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**HYPERNETS LAND AND WATER PROCESSOR**

**PRODUCT DATA FORMAT SPECIFICATION**

**Version 0.0**

**6/2/20**

**Version History**

|  |  |  |  |
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# Introduction

This document aims to specify definitions, conventions and formats of the various data products generated in the Hypernets land and water network processors.

the “General Multilingual Environmental Thesaurus” common vocabularies (https://www.eionet.europa.eu/gemet/en/themes/)

## References

|  |  |
| --- | --- |
| RD-1 | Processor ATBD |
| RD-2 | Calibration data file spec |
| RD-3 | Rugged pc data file spec |

## Glossary and Acronyms

|  |  |
| --- | --- |
| CF | Climate and Forecast |
| NetCDF | Network common data format |

# Product Definitions

The Hypernets land and water network processors process field radiometer data from raw instrument counts to the surface reflectance product through a series of intermediate data products, which are referred to as different processing levels. These data processing Levels are defined in Table 1. It is the scope of this document to define the products generated by the land and water network processors. These are the Level 1 and Level 2 products defined in Table 2.

Level 1 products are generated in the same processing pipeline for both the land and water networks and so the products are of the same format [RD-X]. Although, land and water network Level 2 products are produced through different processing algorithms, they again share the same file format and so are also specified together in the following.

Radiometer measurements are taken in a defined set of geometries called a sequence. Each geometry in a sequence is called a series, as it is composed of a set of repeat measurements called scans that are averaged. Level 1 and Level 2a product files each correspond to one sequence of data. Level 2b temporally interpolates between sequence data to give one file per day.

Table 1 – List Hypernets Processor processing levels

|  |  |
| --- | --- |
| **Level** | **Type** |
| Ancillary | Generic term covering non-measurement data used in processing chain |
| Level 1 | Calibrated instrument data |
| Level 2a | Evaluated surface reflectance |
| Level 2b | Temporally interpolated surface reflectance |

Table 2 – Hypernets products definition

|  |  |  |  |
| --- | --- | --- | --- |
| **Level** | **Abbreviated Name** | **Description** | **File Scope** |
| Ancillary | CDB | Instrument calibration and characterisation data | Defined in [RD-X] |
| 0 |  | Raw instrument data from rugged PC | Defined in [RD-X] |
| 1 | RAD | Radiance data | File per sequence |
|  | IRR | Irradiance data | File per sequence |
| 2a | REF | Surface reflectance data | File per sequence |
| 2b | REFD | Temporally interpolated surface reflectance data | File per day |

# Product Conventions

This section defines the various conventions that apply to the Hypernets data product, including the product file naming convention.

## Product file format

Files shall be in the NetCDF CF-convention version 1.6 format.

## Network naming conventions

Hypernets products may derive from either the Land or Water network, the abbreviations for these are contained in Table 3.

Table 3 – Product network naming conventions

|  |  |
| --- | --- |
| **Abbreviated Name** | **Product Type** |
| L | Land network |
| W | Water network |

## Site name conventions

Table 4 defines the abbreviated name convention applicable to the individual Hypernets sites.

Table 4 – Site name conventions

|  |  |
| --- | --- |
| **Abbreviated Name** | **Site Name** |
| GBNA | Gobabeb, Namibia |
| WYUK | Wytham Woods, Untied Kingdom |
| … |  |

## Filename convention

This section specifies the file naming convention that applies to Hypernets data files. This naming convention is intended to allow the unique identification of all product files and summarise the contents.

The file name is composed of a defined sequence of data fields, separated by an underscore in the following way:

PROJECT\_NETWORK\_SITE\_TYPE\_DATETIME\_VERSION.nc

The files are stored in the NetCDF data format and so have the extension “.nc”. The definition of the data fields and their allowed contents is described in Table 5.

Table 5 – File naming convention data fields

|  |  |
| --- | --- |
| **Field Name** | **Description** |
| PROJECT | “HYPERNETS” |
| Network | Name of product network. Values may be abbreviated network names defined in Table 4. |
| SITE | Name of data site. Values may be abbreviated site names defined in Table 4. |
| TYPE | Name of product type. Values may be abbreviated product type names defined in Table 2. |
| DATETIME | Denotes the acquisition start date and time as UTC, formatted as “YYYYMMDDHHMM”, except for L2b products where format should be “YYYYMMDD”. |
| VERSION | Denotes data version number, formatted as “vXX.X” |

Example

For version 1 of land network radiance product, acquired in Gobabeb at 11:30 on 4/2/2020, the filename should be:

HYPERNETS\_L\_GBNA\_RAD\_202002041130\_v01.0.nc

## Dimensions

All variables are along one or more of the following dimensions:

