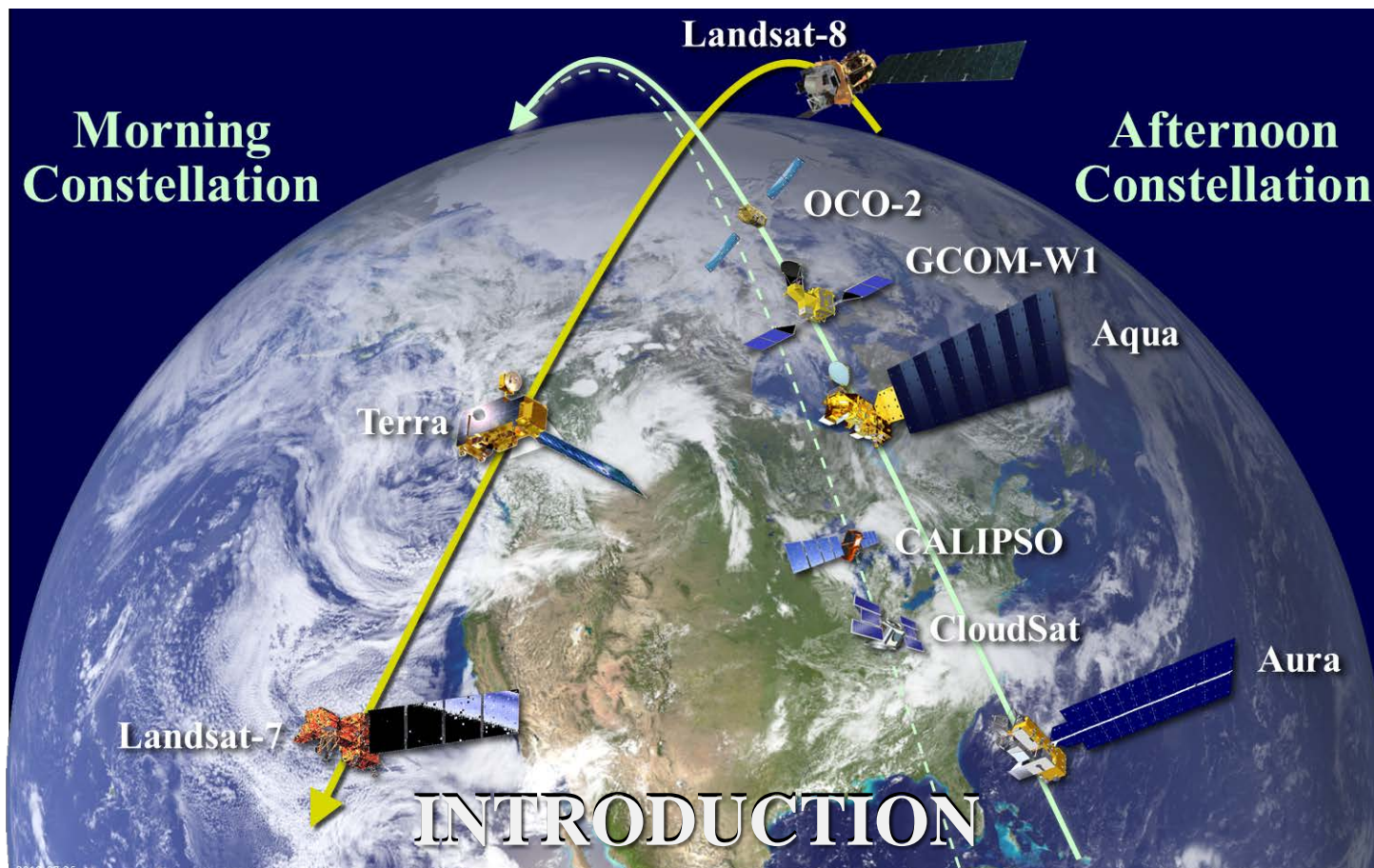


International Earth Science Constellation (ESC)



