ATMOSPHERE

EARTH SYSTEM OBSERVATORY

National Aeronautics and Space Administration

NASA

Open Source Science for ESO Mission Processing Study

Workshop #1
October 19-20, 2021

Atmosphere Observing System Programmatic Perspective

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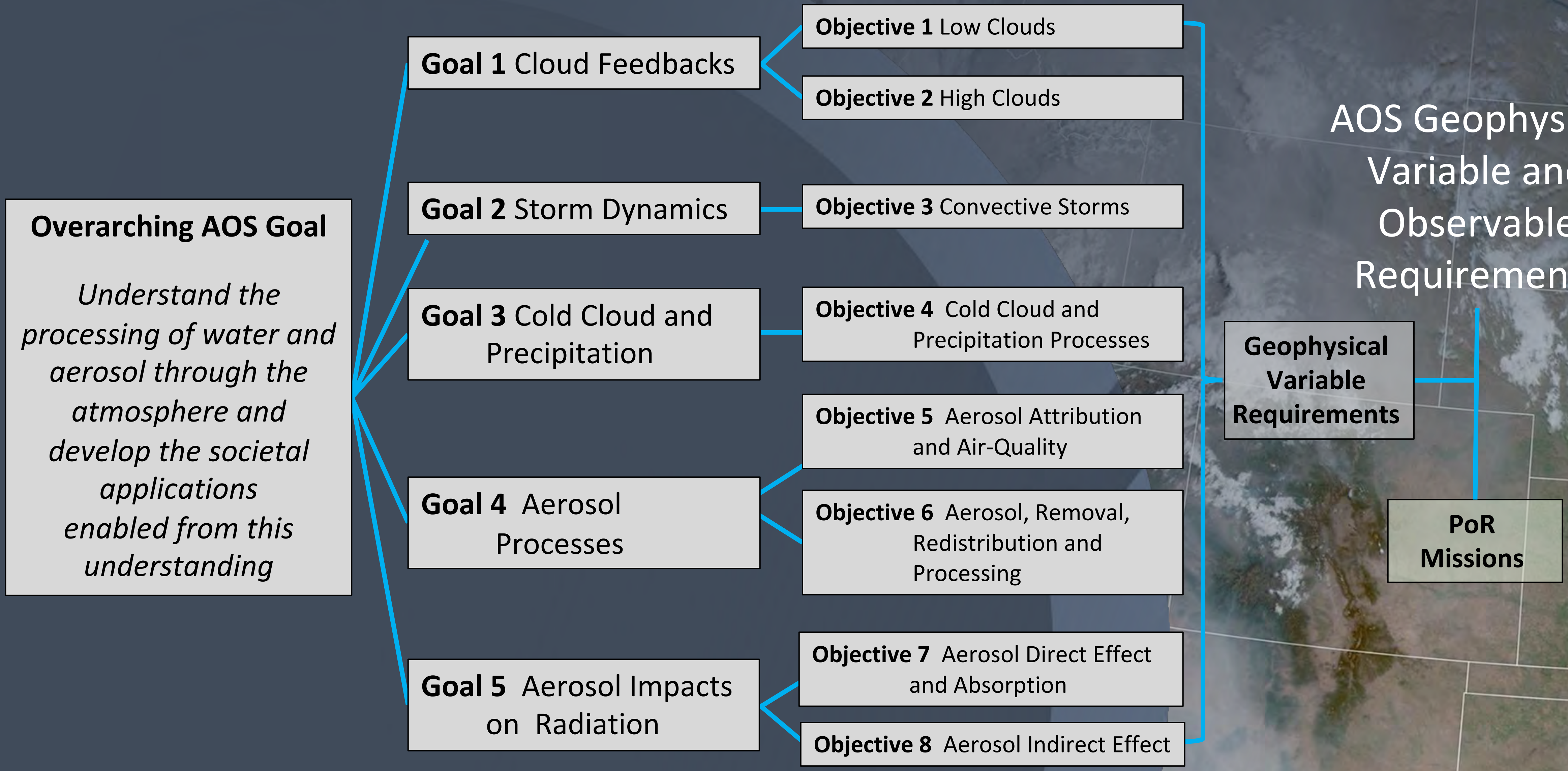
AOS Science Goals and Objectives



