Dynamical Core Model Intercomparison Project 2016

Organizational Issues

June 6th – 17th, 2016

Organized By

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Earth System Grid Federation

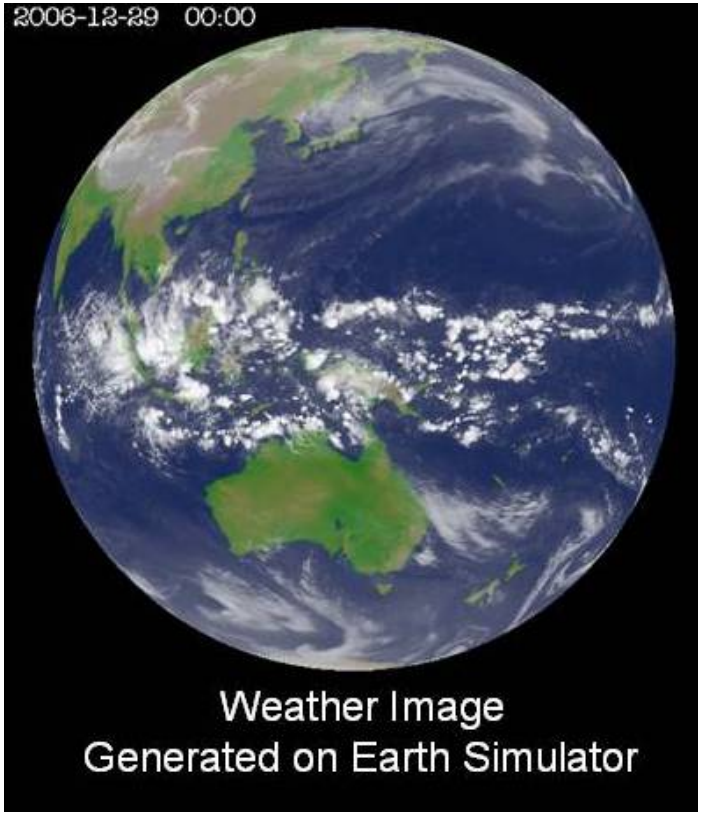
Interactive communication platform via a wiki-driven shared workspace:

https://www.earthsystemcog.org/projects/dcmip-2016/

If you take photos during the workshop and wish to share, you can post them publicly on the DCMIP2016 photo gallery on ESGF-COG.

Group Assignments

Non-hydrostatic ICosahedral Atmospheric Model (NICAM)

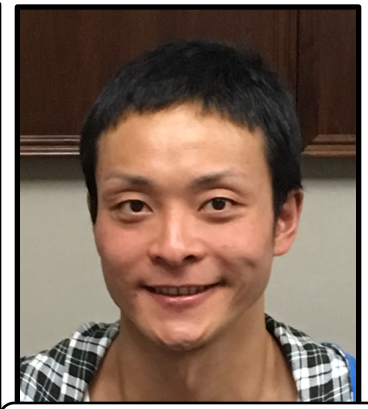


University of Tokyo

NICAM

Ryuji Yoshida

Hiroaki Miura



Tomoki Ohno

Group:

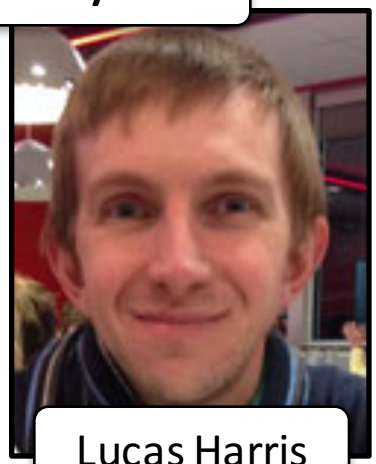
Laura Mazarro
Vinicius Capistrano

Abhishekh Srivastava
Jonathan Meyer

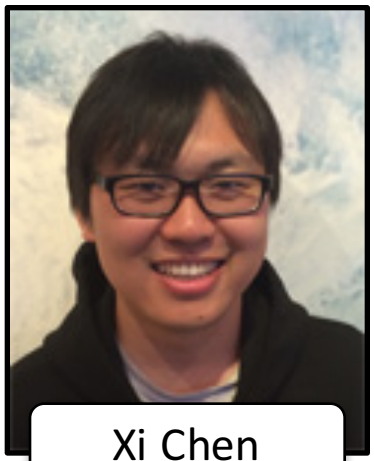
Finite Volume Cubed (FV3) Model

Geophysical Fluid Dynamics Laboratory (GFDL)

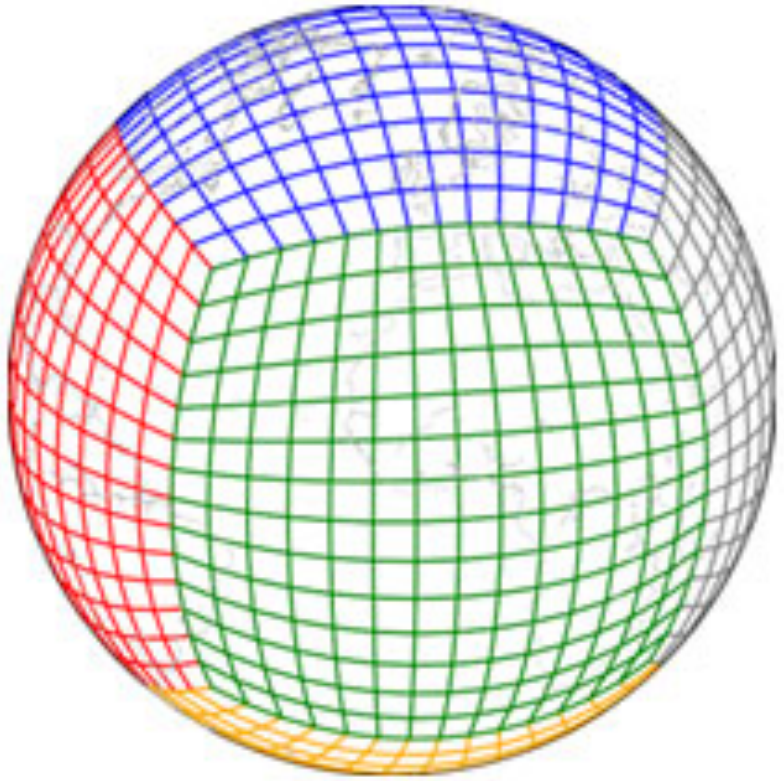
GFDL/FV3



Lucas Harris



Xi Chen



Group:

Jiawei Zhuang
Weiwei Li
Kabir Rasouli

Jared Ferguson
Jorge Guerra

NEPTUNE Model

Naval Research Laboratory (NRL)

NEPTUNE

Kevin Viner

Alex Reinecke

DEPARTMENT OF THE NAVY
USN
ONR
Science & Technology

Group:

Maximo Menchaca
Christopher Eldred
Kazushi Takemura

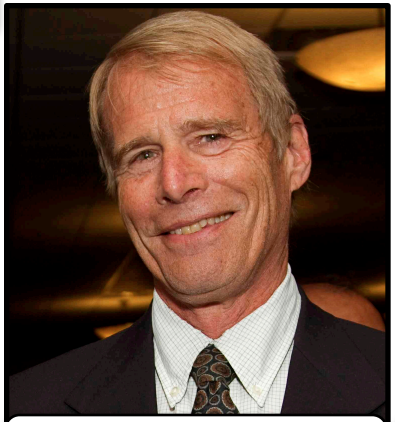
Alexander Goldstein
Emily Foshee

Model for Prediction Across Scales (MPAS)

National Center for Atmospheric Research (NCAR)

