Deforestation detection with PALSAR-2 ScanSAR HH&HV polarizations for JJ-FAST

Manabu Watanabe[1], Christian Koyama[1],Masanobu Shimada[1,2]

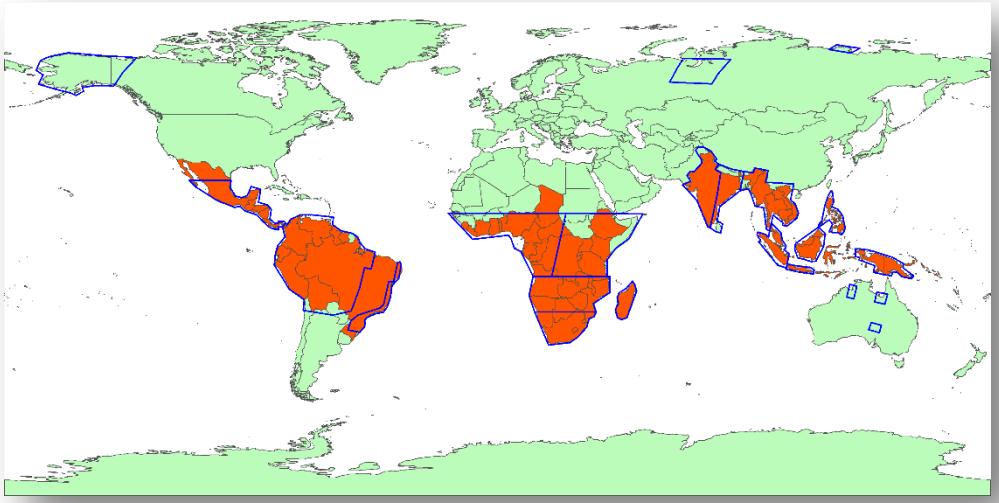
[1]Tokyo Denki University,
[2]JAXA

Outlines

1. About $JJ\text{-}FAST$
   (JICA-JAXA Forest Early Warning System in the Tropics)
2. Field survey
3. Deforestation detection algorithm
4. Summary

1. About JJ-FAST

- Early warning system for deforestation.
- "**Cover 77 countries**" containing tropical forest



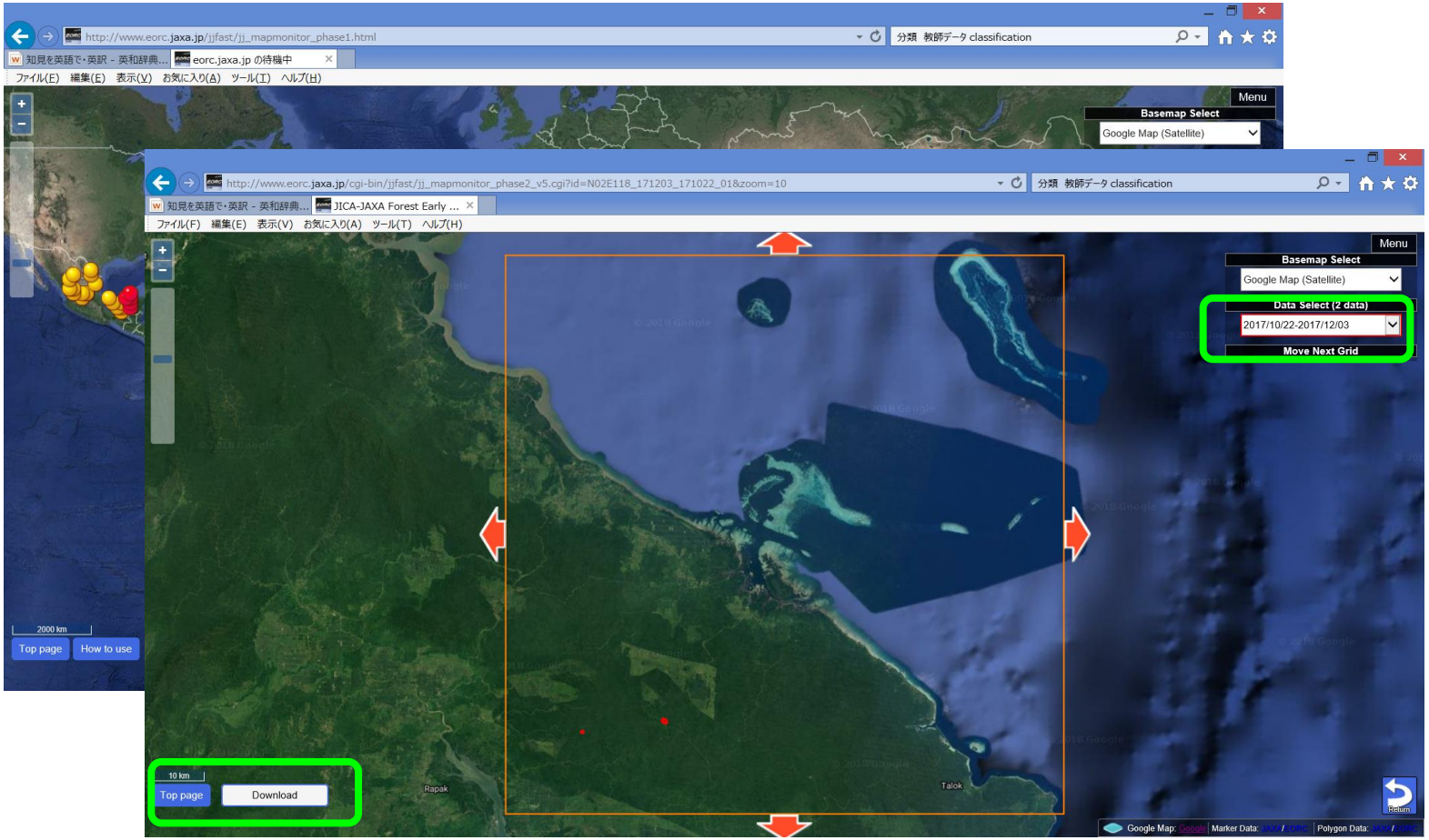
- "**Every ~1.5 month**" deforestation monitoring
- "**Free access & data download from PCs and mobile devices**" from anywhere in the world.
- "**Deforestation in a rainy season**" is detected through **SAR** (PALSAR-2)

