How Can I Choose A Horizontal Grid For My Model?

Celal S Konor, Ross P Heikes and David A Randall
Department of Atmospheric Science
Colorado State University

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Research progress during last six months

- We (Heikes, Konor and Randall) working on two papers:

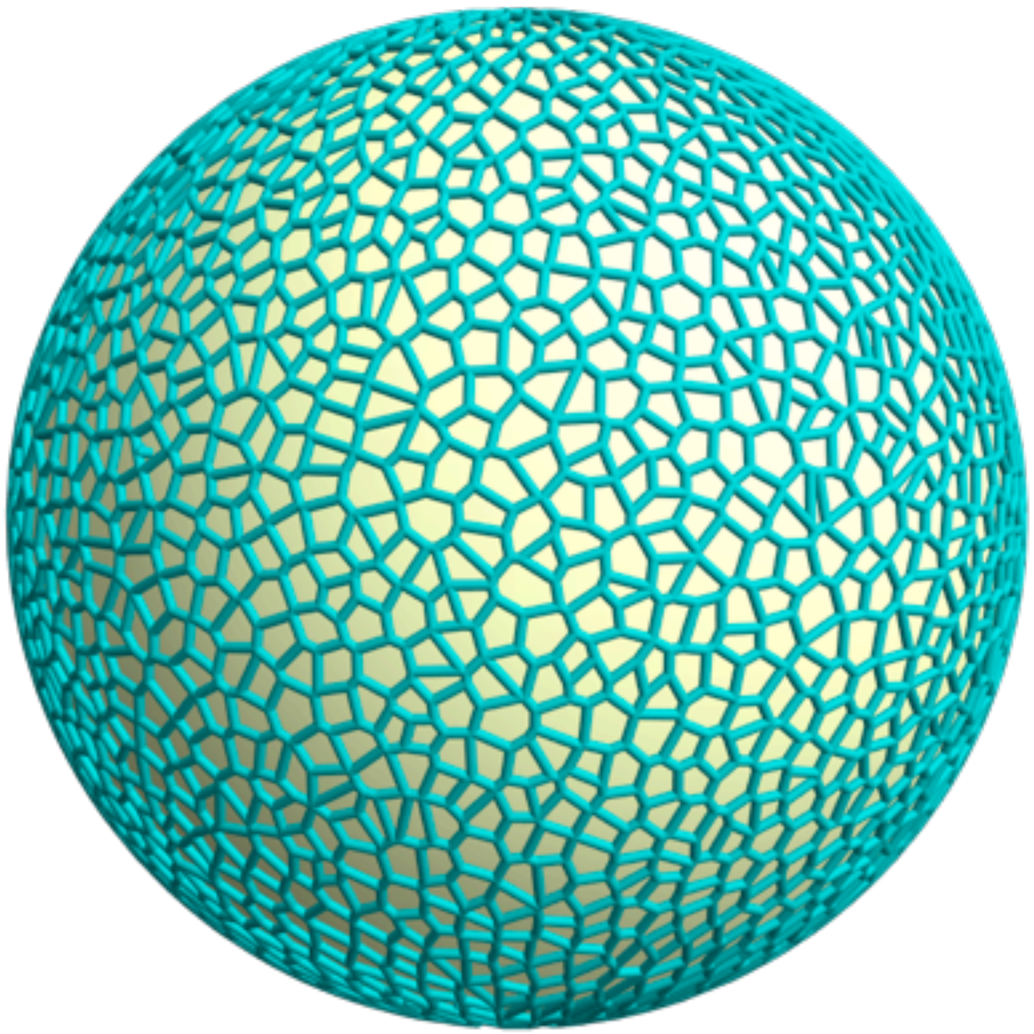
  1. Titled "**Optimized Icosahedral Grids: Performance of Finite-Difference Operators and Multigrid Solvers** ". It discusses (i) generation and optimization of the icosahedral pentagon/hexagon grid [optimization up to the G12 (2 km) resolution has been completed], (ii) performance of Laplacian, Jacobian and divergence operators [the overall performance is good up to the G12], and (iii) performance of 2D and 3D multigrid based elliptic solvers. The grid data and codes will be made available to the community.

