ATMOSPHERE
Observing System

National Aeronautics and Space Administration

EARTH SYSTEM OBSERVATORY

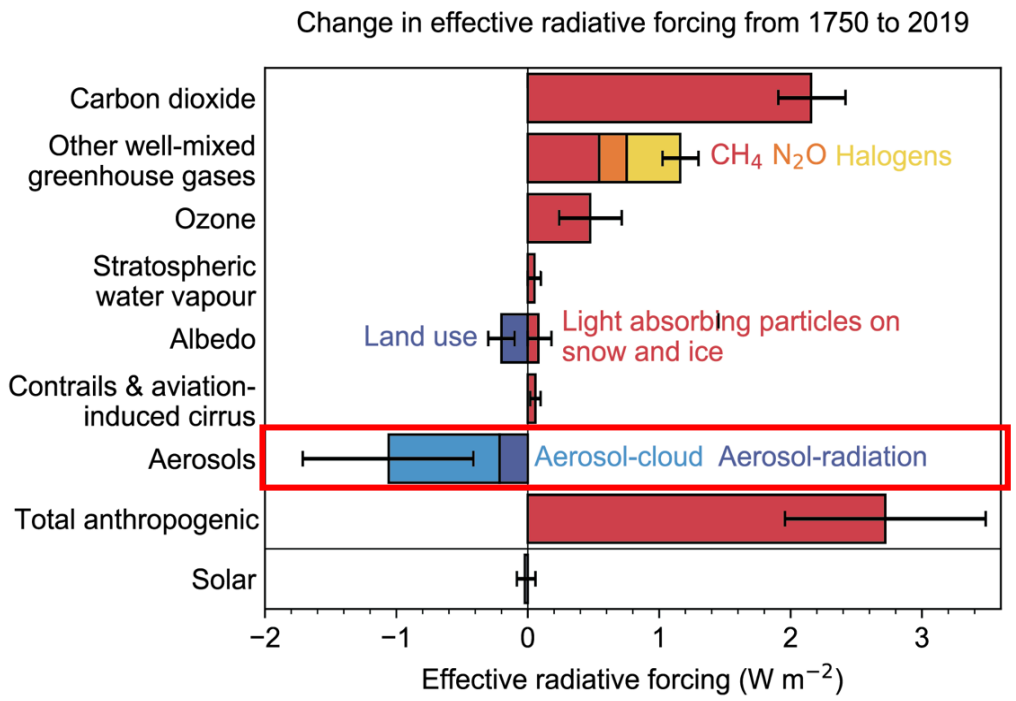
Status of the NASA Atmosphere Observing System (AOS)

Scott Braun, NASA GSFC, AOS Project Scientist (PS)

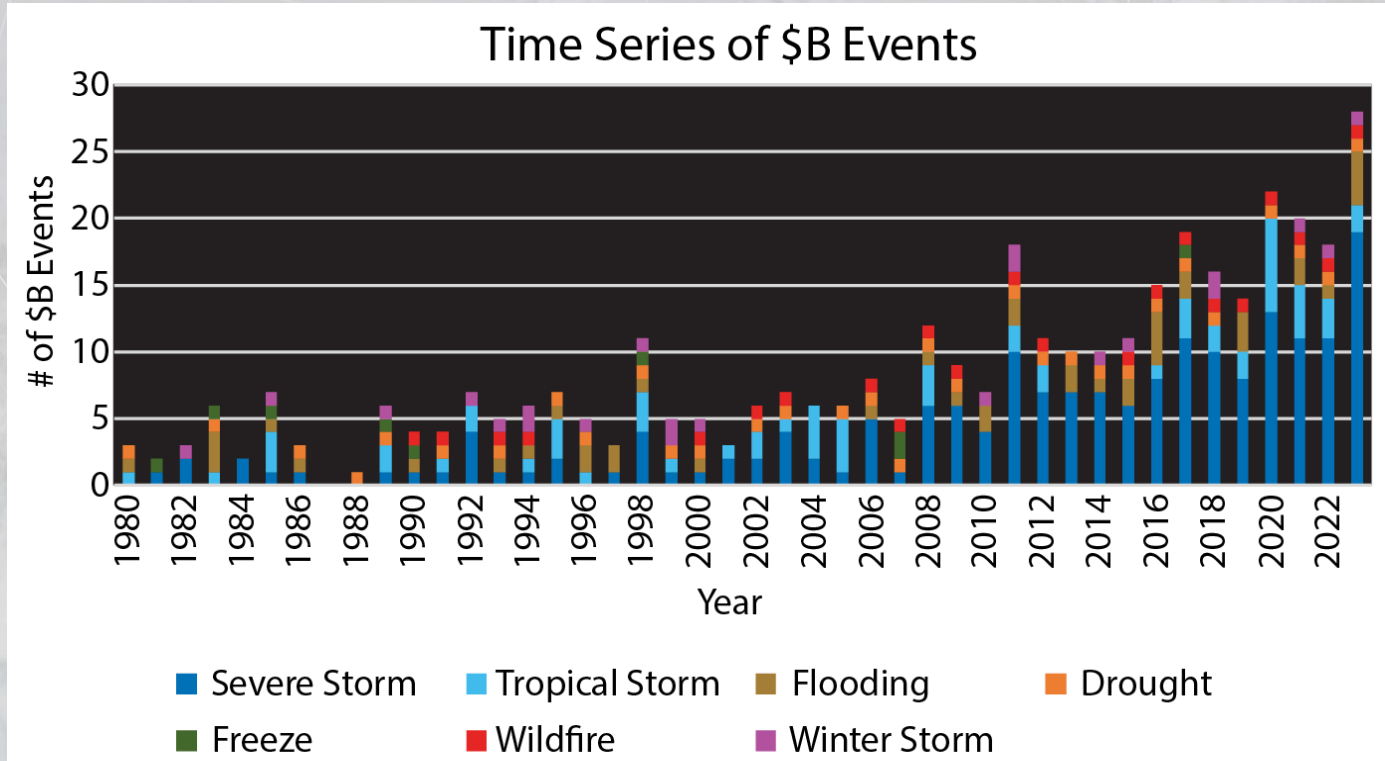
International Precipitation Working Group Meeting
July 15, 2024
Tokyo, Japan

