

**Memorandum of Understanding**  
between the  
**Clouds and the Earth's Radiant Energy System**  
**(CERES) satellite mission**  
of the **NASA Langley Research Center**  
and the  
**Global Modeling and Assimilation Office,**  
**Earth Sciences Directorate**  
of the **NASA Goddard Space Flight Center**

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# **Memorandum of Understanding between the CERES Satellite Project and the Global Modeling and Assimilation Office**

## **1. Purpose and Objective**

The purpose of this Memorandum of Understanding (MOU) between the Clouds and the Earth's Radiant Energy System (CERES) satellite mission at NASA Langley Research Center and the Global Modeling and Assimilation Office (GMAO) in the Earth Sciences Directorate at NASA Goddard Space Flight Center, is to establish a cooperative agreement between both parties that defines a data exchange policy and implementation plan. This agreement outlines broad requirements for GMAO products that support data processing and data analysis activities for the CERES (Terra, Aqua, and NPP) mission. It also outlines responsibilities for developing and maintaining an interface between the CERES project and the GMAO Data Assimilation System (DAS). This MOU may lead to further delineation of responsibilities or amendments as needed to maintain data availability from GMAO.

## **2. General descriptions of CERES and DAS data processing system**

The Clouds and the Earth's Radiant Energy System (CERES) experiment is one of the highest priority scientific satellite instruments developed for EOS. CERES products include both solar-reflected and Earth-emitted radiation from the top of the atmosphere to the Earth's surface. Cloud properties are determined using simultaneous measurements by other EOS instruments such as the Moderate Resolution Imaging Spectroradiometer (MODIS). Analyses of the CERES data, which build upon the foundation laid by previous missions such as the Earth Radiation Budget Experiment (ERBE), will lead to a better understanding of the role of clouds and the energy cycle in global climate change.

CERES instruments were launched aboard the Tropical Rainfall Measuring Mission (TRMM) in November 1997 and on the EOS Terra satellite in December 1999. Two additional instruments have been flying on the EOS Aqua spacecraft since 2002. The CERES FM5 instrument is expected to launch in 2010 as a part of the NPOESS (National Polar-Orbiting Operational Environmental Satellite System) Preparatory Project (NPP). Multiple satellites are needed to provide adequate temporal sampling since clouds and radiative fluxes vary throughout the day. The first 24 months of CERES data collected on both TRMM and Terra demonstrate that the CERES instruments are substantially improved over the ERBE instruments. The CERES data show lower noise, improved ties to the ground calibration in absolute terms, and smaller fields of view. CERES instrument calibration stability on TRMM and Terra is typically better than 0.2%, and calibration consistency from ground to space is better than 0.25%. Onboard calibration sources provide traceability of the measurements to the International Temperature Scale of 1990 at the 0.2% level. Such levels of accuracy have never before been achieved for radiation budget instruments.

A goal of the GMAO is to advance the state of the art for data assimilation and to produce research-quality assimilated global data sets needed to enhance our understanding of the Earth system and processes contributing to global climate change. Since January 2000, the GMAO has been providing operational DAS data products in support of NASA's satellite instrument teams

and other Earth science mission activities. The CERES project requires access to GMAO global assimilated data products to support its instrument calibration, data processing, and analysis activities.

CERES processing subsystems require meteorological and other atmospheric parameters such as surface temperature and pressure, profiles of geopotential height, humidity, and ozone, and column burdens of water vapor, ozone, and aerosols. The bulk of the inputs, namely, the surface temperature and pressure, and profiles of temperature and specific humidity are obtained from the GMAO.

### 3. GMAO and CERES have the following responsibilities

CERES requires a climate-quality input-data set from GMAO which holds the algorithms and the inputs constant from December 1997 forward. So as not to confuse this data set produced exclusively for CERES with the Modern Era Retrospective-analysis for Research and Applications (MERRA) data set, the new data set will be called “G5-CERES”.

It is CERES’ understanding that the G5-CERES data set will be provided in two data streams, Reprocessing and Near-Real-Time (NRT), as described below.

