



The Space Congress® Proceedings

2003 (40th) Linking the Past to the Future - A
Celebration of Space

Apr 29th, 10:00 AM - 11:30 AM

Panel Session I - To Understand and Protect Our Home Planet

NASA's Earth Science Enterprise

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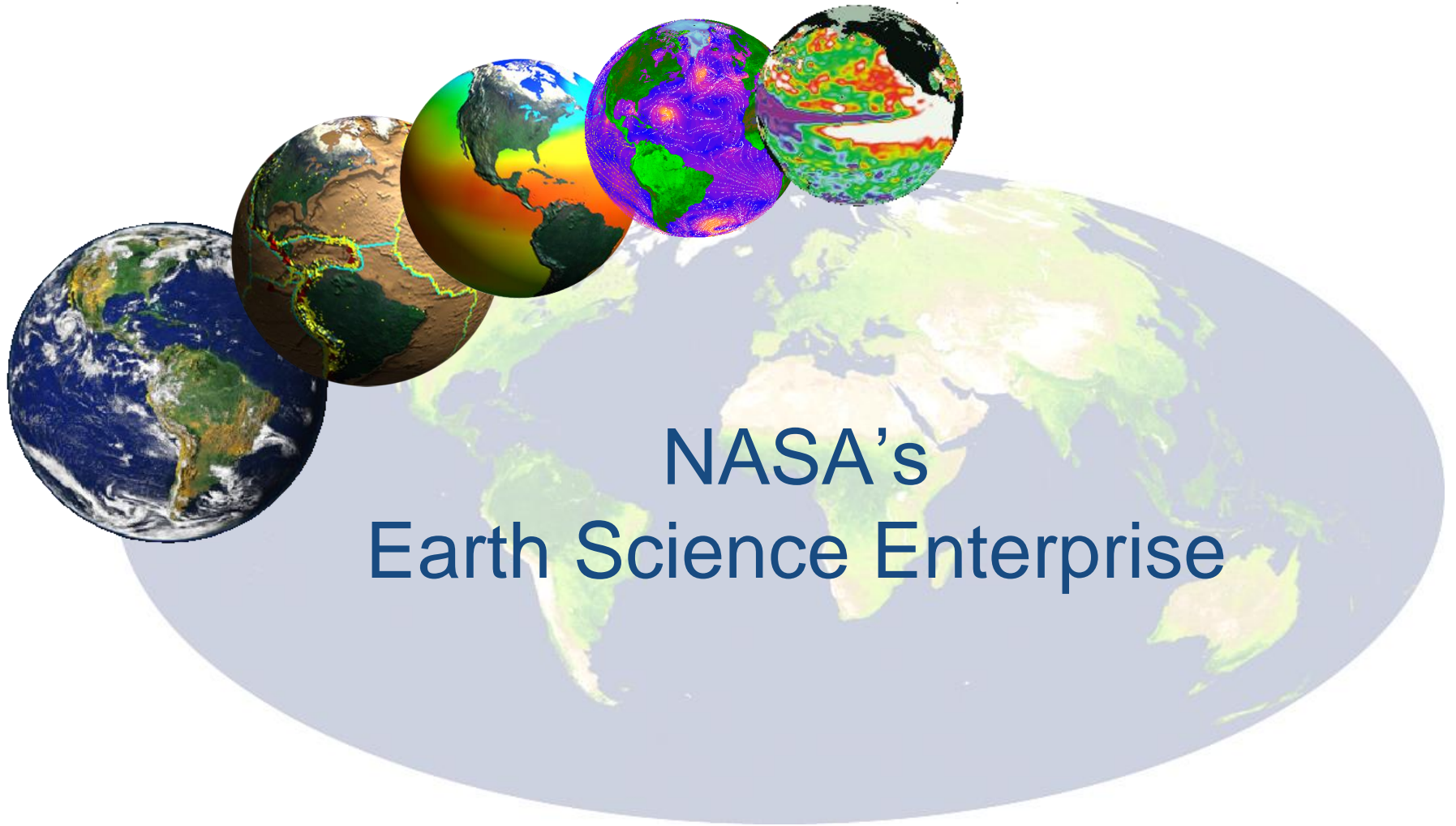
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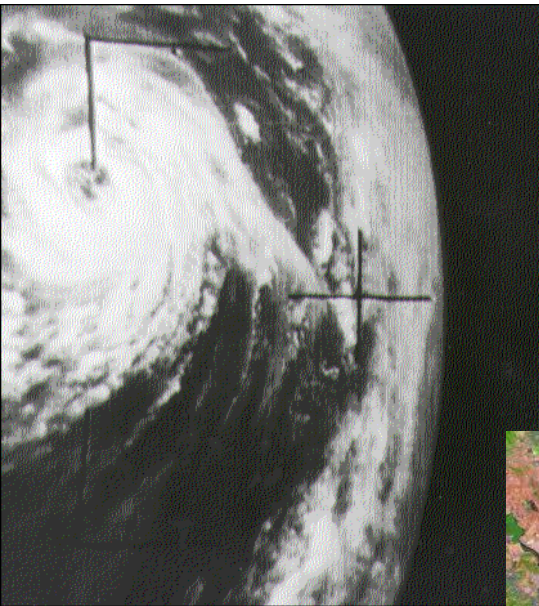


