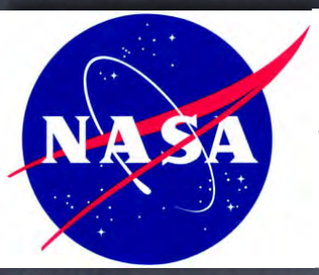


Software Integration & Visualization Office

Goddard Space Flight Center

Capabilities Overview
&
MAP Technology Roadmap Status

MAP Science Team Meeting, March 2007

Michael Seablom - Office Head

Who We Are

Advanced Software Technology Group
Tom Clune

- Develops & maintains application software
- Provides performance tuning of science codes
- Advocates professional software engineering practices
- Coordinates software integration efforts across Goddard and across NASA

Scientific Visualization Studio
Horace Mitchell

- Provides visualization services for a wide range of Earth and Space science customers
- Provides scientific visualizations targeted at NASA managers, policy makers, and the general public
- Develops visualization applications for use as analysis tools by scientists

MAP Integration Group
Gail McConaughy

- Serves the MAP program by selecting and implementing appropriate technologies that will benefit the development of Earth System models
- Develop software in support of Observing System Simulation Experiments (OSSEs)

Education & Public Outreach
David Herring

- Provides freely-available Earth Science visualizations through web-based publications
- Develops products for educators
- Coordinates Goddard Education & Public Outreach activities

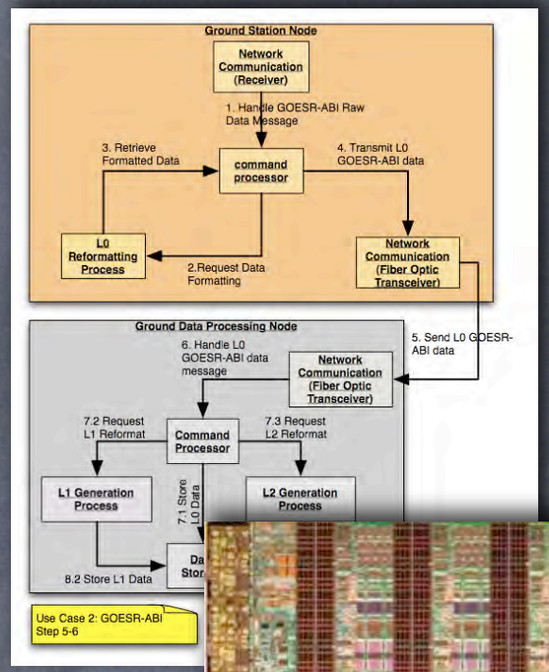
Software Support via NASA High End Computing

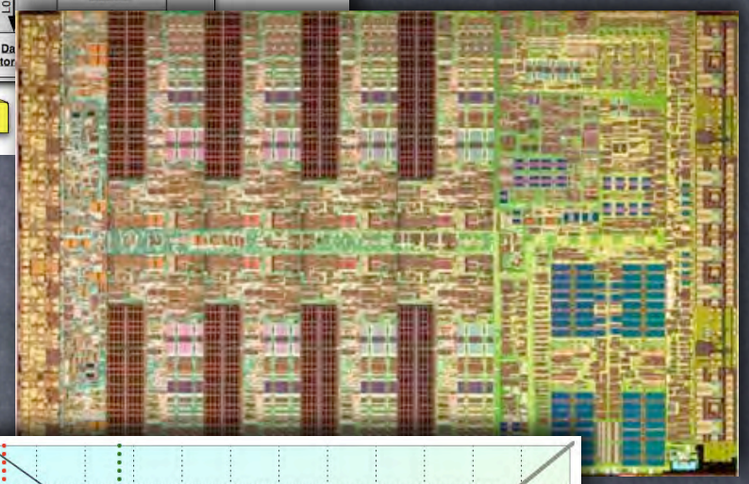
Optimization of scientific codes for high-end computing

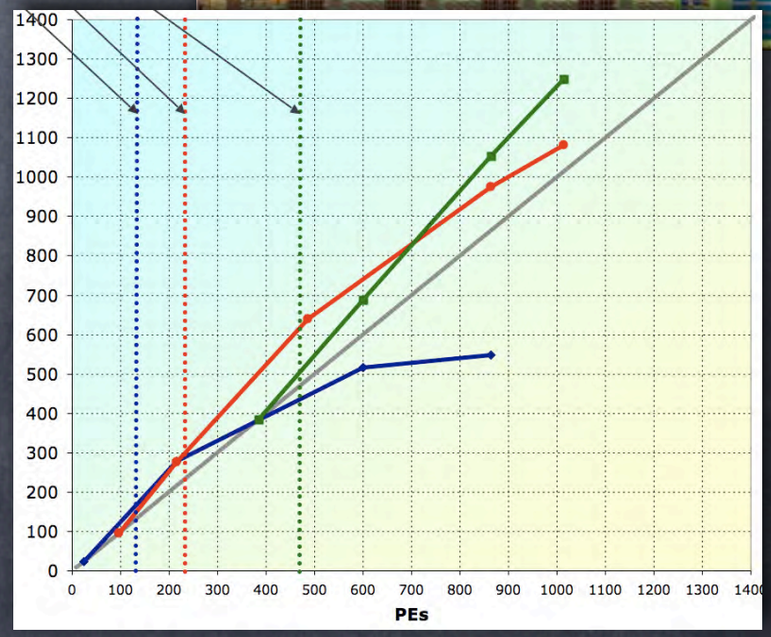
- Identification and mitigation of performance bottlenecks
- Optimization for multiple hardware platforms
- Porting codes to new hardware
- Assessment of granularity
- Technology outlook for hardware & software (current examples include the Cell Broadband Engine Architecture and the Field Programmable Gate Array)

