Version 2.0 of NCAR Global Model Topography Generation Software

https://github.com/NCAR/Topo

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What's new in version 2.0?

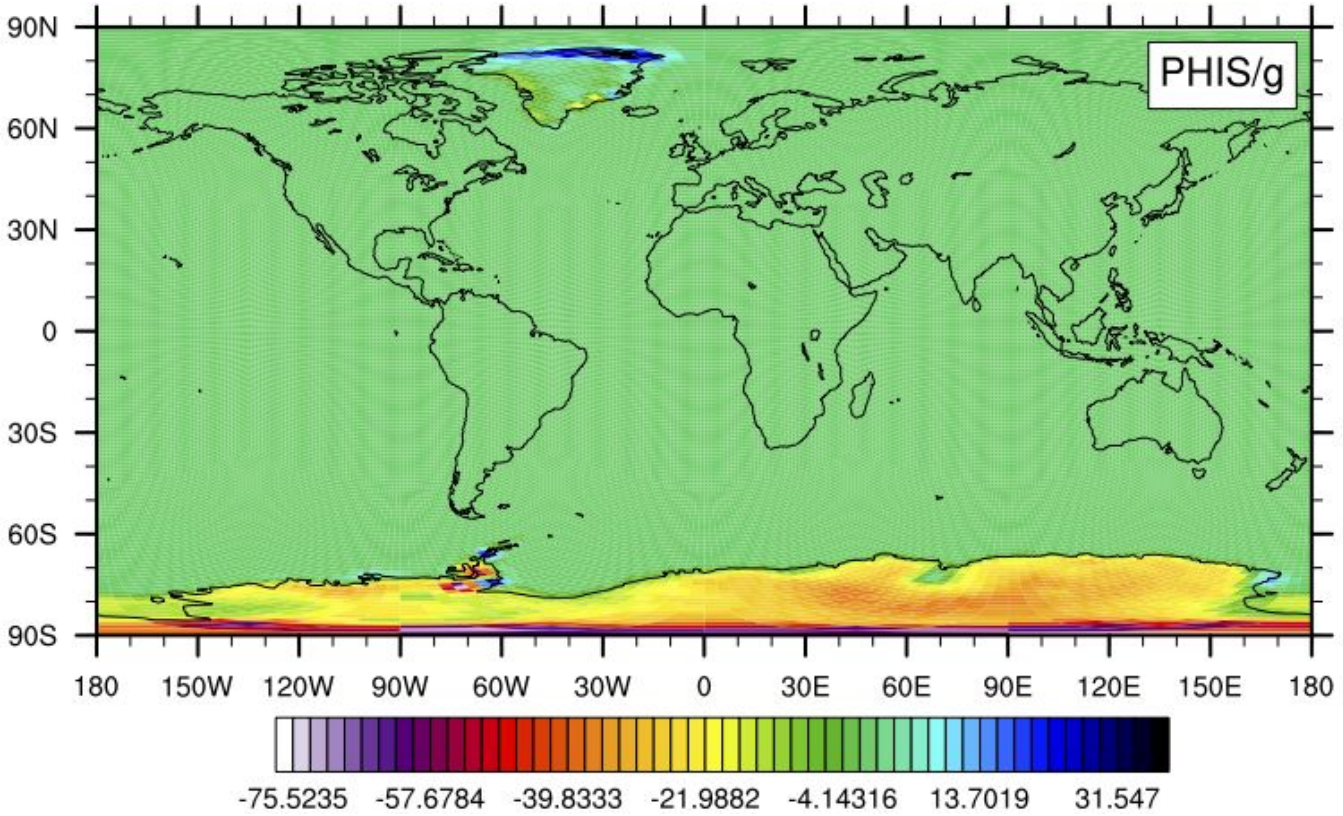
- Command-line execution:

```
./cube_to_target --grid_descriptor_file ne30pg3.nc  --intermediate_cs_name
gmted2010_modis_bedmachine-ncube3000-220518.nc --output_grid ne30pg3 --smoothing_scale 100.0
--name_email_of_creator 'Peter Hjort Lauritzen, pel@ucar.edu'
```

