
The NASA Modeling, Analysis and Prediction (MAP) Modeling Environment
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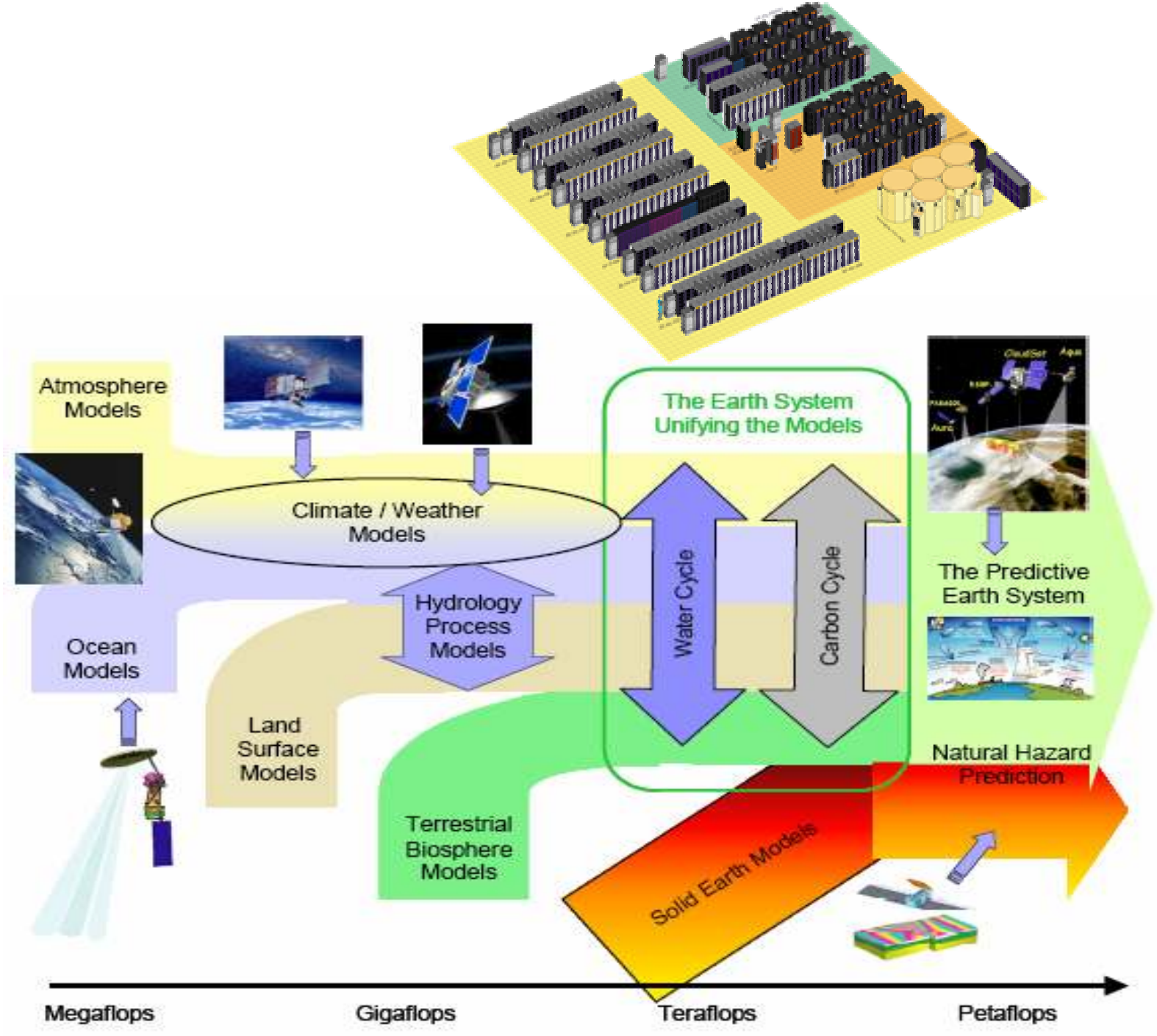

