Product Box F-2 – Boreal Land Cover Classification and Land Cover Change

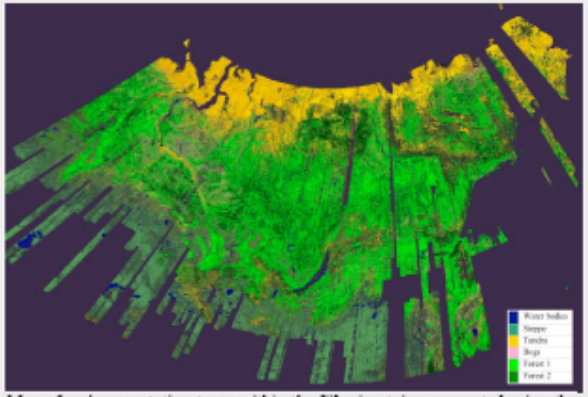
K&C product(s): (LCM6/FCM5)

- Methods for integration of Forest and Land Cover Change theme to improve and update existing land cover products in the boreal zone will be developed.
- Thematic classification for Siberian Taiga based upon dual polarisation dual polarisation PALSAR data, with 2006 being the intended base year.

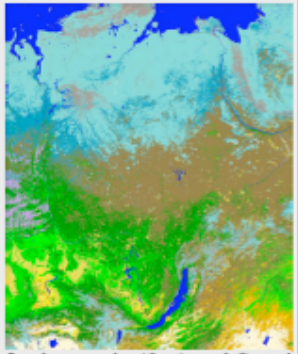
Intended use: Improved land cover maps and land cover change maps to be provided to the carbon community. Land cover mapping has been undertaken previously at 900 m resolution using the Siberia GBFM mosaic (JERS-1 backscatter, 1997-98 acquisitions), a texture measure mosaic obtained by computing the normalized variance of backscatter in a block window of 9x9 pixels and the Siberia Global Land Cover 2000 (GLC2000) map. Preliminary validation using MERIS data has suggested that such a product refines and enhances the mapping accuracy achieved by the optical data alone, especially for some thematic classes, such as bogs and water bodies. Classification of PALSAR mosaic data acquired in 2006 will be extended to the entire Siberian taiga at finer spatial resolution than the JERS-1 SAR mosaics and this is expected to augment our knowledge of this ecosystem in an unprecedented way. The 2006 continental scale snapshot will lay the ground for quantifying changes in land cover and bio-physical parameter estimates derived from the mid-90's JERS-1 data.

Prototype areas: Siberia

Input data: ALOS PALSAR image mosaics, 50 m resolution



Map of major vegetation types within the Siberian taiga generated using the Siberia GBFM JERS-1 SAR mosaic and the Siberia Global Land Cover 20000 map.



Land cover classification of Central Siberia using MODIS data (courtesy of UWS, SIBERIA-II Project).

Product Developers:

Gianfranco De Grandi	Joint Research Centre, E.U.
Christiane Schmullius	Friedrich-Schiller University Jena, Germany

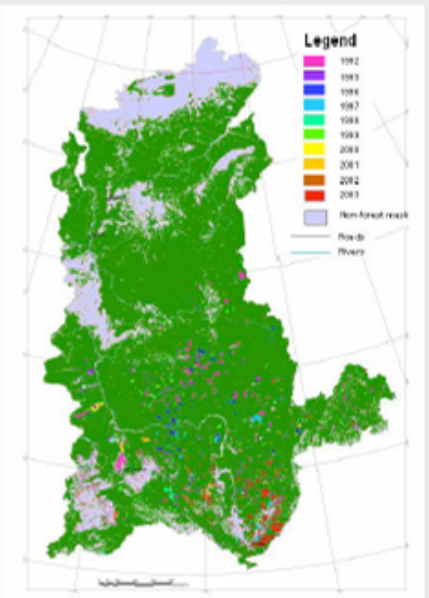
Product Box F-9 – Boreal Disturbance Mapping

K&C product: (FCM6) Maps of boreal forest disturbances

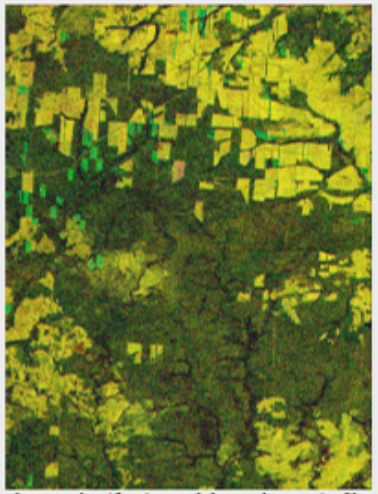
Intended use: High resolution maps of forest disturbances of the type shown below (right) will assist local forest authorities for forest cover changes monitoring and carbon balance computation. The maps will also be used for land cover and land cover change assessments both within the K&C Initiative and in other activities within the global change research community. The maps will also be integrated with land cover maps to improve regional products.

Prototype areas: Central Siberia (SIBERIA-II project area: N50°-78°; E80°-120°).

Input data: ALOS PALSAR Path Images, 50 m resolution



Yearly fire scar map of a 3 Million sq.km area in Central Siberia using MODIS, SPOT VGT and AVHRR data (courtesy of CEH, SIBERIA-II Project).



Land cover classification and forest changes in Chunsky, Central Siberia, as detected using multi-temporal winter JERS-1 SAR backscatter and interferometric SAR coherence (R – coherence winter 1993-1994, G – coherence winter 1995-1996; B – ratio of mean intensity for each image pair). Clear-cuts before 1994 appear in yellow; forests in dark green; areas deforested between 1994 and 1996 appear in light green.

Product Developer:

Christiane Schmullius	Friedrich-Schiller University Jena, Germany

Siberian Earth System Science Cluster (SIB-ESS-C)

Chris Schmullius, Roman Gerlach, Sören Hese, Daniela Knorr, Nils Meier

Department for Earth Observation, Institute of Geography, FSU Jena, Germany

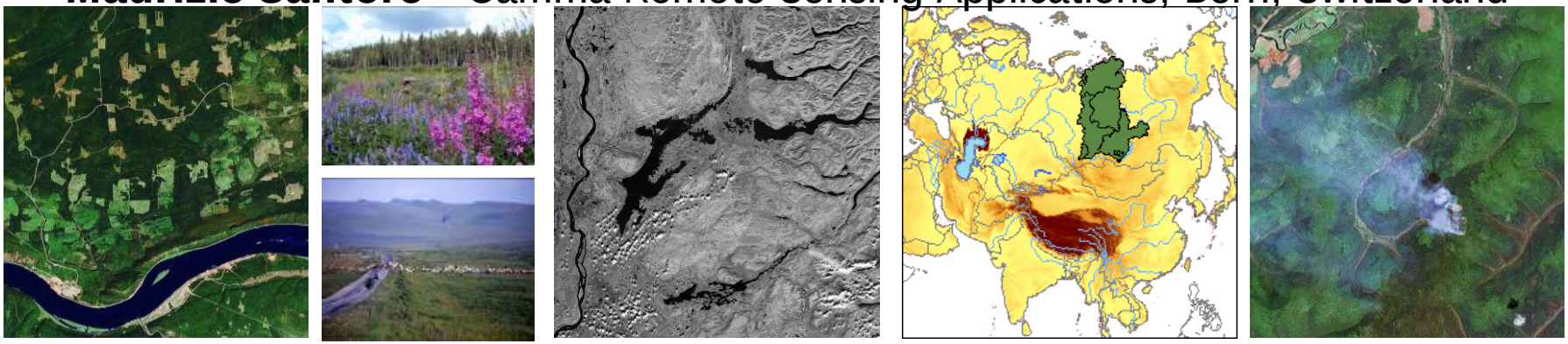
Heiko Balzter - Institute of Geography, University of Leicester, UK

Sergey Bartalev - Lab. for Remote Sensing Applications, IKI-RAS, Russia

Annett Bartsch - Institute for Photogrammetry, TU Wien, Austria

Stefano Nativi – Inst. of Method. for Env. Analysis, IMAA-CNR, Potenza, Italy

Maurizio Santoro - Gamma Remote Sensing Applications, Bern, Switzerland

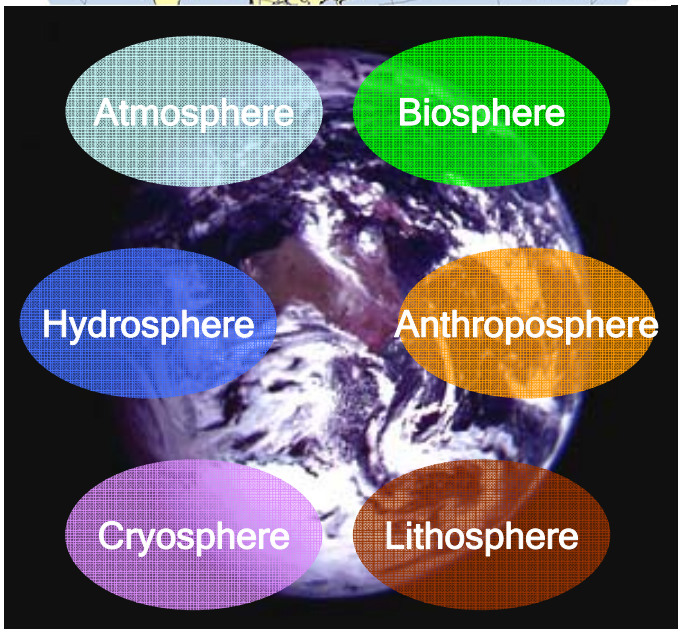


What does 'SIB-ESS-C' imply?

SIB-
Focus on SIBERIA-II Region, entire Siberia envisioned

ESS-
interdisciplinary research of the major spheres and their interaction

C-
Computer Cluster *&* Cluster of Researchers



Overall Objectives

Prime objective of SIB-ESS-C is to develop a spatial data infrastructure to:

→ provide access to the SIBERIA-II Earth Observation products to a broad user community to stimulate further research

→ continue data acquisition and product generation to build up time series

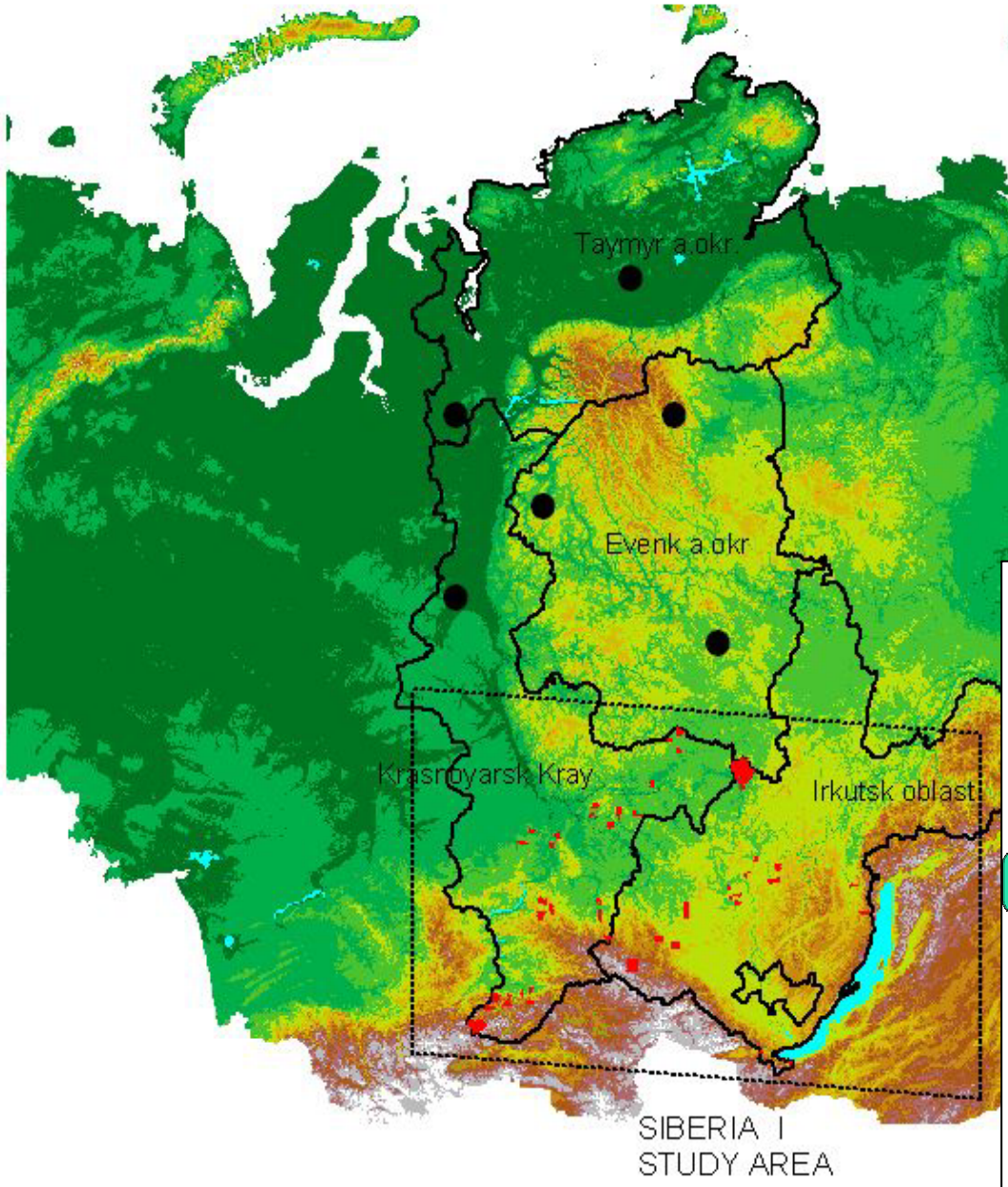
→ provide online geo-visualization tools for spatio-temporal data analysis