Michael J. Machado

ESC Mission Operations Coordination Manager

Mission Validation and Operations Branch – Code 584

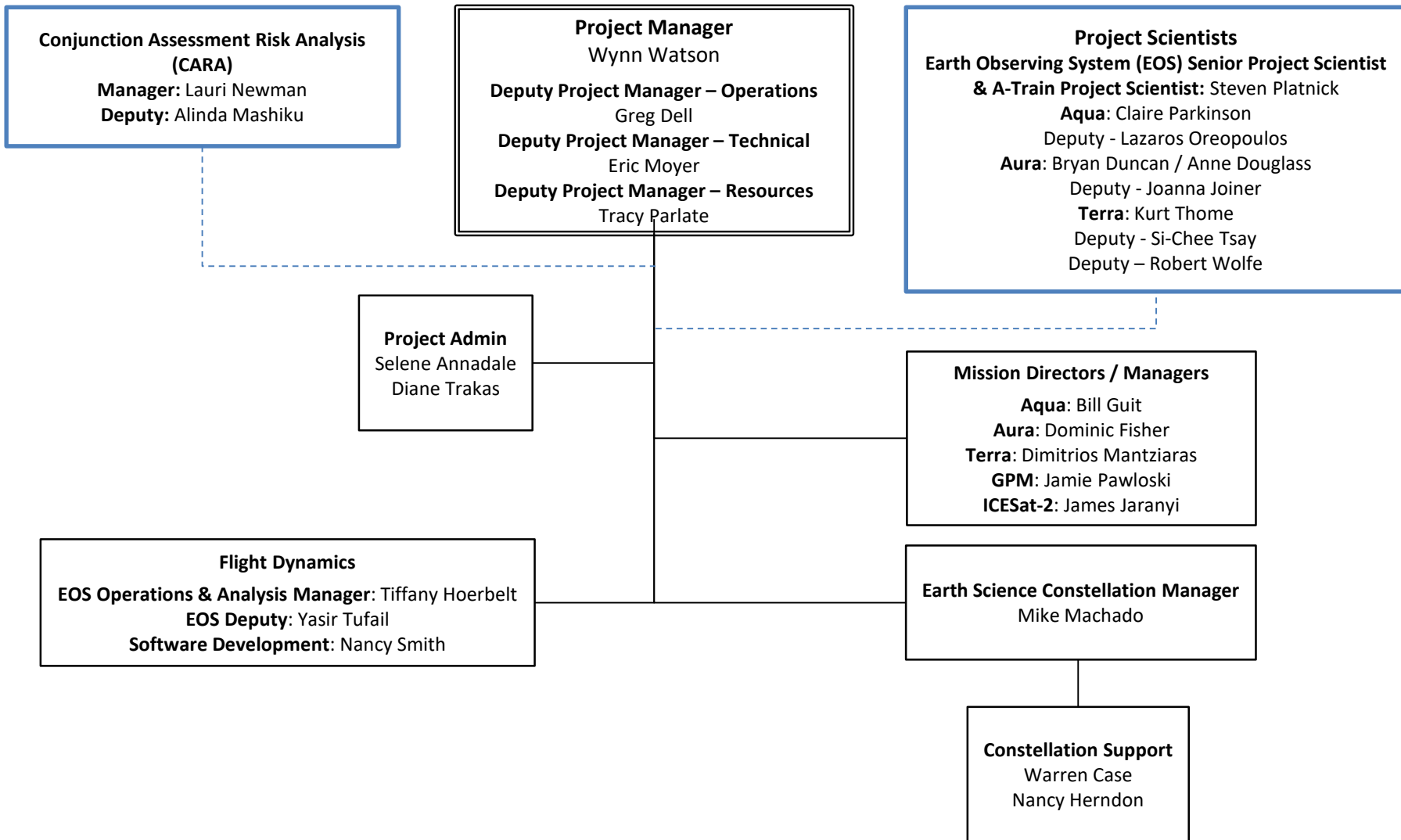
Earth Science Mission Operations (ESMO) Project – Code 428

NASA/Goddard Space Flight Center

Welcome

- *Welcome to all the members of the Mission Operations Working Group (MOWG) of the International Earth Observing Morning and Afternoon Constellations (A-Train & C-Train)!*
- *Special thanks to Northrop Grumman Innovation Systems (NGIS) for hosting!*
- *Welcome to our guests, first time attendees, and telecon participants.*
- *THANK YOU as always for your support!*

Earth Science Mission Operations (ESMO)



MOWG Charter

The Constellation mission teams enable nearly simultaneous science observations by coordinating their operations and cooperating with each other to ensure the safety of the constellations.

Constellation History

- **Anniversaries:**
 - Landsat-7 (April 1999) – *20th anniversary!*
 - Terra (December 1999) – *20th anniversary!*
 - Aura (July 2004) – *15th anniversary!*
 - OCO-2 (July 2014) – *5th anniversary!*
- **Morning Constellation:** Officially began with Landsat-7 (April 1999) and Terra (December 1999), followed by joint EO-1/SAC-C launch (November 2000) and Landsat-8 (February 2013)
- **Afternoon Constellation (A-Train):** Began with the Aqua (May 2002) and Aura (July 2004), then PARASOL (December 2004), and joint CALIPSO/CloudSat launch (April 2006)
- **A-Train Mission Operations Working Group (MOWG):** Exploratory discussions between LaRC (John Stadler) and GSFC (Angie Kelly, Bill Guit and Lauri Newman) in 2002. Officially met for the first time in March 2003
- **Later ESC missions followed:**
 - **OCO (2010) and Glory (2011)** launches failed
 - **GCOM-W1** (May 2012)
 - **Landsat 8** (February 2013)
 - **OCO-2** (July 2014)
- **Formation of the C-Train:**
 - **CloudSat** exited A-Train on February 22, 2018
 - **CALIPSO** exited A-Train in mid-September 2018
 - **C-Train** operational orbit configuration achieved on November 1, 2018

