The COSMO software for processing geospatial data (EXTPAR)
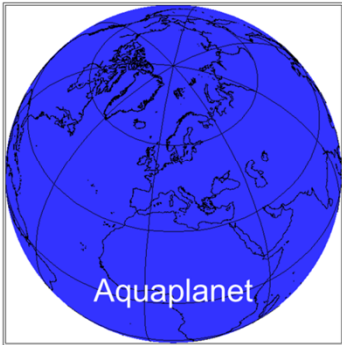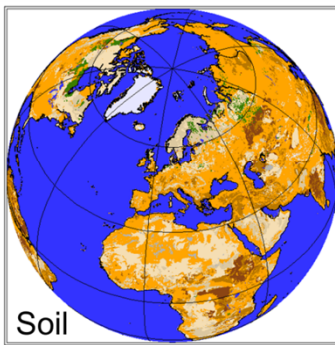
J. Helmert, K. Osterried, L. Kornblueh

EXTPAR - Background
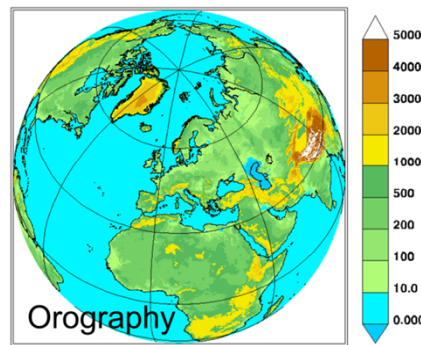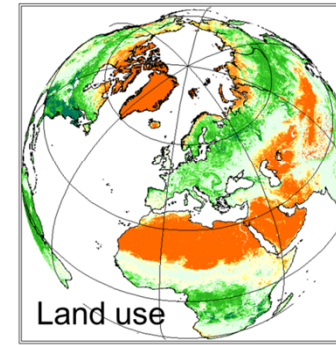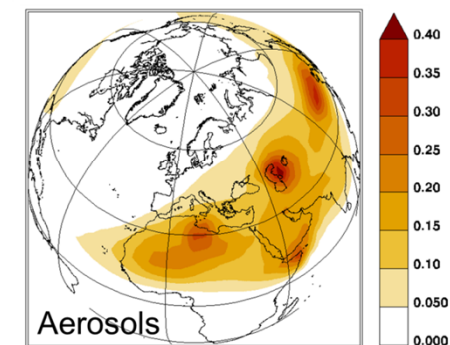
- Geospatial data are retrieved from high-resolution satellite information or land registers and are aggregated to the model's global or limited-area grid.

- In a final processing step all available data are cross-checked for consistency (e.g., to exclude vegetation on glaciers).

- The required model parameters are very similar for NWP models, but the used data sources and the applied tools vary between different models – i.e. different mapping of geospatial information (Onvlee et al, 2014).

J. Helmert et al., 2019 COSMO WG3b

Geospatial data - Problems

Geospatial data are part of the NWP system.

Errors in this system due to these data can arise from:

1. not suitable processed geospatial data

Processing errors in land-sea mask, land-use classes, seasonal cycle)

J. Helmert et al., 2019 COSMO WG3b

Geospatial data - Problems

Geospatial data are part of the NWP system.

Errors in this system due to these data can arise from:

1. not suitable processed geospatial data

2. errors in geospatial data

Land use classes of the Black Sea shoreline in
GLC2000 and GlobCover2009

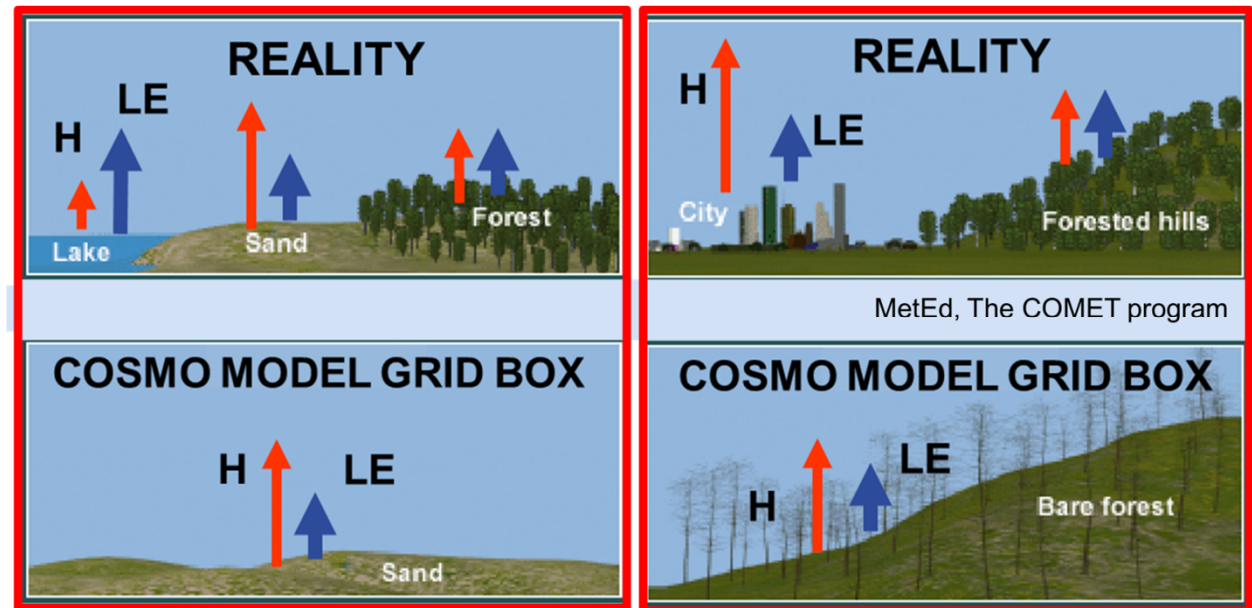Errors in land-sea mask (land-use classes)

Geospatial data - Problems

Geospatial data are part of the NWP system.

Errors in this system due to these data can arise from:

1. not suitable processed geospatial data
2. errors in geospatial data

{ DWD 10101 0000 0-0 h surface 0 FR_LAKE Proportion } * 100.00
mean: 0.45 std: 4.42 min: 0.00 max: 100.00

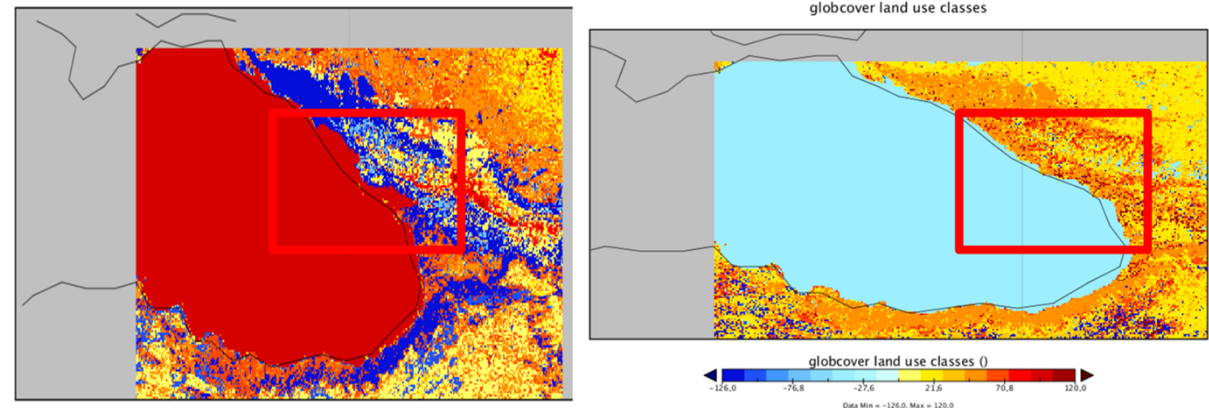Strange sharp decrease of lake fraction in high latitudes

Geospatial data - Problems

Geospatial data are part of the NWP system.