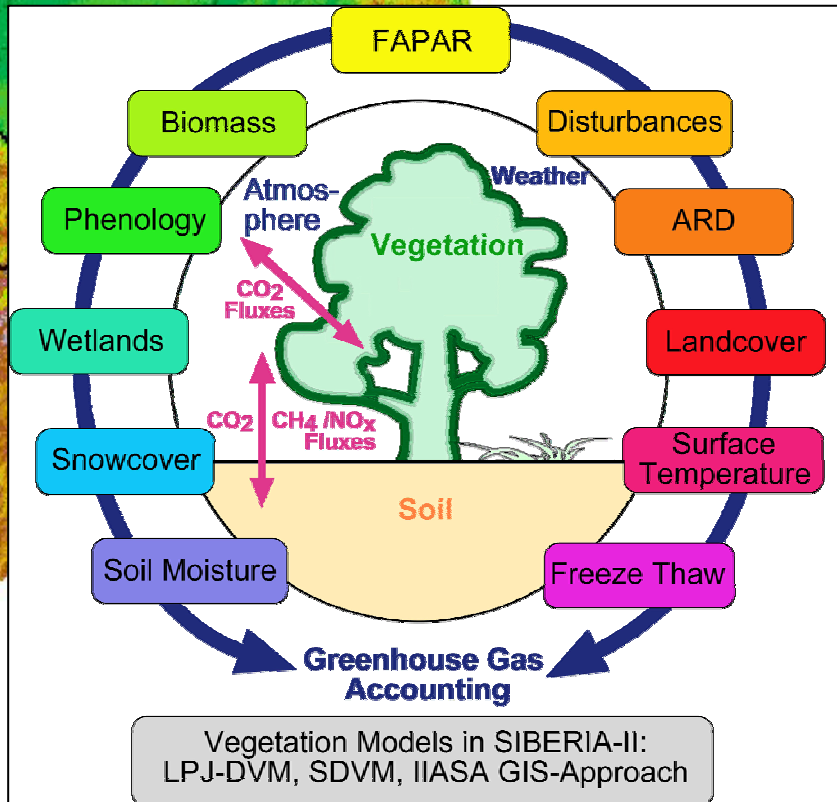
→ integrate biosphere modelling algorithms into SIB-ESS-C (external access via web-interface to trigger model runs)

→ link to any project producing geospatial information in Siberia (e.g. NEESPI projects)

→ initiate additional projects complementing SIB-ESS-C (e.g. through FP7)

SIBERIA-II Heritage: Multi-Sensor Concepts for Greenhouse Gas Accounting of Northern Eurasia (EC Project 2002-2005)

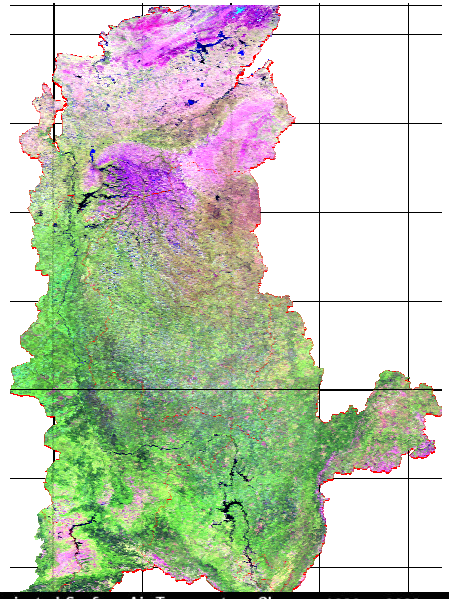


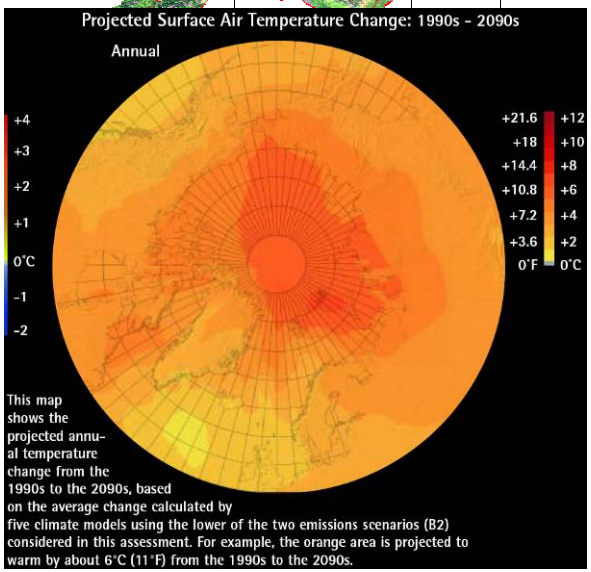


Vegetation Models in SIBERIA-II:
LPJ-DVM, SDVM, IIASA GIS-Approach

Why is this region of interest?

- Diverse:Tundra, Taiga, Steppe ecosystems
- Yenissei watershed
- major changes observed and expected due to rising temperature and human activities
  - melting permafrost
  - burning and logging of boreal forest
  - shift of vegetation zones
  - increase in growing season length
  - increasing fires and insect outbreaks
- Global warming impact on the higher latitudes expected to be more pronounced than in lower latitudes



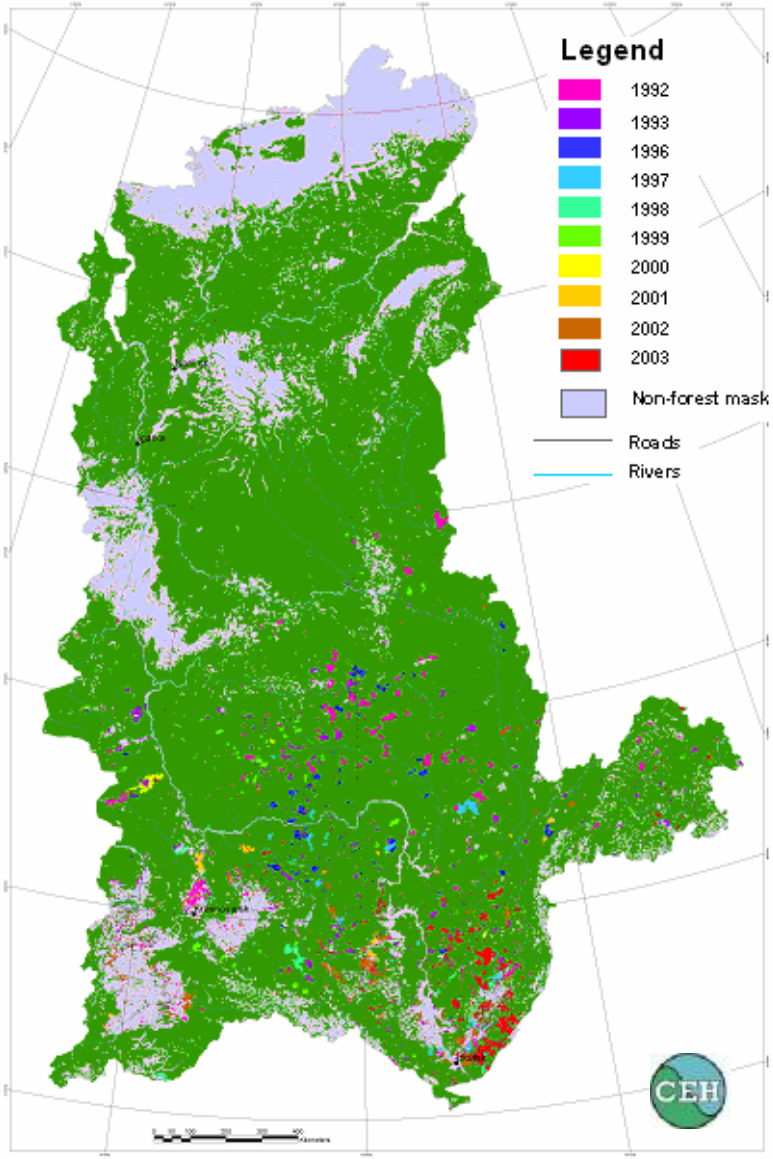


Reference: Arctic Climate Impact Assessment 2004 (ACIA)

Disturbances

Product Summary

- Annual fire disturbances from 1992 to 2003
- “historic” data derived from MODIS & SPOT_VGT using NDSWIR Index in combination with thermal anomaly data from AVHRR, ATSR-2 and MODIS
- “current” fires (2002-03) derived from MODIS 16-day hotspot and NDVI differencing synergy



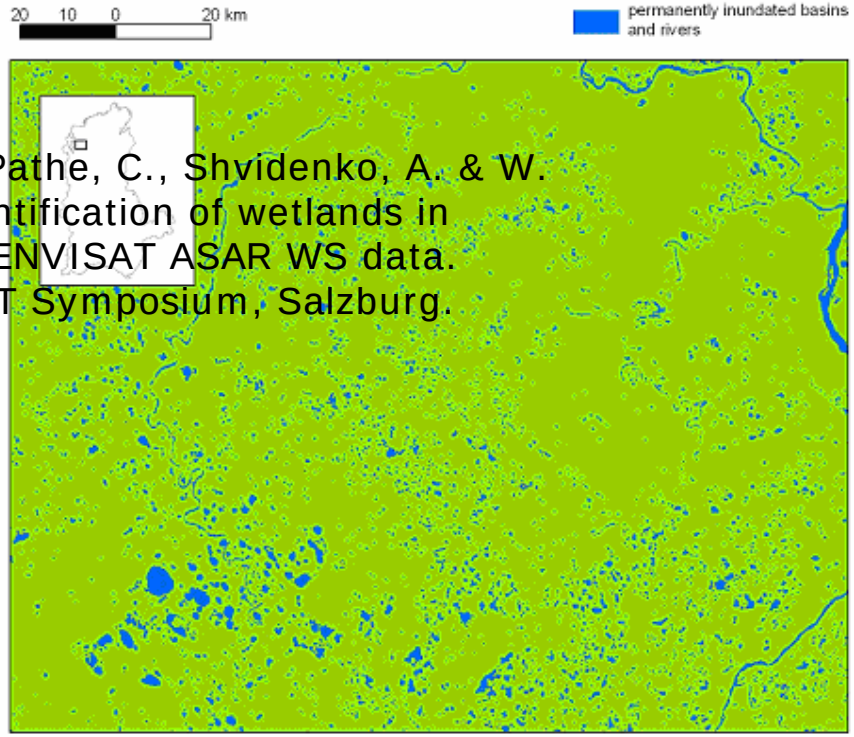
Reference

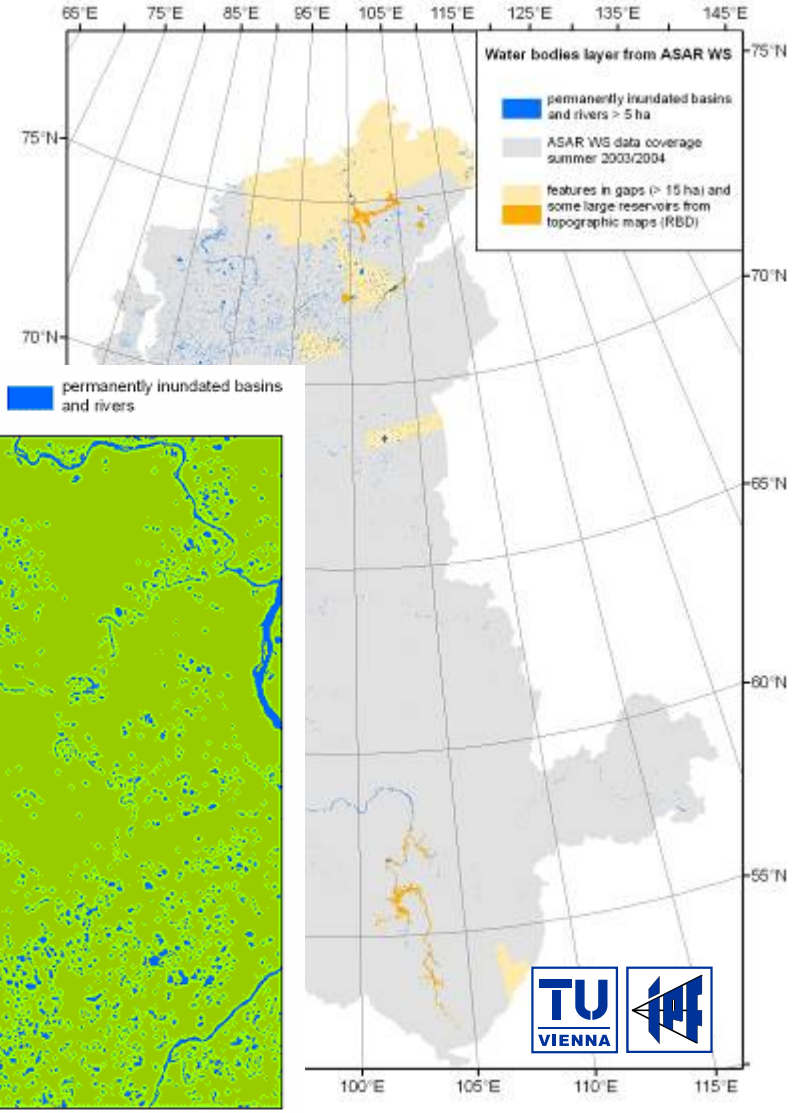
Balzter, H. et al. (2004): Forest fires in Central Siberia and their impact on emissions of greenhouse gases. Proceedings of RSPSoc, Aberdeen, 6-10 September, CD-ROM

Waterbodies

Product Summary

- Permanent open water bodies > 5 ha (15 ha) derived from ENVISAT ASAR WS data (C-Band)
- Spatial resolution: 150m
- Date: summer 2003 & 2004
- Spatial accuracy: ~150m



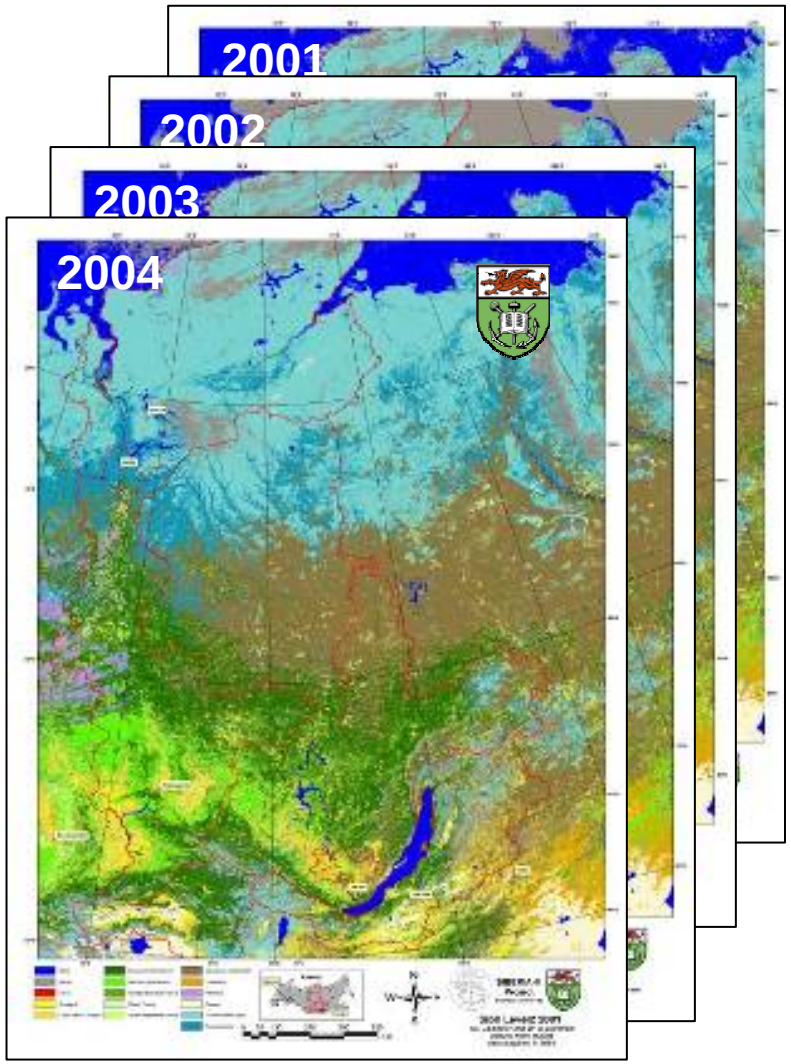


Reference

Bartsch, A., Kidd, R., Pathe, C., Shvidenko, A. & W. Wagner (2004): Identification of wetlands in central Siberia with ENVISAT ASAR WS data. Proceedings ENVISAT Symposium, Salzburg.

