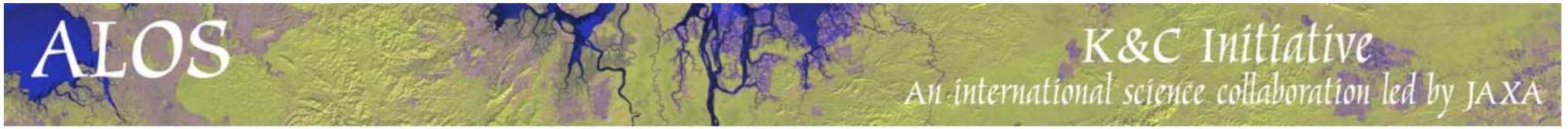

K&C Phase 3 – Brief project essentials

Advances in forestry applications using satellite ALOS PALSAR images

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Project areas

Test sites:

- Remningstorp
- Krycklan

Counties:

- Västra Götaland
- Västerbotten

Country:

- Sweden

(45 million ha – 50% forest)

ALOS PALSAR mosaic over Scandinavia and Finland

ALOS PALSAR data used

Fine Beam Dual (FBD34)

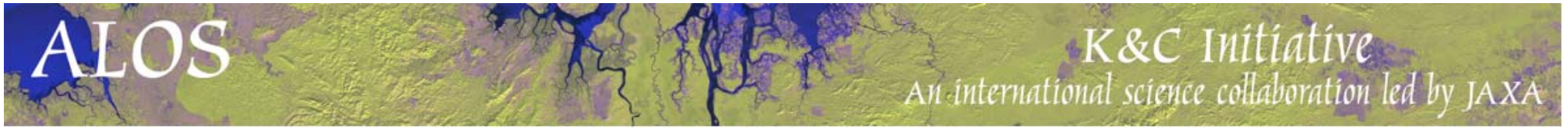
63 strips from

43 orbital tracks

June – October 2009

Other data sources

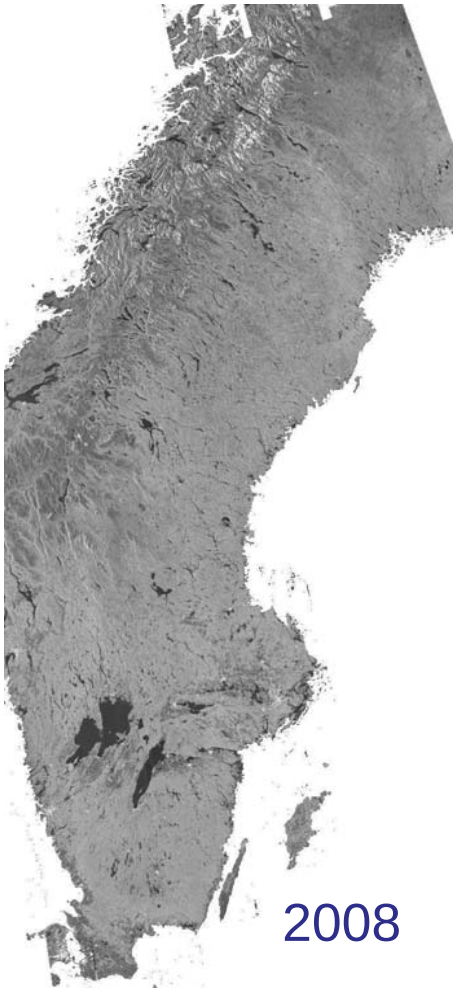
Digital Elevation Model



PALSAR strip dataset

	2008			2009			2010	
RSP	Date	Cycle	RSP	Date	Cycle	RSP	Date	Cycle
613	20080622	20	615	20090613	28	615	20100801	37
615	20080726	21	633	20090713	28	634	20100802	37
634	20080727	21	625	20090715	28	607	20100803	37
607	20080728	21	631	20090725	28	626	20100804	37
626	20080729	21	634	20090730	29	618	20100806	37
629	20080803	21	626	20090801	29	629	20100809	37
621	20080805	21	621	20090808	29	621	20100811	37
605	20080809	21	613	20090810	29	613	20100813	37