  2. Titled "**A global dynamical core based on the unified system** ". A small progress has been made so far.

- Unified model paper in the review process

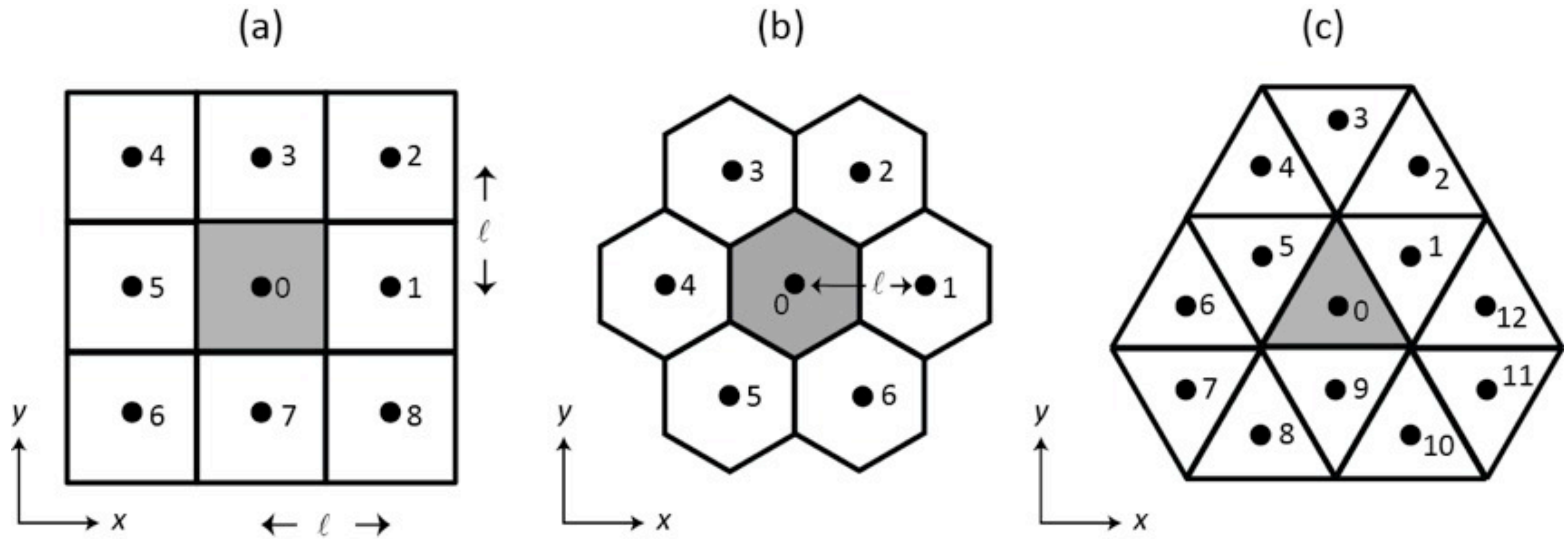
Unstructured irregular grids

Not popular with atmosphere model developers



because it is not easy to satisfy majority of the requirements that atmosphere model developers traditionally follow (Staniforth and Thuburn, 2011; and Heikes et al., 2012)

