Climate-in-a-Box: System Overview

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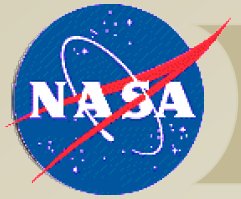
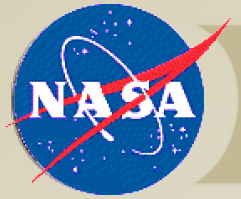


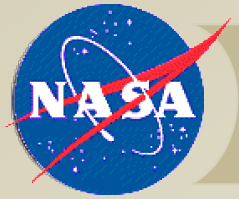
Vision

- Climate in a Box (CIB) seeks to:
  - Open climate/Earth science model development and validation to a community beyond traditional domain scientists
  - Develop/improve models through a more efficient “open” model development and validation process



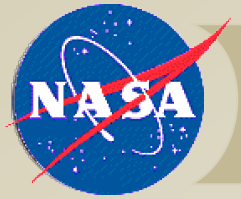
Motivations

- NASA/NOAA climate/earth science models are difficult to use
  - Can be challenging for domain experts
  - Non-typical users (e.g., policymakers and non-domain scientists) may want to run models



Motivations

- Supercomputing resources are not readily accessible
  - Wait times in job queues can be extensive
  - Arduous application process for foreign nationals



Goals

- Make NASA/NOAA climate/earth science models more accessible
- Explore desktop supercomputing architectures
- Package models and support software as a “toolkit” with desktop supercomputers
- Explore use of the system for “open” model development/validation

CIB Overview

Desktop System
(testing, development, lower resolution runs)

Preconfigured Toolkit

Data/Process Management Tools (workflow tool)

NASA/NOAA Models

Analysis Tools

User Additions

User-Provided Models/Tools

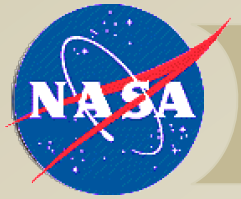
Model Run Information

Traditional Cluster
(high resolution runs)

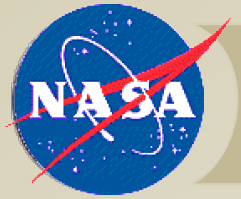
Workflow Tool "Switch Capability"

Modeling Toolkit

- Models (ModelE, GEOS5, WRF, GFS, LIS-6)
- Analysis tools (WMS, GrADS, etc.)
- Social networking/collaboration capabilities through NASA's Modeling Guru
- Process management tools (e.g., workflow tool)

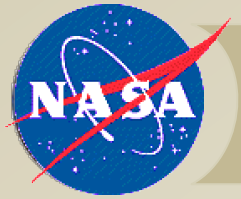


CIB Desktop Architectures



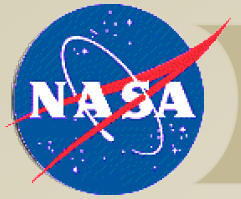
Desktop Architectures

- Cray CX1
  - Project is using 2 CX1's
  - One has Linux and the other Windows HPC Server 2008
- SGI Octane III possible in the future
- Others as needed/available

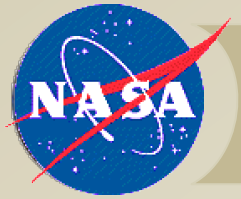


CX1 Configuration

- 8 “compute nodes”
- Each node has
  - Two Intel 3.0ghz quad-core CPUs
    - Linux CX1 with “Nehalem” CPUs
    - Windows CX1 with “Harpertown” CPUs
  - 32gb DDR2 RAM
  - One 320gb 7200rpm hard drive
- Infiniband and GigE networks connecting the compute nodes

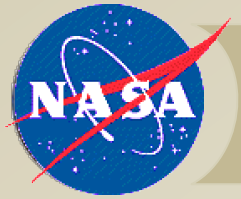


CIB Model Porting



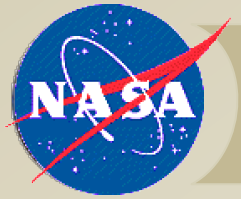
Model Porting Status

- Linux CX1
  - WRF, ModelE, GEOS-5 have been run successfully and validated
  - GFS has been validated on NCCS's Discover Linux platform, and should run on CX1
- Windows HPC CX1
  - ModelE built serially in Visual Studio
  - Incorporated PGI's port of WRF to Visual Studio 2008 into our Windows environments



