ACCP/AOS Community Forum

July 29, 2021

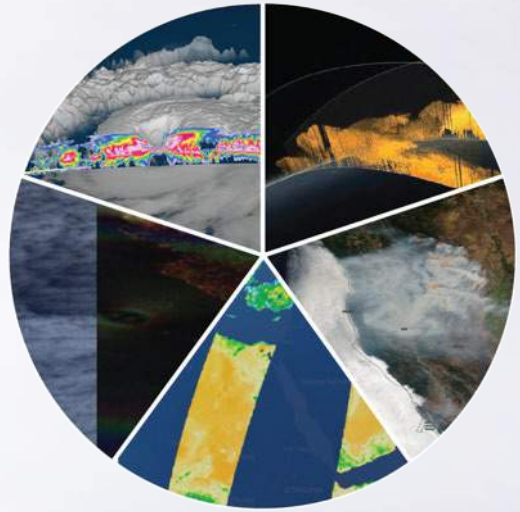
Overview of AOS Mission Concept & Science

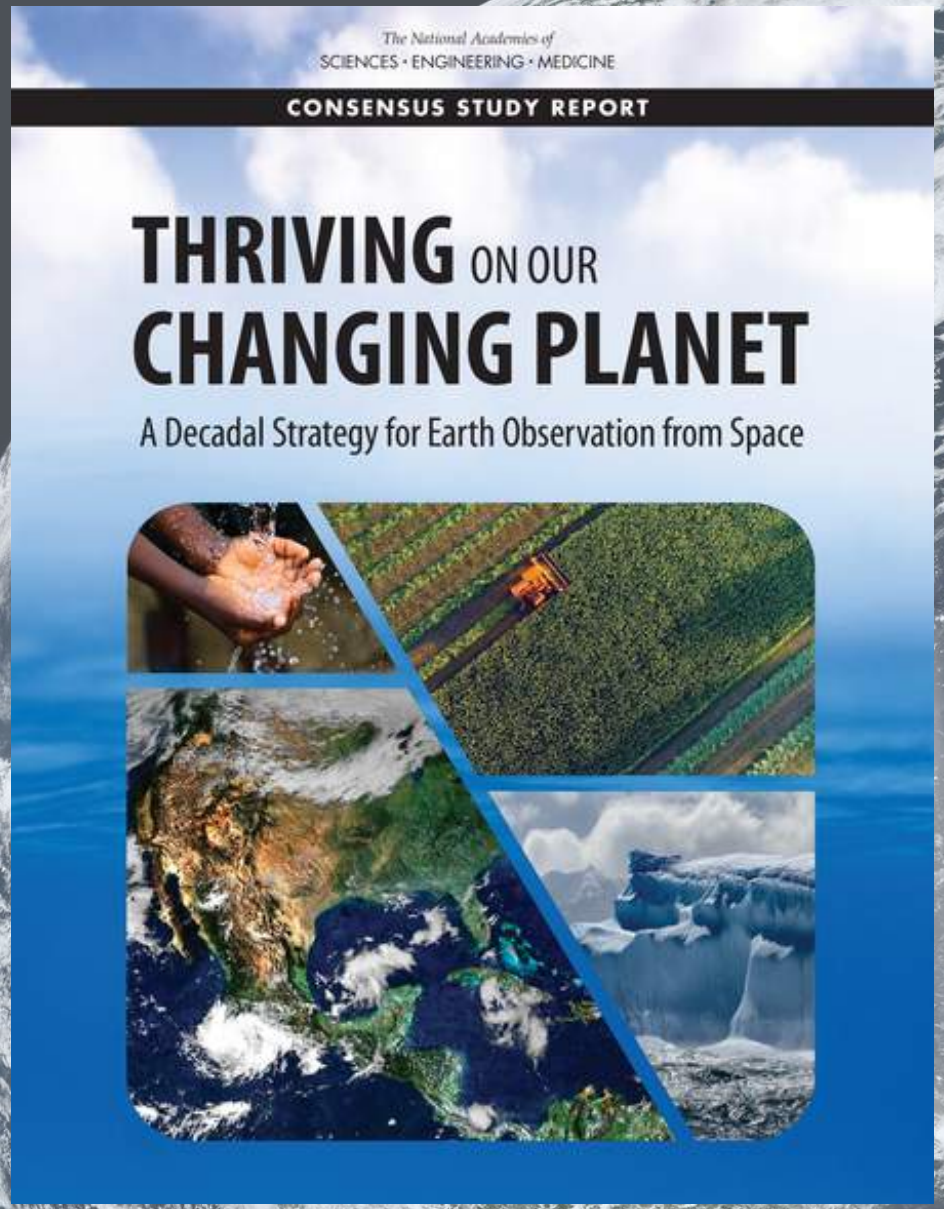
- Welcome and thank you for dialing in!
- We are very excited to have the 1st Community Forum following Project Authorization
- The Earth System Observatory/Atmosphere Observing System (ESO/AOS) is the preliminary name for the Constellation that resulted from the 2+ year Architecture Study responding to the Aerosol (A) and Cloud, Convection and Precipitation (CCP) Designated Observables called out in the 2017 Earth Science Decadal Survey
  - The name ESO/AOS has not been fully approved and is a working name to distinguish between ACCP Architectures and the specific mission that has been moved into Pre-Phase A
  - AOS is an update from the previous acronym AtmOS

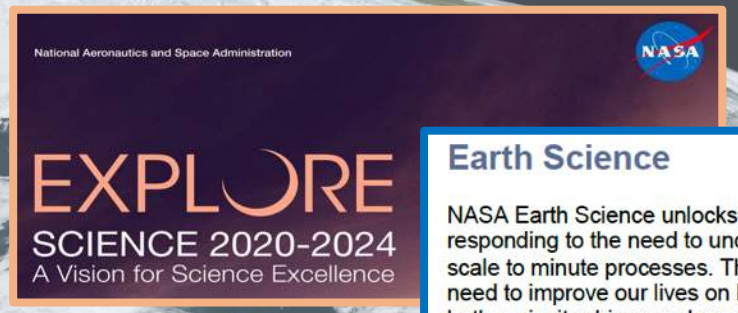
Agenda

Science Overview (15min)	Scott Braun
Architecture & Instrument Overview (10min)	Jeff Piepmeier
Applications Considerations (5min)	Dalia Kirschbaum
Plan Forward for Mission/Projects (5min)	Vickie Moran
Ways to Stay Informed (5min)	
Questions (20min)	

The Atmosphere Observing System: Science Objectives and Activities







Earth Science

NASA Earth Science unlocks the mysteries of our planet, exploring, discovering, and responding to the need to understand our planet's interconnected systems, from a global scale to minute processes. This knowledge and understanding serves the fundamental need to improve our lives on Earth, advancing this frontier for all humanity. NASA pursues both curiosity-driven and practically focused Earth science because our ability to thrive on our home planet is undeniably tied to our scientific understanding and predictive capability of its dynamics and phenomena.

Photo Credit: *NASA's Goddard Space Flight Center*
NASA's Global Modeling and Assimilation Office used Earth science data gathered from multiple missions to visualize several high impact events across the globe between August 2019 and January 2020, including Hurricane Dorian (August to September 2019), major fire events in South America and Indonesia (August to September 2019), and extreme wildfires in Australia (December 2019 to January 2020). The model helps demonstrate how different events interact and the environmental impacts they can have around the globe.