Product Summary

- annual land cover maps for 2001-2004 derived from MODIS 8-day surface reflectance (MOD04A)
- Spatial resolution: 500 m
- 16 classes adopted from GLC2000
- Input data acquired for growing season (June-October)
- Supervised classification scheme using C5.0 decision tree classifier



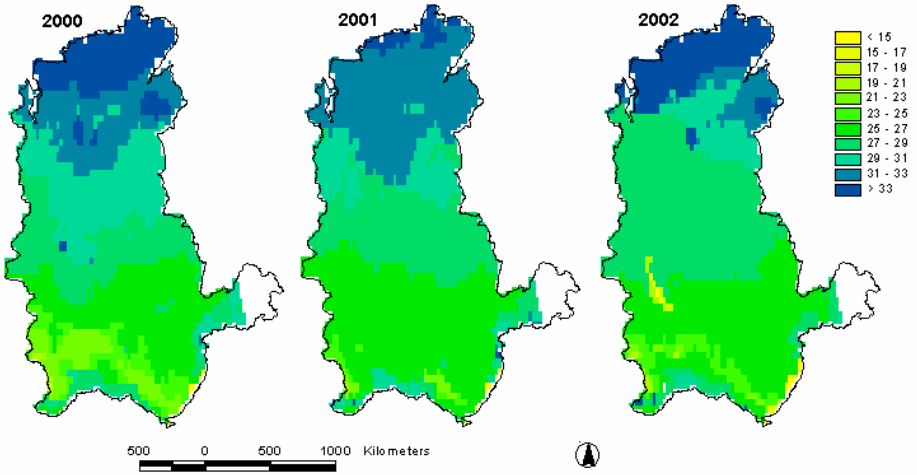
Reference

SKINNER, L., and LUCKMAN, A. (2004): Introducing a land cover map of Siberia derived from MERIS and MODIS data. Proceedings of IGARSS'04, Anchorage, 20-24 September, pp. 223-226.

Snowmelt dates

Product Summary

- Spring snow melt date for 2000-2002
- derived from SSM/I data
- spatial resolution: 25km x 25km
- temporal resolution: 5 day interval

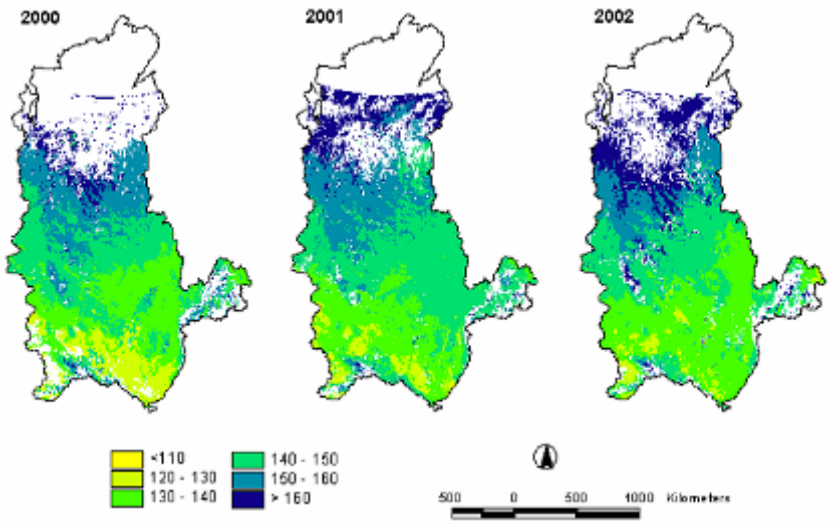


Reference

Grippa M., N. M. Mognard and T. Le Toan, 2005a, Comparison between the interannual variability of snow parameters derived from SSM/I and the Ob river discharge, Remote Sensing of Environment, 98, pp 35-44.

Product Summary

- spring phenology dates for 2000-2003
- Derived from SPOT-VGT 10-day composite data using Normalised Difference Water Index (NDWI)
- Spatial resolution: 1km x 1km



Reference

Delbart N., L. Kergoat, T. Le Toan, J. L'Hermitte and G. Picard, 2005, Determination of phenological dates in boreal regions using normalized difference water index, Remote Sensing of Environment, 97, 1, pp. 26-38.

Delbart, N., T. Le Toan, L. Kergoat, V. Fedotova (2006), Remote sensing of spring phenology in boreal regions: a free of snow-effect method using NOAAAVHRR and SPOT-VGT data (1982-2004), Remote Sensing of Environment, 101, 52-62.

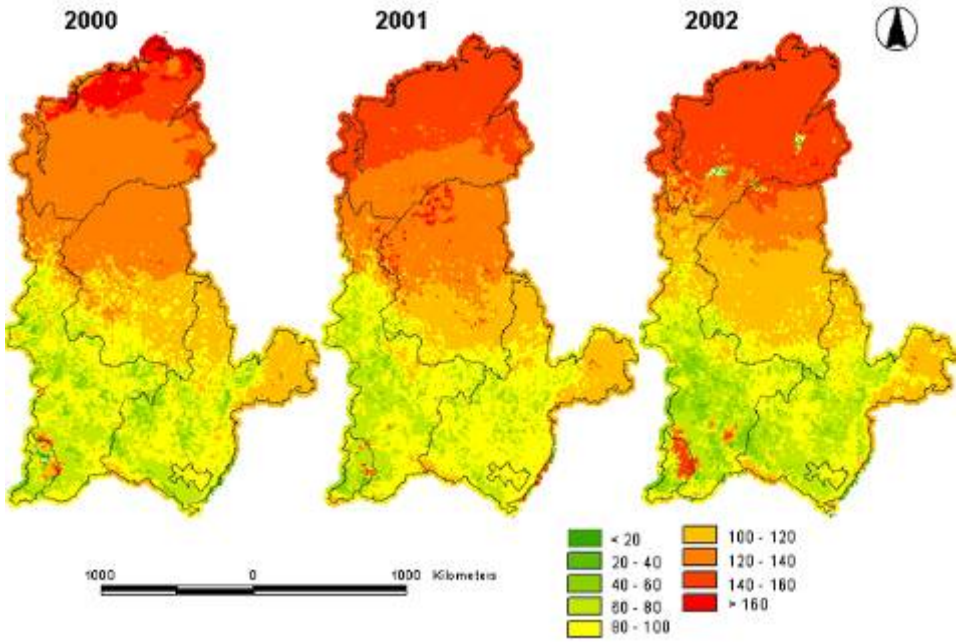
Freeze/ Thaw

Product Summary

- Derived from QuikSCAT (1 Terabyte) Ku Band Scatterometer
- Spatial resolution: 25km (product 10km)
- Temporal resolution: daily

Products for 2000-2003 inc.

- Onset of Thaw/refreeze period
- Duration of Thaw/refreeze period



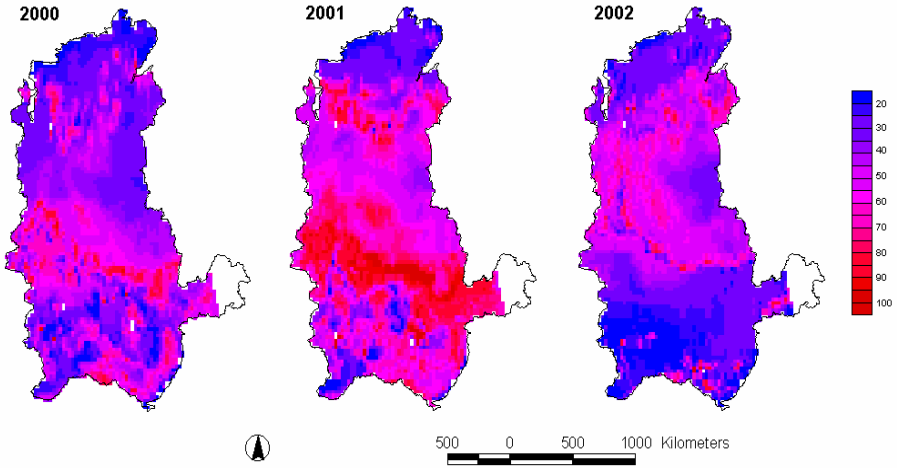
Reference

KIDD, R., BARTSCH, A., and WAGNER, W. (2004): Development and validation of a diurnal difference indicator for freeze-thaw monitoring in the Siberia II Project, Proceedings of 2004 ERS & Envisat Symposium, Salzburg, 6-10 September, SP-572, CD-ROM.

Snowdepth

Product Summary

- monthly snow depth for 2000-2002
- derived from SSM/I data using a new combined dynamic and static algorithm
- spatial resolution: 25km x 25km



Reference

Grippa, M., N.M. Mognard, T. Le Toan and E.G. Josberger 2004a “Siberia snow depth climatology derived from SSM/I data using a combined dynamic and static algorithm, Rem. Sens. Envir. 93:30-41.

Grippa M., N. M. Mognard and T. Le Toan, 2005a, Comparison between the interannual variability of snow parameters derived from SSM/I and the Ob river discharge, Remote Sensing of Environment, 98, pp 35-44.

DGVMs (Dynamic Vegetation Models)

- LPJ: Lund-Potsdam-Jena Digital Global Vegetation Model
  Potsdam Institute for Climate Impact Research (PIK) – Prognostic Process Model

- SDGVM: Sheffield Digital Global Vegetation Model
  Sheffield Centre for Earth Observation Science (SCEOS) – Prognostic Process Model

- TBGHGA: Terrestrial Biota Greenhouse Gas Accounting
  International Institute for Applied Systems Analysis (IIASA) – Static Regression Model

Implementation strategy

Stage 1: *"getting the SIBERIA-II products online"*

- Develop an online data repository including a metadata database and a web interface to enable users to search, (pre-) view and download existing datasets.

Stage 2: *"equip SIB-ESS-C with processing power for continuous product generation"*

- Setting up a PC cluster for operational data processing
- implement tools for data archiving, storage management and automatic metadata creation

Stage 3: *"from data providing to scientific data analysis"*

- implement interactive visualization tools for spatio-temporal analysis

Stage 4: "*integrating SIB-ESS-C into a global network of distributed Earth Science Clusters*"

- offer data/services to external systems
- implement external data/services into SIB-ESS-C

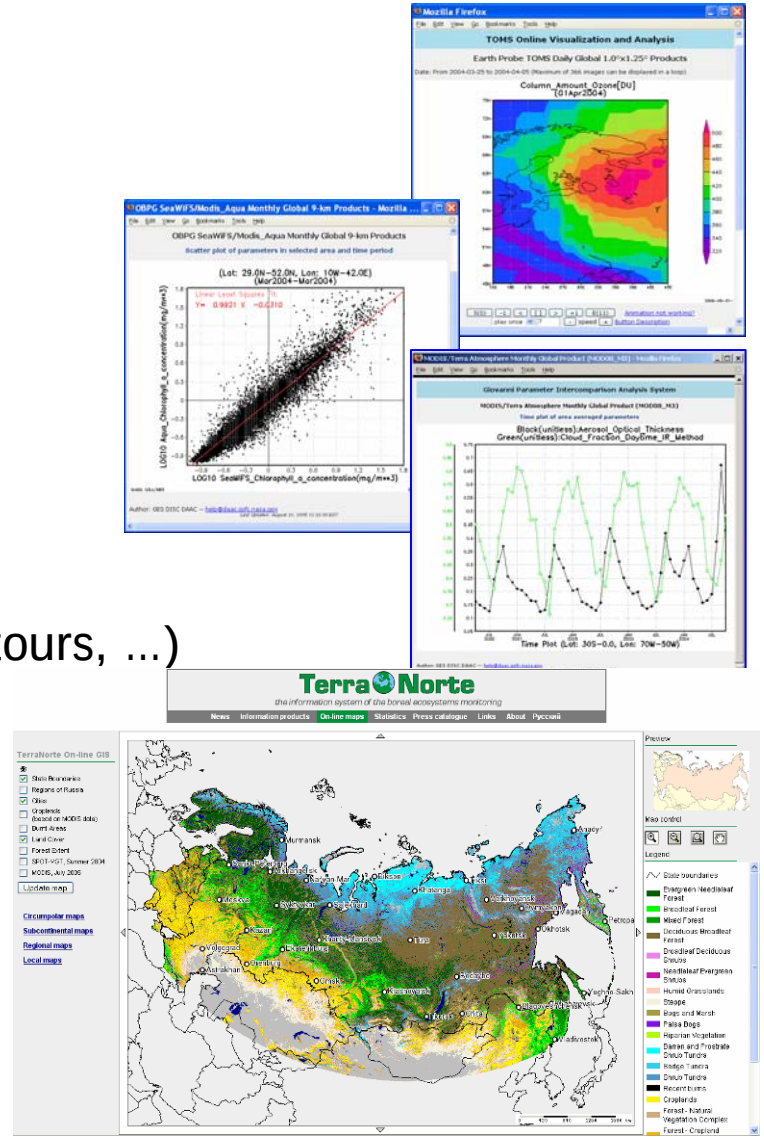
Design philosophy:

- implement free and open source software whenever possible
- use components that are well established in the ESS, EO and GIS communities
- follow standards to strongly support interoperability (OGC, ISO, ...)

