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Forest Biomass map Colombia

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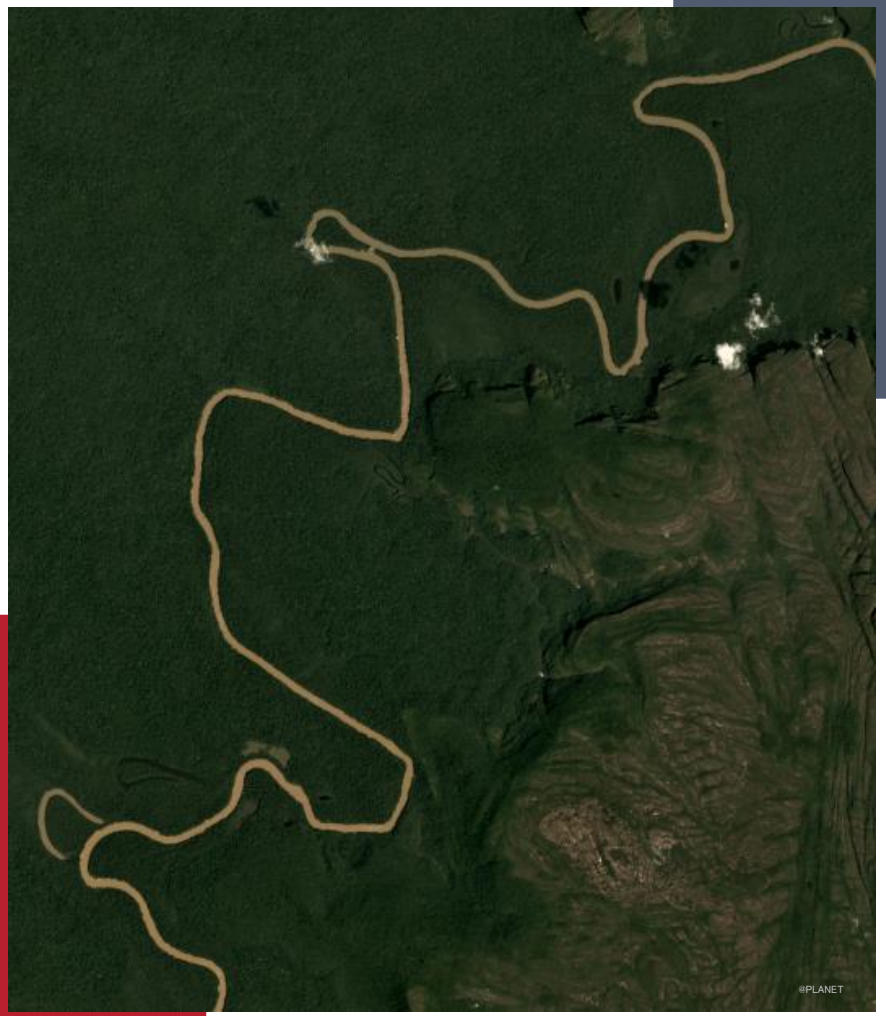

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Biomass / Carbon

- Aboveground Biomass (AGB) is a basic unit to account for carbon
- Essential Climate Variable (ECV) required by the Global Climate Observing System (GCOS) to support UNFCCC and the IPCC
- Reduction of Emissions from Deforestation and Forest Degradation (REDD+) at national and project level require the spatial distribution of biomass stocks to assess carbon gain/loss due to disturbances
- Mapping AGB nationally for Colombia within the framework of the Joint Declaration of Intent

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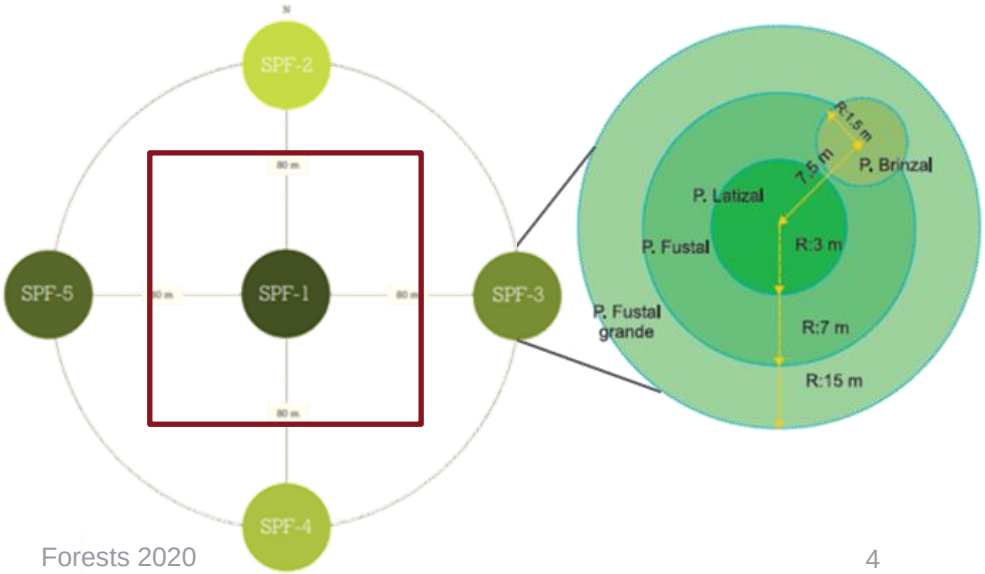
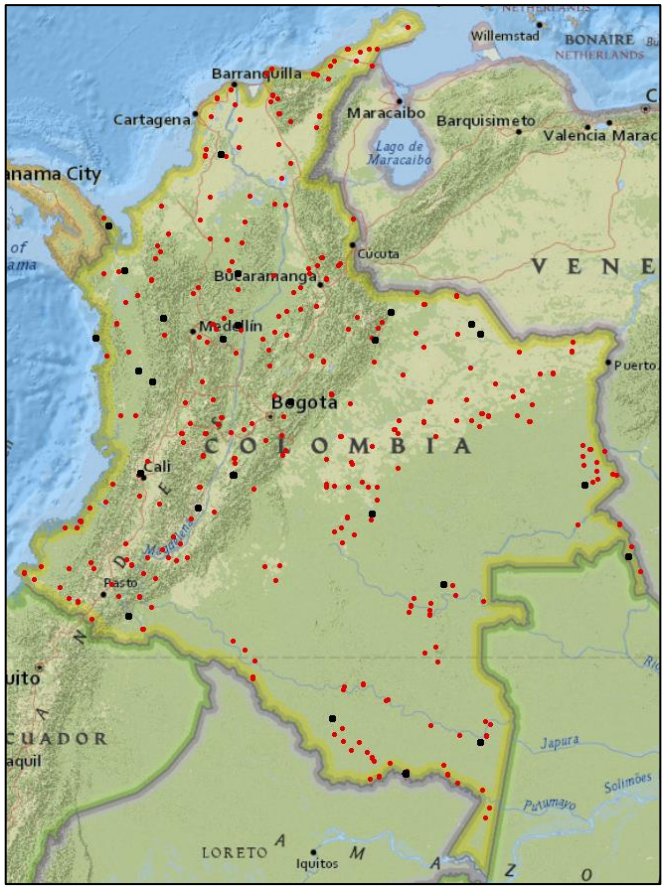
National Forest Inventory

- The National Forest Inventory of Colombia started in 2015 and it is an initiative aiming to monitor forest resources nationwide (IDEAM, 2018)
- The NFI collects information on vegetation structure, composition, richness, biodiversity, biomass, growing stock, soil carbon, and forest dynamics
- This information allows to monitor the status of forests, the carbon stocks, and the composition of forest resources through time
- However, the number of sampling units to date is quite limited due to difficulty to access the most remote forest areas (i.e. Amazon region)

