User manual for the Global EMEP Multi-media Modelling System (GLEMOS)

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1. Basic GLEMOS terms and features

Global modeling framework GLEMOS is a multi-scale multi-pollutant simulation platform developed for operational and research applications within the EMEP programme [*Tarrason and Gusev*, 2008; *Travnikov et al.*, 2009, *Jonson and Travnikov*, 2010, *Travnikov and Jonson*, 2011]. The framework allows simulations of dispersion and cycling of different classes of pollutants (e.g. heavy metals and persistent organic pollutants) in the environment with a flexible choice of the simulation domain (from global to local scale) and spatial resolution. In addition, GLEMOS supports multi-media description of the pollutants cycling in the environment. A modular architecture of the modeling system allows flexible configuration of the model set-up for particular research tasks and pollutant properties. The basic terms and common features of how the model works with which it is best to start getting acquainted with the model are described in this section.

1.1. Pollutant groups definition

The GLEMOS model considers 3 pollutant groups: HM (particle bound heavy metals - Pb, Cd, Cr, Cu, Ni, Zn, As), HG (Mercury - Hg) and POP (persistent organic pollutants - BaP, PCBs, HCB, PBDD/Fs) (substances included to the open-source version are underlined). This classification is based on different physical and chemical properties of the pollutants and different modeling approaches for each group. Thus, some of the configuration and property files that are found in `GLEMOS_Inputs`, relate to the groups, not to single pollutants. Some specific modules of the model in `GLEMOS_Source` are also related to one of these groups (HM, HG, POP).

1.2. Supported horizontal scales and vertical structure

GLEMOS allows application on different geographical scales with various spatial resolutions. The base model grid on a global scale has horizontal resolution 1°×1°. The model grid has variable cell size in the zonal direction next to the poles to avoid extremely small spatial steps (and extra small integration time steps). The standard regional model domain covers the EMEP region (30°N-82°N, 30°W-90°E) with a spatial grid that has a changeable resolution down to 0.1°×0.1°. In addition, a variety of smaller domains can be used for national scale case studies. Parameterization of the horizontal grid is set in the '`Grid_config_YY.dat`' files located in `/GLEMOS_Inputs/Config/` directory (YY – code of the modelling grid, e.g., `EMEP_04x04` or `GLOB_1x1`).

In the vertical the model domain covers the height up to 10 hPa (ca. 30 km). Significant vertical coverage is required for modeling atmospheric dispersion of long-lived substances on a global scale

in order to avoid the need of setting boundary conditions at the upper boundary as well as to take into account possible stratosphere-troposphere exchange. The current vertical structure consists of 20 irregular terrain-following sigma layers. Among them 10 layers cover the lowest 5 km of the troposphere and height of the lowest layer is about 75 m. Parameterization of the vertical structure is set in the '`Atm_config.dat`' file located in `/GLEMOS_Inputs/Config/` directory.

1.3. Field and Matrix calculation modes

There are two types (modes) of the model calculations – 'field' and 'matrix'. The 'matrix' type is used for source apportionment calculations. It means that different emission sources are distinguished. Therefore, the pollution levels from different sources as well as their contribution to total pollution levels are calculated. These sources could be emissions of particular countries, provinces, emission sectors, separate large point sources, secondary sources such as re-emission, wind re-suspension etc. The results of the calculations include so-called source-receptor matrix indicating contribution of emission sources to pollution levels in receptors. The 'field' type means that only total concentrations and deposition are calculated without splitting into particular sources. Switching between 'matrix' and 'field' types is done in the simulation menu table of file `input.GLEMOS.config` in `./GLEMOS_Manager` folder. More information about configuring runs can be found in section 6 of this manual.

The 'matrix' type of the model calculations may require changes in the matrix configuration file `XX_matrix_config_YY.dat` (XX – code of pollutant group, such as HM, HG or POP, and YY – code of the modelling grid, e.g., `EMEP_04x04` or `GLOB_1x1`) and model setup files `RunInfo.dat.spinup` and `RunInfo.dat.main`.

Matrix configuration file (see `./GLEMOS_Inputs/Config/`) contains information about the number of emission sources and their codes. The following parameters are considered:

'`Ant source number:`' - number of anthropogenic sources.

'`Ant sources codes:`' - codes of the anthropogenic sources. Number of the codes must coincide with the number of anthropogenic sources. Number of sources and their codes must correspond to the codes of emission sources in files with anthropogenic emissions. In the example set of input data the sources are emissions of the EMEP countries, e.g., DE – Germany, AT – Austria etc. However, a user can use own set of emission data with own codes.