NASA Earth Science explores our rapidly changing world, where natural and human factors interact, following an interdisciplinary, Earth systems approach that examines the interplay among the atmospheric, ocean, land, and ice systems. Using the recommendations of the 2017 NASA Earth Science Decadal Survey, *Thriving on Our Changing Planet a Decadal Strategy for Earth Observation from Space*, as a compass, NASA Earth Science is developing the observing systems that will answer the most important science and application questions of the next decade across the following focus areas:

- Coupling of the water and energy cycles ✓
- Ecosystem change
- Extending and improving weather and air quality forecasts ✓
- Reducing climate uncertainty and informing societal response ✓
- Sea-level rise
- Surface dynamics, geological hazards and disasters

DS Science Questions Related to ACCP

Weather & Air Quality Panel

- **W-1 (MI): Planetary Boundary Layer Dynamics.**
- **W-2 (MI): Larger Range Environmental Predictions.**
- **W-4 (MI): Convective Storm Formation Processes.**
- **W-5 (MI): Air Pollution Processes and Distribution.**
- **W-6 (I): Air Pollution Processes and Trends.**
- **W-9 (I): Role of Cloud Microphysical Processes.**
- **W-10 (I): Clouds and Radiative Forcing.**

Climate Variability and Change Panel

- **C-2 (MI): Climate Feedback and Sensitivity.**
- **C-5 (I-VI): Aerosols and Aerosol Cloud Interactions.**

Hydrological Cycle Panel

- **H-1 (MI): Coupling the Water and Energy Cycles.**
- **C-8 (I): Causes and Effects of Polar Amplification.**

Most Important

Very Important

Important

DS Science Questions Related to ACCP

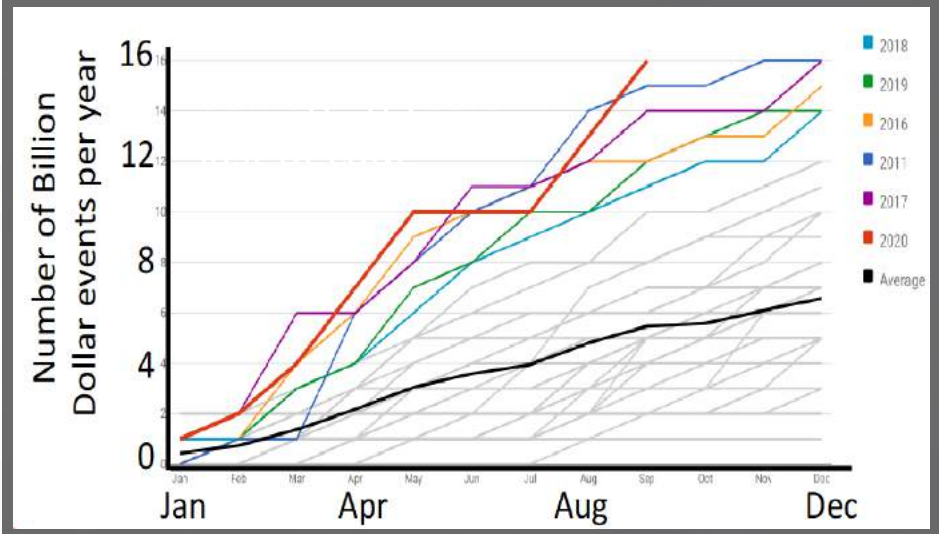
Weather & Air Quality Panel

W-1 (MI): Planetary Boundary Layer Dynamics.

W-2 (MI): Larger Range Environmental Predictions.

W-4 (MI): Convective Storm Formation Processes.

W-5 (MI): Air Pollution Processes and Distribution.



Climate Variability and Change Panel

C-2 (MI): Climate Feedback and Sensitivity.

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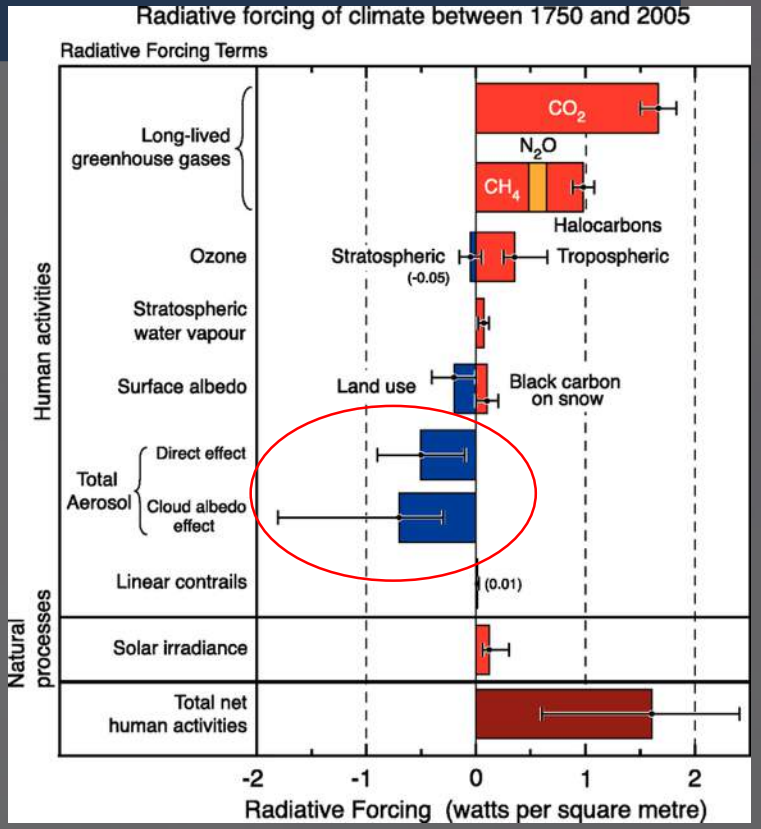
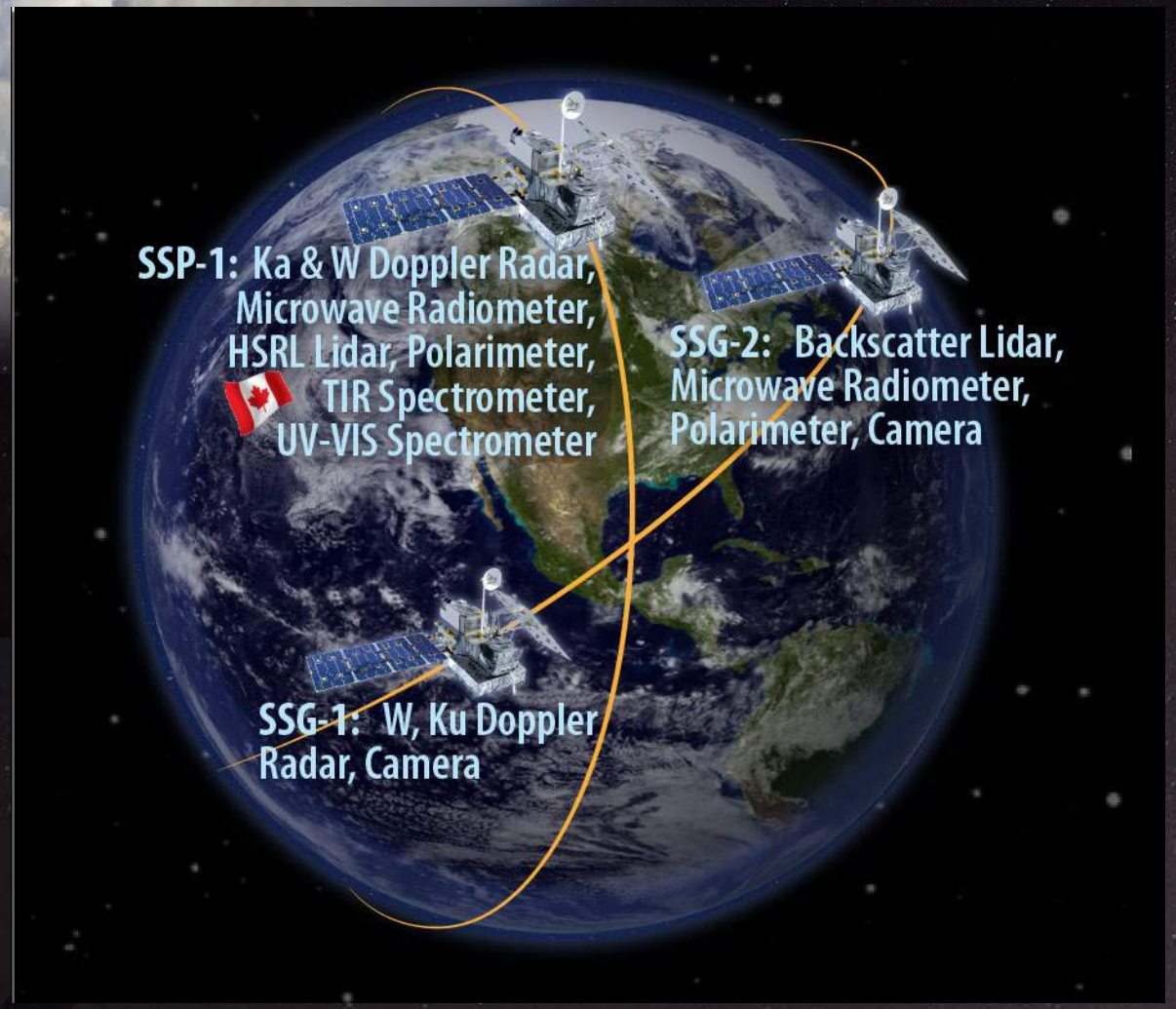
Hydrological Cycle Panel

H-1 (MI): Coupling the Water and Energy Cycles.

