Landscape-scale tropical forest canopy height and aboveground biomass estimation with NASA Harmonized Landsat-8 Sentinel-2 and Airborne Laser Scanner data: A focus study of Mai-Ndombe Province, Democratic Republic of the Congo

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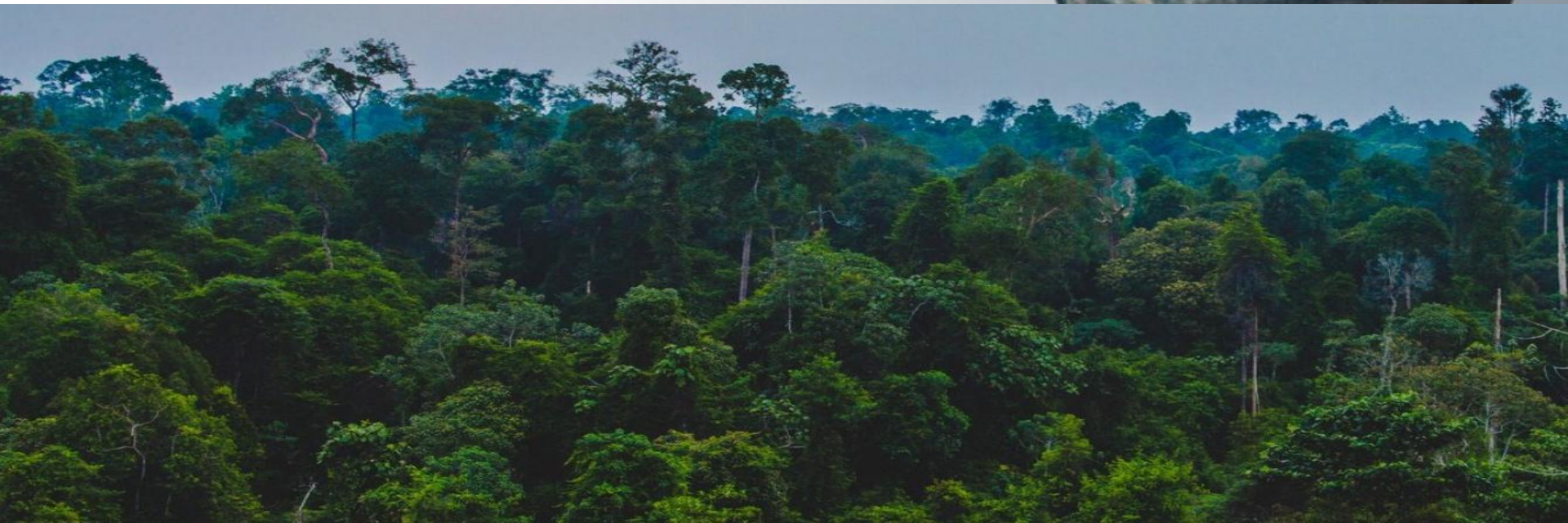
MSU Cloud Computing Fellows 3rd Annual Symposium