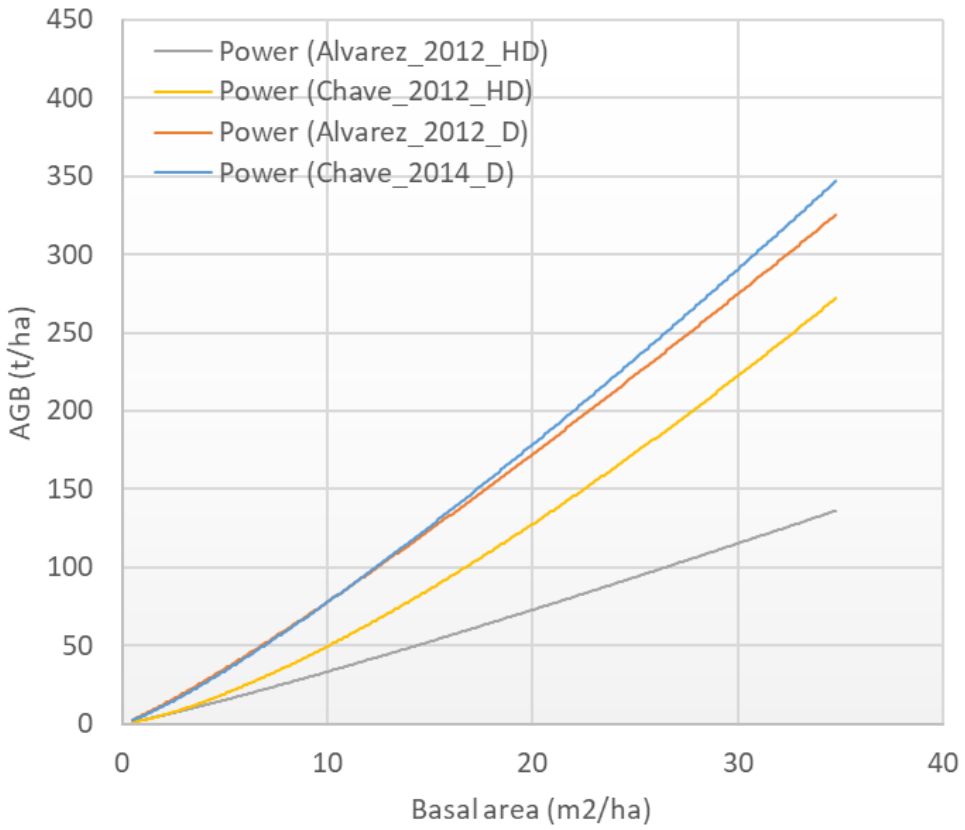
Sampling units

- Plots:
  - Cluster of 5 circular subplots (SPFs) of 30 m diameter (0.07 ha)
  - Total area: 0.35 ha
- Permanent Plots (PPM)
  - 100 m x 100 m
  - Total area: 1 ha





Allometries type I vs type II



- D only models (type II) from pantropical and national allometric models estimate similarly
- H-D models (type I) from pantropical estimate slightly less than D models, but H-D national estimates approximately half than D models

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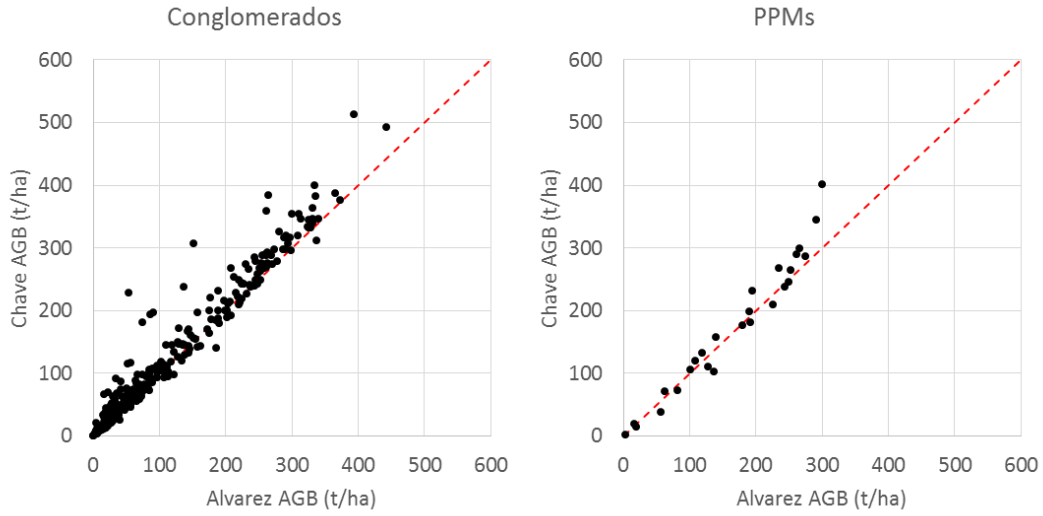
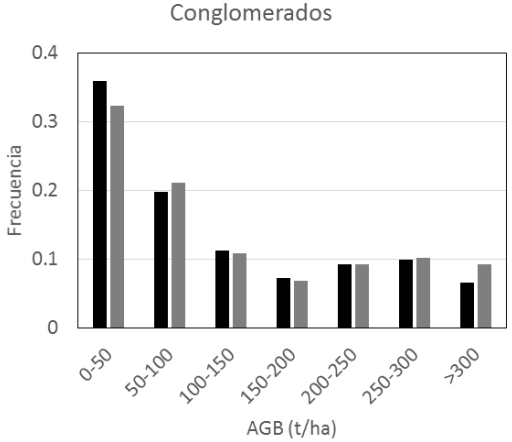
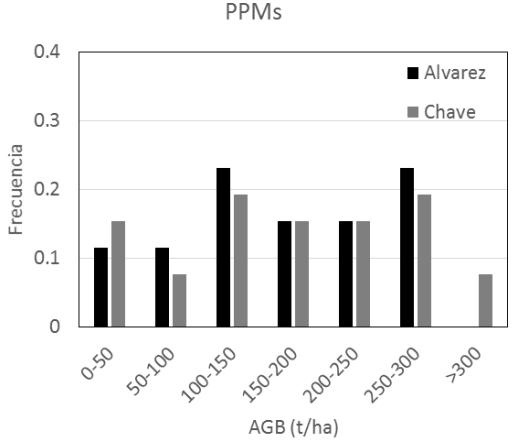
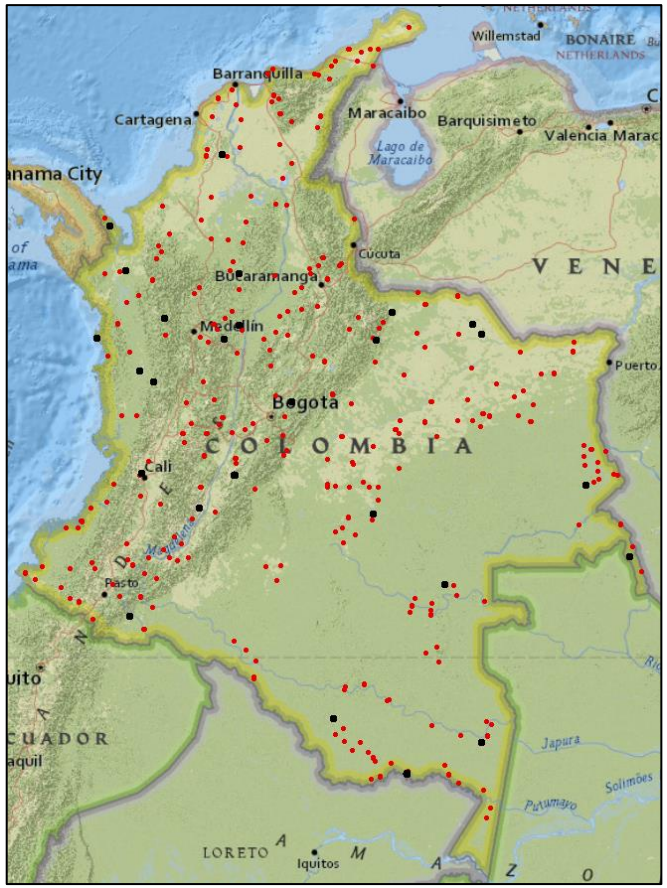
Plots and PPMs









