

National Aeronautics and  
Space Administration



## TECHNOLOGY SOLUTION

### Information Technology and Software

# MERRA/AS and Climate Analytics-as-a-Service (CAaaS)

Ease of access to over 400 climate variables for any location on the earth

The Modern Era-Retrospective Analysis for Research and Applications (MERRA) integrates data from a variety of satellite systems with numerical models to produce a temporally and spatially consistent synthesis of climate variables that are not easily observed. MERRA provides global coverage. The MERRA time period covers the modern era of remotely sensed data, from 1979 to the present.

The breadth of MERRA variables which include atmosphere, ocean, and land surface products makes MERRA ideal for investigating climate variability and for use in an expanding array of applications areas, such as national disasters, civil engineering, ecological forecasting, health and air quality, water resources, and agriculture. However, these data sets are hundreds of terabytes in size, growing to petabytes in size over the coming years. Despite their utility, it is often difficult to use this important information.

#### BENEFITS

- Reduces the need for large data transfers
- Provides a comprehensive set of climate variables
- Provides one stop shopping for historic climate data
- Provides significant time savings in data gathering
- Enables easy API-based application development
- Enables customization through an extensible API
- Enables fast data subsetting and basic operations
- Provides a platform for complex data analytics



## THE TECHNOLOGY

NASA Goddard Space Flight Center now offers a new capability for meeting this Big Data challenge: MERRA Analytic Services (MERRA/AS). MERRA/AS combines the power of high-performance computing, storage-side analytics, and web APIs to dramatically improve customer access to MERRA data. It represents NASAs first effort to provide Climate Analytics-as-a-Service.

Retrospective analyses (or reanalyses) such as MERRA have long been important to scientists doing climate change research. MERRA is produced by NASAs Global Modeling and Assimilation Office (GMAO), which is a component of the Earth Sciences Division in Goddards Sciences and Exploration Directorate. GMAOs research and development activities aim to maximize the impact of satellite observations in climate, weather, atmospheric, and land prediction using global models and data assimilation. These products are becoming increasingly important to application areas beyond traditional climate science.

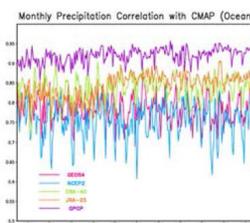
MERRA/AS provides a new cloud-based approach to storing and accessing the MERRA dataset. By combining high-performance computing, MapReduce analytics, and NASAs Climate Data Services API (CDS API), MERRA/AS moves much of the work traditionally done on the client side to the server side, close to the data and close to large compute power. This reduces the need for large data transfers and provides a platform to support complex server-side data analysesit enables Climate Analytics-as-a-Service.

MERRA/AS currently implements a set of commonly used operations (such as avg, min, and max) over all the MERRA variables. Of particular interest to many applications is a core collection of about two dozen MERRA land variables (such as humidity, precipitation, evaporation, and temperature). Using the RESTful services of the Climate Data Services API, it is now easy to extract basic historical climatology information about places and time spans of interest anywhere in the world. Since the CDS API is extensible, the community can participate in MERRA/ASs development by contributing new and more complex analytics to the MERRA/AS service.

MERRA/AS demonstrates the power of CAaaS and advances NASAs ability to connect data, science, computational resources, and expertise to the many customers and applications it serves.

### Key Specs (MERRA dataset)

- Input: 114 observation types (land, sea, air, space) into "frozen" numerical model (~4 million observations/day)
- Output: a global temporally and spatially consistent synthesis of 26 key climate variables (~418 under the hood)
- Spatial resolution: 1/2 ° latitude x 2/3 ° longitude x 42 vertical levels extending through the stratosphere
- Temporal resolution: 6-hours for three-dimensional, full spatial resolution, extending from 1979-Present



## APPLICATIONS

The technology has several potential applications:

- Energy
- Insurance
- Agriculture
- Urban planning
- Water management
- Ecological forecasting
- Resource management

## PUBLICATIONS

Patent No: 9411569; 10075562; 9940329; 10339114

Patent Pending

Schnase, J., Duffy, D., Tamkin, G., Nadeau, D., Thompson, J., Grieg, C., . . . Webster, W. (2014). MERRA Analytic Services: Meeting the Big Data challenges of climate science through cloud-enabled Climate Analytics-as-a-Service. Computers, Environment and Urban Systems.

[technology.nasa.gov](http://technology.nasa.gov)

NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

GSC-17116-1, GSC-17117-1, GSC-17115-1, GSC-17118-1, GSC-16594-1, GSC-17966-2, GSC-17967-2, GSC-17971-2, GSC-17973-2, GSC-TOPS-53