



CloudSat Spacecraft Status

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CloudSat Power System Performance

On May 7, 2018 CloudSat returned to DO-Op with RW#4 powered during umbra

- The CS spacecraft is fully capable of continuing to support DO-Op operations.
- Effective workarounds have been implemented for recent anomalies.
- As predicted, powering RW#4 increased umbra load by $\sim 0.3A$ and PEC increased load by $\sim 0.2A$
 - The battery is supporting the addition of RW#4 load and PEC load with sufficient voltage margin, given the current CPR stability-heater on-time
 - Minimum battery voltages are stable and $>29.0V$ Last year at this time, the minimum battery voltage was $\sim 29.5V$
- We have a weak cell(s). We have identified changes to operations to improve battery performance and reduce battery loads (**Slide #3**). Based on current and past battery performance, we have high confidence that the weak cell will not fully discharge and reverse during the next two years, provided that we implement options to reduce umbra loads and improve battery charge management
 - If the weak cell completely discharges, it will result in an instant decrease of voltage by $\sim 1.3V$ and a possible UV2 (not a UV3)

Seasonal Increase

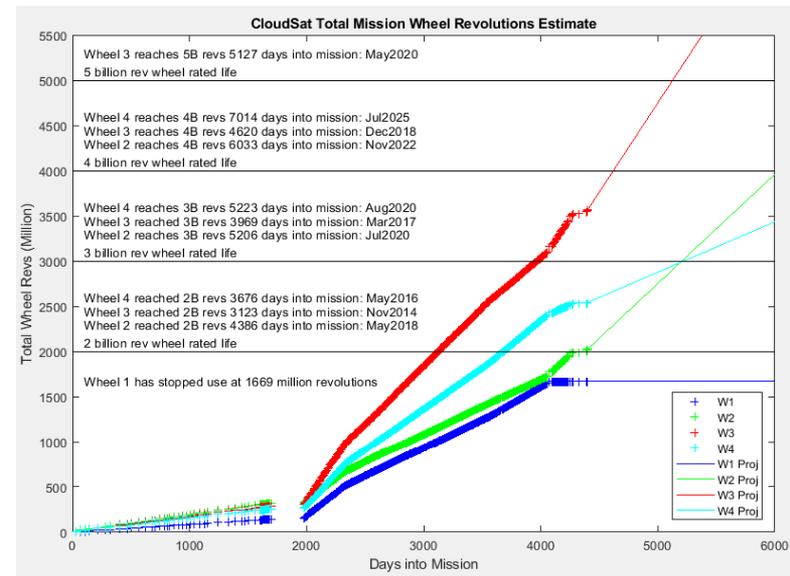
- The seasonal peak loads are CPR Stability-Heater driven and peak in early August. Total duration is approx. 2 months.

Changes to operations to improve battery performance/reduce battery loads

- Go to Standby for ~mid-July through ~mid-September (2 months)
 - Temporary solution for highest load period
- Increased solar heating on CPR stability heater (under study)
 - Increases solar heating on ‘cold’ zone of instrument to reduce stability heater on-time, by completing turns about the instrument boresight during the sun period
- Switch SCC (procedures are written)
 - Will remove PEC load of ~0.2A
- Switch of EIK (procedures are written)
 - Will likely reduce stability heater on-time per current on-orbit telemetry and thermal modeling completed
- “MMKI” and “Step VT” charge-management improvements have shown promise to reduce peak CB.

