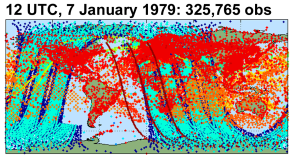
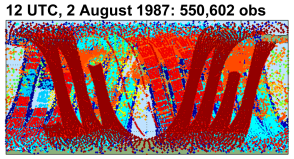
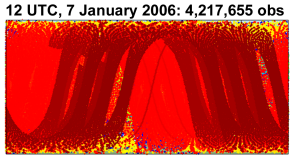
Data Assimilated for MERRA

The volume of data ingested during a 6-hourly assimilation cycle changes dramatically over time. During the EOS era, over 4 million observations are assimilated at one time.







Conventional data & Satellite retrievals

Data Source/Type	Period	Data Supplier
Radiosondes	1970 – present	NCEP
PIBAL winds	1970 - present	NCEP
Wind profiles	1992/5/14 - present	UCAR
Conventional, ASDAR and MDCRS aircraft rep.	1970 - present	NCEP
Dropsondes	1970 - present	NCEP
PAOB	1978 – 2010/8	NCEP
GMS, METEOSAT, cloud drift IR & visible winds	1977 - present	NCEP
GOES cloud drift winds	1997 - present	NCEP
EOS/Terra/MODIS winds	2002/7/01 - present	NCEP
EOS/Aqua/MODIS winds	2003/9/01 - present	NCEP
Surface ship and buoy observations	1977 - present	NCEP
Surface land observations	1970 - present	NCEP
SSM/I V6 wind speed	1987/7 - present	RSS
SSM/I rain rate	1987/7 - present	GSFC
TMI rain rate	1997/12 - present	GSFC
QuikSCAT surface winds	1999/7 – 2009/9	JPL
ERS-1 surface winds	1991/8/5 – 1996/5/21	CERSAT
ERS-2 surface winds	1996/3/19 – 2001/1/17	CERSAT
SBUV ozone (V8 retrievals)	1978/10 - present	GSFC

Satellite radiance data

Data Source/Type	Period	Data Provider
TOVS (TIROS N, N-6, N-7, N-8)	1978/10/30 – 1985/01/01	NCAR
(A)TOVS (N-9, N-10, N-11, N-12)	1985/01/01 – 1997/07/14	NESDIS/NCAR
ATOVS (N-14, N-15, N-16, N-17, N-18)	1995/01/19 - present	NESDIS
EOS/Aqua	2002/10 - present	NESDIS
SSM/I V6 (F08, F10, F11, F13, F14, F15)	1987/7 - present	RSS
GOES Sounder T_B	2001/01 - present	NCEP

Find more information on MERRA

at

http://gmao.gsfc.nasa.gov/merra

MERRA products are available online through the Goddard Earth Sciences Data and Information Services Center:

http://disc.sci.gsfc.nasa.gov/mdisc/data-holdings

MERRA was conducted at the NASA Center for Climate Simulation (NCCS).

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.*

Global Modeling and Assimilation Office

Code 610.1

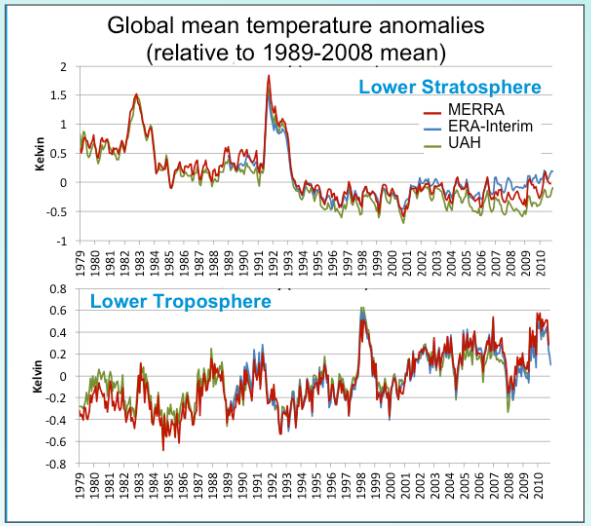
NASA/Goddard Space Flight Center

Greenbelt, MD 20771

http://gmao.gsfc.nasa.gov

MERRA

The Modern-Era Retrospective analysis for Research and Applications



Global Modeling and Assimilation Office

Goddard Space Flight Center

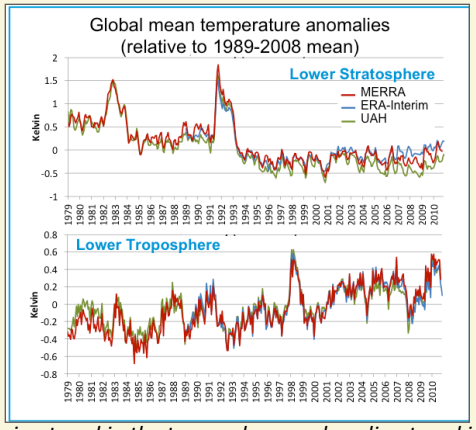
MERRA

The Global Modeling and Assimilation Office (GMAO) has used its GEOS-5 atmospheric data assimilation system (ADAS) to synthesize the various observations collected over the satellite era (from 1979 to the present) into an analysis that is as consistent as possible over time because it uses a fixed assimilation system. This contrasts with a weather -focused analysis where the system changes over time as improvements are implemented to improve weather forecasts. The goal of this historical re-processing - called MERRA, the **Modern-Era Retrospective Analysis for Research and Applications** - is a climate-quality analysis that places NASA's EOS observations into a climate context.

