



Clouds and the Earth's Radiant Energy System



CERES

Aqua Spacecraft and FM3 / FM4 Instrument Status

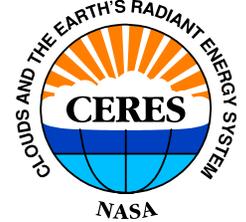
CERES 27th Science Team Meeting

September 17 –19, 2002

Phillip L. Brown



Clouds and the Earth's Radiant Energy System



CERES



- **One of several high priority instruments developed for NASA's Mission to Planet Earth Program (MTPE).**
- **MTPE critical for providing scientific understanding of ongoing natural and human-induced global change.**
- **CERES measures both solar-reflected and Earth-emitted radiation from top of the atmosphere to the surface**
- **Cloud properties including the amount, height, thickness, particle size, and phase of clouds using measurements by other instruments.**
- **Measurements critical for understanding cloud-radiation climate change and improving the prediction of global warming using climate models.**

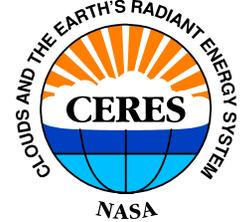
CERES Team Leaders:

Dr. Bruce A. Wielicki, PI
Senior Scientist
Atmospheric Sciences Division

Dr. Kory J. Priestley, Science Lead
Senior Scientist
Atmospheric Sciences Division



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EOS AQUA

The EOS Aqua spacecraft continues to perform nominally to date with very few problems/issues.

Launch: May 4, 2002

705 km orbit achieved: June 17, 2002

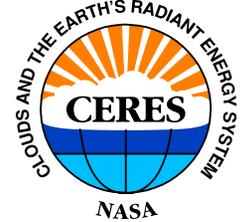
OPERATIONS:

G

- **Supported all real-time communications and data capture.**
- **Current operations using recently installed Build 11 SW.**
- **Problems:**
 - MIR# A2002-0175 CDS DR# 31407 Unable to CMD with SGS due to antenna main computer failure.
 - MIR# A2002-0176 CDS DR# 31408 Unable to CMD with SGS REF MIR# A2002-175.
 - MIR# A2002-0177 CDS DR# 31414 Unable to CMD with WPS due to equipment configuration problems.
 - MIR# A2002-0178, 0183, No X or S band CODA's from EDOS.
 - MIR# A2002-0179 EDOS misconfiguration with PF1 data delay, no data loss.
 - MIR# A2002-0180 FSN/TFSN discrepancy.
 - MIR# A2002-0181 X-band telemetry drop out with PF1, no data loss.
 - MIR# A2002-0182 CLCW errors at AOS with AGS all objective met.
 - MIR# A2002-184 EDOS requested replay on SGS due to data capture problem.
 - MIR# A2002-185 EDOS delay X-band CADU's counts
 - MIR# A2002-186 Uncorrectable CADU's WITH AGS during X- band dump.
 - MIR# A2002-187 Intermitted CODA's from EDOS.



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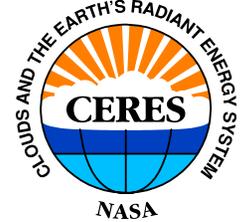


EOS AQUA

- **Command and Data Handling Subsystem:** G
- **Communications Subsystem:** G
- **Guidance, Navigation & Control Subsystem:** G
- **Electrical Power and Thermal Control:** G
- **Flight Software:** G



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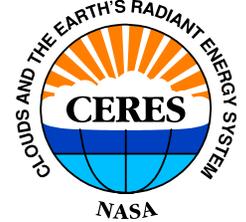
EOS AQUA

Instruments

- **AIRS:** The AIRS instrument is performing nominally.
- **AMSR-E:** The AMSR-E instrument was currently running power-on and in the Normal Mode and spinning at 40 RPM. The SPS Error Flag #5 has been yellow since 09/01/02. The AMSR-E IOT has been notified, and is investigating the problem.
- **AMSU-A:** The AMSU-A instrument was running normal powered-on while in Full Scan Mode. Instrument operations continue to be managed by the JPL IOT as planned.
- **CERES:** Both CERES instruments were running normal powered-on while in Science Mode. CEF is in Cross-track Mode and CEA is in Biaxial Mode.
- **HSB:** The HSB instrument was powered on and in Normal Scan Mode. Instrument operations continue to be managed by the JPL IOT as planned.
- **MODIS:** The MODIS instrument was in Science Mode. All operations are nominal. A fifth MCL command was dropped (245/1650z). Night Mode transition was dropped and instrument remained in Day Mode. A special review meeting was held Wednesday Sept. 04.



