Exploring New Remote Sensing Data for Characterization of Tropical Phenology

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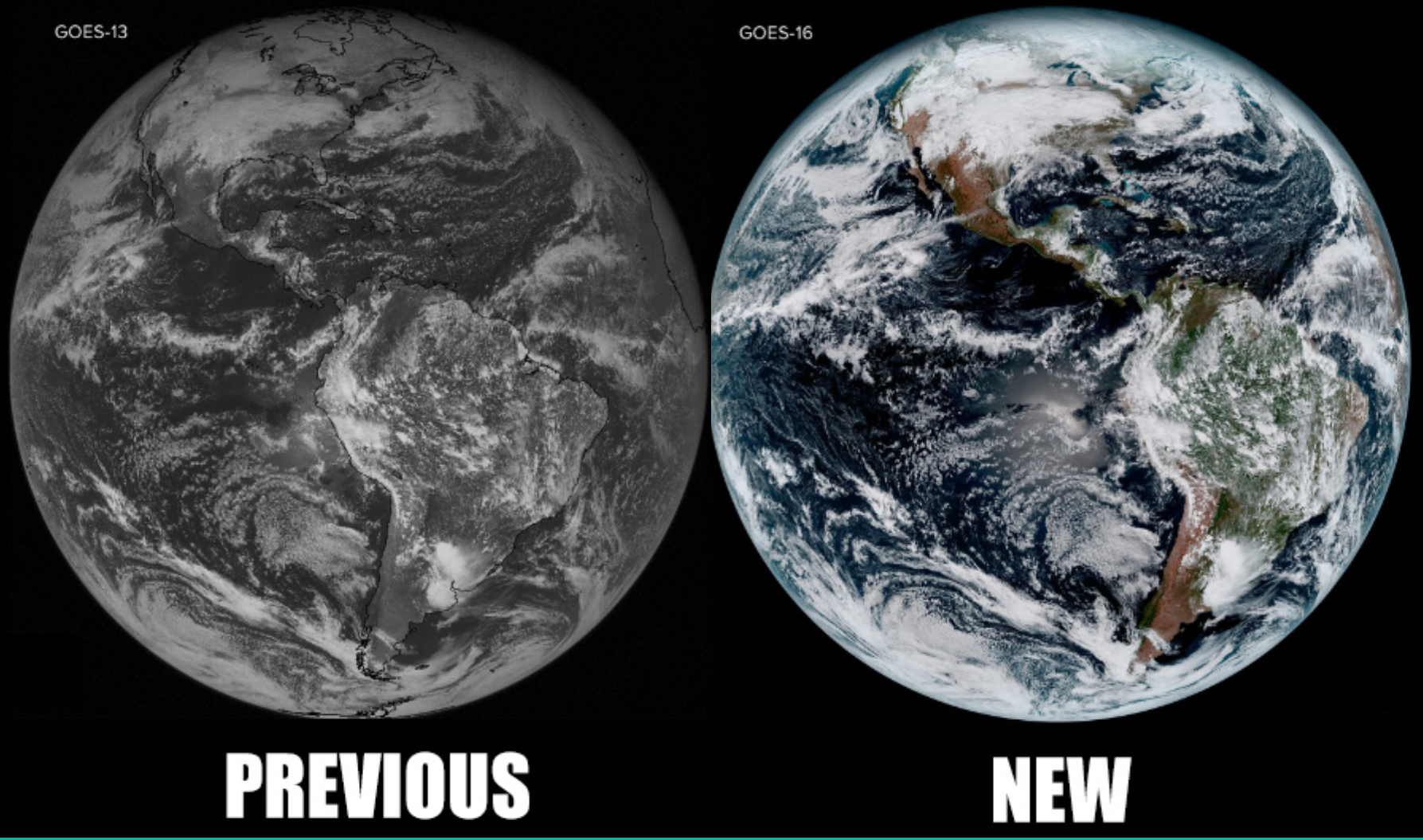
Introduction

- Remote sensing applications in tropical Asia
  - Land use/land cover change analysis (deforestation etc.) with Landsat (30m, every 16-day)
  - Land use characterization with synthetic aperture radar (SAR, all weather capability)
  - Ecosystem productivity and vegetation-climate interactions with MODIS (500m, 1-2 days)
- Biodiversity and ecosystem dynamics studies with remote sensing
  - Frequent and persistent cloud cover making it difficult to observe the surface
  - Moderate-low spatial resolution data nearly impossible to observe vegetation at species level