Atmosphere Models
Climate / Weather Models
Ocean Models
Hydrology Process Models
Land Surface Models
Terrestrial Biosphere Models
The Earth System Unifying the Models
Water Cycle
Carbon Cycle
The Predictive Earth System
Natural Hazard Prediction
Solid Earth Models
Megaflops
Gigaflops
Teraflops
Petaflops

NASA Modeling Paradigm of the Future - Frameworks & Integration

Environmental modeling and prediction (climate, NWP,…)

- Science requires detailed representation of individual physical processes - accuracy, compatibility with observations
- **Systems** integrate diverse components into a comprehensive coupled environmental model

Computing technology…

- Science requires use of scalable computing architectures
- Hardware/webservices advances mean that models can run from desktops, even laptops

⇒ **Increase in hardware and software complexity**

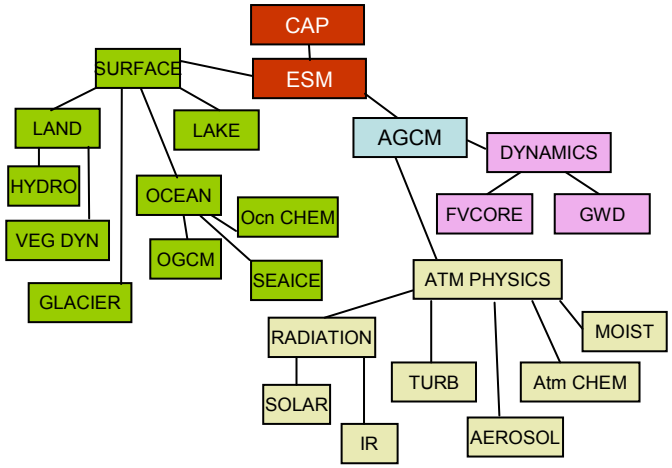
NASA Software Integration and Visualization Office (SIVO)

Earth System Modeling Framework

Potential to bring together major national modeling centers

- ESMF - an environment for assembling geophysical components into applications.
- ESMF - a toolkit that components use to
  i. increase interoperability
  ii. improve performance portability
  iii. abstract common services

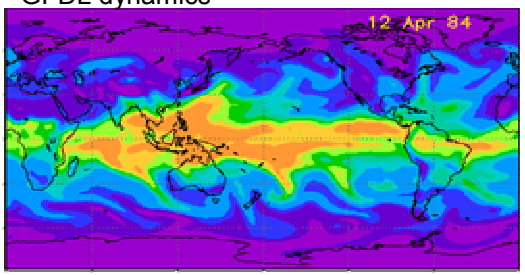
NASA GEOS5 AGCM is first model completely implemented with ESMF



Where we are going: Modern models integrate components from different sources
ESMF accelerates development cycle