Presentation Outline

1.0 Introduction

2.0 Study area and goal

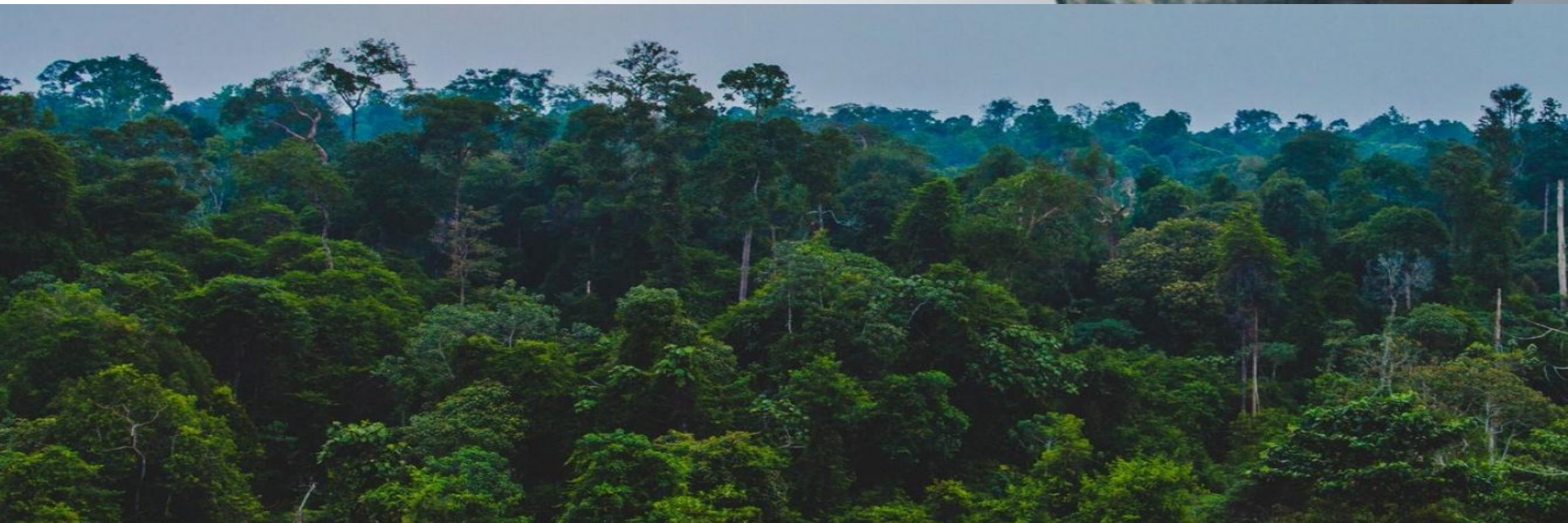
3.0 Data sets

4.0 Cloud resources

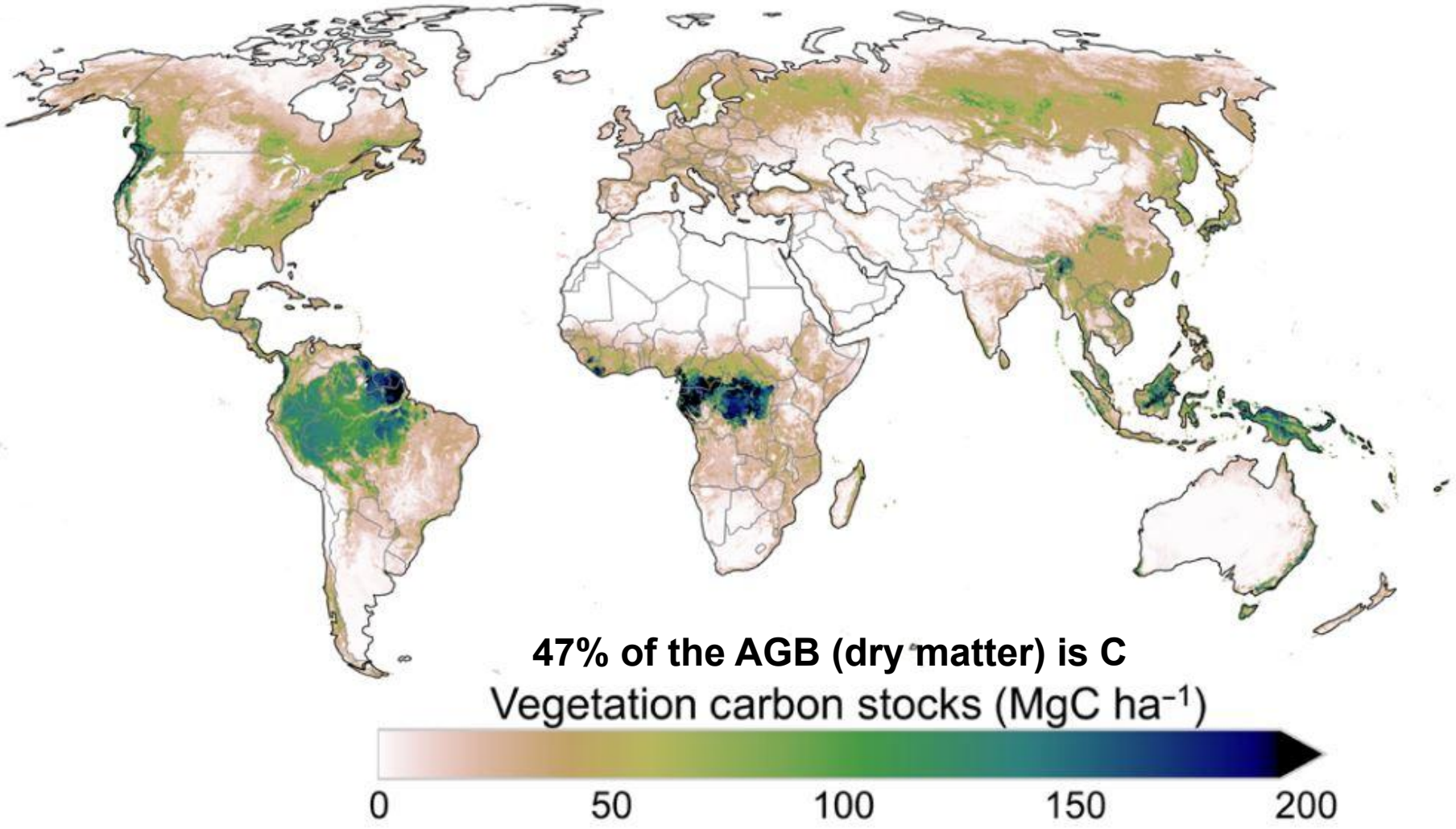
5.0 Method and Results

6.0 Lesson learned

1.0 Introduction

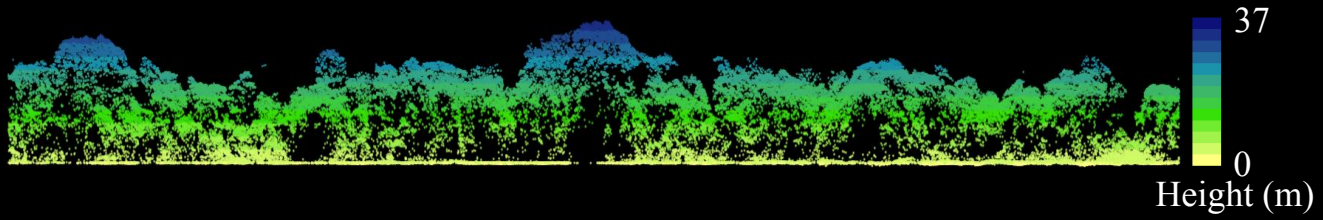


Tropical forests sequester and store large quantities of carbon as above ground biomass (AGB, units: Mg ha-1)

