

GloBAM Data Management Plan

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Colophon

Distributions of this data management plan:

- Latest version (website): <https://enram.github.io/globam-dmp/>
- Latest version (pdf): <https://enram.github.io/globam-dmp/globam-dmp.pdf>
- Latest version (source files): <https://github.com/enram/globam-dmp>
- Periodically archived version (pdf): *to be deposited on Zenodo.org*

Suggested citation for the latest version:

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<https://enram.github.io/globam-dmp/>

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1 Introduction

1.1 Research purpose

Migratory animals play significant roles in shaping ecosystems through a variety of transport and trophic effects that also represent services and disservices to human infrastructure, agriculture and welfare. Their aerial and terrestrial habitats have changed dramatically over the past decades and are expected to change further, particularly due to rapid climate change, increased urbanization, wind energy installations, and habitat fragmentation.

Within *GloBAM: Towards monitoring, understanding and forecasting global biomass flows of aerial migrants*, we aim to use weather radar data to quantify the biomass flows of aerial migrants (birds, insects and bats) from regional to continental scales across Europe and North America, over time-scales from days to years. We are particularly interested in identifying the drivers of migrant movements and abundances and will relate the timing and intensity of movements to a suite of atmospheric, climatic and landscape variables, exploring the implications for aerial migrants in a changing world.

For more information on GloBAM, see the project website.

1.2 Data manager

Peter Desmet is responsible for data management and DMP maintenance in GloBAM. He is also leading *WP1 - Data infrastructure*. Peter works as open data coordinator for the Open science lab for biodiversity at the Research Institute for Nature and Forest (INBO). He and his team have extensive expertise and experience with data management and open data publication meeting FAIR principles.

1.3 How this DMP is maintained

1. This DMP is maintained and versioned on GitHub at <https://github.com/enram/globam-dmp/>.
2. Each chapter is an R Markdown file (`Rmd`) in the `src` directory of that GitHub repository. You can access it directly by clicking the pencil icon in the top navigation of the website version of this DMP.
3. Changes to the R Markdown files can be made by contributors to the GitHub repository or suggested by anyone as pull requests. Textual changes can be done directly on GitHub, code changes are better tested in RStudio first.
4. Accepted changes (i.e. changes to the `master` branch) will trigger an automatic build procedure that will generate a new version of the DMP using the R package bookdown. The date of the build is used as the version number.

Source data

2 European radar data (pvol)

This chapter describes polar volume (`pvol`) data from European weather radars. It is one the main data sources for GloBAM.

2.1 Source

European `pvol` data are collected by weather radars from **national weather services** in Europe. They have different approaches in processing, archiving and providing access to `pvol` data (from restricted access to

open data). Even though some GloBAM partners (e.g. the University of Amsterdam) have archived subsets of these data for research use, the scattered scope and access to European `pvol` data is a serious barrier to GloBAM, which ideally requires access to all European `pvol` data using the same protocol.

The best source for consolidated `pvol` data is therefore **BALTRAD**, managed by SMHI (contact person: Günther Haase). `pvol` data are archived there, but access to that server is restricted to SMHI. See 5.1 for details on how `pvol` data are submitted to this archive.

The rest of this chapter discusses the specifics of the BALTRAD archive.

2.2 License

European radar data exchange is coordinated by the *European Operational Program for Exchange of Weather Radar Information (EUMETNET/OPERA)*. GloBAM has access to these data via the *EIG EUMETNET license agreement for Research use of OPERA data*, which grants a specific list of people (involved in ENRAM and GloBAM) access to radar data from selected countries under the following conditions (excerpt):

The Licensor grants the Licensees a non-Exclusive license to use intellectual property belonging to the EUMETNET members as defined below [...]

The OPERA Members Data will be provided for use within the ENRAM Project for the purpose of extracting animal migration information for scientific research.

The Grant of this License does not permit use of the OPERA Members Data licensed to be used for commercial purposes or exploitation for profit.

The license agreement allows us to access European `pvol` data for the sole purpose of extracting animal migration information for scientific research, which is what GloBAM intends to do. Storing, sharing or other use of these data is **restricted** and requires prior written consent of the Licensor.

