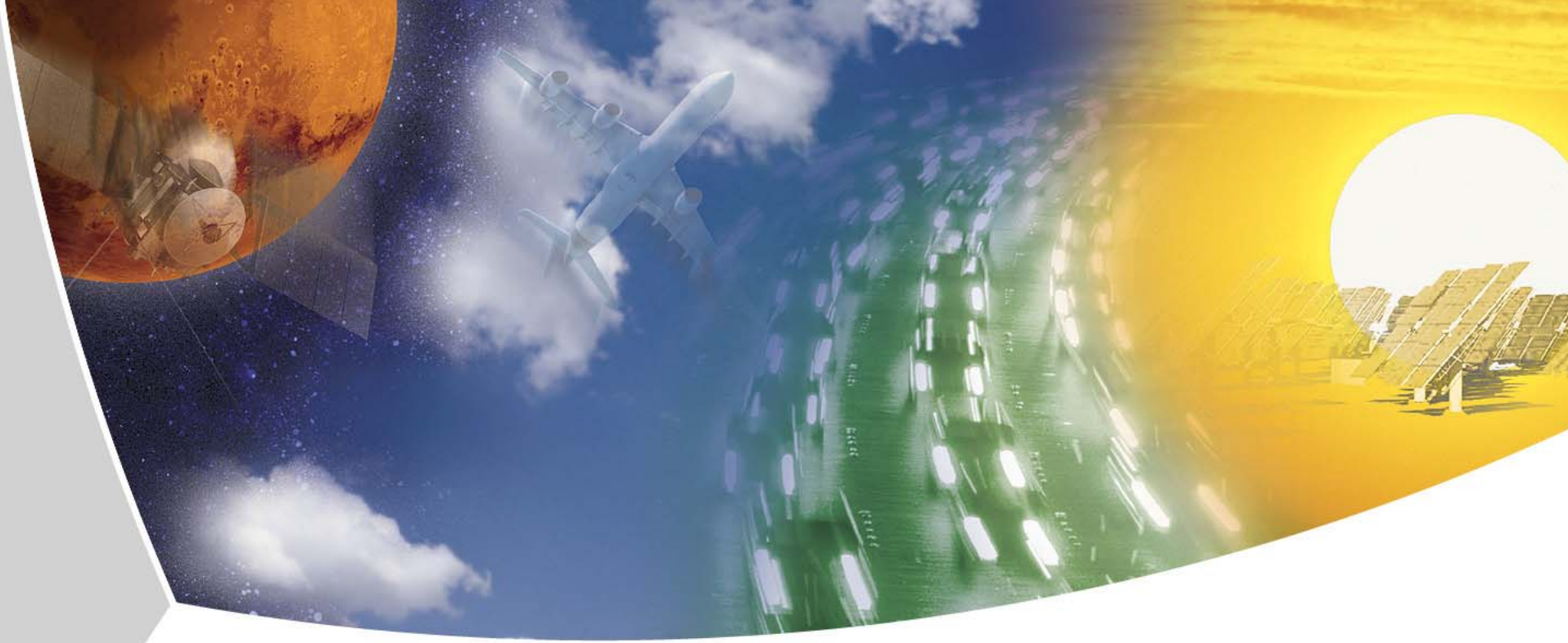


# Remote Sensing and Modeling: A tool to provide the spatial information for biomass production potential

K. P. Günther, E. Borg, K. Wißkirchen, M. Schroedter-Homscheidt, B. Fichtelmann, J. Gehrung

Deutsches Zentrum
DLR für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

# Introduction

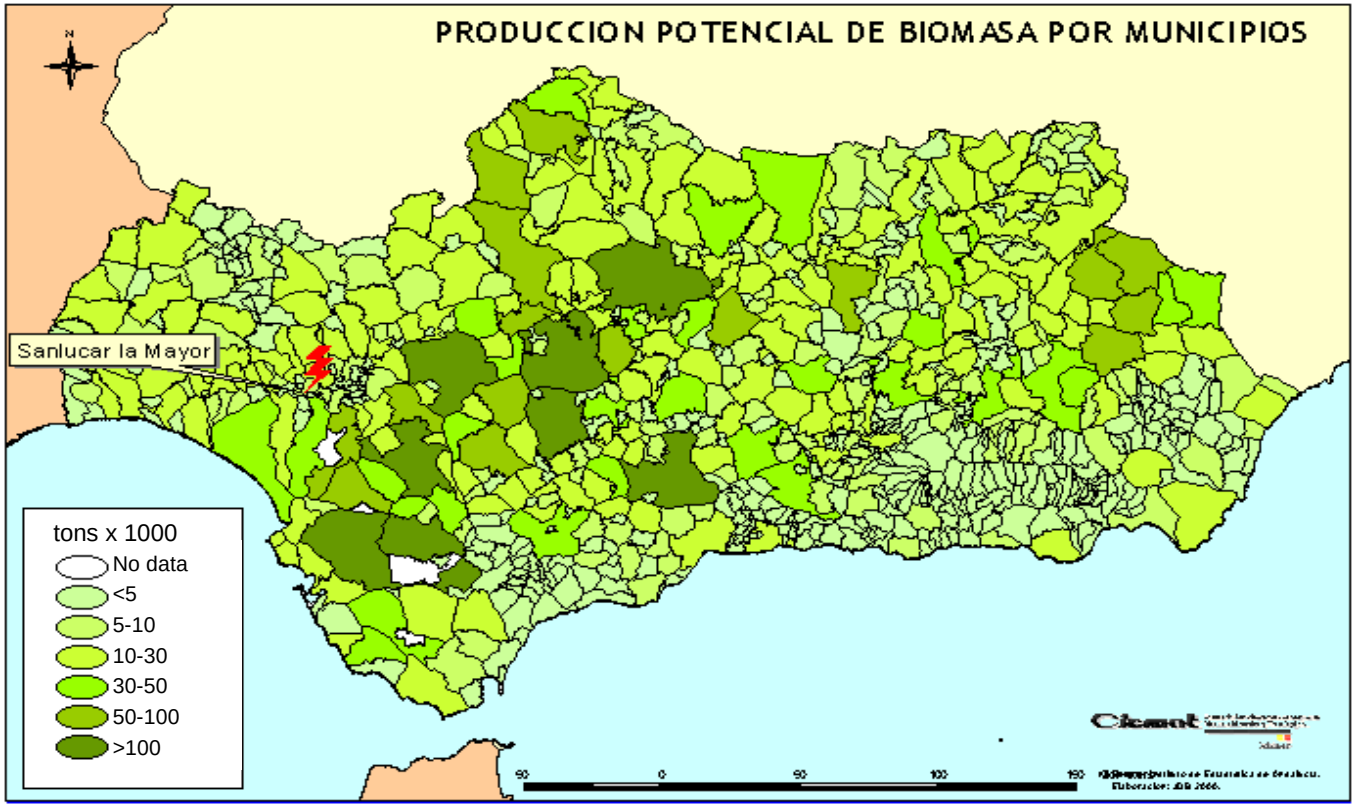
Biomass resource assessment today:

1. Regional or continental estimation of biomass (forestry and agriculture) is based on **statistics** including land cover maps
   -> **EUROSTAT, FAOSTAT**

2. Use of biomass is forced by the evaluation of **restrictions** e.g. technical and environmental constraints associated with
   - slope (-> digital elevation model)
   - soils (-> map)
   - wildlife habitat (-> map) and other site factors.

3. Currently, there is a lack of **reliable, dynamic data** delineating the location, quantity, and quality of available biomass (-> no differentiation with regard to "**energy plants**").

# Typical biomass potential map




- Spatial resolution is limited by the resolution for statistics (in Europe NUTS)

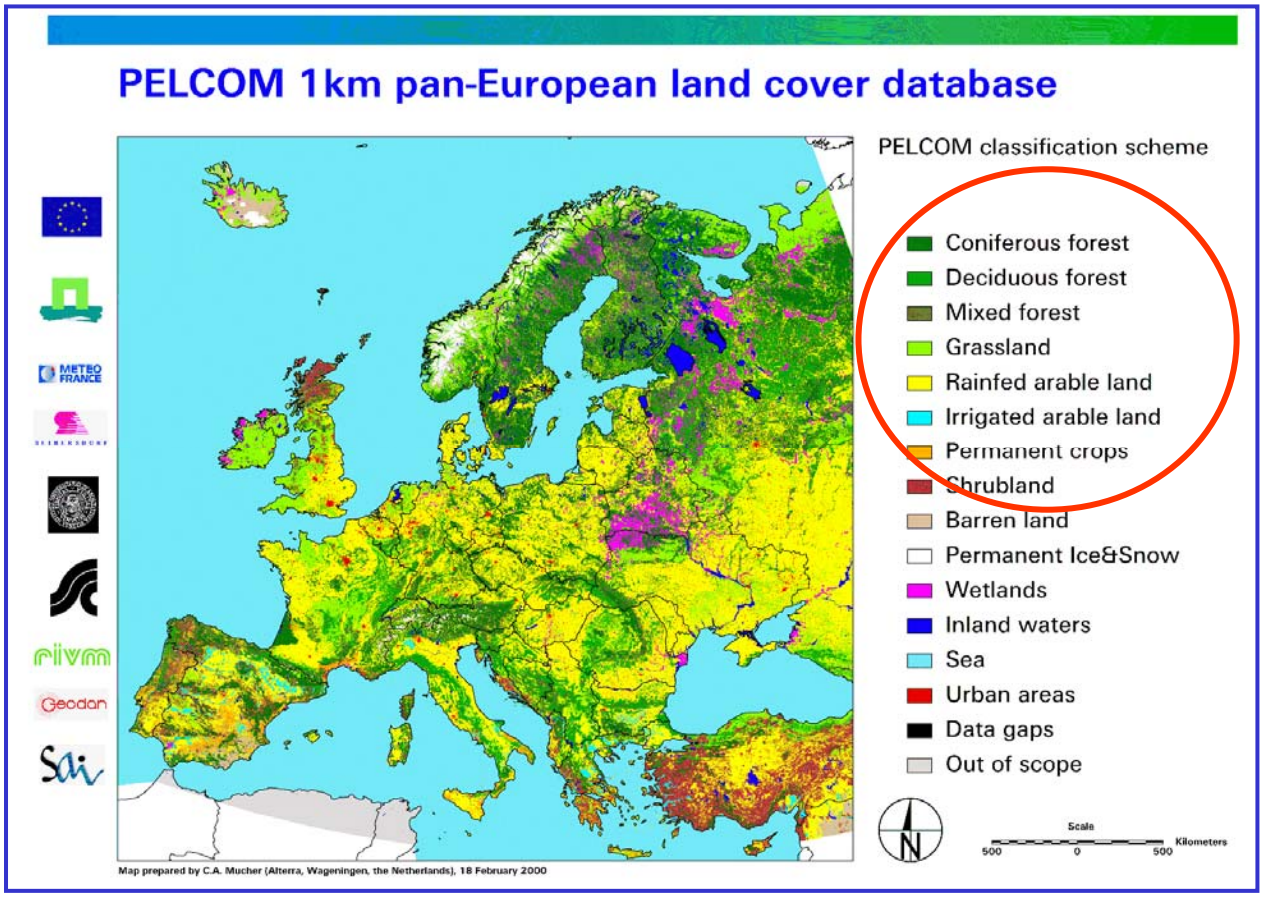
# Goal for the future

Biomass resource assessment tomorrow:

1. Use **remote sensing** data to derive high quality information on land cover / land use and on plant status parameter (leaf area index, temperature,..)
2. Feed a **carbon model** with the remote sensed products to determine the yearly carbon increase (Net Primary Productivity, NPP).
3. Find a relation for biomass ~ NPP.

