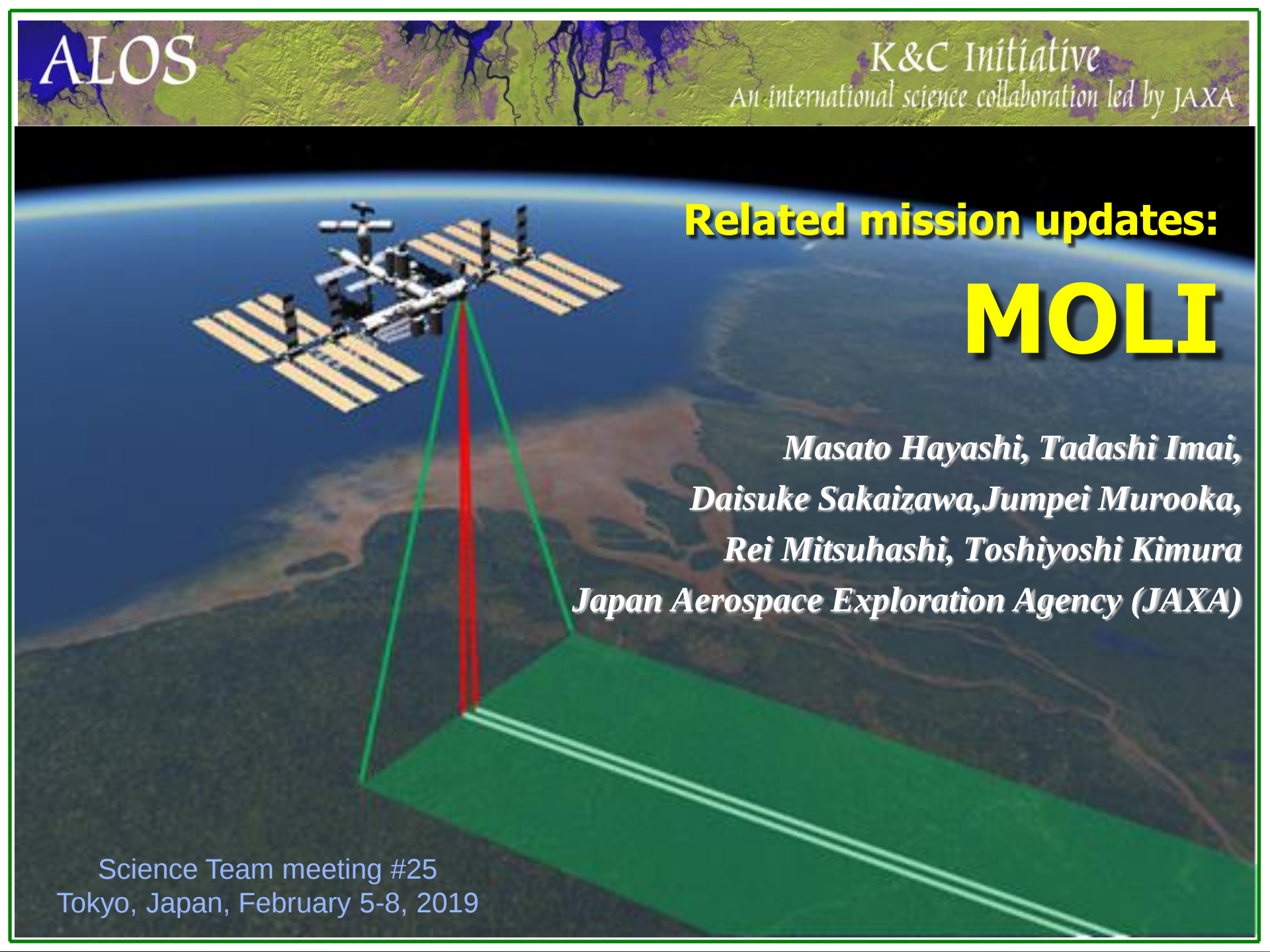




ALOS

K&C Initiative
An international science collaboration led by JAXA

Related mission updates:

MOLI

*Masato Hayashi, Tadashi Imai,
Daisuke Sakaizawa, Jumpei Murooka,
Rei Mitsuhashi, Toshiyoshi Kimura
Japan Aerospace Exploration Agency (JAXA)*

Science Team meeting #25
Tokyo, Japan, February 5-8, 2019

- ☐ **Introduction**
- ☐ **MOLI's feature**
- ☐ **Products of MOLI**
- ☐ **Preliminary results of airborne lidar experiment**
- ☐ **Summary**

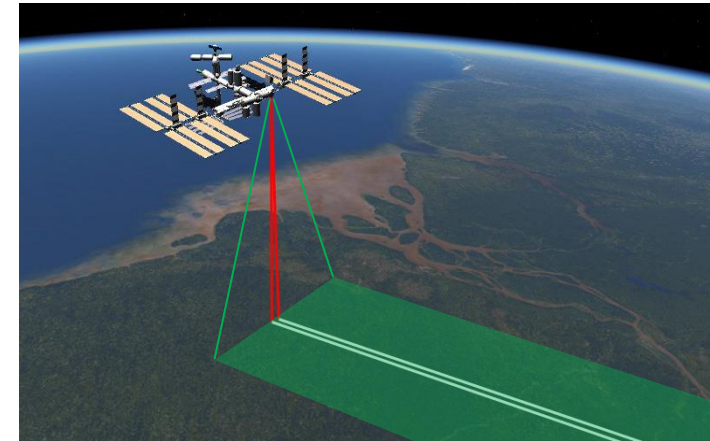
- ☐ **Introduction**
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What's MOLI?