Model Ports: Lessons Learned

- Linux ports were straightforward
- Windows HPC ports are more involved as models were written for Linux
  - Build/run scripts written for Linux shells
  - Language features are not always portable
  - Windows HPC best suited for existing Visual Studio developers

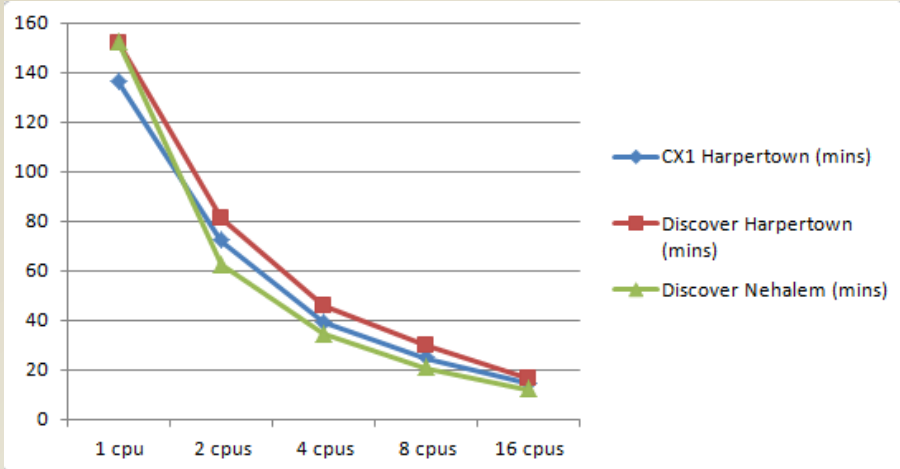


Timing and Accuracy Analysis

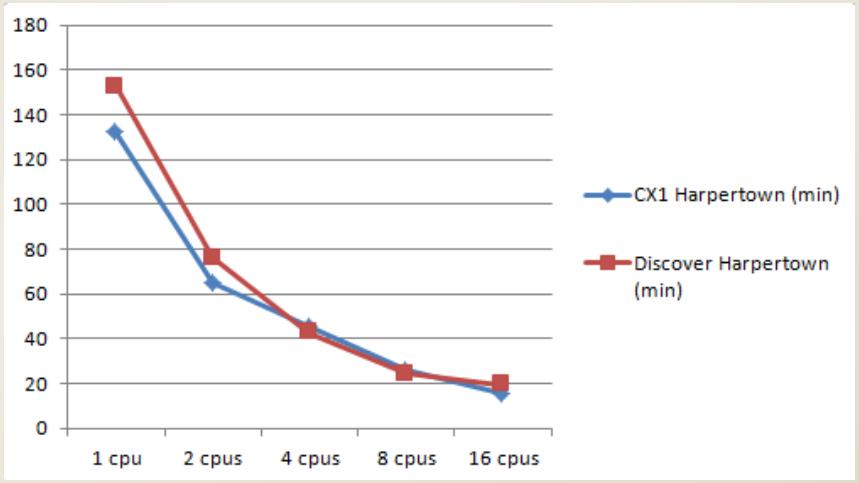
- On the Linux CX1, WRF, GEOS-5, and ModelE showed no difference in science results compared to runs on NCCS's Discover
- Linux CX1 shows comparable performance to Discover

