AI4EO Challenges in the context of the Great Green Wall Initiative

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Great Green Wall Initiative

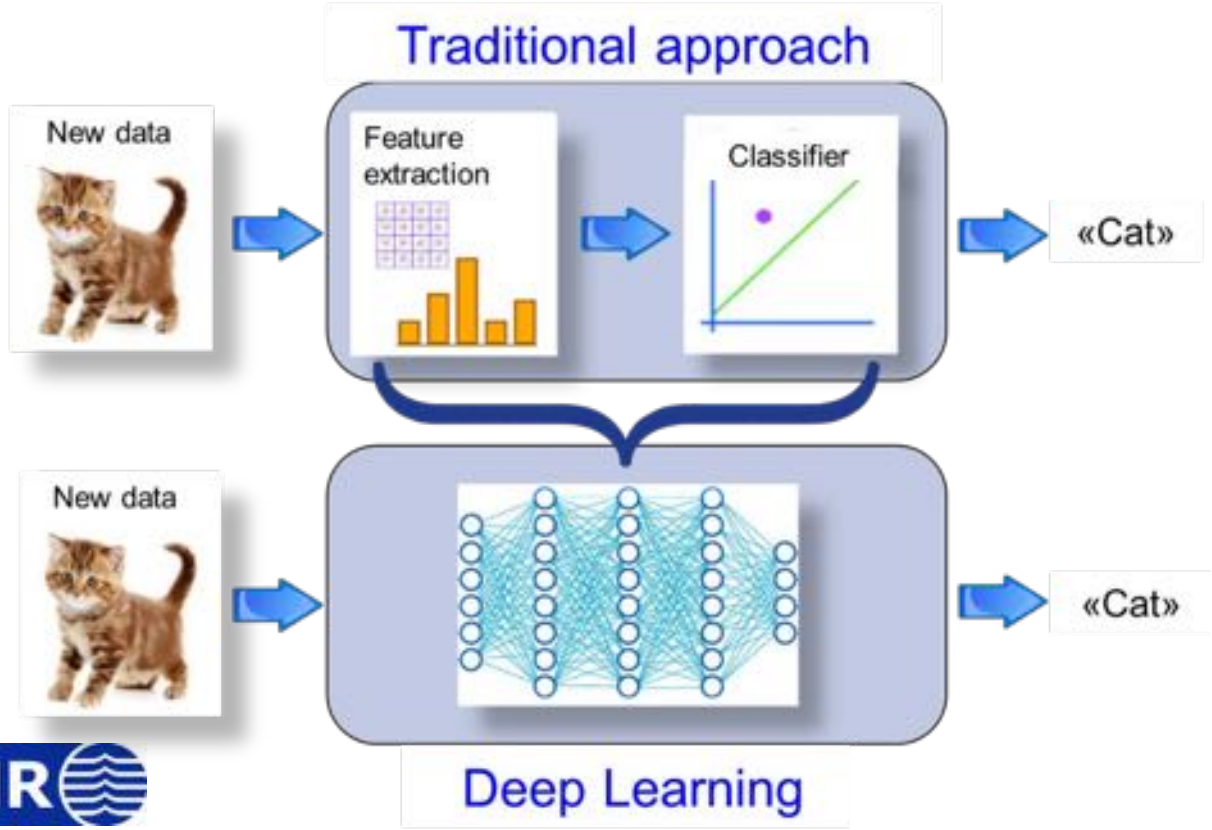
The GGW is a plan to build wall of trees across the African continent – from Senegal in the west to Djibouti in the east.

The GGW will act as a barrier to prevent spread of the desert.

Great Green Wall Initiative

Goal
Explore if deep learning techniques applied to time series of Sentienel-2 data can detect and map dry forest in the Sahel regions

