AO GEO
Earth Observations
for Asia-Oceania

AOGEO
EARTH OBSERVATIONS FOR ASIA-OCEANIA
AOGEO SYMPOSIUM 2019
2-4 November 2019 / Canberra, Australia
#AOGEO

Expectations from Carbon and GHG initiative
- AOGEO Task Group 3 -

CHIBA UNIVERSITY

AsiaFlux
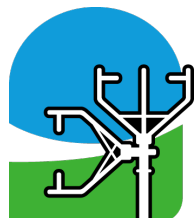
JapanFlux

Kazuhito Ichii

Center for Environmental Remote Sensing
Chiba University, Japan
（JapanFlux Chair）

IPBES Global Assessment
（Approved on May 4, 2019）

"Biodiversity/Ecosystem (Nature) version of IPCC"

ipbes

Science and Policy
for People and Nature

IPBES
GLOBAL
ASSESSMENT
SUMMARY FOR
POLICYMAKERS
(PDF)

K. Ichii; CLA of Chapter 2 Nature

https://www.ipbes.net/

Nature's Contributions to People (NCPs)

50yrs change

[SPM Fig]

[←Climate Regulation]

Regulation of Environment Processes

Material/ Assistance

Non-material

Decline:
14/18 items

Linking Biodiversity to Carbon Budget

RESEARCH ARTICLE SUMMARY

Positive biodiversity-productivity relationship predominant in global forests

Jingjing Liang,* Thomas W. Crowther, Nicolas Picard, Susan Wiser, Mo Zhou, Giorgio Alberti, Ernst-Detlef Schulze, A. David McGuire, Fabio Bozzato, Hans Pretzsch, Sergio de-Miguel, Alain Paquette, Bruno Hérault, Michael Scherer-Lorenzen,

[Liang et al. 2016; Science]

ARTICLES
nature climate change

Carbon-focused conservation may fail to protect the most biodiverse tropical forests

Joice Ferreira [1,18,19]*, Gareth D. Lennox [2,18]*, Toby A. Gardner [3,4,19], James R. Thomson [5,6], Erika Berenguer [2,7], Alexander C. Lees [8,9], Ralph Mac Nally [5,10], Luiz E. O. C. Aragão [11,12], Silvio F. B. Ferraz [13], Julio Louzada [14], Nárgila G. Moura [15], Victor H. F. Oliveira [14], Renata Pardini [16], Ricardo R. C. Solar [17], Ima C. G. Vieira [15] and Jos Barlow [2,14,15,19]

[Ferreira et al. 2018; NCC]

nature geoscience
ARTICLES
Corrected: Author Correction

Carbon stocks in central African forests enhanced by elephant disturbance

Fabio Berzaghi [1,2,3]*, Marcos Longo [4,5], Philippe Ciais [2], Stephen Blake [6,7], François Bretagnolle [3], Simone Vieira [8], Marcos Scaranello [4], Giuseppe Scarascia-Mugnozza [1] and Christopher E. Doughty [9]

[Berzaghi et al. 2019; NGeo]

nature COMMUNICATIONS

ARTICLE
OPEN

Impacts of climate on the biodiversity-productivity relationship in natural forests

Songlin Fei [1], Insu Jo [1], Qinfeng Guo [2], David A. Wardle [3,4], Jingyun Fang [5], Anping Chen [1], Christopher M. Oswalt [6] & Eckehard G. Brockerhoff [7,8]

[Fei et al. 2018; NComm]

Status of CO$_2$ flux observation (Terrestrial CO$_2$ flux and upscaling)

Terrestrial CO₂ budget; Large gaps among approaches..

Terrestrial CO₂ budget (11 regions): 1990s & 2000s

+ : CO₂ Release
- : CO₂ Sink

X-axis Legend:
1: Terrestrial flux: 1990s
2: Terrestrial flux: 2000s
3: Atmospheric
   Inversions: 1990s
4: Atmospheric
   Inversions: 2000s

[IPCC AR5 (Chap 6), 2013]
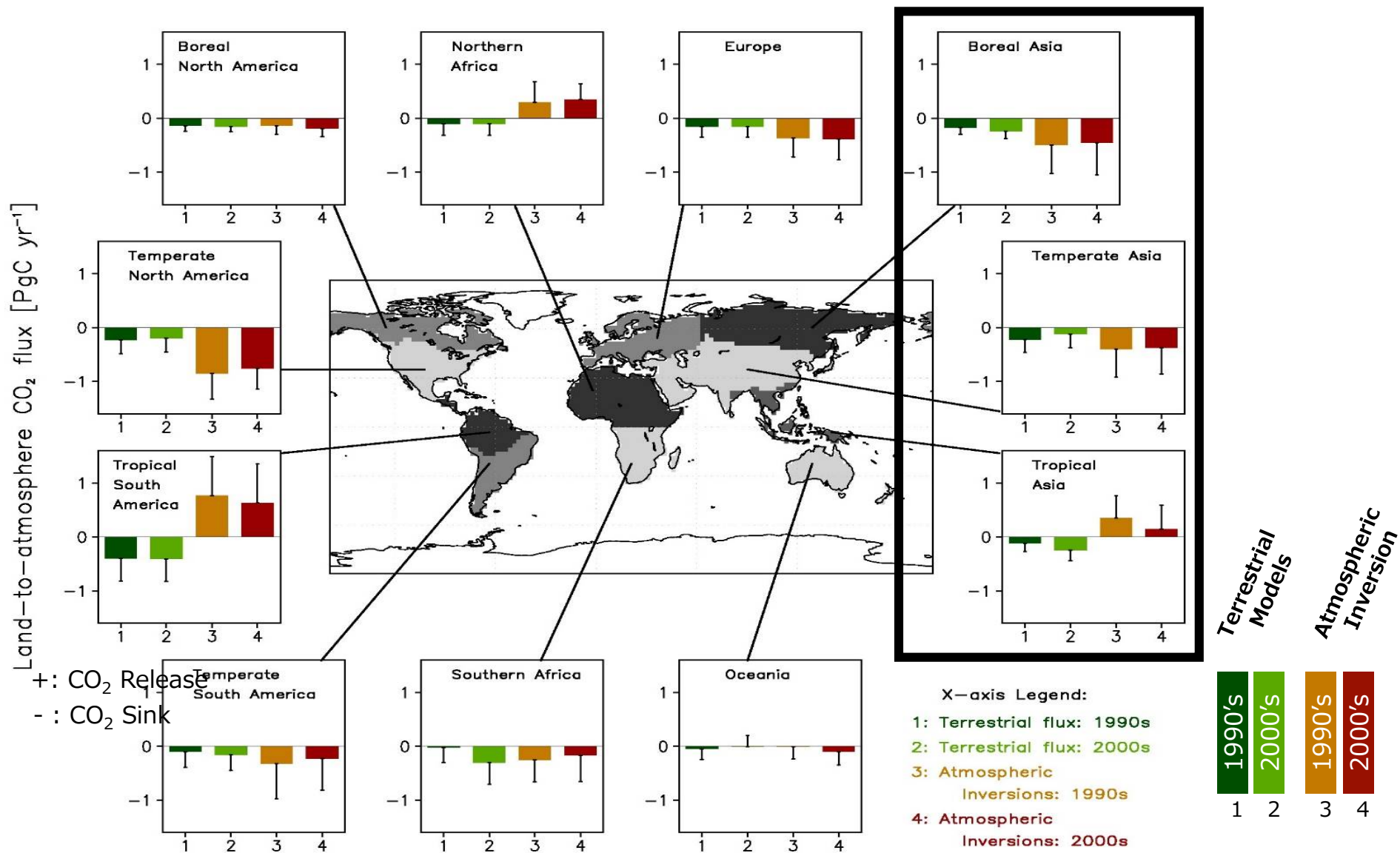
Closing gaps of CO₂ budget in Southeast Asia