Significant Meeting Topics

- **NASA Headquarters Perspective, including Senior Review**
- **Current state of the missions**
 - Results of the A-Train's Fall 2019 inclination adjust maneuvers (IAMs)
 - Landsat 7 anniversary / Restore-L update / Landsat 9 development status
 - C-Train status, ESA EO mission overview and status
- **Evolution of the Constellation**
 - Landsat-9 I&T, ascent review, and preparations for launch
- **Operations Coordination Plan update**
- **Conjunction Assessment (CA) Topics**
 - CARA system updates and CA statistics
 - Space Fence performance during testing and early operations
 - CARA/AFRL partnership to obtain commercial tracking data for CA
 - Value of risk mitigation, Part 2
 - ESMO Devolution status
 - CARMA update
 - Tool Certification and Special Case Flags

State of the Constellations

• Morning Constellation

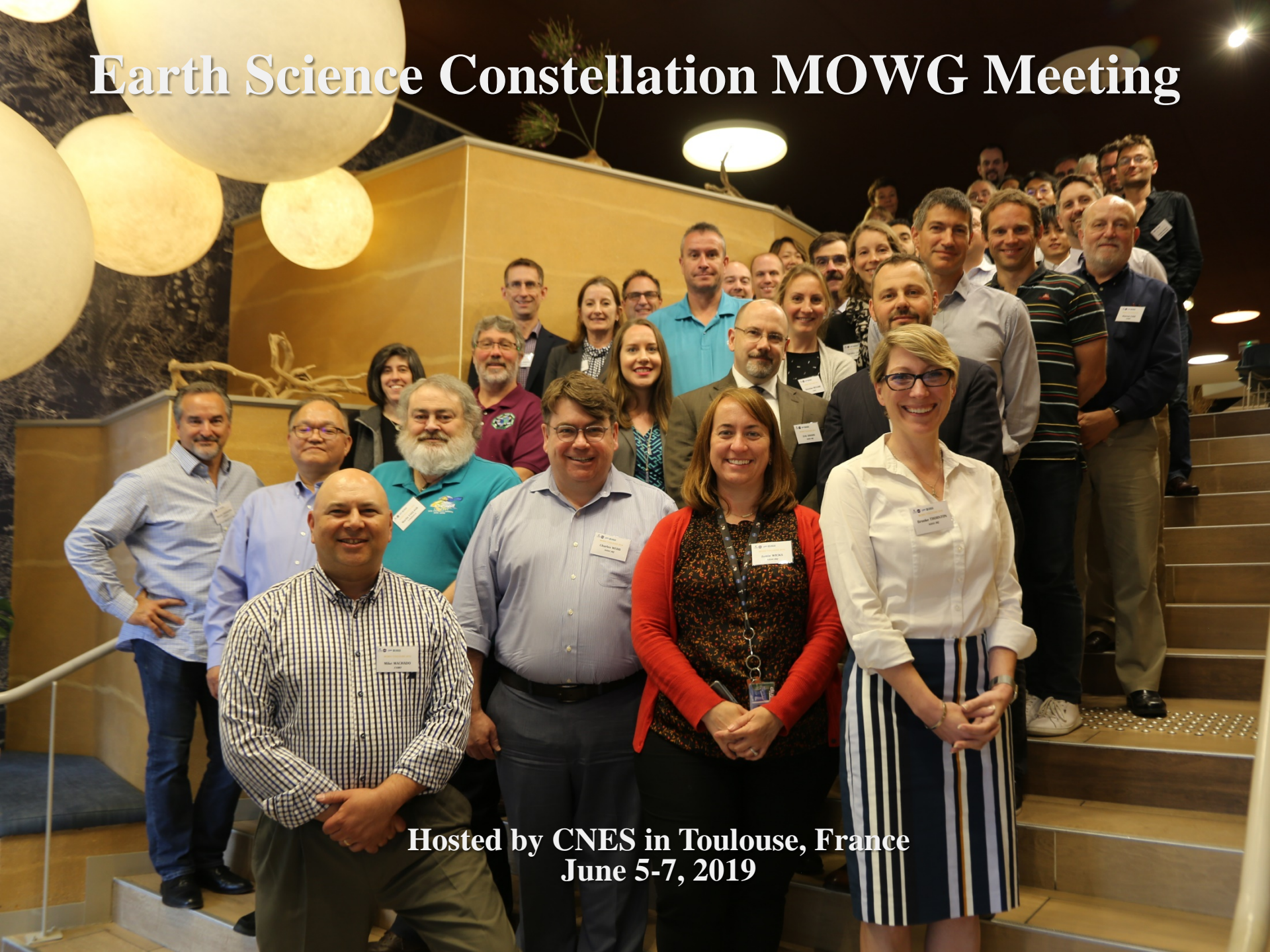
- Landsat 7, Landsat 8 and Terra are performing nominally.
- SAC-C stopped operations in August 2013
- EO-1 was decommissioned and passivated on March 30, 2017
- Landsat 9 progressing toward launch