NASA's Earth Science Enterprise

To Understand and Protect Our Home Planet



1960s to 1980s: Exploring the Possibilities



TIROS VII Image of Hurricane Ginny, 1963

NIMBUS 7 (1978-94) provided data on sea ice extent, ocean color, sea surface temperature, radiation budget, and total column ozone



Landsat 4 (1984) Thematic Mapper image of San Francisco Bay

Seasat (1978) was the first radar satellite



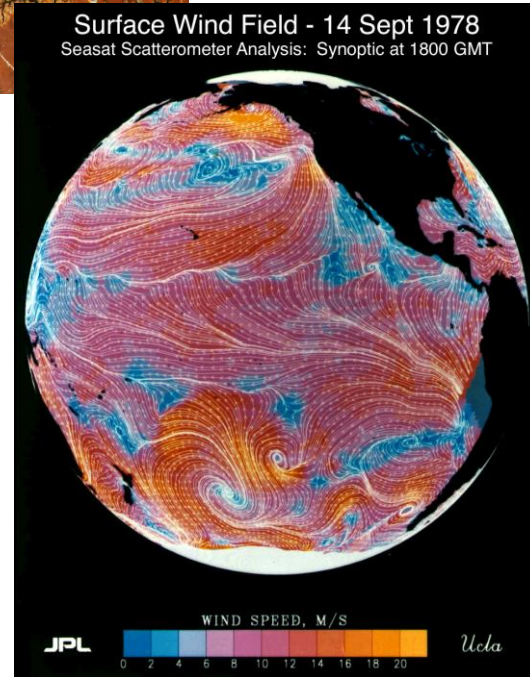


Science Results from the Early Years

- Enabled extension of weather forecasts from two to five days
- Discovery and monitoring of the Antarctic ozone hole
- First measurement of solar irradiance and estimate of the Earth's radiation budget
- Established rate of change in Amazon deforestation
- First global measurements of sea surface temperature, atmospheric temperature and composition
- First space-based measurement of the Earth's geoid and plate movements



Composite image of Amazonia from Landsats 4 & 5 in 1988



First ocean surface wind fields from Seasat in 1978



1990-2000: Surveying the Earth System

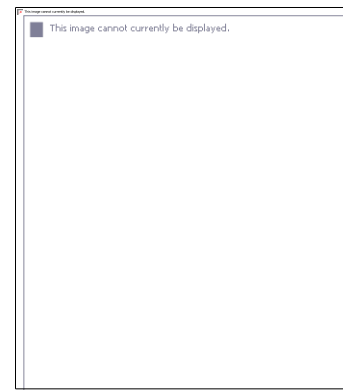
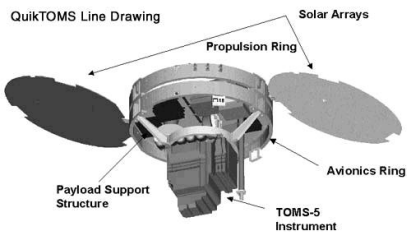
- **The space-based view of the Earth as an integrated system of land, oceans, atmosphere, ice, and life led to a strategy of simultaneous observation of the major interactions among these components of the Earth System**
- **The Earth Observing System (EOS) was conceived**



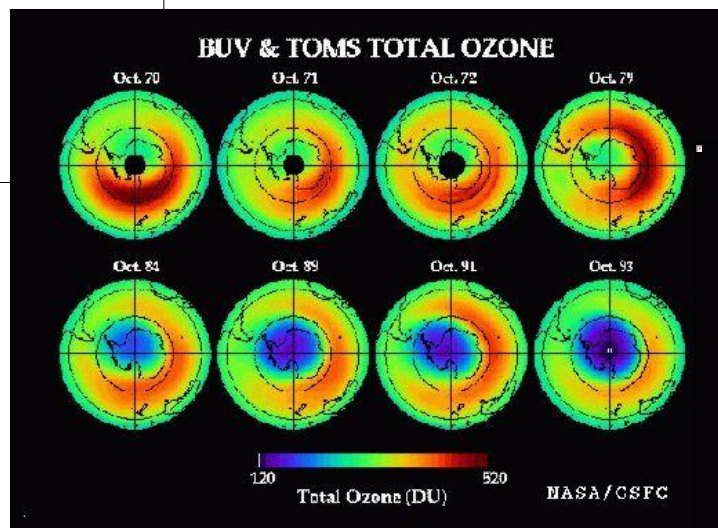
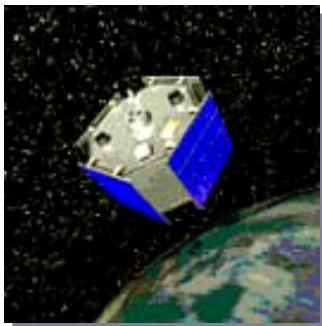