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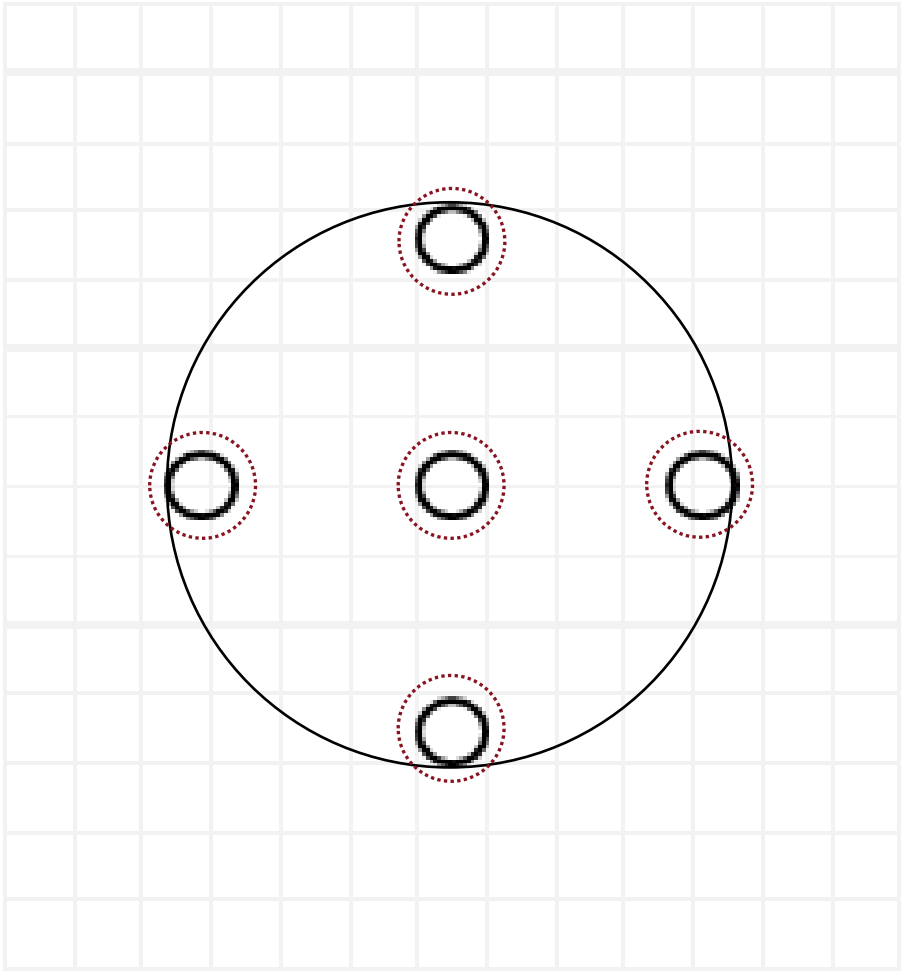
Methods

- Development platform: Google Earth Engine
- Implementation platform: IDEAM Colombia DataCube
- Algorithm: Random Forests Regression
- Training / validation data:
  - Plots (k-fold cal/val)
  - PPM (val)
- EO data
  - L-band SAR ALOS-2 PALSAR-2 dual pol annual mosaics
  - Multispectral Landsat 8 multi-temporal composite

Algorithm training



- SPF (0.07 ha)
  - Geolocation error
  - Big tree problem
- Plots (0.35 ha)
  - Pixels covered by the 5 SPF
- Plots (~4 ha)
  - Pixels covered by area of ~4 ha
- Plots + 10m buffer
  - Pixels covered by area of ~1 ha

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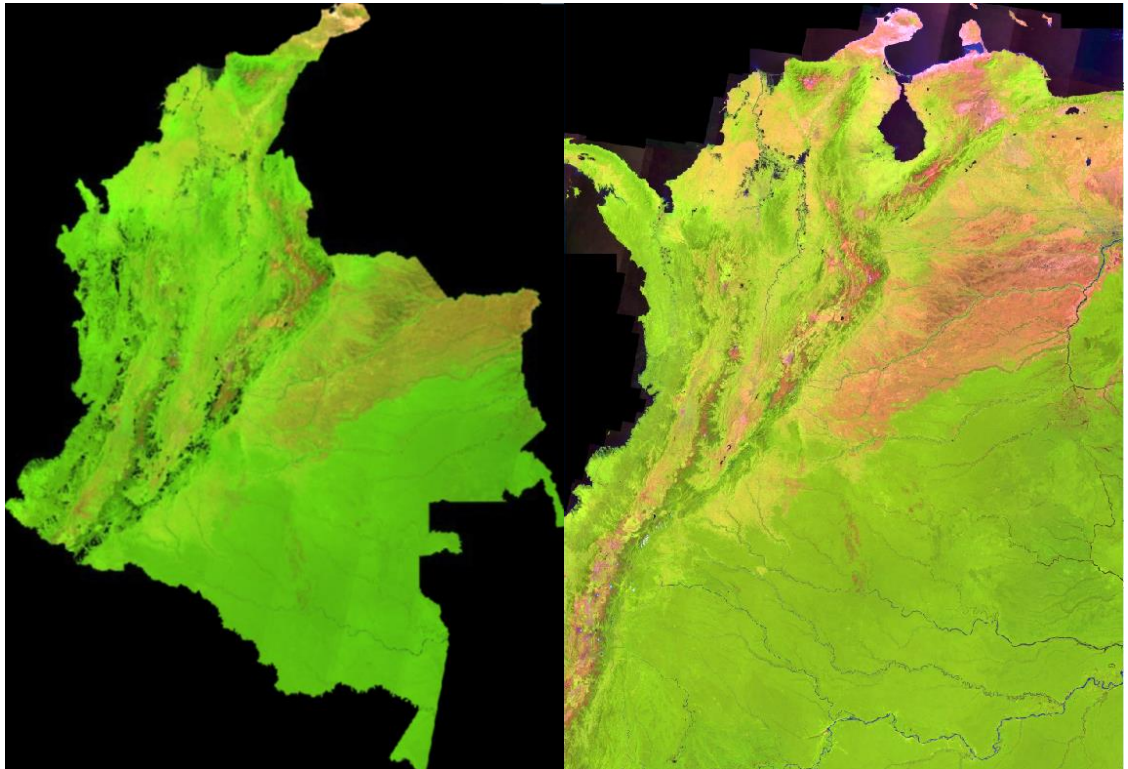
EO Data

- Complicated country in terms of cloud cover, slopes, etc
- EO input variables were selected based on quantitative analyses (i.e. jackknife analyses – R^2, RMSE, bias, etc) as well as qualitative observations (minimum presence of artefacts in the resulting map)
- Several datasets were explored:
  - Landsat 7/8
  - ALOS 2 PALSAR 2
  - Sentinel-1
  - Proba-V 100
  - Landsat PTC
  - Digital Surface Model - DSM
  - IDEAM FNF

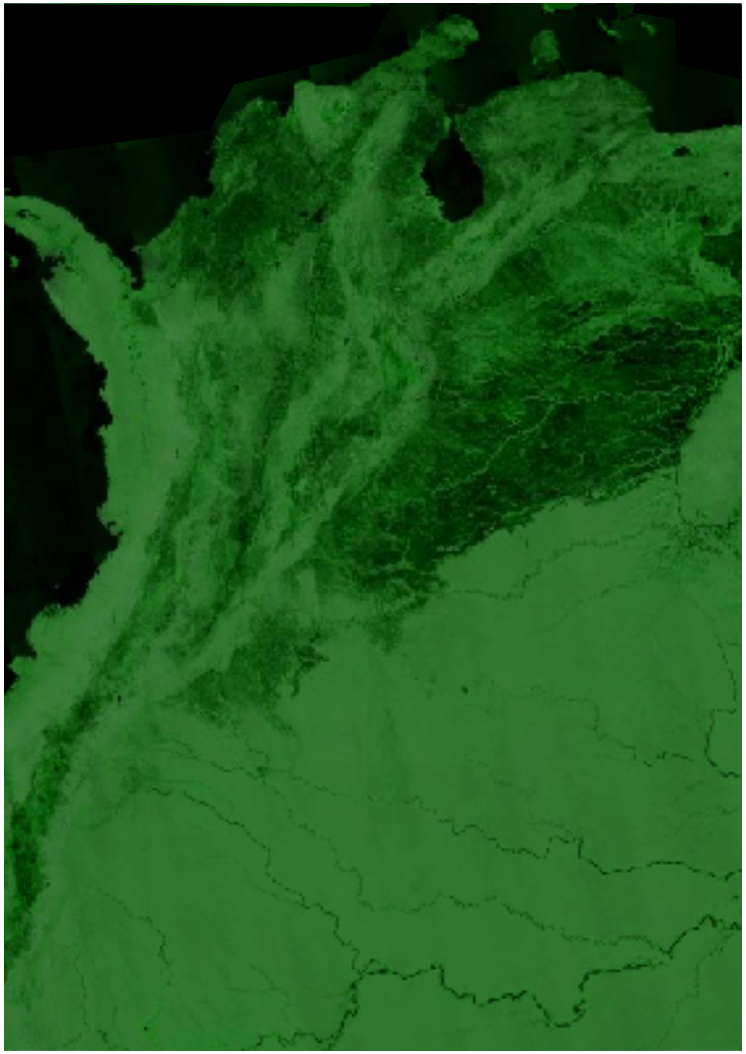
EO Data

- Landsat 8 (2016±1)
  - Surface Reflectance or Top Of Atmosphere (TOA) normalized
  - Cloud / shade masking
  - Spatial resolution: 30mx30m
  - Pixel value corresponds to the median of the annual observations