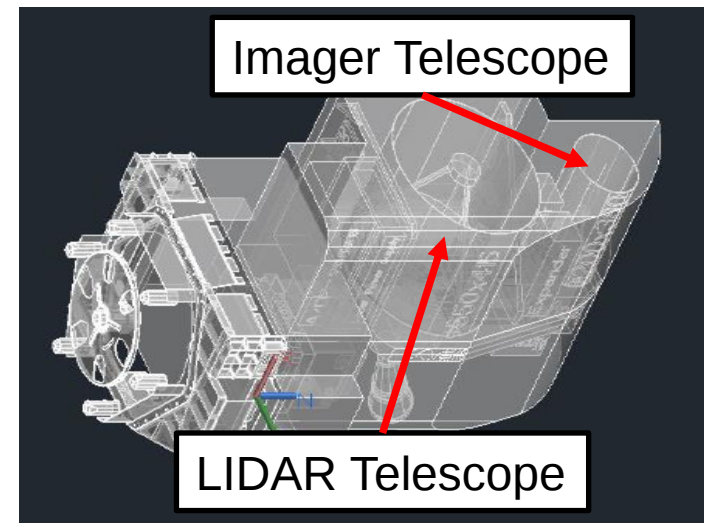
MOLI = 森
forest

□ MOLI (Multi-footprint Observation Lidar and Imager)

Items	Specifications
Mission instruments	○LIDAR Laser wavelength/ 1064nm Number of beam / 2 beam (Split from one beam) Beam power/ 20mJ each Pulse width / less than 7ns Footprint radius / Φ25m
	○Imager Band / Green; 550-630nm Red; 630-740nm NIR: 740-880nm Spatial resolution / 5m Swath / 1km
Size	1605 × 640 × 830 [mm]
Mass	About 300 kg
Power	Less than 400W
Operation	Over 1year
Operational orbit	ISS orbit(Inclination : 51.6 deg) Non-synchronous at an altitude of 400km



Observation Image

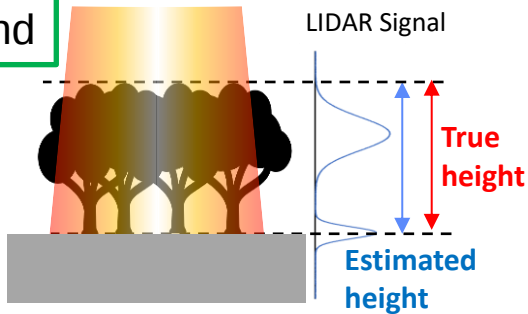


Overview of MOLI

- ☐ Introduction
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- ☐ Summary

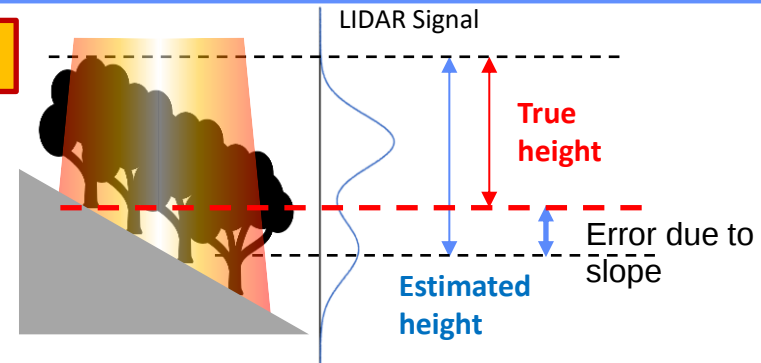
MOLI's feature → Improvement of canopy high observation by “Multi footprint”

flatland

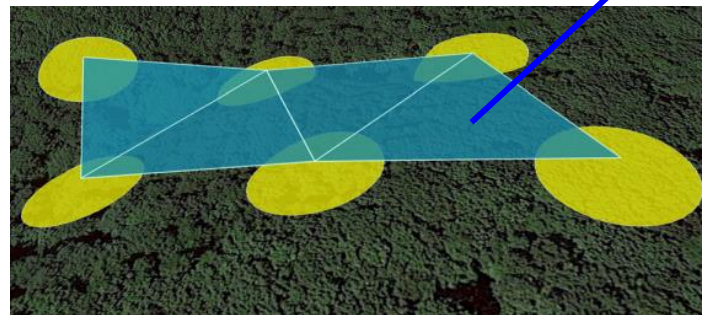
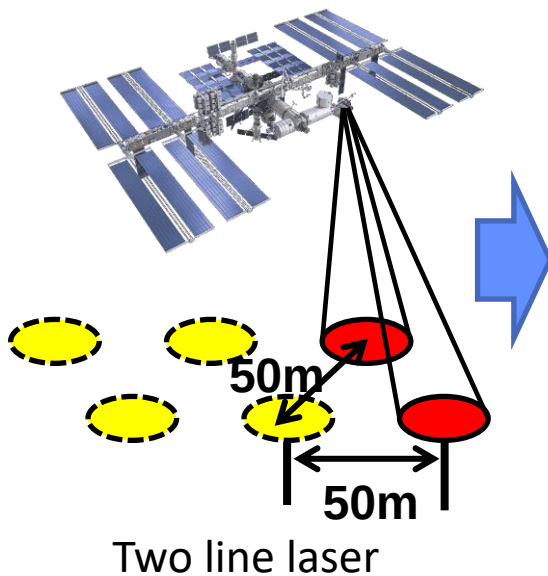


Canopy height
= Distance between Signal start and last pulse

slope



Canopy height
= Distance between Signal start and last pulse
— Term for correcting error from slope



Estimate slope angle from altitude information
of three footprints (observation points)

Expected effect by
“Multi footprint”

Before:
Correction using
DEM data.