Deep Learning learns end-to-end



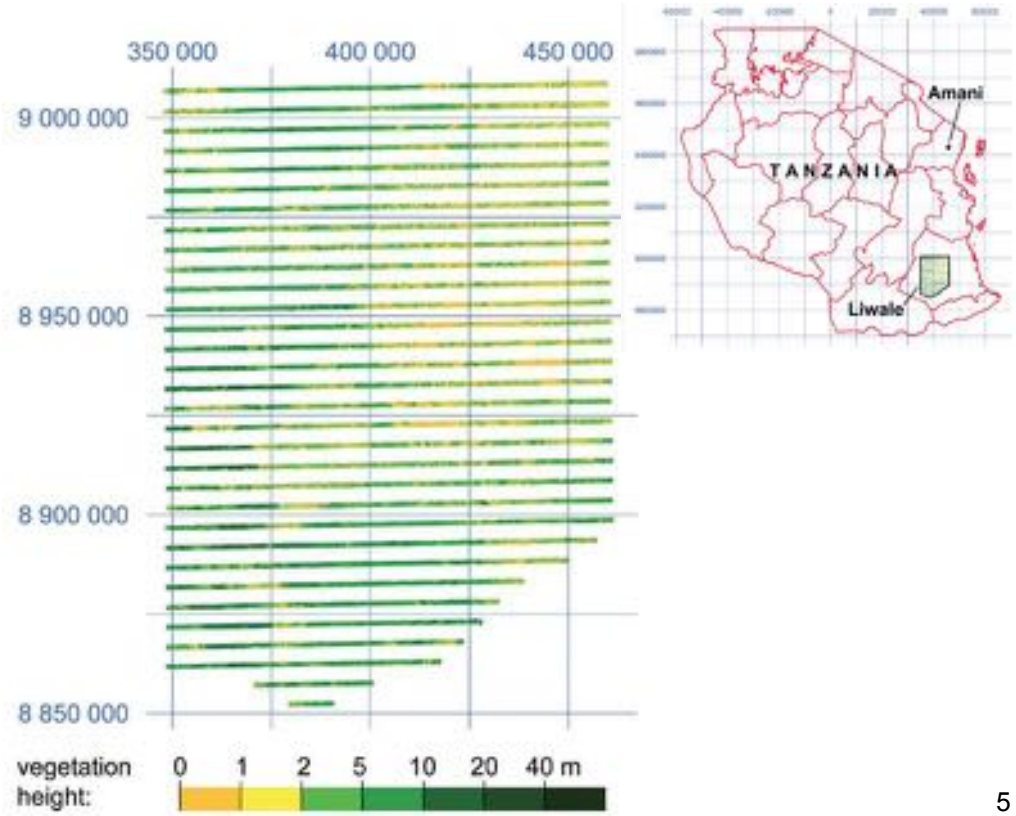
Realized using deep neural networks

Training data

We did not have annotated data available from the Sahel region

But we had lidar data from Liwale, Tanzania (2014)

From the lidar data we processed the **average tree height** [m] per Sentinel-2 pixel



Training data

Corresponding Sentinel-2 data:

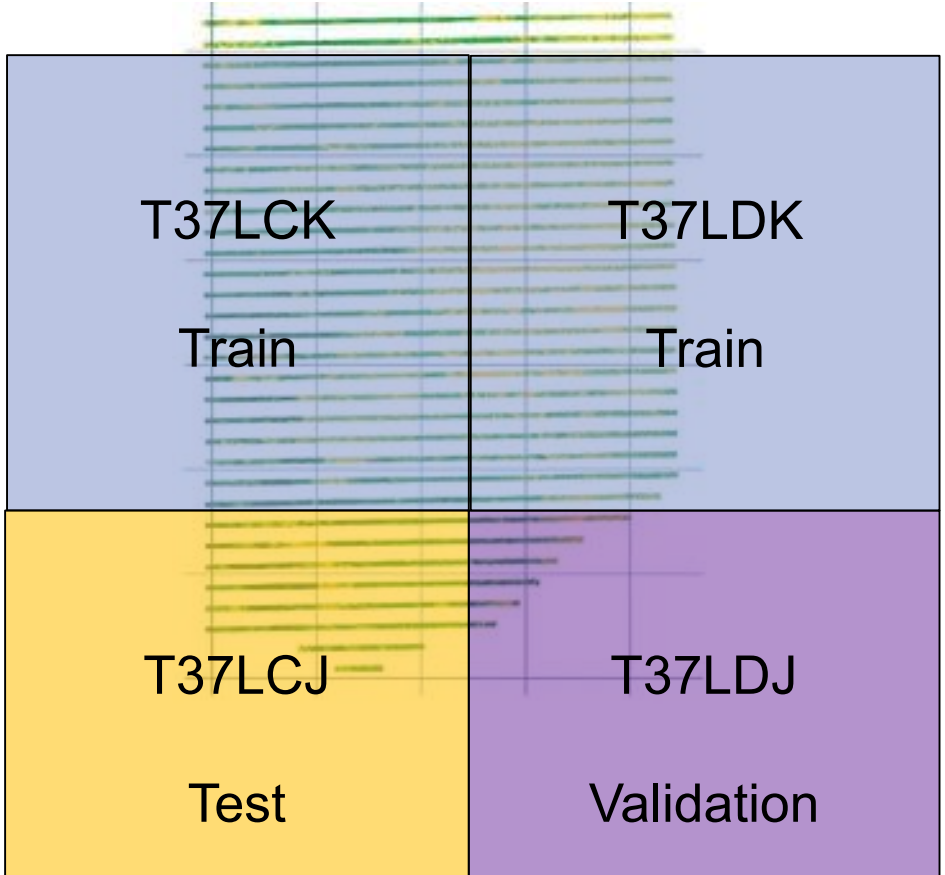
- Training tiles: T37LCK + T37LDK
- Validation tile: T37LDJ
- Test tile: T37LCJ

Test data from the Burkina Faso

- Tiles: T30PWT + T30PXT

Top of the atmosphere reflectance and 10 bands (10m & 20m)

