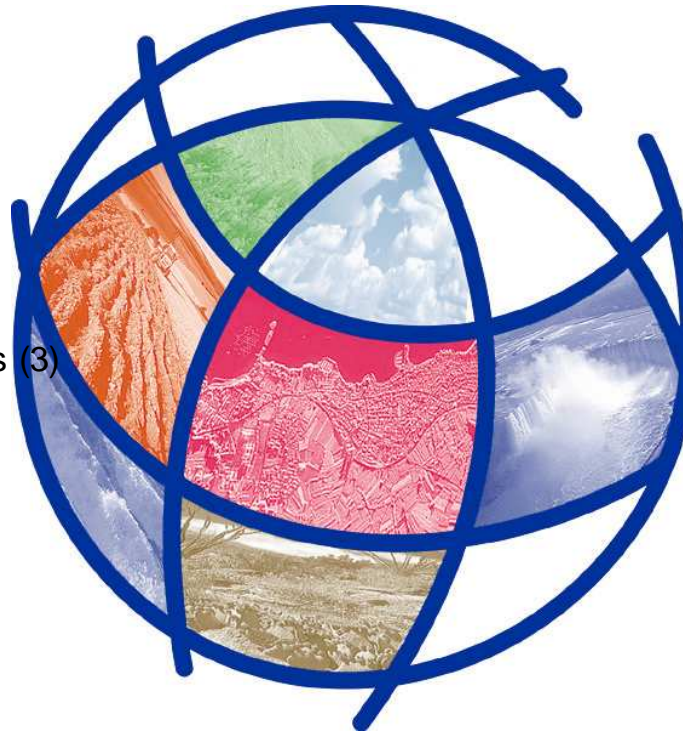




## Near real time detection of seasonal changes of vegetation phenology, small water bodies and fires

B. Combal (1), E. Bartholome (1),  
J.M. Gregoire (1),  
P. Bicheron (2), Leroy M (2),  
G. Borstlap (3), E. Gonthier (3), T. Jacobs (3)  
L. Bydekerke (4), I. Piccard (4),  
H. Baltzer (5), C. Rowland (5)  
S. Bartalev (6)

- 1: European Commission
- 2: Medias France
- 3: VITO
- 4: Universite Catholique de Louvain
- 5: CEH
- 6: Space Research Institute IKI



geoland



*Co-funded by the European Commission within the GMES initiative in FP-6*



# geoland



- geoland is a GMES (Global Monitoring for Environment and Security) project, co-funded by the European Commission
- 6 observatories and 2 core services
- OLF: observatory for land and forest changes
- EO data → information to experts/decision makers
  - Monitoring environmental changes
  - Input to rapid alert systems
  - Information ready to use (eg. for bulletin)
- Geoland/OLF: R&D efforts oriented towards service needs
  - Prototype of service and products
  - Definitions of products: input satellite data, processing, format
  - Definition of services
  - Regions of interest: Africa and Eurasia



# Eurasia



Annual environmental report for Eurasia: summary of data and key events

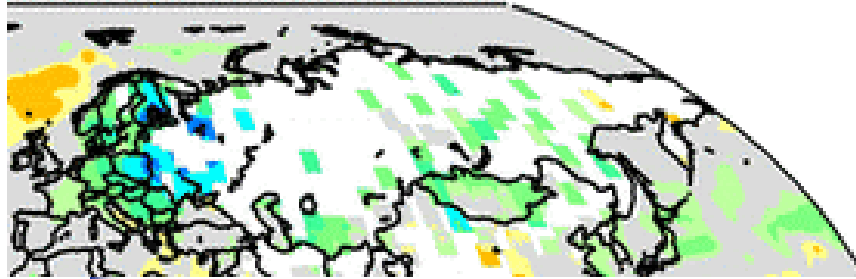
- “Forest conditions report for Russia in 2003” available, will be produced for years 1999 to 2005
- Indicators derived from EO products such as
  - Surface temperature anomalies (satellite + in situ)
  - Fractional vegetation cover
  - Burnt areas
  - Soil moisture (derived from AMSR-E)
  - Vegetation phenology/long term change
- Indicators derived from non EO data
  - Temperature anomalies
  - Precipitations anomalies



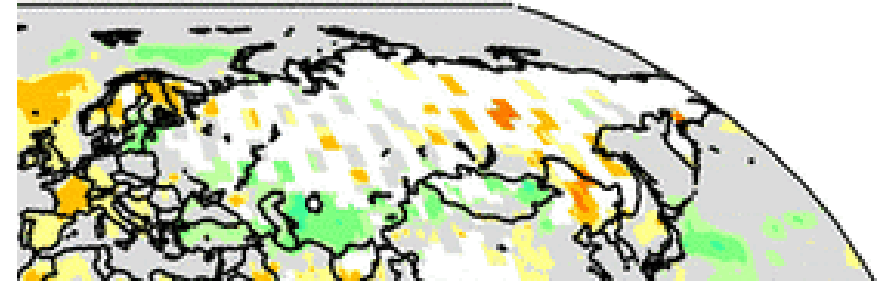
# Surface temperatures



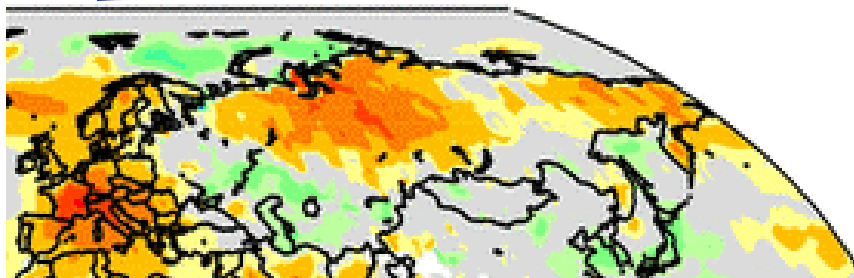
Surface temperature anomalies values are a blend of satellite and in situ observations.  
The climate base period is 1998 – 2003.