C-8 (I): Causes and Effects of



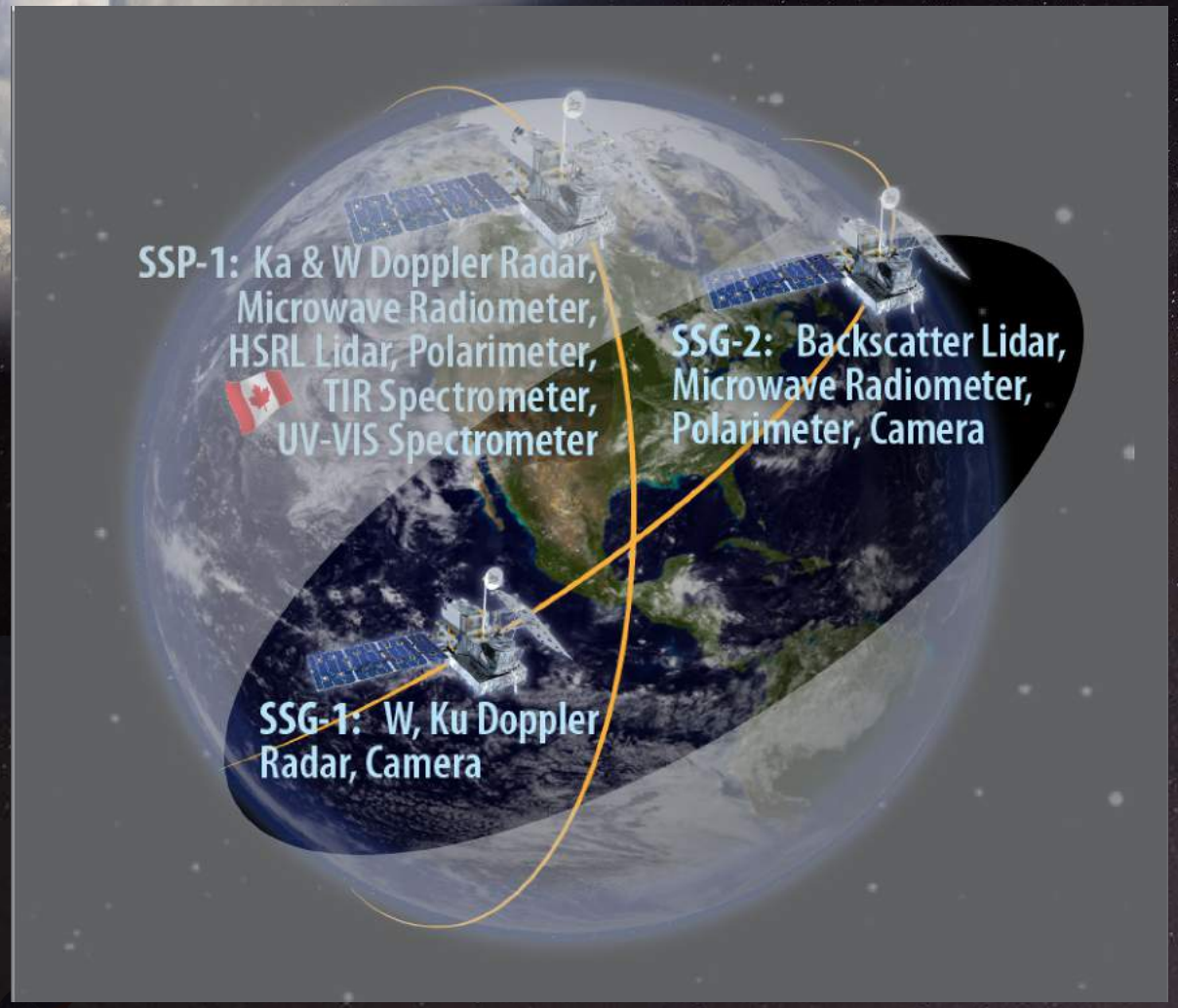
ESO/AOS
One Observing System, Two Synergistic Segments



Constellation

- Based on prioritization of measurements and balance of the climate, convection, and aerosol DS questions
- Polar and Inclined orbits
- Both have radar, lidar, radiometer, and polarimeter instruments

ESO/AOS-I
One Observing System, Two Synergistic Segments



Inclined Orbit

- Key Features: Information on diurnal variability, Ku radar, tandem stereo cameras
- Emphasizes diurnally varying convective clouds to explore connections between vertical air motion and cloud and precipitation processes
- Targets the dynamics of evolving low clouds are aerosol plumes
- Provides insight on sub-daily processes that influence the distribution of aerosols and their linkage to clouds-precipitation

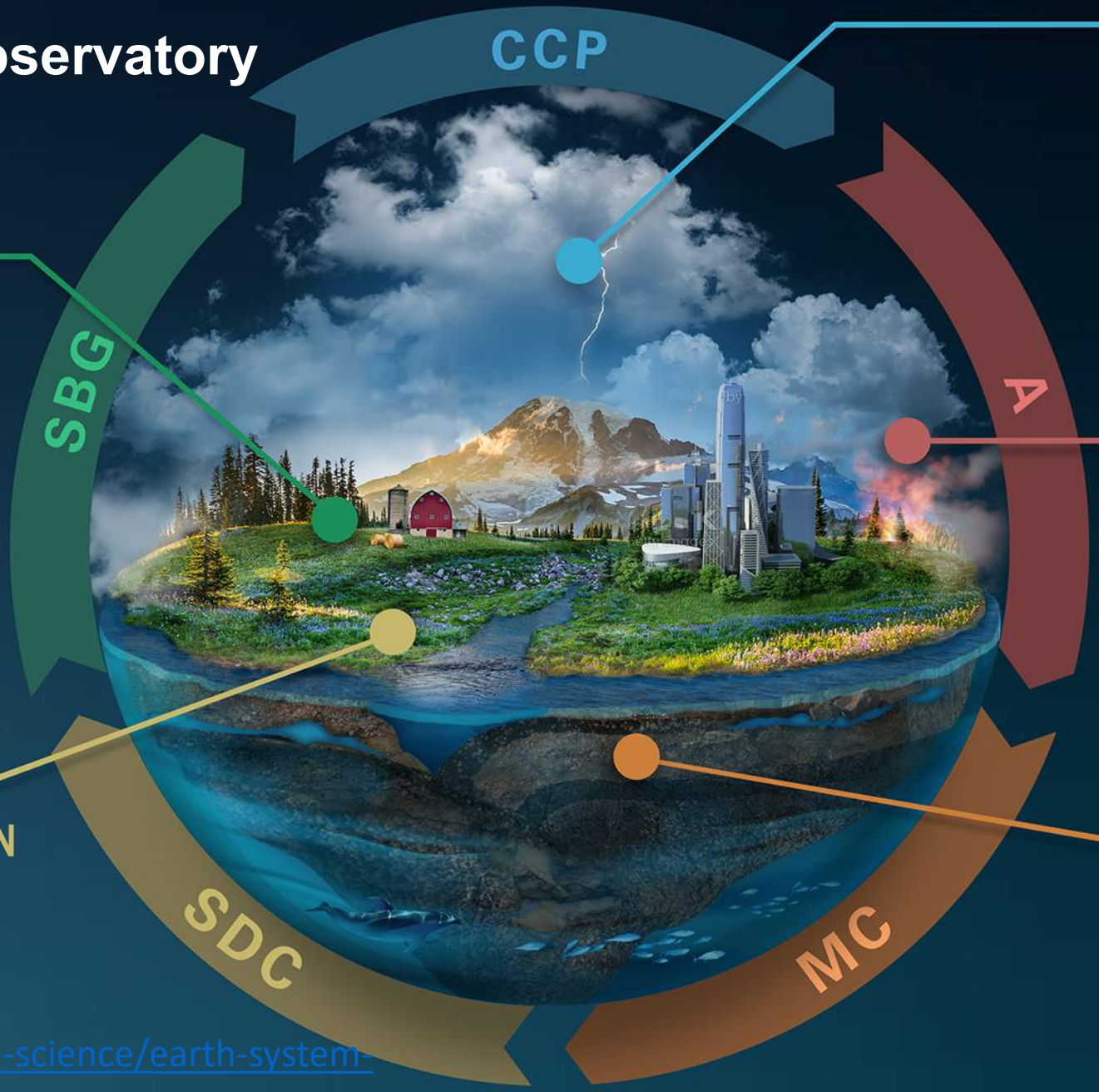
ESO/AOS-P
One Observing System, Two Synergistic Segments