Timing and Accuracy Analysis

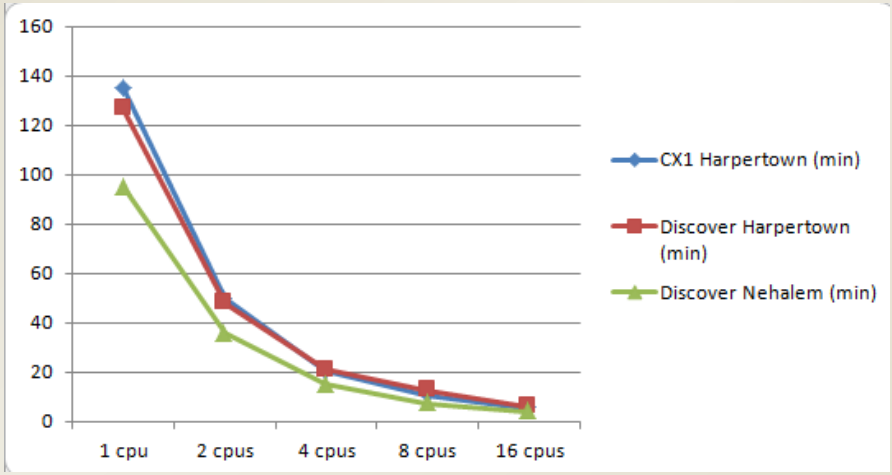
ModelE



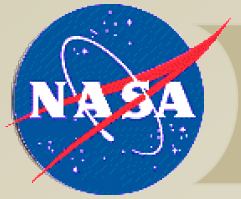
WRF



GEOS



In-depth results are available on **Modeling Guru** modelingguru.nasa.gov



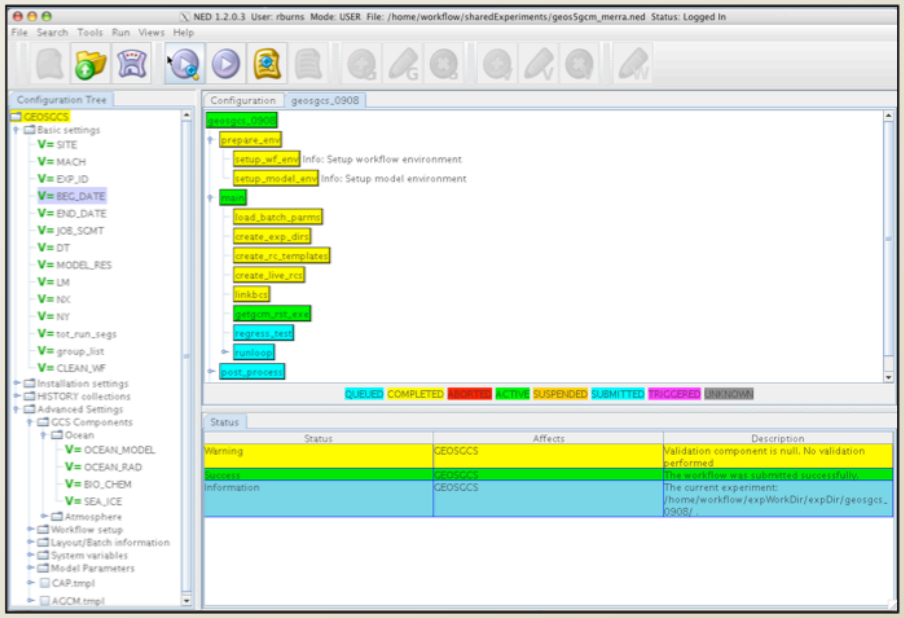
Model Ports Next Steps

- Linux CX1
  - Complete validation and timing of GFS
- Windows HPC CX1
  - Conclude on suitability of Visual Studio as IDE
  - ESMF4 needed for GEOS-5 (NCAR/GMAO)