- a. **G5-CERES Reprocessing Stream** will contain a climate-focused “MERRA” re-analysis for CERES with fixed algorithm and input data types for the time period beginning on December 01, 1997 (TRMM covers opened in December 1997) through January 02, 2008. So, for example, AIRS data which starts in mid-2002 would NOT be used in this re-analysis because it would cause climate data record "shock" from pre-AIRS data to post-AIRS data. The same restriction should be in place for all major input data types, such as,
  - GOES sounder (only 2001 to present, and only for the GOES view: not global)
  - ERS-1 and -2 (missing after 2001)
  - MODIS winds (only mid-2002 to present).

The concept for a climate re-analysis is to use the best input data that are consistently available over the entire climate record.

- b. **G5-CERES Near-Real-Time Stream** will contain a climate-focused data record as described in “a.” except the time period will run from September 30, 2007 through the duration of the CERES Edition3 data set (at least through January 02, 2012). This G5-CERES NRT Stream is needed to support the processing of future CERES climate data records consistently for Terra, Aqua, NPP and in the future, NPOESS, and should continue until CERES and GMAO agree that a new version of both G5-CERES and CERES data products will be re-processed through the entire CERES climate record.

Specifically, it is CERES’ understanding that the following G5-CERES data collections will be provided to the Langley DAAC by GMAO in direct support of the CERES Project,

const\_2d\_asm\_Nx  
inst6\_3d\_ana\_Np  
tavg1\_2d\_slv\_Nx

The total data volume per data day is about 1.8 GB. The first data collection, const\_2d\_asm\_Nx, in the list contains G5-CERES DAS 2d constants and does not need to be transmitted on a routine basis, so it is not included in the daily total. CERES will expect the data format, naming conventions, and variable definitions to be consistent with that described in the “File Specification for GEOS-5 MERRA Gridded Output”.

#### **4. Initial Data Validation Approach**

CERES has requested 5 months of data for initial review – January 2004, April 2004, July 2004, October 2004, and January 2006. So that CERES can validate the G5-CERES data set, GMAO will provide G5-CERES data collections for these 5 months. CERES will compare the 3 CERES requested data collections with the previously acquired MERRA 'p15' data for the same data months. CERES will then use these 5 months of G5-CERES data to generate Meteorological, Ozone, and Aerosol (MOA) data at the CERES Science Computing Facility (SCF) and will evaluate the resulting MOA data. The CERES SCF will provide MOA and preliminary-MOA (PMOA) data for Jul 2004 and Jan 2006 to the Langley DAAC. The Langley DAAC will use these data to generate Terra data products for July 2004 and January 2006 and Aqua data products for January 2006. The data products to be generated will be SSF (Inversion Subsystem), SFC (TISA Gridding Subsystem), and SRBAVG (TISA Averaging Subsystem). CERES will evaluate these resulting data products. In addition, CERES may generate CRS (SARB Subsystem) products for additional analysis at the SCF.

CERES will advise GMAO of the results of these analyses. If any of the results demonstrate that the G5-CERES data are not acceptable, GMAO will make the necessary corrections and the validation process will be repeated

#### **5. Initiate Operational Processing**

GMAO will initiate operational processing after CERES notifies them that their validation effort has been successful. The NRT Stream will have the highest processing priority. Specifically, the catch-up months of the NRT Stream beginning with September 30, 2007 will have the highest priority. So, assuming that operational processing of the G5-CERES data is started on or about February 01, 2008, G5-CERES generation would begin with the September 30, 2007 data at the rate of 8-10 data days/day. This high-priority processing will continue until processing catches up to the current time at which point NRT Stream processing will continue on a “real-time” basis, 1 data day/day. The Reprocessing Stream processing will begin with December 01, 1997 at 8-10 data days/day. The Reprocessing Stream processing will continue through January 02, 2008. The NRT Stream processing will continue at least through January 02, 2012. GMAO will provide the G5-CERES data collections listed above to the Langley DAAC as they are processed through the Reprocessing Stream and the NRT Stream. An Interface Control Document (ICD) prepared by the Langley DAAC will define the delivery arrangements for getting the G5-CERES data collections from GMAO to the Langley DAAC. The Langley DAAC will be responsible for the long-term archive of the G5-CERES data collection. GMAO will also inform the CERES project in a timely manner of any data format or significant schedule changes with the GMAO products and provide counsel on data usage and availability.

CERES will,

- Restrict access to the G5-CERES data collections to members of the CERES, POWER, and