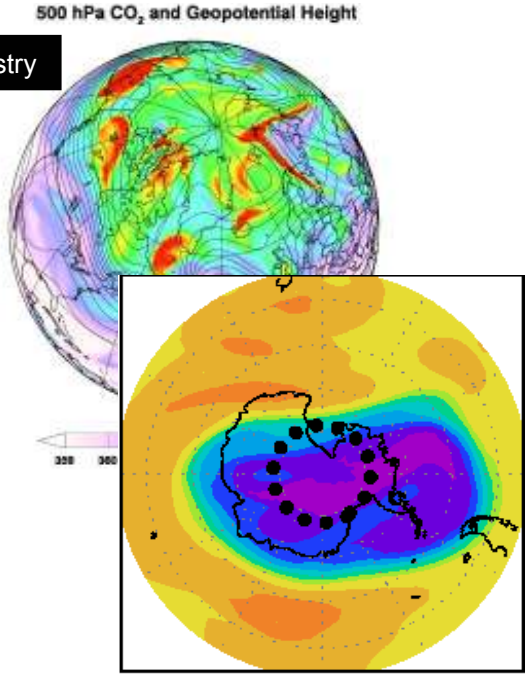
NASA AGCM for climate and weather

GFDL dynamics

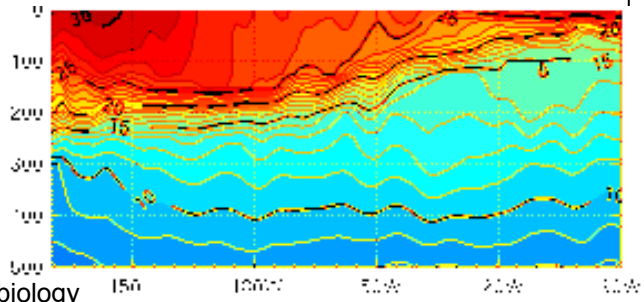


GMAO physics

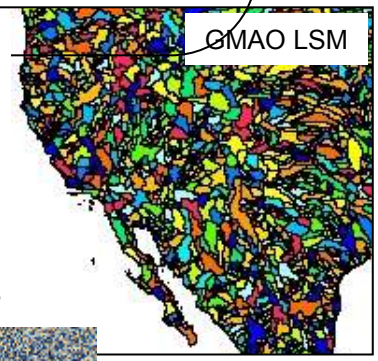
GMI chemistry



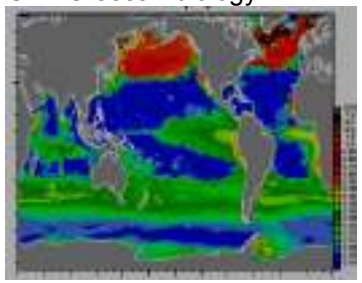
GMU ocean



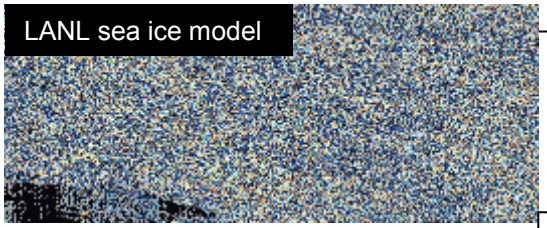
GMAO LSM



GMAO ocean biology

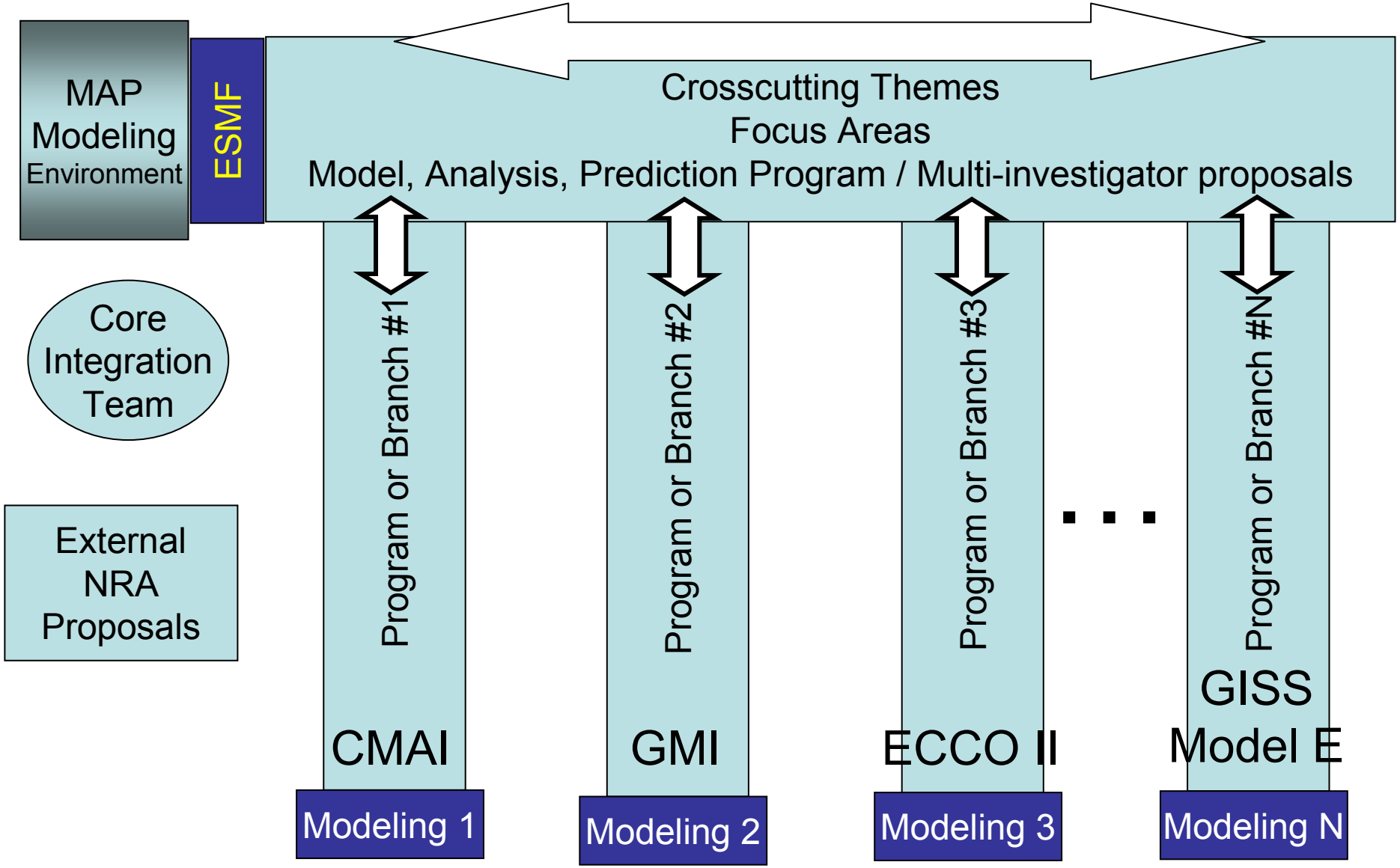


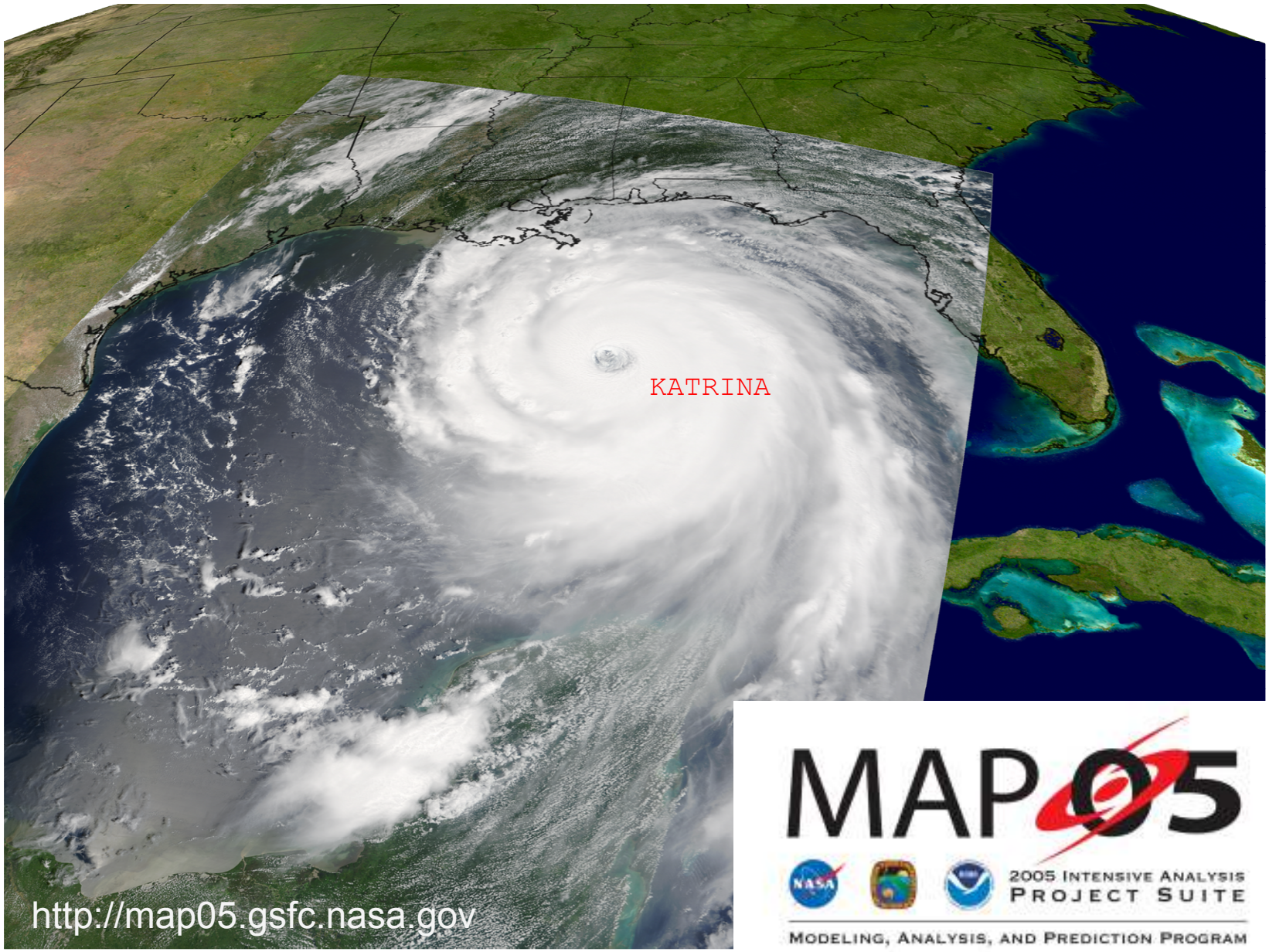
LANL sea ice model



Add in the assimilation components and the satellite data ⇒ science + future mission design

The NASA MAP Modeling Environment Components Added as Program Evolves





MAP05

2005 Intensive Analysis Project Suite

Modeling, Analysis, and Prediction Program

Overarching Goals - MAP '05

- *Understand capabilities for NASA models to predict tropical cyclones & other extreme weather events (GEOS4 & new GEOS5)*
- *Contribute NASA models to the Florida State University hurricane "Superensemble" to test their impact*
- *Deliver output directly to National Hurricane Center for offline evaluation*
- *Exploit Project Columbia capabilities to deliver model output at unprecedented horizontal resolution (1/4 x 1/4°) while meeting NOAA operational delivery schedules*