* “wavelength” – spectral dimension of measurements
* “series” – temporal dimension of measurements within a sequence
* “time” – temporal dimension of measurements for Level 2b daily file
* “latitude” - latitude of measurements in decimal degrees
* “longitude” - longitude of measurements in decimal degrees
* “viewing zenith angle” - zenith angle of the radiance and reflectance measurements in decimal degrees (0°, 90° and 180° is nadir, horizon and zenith viewing, respectively)
* “relative viewing azimuth angle” - azimuth between sun and sensor of the radiance and reflectance measurements in decimal degrees
* “absolute viewing azimuth angle” - azimuth between true north and sensor of the radiance and reflectance measurements in decimal degrees

# Metadata

This section provides a description of the data product metadata. The first subsection describes metadata common to all product types following (when relevant) the INSPIRE directives (http://inspire.ec.europa.eu/glossary/Metadata) in accordance with the EN ISO 19115 for the metadata elements. The second subsection describes the site, instrument, component and system metadata, respectively. The following subsections then define per data type metadata.The metadata partitioning allows to trace in detail the history of the system (e.g., modifications, repairs, updates in the system, components of the system, instrument, or, instrument set-up, i.e., site). Therefore, metadata keys are defined allowing to identify entities, fix relationships between metadata entities and accessing the records of these entities. Fig. XXX shows the metadata diagram with the metadata fields used as unique identification keys. These unique identification keys need to be added to any metadata entity that is related to another. For instance, the system HYPERNETS01\_GBNA

FIG. XXX metadata diagram

## Common Metadata

The common metadata describe the content of the data file and ensure CF compliancy. This is defined in Table 6.

Global attributes can be thought of as conveying five kinds of information:

* What: what are the data in this dataset;
* Where: the spatial coverage of the data;
* When: the temporal coverage of the data;
* Who: who produced the data;
* How: how were the data produced and made available.

Table 6 - Common data product metadata

|  |  |  |
| --- | --- | --- |
| Name | Description | Value |
| What |  |  |
| type | Type of data contained in the file, spatial data set series (series), spatial data set (dataset) or spatial data services (services). | e.g., “dataset” |
| title | A descriptive title for the dataset | e.g., “Hyperspectral surface reflectance surface” |
| abstract | This is a brief narrative summary of the content of the resource. The value domain of this metadata element is free text. |  |
| conventions | Name of the conventions followed by the dataset | “CFv72” and ”NVS2.0” |
| format\_version | File format version (e.g., version of present document) | E.g.: “v1.0” |
| netcdf\_version | Netcdf file format version (if applicable) |  |
| product\_name | Product name for data provider. | e.g., “HYPPSTARR\_L\_GBNA\_RAD\_202002041130\_v01.0.nc” |
| date | The date which specifies when the metadata record was created or update (ISO 8601: yyyy-MM-ddTHH:mm:ssZ) | e.g.: “2020-04-01T00:02:00Z” |
| product\_version | Release number of the data file | e.g.:“0.1” |
| software\_version | Processing software version | e.g.:“Hypernets\_processor v4” |
| references | Web based reference that describe the data or methods used to produce it | e.g.:”https://hypernets-processor.readthedocs.io/en/latest/” |
| history | Provides an audit trail for modifications to the original data. It should contain a  separate line for each modification, with each line beginning with a timestamp,  and including modification name and optional modification arguments. | e.g.:  “2020-04-01T00:02:00Z :  Creation\n  2028-03-23T11:56:12Z :  Merging wind data” |
| source | The method of production of the original data. If it was model-generated, source  should name the model and its version, as specifically as could be useful. If it is  observational, source should characterize it (e.g., “surface observation” or  “radiosonde”) | E.g.: “Land and water observations HYPPSTARR v0.1” |
