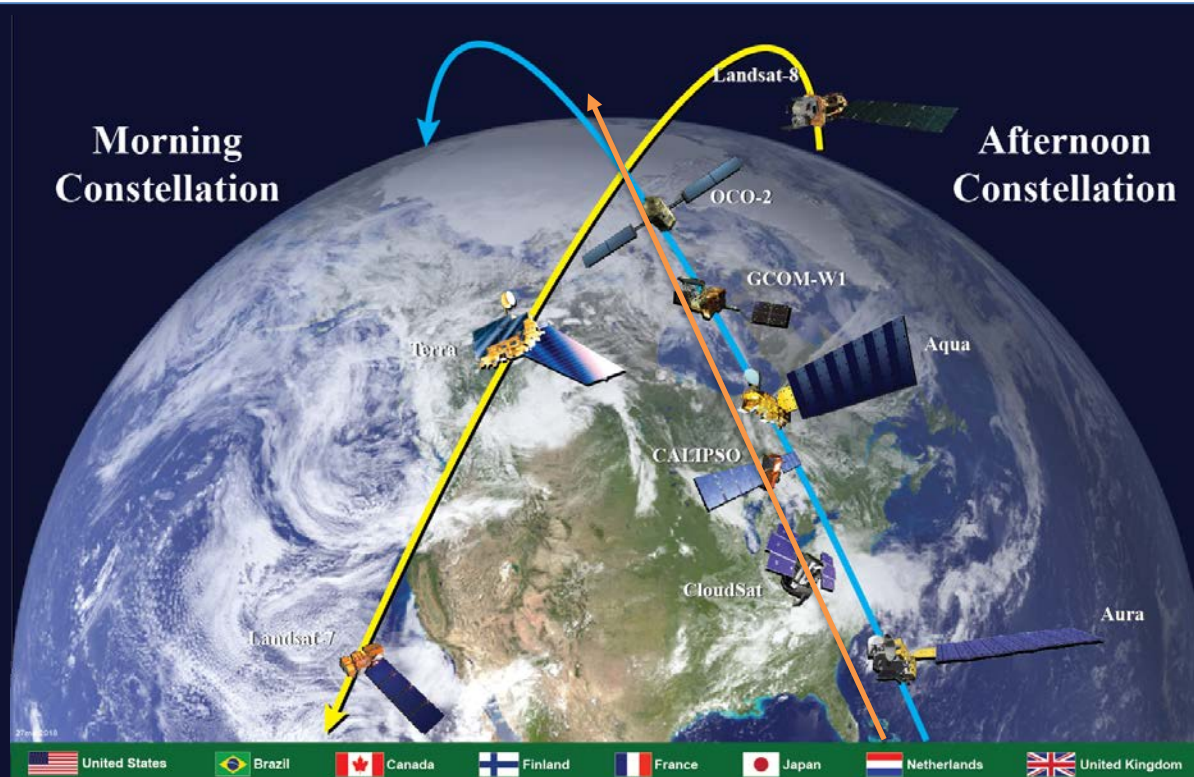


# International Earth Science Constellation (ESC)



## INTRODUCTION

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Mission Validation and Operations Branch – Code 584

