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# Coordinated observation system for extreme weathers consisting of AWS network with lightning sensor and micro-satellites

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# Abstract

In order to predict the intensity and location of extreme weathers, such as torrential rainfall by individual thunderstorm or typhoon, we are developing the new methodology of weather monitoring using a ground AWS network with lightning sensors and micro-satellites weighting about 50kg, which will realize quasi-real-time thunderstorm monitoring with broad coverage. Based on the AWS network data, we plan to operate micro-satellites in nearly real-time, manipulating the attitude of satellite for capturing the most dangerous or important cloud images for 3D reconstruction. We have developed and launched several micro-satellites and been improving the target pointing operation for this decade. We succeeded in obtaining the images of the typhoon center at a resolution of 60-100 m for Typhoon Trami in 2018 and Typhoon Maysak in 2020. Using 4 or a few 10s images captured from different angles by one micro-satellite when it passed over the typhoon area, 3D models of typhoon eye were reconstructed, which have a ground resolution of ~100 m. Due to the unusual temperature profile around typhoon eye, it's very difficult to estimate the height distribution of cloud top only with a thermal infrared image at a resolution of 2 km taken by geostationary meteorological satellite. This is one of the biggest limitations in estimating the precise intensity of typhoons, namely, the center pressure or the maximum wind velocity. The on-demand flexible operation of micro-satellite will achieve the high accuracy estimation of typhoon intensity as well as the speed estimation of individual thunderstorm development, which can be applied to disaster management. This research was conducted by a mixed team of Japan and the Philippines, supported by Science and Technology Research Partnership for Sustainable Development (SATREPS), which is funded by Japan Science and Technology Agency (JST) / Japan International Cooperation Agency (JICA).

# PHL-Microsate

News WOWU, No. 21


ASIA & OCEANIA

## Matching satellite technology with end user needs.

### RARE BUT POSSIBLE

Japan – Hokkaido University Professor Yukihiro Takahashi's flexible scientific interests have evolved over the past few decades, which led him in good stead as he helps push forward the development of a space-based multispectral imager (SMI), a liquid crystal tunable filter camera, currently being pioneered by Hokkaido University. The SMI is capable of detecting wavelengths that the human eye cannot tell from other shades, and can take images at 600 bands, which are generated by a tiny device of just three centimeters in length.

"Based on data from the SMI, we can tell if rice crops have blast infection before farmers can even detect symptoms, and we can pinpoint the location of squid shoals by studying the distribution of phytoplankton in the ocean," Takahashi said.

Arriving at Hokkaido University in 2009, Takahashi was struck by the large number of faculty members that made regular use of satellite data. "By talking to those people, I was able to identify their satellite-data needs," he said. "People may think it's easy to understand users' requirements, but it's actually extremely difficult to match satellite technology with end-users' needs. Indeed, Hokkaido University is the only higher educational institution in the world that can do this."

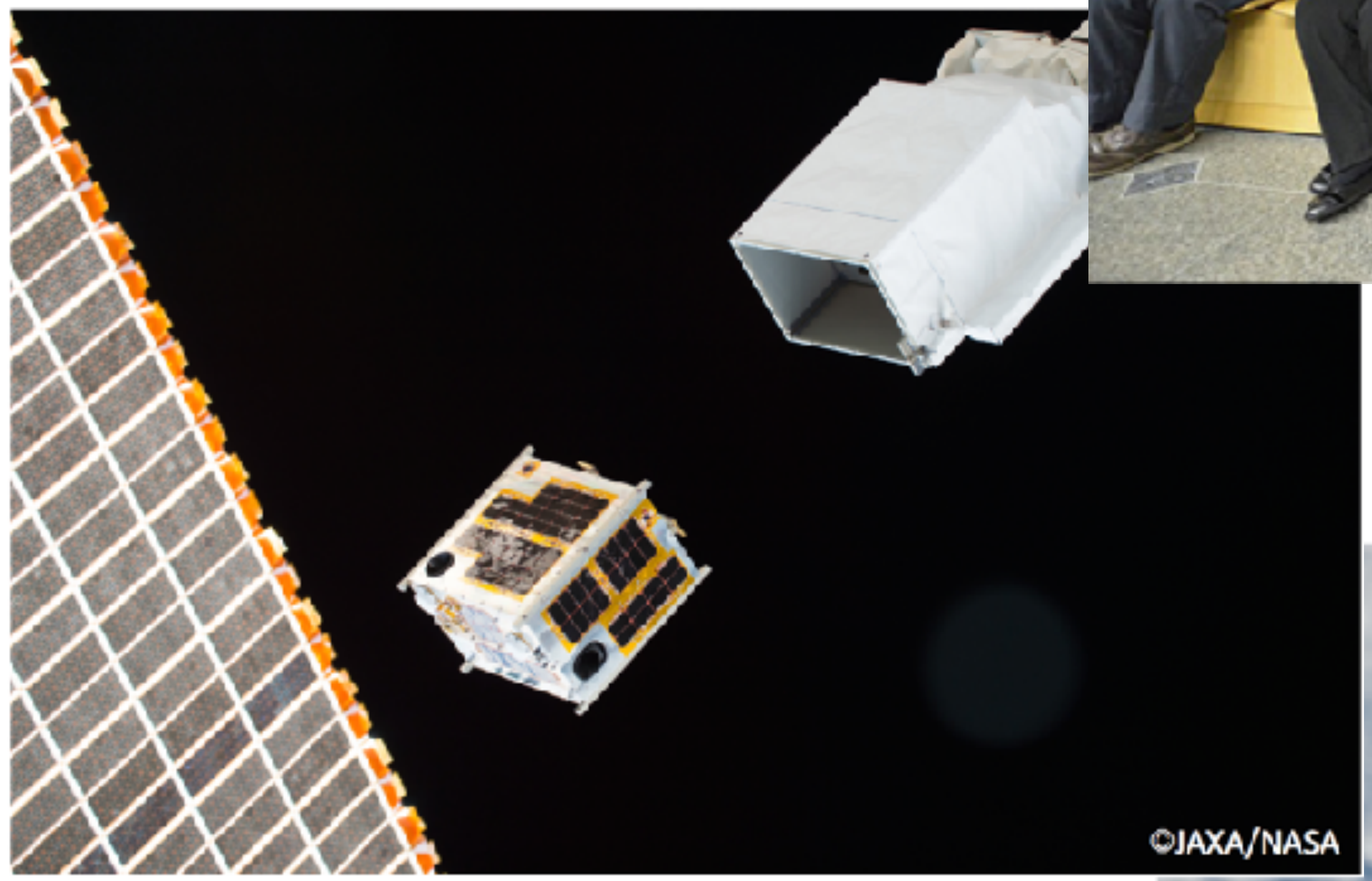
When two undersecretaries of the Philippine Department of Science and Technology (DOST) visited Hokkaido University in January 2015, they were ... microsatellite, the students acquired the hands-on experience necessary to build microsatellites for their homeland. Hokkaido University provided training in the analysis and use of satellite image data, in addition to providing education required for planning, devising and promoting online missions.

Asia Research News 2017 (page 20-21)
http://www.researchsea.com/asia_research_news_2017.php