Planar Cartesian, hexagonal and triangular grids



No computational modes with the Arakawa and Lamb scheme on the C-grid

Best isotropy

Resolution can NOT be changed continuously

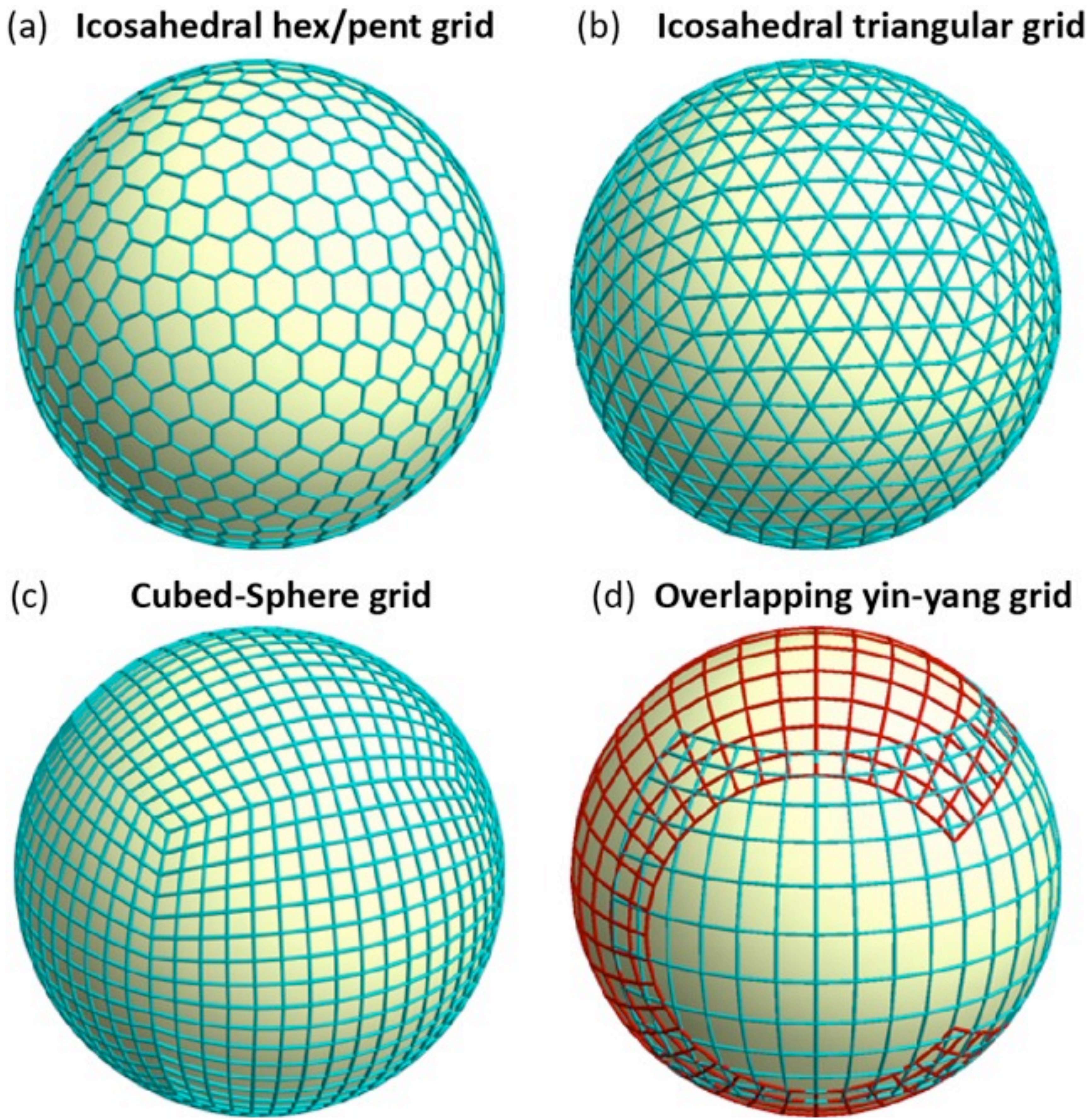
No computational modes with the undistributed vorticity-divergence predicting scheme (the Z-grid)

Worst isotropy

No second-order Laplacian

Computational modes with a C-grid staggering

Popular Global Grids (Nowadays)

