# NOAA Perspective on U Class Satellites

Dan Mamula

Research to Operations and Project Planning Division (ROPPD)

Office of Projects, Planning, and Analysis (OPPA)

NOAA's Satellite and Information Service (NESDIS)

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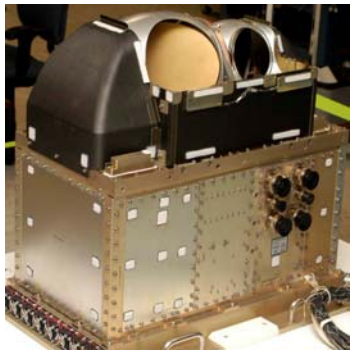
# Outline

- Key data and current studies
- Gap mitigation
- Reliability needs
- Summary

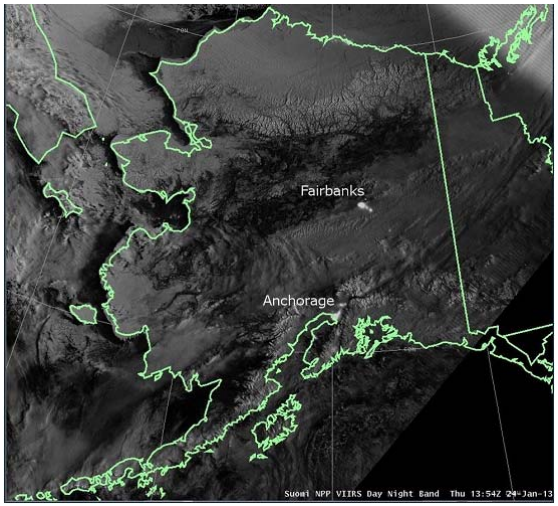
# Key Polar Satellite Data

Microwave and infrared atmospheric sounders on polar orbiting satellites have a large positive impact on reducing numerical weather prediction forecast error



ATMS

CrIS




Imagery from polar orbiting satellites provides enhanced coverage in high-latitudes where geosynchronous satellite coverage is diminished

# Current NESDIS U Class Studies

- MIT / LL U Class Design Studies
  - Provide design, analysis, and other support to inform future development and use of microwave radiometers hosted on small satellites.
  - Study provides risk reduction to the FY2017 President's Budget Request for the Earth Observing Nanosatellite-Microwave (EON-MW) mission under the Polar Follow-on Program.
- JPL Sensor Studies
  - MidWave IR Sounder design and capabilities assessment versus a fully capable CriS – assessment of ability to meet NOAA sounder requirements.

# EON-MW

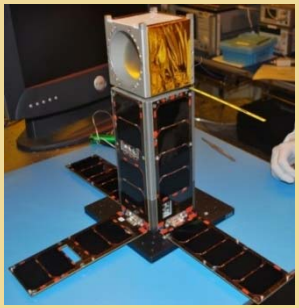
- EON-MW will use miniaturized microwave sounder technology demonstration developed by MIT Lincoln Laboratory (MIT/LL)
- EON-MW uses innovative, proven CubeSat technology to greatly reduce cost of construction and launch compared to traditional space systems
- EON-MW is next evolutionary step to MIT/LL's CubeSat microwave sounder series