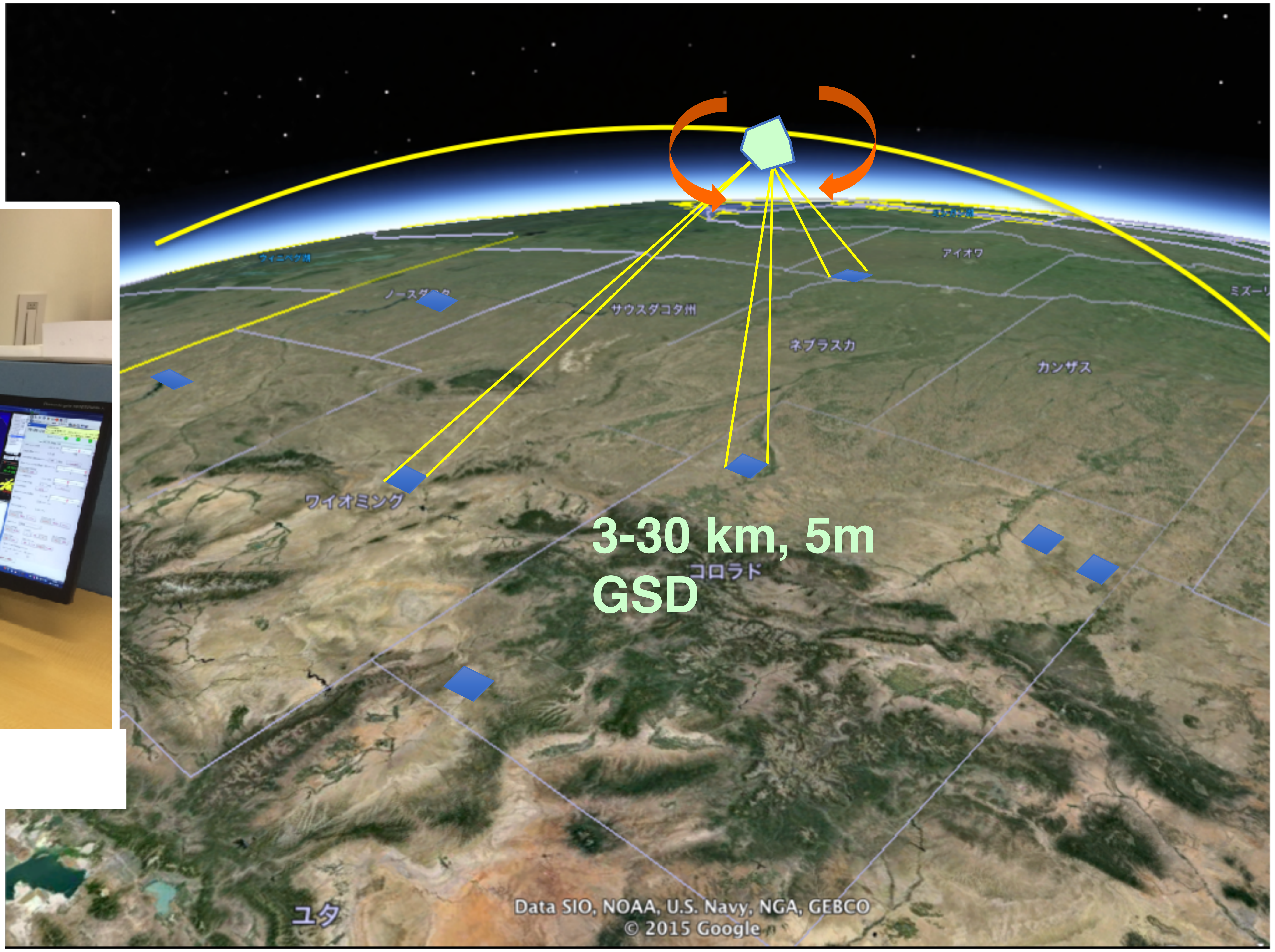

TECHNOLOGY

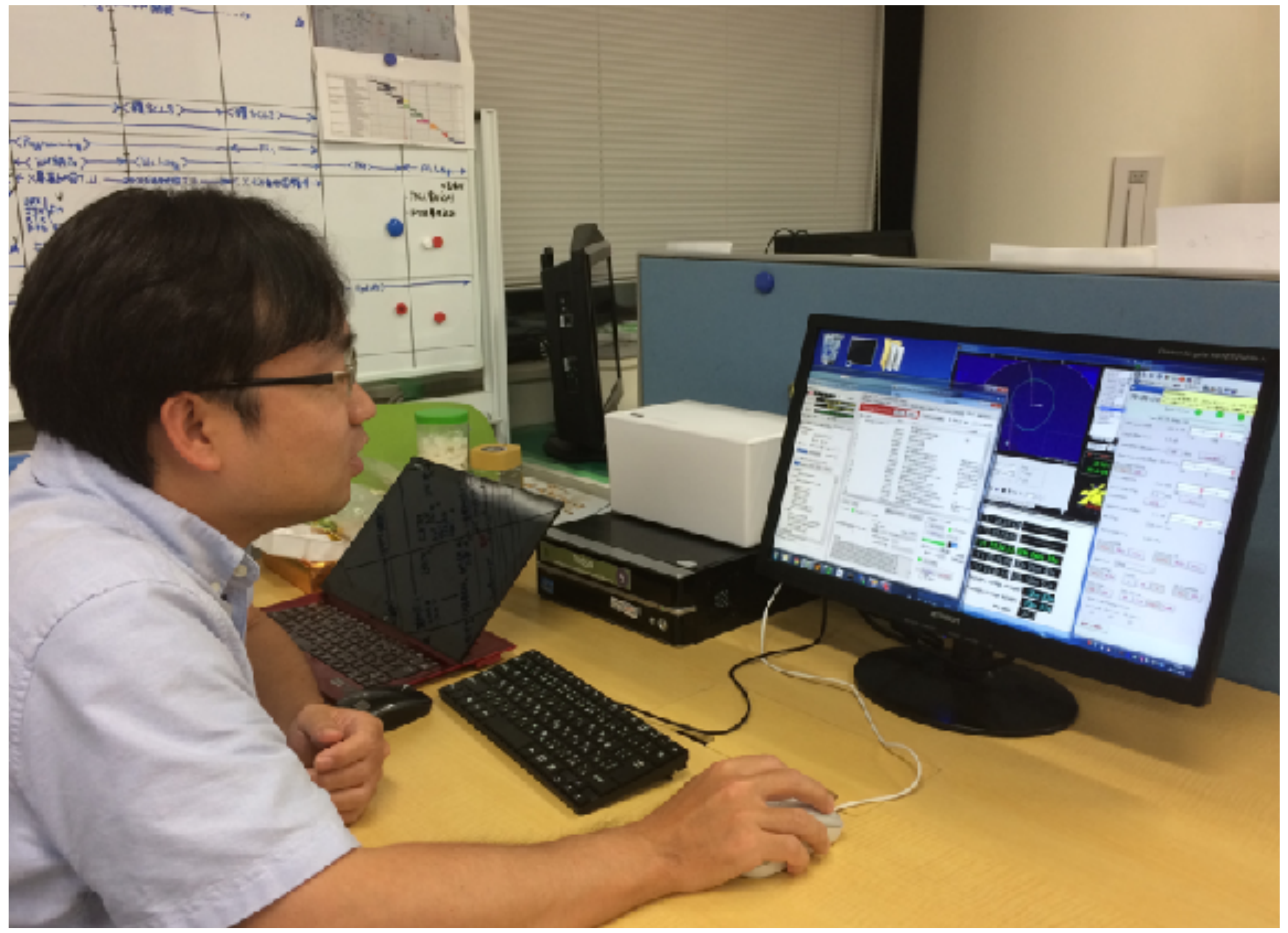
TECHNOLOGY

## PHILIPPINES' FIRST MICROSATELLITE CAPTURES ULTRA-HIGH-RESOLUTION IMAGES




# Target pointing

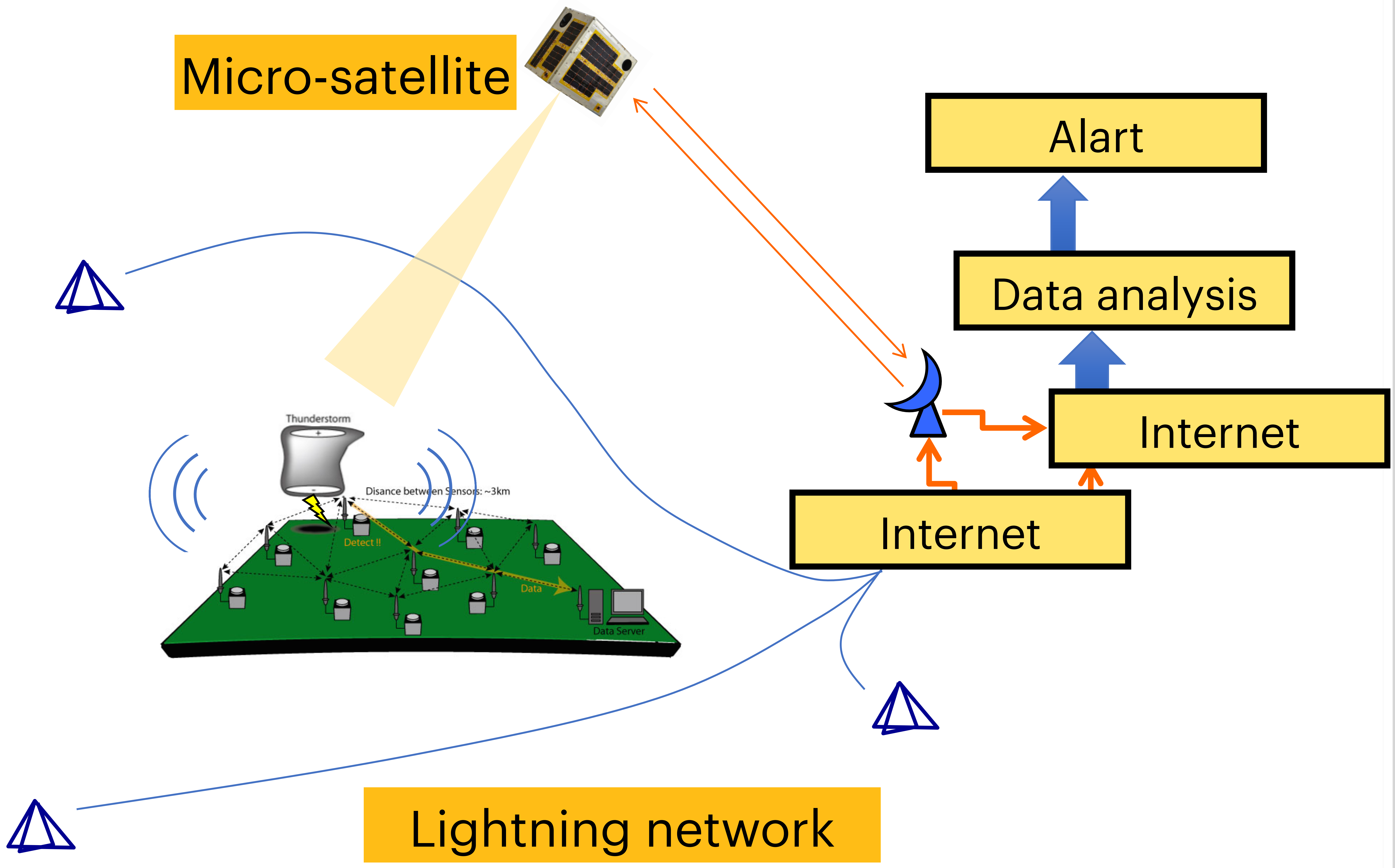


In operation

# Goal of this program

## Combination of micro-satellite and lightning network

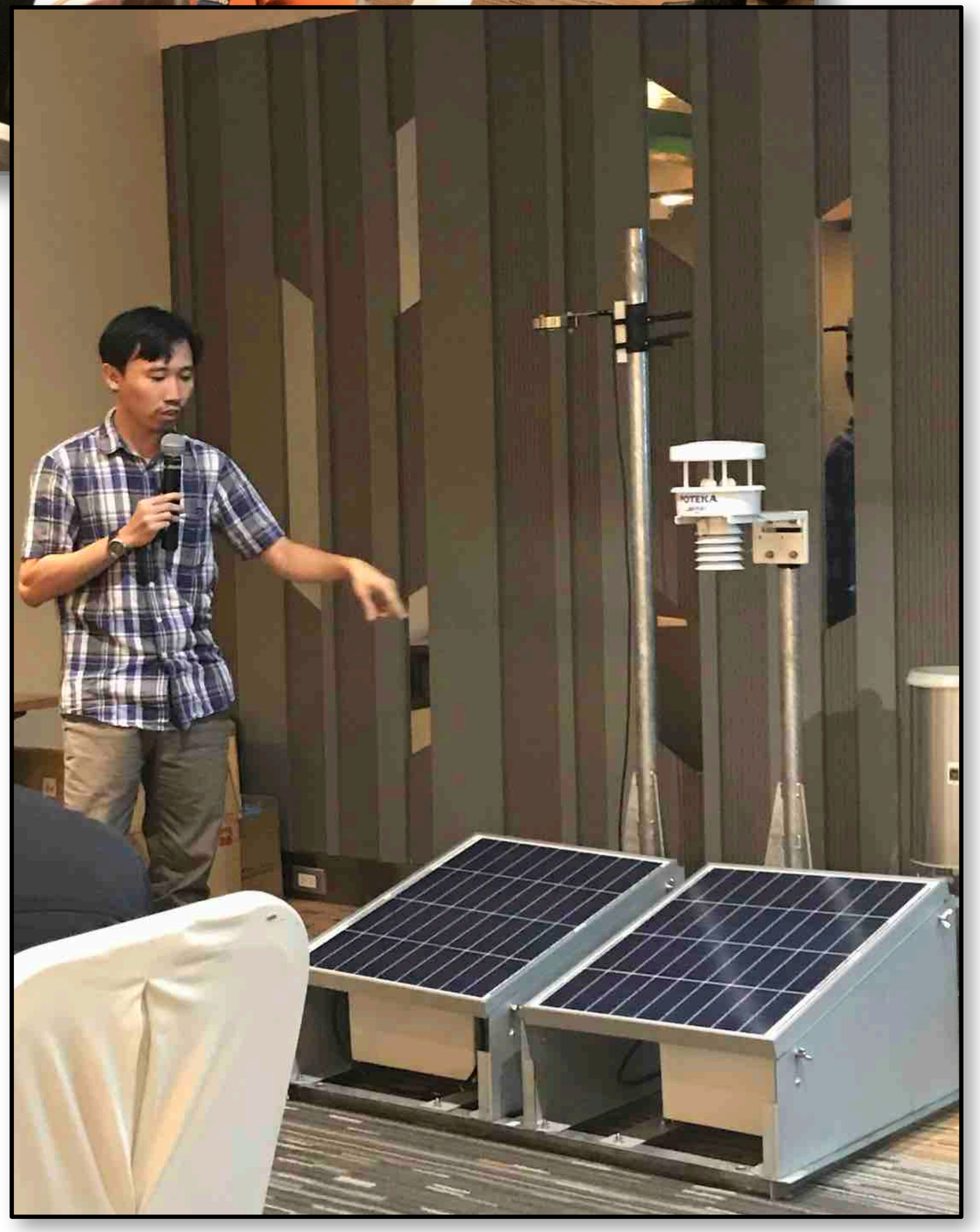


# Lightning measurement

# AWS with lightning sensor: P-POTEKA/V-POTEKA


~70 sets were shipped to the Philippines

# Stake holder meeting in the Philippines



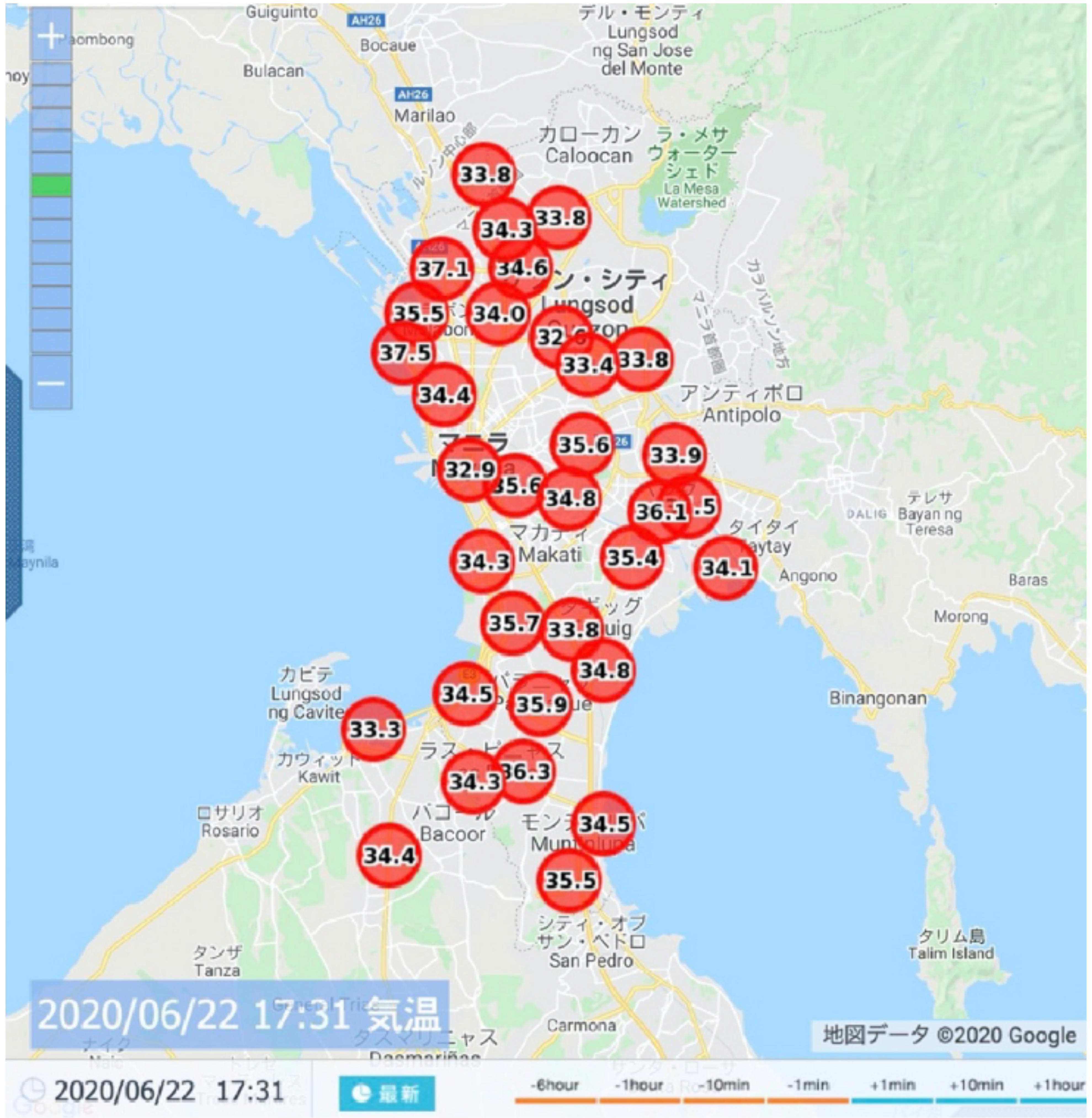
Installation at Pasig RAVE

Installation at Rescue Emergency Disaster Pasig

# P-POTEKA

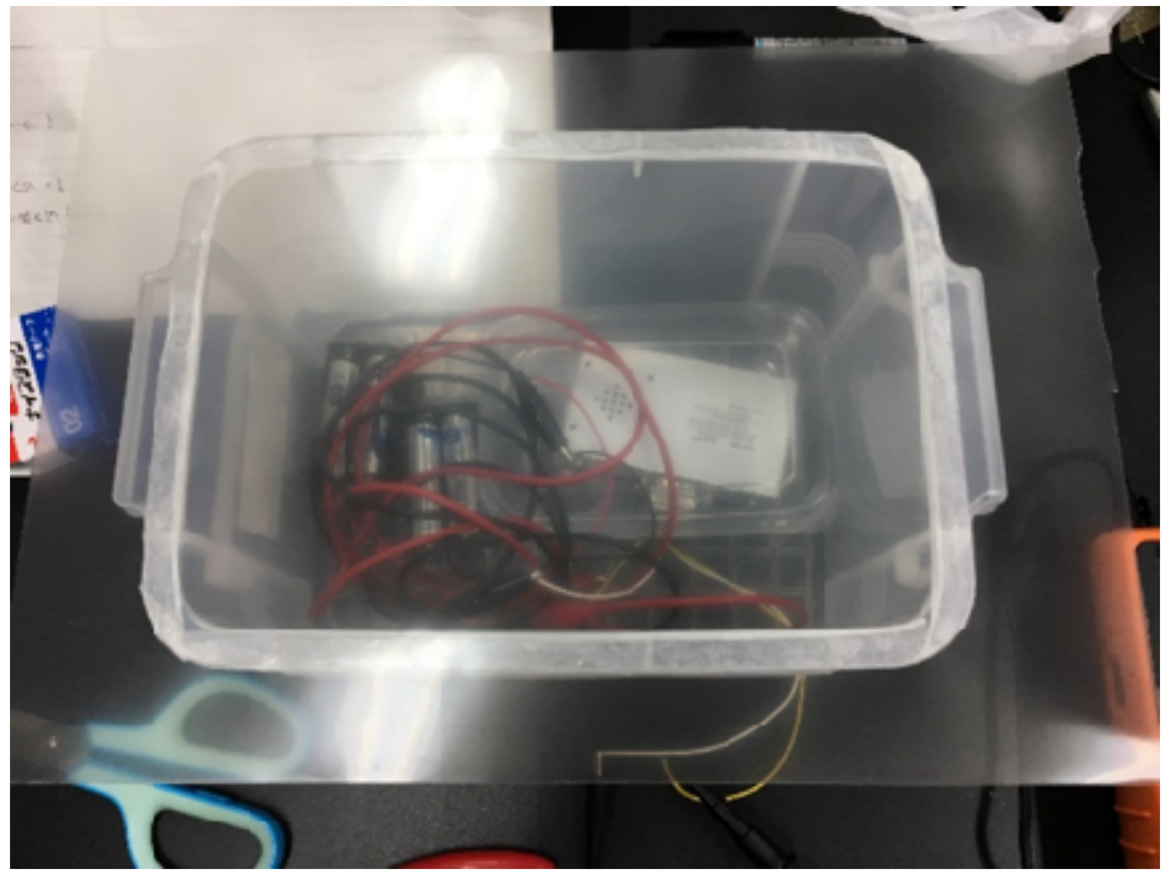
## 35 sites completed among 50

| 設置順 | 観測拠点名 | 設置日 | 位置 |
|---|---|---|---|
| 1 | ASTI | 2018/ 06/ 29 | 14.6471N, 121.0721E |
| 2 | MMDA EFCOS | 2018/ 11/ 21 | 14.5987N, 121.0892E |
| 3 | MMDA Tapayan | 2018/ 11/ 22 | 14.5414N, 121.1156E |
| 4 | MMDA San Andres | 2018/ 11/ 23 | 14.5837N, 121.0061E |
| 5 | DOST | 2019/ 01/ 22 | 14.4896N, 121.0521E |
| 6 | De la Salle Araneta University | 2019/ 01/ 24 | 14.6705N, 120.9974E |
| 7 | MMDA Catmon | 2019/ 01/ 28 | 14.6706N, 120.9552E |
| 8 | CAAP | 2019/ 01/ 29 | 14.5141N, 121.0044E |
| 9 | Valenzuela Brgy. Punturin | 2019/ 02/ 11 | 14.7409N, 120.9899E |
| 10 | Valenzuela Brgy. Ugong | 2019/ 02/ 11 | 14.6941N, 121.0086E |
| 11 | Valenzuela DRRMO | 2019/ 02/ 13 | 14.6934N, 120.9683E |
| 12 | Las Piñas Dr. Felimon C. Aguliar Memorial College | 2019/ 02/ 18 | 14.4385N, 121.0097E |
| 13 | Las Piñas Elias Aldana Brgy. Hall | 2019/ 02/ 20 | 14.4778N, 120.9799E |
