Earth through the Eyes of Napa-1

Commissioning Results and the Next Steps in CubeSat Earth Observation

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24 June 2021

The Napa-1 Mission

Introduction

Napa-1 (Thai: นภา, Nphā, meaning: *firmament*)

First satellite of the Thai government space capabilities program to enhance monitoring and response to natural disasters, including fires, floods, earthquakes, and air quality issues

Mission Objectives

- Capture images of Thailand with target being defined at least 24 hours before hand.

- Ground targets captured with a GSD of at least 40m at 500km orbital altitude.

- Captured data to be downlinked within 24 hours after capture and visualized on ground.

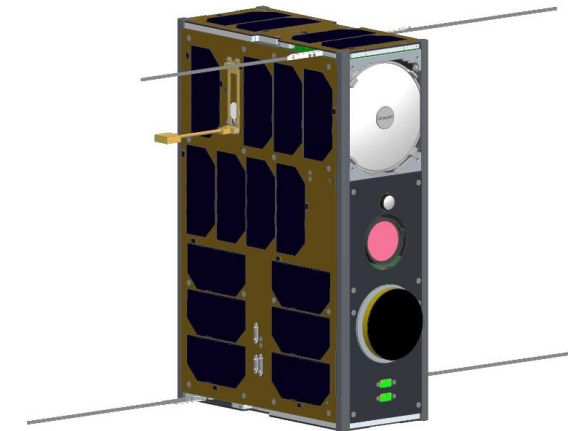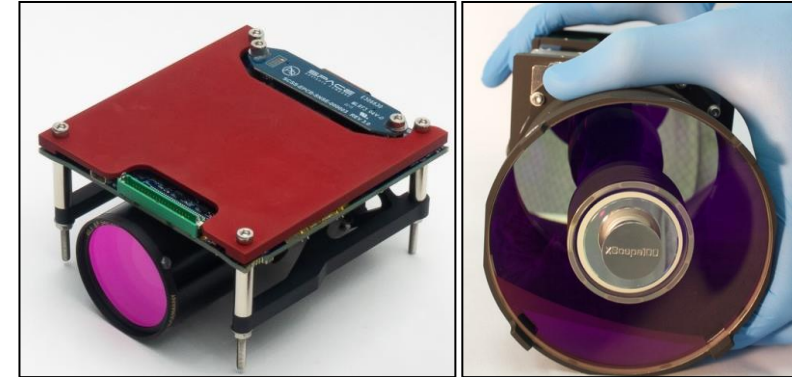# The Napa-1 Mission

The Satellite

Payloads

- SCS Gecko Imager: 40m GSD, RGB, 80km Swath
- Simera Sense TriScape100: <5m GSD, RGB, 20km Swath

Platform

- ISIS Bus: IMEPS, IOBC, PDHU, TRXVU, TXS
- CubeSpace ADCS: 3-Axis CubeADCS

Performance

- Power: 6W OAP, 17.5W Peak, 4W consumed
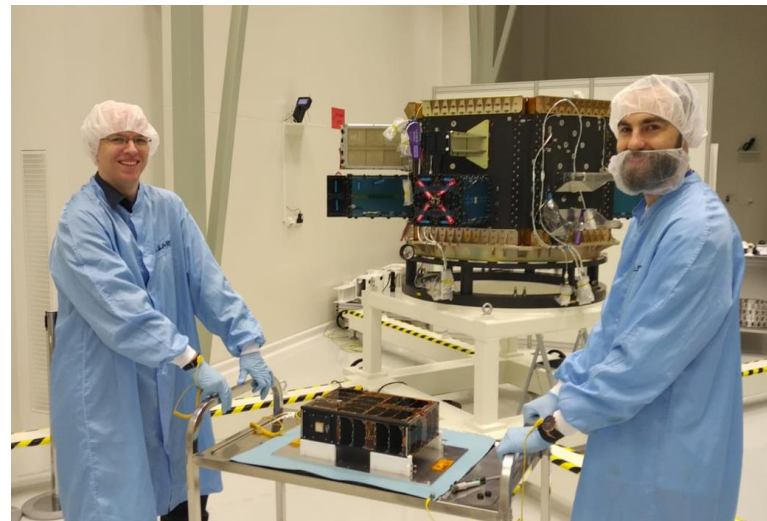- Data-rates: 4.3 Mbps (S), 9.6kbps (VU)
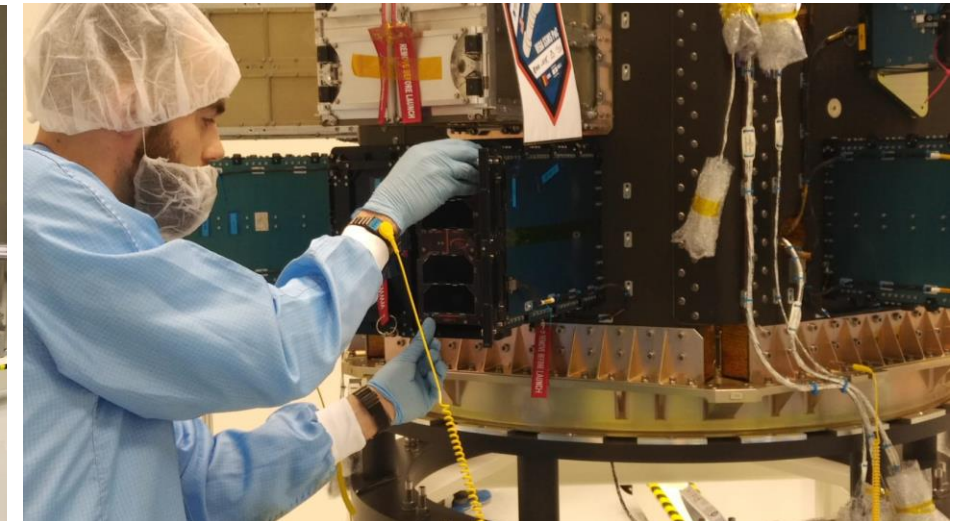
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Launch

Have a safe flight!

