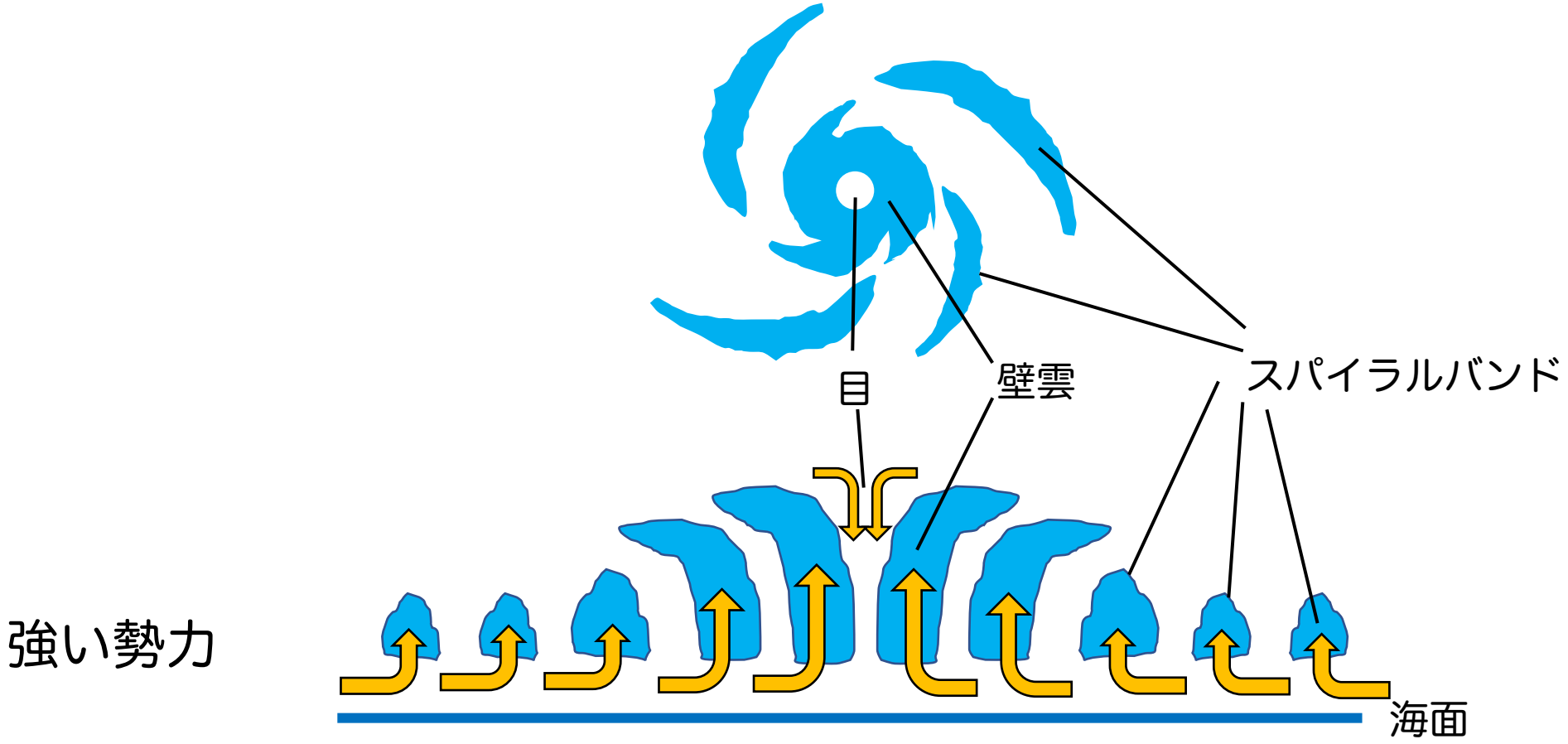
令和4年9月14日(水)
第5回 北海道大学 定例記者会見　資料１

衛星から見る台風

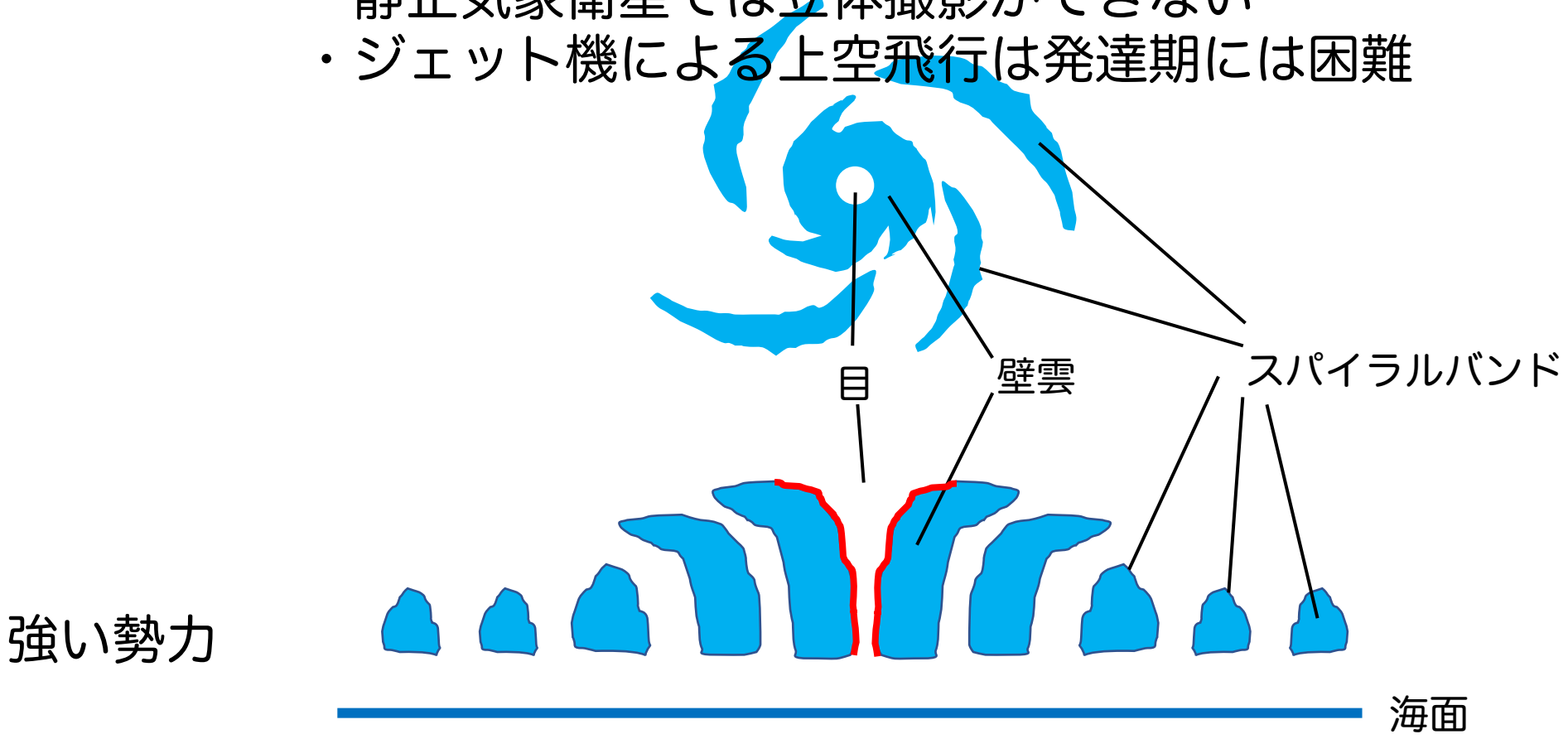
～宇宙から地球を見守る最先端技術～

高橋幸弘

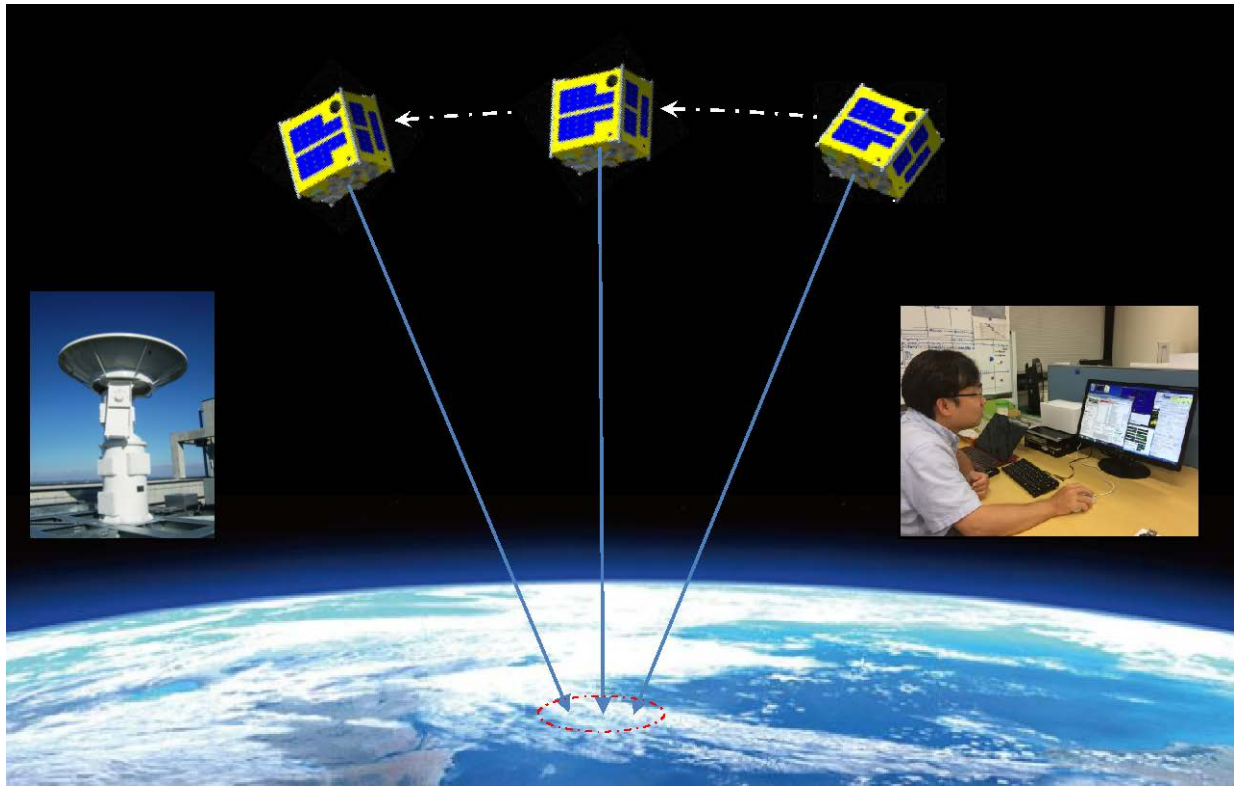
大学院理学研究院 および創成研究機構 宇宙ミッションセンター


目
壁雲
スパイラルバンド
強い勢力
海面
弱い勢力
海面

・静止気象衛星では立体撮影ができない
・ジェット機による上空飛行は発達期には困難