'`Nut sources number:`' - number of natural sources.

'`Nut sources codes:`' - codes of natural sources.

Here 'natural' mean a large group of secondary sources specific for different groups of pollutants. For Hg 'natural source' is natural emission and re-emission of legacy Hg. Natural emission data of Hg are stored and organized in a similar way as emissions from anthropogenic sources. In case of particulate heavy metals like Pb or Cd it is wind re-suspension from environmental surfaces (bare lands – BRN, urban/built-up areas – URB, arable lands – ARB and water surfaces - WTR). There are no specially

prepared files of Pb or Cd re-suspension. Instead, it is calculated using data of wind suspension of dust and concentrations of the metals in topsoils/urban dust. The same codes are used in files with concentrations of these metals in topsoils and in the matrix configuration file. In the case of POPs, 'natural' means re-emission (re-volatilization) of legacy POPs, which is generated within the model.

'`Bnd sources number:`' - number of sources in boundary concentration files.

'`Bnd sources codes:`' - codes of boundary sources.

In this example version of the model concentrations at the domain borders are not split into different sources. Therefore, the number of boundary sources is equal to 1, and the prescribed code is BND. In a more general case, boundary concentration files may include different sources, e.g., those distinguishing contributions of emissions from different continents to pollution in Europe, or contribution of neighboring countries in country-scale simulations. In this case the number and codes of sources in boundary concentration files (stored in the `./OpenData/BoundCond/`, see section 8 of this manual) must correspond to those in the matrix configuration file.

'`Receptor number:`' - number of receptors ('parts') of the modelling domain for which source apportionment calculations are performed. These could be countries, provinces, areas covered by particular ecosystems, watersheds etc. In the example version of the model the receptors are countries within the EMEP domain if regional-scale calculations are performed, or parts of continents in case of global-scale simulations.

'`Receptor codes:`' - codes of the receptors. These codes must correspond to those in the receptor files (see `./GLEMOIS_Inputs/Receptors/`).

If 'matrix' type of calculation is selected, `GLEMOS.dir.maker` script generates `RunInfo.dat.spinup` and `RunInfo.dat.main` files where section 'Sources and receptors (matrix run)' is added. This section allows setting additional options for source apportionment calculations.

'Ant source mode:' gives the possibility of grouping anthropogenic sources. Option 'all' means that all sources presented in the matrix configuration file will be used in modelling. Option 'none' means that no anthropogenic sources are considered. Option 'selected' allows a user to select some anthropogenic sources from those given in the matrix configuration file. Number of these sources is set to '`Ant source number:`', and codes of these sources are listed in '`Ant source codes:`'. Emissions from other sources will be automatically put to an additional source with code '`RestAnt`'. If '`Ant source mode:`' option is 'all' or 'none', options in '`Ant source number:`' and '`Ant source codes:`' have no effect on model calculations. The same options are applied to natural and boundary sources and to receptors.

'`Initial cond mode:`' indicates how initial concentrations, generated in spinup run, are organized. If option 'single' is set, contributions of all sources in files with initial concentrations are not distinguished and attributed to source codes as 'Init'. If option 'multi' is set, contributions of particular sources are saved. The same options are applied to '`Re-emission mode:`'. If option 'single' is set, contributions of secondary sources are attributed to one source coded as '`Reemis`'.

1.4. Recovery files and files containing initial conditions

The GLEMOS model produces 'dump' files. These files are used as both recovery files and files that are used as initial conditions. They can be found in `/run_directory/Output_dir_main/Dump/` and in `/run_directory/Output_dir_spinup/Dump/` depending on the simulation type. The usage difference is that in case of recovery the model reads the timestamp of a dump file and stops with error, if it does not match the end modeling date. At the same time, the model ignores the timestamp of the dump, if it is used for initial conditions.

2. System Requirement

The model has been verified to work on Linux Ubuntu 20.04 with HDF5 v1.10.5, netcdf-c v4.7.2, and netcdf-fortran v4.5.2 preinstalled. The model uses from 10 to 34 GB of RAM, depending on the pollutant and the type of calculation. The matrix calculations require much more RAM than field ones, and Hg uses more RAM than POPs, while POPs uses more than HM). Currently the model is capable only with the f95 compiler that is provided with Oracle Developer Studio 12.6. Besides, the model does not support multithreading (works only in a single thread mode).

