

**Joint NASA LCLUC Science Team Meeting and
GOFC-GOLD/NERIN, NEESPI, MAIRS**

**monitoring land cover, land use and fire in Northern Eurasia
September 16-19, 2009 - NCRST, Almaty, KAZAKHSTAN**

The MARS project: Remote sensing in support of European Agriculture Policies

**Olivier Léo
Bettina Baruth
& Philippe Loudjani**

Outline

- **MARS Unit and JRC**
- **Managing EU Policy**
 - Controls with Remote sensing
 - >Land parcel identification system
- **Monitoring Agriculture**
 - Crop monitoring and Yield forecast
 - Area estimates
- **Conclusions**

JRC's Mission Statement

“... to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies.

the JRC functions as a centre of science and technology reference for the EU, independent of special interests, private and national”.

MARS Project

- Started 20 years ago to provide more timely objective **pan-european** information and forecast on agriculture production (MARS STAT)
- Extended in 93 to the **management and control** of the Common Agriculture Policy (Direct Aids) MARSPAC
- Since 2000 development of Early Warning for **Food Security** MARSFOOD
- Since 2005 : **A GLOBAL STRATEGY**

58 Staff in total

48 paid by JRC,
10 paid by other DG's

27 permanent officials,
31 temporary: 3 Years CA, Post Doc, VS -SNE
+ circa 15 persons outsourced (MARS OP)

Budget (yearly)

JRC credits:	1.1 Mio Euro
Admin Arrangements:	1.7 Mio Euro

AGRI Sub delegations: 6.5 + 1.9 Mio Euro

Main costumers / working relations

EC Directorates: AGRI, ENLARG, AIDCO,
RELEX ENTR, RTD, INFSO...

Core expertise

- Agronomy
- Remote Sensing / Image analysis
- Geomatics, GNSS, GIS
- Crop modeling, Agro-meteorology
- Statistics
- ICT

Additional Expertise

Agricultural insurances
Vulnerability assess.

4 institutional Projects

GEOCAP – Geo-Information Management and Control Methods

Support and addresses new controls needs for European Policies related to Common Agriculture, such as Cross Compliance, Farm Advisory System, traceability...

CID – Community Image Data Portal

Satellite (and aerial) remote sensing data management for DG AGRI and within the JRC.
30 TB on-line archive of HR+VHR imagery

Management / control systems

AGRI4CAST - Crop/Production Forecasts/Estimates and Climate Change Impact on Agriculture

European activities & world wide activities related to Global trade in support to DG AGRI. Research & development related to crop insurance and climate change impact on Agriculture.

Monitoring

FOODSEC - Food Security Assessment

World wide activities related to Food Security, Focus on Sub Saharan Africa- in support to DG RELEX DEV, ECHO & direct links with UN FAO and WFP.
Research & dev on Vulnerability assessment , post harvest losses, etc

- Direct Aids for farmers
 - Total budget of 53 Bio Euros (41 % of 2008 EC budget)
 - area based payments and since 2004, mainly decoupled
 - Single payment scheme
 - conditioned by Cross compliance (respects of EC Rules + maintenance in good conditions)
 - Declarative system and integrated control system (IACS)
 - 100 % administrative checks / risk analysis
 - 5 % minimum On the Spot checks
- Statistics 2008
 - 8.3 Mio applications (27 Member-States)
 - 629,000 OTS checks (7.6%)
 - 338,000 farms controlled with RS (55% of OTS)

CAPI = Computer assisted Photo interpretation

Farmers declaration data

Inputs of observation + anomaly codes

GIS navigation

1m Ortholmage to check area

3 dates Multi spectral to check land use and eligibility Conditions

AUTO: Tech. tolerances, Cross checks, Quality Diagnostic / documentation of Control Report

Session

Login Time	Wed May 20 08:05:51 199
Interpreter	zeus32
Job File	Demo2.job
Number of Farms	4

