Looking into Clouds

Compression and Progressive Rendering

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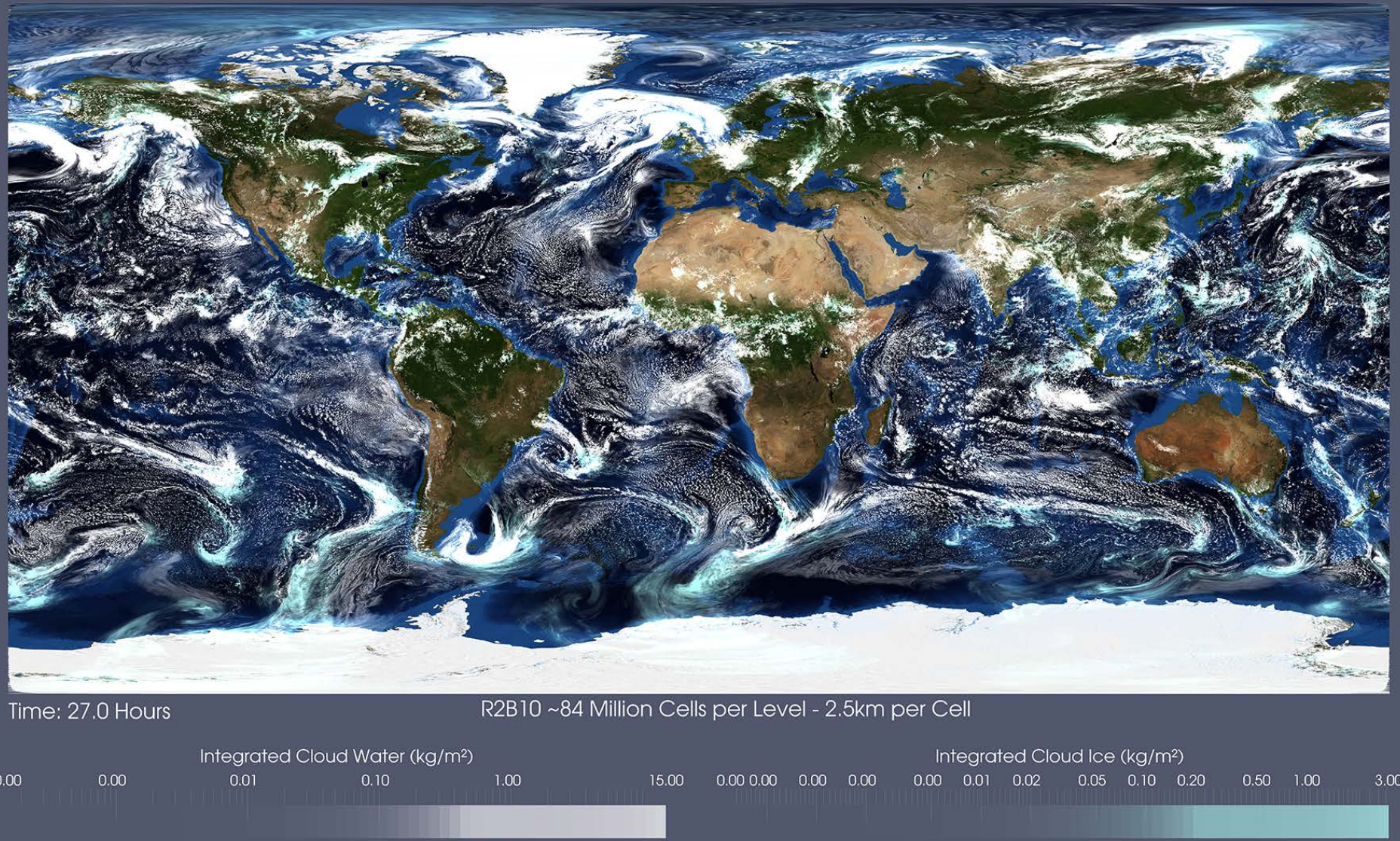