JJ-FAST

Search

provide deforestation information

http://www.eorc.jaxa.jp/jjfast/jj_index.html



Freely available

- Deforestation polygon
- PALSAR-2/ScanSAR ortho-rectified slope corrected image (50m res.).

Brazil & Peru field survey

Sept. 26, 2017～Oct. 16

Bulldozer working for deforestation

Traces of deforestation

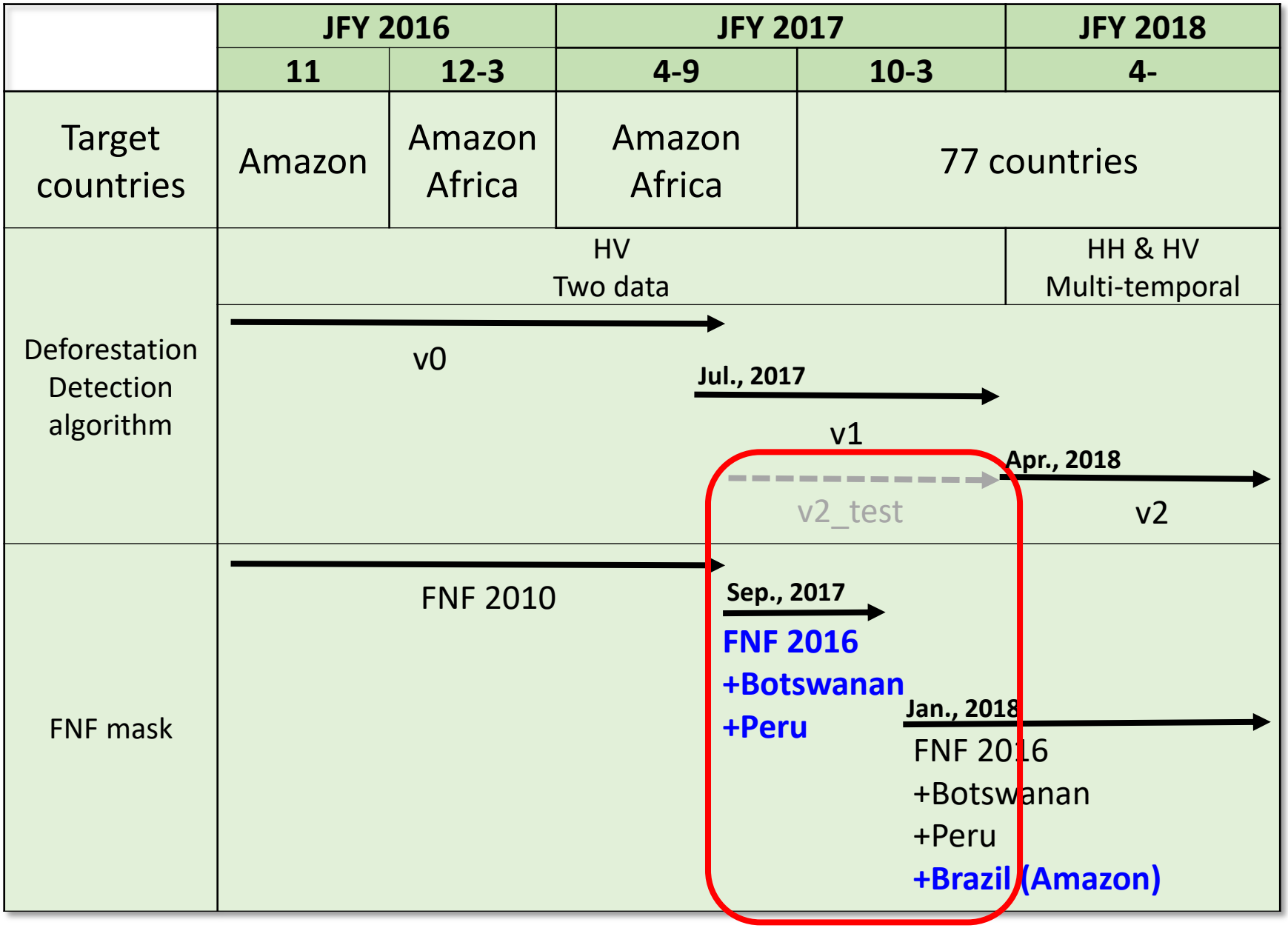
Chain box for chainsaw

Bellow

Mark ?