Declaration

Farmname	farm3
Scheme	General Scheme
No. Of Parcels	22

Field

No. of Polygons	1
Polygons miss.	0
Polygon Area	17.62
Doubledclaration	0

Declared Parcel

Serial	5640
Field No.	16
Subsidy	AAPS
Lf. Area	not declared
UgL	not declared
Crop	Winter Rape
Area Declared	17.98
Polygon Area	17.62

Default Values

Class. Result	Winter Rape (86.4%)
Default: Landuse	Winter Rape
Default: Area	17.98
Default: Code	X

CAPI

Area found	17.98
Landuse found	Winter Rape
TWC - Codes	X
AZL Judge.	--
UGL-A	--
UGL-B	--
UGL-C	--
UGL-V	--
Area Found Type	Declared
Comment	

Poly Info

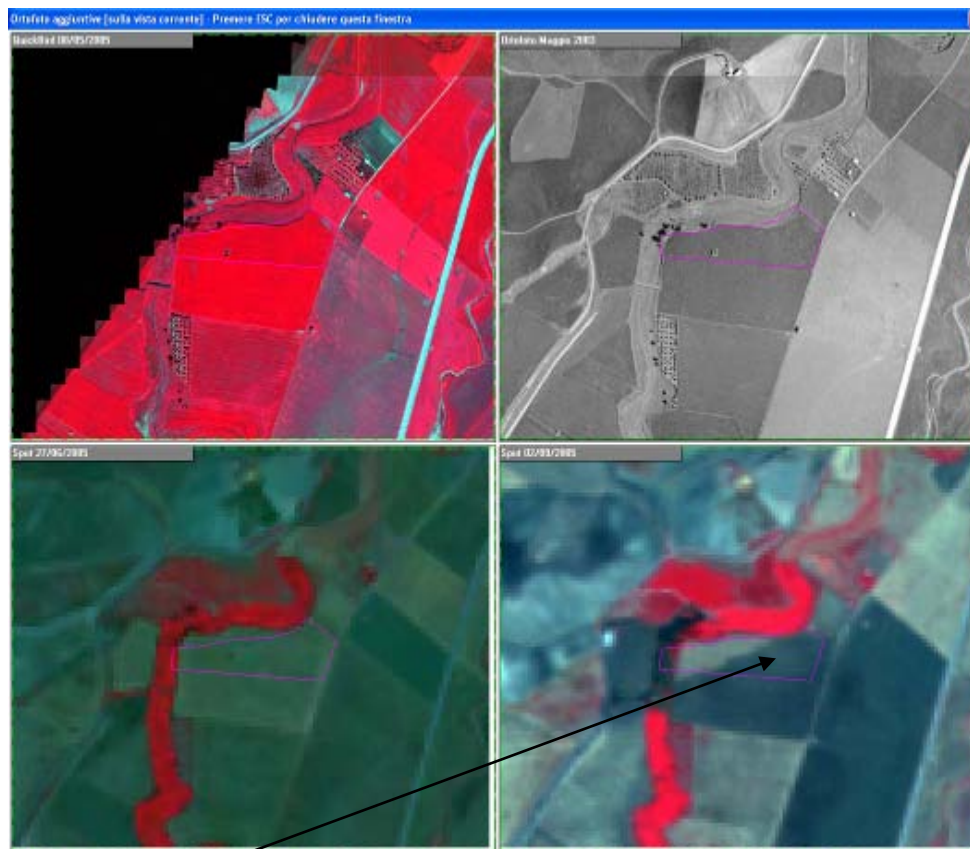
Select parcel by clicking the polygon - Zoom by pushing right mouse butt



SPOT HR
July 2007

(Bulgaria)