Beginning of Long-term Data Sets

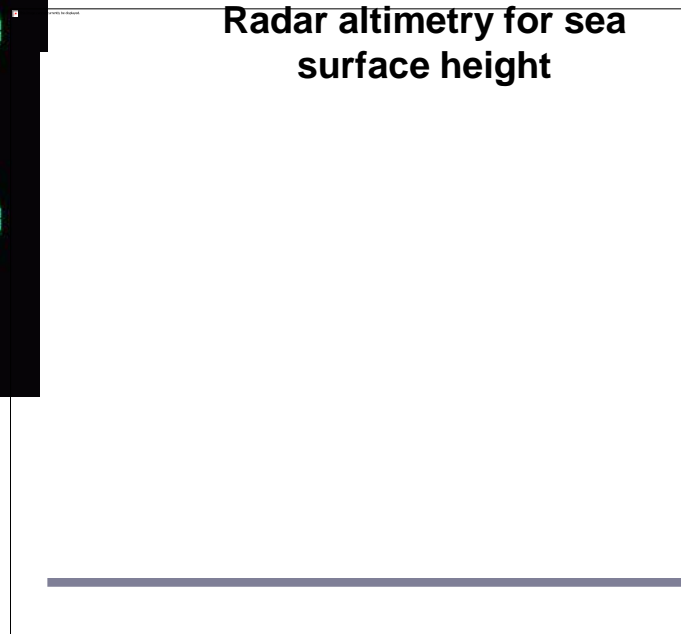
Scanning spectrometer for total column ozone



Active cavity radiometer for solar irradiance



Radar altimetry for sea surface height





Earth Observing Satellites: Enabling Earth System Science

The Earth Observing System -- systematic measurement of interactions among land, oceans, atmosphere, ice & life



Landsat



Aqua

Exploratory missions to probe key Earth system processes globally for the first time



TRMM



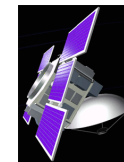
GRACE



Jason



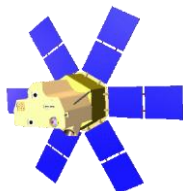
Calipso



Cloudsat



Terra



SORCE

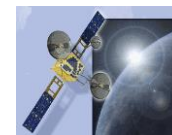
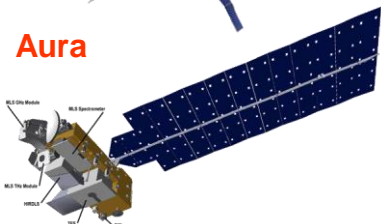