Errors in this system due to these data can arise from:

1. not suitable processed geospatial data
2. errors in geospatial data
3. changed geospatial data

ICON_0026_R03B07_G GCV2009 LUC_CLASS 19 ARTIFCL SURFACE
mean: 0.00 std: 0.01 min: 0.00 max: 1.00

Land-use class fraction for urban areas (e.g. TERRA-URB)
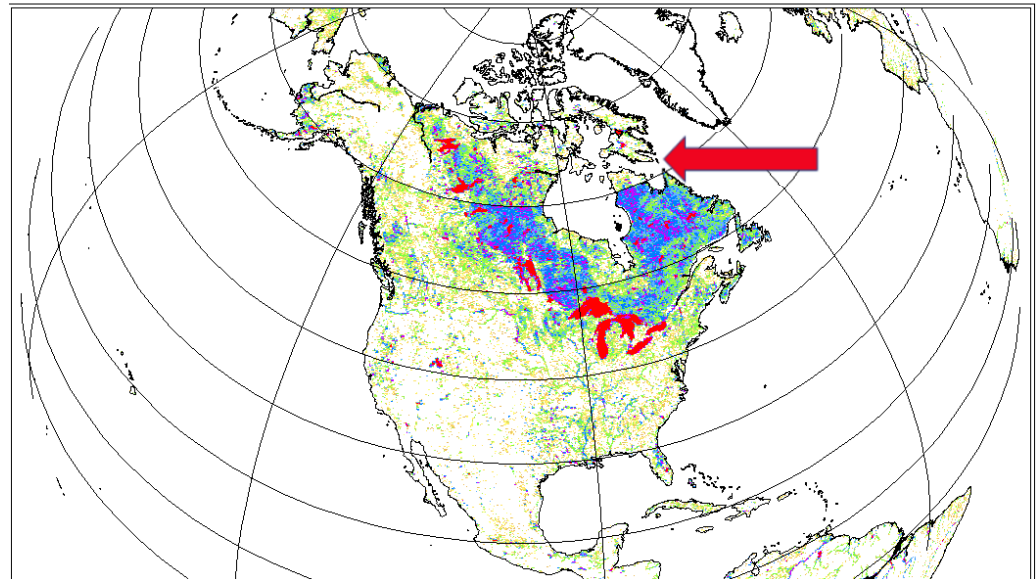
J. Helmert et al., 2019 COSMO WG3b

Geospatial data - Problems

Geospatial data are part of the NWP system.

Errors in this system due to these data can arise from:

1. not suitable processed geospatial data
2. errors in geospatial data
3. changed geospatial data

ICON_0026_R03B07_G ESA CCI LU_CLASS_FRAC 33
mean: 0.00 std: 0.02 min: 0.00 max: 1.00

Land-use class fraction for urban areas (e.g. TERRA-URB)

Geospatial data - Problems

Geospatial data are part of the NWP system.

Errors in this system due to these data can arise from:

1. not suitable processed geospatial data

2. errors in geospatial data

3. changed geospatial data

4. missing geospatial data

DWD 10101 0000 0-0 h surface 0 EMIS_RAD Numeric
mean: 0.99 std: 0.01 min: 0.95 max: 1.00