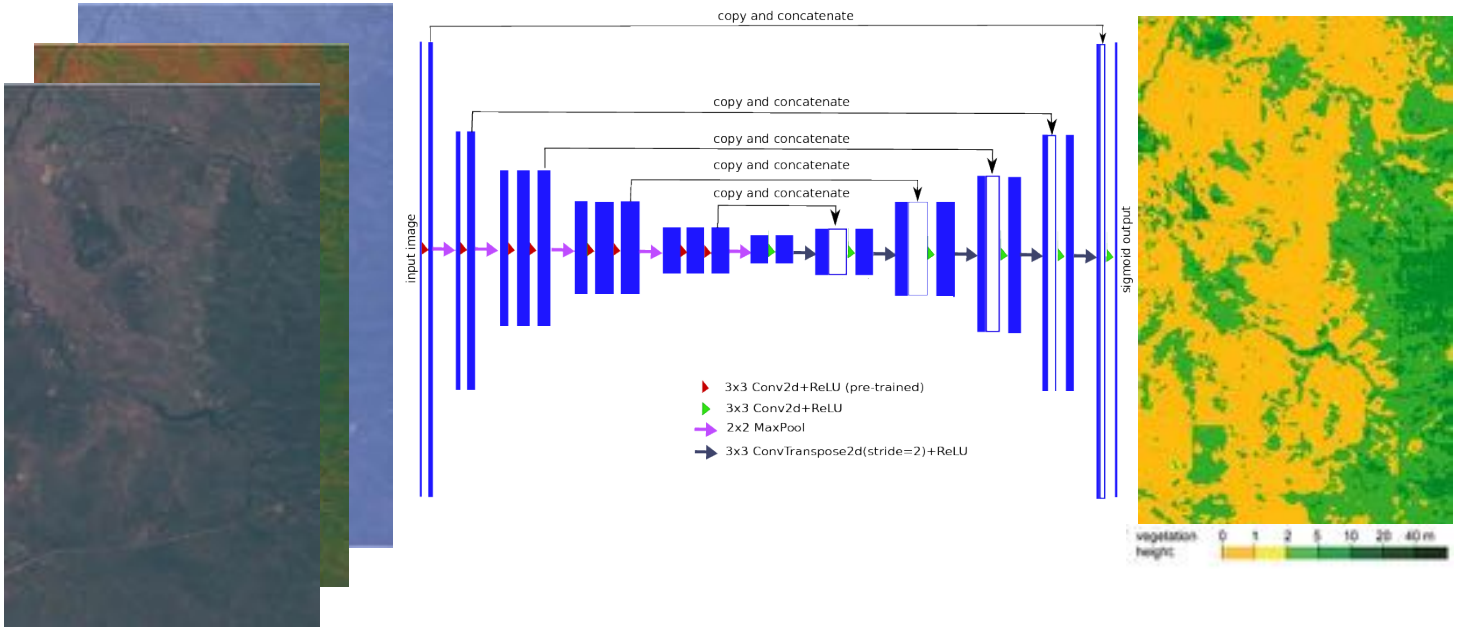
Cloud detection using S2Cloudless



Deep convolutional neural network

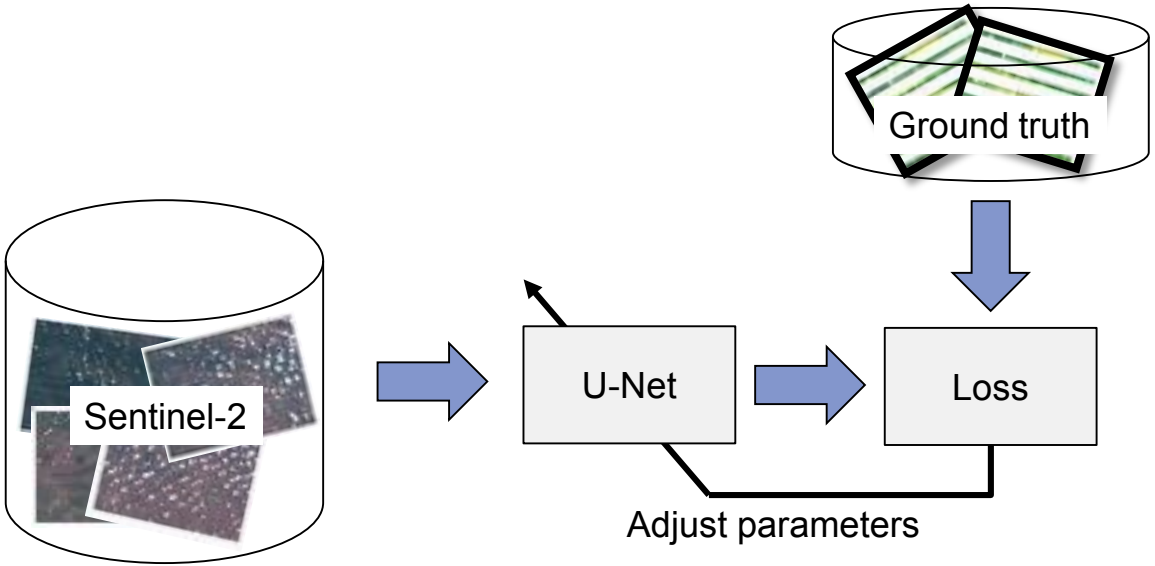
10 bands

Tree height or forest extent

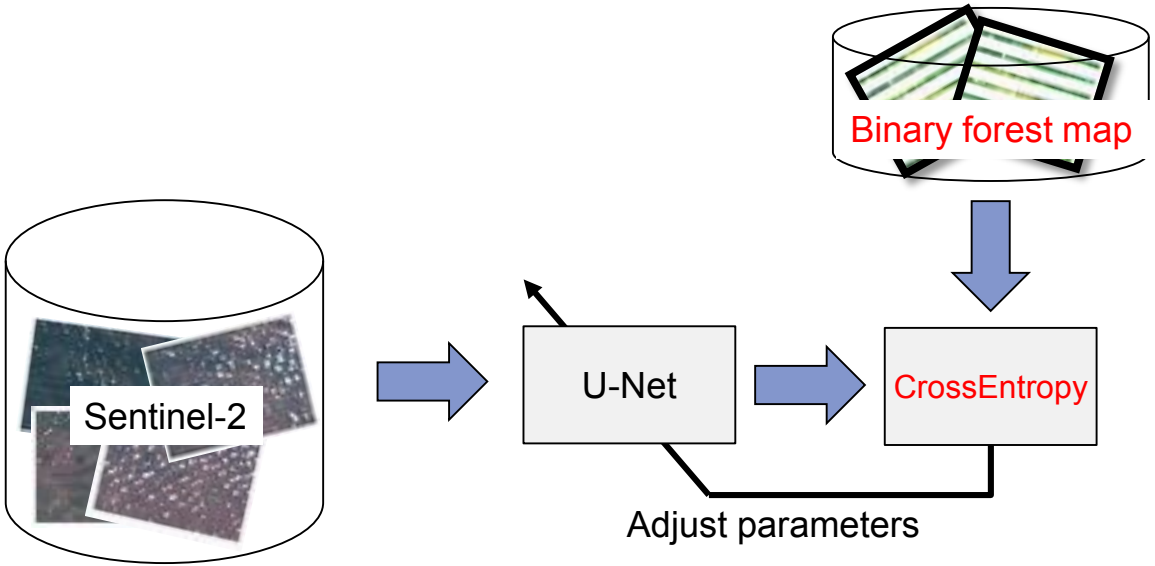


Network: U-Net (Ronneberger et al.)