What Is AOS?

AOS is a Decadal Survey mission that will deliver transformative observations fundamental to understanding coupled aerosol-cloud-precipitation processes that profoundly impact weather, climate, and air quality



IPCC AR6 Report (Forster et al. 2021, Cambridge Univ. Press, doi:10.1017/9781009157896.009)



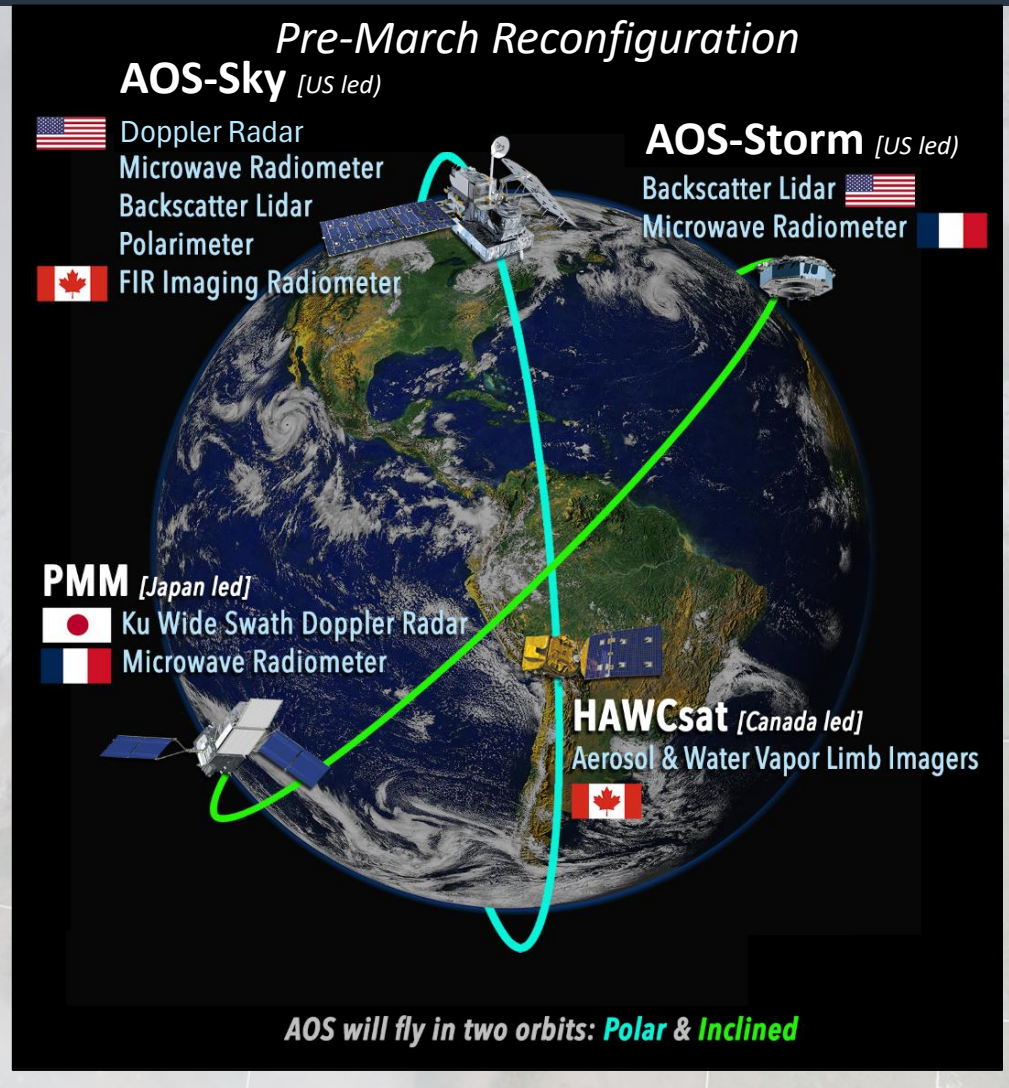
https://www.ncei.noaa.gov/access/billions/time-series

