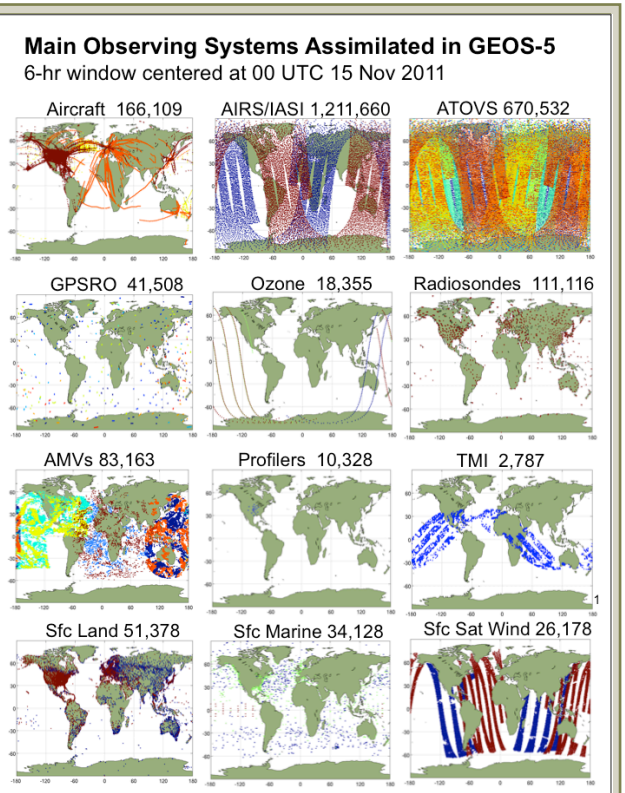


Data Assimilation

Data assimilation provides powerful constraints on predictive models. In assimilation, models are used to synthesize diverse in-situ and satellite data streams into a single product (analysis) that combines the strengths of each data set and also of the model. In the GMAO, we focus on improving the use of NASA's satellite data for weather and air quality prediction and also on bringing a climate perspective to NASA's satellite data by conducting an atmospheric reanalysis of the satellite era – our Modern-Era Retrospective Analysis for Research and Applications (MERRA). Our ocean and land data assimilation systems are developed for climate analyses and short-term climate prediction. These systems are being more tightly coupled as we prepare for an Integrated Earth System Analysis.

The GMAO works to *maximize the impact of satellite observations in the analysis and prediction of climate and weather through integrated Earth system modeling and data assimilation.* To achieve this goal, the GMAO undertakes model and assimilation development, generates products to support NASA instrument teams and the NASA Earth science program, produces reanalyses of historical observations of the atmosphere, ocean and land surface and conducts research to inform system development pathways. Our long-term strategy is the development and application of an Integrated Earth System Model and Assimilation System.

Global Modeling and Assimilation Office

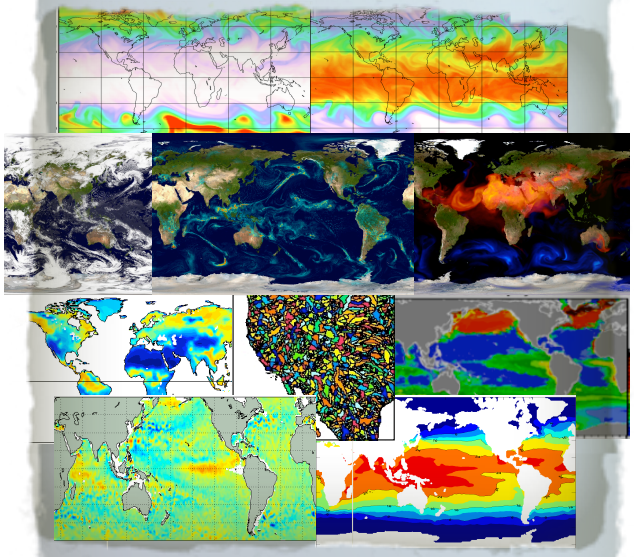
Code 610.1

NASA/Goddard Space Flight Center

Greenbelt, MD 20771

http://gmao.gsfc.nasa.gov

Global Modeling and Assimilation Office



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GMAO Mission and Goals

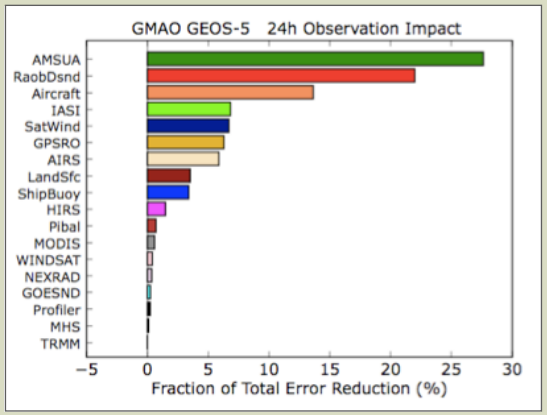
The Global Modeling and Assimilation Office (GMAO) develops and uses comprehensive models and assimilation systems that support NASA's Earth science research enterprise and contribute to the nation's capabilities in climate, weather and air quality prediction.

