

ECOCLIMAP

[land cover + surface parameters] database for meteorological applications

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V. Masson et al., *A Global Database of Land Surface Parameters at 1-km Resolution in Meteorological and Climate Models*, Journal of climate, Vol. 16 No. 9, 2003.

PLAN

I. ECOCLIMAP-I

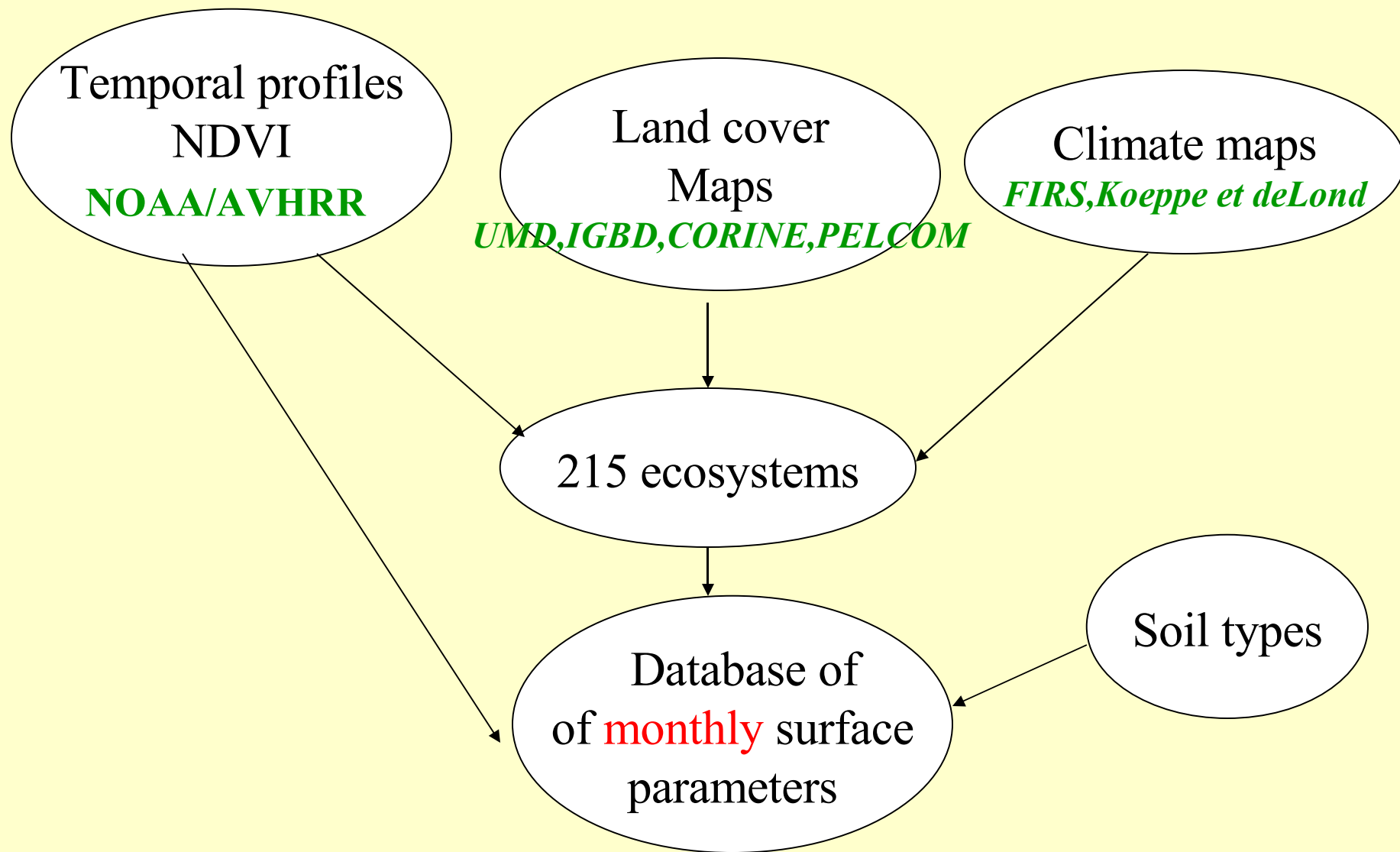
- I. A LAND COVER MAP OF ECOSYSTEMS
- II. A DATABASE OF SURFACE PARAMETERS
- III. RESULTS

II. ECOCLIMAP-II

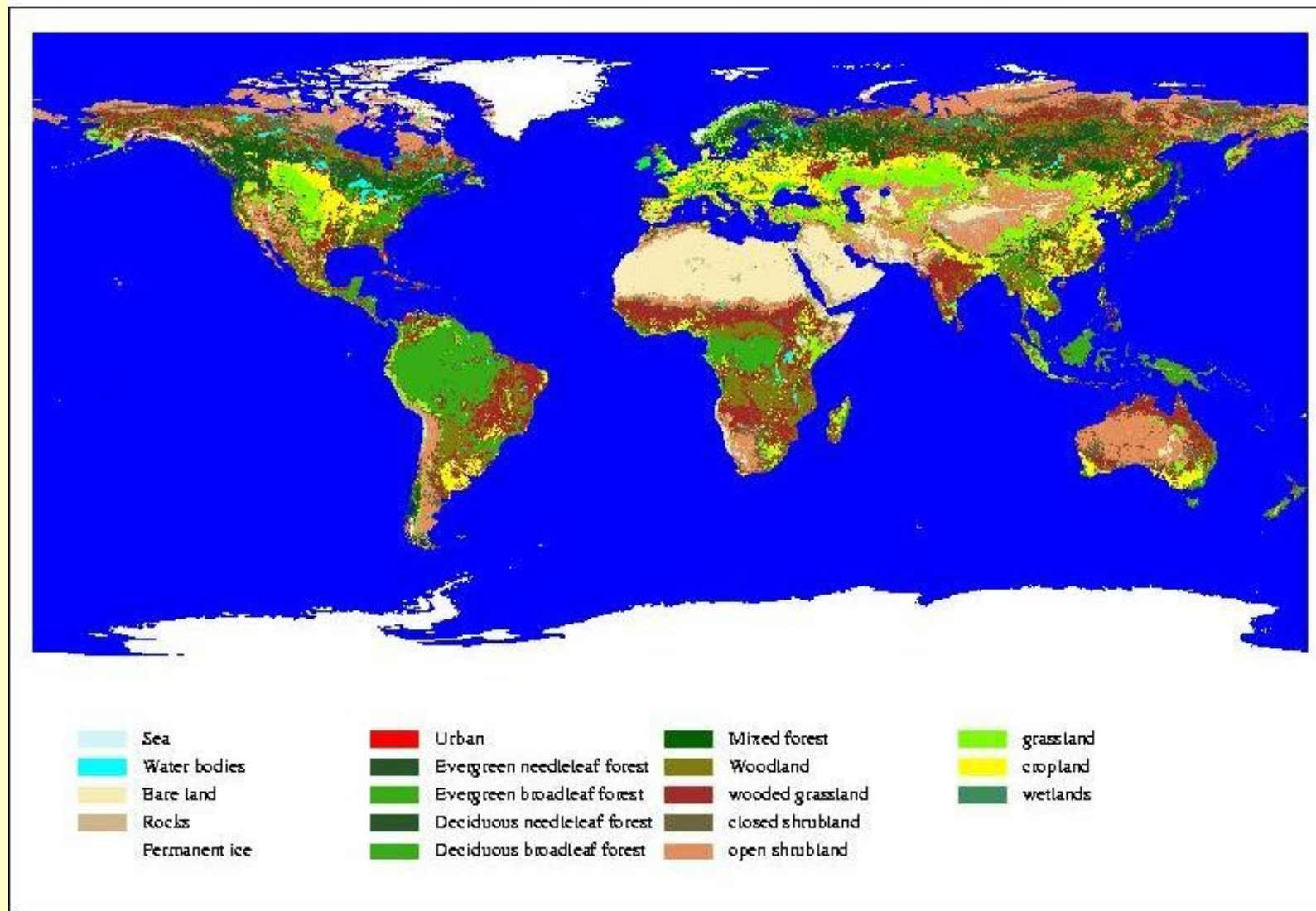
- I. NEW CONCEPT
- II. INPUT DATA
- III. RESULTS

III. CONCLUSION AND PROSPECTS

1.1. A land cover map	1.2. Surface parameters	1.3. Results	2.1. New concept	2.2. Input data	2.3. results	3. Conclusion and prospects
ECOCLIMAP-I			ECOCLIMAP-II			

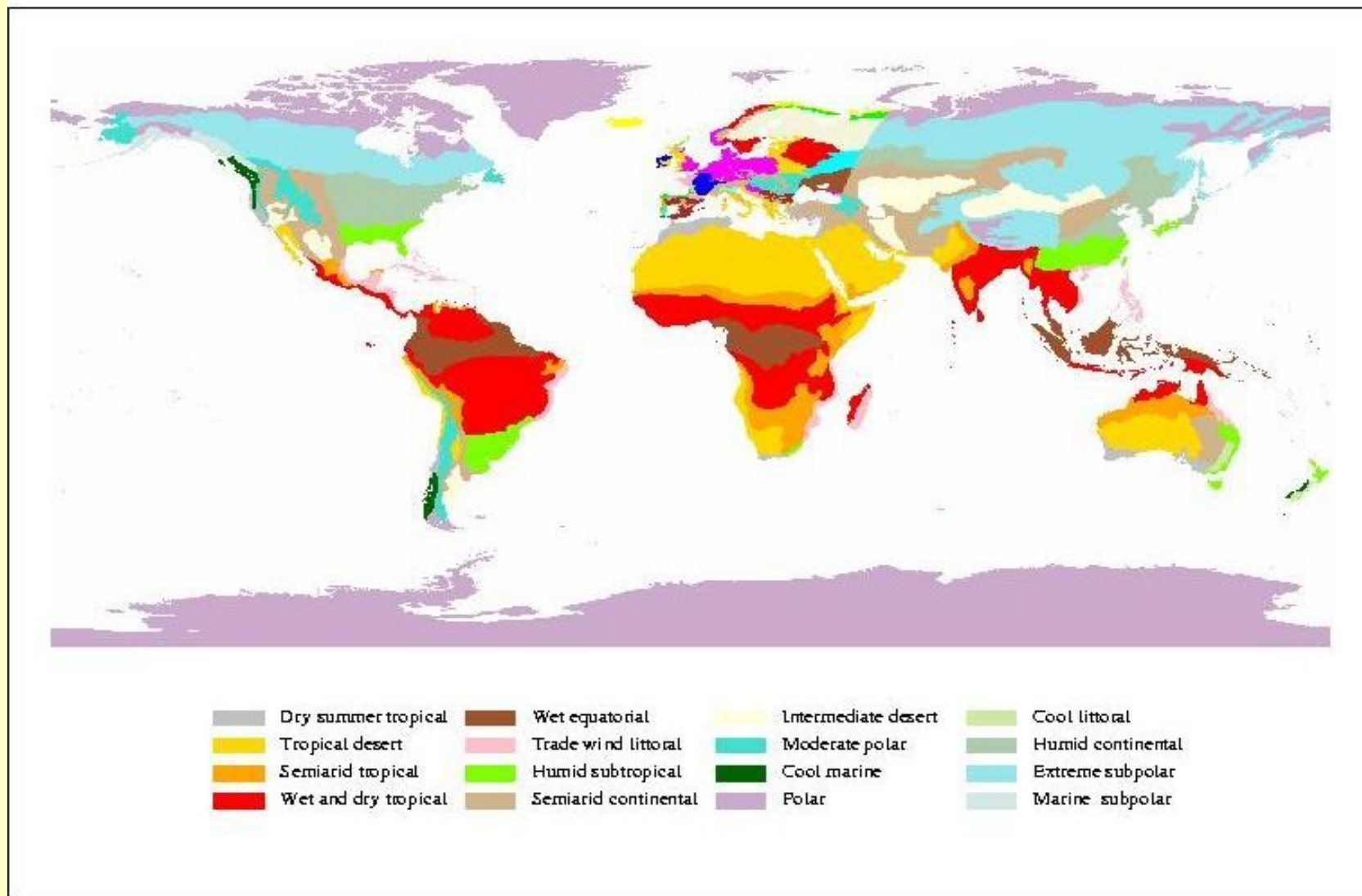


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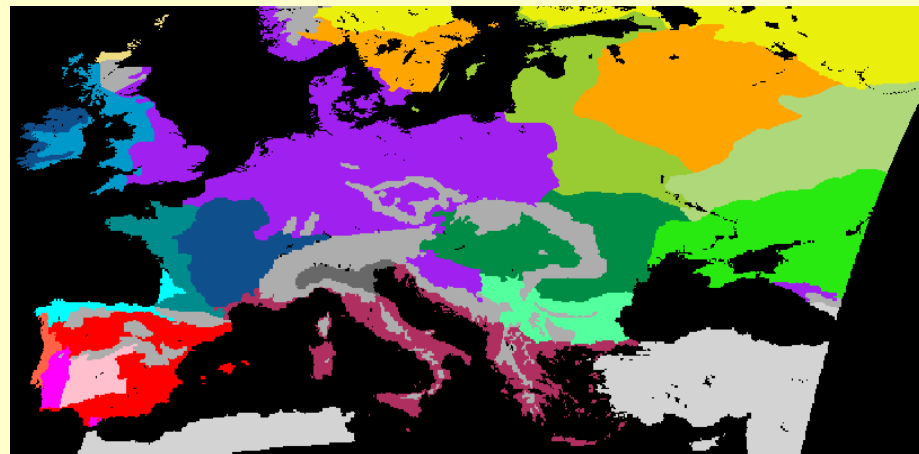
*Land cover map at 1km resolution
(University of Maryland)*

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Climate global map (Koeppen et de Lond, 1958)

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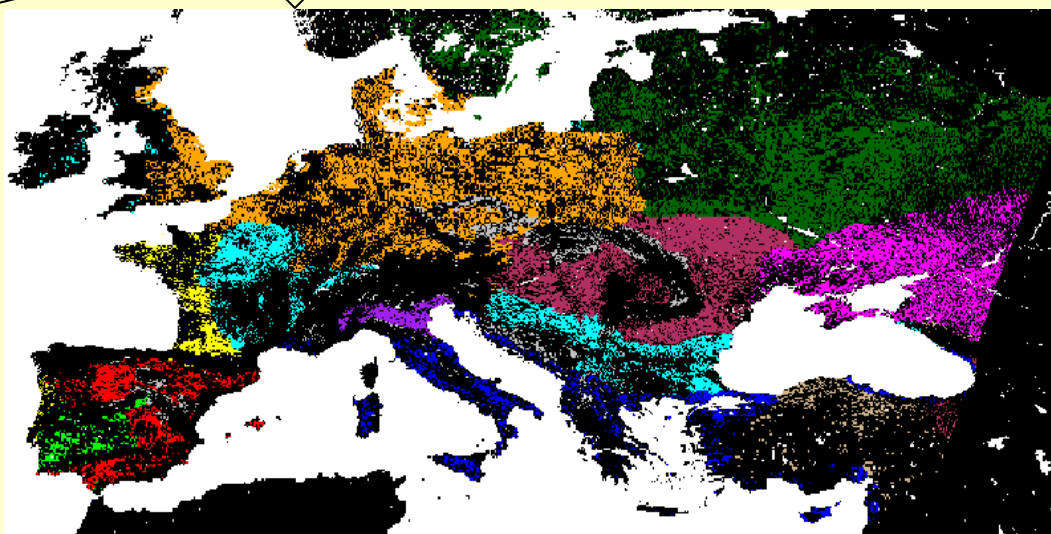
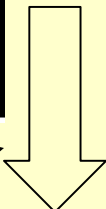


FIRS climate map



CROPS UMD (before crossing with climate map)

+



Several CROPS **ecosystems** linked to climates

Temporal profiles
NDVI
NOAA/AVHRR

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What?