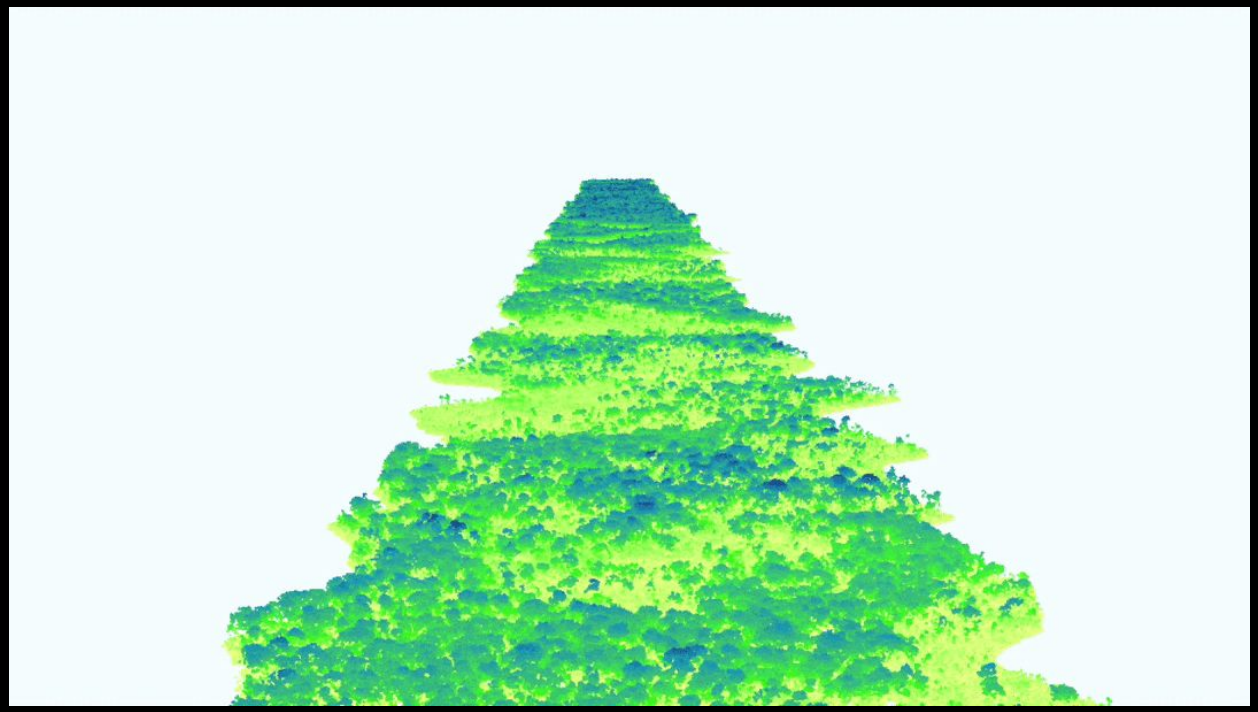


Xu et al.,*Science*,2021

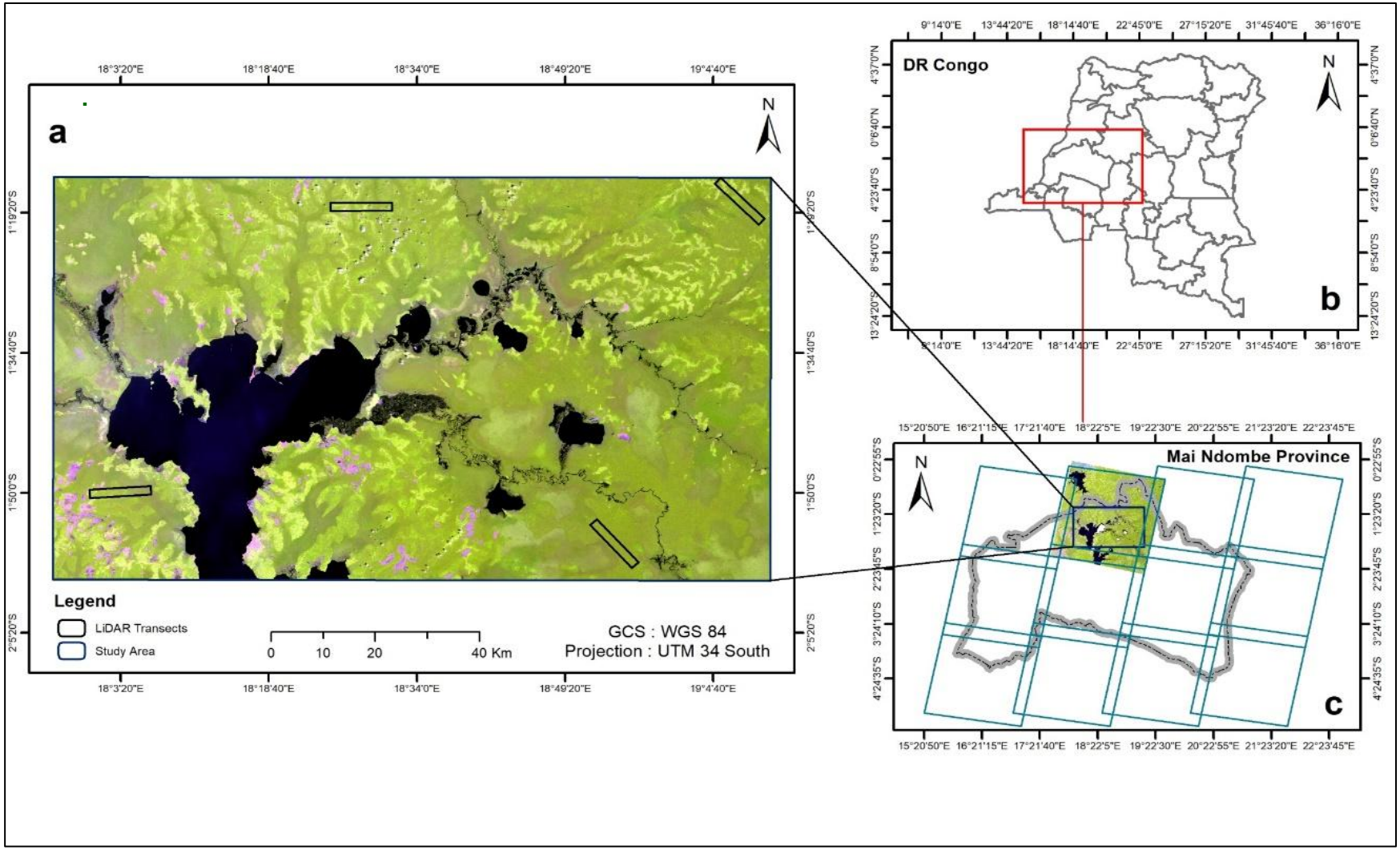
Airbone LiDAR increasingly used to estimate tree height/structure and so AGB