Inter-decadal variation of terrestrial CO_2 budget

- Models (without LUC)
- CO_2 Inversion
- RS-biomass [Liu et al. 2015] (93-12)

Land use change and El Niño-Southern Oscillation drive decadal carbon balance shifts in Southeast Asia

Masayuki Kondo[1,2], Kazuhito Ichii[1,2,3], Prabir K. Patra[2,22], Joseph G. Canadell[4], Benjamin Poulter[5,6], Stephen Sitch[7], Leonardo Calle[5], Yi Y. Liu[8,9], Albert I.J.M. van Dijk[10], Tazu Saeki[3], Nobuko Saigusa[3], Pierre Friedlingstein[7], Almut Arneth[11], Anna Harper[7], Atul K. Jain[12], Etsushi Kato[13], Charles Koven[14], Fang Li[15], Thomas A.M. Pugh[11,16], Sönke Zaehle[17], Andy Wiltshire[18], Frederic Chevallier[19], Takashi Maki[20], Takashi Nakamura[21], Yosuke Niwa[20] & Christian Rödenbeck[17]

[Kondo et al. 2018; Nature Comm.]

Release

8 models w/o LUC
8 models with LUC

Uptake

NBP (kg C m⁻² yr⁻¹)
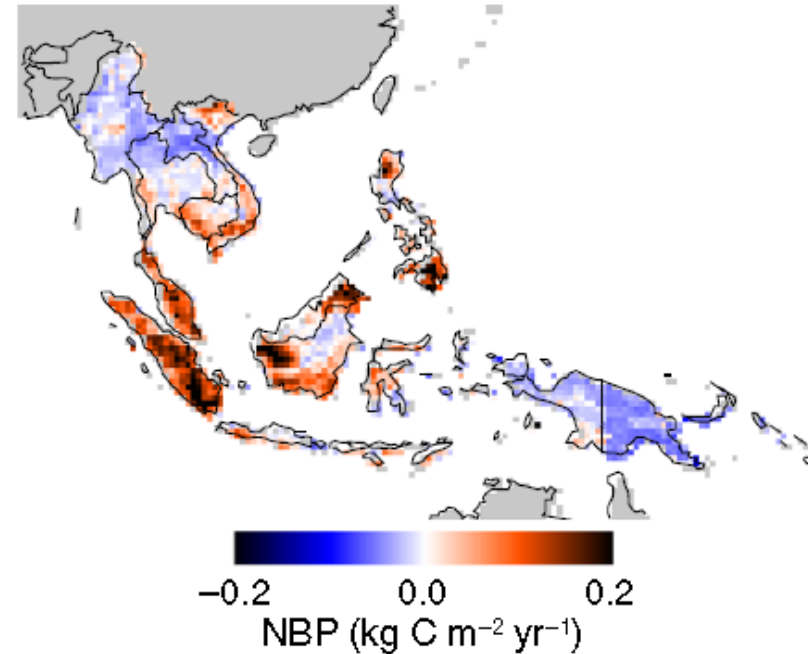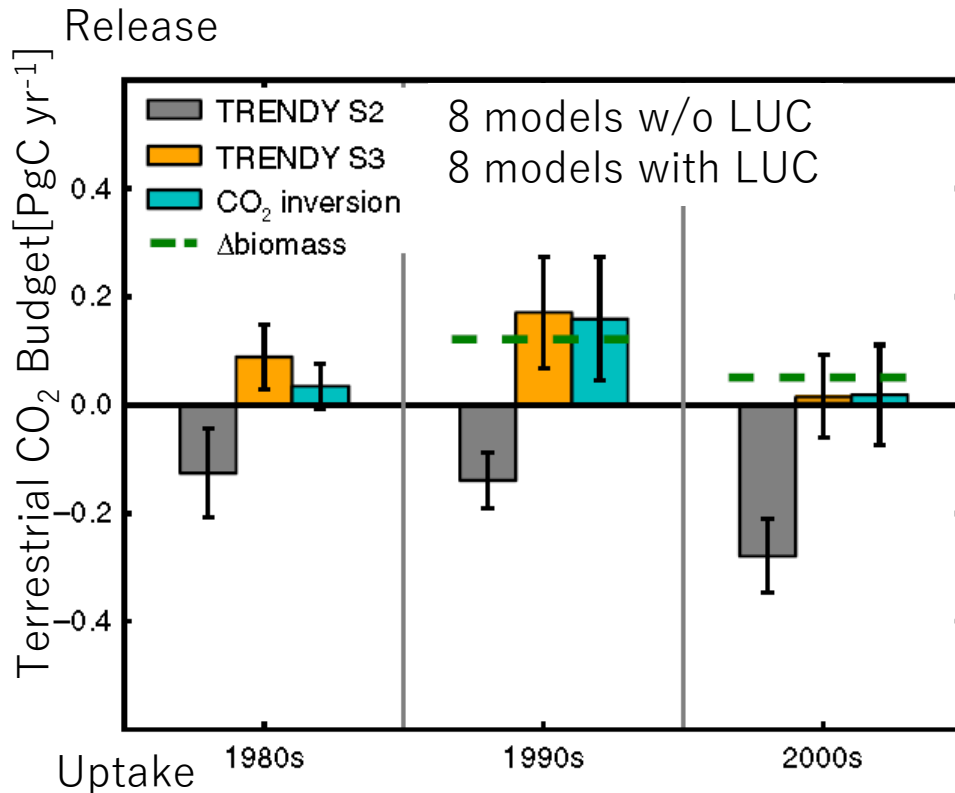
Data-driven CO$_2$ flux estimation (upscaling)