- ☐ Introduction
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- ☐ **Products of MOLI**
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Product level	Product category	Products	Remark
L1 (Standard)	Lidar footprint products	Waveforms (≥ 500 Msp/s)	including geolocation data Footprint Position Accuracy ≤ 15 m
	Imager product (1km swath)	Image (Red, Green,	geometrically corrected
L2 (Standard)	Lidar footprint products	Canopy heights	± 3 m(Canopy Height is under 15m) $\pm 20\%$ (Canopy Height is over 15m)
		Forest biomass	± 25 t/ha (Biomass density is under 100t/ha) $\pm 25\%$ (Biomass density is over 100t/ha)

※ Multi-footprint is expected to compensates each product up to 30 degrees of slope.

Product level	Product category	Products	Remark
L3 (Research)	Integrated products with Lidar and imager (1km swath)	Canopy heights	Target 【Canopy heights】 $\pm \sim 5\text{m}$ (Canopy Height is under 15m) $\pm \sim 40\%$ (Canopy Height is over 15m) 【Forest biomass】 $\pm \sim 40\text{t/ha}$ (Biomass density is under 100t/ha) $\pm \sim 40\%$ (Biomass density is over 100t/ha)
		Forest biomass	
L4 (Research)	Wall-to-Wall map products (Integrated with GCOM-C/SGLI Data)	Canopy height map	
		Forest biomass map	

※ Multi-footprint is expected to compensate each product up to 30 degrees of slope.

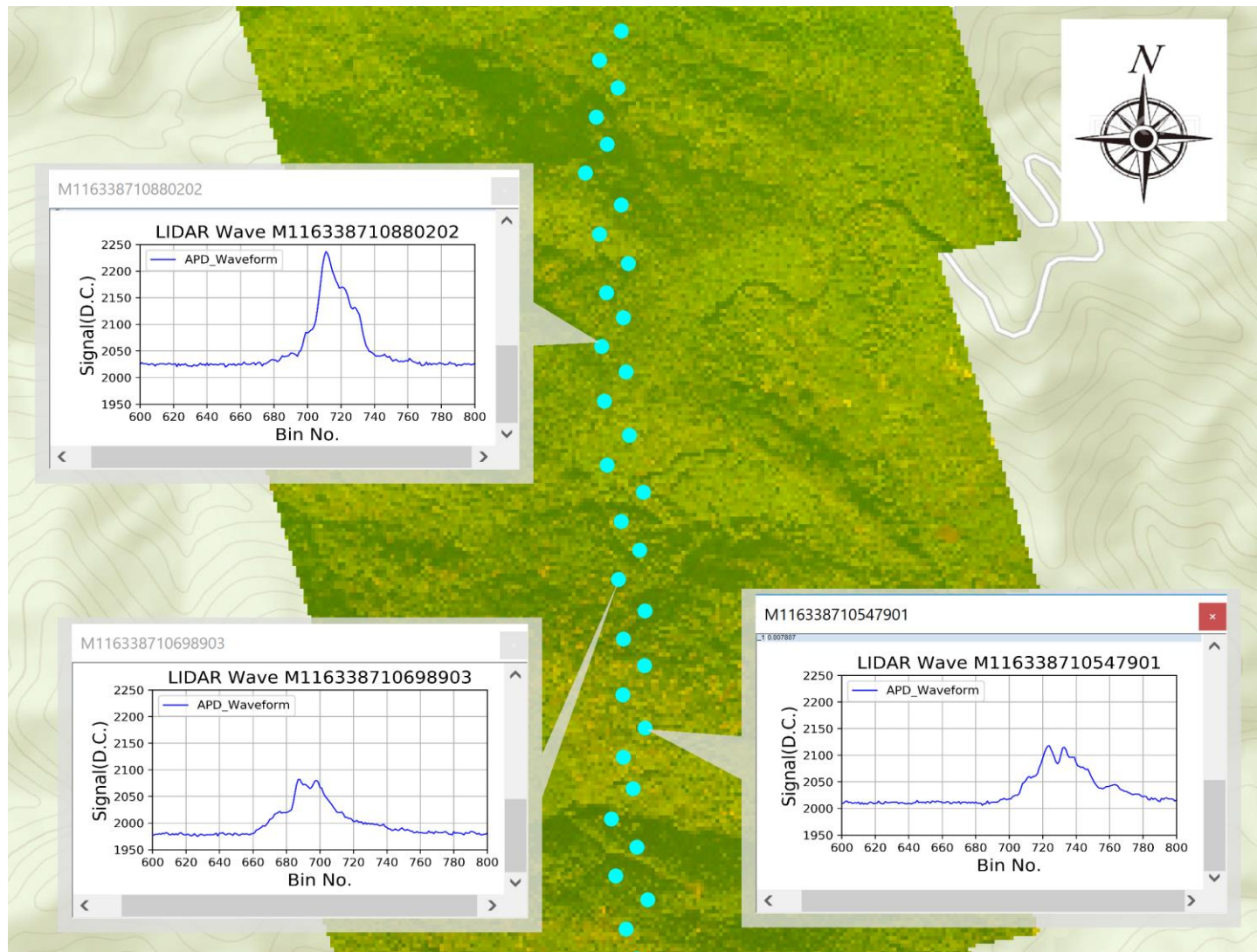


Image of L1 product at GIS software
(Using airborne lidar experiment at Ise forest)

