.

Tag Name	D/A	Type	O/M	Description	Convention/Example
product_group_name	A	String	M	Name of the product group; used as dataset identifier.	See chapter 7; e.g. "METEOSAT_7_MVIRI_ECMWF"
products_missing	A	String	M	Product_name of products included in the product group but missing in the HDF file. In case of more than one missing product, names are comma separated.	See chapter 7; e.g. METEOSAT_7_MVIRI_VIS _ECMWF, METEOSAT_7_MVIRI_VIS _ECMWF
product_datetime_start	A	String	M	Start date and time stamp of product(s) in HDF5 file	See chapter 7; e.g. "01-JAN-2002;12:34:40.120"
product_datetime_end	A	String	M	End date and time stamp of product(s) in HDF5 file (maybe the same as start date) ; Start and end date together define the period for which all products (observations and/or forecasts) included in the HDF5 file are valid; e.g. in case of a time series the start date/time defines the date/time of the first image in the time series and the end date/time defines the date/time of the last image.	See chapter 7; e.g. "01-JAN-2002;12:49:34.880"
abbtitle	A	String	O	Dataset identification: abbreviated title for the dataset	
product_group_title	A	String	O	Dataset identification: the explicit name of the geographic dataset, to sufficiently identify it by the users	
product_group_doc	A	String	O	Documentation reference	
hdftag_version_number	A	String	M	Version number of KNMI HDF-tag	="3.8"
hdf5_url	A	String	O	Internet reference (for the documentation) of HDF5	="https://support.hdfgroup.org/ftp/HDF5 "
hdftag_url	A	String	O	Internet reference of KNMI HDF5 tag	=”http://projects.knmi.nl/datacentrum/catalogus/catalogus/content/hdftag3-5.pdf “
dataset_summary	A	String	O	dataset overview: a brief textual description of the geographic dataset which summarises the content of the geographic dataset	
dataset_org_descry	A	String	O	dataset overview: description of the organisation responsible for commissioning production (together with a statement of status if appropriate)	
dataset_raster_type	A	String	O	dataset overview: type of raster data (spatial data, aerial data, semantic data or grid data, etc.)	
dataset_raster_descry	A	String	O	dataset overview: description of raster data, depending on the type of raster data	
dataset_sample	D	Image	M [1]	Sample of image_data as stored in the Image group. The sample is meant to show an overview of the dataset. This can be a RGB color composite of image layers stored in the HDF file.	
CLASS	A	String	M	Identifier to interpret dataset as image	= "IMAGE"

	IMAGE_SUBCLASS	A	String	O	Indicator of type of palette that should be used	= "IMAGE_TRUECOLOR" or "IMAGE_INDEXED"
	IMAGE_COLORMODEL	A	String	O	Indicator of color model of palette that should be used	= "RGB"
	IMAGE_VERSION	A	String	M	Version number of image specification	= "1.2"
	DISPLAY_ORIGIN	A	String	M [3]	Indicator at which corner pixel (0,0) should be viewed	= "UL" or "LL" or "UR" or "LR"
	PALETTE	A	REF_OBJ	O	Object reference pointer to a color palette in "Visualisation" group	
	INTERLACE_MODE	A	String	O	Indicator of storage layout of image data	= "INTERLACE_PIXEL" or "INTERLACE_PLANE"
dataset_sample_descr		A	String	O	Description of dataset_sample, channels used, …	e.g "R: channel_1,G: channel_2,B: channel_4"
dataset_meta_language		A	String	O	metadata language: language used in the textual statements	e.g. "CEN"
number_image_groups		A	Int	M [2]	Number of image groups present in file	1 or 2 etc.
number_profile_groups		A	Int	M [2]	Number of profile groups present in file	1 or 2 etc.
number_scan_groups		A	Int	M [2]	Number of scan groups present in file	1 or 2 etc.
number_discharge_groups		A	Int	M [2]	Number of discharge groups present in file	1 or 2 etc.
number_rf_data_groups		A	Int	M [2]	Number of rf_data groups present in file	1 or 2 etc.
number_visualisation_groups		A	Int	M [2]	Number of visualisation groups present in file	1 or 2 etc.
number_satellite_groups		A	Int	M [2]	Number of satellite groups present in file	1 or 2 etc.
number_radar_groups		A	Int	M [2]	Number of radar groups present in file	1 or 2 etc.
number_station_groups		A	Int	M [2]	Number of station groups present in file	1 or 2 etc.
number_classification_groups		A	Int	M [2]	Number of classification groups	1 or 2 etc.

[1] : Mandatory, only in case the size of the images, stored in the HDF5 file, makes the inclusion of a quicklook useful.

[2] : Mandatory, only in case the relevant group is represented in the file (so, in case the value of the tag is zero than the tag is not mandatory).

[3] : Mandatory, only in case the (0,0) pixel should **not** be displayed in the upper-left corner.

5.5 Geographic group

All information about the geographic reference of the dataset is placed in this group. This includes map projection and parameters used in this operation. By definition all image data included in one HDF5 dataset have the same geo references. So, the metadata included in this group applies to all images, point, grid, vector and classification data that are stored in the HDF5 file (only **one** Geographic group is included in an HDF5 file).

Name	D/A	Type	O/M	Description	Comment
geo_number_columns	A	Int	M	Number of pixels per line in images (x dimension)	e.g. 256
geo_number_rows	A	Int	M	Number of pixel lines in images (y dimension)	e.g. 256
geo_pixel_size_x	A	Float	M	Horizontal pixel size in projection plane (x-axis positive towards east)	e.g. 2.5

geo_pixel_size_y	A	Float	M	Vertical pixel size in projection plane (y-axis positive towards north)	e.g. -2.5
geo_par_pixel	A	String	M [3]	Geophysical parameters of image coordinates (horizontal, vertical)	e.g. "X,Y"
geo_dim_pixel	A	String	M	Dimensions of image pixel size (horizontal,vertical)	e.g. “KM,KM”
geo_column_offset	A	Float	M	Geographic column offset of pixel (0,0) from origin of projection plane	e.g. 200
geo_row_offset	A	Float	M	Geographic row offset of pixel (0,0) from origin of projection plane	e.g. 100
geo_pixel_def	A	String	M	Definition of lat/lon position inside the image pixels	e.g. "CENTRE" or "LU" etc.
geo_product_center	A	Table of Float	M [1]	Latitude and longitude at the centre point of the image	Tab(Lon, Lat)
geo_product_corners	A	Table of Float	M [1]	Latitude and longitude of each of the four product corners (starting with **southwest** corner and then clockwise)	Tab(Lon1, Lat1, Lon2, Lat2, Lon3, Lat3, Lon4, Lat4)
geo_ref_tiepoints	D	Table of Float	M [2]	List of points mapping pixel co-ordinates (x,y) to (lon,lat). The purpose of this table is to enable a geo navigation in the image by users.	Tab(X1,Y1,LON1,LAT1,X2,Y2,LON2,LAT2, ...)
geo_navigation_accuracy	A	Int	O	Estimated navigation error (number or pixels)	e.g. 1

[1] : One of these tags is mandatory

[2] : Mandatory, only in case of geographical image data without a valid projection

[3] : Mandatory, only in case of non-geographical image data

Map projection subgroup

Name	D/A	Type	O/M	Description	Convention/Example
projection_indication	A	String	M	Projection indication	"Y" or "N"
projection_name	A	String	M	Name of the projection according to strict naming convention	One of: “STEREOGRAPHIC”, “MERCATOR”, “SATELLITE_VIEW”
projection_descr	A	String	O	Description of the projection (formulas) or reference to URL	“https://proj.org/”
projection_proj4_params	A	String	M [1]	List of space separated tag=value pairs to be used with the PROJ4 projection library. Each tag is preceeded with a +. The URL of the PROJ4 document and library is referenced in "projection_descr" (in this case “https://proj.org/”)	e.g. “+proj=stere +a=6378.4 +b=6356.9 +lat_0=90.0 +lon_0=0.0 +lat_ts=60.0”
projection_semi_major_axis	A	Float	O [2]	Semi major axis (earth radius at Equator) in “geo_dim_pixel” units	6378.4
projection_semi_minor_axis	A	Float	O [2]	Semi minor axis (earth radius at pole) in “geo_dim_pixel” units	6356.9
projection_fplat	A	Float	O [2]	Fundamental point in **decimal** latitude degrees (-90.0 - 90.0)	e.g. 90.0
projection_fplon	A	Float	O [2]	Fundamental point in **decimal** longitude degrees (-180.0 - 360.0)	e.g. 0.0
projection_lat_true_scale	A	Float	O [2]	Latitude of true scale in decimal degrees (-90.0 – 90.0)	e.g. 60.0
projection_def_v1	A	Float	O [2]	deflection of vertical 1	
projection_def_v2	A	Float	O [2]	deflection of vertical 2	
projection_def_v3	A	Float	O [2]	deflection of vertical 3	
projection_std_meridian_1	A	Float	O [2]	standard meridian 1	

projection_std_meridian_2	A	Float	O [2]	standard meridian 2	
projection_std_meridian_3	A	Float	O [2]	standard meridian 3	
projection_std_par_1	A	Float	O [2]	standard parallel 1	
projection_std_par_2	A	Float	O [2]	standard parallel 2	
projection_std_par_3	A	Float	O [2]	standard parallel 3	
projection_scale_factor	A	Float	O [2]	Scale factor at the central meridian	
projection_zone	A	String	O [2]	UTM zone number	
projection_height	A	Float	O [2]	Height of satellite platform in “geo_dim_pixel” units	e.g. 35785.831

[1] and [2]: The **projection_proj4_params** tag is only mandatory in case the image data is projected. The tag contains all projection information needed to perform a projection using the PROJ4 library. If the **projection_proj4_params** tag is not available, then the other tags containing projection parameters must be filled.

5.6 Image group

All data related to the image data and the displaying of such must be placed in this group. There can be more than one Image group included in the HDF5 file.

