Cubesat user readiness

Presented by Stephen English to IPETSUP-5 Agenda Item 5.4, 11 February 2019

ECMWF

Cubesats for EO

Aim to provide high temporal and spatial resolution Radio Occultation (e.g. Spire, Geoptics, PlanetiQ) or microwave (e.g. TROPICS, OMS….).

Both government and private enterprise is aiming to deliver Cubesat technology. Cubesats raise many questions in terms of user readiness, such as:

- How will vast numbers of Cubesats be commanded (RF requirements vs other users of RF spectrum)?
- Who/what is target user community and what engagement is taking place?
- How will new operators make data available: format of data, test data, NRT, free availability, meta data, CGMS best practise, SATURN, OSCAR?
- What training events are being organised?
- How will data be validated (cal/val), archived, re-processed?
- Follow-on missions, operational continuity?

IPETSUP members probably have additional valid questions!

In this short presentation we will look in particular at **TROPICS**.

ECMWF

Time-Resolved Observations of Precipitation Structure and Storm Intensity with a Constellation of Smallsats

MIT Lincoln Laboratory (lead organization)

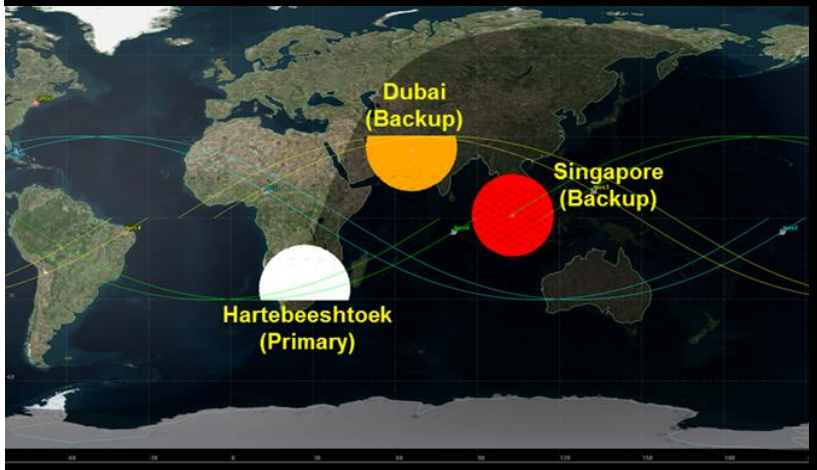
William J. Blackwell, Principal Investigator. Scott Braun (NASA GSFC), Project Scientist

Six 3U CubeSats
Three orbital planes
30-deg inclination
550-km altitude
40-minute median revisit
12-channel radiometer

This material is based upon work supported by the National Aeronautics and Space Administration under Air Force Contract No. FA8702-15-D-0001. Any opinions, findings, conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration .

TROPICS Mission Overview

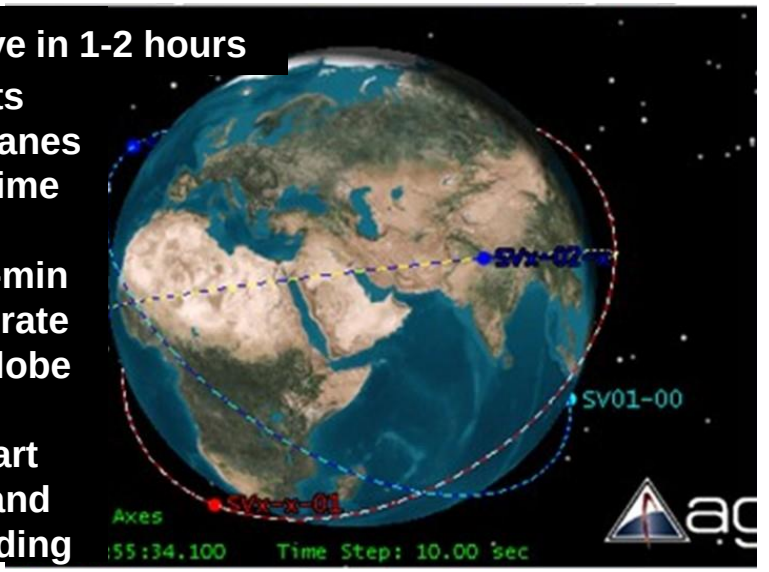
Plan = 24-hr data latency – but significant % of data will arrive in 1-2 hours



