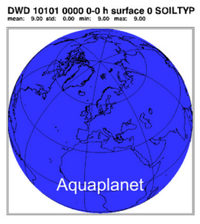
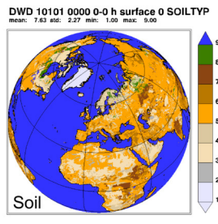
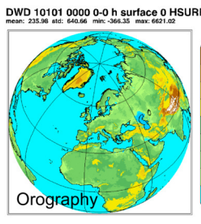
Towards a unified software tool for generation of geospatial datasets applied in global and limited-area numerical weather prediction and climate models

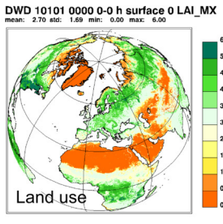
Jürgen Helmert[1], Katherine Silverthorne Osterried[2], Luis Kornblueh[3], Jean-Marie Bettems[4], Dmitrii Mironov[1], and Axel Seifert[1]

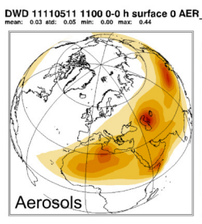
External databases containing geospatial datasets are an important component in operational numerical weather prediction (NWP) and climate model setups. These datasets provide information about orography, land use, soil and surface properties as well as vegetation parameters and determining factors of the models radiation scheme, such as aerosols.









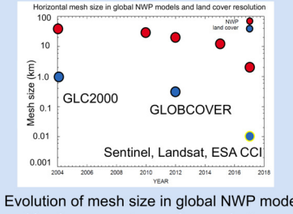


Data sources

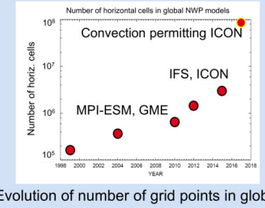
Geospatial data allow numerical simulation beyond the aquaplanet. They are retrieved from high-resolution satellite information or land registers and are aggregated to the model's global or limited-area grid. In a final processing step all available data are cross-checked for consistency (e.g., to exclude vegetation on glaciers). The used data sources and the applied tools vary between different models – i.e. different mapping of geospatial information (Onvlee et al, 2014).

Project

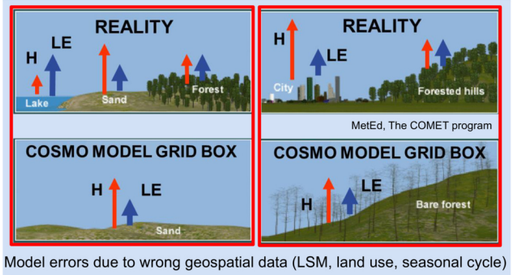
Center for Climate Systems Modeling, Max-Planck-Institut für Meteorologie, and Deutscher Wetterdienst are jointly developing a common code base of geospatial data processing software (**EXTPAR**) for the COSMO and ICON models. The main goals of the project are (i) to merge the development routes within a Git version-control system, and (ii) to perform continuous integration strategies by using different compilers and model grids.



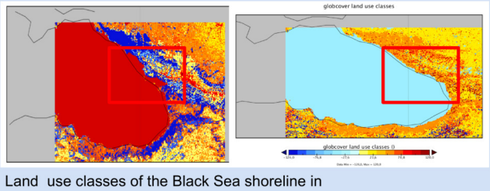
Evolution of mesh size in global NWP models and land use remote sensing products



Evolution of number of grid points in global NWP models



Model errors due to wrong geospatial data (LSM, land use, seasonal cycle)

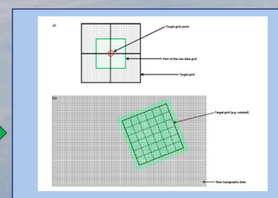


Land use classes of the Black Sea shoreline in GLC2000 and GlobCover2009

(1) Deutscher Wetterdienst, Research & Development, Germany, (juergen.helmert@dwd.de),
(2) Center for Climate Systems Modeling, Switzerland,
(3) Max-Planck-Institut für Meteorologie, Germany,
(4) Federal Office of Meteorology and Climatology MeteoSwiss

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, (HWSD)	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.