Stubble burnt



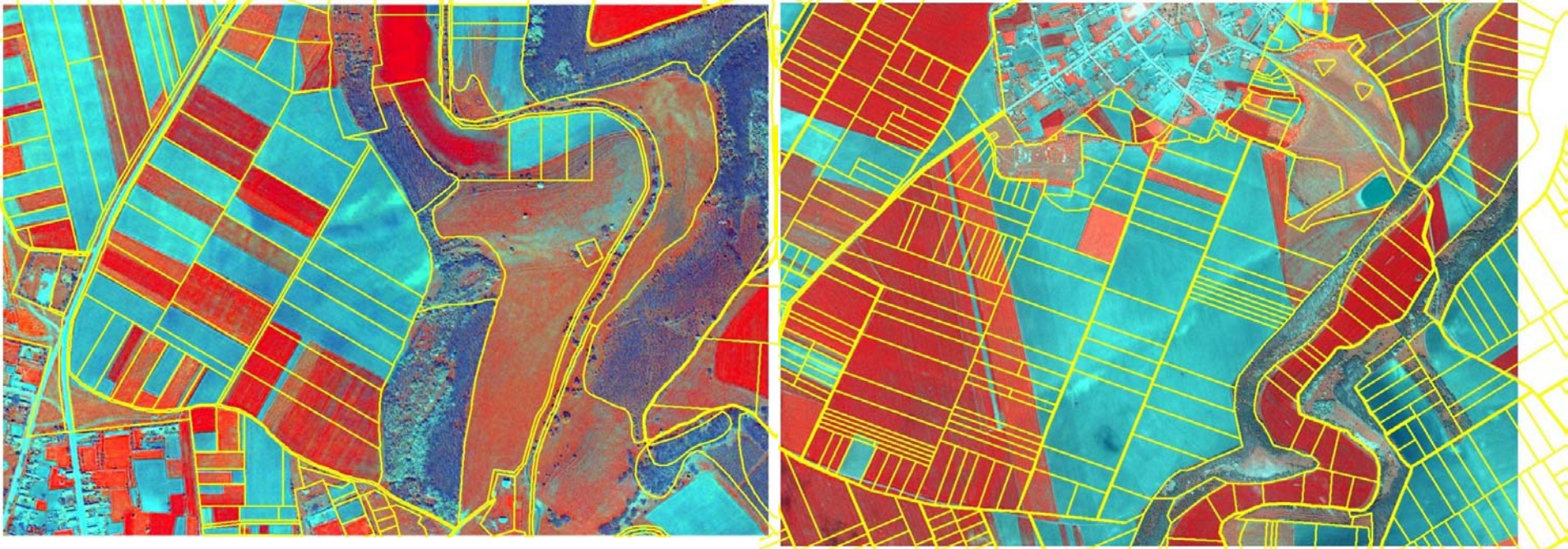
(Italy)