Emissivity (based on look-up table for land-use classes)
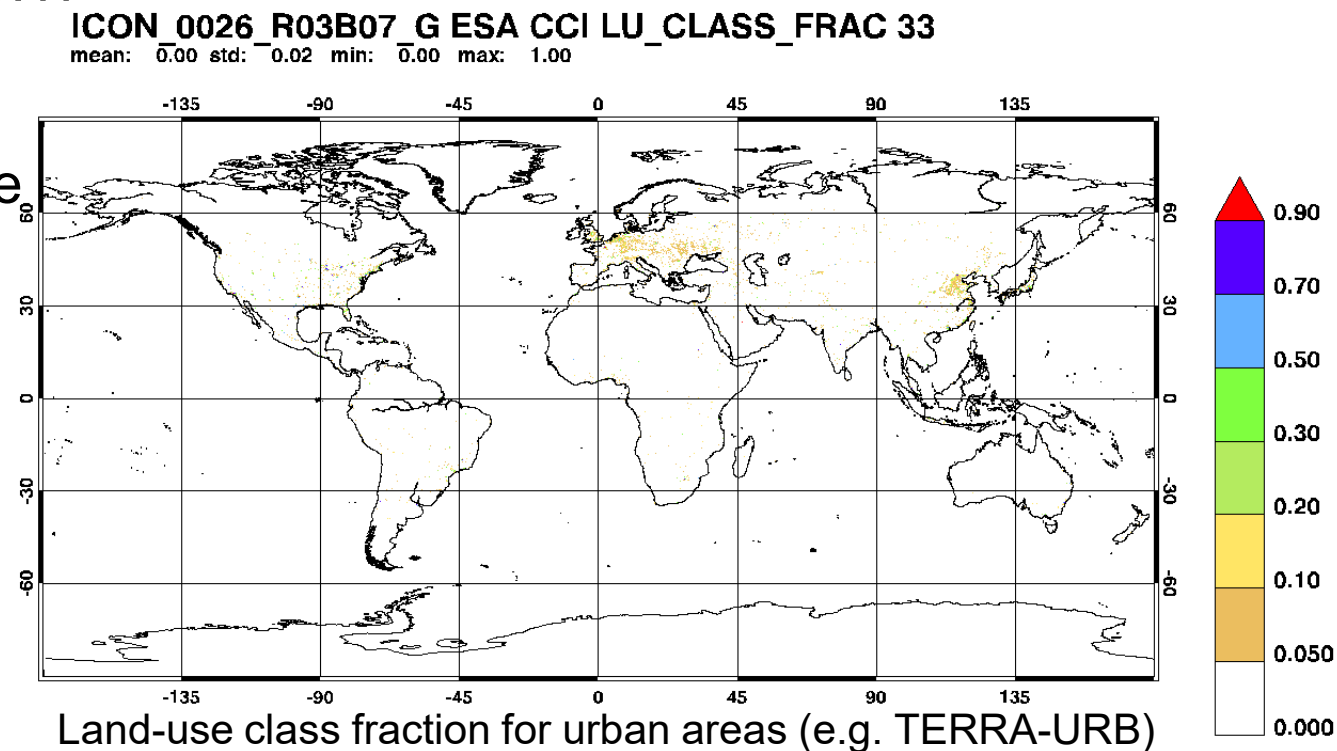