# Land cover classification (LCC)

Input parameter for carbon modeling



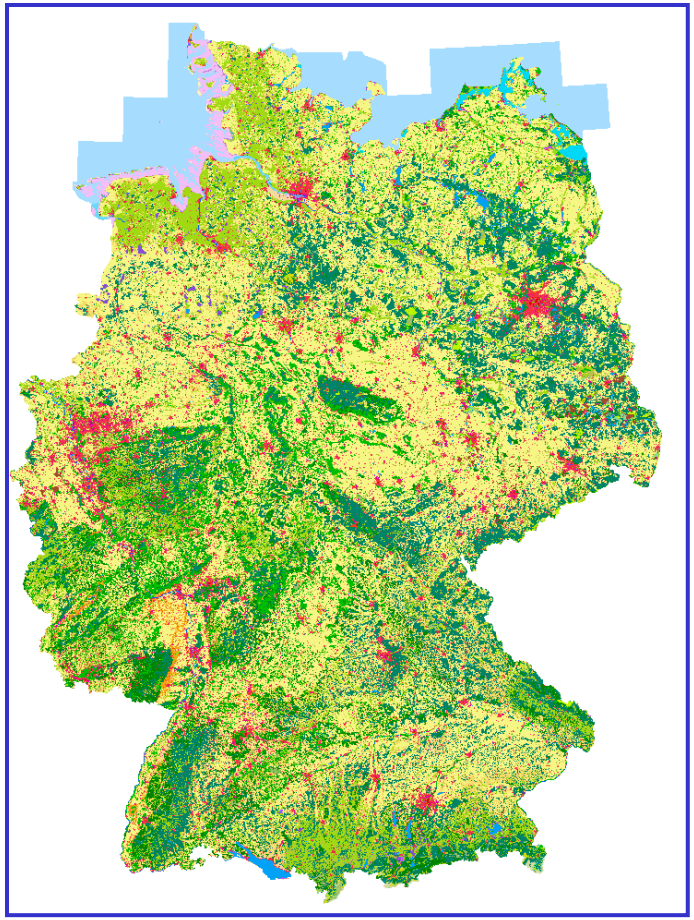

**PELCOM Land Cover**
based on remote sensing data
- AVHRR -

Scale: 1km x 1km
Legend: 16 classes

Reference: 1995

# Land cover classification (LCC)

## Input parameter for carbon modeling



**CORINE Land Cover (CLC 2000)**
based on remote sensing data
- LANDSAT, SPOT -

| | |
|---|---|
| Scale: | 1 : 100,000<br>-> 100m x 100m |
| Legend: | 44 classes (Europe)<br>37 classes (Germany) |
| Reference year: | 2000 |

**ARTIFICIAL SURFACES**
URBAN FABRIC
111 Continuous urban fabric
112 Discontinuous urban fabric
INDUSTRIAL, COMMERCIAL AND TRANSPORT UNITS
121 Industrial, commercial and public units
122 Road and rail networks and associated land
123 Port areas
124 Airport
MINES, DUMPS AND CONSTRUCTION SITES
131 Mineral extraction sites
132 Dump sites
133 Construction sites
ARTIFICIAL NON-AGRICULTURAL VEGETATED AREAS
141 Green urban areas
142 Sport and leisure facilities

**AGRICULTURAL AREAS**
ARABLE LAND
211 Non-irrigated arable land
PERMANENT CROPS
221 Vineyards
222 Fruit trees and berries plantations
PASTURES
231 Pastures
HETEROGENEOUS AGRICULTURAL AREAS
242 Complex cultivation patterns
243 Land principally occupied by agriculture, with significant areas of natural vegetation

**FOREST AND SEMINATURAL AREA**
FORESTS
311 Broad-leaved forest
312 Coniferous forest
313 Mixed forest
SCRUBS AND/OR HERBACEOUS VEGETATION
321 Natural grassland
322 Moors and heathland
324 Transitional woodland-scrub
OPEN SPACES WITH LITTLE OR NO VEGETATION
331 Beaches, dunes, sand
332 Bare rock
333 Sparsely vegetated areas
334 Burnt areas
335 Glaciers and perpetual snow

**WETLANDS**
INLAND WETLANDS
411 Inland marshes
412 Peat bogs
COASTAL WETLANDS
421 Salt marshes
423 Intertidal flats

**WATER BODIES**
INLAND WATERS
511 Water courses
512 Water bodies
MARINE WATERS
521 Coastal lagoons
522 Estuaries
523 Sea and ocean