- Integration in Brno, Czech Republic
- Napa-1 was launched onboard the VEGA SSMS POC VV16 on the 3rd of September 2020
- SSO LTAN 22:30 at 530 km altitude

The Napa-1 Mission
Launch having a narrow escape

The actual launch on Vega SSMS POC VV16 took a few tries though...

#1 Launch failure VV15 before our ride

#2 When launch was to resume, Covid-19 pandemic hit

#3 Strong weather delaying launch twice

SOYUZ
LIFT OFF!

VEGA
IT'S WINDY

And the successor VV17 launch failed again...
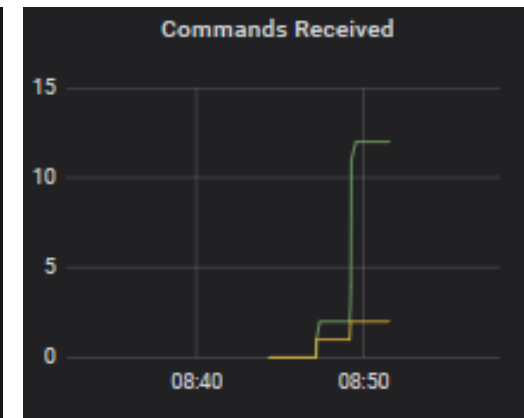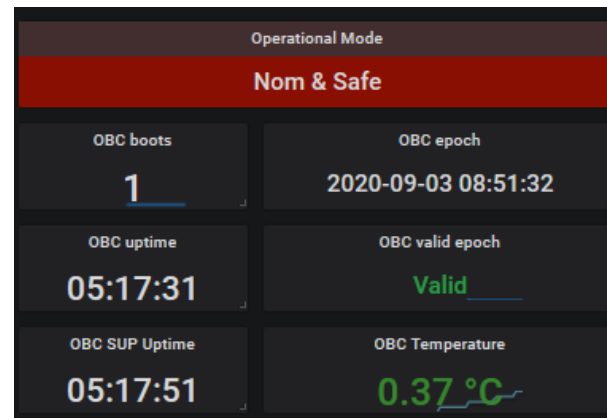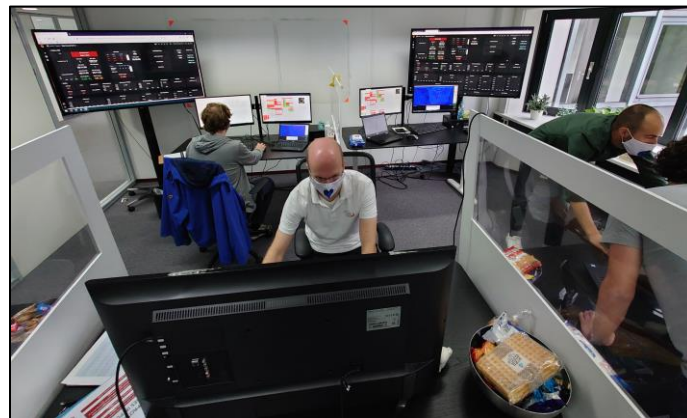
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Launch and Early Operations

First contact

Stressfully waiting for the very first beacons of Napa-1…

First checks are on the reported status of:

- Antenna deployments

- Satellite mode and uptime

- Temperatures

| Operational Mode	
Nom & Safe	
OBC boots	OBC epoch
1	2020-09-03 08:51:32
OBC uptime	OBC valid epoch
05:17:31	Valid
OBC SUP Uptime	OBC Temperature
05:17:51	0.37 °C

