# Modeling of LiDAR and Imager data on MOLI instruments

**– Algorithms for MOLI along-track 1 km-width products –**

Yoshito Sawada (NIES)

# Contents

1. Outlines along-track products

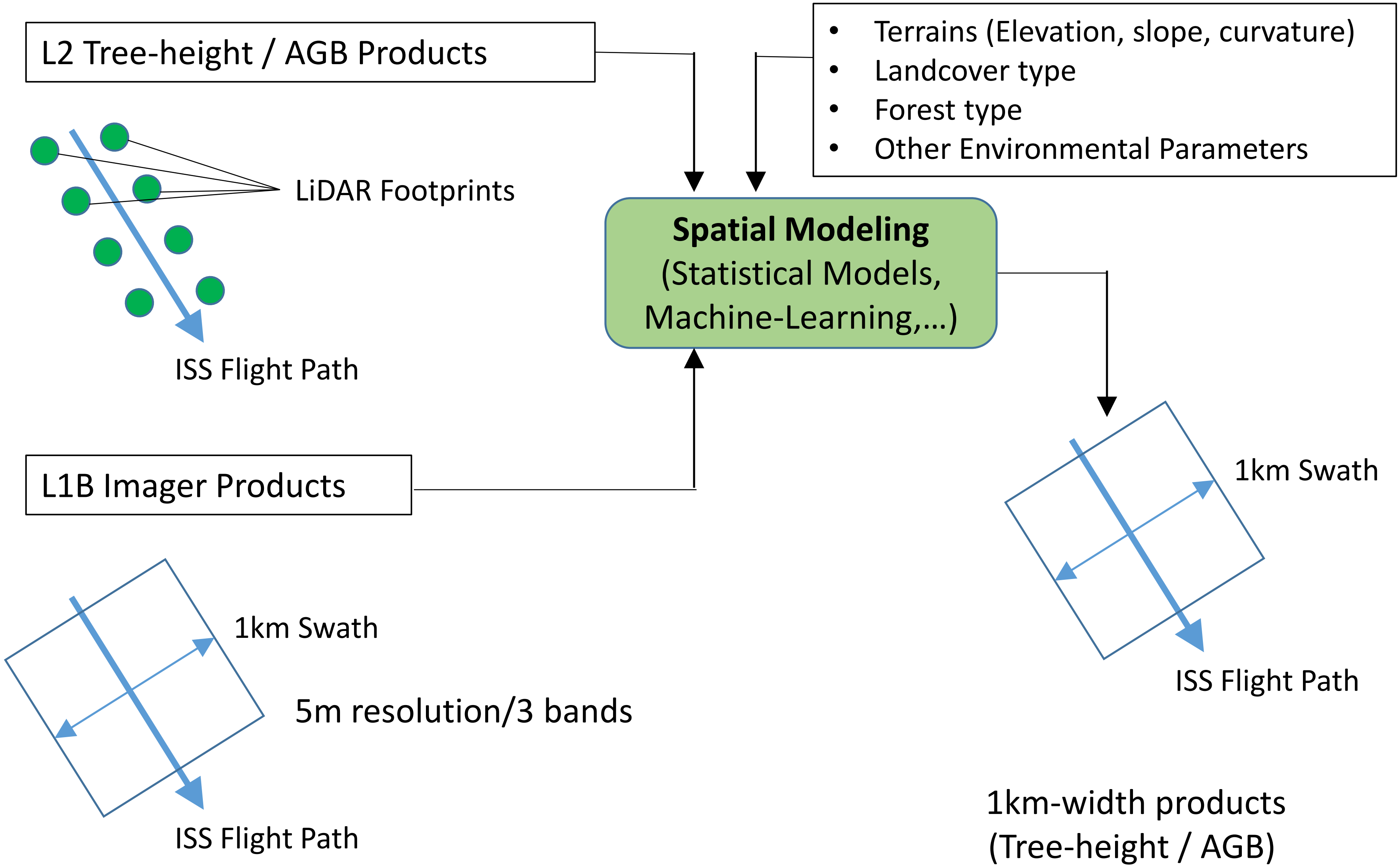
2. Process Flow to make along-track products