2.3 Geographical scope

OPERA manages a list of radars, their unique codes (e.g. `odimcode`) and associated metadata. The list currently contains 232 radars. This **OPERA database** is available as an interactive map derived from a `json` file containing the metadata. To keep track of changes, we archive this `json` on GitHub every time we update the DMP.

The license agreement allows access to data from 20 countries:

##	country	iso_code	radars	operational
##	Austria	AT	5	5
##	Belgium	BE	4	4
##	Croatia	HR	3	3
##	Denmark	DK	5	5
##	Estonia	EE	2	2
##	Finland	FI	11	10
##	France	FR	31	25
##	Germany	DE	20	19
##	Israel	IL	1	1
##	Netherlands	NL	3	2
##	Norway	NO	11	11
##	Poland	PL	8	8
##	Portugal	PT	4	3
##	Slovakia	SK	4	4
##	Slovenia	SI	2	2
##	Spain	ES	15	15

##	Sweden	SE	12	12
##	Switzerland	CH	5	5
##	United Kingdom	GB	16	16
##	Total	-	162	152

The BALTRAD archive does not contain `pvol` data for all of these radars/countries however (see 5.1). Its precise geographical scope is currently **unknown**, but being gathered.

2.4 Temporal scope

The temporal scope of the BALTRAD archive is currently **unknown**, but being gathered. GloBAM needs a **2-3 year archive** of European `pvol` and derived `vp` data to tackle its research questions. By starting from a `pvol` archive, the generation of `vp` data can be reproduced if need be, e.g. to make sure adequate `vol2bird` settings/versions are used.

The `pvol` archive at BALTRAD is likely to be the best source for this archive, but its scope and quality need to be assessed before we can proceed, see 2.7.

2.5 Format

The delivery of European `pvol` data is defined in the license agreement:

The Licensor will make the OPERA Members Data available to the Licensees in accordance to the following data description and technical specifications:

- a. Single-site polar volumes containing reflectivity, optionally also Doppler velocity, uncorrected reflectivity and dual-pol parameters. Data model ODIM as described in OPERA pages of the EUMETNET website (<http://www.eumetnet.eu>)
- b. Update frequency – 15 minutes
- c. Issue time – up to 120 minutes after data time
- d. Format: HDF5
- e. Delivery method: FTP via Internet using an ad hoc server. A username and password will be created for ENRAM.
- f. Availability of OPERA Members Data will be on the basis of reasonable endeavour
- g. Support: OPERA documents are available from the EUMETNET website’s OPERA pages (<http://www.eumetnet.eu>). OPERA Program Manager will manage technical questions related to the OPERA Products but may address more complicated issues to a team member who may charge a fee.

Data is thus provided for every 15 minutes as `hdf5` in the OPERA ODIM_h5 format. These files can be read in `bioRad` with `read_pvolfile()`.

2.6 File name conventions

File names are generally of the format `bejab_pvol_20190620T055500Z_0x9.h5`, where:

- `be`: two-letter code (ISO 3166-1 alpha-2)
- `jab`: three-letter code (last 3 letters from the ODIM code, see 2.3)
- `_pvol_`: indication that this is a `pvol` data file
- `20190620`: date in `yyyymmdd` format
- `T055500Z`: time in `hhmmss` format + timezone (Z for UTC time)
- `_0x9`: suffix (to be ignored)

2.7 Quality assurance

The scope and quality of the BALTRAD archive were assessed in an April 2020 workshop, the results of which can be found in this wiki. The conclusion is the collecting good data through BALTRAD going forward might be challenging because of filtering in some countries (e.g. France and Germany), while it is a good source for historic polar volumes between 2012-2018.

2.8 Storage & backup

European `pvol` data are stored on the BALTRAD archive, managed and financed by SMHI. The archive is a restricted FTP server, only accessible to SMHI (see 5.1).

3 US radar data (`pvol`)

This chapter describes polar volume (`pvol`) data from weather radars in the United States. It is one the main data sources for GloBAM.