| 14 | Las Piñas Science High School | 2019/ 02/ 21 | 14.4330N, 120.9844E |
| 15 | MMDA Balut | 2019/ 02/ 28 | 14.6297N, 120.9687E |
| 16 | Pasig RAVE | 2019/ 03/ 06 | 14.5729N, 121.0974E |
| 17 | Rescue Emergency Disaster Pasig | 2019/ 03/ 07 | 14.5702N, 121.0818E |
| 18 | MMDA Libertad PS | 2019/ 03/ 11 | 14.5448N, 120.9893E |
| 19 | Valenzuela Brgy. Bagbaguin | 2019/ 03/ 13 | 14.7134N, 121.0009E |
| 20 | Navotas Centennial Park | 2019/ 03/ 14 | 14.6509N, 120.9475E |
| 21 | Unibersidad de Manila | 2019/ 05/ 22 | 14.5917N, 120.9815E |
| 22 | Bayanan Elementary School, Muntinlupa City | 2019/ 06/ 04 | 14.2471N, 121.0313E |
| 23 | Anabu 1-B, Imus City | 2019/ 06/ 06 | 14.3962N, 120.9399E |
| 24 | Xavier School, San Juan City | 2019/ 07/ 08 | 14.3623N, 121.0243E |
| 25 | E. Library, Technological College, Pateros City | 2019/ 07/ 11 | 14.5467N, 121.0666E |
| 26 | C3 Building, Mandaluyong City | 2019/ 08/ 30 | 14.5769N, 121.0335E |
| 27 | Colegio de Muntilupa | 2019/ 09/ 04 | 14.4575N, 121.0513E |
| 28 | NAMRIA, Taguig City | 2019/ 09/ 06 | 14.5354N, 121.0412E |
| 29 | New Bilibid Prison (NBP), Muntinlupa City | 2019/ 10/ 14 | 14.3836N, 121.0337E |
| 30 | Technological University of Philippines, Taguig City | 2019/ 10/ 14 | 14.5107N, 121.0358E |
| 31 | Greenheights Subdivision, Paranaque City | 2019/ 10/ 28 | 14.4728N, 121.0185E |
| 32 | PAGASA Science Garden Complex, Quezon City | 2019/ 10/ 28 | 14.6449N, 121.0444E |
| 33 | Quezon City Science High School | 2019/ 12/ 17 | 14.6589N, 121.0298E |
| 34 | Brgy. Nagkaisang Nayon | 2020/ 01/ 29 | 14.7192N, 121.0285E |
| 35 | Brgy. Sineguelasan, Bacoor City | 2020/ 03/ 12 | 14.4599N, 120.9320E |

