
ATMOSPHERE
National Aeronautics and Space Administration
NASA
EARTH SYSTEM OBSERVATORY
AOS Community Forum
November 10, 2021
Pre-Decisional

Overview of AOS Mission Concept & Science

EARTH SYSTEM OBSERVATORY

Welcome and thank you for dialing in!

We are very excited to have the 2nd Community Forum following Project Authorization in May 2021

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 (Pre-Formulation)
- AOS is an update from the previous acronym AtmOS

11/12/2021

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Agenda

Architecture & Instrument Overview (10 min)
Vickie Moran

Science Overview (10 min)
Scott Braun

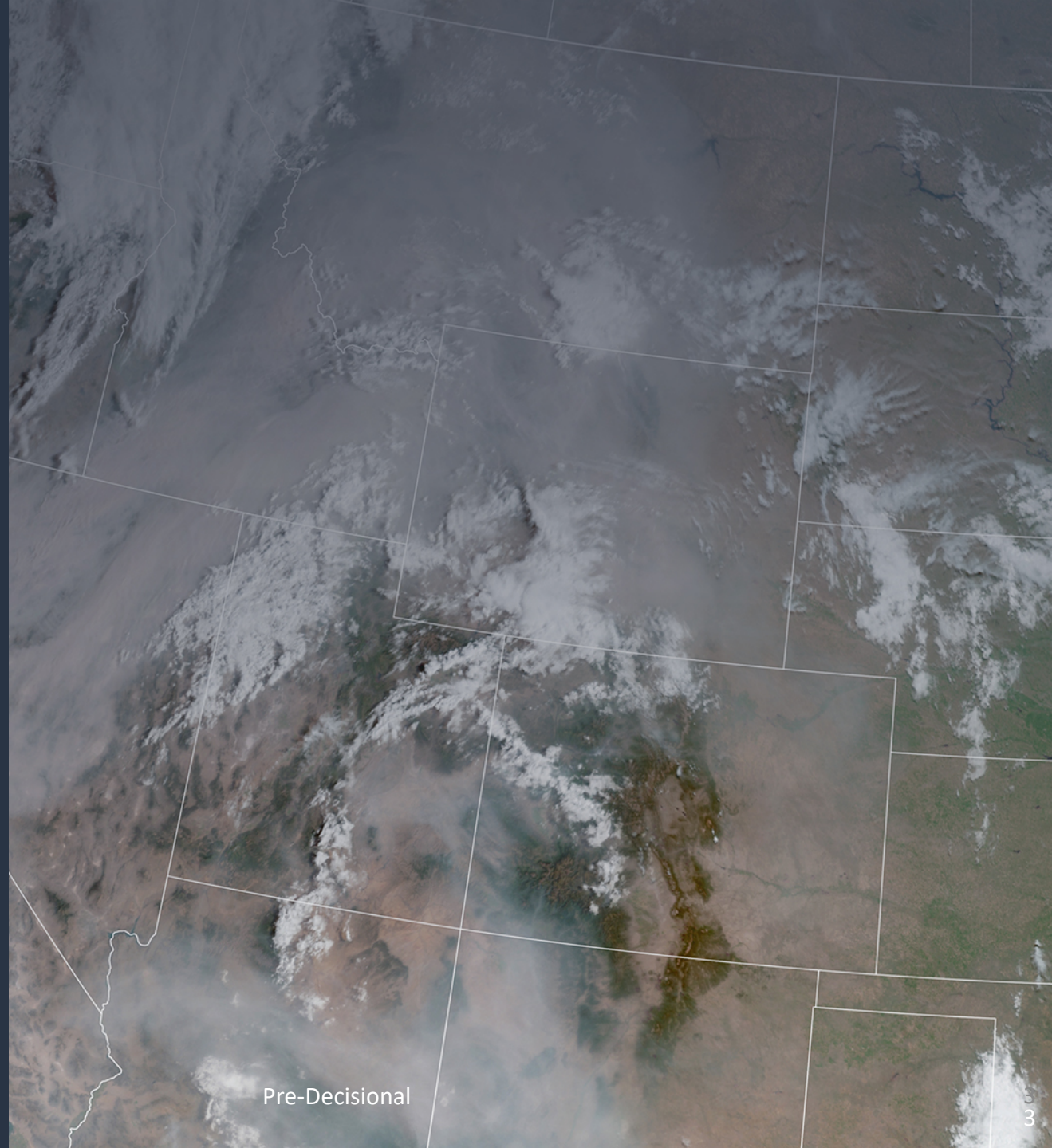
Applications Considerations (5 min)
Emily Berndt

Sub-Orbital Program (5 min)
Dan Cecil

Plan Forward for Mission/Projects (10 min)
Vickie Moran

Ways to Stay Informed (5 min)

Questions (15 min)



Selected Architecture (Architecture Study Reference D1A)

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Launch #1 July 2028 (**Inclined** Orbit)

- NASA Spacecraft: AOS-I1 and AOS-I2

Launch #2 January 2030 (Polar Sun Synchronous Orbit)

- NASA Spacecraft: AOS-P1

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 July 2028 (**Inclined** Orbit)

NASA Spacecraft: AOS-I1 and AOS-I2

Launch #2 January 2030 (Polar Sun Synchronous Orbit)

