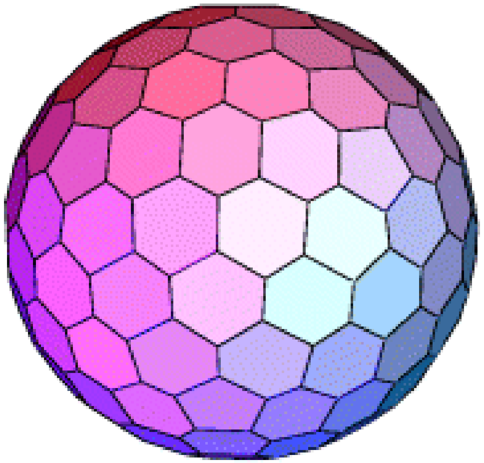
An MPAS Core for CAM
Model for Prediction Across Scales



Bill Skamarock, NCAR

Todd Ringler, LANL

Joe Klemp, NCAR

John Thuburn, Exeter University

Michael Duda, NCAR

Max Gunzburger, Florida State University

Lili Ju, University of South Carolina

Modeling system for unstructured icosahedral (hexagonal) meshes using C-grid discretizations.

Jointly developed, primarily by LANL and NCAR.

MPAS infrastructure - NCAR, LANL, others.

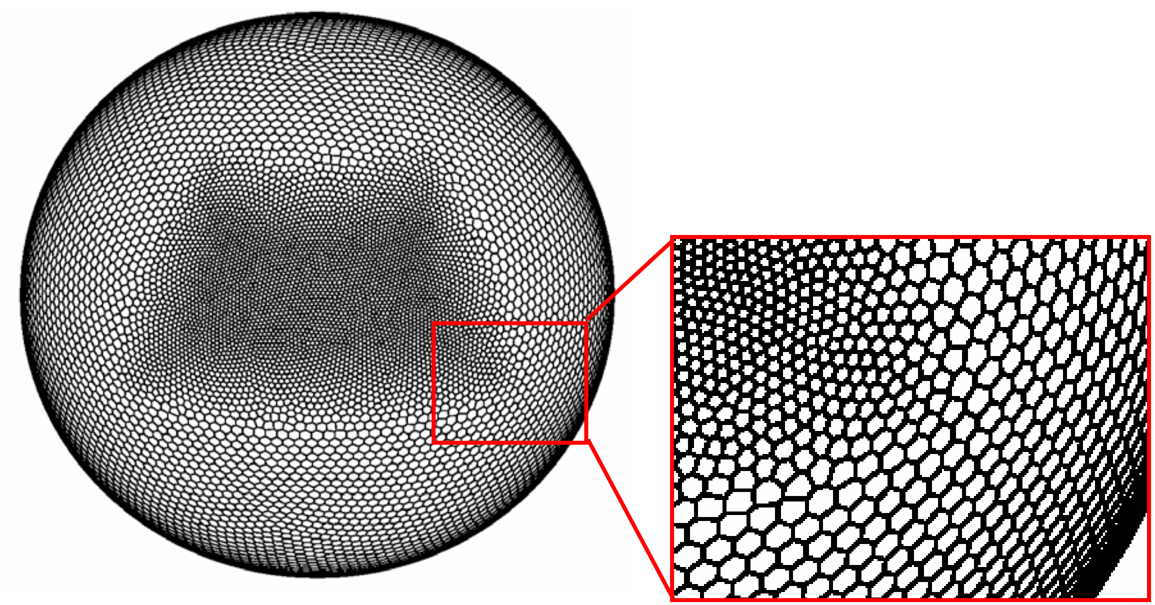
MPAS - Atmosphere (NCAR)

MPAS - Ocean (LANL)

MPAS - Ice, etc.

Applications: Weather, regional climate, climate.

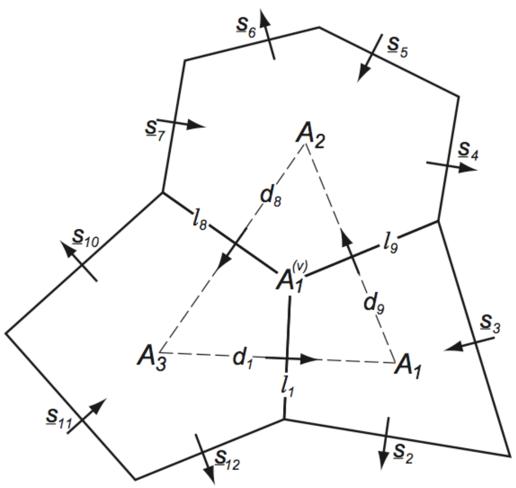
Conformal, Variable-Resolution Meshes



(Michael Duda, MMM)

SCVTs
Spherical Centroidal
Voronoi Tessellations

- Cell center is cell center-of-mass
- Edges of dual grid intersect edges of primary grid at right angles.