Training the deep neural network

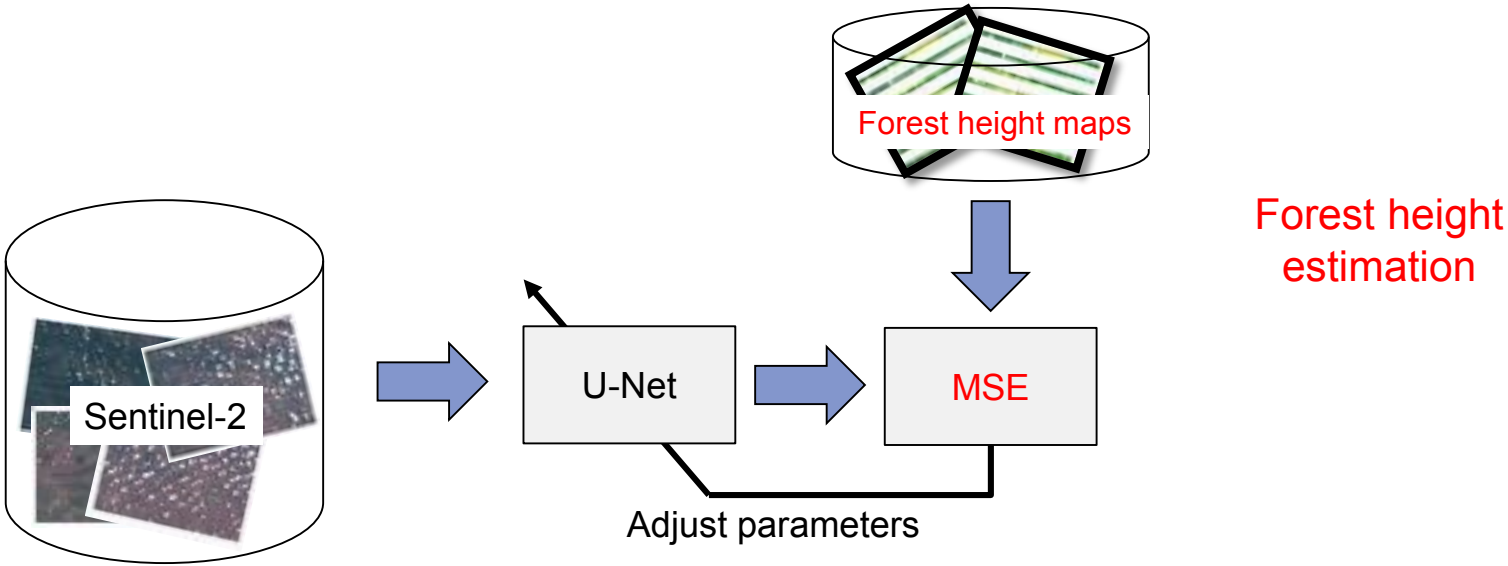


Training the deep neural network



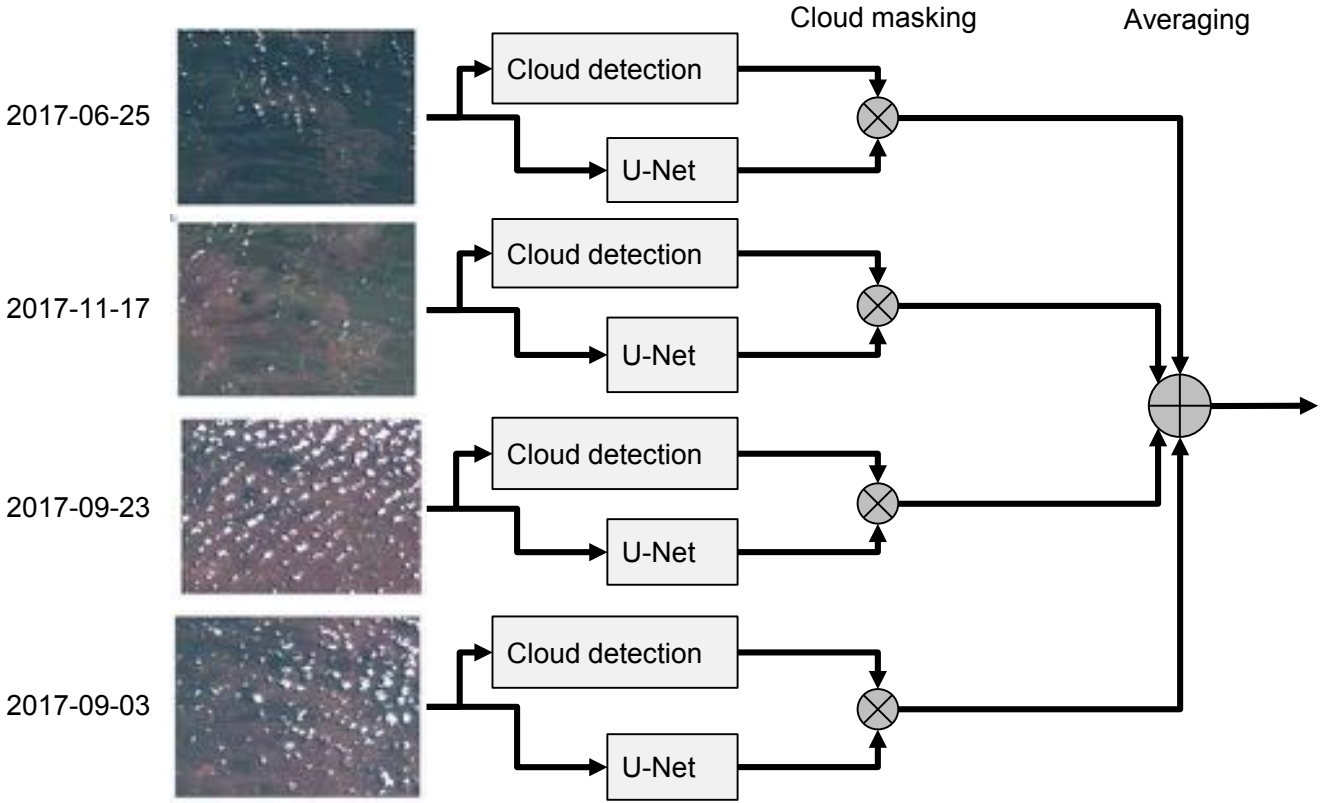
Forest extent mapping

Training the deep neural network



Forest height estimation

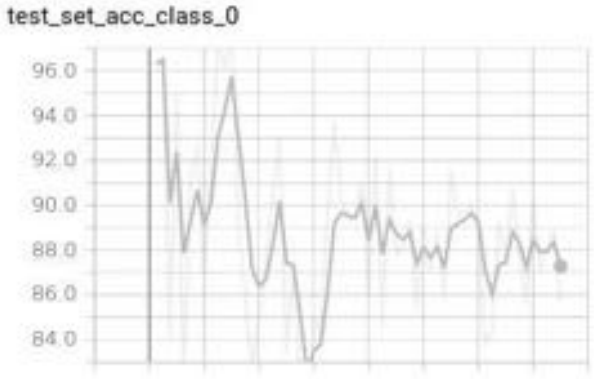