3. Installing required software

3.1. The netcdf4 libraries

The fortran source files of the netcdf4 library, namaly, `typeSizes.f90` and `netcdf.f90`, are used for compiling the GLEMOS model. Therefore this library must be installed in the system. Further, the path to the directory containing the fortran source code of the netcdf library must be specified in the `input.GLEMOS.config` file in the GLEMOS Manager directory (`NETCDFF_DIR` field). Besides, the `HDF5` and the `netcdf-c` libraries have to be installed first in order to successfully install `netcdf-fortran`.

3.2. The compiler

Currently, the only proven way to build GLEMOS is using the `f95` compiler that is provided with Oracle Developer Studio 12.6, a tar file for the Linux system can be found here. You have to install the Java SE Development Kit and the Java SE Runtime Environment first. The path to the `f95` executive file must be specified in the `input.GLEMOS.config` file in the GLEMOS Manager directory (FC field).

4. Downloading the GLEMOS model

The GLEMOS model is reachable on the GitHub page. It consists of four parts that are stored in different repositories, namely the `GLEMOS_source`, the `GLEMOS_Manager`, the `GLEMOS_Inputs` and `GLEMOS_Utilities`. In order to start working with the model, create the `GLEMOS_WorkSpace`

directory where the model is going to set up and run. Change the directory to the `GLEMOS_WorkSpace` and use the commands below to download the source code as well as other components of the model:

```
git clone https://github.com/msc-east/GLEMOS_Source.git
git clone https://github.com/msc-east/GLEMOS_Manager.git
git clone https://github.com/msc-east/GLEMOS_Inputs.git
git clone https://github.com/msc-east/GLEMOS_Utilities.git
```

5. Downloading the Opendata

Create the '`OpenData`' directory inside the GLEMOS_WorkSpace directory. Download archives containing pieces of the input dataset using links below and put them into the `OpenData` directory:

Emissions - https://drive.google.com/file/d/1UlbO98wB_J9sKhq2kuIPt5iDHwY40Jkm/view?usp=sharing

MeteoData - https://drive.google.com/file/d/1K06uLzNB0ZHmt0VbkzDoxuAcP5lyblwy/view?usp=sharing

Dust - https://drive.google.com/file/d/1OM82xTY_q6YIqNu6g0uuAKQ5kjbgZsaH/view?usp=sharing

InitCond - https://drive.google.com/file/d/1HPA7rM-iD0qUD7CHJj4Gavp_4u32xp_L/view?usp=sharing

LandCover - https://drive.google.com/file/d/1Kpp62GMpdVXWgFJ85JRRPirfy50t4dLC/view?usp=sharing

ReactData - https://drive.google.com/file/d/1gsn5z7J77ReN_GfAaL-h5IjqIJjeymKL/view?usp=sharing

Navigate to the `OpenData` and run commands below in order to extract data after downloading is complete:

```
tar -zxvf ./Emissions.tar.gz
tar -zxvf ./MeteoData.tar.gz
tar -zxvf ./Dust.tar.gz
tar -zxvf ./InitCond.tar.gz
tar -zxvf ./LandCover.tar.gz
tar -zxvf ./ReactData.tar.gz
```

The obtained dataset covers a short time period (January 2020) and is an example of input data for the model. It includes data for monthly modeling of Hg, Cd, Pb and BaP on global 1°x1° and on regional 04°x04° scale (the regional one covers the EMEP region). All questions regarding the preparation of input data for longer intervals as well as for other domains please send to msce@msceast.org. The subdirectories of the OpenData are listed in Table 1.