| topic\_category | The topic category is a high-level classification scheme to assist in the grouping and topic-based search of available spatial data resources. (in accordance with ISO191152) | e.g.: “biota, environement,oceans,inlandwaters” |
| keyword | INSPIRE requests, if the resource is a spatial data set or spatial data set series, at least one keyword provided from the general environmental multilingual thesaurus\*. The keyword value is a commonly used word, formalised word or phrase used to describe the subject. While the topic category is too coarse for detailed queries, keywords help narrowing a full text search and they allow for structured keyword search.The value domain of this metadata element is free text.  \* e.g.: GEMET - version 4.1.4, 13 Feb 2020, AGROVOC is an RDF/ SKOS-XL concept scheme, INSPIRE Spatial Data Theme | e.g.: “[Environmental monitoring Facilities](https://inspire.ec.europa.eu/Themes/120/2892) (INSPIRE Spatial Data Theme), reflectance (http://aims.fao.org/aos/agrovoc/c\_28538), optical properties (http://aims.fao.org/aos/agrovoc/c\_5371), vegetation (http://www.eionet.europa.eu/gemet/concept/8922), inland waters (http://www.eionet.europa.eu/gemet/concept/4333), sea (http://www.eionet.europa.eu/gemet/concept/7495)” |
| comment | Miscellaneous information about the data or methods used to produce it. Any free-  format text is appropriate. | e.g.: “Any free-format text is appropriate.” |
| locator | Link(s) to the resource and/or the link to additional information about the resource. The value domain of this metadata element is a character string, commonly expressed as uniform resource locator (URL). | e.g.: “www.hypernets.eu, www.waterhypernet.org” |
| Where |  |  |
| area | Geographical coverage | “Global” |
| easting |  | “longitude” |
| northing |  | “latitude” |
| southermost\_latitude | This is the extent of the resource in the geographic space, given as a bounding box.The bounding box shall be expressed with westbound and eastbound longitudes, and southbound and northbound latitudes in decimal degrees, with a precision of at least two decimals. Value between “-90.00” and “90.00”. | e.g.:“-90.00” |
| northernmost\_latitude | Value between “-90.00” and “90.00”. | e.g.:“90.00” |
| westernmost\_longitude | Value between “-180.00” and “180.00”. | e.g.:“-180.00” |
| easternmost\_longitude | Value between “-180.00” and “180.00”. | e.g.:“180.00” |
| When |  |  |
| time\_coverage\_start | Start date of the data (ISO 8601). | e.g.: “2020-04-01T00:02:00Z” |
| time\_coverage\_end | End date of the data (ISO 8601). | e.g.: “2020-04-01T00:02:00Z” |
| Who |  |  |
| contact\_name | Data provider name | “Sam Hunt” |
| contact\_email | Data provider email | “sam.hunt@npl.co.uk” |
| responsible\_party | Institution in charge of the data distribution (and management) of the data file | “National Physical Laboratory, UK” |
| acknowledgement |  | e.g.: “HYPERNETS project is funded by Horizon 2020 research and innovation program, Grand Agreement No 775993. Consortium of project of the Hypernets test sites, .... are greatly acknowledged.” |
| How |  |  |
| project\_name | Project name and grand number if any | e.g.:“H2020 HYPERNETS GN 775993” |
| language | This is the language in which the metadata elements are expressed. | “English” |
| operational\_status | Statement like : “under development” or “operational” or “experimental” | e.g.: “operational” |
| limitations | Provide information on the limitations to access and the reasons for them or, in case of no limitations on public access, indicate that fact. The value domain of this metadata element is free text, e.g., “no limitations” or “registered users only”. | e.g.: “no limitations to public access” |
| licence | Creative Commons licenses providing information on the publication and re-use of the data. | “Attribution-NonCommercial-NoDerivs CC BY-NC-ND” |
| conformity | Degree of conformity: Conformant (conformant), not conformant (NotConformant) or not evaluated (notEvaluated) | e.g.: “notEvaluated” |
| lineage | This is a statement on process history and/or overall quality of the spatial data set. Where appropriate it may include a statement whether the data set has been validated or quality assured, whether it is the official version (if multiple versions exist). The value domain of this metadata element is free text. | e.g.: “Quality assured following [URL data processing/QC]” |

