Modeling of LiDAR and Imager data on MOLI instruments

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

Yoshito Sawada (NIES)

Contents

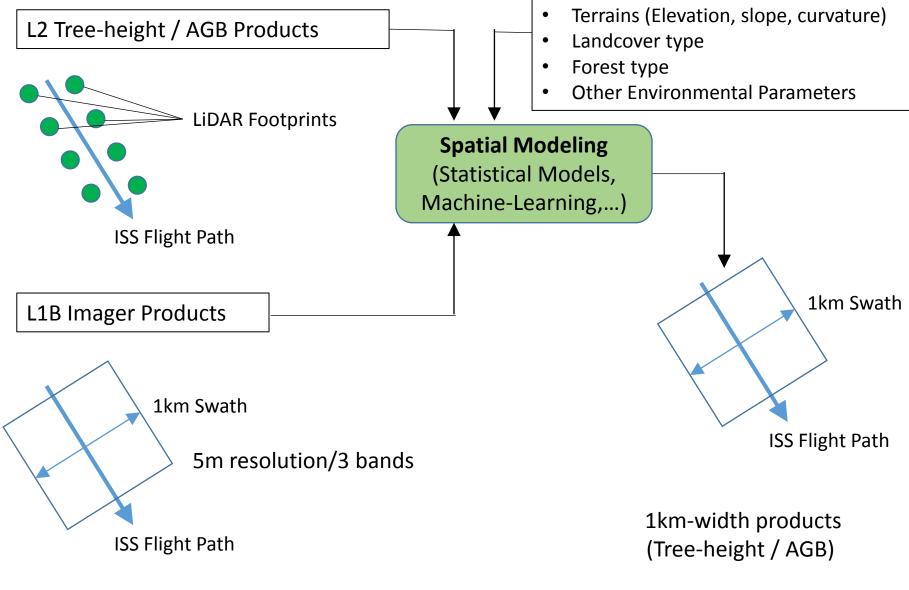
- 1. Outlines along-track products
- 2. Process Flow to make along-track products
- 3. Spatial Modeling Algorithms
 - Statistical Modeling
 - Machine Learning

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:

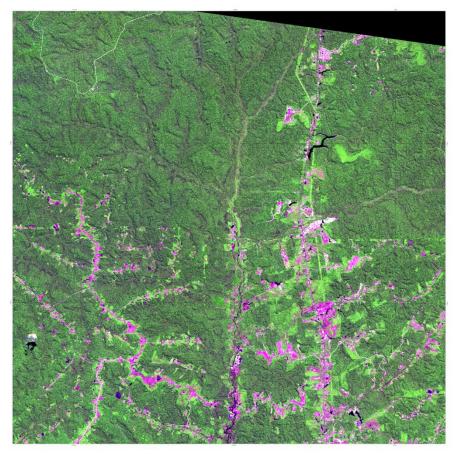
- LiDAR: ICESat/GLAS (GLA01, GLA14)
- Imager: RapidEye (1 and 2) 5m/5bands MODIS, GSMaP, SRTM (3)

Spatial Modeling of LiDAR and Imager

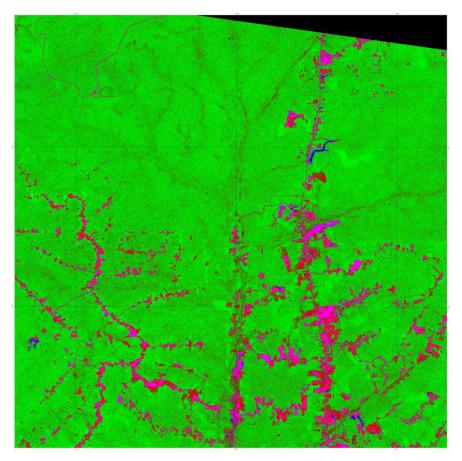
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e © 2015 DigitalGlobe	453807458 31 281452046 33 446688633 37	10 km

• RapidEye (5m/5 bands) \rightarrow Vegetation Fraction, Spatial Frequency (Texture)