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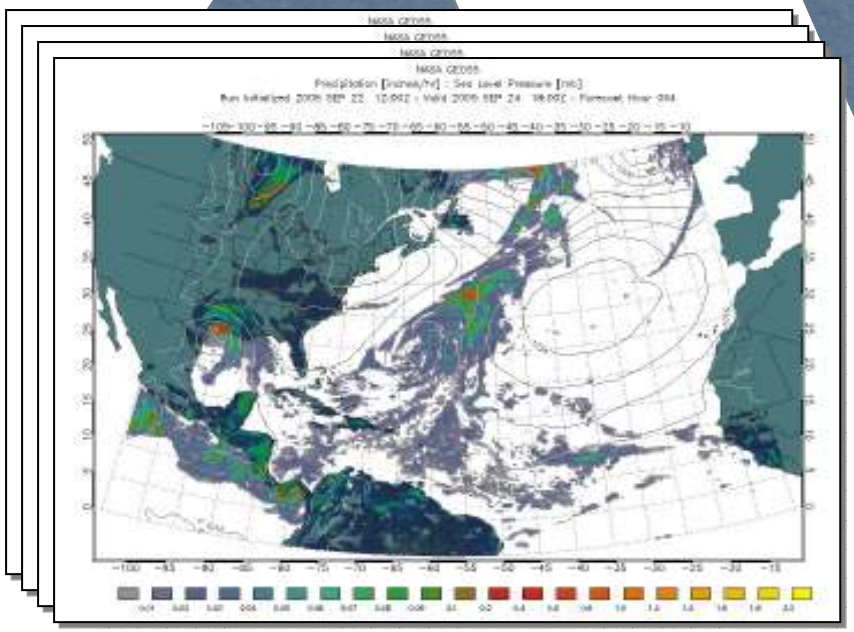
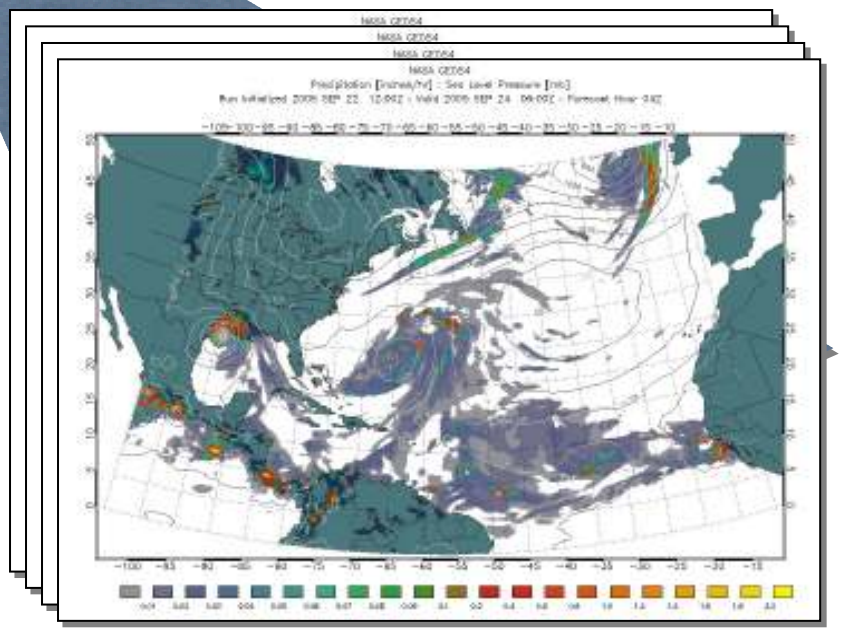
TIFF (Uncompressed) decompressor
are needed to see this picture.

GEOS4: Existing Model



GEOS5: Model in Beta Testing



Integrating Multi-Sensor Observations to Improve Models

- Leverage international, multi-agency field campaigns (process-focused intensive observing periods) to test, improve model physics
- Cross-reference with multi-year, global satellite data sets to understand, improve coupled model performance, simulations of interactive climate processes, document biases
- Regional model development and validation of downscaling of global forecasts for regional climate assessment and decision-making

Ocean, Land and Atmosphere Process studies

Long-term in-situ Observation Data

Satellite Remote Sensing: TRMM rainfall, CERES surface fluxes, AMSR cloud water / ice, Cloudsat and CALIPSO cloud / aerosol vertical profiles, Quikscat wind stress, AIRS, AMSU, HSB thermal & moisture profiles , MODIS winds, aerosol,clouds,,,