## Instrument and system Metadata

### Instrument metadata

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Value** |
| instrument\_id | Serial number or identifier for the instrument package mounted in system\_id | e.g.:“HYPPSTARR001” |
| instrument\_manufacturer | Name of manufacturer for the instrument in instrument\_id | “Tartu University” |
| instrument\_model | Name of make or model of the instrument in instrument\_id (ex/ ‘HYPSTAR’). | “HYPPSTARR” |
| instrument\_date\_manufacture | Date of manufacture of the instrument in instrument\_id | “2020-04-01” |
| instrument\_version | Design version of the instrument in instrument\_id | “v001” |
| instrument\_firmware | Name of the firmware within the instrument | “Firmware4HYPPSTARR” |
| instrument\_firmware\_version | Firmware version for the instrument in instrument\_id | “v001” |
| instrument\_documentation\_references | Reference to documentation about the instrument | “www.hypernets/firmware4hyppstarr/” |
| instrument\_history | Free text about the instrument history and description | e.g.:  “2020-04-01T00:02:00Z :  Creation\n  2028-03-23T11:56:12Z :  Radiance head replaced” |
| instrument\_deployment\_date | Date of deployment of the instrument (should correspond to date of the first data send by the instrument) | e.g.: “2020-04-25” |

### System metadata

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Value** |
| system\_id | Identifier for the deployed system package (instrument + pan\_tilt + sensors) | e.g. “HYPERNETS00102” |
| system\_model | Name of make or model of the deployed system (ex/ ‘PANTHYR’ or name of HYPERNETS package) in system\_id | e.g.: ”HYPERNETS” |
| system\_manufacturer | Name of manufacturer for the deployed system package in system\_id | e.g.: “[Laboratoire d'Océanographie de Villefranche](http://http://lov.obs-vlfr.fr/) UMR 7093 - CNRS / Sorbonne Univ” |
| system\_date\_manufacture | Date of manufacture of the system in system\_id | “2028-03-01” |
| system\_version | Design version of the system in system\_id | “v02” |
| system\_firmaware\_version | Firmware version for the system in system\_id | “v02” |
| system\_logfile | Reference to logfile of the system including details about maintenance, updates, cleaning, ect. | e.g.:“www.waterhypernet/HYPPSTARR01\_GBNA/logfile.txt” |
| system\_documentation\_references | Reference to documentation about the system | e.g.:www.hypernets.eu/system\_documentation |
| system\_deployment\_date | Date of deployment of the system (should correspond to date of the first data send by the system). Data should be later or similar to the instrument\_deployment\_date | e.g.: “2028-03-23” |

### Components metadata

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Value** |
| ***[rgb\_camera][rain\_sensor][light\_sensor]*** | | |
| [name]\_id | Unique identification for the component | e.g.: “cameraID01234”, “rainsensorID01234” |
| [name]\_manufacturer | Manufacturer of the component | e.g.: “ABUS”, “KemoElectronic” |
| [name]\_date\_manufacture | Data of manufacture | e.g.: “20191102” |
| ***[radiance][irradiance]\_[vnir][swir]\_head*** | | |
| [name]\_[www]\_head\_id | Serial number of the radiance/irradiance head. For HYPSTAR this sensor is inside of the instrument in instrument\_id. | e.g.: “IBSENUVNIR001” |
| [name]\_[www]\_head\_manufacturer | Name of manufacturer of the sensor head in [name]\_[www]\_head\_id | e.g.: “Ibsen” |
| [name]\_[www]\_head\_model | Name of make or model | e.g.: “Freedom FSA-101” |
| [name]\_[www]\_head\_manufacture | Date of manufacture | e.g.: “20190120” |
| [name]\_[www]\_head\_version | Design version | e.g.: “101” |
| [name]\_[www]\_head\_firmware\_version | Firmware version for the sensor in [name]\_[www]\_head\_id | e.g.: “v001” |
| [name]\_[www]\_head\_ documentation\_reference | URL to the documentation of the characterisation/calibration files (including straylight, linearity, … ) used for the characterisation of the sensor in [name]\_[www]\_head\_id | e.g.: “https://hypernets.to.ee/documentation” |
| [name]\_[www]\_head\_description | Any free-format text if required with additional information/specifications | e.g.: “custom 25 μm slit width for the VNIR spectral region” |
| [name]\_[www]\_head\_radiometric\_resolution | Radiometric resolution (bits) for sensor in [name]\_[www]\_head\_id | e.g.: “16” |
| [name]\_[www]\_head\_spectral\_range | Spectral range of measurements for sensor in [name]\_[www]\_head\_id | e.g.: “190-1100” |
| [name]\_[www]\_head\_spectral\_sampling | Spectral sampling for a single channel/pixel of the sensor in [name]\_[www]\_head\_id | e.g.: “1.5” |
| [name]\_[www]\_head\_spectral\_resolution | Spectral resolution expressed in Full-Width-Half\_Maximum (FWHM) from [name]\_[www]\_head\_id in nm | e.g.: “3” |
| [name]\_[www]\_head\_spectral\_accuracy | Spectral accuracy from [name]\_[www]\_head\_id in nm | e.g.: “0.3” |
| [name]\_[www]\_head\_spectral\_fov | Field of view of the radiance sensor [name]\_[www]\_head\_id in decimal degrees | e.g.: “7” |
| ***[Pointing system]*** | | |
| pointing\_system\_id | Unique identification for the component | e.g.: “MAD01234” |
| pointing\_system\_manufacturer | Name of the manufacturer of the pointing system | e.g.: “Will Burt” |
| pointing\_system\_model | Date of manufacture | e.g.: “Bowler-RX” |
| pointing\_system\_date\_manufacture | Name of make or model | e.g.: “20180101” |
| pointing\_system\_version | Design version | e.g.: “RX001” |
| pointing\_system\_documentation\_directory | URL to the documentation of the pointing system | e.g.: “https://www.willburt.com/mad/pan-and-tilt-heads/light-duty” |
| pointing\_system\_description | Any free-format text if required with additional information/specifications | e.g.: “pan and tilt with custom azimuth to 359°” |
| ***[Calibration device]*** | | |
| calibration\_device\_id | Identifier for the calibration device | e.g.: “CALspars01234” |
| calibration\_device\_manufacturer | Name of manufacturer for the the calibration device | E.g.: “Tartu University” |
| calibration\_device\_model | Name of make or model of the deployed the calibration device | e.g. : “Calspars01” |
| calibration\_device\_date\_manufacture | Date of manufacture of the the calibration device | e.g. “20200101” |
| calibration\_device\_version | Design version of the the calibration device | e.g.: “v01” |
| Calibration\_device\_LED\_ID | Identifier for the LED source within the calibration device | e.g.: “LOLTW01234” |
| Calibration\_device\_LED\_model | Description of LED source used within the calibration device | e.g.: “LTW-2S3D7” |
| Calibration\_device\_LED\_manufacturer | Manufacturer of the LED source within the calibration device | e.g.: “Lite-On” |
| calibration\_device\_documentation\_directory | URL to the documentation of the calibration device including files or reference to the calibration files of the LED source | e.g.: “https://www.hypernets/eu/Calspars\_CalibrationDevice” |
| calibration\_device\_description | Any free-format text if required with additional information/specifications | e.g.: “Nothing to add” |