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AOS addresses both Aerosol and Clouds, Convection, & Precipitation DO Science

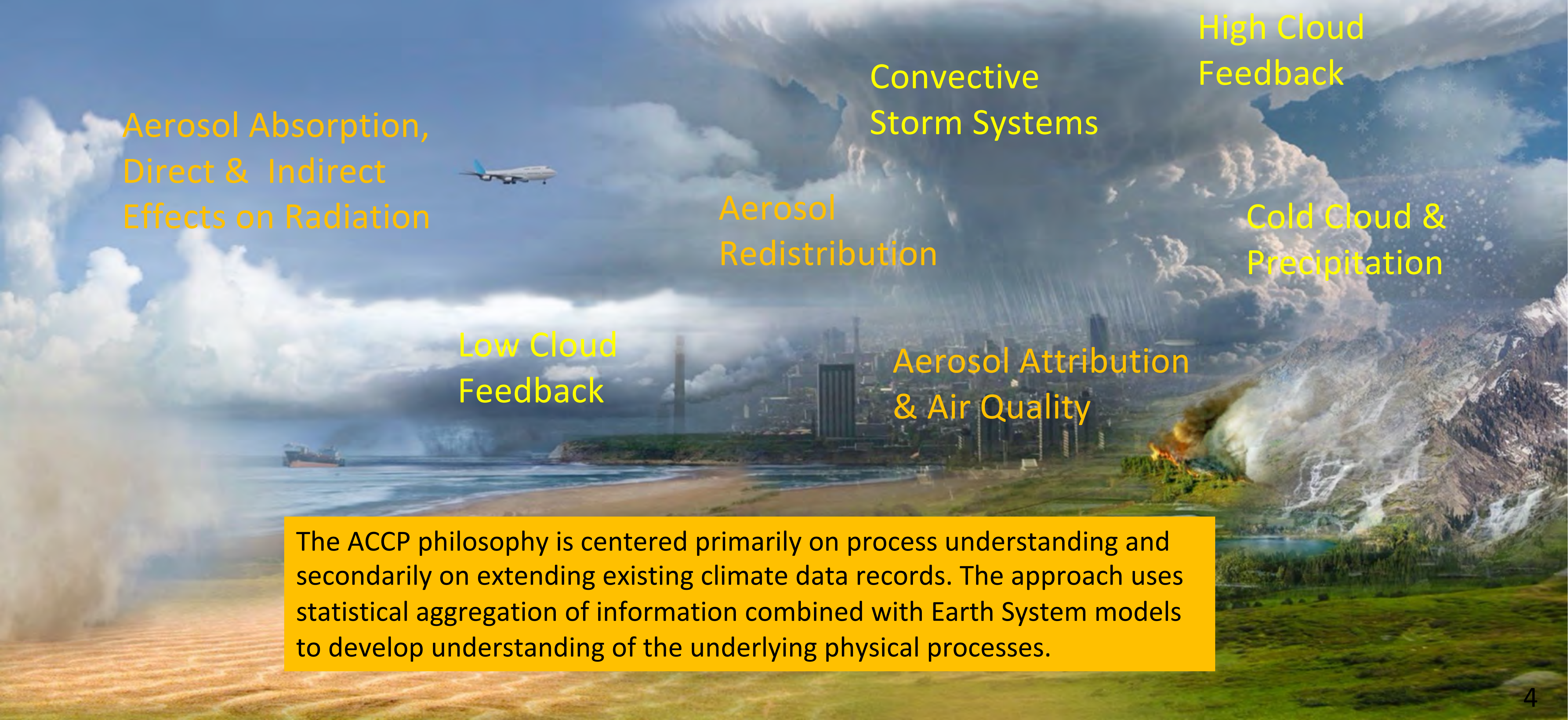
Overarching AOS Goal	A+ CC P	A	CC P	2017 DS Most Important Very Important	Goals
Understand the processing of water and aerosol through the atmosphere and develop the societal applications enabled from this understanding.				W-1a, W-2a, C-2a (Most Important); C-2g (Very Important)	**G1** Cloud Feedbacks Reduce the uncertainty in low- and high-cloud climate feedbacks by advancing our ability to predict the properties of low and high clouds.
				W-1a, W-2a, W-4a, H-1b (Most Important); C-2g, C-5c (Very Important)	**G2** Storm Dynamics Improve our physical understanding and model representations of cloud, precipitation *and dynamical* processes within convective storms.
				H-1b, W-1a, S-4a (Most Important); W-3a (Very Important)	**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.
				W-1a, W-5a (Most Important); C-5a (Very Important)	**G4** Aerosol Processes Reduce uncertainty in key processes that link aerosols to weather, climate and air quality related impacts.
		D I		C-2a, C-2h (Most Important); C-5c (Very Important)	**G5** Aerosol Impacts on Radiation Reduce the uncertainty in Direct (D) and Indirect (I) aerosol-related radiative forcing of the climate system.