Baggage of weed for cow

3. Deforestation detection algorithm



Deforestation

Time

Before deforestation

After deforestation

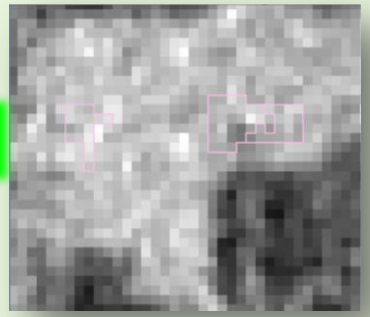
PALSAR-2

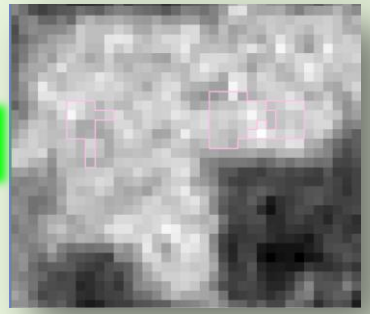
HH

HV

Sentinel-2

27/07/2017

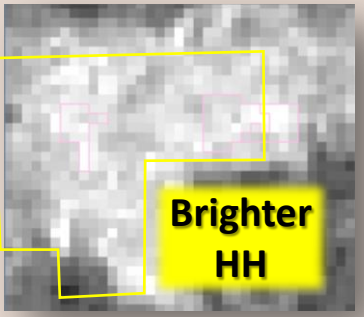


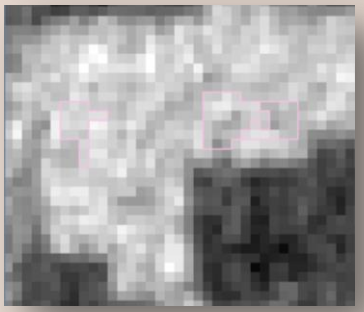


05/07/2017

Before burning

21/09/2017



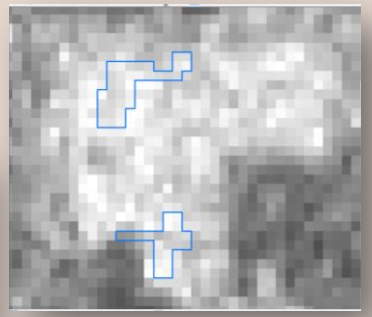


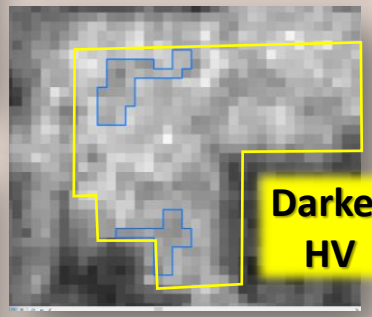
23/09/2017

30/09/2017

After burning

19/10/2017





13/10/2017

Deforestation

Time

Before deforestation

After deforestation

Before burning

- ✓ Brighter HH
- ✓ Method : **HH**, **HH × HV**

After burning

- ✓ Darker HV
- ✓ Method : **HV**, **HH/HV**

Deforestation detection during rainy season

Before deforestation

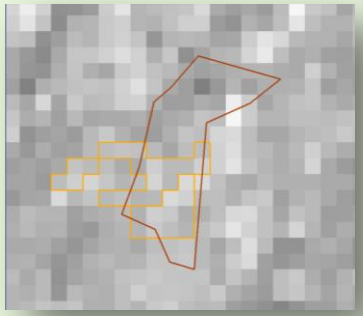
After deforestation

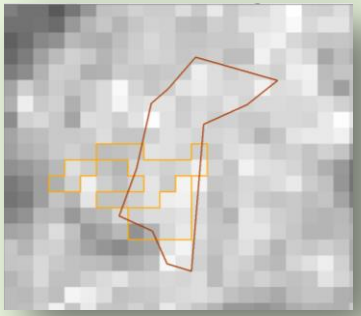
PALSAR-2

HH

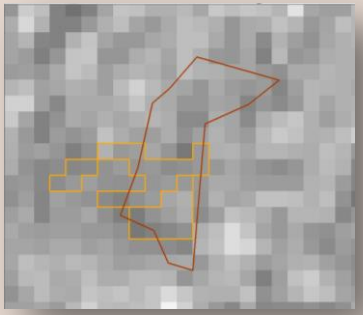
HV

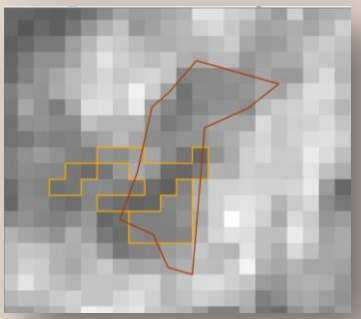
23/02/2017





06/04/2017





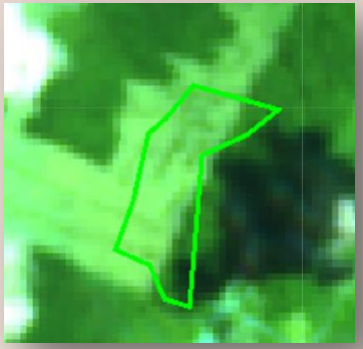
05/10/2017

Flat soil
Branches collected.

