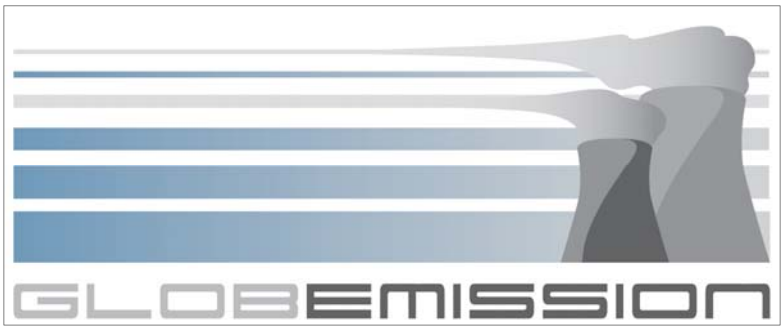

GlobEmission

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Product Specification Document

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1 Introduction

1.1 Purpose and scope

Emission inventories of greenhouse gases (GHGs), reactive gases and aerosols are needed as input for atmospheric climate and chemistry transport models (CTMs) to be able to assess and predict the climate impacts, air pollution concentrations or deposition of elements to ecosystems. Emission inventories also provide the link to sources which can be mitigated by implementing policies to reduce emissions and thereby avoid or mitigate undesirable environmental impacts. Therefore, emission inventories Emission inventories are used since a few decades by both policy makers as well as climate modellers and atmospheric modellers.

In the GlobEmission project new emission estimates will be delivered based on data from operational satellites. These inventories will cover several important species related to anthropogenic and biogenic activities. They will be processed on both a global and regional scale, depending on the wishes of 6 committed end-users (See **Fout! Verwijzingsbron niet gevonden.**). Based on the user requirements [RD-1] as well as the technical capability of the partners involved in the project a product specification was made for all the emission datasets to be delivered within the GlobEmission project. The purpose of this report is to document these product specifications in a detailed way.

In chapter 3 overviews of the product specification are given detailing the used satellite instruments, region coverage, time period, foreseen accuracy, spatial grid, temporal frequency and data format. For each product special attention is given to the relation between the specification and the respective user requirements. In chapter 4 detailed technical descriptions of the expected data files are given. In principle, the meta data description as well as the variables describe the data sets in their full extend. The meta data have been harmonised among the partners and include the data origin, comments, and all emission category and domain descriptors. As such the foreseen data products will be compliant with GEOSS recommendations ensuring easy access to the data.

2 Documents

2.1 Reference documents

[RD-1] GlobEmission User Requirement Documents (GE_URD_01_01)

2.2 Informative documents

3 Product Specifications

3.1 Global products

BIRA-IASB will provide:

- global emissions of biogenic isoprene
- global emissions of fire-related NMVOCs
- agricultural waste burning emissions in the North China Plain region
- regional emission data of anthropogenic NMVOCs for China, the Middle East and Korea
- global emissions of SO_2 for one particular year with focus on China (feasibility study)
- feasibility study on the derivation of NMVOC emission fluxes for Brazil, and South Asian countries

Relation between requirements and the specifications

For all these products monthly averaged global emission data will be provided between 2007 and 2014 at a spatial resolution of 0.5x0.5 degree. The data format will be adapted to the users' needs. In general this covers all user requirements. The Laboratoire Atmosphères, Milieux, Observations Spatiales (LATMOS) and the University Amsterdam is interested in using NMVOC emissions on the global scale. The National Institute for Environmental Studies (NIES), the Qatar Environment and Energy Research Institute (QEERI), the Inha University, and the South African National Space Agency (SANSA) are interested in emissions over Asia, the Middle East, Korea and neighboring regions, and South Africa, respectively. The temporal frequency of one month covers the minimal expectations of all users. However, the University of Amsterdam, QEERI and SANSA would prefer data on a finer spatial resolution (0.25x0.25 degree or finer), whereas weekly averaged data could be useful for NIES and SANSA.