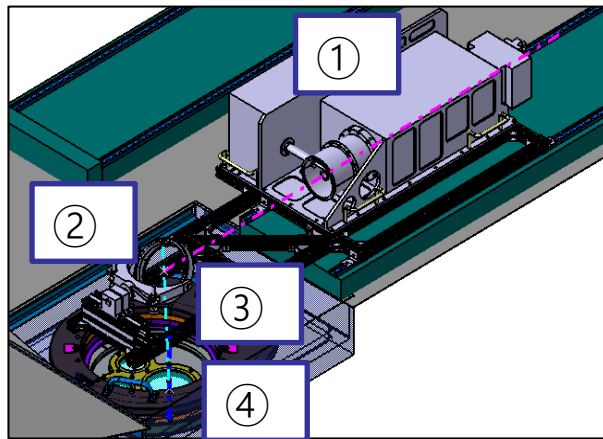
- ☐ Introduction
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Test configuration

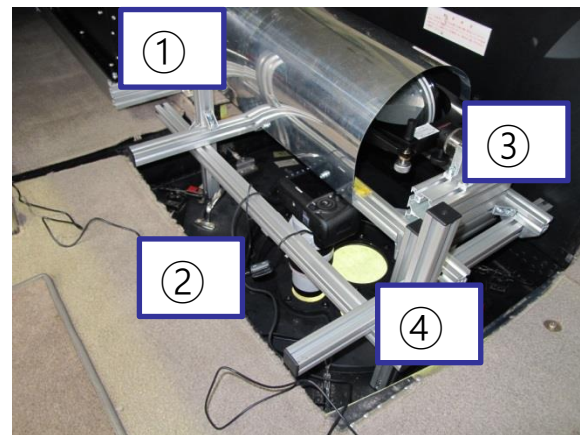
We installed a multi-foot print lidar system on aircraft(King Air 200T) with CCD camera (Canon EOS 5D Mark III).



Overview of King Air 200T



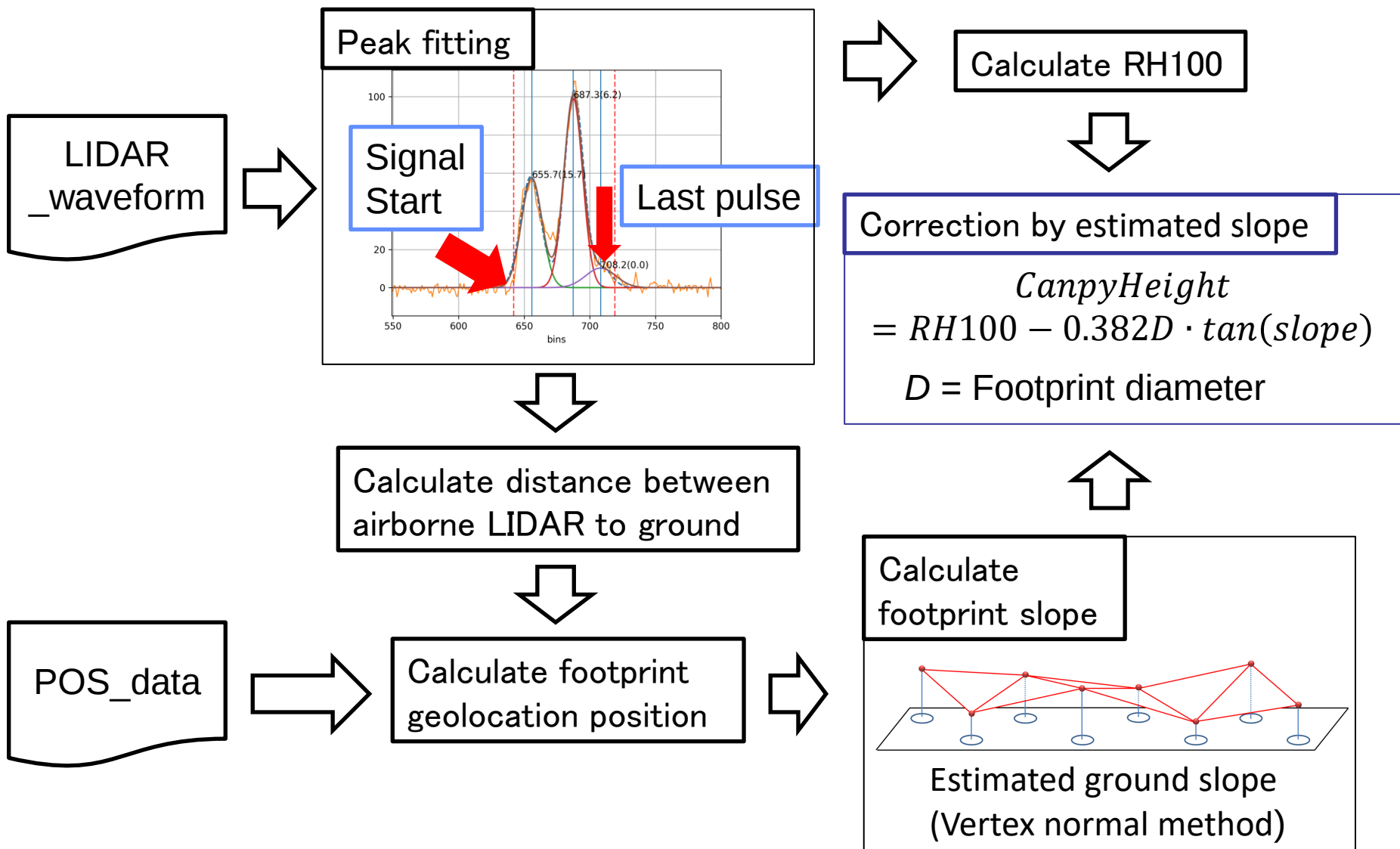
Lidar System(CAD model)