Solution to the C-grid problem of non-stationary geostrophic modes on hexagonal grids:

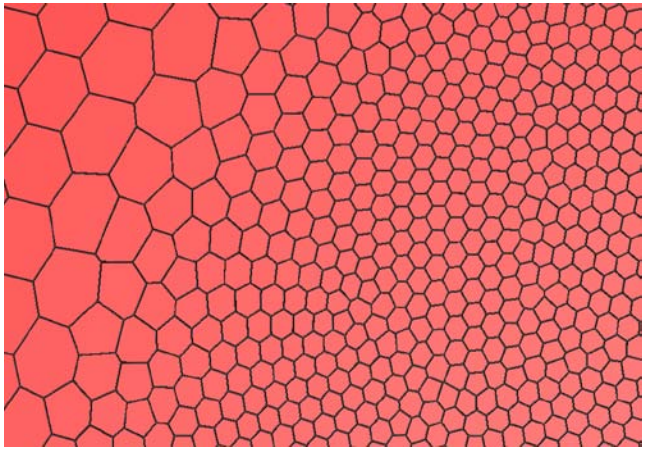
Thuburn, Ringler, Skamarock and Klemp, Numerical Representation of Geostrophic Modes on Arbitrarily Structured C-Grids. JCP 2009.

Ringler, Thuburn, Skamarock and Klemp, Numerical Treatment of Energy and Potential Vorticity on Arbitrarily Structured C-Grids. JCP, accepted.

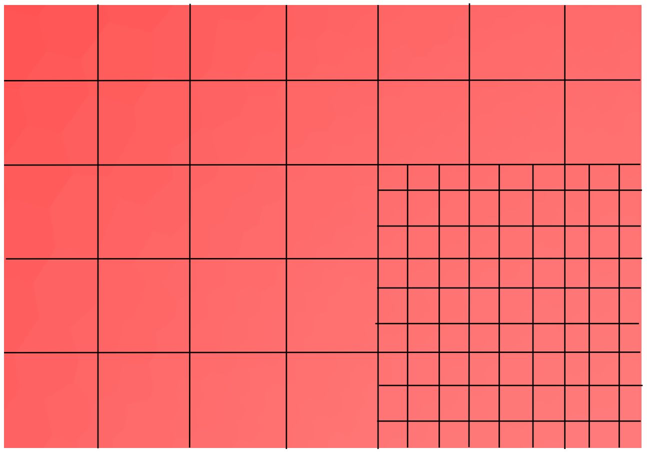
Conformal, Variable-Resolution Meshes

A conformal mesh is a mesh with no hanging nodes.