Table 1. The Content of the OpenData

№	Name	Time interval	Simulations that require data	Description
1	`BoundCond`	----------	All regional simulations	The storage for the boundary conditions that can be obtained from the '`Boundary`' GLEMOS utility
2	`Dust`	01/01/2020 - 31/01/2020	All Cd and Pb simulations	Wind suspension of dust partciles is calculated usinf Dust_susp utility. These data are used in generation of re-suspension of particlate metals (e.g., Pb, Cd)
3	`Emissions`	01/01/2020 - 31/12/2020	All simulations	EMEP emissions are used for reginal-scale modelling. For global-scale simulations of Hg AMAP/UNEP/PKU emission is used.
4	`LandCover`	all years	All simulations	The MODIS 'MOD12' LC dataset is fixed (the same for any year) and has an index of 9999
5	`MeteoData`	01/01/2020 - 31/01/2020	All simulations	ECMWF analysis data preprocessed by WRF.
6	`InitCond`	----------	We provide users with initial conditions for Hg simulations on a global 1x1 scale, that are obtained as a result of 3-year spin-up (Global Hg runs require 3 years spin-up in order to fill the atmosphere). For regional Hg simulations as well as for any simulations of other substances 1 month spin-up is enough	By default, the model takes initial conditions from dump files from this directory if 'RUN `MODE ''` in the `input.GLEMOS.config` file is set to '`cond`'. The model reads the path to the location with initial conditions from the `RunInfo.dat.main` file in the Info subdirectory of the run directory. You can change this path if you need or manually create a subdirectories in `InitCond` and put a dump file there
7	`ReactData`	01/01/2020 - 31/012020	All Hg and BaP simulations	O3, OH, BC, OC air concentration data is a result of the GEOS-Chem classic model (v12.8.2) standard simulation with 2x2.5 resolution using MERRA2 meteodata. The Br air concentrations are obtained using the p-TOMCAT model

6. Configuring of model runs

All simulations are divided into main run and spin-up. The GLEMOS_manager allows you to run the model with the necessary spin-up and automatically manages the whole process. In the run directories words ‘main’ and ‘spinup’ mark files and directories related to these types of simulations. The purpose of the spin-up simulations is to produce initial and boundary conditions for the main simulation, therefore, there is no standard way to manage spin-up’s output, it is set by default.

Once you have downloaded the model and input data, a preparation for a first GLEMOS run can be started. Switch to the `GLEMOS_Manager` directory. In this directory there is a Python3 script named `GLEMOS.dir.maker` that generates run directories for GLEMOS simulations. This script uses an input file named `input.GLEMOS.config`, which is also located in the same directory. The `input.GLEMOS.config` file has two sections: the top one, where you have to customize the directory paths and other general settings, and the simulation menu in the bottom, that allows you

to choose pollutant for modeling, time frames and other specific options. Description of the fields of the top section is provided in table 2. For the first time we recommend to remain all the fields unchanged except for fields 2, 3, 4, 9, 10, 11, 12, 13, 15, which must be specified depending on your system settings and desired output. Note, that ':' is a mandatory delimiter in the top section. It should be noted that the input.GLEMOS.config file in the current edition provides only a small sample of the possible simulations that can be run. This file is designed to be flexible for different research tasks and entries with desired parameters can be added to the simulation menu.

Table 2. The description of the fields of the top section in the `input.GLEMOS.config` file

№	Field	Descriprion
1	VERSION	The version of the GLEMOS model. The current version is 2.2.2.
2	GRM_DIR	The full path to the GLEMOS_Maneger directory
3	GLEMOS_DIR	The full path to the GLEMOS_Source directory
4	DATA_PATH	The full path to the directory containing input data for simulation (Opendata)
5	METEO_PATH	The path to the directory containing meteorological data
6	REACT_PATH	The path to the directory containing data on concentrations of chemical substances in the atmosphere (O3, OH, Br, BC, OC)
7	BOUND_COND_PATH	The path to the directory containing boundary conditions (required only for regional simulations)
8	INIT_COND_PATH	The path to the directory containing files with initial conditions for simulations
9	INPUT_DIR	The full path to the GLEMOS_Inputs directory
10	FC	The full path to the f95 compiler executive file
11	NETCDFF_DIR	The full path to the netcdf4-fortran source directory
12	OUTPUT_FORM_MODE	The output formation mode. The options are: 'auto' or 'file'. In auto mode the script will automatically choose duration of the output depending on time frames of the simulation (for example: monthly simulation => monthly output, less than monthly simulation => daily output, yearly simulation => monthly and yearly output). In 'file' mode the script will copy settings from the output configuration files that can be found in `/GLEMOS_Manager/output_config/`. There are output configuration files for each pollutant.
13	OUTPUT_FOR_BOUND	This switch allows to automatically turn on 6hourly netcdf output that is required for further boundary conditions production. Also, there is always an option to turn on this kind of output in files located in `/GLEMOS_Manager/output_config/` directory. The switch just duplicates this functionality in order to provide users with a more convenient experience.
14	RUN_DIR_PATH	The full path to the directory, where the GLEMOS run directories will be created
15	RUN_DIR_SUFF	The suffix that will be added to the run directory name after creation (for example: '**_run1**' => Cd_GLOB_1x1_field**_run1**)

The bottom section is a table with a simulation menu. One row of this table means a simulation with specified parameters. The simulation can be activated by deleting '#' sign in the beginning of the row and *vice versa*. In one time only one row can be activated in order to successfully run the `GLEMOS.dir.maker`. The '|' sign is a mandatory delimiter in this table, the script will stop with an error in case of incorrect number of delimiters in the row. The description of the table columns can be found in Table 3.