Early Phase-A Architecture

AOS-Storm
- 55° inclined orbit
- Target launch no later than March 2029
- Partnerships with JAXA, CNES

AOS-Sky
- Polar, sun-synchronous orbit, 01:30 Equatorial crossing time
- Target launch no earlier than December 2031
- Partnership with CSA
- Potential partnership with Italy for lidar

Suborbital
- Multi-aircraft field campaigns after launches
- Leverage partnerships and ground-based sites / networks



Graphic reflects initial architecture concept directed at KDP-A. Additional direction was provided to study architecture changes, which are still on-going.

Changes in the AOS Planned Acquisition under the Decouple, Partner and Compete Approach

Tightly Coupled Architecture

Inclined Orbit

PMM (2029) Japan
- Radiometer (France)

AOS-Storm (2029)
- Backscatter Lidar
- Radiometer (France)

Co-Launch

Polar Orbit

AOS-Sky (~2031)
- Backscatter Lidar
- Doppler RADAR
- Microwave Radiometer
- Polarimeter
- TICFIRE Far infrared (Canada)

Co-Launch

HAWCsat (Canada)
- Aerosol and Water Vapor Limb imager

FROM TO

Decoupled Architecture

PMM (2029) Japan
- Radiometer (France)

AOS Storm Smallsat (2029)
- Radiometer (France)

Co-Launch

CALIGOLA (~2029) Multipurpose Lidar (Italy)
- Detectors

AOS Sky (~2030) Microwave Radiometer Polarimeter
- TICFIRE (Canada)

AOS-Cloud Competed Mission (~2031)

Details pending Community Announcement

Co-Launch

HAWCsat (Canada)
- Aerosol and Water Vapor Limb imager

Legend

- Directed (NASA)
- Open Phase A Trade
- Partner Contribution
- Competed (NASA)

New AOS Architecture

AOS-Storm (Partnerships with JAXA, CNES)

- NASA providing second spacecraft, launch

AOS-Sky (Partnership with CSA)

- Passive capabilities (polarimeter, radiometer, CSA TICFIRE)

CALIGOLA (Partnership with ASI)

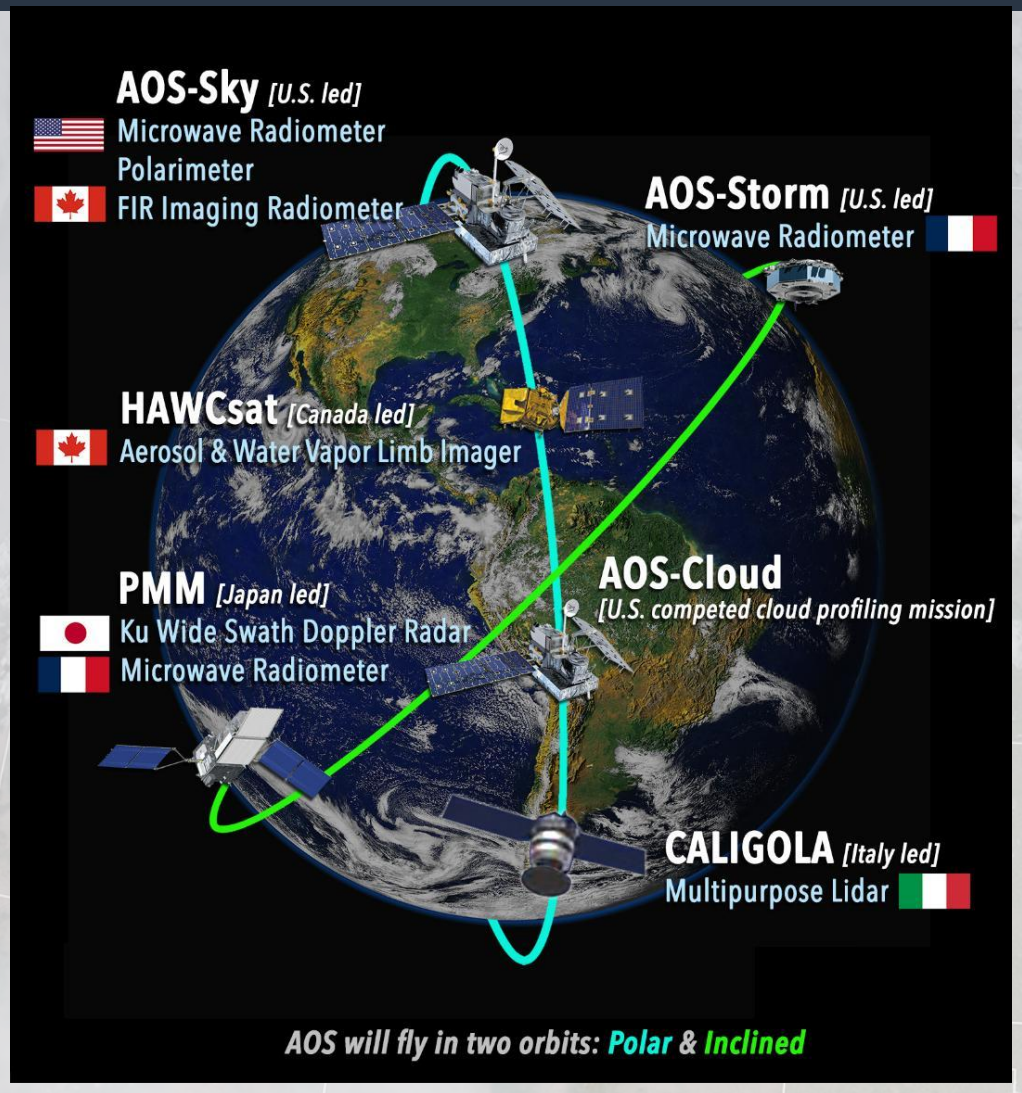
- 8-channel lidar for aerosol and ocean measurements
- NASA providing detector systems

