→ SENTINEL-2 FOR SCIENCE WORKSHOP

The Land Cover project of the ESA Climate Change Initiative - **Towards a Decametric Land Cover Map over Africa based on Sentinel-2 time series**

Defourny P., Brockmann C., Achard F., Boettcher M., Bontemps S., Gamba P., Hagemann S., Hartley A. , Khlystova I., Kirches G., Lamarche C., Lisini G., MacBean N. , Mayaux P., Pathe C., Peylin P., Poulter B., Radoux J., Riedel T., Santoro M., Schmullius C., Van Bogaert E., Verhegghen, A., Wegmüller U., Zuehlke M., Ramoino F.., Seifert F-M., Arino O.

GAMMA REMOTE SENSING

UCL Université catholique de Louvain – UCL-Geomatics, Belgium

Brockmann Consult

Wageningen University – Wageningen UR

Friedrich-Schiller-Universität Jena

European Commission

LSCE

Max-Planck-Institut für Meteorologie

Met Office

Centre de Recherche Public Gabriel Lippmann

20–22 May 2014 | ESA–ESRIN | Frascati (Rome) Italy

European Space Agency

Currently 5 Terrestrial ECVs in the CCI esa

land cover

ice sheets

soil moisture

fire

glaciers

Pierre Defourny, Emilio Chuvieco, René Forsberg, Frank Paul, Wolfgang Wagner

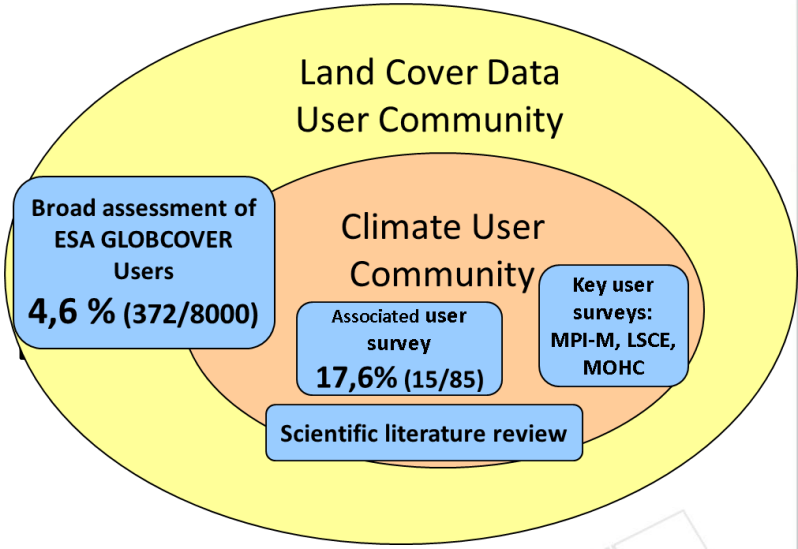
Science Leaders

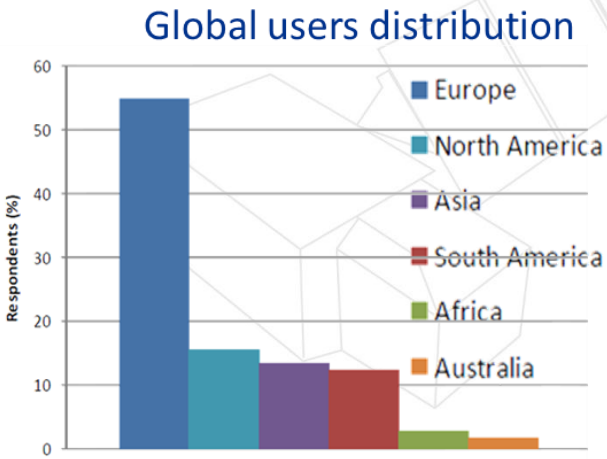
CCI-LC users' consultation

- 4 levels of users surveys
- Key findings:

– Priority for both stable and consistent products over time

– Need for more dynamic information reflecting LC change and vegetation phenology





WAGENINGEN UNIVERSITY
WAGENINGEN UR

Users Consultation with climate focus

	Threshold requirement	Target requirement
Temporal sampling	**Best/stable map and regular updates**	Monthly data on vegetation dynamics and change
Temporal extent	1-2 years, most recent	1990 (or earlier)-present
Horizontal resolution	1000 m	**30 m**
Precision	Thematic land cover detail to meet modelling needs	Thematic land cover detail to meet future model needs
Accuracy	Higher accuracy than existing datasets	Errors of 5-10% per class or as overall accuracy
Stability	**Higher stability than existing datasets**	Errors of 5-10% per class or as overall accuracy
Error Characteristics	Independent one-time accuracy assessment	Operational and independent multi-date validation

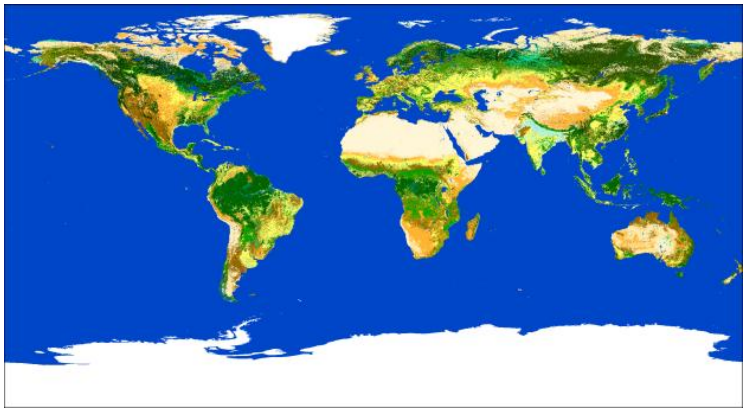
- **HR LC map relevant for Impact Assessment Model and mitigation strategy**

Revisited land cover concept

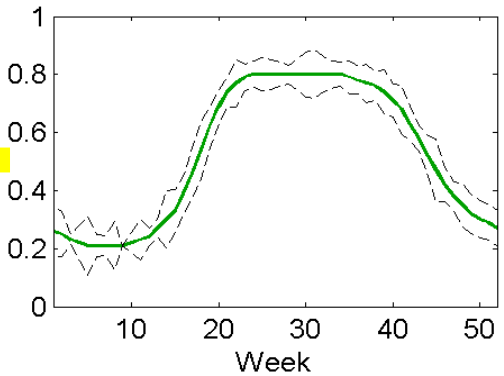
Land cover can not be the (observed) physical and biological cover on the terrestrial surface (LCCS 2005; GTOS ECV 2009) …

and remains stable and consistent over time (as requested by climate modelers)

Mapping land cover **state** and **3** land cover **conditions**

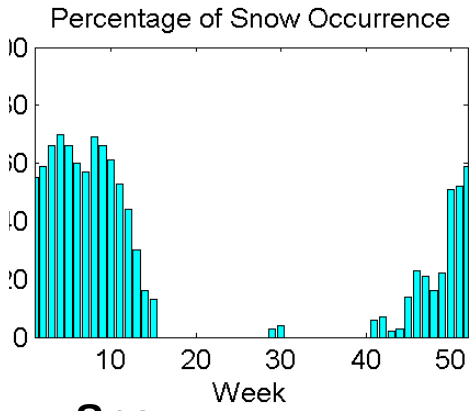


+



- **NDVI**

Average
Inter-annual variability

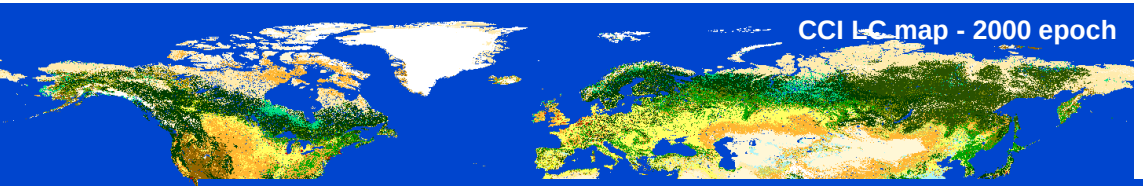


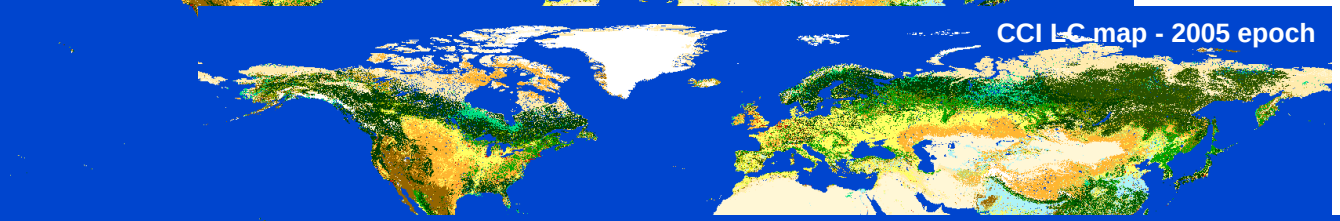
- **Snow**
- **Burnt Areas**

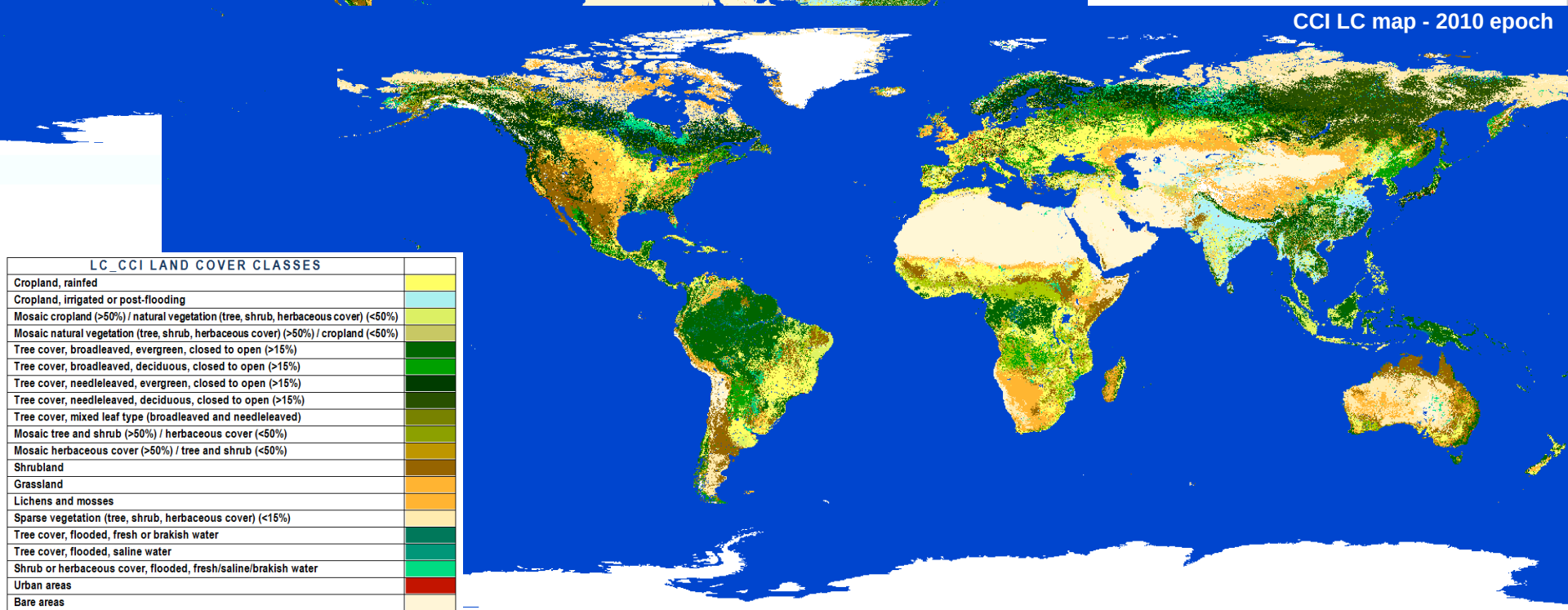
Occurrence Probability

+ **LC consistency over time and across conditions**

Consistent land cover state products





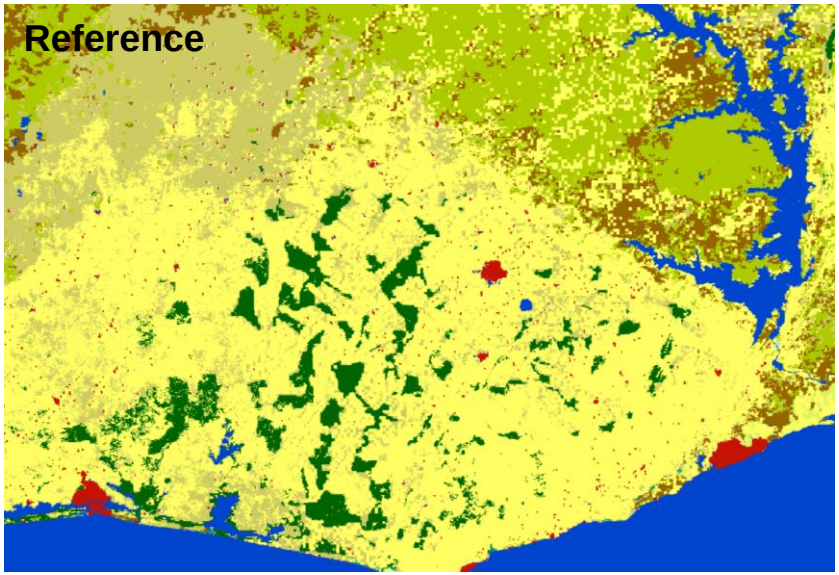


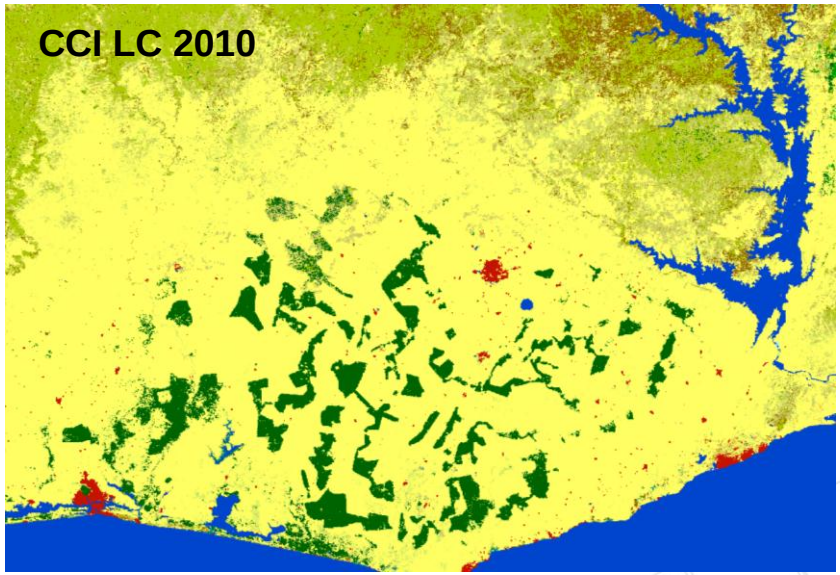
LC_CCI LAND COVER CLASSES	
Cropland, rainfed	
Cropland, irrigated or post-flooding	
Mosaic cropland (>50%) / natural vegetation (tree, shrub, herbaceous cover) (<50%)	
Mosaic natural vegetation (tree, shrub, herbaceous cover) (>50%) / cropland (<50%)	
Tree cover, broadleaved, evergreen, closed to open (>15%)	
Tree cover, broadleaved, deciduous, closed to open (>15%)	
Tree cover, needleleaved, evergreen, closed to open (>15%)	
Tree cover, needleleaved, deciduous, closed to open (>15%)	
Tree cover, mixed leaf type (broadleaved and needleleaved)	
Mosaic tree and shrub (>50%) / herbaceous cover (<50%)	
Mosaic herbaceous cover (>50%) / tree and shrub (<50%)	
Shrubland	
Grassland	
Lichens and mosses	
Sparse vegetation (tree, shrub, herbaceous cover) (<15%)	
Tree cover, flooded, fresh or brakish water	
Tree cover, flooded, saline water	
Shrub or herbaceous cover, flooded, fresh/saline/brakish water	
Urban areas	
Bare areas	
Water bodies	
Permanent snow and ice	