New Remote Sensing Data 1:
Third-Generation
Geostationary Satellites

New Remote Sensing Data 2:
Commercial Satellites

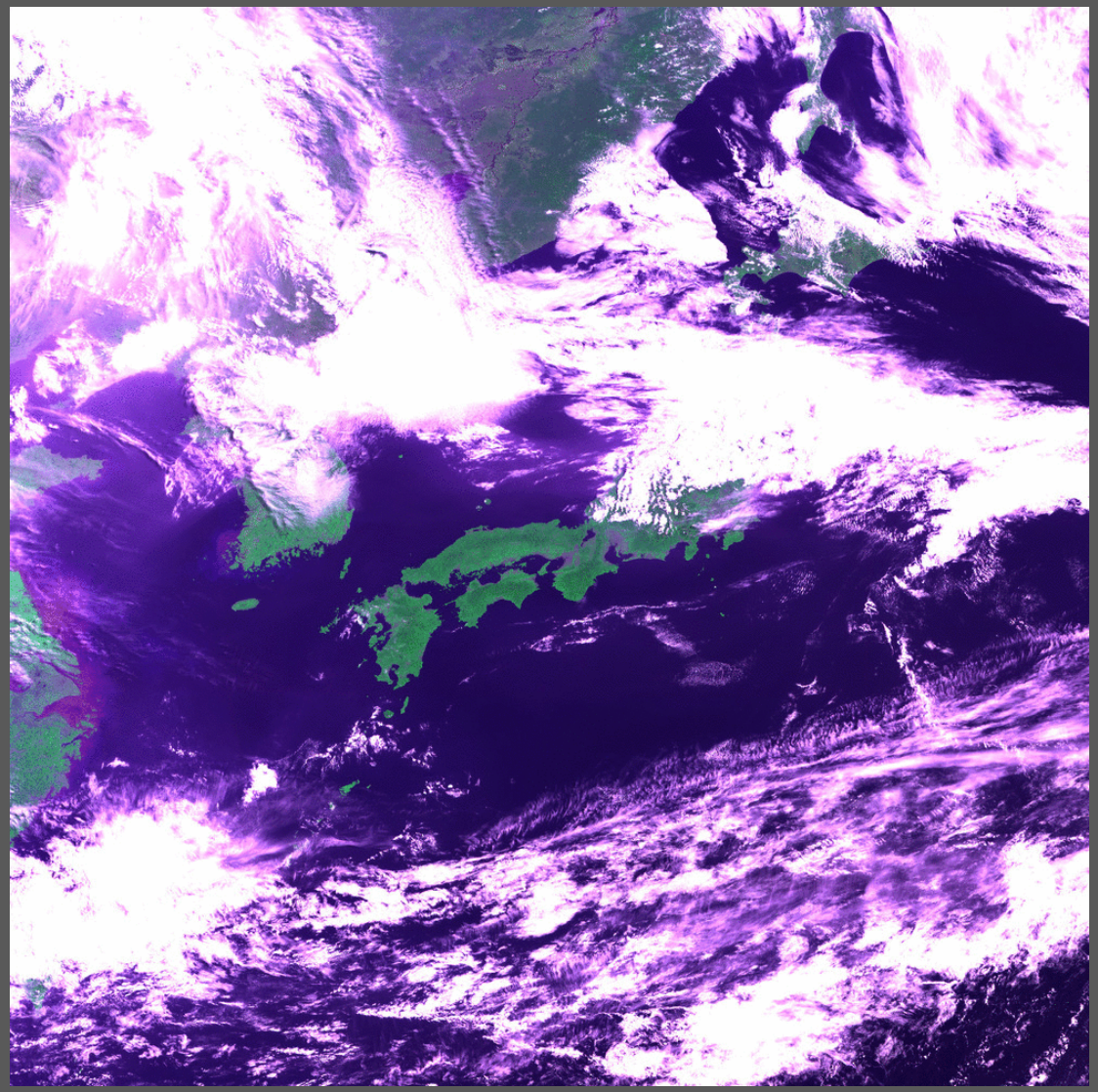


New-generation Geostationary Imagers

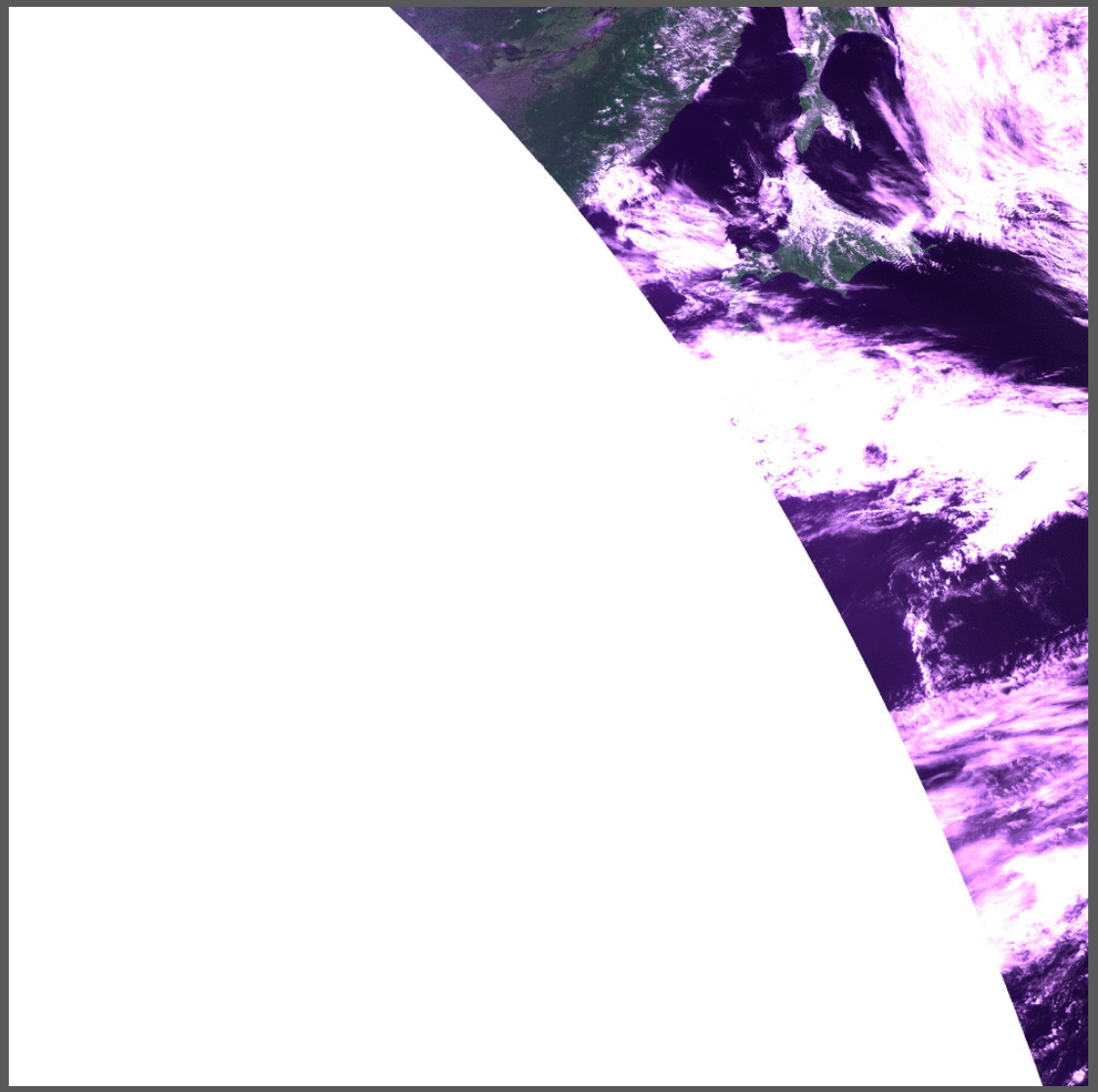
- Larger number of “narrow” spectral bands
- Higher spatial resolution (1-2km)
- Higher temporal resolution (~10 min)