Goal only fully realizable via combined mission.

A or CCP makes meaningful contribution to goal

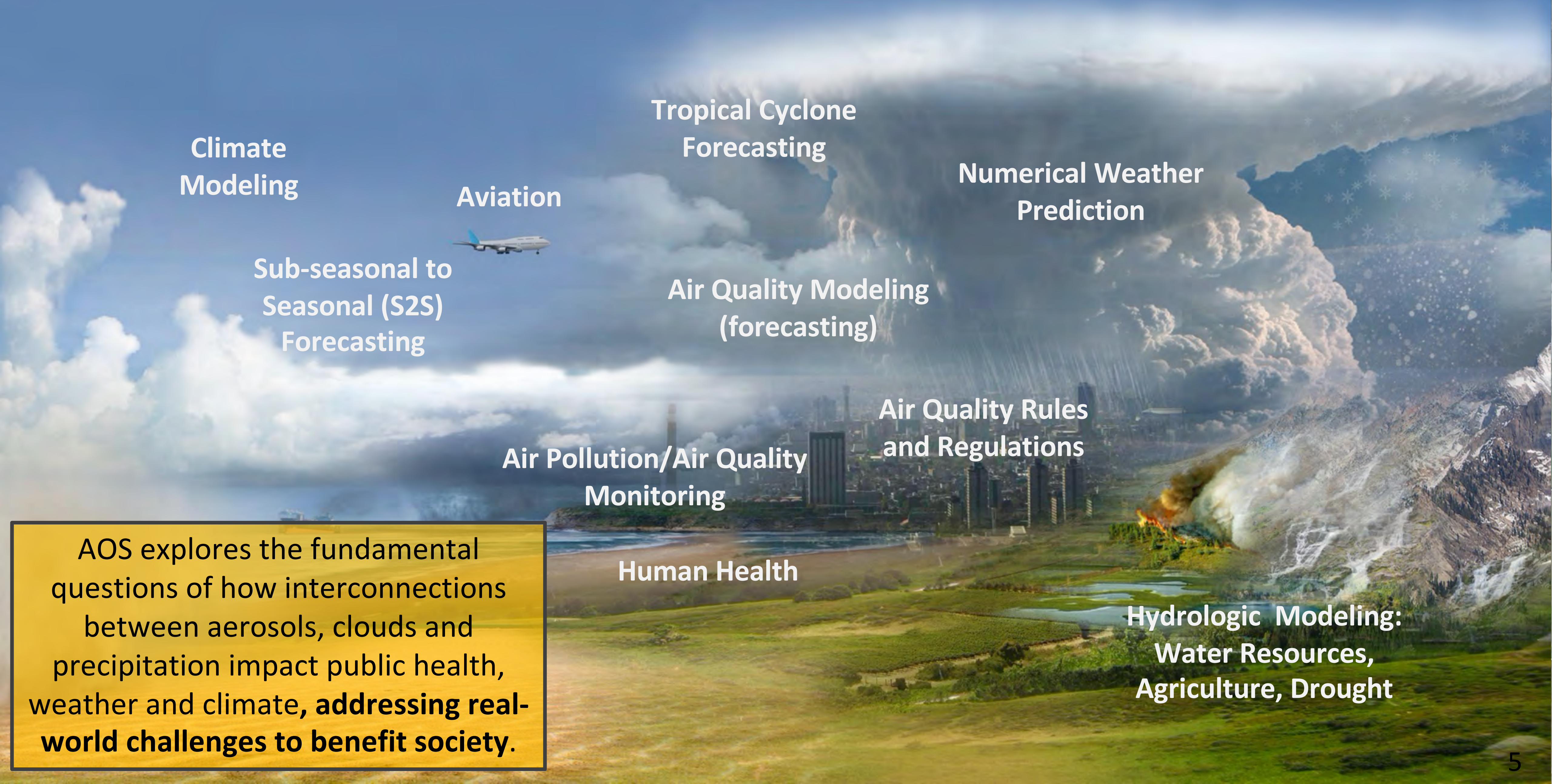
Science Objectives

8 Science Objectives
Traceable to the 2017 Decadal Survey



The ACCP philosophy is centered primarily on process understanding and secondarily on extending existing climate data records. The approach uses statistical aggregation of information combined with Earth System models to develop understanding of the underlying physical processes.