Polar Orbit

- Key Features: Enhanced W-band Doppler capability, HSRL lidar, radiation
- Significantly advances our understanding of how clouds and aerosols interact with each other and with radiation to influence Earth's energy and water cycles
- Provides critical measurements on aerosol properties that will greatly aid air quality forecasts
- Emphasizes processes critical to aerosol forcing, cloud feedbacks, and air quality

Earth System Observatory

Interconnected Missions



CLOUDS, CONVECTION AND PRECIPITATION

Water and Energy in the Atmosphere

SURFACE BIOLOGY AND GEOLOGY

Earth Surface & Ecosystems

AEROSOLS

Particles in the Atmosphere

SURFACE DEFORMATION AND CHANGE

Earth Surface Dynamics

MASS CHANGE

Large-scale Mass Redistribution

https://science.nasa.gov/earth-science/earth-system-observatory

Science Team – Activities & Organization

The Science Team is charged with **defining orbital and suborbital requirements and products to implement ACCP science**

Teams

- *Science and Applications Transition Team (SATT)*: Science requirements and documentation
- *Algorithm Working Groups*: Products, algorithms, science traceability
- *Suborbital (SO) Working Group*: SO requirements definition
- *Applications Impact Team:* Assess community needs and priorities, latency requirements
- *Modeling & Data Assimilation Working Group*: Modeling and DA needs, forward models, OSSEs

Deliverables

- Finalize science traceability matrix
- Input on trade studies
- Program Level-1 Requirements Appendix
- Mission Concept Review package
- Community Assessment Report
- Draft of Project Applications Plan

Org Chart

Project Science, SATT Leads

Scott Braun, PS (GSFC)
John Yorks, DPS Inclined (GSFC)
Tyler Thorsen, DPS Polar (LaRC)
Daniel Cecil, DPS SO (MSFC)

SATT Members

- Graeme Stephens, Duane Waliser (JPL)
- Arlindo da Silva, Dalia Kirschbaum (GSFC)
- Dave Winker, Rich Ferrare (LaRC)
- Walter Petersen (MSFC)
- Meloë Kacenelenbogen (ARC)
- Jens Redemann (OU)
- Jay Mace (U. Utah)
- Ralf Bennartz (Vanderbilt)
- Greg Carmichael (U. Iowa)
- Susan van den Heever (CSU)

Modeling and DA Leads

Arlindo da Silva (GSFC)
Patricia Castellanos (GSFC)
Will McCarty (GSFC)
Derrek Posselt (JPL)

Applications Leads

Dalia Kirschbaum (GSFC)
Emily Berndt (MSFC)
Ali Omar (LaRC)

Algorithm Working Group

- Radiometer: Ian Adams (IS, GSFC), Joe Turk (JPL)
- Radar: S. Tanelli (IS, JPL), Matt Lebsock (IS, JPL), Pavlos Kollias (Stony Brook)
- Lidar: C. Hostettler (IS, LaRC), Ed Nowottnick (IS, GSFC), J. Yorks (GSFC), T. Thorsen (LaRC), R. Holz (U. Wisc.)
- Polarimeter: K. Knobelspiesse (IS), Brian Cairns (GISS)
- Cameras: Felix Seidel (IS, JPL), Roj Marchand (U. Wash.)
- Spectrometers: Kerry Meyer (IS, GSFC), Jean-Pierre Blanchet (IS, U. Quebec, Montreal), Seiji Kato (radiation, LaRC), Olga Kalashnikova (JPL)

Suborbital WG Leads

- Felix Seidel (JPL)
- Jens Redemann (OU)
- Jay Mace (U. Utah)
- Rich Ferrare (LaRC)

For more information

- ACCP SATM:

https://vac.gsfc.nasa.gov/accp/docs/ACCP_SATM_Rel_Candidate_G.pdf

- ACCP Science Narrative:

https://vac.gsfc.nasa.gov/accp/docs/ACCP_Science_Narrative-2021.07.19.pdf

- ACCP Final Architecture Recommendation Review:

https://vac.gsfc.nasa.gov/accp/docs/Architecture_Recommendation_Review.pdf

Extras

Activities During Pre-Phase A

- Science and Applications Transition Team
  - Development of Level-1 baseline and threshold measurement requirements
  - Minimum success criteria
- Algorithm Working Groups
  - Initial product definition, i.e., types and numbers of products
  - Scoping of potential algorithm approaches
  - Tracing Level-1 requirements to geophysical variables
- Suborbital Working Group
  - Identify priorities/provide recommendations for suborbital science based on 2nd SO workshop
  - Focus on measurements that cannot be made from space

Activities During Pre-Phase A

- Applications Team
  - Community Assessment Report
  - Project Applications Plan
- Modeling and Data Assimilation Team
  - Assess the potential impact of AOS data on predictive modeling skill
  - Identify feasible Level-4 products
  - Address potential modeling needs
- Trade studies
  - Orbit inclination for inclined, impacts of disaggregation for polar
  - Science enhancements from international contributions
  - Latency requirements

Mapping Top DS Questions to ESO/AOS Goals

Key MI DS Questions

W-4 (MI): Convective Storm Formation Processes.

W-5 (MI): Air Pollution Processes and Distribution.

C-2 (I-MI): Climate Feedback and Sensitivity.

SATM Release G: https://vac.gsfc.nasa.gov/accp/docs/ACCP_SATM_Rel_Candidate_G.pdf

Linked ACCP Goals

G2 Storm Dynamics

Improve our physical understanding and model representations of cloud, precipitation and dynamical processes within convective storms

G4 Aerosol Processes

Reduce uncertainty in key processes that link aerosols to weather, climate and air quality related impacts.

G1 Cloud Feedbacks

Reduce the uncertainty in low- and high-cloud climate feedbacks by advancing our ability to predict the properties of low and high clouds

G3 Cold Cloud and Precipitation

Improve understanding of cold (supercooled liquid, ice, and mixed phase) cloud processes and associated precipitation and their coupling to mid-to-high latitude water and energy cycles

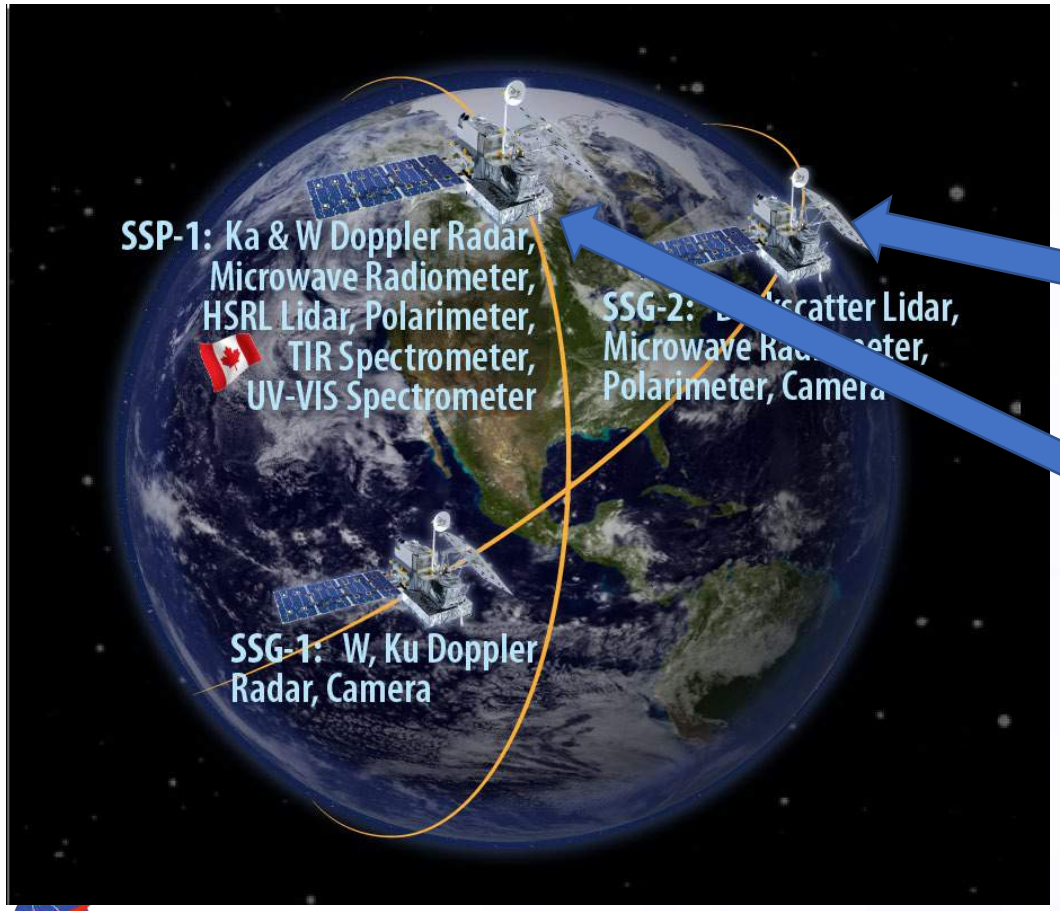
G5 Aerosol Impacts on Radiation

Reduce the uncertainty in Direct (D) and Indirect (I) aerosol-related radiative forcing of the climate system.