SPOT HR
September 2005

Physical blocks and location of farmers as 27.11.2006 : 105 221 km² – 95%

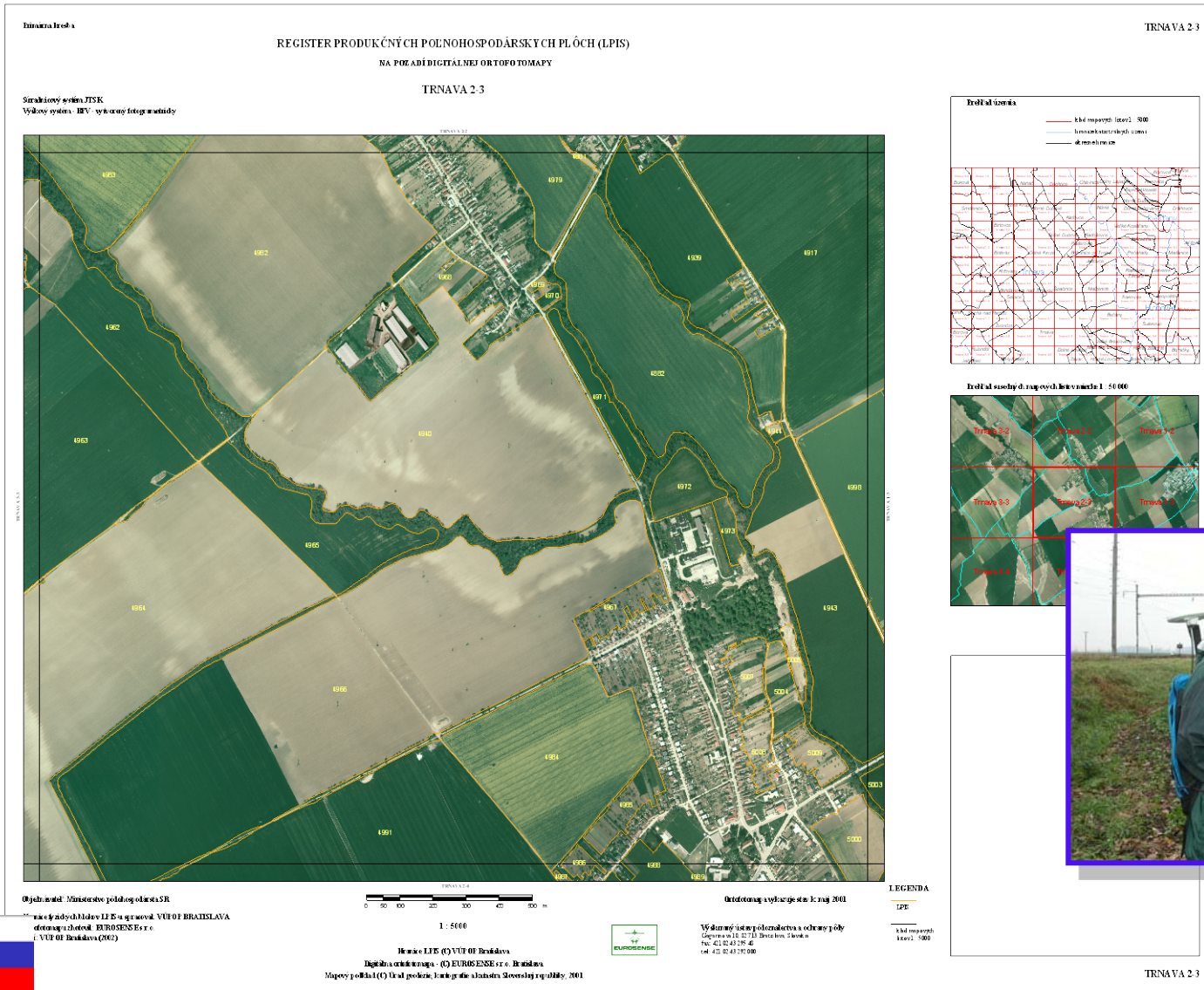
Physical Block: 322 500 (without family gardens) -Mean area of the Physical Block : 15 ha

