A UT/ORNL PARTNERSHIP
NATIONAL INSTITUTE FOR COMPUTATIONAL SCIENCES
NICS

An International, Dedicated High-End Computing Project to Revolutionize Climate Modeling

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Collaborators

COLA	Center for Ocean-Land-Atmosphere Studies, Calverton, MD, USA
ECMWF	European Center for Medium-Range Weather Forecasts, Reading, England
JAMSTEC	Japan Agency for Marine-Earth Science and Technology, Tokyo, Japan
U of Tokyo	University of Tokyo, Japan
NICS	National Institute for Computational Sciences, University of Tennessee, Knoxville, TN, USA

Project objectives

Use *dedicated* HPC resources – Cray XT4 (Athena) at NICS to

- **Simulate the mean climate, including all its moments and extremes, at unprecedented high horizontal resolution in an (uncoupled) atmospheric general circulation model**
  - **Forecast intraseasonal climate variability, without parameterization of important physical processes such as cumulus parameterization**
    - **Simulate the effect of increased greenhouse gases on regional aspects of climate, such as precipitation and storminess, and assess the impact of resolution in time-slice mode on depicting the climate change signal**

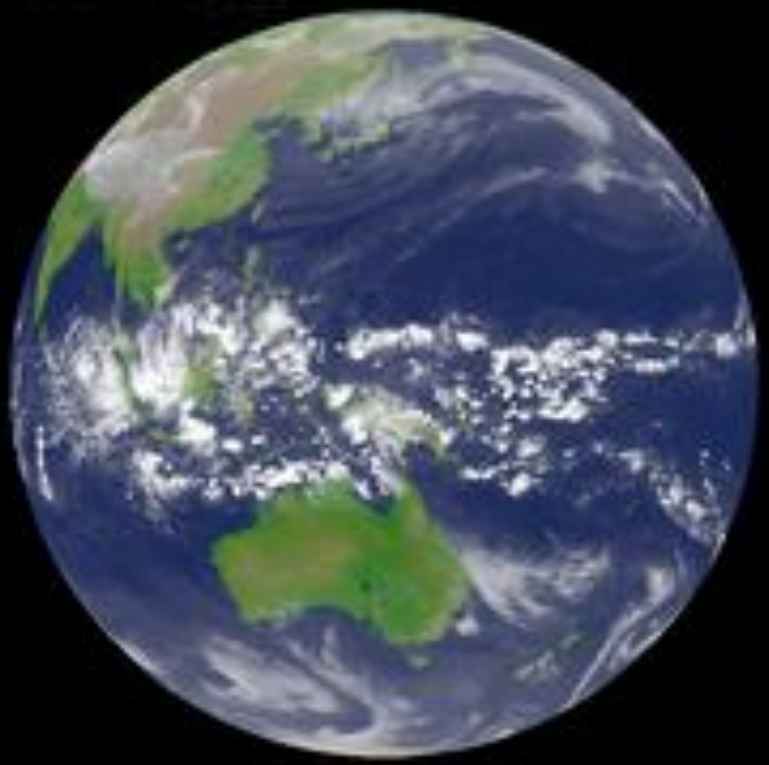
Codes

NICAM (Japan)	Nonhydrostatic, Icosahedral, Atmospheric Model
IFS (Europe)	ECMWF Integrated Forecast System