conformal



non-conformal

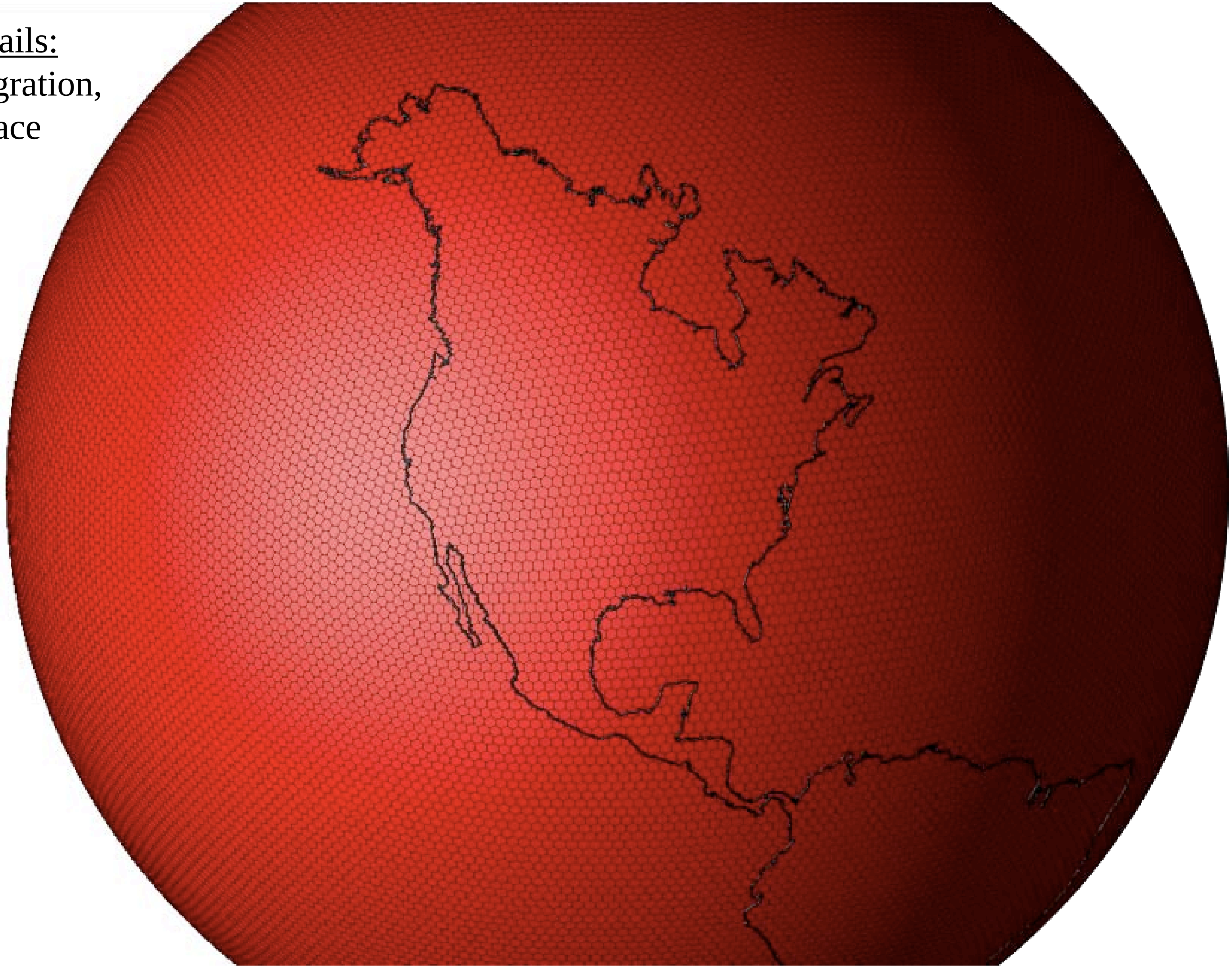


We are developing algorithms that target conformal meshes. These meshes include arbitrary Voronoi tessellations and Delaunay triangulations (as well as the standard Lat/Lon and conformally-mapped cubed sphere.)

Conjecture: smooth refinement on conformal meshes should mitigate many refinement problems.

Nested, Conformal, Variable-Resolution Meshes

<u>Simulation details:</u>
RK4 time integration, centered-in-space numerics, no dissipation.



North American refinement

QuickTime™ and a
decompressor
are needed to see this picture.

Refinement for equatorial convection

QuickTime™ and a
decompressor
are needed to see this picture.

Refinement around the Andes

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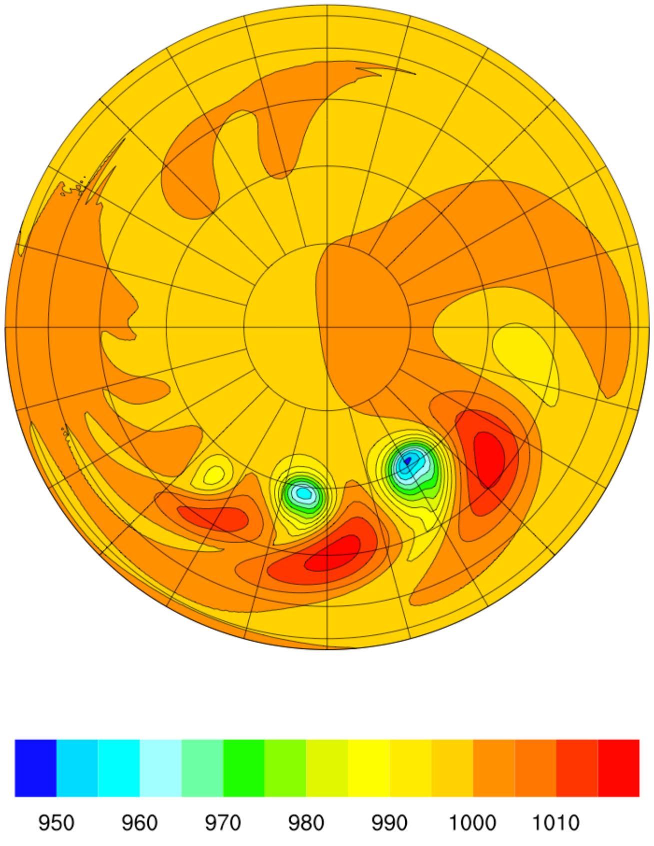
decompressor
are needed to see this picture.