3.1 Source

US `pvol` data are collected by the National Oceanic and Atmospheric Administration (NOAA), which operates a network of approximately 160 Next Generation Weather Radar (NEXRAD), WSR-88D sites in the US and associated territories. Archived polar volumes (`pvol`s) (called “level II data” in the US) are stored on various services:

1. Amazon S3, see NEXRAD on AWS. Archived data are hosted in the `noaa-nexrad-level2` Amazon S3 bucket in the `us-east-1` AWS region. These data are made available 10-20 minutes lag relative to real-time. There is also a real-time data stream, for which scans have not been merged yet into polar volumes.
2. Google Cloud.

3.2 License

There are no restrictions on the use of these data.

3.3 Geographical scope

The NEXRAD network covers continental US, Alaska, Hawaii, Guam, South Korea and Puerto Rico. Sites in use vary slightly over time, see [here](#) for more information, [maps here](#).

3.4 Temporal scope

The archive spans from June 1991 to present. However, during this time significant changes have been made. A resolution increase was implemented in 2008-2009 (so-called superresolution data). Dual polarization capabilities were added in 2010-2013.

NEXRAD Coverage Below 10,000 Feet AGL

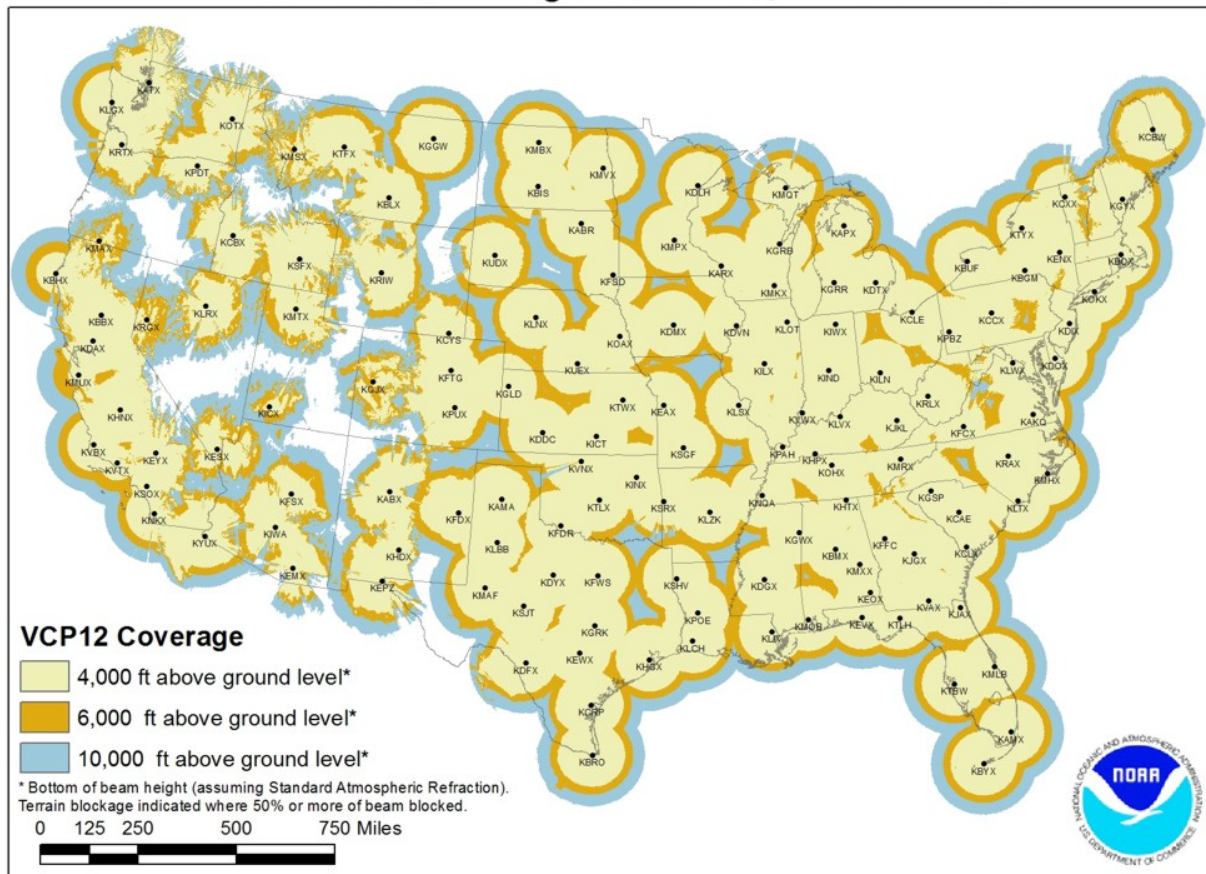


Figure 1: NEXRAD radar network in the lower 48 states

3.5 Format

See this page for available decoding tools of the radar format. US pvol data can be read in bioRad with `read_pvolfile()`.

3.6 File name conventions

From the AWS open data project documentation for archive data:

Each volume scan file of archival data is available as an object in Amazon S3. The basic data format is:

`/<Year>/<Month>/<Day>/<NEXRAD Station>/<filename>`

Where:

- `<Year>` is the year the data was collected
- `<Month>` is the month of the year the data was collected
- `<Day>` is the day of the month the data was collected
- `<NEXRAD Station>` is the NEXRAD ground station (map of ground stations)
- `<filename>` is the name of the file containing the data. These are compressed files (compressed with gzip). The file name has more precise timestamp information.

All files in the archive use the same compressed format (.gz). The data file names are, for example, `KAKQ20010101_080138.gz`. The file naming convention is:

`GGGGYYYYMMDD_TTTTTT`

Where:

- `GGGG` = Ground station ID (map of ground stations)