## Site Metadata

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Value** |
| site\_id | Unique site identification | e.g.: “BSBE” |
| site\_description | Short site description with some details about the target surface/water type | e.g.:”De Blankaart, Belgium Viewing direction, southern side of the reservoir” |
| site\_latitude |  | "50.8364045” |
| site\_longitude |  | “4.37563433” |
| site\_owner | Owner of the site (public or private institute) | “De Watergoep” |
| site\_operator | Operator at the site (e.g., during the project this should be a member of the consortium) | “RBINS” |
| site\_manager | Site manager (not necessarily a member of the consortium) | “De Watergroep” |
| site\_contact\_details | At least name and email of the contact person at the site | “Clémence Goyens, [cgoyens@naturalsciences.be](mailto:cgoyens@naturalsciences.be)” |
| Site\_documentation reference | URL to the documentation of the site (including documentation about spatial and temporal variability, guidelines in terms of measurement and validation protocols and other possible publications) | “www.waterhypernet.org/sites/deBlankaart/South” |

## Calibration Data Metadata

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Value** |
| [name]\_[www]\_head\_cosine\_documentation\_reference | URL to the files containing the angular response functions of the sensor head | “www.waterhypernet.org/calibration/IBSENUVNIR001/cosine” |
| [name]\_[www]\_head\_calibration\_documentation\_reference | URL to the files containing the spectral responsivity coefficients of the sensor head | “www.waterhypernet.org/calibration/IBSENUVNIR001/spectralResp” |
| [name]\_[www]\_head\_linearity\_documentation\_reference | URL to the files containing the radiometric linearity data | “www.waterhypernet.org/calibration/IBSENUVNIR001/lin” |

## Product Metadata

### Radiance/Irradiance Product Metadata

Table 7 provides additional radiance/irradiance product metadata.

Table 7 – Radiance/irradiance product metadata

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Value** |
| processor\_name | Name of the processor for the computation of the radiance and irradiance product |  |
| processor\_version | Version number of the processor |  |
| processor\_configuration\_file | Configuration filename used for the processing of the data |  |
| processor\_atbd | URL to the ATBD/documentation about the processing |  |
| [orientation]\_[radiometry]\_inputfile | Filename of the raw data file |  |
| sequence\_id | Unique identifier of the sequence including references to site, date and time (see Sequence Scheduler) |  |
| series\_id | Unique identifier of the series including references to site, date and time, viewing angles and measurement quantity (radiance or irradiance) |  |
| sequence\_config\_file | Filename of the instrument configuration file |  |
| sequence\_file | Filename of the sequence scheduler |  |
| [orientation]\_[radiometry]\_datetime\_average | Average time during series |  |
| [orientation]\_[radiometry]\_datetime\_start | Start time of the series |  |
| [orientation]\_[radiometry]\_datetime\_end | End time of the series |  |
| [orientation]\_[radiometry]\_scans\_total | Total number of scans during the series |  |
| [orientation]\_[radiometry]\_units | Units of the L1 radiance/irradiance data |  |
| [orientation]\_[radiometry]\_average\_saa | Average solar azimuth angle during the series |  |
| [orientation]\_[radiometry]\_average\_raa | Average relative azimuth angle during the series |  |
| [orientation]\_[radiometry]\_average\_vza | Average viewing zenith angle during the series |  |
| [orientation]\_[radiometry]\_average\_sza | Average zenith angles during the series |  |
| [orientation]\_[radiometry]\_min\_saa | Minimum solar azimuth angle during the series |  |
| [orientation]\_[radiometry]\_min\_raa | Minimum relative azimuth angle during the series |  |
| [orientation]\_[radiometry]\_min\_vza | Minimum viewing zenith angle during the series |  |
| [orientation]\_[radiometry]\_min\_sza | Minimum zenith angles during the series |  |
| [orientation]\_[radiometry]\_max\_saa | Maximum solar azimuth angle during the series |  |
| [orientation]\_[radiometry]\_max\_raa | Maximum relative azimuth angle during the series |  |
| [orientation]\_[radiometry]\_max\_vza | Maximum viewing zenith angle during the series |  |
| [orientation]\_[radiometry]\_max\_sza | Maximum zenith angles during the series |  |

### Reflectance Product Metadata

Table 8 provides additional radiance/irradiance product metadata.

