The EUMETSAT Network of Satellite Application Facilities

LSA SAF
Land Surface Analysis

The vegetation monitoring in LSA SAF: overview and potential applications

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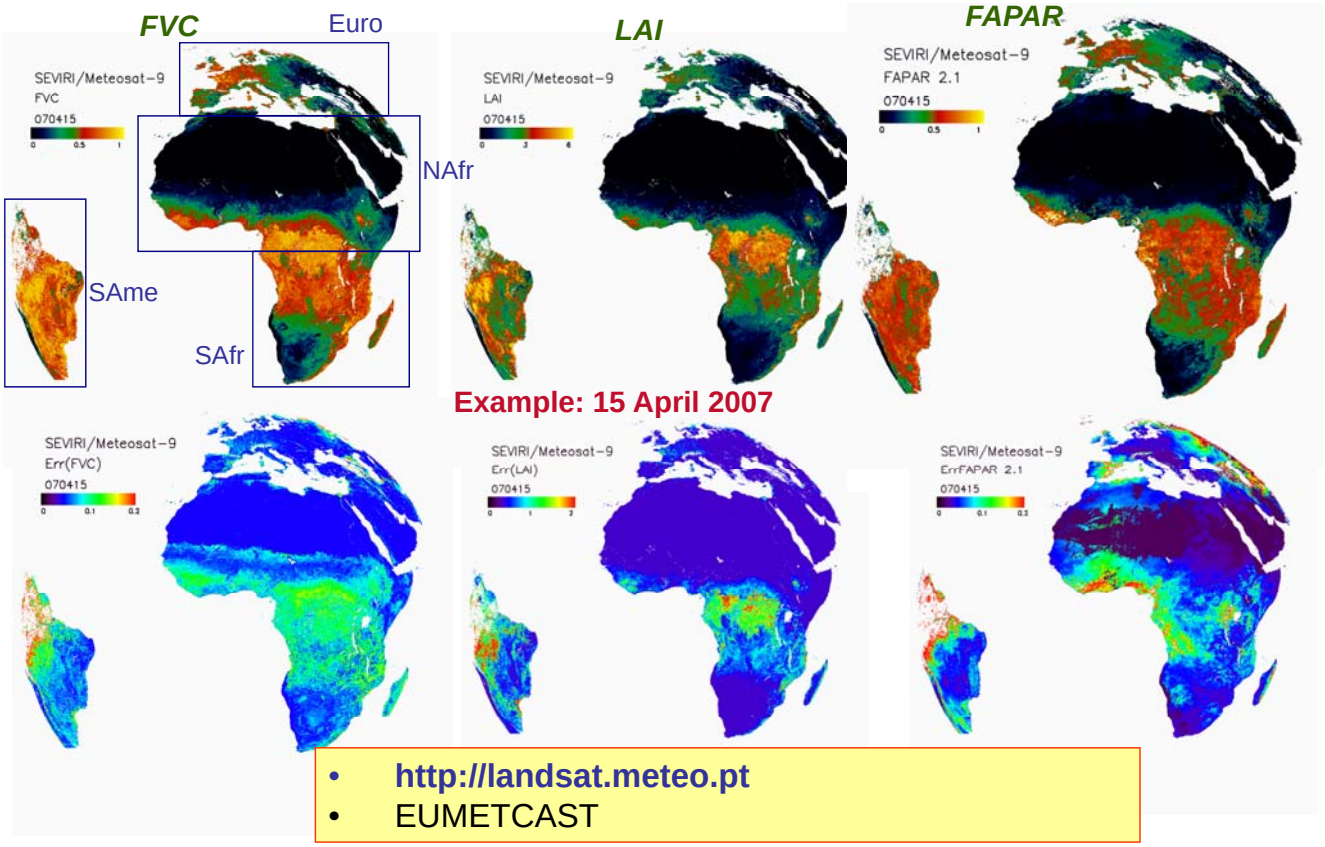
5th LSA SAF User Workshop 17-19 June 2013, Karlsruhe

INDEX

- VEGA products:
  - Product description & Expert knowledge
  - Quality monitoring
- Development of new products: EPS VEGA, CWC, GPP
  - Algorithm prototyping (SENTINEL-2 like, MODIS,…)
- Potential applications
  - Real time monitoring of drought related disturbances

PRODUCT CONTENT

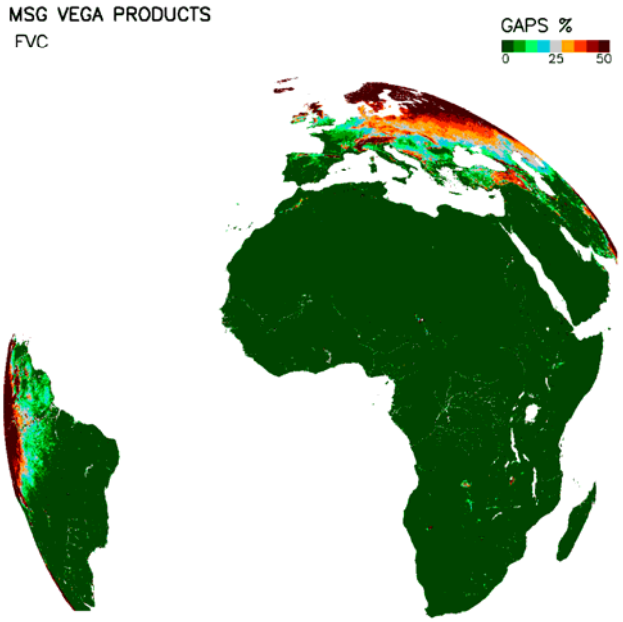
- SEVIRI "VEGA": daily products



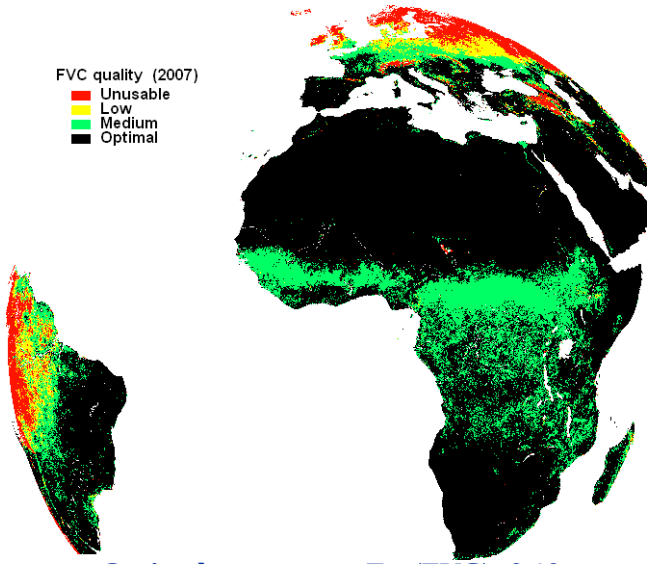
- **http://landsat.meteo.pt**
- EUMETCAST

PRODUCT DESCRIPTION

Percentage of gaps over 1 year of data



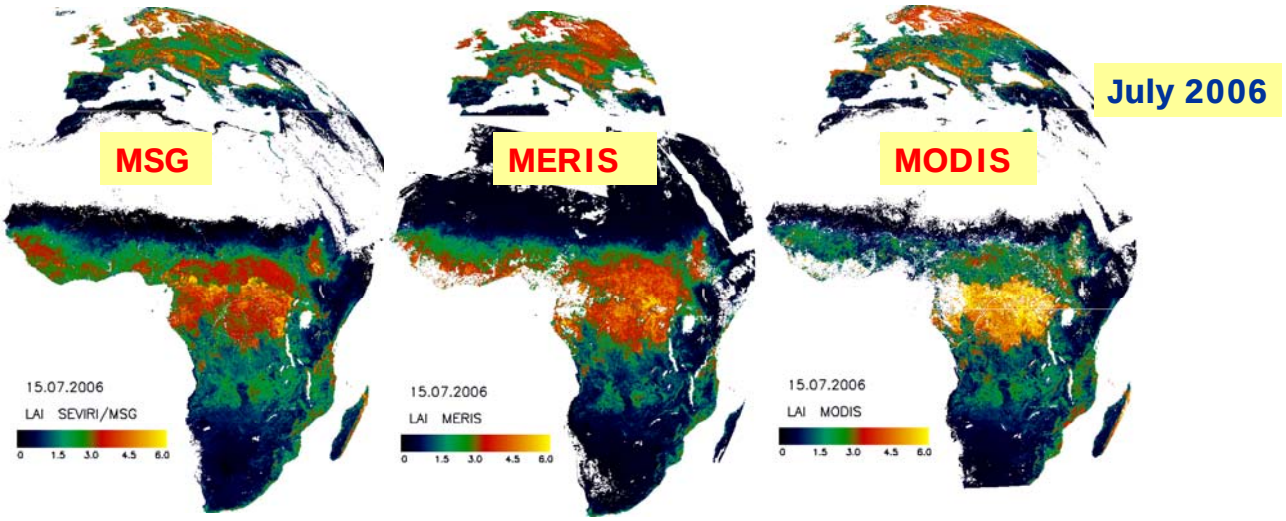
Compliance with the URD



Optimal:	**Err(FVC)<0.10**
Medium:	**0.10<Err(FVC)<0.15**
Low:	**0.15<Err(FVC)<0.20**
Unusable	**Err(FVC)>0.20**

- Usability of VEGA products is only limited for high view zenith angles

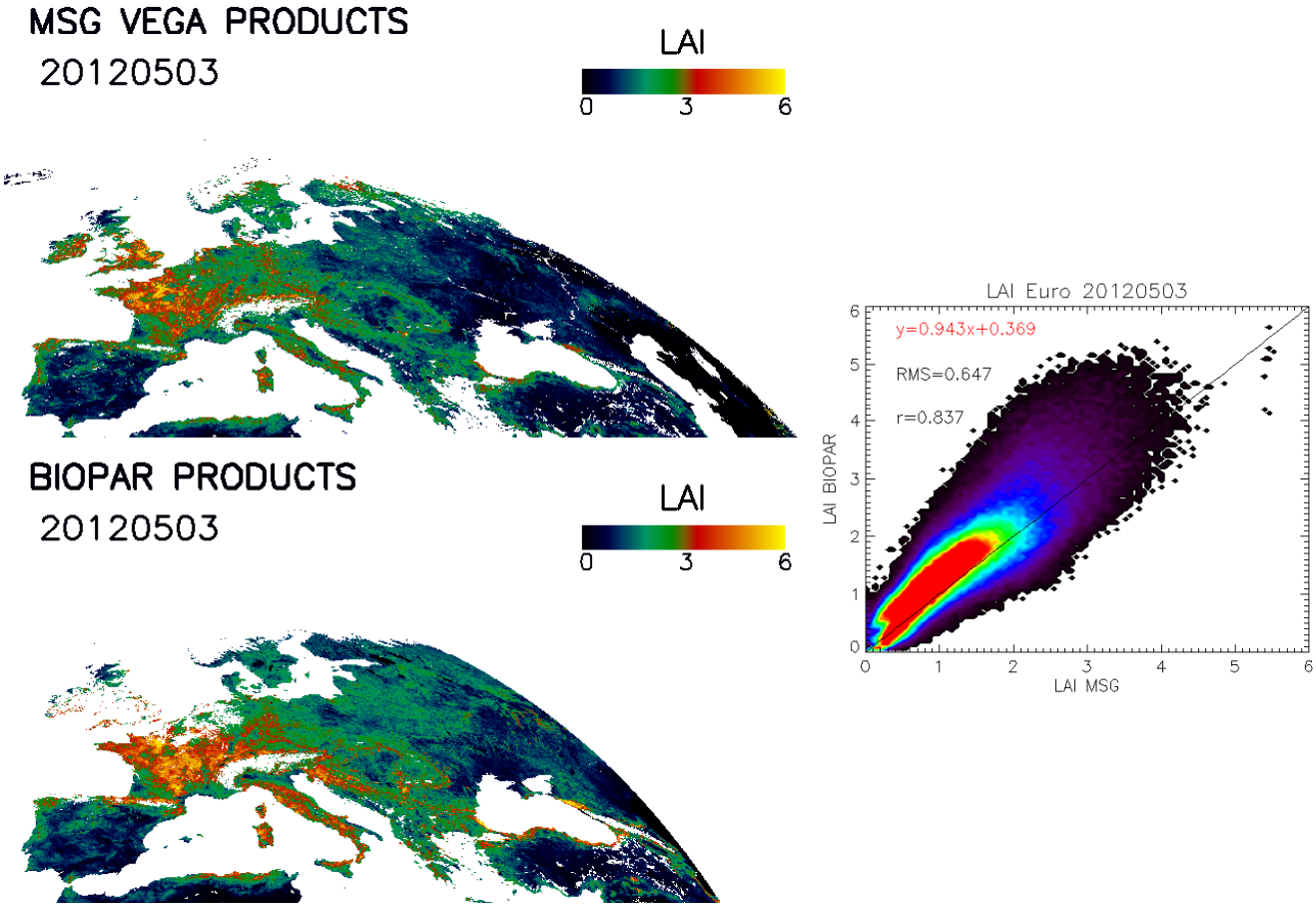
Product validation & Expert knowledge



- Algorithms robust, validated against common literature methods
- Products include pixel-level information (error estimate, QF) and fit well with the existing satellite and ground truth within the error bars
  - FVC: 0.10-0.15 LAI: 0.5-1.0
  - FAPAR: 0.10-0.15 (MSG), 0.20 (other products)
- Take care about a possible over-estimation of FVC for low values (semi-arid areas).
- FAPAR profiles present some noise introduced for the k2 BRDF parameter.
- Changes in the algorithm could introduce changes in products – No back-processing (so far)

Quality monitoring

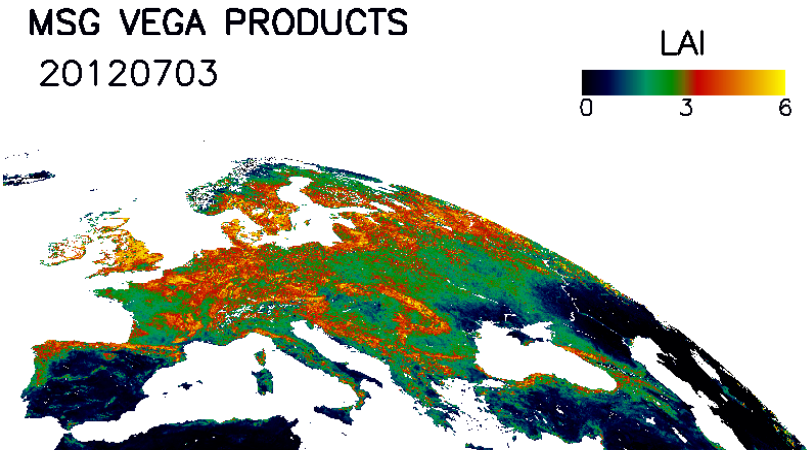
Consistency LSASAF and Copernicus Global Land

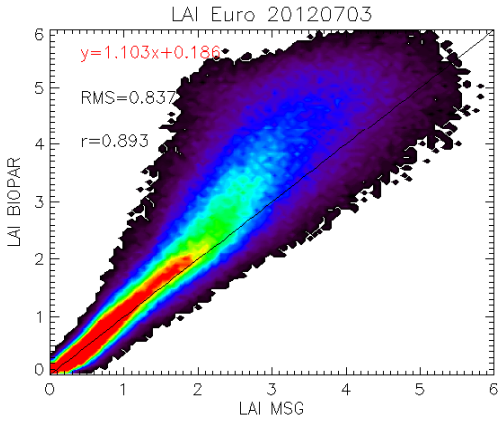


Quality monitoring

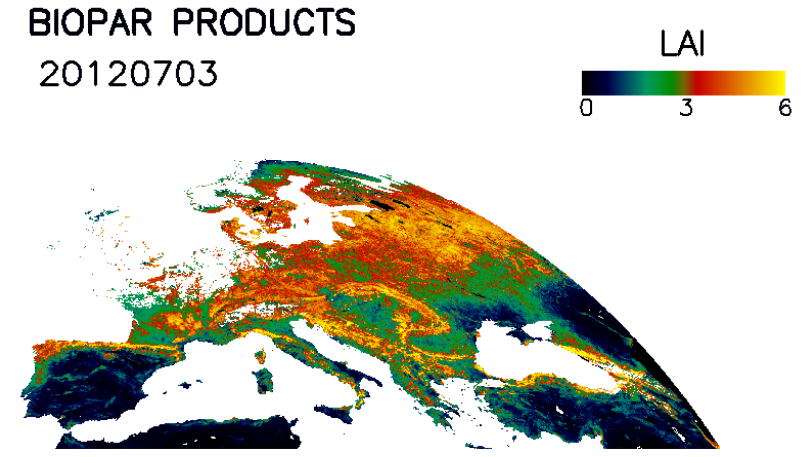
Consistency LSASAF and Copernicus Global Land

MSG VEGA PRODUCTS
20120703





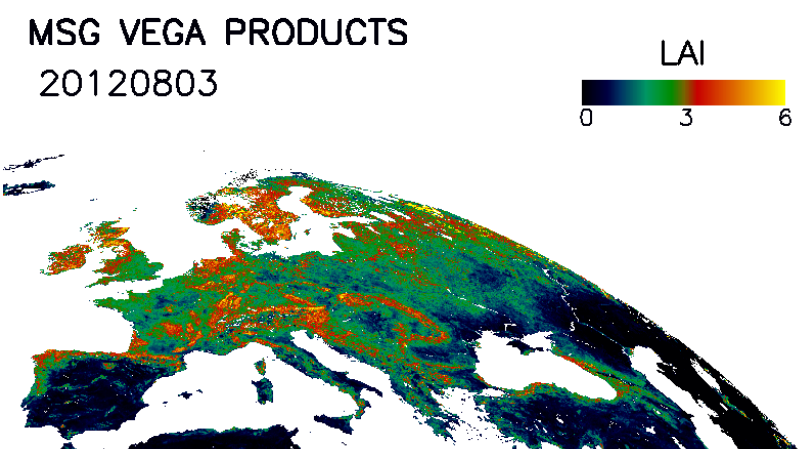
BIOPAR PRODUCTS
20120703

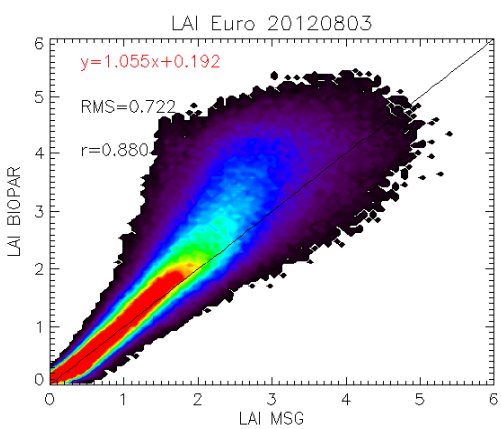


Quality monitoring

Consistency LSASAF and Copernicus Global Land

MSG VEGA PRODUCTS
20120803





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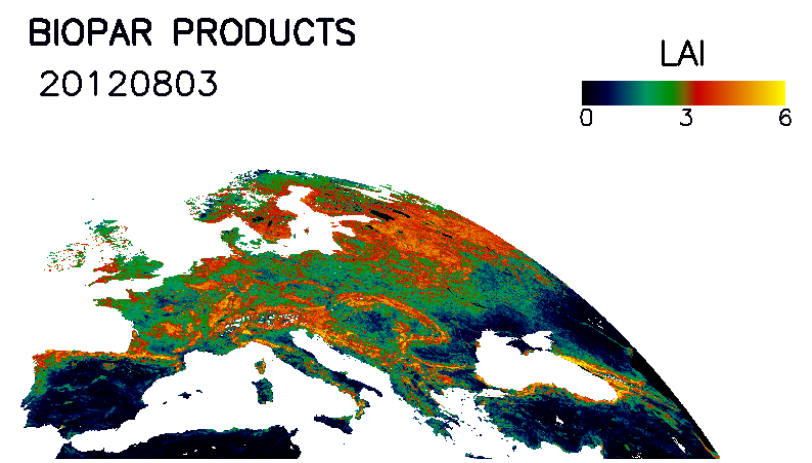

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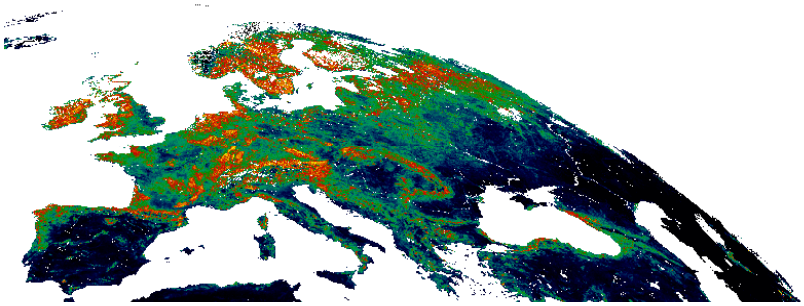

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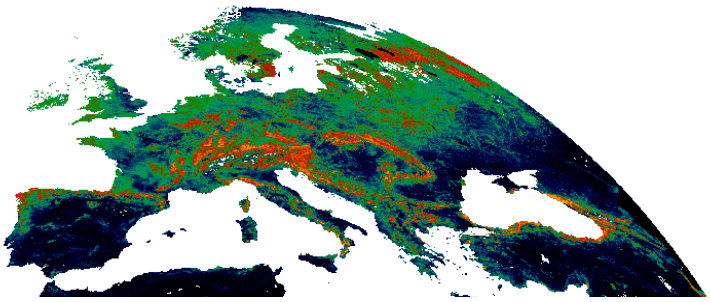

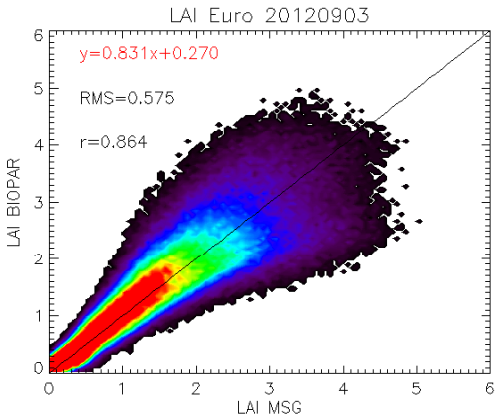

Quality monitoring

Consistency LSASAF and Copernicus Global Land

BIOPAR PRODUCTS
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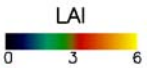

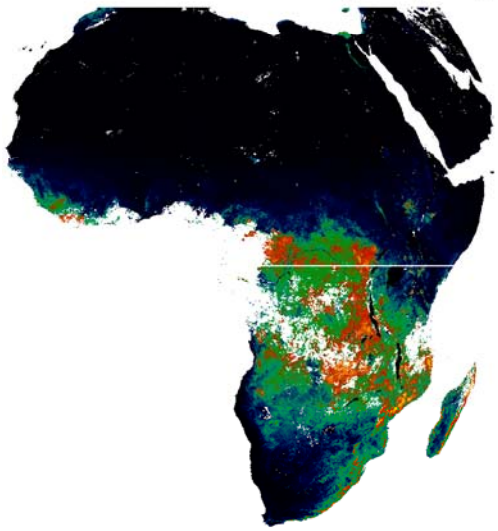

MSG VEGA PRODUCTS
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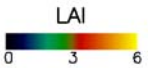
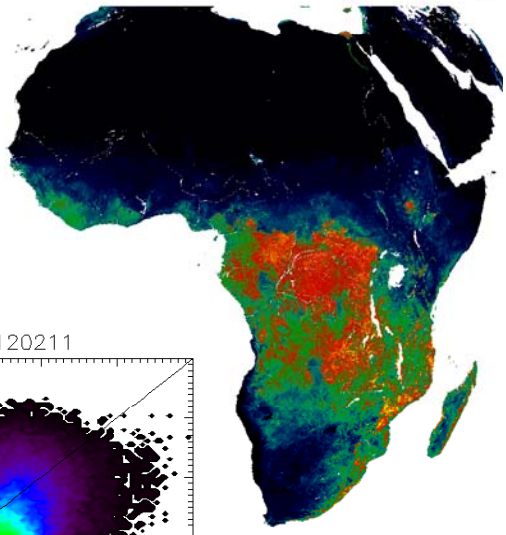
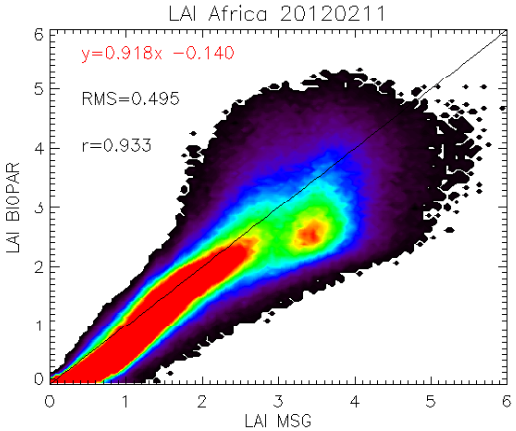
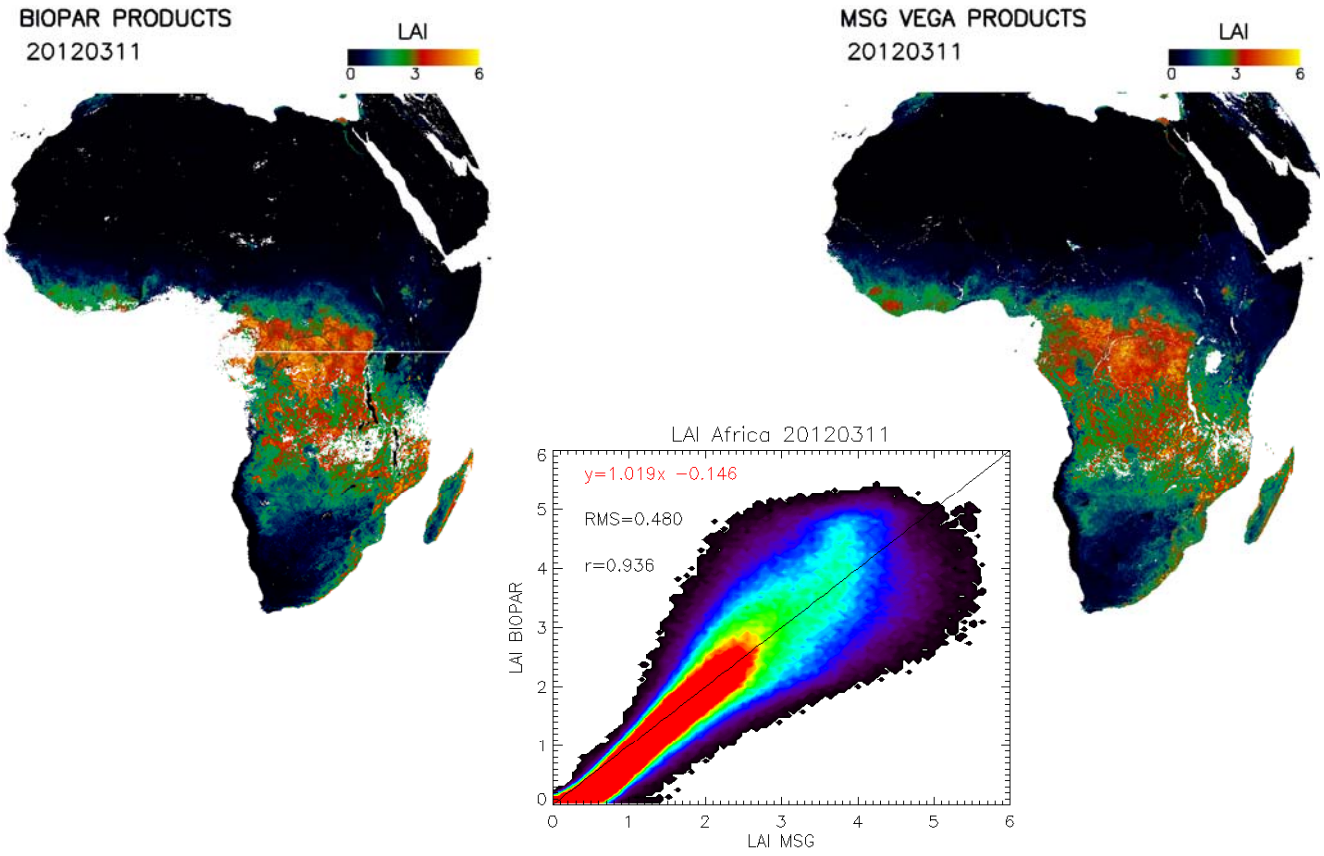