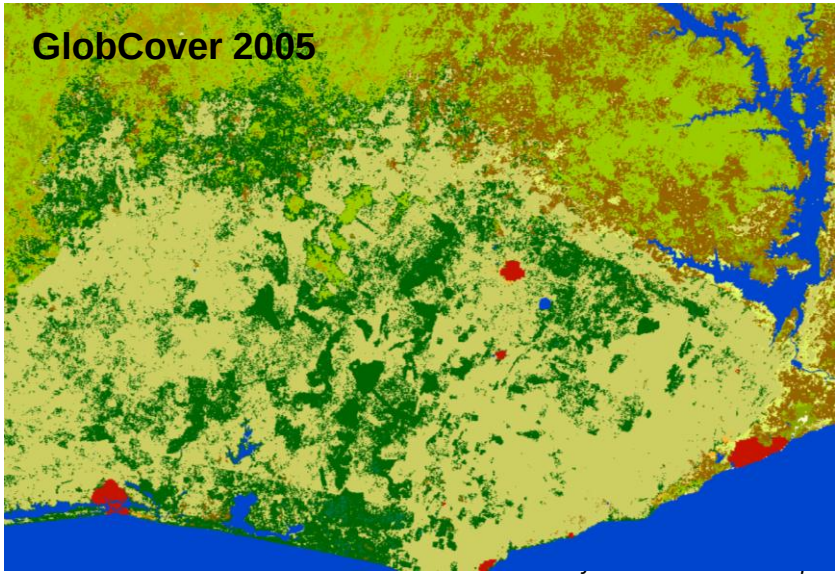
LC_CCI Products accessible on line

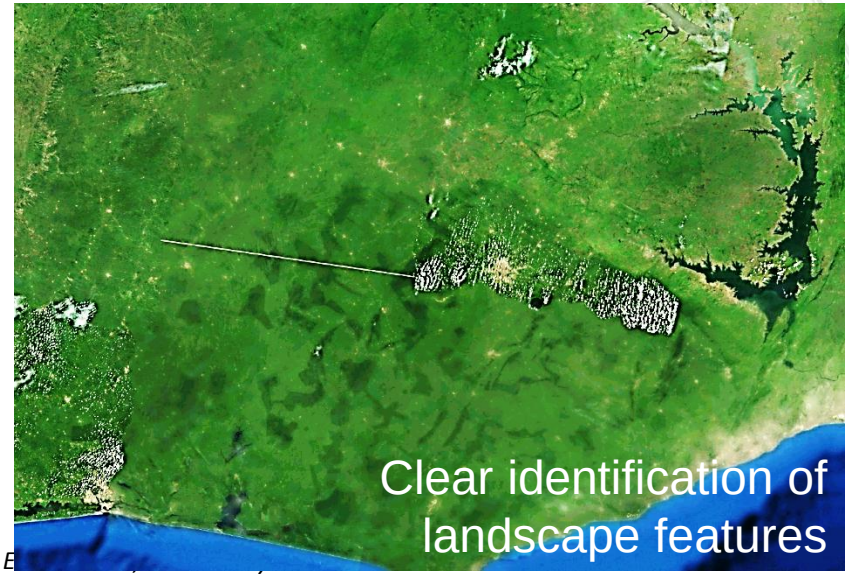
+ quality flags and metadata

2010 Epoch – West Africa

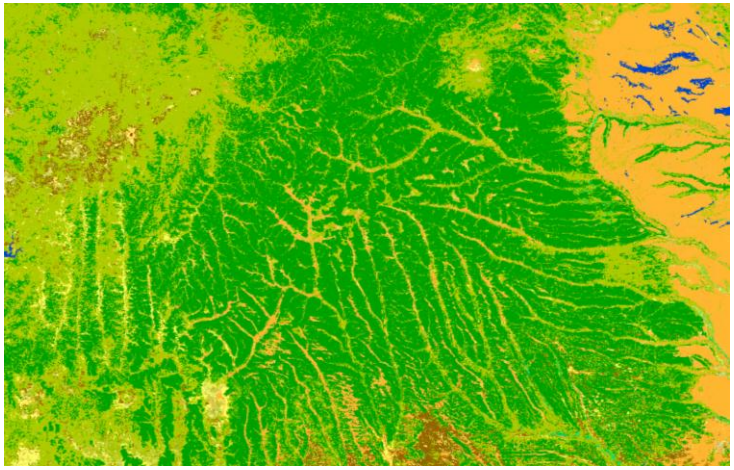


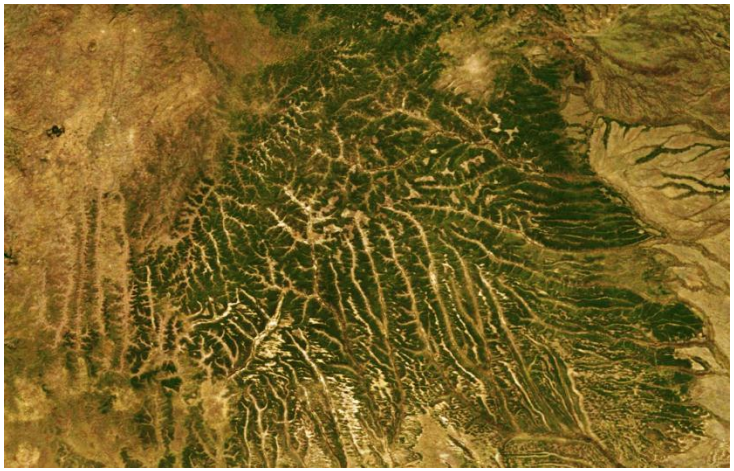


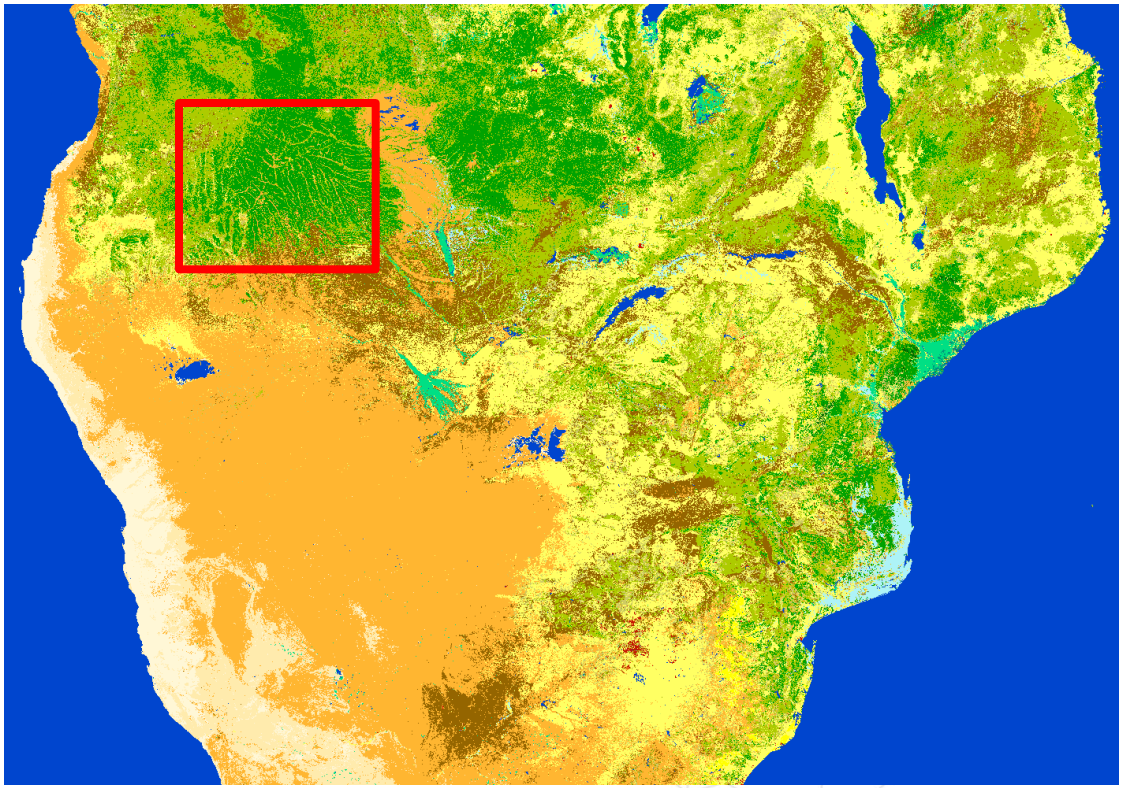




2010 Epoch – South Africa



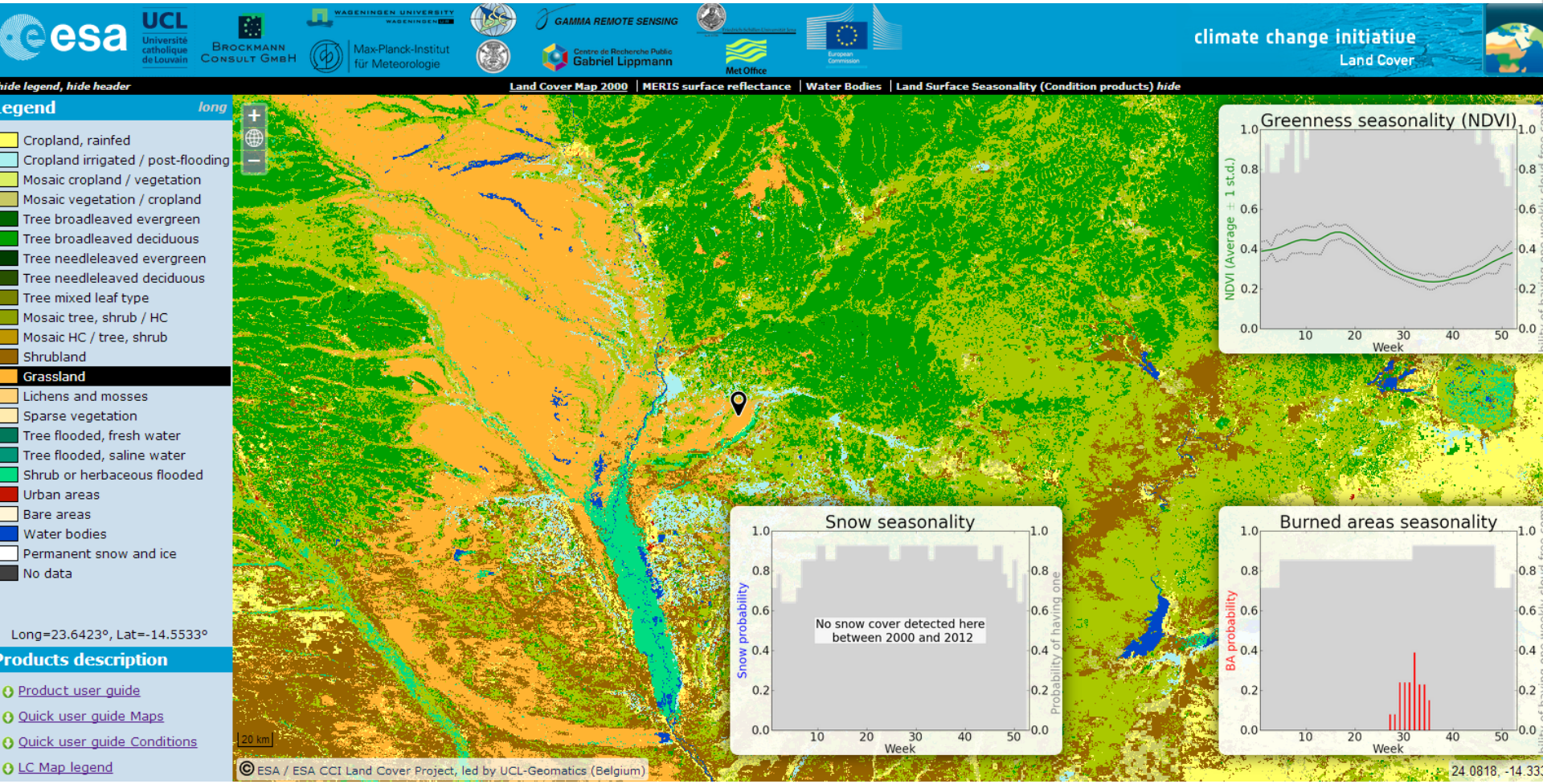




CCI LC 2010

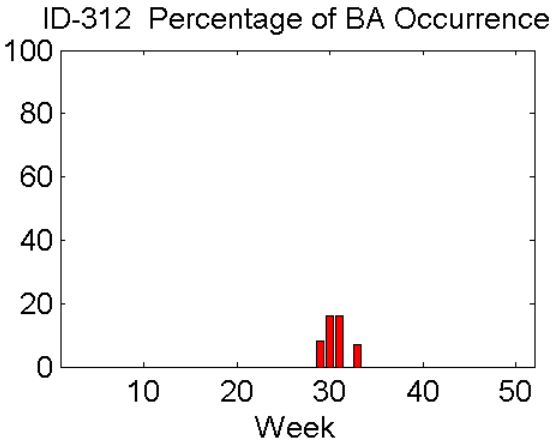
LC_CCI maps accessible on-line with 3 associated consistent conditions

