GCOM-C PI Meeting of JAXA Earth Observation Missions, FY2021

(RA2 #106)

Algorithm development of Land Surface Phenology (LSP) and Net Primary Production (NPP) products for GCOM-C

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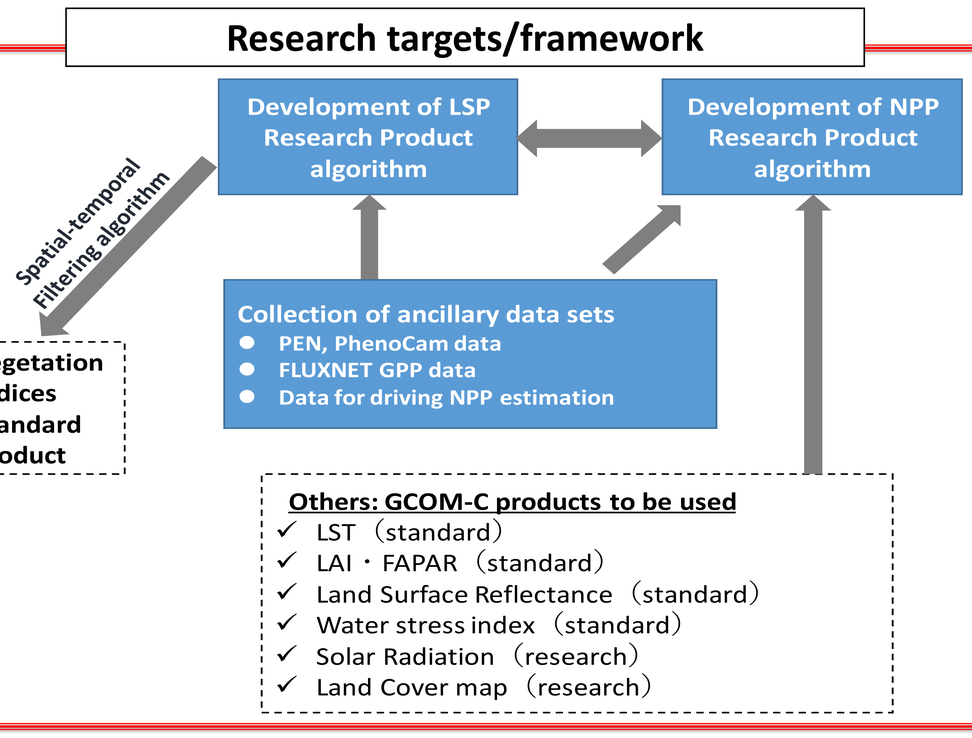
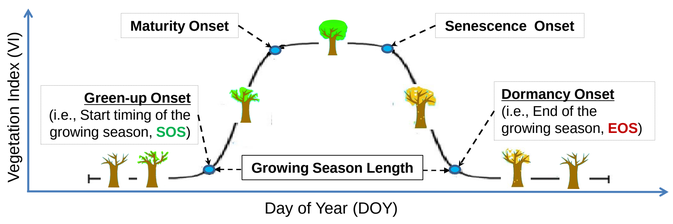
Research targets/framework



❑ LSP Algorithm development

➢ Definition of Phenological Metrics



(1) Greenup onset: the date of onset of VI increase;
(2) Maturity onset: the date of onset of VI maximum;
(3) Senescence onset: the date of onset of VI decrease;
(4) Dormancy onset: the date of onset of VI minimum.

➢ General Flow for Phenology Estimation

Step [1] Computation of Vegetation Index (VI) → Normalized Difference Greenness Index (NDGI)

$$NDGI_{MODIS} = \frac{0.65\times R_{Green} + 0.35\times R_{NIR} - R_{Red}}{0.65\times R_{Green} + 0.35\times R_{NIR} + R_{Red}}$$

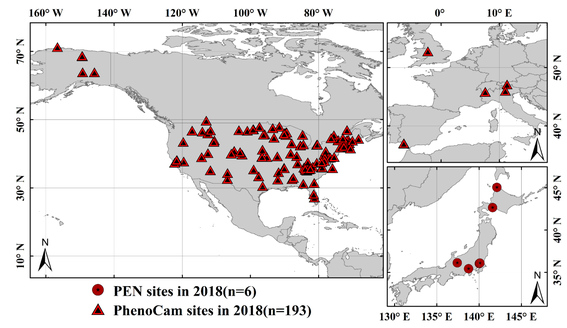
Step [2] Quality Improvement of VI Time Series → Double Logistical Function filter

(Yang et al., 2019, Remote Sens. Environ.)