ICESat



SeaWiFS

Aura



EO-3: GIFTS



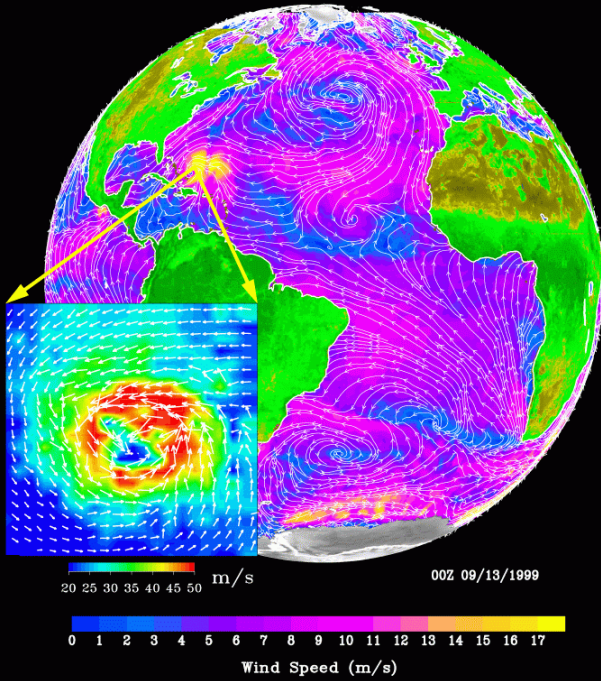
EO-1: ALI & Hyperion

*Operational precursor /
Technology demos*



Characterizing Regional & Local Events in Their Global Context

Global Coverage and Detailed Structure of Hurricane Floyd



**Hurricane size and
landfall observation
from GOES**

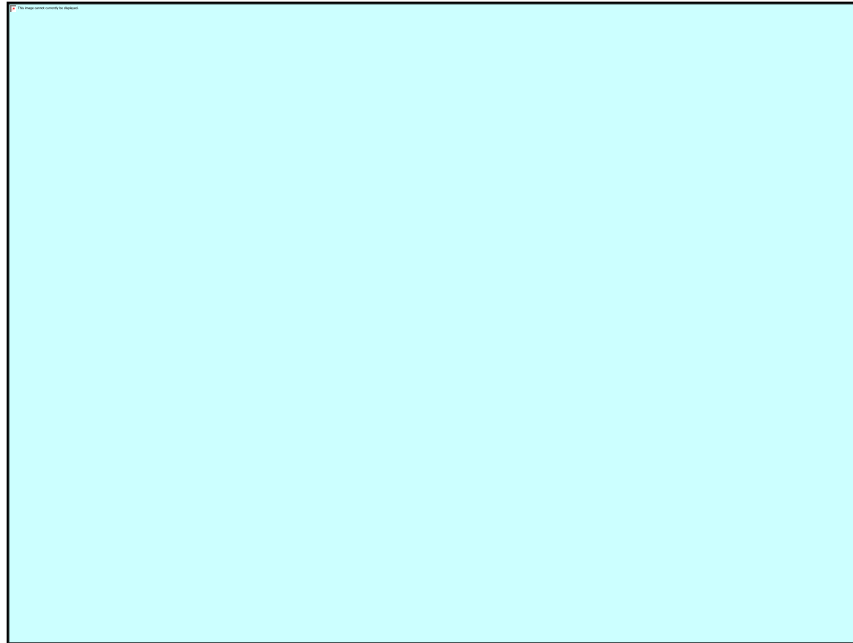
**Hurricane winds as
an ocean anomaly
from QuikSCAT**

**Pamlico River, NC
After Hurricane
Floyd from Landsat 7**





Understanding Earth System Interactions



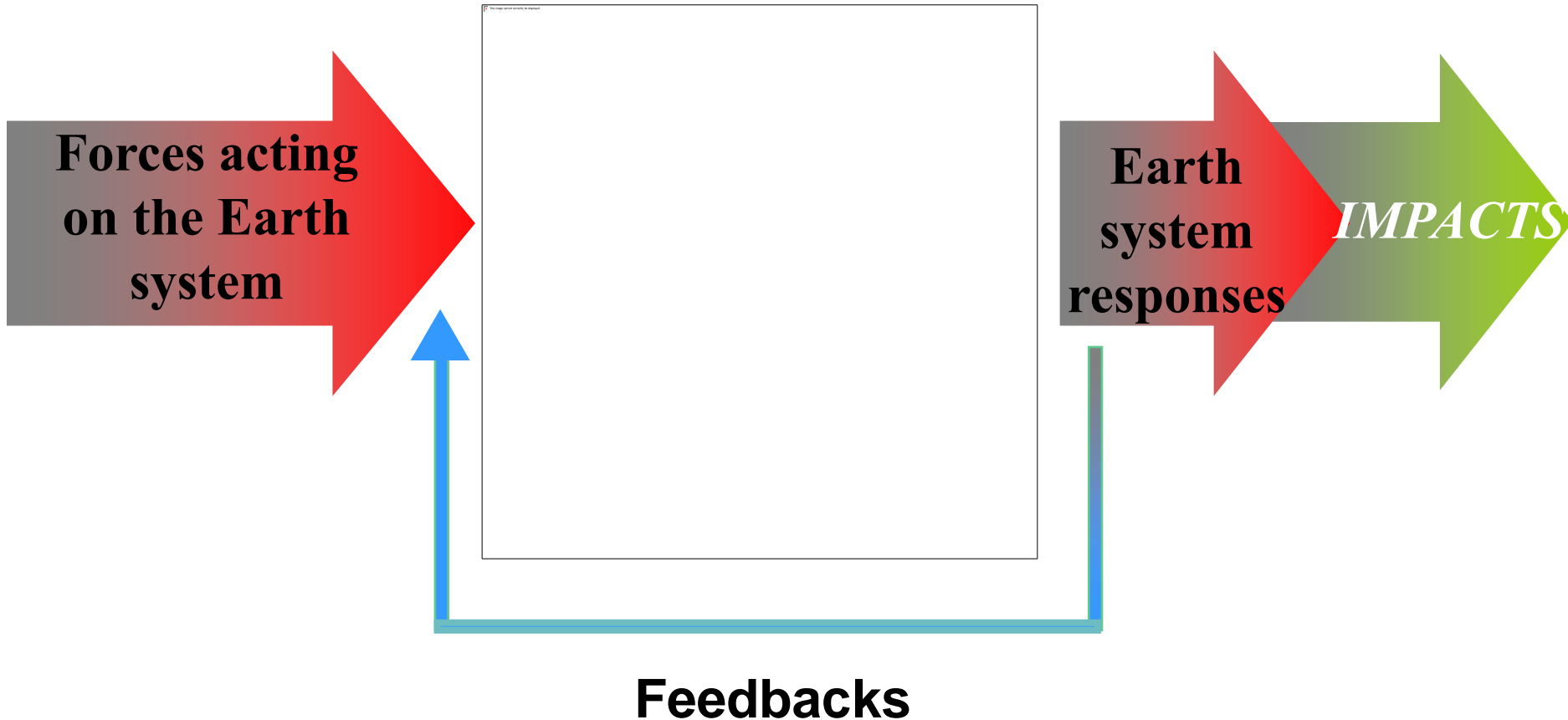
*View of the 1997-99 El Niño
combining ocean surface
topography, temperature,
and winds*