Quality monitoring

Consistency LSASAF and Copernicus Global Land



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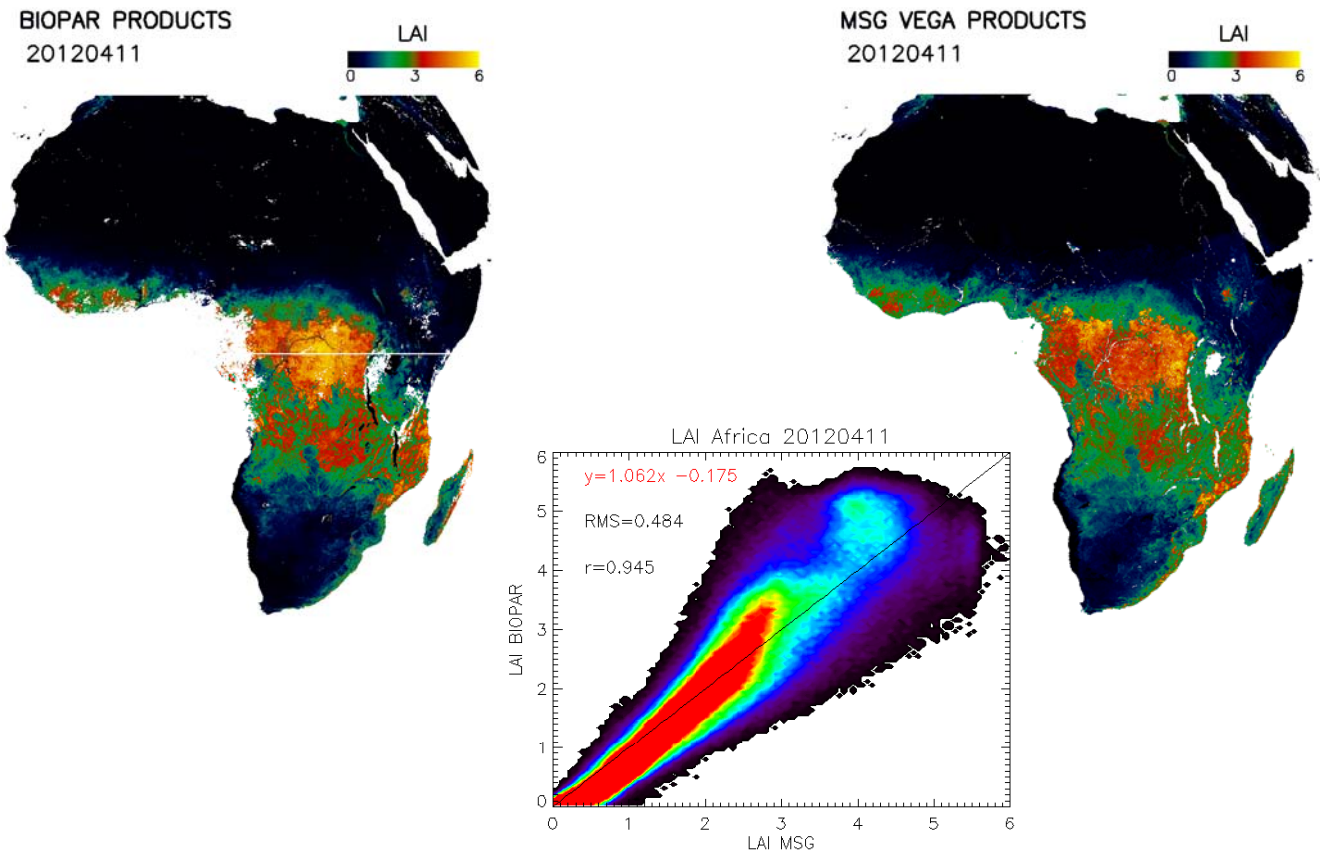
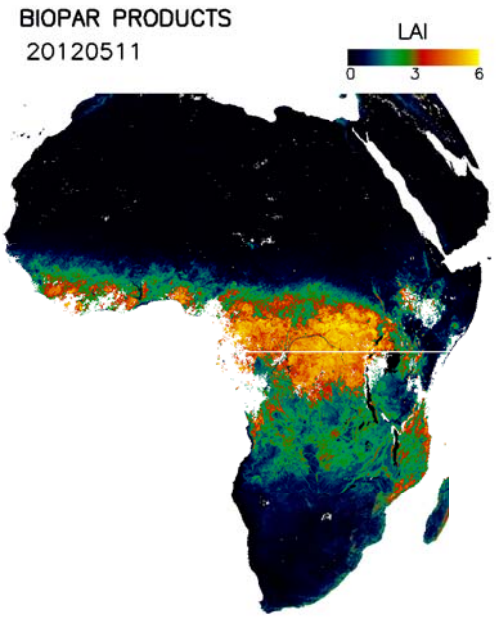
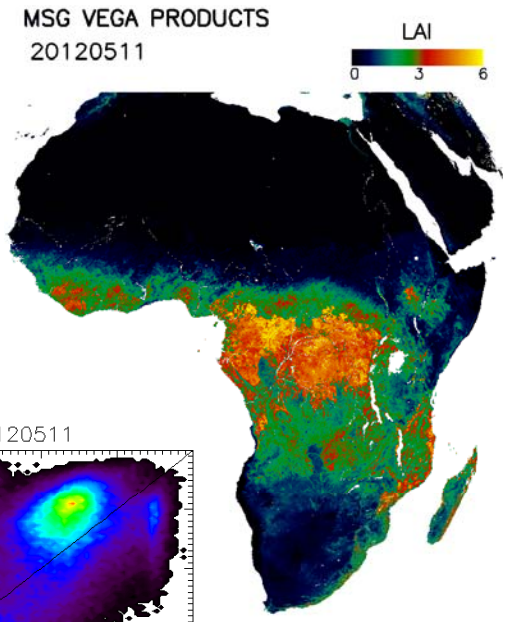
Consistency LSASAF and Copernicus Global Land

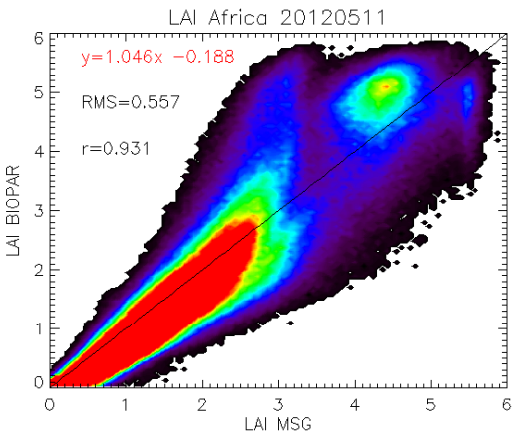


Quality monitoring

Consistency LSASAF and Copernicus Global Land

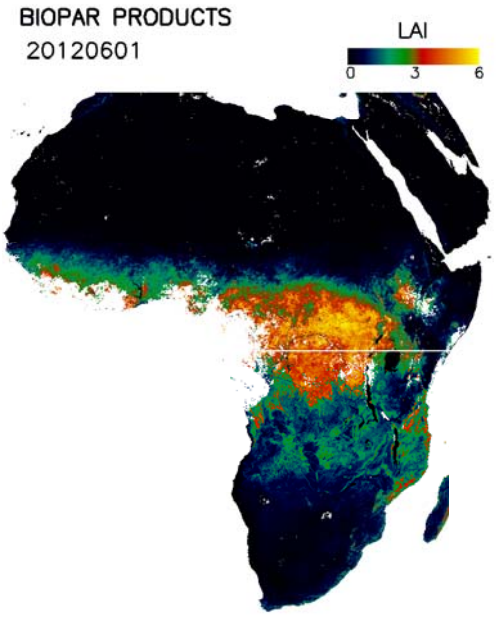


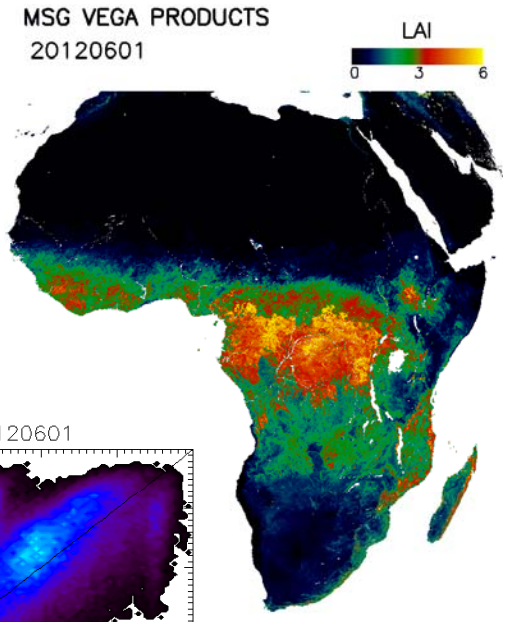


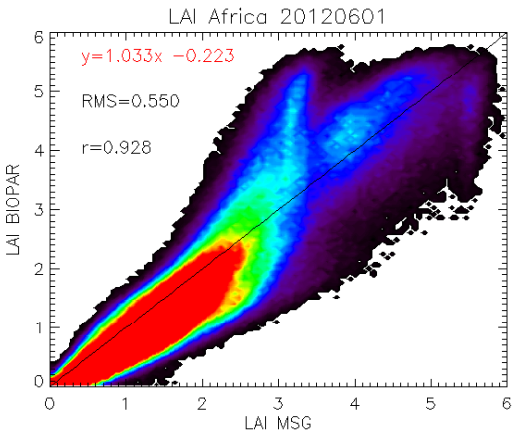


Quality monitoring

Consistency LSASAF and Copernicus Global Land







Quality monitoring

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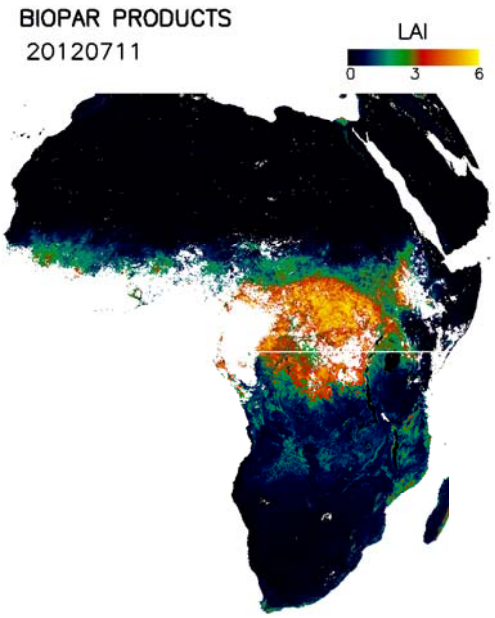
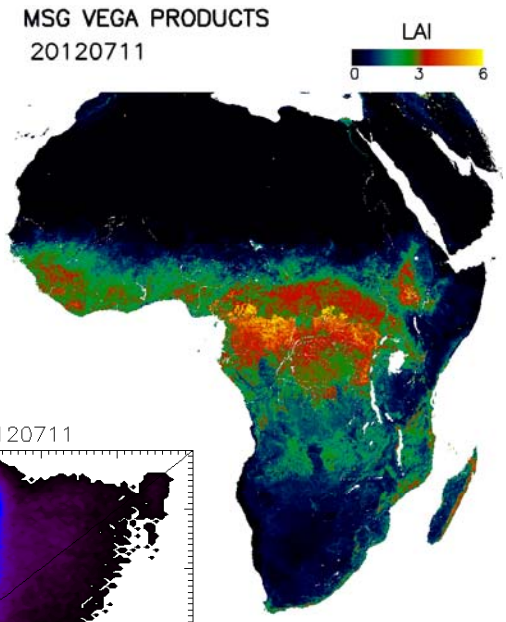
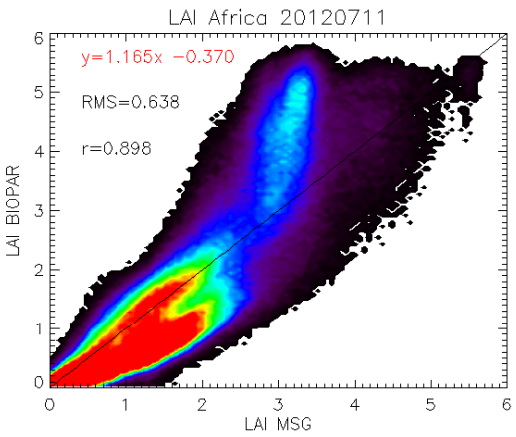
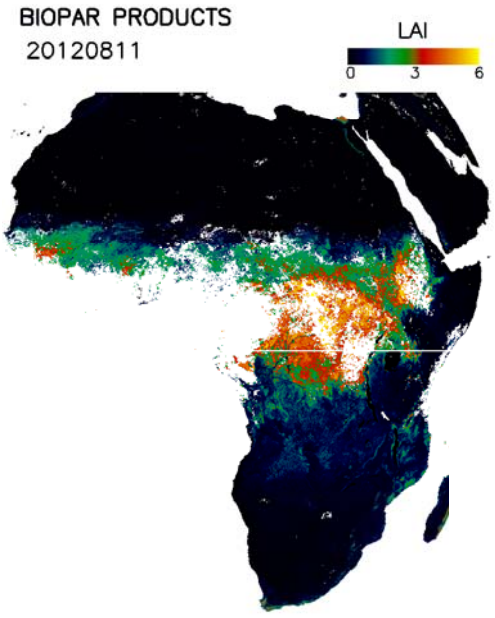


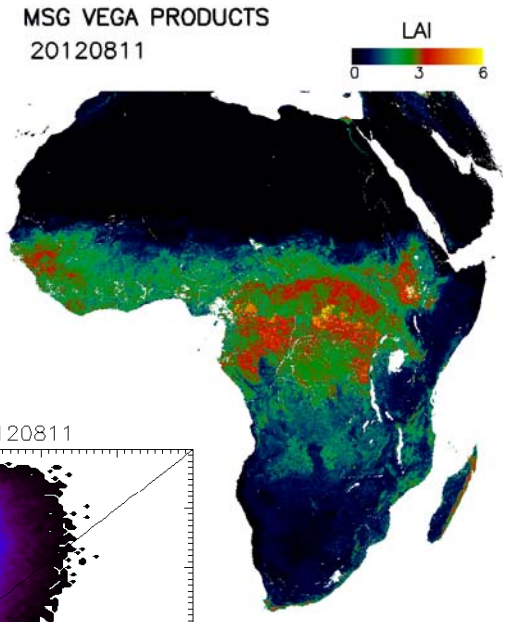


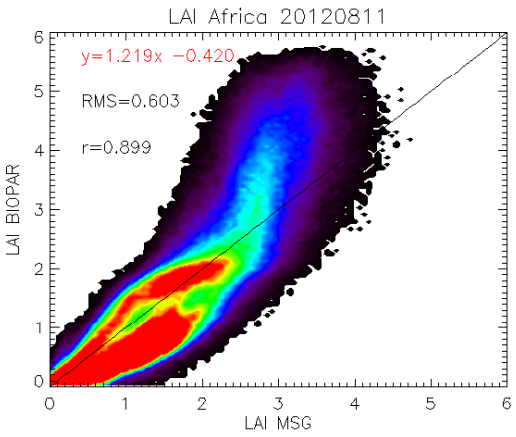


Quality monitoring

Consistency LSASAF and Copernicus Global Land

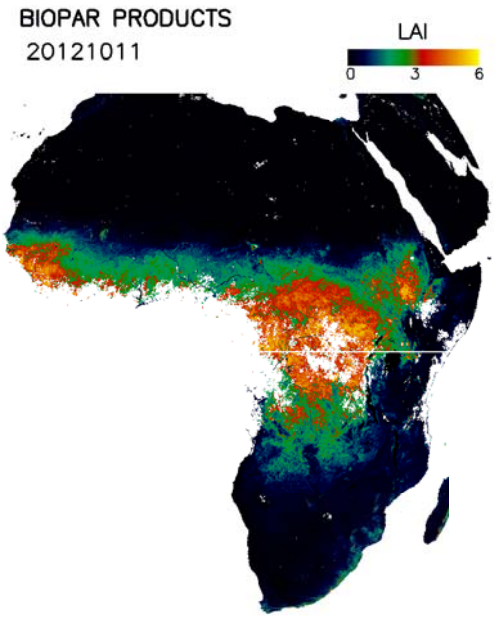


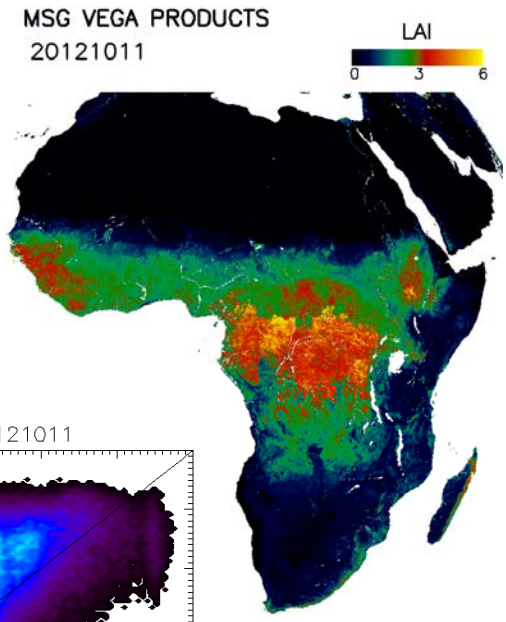


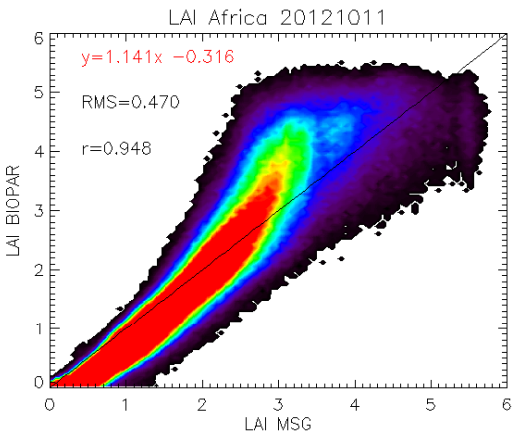


Quality monitoring

Consistency LSASAF and Copernicus Global Land

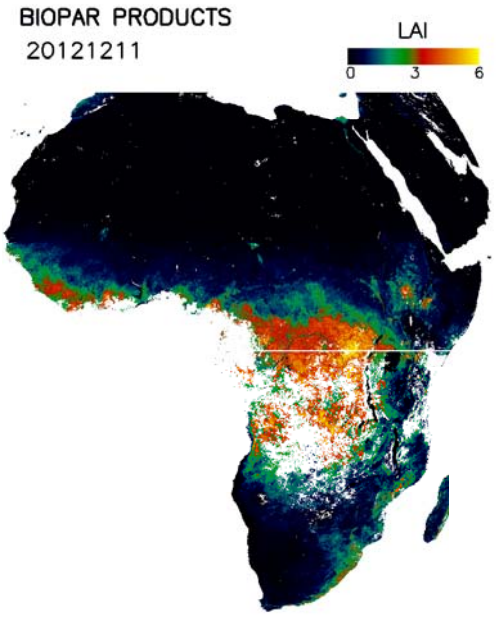


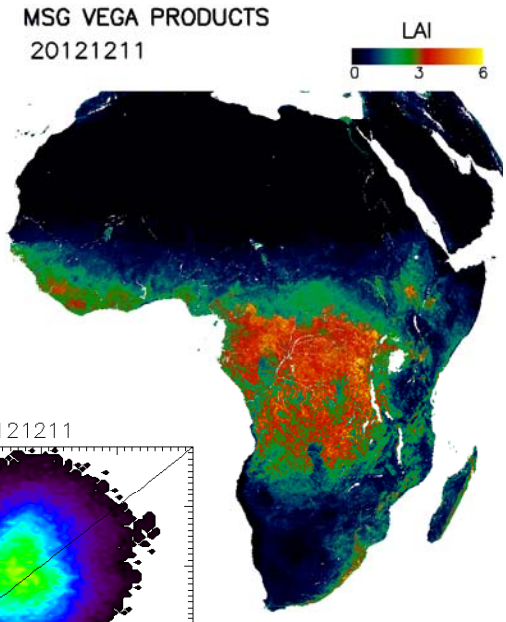


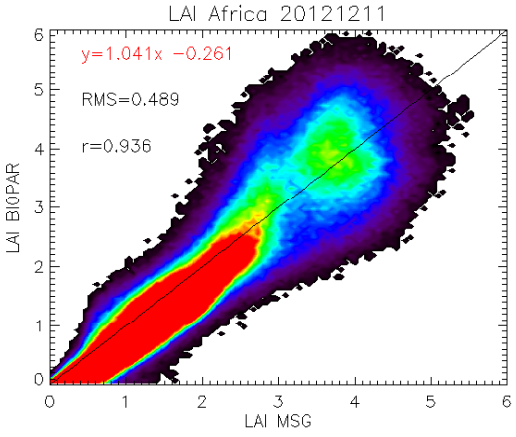


Quality monitoring

Consistency LSASAF and Copernicus Global Land

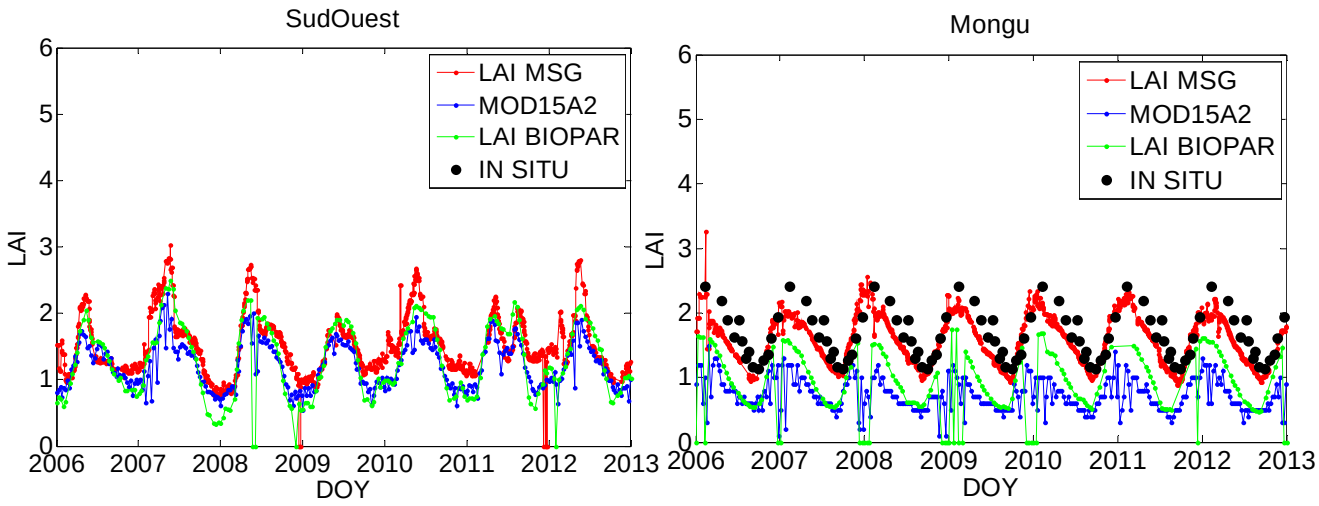






Quality monitoring

Temporal consistency

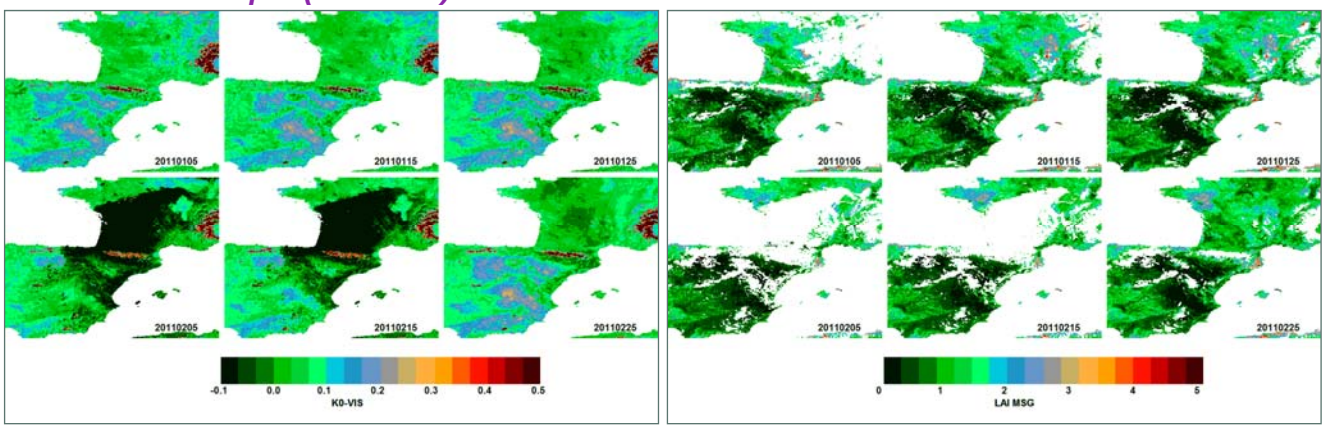


PRODUCT DESCRIPTION

Identified artefacts

Input (BRDF K0)

LAI



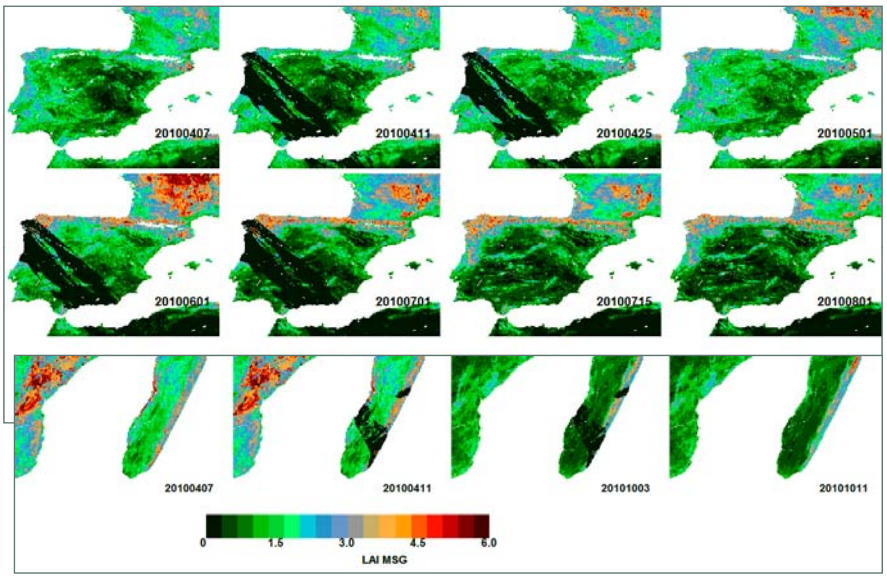
Artefacts during late winter 2011

- at some specific locations in the four SEVIRI regions.
- Caused by a sharp decrease in the BRDF bands, unadressed by quality flag

Documented in Updated Validation Report

PRODUCT DESCRIPTION

Identified artefacts



Iberian Peninsula

Madagascar

Strips in FVC and LAI at some periods of year 2010

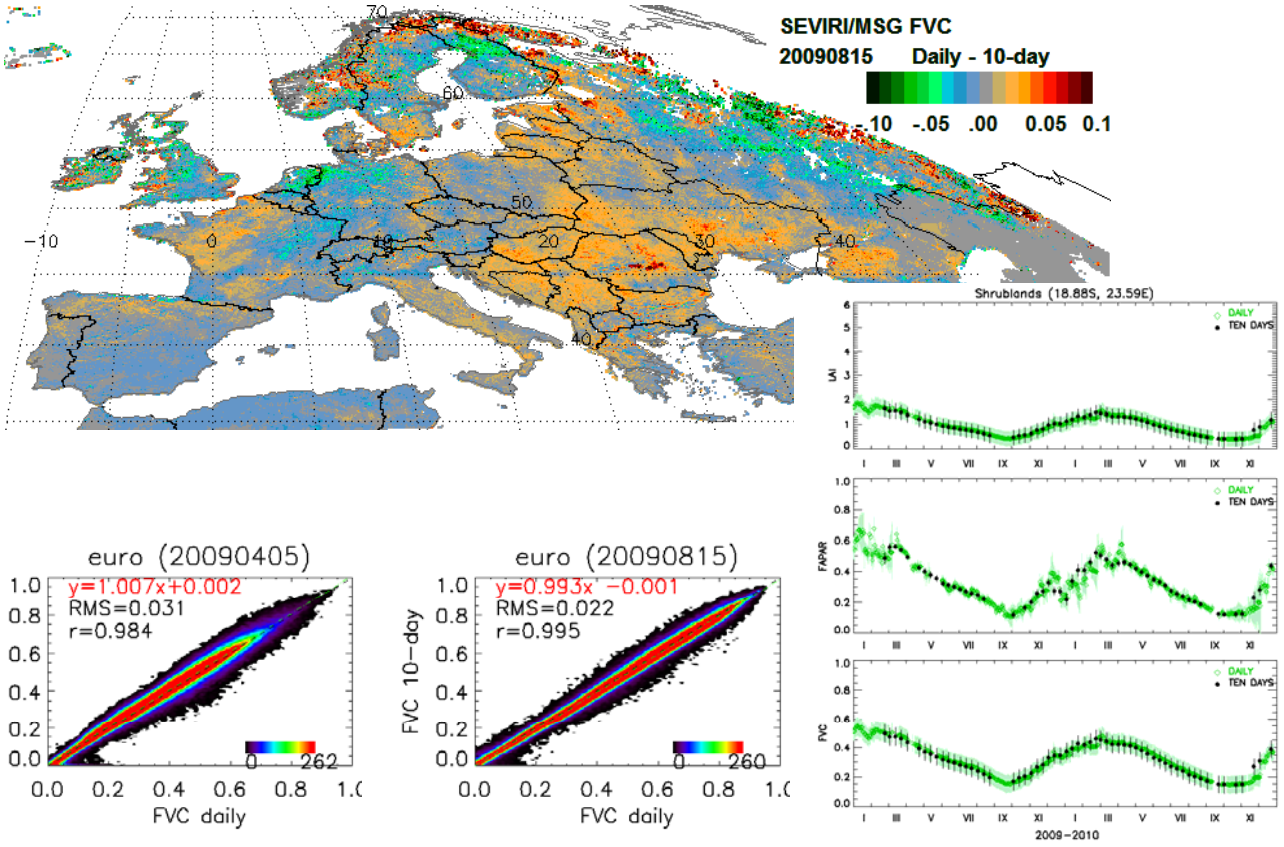
- Assigned an erroneous value of 0
- Unaddressed by quality flag

Documented in Updated Validation Report

New products

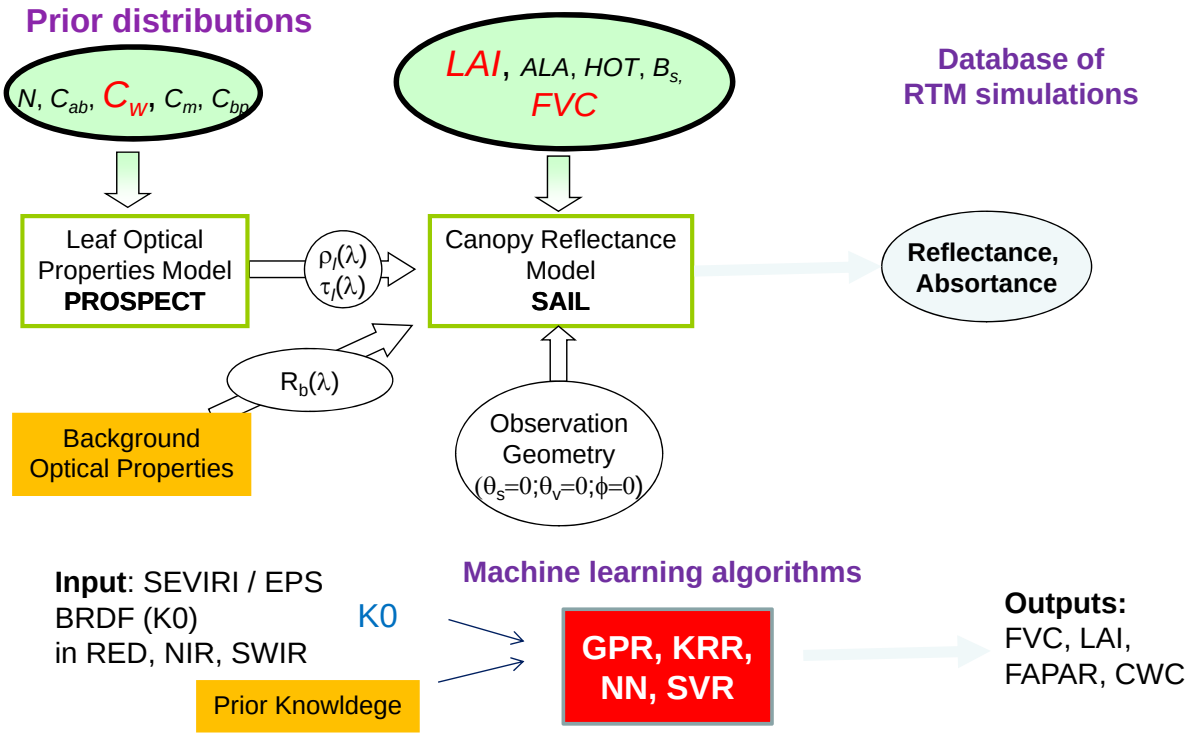
10-day VEGA (MTVEGA)