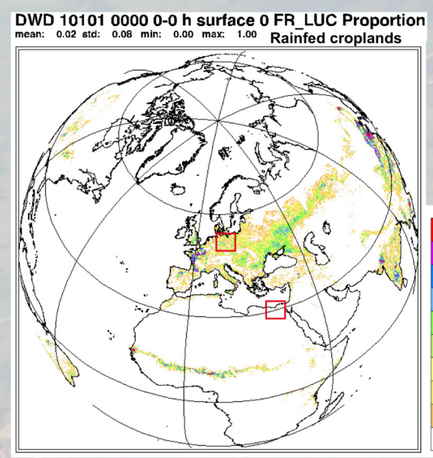
Aggregation, Interpolation (Fortran,Python, cdo)

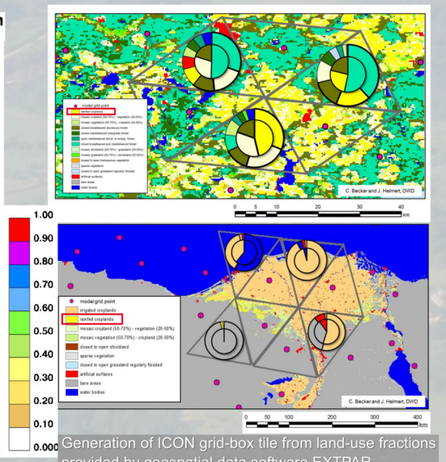
Consistency check (Fortran)
Data output for model grid (NetCDF, cdi-lib)

EXTPAR development

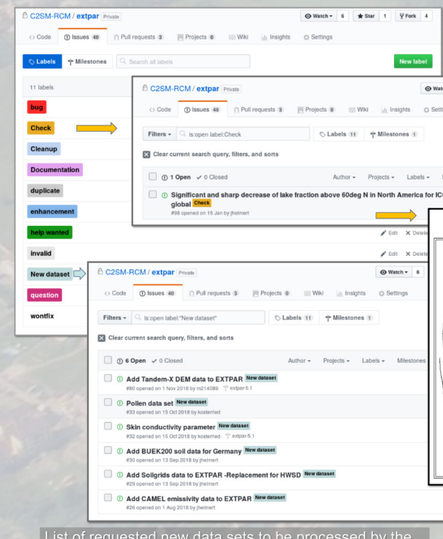
Since several years the development route of EXTPAR diverged in its different variants (COSMO-NWP, COSMO-CLM, ICON). There are only limited resources to maintain and develop EXTPAR for addressing the challenges in increasing resolutions of satellite input data sets and model grids as well as to add new input data into the processing workflow.
Given the major goals of the project the unified version of EXTPAR allows

- Consistent integration for new and high-resolution data sources and high-res model grids (modular concept, OpenMP added)
- Usage of existing tools and libraries for data processing task (cdo, python, cdi-lib)
- Community development approach – access with git version control
- Automatic build checks with different compilers, models, domains, and resolutions
- Consistent documentation
- Possible joint development in the framework of Coordination on Short-Range Numerical Weather Prediction Programme (C-SRNWP)





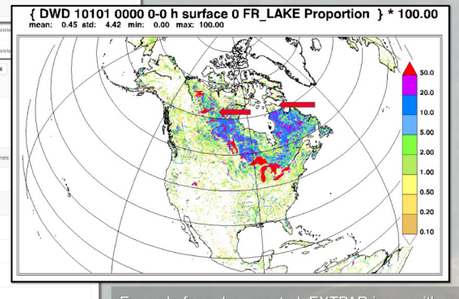
Generation of ICON grid-box tile from land-use fractions provided by geospatial data software EXTPAR.



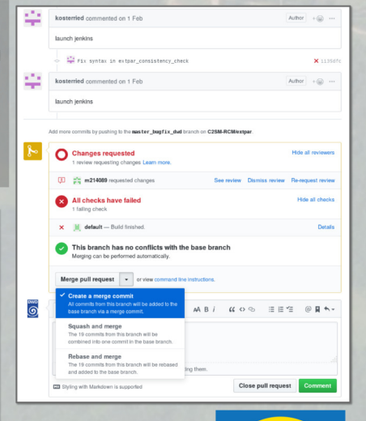
List of requested new data sets to be processed by the EXTPAR software.

EXTPAR workflow

The source code of EXTPAR is hosted at GitHub, which provides access control and collaboration features. Bug tracking, feature requests, task management, and wikis are used in the project. Furthermore, the integration of Jenkins allows automatic tests for modified code.



Example for a documented EXTPAR issue with request on check of the significant and sharp decrease of the lake fraction parameter above 60 deg N in North America as seen in the global grid of ICON-NWP at 13 km resolution (R03B07G).



Photography encouraged

We are looking forward to your comments and suggestions:
#extpar_project

Asensio H. et al. (2018) External Parameters for Numerical Weather Prediction and Climate Application. EXTPAR v5.0

Onvlee J. et al. (2014) Geospatial datasets for use in NWP (and climate) models

Smiatek G., Rockel B., Schaettler U. (2008) Time invariant data preprocessor for the climate version of the COSMO model (COSMO-CLM). Meteorol Z 17(4, Sp. Iss. SI):395–405. doi: 10.1127/0941-2948/2008/0302