北海道大学の新手法：オンディマンド・ターゲットポインティング



高度600kmから複数角度で連写

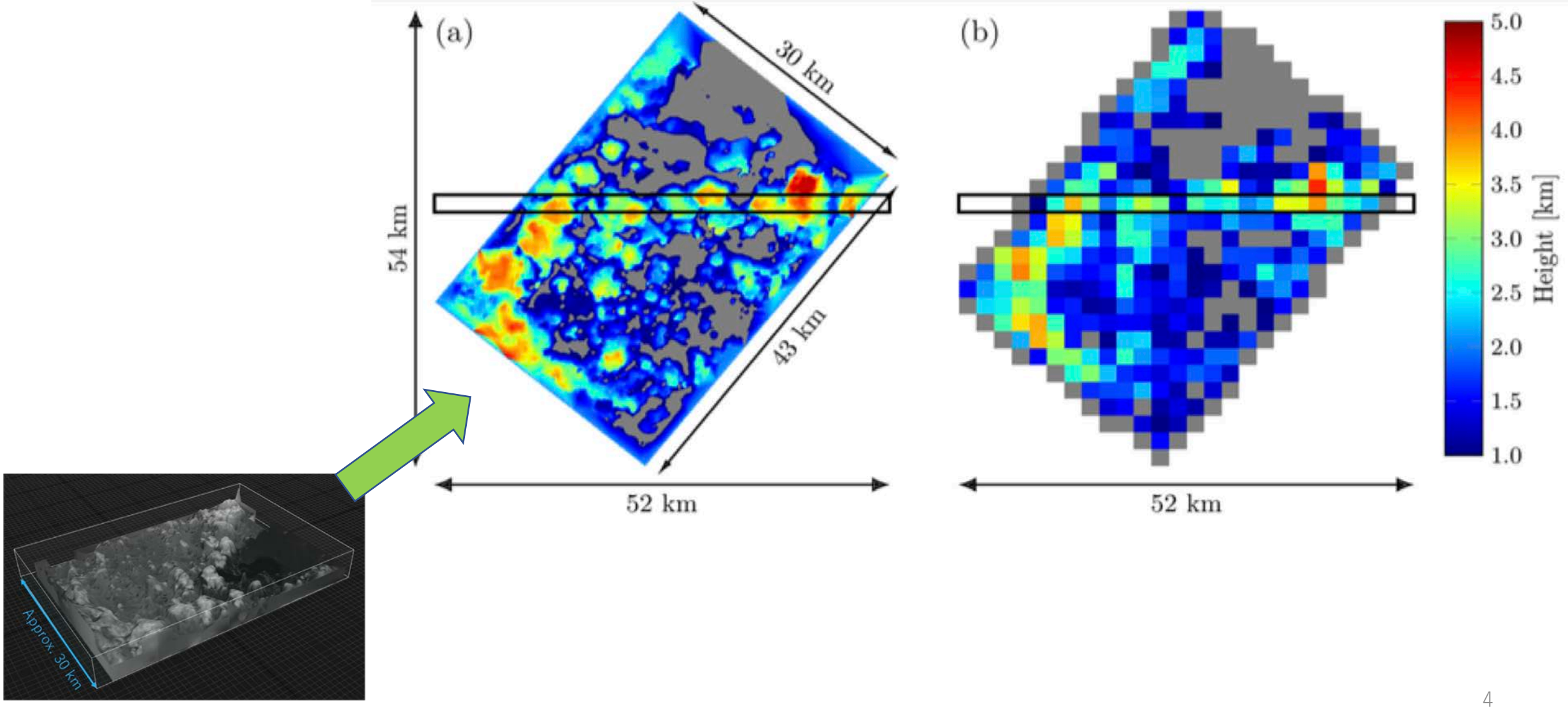
↓

雲の立体構造を推定

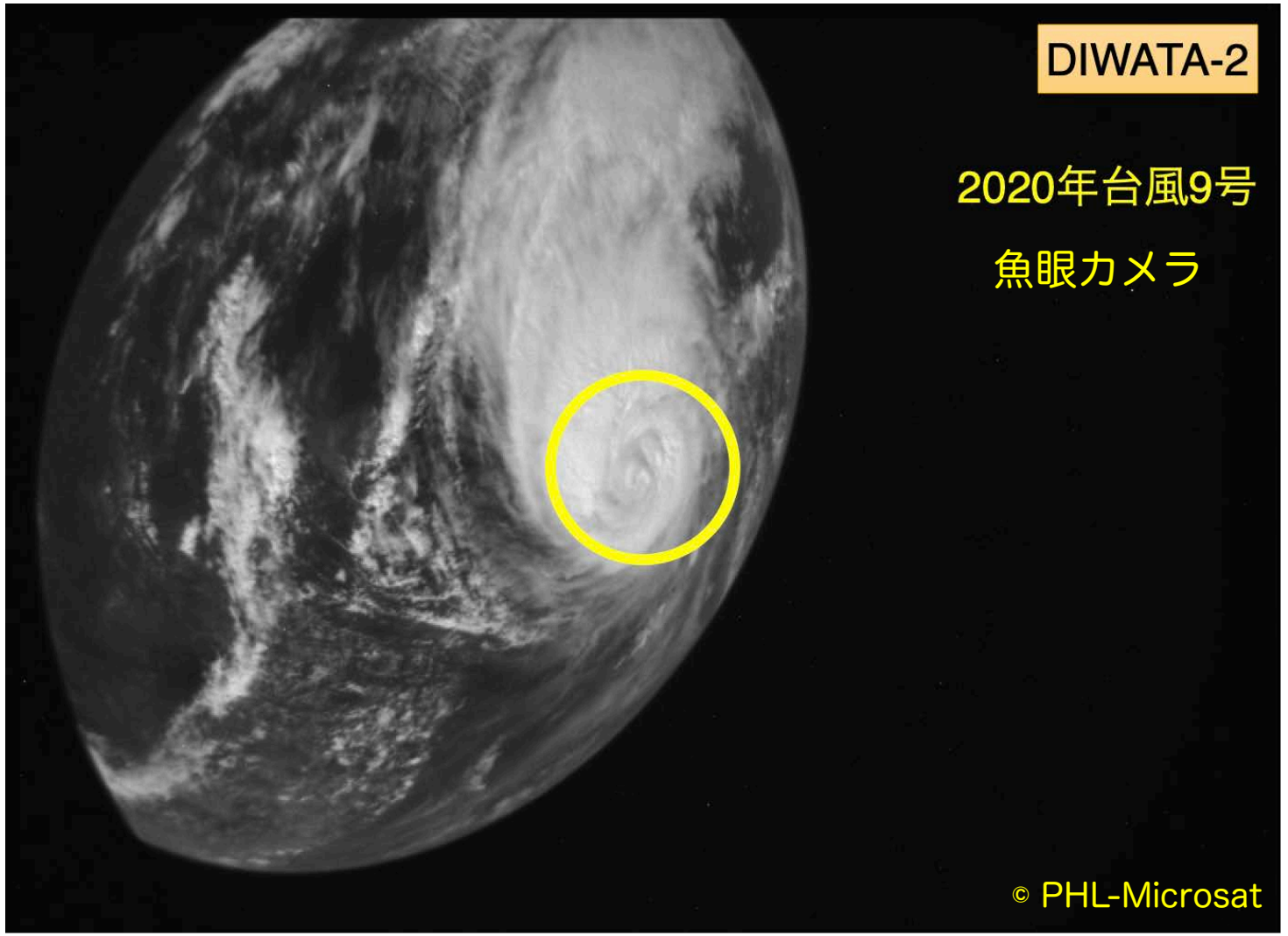
Castro et al., 2020

DIWATA-1

HIMAWARI-8



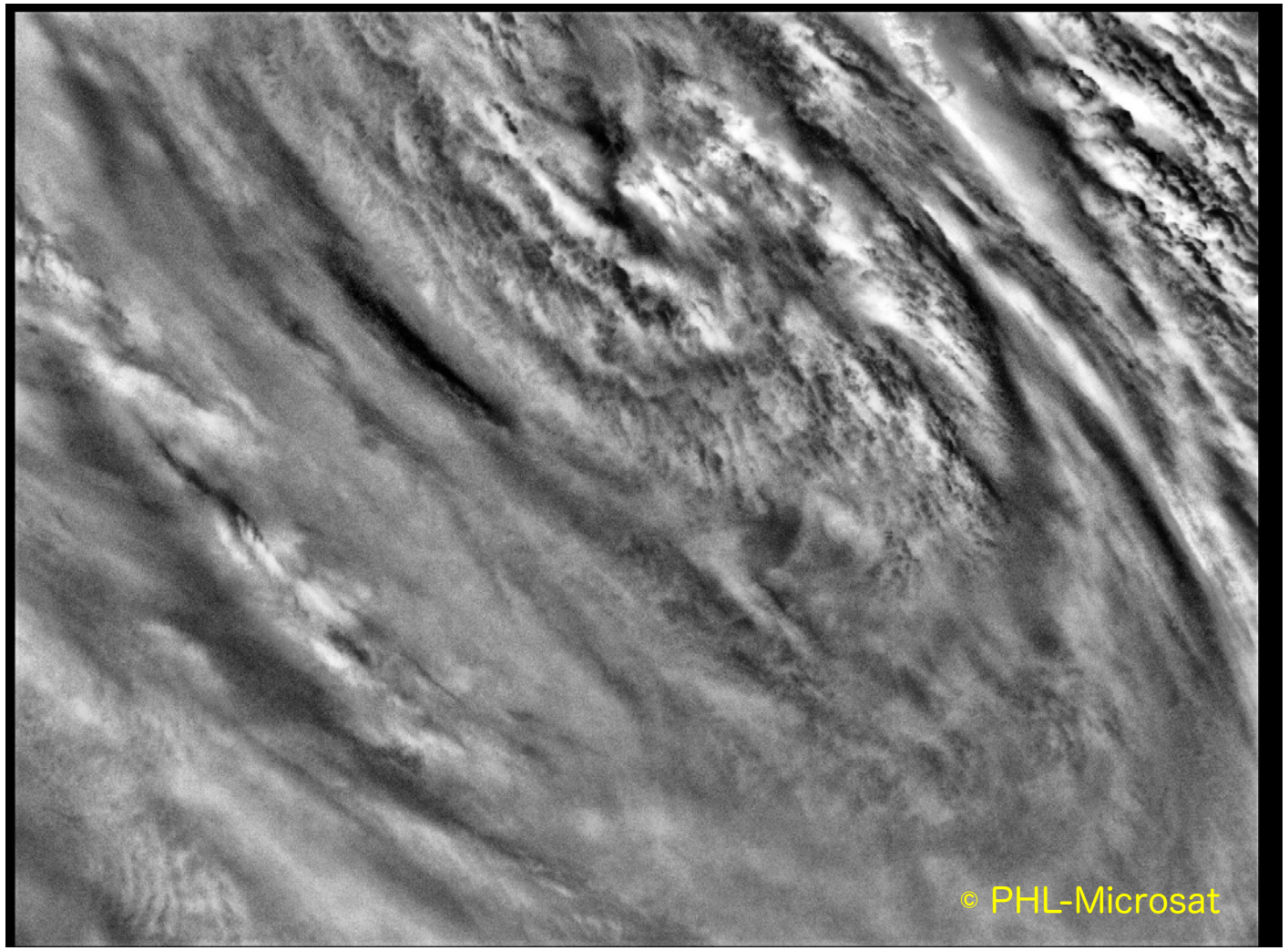
2020年台風9号



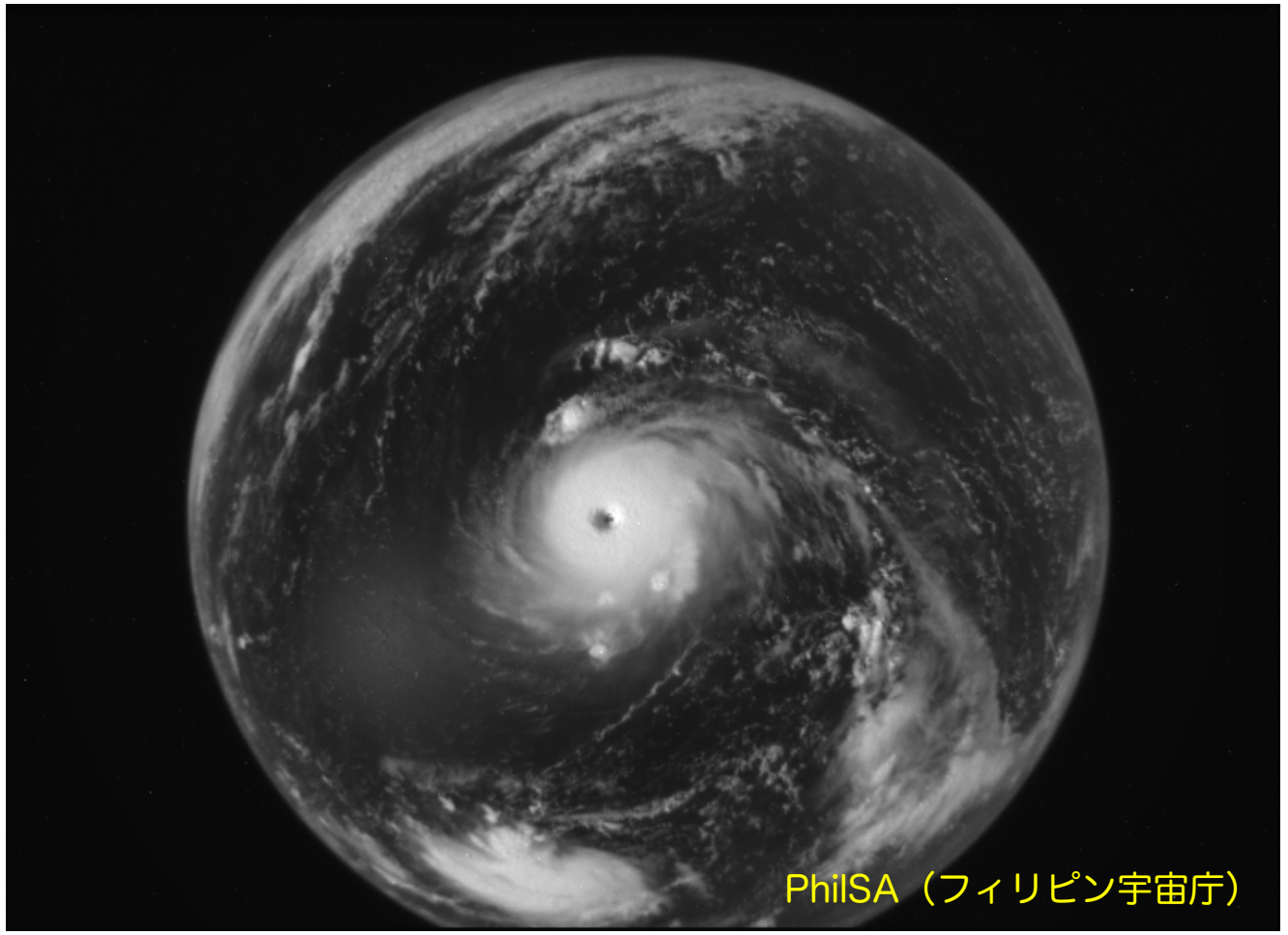