Overview ESO/AOS Architecture & Instruments

Selected Architecture (Architecture Study Reference D1A)

- Launch #1 2028 (**Inclined** Orbit)
  - NASA Spacecraft: SSG-1 and SSG-2
- Launch #2 2029 (**Polar** Sun Synchronous Orbit)
  - NASA Spacecraft: SSP-1



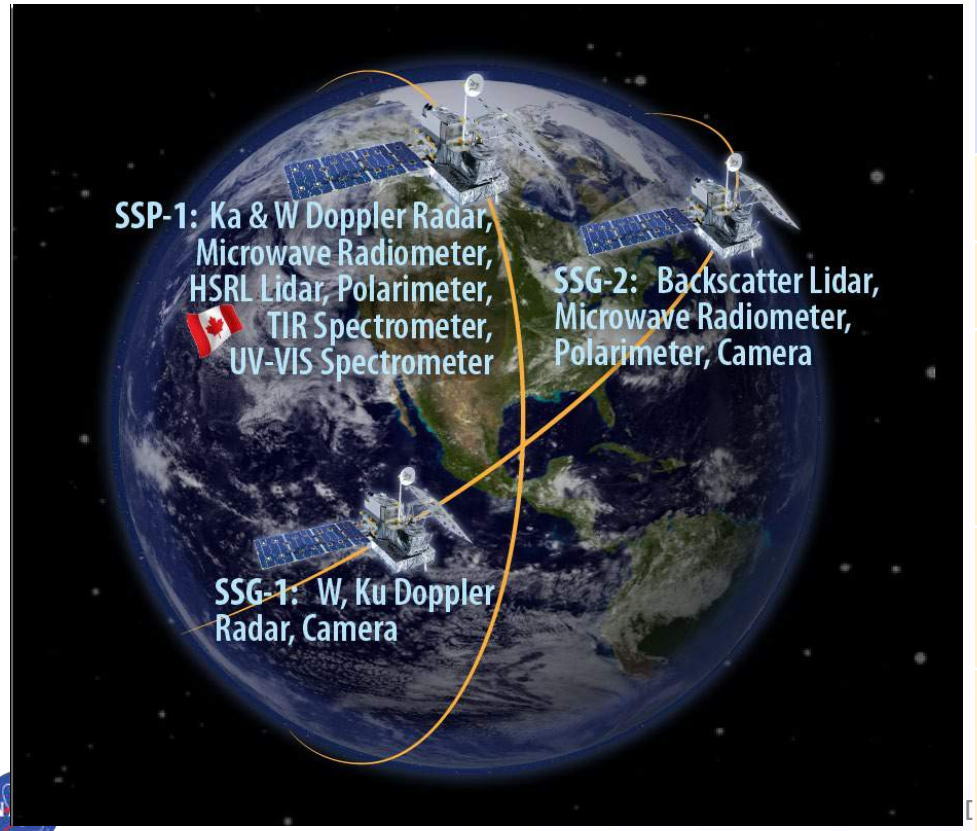
Cost caps and desire for early launch (2028) forces lower cost/higher maturity for the Inclined orbit

Inclined Orbit: SmallSat-compatible Radar/Lidar; min of two spacecraft for stereo imaging of clouds (45 sec sep) and delta-time measurements

Polar Orbit: Larger, more-capable Radar/Lidar requiring larger spacecraft and more time for instrument development

Selected Architecture (PAL Reference D1A)

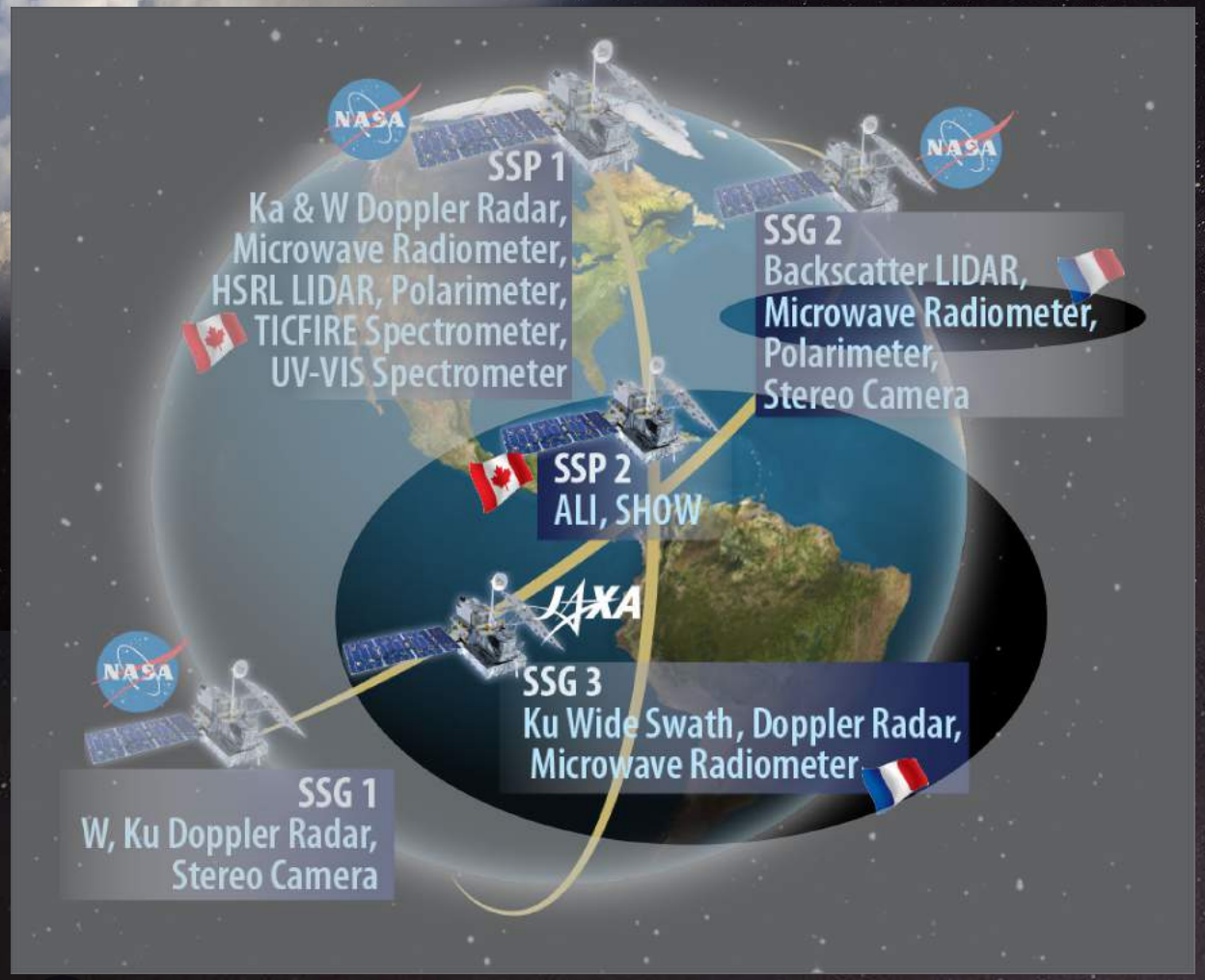
- Launch #1 2028 (**Inclined** Orbit)
  - NASA Spacecraft: SSG-1 and SSG-2
- Launch #2 2029 (**Polar** Sun Synchronous Orbit)
  - NASA Spacecraft: SSP-1