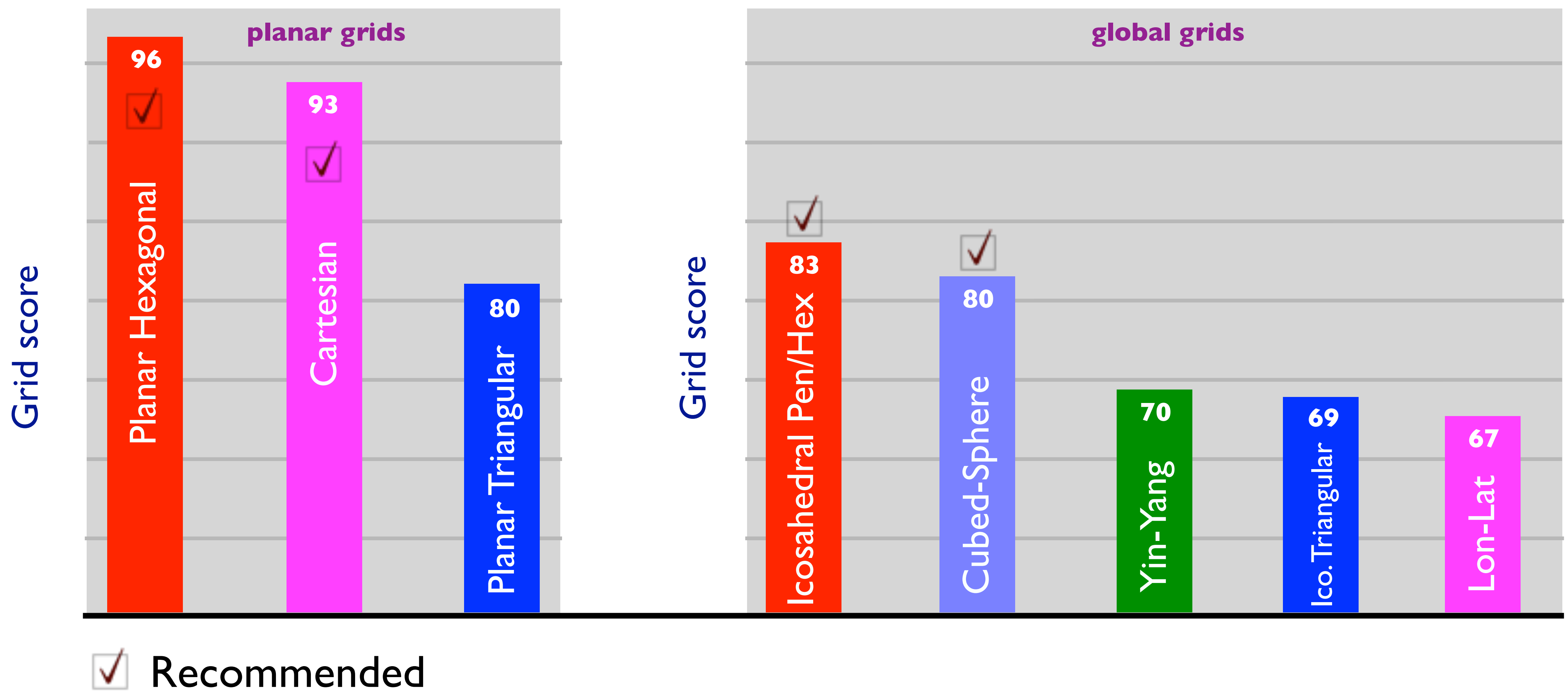


Criteria to choose a grid

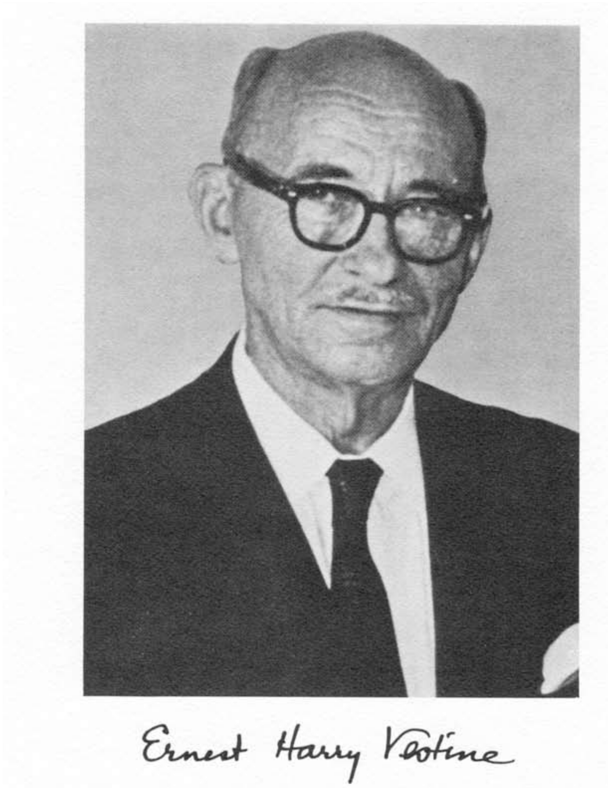
- Uniformity (in area, shape etc.) (Weighting factor: 7/28)
- Isotropy (Weighting factor: 6/28)
- Avoiding computational modes (Weighting factor: 5/28)
- Allowing "consistency" (Weighting factor: 4/28)
- Allowing conservation (Weighting factor: 3/28)
- Allowing computational efficiency (Weighting factor: 2/28)
- Allowing smooth resolution change (Weighting factor: 1/28)

