Clouds and the Earth's Radiant Energy System (CERES)

ProtoFlight Model (PFM)

Initial Activation and Evaluation Checkout Plan

to support the

DAA +15-Volt Anomaly Investigation

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CERES PFM Initial Activation and Evaluation Checkout Plan

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1.0 Introduction

The purpose of this document is to provide information needed for activating and performing an engineering checkout of the CERES PFM instrument that has been powered off since 1 September, 1998. Instrument shut-down occurred due to higher-than normal anomalous measurements of the DAA +15-volt DC-DC converter. An engineering checkout is deemed necessary before the instrument is returned to full mission science status. Information provided herein includes activation requirements, engineering test plans, and data evaluation tasks. During this checkout testing period, it is anticipated that routine telecons will occur between the CERES, TRMM MOC, and TRW teams to review the data and courses of action.

While the instrument has been operating in the Survival mode, a CERES tiger team has been investigating this voltage anomaly and has tried to assess potential impacts on further mission operations. Some pertinent conclusions from this investigation are listed below, and more details can be found in Appendix A.

- The anomalous readings are due to a degraded DC-DC converter and not due to a faulty measurement system.
- Analysis of the instrument engineering data indicate that the DAA +15-volt converter will be required to operate at higher than normal values, by as much as three to five volts, even without further degradation.
- Ground experiments indicate that the converter and the down stream electronics could operate at higher converter output values, even to its maximum output of 29.4-volts for a 32-volt input. However, there are no data or experience in predicting the converter behavior with respect to temperature or any other parameter if further degradation occurs.
- Furthermore, only after analysis of radiometric data at ever higher voltage values than measured so far, can any conclusions be drawn about the validity of science data at these higher voltage values.

Based on these conclusions, the tiger team has determined that the PFM instrument can be safely, but cautiously, reactivated and a checkout performed. This checkout will be used to confirm investigation hypotheses and results and to identify potential operational constraints that may affect the return to mission status. This information will become the basis for developing a final operational plan that, with science team approval, will return the instrument to science operations.

2.0 Evaluation Objectives

The objectives of this reactivation and engineering checkout period are to address some of the following issues:

- Check that the TSM system safely shuts down the instrument if a converter red limit occurred.
- Assess the current instrument state and the performance of the DAA+15 volt converter.
- Evaluate effects of certain operational configurations, e.g., azimuth orientation.
- After testing is completed, identify potential constraints that may affect the return to nominal mission operations and the impact on science data validity.

3.0 Activation and Checkout Test Plan Summary

The activation and engineering checkout test plans will be described in this section, along with brief rationales, and can be summarized by the following six day time-line. All time of day references are in universal time [UT] unless indicated otherwise.

Day 1: Power-up and initialize the instrument and allow it to thermally stabilize. Initial power is planned for around midnight UT, 14 October (8 P.M. EDT, 13 October).

Day 2: Command the instrument to the Standby mode and rotate the azimuth gimbal to the 180 degree position (the normal crosstrack science orientation).

Day 3: Command the instrument to begin elevation scanning operations.

Day 4: Command the instrument to perform two internal calibrations.

Day 5: Command the instrument to stow the elevation gimbal and begin performing an azimuth A-B asynchronous rotation operation.

Day 6: Command the instrument to perform the biaxial operation. At the end of the day, command the instrument to the Safe mode and remove power.

Assumptions about this plan and its implementation are noted below, in no particular order:

1. This checkout time line assumes no further serious degradation or failure of the +15-volt converter that would necessitate shutting down the instrument prematurely. Increases in converter output with increases in the diurnal temperatures at the beginning of a universal day should follow the trends occurring prior to August 31. This trend rate was approximately 0.1 volt-per-orbit for the first six hours of the day. It is hoped that the rate of approximately 0.45 volt-per-orbit increase that occurred on 1 September, reflected the SWICS loading effect and will not occur in the future. At this rate, the DC converter output would reach the 18 volt red limit in approximately 6-2/3 orbits, or approximately 10 hours, which is before the diurnal peak. During initial activation CERES personnel will need to closely monitor this and be prepared to direct the MOC to shutdown the instrument accordingly.
2. Should an early shutdown become necessary, further testing may be aborted. Otherwise, once the instrument is activated, it will remain on for the duration of the checkout tests.