Sample Images: 2016-05-01

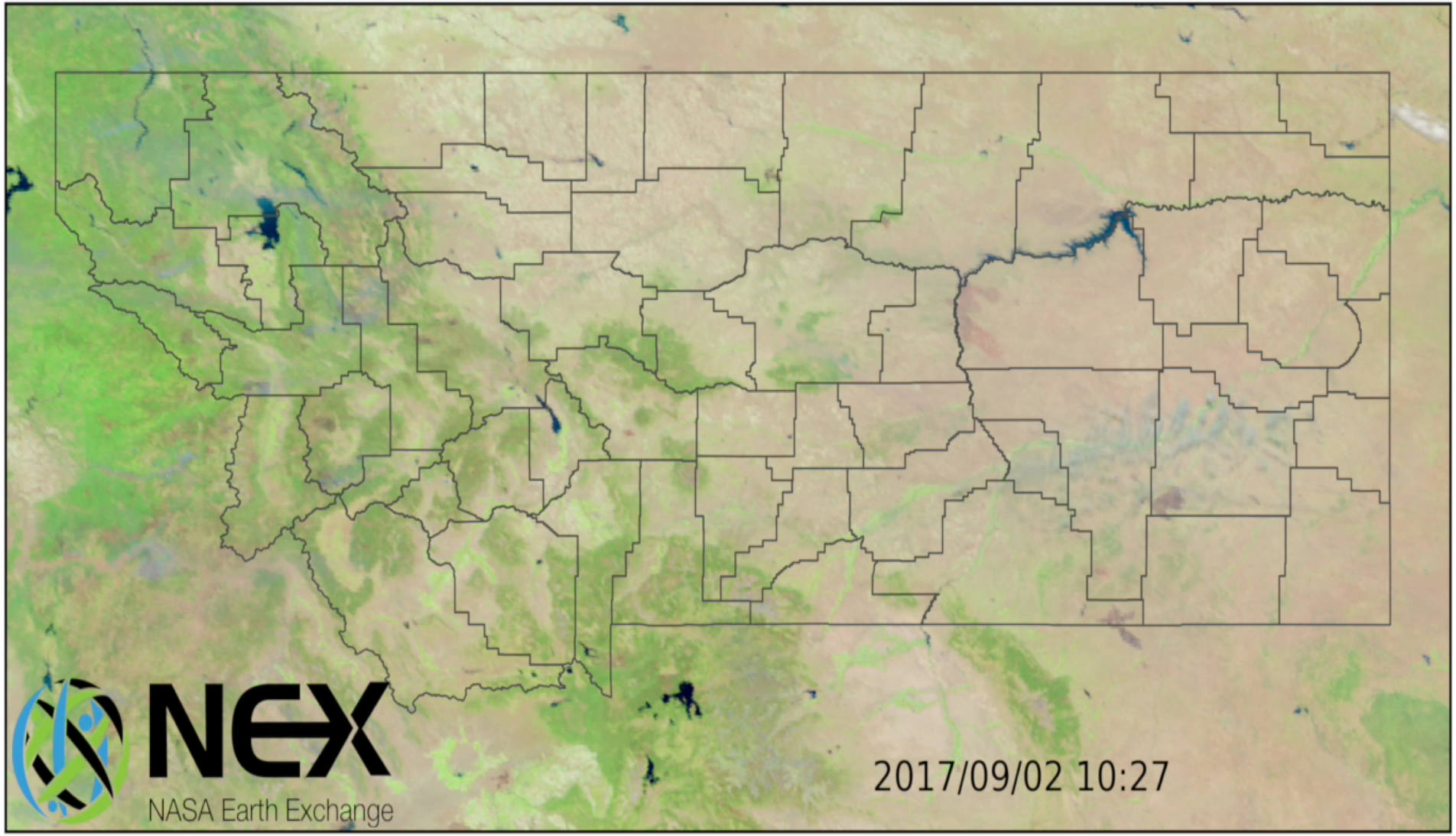
Himawari-8 AHI



S-NPP VIIRS

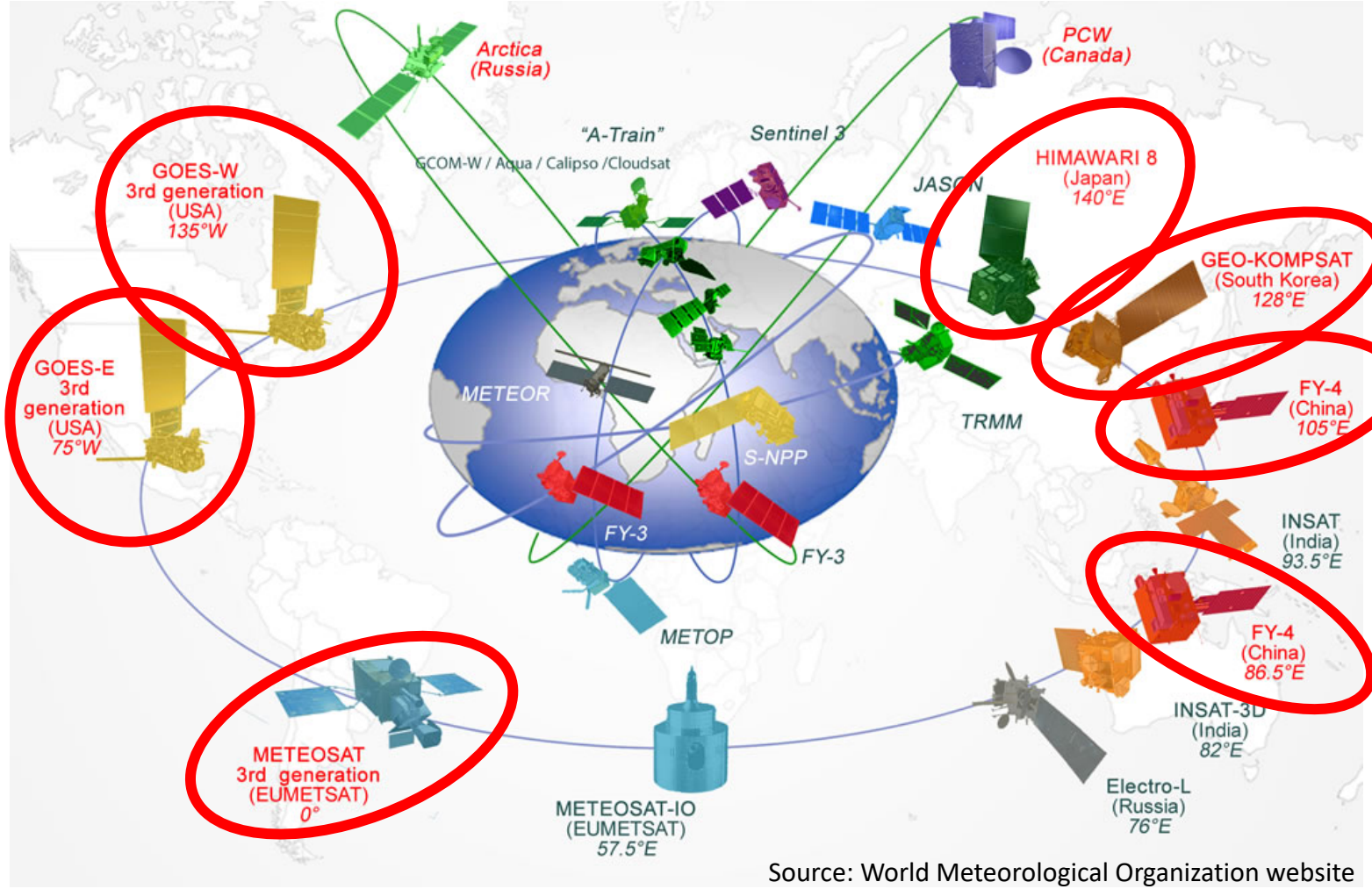


Diurnal wildfire dynamics, Montana, US



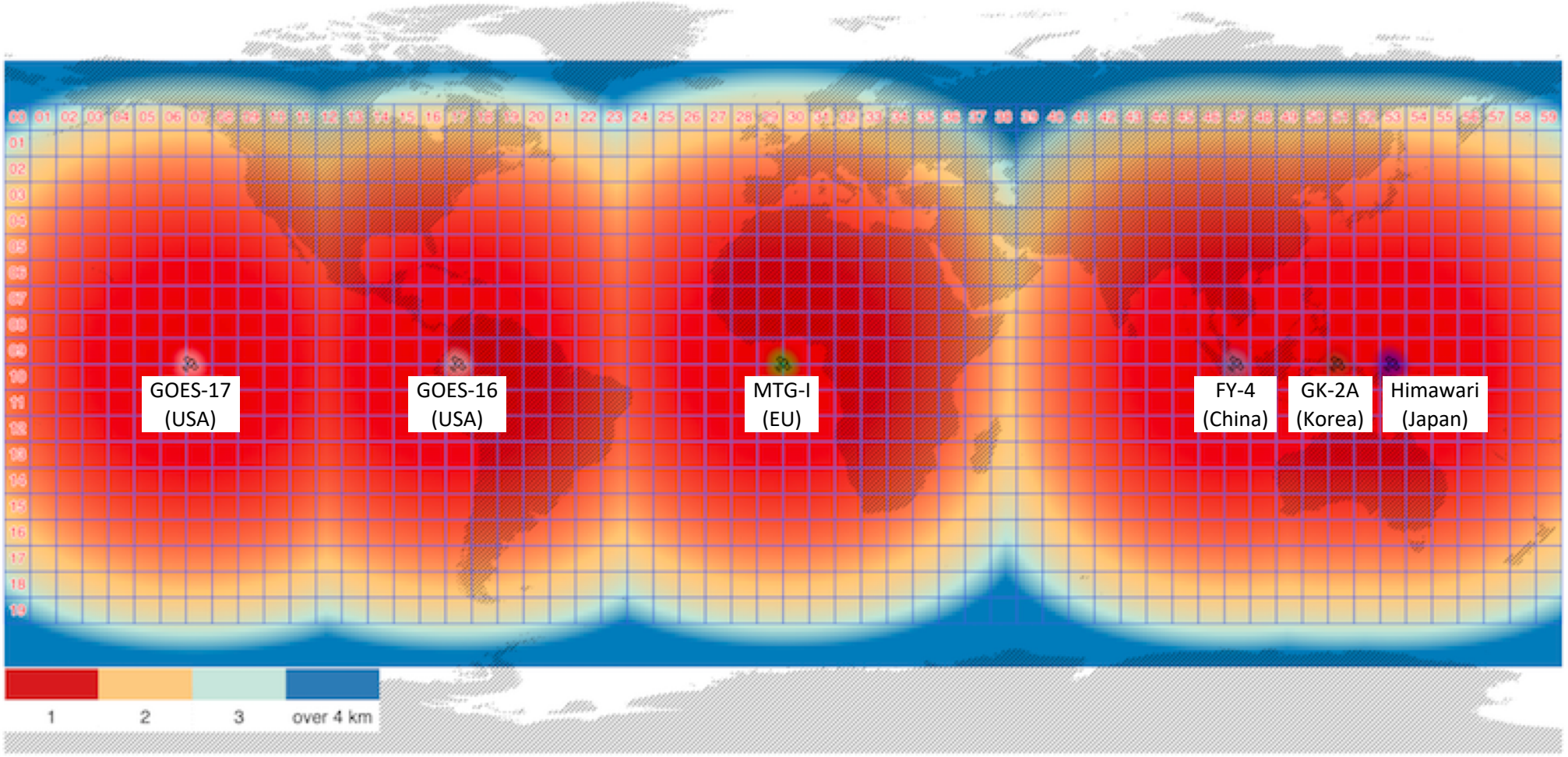
By early afternoon, fires create local circulations and break out. (Nemani et al., 2019)

International Constellation of Third-Generation Geostationary Satellites



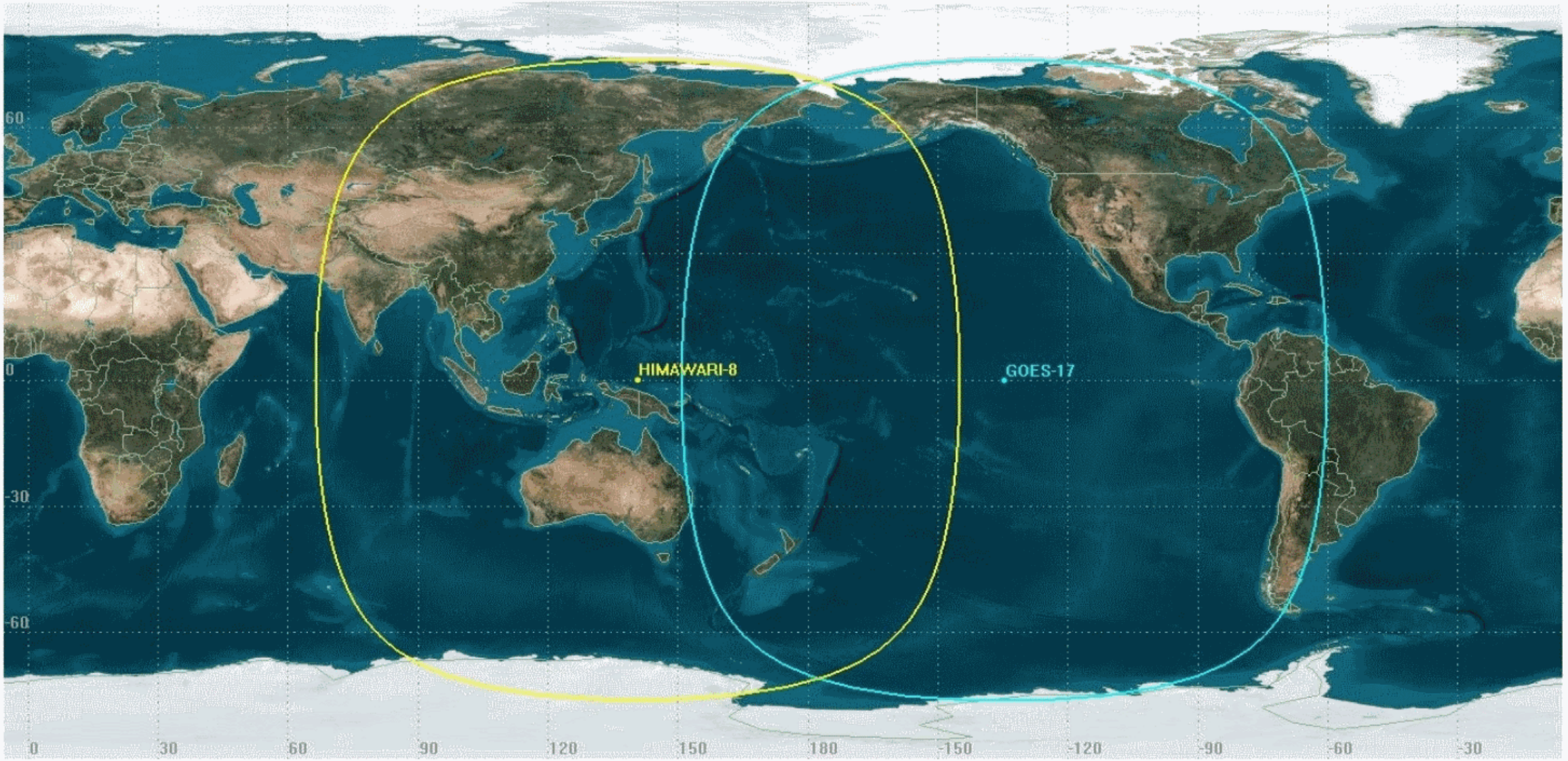
Source: World Meteorological Organization website (http://www.wmo.int/pages/prog/sat/globalplanning_en.php)

International constellation
1-2km coverage for large portions of the Earth
at 5-15 minute interval



(Source: Nemani et al., 2019)