Existing Cadastre

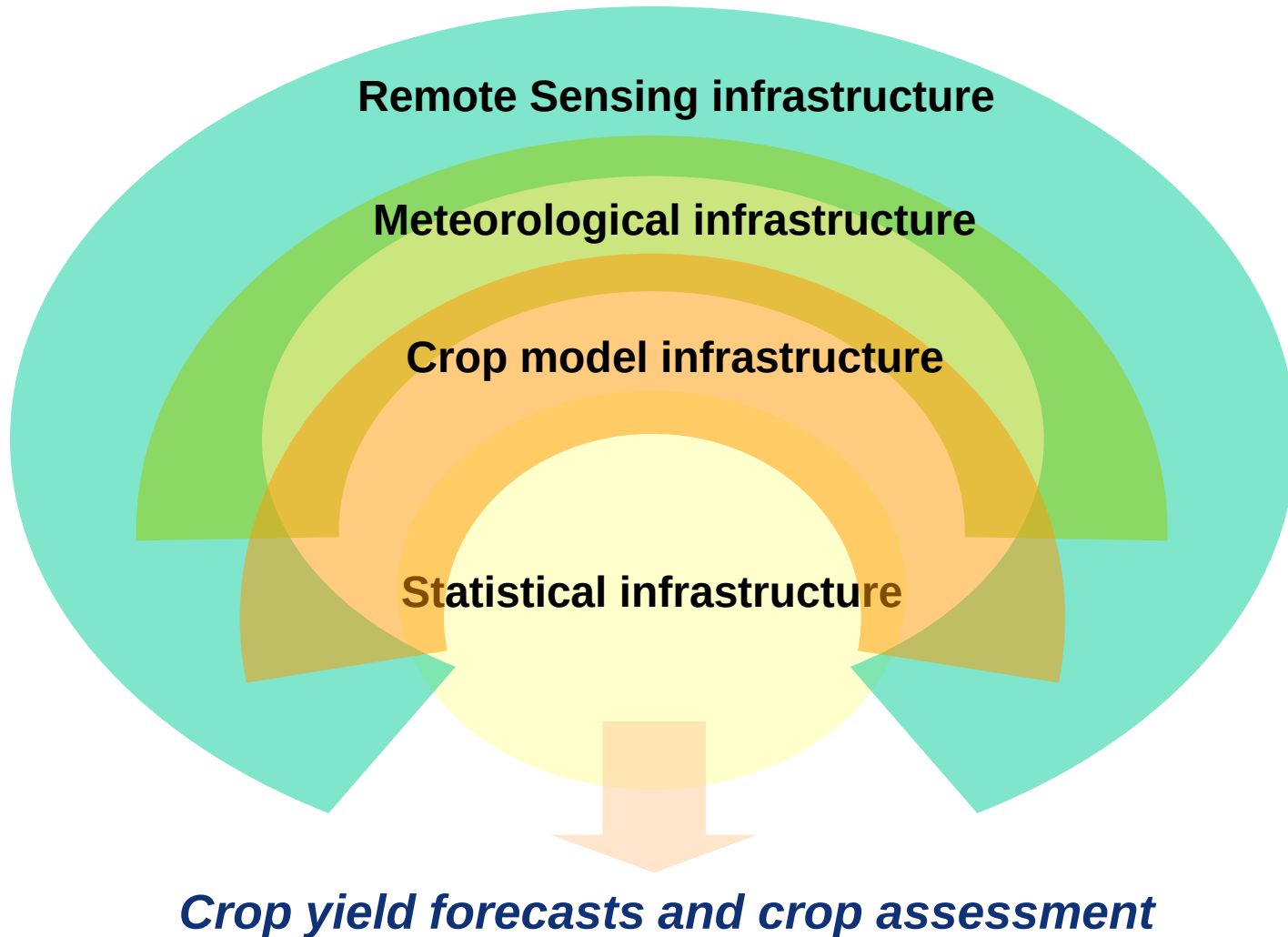


Recent archive Satellite 1m ortho were produced for 30% of the area
to allow block creation << 2007

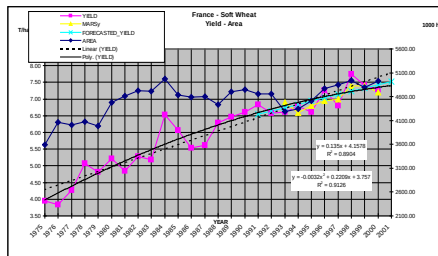
Complete 50cm color orthophoto cover in 08