- Delivery of 10-day VEGA (MTVEGA) based on AL3 (time scale of 30-day)



Algorithm develpmement (EPS)

- Joint retrieval of VEGA+CWC by inverting data generated from RTMs
- Powerful non parametric nonlinear retrieval methods

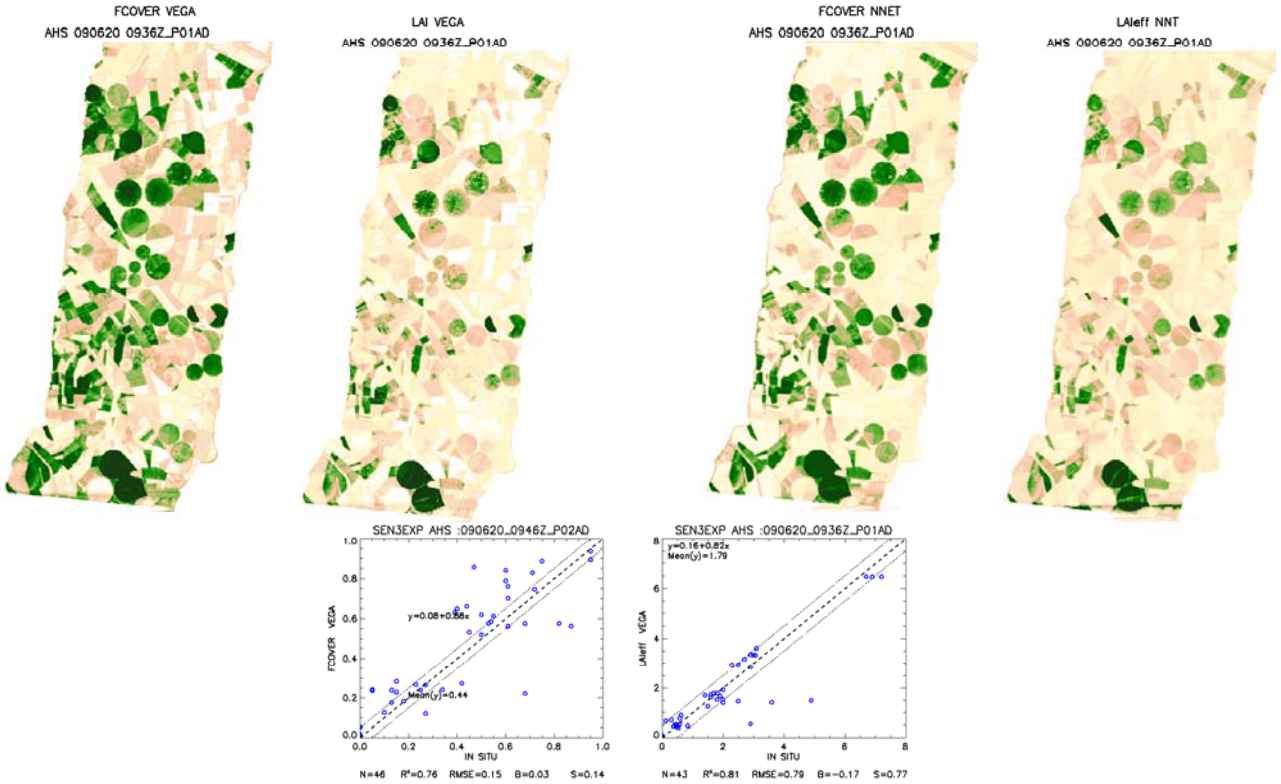


Algorithm Prototyping

VALSE2: intercomparison of algorithms for S2

Example: SEN3EXP: Sentinel2 simulated from AHS

LSA SAF ***NNET (Baret et al.)***



Algorithm Prototyping

VEGA and NN algorithm over SEVIRI

LSA SAF *LSA SAF – PROSAIL NN*

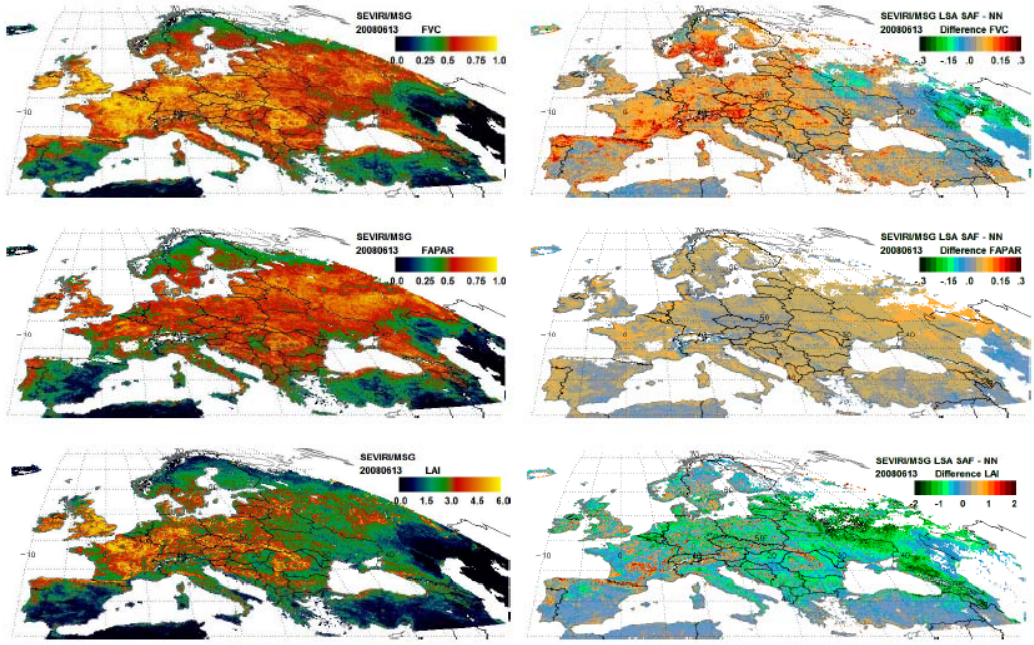


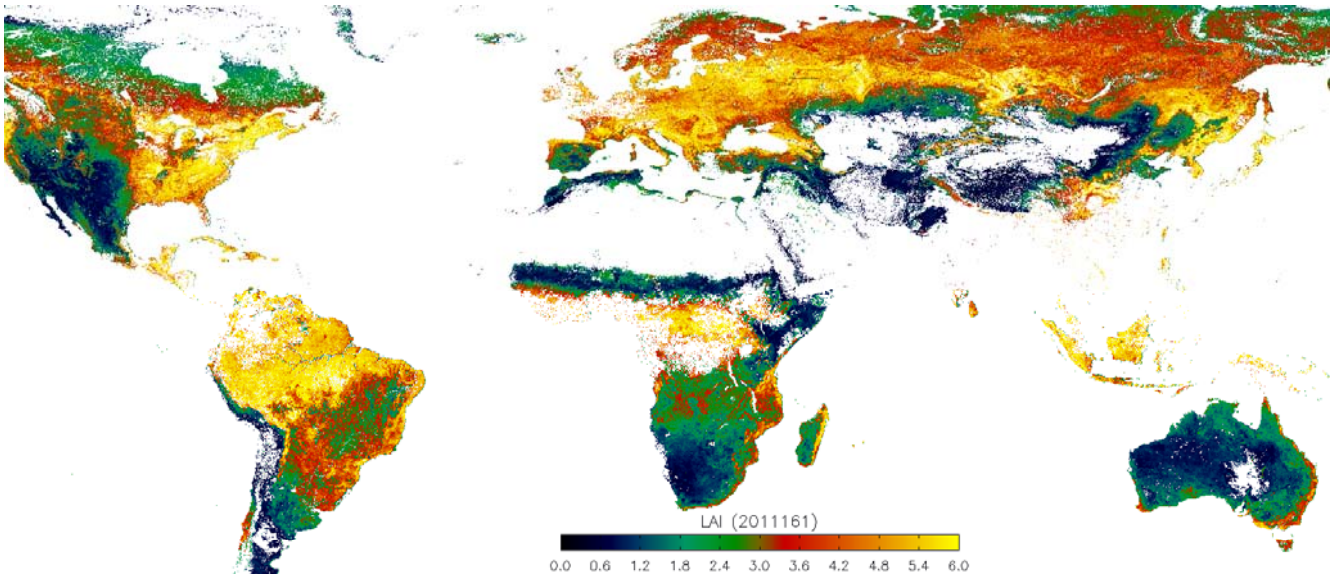
Figure 1. Left: LSA SAF FVC, FAPAR and LAI maps of Europe for the date 2008/06/13. Right: maps of differences of the comparison of LSA SAF and neural network (NN) FVC, FAPAR and LAI estimates.

A.Verger, F. Baret, F.J. García-Haro, F.Camacho and J. Meliá. **Consistency of vegetation estimates from SEVIRI/MSG observations and operational algorithms**. Proceedings **RAQRSS-III**. Torrent, Spain, 27 Sept-1 Oct. 2010, pp: 99-104.

Algorithm Prototyping

Global estimates from MODIS (MCD43)

Example: LAI, 10 June 2011

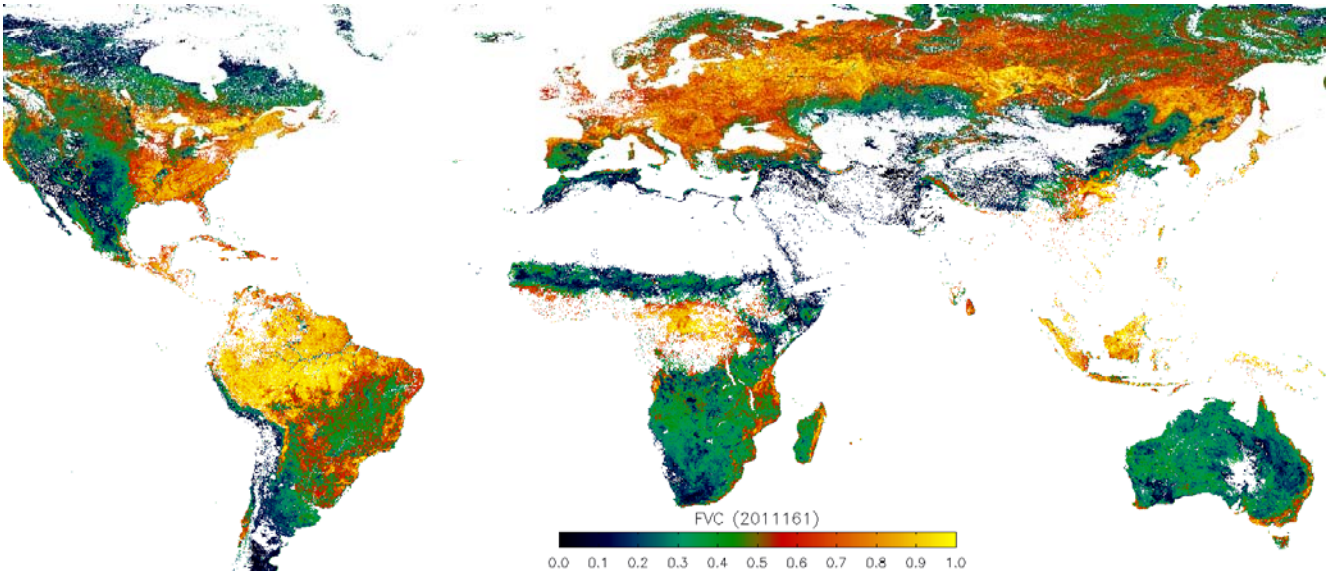


- Retrieval method: Gaussian Processes Regression (GPR)

Algorithm Prototyping

Global estimates from MODIS (MCD43)

Example: FVC, 10 June 2011



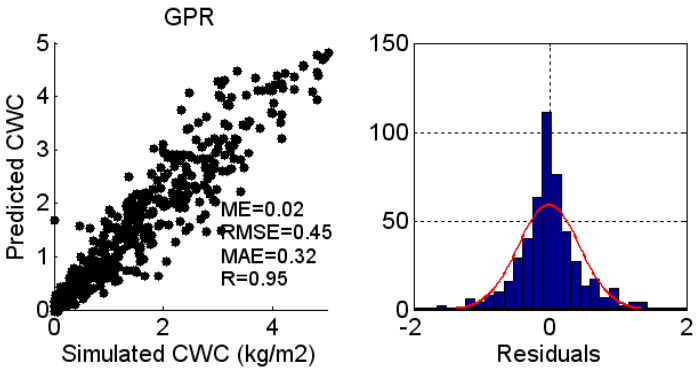
- Retrieval method: Gaussian Processes Regression (GPR)

New products

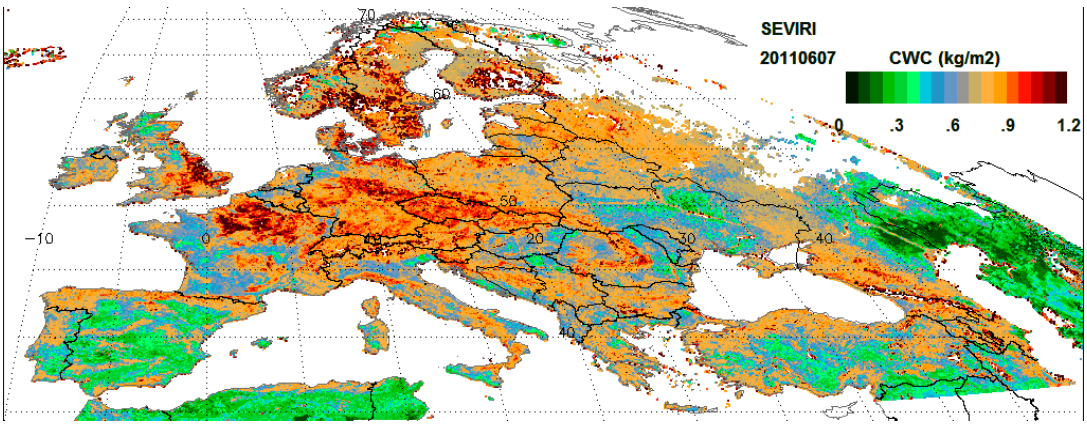
Prototyping of water content

Canopy Water Content (kg/m^2), Fuel Moisture Content (%)

- Inversion of PROSAIL Prototyped on CHRIS/PROBA, SEVIRI, and MODIS
- Different retrieval Algorithms: GPR, NN,…



Example: 7 June 2011



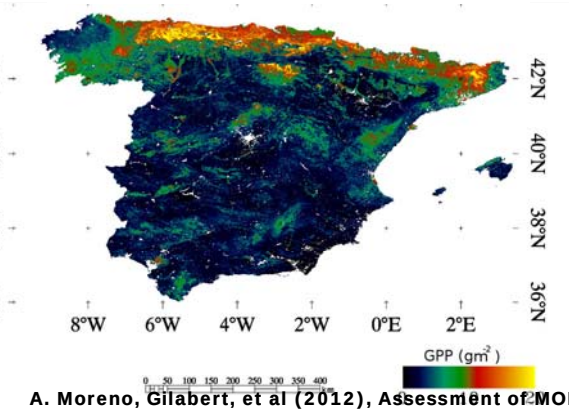
New products

Prototyping of primary production

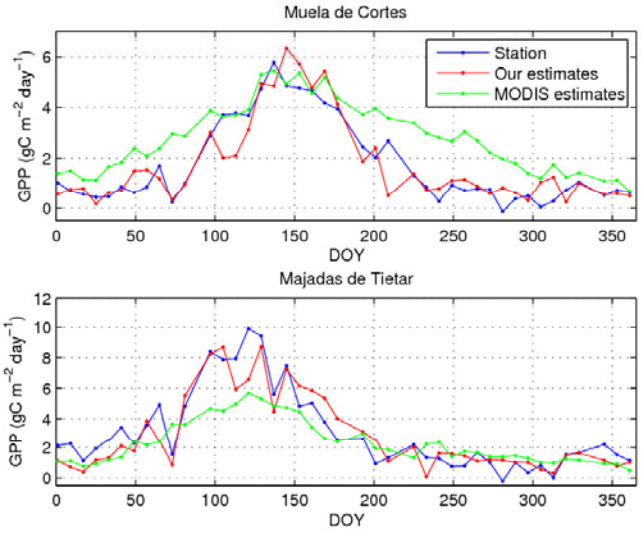
NPP – Net Primary Production,
GPP – Gross Primary Production

- A Monteith type parametric (C-Fix) model through the assimilation of LSA SAF products (DSSF, FAPAR, LST).
- Prototyped with MODIS

Example: GPP, 21 June 2011



- VALIDATION
  - flux towers (eddy-covariance)
  - Intercomparison with MOD17

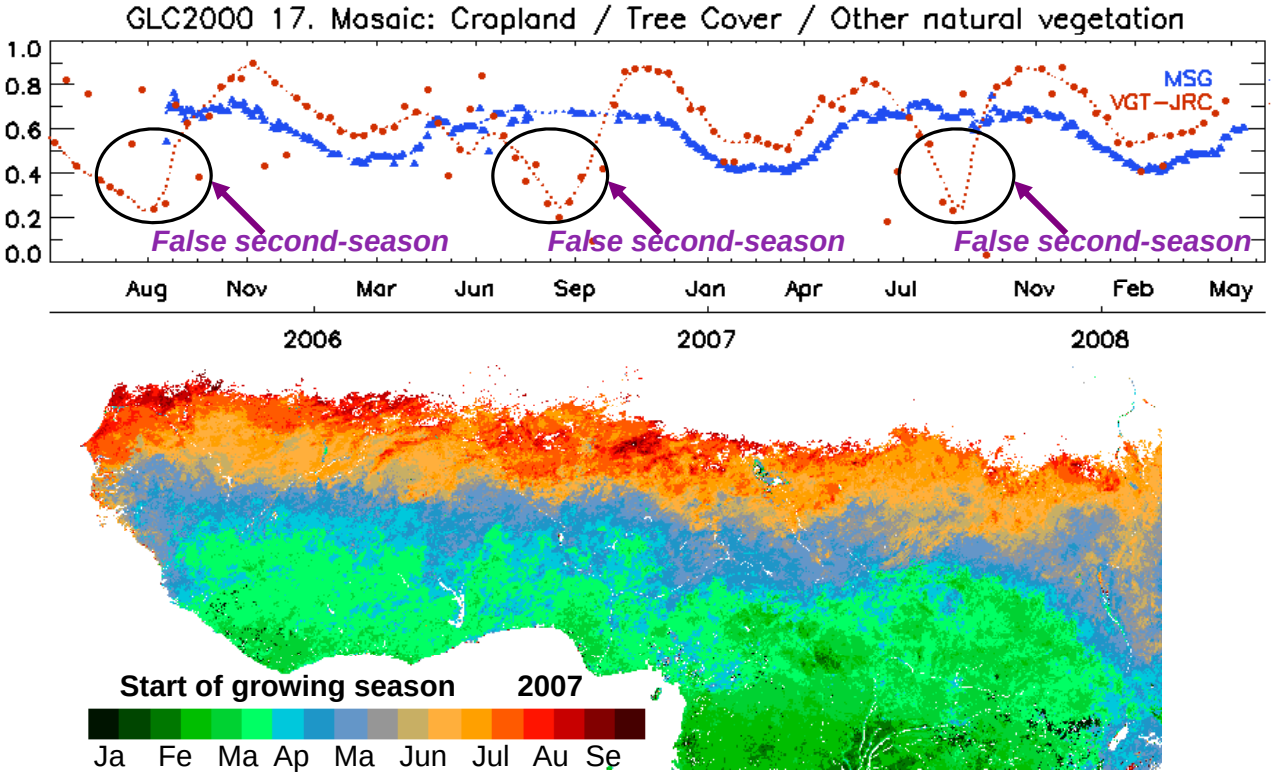


A. Moreno, Gilabert, et al (2012), Assessment of MODIS imagery to track light-use efficiency in a water-limited Mediterranean pine forest. Remote Sensing of Environment, 123, 359–367.

M.A. Gilabert, A. Moreno, F. Maselli, M. Chiesi, B. Martínez, F.J. García-Haro, A. Pérez- Hoyos, A. Carrara, J. Meliá (2013), Estimación de la producción primaria bruta en España empleando datos meteorológicos e imágenes MODIS y MSG, Proc. XV Congr. AET, Madrid 22-24 Octubre 2013.

Reconstruction of seasonal curves

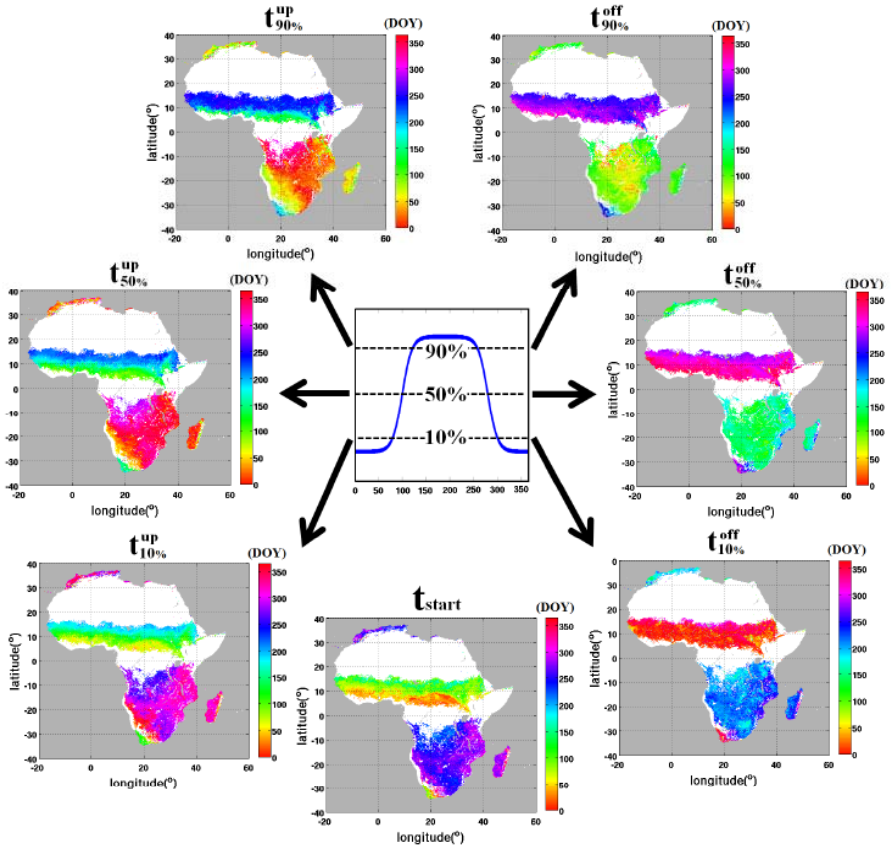
Potential applications



- Africa is a consolidated region: no gaps, temporal continuity, improving the capabilities of polar orbiters to characterise the phenology

Deriving phenologic attributes

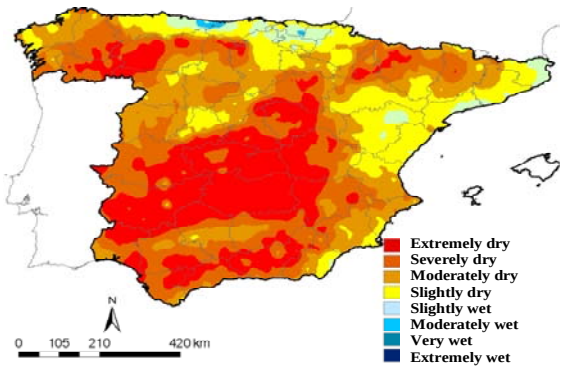
Potential applications



Guan, K., E. F. Wood, D. Medvigy, K. K. Caylor, S. Li and S. J. Jeong, 2013, Derive vegetation phenological time and structure information over Africa using SEVIRI daily LAI, *IEEE transactions on Geoscience and Remote Sensing*, in press.

FEEDBACKS CLIMATE-VEGETATION

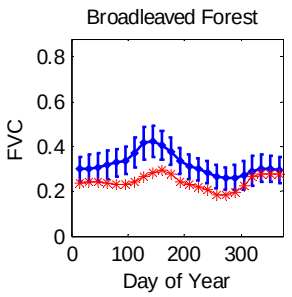
Impact of 2004-06 drought in Spain

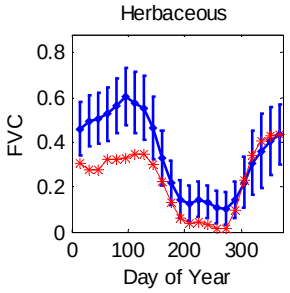


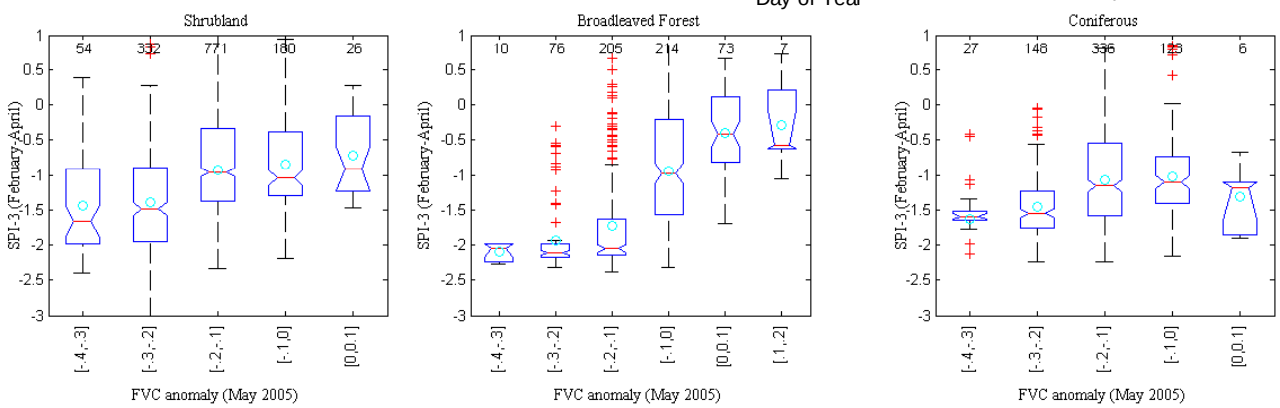
***SPI-12* (August'04 – July'05)**

FVC shows large deviation for certains classes/periods in water-limited areas

Shrub, herbaceous and broadleaved are very sensitive to drought







Automated monitoring of vegetation disturbance

Modeling the dynamics of vegetation

- Season-trend parametric model:

Model → $Trend_t + Stational_t$; Residual → $Random_t$

$$Y_t = Trend_t + Stational_t + Random_t$$

Example: Time series of SEVIRI FVC

$$FVC(t) = a_0 + a_1 t + \sum_{k=1}^{3} A_k \sin(kwt + \varphi_k)$$

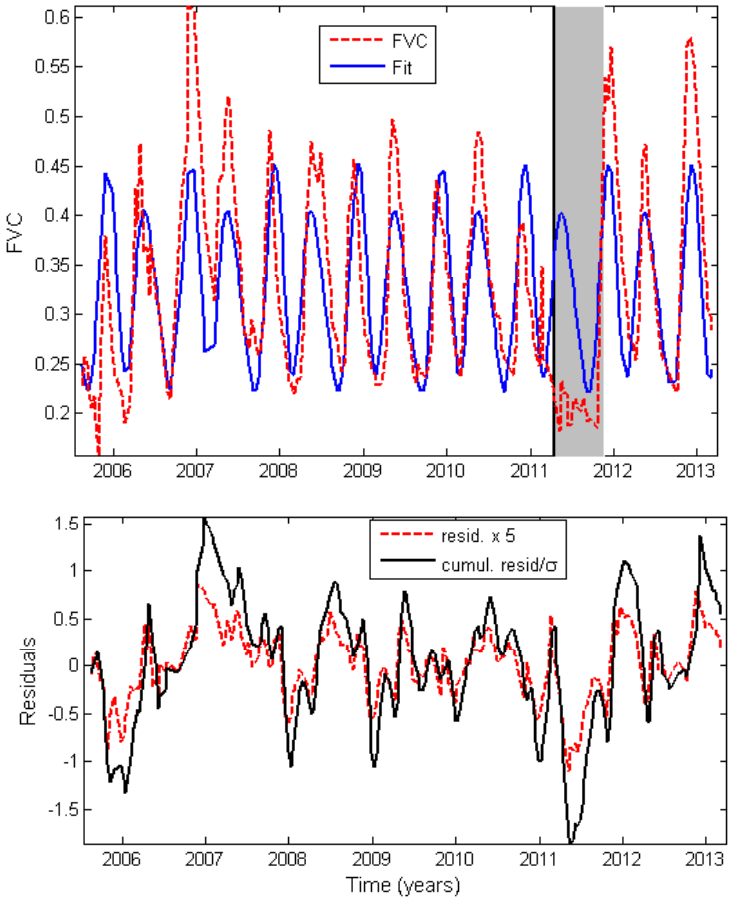
Example: Disturbance measure

$$std\_resid(t) = \frac{\langle Y_t - \hat{Y} \rangle}{\sigma_y}$$

APPLICATIONS:

- Real time detection (drought, fire):
- Retrospectively monitoring the extent of disturbances

Automated monitoring of vegetation disturbance



Example: Drought in Somalia (2011)

- FVC/MSG time series
- Savanna, 2 growing seasons

Fully automated:

- Probability of disturbance maps (typically significant for *std_resid*<-1)
- Period of recovery (e.g. std_resid pass from -1 to 0)

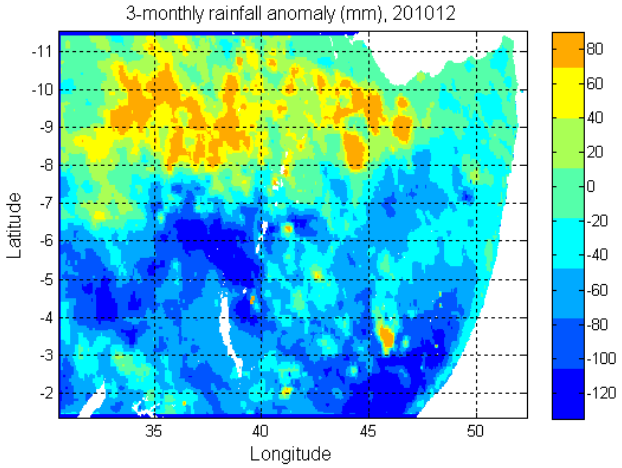
SEVIRI Capabilities (VEGA)