Data-driven estimations (SVR with AsiaFlux)

[8-day, 0.25deg, 2000-2015]

Site Obs (e.g. AsiaFlux)
(Photosynthesis, net CO_2 exchange)
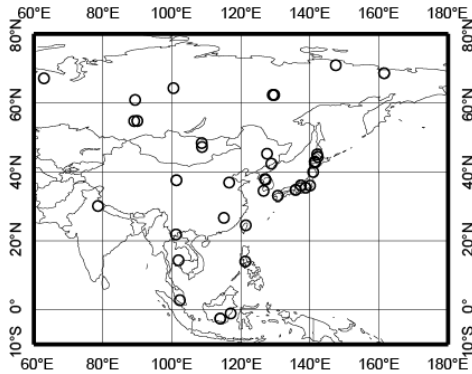
Input variables (RS)
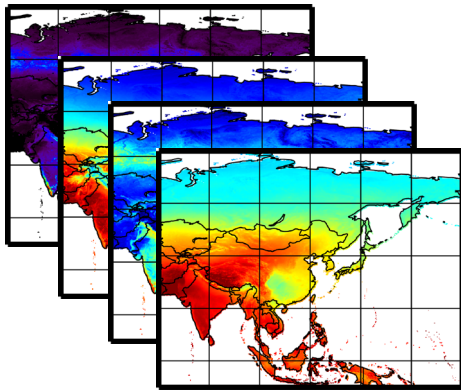
e.g. Vegetation Index, Temperature,
Radiation, Land Cover (based on MODIS)

Data-driven model

Machine-learning
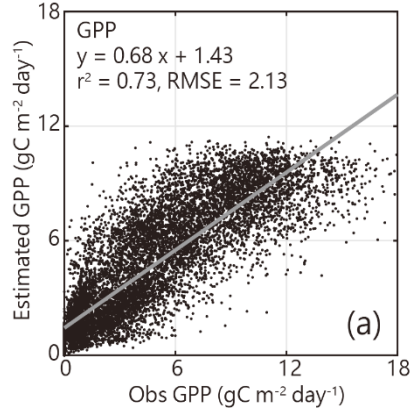(Support Vector Regression; **SVR**)

Site-level test

GPP
y = 0.68 x + 1.43
r² = 0.73, RMSE = 2.13
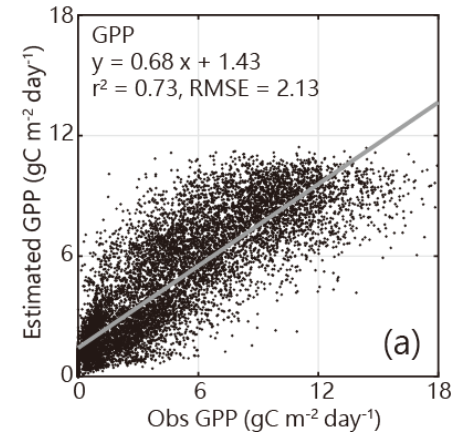
Spatial estimation

GPP (gC m⁻² year⁻¹)
0.0   1.5   3.0
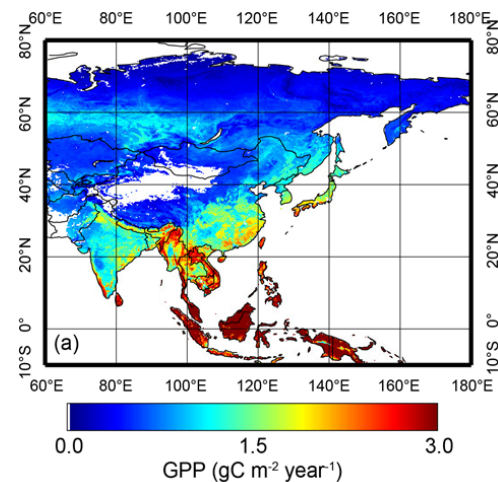
[Ichii et al. 2017; JGR-Biogeosciences]

Some Results

Site-level Evaluation

Gross Primary Productivity (GPP)

GPP
$y = 0.68\,x + 1.43$
$r^2 = 0.73$, RMSE = 2.13

(a)

CO_2 exchange (GPP − Resp)

NEE
$y = 0.40\,x - 0.22$
$r^2 = 0.42$, RMSE = 1.40

(b)

※All sites, 8-days

Spatial Upscaling

GPP

(a)

CO_2 exchange (NEE)

(b)

(2000-2015 mean)

