ncremap, a new netCDF Operator

Regrid Curvilinear, Rectangular, and Unstructured Data (CRUD) with ncremap, a new netCDF Operator

Regional Swath Data

Regrid NASA AIRS Level 2 Swath Data in raw HDF4 format from regional curvilinear 45x30 source grid to equiangular 1x1 degree:

```
ncremap -s AIRS_2014.10.01 swath1.nc -d 1x1.nc
```

Global Sea-Ice (CICE) Data

Native CICE grid has _FillValue in mask variable (trask), which NCL function curvilinear_to_SCRIP() and ESMF do not understand. Unless user first manually sets _FillValue to 0, NCL generates incorrect grid, and regridding produces subtly biased results.

```
ncremap handles missing values in masks without user intervention.
```

Invocation Modes

1. Free-will: Infer source and destination grids to generate mapfile

```
ncremap -s src.nc -d dst.nc
```

2. Old grid: Uses known-good grid(s) to generate mapfile then regrid

```
ncremap -g grd.nc -s src.nc -d dst.nc
```

3. New grid: Generate source-grid from ncks parameter string

```
ncremap -G -rgr latlon=40,40 -rgr snwe=30.0,-130.0,-90.0,0.0
```

4. Pre-Destination: Apply supplied mapfile to all input files (fastest)

```
ncremap -s src.nc -m map.nc
```

Examples

```
ncremap -s swath1.nc -d swath2.nc # Curvilinear → Curvilinear
ncremap -v temperature -s mpas_ocean.nc -d cam_se.nc # Unstructured → Unstructured
ncremap -x TSurfStd_ct -s AIRS_2014.10.01 swath1.nc -d cam_se.nc # Curvilinear → Rectangular
ncremap -v StepTwoO3 -s OMI-Aura_L2-OMTO3_2015m0731t0034-o58727_v003-2015m0731t080836.he5 -d cam_fv.nc # Subsetting
ncremap -s AIRS_2014.10.01 swath1.nc -d 1x1.nc # Curvilinear → Rectangular
```

Regridder Bake-Off

Three regridder (UV-CDAT, NCL, NCO) on CAM-SE unstructured grid datasets from ~1-13 GB on multicore nodes:

<table>
<thead>
<tr>
<th>Regrider</th>
<th>UV-CDAT</th>
<th>NCL</th>
<th>NCO</th>
</tr>
</thead>
<tbody>
<tr>
<td>map_ne30p4t_h3x256_aave_150418.nc</td>
<td>0m20s-0m35s</td>
<td>0m20s-0m12s</td>
<td>0m20s-0m20s</td>
</tr>
<tr>
<td>map_ne30p4t_h257x12_aave_150418.nc</td>
<td>0m20s-0m35s</td>
<td>0m20s-0m12s</td>
<td>0m20s-0m20s</td>
</tr>
<tr>
<td>map_ne30p4t_h257x12_aave_150418.nc</td>
<td>1m19s-1m32s</td>
<td>4m00s-4m20s</td>
<td>0m45s-0m49s</td>
</tr>
<tr>
<td>map_ne30p4t_h450x1800_bik2_150418.nc</td>
<td>2m44s-4m00s</td>
<td>15m00s-16m01s</td>
<td>1m30s-1m40s</td>
</tr>
</tbody>
</table>

Summary

ncremap improves previous remapping solutions in multiple ways:
1. Single command regreds Curvilinear, Rectangular, and Unstructured Data (CRUD)
2. Infers accurate grids from CRUD without user intervention
3. Threading across variables makes it fastest regridder tested

Features

1. Curvilinear, Rectilinear, and Unstructured grids
2. Global and regional source and destination grids
3. Generates Accurate Gaussian grid boundaries (only known regridder that does, uses Newton-Raphson technique)
4. Diagnoses convex polygon area for any grid boundaries (necessary, e.g., with ESMF bilinear interpolation maps)
5. Built-in database of dimension/coordinate names
6. Adds latitude-weights (rectangular grids only)
7. Adds bounds variables when possible (even if missing from mapfile)
8. Propagates input metadata to output (adds NCO provenance info)
9. Subsets variables using regular expressions
10. CF metadata annotation (bounds, axis, cell_area, cell_methods)
11. OpenMP threading (OMP_NUM_THREADS=8 works well)
12. Compatibility: all tested versions of ESMF, TempestRemap
13. Extensive variables (nascent support)

Smoke-tested

ncremap tested on notable CRUD including: AIRS, CAM-FV, CAM-SE, CERES, CICE, CMIPS, MPAS-OI, OMI, POP, and WRF.

Vaporware

More extensive variable support
Multi-grid support (e.g., simultaneous cell center + edge regridding)
Automatic dimension permutation for non-trailing horizontal dimensions
Radius-of-influence interpolation algorithms

Parallelism

ncremap is threaded over variables with OpenMP and scales well up to 8-16 threads

<table>
<thead>
<tr>
<th>Table 3: Parallel Configurations</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCO (serial, m3)</td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td>map_ne30p4t_fv1200x256_aave_150418.nc</td>
</tr>
<tr>
<td>map_ne30p4t_fv257x12_aave_150418.nc</td>
</tr>
<tr>
<td>map_ne120p4t_fv257x12_aave_150418.nc</td>
</tr>
<tr>
<td>map_ne120p4t_fv480x1800_bik2_150418.nc</td>
</tr>
</tbody>
</table>

Support


netCDF Operators (NCO) Software Stack

GSL

www.postersession.com