- *depending on soil*
 - *Percentage of sand and clay*
 - *Soil depth*
- *depending on vegetation*
 - *Fraction of vegetation (veg)*
 - *Leaf area index (LAI)*
 - *Minimal stomatal resistance*
 - *Roughness length (z_0)*
- *depending on soil and vegetation*
 - *Albedo*
 - *Emissivity*

A set of these parameters
for each new ecosystem

How?



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How?

- $$LAI = LAI_{min} + (LAI_{max} - LAI_{min}) * (NDVI - NDVI_{min}) / (NDVI_{max} - NDVI_{min})$$

with LAI_{min} and LAI_{max} fixed for each ecosystem

**Fractionation
of each
ecosystem
among....**

12 elementary vegetation types:

% Permanent snow

% C3 crops

% C4 crops

% Natural herbaceous (tropics)

LAI

LAI

LAI

% Neddleleaf forest

% Natural herbaceous (temperate)

LAI

LAI

% Deciduous broadleaf forest

Wetlands and irrigated herbaceous

LAI

LAI

% Evergreen broadleaf forest

% irrigated crops

% Rocks

% bare soil

LAI

LAI

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Composition of each ecosystem among the 12 elementary vegetation types

12 Elementary vegetation types

	bare soil:	woody vegetation:	herbaceous:
	bare soil / rocks / permanent snow	evergreen broadleaf / deciduous broadleaf / needleleaf	C3 / C4 / irr. crops /
			natural herbaceous (temperate) / natural herbaceous (tropics)
			wetland and irr. herbaceous

215
Ecosystems

any forest			100%
woodland	0-10%	40-50%	50%
wooded grassland	0-20%	20-30%	50-70%
closed shrubland	20-30%	20%	50-60%
open shrubland	20-60%		40-80%
grassland			100%
crops			100%
bare soil; rock, permanent snow	90-100%		0-10%

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Other parameters

- **Veg, Z0** = f (LAI, vegetation type)
- For the other parameters: **look-up tables** from in-situ measurements

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Parameters values for the 12 elementary vegetation types

vegetation type	total vegetation fraction	roughness length (m)	albedo of vegetation	minimal stomatal resistance (sm^{-1})	emissivity of vegetation
bare soil	0	0.013			
rocks	0	0.13			
permanent snow and ice	0	0.0013			
C3 crops	$1 - e^{-0.6LAI}$	$0.13 \min(1, e^{\frac{LAI-3.5}{1.3}})$	0.20	40	0.97
C4 and irr. crops	$1 - e^{-0.6LAI}$	$0.13 \min(2.5, e^{\frac{LAI-3.5}{1.3}})$	0.20	40	0.97
natural herbaceous (tropics)	0.95	$0.13 \frac{LAI}{6}$	0.20	120	0.97
Other herbaceous	0.95	$0.13 \frac{LAI}{6}$	0.20	40	0.97
Needleleaf trees	0.95	$0.13 h$	0.10	150	0.97
Evergreen broadleaf trees	0.99	$0.13 h$	0.13	250	0.97
Deciduous broadleaf trees	0.95	$0.13 h$	0.15	150	0.97

Known values of parameters
For these 12 elementary
Vegetation types

Depending on LAI

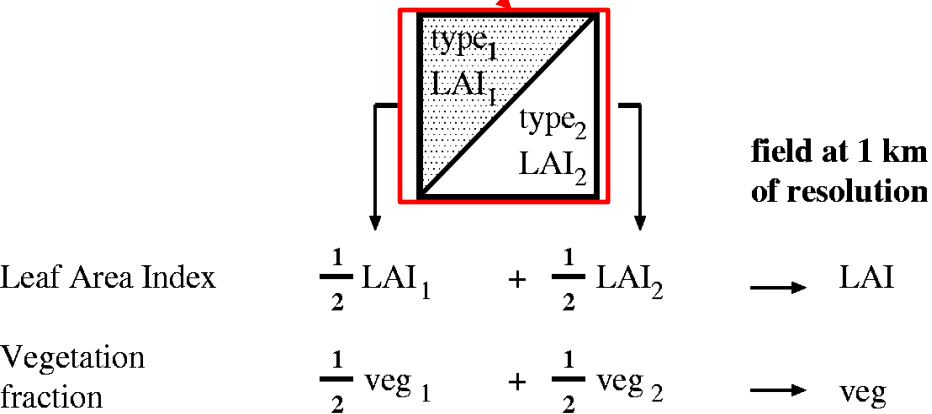
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Aggregation of parameters for mixed ecosystems

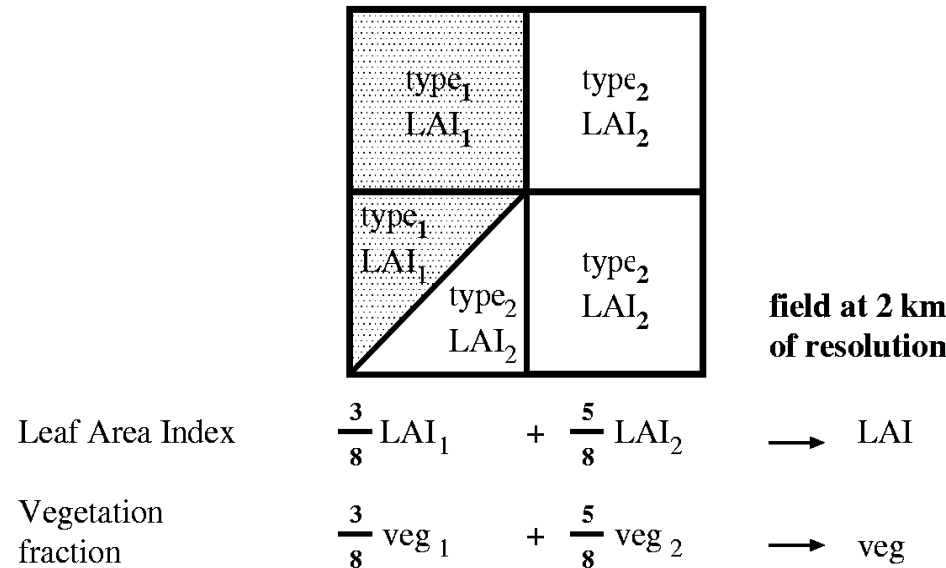
1 ecosystem=SUM(%[some of the 12 elementary veg. types])

a) Example: aggregated parameters for:
1 pixel of mixed ecosystem, (say a woodland)

→ This ecosystem = 50%[type1 LAI1] + 50%[type2 LAI2]

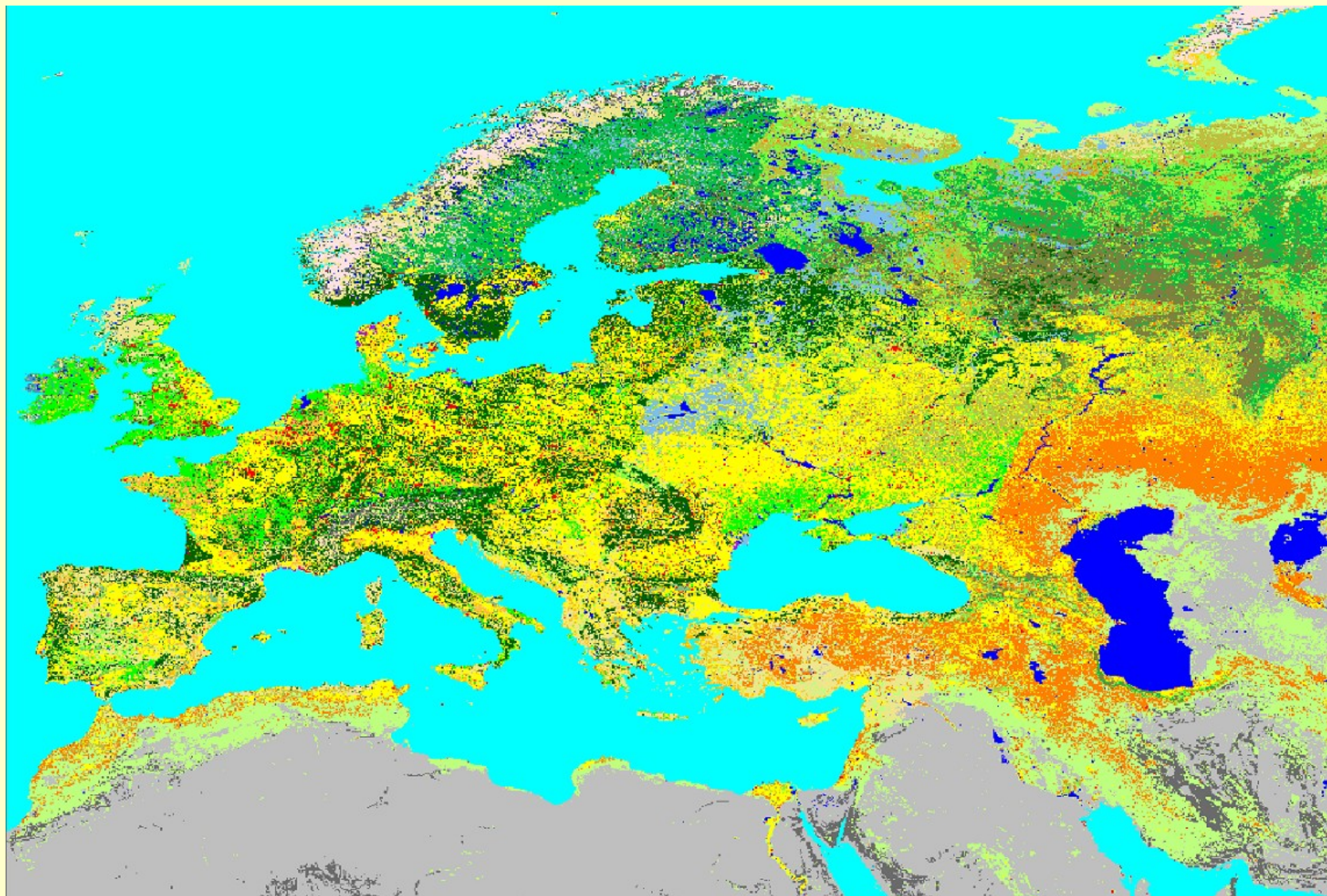


b) Example: aggregation of 4 pixels:
 1 pixel of pure ecosystem "1" (say a forest),
 2 pixels of pure ecosystem "2" (say crops),
 1 pixel of mixed ecosystem "3", (say a woodland)

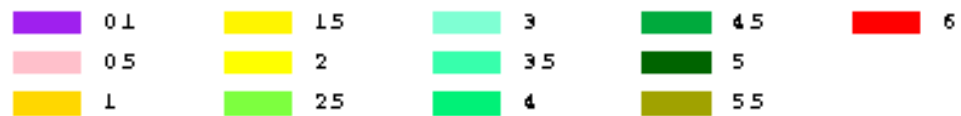
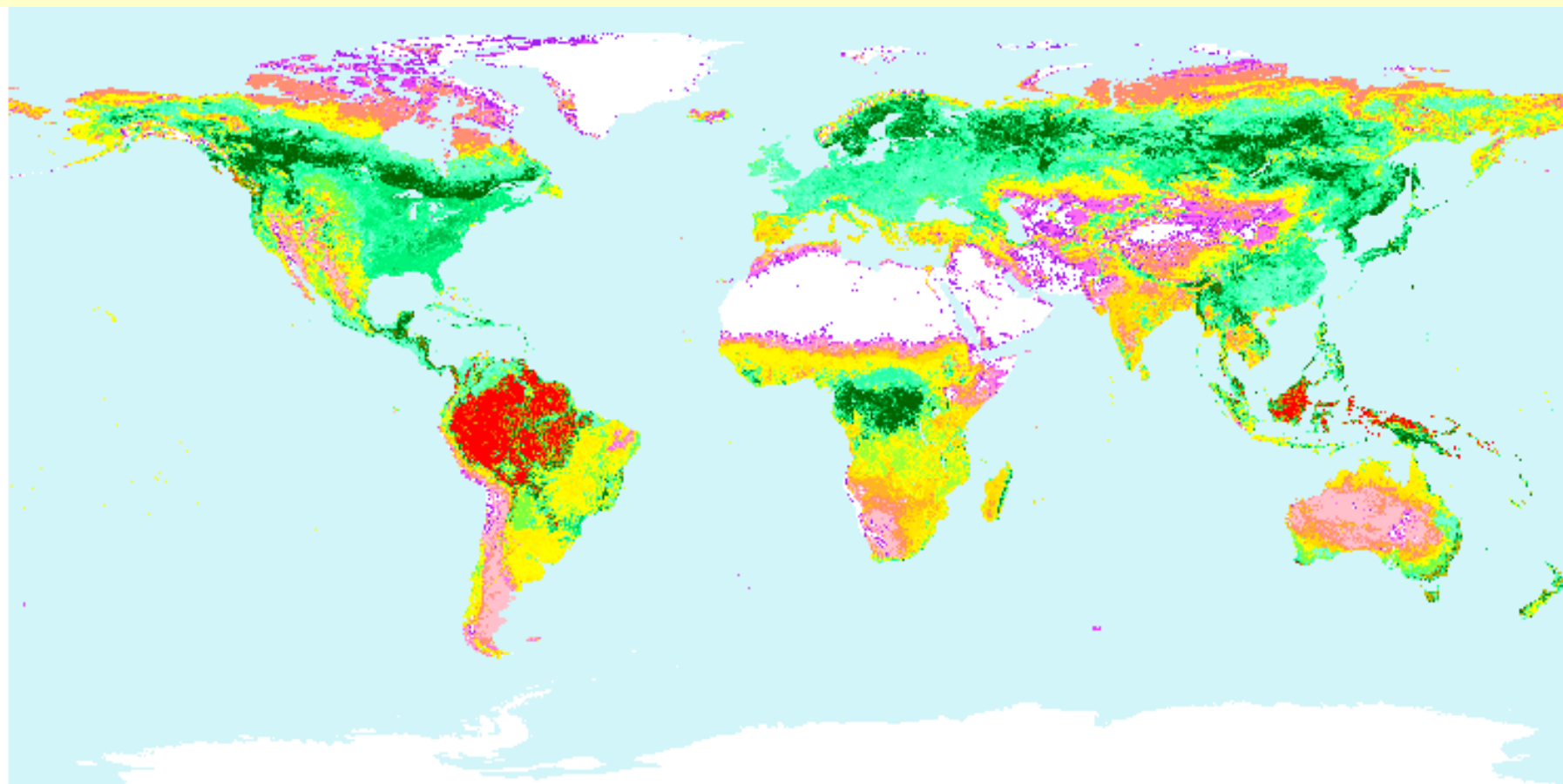


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ECOCLIMAP-I: land cover map – 215 classes for the global map

