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 curiously-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.

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’s 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.

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.

DS Science Questions Related to ACCP
- Number of Billion Dollar events per year over the years from 2002 to 2019.
- Radiative forcing of climate between 1750 and 2005.
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
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

- **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

**Polar Orbit**
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

**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)

**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)

**Project Science, SATT Leads**
- Scott Braun, PS (GSFC)
- John Yorks, DPS Inclined (GSFC)
- Tyler Thorsen, DPS Polar (LaRC)
- Daniel Cecil, DPS SO (MSFC)

**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)

**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:

• ACCP Final Architecture Recommendation Review:
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.**

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.

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

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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

<table>
<thead>
<tr>
<th>Description</th>
<th><strong>SSG-1</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>SmallSat Radar</td>
<td>Ku w/Higher Accuracy Doppler and W Band w/Lower Accuracy Doppler</td>
</tr>
<tr>
<td>Stereo Camera</td>
<td>Visible Camera #1 of 2 for Tandem Measurements on 2 Spacecraft</td>
</tr>
</tbody>
</table>

### Polar Elements

<table>
<thead>
<tr>
<th>Description</th>
<th><strong>SSG-2</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Backscatter Lidar</td>
<td>532nm, 1064nm</td>
</tr>
<tr>
<td>Microwave Radiometer</td>
<td>118-880GHz OR 89-325GHz</td>
</tr>
<tr>
<td>Polarimeter</td>
<td>UV/VIS, VNIR/SWIR Narrow Swath</td>
</tr>
<tr>
<td>Stereo Camera</td>
<td>Visible Camera #2 of 2 for Tandem Measurements on 2 Spacecraft</td>
</tr>
</tbody>
</table>
ESO/AOS
One Observing System,
Two Synergistic Segments

- 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

International Contributions Under Study
Applications Considerations
# ESO/AOS Applications Latencies

## Long-term Decisions

**Weather Forecasting**
- **> 6 hour Latency**
  - Applied research studies
  - Improve algorithms
  - Model verification

**Disaster Modeling/Monitoring**
- **> 6 hour Latency**
  - Disaster relief & preparedness
  - Community planning
  - Developing models and studying past events

**Health & Air Quality**
- **> 6 hour Latency**
  - Exceptional event demonstrations and aerosol transport
  - Health studies/trends

## Short-term Decisions

**Weather Forecasting**
- **3-6 hour Latency**
  - Operational hurricane forecasting
  - Operational weather forecasting
  - Operational model data assimilation

**Disaster Modeling/Monitoring**
- **3-6 hour Latency**
  - Volcanic disasters/warnings for aviation
  - Smoke/dust and air quality warnings for human health

**Health & Air Quality**
- **3-6 hour Latency**
  - Air quality model data assimilation
  - Air quality forecasting
  - Smoke modeling

## Time-critical Decisions

**Weather Forecasting**
- **1 hour Latency**
  - Weather nowcasting/warnings
  - Fire weather/smoke forecasts
  - Dust storm warnings
  - Ingest in rapid update models

**Disaster Modeling/Monitoring**
- **1 hour Latency**
  - Disaster warning, evacuation, response, mobilization
  - Short-term flooding/landslide risk assessment