AOS-Cloud

- Future Announcement of Opportunity focused on cloud profiling

Suborbital

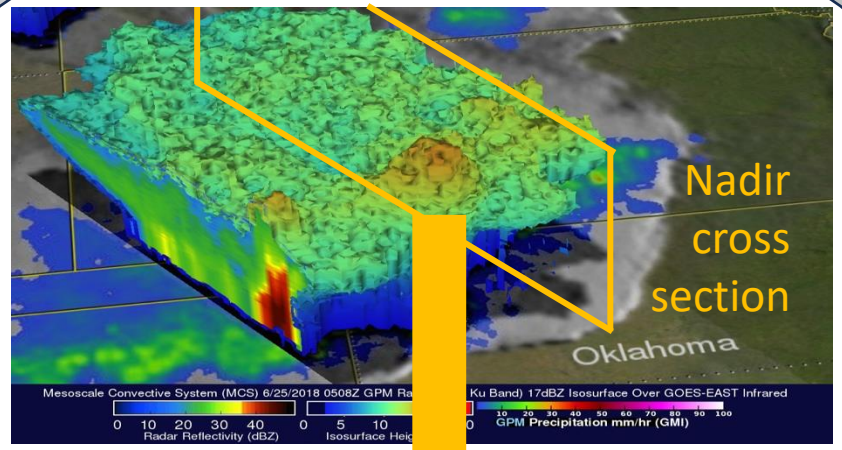
- Multi-aircraft field campaigns
- Leverage partnerships and ground-based sites / networks



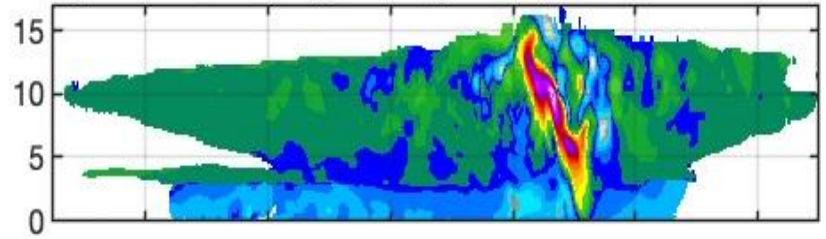
Projects are cost capped and contingent upon available funds

AOS-Storm Measurements

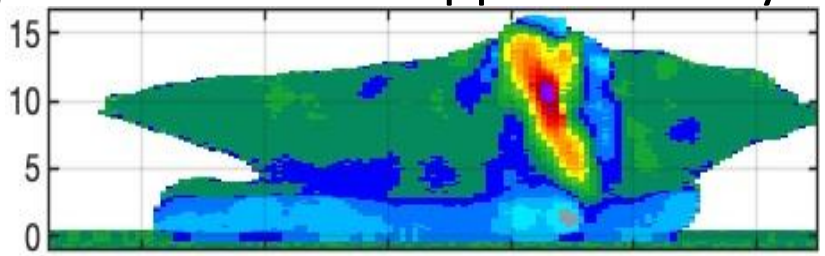
JAXA Wide Swath Ku Doppler Radar



Model "Truth"