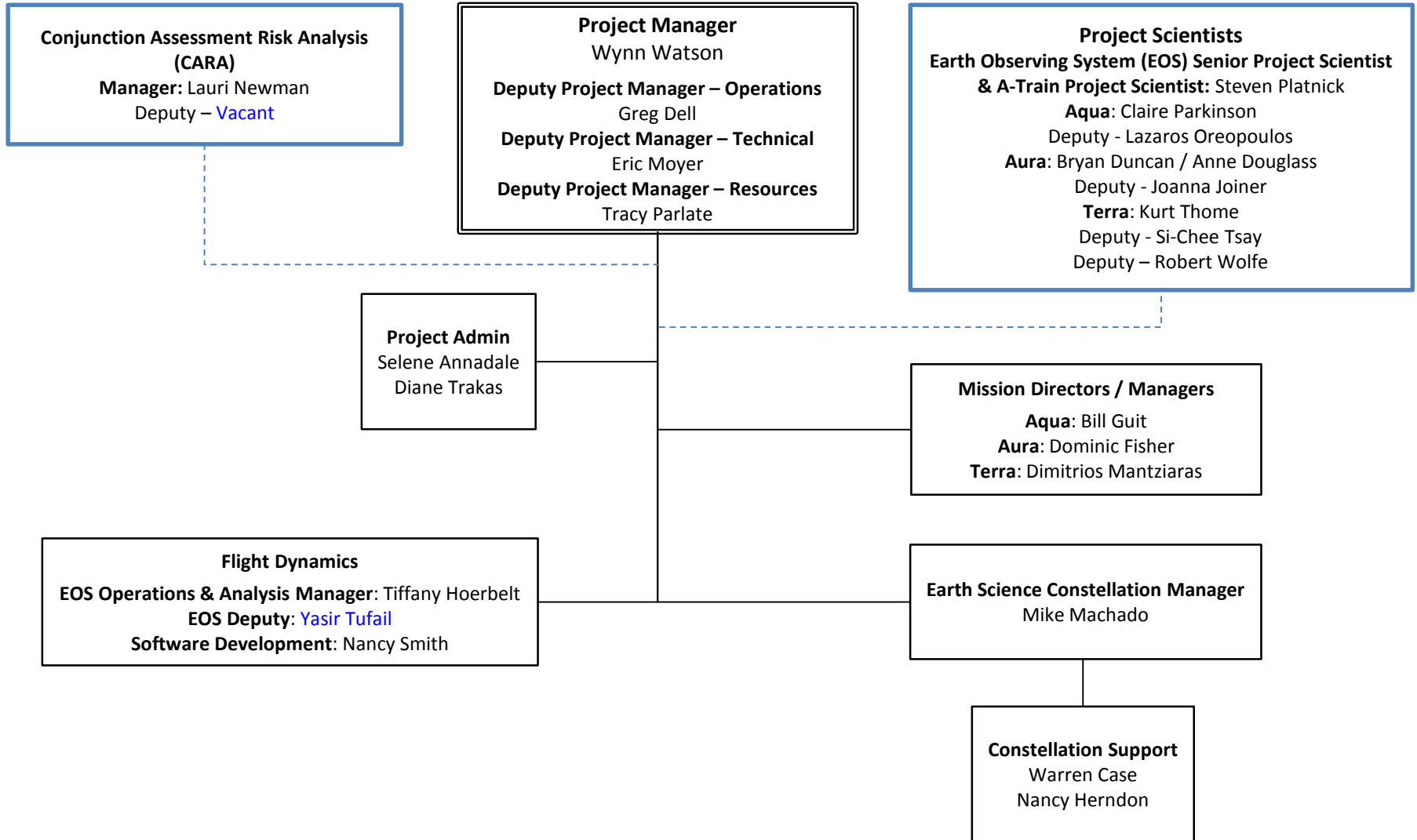
Earth Science Mission Operations (ESMO) Project – Code 428

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 Centre national d'études spatiales (CNES) for hosting!*
- *Welcome to our European Space Agency (ESA) participants and also to our guests, first time attendees, as well as our 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

- **Morning Constellation:** Officially began in 1999 with the Landsat-7 launch in April and Terra launch in December. EO-1 and SAC-C successfully joined in November 2000. Landsat-8 launched in February 2013.
- **Afternoon Constellation (A-Train):** Began with the Aqua launch in May 2002, followed by Aura in July 2004, PARASOL in December 2004, and the joint CALIPSO/CloudSat launch in April 2006 (“formation flying”)
- **A-Train Mission Operations Working Group (MOWG):** Officially met for the first time in March 2003, preceded by exploratory discussions between LaRC (John Stadler) and GSFC (Angie Kelly, Bill Guit and Lauri Newman) in 2002
- **Later ESC missions followed:**
  - **OCO (2010) and Glory (2011)** launches failed
  - **GCOM-W1** successfully launched in May 2012
  - **Landsat 8** successfully launched in February 2013
  - **OCO-2** successfully launched in 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

- **Overview of the CNES Earth Observation Programme**
- **NASA Headquarters Perspective**
- **Current state of the missions**
  - 2019 IAM series results
  - Landsat 7 anniversary / Restore-L update / Landsat 9 development status
  - C-Train status, ESA EO mission overview and status
- **Evolution of the Constellation**
  - GCOM-W1 IAM and plans to change phasing
- **Operations Coordination Plan update**
- **French Space Operations Act**
- **Conjunction Assessment (CA) Topics**
  - CNES collision risk assessment (theoretical vs operational)
  - Value of risk mitigation
  - CARMA update
  - ESMO Devolution status
  - CARA system updates (telecom)

## 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 December 2020 launch date

### • 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 continue to be Constellation MOWG family!

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



# International Earth Observing Constellations



Mission Operations Working Group Meeting  
December 4-6, 2018  
NASA Goddard Space Flight Center

## *Since the last meeting . . .*

- The A-Train conducted its Spring Inclination Adjust Maneuver (IAM) campaign between March 6 and May 22. Despite some conjunctions that caused midpoint delays, the maneuvers were successfully executed.
- GCOM-W1 phasing with Aqua has changed and a Constellation Change Request will be used to document the new configuration.
- CCS Release 2019.1 deployed to operations May 1, 2019
  - Future CCS releases will focus on maintenance aspect
  - What would be the impact of reduced CCS support?
- We continue to monitor TanSat crossings with Constellation missions (next A-Train crossings August-October 2019)
- The A-Train-mowg email distribution list has been moved to the ESC-MOWG email ([ESC-MOWG@lists.nasa.gov](mailto:ESC-MOWG@lists.nasa.gov)). Operational emails should still be sent to the 705 distribution list.