Inclined Elements	Description
SSG-1	
SmallSat Radar	Ku w/Higher Accuracy Doppler and W Band w/Lower Accuracy Doppler
Stereo Camera	Visible Camera #1 of 2 for Tandem Measurements on 2 Spacecraft
SSG-2	
Backscatter Lidar	532nm, 1064nm
Microwave Radiometer	118-880GHz OR 89-325GHz
Polarimeter	UV/VIS, VNIR/SWIR Narrow Swath
Stereo Camera	Visible Camera #2 of 2 for Tandem Measurements on 2 Spacecraft

Polar Elements	Description
Dual Doppler Radar	Ka w/High Accuracy Doppler and W w/High Accuracy Doppler
Microwave Radiometer	118-880 GHz
HSRL Lidar	532nm HSRL, 1064nm
Polarimeter	UV/VIS, VNIR/SWIR Wide Swath
TICFIRE Spectrometer	LWIR, FIR
UV-VIS Spectrometer	UV, VIS, NIR, SWIR

ESO/AOS
One Observing System, Two Synergistic Segments



International Contributions Under Study

- JAXA wide-swath Ku-band Doppler radar for precipitation mapping and GPM continuity
- CNES tandem high-frequency (89, 183, 325 GHz) passive microwave radiometers for time-differenced measurements
- CSA limb sounders for upper tropospheric/ lower stratospheric aerosol and moisture sounding

Applications Considerations

ESO/AOS Applications Latencies

	Weather Forecasting	Disaster Modeling/Monitoring	Health & Air Quality
Long-term Decisions	**> 6 hour Latency** • Applied research studies • Improve algorithms • Model verification	**> 6 hour Latency** • Disaster relief & preparedness • Community planning • Developing models and studying past events	**> 6 hour Latency** • Exceptional event demonstrations and aerosol transport • Health studies/trends
Short-term Decisions	**3-6 hour Latency** • Operational hurricane forecasting • Operational weather forecasting • Operational model data assimilation	**3-6 hour Latency** • Volcanic disasters/warnings for aviation • Smoke/dust and air quality warnings for human health	**3-6 hour Latency** • Air quality model data assimilation • Air quality forecasting • Smoke modeling
Time-critical Decisions	**1 hour Latency** • Weather nowcasting/warnings • Fire weather/smoke forecasts • Dust storm warnings • Ingest in rapid update models	**1 hour Latency** • Disaster warning, evacuation, response, mobilization • Short-term flooding/landslide risk assessment	**1 hour Latency** • Air quality forecasting • Public health warnings (plume or catastrophic releases) • Chemical weather forecasting

Recommendations from AIT

- Initial AIT latencies were based on delivery of products to stakeholders
- The engineering team needs to work with ground system latencies to anticipate use of NASA's Near Earth Network (or TDRSS) to determine data rates and desired/required downlinks per day
- These initial recommendations will change based on more information on:
  - expected algorithms and products
  - multi-instrument products

Instrument	Requires baseline ground system latency (aka measurement latency) through LZP within	In order to deliver _____ to end users	with end user data latency of
Radiometer	<1 hour	L1b radiances	1 – 3 hours
Radar	2 hours	L1 – L2 products	3 – 6 hours
Lidar	2 hours	L1 – L3 products	3 – 6 hours
Polarimeter	2 hours	L1 – L3 products	3 – 6 hours
Spectrometer	3-6 hours	L1 – L3 products	≤ 6 hours

Applications Impact Team – Updates & Engagements

The ACCP Applications Impact Team (AIT) is charged with **ensuring that applications are considered to the greatest extent possible in mission design.**

Activities

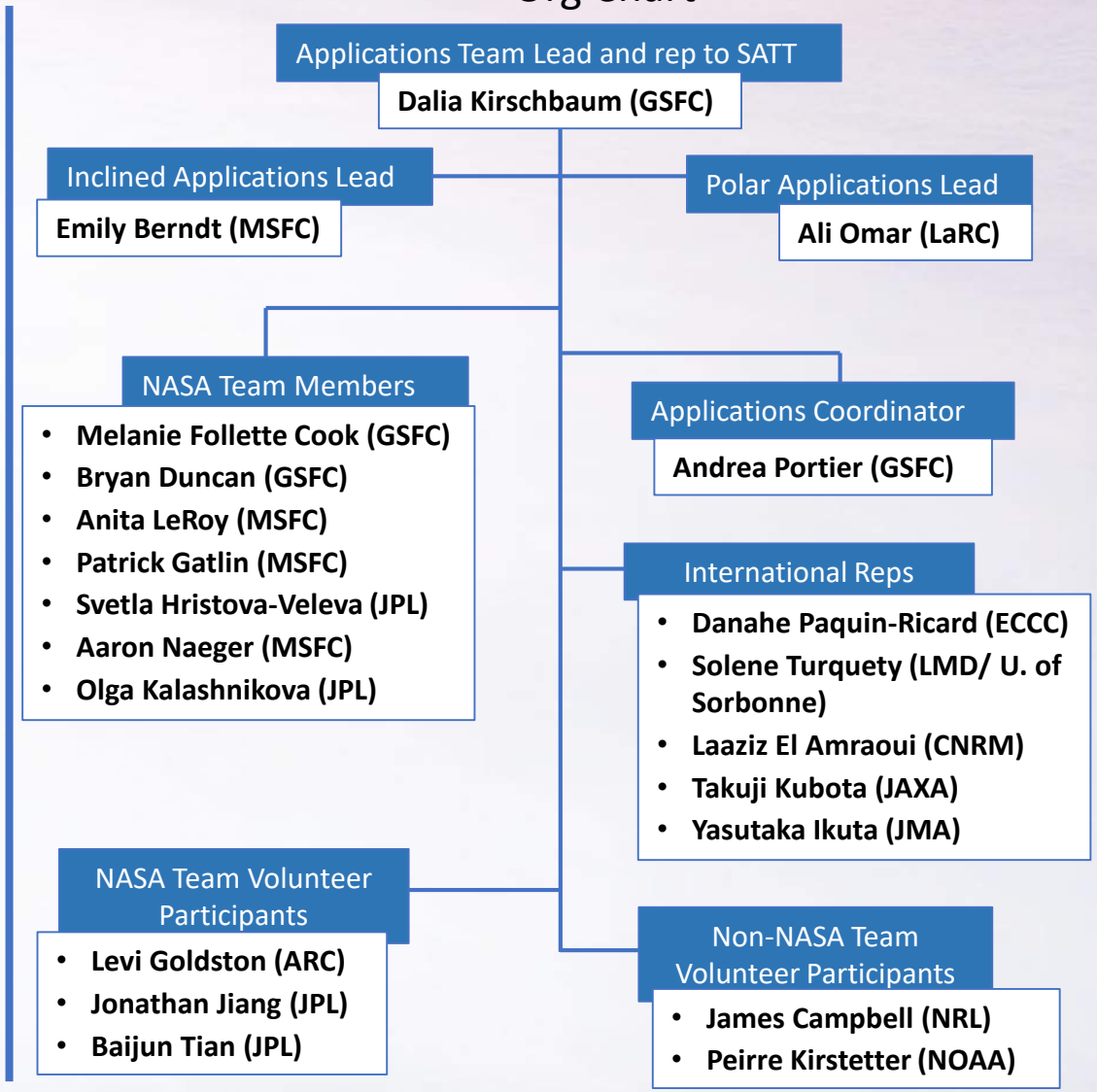
- *Project Studies:* applications-oriented studies on latency, inclination, instruments needs, etc.) that would impact applications value
- *Pre-Phase A Working Groups:* Participate Science Team on L1-L4 algorithm development and needs to inform L1 science requirements
- *Stakeholder outreach*: Engage applications communities through workshops, thematic discussions, focus groups, newsletters, etc.
- *Coordinate/Collaborate* with other DO projects

Deliverables

- Community Assessment Report (Pre-Phase A Requirement)
- Draft of Project Applications Plan (KDP-A Activity)

We welcome new members! If you are interested to learn more, please contact Andrea Portier (andrea.m.portier@nasa.gov) or Dalia Kirschbaum (dalia.Kirschbaum@nasa.gov).