Sentinel-2

30/11/2016

09/04/2017



Deforestation detection with 1ha size

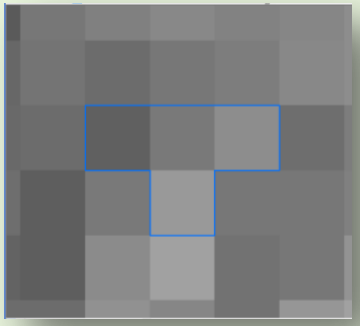
Before deforestation

After deforestation

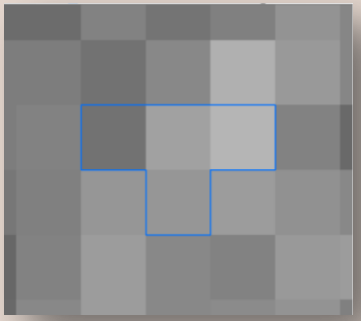
PALSAR-2

HH

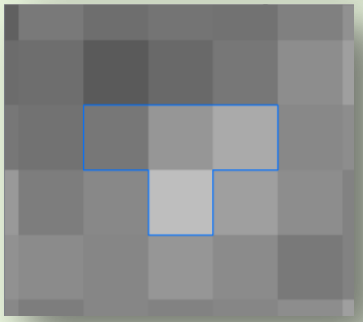
20/07/2017

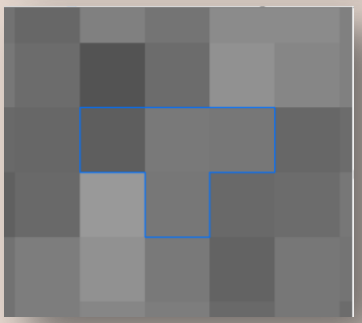


31/08/2017



HV





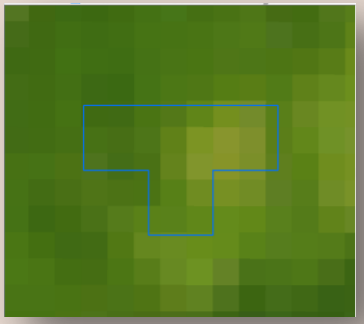
09/10/2017

Felled burned trees left.
Corn field.

