FNF product status

Time series analysis of the radar backscatter and forest area

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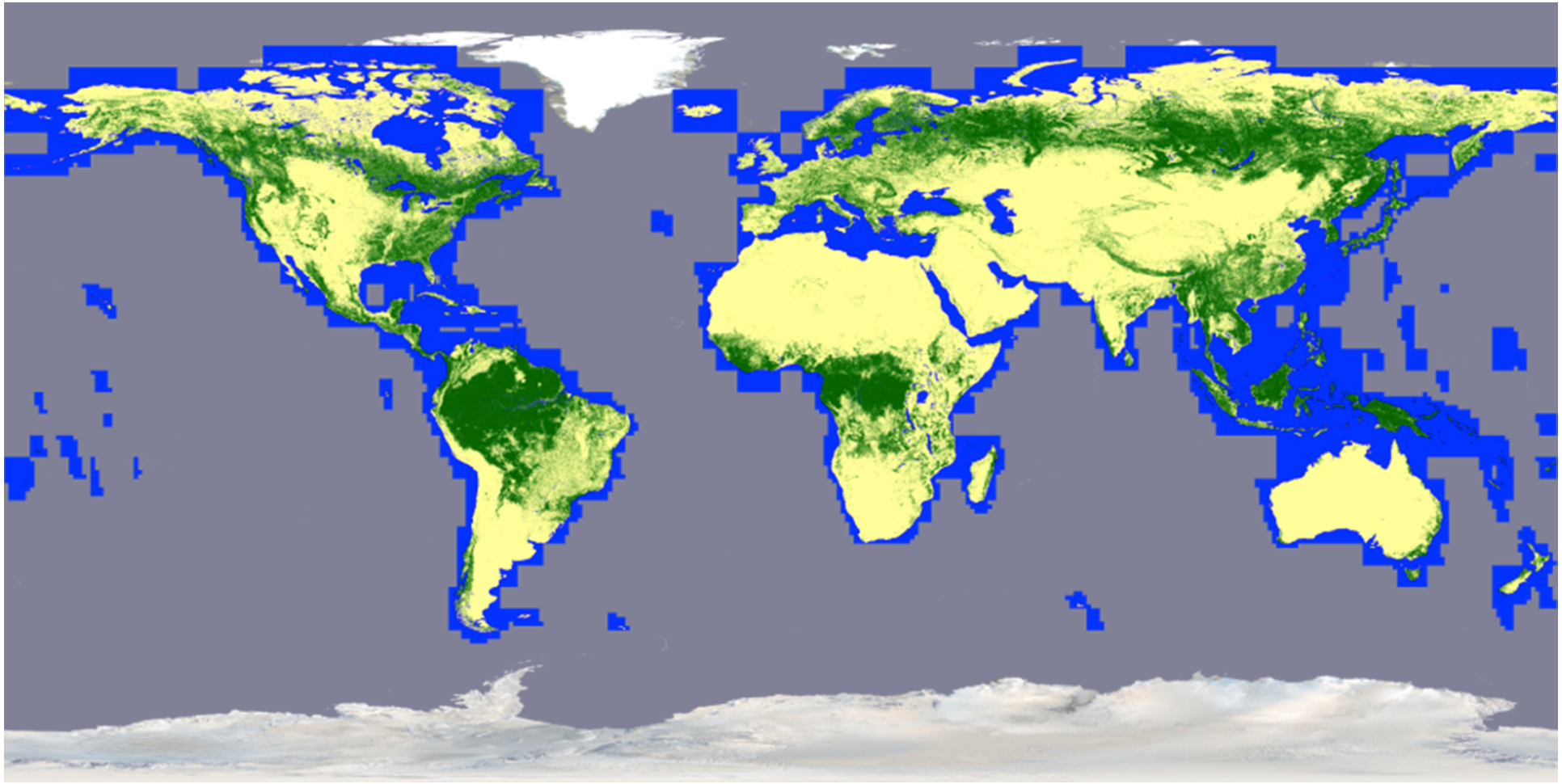
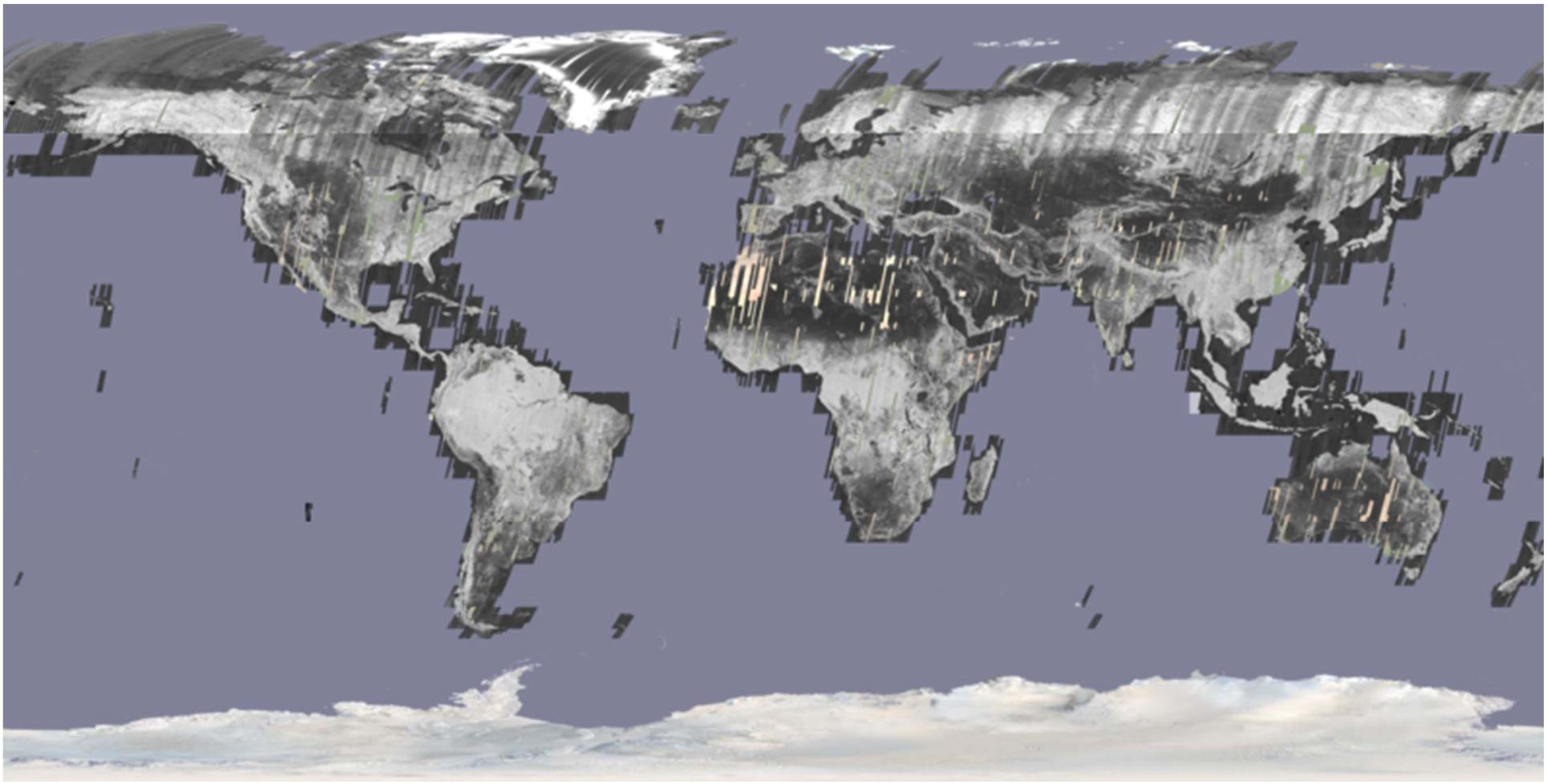
PALSAR 10m Global Forest/Non-Forest Map 2009