x

2020年台風9号

拡大カメラ

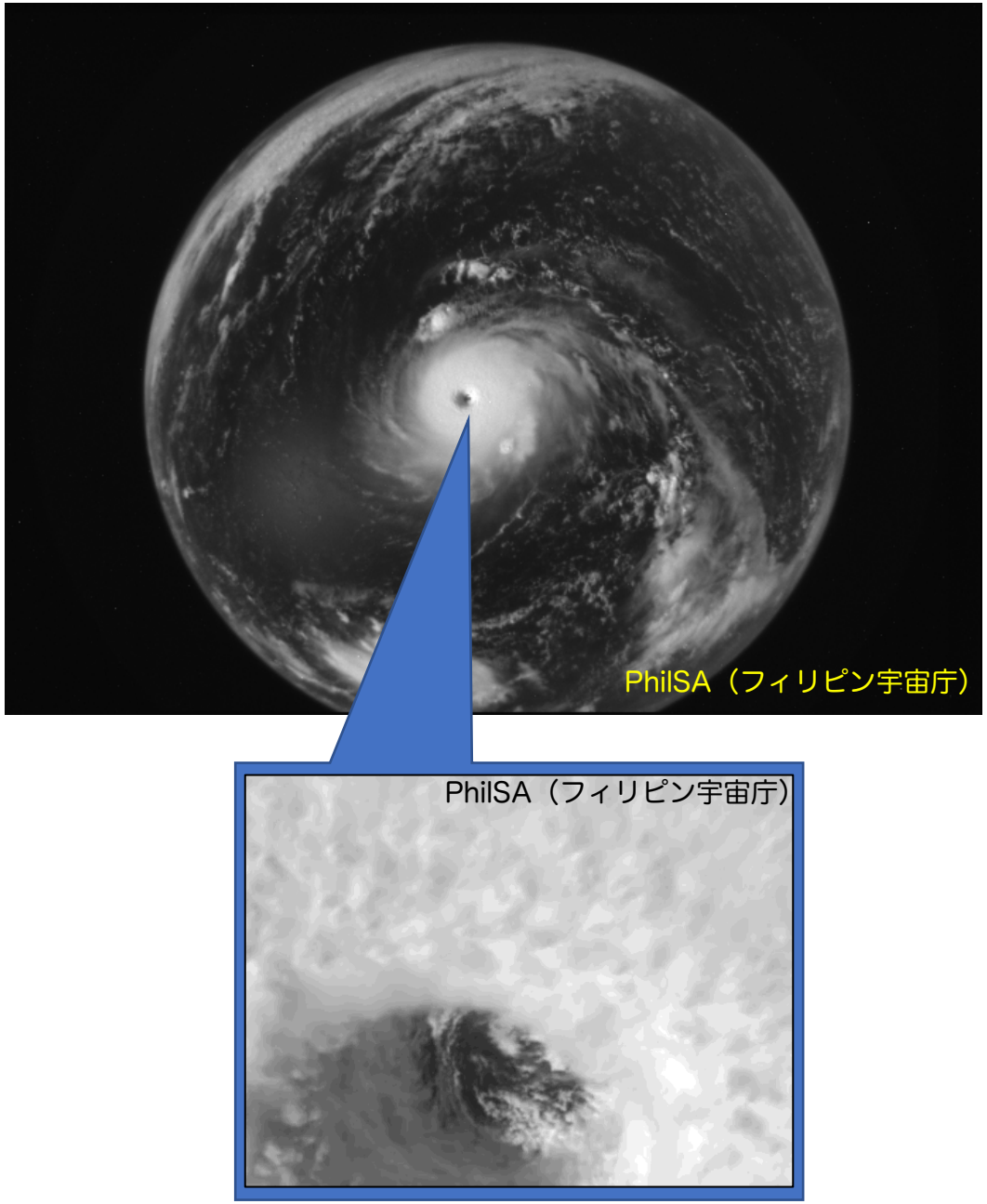


2022年台風11号

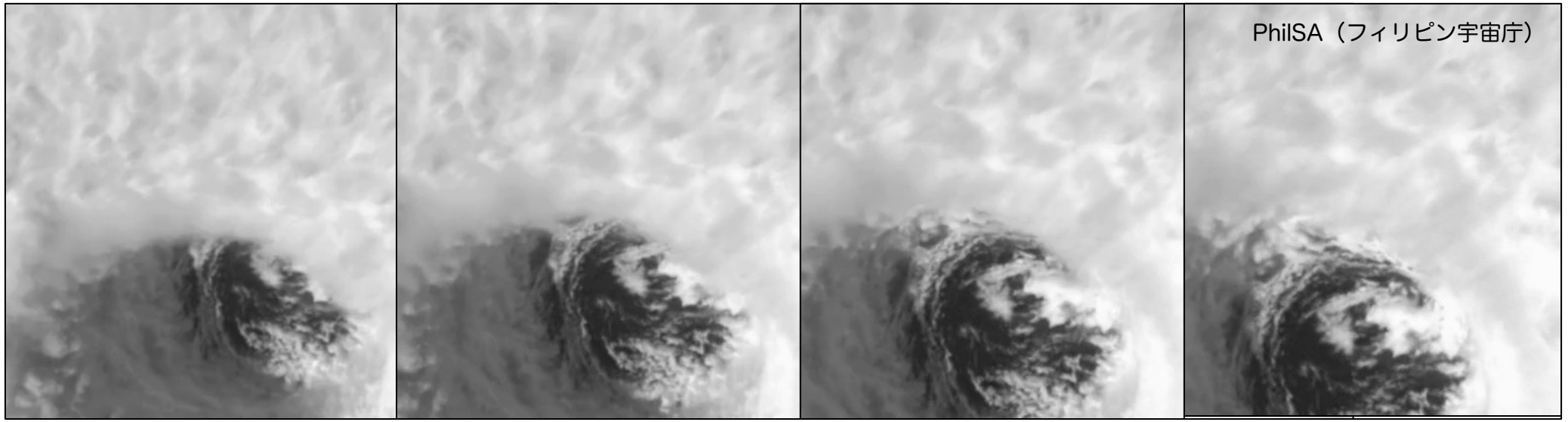


日本時間2022年8月30日 14:43:51に魚眼カメラが捉えた台風11号。
解像度は約7km。

2022年台風11号

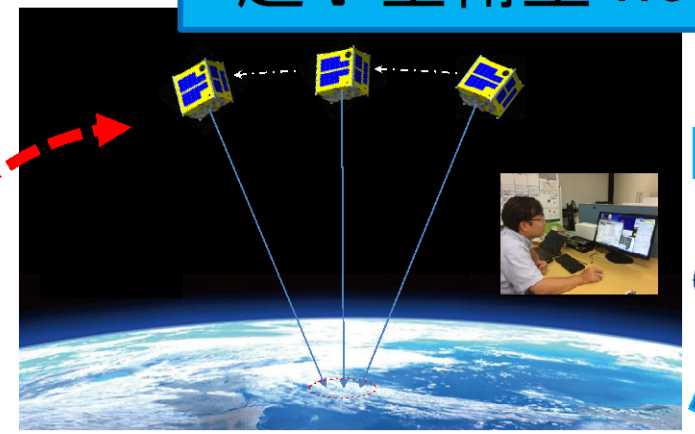


2022年台風11号

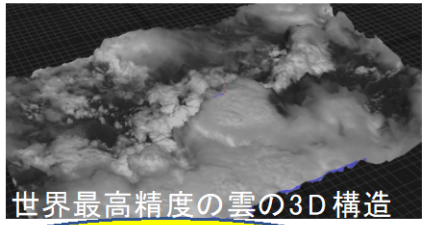


