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European Regional Development Fund

Development of an Automatic Near-Real-Time Image Processing Chain for Small Satellites

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http://www.space.si

5th Nano-Satellite Symposium, Tokyo, Japan, November 20th-22nd, 2013

It's getting harder to hide if you're doing bad stuff. Bono, TED, 2013

Overview

- Motivation
- General facts about Space-SI processing chain
- Details about individual modules of prototype Space-SI processing chain – current status
- Future plans

Motivation

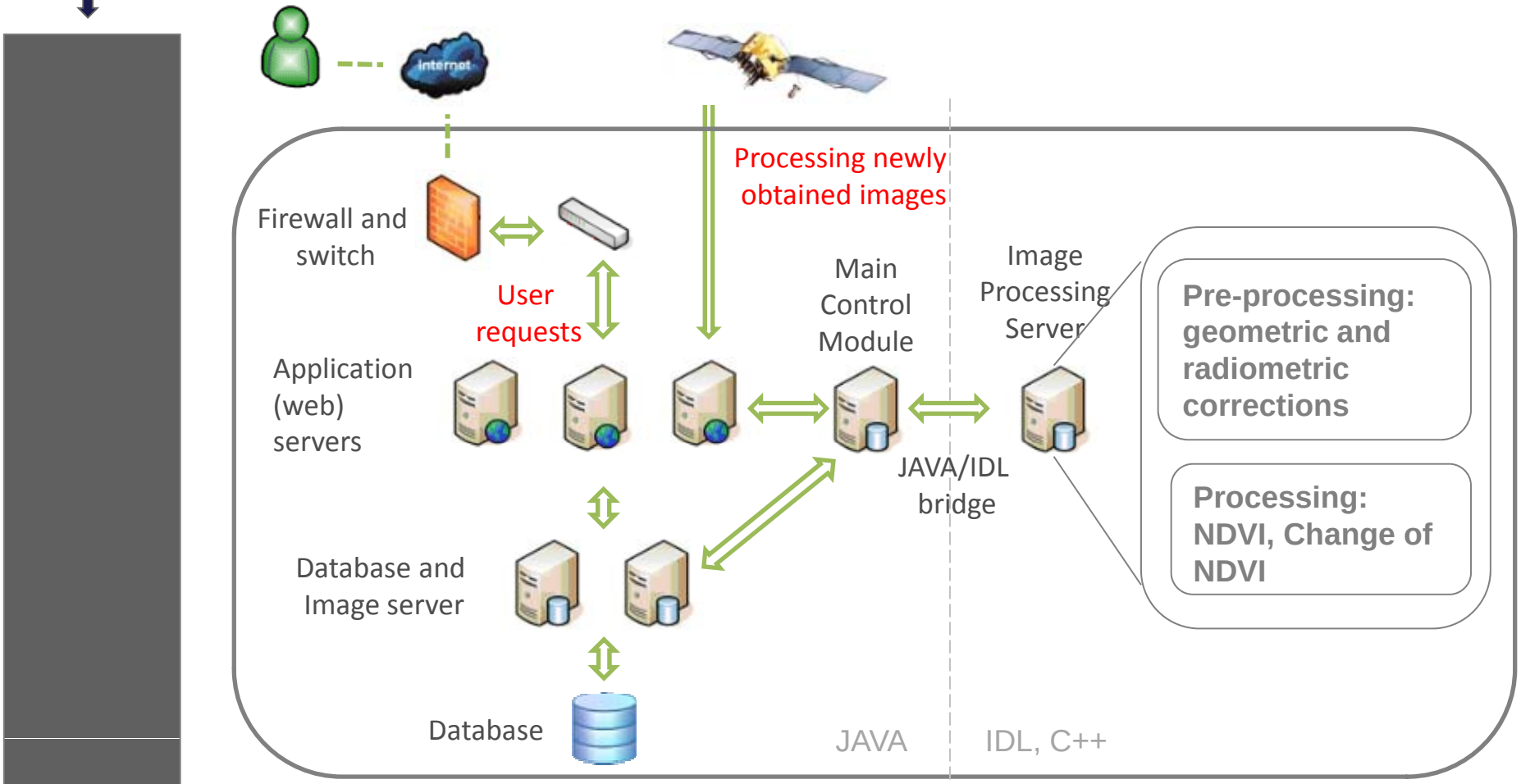
increasing amount of remote sensing data
(in great portion not used at all)

automatic processing and fast delivery of products generated from recently acquired satellite data

end-users having:
> precise expert needs
> basic knowledge of web mapping
> limited or no knowledge about satellite data capabilities