*View of the Gulf Stream
combining ocean
circulation and surface
temperature*





Earth is a Complex & Dynamic System



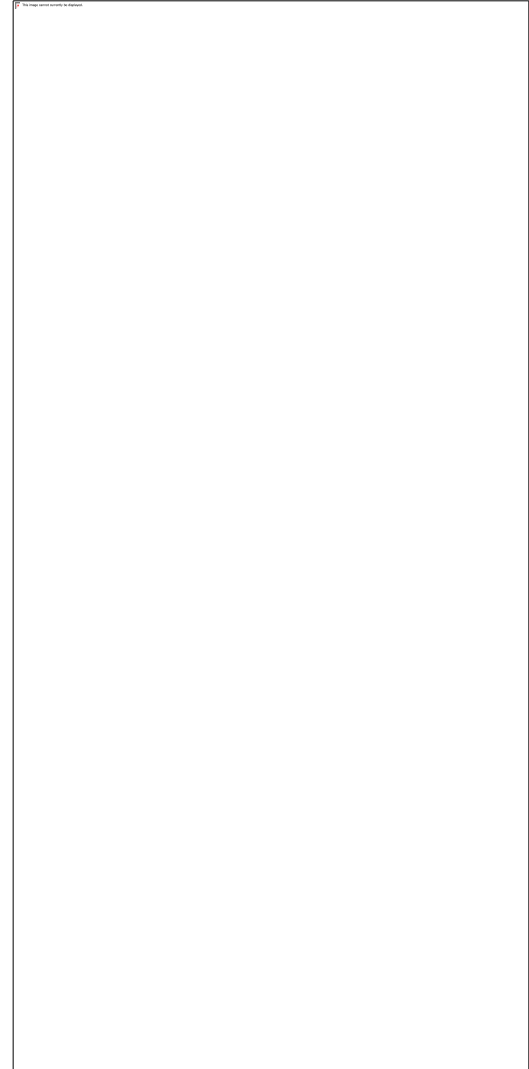
Of the total forcing of the climate system, 40% is due to the direct effect of greenhouse gases and aerosols, and 60% is from feedback effects, such as increasing concentrations of water vapor as temperature rises.



Fundamental Science Questions

How is the Earth changing and what are the consequences of life on Earth?

- How is the global Earth system *changing*?
- What are the primary *forcings* of the Earth system?
- How does the Earth system *respond* to natural and human-induced changes?
- What are the *consequences* of changes in the Earth system for human civilization?
- How well can we *predict* future changes in the Earth system?