Applications Objectives



AOS explores the fundamental questions of how interconnections between aerosols, clouds and precipitation impact public health, weather and climate**, addressing real-world challenges to benefit society**.

AOS: One Observing System, Two Synergistic Space Segments

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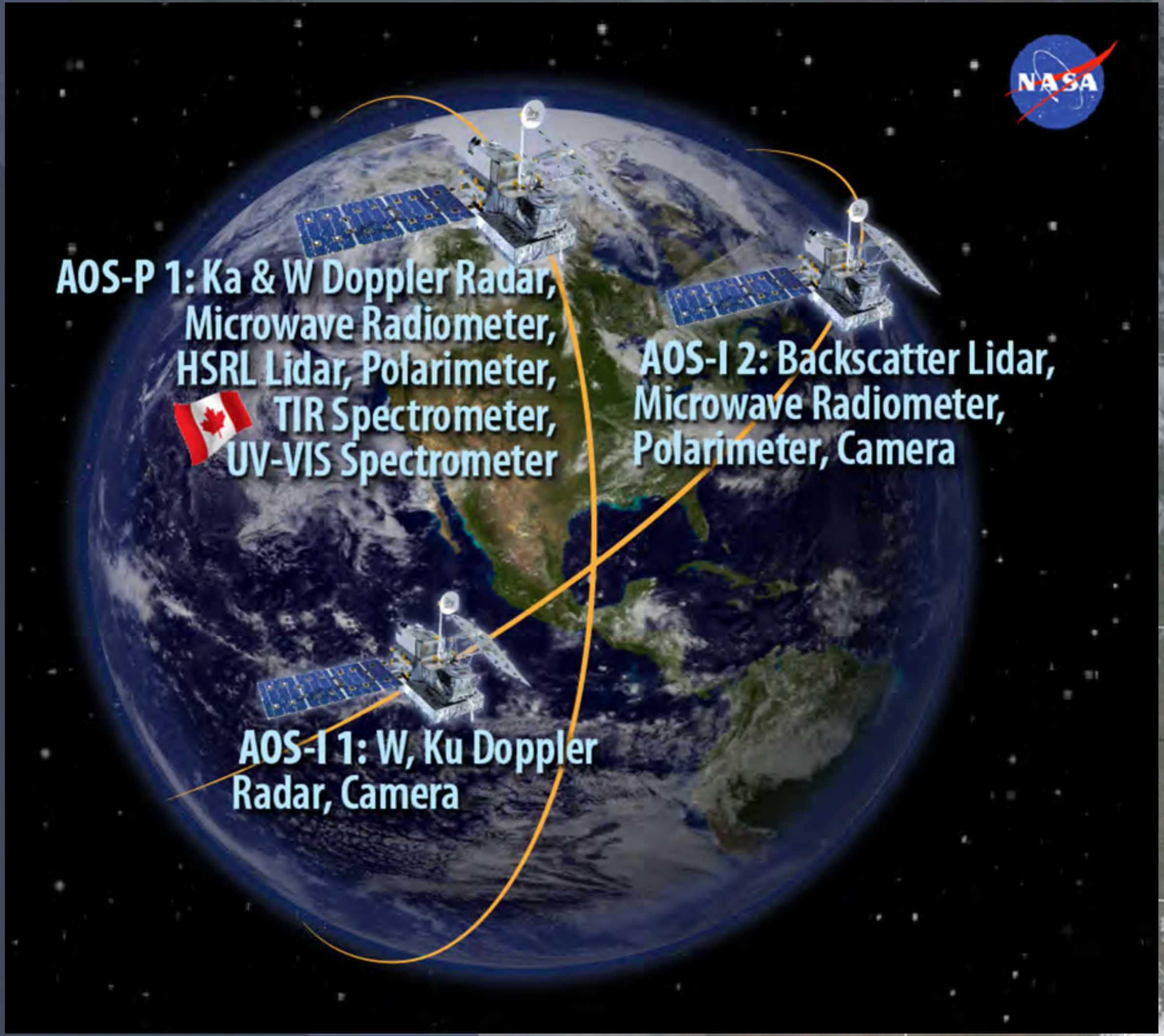
Constellation:

- Inclined orbit targets sub-daily variability, with unique measurements with Ku Doppler radar, tandem stereo cameras
- Polar orbit targets climate processes with enhanced W-band Doppler capability, HSRL lidar, radiation
- Additional contributions from JAXA, CSA, CNES under study



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AOS Sensors: Spaceborne & Suborbital

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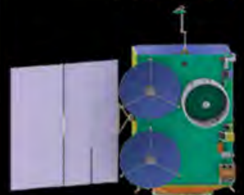
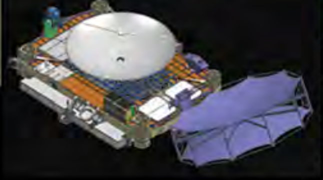
AOS - P1



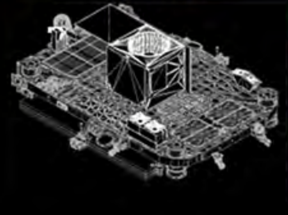
AOS-P1 Total Payload Mass/Power		
	Mass from RFI	QA Power RFI
Ka & W Doppler Radar	114.40	318.50
Lidar05	435.50	643.50
Microwave Radiometer	3.90	15.60
Polarimeter	61	60
TIR Spectrometer	13.00	19.50
UV-VIS Spectrometer	39	91
Total	667	1148

AOS-I1



AOS-I1 Total Payload Mass/Power		
	Mass	Power
Ku Doppler & W Radar	92.08	225.00
Camera	7.20	12.70
Total	99	238

AOS-I2



AOS-I2 Total Payload Mass/Power		
	Mass	Power
Backscatter Lidar	132.60	382.20
Microwave Radiometer	3.90	15.60
Polarimeter	27	60
Camera	7.20	12.70
Total	170.7	470.5