Table 3. The description of the table columns in the simulation menu in input.GLEMOS.config file

№	Column name	Description
1	POLLUTANT	Name of the pollutant
2	GRID CODE	Grid code of the domain
3	MAIN SIMULATION START TIME	Start date of the main simulation
4	MAIN SIMULATION END TIME	End Date of the main simulation
5	TYPE (field/matrix)	if set on 'matrix' it turns on calculation of an emitter-receptor matrix in addition to the basic calculation ('fields'). Emitters and receptors for matrix calculations are set using matrix configuration files located in `/GLEMOS_Inputs/Config/.`
6	MEDIA (Atm, Soil ,Ocn, Veg)	The media to be used in the modeling. Currently Hg, Cd and Pb are support only atmospheric media and deposition on other media while BaP modeling is multimedia and includes exchange between media (this field is already set for all pollutants, remain is as it if you are not experienced user)
7	ANTHROPOGENIC EMISSION DATASET NAME SUFFIX	The suffix of the emission dataset to use in modeling (it is already set for the first run)
8	RUN MODE (zero/cond/spin-up)	Defines the conditions from which the simulation will start
9	SPIN-UP START	Start date of the spin-up simulation (the model use it only if RUN MODE is set on 'spin-up'
10	SPIN-UP END	End date of the spin-up simulation (the model use it only if RUN MODE is set on 'spin-up'
11	NUMBER OF SPIN-UPS	Number of spin-up repetitions from start to end. In the basic case it must be set on 1. For example it can be used for conducting a several-year spin-up on a single-year data.

Once you have edited `input.GLEMOS.config` file, a run directory for customized simulation can be generated by typing in your terminal:

```
./GLEMOS.dir.maker
```

A new run directory will be created as a subdirectory of RUN_DIR_PATH that you specified in the path menu in the `input.GLEMOS.config` file.

7. Compiling and running the model

7.1. Basic use

Navigate to your newly created run directory. The information regarding the run is located in the Info subdirectory. You can find main configuration files for this particular run in this directory as well because `GLEMOS_Manager` copies them from `GLEMOS_Inputs`. The more detailed run settings can be found in `RunInfo.dat.main` and `RunInfo.dat.spinup` files that includes specifying particular datasets to use (meteodata, reactdata, land cover, etc) and climatic mode switches for each major data source.

The GLEMOS supports modeling in the 'climatic' mode. This means that you can fix the year of particular input datasets while conducting multi-year modeling. This feature is available for meteorological datasets, land cover data and data on reactants concentration in the atmosphere. It can be turned on in the `RunInfo.dat.main` and `RunInfo.dat.spinup` files in the Info subdirectory of the run directory. The 'climatic' mode for land cover data is set by default.

The output settings are in `Output_config.dat.main` and `Output_config.dat.spinup`. Despite that output settings are set on the previous step (in Configuring runs section), there is still an opportunity to change them in `Output_config.dat.main` before the model runs. Note, that if the spin-up was turned off you would not find `RunInfo.dat.spinup` and `Output_config.dat.spinup` files in this directory. Next, compile the model by typing:

```
./make.GLEMOS
```

After successful compilation, a `run.GLEMOS` file will appear in the directory. Now, to run the simulation just type:

```
./run.GLEMOS
```

You will find the output of spin up and main simulation in output subdirectories with corresponding suffixes. All properties and configuration files used in the simulation as well as `RunInfo` files for both spin up and main run are located in the Info subdirectory.

To restore the simulation in case of stop simply type `./run.GLEMOS` again. To remove all data that has already been modeled and to start from the beginning just delete the `CalcRun.log` files in the output subdirectories and run `run.GLEMOS` again.

7.2. The output structure

The GLEMOS output can be found in the `Output_dir_main` subdirectory of the run directory. The model supports output in netcdf4 and text formats. The model produces output with a frequency and in the format that is specified in the file in `/Info/Output_config.dat.main`. At one time multiple frequencies and formats can be selected.