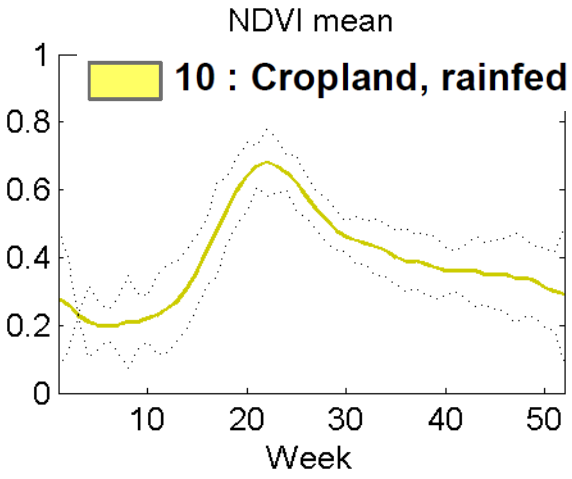
http://maps.elie.ucl.ac.be/CCI/viewer/index.html

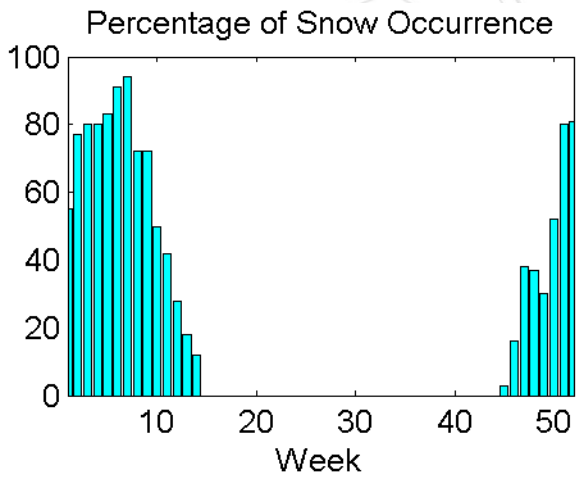


Consistency between the dynamic component

7-day resolution for ‘climatological’ data set (from 12 years of data)



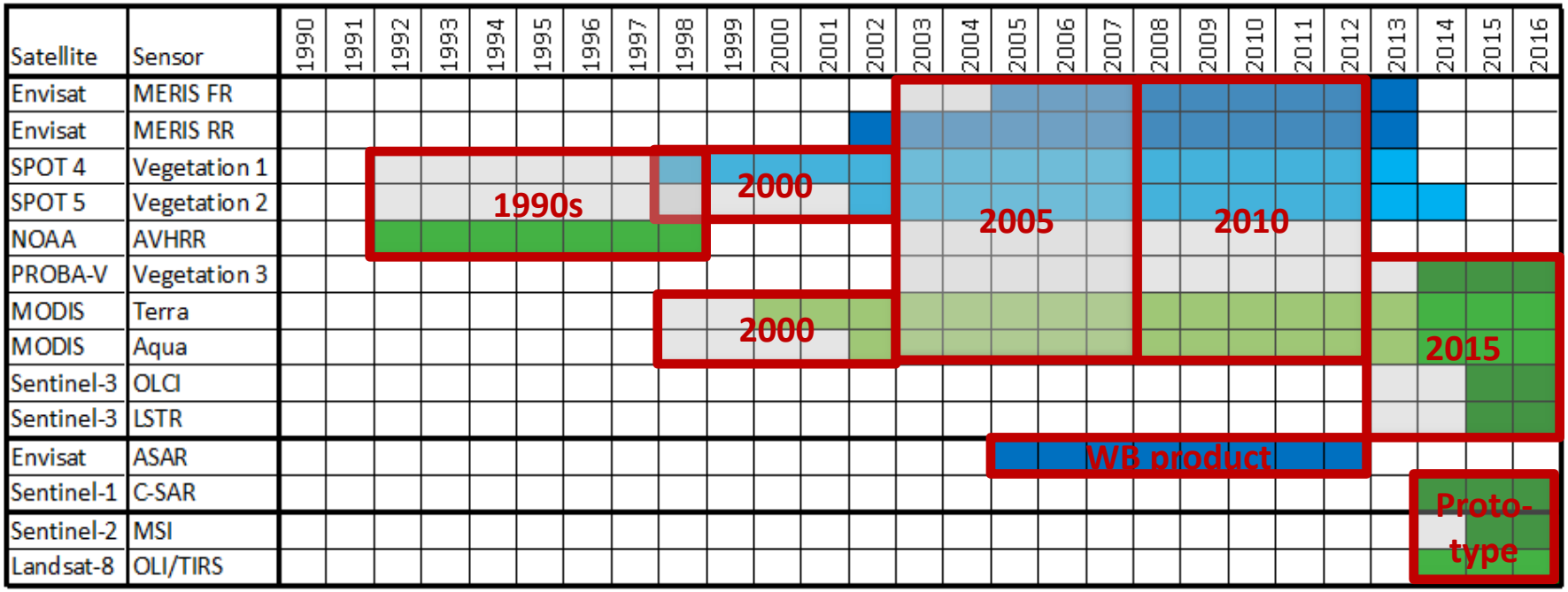




LC_CCI Phase II EO data input

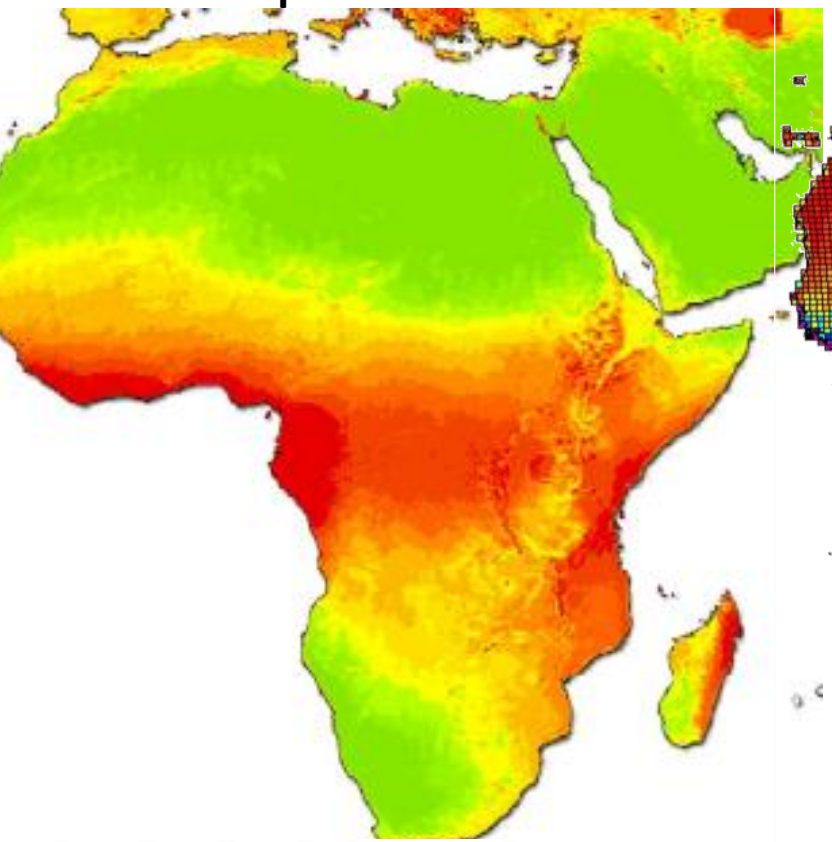
7 different instruments including Sentinel-1, 2 and 3

SR time series + LC maps

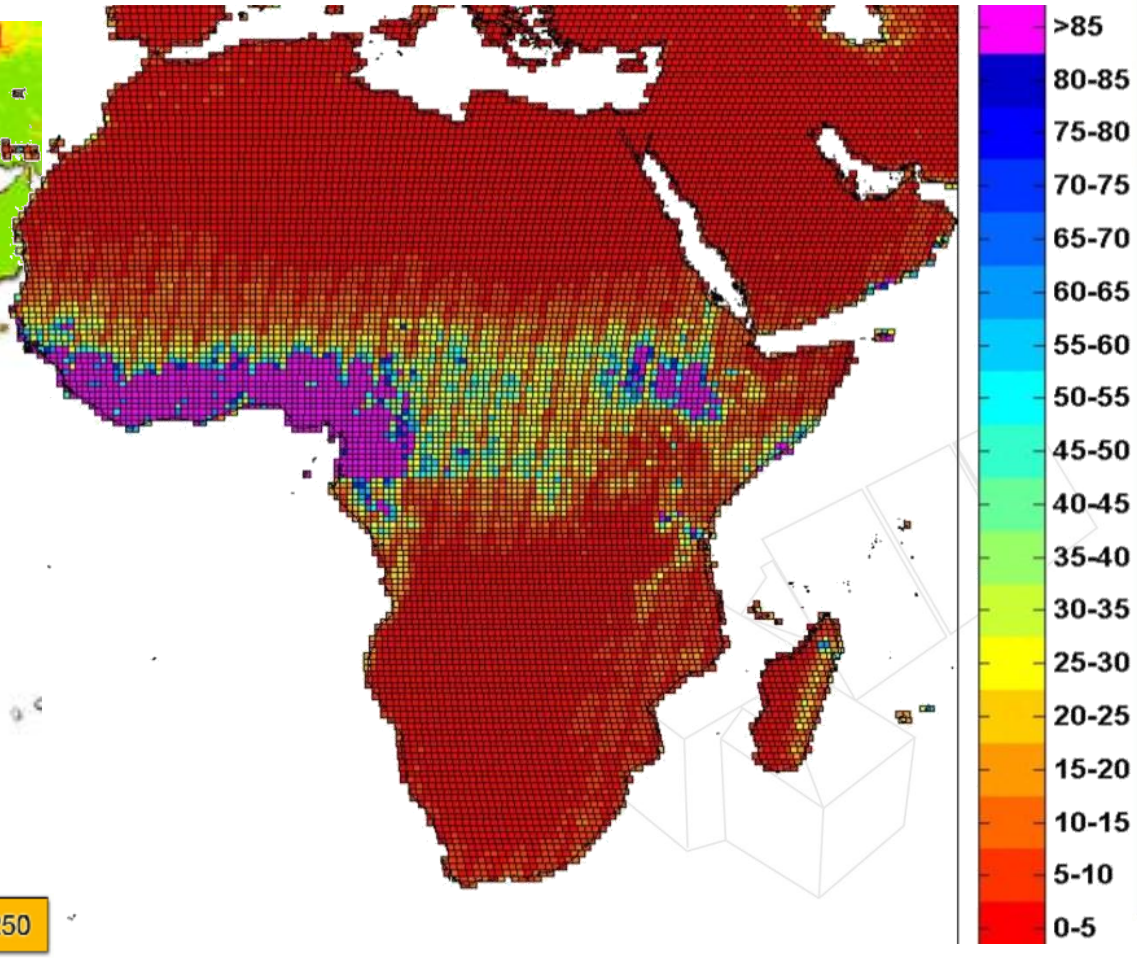


Sentinel-2 data time series acquisition much constrained by cloud coverage

Cloud free obs. with 2 overpass /day MODIS on Aqua and Terra

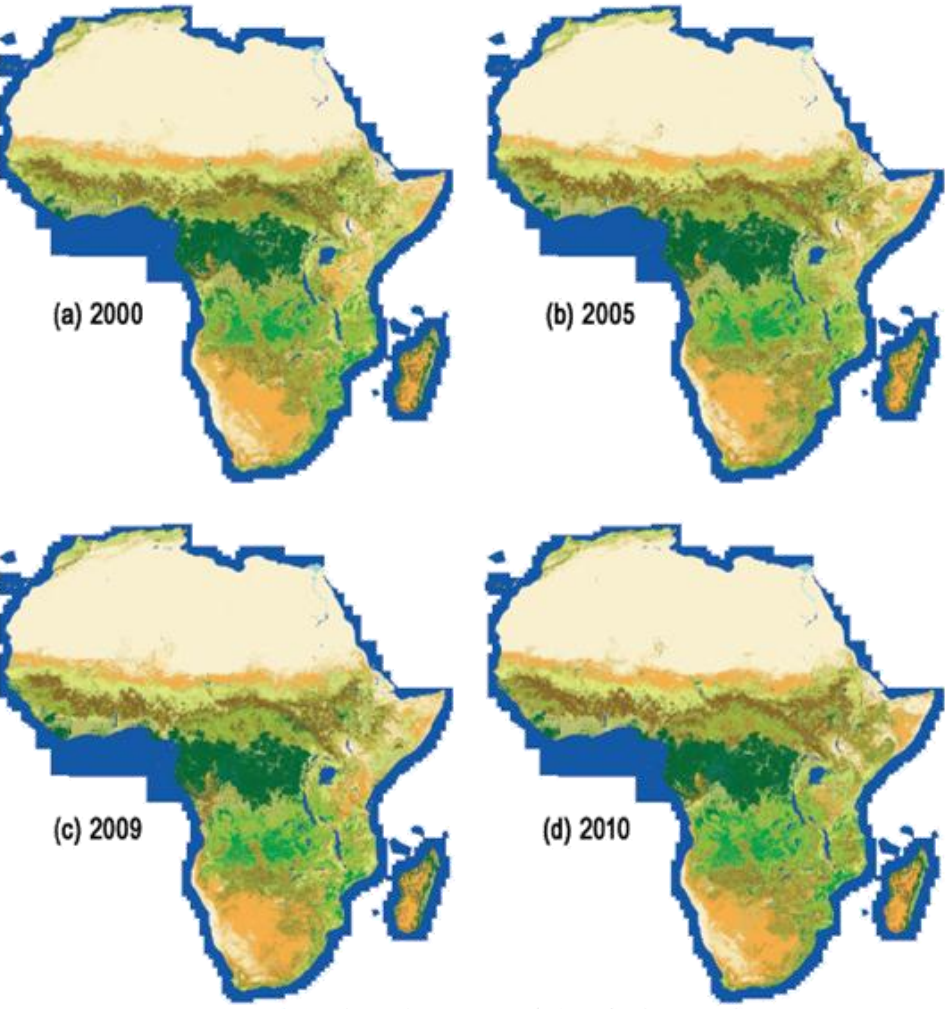


Sentinel 2 - annual coverage with 2 sat.

