A Hexagonal Box Spline Wavelet for Multiresolution Visualization of Digital Earth Data

Mohammad Imrul Jubair [1], Usman Alim [2], Niklas Roeber [3], John Clyne [4], Ali Mahdavi-Amiri [5] and Faramarz Samavati [6]

[1,2,5,6] University of Calgary, [3] German Climate Computing Centre, [4] University Corporation for Atmospheric Research

UNIVERSITY OF CALGARY

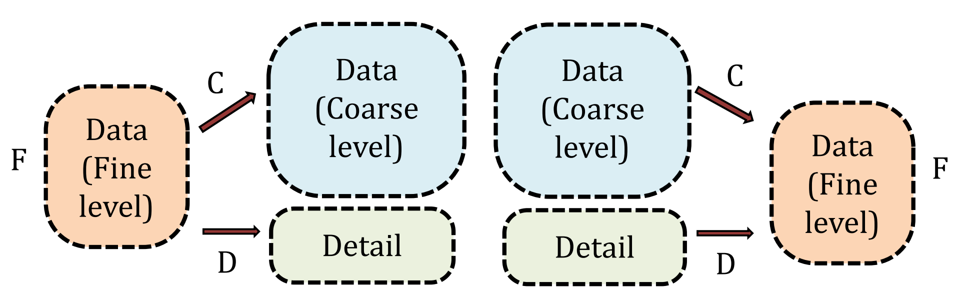
UCAR

DKRZ DEUTSCHES KLIMARECHENZENTRUM

Introduction

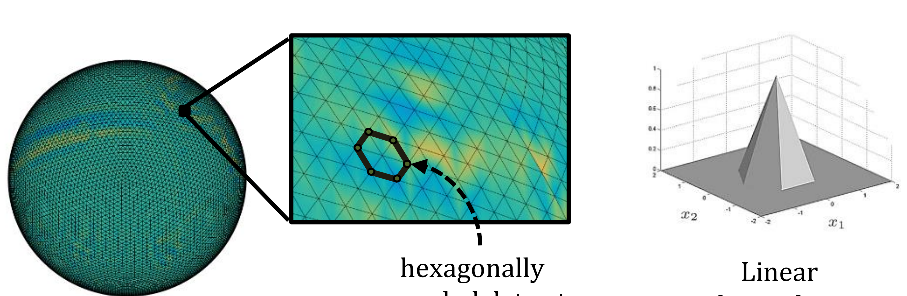
Motivation

- Digital Earth, or virtual Globe, has become an important subject in the field of Climatology. In most cases, such frameworks deal with discretizing the Earth's surface into different geometric objects and the governing equations of state for the simulation are solved on the resulting grid. These cells represent areas that contain geospatial information related to the point of interest.
- Multiresolution analysis provides facilities to visualize large data at different levels of detail (LoD) while providing the advantages of efficient data compression and transmission.



Contribution

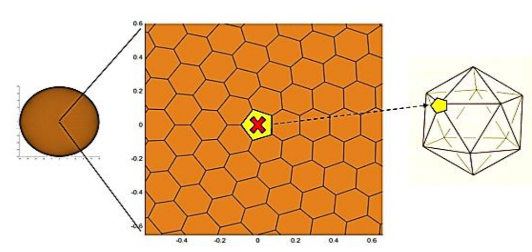
- The computational geosciences community has historically used latitude-longitude (regular structured) grids. But due to reasons of improved scalability, and better handling of the singularities that result the poles with latitude-longitude grids, the computational geosciences community is moving toward less regular discretization. A major contribution of this work is to develop a wavelet that operates on hexagonal cells.
- Multiresolution filters are designed based on the three directional linear box-spline which is natively supported by modern GPUs.



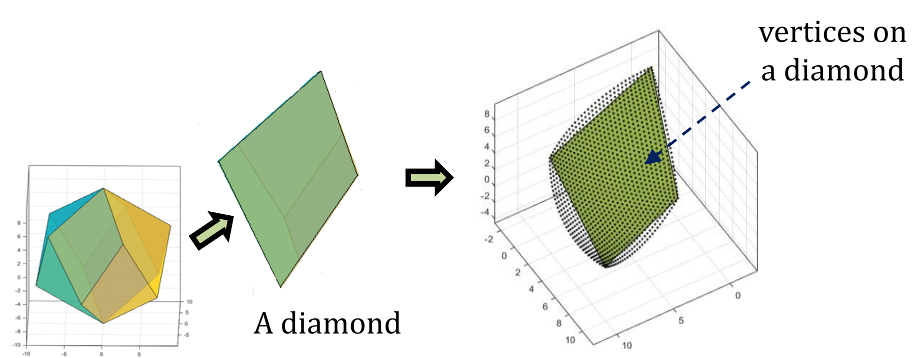
Methodology

Data Structure for DE

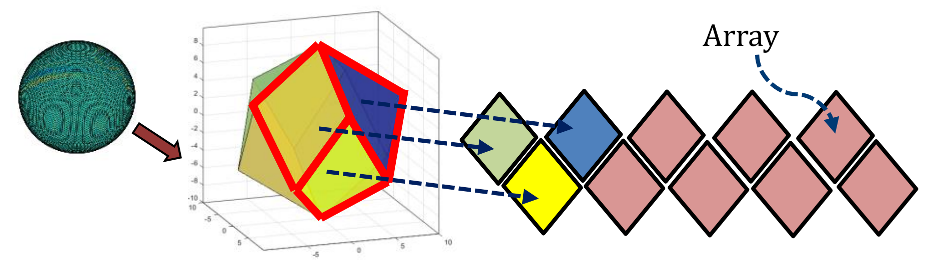
In this work, we employ Atlas of Connectivity Maps (ACM) , which maps vertex connectivity information to separate two-dimensional arrays. Many digital Earth models are obtained by refining an icosahedron. ACM splits the icosahedron into a set of diamonds. Vertex information on the diamonds is stored in individual 2D arrays. Thus, the connectivity information of the entire digital Earth model is mapped to ten different arrays. This type of data structure provides simple and efficient ways to traverse the vertices and retrieve neighbourhood information