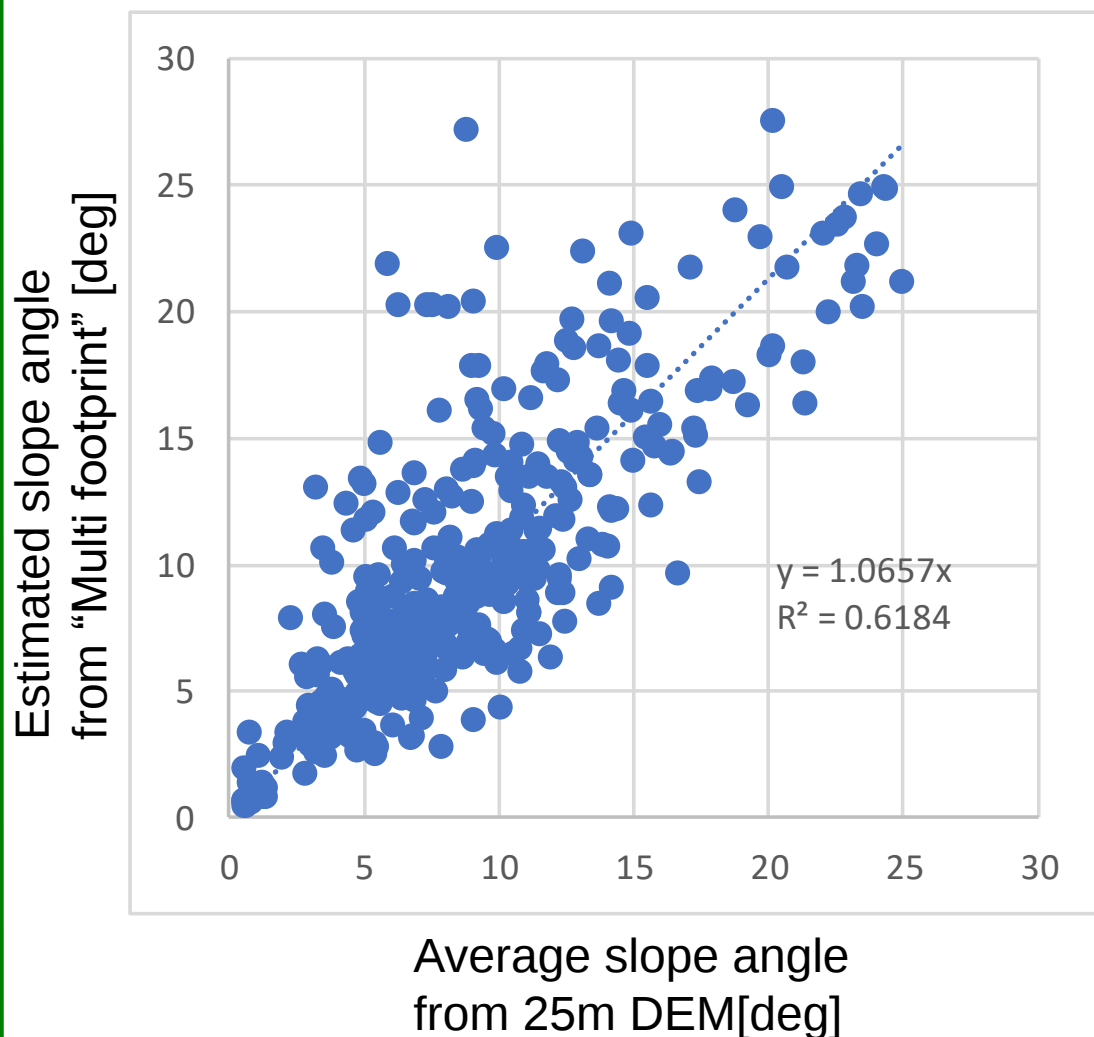
Lidar System(picture)

- ① 1 lidar
- ② CCD camera
- ③ reflection mirror
- ④ window (AR Coating)