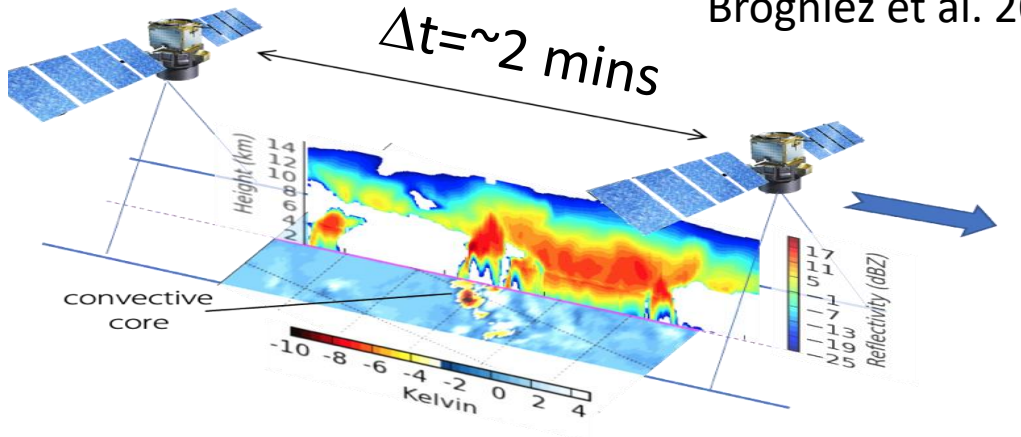
Simulated Ku Doppler Velocity

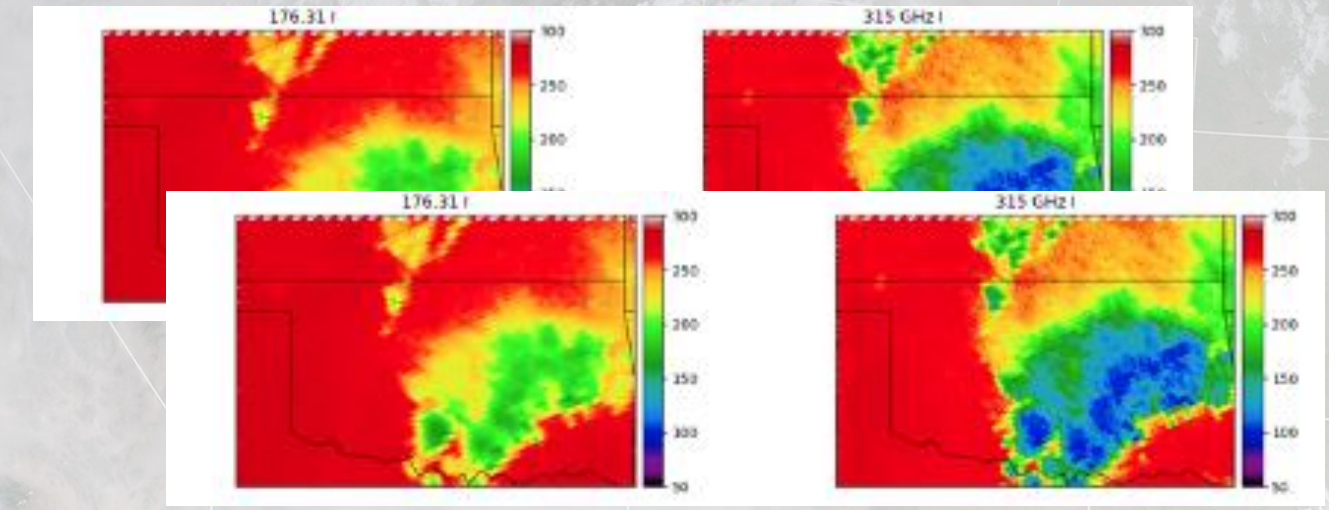


Courtesy of Pavlos Kollias

CNES Microwave Radiometers (89, 183, 325 GHz)