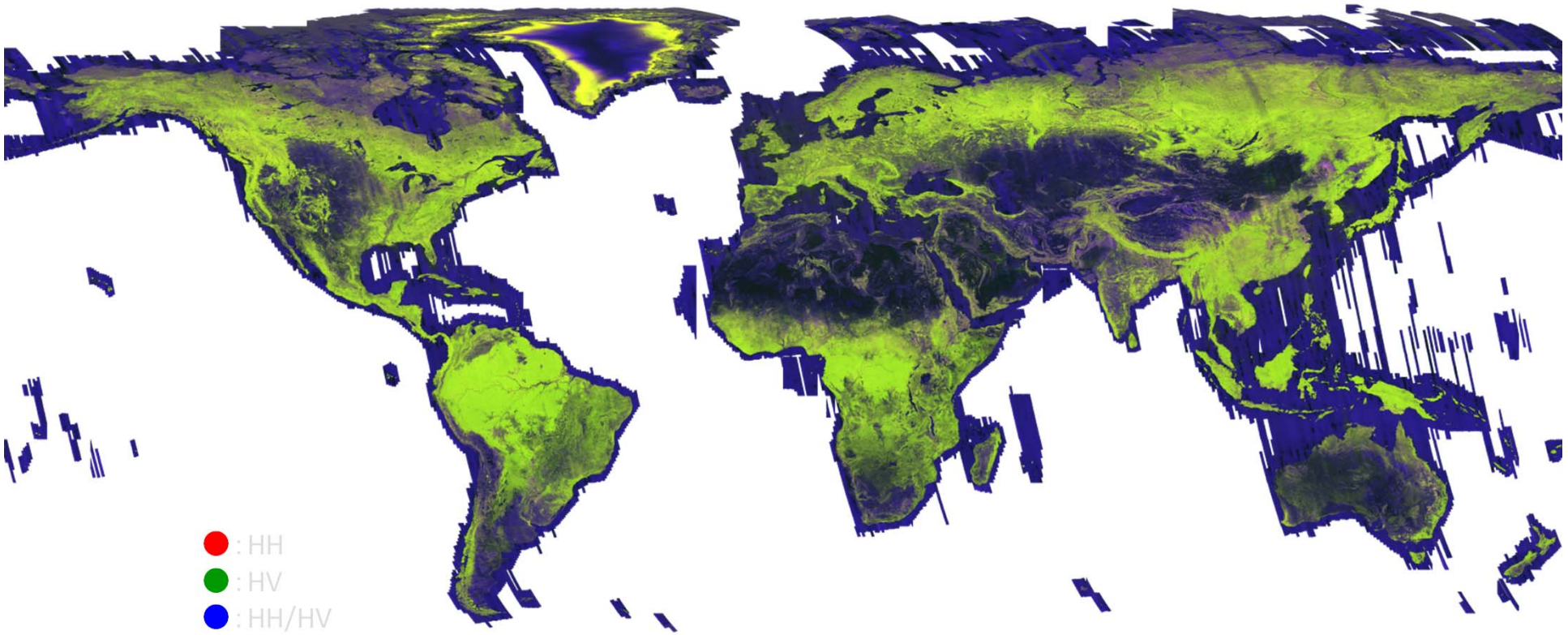
What is forest and non-forest?

- Previous version -14dB threshhold
- Saturation level?
- Country dependent definition
- 20% of forest cover

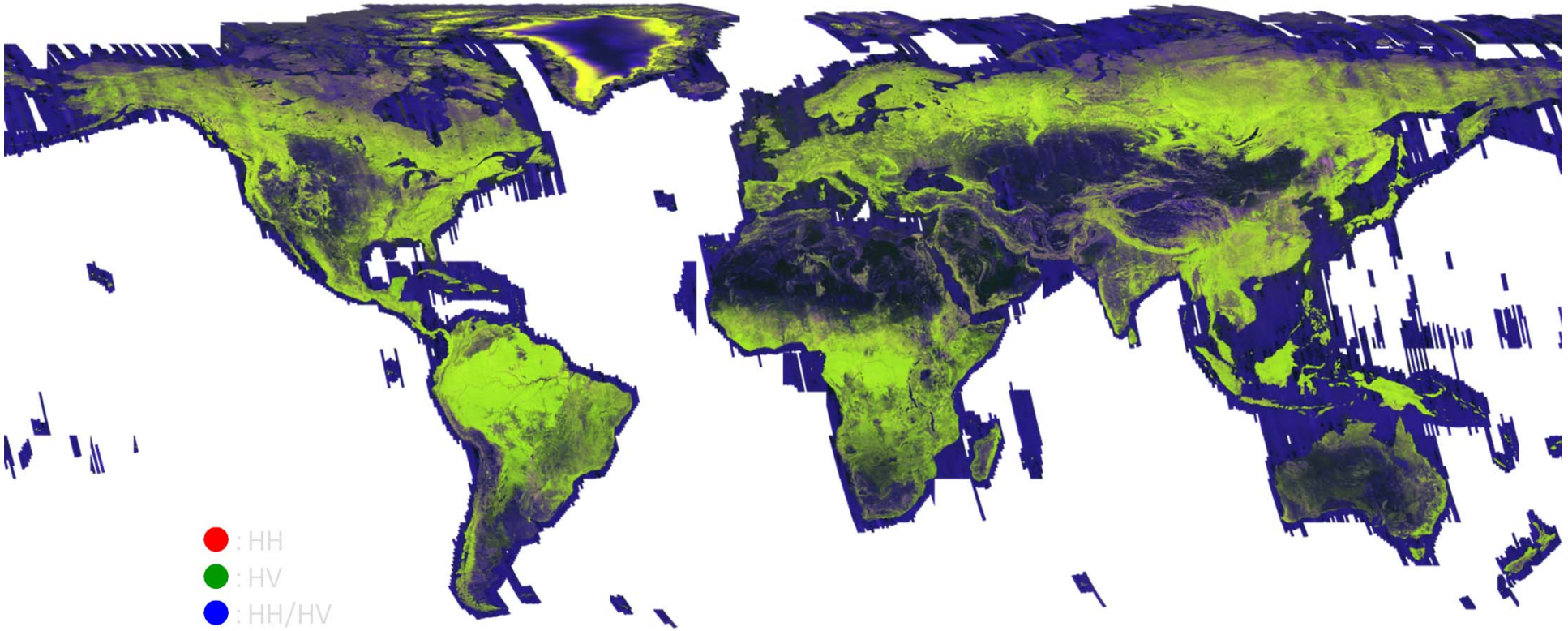
JERS-1 SAR 25m Mosaic- 1995
HH Image



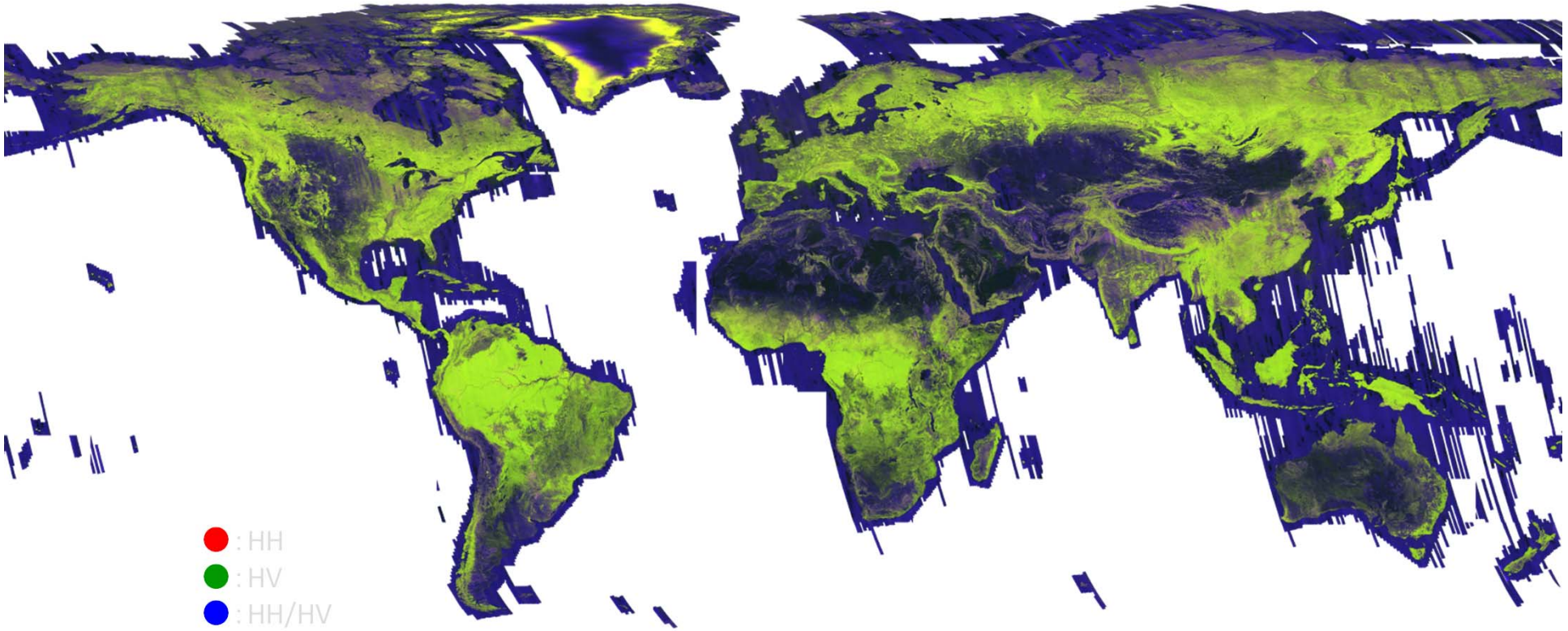
PALSAR 25m Mosaic 2007
RGB Composite Image