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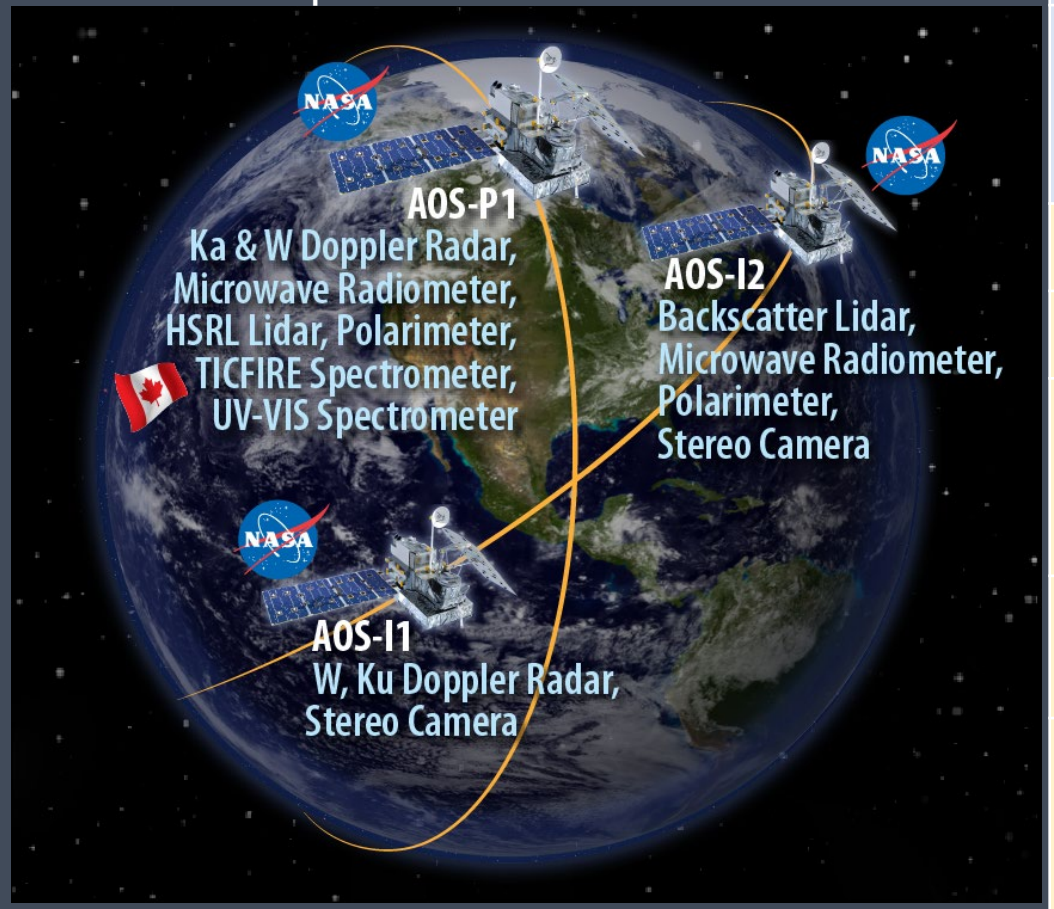
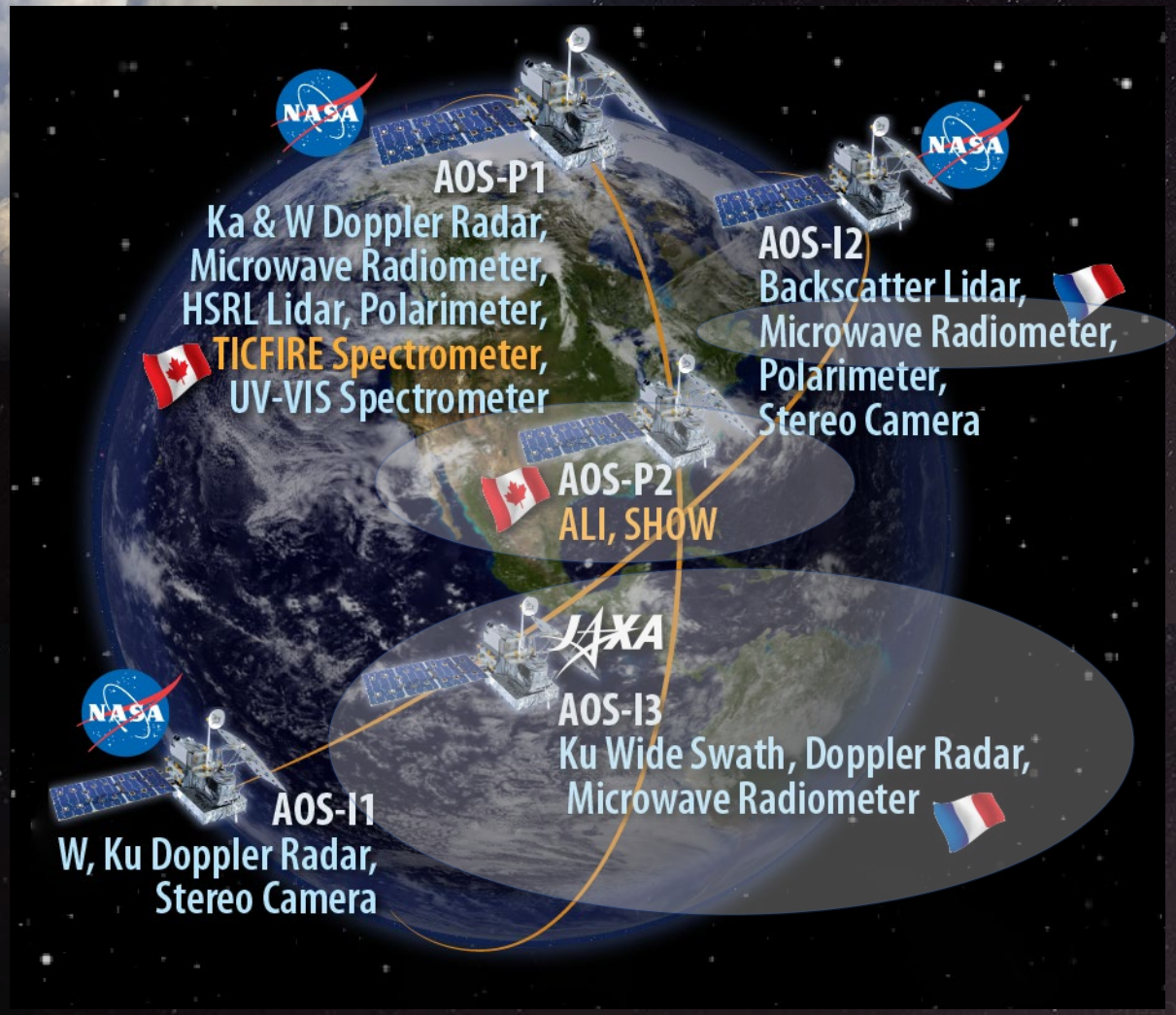


Inclined Elements	Description
AOS-I1	
SmallSat Radar	Ku w/Higher Accuracy Doppler and W Band w/Lower Accuracy Doppler
Stereo Camera	Visible Camera #1 of 2 for Tandem Measurements on 2 Spacecraft
AOS-I2	
Backscatter Lidar	532nm, 1064nm
Microwave Radiometer	118-880GHz OR 89-325GHz
Polarimeter	UV/VIS, VNIR/SWIR Narrow Swath
Stereo Camera	Visible Camera #2 of 2 for Tandem Measurements on 2 Spacecraft

EARTH

Polar Elements	Description
AOS-P1	
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

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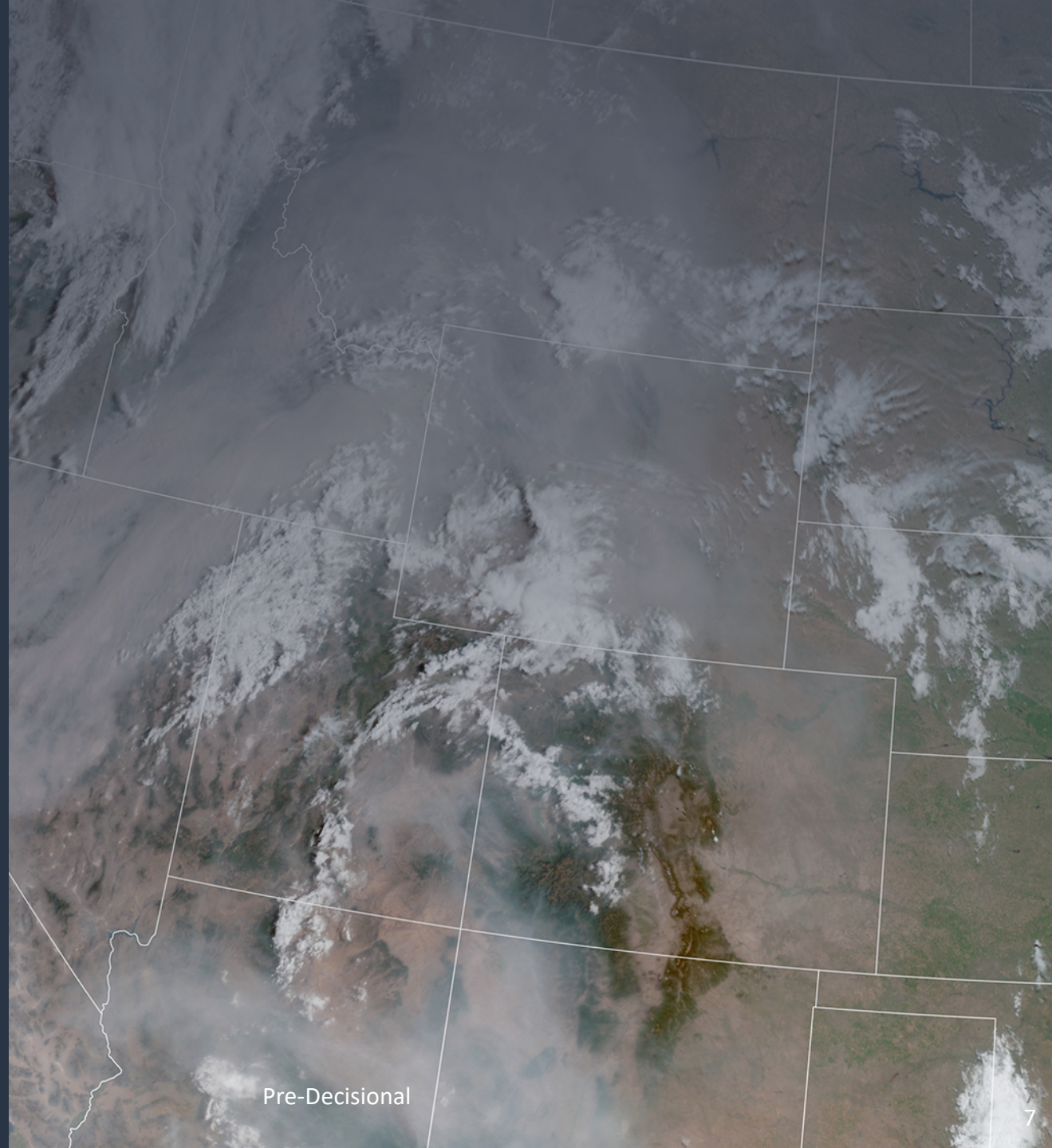


Constellation Science Objectives

O1 Low Clouds | **O2** High Clouds | **O3** Convective Storms | **O4** Cold Clouds/ Precip | **O5** Aerosol Attrib. & AQ | **O6** Aerosol Removal, Redistrib. Processing | **O7** Aerosol DI & Absorption | **O8** Aerosol Indirect Effect