Commands Received

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Launch and Early Operations

Closing LEOP phase

- Successful verification of antenna deployments and communication
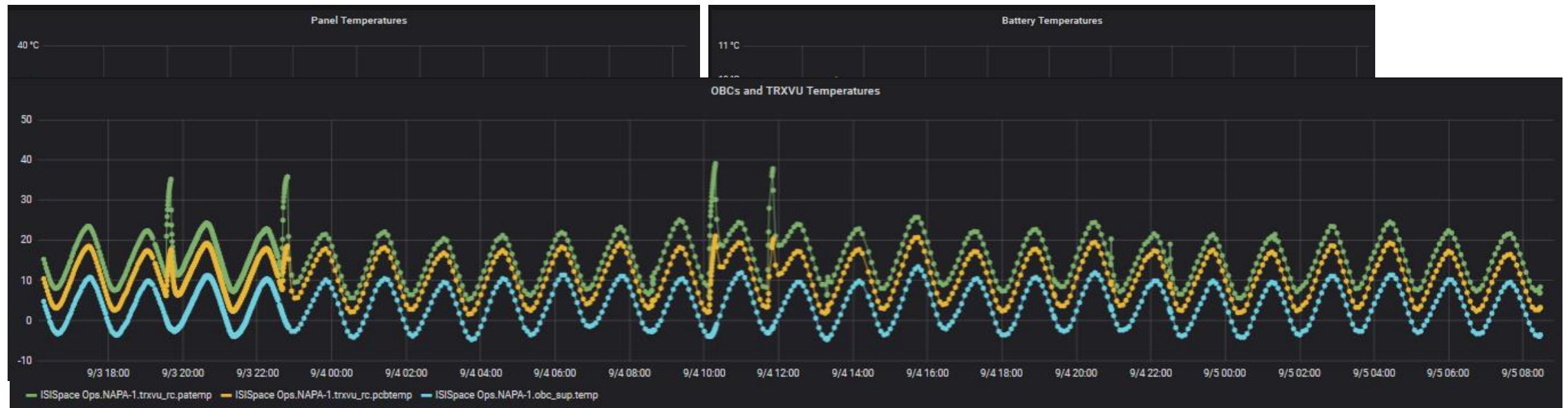- Successful verification of satellite safe mode (power and thermal)
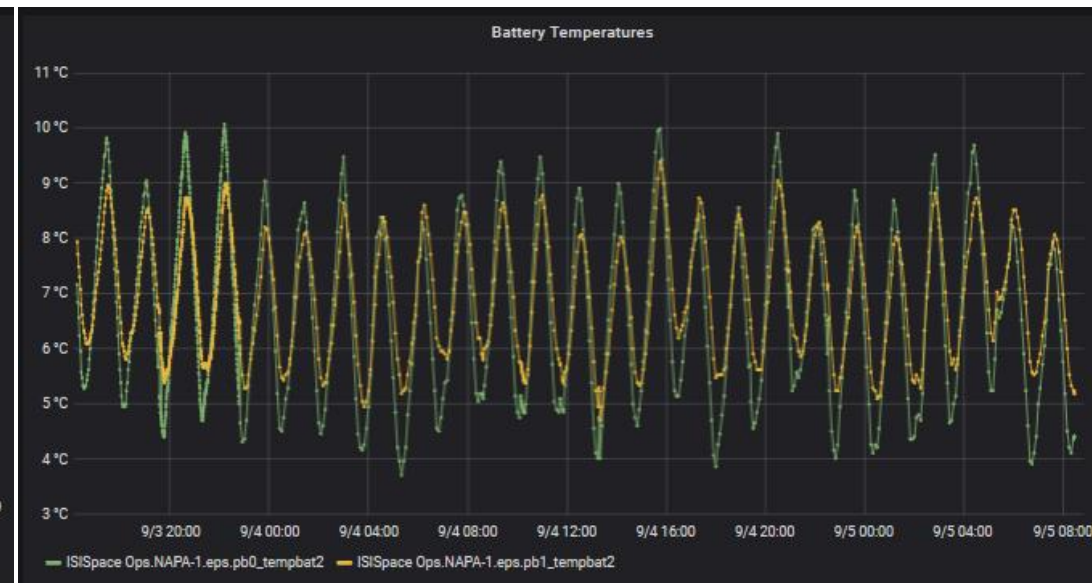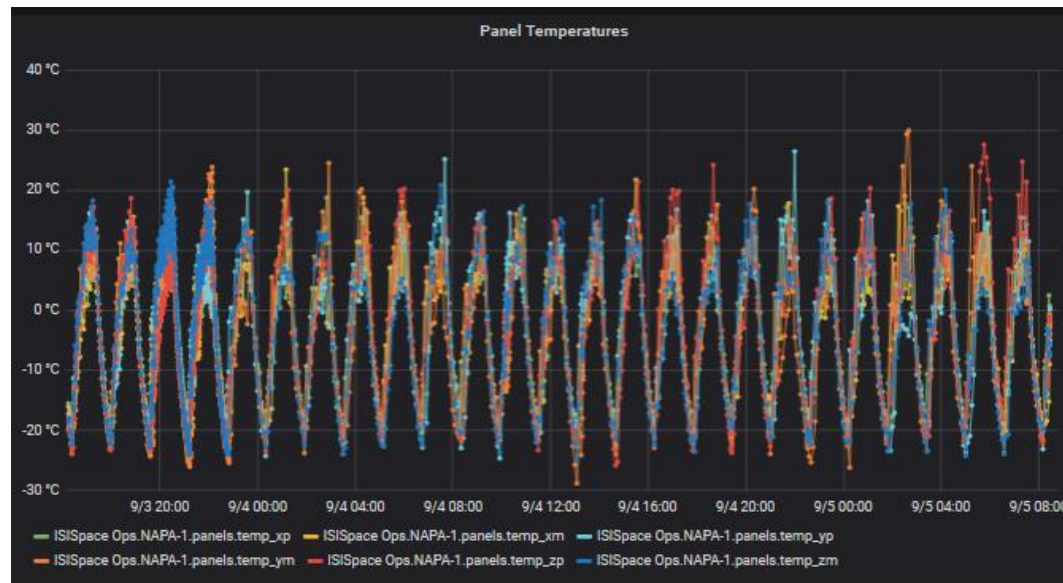
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Launch and Early Operations