Himawari-8 Ground Coverage



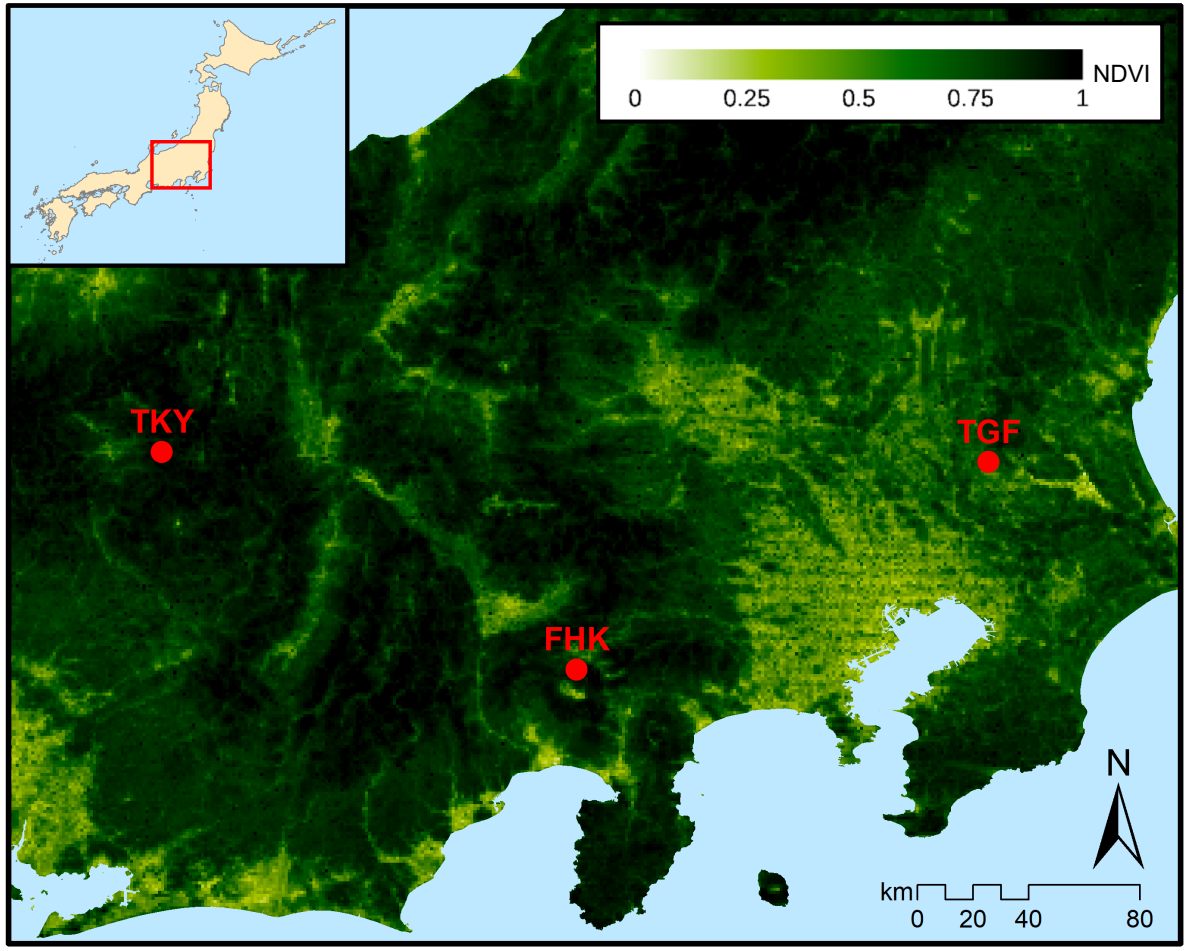
https://sciblogs.co.nz/out-of-space/2019/01/16/satellite-orbits-geostationary/

Article | Open Access | Published: 30 October 2019

Improved Characterisation of Vegetation and Land Surface Seasonal Dynamics in Central Japan with Himawari-8 Hypertemporal Data

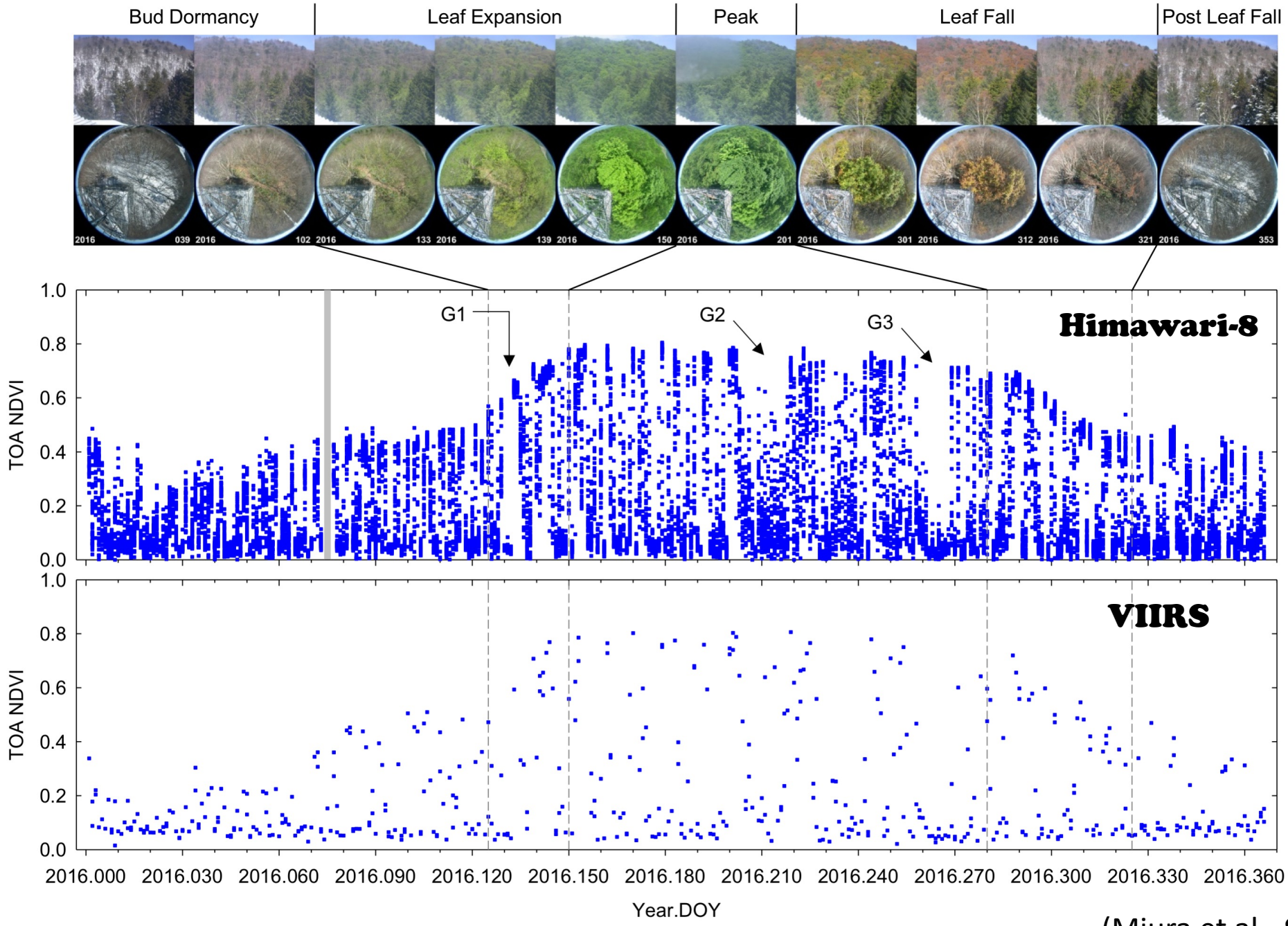
Tomoaki Miura, Shin Nagai, Mika Takeuchi, Kazuhito Ichii & Hiroki Yoshioka

Scientific Reports **9**, Article number: 15692 (2019) | Cite this article



Himawari-8 NDVI image for the month of July 2016

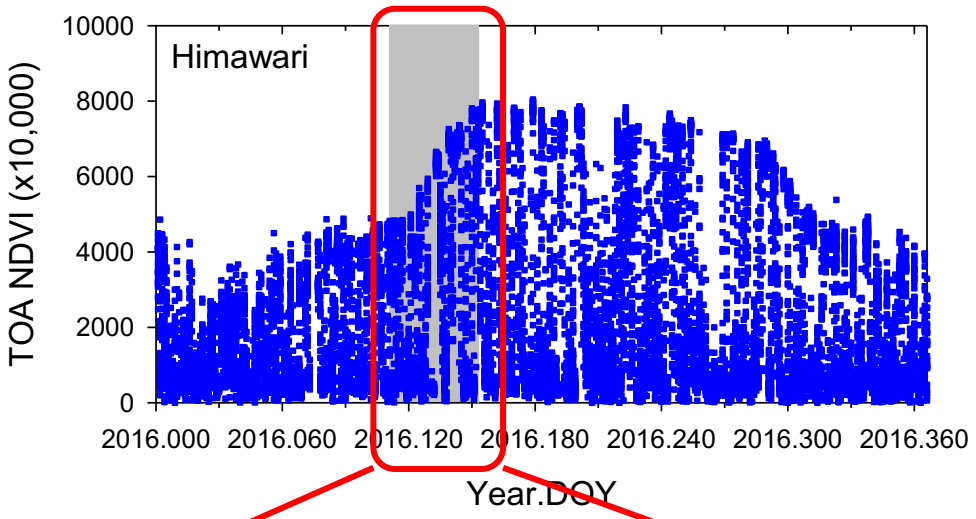
NDVI Temporal Profiles for Takayama (TKY)