Web Server:	Apache HTTP Server
Database:	ProstgreSQL + PostGIS
Map Server:	UMN MapServer, Mapbender
Data access:	WCS, OPeNDAP, NetCDF
Data management:	THREDDS
Visualization:	IDV, GrADS
Cluster/GRID:	LAM/MPI
EO Processing:	IDL, Gamma, GMT, GRASS
Exchange:	XML, GML

Analysis

- online, through web interface
- cross-comparison of data products
- GIS functionalities (e.g. overlay analysis)
- option to extract results as:
  - Maps (GIF, EPS, ...)
  - Graphs (1D time series, profiles, 2D contours, ...)
  - Text files (CSV, XML, ...)
  - “real data” (netCDF, binary, ...)



Data policy

→ derived products are provided free of charge (registration only)

→ Access to data products:

- FTP
- Web Coverage Service (WCS)

→ in the future: user adjusted data products (spatial extend, time step data format, coordinate system, ...)

Related Projects

- "IRIS – Irkutsk Regional Information System for Environmental Protection"
  funded by EC (07/2006 – 06/2008)

- "GMES Service Element: Forest Monitoring Russia (Stage 1 & 2)"
  funded by ESA (2006 – 2008)

- "SibFORD – Estimating Carbon Emissions from Forest Disturbance in Siberia"
  funded by INTAS/ESA (01/2007 – 12/2009), cooperation with Dr. Sergey Bartalev, IKI Moscow

- "Climatic change in permafrost regions observed by satellites
  Firnberg Stipedium: Dr. Annett Bartsch (IPF Vienna)

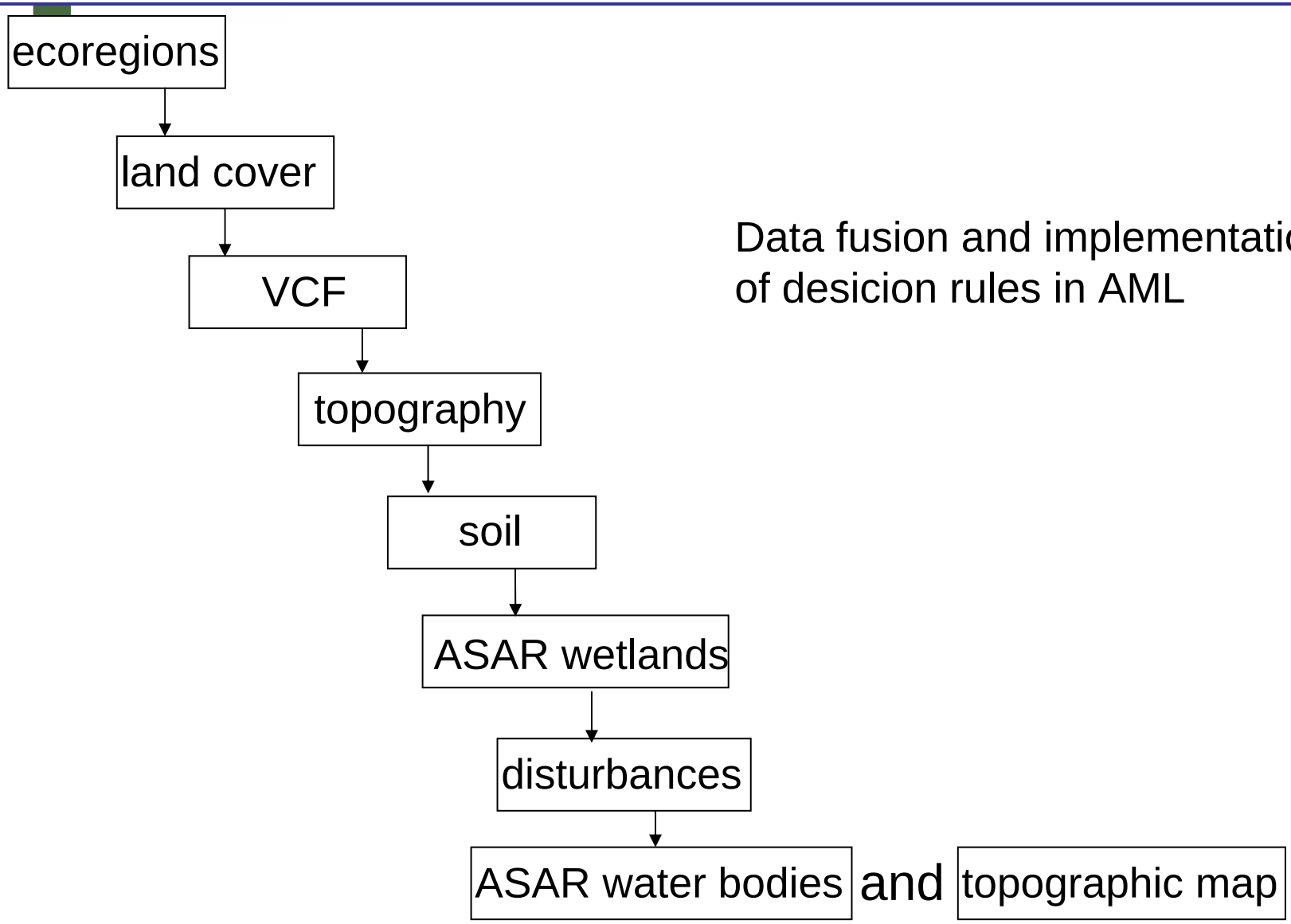
- "FFID - Spatio-temporal characterisation of boreal forest fire intensity dynamics and its impact on carbon flux estimation"
  funded by NERC (10/2005 – 09/2008), Prof. Heiko Balzter (Leicester/UK)

Examples

- Ph.D. Daniela Knorr: Spatial Modelling Techniques for an Ecosystem GIS
- Maurizio Santoro: Biomass Mapping with ASAR WS
- FRA-SAR 2010: TerraSAR-X and ALOS PALSAR to support the UN Forest Resource Assessment 2010
- Student Work: VCF-validation using Google Earth