System architecture

push of the sensor-corrected optical satellite image to the dedicated FTP



orthoimage, radiometrically corrected image, various interpretations (NDVI, change detection, …) in the suitable for specific end-user

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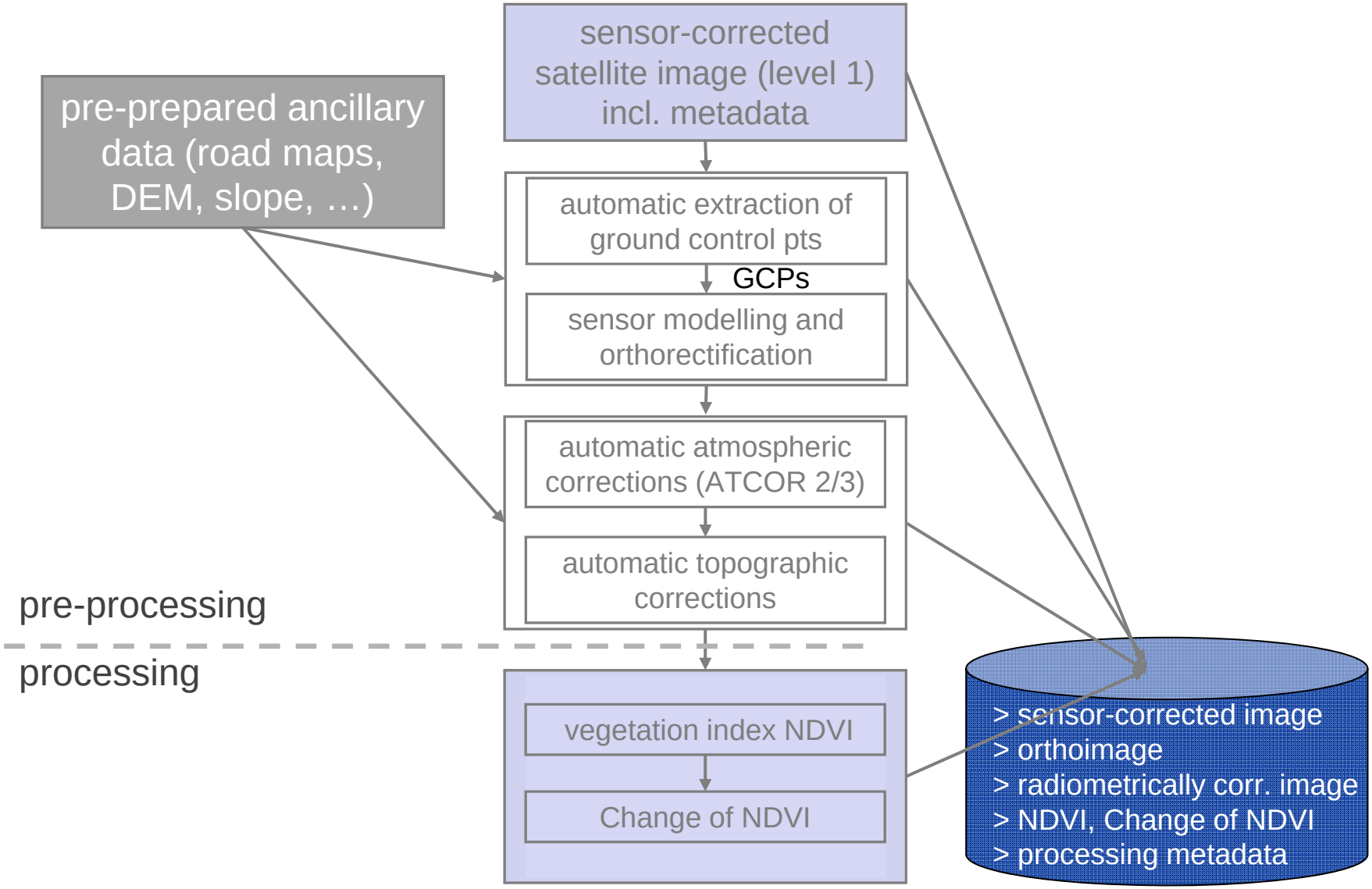
Prototype Space-SI processing chain: Processing workflow