- New improved source topography data (ice sheet regions)
- Internal iterative Laplacian smoother with "no leak" option
- Support for SCRIP and ESMF grid descriptor file formats
- Seamless support for variable resolution grids
  (sub-grid-scale variables and smoothing seamlessly adapts to resolution changes)
- CESM compliant metadata on netCDF file

New improved source topography data:

“old” GMTED2010 dataset merged with the GrIS and AIS high resolution bedmachine data, for more accurate representation of ice sheets. Figure shows new minus old PHIS/g



More details
https://github.com/NCAR/Topo/issues/10

Internal iterative Laplacian smoother with “no leak” option

Smoothing of PHIS occurs on intermediate cubed-sphere grid (used to separate scales for SGH and SGH30); changed from distance weighted smoother to Laplacian:

For an arbitrary variable U, the Laplacian terms in the above equation can be written in the following explicit form:

$$\sqrt{G}\nabla_s^2 U \equiv \sqrt{G}\,\mathrm{div}[\mathrm{grad}(U)]$$
$$= \frac{\partial}{\partial x^1}\left[\sqrt{G}G^{11}\frac{\partial U}{\partial x^1} + \sqrt{G}G^{12}\frac{\partial U}{\partial x^2}\right]$$
$$+ \frac{\partial}{\partial x^2}\left[\sqrt{G}G^{21}\frac{\partial U}{\partial x^1} + \sqrt{G}G^{22}\frac{\partial U}{\partial x^2}\right]. \quad (3)$$

$$G_{ij} = \frac{R^2}{\rho^4 \cos^2 x^1 \cos^2 x^2}\begin{bmatrix} 1+\tan^2 x^1 & -\tan x^1 \tan x^2 \\ -\tan x^1 \tan x^2 & 1+\tan^2 x^2 \end{bmatrix},$$

where $i, j \in \{1, 2\}$ and $\rho^2 = 1 + \tan^2 x^1 + \tan^2 x^2$. The Jacobian of the transformation (the metric term) is $\sqrt{G} = [\det(G_{ij})]^{1/2}$.

Note: must use the inverse of G_{ij} in equation (3) that uses G^{ij}

See Nair (2009): https://journals.ametsoc.org/view/journals/mwre/137/10/2009mwr2843.1.xml

Internal iterative Laplacian smoother with “no leak” option

“No leak” option: Do not apply Laplacian smoother over ocean (`LANDFRAC=0 .and. PHIS==0`) and scale PHIS so that the volume of topography is preserved

