NASA AMES AIRBORNE SCIENCE

MATT FLADELAND & VED CHIRAYATH
LAB FOR ADVANCED SENSING
EARTH SCIENCES DIVISION
NASA AMES RESEARCH CENTER

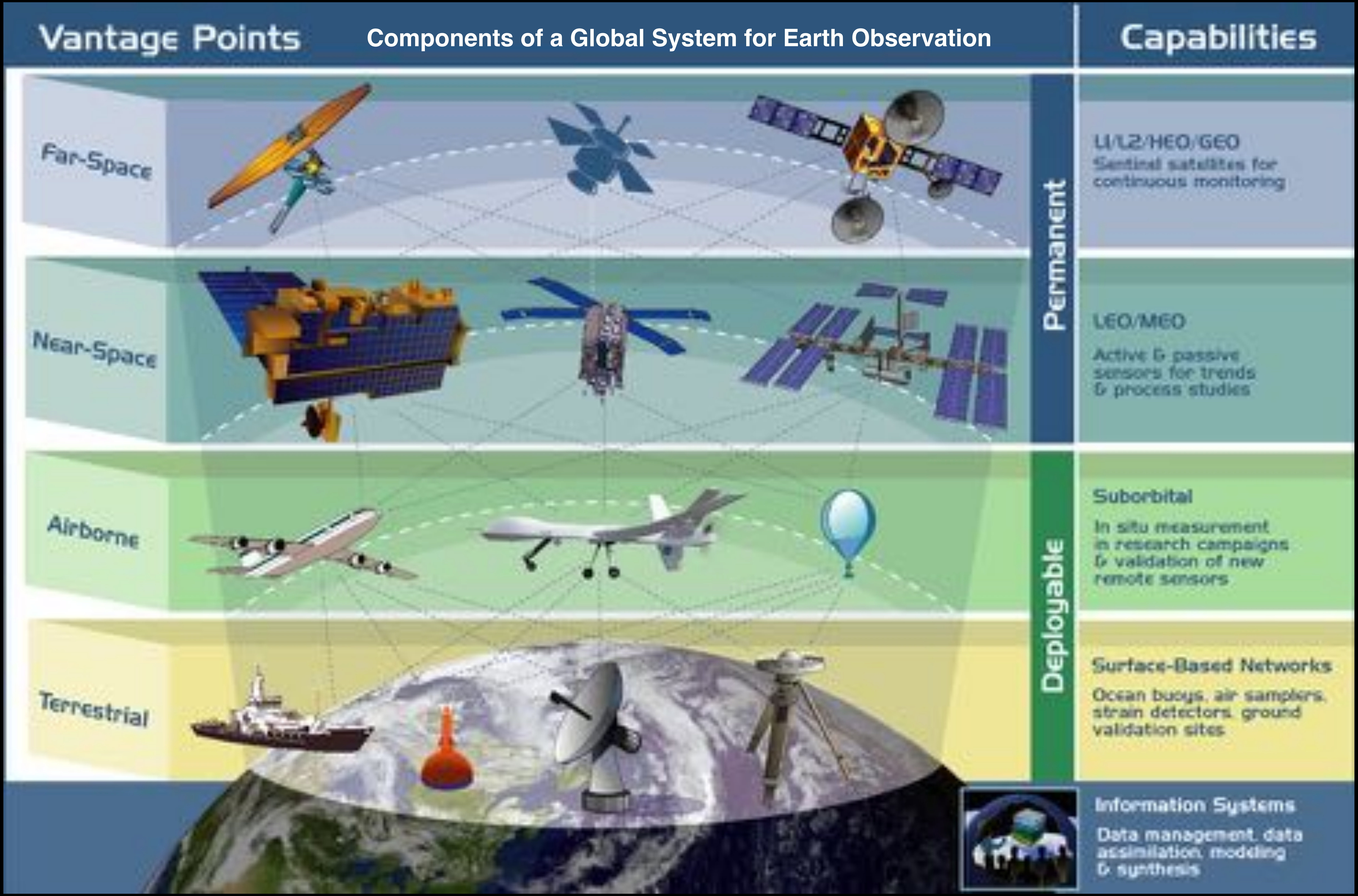
NASA AMES EARTH SCIENCE DIVISION

National Aeronautics and Space Administration

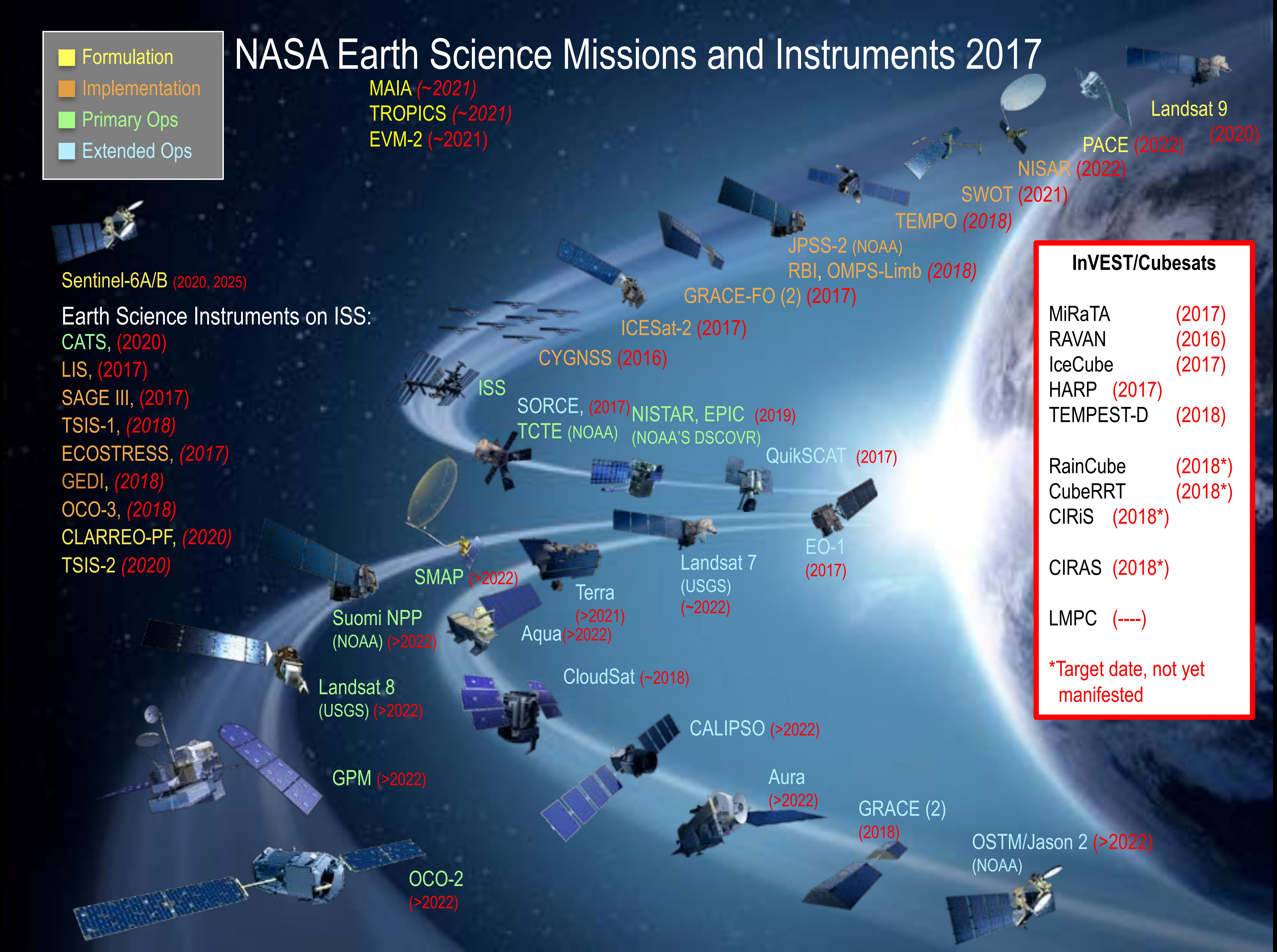
Ames

Discovery Innovations Solutions


Sun- Earth Connection
Climate Variability and Change
Carbon Cycle and Ecosystems
Earth Surface and Interior
Atmospheric Composition
Weather
Water & Energy Cycle



Vantage Points
Components of a Global System for Earth Observation
Capabilities
Far-Space
Near-Space
Airborne
Terrestrial
Permanent
Deployable
L1/L2/HEO/GEO
Sentinel satellites for continuous monitoring
LEO/MEO
Active & passive sensors for trends & process studies
Suborbital
In situ measurement in research campaigns & validation of new remote sensors
Surface-Based Networks
Ocean buoys, air samplers, strain detectors, ground validation sites
Information Systems
Data management, data assimilation, modeling & synthesis