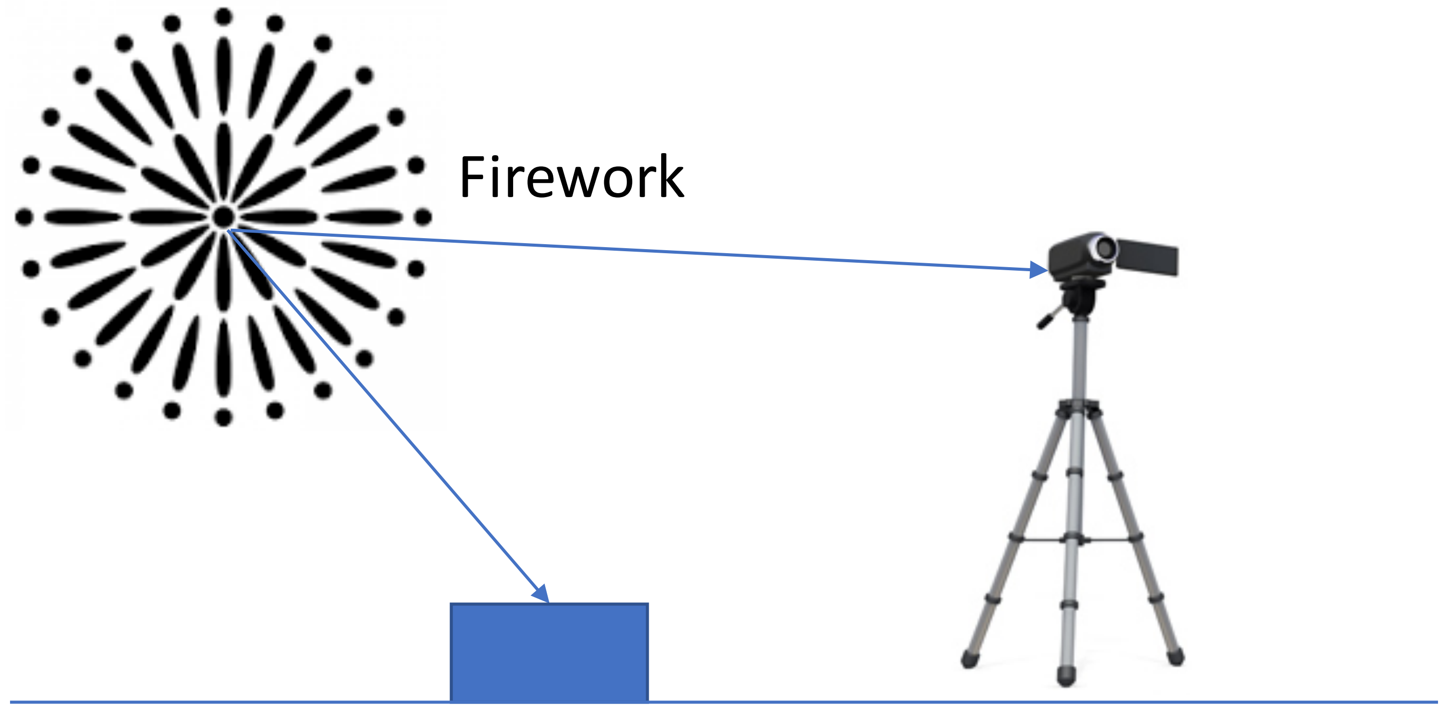


# Infrasound sensor calibration using fireworks

EGU21-16237
Estimation of dissipated lightning energy by infrasound measurement
by Narumi Watabe et al.



Calibration

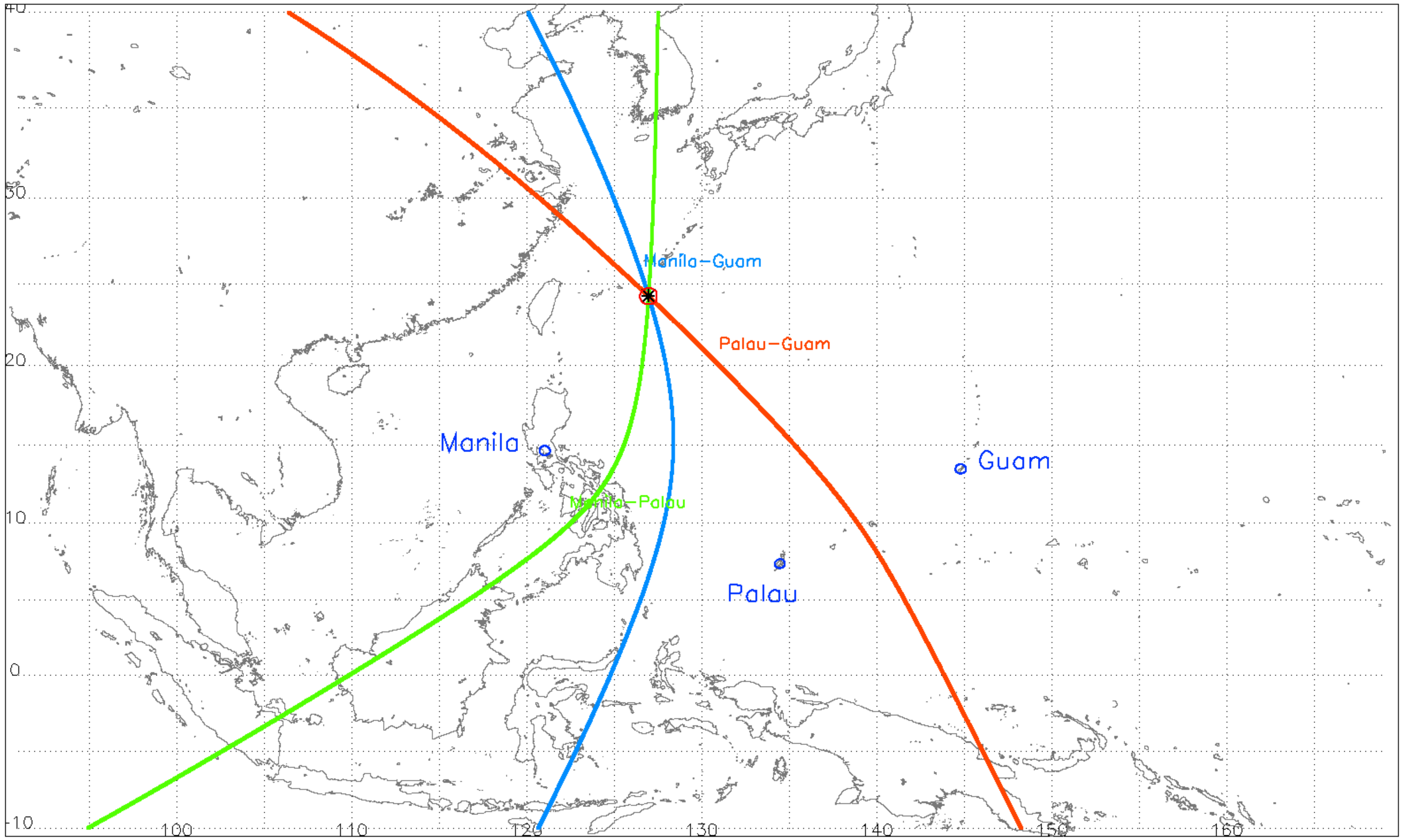



# V-POTEKA

Rooftop at Hokkaido Univ.