Product Specification tables

Table.1 Product Specifications for natural emissions of isoprene.

	Specification
Used satellite instruments	GOME-2 and OMI
Region coverage	Global

Time period	2007-2014
Accuracy	Will be adapted to the users requirements
Spatial grid	0.5 x 0.5 degree
Temporal frequency	Monthly and daily (hourly data available on request)
Data format	NetCDF

Table.2 Product Specifications for anthropogenic NMVOC emissions.

	Specification
Used satellite instruments	GOME-2 and OMI
Region coverage	China, Korea, and the Middle east
Time period	2007-2014
Accuracy	Will be determined through sensitivity inversions, and adapted to the users requirements
Spatial grid	0.25 x 0.25 degree
Temporal frequency	Monthly
Data format	NetCDF

Table.3 Product Specifications for biomass burning NMVOC emissions

	Specification
Used satellite instruments	GOME-2 and OMI
Region coverage	Global
Time period	2007-2014
Accuracy	Will be determined through sensitivity inversions, and adapted to the users requirements
Spatial grid	0.5 x 0.5 degree
Temporal frequency	Monthly
Data format	NetCDF

Table.4 Product Specifications for anthropogenic SO_2 emissions

	Specification
Used satellite instruments	OMI
Region coverage	Global
Time period	2010
Accuracy	Feasibility study, no particular accuracy assessment is planned
Spatial grid	0.5 x 0.5 degree
Temporal frequency	Monthly
Data format	NetCDF

Table.5 Product Specifications for NMVOC emission fluxes for Brazil, and South Asian countries

	Specification
Used satellite instruments	OMI
Region coverage	Brazil, and South Asian countries
Time period	2010
Accuracy	Feasibility study, no particular accuracy assessment is planned
Spatial grid	0.5 x 0.5 degree
Temporal frequency	Monthly
Data format	NetCDF

Table.6 Agricultural waste burning emissions for North China Plain region

	Specification
Used satellite instruments	OMI
Region coverage	North China Plain (32-40°N, 112.5-120°E)
Time period	2005-2012

Accuracy	To be determined through sensitivity inversions
Spatial grid	0.5 x 0.5 degree
Temporal frequency	Monthly
Data format	NetCDF

List of auxiliary data

Isoprene emissions obtained from the MEGAN-ECMWFv2 model (Stavrakou et al., 2014) are freely available at http://tropo.aeronomie.be/models/isoprene.htm between 1979 and 2013. This data is provided on the global scale at a resolution of 0.5x0.5 degree.

3.2 Regional products (China, India, South Africa, Middle East)

KNMI will provide emission estimates of NO_x on a 0.25 degree resolution for the domains of China, India, Middle East, and South Africa. The first three products will be directly made available to their users (Satellite Environment Center of China (SEC), the Indian Institute of Tropical Meteorology (IITM), and the Qatar Environment and Energy Research Institute (QEERI), respectively). The last product will be delivered to VITO, who will apply spatial disaggregation techniques to increase the resolution of the inventory to 5km before delivering to the South African Weather Service (SAWS), see Section 3.2.1.

NO_x emission estimates will be done with the DECSO algorithm (Daily Emission estimates Constrained by Satellite Observations) for retrievals of tropospheric NO_2 by the GOME-2 and OMI satellite instrument, combined with simulations of the CHIMERE regional transport model. At first, only NO_x emissions are delivered (possibly with related air pollutants for which NO_x acts as a proxy, e.g. anthropogenic PM10). At a later stage is evaluated whether emission estimates constrained by less sensitive retrievals of SO_2 and HCHO are feasible.

Differences with requirements of SEC

Emissions of PM10, PM2.5, CO, SO_2, O_3, CO_2, CH_4, BC, OC are not directly addressed. Emissions of PM10 and PM2.5 might be estimated using NO_x as a proxy. Concentration modeling of O_3 probably will be improved by using the updated NO_x emission inventory, which should be tested in a mutual validation effort. A feasibility study will be done to assess if SO_2 emission estimates are useful. The desired spatial resolution of 1-10km can not be accomplished with the current generation of space-born spectrometers of backscattered solar radiation. Instead, the emissions will be delivered at a 20-25km resolution. Daily emission estimates, as requested, can be delivered, although it is recommended to use monthly averages to suppress noise due to observational errors.