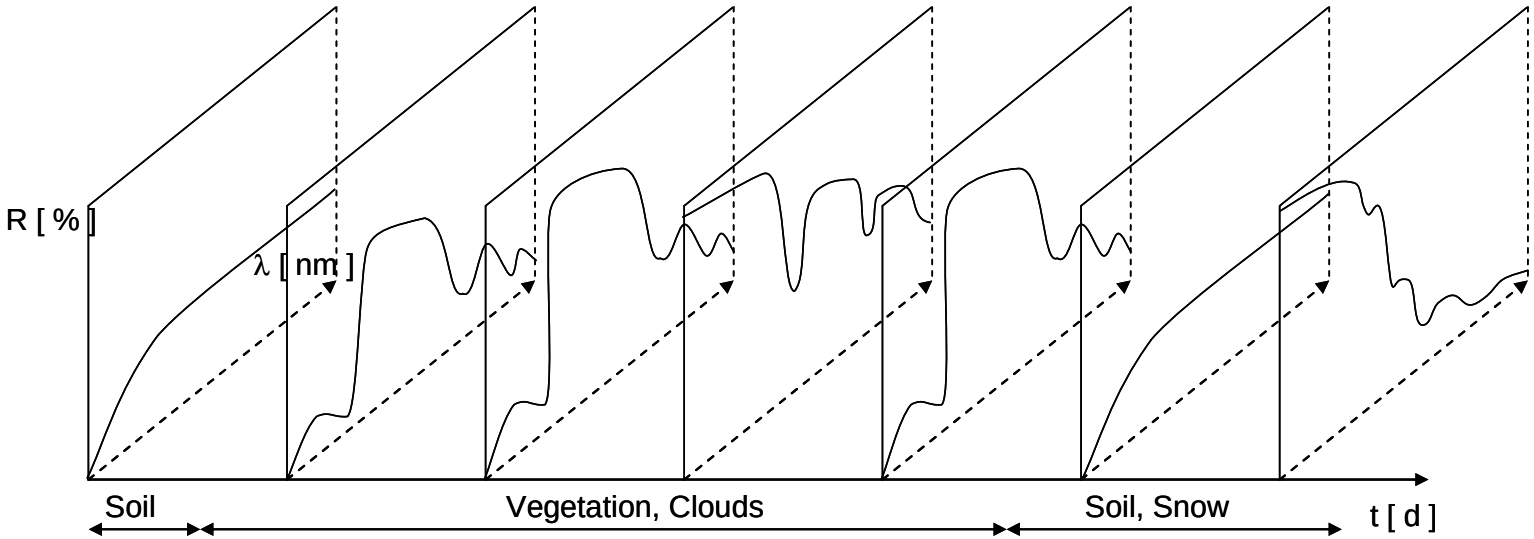
Umwelt Bundes Amt
Für Mensch und Umwelt

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

DLR Deutsches Zentrum für Luft- und Raumfahrt e.V.

# Land cover classification (LCC)

## Approach for automatic classification




Schematic presentation of the variation of spectral signature of a landscape object for a year, which is additionally disturbed by cloud cover and snow cover.

# First conclusion concerning LCC

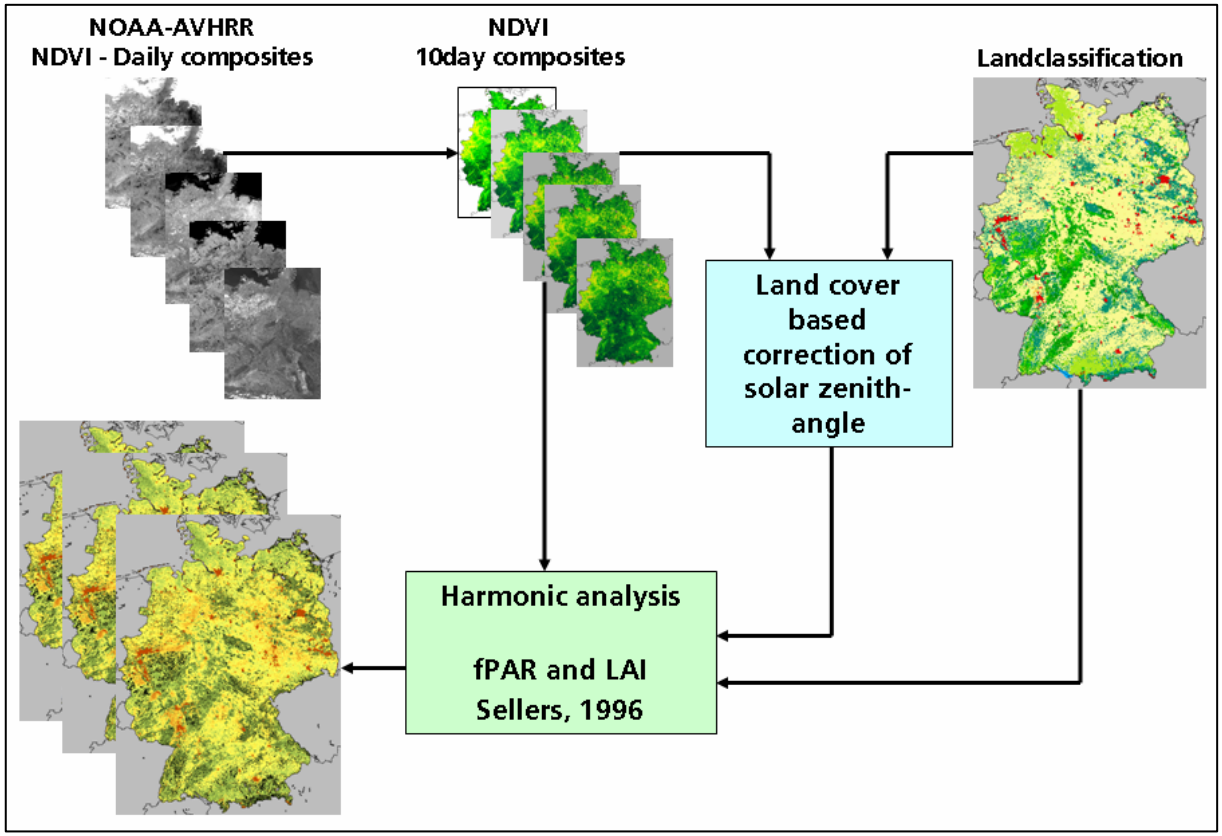
- In the near future, land cover / **land use** mapping using remote sensing data will be performed in an automatic way by integrating multi-spectral and multi- temporal data sets. Basic tools are under development at DLR.

- Differentiation of agricultural plants is a challenge for the future and will be integrated.

