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Deriving New Topography-based Global Datasets for Land Surface Modeling

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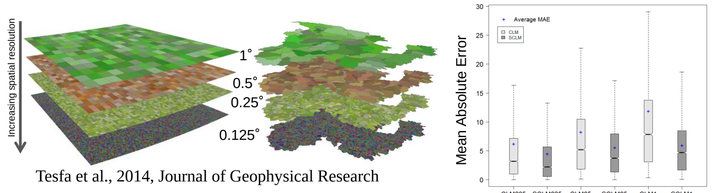
Background and Motivation

Topography exerts a major control on land surface processes through its influence on atmospheric forcing, properties of soil and vegetation, network topology (connectivity) and drainage area. Land surface spatial structure that captures spatial heterogeneity influenced by topography is expected to improve representation of land surface processes in land surface models. For example, land surface modeling using subbasins instead of regular grids as computational units has demonstrated improved scalability of simulated runoff and streamflow processes.



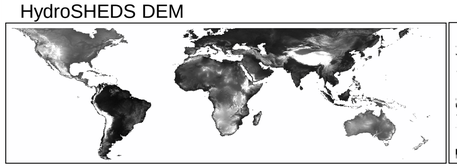
Tesfa et al., 2014, Journal of Geophysical Research

In this study, a global subbasin dataset and other various surface datasets are developed from a more consistent high resolution global Digital Elevation Model developed in this effort. A local classification method is applied to derive a new land surface spatial structures defined by further dividing subbasins/grids into subgrid units topographic information to take advantage of the emergent patterns and scaling properties of atmospheric, hydrologic, and vegetation processes in land surface models. This presentation reports recent results.

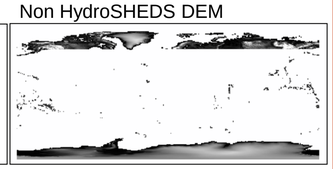
Approach

Develop A High Resolution Global Digital Elevation Model (DEM)

HydroSHEDS DEM

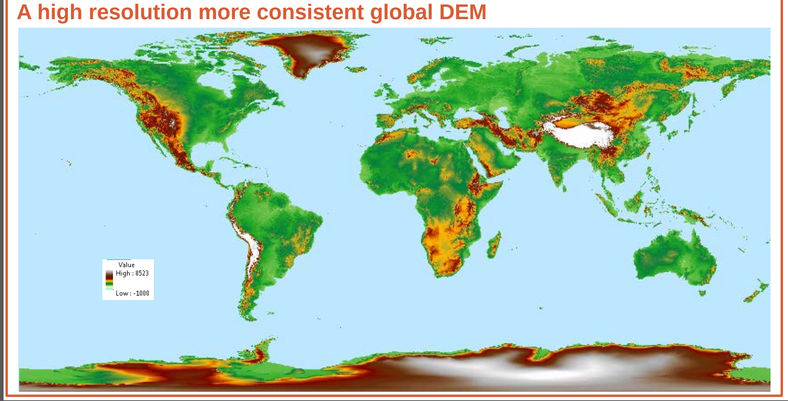


Non HydroSHEDS DEM



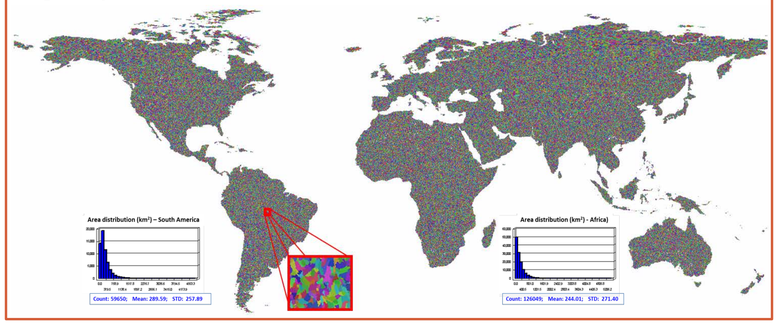
- The HydroSHEDS Digital Elevation Model covers only land surface of the globe north of 56° south (excluding Antarctica) and south of 60° north latitude.
- There is a need to fill the regions missing from the HydroSHEDS DEM to develop a global DEM.
- A more consistent 90 meter resolution global elevation dataset has been developed by blending the HydroSHEDS DEM with other elevation datasets covering areas that are missing in the HydroSHEDS DEM. The non HydroSHEDS elevation data were downloaded from http://www.viewfinderpanoramas.org/dem3.html.