0.0   1.5   3.0   GPP (gC m^{-2} year^{-1})
-0.6   0.0   0.6   NEE (gC m^{-2} year^{-1})
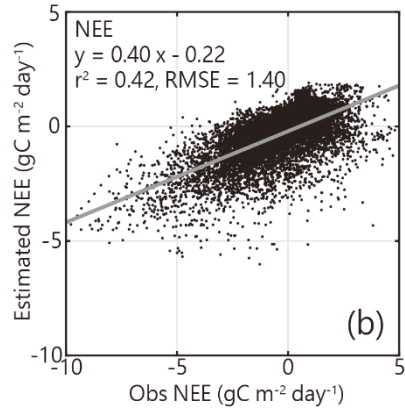
GPP trend (2000-15)
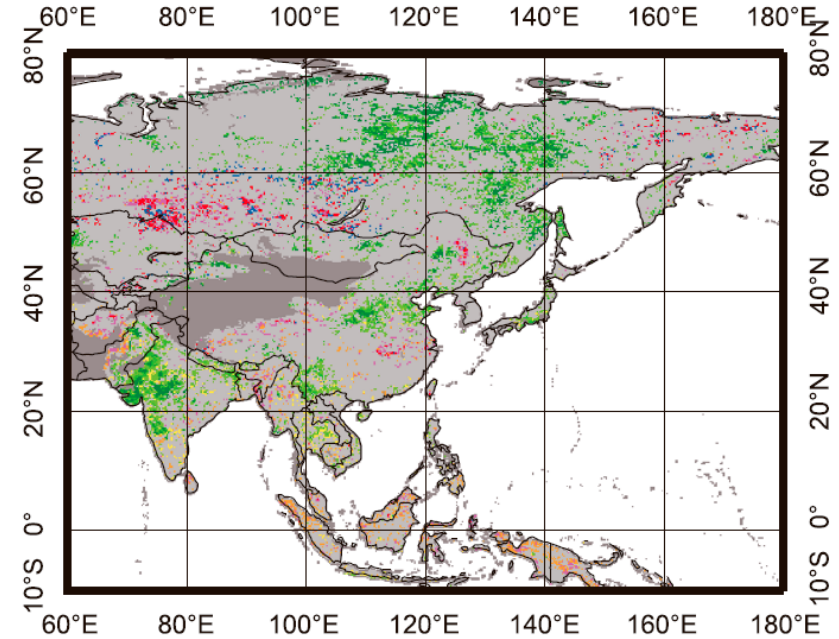
Insignificant Change   Non-Vegetated

-20.0   -10.0   0.0   10.0   20.0
GPP Trend (%)

Kazuhito Ichii[1,2,3], Masahito Ueyama[4], Masayuki Kondo[1,3], Nobuko Saigusa[2], Joon Kim[5,6], Ma. Carmelita Alberto[7], Jonas Ardö[8], Eugénie S. Euskirchen[9], Minseok Kang[6], Takashi Hirano[10], Joanna Joiner[11], Hideki Kobayashi[1], Luca Belelli Marchesini[12,13], Lutz Merbold[14,15], Akira Miyata[16], Taku M. Saitoh[17], Kentaro Takagi[18], Andrej Varlagin[19], M. Syndonia Bret-Harte[9], Kenzo Kitamura[20], Yoshiko Kosugi[21], Ayumi Kotani[22], Kireet Kumar[23], Sheng-Gong Li[24], Takashi Machimura[25], Yojiro Matsuura[26], Yasuko Mizoguchi[27], Takeshi Ohta[22], Sandipan Mukherjee[23], Yuji Yanagi[1], Yukio Yasuda[28], Yiping Zhang[29], and Fenghua Zhao[24]
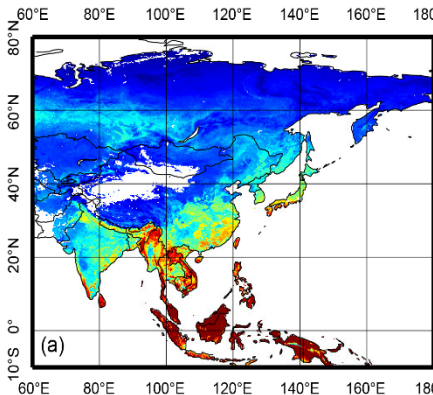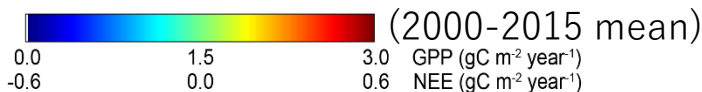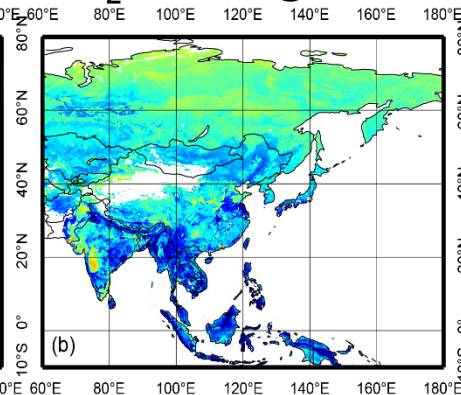
Issues of CO$_2$ flux observation

Asia-Oceania: AsiaFlux, OzFlux

Measuring land-atmosphere fluxes (energy, water, gases)
based on micrometeorological methods (eddy-covariance, chamber etc.)