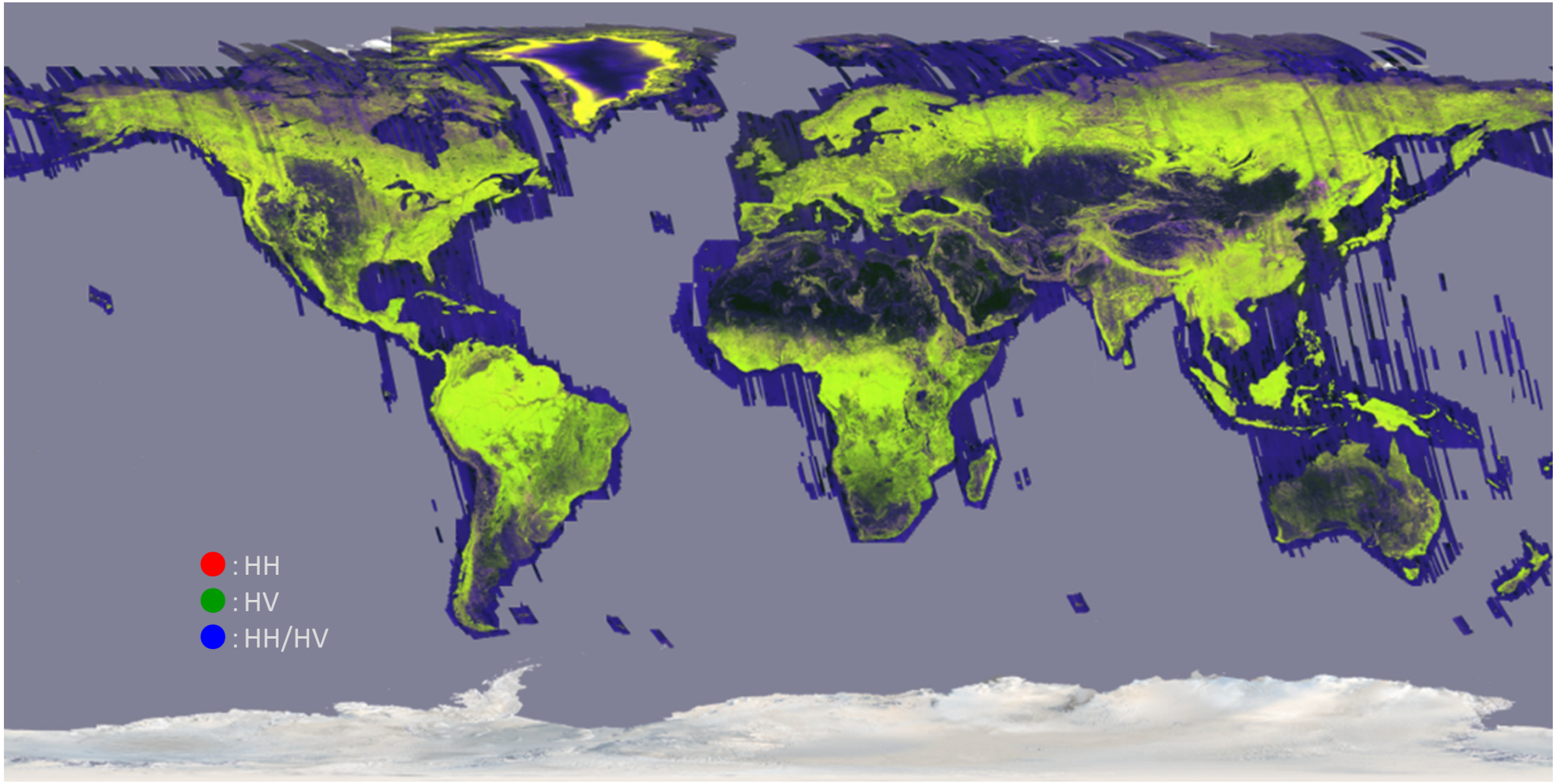
PALSAR 25m Mosaic 2008
RGB Composite Image



PALSAR 25m Mosaic 2009
RGB Composite Image



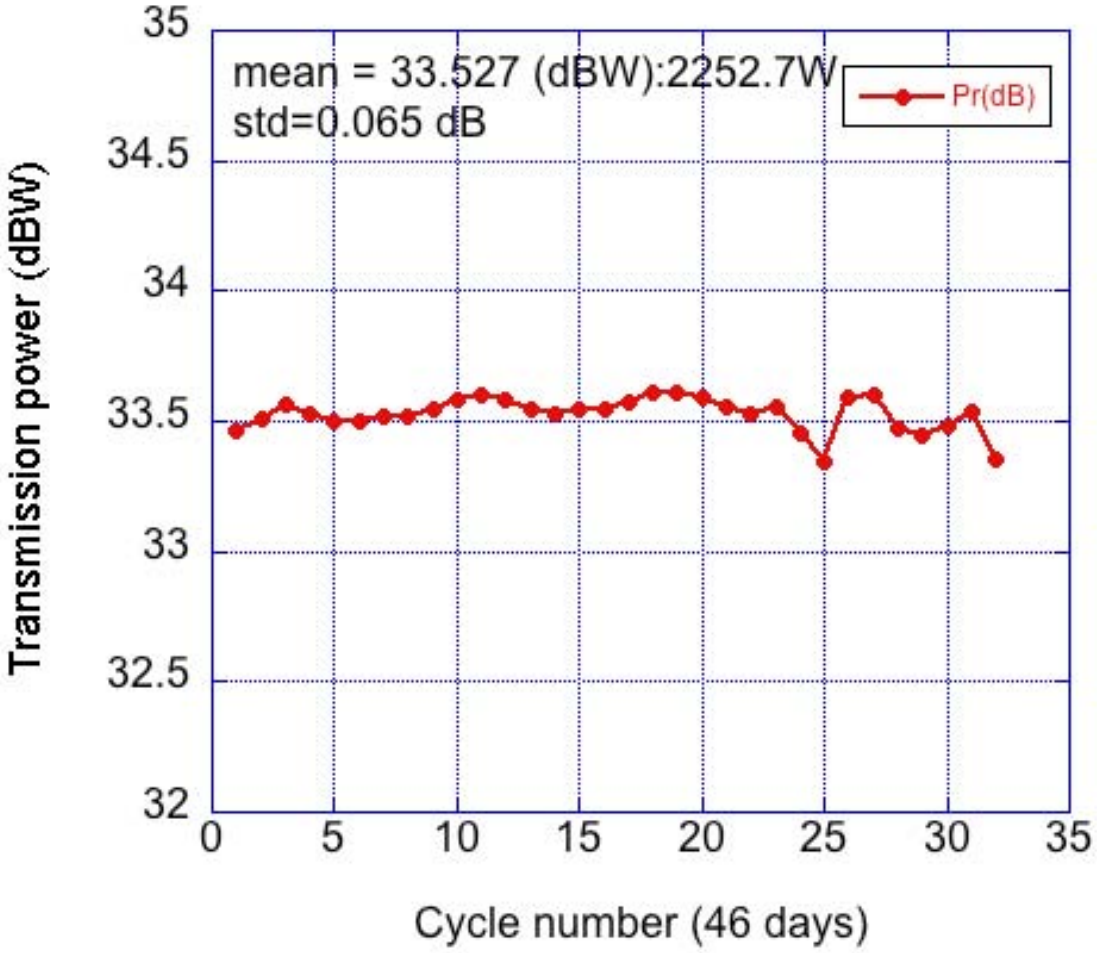
PALSAR 25m Mosaic 2010
RGB Composite Image



Evaluation of the SAR data set

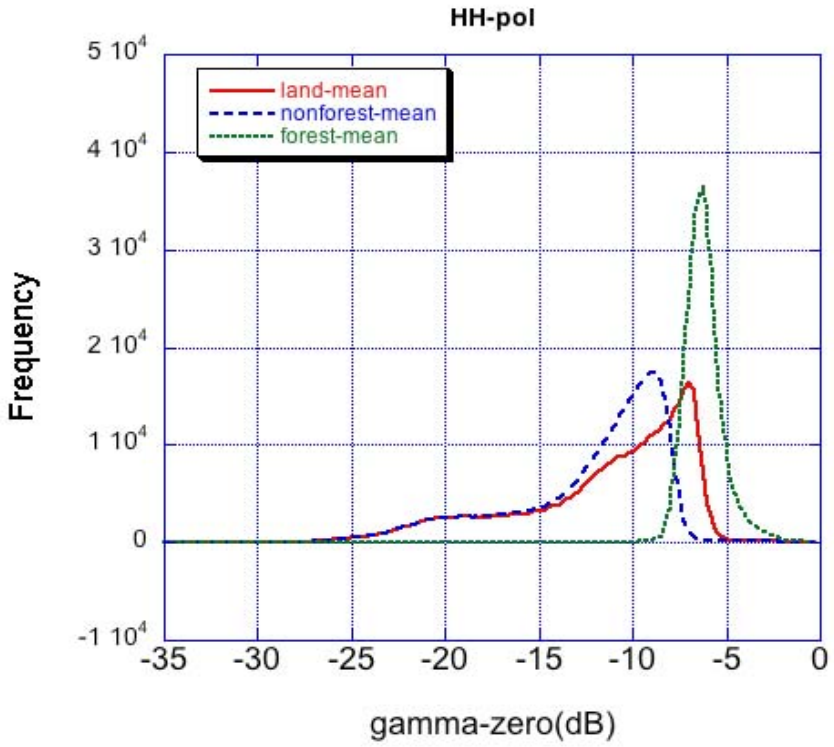
- Stability
- Relationship between gamma-naught and the forest status
- Histogram
- Locality