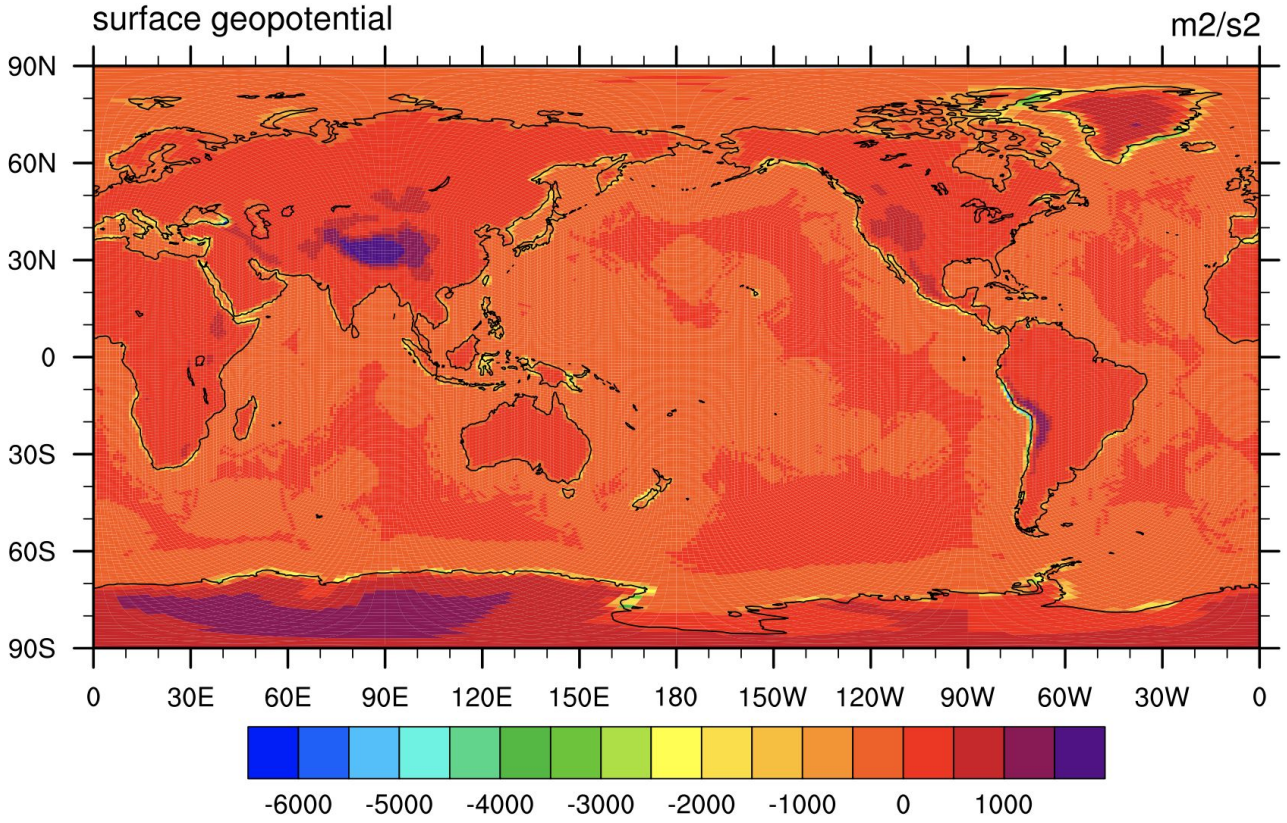


Figure shows effect of not smoothing over ocean (using -m option)

The differences over land are due to “topographic volume” lost over ocean.

Internal iterative Laplacian smoother with “no leak” option

“No leak” option: Do not apply Laplacian smoother over ocean (`LANDFRAC=0 .and. PHIS==0`) and scale PHIS so that the volume of topography is preserved

