GeoModelGrids: Storage Scheme for 3D Seismic Velocity Models

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- **Goal**

  Portable, flexible, efficient storage of variable resolution grid-based data

- **Requirements**
  - Accommodate models with or without topography
  - Variable resolution with depth
  - Self-describing binary format
  - Allow loading only a piece of the model into memory
  - Allow serial and massively parallel querying

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Graymer et al. Delta Model

Developing new, improved storage scheme
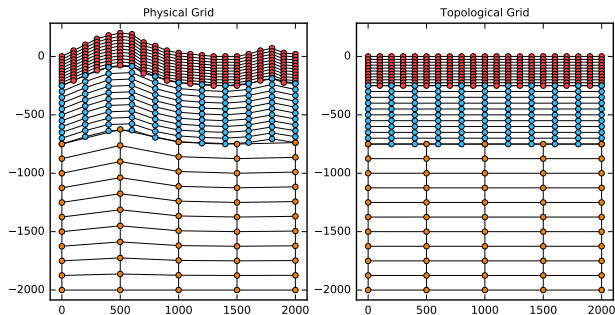
Linear mapping between positions in logical grid, $z^{logical}$, and positions in physical grid, $z^{physical}$.

$$z^{physical} = z_{bottom} + (z_{topo}^{physical} - z_{bottom})/(z_{top}^{logical} - z_{bottom}) * (z_{top}^{grid_i} - z^{logical} - z_{bottom}) \quad (1)$$

Storage Scheme Key Features

Transparent layout   stack of logical grids with uniform resolution

Fast   Index into grid for any location can be computed from metadata alone

Compact   No extra points in "air"

Flexible   Can be used in other geographic regions with other data (e.g., SCEC CVMs and CSMs)

Datasets

topography
$grid_0$
$\vdots$
$grid_n$

Metadata

- Description
- Domain (dimension and number of grids)
- Coordinate system
- Data stored in model (names of values and their units)
- Topography (resolution)
- Grid (horizontal and vertical resolution, top elevation)

Could be accompanied by Xdmf metadata file for seamlessly viewing a model directly in widely-used ParaView and Visit open-source visualization software.

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- **Serial interface**: Use caching for fast access without reading in entire model
  - Longitude/latitude/elevation $\rightarrow x$, y, $z \rightarrow index^{grid_i}$
  - Utilities for extracting virtual boreholes, isosurfaces
- **Parallel interface**: Avoid I/O bottlenecks on massively parallel clusters
  - Build upon or adapt LLNL R(aster) interface