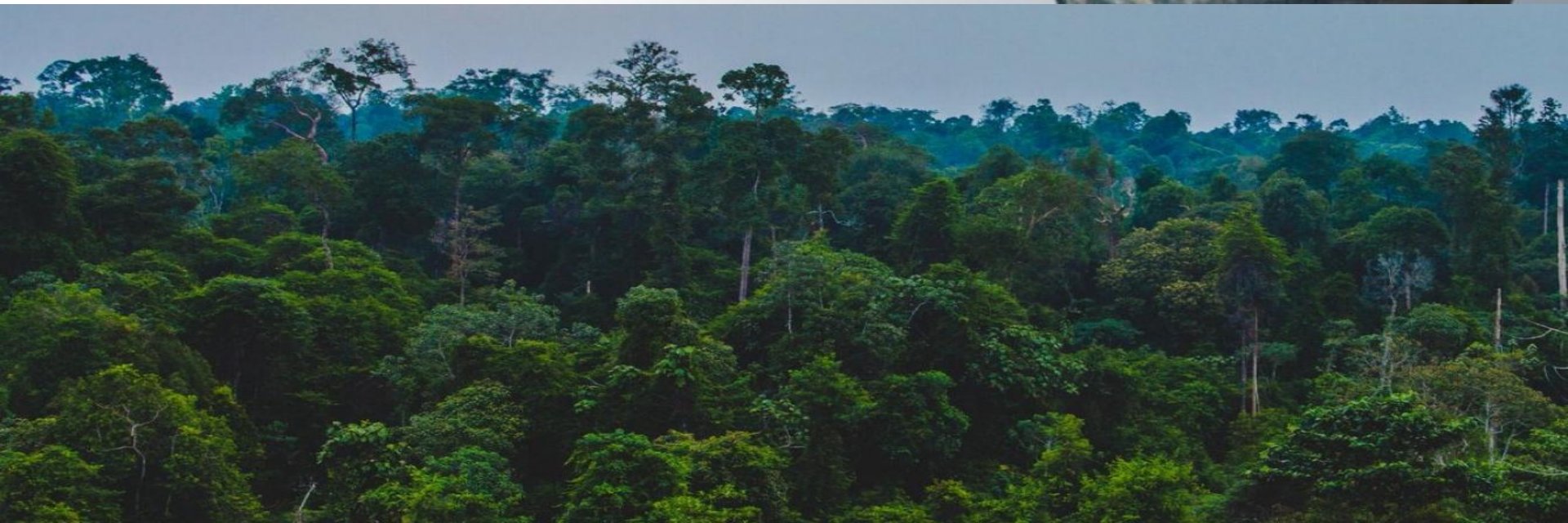
Mai-Ndombe, DRC



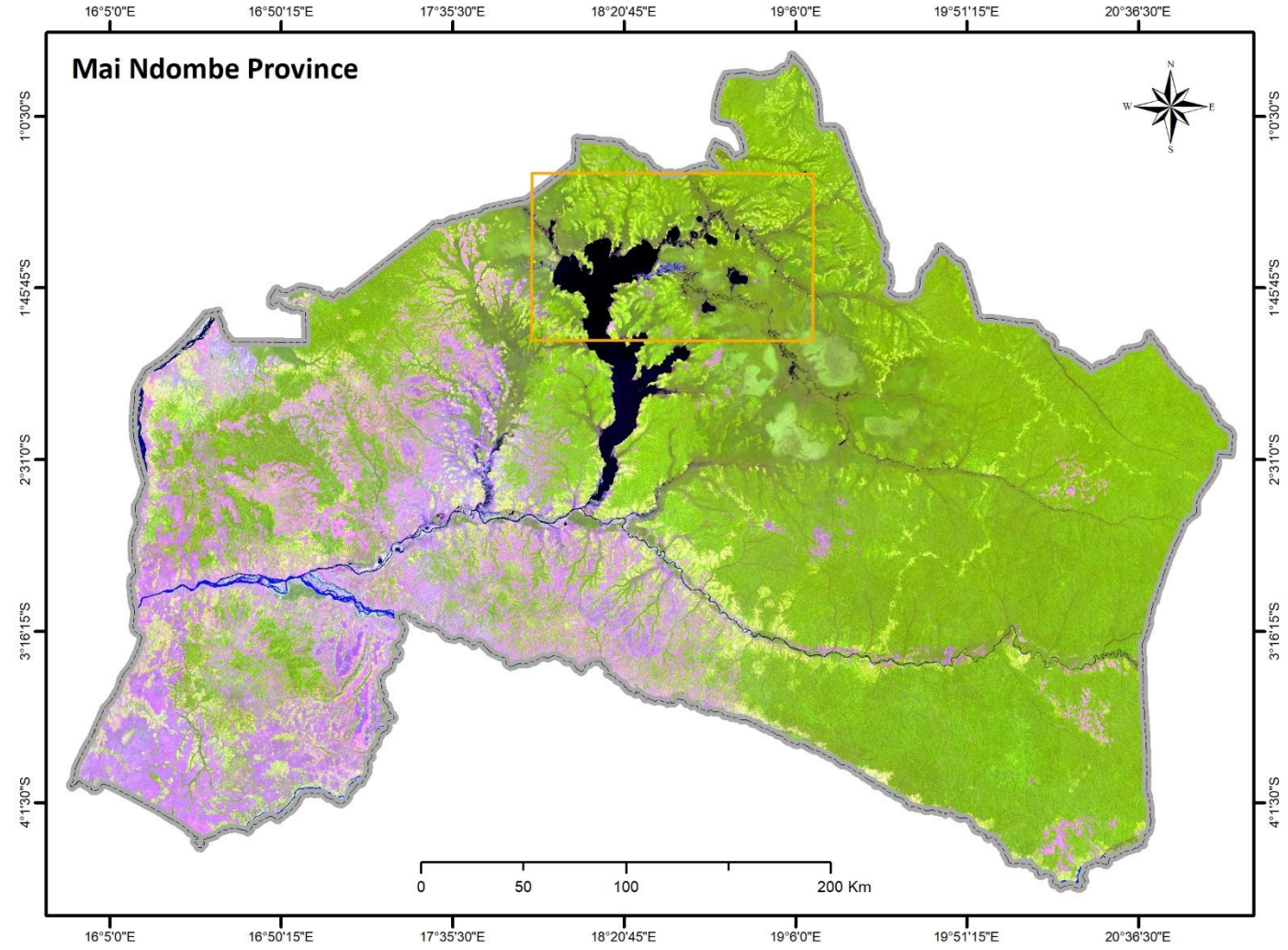
Kashongwe, Roy, Bwangoy, 2020,
Democratic Republic of the Congo tropical Forest Canopy Height and Aboveground Biomass Estimation with Landsat-8 Operational Land Imager (OLI) and Airborne LiDAR Data: The Effect of Seasonal Landsat Image Selection,
Remote Sensing, 12, 211.

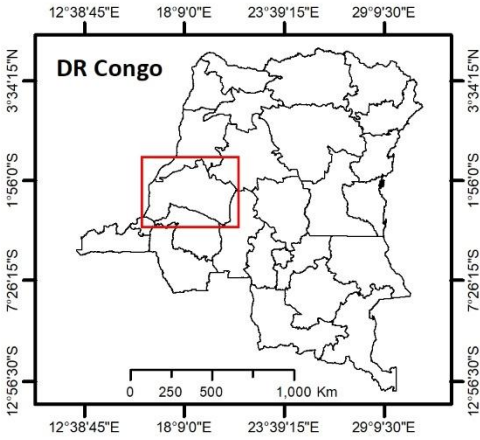


2.0 Study Area and Goal



Mai Ndombe province study area





Research Goal

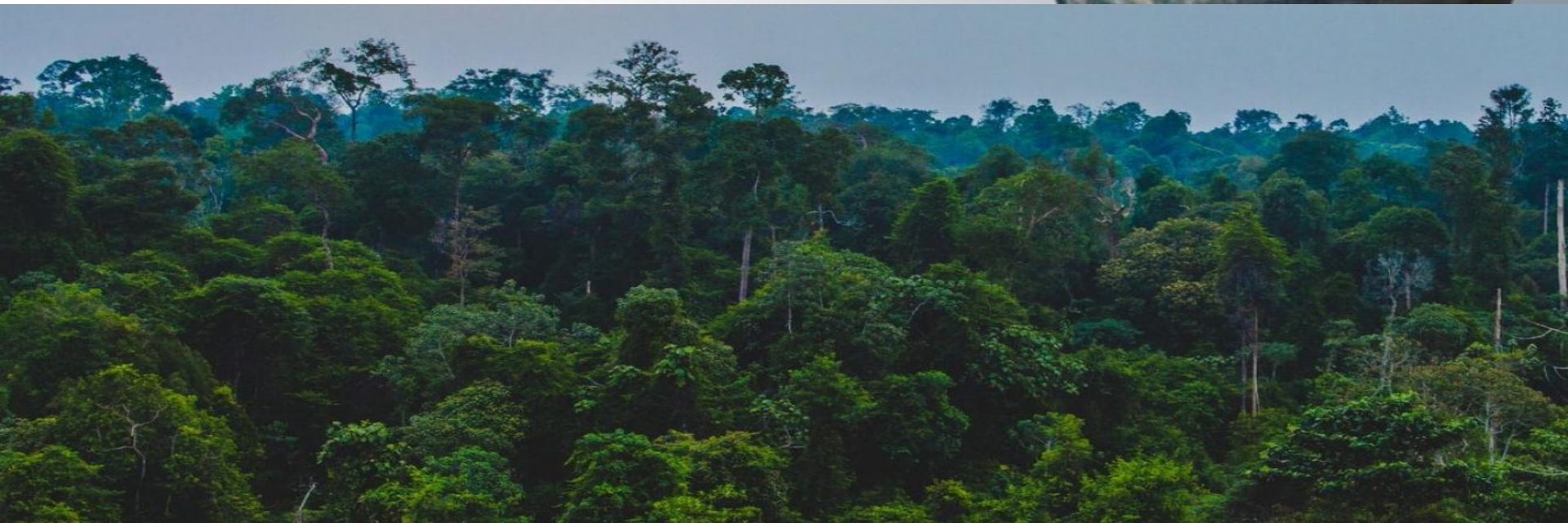
The main goal is to use cloud computing resources to scale my research to larger domains in space and time, specifically :

- From a 11,000 km^2 study site in Mai Ndombe province (orange square) , DRC to the entire province (~ 128,000 km^2)
- From single date satellite data analysis (14 July 2013 and 8 December 2014, see Kashongwe et al. 2020) to time series satellite data analysis (From 1 January 2020 - 31 December 2021).