• Afternoon Constellation (A-Train & C-Train)

- Aqua, Aura, GCOM-W1, and OCO-2 are performing nominally
- PARASOL exited the A-Train in 2013
- CloudSat & CALIPSO just passed one year of operations in the C-Train (formed November 1, 2018) and continue to be Constellation MOWG family!

*Constellations are operating successfully
and producing valuable science data
Excellent cooperation! Still evolving and learning!*

Earth Science Constellation MOWG Meeting



Hosted by CNES in Toulouse, France
June 5-7, 2019

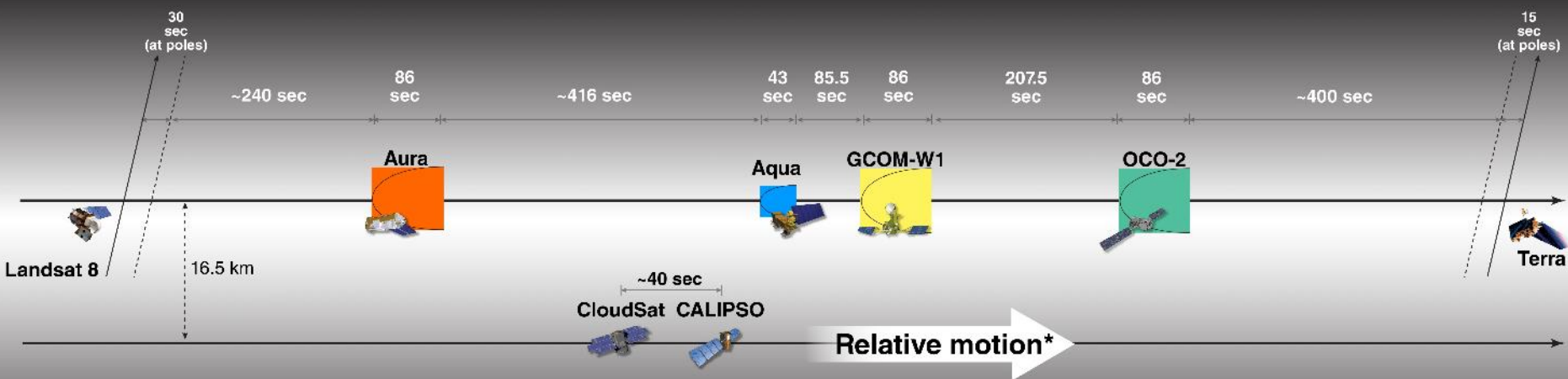
Since the last meeting . . .

- The A-Train conducted its Fall 2019 Inclination Adjust Maneuver (IAM) campaign on October 2-3. All maneuvers were successfully executed.
- CCS Release 2019.2 deployed to operations in October 15, 2019
 - **Future CCS releases will focus on maintenance aspect**
 - **Are there any impacts from the reduced CCS support?**
- We continue to monitor TanSat crossings with Constellation missions
- Constellation Change Request #19 documenting GCOM-W1 new phasing with Aqua was approved and distributed on September 27.
- Revised A-Train / C-Train graphics produced by Steve Platnick, A-Train Project Scientist were made available (see next 2 slides)

Updated A-Train + C-Train Updated Graphics (1 of 2)
 (Reflects GCOM-W1's new position)