Decision Rules

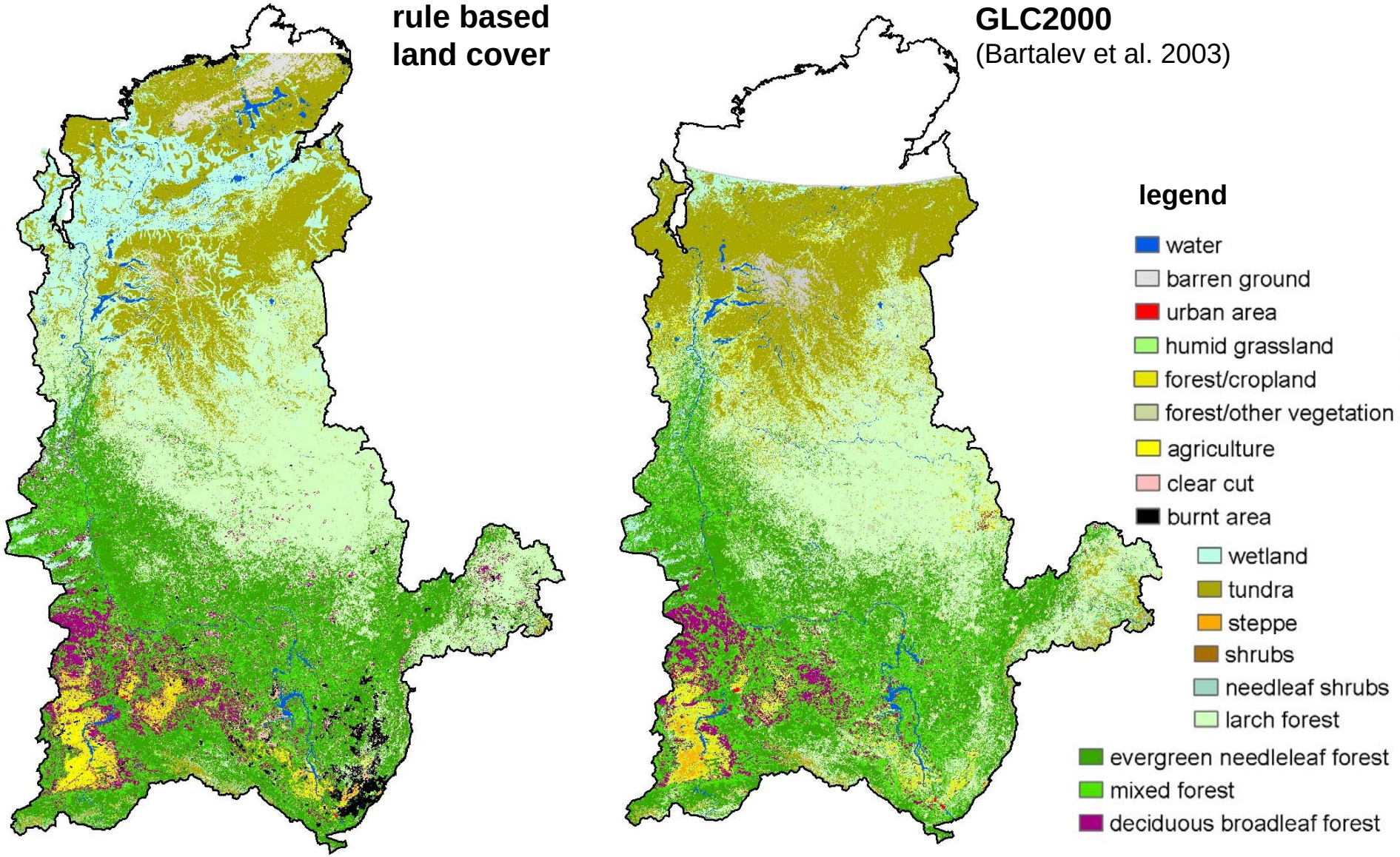
D. Knorr



Data fusion and implementation of desicion rules in AML

Result of land cover classification

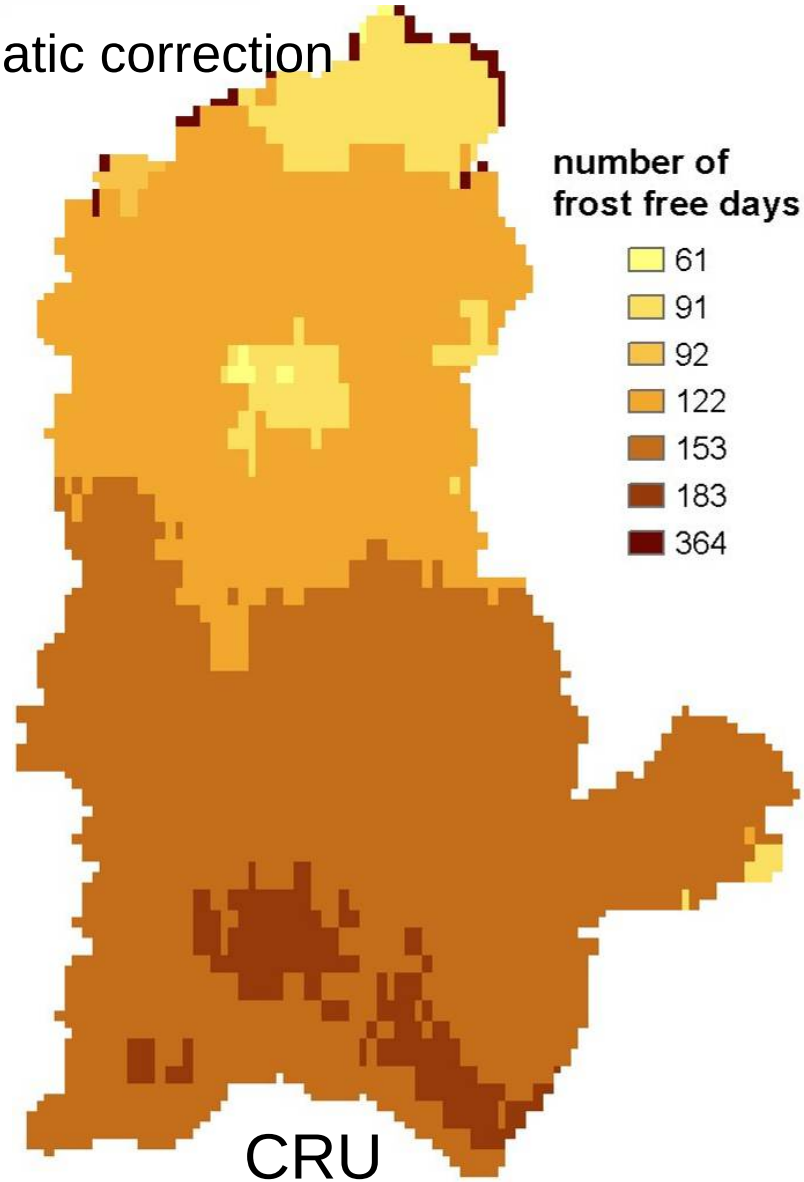
D. Knorr



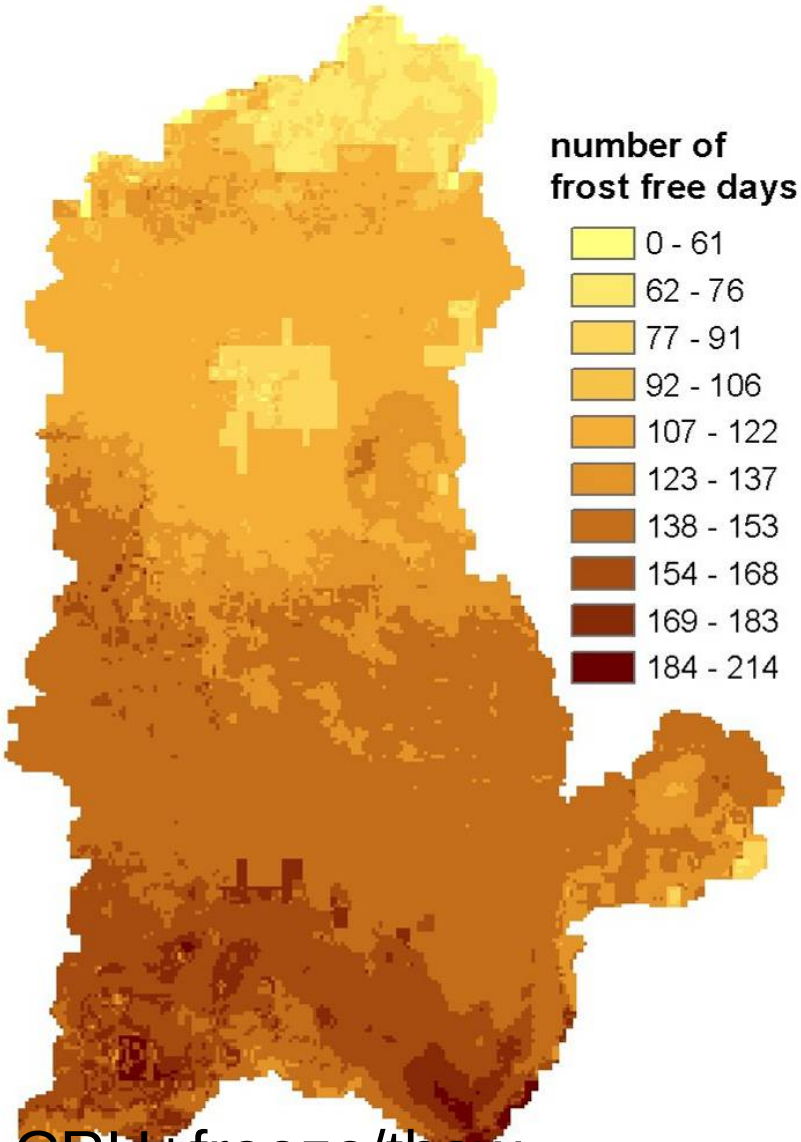
Other input parameters

D. Knorr

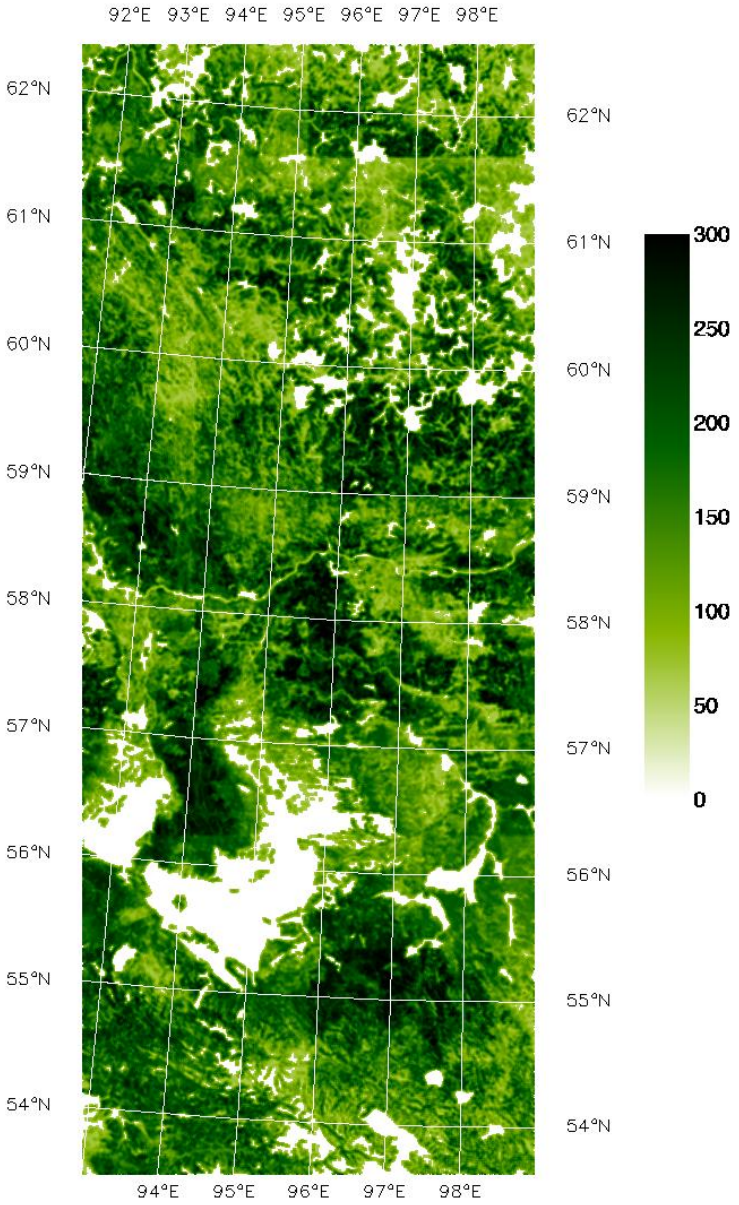
Climatic correction



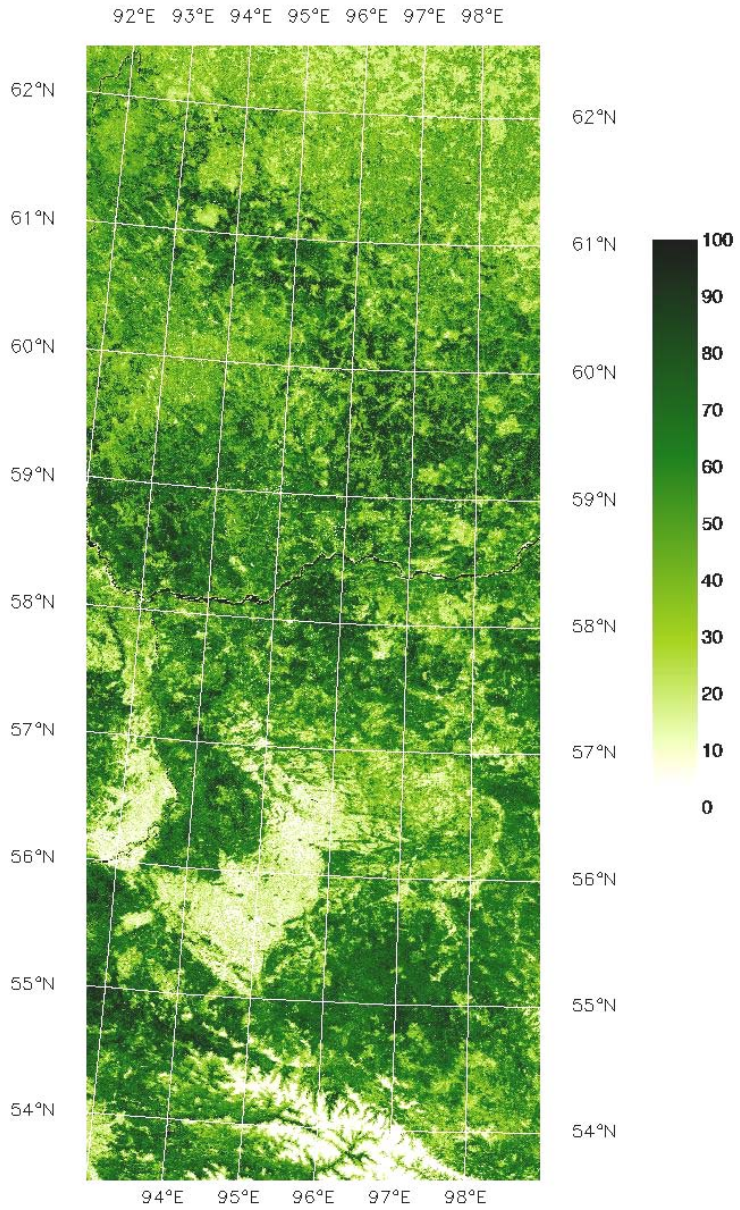
CRU



CRU+freeze/thaw

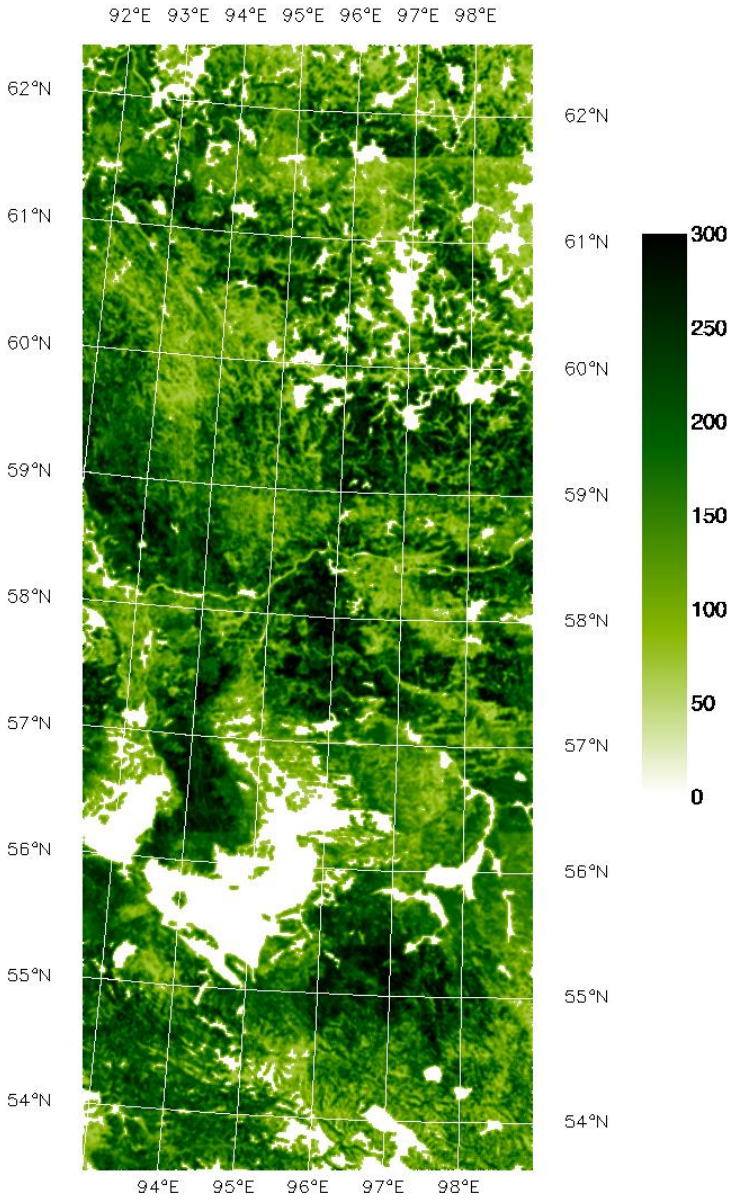


Multi-temporal ENVISAT ASAR Wide Swath growing stock volume (m^3/ha)

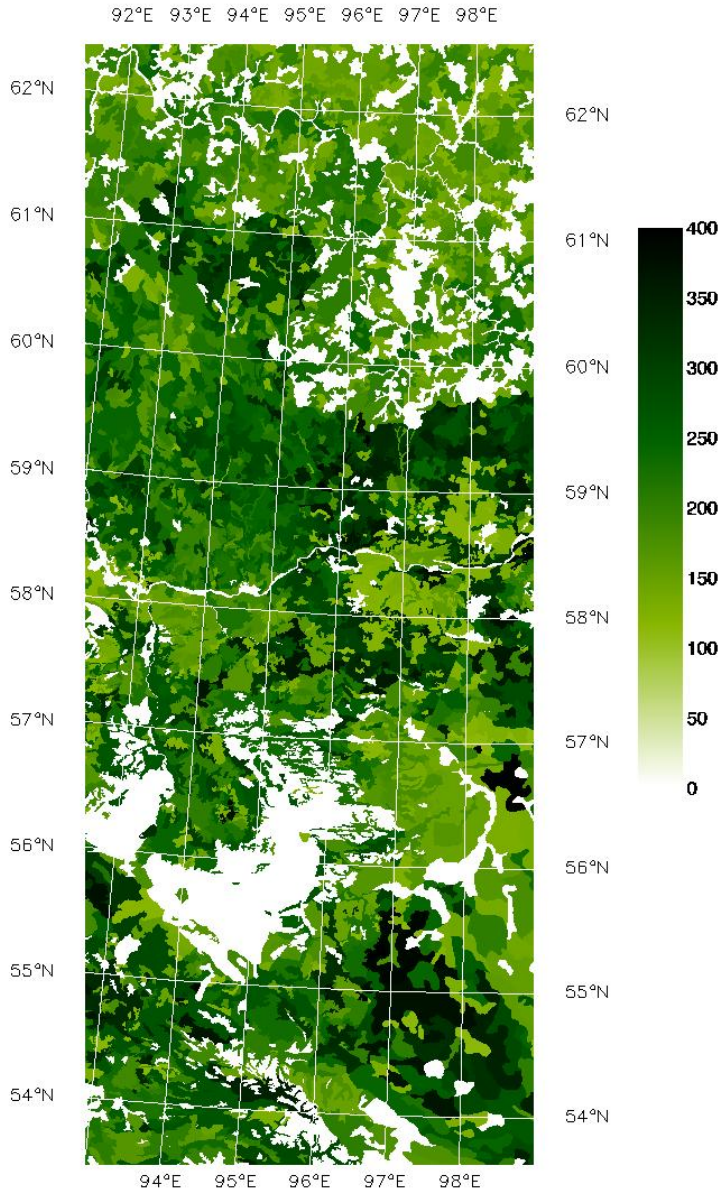


MODIS Vegetation Continuous Fields tree cover percentage (%)

[Courtesy: M. Santoro]



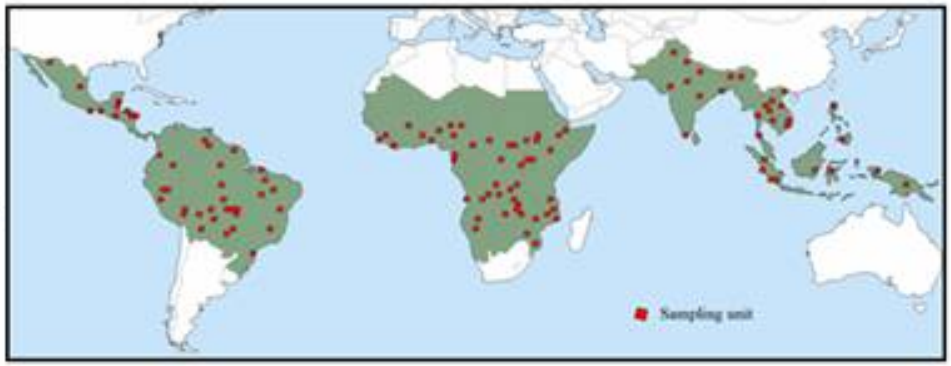
Multi-temporal ENVISAT ASAR Wide Swath growing stock volume (m^3/ha)