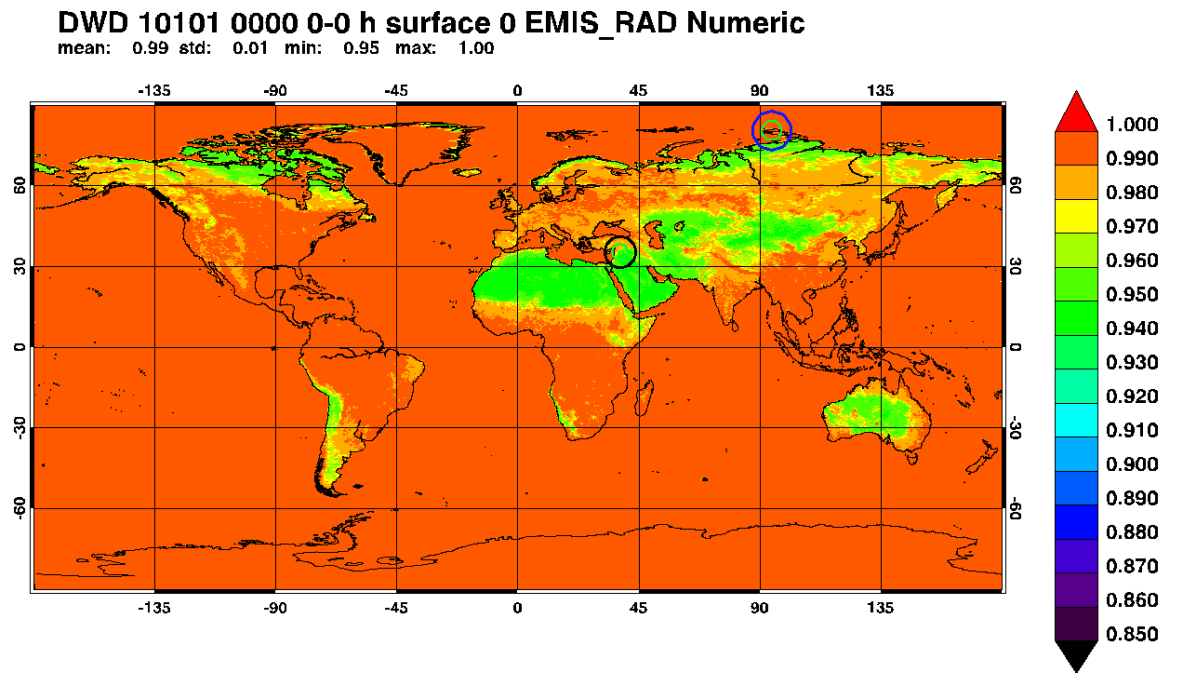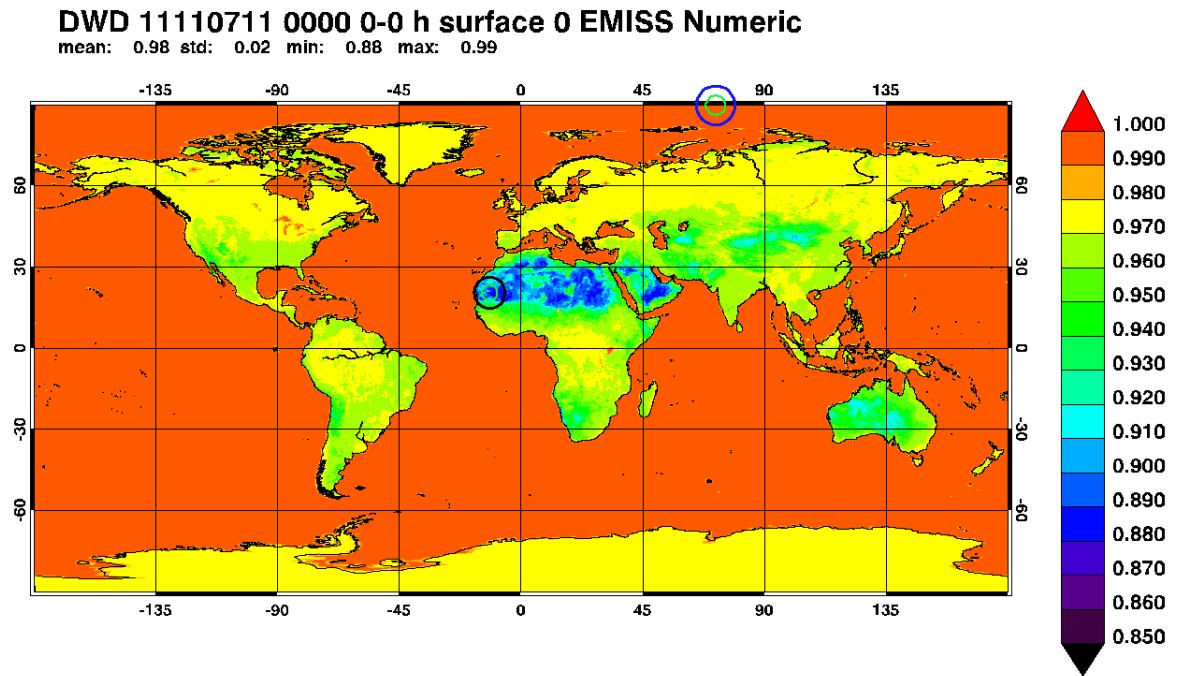
J. Helmert et al., 2019 COSMO WG3b

