



ESMPy and OpenClimateGIS: Python Interfaces for High Performance Grid Remapping and Geospatial Dataset Manipulation

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The Earth System Modeling Framework (ESMF) Python interface (ESMPy) supports analysis and visualization in Earth system modeling codes by providing access to a variety of tools for data manipulation. ESMPy started as a Python interface to the ESMF grid remapping package, which provides mature and robust high-performance and scalable grid remapping between 2D and 3D logically rectangular and unstructured grids and sets of unconnected data. ESMPy now also interfaces with OpenClimateGIS (OCGIS), a package that performs subsetting, reformatting, and computational operations on climate datasets.

ESMPy exposes a subset of ESMF grid remapping utilities. This includes bilinear, finite element patch recovery, first-order conservative, and nearest neighbor grid remapping methods. There are also options to ignore unmapped destination points, mask points on source and destination grids, and provide grid structure in the polar regions. Grid remapping on the sphere takes place in 3D Cartesian space, so the pole problem is not an issue as it can be with other grid remapping software. Remapping can be done between any combination of 2D and 3D logically rectangular and unstructured grids with overlapping domains. Grid pairs where one side of the regridding is represented by an appropriate set of unconnected data points, as is commonly found with observational data streams, is also supported.

There is a developing interoperability layer between ESMPy and OpenClimateGIS (OCGIS). OCGIS is a pure Python, open source package designed for geospatial manipulation, subsetting, and computation on climate datasets stored in local NetCDF files or accessible remotely via the OPeNDAP protocol. Interfacing with OCGIS has brought GIS-like functionality to ESMPy (i.e. subsetting, coordinate transformations) as well as additional file output formats (i.e. CSV, ESRI Shapefile).

ESMPy is distinguished by its strong emphasis on open source, community governance, and distributed development. The user base has grown quickly, and the package is integrating with several other software tools and frameworks. These include the Ultrascale Visualization Climate Data Analysis Tools (UV-CDAT), Iris, PyFerret, cpython, and the Community Surface Dynamics Modeling System (CSDMS).

ESMPy minimum requirements include Python 2.6, Numpy 1.6.1 and an ESMF installation. Optional dependencies include NetCDF and OCGIS-related dependencies: GDAL, Shapely, and Fiona. ESMPy is regression tested nightly, and supported on Darwin, Linux and Cray systems with the GNU compiler suite and MPI communications. OCGIS is supported on Linux, and also undergoes nightly regression testing. Both packages are installable from Anaconda channels.

Upcoming development plans for ESMPy involve development of a higher order conservative grid remapping method. Future OCGIS development will focus on mesh and location stream interoperability and streamlined access to ESMPy’s MPI implementation.