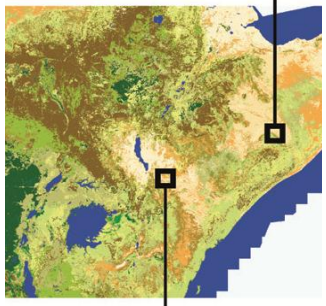


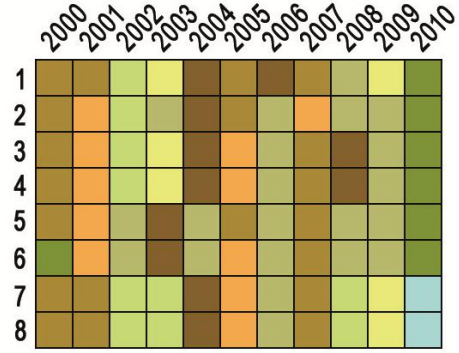
(Pekel et al. , RSE 2014)

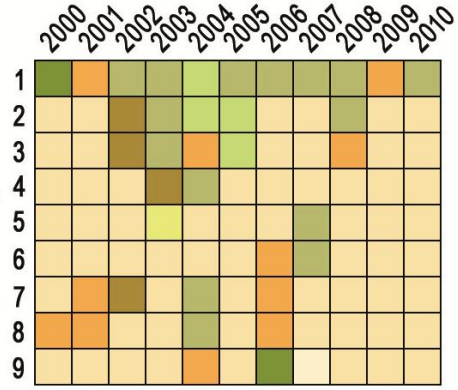
Annual or limited time series : unconsistency risk between LC maps



GlobCover legend over Africa (color codes)





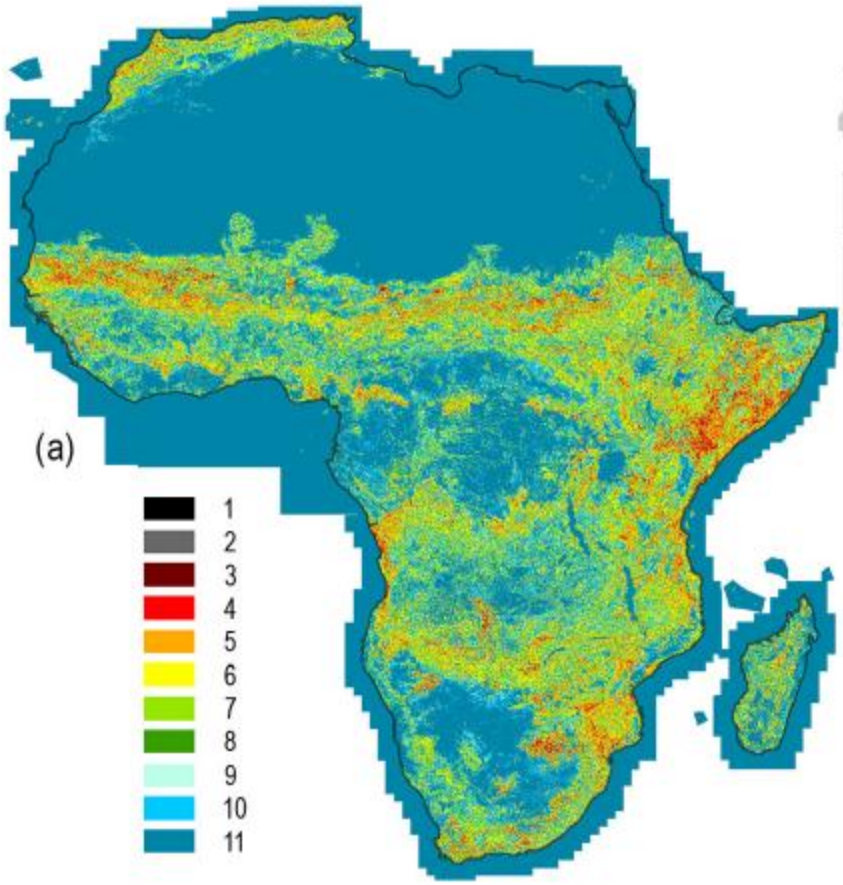


Irrigated crops
Rainfed crops
Mosaic crops / nat. vgt
Mosaic nat. vgt / crops
Closed broad. dec. forest
Mosaic forest-shrub / grassland
Mosaic grassland / forest-shrub
Shrubland
Grassland
Sparse vegetation
Bare areas

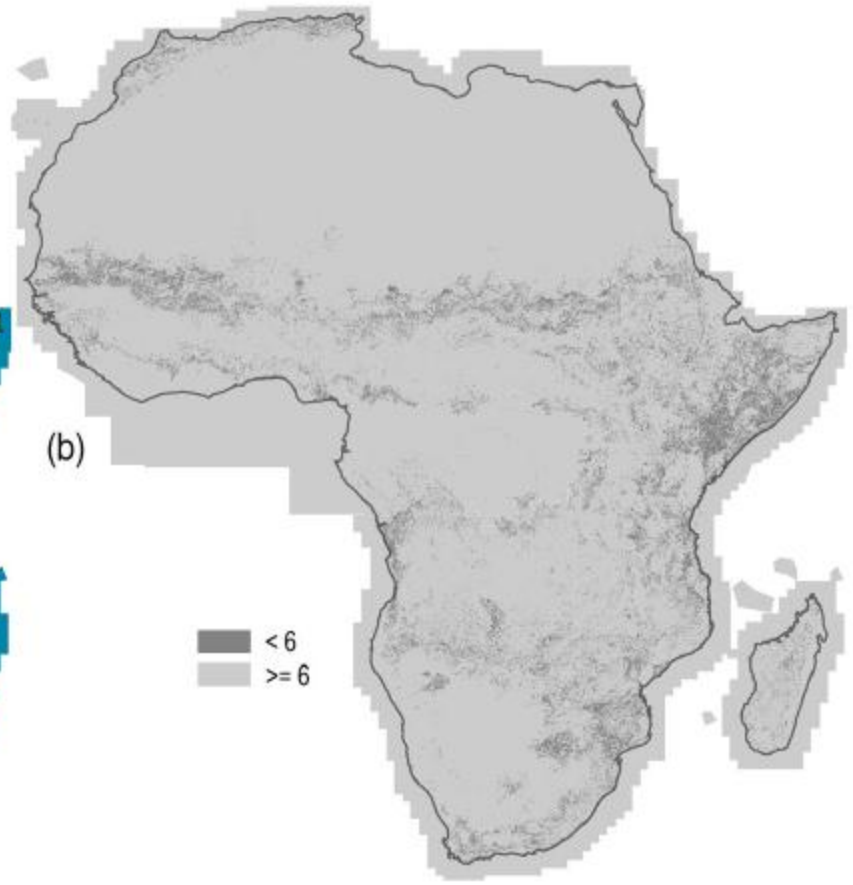
(Bontemps S. et al., BGS 2012)

Annual or limited time series : transition zone prone to LC unconsistency

Nbr of occurence of the same LC class from annual land cover maps

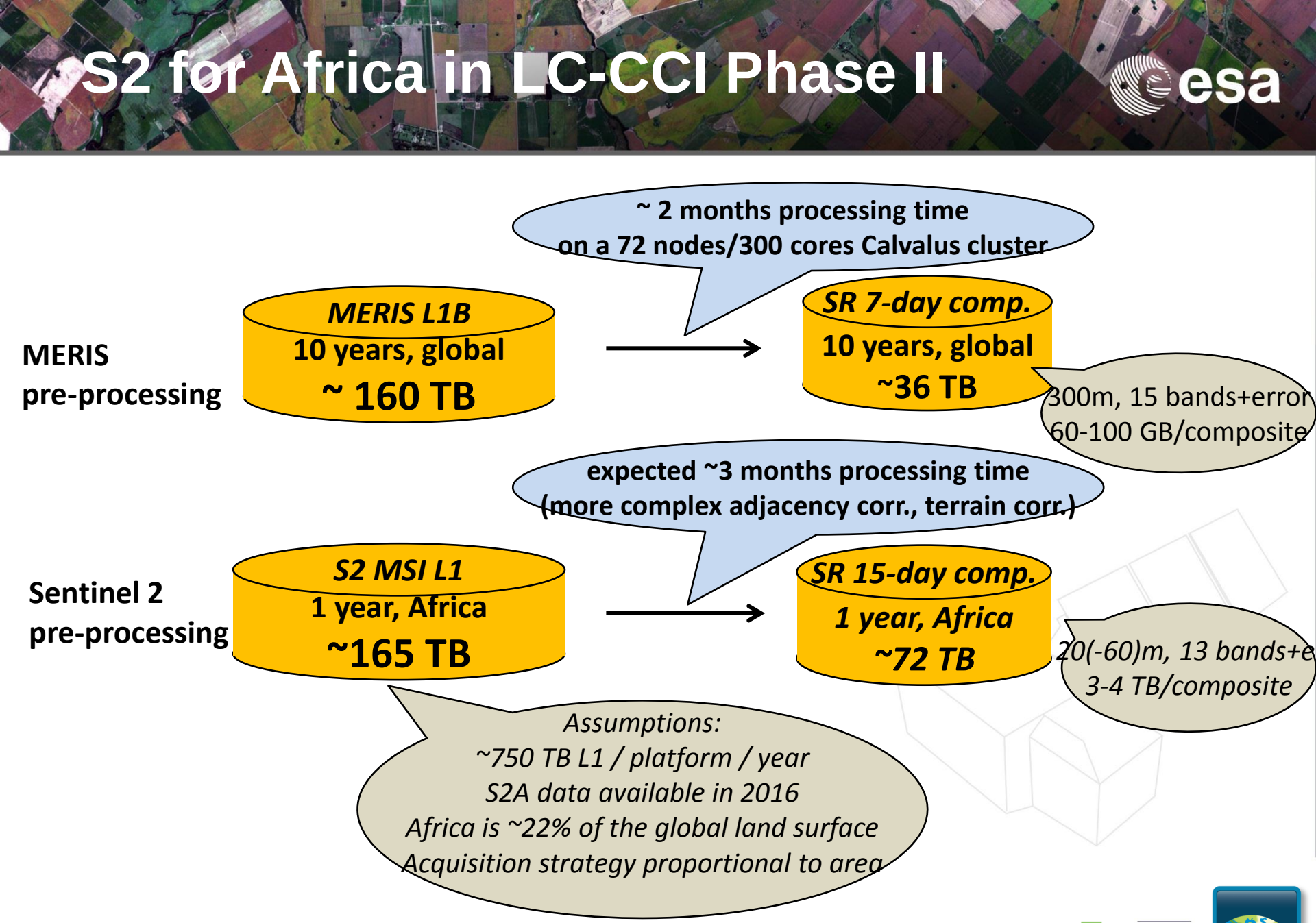


Stable versus less stable region for land cover mapping

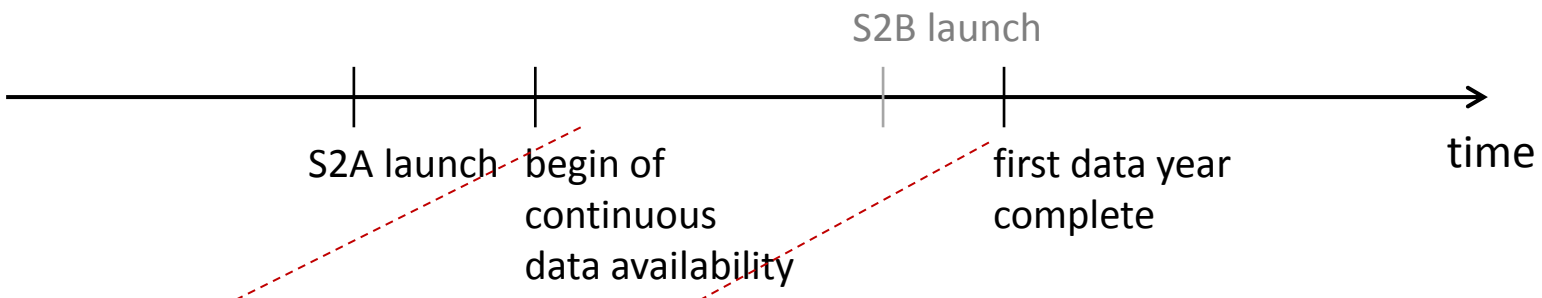


(Bontemps S. et al., BGS 2012)

S2 for Africa in LC-CCI Phase II



S2 for Africa in LC-CCI Phase II

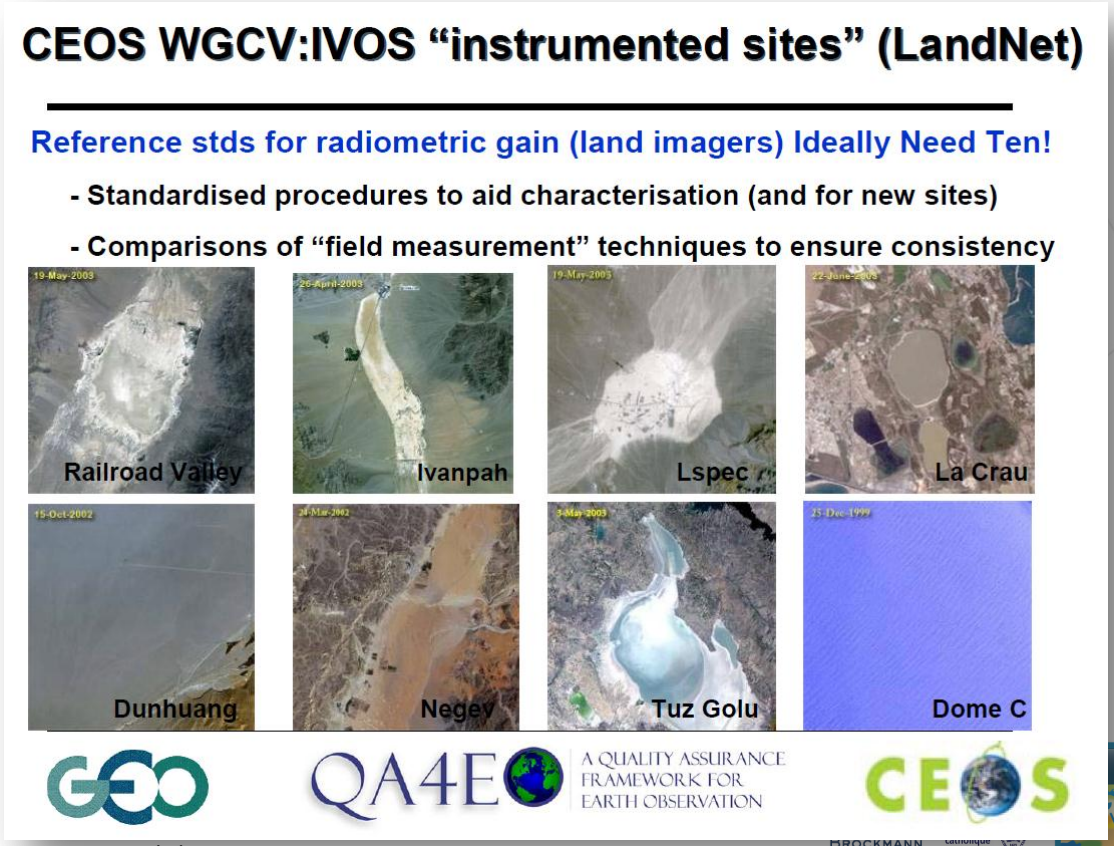


- Option 1: Continuous download along data availability
  - 165 TB/year = 500 GB/day = ~50 Mbit/s
  - allows for continuous processing
  - lower risk, higher effort and costs
- Option 2: Delivery on media of first data year
  - Ingestion of 165 TB into Calvalus cluster needs <4 days
  - allows for longer algorithm development period
  - higher risk, lower costs