Step [3] Extraction of Phenological Metrics → NDGI-based Relative Threshold method

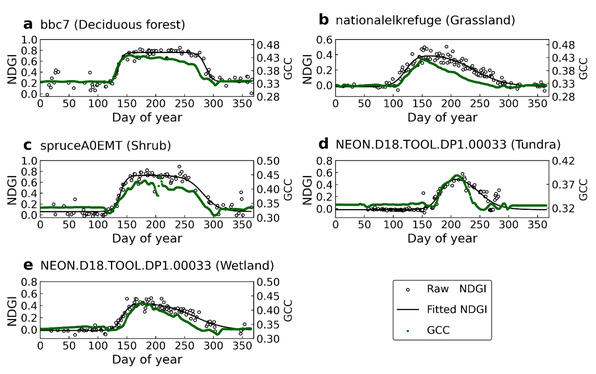
(Wu, Yang et al., 2019, Remote Sens.)

➢ Collection of PhenoCom and PEN data sets



- GCC time series in 2018 was collected and pre-processed.
- Phenological metrics (SOS & EOS) were extracted from the GCC.

➢ Time series comparison of NDGI and GCC

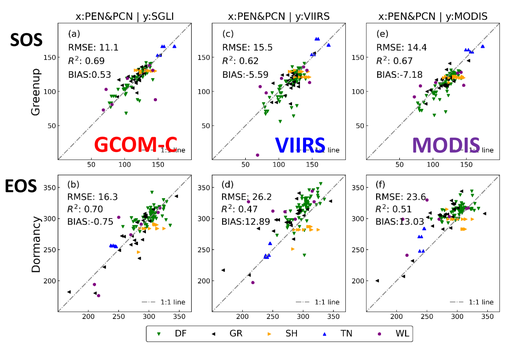


- Better agreements in spring than in autumn.

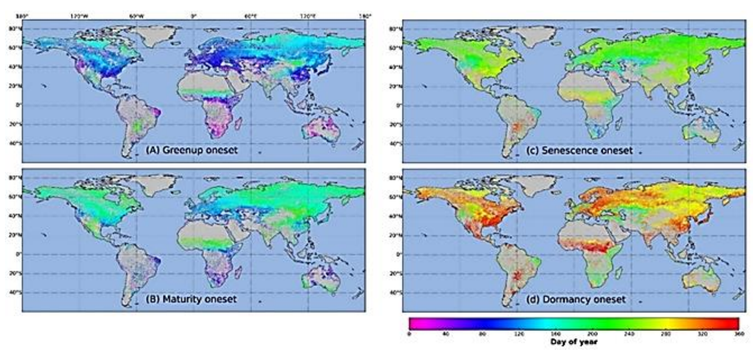
➢ GCOM-C LSP algorithm and product

- Thresholds of 20% and 45% were determined for SOS and EOS, respectively.

Phase	Thresholding	RMSE	Bias	R2	Phase	Thresholding	RMSE	Bias	R2
	10	13.8	-5.53	0.63		10	38.5	32.37	0.55
	15	11.8	-2.03	0.67		15	31	24.69	0.61
	20	**11.1**	**0.53**	**0.69**		20	25.8	18.93	0.65
SOS	25	11	2.6	0.71	EOS	25	22	14.15	0.68
(Greenup	30	11.3	4.52	0.72	(Dormancy	30	19.1	10	0.69
onset)	35	11.9	6.17	0.73	onset)	35	17.2	6.13	0.7
	40	12.7	7.74	0.73		40	16.4	2.67	0.7
	45	13.7	9.34	0.74		**45**	**16.3**	**-0.75**	**0.7**
	50	14.8	10.81	0.74		50	17	-4.04	0.69



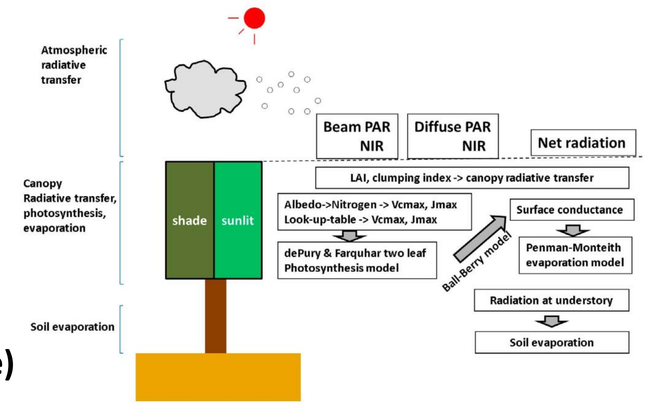
- Better accuracies have been achieved, especially for EOS (Dormancy onset).