3.0 Data sets

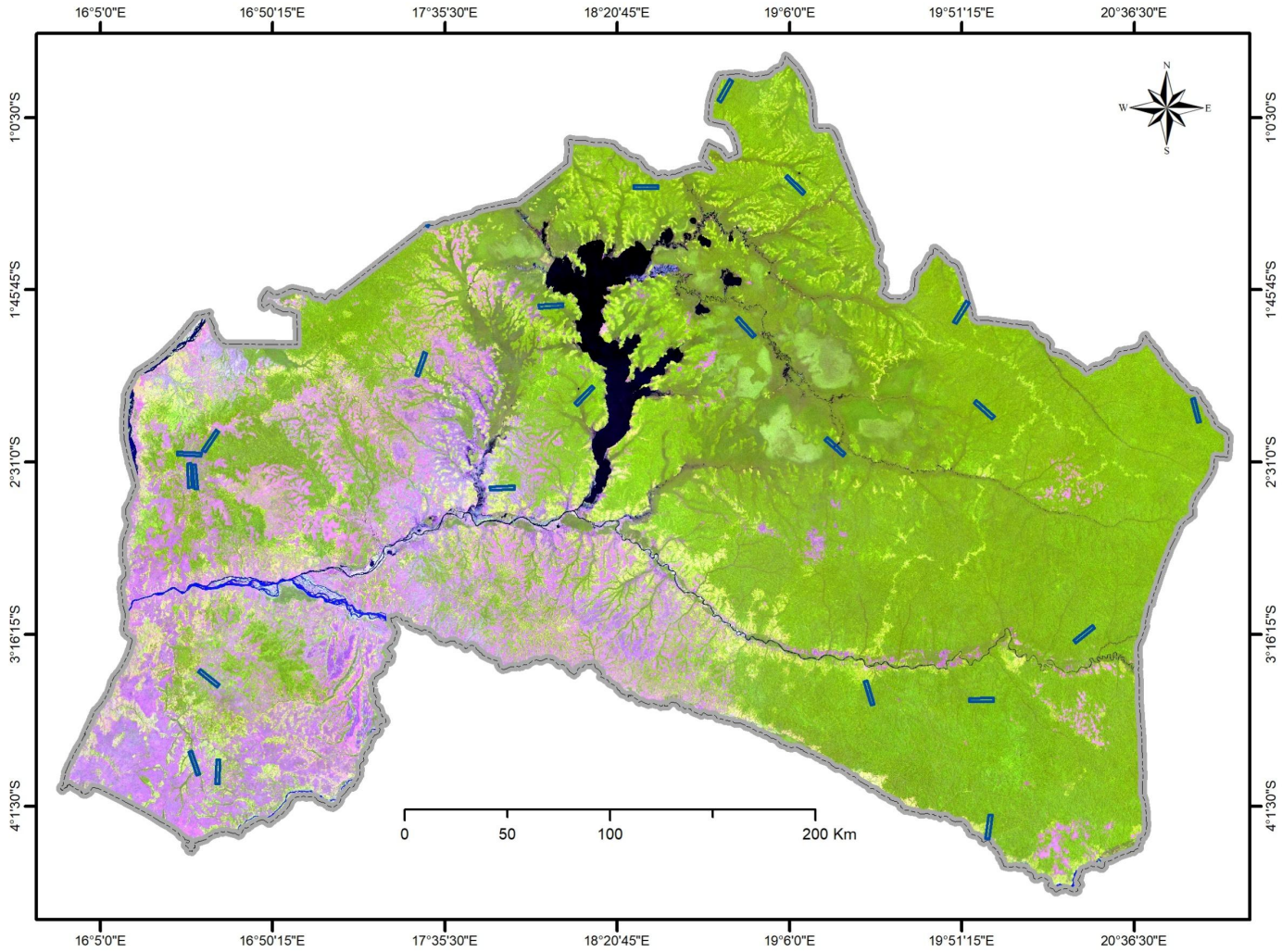
- Airborne Laser Scanner (ALS) data 2014

- NASA HLS 30 m images 2020-2021



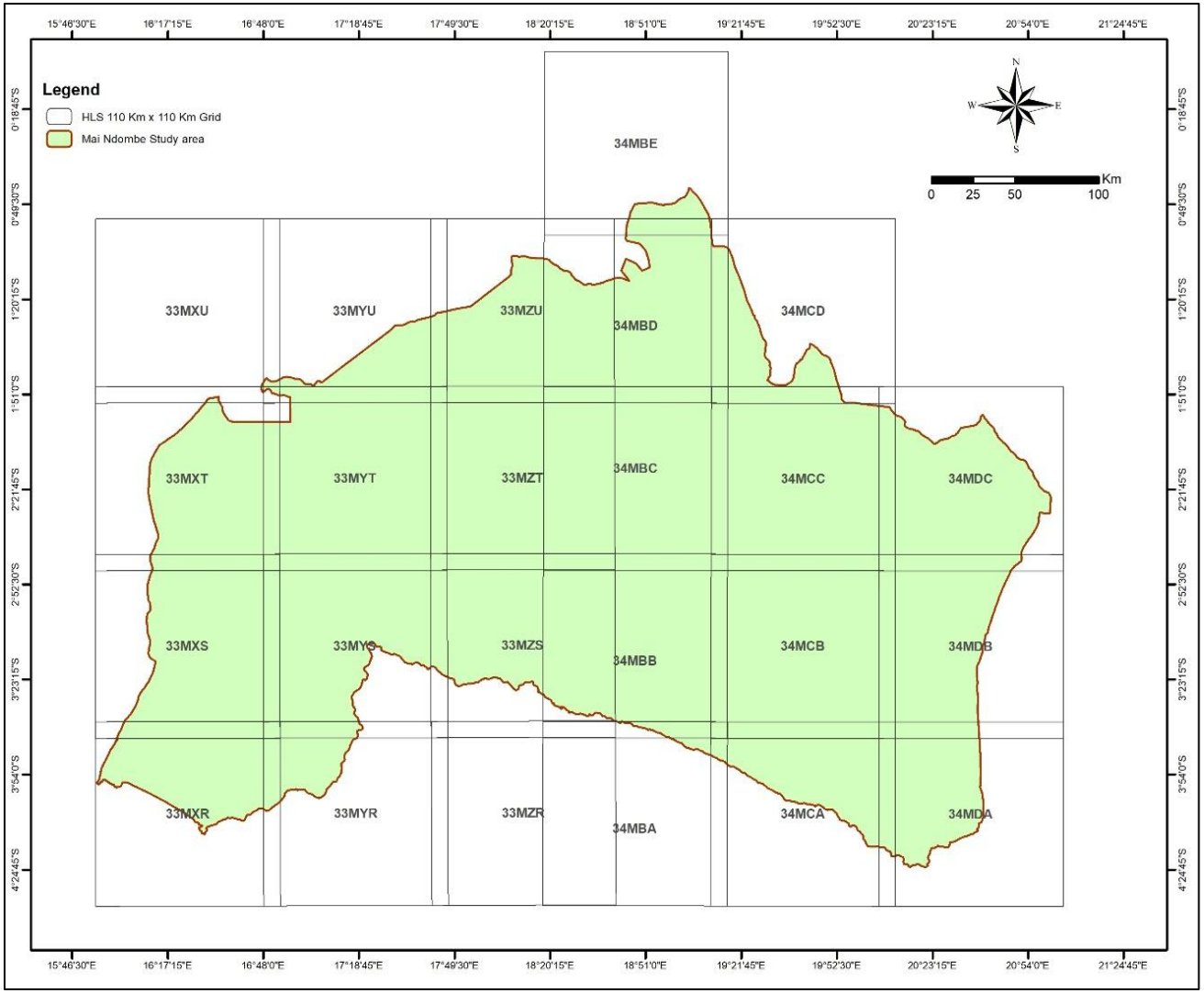
Airborne Laser Scanner (ALS) data

- ALS data were collected in 2014 as part of a DRC World Wildlife Fund carbon project (Xu et al. 2017). All the 24 ALS transects (blue boxes) were used in this research.