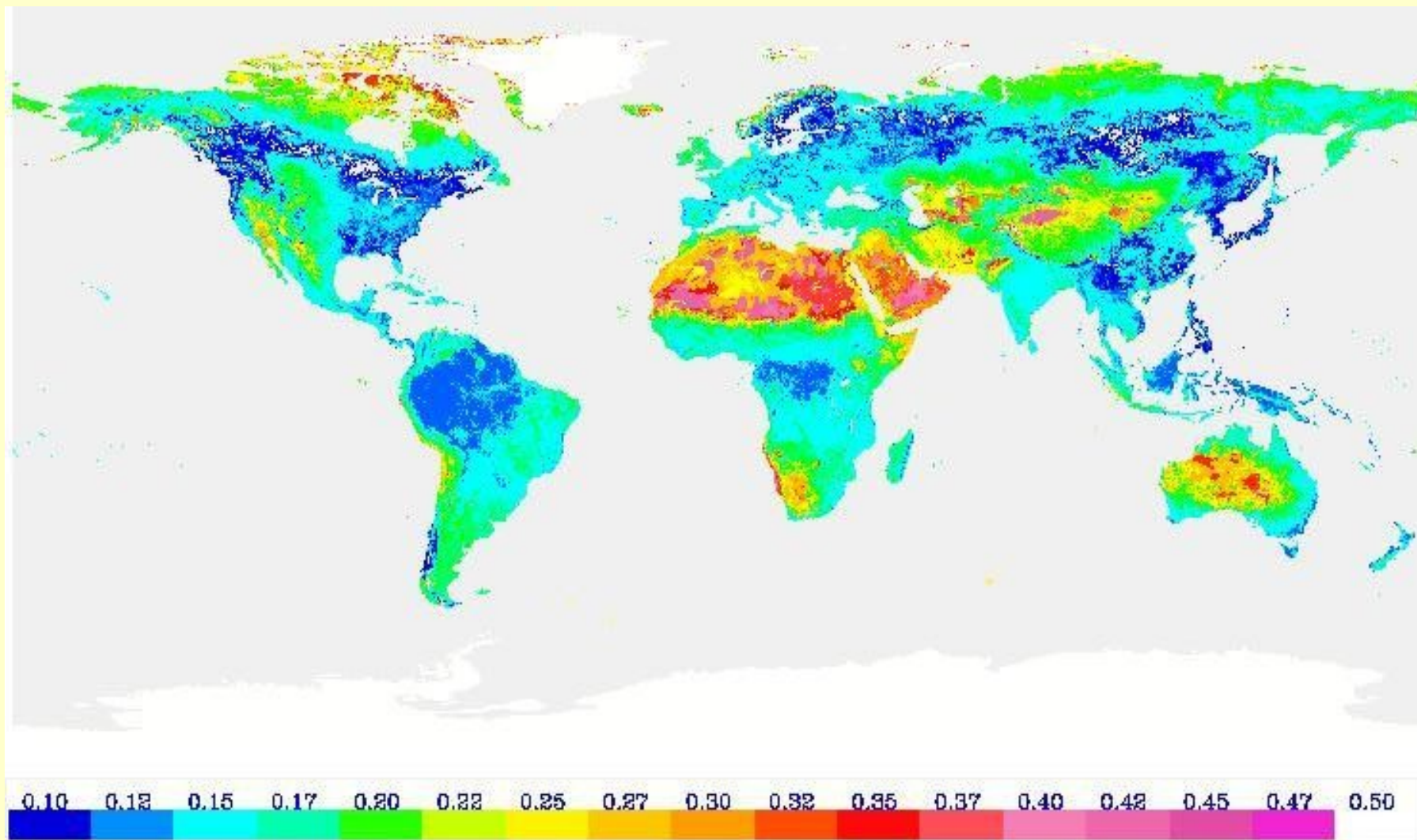


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Leaf Area Index for July

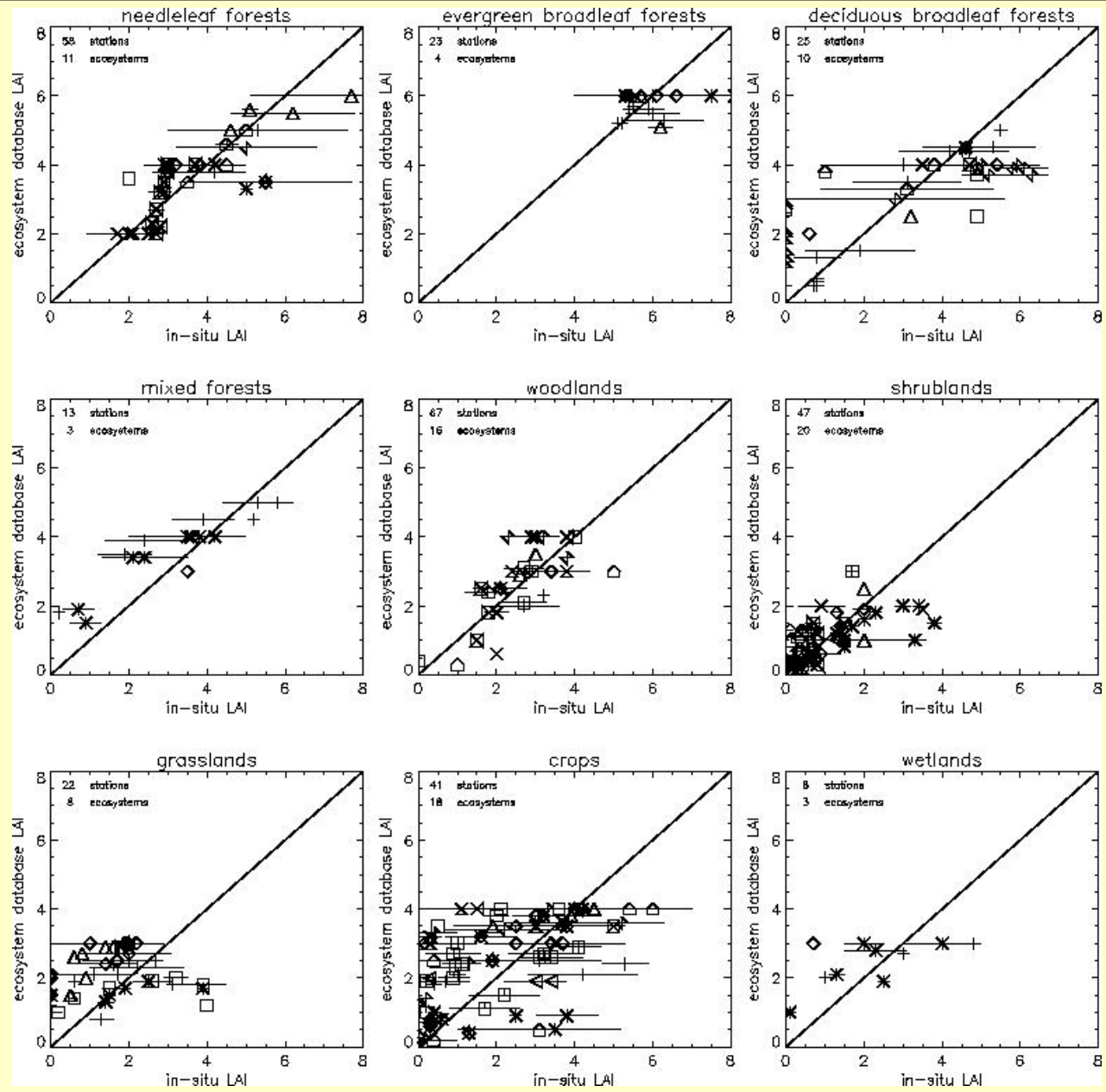
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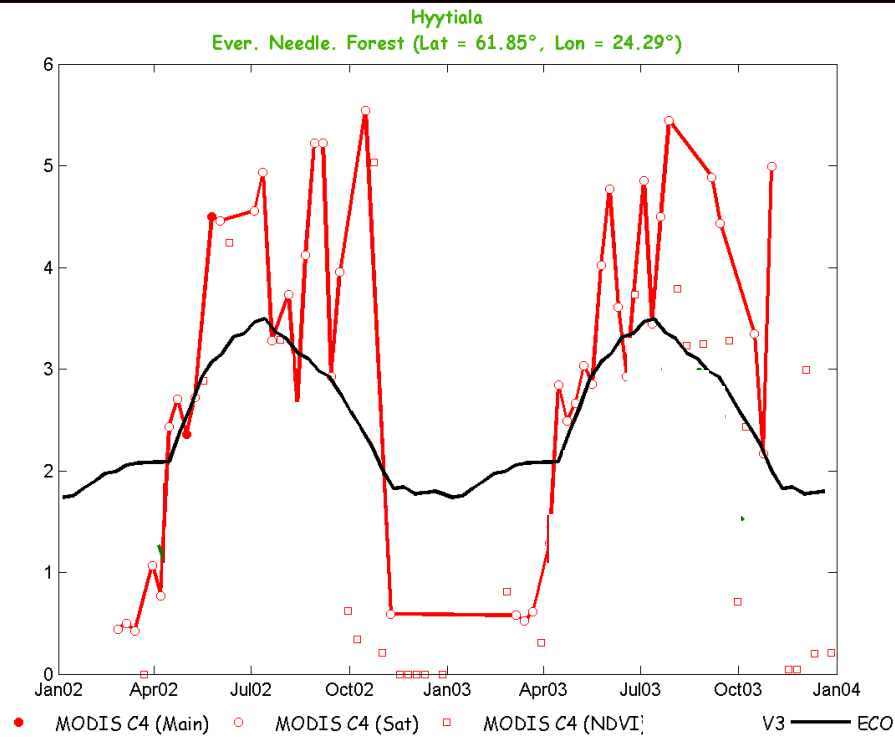
Annual mean Albedo

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Comparison
 LAI
 ECOCLIMAP
 (in Y-axis)
 and
 LAI in situ
 (in X-axis)



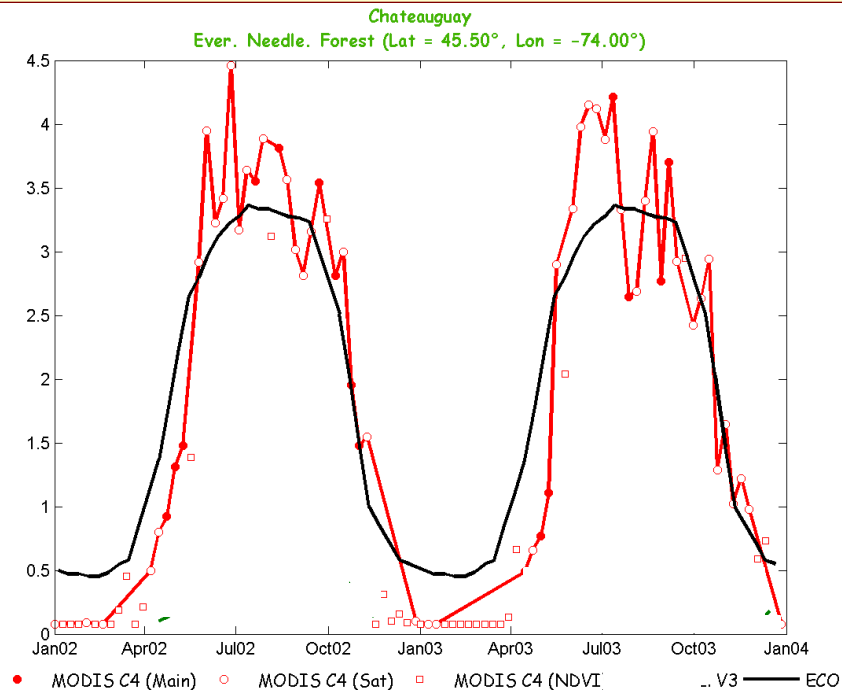
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Comparison between LAI from ECOCLIMAP-I and MODIS

Hyttiala (Finland),
Evergreen needle-leaf forest

Chateauguay (France),
Evergreen needle-leaf forest



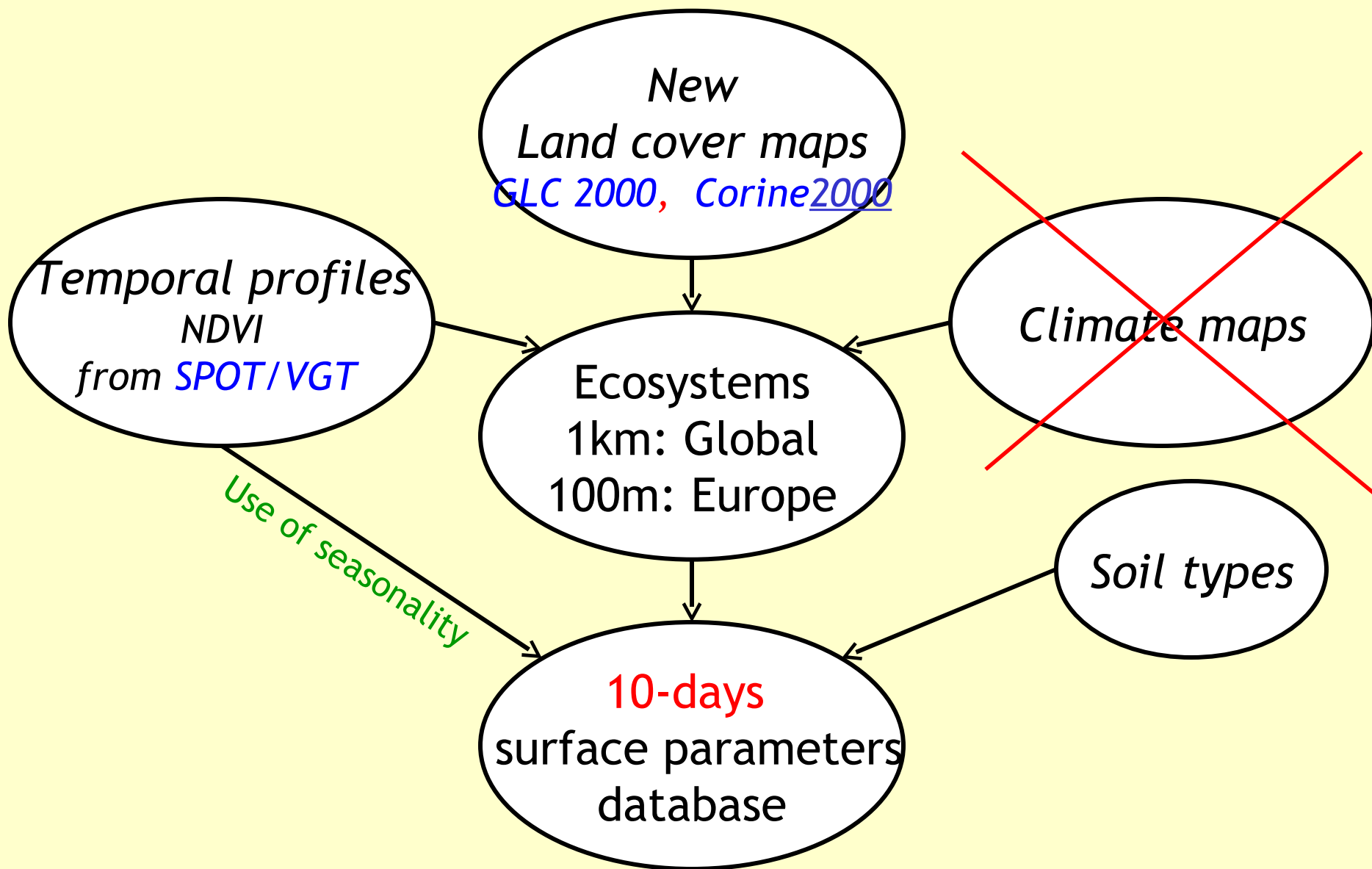
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Last improvements in ECOCLIMAP 1