Pre-processing for high resolution data

Sentinel-2 and Landsat-8 surface reflectance time series

- Assessment of geolocation **accuracy** between S-2 and Landsat-8
- Analyse **inter-calibration** between S-2 and Landsat-8 over CEOS LandNet sites



Slide from
Towards an "operational" network of instrumented test-sites: LANDNET (Radiometric Gain)
Nigel Fox, Mar 2013
CEOS IVOS 25 ESRIN

Pre-processing for high resolution data

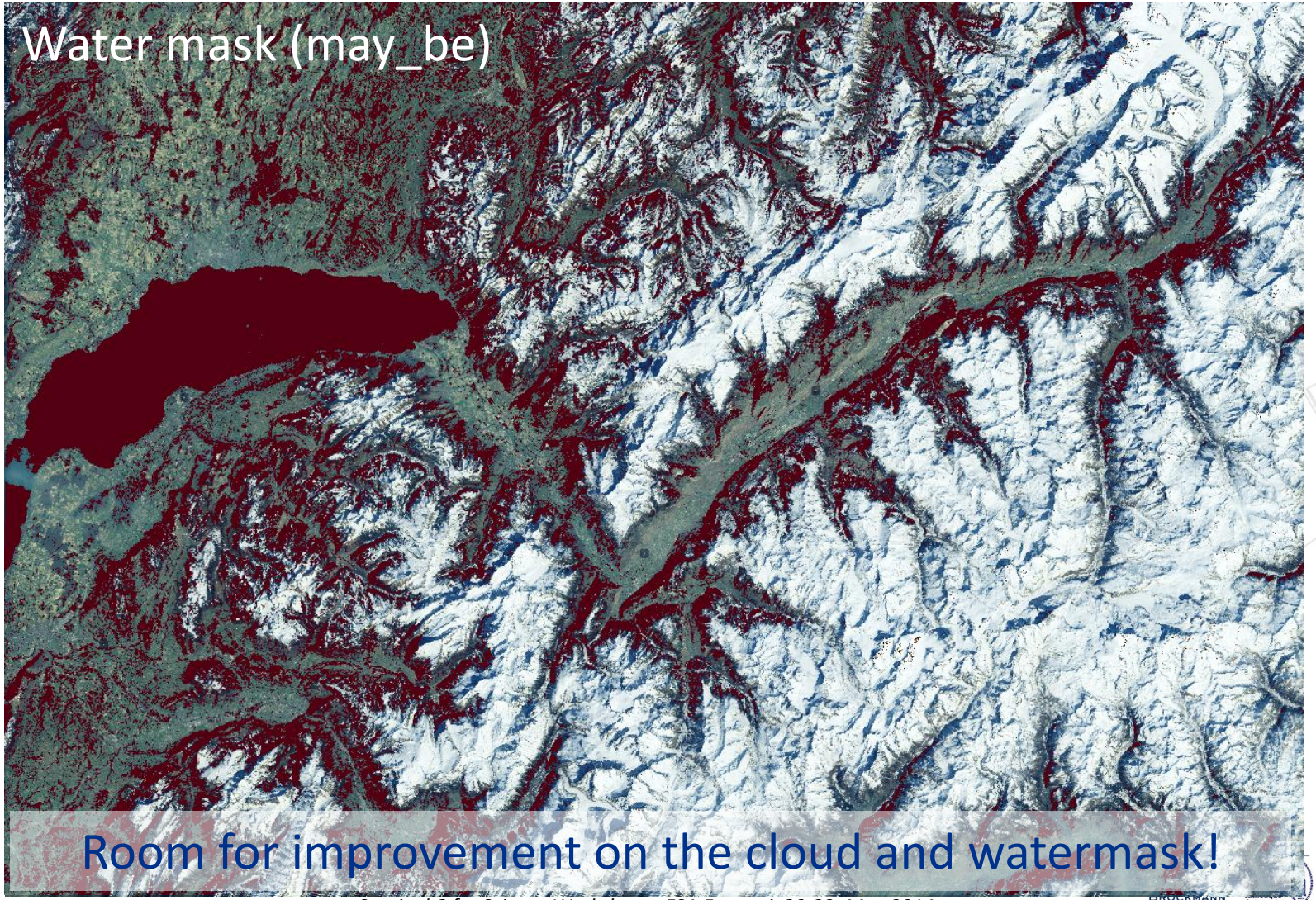
Sentinel-2 and Landsat-8 surface reflectance time series

- Assessment of geolocation accuracy between S-2 and Landsat-8
- Analyse inter-calibration between S-2 and Landsat-8 over CEOS LandNet sites

- Assessment and adaption of the pre-processing chain for S-2 and Landsat-8
  - Cloud detection,
  - Atmospheric correction including terrain and neighbourhood effects,
  - BRDF correction.
- Investigation of different merging strategies for Sentinel-2 and Landsat-8 for the synergistic use of the both sensor data

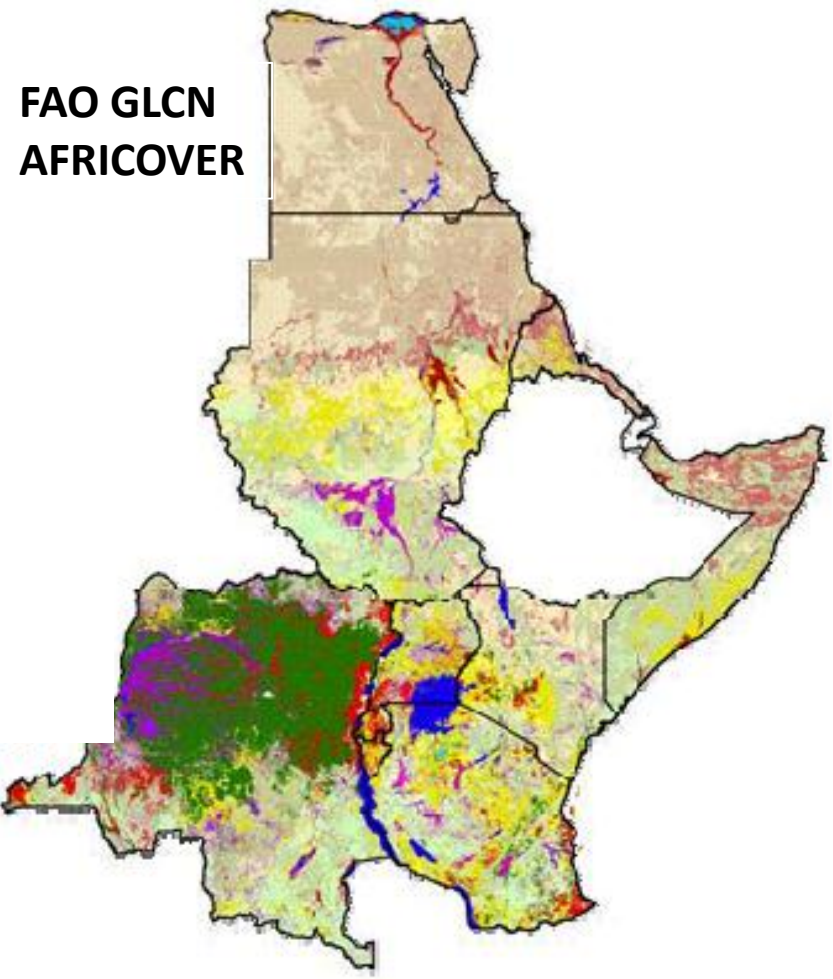
Preprocessing : pixel Identification to possibly improve the Landsat cloud screening

Landsat 8 - 20 March 2014 Lake Geneva (LC81950282014079LGN00)

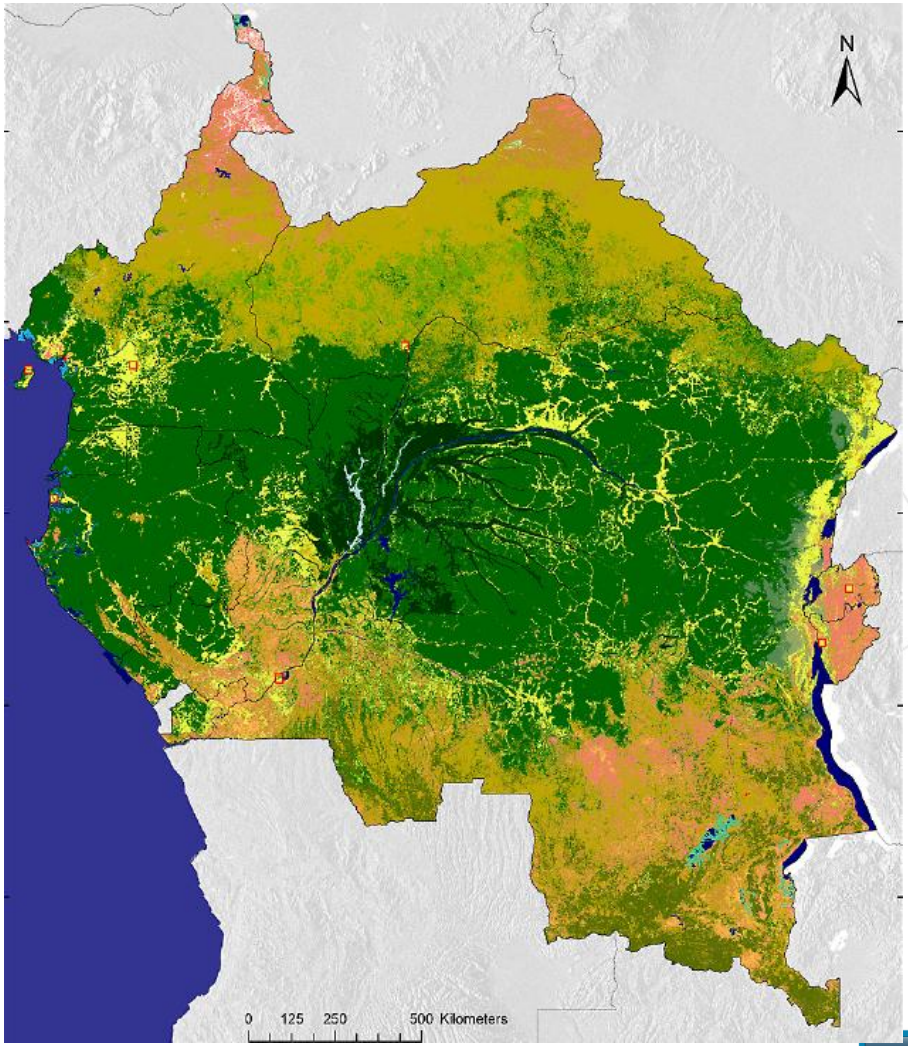


LC method building on existing data set

FAO GLCN AFRICOVER



Burundi, DR Congo, Egypt, Eritrea, Kenya, Rwanda, Somalia, Sudan, Tanzania and Uganda.



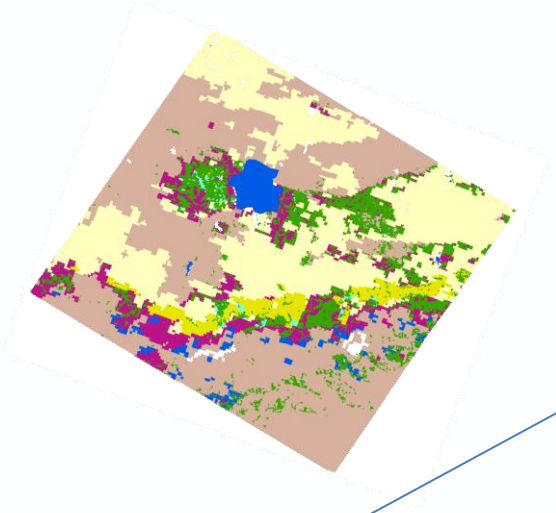
(Verhegghen et al., 2012)