  - **Keyword: energy plants for biomass use**

# Plant status (Leaf Area Index LAI)

## Input parameter for carbon modeling



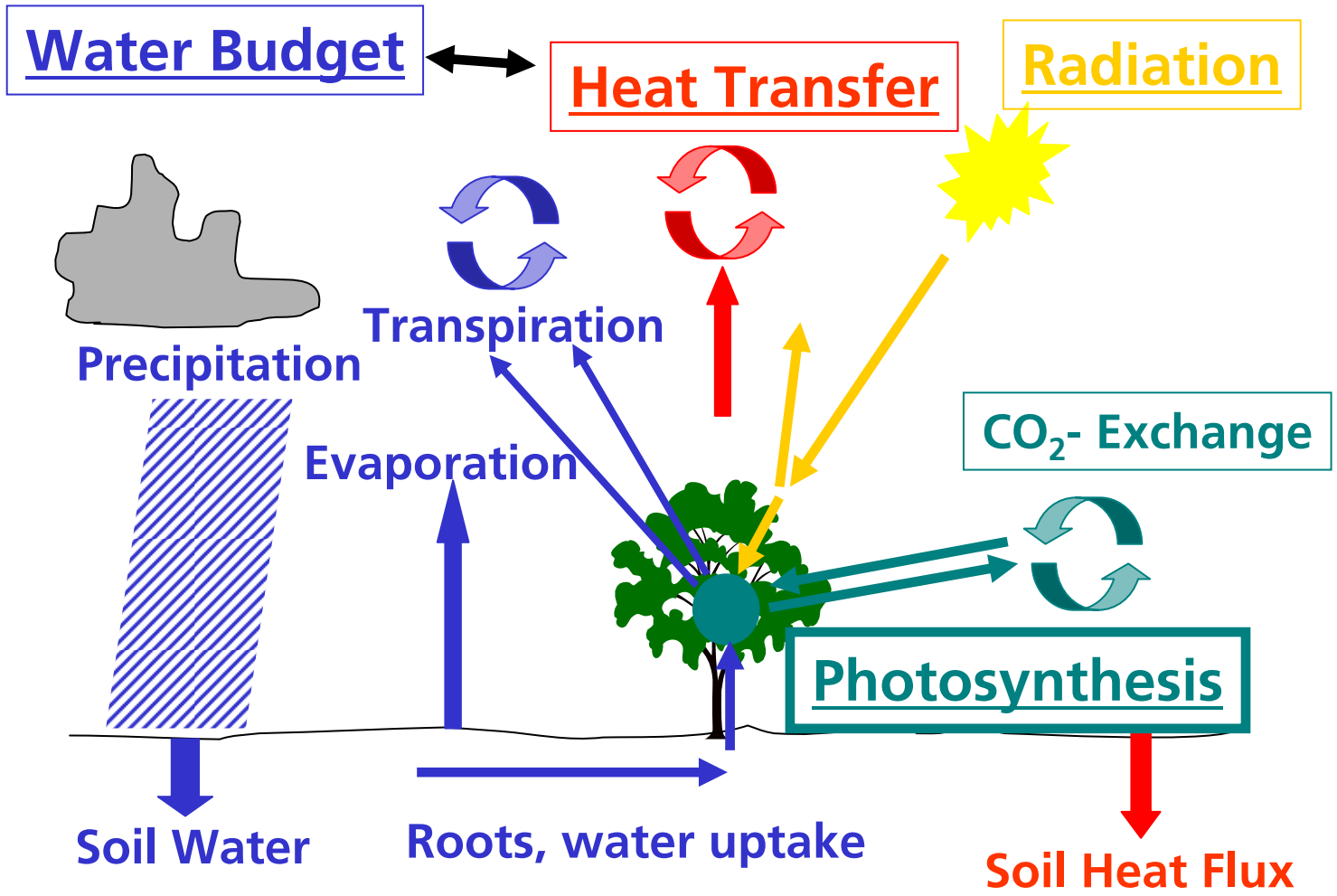

Flowchart of data processing for LAI time series

NDVI:
Normalized Difference Vegetation Index

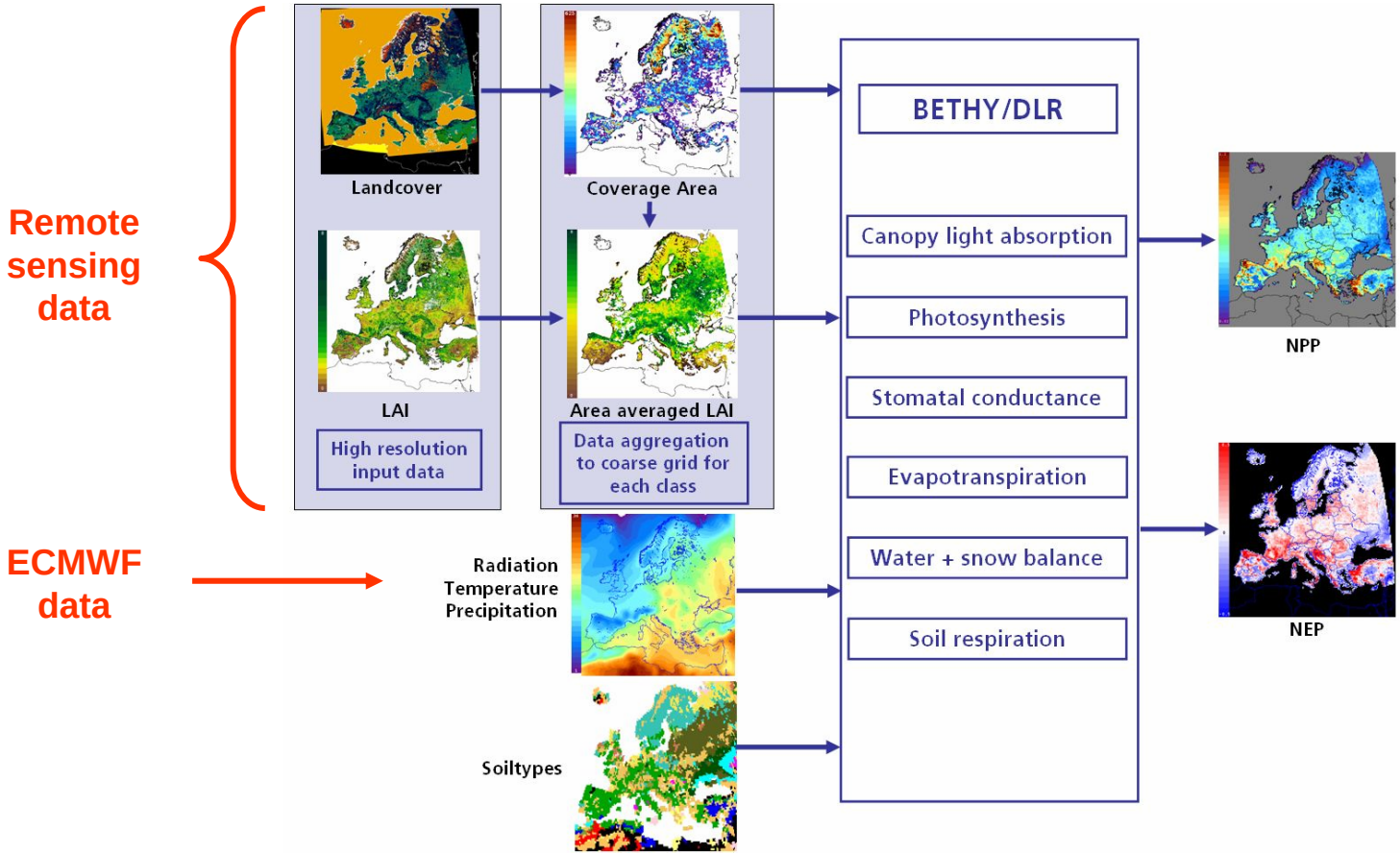