Quantification of criteria to choose grids

	Cartesian	Planar Hexagonal	Planar Triangular	Lon-Lat	Icosahedral Pen/Hex	Icosahedral Triangular	Cubed-Sphere	Yin-Yang
Uniformity (0.250)	7(1.750)	7(1.750)	7(1.750)	3(0.750)	5(1.250)	6(1.500)	4(1.000)	5(1.500)
Isotropy (0.214)	5(1.070)	7(1.498)	4(0.856)	3(0.642)	6(1.284)	4(0.856)	4(0.856)	4(0.856)
Comp. modes (0.178)	7(1.246)	7(1.246)	4(0.712)	7(1.246)	7(1.246)	4(0.712)	5(0.890)	5(0.890)
Consistency (0.142)	7(0.994)	7(0.994)	7(0.994)	7(0.994)	6(0.852)	4(0.568)	5(0.710)	4(0.568)
Conservation (0.107)	7(0.749)	6(0.642)	5(0.535)	7(0.749)	6(0.642)	5(0.535)	6(0.642)	4(0.428)
Comp efficiency (0.071)	7(0.497)	7(0.497)	7(0.497)	3(0.213)	6(0.426)	6(0.426)	6(0.426)	6(0.426)
Smooth res. change (0.035)	7(0.245)	3(0.105)	7(0.245)	3(0.105)	3(0.105)	7(0.245)	7(0.245)	7(0.245)
Overall score	(6.551)	(6.732)	(5.589)	(4.699)	(5.805)	(4.842)	(5.625)	(4.913)