Name	D/A	Type	O/M	Description	Convention/Example
image_product_name	A	String	M	Name of product stored in the Image group	See chapter 9; e.g. "METEOSAT_7_MVIRI_VIS _ECMWF "
image_source_ref	A	Table of REF_OBJ	O	Reference to "source" metadata as stored in Satellite, Radar or Lightning groups (see paragraphs 5.8-5.10). In case of "fused" products this tag may contain more then one reference to different groups.	
image_data	D	Image	M	Image, stored in 2-dimensional array of “Nrows x Ncolumns “	The NCSA specs are implemented here
CLASS	A	String	M	Identifier to interpret dataset as image	= "IMAGE"
IMAGE_SUBCLASS	A	String	O	Indicator of type of palette that should be used	= "IMAGE_TRUECOLOR" or "IMAGE_INDEXED" or "IMAGE_BITMAP"
IMAGE_COLORMODEL	A	String	O	Indicator of color model of palette that should be used	= "RGB"
IMAGE_WHITE_IS_ZERO	A	Int	O	Used in case of "IMAGE_BITMAP" to define bit	0 = false, 1 = true
IMAGE_VERSION	A	String	M	Version number of image specification	= "1.2"
DISPLAY_ORIGIN	A	String	M [4]	Indicator of at which corner pixel (0,0) should be viewed	= "UL" or "LL" or "UR" or "LR"
PALETTE	A	REF_OBJ	O	Object reference pointer to colour palette in "Visualisation" group	
image_size	A	Long	M	The total size of the image data in bytes	e.g. 1123078
image_bytes_per_pixel	A	Int	M	Number of bytes used to represent a pixel value	e.g. =1, for one-byte-per-pixel data
image_geo_parameter	A	String	M	Geophysical parameter or quantity with unit represented in image	e.g. ="TEMPERATURE_[K]"
image_preview	D	Image	M [1]	Thumbnail of image_data (for quicklook purposes). E.g. including every 10th pixel column and row of original image.	The NCSA specs are implemented here;

	CLASS	A	String	M	Identifier to interpret dataset as image	= "IMAGE"
	IMAGE_SUBCLASS	A	String	O	Indicator of type of palette that should be used	= "IMAGE_TRUECOLOR" or "IMAGE_INDEXED" or "IMAGE_BITMAP"
	IMAGE_COLORMODEL	A	String	O	Indicator of color model of palette that should be used	= "RGB"
	IMAGE_WHITE_IS_ZERO	A	Int	O	Used in case of "IMAGE_BITMAP" to define bit	0 = false, 1 = true
	IMAGE_VERSION	A	String	M	Version number of image specification	= "1.2"
	DISPLAY_ORIGIN	A	String	M [4]	Indicator of at which corner pixel (0,0) should be viewed	= "UL" or "LL" or "UR" or "LR"
	PALETTE	A	REF_OBJ	O	Object reference pointer to colour palette in "Visualisation" group	
image_start_obs		A	String	M [2]	Date and time when image observation is started	See chapter 7;e.g. "01-JAN-2002;12:34:40.120"
image_end_obs		A	String	M [2]	Date and time when image observation is ended	See chapter 7;e.g. "01-JAN-2002;12:49:34.880"
image_datetime_valid		A	String	M [5]	Date and time for which the forecast product being stored in this image group is valid.	See chapter 7; e.g. "01-JAN-2002;12:49:34.880"
image_number_image_obs		A	Int	M [3]	Number of image observations included in composites.	e.g. 10
image_obs_timestamp		A	Table of String	M [3]	Timestamp for each image included in the composite. UTC time stamps of each image, included in composite, are listed. Timestamps are comma separated	For time stamps convention see chapter 7. E.g. Tab(01-JAN-2002;12:34:40.120,02-JAN-2002;12:24:32.130,...)
image_cloud_mask_applied		A	Int	O	By evaluation of Meteosat imagery a mask is derived that shows the area without any clouds. Assuming no rain falls in these masked areas all observed non-zero reflectivity's are set to zero in these areas (for reflectivity products). Allowable values[0.,1]	e.g. 1

[1] : Mandatory, only in case the size of the image, stored in the Image group, makes the inclusion of a preview useful (e.g. > 256 x 256 pixels in an original image).

[2] : Mandatory, only in case the observation times of the image deviate from the observation times included in the Overview group

[3] : Mandatory, only in case of a composite image.

[4] : Mandatory, only in case the (0,0) pixel should **not** be displayed in the upper-left corner.

[5] : Mandatory, only in case of a forecast image

Calibration subgroup

Name	D/A	Type	O/M	Description	Convention/Example
calibration_flag	A	String	M	Is image data calibrated? Is there a fixed relation between the pixel bytes and a geophysical parameter?	"Y" = data is calibrated "N" = data is uncalibrated (raw)
calibration_level	A	String	O	Level of calibration? E.g. the NASA definition: 0 = raw, 1 = sensor calibrated, 2 = atmospheric corrected, etc.	e.g. "NASA level 0"
calibration_reference	A	String	O	Reference to calibration data used (e.g. NOAA tables); e.g. NOAA URL	
calibration_formulas	A	String	M [1]	Text representation of formulas used for conversion of pixel values (PV) to geophysical parameter or quantity (GEO). The layout is fixed.	e.g. "GEO=0.933*PV+1.444"
calibration_table	D	Table of float	M [1]	Table containing mapping between pixel values and calibrated geophysical	e.g. see chapter 6, table 1.1 and 1.2

				parameter or quantity	
calibration_missing_data	A	Int	M	Pixel value representing missing data (e.g. bad or missed lines)	e.g. 255
calibration_out_of_image	A	Int	M	Pixel value representing "out of image" or "out of range"	e.g. 255
calibration_annotation_tables	D	Table of string	O	Table containing mappings from pixel values to some textual values (for the purpose of annotation).	e.g. see chapter 6, table 1.3

[1] Either a formula or table is needed in this subgroup. In case of a simple formula (e.g. linear cases) a formula is preferred, otherwise a table.

Statistics subgroup

Name	D/A	Type	O/M	Description	Convention/Example
stat_min_value	A	Float	M	Minimum **geopysical** pixel value present in image (one value for each image)	e.g. 260.5
stat_max_value	A	Float	M	Maximum **geopysical** pixel value present in image (one value for each image)	e.g. 315.6
stat_min_value_5	A	Float	O	Minimum **geopysical** pixel value after 5% of the pixels are clipped from the low end of the histogram (one value for each image)	e.g. 261.5
stat_max_value_5	A	Float	O	Maximum **geopysical** pixel value after 5% of the pixels are clipped from the high end of the histogram (one value for each image)	e.g. 299.7
stat_histogram	A	Table of Long	O	Histogram for image in the image group	e.g. Tab(0,0,25,50,300,...)
stat_bin_count	A	Integer	O	Number of bins used in the histogram	e.g. 15
stat_bin_size	A	Integer	O	Size of each bin (in counts)	e.g. 17
stat_std_dev	A	Float	O	Standard deviation of pixel values in image	e.g. 80.22
stat_mean	A	Float	O	Mean of pixel values in image	e.g. 155.5
stat_cell_number	A	Integer	O	Number of cells detected in the image for which properties are stored	e.g. 10
stat_cell_threshold	A	Float	O[1]	Threshold value of **geophysical** quantity for cell finding	e.g. 30.0
stat_cell_area	A	Table of float	O[1]	Areas of the detected cells in km^2	e.g. Tab(10500.8,5070.0,4658.8,…)
stat_cell_mean	A	Table of float	O[1]	Mean value of **geophysical** quantity stored in image over cell area in units of the parameter	e.g. Tab(34.5,67.3,12.1,8.9,9.8,…)
stat_cell_max	A	Table of float	O[1]	Maximum value of **geophysical** quantity stored in image over cell area in units of the parameter	e.g. Tab(38.5,75.3,16.4,9.5,19.8,…)
stat_cell_column	A	Table of integer	O[1]	Column coordinate (pixel number) in image of maximum value detected in cell area	e.g. Tab(231,145,78,480, …)
stat_cell_row	A	Table of integer	O[1]	Row coordinate (pixel number) in image of maximum value detected in cell area	e.g. Tab(131,248,478,290, …)

[1] Mandatory when attribute "stat_cell_number" is present.

Satellite subgroup

All information related to the quality and to the processing of the image/VAP is placed in this group. This includes level of processing, e.g. level1 (pan corrected and orthorectified), level2 (map projected). Other information that can be placed here is a reference to the algorithms used by the processor. Reference to external processing procedures, e.g. NOAA. There can be more than one Satellite group included in the HDF5 file.

Name	D/A	Type	O/M	Description	Convention/Example
satellite_product	A	String	O	Description of satellite product contained in image	e.g. "AVHRR_CHANNEL_1"
image_acquisition_time	A	String	O	UTC when the input data for this image dataset was received on site (e.g. at KNMI)	For UTC convention see chapter 7
image_generation_time	A	String	O	UTC when this image dataset was produced	For UTC convention see chapter 7
image_processing_level	A	String	O	Level of processing	Any convention can be used here
image_processing_software	A	String	O	Processing software used: reference to algorithms used	Can be a URL (where a document is located)
image_processing_hist	A	String	O	Processing history: listing of processing steps	e.g. "CALIBRATED, NAVIGATED, PROJECTED"
navigation_processing_hist	A	String	O	Navigation processing history: description of navigation steps	e.g. "LANDMARK_CORRECTION"
image_accuracy_indication	A	String	O	Accuracy indication of geophysical pixel value: e.g. for SST image (static information)	e.g. "0.5 C"
image_quality_indication	A	String	O	Indication if quality metadata available	"Y" = quality fields included "N" = quality fields not included
image_quality_ingest	A	String	O	Ingest quality parameters	
image_quality_ber	A	Double	O	Bit Error Rate	
image_nbr_missing_lines	A	Int	O	Number of detected missing lines	
image_missing_line_numbers	A	Table of Int	O	The line numbers of the missing lines	Tab(1, 103, …)
missing_lines_correction_procedures	A	String	O	Procedure used to correct for missing or bad lines.	e.g. "DUPLICATE_LAST" or "IGNORE" or "BLEND" or "NONE"
lineage_id	A	Long	O	image quality: unique id for the process history of the data set	
lineage_method	A	String	O	image quality: method used for creating or processing data set	
lineage_organisation	A	String	O	image quality: organisation applying the method on the dataset	
lineage_start_date	A	String	O	image quality: start date of process	
lineage_end_date	A	String	O	image quality: end date of process	
lineage_purpose	A	String	O	image quality: purpose	
lineage_confidence	A	String	O	image quality, meta quality: confidence	

lineage_reliability	A	String	O	image quality, meta quality: reliability	
lineage_methodology	A	String	O	image quality, meta quality: methodology	
lineage_abstraction	A	String	O	image quality, meta quality: abstraction effect	

Radar subgroup

Name	D/A	Type	O/M	Description	Convention/Example
radar_product	A	String	O	Description of radar product contained in image	e.g. “PCAPPI”
radar_product_parameter	A	String	O	Parameter specifying radar product, e.g. height of CAPPI	e.g. “0.8KM”
radar_method	A	String	O	Description of method used to derive radar product	e.g. “Interpolation”
radar_quality	A	String	O	Indication of quality	e.g. “The_best”
radar_elevation	A	Float	O	Elevation of radar beam in degrees	e.g. 0.3
radar_rotation	A	Float	O	Azimuthal speed of radar antenna in degrees/sec.	e.g. 18
radar_prf_low	A	Float	O	Low PRF used during acquisition of radar data in Hz.	e.g. 750
radar_prf_high	A	Float	O	High PRF used during acquisition of radar data in Hz.	e.g. 1000

5.7 Profile group

This repeated group is intended for storage of vertical profiles from e.g. weather radars, sodars, or profilers, and it can be extended from radiosonde observations of model profiles. The values of a variable at the different levels/heights in a profile are stored in a datasets. Different datasets are proposed for several variables and additional datasets can be included. The only mandatory dataset is the one described the geometric height of the vertical levels in the profile.