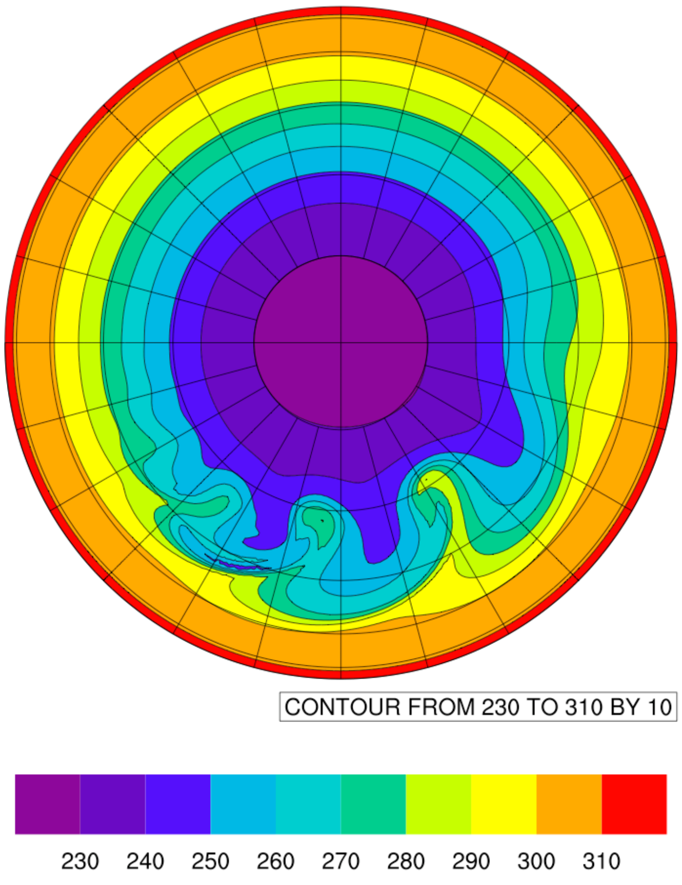
MPAS 3D Global Hydrostatic Core

Jablownowski and Williamson Baroclinic Wave Test Case (*QJRMS 2006*)
Hexagonal C-grid, average cell spacing ~ 120 km

Surface pressure (hPa), day 9



Potential temperature (K), day 9
(lowest model level)



MPAS 3D Global Hydrostatic Core

Jablownowski and Williamson Baroclinic Wave Test Case (*QJRMS 2006*)
Hexagonal C-grid, average cell spacing ~ 60 km

Surface pressure (hPa), day 16

Relative vorticity (s^{-1}), day 16
(jet level)

QuickTime™ and a
decompressor
are needed to see this picture.

QuickTime™ and a
decompressor
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(contour inc = 5 hPa)