Table 8 – Reflectance product metadata

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Value** |
| processor\_name | Name of the processor for the computation of the radiance and irradiance product |  |
| processor\_version | Version number of the processor |  |
| processor\_configuration\_file | Configuration filename used for the processing of the data |  |
| processor\_atbd | URL to the ATBD/documentation about the processing |  |
| sequence\_id | Unique identifier of the sequence including references to site, date and time (see Sequence Scheduler) |  |
| upwelling\_radiance\_l1\_file | Filename of the L1 upwelling radiance file |  |
| downwelling\_radiance\_l1\_file | Filename of the L1 downwelling radiance file |  |
| downwelling\_irradiance\_l1\_file | Filename of the L1 downwelling irradiance file |  |
| sequence\_config\_file | Filename of the instrument configuration file |  |
| sequence\_file | Filename of the sequence scheduler |  |
| timestamp | Date and time associated to the L2 data |  |
| relative\_azimuth\_angle | Relative azimuth angle between sun and sensor used for the processing of L2 data |  |
| solar\_azimuth\_angle | Solar azimuth angle used for the processing of the L2 data |  |

# 

Table 8a – Reflectance product metadata specific for water applications

|  |  |  |
| --- | --- | --- |
| **Name** | **Description** | **Value** |
| fresnel\_rhof |  | e.g.: “0.0262002” |
| fresnel\_type |  | e.g.: “Mobley” |
| fresnel\_wind |  | e.g.: “2” |
| fresnel\_sza |  | e.g.: “79.98” |
| fresnel\_vza |  | e.g.: “40” |
| fresnel\_raa |  | e.g.:”90" |
| cloud\_cover |  |  |
| aot |  |  |
| radiance\_inclination |  |  |
| irradiance\_inclination |  |  |
| lu\_scans\_good |  |  |
| lu\_scans\_temporalvsincomplete |  |  |
| ld\_scans\_good |  |  |
| ld\_scans\_temporalvsincomplete |  |  |
| ed\_scans\_good |  |  |
| ed\_scans\_temporalvsincomplete |  |  |
| glint\_corr |  |  |
| simil\_wavelength\_1 |  |  |
| simil\_wavelength\_2 |  |  |
| epsilon\_average |  |  |
| epsilon\_min |  |  |
| epsilon\_max |  |  |
| epsilon\_sd |  |  |
|  |  |  |

# Variables

This section provides a description of the data product variables. The first subsection describes variables common to all product types (as defined in Table 2). The following subsections then define per data type variables.

## Common Variables

The common data variables are defined in Table 9. The remaining tables in this subsection define each of the common data variables.

To add: common vocabularies for each variable

Normalised water-leaving radiance

<http://vocab.nerc.ac.uk/collection/P01/current/NRWLRCR1/>

Water leaving radiance

<http://vocab.nerc.ac.uk/collection/P01/current/RWLRCCR1/>

Surface radiance measured above water

<http://vocab.nerc.ac.uk/collection/P01/current/TTWTIR01/>

Sky radiance

<http://seadatanet.maris2.nl/bandit/browse_step.php?&step=011R410_006S0600139>

Downwelling irradiance

<http://vocab.nerc.ac.uk/collection/P01/current/CSLRCCR1/>

Table 9 - Common product data variables

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable Name** | **Standard Name** | **Data Type** | **Dimension** |
| wavelength | wavelength | int32 | wavelength |
| viewing\_azimuth\_angle | viewing\_azimuth\_angle | int32 | series |
| viewing\_zenith\_angle | viewing\_zenith\_angle | int32 | series |
| sun\_azimuth\_angle | sun\_azimuth\_angle | int32 | series |
| sun\_zenith\_angle | sun\_zenith\_angle | int32 | series |
| acquisition\_time | time | int32 | series |

Table 10 - wavelength variable definition

|  |  |  |  |
| --- | --- | --- | --- |
| **wavelength** | **Attribute** | **Value** | **Comment** |
| \_FillValue | -999999 |  |
| standard\_name | wavelength |  |
| long\_name | Wavelength |  |
| units | nm |  |
| scale\_factor | 0.01 |  |
| add\_offset | 0.0 |  |
| ancillary\_variables |  |  |

Table 11 - viewing\_azimuth\_angle variable definition

|  |  |  |  |
| --- | --- | --- | --- |
| **viewing\_azimuth\_angle** | **Attribute** | **Value** | **Comment** |
| \_FillValue | -999999 |  |
| standard\_name | viewing\_azimuth\_angle |  |
| long\_name | Viewing azimuth angle |  |
| units | degrees |  |
| scale\_factor | 0.01 |  |
| add\_offset | 0.0 |  |
| ancillary\_variables |  |  |