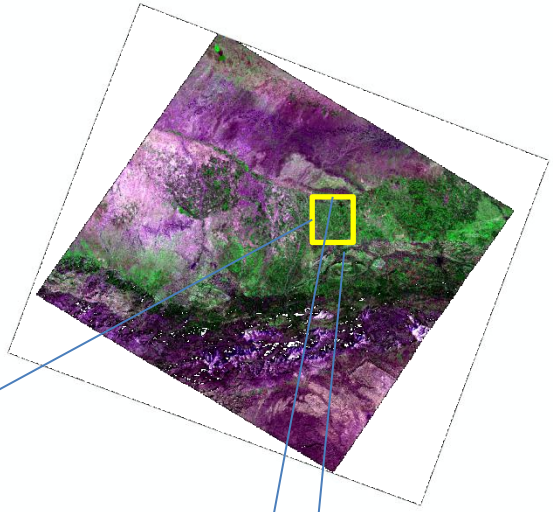
Example Globcov Morrocco

LC method using existing processing chain

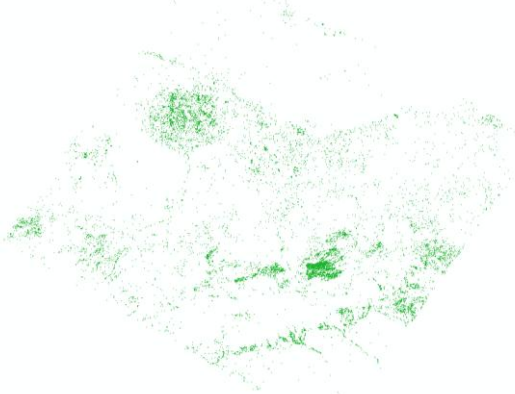
Reference

Spot4 31/01/2013

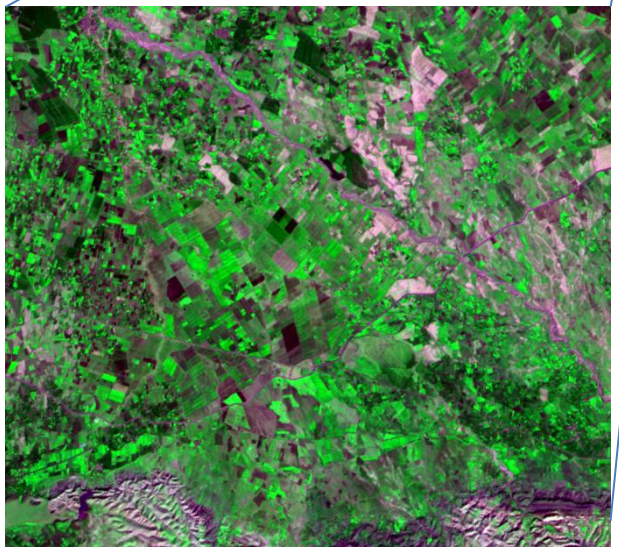


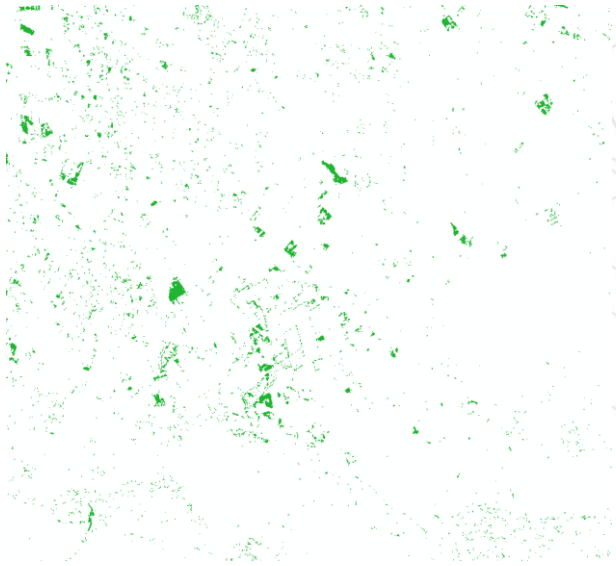


Result for 1 class

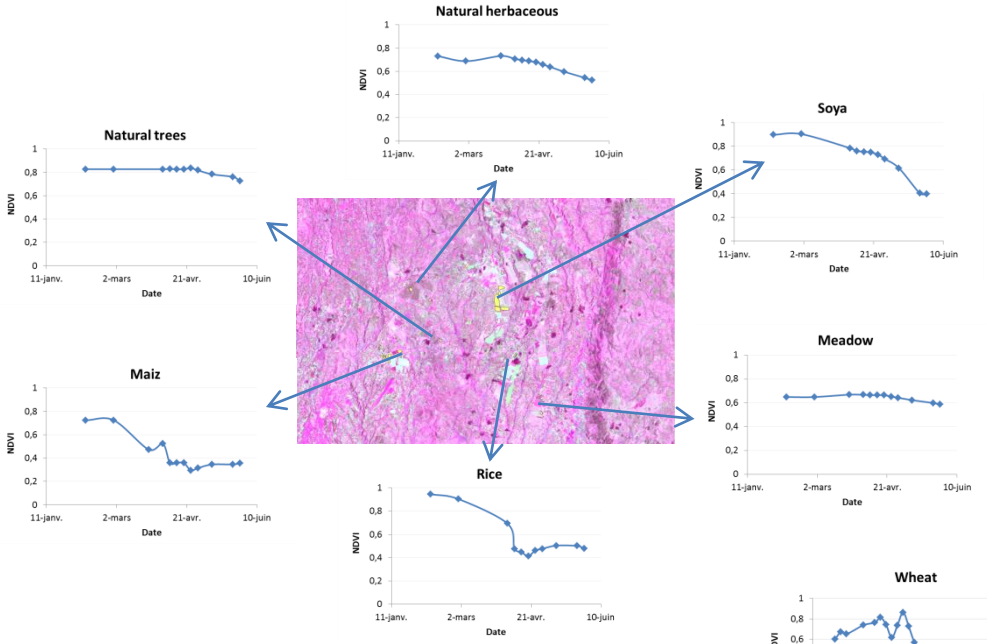


Zoom



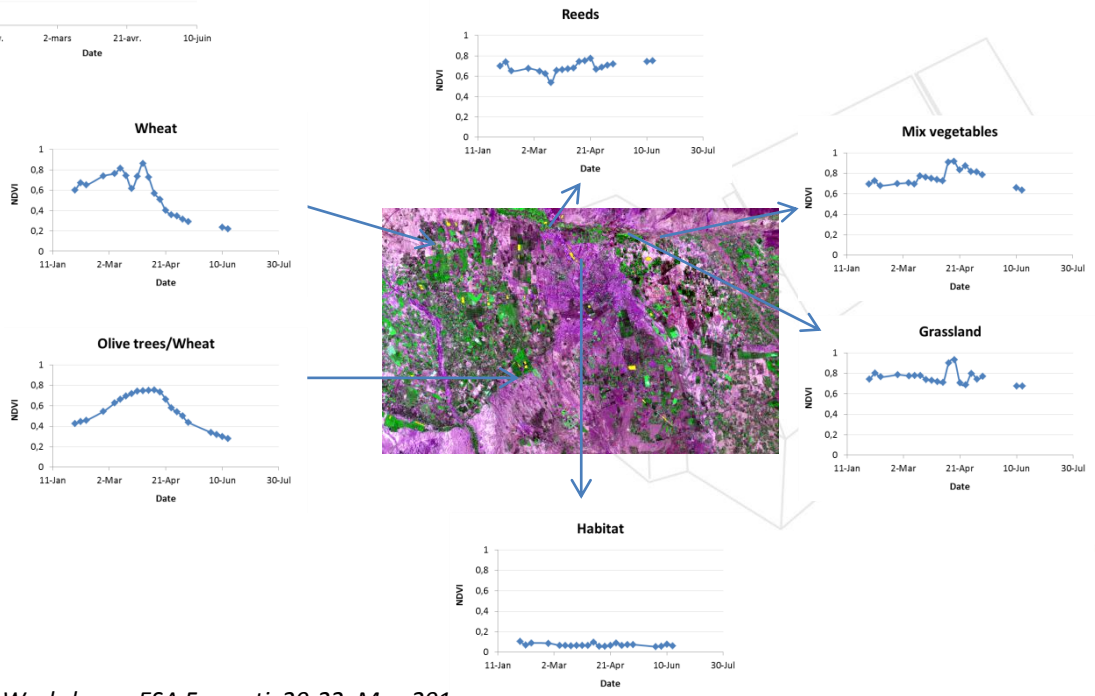


LC method to be tested on SPOT 4 T5



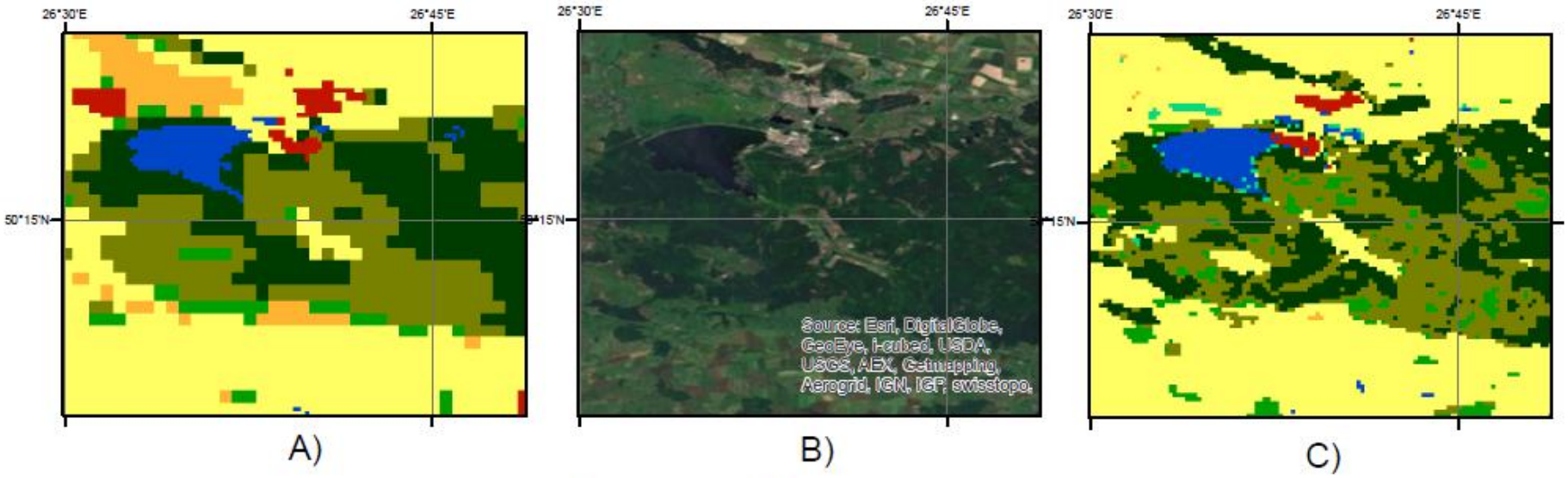
Madagascar Site,
Spot Take 5 image from 28 February

Morocco Site ,
Spot Take 5 image from 6 May



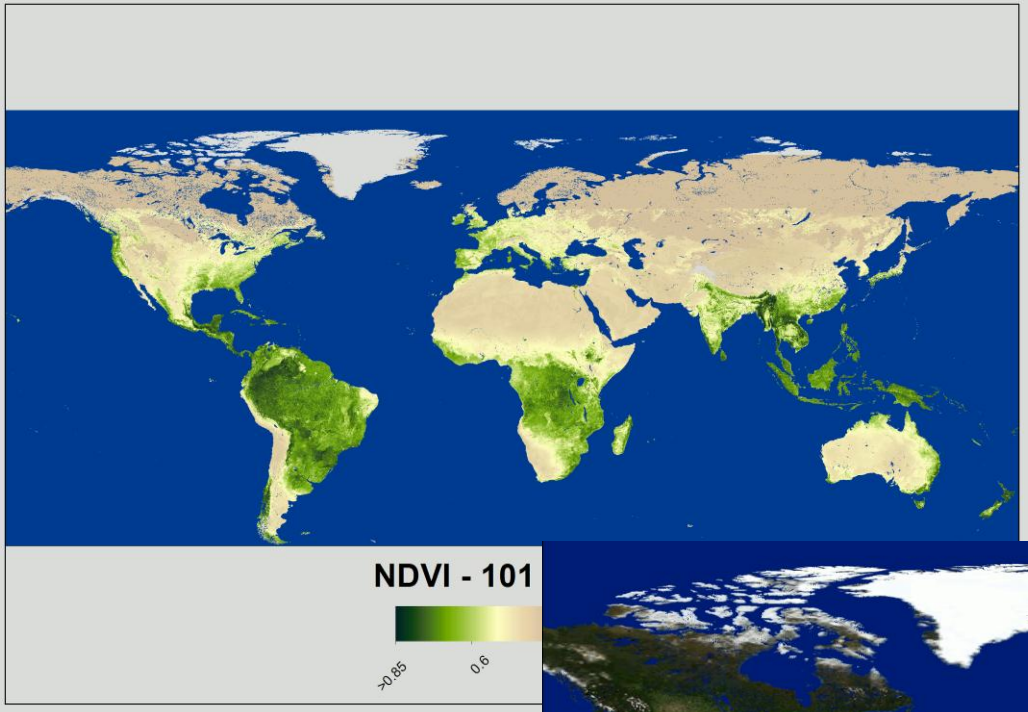
LC Method : automated extraction of training samples for regional land cover classification

Multiclass Border Reduction Filter in order to mitigate the errors in automatic training set



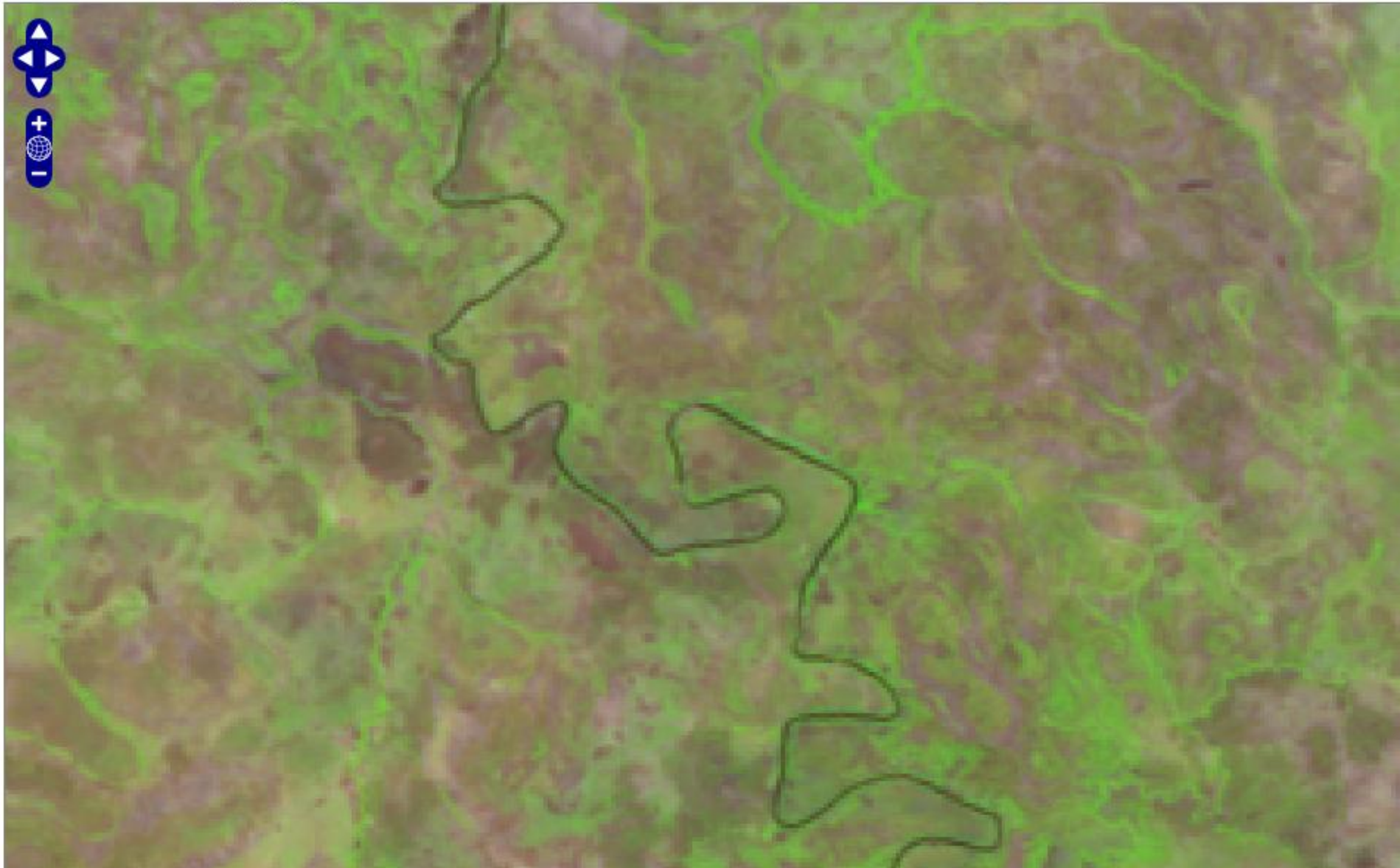
(Radoux et al. UCL, RS 2014)