NASA Earth Science Missions and Instruments 2017
Formulation
Implementation
Primary Ops
Extended Ops
MAIA (~2021)
TROPICS (~2021)
EVM-2 (~2021)
Landsat 9 (2020)
PACE (2022)
NISAR (2022)
SWOT (2021)
TEMPO (2018)
JPSS-2 (NOAA)
RBI, OMPS-Limb (2018)
GRACE-FO (2) (2017)
ICESat-2 (2017)
CYGNSS (2016)
Sentinel-6A/B (2020, 2025)
Earth Science Instruments on ISS:
CATS, (2020)
LIS, (2017)
SAGE III, (2017)
TSIS-1, (2018)
ECOSTRESS, (2017)
GEDI, (2018)
OCO-3, (2018)
CLARREO-PF, (2020)
TSIS-2 (2020)
ISS
SORCE, (2017)
TCTE (NOAA)
NISTAR, EPIC (2019)
(NOAA'S DSCOVR)
QuikSCAT (2017)
EO-1
(2017)
Landsat 7
(USGS)
(~2022)
Terra
(>2021)
Aqua (>2022)
SMAP (>2022)
Suomi NPP
(NOAA) (>2022)
Landsat 8
(USGS) (>2022)
CloudSat (~2018)
CALIPSO (>2022)
GPM (>2022)
Aura
(>2022)
GRACE (2)
(2018)
OSTM/Jason 2 (>2022)
(NOAA)
OCO-2
(>2022)
InVEST/Cubesats
MiRaTA (2017)
RAVAN (2016)
IceCube (2017)
HARP (2017)
TEMPEST-D (2018)
RainCube (2018*)
CubeRRT (2018*)
CIRiS (2018*)
CIRAS (2018*)
LMPC (----)
*Target date, not yet manifested