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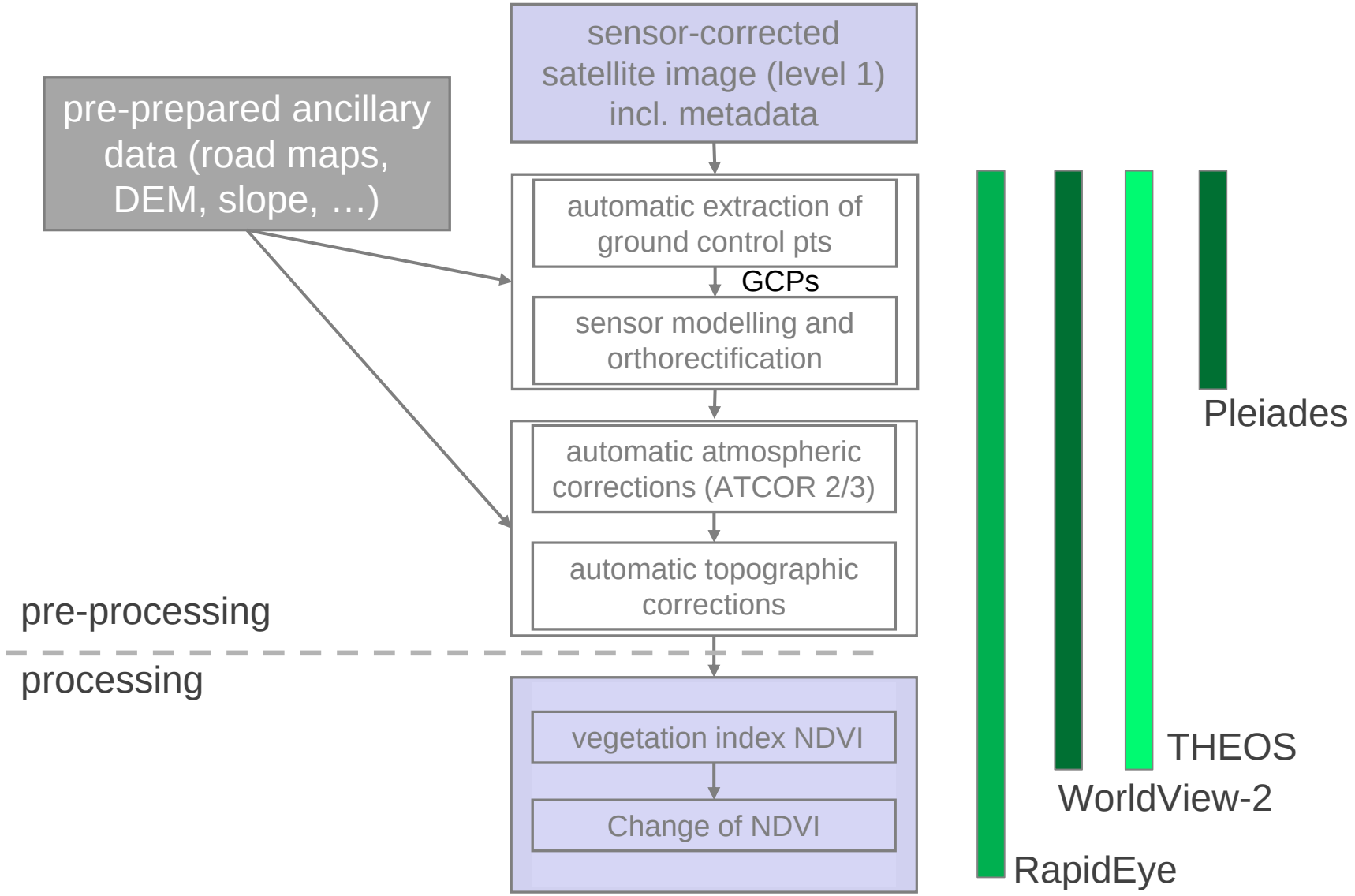
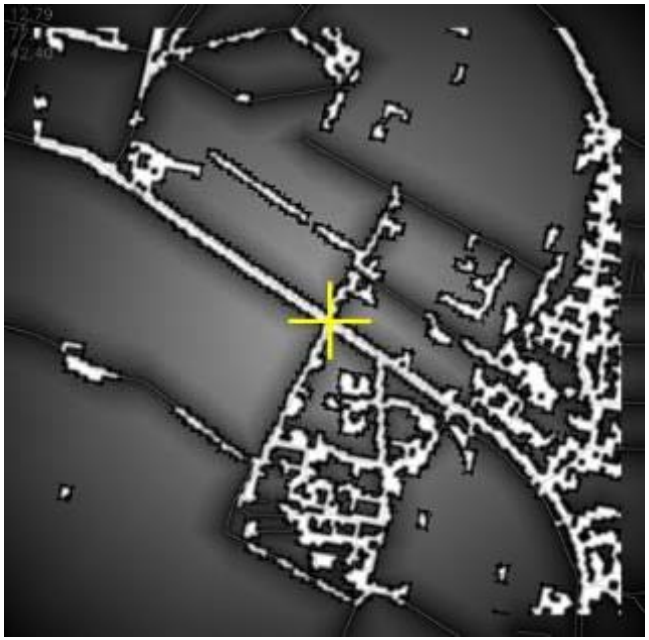
Prototype Space-SI processing chain: Sensors supported so far