LAI:
Leaf Area Index

fPAR:
Fraction of absorbed PAR

# Carbon modeling (BETHY - DLR)

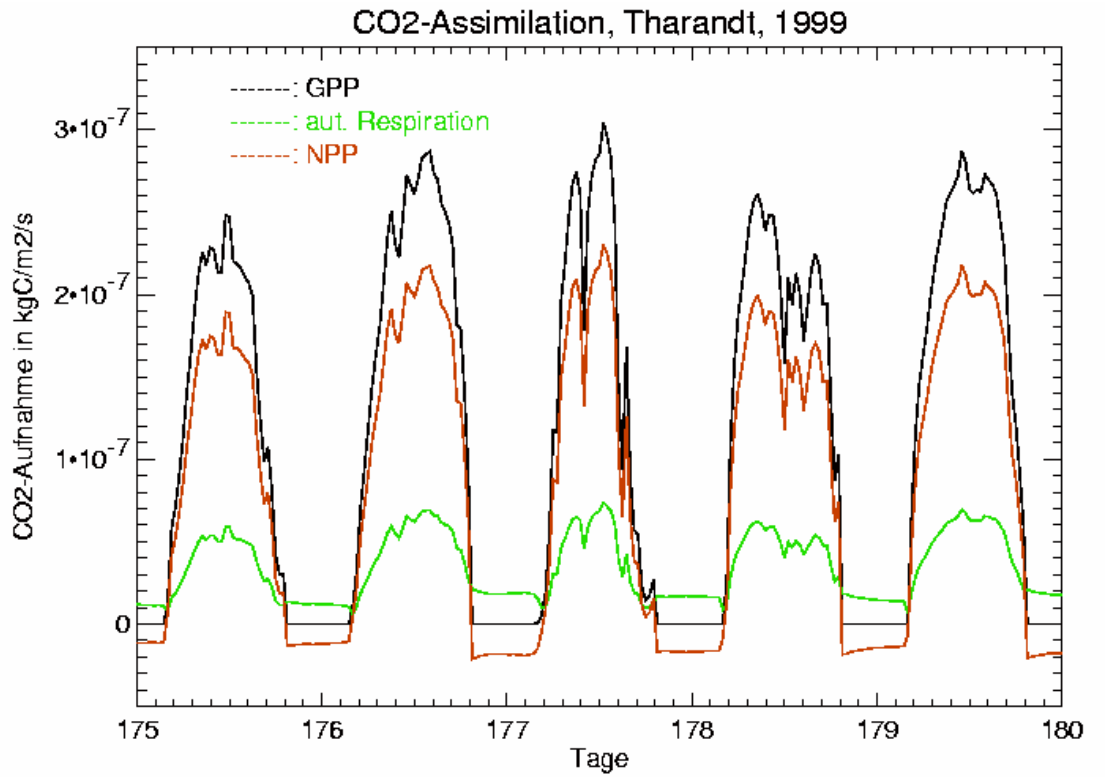


# Carbon modeling (BETHY - DLR)




**BETHY: Biosphere Energy Transfer Hydrology Model**
**Wolfgang Knorr, MPI for Biogeochemistry Jena, 1997**
**Klaus Wißkirchen, DLR, 2005**