LC method using LC_CCI 7-d time series

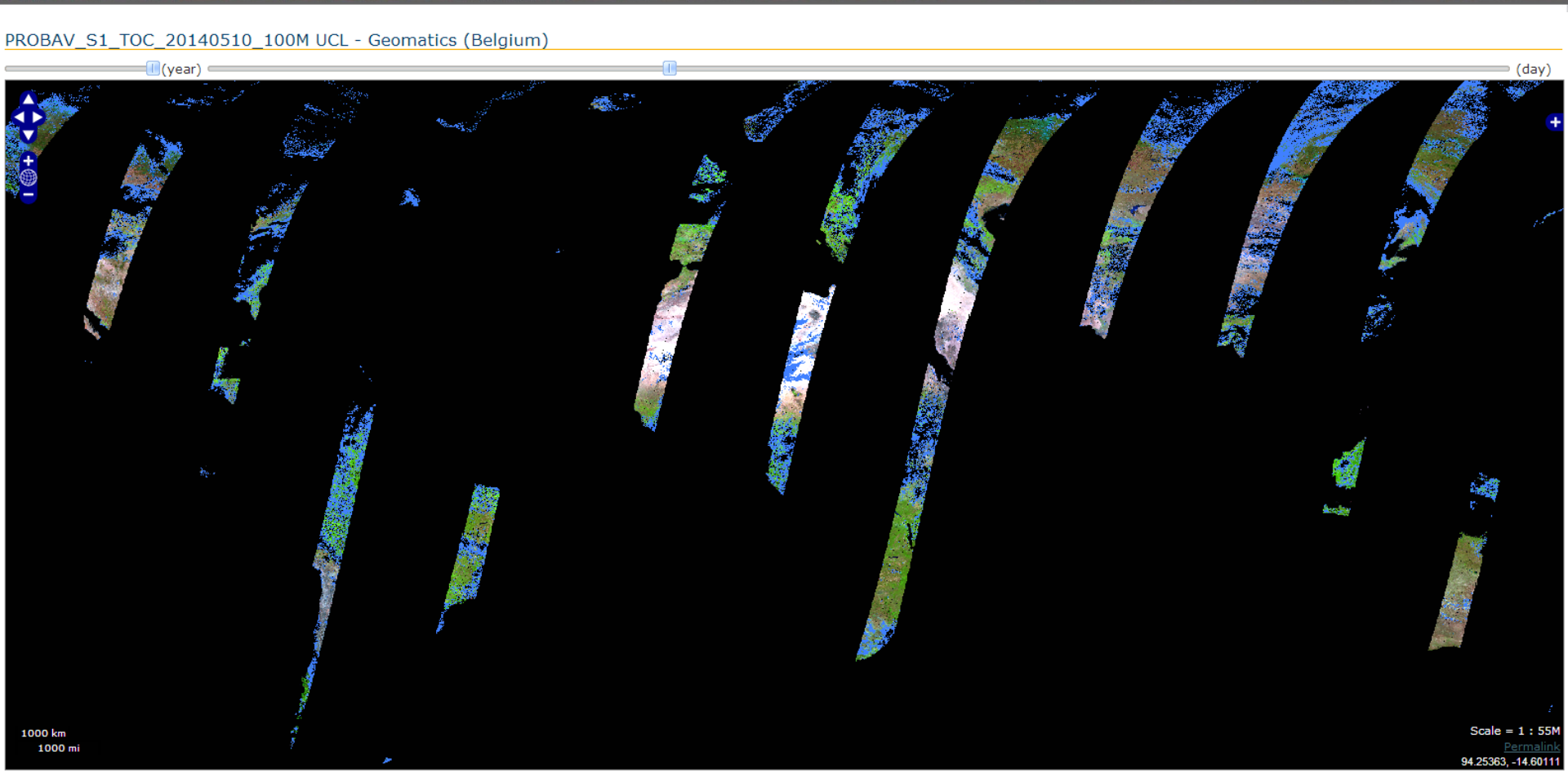


PROBAV_S1_TOC_20140510_100M UCL - Geomatics (Belgium)

(year)

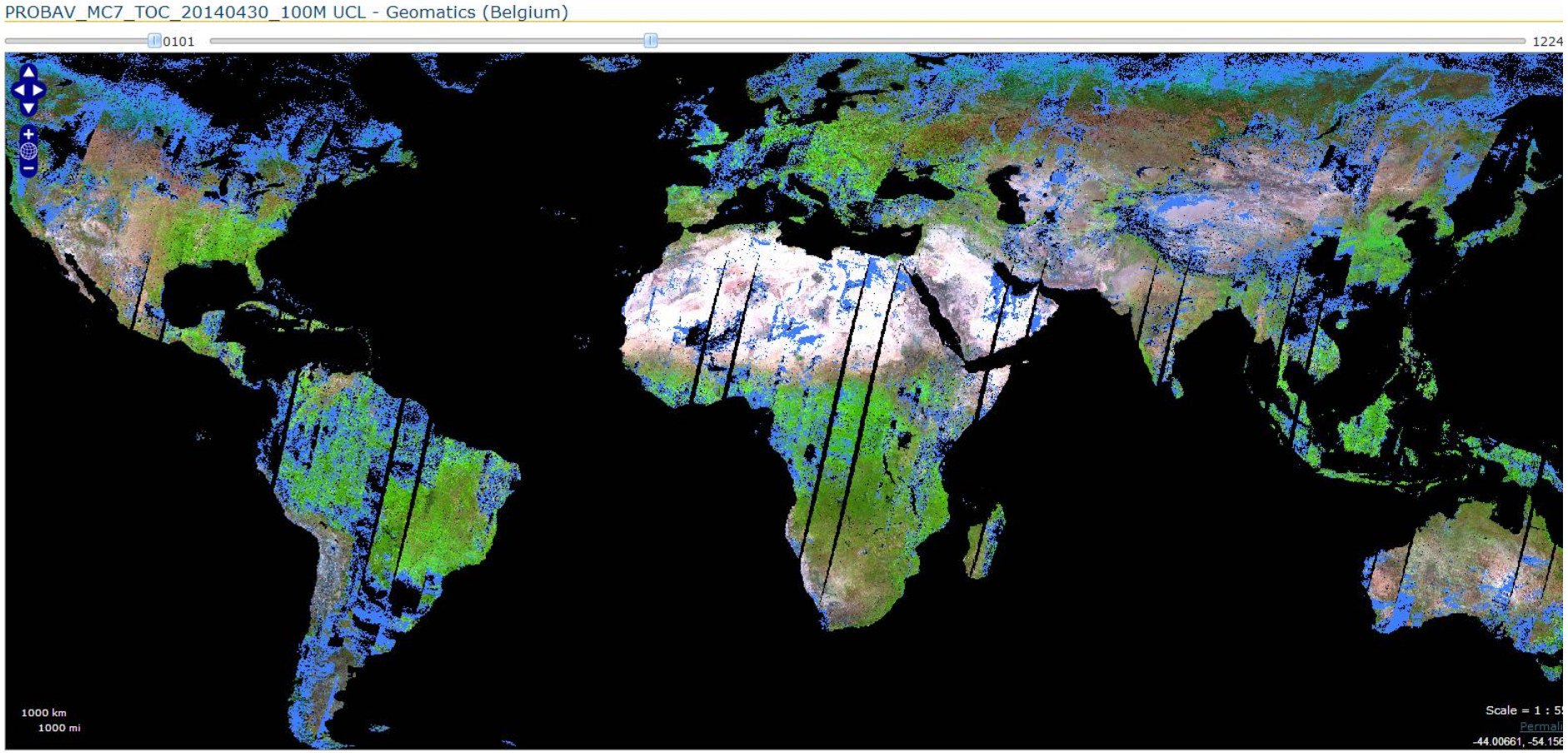


PROBA-V to support the LC mapping



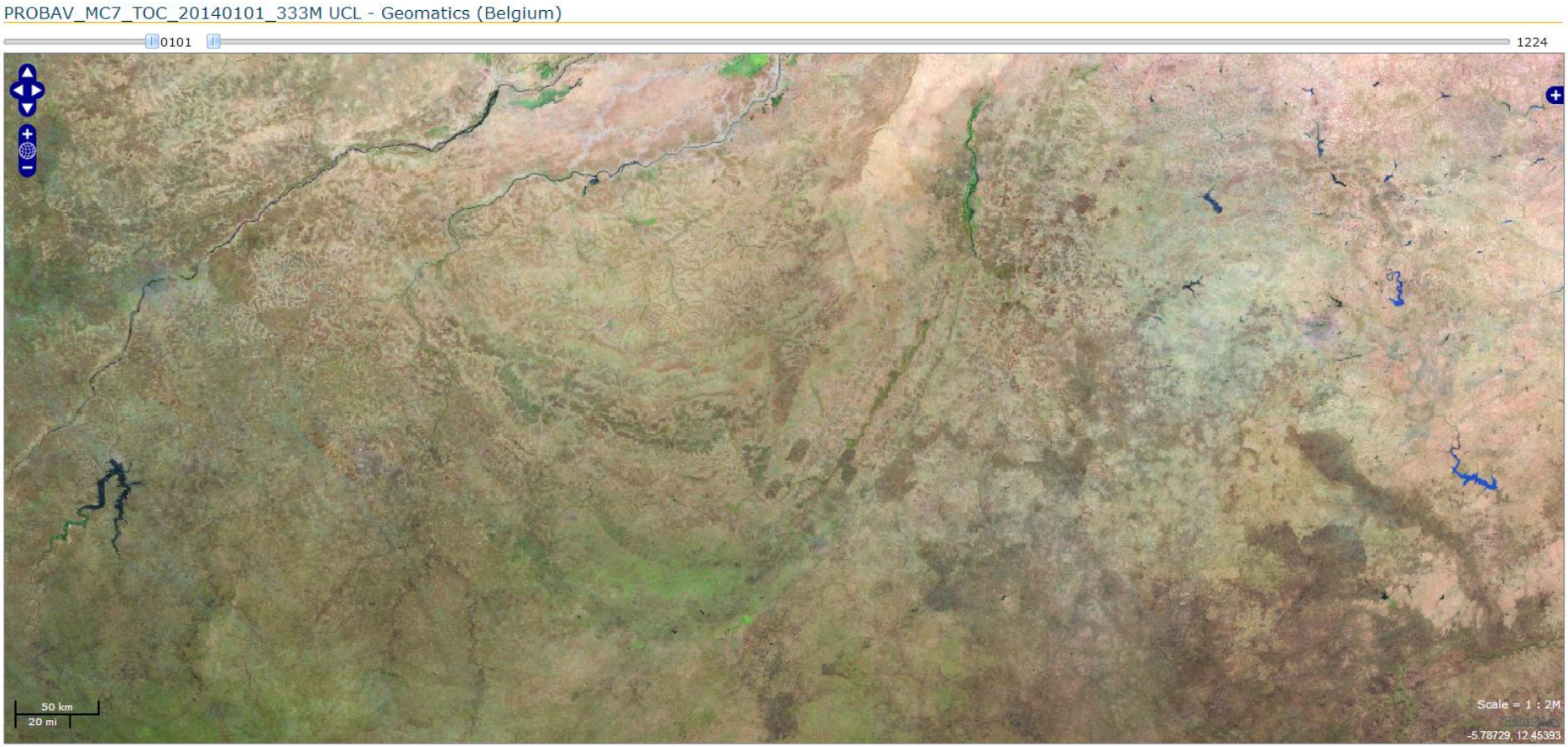
100-m daily global observation – 10 May 2014