Generating Icosahedron based on extra-ordinary vertices (having five valance)



Vertices on the region of a single diamond



Storing connectivity information of vertices into 10 arrays

Multiresolution Scheme:

Decomposition:

$$C = (((F * u) * a)_{\downarrow 2}) * a^{-1},$$
$$D = (F * \hat{w})_{\downarrow 2},$$

where F is the fine resolution, and C and D are coefficients and details respectively. Here, u is a scale filter obtained by leveraging the self-similarity of the linear box spline , and the auto-correlation filter a and a^{-1} perform an orthogonal projection of the fine level down to the coarse level. The weight filter "$\hat{w}$" is obtained by enforcing orthogonality property of D and F spaces.

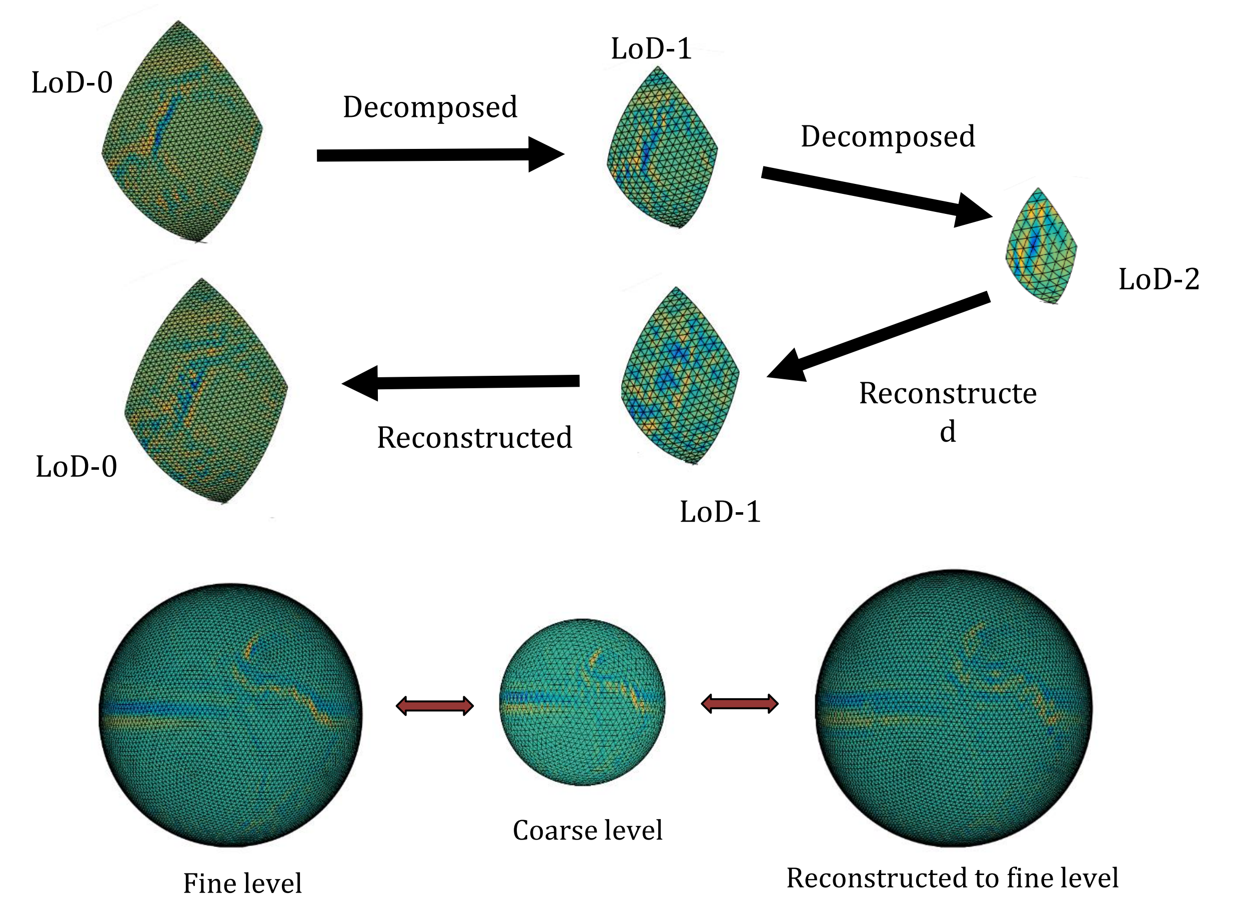
Methodology

$$F = (C_{\uparrow 2}) * u + (D_{\uparrow 2}) * w,$$

where F is the fine level which is reconstructed perfectly from coarse level coefficients C and details D. The filter w is obtained from $\hat{w}$ by exploiting the fact that w and $\hat{w}$ form a biorthogonal wavelet.

Preliminary Results

Data set : ICON (**ICO**sahedral **N**on-hydrostatic, *Courtesy: German Climate Computing Centre*)



Future Work

- Applying the multiresolution scheme on larger scale data set.
- Investigating the error occurred during reconstruction.

References

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