NICAM

Satellite Observation

Model Simulation

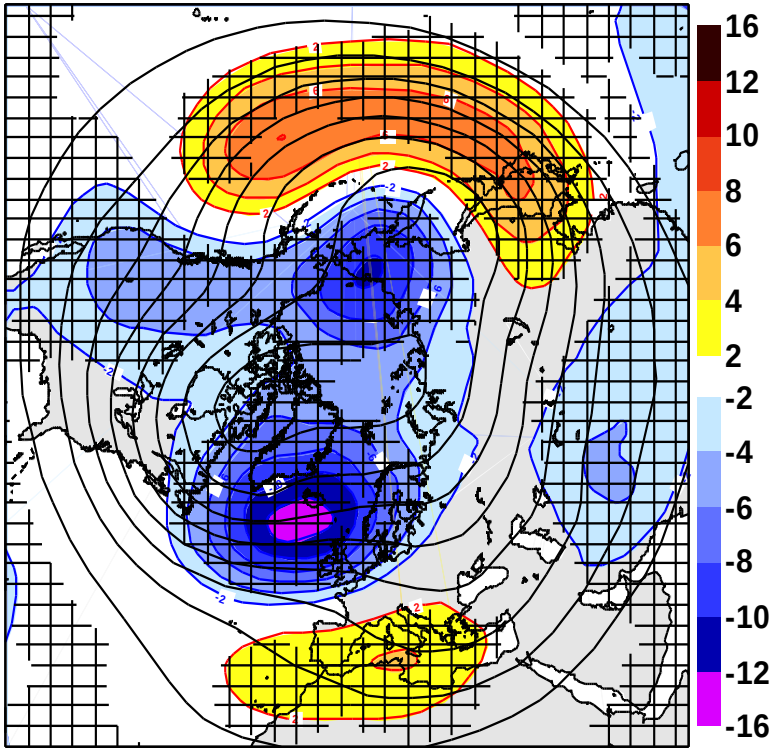


The only **global** atmospheric **climate** model capable of resolving cloud systems