Data processing



Estimated slope angle



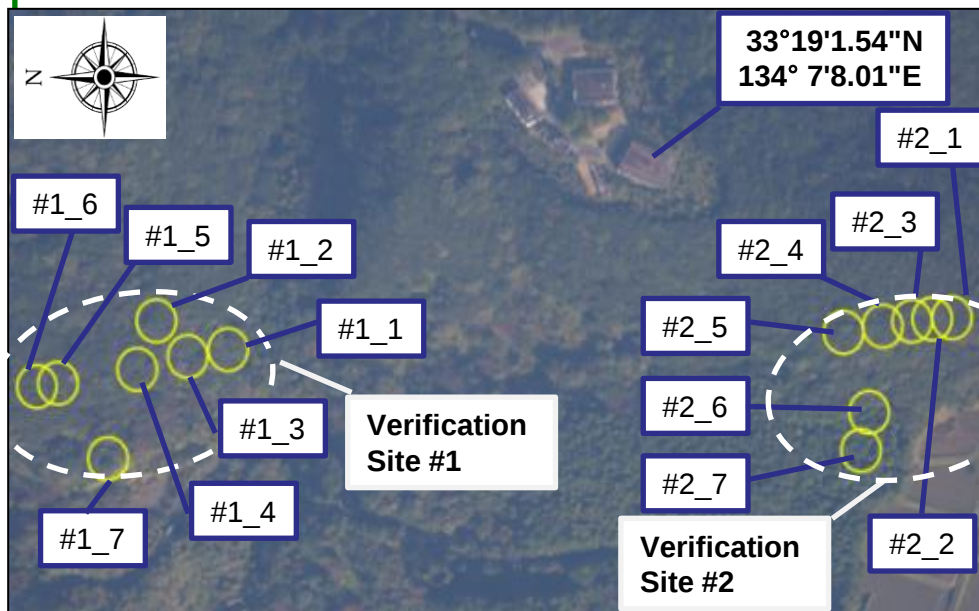
First, we compared estimated some footprint slope angle calculated by “Multi footprint” with DEM data.

The DEM was resampled to 25 m square and calculated slope according to the footprint diameter of MOLI

From this result, we confirmed that the Multi footprint method can estimate roughly ground slope.

Verification (Muroto forest)

We validated the canopy height directly to verify the observation results at 3 sites. (Muroto, Gero)

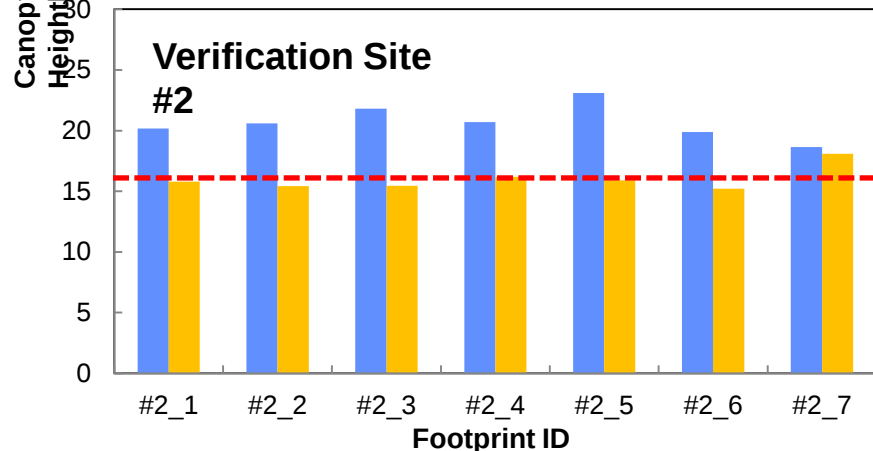
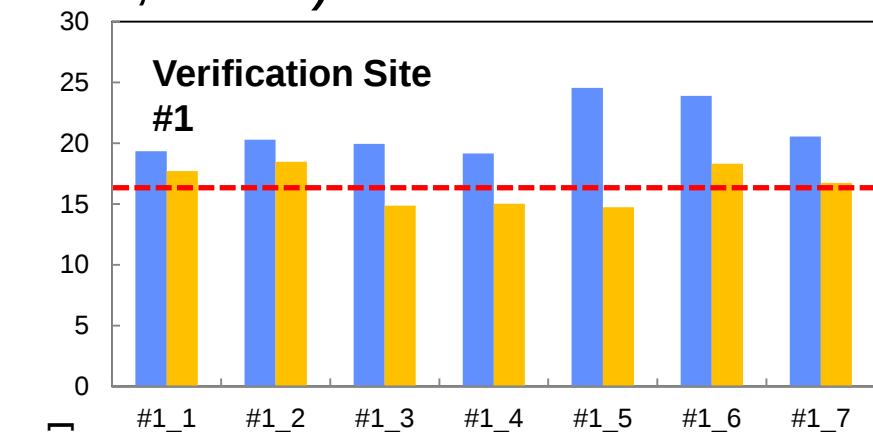


Verification Site #1

Error of before the correction : 4.94[m]
Error of after the correction : **1.54[m]**

Verification Site #2

Error of before the correction : 4.30[m]
Error of after the correction : **1.08[m]**