Closing LEOP phase

- Successful verification of antenna deployments and communication
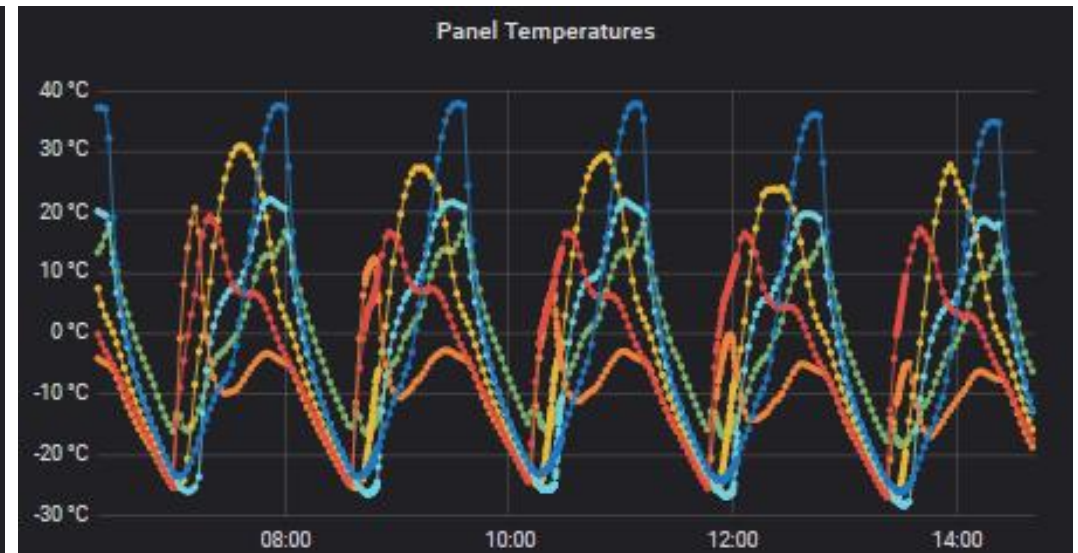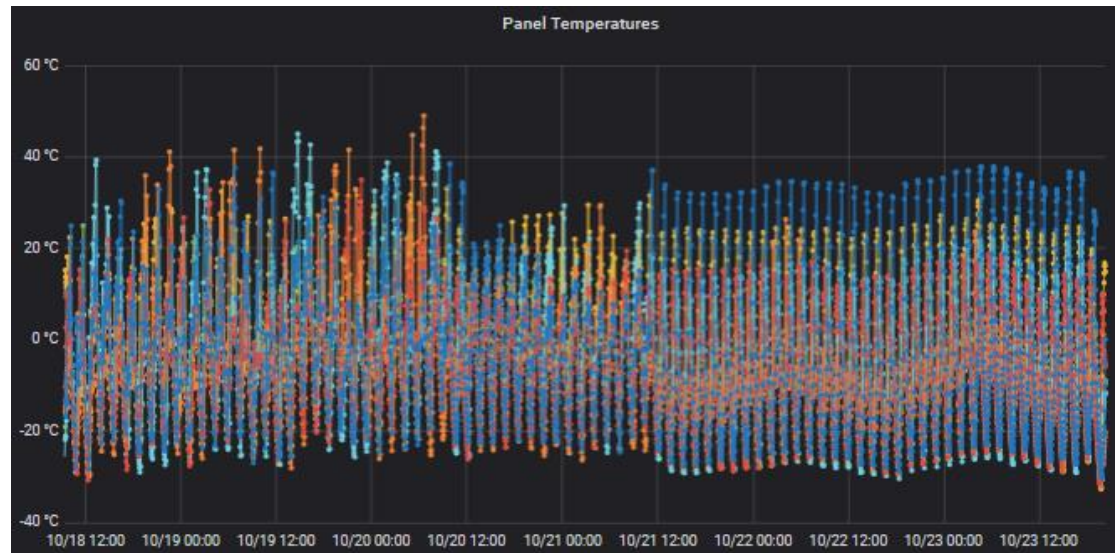- Successful verification of satellite safe mode (power and thermal)

The Napa-1 Mission

Commissioning

Data, data, and.. more data!

- Temperatures external profiles severely impacted by S/C attitude
- Difference between random tumble and nadir-pointing clearly visible in temperature behavior
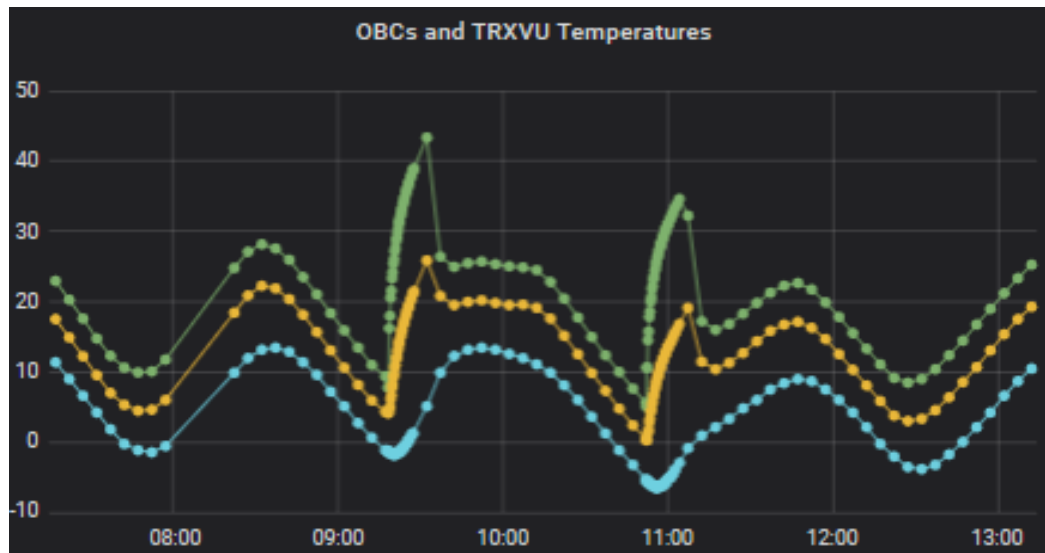
The Napa-1 Mission

Commissioning

Data, data, and.. more data!