CIB Workflow Tool

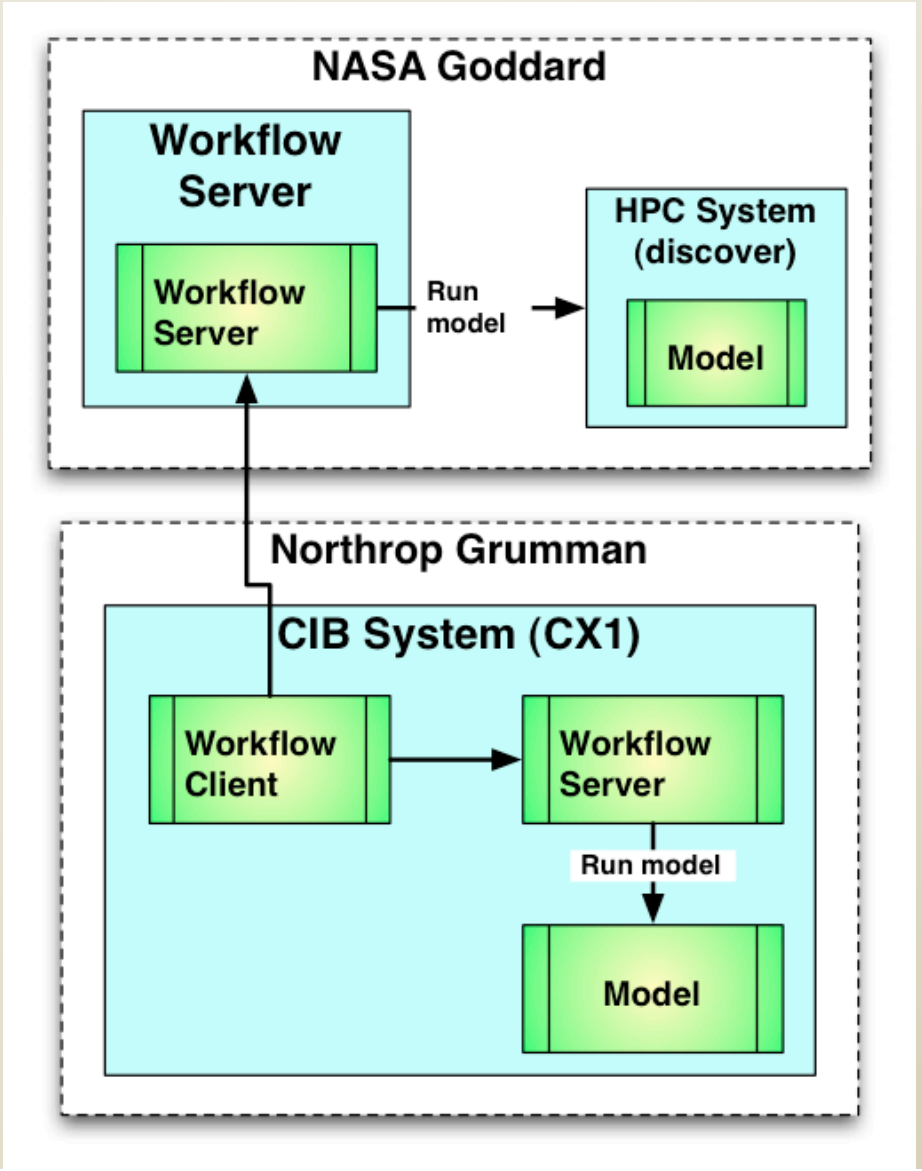
Workflow Tool

- Simplifies/Automates model execution management and other processes
- Provides common look and feel between models and systems
- Allows for experiment sharing and repeatability



CIB Workflow Tool Status

- In-house workflow tool (GUI client & server) installed on CX1)
- Tool can access either CX1 or NCCS workflow servers
- Model workflows (e.g., GEOS5) not yet ported)



