

Mapping paddy rice fields and cropping intensity using google earth engine

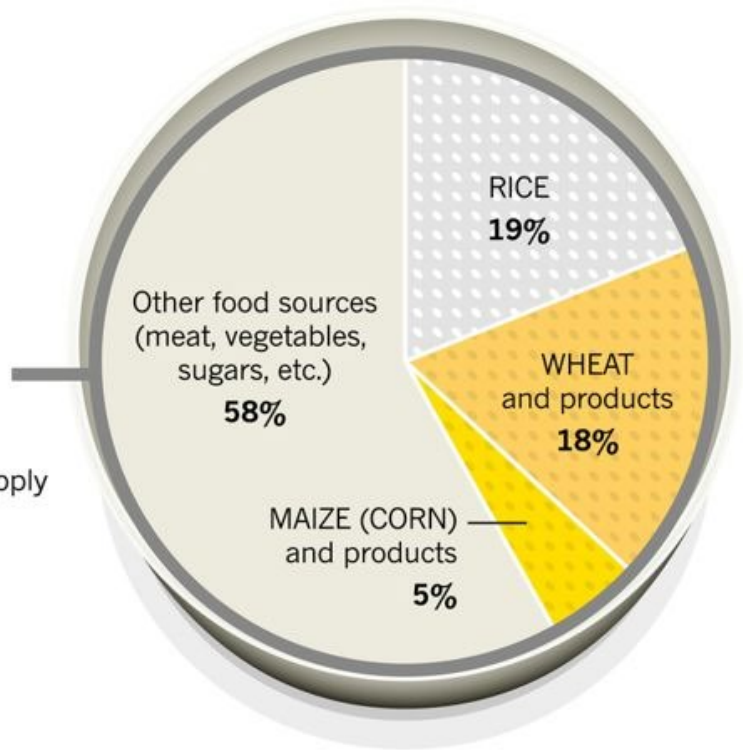
Miao Zhang, Xin Zhang, Bingfang Wu, Hongwei Zeng, Fuyou Tian, Chong Liu
Aerospace Information Research Institute,
Chinese Academy of Sciences

July 23rd 2019

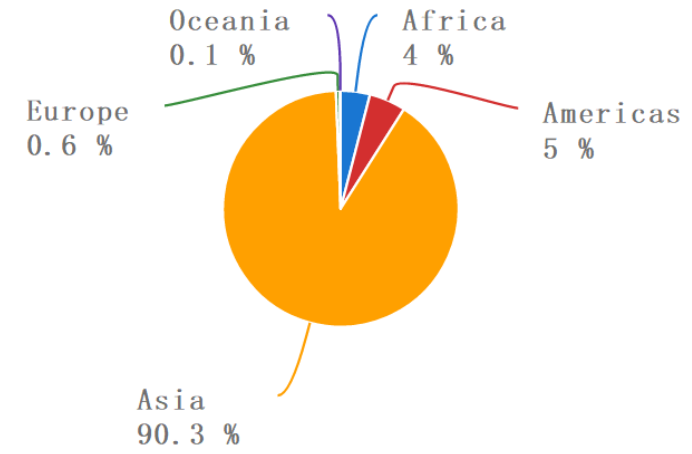


2,868 kcal

42% of our daily energy supply comes from cereal crops (rice, wheat and maize).



Elert, E., 2014. Nature



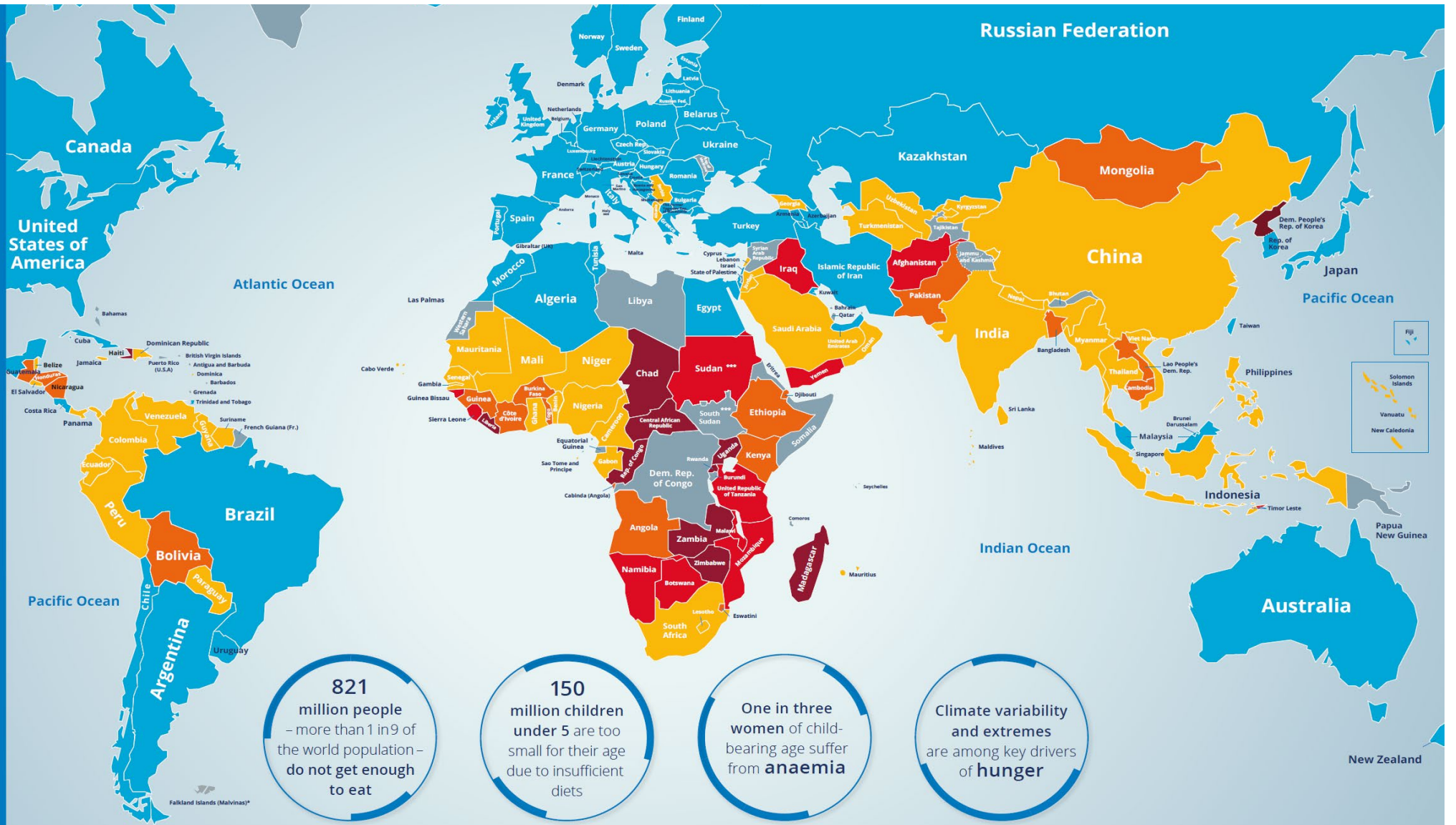
- Africa
- Americas
- Asia
- Europe
- Oceania

Source: FAOSTAT (July 2019)

Rice as a staple food

SAVING LIVES
CHANGING LIVES

Hunger Map 2018



821 million people – more than 1 in 9 of the world population – do not get enough to eat

150 million children under 5 are too small for their age due to insufficient diets

One in three women of child-bearing age suffer from **anaemia**

Climate variability and extremes are among key drivers of **hunger**



World Food Programme

PREVALENCE OF UNDERNOURISHMENT IN THE TOTAL POPULATION (PERCENT) IN 2015-17



Very low



Moderately low



Moderately high



High



Very high



Missing or insufficient data

Undernourishment is defined as the condition in which an individual's habitual food consumption is insufficient to provide the amount of dietary energy required to maintain a normal, active, healthy life. The indicator is reported as the prevalence of undernourishment (PoU), which is an estimate of the percentage of individuals in the total population that are in a condition of undernourishment. To reduce the influence of possible estimation errors in some of the underlying parameters, national estimates are reported as a three-year moving average.
Source: FAO, IFAD, UNICEF, WFP and WHO, 2018. The State of Food Security and Nutrition in the World 2018. Building climate resilience for food security and nutrition. Rome, FAO.
Further information is available at www.wfp.org/concern/2018-state-food-security-and-nutrition-world-sofi-report

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The designations employed and the presentation of material in this map does not imply the expression of any opinion whatsoever on the part of WFP concerning the legal or constitutional status of any country, territory or sea area, or concerning the delimitation of frontiers.

* A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Malvinas).

** Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties.

*** Final boundary between the Republic of Sudan and the Republic of South Sudan has not yet been determined.



Difficulties in data acquisition: frequent cloud cover over rice growing regions



Rice calendar is dynamic and might be same as other summer crops



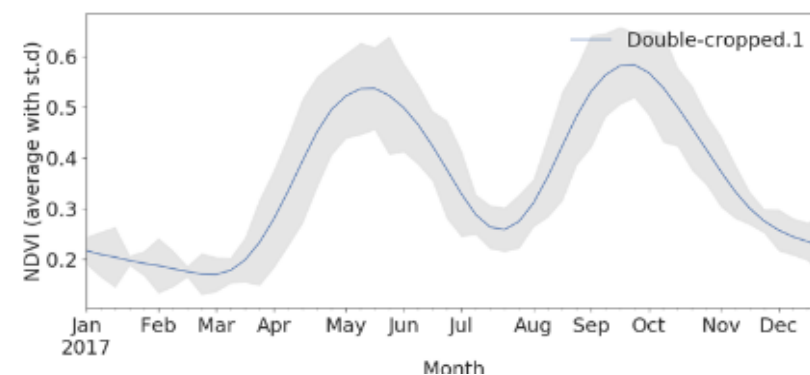
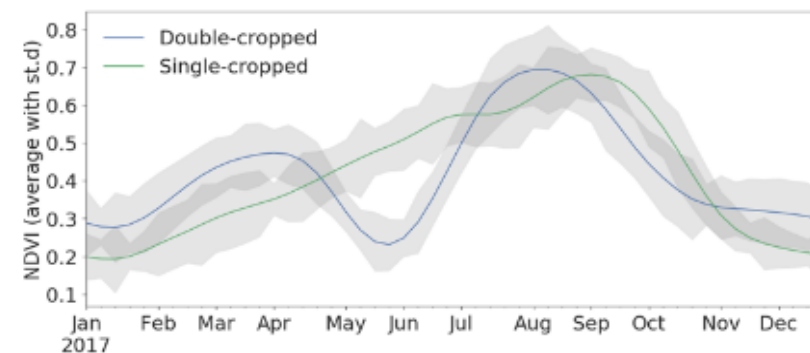
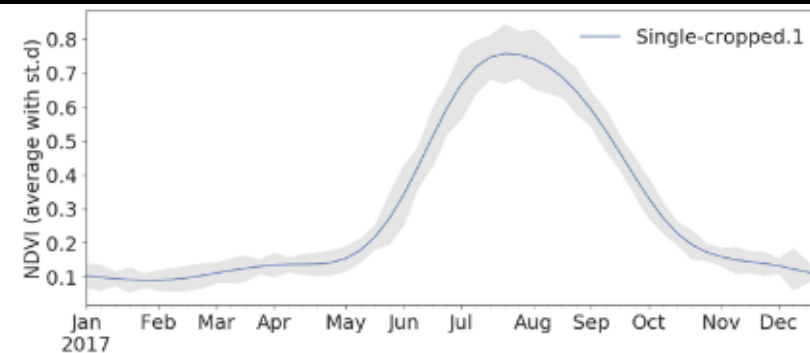
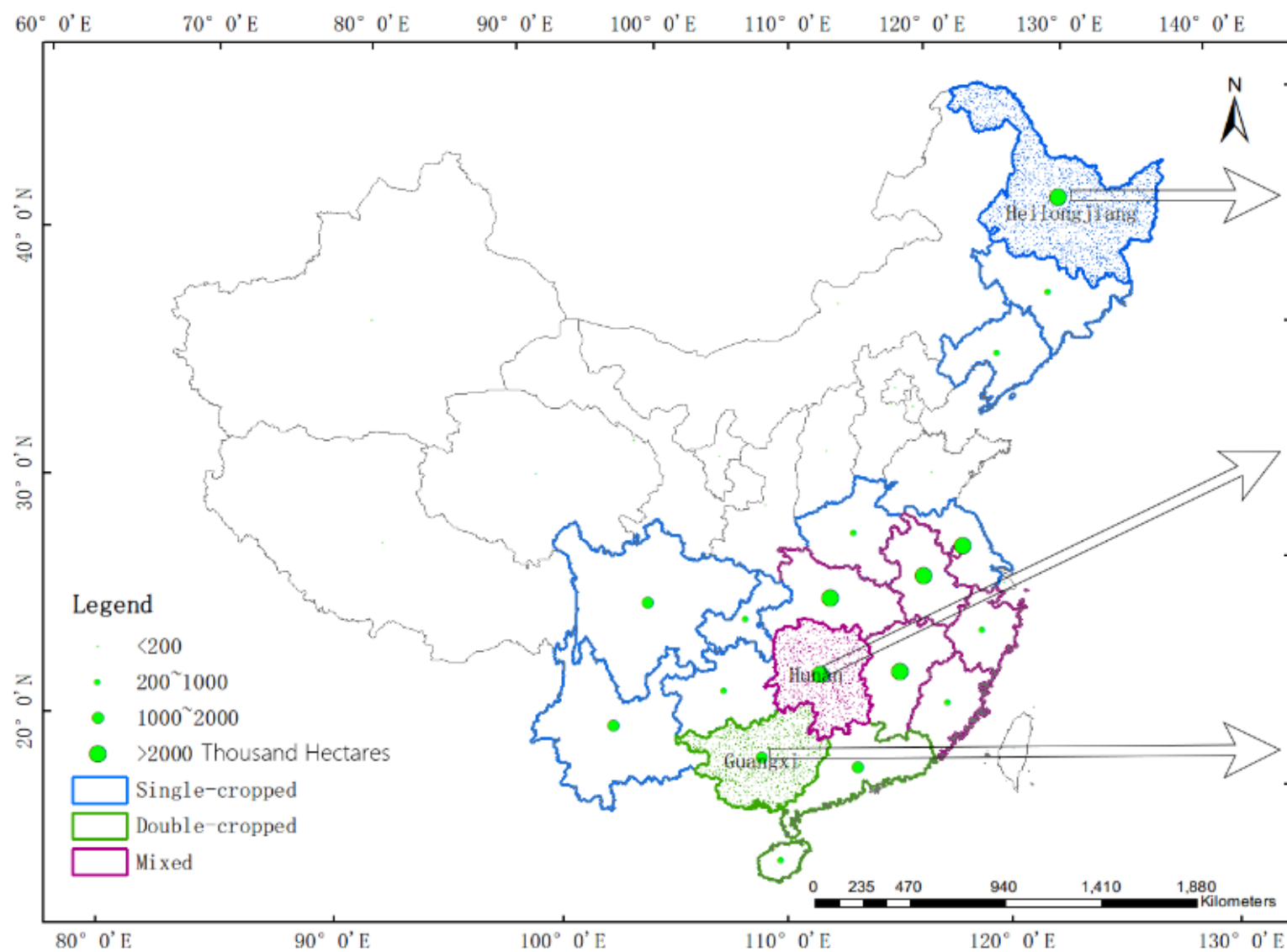
Inhomogeneity and fragmented rice fields



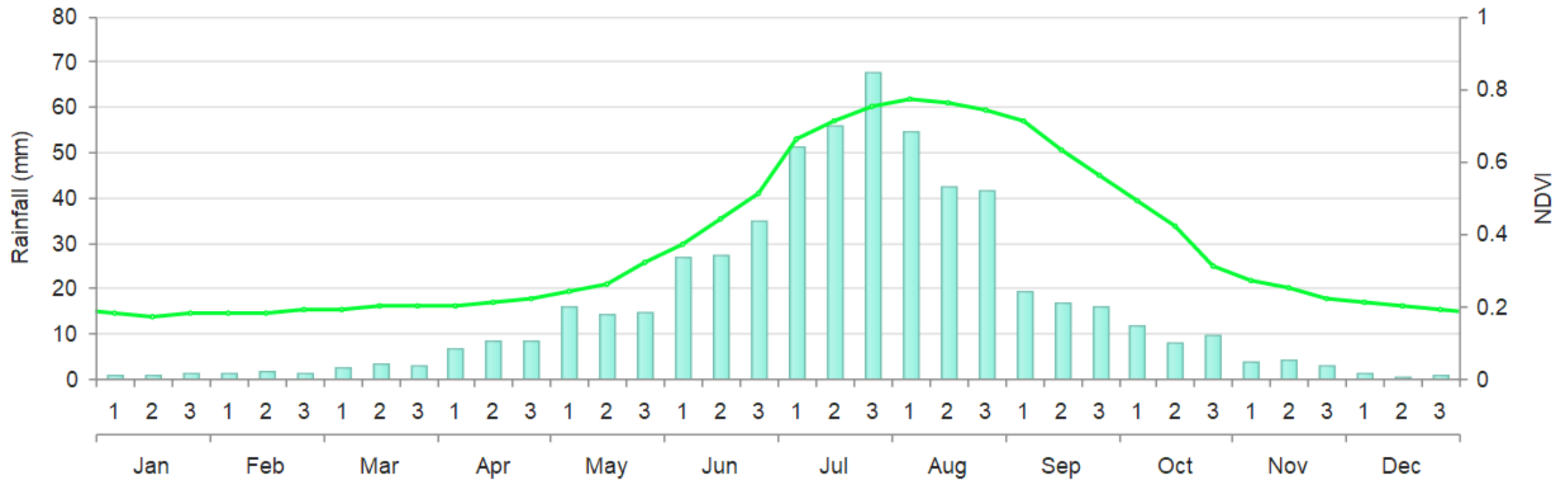
Rice is commonly cultivated in many countries in Asia