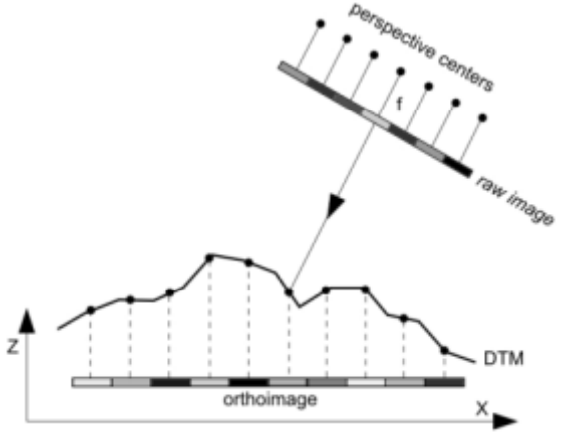


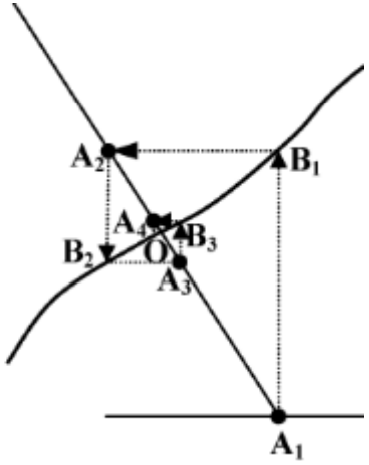
P1 Automatic geometric corrections: Automatic Extraction of GCPs

- automatic extraction of GCPs on multi-temporal/ multi-sensor images is extremely difficult due to temporal variability of objects
- we are performing image matching onto rasterized road maps



P1 Automatic geometric corrections: Sensor model and orthorectification





- rigorous sensor model was defined to accommodate various (full-frame and pushbroom) optical sensors
- 24 parameters for exterior orientation (2 segments of orbit)
- satellite metadata for initial approximation
- methods for elimination of inaccurate GCPs (Robust estimation, RANSAC)
- orthorectification with single-ray backprojection method on DEM 12.5 m

P1 Automatic geometric corrections: Computed accuracy

RapidEye image	All points			RANSAC + Robust Est.		
	Num points	GCP RMSE	CHK RMSE	Num points	GCP RMSE	CHK RMSE
11.3.2011	212	0.90	0.72	193	0.79	0.70
11.6.2011	228	0.75	0.92	209	0.67	0.97
7.7.2011	303	0.84	0.93	204	0.75	0.92
2.9.2011	126	0.99	0.95	114	0.75	0.66