Polar

Climate-related processes emphasized

- **O1** Low Clouds
- **O2** High Clouds
- **O3** Convective Storms
- **O4** Cold Clouds/ Precip
- **O5** Aerosol Attrib. & AQ
- **O6** Aerosol Removal, Redistrib. Processing
- **O7** Aerosol DI & Absorption
- **O8** Aerosol Indirect Effect

Inclined

Sub-daily variability emphasized

- **O3** Convective Storms
- **O2** High Clouds
- **O1** Low Clouds
- **O6** Aerosol Removal, Redistrib. Processing
- **O5** Aerosol Attrib. & AQ

Suborbital

Emphasizes science not achievable from space

- **O1** Low Clouds
- **O4** Cold Clouds/ Precip
- **O8** Aerosol Indirect Effect
- **O2** High Clouds
- **O3** Convective Storms
- **O5** Aerosol Attrib. & AQ
- **O6** Aerosol Removal, Redistrib. Processing
- **O7** Aerosol DI & Absorption

Requirements Development

Key points:

- Science objectives determined during ACCP
- Full GV list, essential GVs, PoR assets identified in ACCP SATM
- AOS team currently using SATM to form essential GV requirement statements
- AOS team has developed measurement reqs.

Requirements Flowdown

ACCP/AOS Objectives

Objective 1 Low Clouds

Objective 2 High Clouds

Objective 3 Convective Storms

Objective 4 Cold Cloud and Precipitation Processes

Objective 5 Aerosol Attribution and Air-Quality

Objective 6 Aerosol, Removal, Redistribution and Processing

Objective 7 Aerosol Direct Effect and Absorption

Objective 8 Aerosol Indirect Effect

Essential GV Requirements:
Minimum list of GVs needed to address science objectives and drive measurement requirements

PoR GVs:
Orbital and suborbital measurements overlapping with AOS and needed to address objectives

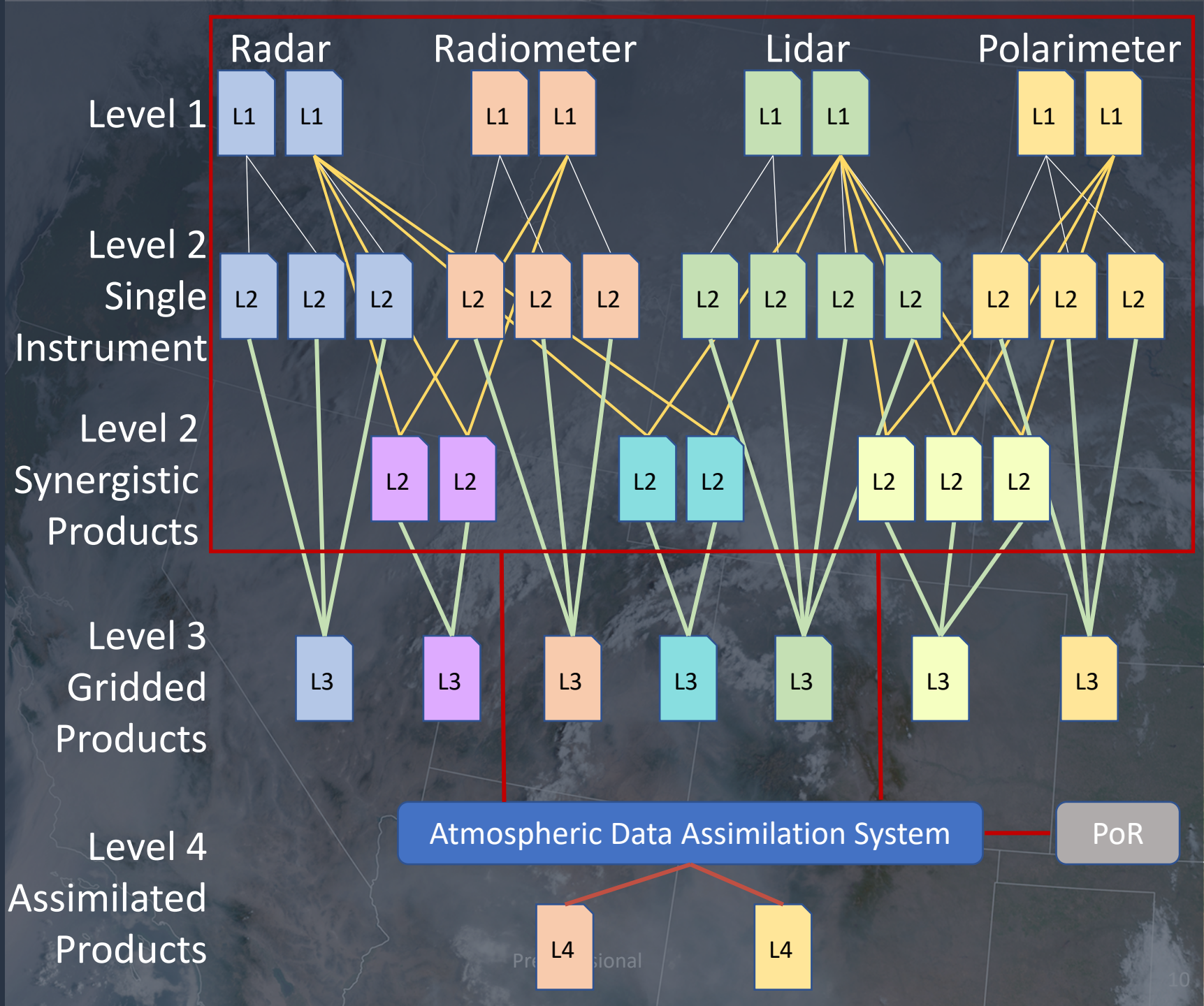
Measurement Requirements:
Key measurements and characteristics delivered by sensors that are used to derive the GVs

Data Products & Algorithm Development

- AWGs identifying list of single-instrument & synergistic products

Near term:

- Detailed map of flow down of products
- Remove redundancies
- Need to identify at-launch vs. post launch products



Prioritizing Descopes Options

- Mission descopes will be needed
- Initial efforts focus on inclined
- Will eventually need to target polar capabilities

Descope prioritization based on importance of inclined mission to key objectives

Assume Inclined threshold has Ku Doppler radar

Team identified W-band radar, backscatter lidar, radiometer, and polarimeter as high value components

Threshold cutoff still to be determined

Inclined

Sub-daily variability emphasized

O3 Convective Storms

O2 High Clouds

O1 Low Clouds

O6 Aerosol Removal, Redistrib. Processing

O5 Aerosol Attrib. & AQ

For more information

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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