The MERRA System

MERRA is being conducted with version 5.2.0 of the GEOS-5 ADAS with a 1/2˚ latitude × 2/3˚ longitude × 72 layers model configuration.

A key development in the GSI, not available for the previous generation of reanalyses, has been the online bias correction for satellite radiance observations. Such corrections are needed to compensate for sensor drifts as well as to ensure that observations from different satellites, which have been calibrated independently, provide consistent measurements of our environment.



The warming trend in the troposphere and cooling trend in the stratosphere are evident in the MERRA and ERA-Interim results, and are in good agreement with the independent estimate based on MSU retrievals from the University of Alabama at Huntsville (UAH). From about 2004 onwards the additional data used in the reanalyses introduce larger discrepancies from the estimate using MSU/AMSU alone.

Products

MERRA has completed analysis of over 30 years of data and is now proceeding forward in near real-time as a climate analysis. Products are distributed through the GES DISC (http://disc.sci.gsfc.nasa.gov/MDISC/dataprods/merra_products.shtml) with several download options.

There are 26 product collections. Products are generated on three horizontal grids:

Native ---------- (1/2º × 2/3º using model conventions)
Reduced ------- (1¼º × 1¼º, dateline-edge, pole-edge)
Reduced FV -- (1× 1¼º using model conventions)

3-D data are 72 model layers or 42 pressure levels.

Products include:

Analyzed Fields (u, v, t, q,O_3, ps): native grid, 6-hourly instantaneous fields, on model and pressure levels

Assimilated Fields: reduced grid, 3-hourly instantaneous fields on pressure levels

3-D Diagnostic Fields: reduced grid, 3-hourly time-averaged fields on pressure levels.

2-D Diagnostic Fields: native grid, hourly time-averaged fields

Products for Offline CTMs: various resolutions, frequencies and grids.

Ocean Surface Diagnostic Fields: native resolution, 1-hourly, 2D fields that can be used for ocean models

MERRA-Land Surface Diagnostic Fields: a supplemental product from a version of the Catchment Land Surface Model driven offline with MERRA forcing except that precipitation has been corrected with a global gauge-based data set from NOAA's Climate Prediction Center (see http://gmao.gsfc.nasa.gov/merra/news/merra-land_release.php).

Selected MERRA monthly mean products have been made available at PCMDI's Earth System Grid for CMIP5 model evaluations.

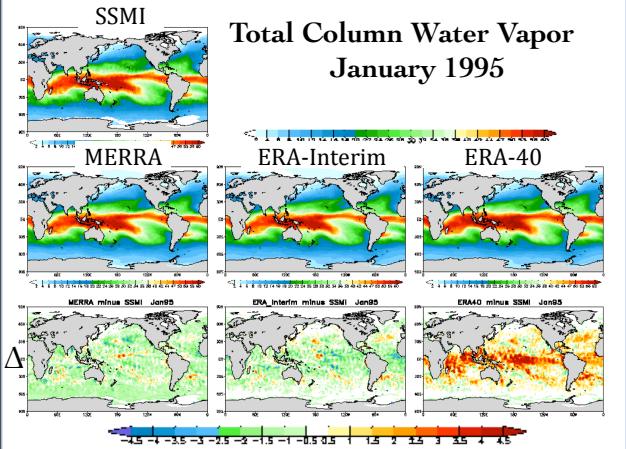
Resources

An atlas of MERRA climate with comparisons with other reanalyses and with gridded observations is available at: **http://gmao.gsfc.nasa.gov/ref/merra/atlas/.**

MERRA is documented in a set of publication that forms the *MERRA Collection* in the Journal of Climate: **http://journals.ametsoc.org/page/MERRA.**

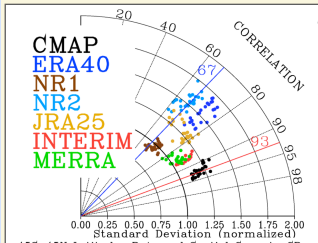
Some Results

Since MERRA focused on the hydrological cycle, our early evaluation of the system has looked at various aspects of the moisture distribution and variability, compared with the previous reanalyses and also the more recent reanalysis (ERA-Interim) from ECMWF.



Monthly mean TCWV (kg m^{-2}) from reanalyses (2nd row) compared with that from SSMI (top row). The differences (reanalysis-SSMI) are shown in the bottom row. MERRA and ERA-Interim are very close and are slightly drier than the observations. Absolute differences are mostly smaller than 2 kg m^{-2}. In contrast, ERA-40 is much wetter than SSMI over much of the tropics.

The quality of the tropical (15S-15N) precipitation from the various reanalyses is evaluated by comparison with GPCP. A different observational product, CMAP, provides a baseline for the limit to how good a comparison can be expected. The comparisons are summarized in a Taylor diagram (upper plot) of the correlation and standard deviation normalized by GPCP. The dots for each system are for annual means of different years. A perfect comparison would be (1, 100).



The lower plots show time series of annual means of spatial correlation and mean bias. Clearly both MERRA and ERA-Interim have improved upon earlier reanalyses.