Six CubeSats
Three orbital planes
15-month lifetime

Better than 60-min median revisit rate over most of globe

State-of-the-art temperature and moisture sounding



KSAT

Ground Station Network

BCT

Mission Operations Center

MIT LL

Science Operations Center

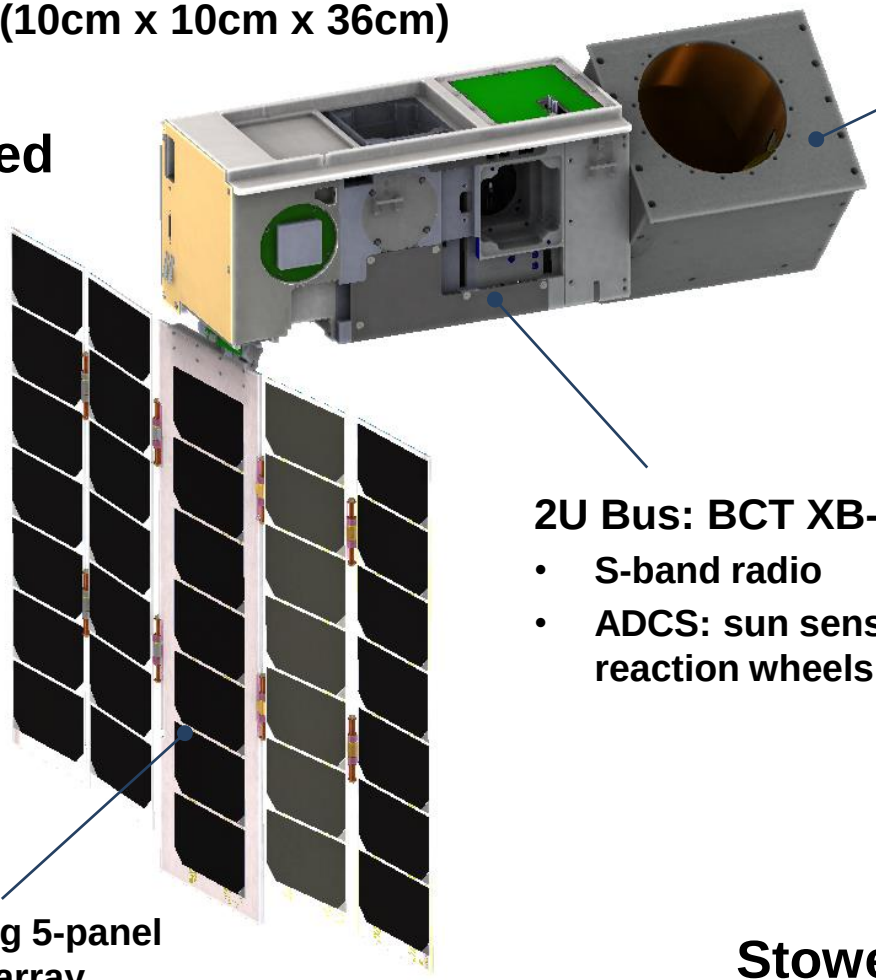
UW-SSEC

Data Processing Center

TROPICS CubeSat Overview

3U CubeSat
(10cm x 10cm x 36cm)

Deployed



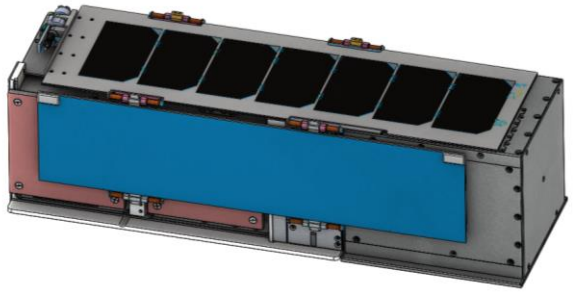
Articulating 5-panel solar array

1U Payload
- Rotating microwave radiometer
- Scanner assembly
- 83 mm aperture
- Noise-diode / sky calibration

Ultra-compact W / F / G radiometer
- W band 92 GHz
- F band 7 ch (114-119 GHz)
- G band 4 ch (183±1, 3, 7), 204 GHz

2U Bus: BCT XB-1
- S-band radio
- ADCS: sun sensor(s), star-camera, reaction wheels, torque rods