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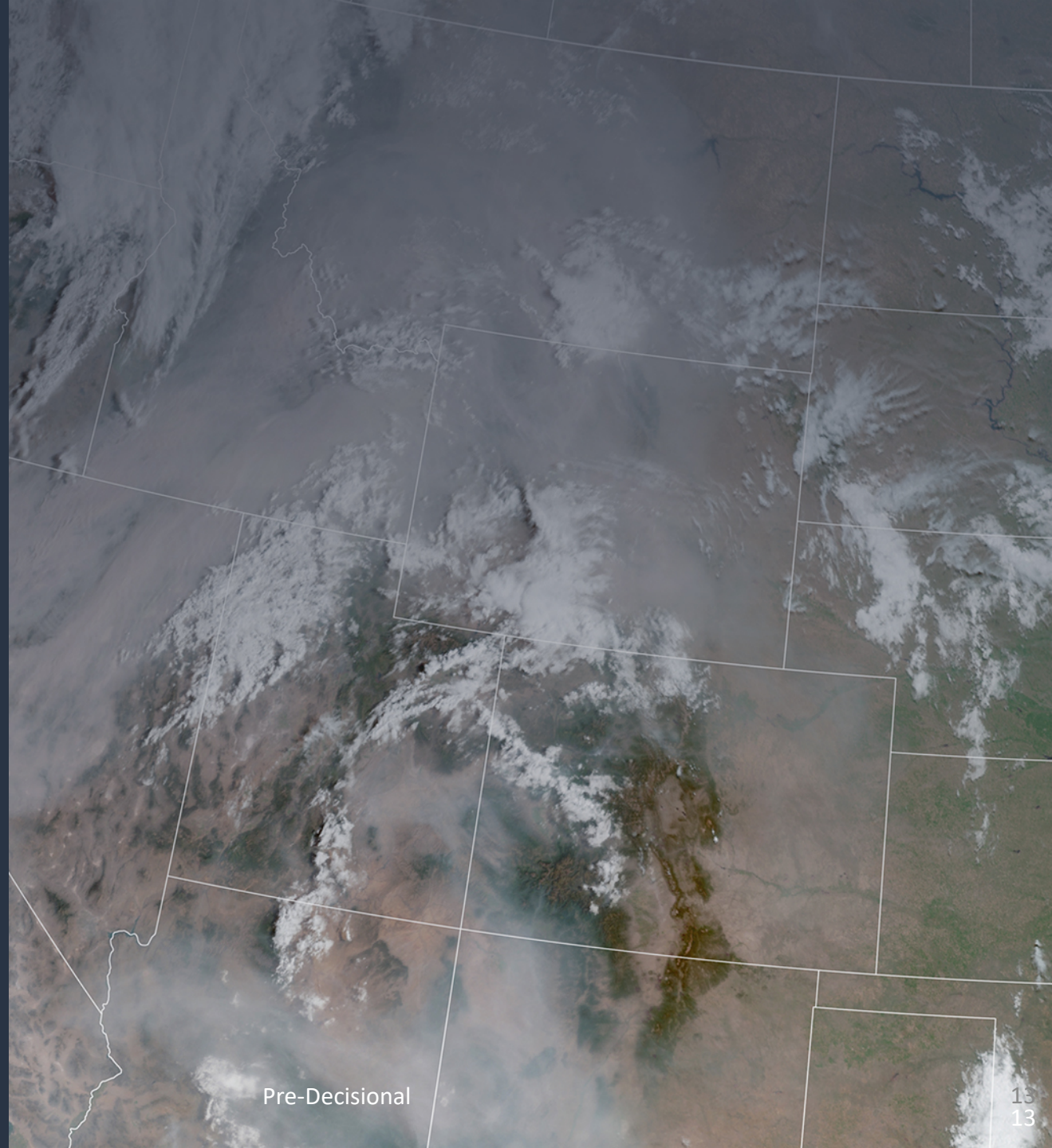

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The Applications Impact Team (AIT) is charged with **ensuring that applications are considered to the greatest extent possible in mission design.**

Activities

- **Stakeholder outreach:** Engage applications communities through workshops, thematic discussions, focus groups, newsletters, etc.
- **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
- **Coordinate/Collaborate** with other DO projects, particularly in reference to the CAR

Deliverables

Community Assessment Report (Pre-Phase A Requirement)

Draft of Project Applications Plan (KDP-A Activity)

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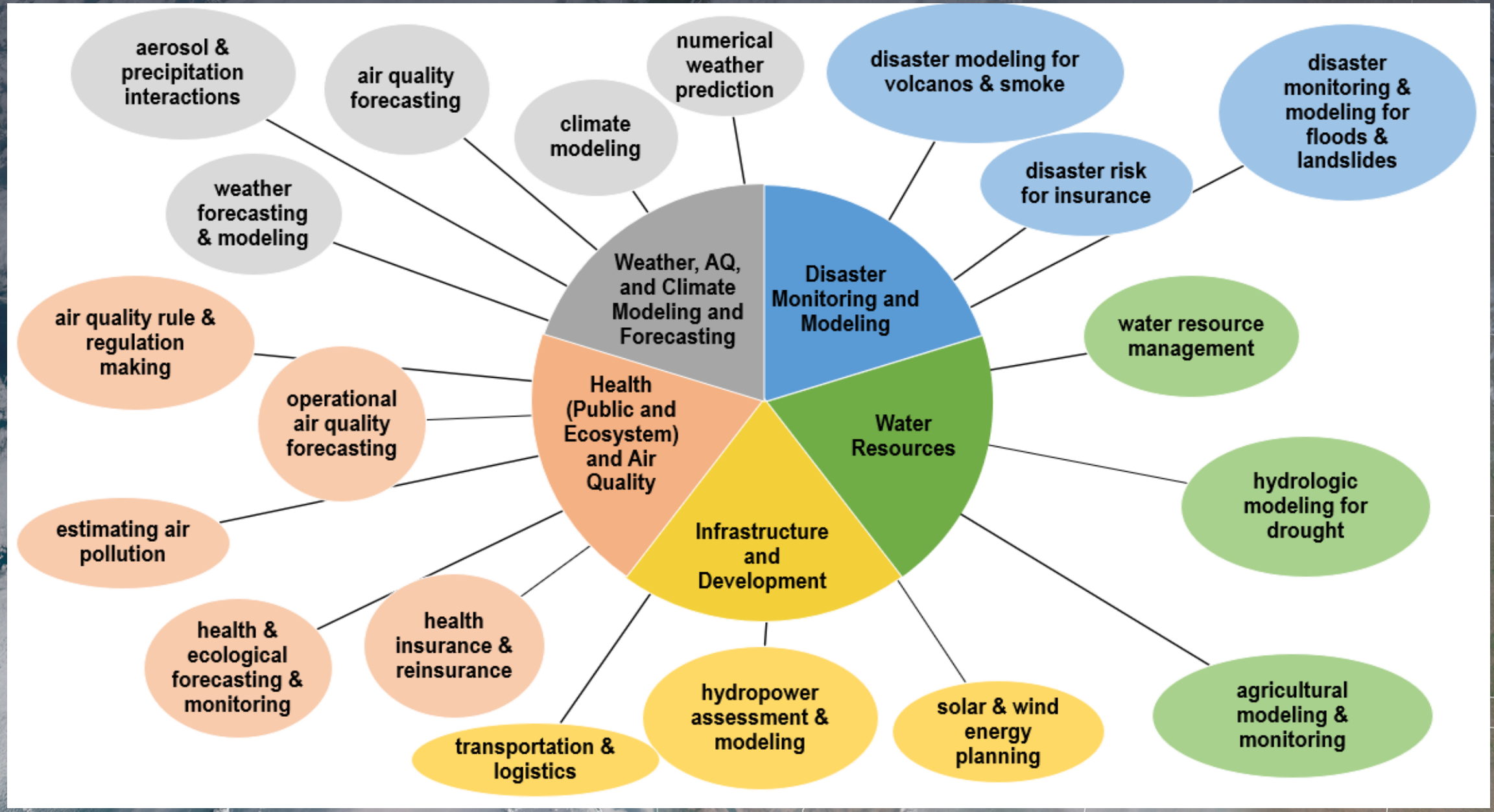
Pre-Decisional

Applications Thematic Areas and High-level Enabled Applications



Project Studies: Applications Needs and Latency

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	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

3-6 hr **Spectrometer** measurement latency to deliver L1-L3 products >6 hrs

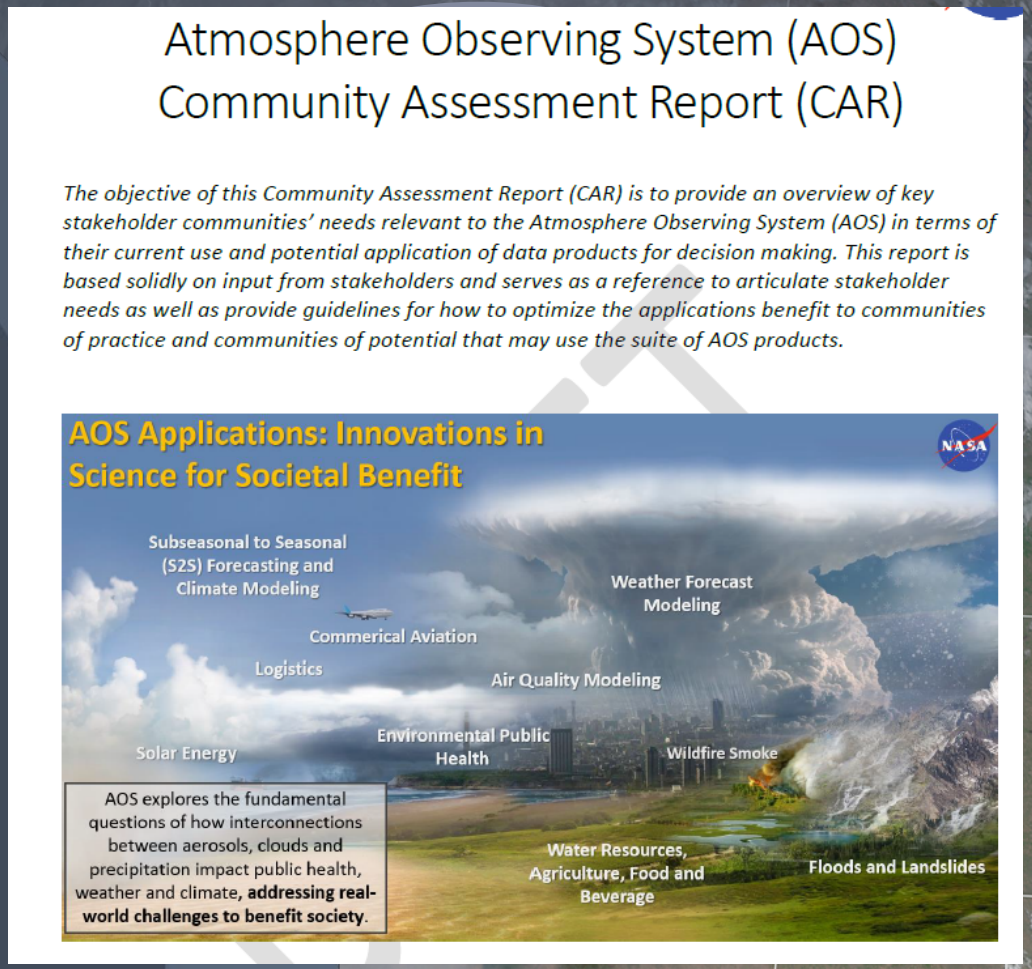
2 hr **Radar, Polarimeter & Lidar** measurement latency to deliver L1-L3 products within 3-6 hrs