Introduction of icosahedral grids to geosciences



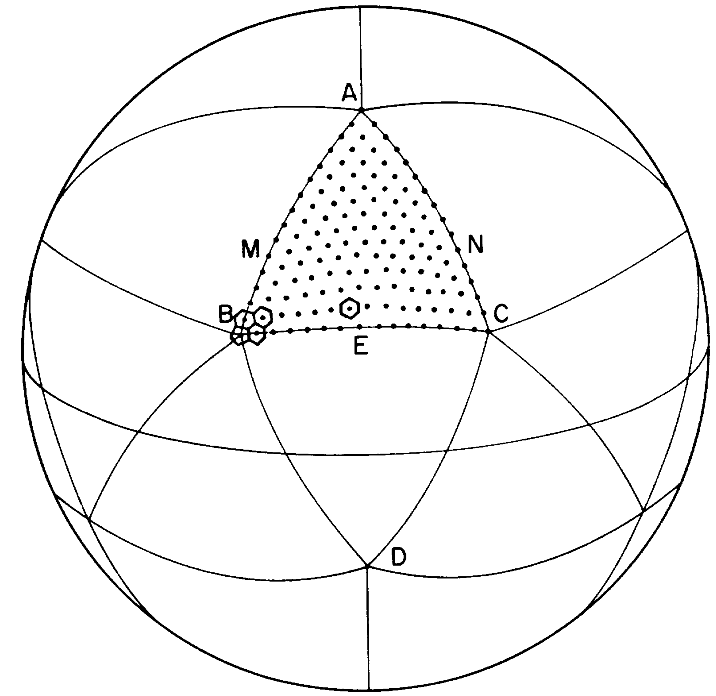
NATIONAL ACADEMY OF SCIENCES

ERNEST HARRY VESTINE

May 9, 1906—July 18, 1968

BY SCOTT E. FORBUSH

Ernest Harry Vestine was born in Minneapolis, Minnesota on May 9, 1906, the son of Swedish parents, Frida Christine (Lund) and Olaf Vestine, who left the United States to live near Edmonton, Alberta. Here he received all his early education and a B.Sc. degree from the University of Alberta in 1931. In 1932 he joined the Canadian Meteorological Office in Toronto, where he was occupied with meteorological and geomagnetic measurements.



PROFESSIONAL POSITIONS

University of California, Los Angeles, Professor of Meteorology, 1966–68

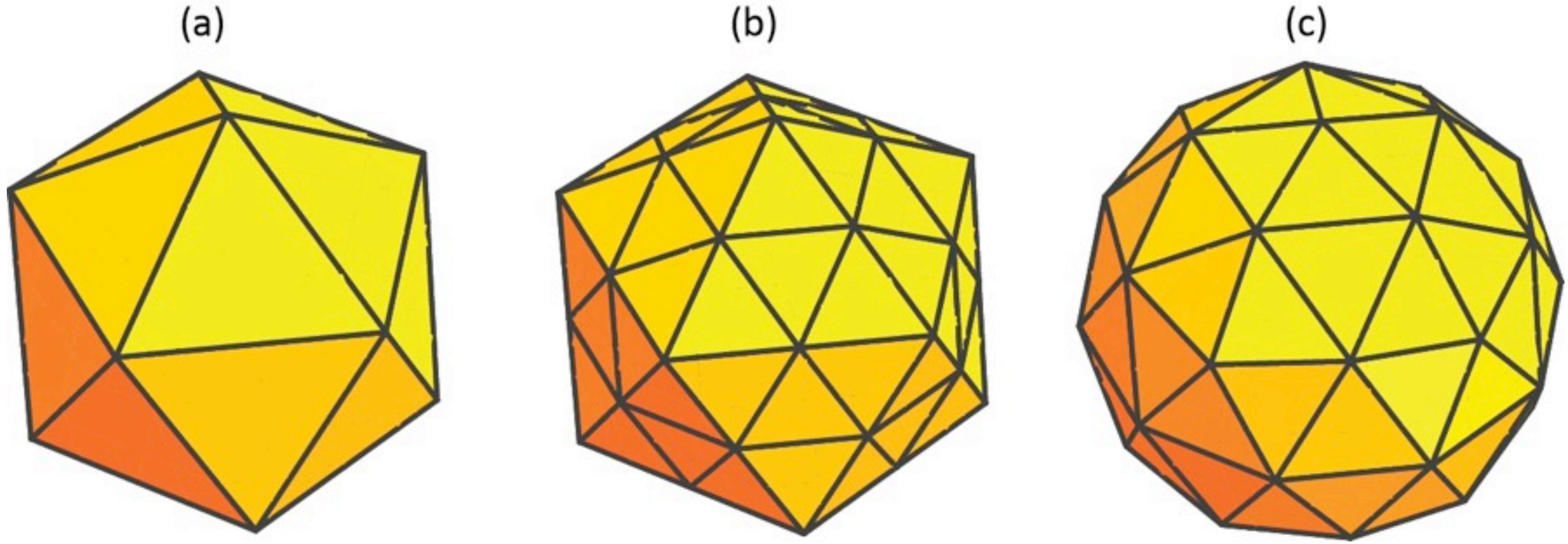
With W. L. Sibley, J. W. Kern, and J. L. Carlstadt. Integral and spherical-harmonic analyses of the geomagnetic field for 1955.0, Part II. J. Geomagn. Geoelectr., 15:73–89.