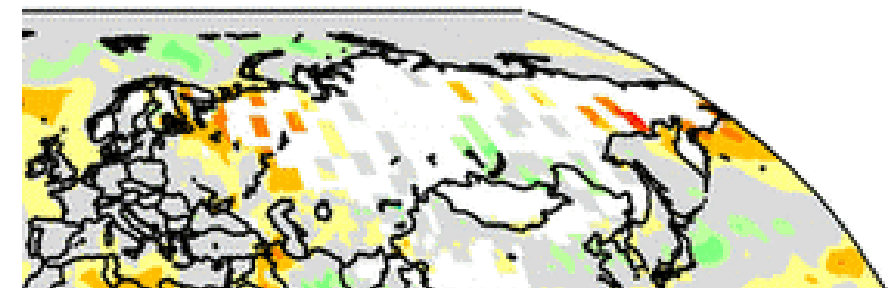
Winter (December-February) 2002-2003



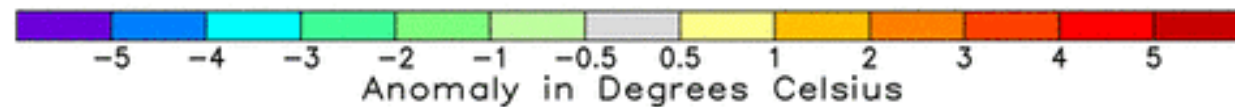
Spring (March-May) 2003



Summer (June-August) 2003



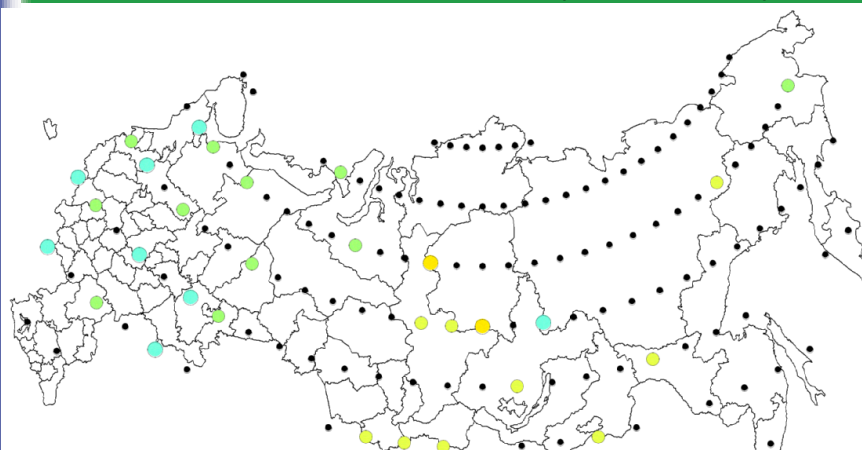
Autumn (September-November) 2003



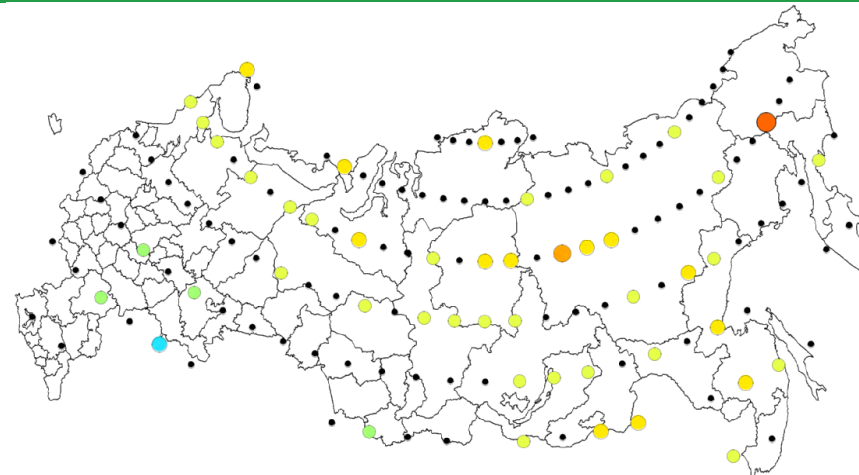
# Temperature anomalies - Eurasia



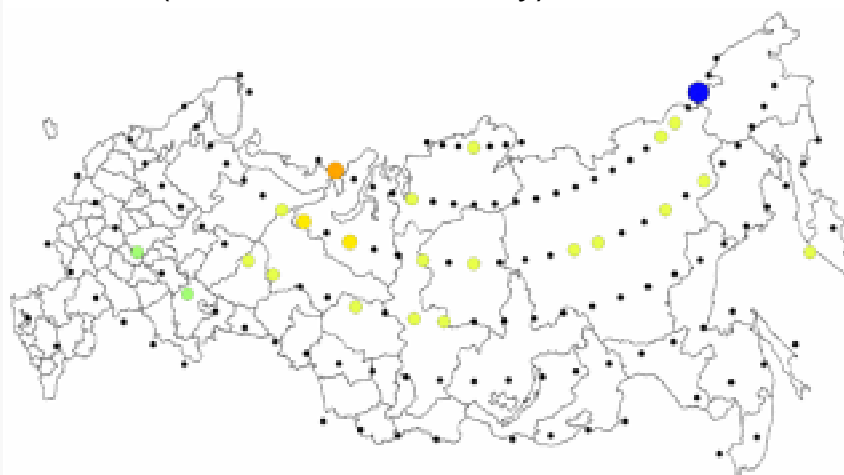
Temperature anomalies calculated from the global historical climatology network data set of land surfaces stations (1961-1990)