<1 hr **Radiometer** measurement latency to deliver L1b radiances within 1h

Latency needs were determined from stakeholder engagement. Measurement latency refers to the baseline ground system latency, product latency refers to the near-real time data latency for products distributed to users.

Community Assessment Report

- Deliverable: Pre-Phase A Requirement
- CAR serves to document and synthesize information and needs from applications communities relevant to AOS that include communities of practice and potential
- CAR makes recommendations and provides suggested guidelines for how components of the AOS mission may be optimized for enhanced applications value
- CAR is a living document and is currently in draft form for internal review



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Applications Seminar Goals

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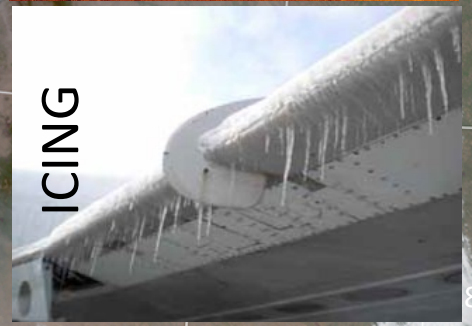
Introduce topics to the community to foster a dialogue on:

- Opportunities to leverage AOS data products in stakeholder applications and research
- Existing gaps in data needs that may present future opportunities for ESO and AOS
- Engagement of communities to increase awareness of and participation in AOS
- Expand breadth of thematic areas covered in preparation for future activities, including Early Adopter Program



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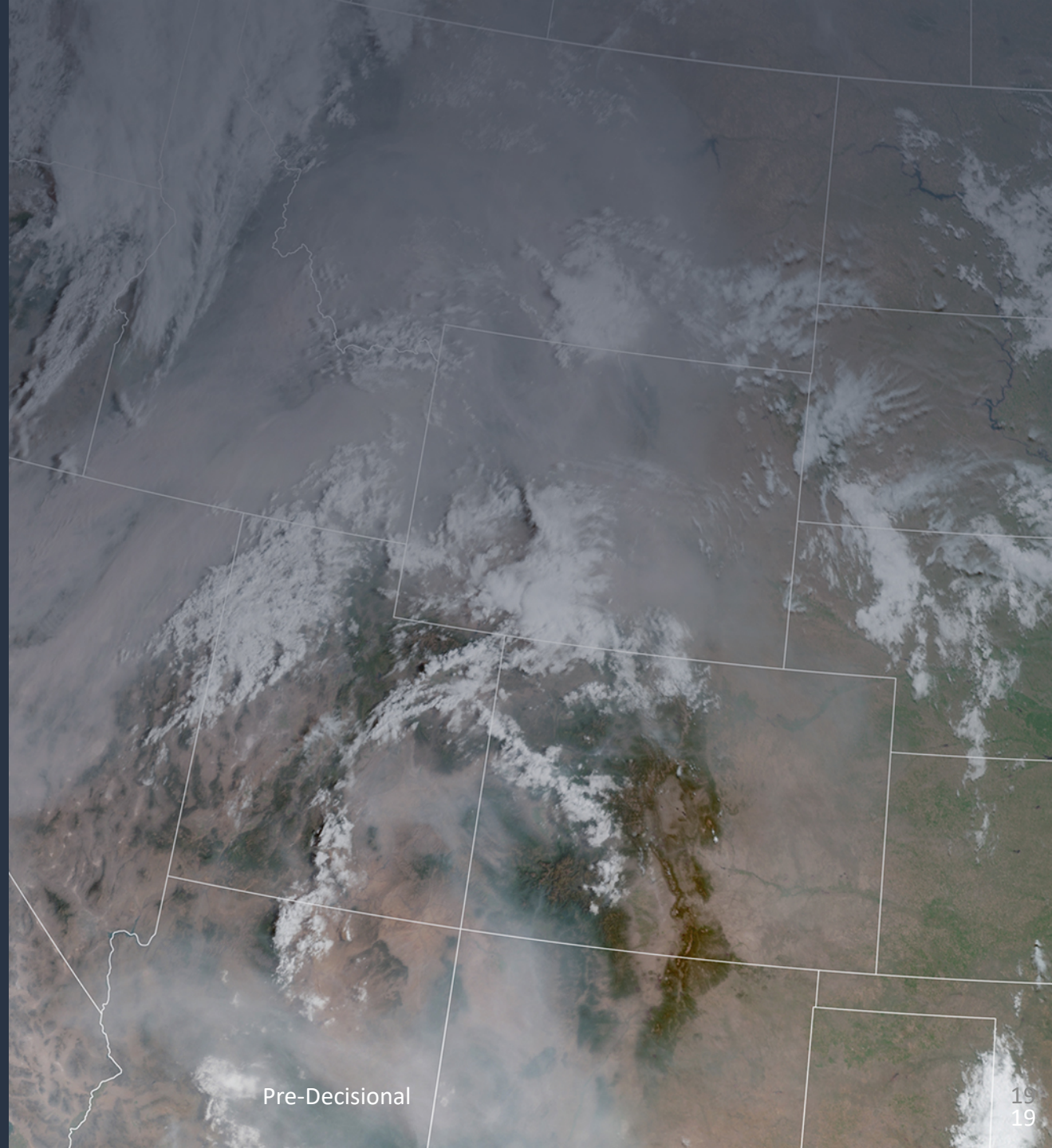

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AOS Suborbital's Focus

Science investigations that:

a) Are *best*, *better*, or *only* done from sub-orbital

b) Provide priors for or are useful to algorithms

c) Provide synergies with calibration / validation

d) Bridge gaps between Program of Record and/or launch schedule

e) Fill gaps that result from descopes in the orbital missions (TBD)

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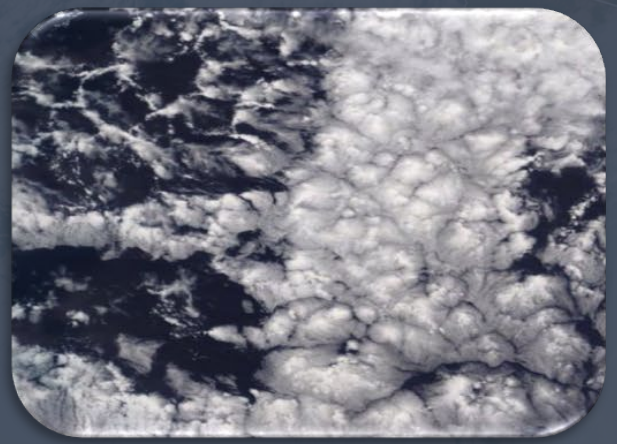
AOS Suborbital Science Themes and Modules

	Low Cloud/ACI	Convection and High Cloud	Aerosol ACI, Attrib./Redistrib.
Science Themes			
Modules	• Precipitation initiation in shallow Cumulus • Open/Close cell transitions in marine stratocumulus • Ice precipitation process in cold marine PBL clouds	• Convective core processes and environment controls • Convective detrainment • Anvil cirrus lifecycle	• Vertically-resolved aerosol effects on cloud formation • Impact of convection on aerosol redistribution and removal • Influence of PBL on aerosol attribution and vertical redistribution

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Science Objectives flow down from our themes / modules:

Low Clouds / Aerosol-Cloud Interaction
Characterize processes associated with precipitation initiation in shallow cumulus and marine stratocumulus, and processes associated with ice-phase precipitation in cold marine planetary boundary layer clouds.