Differences with requirements of IITM

Emissions of CO are not addressed. Time coverage is requested from 2001 onward. We suggest to start the processing at 2007, from which both OMI and GOME-2 are operational.

Differences with requirements of QEERI

At the first stage, emissions other than NOx are not addressed. We suggest to start the processing at 2010, with an option for a reprocessing from 2007 which both OMI and GOME-2 are operational. Spatial and temporal resolution are downgraded to what seems appropriate for the current capabilities of the DECSO algorithm: monthly averaged emission inventories on a 0.25 degree resolution.

Differences with requirements of SAWS

See remarks in the next section: 3.2.1.

Table.7 Product Specifications for Regional NO_x Emission Estimates in China

	Specification
Used satellite instruments	GOME and OMI
Region coverage	East China, 18˚N–50˚N, 102˚E–132˚E
Time period	2007 – present (possibly extended with 2005-2006)
Accuracy	Below 50%
Spatial grid	0.25 x 0.25 degree
Temporal frequency	Daily (on request, use not recommended), Monthly
Data format	NetCDF, text

Table.8 Product Specifications for Regional NO_x Emission Estimates in India

	Specification
Used satellite instruments	GOME-2 and OMI
Region coverage	India, 4˚N–34˚N, 67˚E–92˚E
Time period	2007 – present
Accuracy	Below 50%
Spatial grid	0.25 x 0.25 degree
Temporal frequency	Monthly, Seasonal
Data format	NetCDF, text

Table.9 Product Specifications for Regional NO_x Emission Estimates in Middle East

	Specification
Used satellite instruments	GOME-2 and OMI
Region coverage	10.125˚N–37.875˚N, 29.375˚E–63.375˚E Entire Arabian peninsula and Persian Gulf, Eastern Mediterranean contries, large part of Iran, Cairo and Nile river
Time period	2010 – present. Optional processing of earlier years.
Accuracy	Below 50%
Spatial grid	0.25 x 0.25 degree
Temporal frequency	Monthly
Data format	NetCDF, text

Table.10 Product Specifications for Regional NO_x Emission Estimates in South Africa

	Specification
Used satellite instruments	GOME-2 and OMI
Region coverage	South Africa, 19˚S–37˚S, 10˚E–42˚E
Time period	2011 – present. Optional processing of earlier years.
Accuracy	Below 50%
Spatial grid	0.25 x 0.25 degree
Temporal frequency	Monthly
Data format	NetCDF, text

3.2.1 Regional products: South Africa

The South African Weather Service (SAWS) requires regional emission inventories of the trace gases CO, SO_2, NOx, NH_3, NMVOCs and other trace species relevant in atmospheric modeling. Also an emission inventory of particulate matter PM10 and/or PM2.5 is required. VITO will downscale the regional emission inventory as developed by KNMI, in order to come to the high resolution emissions SAWS is interested in. The availability of high resolution emissions for the different pollutants will however be limited to the pollutants in

the KNMI emission inventory for South Africa. Currently KNMI plans to set up the inverse modeling procedure for NOx emissions. By the end of the GlobEmission project, the KNMI and thus VITO species list eventually might be extended towards other species.

In the initial interest of the SAWS, a time period coverage from 1997 to present was asked. The time window in which high resolution emissions for the different pollutants will be provided, will be the same as the time window of the KNMI emission inventory for South Africa. At first stage, the starting point of the KNMI and thus VITO emissions time series is 1-1-2011. KNMI however intends to start the time series a couple of years earlier at a later stage in the GlobEmission project. The downscaling for South Africa will be adapted to the most extensive time window available.