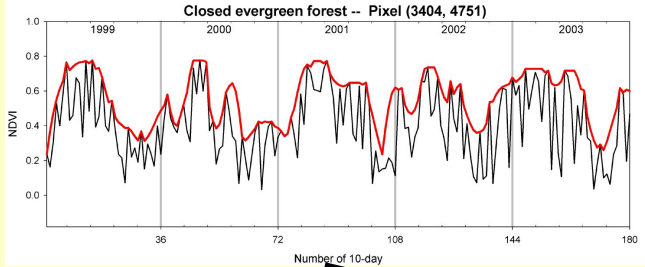
- New fractions of C3/C4 crops
- Decrease of permanent snow cover in Scandinavia
- Correction of forests types in Australia
- New parameters for interactive vegetation scheme (ISBA -A-gs)

http://www.cnrm.meteo.fr/gmme/PROJETS/ECOCLIMAP/page_ecoclimap.htm

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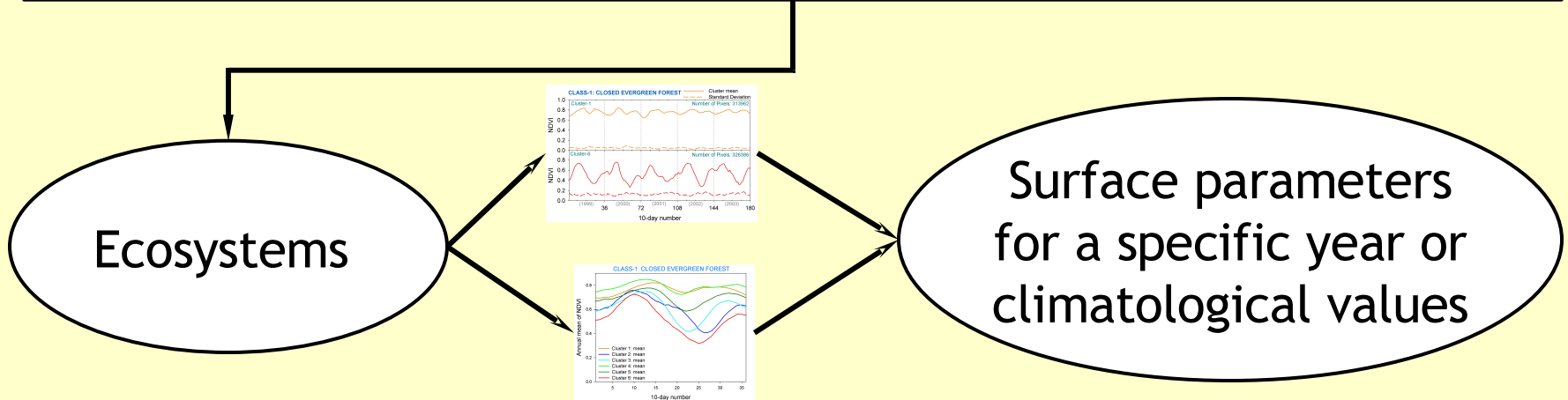
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Land cover class on a continent base

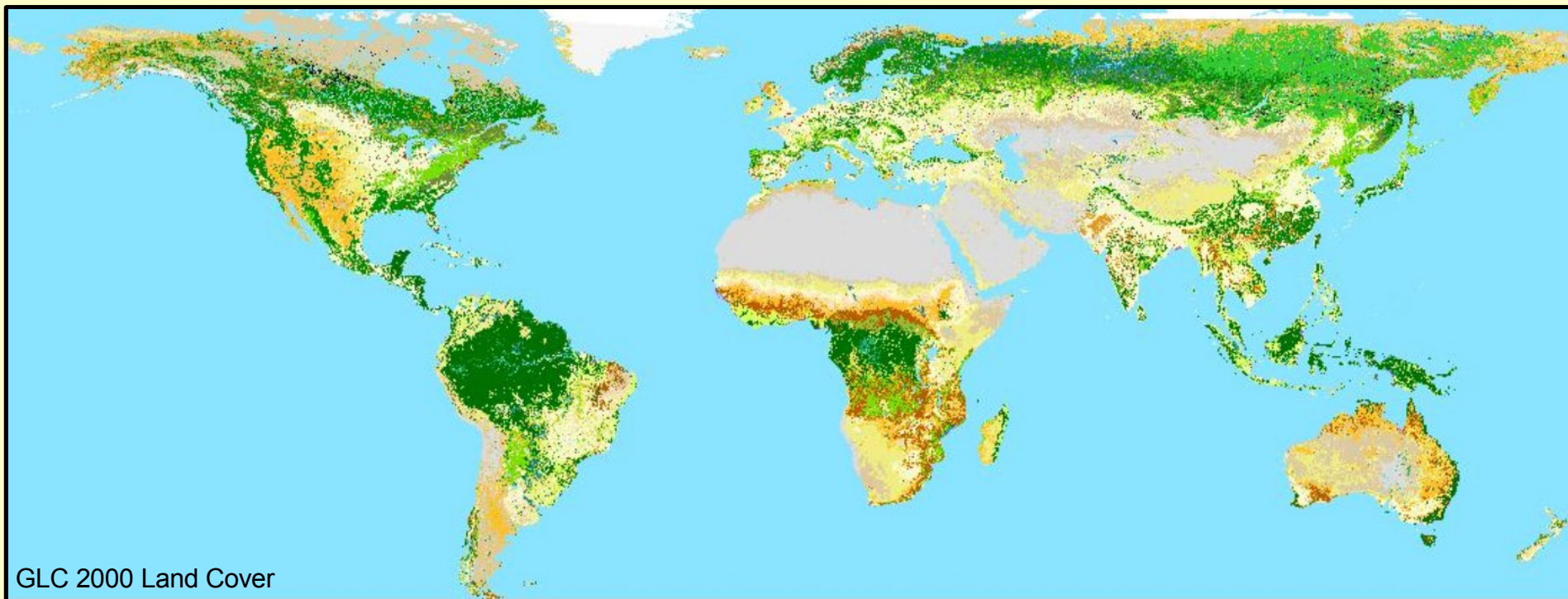
Auxiliary data e.g. climate

The objective: Split the land cover classes in homogeneous ecosystems using the NDVI profiles (pixel base) and auxiliary data by a classification process



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GLC2000 land cover map at 1km resolution (from JRC,2003)

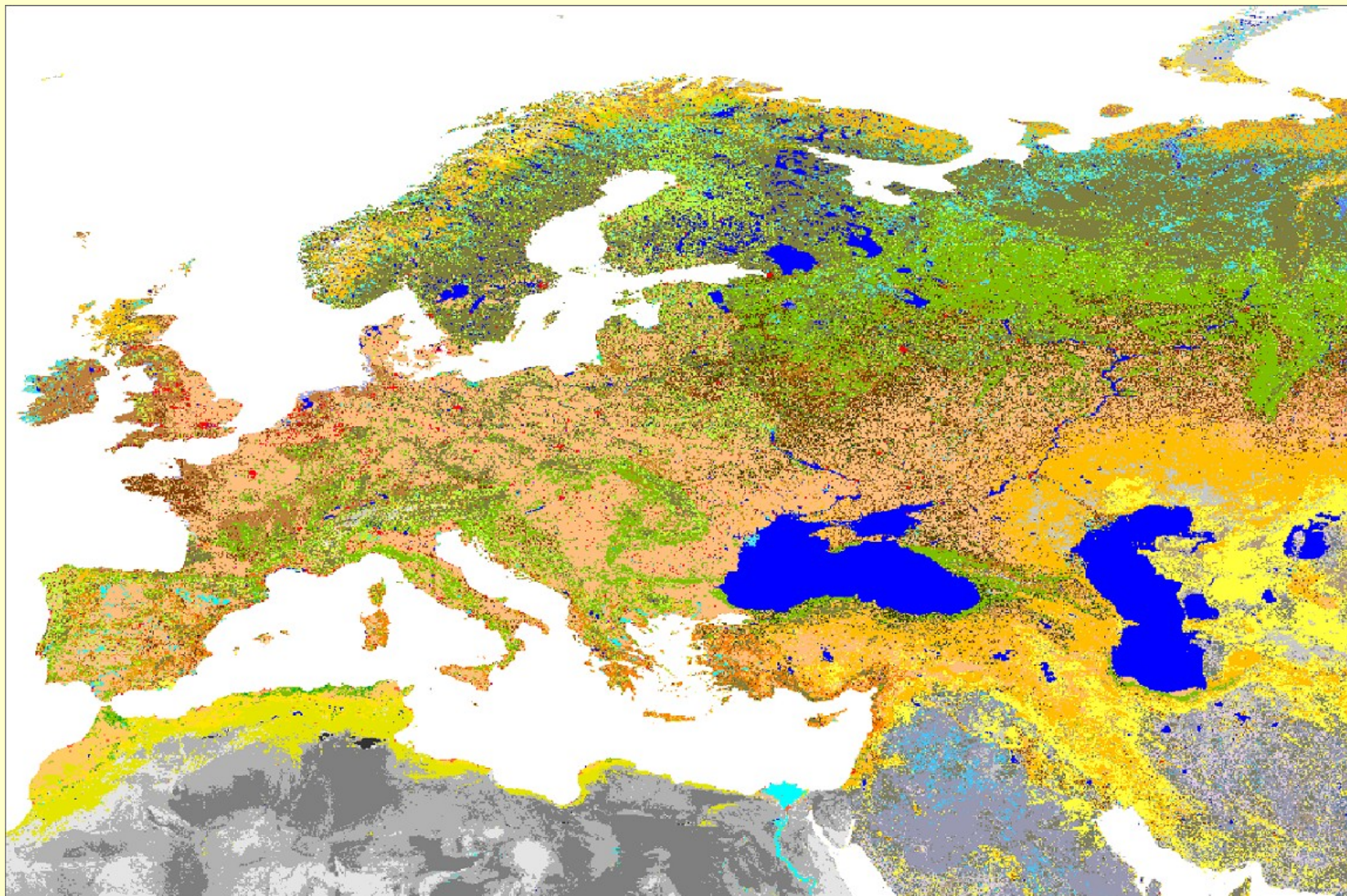


 Tree Cover, broadleaved, evergreen	 Mosaic: Tree Cover/Other NV*	 Mosaic: Cropland/Tree Cover/Other NV*
 Tree Cover, broadleaved, deciduous, closed	 Tree Cover, brunt	 Mosaic: Cropland/Shrub/Grass
 Tree Cover, broadleaved, deciduous, open	 Shrub Cover, closed-open, evergreen	 Bare Areas
 Tree Cover, needle-leaved, evergreen	 Shrub Cover, closed-open, deciduous	 Water Bodies
 Tree Cover, needle-leaved, deciduous	 Herbaceous Cover, closed-open	 Snow and Ice
 Tree Cover, mixed leaf type	 Sparse herbaceous or sparse shrub cover	 Artificial Surfaces and associated areas
 Tree Cover, regularly flooded, fresh water	 Regularly flooded shrub/herbaceous cover	 No data
 Tree Cover, regularly flooded, saline water	 Cultivated and managed areas	

*** NV: Natural Vegetation**

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Land cover map used in input of the algorithm: GLC2000+CORINE2000
76 classes



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Climate

Variable	Spatial resolution	Temporal resolution	Accuracy	Availability
Global models (NWP/Climate)	<u>Users requirements for surface parameters</u>			
Land cover	1km	5 years		1 year
LAI	1km	10-days	10%	1 year
fraction vegetation	1km	10-days	5%	1 year
albedo	1km	10-days	1%	1 year
rugosity	5km/20km	10-days	5%	1 year
émissivity	5km/20km	10-days	1%	1 year
surface temperature	5km/20km	1 hour	1K	1 year
soil moisture	5km/20km	10-days	0.04 m3m-3	1 year
snow (mask,quantity,albedo)	5km	daily	5%	1 year

Operationnal

Operationnal meso-scale models				
Land cover	250m	1 year		3 months
LAI	250m	10-days		near real-time
fraction vegetation	250m	10-days		near real-time
albedo	250m	10-days		near real-time
rugosity	250m	10-days		near real-time
émissivity		10-days		
surface temperature		1 hour		real time
soil moisture		6 hours		real time
snow (mask,quantity,albedo)	1km	6 hours		real time

Research

Research meso-scale models				
Land cover	10-20m	1 year		3 months
LAI	100m	10-days		near real-time
fraction vegetation	100m	10-days		near real-time
albedo	100m	10-days		near real-time
rugosity		10-days		near real-time
émissivity		10-days		
surface temperature		1 hour		real time
soil moisture		6 hours		real time
snow (mask,quantity,albedo)		6 hours		real time

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NDVI satellite data: comparison between I & II

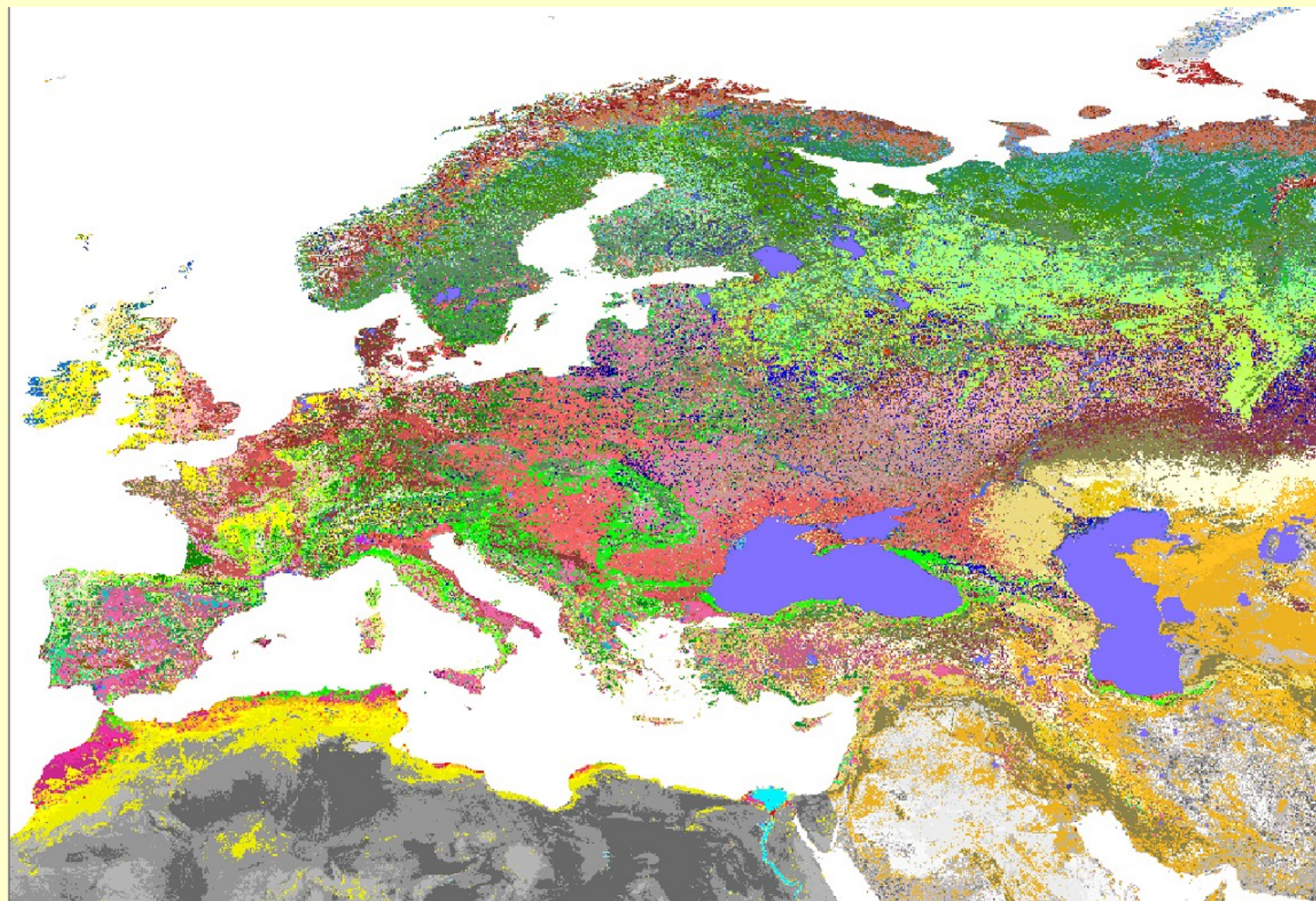
NDVI (Normalized Difference Vegetation Index)

$$\text{NDVI} = (\text{NIR-RED}) / (\text{NIR+RED}) = (\text{B3-B2}) / (\text{B2+B3})$$