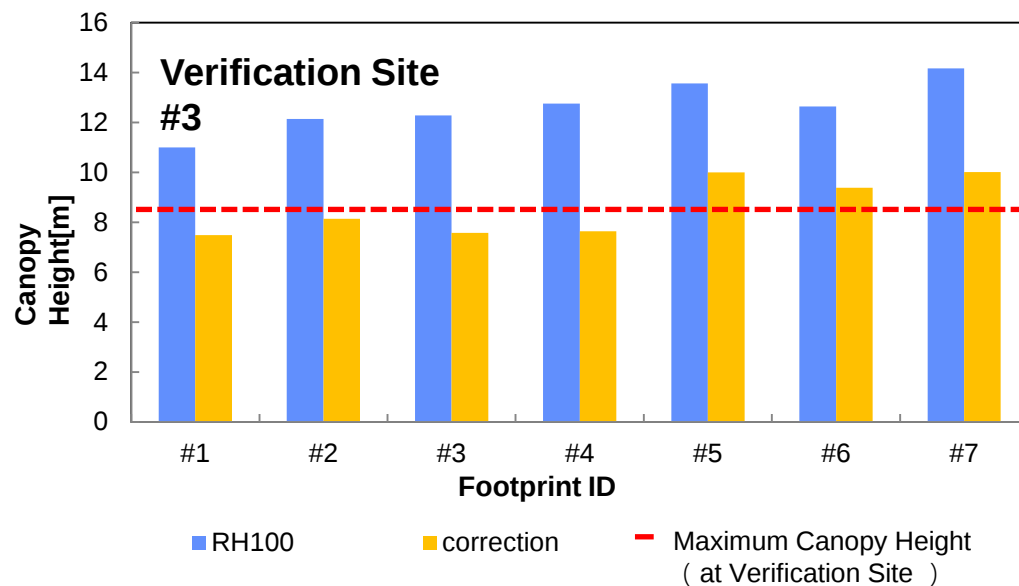
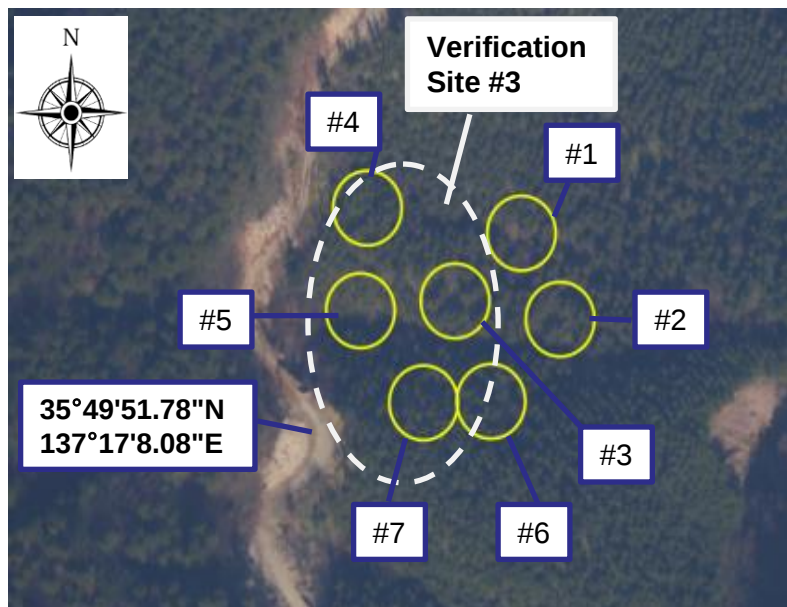


■ RH100

■ correction

— Maximum Canopy Height
(at Verification Site)

Verification (Gero forest)



Verification Site #3

Error of before the correction : 4.63[m]

Error of after the correction : **1.18[m]**

These results show validity of the observation method using Multi-footprint for the mission requirement in 3 verification sites.

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- ☐ System Design
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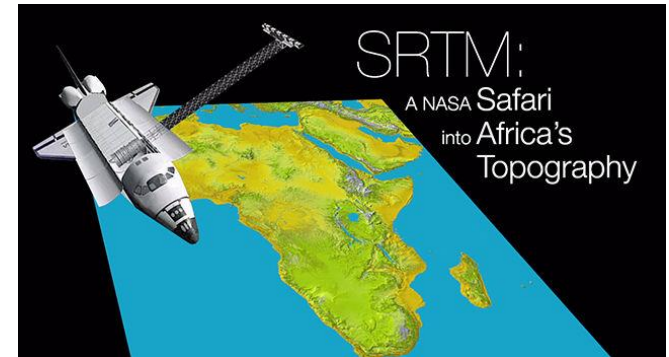
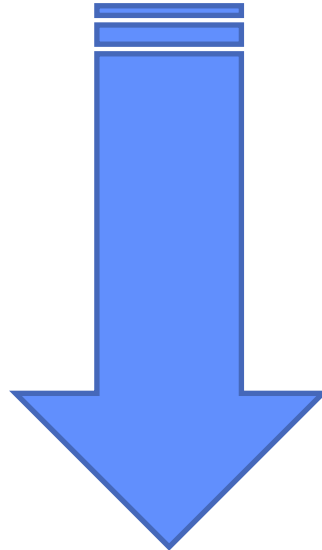
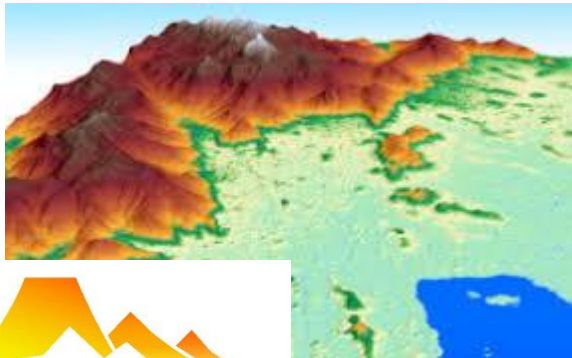
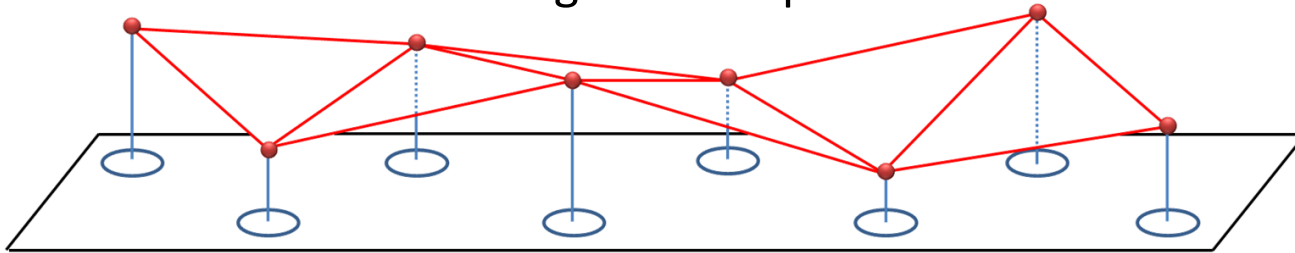
Summary