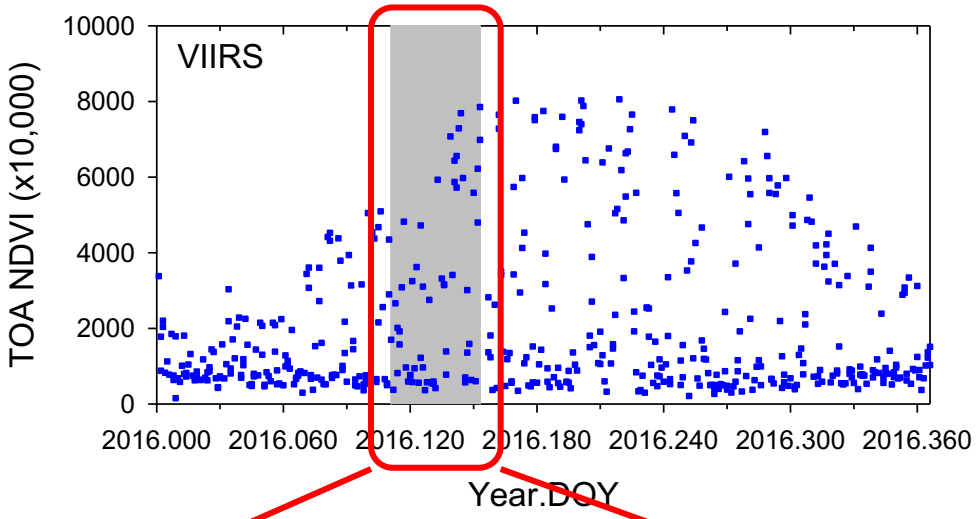


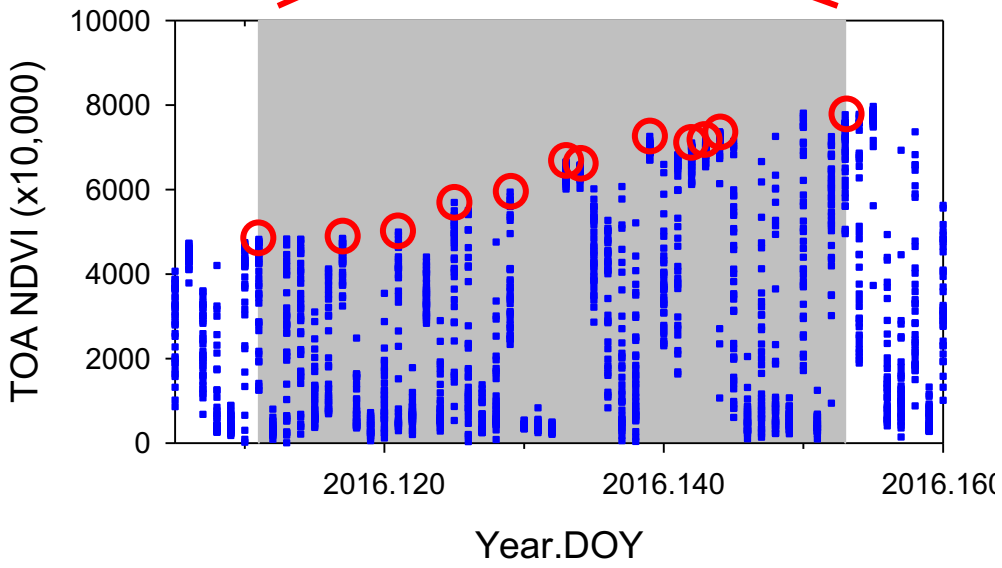
UNIVERSITY of HAWAI'I® MĀNOA

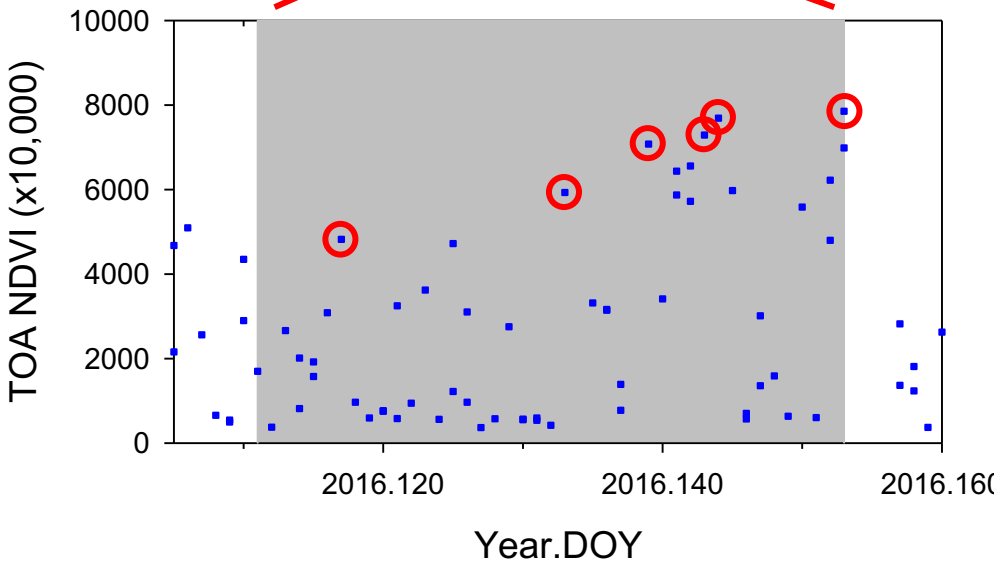
国立研究開発法人海洋研究開発機構 JAMSTEC Japan Agency for Marine-Earth Science and Technology

(Miura et al., *Scientific Reports*, 2019)









Himawari - out of 43 days of green-up period:

- **12 days** with confirmed cloud-free observations

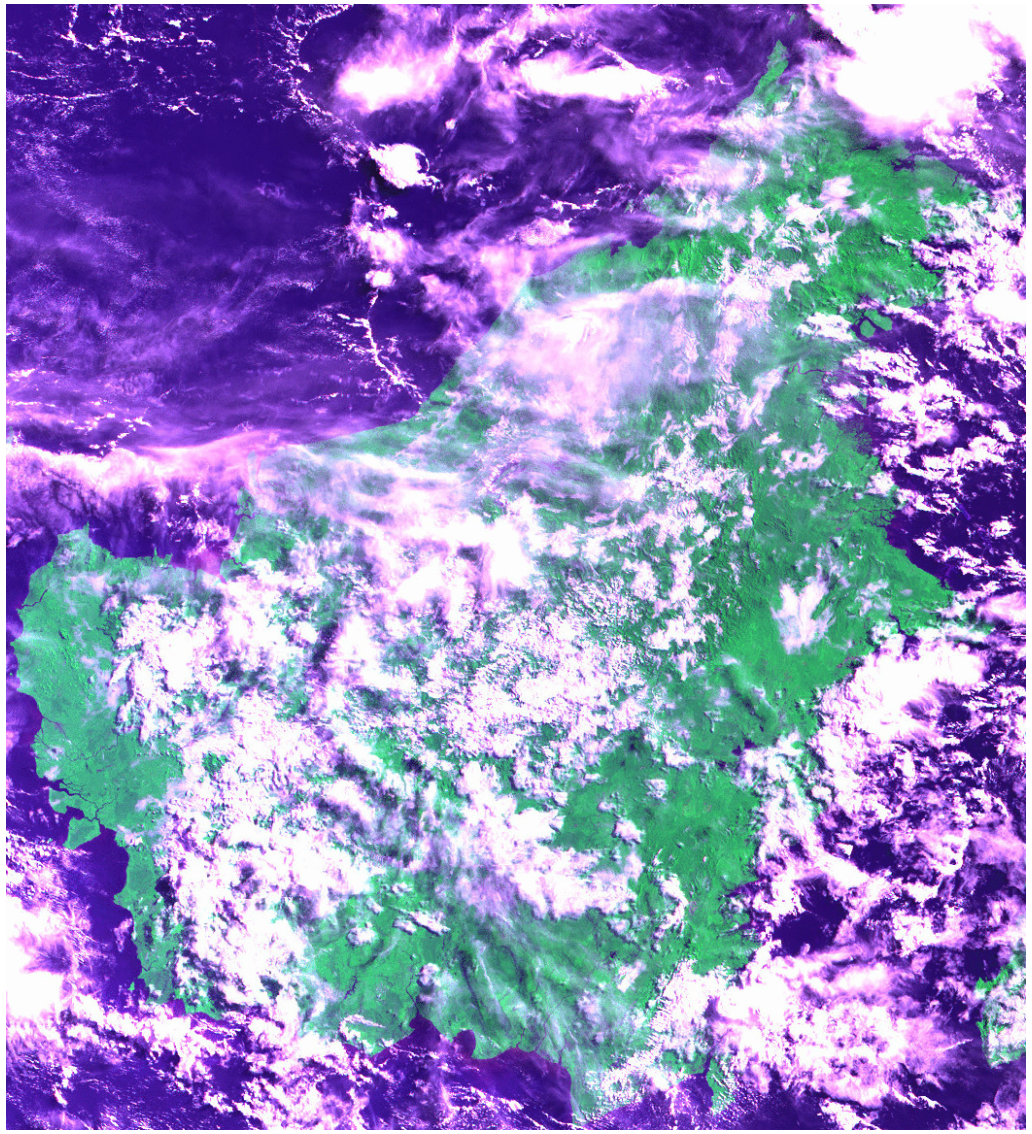
VIIRS - out of 43 days of green-up period:

- **6 days** with confirmed cloud-free observations

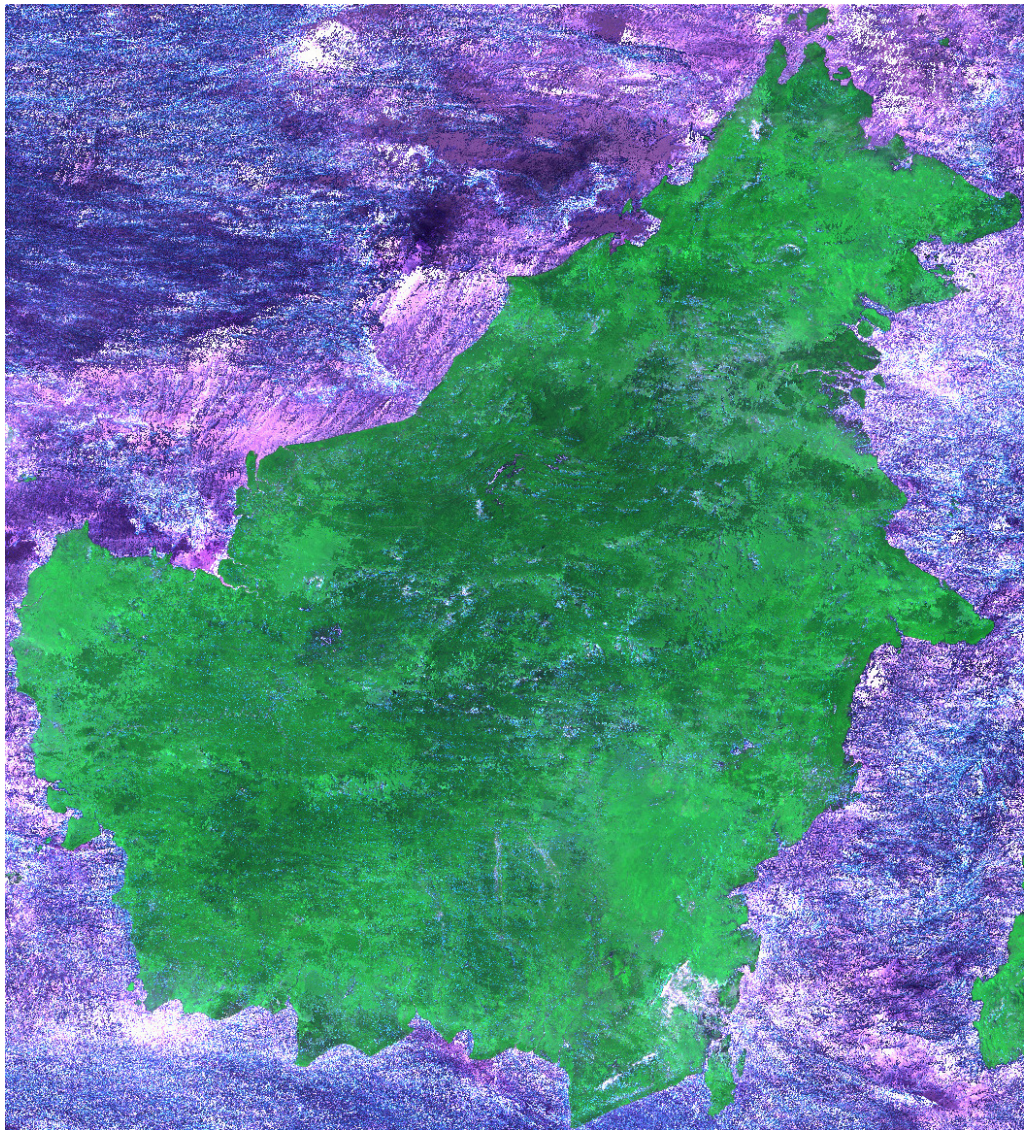
(Miura et al., *Scientific Reports*, 2019)

Himawari-8 Images of Borneo: 31-May-2019

10 min resolution image

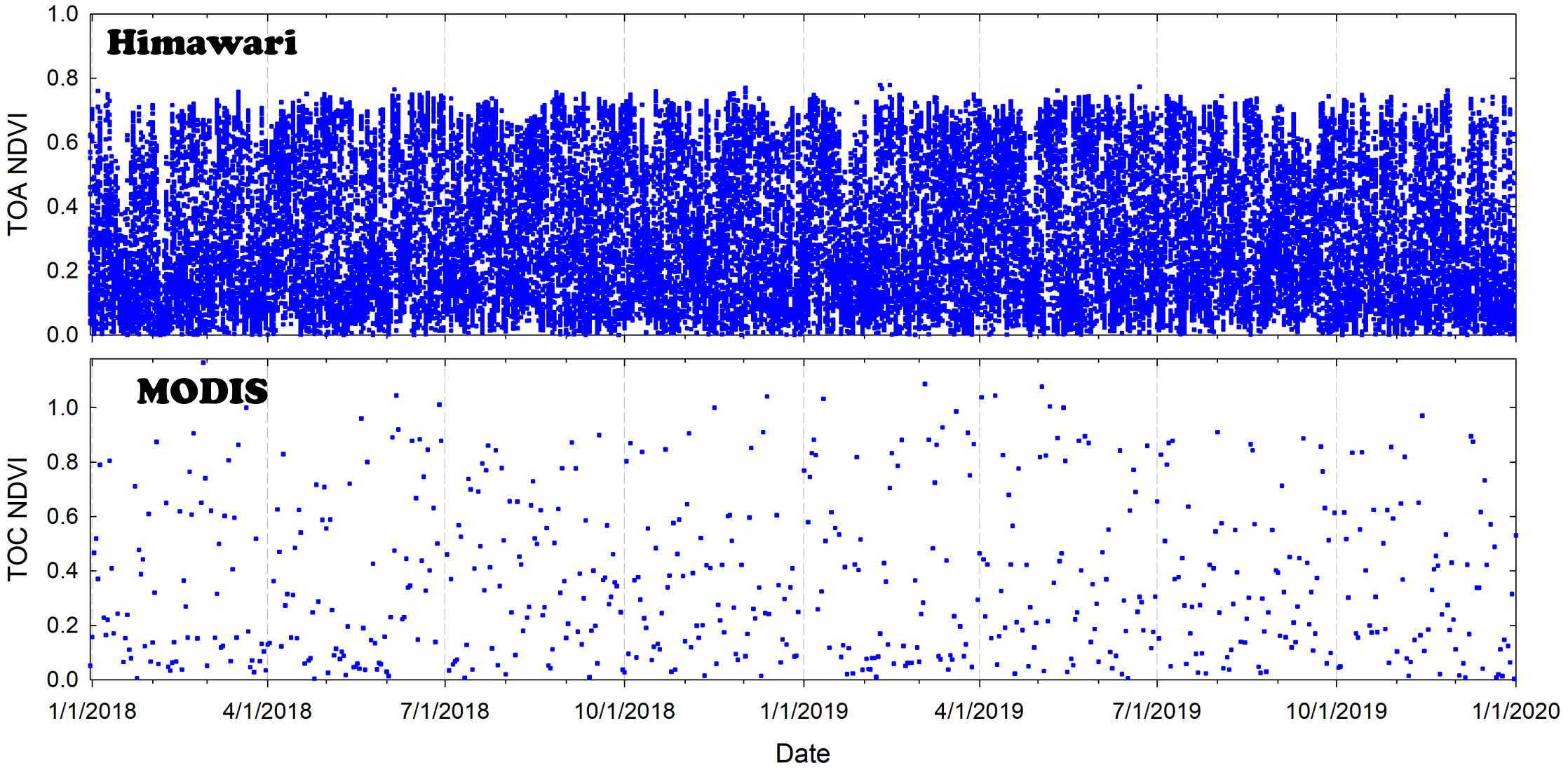


Daily composite image



With Shin Nagai@JAMSTEC and Kazuhito Ichii@CEReS - Chiba University

NDVI at Lambir Hills: Himawari-8 vs. MODIS



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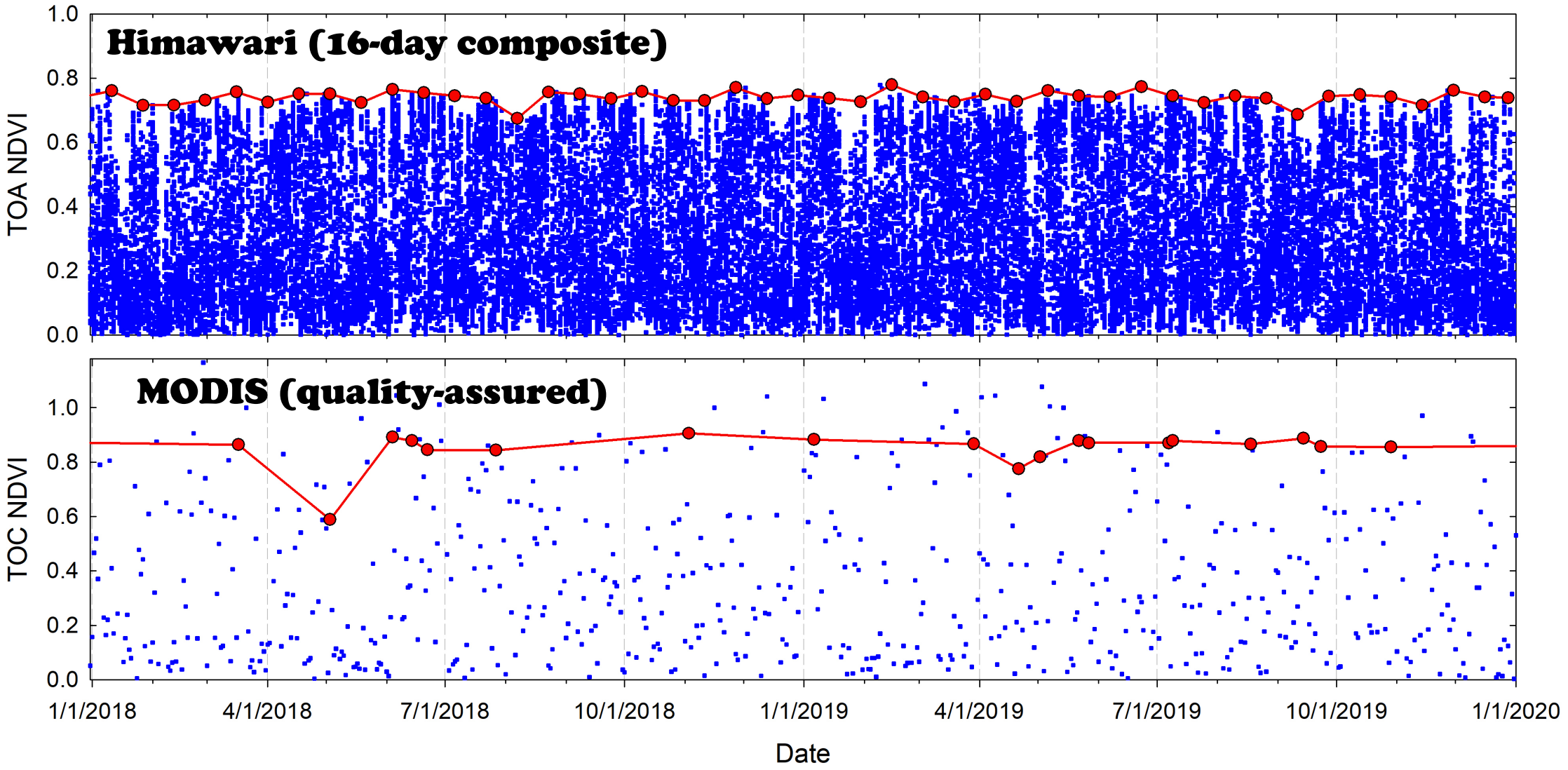