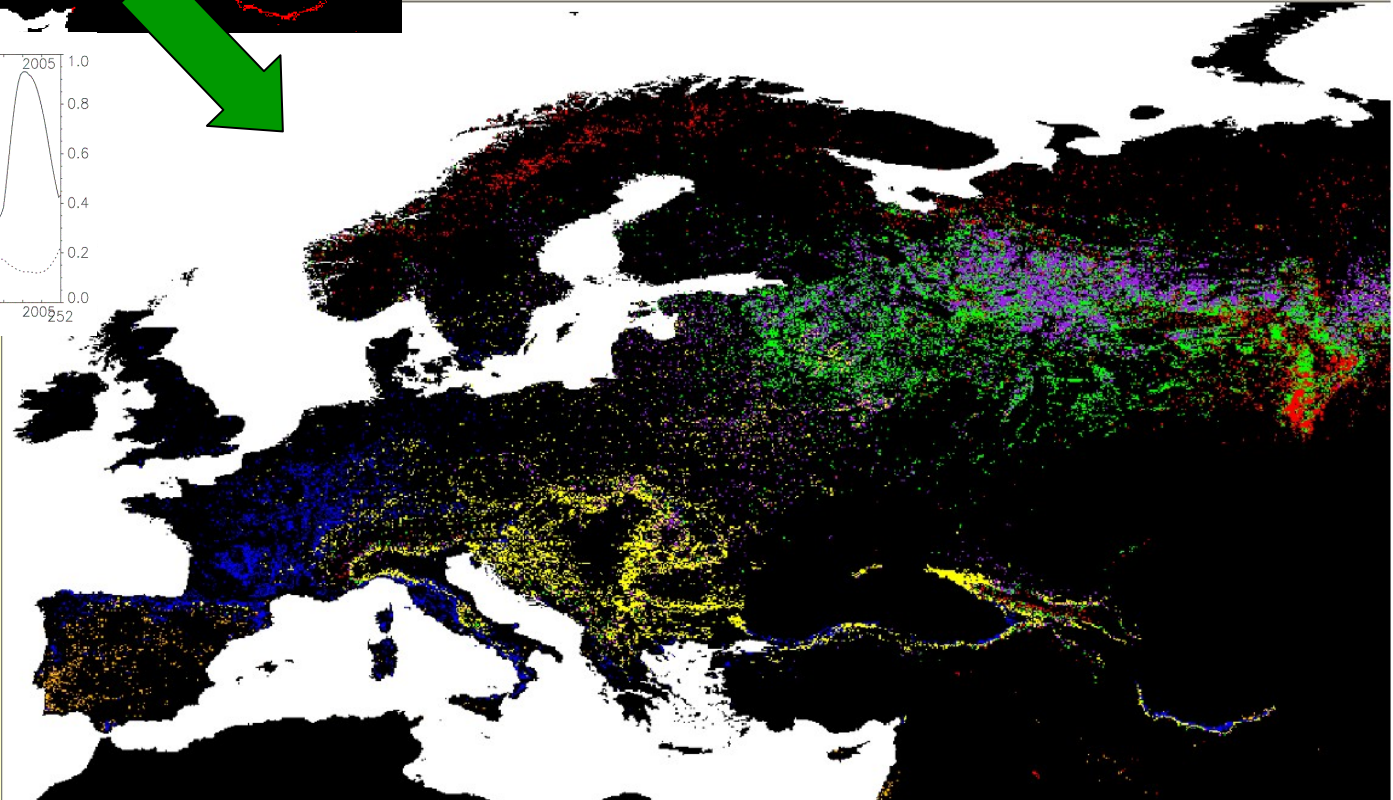
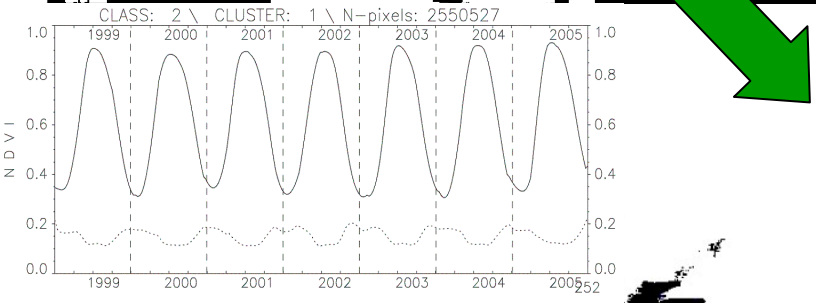
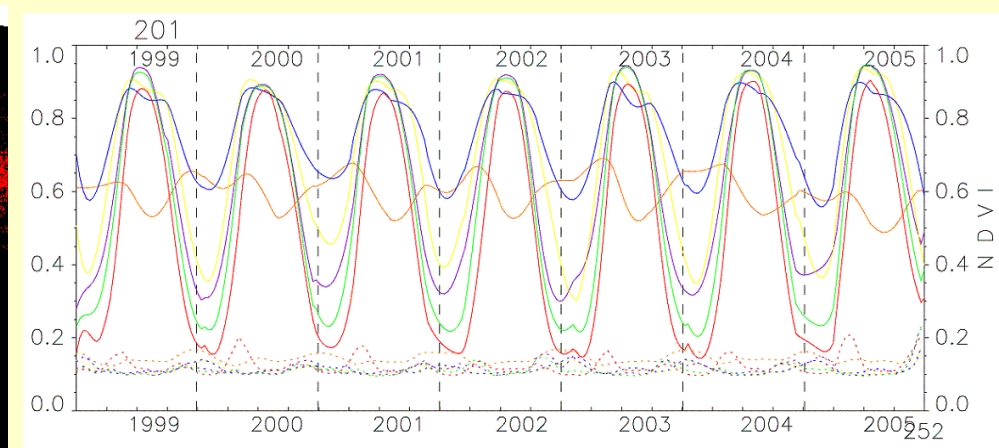
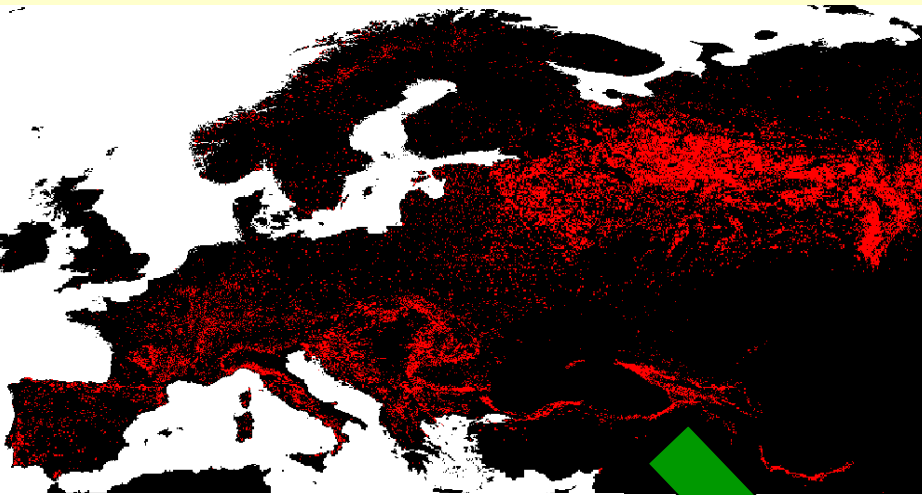
	<i>ECOCLIMAP-I</i>	<i>ECOCLIMAP-II</i>
<i>SOURCE</i>	NOAA/AVHRR	SPOT/VEGETATION
<i>SPATIAL RESOLUTION</i>	1km resampled	1km true
<i>TEMPORAL RESOLUTION</i>	Monthly	10-days
<i>TIME SERIES</i>	1 annual cycle	7 annual cycles (1999-2005)

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Resulting land cover map: 161 ecosystems

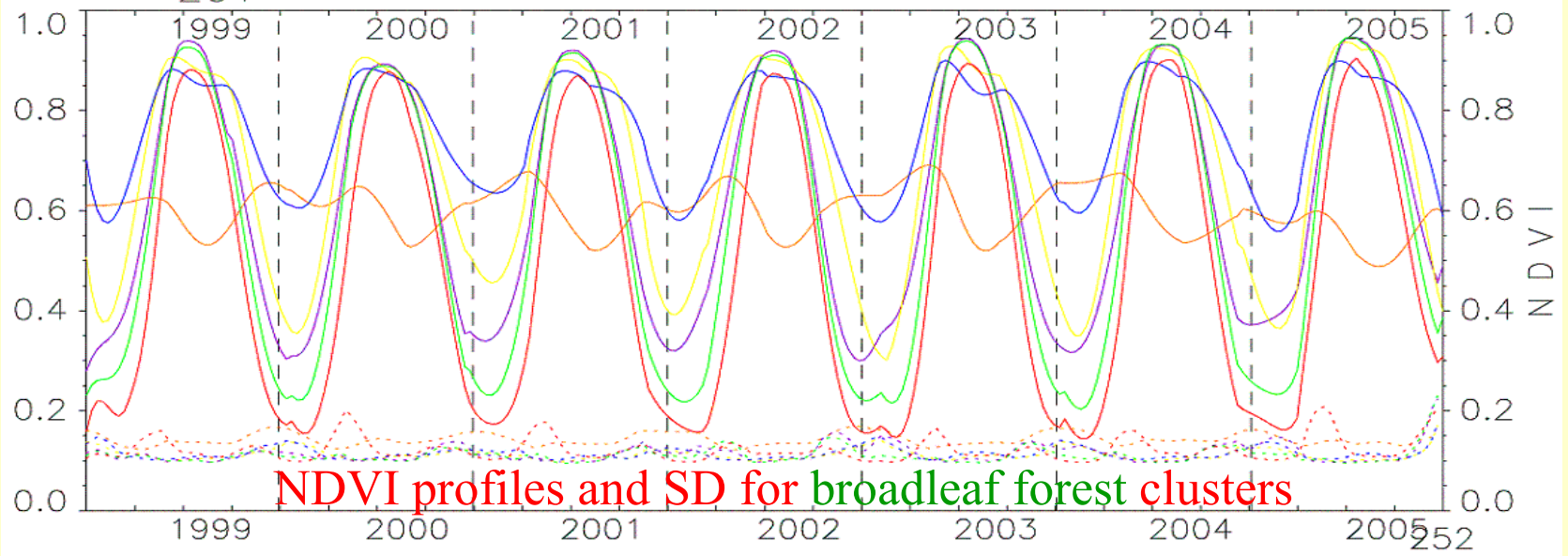
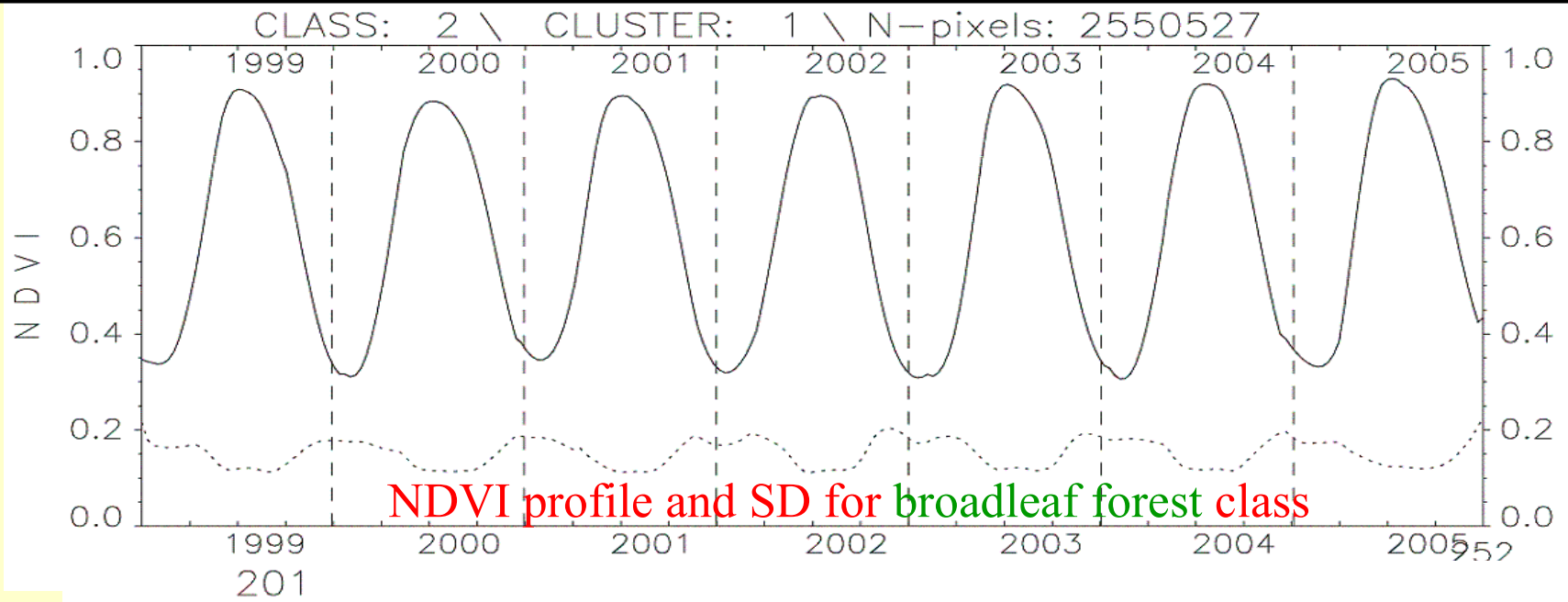