PALSAR stability

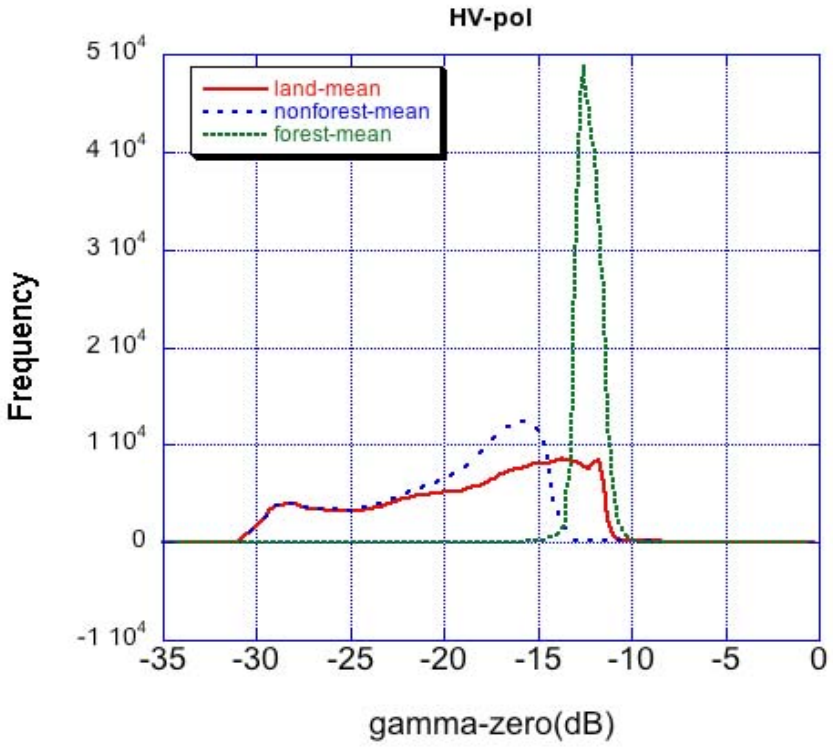


RMS = 0.06 dB ⟷ 4 years

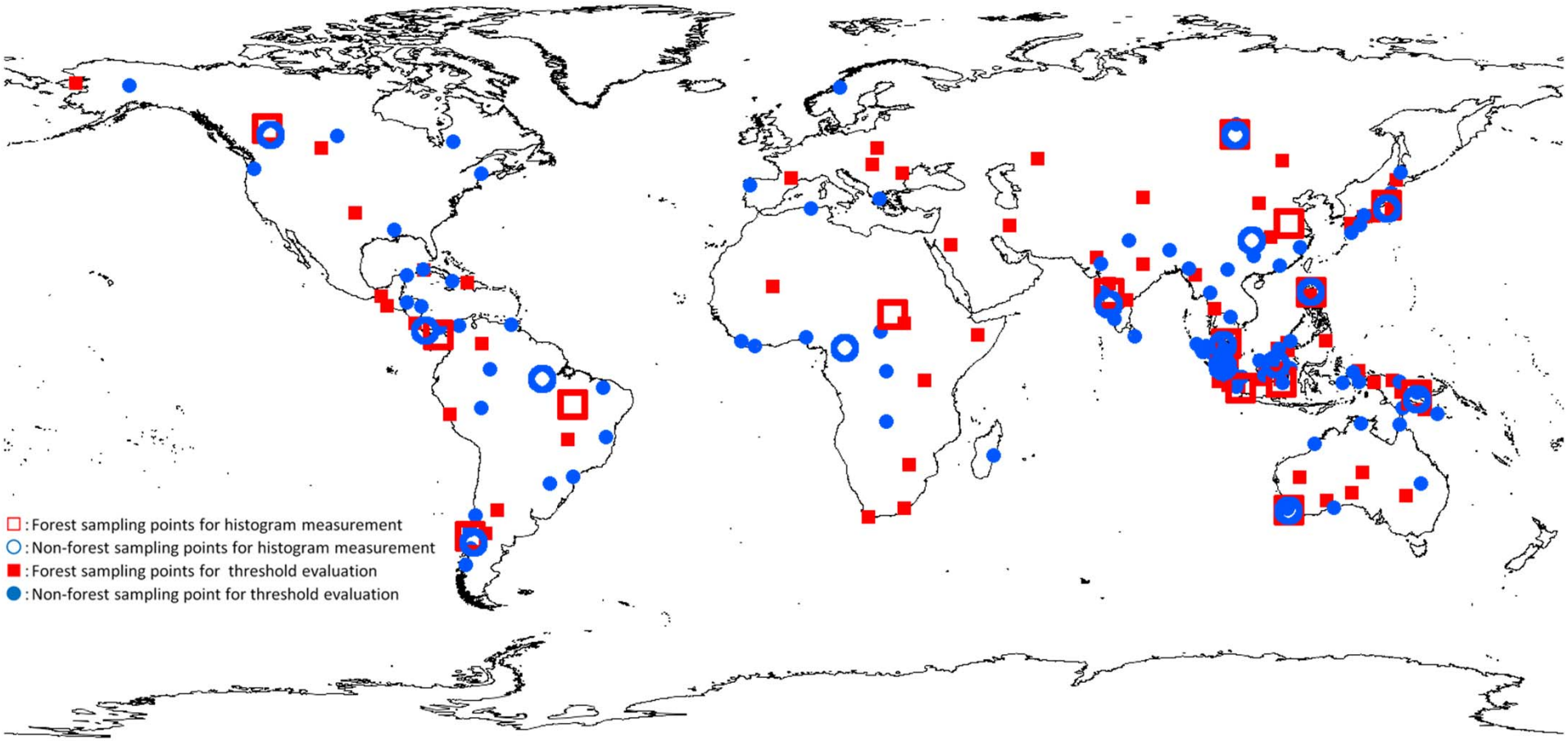
Forest/Non-forest property WRT radar backscatter



HH polarization



HV polarization


□ : Forest sampling points for histogram measurement
○ : Non-forest sampling points for histogram measurement
■ : Forest sampling points for threshold evaluation
● : Non-forest sampling point for threshold evaluation

Typical distribution of the Forest/Non-forest at the 19 different areas

		Forest				Non-Forest			
		HH		HV		HH		HV	
		mean	standard div	mean	standard div	mean	standard div	mean	standard div
1.	Sumatra	−7.19	1.46	−11.86	1.41	−7.35	1.36	−12.39	1.38
2.	NewGuinea	−6.90	1.46	−11.98	1.45	−6.70	1.84	−13.15	2.22
3.	Borneo	−6.59	1.19	−11.51	1.17	−6.84	1.28	−12.21	1.26
4.	Malaysia	−6.70	1.39	−11.69	1.35	−7.16	2.02	−15.18	1.82
5.	Philippines	−8.03	2.17	−12.64	2.07	−9.19	3.80	−18.64	2.57
6.	East Asia	−7.63	2.80	−12.79	2.46	−9.29	3.05	−19.31	3.05
7.	Japan	−6.26	1.92	−11.26	1.78	−7.07	3.17	−15.17	3.18
8.	India	−6.06	1.77	−11.47	1.60	−8.84	2.13	−20.05	2.91
9.	Europe	−5.85	1.38	−10.36	1.35	−10.96	2.57	−18.34	2.72
10.	Russia	−5.31	1.42	−10.65	1.40	−8.27	1.81	−16.00	2.57
11.	Australia (West)	−8.98	1.33	−15.32	1.58	−10.47	1.74	−17.89	1.80
12.	Australia(East)	−8.02	1.50	−13.29	1.56	−9.67	2.31	−17.41	2.49
13.	Amazon	−6.60	1.50	−11.48	1.45	−7.41	2.91	−13.61	3.15
14.	Chile	−6.89	1.85	−12.21	1.79	−8.41	1.92	−15.38	2.55
15.	Africa (Central)	−6.01	1.28	−11.84	1.37	−6.96	1.75	−13.33	2.04
16.	Africa (South East)	−7.03	1.66	−12.38	1.59	−10.57	3.13	−17.85	2.74
17.	USA (South East)	−5.70	1.79	−10.71	1.66	−8.73	3.64	−14.64	3.57
18.	North America	−6.36	1.67	−12.78	1.90	−7.53	1.47	−15.03	1.90
19.	Central America	−8.08	2.52	−13.02	2.37	−8.58	3.27	−16.95	3.04

Stability of the gamma-naught at the forest area/non-forest area for 19 different test sites.