Geospatial data - Problems

Geospatial data are part of the NWP system.

Errors in this system due to these data can arise from:
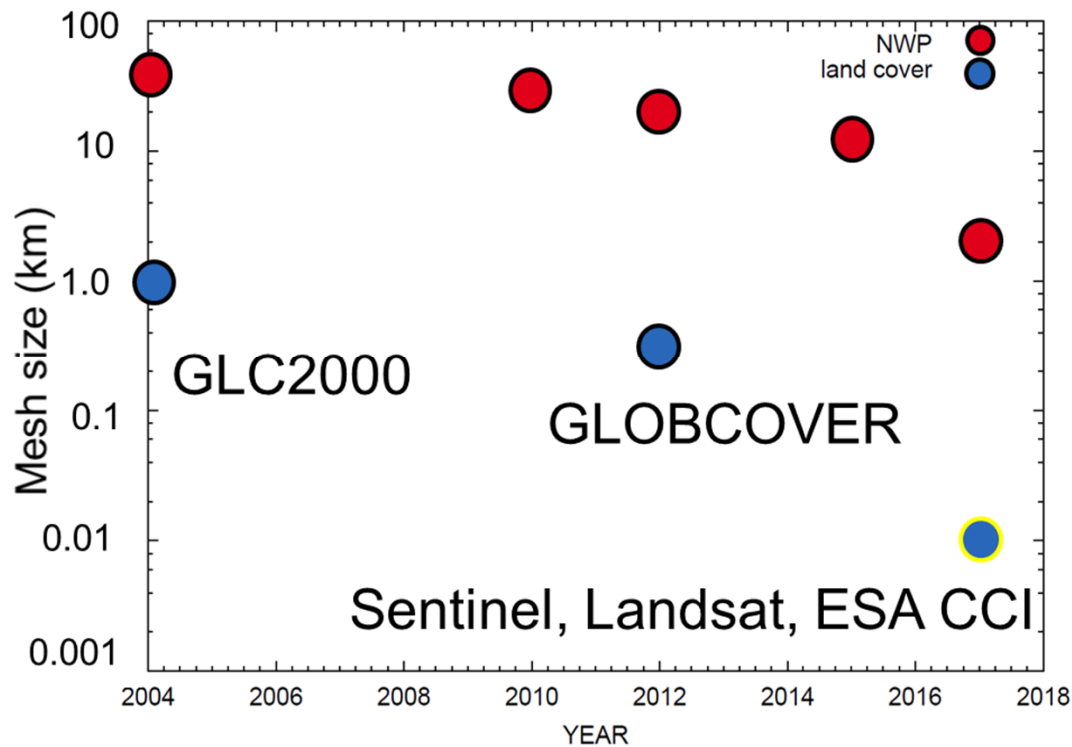
1. not suitable processed geospatial data