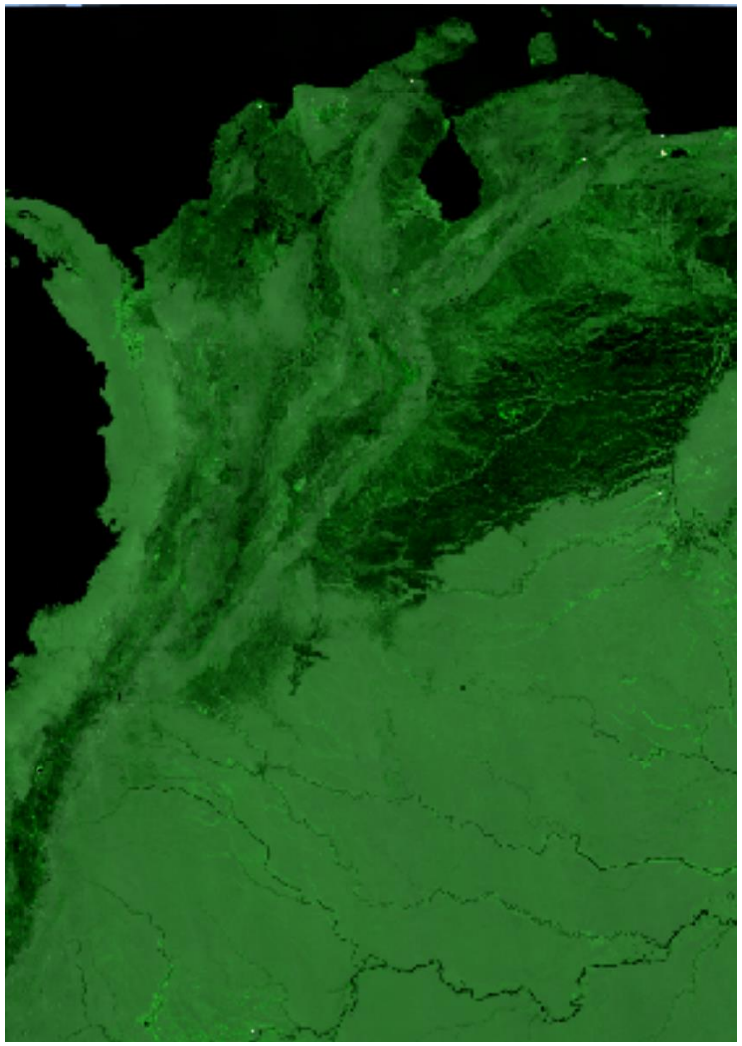


EO Data

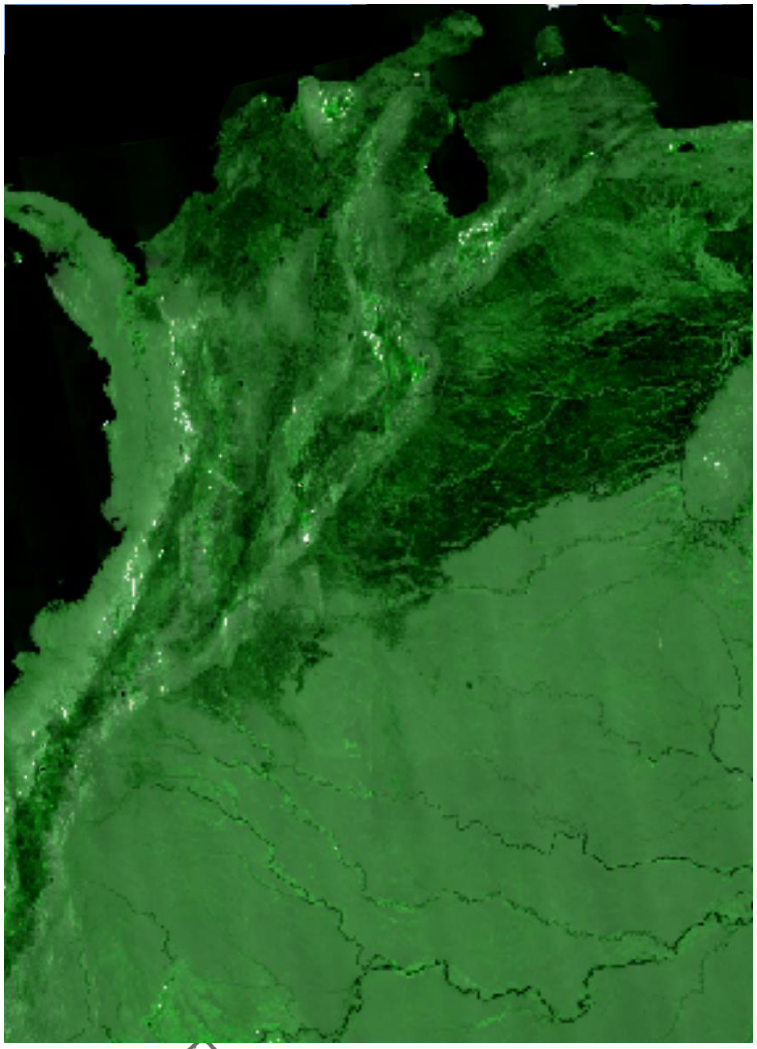
- L-band ALOS-2 PALSAR-2 2015-17
  - Standard SAR pre-processing (Shimada et al., 2014): Calibration, multi-looking (output of 16 looks), projection, ortho-rectification, slope correction using SRTM DEM and an additional destriping process (Shimada and Isoguchi, 2002)
  - Spatial resolution: 25mx25m
  - Additional processing
    - Masking problematic pixels
    - Multi-channel filtering (7x7 window)
    - Normalization to PALSAR
    - Correction based on PALSAR
    - Gap-filling



ALOS PALSAR
2007 - 2010



ALOS 2 PALSAR 2
2015 - 2017



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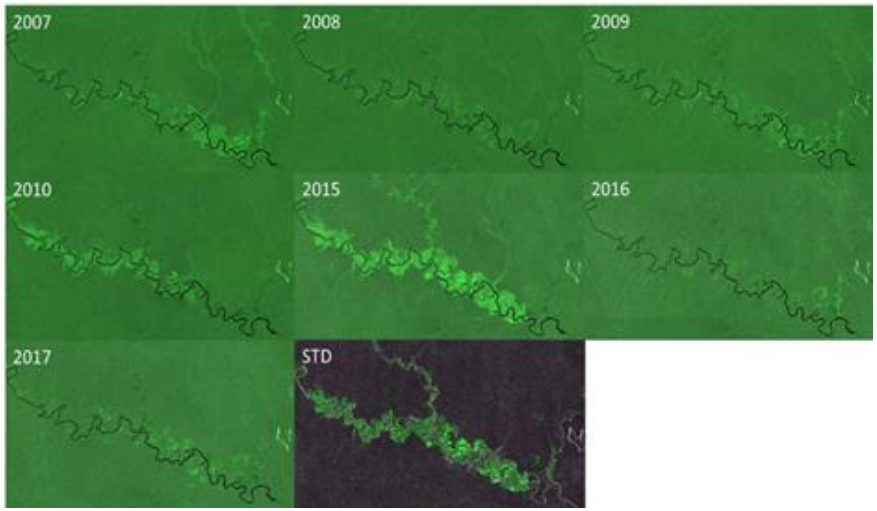
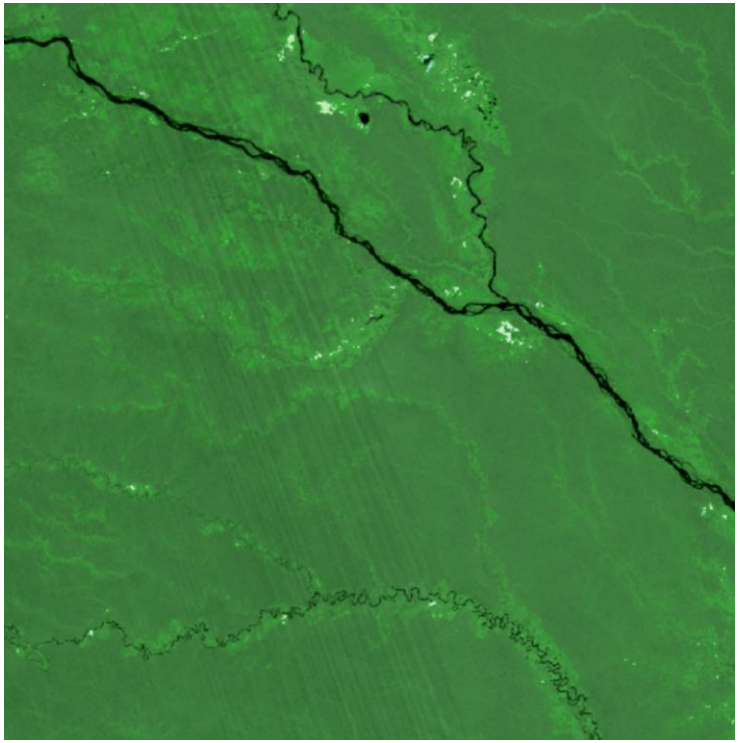
Issues with K&C mosaics