Instrument Identification

Instrument Identification		
Instrument	**Size**	**Description**
Ka & W Doppler Radar	Medium Sat Radar	W Band Doppler, Ka Band Doppler; 15km Swath
Ku Doppler & W Radar	Small Sat Radar	W Band Doppler, Ku Band Doppler
Microwave Radiometer	Small Sat Radiometer	118, 183, 240, 310, 380, 660, 880 GHz
HSRL Lidar	Medium Sat Lidar	532nm HSRL; 1064nm Backs catter
Backscatter Lidar	Small Sat Lidar	532nm, 1064nm Back-Scatter
Microwave Radiometer	Small-Med Sat Polarimeter	550km Swath; .5km resolution
Polarimeter	Small Sat Polarimeter	1130km Swath; 1km resolution
TIR Spectrometer	Small Sat Spectrometer	Long Wave Infrared
UV-VIS Spectrometer	Small Sat Spectrometer	Short Wave Infrared
Camera	Small Sat Cameras	Stereo Camera Visible Imaging

Radar sends out radio waves and picks them up again after the waves strike another object and bounce back.

Lidar is similar to radar, but instead of bouncing radio waves off its target, lidar uses short pulses of laser light.

Radiometers are often combined with radar and lidar to derive meteorological parameters such as temperature, humidity, and water vapor.

Spectrometer is used to separate and measure wavelengths of light as it interacts with materials, in this case trace gases and particulates.

Polarimeter measures the angle of rotation of different angles of sunlight scattering off substances such as aerosols.

Suborbital

Suborbital instruments and sensors support science, calibration/validation and environmental monitoring activities by providing ancillary data for satellite calibration and validation and finer-scale process studies.

How do we better predict storms with powerful updrafts that "overshoot" their tops, churning out tornadoes and destructive hailstones?

How do tiny airborne particles – known as "aerosols" – affect cloud and precipitation formation in clouds at various altitudes? How do the aerosols influence radiation transfer over or near clouds?

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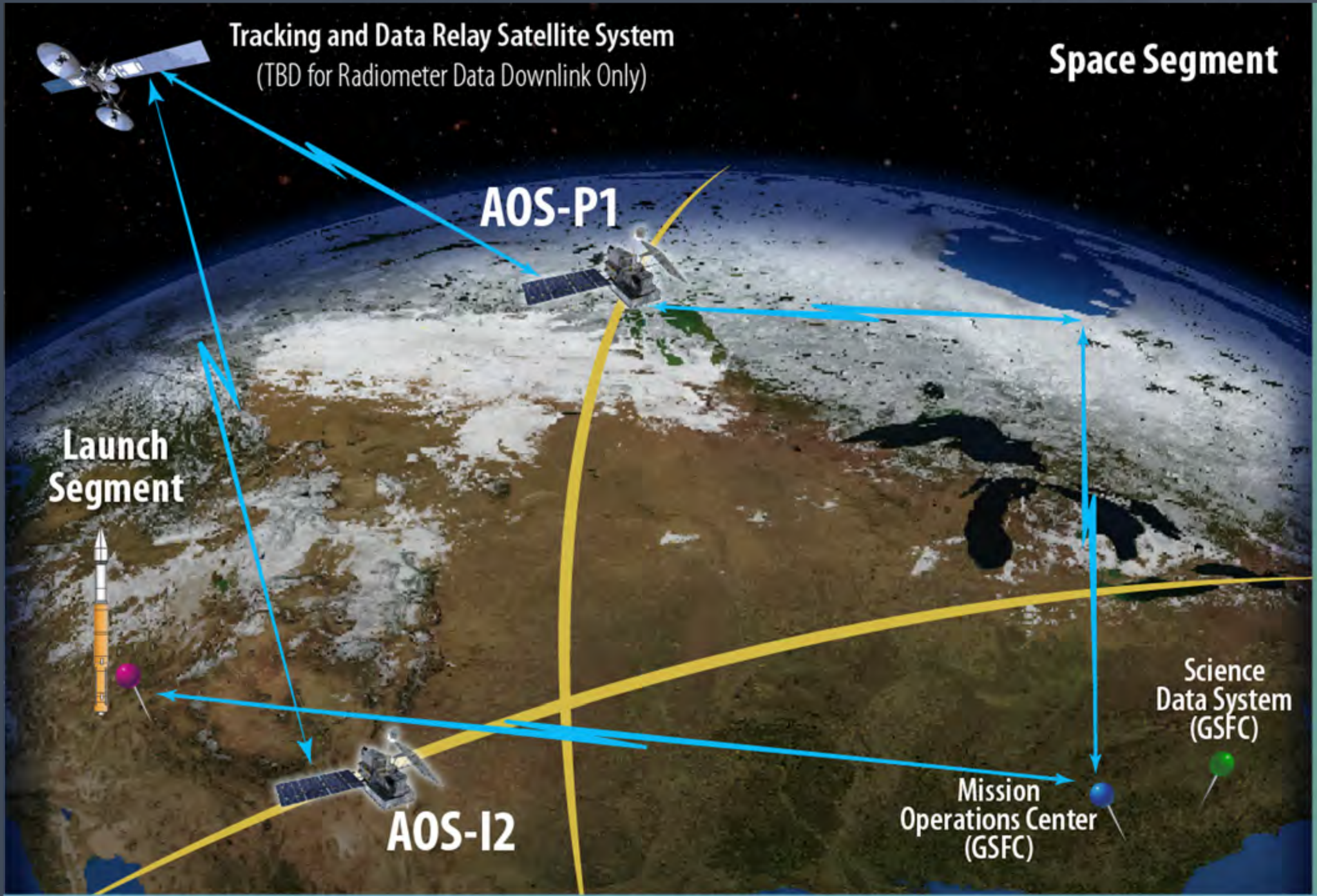