- Temperatures internally following panels temperature profile
- Battery temperature dipped below 0°C few times; accepted

The Napa-1 Mission

Commissioning

Data, data, and.. more data!

- Angular rates and RPY angles controlled but (nearly) every orbit after obtaining a Sun vector the attitude was realigned by the ADCS

- Acquisition of Sun vector took 'long' and therefore impacts payload operations above poles, although not required from a mission perspective
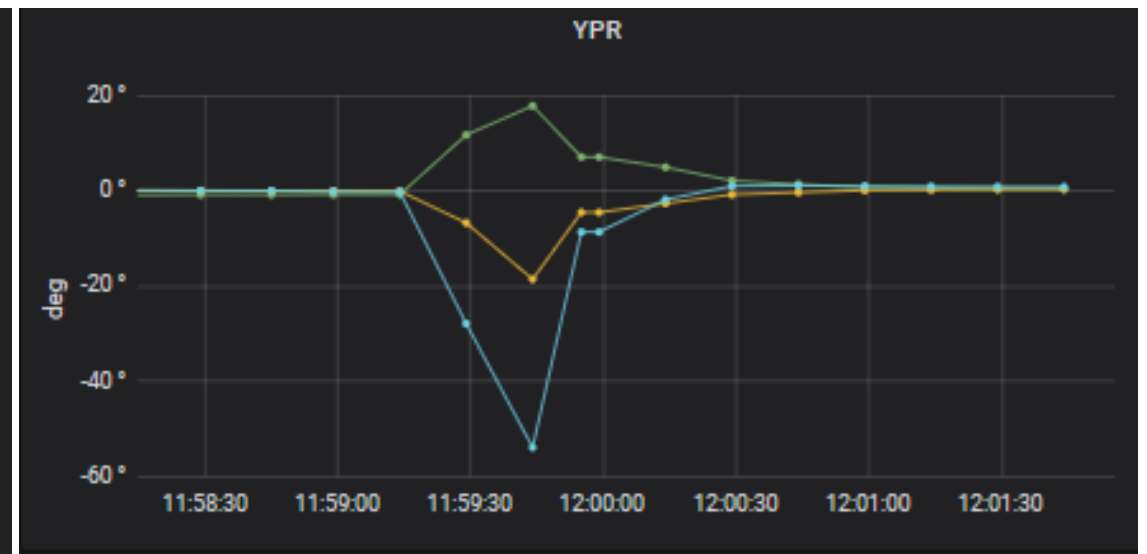
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Payload Commissioning

Yes, we really are in space!

- First image taken while having ground station contact over Delft, The Netherlands
- Verification of camera and payload data chain

Essen, Germany
Googlemaps snippet overlaid in the Gecko image
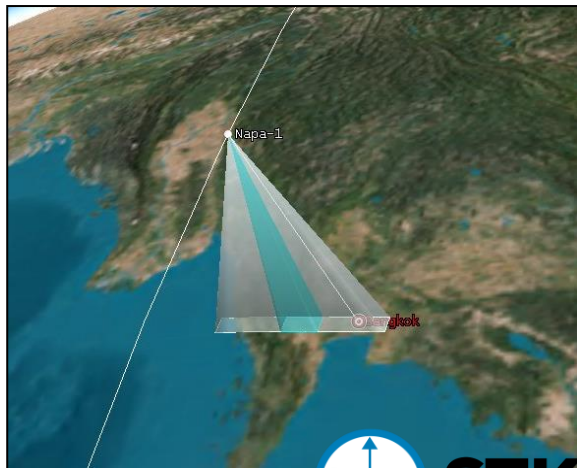
The Napa-1 Mission

Payload Commissioning

Mission use cases

- Image Thailand and specifically Bangkok
- Take 8 images (in a row) and download within 24 hours

