BACKSCATTER SIGNATURES OF WIND-THROWN FOREST IN SATELLITE SAR IMAGES

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INTRODUCTION

In 2005 and 2007 devastating storms hit Sweden (among other countries) causing large damages to forested areas. Rapid mapping of wind-thrown forests is crucial in order to assess the damage, salvage timber values and prevent insect outbursts that could kill the remaining standing trees. To explore the feasibility of mapping wind-thrown forest with radar remote sensing, two controlled experiments were conducted to simulate wind-thrown forest. The experiments took place in 2006 and 2009 at the test site Remningstorp located in the south of Sweden.

METHOD

The simulation of wind-thrown forest was done by manual felling of trees in two directions to simulate two possible main wind directions during a storm. In both 2006 and 2009 four coniferous stands, each with a size of about 1.0 to 1.2 ha, were felled and the trees were left for a few satellite orbit repeat cycles to ensure image acquisitions after the "storm". The felled trees were then harvested and removed and the areas could be used for analysis of signatures from clear-cuts. Locations of test areas and reference areas are shown in Fig. 1.

SATELLITE DATA

During both experiments, data from the Advanced Land Observing Satellite (ALOS) Phased Array type L-band Synthetic Aperture Radar (PALSAR) were acquired and in 2009 SAR data with high spatial resolution were also acquired with Radarsat-2 and TerraSAR-X. From each satellite about 20 images have been analyzed. ALOS PALSAR data were acquired at 34.3° look angle with Fine Beam Single (FBS) polarization (HH) or Fine Beam Dual (FBD) polarization (HH + HV) mode. Radarsat-2 (RS2) and TerraSAR-X (TSX) were programmed to acquire data at different look angles and in both ascending and descending passes to study differences in the shadowing effects.

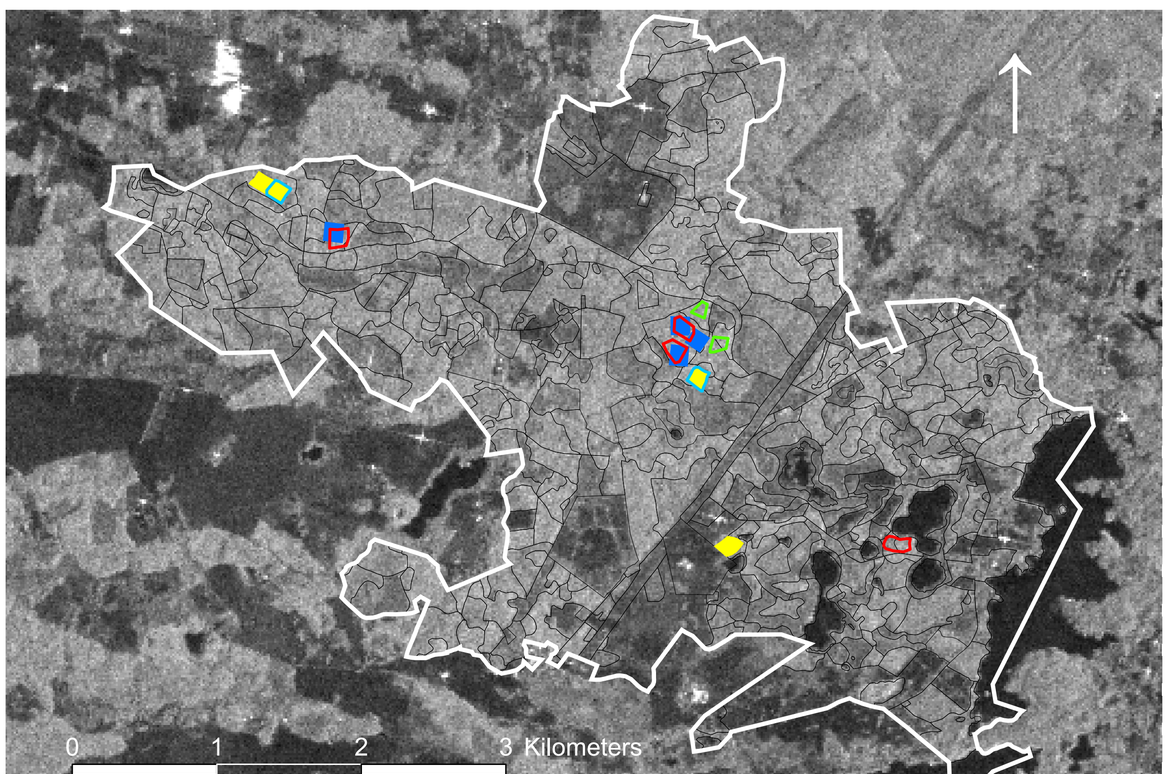

Figure 1. Remningstorp test site (white boundary) showing 4 stands in yellow and 4 stands in blue subject to treatments in 2006 and 2009, respectively (artificially wind-thrown and clear-felled forest), 4 forest reference stands from 2006 with red boundaries, 2 forest reference stands from 2009 with green boundaries, 2 clear-felled reference stands from 2009 with light blue boundaries, and stand delineations (black boundaries). Displayed in the background is the average backscatter intensity from two PALSAR FBS images acquired on 2006-09-08 and 2006-10-07 (© JAXA/METI 2006).