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Himawari-8 NDVI Comparison with *In Situ* Cloud Cover Measurements at Lambir Hills

Year 2015

Very Sunny (3)

2015-358 at 16:15

Sunny (2)

2015-358 at 13:15

Cloudy (1)

2015-358 at 09:15

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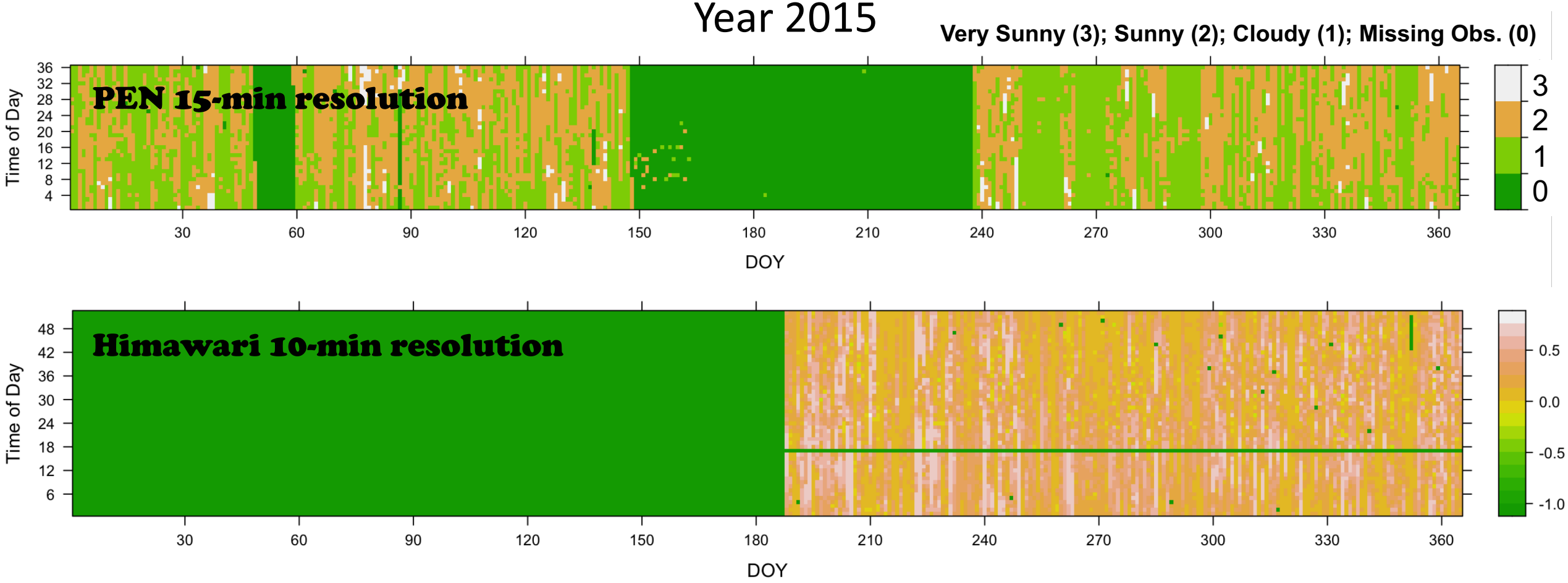

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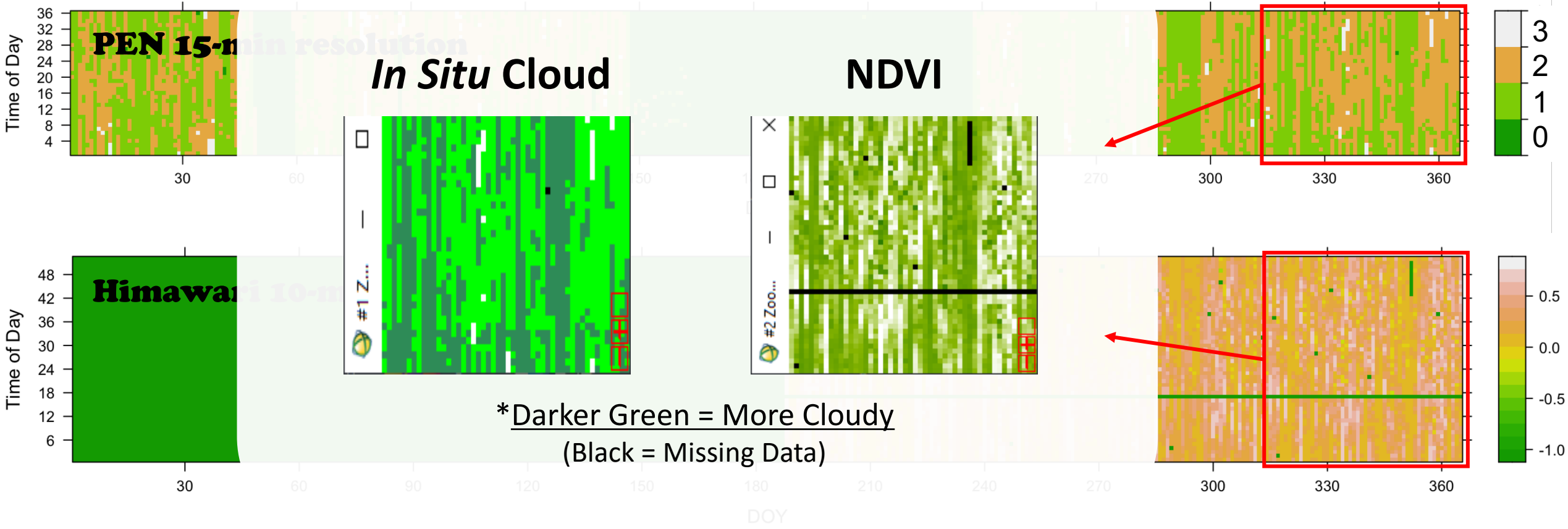

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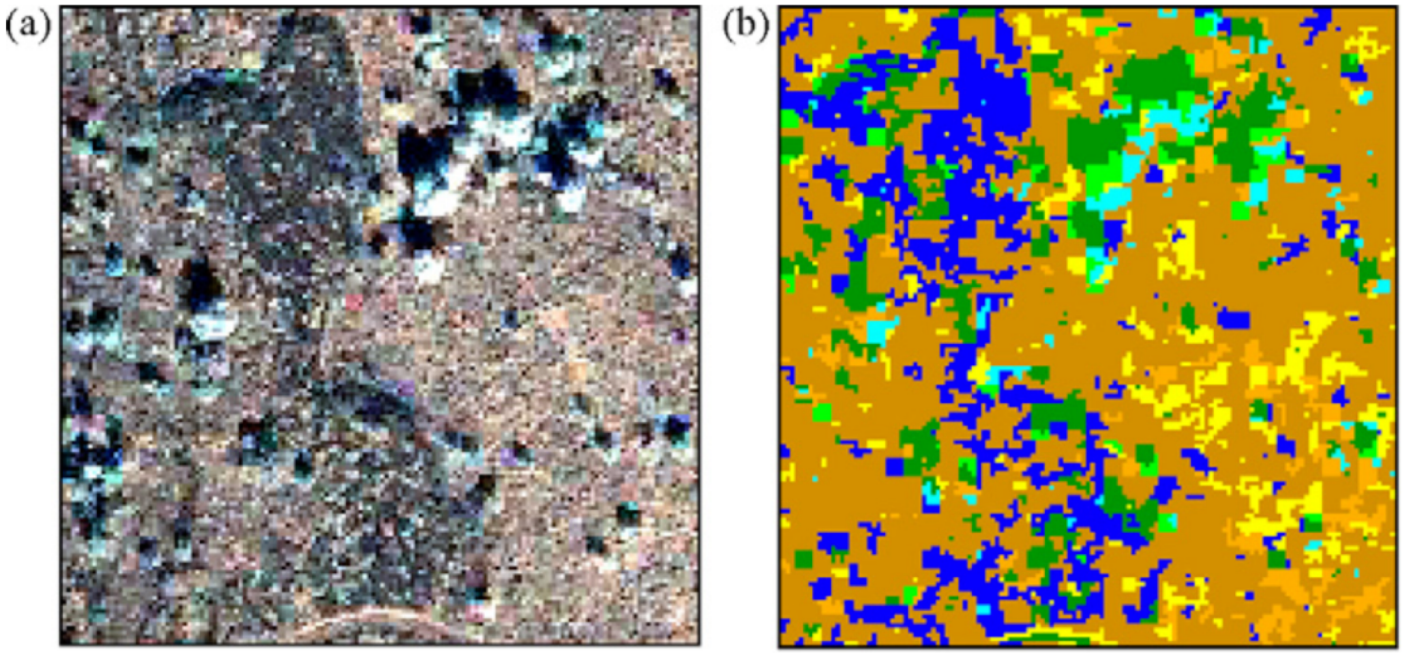
Commercial Satellite Remote Sensing