Furthermore, a spatial resolution of 1km and a monthly temporal resolution was asked by SAWS. The state-of-the-art in emission downscaling is however not allowing such a high spatial resolution in South Africa, i.e. the gridding could be done at a 1km resolution, but the accuracy would be very low and the errors very high. Therefore, the higher resolution would no longer provide added value. As such, VITO prefers to offer a 5 km resolution downscaling, The required monthly temporal resolution will be met.

In the initial user requirements specified by SAWS, no sectoral split was mentioned. The GlobEmission product will however be used by the SAWS and the South African Department of Water and Environmental Affairs (DWEA) as an emission inventory module in the South African Air Quality Information System (SAAQIS). As such, sectoral emissions (i.e. emissions stemming from power plants, industry, transport, ...) will be needed. The low resolution emission inventory, stemming from satellite data, will not be sector dependent. To obtain an optimal spatial disaggregation, the regional inventory will be split over different sectors. The quality of the resulting sectoral emissions will strongly depend on the input VITO will get from the end user or from local authorities.

Table.11 Product Specifications for downscaled regional NO_2 emissions for South Africa

	Specification
Used satellite instruments	GOME-2 and OMI
Region coverage	South Africa
Time period	Starting point time series at least on 1-1-2011, eventually earlier (1-1-2009)
Accuracy	Better than 50 %
Spatial grid	0.05 x 0.05°
Temporal frequency	Monthly

Data format	NetCDF, Text format

The downscaling procedure VITO is usually applying (within Europe), is based on spatial proxy data, i.e. road maps, land use maps, population density maps, exact locations and parameters of power plants, ... In European emission inventories, sources are broken down over 11 SNAP (Selected Nomenclature for sources of Air Pollution) categories. For each of these SNAP sectors an appropriate proxy is used (Agriculture: land use + livestock data; Transport: Road maps; ...). In order to extend the downscaling technique towards South Africa, the availability of good proxy data is crucial. A first screening on the net reveals that there is quite some information freely available:

- Geographic locations of the main ESKOM power plants, capacity (MW), stack heights and collective emission data as reported by ESKOM in the Environmental Reports;
- Road and railroad network for South Africa in ArcGIS format (e.g. www.openstreetmap.org; ArcGIS World Street Map, World Transportation Map; Surveyor General of South Africa (DCW));
- Population density (July 2000) in South Africa (people/km^2) based on the 1994 Census per magisterial district, from Department of Environmental Affairs and Tourism;
- Land Use map for South Africa (Department of Environmental Affairs and Tourism) and Global Land Cover GLC2000 data;
- Vegetation types in South Africa (Department of Environmental Affairs and Tourism);
- Gross Geographic Product per province and per economical sector in South Africa (Department of Environmental Affairs and Tourism);
- GEIA global emission inventory;
- EDGAR global emission inventory;
- DEAT (Department of Environmental Affairs and Tourism of the South African Government) emission inventory;
- CSIR (Council for Scientific and Industrial Research, South Africa) emission inventory;

3.3 European products

The goal of this study is to contribute to the verification and improvement of the EMEP emission inventory for Europa by using satellite data. In conjunction with EEA and an end-user it will be tested to which extend the use of satellite data can contribute to the improvement the EMEP emission database and to develop a prototype service that provides national total emission estimates for two years for which official data are not yet available. In this study target years for the latter are 2009 and 2010. The species under consideration will be NOx, SO2, and CO.

In principle, EEA requests annual emission totals per country, but highlights the need for improved model input datasets. As such it requests emission at a 10x10 Km resolution. The

spatial resolution aimed for is the resolution of the MACC emission database. The 0.125*0.0625 degree lon-lat resolution is about 7x7 Km, fulfilling the need throughout the European domain. As this database is used throughout Europe, the adaptation of this dataset within the project ensures an easy implementation outside the project. Moreover, we will deliver the complete emission dataset including all other air pollutants (e.g. PMx, NMVOC). Also, EEA mentions the need of improved temporal factors. This issue will be addressed and it is planned that the existing temporal factors will be tested and when possible improved.

