Preparation of land–cover and orography data for GRITOP-L

David Grawe, K. Heinke Schlünzen

Meteorologisches Institut, CEN, Universität Hamburg
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Abstract

This document describes the preparation of land-cover and orography data for GRITOP-L. GRITOP-L prepares METRAS grid files based on raster data for land-cover and orography. In the context of GRITOP-L this data should be easily usable and it should be available in a sufficiently high resolution to be used for METRAS model runs in the context of the TA Luft.

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1 Introduction

This document describes the preparation of land-cover and orography height data for GRITOP-L. GRITOP-L prepares METRAS grid files based on raster data for land-cover and orography. In the context of GRITOP-L this data should be easily usable and it should be available in a sufficiently high resolution to be used for METRAS model runs in the context of the TA Luft.

The approach employed here prepares available data to cover all of Germany. To run GRITOP-L all of the data should be made available and the program selects relevant data for the requested model domain automatically.

The data is based on two data sources LBM-DE2012 for land cover data (section 2) and EU-DEM for orography height (section 4).

2 Land cover data

The LBM-DE2012 was provided to UHH on five DVDs subdivided in folders for federal states (some states were split in 2 folders). Within each of these folders there is a shape file lbm-de2012.shp and assisting files (e.g. .dbf). These shape files consist of a topology of polygons which are each assigned an ID and several other attributes, such as Corine landuse classification (CLC-St), land use (LN-Akt) and land cover (LB-Akt). The minimum mapping area is 1 ha, and the minimum mapping width is 15 m. However, the data set contains polygons of smaller size than 1 ha due to specific usage that can not be generalised with the surrounding land use classes.

2.1 Data preparation

The following steps are performed to process the land cover data:

2.1.1 Data processing

The aim of the data processing is to have high resolution raster files of the land cover class available as ASCII grid files (here known as PK files). Each file shall be limited in size to make data processing in GRITOP-L more efficient. The data processing is performed using SAGA-GIS Version 6.3.0. with scripts using the command line interface.

2.1.2 Coordinate transformation

The original files are in UTM projection, therefore the coordinate system has to be transformed to geographic coordinates with the reference ellipsoid (Datum) WGS 84. This is performed for each input file individually.

```
saga_cmd pj_proj4 2 -CRS_PROJ4="+proj=longlat +datum=WGS84
+no_defs" -SOURCE=$infile -TARGET=$outfile
```

2.1.3 Reduce table size

Remove unneccessary columns to make file size handable. First copy the column headers to $infile.header using python3:

```
import sys
import csv
from dbfread import DBF
table = DBF(infile)
writer = csv.writer(sys.stdout)
writer.writerow(table.field_names)
>> $infile.header
```

Then remove all columns except CLC_st1:

```
saga_cmd table_tools 11 -TABLE=$infile -FIELDS=‘cat \
$infile.header|sed "s/,CLC_st1//"‘-OUT_SHAPES=$outfile
```

2.1.4 Merge shape files

The data is originally subdivided into 18 subsets mainly following federal state borders. Therefore the data is merged into one dataset.

```
saga_cmd shapes_tools 2 -INPUT=$shapelist -MERGED=$outfile
```

2.1.5 Raster grid

The vector data is converted to raster by gridding. Gridding is performed for the field CLC_st1 with a resolution of 0.0001 deg ≈ 10 m.

```
saga_cmd grid_gridding 10 \
-POLYGONS=$infile \
-FIELD=CLC_st1 \
-METHOD=1 \
-MULTIPLE=1 \
-TARGET_DEFINITION=0 \
-TARGET_USER_SIZE=0.0001 \
-CATEGORY=$outfile
```

2.1.6 Tiles

Processing the full raster data set with GRITOP-L would be computationally inefficient. Therefore the data is subdivided into regular tiles of 1000 x 1000 raster cells each. This leads to a high number of individual files, however GRITOP-L can automatically select the relevant files from the full list.

```
saga_cmd grid_tools 27 -GRID=$infile -OVERLAP=20 -TILES_SAVE=1
-TILES_PATH=$outdir -TILES_NAME=$outname -NX=1000 -NY=1000
```

2.1.7 Export

All tiles are stored as ASCII grid to be read by GRITOP-L. These files are internally named 'PK files' . Each file has a header consisting of six lines which define the geographic location, raster size, number of raster elements and a default data value. This is followed by an NxM matrix which contains the land cover information.

```
$saga_cmd io_grid 0 -GRID=$infile -PREC=0 -FILE=$outfile
```