Merging multiple predictions

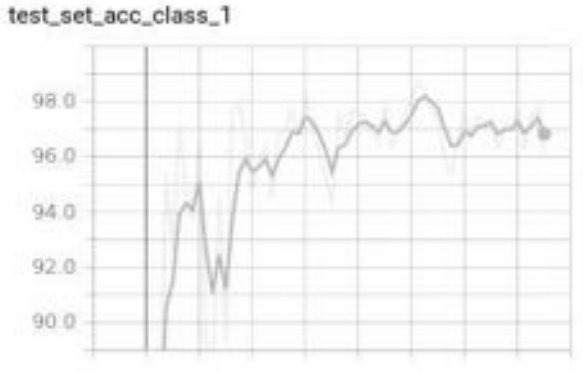


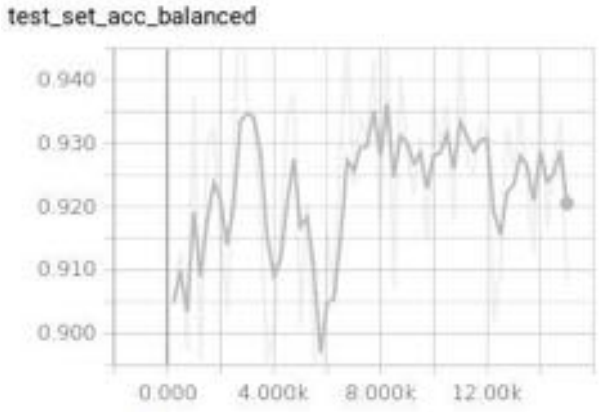
Results – Forest extent mapping, Liwale

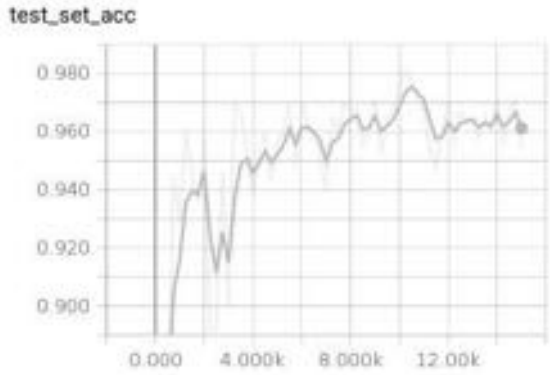
Mean tile NDVI > 0.6
Test tile: T37LCJ

Configurations
- UNet
- Adam optimizer, LR=0.0004