2. errors in geospatial data

3. changed geospatial data

4. missing geospatial data

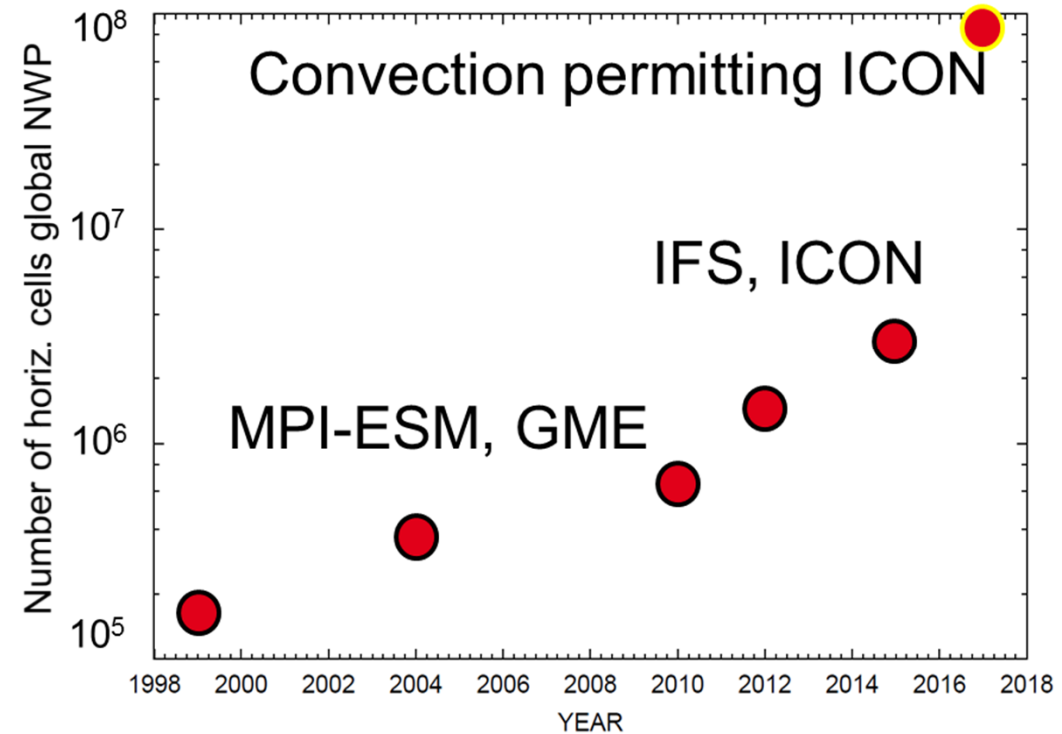DWD 11110711 0000 0-0 h surface 0 EMISS Numeric
mean: 0.98 std: 0.02 min: 0.88 max: 0.99

Experimental product based on Combined ASTER and MODIS Emissivity database over Land (CAMEL) - B. Fay (DWD)

J. Helmert et al., 2019 COSMO WG3b

Evolution of the mesh size in global NWP models and land use remote sensing products

Evolution of number of grid points in global NWP models

1. Demand for high-resolution remote sensing data to be used for:

2. convection permitting global NWP or LES-type limited-area models.

3. Increasing number of users for aggregated data on model's grid
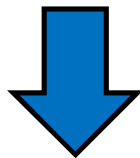
- Increase in storage costs

- Increase in I/O costs

- Demand for improved approaches for data aggregation (e.g. soil)

- Need for preprocessing of data (Python, cdo, NetCDF tools)

- Need for parallelization (Open-MP, MPI)

- Need for user-friendly, low maintainance front ends

J. Helmert et al., 2019 COSMO WG3b

EXTPAR - Approach
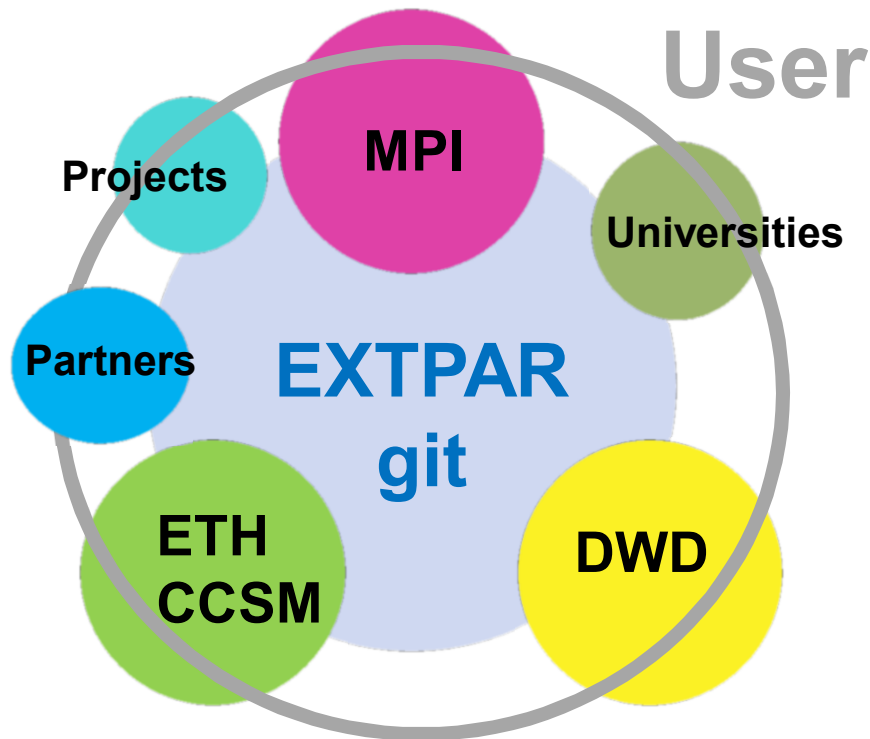
- Unified code of EXTPAR available for project partners