Inundation / moisture



Ionosphere effects



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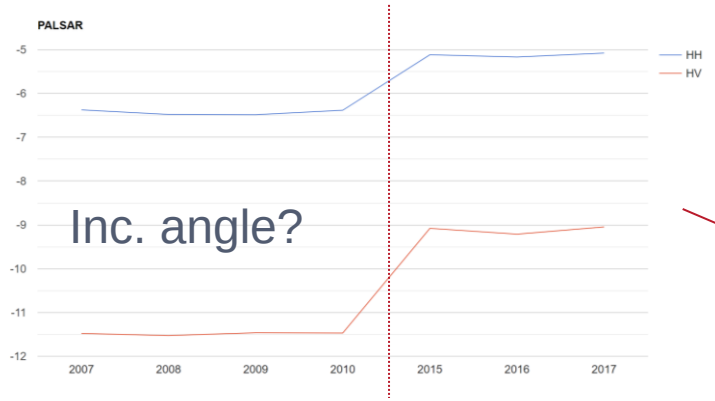
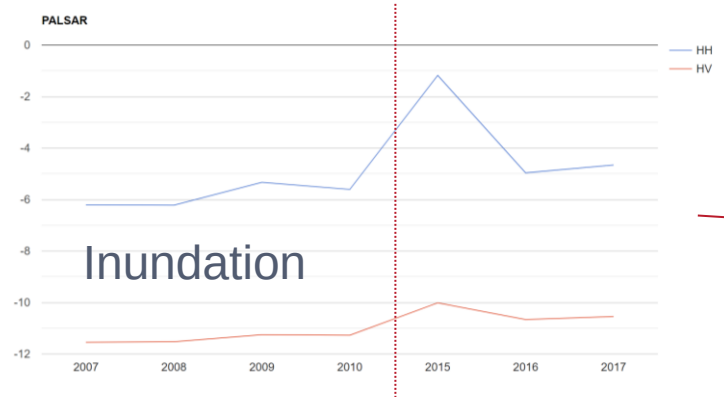
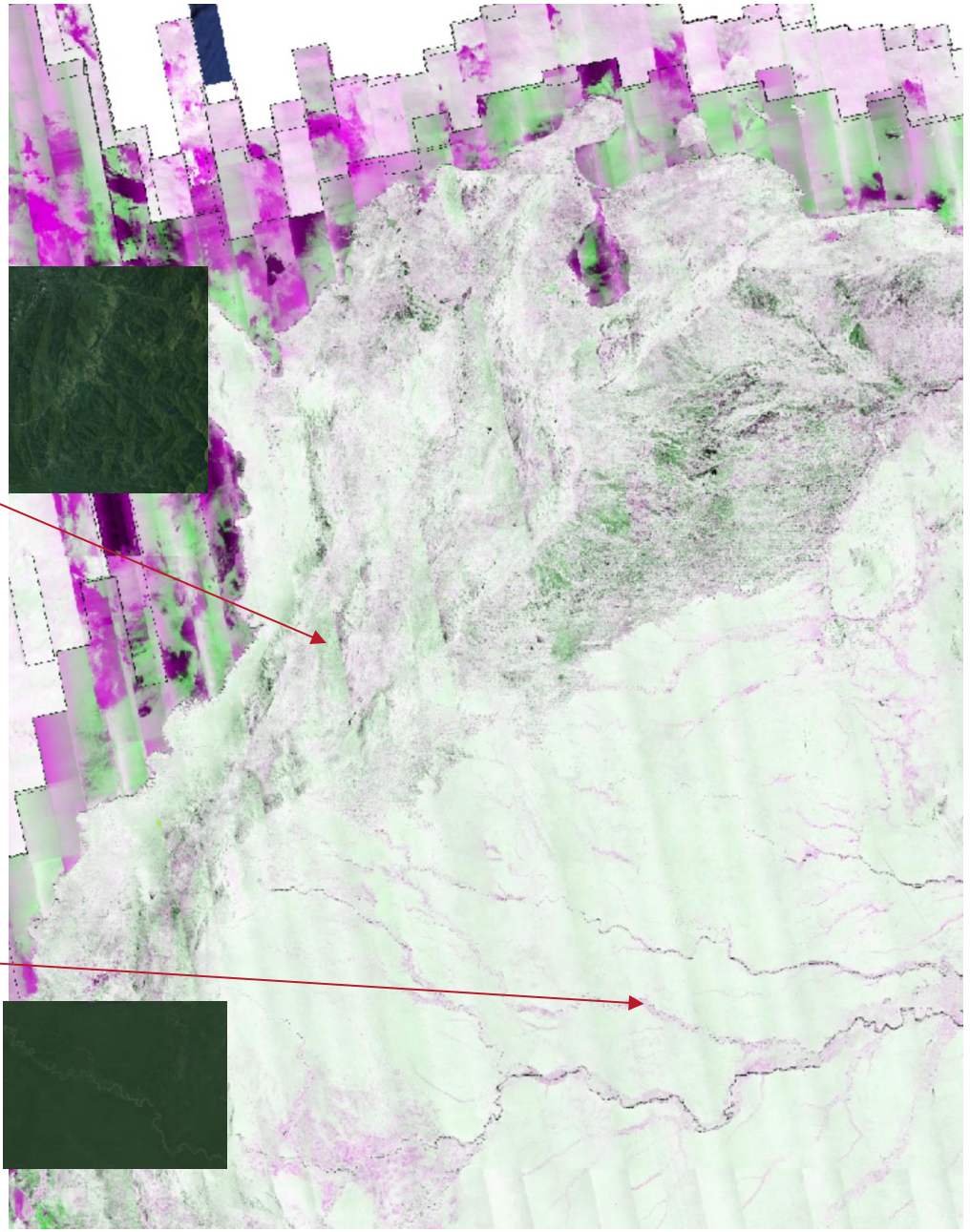
Issues with K&C mosaics







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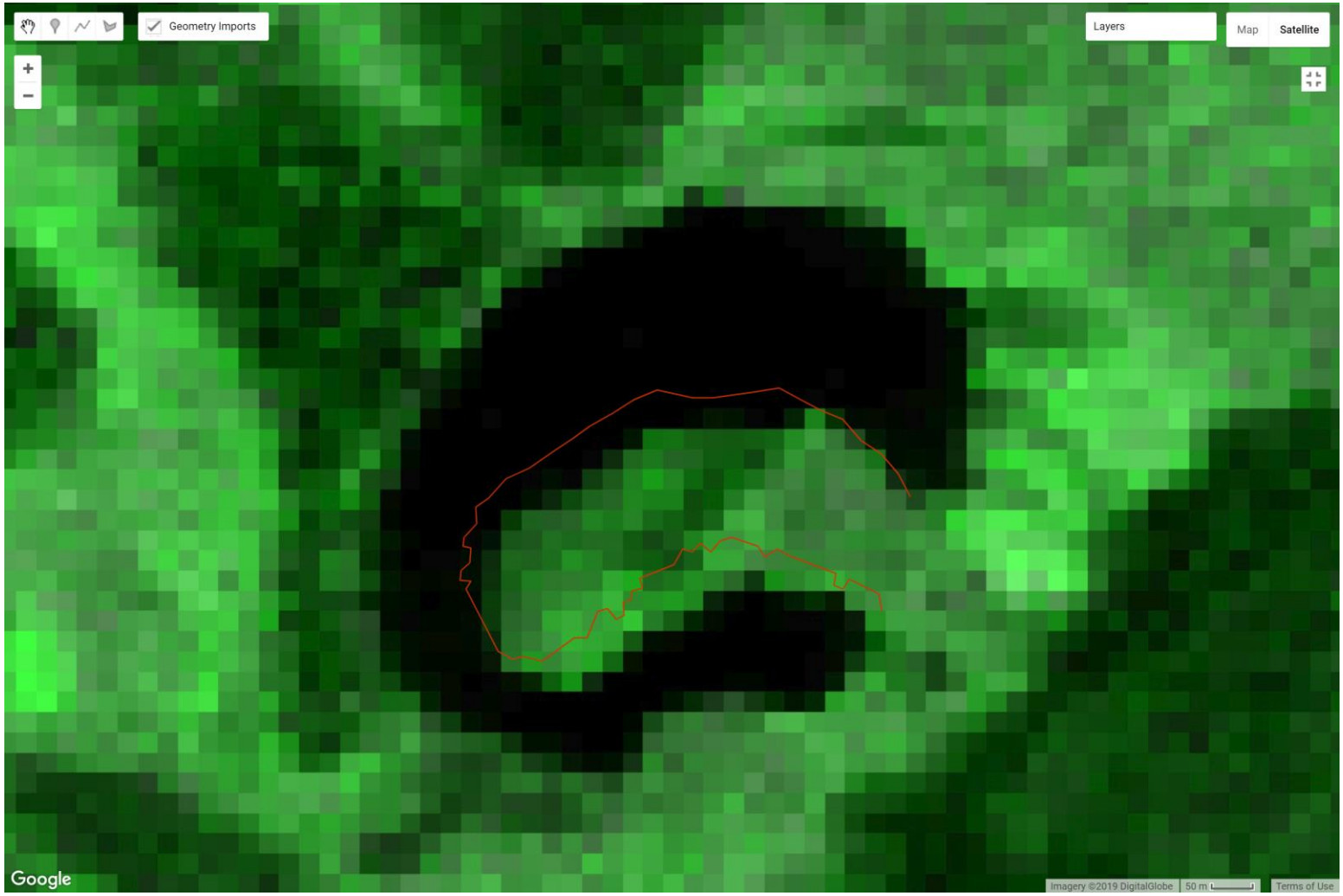
Other issues