## MicroMAS-1

**3U cubesat with 118-GHz radiometer**

**8 channels for temperature measurements**

**July 2014 launch, March 2015 release; validation of spacecraft systems; eventual transmitter failure**

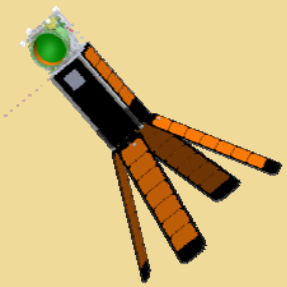


## MicroMAS-2

**3U cubesat scanning radiometer with channels near 90, 118, 183, and 206 GHz**

**12 channels for moisture and temperature profiling and precipitation imaging**

**Two launches, first in 2017**

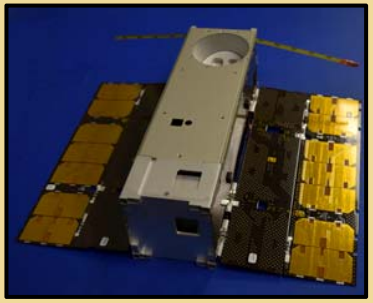


## MiRaTA

**3U cubesat with 60, 183, and 206 GHz radiometers and GPS radio occultation**

**10 channels for temperature, moisture, and cloud ice measurements**

**Launch on JPSS-1**



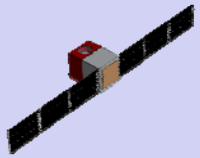
## EON-MW

**12U satellite with 22 channels to replicate ATMS**

**High-performance, radiation tolerant design; 2-3 year mission life**

**Included in 2017 NOAA budget**

**30 month build and test**



**22x22x34 cm; 20 kg; 50 W**

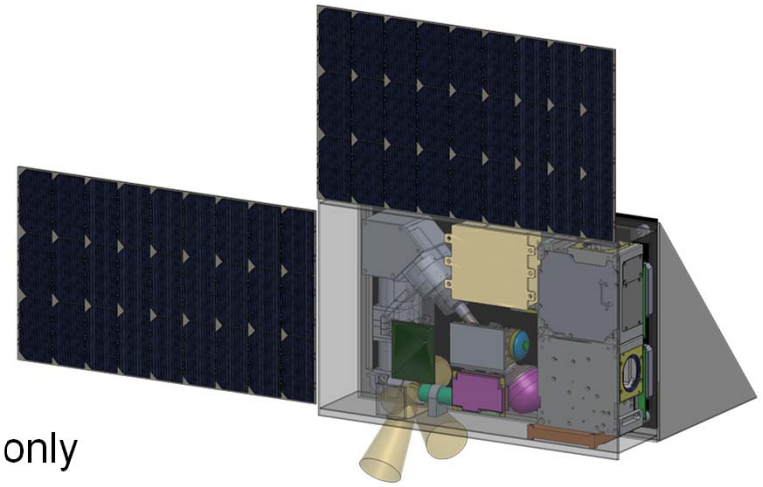
# EON-MW: Investment in New Technology

- Demonstrating a low cost, small satellite alternative could lead to more sustainable and robust sources of microwave sounding data
- Upon successful demonstration EON-MW can be transitioned to industry for production of a microwave sounding gap-filler or low-cost ATMS replacement
- Implementation of EON-MW will be critical to furthering the design of a flexible and cost-efficient observing capability
  - Provides for the government, national laboratories, academia and the commercial sector work together to develop and demonstrate a critical capability that has the potential to reduce the out-year costs of sounding instruments

# EON-IR

NOAA is working with JPL to develop designs for EON-IR concept

- CubeSat-based mid-wave IR sounder (4.8 – 5.1 microns)
- Mitigate against the loss of CrIS on S-NPP and JPSS
- Leverages NASA/JPL CIRAS demonstration mission with design modified to meet NOAA's observational and operational requirements
  - Scanning sensor head
  - High reliability components
  - Meet power and thermal requirements for operational duty cycle
- Current Work
  - Detailed design study to reduce risk on parts reliability, scanning mechanism, and thermal/mechanical interference
  - Study to determine impact of mid-wave IR only sounding



# Data Impact Studies

**Scope:**

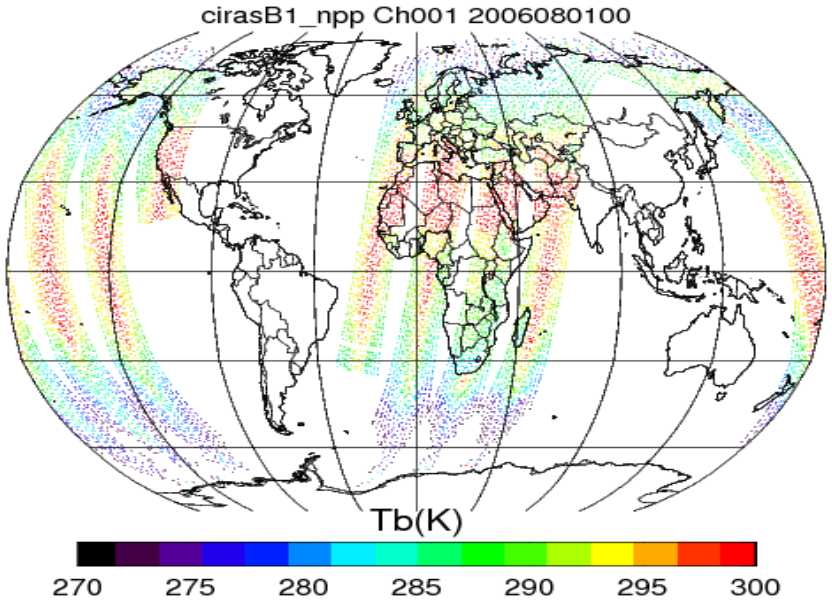
- Determine the quantitative value of MicroMAS and CIRAS in the reduction of forecast error in global and regional NWP models:
  - Impact of MicroMAS-2 in the absence of PM microwave sounder data
  - Impact of CIRAS in the absence of PM IR sounder data