- Characterized by *very high spatial resolution imagery* (50 cm – 4 m)
- Available since the year 1999, but at very low temporal frequencies

Mapping Trees in the Puu Waawaa Tropical Dry Forest in Hawaii



(Martinez-Morales, Miura, & Idol, 2008, *For. Ecol. Manag.*)

Commercial Satellite Remote Sensing

- Characterized by *very high spatial resolution imagery* (50 cm – 4 m)
- Available since the year 1999, but at very low temporal frequencies

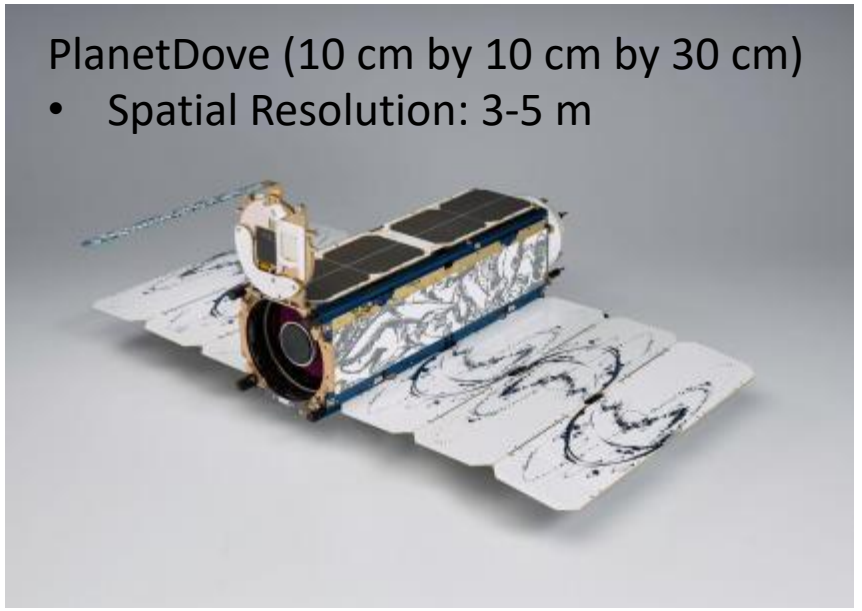

N21.3012°
Image © 2021 Maxar Technologies
55 m
Google Earth

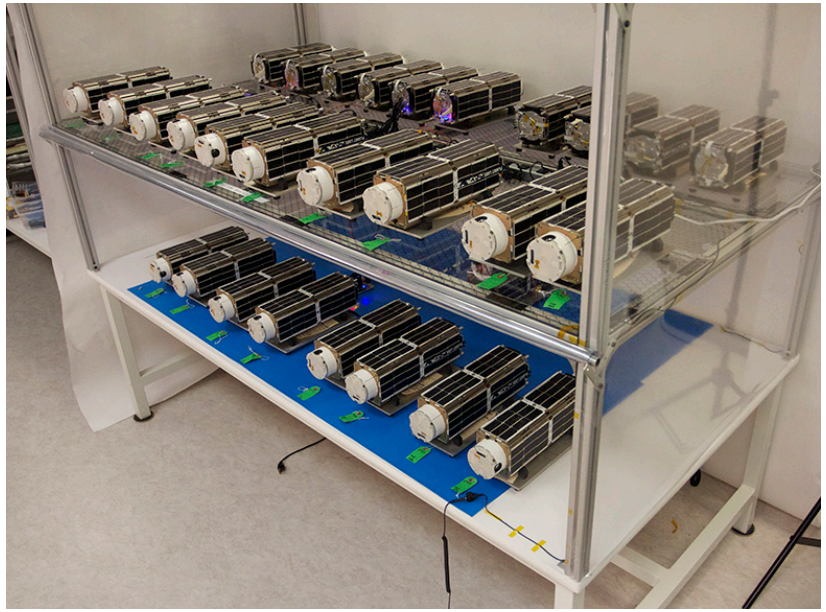
WorldView-2 50-cm Natural Color – Central City, Pennsylvania; October 1, 2012
(http://apollomapping.com/imagery/high-resolution-imagery/worldview-2)

Commercial Satellite Remote Sensing

- Recently, high resolution commercial remote sensing data have become available at higher temporal frequencies

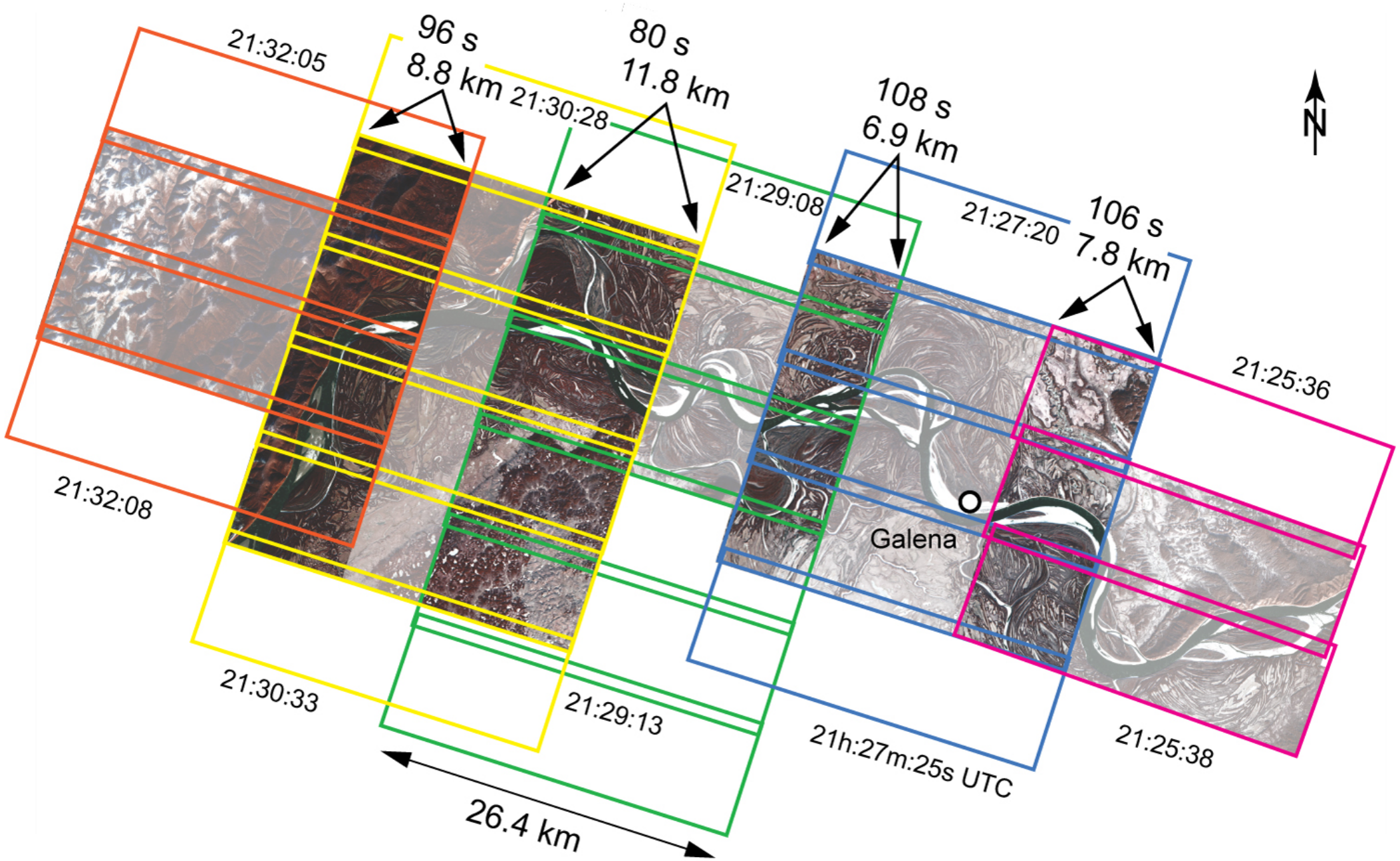
PlanetDove (10 cm by 10 cm by 30 cm)
- Spatial Resolution: 3-5 m





(Source: https://www.planet.com/company/approach/)

https://storage.googleapis.com/planet-ditl/day-in-the-life/index.html



(Kääb et al., 2019, Hydrol. Earth Syst. Sci., https://doi.org/10.5194/hess-23-4233-2019)

Summary

- Third-generation geostationary satellites
  - New data source for improved monitoring of tropical phenology and ecosystem productivity
- High resolution commercial satellites
  - Suitable data source for augmenting and/or spatially-extending field-based species-level observations of tropical phenology