Brogniez et al. 2022

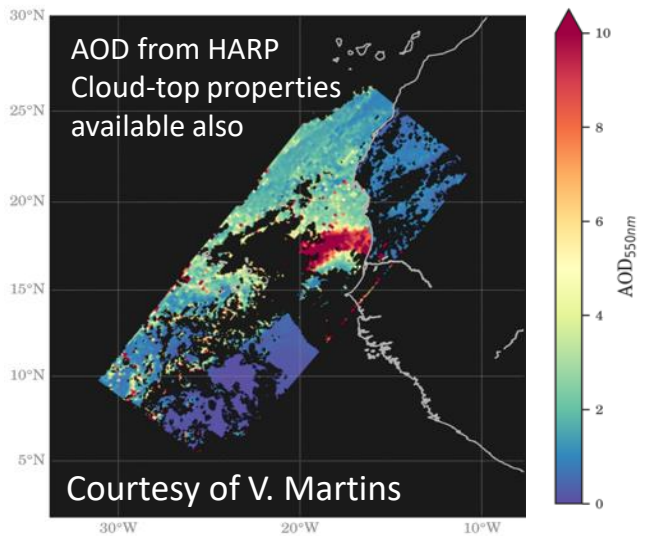




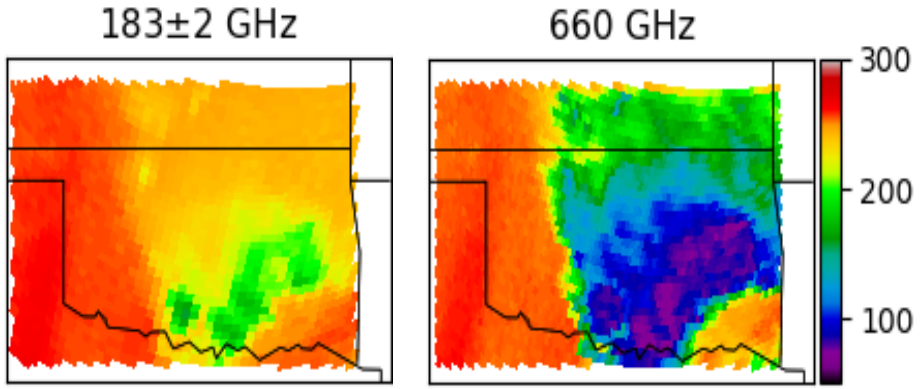
Images courtesy of Yuli Liu, UMBC

AOS-Polar Passive Measurements

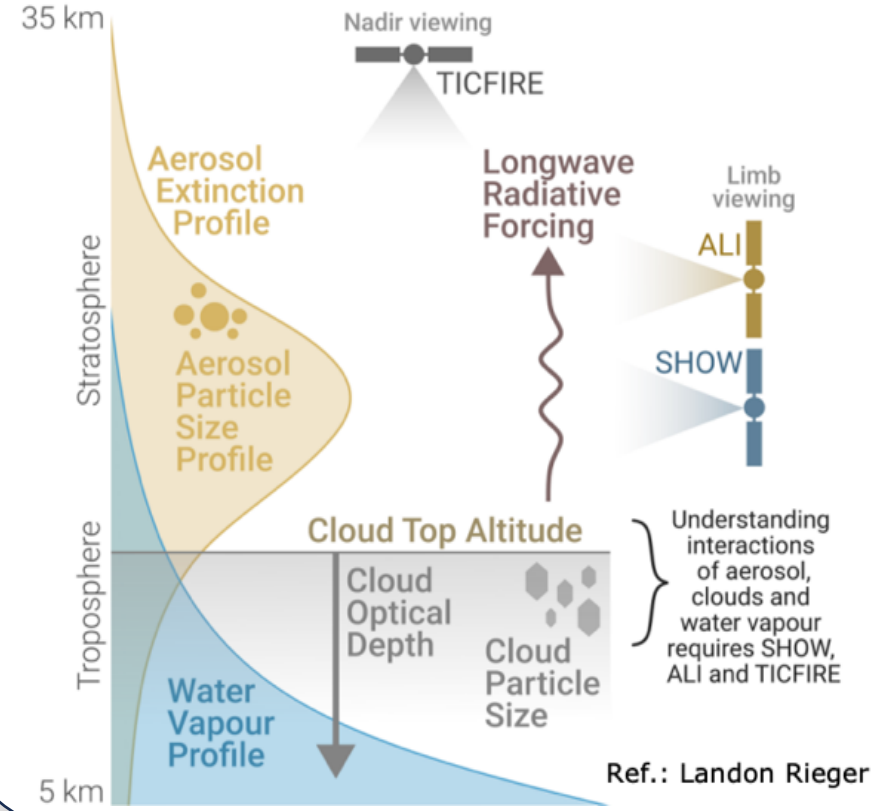
Multi-angle Polarimeter



Microwave Radiometer: 89-700 GHz



CSA LWIR-FIR Radiometer (4-73 μm), Aerosol/Moisture Limb Sounding



CALIGOLA Lidar, Partnership With ASI

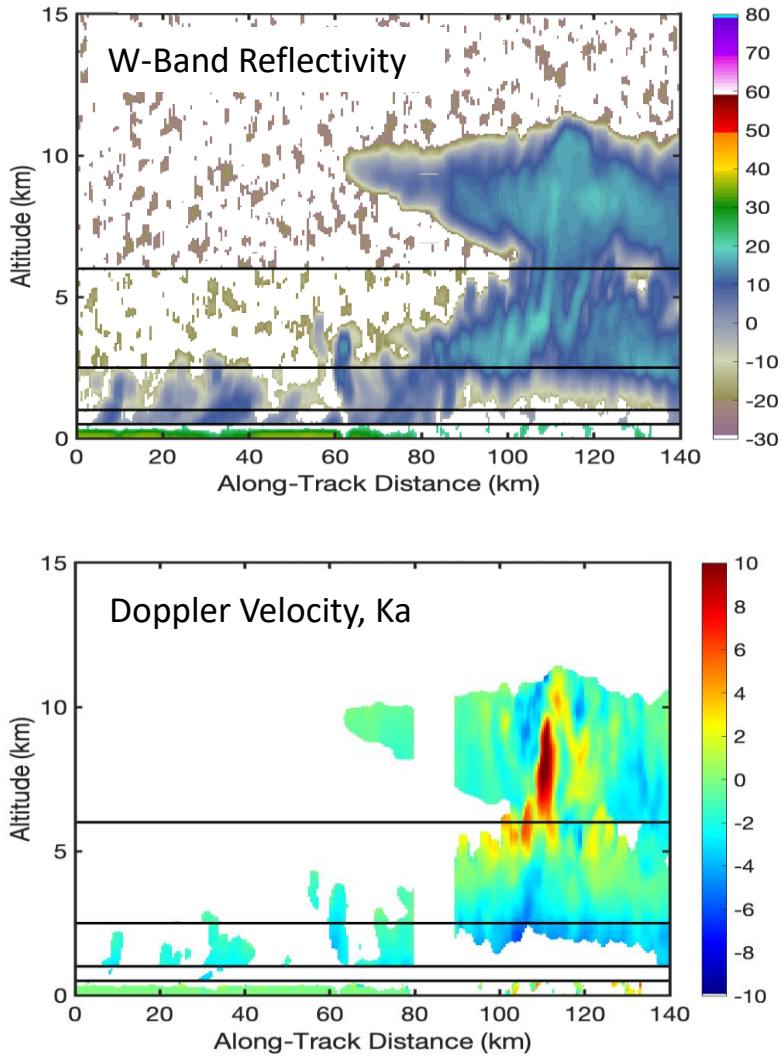
- Partnership with the Italian Space Agency (ASI), NASA effort led by Langley Research Center
  - Key items to coordinate: Orbit crossing time, orbit altitude, etc…
  - Transmits 3 wavelengths, 8 detection channels
  - Need to decide between
    - Two Rotational Raman channels to enable accurate backscatter/extinction coef. retrievals, or
    - One combined Raman channel and one ocean fluorescence channel
  - Target launch in 2031

Transmitted wavelengths	Receiver wavelengths [nm]				
	Total/parallel elastic backscatter	Perpendicular elastic backscatter	Rotational N_2+O_2 Raman backscatter	Rot.-vibrational H_2O Raman backscatter	Fluorescence