MARS general system design

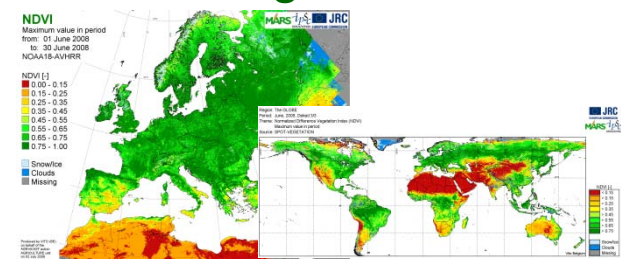


Statistical infrastructure



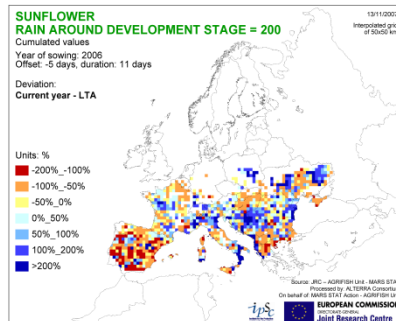
time series regression,
similarity analyses

Remote Sensing infrastructure

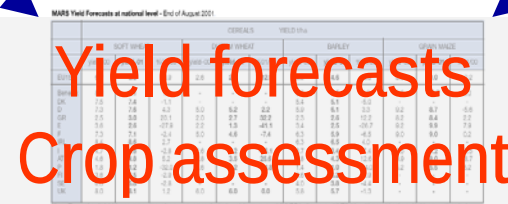


Vegetation state & meteo indicators
since 1981 Europe, 1998 worldwide

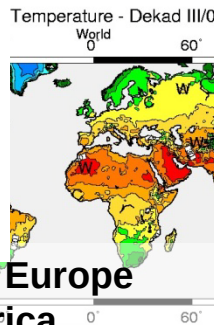
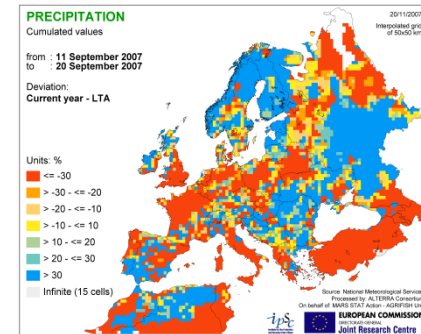
Crop Model infrastructure



Agrometeo indicators derived from crop growth
model – WOFOST / LINGRA / WARM and GWSI



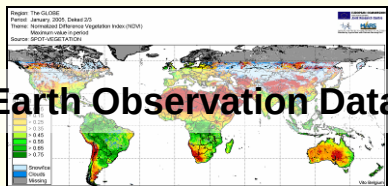
Meteorological infrastructure



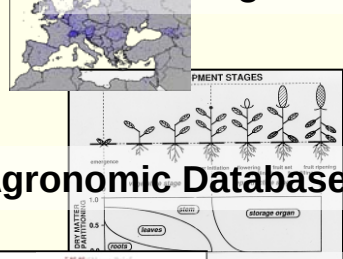
observed data since 1975 Europe
under construction for Africa
worldwide ECMWF data + archive

NRI, monthly / ad hoc monitoring

Data collection & retrieval



Meteorological Data

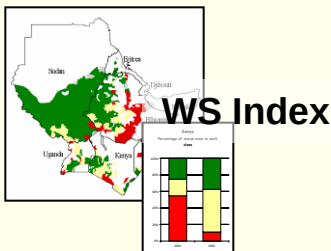
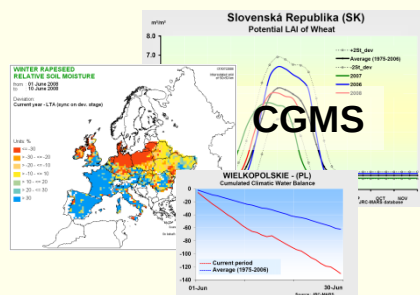
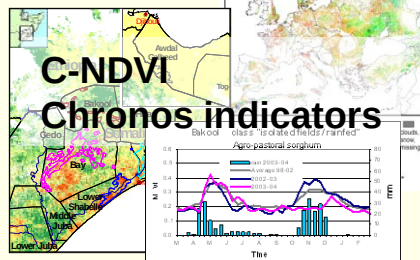