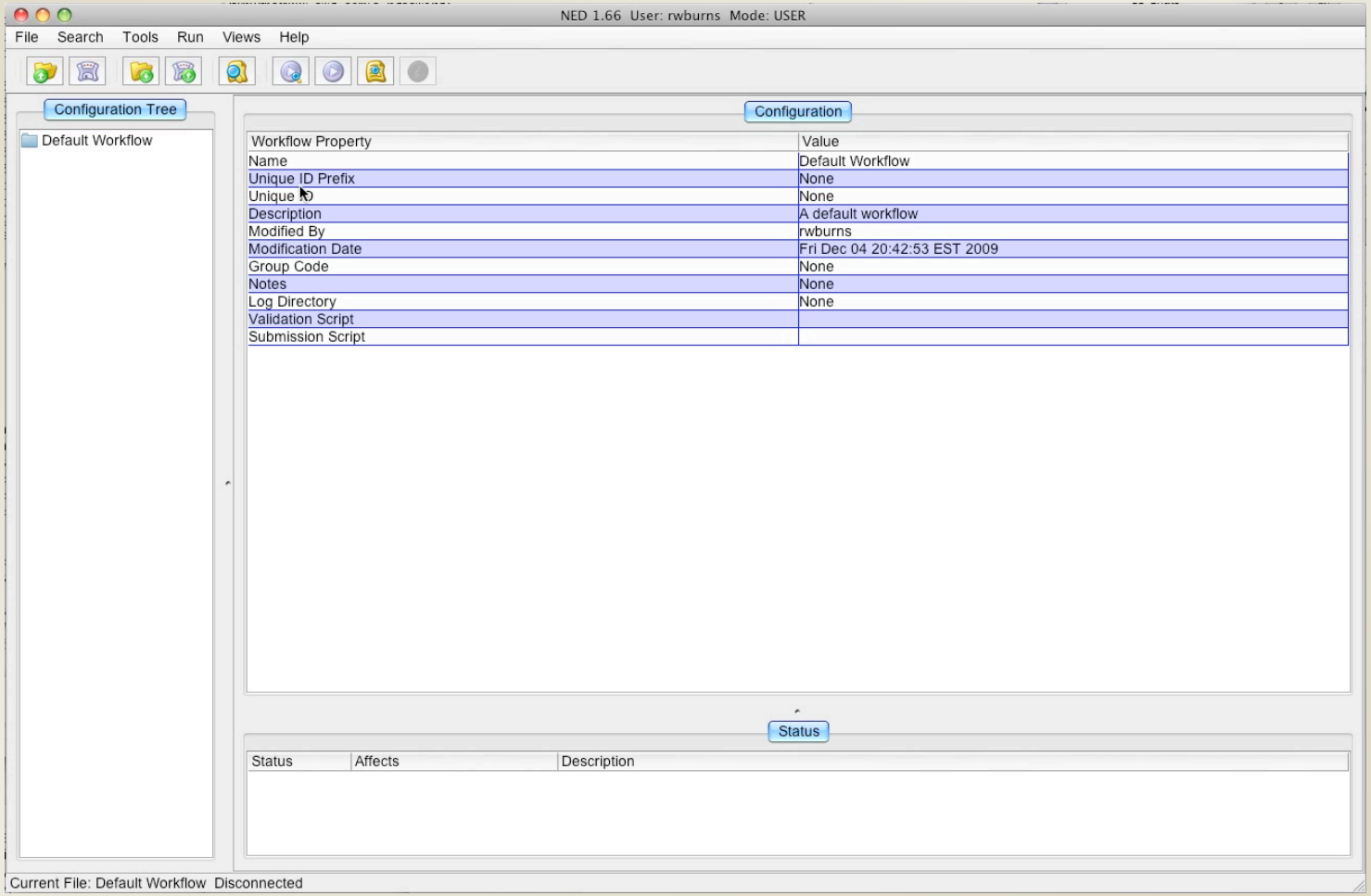
Workflow Tool Porting

- Core workflow tool easily ported (Java)
- GEOS-5 workflow previously tailored to NCCS
  - Requires generalizations of workflow
  - Requires CX1-specific settings
- Other model workflows reguire similar changes

Workflow Tool Switch Capability

- Enable model execution to be as seamless as possible between CIB and NASA HPC environment
  - Large HPC systems can be used for validation and simulations at a higher resolution
- Security: data movement through workflow or shared/open resource
- Virtualization: explore a virtual image that can be moved from CIB to NASA