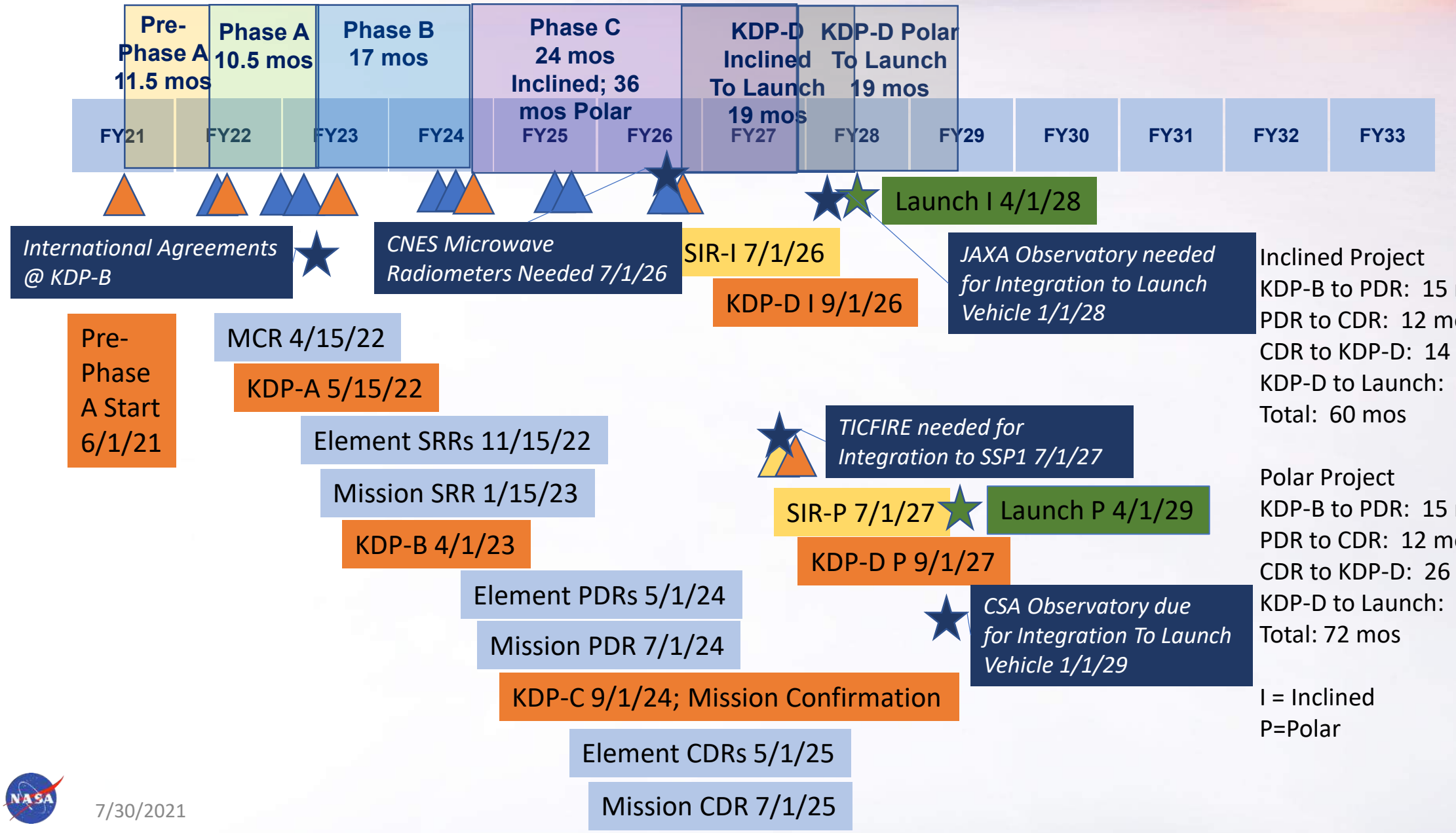
Org Chart



Community Assessment Report for ACCP: Enabled Application Areas Covered

Plan Forward for Mission / Projects

ESO/AOS-I and AOS-P Projects "No Earlier Than" Schedule

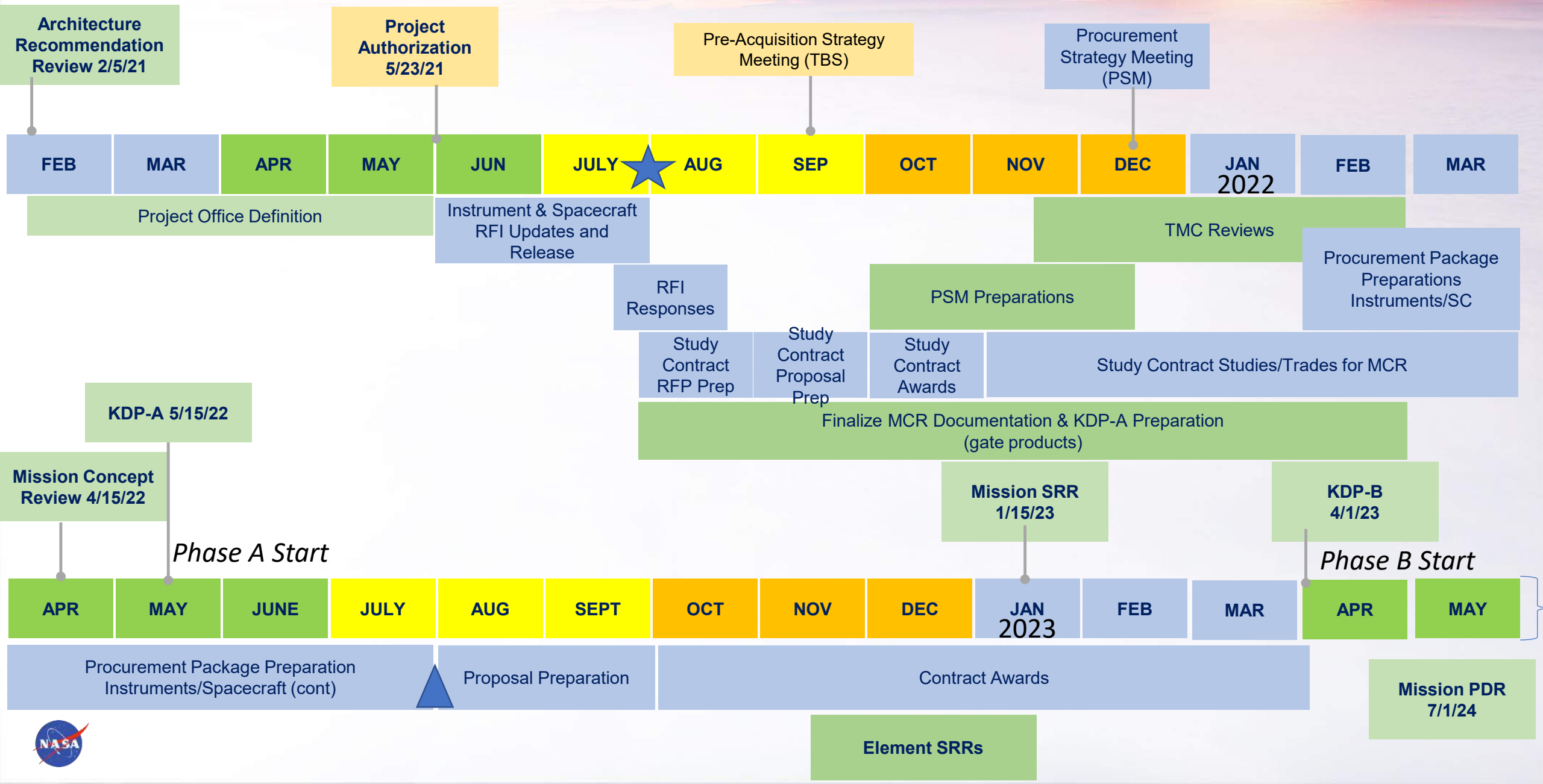


Inclined Project
KDP-B to PDR: 15 mos
PDR to CDR: 12 mos
CDR to KDP-D: 14 mos
KDP-D to Launch: 19 mos
Total: 60 mos

Polar Project
KDP-B to PDR: 15 mos
PDR to CDR: 12 mos
CDR to KDP-D: 26 mos
KDP-D to Launch: 19 mos
Total: 72 mos

I = Inclined
P=Polar

Pre-Phase A High Level Schedule—Look Ahead Phase A



Requests for Information—Instruments & Spacecraft

RFIs on sam.gov—deadlines can be extended upon request

https://sam.gov/opp/80bae0cd35b54479a775e6eca2ea698f/view -Polarimeter

https://sam.gov/opp/c33da7542ec34638b5a637da6e196a55/view -Radiometer

https://sam.gov/opp/00f6a5aecc11443b9de3f6d7eb691dff/view -Stereographic Cameras

https://sam.gov/opp/61587d141bbe40969e6250da4c657d3b/view -Spectrometer

https://sam.gov/opp/b837e19017374319af622320f7724516/view - Backscatter Lidar

https://sam.gov/opp/d580ddeae7524a76a5314aa081df2685/view - HSRL Lidar

https://sam.gov/opp/641f13bd2bea4b74a119c04889f4014e/view - Spacecraft RFI (Inclined Orbit)