Earth System Observatory
AOS
Atmosphere Observing System

Science & Applications

Data Segment

Data Processing

- Operations
- Software
- Instrument Calibration
- Validation

External Elements

- Distributed Active Archive Center
- Vicarious Calibration
- Competed Science
- Research Community

Ground Segment

Fairbanks
Alaska US

Punta Arenas
Chile

Svalbard
Norway

Wallops
Viriginia, US

Primary Telemetry & Command (T&C) and Science Data Downlink (via ~8 Contacts/day 4.8 Gbps Ka Band) with Potential Contribution from CSA at Inuvik. Potential option for inclined spacecraft to use Starlink communi-cations at 1Gbps (cross-linked) to reduce latency <1s

White Sands
New Mexico, US

Augments Science Data Downlink To Reduce Latency

Goddard Space Flight Center (GSFC)
Maryland, US

Mission Operations Center

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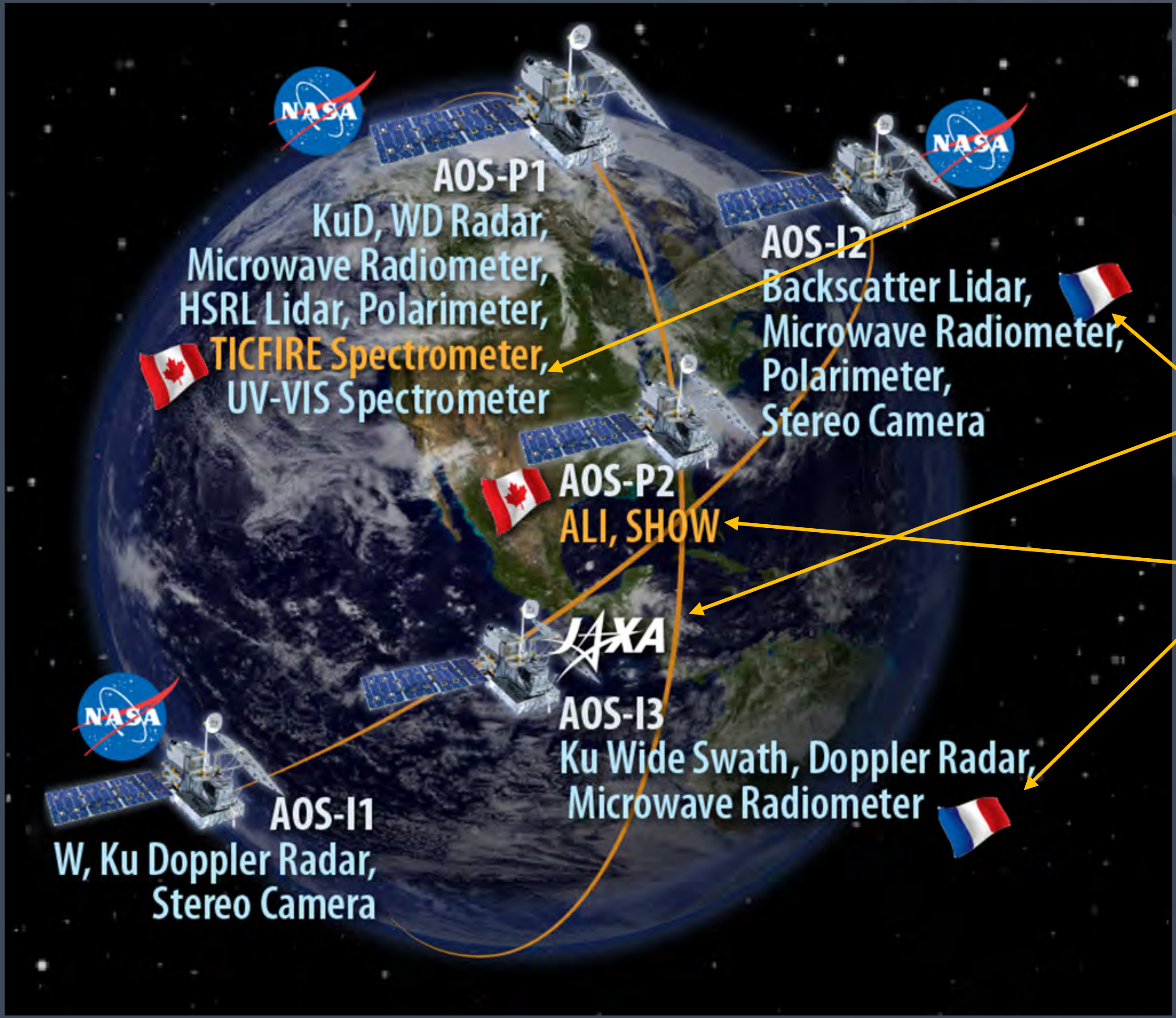
International Contributions to AOS



Extremely valuable contributions to the AOS Constellation (notionally shown in the figure to the left)

TICFIRE Spectrometer in Polar Orbit on NASA Spacecraft AOS-P1

- *In Baseline and Considered Essential Important for linking Global Radiation to Aerosol and Cloud Microphysics*

Additional Contributions Under Study

- *JAXA Spacecraft with Wide Swath Ku Band Doppler Radar provides precipitation and context for Doppler Measurements of Convection*
- *CNES Microwave Radiometers Pair provides shorter time scale process information*
- *Canadian Spacecraft with ALI and SHOW in Polar Orbit*
    - *ALI provides additional Aerosol observations and provides an understanding of Aerosol Redistribution to the Upper Troposphere & Lower Stratosphere (UTLS)*
    - *SHOW adds to the understanding of the moistening of the UTLS*

Q & A

Q: How does open-science fit within your program objectives?

A: OS will help enable the national and international science community wrestle with the multi/inter-disciplinary character of AOS

Q: What investments are you making towards open-science and what are the expected outcomes?

A: None, yet; we are in Prephase A; this workshop should be seen as an introduction, the SAWG should at least stay connected to AOS in small scale meetings and informal interactions

Q: What barriers exist across NASA that inhibit participation to open-science?

A: Suborbital measurements

A: Measurements made by internationally contributed sensors