Credit: Steve Platnick, A-Train Project Scientist

Location: https://atrain.nasa.gov/control_boxes.php

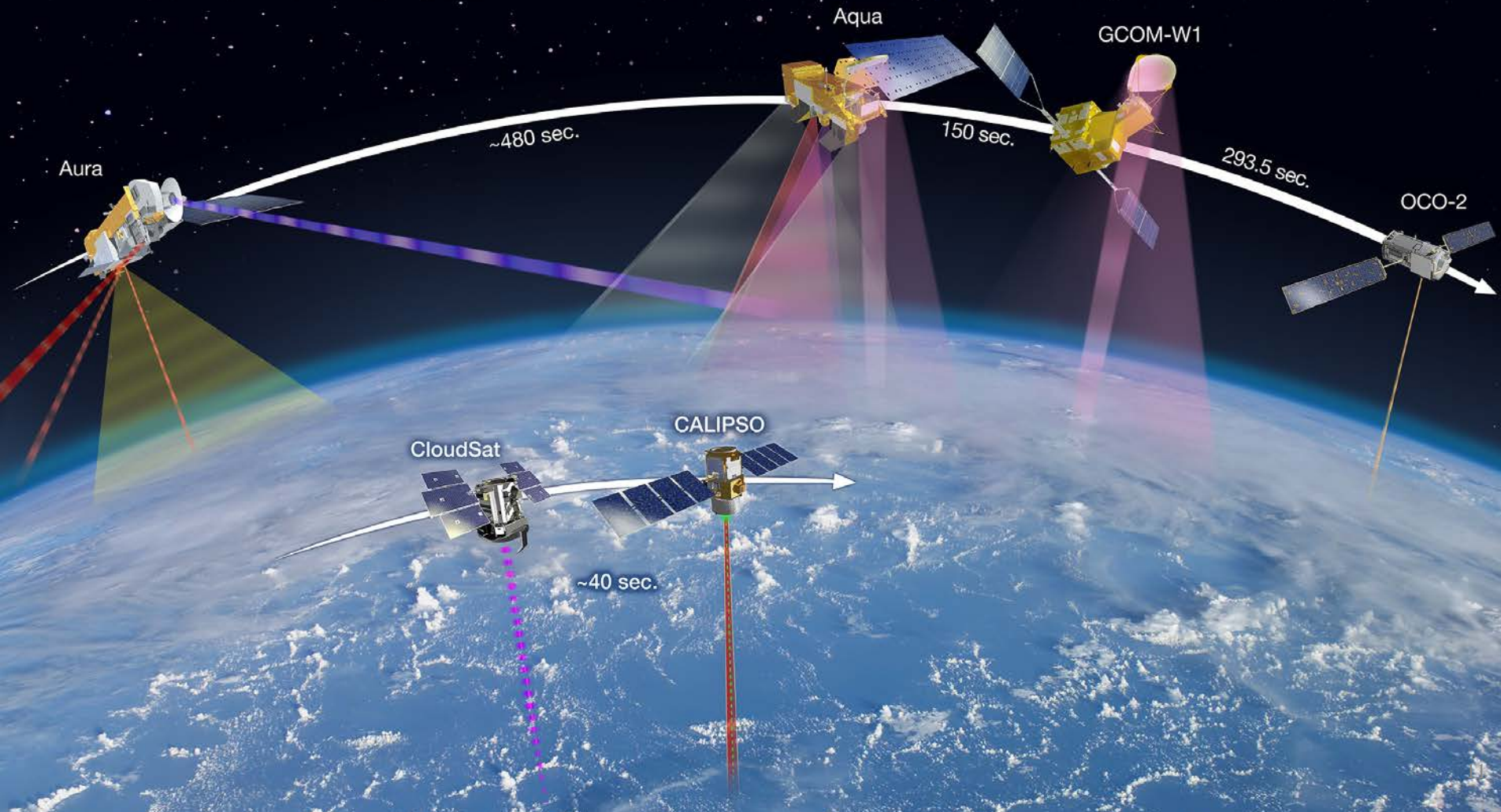


*CALIPSO and CloudSat pass underneath the A-Train every ~20 days

Updated A-Train + C-Train Updated Graphics (2 of 2)
(Reflects GCOM-W1's new position)

Credit: Steve Platnick, A-Train Project Scientist

Location: <https://atrain.nasa.gov/intro.php>



Future TanSat crossings with Aqua

Continue to monitor TanSat neighbor activity for close approaches

| Plus-Early | Mean-Nom | Minus-Late |
|-------------|-------------|-------------|
| Jun 13 2020 | Apr 26 2020 | Apr 15 2020 |
| May 07 2022 | Jan 21 2021 | Dec 25 2020 |
| Sep 25 2022 | Feb 24 2022 | Oct 30 2021 |

NOTES:

- “Plus-Early”, “Mean-Nominal”, and “Minus-Late” dates were generated based on the range of Schatten solar flux predictions
- These long-term crossing date predictions are for Aqua only. OCO-2 and GCOM-W1 crossing dates will be earlier. Aura crossing dates will be later.

Reminder . . .

- Constellation Visualization Tool (CVT) Software Release Request Authorization approved! Available via NASA software catalog:

<https://software.nasa.gov/> (and search for 'CVT')

Constellation Visualization Tool



Category: Vehicle Management
(Space/Air/Ground)

Release Type: U.S. and Foreign Release
Center: GSFC

Reference Number: GSC-17917-1

Release Date: 05/15/2018

[> View this software](#)



Software Usage Agreement Questionnaire

This questionnaire is not a software usage agreement (SUA). An SUA is the legal document needed to transfer software. This form collects the information needed to prepare an SUA between your company/you and NASA.