2-4 pixels off



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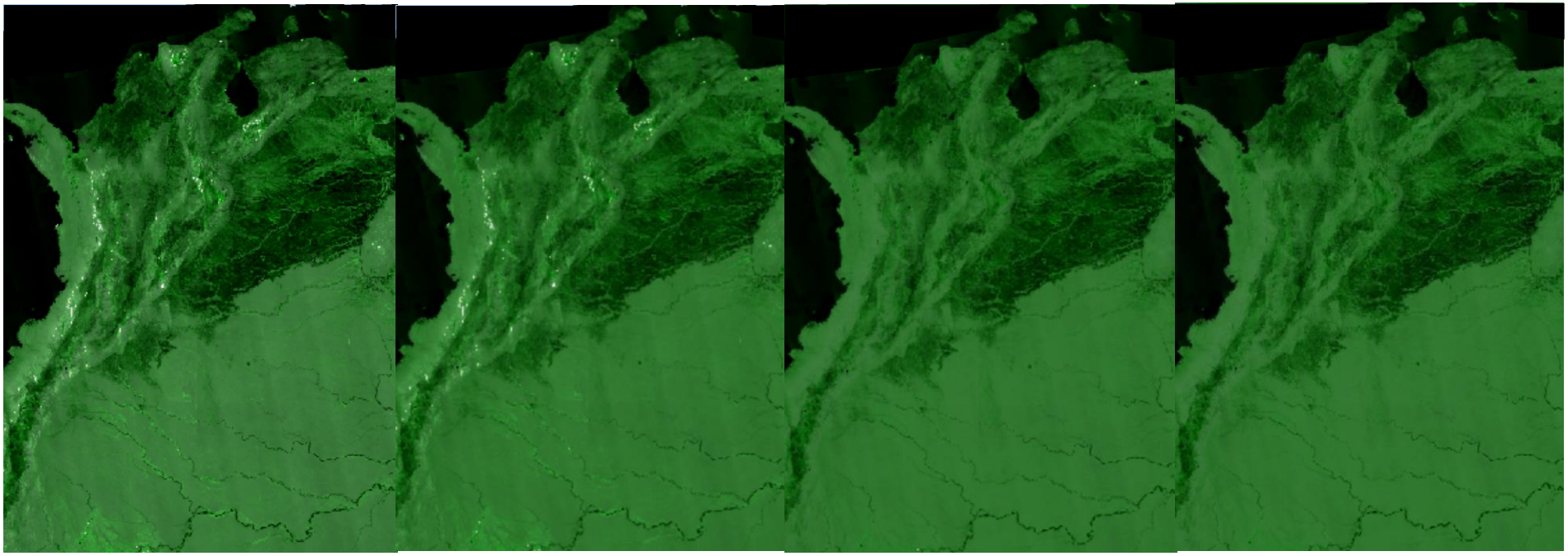
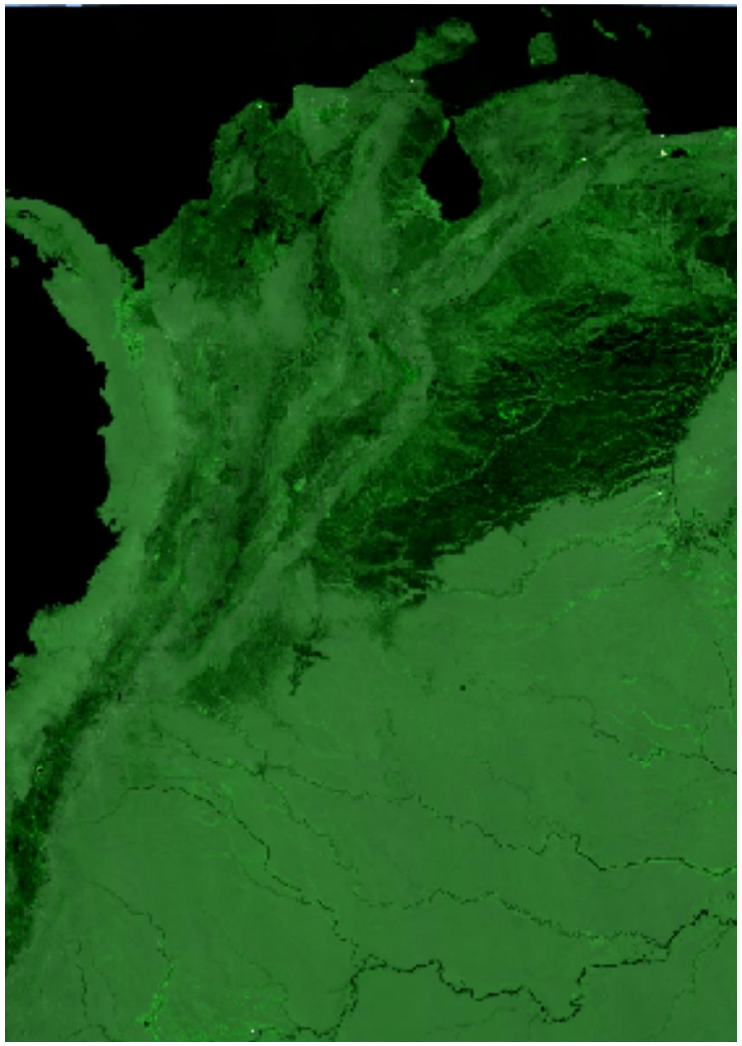
EO Data

Original -> Normalization -> Correction -> Gap filling

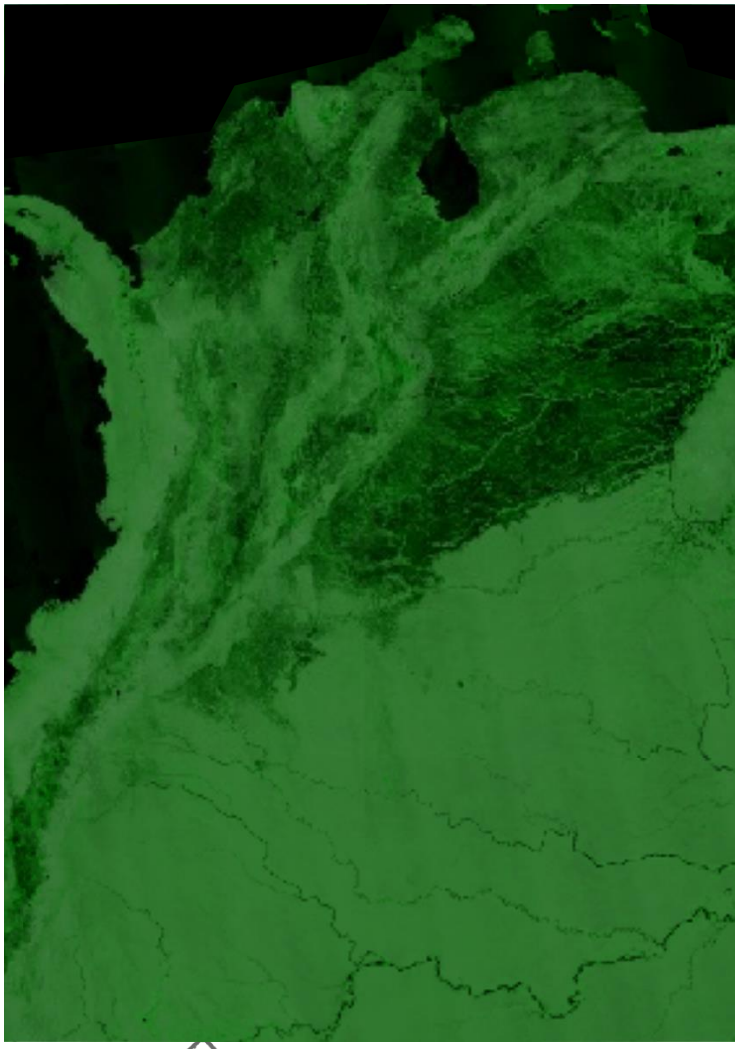


- Normalization based on ALOS PALSAR 2007-2010 (master)
- Correction of pixels from ALOS 2 PALSAR 2 2015-2017 based on ALOS PALSAR (master) temporal statistics