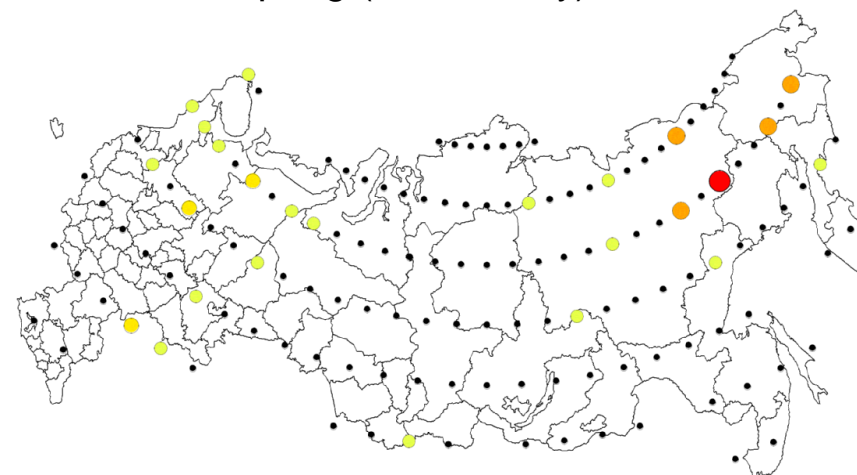
Winter (December-February) 2002-2003



Spring (March-May) 2003



Summer (June-August) 2003



Autumn (September-November) 2003

Temperature anomalies (°C) ● -5 ● -4 ● -3 ● -2 ● -1 ● 0 ● 1 ● 2 ● 3 ● 4 ● 5





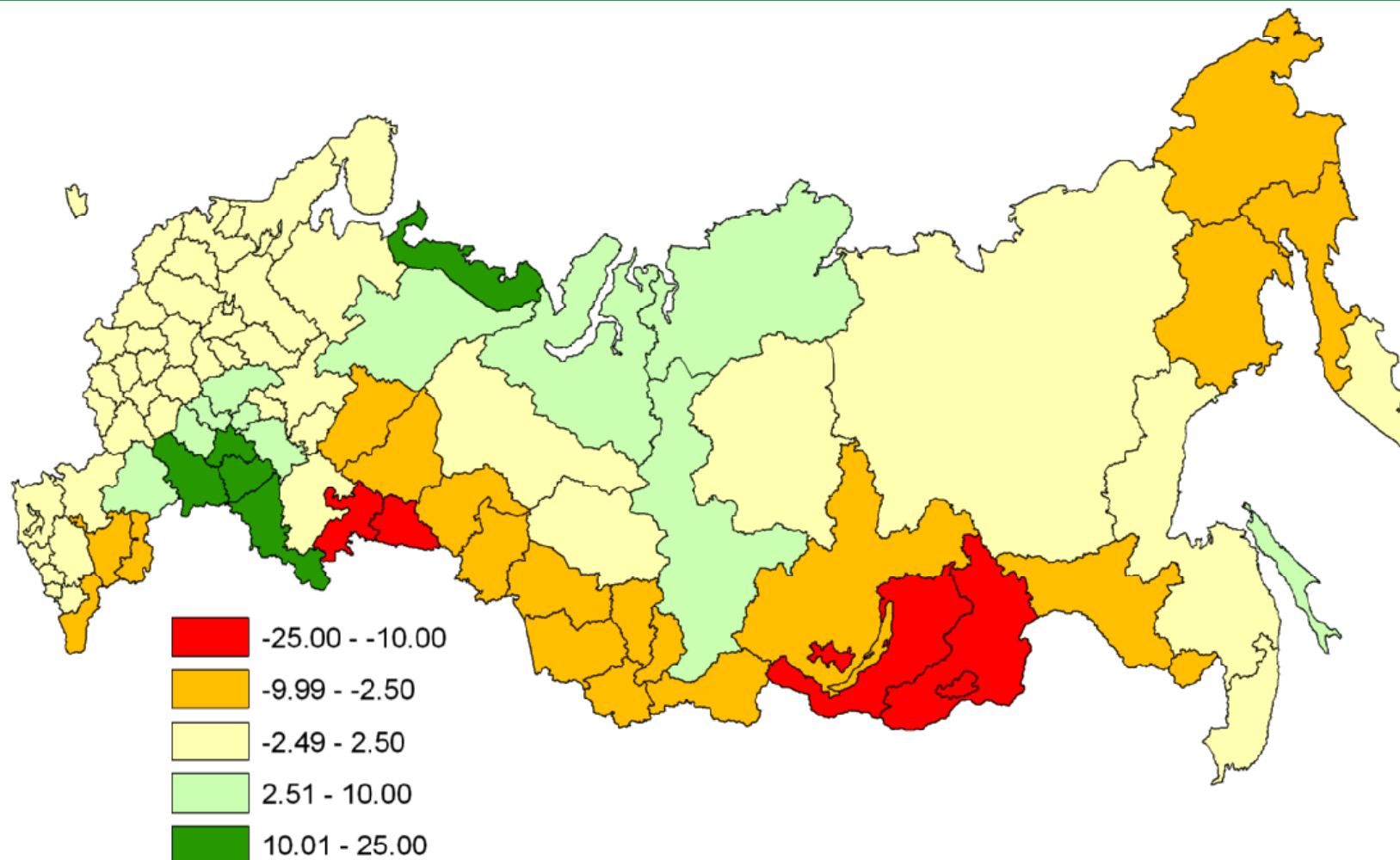
geoland

MEDIAS  
FRANCE

# fCover - Eurasia



Difference in 2003 and 2002 fcover per oblast



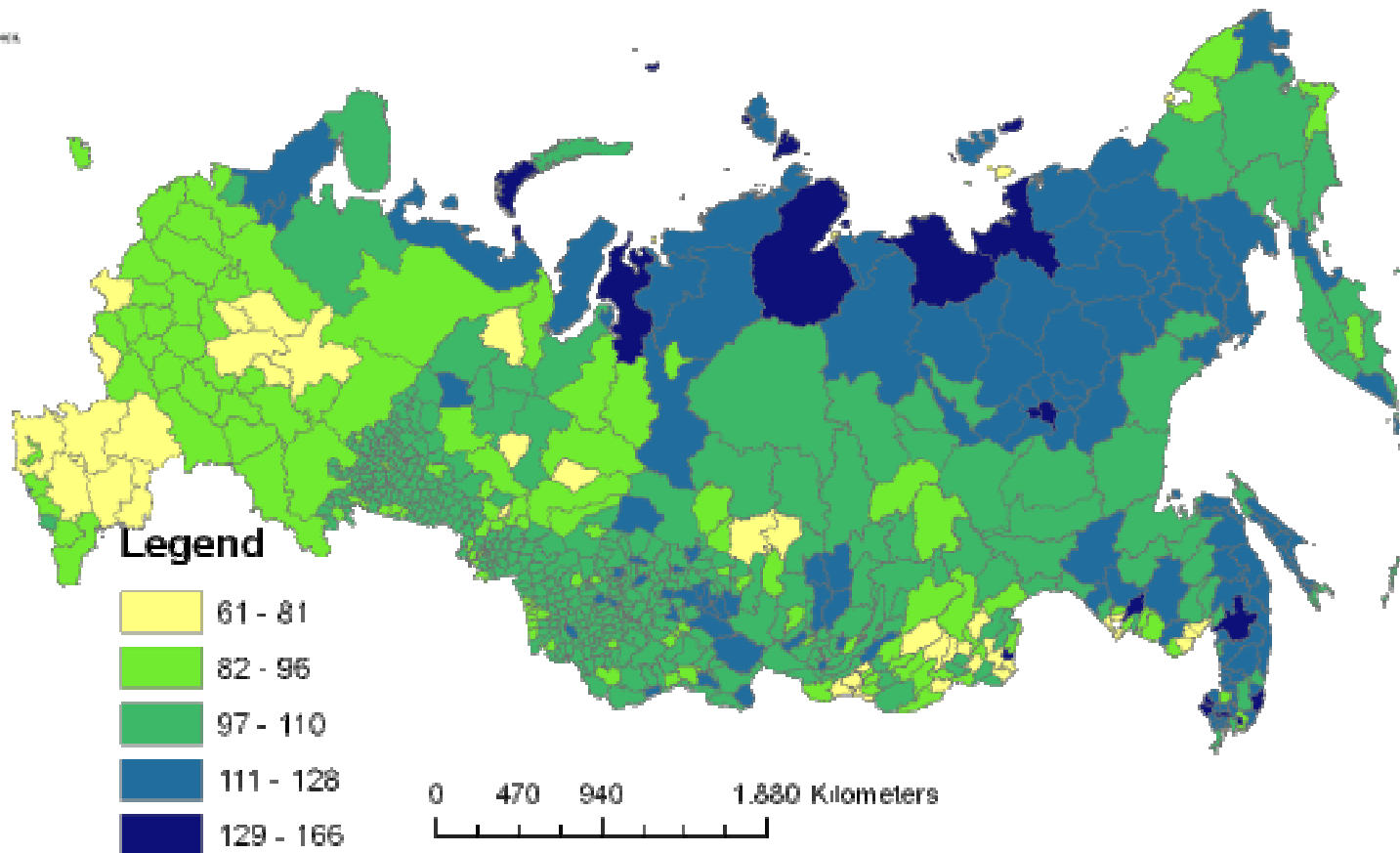
Difference based on July & August Maximum Value Composite fCover images



# Phenology - Eurasia



Start of season date (day of the year) for 2003, derived from AVHRR GIMMS NDVI



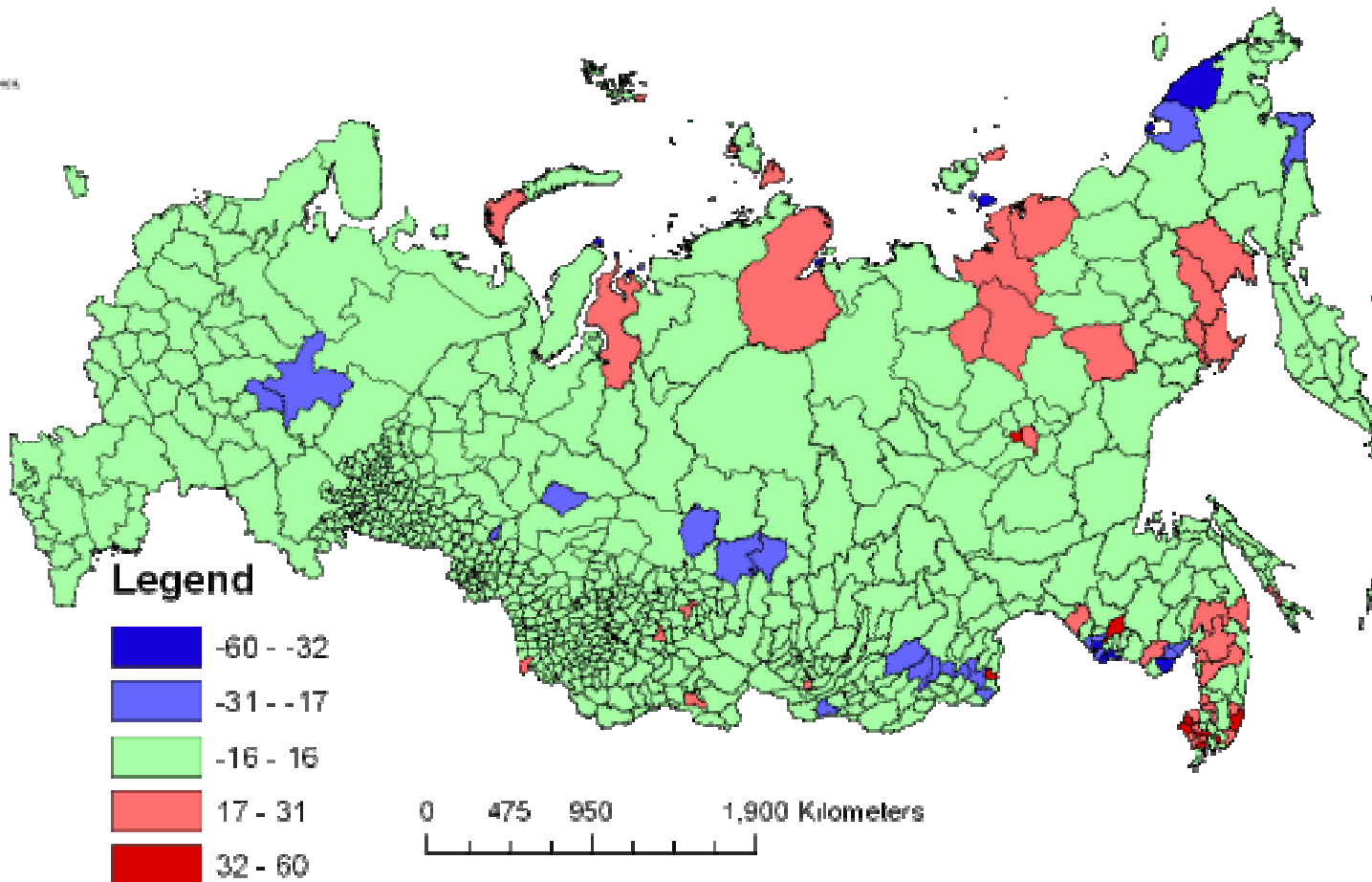
Values displayed per oblast for European Russia and per region for Siberia and the Far East



# Phenology - Eurasia



Anomalies in start of season timing for 2003 compared to long-term average (1982-2003)



Negative values show early and positive values show late start of season.

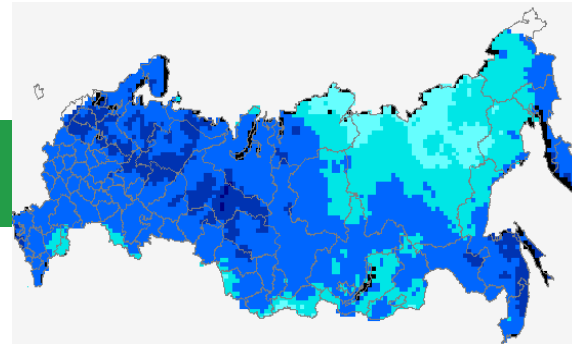
Values displayed per oblast for European Russia and per region for Siberia and the Far East.