日本時間2022年8月30日 14:42:51-14:44:51に、視野に台風中心を捉えたまま
6秒間隔で18回の連写を行なった。その中の24秒ごとに撮影された4枚。
解像度は約55m。

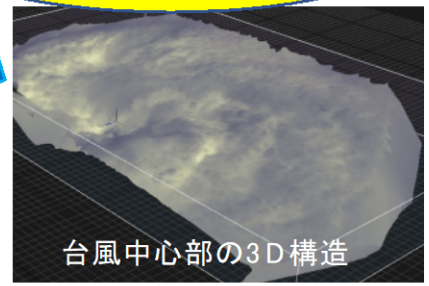
超小型衛星 x3



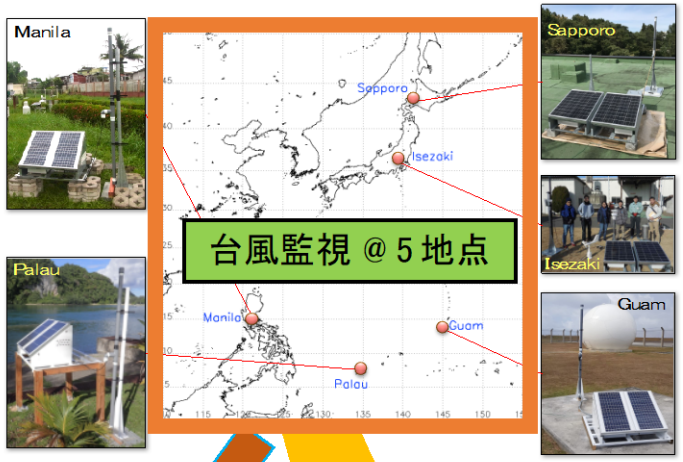
地上の雷・気象観測情報などに基づき、準リアルタイムで衛星を運用し、目標とする雲の3D撮像を行う



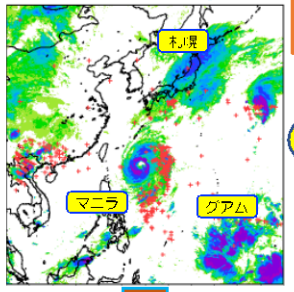
積乱雲の規模
台風の強度