Space / time precipitation distribution

atmospheric stability

Stratiform cloud production

Model Problems / Challenges

Inter Annual Variability & Dynamical Feedback to Climate System

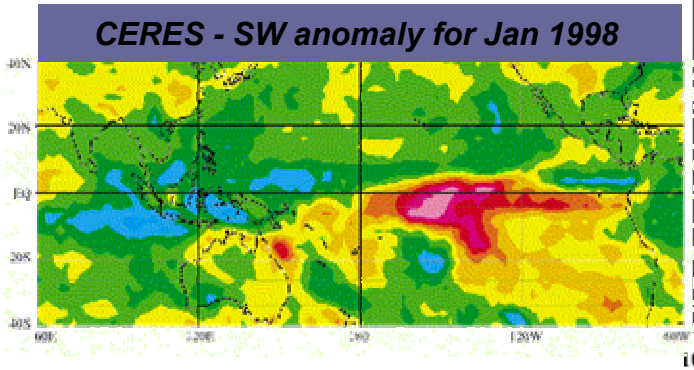
Cloud radiative forcing / feedback

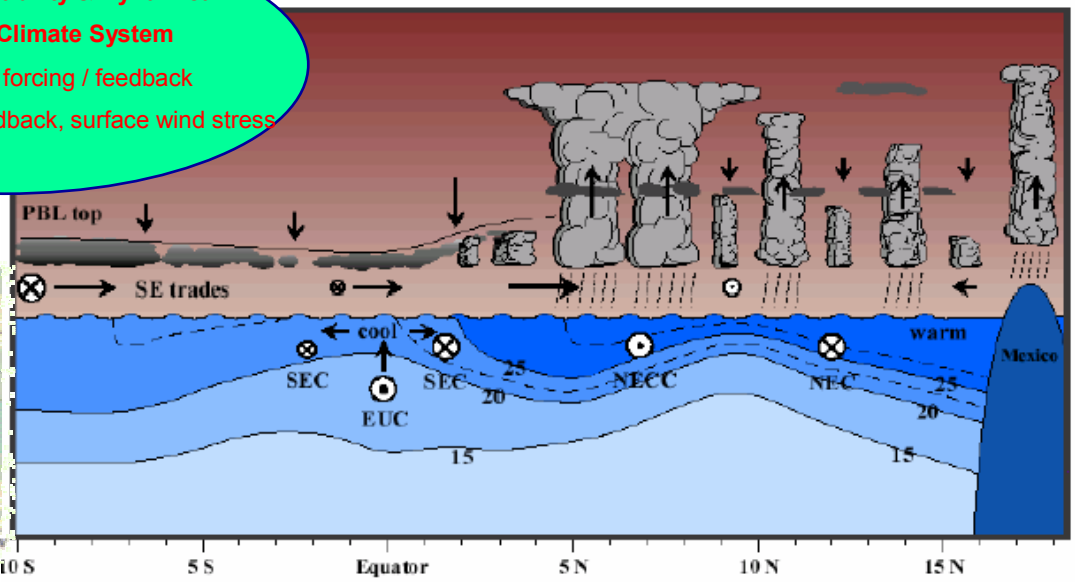
Conv / ocean evap feedback, surface wind stress

Linkage to National and International Programs…

-GCRP GEWEX/CEOP (Land hydrology focus)

-WCRP and US CLIVAR (Global oceans and land)





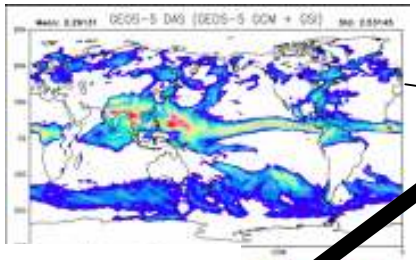
The NASA MAP Modeling Environment:

Integrating Earth System Modeling and Observations

Coupled Earth SYSTEM Modeling and Data Assimilation System for Earth-Sun Science

2006 NASA Modeling Environment

ESMF



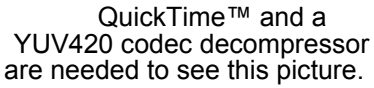
GEOS-5

2005 Project Hurricane

JCSDA/GSI

fvGCM (GEOS4)

Project Columbia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NASA Earth Sciences Program Management after Jackie Gasch