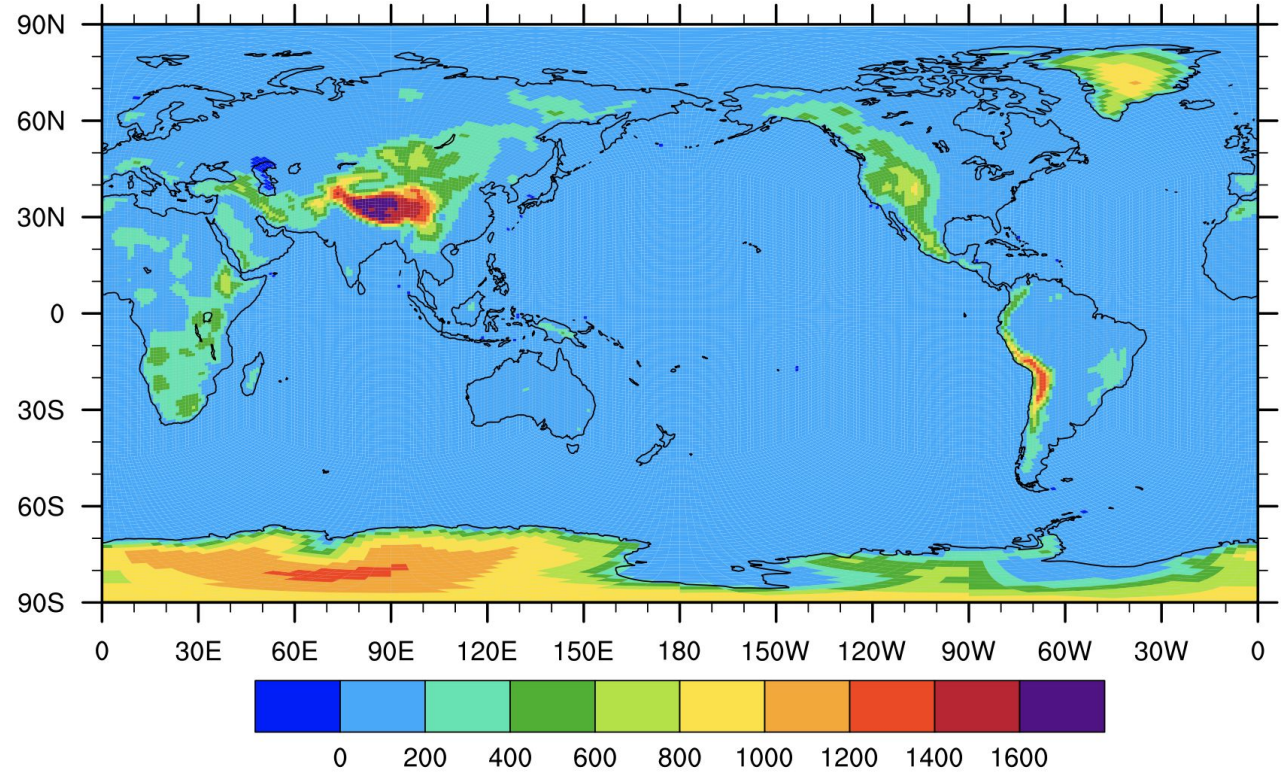