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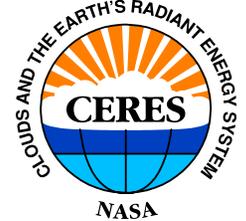


CERES -Aqua Activation and Operation

- **CERES instrument activation and checkout was accomplished via real time CECIL procedure execution. A majority of the CECIL procedures executed were for activation and checkout only and are not planned for future use.**
- **In-orbit operation of the CERES is accomplished through separate CEA and CEF MCL stored command loads. CERES IOT schedules MMS activities in support of MCL builds and reviews and approves daily the as-built MCL load files.**
- **CERES performed MCL (Master Command Load - s/c stored commanding) operation as part of its final checkout prior to opening covers/doors (pre-cover MCL operation: 4 June, DOY 155 – June 18, DOY 169).**
- **Some CECIL procedures may be needed for in-orbit commanding or mode execution to cover special operations, workarounds, and emergency and recovery operations. CERES IOT supports this type of activity real time.**
- **CERES commanding to safe or survival by the S/C as a result of the onboard fault management system is accomplished through appropriately Stored Command Sequences (SCSs).**
- **CERES uses S/C TMON system for instrument critical H/K temperatures and voltages to automatically command CEA or CEF to survival in the event of a red limit.**
- **CERES commanding in response to non-TMON red limits (H/K temperatures or voltages) is accomplished by the FOT. FOT to execute CERES “survival” SCS .**



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CERES - Aqua Activation and Checkout

- **Survival mode - 4 May(L+3.5 hours), 19 May (911 trip)**
- **Power on – 8 May (CEA: 128:02:40; CEF: 128:03:25), 21 May**
- **Functional Checkout – 15 May through 3 June**

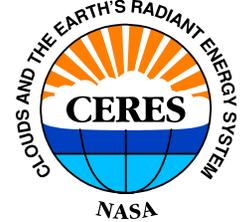
Diag Memory patch, MEM dump, Azimuth brake release, Azimuth position check and scan functional testing, Memory loads, Packet types, Detector bridge balance check, Elevation scan mode testing, Instrument Mode testing – XT, BIAX, INT CAL, SOL CAL, Solar Presence Sensor testing, scan timeout counter test, Azimuth rate testing.

- **MCL Checkout – 4 June through 18 June**

MCLs included commanding to place CEA and CEF into Crosstrack mode, Biaxial mode with solar avoidance commanding , Internal Calibration mode, Solar Calibration mode, Contamination Safe mode, Spare Sequence mode, Standby mode. Also included azimuth commanding as trial run for CRYSTAL-FACE scanning campaign .



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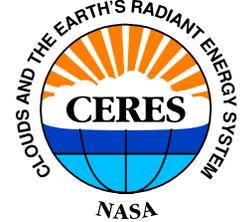


Activation / Checkout (cont.)

- **Main Covers and MAM Door opened – 18 June (DOY 169)**
CEA and CEF main cover and Mirror Attenuated Mosaic (MAM) baffle door opened via CECIL procedures. CERES begins acquisition of first-light data with CEA and CEF in Crosstrack mode.
- **CEA and CEF return to MCL operation – 19 June (DOY 170)**
- **CEA and CEF Sunrise Solar Calibration Activity via MCL – 26 June**
The objective of this activity was to assess the possibility of spacecraft/instrument glint during sunrise solar calibrations at low Beta angles.
Series of 5 S/C maneuvers, 3 of which yawed the S/C to a minimum Beta angle of 16.5 degrees, and 2 which yawed the S/C to max Beta angle of 32 degrees. Each S/C yaw performed prior to orbital sunrise. CEA and CEF positioned during each yaw and then commanded to solar calibration mode.



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Activation / Checkout (cont.)

- **CERES supports CRYSTAL-FACE targeting via MCL (3 July – 31 July)**

CERES Aft (FM3) commanded via MCL activity 1–3 orbits/day to scan over Florida Keys

Cirrus Regional Study of Tropical Anvils and Cirrus Layers – Florida Area Cirrus Experiment (CRYSTAL – FACE)

CRYSTAL-FACE is a measurement campaign designed to investigate tropical cirrus cloud physical properties and formation processes. Understanding the production of upper tropospheric cirrus clouds is essential for the successful modeling of the Earth's climate.
- **CERES Aqua–Terra Inter-calibration scanning via MCL (4 July – 22 Aug)**

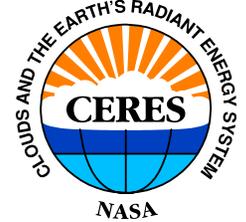
Radiometric intercomparison is accomplished by having both spacecraft scan the same scenes within a short time interval and with matched viewing angle directions.