624	20080810	21	632	20090811	29	632	20100814	37
627	20080815	21	605	20090812	29	605	20100815	37
619	20080817	21	624	20090813	29	635	20100819	37
611	20080819	21	619	20090820	29	627	20100821	37
630	20080820	21	611	20090822	29	619	20100823	37
603	20080821	21	622	20090825	29	611	20100825	37
622	20080822	21	617	20090901	29	630	20100826	37
633	20080825	21	609	20090903	29	622	20100828	37
625	20080827	21	628	20090904	29	633	20100831	37
617	20080829	21	620	20090906	29	625	20100902	37
609	20080831	21	623	20090911	29	617	20100904	37
620	20080903	21	607	20090915	30	609	20100906	37
631	20080906	21	629	20090921	30	628	20100907	37
623	20080908	21	627	20091003	30	631	20100912	37
632	20080923	22	630	20091008	30	624	20101001	38
628	20081017	22	603	20091009	30	623	20101030	38

Yearly mosaics of PALSAR strip images covering Sweden



2008

2009

2010

ALOS

K&C Initiative

An international science collaboration led by JAXA

PALSAR mosaic 2009

Clear-cuts 2008-2009

Counties (21)

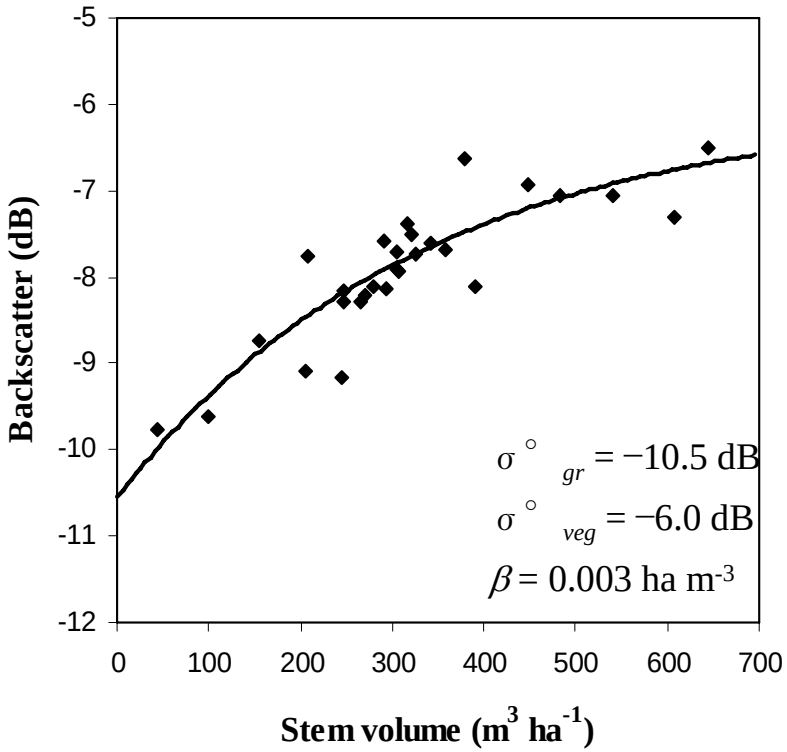
Estimation of clear-felled areas 2008-2010 (on average)