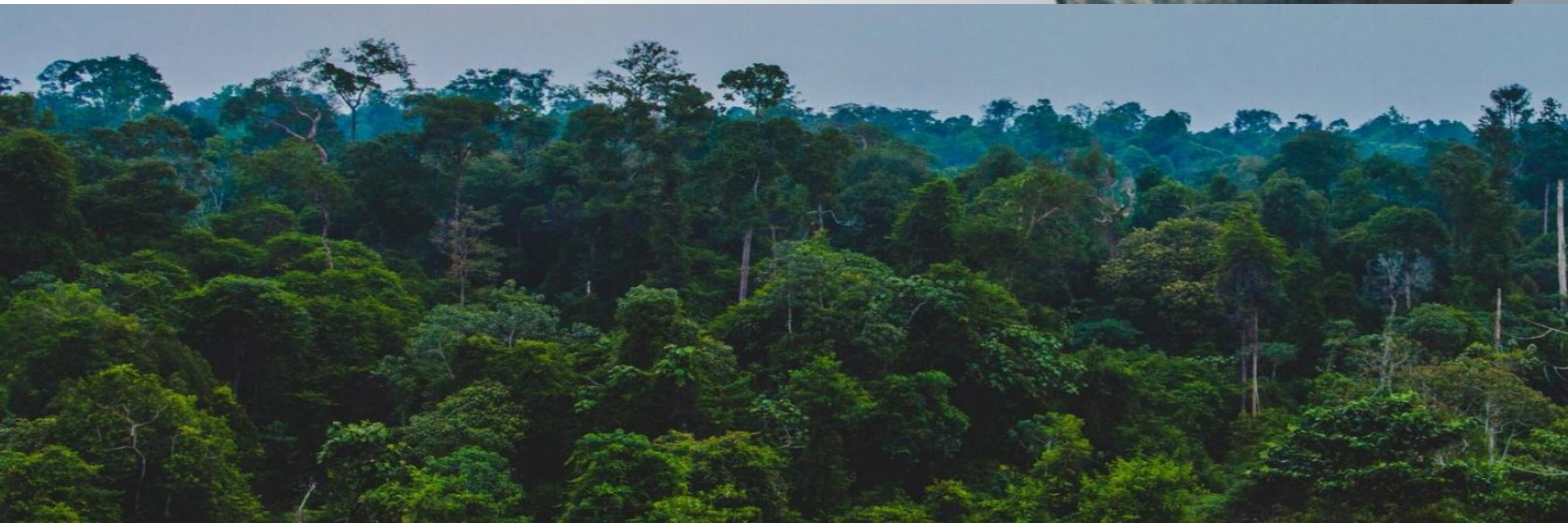
NASA Harmonized Landsat-8 and Sentinel-2 (HLS) data

- All available HLS data over the study area for 2020-2021 was used in this research.



4.0 Cloud resources

MSU HPCC onDemand Resources



OnDemand address

http://ondemand.hpcc.msu.edu

ICER

INSTITUTE FOR CYBER-ENABLED RESEARCH

MSU HPCC onDemand Resources

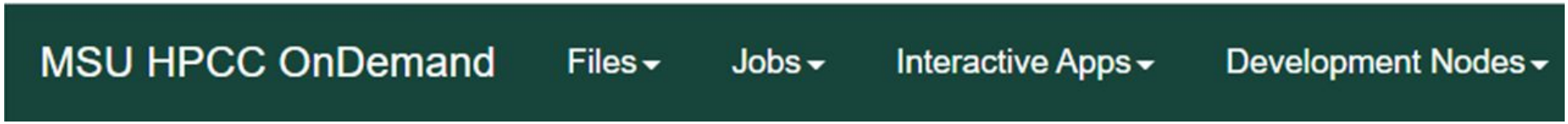
OnDemand - software providing easy web access with graphical interfaces to ICER's HPCC system

- No secure shell (SSH) client needed
- Valid ICER HPCC account required to access websites

The features of the web portal include :

- Easy file management
- Command-line shell access
- Job submission, management and monitoring across different nodes and resource managers
- Graphical desktop environments and specific applications

MSU HPCC onDemand Resources used in this research



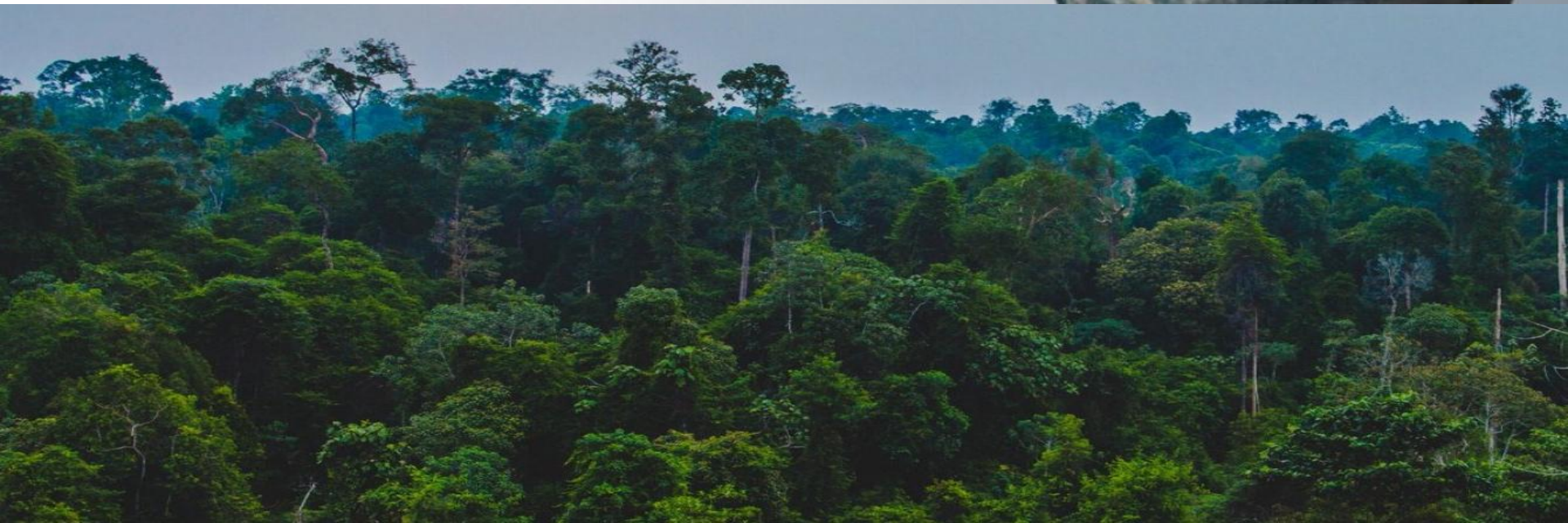
HPCC VM provides 1TB storage.