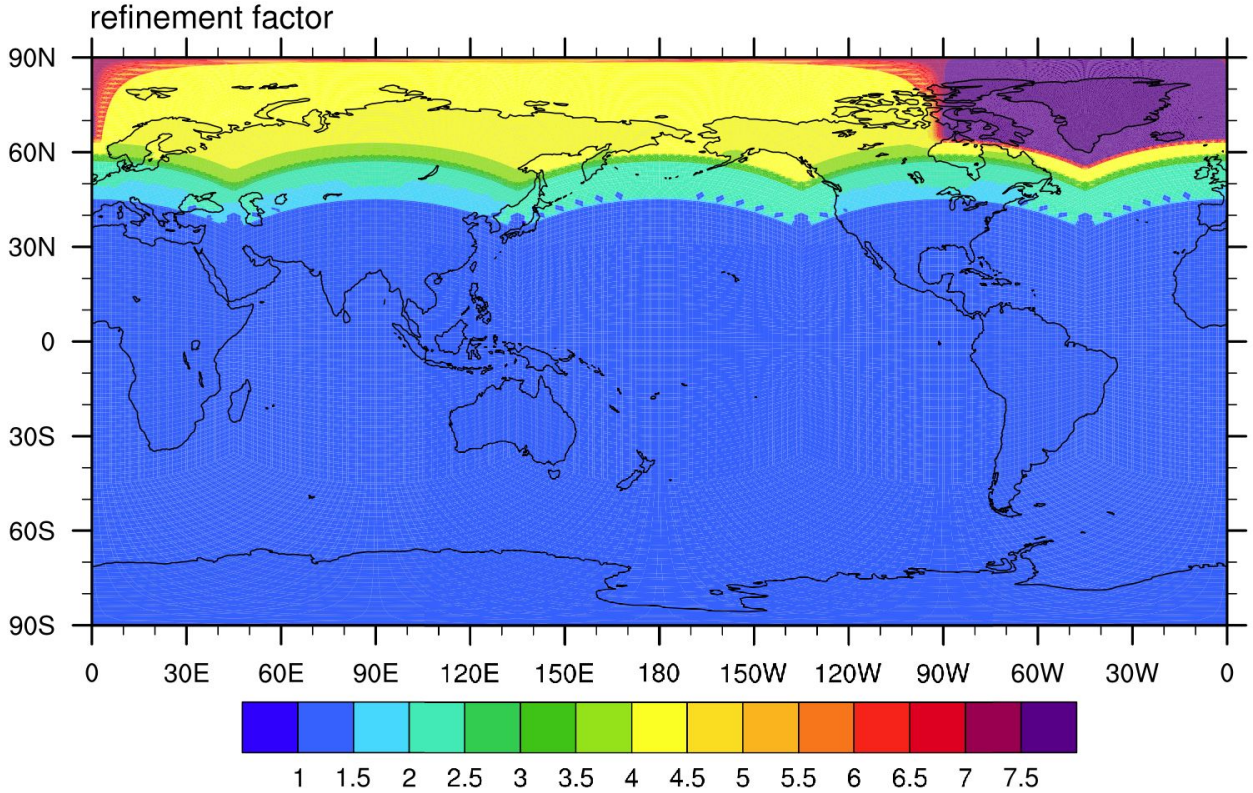