Installation in the Philippines

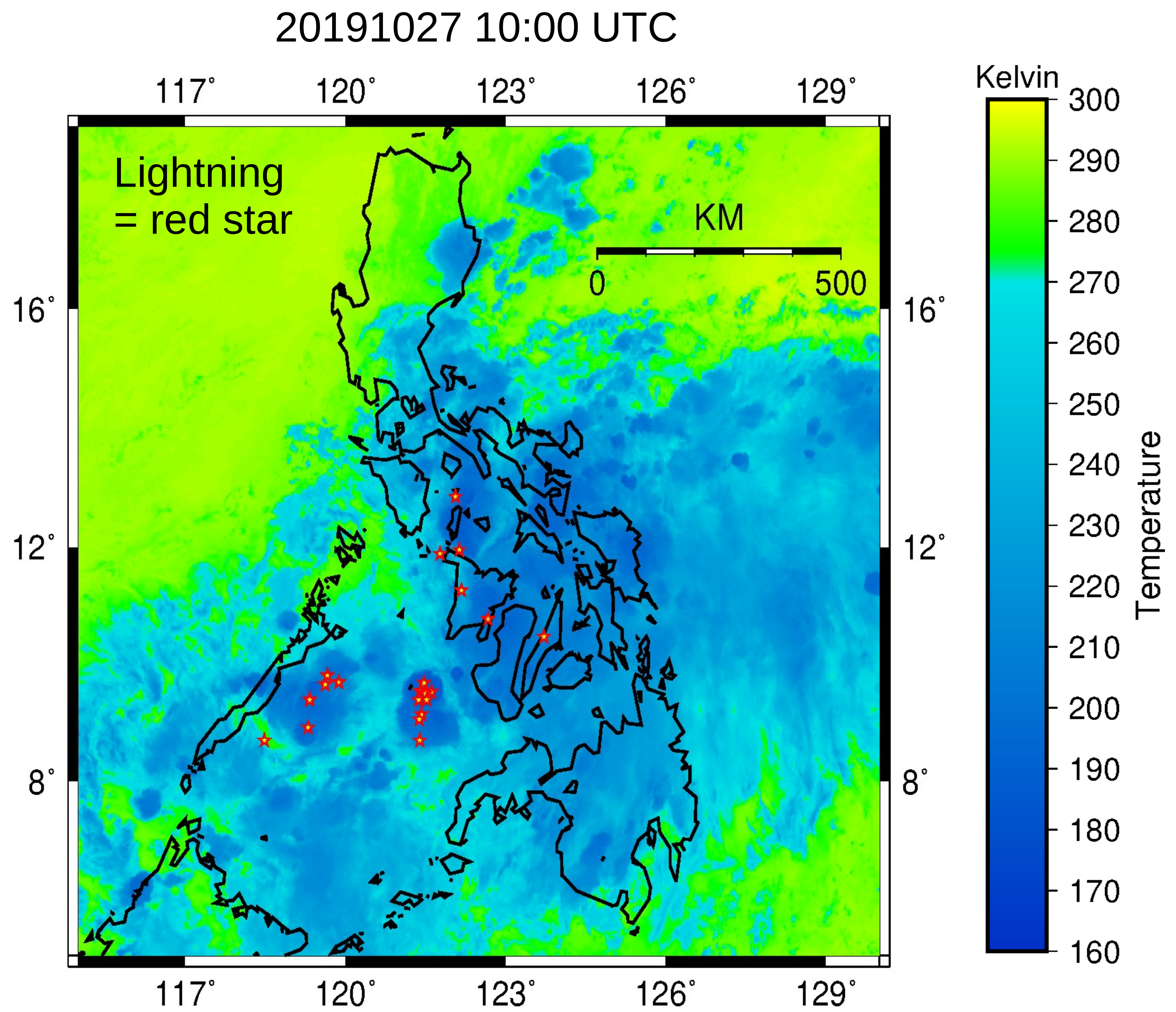
# Lightning geolocation by V-POTEKA



# V-POTEKA

## 6 sites completed among 10

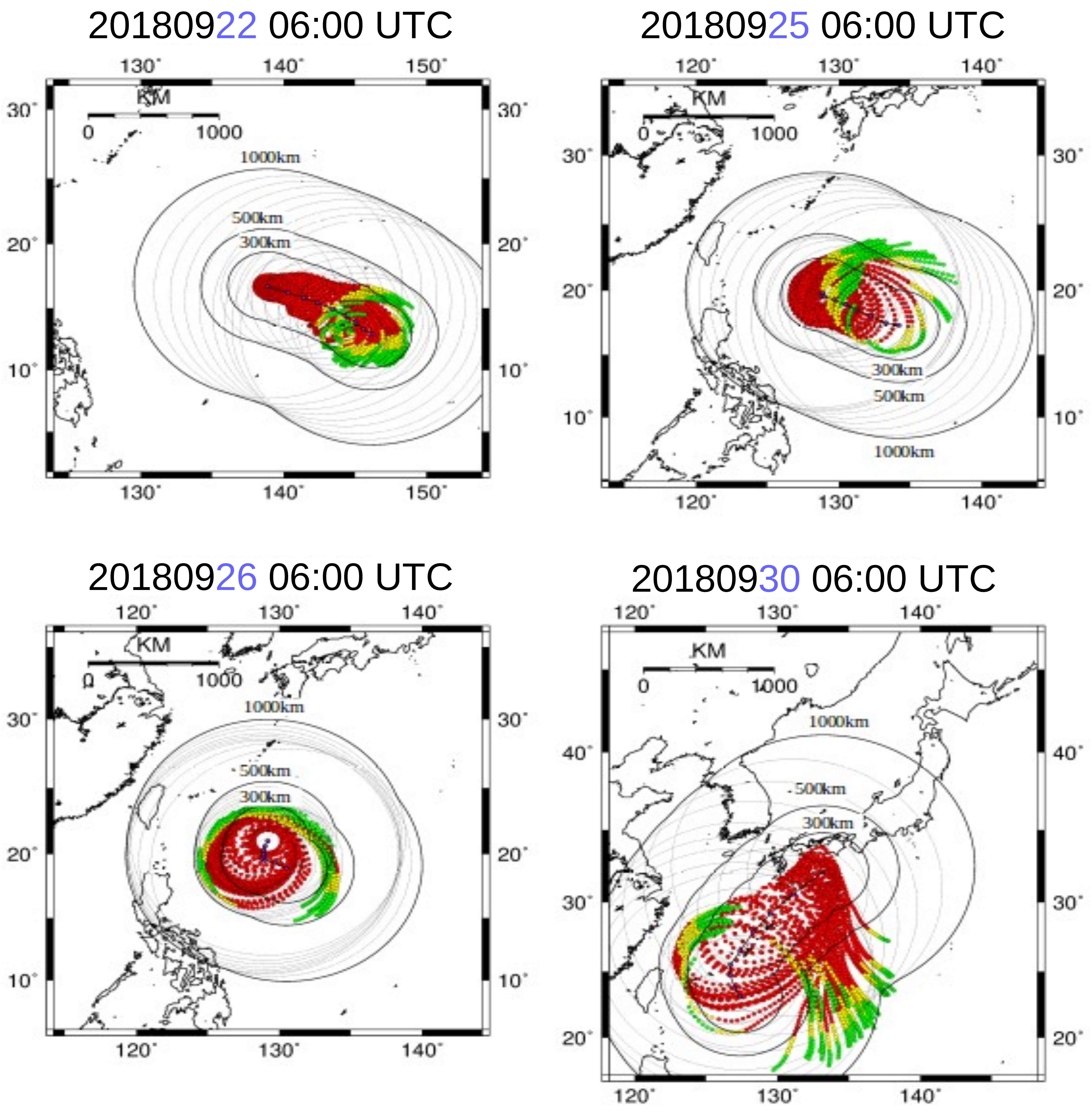
| 設置順 | 観測拠点名 | 設置日 | 位置 |
|---|---|---|---|
| 1 | University of the Philippine, Los Baños | 2018/ 11/ 27 | 14.1650N, 121.2501E |
| 2 | Puerto Prinsesa, Palawan | 2019/ 06/ 18 | 9.7400N, 118.7586E |
| 3 | Legaspi, Albay | 2019/ 06/ 26 | 13.0903N, 123.4369E |
| 4 | Davao | 2019/ 07/ 25 | 7.1280N, 125.6549E |
| 5 | PAGASA-Dagupan | 2019/ 11/ 29 | 16.0870N, 120.3519E |
| 6 | PAGASA-Muñoz | 2020/ 02/ 12 | 15.7359N, 120.9368E |

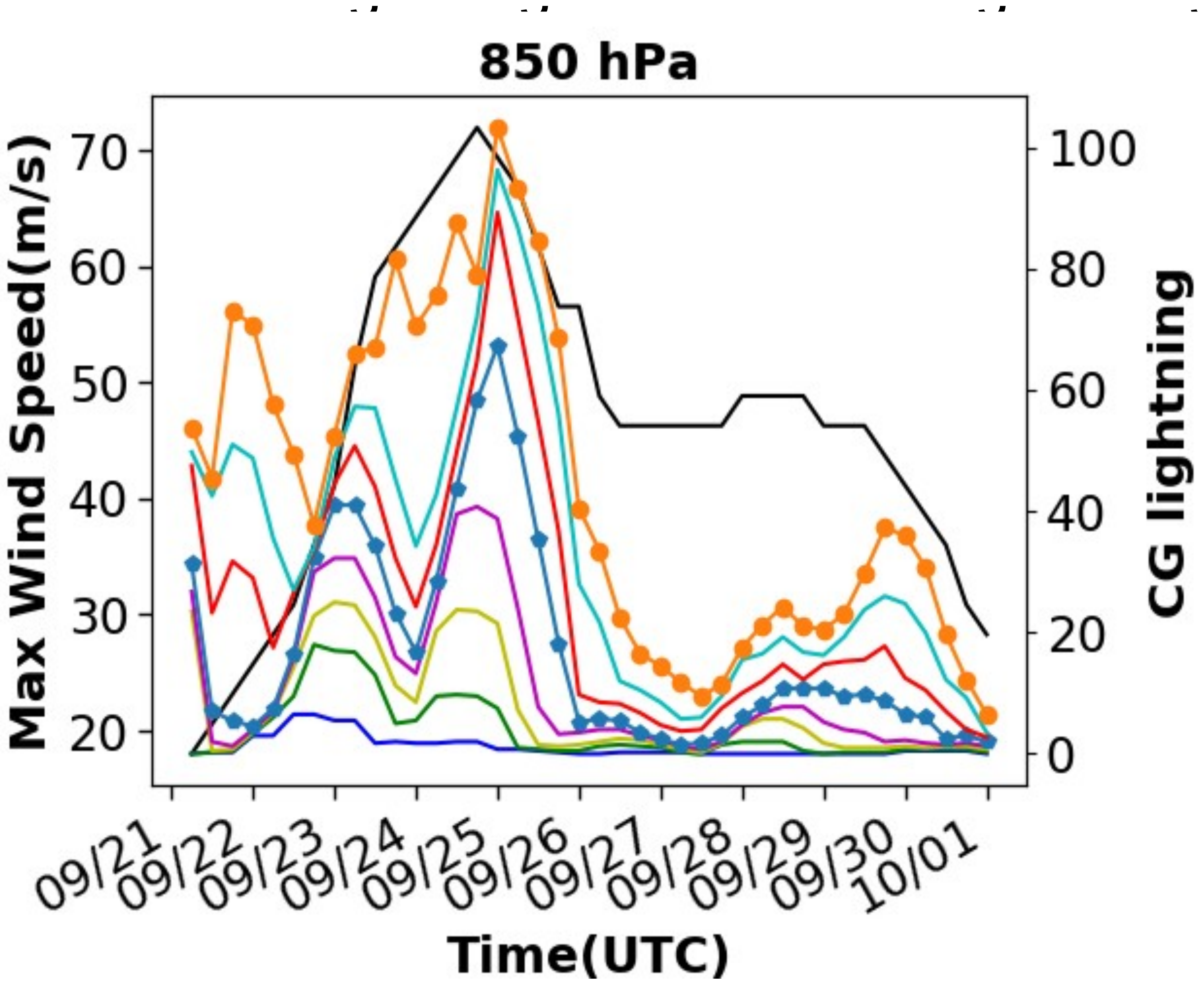



Lightning geolocation by V-POTEKA

Purwadi, PhD thesis, Hokkaido UNnv.