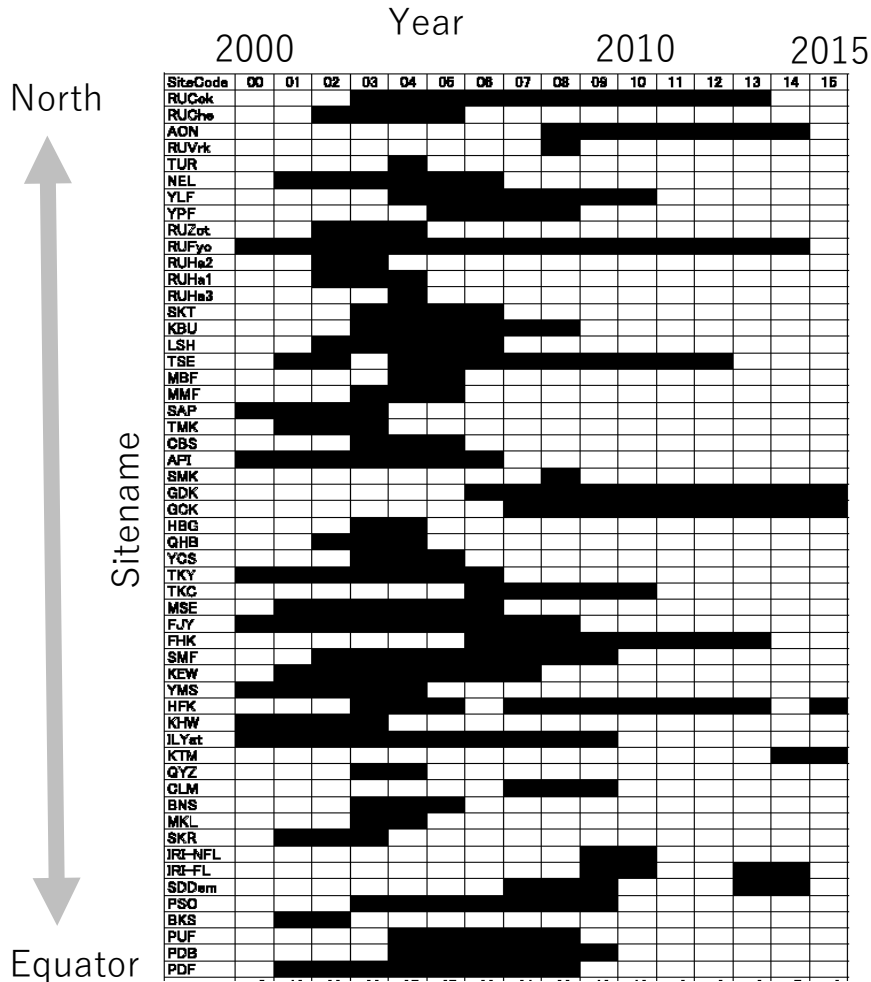[http://asiaflux.net/]
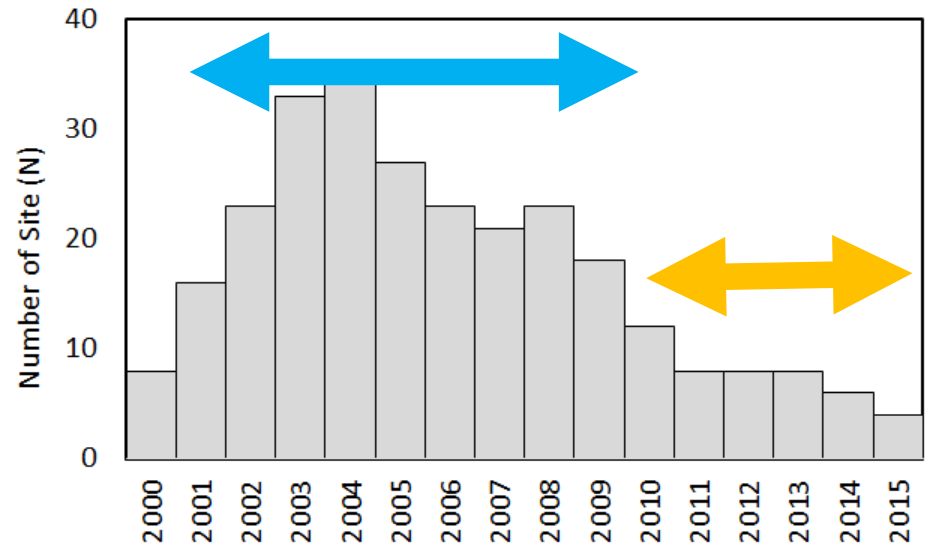

http://www.ozflux.org.au/

36 sites

~40 sites
Regularly updated

AsiaFlux data Availability

（no registered data after 2015…）

(54 sites, 279 site-years)

☑ Less submitted data in recent years

☑ Difficulty: Many countries, policies
　　　　　(no strong obligation for data submission)

☑ Tasks: Promotion of data submission

[Data: Ichii et al. 2017]

OzFlux data Availability

Differences: AsiaFlux, OzFlux

Welcome to AsiaFlux website!
AsiaFlux is a regional research network bringing together scientists from universities and institutions in Asia to study the exchanges of carbon dioxide, water vapor, and energy between terrestrial ecosystems and the atmosphere across daily to inter annual time scales.
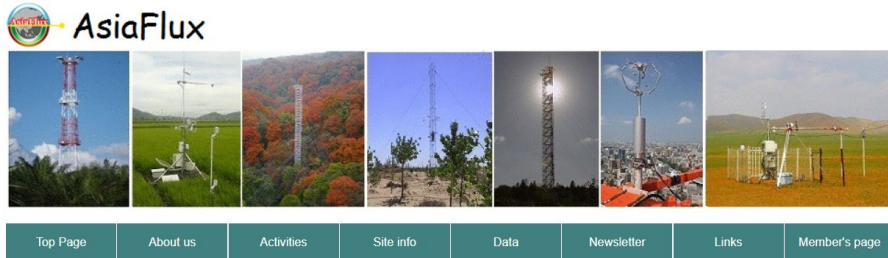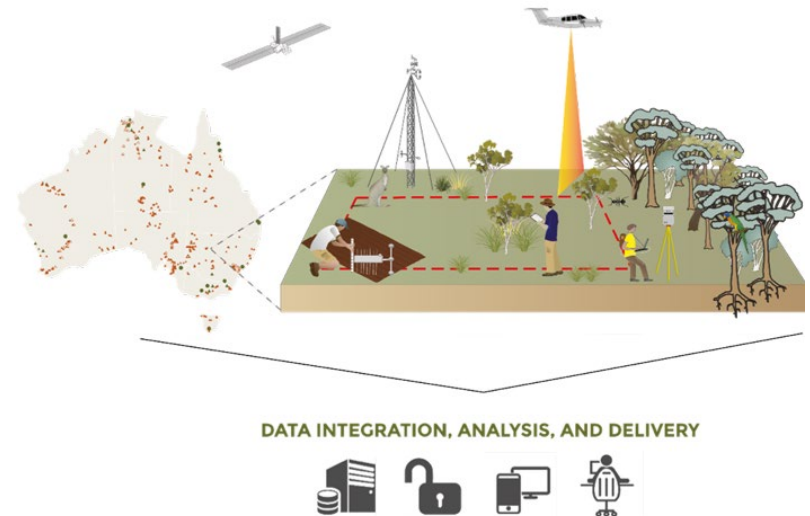
Multiple countries
Small groups, network
Heavy work for data submission
No strong obligation
      for data submission

e.g. JapanFlux

   Decided to use European DB
      framework for data submission
(Students in my group started working)