Software Information:

Case Number:

GSC-17917-1

Software Title Requested:

Constellation Visualization Tool

Will this software be used for U.S. Government Contract, Grant, Cooperative Agreement, or Space Act Agreement?

Yes No

I do hereby state that I have the company/university authority to sign a Software Usage Agreement (SUA) to legally bind all users regarding the transfer of this software. Typically, that person would be an officer of the company (e.g., President, CEO, etc.) or an officer within the university's administration.

Upcoming Events . . .

| EVENT | DATE |
|--|---|
| <p><i>Fall 2019 MOWG Meeting</i></p> <p>Sponsor: Northrup Grumman Location: Gilbert, Arizona</p> | <p><i>December 3-5</i></p> |
| <p><i>1st International Orbital Debris Colloquium</i></p> <p>Sponsor: NASA Johnson Space Center Location: Sugar Land, Texas (SW of Houston)</p> | <p><i>December 9-12</i></p> |
| <p><i>ESMO Annual Review</i></p> <p>Sponsor: ESMO NASA Goddard Space Flight Center Location: Greenbelt, Maryland</p> | <p><i>February 4-5, 2020</i></p> |
| <p><i>2020 MOWG Meeting</i></p> <p>Sponsor: ESMO NASA Goddard Space Flight Center Location: Greenbelt, Maryland</p> | <p><i>TBD</i></p> |

Potential Future MOWG Meetings . . .

Past Locations

- Boulder/Ft. Collins, CO
- KAFB, Albuquerque, NM
- France
- GSFC, MD
- Gilbert, AZ
- Japan
- JPL/Pasadena area, CA
- KSC area, FL
- LaRC/Norfolk area, VA
- OSC ATK, Dulles, VA
- Sioux Falls, SD

Other Locations Discussed

- Alaska Ground Station Facility
- JSC, TX
- Stennis, MS
- *Host desired location*

Sponsors

- CALIPSO/CNES
- CALIPSO/LaRC
- CloudSat/JPL
- CloudSat/KAFB
- ESMO missions/GSFC
- GCOM-W1/JAXA
- Landsat/NGIS
- Landsat/USGS
- OCO-2/JPL
- OCO-2/OSC ATK



Mission Operations Working Group

December 3-5, 2019

ESC MOWG Action Items

From June 2019 MOWG meeting



| # | Assignee | Description | Status / Due Date |
|---------|-------------------------|--|---|
| 1906-01 | ESMO/ OCO-2 teams | <p>Conduct Constellation-Near Earth Network (NEN) Working Group meeting to discuss station scheduling changes which allow OCO-2 to use ground station contacts currently used by Aqua/Aura.</p> <p>OCO-2 requires an X-band downlink that doesn't have any Star Tracker Assembly (STA) occultation's and would like to work with Aqua/Aura to identify and resolve any potential antenna scheduling constraints.</p> | <p>CLOSED / July 12, 2019 Per email from M. Garcia/JPL. OCO-2, Aqua, Aura and EDOS met on June 11 and agreed to investigate the required ground station certification.</p> |
| 1906-02 | ESMO / USGS | Organize a working group to conduct an orbital safety review of Landsat-7 drifting through the A-Train during the 2021 timeframe. Teams may need to supply long term ephemeris in support of these meetings. | OPEN / December 2019 |
| 1906-03 | All teams | Generate questions for Landsat-7 regarding Restore-L to address MOWG missions concerns. | CLOSED / October 2019 No responses received |
| 1906-04 | All teams | CCS support will be reduced in the future as it moves to a maintenance only mode of operations. Identify any critical operations that CCS performs for your team. | CLOSED / December 2019 No responses received |
| 1906-05 | Mike Machado | Send out email asking for feedback/ideas on the future of the MOWG and its meetings. | OPEN / December 2019 |

Meeting Logistics

- **Presentations**

- Please e-mail your presentation updates to warren.f.case@nasa.gov and nancy.c.herndon@nasa.gov
- All the presentations will be made available after the meeting via a large file transfer service. Download instructions will be sent.
- Let us know if your presentations are “*not for public view*”.