MPAS

William Skamarock



Joseph Klemp

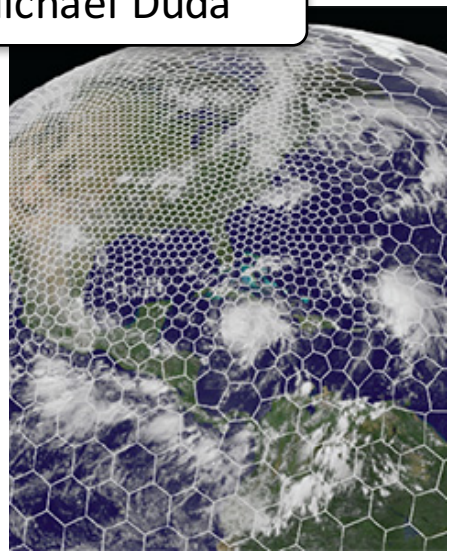
Sang-Hun Park

Michael Duda

Group:

Eric Wolf
Sabina Abba Omar
Koichi Sakaguchi

Ross Dixon
Pushp Raj Tiwari

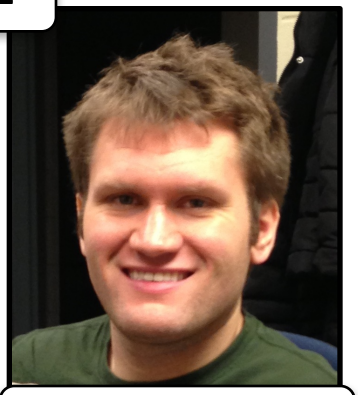


High Order Method Modeling Environment (HOMME) / CAM Spectral Element

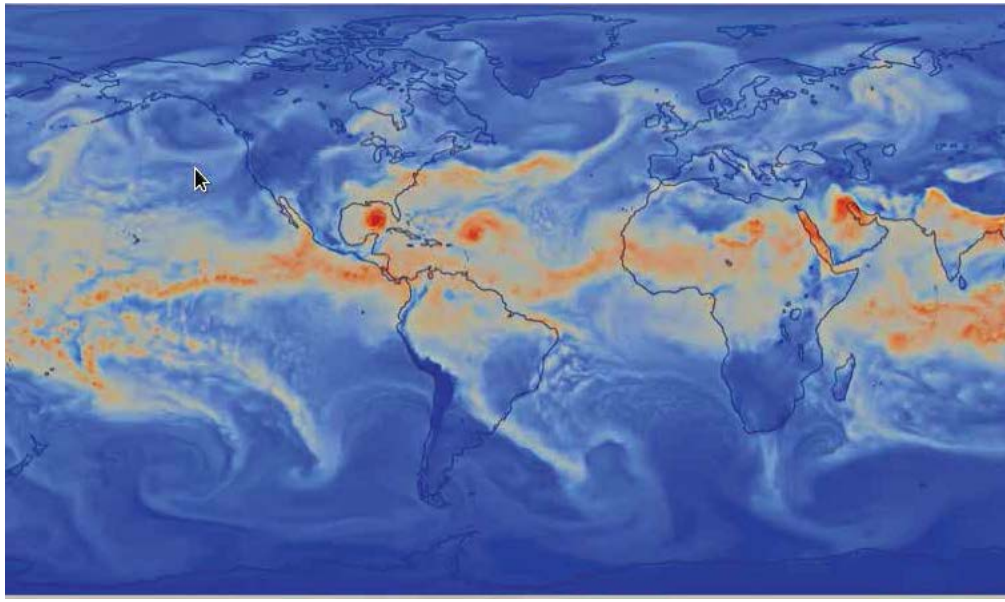
Department of Energy (DOE), National Center for Atmospheric Researhc (NCAR), CU Boulder

HOMME-NH/CAM-SE

David Hall



Colin Zarzycki



Group:

Ariane Frassoni
Tobias Bauer

Dave Lee
Spencer Clark

Finite Volume Model (FVM)

European Center for Medium-Range Weather Forecasting (ECMWF)

IFS/FVM (ECMWF)

Christian Kuehnlein

Group:

Sungduk Yu
Zheng Wu
John O'Brien

Adam Herrington
Bjarke Tobias Olsen

Unified Z-Grid Icosahedral Model (UZIM)

Colorado State University (CSU)

UZIM (CSU)

David Randall

Don Dazlich

Celal Konor

Ross Heikes

Group:

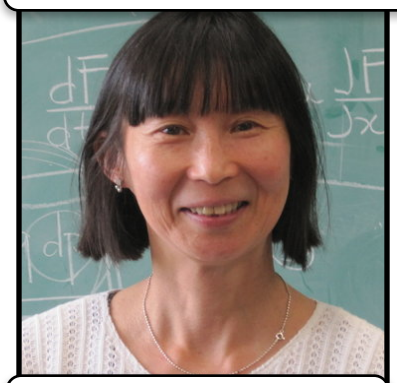
Hossein Parishani
Richard Urata
James Shaw

Chasity Henson
Scott Bachman

Global Environment Model (GEM)

Environment Canada

GEM



Vivian Lee

Abdessamad Qaddouri

Group:

Konrad Simon
Farshid Nazari
Gokhan Sever

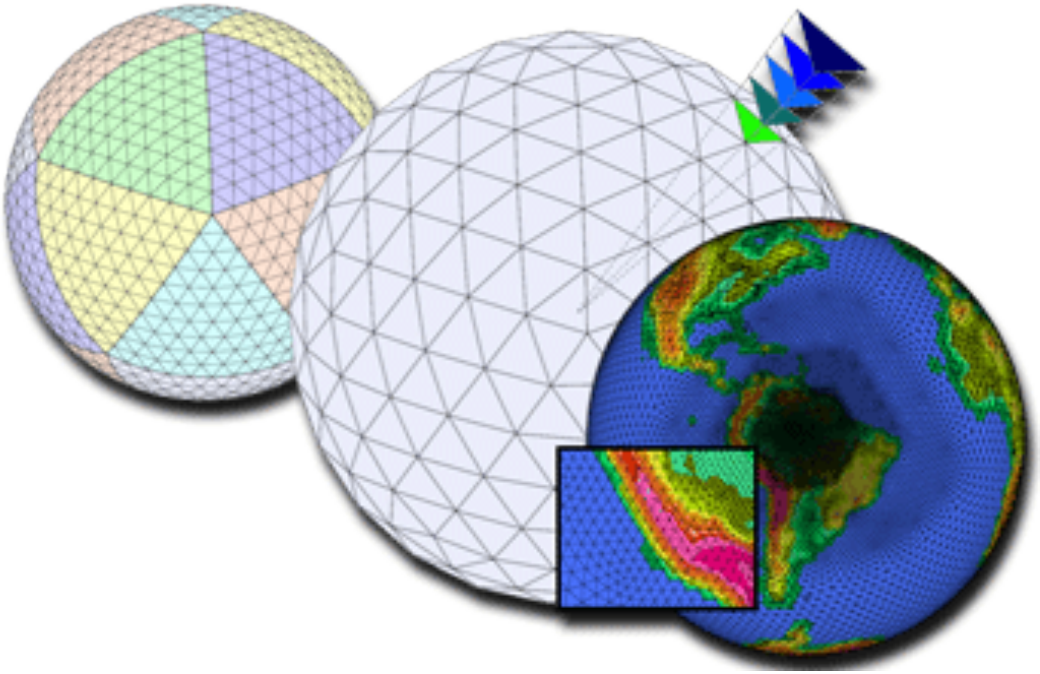
Haiyang Yu
Amanda Back

Ocean-Land-Atmosphere-Model (OLAM)

Environmental Protection Agency (EPA), University of Miami

OLAM

Bob Walko



Group:

Robert Fajber
Charles Pelletier
Lei Wang
Karin van der Wiel
Tsung-Lin Hsieh

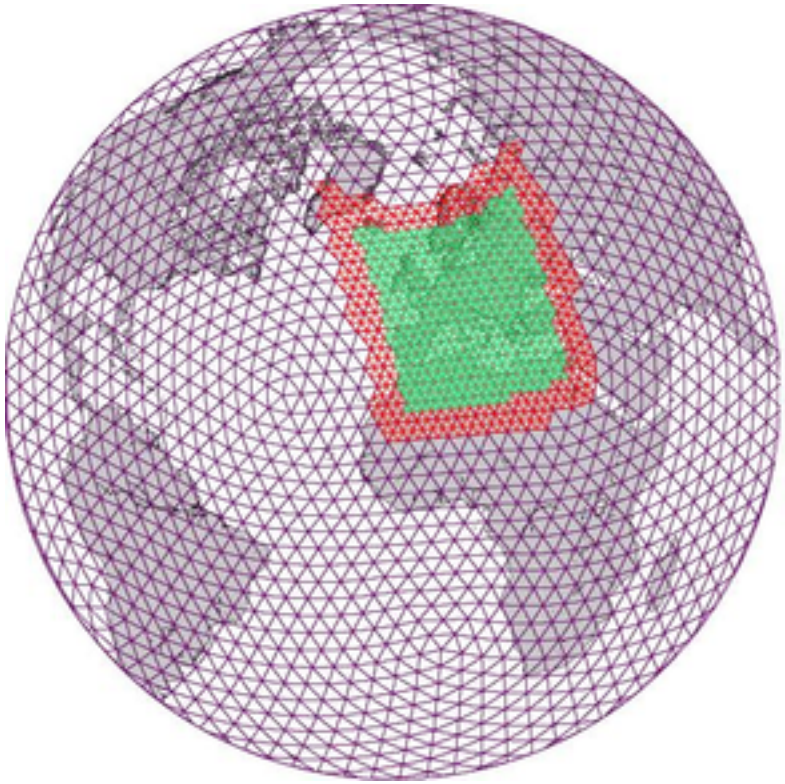
ICOsahedral Non-hydrostatic (ICON) Model

Max-Planck Institute (MPI), Germany

ICON

Daniel Reinert

Marco Giorgetta

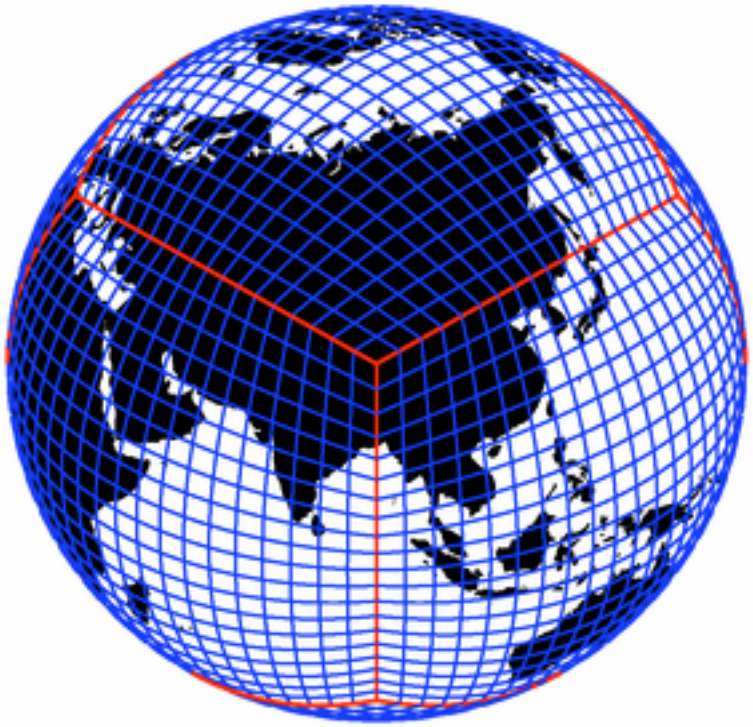


Group:

Chii-Yun Tsai
Thomas Rackow
Nicholas Szapiro
Cameron Rencurrel
Theodore Letcher

DCMIP Models…

Cubed Sphere Grids



HOMME-NH / CAM-SE

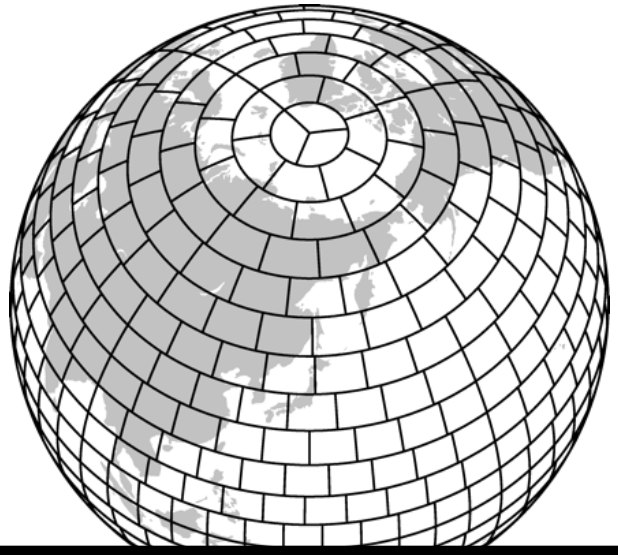
FV3/GFDL

TEMPEST

DCMIP Models…

Latitude Longitude Grids

ENDGame

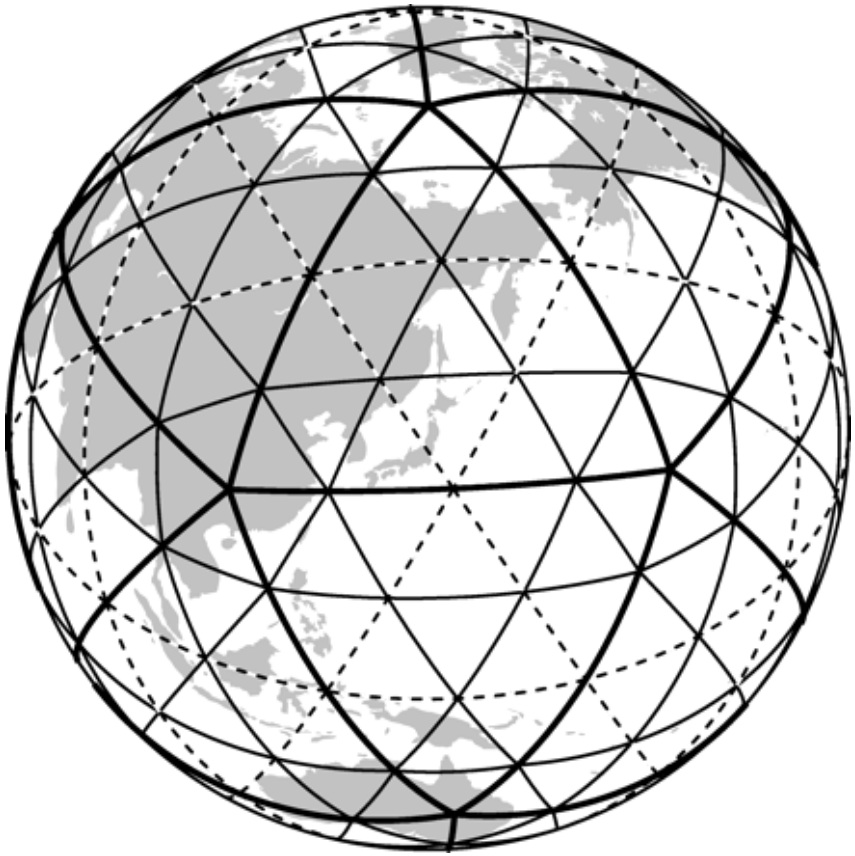


Reduced Gaussian Grid

IFS-FV (ECMWF)