Terrestrial Ecosystem Research Network
(<u>National Research Infrastructure</u>)

DATA INTEGRATION, ANALYSIS, AND DELIVERY

Data submission REQUIRED

Geostationary Satellite
as a New Opportunity of Earth Observation

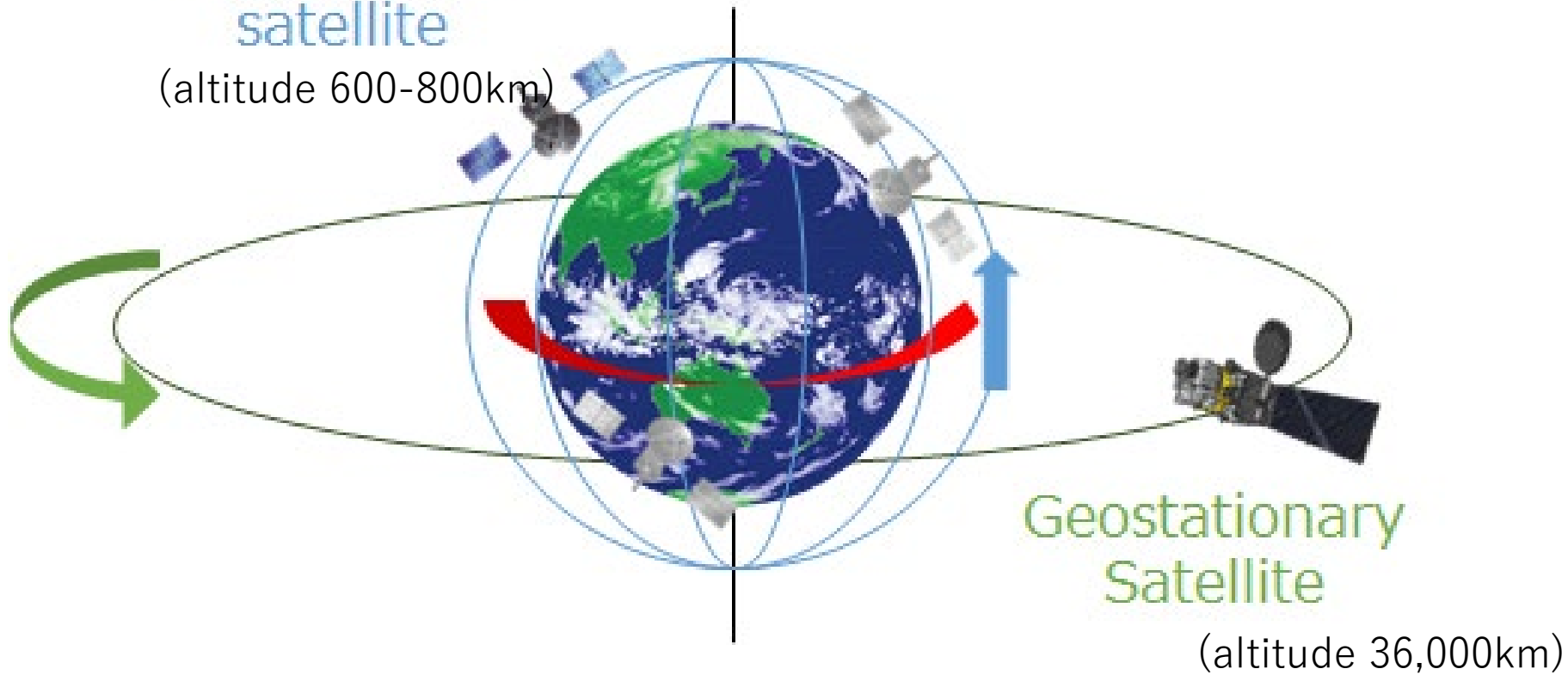# Geostationary vs Polar-orbiting Satellite

[e.g. Himawari-8, FY-4, GK2A]   [e.g. NOAA-series, Terra, Aqua]

○   Global Coverage
△   Less frequent revisiting (e.g. Daily)
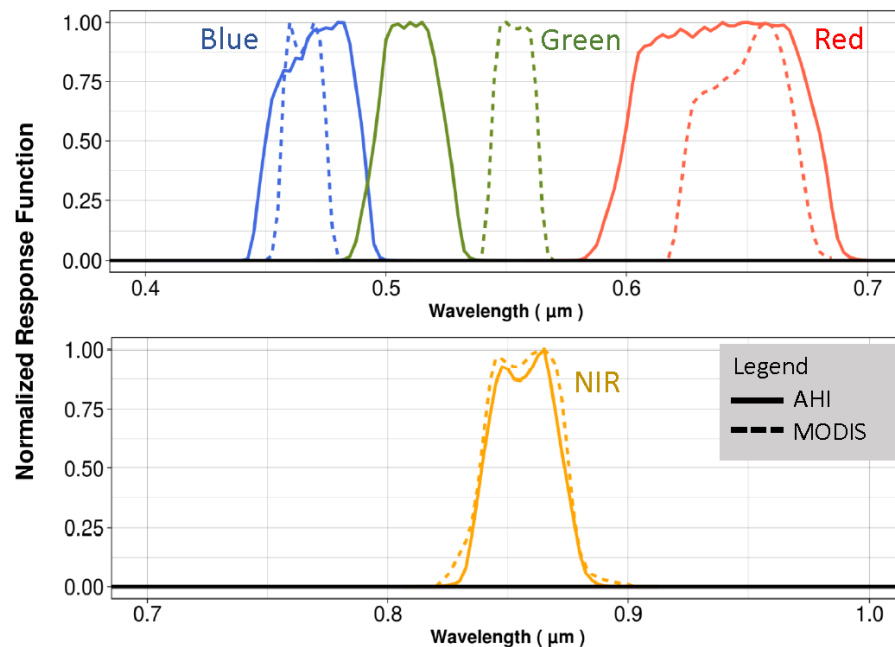
Polar-orbiting satellite
(altitude 600-800km)

Geostationary Satellite
(altitude 36,000km)

×   Fixed Coverage
○   High observation frequency (e.g. 10 min)

Himawari-8 AHI (H8-AHI) specification (2015/07-)

☑ Similar to MODIS VIS-NIR-SWIR wavelength

☑ Very high obs frequency (10 min.)