Maintenance and execution of benchmarking suite

- Access to wide range of vendors, hardware







Software Engineering Support

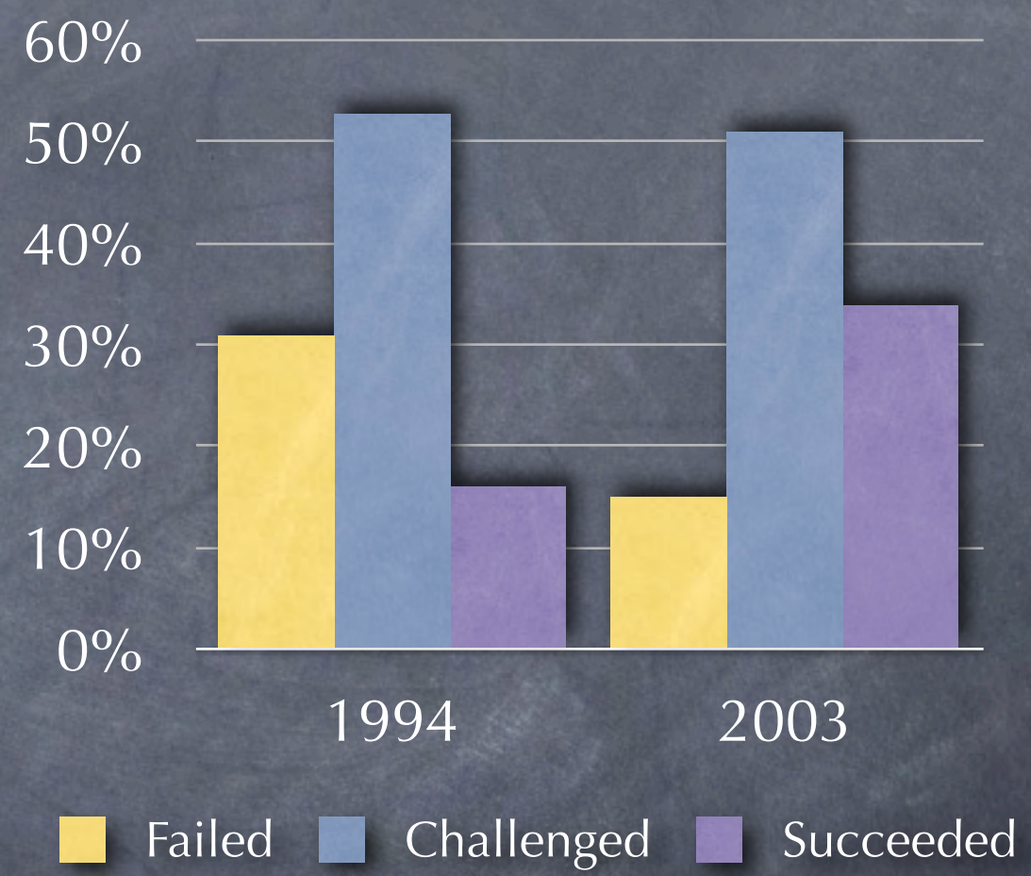
Motivation

- **Cost, Risk**
  - Study by Hatton[1] of scientific software found on average 12 defects for every 1000 lines of code (mostly Fortran codes)
- **Leadership in current software engineering practices**
  - New design methods
  - User training for current techniques (OO design, unit and system level testing, rapid prototyping, configuration management)
  - Risk assessment

Re-engineering of legacy codes

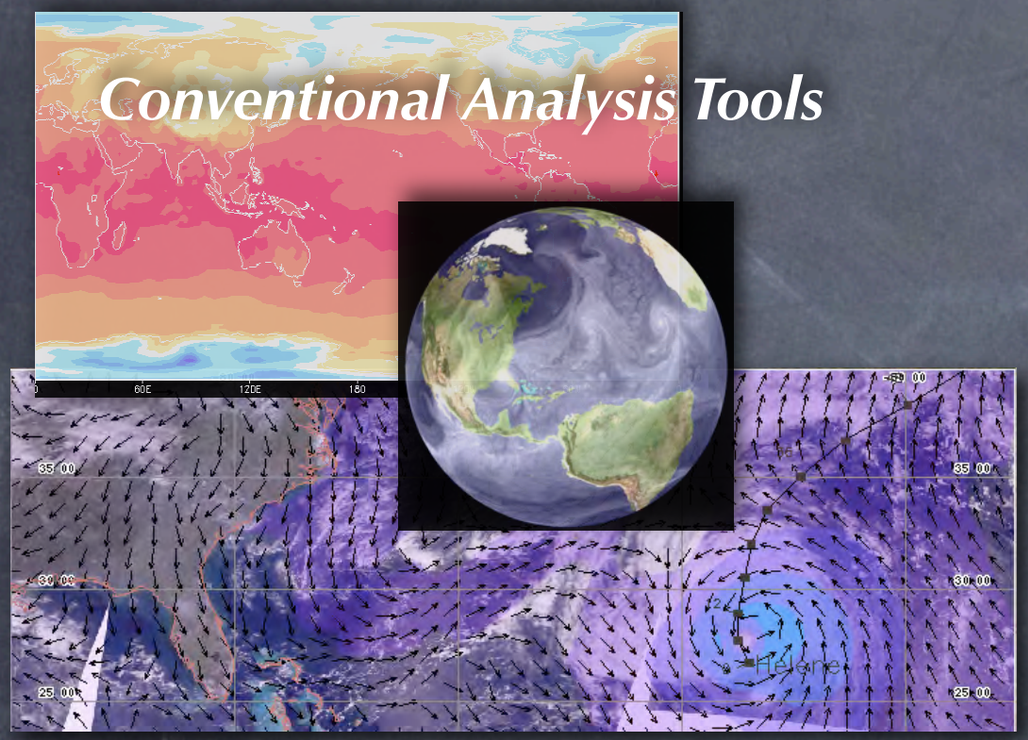
- Redesign for improved modularization (removal of global variables, better use of user-defined data structures, etc.)
- Assistance with implementation of Earth System Modeling Framework (ESMF)