- Median frequency balancing





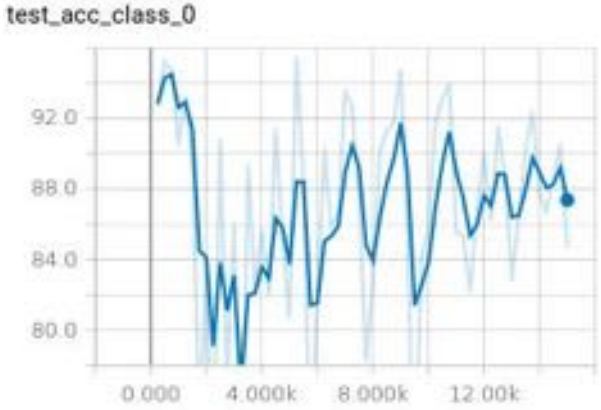


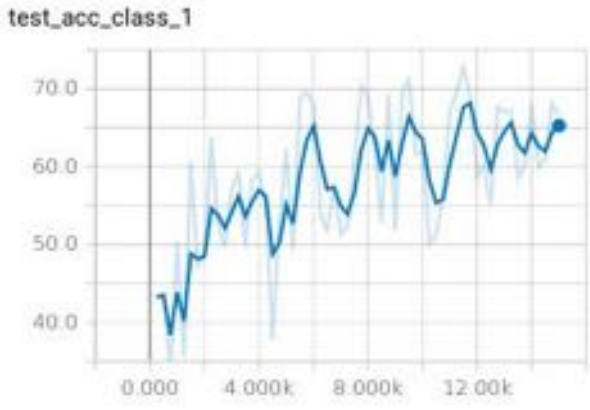


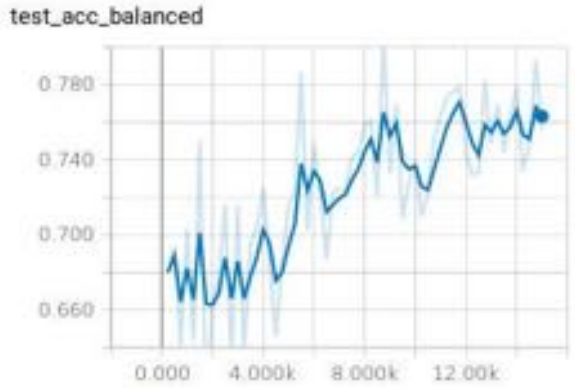
Results – Forest extent mapping, Liwale

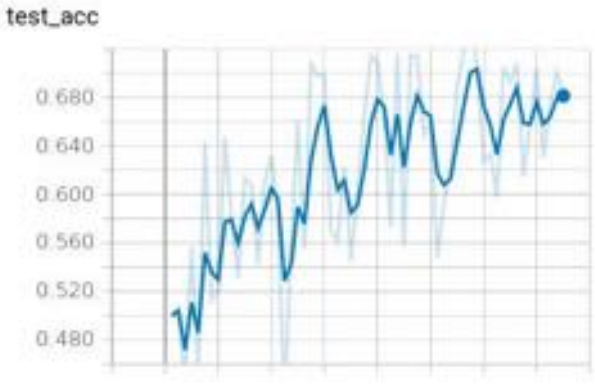
Mean tile NDVI: [0.4 – 0.5]
Test tile: T37LCJ