RESULTS

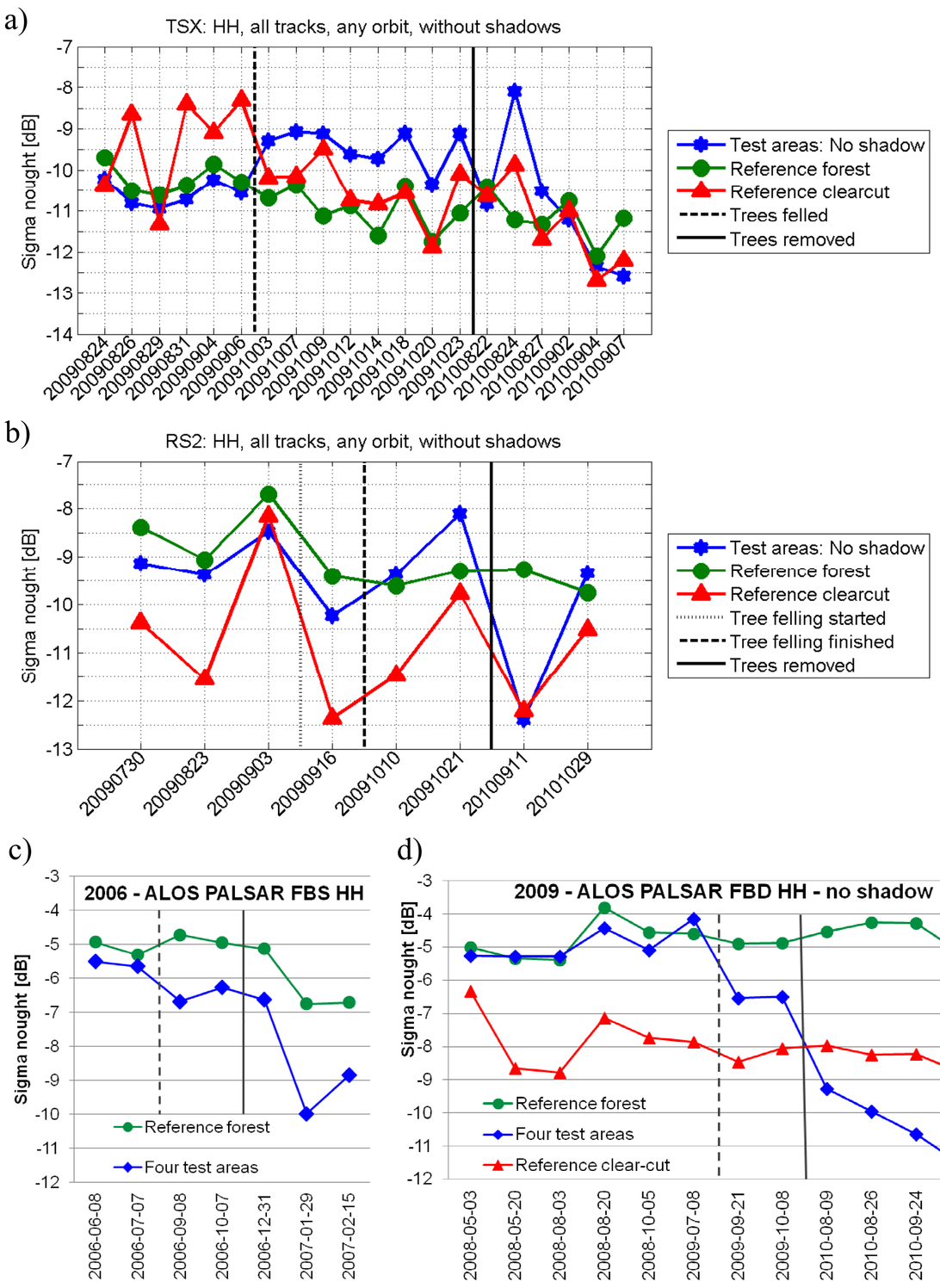

Figure 2. Backscatter values for (a) TerrraSAR-X (b) Radarsat-2 and (c and d) ALOS PALSAR. All values are for HH polarization. In all cases except for (c), parts of the test areas affected by shadowing or layover have been excluded. (a) and (c) contain values from both ascending and descending orbits, while for (b) and (d) all values are from ascending orbits.

DISCUSSION AND CONCLUSIONS

The experiments indicate that wind-thrown forest can be detected as changes in backscatter level for spaceborne L- and X-band SAR at HH polarization. To increase the reliability of the detections several images might be required. For areas without shadowing effects, C-band SAR seems less suitable. The backscatter changes are stronger (5 to 9 dB) for areas where new shadows occur (or disappear) after a storm, but a spatial resolution finer than about 10 m is required. The results also confirm that L-band HH backscatter can be used for detection of clear-felled stands at least 1.0 ha large. At X-band there is a significant overlap between backscatter levels from clear-cut and forest and at C-band clear-felled stands sometimes have backscatter values as high as for dense forest.

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