

CloudSat Safety Operations at Vandenberg AFB

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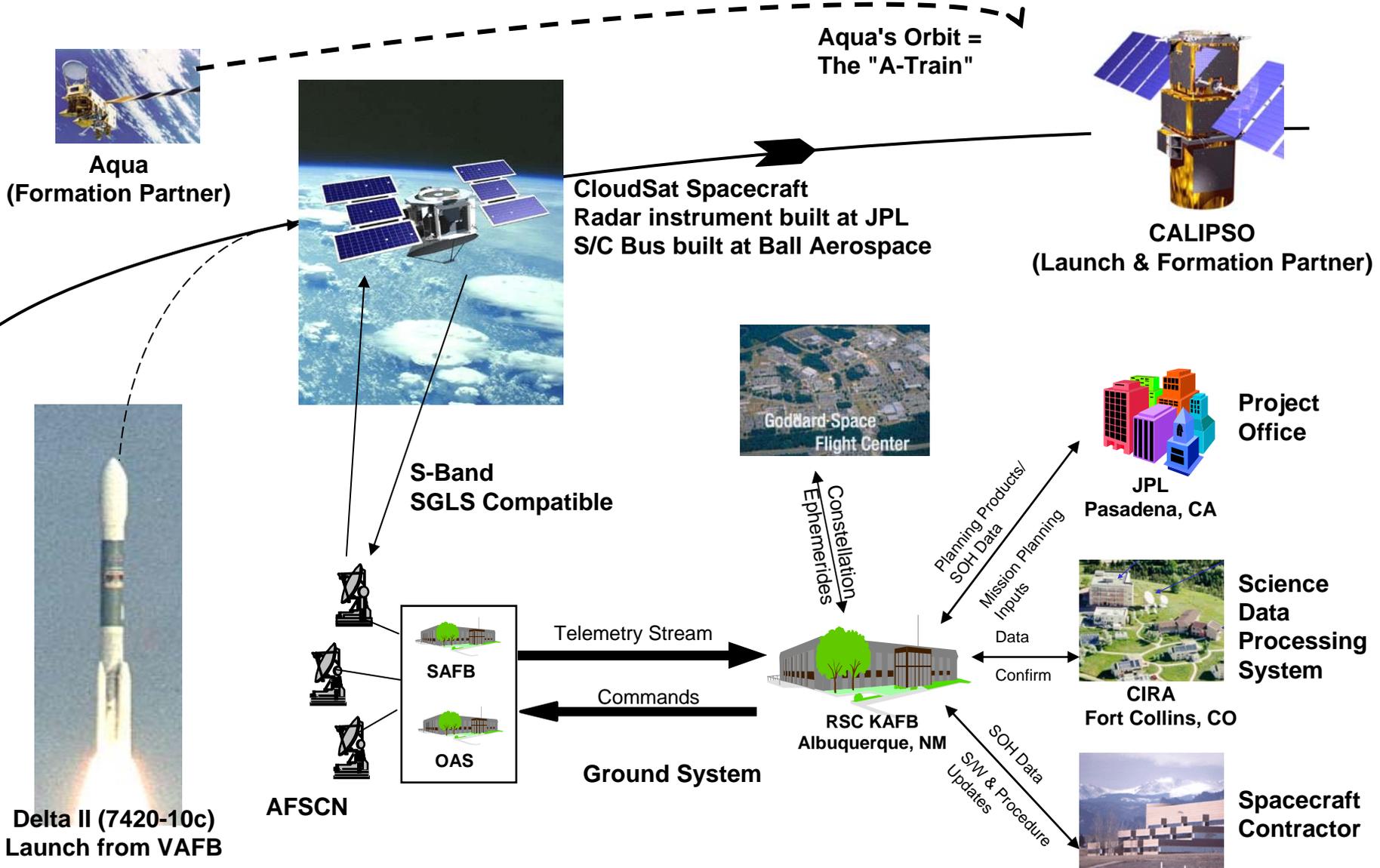


Topics

- **CloudSat Project Overview**
- **Vandenberg Ground Operations**
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- **System Safety Management**
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- **CALIPSO Supplemental Safeguards**
- **Joint System Safety Operations**
- **Extended Stand-down**
- **Launch Delay Safety Concerns**
- **Lessons Learned**



CloudSat Project Overview

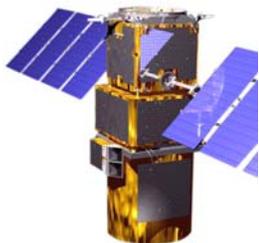




Vandenberg Ground Operations



CloudSat arrives from Boulder - May 3, 2005



CALIPSO arrives from France - May 13, 2005

QuickTime™ and a TIFF (Uncompressed) decompressor are needed to see this picture.