Name	D/A	Type	O/M	Description	Convention/Example
profile_number_levels	A	Int	M	Number of vertical levels in profile, i.e., length of profile datasets	e.g. 15
profile_missing_data	A	Float	M	Float value indicating “missing data” in profile datasets	e.g. –9999.0
profile_height	D	Table of Float	M	Dataset with geometric height of vertical levels in profile in meter	e.g. Tab(100,300, …)
profile_u_wind	D	Table of Float	O	Dataset with east-west component of wind in m/s	e.g. Tab(–5.0,13.0,…)
profile_v_wind	D	Table of Float	O	Dataset with north-south component of wind in m/s	e.g., Tab(20.0, 15.4,…)
profile_w_wind	D	Table of Float	O	Dataset with vertical component of wind in m/s	e.g. Tab(0.5, -1.0,…)
profile_radial_stddev	D	Table of Float	O	Dataset with standard deviation of radial velocity as deduced from the wind model fit used in profile extraction in m/s	e.g. Tab(1.0,1.5, …)
profile_reflectivity	D	Table of Float	O	Dataset with reflectivity factor at levels in profile in dBZ	e.g. Tab(–31.5, -20.5, …)
profile_bird_reflectivity	D	Table of Float	O	Dataset with bird reflectivity at levels in profile in cm^2/km^3	e.g. Tab(0,1,10.0,…)

profile_number	D	Table of Int	O	Dataset with number of points used to compile values at each level	e.g. Tab(1000,400, …)

5.8 Scan group

This repeated group is intended for storage of raw scan data ("volume data") of weather radars. Each scan group can be used to store all radar data and corresponding metadata collected at a certain elevation. The raw scan data must be sorted such that the first ray of the scan always starts at zero azimuth. An indicator to the ray where the raw scan originally started is stored in the metadata.

Name	D/A	Type	O/M	Description	Convention/Example
scan_datetime	A	String	M	Starting date and time of scan contained in this repeated group	See chapter 7; e.g. "01-JAN-2002;12:34:40.120"
scan_start_azim	A	Int	O	Indicator (number) to azimuthal ray where the radar scan started. Note that stored scan data are always sorted to start at zero azimuth.	e.g. 206
scan_number_range	A	Int	M	Number of range bins for all azimuthal rays in radar scan data	e.g. 320
scan_number_azim	A	Int	M	Number of azimuthal rays of radar scan data	e.g. 360
scan_range_bin	A	Float	M	Length of range bins of radar scan data in km	e.g. 0.5
scan_azim_bin	A	Float	M	Width of aziuthal rays of radar scan data in degrees	e.g. 1.0
scan_elevation	A	Float	M	Elevation at which radar scan data have been recorded in degrees	e.g. 0.3
scan_low_PRF	A	Float	O	Low Pulse Repetition Frequency (PRF) used to record radar scan data in Hz. In case of single-PRF data, this value is set to zero.	e.g. 750.0
scan_high_PRF	A	Float	O	High PRF used to record radar scan data in Hz	e.g. 1000.0
scan_range_samples	A	Int	O	Number of samples averaged in range bins	e.g. 8
scan_azim_samples	A	Int	O	Number of samples averaged in azimuthal direction	e.g. 50
scan_pulse_width	A	Float	O	Width of transmitted radar pulses in microseconds	e.g. 2.0
scan_radar_constant	A	Float	O	Value of radar constant for conversion from received power in dBm to reflectivity in dBZ. Constant is given in dB at range of 1 km.	e.g. 67.8
scan_TX_power_nom	A	Float	O	Nominal power of transmitted pulses in kW used to calculate radar constant	e.g. 267.5
scan_antenna_velocity	A	Float	O	Antenna rotation speed in degrees/second	e.g. 24.0
scan_filter_width	A	Float	O	Spectral width of applied Doppler clutter filter in m/s	e.g. 1.0
scan_threshold_CSR	A	Float	O	Clutter-to-Signal-Ratio threshold in dB	e.g. 20.0
scan_threshold_SQI	A	Float	O	Signal-Quality-Index threshold	e.g. 0.3
scan_threshold_ZSQI	A	Float	O	Signal-Quality-Index threshold for reflectivity data	e.g. 0.3
scan_threshold_LOG	A	Float	O	LOG threshold in dB	e.g. 0.5

scan_Z_data		D	Image	Z	Clutter corrected reflectivity scan data in polar coordinates for the horizontal channel, ray-by-ray. Note that the scan data are sorted such that the first ray always starts at zero azimuth.	
	CLASS	A	String	M	Identifier to interpret dataset as image	= "IMAGE"
	VERSION	A	String	M	Version number of image specification	= "1.2"
	PALETTE	A	REF_OBJ	O	Object reference pointer to colour palette in "Visualisation" group	
scan_Zv_data		D	Image	Z	Clutter corrected reflectivity scan data in polar coordinates for the vertical channel, ray-by-ray. Note that the scan data are sorted such that the first ray always starts at zero azimuth.	
	CLASS	A	String	M	Identifier to interpret dataset as image	= "IMAGE"
	VERSION	A	String	M	Version number of image specification	= "1.2"
	PALETTE	A	REF_OBJ	O	Object reference pointer to colour palette in "Visualisation" group	
scan_uZ_data		D	Image	O	Uncorrected reflectivity scan data in polar coordinates for the horizontal channel, ray-by-ray. Note that the scan data is sorted such that the first ray always starts at zero azimuth.	
	CLASS	A	String	M	Identifier to interpret dataset as image	= "IMAGE"
	VERSION	A	String	M	Version number of image specification	= "1.2"
	PALETTE	A	REF_OBJ	O	Object reference pointer to colour palette in "Visualisation" group	
scan_uZv_data		D	Image	O	Uncorrected reflectivity scan data in polar coordinates for the vertical channel, ray-by-ray. Note that the scan data is sorted such that the first ray always starts at zero azimuth.	
	CLASS	A	String	M	Identifier to interpret dataset as image	= "IMAGE"
	VERSION	A	String	M	Version number of image specification	= "1.2"
	PALETTE	A	REF_OBJ	O	Object reference pointer to colour palette in "Visualisation" group	
scan_V_data		D	Image	O	Clutter corrected radial velocity data in polar coordinates for the horizontal channel, ray-by-ray. Note that the scan data are sorted such that the first ray always starts at zero azimuth.	
	CLASS	A	String	M	Identifier to interpret dataset as image	= "IMAGE"
	VERSION	A	String	M	Version number of image specification	= "1.2"
	PALETTE	A	REF_OBJ	O	Object reference pointer to colour palette in "Visualisation" group	
scan_Vv_data		D	Image	O	Clutter corrected radial velocity data in polar coordinates for the vertical channel, ray-by-ray. Note that the scan data are sorted such that the first ray always starts at zero azimuth.	
	CLASS	A	String	M	Identifier to interpret dataset as image	= "IMAGE"
	VERSION	A	String	M	Version number of image specification	= "1.2"

	PALETTE	A	REF_OBJ	O	Object reference pointer to colour palette in "Visualisation" group	
scan_W_data		D	Image	O	Spectral width scan data in polar coordinates for the horizontal channel, ray-by-ray. Note that the scan data are sorted such that the first ray always starts at zero azimuth.	
	CLASS	A	String	M	Identifier to interpret dataset as image	= "IMAGE"
	VERSION	A	String	M	Version number of image specification	= "1.2"
	PALETTE	A	REF_OBJ	O	Object reference pointer to colour palette in "Visualisation" group	
scan_Wv_data		D	Image	O	Spectral width scan data in polar coordinates for the vertical channel, ray-by-ray. Note that the scan data are sorted such that the first ray always starts at zero azimuth.	
	CLASS	A	String	M	Identifier to interpret dataset as image	= "IMAGE"
	VERSION	A	String	M	Version number of image specification	= "1.2"
	PALETTE	A	REF_OBJ	O	Object reference pointer to colour palette in "Visualisation" group	
scan_Zdr_data		D	Image	O	Clutter corrected differential reflectivity scan data in polar coordinates, ray-by-ray. Note that the scan data are sorted such that the first ray always starts at zero azimuth.	
	CLASS	A	String	M	Identifier to interpret dataset as image	= "IMAGE"
	VERSION	A	String	M	Version number of image specification	= "1.2"
	PALETTE	A	REF_OBJ	O	Object reference pointer to colour palette in "Visualisation" group	
scan_RhoHV_data		D	Image	O	Clutter corrected horizontal/vertical correlation coefficient scan data in polar coordinates, ray-by-ray. Note that the scan data are sorted such that the first ray always starts at zero azimuth.	
	CLASS	A	String	M	Identifier to interpret dataset as image	= "IMAGE"
	VERSION	A	String	M	Version number of image specification	= "1.2"
	PALETTE	A	REF_OBJ	O	Object reference pointer to colour palette in "Visualisation" group	
scan_PhiDP_data		D	Image	O	Clutter corrected differential phase scan data in polar coordinates, ray-by-ray. Note that the scan data are sorted such that the first ray always starts at zero azimuth.	
	CLASS	A	String	M	Identifier to interpret dataset as image	= "IMAGE"
	VERSION	A	String	M	Version number of image specification	= "1.2"
	PALETTE	A	REF_OBJ	O	Object reference pointer to colour palette in "Visualisation" group	
scan_uPhiDP_data		D	Image	O	Uncorrected differential phase scan data in polar coordinates, ray-by-ray. Note that the scan data are sorted such that the first ray always starts at zero azimuth.	
	CLASS	A	String	M	Identifier to interpret dataset as image	= "IMAGE"

	VERSION	A	String	M	Version number of image specification	= "1.2"
	PALETTE	A	REF_OBJ	O	Object reference pointer to colour palette in "Visualisation" group	
scan_KDP_data		D	Image	O	Clutter corrected specific differential phase scan data in polar coordinates, ray-by-ray. Note that the scan data are sorted such that the first ray always starts at zero azimuth.	
	CLASS	A	String	M	Identifier to interpret dataset as image	= "IMAGE"
	VERSION	A	String	M	Version number of image specification	= "1.2"
	PALETTE	A	REF_OBJ	O	Object reference pointer to colour palette in "Visualisation" group	
scan_CPA_data		D	Image	O	Clutter phase alignment data in polar coordinates for the horizontal channel, ray-by-ray. Note that the scan data are sorted such that the first ray always starts at zero azimuth.	
	CLASS	A	String	M	Identifier to interpret dataset as image	= "IMAGE"
	VERSION	A	String	M	Version number of image specification	= "1.2"
	PALETTE	A	REF_OBJ	O	Object reference pointer to colour palette in "Visualisation" group	
scan_CPAv_data		D	Image	O	Clutter phase alignment data in polar coordinates for the vertical channel, ray-by-ray. Note that the scan data are sorted such that the first ray always starts at zero azimuth.	
	CLASS	A	String	M	Identifier to interpret dataset as image	= "IMAGE"
	VERSION	A	String	M	Version number of image specification	= "1.2"
	PALETTE	A	REF_OBJ	O	Object reference pointer to colour palette in "Visualisation" group	
scan_CCOR_data		D	Image	O	Clutter correction scan data in polar coordinates for the horizontal channel, ray-by-ray. Note that the scan data are sorted such that the first ray always starts at zero azimuth.	
	CLASS	A	String	M	Identifier to interpret dataset as image	= "IMAGE"
	VERSION	A	String	M	Version number of image specification	= "1.2"
	PALETTE	A	REF_OBJ	O	Object reference pointer to colour palette in "Visualisation" group	
scan_CCORv_data		D	Image	O	Clutter correction scan data in polar coordinates for the vertical channel, ray-by-ray. Note that the scan data are sorted such that the first ray always starts at zero azimuth.	
	CLASS	A	String	M	Identifier to interpret dataset as image	= "IMAGE"
	VERSION	A	String	M	Version number of image specification	= "1.2"
	PALETTE	A	REF_OBJ	O	Object reference pointer to colour palette in "Visualisation" group	
scan_SQI_data		D	Image	O	Signal quality index scan data in polar coordinates for the horizontal channel, ray-by-ray. Note that the scan data are sorted such that the first ray always starts at zero azimuth.	