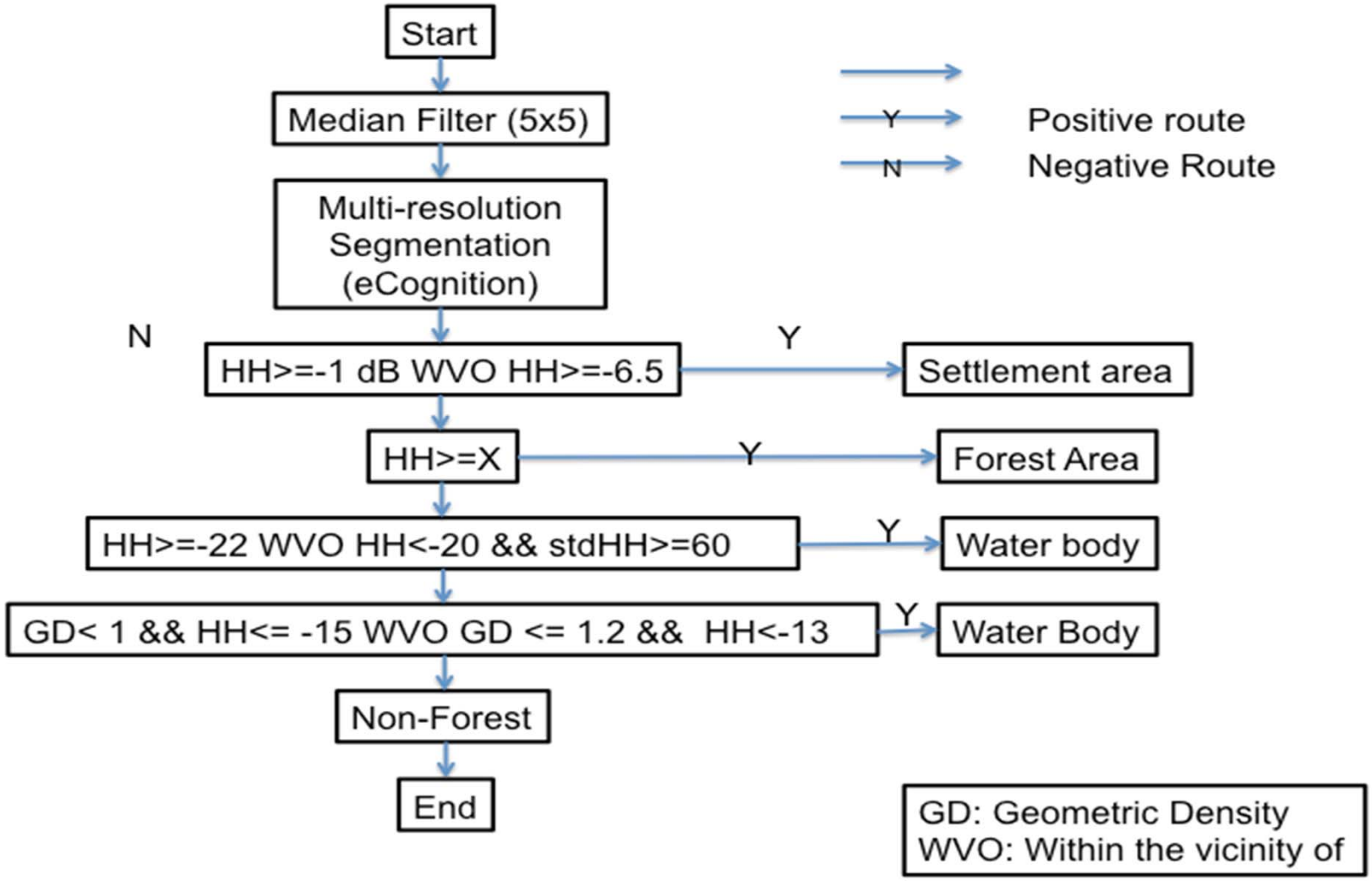
Area	HH (dB)	HV (dB)
Sumatra	-7.68 (0.05), 2.84	-12.54 (0.04), 2.72
New Guinea	-6.86 (0.02), 2.41	-11.62 (0.01), 2.32
Borneo	-6.96 (0.02), 1.90	-11.77 (0.02), 1.80
Malaysia	-7.09 (0.14), 2.04	-11.96 (0.14), 1.94

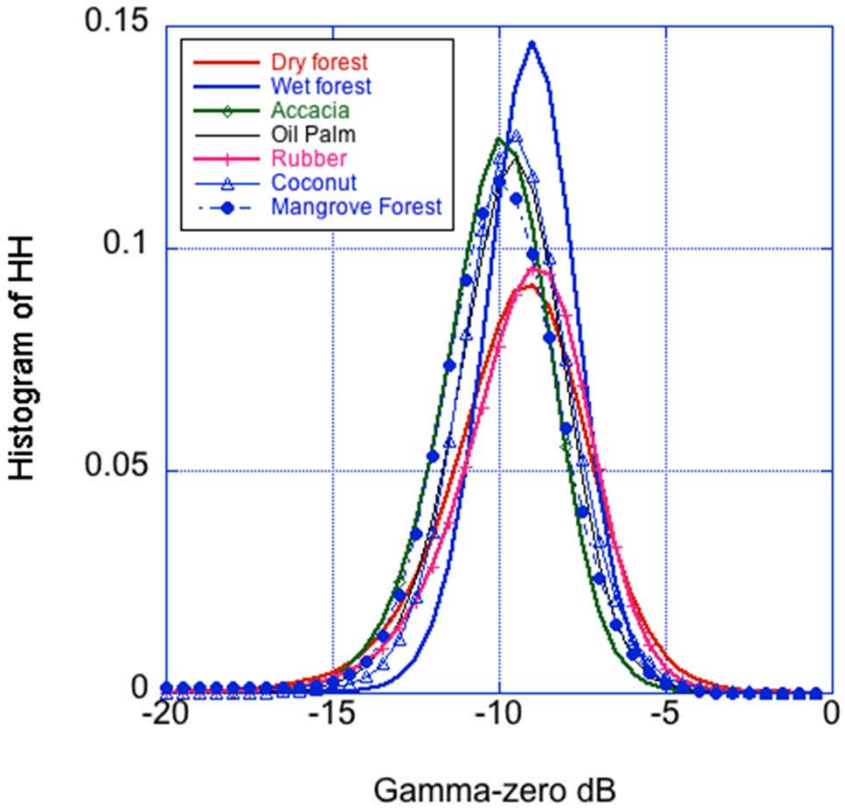
Total	HH (dB)	HV (dB)
mean	-6.93 (-5.56~-8.52)	-12.12(-10.75~-14.45)
Dev. of 4 means	0.07(0.01~0.17)	0.054(0.01~0.14)
STD_vari.	1.4714(1.46~3.25)	1.4440(1.38~3.10)

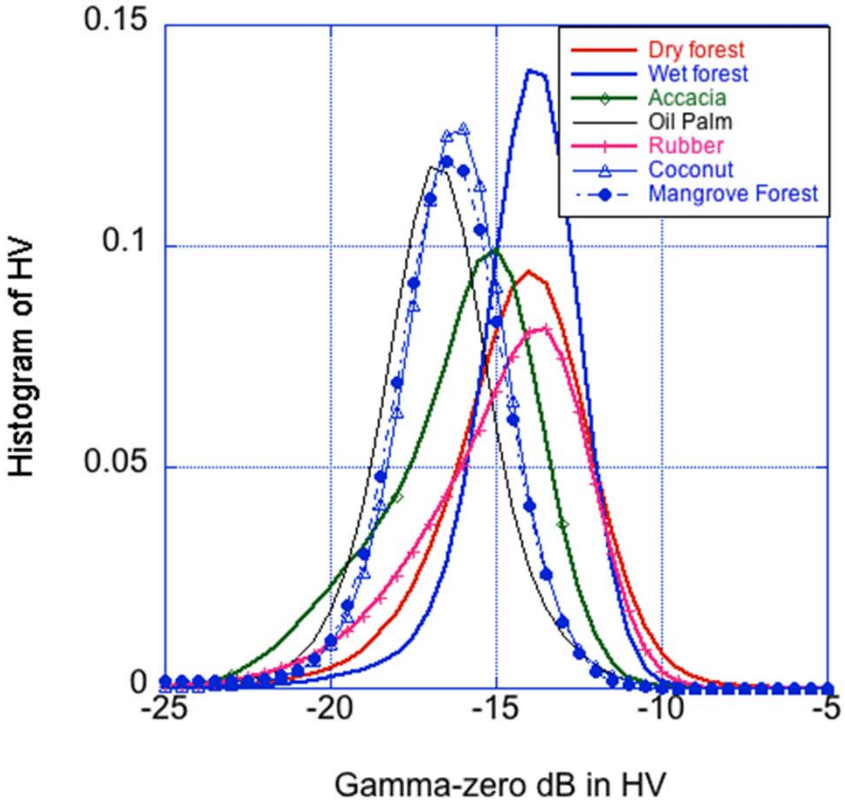
σ σ

3. Generation of the forest/non-forest Classification

- Histogram Measurements at several different areas
- Threshold determination
- Segment based classification: Process flow


Start
Median Filter (5x5)
Multi-resolution Segmentation (eCognition)
HH>=-1 dB WVO HH>=-6.5
Y
Settlement area
N
HH>=X
Y
Forest Area
HH>=-22 WVO HH<-20 && stdHH>=60
Y
Water body
GD< 1 && HH<= -15 WVO GD <= 1.2 && HH<-13
Y
Water Body
Non-Forest
End
Y
Positive route
N
Negative Route
GD: Geometric Density
WVO: Within the vicinity of


Histogram of HH
0.15
0.1
0.05
0
-20
-15
-10
-5
0
Gamma-zero dB
Dry forest
Wet forest
Accacia
Oil Palm
Rubber
Coconut
Mangrove Forest


Histogram of HV
0.15
0.1
0.05
0
-25
-20
-15
-10
-5
Gamma-zero dB in HV
Dry forest
Wet forest
Accacia
Oil Palm
Rubber
Coconut
Mangrove Forest

Determination of the threshold

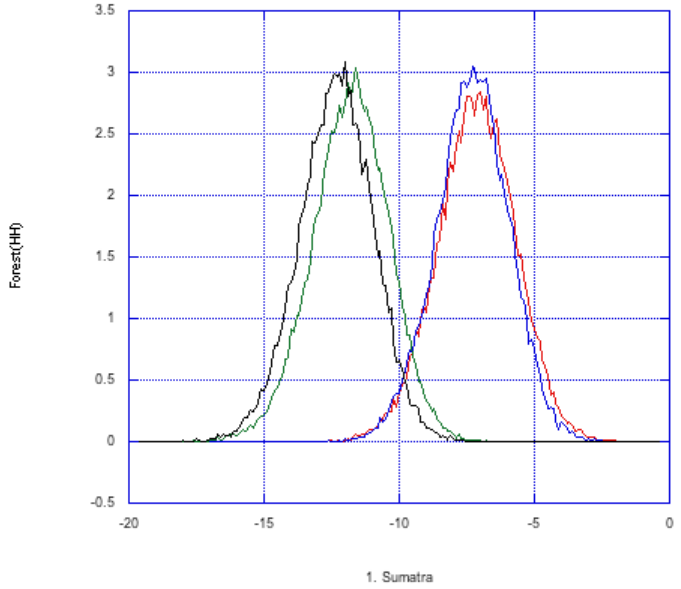
1) Measure the DF of “Forest” & “Non-F”
2) Calculate the Cumulative DFs and measure the “threshold” that maximizes the both.