- **Telecon Number (use Passcode 930459# for all numbers):**

- France Toll Free 0 800 949 765 (or 0805 101 207)
- US toll free 1-844-467-4685
- Japan Toll Free (Tokyo): +81 (0) 3 4560 1264 (or 0066 3386 1015)

- **Traditional group photo** – Day 1 during afternoon break

- **Wi-Fi access**

- **WebEx access available on request**

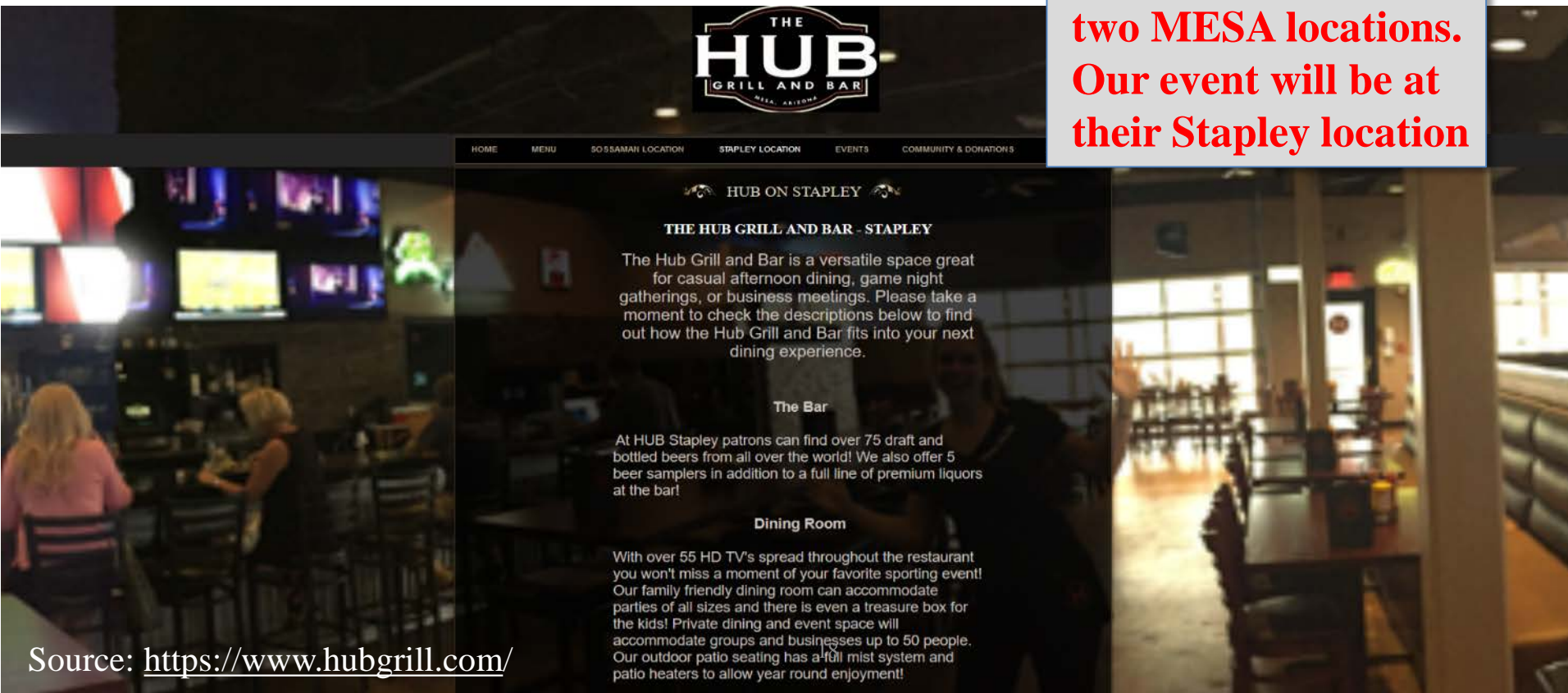
Mission Operations Working Group

December 3-5, 2019

Group Dinner

- **Date/time:** Wednesday evening at 7:00 p.m.
- **Location:** *The Hub On Stapley* (1860 S. Stapley Drive, Mesa, AZ)
- **URL:** <https://www.hubgrill.com/>
- **Logistics:** Guests allowed. Parking available. Individual payments accepted.

Note: The Hub has two MESA locations. Our event will be at their Stapley location



THE HUB GRILL AND BAR MESA, ARIZONA

HOME MENU SOSSAMAN LOCATION STAPLEY LOCATION EVENTS COMMUNITY & DONATIONS

HUB ON STAPLEY

THE HUB GRILL AND BAR - STAPLEY

The Hub Grill and Bar is a versatile space great for casual afternoon dining, game night gatherings, or business meetings. Please take a moment to check the descriptions below to find out how the Hub Grill and Bar fits into your next dining experience.

The Bar

At HUB Stapley patrons can find over 75 draft and bottled beers from all over the world! We also offer 5 beer samplers in addition to a full line of premium liquors at the bar!