❑ GPP/NPP Algorithm development

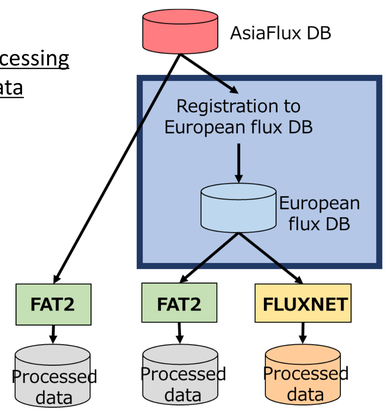
➢ Algorithm: BESS (Breathing Earth System Simulator) [Ryu et al. 2011]

- RS data-driven
- Fast Computation （⇔ BEAMS, CASA）
- Mechanistic algorithm （⇔ MODIS-GPP/NPP; simple LUE）
- Outputs: Daily ET, GPP etc. （no respiration module）



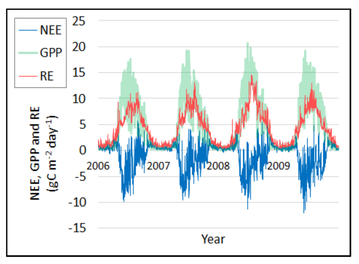
➢ Collecting JapanFlux Data (and Update)

Pre-processing of EC data



Collecting eddy-covariance data (from JapanFlux) and other networks

☑ YR2018 to present (no open DB for Asia)
☑ Require Consistent pre-processing

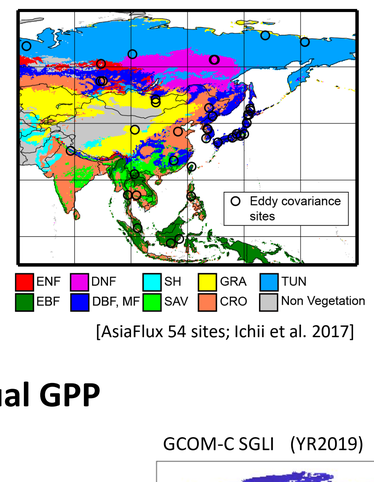


Example: FHK (富士北麓) (2006-2009)

➢ Further Improvement

1. Model parameter optimization

Parameter Refinement & Run the model



[AsiaFlux 54 sites; Ichii et al. 2017]

2. Respiration Module (respiration & C budget)

$$R_{ECO} = \underbrace{\left(R_{LAI=0} + a_{LAI}\times LAI_{MAX} + k_2 GPP\right)}_{R_0} \times e^{E_0\left(\frac{1}{T_{ref}-T_0}-\frac{1}{T_A-T_0}\right)} \times \frac{\alpha k + P(1-\alpha)}{k + P(1-\alpha)}$$