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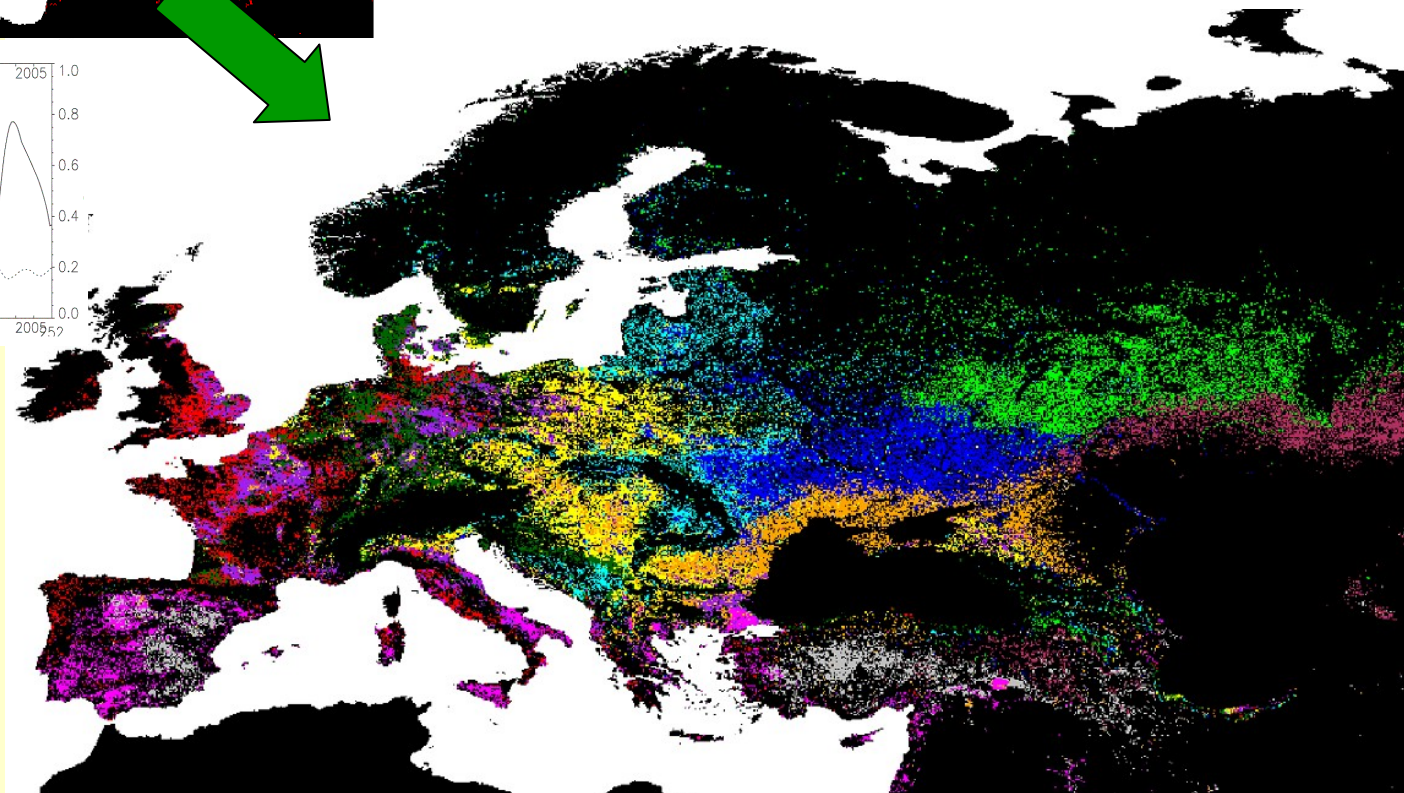
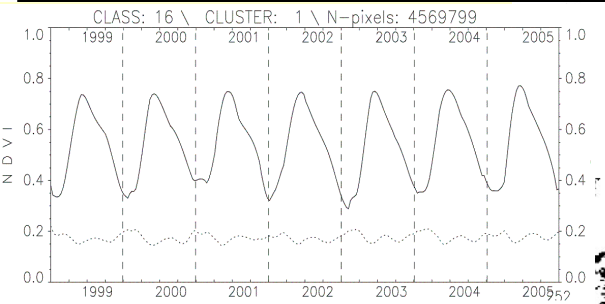
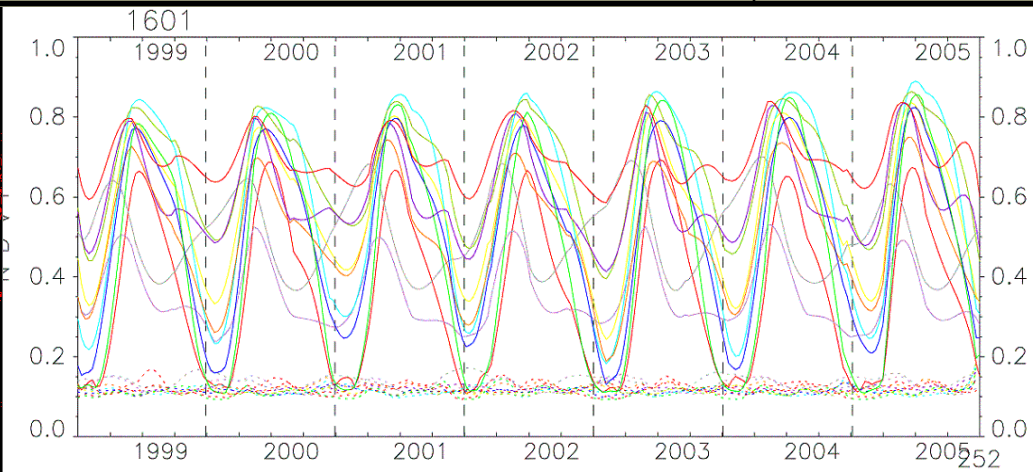
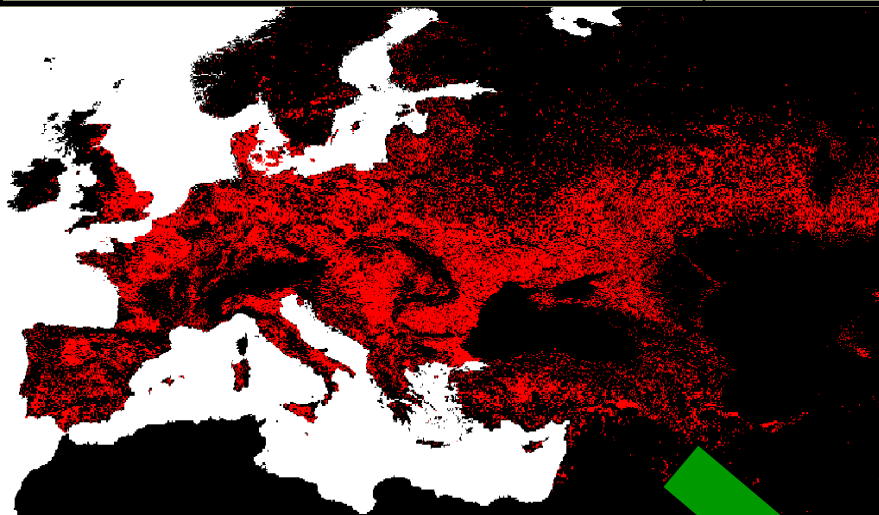


Broadleaf forests
ecosystems

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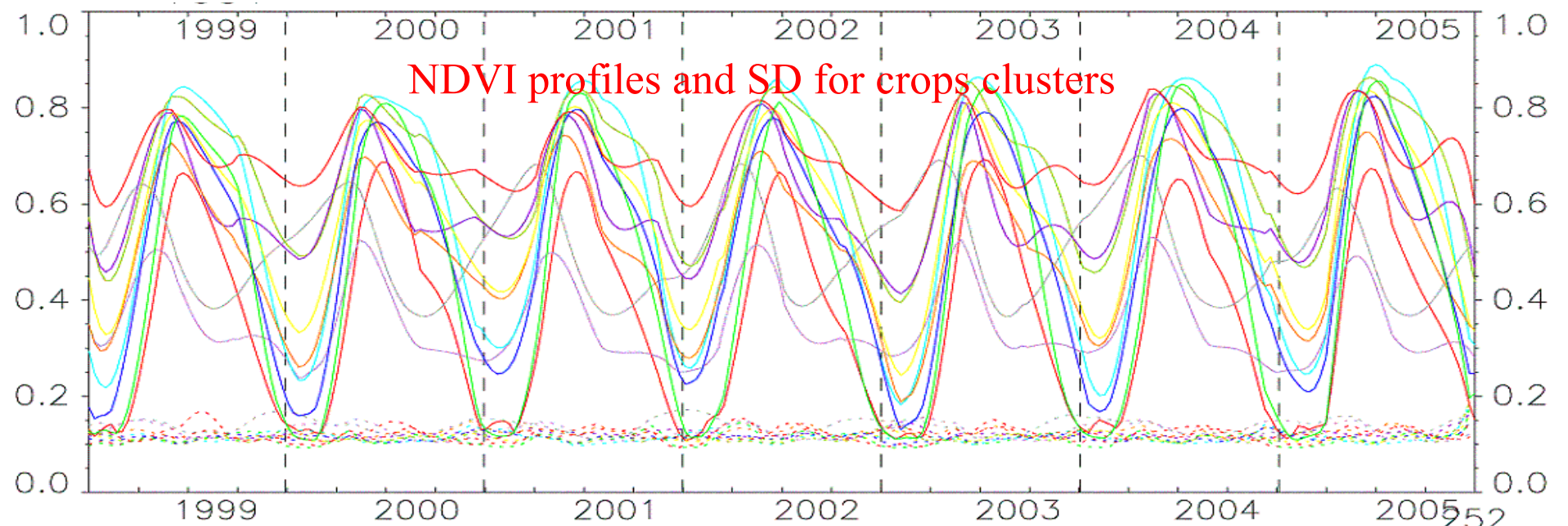
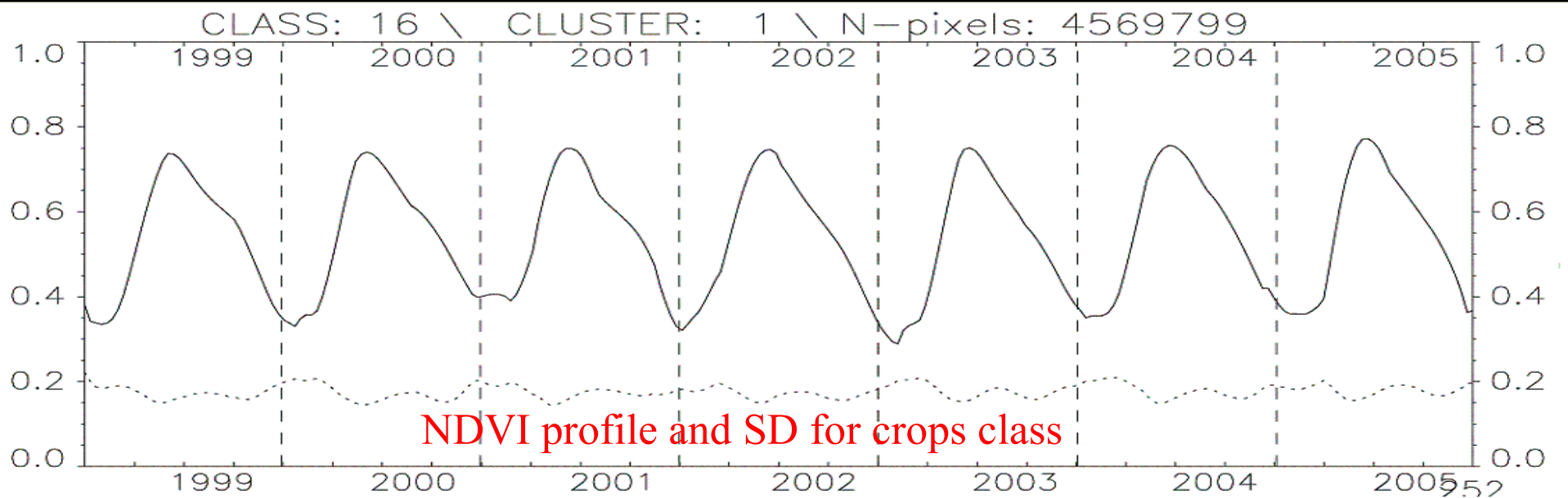


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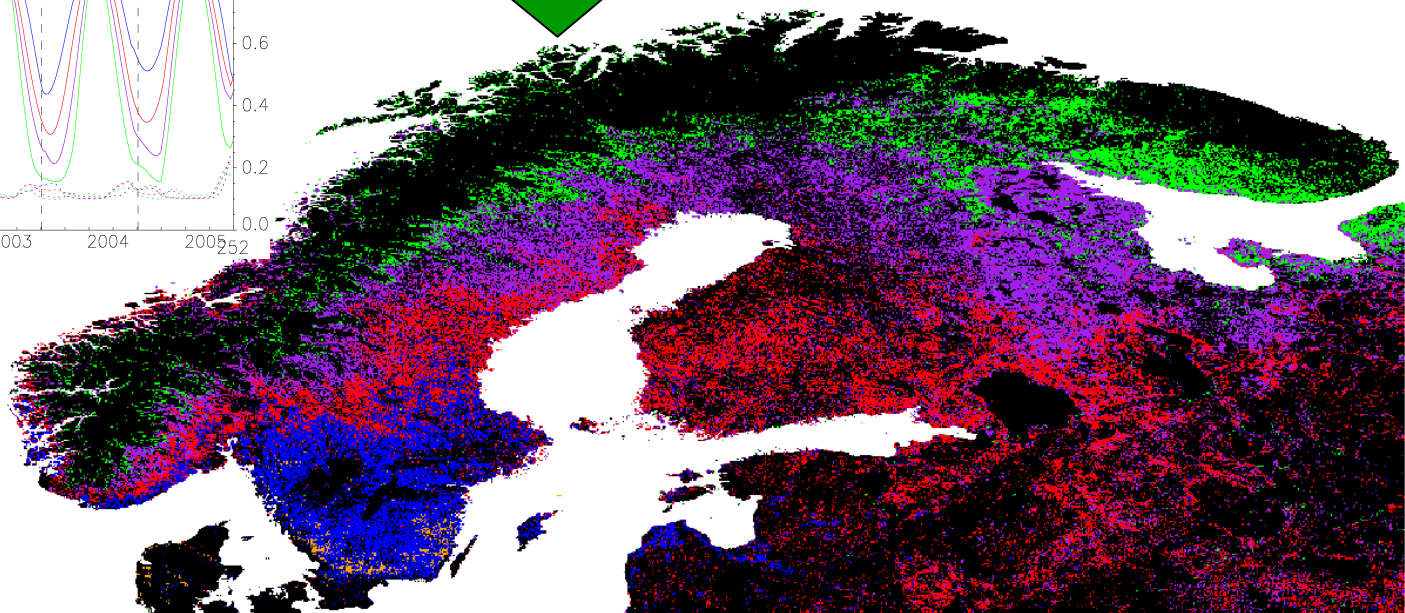
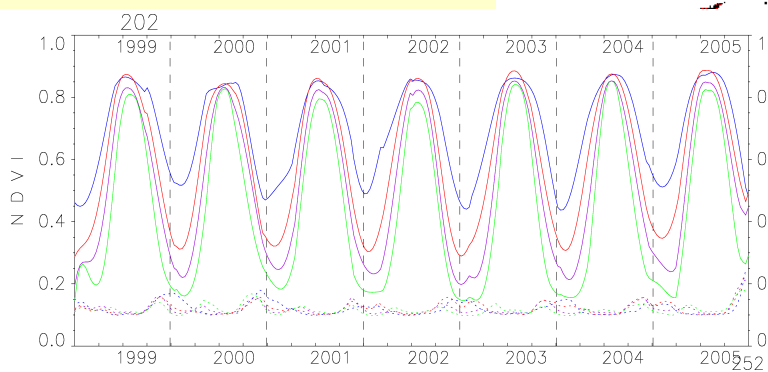
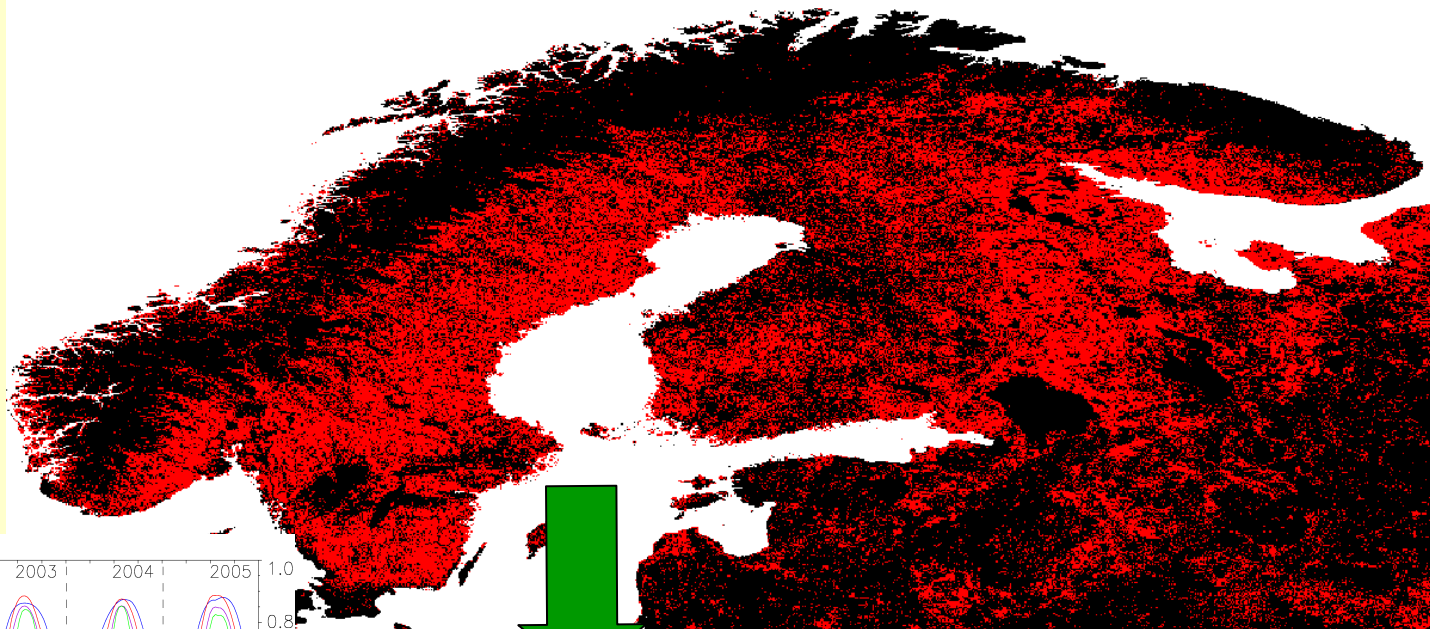
Crops
ecosystems