- `YYYY` = year
- `MM` = month
- `DD` = day
- `TTTTTT` = time when data started to be collected (GMT)

Note that the 2015 files have an additional field on the file name. It adds “_V06” to the end of the file name. An example is `KABX20150303_001050_V06.gz`.

3.7 Quality assurance

Unknown.

3.8 Storage & backup

US pvol data are stored on AWS and other cloud services, see 3.1.

4 Other external data

This chapter describes other external data sources required by GloBAM.

4.1 Wind/weather data

4.1.1 Users

Needed for at least WP3, WP4, WP5 and maybe WP2. The type of weather data (wind, precipitation) will differ between analyses.

4.1.2 Sources

- World: to be defined
- US: NCEP/NCAR Reanalysis data from NOAA has been used before.
- Europe: to be defined, see <https://github.com/enram/globam-dmp/issues/21>

4.2 Land use

To be defined, see <https://github.com/enram/globam-dmp/issues/25>

4.3 Artificial light

4.3.1 Users

Needed for WP3.

4.3.2 Sources

Visible Infrared Imaging Radiometer Suite (VIIRS) Day/Night Band provided by NOAA. See that page for a description, filenaming conventions, data types/formats and providing credit.

We may also use the new Black Marble product from NASA (not yet released).

4.4 Wind energy installations

4.4.1 Users

Needed for WP4 (Judy Shamoun-Baranes).

4.4.2 Sources

Depends on the exact research questions and what is available. Will be updated in DMP once known.

Produced data

5 Processing pipeline

This chapter describes the processing pipeline from `pvol` over `vp` to `vpts` data.

5.1 European pvol

BALTRAD collects `pvol` data for Europe. For `pvol` data to be available in BALTRAD, several conditions need to be met:

1. A country should send both reflectivity and radial velocity data to the OPERA data centre, which is called ODYSSEY. While many countries are sending reflectivity data, radial velocities are still unavailable for many countries.
2. ODYSSEY should forward these data to the BALTRAD datahub. It is standard policy to do so, but in practice data is not yet forwarded correctly for some radars/countries.
3. Currently BALTRAD and ODYSSEY store data at a 15 minute interval, higher resolution data is not yet available.

5.2 European pvol to vp

A server at BALTRAD processes any incoming `pvol` data with `vol2bird`. This pipeline is maintained by Günther Haase (SMHI).