世界最高解像度の雲の3D構造推定から、降雨量予測や台風強度推定を実現

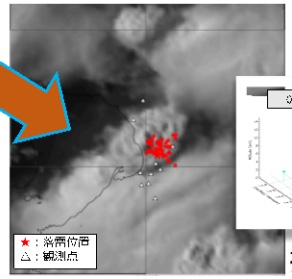


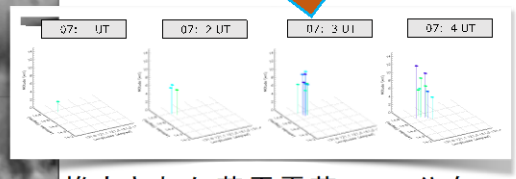
雷/気象観測網 x3



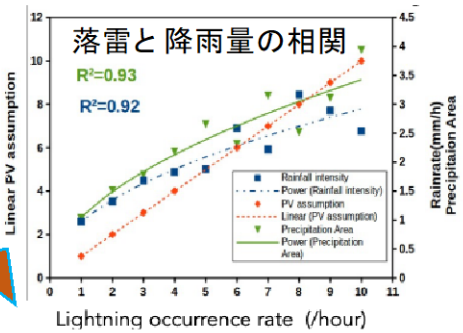
積乱雲の強度・位置
雨量

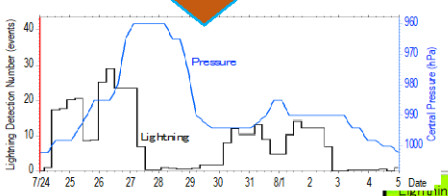
世界最高密度の観測網による、電荷分離・電の3D観測に基づき、積乱雲の発達を監視。雷放電活動から降雨量を監視