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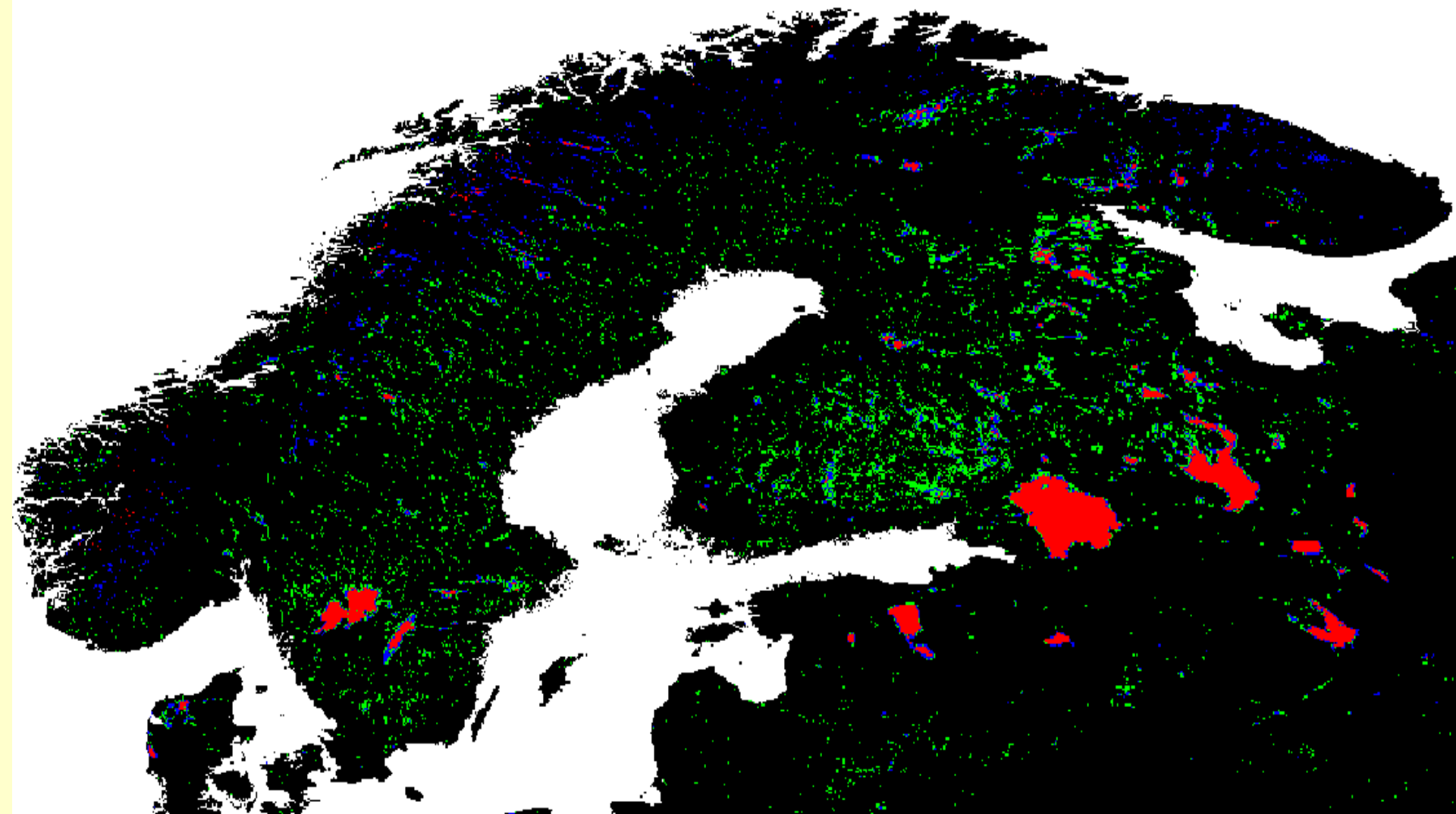
Needle-leaf Forests on Scandinavia before classification



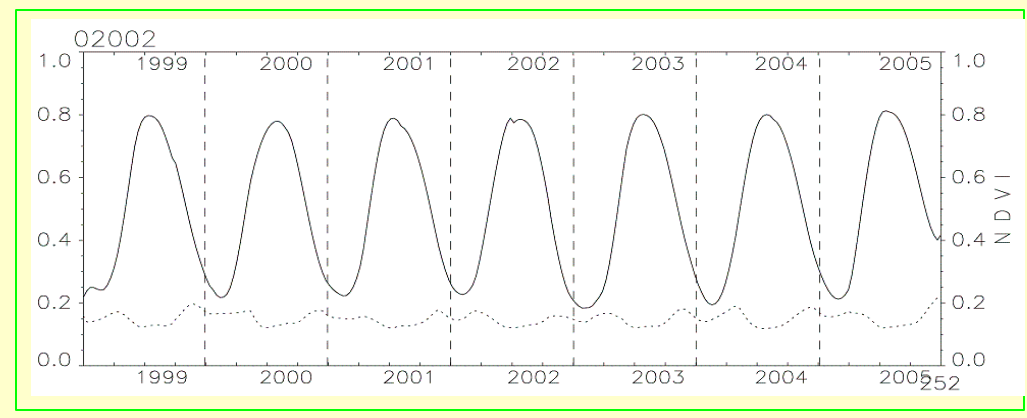
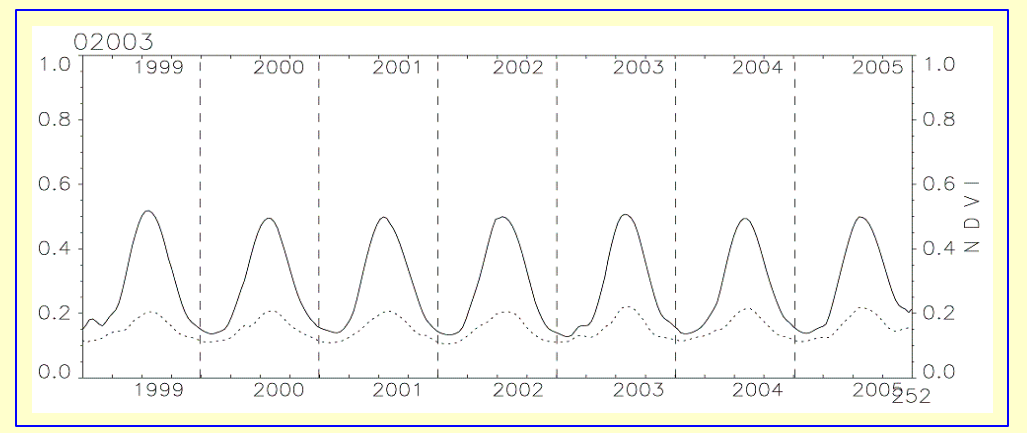
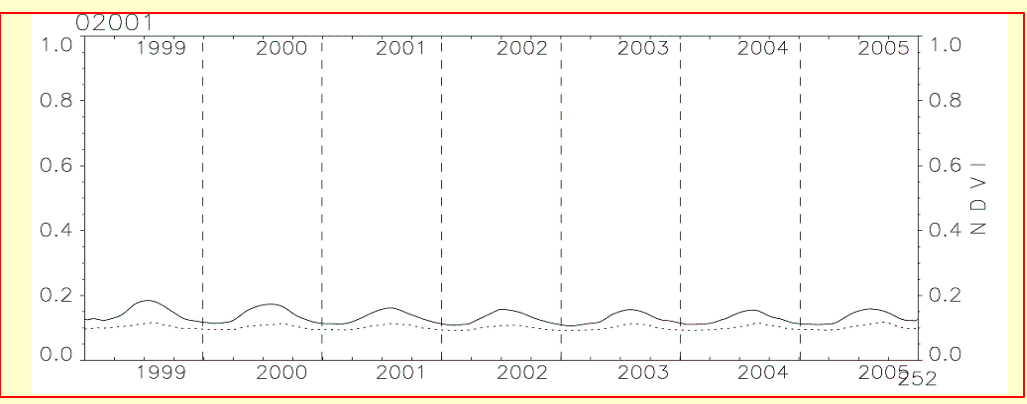
Needle-leaf Forests on Scandinavia after classification

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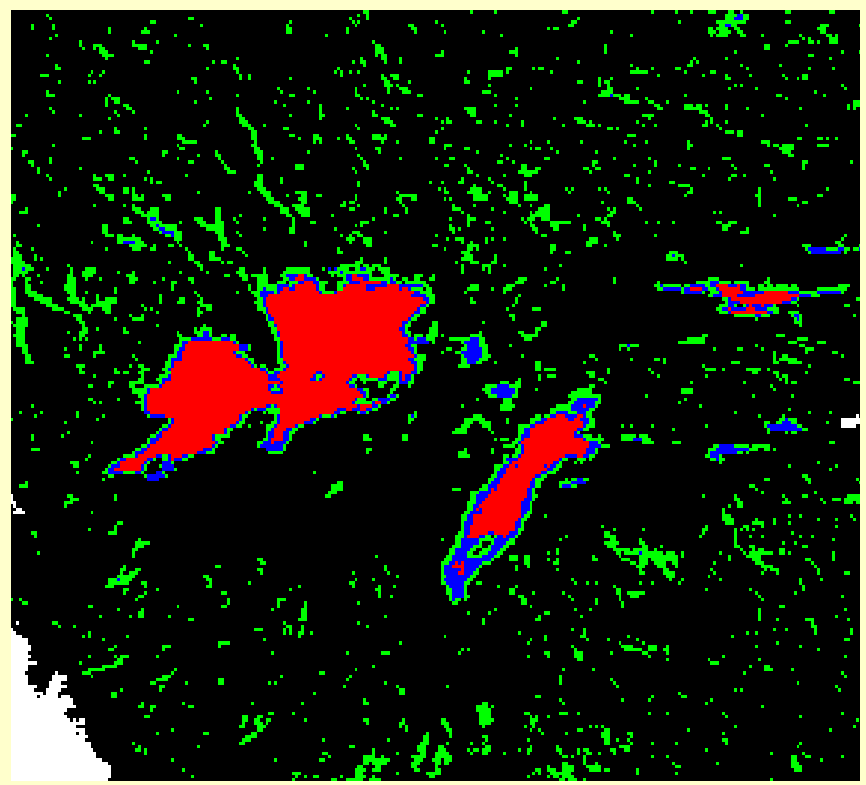
ECOCLIMAP-II: inland waters



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ECOCLIMAP-I			ECOCLIMAP-II			



Inland water clusters



1.1. Land cover map	1.2. Surface parameters	1.3. Results	2.1. New concept	2.2. Input data	2.3. results	3. Conclusion and prospects
ECOCLIMAP-I			ECOCLIMAP-II			

ECOCLIMAP-II: urban areas: example



1.1. Land cover map	1.2. Surface parameters	1.3. Results	2.1. New concept	2.2. Input data	2.3. results	3. Conclusion and prospects
ECOCLIMAP-I			ECOCLIMAP-II			

List of urban classes in ECOCLIMAP-II

- **GLC african cities**, 2 clusters, *12978 px*
- **CORINE Continuous urban fabric**, 4 clusters, *2850 px*
- **CORINE discontinuous urban fabric**, 6 clusters, *161565 px*
- **CORINE Industrial or commercial units**, *6836 px*
- **CORINE Road and rail network and associated land**, *78 px*
- **CORINE Port areas**, *372 px*
- **CORINE Airports**, 2 clusters, *2255 px*
- **CORINE Mineral extraction sites**, *2447 px*
- **CORINE Dump sites**, *446 px*
- **CORINE Construction sites**, *230 px*
- **CORINE Green urban areas**, *783 px*
- **CORINE Sport and leisure facilities**, *2534 px*

→ 22 classes

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ECOCLIMAP 2 – New developments

- New concept and new landcover maps to determine ecosystems
- Interannual database with the SPOT/VEGETATION data
- Improvement of surface parameter fields by comparison with other datasets (MODIS, SAF Land)
- with a particular effort on the albedo fields
- using CYCLOPES and MSG products

Available in summer 2007 over Europe

1.1. Land cover map	1.2. Surface parameters	1.3. Results	2.1. New concept	2.2. Input data	2.3. results	3. Conclusion and prospects
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prospects

- **Ending of the map on Europe: control, class naming, attribution of parameters**
- **Comparison with MODIS and MERIS (GLOBCOVER)**
- **Product for the whole globe**
- **Numerical simulations to validate the database**
- **Resolution brought to 100m on chosen areas (Europe CORINE)**