Challenges

Major rice producing provinces

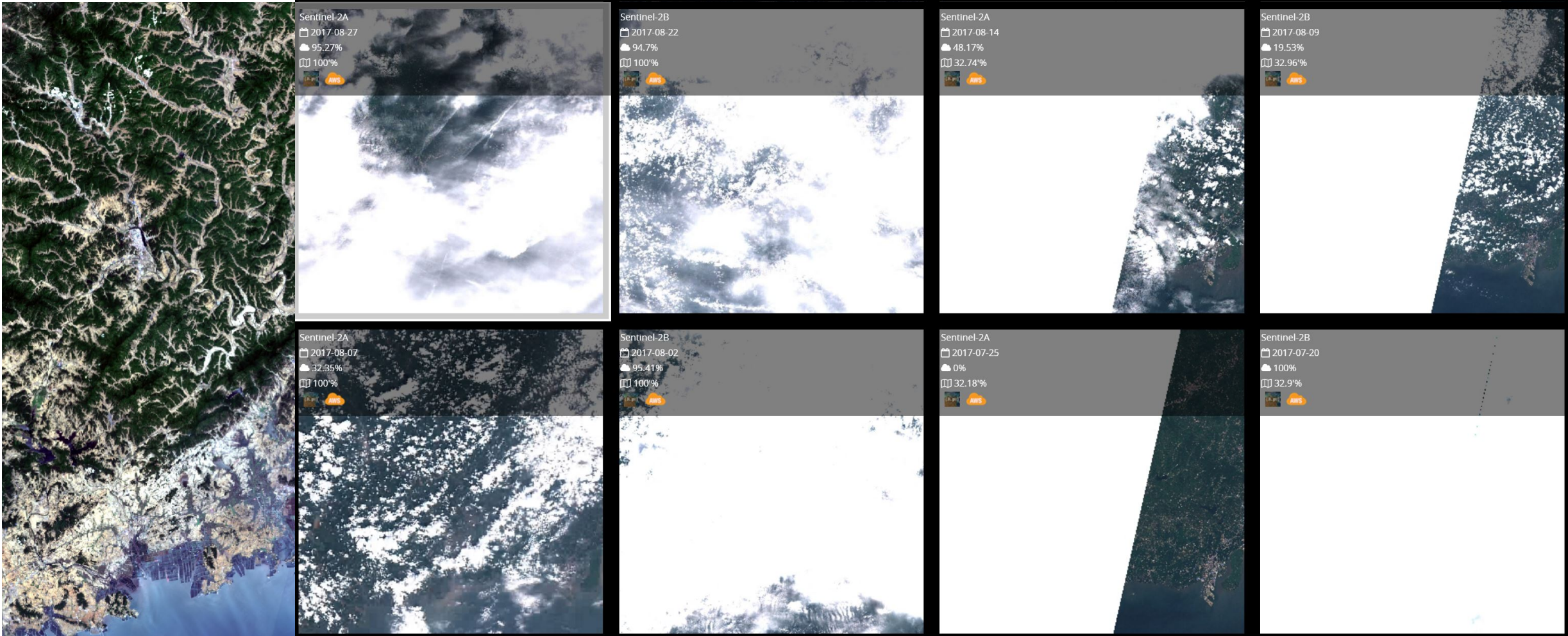


Rice growing season and rainy season



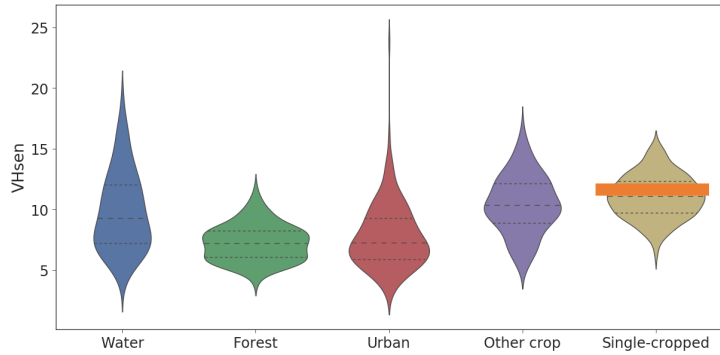
Availability of optical data

June 8, 2017

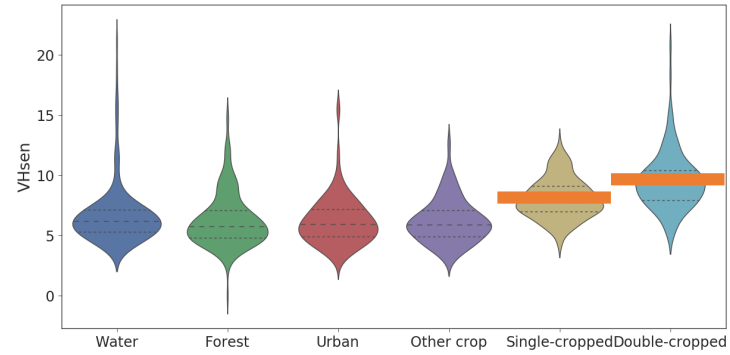


Source <https://remotepixel.ca/>

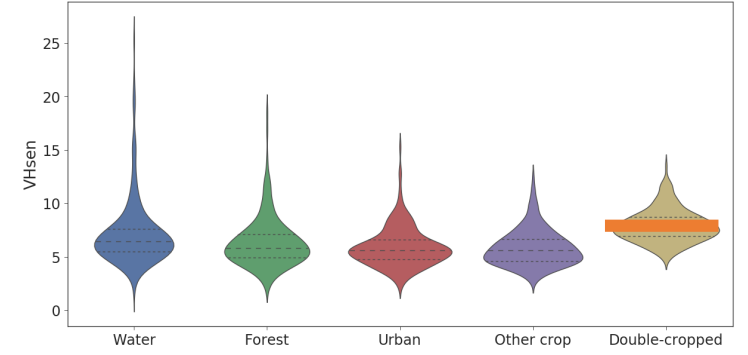
Heilongjiang



Hunan



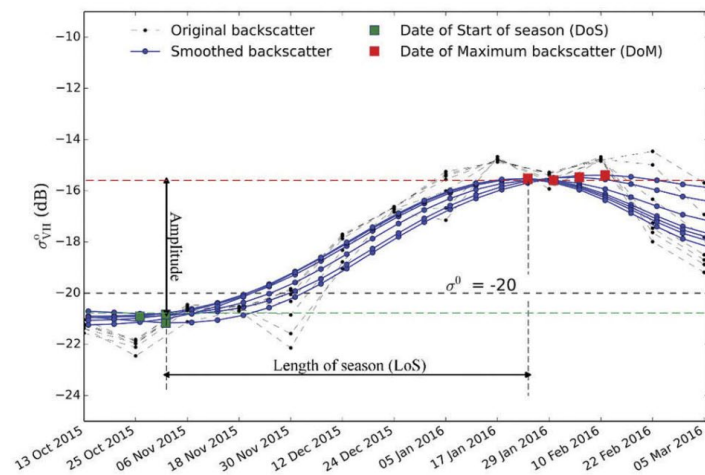
Guangxi



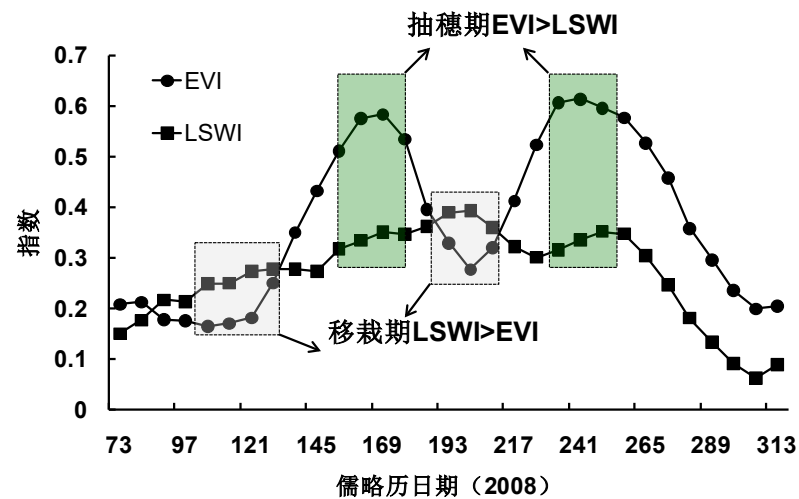
Feature of rice field using Sar

- Calendar of rice is similar to maize, soybean and other summer crops; Crop spectral feature is also similar
- But rice field is unique during planting period (covered by water); SAR data is sensitive to water body, water content, etc

Key points

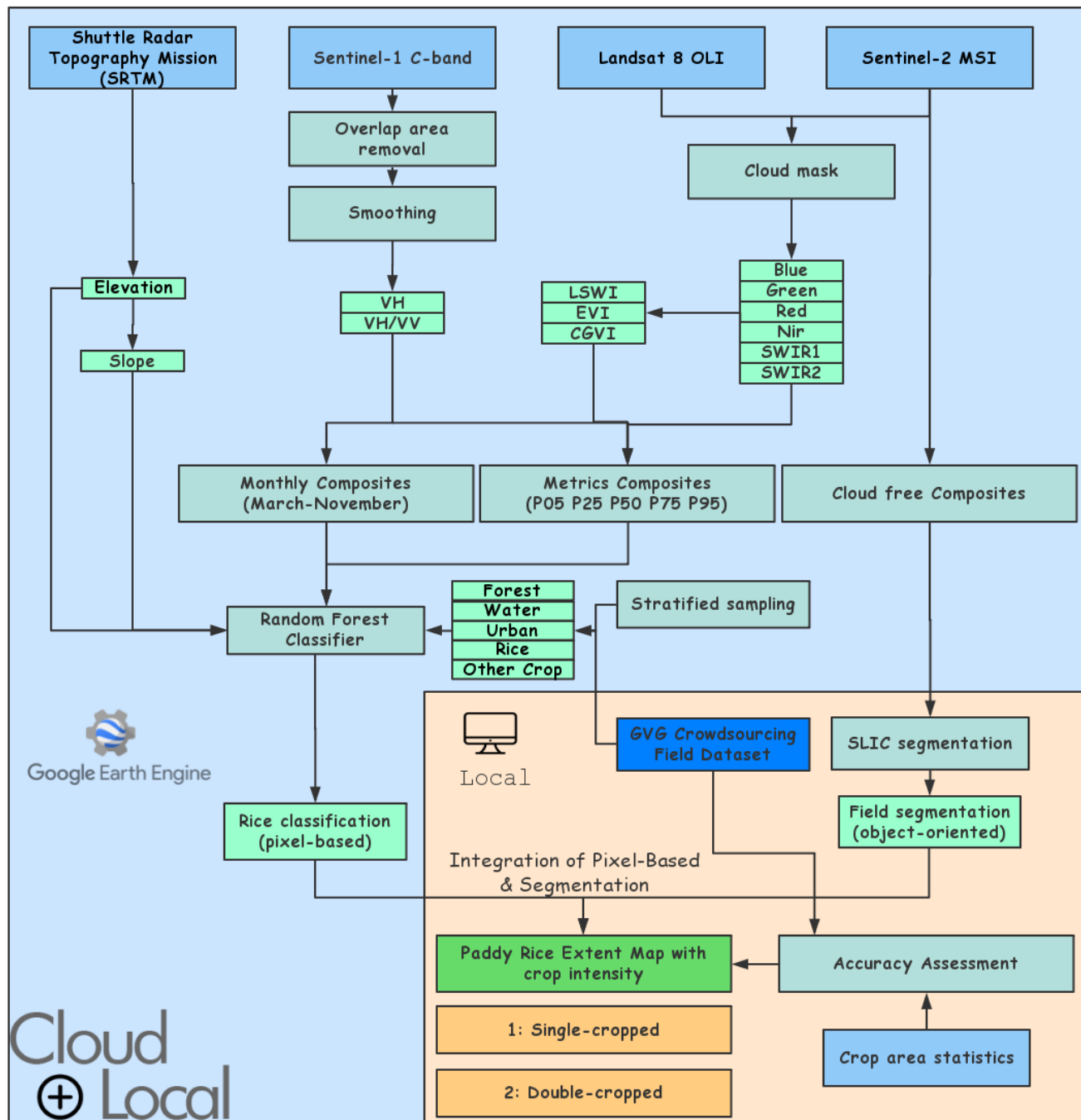


Rice phenological parameters and empirical threshold derivation for rice classification.
Nelson, A., et al., 2014. Land Applications of Radar Remote Sensing.



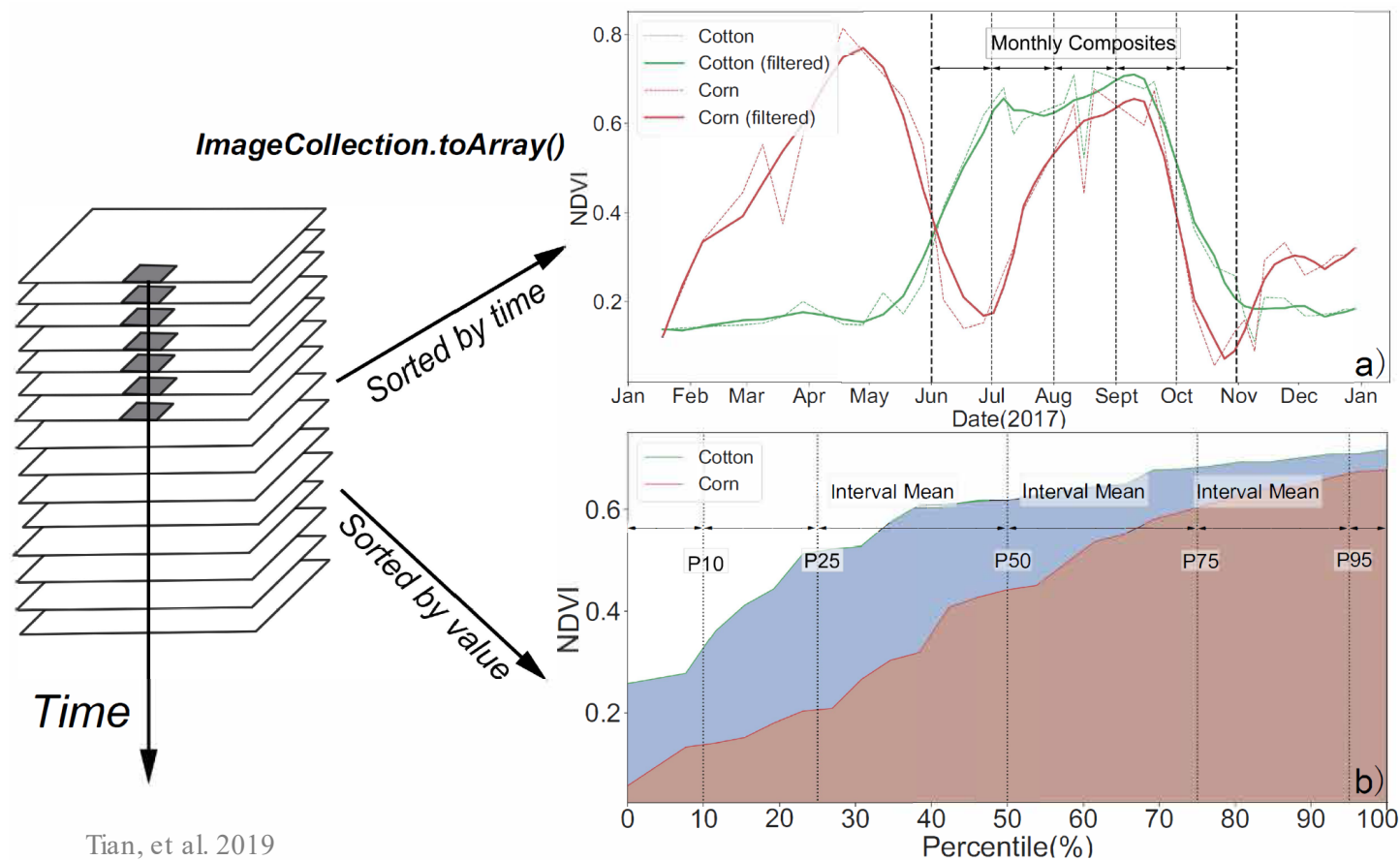
Huang., et al., 2013.

Methodology



Data composition

- Monthly composite
- Percentile composite



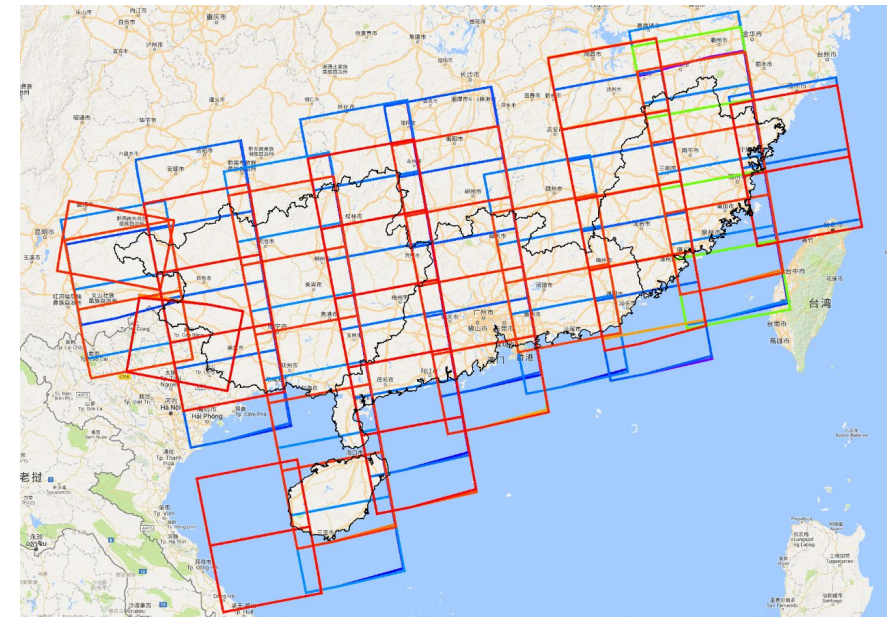
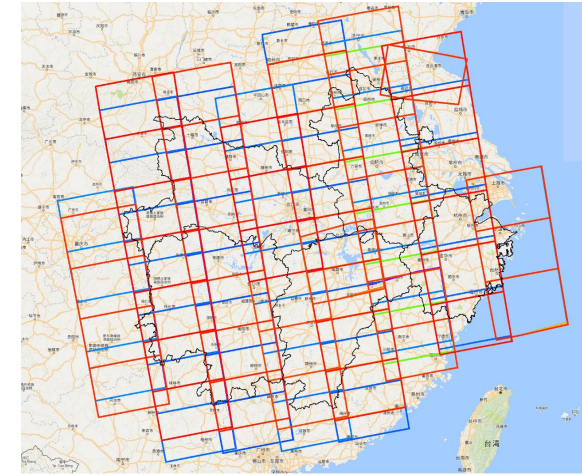
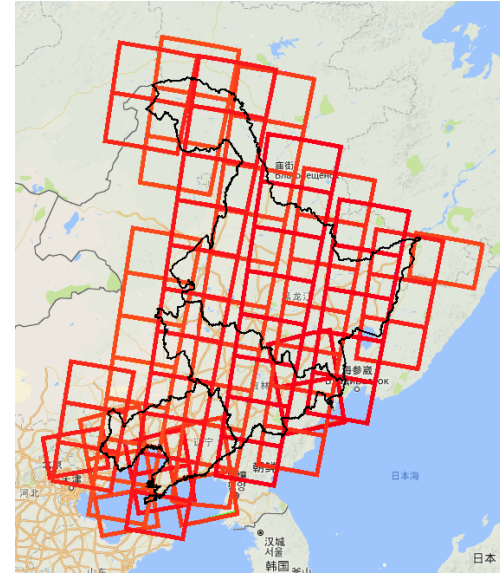
Data sources