- Possible to run EXTPAR on different platforms (compilers)
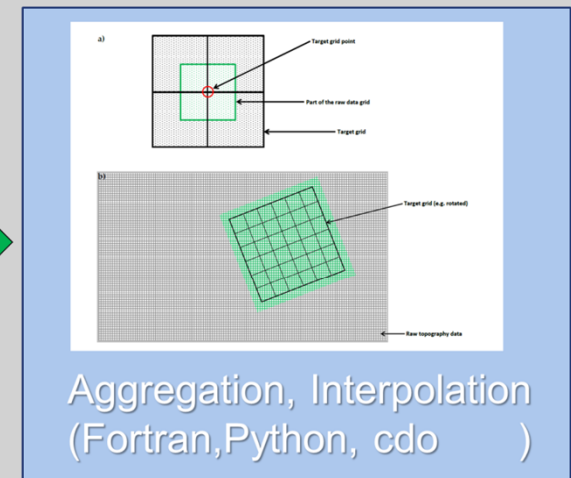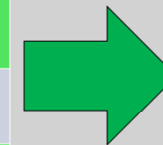
- Use a modern development platform (git)

- Allow automatic tests of modified code (compilers and output)

- Benefit from developments in CLM/DWD/MPI

- Reduce maintanance overhead for developers

- Common code platform for new developments (e.g., Tandem-X, SoilGrids)

Geospatial data community

Component	COSMO-NWP	COSMO-CLM	ICON	HIRLAM/ HARMONIE	ECMWF
Orography	Globe, ASTER	GLOBE, ASTER	GLOBE, ASTER, (TANDEM-X)	GMTED2010	Composit
Soil	DSMW FAO, HWSD	DSMW FAO, HWSD	DSMW FAO, HWSD, (SoilGrids)	DSMW FAO, (SoilGrids)	DSMW FAO
Land use	GlobCover , GLCC	ECOCLIMAP	GlobCover, GLCC (ESA CCI LC)	ECOCLIMAP	GLCC
Lakes	GLDB	GLDB	GLDB	GLDB	GLDB
Vegetation cycle	NASA/GSFC SEAWIFS	NASA/GSFC SEAWIFS	NASA/GSFC SEAWIFS	ECOCLIMAP	MODIS
Aerosols	NASA/GISS GACP, AEROCOM	NASA/GISS GACP, AEROCOM	NASA/GISS GACP, AEROCOM	NASA/GISS GACP	CAMS
Albedo	MODIS	MODIS	MODIS	ECOCLIMAP SURFEX	MODIS

Workflow of geospatial data used for NWP and climate models from several data sources. Differences between models exist in the used sources as well as the applied tools and methods for aggregation, interpolation, and consistency checks. For the COSMO and ICON model in NWP and climate mode, the COSMO software EXTPAR (Smiatek et al., 2008, Asensio et al., 2018) is used to generate the required geospatial data.

Aggregation, Interpolation (Fortran,Python, cdo   )

Consistency check (Fortran) Data output for model grid (NetCDF, cdi-lib   )

Geospatial data community

ALADIN	COSMO	HIRLAM	MetOffice	LACE	SEECOP	ECMWF

data quality

data formats

new geospatial data

technical concepts

Common interests in:

- geospatial data retrieved from high-resolution satellite information or land registers and are aggregated to the model's global or limited-area grid.

- exploration of new geospatial data

- common standards for data formats (CF-1.X)

- collection of reports on data quality issues (e.g. HWSD)

- report on measures to address technical challenges (data in cloud, artificial intelligence?, user access, …)