PROBA-V to support the LC mapping

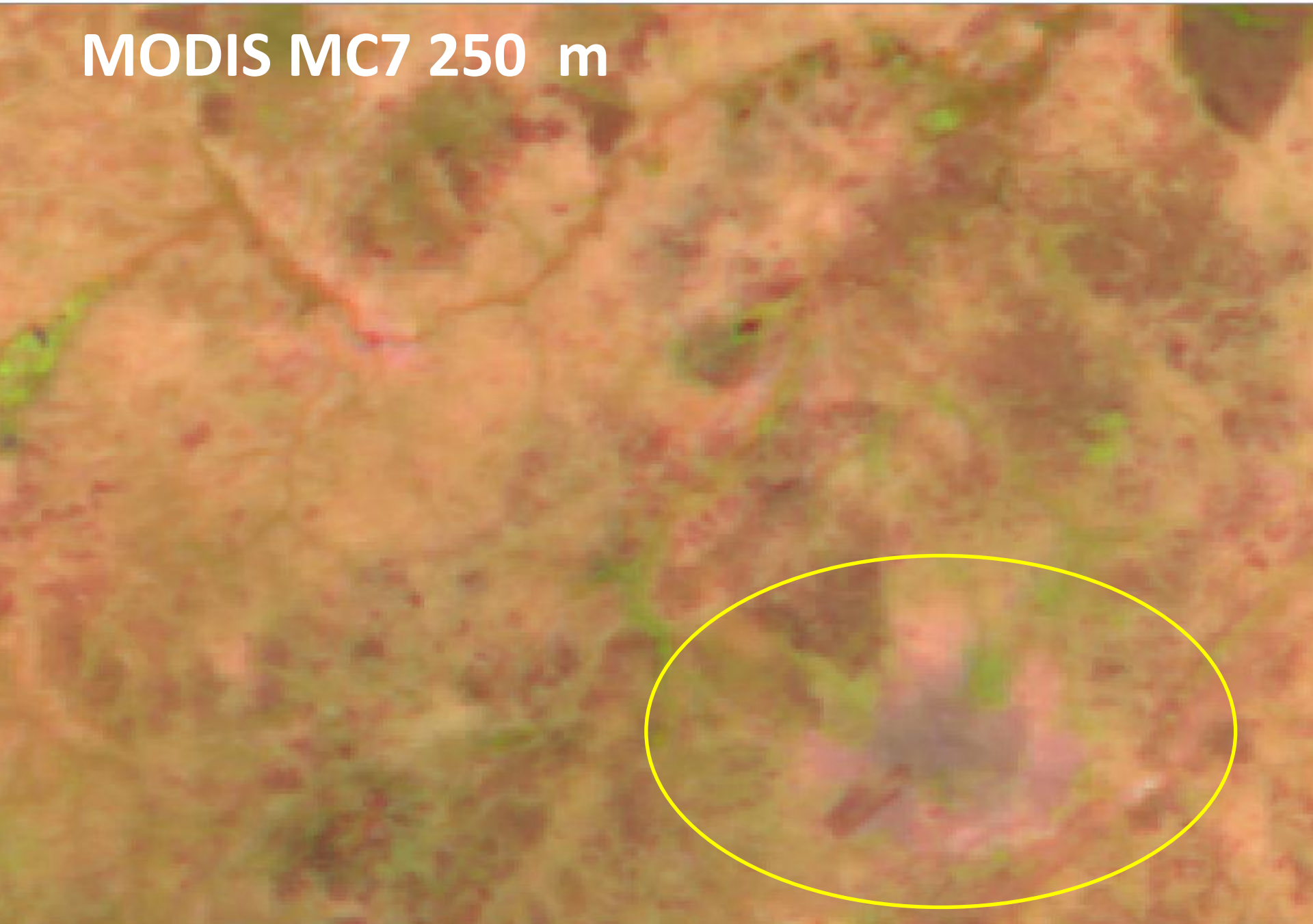


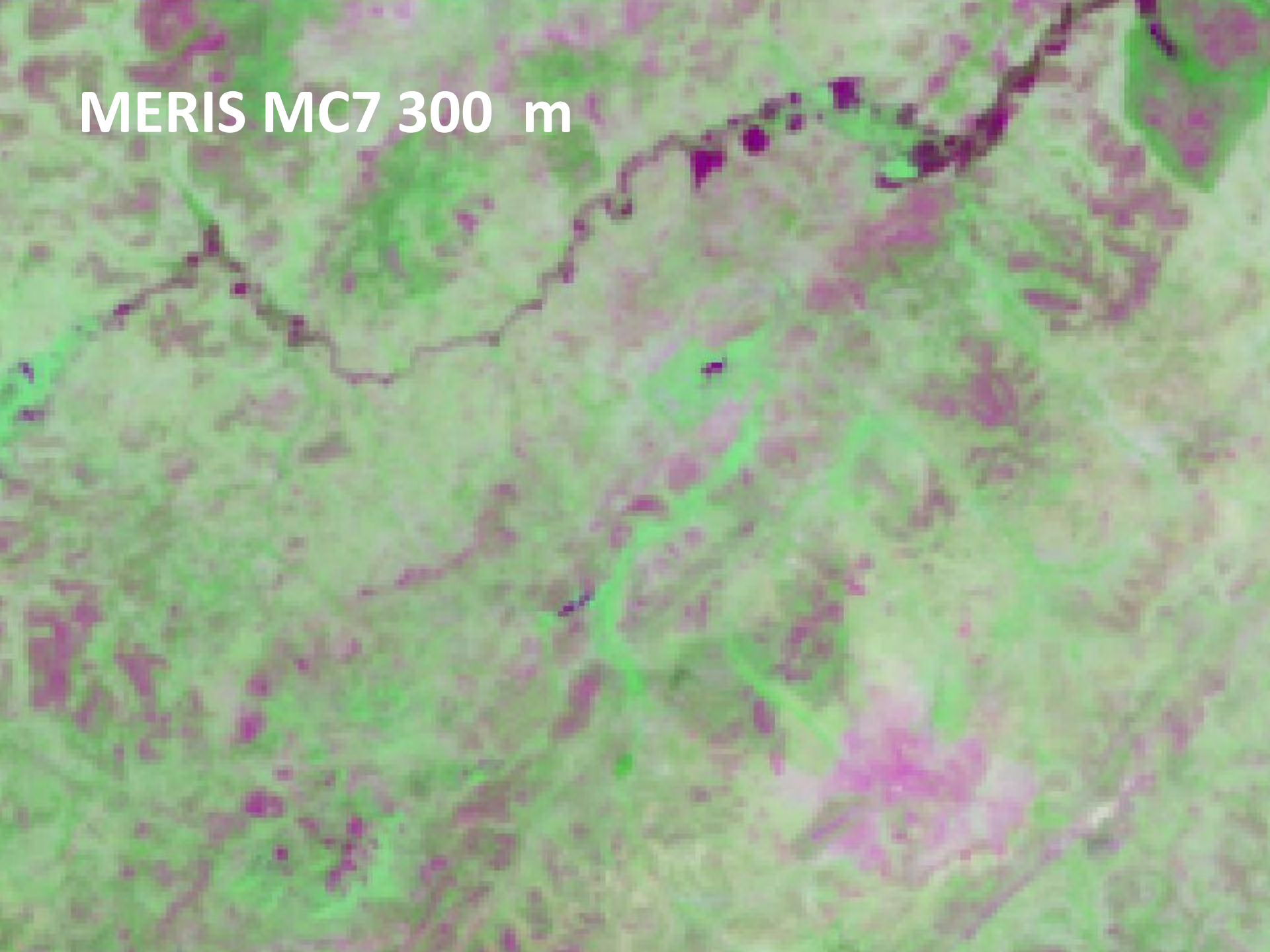
100-m 7-d global composite – 1st week of May 2014

PROBA-V to support the LC mapping
333 m – 4 bands daily global



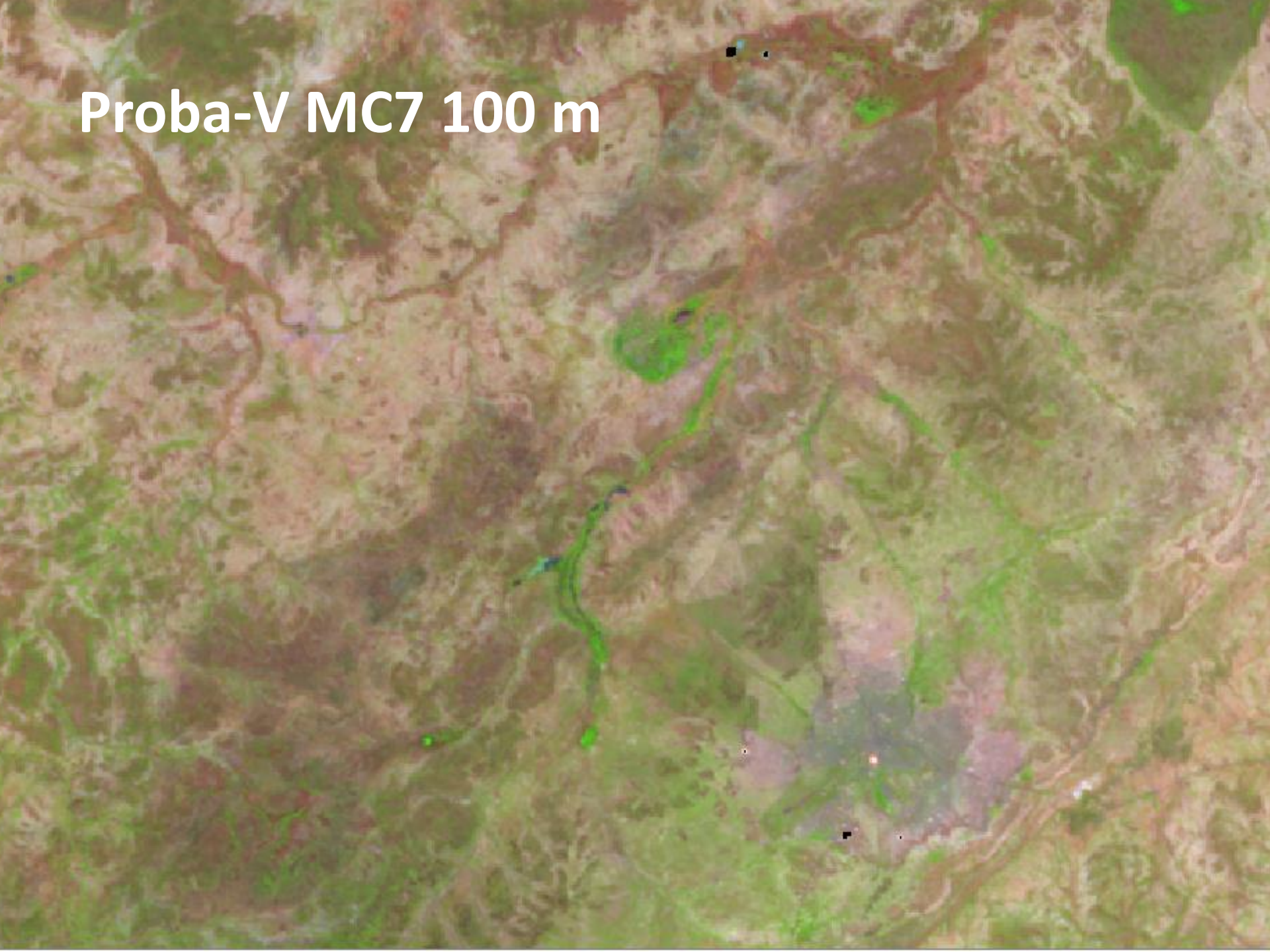
7-d composite (MC7) – Southern Mali, Western Burkina Faso


MODIS MC7 250 m

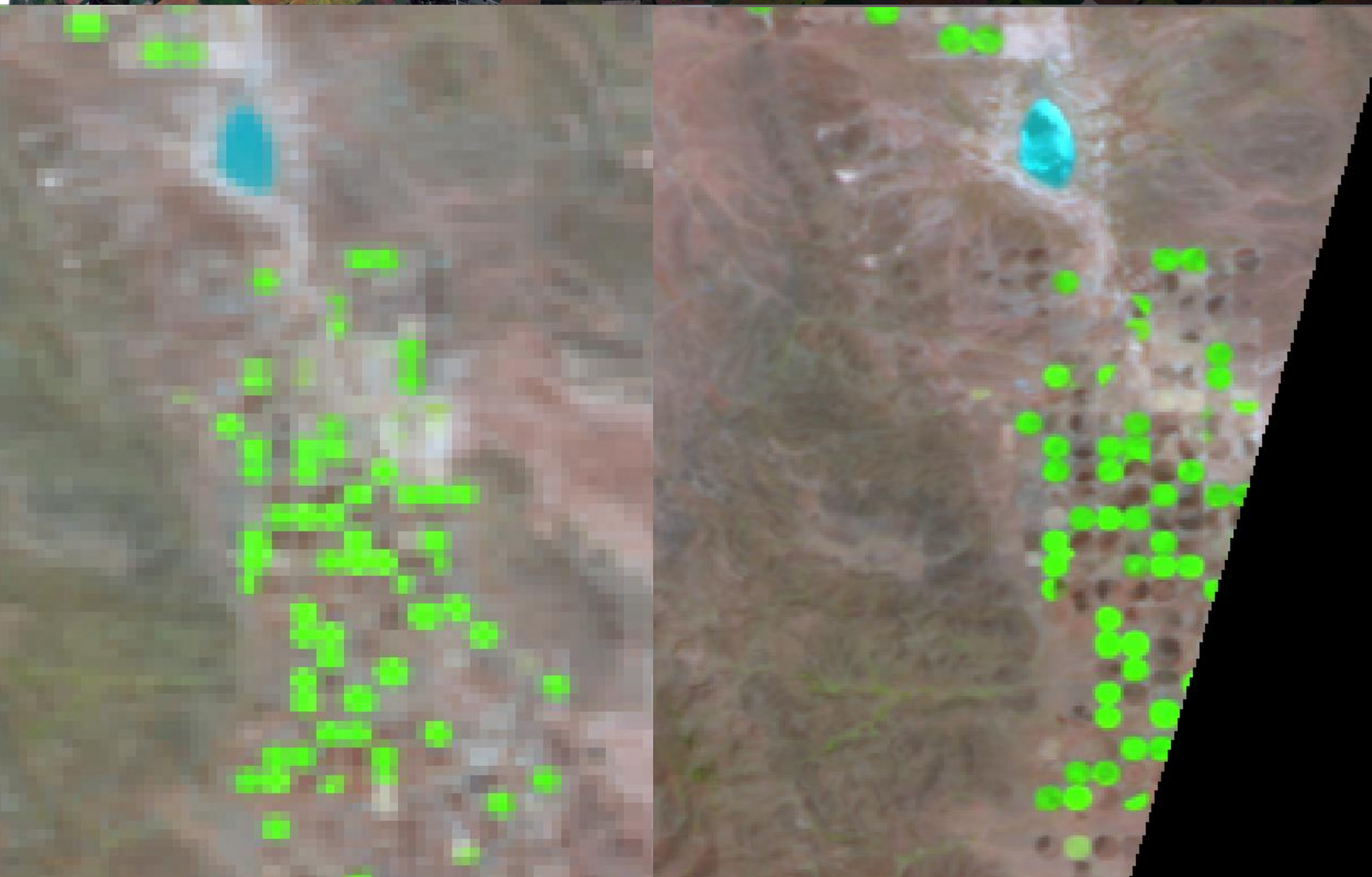

MERIS MC7 300 m

Proba-V MC7 333 m

Proba-V daily 333 m


Proba-V MC7 100 m

PROBA-V 333 m versus 100 m



Perspectives

- Sentinel-2 + Landsat 8 time series to make a significant difference in land surface mapping and land cover change detection
- Land cover legend still to be defined for this 10 m scale
- Mission providing daily acquisition over several years to reduce the expected interannual variability of output in the transition zone
- Validation will become an major challenge for such continental product at 10 m resolution *(see S. Bontemps talk)*

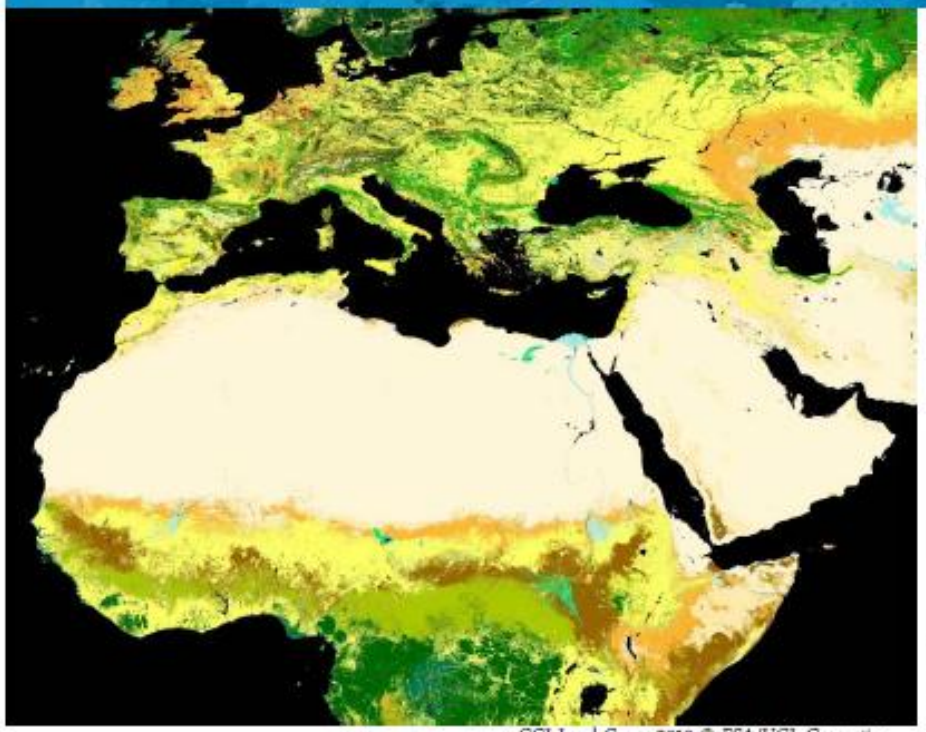
Thank you for attention

esa

→ CLIMATE CHANGE INITIATIVE

Land Cover CCI Newsletter

Issue n. 5 | August 2013



CCI Land Cover 2010 © ESA/UCL-Geomatics

In this issue:

- Internal release of the CCI LCproducts
- 3 global LC maps
- 3 global LC condition products
- Global SAR-based Water Body product
- MERIS surface reflectance time series
- Building a validation database
- Climate modellers assessment