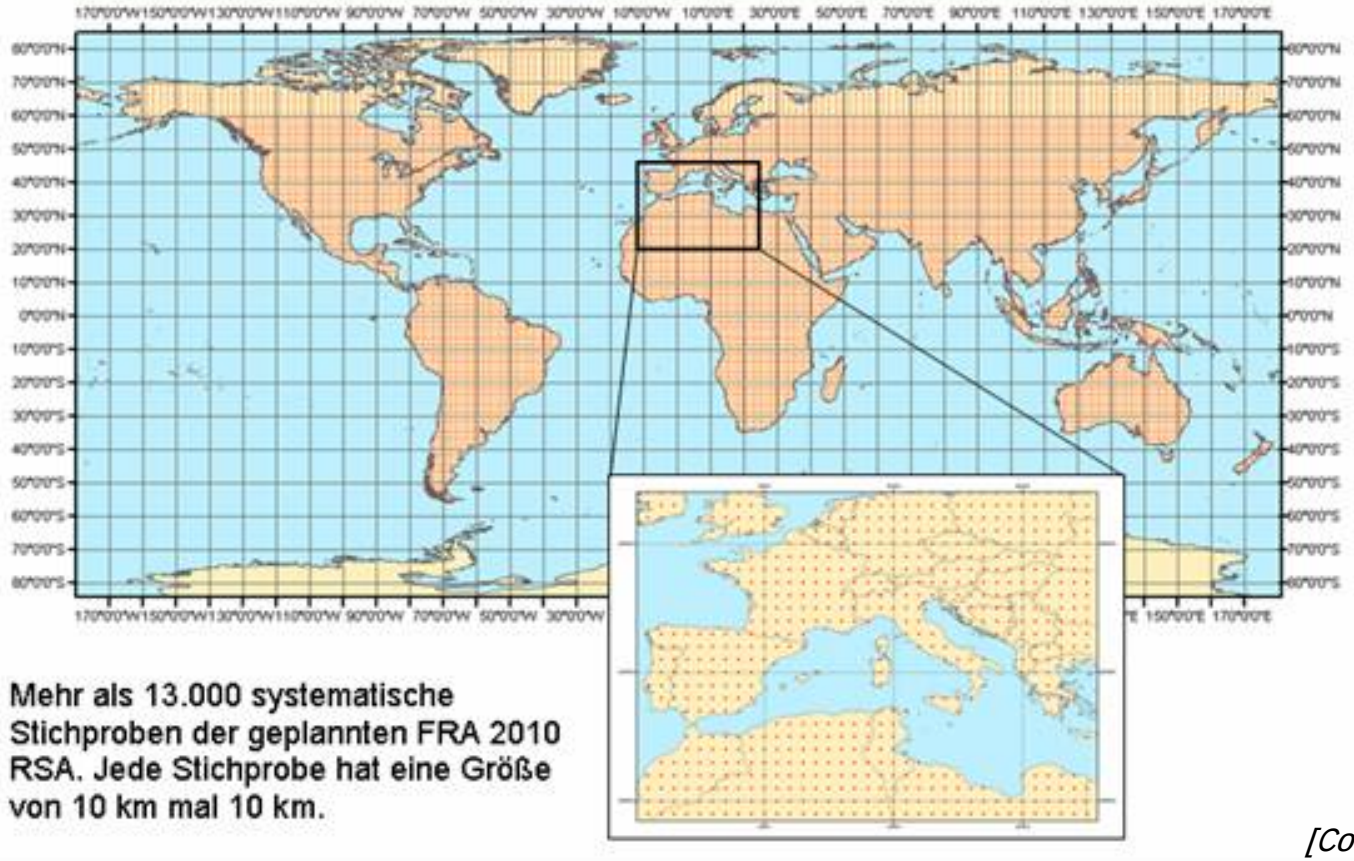


Inventory data from IIASA (SIBERIA-II) (m^3/ha)

[Courtesy: M. Santoro]

117 vollständige Landsat-Stichproben (185 km x 185 km) der FRA Fernerkundungs-kampagne 1990 und 2000 in den Tropen





Mehr als 13.000 systematische Stichproben der geplannten FRA 2010 RSA. Jede Stichprobe hat eine Größe von 10 km mal 10 km.

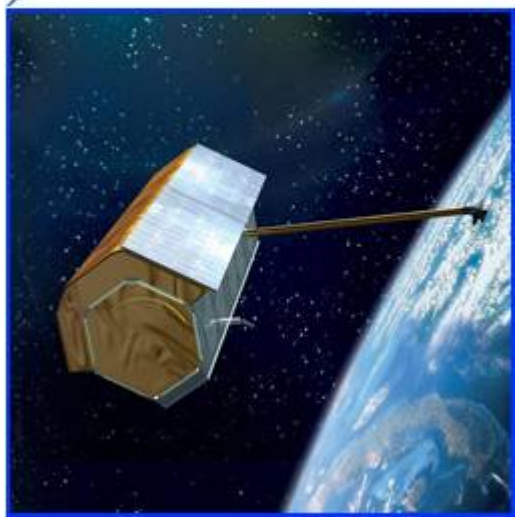
[Courtesy: R. Ridder]

Fully polarimetric L-band meets high resolution fully polarimetric X-band

PALSAR
L-band

Commercial acquisition starts
November 2006

+



Launch **31. October 2006**

Fine Resolution Mode
8.0-60.0 deg.
HH or VV / HH+HV or VV+VH
7.0-44.3m / 14.0-88.6m
40-70km / 40-70km

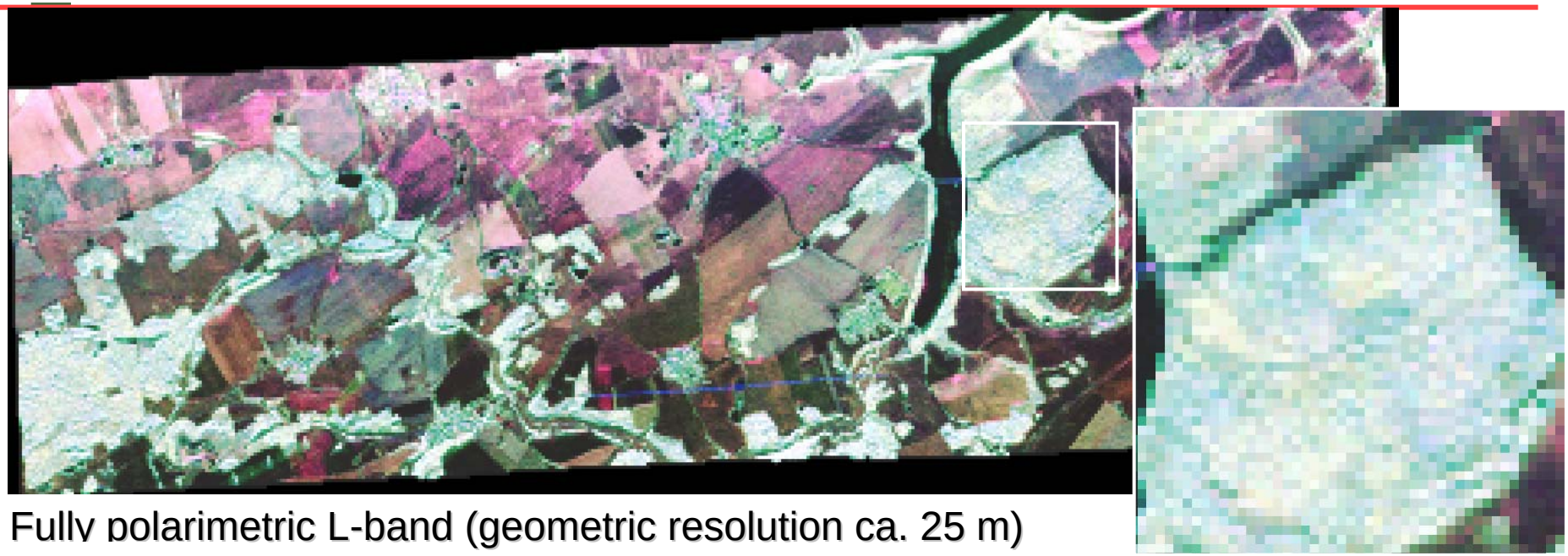
ScanSAR Mode
18.0-43.0 deg.
HH or VV / 100m / 250-350km

Polarimetric Mode
8.0-30.0 deg.
HH + HV + VH + VV
24.1-88.6m / 20-60km

Standard Imaging Mode

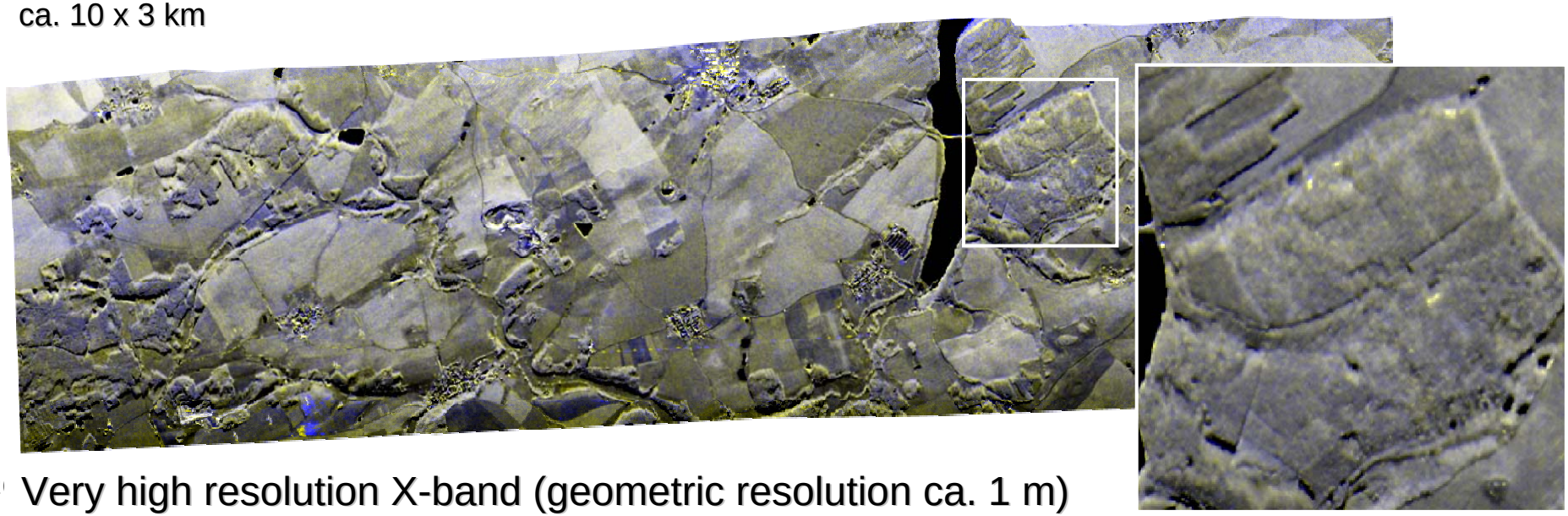
	Spotlight	StripMap	ScanSAR
Geometric Resolution	1 m	3 m	16 m
Image Swath Width	10 km	30 km	100 km
Maximum Length per Image	5 km	3000 km	3000 km

Sensor Synergy: high dynamic range (L-) plus detailed texture (X-band)



Fully polarimetric L-band (geometric resolution ca. 25 m)