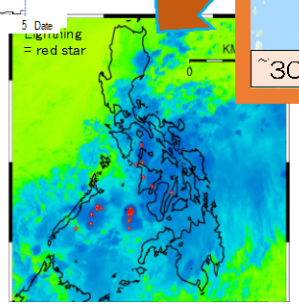


推定された落雷電荷の3D分布





雷放電活動と台風強度の相関を利用した、台風強度予測



雷放電活動に基づく、フィリピン全土の豪雨地域のリアルタイム監視

ULA
Understanding Lightning and Thunderstorm

豪雨・台風の監視と予測

気象・防災機関と情報共有し
被雷・洪水・高潮・強風被害を軽減

フィリピン第１号/2号超小型衛星: DIWATA-1/-2

フィリピン科学技術大臣との面談(2013)

フィリピン科学技術省・副大臣の訪問団が来日（2014）

- 2013年2月に科学技術省のモンテホ大臣、ゲバラ副大臣らと面談
- 数ヶ月後にフィリピン科技省から共同開発の相談。
  欧米等ではなく（NASAを退けて）、北大・東北大での開発を選択
- 2015年1月から3年間のプロジェクトがスタート。
- 2016年4月、国際宇宙ステーションより放出、現在順調に運用中。
- 北大（搭載観測器・データ利用）と東北大（衛星バス）で修士学生10人弱を教育
- 総額約10億円（衛星2機）はフィリピン科学技術省が全額負担

欧州を中心に国際的に広く報道されている

News WOWU, No. 21

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."

Among other prominent competitors, the collaboration of Hokkaido and Tohoku universities is heralding an era of miniature-satellite constellations. "Scientists and engineers are able to discuss a specific mission while seated around the same table—a scene that very rarely plays out elsewhere. We won't be able to prosper globally if we don't pitch our advantages," Takahashi explained the team's strength.

When Hokkaido University accepted three graduate students from the Philippines as part of a deal to develop the DIWATA-1 microsatellite, [illegible] the hands-on [illegible] build microsate[illegible] Hokkaido Univ[illegible] in the analysis [illegible] data, in additio[illegible] required for [illegible] promoting entir[illegible]

When two u[illegible] Philippine Dep[illegible] Technology (D[illegible] University in J[illegible] deeply impress[illegible] future satellites[illegible] protection from[illegible] country's first[illegible] DOST selecte[illegible] team from am[illegible] NASA. "Sharin[illegible] hearts," Takaha[illegible] two DOST off[illegible] should work t[illegible] build lasting c[illegible] the team."

Asia Research News 2017 (page 20-21)

http://www.researchsea.com/asia_research_news_2017.php

PHILIPPINES' FIRST MICROSATELLITE CAPTURES ULTRA-HIGH-RESOLUTION IMAGES

Graduate students from the Philippines assembling DIWATA-1 in Tohoku University in Japan.

Satellite success is a big step forward for the Philippines and for broader efforts to establish a microsatellite consortium across Asia.

The DIWATA-1 microsatellite, developed jointly by the Philippines and Japan, took pictures of the Earth's surface with a resolution ten times better than the much larger US Landsat 8 satellite. DIWATA brought into sharp focus what was a blurry abstract of colours with a data point captured every three metres on the ground versus every 30 metres by Landsat 8.

The more detailed information will help the country better observe weather patterns and typhoons, which will improve disaster preparations and assist farmers with real-time harvest decisions. The remote sensing data will also aid long-term management of fields, forests, water resources and fisheries.

The Philippines Department of Science and Technology and the University of the Philippines Diliman partnered with Hokkaido University and Tohoku University in Japan to design and build the microsatellite, which was released into orbit in April 2016.

Diwata is the Filipino word for 'fairy'. True to its name, the satellite is much smaller and nimbler than its larger counterparts. It weighs about 50kg (110 pounds) and is about the size of a carry-on suitcase. It is equipped with four imaging sensors, including a high precision telescope and a wide-angle lens camera. The on-board liquid crystal multispectral camera, developed by Tohoku and Hokkaido universities, is capable of detecting visible and near-infrared wavelengths—seeing far more than regular cameras that just capture three spectral bands (red, green and blue).

DIWATA also collects images with much greater frequency. The microsatellite can capture images of an area on the Earth's surface once a day because it can be rotated as needed and has four fields of view. In contrast, larger satellites with cameras that are set to a fixed position image the same area every 16 days.

"Based on data from the space-based multispectral imager, we can tell if rice crops have blast infection before farmers can even detect symptoms," says Professor Yukihiro Takahashi of Hokkaido University, who helped design the imager and organize the partnership with the Philippines. Blast infection is a fungal disease that destroys large numbers of crops every year. The camera is capable of detecting subtle disease-causing changes in the crop spectra that the human eye cannot detect, explains Takahashi.

The microsatellite can also be used to pinpoint the location of squid shoals by studying the distribution of phytoplankton in the ocean, he adds.

DIWATA-1 is part of a broader effort to grow the new Asian Micro-Satellite Consortium, which aims to launch 50 to 100 microsatellites to collect data for nine countries. The consortium formally began November 2016, with a signing ceremony.

Takahashi spearheaded the formation of the consortium, which includes Japan, the Philippines, Vietnam, Myanmar, Thailand, Mongolia, Malaysia, Indonesia and Bangladesh. The goal is to strengthen the region by sharing information across borders using standardized data collection tools. Any participating country, even if it has not launched a microsatellite, will have access to the data.

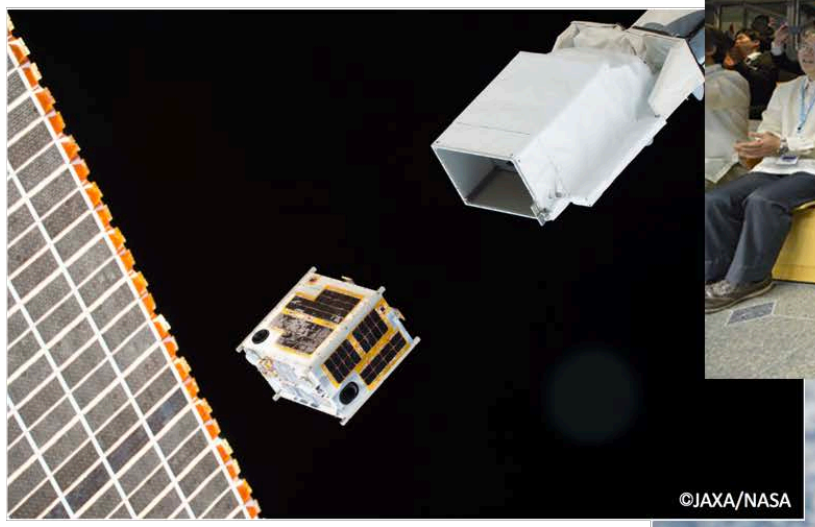
Several more satellites from participating countries are in the works, with expected launches in 2017 and 2018. Since they are smaller, microsatellites are much easier and cost-effective to launch on a regular basis. For the price of one large satellite, Takahashi anticipates 100 Asian microsatellites will be orbiting the Earth within the next ten years.