Convection and High Clouds
Understand controls on convective storm processes and lifecycle, from (i) thermodynamic and aerosol characteristics of the storm inflow and outflow, through (ii) vertical evolution of cloud and precipitation microphysics and properties of vertical motions, to (iii) coupling with convective detrainment and (iv) anvil cirrus lifecycle.

Aerosol Cloud Interaction, Attribution, and Redistribution
Vertically resolve aerosol effects on cloud formation, understand (quantify?) the effect of convection on aerosol redistribution and removal, and characterize the influence of the planetary boundary layer on aerosol attribution and vertical redistribution.

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Some outstanding questions:

a) For algorithm teams, what are the most crucial needs from suborbital?

b) What is the timing of those needs, relative to launch dates?

c) For instrument teams, are there key cal/val needs that might not align with the suborbital science investigations (i.e., something requiring a different measurement or regime than we are likely to target otherwise)?

d) Prioritizations of baseline vs threshold

e) Prioritizations of schedule vs launch dates

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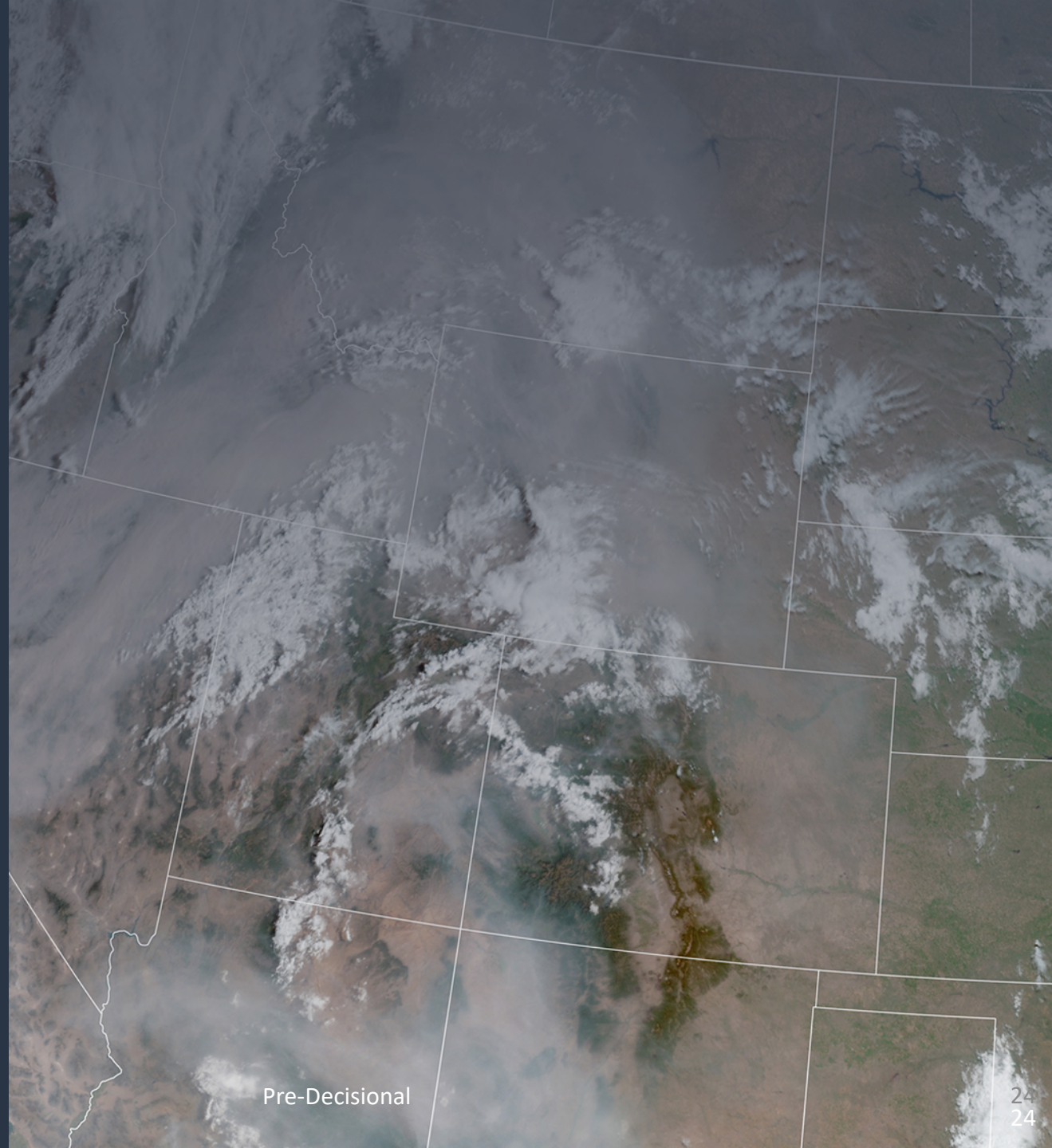
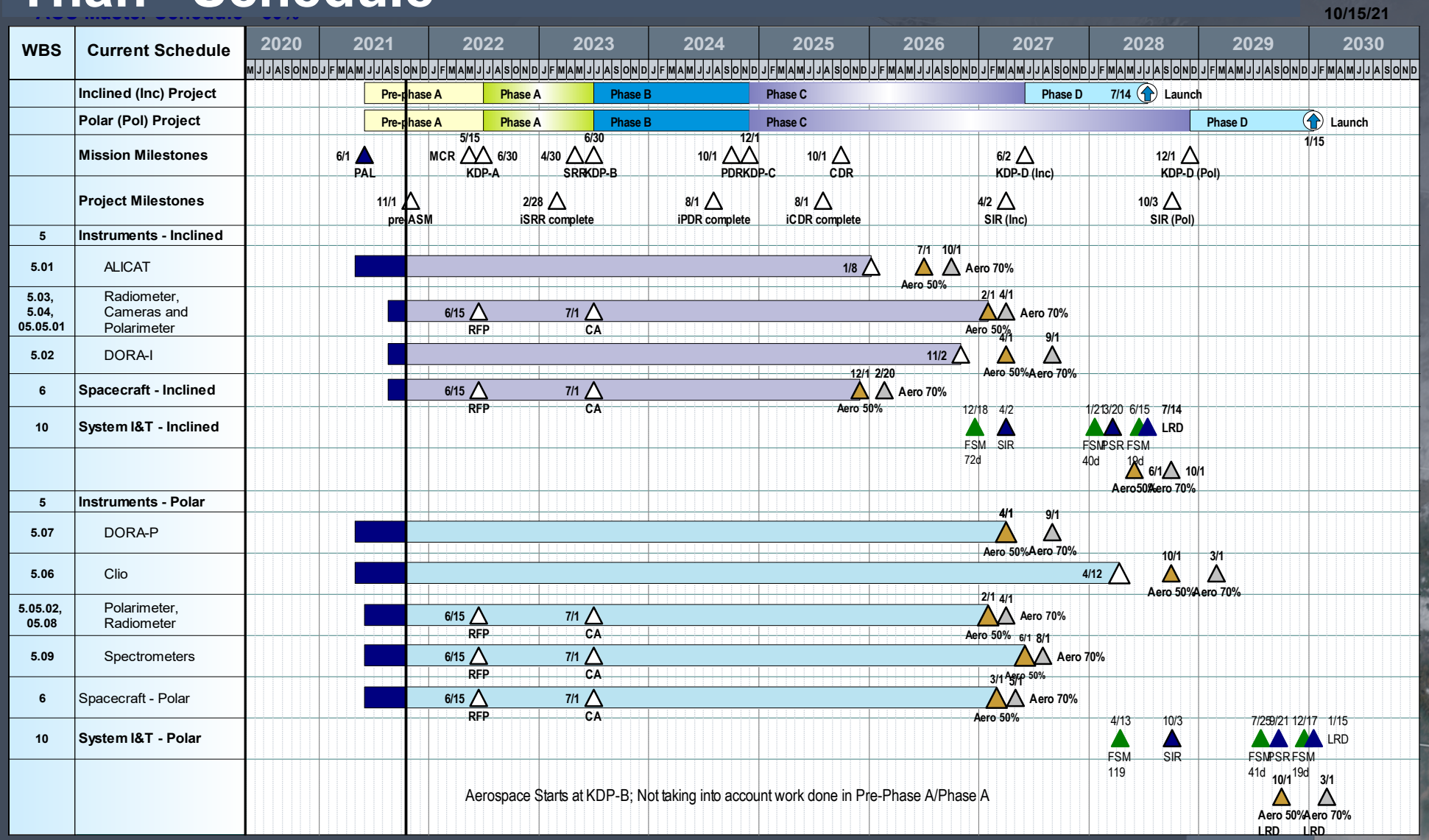