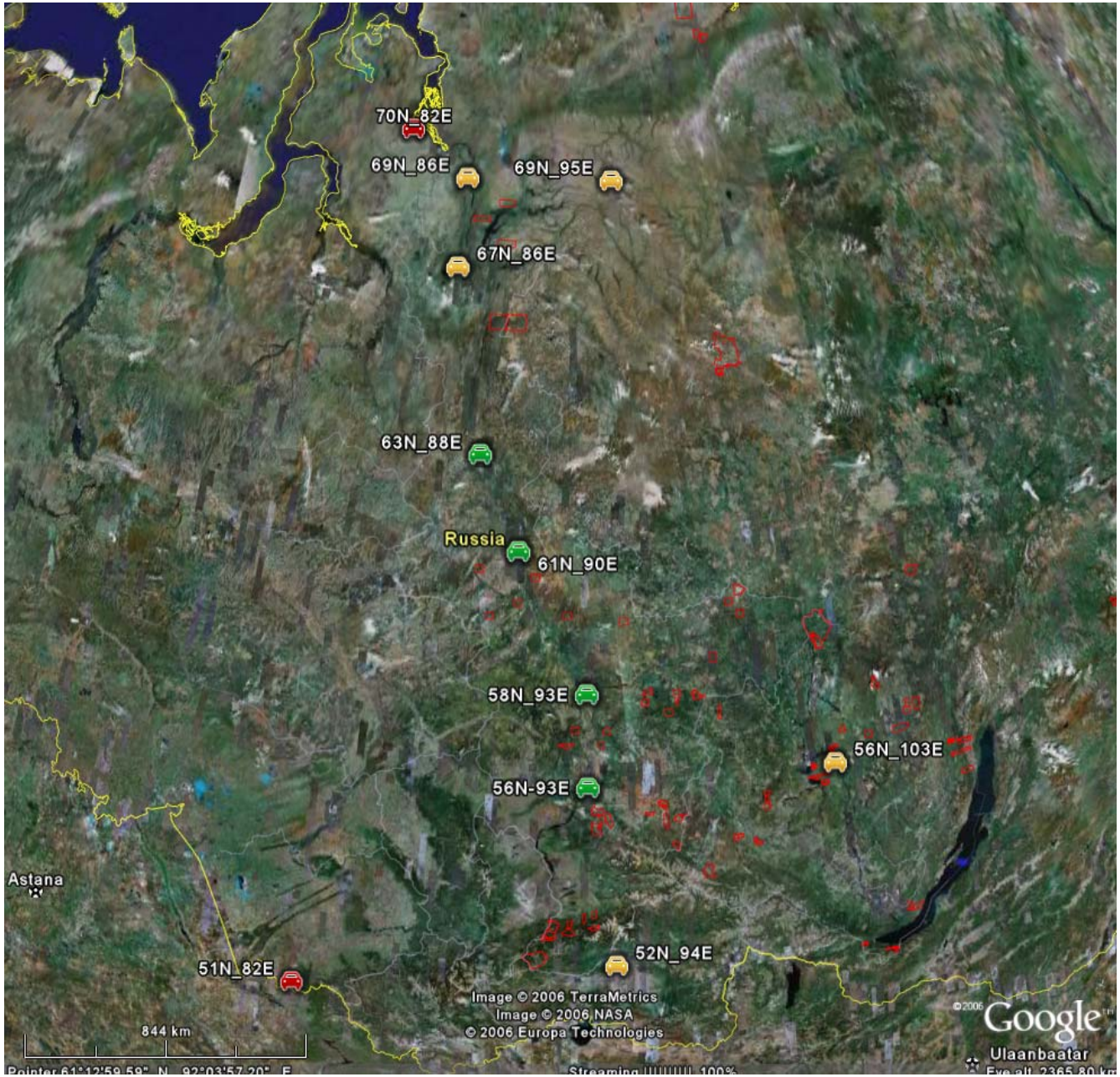
ca. 10 x 3 km

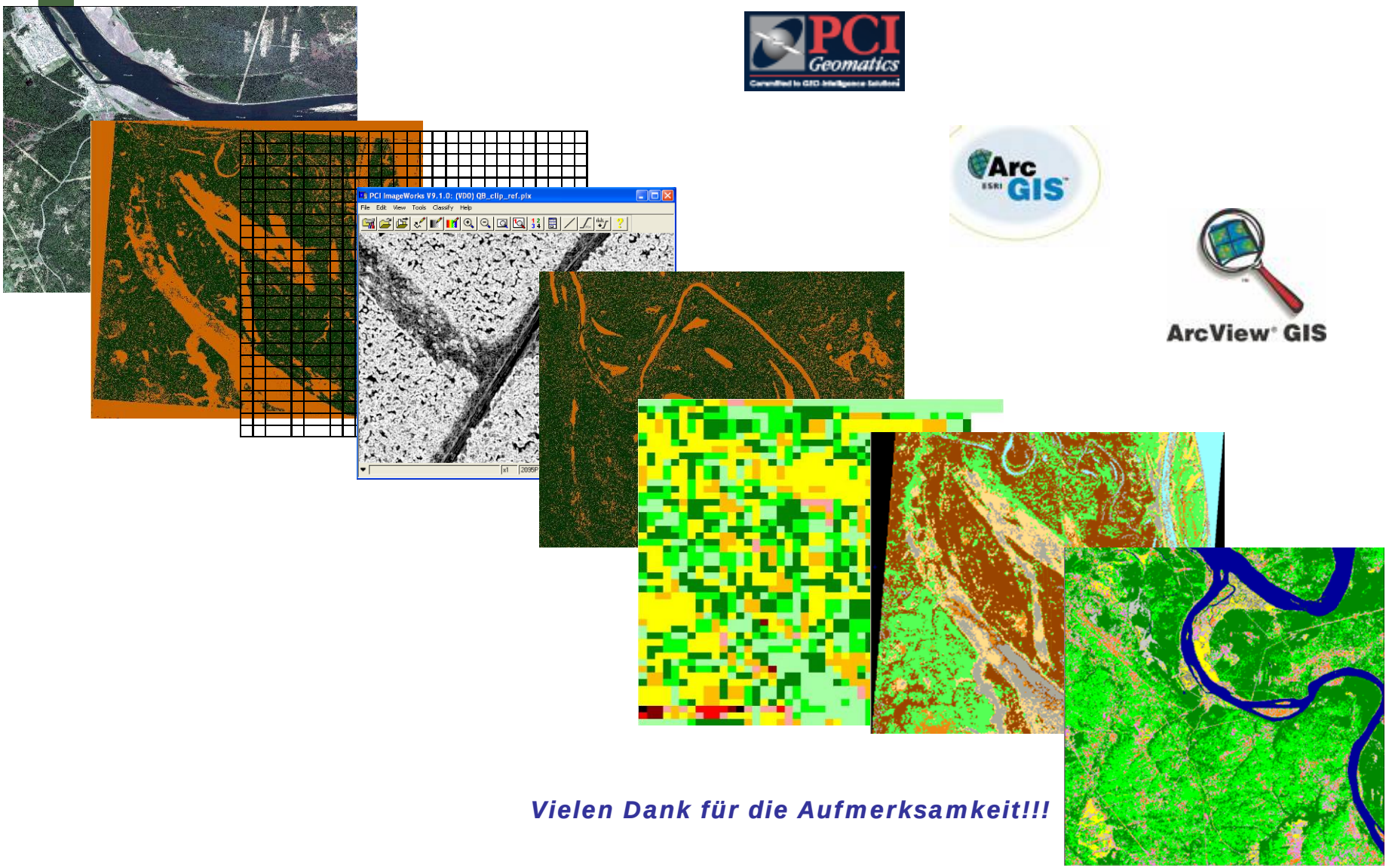


Very high resolution X-band (geometric resolution ca. 1 m)

SIB-ESS-C

VCF-validation using Google Earth at FRA-sites





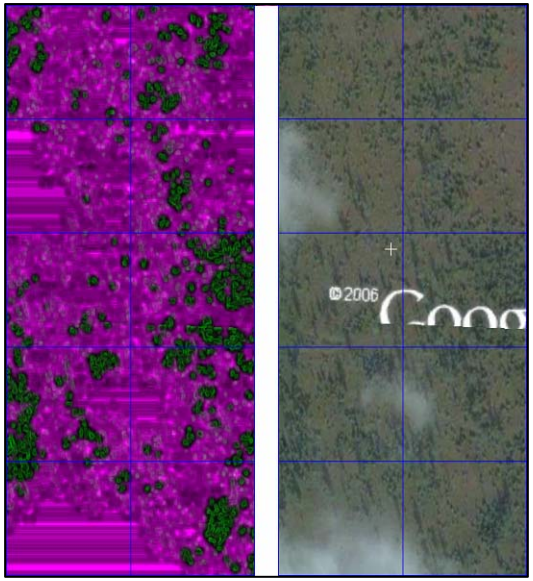
PCI Geomatics

ArcGIS ESRI

ArcView® GIS

Vielen Dank für die Aufmerksamkeit!!!

2.1 Interpretationsschlüssel für prozentuale Baumbedeckung



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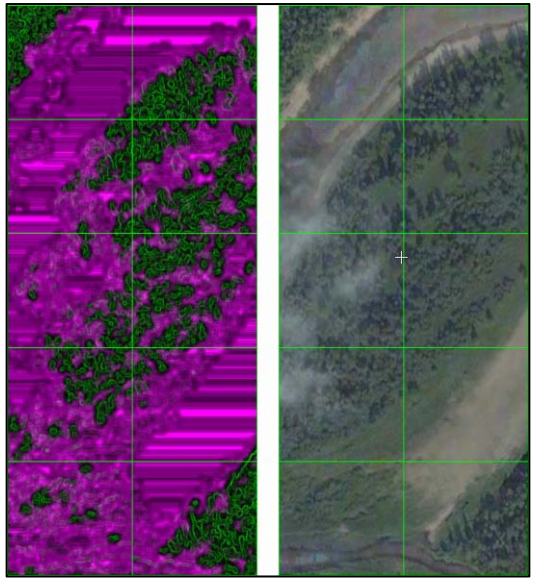

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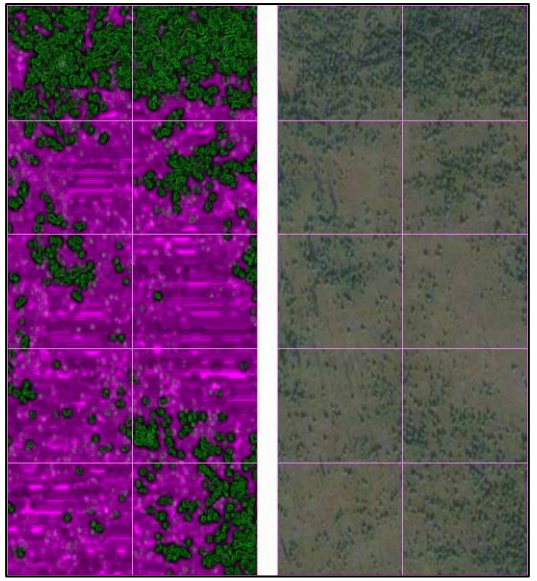

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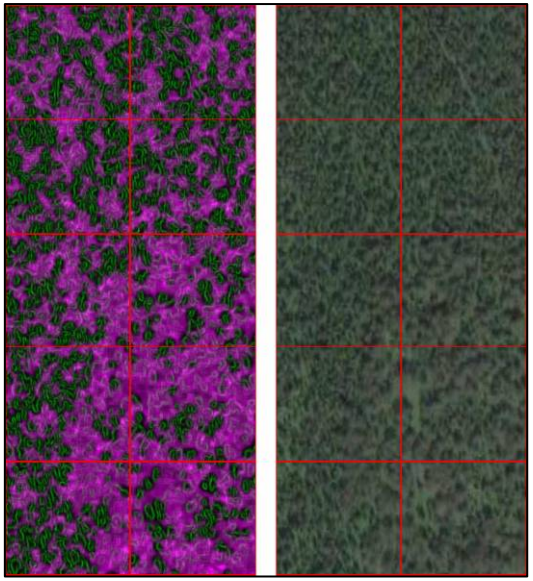
2.1 Interpretationsschlüssel für prozentuale Baumbedeckung



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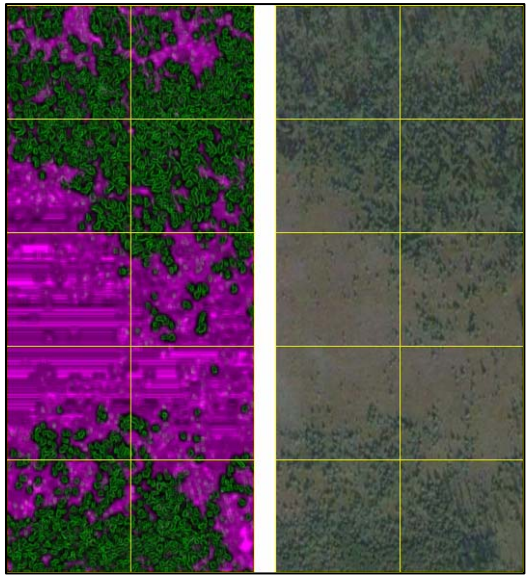

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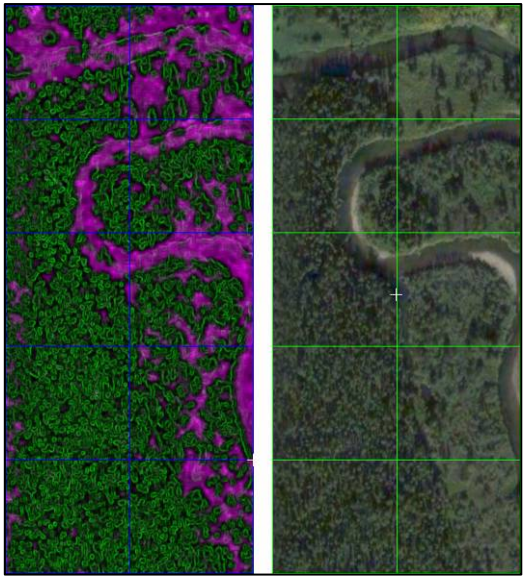

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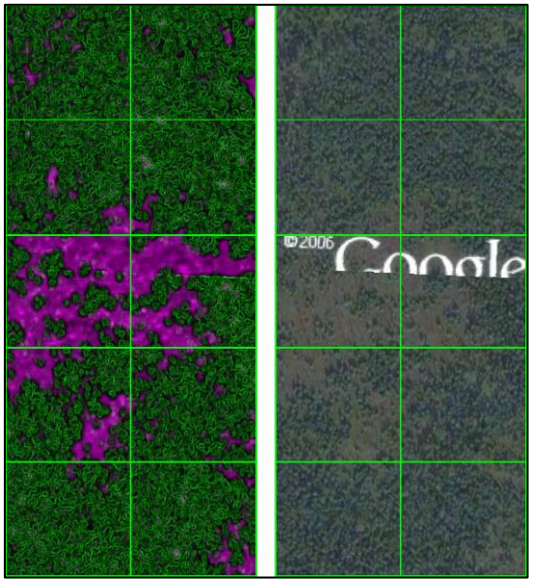
2.1 Interpretationsschlüssel für prozentuale Baumbedeckung



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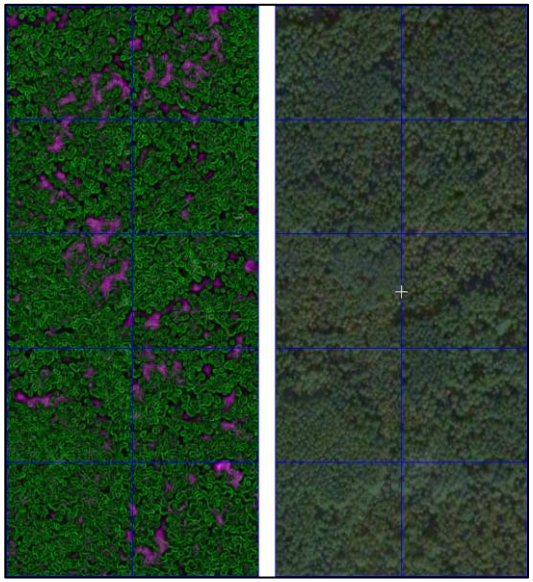