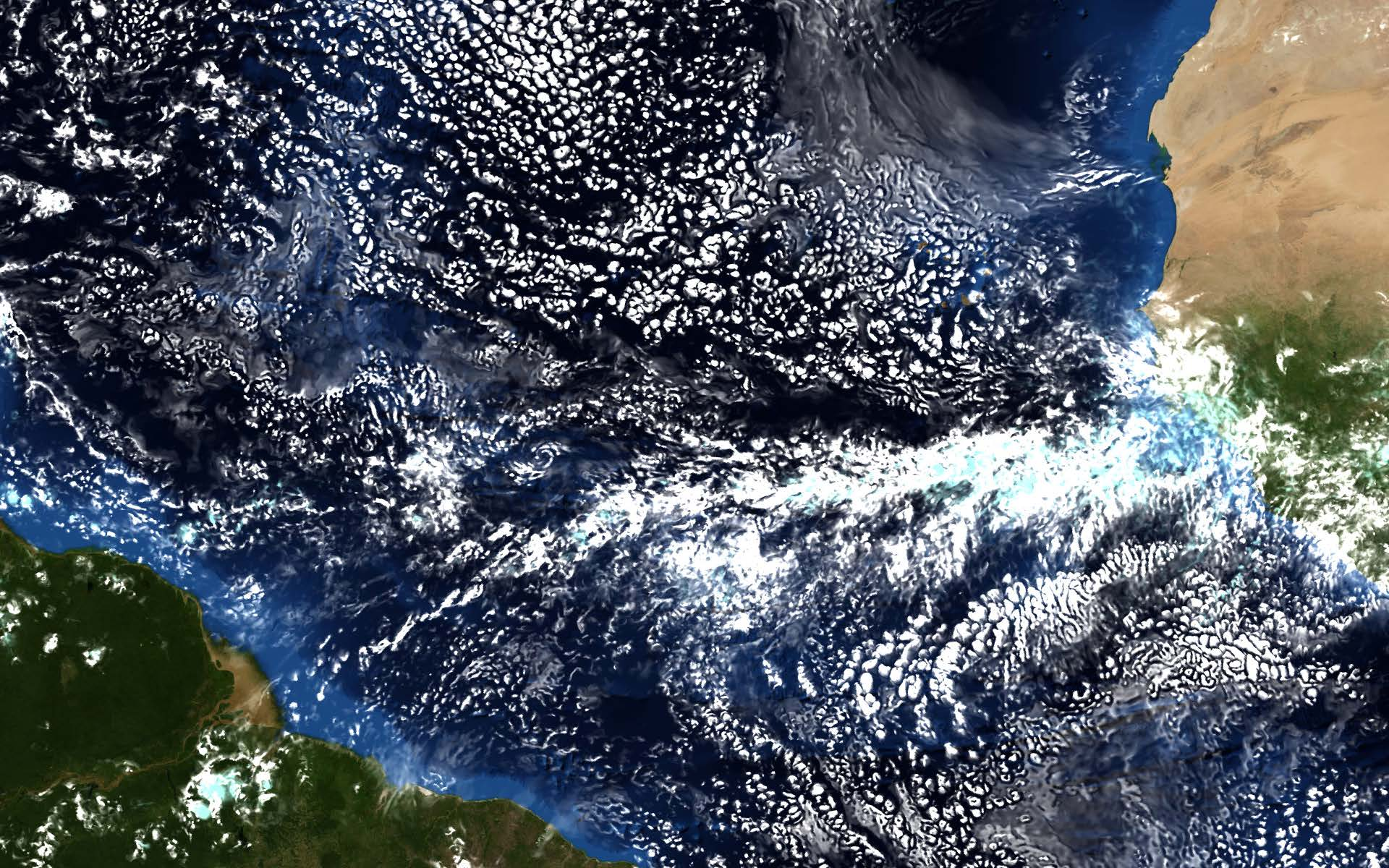
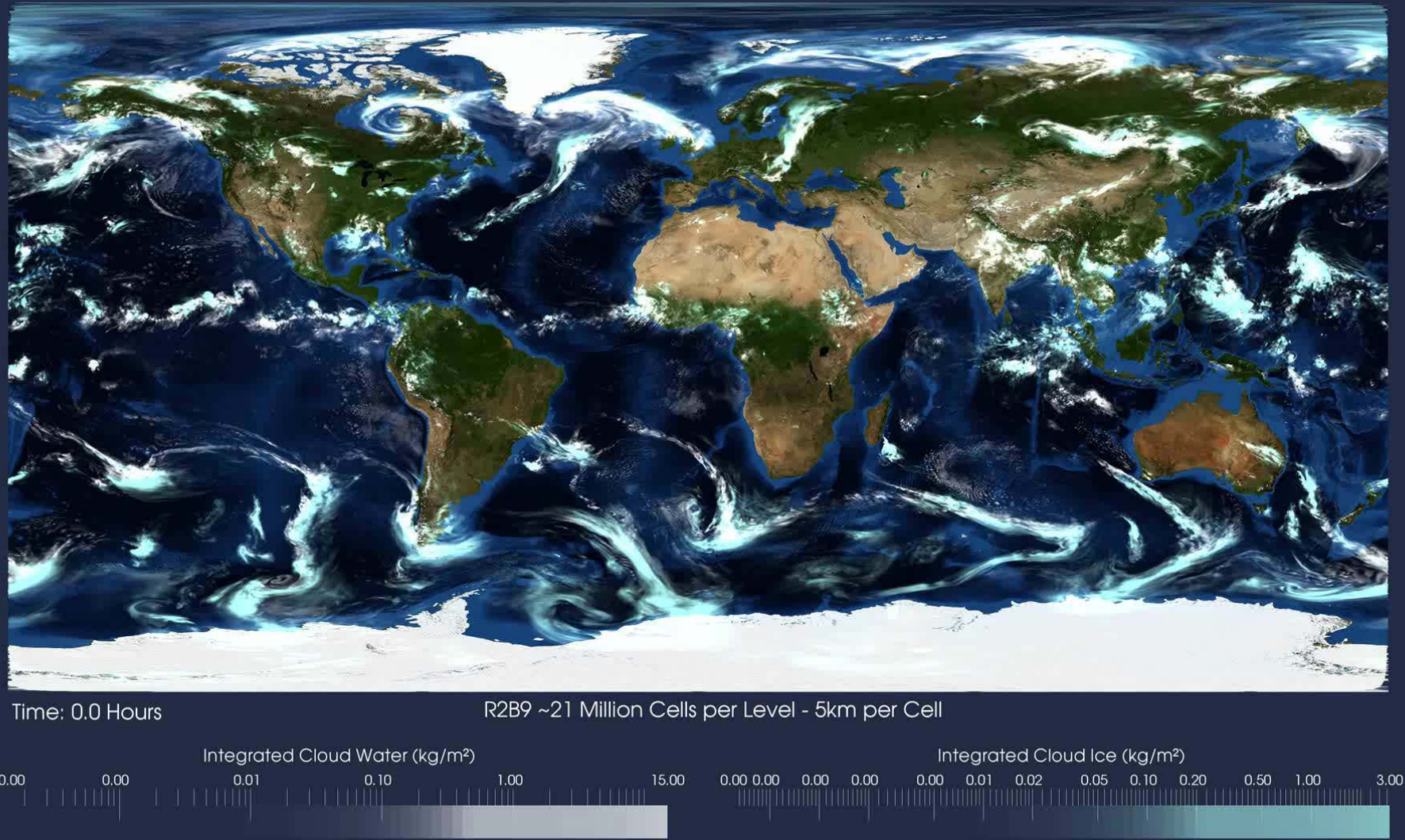