P1 Automatic geometric corrections: Visual accuracy

RapidEye image, 6.5 m

aerial orthophoto, resampled to 2 m

P2.2 Automatic topographic corrections

The total irradiance was modeled as a three-component irradiance:

- direct (dependent on incidence angle, sun zenith angle, and slope),
- diffuse from the sky (dependent mainly on sky-view factor),
- diffuse reflected from the terrain (dependent on sky-view factor and albedo).

Solved with an extension of Image Processing Workbench (IPW) method with Minnaert method.

P2.2 Automatic topographic corrections

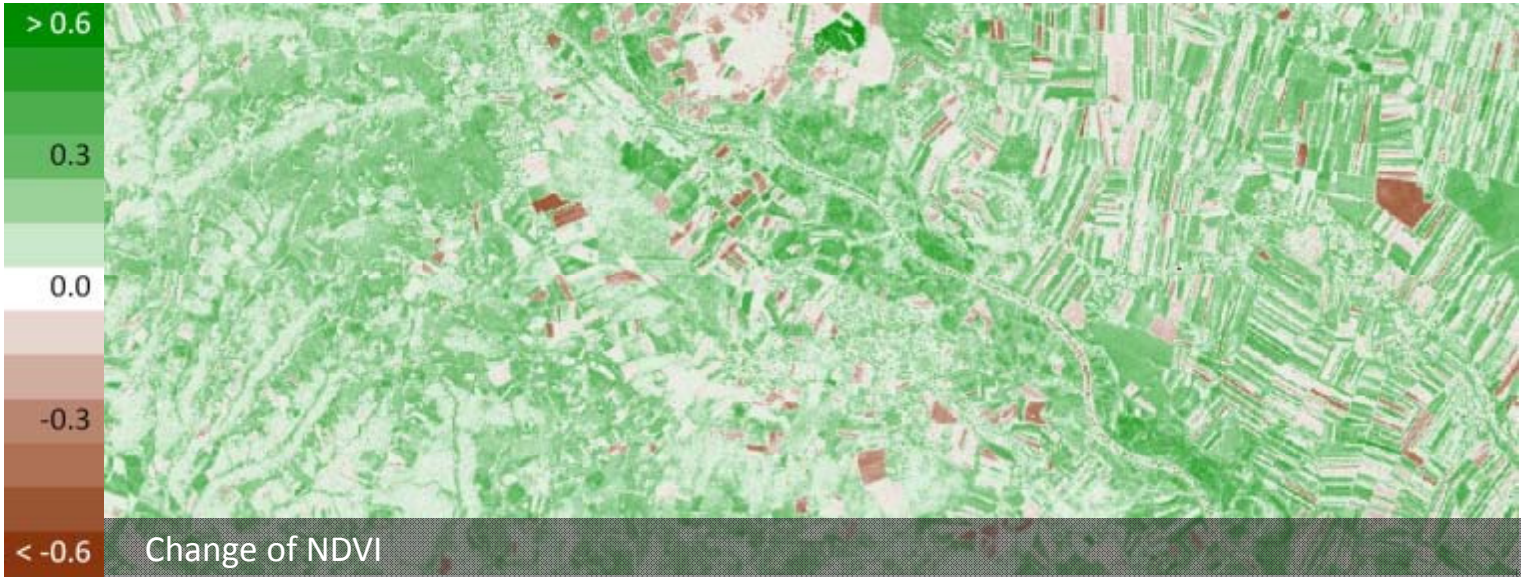
False color composite of non-corrected and topographically corrected image