NASA Earth Science
Purposes for Airborne Platforms

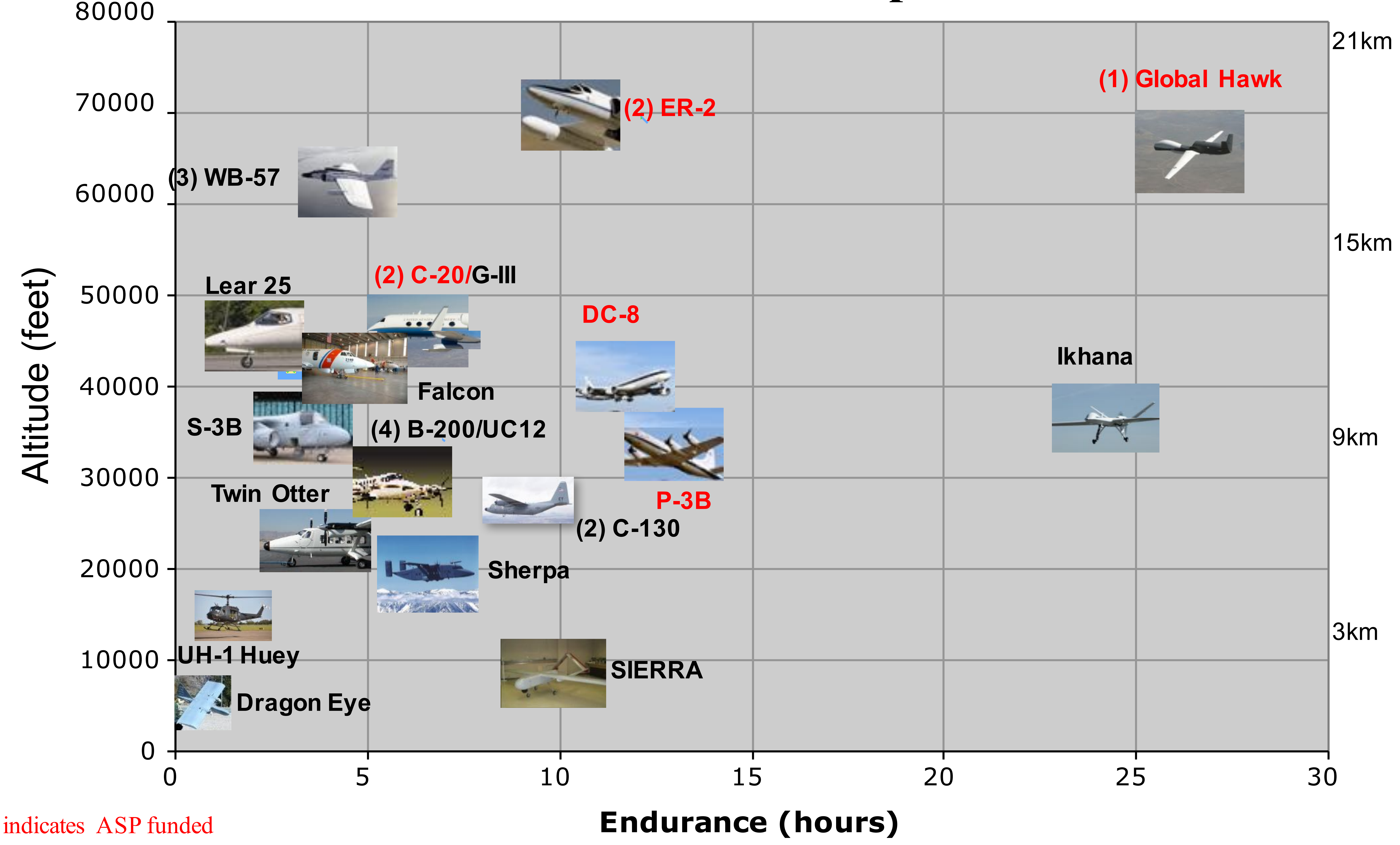
Scientific

- Make important scientific measurements not possible from satellite or surface-based platforms
- Calibration and validation of satellite remote sensing observations and models

Programmatic

- Develop new remote sensing and in-situ instruments
- Develop early career investigators
- Develop leadership skills in promising early and mid-career investigator

NASA Earth Science Research Capable Aircraft



Red indicates ASP funded

Ames Research Center

Coastal-Airborne In-situ Radiometers (C-AIR)

Liane Guild & Steve Dunagan (ARC), Stanford Hooker (GSFC), John Morrow (Biospherical Instr.)

Readiness level:
- ☐ TRL 1-3: Concept
- ☐ TRL 4-6: Prototype
- ☑ TRL 7-9: Demonstrated

NASA Ames Instrumentation

Technology / Application

Description

C-AIR microradiometer instruments are COTS systems designed to help retrieve aquatic normalized exact water-leaving radiance for satellite-based ocean color research. A **microradiometer** consists of a microprocessor, photodetector, preamplifier with controllable gain, 24-bit analog-to-digital converter, and a serial port, all on one small circuit board assembly. The brass sleeve provides support and isolation from electronic noise. **Aggregators** are used to bundle clusters of microradiometers and auxiliary sensors as would typically exist in individual instrument heads. They have on-board power control, and additional sensors including tilt angles, input voltage and current, internal humidity and temperature. C-AIR sensors feature:

- **Spectral range: 320-1640 nm with 10 nm FWHM bandwidth; 15 Hz data rate;**
- **Very wide dynamic range (10 decades), will not saturate with Sun glint**
- **Radiance (2.5^{o} FAFOV) and irradiance configurations**
- **NIST traceable calibrations**.