Figure shows effect of scaling topography to preserve volume (PHIS; m2/s2)

New PHIS minus PHIS without scaling to preserve volume.

Seamless support for variable resolution grids

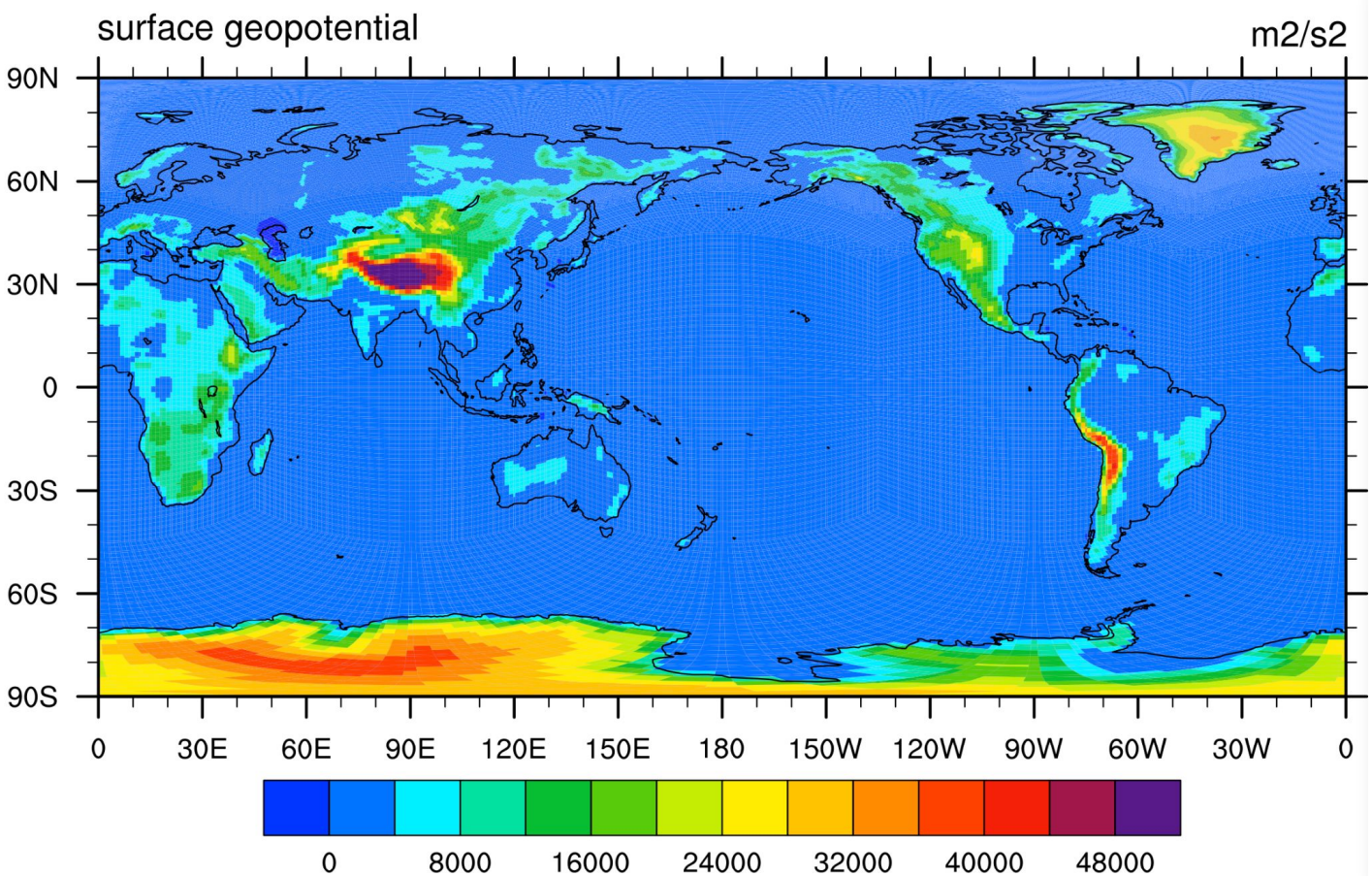
Example: spectral-element refined grid over Greenland 1 degree -> ⅛ degree