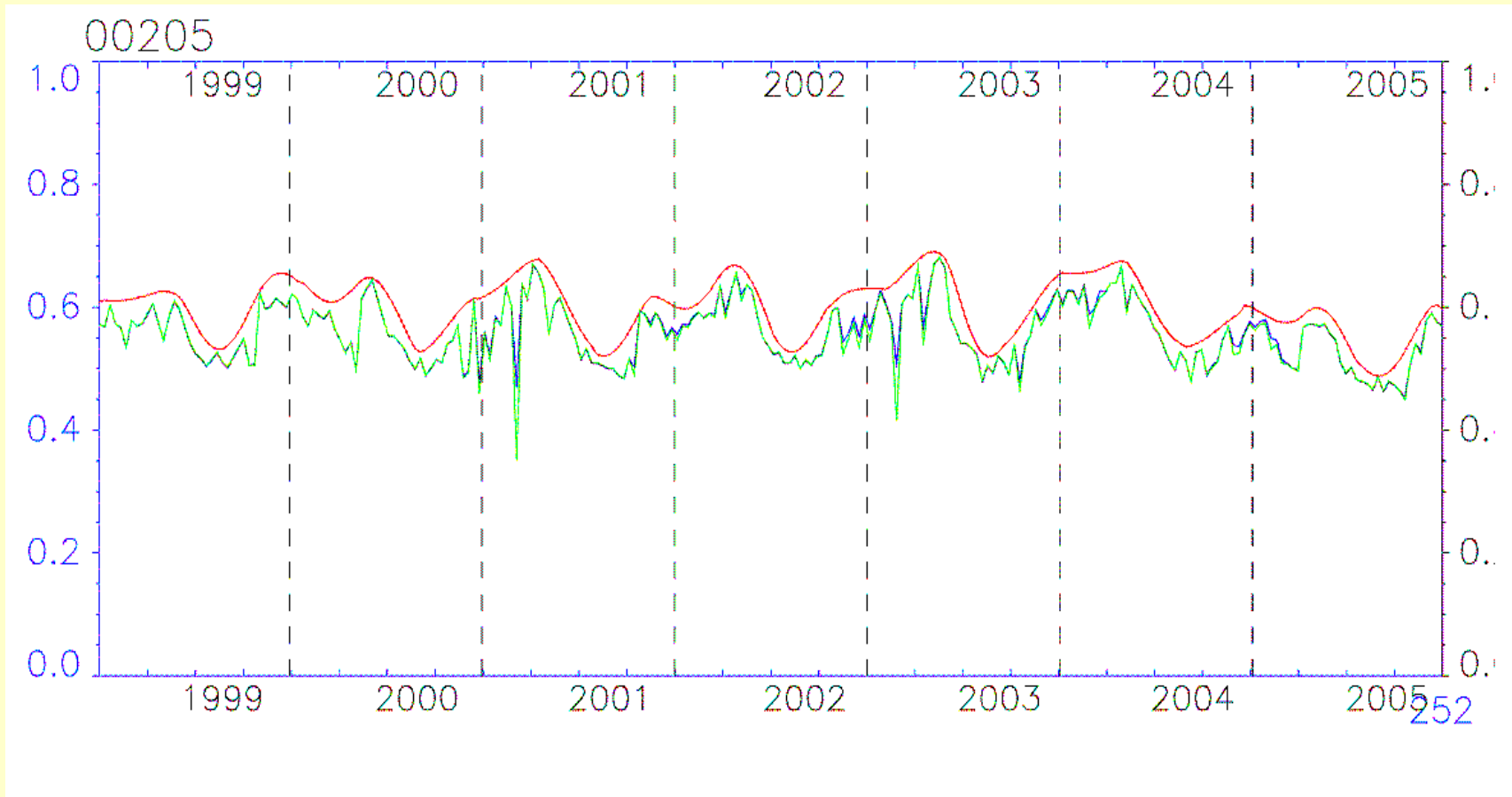
Return of the call to ALADIN/HIRLAM partners for data and informations about land use on their own countries (call in June, 2006)

Answers from:

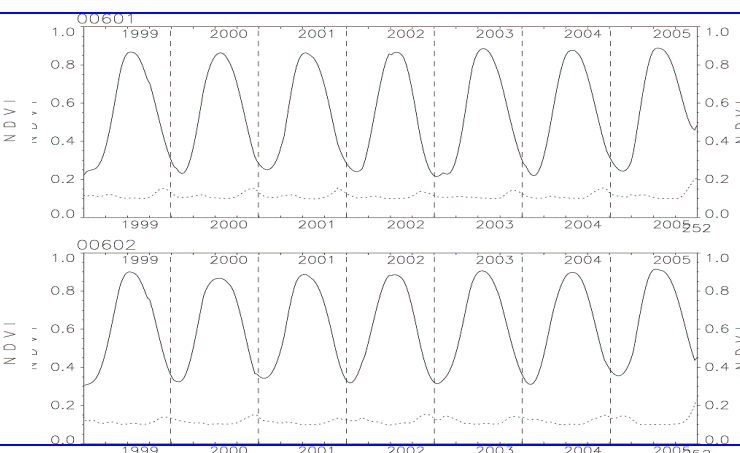
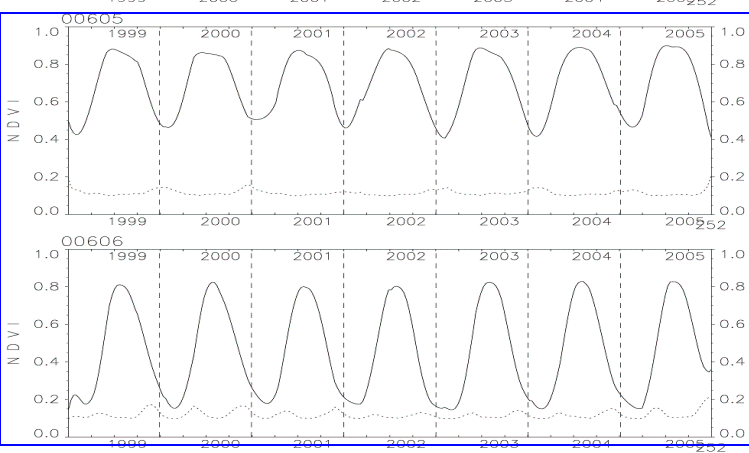
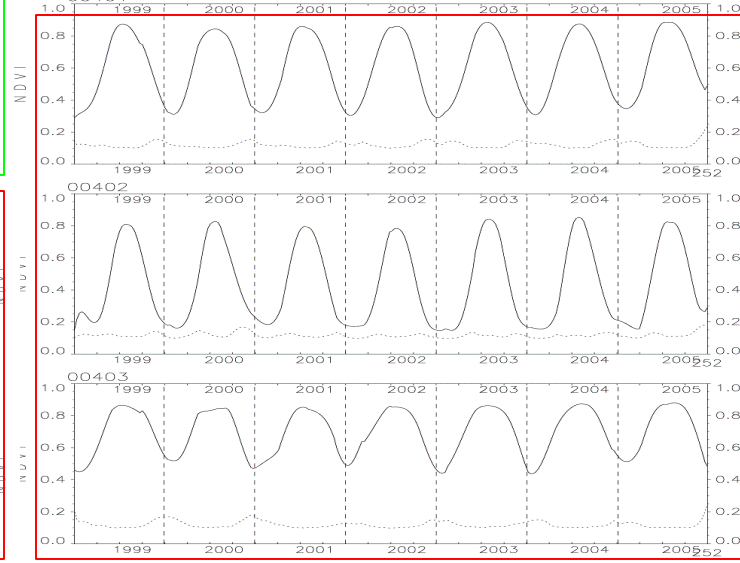
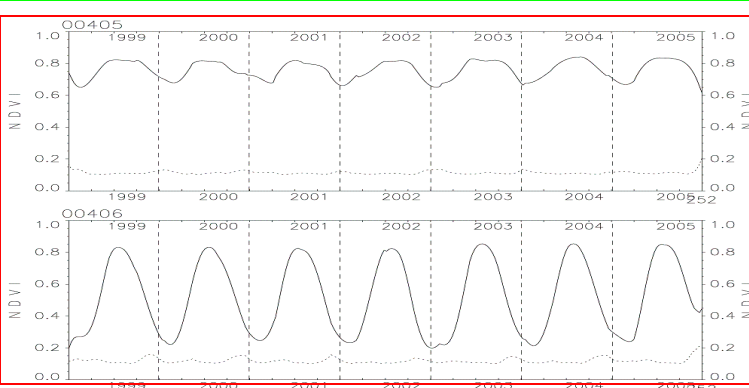
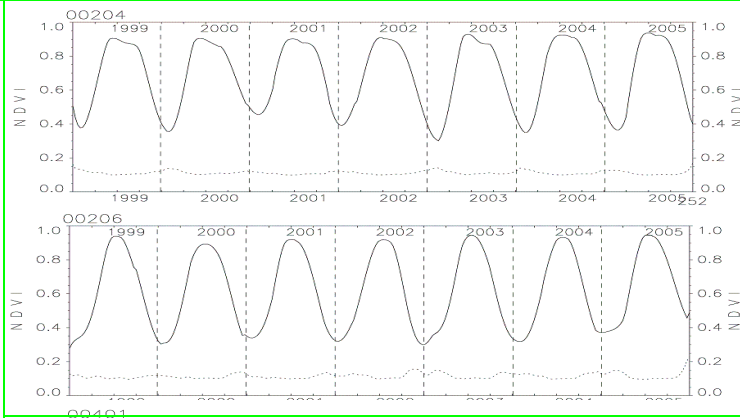
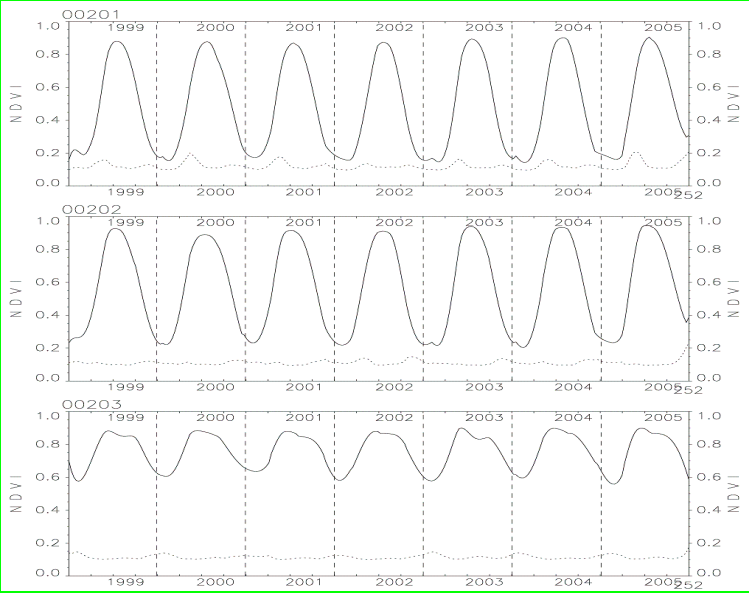
- NORWAY: <http://nijos.no> provides a land cover map on Norway: 8 classes, 100m resolution
- DANEMARK: no data available
- SLOVAKIA: no data available

Smoothing NDVI time profiles

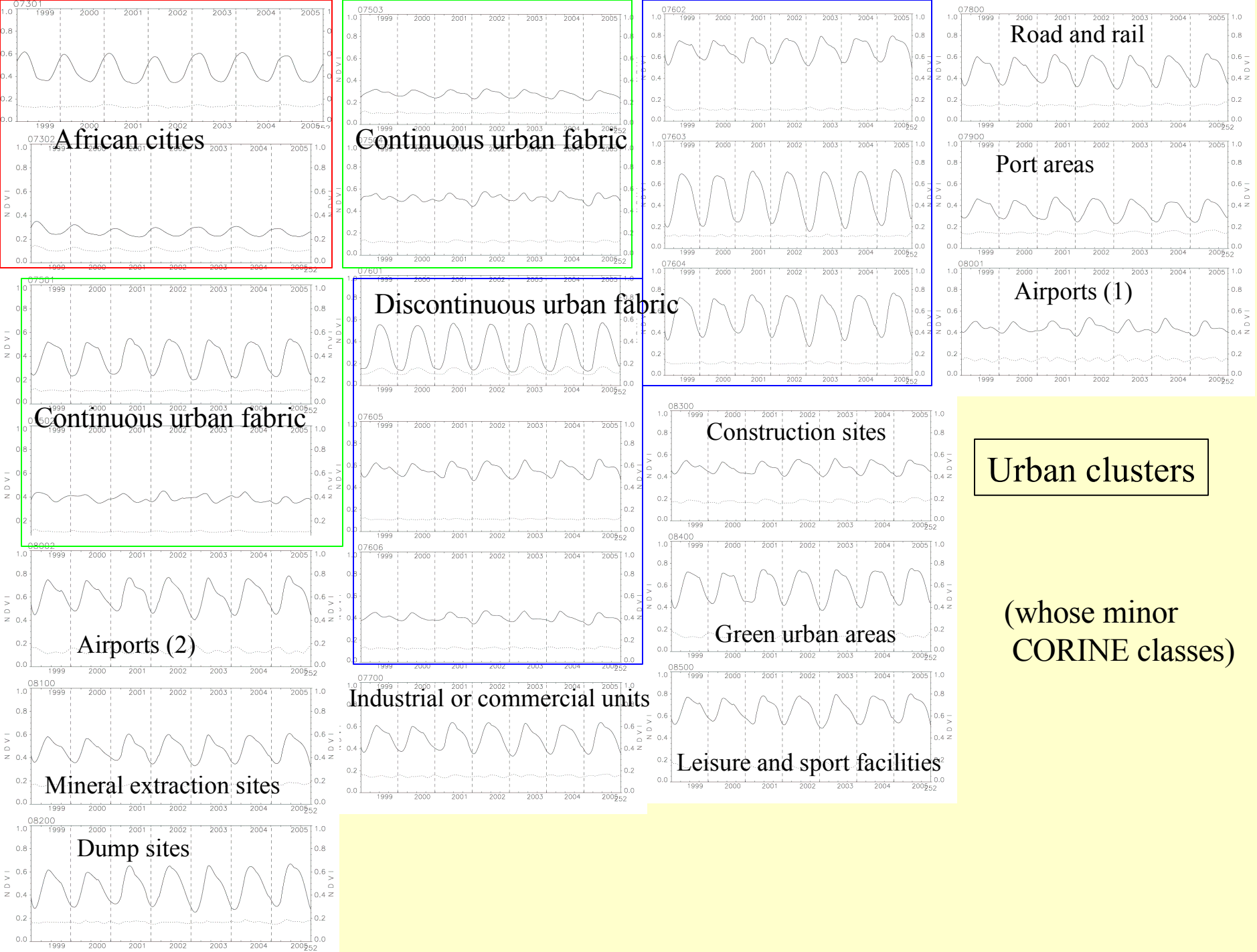
-> a 4th degree polynomial fit, scaled at the maximum of raw data
(assuming that maximum value of NDVI is the one correct)



NDVI forests Profiles on scandinavia



Broadleaf
Coniferous
mixte



Choice of the clusters' number

1st classification: big numbers of clusters

**Analysis of mean profiles, standard deviation,
geographic localisation for each cluster**

2, 3 iterations

Classification with reduced numbers of clusters



161 classes over Europe