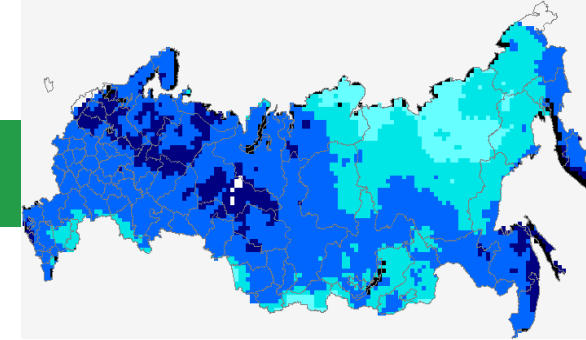


## Soil moisture - Eurasia

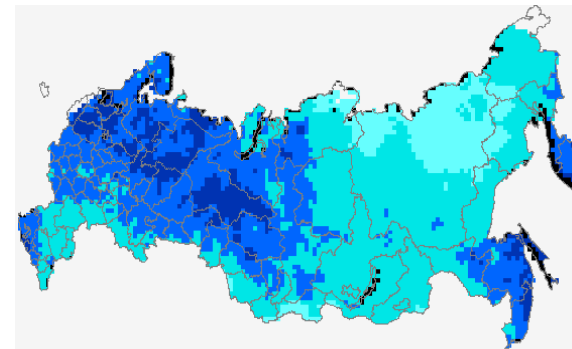
April 2003



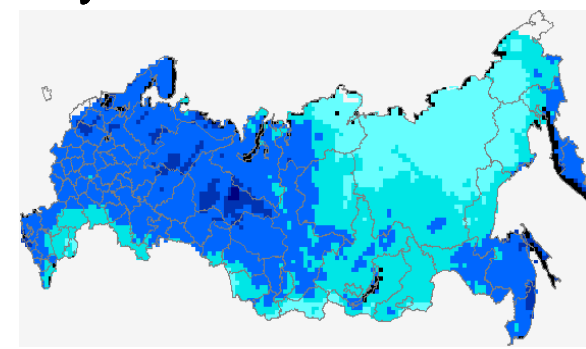
May 2003



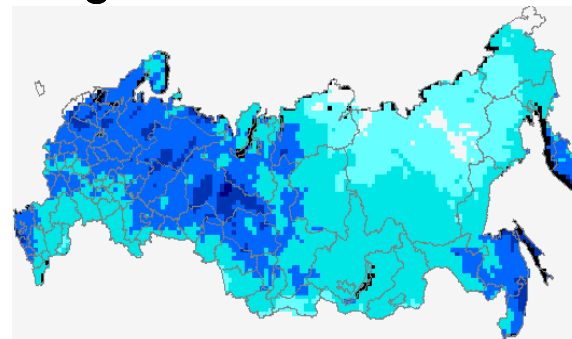
June 2003



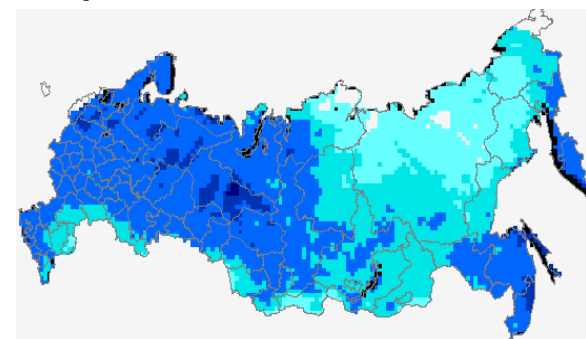
July 2003



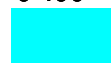
August 2003



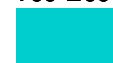
September 2003



0-100



100-200



200-300



300-400



400-500



mm water (in top meter of soil)

Regression method using long  
term soil moisture measurements  
as ground truth  
Accuracy: 63mm



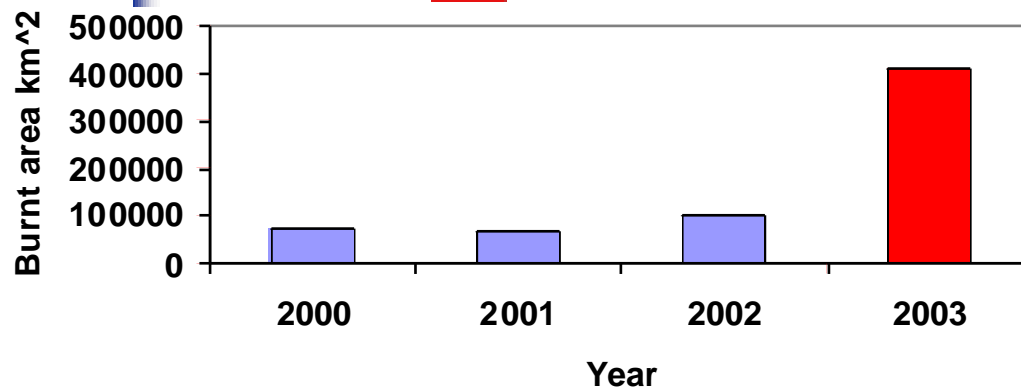
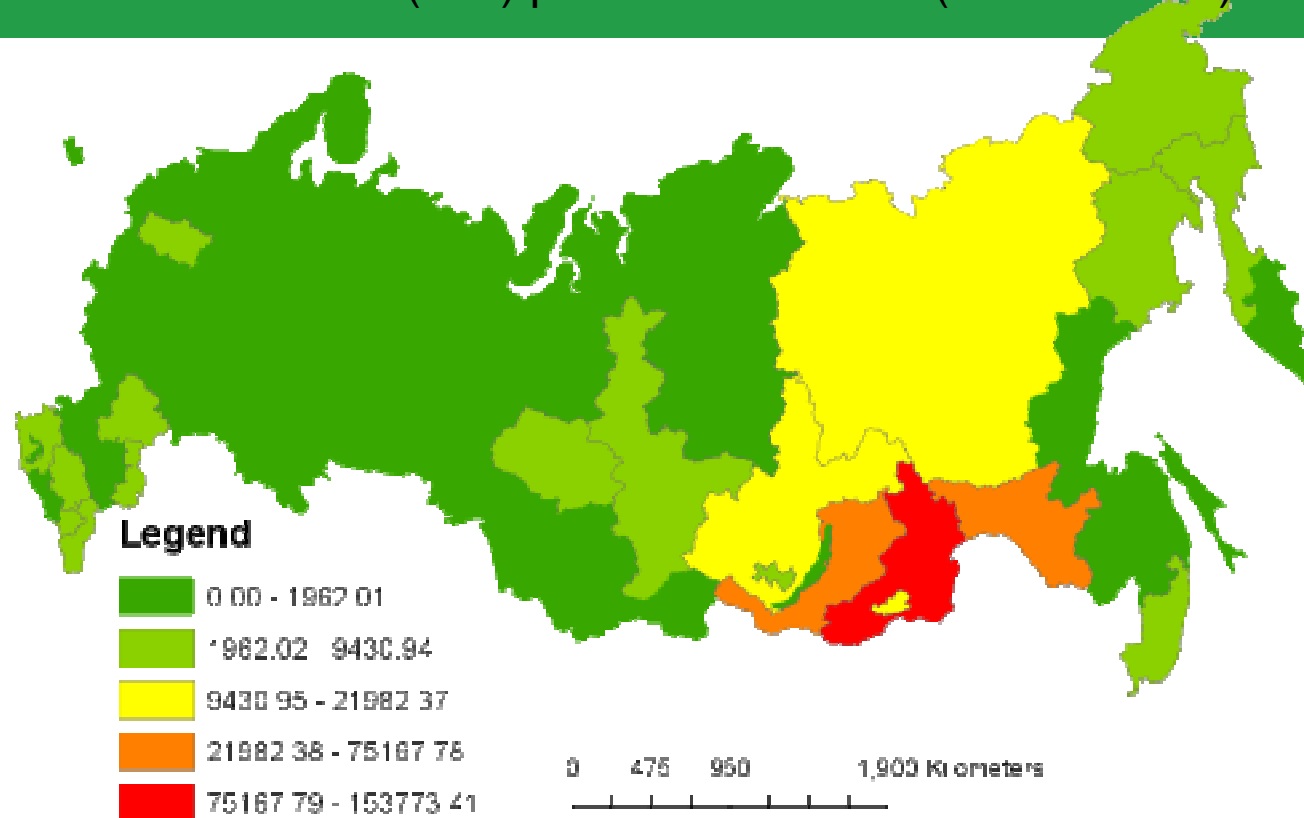
geoland



# Burnt areas - Eurasia



Total burnt area (km<sup>2</sup>) per oblast for 2003 (IKI estimates)



Total 2003 burnt area: **412585 km<sup>2</sup>**

- in evergreen needleleaf forest: **18666km<sup>2</sup>**
- in deciduous needleleaf forest: **155705 km<sup>2</sup>**
- in deciduous needleleaf forest: **34369 km<sup>2</sup>**



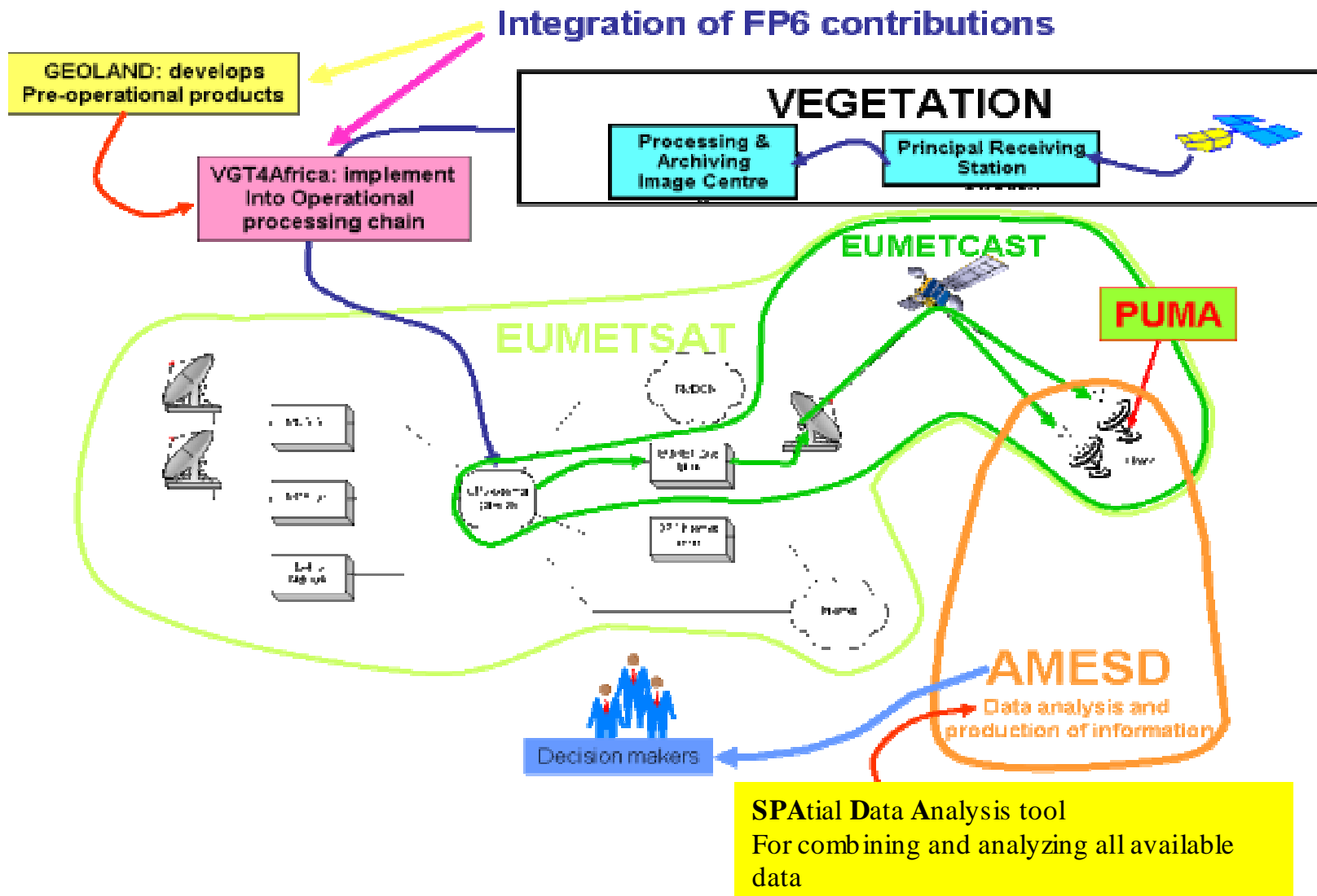
# Environmental Assessment Report - Eurasia