3. All operating constraints, as outlined in the Operations Agreement document, will be in effect during this testing period unless stated otherwise.

4. Accommodations are needed for spacecraft communication contact schedules, delta-V (attitude adjustment), and yaw maneuvers. For example, a 180 degree yaw maneuver to the +X-axis orientation is planned for 17 October, 1998, Day 4 of this plan. During such spacecraft maneuvers, the instrument is to be placed into the Safe mode for the duration of these maneuvers.

5. Leaving the instrument in a single specific orientation for an entire day will help clarify diurnal variation effects while minimizing perturbation influences.

6. All science telemetry data are to be collected with the diagnostic no-archive-science type packet APID (56). The instrument mode should show either Safe or Standby during most of the test period, with the internal calibrations indicated when they occur.

7. Quick-look science telemetry data is expected to be requested for the first few hours of each day UT, for specific test events (e.g., internal calibrations or spacecraft yaw maneuvers), and during the diurnal peaks (e.g., between 1100 and 1400 GMT). Quick-look data files typically have contained data for one orbit.

8. The DAAC is to try to complete processing of overnight quick-look science telemetry data by 7 A.M. EDT the next morning, per normal quick-look processing procedures. Level-0 data, without actual ephemeris, is to be processed in the instrument-only mode by 7 A.M. EDT on the day of receipt. (This typically takes up to one-half hour to complete.)

9. No solar calibrations will be performed to avoid the associated higher thermal conditions.

10. Commanding should be performed, as much as practical, during real-time contacts. However, solar avoidance operations during the anticipated internal calibration and biaxial tests will probably use on-board stored commands typically uploaded prior to the beginning of the day.

11. The DAA +15-volt yellow limit is set at 15.7 volts and the red limit is set to 18.0 volts for the TSM and the MOC ground monitoring systems. Corresponding low limit values have also been set. As changes to the TSM limits require a four day turn-around, these limits will not be changed during the test period.

12. It is anticipated that the DAA +15-volt output will often reach the high yellow limit value. The MOC operators should verify that a TSM log entry has created for a yellow limit occurrence.

13. Monitoring of the DAA +15-volt housekeeping parameter at the TRMM MOC can use the data plotting capabilities at the MOC while CERES personnel are on-site. Graphical displays of this voltage using real-time and play-back data will be used to assess the rate of changes during increasing diurnal temperature periods. This evaluation will be helpful in determining appropriate actions for the next real-time pass.

14. Any planned commanding of the elevation gimbal should be executed outside the Sun-avoidance zones [based on values of predicted Sun elevation angle].

3.1 Activation Conditions Plan

The initial instrument activation should be performed based on satisfying several conditions. The order for evaluating these conditions, independent of real-time monitoring considerations, is as follows:

1. Identify a start-up day or general period to initiate this checkout plan based on when the solar beta angle is predicted to have minimal effects on temperatures and voltages. Analyses have shown that this occurs when the solar beta angle region is between -10 and +10 degrees and while the beta angle is heading towards zero degrees. However, as this test plan requires six days, a wider range can be used, e.g., -15 to +15 degrees.
2. Identify an activation time period when the orbit-to-orbit, or diurnal, variations can be used to predict when minimal temperature and voltage effects will occur. Analyses have shown that a specific orbit, generally near beginning of the day, i.e., around midnight GMT, could be selected for issuing commands on the first and each subsequent day.
3. Identify within each orbit, identified in step 2, when commands could be issued relative to in-orbit solar effects correlated to both instrument and spacecraft temperatures and voltages. Identification will need to use the latest predicted solar elevation angles contained in the CERES Sun angle reports.

a. Correlation analyses have indicated that the DAA + 15-volt measurements where decreasing for several minutes before reaching minimum values near the time when the solar elevation angle passes through zero degrees after a Sunrise. However, it is recommended that activation occur several minutes, e.g., 15 minutes, before the predicted angle reaches zero degrees. This should be consistent with the desire to avoid the Sun-avoidance zones.

b. Furthermore, the voltage-solar elevation angle correlation is different depending on whether spacecraft is oriented + X or - X forward. It is suggested that data from 24, August and 30, August [beta angle was negative and postive, repectively] be used as the basis for selecting times within the orbits for commanding the instrument before and after the spacecraft yaw.

c. Correlations between the +15-volt and the spacecraft +28-volt non-essentual bus voltage suggests that activation should occur when the voltage is as low as possible, e.g., around 26 volts. However, this occurs just before sunrise. Therefore, activation should occur several minutes, e.g., 15 minutes, which will be before this voltage reaches minimum values.