$$F_F(x) = 1 - F_{NF}(x)$$

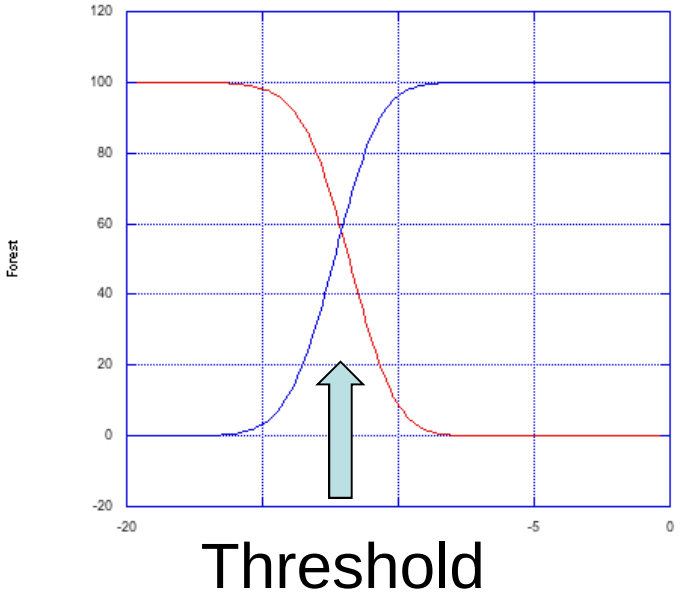
$$F_F(x) \equiv \int_x^{\infty} f_F(x')dx'$$

$$F_{NF}(x) \equiv \int_{-\infty}^{x} f_{NF}(x')dx'$$

Histograms for Forest & Non-forest (Accassia)

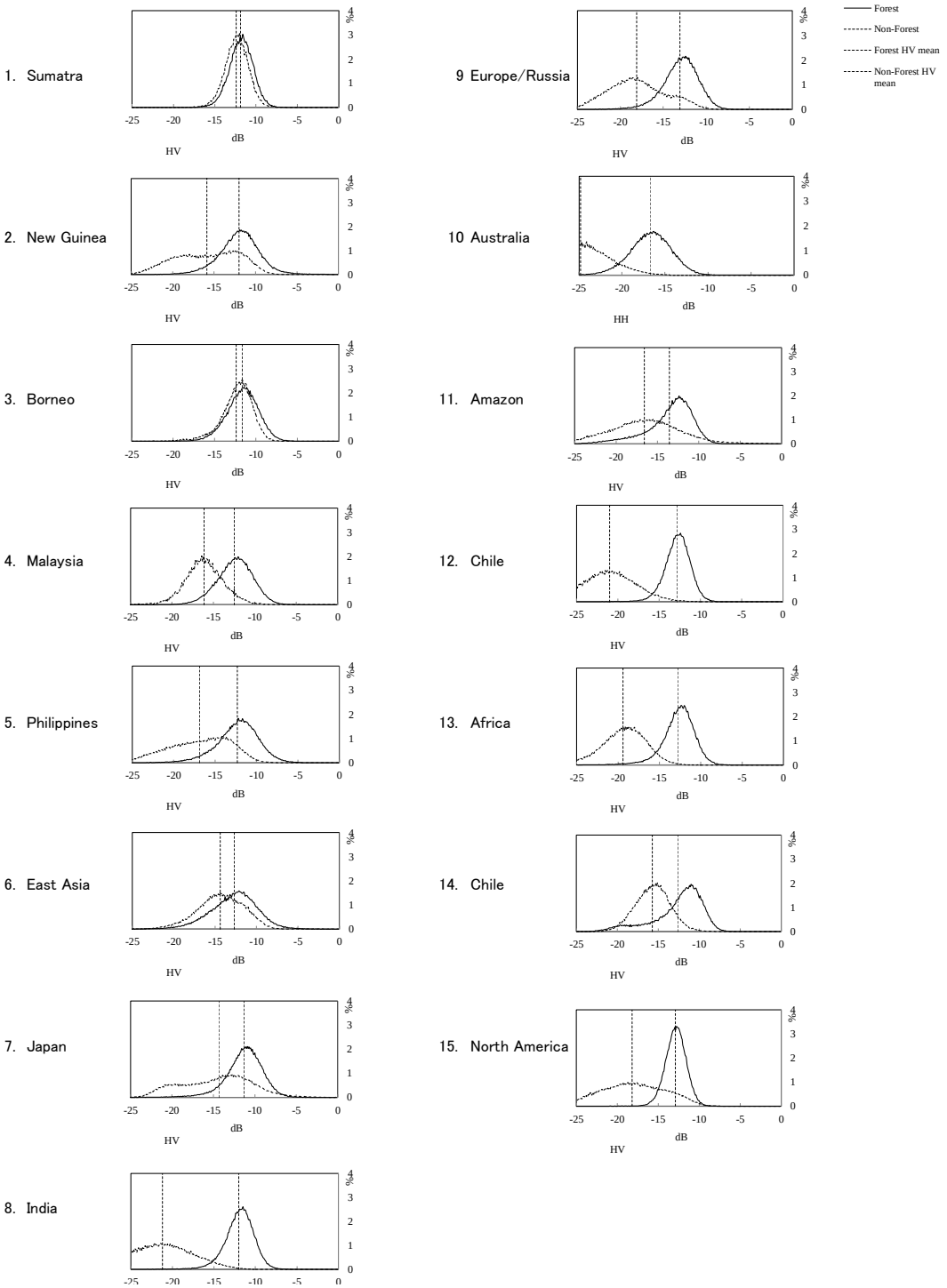


Cumulative Distribution Fn.