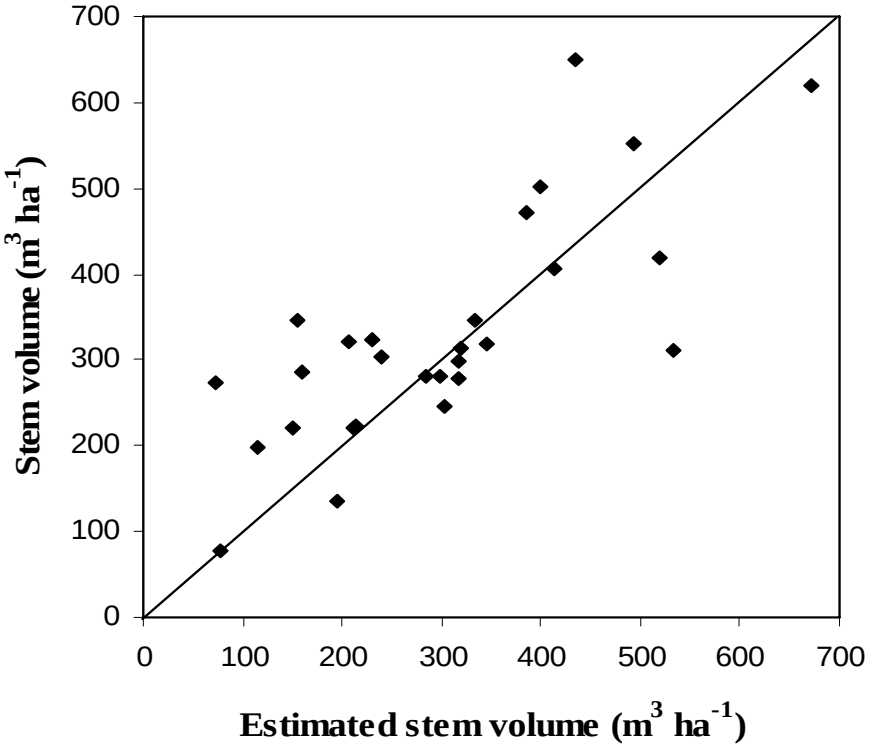
County	ALOS PALSAR (ha)	Swedish Forest Agency (ha)	Swedish National Forest Inventory (ha)	Rel. RMSE of Swedish NFI (%)	Notified areas of final felling (ha)
Norrbotten	20,982	22,343	24,060	50.3	22,113
Västerbotten	21,241	21,220	23,787	45.1	26,606
Jämtland	14,313	21,526	19,230	60.4	25.989
Västernorrland	12,277	14,928	10,923	56.0	23,354
Gävleborg	12,398	15,880	2,453	72.4	18,251
Dalarna	14,115	11,953	21,133	50.5	21,978
Värmland	7,272	10,796	9,368	58.9	15,171
Örebro	3,899	7,644	6,727	62.0	8,710
Västmanland	1,992	4,098	159	100.0	4,517
Uppsala	4,233	3,921	9,313	48.0	6,281
Stockholm	1,490	1,580	1,354	70.3	2,276
Södermanland	1,321	2,068	2,825	63.3	4,150
Östergötland	2,535	-	16,579	51.9	9,067
Västra Götaland	6,842	12,828	12,344	57.7	18,075
Jönköping	3,095	5,517	4,050	28.3	8,927
Kronoberg	2,514	4,302	12,930	33.3	4,548
Kalmar	5,067	3,879	9,134	43.2	11,248
Gotland	2,012	832	0	-	5,215
Halland	714	1,620	854	66.1	3,735
Blekinge	1,137	2,422	3,134	88.9	1,723
Skåne	1,175	3,177	118	132.1	6,401
Total (Sweden)	140,618	172,532	194,586	15.0	254,014

Standwise stem volume estimation

$$\sigma^{\circ}_{for} = \sigma^{\circ}_{gr} \times e^{-\beta V} + \sigma^{\circ}_{veg} \times (1 - e^{-\beta V})$$

$$\hat{V} = -\frac{1}{\beta} \times \ln\left(\frac{\sigma^{o}_{veg} - \sigma^{o}_{for,meas}}{\sigma^{o}_{veg} - \sigma^{o}_{gr}}\right)$$





FBS 34.3° HH, 2007-01-29 (best case)

Project objectives

To further validate the methodology to detect and delineate forest cover change in terms of clear-felled areas at the test sites (and possible for the entire Sweden using PALSAR data from 2008-2010).

To further develop and validate methods for large-scale biomass mapping for the entire Sweden (base year 2010) using PALSAR data

The methods and algorithms that will be developed also aim to demonstrate the large-scale forestry monitoring goals of the JAXA's ALOS Kyoto & Carbon Initiative. Here, synergy with the K&C Phase 3 proposal "Coupling radar-based estimates of forest information with biosphere models for improved carbon flux estimation" by Maurizio Santoro will be exploited.

Project schedule

The objectives will be achieved by applying and extend the experiences in Phase 1 and 2 and by performing a scientific evaluation of clear-cut and biomass mapping

Clear-cut mapping:

- Detailed investigation of the algorithm used in Phase 2 and comparison (after adjustments) with other algorithms found in literature at the test sites (2011, beginning of 2012) – ONGOING
- Possible up-scaling and testing of methodology from local to regional to national scale using the processing chain developed in Phase 2 (2012-2013)
- Production of clear-cut maps at the test sites (2012) and possible for the entire Sweden using PALSAR data from 2008-2010 (2012-2013)
- Final delivery of the product with a written report to JAXA (2014)

Project schedule (cont.)