4. A real-time contact that will allow power-up and initialization to commence starting around the beginning of the contact. This contact should last for at least 30 minutes. This will allow the instrument's bolometer heatsinks to be monitored for thermal stabilization and allow for real-time contingency commanding, should it be necessary.

With these conditions in mind, the desired instrument power-on should be within one orbit of either side of midnight (00:00:00) UT on 14 October, 1998. The predicted beta angle will be approximately -16 degrees.

3.2 Test Plan

The following is a preliminary plan, with rationale, for turning on and checking out the CERES instrument. The detailed commands and monitoring requirements are specified in a later section.

Day 1: Power-up and initialize the instrument. Let the instrument remain in the Safe mode while the instrument warms up to nominal operating temperatures (which takes approximately 24 hours).

Rationale: This warm-up period is necessary to establish the baseline status of the instrument before further testing begins. Furthermore, while the azimuth gimbal is currently at the 5 degree position, additional data are needed that reflect diurnal variations without interfering instrument actions. This data will be used to corroborate the 8/31/98 data.

Day 2: Command the instrument to the Standby mode and then rotate the azimuth gimbal to 180 degrees. Let the instrument operate in this configuration for the remainder of the day.

Rationale: This is the normal azimuth gimbal orientation for science data cross-track operation and is used two-thirds of the mission time. Operation during this day will provide temperature and voltage effects which are independent of elevation scan head operations. Should further instrument deterioration occur, having the azimuth gimbal at the nominal crosstrack position can help maintain scientific consistency whenever data can be collected.

Day 3: Command the instrument to begin elevation scanning operations. Use the normal-earth scan profile. Command execution should occur outside the Sun-avoidance zones (based on predicted Sun elevation angles).

Rationale: Operations during this day will provide temperature and voltage effects, including diurnal variations, while in the typical mission crosstrack configuration. Further, these data can be correlated to data collected during crosstrack days in August to corroborate trends.

Day 4: Command the instrument to perform two internal calibrations. Perform the abbreviated calibration sequence near beginning of the day during the night portion of the orbit. Perform the full calibration sequence near the end of the day during the day portion of the orbit. This may be accommplished using on-board stored commands in order to satisfy operational constraints.

Rationale: Turning the SWICS on at level-3 on 31, August, and leaving it on for several hours, appeared to cause a significant increase in the value of the DAA +15-volt measurement. However, since the SWICS does not remain on for very long during internal calibrations, these tests should help define how temperatures and voltages will be affected during future internal calibrations. The first abbreviated calibration during the night time period should present the coolest and least demanding conditions to the 15-volt converter. (As the SWICS power is directly provided by this converter, initial minimal load changes would be prudent.)

If the results of the first calibration indicate minimal converter perturbations, then the second full calibration at the end of the day can be performed. (The end of the day typically presents lower diurnal temperatures.) Due to the 35 minutes required of a full internal calibration, this is best performed during the day period of the orbit.

Day 5: Command the instrument to the Standby mode and then begin performing an azimuth A-B asynchronous rotation operation. The elevation gimbal should remain in the stow position. The azimuth defined A position should be 110 degrees and the azimuth defined B position should be 250 degrees. This corresponds to the solar avoidance rotational range for low beta angle periods. Normal operational solar avoidance procedures are to be disabled

Rationale: Instrument operations during August revealed that biaxial scans showed higher operating temperatures and that the DAA +15-volt measurements increased. This is most evident by the MAM temperatures. Data obtained during this period will allow direct comparison of temperatures and voltages with data measured on Day 2. These comparisons should help clarify azimuth rotational effects, independent of the elevation scanning operations.

Day 6: Command the instrument to perform a biaxial operation. This is best accomplished by commanding the elevation gimbal to begin performing a normal-earth scan profile. Normal solar avoidance procedures are to be followed.

Rationale: Data from this period can be directly compared with Day 3 data, when the instrument operates in the cross-track scan mode. Data comparisons with Day 4 data should help define elevation scan motion effects in conjunction with asynchronous azimuth rotation. Finally, these data can be correlated to data collected during biaxial days in August to corroborate trends.