Table 12 - viewing\_zenith\_angle variable definition

|  |  |  |  |
| --- | --- | --- | --- |
| **viewing\_zenith\_angle** | **Attribute** | **Value** | **Comment** |
| \_FillValue | -999999 |  |
| standard\_name | viewing\_zenith\_angle |  |
| long\_name | Viewing zenith angle |  |
| units | degrees |  |
| scale\_factor | 0.01 |  |
| add\_offset | 0.0 |  |
| ancillary\_variables |  |  |

Table 13 - sun\_azimuth\_angle variable definition

|  |  |  |  |
| --- | --- | --- | --- |
| **sun\_azimuth\_angle** | **Attribute** | **Value** | **Comment** |
| \_FillValue | -999999 |  |
| standard\_name | sun\_azimuth\_angle |  |
| long\_name | Sun azimuth angle |  |
| units | degrees |  |
| scale\_factor | 0.01 |  |
| add\_offset | 0.0 |  |
| ancillary\_variables |  |  |

Table 14 - sun\_zenith\_angle variable definition

|  |  |  |  |
| --- | --- | --- | --- |
| **sun\_zenith\_angle** | **Attribute** | **Value** | **Comment** |
| \_FillValue | -999999 |  |
| standard\_name | sun\_zenith\_angle |  |
| long\_name | Sun zenith angle |  |
| units | degrees |  |
| scale\_factor | 0.01 |  |
| add\_offset | 0.0 |  |
| ancillary\_variables |  |  |

Table 15 - acquisition\_time variable definition

|  |  |  |  |
| --- | --- | --- | --- |
| **acquisition\_time** | **Attribute** | **Value** | **Comment** |
| \_FillValue | -999999 |  |
| standard\_name | time |  |
| long\_name | Acquisition time in seconds since 1970-01-01 00:00:00 |  |
| units | s |  |
| scale\_factor | 0.01 |  |
| add\_offset | 0.0 |  |
| ancillary\_variables |  |  |

## Radiance Variables

Data variables specific to radiance products are defined in Table 16. The remaining tables in this subsection define each of the listed data variables.

Table 16 - Radiance product variables

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable Name** | **Standard Name** | **Data Type** | **Dimension** |
| radiance | radiance | int32 | wavelength, series |
| u\_random\_radiance | u\_random\_radiance | int16 | wavelength, series |
| u\_systematic\_radiance | u\_systematic\_radiance | int16 | wavelength, series |
| quality\_flag | quality\_flag | int16 | series |

Table 17 - radiance variable definition

|  |  |  |  |
| --- | --- | --- | --- |
| **radiance** | **Attribute** | **Value** | **Comment** |
| \_FillValue | -999999 |  |
| standard\_name | radiance |  |
| long\_name | Radiance |  |
| units | mW m^-2 sr^-1 nm^-1 |  |
| scale\_factor |  |  |
| add\_offset | 0.0 |  |
| ancillary\_variables | quality\_flag |  |

Table 18 - u\_random\_radiance variable definition

|  |  |  |  |
| --- | --- | --- | --- |
| **u\_random\_radiance** | **Attribute** | **Value** | **Comment** |
| \_FillValue | -999999 |  |
| standard\_name | u\_random\_radiance |  |
| long\_name | Random radiance uncertainty |  |
| units | % |  |
| scale\_factor | 0.01 |  |
| add\_offset | 0.0 |  |
| ancillary\_variables | - |  |

Table 19 - u\_systematic\_radiance variable definition

|  |  |  |  |
| --- | --- | --- | --- |
| **u\_systematic\_radiance** | **Attribute** | **Value** | **Comment** |
| \_FillValue | -999999 |  |
| standard\_name | u\_systematic\_radiance |  |
| long\_name | Systematic radiance uncertainty |  |
| units | % |  |
| scale\_factor | 0.01 |  |
| add\_offset | 0.0 |  |
| ancillary\_variables | - |  |

Table 20 - quality\_flag variable definition

|  |  |  |  |
| --- | --- | --- | --- |
| **quality\_flag** | **Attribute** | **Value** | **Comment** |
| standard\_name | quality\_flags |  |
| long\_name | Quality indicator per acquisition |  |
| flag\_masks | 1,2,4,8,16,32,64,128 |  |
| flag\_meanings | Blah  Blah  Blah |  |

## Irradiance Variables

Data variables specific to irradiance products are defined in Table 21. The remaining tables in this subsection define each of the listed data variables.

