CHALMERS SLU

LARGE-SCALE MAPPING OF STEM VOLUME WITH INTERFEROMETRIC RADAR

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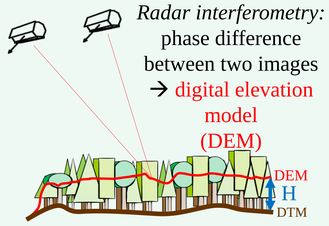
METHOD



Radar interferometry: phase difference between two images → digital elevation model (DEM)

interferometric forest height (H) = digital elevaiton model (DEM) – digital terrain model (DTM)

Empirical results show correlation between interferometric forest height (H) and stem volume (V)

DATA

TanDEM-X:

- two satellites in formation flight,
- synthetic-aperture radar (SAR), 11-day cycle, approx. res.: 3 m × 1 m
- X-band (f=9.65 GHz, λ=3.1 cm)
- global data for 2011 & 2012

Digital terrain model (DTM):

- from national lidar scanning campaign
- res: 2 m × 2 m, uncertainty: <0.5 m

Reference data:

- 238 circular National Forest Inventory (NFI) plots (permanent, radius: 10 m), secret positions over entire Västergötland, sampled 2009-2013, stem volume estimation uncertainty: ~20 %
- 32 circular plots from Remningstorp (radius: 40 m), sampled 2010-2011, stem volume estimation uncertainty: ~13 %
- Land use map (raster, resolution: 25 m × 25 m) and overview map (vector) from Swedish National Land Survey (Lantmäteriet)

MODEL

238 plots in Västergötland used for training and give the empirical model:

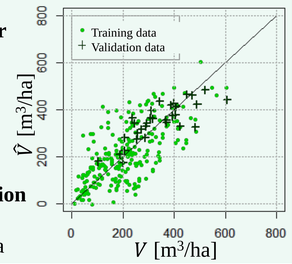
$$\hat{V} = 25 \cdot \mathrm{H} + 2 \cdot \mathrm{HOA} - 80$$

$R^2 = 0.86$ and RMSE = 97 m³/ha

(HOA = interferometric height resolution [m])

32 plots from Remningstorp used for validation and give the prediction error:

$R^2 = 0.65$ and RMSE = 66 m³/ha



RESULTS & DISCUSSION

Map shows **stem volume in cubic metres per hectare** for the central part of the province of Västergötland. **Resolution is 25 m × 25 m and estimation error (RMSE) is about 66 m³/ha.**

9 HH-polarised TanDEM-X image pairs with incidence angles between 38° and 45° have been used. Acquisition date is shown in red and the earliest image is chosen in case of overlap. Images have been delivered by DLR within project XTI_VEGE0376. Average daily temperatures from SMHI are shown in blue for the relevant dates and stations.

Lakes and non-forested areas have been masked out using **land use map**. Contours for cities and rivers have been obtained from **overview map**. The two maps, together with the **DTM**, have been delivered by Swedish National Land Survey (Lantmäteriet).

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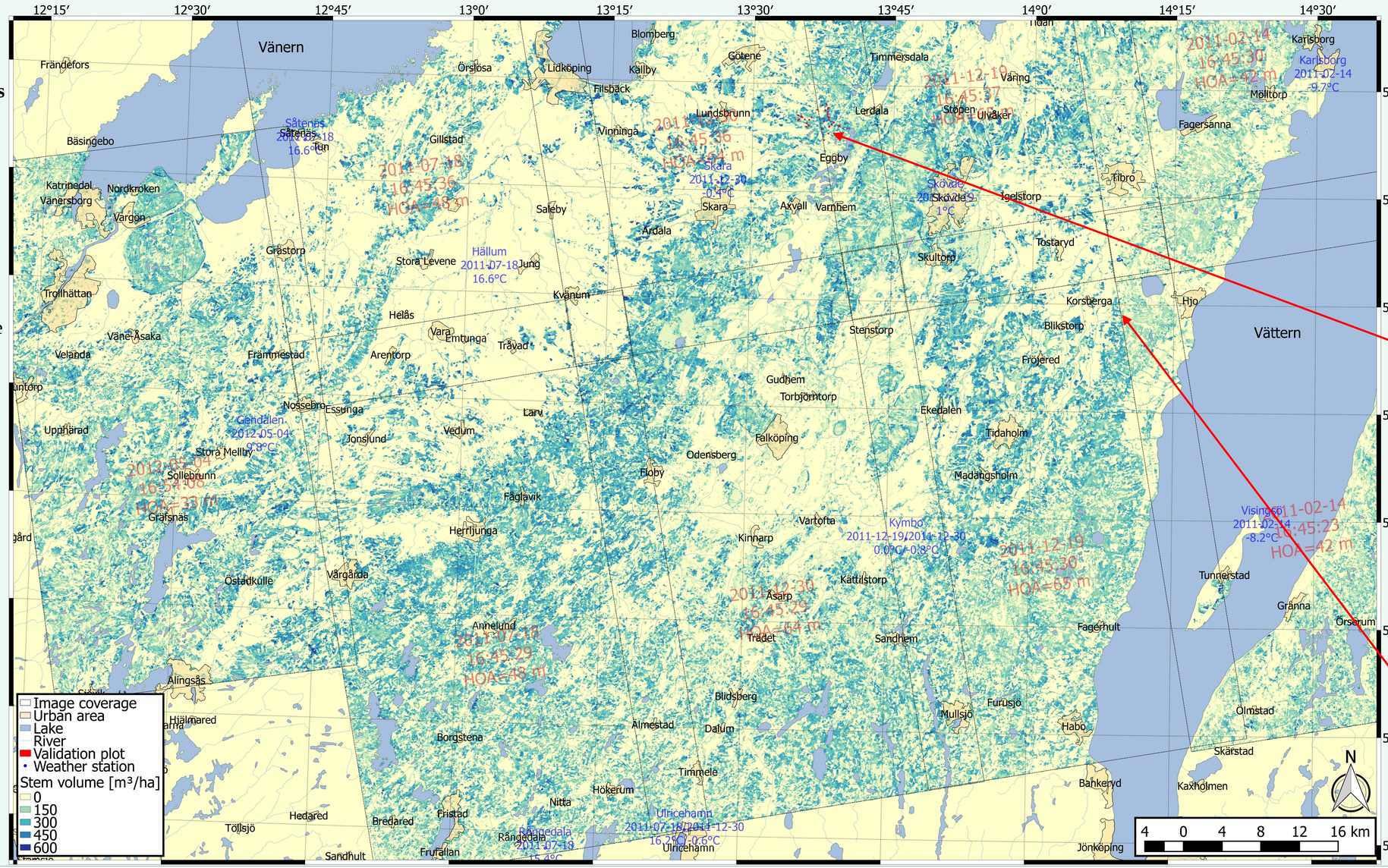

Satellite radar interferometry with TanDEM-X gives fine resolution and possibility for frequent, global acqusitions independent of clouds and solar illumination.

Good estimation accuracy is shown on 32, 0.5-ha plots, for which all trees with diameter at breast height larger than 4 cm were calipered in 2010 och 2011.

The 238 permanent NFI plots are localised within so-called tracts, in a systematic grid.

Clear border effect between images from December and February. Frost shifts the scattering centre towards ground and causes underestimation of stem volume.

AUTHORS

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