## Summary of data availability for the Geoland-OLF boreal forest environmental assessment for Russia

	Product	Data producer	1999	2000	2001	2002	2003	2004	2005	2006
<b>External data sets</b>	Surface temperature anomalies	GHCN (NOAA)	✓	✓	✓	✓	✓	✓	✓	✓
	Precipitation anomalies	GHCN (NOAA)	✓	✓	✓	✓	✓	✓	✓	✓
<b>Core Geoland data sets</b>	Fcover	Medias, France					✓	✓		
	Soil moisture: AMSR	University of Bonn					✓	✓		
<b>Additional Geoland data sets</b>	Burnt area	IKI Moscow		✓	✓	✓	✓	✓	✓	✓
	Satellite phenology: GIMMS	CEH Monks Wood	✓	✓	✓	✓	✓			
	Satellite phenology: FASIR	CEH Monks Wood	✓							

- Environmental Assessment reports will be produced for 1999-2005, although contents will vary depending on availability of data sets, as shown in table.
- The environmental assessment reports will be available on the Geoland website (probably in December).
- The reports can be produced annually on an operational basis, if sufficient data sets are available and if there is sufficient interest in the product.
- External data sets are available from the data set producers.
- Core Geoland data sets are available via the Geoland website.
- The IKI Burnt area product is available via the Terranorte website.
- The CEH phenology products will not be available until validated.

# Near real time monitoring of land and forest changes - Africa





## Geoland/vgt4africa products - Africa



Product Family	Product Name	Comments	Output resolution, update	Generation level	
Phenology	Seasonality (start, max, half-senescence, duration, value of the index at maximum). Indeed apparent seasonality (remote sensing defined rather than agronomically defined, connection to be established within the user applications)	Real time, derived from vegetation index time series, or water index, or fCover, or Fapar, or temperature. Maps of dates, in number of dekads, counted from 1/1/1980 (16 bits). Per pixel	per pixel, updated every 10-days	A	C
	Comparison analysis	Compares apparent	per pixel, updated every 10-days	A	L
	NDVI Change with respect to previous observation	Is the present dekad significantly different from the previous one? Per pixel	per pixel, updated every 10-days	A	L
	NDVI Change with respect to previous year	Is the present dekad significantly different from the same dekad 1 year before? Per pixel	per pixel, updated every 10-days	A	L
	NDVI Change with respect to multi-year average(or median, TBD)	Is the present dekad significantly different from the averaged dekad? Per pixel.	per pixel, updated every 10-days	A	L
	Overall change of the current year wrt the entire previous year.	Per pixel. Based on vector change analysis. Likely to be implemented on season rather than on year comparisons. Compares NDVI (or similar inputs)	per pixel	U	L
	Presence and amount of sparse vegetation in desert areas	indication of the presence and amount of vegetation in arid regions after decontamination of soil, atmosphere and angular effects on vegetation index (or similar measurement). Per pixel	per pixel, updated every 10-days	A	C

A: automatic  
 U: user parameters  
 C: Core service  
 L: Locally produced



Product Family	Product Name	Comments	Output resolution, update	Generation level
Surface small waterbodies (inputs are dekadal small)	Seasonnality (start of replenishment, end of drainage, type of waterbodies: free water, humid area or mixture)	updated every 10days	per pixel, updated every 10-days	A C
	History of occurrences	record of all possible detection: pixel set to one if already detected as a small waterbodies in the past (during at least 4 dekads in a raw).	per pixel, updated every 10-days	A C
	Synthesis	amount of waterbodies detected among all possible detections (as recorded in the history of occurrences)	synthesis by 1°×1°, or ½°×½°×1°, or administrative units	U L
Spot/VGT burnscar	10 days synthesis	synthesis of the daily detection	per pixel, updated every 10-days	A A 2000-2003
	fire spatial pattern	Synthetic description of the spatial arrangement of fires in a given period of time	per pixel, updated every 10-days	A A 2000-2003
	Seasonnality	Start/end of season	½°×½° grid, updated every 10-days	A A 2000-2003

A: automatic

U: user parameters

C: Core service

L: Locally produced

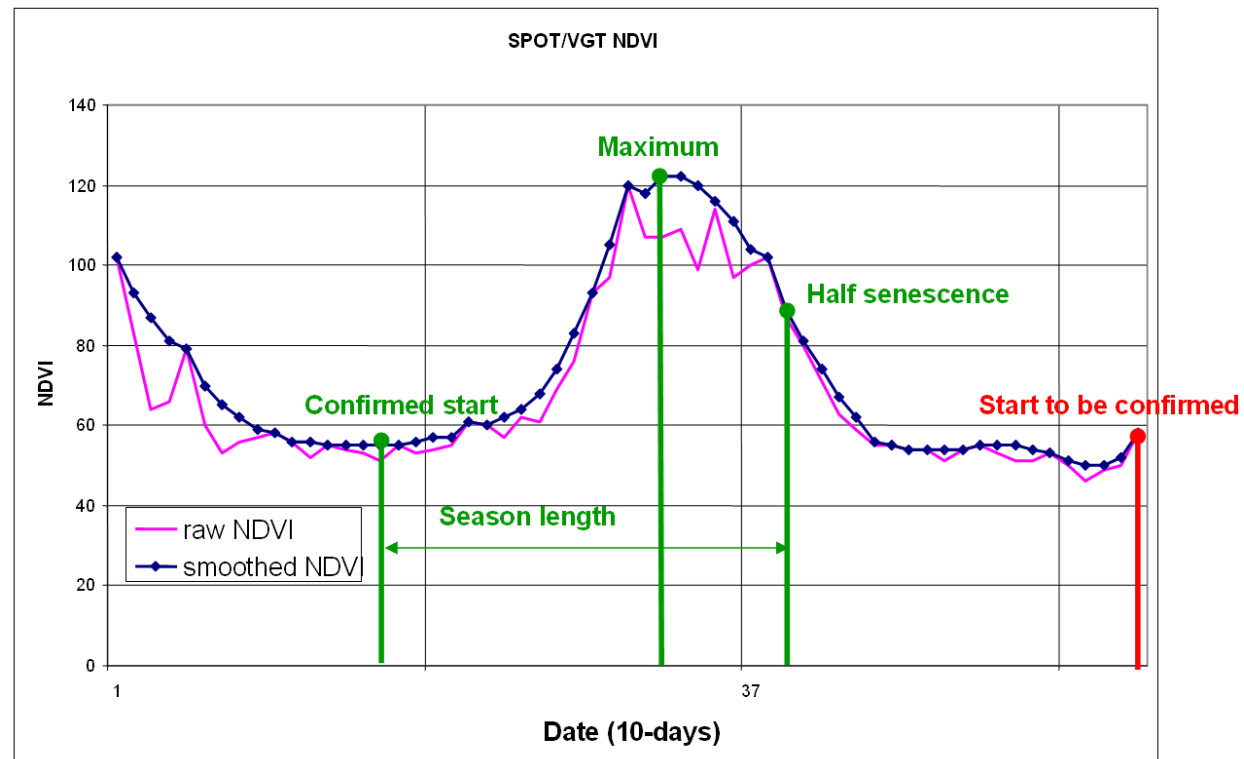




# Real time detection of phenological stages Africa



- Spot/VEGETATION S10-NDVI
- Time series / pixel
- Time series reconstruction (iterative polynomial fitting)
- Detection of phenological stages