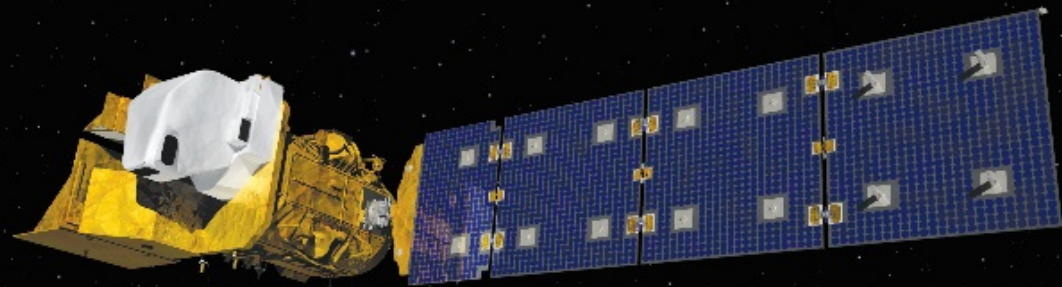
Dining Room

With over 55 HD TV's spread throughout the restaurant you won't miss a moment of your favorite sporting event! Our family friendly dining room can accommodate parties of all sizes and there is even a treasure box for the kids! Private dining and event space will accommodate groups and businesses up to 50 people. Our outdoor patio seating has a full mist system and patio heaters to allow year round enjoyment!

NGIS Facility Tour

- **Date/time:** Thursday and Friday morning at 8:30 a.m.
- **Highlights:** Landsat-9 and JPSS-2 spacecraft in development and test
- **Scheduling:** The facility is not large enough to accommodate our entire group on a single tour, so the tour will be given twice. Everyone will be scheduled accordingly.
- **Note:** Unfortunately, the tour can only be given to U.S. citizens

Landsat 9



ありがとうございます

Arigatou Gozaimasu

Merci

Thank you

Questions?

Mission Operations Working Group

December 3-5, 2019

Abbreviations / Acronyms List

| | | | | | |
|---------|--|--------|---|-------|--|
| AFRL | Air Force Research Laboratory | ESA | European Space Agency | MLT | Mean Local Time |
| AIRS | Atmospheric Infrared Sounder | ESC | Earth Science Constellation | MMOD | Micrometeorite Orbital Debris |
| ALI | Advanced Land Imager | ESDIS | Earth Science Data and Information System | MOWG | Mission Operations Working Group |
| AMSR-E | Advanced Microwave Scanning Radiometer for EOS | ESMO | Earth Science Mission Operations | NASA | National Aeronautics & Space Administration |
| AMSR2 | Advanced Microwave Scanning Radiometer 2 | ETM+ | Enhanced Thematic Mapper Plus (Landsat 7) | NET | No Earlier Than |
| ASTER | Advanced Spaceborne Thermal Emission and Reflection Radiometer | FAQ | Frequently Asked Question | NGAS | Northrop Grumman Aerospace Systems |
| CA | Conjunction Assessment | FDS | Flight Dynamics System | NOAA | National Oceanic and Atmospheric Administration |
| CAM | Command Authorization Meeting | FOT | Flight Operations Team | OCO | Orbiting Carbon Observatory |
| CALIPSO | Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations | FSW | Flight Software | OIIR | NASA Office of International and Interagency Relations |
| CARA | Conjunction Assessment Risk Analysis | FY | Fiscal Year | ORR | Operational Readiness Review |
| CCR | Configuration Change Request | GCOM-W | Global Change Observation Mission – Water | PS | Project Scientists |
| CCS | Constellation Coordination System | GMT | Greenwich Mean Time | RMM | Risk Mitigation Maneuver |
| CNES | Centre National d’Etudes Spatiales | GS | Global Survey | RWA | Reaction Wheel Assembly |
| CRMS | Collision Risk Management System | GSFC | Goddard Space Flight Center | SAC-C | Satellite de Aplicaciones Cientificas (Scientific Application Satellite) |
| CVT | Constellation Visualization Tool | HIE | High Interest Event | SC | Spacecraft |
| DAM | Debris Avoidance Maneuver | HQ | Headquarters | S5P | Sentinel-5 Precursor |
| DB | Direct Broadcast | IAM | Inclination Adjustment Maneuver | SNPP | Suomi National Polar-orbiting Partnership |
| DO-OP | Daylight Only Operations | ISS | International Space Station | SWIR | Short Wave Infrared |
| EAR | Export Administration Regulations | ITAR | International Traffic in Arms Regulations | TBD | To Be Determined |
| EO | Earth Observation | JAXA | Japan Aerospace Exploration Agency | TES | Tropospheric Emission Spectrometer |
| EO-1 | Earth Observing-1 | JPL | Jet Propulsion Laboratory | USGS | U.S. Geological Survey |
| EOMP | End of Mission Plan | JPSS | Joint Polar Satellite System | WRS | World Reference System |
| EOS | Earth Observing System | JSC | Johnson Space Center | | |
| EROS | Earth Resources Observation and Science | JSpOC | Joint Space Operations Center | | |
| | | KSC | Kennedy Space Center | | |
| | | LaRC | Langley Research Center | | |