Sensors	Band	Use	Wavelength	Res	Provider
Sentinel-2 MSI	B2	Blue	490 μm	10m	ESA
	B3	Green	560 μm	10m	
	B4	Red	665 μm	10m	
	B8	Near Infrared	842 μm	10m	
	B11	Short-wave Infrared 1	1610 μm	20m	
	B12	Short-wave infrared 2	2190 μm	20m	
Landsat 8 OLI	B2	Blue	0.45 - 0.51 μm	30m	USGS
	B3	Green	0.53 - 0.59 μm	30m	
	B4	Red	0.64 - 0.67 μm	30m	
	B5	Near Infrared	0.85 - 0.88 μm	30m	
	B6	Short-wave Infrared 1	1.57 - 1.65 μm	30m	
	B7	Short-wave infrared 2	2.11 - 2.29 μm	30m	
	Sentinel-1 C	VV	dual-band cross-polarization, vertical		
VH		transmit/horizontal receive		10m	
SRTM	Elevation			30m	NASA/USGS
Landsat	Hansen Global Forest Change			30m	GEE
Landsat	JRC Global Surface Water Mapping			30m	GEE

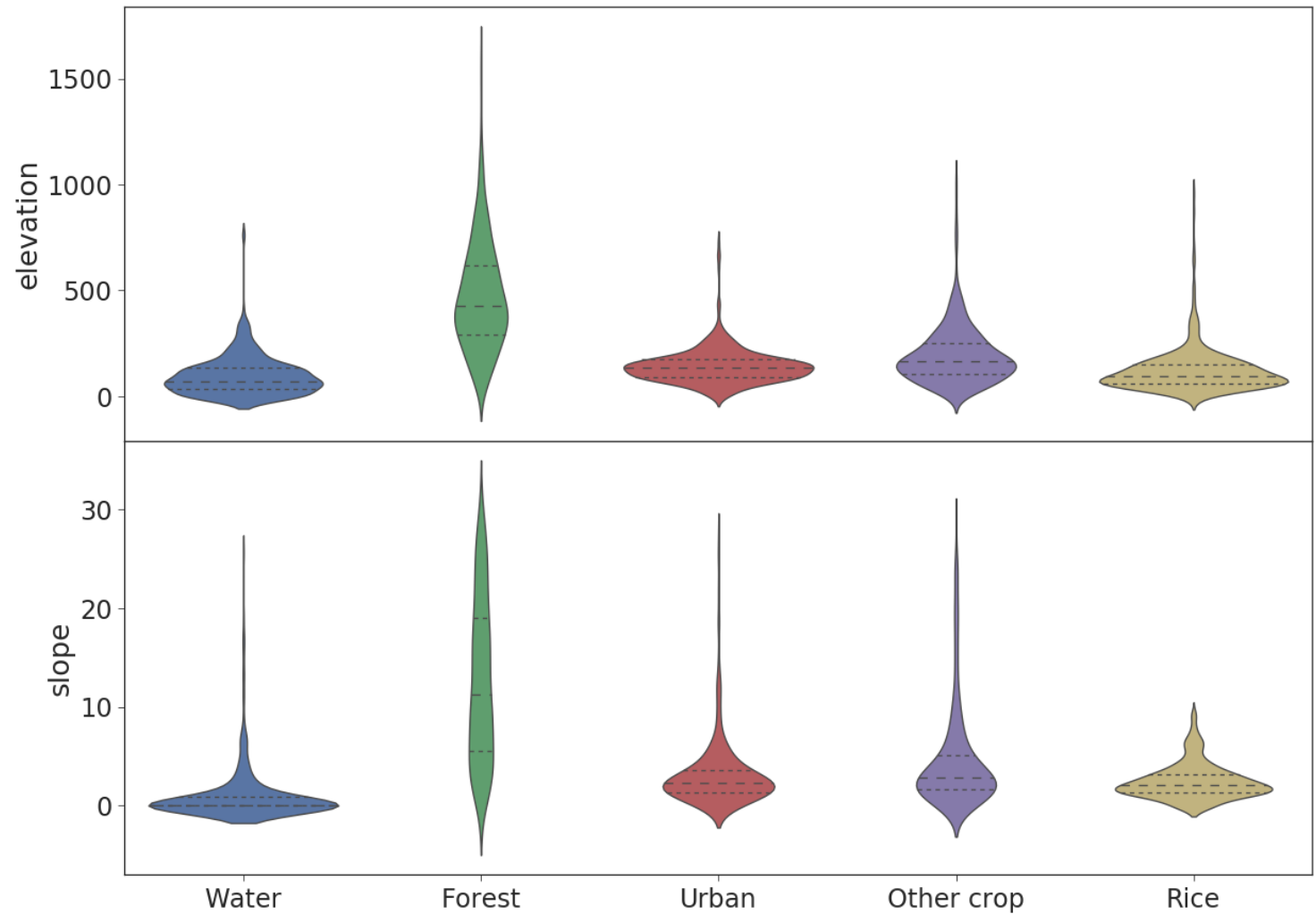
Sensors(1 st March to 30 th November, 2017)	Heilongjiang	Huan	Guangxi	
Landsat 8 OLI	Scenes	752	187	209
	Footprints	53	21	20
Sentinel-2 MSI	Scenes	4116	1411	1580
	Footprints	86	41	48
Sentinel-1 C-band	Scenes	828	364	340
	Mode	Interferometric Wide swath <input type="checkbox"/> IW <input type="checkbox"/>		
	Orbit Properties	Descending	Ascending	Ascending

Satellite data used

- Sentinel – 1: 5532 scenes
- Sentinel – 2: 20209 scenes
- Landsat – 8: 869 scenes
- Online processing on Google Earth Engine