	CLASS	A	String	M	Identifier to interpret dataset as image	= "IMAGE"
	VERSION	A	String	M	Version number of image specification	= "1.2"
	PALETTE	A	REF_OBJ	O	Object reference pointer to colour palette in "Visualisation" group	
scan_SQIv_data		D	Image	O	Signal quality index scan data in polar coordinates for the vertical channel, ray-by-ray. Note that the scan data are sorted such that the first ray always starts at zero azimuth.	
	CLASS	A	String	M	Identifier to interpret dataset as image	= "IMAGE"
	VERSION	A	String	M	Version number of image specification	= "1.2"
	PALETTE	A	REF_OBJ	O	Object reference pointer to colour palette in "Visualisation" group	
scan_TX_power		D	Table of float	O	Averaged transmitted power for each ray in the scan data. Note that the data are sorted such that the first ray always starts at zero azimuth.	

Calibration subgroup

Name	D/A	Type	O/M	Description	Convention/Example
calibration_Z_formulas	A	String	M [1]	Text representation of formulas used for conversion of raw scan data values (PV) to radar reflectivity in dBZ (GEO) for the horizontal channel. The layout is fixed.	e.g. "GEO=0.933*PV+1.444"
calibration_Zv_formulas	A	String	M [1]	Text representation of formulas used for conversion of raw scan data values (PV) to radar reflectivity in dBZ (GEO) for the vertical channel. The layout is fixed.	e.g. "GEO=0.933*PV+1.444"
calibration_uZ_formulas	A	String	M [1]	Text representation of formulas used for conversion of raw scan data values (PV) to uncorrected radar reflectivity in dBZ (GEO) for the horizontal channel. The layout is fixed.	e.g. "GEO=0.933*PV+1.444"
calibration_uZv_formulas	A	String	M [1]	Text representation of formulas used for conversion of raw scan data values (PV) to uncorrected radar reflectivity in dBZ (GEO) for the vertical channel. The layout is fixed.	e.g. "GEO=0.933*PV+1.444"
calibration_V_formulas	A	String	M [1]	Text representation of formulas used for conversion of raw scan data values (PV) to Doppler radar radial velocity in m/s (GEO) for the horizontal channel. The layout is fixed.	e.g. "GEO=0.933*PV+1.444"
calibration_Vv_formulas	A	String	M [1]	Text representation of formulas used for conversion of raw scan data values (PV) to Doppler radar radial velocity in m/s (GEO) for the vertical channel. The layout is fixed.	e.g. "GEO=0.933*PV+1.444"
calibration_W_formulas	A	String	M [1]	Text representation of formulas used for conversion of raw scan data values (PV) to Doppler radar spectral width in m/s (GEO) for the horizontal channel. The layout is fixed.	e.g. "GEO=0.933*PV+1.444"
calibration_Wv_formulas	A	String	M [1]	Text representation of formulas used for conversion of raw scan data values (PV) to Doppler radar spectral width in m/s (GEO) for the vertical channel. The layout is fixed.	e.g. "GEO=0.933*PV+1.444"

calibration_Zdr_formulas	A	String	M [1]	Text representation of formulas used for conversion of raw scan data values (PV) to differential radar reflectivity in dB (GEO). The layout is fixed.	e.g. "GEO=0.933*PV+1.444"
calibration_RhoHV_formulas	A	String	M [1]	Text representation of formulas used for conversion of raw scan data values (PV) to horizontal and vertical correlation coefficient (GEO). The layout is fixed.	e.g. "GEO=0.933*PV+1.444"
calibration_PhiDP_formulas	A	String	M [1]	Text representation of formulas used for conversion of raw scan data values (PV) to differential phase in degree (GEO). The layout is fixed.	e.g. "GEO=0.933*PV+1.444"
calibration_uPhiDP_formulas	A	String	M [1]	Text representation of formulas used for conversion of raw scan data values (PV) to uncorrected differential phase in degree (GEO). The layout is fixed.	e.g. "GEO=0.933*PV+1.444"
calibration_KDP_formulas	A	String	M [1]	Text representation of formulas used for conversion of raw scan data values (PV) to specific differential phase in degree / km (GEO). The layout is fixed.	e.g. "GEO=0.933*PV+1.444"
calibration_CCOR_formulas	A	String	M [1]	Text representation of formulas used for conversion of raw scan data values (PV) to clutter correction in dB (GEO) for the horizontal channel. The layout is fixed.	e.g. "GEO=0.933*PV+1.444"
calibration_CCORv_formulas	A	String	M [1]	Text representation of formulas used for conversion of raw scan data values (PV) to clutter correction in dB (GEO) for the vertical channel. The layout is fixed.	e.g. "GEO=0.933*PV+1.444"
calibration_CPA_formulas	A	String	M [1]	Text representation of formulas used for conversion of raw scan data values (PV) to clutter phase alignment (GEO) for the horizontal channel. The layout is fixed.	e.g. "GEO=0.933*PV+1.444"
calibration_CPAv_formulas	A	String	M [1]	Text representation of formulas used for conversion of raw scan data values (PV) to clutter phase alignment (GEO) for the vertical channel. The layout is fixed.	e.g. "GEO=0.933*PV+1.444"
calibration_SQI_formulas	A	String	M [1]	Text representation of formulas used for conversion of raw scan data values (PV) to signal quality index (GEO) for the horizontal channel. The layout is fixed.	e.g. "GEO=0.933*PV+1.444"
calibration_SQIv_formulas	A	String	M [1]	Text representation of formulas used for conversion of raw scan data values (PV) to signal quality index (GEO) for the vertical channel. The layout is fixed.	e.g. "GEO=0.933*PV+1.444"
calibration_missing_data	A	Int	M	Pixel value representing missing data (e.g. bad or missed lines)	e.g. 255

[1] Mandatory when corresponding dataset in scan-group is present

5.9 Discharge group

This group is intended for storage of the time series of the localizations observed by a lightning detection system. The time series of each parameter detected by the system is stored as an array in a dataset. The data and time of each discharge event (localization) are given as a time offset in seconds against a reference data and time which is stored in this group as well. The time offset is stored in a dataset of doubles to allow for storage of a high accuracy time offset (microsec.) over a daily period. A number of parameters describing the characteristics of a discharge have been defined, but addition of other datasets is possible.

Since 1 jan 2015 the station_reporting tag has been added an is available in the Meteorage LAM products

Name	D/A	Type	O/M	Description	Convention/Example
number_discharges	A	Int	M	Number of discharges in time series, i.e., length of discharge datasets	e.g. 100
reference_datetime	A	String	M	Date and time stamp against which discharges are referenced	See chapter 7; e.g. "01-JAN-2002;12:34:40.120"
time_offset	D	Table of Double	M	Dataset with time offsets of discharges with respect to reference date and time in sec., double allows for microsec accuracy	e.g., Tab(0.001,0.0011, …)
longitude	D	Table of Float	M	Dataset with geographical longitudes of discharges in decimal degrees	e.g., Tab(4.78,5.17,…)
latitude	D	Table of Float	M	Dataset with geographical latitudes of discharges in decimal degrees	e.g. Tab(51.1,52.9, …)
event_type	D	Table of Char	O	Dataset with types of observed discharges: “0” single-point (FLITS only), “1” start of CC (FLITS only) , “2” CC discharge next point (FLITS only), “3” end of CC(FLITS only), “4” CG stroke, “5” CG return stroke 13=cloud discharge(Meteorage only)	e.g. Tab(1,2,2,3,….)
position_error	D	Table of Float	O	Dataset with position errors of CG stroke localizations as deduced by detection system in meter	e.g. Tab(500,1500,..)
rise_time	D	Table of Float	O	Dataset with rise times of induced current for detected CG strokes in sec.	e.g. Tab(0.000010,0.000020, …)
decay_time	D	Table of Float	O	Dataset with decay times of induced current for detected CG strokes in sec.	e.g. Tab(0.000125,0.0005,…)
current	D	Table of Float	O	Dataset with estimated currents of CG strokes in ampere	e.g., Tab(100000,250000, ….)
stations_reporting	D	Table of Integer	O	Number of stations that has reported the discharge.	

5.10 RF_data group

This group is used Safir/FLITS style, available in _LAP_ products, (available until 31 December 2014)

This repeated group is intended for storage of the time series of the raw Radio-Frequency (RF) data from a lightning detection network. The time series of each parameter detected by the RF antennas of the system is stored as an array in a dataset. The data and time of each RF event are given as a time offset in seconds against a reference data and time which is stored in this group as well. The time offset is stored in a dataset of doubles to allow for storage of a high accuracy time offset (microsec.) over a daily period. A number of parameters typically detected by low-frequency (LF) and high-frequency (VHF) antennas have been defined, but addition of other datasets is possible.