355 nm	355 O L A	355 O L A	353.85 A; 355.75 A	405 O L	675-695 O L
532 nm	532 O L A	532 O L A			
1064 nm	1064 L A				

Channel usage:
- O Ocean
- L Land
- A Atmosphere

Current AOS Baseline

AOS-Cloud, Competed Mission



Courtesy of Matt McLinden

- Announcement of Opportunity (AO) to be released in Fiscal Year (FY) 2025
- PI-led, cost capped mission, called Atmosphere Observing System - Cloud (AOS-Cloud) focusing on the CCP observables
- Combined Phase A-F cost of up to $400M (FY 2026), excluding launch and ESO integrated science
- Step 1: Selection of up to 3 concepts for 9-month Phase A concept studies
- Step 2: Down-select to one concept
- Target launch in 2031

Airborne Campaign Concepts

EARTH SYSTEM OBSERVATORY

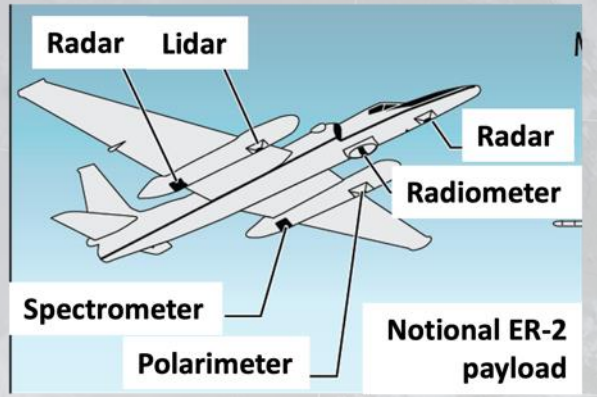
Low Clouds: *Microphysics, precipitation initiation*

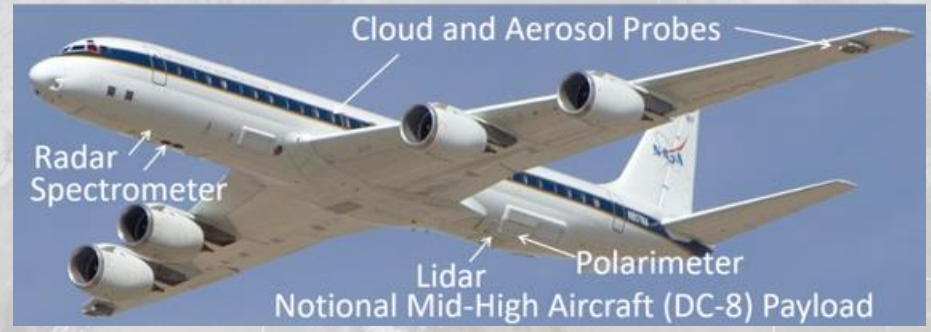
Convection/High Clouds: *Microphysics and dynamics, anvil cirrus lifecycle.*