The resulting `vp` files are stored for 2 days on a private FTP server to which we have access. The used `vol2bird` version is stored in the metadata of the `vp` files and can differ over time. The latest files are created with `vol2bird 0.3.20` (last tested April 11, 2019).

5.3 vp archiving

European `vp` data are archived daily by a pipeline running on Amazon Web Services (AWS) which transfers `vp` files from the BALTRAD FTP server to a public S3 bucket. This pipeline is maintained by the Open science lab for biodiversity and its code and documentation are available in this repository. Note that any issues in the pipeline that are not resolved within 2 days (the time `vp` data are kept on the FTP server) **can result in data loss**.

The pipeline also updates a coverage file and bundles `vp` files in monthly zips per radar (e.g. `bejab201904.zip`). A public website allows easier file navigation of the S3 bucket.

United States `vp` data are currently not archived. See <https://github.com/enram/globam-dmp/issues/19>

5.4 vp to vpts

Not yet defined, but likely to be part of the ENRAM pipeline (see 5.3).

6 Vertical profiles of aerial migrants data (vp)

This chapter describes vertical profiles of aerial migrants/biological signals (`vp`) data for Europe and the United States. Vertical profiles contain the speed, direction and density of aerial migrants at different altitudes for a specific radar location and time, and form the source data for GloBAM specifically and aeroecological research in general.

6.1 Source

European `vp` data are generated daily from `pvol` data on the BALTRAD server (see 5.2) and then transferred to the public ENRAM data repository (see ??). **United States** `vp` data are being generated for the 25 year `pvol` archive, but not yet publicly archived.

vp files can be downloaded from the ENRAM data repository individually, as monthly zips, or automatically in bioRad with `download_vpfiles()`.

6.2 License

Data in the ENRAM data repository are available as **open data** under a Creative Commons Zero waiver.

For the **European data** it is recommended to acknowledge EUMETNET/OPERA in publications resulting from the use of these data as follows:

We acknowledge the European Operational Program for Exchange of Weather Radar Information (EUMETNET/OPERA) for providing access to European radar data, facilitated through a research-only license agreement between EUMETNET/OPERA members and ENRAM.

6.3 Geographical scope

The coverage of the ENRAM data repository is recorded daily in `coverage.csv` and summarized here:

##	radar	2016	2017	2018	2019	2020	Total
##	bejab	21	NA	194	312	155	682
##	bewid	19	12	205	310	112	658
##	bezav	21	NA	NA	NA	NA	21
##	bgvar	21	NA	NA	NA	NA	21
##	chalb	NA	NA	NA	77	155	232
##	chdol	NA	NA	NA	76	155	231
##	chlem	NA	NA	NA	77	153	230
##	chppm	NA	NA	NA	76	155	231
##	chwei	NA	NA	NA	77	155	232
##	ctcdv	21	NA	NA	NA	NA	21
##	ctpda	21	NA	NA	NA	NA	21
##	czbrd	21	NA	286	311	155	773
##	czska	21	NA	286	313	155	775
##	deasb	NA	NA	221	170	155	546
##	deboo	31	17	305	165	155	673
##	dedrs	31	21	304	170	155	681
##	deeis	31	21	304	170	155	681
##	deemd	NA	20	49	NA	NA	69
##	deess	31	21	304	170	155	681
##	defbg	31	NA	NA	77	155	263
##	defld	31	21	303	169	133	657
##	deflg	NA	21	49	NA	NA	70
##	dehnr	31	21	304	170	151	677
##	deisn	31	NA	NA	77	153	261
##	demem	31	21	301	170	155	678
##	deneu	31	21	301	170	155	678
##	denhb	31	21	300	167	153	672
##	deoft	31	21	304	170	154	680
##	depro	31	21	302	170	155	679
##	deros	25	21	294	170	154	664
##	desna	NA	21	303	93	NA	417
##	detur	29	21	303	170	155	678
##	deumd	31	21	304	170	155	681
##	dkbor	NA	34	85	314	155	588
##	dkrom	NA	38	85	314	153	590