QuickTime™ and a
decompressor
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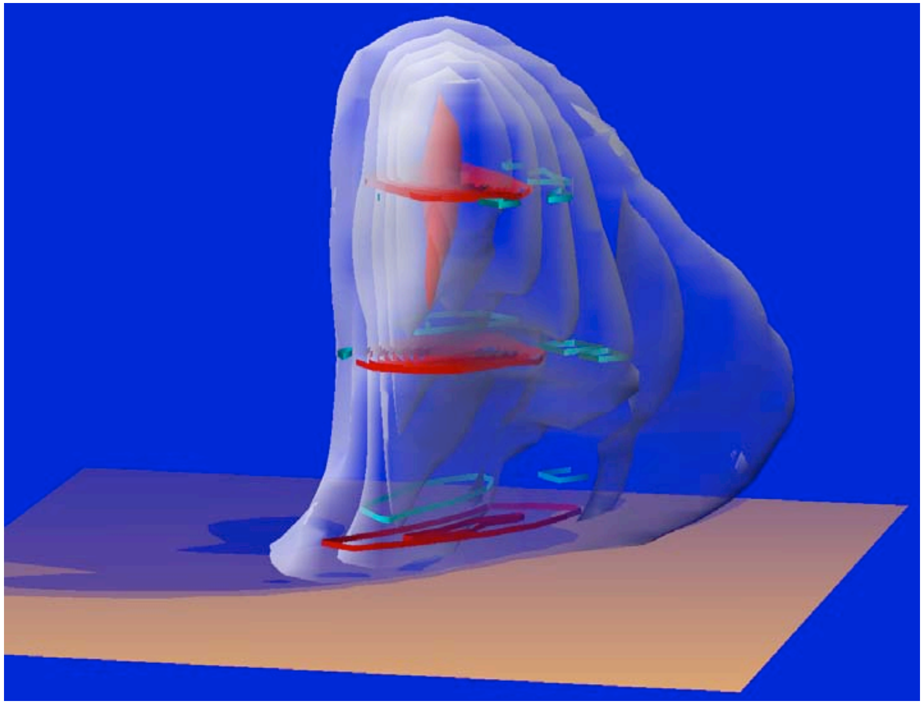
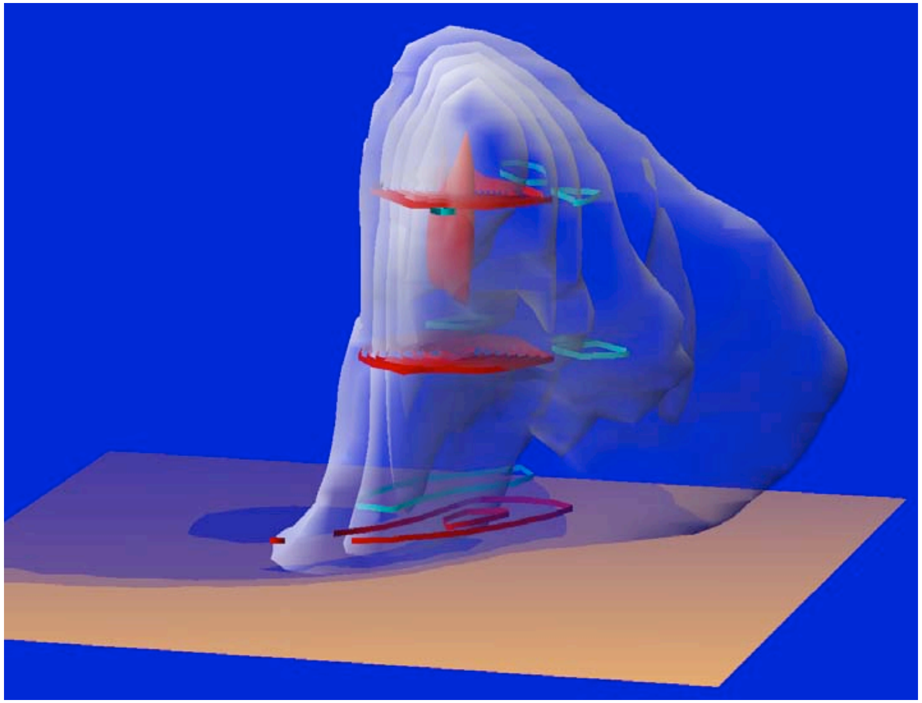
3-D Supercell Simulation ~2000 m Horizontal Grid

Rectangular Grid



Hexagonal Grid



Vertical velocity contours at 1, 5, and 10 km (c.i. = 3 m/s)

30 m/s vertical velocity surface shaded in red

Rainwater surfaces shaded as transparent shells

Perturbation surface temperature shaded on baseplane

MPAS integration into CAM

LLNL: Art Mirin, Mike Wickett and Dan Bergmann

MPAS-A hydrostatic core

QuickTime™ and a
decompressor
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MPAS integration into CAM

QuickTime™ and a decompressor are needed to see this picture.

LLNL: Art Mirin, Mike Wickett and Dan Bergmann

- MPAS-A hydrostatic core
- Primary tasks: Constructing interface routines, removing CAM vertical-coordinate where it is hardwired in physics and init routines, ensure full (scalar) mass conservation.
- Timeframe: Aquaplanet simulations in the next several months.

QuickTime™ and a decompressor are needed to see this picture.

Observation: Need for generalization of CAM physics for alternative dycores.