Re3D goals:

- Enhance use of NASA data for weather, air quality, and climate prediction;
- Bring tools from models and assimilation systems into new mission development, and to contribute to observing system science for climate and weather prediction;
- Use NASA observations and data assimilation to improve climate models.

Application goals:

- Generate products for NASA instrument teams and field campaigns;
- Generate climate reanalyses of the satellite era for the science community and the public;
- Contribute climate model integrations to national multi-model ensemble predictions and international assessments.



The adjoint of the GEOS-5 data assimilation system has been used to measure the impact of observations on weather forecasts. Here we show the fractional contributions of the major observing systems to the reduction of a global energy measure of 24-h forecast error for the period 10 Nov 2010 – 2 Jan 2011. The measure combines errors in wind, temperature and surface pressure with respect to the verifying analysis, in terms of energy per unit mass.

Our Systems

The GEOS Modeling System

Our Goddard Earth Observing System (GEOS) model is used for global weather and climate applications, in assimilation as well as simulation. Focus is on high resolution global simulations. The GEOS Atmosphere-Ocean general circulation model (AOGCM) integrates MOM4 from GFDL and CICE from LANL. The GEOS Earth System Model includes atmospheric chemistry, ocean biology and other modules.

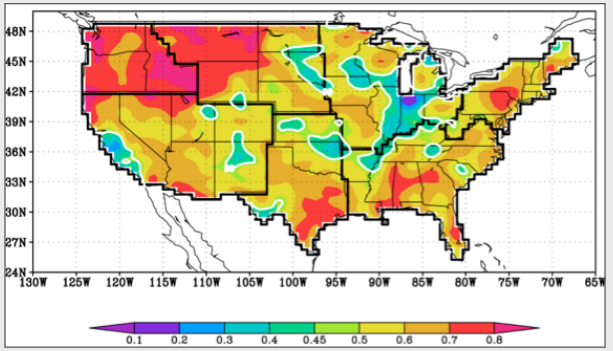
Assimilation Systems

For the *atmosphere*, we are developing a 4DVar system, contributing to observing system science, and developing infrastructure for Observing System Simulation Experiments. In addition to meteorological analyses, we generate aerosol analyses in near-real-time. For the *ocean*, focus is on assimilation of satellite altimetry and sea surface salinity and on initialization of climate prediction. For the *land surface*, developments are directed towards the assimilation of satellite-derived soil moisture and temperature retrievals with a focus on the generation of a Level-4 surface and root-zone soil moisture product for SMAP. Currently assimilation is carried out separately for different components. However, we are gradually coupling the different components for an *Integrated Earth System Analysis*, a consistent analysis of the Earth's environment.

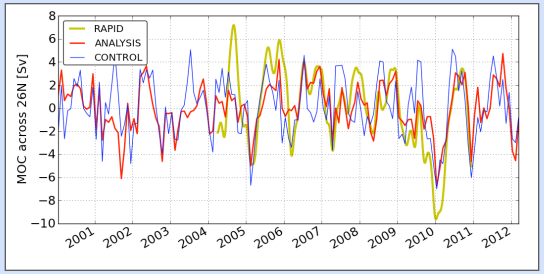
Products

GEOS-5 meteorological products are generated in near-real-time for NASA instrument teams and field campaigns. Information on access can be found at http://gmao.gsfc.nasa.gov/products/. MERRA is distributed through the GES DISC (http://disc.sci.gsfc.nasa.gov/MDISC/dataprods/merra_products.shtml). The GEOS-5 AOGCM also generates seasonal and decadal forecasts.

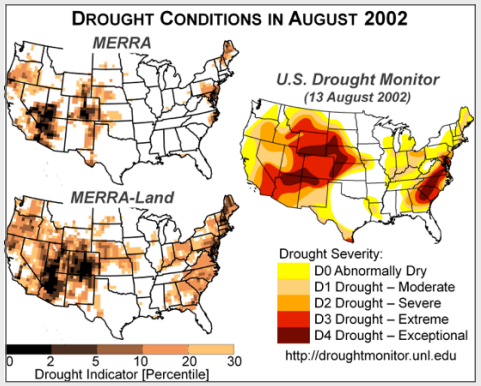
A 2-year 10-km GEOS-5 simulation with GOCART allowed the inclusion of the direct radiative effects of aerosols which were advected by the model's wind field. Red: Dust; Green: Organic and Black Carbon; Blue: Sea salt; White: Sulphate.



Correlation of MERRA summertime (JJA) precipitation for 33 years with gauge observations (Climate Prediction Center), where the white contour indicates the 99% significance level. The black outlines denote regions defined for the National Climate Assessments. MERRA generally correlates well with observations, especially in the northwestern United States.



Interannual anomalies of Atlantic Meridional Overturning Circulation across 26N. Red line: GEOS ocean data assimilation estimate; Gold line: observations; Blue line: a control run assimilating only SST and sea-ice concentration.



Drought indicator derived from (top left) MERRA and (bottom left) MERRA-Land root zone soil moisture estimates for August 2002, with the drought assessment from the US Drought Monitor for 13 August 2002 (right). MERRA-Land uses MERRA surface forcing, with a correction for precipitation, to drive the GMAO's Catchment Land Surface Model.