3. Spatial Modeling Algorithms
    - Statistical Modeling
    - Machine Learning

# Outlines along-track products

- Along-track 1km width (same as swath of MOLI imager)
- Expanding LiDAR data by spatial modeling
- Data Sets:
  1. Tree-height
     Canopy Height (RH100), RH90, RH80, RH70,…, RH10
  2. Above Ground Biomass
- Spatial Resolution:
  50(m) (TBD)
- Input for
  Producing L3 wall-to-wall tree-height / biomass maps with uncertainty at global scale

# Process Flow to make along-track products



# Development of Spatial Modeling Algorithms

Objectives:

To develop methodologies of producing Tree-height maps by using LiDAR and Imager data

We are trying three approaches:

1. **Statistical Model** (FOTO, Proisy et al., 2012)
2. Convolutional Neural Network (Krizhevsky et al., 2012)
3. **Machine Learning Method** (SOR, Sawada et al. 2015)

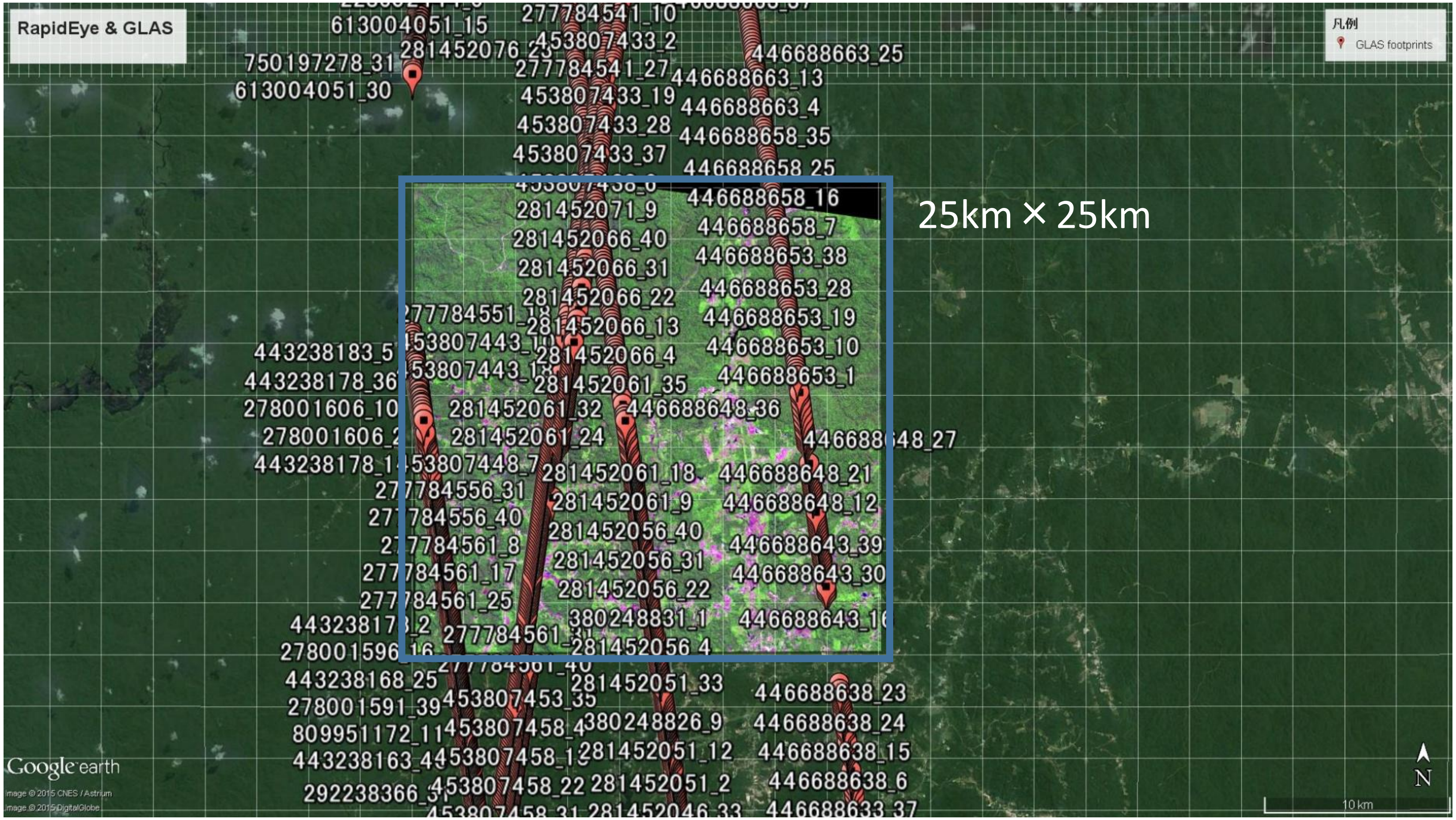
Data used:

LiDAR: ICESat/GLAS (GLA01, GLA14)

Imager: RapidEye (1 and 2) 5m/5bands

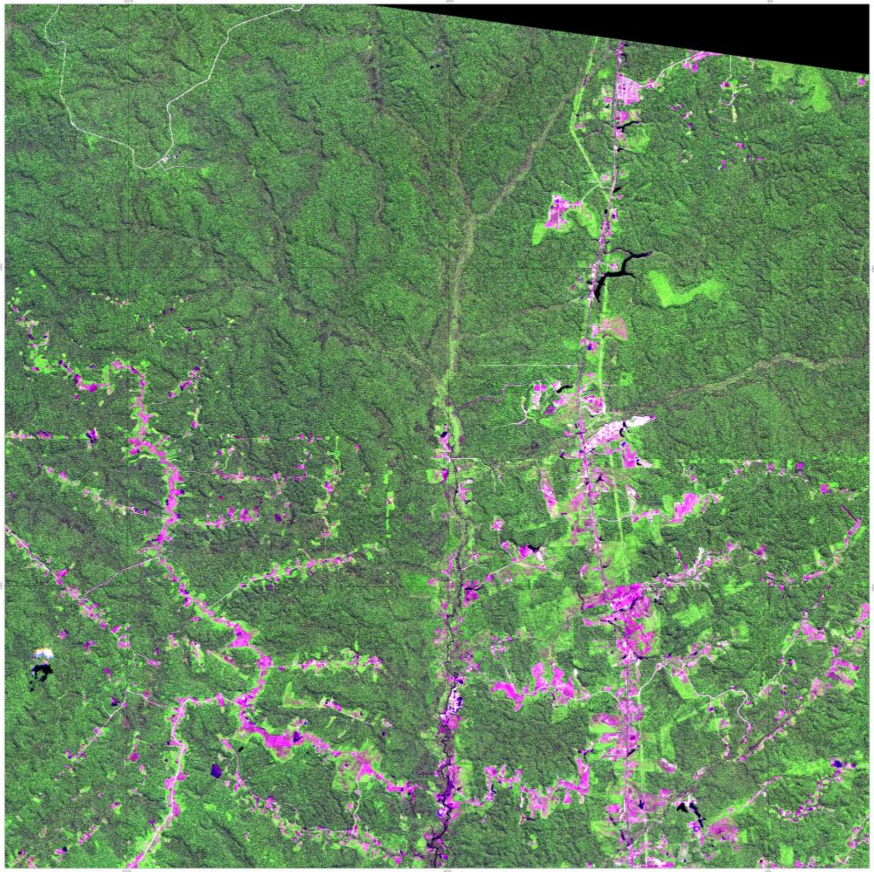
MODIS, GSMaP, SRTM (3)