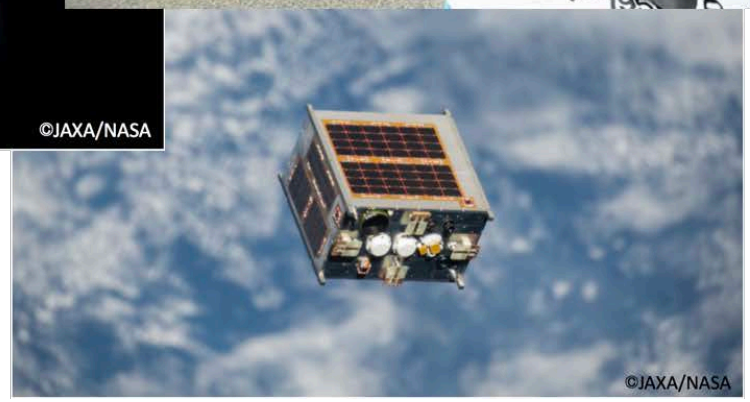
The (a) and (b) inserts compare two RGB images of Dumingag on the island of Mindanao, Philippines. Image (a) was taken by the high performance telescope installed in DIWATA-1, while image (b) was taken by Landsat 8's operational land imager. These results demonstrate that DIWATA-1 can observe the Earth at significantly higher resolutions than existing large satellites.

Further information: Professor Yukihiro Takahashi | E-mail: [illegible]
Department of Earth and Planetary Sciences
Hokkaido University

途上国も主役になれる時代に

国際宇宙ステーションからDIWATA-1を放出
（2016年4月27日@JAXAつくば）



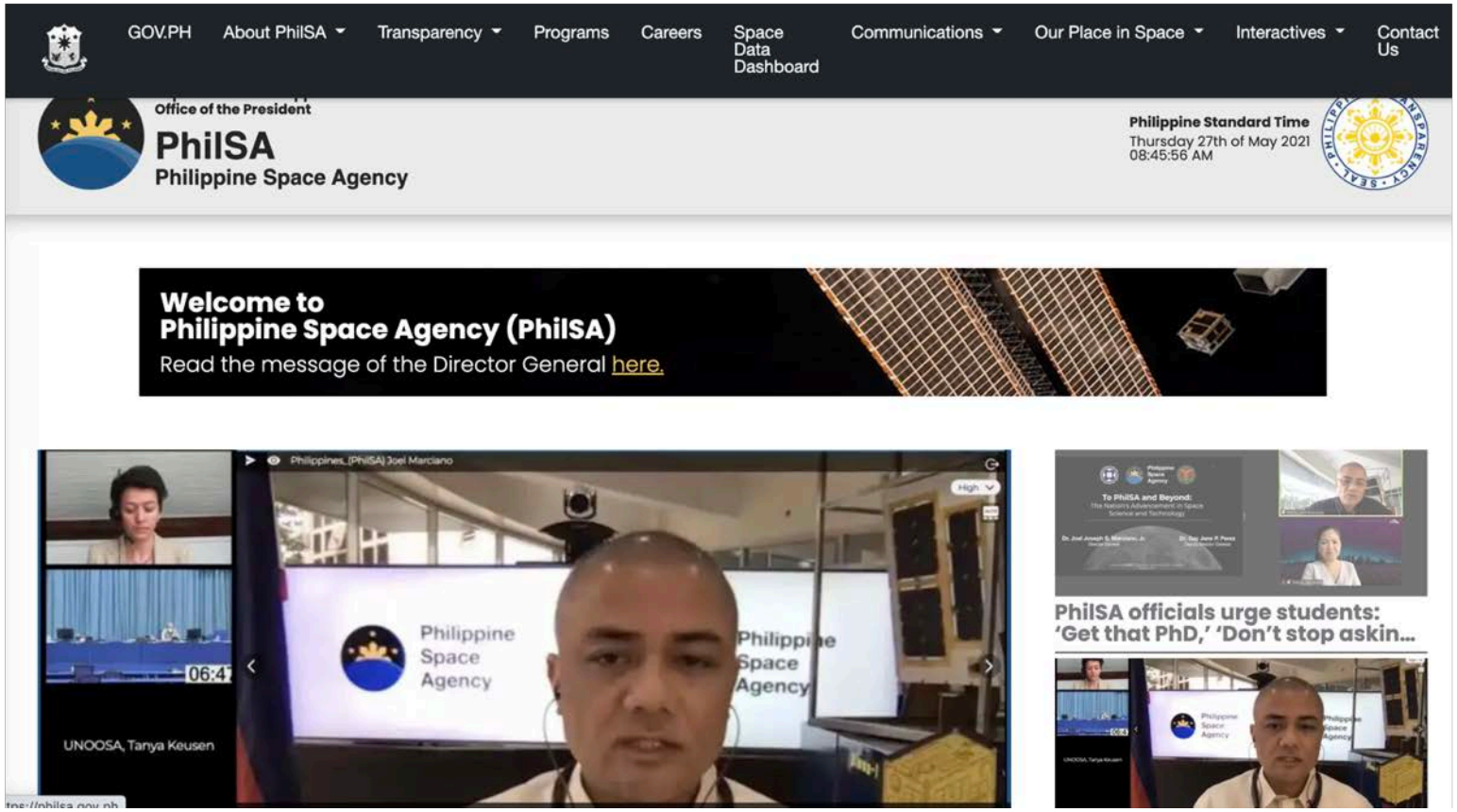


アキノ元大統領のフェイスブックから

フィリピン科学技術大臣（当時）が北大の大学院卒業式に参列

2019年8月8日フィリピンに宇宙庁（PhilSA）が設立

・カウンターパートのフィリピン大学教授が長官（閣僚）



2022年3月4日に大学として初めて北大がMOUを締結

群を抜くミッション本位の超小型衛星開発

国内随一の超小型衛星開発/成功実績

大型衛星も凌ぐ撮影性能

(青字: 東北大学の衛星バス)

SPRITE-SAT (2009) ：科研費

RISING-2 (2014) ：文科省事業

UNIFORM-1 (2014)：文科省事業

DIWATA-1 (2016) ：フィリピン科技省

DIWATA-2 (2018)：フィリピン科技省

RISESAT (2019)：JSPS(FIRST)

