Milestone Summary Report: M3

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Work Package: *WP1 - Satellite data and derived products*
Milestone name: *M3: Method developed for dynamical roughness assessment from satellite data*
Milestone status: *Completed*

Milestone description

The purpose of M3 is to demonstrate that activities in the InnoWind project are able to utilise satellite data to derive dynamical roughness layers as input to wind modeling. Copernicus data are utilised to ensure low cost services are developed that can be delivered globally.

Activities and tasks completed

The following activities has been completed to demonstrate the potential to retrieve spatially continuous forest canopy parameters which will be used for improved wind flow modelling:

Prototype for forest height modelling at Østerild, Denmark

Here we test the potential to predict forest canopy height from freely available Sentinel and Landsat data. The model required calibration/validation data of known forest heights from the Østerild site, together with predictive variable derived from freely available Sentinel and Landsat data.

Calibration/Validation Data
For calibration and validation data we used a high-resolution map of forest height available for the Østerild site. This high-resolution dataset was first resampled to 30m to match the pixel resolution of the Sentinel and Landsat data. For the model calibration data, we chose a random sample of 300 pixels of forest canopy height. For validation we used all remaining forest height pixels.

Predictive Variables
From Sentinel-1 (radar imagery) we used Interferometric Synthetic Aperture Radar (InSAR) to produce a predictive variable useful for forest height modelling. The variable used was InSAR coherence. We calculated coherence values for all Sentinel-1 images available for year 2017 and then took the 95 quantile.

From Landsat 8 (optical imagery) we calculated temporal statistics for the Østerild site. For each band and a selection of spectral indices we calculated the annual mean, range, and quantiles.

Forest Height Modelling
For forest height modelling we tested several machine learning regression models. These models take the forest height calibration data and try to find relationships between these heights and the predictive variables from Sentinel and Landsat. After testing a number of different models, we used Support Vector Machine regression as it outperformed other methods.

Results
The results showed that forest height can be estimated effectively using freely available data from Sentinel and Landsat (Figure 1). We validated the results by comparing predicted forest height estimations with the validation dataset described above (Figure 2). We used the Mean Absolute Error

(MAE) as a measure of agreement between the two datasets. The MAE was found to be 2.5 meters, which is within the acceptable range needed for improved wind flow modelling.

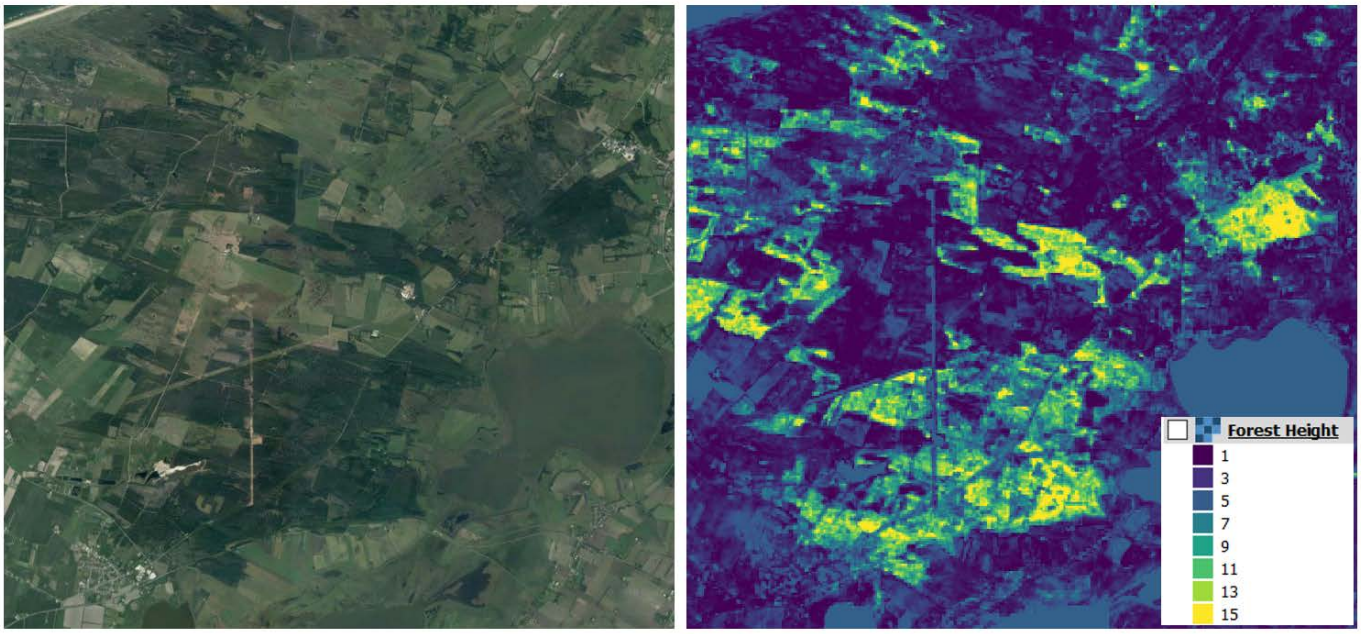

Figure 1 – High-resolution image showing forest at the Osterild site (left), and predicted forest heights derived from the Innowind project.

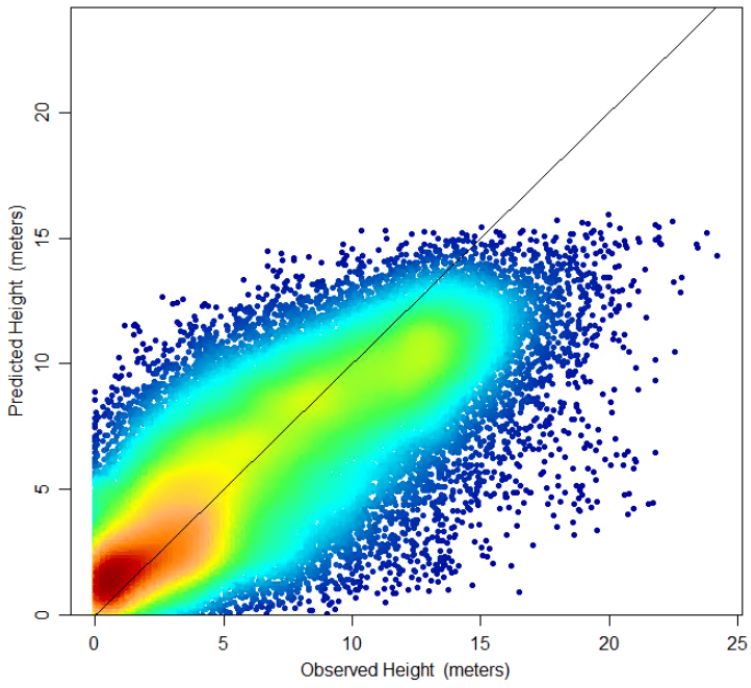

Figure 2 – Predicted forest height plotted against the observed forest height (validation data).

Deliverables and outcomes

The M3 is successfully completed as it has been demonstrated that the project is able to derive dynamical roughness layers in a scalable and consistent manner. The roll-out of this service will depend on further user requirements and market analysis.