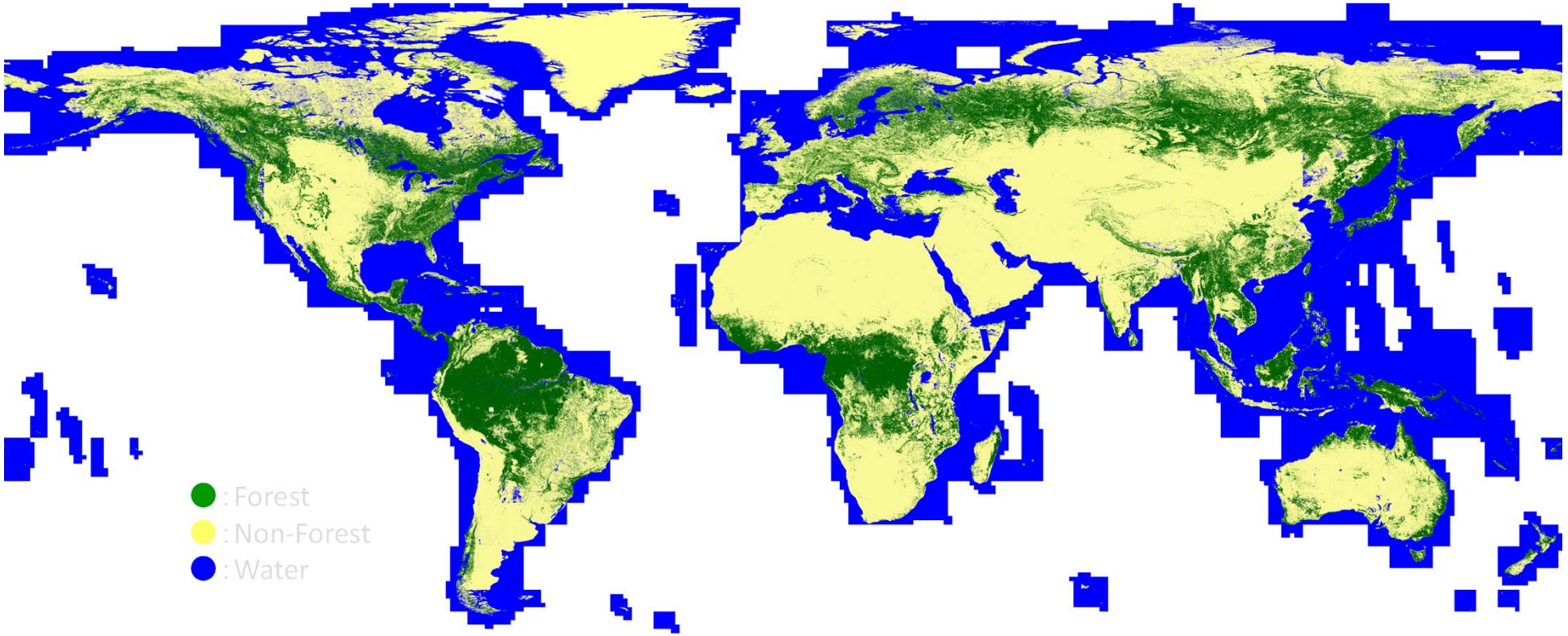


Sumatra Case

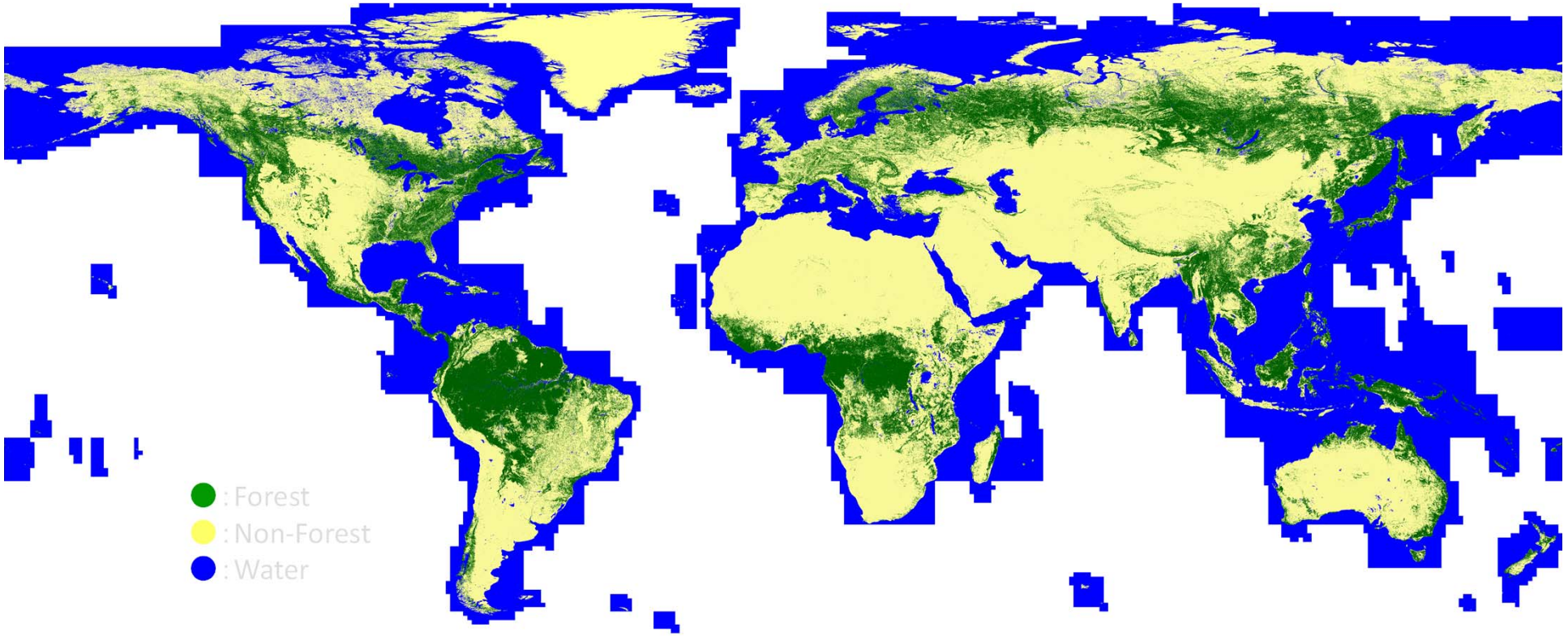
Threshold


1. Sumatra
2. New Guinea
3. Borneo
4. Malaysia
5. Philippines
6. East Asia
7. Japan
8. India
9 Europe/Russia
10 Australia
11. Amazon
12. Chile
13. Africa
14. Chile
15. North America
Forest
Non-Forest
Forest HV mean
Non-Forest HV mean
%
dB
HV
HH
-25 -20 -15 -10 -5 0
0 1 2 3 4

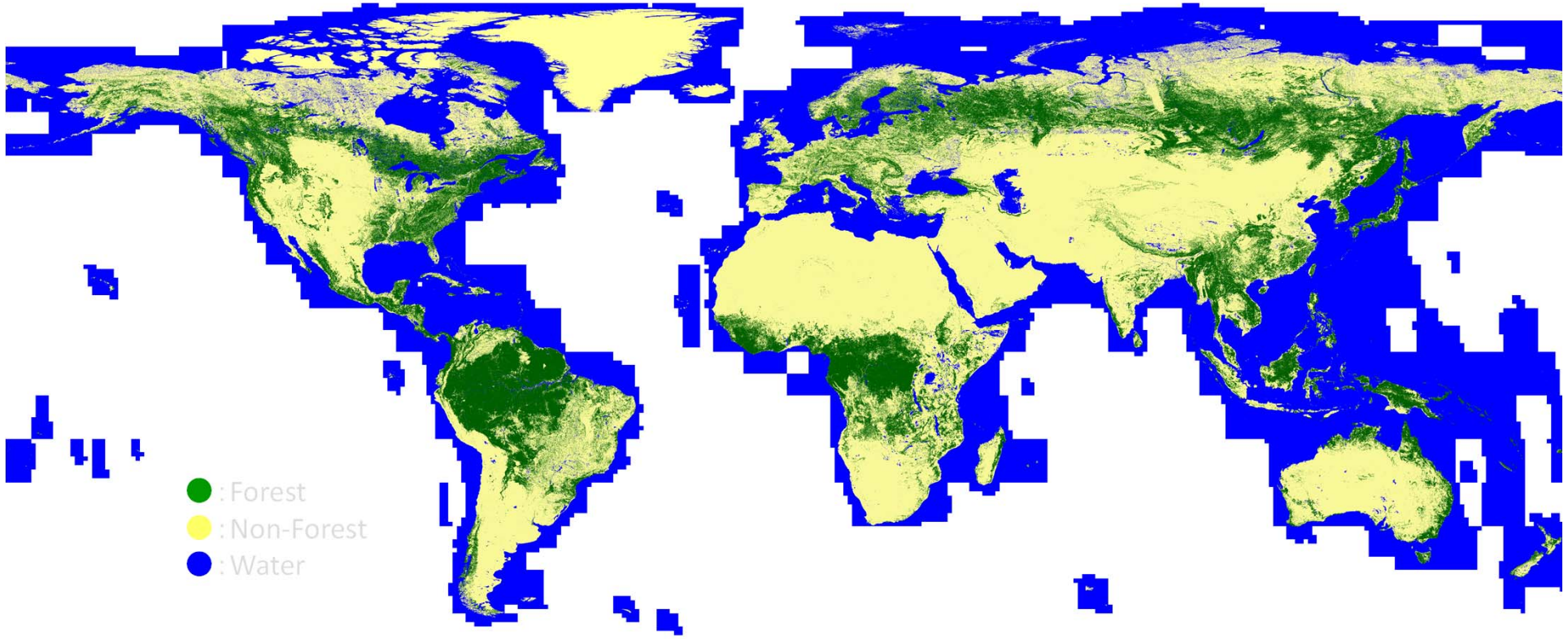
PALSAR 25m Mosaic 2007
Forest/Non-Forest Map, (produced in 2013, Feb.)



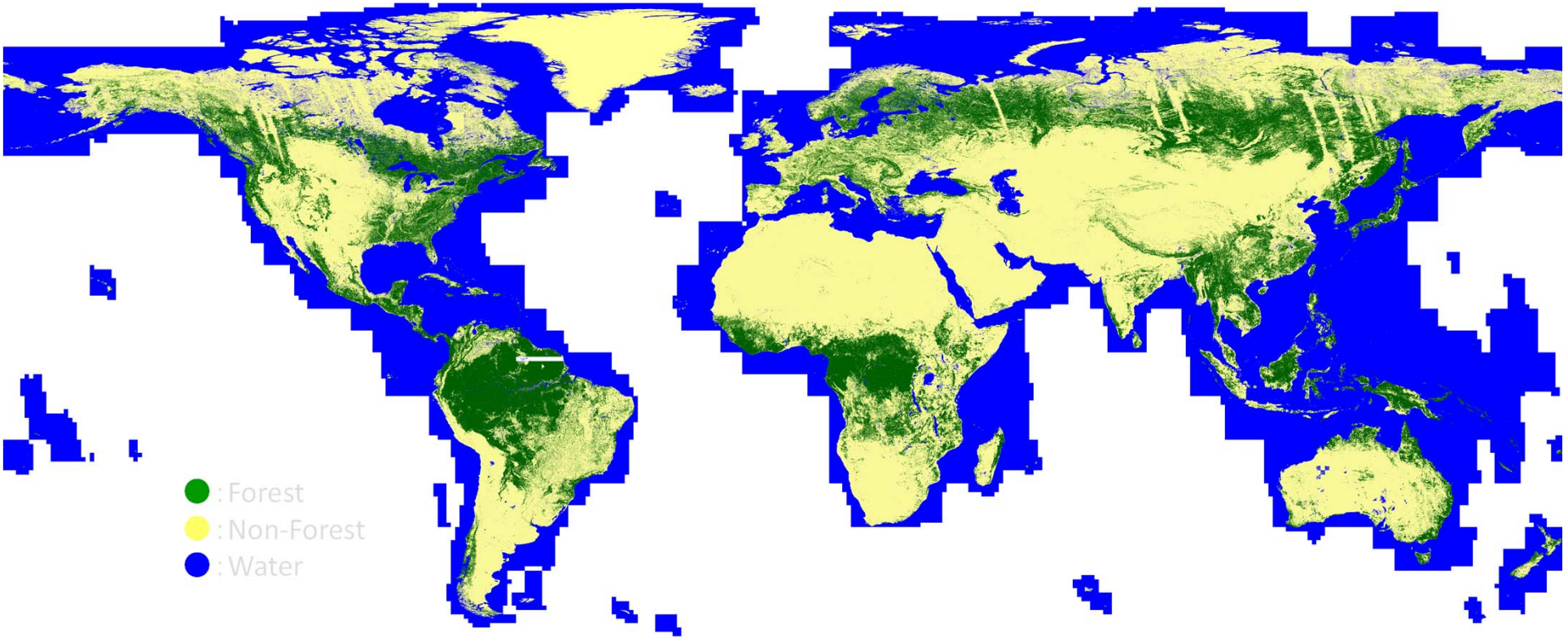
PALSAR 25m Mosaic 2008
Forest/Non-Forest Map, (produced in 2013, Feb.)