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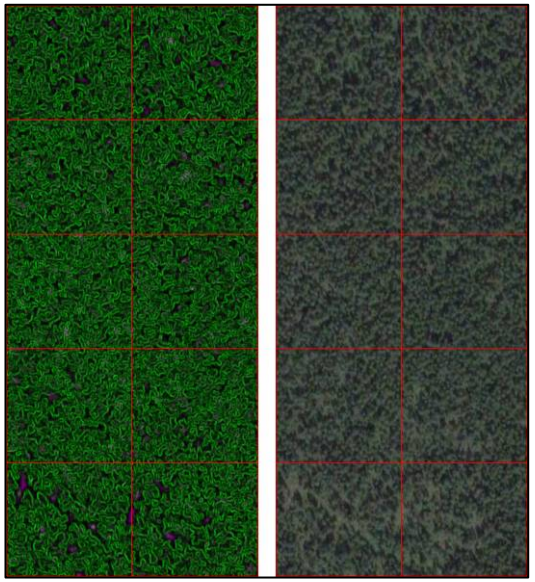

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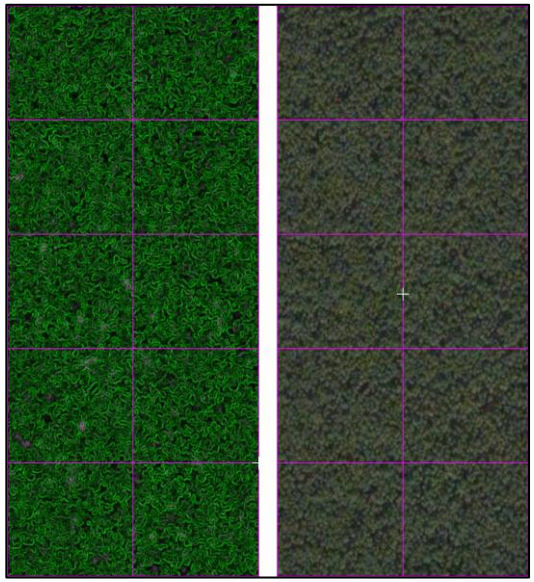
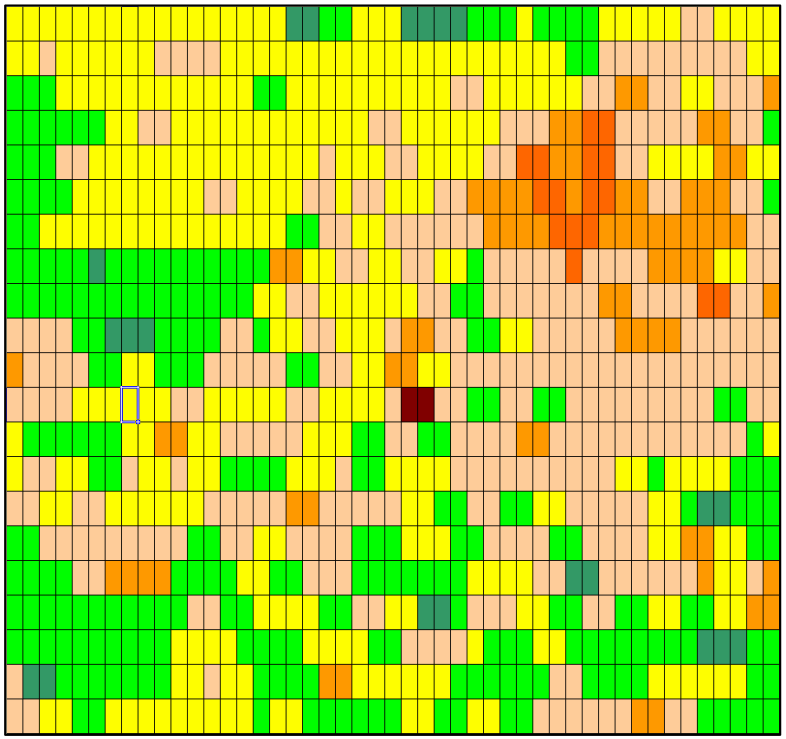
2.1 Interpretationsschlüssel für prozentuale Baumbedeckung



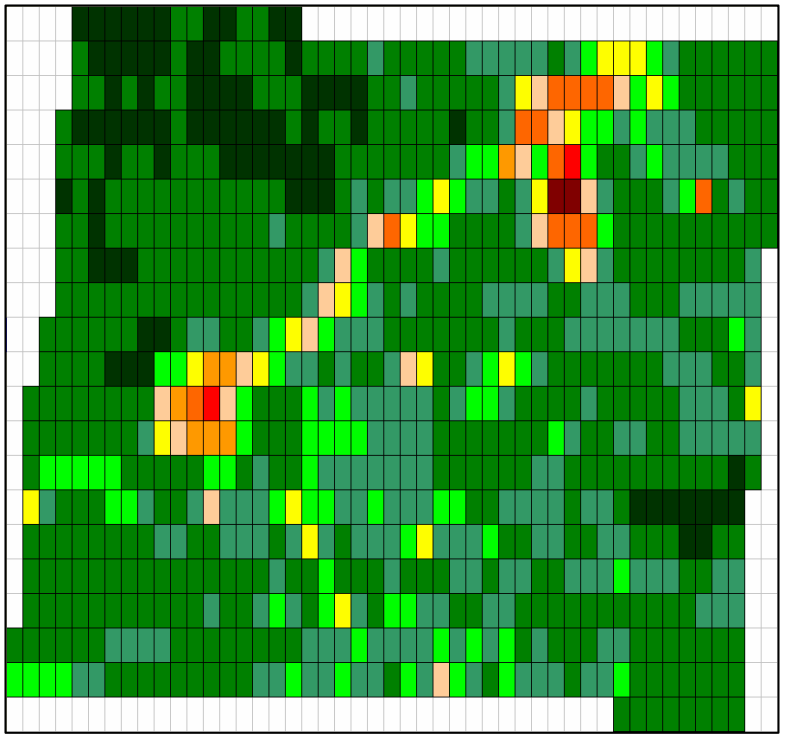
100%

2.2 Ergebnis

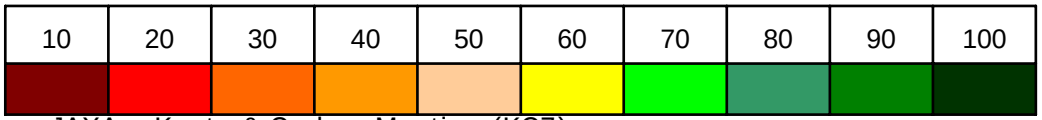
VCF



vis. Interpretation QB

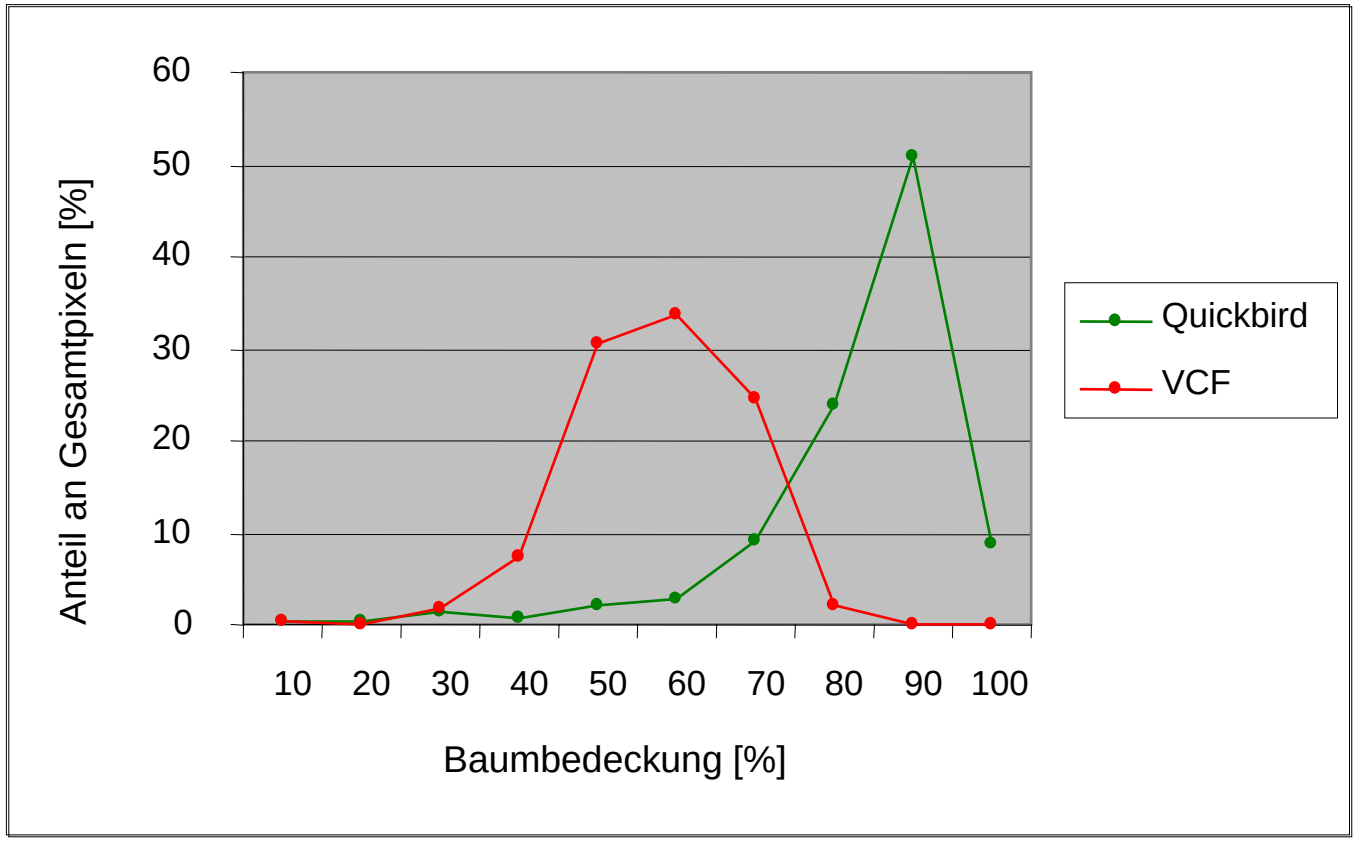


Baumbedeckung [%]



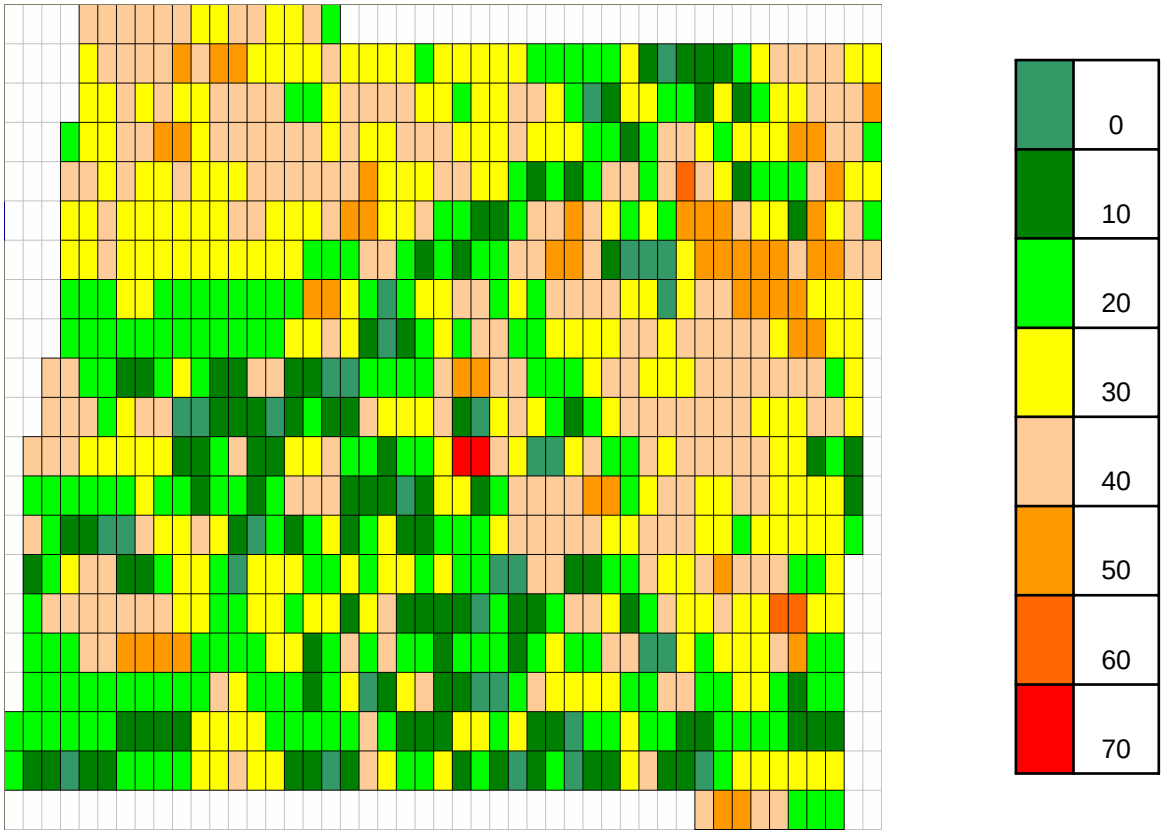
2. Validierung VCF mittels QuickBird

Vergleich Baumbedeckung VCF / visuelle Interpretation



2.2 Ergebnis

Abweichung VCF / QB [%]



Summary

SIB-ESS-C provides an information infrastructure to facilitate Earth System Science

Key aspects:

- regional focus on Siberia because it represents a temperature change hot-spot of global importance
- focus on Earth Observation techniques (EO-derived time series, validation and cross-comparison of products)
- complementary projects need to be initiated that are driven by global change science questions to ensure continued data acquisition, product generation and improvement/development of information extraction
- link to modeling community (DGVMs, GCMs, ...) as crucial and challenging task

- Several national case studies are ongoing using GOFC-GOLD guidelines (i.e. PNG, Vanuatu, Bolivia, Cameroon, Congo)
- April 2007 - 2nd GOFC-GOLD workshop on reducing emissions from deforestation:
  - *"Measuring and monitoring greenhouse gas emissions from deforestation in developing countries: from case studies to implementation guidelines"*
- Role for Kyoto and Carbon team:
  - *JERS/ALOS global mosaics may provide a useful addition to the measurements and monitoring plans outlined in the GOFC-GOLD technical document mainly building on optical data*
  - *Radar approach could be investigated as part of the ongoing pilot studies with operational focus*
  - *Appropriate Radar datasets are to be made available soon, with full access, and for all developing countries to have impact in this process*

Thank you for your attention!

http://www.sibessc.uni-jena.de