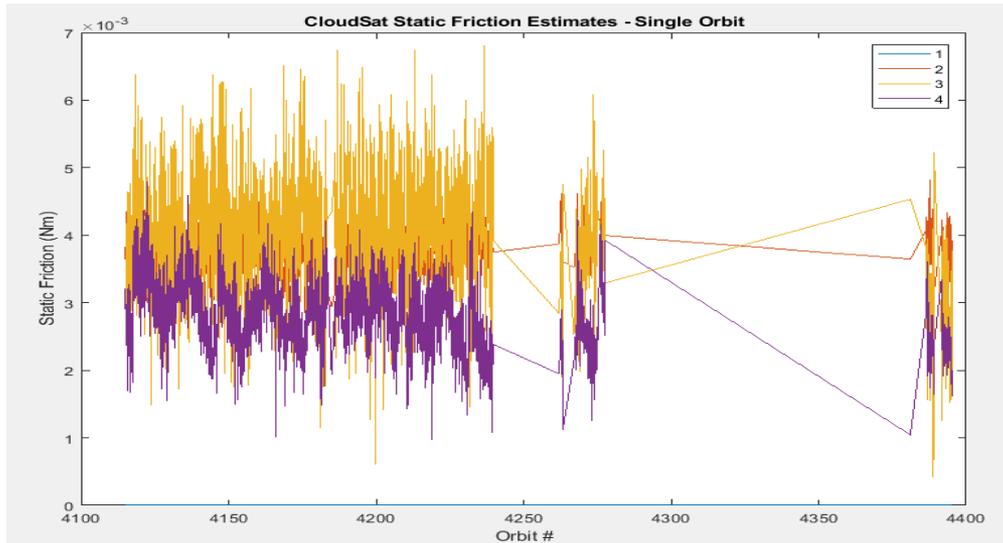
CloudSat Reaction Wheels

- Wheel 1 failure root-cause not clearly understood.
- Wheel 4 power relay failure not understood.
 - Wheel #4 relay is now always on.
- Wheel Life
 - Flight experience shows that 3 in the family of these wheels has lasted for 6 B revs or more.



- ❖ **Wheel-1** failed on June 2, 2017 after 1.7B revs
- ❖ **Wheel-3** will reach 4B revs in May 2020

Flight Telemetry Indicates Nominal Wheel Performance



- Wheel speed and commanded torque data indicates that the wheels' friction terms have remained in family
- No friction anomalies observed on remaining wheels 2,3,4



Projected Life of Other SC Components

Component	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Receiver-1 ^a	Red											
Receiver-2	Green											
CDU-1 ^b	Yellow											
CDU-2	Green											
SCC-1	Green											
SCC-2 ^e	Yellow											
PEC-1 ^d	Green											
PEC-2 ^e	Yellow											
DTU-1	Green											
DTU-2 ^e	Yellow											
SEP-1	Green											
SEP-2 ^e	Yellow											
GPS Rcvr-1	Green											
GPS Rcvr-2 ^e	Yellow											
Star Tracker-1	Green											
Star Tracker-2	Green											
Torque Rods	Green											
Magnetometers	Green											
Sun Sensors	Green											
PCU-1	Green											
PCU-2	Green											
NBTX-1	Green											
NBTX-2	Green											
WBTX-1	Green											
WBTX-2 ^e	Yellow											
SSR-1	Green											
SSR-2 ^e	Yellow											
Thermal	Green											
Cat-Bed Htrs ^c	Yellow											

Redundancy: Redundancy is still available for most components.

- a. Receiver-1 “locked-up” in 2011 during UV3 event. Voltage dropped below 24V and then recovered too slowly. Probably recoverable but operationally risky.
- b. CDU-1 can’t be used for real-time commanding since RCVR-1 is locked-up.
- c. One of two redundant heaters on the Cat-Bed’s of all thrusters have failed or the clamp band has come loose. No impact on thruster performance.
- d. Heater on Oven Controlled Crystal Oscillator in PEC1 failed in 2017. Clock stability is still meeting requirements.
- e. = Redundant unit.

Other components:

- Fuel: At the rate of usage while formation flying in the A-Train, fuel would last beyond 2024.
- Rated life of slip rings in SA drive is 70k revs. Reaches rated life in June 2019, but slip rings typically go well beyond their rated life. Have seen no failures on-orbit (including Quikscat).
- Rated life of relays is 200k cycles. Reaches rated life in Aug 2037. Power relay for Wheel 4 failed to respond twice. Wheel 4 no longer power cycled.

CloudSat Has Demonstrated Precision Formation Flying Burns With Three Wheels

3-Wheel Burn Performance Data meets requirements.

- August and September burns were done on 3 wheels.

Date	Description	Wheels Used	Desired Burn (cm/s)	Burn Accuracy (cm/s)	Error (%)
12/14/2016	Orbit Raise	1, 2, 3 & 4	6.74	6.71	0.45
3/22/2017	Orbit Lower	1, 2, 3 & 4	-1.98	-2.04	-3.03
4/14/2017	Orbit Raise	1, 2, 3 & 4	5.77	5.79	0.35
5/25/2017	Orbit Lower	1, 2, 3 & 4	-1.96	-1.98	
8/24/2017	Orbit Raise	2, 3 and 4	8.71	8.68	-0.34
9/20/2017	Orbit Raise	2, 3 and 4	7.29	7.28	-0.14