Stowed



TROPICS Channel Set

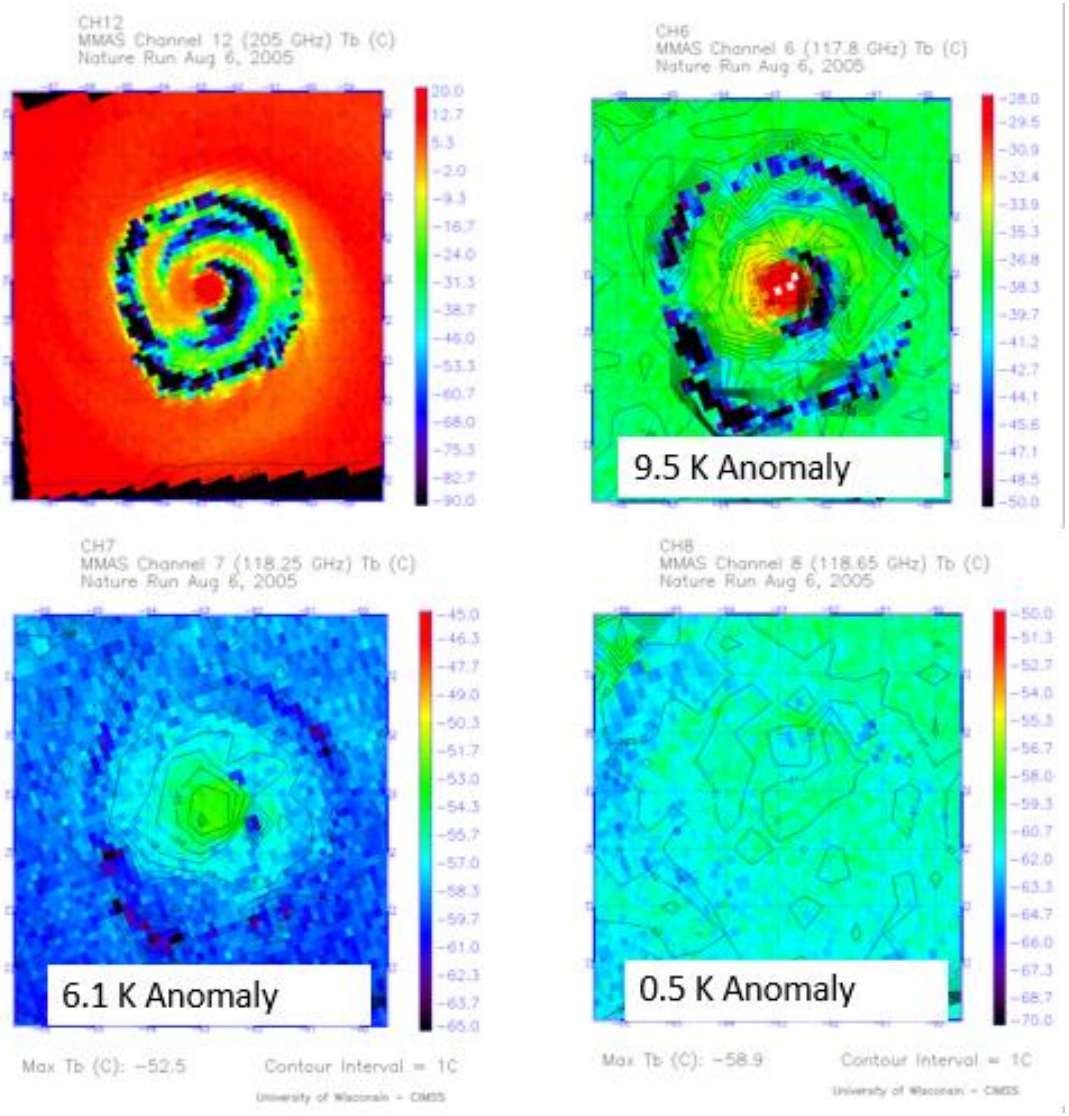
TROPICS Chan.	Center Freq. (GHz)	Bandwidth (GHz)	RF Span (GHz)	Beamwidth (degrees) Down/Cross	Nadir Footprint Geometric Mean (km)*	Measured NEdT (K)
1	91.656 ± 1.4	1.000	89.756-90.756 92.556-93.556	3.0/3.17	29.6	0.66
2	114.50	1.000	114.00-115.00	2.4/2.62	24.1	0.96
3	115.95	0.800	115.55-116.35	2.4/2.62	24.1	0.82
4	116.65	0.600	116.35-116.95	2.4/2.62	24.1	0.86
5	117.25	0.600	116.95-117.55	2.4/2.62	24.1	0.79
6	117.80	0.500	117.55-118.05	2.4/2.62	24.1	0.81
7	118.24	0.380	118.05-118.43	2.4/2.62	24.1	0.90
8	118.58	0.300	118.43-118.73	2.4/2.62	24.1	1.03
9	184.41	2.000	183.41-185.41	1.5/1.87	16.9	0.58
10	186.51	2.000	185.51-187.51	1.5/1.87	16.9	0.55
11	190.31	2.000	189.31-191.31	1.5/1.87	16.9	0.53
12	204.8	2.000	203.8-205.8	1.35/1.76	15.2	0.52