Making A Forest Mask



R/G/B = 4/5/2

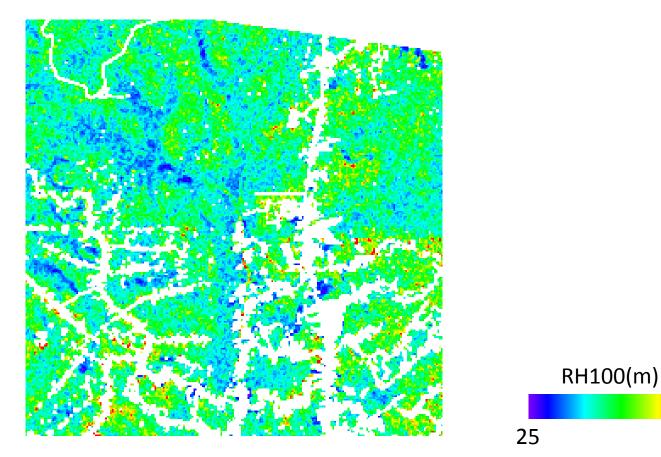


R/G/B = Soil/Vegetation/Water

Enhance:	
R	0.0~0.5
G	0.5 ~ 1.0
В	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, ...)

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Machine Learning Method (Course Resolution)

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

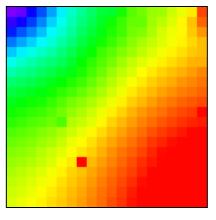
for ICESat/GLAS data

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

Training Dataset were classified by SOM algorithm

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To scale up by SOR algorithm

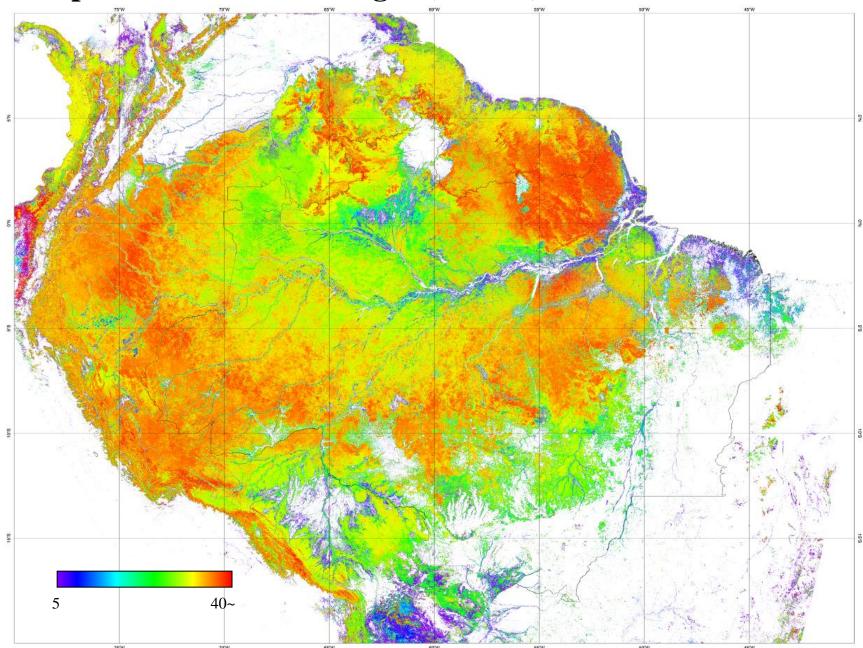


Tree Height (m)

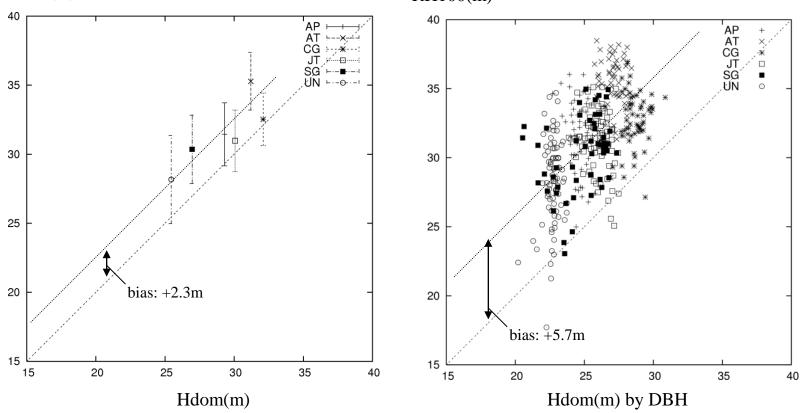
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PC1	annual average of NDVI and/or NDII
PC2	Land Surface Temperature (LST)
PC3	Rainfall
PC4	Slope, Plateau ratio
PC5,PC6	DEM, Seasonal Change of LST
PC7	DEM
PC8	Seasonal Change of rainfall
PC9	Seasonal Change of NDVI and/or NDII
PC10	Vegetation Dryness

A map of estimated tree height (RH100)



Validation of estimated tree heights



RH100(m)

RH100(m)

- 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