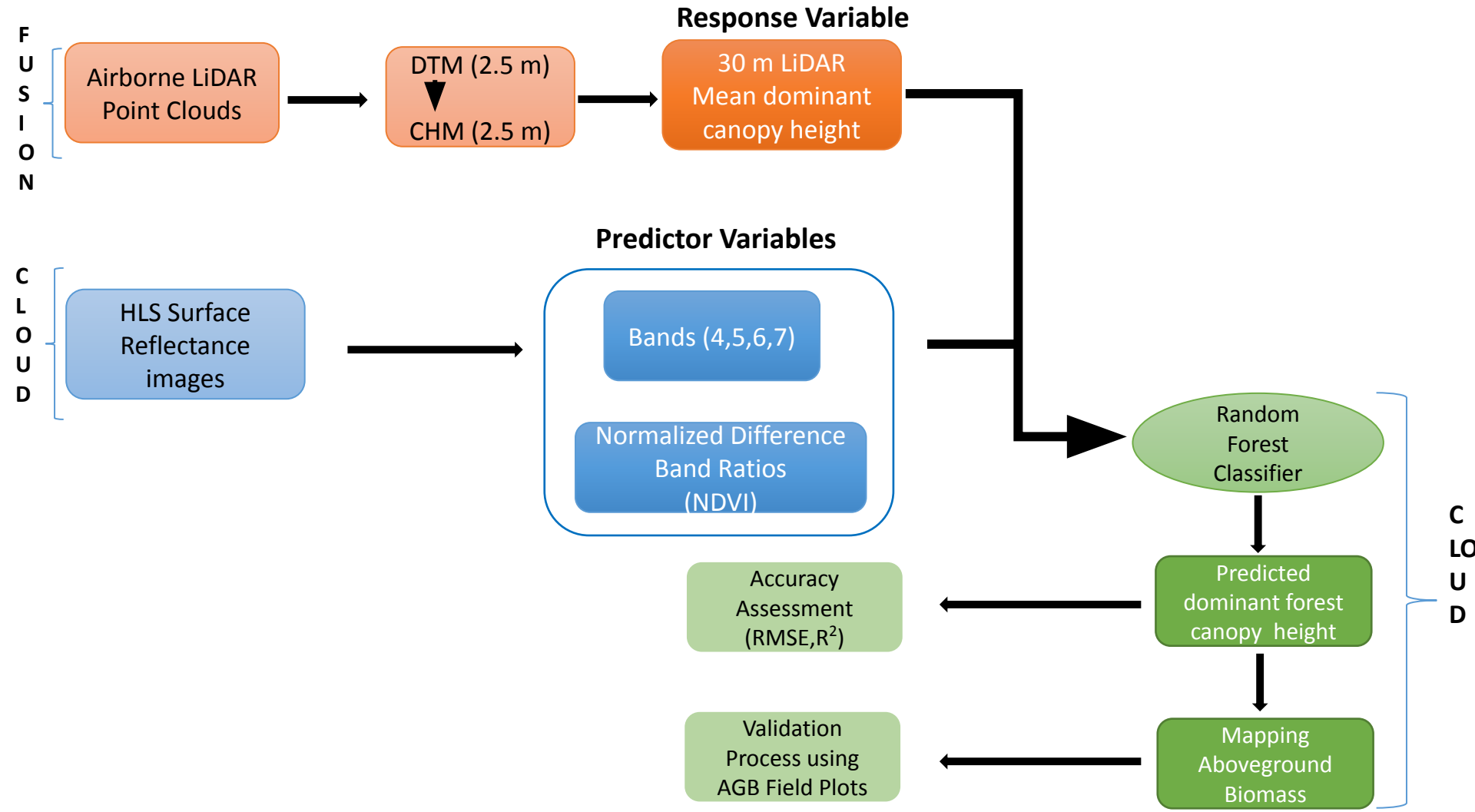
Interactive Apps : Rstudio to edit and test my code directly to the HPCC VM.

Jobs : Job submission, management, and monitoring across different nodes

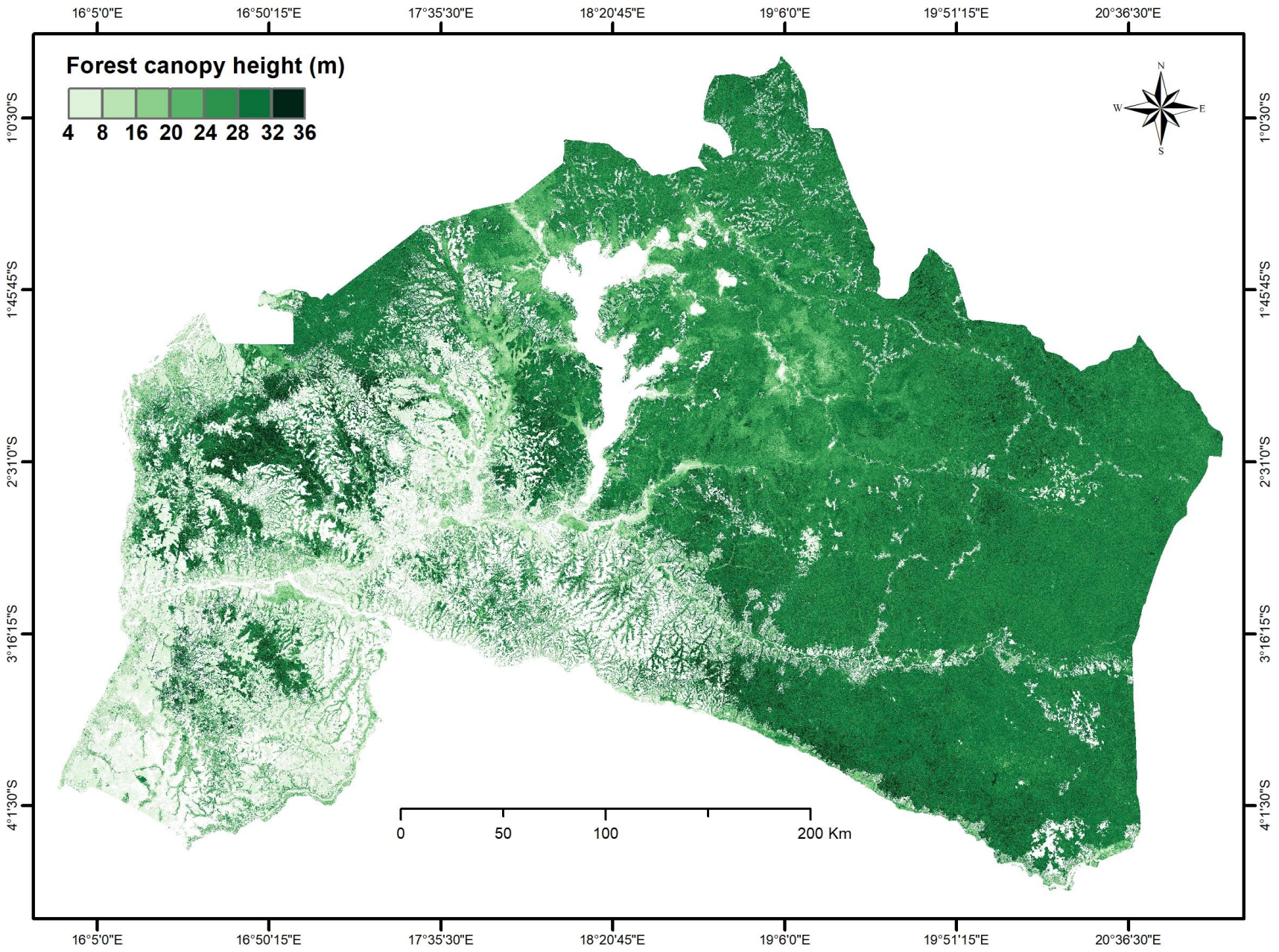
Developments nodes : Command-line shell access to specific HPCC dev nodes