./cube_to_target --write_rrfac_to_topo_file --grid_descriptor_file='/glade/p/cesmdata/inputdata/atm/cam/coords/ne0ARCTICGRISne30x8_scrip_c191209.nc' --intermediate_cs_name='../regression-test-data/gmted2010_bedmachine-ncube0540-220518.nc' --output_grid='ne0ARCTICGRISne30x8' --smoothing_scale=100.0 -u 'Peter Hjort Lauritzen, pel@ucar.edu' -q 'output/' -r -y 8 -v

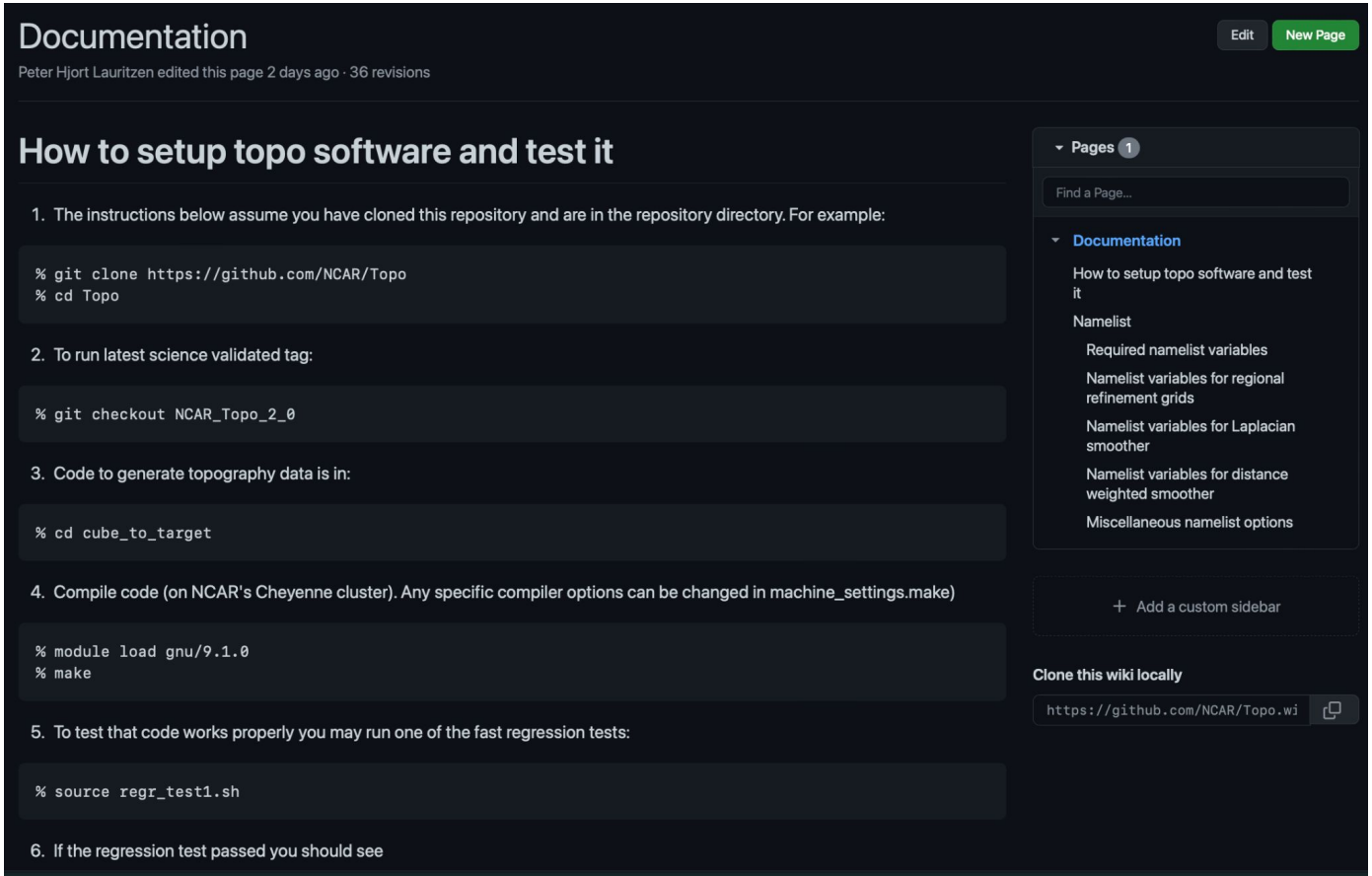
Seamless support for variable resolution grids

Example: spectral-element refined over Greenland 1 degree -> ⅛ degree



User’s guide:

https://github.com/NCAR/Topo/wiki/Documentation



Documentation

Edit New Page

Peter Hjort Lauritzen edited this page 2 days ago · 36 revisions

How to setup topo software and test it

1. The instructions below assume you have cloned this repository and are in the repository directory. For example:

```
% git clone https://github.com/NCAR/Topo
% cd Topo
```

2. To run latest science validated tag:

```
% git checkout NCAR_Topo_2_0
```

3. Code to generate topography data is in:

```
% cd cube_to_target
```

4. Compile code (on NCAR's Cheyenne cluster). Any specific compiler options can be changed in machine_settings.make)

```
% module load gnu/9.1.0
% make
```

5. To test that code works properly you may run one of the fast regression tests:

```
% source regr_test1.sh
```

6. If the regression test passed you should see

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  - Namelist
    - Required namelist variables
    - Namelist variables for regional refinement grids
    - Namelist variables for Laplacian smoother
    - Namelist variables for distance weighted smoother
    - Miscellaneous namelist options