PALSAR 25m Mosaic 2009
Forest/Non-Forest Map, (produced in 2013, Feb.)



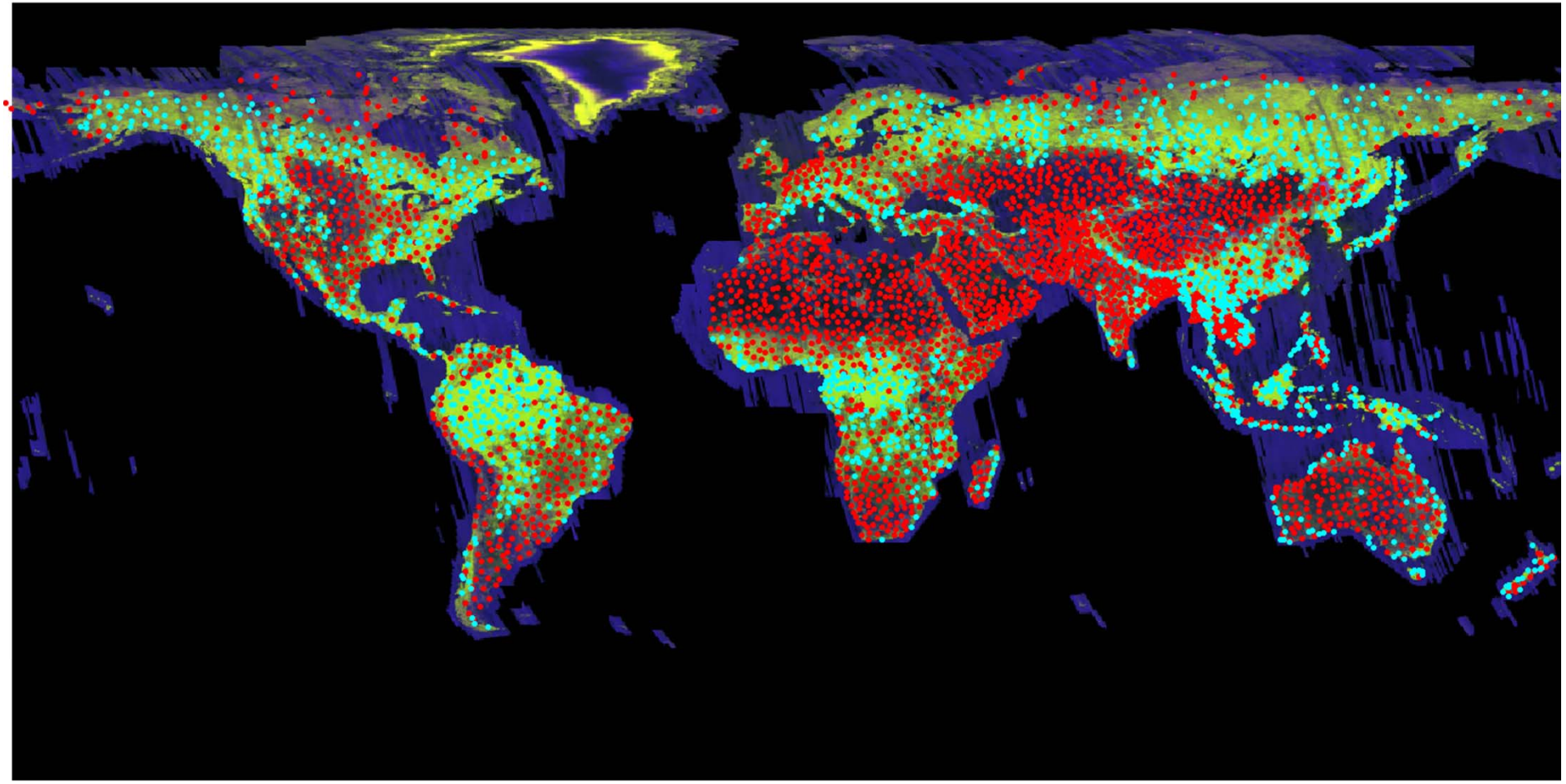
PALSAR 25m Mosaic 2010
Forest/Non-Forest Map, (produced in 2013, Feb.)



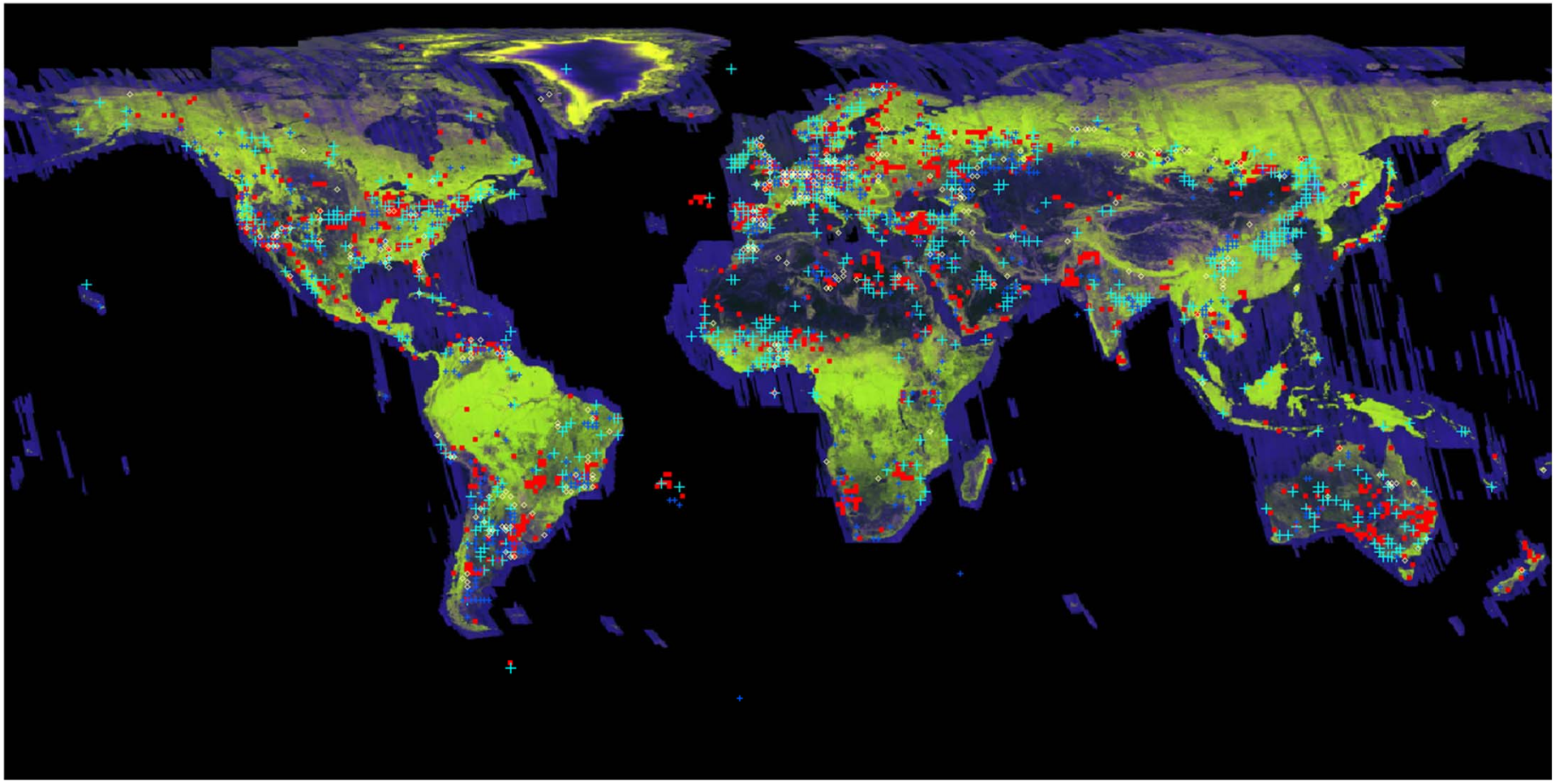
Validation

- Direct Comparison with GE image based Forest Info.
- Direct Comparison with DCP based info.
- Comparison with FRA 2010
- Change of the FNF info.

Validation Using the GE images



Degree Confluence Project (DCP)



Accuracy measure of the FNF using the database

Year	GE	DCP
2007	91.49	85.19
2008	90.58	84.78
2009	90.98	82.36
2010	91.93	87.14
Mean	**91.25**	**84.86**

Note: GE>4000 points, DCP>2000 points

Summary 2

- Time series Global Mosaic can tell us the forest decrease as well as the gamma-naught decrease.
- Annual Forest decrease rate could be -281,180 km2/year rate while FRA has -280,000km2/year.

Conclusion

- L-band time series SAR data showed the decrease of backscatter and forest areas.
- This means that the earth surface becomes smoother than before.
- JERS-1 SAR will be included in near future for longer time variation and ALOS-2/PALSAR-2 will be used for forest variation after 2013.

Acknowledgements

- Great Thanks to RESTEC researchers
- T. Yamanokuchi, T. Itoh, O. Isoguchi, and H. Okumura