3.3 Implementation Considerations:

Activating and testing the instrument is influenced by the desire to operate the instrument under the most benign environmental conditions possible. This implementation factors in results from the following analyses.

3.3.1 Solar Beta Angle

To minimize heating effects at the time of instrument activation, it is preferable that the beta angle values are near zero; i.e., when the Sun is near the orbit plane. Furthermore, beta angle values should be approaching zero, not away from zero. However, by following this recommendation, a 180-degree yaw maneuver can be expected to be performed during the test period. The next occurrence of a beta angle value of zero will be October 17 (Day 4).

This recommendation is based on reviewing MAM Assembly temperature data since January, 1998. The data show that the lowest and highest values of MAM temperatures generally occur for beta angles equal to zero and at maximum values, respectively. Note however, that the highest temperature values recorded since January do not correspond to the maximum or minimum values of beta angle. Furthermore, during August when values of the DAA +15-volt measurement showed increases, values of the mean MAM temperature were about 19.5 degrees or less; whereas mean MAM temperatures of 20.5 degrees and higher have been observed several times since launch.

3.3.2 Orbital Solar Conditions

Instrument activation and any operational changes should, to the extent practical, be made at times when the solar elevation values are near their orbital minimum; typically at around orbit midnight. In essentially all cases, the temperature and voltage values at this solar condition have peaked out and are decreasing.

3.3.3 Time of the Universal Day

It is recommended that the instrument activation and any subsequent operational changes be made near the beginning or ending of a universal day, to the extent practical. This is a reflection of a diurnal temperature effect that occurs in addition to orbit-to-orbit variations. These diurnal effects can be seen in the MAM Assembly temperature values and have been observed since launch.

These variations cannot be directly correlated to changes in beta angle, and at this time have not been explained. The temperatures typically begin to increase during the first few hours after the beginning of the day and normally peak out during a period of the day centered around noon, universal time. However, this typical pattern is not always followed uniformly during every 24-hour period. Further analysis will be persued.

3.3.4 Spacecraft Operations

Since a yaw maneuver and possible delta-V maneuvers are expected during this testing period, CERES plans to use the Safe mode instead of the Contamination Safe mode sequences during these events. This allows the instrument to ignore the command that would return it to a mode that could be inconsistent with the checkout plan. For these spacecraft events (unless otherwise specified in the detailed daily plan), the procedures shown below should be followed:

1. If the azimuth gimbal position is not at 180 degrees and if the azimuth bearing temperature is above 0 degrees, execute the CAZMODE\CT command.

   - Verify the azimuth position is 180 degrees.

2. Then execute the CINSTMODE\SAFE command at least 15 minutes prior to a maneuver.

   - Verify the instrument is in the Safe mode and the azimuth brake applied.

3. During the next real-time contact after a maneuver is completed, execute the CINSTMODE\STDBY command.

   - Verify the instrument is in the Standby mode.

4. Execute the CAZBRAKE\REL command (releases the azimuth brake released).

- Verify that the azimuth is released.

5. Execute the appropriate commands to return the instrument to the test configuration it was in prior to the spacecraft maneuver.

3.3.5 TSM Operations

With the potential for further DAA +15-volt degradation, it is desirable to keep the output voltage from going higher than 18 volts during this test period. Operational monitoring during real-time contacts will be used to check the converter output and an instrument shutdown procedure is issued if an 18-volt red limit occurs. This shut down procedure is the following:

- Issue the CINSTMODE\SAFE command.
- After 15 seconds, issue a CAPWROF command

During non-contact periods, the on-board TSM system is expected to shut down the instrument if a converter red limit occurs. While extensive simulator ground testing indicates that the monitoring and shutdown procedures should work, an on-orbit test of the shutdown procedures is not planned during this checkout period. Instead, during each real-time contact, the MOC operator is to check if the TSM system executed an instrument shutdown. If it did not and the converter output has exceeded the 18-volt limit, the operator is to execute an immediate instrument shutdown. Instructions for yellow high and low and red low limits will generally follow TSM actions. CERES on-site personnel will verify with the MOC appropriate actions.