# Spatial Modeling of LiDAR and Imager

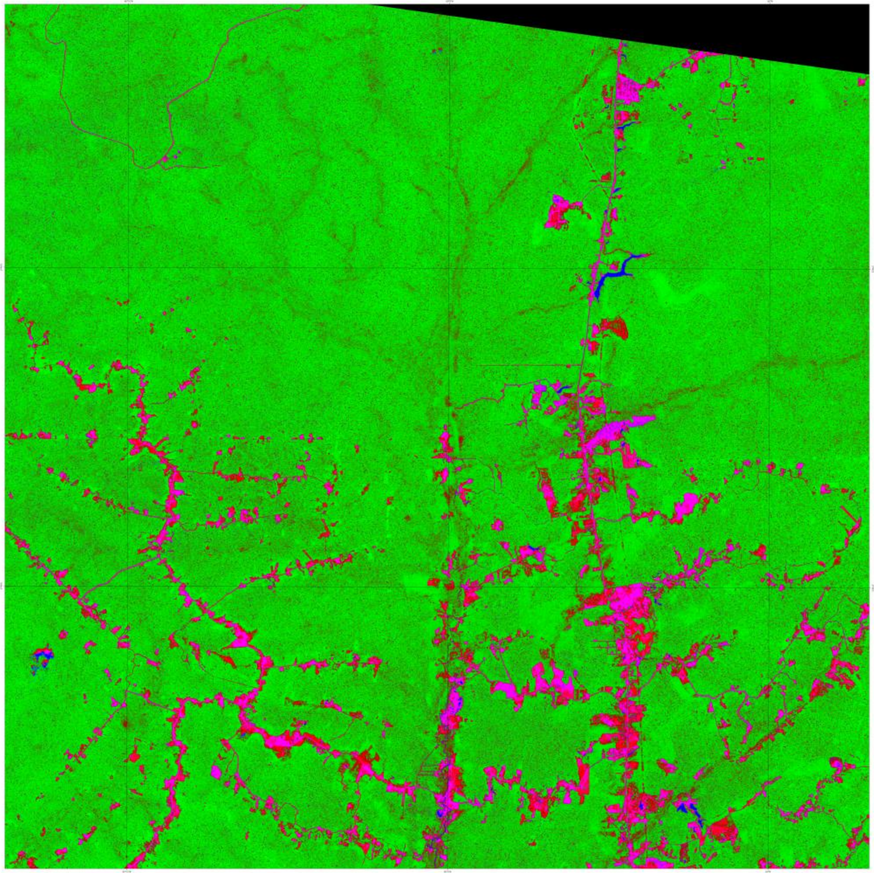



- RapidEye (5m/5 bands) → Vegetation Fraction, Spatial Frequency (Texture)