ALOS PALSAR
2007 - 2010



ALOS 2 PALSAR 2
2015 - 2017



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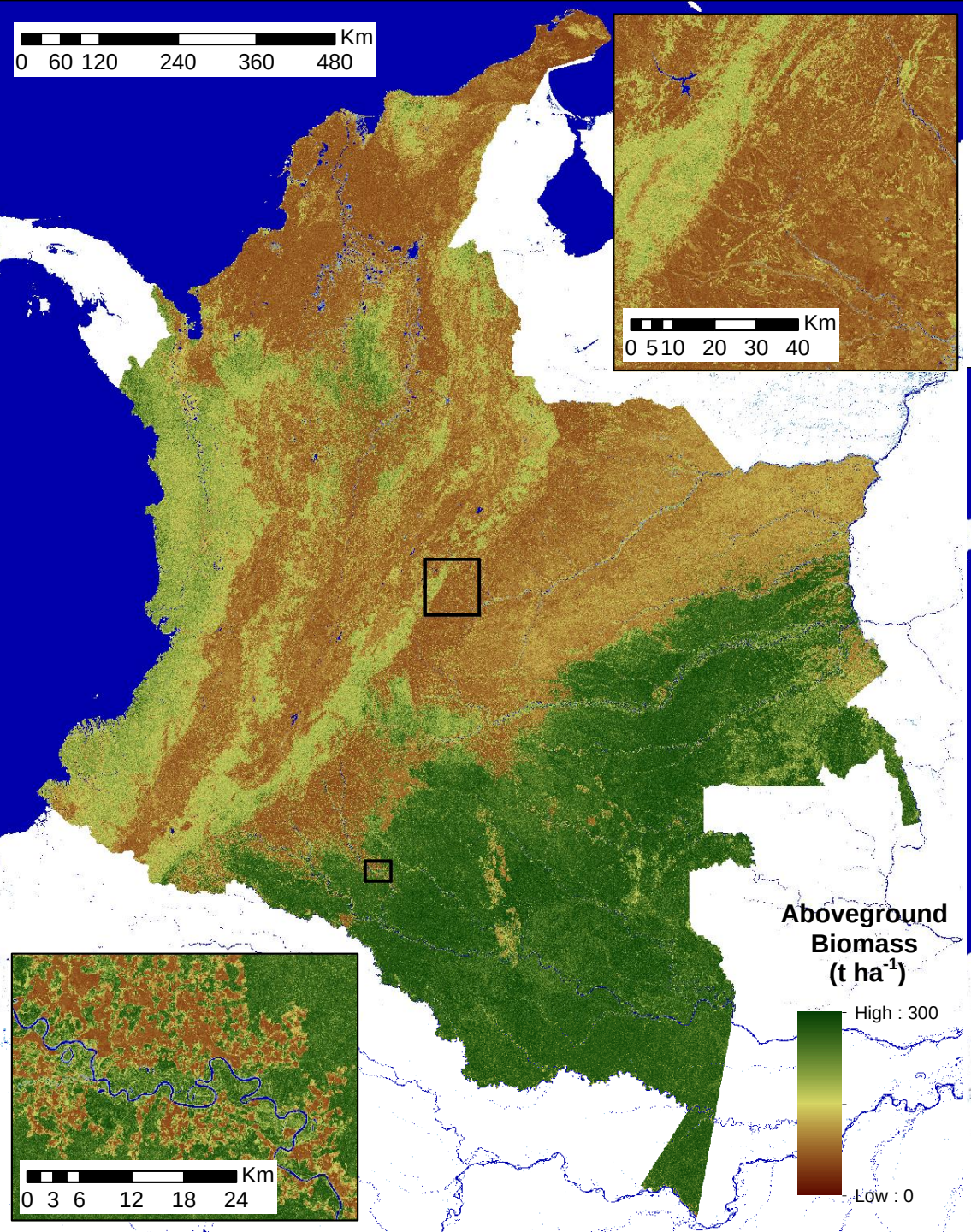
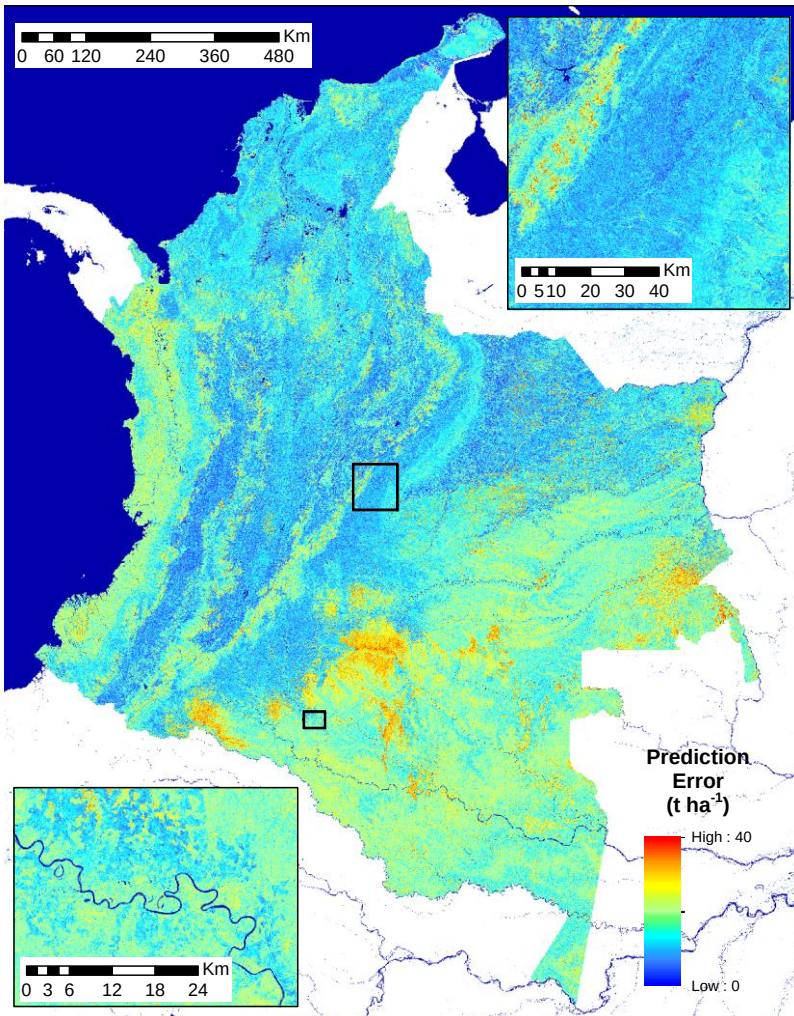
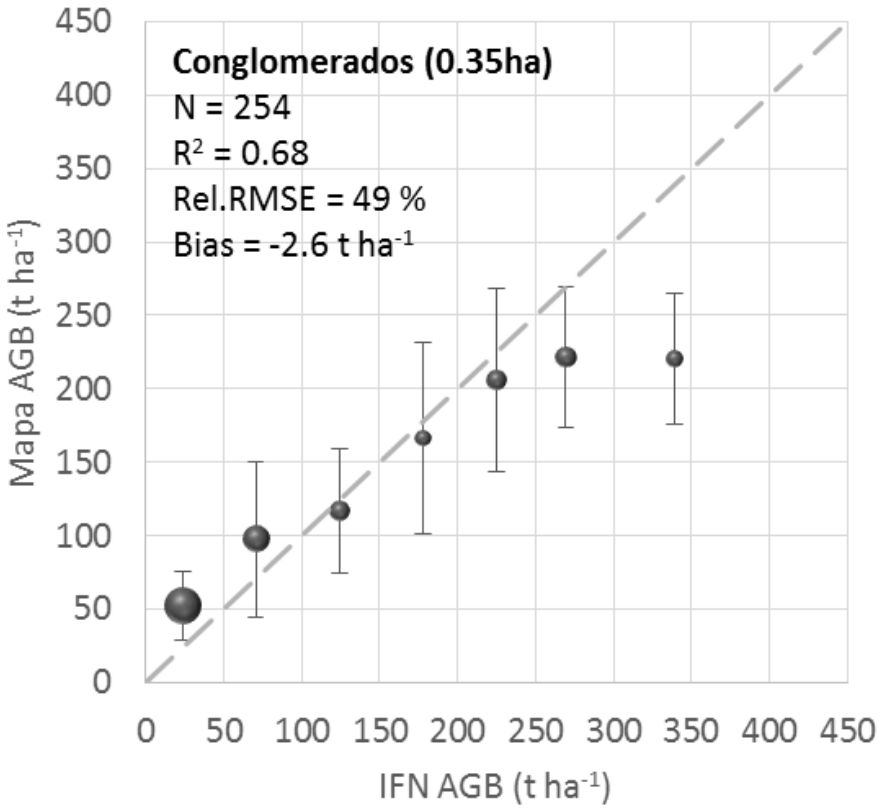
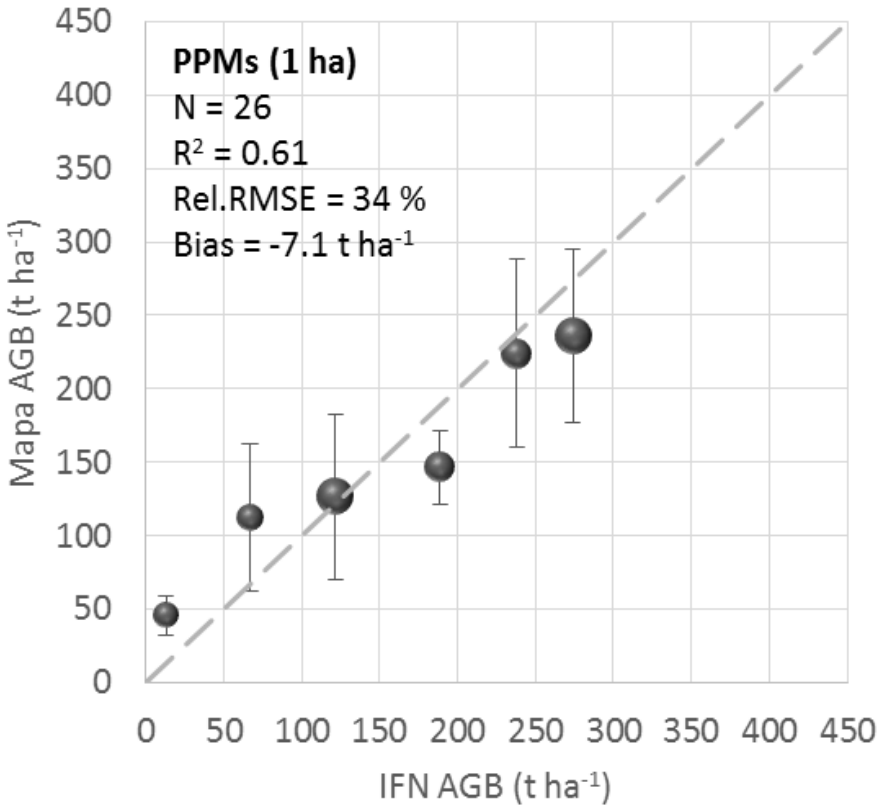
Biomass map