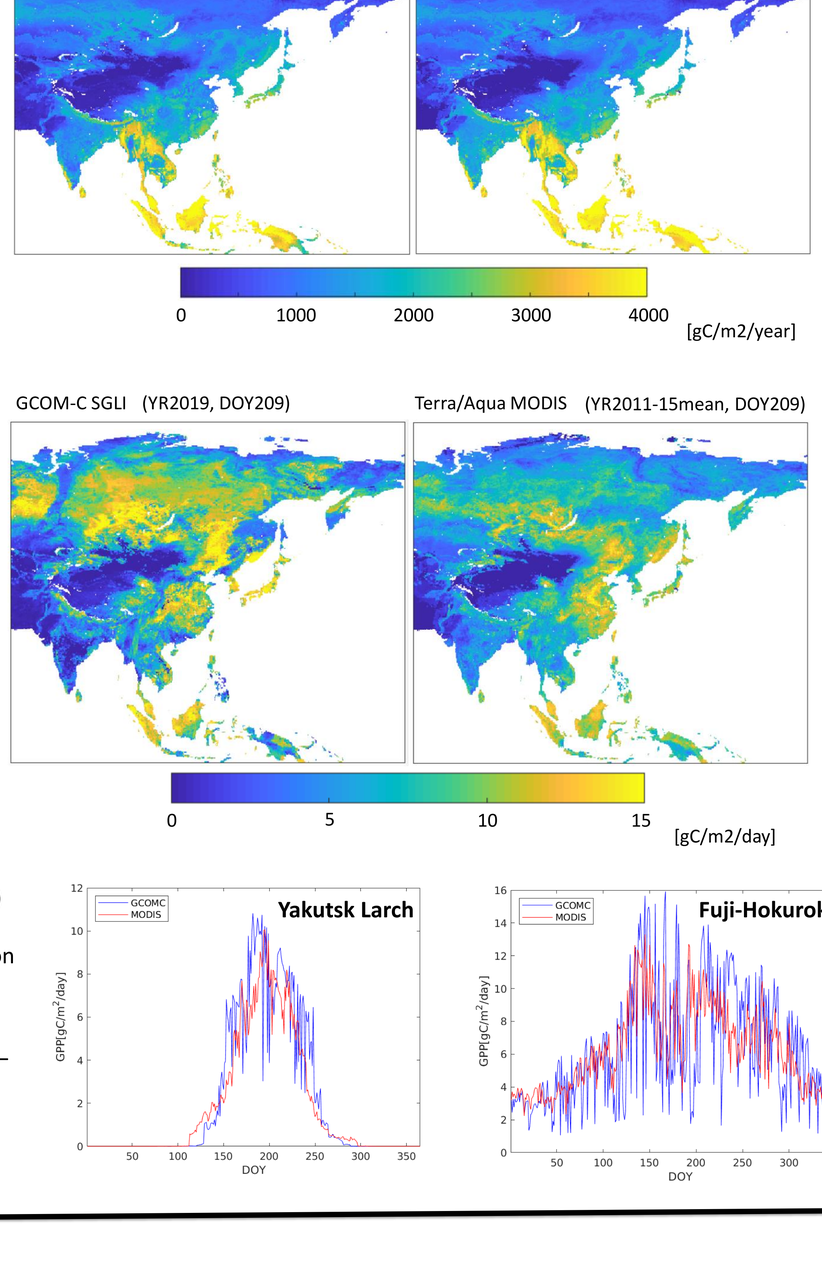
R_0: Base Respiration Rate; $e^{E_0(\cdots)}$: Temperature Effect; $\frac{\alpha k + P(1-\alpha)}{k + P(1-\alpha)}$: Moisture Effect (P: Precip)

[Migliavacca et al. 2011]

Apply a simple model with parameter optimization

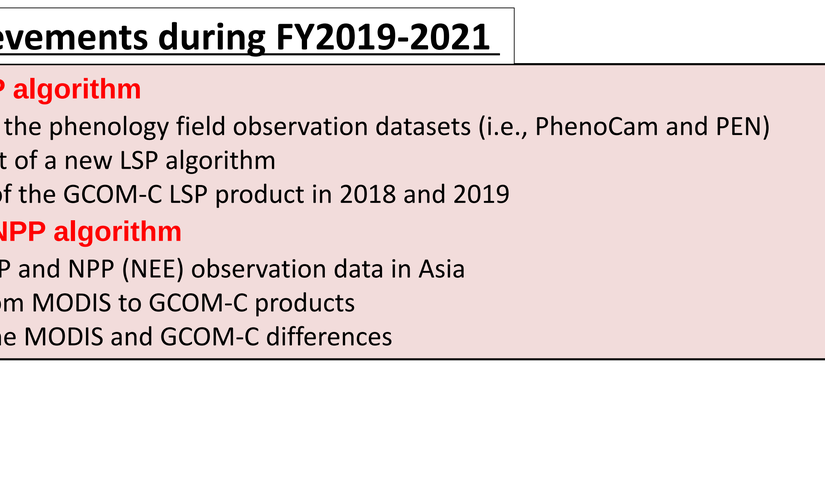
➢ Estimated annual GPP

GCOM-C SGLI: Input ➔ LAI/FPAR and LST (Level 3 data)
Others ➔ MODIS and JRA-Reanalysis



➢ Estimated 8-day GPP

GCOM-C SGLI: Input ➔ LAI/FPAR and LST (Level 3 data)
Others ➔ MODIS and JRA-Reanalysis



➢ Seasonal Variation

MODIS YR2011-15 mean
GCOM YR2019 (LAI and LST from GCOM-C)

Model Parameters are based on optimization with MODIS-ver and Observation

Potential Causes: Differences of (1) MODIS – GCOM, (2) coverage years, (3) QA/QC methods etc…

Overall achievements during FY2019-2021

- **GCOM-C LSP algorithm**
  1. Collection of the phenology field observation datasets (i.e., PhenoCam and PEN)
  2. Development of a new LSP algorithm
  3. Generation of the GCOM-C LSP product in 2018 and 2019
- **Global GPP/NPP algorithm**
  1. Prepared GPP and NPP (NEE) observation data in Asia
  2. Switching from MODIS to GCOM-C products
  3. Compared the MODIS and GCOM-C differences