

FRM4DOAS Level-1 data

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BIRA-IASB

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Introduction

Level-1 data shall consist in calibrated radiance spectra, dark current and offset corrected. The recommended format of these files is “netCDF”. There should be one file per measurement day. The proposed format offers the data submitters the possibility to include key data (e.g. the reference spectrum and the slit function) and ancillary data (for example, pressure and temperature profiles).

This format will be used first by QDOAS for DOAS retrieval. The output data generated by QDOAS will be submitted to QA/QC procedure that will add quality flags to the data and will complete slant columns with the relevant ancillary information for profiling algorithms (temperature and pressure profiles if existing, geolocation and altitude of the instrument). The proposed file follows the CF-1.6 convention.

Global attributes

- **Conventions** : the format convention (recommended to be CF compliant)
- **title** : description of the data set (e.g., “Level-1 data for the FRM4DOAS MAXDOAS processor”)
- **source** : description of the origin of the data
- **instrument_number** : unique number identifying the instrument (will be provided by BIRA)
- **instrument_channel** : channel number (depending on the instrument; to provide later in the metadata; for example, 1 for VIS, 2 for UV)
- **instrument_type** : maxdoas or zenith
- **institution** : the affiliation name
- **pi_name, pi_email** : the name and email address of the principal investigator
- **do_name, do_email** : the name and email address of the data originator
- **ds_name, ds_email** : the name and email address of the data submitter

Groups

The following groups are proposed in the netCDF file :

- **ancillary** : for ancillary data;
 - **meteorological_data** : temperature and pressures profiles
- **instrument_location** : name of the station, latitude, longitude and altitude of the instrument
- **keydata** :
 - **reference_spectrum** : reference spectrum (not mandatory)

- **slit_function** : measured slit function(s)
- **measurements** : radiances, radiances errors if known, radiances quality flags and wavelengths
- **metadata** : currently limited to data present in ASCII files proposed for CINDI-2 reprocessing but could be extended to any data relevant for ground-based measurements (for example, scan index, temperature of the detector, ...)

Dimensions

The two most important dimensions are :

- **det_size** : the size of the detector
- **num_rec** : the number of records

They are completed with :

- The dimensions for TP profiles
 - **meteo_levels_size** : the number of altitude levels
 - **meteo_time_size** : the number of profiles (depending on time)
- The dimensions of the slit functions matrix
 - **slit_dimx** : the number of relative wavelengths (grid on which the slit function is defined)
 - **slit_dimy** : the number of measured slit functions (the wavelengths have to be provided)
- **datetime_size** : for date and time variables, year, month, day, hours, minutes, seconds and milliseconds are provided in separate columns
- **dim1_size** : generic 1-length dimension (for example, the list of wavelengths at which the slit functions are provided).

Variables

See tables below.

Name of files

The following convention based on CCI and GEOMS file naming is proposed :

ESA-FRM4DOAS-L1-BIRA.IASB-HARESTUA-004-1-20160922T045537Z-20160922T181033Z-fv001.nc

Prefix for the project : ESA-FRM4DOAS

Processing level code : in this case, L1 for Level-1 data

Affiliation : name of the institute as it appears in the GEOMS Table Attribute Value (TAV; see https://avdc.gsfc.nasa.gov/PDF/tableattrvalue_04R033.dat)

The name of the station : taken from the GEOMS TAV (see the above link).

Instrument number : for example, 4 (this number will be assigned at the registration of the instrument)

Channel number : in this example, 1 (the description will be provided in metadata file)

Indicative date and time coverage

fv : file version

nc : extension for netCDF files

Group : instrument_location

Name	Dim	Type	Unit	Fill value	Description	Mandatory
altitude	1	float32	m	NaN	Altitude of the instrument (a.s.l)	Y
altitude_agl	1	Float32	m	NaN	Altitude of the instrument (a.g.l)	Y
latitude	1	float32	degrees_north	NaN	Latitude of the instrument	Y
longitude	1	float32	degrees_east	NaN	Longitude of the instrument	Y
station_name	1	str		x	Station name retrieved from GEOMS tables	N

Group : ancillary/meteorological_data (mandatory : N; default : standard climatology tables)

Name	Dim	Type	Unit	Fill value	Description
altitude_levels	meteo_levels_size	float32	km	NaN	altitudes levels above sea level
meteo_time	meteo_time_size	float32	hour	NaN	meteo measurement time in fractional time
pressure	meteo_levels_size, meteo_time_size	float32	hPa	NaN	Pressure profiles measured at different times and for different levels of altitudes
temperature	meteo_levels_size meteo_time_size	float32	K	NaN	Temperature profiles measured at different times and for different levels of altitudes
surface_pressure	meteo_time_size	float32	hPa	NaN	Surface pressures measured at different times
surface_temperature	meteo_time_size	float32	K	NaN	Surface temperatures measured at different times

Group : keydata/slit_function (mandatory : N; default : characterized by QDOAS)

Name	Dim	Type	Unit	Fill value	Description
slit_function_relative_wavelengths	slit_dimx	float32	nm	NaN	relative wavelength grid
slit_function_measured_wavelengths	slit_dimy	float32	nm	NaN	wavelengths at which the slit function has been measured
slit_function	slit_dimx,slit_dimy	float32		NaN	measured slit function(s)

Group : keydata/reference_spectrum (this field is not mandatory, by default : automatically selected by QDOAS)

Name	Dim	Type	Unit	Fill value	Description
ref_wavelength	det_size	float32	nm	NaN	reference wavelength grid

ref_spectrum	det_size	float32		NaN	Reference spectrum
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Group : measurements

Name	Dim	Type	Unit	Fill value	Description	Mandatory
wavelengths	num_rec, det_size	float32	nm	NaN	wavelengths	Y
radiances	num_rec, det_size	float32		NaN	spectra (counts number)	Y
radiances_errors	num_rec, det_size	float32		NaN	instrumental errors if known (counts number)	N
radiances_quality_flags	num_rec, det_size	int16		1	pixel quality flags (currently 0 or 1 but probably to complete later)	Y

Group : metadata

Name	Dim	Type	Unit	Fill value	Description	Mandatory
elevation_viewing_angle	num_rec	float32	degrees	NaN	viewing elevation angle	Y
azimuth_viewing_angle	num_rec	float32	degrees	NaN	viewing azimuth angle 0..360, measured towards the east, from north	Y
solar_zenith_angle	num_rec	float32	degrees	NaN	solar zenith angle	Y
solar_azimuth_angle	num_rec	float32	degrees	NaN	solar azimuth angle 0..360, measured towards the east, from north	Y
exposure_time	num_rec	float32	sec	NaN	exposure time	N
measurement_type	num_rec	int16		0	measurement type : 1-offaxis, 2-direct sun, 3-zenith, 7-almucantar, 11-horizon, 12-direct moon	Y

datetime	num_rec, datetime_size	int16		0	measurement date and time (UT YYYY,MM,DD,hh,mm,ss,ms)	Y
datetime_start	num_rec, datetime_size	int16		0	start date and time (UT YYYY,MM,DD,hh,mm,ss,ms)	N
datetime_end	num_rec, datetime_size	int16		0	end date and time (UT YYYY,MM,DD,hh,mm,ss,ms)	N
total_acquisition_time	num_rec	float32	sec	NaN	total acquisition time (the total time the detector is exposed to light to produce the spectrum)	N
total_measurement_time	num_rec	float32	sec	NaN	total measurement time (should be the time difference in seconds between UTC time start and UTC time stop)	N
scan_index	num_rec	int16		9999	Scan index	Y