Time: 27.0 Hours
R2B10 ~84 Million Cells per Level - 2.5km per Cell
Integrated Cloud Water (kg/m²)
0.00 0.00 0.01 0.10 1.00 15.00
Integrated Cloud Ice (kg/m²)
0.00 0.00 0.00 0.00 0.00 0.01 0.02 0.05 0.10 0.20 0.50 1.00 3.00

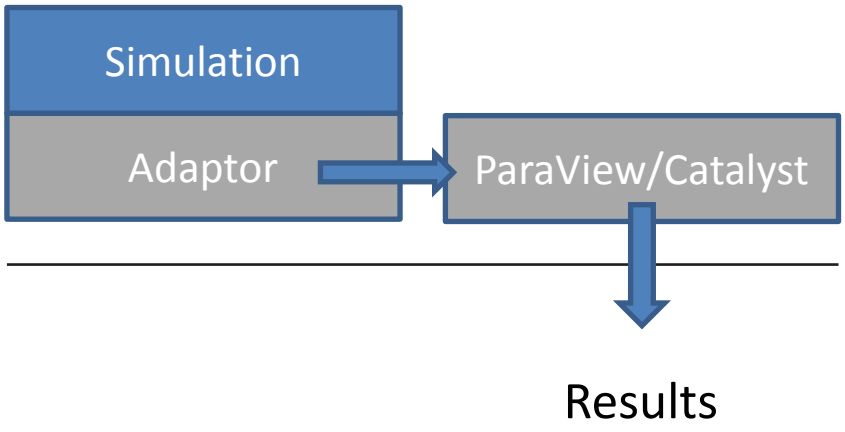



Time: 0.0 Hours
R2B9 ~21 Million Cells per Level - 5km per Cell
Integrated Cloud Water (kg/m²)
0.00 0.00 0.01 0.10 1.00 15.00
Integrated Cloud Ice (kg/m²)
0.00 0.00 0.00 0.00 0.00 0.01 0.02 0.05 0.10 0.20 0.50 1.00 3.00

Visualization of LARGE Data Sets

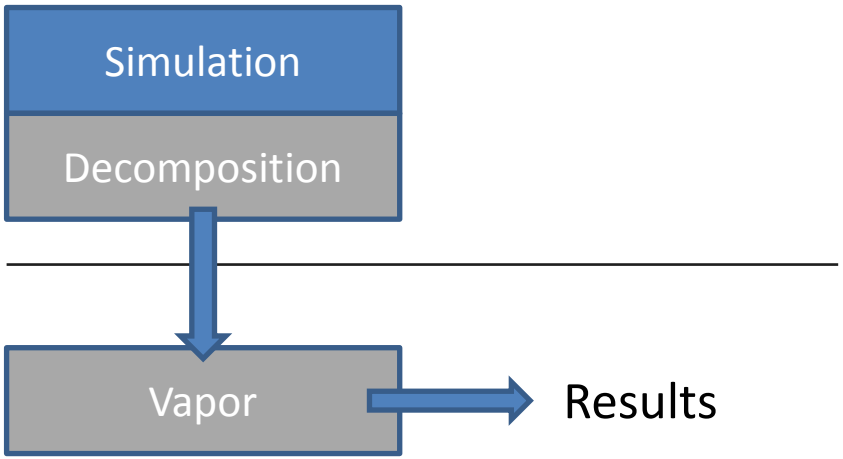
in-situ Visualization

(ParaView/Catalyst)



in-situ Compression

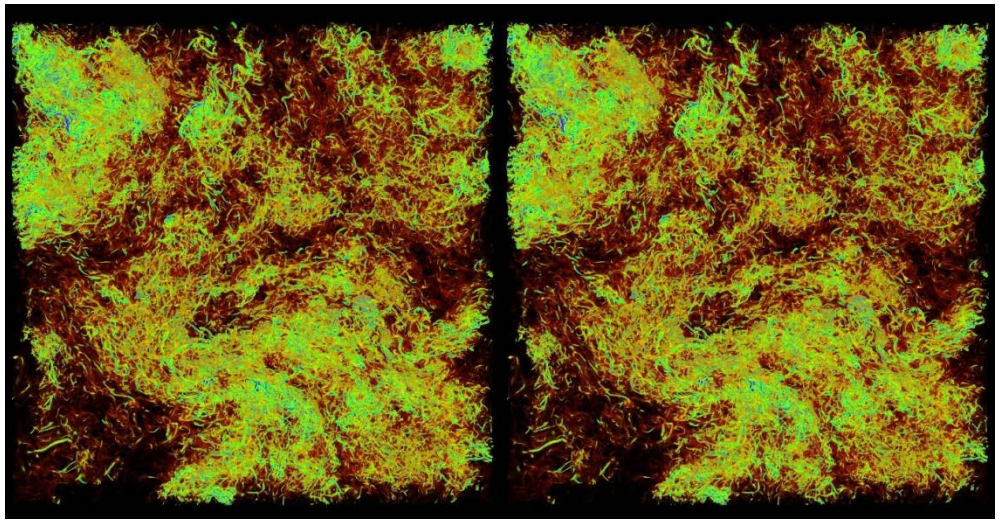
(Vapor)