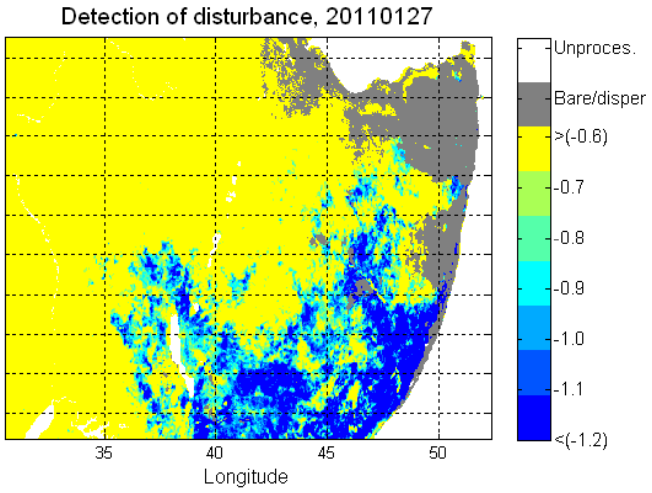
- High frequency and continuity

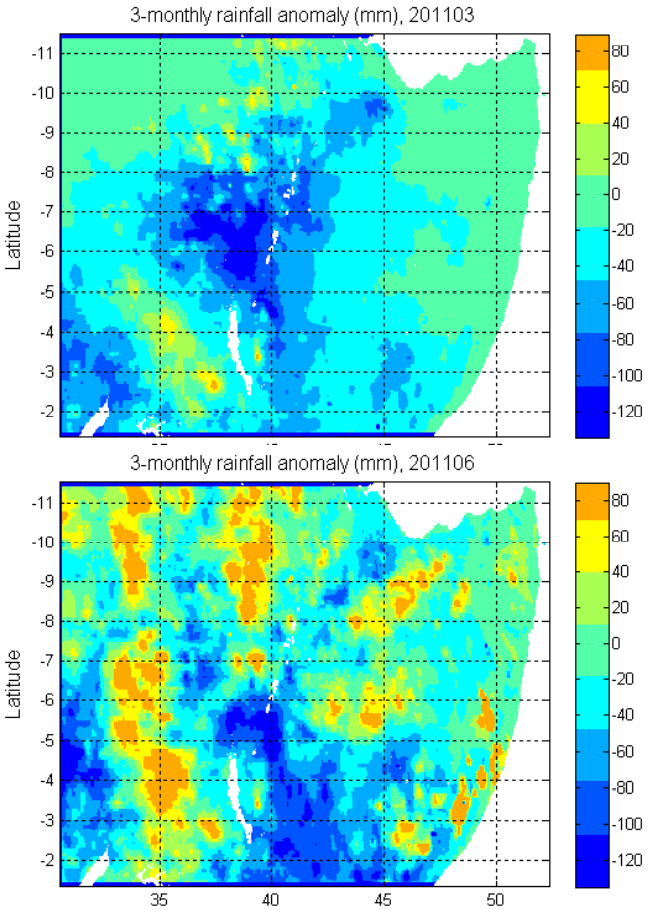
⇒ VEGA is specially suited for very rapid detection (e.g. < 1 month)

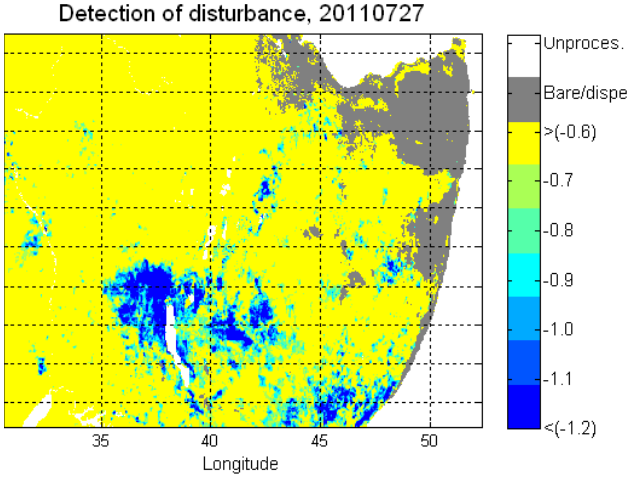
Severe drought in Horn of Africa (2011):

- Shortage of rain in the two rainy seasons (autumn and spring)



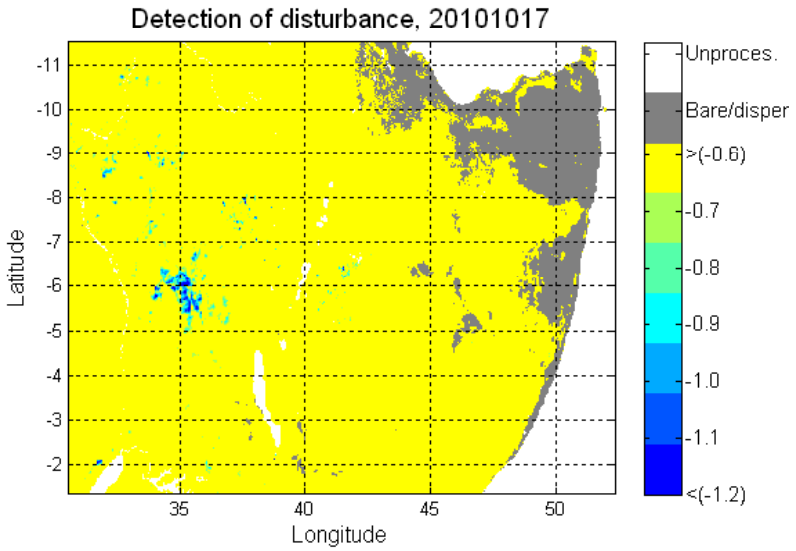






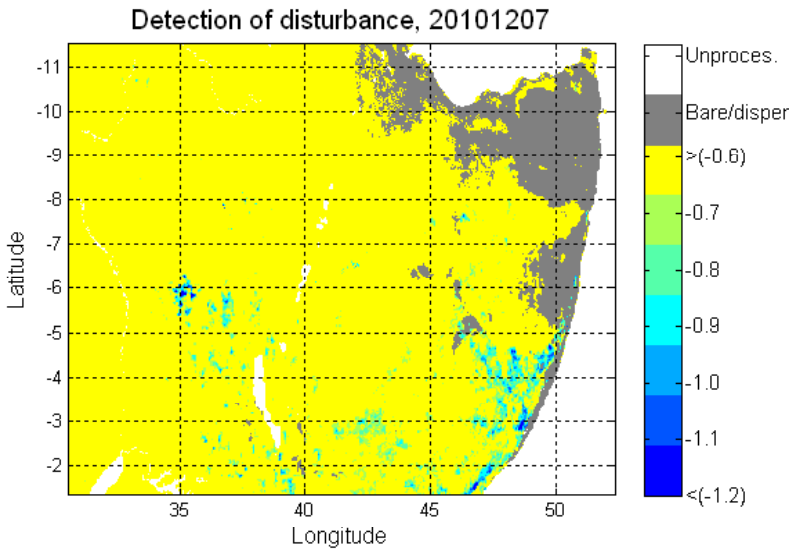
Drought monitoring

Horn of Africa (2011)



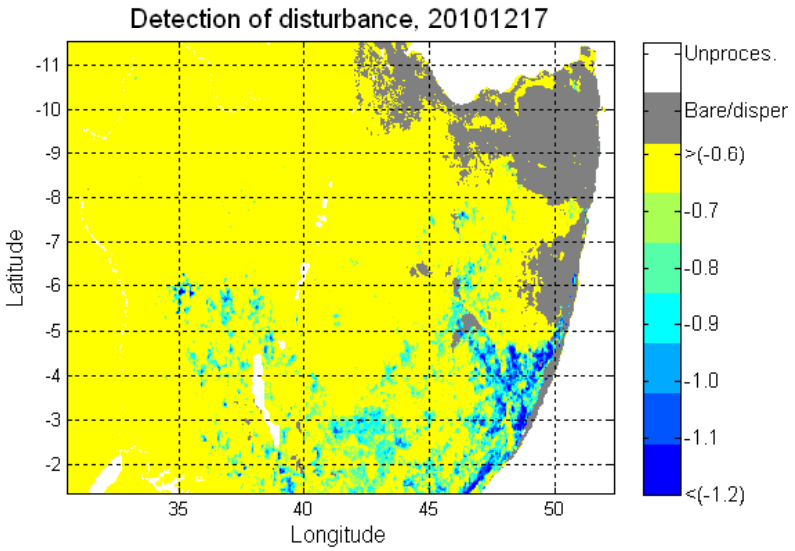
Drought monitoring

Horn of Africa (2011)



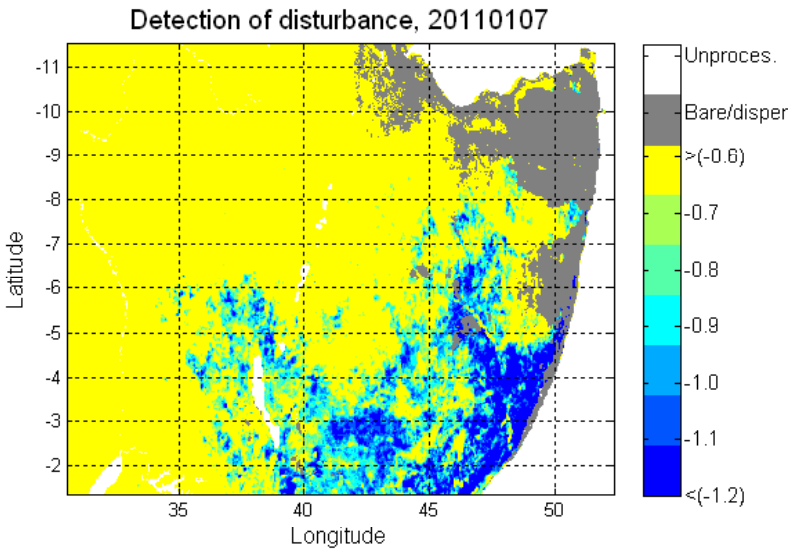
Drought monitoring

Horn of Africa (2011)



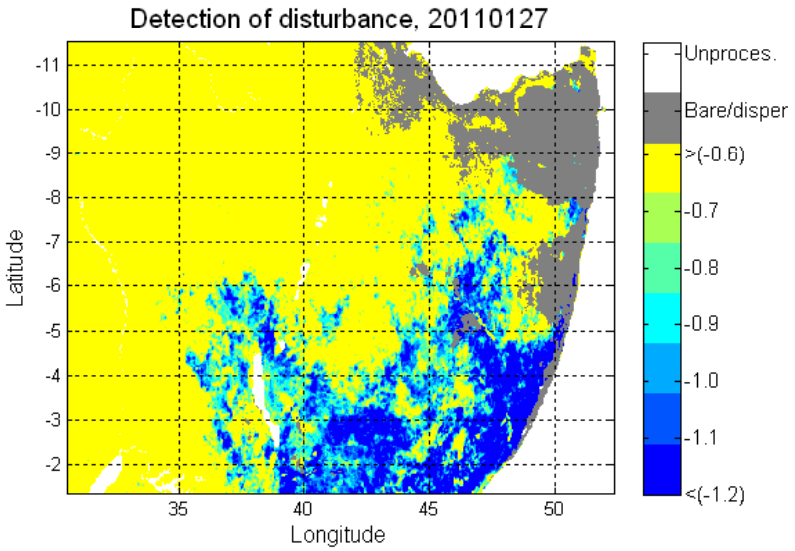
Drought monitoring

Horn of Africa (2011)



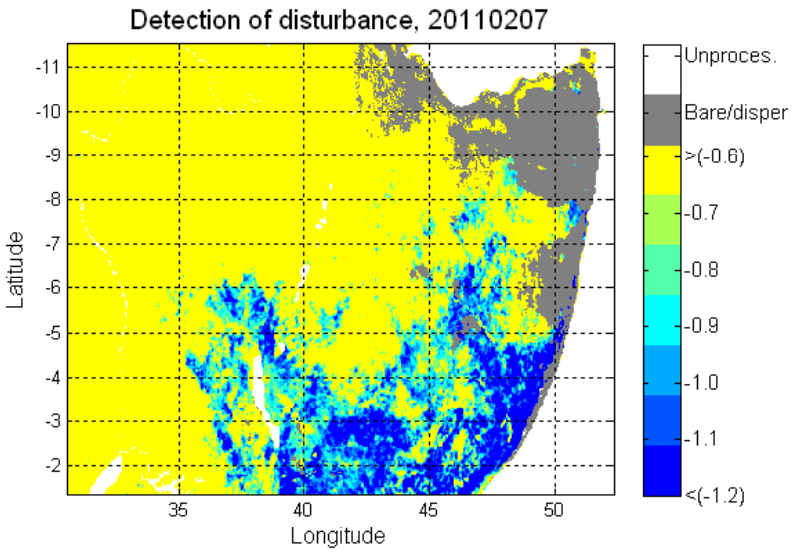
Drought monitoring

Horn of Africa (2011)



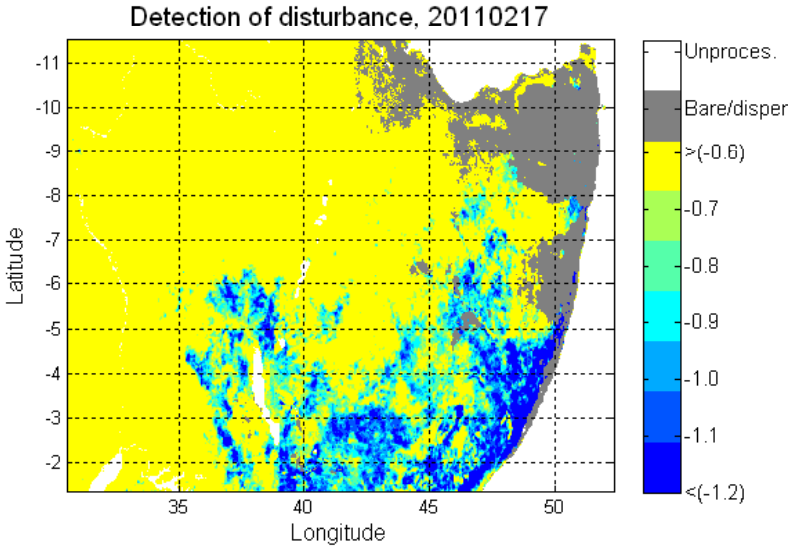
Drought monitoring

Horn of Africa (2011)



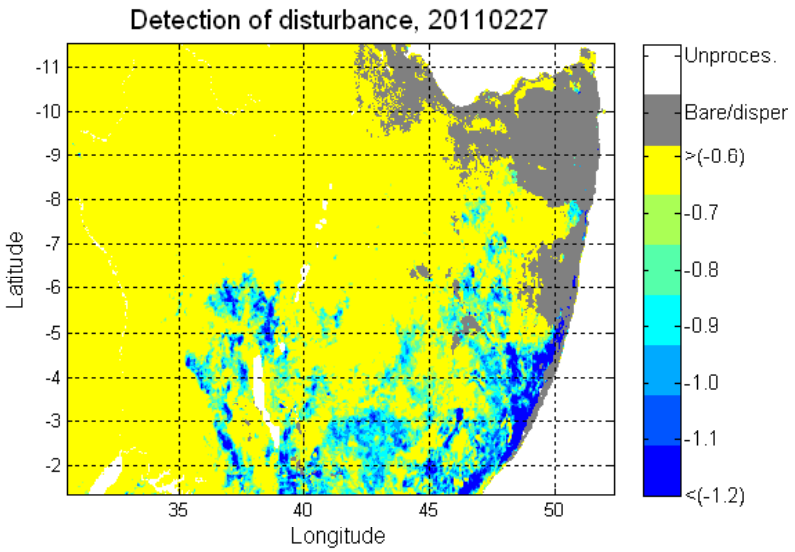
Drought monitoring

Horn of Africa (2011)



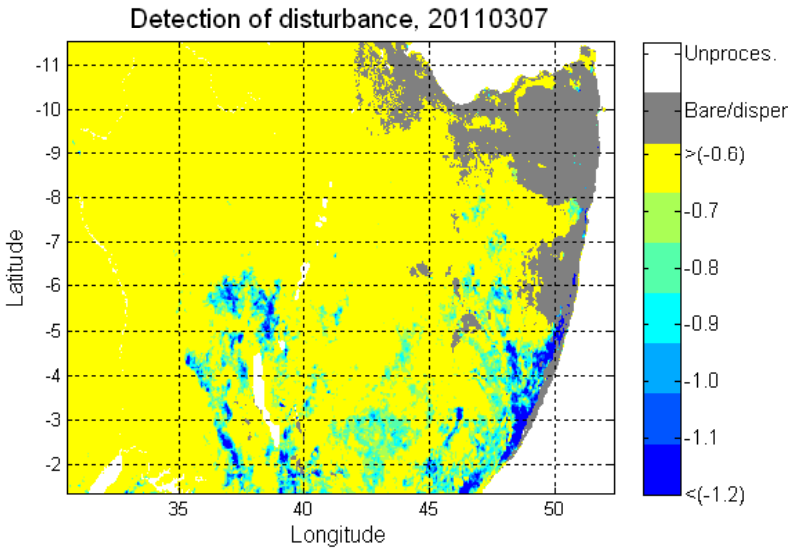
Drought monitoring

Horn of Africa (2011)



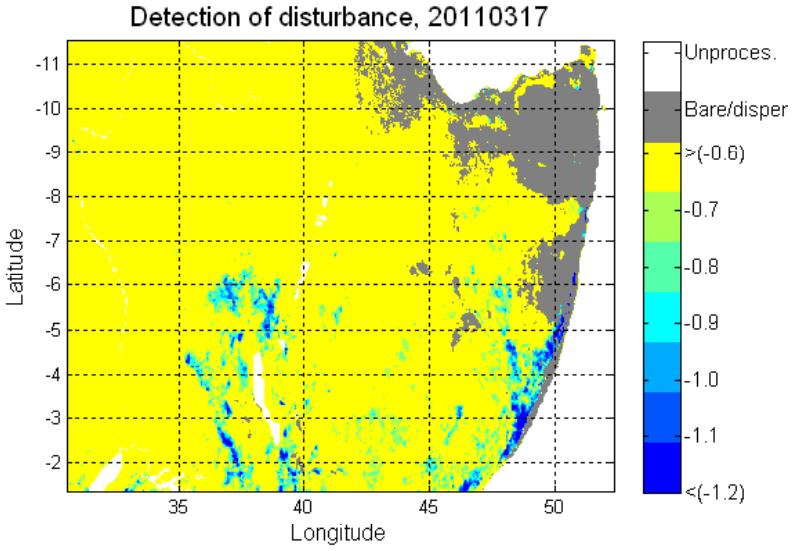
Drought monitoring

Horn of Africa (2011)



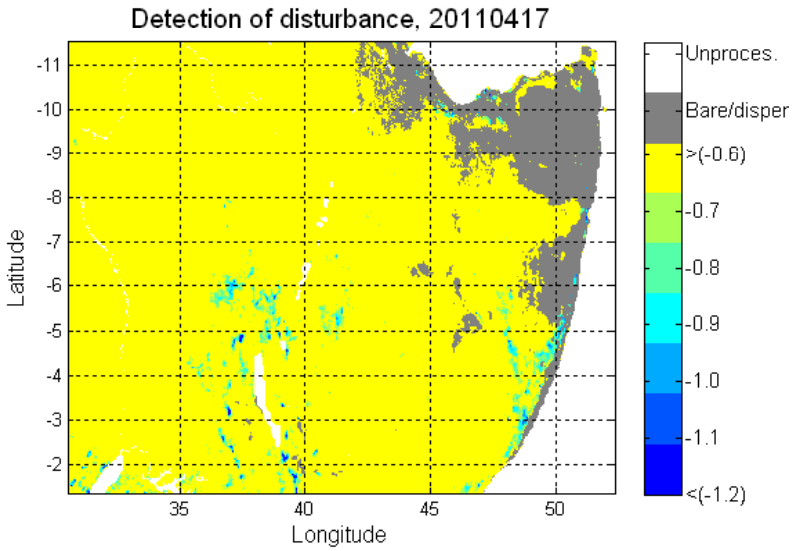
Drought monitoring

Horn of Africa (2011)



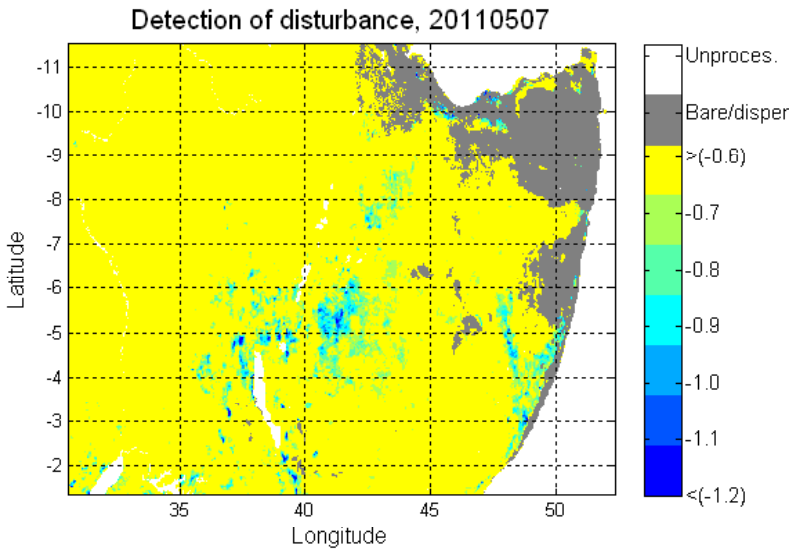
Drought monitoring

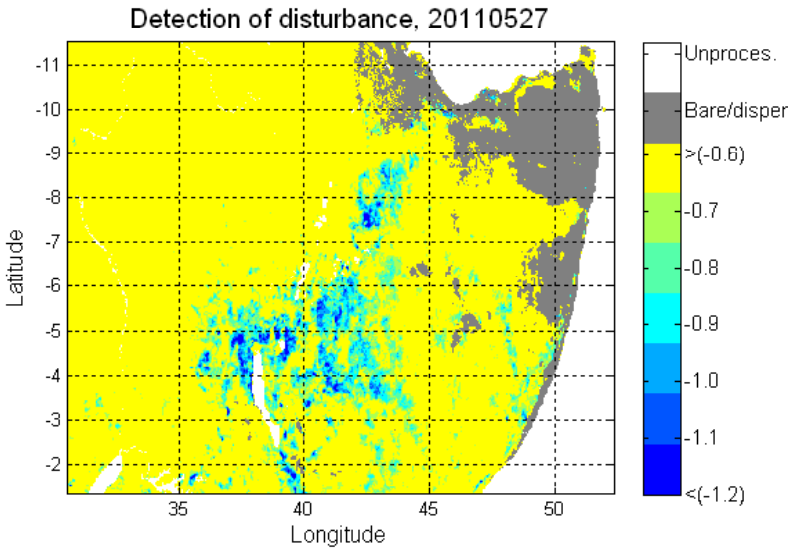
Horn of Africa (2011)



Drought monitoring

Horn of Africa (2011)




Detection of disturbance, 20110527
Latitude
Longitude
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35
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Unproces.
Bare/disper
>(-0.6)
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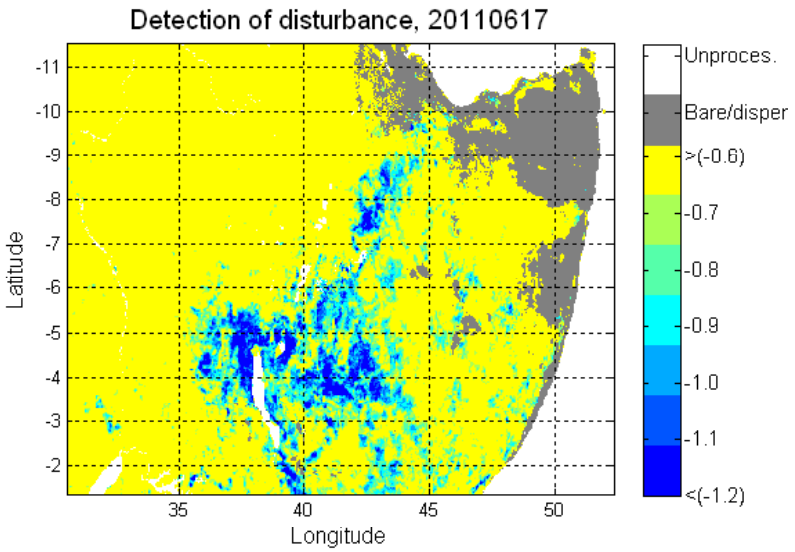
-1.0
-1.1
<(-1.2)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Longitude
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Unproces.
Bare/disper
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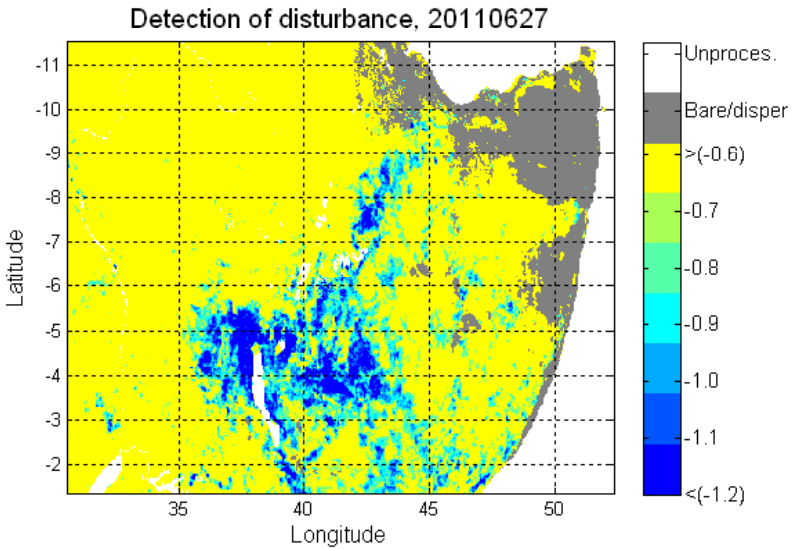
-1.1
<(-1.2)

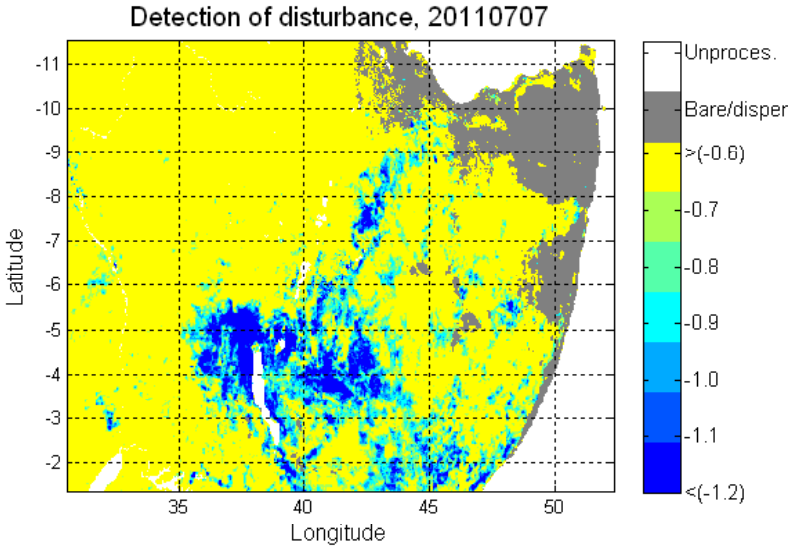
Drought monitoring

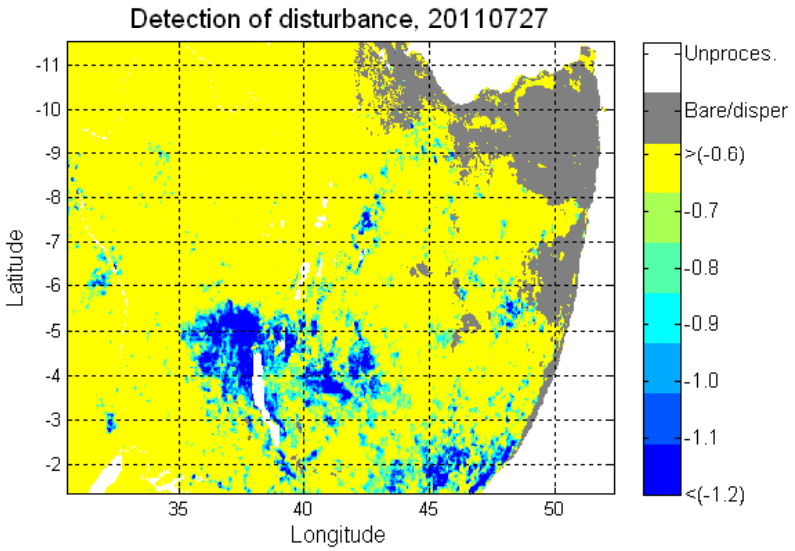
Horn of Africa (2011)



Drought monitoring

Horn of Africa (2011)