DCMIP Models…

Triangular Grids



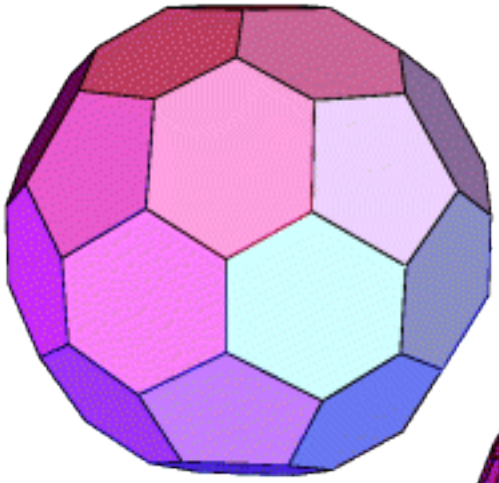
ICON

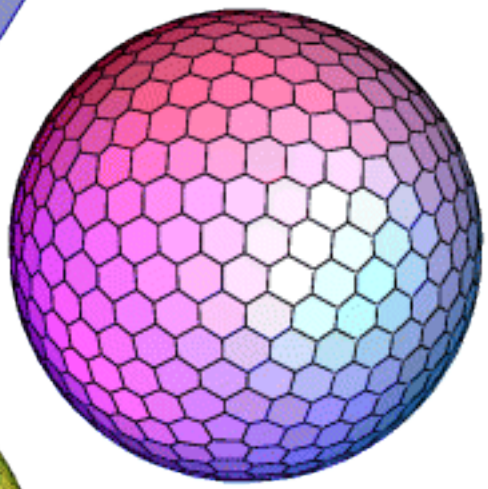
DYNAMICO

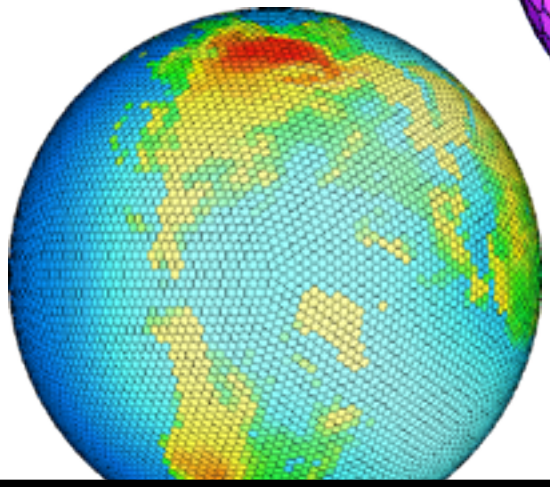
NICAM

OLAM

DCMIP Models…







Hexagonal or Spherical Voronoi Grids

ICON

MPAS

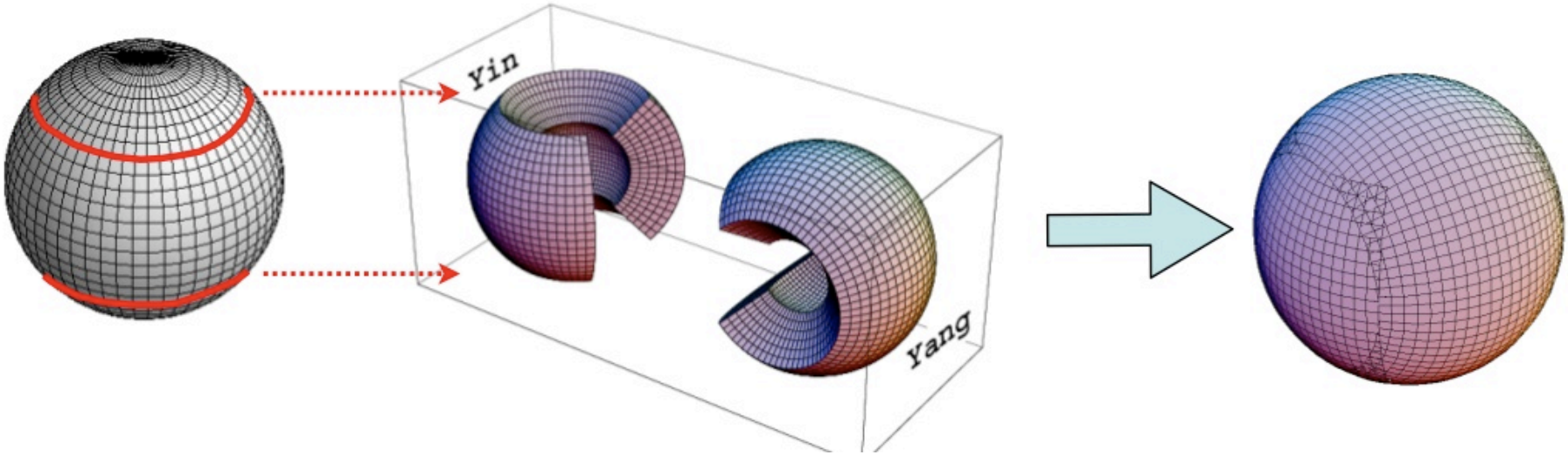
OLAM

UZIM (CSU)