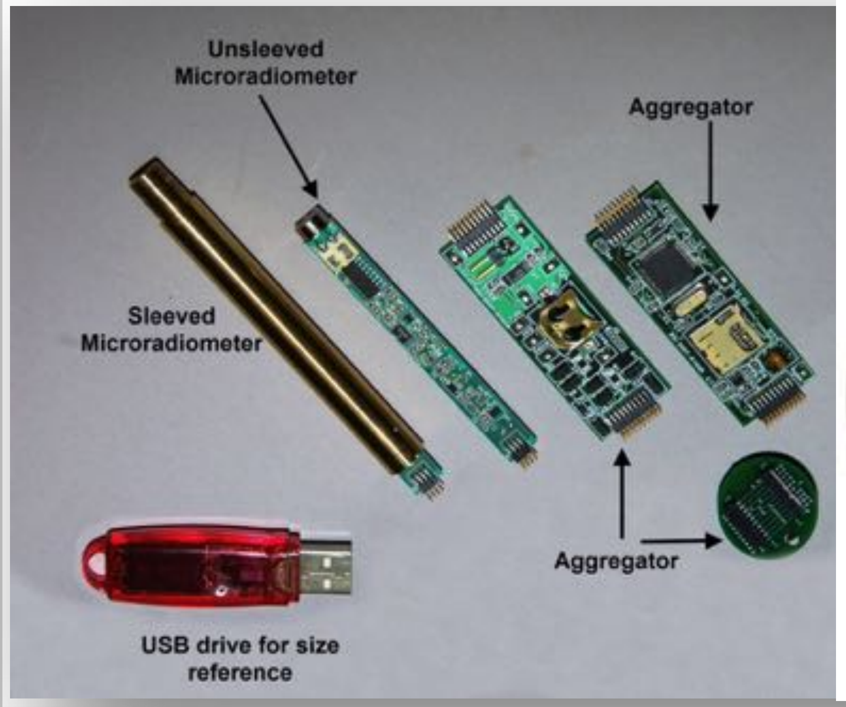
Fight requirements: flight track within the solar principal plane

Needed: application specific GUI software development

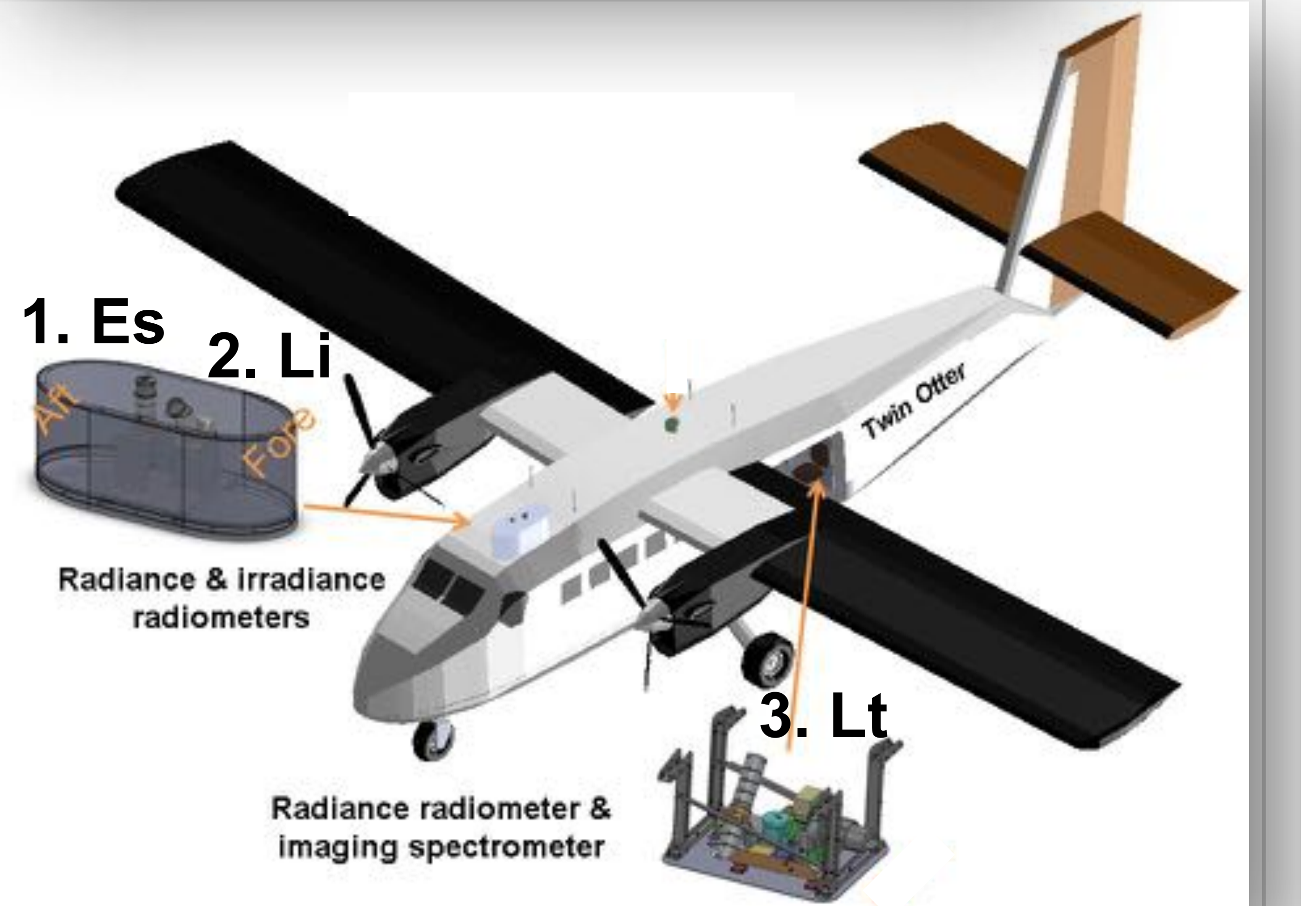
References:

Morrow, J.H., S.B. Hooker, C.R. Booth, G. Bernhard, R.N. Lind, and J.W. Brown, 2010: Advances in Measuring the Apparent Optical Properties (AOPs) of Optically Complex Waters. *NASA Tech. Memo. 2010–215856*, NASA GSFC, Greenbelt, Maryland, 80 pp.

Guild L., J. Dungan, M. Edwards, P. Russell, S. Hooker, J. Myers, J. Morrow, S. Dunagan, P. Zell, R. Berthold, and C. Smith, 2011, *NASA's Coastal and Ocean Airborne Science Testbed (COAST)*, Proceedings, 34th International Remote Sensing of Environment, April 10-15, 2011, Sydney, Australia.



Microradiometer radiance bundle



NPS CIRPAS Twin Otter, Marina, CA

Funding / Timeline

Based on SBIR microradiometer package for in-water bio-optical measurements
- **2010** Proposed for airborne suite (HOPE) **2011** 1st airborne flight (COAST)
- **2013** 2nd airborne mission (SIF OCEANIA) supporting cal/val of HyspIRI CA
- Future work (e.g. SIF, CIF, EVS)

POC

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Korea - United States Air Quality (KORUS-AQ) Study: A Cooperative Air Quality Field Study in Korea

Dates: 1 May – 15 June 2016
Location: Osan Air Base, South Korea

Participants:

Korea - Ministry of Environment, National Institute of Environmental Research, and Korean Universities

US - NASA, EPA, NCAR, and Universities

Airborne Platforms:

•NASA DC-8 (with 6 Korean research groups)
•LaRC King Air (TEMPO airborne simulator, GeoTASO, and MOS ocean color imager)
•Hanseo University King Air (HCHO instrument from the U.S. team)

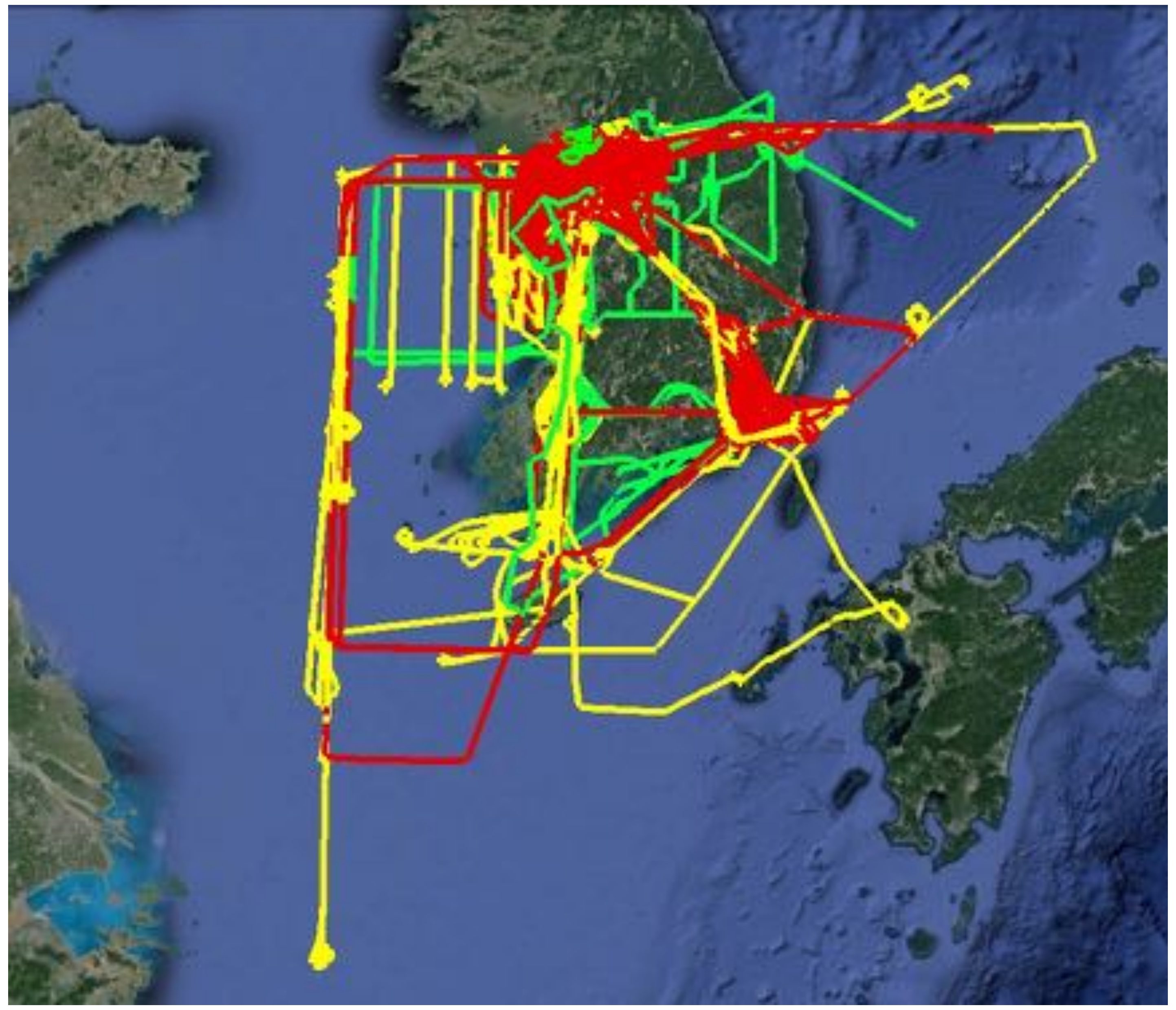
Surface Network and Ships:

•Extensive network of ground sites operated by Korean air quality agencies and universities
•NASA contributions included a network of ground-based remote sensors (Pandora and AERONET), multiple lidar and ozonesonde sites.
•A companion ship-based collaboration examining ocean color (KORUS-OC) is being conducted by NASA and KIOST

Science:
Better understanding of the factors controlling air quality to enable improved capability for satellite remote sensing and model simulation of air quality

International Collaboration:
Develop relationships that will enhance the global air quality satellite constellation of geostationary air quality observations from TEMPO (NASA), GEMS (KARI), and Sentinel-4 (ESA).

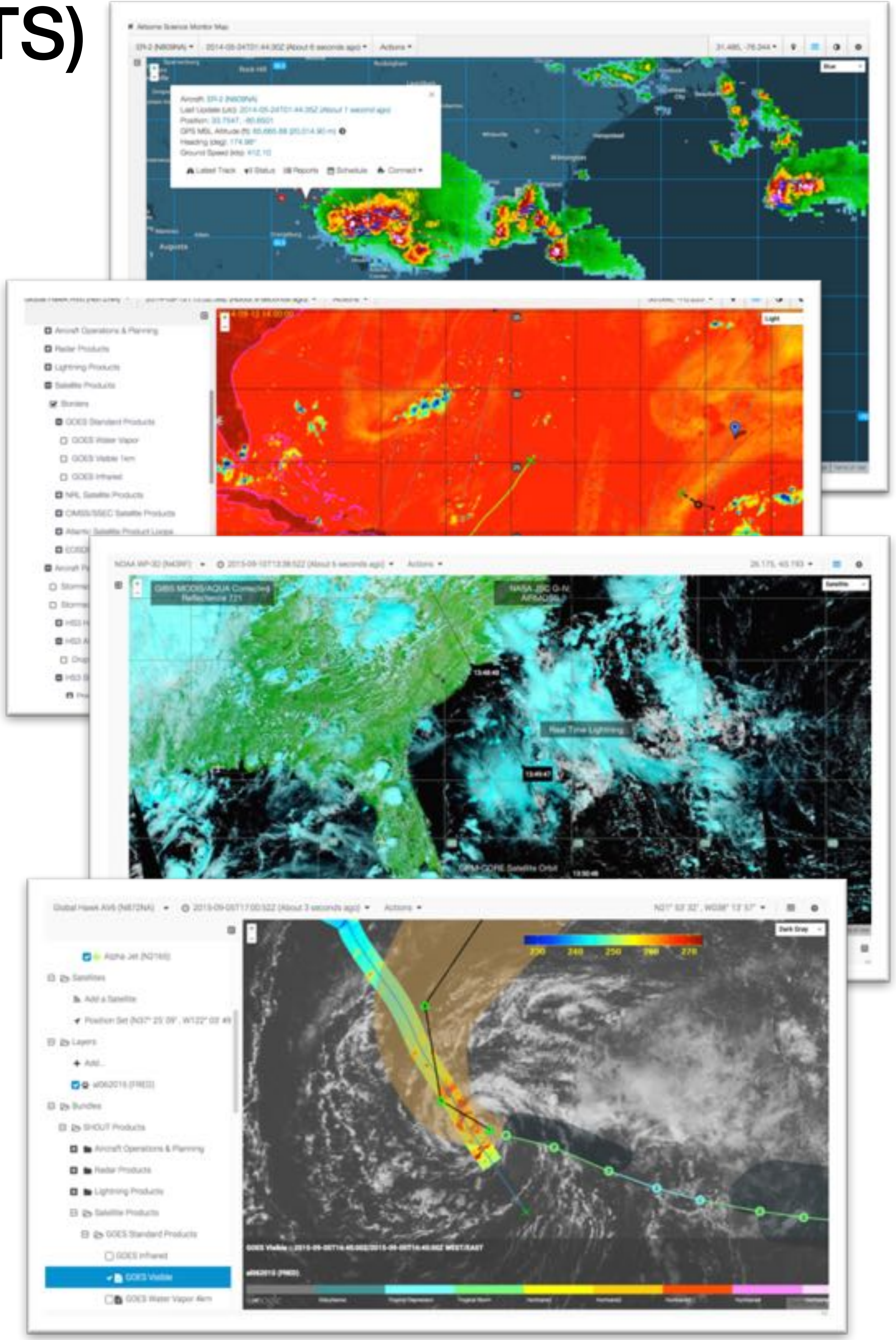
Capacity Building:
Develop a stronger airborne science community in Korea through direct experience on the NASA DC-8 and participation in the planning of research flights



MISSION TOOLS SUITE (MTS)