Name	D/A	Type	O/M	Description	Convention/Example
rf_sensor	A	String	M	Frequency range or type of RF sensor from which data are originating	e.g. “LF” or “VHF”
rf_number_data	A	Int	M	Number of RFdata in time series, i.e., length of discharge datasets	e.g. 1000
rf_reference_datetime	A	String	M	Date and time stamp against which RF data are referenced	See chapter 7; e.g. "01-JAN-2002;12:34:40.120"
rf_time_offset	D	Table of double	M	Dataset with time offsets of RF data with respect to reference date and time in sec., double allows for microsec accuracy	e.g. Tab(0.001,0.0011, …)
rf_station	D	Table of char	M	Dataset indicating at which station each RF event is recorded. Station numbers must correspond to the numbers of repeated “Station groups”.	e.g. Tab(1,5,3,2, …)
rf_azimuth	D	Table of float	O	Dataset with azimuths of recorded RF events in degrees	e.g. Tab(90.0,23.1,358.9, …)
rf_duration	D	Table of float	O	Dataset with duration of recorded RF events in sec.	e.g. Tab(0.000010,0.000020, …)
rf_amplitude	D	Table of float	O	Dataset with amplitudes of recored RF events in V/m or in arbritary units (when not calibrated).	e.g. Tab(20.0,4.0,,0.0, …)
rf_rise_time	D	Table of float	O	Dataset with rise times of recored RF events in sec.	e.g. Tab(0.000010,0.000020, …)
rf_decay_time	D	Table of float	O	Dataset with decay times of recorded RF events in sec.	e.g. Tab(0.000125,0.0005,…)

5.11 Visualisation group

In this group a color_palette is stored. Documentation on how the use of color_palettes is implemeted in the HDF5 tag is described in chapter 8. There can be more than one Visualisation group stored in one HDF5 file.

Name		D/A	Type	O/M	Description	Convention/Example
color_palette		D	Table	M	Color palette in RGB format: two-dimensional array of “Ncolors x 3”	The NCSA specs are implemented here;
	CLASS	A	String	M	Identifier to interpret dataset as color palette	= "PALETTE"
	PAL_VERSION	A	String	M	Version number of palette specification	= "1.2"
	PAL_TYPE	A	String	M	Definition of type of palette, usually a directly indexed array	=”STANDARD8”
	PAL_COLORMODEL	A	String	M	Definition of the color model used in palette, usually RGB	=”RGB”

5.12 Satellite group

In this group, mostly static information regarding the satellite is placed. This includes the position of the satellite at the time of data capturing. Also descriptions of the on-board instruments can be placed here (e.g. spectral bands related to channels). Moreover, in case of polar orbiting satellites actual orbit information is stored.

Name	D/A	Type	O/M	Description	Convention/Example
satellite_name	A	String	M	Name of satellite (e.g. NOAA)	e.g. "NOAA" or "METEOSAT", etc.
satellite_id	A	String	M	ID of satellite (e.g. 16)	e.g. 16 or 7
satellite_description	A	String	O	Textual description of satellite or reference to URL	e.g. "http://www.eumetsat.de/"
satellite_agency	A	String	O	Owner/agency of satellite (e.g. RADARSAT International)	e.g. "EUMETSAT"
satellite_platform_type	A	String	O	Polar orbiting, geostationary, ground based	e.g. "GEOSTATIONARY"
satellite_platform_position	A	String	M	Position relative to ground of the satellite (or instrument in case of weather radar)	e.g. "AT CROSSING POINT OF EQUATOR AND MERIDIAN"
satellite_launch_date	A	String	O	Start Date of the source identifier (can be launch date of satellite or first date of first operational data delivery).	e.g. "17 MARCH 1996"
satellite_acquisition_station	A	String	O	Groundstation where the data is gathered from the satellite	e.g. "KNMI in De Bilt"
satellite_asc_desc_flag	A	String	M [1]	Satellite pass is ascending or descending	"A" = ascending; "D" = descending;
satellite_subtrack	A	Table of Float	M [1]	Satellite sub track (at nadir) ; Two pairs of Lat/Lon are included: the position of the satellite at start_obs and at end_obs.	Tab(Lat(start), Lon(start), Lat(end), Lon(end))
satellite_orbit_number	A	Int	O [1]	Orbit number for pass	e.g. 12388
satellite_orbit_prop_ind	A	String	O [1]	Indicator which orbit proposition data is present in group	"TBUS "= TBUS data is present "TLE" = Two line elements is present "SV" = State vector is present "NONE" = no orbit prop data is present
satellite_orbit_prop	A	String	O [1]	State vector, or TBUS message or two line elements used in the navigation processing. For info see: noaasis.noaa.gov/NOAASIS/ml/navigation.html	The TBUS, state vector or two-line elements in the form of a text string
satellite_orbit_prop_age	A	String	O [1]	Age of state vector (or TBUS or two-line elements). Date of the TBUS message, state vector or two-line elements.	20-JAN-2002

[1] These fields are included only in case of polar orbiting satellites.

Sensor subgroup

Name	D/A	Type	O/M	Description	Convention/Example
sensor_name	A	String	M	Name of instrument/sensor (of which data is included in dataset)	e.g. "MVIRI" or "AVHRR"
sensor_type	A	String	O	Type of sensor	e.g. "IMAGER" or "SOUNDER"
sensor_descr	A	String	O	Short description sensor or instrument	e.g. "ADVANCED VERY HIGH RESOLUTION RADIOMETER"

sensor_descr_long	A	String	O	Long description sensor or instrument or reference to URL	e.g. "www.eumetsat.de"
sensor_number_channels	A	Int	O	Number of channels	e.g. 5
sensor_desc_channels	A	String	O	Description of channels(waveband, signal/noise ratio)	See chapter 7
sensor_radiometric_res	A	String	O	Radiometric resolution of sensor (Number of bits)	e.g. "10 BITS"
sensor_spatial_res	A	String	O	Spatial resolution (NADIR in km)	e.g. "1.1 KM"
sensor_temporal_res	A	String	O	Temporal resolution or repetition frequency	e.g. "9 DAYS" or "30 MINUTES"

5.13 Radar group

Name	D/A	Type	O/M	Description	Convention/Example
radar_id	A	String	M [1]	ID of radar station or WMO station number	e.g. “NL50”
radar_name	A	String	M [1]	Name of radar station	e.g. “DE_BILT”
radar_location	A	Table of float	M	Longitude and latitude of radar station in decimal degrees	e.g. Tab(5.17, 52.10)
radar_operational	A	Int	O	Radar is in operational use and contributing to the composite product. Allowable values [0,1]	e.g. 1
radar_height	A	Float	O	Height above mean-sea level of radar antenna feed in meters	e.g. 48.0
radar_num_contrib	A	Int	O	Number of scans that this radar has contributed to image data	e.g. 96
radar_adjustment	A	String	O	String describing adjustment applied to radar reflectivity observations	e.g. “F=0.0+0.01*range”
radar_system	A	String	O	Description of radar hardware and manufacturer	e.g. “METEOR_360AC”
radar_software	A	String	O	Description of radar processing software	e.g. “RAINBOW”
radar_wavelength	A	Float	O	Wavelength of radar in cm	e.g. 5.2
radar_beamwidth	A	Float	O	3dB width of radar beam in degree	e.g. 1.0
radar_angles	A	Table of float	O	Elevations of radar antenna used in degree	e.g. Tab(0.3, 1.1, 2.0, 3.0)

[1] One of these tags is required.

5.14 Station group

Station Group in Safir/FLITS style available in _LAP_ products, in use until 31 Decemer 2014

Name	D/A	Type	O/M	Description	Convention/Example
station_id	A	String	M [1]	ID of detection station or WMO station number	e.g. “NL06”
station_name	A	String	M [1]	Name of detection station	e.g. “HOOGEVEEN”

station_location	A	Table of float	M	Longitude and latitude of detection station in decimal degrees	e.g. Tab(5.17, 52.10)
station_height	A	Float	O	Height above mean-sea level of detection station in meters	e.g. 48.0
station_availability	D	Table of Char	O	Array with availability reports in 1-minute intervals. For each 1-minute interval the number of seconds with a functioning station is reported.	e.g. Tab(60,60,…)
station_availability_hq	D	Table of Char	O	Array with availability reports in 1-minute intervals. For each 1-minute interval the number of seconds with a properly (high-quality) functioning station is reported.	e.g. Tab(60,60,…)
station_number_availability	A	Int	O	Number of 1-minute availability reports in “station_availability” and “station_availability_hq”arrays	e.g. 5
station_system	A	String	O	Description of detection hardware and manufacturer	“SAFIR”

[1] One of these tags is required.

Station Group in Meteorage style available in _LAM_products, in use since 01 January 2015

Name	D/A	Type	O/M	Description	Convention/Example
station_id	A	String	M [1]	ID of detection station	e.g. “94”
station_name	A	String	M [1]	Name of detection station	e.g. “Rheine”
station_location	A	Table of float	M	Longitude and latitude of detection station in decimal degrees	e.g. Tab(5.17, 52.10)
station_lf-gain	A	String	O	“lfgain=30”	
station_availability	D	Float	O	Percentage of the day the station was available [0..100](station up, comms up)	e.g. 99,890
station_type	A	String	O	Description of detection hardware and manufacturer	“LS7002”

5.15 Classification group

This group is meant to store "classified" image data. E.g. a land/sea/cloud mask that can be used for presentation purposes or to enable the user to do calculations only for certain surfaces (e.g. SST's only for cloudfree sea pixels). The classification group contains one image, where the pixel values are encoded to represent different features in the image.

Name	D/A	Type	O/M	Description	Convention/Example
classification_flag	A	String	M	YES means that the image has been classified, NO otherwise	"Y" or "N"
classification_type	A	String	M	Type of classification	e.g. "LANDSEACLOUDMASK"
classification_image	D	Image	M	An image mask with encoded values (X/Y array)	The NCSA specs are implemented here
CLASS	A	String	M	Identifier to interpret dataset as image	= "IMAGE"

	IMAGE_SUBCLASS	A	String	O	Indicator of type of palette that should be used	= "IMAGE_TRUECOLOR" or "IMAGE_INDEXED" or "IMAGE_BITMAP"
	IMAGE_COLORMODEL	A	String	O	Indicator of color model of palette that should be used	= "RGB"
	IMAGE_WHITE_IS_ZERO	A	Int	O	Used in case of "IMAGE_BITMAP" to define bit color	0 = false, 1 = true
	IMAGE_VERSION	A	String	M	Version number of image specification	= "1.2"
	DISPLAY_ORIGIN	A	String	M [1]	Indicator of at which corner pixel (0,0) should be viewed	= "UL" or "LL" or "UR" or "LR"
	PALETTE	A	REF_OBJ	O	Object reference pointer to colour palette in "Visualisation" group	
classification_table		D	Table of string	M	A table with information on how to interpret the encoded values in the image mask	e.g. see chapter 6, table 1.3

[1] **:** Mandatory, only in case the (0,0) pixel should **not** be displayed in the upper-left corner.

Processing subgroup

Name	D/A	Type	O/M	Description	Convention/Example
processing_software	A	String	O	Reference to the processing software. E.g. a URL	
processing_algorithm	A	String	O	Reference to algorithm or method used. E.g. a URL	

5.16 Quality group

This group is only available in Meteorage style _LAM_ products (available since 01 January 2015)

In the quality group metadata that affects the interpretation of the data is added.