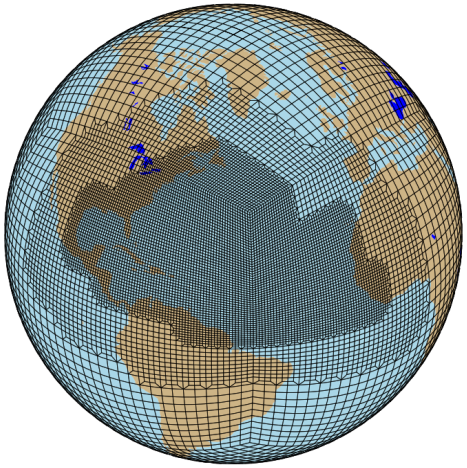
DCMIP Models…

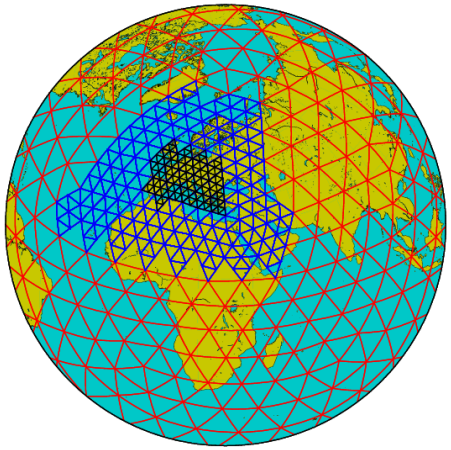
Yin-Yang Grids

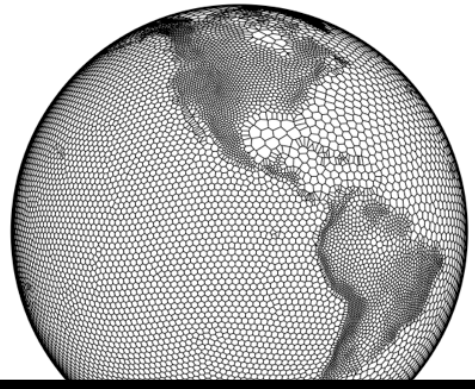
GEM-yinyang

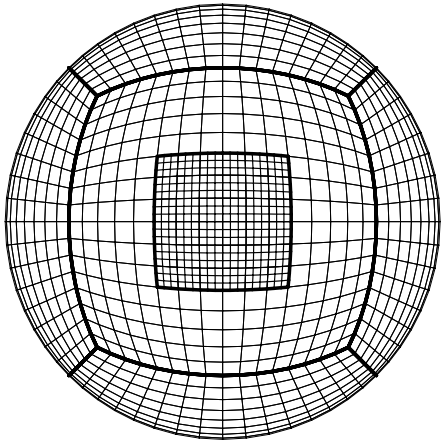


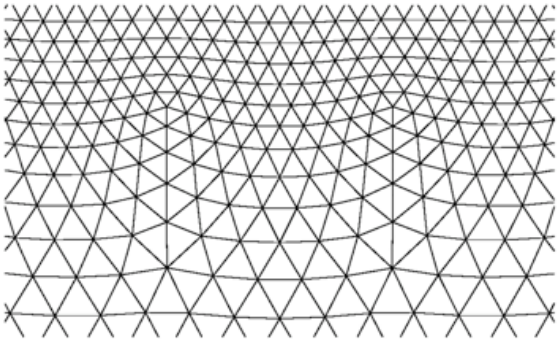
DCMIP Models…







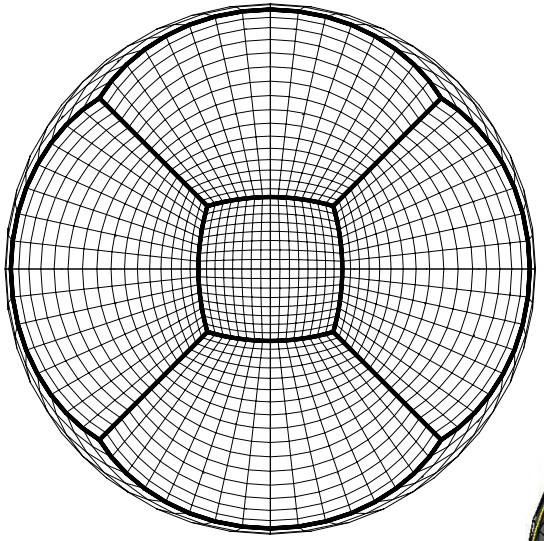


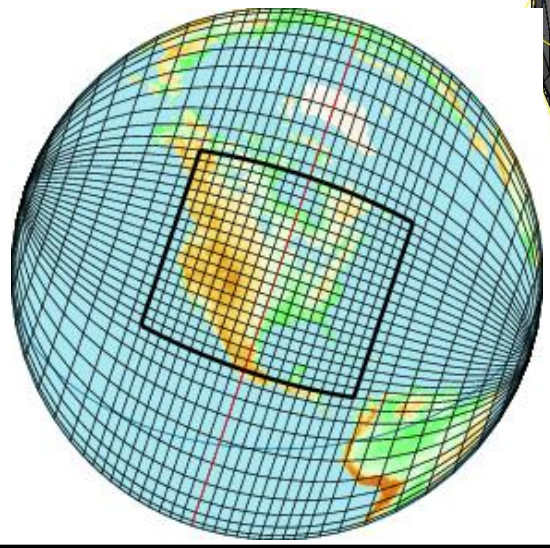


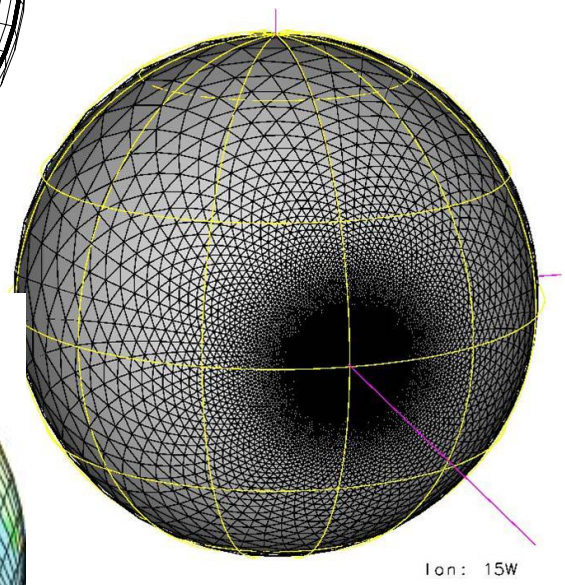
Variable-Resolution Grids

HOMME-NH/CAM-SE
FV3/GFDL
ICON
MPAS
NEPTUNE
OLAM

DCMIP Models…







Stretched Grids

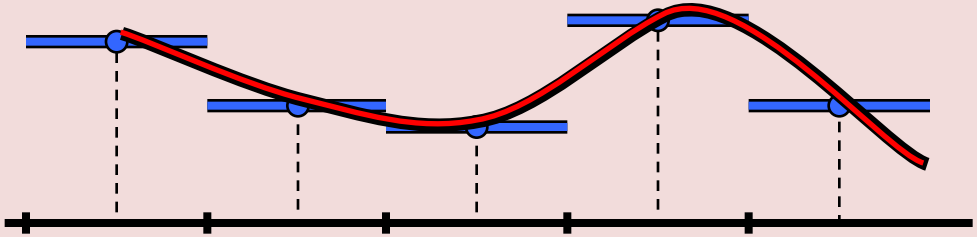
HOMME-NH/CAM-SE

NICAM

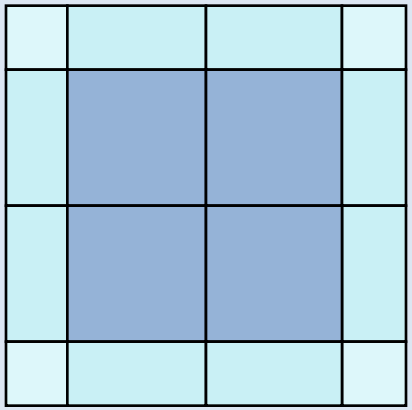
GEM

DCMIP Models…