Earth System Science



Sun- Earth
Connection

Climate Variability
and Change

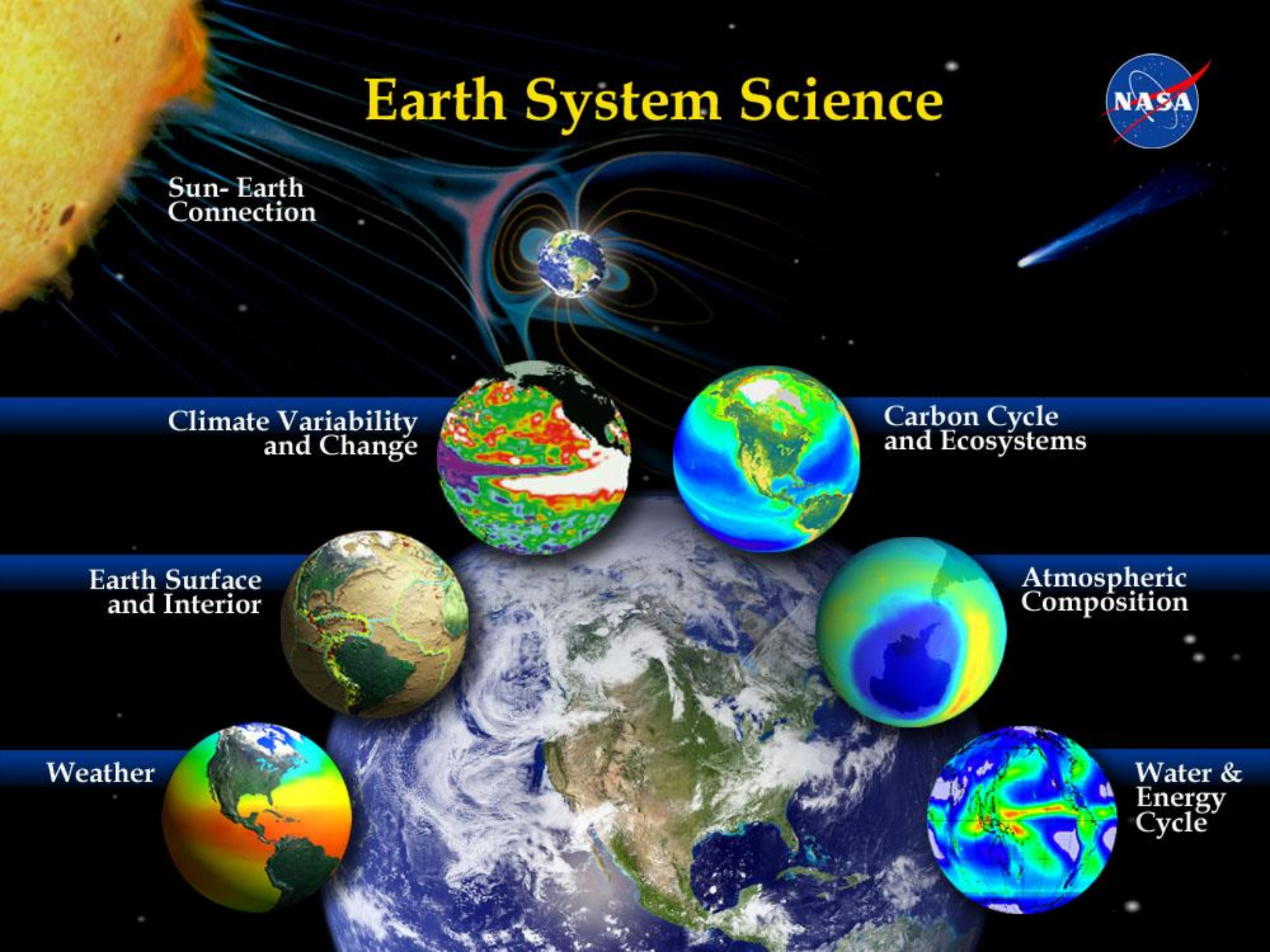
Carbon Cycle
and Ecosystems

Earth Surface
and Interior

Atmospheric
Composition

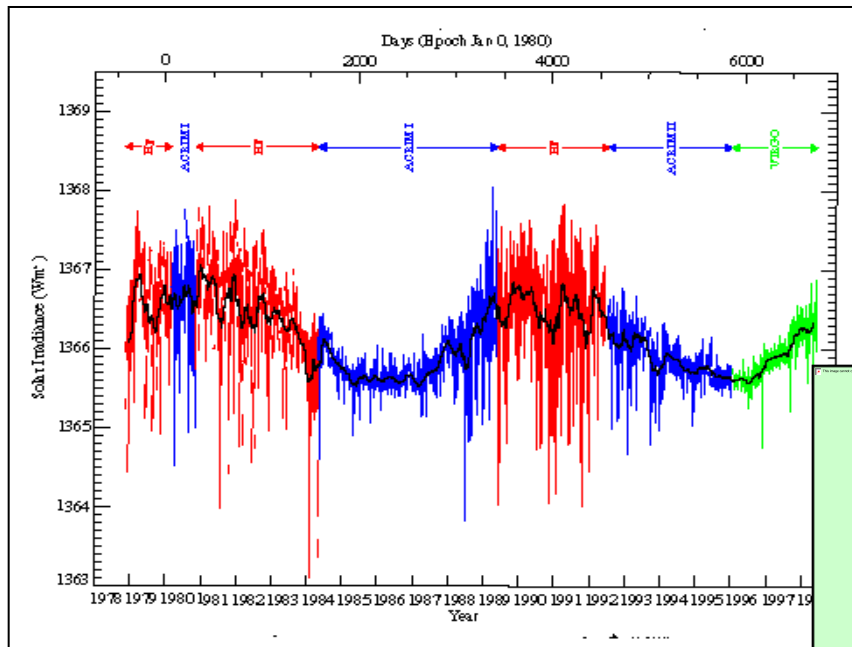
