Dynamical core development opportunities



Peter H. Lauritzen on behalf of CESM/CAM

Climate and Global Dynamics Laboratory, National Center for Atmospheric Research

CESM Atmosphere Model Working Group Meeting, 19 – 21 February 2019

What applications are dynamical cores used for in CESM?

- **"IPCC class" simulations: 1º, 32 levels, 33 tracers**
  - throughput important (~20 SYPD): CAM-FV (needs to be replaced!)
- **WACCM(-x): well-resolved stratosphere, 1º, 70 levels, 200 tracers**
  - throughput important (~4 SYPD): CAM-FV (needs to be replaced!)
- **New(er) frontiers:**

  - data-assimilation (Pause-Resume project + SIMA)

  - variable resolution climate modeling (~100km to ~25km or ~10km); Artic configuration!

  - SIMA: coupled and uncoupled "weather"-scale modeling (~3-10km)

  -> at ~3km need non-hydrostatic equation set

  applications: regional air quality, tropical cyclones, hydrological extremes

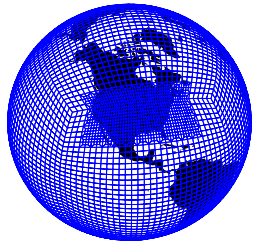
  - SIMA: geospace modeling (to ionosphere)

  -> should use "deep" equation set

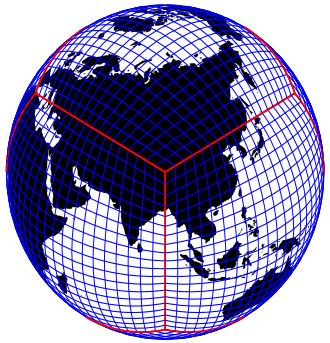
SIMA = System for Integrated Modeling of the Atmosphere (used to be called SingleTrack)
SIMA is composed of common atmospheric model components & infrastructure

NCAR
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

Current status of dynamical cores in CESM/CAM

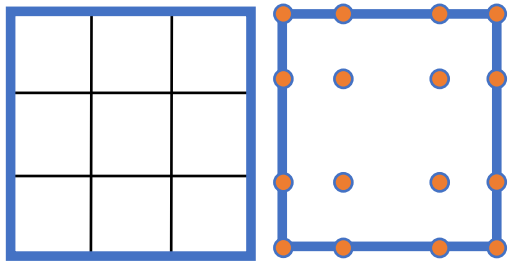


- **CAM-FV:** only fixing bugs, no new development



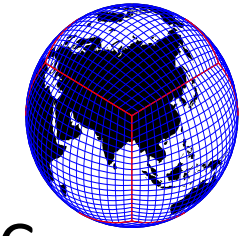
- **CAM-SE and CAM-SE-CSLAM developments:**
  - dry mass vertical coordinate (Lauritzen et al., 2018)
  - separate physics grid option (Herrington et al., 2018)
  - more accurate and faster transport option (Lauritzen et al., 2017)
  - ~20 SYPD with CAM6 on ~1800 cores
    ~4 SYPD WACCM6 with ~5400 cores
  - support for variable resolution (Zarzycki et al., 2017, …)
  - promising CAM-SE-CSLAM AMIP results thus far
  - still needs to be setup and evaluated in coupled configuration and scientifically evaluated in WACCM and CAM-Chem

Challenging for less diffusive dycores …



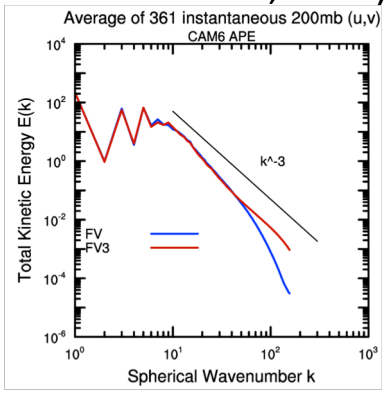
NCAR
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

Current status of dynamical cores in CESM/CAM



- **CAM-FV3:** NOAA funded effort to integrate the official EMC version of FV3 dynamical core into CAM
  - hydrostatic version integrated (non-hydrostatic is a “switch”)

  (scientifically verified that it is coupled to physics correctly using energy diagnostics – Lauritzen et al., 2019)
  - Simpler models configurations tested
  - AMIP configuration is being scientifically evaluated
  - working towards a CAM trunk supported version
  - setting up coupled & WACCM configurations



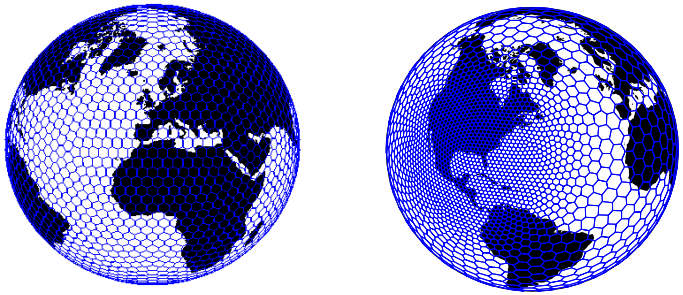
  - our deliverable to NOAA is functional support for various configurations (includes making sure it is integrated scientifically correctly) and making it accessible to the community

NCAR
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

Current status of dynamical cores in CESM/CAM

- **CAM-MPAS developments (SIMA effort):**

  - Non-hydrostatic dynamical core with mesh-refinement capability
  - Being integrated into CAM in a way that it can be supported (both scientifically and from a software engineering perspective)
  - Collaboration between MMM, CISL and CGD.
  - Status: MPAS build inside of CESM/CAM complete; next step is setting up grids in CAM and coupling to CAM physics



NCAR
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

Summary

- **CAM-SE and CAM-SE-CSLAM nearly ready to attempt to replace FV for CAM, CAM-Chem, and WACCM applications; CGD is working with HAO on CAM-SE-CSLAM version for WACCM-x.**
- **Several CESM/CAM dycore integration efforts ongoing (FV3 and MPAS)**

  -> Once they are integrated we can start evaluating them for various applications:

  Last year we discussed idealized testing for CAM applications

  http://www.cesm.ucar.edu/events/wg-meetings/2018/presentations/amwg/lauritzen.pdf

- **Note: None of the new (or old) dynamical cores currently have non-hydrostatic deep atmosphere capability!**

- **Please contact me if you want to be involved in dynamical core testing and evaluation**