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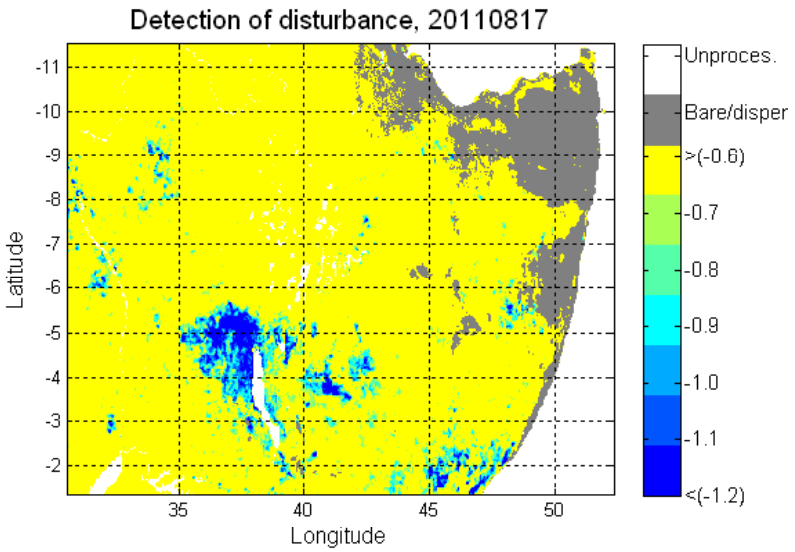
Detection of disturbance, 20110817
Latitude
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Longitude
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>(-0.6)
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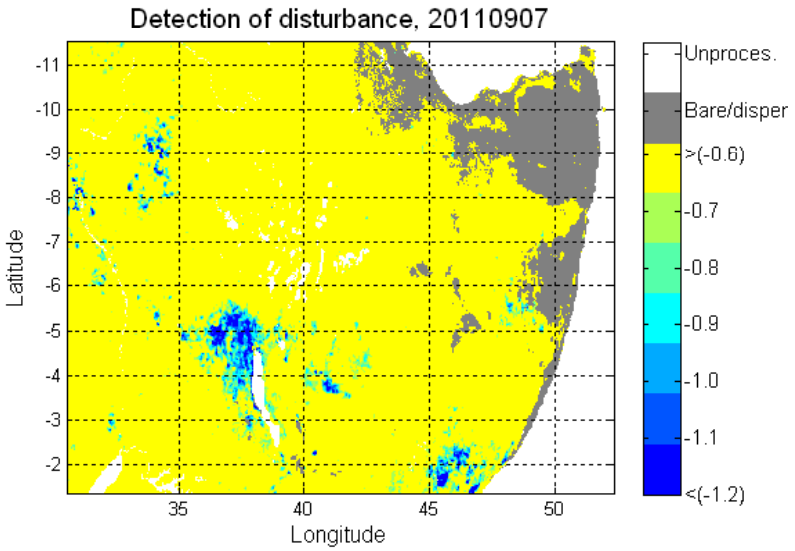
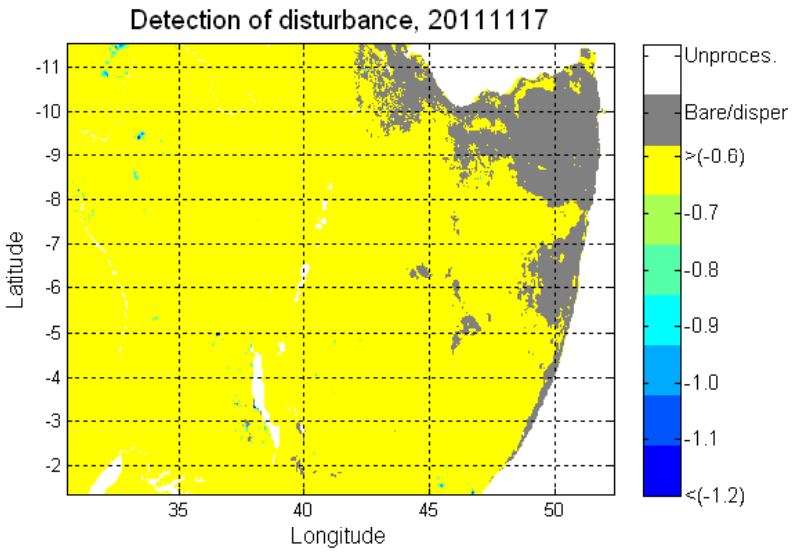
Drought monitoring

Horn of Africa (2011)



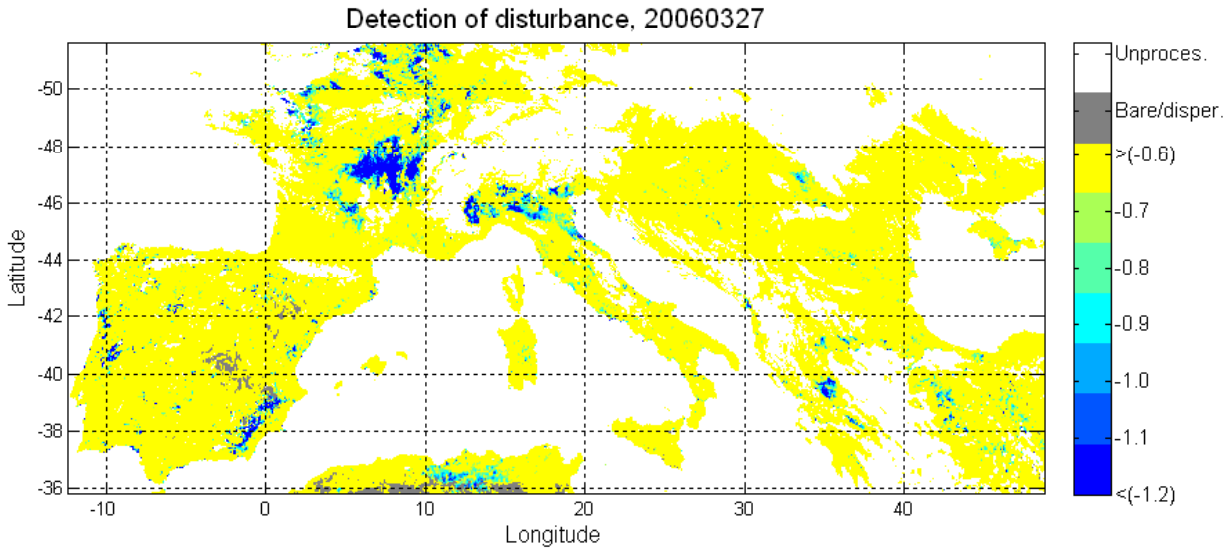
Drought monitoring

Horn of Africa (2011)



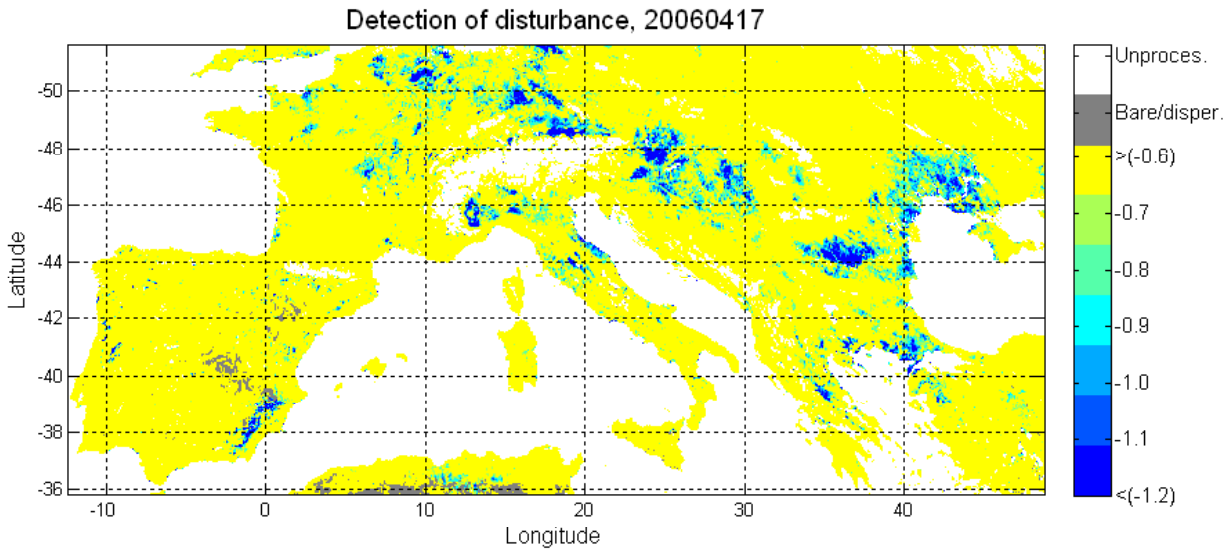
Drought monitoring

Southern Europe



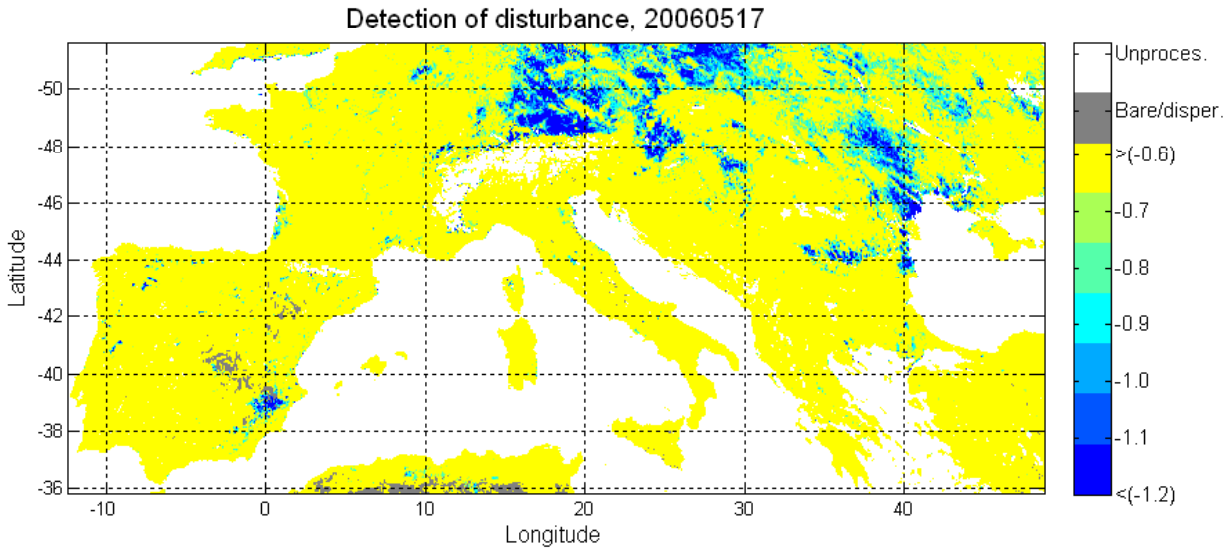
Drought monitoring

Southern Europe



Drought monitoring

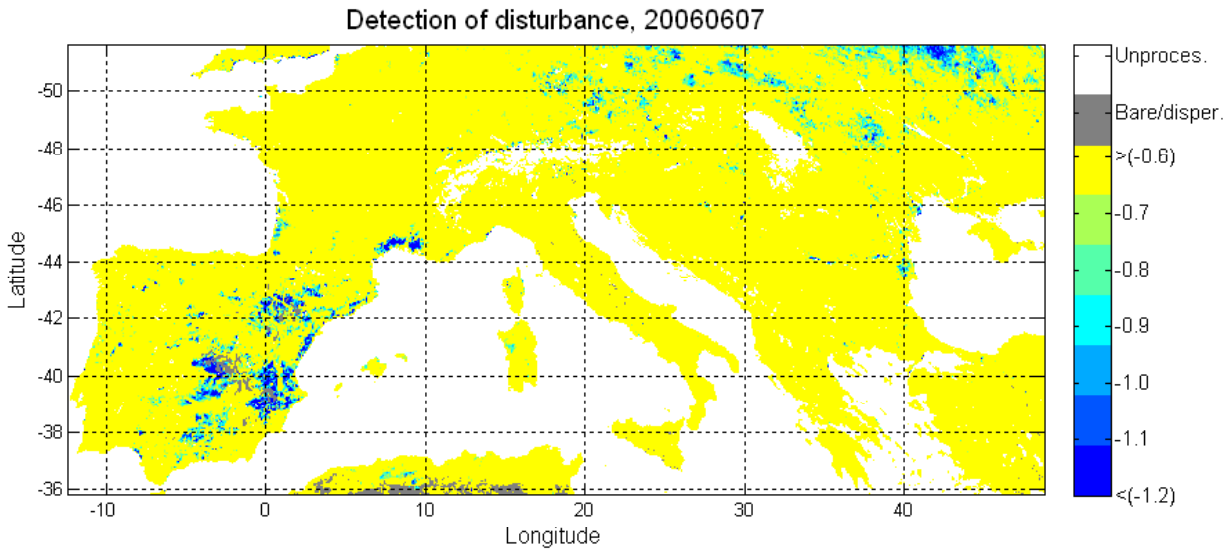
Southern Europe



Central Europe (May, 2006)

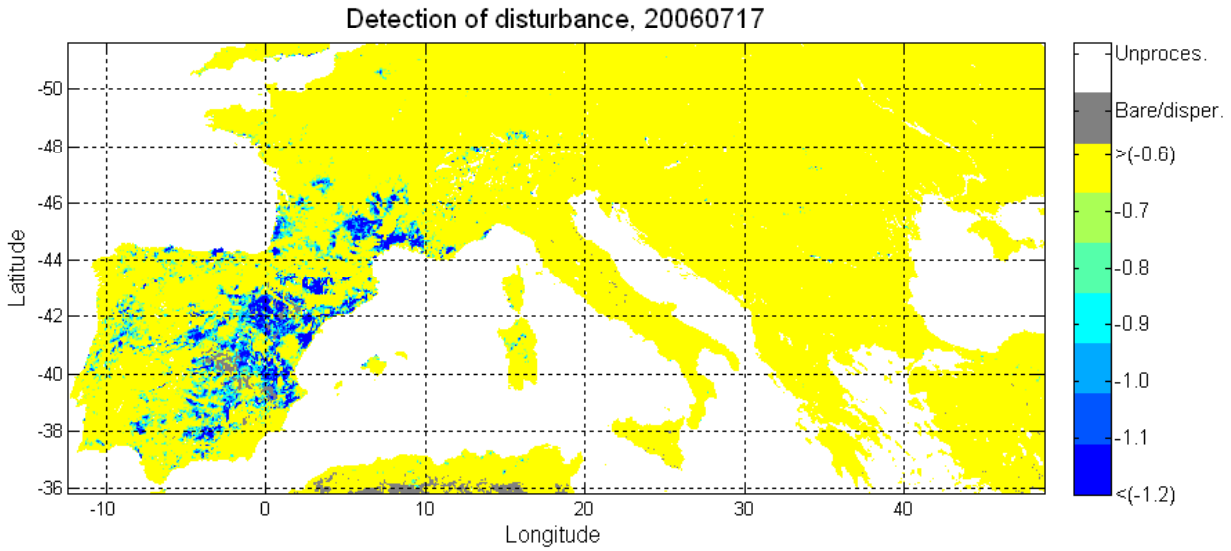
Drought monitoring

Southern Europe



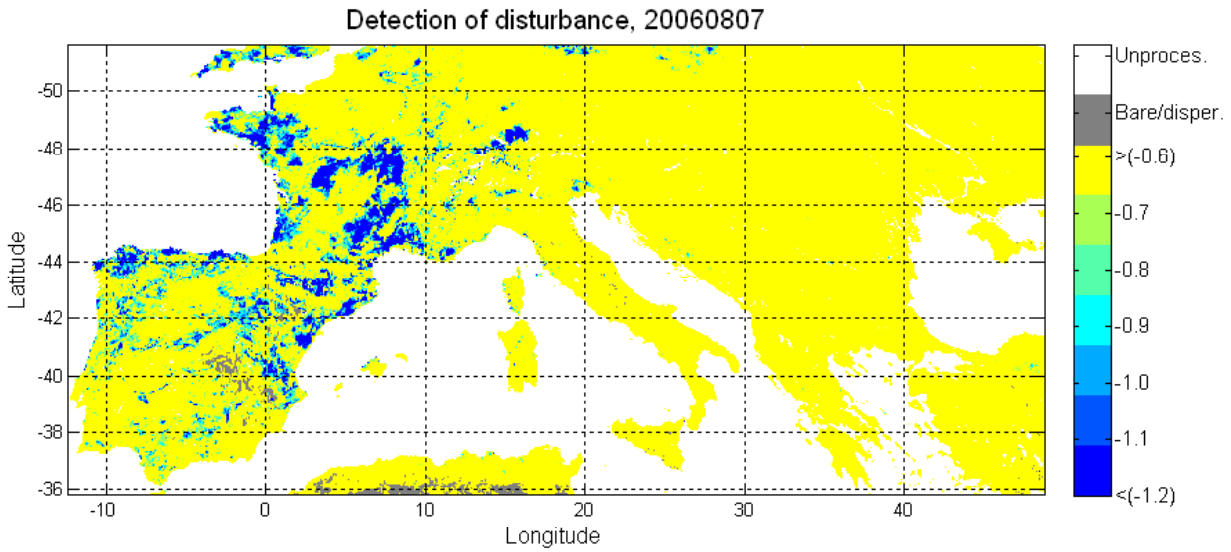
Drought monitoring

Potential applications



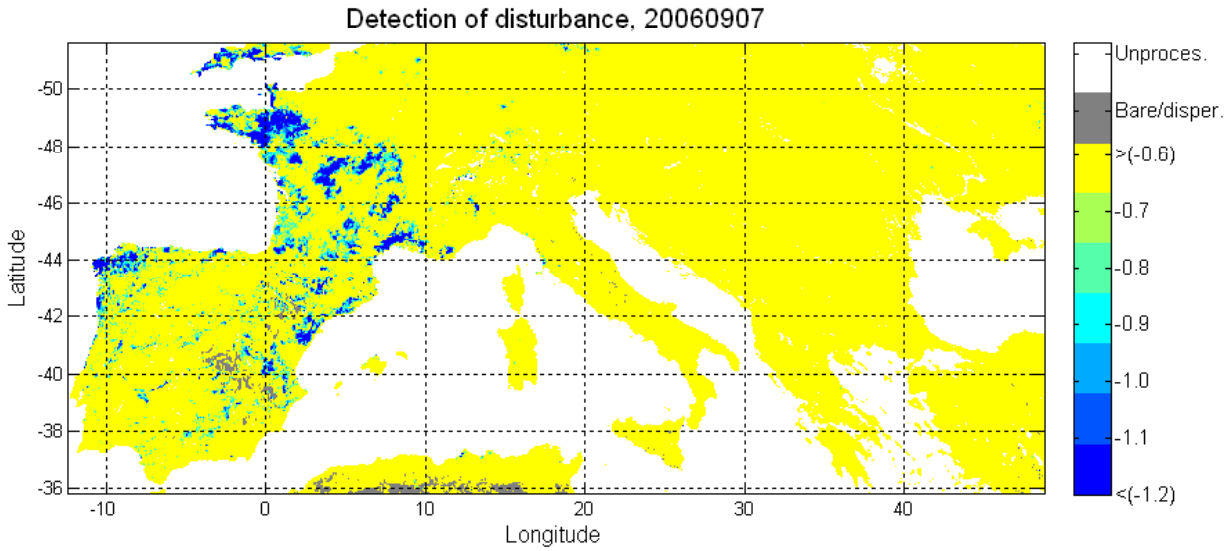
Drought monitoring

Southern Europe



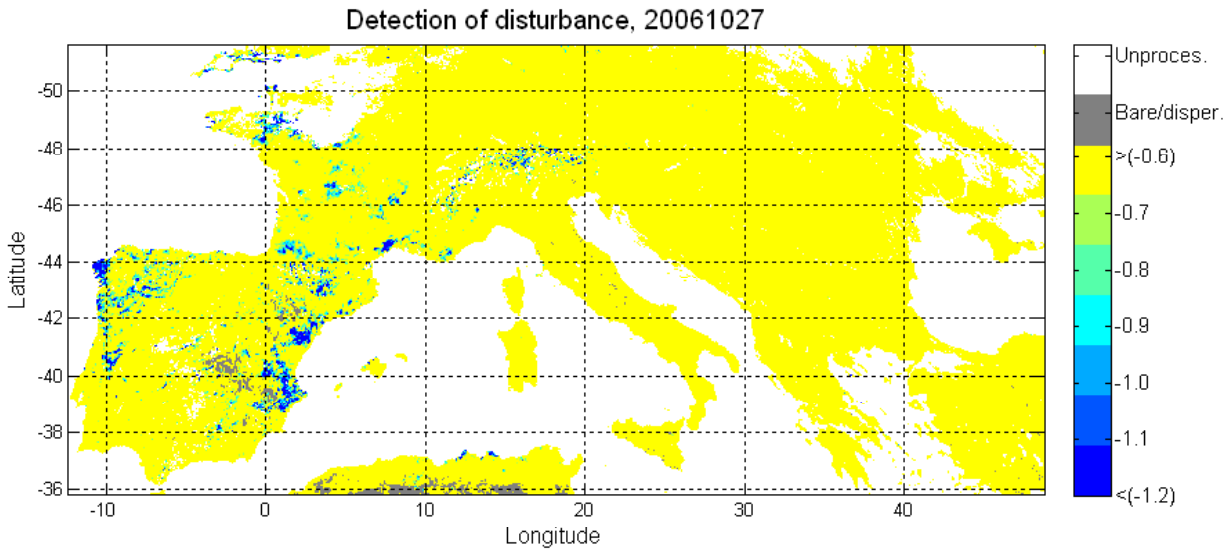
Drought monitoring

Southern Europe



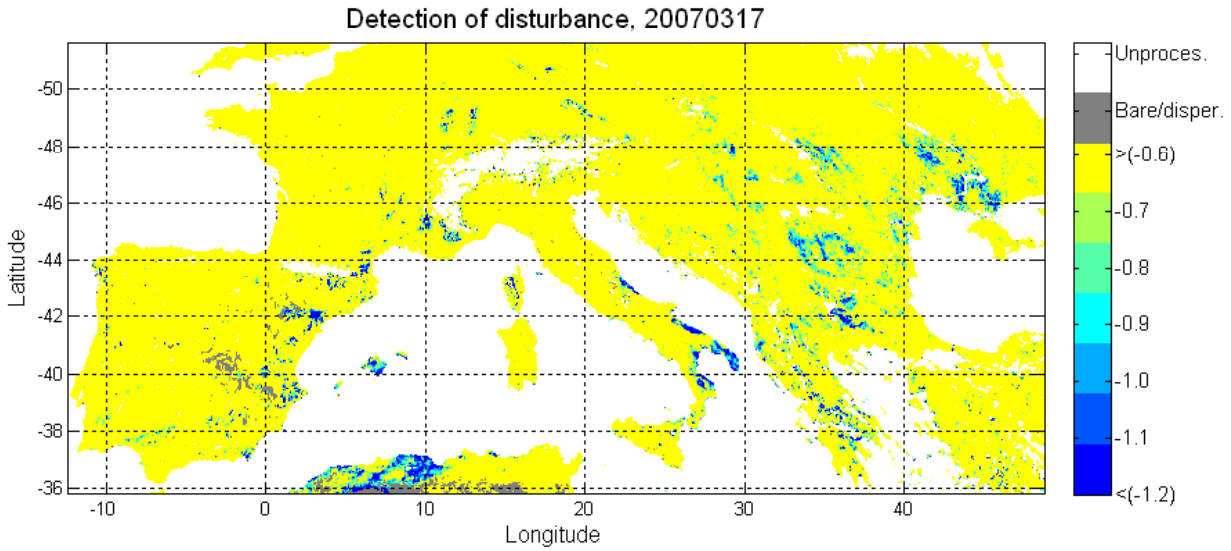
Drought monitoring

Southern Europe



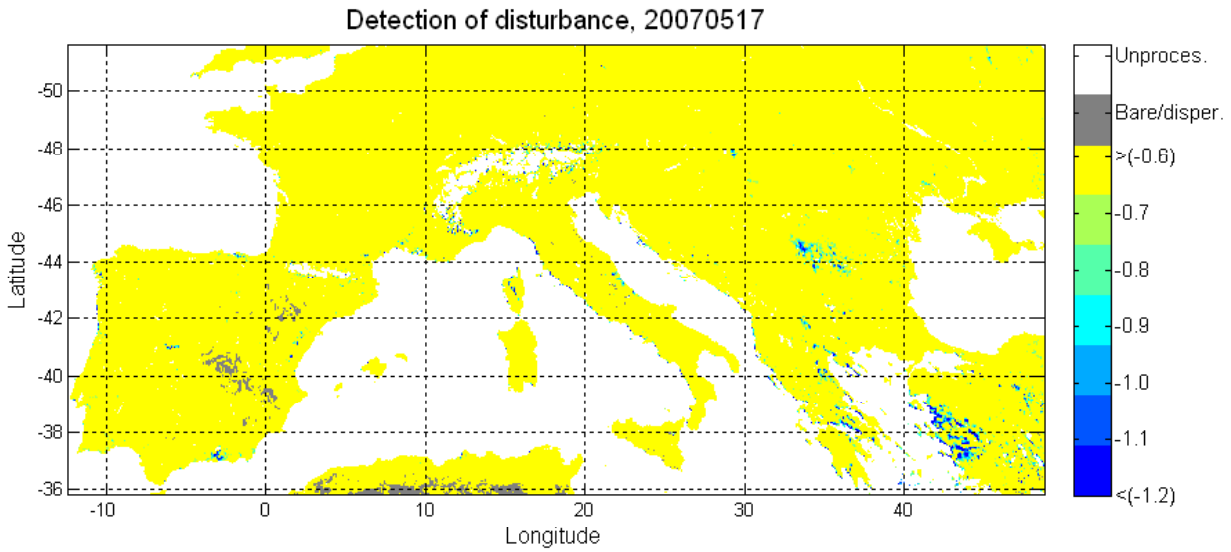
Drought monitoring

Southern Europe



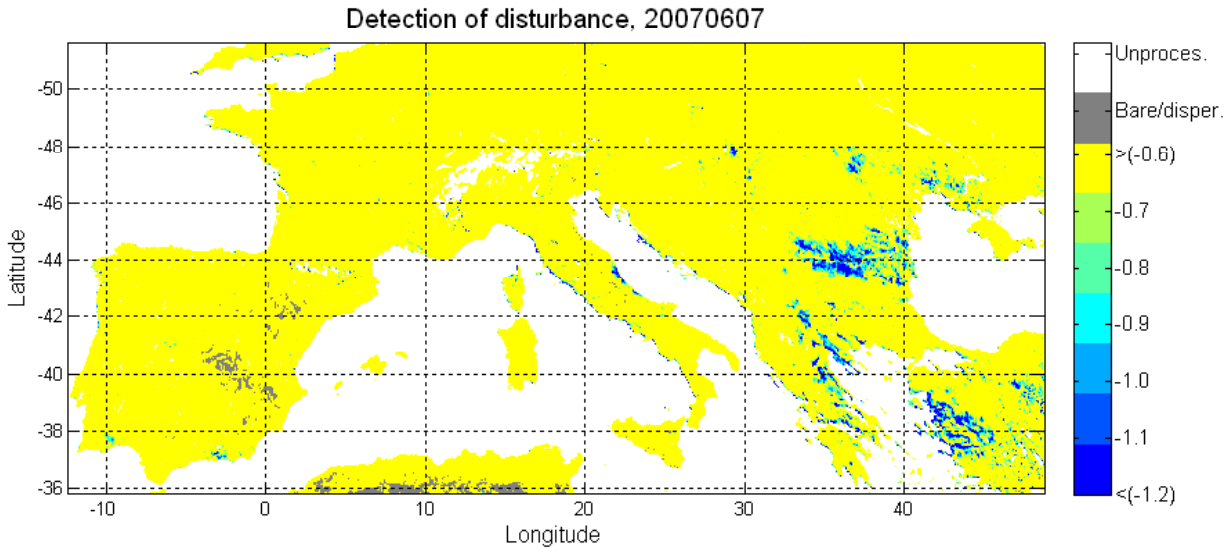
Drought monitoring

Potential applications



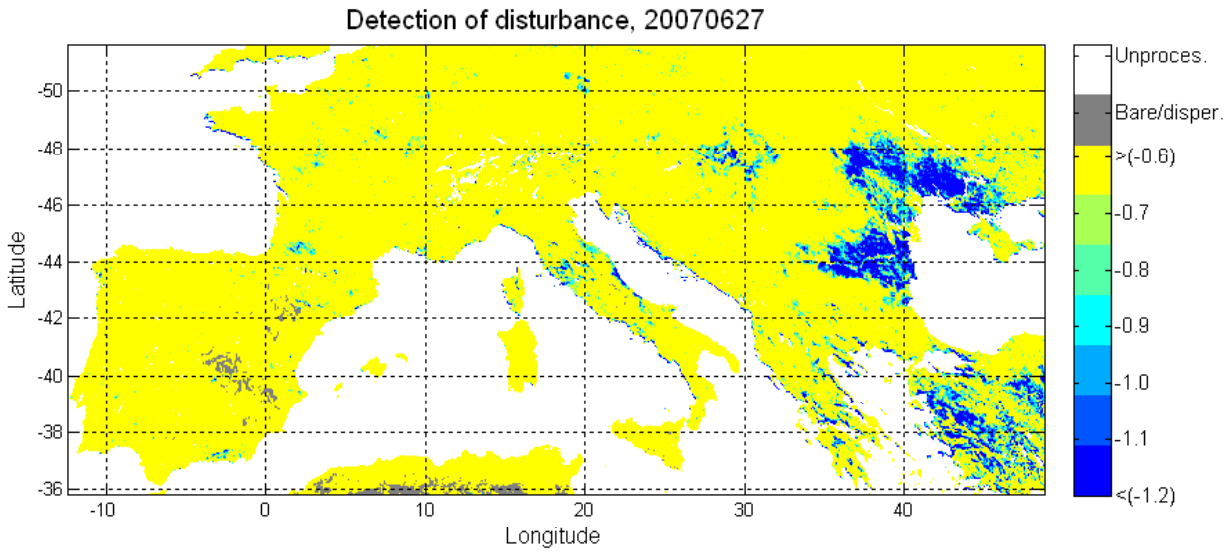
Drought monitoring

Southern Europe



Drought monitoring

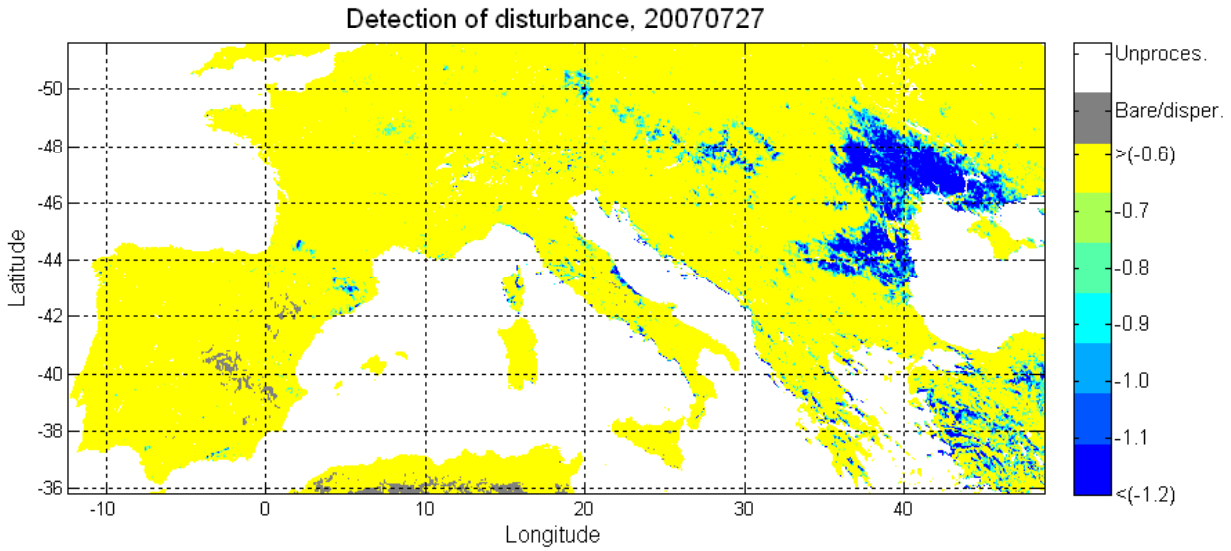
Southern Europe



Eastern Europe (summer, 2007)