Weather

Water &
Energy
Cycle



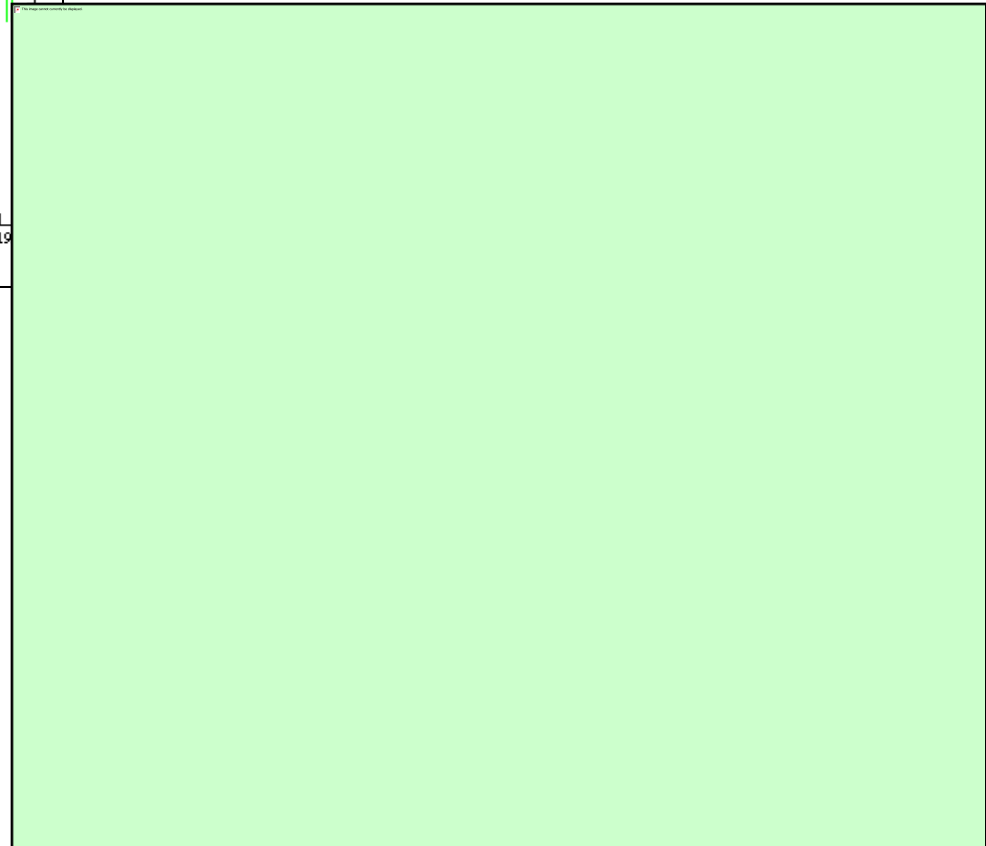


Earth System Models: Predicting Climate & Weather



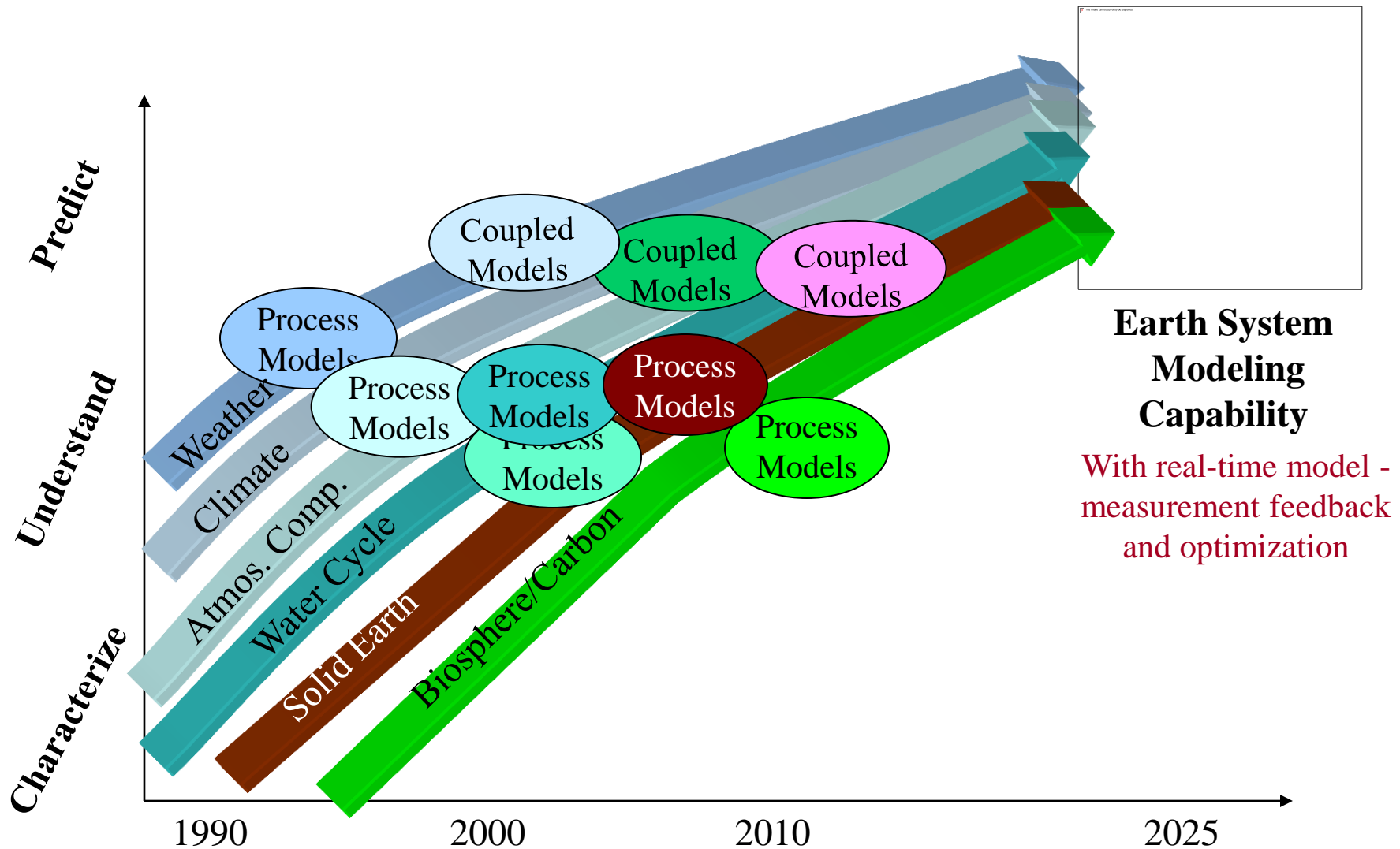
**Experimental Weather
Prediction Assimilating New
Data Types**