+ Add a custom sidebar

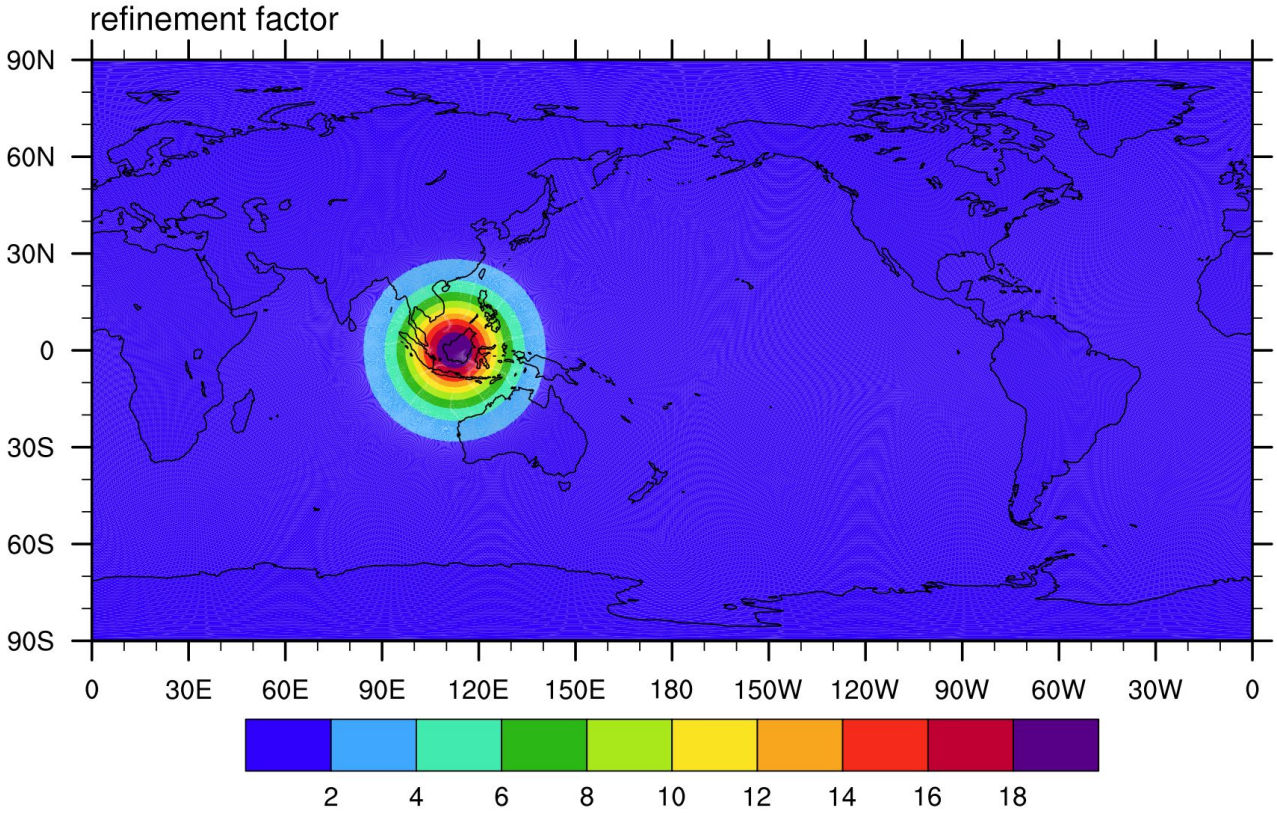
Clone this wiki locally

https://github.com/NCAR/Topo.wi

Extra slides

Seamless support for variable resolution grids

Example: MPAS refinement ~60km -> 3km



./cube_to_target --write_rrfac_to_topo_file --grid_descriptor_file='/glade/p/cgd/amp/pel/topo/grids/mpas-60-3km-WestPacific/mpas_x20.835586.wpac.1_scrip.nc' --intermediate_cs_name='../regression-test-data/gmted2010_bedmachine-ncube0540-220518.nc' --output_grid='mpas-60-3km-WestPacific' --smoothing_scale=50.0 -u 'Peter Hjort Lauritzen, pel@ucar.edu' -q 'output/' -r -y 20