Configurations
- UNet
- Adam optimizer, LR=0.0004
- Median frequency balancing



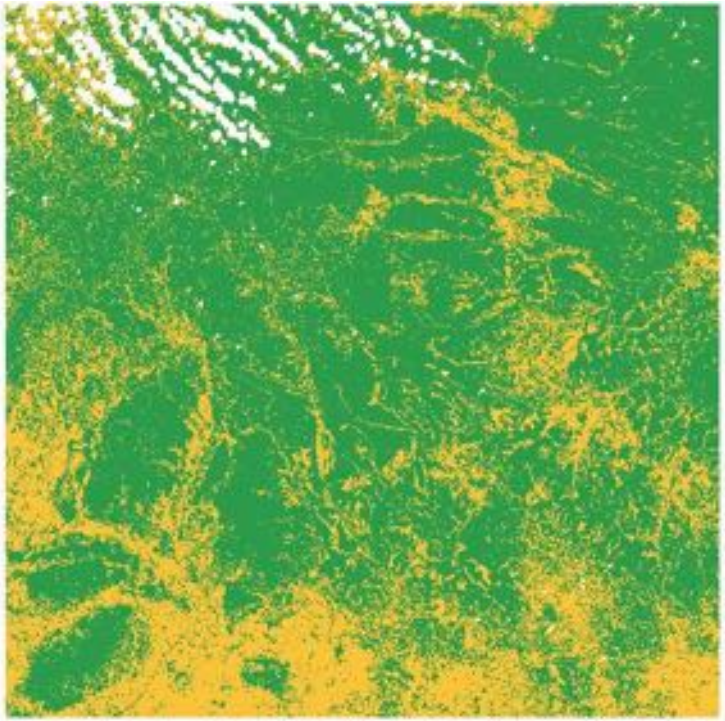






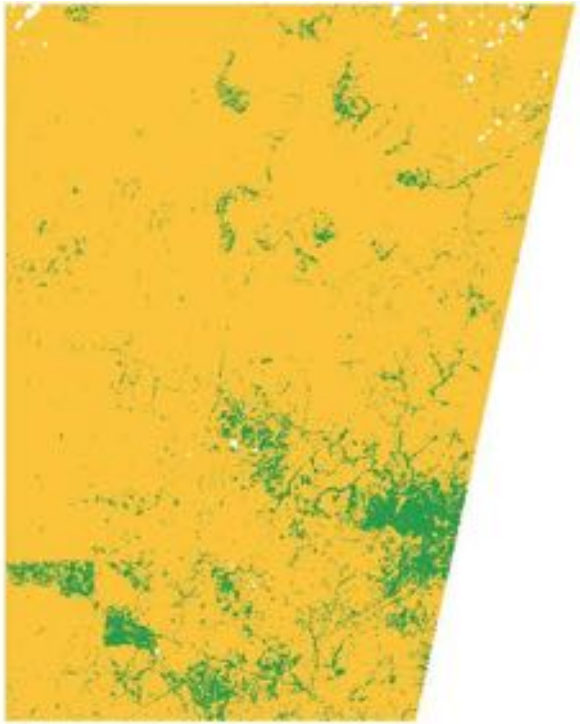
Results – Forest extent mapping, Liwale

Tile: T37LCJ



Results – Forest extent mapping, Sahel

Tile: T30PXT

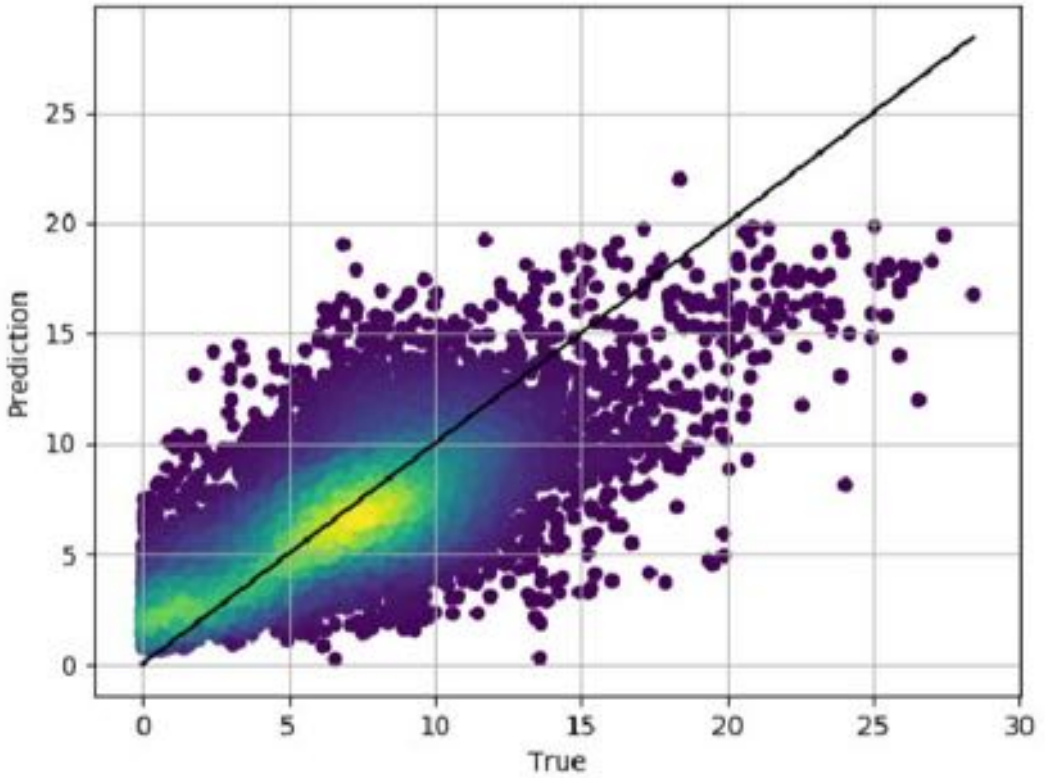


Results – Three height prediction, Liwale

Test tile: T37LCJ

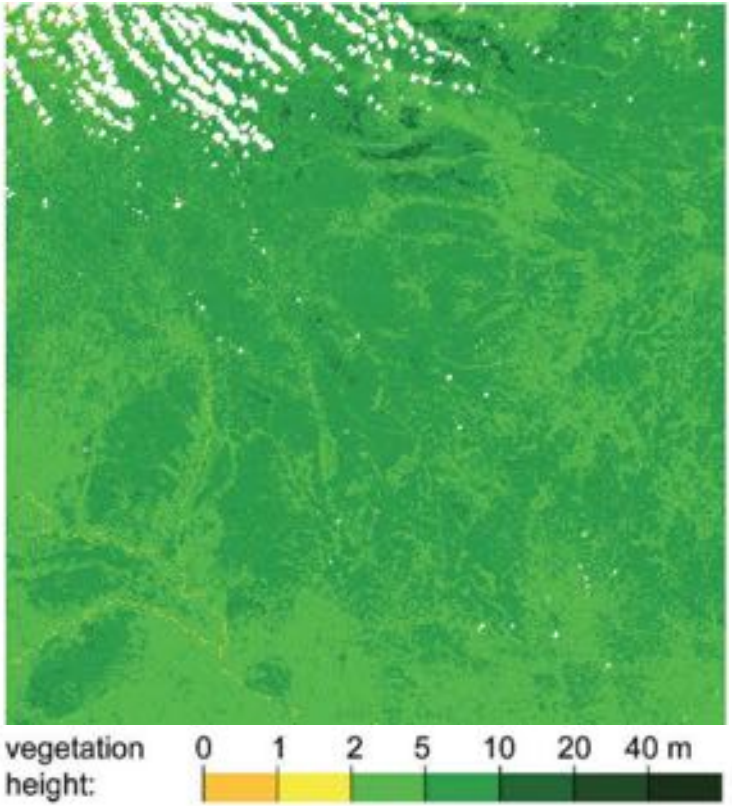
Configurations

- Mean tile NDVI > 0.6
- UNet
- Adam optimizer, LR=0.0004
- Balanced histogram sampling



Results – Three height prediction, Liwale

Tile: T37LCJ



Conclusions

- The deep learning based valid chain is flexible. The same chain is used for both forest extent mapping and tree height estimation.
- The results depends strongly on the greenness of the vegetation.
  Tiles with high mean NDVI values gave better results than tiles with low NDVI values.
- The results of the tree height prediction is in general good, but the algorithm struggles to predict tree heights above 15m
- The results for Burkina Faso (Sahel) need to be evaluated properly.
- Further studies will be to investigate multi-sensor approaches (include Setinel-1) and surface reflectance data