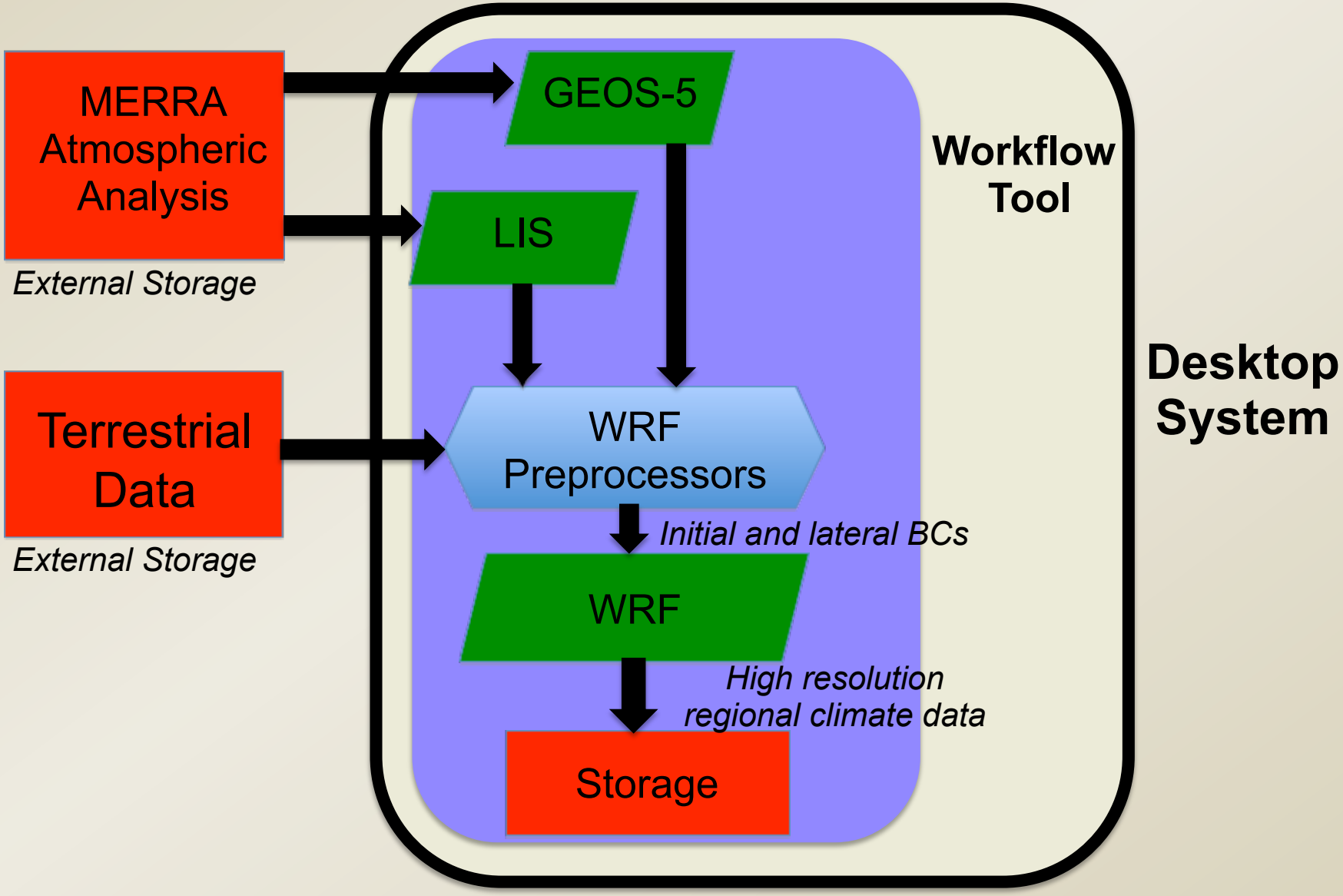
Workflow Tool Video



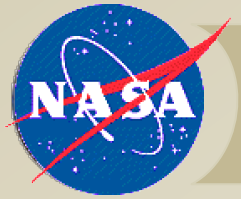
CIB Use Case

- Regional GEOS-5 to WRF downscaling
  - Hurricane Isabel's Landfall on the Mid Atlantic US Coast, Sep 18-21, 2003 (UTC)
  - GEOS-5 data at 0.5°x0.67° input to WRF
  - WRF downscaled from 36 km to 12 km to 4km

CIB Use Case Overview



CIB Use Case Video

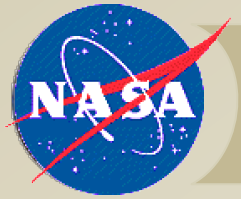


Summary

- CIB system is being developed as an alternative/complement to developing/running models on existing large supercomputing clusters
- Desktop supercomputers are being evaluated for climate/weather models
  - Testing started on Cray CX1s with Linux and Windows HPC Server 2008
  - Others to be tested when available

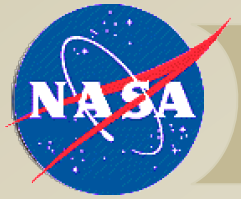
Summary

- Models ported to CX1
  - Linux: WRF, ModelE, GEOS-5
  - Windows HPC Server: ModelE (Serially) and WRF to Visual Studio 2008
- SIVO's workflow tool ported to CX1 for process/data management
- Use case being pursued: Downscaling of Hurricane Isabel's Landfall, Sep 2003



Next Steps

- Desktop Architectures
  - Continue testing on CX1
  - Investigate SGI Octane III
- Models
  - Port GFS to Linux CX1



Next Steps

- Workflow Tool
  - Finish port to Windows HPC and Linux
  - Design and implement Switch Capability
- Use Case
  - Port necessary models to Linux CX1
  - Perform downscaling simulation on Linux CX1

Next Steps

- Explore data/process management aspects
  - Model code updates
  - Data transfer
  - IT security
  - Social networking