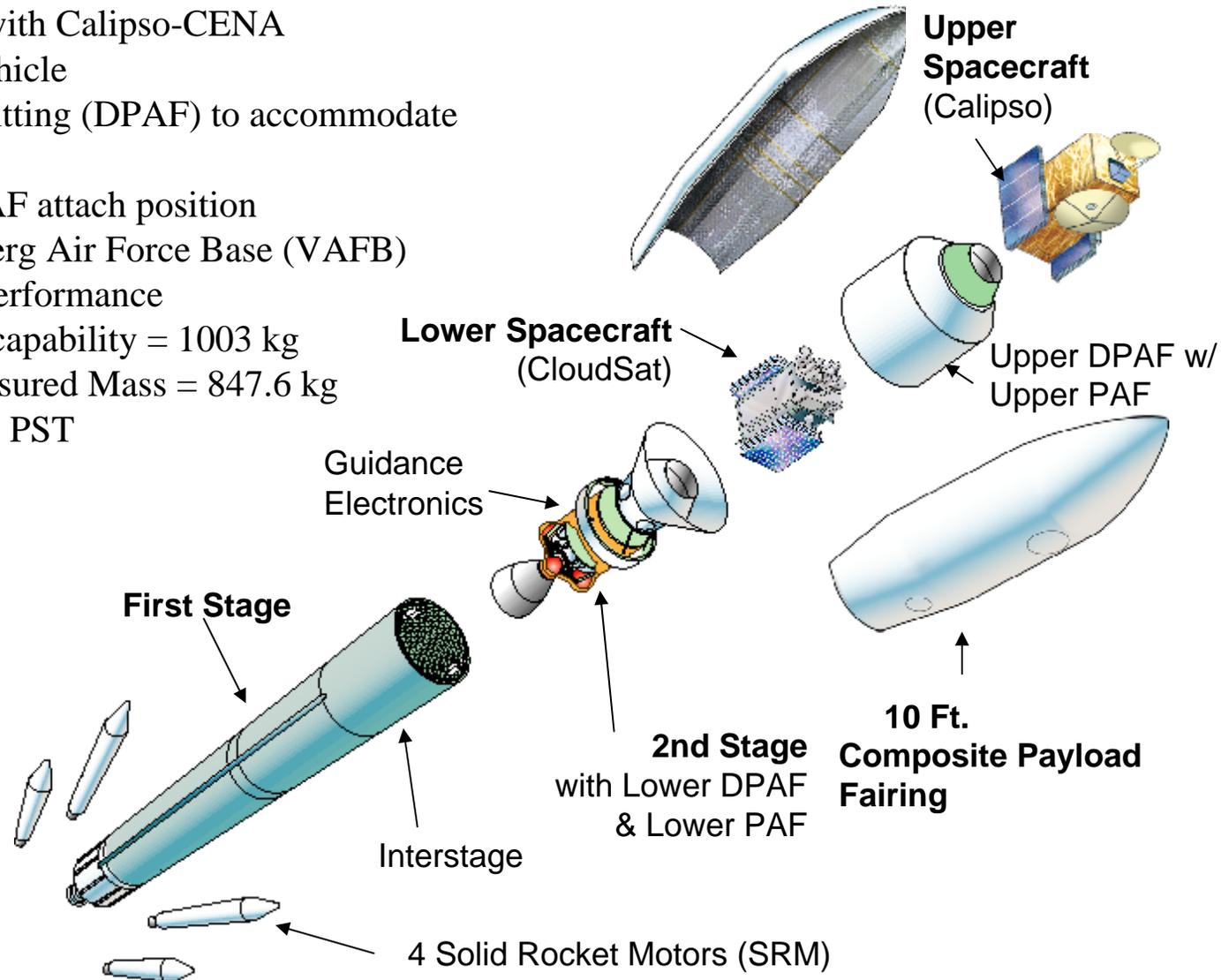


Processing at Astrotech, Vandenberg AFB



Launch at SLC-2

- Co-manifested launch with Calipso-CENA
- Delta II (7420-10C) vehicle
- Dual Payload Attach Fitting (DPAF) to accommodate two spacecraft
- CloudSat in lower DPAF attach position
- Launch from Vandenberg Air Force Base (VAFB)
- Launch vehicle mass performance
 - Mass to orbit capability = 1003 kg
 - CloudSat Measured Mass = 847.6 kg
- Launch time: 03:02:17 PST