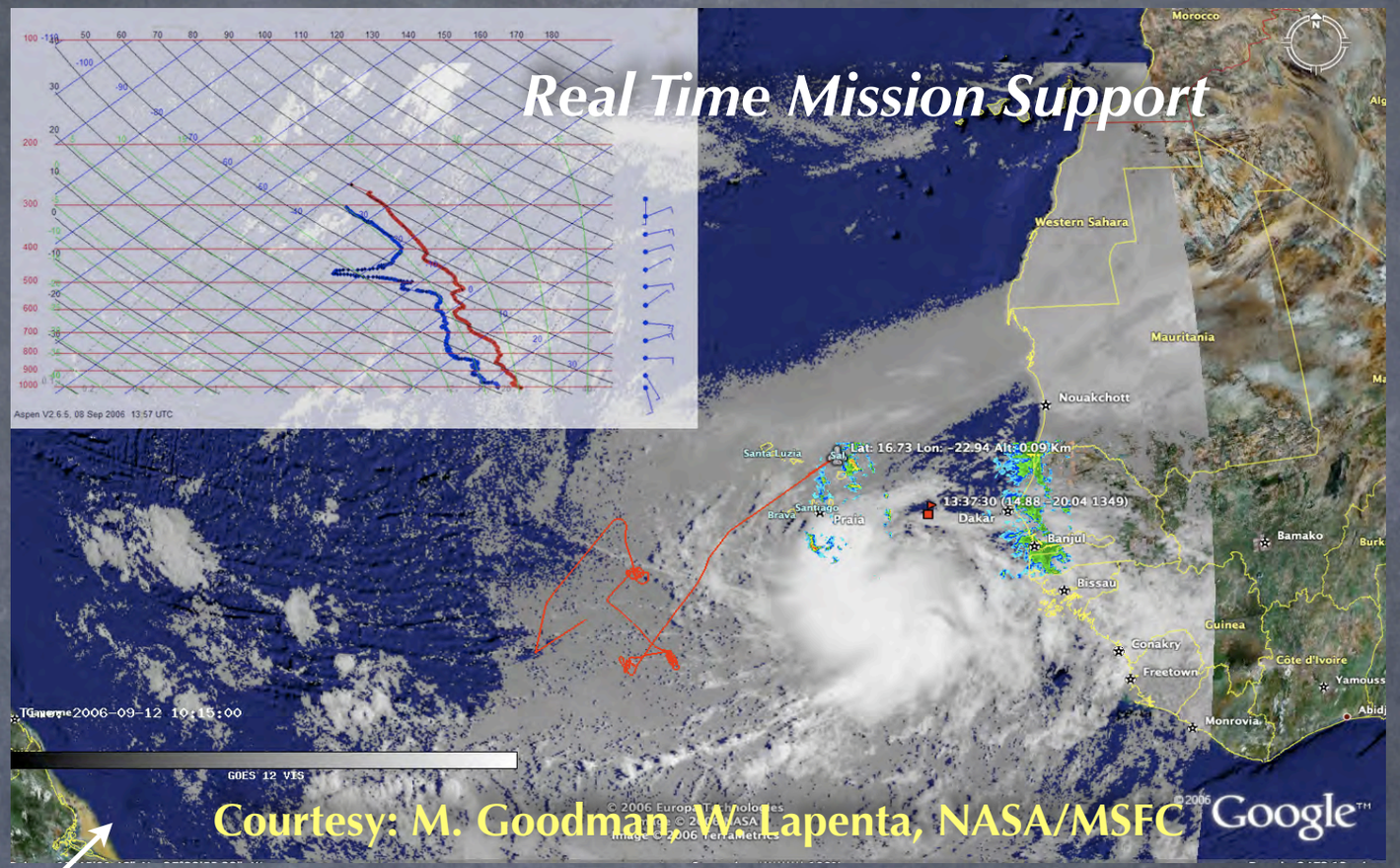
2003 Standish Group Study of Commercial Software Projects[2]