## Future TanSat crossings with Aqua

Continue to monitor TanSat neighbor activity for close approaches

Plus-Early	Mean-Nom	Minus-Late
Sep 20 2019	Sep 10 2019	Sep 10 2019
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

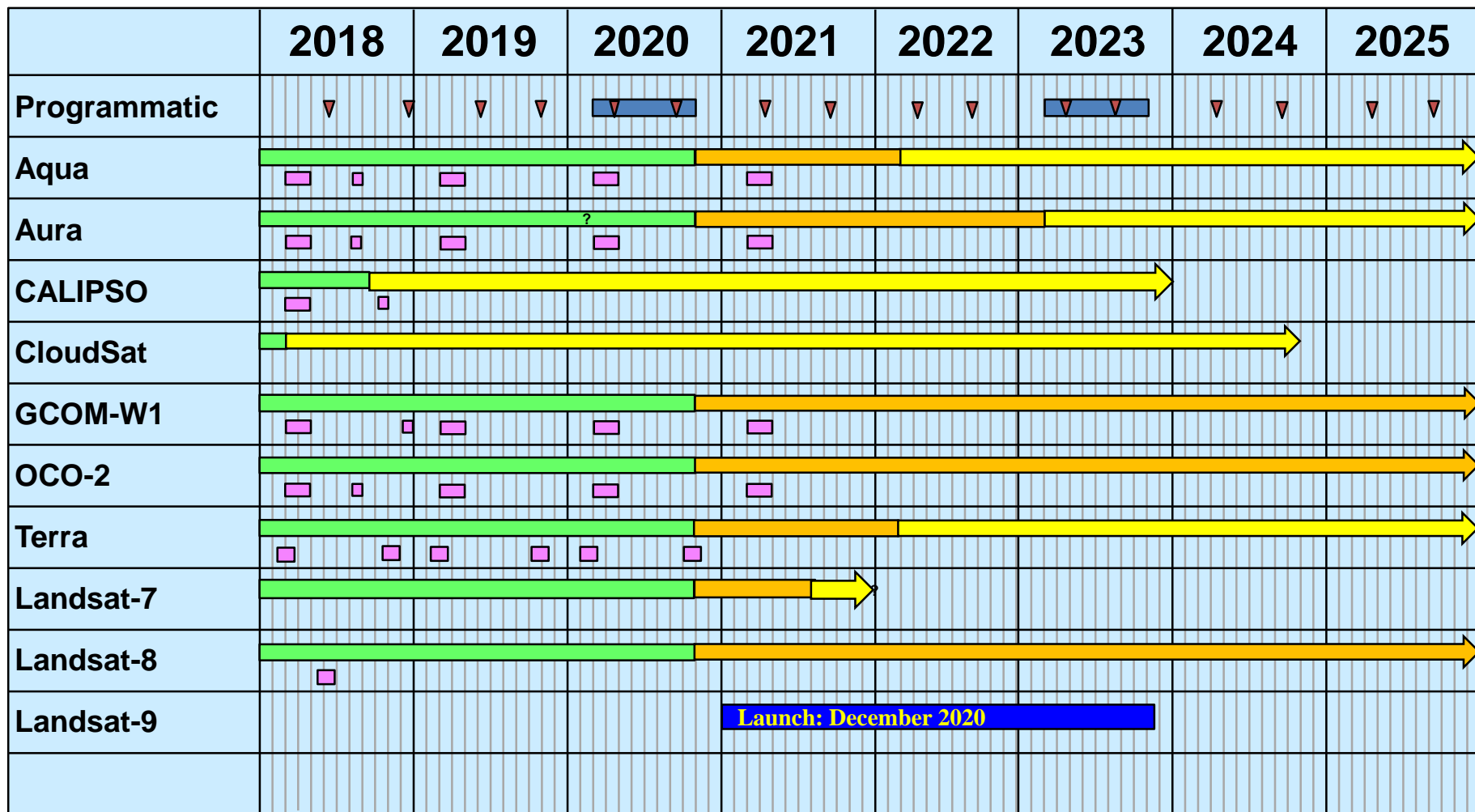
Will this software be used for U.S. Government Contract, Grant, Cooperative Agreement, or Space Act Agreement?

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.