Drought monitoring

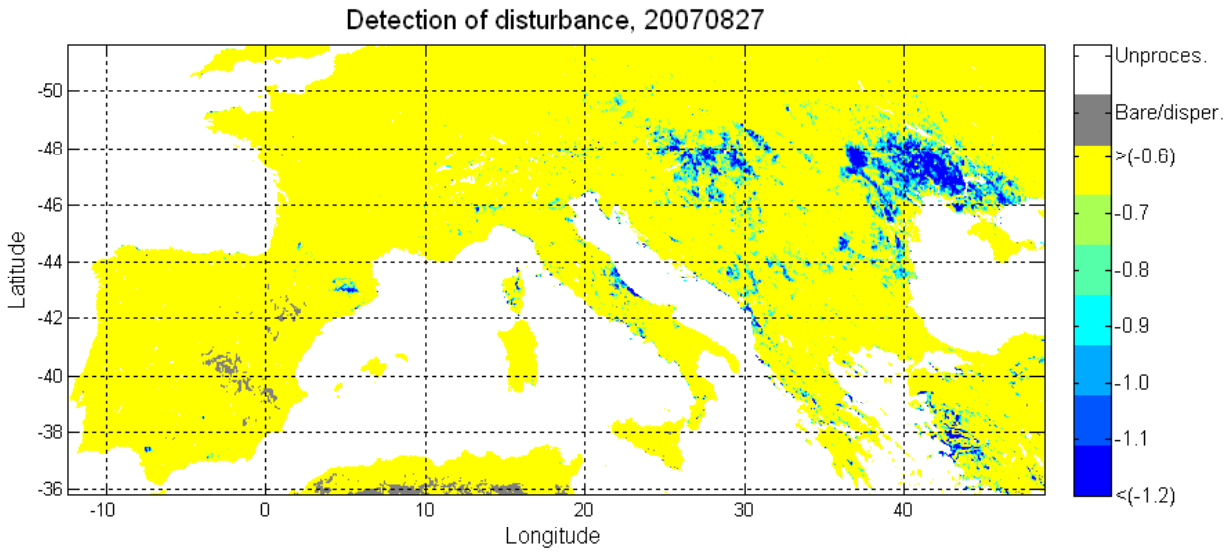
Southern Europe



Eastern Europe (summer, 2007)

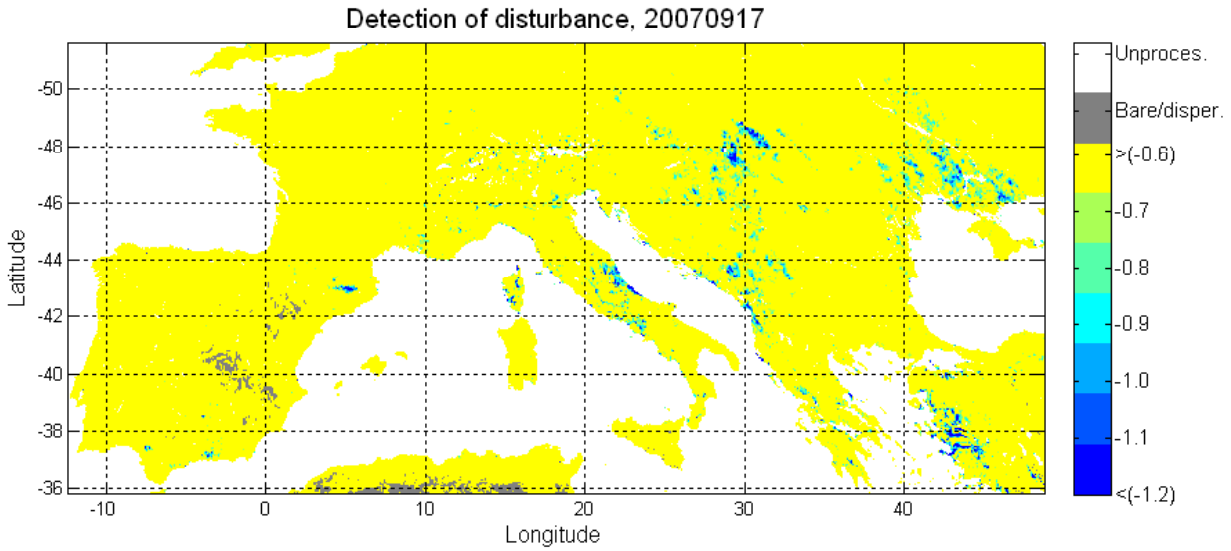
Drought monitoring

Southern Europe



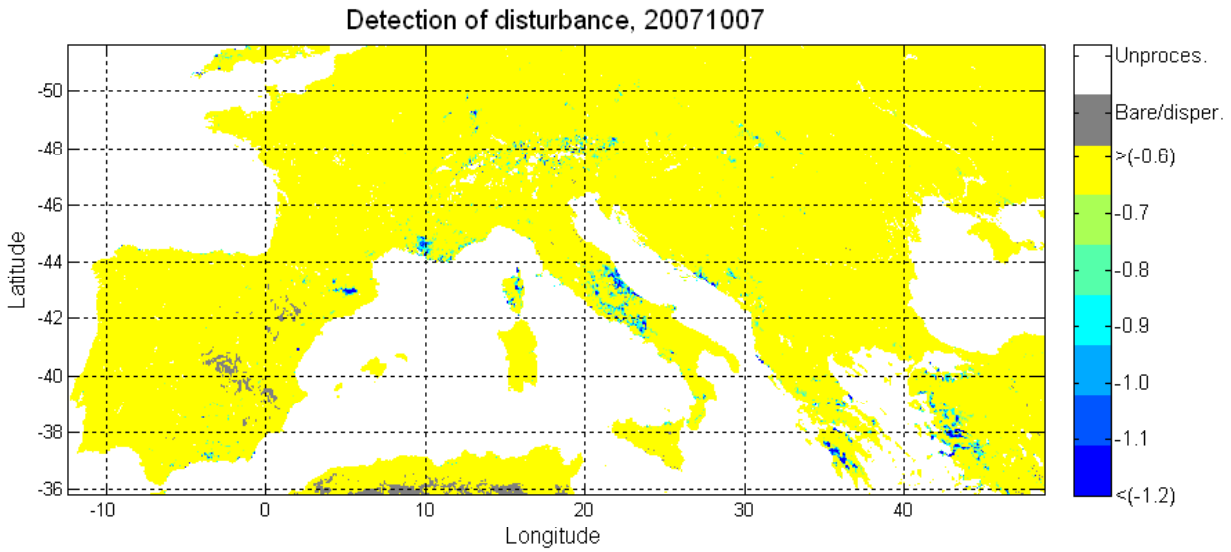
Drought monitoring

Southern Europe



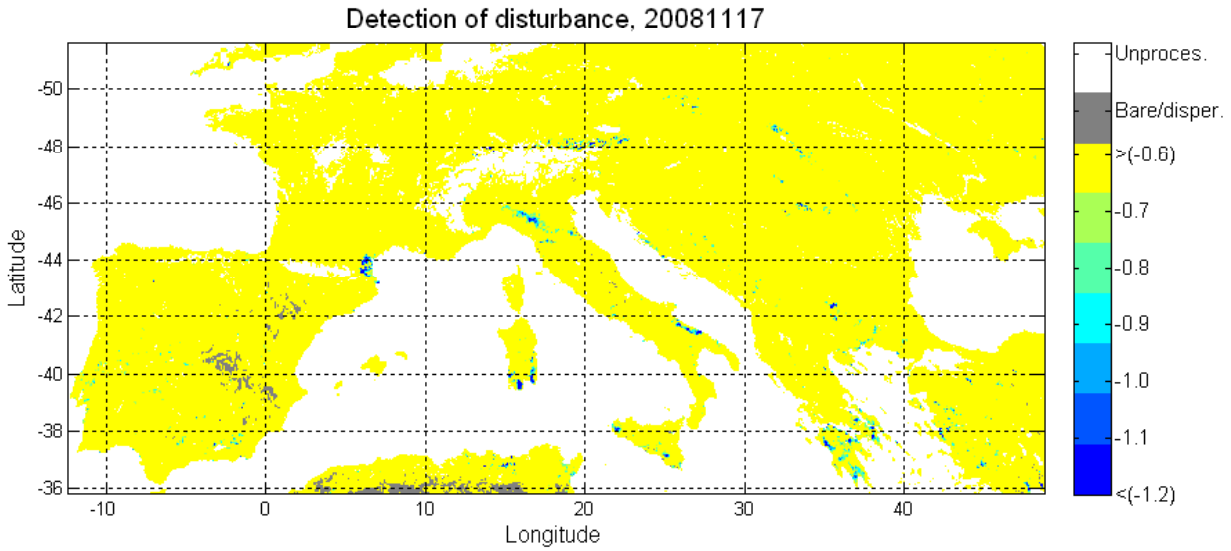
Drought monitoring

Southern Europe



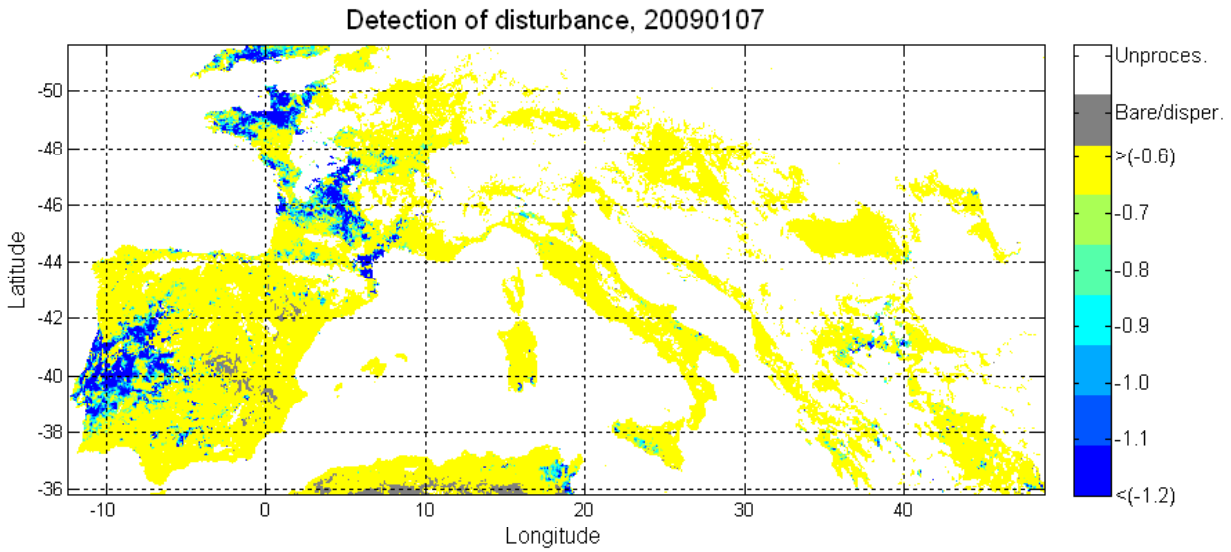
Drought monitoring

Southern Europe



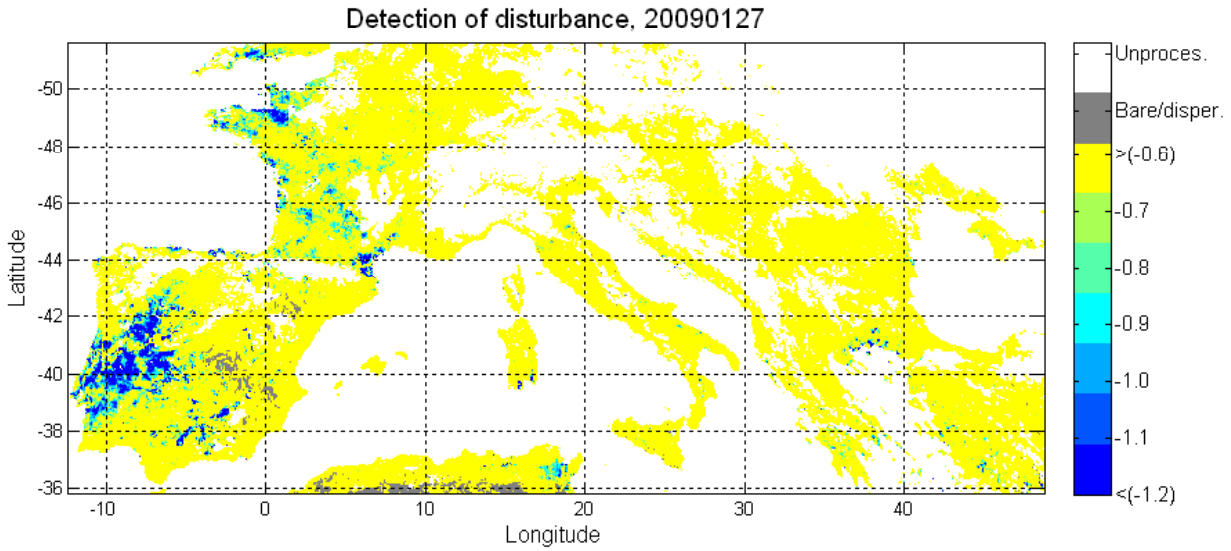
Drought monitoring

Southern Europe



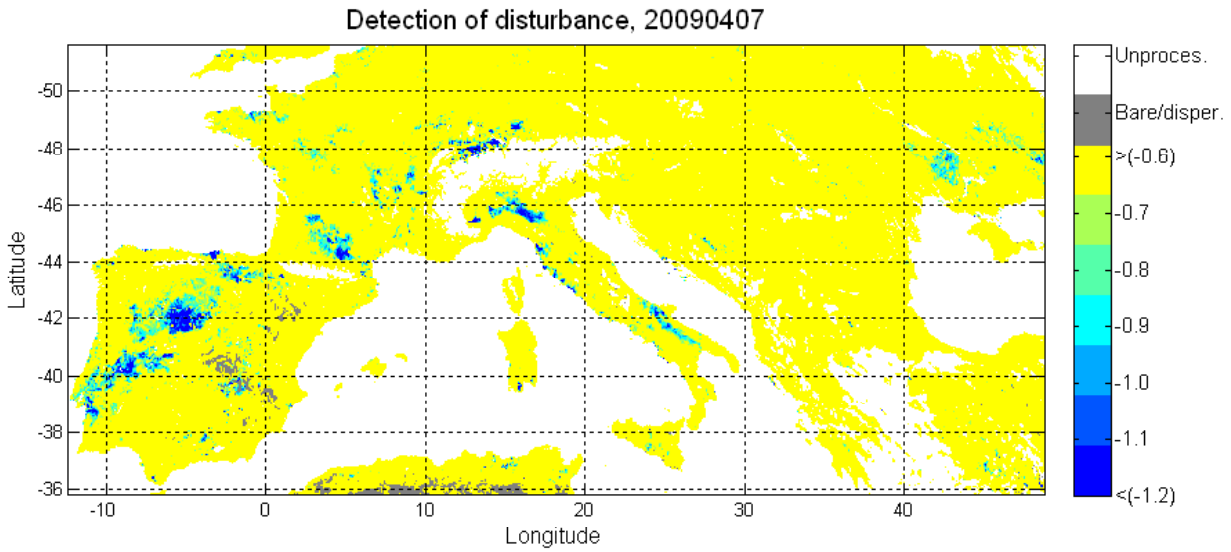
Drought monitoring

Southern Europe



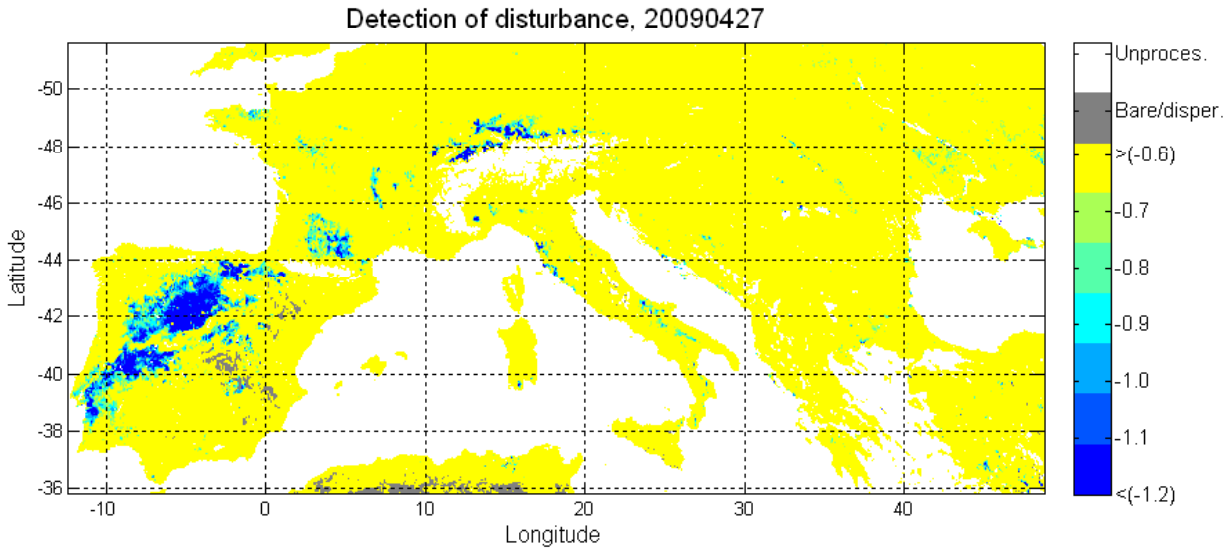
Drought monitoring

Southern Europe



Drought monitoring

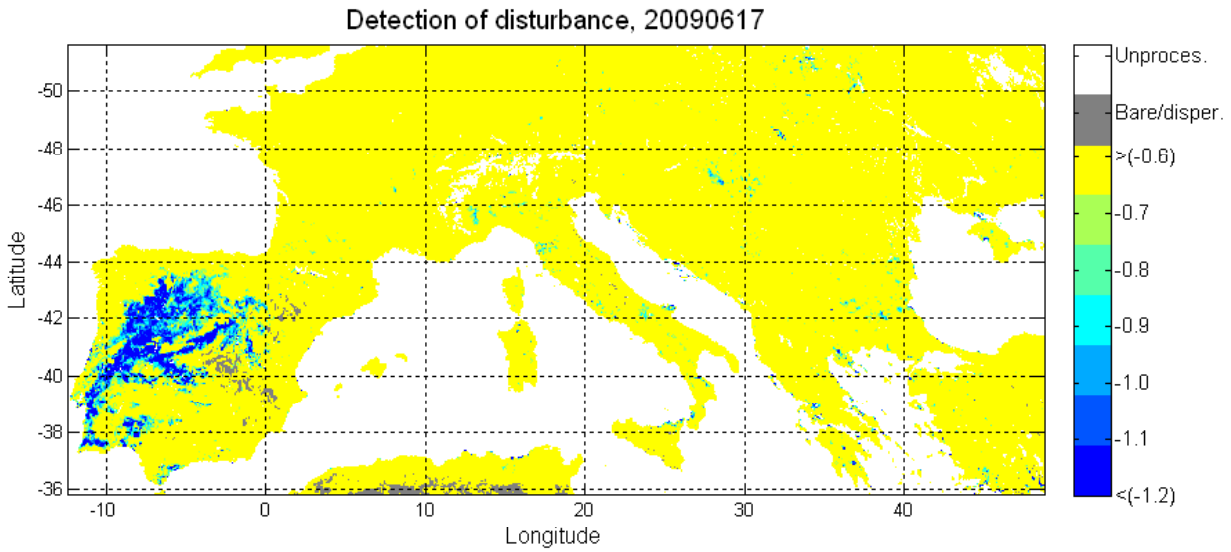
Southern Europe



Iberian Peninsula (spring, 2009)

Drought monitoring

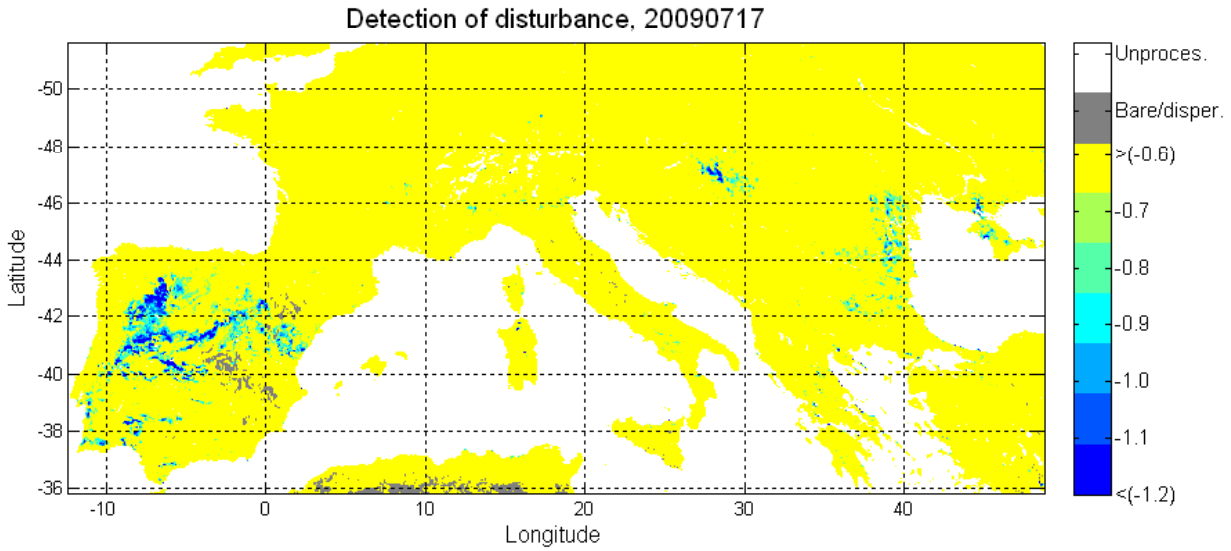
Southern Europe



Iberian Peninsula (spring, 2009)