VAPOR and Compression

- Wavelet-based intelligent data storage
- Progressive data access with multiresolution rendering
- Coefficients are sorted and prioritized

Original
275 GBs / 3D field



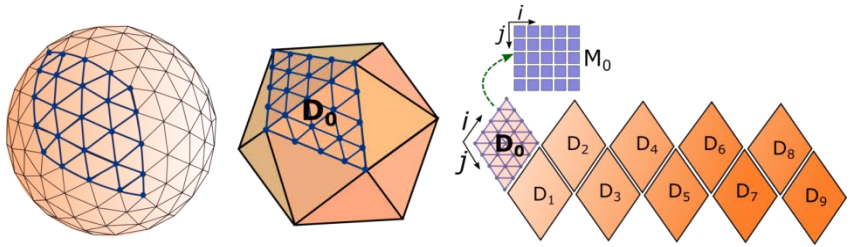
800:1
0.34 GBs / 3D field

(c) John Clyne

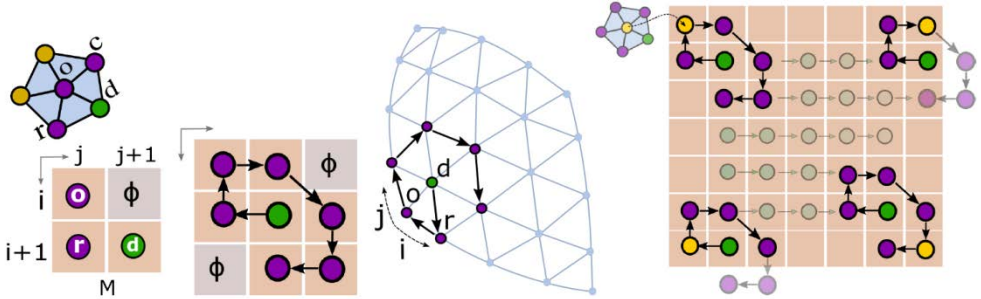
Discrete Hexagonal Wavelet Transform for ICON/MPAS

Decompose sphere into 10 diamonds

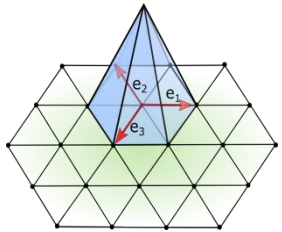
- Diamond vertices at original base icosahedron vertices
- Each diamond has regular topology



Map centroids of quad, triangle, and hexagon cells into a hexagonal mesh with explicit connectivity