## Mission Longevity Estimates

*Inputs needed from MOWG teams*



■ Senior Review   
 ■ IAM   
 ■ Approved ESC Ops   
 ■ Extended Ops \*Contingent on available funding  
▼ MOWG Mtg   
 ■ Possible Extended ESC Ops



## *Upcoming Events . . .*

EVENT	DATE
<p><i>Spring 2019 MOWG Meeting</i></p> <p>Sponsor: CNES Location – Toulouse, France</p>	<p><i>June 5-7, 2019</i></p>
<p><i>International Conjunction Assessment Workshop</i></p> <p>Sponsor: CNES Location – Paris, France</p>	<p><i>June 26-28, 2019</i></p>
<p><i>Fall 2019 MOWG Meeting</i></p> <p>Sponsor: Northrup Grumman Location – Gilbert, Arizona</p>	<p><i>November 19-21 or December 3-5 (TBC)</i></p>

## *Potential Future MOWG Meetings . . .*

### Past Locations

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

### Other Locations Discussed

- Gilbert, AZ (L-9 I&T – Fall 2019)
- Alaska Ground Station Facility
- JSC, TX
- Stennis, MS
- *Host desired location*

### Sponsors

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



# Mission Operations Working Group

June 5-7, 2019

## ESC MOWG Action Items *December 2018 MOWG meeting*



#	Assignee	Description	Status / Due Date
1812-01	Team leads	Mission team to provide preliminary estimates to Mike Machado of the number of people expected to attend the MOWG meeting in Toulouse, France on June 5-7, 2019.	<b>CLOSED</b> / January 25, 2019 Received estimates and provided estimates to CNES.
1812-02	Team leads	Mission team to identify to Mike Machado if their team can support the MOWG meeting in Gilbert, Arizona on either or both of the following proposed dates: - 1 <sup>st</sup> choice: December 3-5 - 2 <sup>nd</sup> choice: November 19-21	<b>CLOSED</b> / December 21, 2018 Received feedback from most teams. Aside from preference, only conflict was with Landsat MRT 2 Dec 3-5.

## ESC MOWG Action Items

### *June 2018 MOWG meeting*

#	Assignee	Description	Status / Due Date
1806-01	All teams	<p>Mission teams to identify if there are any science impacts caused by Aura leaving the 705 km orbit in early 2020.</p> <p>Decommissioning to occur at the lower orbit in about February 2025, although this could be extended to as late as 2036. Two upcoming meetings (OMI Science Team in September and the Aura Science Team in January 2019) should clarify Aura's detailed exit plans.</p>	<p>CLOSED/ November 2018</p> <p>No science impacts identified</p>
1806-02	ESMO	Distribute the request for information regarding a mission's estimated long term plans (e.g., fuel remaining, 705 orbit exit date, any other orbit lowering dates, passivate dates, etc.)	CLOSED/ June 29, 2018
	All teams	All teams supply their updated information.	CLOSED/ October 2018 Some inputs received
1806-03	All teams	Let ESMO know if your mission team can start supplying a 7-week ephemeris once per week <u>or</u> a 12-week ephemeris every month.	CLOSED/ October 2018 Start mid-January 2019 (affected by shutdown).
1806-04	All teams	Previously, missions teams avoided performing maneuvers within +/- 2 days of a TanSat passing. During this MOWG meeting, mission teams reduced that to +/- 1 day. All teams are now asked to offer any further suggestions for changes to this maneuver avoidance guideline.	CLOSED/ October 2018 +/- 1 day used as the new maneuver avoidance period
1806-05	All teams	Each team is to identify which control box that CCS should use for everyone's e-mail alerts, i.e., either <ul style="list-style-type: none"> <li>(a) the ground track control box or</li> <li>(b) the phasing control box.</li> </ul>	CLOSED/ October 2018 Discussed at Dec 2018 MOWG meeting. Pursue both and allow teams to subscribe.

## Meeting Logistics

- **Presentations**

- Please e-mail your presentation updates to [warren.f.case@nasa.gov](mailto:warren.f.case@nasa.gov) and [michael.j.machado@nasa.gov](mailto:michael.j.machado@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:**

- **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)**
- **PASSCODE (same for all numbers): 930459#**

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

- **Wi-Fi access**



## Other Scheduled Activities

- **Wednesday**
  - Group dinner
- **Thursday**
  - Walking tour
  - Wine tasting and food
- **Friday**
  - CNES tour (for attendees who provided security info)
  - Lunch
  - Exhibition: La Halle del La Machine
  - [www.halledelamachine.fr/](http://www.halledelamachine.fr/)

*ありがとうございます*

*Arigatou Gozaimasu*

*Merci*

*Thank you*

**Questions?**

# Mission Operations Working Group

## June 5-7, 2019

# Abbreviations / Acronyms List

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		
ESA	European Space Agency	KSC	Kennedy Space Center		
		LaRC	Langley Research Center		
		MLT	Mean Local Time		