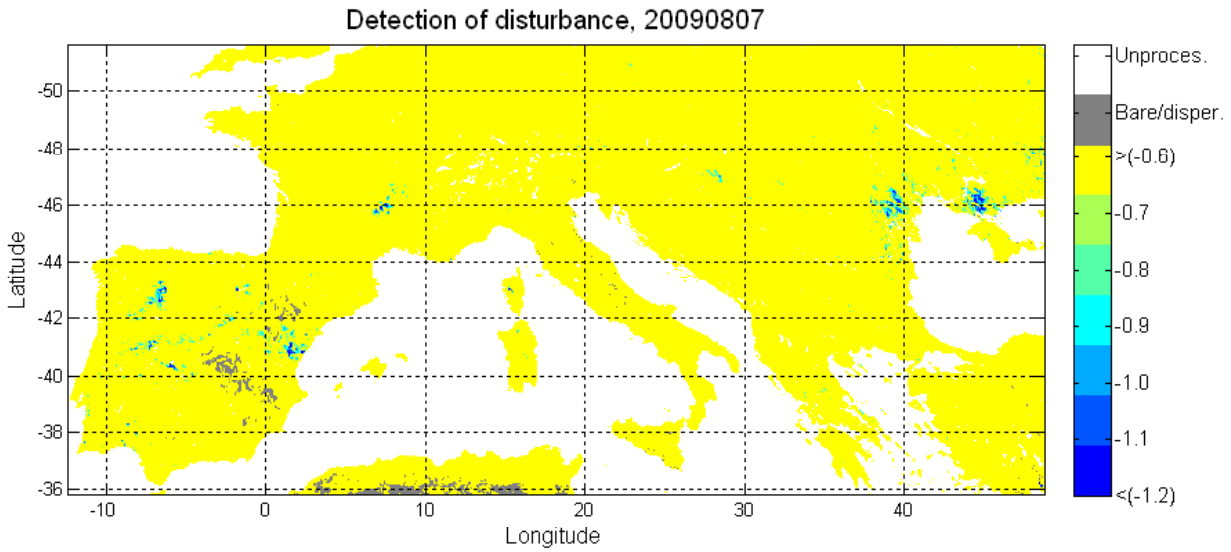
Drought monitoring

Southern Europe



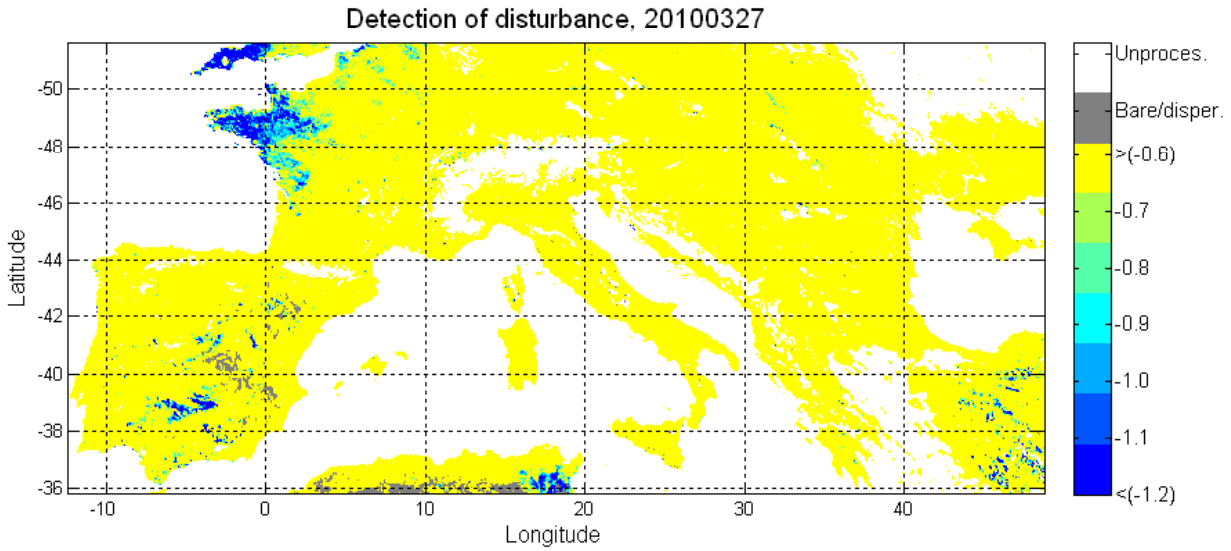
Drought monitoring

Southern Europe



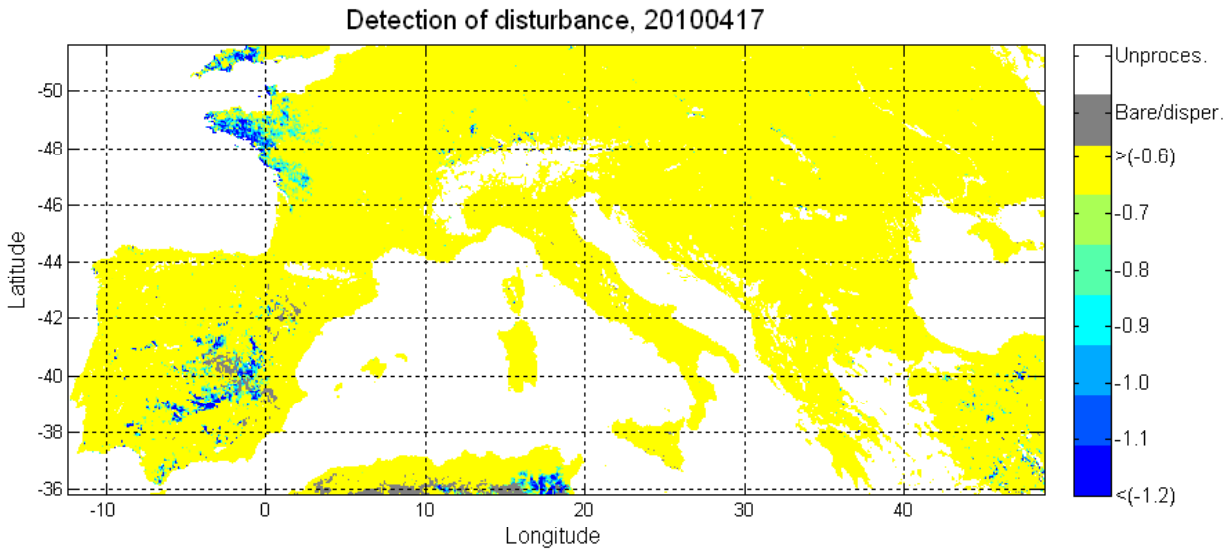
Drought monitoring

Southern Europe



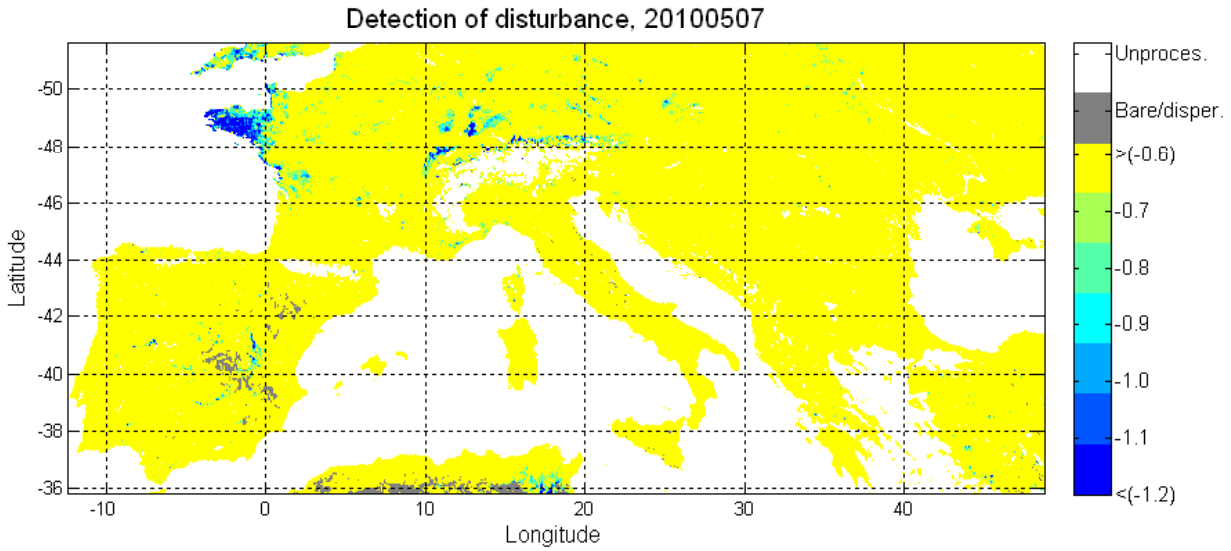
Drought monitoring

Southern Europe



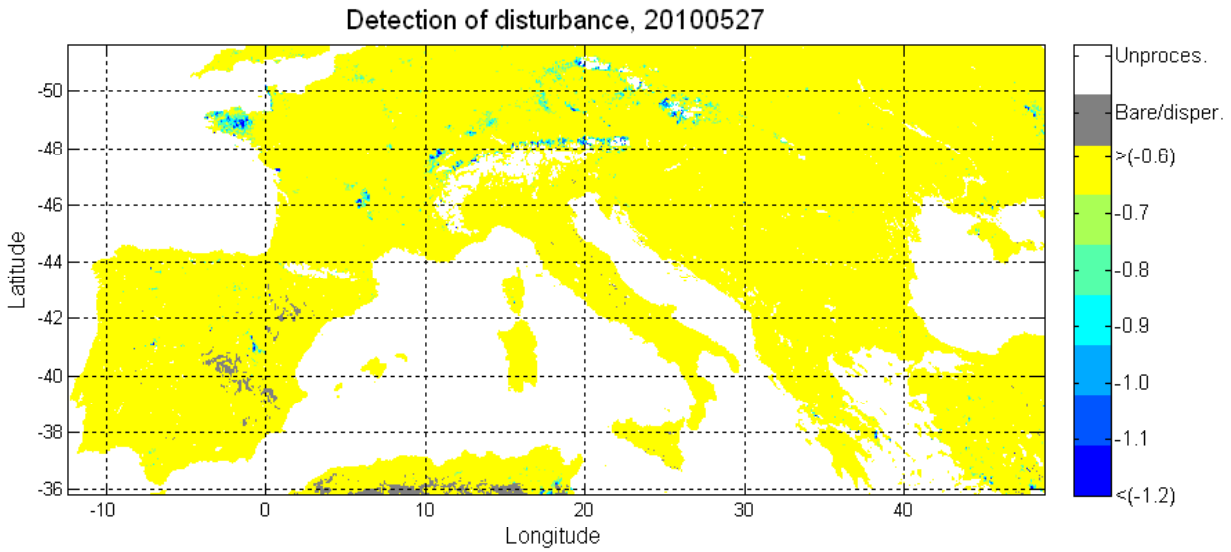
Drought monitoring

Southern Europe



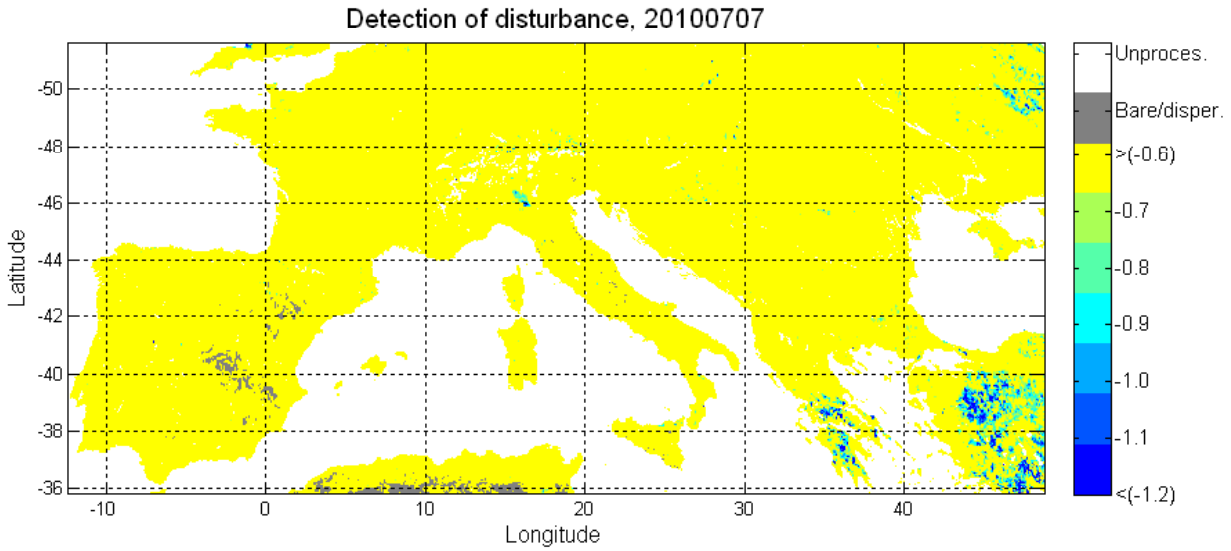
Drought monitoring

Southern Europe



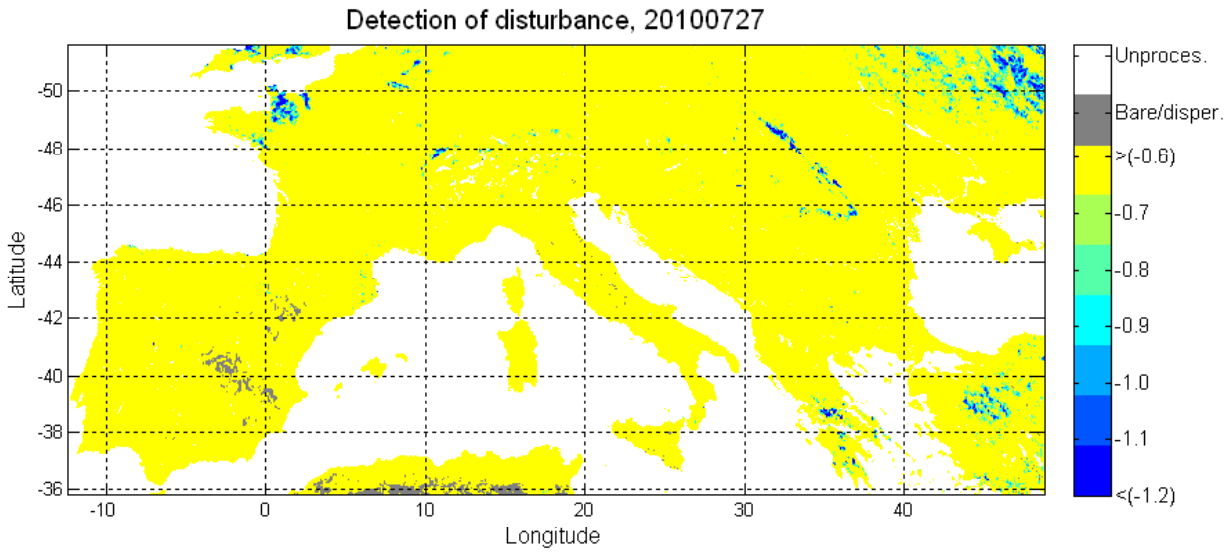
Drought monitoring

Southern Europe



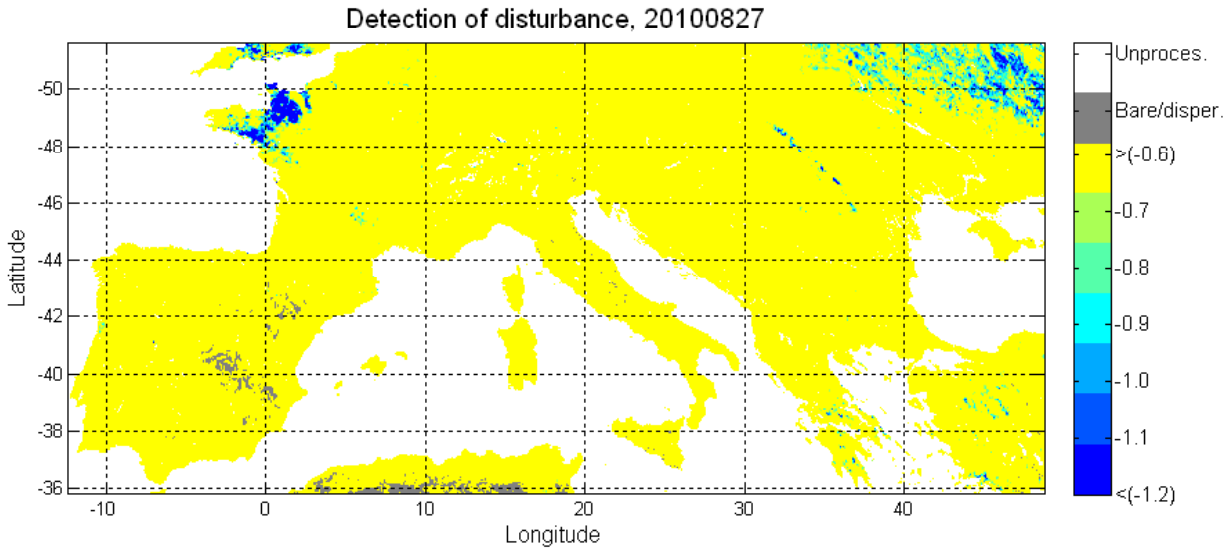
Drought monitoring

Southern Europe



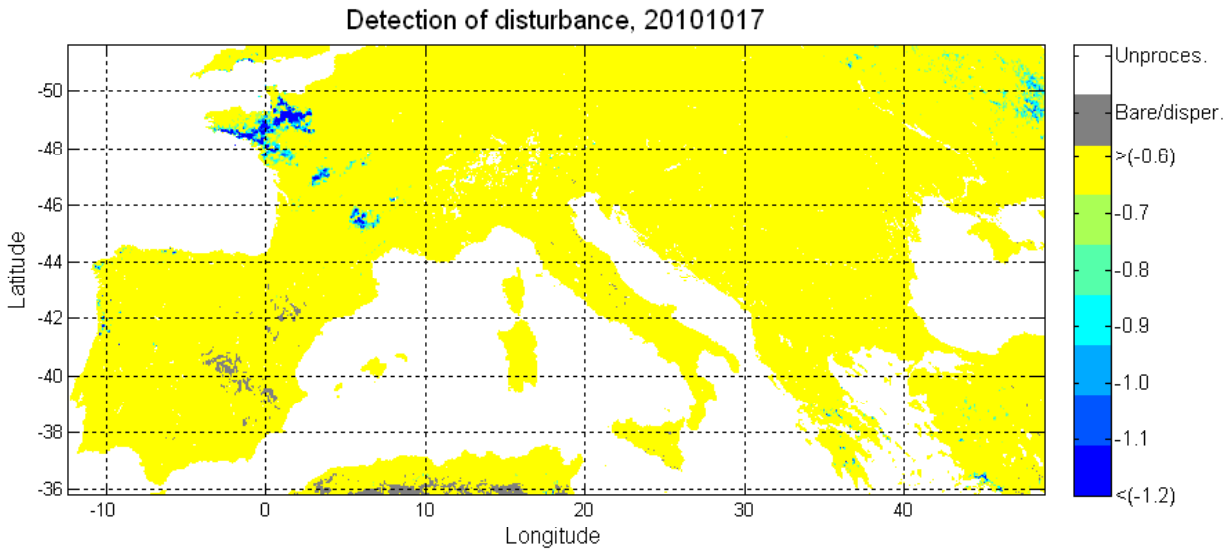
Drought monitoring

Southern Europe



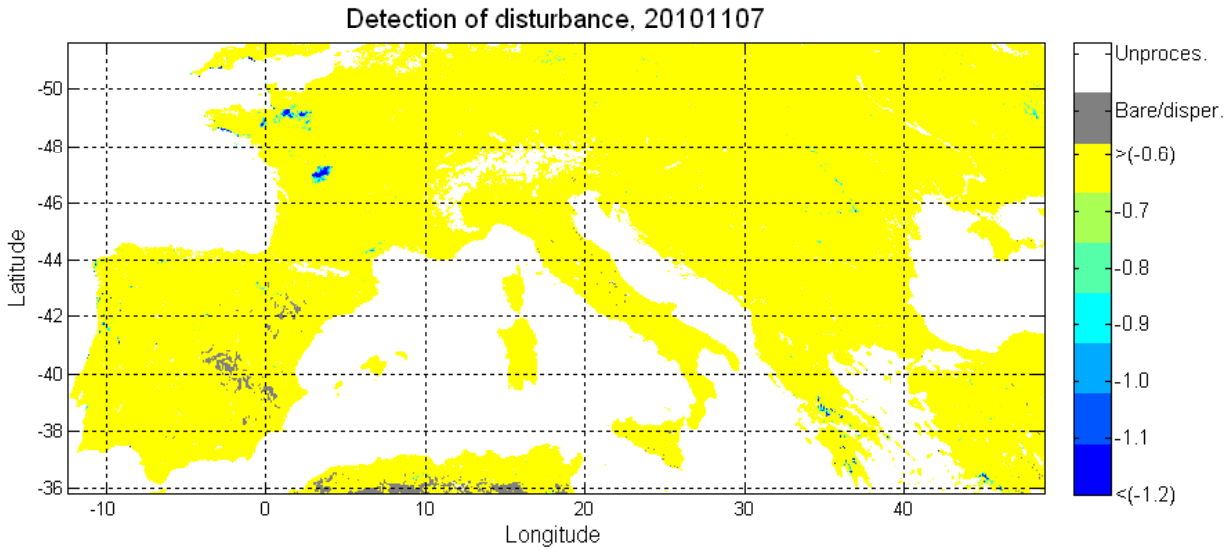
Drought monitoring

Southern Europe



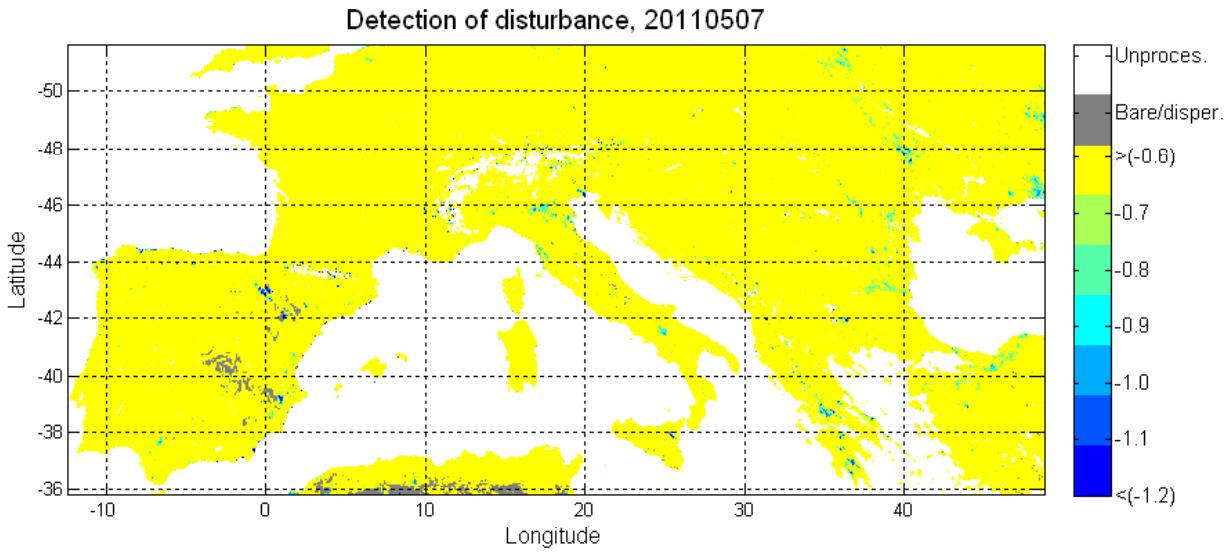
Drought monitoring

Southern Europe



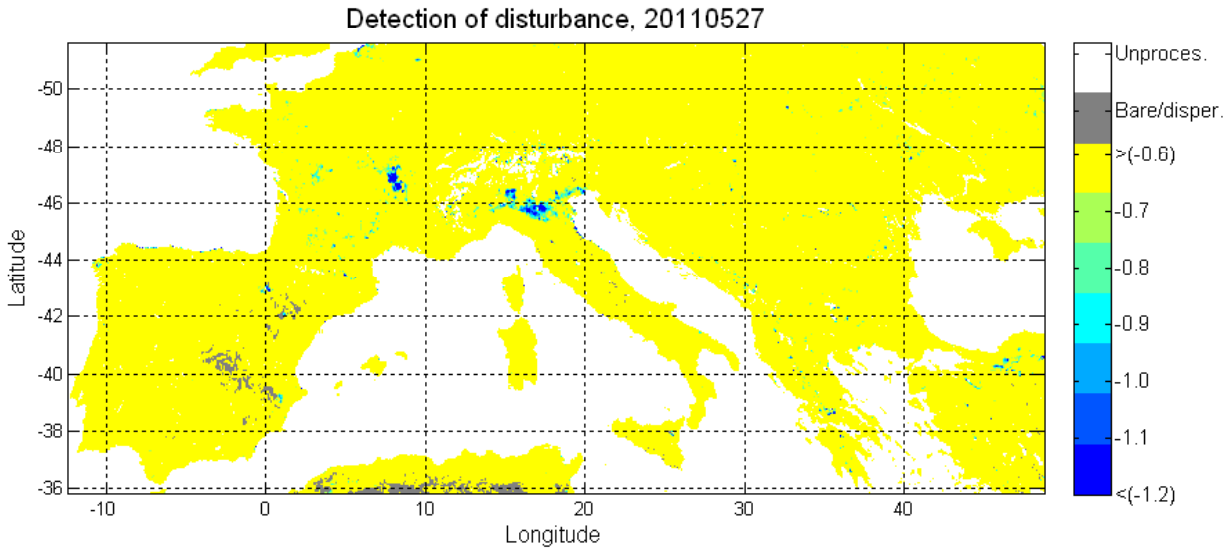
Drought monitoring

Southern Europe



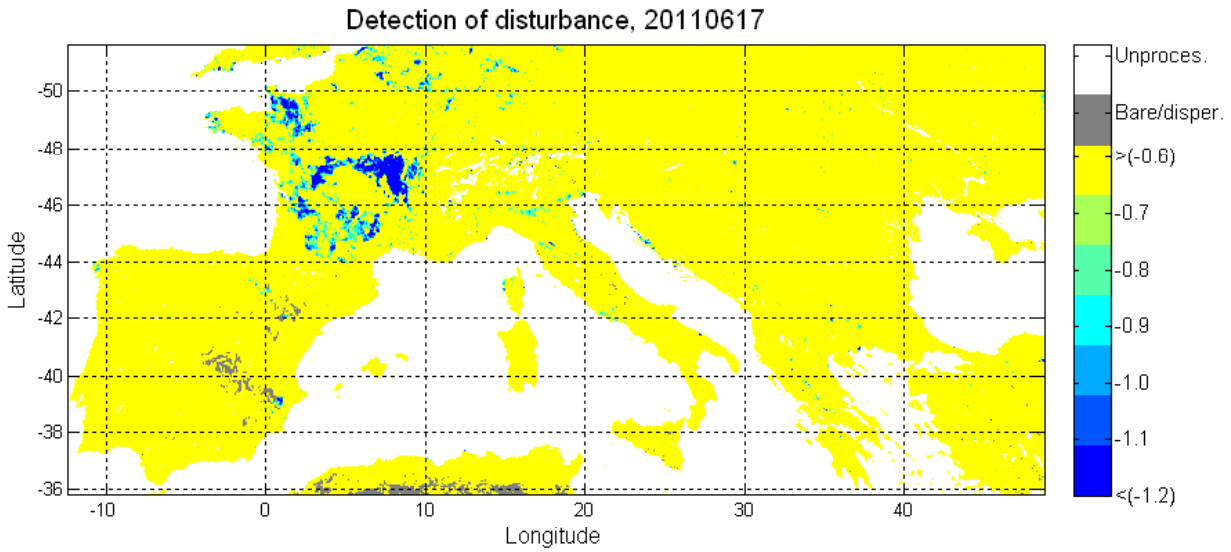
Drought monitoring

Southern Europe



Drought monitoring

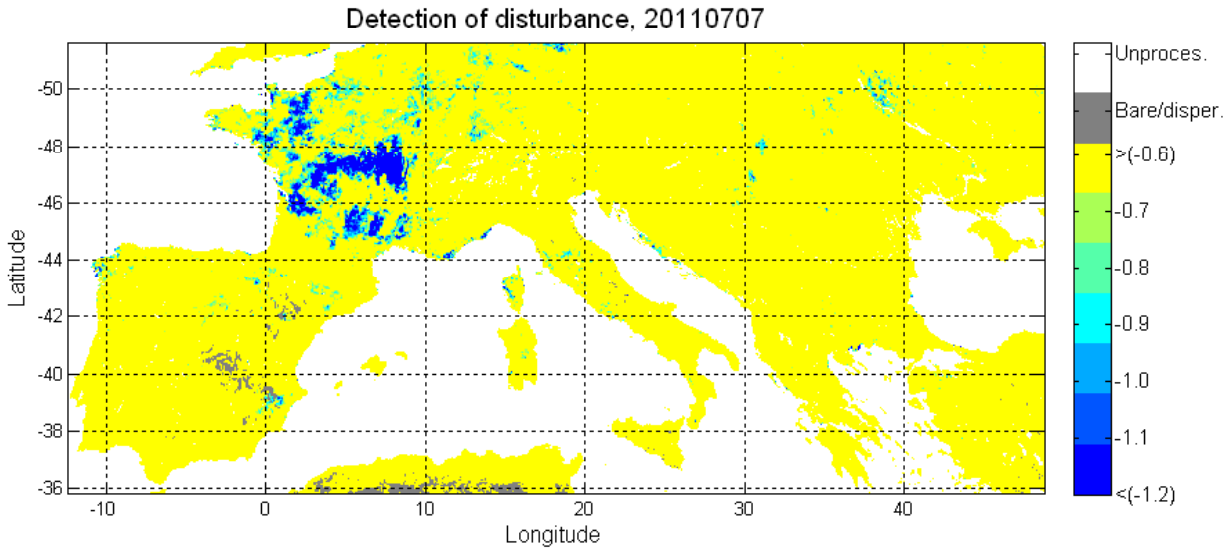
Southern Europe



France (summer, 2011)

Drought monitoring

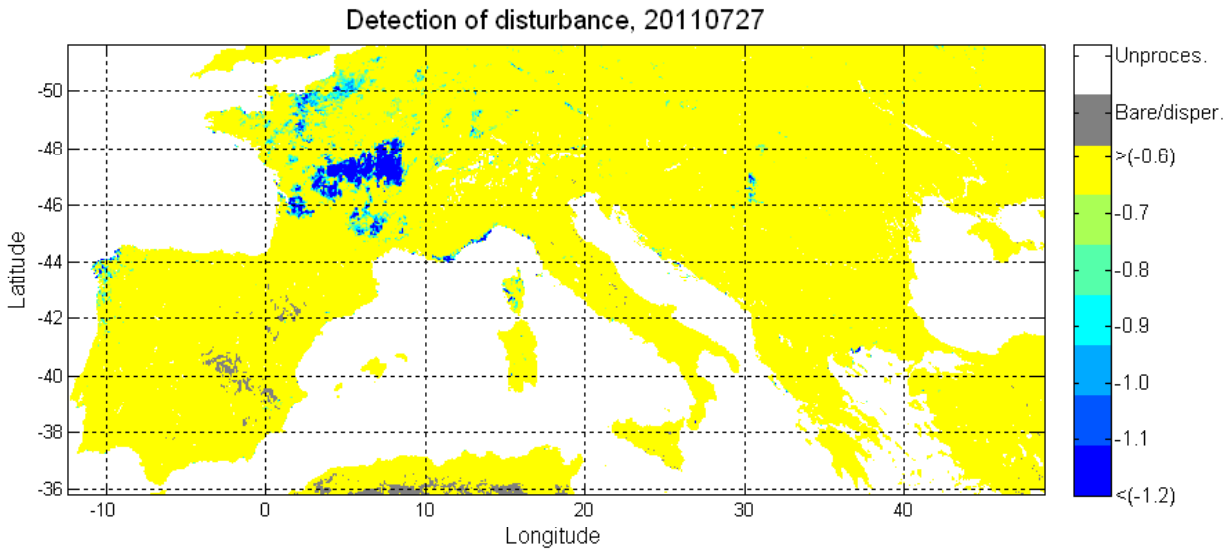
Southern Europe



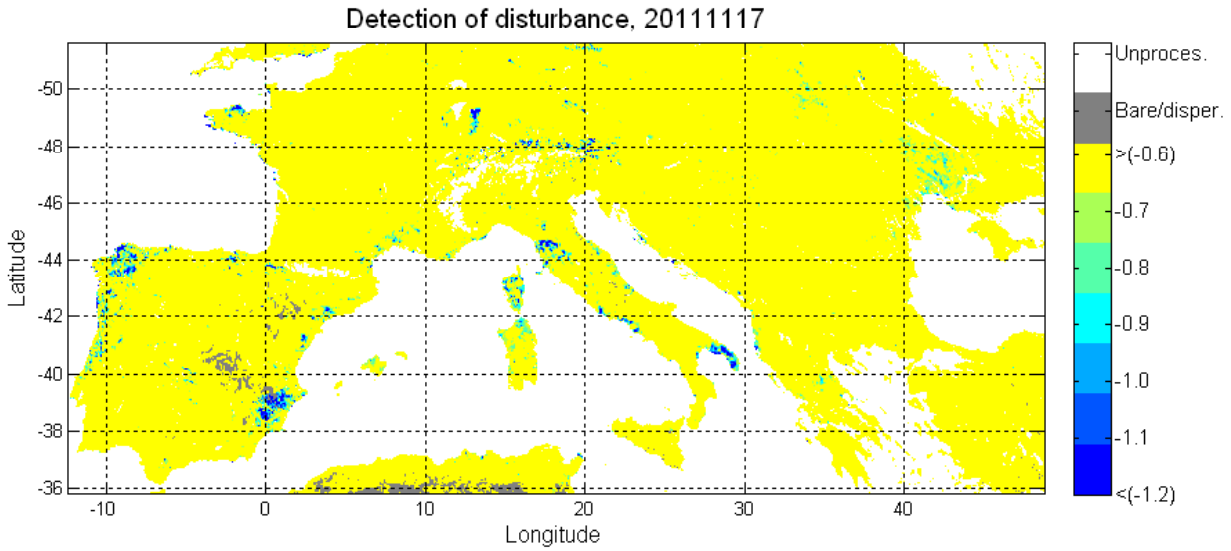
France (summer, 2011)

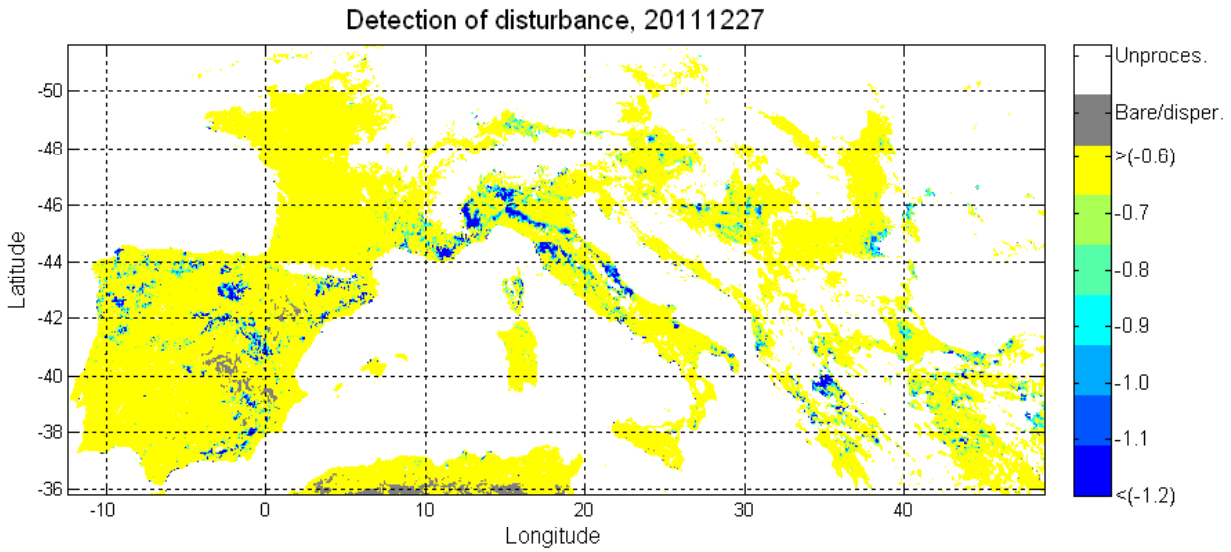
Drought monitoring

Potential applications



France (summer, 2011)


Detection of disturbance, 20111117
Latitude
Longitude
-50
-48
-46
-44
-42
-40
-38
-36
-10
0
10
20
30
40
Unproces.
Bare/disper.
>(-0.6)
-0.7
-0.8
-0.9
-1.0
-1.1
<(-1.2)


Detection of disturbance, 20111227
Latitude
Longitude
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-48
-46
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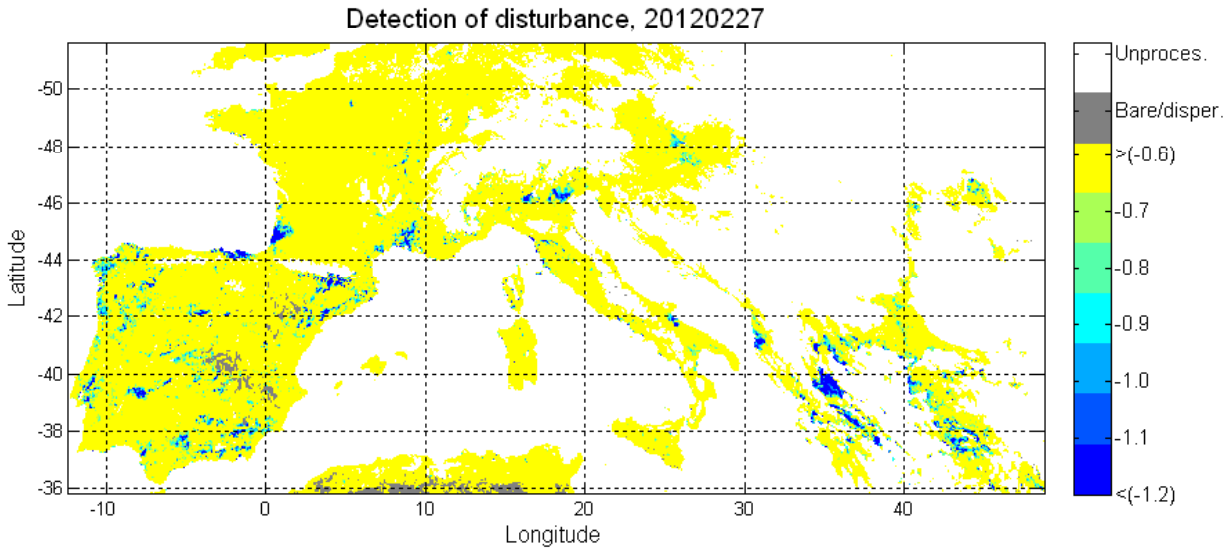
-42
-40
-38
-36
-10
0
10
20
30
40
Unproces.
Bare/disper.
>(-0.6)
-0.7
-0.8
-0.9
-1.0
-1.1
<(-1.2)