Besides the emission database also the temporal profiles will be delivered per country and SNAP sector.

Table.12 Product Specifications for European emissions of NOx

	Specification
Used satellite instruments	OMI, GOME-2
Region coverage	Europe
Time period	2009, 2010
Accuracy	Better than 50%
Spatial grid	0.125*0.0625 degree lon-lat
Temporal frequency	Annual
Data format	NetCDF

3.4 Aerosol products

Two aerosol-related datasets will be produced: the emission estimates based on inverse modeling and background emission inventories for total aerosol emission, and the fire emission product based on satellite measurements of active-fire radiative power.

Most users have emphasized the need for spatially resolving emission data with monthly or better temporal resolution. In the case of the total aerosol emission product, the spatial resolution is equal to the model resolution of 0.2 to 0.4 degrees depending on the domain size. Further downscaling will be necessary to provide the 1 km resolution requested by SEC. The daily emission adjustments can be aggregated to monthly level for better robustness, and also to the yearly national totals as required EEA for the verification of emission inventories.

The fire emission product is produced globally on daily temporal resolution. The emission estimates will be produced daily for modeling purposes. However, also retrospective analyses, as requested by VU Univ. of Amsterdam are feasible to the extent covered by the satellite data. Resolution of the global retrospective dataset will be 0.5 degree to achieve higher stability of the emission over time.

Table.13 Product Specifications for FMI Fire emission product.

	Specification
Used satellite instruments	MODIS, SEVIRI
Region coverage	Global
Time period	2008 – present
Accuracy	40% (to be confirmed at evaluation stage)
Spatial grid	0.5° x 0.5°
Temporal frequency	daily plus fixed hourly time variation coefficients
Data format	NetCDF, ascii

Table 14. Product Specifications for FMI Aerosol emission product.

	Specification
Used satellite instruments	AATSR, MODIS,
Region coverage	Europe, Asia, Africa south of the equator,
Time period	2011 – present
Accuracy	40% (to be confirmed at evaluation stage)
Spatial grid	0.4° x 0.4° for the Asian domain, 0.2° x 0.2° for Europe, 0.3° x 0.3° for the others
Temporal frequency	monthly
Data format	NetCDF

4 Data structure

In tables 15-20 the foreseen data structures of the GlobEmission emission inventories are presented. In principle, the meta data description as well as the variables describe the data set in it full extend. The meta data have been harmonised among the partners and include the data origin, comments, and all emission category and domain descriptors. As such the foreseen data products will be compliant with GEOSS recommendations ensuring easy access to the data.

4.1 Global products

Table.15 Data structure for NMVOCs and glyoxal.

Attribute	Meta Data Description
X1: author	name of creator
X2: Institution	name of institute
X3: Comment	general remarks
X4: date	Time period of emission inventory
X5: Emission_category_convention	convention description
X6: grid_westb	west bound of regular grid
X7: grid_westb_unit	units of west bound of regular grid
X8: grid_eastb	east bound of regular grid
X9: grid_eastb_unit	units of east bound of regular grid
X10: grid_lon_res	longitudinal resolution of regular grid
X11: grid_lon_res_unit	units of longitudinal resolution of regular grid
X12: grid_dlon	longitudinal spacing of regular grid
X13: grid_dlon_unit	units of longitudinal spacing of regular grid
X14: grid_nlon	number of longitude cells in regular grid
X15: grid_south	south bound of regular grid
X16: grid_southb_unit	units of south bound of regular grid
X17: grid_northb	north bound of regular grid
X18: grid_northb_unit	units of north bound of regular grid