NASA AIRBORNE SCIENCE PROGRAM

- Tactical decision-making and distributed team situational awareness
- Real time position and instrument telemetry ingest and visualization for single- and multi-asset campaigns
- Access to low latency satellite, radar, global lightning and other meteorological and mission products
- Communication and collaboration tools including document sharing and turn-key chat solutions
- Satellite pass prediction and swath visualization
- Mission operation and planning tools



Project Lead: Aaron R. Duley, Ph.D.
NASA Airborne Science Program
Ames Research Center, Moffett Field, CA

For more information visit: https://mts.nasa.gov

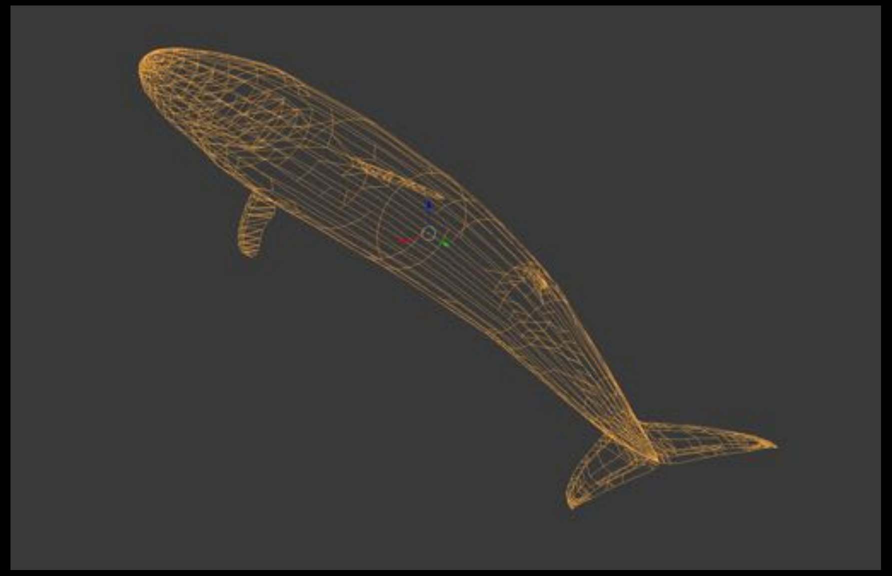
NASA AMES
LABORATORY FOR ADVANCED SENSING