- MOLI Target launch : 2022~ (Now Phase A to B)
- JAXA/EORC called for MOLI's research proposals.
(EO-RA2)

Future Work

- ↓ Method of slope angle calculation will improve.
- ↓ To evaluate the accuracy using Airborne Laser Scanning (ALS) data.
- ↓ To trial Integrated products with large footprint airborne Lidar data and imager(CCD camera) data.

Estimated ground slope result



Improve the
estimated result?

Summary

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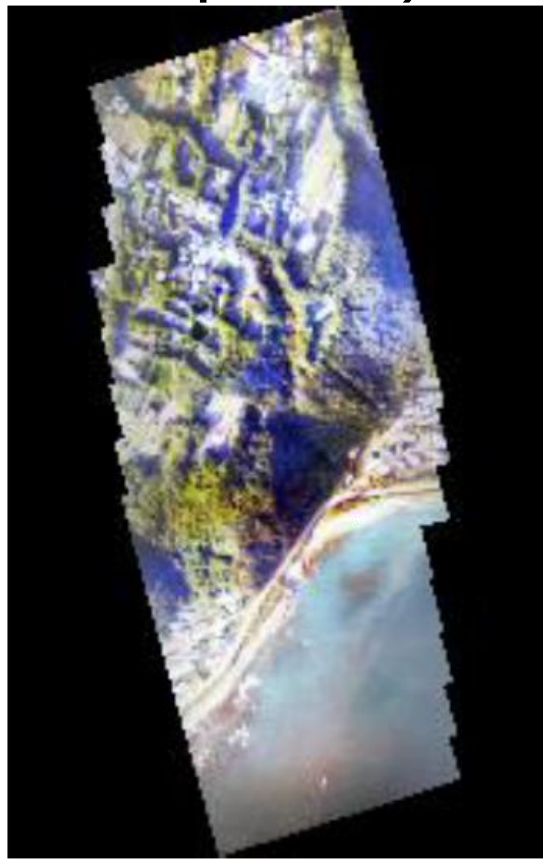
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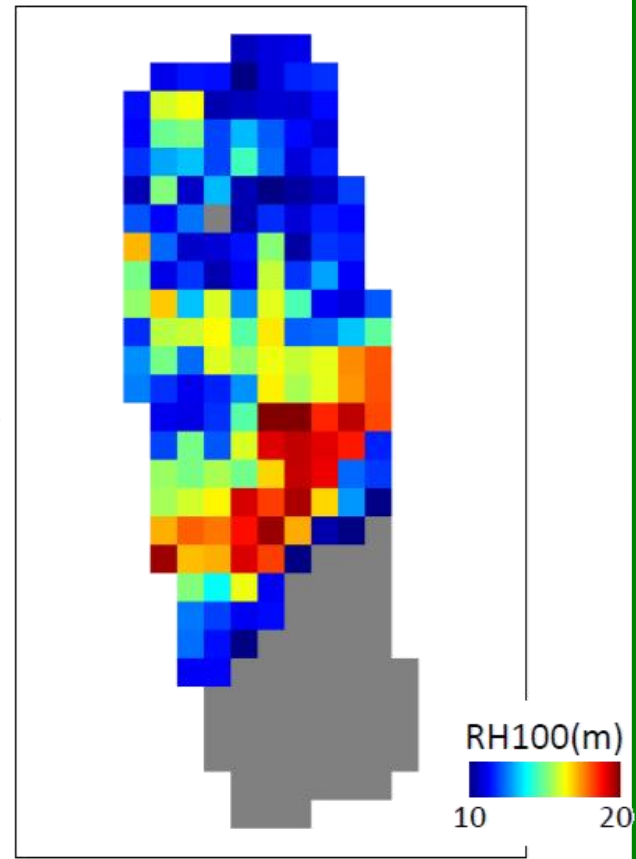
Prototype MOLI L3 product to airborne lidar experiment (Algorithm under development)



Raw CCD camera data
Spatial resolution ~10cm



Adjust to MOLI Imager
resolution(5m) and
Smoothing local contrast



Integrated products with
Lidar and imager data
(40m mesh, RH 100)

**Thank you so much for
your kind attention**