X19: grid_lat_res	latitudinal resolution of regular grid
X20: grid_lat_res_unit	units of latitudinal resolution of regular grid
X21: grid_dlat	latitudinal spacing of regular grid
X22: grid_dlat_unit	units of latitudinal spacing of regular grid
X23: grid_nlat	number of latitude cells in regular grid
Variable	**Description + unit**
V1: emis_cat_name	emission category name [character string] NMVOC's
V2: grid_area	cell area in regular grid [m2]
V3: longitude	longitude centers [degrees_east]
V4: latitude	latitude centers [degrees_north]
V5: nmvoc_ant	anthropogenic non-methane volatile organic carbon emission [kg/year]
V6: nmvoc_bur	biomass-burning non-methane volatile organic carbon emission [kg/year]
V7: nmvoc_bio	Isoprene emission [kg/year]
V8: glyoxal_primary	Glyoxal total primary source [kg/year]
V9: glyoxal_missingbio	Glyoxal missing biogenic source [kg/year]
Flags	**Definition**
-	

4.2 Regional products (China, India, South Africa, Middle East)

Table.16 Data structure for regional emission inventories China, India, South Africa, Middle East.

Attribute	Meta Data Description
X1: author	name of creator
X2: Institution	name of institute
X3: Comment	general remarks

X4: date	Time period of emission inventory
X5: Emission_category_convention	convention description
X6: grid_westb	west bound of regular grid
X7: grid_westb_unit	units of west bound of regular grid
X8: grid_eastb	east bound of regular grid
X9: grid_eastb_unit	units of east bound of regular grid
X10: grid_lon_res	longitudinal resolution of regular grid
X11: grid_lon_res_unit	units of longitudinal resolution of regular grid
X12: grid_dlon	longitudinal spacing of regular grid
X13: grid_dlon_unit	units of longitudinal spacing of regular grid
X14: grid_nlon	number of longitude cells in regular grid
X15: grid_south	south bound of regular grid
X16: grid_southb_unit	units of south bound of regular grid
X17: grid_northb	north bound of regular grid
X18: grid_northb_unit	units of north bound of regular grid
X19: grid_lat_res	latitudinal resolution of regular grid
X20: grid_lat_res_unit	units of latitudinal resolution of regular grid
X21: grid_dlat	latitudinal spacing of regular grid
X22: grid_dlat_unit	units of latitudinal spacing of regular grid
X23: grid_nlat	number of latitude cells in regular grid
Variable	**Description + unit**
V1: emis_cat_code	emission category codes
V2: emis_cat_description	emission category description [character string]
V3: grid_longitude	cell longitudes in regular grid (cell centers) [degrees_east]
V4: grid_latitude	cell latitudes in regular grid (cell centers) [degrees_north]
V5: grid_area	cell area in regular grid [m2]
V7: NOx	nitrogen-oxides emission from source [1e15 molecules/cm2/h]

V8: NOx_alt	nitrogen-oxides emission from source [Gg N/cell/yr]
Flags	**Definition**
-	

4.2.1 Regional products: South Africa

Table.17 Data structure for downscaled regional NO_2 emissions for South Africa

Attribute	Meta Data Description
X1: author	name of creator
X2: Institution	name of institute
X3: Comment	general remarks
X4: date	Time period of emission inventory
X5: Emission_category_convention	convention description
X6: grid_westb	west bound of regular grid
X7: grid_westb_unit	units of west bound of regular grid
X8: grid_eastb	east bound of regular grid
X9: grid_eastb_unit	units of east bound of regular grid
X10: grid_lon_res	longitudinal resolution of regular grid
X11: grid_lon_res_unit	units of longitudinal resolution of regular grid
X12: grid_dlon	longitudinal spacing of regular grid
X13: grid_dlon_unit	units of longitudinal spacing of regular grid
X14: grid_nlon	number of longitude cells in regular grid
X15: grid_south	south bound of regular grid
X16: grid_southb_unit	units of south bound of regular grid
X17: grid_northb	north bound of regular grid
X18: grid_northb_unit	units of north bound of regular grid
X19: grid_lat_res	latitudinal resolution of regular grid