**Coupled Ocean, Atmosphere &
Land modeling for Seasonal
Time scales**





To 2020 and Beyond: Predicting Earth System Behavior





Turning Observations into Information

Petabytes 10^{15}

Multi-platform, multi-parameter, high spatial and temporal resolution, remote & in-situ sensing

Calibration, Transformation To Characterized Geophysical Parameters

Terabytes 10^{12}

Interaction Between Modeling/Forecasting and Observation Systems

Gigabytes 10^9

Interactive Dissemination

Predictions

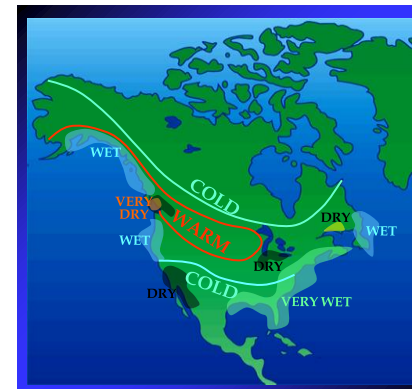
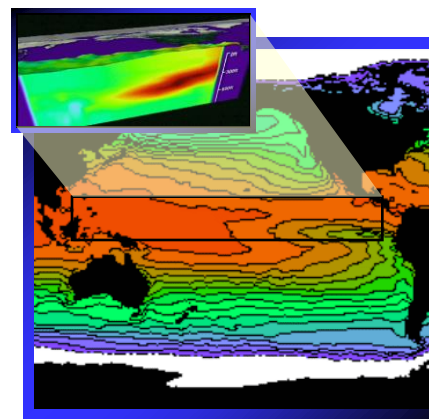
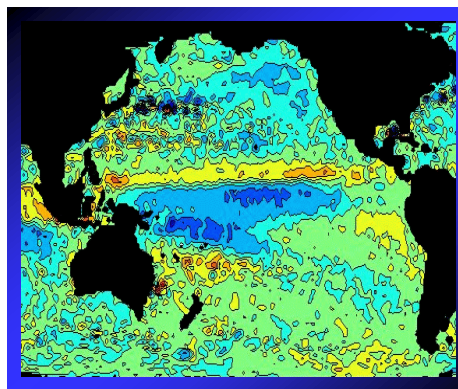
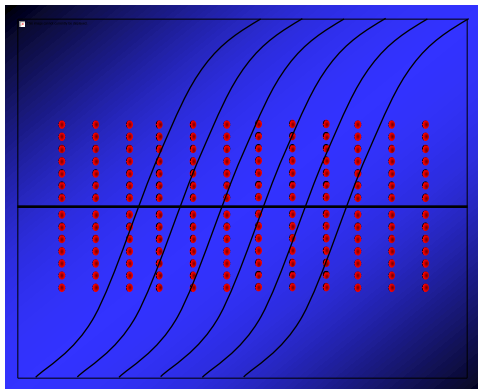
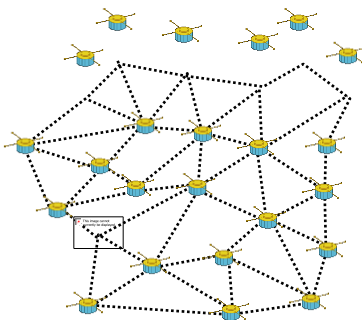
Megabytes 10^6

Advanced Sensors

Data Processing & Analysis

Information Synthesis

Access to Knowledge





The Challenge: as only NASA can

- Characterizing, understanding & predicting the interactions among Earth's continents, oceans, atmosphere, ice, and life
- Establishing the foundation for a comprehensive, flexible, and evolvable Earth observing system
- Forging the partnerships required to sustain the system, and to use it for scientific exploration and practical applications
- Training the next generation of scientists, engineers, and decision-makers