# Carbon modeling (BETHY - DLR)



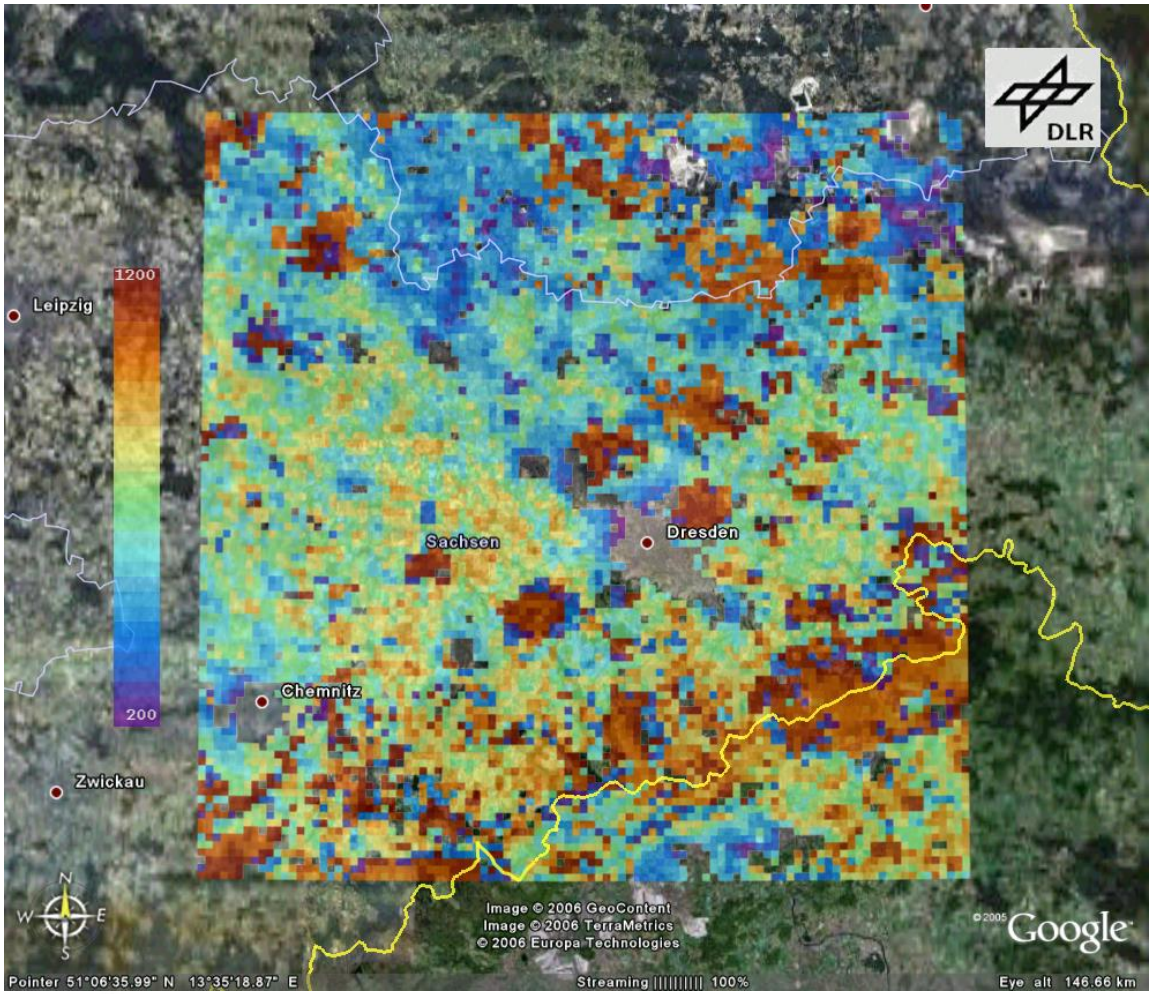

GPP:
Gross Primary Productivity

NPP:
Net Primary Productivity

**NPP = GPP – aut. Respiration**

Modelled daily cycle of NPP [kgC $m^{-2}$ $s^{-1}$] (red line) at Tharandt

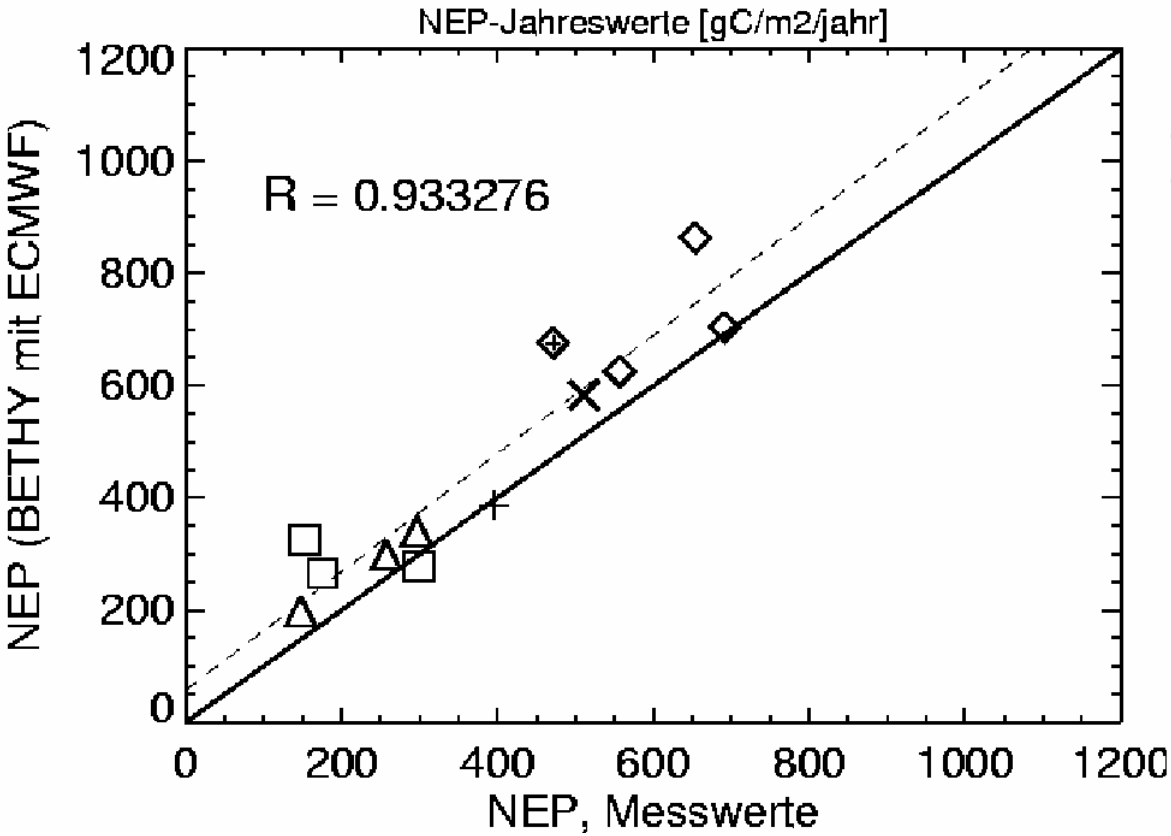
# Carbon modeling (BETHY - DLR)




Regional simulation result of NPP [gC $m^{-2}$ $y^{-1}$] for the region of Tharandt, near Dresden / Germany.