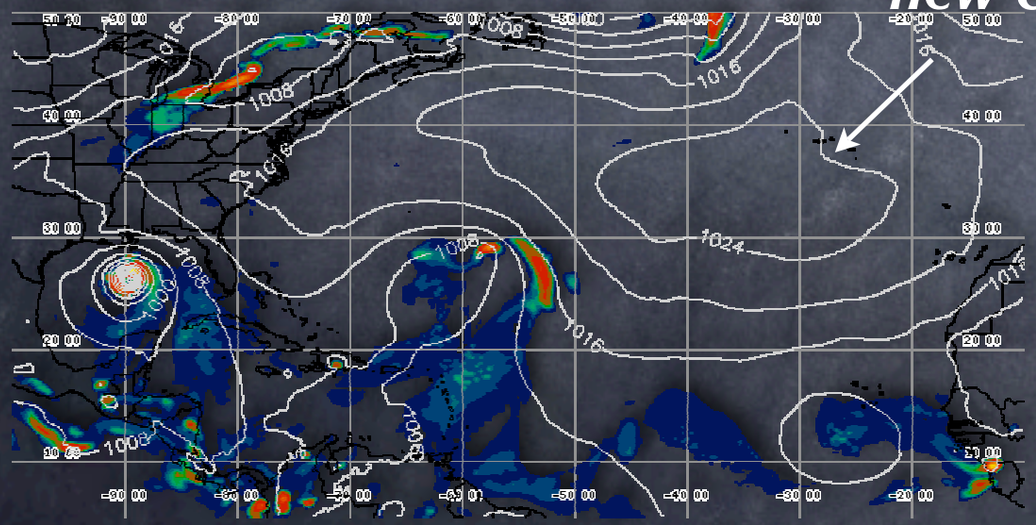
1. Hatton, L., 1997: The T Experiments: Errors in scientific software, IEEE Comp. Sci. & Eng., 4, No. 2, 27.
2. The Standish Group, 2003: “Chaos Report 2003”.

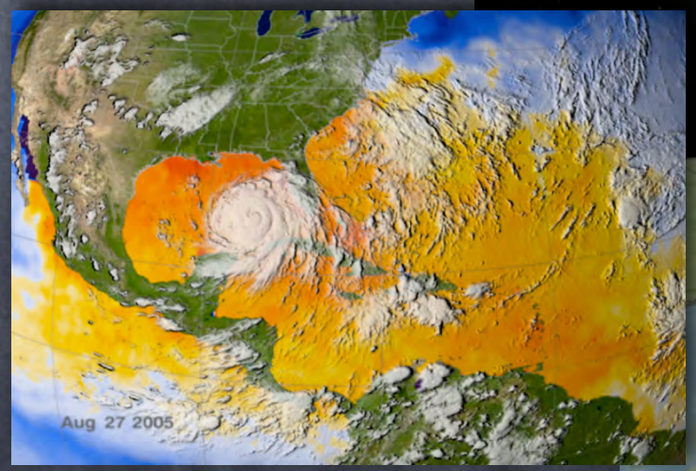
Scientific Visualization Studio

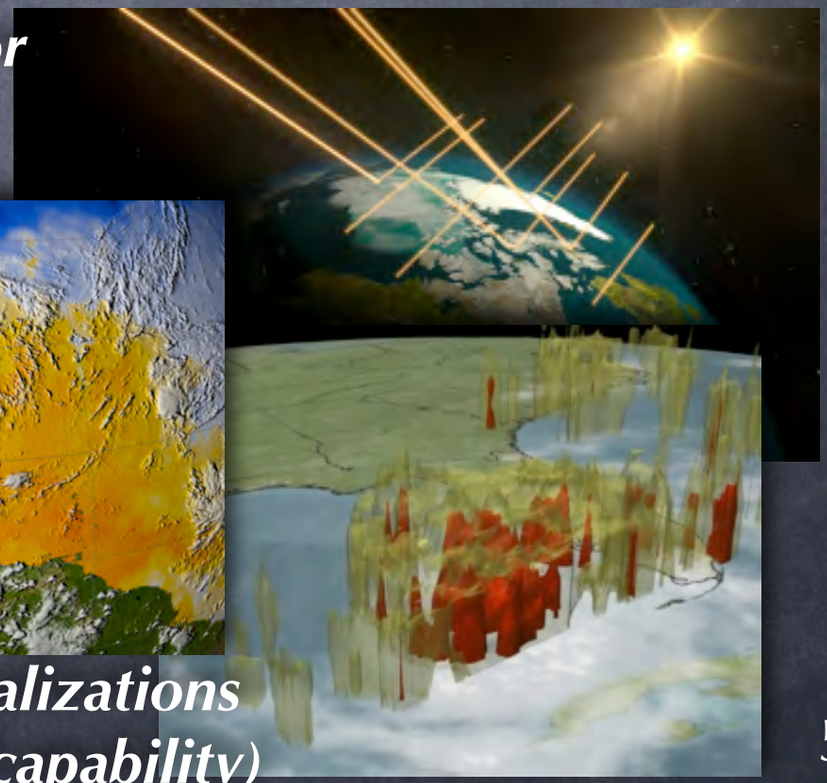




Emerging (OGC) Tools (focus for new capabilities)