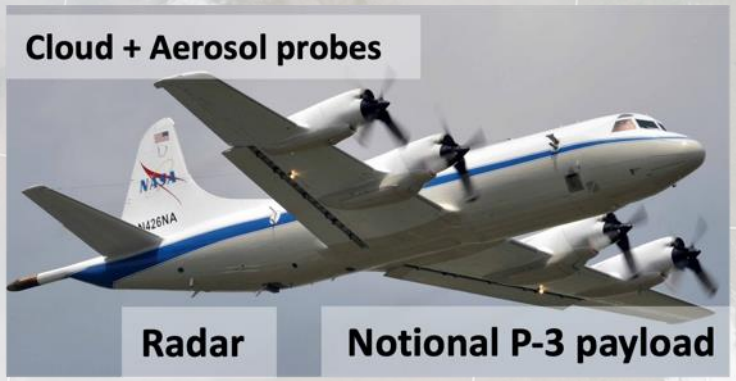
Aerosol-Cloud-Radiation Interactions: *Vertically resolved aerosol-cloud-radiation interaction processes and lifecycle.*

May include large post-launch campaigns and smaller pre-launch campaigns

Payloads depicted are notional… instruments to be prioritized / deconflicted for each campaign

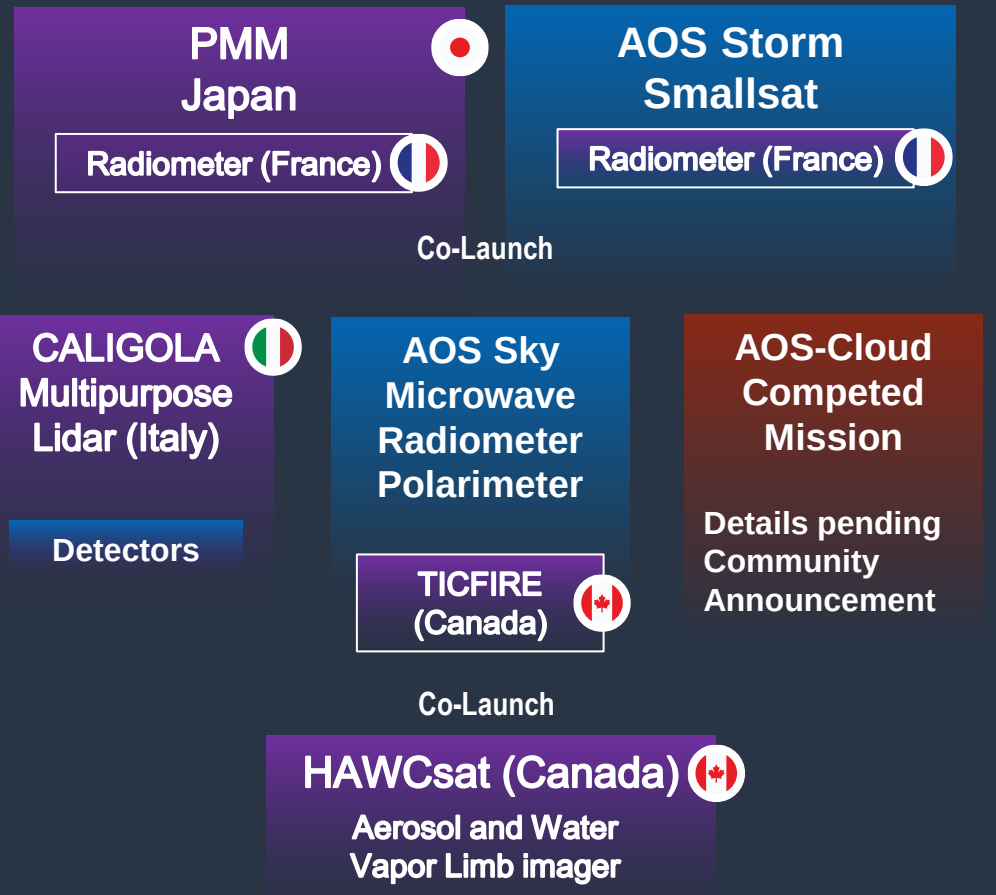






Summary/Current Work

- AOS was two projects (AOS-Sky, AOS-Storm), now four:
  - AOS-Storm
  - AOS-Sky (passives)
  - AOS-Cloud
  - CALIGOLA
- Each element is cost-capped
- Working trades for spacecraft for second CNES radiometer and for AOS-Sky capabilities
- AOS-Cloud capabilities will not be known until final selection



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