SENSING TECHNOLOGIES & INSTRUMENTS

FluidCam

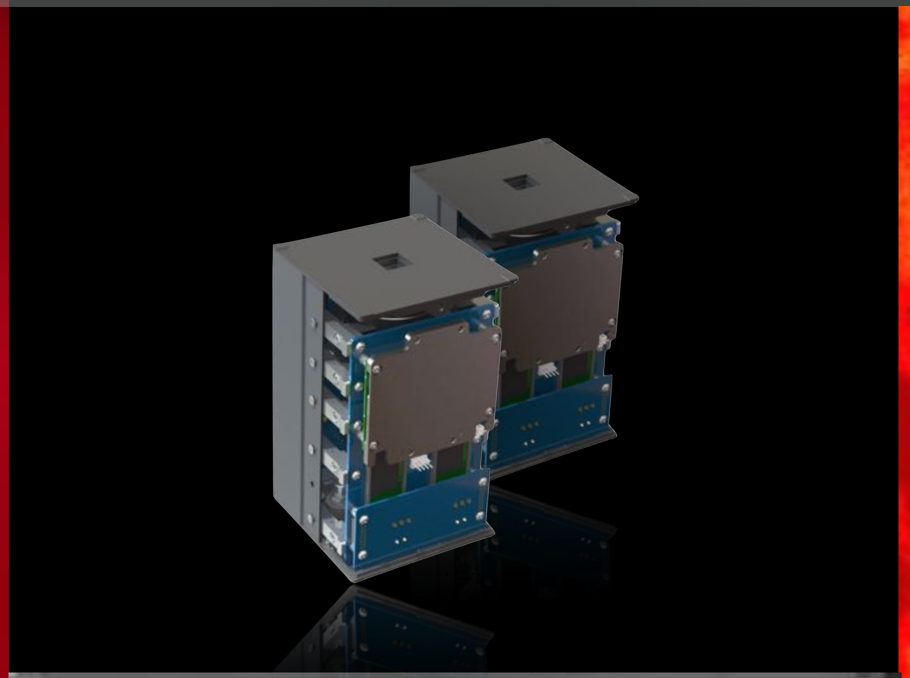
MiDAR

3D CETACEAN IMAGING 2016-2017



MiDAR

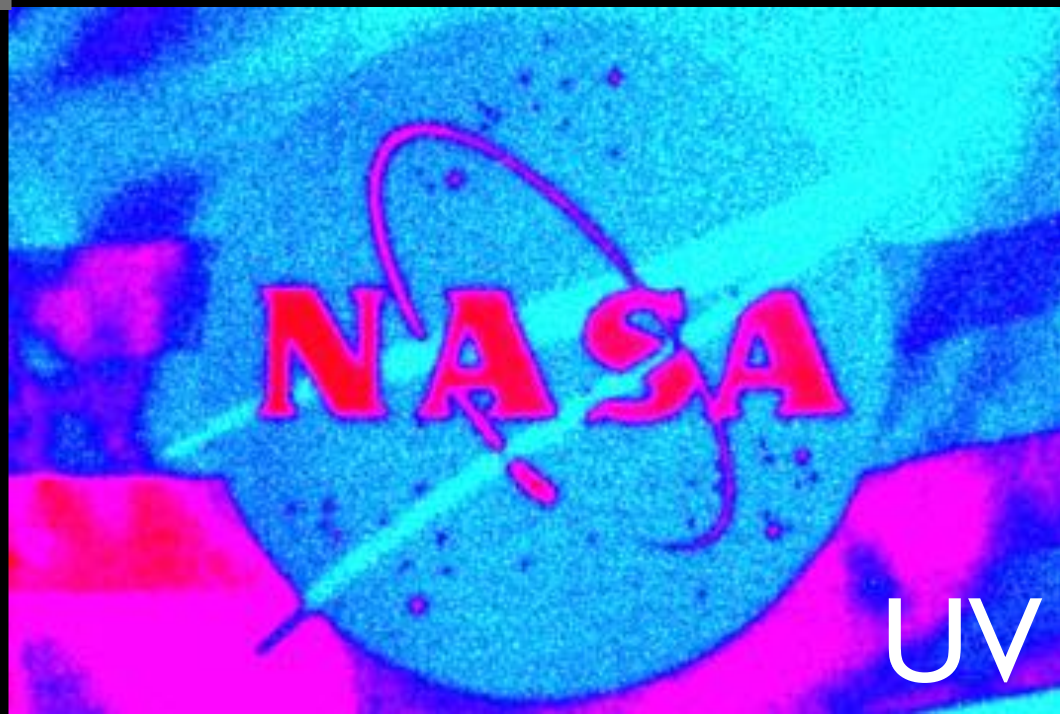
MULTISPECTRAL IMAGING, DETECTION AND ACTIVE REFLECTANCE




NIR

Panchromatic

Visible



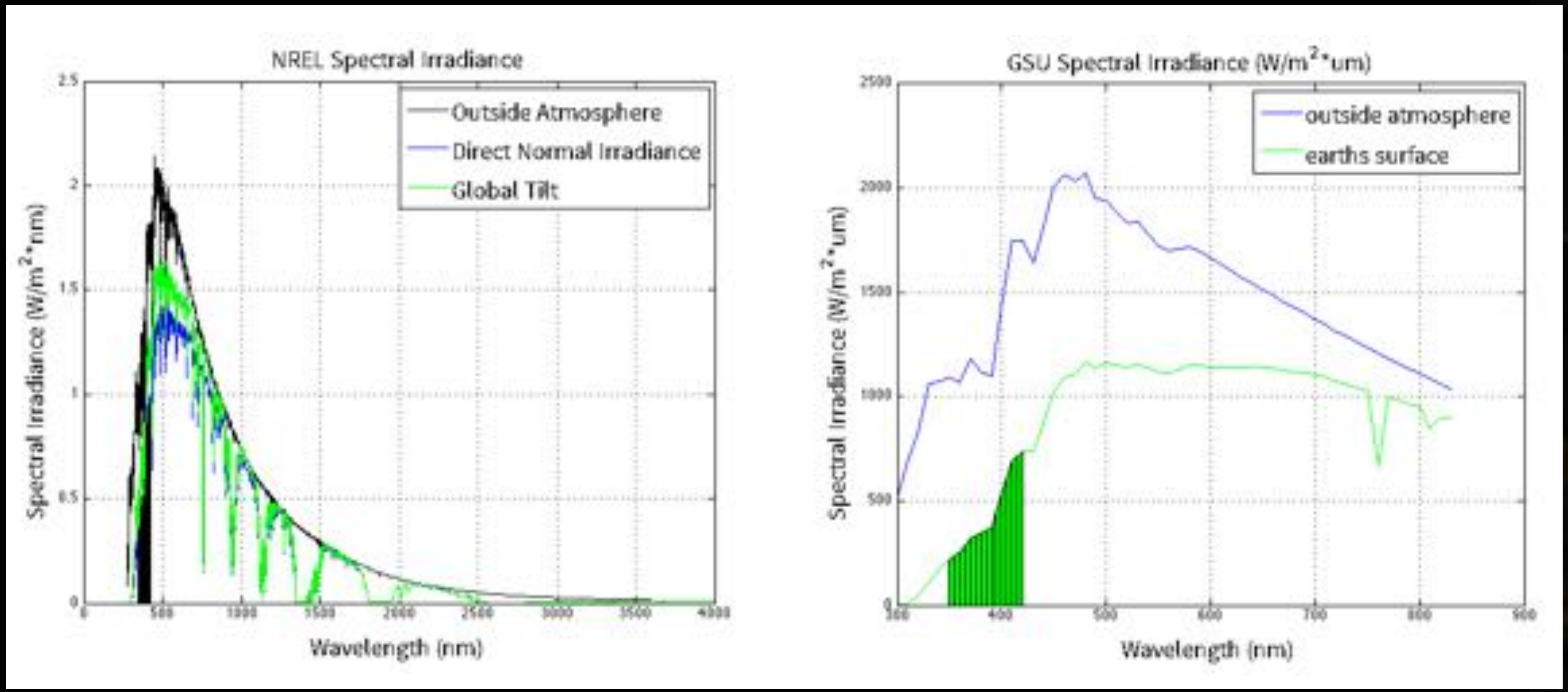
UV

MiDAR 7-CHANNEL PROTOTYPE

MiDAR REMOTE SENSING

MiDAR SCIENCE APPLICATIONS

MiDAR SCIENCE APPLICATIONS



NASA AMES LAS - EPA/ARMY PLUME SAMPLING 2016-2017

www.nasa.gov/ames/la

THANK YOU!

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