Sentinel-2

03/07/2017

21/09/2017



Deforestation detection flow

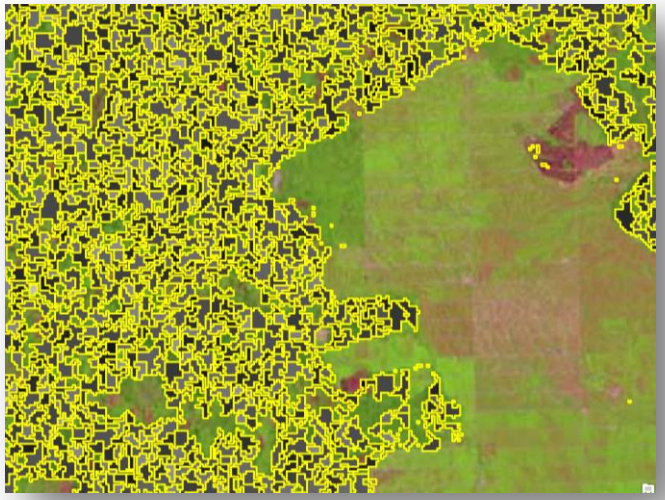
Multi-temporal HH & HV

↓

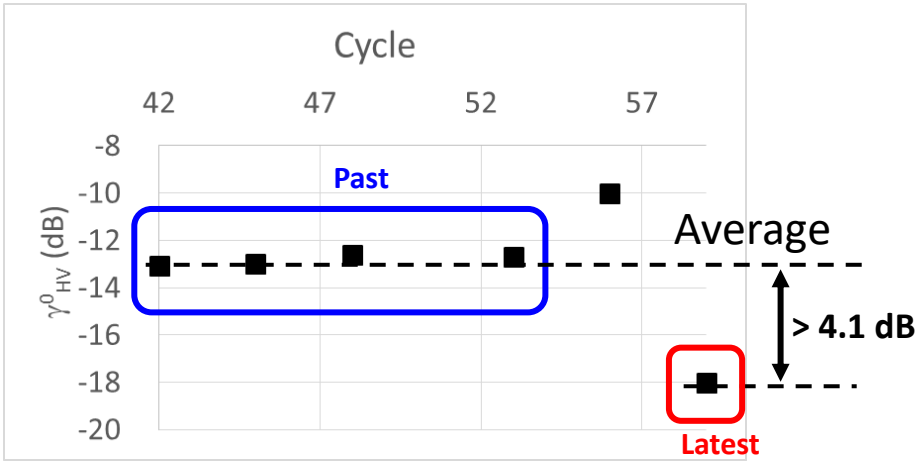
Mask non-forest & apply segmentation

↓

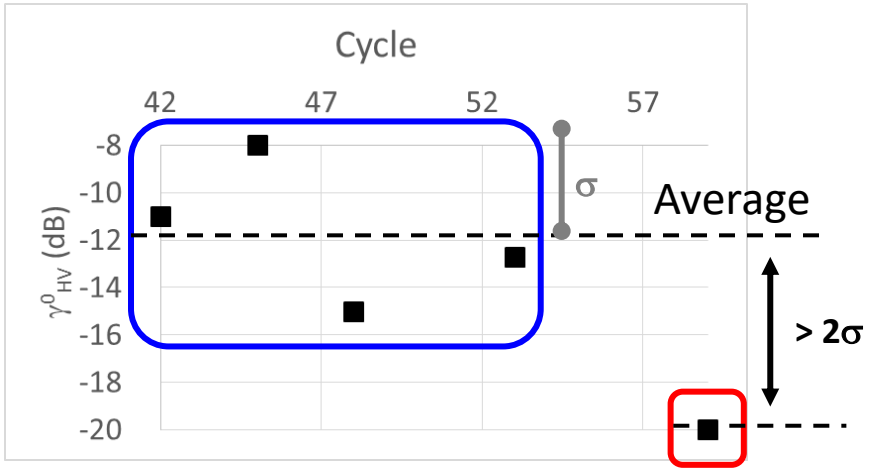
- Check HV, HH, HH/HV, HH × HV variation to detect various deforestation stage
- Adaptive threshold level.



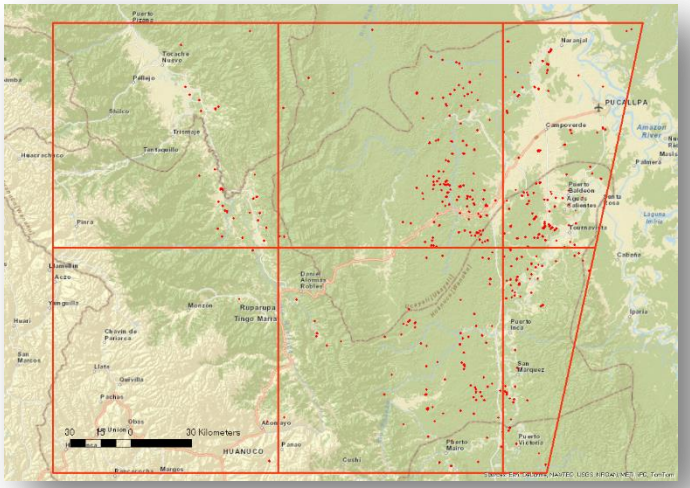
Smaller deviation
→**Fixed threshold** level.



Larger deviation
→**Larger threshold** level.



Detection accuracies



Place : Pucallpa(Peru)
Condition : Dry season
Automatic detection
Minimum size 3ha
Validation : GLAD
Minimum size: 0.09 ha

	HH	HV	HH/HV	HH×HV	Total	HV (2 data)
Detected polygons	259	49	214	4	444	390
Correct polygons	203	36	178	3	346	80
Validation	20021	13598	20021	13634	20021	20021
User's accuracy	78.4	73.5	83.2	75.0	**77.9**	**20.5**
Producer's accuracy	1.0	0.3	0.9	0.0	**1.7**	**0.4**

- User's accuracy become lower during rainy season.
- Lower producer's accuracy is due to
  Validation data : >0.09 ha Detected polygon: > 3ha.
  Severe threshold level.

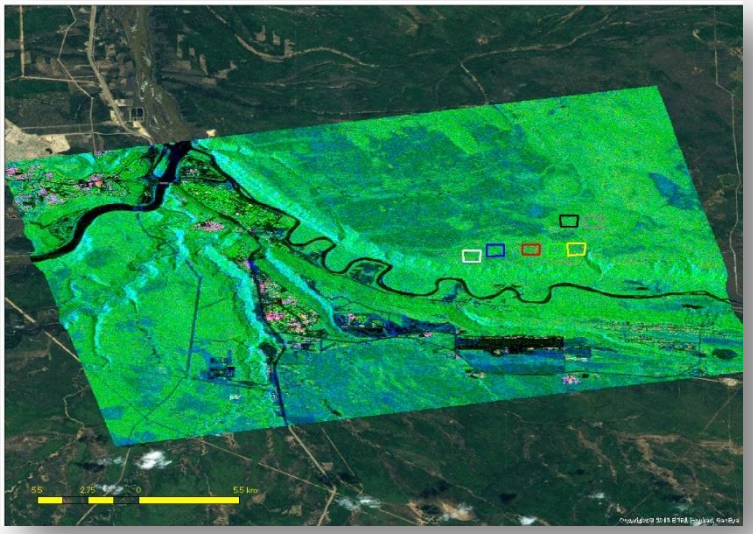
Polarization	Threshold (dB)	σ
HV	–4.1	2
HH	2.0	1
HH/HV	2.8	3
HH × HV	2.8	5