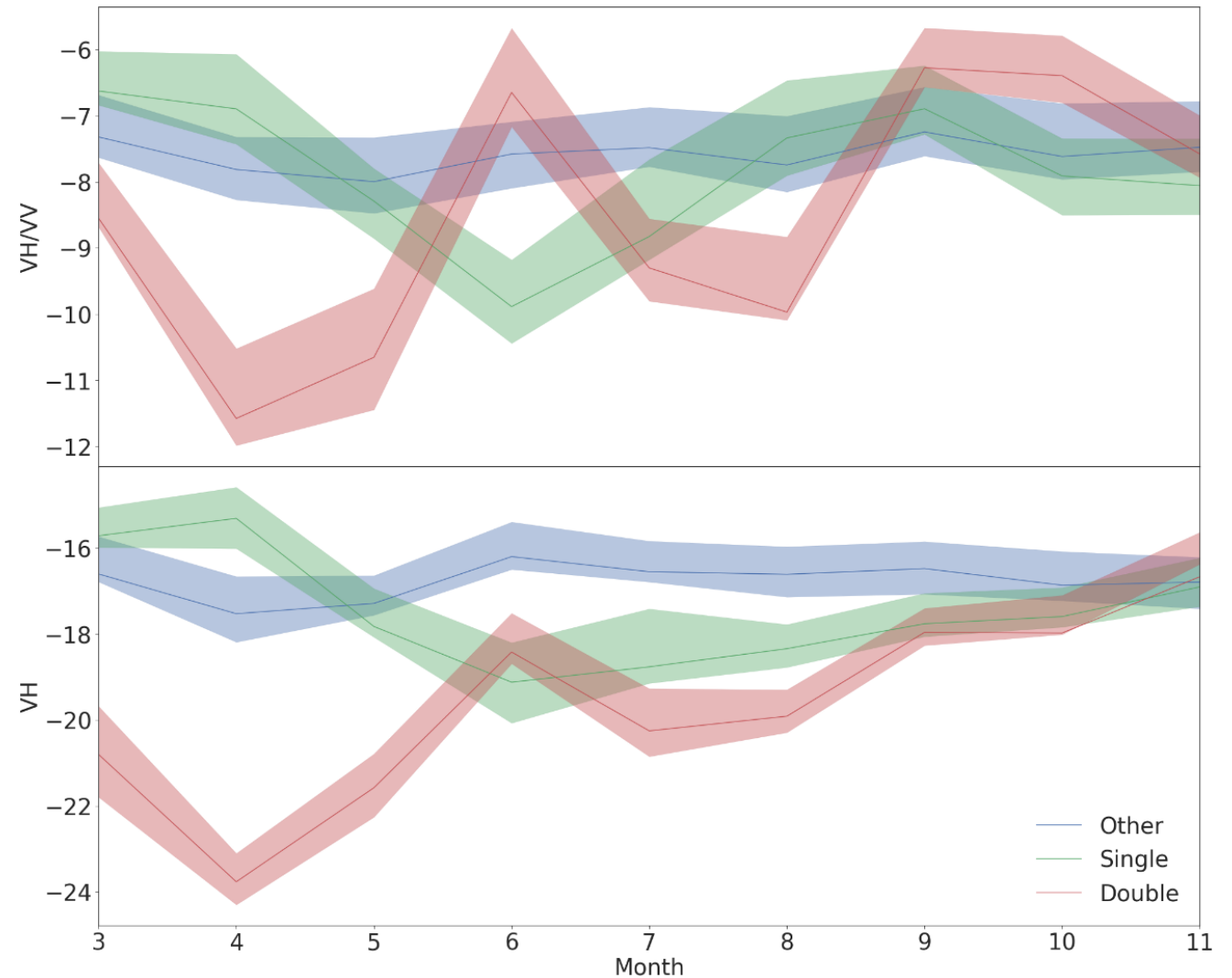


Slope and elevation



Feature analysis

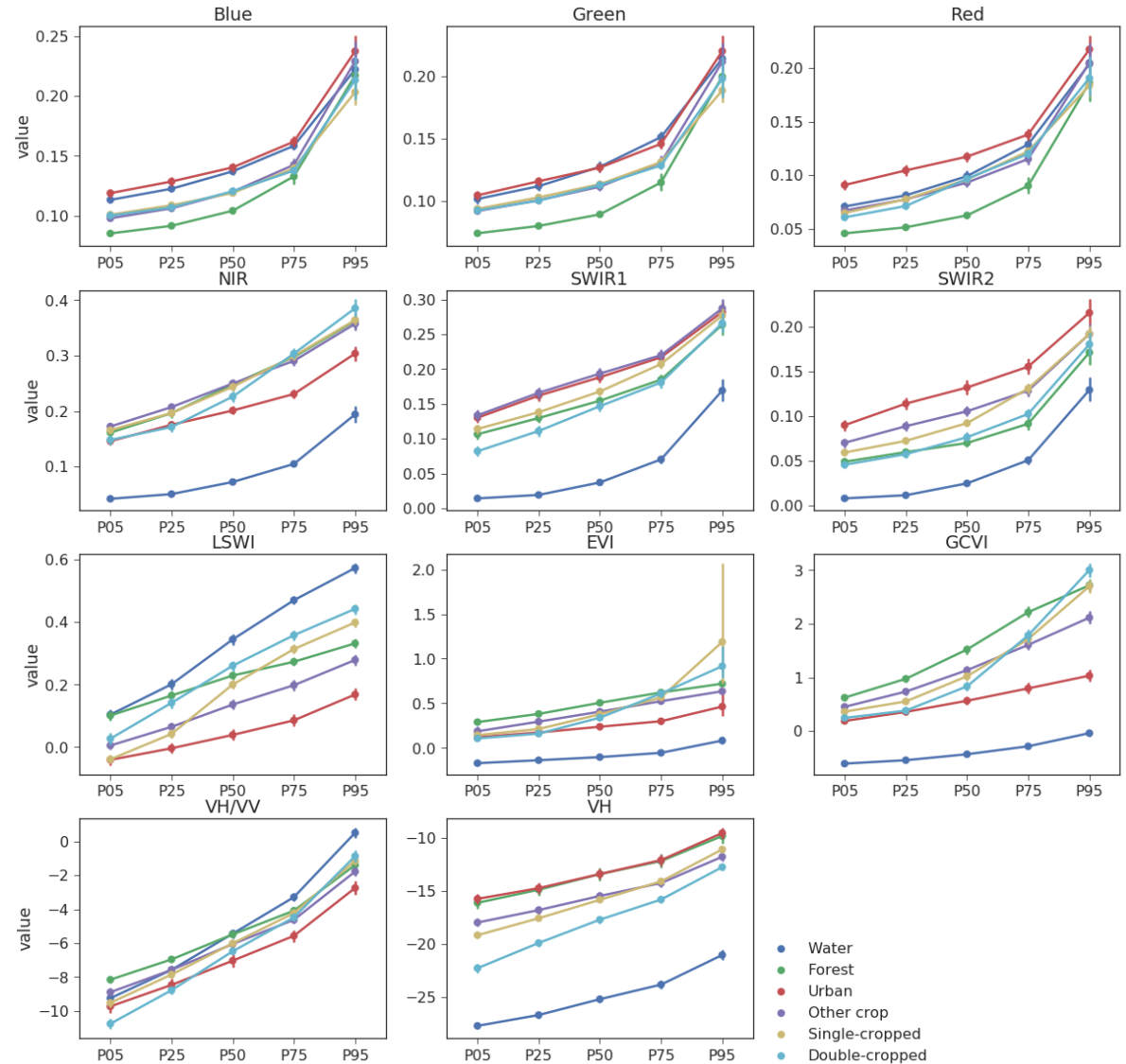
- Monthly mean value for SAR backscatter coefficient
- Layerstack to get time series monthly SAR backscatter coefficient
- Filter ImageCollection for each month;
- ImageCollection.mean()



Hunan

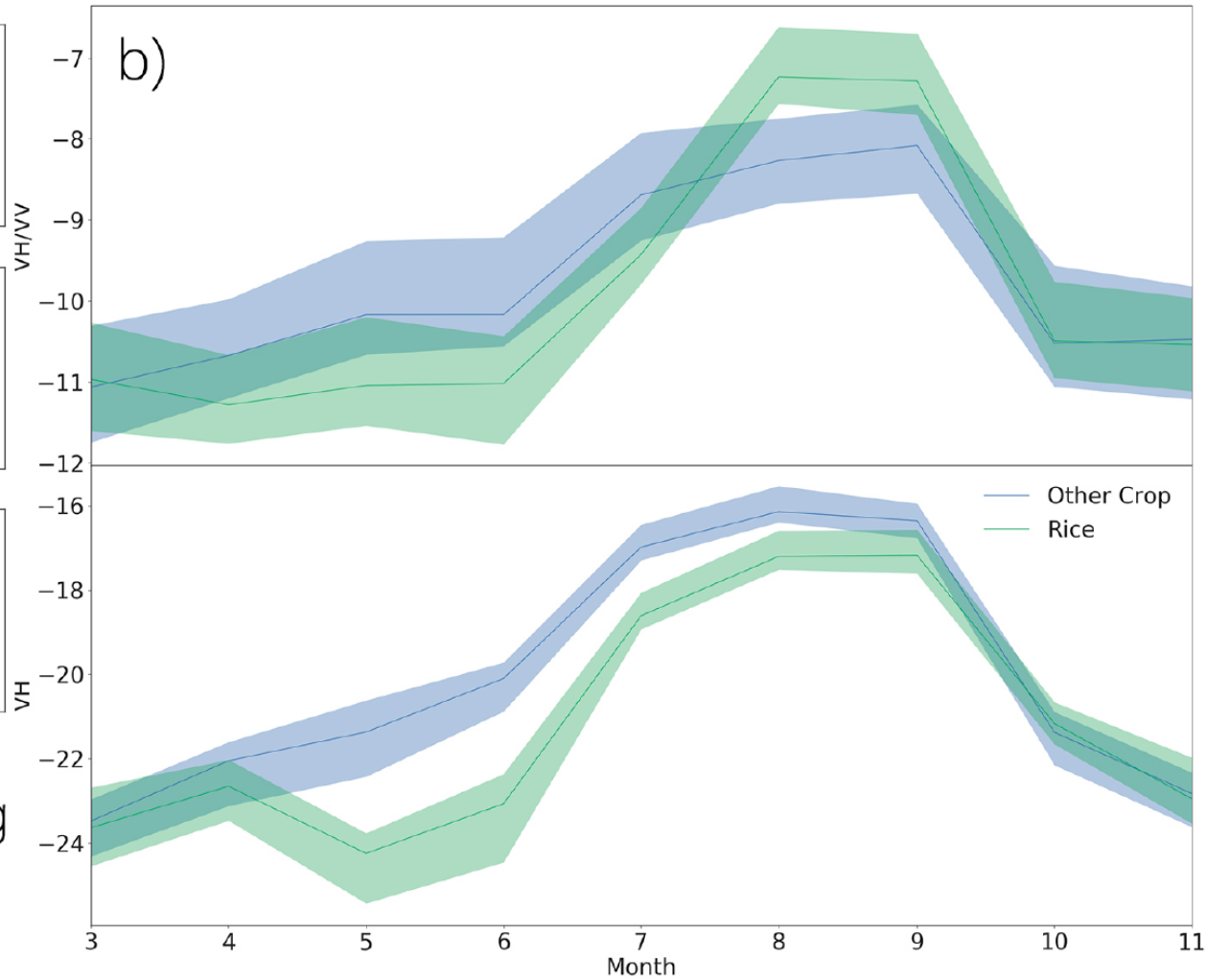
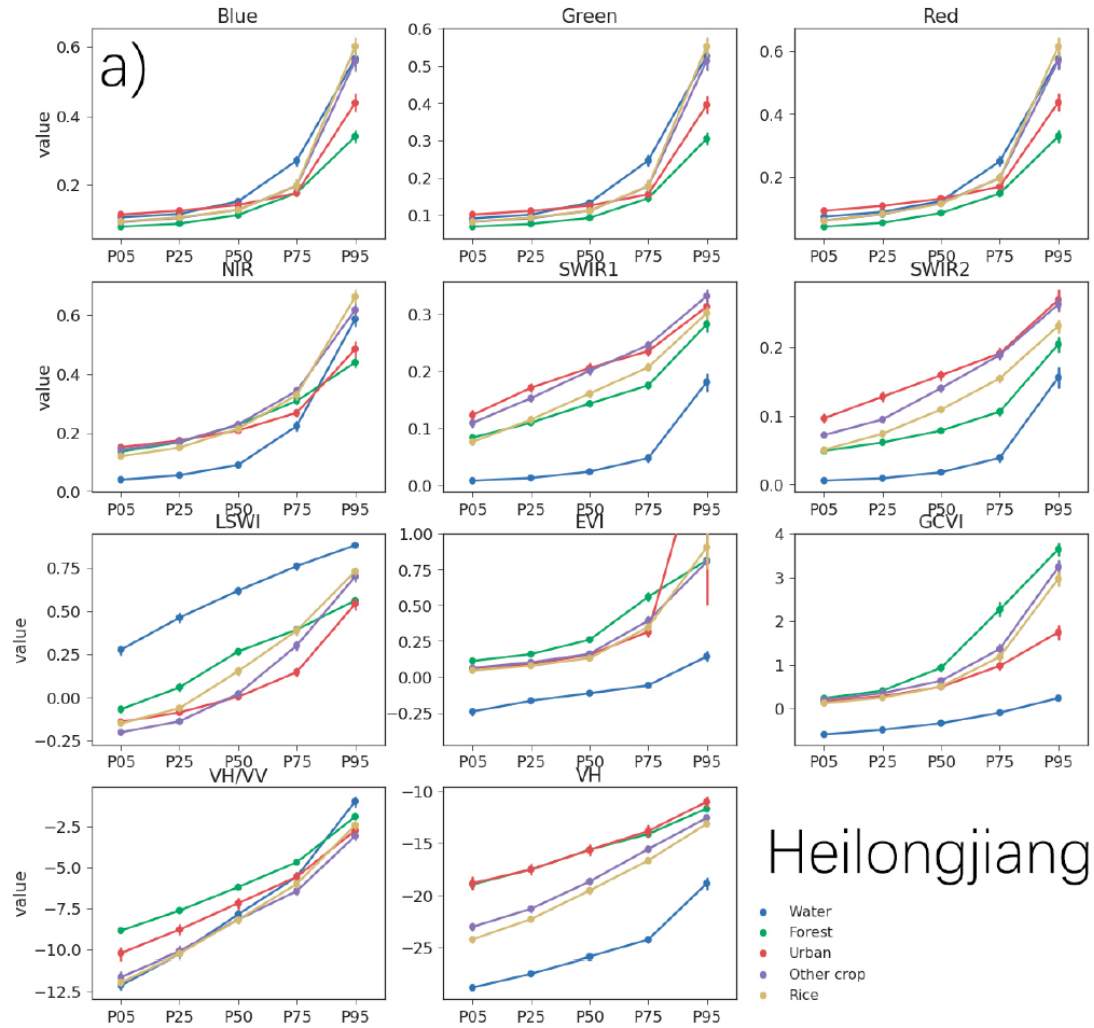
Feature analysis

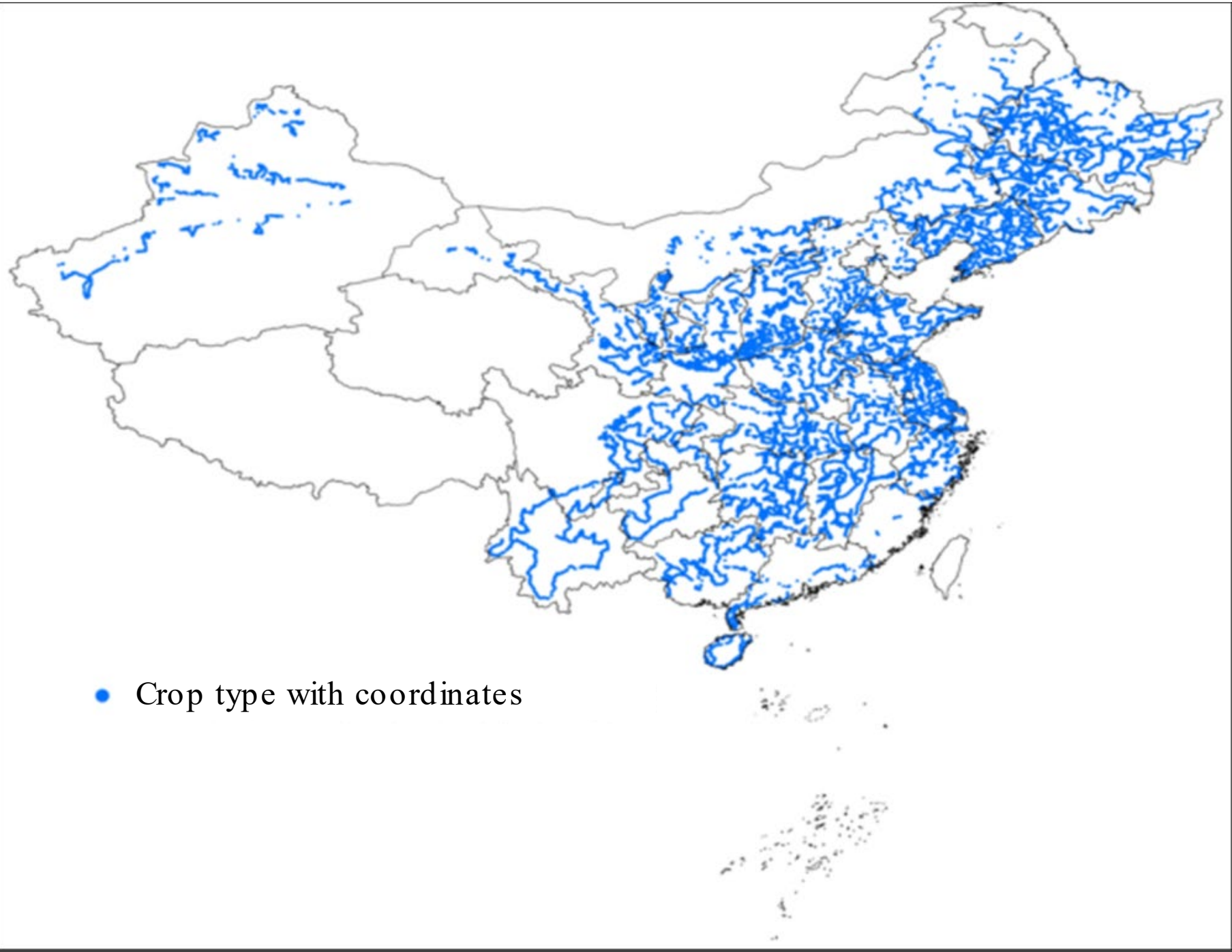
- Percentile composite
- Time series smoothing
- `ee.Reducer.percentile()`