R2.1 Automatic generation of vegetation index NDVI

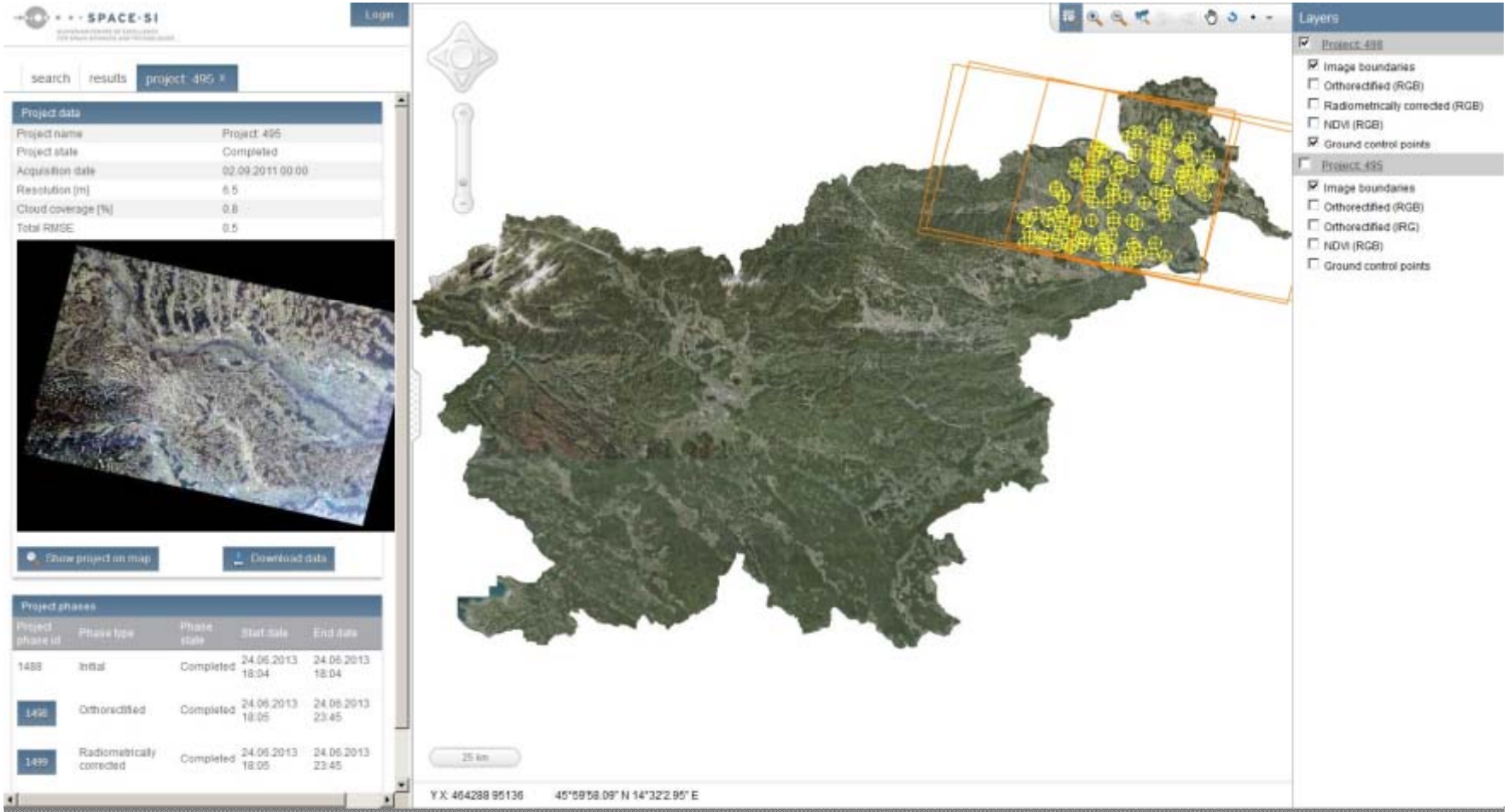
- simple product
- theoretical values [-1.0, 1.0]
- RGB-rendering with fixed color table to enable comparability

R2.2 Automatic generation of Change of NDVI

- difference between two NDVI products
- theoretical values [-2.0, 2.0]
- RGB-rendering with fixed color table to enable comparability