##	dksin	NA	38	85	315	155	593
##	dkste	NA	38	85	314	155	592
##	dkvir	NA	27	85	315	155	582
##	eehar	NA	20	35	78	155	288
##	eesur	NA	20	35	77	142	274
##	esalm	NA	38	287	255	155	735
##	esbad	NA	38	302	255	155	750
##	esbar	NA	38	303	255	152	748
##	escor	NA	38	287	255	154	734
##	eslid	NA	38	303	255	147	743
##	eslpa	NA	NA	14	5	NA	19
##	esmad	NA	38	301	252	155	746
##	esmal	NA	38	303	255	153	749
##	esmur	NA	38	302	252	141	733
##	espma	NA	38	303	249	153	743
##	essan	NA	38	302	252	155	747
##	essev	NA	36	300	248	155	739
##	essse	NA	38	303	248	99	688
##	esval	NA	38	294	254	155	741
##	eszar	NA	38	303	251	155	747
##	fianj	22	154	38	77	155	446
##	fiika	22	153	39	77	155	446
##	fikes	22	151	38	75	155	441
##	fikor	22	146	38	77	155	438
##	fikuo	22	156	38	77	155	448
##	filuo	22	153	38	77	155	445
##	finur	NA	NA	NA	NA	18	18
##	fipet	22	99	NA	77	155	353
##	fiuta	22	157	38	77	155	449
##	fivan	22	157	39	77	155	450
##	fivim	22	132	34	77	155	420
##	frabb	21	38	320	298	155	832
##	fraja	NA	NA	NA	83	155	238
##	frale	21	26	321	296	155	819
##	frave	21	NA	283	315	135	754
##	frbla	21	38	321	306	155	841
##	frbol	21	38	279	210	121	669
##	frbor	21	36	321	315	155	848
##	frbou	21	38	173	312	155	699
##	frcae	21	38	320	312	154	845
##	frche	21	38	317	305	155	836
##	frcol	21	38	312	313	155	839
##	frgre	21	38	320	310	154	843
##	frlep	21	38	320	301	155	835
##	frmcl	21	38	304	313	147	823
##	frmom	21	38	320	315	155	849
##	frmtc	21	35	302	248	133	739
##	frnan	21	38	317	314	155	845
##	frnim	21	38	320	315	155	849
##	frniz	21	NA	281	315	155	772
##	fropo	21	38	241	107	155	562
##	frpla	21	38	315	315	155	844
##	frtou	21	37	305	312	154	829
##	frtra	21	38	320	313	154	846

##	frtre	6	38	316	315	154	829
##	frtro	21	NA	282	314	149	766
##	hrbil	NA	38	35	77	151	301
##	hrosi	NA	38	35	77	149	299
##	hrzag	NA	NA	NA	72	98	170
##	nldbl	22	4	NA	NA	NA	26
##	nldhl	21	125	295	313	154	908
##	nlhrw	NA	21	294	314	155	784
##	noand	NA	NA	NA	NA	143	143
##	nober	NA	NA	NA	NA	155	155
##	nobml	NA	NA	NA	NA	155	155
##	nohas	NA	NA	NA	NA	155	155
##	nohfj	NA	NA	NA	NA	4	4
##	nohgb	NA	NA	NA	NA	153	153
##	nohur	NA	NA	NA	NA	155	155
##	norsa	NA	NA	NA	NA	150	150
##	norst	NA	NA	NA	NA	148	148
##	nosmn	NA	NA	NA	NA	107	107
##	nosta	NA	NA	NA	NA	152	152
##	plbrz	21	3	261	313	155	753
##	plgda	21	3	261	312	155	752
##	plleg	21	3	259	313	155	751
##	plpas	NA	3	259	313	155	730
##	plpoz	21	3	260	313	155	752
##	plram	21	3	260	313	155	752
##	plrze	21	3	222	314	155	715
##	plswi	21	3	260	313	155	752
##	ptfar	119	NA	NA	129	155	403
##	ptlis	NA	NA	NA	72	36	108
##	ptliz	122	NA	NA	NA	NA	122
##	ptprt	113	NA	NA	186	40	339
##	seang	21	137	310	258	152	878
##	searl	21	153	318	123	NA	615
##	sease	21	16	NA	NA	NA	37
##	seatv	NA	NA	NA	150	155	305
##	sebaa	NA	NA	NA	97	155	252
##	sehem	NA	43	314	304	148	809
##	sehud	21	NA	NA	NA	NA	21
##	sehuv	NA	36	295	305	154	790
##	sekaa	NA	NA	NA	209	155	364
##	sekir	21	144	318	315	155	953
##	sekkrr	21	157	171	NA	NA	349
##	selek	21	118	208	299	149	795
##	sella	NA	NA	NA	208	154	362
##	selul	21	148	183	NA	NA	352
##	seoer	NA	36	307	305	152	800
##	seosd	NA	142	311	302	130	885
##	seosu	13	NA	NA	NA	NA	13
##	seovi	21	59	NA	NA	NA	80
##	sevar	21	NA	NA	NA	NA	21
##	sevox	NA	133	312	284	154	883
##	sevil	21	153	318	29	NA	521
##	silis	21	35	304	300	152	812
##	sipas	21	35	311	271	154	792