**Recent Work:**

- Created simulated MicroMAS-2 and CIRAS data CubeSat Sounders for studying impact
- Created orbit simulator for MicroMAS-2 and CIRAS

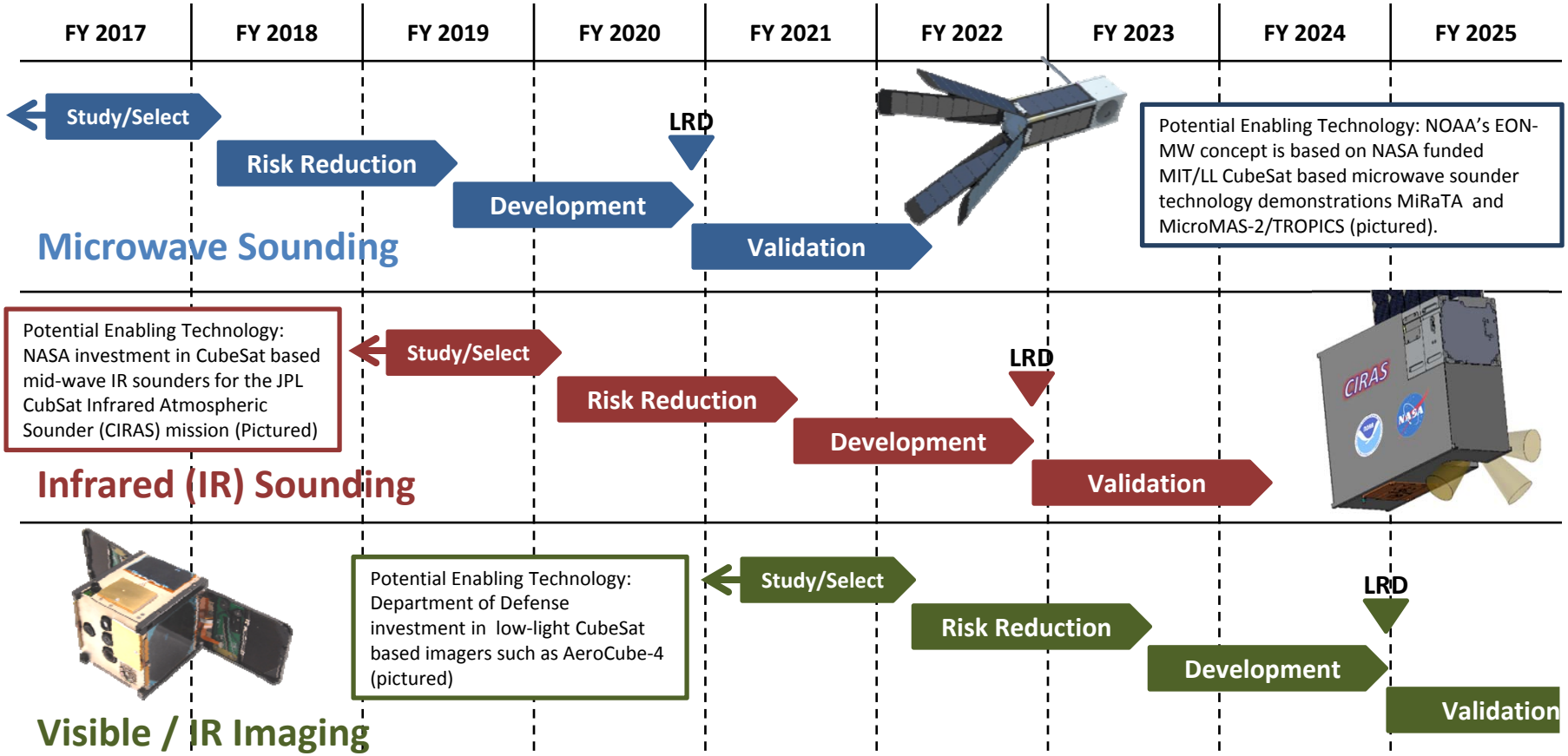
**Next Steps:**

- Impact study on local severe storm forecast



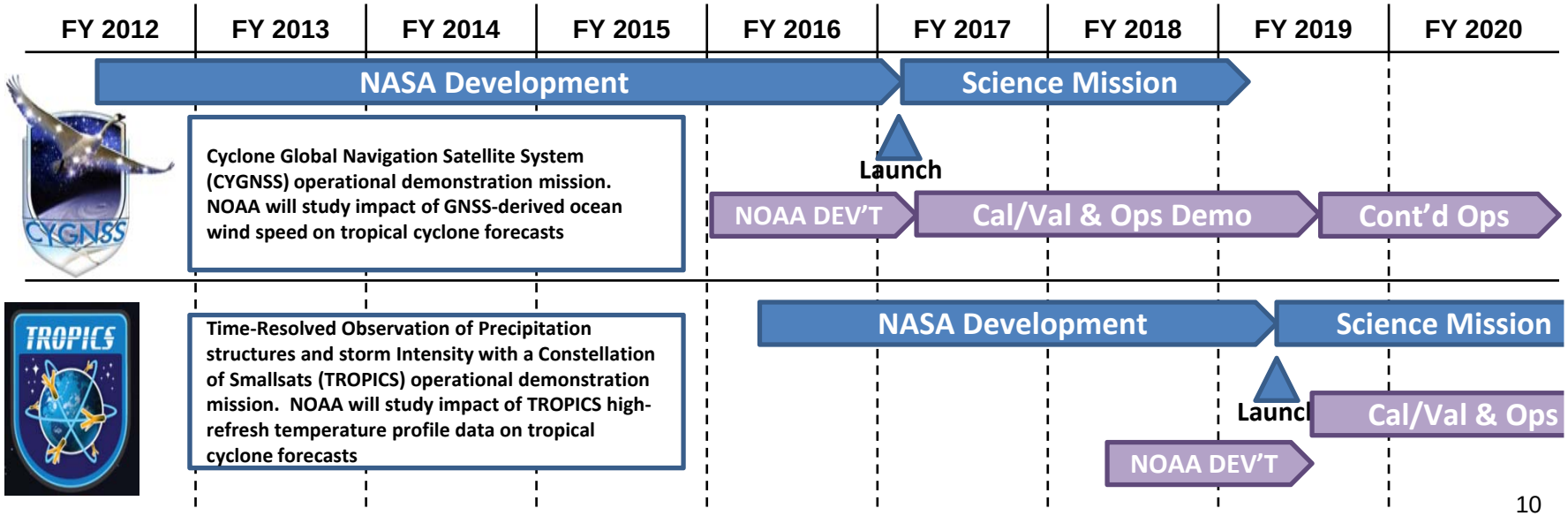

Simulated CIRAS data using JPSS CrIS

# Strategy for Gap Mitigation



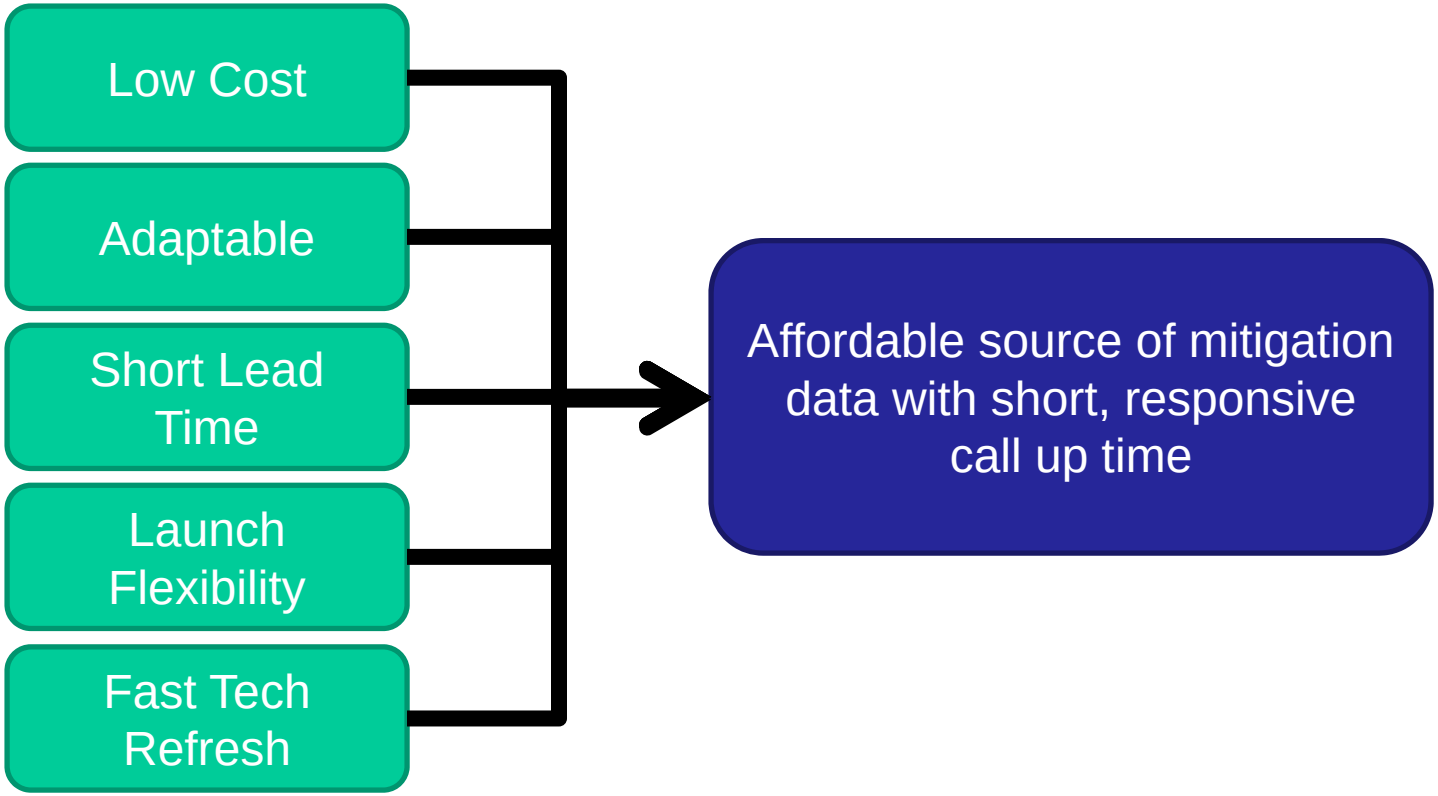
# SmallSat Constellations

- Flying identical satellites in a constellation can improve reliability
- Data from domestic and international research missions can be used to reduce error in numerical weather prediction models
  - NASA's upcoming CYGNSS GNSS reflection mission and TROPICS microwave sounder constellation mission show promise for transition from research to operations