MicroDragon (2019)Vietnam: ODA

LAPAN A-4 (2021) Indonesia：JST e-ASIA

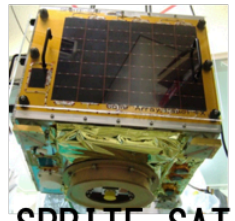
LCTF

LCTF

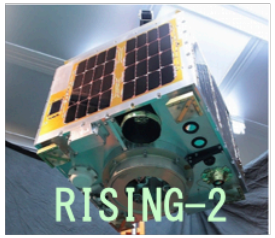
LCTF

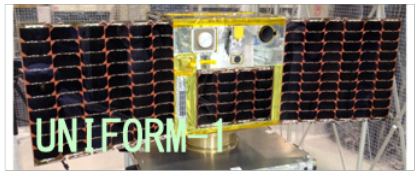
LCTF

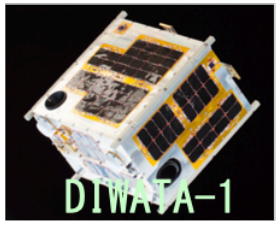
LCTF

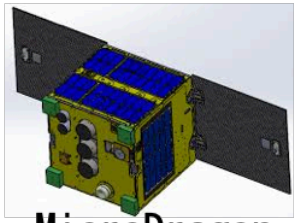


SPRITE-SAT

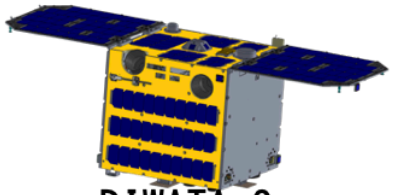








MicroDragon



DIWATA-2

アジア・マイクロサテライト・コンソーシアム

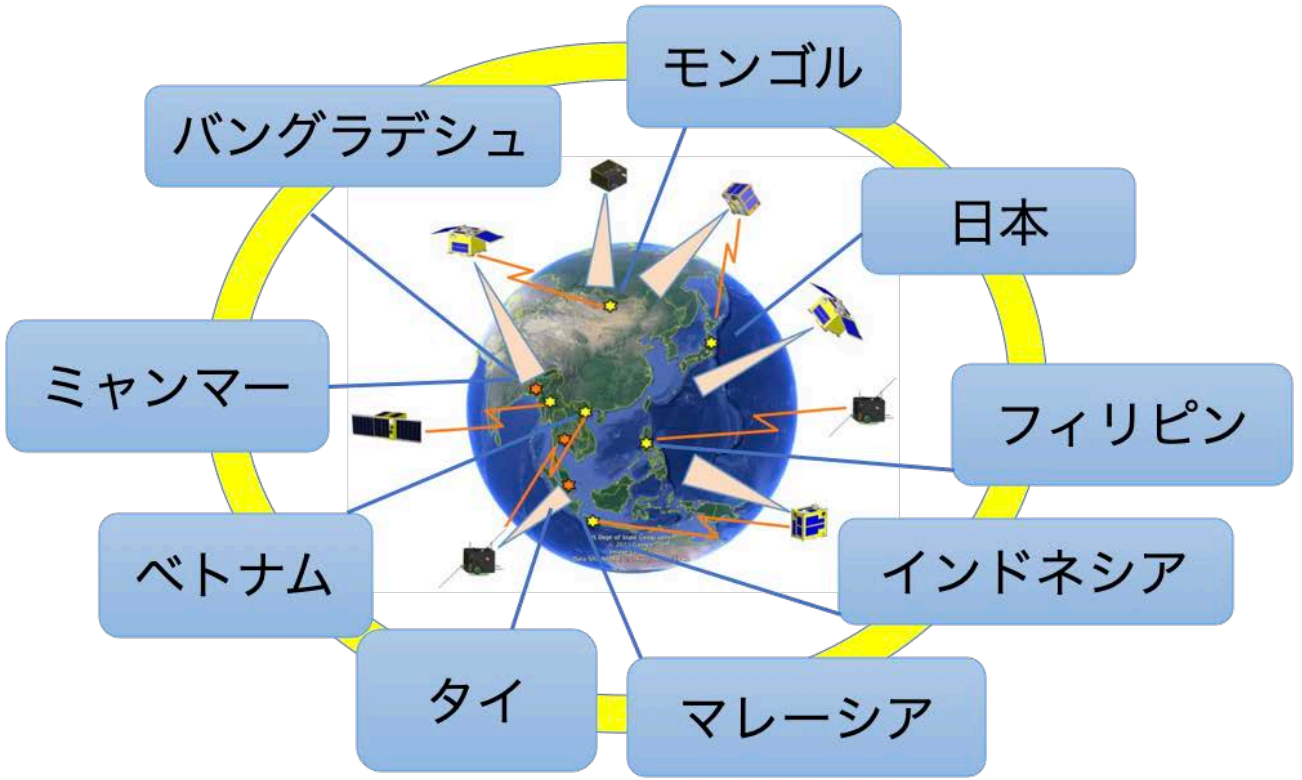
新しい宇宙利用の世界標準/秩序を日本から！

■ 衛星及び搭載センサー技術、データ、データ利用手法を共有
■ 標準化されたセンサーと衛星・運用システムの共同開発
■ 地上検証の促進

6年かけて北大からアジア9カ国に参加を呼びかけ。
（大学総長、政府高官、10名以上の大臣などに直接面談）
16機関による署名、2016/11/18発効。
将来的に、連続撮像を可能にする約50機のコンステレーションを目指す。

さらに、南米、アフリカへ

アジア マイクロサテライト コンソーシアム



国際協力でデータ共有のプロトコルの確立を目指す

食料生産性向上

先端ビジネスの創出

地球環境計測

途上国含む情報共有・国際協働

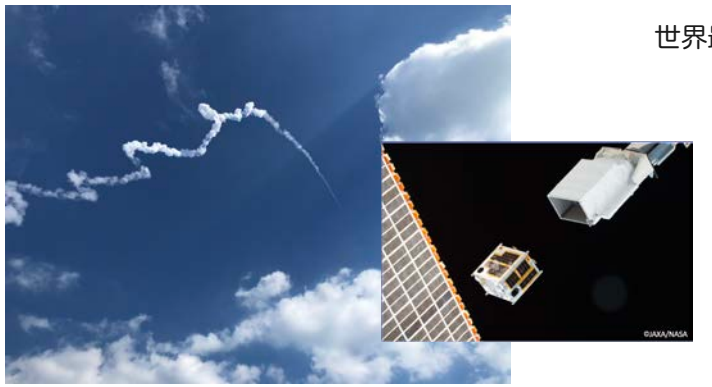
100か国が参加する超小型衛星プラットフォームの構築

人類に残された最大の公共空間＝宇宙を、全世界の持続的発展のために利用するフレームを、**北海道大学のイニシアチブ**で実現する。

衛星開発・運用・利用の教育

技術・データ・利用方法・マシンタイムの“共有”（シェアリング）システム

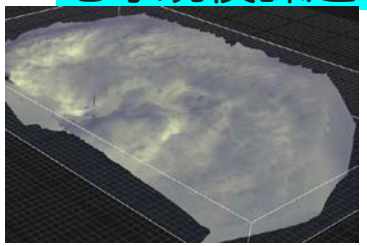
国内射場からの打上げ・放出機会提供



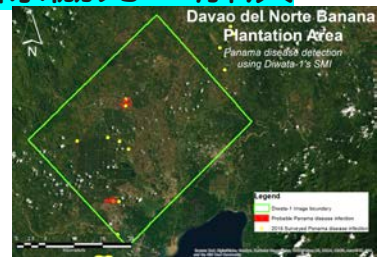
SDGsへの貢献

「公共」と「ビジネス」の両輪で国際関係強化

地球規模課題を国際協力で解決

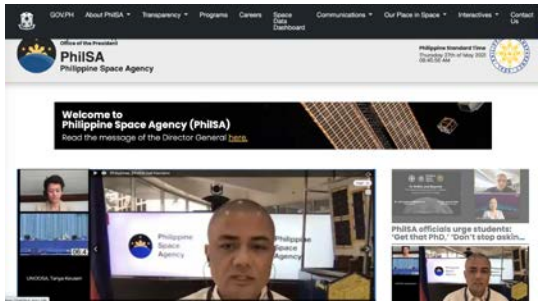


世界最高精度で台風の立体構造を計測



バナナの伝染病地域の同定に成功

宇宙機関設立支援



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