The value recorded in this group is the network quality index: this is an index constructed from the network topology or when lightning is present from the number of stations reporting a lightning event. This index ranges from 0 to 5 where 0 stands for poor quality and 5 for an optimal quality. This value is valid for a region described by a polygon that is defined by upper left en lower right points in a stereographic grid.

Name	D/A	Type	O/M	Description	Convention/Example
number_polygons	A	Integer	M	Number of polygons, i.e., the length of the array that stores the polygons.	e.g. “196
update_datetime	A	String	M	Date and time stamp that states the last time that the quality indicator has been updated.	
network_quality	D	Table of Char	M	Dataset with the quality indicator [0..5] (0=low , 5=optimal quality)	
longitude_ul	D	Table of Float	M	Dataset with geographical longitudes of upper left point of the polygon. (decimal degree)	
latitude_ul	D	Table of float	M	Dataset with geographical latitudes of upper left point of the polygon. (decimal degree)	

longitude_lr	D	Table of float	M	Dataset with geographical longitudes of lower right point of the polygon. (decimal degree)	
latitude_lr	D	Table of float	M	Dataset with geographical latitudes of lower right point of the polygon. (decimal degree)	

6 Data types

In this section some of the data types found in KNMI HDF5 Data Format Specification are described.

Data types	Description
Int	Integer value
Long	Long integer value
Float	Float value
Double	Double value
String	Character-array
Image	Two-dimensional array of 1,2, 4 byte values
Table	One/two dimensional array of data values

6.1 Table

A table is a one or two dimensional array of data elements.

Calibration/annotation/classification tables are two dimensional arrays. These tables contain two colums. The first column contains the pixel values of a product. The second column contains the related calibrated value or a text representation. In HDF5 all elements of a table need to be of the same data type. So, if text is included in the second column then the elements in the first column (the pixel values) need to be also string typed.

Not all pixel values need to be represented in the table. E.g. in case of linear calibrations it is allowed to exclude one or pixel values in the first column (the idea behind this is that tables become a lot shorter). The excluded pixel values can then be calculated by the user by interpolation between the neighbouring pixel values that are included in the table.

Table 1.1 Table showing calibration of pixel values in channel 4 to °C

Integer value	Calibrated value
0.0	-50.0
1.0	-49.5
2.0	-49.0
…	…
251.0	75.5
252.0	76.0
253.0	76.5
254.0	77.0
255.0	77.5

Table 1.2 Same example as table 1.1, but now only the first and last pixel value are included. The values in between can be calculated by interpolation.

Integer value	Calibrated value
0.0	-50.0
255.0	77.5

Table 1.3 Table showing annotation of values in a classification image. Table showing annotation of values in a classification image.

Data value	Classification
“0”	“Unclassified”
“1”	“Sea”
“2”	“Land”
“3”	“Clouds”
“4”	“Snow”

7 Conventions

7.1 Timestamps

When timestamps are represented as text they shall have the following convention: **DD-MON-YYYY;HH:MM:SS.sss.**

DD two digit number representing the day of the month, e.g 05.
MON three character normal english abbreviated month name, e.g. JAN, FEB, MAR, and so on.
YYYY four digit year number, e.g. 2000.
HH two digit number representing the hour of the day, e.g. 08,
MM two digit number representing the minute of the hour, e.g 58.
SS two digit number representing the seconds of the minute, e.g 23.
sss three digit number representing the milliseconds of the second, e.g 549

Full example: 05-JAN-2000;08:58:23.549

7.2 HDF5 file naming convention

Within the image data infrastructure of KNMI (BIK), files are generated, stored and dispatched. Within BIK there is a convention for the names of the generated HDF5 files:

<product_group_name>[subsystem][processing_param]<timestamp>.H5

The fields within <..> are mandatory while the one within [..] are optional. Note that there can be more than one processing_param, they will then be separated by '_'.

Explanation of fields:

- product_group_name = Product group name as defined within OMNIVOOR-beelden (see chapter 9)
- subsystem =
  - automatic_production -> AP,
  - interactive_production (via Web) -> USERNAME
  - rt server -> RT,
- processing param (when file is generated in production shell of Omnivoor/Beelden)=
  - IMAGE_WARP, SUBSET,
  - COMPOSITION,
  - PIXEL_CONVERT
  - LAYER_EXTRACT
- timestamp = time when file was generated in BIK. Convention: YYYYDDMMHHMM (year-month-day-hour-minute)

7.3 Product_group_name convention

Product_group_names and product_names are to be generated by the frontend systems and then to be included in the HDF5 files. The convention for the names is defined in the Omnivoor/Beelden database project and the frontends need to confirm to this convention. The product_group_name is primarily used to link the dynamic metadata in the HDF5-file to the Omnivoor metadata database. Each productgroup contains a unique set of one or more products as defined by the administrator/ manager of BIK
The product_group_name will be a unique static identifier to classify an image-productgroup and will be included in the "overview" group of the HDF5 tag.
The following **general** convention rules are implemeted in BIK:

- The product_group_name is uniquely linked to a **defined set of products**.
- The product_group_name is a string that has **variable length** but a **maximum length of 50** characters.
- The product_group_name always contains **three** "underscores".
- In case it is impossible to fill in something, NA (not applicable) has to be filled in.
- The product_group_name is always written in **CAPITALS**.

The naming convention and examples for three data types (satellite, radar and lightning) is described.

I. Satellite Data

The product_group_name is divided in four parts, describing:

1. the **source type** (e.g. NOAA, METEOSAT, MSG)
2. the mission **ID** of satellite (e.g. 16, 7, 1)
3. type of **sensor**(s) (e.g. AVHRR, MVIRI, SEVIRI)
4. a **miscellaneous** field for geography or other information (e.g. FULL PASS, GLOBE, ECMWF)

Examples:

Sourcetype	_ID	_sensor	_miscellaneous	product_group_name
METEOSAT	7	MVIRI	GLOBE	METEOSAT_7_MVIRI_GLOBE
MSG	1	SEVIRI	ECMWF	MSG_1_SEVIRI_ECMWF
MSG	1	SEVIRI	HRVEUROPE	MSG_1_SEVIRI_HRVEUROPE
MSG	1	SAFNWC	CTEUROPE	MSG_1_SAFNWC_CTEUROPE
NOAA	16	AVHRR	FULL PASS	NOAA_16_AVHRR_FULLPASS

II. Radar Data

The product_group_name is divided in four parts, describing:

- The **Source type**. For radar data it is always equal to: **RAD**
- The **Radar ID**. The radar ID consists of four characters: **AAII**. The first two letters indicate the country from which the radar data is originating, and the last two numbers indicate the specific radar or composite content. Country abbreviations and number are taken from OPERA (see below).

- The **Product type**. The type of radar product, e.g. pseudoCAPPI, echotops, is indicated by a three character string in agreement with current CRIS definition (see below)
- A **Miscellaneous field**. The miscellaneous field is used for instance to indicate accumulation time.

Table Radar I. *The AA subfield of the ID is used to define from which country the radar product is originating. Abbreviations are taken from OPERA.*

AA	Country
NL	Netherlands
DL	Germany
UK	United Kingdom
BX	Belgium
FR	France
DN	Denmark

Table Radar II. *The II subfield of the ID is used to define which radar site or composite image is contained by datafile. Definition is in agreement with OPERA standards*.

II	Content
00	Not used.
01-19	Not used for radar data (normally used for 'global distribution')
20-39	Used to identify national and regional composites.
40-89	Used to identify radar site data.
90-99	Reserved but frequently used for test bulletins

Table Radar III. *The Product type field (PPP) is used to specify the type of radar product in accordance with definition in current CRIS/Rainbow.*

PPP	Product
PPZ	Plan-Position Indicator of reflectivity Z, or similarly for velocity V, spectral width W, co-polar correlation coefficient R, differential reflectivity D, differential phase F, and specific differential phase K.

PCP	PseudoCAPPI of reflectivity
CLT	Cluttermap corresponding to pseudoCAPPI
ETH	Echotop product (general)
ETW	Echotop for Hail Warning (45dBZ)
HAW	Hail Warning Product
VP2	Wind Profile
RAU	Rainfall Accumulation (uncorrected)
RAC	Rainfall Accumulation (corrected)
SRI	Surface Rainfall Intensity
CAL	Calibration Data
BIT	BITE messages
LOG	LOG messages

Examples of radar product_group_names:

Source	_ID	_Product	_miscellaneous	product_group_name
RAD	NL50	ETH	NA	RAD_NL50_ETH_NA
RAD	NL21	PCP	NA	RAD_NL21_PCP_NA
RAD	NL51	RAU	24H	RAD_NL51_RAU_24H
RAD	NL50	CAL	DBZ	RAD_NL50_CAL_NA
RAD	FR21	PCP	NA	RAD_FR21_PCP_NA
RAD	EU20	PCP	FIRST	RAD_EU20_PCP_FIRST

III. Lightning Data

The product_group_name is divided in four parts, describing:

- The **Source type**. For lightning data it is always equal to: **LGT**
- The Lightning **ID**. The Lightning ID consists of four characters: **AAII**. The first two letters indicate the country from which the lightning data is originating, and the last two numbers indicate the specific content. Lightning data are considered to be a composite, thus it will be in the range 21..40. Country abbreviations and number are taken from OPERA (see below table L.I and L.II).
- The **Product type**. The type of lightning product, e.g. Localization files, Density maps or Hazardous weather forecast, is indicated by a three character string, meaning is stated below in table L.III.
- A **Miscellaneous field**. The miscellaneous field is used for instance to indicate accumulation time.