# Small Satellites and Gap Mitigation

Small satellites are especially suitable for gap mitigation



# Why U Class Satellites?

- Current satellites are expensive
  - No ability for spares
  - Long development cycle
  - Failure means lack of data availability
- U Class satellites could be the future for some observations
  - Lower cost alternatives
    - Use commercially available parts
    - Less weight means low launch costs
    - Can afford to have a spare for Gap Mitigation
  - Much shorter development time
  - Commercial launch availability
  - Loss of a single spacecraft does not result in the loss of all instruments
- U Class constellations can provide more key observations
  - Improved performance of Numerical Weather Prediction (NWP) models

# NOAA Reliability Needs

- NOAA provides operational weather data
  - Initial SmallSat usage for gap mitigation
  - 2-3 yr mission life appears to be adequate
  - Affordability and lead time
  - Potential SmallSat usage as operational constellation
- NOAA 15, 18, and 19 satellites still in operation
  - Well beyond 2 yr engineering design life
- What reliability efforts are necessary for SmallSats?
- Create new models for SmallSat reliability?
- Which radiation tolerant parts are necessary for LEO missions?

# Summary

- NOAA is interested in SmallSats as potential Gap Mitigation and for playing a role in future space architectures
- NOAA looking to leverage the investments of NASA, DoD and other partners to begin developing SmallSat capabilities
- NOAA envisions that SmallSats may play a role as an element in NOAA's observation system

# Contact Information

Dan Mamula

dan.mamula@noaa.gov

301-713-7159