4.0 Procedures

This section will provide the daily procedures and criteria for activating, operating, and monitoring the instrument. Unless specified otherwise, commands should be executed via the first real-time contact at the beginning of the diurnal day and at the orbital midnight, to the extent practical. Instrument commands for spacecraft maneuver events are described in Section 3.3.4.

4.1 Day 1 (DOY 287): Power-up and initialize the instrument.

Below are the commands and procedures for activating the instrument around midnight UT, DOY 287, during the real-time contact that satisfies the activation requirements discussed in Section 3.1. The procedures below follow the established normal power-up procedures and as agreed to in the Operations Agreement document. While the instrument remains in the Safe mode, the instrument will be allowed to warm up to nominal operating temperatures (which takes approximately 24 hours).

Note: the safing procedures specified in Section 3.3.4 are not to be followed. The instrument will already be in the Safe mode. But the azimuth is not to be rotated this day.

1. Verify that the TSM and DAA +15-volt housekeeping monitoring yellow and red limits are set to 15.7 volts and to 18.0 volt, respectively and that the TSM is not currently active.
2. CAPWRON (Applies operational power via the bus A side).

   - After the instrument is in the SAFE mode, verify the azimuth angle reads 5 degrees +/- 2.0 degrees. If it does not, and the DAA +15-volt has not exceeded the red limit, follow the azimuth 23 degree anomaly procedures and observe the azimuth angle after the power cycle.

   - Next, proceed with the following initialization steps. These steps are intended to load the memory patches listed in Section 4.1.1 and modify the default parameters listed in Section 4.1.1.4 of the Operations Agreement.
3. CINSTMODE\DIAG (Places the instrument in the Diagnostic Mode).

   - Verify that the instrument is in the Diagnostic Mode.
4. Load the six memory patches in the order given in the Operations Agreement.

   - Verify the DAP and ICP checksums have the following values after the final load:

     CDAPRAMCSUM = 29832

     CICPRAMCSUM = 11345
5. CAZPOS\CALANG\POS=180 (Modifies the solar cal angle to 180 degrees).

   - Verify the Solar Cal Angle CAZSOLCALPOS = 180.
6. CAZSCAN\ASYNC\RATE=913 (Modifies the Biaxial Scan Rate to 6 degrees per second).

   - Verify the Biaxial scan rate CAZASYNC = 913.
7. CINSTMODE\SAFE (Returns the instrument to the Safe mode).

   - Verify the instrument is in the Safe mode.
8. Activate the TSM system per CERES on-site personnel approval.

4.2 Day 2 (DOY 288): Command the instrument to the Standby mode and rotate the azimuth gimbal to 180 degrees.

If the instrument has not been shutdown due to a red limit, command the instrument to the Standby mode, followed by an azimuth rotation. Let the instrument remain in the standby mode/cross-track azimuth position for the remainder of the day.

During the first real time contact soon after the beginning of DOY 288 (and preferably around orbital midnight), execute the following commands:

1. CINSTMODE\STDBY (Places the instrument in the Standby mode)

   - Verify the instrument is in the Standby mode.

2. CAZBRAKE\REL (releases the azimuth brake released)

   - Verify that the azimuth is released.
   - Verify that the azimuth bearing temperatures are above 0 degrees.

3. CAZMODE\CT (Rotates the azimuth to the crosstrack position)

   - Verify the azimuth gimbal position is 180 degrees.

4.3 Day 3 (DOY 289): Command the instrument to begin elevation scanning operations.

If the instrument has not been shutdown due to a red limit, command the instrument to begin performing a normal-earth scan. Command execution should occur outside the Sun-avoidance zones (based on predicted Sun elevation angles). Let the instrument remain in this elevation scanning operation the remainder of the day.

1. Verify that the elevation bearing (motor bearing) is above 0 degrees C. Then execute the following command during the first real time contact soon after the beginning of DOY 289 (and preferably around orbital midnight).

2. CEVMODE\NORM (Places the elevation into the normal scan mode)

   - Verify the elevation scan mode shows normal.

4.4 Day 4 (DOY 290): Command the instrument to perform two internal calibrations.

If the instrument has not been shutdown due to a red limit and while the instrument continues to operate in the crosstrack, normal-earth scan configuration, perform two calibration sequences per the following steps. Furthermore, quick-look data files are to be generated that encompasses each internal calibration event.