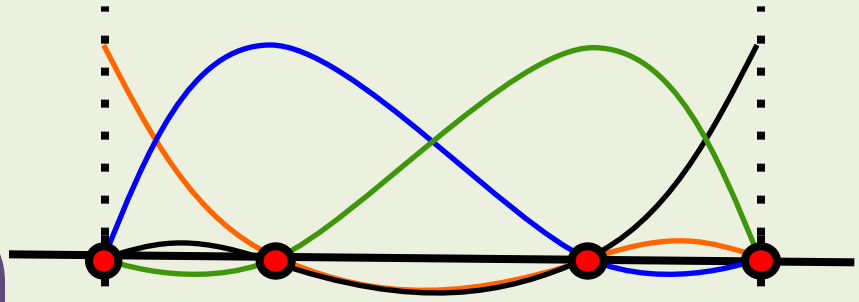
Finite-Volume



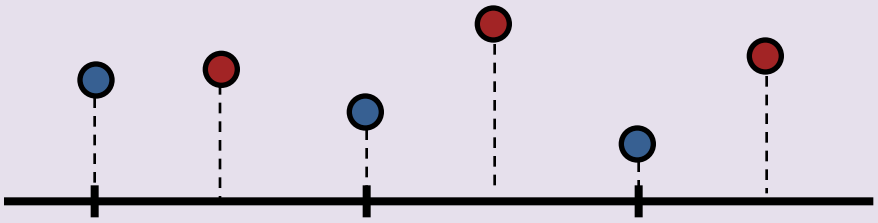
Spectral Finite-Volume



Finite-Element

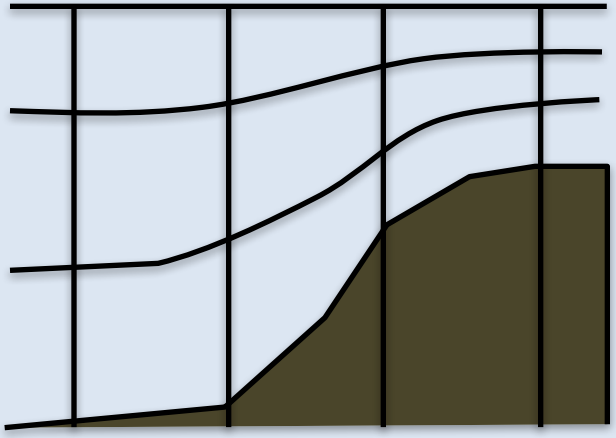


Staggered Finite-Difference

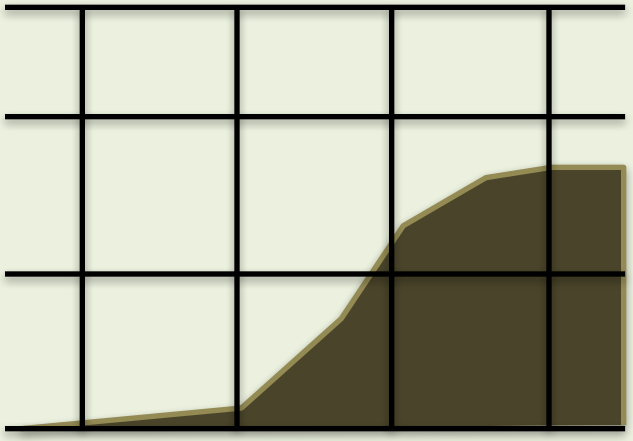


DCMIP Models…

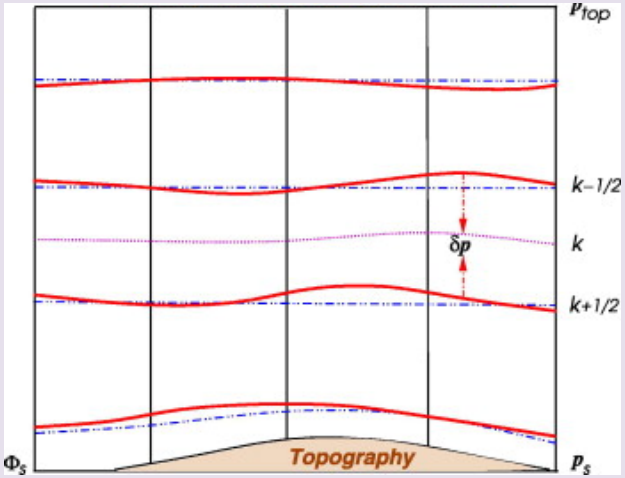
Terrain Following Coordinates



Cut Cells

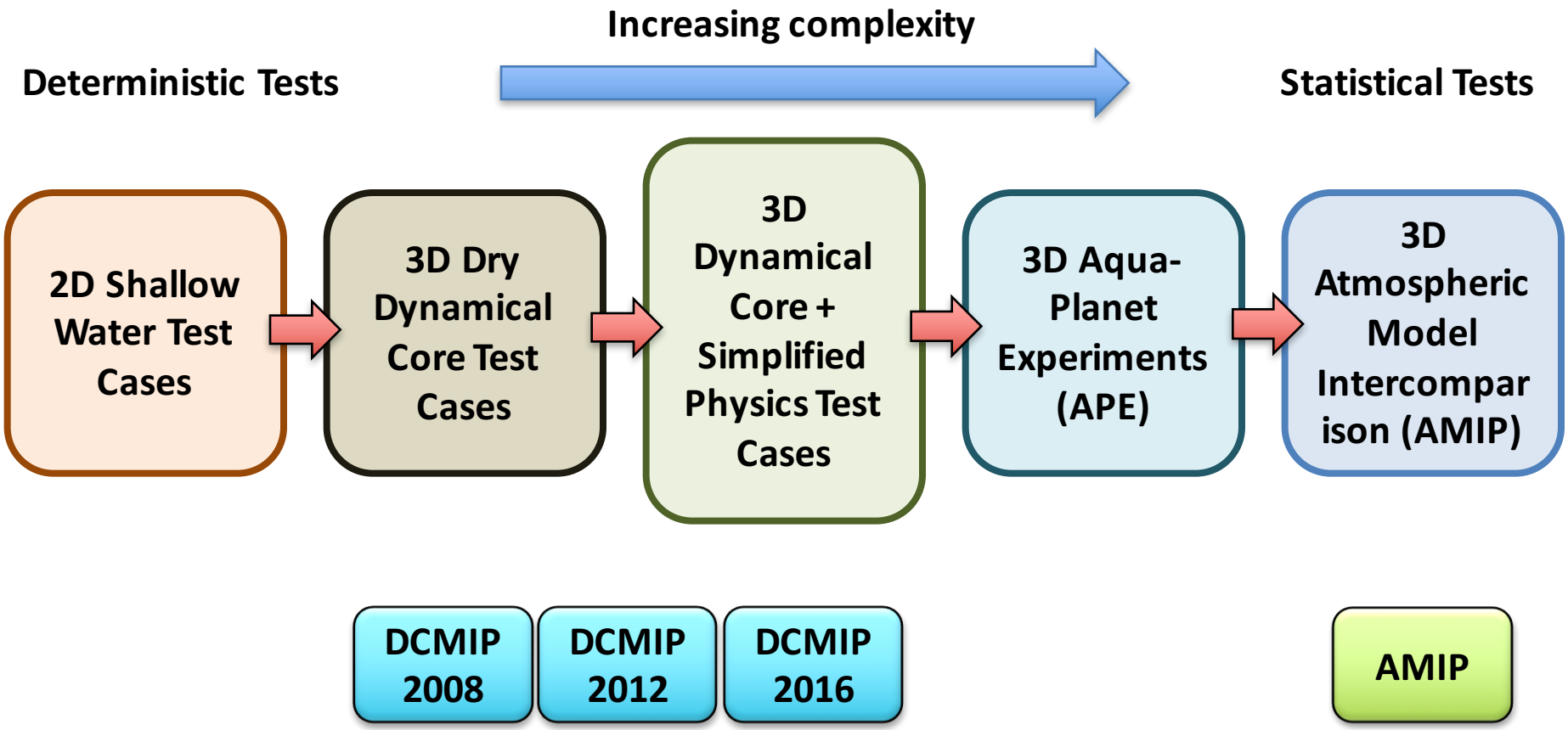


Vertically Lagrangian Surfaces

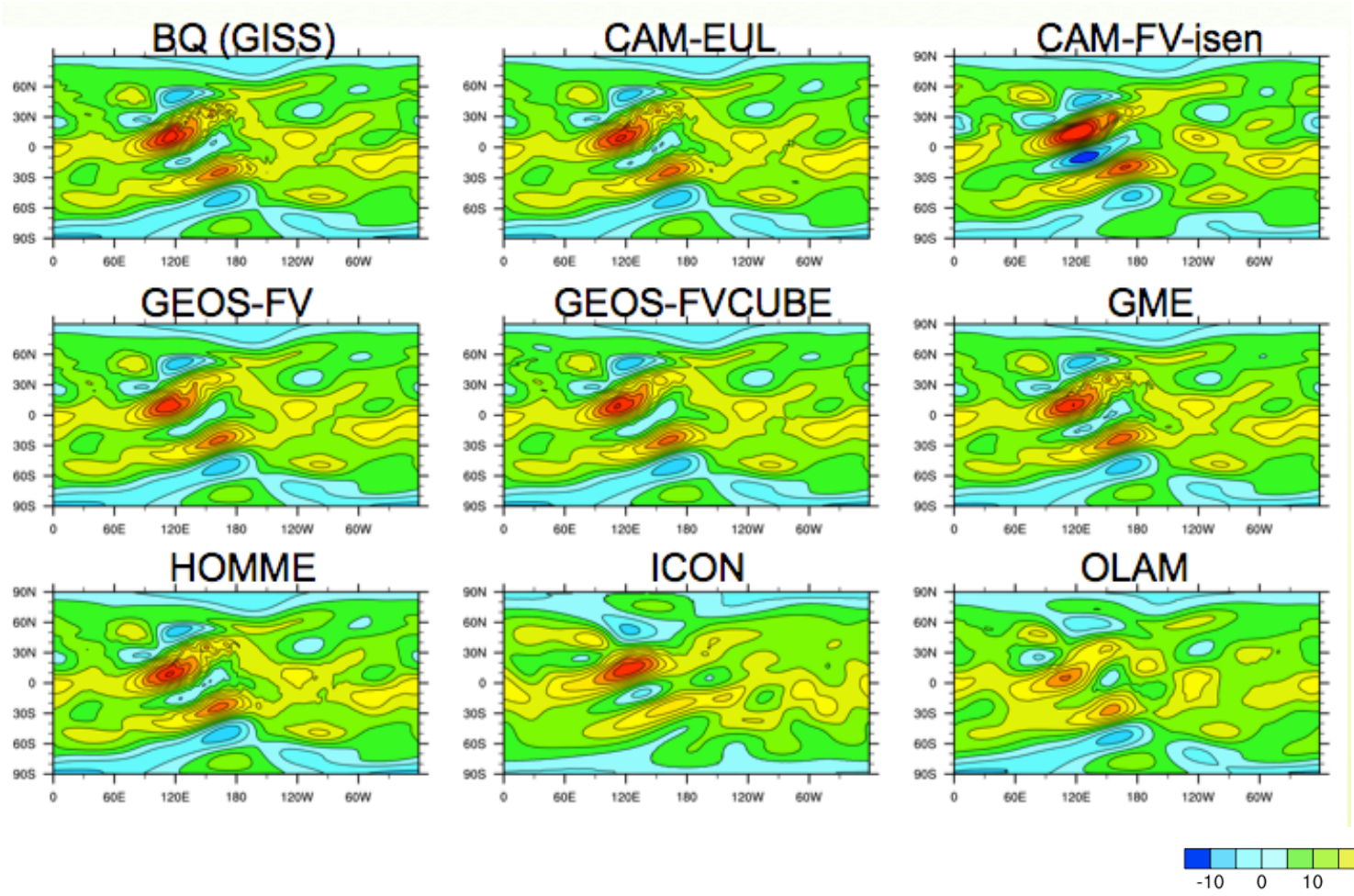


DCMIP Test Suite

Define and establish a collection of easy-to-use idealized test cases for different flow scenarios to foster objective dynamical core intercomparisons.