Table Lightning I. *The AA subfield of the ID is used to define from which country the lightning product is originating. Abbreviations are taken from OPERA. only countries of interest for the Dutch lightning detection system are named here.*

AA	Country
NL	Netherlands
DL	Germany
BX	Belgium
FR	France

Table Lightning II. *The II subfield of the ID is used to define which lightning composite image is contained by datafile. Definition is in agreement with OPERA standards.*

II	Content
20-39	Used to identify national and regional composites.
90-99	Reserved but frequently used for test bulletins

Table Lightning III. *The Product type field (PPP) is used to specify the type of lightning product in accordance with definitions in the current SAFIR system,*

PPP	Product
LAP	Lightning Accumulated Positions
LAM	Lightning Accumulated Meteorage
LOG	LOG messages

Examples of lightning product_group_names:

Source	_ID	_Product	_miscellaneous	product_group_name
LGT	NL21	LAP	05M	LGT_NL21_LAP_05M
LGT	NL25	LAM	24H	LGT_NL21_LAP_24H

7.4 Product_name convention

The product_name will be a unique static identifier to classify an image-product and will be included in the "Image" group of the HDF tag .
The following **general** convention rules are implemeted in BIK:

- The product_name is a string that has **variable length** but a maximum length of **50** characters.
- The Product_name always contains **four** "underscores".
- In case it is impossible to fill in something, NA (not applicable) has to be filled in.
- The product_name is always written in **capitals.**

I. Satellite Data

The product_name is divided in five parts, describing:

1. the **source type** (e.g. NOAA, METEOSAT, MSG)
2. the mission **ID** of satellite (e.g. 16, 7, 1)
3. type of **sensor(**s) (e.g. AVHRR, MVIRI, SEVIRI)
4. description of **product type** (e.g. VIS, IR, CH1, CH5)
5. a **miscellaneous** field for geography or other information (e.g. GLOBE, EUROPE, FULL PASS)

Examples:

Source type	_ID	_sensor	_type	_miscellaneous	Product_name
METEOSAT	7	MVIRI	VIS	GLOBE	METEOSAT_7_MVIRI_VIS_GLOBE
MSG	1	SEVIRI	VIS0.6	ECMWF	MSG_1_SEVIRI_VIS0.6_ECMWF
MSG	1	SEVIRI	HRV	EUROPE	MSG_1_SEVIRI_HRV_EUROPE
MSG	1	SAFNWC	CT	EUROPE	MSG_1_SAFNWC_CT_EUROPE
NOAA	16	AVHRR	CH1	FULLPASS	NOAA_16_AVHRR_VIS_FULLPASS

II. Radar Data

The product_name is divided in five parts, describing:

1. The **Source type**. For radar data it is always equal to: **RAD**
2. The **Radar ID**. The radar ID consists of four characters: **AAII**. The first two letters indicate the country from which the radar data is originating, and the last two numbers indicate the specific radar or composite content. Country abbreviations and number are taken from OPERA (see Tables R.I and R.II).
3. The **Product type**. The type of radar product, e.g. pseudoCAPPI, echotops, is indicated by a three character string in agreement with current CRIS definition (see Table R.III)
4. The **Product parameter**. Parameter describing the elevation of a PPI, the height of a pseudoCAPPI, threshold of an echotop product, etc…
5. A **Miscellaneous field**. The miscellaneous field is used for instance to indicate accumulation time.

Four parts of the **product_name** are equal to the **product_group_name**, and only the product parameter is different. The convention for the product parameter is given below.

Table Radar IV. *The Product Parameter field (PARM) is used to detail the product information. It always consists of one letter and a float (AF.F). The letter indicates the type of parameter and the float its value.*

PPP	PARM	Description
PPZ	E0.3	PPI taken at elevation of 0.3 degrees
PCP	H0.8	CAPPI taken at altitude of 0.8 km
ETH	Z7.0	Echotops using reflectivity threshold of 7.0 dBZ

Examples:

Typesource	_ID	_Product	_Param	_miscellaneous	Product_name
RAD	NL50	PPZ	E0.5	NA	RAD_NL50_PPZ_E0.5_NA
RAD	NL21	ETH	Z7.0	NA	RAD_NL21_ETH_Z7.0_NA
RAD	BX21	PCP	H1.0	NA	RAD_BX21_PCP_H1.0_NA

III. Lightning Data

The product_name is divided in five parts, describing:

- The **Source type**. For lightning data it is always equal to: **LGT**
- The **lightningID**. The lightning ID consists of four characters: **AAII**. The first two letters indicate the country from which the lightning data is originating, and the last two numbers indicate the specific radar or composite content. Country abbreviations and number are taken from OPERA (see Tables L.I and L.II).
- The **Product type**. The type of lightning product, (see Table L.III)
- The **Product parameter**. Parameter describing the type of strokes included in the product (see Table L.IV).
- A **Miscellaneous field**. The miscellaneous field is used for instance to indicate accumulation time.

Four parts of the **product_name** are equal to the **product_group_name**, and only the product parameter is different. The convention for the product parameter is given below in the examples

Table Lightning IV. *The Product Parameter field (_Param) is used to describe the stroke types included in the product.*

_Param	Description
ALL	All kind of strokes are included
CC	Only cloud-cloud strokes are included
CG	Only cloud-ground strokes are included
NA	Not applicable

Examples:

Typesource	_ID	_Product	_Param	_miscellaneous	Product_name
LGT	NL21	LAP	ALL	05M	LGT_NL21_LAP_ALL_05M
LGT	NL21	LAP	CG	24H	LGT_NL21_LAP_CG_24H

A. Addendum: KNMI Lightning Data Information Model

The master text of this document is available as KNMI_KLDN_A06_KLiDIM_20150223

Revisions

date	author	description
20140407	JHB	• changed filename convention for NL25 and NL23
20140514	JHB	• added /quality group • described visualization group
20140612	JHB	• changes in quality group • changes in station group • added “discharge/number stations reporting”
20140710	JHB	• changed hdftag version to 3.8. • changes in quality group
20141009	JHB	extended 3.1. overview group
20150223	JHB	remarks by LVNL addressed

A.1. Introduction

HDF5 is the standard file format for all operational image data to be used within KNMI and to be delivered by KNMI to external users. The specific HDF5 version used within KNMI is developed in 2002 as a joint effort between KNMI and Kongsberg/Spacetec.
Originally developed originally to transport image data and its meta information it has grown into an data information model that is used for radar and lightning data as well.

A.1.1. What is HDF5

HDF5 (Hierarchical Data Format) is a multi-object file format for sharing scientific data in a distributed environment. An important feature of HDF5 files is that they are self-describing. The format was developed at the National Centre for Supercomputing Applications (NCSA) at the University of Illinois. The aim of KNMI HDF5 is to make files containing earth observation data self-contained. By grouping related pieces of information together and forcing a certain structure of the file, it will be easy for other users to make use of the data in the files.
Self-contained also means that all meta-data associated with the dataset and/or used in the processing of the dataset is included in the file. The description is generic. Fields that are intended for use solely by KNMI are included in the “User specific” data group.

A.1.2. What is the KLiDIM

On the HDF5 standard KNMI defined an implementation of a data information model. This information model is used for satellite, radar and lightning data. For lightning data the model is called KNMI Lightning data information model (KLiDIM). The KNMI reference document “KNMI Hdf Data Format Specification” will be updated from version 3.7 to version 3.8 in order to contain the latest version of the KLiDIM.

A.2. KLiDIM filename convention

The file names delivered adhere to the following conventions:

For the 1 minute W. Europe accumulation: LGT_NL23_LAM_01M_YYYYMMDDhhmm.h5

For the 1 minute Benelux accumulation: LGT_NL25_LAM_01M_YYYYMMDDhhmm.h5

For the 5 minute W.Europe accumulation: LGT_NL23_LAM_05M_YYYYMMDDhhmm.h5

For the 5 minute Benelux accumulation: LGT_NL25_LAM_05M_YYYYMMDDhhmm.h5

For the 24 hour W. Europe accumulation: LGT_NL23_LAM_24H_YYYYMMDDhhmm.h5

For the 24 hour Benelux accumulation: LGT_NL25_LAM_24H_YYYYMMDDhhmm.h5

Where YYYYMMDDhhmm is a placeholder for the date and time at the START of the interval covered. So the file LGT_NL25_LAM_05M_yyyyMMDD1400.H5 will cover data 14:00:00 to 14:04:59 including the whole last second.

Attention: This is a change to the convention used by the SAFIR/FLITS system. In this system the LGT_NL21_LAP_XXX_YYYYMMDDhhmm.h5 output files the filename was derived from the end of the interval. (thus in the case above the FLITS output file was named LGT_NL21_LAP_05M_yyyyMMDD1405.H5)

A.3. KLiDIM organization

A.3.1. What is contained in KLiDIM

In a KLiDIM file the primary data is available as an indexed array of lightning events.
To aid visualisation the data is available as images as well. Moreover metadata information on the contributing sensors and quality is added.

- The data is accumulated over a certain period (1 minute, 5 minutes or 24 hours).
  In the array of lightning events are stored several parameters such as time, location, type, current etc.
- The data is mapped to a geographic grid. The grid used is the same grid as that what is used for presentation of radar data. As it is allowed within HDF5 to store several images within one file there are defined two images, one containing the accumulation of all discharges (\image1: ALL (CG+CC)) in the specified interval, the second (\image2: CG) is the accumulation of all ground discharges in the same interval.

The data stored in this version of KLiDIM are a superset of the parameters used in the output of the current lightning location files stemming from the SAFIR/FLITS system, so migrating these data should be relatively easy.

A.3.2. Datatypes

In the tables the columns Hdftype and Datatype the following is coded:

Hdftype

G denotes a group (which is a container for a (sub)data structure
A denotes an attribute (describing the properties of the specific group)
D denotes a dataset (describing the data in the specific group)

Dataset

S string
C char 8bit positive number (0-255)
I integer 16bit positive number

L long 32bit positive number
F float single precision
D double precision floating number

(x) denotes a multiplier.
Example F(2) means two floating point numbers are coded in a field.

A.3.3. Groups in the KLiDIM

The KLiDIM files contain several groups:

- The /overview group contains data that are commonly required for all KNMI hdf files.
  They contain the name of the product and start and stop times of the lightning data acquisition. Moreover in the files there is stated housekeeping information on the the number of images and the number of lightning sensors etc..
- In the /geographic group the parameters used for the projection of data on the WGS84 globe model are presented, and the picture size. KNMI uses a stereographic projection on an ellipsoid earth model according to WGS84.
- The /discharge group codes the individual events that are recorded by the lightning detection system. The information presented is a array with a depth of /number_discharges.
- The /image group maps the discharge output into images. Several types of images are defined: an accumulation of all events (CG+CC), and a accumulation of only those discharges that hit the ground (CG only), and an image that contains the Estimated Detection Efficiency
- The /stations group contains information over the location and naming of the sensors.
- The /quality group contains the evaluated network quality.
- The /visualisation group contains information on the translation of values in the image into screen colours. This group is optional

A.3.4. The /overview group

Contains data that are required for all KNMI hdf files and contain the name of the product and start and stop times of the product acquisition. Moreover this group contains information concerning what other groups are found within the structure of the files.