# Making A Forest Mask



R/G/B = 4/5/2



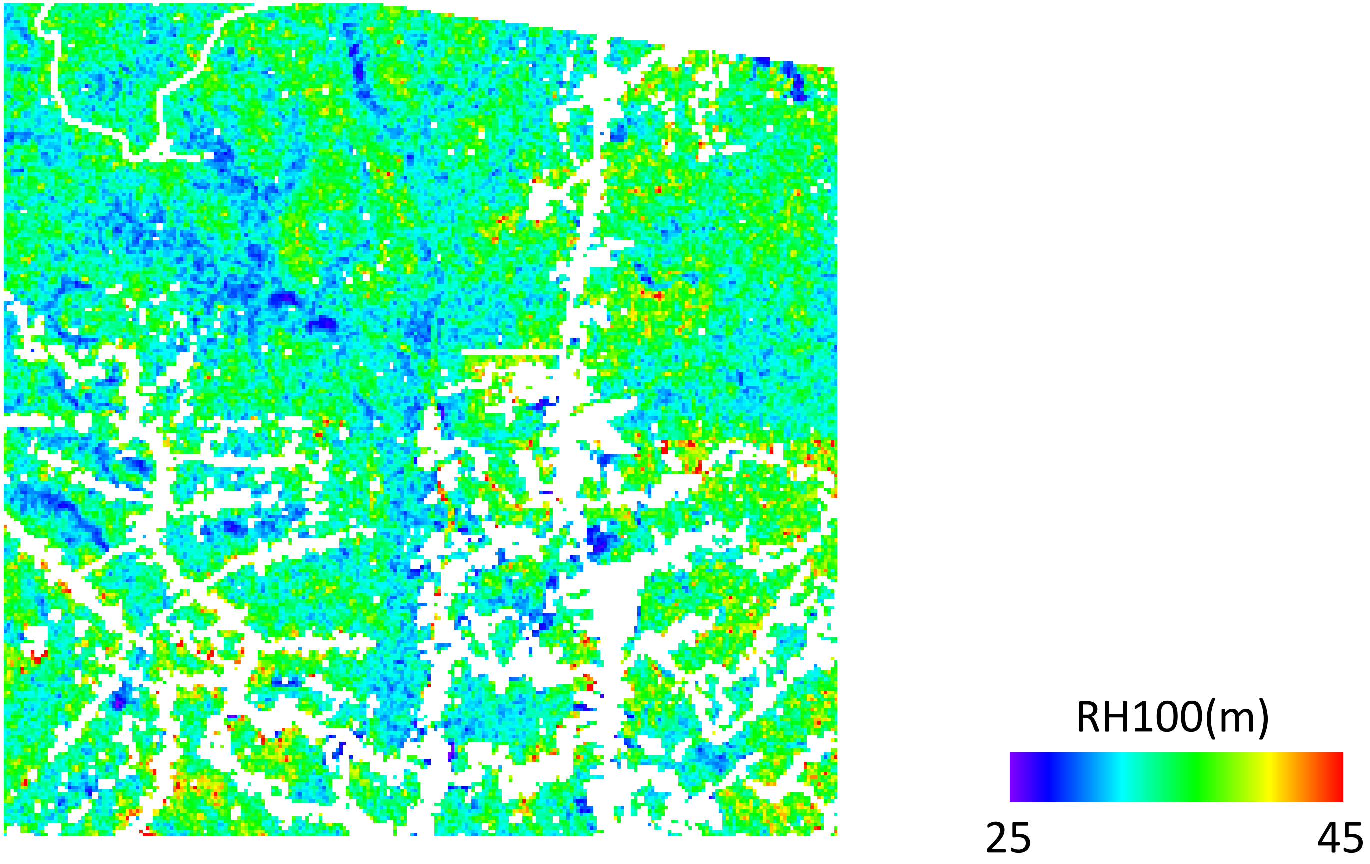
R/G/B = Soil/Vegetation/Water

Enhance:

| | |
|---|---|
| R | 0.0～0.5 |
| G | 0.5～1.0 |
| B | 0.0～0.2 |

# Preliminary Results by modified FOTO:

A Canopy-Height (RH100) Map with 100m resolution




- Need to validation (by Cross-Validation, canopy height from UAV measurements, …)

# Machine Learning Method (Course Resolution)

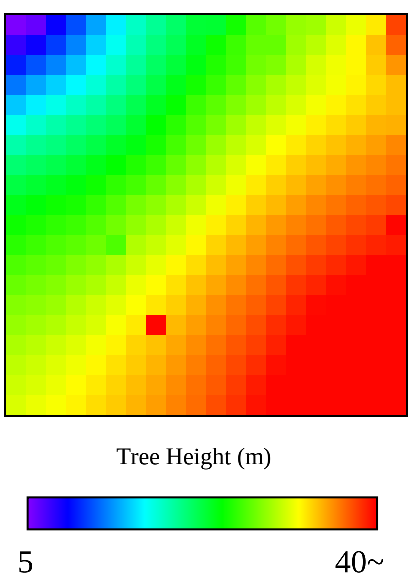
Self-Organizing Relationships algorithm (SOR, Yamakawa et al., 1999,2005) are used.

