Metrics and MODIS

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Science Questions:

- ***How are global ecosystems changing? (Question V3)***
- ***What changes are occurring in global land cover and land use, and what are their causes? (Question F2)***
- ***How do ecosystems respond to and affect global environmental change and the carbon cycle? (Question R2)***
- ***What are the consequences of land cover and land use change for the sustainability of ecosystems and economic productivity? (Question C2)***
- ***What are the consequences of climate and sea level changes and increased human activities on coastal regions? (Question C3)***
- ***How well can cycling of carbon through the Earth system be modeled, and how reliable are predicted future atmospheric concentrations of carbon dioxide and methane by these models? (Question P5)***

Desired Outcomes:

- **Scientific assessments** of specific ecosystem responses to potential environmental changes and quantitative carbon budgets and emissions estimates of key global ecosystems for decision-making purposes

- **Fundamental understanding** of primary productivity and the consequences of land cover and land use change as a basis for applications to agriculture, forestry, fisheries, sustainable land and marine resource management, and biodiversity conservation

- **Information on ecosystem interactions** with the atmosphere that can be used to improve weather and climate prediction and to assess impacts on atmospheric chemistry

Back-up Charts

Expected Scientific Achievements

Question V3: How are global ecosystems changing?

Expected new knowledge in the next 5 years

- Year-to-year variations in global marine primary productivity quantified;
- Year-to-year variations in global terrestrial primary productivity quantified.

Expected new knowledge in the next 10 years

- Decadal variability in ocean primary productivity;
- Relationship between year-to-year variations in net primary production and agricultural and forest productivity at regional scales.

Expected Scientific Achievements

Question F2: What changes are occurring in global land cover and land use, and what are their causes?

Expected new knowledge in the next 5 years

- First quantitative inventory of global forest cover based on Landsat data;
- Global inventory of land cover and analysis of land cover change based on Landsat data, establishing a basis for periodic assessments of global land cover change;
- First ecological, biogeochemical cycling, and land use model simulation results incorporating actual land cover observations;
- Global inventory of fire occurrence.

Expected new knowledge in the next 10 years

- Quantitative assessments of global land cover change on 5 year periods;
- Predictive, coupled socio-economic and ecological models of land cover and land use change.

Expected Scientific Achievements

Question R2: How do ecosystems respond to and affect global environmental change and the carbon cycle?

Expected new knowledge in the next 10 years

- Prediction of the magnitude of carbon export to the deep ocean, and assessment of its sensitivity to environmental factors;
- First quantitative, globally consistent estimate of the rate and amount of carbon uptake in ecosystems responding to disturbance (i.e., secondary forest growth, re-forestation, recovery from stress or catastrophic events);
- Credible estimates of annual carbon uptake and storage in key land regions of the Northern Hemisphere.

Expected Scientific Achievements

Question C2: What are the consequences of land cover and land use change for the sustainability of ecosystems and economic productivity?

Expected new knowledge in the next 5 years

- Evaluation of the utility of remote sensing imagery for assessing the impacts of land cover and land use change on biodiversity.

Expected new knowledge in the next 10 years

- Regional assessments of the consequences of land use change and a first global synthesis;

Expected Scientific Achievements

Question C3: What are the consequences of climate and sea level changes and increased human activities on coastal regions?

Expected new knowledge in the next 5 years

- An accurate map of the extent of coral reefs in the global ocean;
- Discrimination of phytoplankton from detrital material in the coastal ocean;
- Establishment of relationships between ocean processes and fish populations in coastal upwelling regimes.

Expected new knowledge in the next 10 years

- First predictions of the occurrence of harmful algal blooms in coastal waters;
- Quantitative estimates of the exchanges of materials between the land and the coastal ocean;
- Quantitative estimation of coral reef structure from airborne or space platforms.

Expected Scientific Achievements

Question P5: How well can cycling of carbon through the Earth system be modeled, and how reliable are predicted future atmospheric concentrations of carbon dioxide and methane by these models?

Expected new knowledge in the next 5 years

- Coupled land-atmosphere model predictions of carbon dioxide fluxes from terrestrial ecosystems.

Expected new knowledge in the next 10 years

- Coupled land-ocean-atmosphere model predictions of carbon dioxide fluxes and concentrations in the atmosphere;
- Coupled land-atmosphere model predictions of methane fluxes from terrestrial ecosystems, including wetlands.

MODIS CONTRIBUTIONS TO FY 2002 NASA ESE METRICS

Objective (IA): Discern and describe how the global Earth system is changing.