Parameter is under adjusting

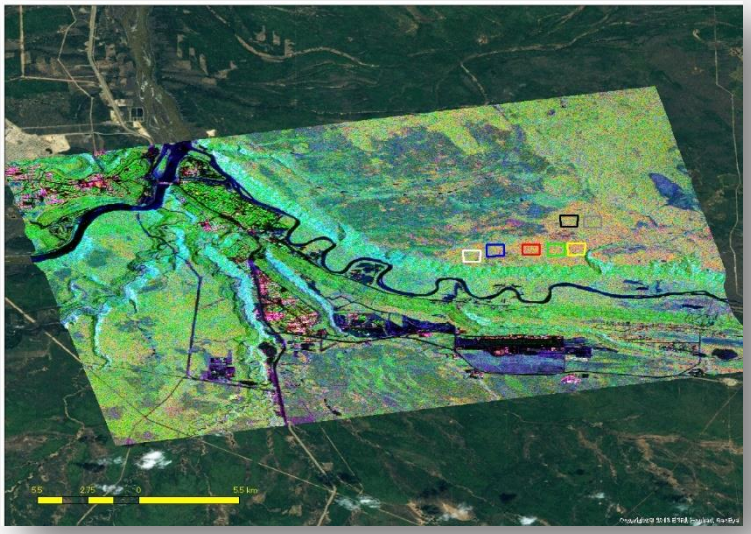
Forest fire detection

Sensor : PALSAR-2
Mode : Polarimetry

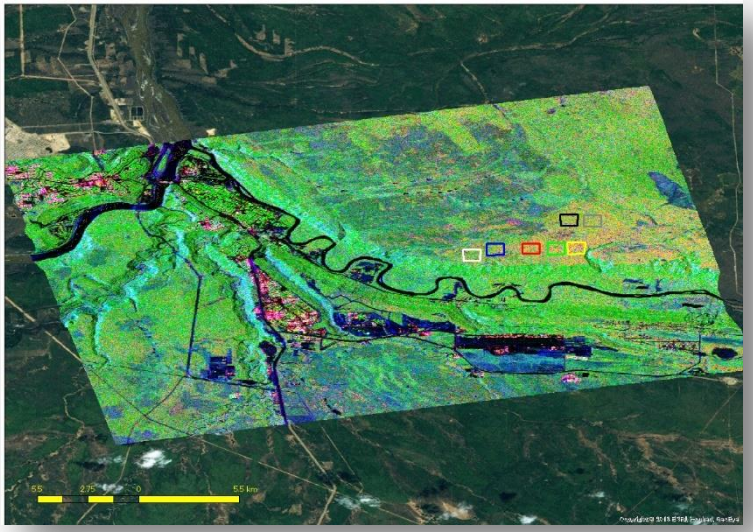
Before fire
(May 11, 2015)



Just after fire
(May 9, 2016)



After fire
(May 23, 2016)



Strong double bounce scattering after fire

R : double
G: volume
B: surface

4 pol. parameters before & after

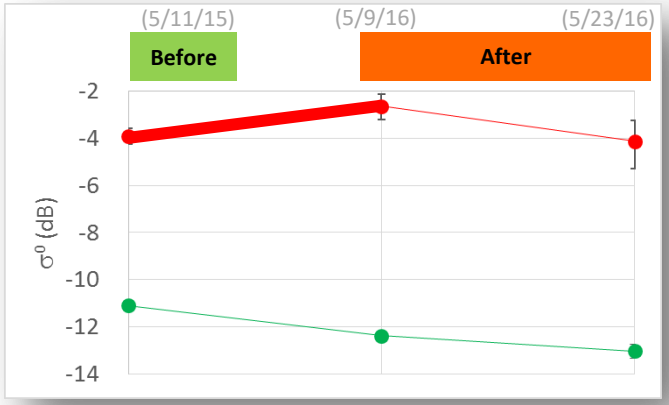
σ^0

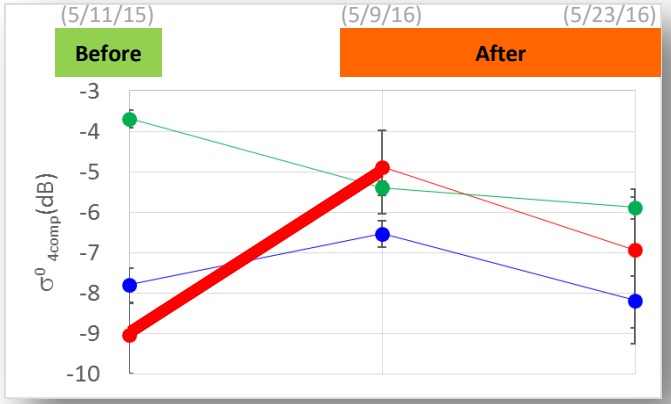
R : σ^0_{HH} G: σ^0_{HV}

4 component decomp.