5.0 Method and Results

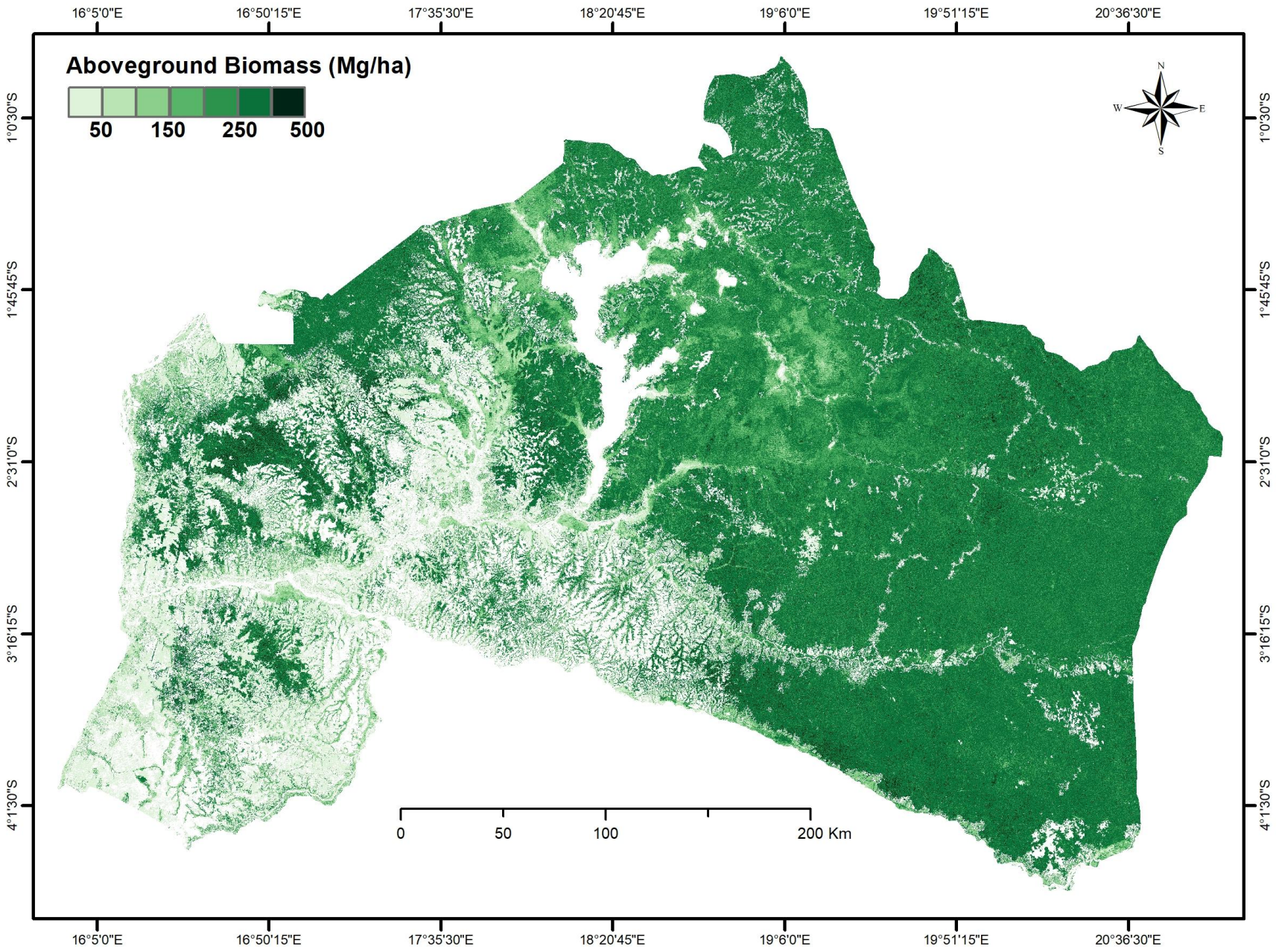



FUSION
Airborne LiDAR Point Clouds
DTM (2.5 m)
CHM (2.5 m)
Response Variable
30 m LiDAR Mean dominant canopy height
CLOUD
HLS Surface Reflectance images
Predictor Variables
Bands (4,5,6,7)
Normalized Difference Band Ratios (NDVI)
Random Forest Classifier
Predicted dominant forest canopy height
Accuracy Assessment (RMSE,R^2)
Mapping Aboveground Biomass
Validation Process using AGB Field Plots
CLOUD

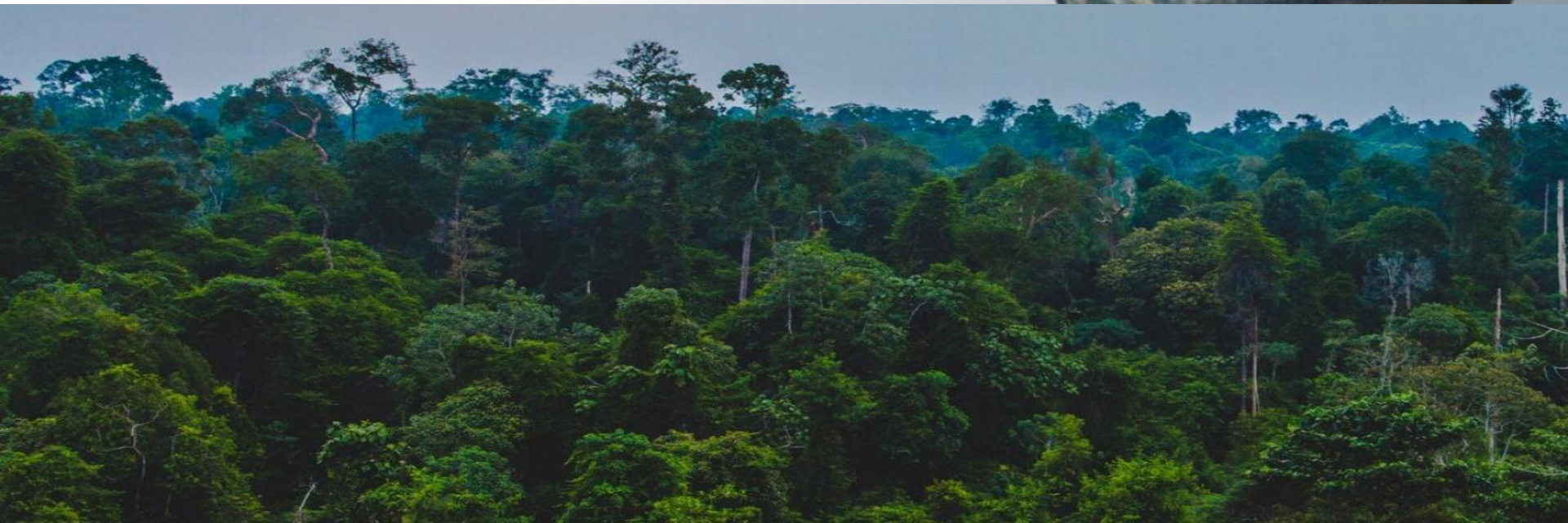
Study area Forest canopy height map (m)



Study area AGB map (AGB = 1.88 × $h^{1.55}$; Xu et al. 2017)



6.0 Lesson learned and future work



Lessons Learned

This fellowship introduces me the world of big data processing using cloud computing. I particularly learned how powerful is could computing in processing big data. I have also learned to be flexible in term of coding software to use as things evolve really fast in that area and that adaptation is something that should be included in a scientist daily life.

Future work

The next step will be to shared with external collaborators that don’t have access to on-campus HPCC using the Azure platform.

THANK YOU