X20: grid_lat_res_unit	units of latitudinal resolution of regular grid
X21: grid_dlat	latitudinal spacing of regular grid
X22: grid_dlat_unit	units of latitudinal spacing of regular grid
X23: grid_nlat	number of latitude cells in regular grid
Variable	**Description + unit**
V1: emis_cat_code	emission category codes as used in E-MAP model
V2: emis_cat_description	emission category description [character string]
V3: source_type	source type: 'p' for point source, 'a' for area source
V4: source_type_name	source type name [character string]
V5: grid_longitude	cell longitudes in regular grid (cell centers) [degrees_east]
V6: grid_latitude	cell latitudes in regular grid (cell centers) [degrees_north]
V7: pointsource_longitude	longitude of point source [degrees_east]
V8: pointsource_latitude	latitude of point source [degrees_north]
V9: effective heat capacity	heat capacity of source [MW]
V10: effective_height	injection height of source [m]
V11: nox	nitrogen-oxides emission from source [kg/year]
Flags	**Definition**
-	

4.3 European products

Table.18 Data structure for TNO anthropogenic emission file.

Attribute	Meta Data Description
X1: author	name of creator
X2: Institution	name of institute
X3: Comment	general remarks

X4: date	Time period of emission inventory
X6: grid_westb	west bound of regular grid
X7: grid_westb_unit	units of west bound of regular grid
X8: grid_eastb	east bound of regular grid
X9: grid_eastb_unit	units of east bound of regular grid
X10: grid_lon_res	longitudinal resolution of regular grid
X11: grid_lon_res_unit	units of longitudinal resolution of regular grid
X12: grid_dlon	longitudinal spacing of regular grid
X13: grid_dlon_unit	units of longitudinal spacing of regular grid
X14: grid_nlon	number of longitude cells in regular grid
X15: grid_south	south bound of regular grid
X16: grid_southb_unit	units of south bound of regular grid
X17: grid_northb	north bound of regular grid
X18: grid_northb_unit	units of north bound of regular grid
X19: grid_lat_res	latitudinal resolution of regular grid
X20: grid_lat_res_unit	units of latitudinal resolution of regular grid
X21: grid_dlat	latitudinal spacing of regular grid
X22: grid_dlat_unit	units of latitudinal spacing of regular grid
X23: grid_nlat	number of latitude cells in regular grid
Variable	**Description + unit**
V1: country_id	country codes [ISO3 character string]
V2: country_name	country name [character string]
V8: grid_longitude	cell longitudes in regular grid (cell centers) [degrees_east]
V9: grid_latitude	cell latitudes in regular grid (cell centers) [degrees_north]
V10: grid_b_longitude	cell boundary longitudes in regular grid [degrees_east]
V11: grid_b_latitude	cell boundary latitudes in regular grid [degrees_north]
V12: grid_longitude_borders	cell boundary longitudes in regular grid [degrees_east]

V13: grid_latitude_borders	cell boundary latitudes in regular grid [degrees_north]
V14: grid_area	cell area in regular grid [m2]
V15: longitude	longitude of source [degrees_east]
V16: latitude	latitude of source [degrees_north]
V17: longitude_index	longitude index in regular grid of source
V18: latitude_index	latitude index in regular grid of source
V19: country_index	index in country array of source
V20: emission_category_index	index in category array of source
V21: emission_category_le_snap	emission category code as used in L.E. model of source
V22: emission_category_snap1	emission category following SNAP1 of source
V23: source_type_index	index in source type array of source
V24: effective_height	injection height of source [m]
V25: ch4	methane emission from source [kg/year]
V26: co	carbon-monoxide emission from source [kg/year]
V27: nh3	ammonia emission from source [kg/year]
V27: nmvoc	non-methane volatile organic carbon emission from source [kg/year]
V28: nox	nitrogen-oxides emission from source [kg/year]
V29: pm10	particulate matter 0-10um diameter emission from source [kg/year]
V30: pm2_5	particulate matter 0-2.5um diameter emission from source [kg/year]
V31: so2	sulphur dioxide emission from source [kg/year]
Flags	**Definition**
-	