Hunan

Heilongjiang





选择土地利用类型 完成

森林起源类型			
天然林	次生林	人工林	

森林用途			
用材林	薪炭林	特种用途林	苗圃

植被高度			
乔木	3-7m	7-14m	>14m

覆盖度			
<4%	4-20%	20-40%	40-65%
>65%			

植被层次性			
乔木	乔灌	乔灌草	乔草

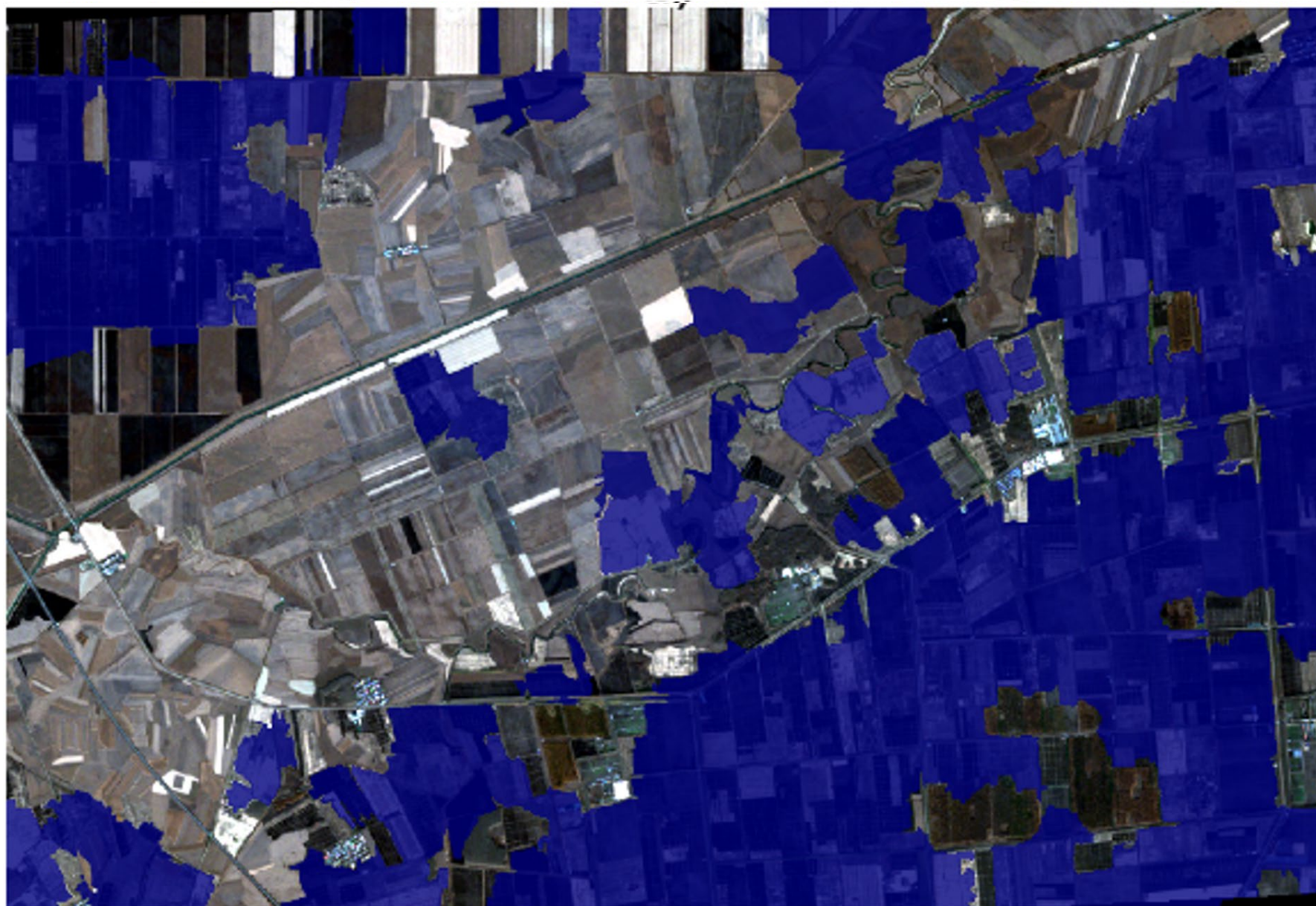
优势树种			
竹林	桉树林	杉木林	马尾松林
红树林	橡胶林	杨树	柞树

- Crop type with coordinates

Gro

re

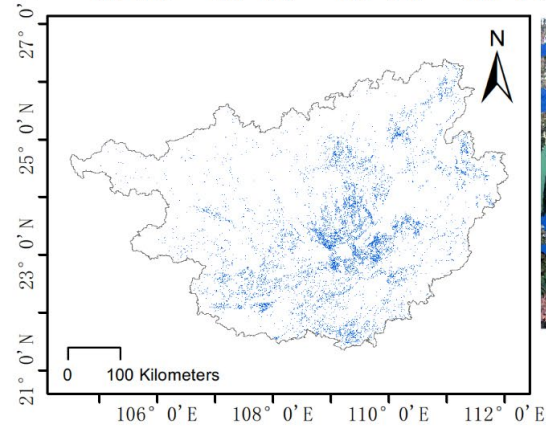
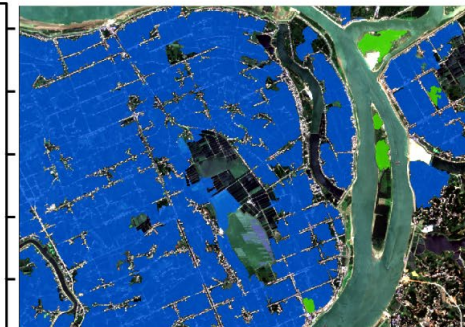
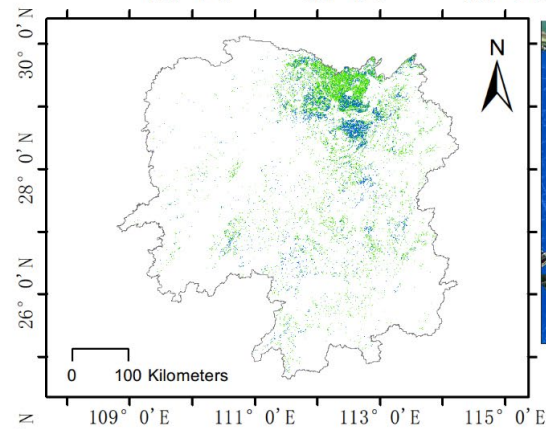
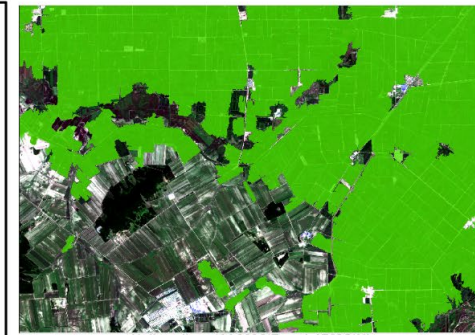
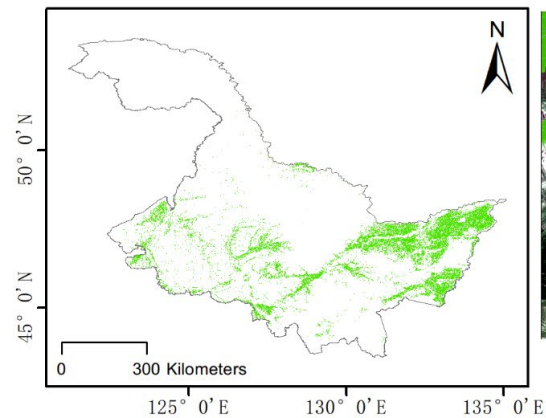
Pixel based + object based classification



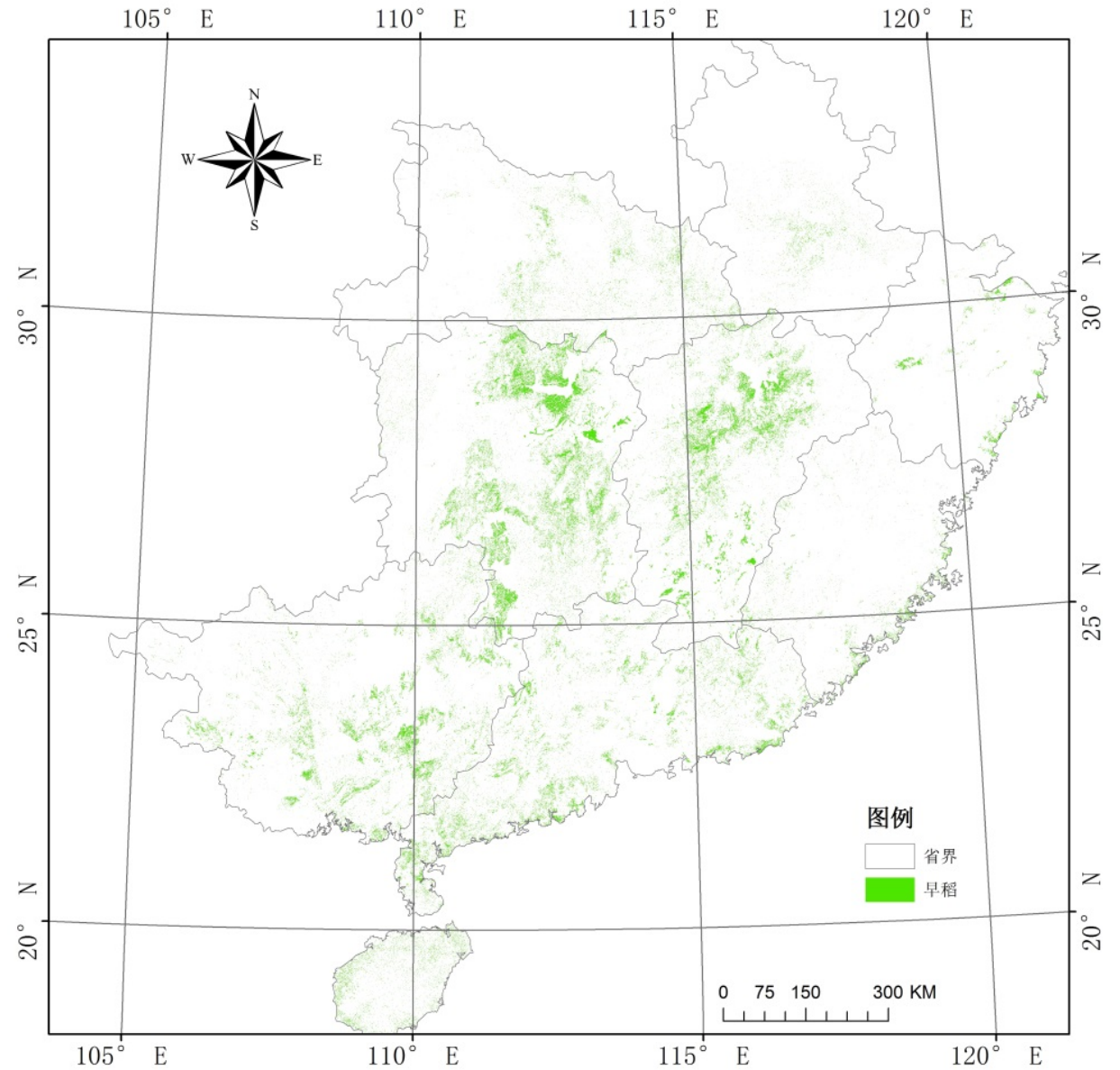
$$lable = \begin{cases} mean \geq 0.6 & rice \\ mean < 0.6 & no\ rice \end{cases}$$