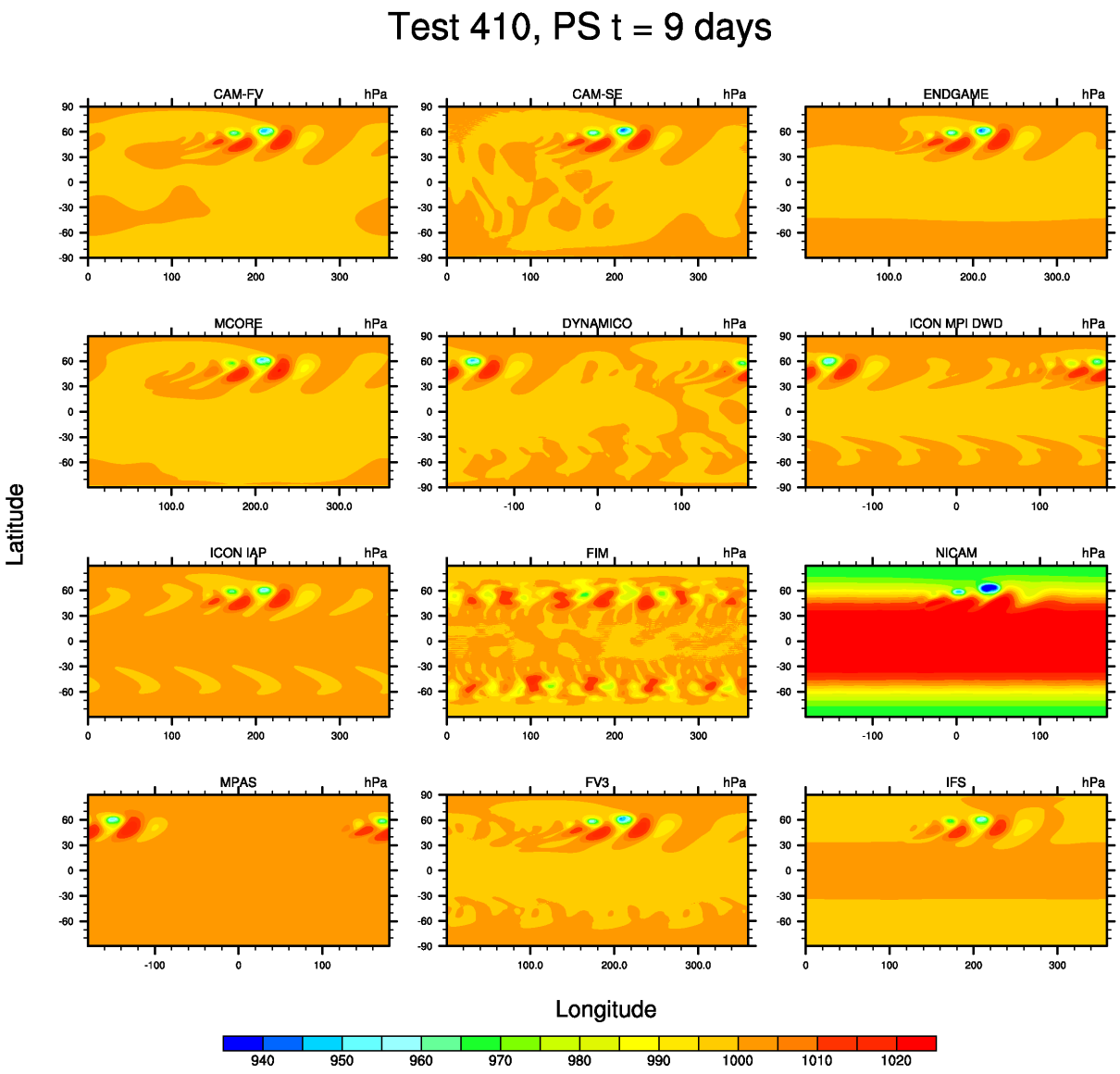


DCMIP2008 Results



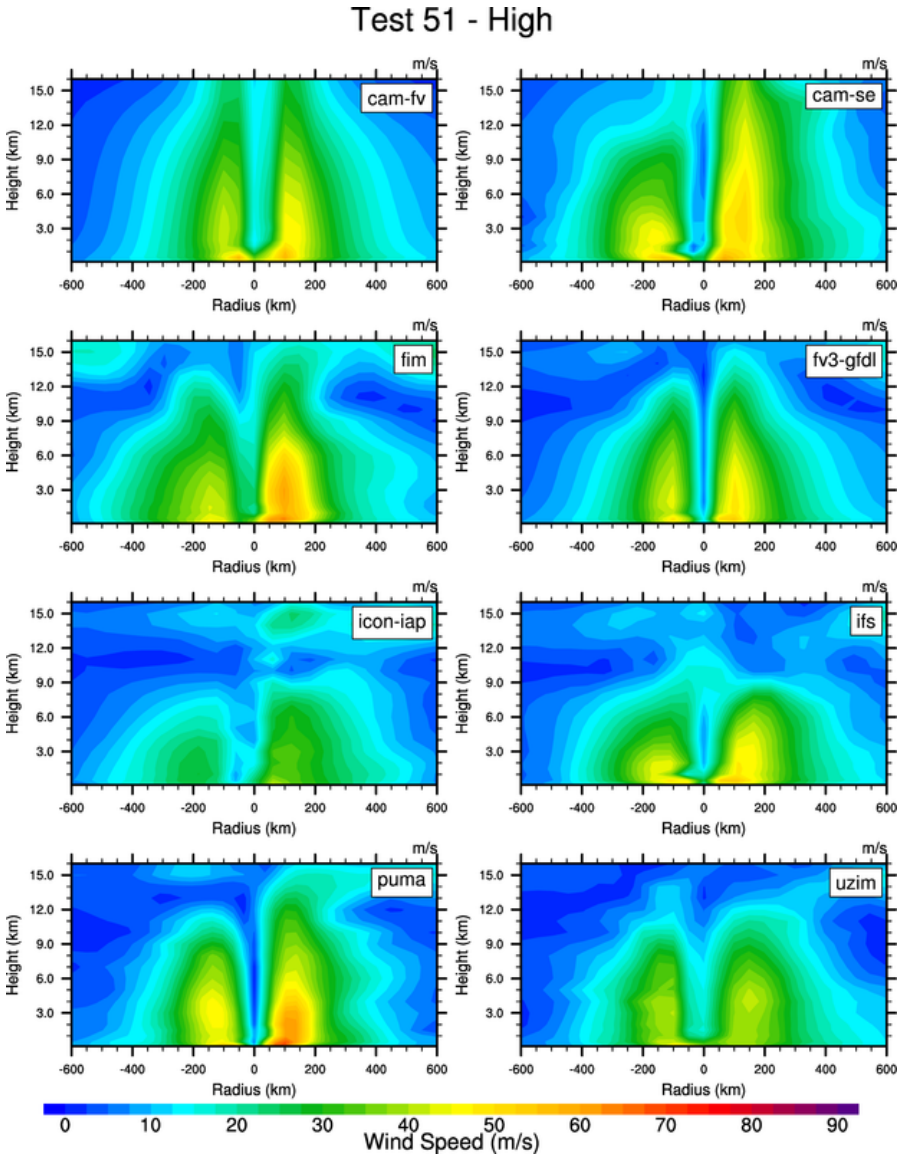
Results from the 2008 Dynamical Core Intercomparison during the NCAR ASP Summer Colloquium: Mountain-generated Rossby waves, 700 hPa zonal wind (m/s) at day 15

DCMIP2012 Results



Results from the 2012 Dynamical Core Intercomparison during the NCAR ASP Summer Colloquium: Jablonowski-Williamson Baroclinic instability surface pressure after 9 days.