Spatial resolution is 1.1 km
Time: 1998

# Validation of NEP




GPP:
Gross Primary Productivity

NPP:
Net Primary Productivity

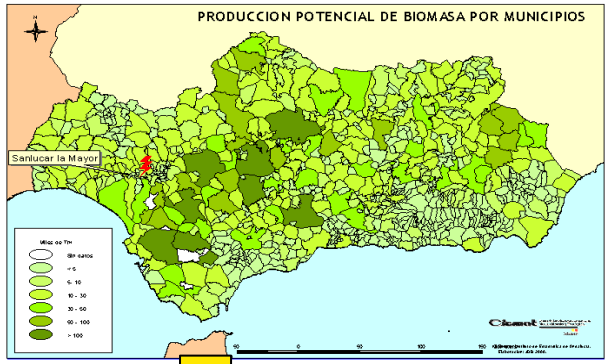
NEP:
Netto Ecosystem Productivity

**NPP = GPP – Aut. Respiration**

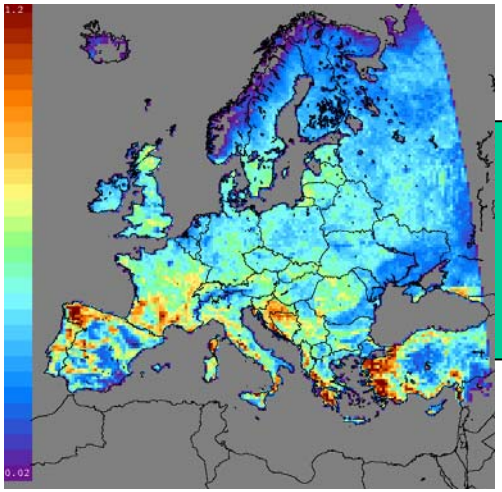
**NEP = NPP – Het. Respiration**

# Combining NPP & crop statistics

Crop statistics

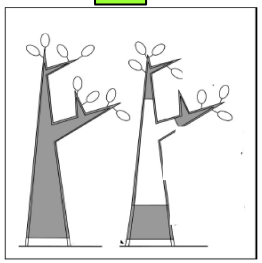



Potential of cereal straw
… and other energy plants …



NPP (TgC/year/pixel)
for one class

Annual energy yield
or potential, monitoring
resources

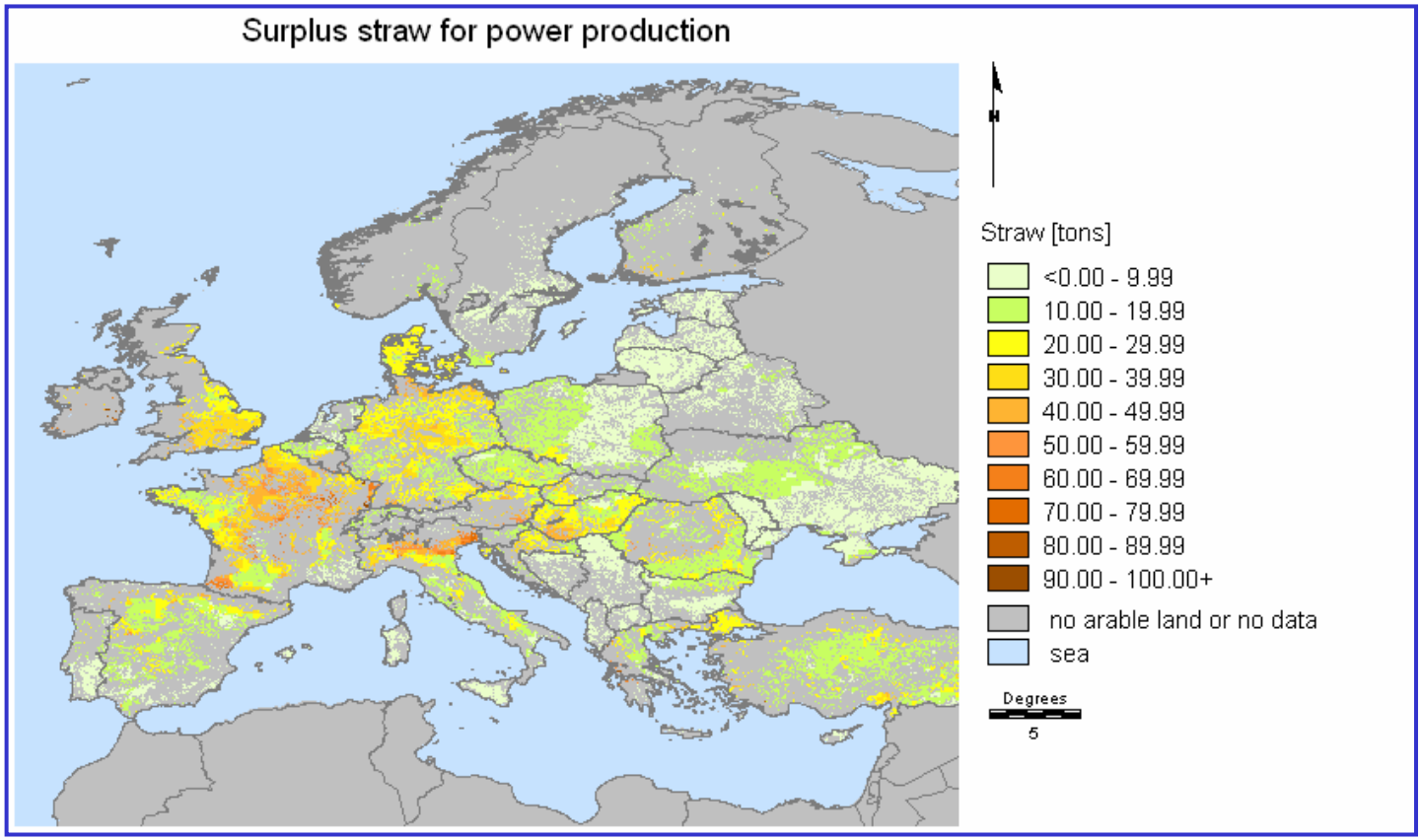


Allocation parameter
or model for energy
yield or potential

*after Dieter and Englert, 2001*

# Straw potential

derived from statistics and NPP (as distribution parameter)




From: Julia Gehrung (DLR, University Karlsruhe), Diploma Thesis, 2006

# Conclusion

- Remote sensing and carbon modeling delivers maps of Net Primary Productivity (NPP).
- Depending on the spatial resolution of the remote sensing data, local to continental maps of NPP will be available.
- Looking at energy plants for sustainable biomass use, land use maps are necessary indicating the location of energy plants as well as their plant status.