4.4 Aerosol products

Table.19 Data structure for the FMI aerosol emission product

Attribute	Meta Data Description
X1: author	name of creator
X2: Institution	name of institute
X3: Comment	general remarks
X4: date	Time period of emission inventory
X6: grid_westb	west bound of regular grid
X7: grid_westb_unit	units of west bound of regular grid
X8: grid_eastb	east bound of regular grid
X9: grid_eastb_unit	units of east bound of regular grid
X10: grid_lon_res	longitudinal resolution of regular grid
X11: grid_lon_res_unit	units of longitudinal resolution of regular grid
X12: grid_dlon	longitudinal spacing of regular grid
X13: grid_dlon_unit	units of longitudinal spacing of regular grid
X14: grid_nlon	number of longitude cells in regular grid
X15: grid_south	south bound of regular grid
X16: grid_southb_unit	units of south bound of regular grid
X17: grid_northb	north bound of regular grid
X18: grid_northb_unit	units of north bound of regular grid
X19: grid_lat_res	latitudinal resolution of regular grid
X20: grid_lat_res_unit	units of latitudinal resolution of regular grid
X21: grid_dlat	latitudinal spacing of regular grid
X22: grid_dlat_unit	units of latitudinal spacing of regular grid
X23: grid_nlat	number of latitude cells in regular grid

Variable	Description + unit
V1: emis_cat_code	emission category codes
V2: emis_cat_description	emission category description [character string]
V3: grid_longitude	cell longitudes in regular grid (cell centers) [degrees_east]
V4: grid_latitude	cell latitudes in regular grid (cell centers) [degrees_north]
V5: _5% height	injection 5% height of source [m]
V6: 50% height	injection 50% height of source [m]
V7: 80% height	injection 80% height of source [m]
V8: top height	injection top height of source [m]
V9: pm10	particulate matter 0-10um diameter emission from source [kg/sec]
V10: pm2_5	particulate matter 0-2.5um diameter emission from source [kg/sec]
Flags	**Definition**
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Table.20 Data structure for the FMI fire emission product

Attribute	Meta Data Description
X1: author	name of creator
X2: Institution	name of institute
X3: Comment	general remarks
X4: date	Time period of emission inventory
X5: Emission_category_convention	convention description
X6: grid_westb	west bound of regular grid
X7: grid_westb_unit	units of west bound of regular grid
X8: grid_eastb	east bound of regular grid
X9: grid_eastb_unit	units of east bound of regular grid
X10: grid_lon_res	longitudinal resolution of regular grid

X11: grid_lon_res_unit	units of longitudinal resolution of regular grid
X12: grid_dlon	longitudinal spacing of regular grid
X13: grid_dlon_unit	units of longitudinal spacing of regular grid
X14: grid_nlon	number of longitude cells in regular grid
X15: grid_south	south bound of regular grid
X16: grid_southb_unit	units of south bound of regular grid
X17: grid_northb	north bound of regular grid
X18: grid_northb_unit	units of north bound of regular grid
X19: grid_lat_res	latitudinal resolution of regular grid
X20: grid_lat_res_unit	units of latitudinal resolution of regular grid
X21: grid_dlat	latitudinal spacing of regular grid
X22: grid_dlat_unit	units of latitudinal spacing of regular grid
X23: grid_nlat	number of latitude cells in regular grid
Variable	**Description + unit**
V1: grid_longitude	cell longitudes in regular grid (cell centers) [degrees_east]
V2: grid_latitude	cell latitudes in regular grid (cell centers) [degrees_north]
V3: _5% height	injection 5% height of source [m]
V4: 50% height	injection 50% height of source [m]
V5: 80% height	injection 80% height of source [m]
V6: top height	injection top height of source [m]
V7: pm10	particulate matter 0-10um diameter emission from source [kg/sec]
V8: pm2_5	particulate matter 0-2.5um diameter emission from source [kg/sec]
V9: NO2	emission from source, nitrogen dioxide [kg/sec]
V10: SO2	emission from source, sulphur dioxide [kg/sec]
V11: CO	emission from source, carbon monoxide [kg/sec]
V12: NH3	emission from source, ammonia [kg/sec]

Flags	Definition
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