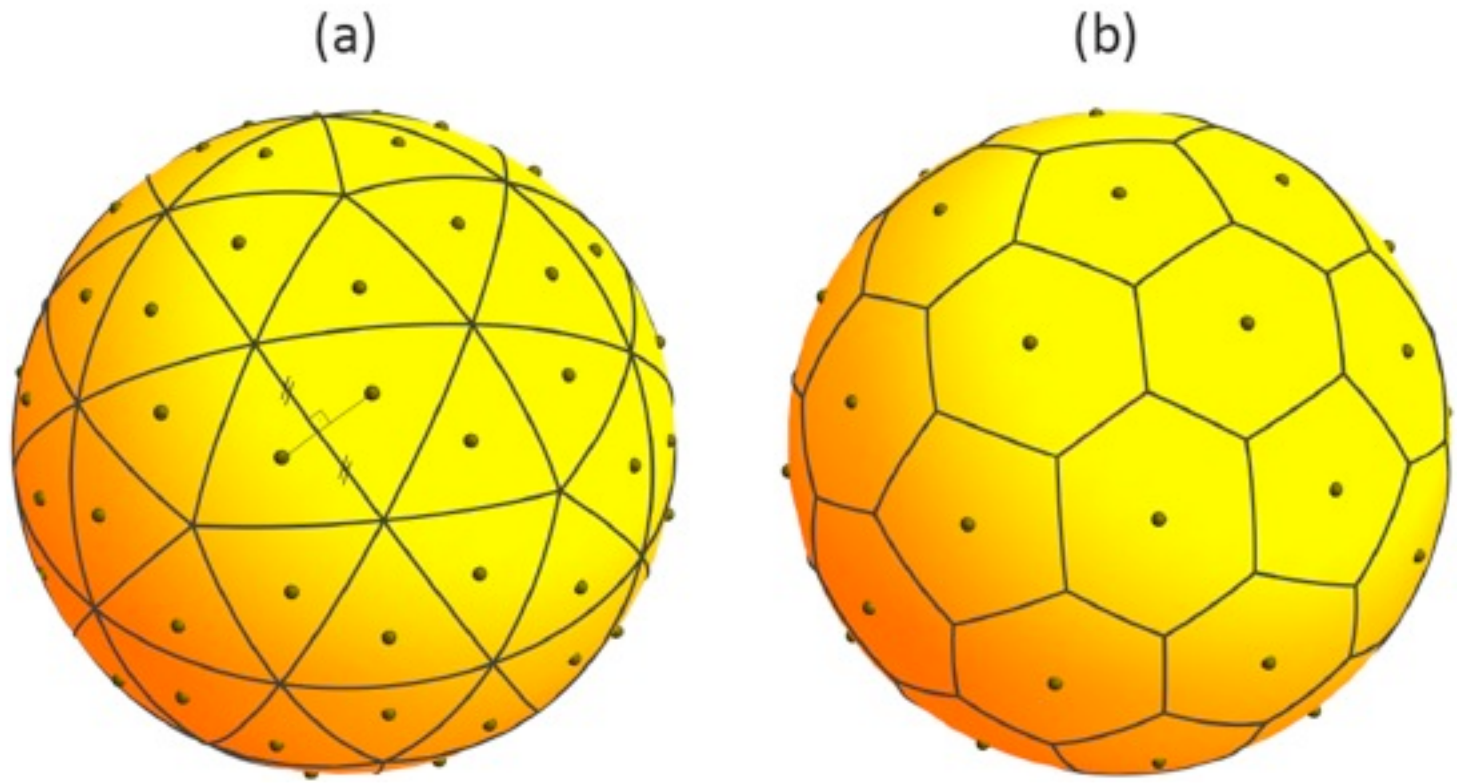
Available from Rand corporation (hard copy) and NASA's archives (electronic copy)