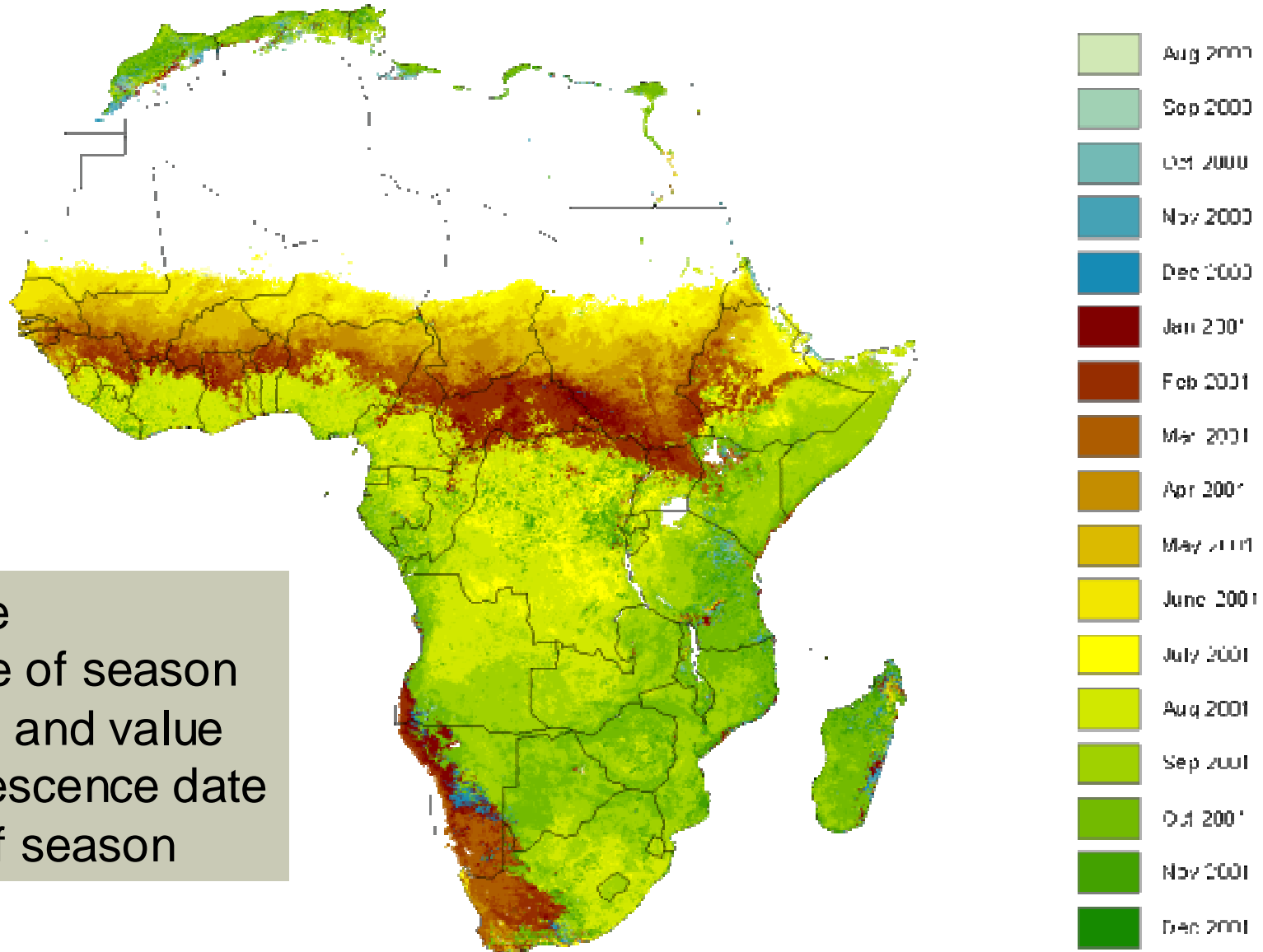




# Start of season observed on december 2001



## Full resolution seasonality products, every 10-days



Users receive

- Start date of season
- Max date and value
- Half senescence date
- Length of season



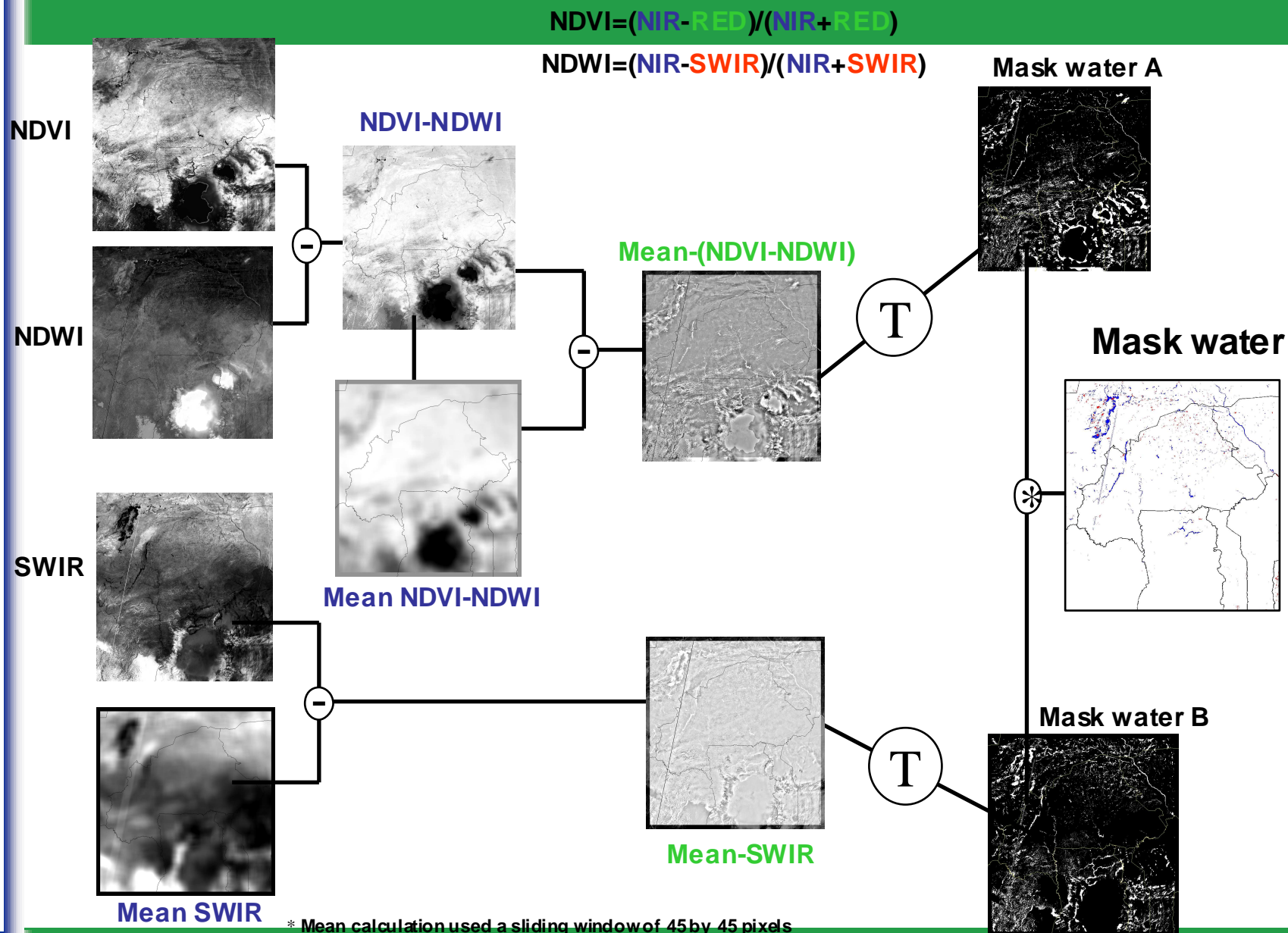
## Small water bodies - Africa

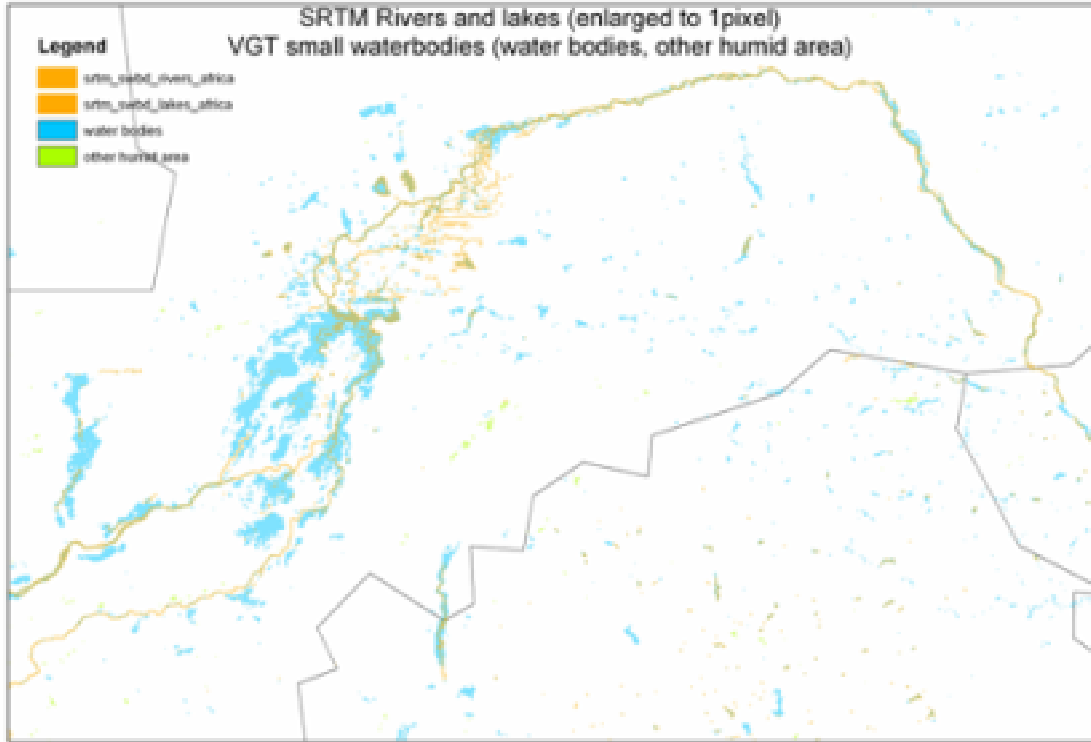


- Detection of small water bodies in arid and semi arid regions
- Assessment of date of the start of replenishment and date of end of drainage
- 1km ground resolution, updated every 10-days
- Detection based on spectral properties + contrast with the neighborhood
- To address questions like
  - Water availability for people and cattle, irrigations
  - Biodiversity
  - Area of development of vector-borne diseases
  - Signal of climate variability
- Validation completed for CILSS countries, in progress for other regions (semi-arid is priority)