# Typhoon

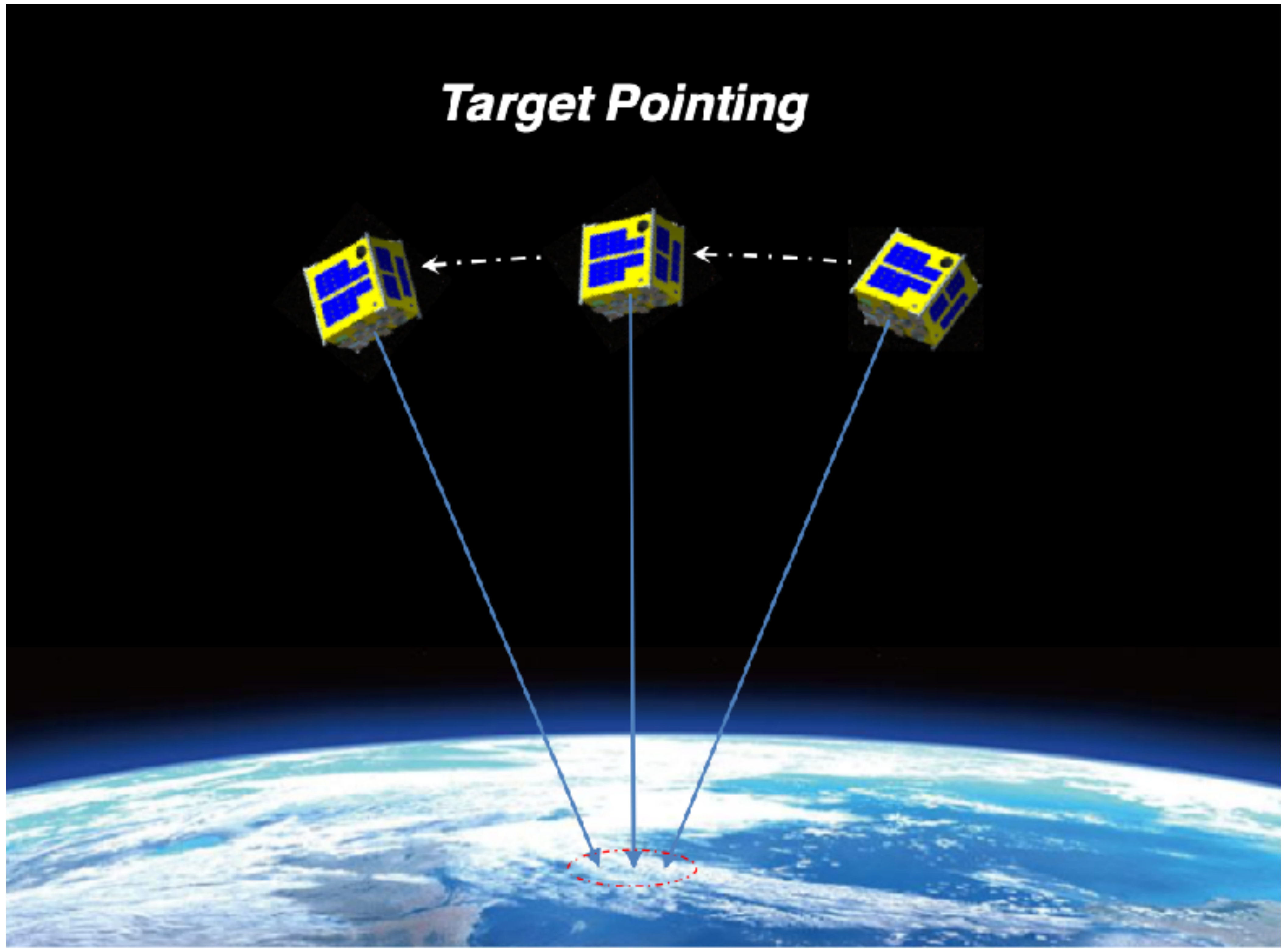


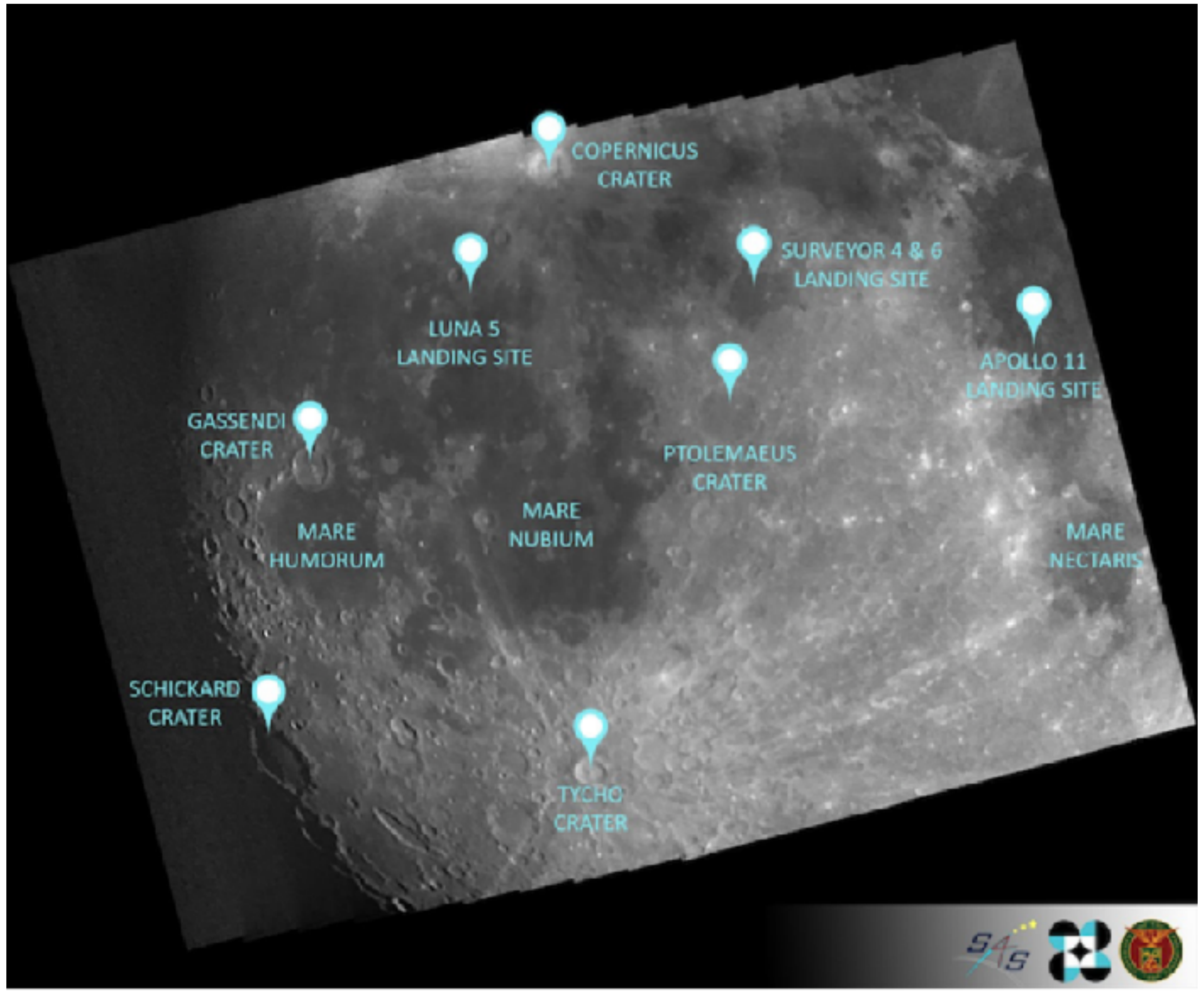




Time variation of lightning activity arriving at typhoon center

Purwadi, PhD thesis, Hokkaido Univ.