ESO/AOS-I and AOS-P Projects "No Earlier Than" Schedule



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Current construct:
Two Projects fulfilling the AOS Constellation

AOS-Inclined Project (with Launch in July 2028) is responsible for Constellation Level Requirements management/flow down, Instrument & Spacecraft development for the Inclined Orbit launch, Mission Operations & Science Data Processing for the Constellation

AOS-Polar Project (with Launch in January 2030) is responsible for Instrument & Spacecraft development for the Polar Orbit launch and support to Mission Operations and Science Data Processing

Schedule is dependent upon funding profile available

Pre-Phase A High-Level Schedule

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Architecture Recommendation Review 2/5/21

Project Authorization 5/23/21

Pre-Acquisition Strategy Meeting (TBS)

Procurement Strategy Meeting (PSM)

FEB | **MAR** | **APR** | **MAY** | **JUN** | **JULY** | **AUG** | **SEP** | **OCT** | **NOV** | **DEC** | **JAN** 2022 | **FEB** | **MAR**

Project Office Definition

Instrument & Spacecraft RFI Updates and Release

RFI Responses

Study Contract RFP Prep

TMC Reviews

PSM Preparations

Procurement Package Preparations Instruments/SC

Study Contract Proposal Prep & Contract Awards

Study Contract Studies/Trades for MCR

Finalize MCR Documentation & KDP-A Preparation (gate products)

NET KDP-A June 2022

Mission Concept Review 5/15

Phase A Start

Mission PDR 10/1/2024

Mission SRR 4/30/2023

KDP-B 6/30/2023 (Phase B Start) Mission PDR 10/1/2024

APR | **MAY** | **JUNE** | **JULY** | **AUG** | **SEPT** | **OCT** | **NOV** | **DEC** | **JAN** 2023 | **FEB** | **MAR** | **APR**

Procurement Package Preparation Instruments/Spacecraft (cont)

Proposal Preparation

Contract Awards

RFP Release

Element SRRs

Requests for Quote—Instruments & Spacecraft

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Thank you to all the organizations which responded to the RFIs on sam.gov for the Polarimeter, Radiometer, Stereographic Camera, Spectrometer, Backscatter Lidar, HSRL Lidar and Inclined Spacecraft in July-August 2021; These were extremely helpful in updating the instrument capabilities and spacecraft accommodations from the Architecture Study

There are now pending RFQs for Study Contracts ($125K/award; multiple awards) on sam.gov

Polarimeter, Stereographic Camera, Spectrometers due today 11/10/21

- https://sam.gov/opp/497fe761603a4da7a2c032187f8e1bdb/view (Polarimeter)
- https://sam.gov/opp/8025c63cfd0b4a06b75ca343e67693be/view (Spectrometer)
- https://sam.gov/opp/ddcc153a460e4462b9210f1071f23098/view (Camera Suite)

Radiometer and Inclined Spacecraft due 11/17/21

- https://sam.gov/opp/44364c75c82b44c4871c562c2a286d71/view (Radiometer)
- https://sam.gov/opp/ee9687feefcb4eeba94c54c52a6a9fbe/view (Access to Space; Spaceflight Solutions Inclined)

Lidar due 11/19/21

- https://sam.gov/opp/e8fa472015f94fe0ab2a41b403c8409b/view (Lidar)

Study Contracts—Instruments

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We intend to work with instrument study contract awardees to iterate on instrument capabilities and development approaches which are achievable within cost constraints to inform/validate baseline mission at the Mission Concept Review in May 2021

Requests for Proposals for flight instruments expected to be released in Summer 2022

Study Contracts—Access To Space/Spacecraft

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We intend to work with access to space/spacecraft contract awardees on innovative approaches to launch and operate instruments in inclined orbit preferably with reduced data latency and to examine low cost rideshare opportunities with JAXA spacecraft

This will define the achievable baseline going into the Mission Concept Review in May 2021

Requests for Proposals for spacecraft/hosted payloads expected to be released in Summer 2022

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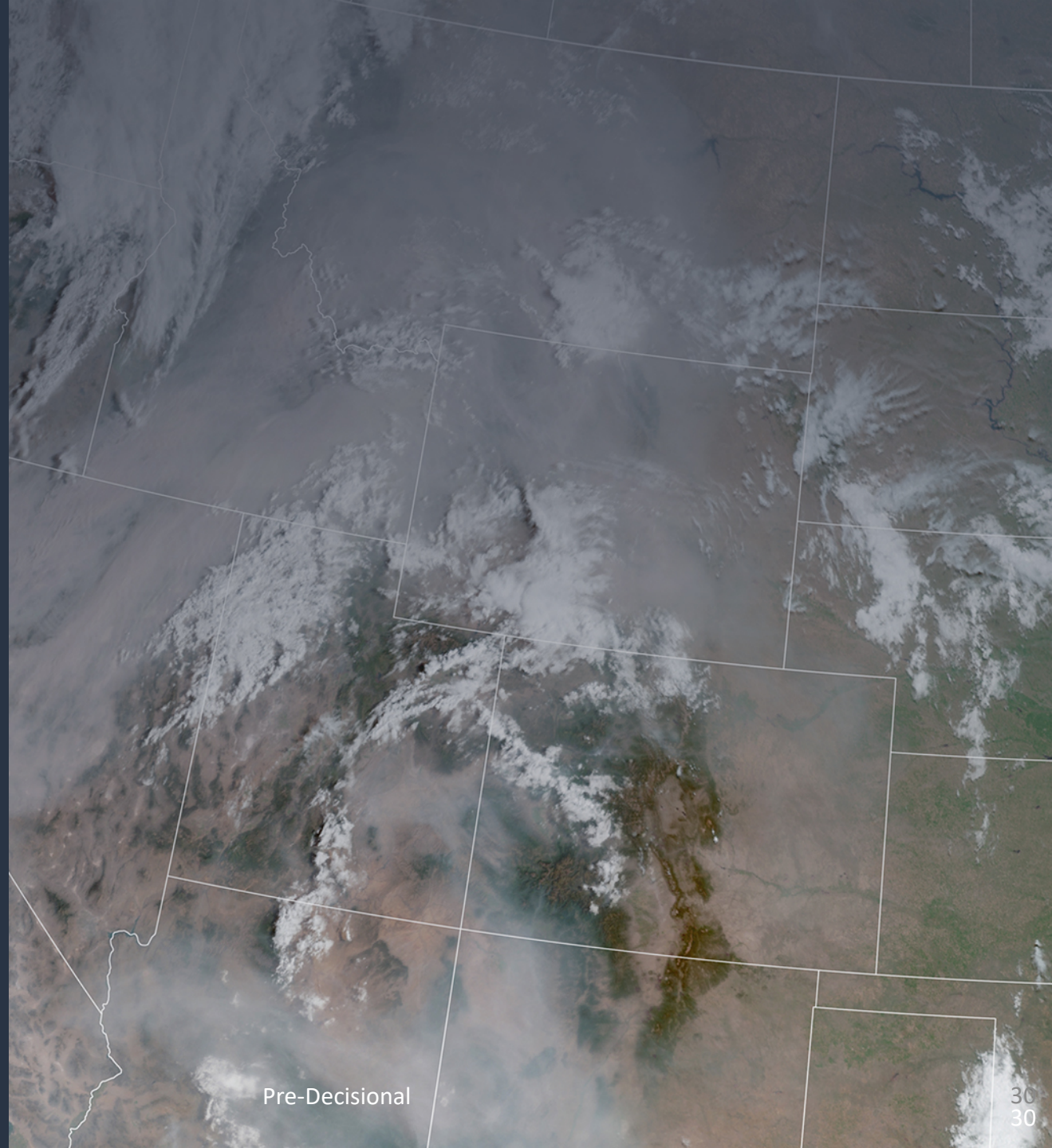