##	skjav	NA	38	301	314	155	808
##	skkoj	NA	38	301	307	155	801
##	skkub	NA	NA	280	313	150	743
##	sklaz	NA	NA	280	312	155	747

6.4 Temporal scope

Data transfer to the ENRAM data repository become more or less operational in March 2018 (with a gap in July 2018). Data from 2016 were uploaded for the European flyway study Nilsson et al. 2019.

6.5 Format

A `vp` file is generated for each originating `pvo1` file and thus has the same granularity. `vp` data are stored as `hdf5` files in the ODIM bird profile format specification. These files can be read in `bioRad` with `read_vpfiles()`.

6.6 File name conventions

File names follow the same format as `pvo1` files (see 2.5), but with `_vp_` (e.g. `bejab_vp_20190620T055500Z_0x9.h5`). The directory structure of the ENRAM data repository is documented here.

6.7 Quality assurance

To be defined.

6.8 Storage & backup

European `vp` data are stored on AWS (see 5.3). Each file transferred to the S3 bucket is also backed up in a second S3 bucket.

7 Time series of vertical profiles data (`vpts`)

This chapter describes time series of vertical profiles (`vpts`). `vpts` are `vp` data bundled in time series (without data loss) and are a more convenient way for downloading and reading this type of data.

7.1 Source

These files are not yet generated, but will be stored in the ENRAM data repository.

7.2 License

To be defined, but likely as **open data** under a Creative Commons Zero waiver.

7.3 Geographical scope

To be defined, but likely the same as the `vp` data.

7.4 Temporal scope

To be defined, but likely the same as the `vp` data.

7.5 Format

Not yet defined, but likely text format (`txt`, `json`, `csv`) and tabular. See this issue.

7.6 File name conventions

To be defined.

7.7 Quality assurance

To be defined.

7.8 Storage & backup

To be defined, but likely the same as the `vp` data.

Publishing & preservation

8 Open data

This chapter describes how we will publish data of long term value that GloBAM will use and generate.

8.1 Data

The data of long term value that GloBAM will generate are the `vp/vpts` data for Europe and the United States (see the respective chapters).

8.2 Repository

As there is no specific research repository for `vp/vpts` data, we will publish these data on the general research repository Zenodo. This has already been done for Nilsson et al. 2018 and will likely look similar for data published for GloBAM. Data packages published on Zenodo are assigned a Digital Object Identifier (DOI) for easier referencing (both a generic one and one for each updated version).

8.3 License

Data will be published under a Creative Commons Zero waiver.

8.4 Metadata

Data will be documented with metadata describing the contributors, provenance, resolution, temporal and spatial coverage, and how to use these with open source software developed or contributed to by GloBAM.

8.5 Standards

Data will be kept in their source format, i.e. the ODIM bird profile format specification (see 6.5).

8.6 Frequency

Data will be published on Zenodo every two years. Closer to real-time data are already publicly available in the ENRAM data repository.