Icosahedral Equal-Area Grid

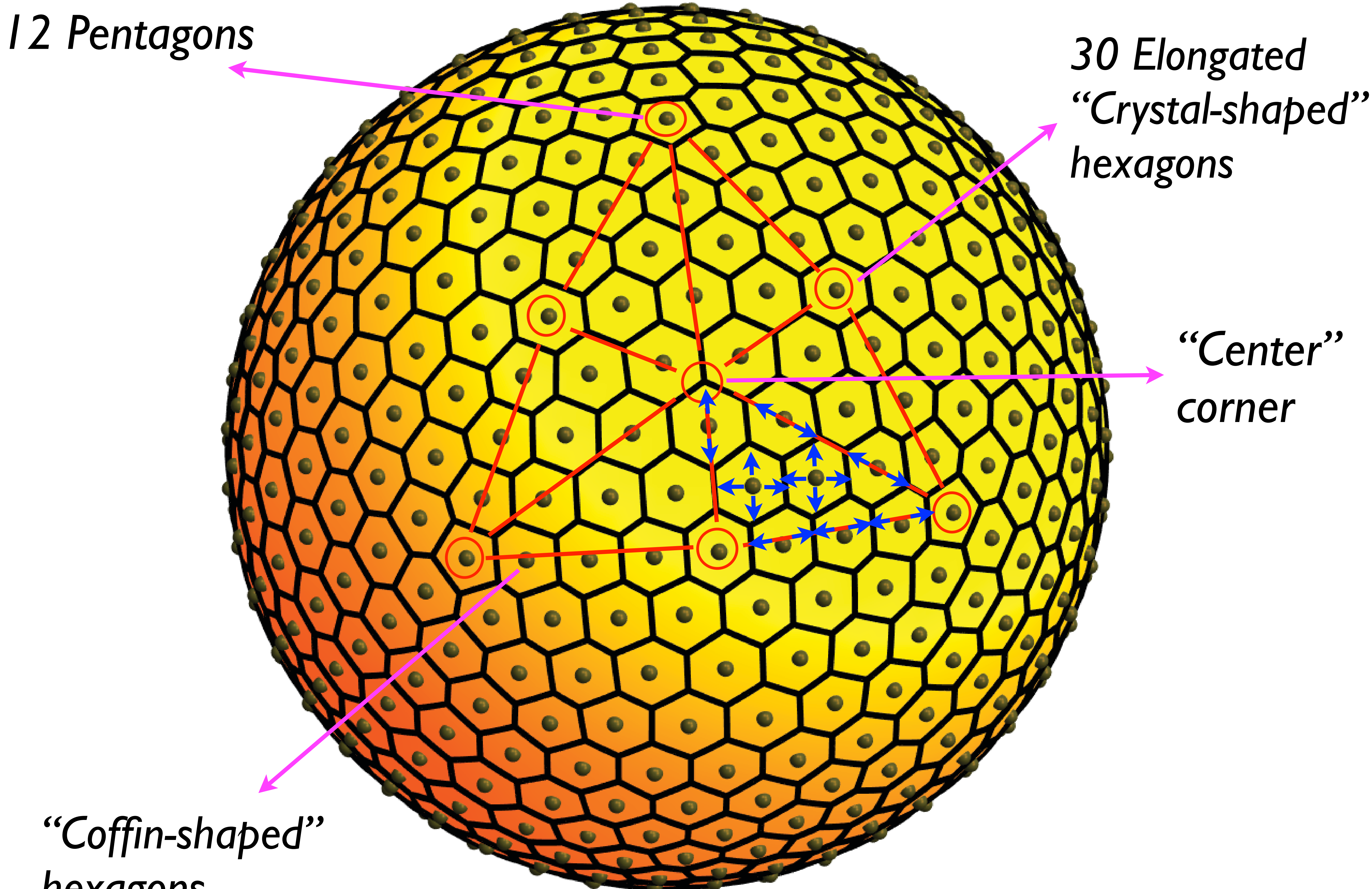
The foregoing discussion has shown why it is desirable to have sectors with equal areas [“uniformity-1”], with a high degree of symmetry about their [“isotropy”] centers, and with shapes that are independent of their location on the [“uniformity-2”] sphere. From this, J. W. Kern decided that the icosahedron, being the highest-degree regular polyhedron, is an excellent model for subdividing a sphere.

Generation of Icosahedral Pen/Hex Grid





Some features of the icosahedral pen/hex grid



G3 642 cells (~1000 km)