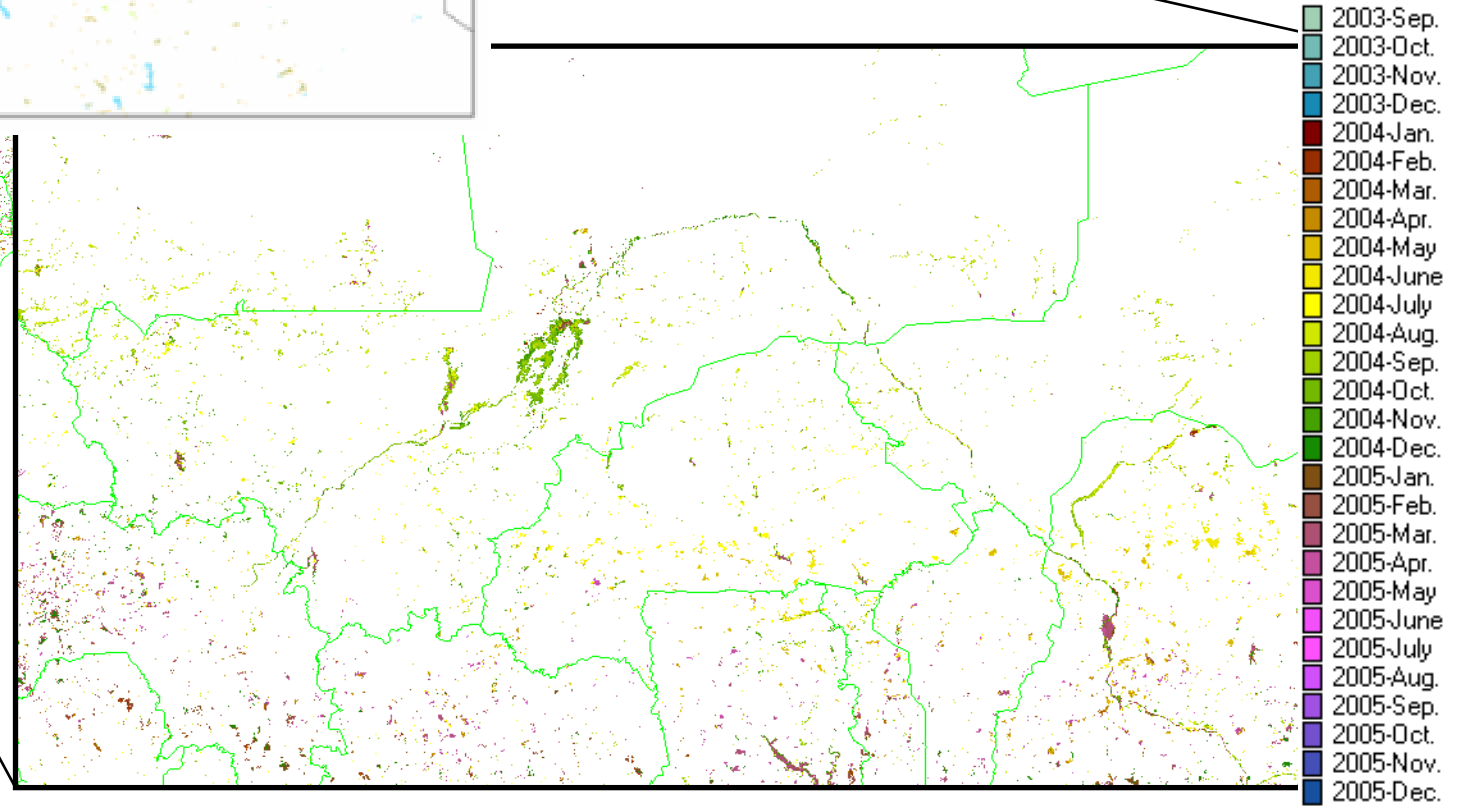
# Small water bodies - Africa





Per pixel accuracy on semi-arid regions

- Valid water bodies: 91.5%
- Positive vegetation anomalies: 7.2%
- Noise: 1.3%







# Burnt areas



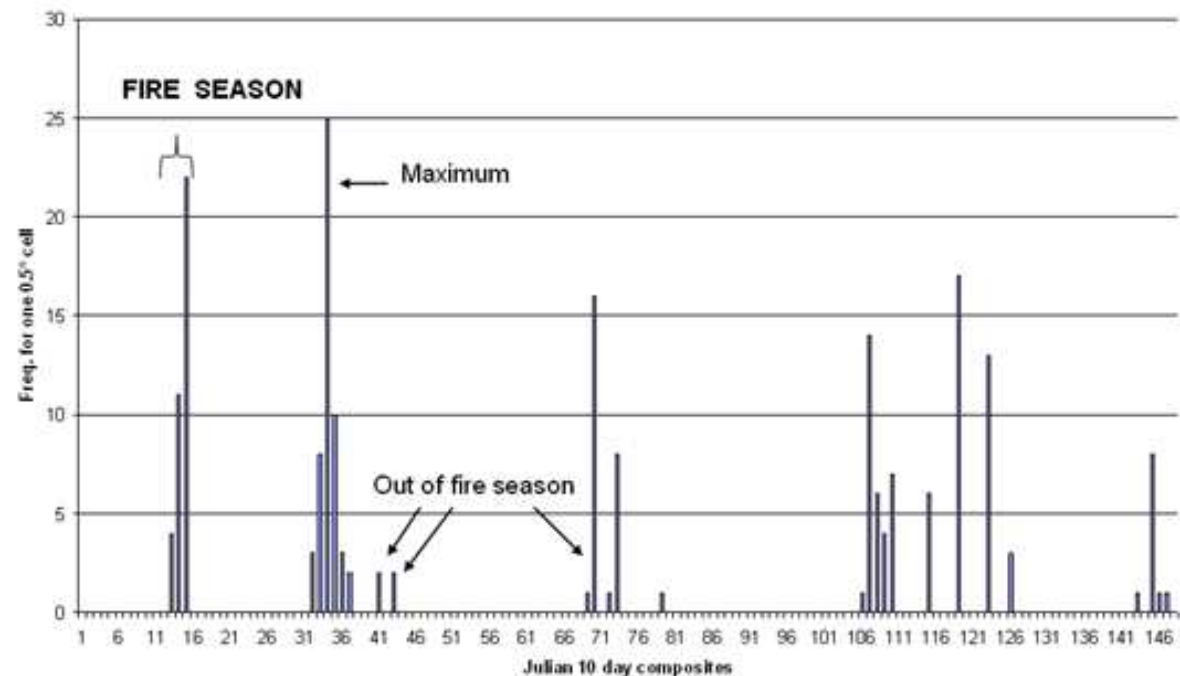
## Africa: Spot/VEGETATION

- Burnt areas: minimum near infrared synthesis, analysis of change between two synthesis, 1km resolution, every 10-days
- Season start/max/end found from the time series,  $\frac{1}{2}^{\circ} \times \frac{1}{2}^{\circ}$ , every 10-days

Detection (1 image per day)