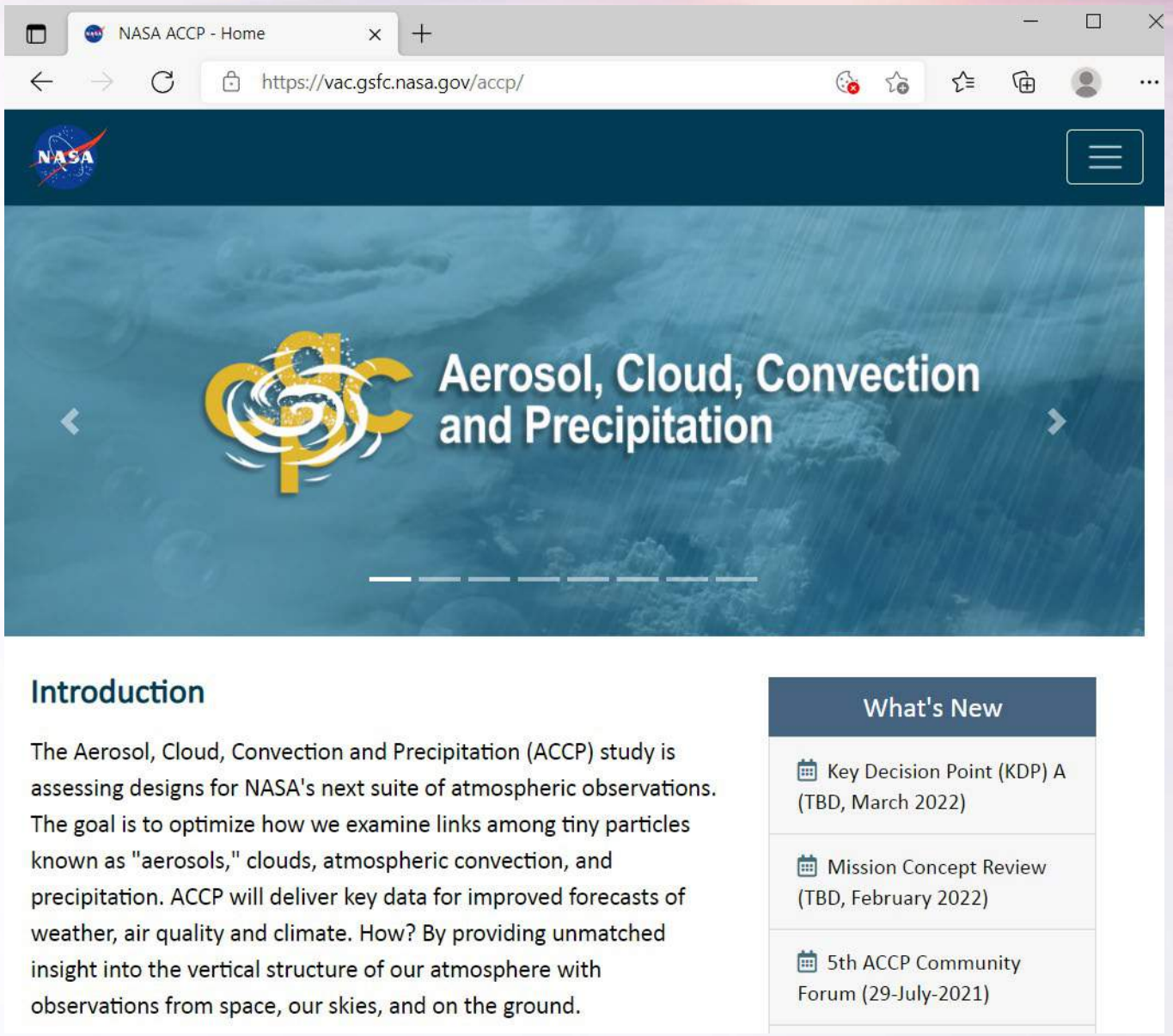
Ways to stay informed

- Web-Site (demo to follow)
- Contact Sheri Smith a-ccp-comments@lists.nasa.gov to get on Community Emails
- Contact Project Team Personnel (high level org chart included)
- Webinars
  - Applications Webinars Starting Fall 2021
- Next Community Forum November 4
- AGU Townhall & Other Sessions December

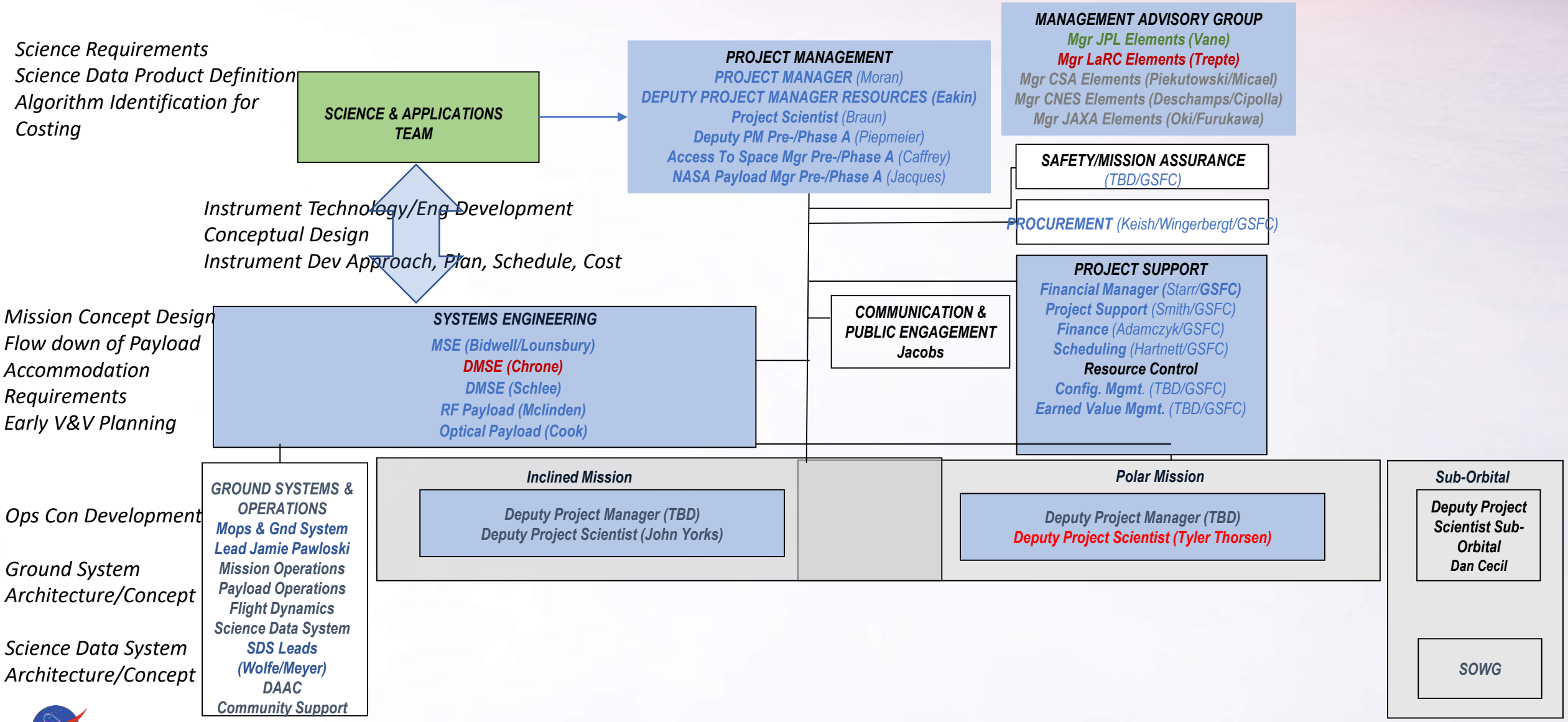
Web-Site Demo

Existing ACCP Architecture Study Web-Site In Use

New Mission/Project Web-Site In Development



Project Organization--Preliminary



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Wingerberg, Jonathon D. (GSFC-210Y)
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Questions/Comments

- Open Discussion—Panel include Presenters