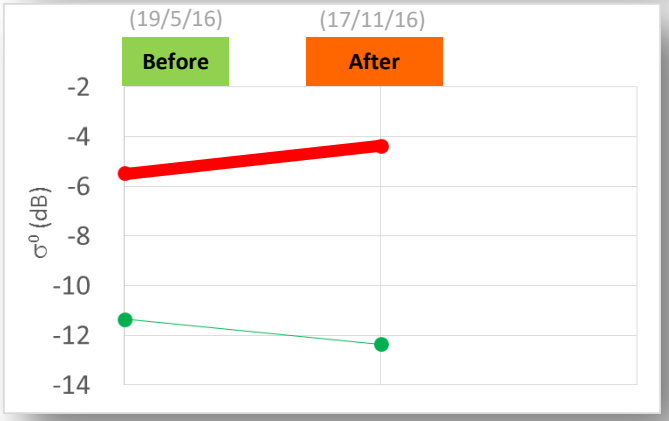
R : double G: volume B:Surface

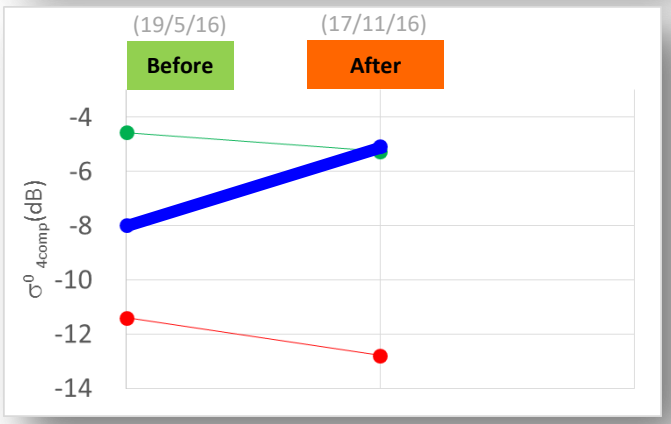
Forest fire





Deforestation





1 dB brighter in σ^0_{HH}

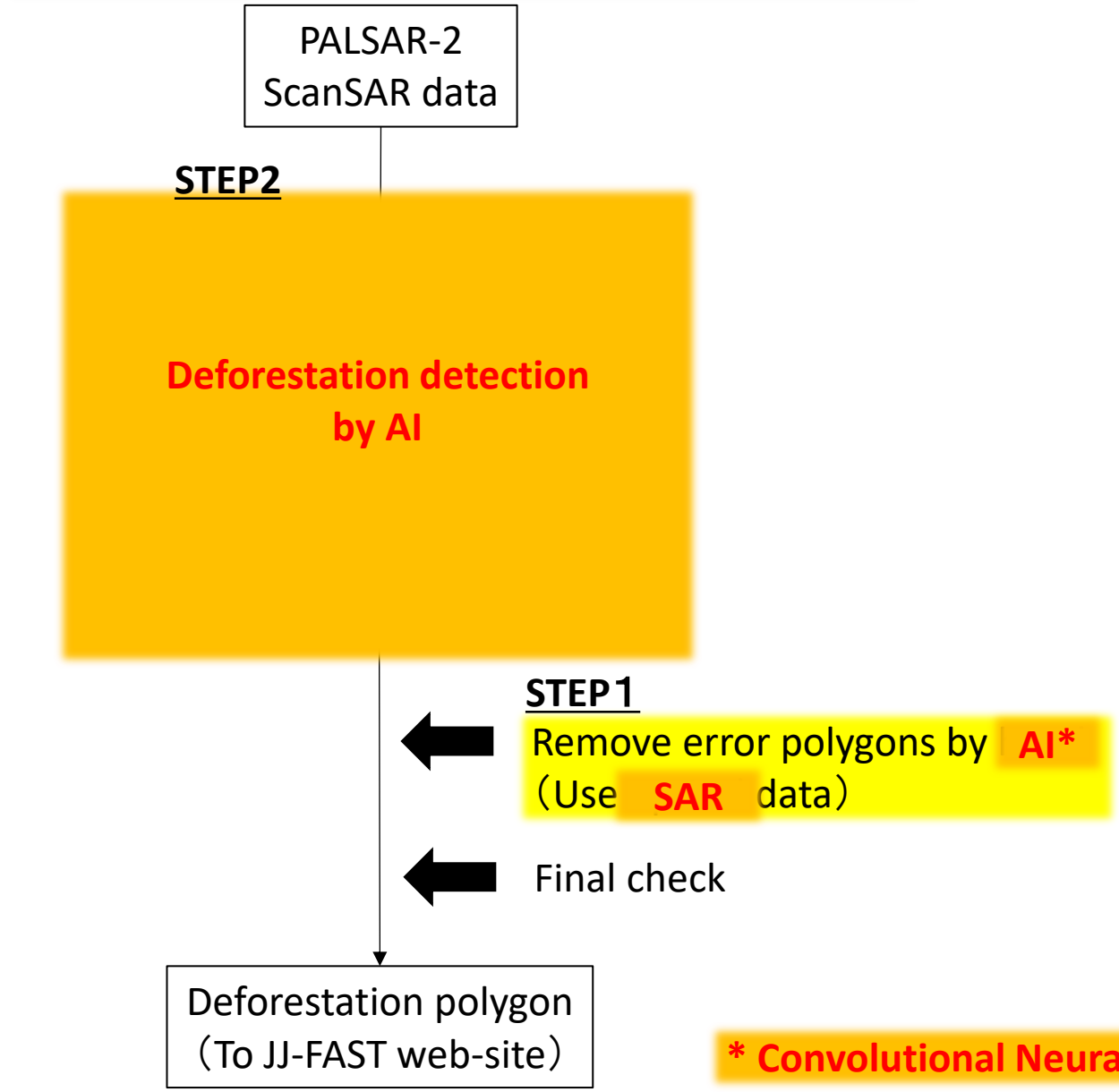
After fire : Increase double bounce

After deforestation : Increase surface

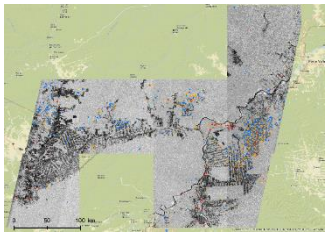
Current algorithm detects heavily burned forest fire sites

Manabu Watanabe,et al., Proc. of IGARSS2017, 2017

Improvement of detection accuracies by using deep learning



Test CNN



Teacher/validation data

- Place：Rio Branco (Brazil） Cycle 53-59
- Pick up deforestation polygon by the algorithm (v2_test).
- 25% is assigned for evaluation

HV(168)

HH(1432)

HH/HV(2340)

HH × HV(158)