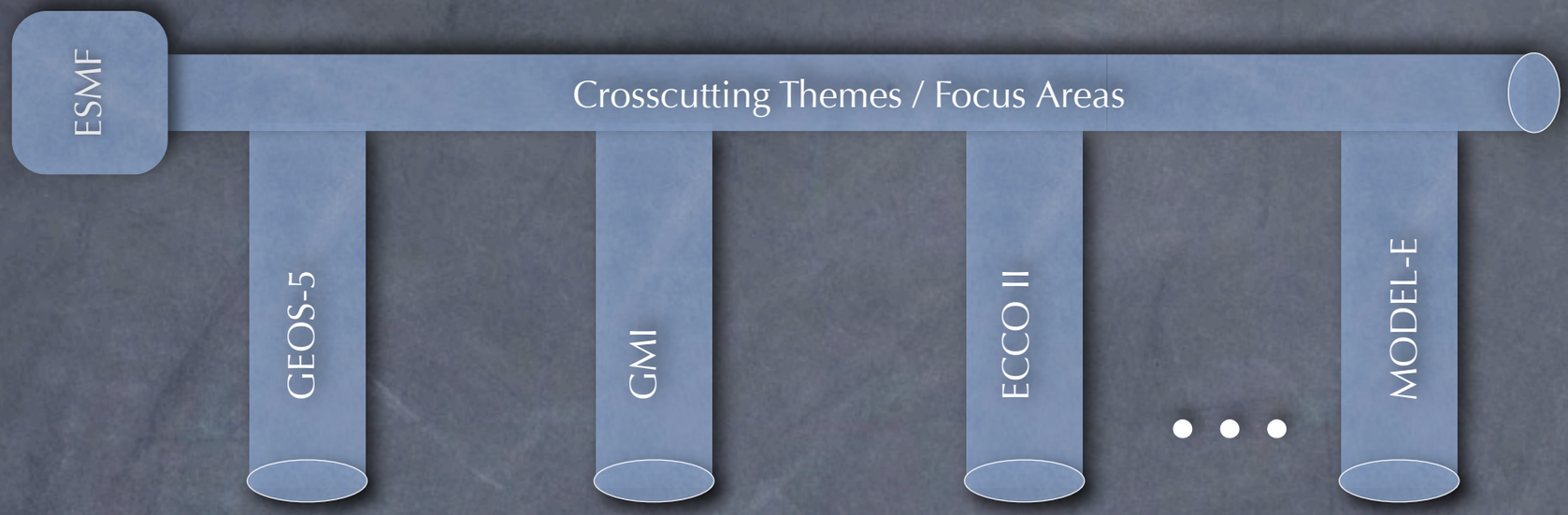






High End Visualizations (existing core capability)

MAP-Specific Software Support



"NASA plans to initiate an integration of its research modeling activities to focus the research among NASA crosscutting themes…"

"MAP will enhance ESMF-compliant modeling and assimilation resources to support the broader research programs…this will require the delivery and maintenance of software for the MAP program…"

"[MAP] will support a Core Integration Team that will have responsibility to assist funded scientists in this software delivery…"

"…In the third year of the current proposal cycle the activities residing in the multi-investigator proposals will converge into a shared MAP modeling environment [that] will be ESMF compliant and investigators will be able to configure model and assimilation systems to support specific applications…"

Main Drivers (2011 MAP Vision)

Coupled Earth System Models

Models easily reconfigured
Contributions to climate model development for diverse expert group
Implementation of 4D Var DAS with new data types
Open standards

Increased Model/ Analysis Fidelity

Enhanced resolution (horizontal, vertical, temporal, spectral)
Better estimates of uncertainty/reliability
Large, single- and multi-model ensembles

Enhanced Validation

Better tools for testing new methods
Observing System Simulation Experiments (OSSEs)
Rapid, seamless access to data
Better access to high-end visualization tools

The MAP Modeling Environment (MAPME)

Better Access & Reconfigurability
Turn on/off components on/ off outputs, user switchable via web service

Service-Based Compute Resources
Load balanced; scheduled vs. queued; transparent site selection

Cross Site Workflow
Remotely initiated via web schedule; monitor, manage across multiple sites

Enhanced Visualization & Analysis
Servers providing on-demand support

ESMF
MAP Repository
Curator Project
Service Layers (SOAs)
Next-Generation Networks
Customized ECMWF tools
Web-Based Analysis Tools
HEC-linked Resources
Advanced Rendering
OGC - GrADS
• • •

Crosscutting research themes are emphasized by the MAP Program, enabled by MAP-ME

Goal is to provide an environment in which MAP investigators can configure, obtain, contribute source, and experiment with systems of model elements

- Web-based MAP-ME repository **FEEDBACK NEEDED!**
- SIVO staff works with project scientists to provide programming support for integrating model elements (e.g., atmosphere with ocean, insertion of new dynamical core, etc.)
- SIVO to provide independent testing
  - Software verification
  - System validation (metrics to be provided by scientists)