Synthesis: 10-days,  $\frac{1}{2}^{\circ} \times \frac{1}{2}^{\circ}$  cells

Detection of seasonality

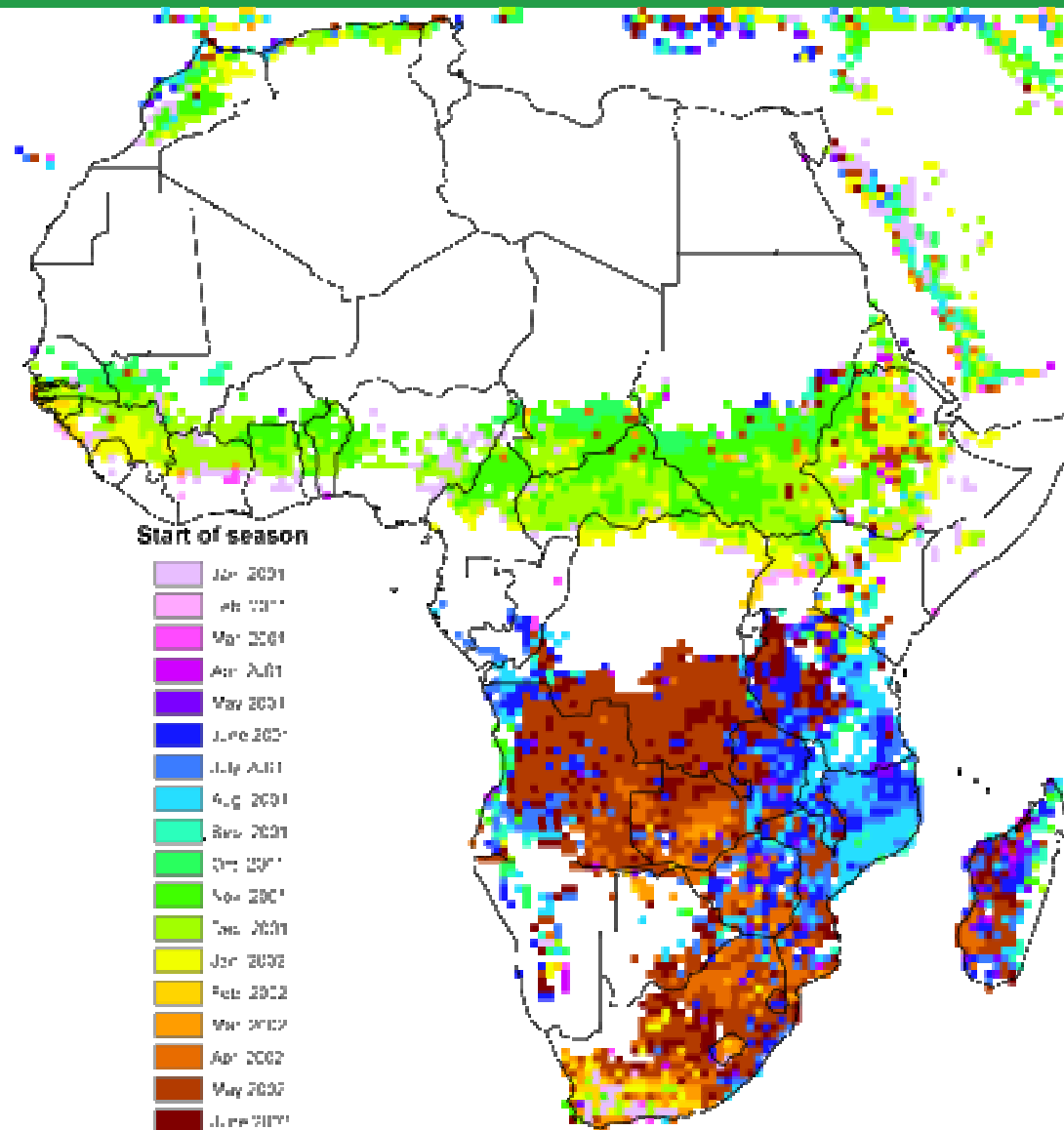




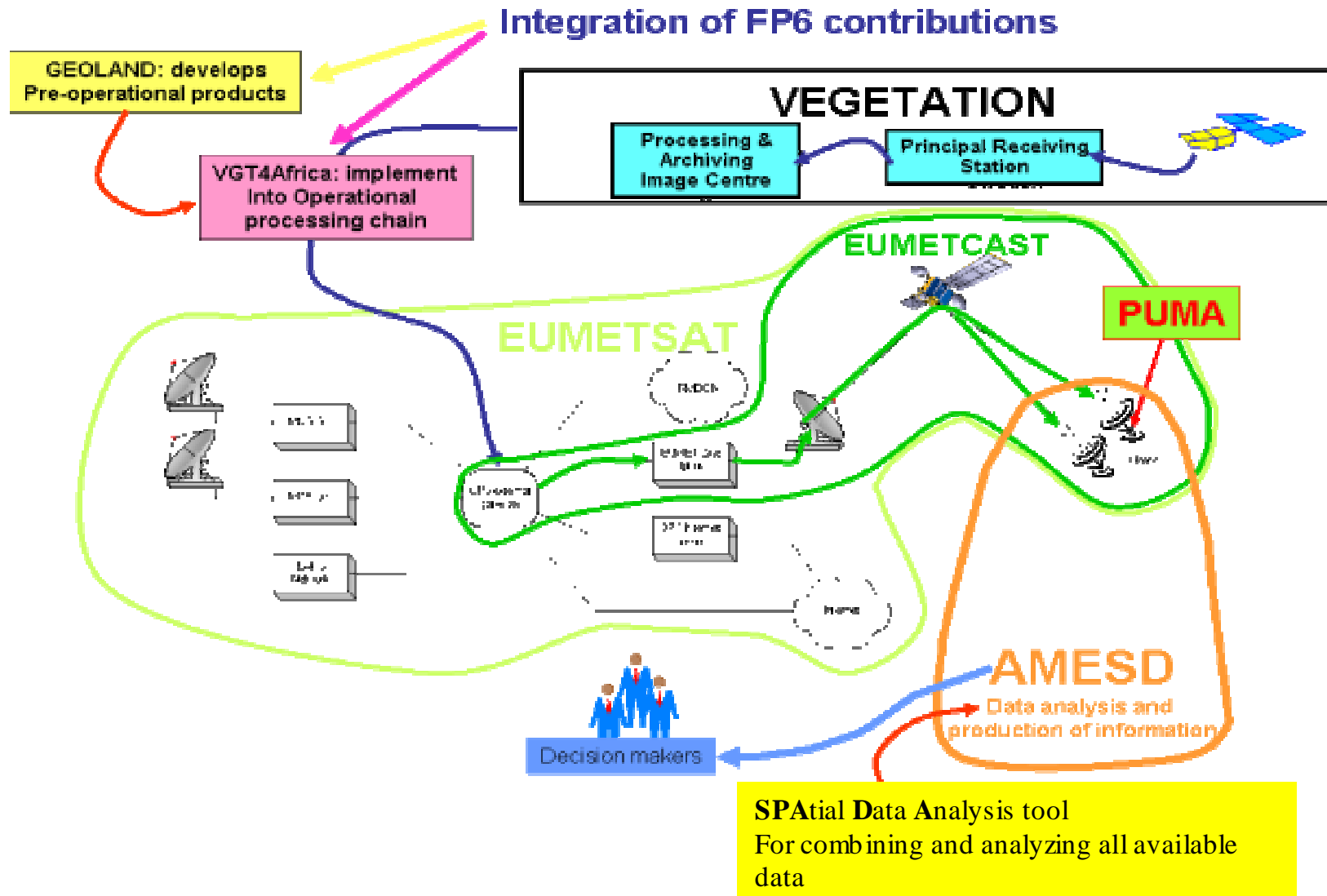
## Burnt areas - Africa



Seasonality dates (start, max, end of season),  $\frac{1}{2}^{\circ} \times \frac{1}{2}^{\circ}$ , every 10-days



# Operation service: from sensor to users





## SPAtial Data Analysis software



- SPADA Multi-criteria analysis tool
  - Concept validated at users meeting
  - Geographic database: manage data received from local PUMA receiving station
  - Let the user combine several criteria into its own indicator
  - First version of software up and running
  - A 2 DVDs demo package distributed jointly with VGT4Africa to all national met services in Africa at the Maputo EUMETSAT workshop, with 40 GB of data





**Geoland Analysis Tool - Processing Details**

gr\_20040111

Operation      Weighting      Stratification      Dynamics

---

**Geoland Analysis Tool - Data Processing**

Results

```

Processing ..... c:\data\temp\gr_DIFF_222006151904..... Done!
Processing ..... c:\data\output\gr_STRATIFY_222006151908..... Done!
Processing ..... c:\data\temp\nd_DIFF_222006151919..... Done!
Processing ..... c:\data\output\nd_STRATIFY_222006151924..... Done!
Processing ..... c:\data\temp\ra_DIFF_222006151933..... Done!
Processing ..... c:\data\output\ra_STRATIFY_222006151940..... Done!
Processing ..... c:\data\output\COMBINE_222006151950..... Done!
Processing ..... c:\data\output\STATISTICS_222006151955..... Done!
Computation Finished

```

Results List:

- c:\data\output\gr\_STRATIFY\_222006151908
- c:\data\output\nd\_STRATIFY\_222006151924
- c:\data\output\ra\_STRATIFY\_222006151940
- c:\data\output\COMBINE\_222006151950
- c:\data\output\STATISTICS\_222006151955

**Result Sample**

-100      +100

c:\data\output\ra\_STRATIFY\_222006151940.gif

Geoland icons:

Navigation: < Back      Next >

Vertical sidebar: stability, 5, 5, 5, 5, 5, 5, 5



## Project status



- Africa: pre-operational production line done and products generated for 2000-2003 (phenology, small water bodies)
- Data will be made available on the geoland web site for the period 2000-2003 ([www.gmes-geoland.info](http://www.gmes-geoland.info))
- Operational production lines will broadcast the products every 10 days through Eumetcast
- A data set of phenology seasonality was produced from AVHRR data set, for 1983-2002, for long term analysis
- Processing tools for users of the PUMA receiving stations (vgt4africa users)
- 4 training sessions done in Africa





# Integrated GMES Project on Landcover and Vegetation

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Observatory on Land  
Cover & Forest  
Change (OLF)



# geoland

geoland coordinators:



Co-funded by the European Commission within the GMES initiative in FP-6