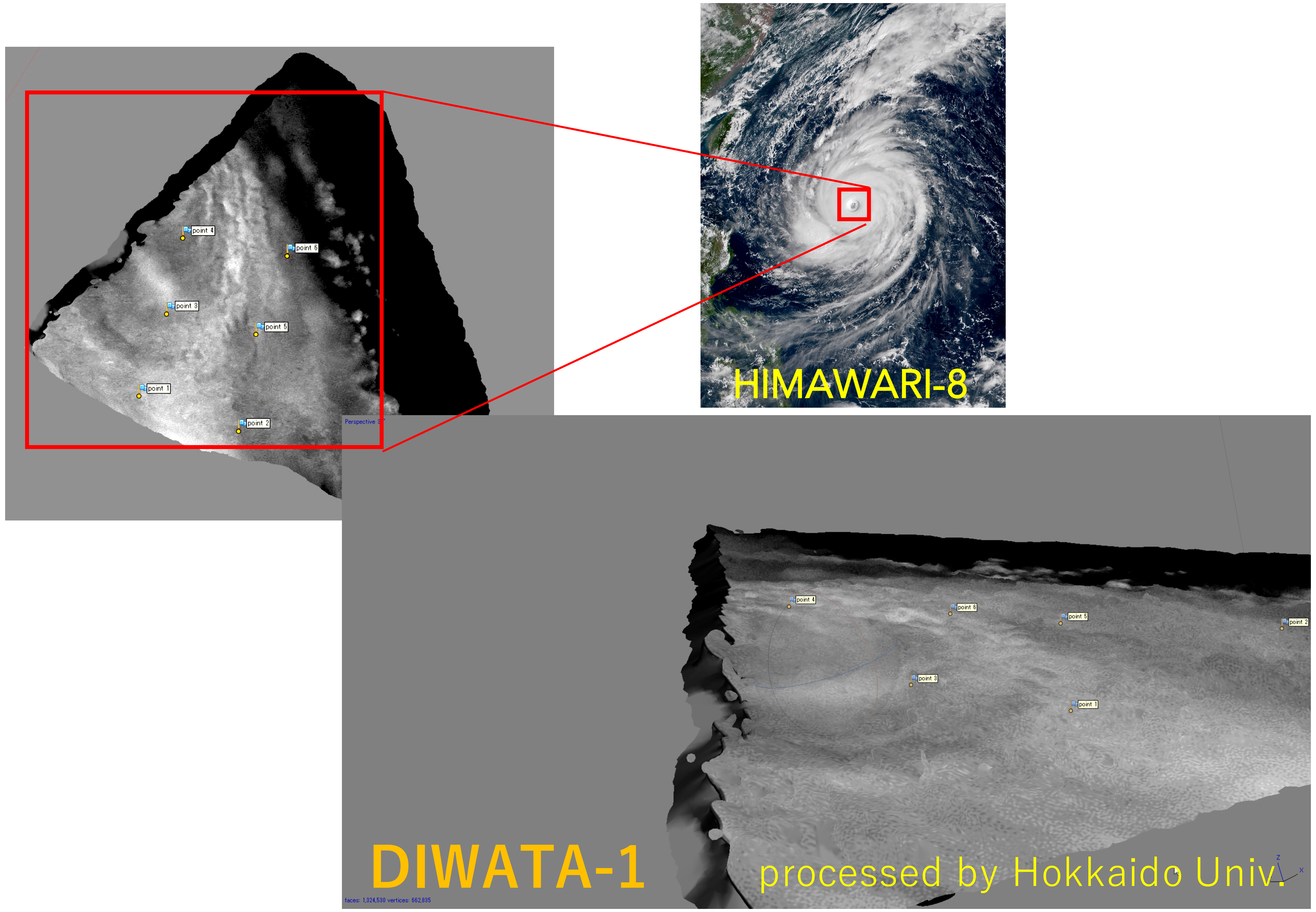
# Micro-satellite





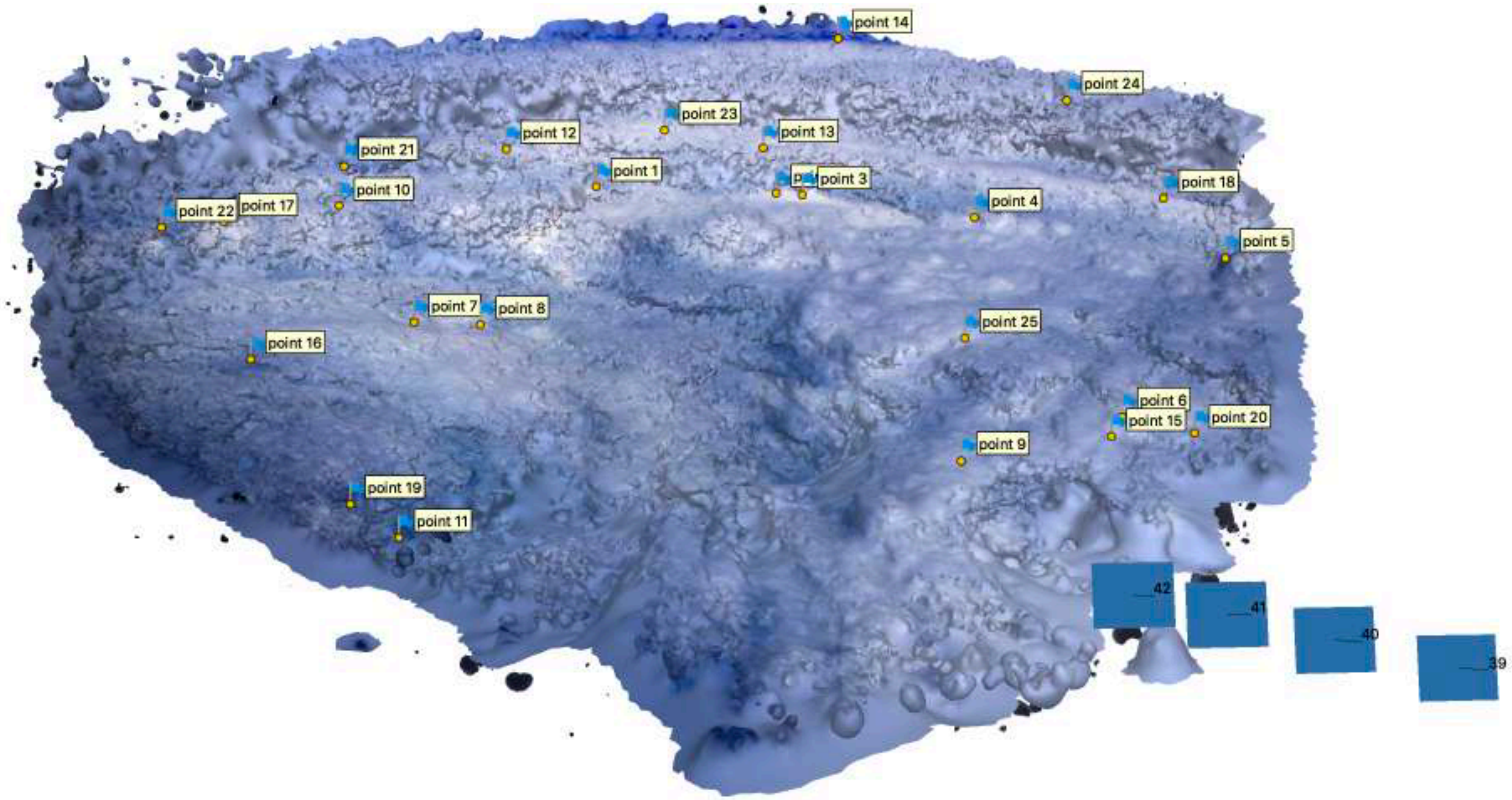

Target pointing and moon shot by micro-satellite

# 3D cloud modeling




Typhoon #24, 2018 (Trami) captured by micro-satellite, DIWATA-1

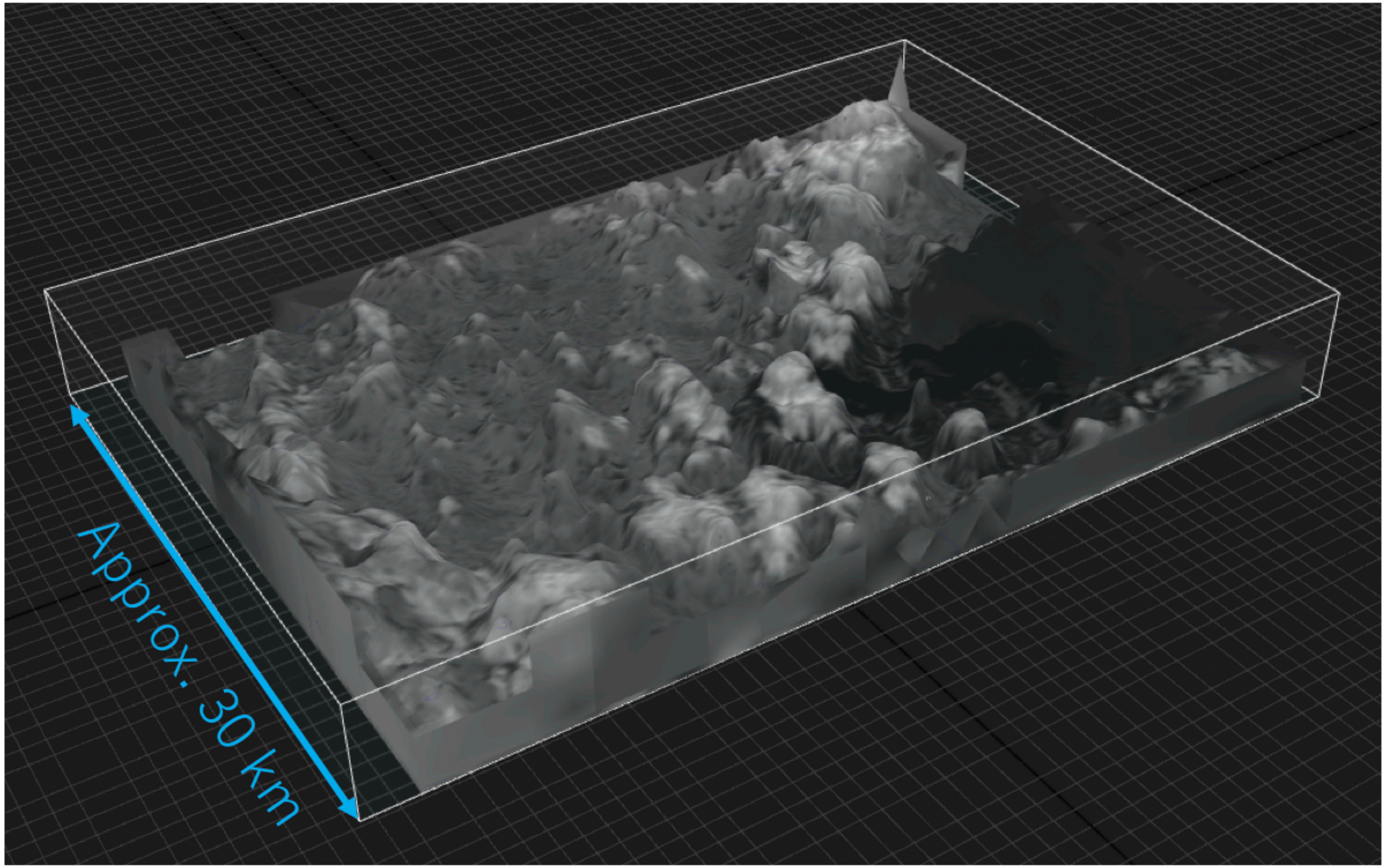
# 3D cloud modeling near typhoon center by airplane




EGU21-14160
3D Reconstruction of Typhoon and Thunderstorm Cloud Top Using Airborne Camera 
by Meryl Algodon et al.

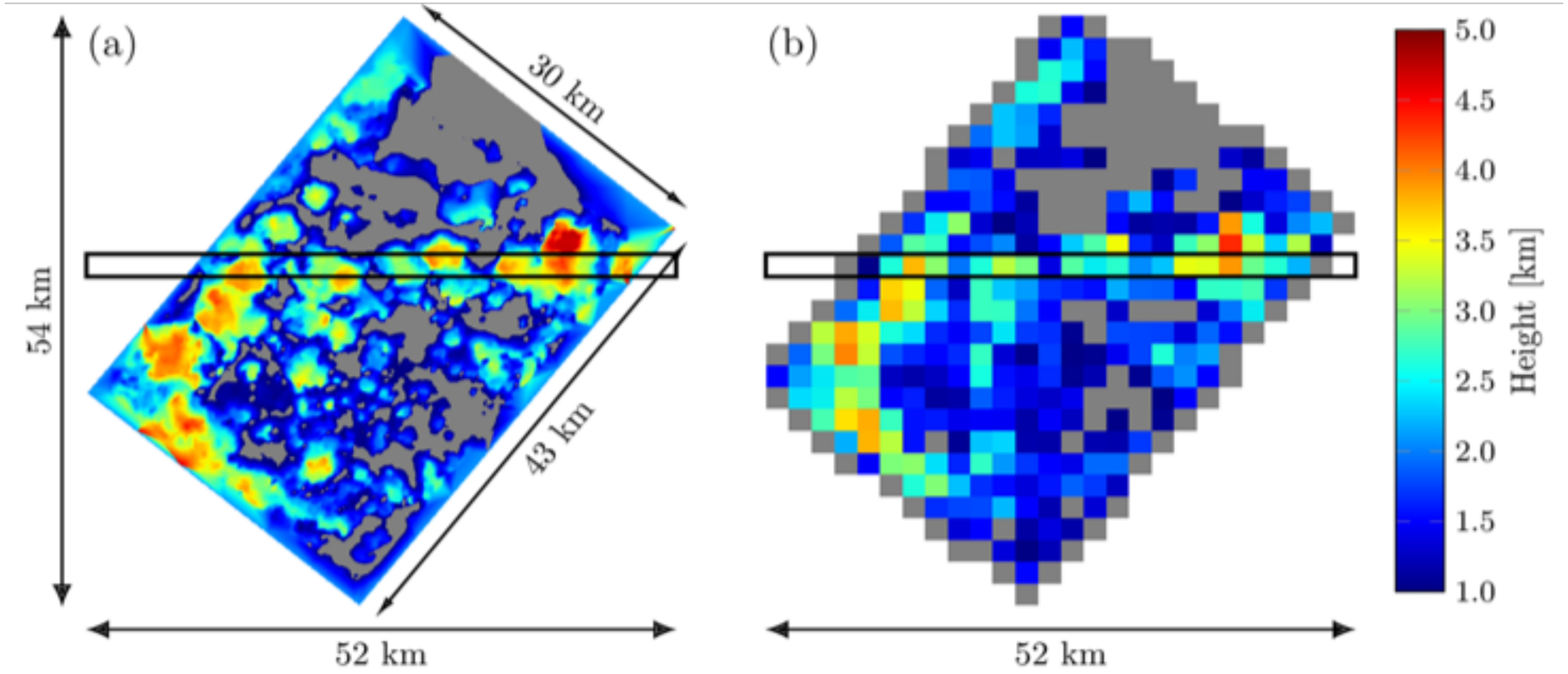
# 3D cloud modeling

*Castro et al., Scientific Reports* ***10****, Article number: 7570 (2020)*




captured by micro-satellite, DIWATA-1

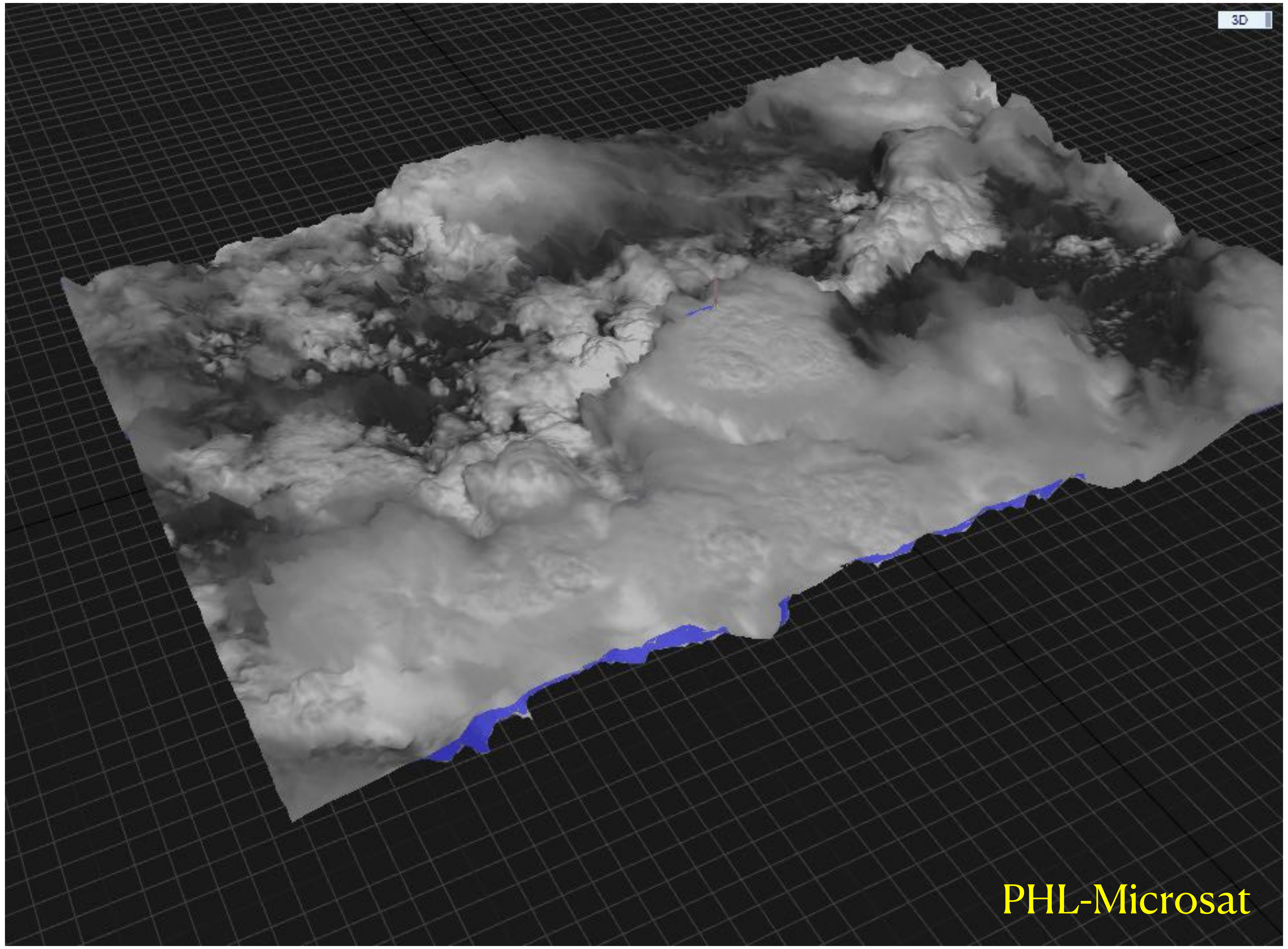
Castro et al., Scientific Reports **10**, Article number: 7570 (2020)