Standardized documentation

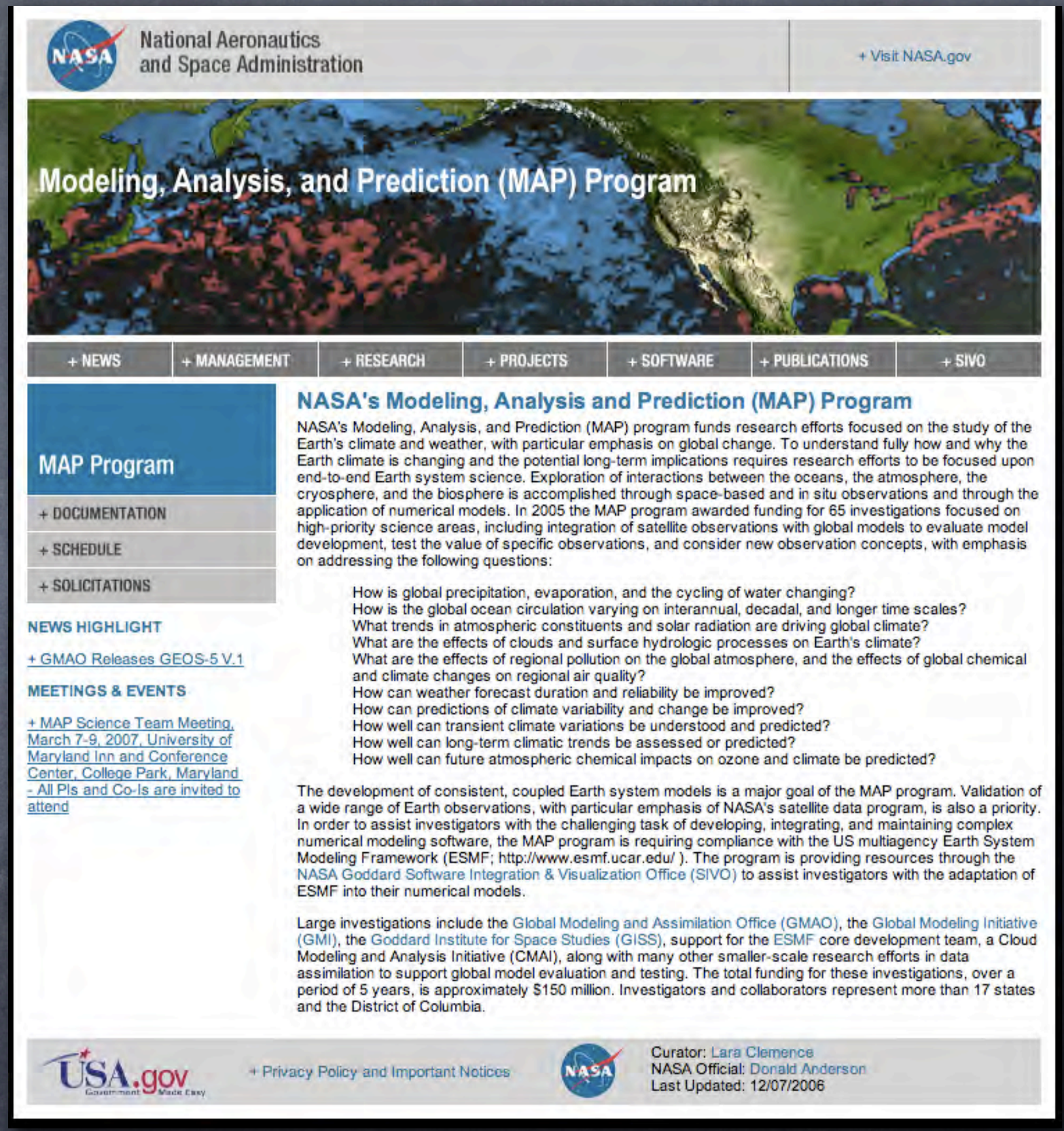
Integration tools

Source: McConaughy, G., 2006, "Modeling, Analysis, and Prediction Program Technology Roadmap", presentation to NASA Headquarters

MAP Information Portal

"One stop shopping" for models, tools, and general information about MAP-sponsored activities

Publications
Upcoming Events
Software Downloads
Help



MAP Software

PROPOSED - FEEDBACK NEEDED!

Goal is to create a portal to major model development projects (initial set of models are in place)

We are proposing two types of support:

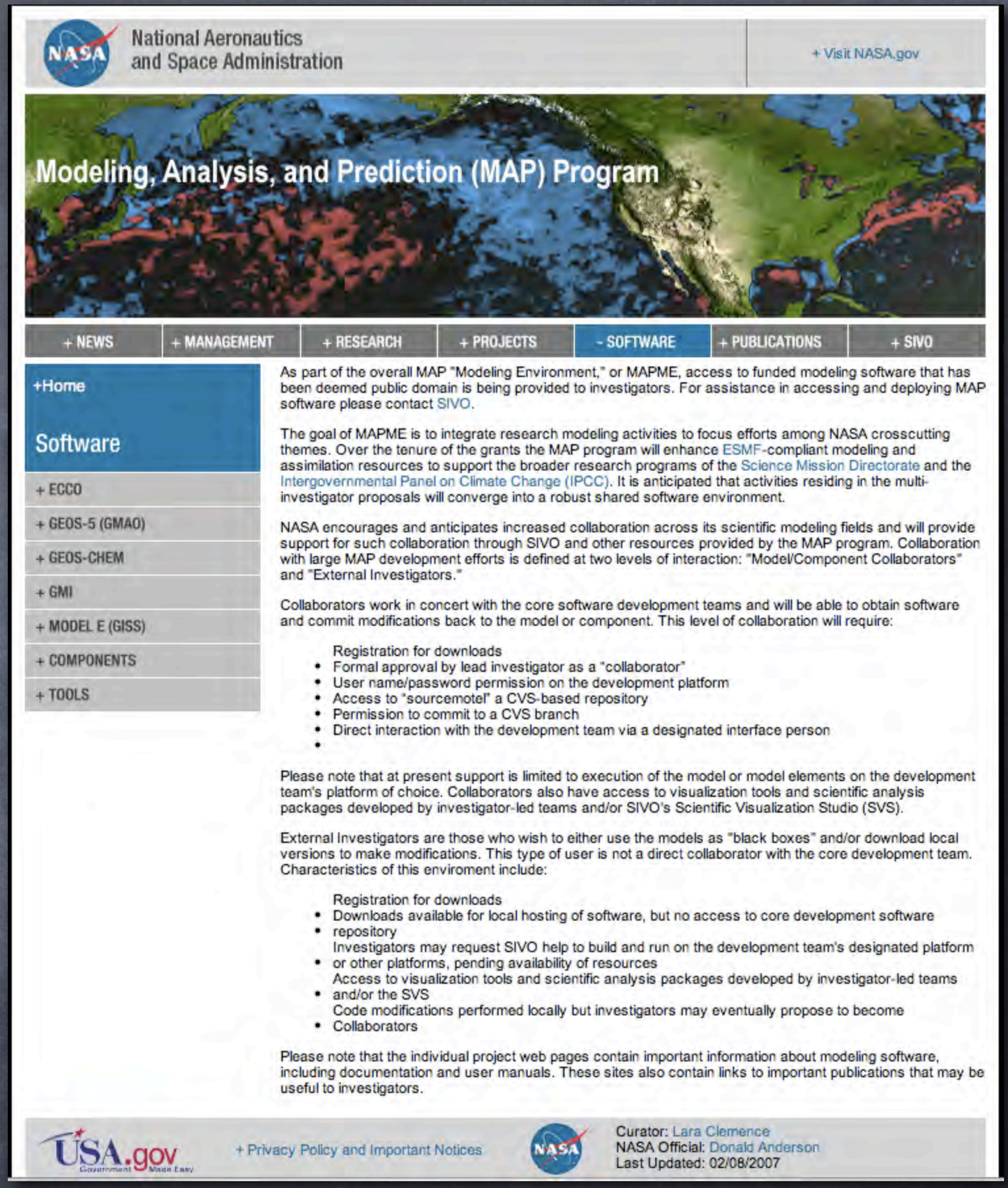
1. "Internal Collaborators"

   Work with PIs core development team & have access to project developer's repository (eventually the MAP repository), AND have access to resources as do External Investigators

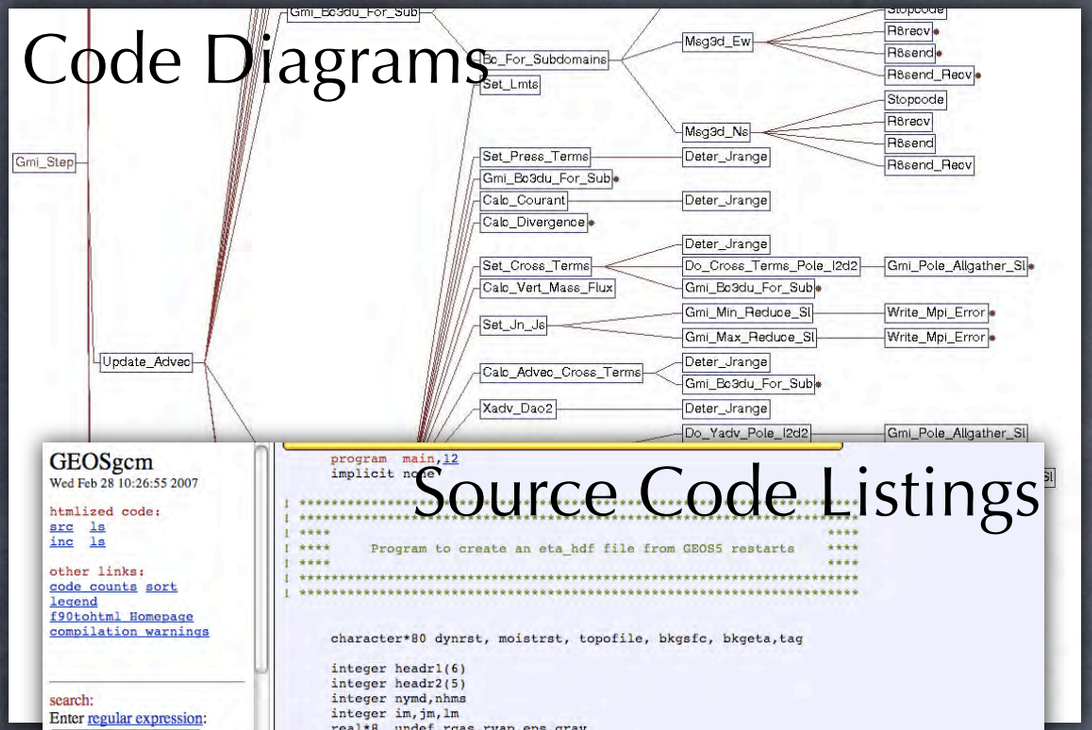
2. "External Investigators"

