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

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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

Summer (June-August) 2003

Spring (March-May) 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
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
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

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

April 2003

May 2003

June 2003

July 2003

August 2003

September 2003

mm water (in top meter of soil)
Burnt areas - Eurasia

Total burnt area (km$^2$) per oblast for 2003 (IKI estimates)

- Total 2003 burnt area: 412,585 km$^2$
  - in evergreen needleleaf forest: 186,666 km$^2$
  - in deciduous needleleaf forest: 155,705 km$^2$
  - in deciduous needleleaf forest: 34,369 km$^2$
### Environmental Assessment Report - Eurasia

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

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

- 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

Integration of FP6 contributions

GEOLAND: develops Pre-operational products

VGT4Africa: implement Into Operational processing chain

VEGETATION
Processing & Archiving Image Centre
Principal Receiving Station

EUMETCAST

EUMETSAT

PUMA

AMESD
Data analysis and production of information

SPAtial Data Analysis tool
For combining and analyzing all available data

Decision makers
# Geoland/vgt4africa products - Africa

<table>
<thead>
<tr>
<th>Product Family</th>
<th>Product Name</th>
<th>Comments</th>
<th>Output resolution, update</th>
<th>Generation level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phenology</td>
<td>Seasonality (start, max, half-senescence, duration, value of the index at maximum)</td>
<td>Real-time, derived from vegetation index time series, or water index, or Cover, or Papar, or temperature Maps of dates, in number of dekads, counted from 1/1/1980 (16 bits). Per pixel</td>
<td>per pixel, updated every 10-days</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Comparison analysis</td>
<td>Compares apparent</td>
<td>per pixel, updated every 10-days</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>NDVI Change with respect to previous observation</td>
<td>Is the present dekad significantly different from the previous one? Per pixel</td>
<td>per pixel, updated every 10-days</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>NDVI Change with respect to previous year</td>
<td>Is the present dekad significantly different from the same dekad 1 year before? Per pixel</td>
<td>per pixel, updated every 10-days</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>NDVI Change with respect to multi-year average(3 month, TBC)</td>
<td>Is the present dekad significantly different from the averaged dekad? Per pixel</td>
<td>per pixel, updated every 10-days</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Overall change of the current year wth the entire previous year.</td>
<td>Per pixel. Based on vector change analysis. Likely to be implemented on season rather than on year comparisons. Compares NDVI (or similar inputs)</td>
<td>per pixel</td>
<td>U</td>
</tr>
<tr>
<td></td>
<td>Presence and amount of sparse vegetation in desert areas</td>
<td>Indication of the presence and amount of vegetation in and regions after decontamination of soil, atmosphere and angular effects on vegetation index (or similar measurement). Per pixel</td>
<td>per pixel, updated every 10-days</td>
<td>A</td>
</tr>
<tr>
<td>Product Family</td>
<td>Product Name</td>
<td>Comments</td>
<td>Output resolution, update</td>
<td>Generation level</td>
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</tr>
<tr>
<td>Surface small waterbodies (inputs are at decadal scale)</td>
<td>Seasonality (start of replenishment, end of drainage, type of waterbodies: free water, humid area or mixture)</td>
<td>updated every 10 days</td>
<td>per pixel, updated every 10 days</td>
<td>A C</td>
</tr>
<tr>
<td></td>
<td>History of occurrences</td>
<td>record of all possible detection: pixel set to one if already detected as a small waterbody in the past (during at least 4 decades in a raw).</td>
<td>per pixel, updated every 10 days</td>
<td>A C</td>
</tr>
<tr>
<td>Syntesis</td>
<td>Synthesis</td>
<td>amount of waterbodies detected among all possible detections (as recorded in the history of occurrences)</td>
<td>synthesis by 1°×1°, or ½°×½°×1°, or administrative units</td>
<td>U L</td>
</tr>
<tr>
<td>Spot/VGT burnscar</td>
<td>10 days synthesis</td>
<td>synthesis of the daily detection</td>
<td>per pixel, updated every 10 days</td>
<td>A A</td>
</tr>
<tr>
<td></td>
<td>fire spatial pattern</td>
<td>Synthetic description of the spatial arrangement of fires in a given period of time</td>
<td>per pixel, updated every 10 days</td>
<td>A A</td>
</tr>
<tr>
<td></td>
<td>Seasonality</td>
<td>Start/end of season</td>
<td>½°×½° grid, updated every 10 days</td>
<td>A A</td>
</tr>
</tbody>
</table>
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

\[
NDVI = \frac{(NIR - RED)}{(NIR + RED)}
\]

\[
NDWI = \frac{(NIR - SWIR)}{(NIR + SWIR)}
\]

*Mean calculation used a sliding window of 45 by 45 pixels.*
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
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

Integration of FP6 contributions

GEOLAND: develops Pre-operational products

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SPAtial Data Analysis tool
For combining and analyzing all available data

Decision makers
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
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)
- 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 coordinators:
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Medias-France

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