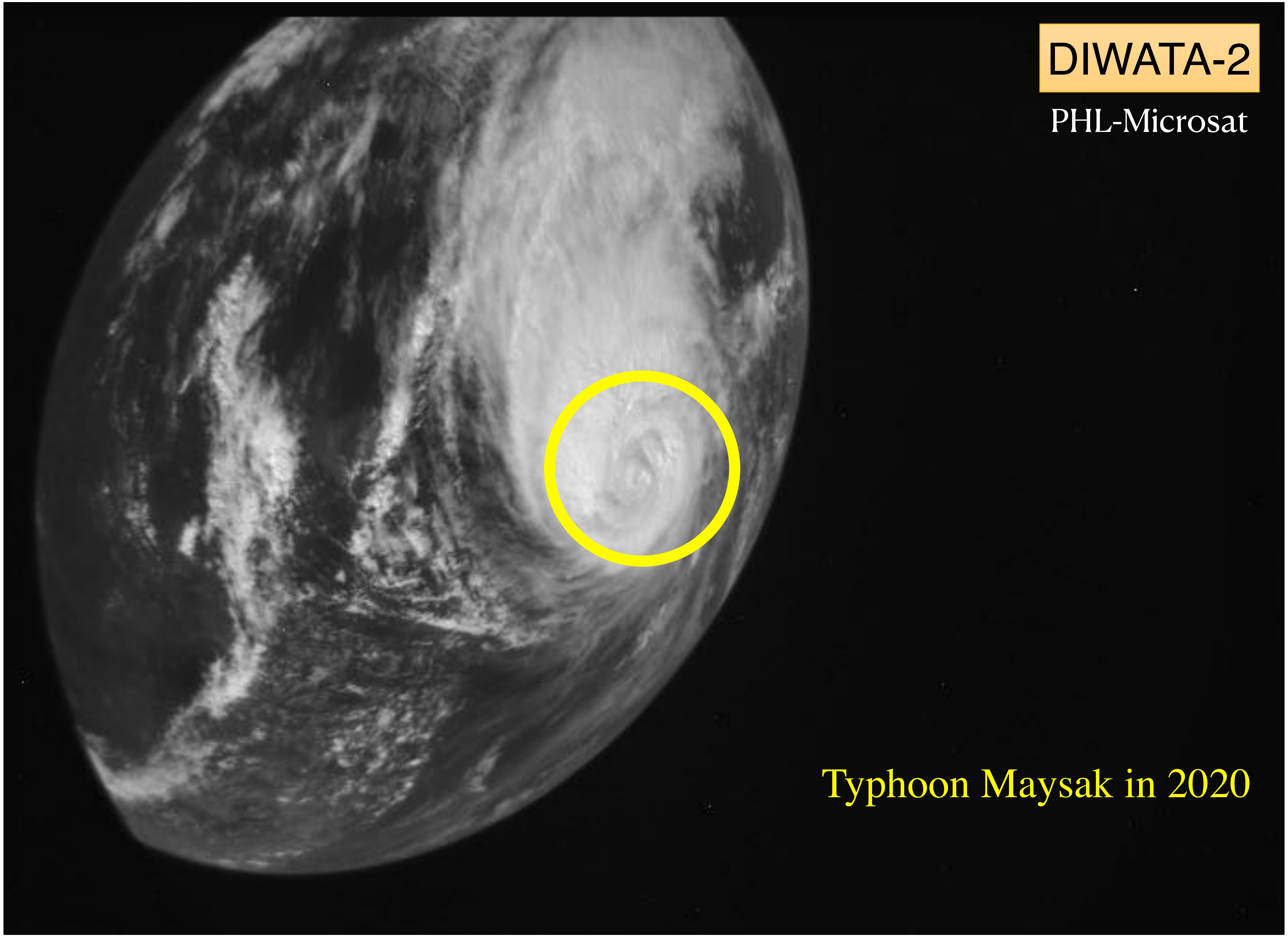

DIWATA-1

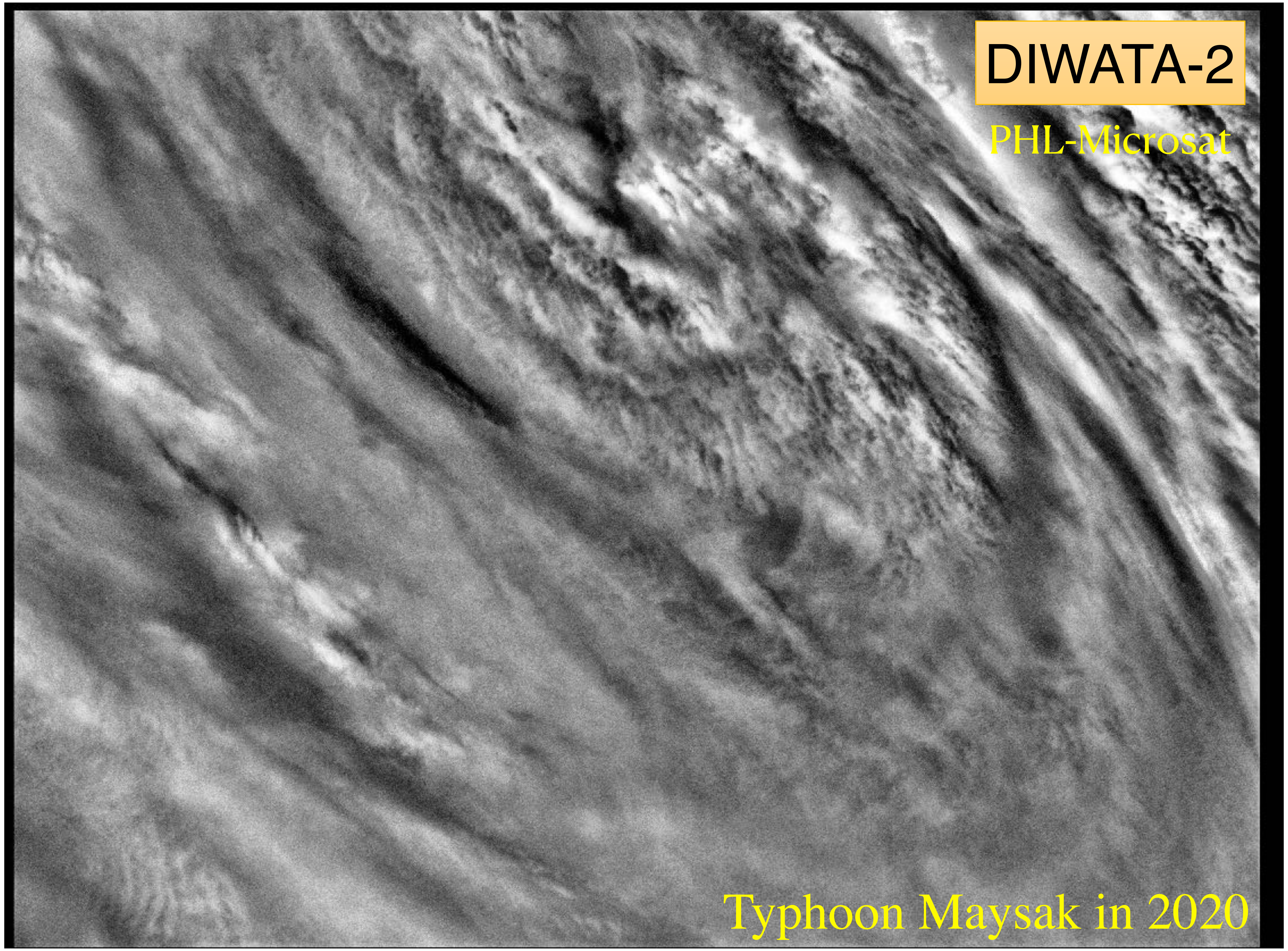
HIMAWARI-8

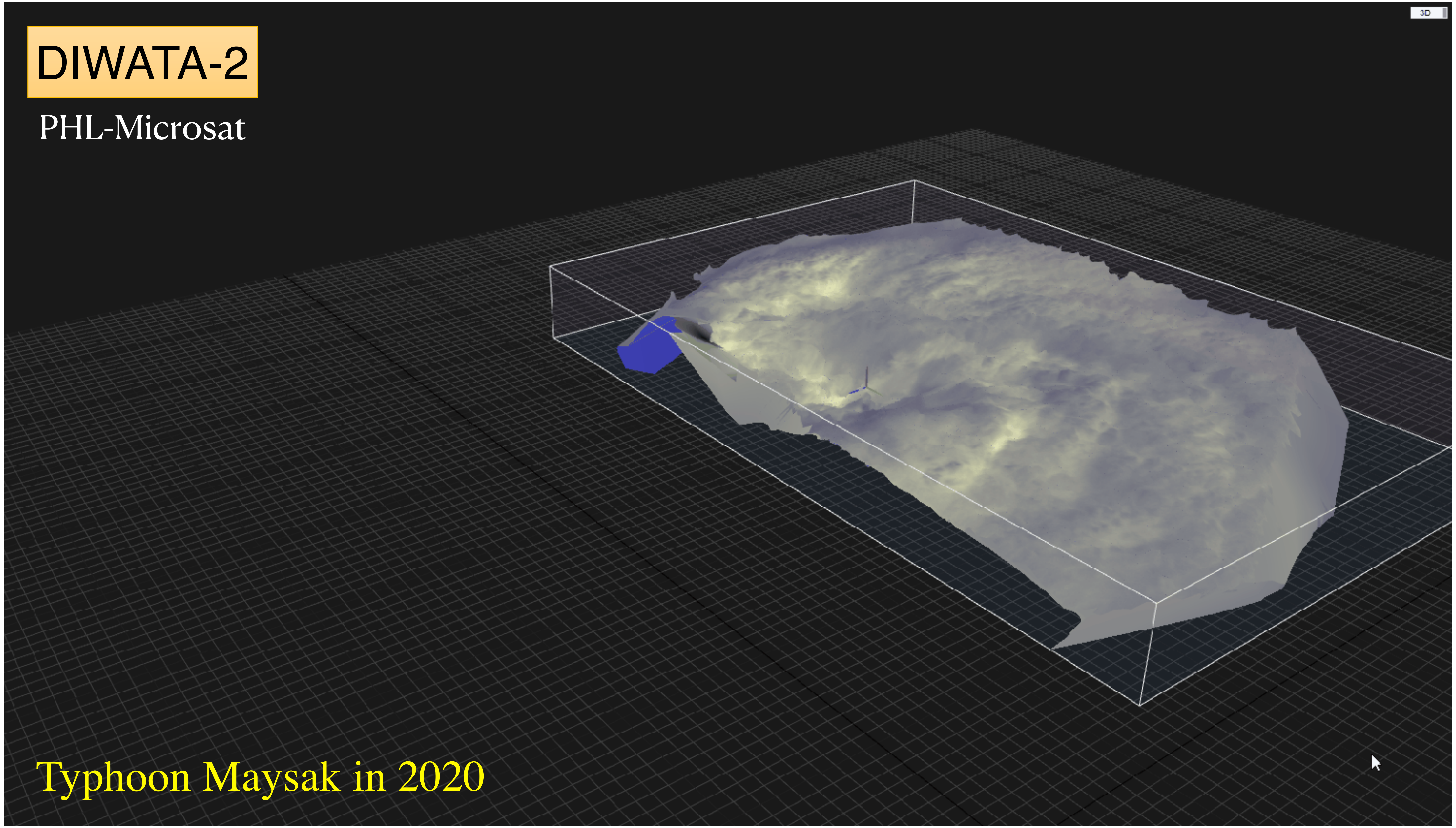
# 3D cloud modeling




captured by micro-satellite, DIWATA-2


DIWATA-2
PHL-Microsat
Typhoon Maysak in 2020


DIWATA-2
PHL-Microsat
Typhoon Maysak in 2020


DIWATA-2
PHL-Microsat
Typhoon Maysak in 2020

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- We are establishing nearly real-time cloud imaging, manipulating the attitude of satellite for capturing the most dangerous or important cloud images for 3D reconstruction.

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