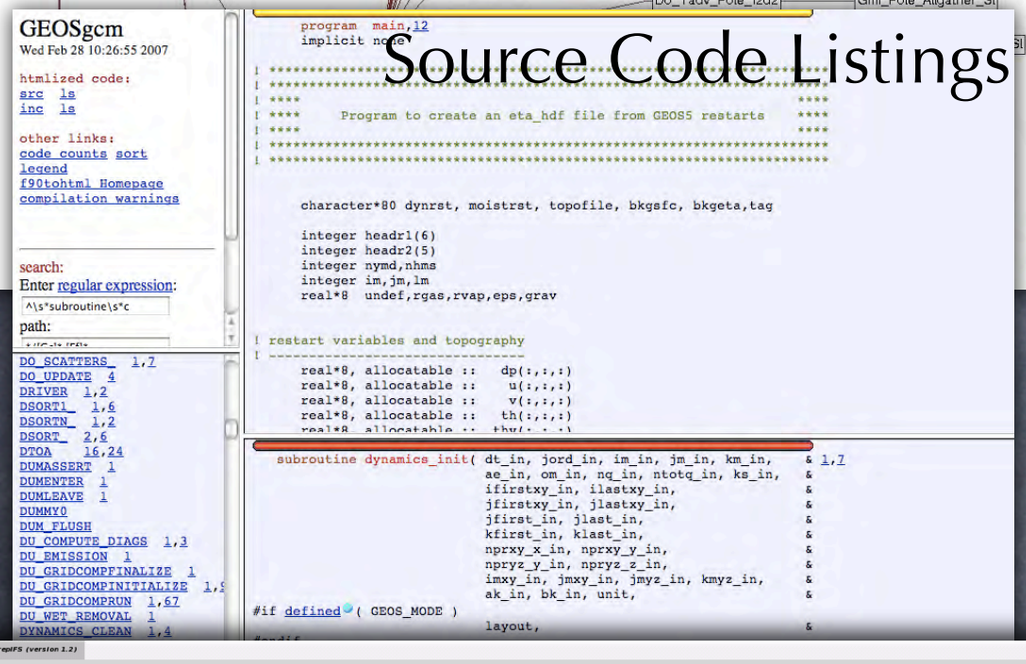
   Have the ability to register for downloads, can request help from SIVO for training and to build and execute the model, can access visualization tools developed by the SVS

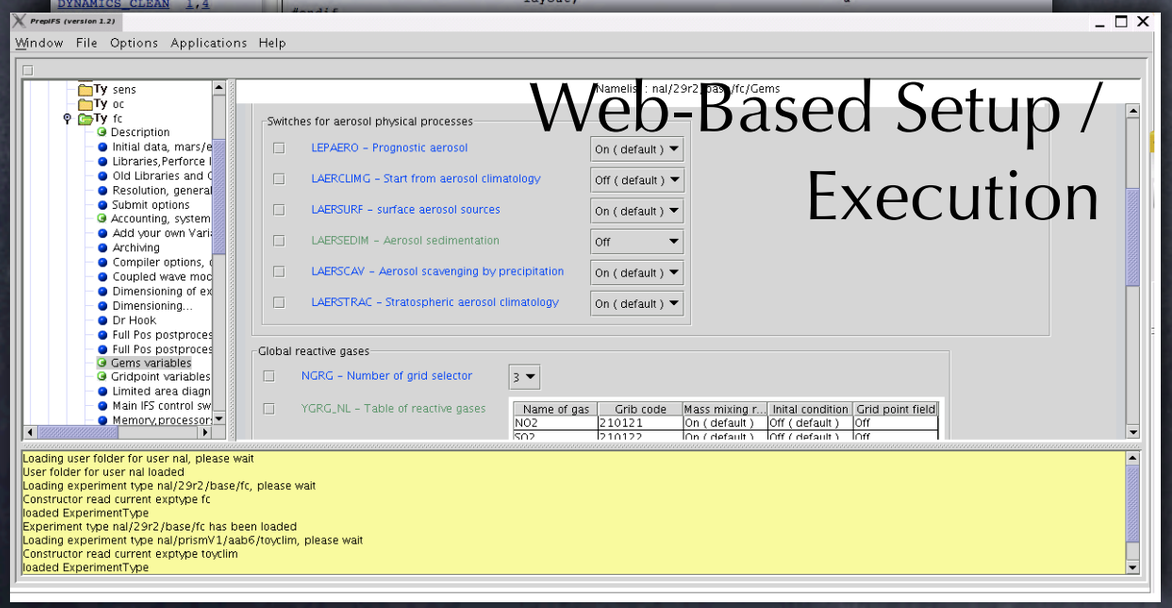
Links provided to home web sites for complete project information, documentation



Model Service Layer







PROPOSED - FEEDBACK NEEDED!

Problem: Lack of consistent, easy accessibility to models

- Knowledge of how to execute models exists in the heads of very busy scientists
- Restrictive IT security policies prevent certain individuals (e.g., foreign nationals) from access
- Computing center administration policies vary from site to site
- Porting codes between platforms is expensive, maintenance costs accumulate

Proposed: Service layer to separate the back end computing platforms from the users' work environments

- Initially, allows set up and execution of a model when used as a "black box"
- Eventually, will allow model elements to be edited, uploaded, recompiled; couplings performed via Curator metadata