At the soon after the beginning of DOY 290 and after the first sunset event, execute the following command:

1. CINSTMODE\ABRINTCAL (Performs an abbreviated internal calibration.)

   - Verify the mode sequence says abbreviated internal cal.

At the end of DOY 290 prior to the last sunset event, execute the following command:

2. CINSTMODE\INT (Performs a full internal calibration.)

   - Verify the mode sequence says internal cal.

4.5 Day 5 (DOY 291): Command the instrument to stow the elevation gimbal and begin performing an azimuth A-B asynchronous rotation operation.

If the instrument has not been shutdown due to a red limit, command the instrument to stow the elevation gimbal and begin performing an azimuth A-B asynchronous operation. The command to stow the elevation should be executed outside the Solar-avoidance zones (based on the predicted Sun elevation angles). Let the instrument remain in this operating configuration for the remainder of the day. The routine solar avoidance commands that normally occurs during an azimuth operation are to be disabled.

During the first real time contact soon after the beginning of DOY 291 (and preferably around orbital midnight), execute the following commands:

1. CEVMODE\STOW (Places the elevation into the stow mode.)

   - Verify the elevation scan mode shows stow. Then:

2. CAZPOS\POSA\POS=110 (Sets the defined A position.)
3. CAZPOS\POSB\POS=250 (Sets the defined B position.)
4. CAZMODE\ABASYNC (Rotates the azimuth asynchronously.)

   - Verify the azimuth gimbal is rotating between 110 and 250 degrees.

4.6 Day 6 (DOY 292): Command the instrument to begin elevation scanning operations while the azimuth is performing an A-B asynchronous operation. At the end of the day, command the instrument to the Safe mode and remove power.

If the instrument has not been shutdown due to a red limit, execute the following commands.

- Verify that the solar avoidance commands that are routinely part of a biaxial operation have been uploaded before elevation gimbal operations can commence.

During the first real time contact soon after the beginning of DOY 292 (and preferably around orbital midnight), execute the following command:

1. CEVMODE\NORM (Places the elevation into the normal scan mode).

   - Verify the elevation scan mode shows normal.

During the last real time contact for DOY 292, execute the following commands:

2. CEVMODE\STOW (Places the elevation into the stow mode.)

   - Verify the elevation scan mode shows stow.

3. CAZMODE\CT (Rotates the azimuth to the crosstrack position.)

   - Verify the azimuth gimbal position is 180 degrees.

4. CINSTMODE\SAFE (Place the instrument in the Safe mode.)

   - Wait until the azimuth brake is applied and the elevation head is in the stow position.

5. CAPWROF (Removes operational power from side A).

   - Verify that all survival heaters are operating.

5.0 Data Monitoring and Analysis

This section will describe some of data evaluation tasks to be performed to support these tests.

5.1 Operational Monitoring

Primary operational monitoring of the instrument during this test period will be performed at the TRMM MOC. MOC monitoring will focus on verifying the execution of the test plan and watching the DAA +15-volt parameter and the TSM for red limit conditions during real-time contacts.

While the CERES personnel are on-site during the initial checkout period, the following additional DAA +15-volt monitoring is requested. Similar monitoring by LaRC personnel will be performed using the snap files throughout the test period.

1. During real-time passes, graphically plot the DAA +15V values.

   - This will be used to assess the likelihood of the DC converter output reaching the red limit before the end of the real-time pass. An instrument shutdown is to be issured if a red limit occurs, instead of letting the TSM system perform the shutdown.

2. After real-time passes, graphically plot the DAA +15V and the MAM Total Assembly Temperature from the play-back data.

   - Determine a +15-volt trend regression slope. Hopefully, the rate should be around 0.1 to 0.15 volts per orbit for the first half of the day. If the rate is higher than this, then the DC output may reach the TSM limit. Be prepared to shutdown the instrument during the next real-time pass in case the TSM system did not. (Expect WN bridge balance DAC resets during the first hour after initial power, which may fool the TSM system.)
   - Compare any voltage increases to the orbital variations in the MAM temperature.

3. As the snap file, spacecraft, and predictive solar data become available, the following plots would be helpful:

   - The spacecraft bus voltage, solar elevation angle, and DAA +15-volt for orbital correlations.
   - The DAA +15-volt and the main cover temperature for diurnal variations. (The MAM temperatures are not in the housekeeping data.)