Simulated Warm Core Anomalies
Strong Storm: 110 kn

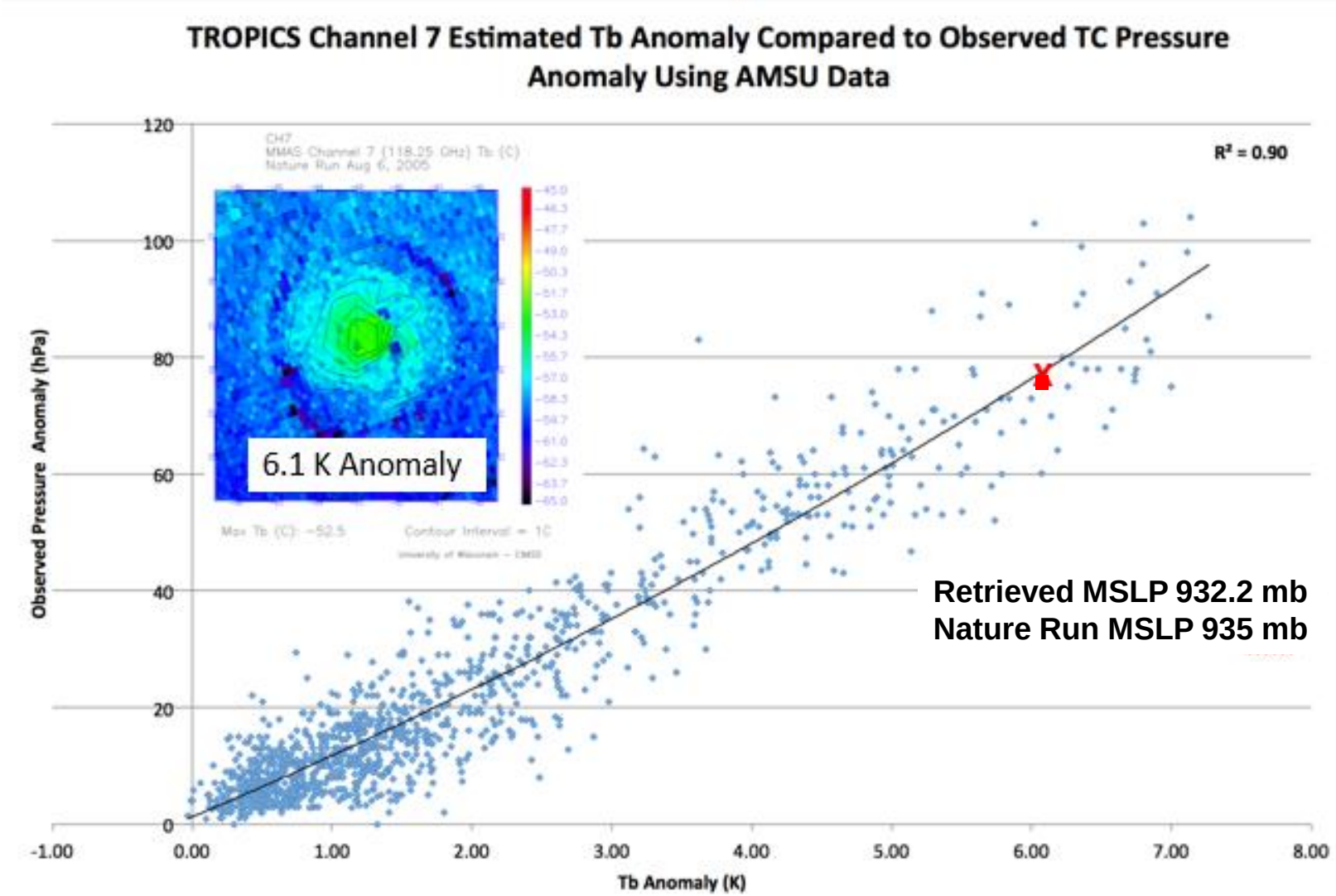
MMAS2 Nature Run Test 2 with a stronger Tropical Cyclone

TC exhibits secondary eyewall in CH 12

Large eye allows sensor to resolve warm anomaly



TC intensity correlation with BT anomaly



User readiness preparations

- TROPICS user community includes academia, forecasters, NWP centres.

- Engagement to prepare user community through:
  - Applications workshop
  - Quarterly telecons with users
  - TROPICS has an ”early adopter" programme (e.g. ECMWF) https://www.nsstc.uah.edu/tropics/early_adopters.html
  - Proxy data in various formats.

- Data provision
  - “Best endeavours NRT”
  - No data restrictions (free exchange)

- Mechanisms in place – but how ready are users for TROPICS and similar missions?