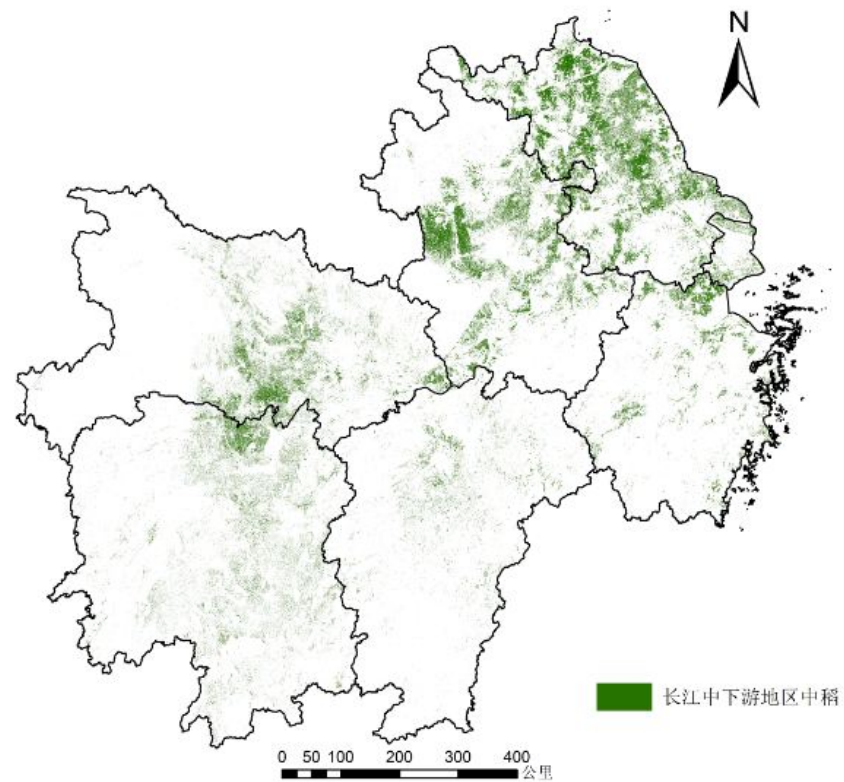
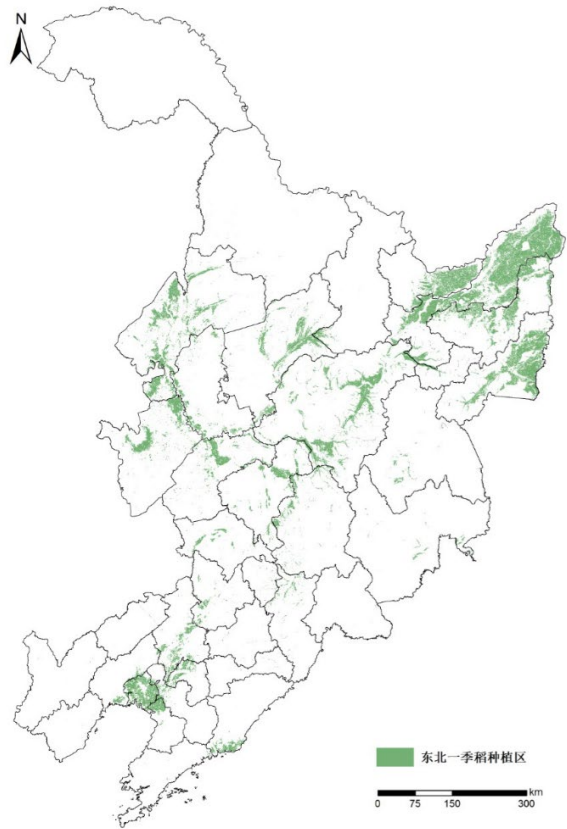
the pixel-based classification from random forest classifier;(c) the object-based SLIC image segmentation result and (d) the merged results with SLIC segmentation result with pixel-based Random Forest classification.

Rice mapping



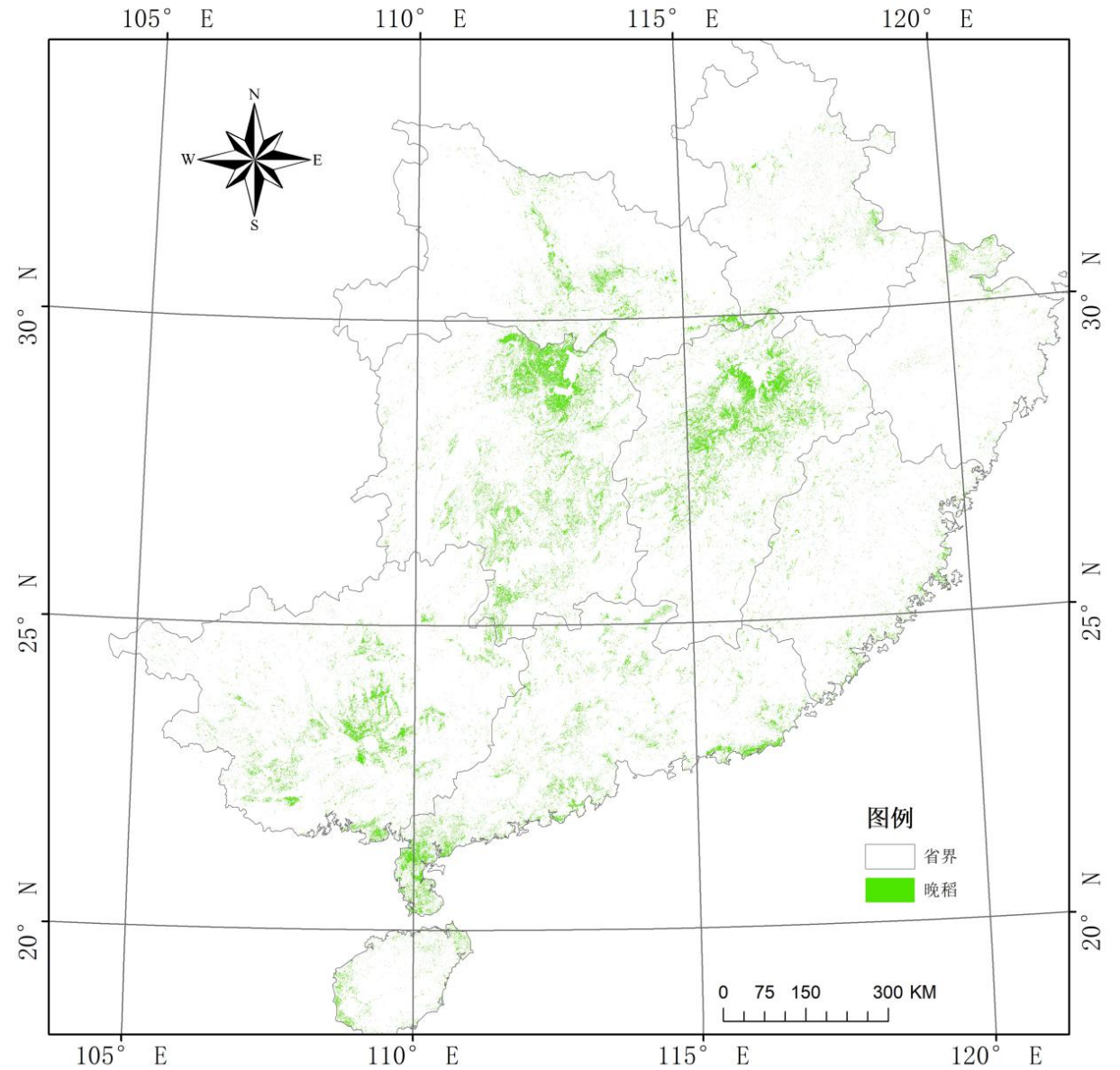
Early rice





Single/Semi-late rice

Late rice



Accuracy assessment

- In situ data: 80% of samples used for training □ 20% for validation
- Overlap the two to calculate the number of samples classified correctly and wrong
- To generate confusion Matrix

$$OA = \frac{S_d}{n} \times 100\%$$

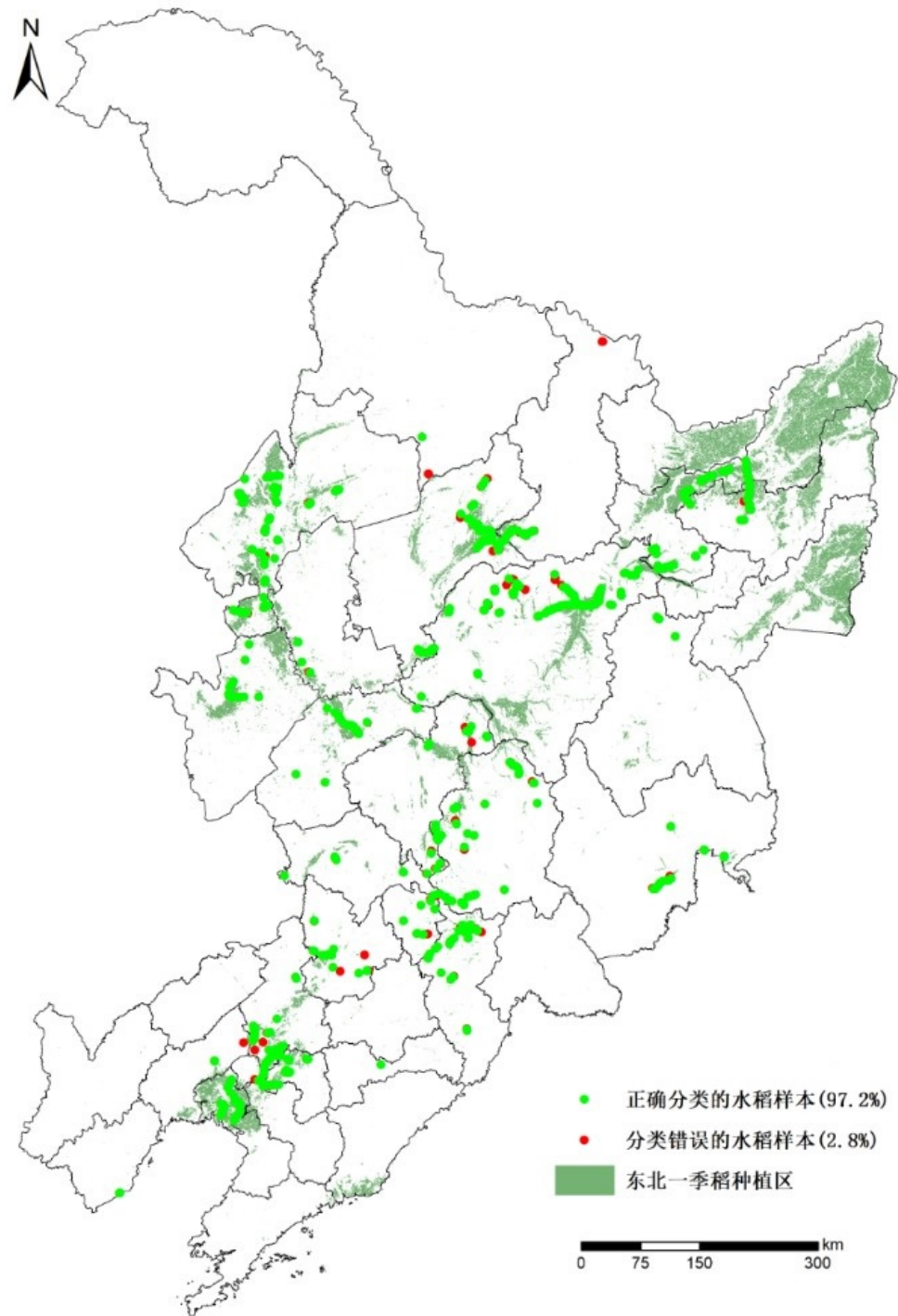
$$UA = \frac{X_{ij}}{X_j} \times 100\%$$

$$PA = \frac{X_{ij}}{X_i} \times 100\%$$

$$F_{score} = \frac{UA \times PA}{UA + PA} \times 2$$

where S_d represents the total number of correctly classified pixels, n represents the total number of validation pixels, and X_{ij} represents an observation in row i and column j in the confusion matrix; X_i represents the marginal total of row i , and X_j represents the marginal total of column j in the confusion matrix.