5.2 Science Data Monitoring

With the receipt of daily quick-look data files that are planned to be processed first thing in the morning at the LaRC DAAC, the following plots are to be generated by SAIC analysts for discussions during the telecons and tiger team meetings.

1. A scatter diagram of the DAA +15-volt versus the MAM TOT Assy Temperature, with a linear regression line for the cumulative quick-look data period.
2. Line plots of the DAA +15-volt and MAM TOT Assy Temperature versus time. A linear regression line for the first 3-4 orbits of the 15-volt should be made and the rate of change in volts-per-orbit calculated.
3. IDL (view_hdf) plots of all DAA related voltage parameters to identify variations, if any.
4. Line plots of solar beta angles and solar elevation angles.

When the level-0 data are processed, these same plots are to be generated. In addition, the statistical trending plots of the DAA related voltages and temperatures are to be updated. Spacecraft non-essentual bus voltage should be plotted against the DAA +15-volt and the solar elevation angles for correlation analysis. The internal calibration data will be investigated to identify any possible radiometric changes.

6.0 Logistics

The following specific tasks and responsibilities for implementing this plan have been identified.

Operations at GSFC:
Coordinate instrument test operations and monitor housekeeping telemetry.

Operations at LARC:
Verify instrument operations.
Monitor and evaluate housekeeping and science telemetry.
Process and evaluate science telemetry.
Coordinate timely science telemetry processing with the DAAC.
Review the planning aids to identify commanding periods.

Appendix A: Anomaly Background Information

Since launch, the DAA +15-volt measurements have remained at a nominal value of about 14.89 volts until July 31, 1998. Beginning on July 31, the DAA +15-volt measurement values began to show variations and continued to rise during the entire month of August with the largest increases occurring on days when the instrument operated in the biaxial scan mode. This increase was noted when an operational yellow limit of 15.7 volts was reached on August 18.

Upon investigation, data analysts looked into variations in temperatures since launch as well as the variations in values of the DAA +15-volt measurement during the month of August, 1998. Analyses of these variations to determine how they are affected by changes in solar beta angle and in-orbit changes in solar heating conditions were performed. Orbit-to-orbit temperature variations have been observed since launch, but their causes have not been explained. Therefore, since most temperature variations result from solar heating, any instrument reactivation plans should take into account the various on-orbit factors that effect changes in solar heating.

Furthermore, the fluctuations in the DAA +15-volt measurements during August have shown a close correlation with the normal variations in the MAM Assembly temperature. (MAM Assembly temperatures are the closest temperature sensors to the DC converter, located in the DCA box.) However, some of the voltage value increases occurred at MAM temperature values that were not increasing, suggesting another degradation mechanism. By correlating only the voltage values that vary as a function of temperature variations, a straight line regression equation can be derived that indicates a voltage-to-temperature sensitivity. Using data from 31 August, this equation is:

+15-volt value = (0.6654 * MAM Assy Temperature value) + 3.5262

Furthermore, using this correlation of MAM Assembly temperatures with beta angle values from January through August, 1998, and excluding temperatures during solar calibration events, the following results are obtained:

Max value observed (including biaxial operation) = 22.25 deg
Max value observed (cross-track scan operation) = 21.50 deg
Max values for more than half the time = 21.75 deg

Using these values in the regression equation above, the following DAA +15-volt measurement values can be predicted (and were used for setting the testing red limit value):

Mode	Max Temp	Max Predicted Voltage
Biaxial	22.20 deg	18.33 volts
Biaxial scan	21.75 deg	17.50 volts
half time	21.00 deg	18.00 volts

If it turns out that this correlation is a reasonable predictor of future changes in values of the DAA +15-volt measurement, future operation of the instrument may have to be restricted, or the instrument may have to operate at the higher-than-normal values as shown above.

Additional analysis of spacecraft housekeeping data has also revealed a correlation between the DAA +15-volt output to variations in the spacecraft bus voltage. In particular, it has been noted that when the spacecraft enters a sun-rise period, there is brief “surge” lasting approximately 20 seconds. This corresponded to a solar elevation angle of about -18 degrees (based on the CERES planning aid data). This three volt “surge” results in an identifiable and corresponding spike on the DAA +15-volt converter output. This spike suggests that the converter is also sensitive to line regulation degradation effects as well as temperature effects.