To scan the same scenes, match viewing angles, and obtain the shortest observation time interval, the spacecraft orbit crossing nodes must be used.

CERES Fore (FM4) commanded in azimuth via MCL to target 70 degrees north latitude and 70 degrees south latitudes each orbit. The northern crossing is around noon over the Arctic and the southern crossing is around midnight over the Antarctic.



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CERES Instrument MMS Scheduling Status

Aqua Instrument operations scheduling parallels Terra Instrument scheduling.

Normal scanning for both instruments is scheduled on the MMS Timeline for approximately 2 weeks into the future at any given time. Normal scheduling around maneuver events includes one Dual Contam Safe starting at least five minutes prior to Attitude Maneuver and a second Dual Contam Safe starting five minutes prior to thruster activity, if any. Return to normal scanning approximately one orbit after maneuver completion.

As of August 1, nominal Biax unit is CEA and nominal Crosstrack unit is CEF. Change from Biax to Crosstrack occurs on a three-month cycle. During changeover, diagnostic data is collected for azimuth gimbal performance (stowed elevation) for the both the outgoing Biax unit and the incoming Biax unit.

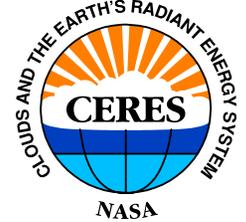
Fore Instrument: Crosstrack Scanning and Terra Intercalibration twice per orbit using fixed Azimuth scanning at Spare1 position of 180 ± 25 degrees for 2 minutes at the North and South Orbit crossing points of 72 degrees.

Aft Instrument: Biaxial Scanning at 6 deg/sec azimuth rate. Alongtrack every 14 days (on Tuesday). Crosstrack every 28 days.

Both Instruments: Solar cal every two weeks, on Wednesday. Full internal cal every week, on Wednesday. Black body only (no SWICS) internal cal every week on Monday and Friday.



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CERES – Aqua Database Status

- CERES Command Database Status: G

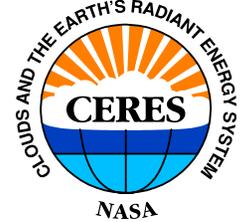
Build 11 SW database contains latest CERES updates

- CERES Telemetry Database Status: G

Good – no issues



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Remaining Activities

- **CERES baseline Activation and Check-Out activities complete**
- **CERES Deep Space Calibration on hold pending Aqua program review**

13. Final Notes

- **Contact information:**

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Fax: 757-864-7879

New CERES Mission Operations Manager (effective October 1, 2002)
Mike Cisewski
NASA- LaRC
Tel: 757-864-1861

Others: see Operations Agreement



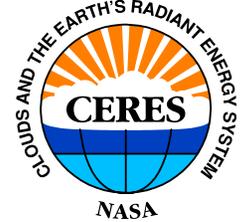
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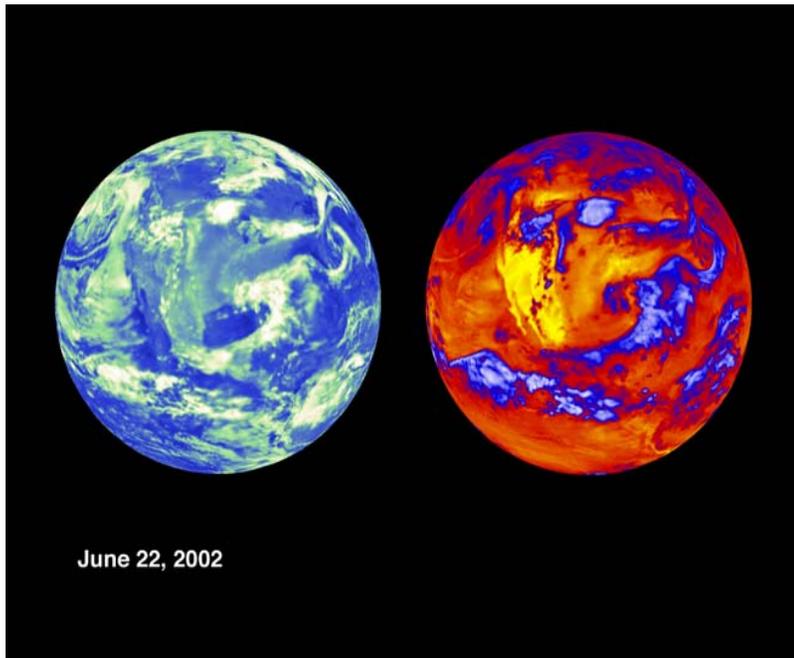
Back Up Charts



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CERES detects the amount of outgoing heat and reflected sunlight leaving the planet. A detailed understanding of how clouds affect the energy balance is essential for better climate change predictions.