End-user viewer



Java-based end-user viewer

Web based control application

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PROJECT ID	PROJECT NAME	PROJECT STATE	SENSOR TYPE	ACQUISITION DATE	LAST PHASE NAME	LAST PHASE STATE	LAST PHASE START DATE	LAST PHASE END DATE
400	Project: 400	Completed	RapidEye	11.3.2011	NDVI - vegetation	Completed	29.3.2013	29.3.2013
399	Project: 399	Completed	RapidEye	11.3.2011	NDVI - vegetation	Completed	29.3.2013	29.3.2013
379	Project: 379	Completed	RapidEye	14.3.2013	NDVI - vegetation	Completed	14.3.2013	14.3.2013
377	Project: 377	Completed	RapidEye	14.3.2013	NDVI - vegetation	Completed	14.3.2013	14.3.2013
376	Project: 376	Completed	RapidEye	14.3.2013	NDVI - vegetation	Completed	14.3.2013	14.3.2013
375	Project: 375	Completed	RapidEye	14.3.2013	NDVI - vegetation	Completed	14.3.2013	14.3.2013
372	Project: 372 - Radlje ob Daravi 1	Completed	RapidEye	14.3.2013	NDVI - vegetation	Completed	14.3.2013	14.3.2013
371	Project: 371	Completed	RapidEye	13.3.2013	NDVI - vegetation	Completed	13.3.2013	14.3.2013
341	Project: 341 - Radgona	Completed	RapidEye	16.1.2013	NDVI - vegetation	Completed	16.1.2013	13.3.2013
323	Project: 323	Completed	RapidEye	15.1.2013	NDVI - vegetation	Completed	15.1.2013	16.1.2013
281	Project: 281	Completed	RapidEye	4.6.2012				
263	Project: 263	Completed	RapidEye	4.6.2012	NDVI - vegetation	Completed	4.6.2012	4.6.2012
262	Project: 262 - Dragotinci	Completed	RapidEye	4.6.2012	NDVI - vegetation	Completed	4.6.2012	4.6.2012
243	Project: 243	Completed	RapidEye	25.5.2012	NDVI - vegetation	Completed	25.5.2012	25.5.2012
242	Project: 242 - Radgona 1	Completed	RapidEye	19.3.2013	NDVI - vegetation	Completed	25.5.2012	25.5.2012
241	Project: 241 - Krsko 1	Completed	RapidEye	25.5.2012	NDVI - vegetation	Completed	25.5.2012	25.5.2012
229	Project: 229 - Krško	Completed	RapidEye	24.5.2012	NDVI - vegetation	Completed	24.5.2012	25.5.2012
228	Project: 228	Completed	RapidEye	24.5.2012	NDVI - vegetation	Completed	24.5.2012	25.5.2012
227	Project: 227	Completed	RapidEye	24.5.2012	NDVI - vegetation	Completed	24.5.2012	25.5.2012
226	Project: 226 - Radlje ob Dravi	Completed	RapidEye	24.5.2012	NDVI - vegetation	Completed	24.5.2012	25.5.2012
225	Project: 225	Completed	RapidEye	24.5.2012	NDVI - vegetation	Completed	24.5.2012	25.5.2012
224	Project: 224	Completed	RapidEye	24.5.2012	NDVI - vegetation	Completed	24.5.2012	25.5.2012
223	Project: 223	Completed	RapidEye	24.5.2012	NDVI - vegetation	Completed	24.5.2012	24.5.2012
222	Project: 222 - Murska Sobota	Completed	RapidEye	24.5.2012	NDVI - vegetation	Completed	24.5.2012	24.5.2012
221	Project: 221	Completed	RapidEye	24.5.2012	NDVI - vegetation	Completed	24.5.2012	24.5.2012