DCMIP2012 Results



Results from the 2012 Dynamical Core Intercomparison during the NCAR ASP Summer Colloquium: Idealized Tropical Cyclone longitude-height cross section after 5 days (0.5 degrees resolution).

DCMIP2012 Test Case Suite

The 2012 test case suite incorporated many different tests…

- **Advection**
  - Pure 3D advection without orography
  - Pure 3D advection in the presence of orography
- **Dry dynamical core without rotation**
  - Stability of a steady-state at rest in presence of a mountain
  - Mountain-induced gravity waves on small planets
  - Thermally induced gravity waves on small planets
- **Dry dynamical core with the Earth's rotation**
  - From large (hydrostatic) to small (nonhydrostatic) scales, nonlinear baroclinic waves on a shrinking planet
- **Simple moisture feedbacks**
  - Moist baroclinic waves with large-scale condensation
  - Moist baroclinic waves with simplified physics (simple-physics)
  - Idealized tropical cyclones

DCMIP2016 Test Suite Goals

DCMIP2016 Test Cases …

- are designed for non-hydrostatic dynamical cores on the sphere, and work for both shallow- and deep-atmosphere models,
- include easy-to-use initialization routines,
- aim to be easy to run and useful to evaluate, including standard qualitative and quantitative diagnostics
- are relevant for observed atmospheric phenomena (extratropical cyclones, tropical cyclones, atmospheric rivers, mesoscale storms)
- reveal important characteristics of the dynamical core
- will (hopefully) find broad acceptance in the modeling community

DCMIP2016 Test Suite

Focus on non-hydrostatic models, physics-dynamics coupling and variable-resolution modeling systems.

- **Test 1:** Moist baroclinic instability with “toy” Terminator chemistry
- **Test 2:** Moist tropical cyclone test
- **Test 3:** Moist supercell storm test

Physics Routines

Kessler Microphysics: Requires water species for water vapor, cloud water and rain water. Computes tendencies for evaporation, autoconversion, collection and precipitation.

Latent heat release: $$\frac{\Delta\theta}{\Delta t} = -\frac{L}{c_p \pi}\left(\frac{\Delta q_{vs}}{\Delta t} + E_r\right)$$

Water vapor tendency: $$\frac{\Delta q_v}{\Delta t} = \frac{\Delta q_{vs}}{\Delta t} + E_r$$

Cloud water tendency: $$\frac{\Delta q_c}{\Delta t} = -\frac{\Delta q_{vs}}{\Delta t} - A_r - C_r$$

Rain water tendency: $$\frac{\Delta q_r}{\Delta t} = -E_r + A_r + C_r - V_r \frac{dq_r}{dz}$$

Reference: J. B. Klemp, W.C. Skamarock, and S.-H. Park (2015) "Idealized global nonhydrostatic atmospheric test cases on a reduced-radius sphere." *J. Adv. Model. Earth Syst.*, 07, doi:10.1002/ 2015MS000435

Physics Routines

Boundary Layer and Surface Fluxes: A simple mixing parameterization that represents boundary layer processes and surface fluxes (based on Reed and Jablonowski, 2012).

$$\frac{\Delta T}{\Delta t} = -\frac{1}{\rho}\frac{d}{dz}\left(\rho\overline{w'T'}\right)$$
$$\frac{\Delta q_v}{\Delta t} = -\frac{1}{\rho}\frac{d}{dz}\left(\rho\overline{w'q'}\right)$$
$$\frac{\Delta u}{\Delta t} = -\frac{1}{\rho}\frac{d}{dz}\left(\rho\overline{w'u'}\right)$$
$$\frac{\Delta v}{\Delta t} = -\frac{1}{\rho}\frac{d}{dz}\left(\rho\overline{w'v'}\right)$$

Surface Fluxes:

$$(\overline{w'u'})_s = -C_d|\mathbf{v}_a|u_a$$
$$(\overline{w'v'})_s = -C_d|\mathbf{v}_a|v_a$$
$$(\overline{w'T'})_s = C_H|\mathbf{v}_a|(T_s - T_a)$$
$$(\overline{w'q'})_s = C_E|\mathbf{v}_a|(q_{vs,s} - q_a)$$

Boundary layer mixing:

$$\overline{w'u'} = -K_m\frac{du}{dz} \qquad \overline{w'\theta'} = -K_E\frac{d\theta}{dz}$$
$$\overline{w'v'} = -K_m\frac{dv}{dz} \qquad \overline{w'q'} = -K_E\frac{dq}{dz}$$

Reference: Reed, K. A. and C. Jablonowski (2012), Idealized tropical cyclone simulations of intermediate complexity: a test case for AGCMs, J. Adv. Model. Earth Syst., 4, M04001, doi:10.1029/2011MS000099.

Workshop

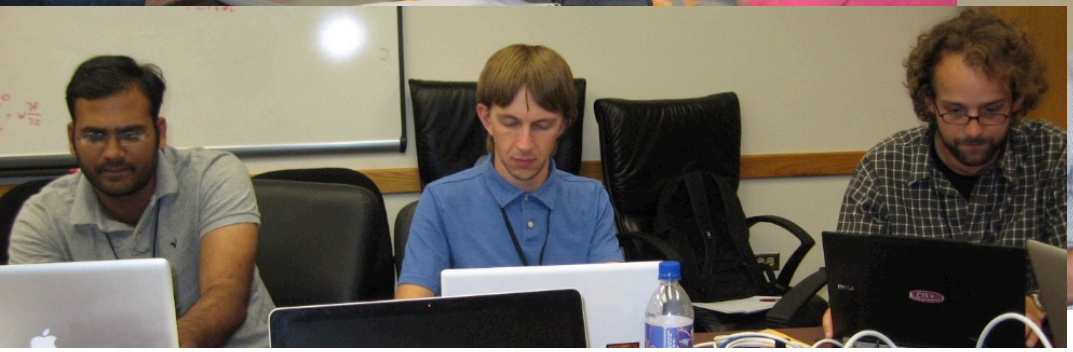
- Modeling teams will stay together for the two week period.
- The teams will be given the task of running baseline simulations on the NCAR Yellowstone Supercomputer.
- Teams will be given the option and ability to experiment with the models, with a focus on (a) physical parameterizations, (b) physics-dynamics coupling, and (c) variable-resolution.
- Teams will analyze and intercompare the data via GUI interfaces and prepared NCL scripts.
- Teams will disseminate model results to the DCMIP2016 website.
- Organizers will be present to assist with NCL, graphics, NCO, and NetCDF data formats.
- On Day 9 and 10 teams will present their findings at a short 15 minute presentation.

What happens on a typical afternoon?

- Have fun and interact
- Run test cases
- Suggest modifications of the test setups: for example, why not test a different diffusion coefficient, a variable-resolution setup, a different physics-dynamics coupling frequency
- Analyze your data, and intercompare the data with others
- Discuss your findings in your groups and with others
- Edit the DCMIP webpage, create new pages, upload figures and comment on them
- Help quality-control the netCDF data, as they need to comply with the DCMIP standards
- Produce plots for the eventual publication of our results.

DCMIP2012

DCMIP2012



Yellowstone

Yellowstone Supercomputer

- Student accounts have been created on the National Center for Atmospheric Research (NCAR) Yellowstone supercomputing cluster

- Login verification uses an encrypted RSA (physical) system via a personal **Yubikey**.

- A lost Yubikey costs $25, so protect it!

- If you have received an Yubikey today, please return it on June 17th before you leave.