Planning · Flight plan Assembly · Acquisition & Download

The Napa-1 Mission

Payload Commissioning

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The Napa-1 Mission

Payload Commissioning

Mission use cases

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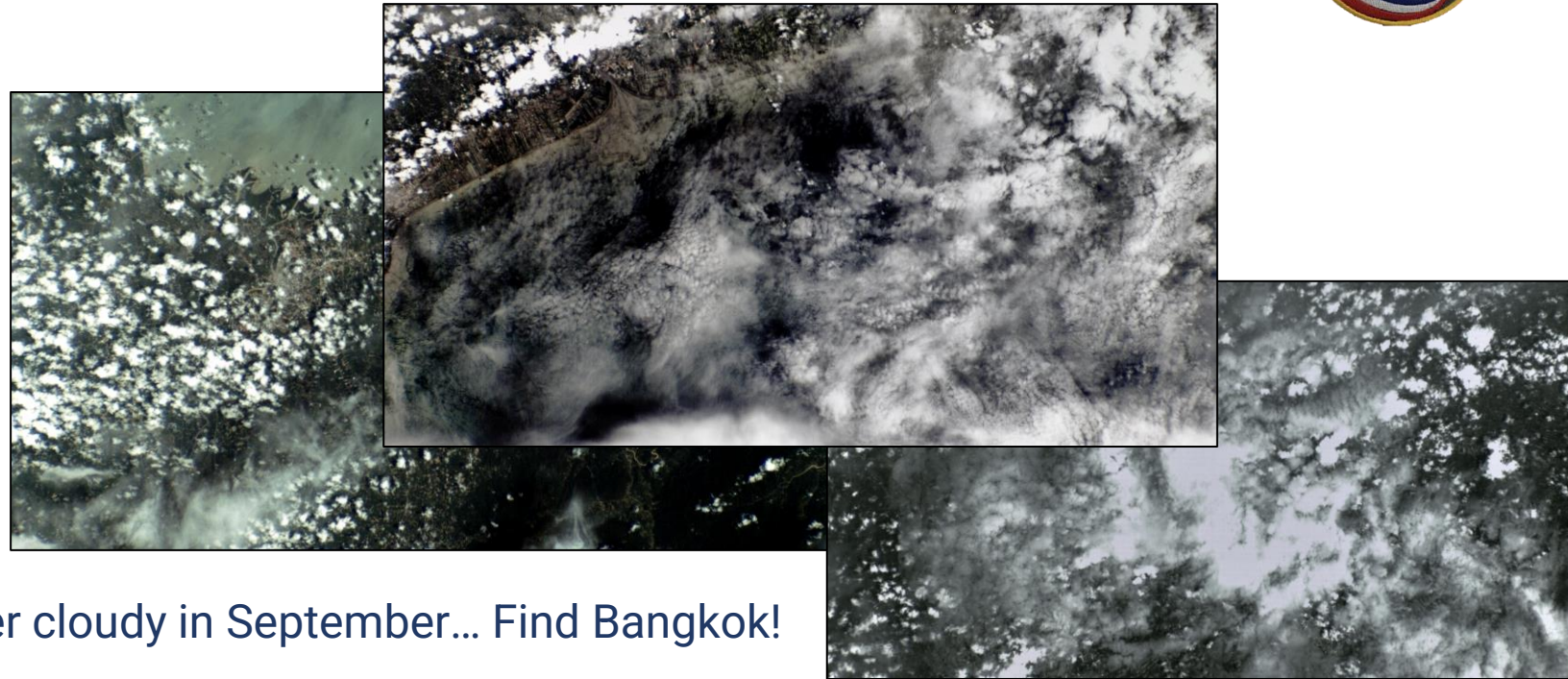However…

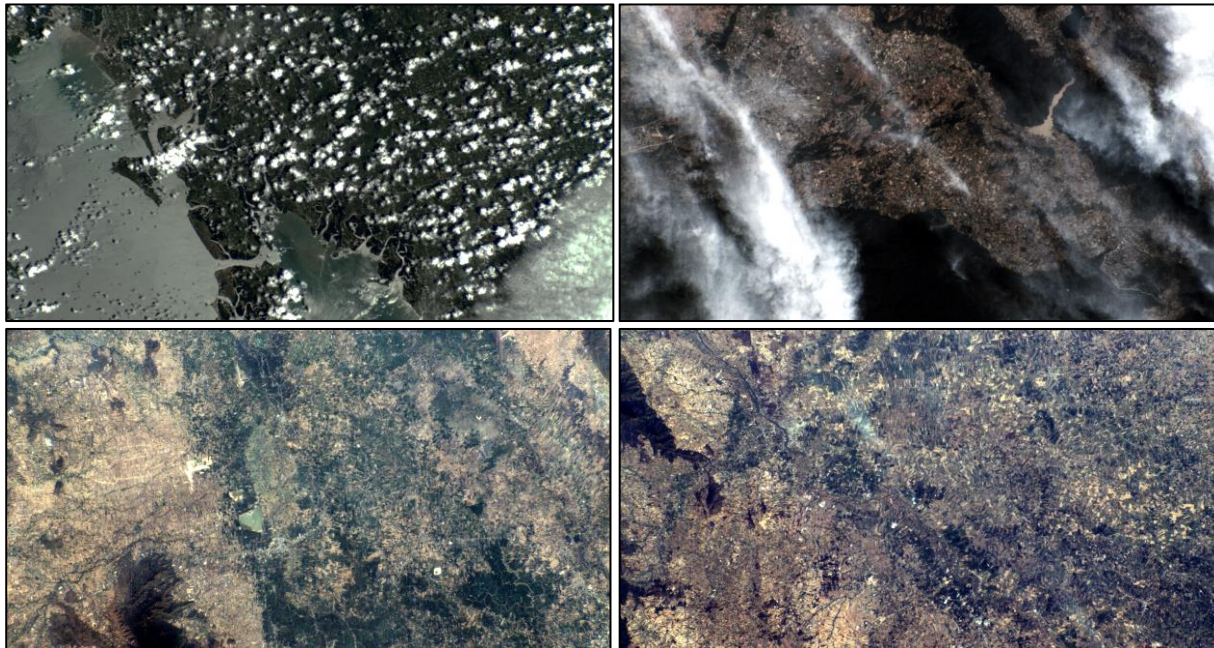Thailand is rather cloudy in September… Find Bangkok!

The Napa-1 Mission

Payload Commissioning

Mission use cases

- Every time an opportunity presented itself images were taken above Thailand

- Many cloudy images **but** also clear images!