JPL

The A- Train



CALIPSO

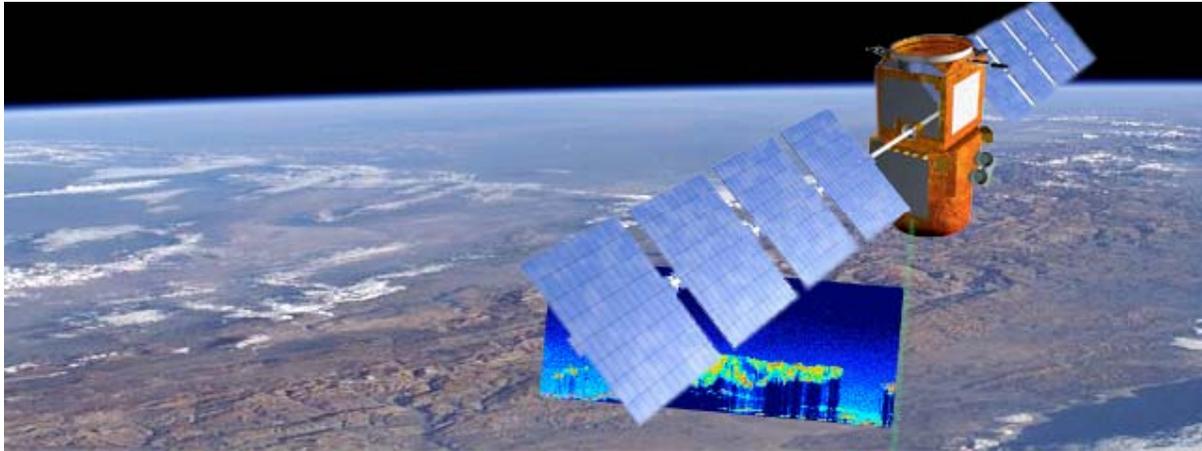
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The Afternoon Constellation is comprised of Aqua, as the leading satellite, followed by CALIPSO, CloudSat, Parasol, and Aura.

All are in a sun- synchronous orbit at 705 km and ≈13:30 hours local time.

- CloudSat/CALIPSO dual manifest resulted in extensive operational and hazards communications coordination between NASA JPL, KSC, LaRC, GSFC, Range Safety, CNES (French Space Agency), & Boeing
- Two spacecraft with different operational and test requirements
 - CloudSat - 94Ghz Radar instrument
 - CALIPSO - LIDAR (Laser) instrument
- Processing initially started in separate, adjoining high bays
- Post fueling, both spacecraft resided in the same high bay
- Once both spacecraft were co-located in the same bay, and mated, they were treated as a single spacecraft with respect to safety system implementations





- **CALIPSO - Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation**
- **Joint NASA and CNES Spacecraft Mission**
 - Instrument built by Ball Aerospace under contract to GSFC
 - S/C bus built by Alcatel under contract to CNES
- **NASA provided Range Safety interface, System Safety oversight**
 - Flagged propulsion system design as not meeting Range Safety requirements
 - Prop system was designed with AN threaded fittings, not a welded system
 - Single fault tolerant to inadvertent thruster leakage
 - Coordinated hazards assessment, NASA waiver, and enhanced mitigation measures

- **Enhanced Hydrazine Monitoring**
 - **Primary monitoring resides within the facility**
 - **Secondary monitoring provided by NASA**
 - Zelwegger portable gas monitoring system
 - Sensitive to 1 ppb
 - To be placed as close as practical to the fueled S/C
 - **Enhanced Hydrazine Leak Checks**
 - Two person entry into the High Bay, at the beginning of each 8 hour shift
 - Use of Interscan 4000 handheld leak monitor sensitive to 0.1 ppm for hydrazine
 - **Enhanced Hydrazine Training**
 - PPE and SLC-2 evacuation exercises
 - Hydrazine familiarization for all operations personnel
 - Basic hydrazine hazards
 - Leak Detector Sensors
 - Alarm Systems
 - Evacuation Procedures
 - Exposure Symptoms
 - **Single Safety Lead - Ground Operations Safety Program Lead (GOSPL)**
 - Overall NASA responsibility for CALIPSO/CloudSat post fueling
 - Ensures that all supplemental safeguards are implemented
 - All project safety organizations report to the GOSPL