Accuracy



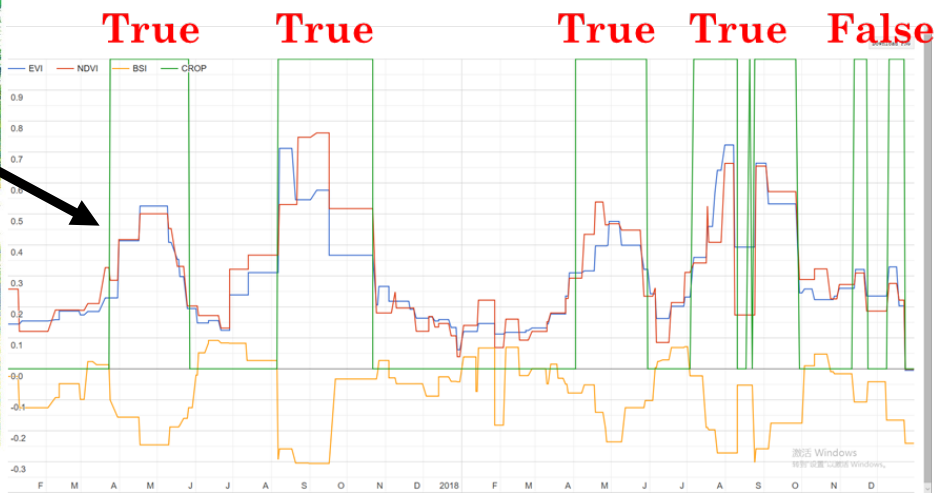
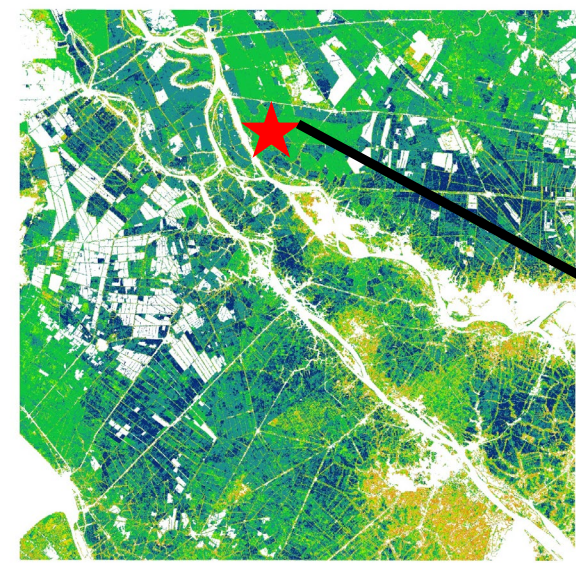
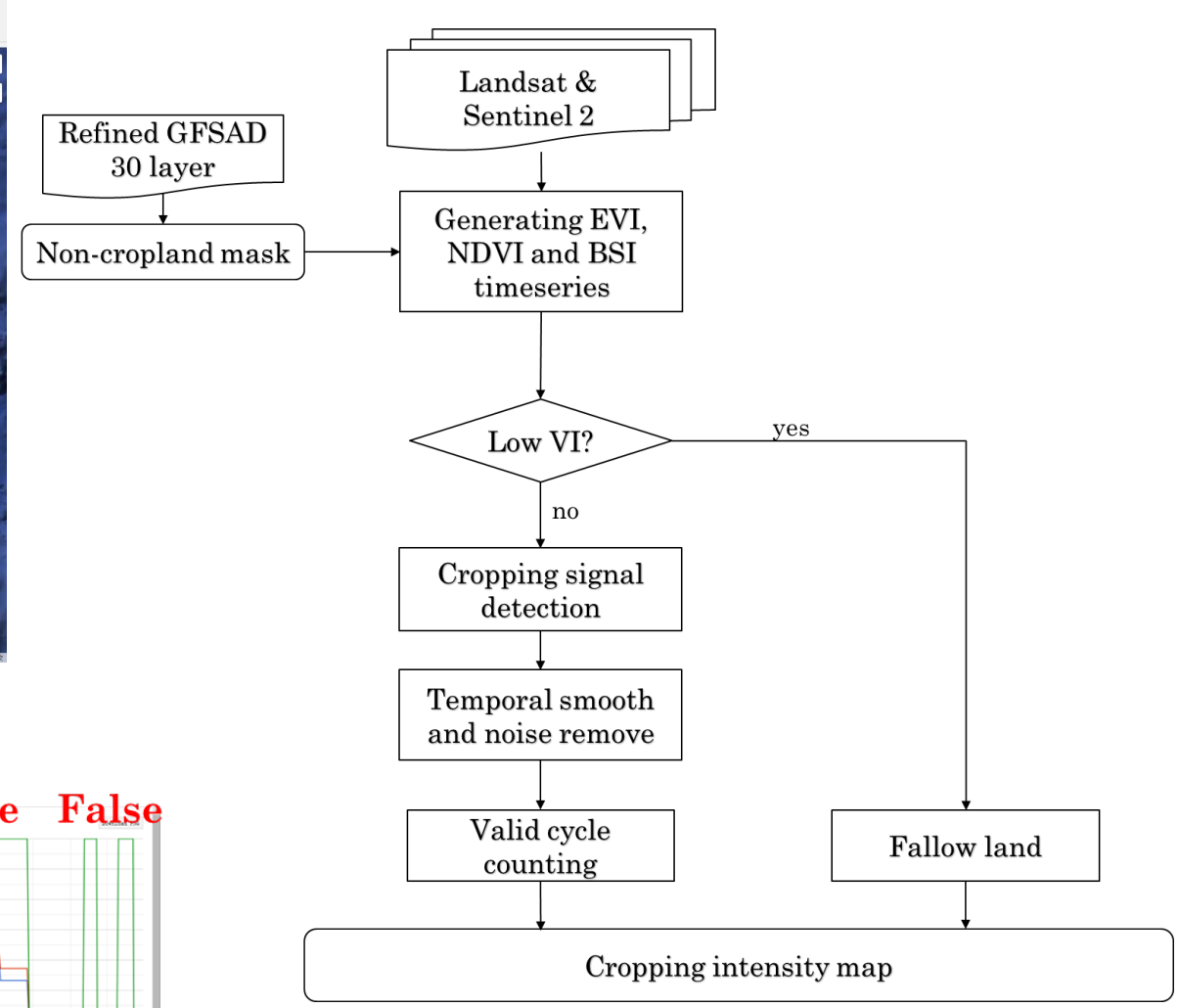
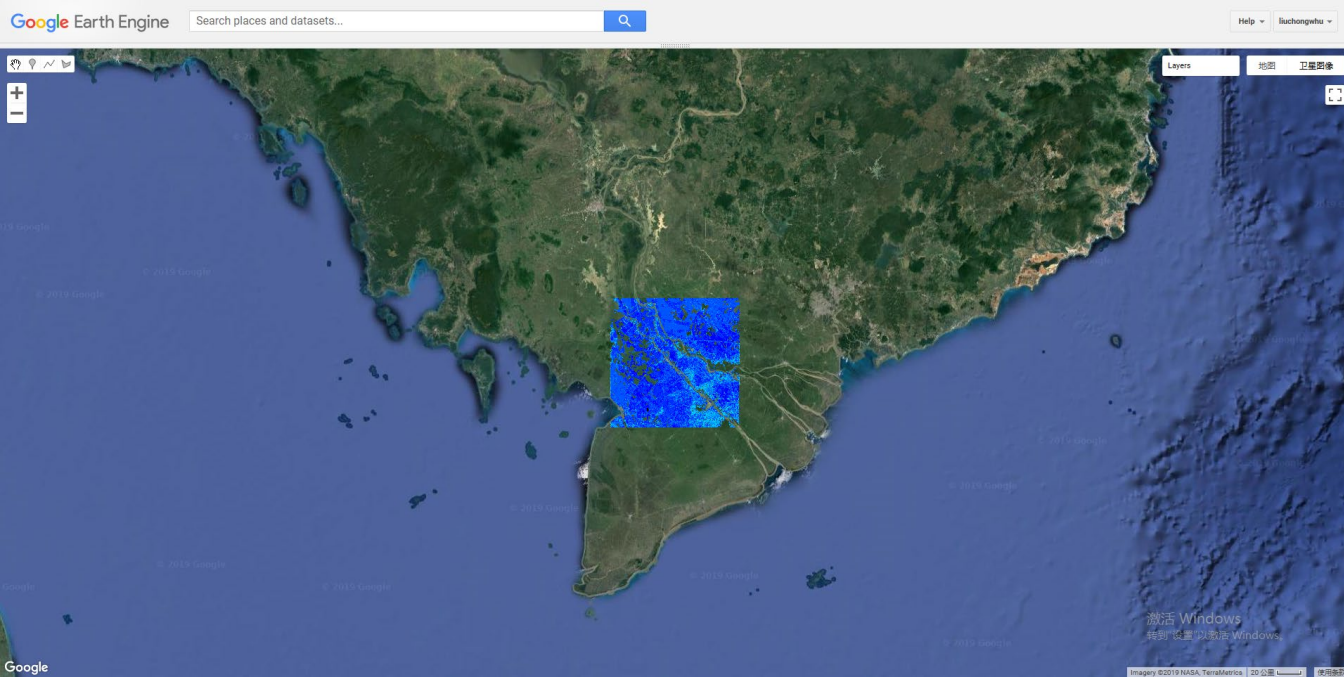
Accuracy

Heilongjiang		Field Data			User Accuracy
		Other Crops	Rice	Total	
Map Data	Other crops	870	33	903	96.35%
	Rice	50	298	348	85.63%
Total		920	331	1251	
Producer Accuracy		94.57%	90.03%		
Overall Accuracy		93.37%	F score		87.78%

Hunan		Field Data			User Accuracy	
		Other Crops	Single Rice	Double Rice		Total
Map Data	Other crops	5	5	0	95	94.74%
	Single rice	130	130	6	139	93.53%
	Double rice	15	15	50	69	72.46%
Total		97	150	56	303	
Producer Accuracy		92.78%	86.67%	89.29%		
Overall Accuracy		89.11%	F score	Single rice Double rice		89.97% 80.00%

Guangxi		Field Data			User Accuracy
		Other Crops	Rice	Total	
Map Data	Other crops	280	5	285	98.25%
	Rice	11	60	71	84.51%
Total		920	331	1251	
Producer Accuracy		96.22%	92.31%		
Overall Accuracy		95.51%	F score		88.24%

Zhang et al., 2018;



Cropping intensity (ongoing)

- ◆ Mapping at 30 m spatial resolution
- ◆ Adaptive for different agriculture systems: dry/wet, large farm/smallholder
- ◆ Flexible for multiple satellite sensor integration

Thanks for your attention!

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Contacts: zhangmiao@radi.ac.cn; wubf@radi.ac.cn;