for ICESat/GLAS data

Tree Height by ICESat/GLAS + PCA score（PC1~12）→ Training Dataset

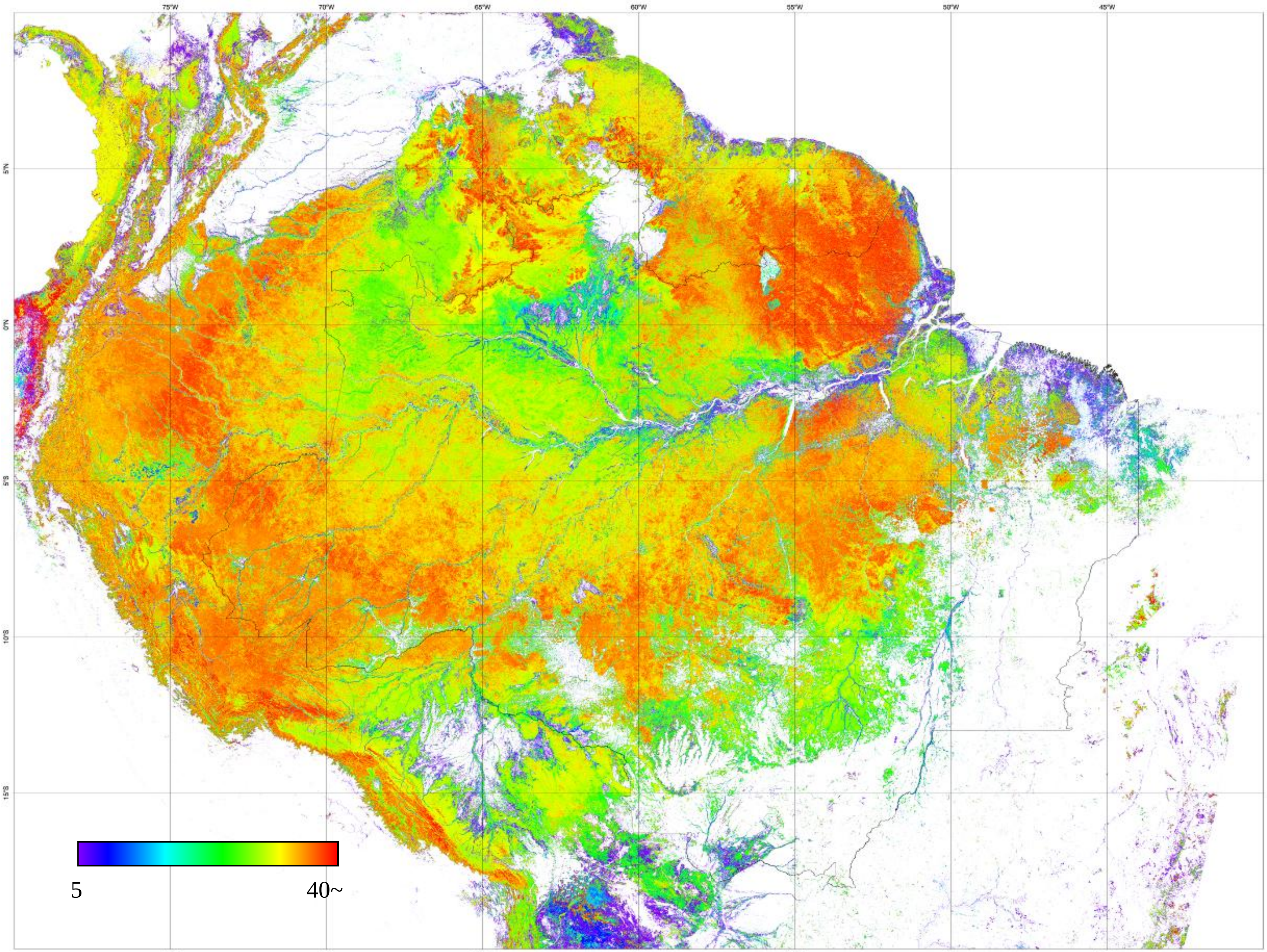
Training Dataset were classified by SOM algorithm