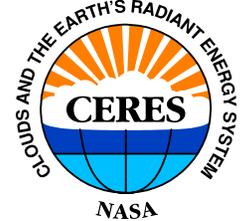
These Aqua images show CERES measurements over the United States from June 22, 2002.

Clear ocean regions, shown in dark blue on the left image, reflect the least amount of sunlight back to space. Clear land areas, shown in lighter blue, reflect more solar energy. Clouds and snow-covered surfaces, shown in white and green, reflect the greatest amounts of sunlight back to space.

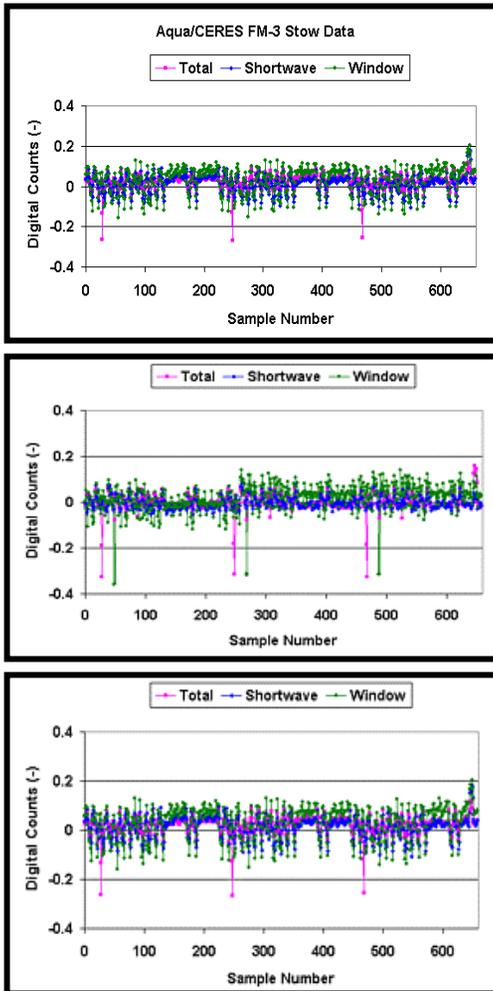
Clear warm regions, shown in yellow over much of the western U.S. on the right image, emit the most heat. High, cold clouds, shown in blue and white, significantly reduce the amount of heat lost to space.



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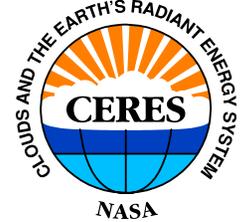
Stowed Sensor Output



These images represent the first 24 hours of high-rate science data collection from the 2 CERES instruments on Aqua. The sensor scan head remained stowed, staring at internal instrument structure which provides a stable source so characteristic noise patterns of the sensors may be quantified. CERES collects 660 samples (abscissa) in a data packet, representing a 6.6 second packet length, the ordinate represents raw digital output of the sensors. A single count is equivalent to roughly 0.5W/m² TOA flux. Globally averaged Outgoing Longwave Radiation and reflected Solar radiation values are typically 240W/m² and 100 W/m² respectively. Patterns in the data are correlated with onboard microprocessor activities. There is no measurable difference from identical measurements made during ground calibrations prior to launch.



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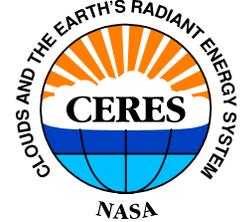


Documentation

- **CERES – Aqua ICD (TRW, D24846, Rev A)**
Defines and controls the interface requirements between CERES and Aqua S/C
- **CERES Interface Database (TRW 62727.2.230.005)**
Documents the estimated and measured interface parameters between CERES and Aqua S/C
- **CERES UIID (GSFC 422-12-13-02)**
Defines the special interface requirements that are unique to CERES
- **CERES IDD (GSFC 422-12-13-03)**
Instrument Description Document. Provides mechanical, thermal, electrical, and C&DH descriptions for CERES
- **CERES Operations Manual (TRW – CERES, D26571)**
Describes operations and constraints for CERES



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Documentation (cont.)

- **CERES – Aqua Operations Agreement (ITMI-189/04-01-05C)**
Specifies and controls operational interface between Aqua S/C FOT and the CERES IOT
- **EOS PM-1 S/C to EOS Ground System ICD (GSFC 422-11-19-03)**
Defines the data format interface between the Aqua S/C and the EOS ground system
- **Interface with PM-1 Spacecraft Appendix Z (GSFC 422-11-19-04)**
Includes additional interface information that directly impacts and controls the interface between the S/C and EMOS and the instruments and EMOS

Note: All documents have been officially signed off.