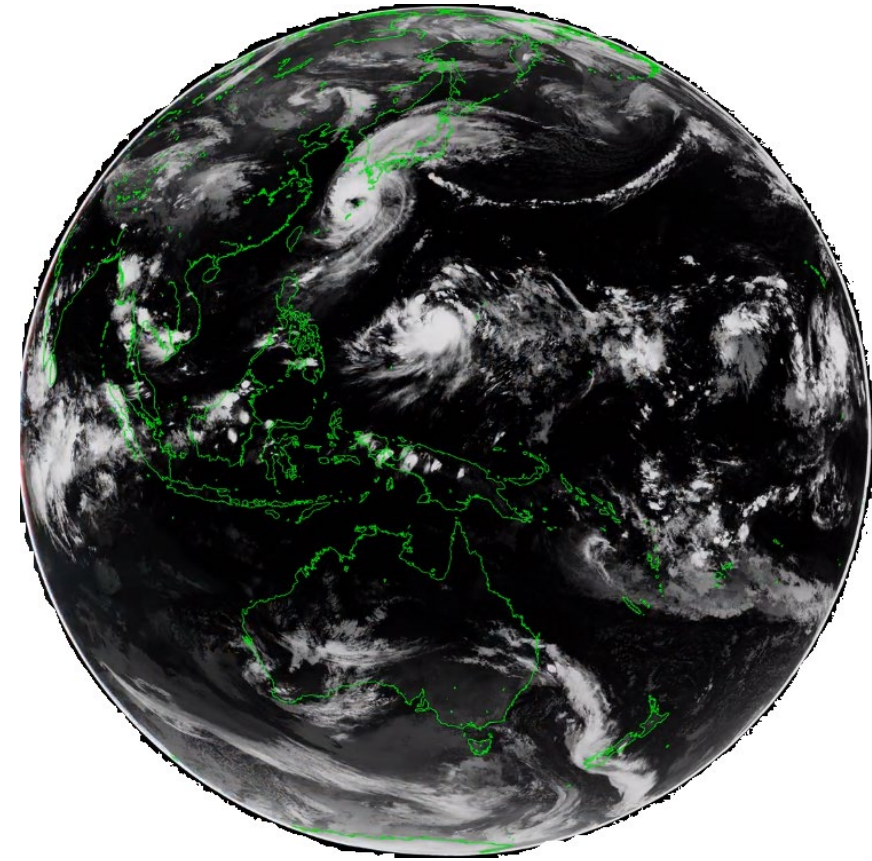☑ Challenge:
Only Top-of-Atmosphere (TOA) reflectance provided

H8AHI vs Himawari-7, MODIS (Terra, Aqua)

|	Himawari-8	Himawari-7	MODIS (Terra, Aqua)
Bands	16bands VIS, NIR, SWIR, MTIR, TIR	5bands VIS-NIR(1), MTIR, TIR	36bands VIS, NIR, SWIR, MTIR, TIR
Spatial Resolution (at Nadir)	0.5 – 2 km	1km, 4km	0.25km, 0.5km, 1km
Temporal Resolution (Obs Frequency)	10min	30min	1day

H8-AHI coverage & available data
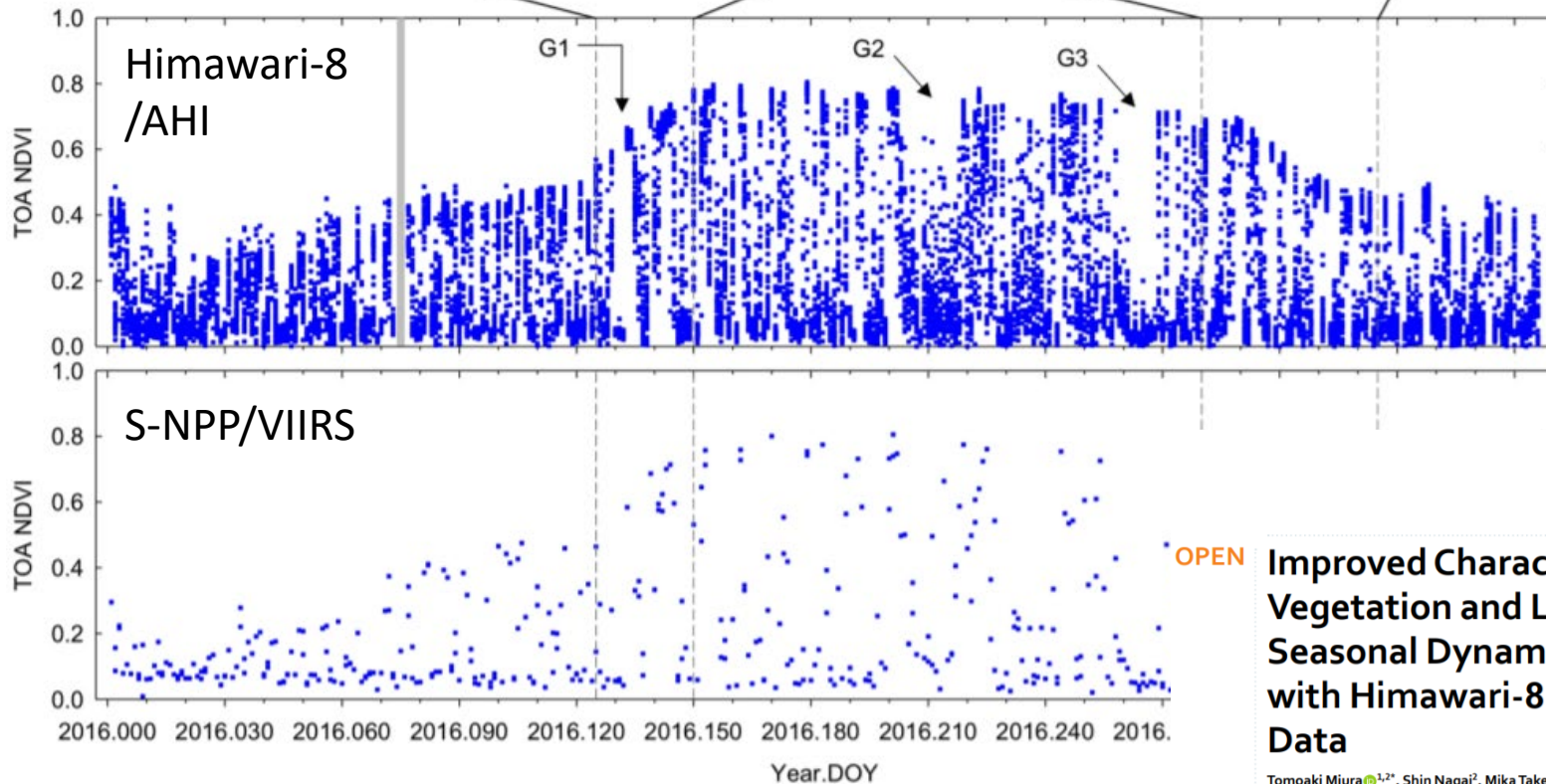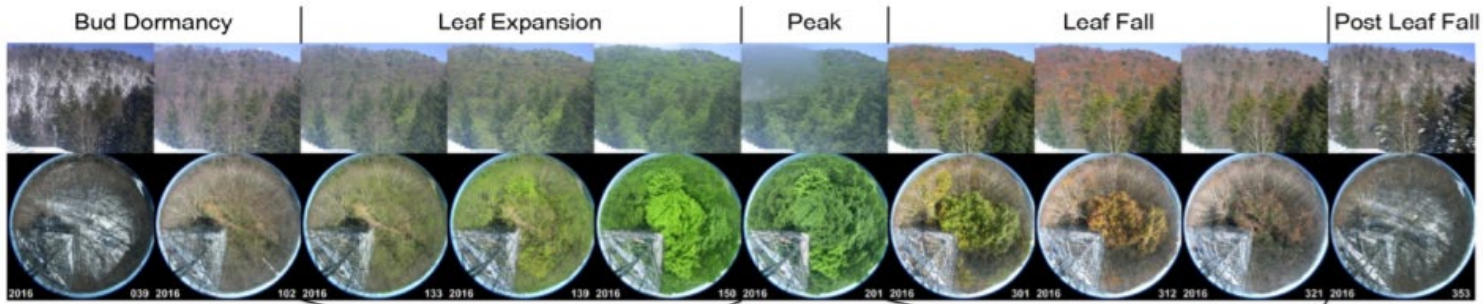
Full-Disk (whole observation area)