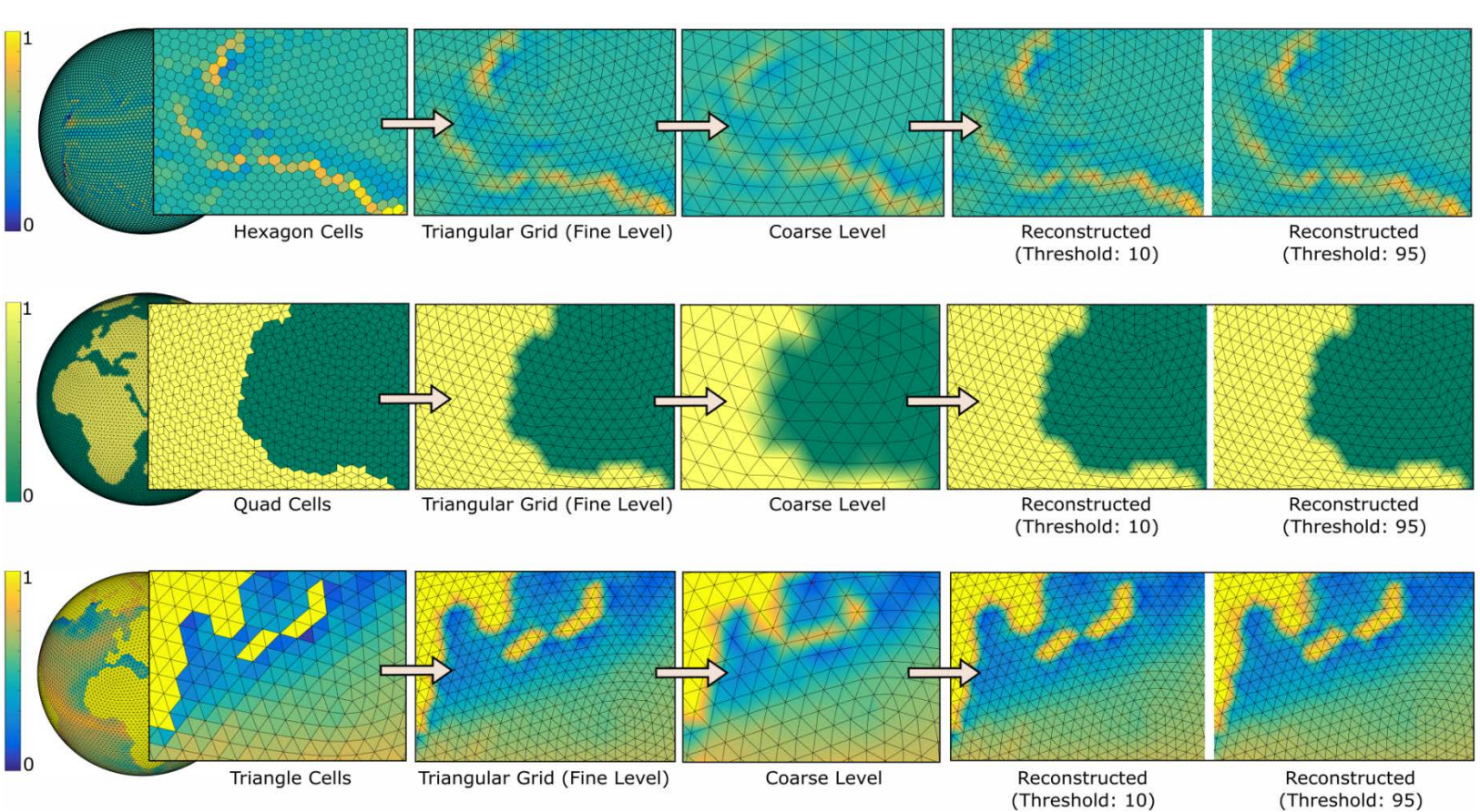
Apply discrete wavelet transform to each regular hexagonal mesh (diamond)



$$f(\mathbf{x}) = \sum_{\mathbf{k}} \overbrace{F[\mathbf{k}]}^{\text{data}} \overbrace{\varphi(\mathbf{x}-\mathbf{L}\mathbf{k})}^{\text{box spline}}$$

[1] Jubair et.al. *"Icosahedral Maps for a Multiresolution Representation of Earth Data"*, VMV 2016

Multiresolution with Icosahedral Maps



[1] Jubair et.al. *"Icosahedral Maps for a Multiresolution Representation of Earth Data"*, VMV 2016

Closing Thoughts

- Looking at ways to work and **interact** with LARGE data
  - In-situ compression and progressive data visualization
  - Wavelets are computationally efficient
  - Significant data reduction without impairing visualization
- *Lossy* compression has always been applied
  - Float vs. double, temporal/spatial resolution
- Next Steps
  - VAPOR release with ICON/MPAS support (irregular grid)
  - Wavelet evaluation paper (in continuation of [2])
  - In-situ compression module for ICON

[2] Baker et.al. *"A Methodology for Evaluating the Impact of Data Compression on Climate Simulation Data"*, HPDC 2014