To scale up by SOR algorithm

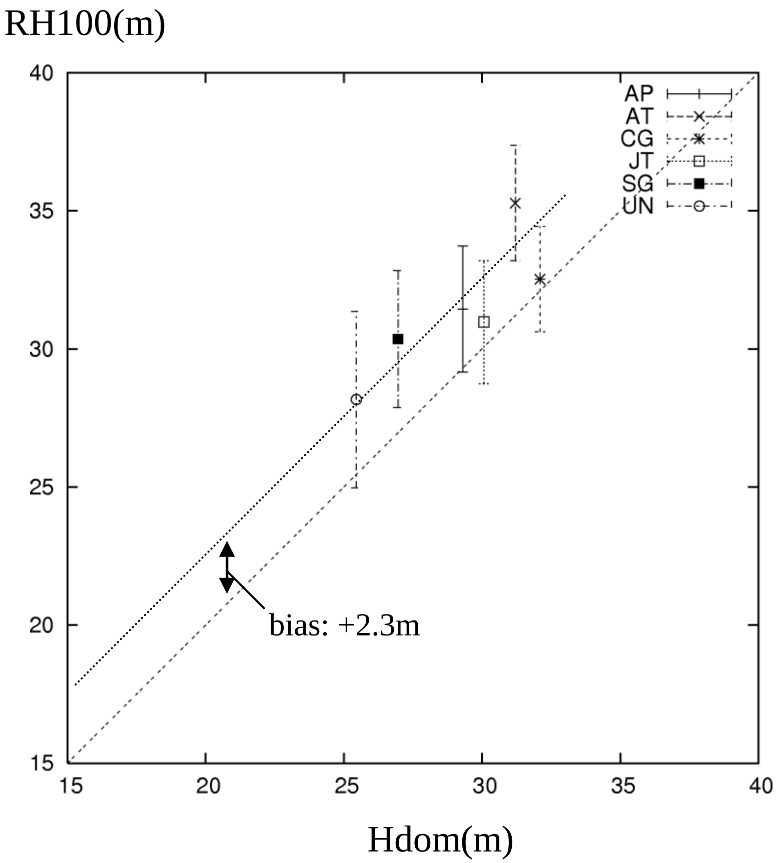


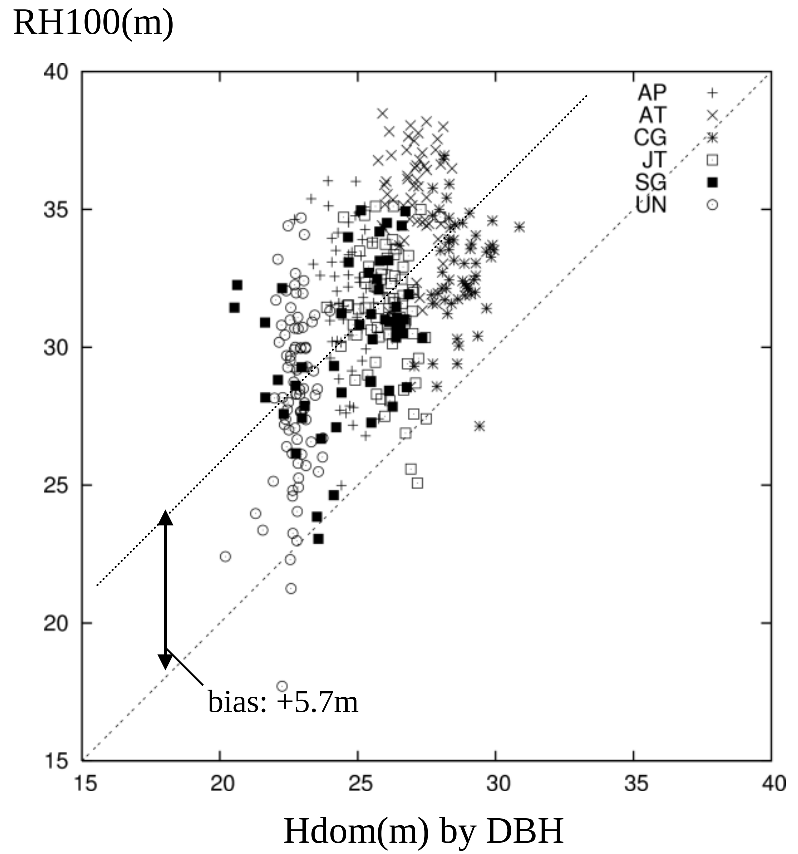

| | |
|---|---|
| PC1 | annual average of NDVI and/or NDII |
| PC2 | Land Surface Temperature (LST) |
| PC3 | Rainfall |
| PC4 | Slope, Plateau ratio |
| PC5,PC6 | DEM, Seasonal Change of LST |
| PC7 | DEM |
| PC8 | Seasonal Change of rainfall |
| PC9 | Seasonal Change of NDVI and/or NDII |
| PC10 | Vegetation Dryness |

# A map of estimated tree height (RH100)



# Validation of estimated tree heights




- Hdom was calculated from data of ground surveys
- RH100 was estimated by using only satellite data such as ICESat/GLAS, MODIS
- Error bars means 1σ

# Summary

Our Objectives:

To develop methodologies of producing Tree-height maps by using LiDAR and Imager data

We are trying three approaches:

1. Statistical Model (FOTO, Proisy et al., 2012)
2. Convolutional Neural Network (Krizhevsky et al., 2012)
    - To validate results and to improve methodology are necessary
3. Machine Learning Method (SOR, Sawada et al. 2015)
    - A Coarse Resolution (500m) Canopy height map was created successfully.
    - To apply to 5m resolution data

Future Plan:

- To produce above-ground biomass maps