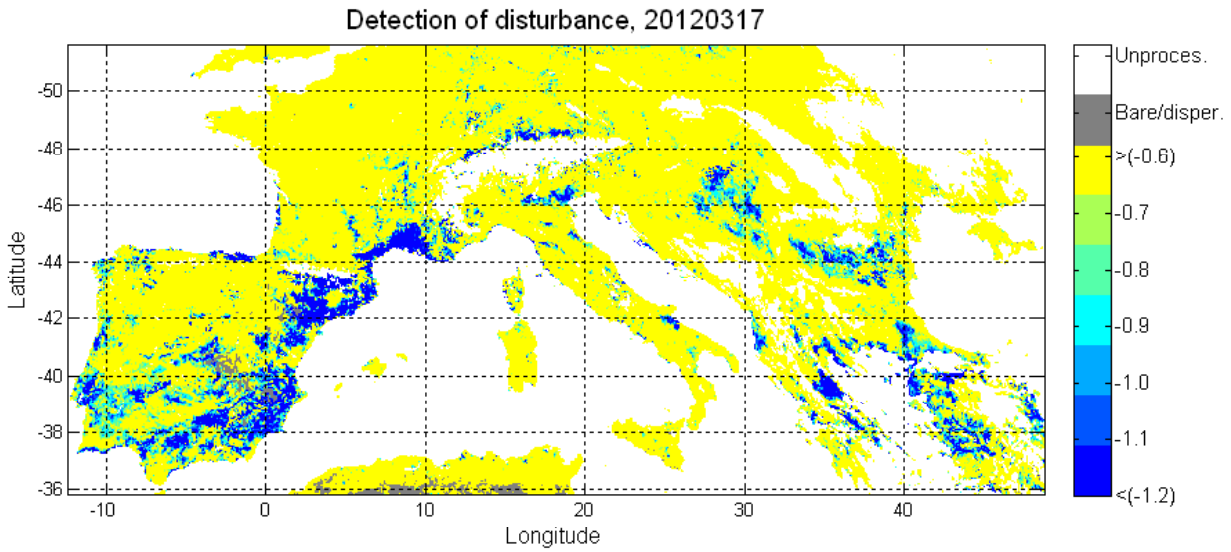
Drought monitoring

Potential applications



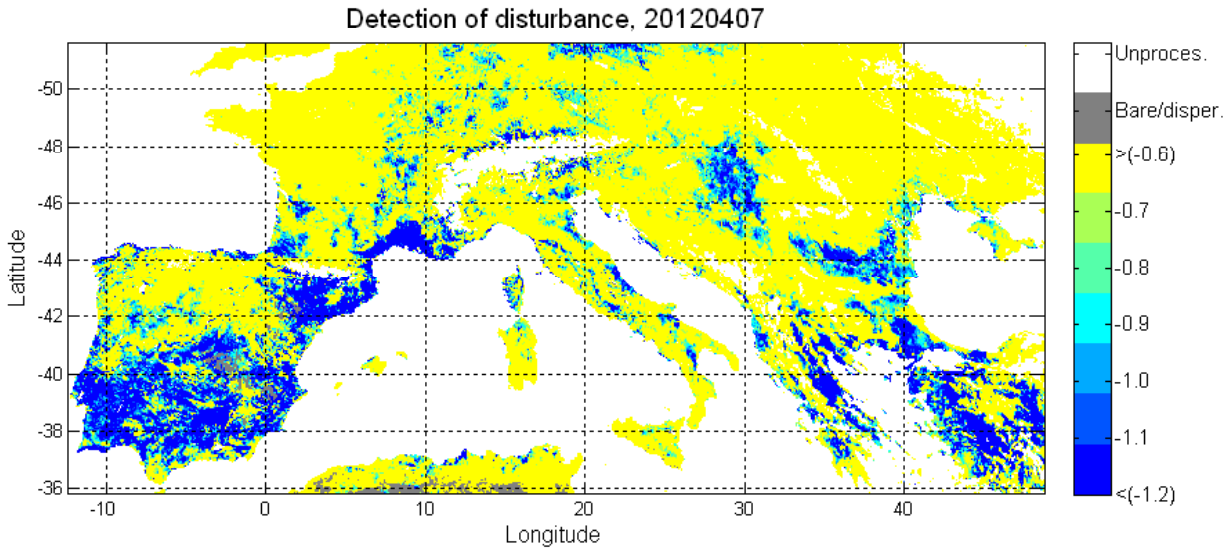
Drought monitoring

Southern Europe



Drought monitoring

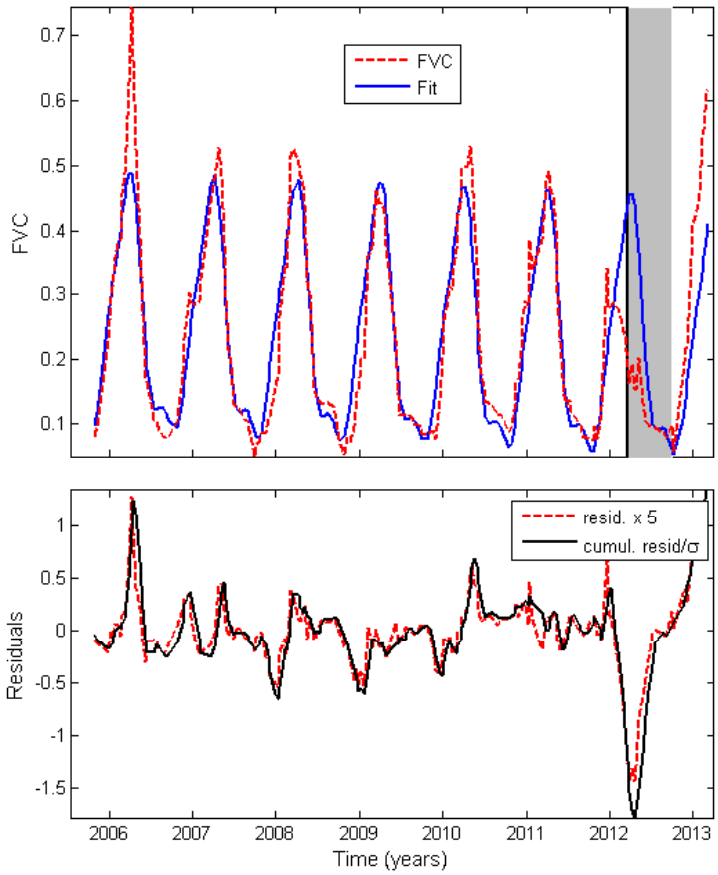
Southern Europe



Mediterranean countries (spring, 2012)

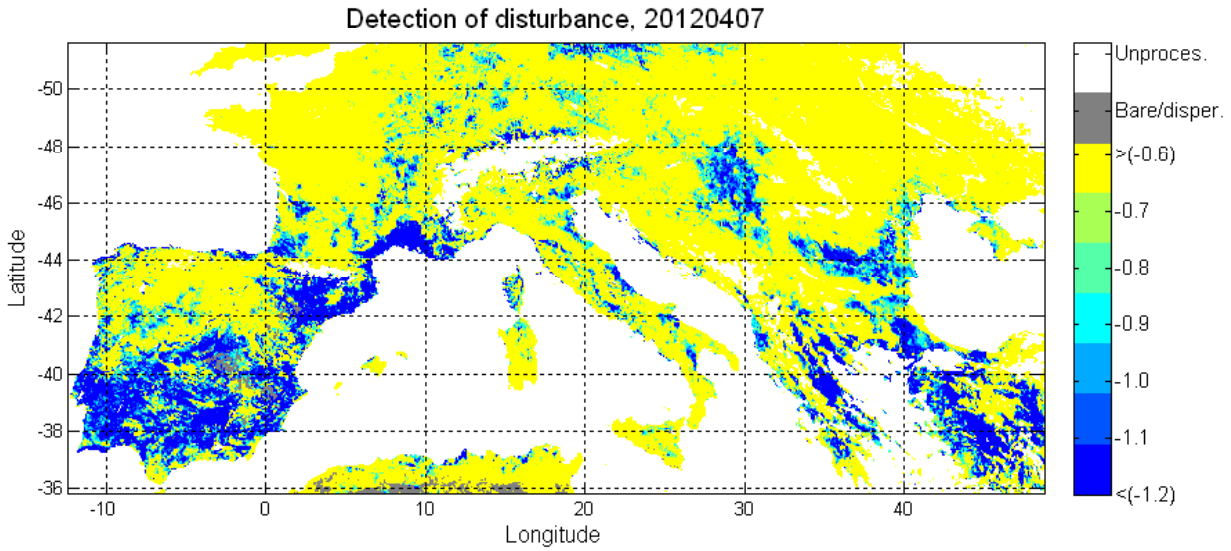
Drought monitoring

Iberian Peninsula Drougth (2012)



Drought monitoring

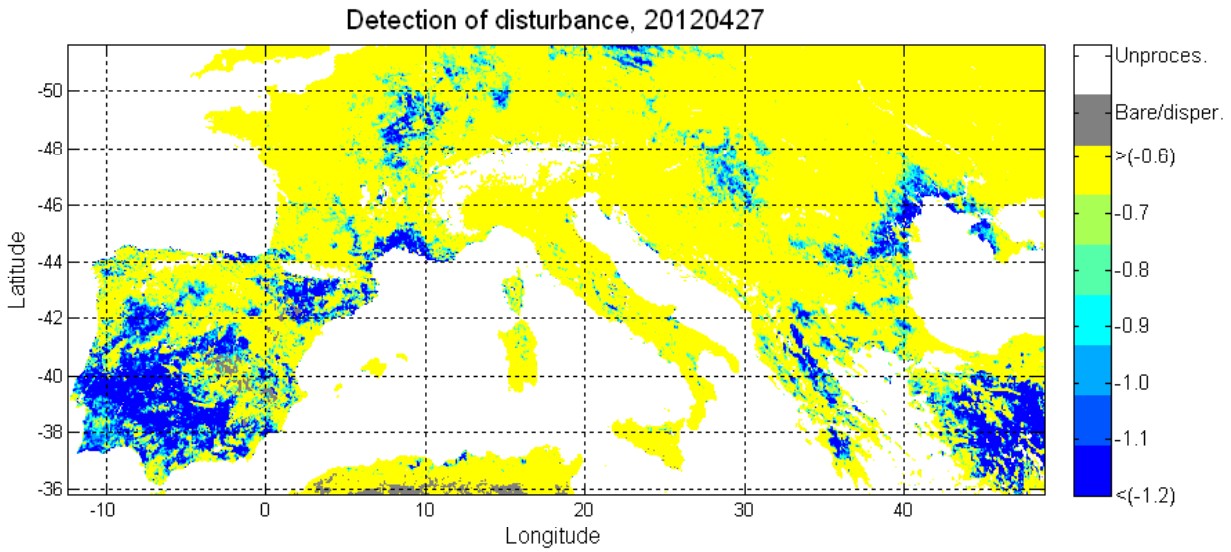
Southern Europe



Mediterranean countries (spring, 2012)

Drought monitoring

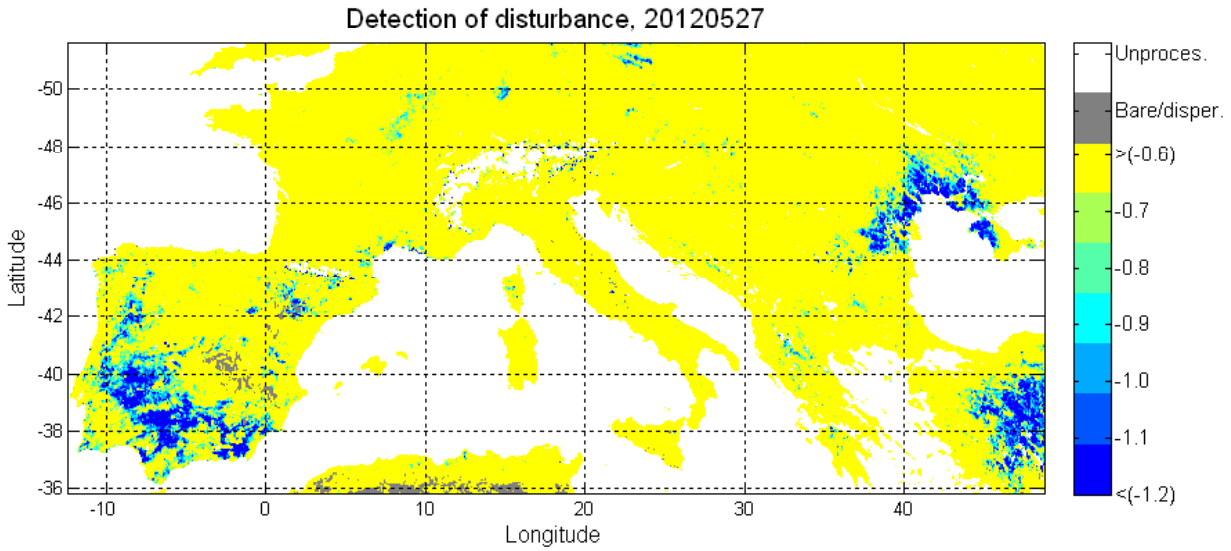
Southern Europe



Mediterranean countries (spring, 2012)

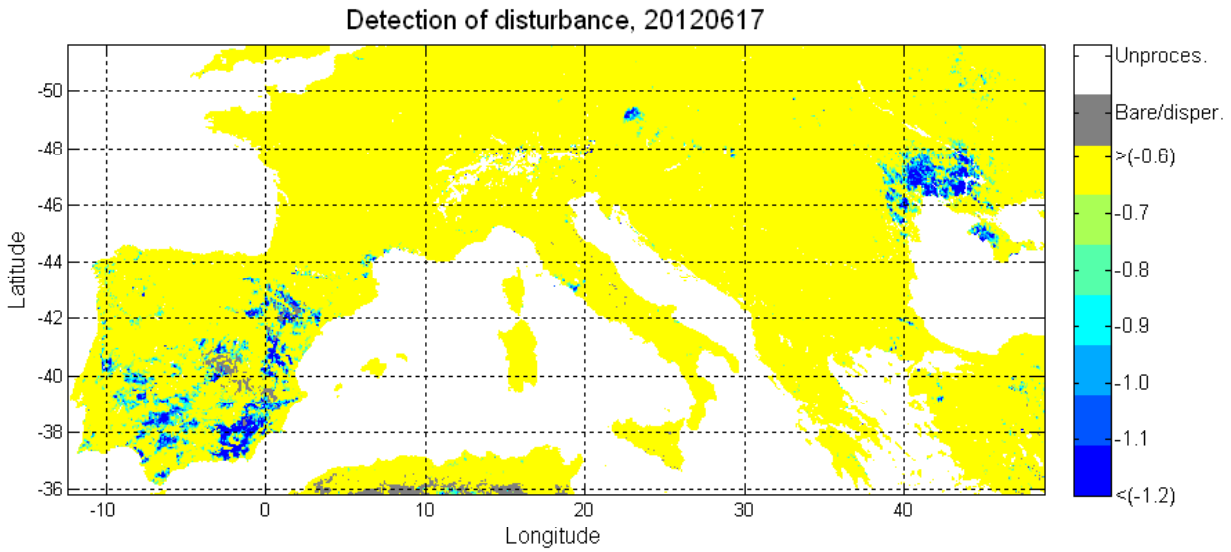
Drought monitoring

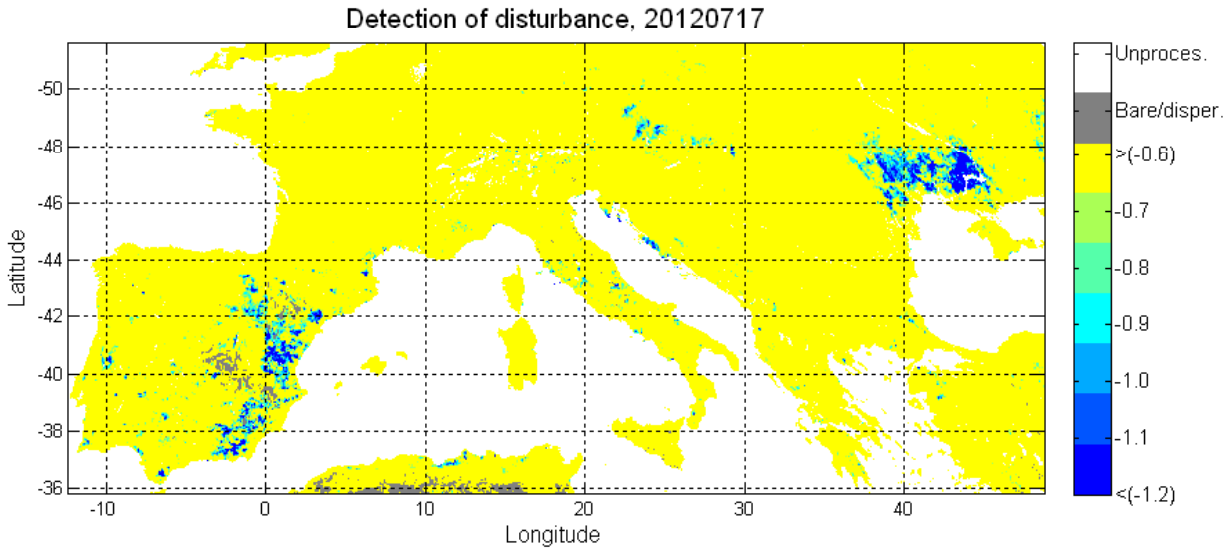
Southern Europe

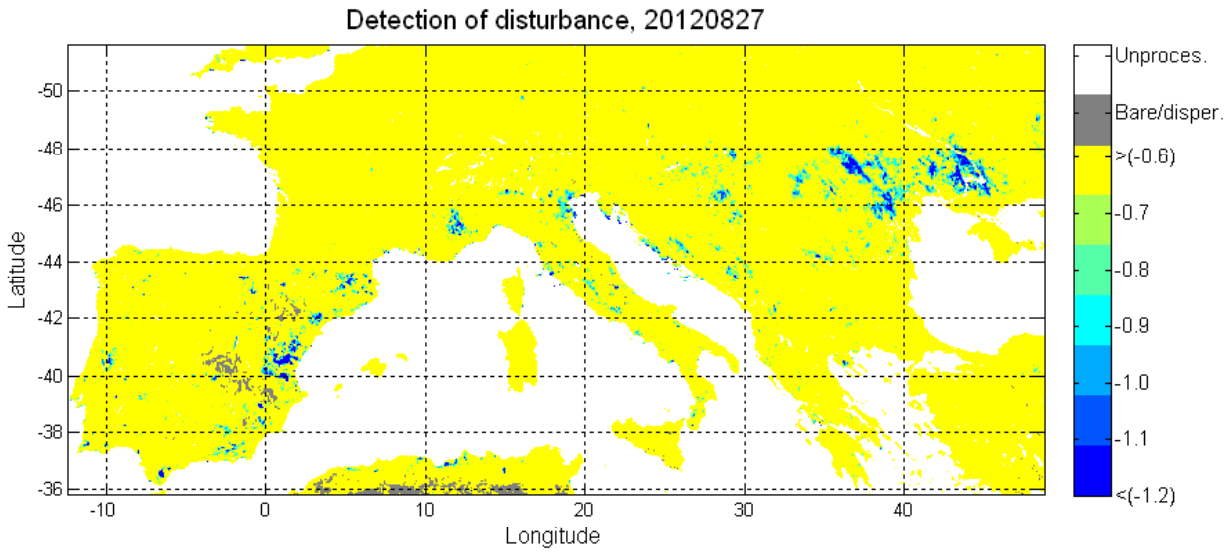


Drought monitoring

Potential applications




Detection of disturbance, 20120717
Latitude
Longitude
-50
-48
-46
-44
-42
-40
-38
-36
-10
0
10
20
30
40
Unproces.
Bare/disper.
>(-0.6)
-0.7
-0.8
-0.9
-1.0
-1.1
<(-1.2)


Detection of disturbance, 20120827
Latitude
Longitude
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-48
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-44
-42
-40
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-36
-10
0
10
20
30
40
Unproces.
Bare/disper.
>(-0.6)
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-0.9
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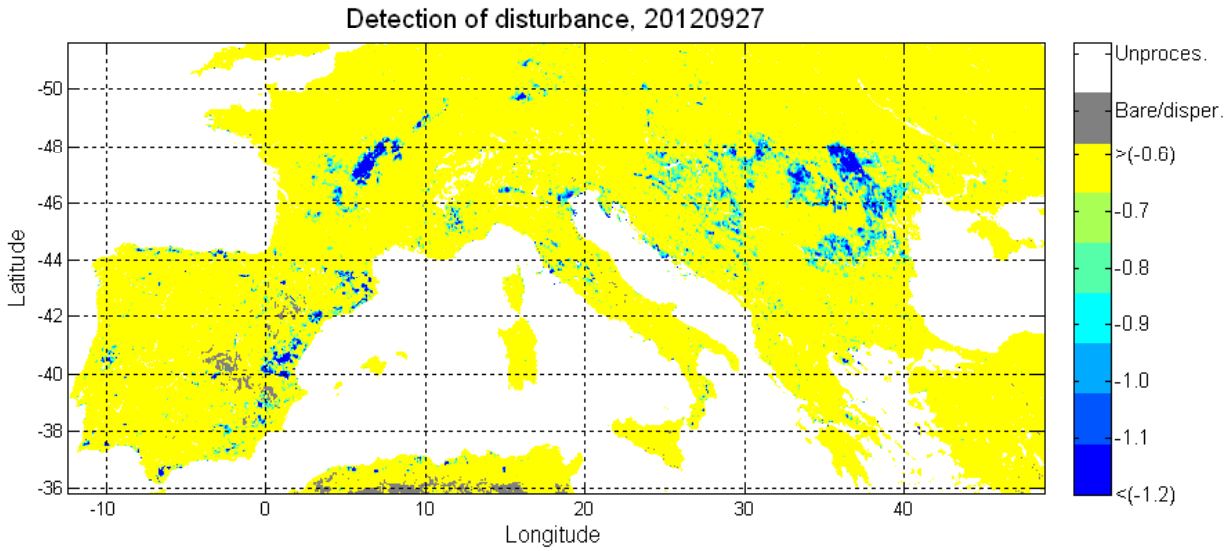
<(-1.2)

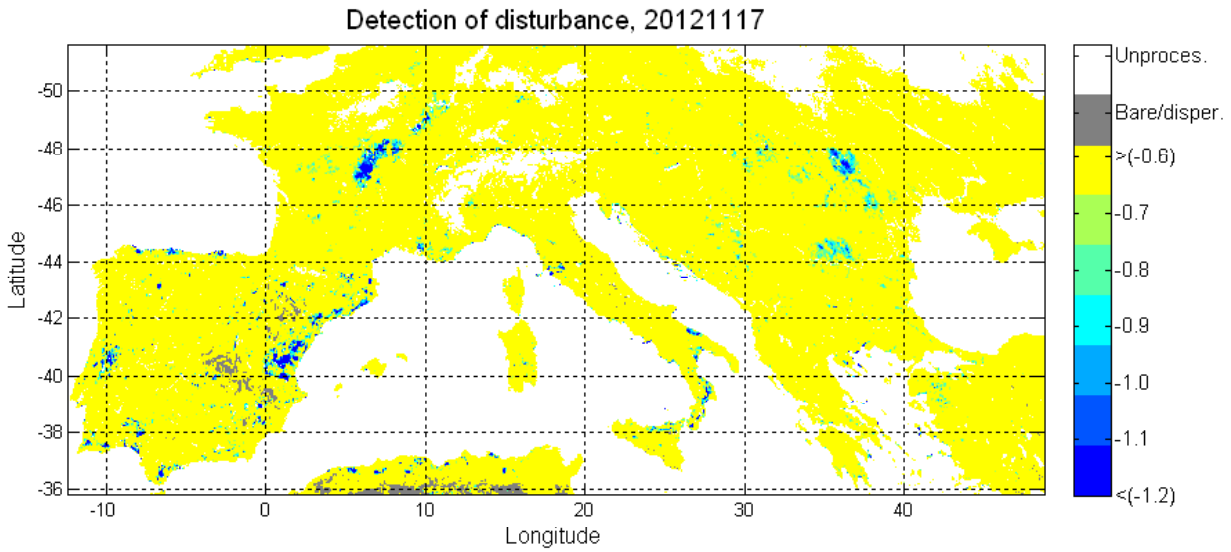
Drought monitoring

Southern Europe



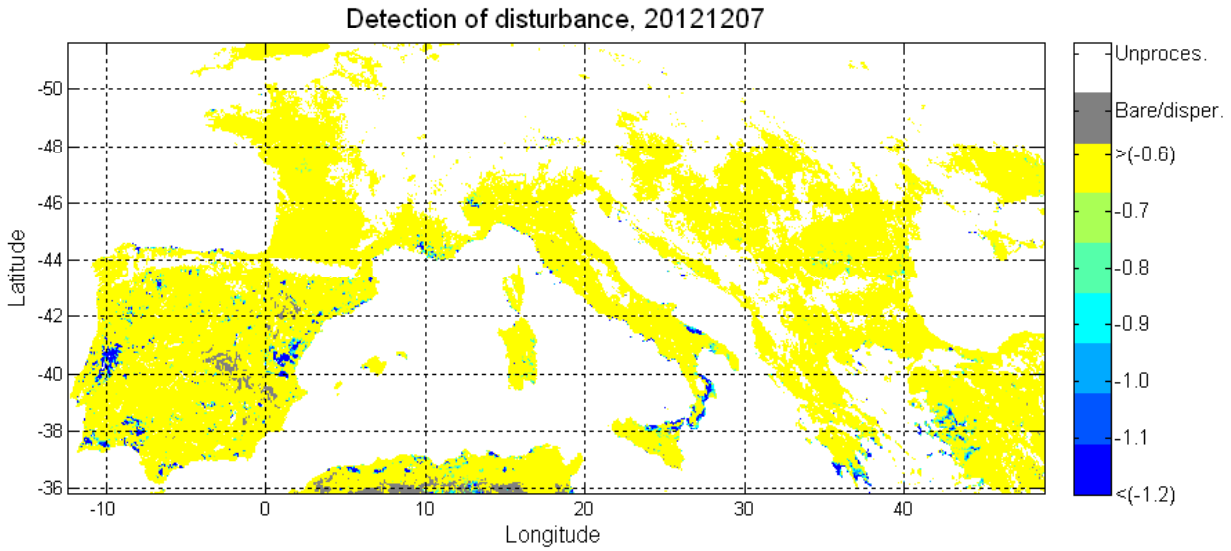
Drought monitoring

Southern Europe



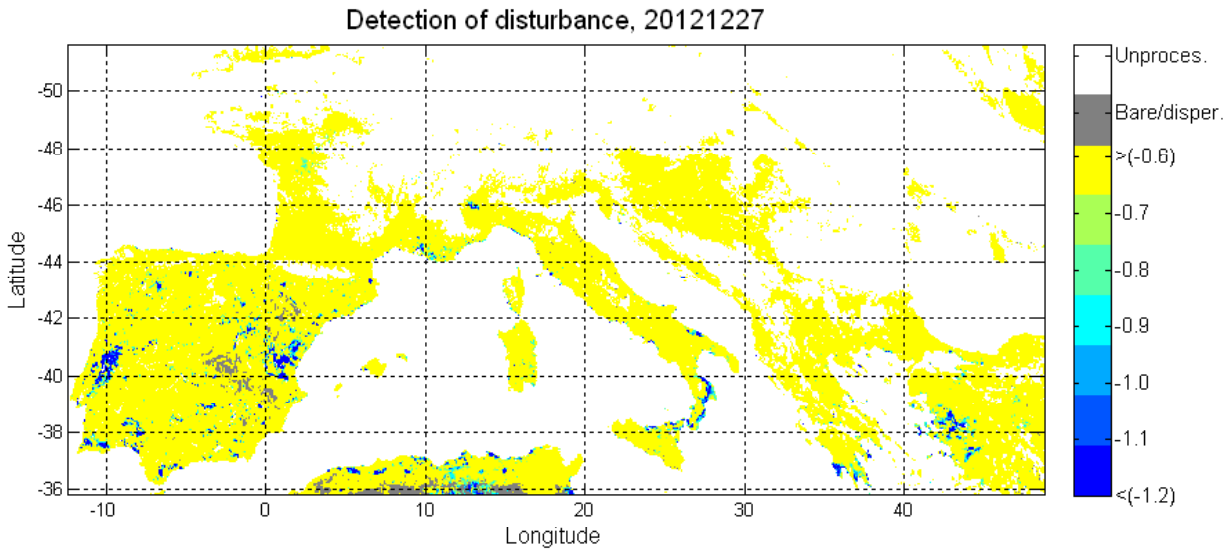
Drought monitoring

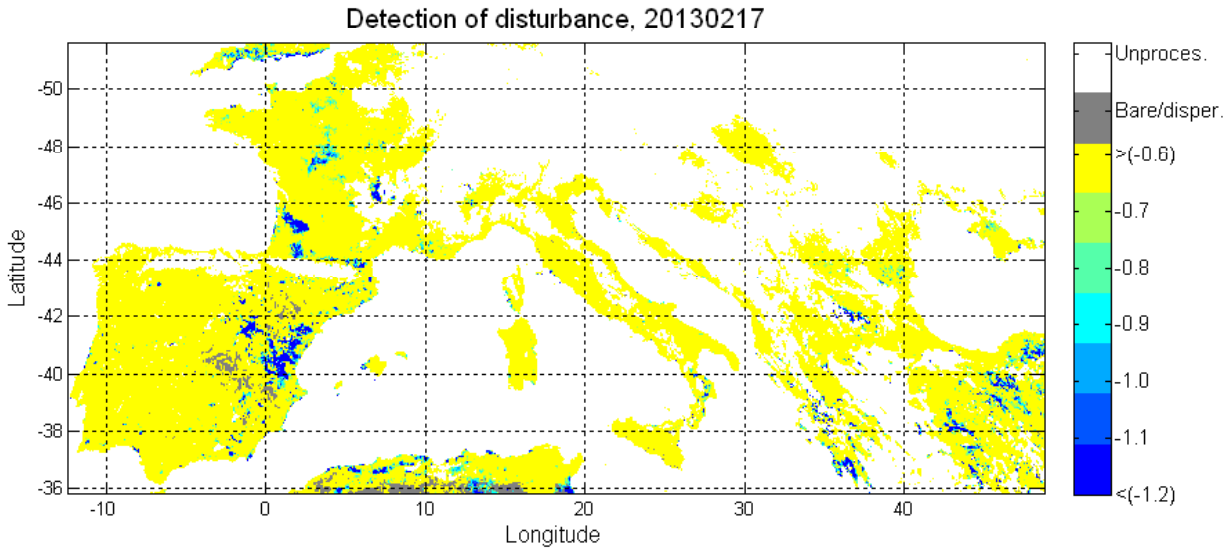
Southern Europe



Drought monitoring

Potential applications





The EUMETSAT Network of Satellite Application Facilities

LSA SAF
Land Surface Analysis

The vegetation monitoring in LSA SAF: overview and potential applications

F. J. García-Haro, F. Camacho, B. Martínez, M.A. Gilabert, A. Moreno, J. Meliá

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