A high resolution more consistent global DEM



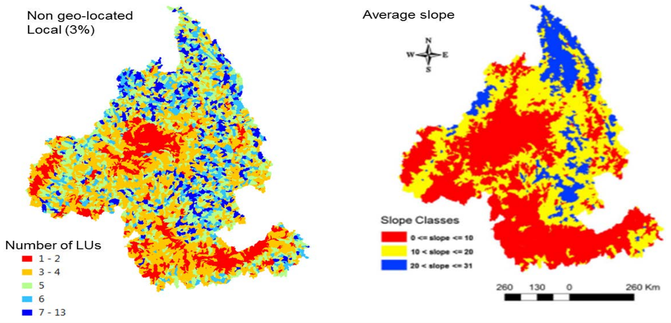
Develop A New Global Subbasin Dataset

- New global subbasin (watershed) and stream network datasets have been derived from the high resolution globally consistent DEM developed in this effort.
- The Terrain Analysis Using Digital Elevation Models (TauDEM) was used to delineate the watersheds for each continent and islands represented in the DEM.
- Topographic attributes such as slope and aspect are also derived from the DEM using TauDEM to be used for deriving the subbasin-based subgrid land unit dataset globally.



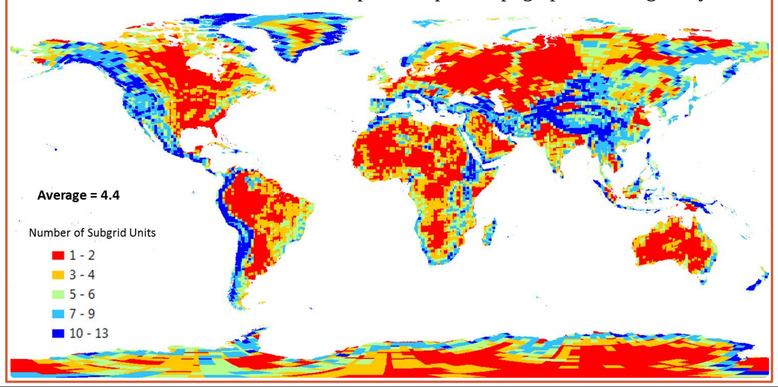
Develop A New Subbasin-based Subgrid Dataset

- Each subbasin is discretized into multiple land units using a local classification scheme developed to capture topographic heterogeneity.



Develop A New Grid-based Subgrid Dataset

- Each grid (1 degree CAM SE grid) is discretized into multiple subgrid units using a local classification scheme developed to capture topographic heterogeneity.

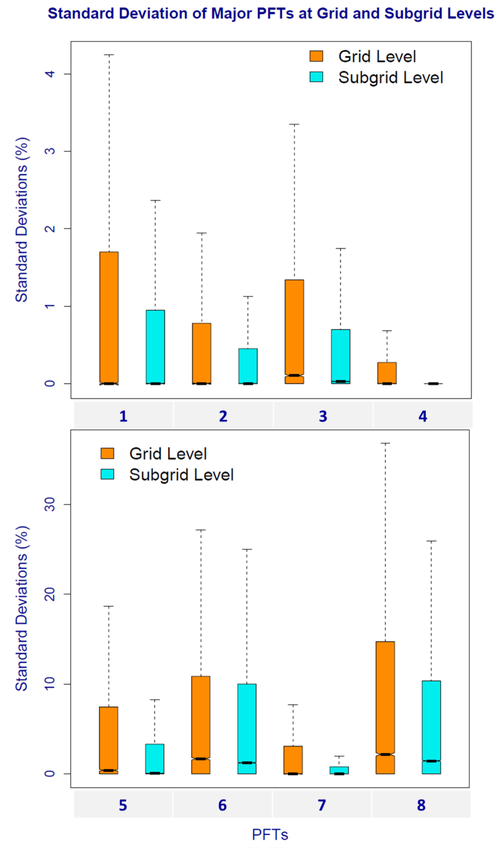


Develop surface datasets based on the new subgrid structure

- Surface datasets of PFTs, soils, and land cover type have been developed for the ACME Land Model using the subgrid structures derived based on the 1 degree CAM SE grids.
- Variables are first converted from netCDF into one of GIS grid formats. Then, values for each subgrid unit are calculated by averaging the grids falling within its boundary.

Preliminary Analyses

- Preliminary analyses are performed on the PFT dataset to evaluate whether the subgrid units are representing more homogenous areas in terms of PFT composition.
- For each PFT type, standard deviation values (%) are calculated at grid (1 degree CAM SE) and subgrid levels globally.
- Box plots are used to compare the standard deviation values of major PFTs at grid and subgrid levels.
- Generally, standard deviation values are lower at subgrid level than at grid level.



PFT	Name
1	Needle leaf evergreen trees (temperate)
2	Needle leaf evergreen trees (boreal)
3	Needle leaf deciduous trees (boreal)
4	Broad leaf evergreen trees (tropical)
5	Bare soil
6	Broad leaf deciduous shrub (temperate)
7	Grass
8	Crop

Summary and Conclusions

- A more consistent high resolution (90 m) global DEM has been developed by blending HydroSHEDS DEM with other elevation datasets.
- Taking the advantage of the DEM, a new global subbasin dataset equivalent to 1/8th degree grid and other hydrologically relevant datasets have been developed.
- New topography-based subgrid structures are developed using local subbasin/grid discretization scheme designed to capture topographic heterogeneity.
- Various land surface datasets are being developed based on the new subgrid structures.
- Standard deviation values of PFTs at subgrid level are generally lower than at the grid level, suggesting improved representation of PFTs at the subgrid level.

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