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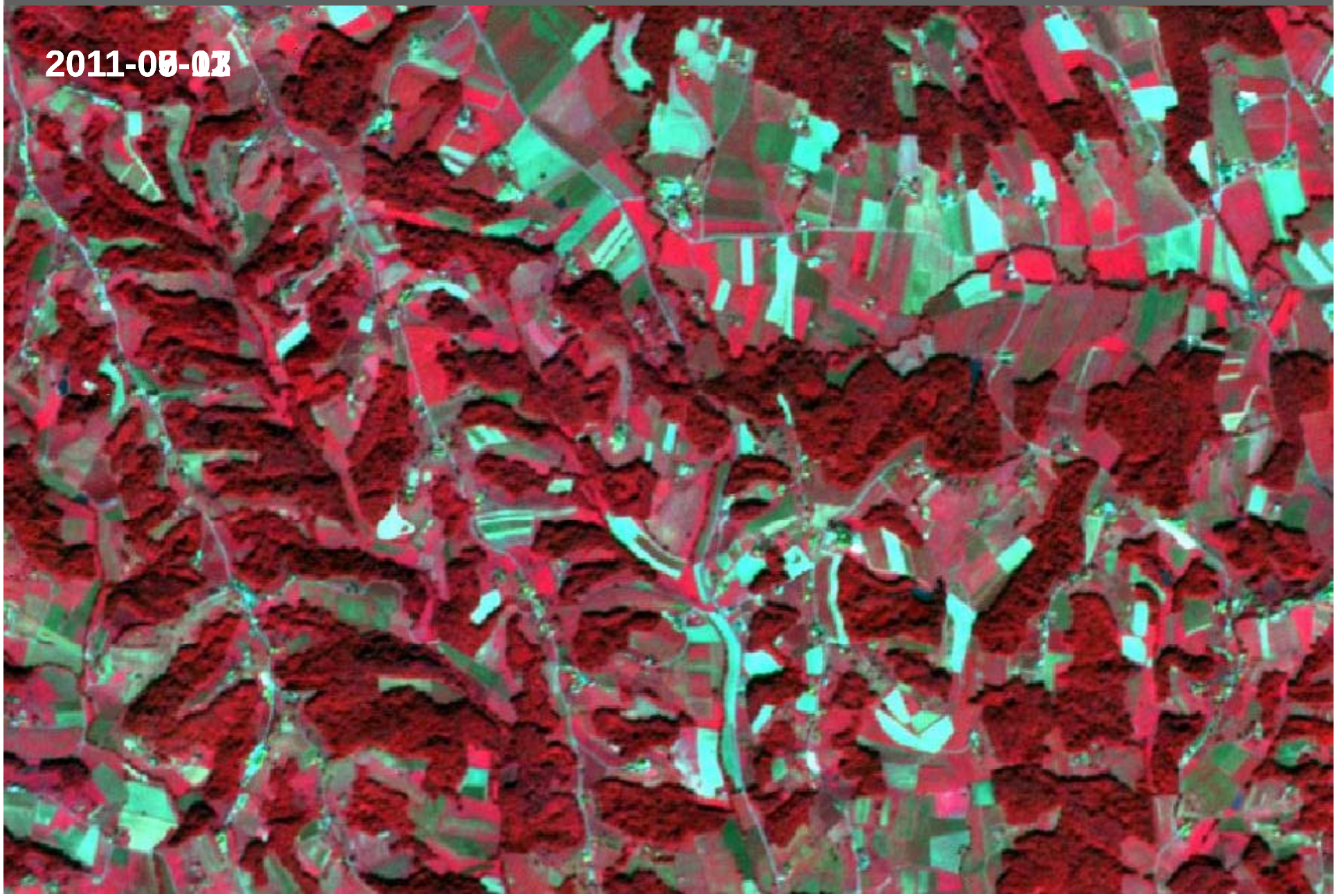
Future development

Towards the full processing chain (end of 2013):

- accuracy validation, optimisation of the implemented prototype modules
- implementation of all planned modules
- support to various full-frame and pushbroom sensors – **provide us with data for your system**

Upgrades after 2013:

- specific products (insurance, agriculture applications),
- support to different regions and coordinate systems,
- pan-sharpening, image stacking (super resolution), moving to the cloud …


2011-06-07

Summary

- Fully automatic processing chain is a dream for every remote sensing professional
- Implemented prototype is functional
- More effort is put towards the pre-processing steps than to the processing/interpretation steps
- Finetuning and upgrades

"A journey of a thousand miles begins with a single step." – *Confucius*

Contacts

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Acknoledgements

SPACE-SI is an operation partly financed by the European Union, European Regional Development Fund, and Republic of Slovenia, Ministry of Education, Science, Culture and Sport.

Special thanks goes to UNISEC who has kindly provided support for travel and accommodation.