The structure and the content of the Output_dir_main is described in Table 4. The netcdf files can be found in `/Fields_NCF/` subdirectory of each media folder (Atm, Ocn, etc) in `Output_dir_main` if netcdf format is turned on. This folder contains information on air concentrations of a pollutant (‘`_Conc_`’ files), wet deposition (‘`_wetdep_`’ files) and dry_deposition (‘`_drydep_`’ files). The model outputs dry and wet deposition data to different surface types listed as the column names in the input land cover data file (see section 5 of this manual. The six-hour ‘`_MixRat_`’ files are used for boundary conditions production. If fields output turned on the /Fields/ subdirectory contains two-dimensional wet and dry deposition fields as well as surface layer from netcdf air concentration files in text format. It should be noted that layer numbering starts from the surface.

Air concentration files contain fields corresponding to each chemical form of the simulated pollutant stored in corresponding variables of netcdf4 file (in corresponding columns in case of text file). The output includes two separate variables (columns) for gas and particulate forms in case of POPs, a single particulate form variable (column) in case of heavy metals and variables (columns) for each chemical form in case of Hg (by default amounted to 6). In the case of matrix calculation, the data in each variable of air concentration in the netcdf 4 file is divided into the contributions of each source (an additional dimension is added, the size of which corresponds to the number of sources). All questions regarding the structure and processing of the GLEMOS output data please send to msce@msceast.org.

Table 4. Content of the GLEMOS output

№	Directory	Description
1	`/Output_dir_main/Dump/`	Storage of the dump files
2	`/Output_dir_main/Balance/`	Storage of the diagnostic files
3	`/Output_dir_main/CalcRun.log`	The log file of the main run
4	`/Output_dir_main/Atm/`	The storage of model results. Such storage will be created for each turned on media according to the configuration in `/Info/Output_config.dat.main` file. This directory contains `/Fields/` (2D text fields), `/Fields_NCF/` (3D netcdf4 files) and `/Monitoring/`. The last one contains already interpolated data at the locations of the measuring sites. The coordinates of these sites are set in `/GLEMOS_Inputs/Stations/`. In case of ‘matrix’ mode the `/Matrix/` subdirectory appears and contains source-receptor matrixes output.

8. The GLEMOS Boundary utility

Currently the `GLEMOS_Utilities` repository contains only the Boundary utility that allows producing boundary conditions required for regional simulations. It takes six-hour netcdf atmospheric ‘`_MixRat_`’ files as an input. These files can be found in the Output_dir_main directory in the simulation run directory. An example:

`/runs/Cd_GLOB_1x1_field_run/Output_dir_main/Atm/Fields_NCF/6hourly`

The six-hour netcdf output for boundary conditions can be automatically enabled in `input.GLEMOS.config` with `OUTPUT_FOR_BOUND` option set to 'on' or manually in the output config file in the `/GLEMOS_Manager/output_config/`. Note that in order to use output configurations from these files the `OUTPUT_FORM_MODE` option in `input.GLEMOS.config` must be set to 'file'.

After downloading the repository with the utility, you need to specify the paths and compiler settings in the `/GLEMOS_Utilities/Boundary/scripts/compiler_settings.boundary`. Description of the parameters is provided in Table 5.

Table 5. Content of the compiler_settings.boundary file.

№	Field	Description
1	FC	The full path to the f95 executable file;
2	FFLAGS1 and FFLAGS2	The flags for the compiler (remain unchanged)
3	LDLIBSOPTIONS	The path to the hidden fortran netcdf libraries
4	PRJDIR	The full path to the boundary utility directory
5	SRCDIR	The full path to the boundary source files
6	OBJDIR and MODDIR	The paths to the directories that contains object and module files (remain unchanged)
7	NSRCDIR	The full path to the fortran netcdf library source directory

The utility can be compiled with the `./make.boundary` command from the /Boundary/scripts/ directory. In order to recompile the utility run the `./make.boundary` clean command first.

The parameters for the program are specified in the `proc_boundary.conf.dat` file. Description of the parameters can be found in Table 6. Filling the configuration file, note that '/' is the mandatory end of all paths. To start the utility type in terminal:

```
./proc_boundary
```

Table 6. Content of the `proc_boundary.conf.dat` file

№	**Field**	**Description**
1	Substance	Pollutant name
2	Input grid code	The code of the input files domain and grid resolution
3	Output grid code	The code of the output files domain and grid resolution
4	Start date	Start date
5	Finish date	Finish date

6	Input file	The suffix of the input files names (remain unchanged)
7	Grids path	The full path to the `/GLEMOS_Inputs/Config/`
8	Input path	The full path to the directory containing 6-hour netcdf4 files
9	Output path	The full path to the boundary conditions storage

References

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