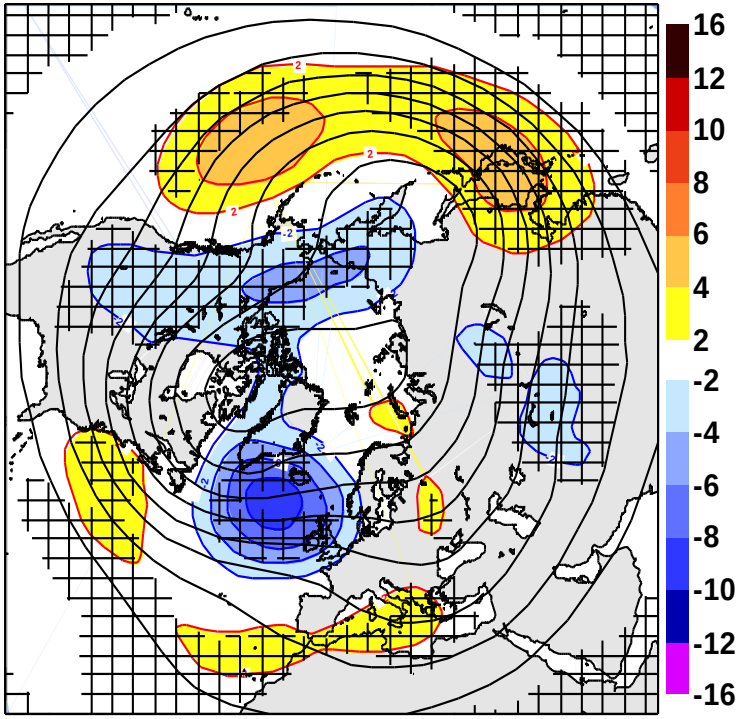
IFS

Numerical Weather Prediction Model being used for climate simulation

200 km resolution



40 km resolution



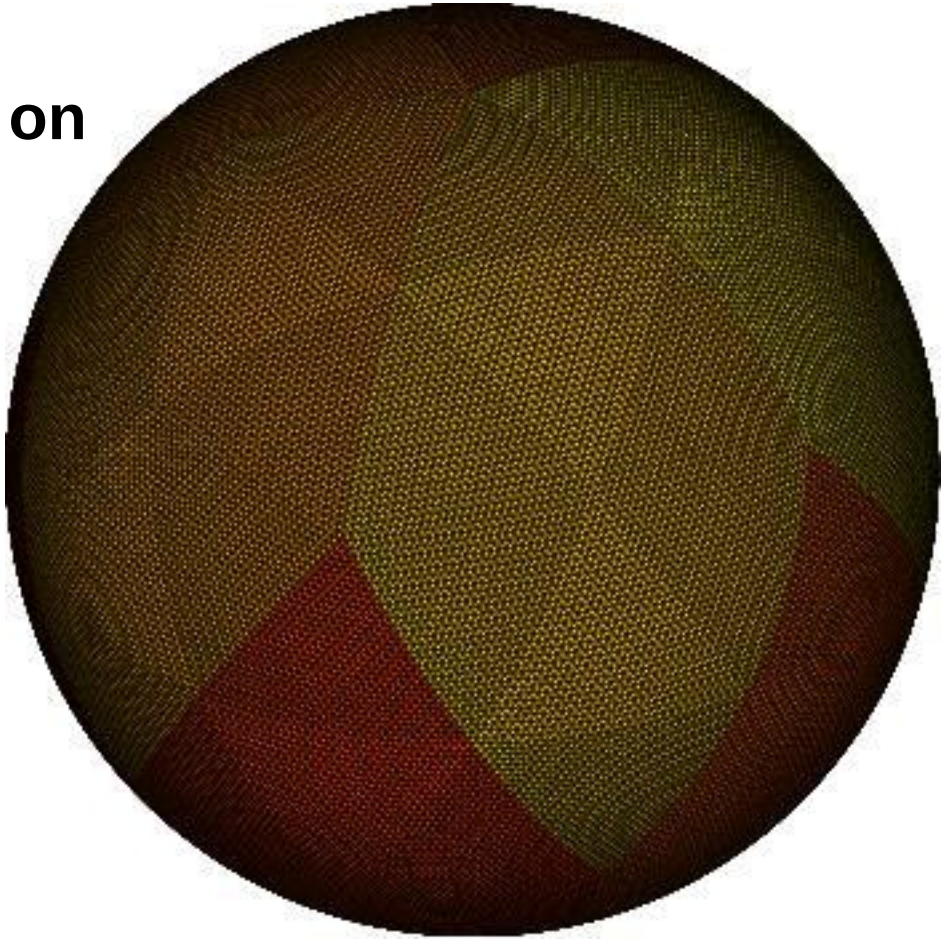
Systematic error with respect to observations of geopotential height over North Pacific and North Atlantic viewed from above the North Pole

Computational challenges

- General Circulation Models (GCMs) are both highly computing- and data-intensive applications
  - GCMs have frequent I/O accesses, large memory requirements, and intensive data flow
  - Climate science experiments generate large output that requires long-term storage

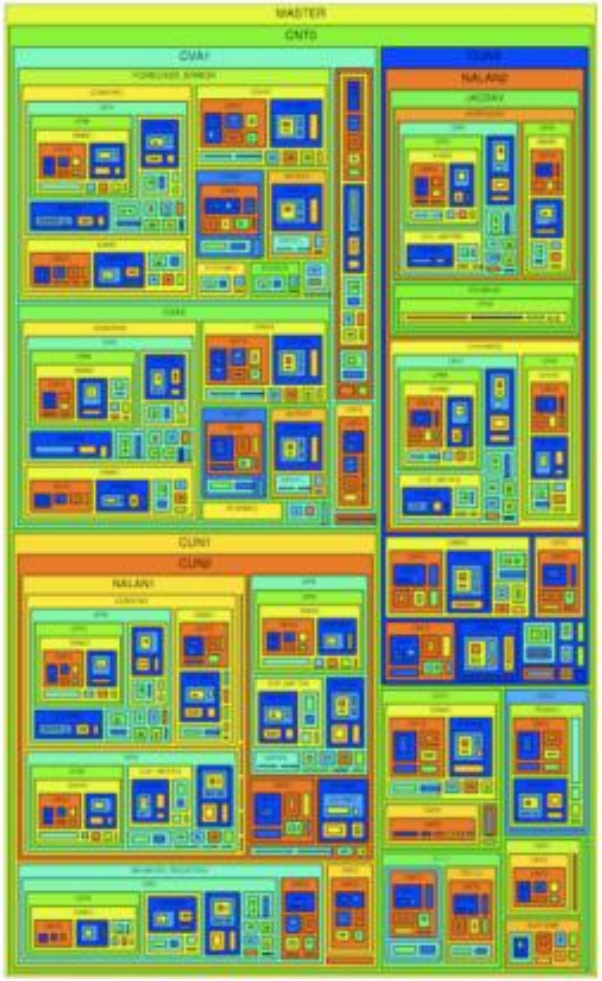
Computational challenges NICAM

- 2D domain decomposition on an icosahedral grid
- 10×211+2 grid points for 3.5 km resolution
- MPI parallelization
- Sustained performance, TFLOPS, memory, archival