Table 21 - Irradiance product variables

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable Name** | **Standard Name** | **Data Type** | **Dimension** |
| irradiance | irradiance | int32 | wavelength, series |
| u\_random\_irradiance | u\_random\_irradiance | int16 | wavelength, series |
| u\_systematic\_irradiance | u\_systematic\_irradiance | int16 | wavelength, series |
| quality\_flag | quality\_flag | int32 | series |

Table 22 - irradiance variable definition

|  |  |  |  |
| --- | --- | --- | --- |
| **irradiance** | **Attribute** | **Value** | **Comment** |
| \_FillValue | -999999 |  |
| standard\_name | irradiance |  |
| long\_name | Irradiance |  |
| units | mW m^-2 nm^-1 |  |
| scale\_factor |  |  |
| add\_offset | 0.0 |  |
| ancillary\_variables | quality\_flag |  |

Table 23 - u\_random\_irradiance variable definition

|  |  |  |  |
| --- | --- | --- | --- |
| **u\_random\_irradiance** | **Attribute** | **Value** | **Comment** |
| \_FillValue | -999999 |  |
| standard\_name | u\_random\_irradiance |  |
| long\_name | Random irradiance uncertainty |  |
| units | % |  |
| scale\_factor | 0.01 |  |
| add\_offset | 0.0 |  |
| ancillary\_variables | - |  |

Table 24 - u\_systematic\_irradiance variable definition

|  |  |  |  |
| --- | --- | --- | --- |
| **u\_systematic\_irradiance** | **Attribute** | **Value** | **Comment** |
| \_FillValue | -999999 |  |
| standard\_name | u\_systematic\_irradiance |  |
| long\_name | Systematic irradiance uncertainty |  |
| units | % |  |
| scale\_factor | 0.01 |  |
| add\_offset | 0.0 |  |
| ancillary\_variables | - |  |

Table 25 - quality\_flag variable definition

|  |  |  |  |
| --- | --- | --- | --- |
| **quality\_flag** | **Attribute** | **Value** | **Comment** |
| standard\_name | quality\_flags |  |
| long\_name | Quality indicator per acquisition |  |
| flag\_masks | 1,2,4,8,16,32,64,128 |  |
| flag\_meanings | Blah  Blah  Blah |  |

## Reflectance Variables

Data variables specific to Level 2a and Level 2b reflectance products are defined in Table 26 and Table 27 respectively. These variables only differ by dimensions and so the remaining tables in this subsection define each of the listed data variables for both products together.

Table 26 – L2a reflectance product variables

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable Name** | **Standard Name** | **Data Type** | **Dimension** |
| reflectance | reflectance | int16 | wavelength, series |
| u\_random\_reflectance | u\_random\_reflectance | int16 | wavelength, series |
| u\_systematic\_reflectance | u\_systematic\_reflectance | int16 | wavelength, series |
| quality\_flag | quality\_flag | int32 | series |

Table 27 – L2b reflectance product variables

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable Name** | **Standard Name** | **Data Type** | **Dimension** |
| reflectance | reflectance | int16 | wavelength, time |
| u\_random\_reflectance | u\_random\_reflectance | int16 | wavelength, time |
| u\_systematic\_reflectance | u\_systematic\_reflectance | int16 | wavelength, time |
| quality\_flag | quality\_flag | int32 | time |

Table 28 - irradiance variable definition

|  |  |  |  |
| --- | --- | --- | --- |
| **reflectance** | **Attribute** | **Value** | **Comment** |
| \_FillValue | -999999 |  |
| standard\_name | reflectance |  |
| long\_name | Reflectance |  |
| units | mW m^-2 nm^-1 |  |
| scale\_factor |  |  |
| add\_offset | 0.0 |  |
| ancillary\_variables | quality\_flag |  |

Table 29 - u\_random\_irradiance variable definition

|  |  |  |  |
| --- | --- | --- | --- |
| **u\_random\_reflectance** | **Attribute** | **Value** | **Comment** |
| \_FillValue | -999999 |  |
| standard\_name | u\_random\_reflectance |  |
| long\_name | Random reflectance uncertainty |  |
| units | % |  |
| scale\_factor | 0.01 |  |
| add\_offset | 0.0 |  |
| ancillary\_variables | - |  |

Table 30 - u\_systematic\_irradiance variable definition

|  |  |  |  |
| --- | --- | --- | --- |
| **u\_systematic\_reflectance** | **Attribute** | **Value** | **Comment** |
| \_FillValue | -999999 |  |
| standard\_name | u\_systematic\_reflectance |  |
| long\_name | Systematic reflectance uncertainty |  |
| units | % |  |
| scale\_factor | 0.01 |  |
| add\_offset | 0.0 |  |
| ancillary\_variables | - |  |

Table 31 - quality\_flag variable definition

|  |  |  |  |
| --- | --- | --- | --- |
| **quality\_flag** | **Attribute** | **Value** | **Comment** |
| standard\_name | quality\_flags |  |
| long\_name | Quality indicator per acquisition |  |
| flag\_masks | 1,2,4,8,16,32,64,128 |  |
| flag\_meanings | Blah  Blah  Blah |  |