Annual Performance Goal (1A3). Increase understanding of global ecosystems change by meeting at least 3 of 4 performance indicators.

Performance Indicator: Merge Moderate-Resolution Imaging Spectroradiometer (MODIS) instrument and Sea-viewing Wide Field-of-view Sensor (SeaWiFS) data to increase the global ocean color data coverage by 25% from a baseline of 17% per day.

Performance Indicator: Test our ability to discriminate phytoplankton from other constituents in coastal waters using observations of phytoplankton fluorescence observations acquired by MODIS.

Performance Indicator: Release first comprehensive validation of MODIS land data products using results from the South African Fire-Atmospheric Research Initiative (SAFARI 2000) field campaign and related field validation programs.

Performance Indicator: Establish a quantitative relationship between vegetation indices time series derived from Advanced Very High-Resolution Radiometer (AVHRR) and MODIS to ensure long-term continuity and comparability of time series.

Objective (IB): Identify and measure the primary causes of change (forcings) in the Earth system.

Annual Performance Goal (1B1). Increase understanding of trends in atmospheric constituents and solar radiation and the role they play in driving global climate by meeting at least 3 of 4 performance indicators.

Performance Indicator: Provide first comprehensive multi-instrument/multi-angle integrated data set for study of sources/sinks and distribution of tropospheric aerosols over land based on data from Total Ozone Mapping Spectrometer (TOMS), MODIS, and Multi-angle Imaging Spectroradiometer (MISR) instruments.

Annual Performance Goal (1B2). Increase understanding about the changes in global land cover and land use and their causes by meeting at least 2 of 3 performance indicators.

Performance Indicator: Characterize the role of land cover changes associated with natural fires in determining the carbon balance of ecosystems in at least two major regions of the boreal forests, quantify their impact on the global carbon budget, and submit the results for publication.

Objective (IC): Determine how the Earth system responds to natural and human-induced changes.

Annual performance Goal (1C1). Increase understanding of the effects of clouds and surface hydrologic processes on climate change by meeting at least 4 of 5 performance indicators.

Performance Indicator: Continue assembling and processing of satellite data needed for the multi-decadal global cloud Climatology being developed under the International Satellite Cloud Climatology Project (ISCCP). Reduce uncertainty (3-7% in monthly mean) in the current ISCCP dataset of globally observed cloud characteristics, particularly in the polar regions, by comparing it with new satellite datasets that provide new constraints on the derived quantities and with in situ ground-based and airborne measurements.

Performance Indicator: Improve the understanding and modeling of the aerosol radiative forcing of climate and its anthropogenic component (reduce current uncertainties of 0.1 to 0.05 in the aerosol column optical thickness and 1 to 0.4 in the Angstrom coefficient). Develop and validate aerosol retrieval and cloud screening algorithms, and processing of satellite data and transport model evaluations for a 20-year Climatology of aerosol optical thickness and particle size.

Objective (ID): Identify the consequences of change in the Earth system for human civilization.

Annual Performance Goal (1D3). Increase understanding of the consequences of climate and sea level changes and increased human activities on coastal regions by meeting 2 of 2 performance indicators.

Performance Indicator: Develop an improved algorithm for retrievals of ocean color information from remotely sensed observations of turbid coastal systems (i.e. Case 2 water).

SELF-ASSESSMENT OF FY 2000 METRIC

• Continue to collect near-daily global measurements of the terrestrial biosphere (an index of terrestrial photosynthetic processes from which calculations of carbon uptake are made) from instruments on the EOS AM-1 (now called Terra) spacecraft.

Actual performance: The Terra spacecraft was launched in December, 1999, and has checked out well. Its instruments were activated for science operations on February 24, 2000, and continue to operate nominally. Calibration and validation activities are still underway, but the data quality from all Terra's sensors appears to be exceptional.

Target Assessment: Green; near-daily global measurements (Level 0 data) of the terrestrial biosphere have been collected by the Moderate Imaging Spectroradiometer (MODIS) instrument and archived since February 24, 2000. Overlap with the NOAA Advanced Very High Resolution Radiometer (AVHRR) sensor, to establish continuity of the data from the AVHRR to that from Terra's MODIS sensor was achieved. These are sufficient to meet the metric.

Data validation: The MODIS global Level 0 data, as well as the Level 1A and 1B data (processed, calibrated data), are physically archived at the Goddard Space Flight Center (GSFC) Distributed Active Archive Data Center (DAAC) in the basement of Building 32 at GSFC. They can be searched and ordered through the following web site: http://redhook.gsfc.nasa.gov/~imswww/pub/imswelcome/

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