# New CAM (NSF-DOE Community Atmosphere Model) topography generation software: CAM5.2

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## Introduction

• A new algorithm and associated software (released with CAM5.2) to generate surface height and associated sub-grid-scale orographic variances is presented.

• Atmospheric models usually need the following topography related variables

- PHIS : geopotential height of surface
- LANDFRAC: land fraction (0,1)
- SGH30 : standard deviation of PHIS on scales approximately less than 6km (for turbulent mountain stress parameterization)
- SGH : standard deviation of PHIS on scales approximately longer than ~6km and less than model grid scale (for gravity wave drag parameterization)

• The "raw" topographic data (USGS 30sec) is binned to an intermediate gnomonic cubed-sphere grid which, contrary to the older versions of CAM topography generation software, results in a **quasi-isotropic separation of scales** over the entire sphere for SGH30 and SGH (see center Figure).

• The cubed-sphere data is thereafter **rigorously remapped** using a volume conserving method (Lauritzen et al. 2010, Ullrich et al. 2009) to any target model grid. The algorithm supports structured and unstructured meshes; even meshes with non-convex control volumes.

• PHIS is usually smoothed to avoid noise problems; after smoothing PHIS the SGH variable is recomputed to include the extra sub-grid-scale variance in SGH introduced by the smoothing of PHIS.

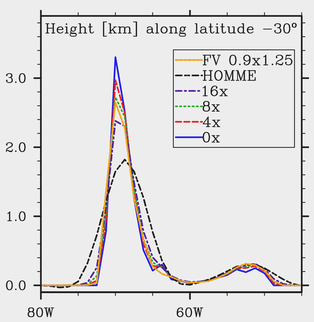
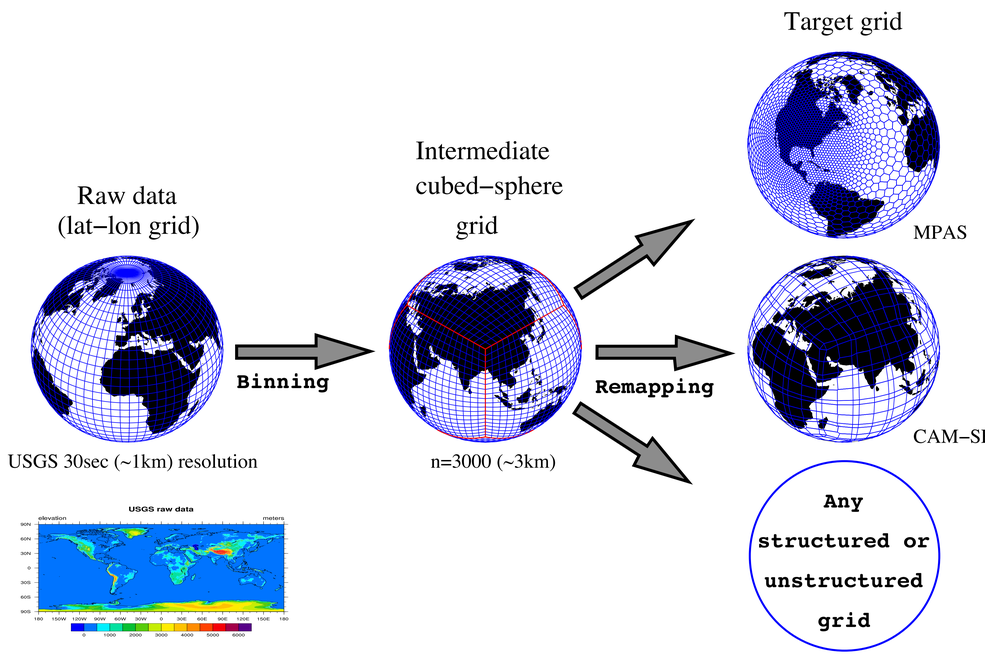



Figure: Cross sections of height through the Andes for different levels of PHIS smoothing in CAM-SE (spectral elements) as well as HOMME (High-Order Methods Modeling Environment) and CAM-FV (finite volume) height.

"0x", "4x", "8x", "16x" = level of smoothing in CAM-SE from no smoothing ("0x") to more smoothing ("16x")




variables:
h
(height in m)
LANDFRAC
(land fraction [0,1])

variables:
PHIS
(surface geopotential)
LANDFRAC
SGH30
(standard deviation
of 30sec PHIS)

variables:
PHIS
LANDFRAC
SGH30
SGH
(standard deviation of
~3km cubed–sphere PHIS)

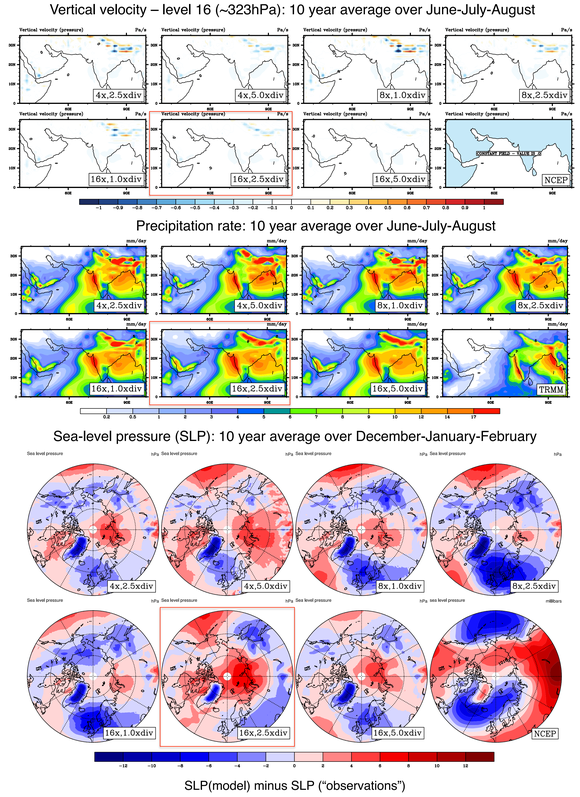
## Summary

- Topography generation software that consistently separates scales for sub-grid-scale parameterizations and volume-conserving remaps variables directly to any spherical target grid has been released with CAM5.2.
- Different levels of smoothing of PHIS for the new dynamical core in CAM based on spectral elements (SE) have been tested in 'AMIP'-like simulations and a balance between roughness of PHIS, level of additional divergence damping and simulation quality has been found: 16x, 2.5x div

This research was funded by the National Science Foundation (NSF) and DOE SciDAC Program under award register ER65354

## 10 year `AMIP'-like simulations with CAM-SE at approximately 1° resolution

To damp noise we increase coefficient for hyperviscosity on the divergent modes (notation: "2.5div" = 2.5 times larger coefficient on hyperviscosity on divergent modes compared to rotational modes)




## References

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Ullrich P.A., P.H. Lauritzen, C. Jablonoski. 2009. Geometrically exact conservative remapping (GECoRe): Regular latitude-longitude and cubed-sphere grids. *Mon. Wea. Rev.* **137**: 1721-1741.

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