Computational challenges IFS

Calling Tree

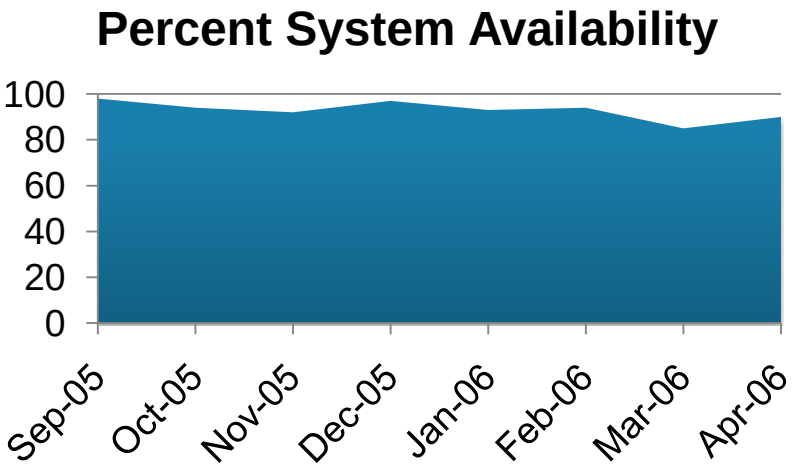


Variable grid point decomposition

Athena utilization

- Athena has been very reliable
- System utilization was ~95% for the 6 month period (includes scheduled and unscheduled downtime)
- The project used ~70M hours over 6 months on Athena, out of a total of ~78M hours available in the 6 months; 90% utilization by COLA

Oct-09	98%
Nov-09	94%
Dec-09	92%
Jan-10	97%
Feb-10	93%
Mar-10	94%



Experiments catalog

Athena: Project Home Page

http://wxmaps.org/athena/home/

NCSA Wiki Doodle CISL GDS Google Mail GrADS Apple .Mac eBay Apple (133) News (1120) Amazon

- Home
- Experiments
- Data Catalog
- Workshop Agenda
- Publications
- Acknowledgments

Movies:

- NICAM Precip (354Mb)

Model Output:

- IFS Hindcast
- IFS AMIP
- IFS Time Slice
- NICAM Hindcast

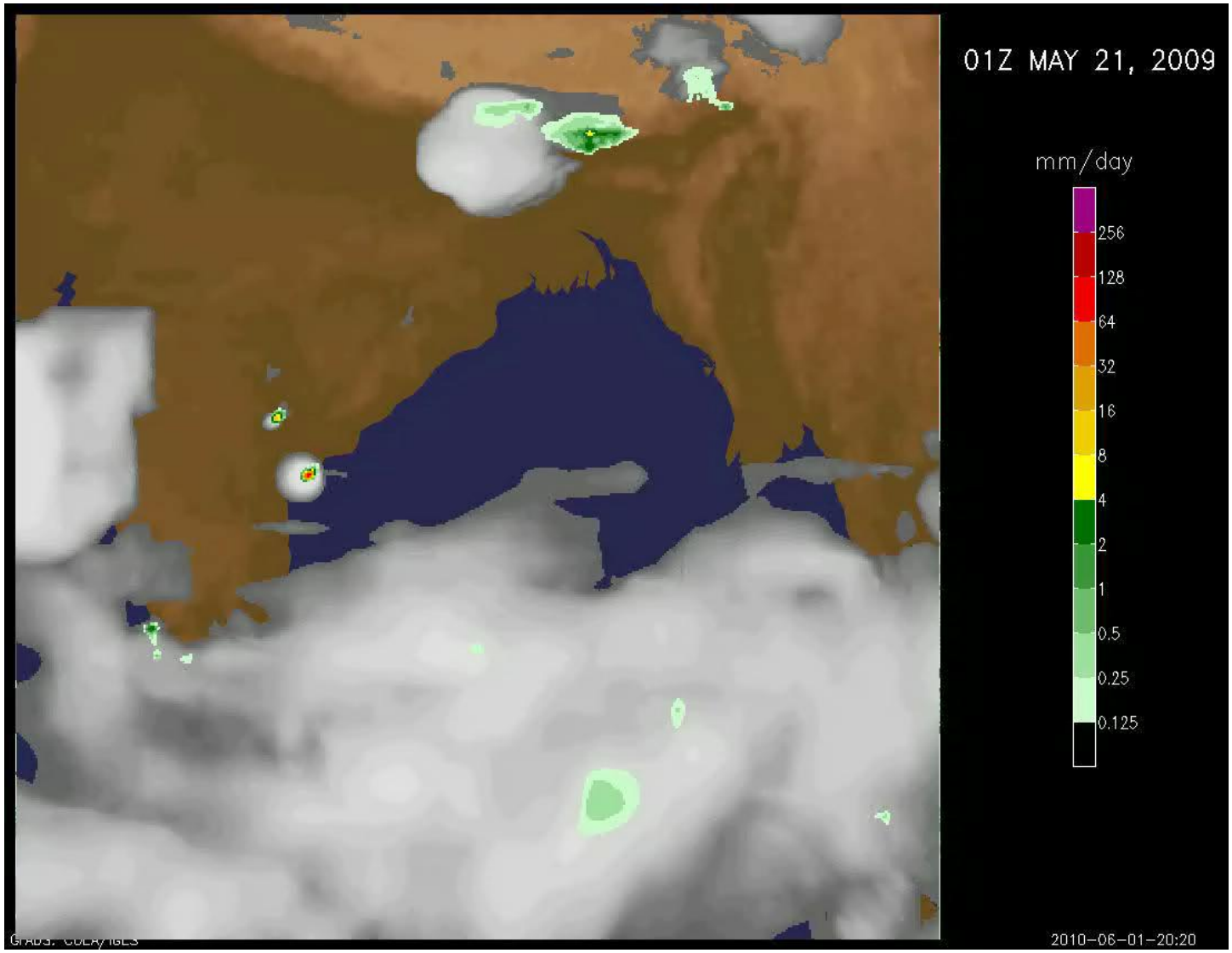
Project Athena: High Resolution Global Climate Simulations

COLA | ECMWF | JAMSTEC | NICS

Model / Experiment	Resolution	Grid Size	# Cases	Time Period	Data Volume	Comments
NICAM 103-day Hindcasts		8 km	8*	103 Days	640 Tb	21 May - 30 Aug 2001 - 2009 * Unable to complete 2003
IFS 13-month Hindcasts	T159 T511 T1279	125 km 39 km 16 km	48	395 Days	0.7 Tb 7 Tb 41 Tb	1 Nov - 30 Nov (of next year) 1960 - 2007
IFS 13-month Hindcasts	T2047	10 km	20	395 Days	51 Tb	1 Nov - 30 Nov (of next year) 1989 - 2007
IFS 103-Day Hindcasts	T159 T511 T1279 T2047	125 km 39 km 16 km 10 km	9	103 Days	0.03 Tb 0.3 Tb 2 Tb 6 Tb	21 May - 30 Aug 2001 - 2009 NICAM Analogs
IFS 10-Member Ensembles (Summers)	T511 T1279	39 km 15 km	6	132 Days	3.2 Tb 20 Tb	21 May - 30 Sep Selected Years
IFS 10-Member Ensembles (Winters)	T511 T1279	39 km 16 km	6	151 Days	3.7 Tb 23 Tb	1 Nov - 31 Mar Selected Years
IFS Time Slice	T159 T1279	125 km 16 km	1	47 Years	0.6 Tb 38 Tb	2071 - 2117
IFS AMIP	T159 T1279	125 km 16 km	1	47 Years	0.6 Tb 38 Tb	1961 - 2007
					875 Tb	**Total volume of raw output**

NICS

Results



NICAM
Hourly simulation of precipitation and clouds during May–August 2009

Courtesy:
Brian Doty, COLA

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Ben Cash	Larry Marx	Tom Wakefield

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