Forest

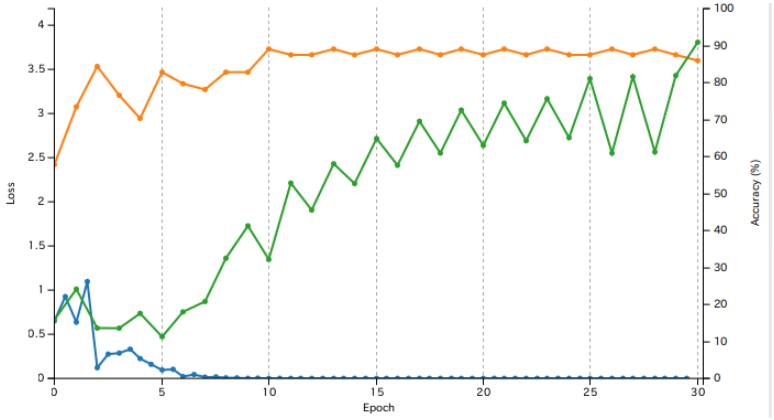
Deforestation

Forest

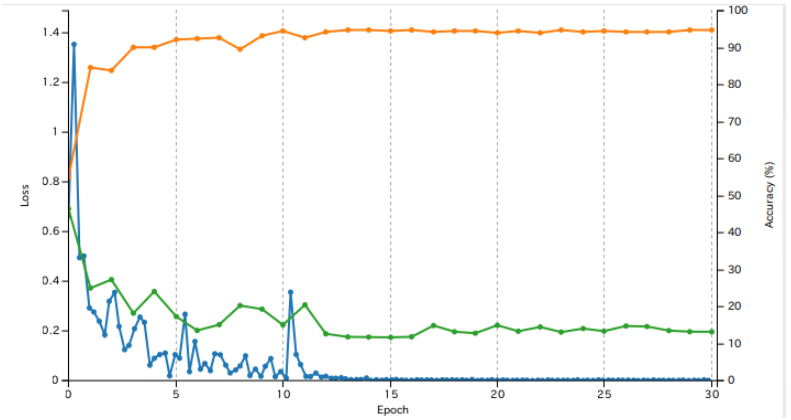
Deforestation

Preliminary evaluation

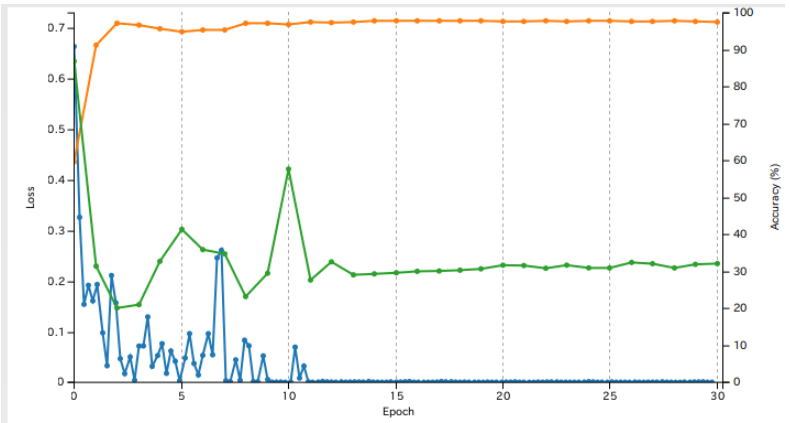
HV



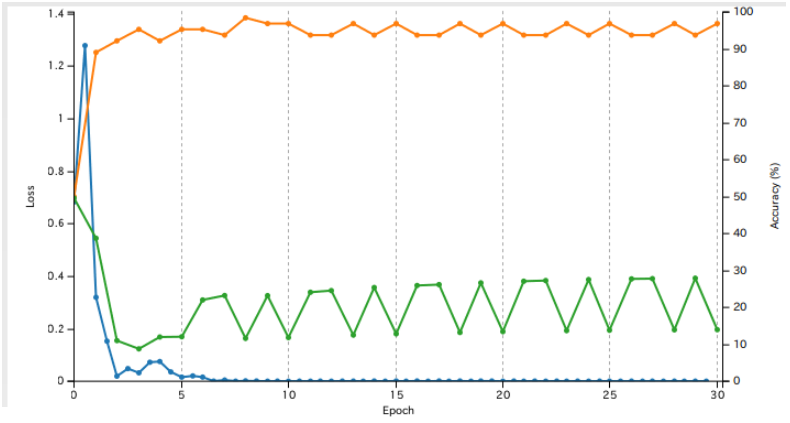
HH



HH/HV



HH × HV



loss (train) accuracy (val) loss (val)

Show prospective results

Accuracy：～90%　Loss：10-80%

Summary

- Introduction of JJ-FAST & field survey
- Deforestation detection algorithm
  - ✓ **Use HH, HV, HH/HV, HH × HV** to detect various deforestation stage.
  - ✓ User's accuracy : 77.9 % Producer's accuracy: 1.7 %
    Place : Peru
    Condition : Dry season, Automatic detection, Size: >3ha
  - ✓ Detects heavily burned forest fire sites
  - ✓ **Start to use from Apr. 2018**

Future

- Adjusting threshold level.
- Introduce CNN (convolutional neural network.)

ACKNOWLEDGEMENTS

This research was supported by the research budget of JAXA. The research results will be used for the JJ-FAST system, funded by JICA (Japan International Cooperation Agency) and JAXA, and will be used for early-deforestation detection in global tropical forests.