Km
0 60 120 240 360 480
Km
0 5 10 20 30 40
Km
0 3 6 12 18 24
Aboveground Biomass (t ha-1)
High : 300
Low : 0


Km
0 60 120 240 360 480
Km
0 5 10 20 30 40
Km
0 3 6 12 18 24
Prediction Error (t ha-1)
High : 40
Low : 0

Accuracy assessment
Plots & PPMs





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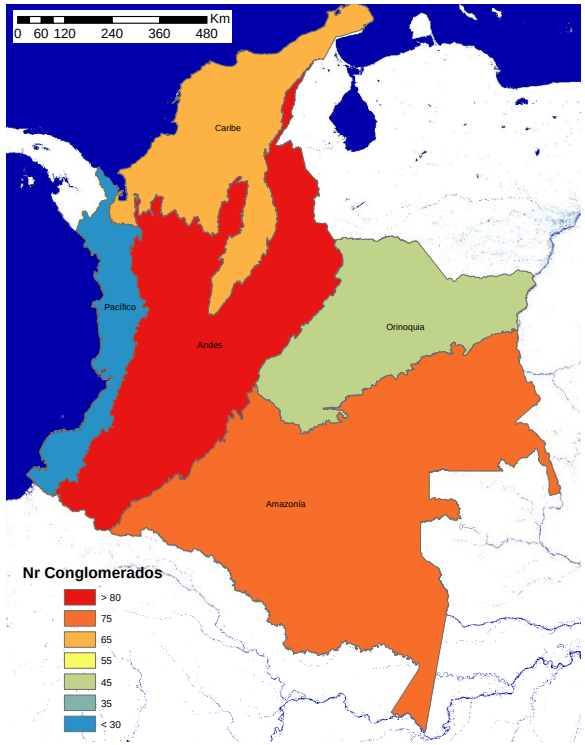
Comparison to NFI estimates

The NFI calculates carbon stocks nationally and regionally using the ratio estimator frequently used for the Global Forest Resources Assessment reporting (Marklund et al., 2005).

Region	AGB (t/ha)	Total AGB (Pg)	Difference to NFI (Pg)	Difference to NFI (%)
Amazonía	200.50	9.19	1.45	13.65
Andes	75.38	2.20	0.25	10.28
Caribe	45.63	0.70	0.006	0.87
Orinoquía	32.70	0.55	0.21	28.19
Pacífico	122.53	0.82	0.15	15.14
Total	118.14	13.47	0.41	2.93



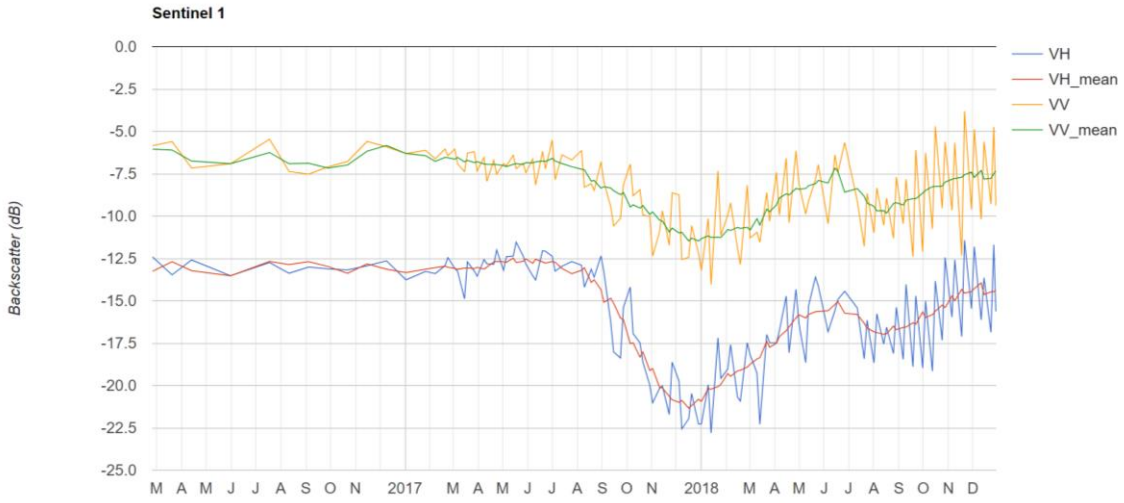
The AGB stocks calculated using the AGB map were comparable to current estimates from the NFI. Although the AGB estimates derived from the map are lower than the NFI estimates, the differences are not significative. The total AGB estimate for the whole country was only a 2.93% lower than the NFI national estimate, while regionally the differences were between 0.87% and 28.19%

Conclusions

- This is the most detailed and accurate map to date produced for Colombia using national data.
- Initial results using a combination of SAR ALOS-2 PALSAR-2 and multispectral Landsat 7 & 8 annual composites show promising results.
- Several issues of the K&C PALSAR-2 mosaics have been observed and need to be corrected
- Current work is using allometric models with D, H, and ρ as predictors to generate more accurate AGB plot data to train the algorithm
- The use of PPM data instead of plots should be explored

Additional slide

- Investigating forest disturbances and growth in West Java (Indonesia) using SAR temporal profiles
- 6th ALOS 2 Research Announcement
- JSPS fellowship at Kyoto University
- ALOS PALSAR, ALOS 2 PALSAR 2, and Sentinel-1/-2



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Thanks!

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