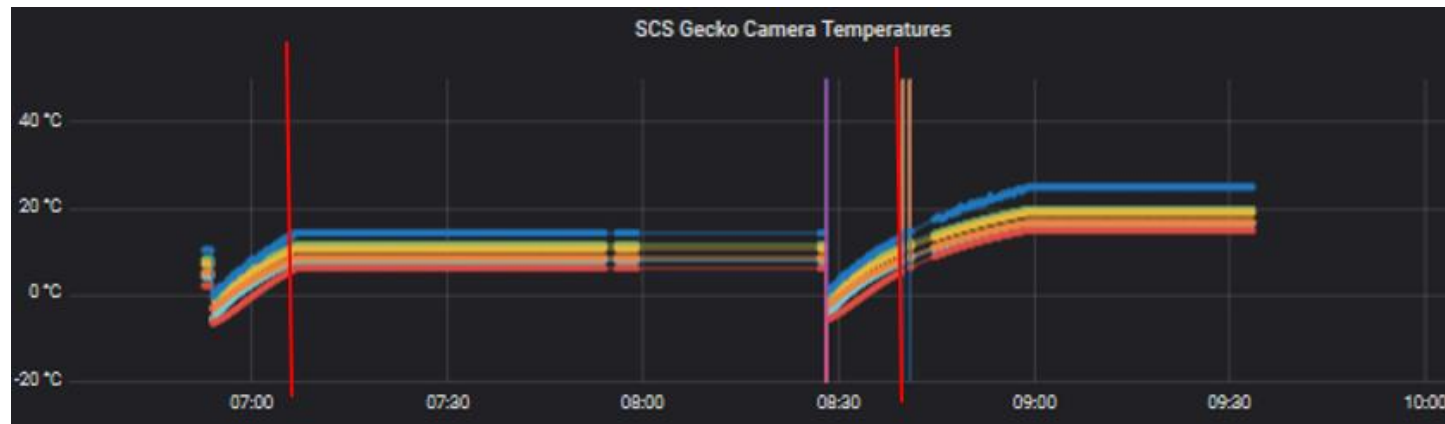- >8 images downloaded in a single pass

Bangkok, Thailand

ISISpace

The Napa-1 Mission

Payload Commissioning

Ice, ice, baby!

- Camera on the colder end of the spectrum when switched on: < 0°C

- Optimal optical performance in thermal range ~10°C and up

- Solution: switch camera on 10 minutes before target

GECKO temperatures, red line indicates image acquisition

A perfect shape

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Payload Commissioning

Photoshoot of nature's finest
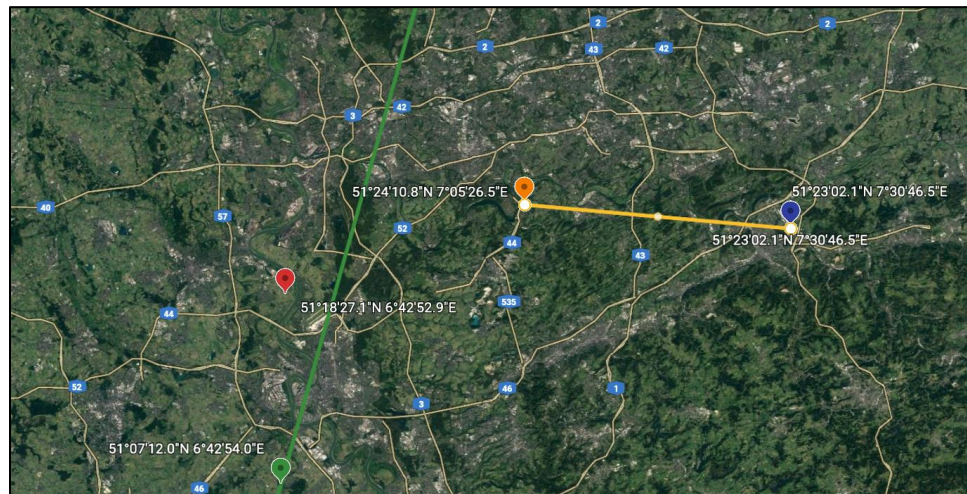
While waiting for Thailand image opportunities....

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Payload Commissioning

Geolocating the images

- Image metadata consisting of time, lat/lon, altitude, and satellite attitude
- Center of images often posing significant off-set compared to what data provided
- Ground control points allowed for locating center through Google maps

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SIMERA TriScape Commissioning

In-Orbit demonstrator

- Out of contract scope but goal to de-risk for Napa-1 successor, if time…

- Target fly-over, no ground target tracking

- However, without ground target tracking the integration time is too short

- Smearing occurs due to camera GSD and along-track velocity
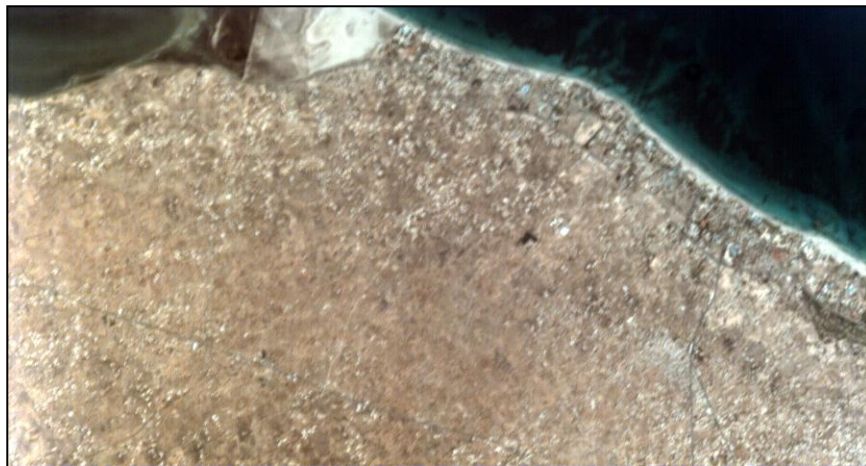
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IOCR and Training

Thailand here we come!