**Health & Air Quality**
- **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

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Requires baseline ground system latency (aka measurement latency) through LZP within</th>
<th>In order to deliver ____ to end users</th>
<th>with end user data latency of</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiometer</td>
<td>&lt;1 hour</td>
<td>L1b radiances</td>
<td>1 – 3 hours</td>
</tr>
<tr>
<td>Radar</td>
<td>2 hours</td>
<td>L1 – L2 products</td>
<td>3 – 6 hours</td>
</tr>
<tr>
<td>Lidar</td>
<td>2 hours</td>
<td>L1 – L3 products</td>
<td>3 – 6 hours</td>
</tr>
<tr>
<td>Polarimeter</td>
<td>2 hours</td>
<td>L1 – L3 products</td>
<td>3 – 6 hours</td>
</tr>
<tr>
<td>Spectrometer</td>
<td>3-6 hours</td>
<td>L1 – L3 products</td>
<td>≤ 6 hours</td>
</tr>
</tbody>
</table>
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**
- **Applications Team Lead and rep to SATT**
  - Dalia Kirschbaum (GSFC)
- **Inclined Applications Lead**
  - Emily Berndt (MSFC)
- **Polar Applications Lead**
  - Ali Omar (LaRC)
- **NASA Team Members**
  - Melanie Follette Cook (GSFC)
  - Bryan Duncan (GSFC)
  - Anita LeRoy (MSFC)
  - Patrick Gatlin (MSFC)
  - Svetla Hristova-Veleva (JPL)
  - Aaron Naeger (MSFC)
  - Olga Kalashnikova (JPL)
- **Applications Coordinator**
  - Andrea Portier (GSFC)
- **International Reps**
  - Danahe Paquin-Ricard (ECCC)
  - Solene Turquet (LMD/ U. of Sorbonne)
  - Laaziz El Amraoui (CNRM)
  - Takuji Kubota (JAXA)
  - Yasutaka Ikuta (JMA)
- **NASA Team Volunteer Participants**
  - Levi Goldston (ARC)
  - Jonathan Jiang (JPL)
  - Baijun Tian (JPL)
- **Non-NASA Team Volunteer Participants**
  - James Campbell (NRL)
  - Peirre Kirstetter (NOAA)
Community Assessment Report for ACCP: Enabled Application Areas Covered

- Environmental Public Health and Pollution
- Numerical Weather Prediction and Tropical Cyclone Forecasting
- S2S Forecasting and Climate Modeling
- Air Quality Modeling (forecasting)
- Commercial Aviation
- Logistics
- Food and Beverage Companies in Tropical Climates
- Water Resources
- Solar Energy
- Data Driven Agriculture
- Wildfires and Smoke
- Wildfires and Smoke
- Commercial Aviation
Plan Forward for Mission / Projects
ESO/AOS-I and AOS-P Projects “No Earlier Than” Schedule

**FY21**
- Pre-Phase A Start: 6/1/21
- Pre-Phase A: 11.5 mos

**FY22**
- Phase A: 10.5 mos
- Phase A Start: 6/1/21

**FY23**
- Phase B: 17 mos
- Element SRRs: 11/15/22
- Mission SRR: 1/15/23
- KDP-A: 5/15/22

**FY24**
- Phase C: 24 mos (Inclined; 36 mos Polar)
- FY25: 8 mos
- FY26: 26 mos

**FY25**
- KDP-D: Inclined
- To Launch: 19 mos
- FY27: 14 mos

**FY26**
- KDP-D Polar
- To Launch: 19 mos
- FY28: 14 mos

**FY27**
- Element PDRs: 5/1/24
- Mission PDR: 7/1/24
- KDP-C: 9/1/24; Mission Confirmation

**FY28**
- Element CDRs: 5/1/25
- Mission CDR: 7/1/25
- SIR-P: 7/1/27
- Launch P: 4/1/29

**FY29**
- KDP-D Polar: 9/1/27

**FY30**
- 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

**FY31**
- 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

International Agreements
- @ KDP-B
- TIFIRE needed for Integration to SSP1 7/1/27
- CSA Observatory due for Integration to Launch Vehicle 1/1/28

Launch I: 4/1/28
Pre-Phase A High Level Schedule—Look Ahead Phase A

- **Project Authorization 5/23/21**
- **Pre-Acquisition Strategy Meeting (TBS)**
- **Procurement Strategy Meeting (PSM)**
- **Instrument & Spacecraft RFI Updates and Release**
- **RFI Responses**
- **Study Contract Proposal Prep**
- **Study Contract Awards**
- **Study Contract Studies/Trades for MCR**
- **Finalize MCR Documentation & KDP-A Preparation (gate products)**
- **Mission SRR 1/15/23**
- **KDP-B 4/1/23**
- **Mission PDR 7/1/24**

**Important Dates:**
- **KDP-A 5/15/22**
- **Mission Concept Review 4/15/22**
- **Phase A Start**
- **Phase B Start**
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

Introduction

The Aerosol, Cloud, Convection and Precipitation (ACCP) study is assessing designs for NASA’s next suite of atmospheric observations. The goal is to optimize how we examine links among tiny particles known as "aerosols," clouds, atmospheric convection, and precipitation. ACCP will deliver key data for improved forecasts of weather, air quality and climate. How? By providing unmatched insight into the vertical structure of our atmosphere with observations from space, our skies, and on the ground.
## Directory

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### Project Support/Communications
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Questions/Comments

• Open Discussion—Panel include Presenters