Ways to stay informed

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Web-Site (demo to follow)

Contact Sheri Smith @ a-ccp-comments@lists.nasa.gov

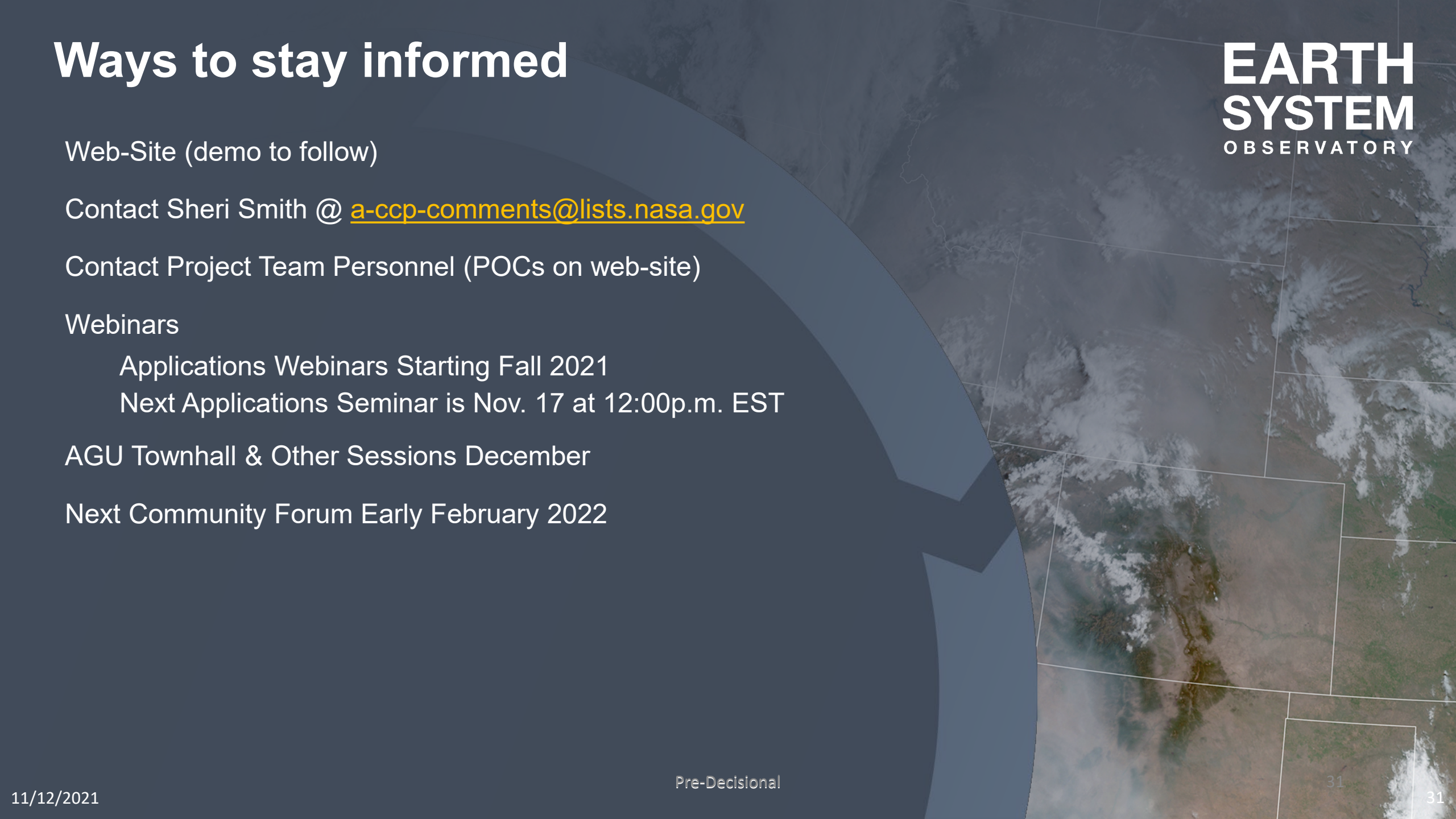
Contact Project Team Personnel (POCs on web-site)

Webinars

- Applications Webinars Starting Fall 2021
- Next Applications Seminar is Nov. 17 at 12:00p.m. EST

AGU Townhall & Other Sessions December

Next Community Forum Early February 2022



New Project Web-Site

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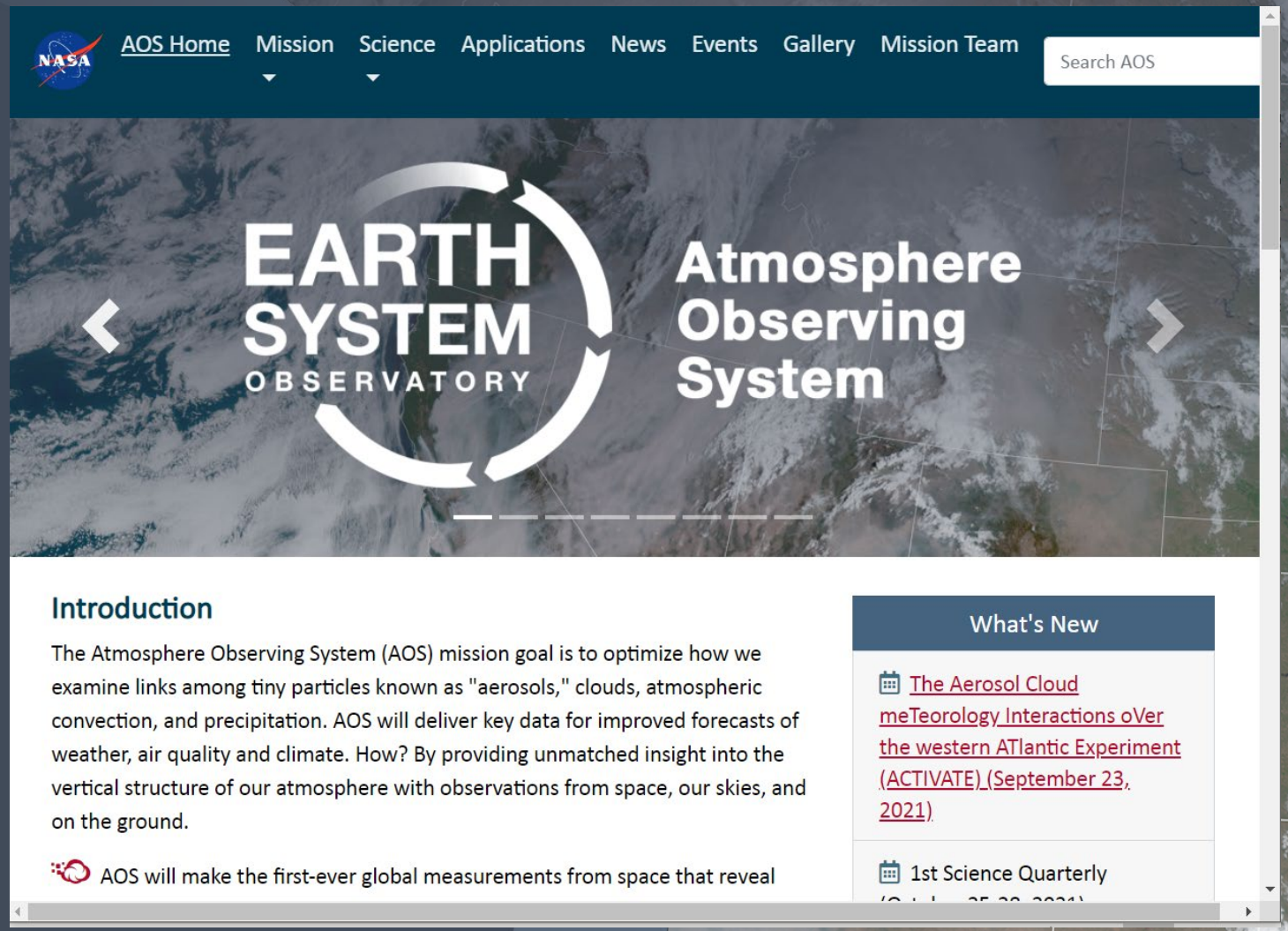
Existing ACCP Architecture Study Web-Site In Use

New Mission/Project Web-Site In Development
https://aos.gsfc.nasa.gov

Note: For now, https://aos.gsfc.nasa.gov redirects back to ACCP Architecture Study web-site



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