3 Determination of metras50 classes from LBM-DE2012 data

Several hundred land use classes can be used in METRAS (MeMi classes). However, in order to assess the meteorological impact of each of these classes, material properties need to be assigned. Approx. 50 material classes are known to METRAS. Therefore, the land use classes need to be assigned to one or several of the material classes.
Based on the information in the LBM-DE2012 dataset such an assignment could be derived. Each polygon in the dataset is assigned a CLC (Corine land cover) class as well as an LB (Landbedeckung) class. The LB class is the more relevant information for the meteorological model, however, for licensing reasons a high resolution raster of the LB class could not be made freely available.
Therefore, a combination of the CLC class and the LB class information has been used to assess the relative fractions of each LB class in every CLC class. The LB land cover information can easily be matched to the metras50 material classes. Statistics covering the full LBM-DE2012 data set have been derived, thereby determining the relative fraction of each metras50 material class for each CLC class.
With this additional information the rastering of data can be performed using CLC class information, so that the data can be made available to users, while at the same time the material composition of each CLC class is (at least in the statistical average) retained.

4 Orography data

The EU-DEM data was downloaded on 26 September 2017 from the European Environmental Agency's Copernicus Land Monitoring Service [1]. The data covering Germany is downloaded as nine seperate files. The following steps are performed to process the orography data:

[1] https://www.eea.europa.eu/data-and-maps/data/copernicus-land-monitoring-service-eu-dem

4.0.1 Mosaic

All downloaded files are merged into one file.

```
saga_cmd grid_tools 3 -GRIDS=$filelist -NAME=$name
-TYPE=7 -RESAMPLING=0 -TARGET_OUT_GRID=$outfile
```

4.0.2 Coordinate transformation

The original files need to be transformed to geographic coordinates with the reference ellipsoid (Datum) WGS 84.

```
saga_cmd pj_proj4 4 -CRS_PROJ4='+proj=longlat
+datum=WGS84 +no_defs' -SOURCE=$infile -RESAMPLING=0
-GRID=$outfile
```

4.0.3 Tiles

Processing the full raster data set with GRITOP-L would be computationally inefficient. Therefore the data is subdivided into regular tiles of 1000 x 1000 raster cells each. This leads to a high number of individual files, however GRITOP-L can automatically select the relevant files from the full list.

```
saga_cmd grid_tools 27 -GRID=$infile -OVERLAP=0
-TILES_SAVE=1 -TILES_PATH=$outdir -TILES_NAME=$outname
-NX=1100 -NY=1100
```

4.0.4 Export

All tiles are stored as ASCII grid to be read by GRITOP-L. These files are named 'PK files' . Each file has a header consisting of six lines which define the geographic location, raster size, number of raster elements and a default data value. This is followed by an NxM matrix which contains the orography height.

```
saga_cmd io_grid 0 -GRID=$infile -PREC=1 -FILE=$outfile
```

5 Technical information

5.1 Data storage

To reproduce the data, LBM-DE2012 should be stored at

- `mistral:/work/um0053/rawdata/LBM-DE2012` (input shape files)
- `mistral:/work/um0053/data/GRITOP-L_DATA` (output PK files)

For processing the files for conversion to PK files the data sets should be collected in one subdirectory per federal state. The name of each subdirectory should be two characters. This was the case on the original DVDs.

EU-DEM should be stored at

- `mistral:/work/um0053/rawdata/EU-DEM` (input GeoTIFF files)
- `mistral:/work/um0053/data/GRITOP-L_DATA` (output PK files)

5.2 Scripts

The scripts for preprocessing the LBM-DE2012 data for GRITOP-L can be found in:

- `gitlab.dkrz.de:memi/pretop`
- branch `develop`
- directory `SAGA`
- file `lbm-de2pk_merge.tcsh` for LBM-DE2012
- file `dbf_header.tcsh` for LBM-DE2012
- file `eu-dem2pk.tcsh` for EU-DEM

5.3 SAGA-GIS

SAGA-GIS Version 6.3.0 (System for Automated Geoscientific Analyses) is for the preparation of the files. SAGA is a Geographic Information System (GIS) software. It is installed at DKRZ and can also be downloaded from `http://www.saga-gis.org/`. Some Linux installations include saga-gis, however, the version may be older. Version 6.3.0 or newer is required to perform the gridding adequately.