Joint System Safety Operations



- CloudSat/CALIPSO fueled - Aug '05**
- CloudSat DPAF encapsulation - Aug '05**
- CALIPSO stacked upper DPAF - Sept '05**



- **Continuous hydrazine leak detection since fueling due to CALIPSO threaded fittings concern - No leaks detected**
- **KSC GOSPL maintained constant presence at VAFB - coordinated all CloudSat/CALIPSO hazardous operations**
- **Changing launch date resulted in potential for concurrent hazardous operations**
- **All NASA centers and CNES worked with KSC and Range Safety to coordinate concurrent hazardous operations during the flight preparations**
- **Range Safety allowed concurrent hazardous operations to occur with the following constraints:**
 - Continuous KSC GOSPL support maintained
 - Consider the two S/C as one hazardous system
 - Maintain a 1 meter clear area around hazard zones as specified in haz-op procedures.



- **1st launch attempt planned for Oct. 2005**
 - Delayed due to USAF high priority launches
- **2nd launch attempt planned for Nov. 2005**
 - Delayed due to Boeing labor dispute (beginning Nov. 3, 2005)
- **3rd launch attempt planned for Dec. 2005**
 - Delayed due to continuing labor dispute and Range shutdown for maintenance
- **4th launch attempt planned for Feb. 2006**
 - Delayed due to continuing labor dispute (settled March 3, 2006)
 - Concerns raised over limited life components and S/C command software
- **5th launch attempt planned for April 2006**
 - Arrived at SLC-2 April 8
 - Launched successfully on April 28



- **Fueling and pressurization completed for both S/C Aug. 2005**
- **No pressure or temperature monitoring after fueling planned for CloudSat**
 - Electrical GSE specific to CloudSat was relocated to the launch complex in Sept. 2005 in preparation for launch
 - No plan to return EGSE to Astrotech as delays continued
 - Resulting concern raised over hydrazine pressure and temperature post fueling
 - Limited data set available post fueling
 - JPL conducted an analysis on the post fueling data set
 - Conclusion reached that potential for increasing pressure and temperature risk was low
 - Range Safety accepted JPL's conclusions
 - Plan to continue as configured was based in part on the continuous secondary hydrazine monitoring and enhanced training due to the CALIPSO waiver

- **GSE proof tests and calibration dates expired during the stand-down.**
 - MGSE and EGSE proof/calibrations required recertification during the time of extended stand-down
 - Required GSE to be returned to Ball Aerospace, Boulder, Colo. for recertifications
 - Could have resulted in loss of use for potential contingency
 - Critical equipment required for S/C lifting and emergency fuel off-loading was maintained at Vandenberg, in climate controlled facilities, dedicated to our project
 - Range Safety accepted out-of-date certs for critical equipment with the understanding that they were dedicated
 - All other GSE returned to Vandenberg with-in 30 days



- **Vandenberg Tracking Station (VTS) range radar and tracking systems in periodic use - supporting USAF launch and space operations**
 - Periodic CloudSat receiver lock-ups occurred resulting in the inability to verify S/C system status
 - Could have resulted in additional launch delays if occurrence coincided with a launch attempt
 - NASA and Project Mgmt worked with VTS to establish sector blanking where possible, and advanced notifications of pending VTS operations
 - Communication between NASA and VTS helped assure successful launch



- **The extended stand-down raised several safety concerns complicated by:**
 - Two fueled and pressurized S/C
 - Additional safety mitigations resulting from the CALIPSO prop system design waiver
- **CloudSat EGSE redeployed to SLC-2, no post fueling temperature and pressure monitoring capability**
- **Proposed re-verification of S/C powered systems was severely restricted due to our fueled condition**
- **Limited life components can cause unexpected change-outs, retest, and servicing which would result in removing inhibits from a fueled propellant system**
- **Expiring GSE certifications result in need to re-certify, potentially making this equipment unavailable for contingency operations**

Be prepared for the unexpected to happen