On-site training given to RTAF operators:

1. Napa-1 satellite operations
2. Mission control and planning
3. Off-nominal Situation handling
4. RTAF operators full control and handover

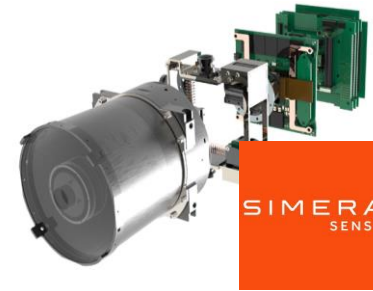KEEP CALM YOU'RE IN CONTROL

The Napa-1 Mission

Next steps and future outlook

NAPA-2 (launch June 25, 2021)

More bands

Simera Sense Multispectral Line scanner
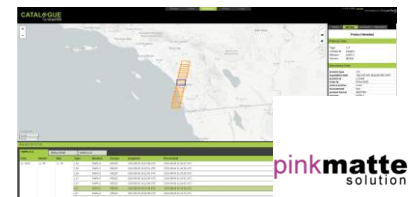MultiScape 100
VNIR 7-bands 4,75GDS @500km

Improved AOCS capabilities

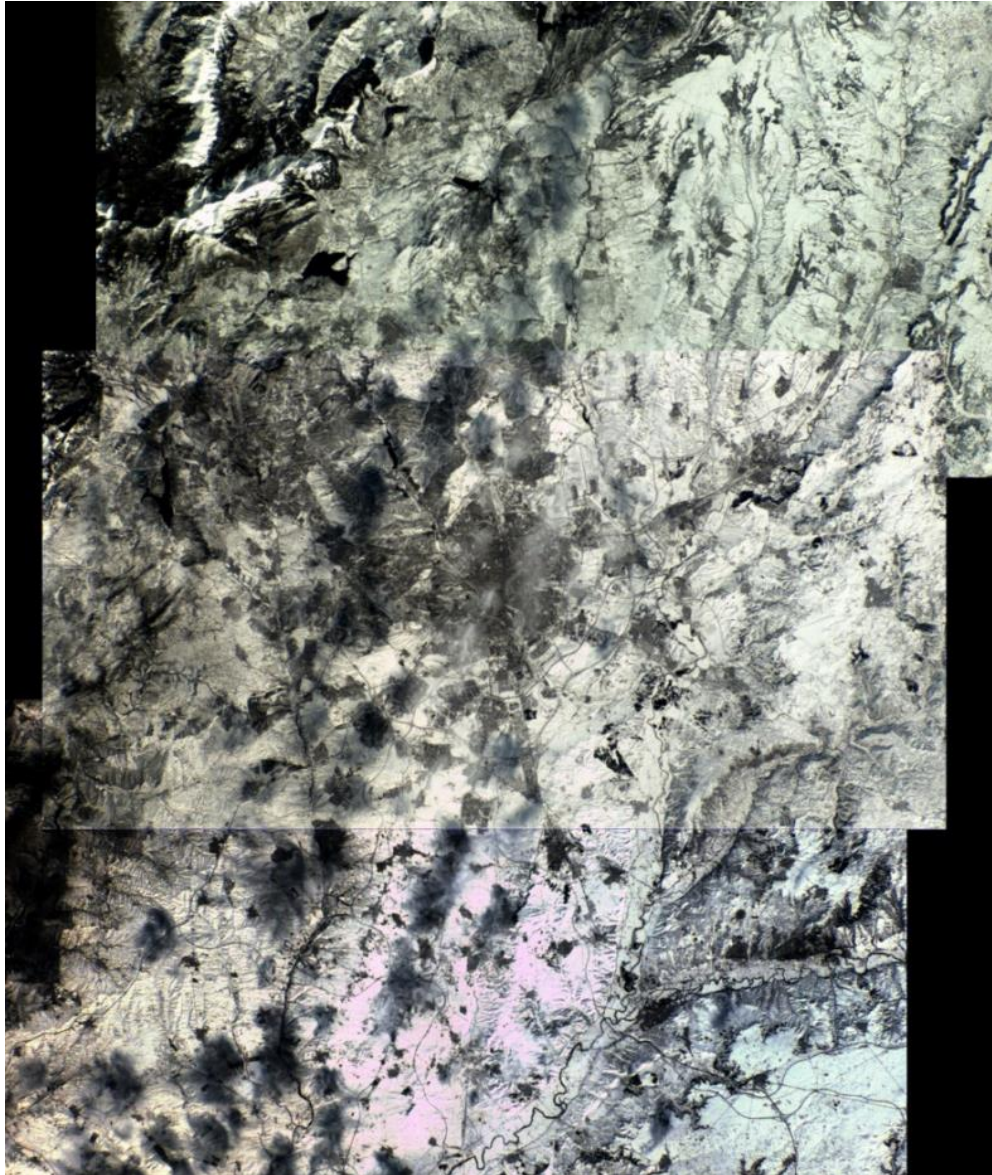ISISpace high performance AOCS suite, incl. 3x RWU 30mNms
Thrustme I2T5 Thruster

Advanced direct L0-L1B Image Processing

Pinkmatter Farearth system

Thank you

Snow-covered Madrid, Spain

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