Biomass mapping:

- Further investigations of the methodology used in Phase 1 (water cloud model) at the test sites (2012) – ONGOING
- Comparison (after adjustments) with other algorithms found in literature (or in-house) at the test sites (2011-2012) – ONGOING
- Develop a processing chain at the test sites (2012)
- Adaptation of processing chain from local to regional to national scale (2012-2013)
- Up-scaling and testing of methodology (2013)
- Production of biomass maps (base year 2010) (2013)
- Final delivery of the product with a written report to JAXA (2014)

Support to JAXA's global forest mapping effort

Clear-cut mapping:

The product by JAXA will be compared against the maps produced in:

- Phase 2 using PALSAR strip data for the entire Sweden (2008-2010). Here, a comparison will also be made against the estimates of clear-felled areas by the Swedish Forest Agency (based on optical satellite data) and Swedish National Forest Inventory (based on sample plot data)
- Phase 3 using PALSAR data applying other methodologies than in Phase 2 for the test sites and possible also for the entire Sweden (2008-2010)

(If possible, local information about clear-cuts will be obtained. It should, however, be clarified whether this information can be delivered to third parties)

Support to JAXA's global forest mapping effort

Biomass mapping:

The product by JAXA will be compared against the maps produced in:

- Phase 3 using PALSAR strip data for the entire Sweden (2008-2010) (base year 2010). Here, a comparison will also be made against the estimates of biomass obtained from combining sample plot data from the Swedish National Forest Inventory and optical satellite data (*k*NN-Sweden 2010)

Support to JAXA's global forest mapping effort

Ground truth data that will be shared with JAXA:

- Field inventory data and laser data from the test sites (collected through ESA airborne campaigns conducted within the framework of the ESA Earth Explorer mission BIOMASS in cooperation with the Swedish Defence Research Agency (FOI), Chalmers University of Technology) Remningstorp (2007 and 2010) and Krycklan (2008)
- The datasets are available at registration via the ESA PI Portal (follow the "campaign" link under http://eopi.esa.int/esa/esa). The ESA contact person is Malcolm Davidson (Head of Campaigns Section, Mission Science Division at ESA)

Support to JAXA's global forest mapping effort

Ground truth data that will be shared with JAXA (cont.):

Remningstorp and Krycklan datasets

At plot level (about 250 and 311 field plots, respectively):

- Biomass (tons/ha)
- Diameter at breast height (cm)
- Tree height (dm)
- Centre coordinate of the field plot (UTM Zone 34N, WGS84)

At raster level (10 m × 10 m, almost complete coverage of the test sites):

- Laser derived biomass map (tons/ha)
- Height percentiles (dm) and density measure of the forest (0-1)
- Laser derived Digital Elevation Model and Digital Surface Model

Support to JAXA's global forest mapping effort

Ground truth data that will be shared with JAXA (cont.):

Remningstorp and Krycklan datasets

At stand level (about 300 and 31 stands, respectively):

- Laser derived biomass (tons/ha)
- Laser derived tree height (dm)
- Files generated by ArcGIS to represent all forest stand polygons (UTM Zone 34N, WGS84)
- Stand errors of biomass estimates

Deliverables

- Clear-cut map for Sweden obtained from PALSAR strip data for the time period 2008-2010 (delivered to JAXA at the end of Phase 2)
- Clear-cut maps for the test sites applying other methodologies than in Phase 2 (possible also for Sweden (2008-2010))
- Biomass map for Sweden (base year 2010) obtained from PALSAR strip data (2008-2010)
- Improved/revised JAXA forest change and biomass maps for Sweden
- Ground truth data from the test sites (Remningstorp and Krycklan) including estimates of forest variables (at plot, raster and stand level)
- Yearly feed-back to JAXA on progress

Acknowledgments

- JAXA EORC and ALOS K&C support team
- Swedish National Space Board
- Hildur and Sven Wingquist's Foundation for Forest Research
- Forestry Society's Estate Management Company (Skogssällskapet)
- Swedish Meteorological and Hydrological Institute (SMHI)
- Svartberget's research station, SLU
- Swedish National Land Survey
- Sveaskog (Swedish forest company)