Reprojection (Lon-Lat gridded)
Geometrically corrected

Himawari-8 (vis.01) 20160512 0300UTC

[e.g. Japan Meteorological Agency]
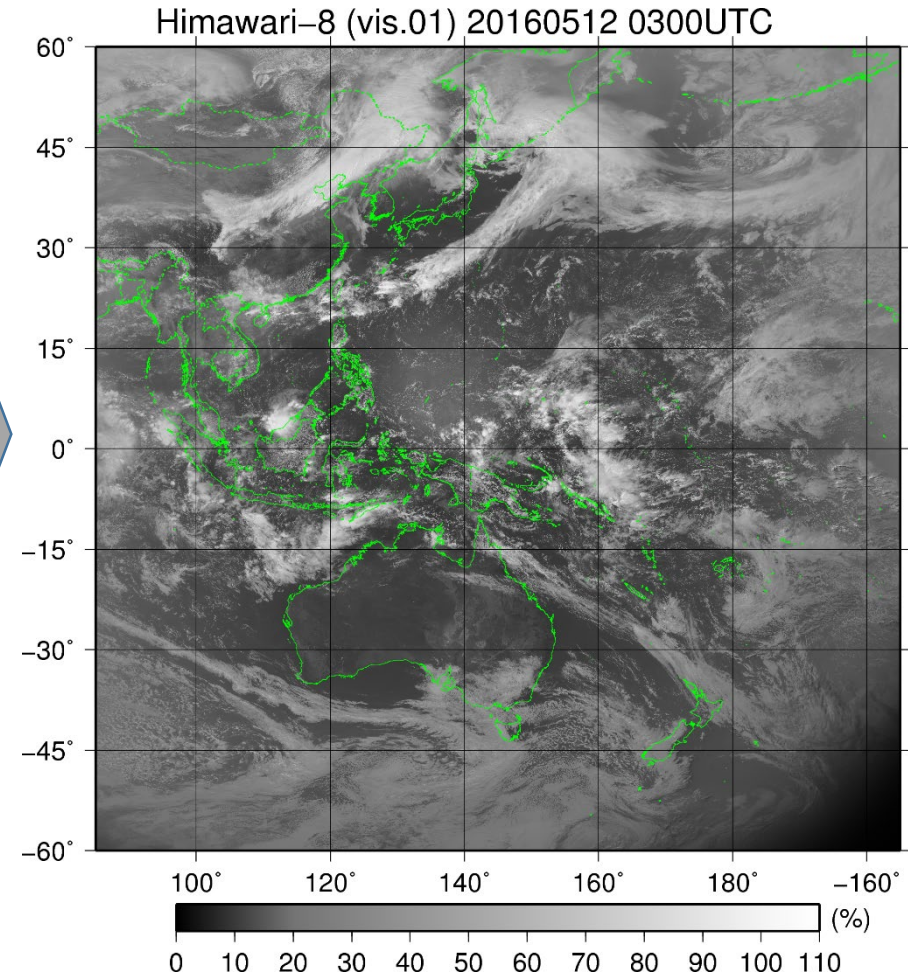
[CEReS, Chiba University]

Himawari-8 vs S-NPP VIIRS in Japan

Takayama (TKY) Supersite, Japan

[Miura et al. 2019]

Issues, Questions

- Hard to validate with observation at present
    (Very few recent datasets in Asia)

- Promoting publicly available dataset

- Experiences in TERN/ICOS etc.

- Experiences in TG-2, Linking TG-2 and TG-3?