Group and Tag name	Hdftype	Datatype	example
/overview	G		
/overview/product_group_name	A	S	“LGT NL25 LAM 05M”
/overview/product_missing	A	S	“”
/overview/hdf5tag_version_number	A	S	“3,8”

/overview/dataset_sample_descr			MTRGhdf-6.2-5
/overview/dataset_summary	A	S	KLDN lightning data provided by Meteorage
/overview/product_datetime_start	A	S	“03-SEP-2014;16:45:00.000."
/overview/product_datetime_end	A	S	“03-SEP-2014;16:49:59.000."
/overview/number_image_groups	A	I	2
/overview/number_quality_groups	A	I	1
/overview/number_visualisation _groups	A	I	1
/overview/number_image_groups	A	I	2
/overview/number_station_groups	A	I	xx (all stations that are configured to be part of the KLDN)

A.3.5. The /discharge group

The structure of the /discharge group

Group and Tag name	Hdftype	Datatype	example
/discharge1	G		
/discharge1/number_discharges	A	I	Number of discharges in time series, i.e., length of discharge datasets.
/discharge1/reference_datetime	A	S	Date and time stamp against which discharges are referenced.
/discharge1/time_offset	D	D	Dataset with time offsets of discharges with respect to reference date and time, double allows for micro seconds accuracy. (unit seconds)
/discharge1/longitude	D	F	Dataset with geographical longitudes of discharges. (unit decimal degree)
/discharge1/latitude	D	F	Dataset with geographical latitudes of discharges. (unit decimal degree)
/discharge1/event_type	D	C	Dataset with types of observed discharges: 4=CG stroke, 5=CG return stroke, 13=cloud discharge.
/discharge1/position_error	D	F	Dataset with position errors of CG stroke localizations as deduced by detection system. (unit meter)
/discharge1/rise _time	D	F	Dataset with rise times of induced current for detected CG strokes. (second)
/discharge1/decay_time	D	F	Dataset with decay times of induced current for detected CG strokes. (unit second)
/discharge1/current	D	F	Dataset with estimated currents of CG strokes. (unit ampere)
/discharge1/stations_reporting	D	I	Number of stations that has reported the discharge

A.3.6. The /geographic group

Group and Tag name	Hdftype	Datatype	example
/geographic	G		
/geographic/geo_number_columns	A	I	700 (pixels)
/geographic/geo_number_rows	A	I	765 (pixels)
/geographic/geo_pixel_size_x	A	F	1.0 (km)
/geographic/geo_pixel_size_y	A	F	1.0 (km)
/geographic/geo_par_pixel	A	S	X,Y
/geographic/geo_dim_pixel	A	S	“KM,KM”
/geographic/geo_column_offset	A	F	0.0 (km)
/geographic/geo_row_ofsett	A	F	3649.9814 (km)
/geographic/geo_pixel_def	A	S	“LU”
/geographic/geo_product_corners	A	F(8)	0.0,49.362;0.0,55.974;10.856,55.389;9.009,48.895
/geographic/map_projection	G		
/geographic/map_projection/projection_indication	A	S	“Y”
/geographic/map_projection/projection_name	A	S	“STEREOGRAPHIC”
/geographic/map_projection/projection_proj4_parms	A	S	+proj=stere +x_0=0 +y_0=0 +lat_0=90 +lon_0=0 +lat_ts=60 +a=6378.388 +b=6356.906

A.3.7. The /image group

- The product contains the accumulated count of the detected events over a certain pixel, in the specified integration time interval.
- Geographical projection and cut are identical with the radar products of the KNMI, containing 700 x 765 pixels, in a stereographic projection. For the projection parameters see section 5 of this document.

Group and Tag name	Hdftype	Datatype	Example
/image1	G		(lightning accumulation product for All events)
/image1/image_product_name	A	S	“LGT NL25 LAM ALL 05M”
/image1/image_size	A	L	553500
/image1/image_bytes_per_pixel	A	I	1
/image1/image_geo_parameter	A	A	“COUNT" (total of ALL events recorded at this pixel)
/image1/calibration	G		
/image1/calibration/calibration_flag	A	S	“N”
/image1/calibration/calibraton_formulas	A	S	“NA”
/image1/calibration/image_missing_data	A	I	255
/image1/calibration/image_out_of_image	A	I	255
/image1/image_data	D	C	255, 255, 255, 255, 255,….
/image1/image_data/CLASS	A	S	“IMAGE”
/image1/image_data/PALETTE	A	R	reference to object
/image1/image_data/VERSION	A	S	“1.2”
/image1/statistics	G		
/image1/statistics/stat_min_value	A	F	0
/image1/statistics/stat_max_value	A	F	16
/image2	G		(lightning accumulation product for CG events)
/image2/image_product_name	A	S	“LGT NL25 LAM CG 05M”
/image2/image_size	A	L	553500
/image2/image_bytes_per_pixel	A	I	1
/image2/image_geo_parameter	A	A	“COUNT" (total CG events recorded at this pixel)
/image2/calibration	G		
/image2/calibration/calibration_flag	A	S	“N”
/image2/calibration/calibraton_formulas	A	S	“NA”

/image2/calibration/image_missing_data	A	I	255
/image2/calibration/image_out_of_image	A	I	255
/image2/image_data	D	C	255, 255, 255, 255, 255,….
/image2/image_data/CLASS		S	“IMAGE”
/image2/image_data/IVERSION		S	“1.2”
/image2/statistics	G		
/image2/statistics/stat_min_value	A	F	0
/image2/statistics/stat_max_value	A	F	16

A.3.8. The /station group

The /stations group contains information regarding the location and naming of the stations.

Group and Tag name	Hdftype	Datatype	Example
/station1	G		
/station1/station_id	A	S	“DF120”
/station1/station_name	A	S	“Valkenburg”
/station1/station_location	A	F (2)	4.423,52.162
/station1/station_type	A	S	“LS7001”
/station1/station_gain	A	S	“lfgain=30”
/station1/station_availability	D	F	Percentage of the day the station was available [0..100](station up, comms up)

A.3.9. The /visualisation group

The visualisation group defines a pallet to be used in the translation of pixel values in the image to an colourable. By adding this group the default palette is overruled. This eases viewing of the files in a hdf-viewer.

The /visualisation group contains a palette, which is a table of 3*256 values, coding for the RGB values of the pixel values in the images contained in the file. This group is optional

Group and Tag name	Hdftype	Datatype	example
/visualisation1	G		
/visualisation1/color_palette/CLASS	A	F	“PALETTE”
/visualisation1/color_palette/PAL_COLORMODEL	A	S	“RGB”
/visualisation1/color_palette/PAL_TYPE	A	S	“STANDARD8”
/visualisation1/color_palette/PAL_VERSION	A	S	“1.2”
/visualisation1/color_palette	D	C	255,255,255

The color_palette is a dataset table of 256 x 3 unsigned chars (bytes) as follows

Value 1	white	RGB(255,255,255)
Value 2-3	magenta	RGB(000,255,255)
Value 4-7	yellow	RGB(255,255,000)
Value 8-15	orange	RGB(255,127,000)
Value 16-31	red	RGB(255,000,000)
Value >32	purple	RGB(127,000,255)

A.3.10. The /quality group

In the quality group metadata that affects the interpretation of the data is added.

The value recorded in this group is the network quality index: this is an index constructed from the network topology or when lightning is present from the number of stations reporting a lightning event. This index ranges from 0 to 5 where 0 stands for poor quality and 5 for an optimal quality. This value is valid for a region described by a polygon that is defined by upper left en lower right points in a stereographic grid.

Group and tag name	HDFtype	Datatype	Example//Description
/quality	G		
number_polygons	A	I	Number of polygons, i.e., the length of the array that stores the polygons.
update_datetime	A	S	Date and time stamp that states the last time that the quality indicator has been updated.
network_quality	D	C	Dataset with the quality indicator [0..5] (0=low , 5=optimal quality)
longitude_ul	D	F	Dataset with geographical longitudes of upper left point of the polygon. (decimal degree)
latitude_ul	D	F	Dataset with geographical latitudes of upper left point of the polygon. (decimal degree)
longitude_lr	D	F	Dataset with geographical longitudes of lower right point of the polygon. (decimal degree)
latitude_lr	D	F	Dataset with geographical latitudes of lower right point of the polygon. (decimal degree)

A.3.11. Changes between KLDN and FLITS information model

Changes in the /discharge group

added: /discharge1/event_type added event_type=13 which codes a CC
added: stations_reporting

Added /quality group

added: number_polygons
added: update_datetime
added: network_quality
added: longitude_ul
added: latitude_ul
added: longitude_lr
added: latitude_lr

Changes in /station group

added: station_type
added: station_lf_gain
added: station_availability
removed: station_status
removed: station_status_hq

Removed /RF group

A.4. Additional information

A.4.1. Libraries

There are free libraries available for accessing hdf5-formatted data. This includes a free, java based, viewer for hdf files.
They can be accessed at the HDFgroup website (http://www.hdfgroup.org/)

A.4.2. Hdf2txt tool

A tool is available that can decode a KNMI HDF lightning file, extracting and condensing the information stored in this file. This tool is available in compiled form on linux platforms. Source code is freely available on request directed to your account manager.

A.4.3. Hdftag 3.7

Where “HDF5” is specified in this document, reference is made to the KNMI implementation as described in the document “KNMI HDF5 Data Format Specification v3.7”.
This document is freely available on request directed to your account manager.

A.4.4. Proj4

When using geographical projection formulas the use of the free available proj4 library is highly recommended. See Evenden, G.: 1990, PROJ.4 Cartographic Projections Library (see http://trac.osgeo.org/proj/) developed at US Geological Survey.

A.5. geographic parameters

The geographic parameters of the delivered files is stated below. Please note that NL21 production is obsolete and produced by FLITS only.

A.5.1. NL21

NI21 is is the legacy format that is produced by FLITS
The /geographic group for NL21 reads:

geo_column_offset = 0.0
geo_dim_pixel = KM,KM
geo_number_columns = 256
geo_number_rows = 256
geo_par_pixel = X,Y
geo_pixel_def = LU
geo_pixel_size_x = 2.4999878
geo_pixel_size_y = -2.499921
geo_product_corners = 0.0,49.768875,0.0,55.296005,9.742992,54.818184,8.337001,49.373005
geo_row_offset = 1490.9646

A.5.2. NL25

NL25 matches the NL25 radar coverage
The /geographic group for NL25 reads:

geo_column_offset = 0.0
geo_dim_pixel = KM,KM
geo_number_columns = 700
geo_number_rows = 765
geo_par_pixel = X,Y
geo_pixel_def = LU
geo_pixel_size_x = 1.0000035
geo_pixel_size_y = -1.0000049
geo_product_corners = 0.0,49.362064,0.0,55.973602,10.856453,55.388973,9.009301,48.895306
geo_row_offset = 3649.9814

A.5.3. NL23

NL23 is the coverage of the West European composite.
The /geographic group for NL23 reads:

geo_column_offset = -213.99763
geo_dim_pixel = KM,KM
geo_number_columns = 512
geo_number_rows = 512
geo_par_pixel = X,Y
geo_pixel_def = LU
geo_pixel_size_x = 3.9998949
geo_pixel_size_y = -3.9997878
geo_product_corners = -9.270578,41.937218,-14.993001,59.002003,20.453014,58.089085, 12.806002,41.420002
geo_row_offset = 799.0618

for all files the earth model is given by the group /geographic/map_projection
projection_indication = Y
projection_name = STEREOGRAPHIC
projection_proj4_params = +proj=stere +x_0=0 +y_0=0 +lat_0=90 +lon_0=0 +lat_ts=60 +a=6378.388 +b=6356.906

-=<O>=-