Agronomic Database

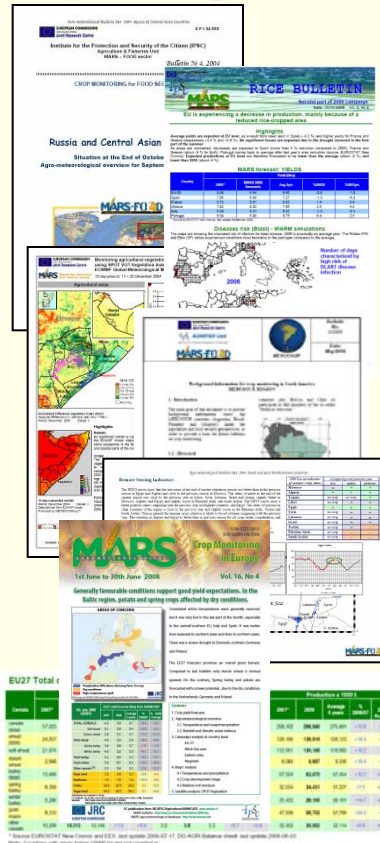
WEB Information Media Monitor Magazines

Agro-phenological network

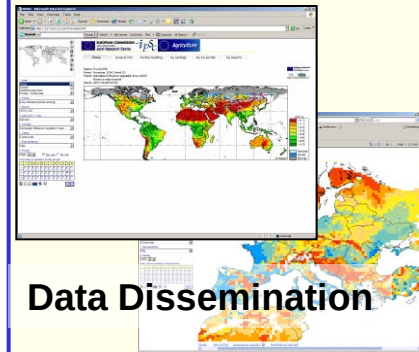
Processing & Analysis



Reporting



Dissemination

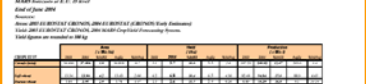
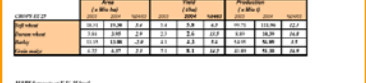
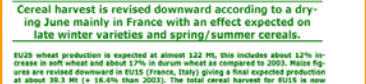
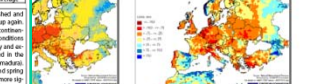
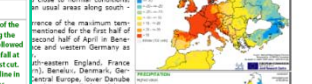
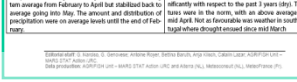
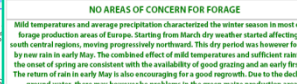


Bulletin Dissemination

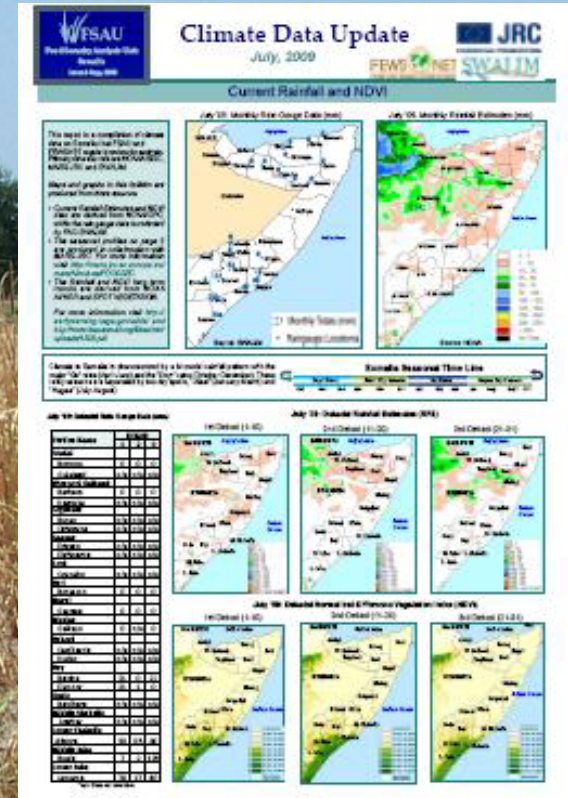
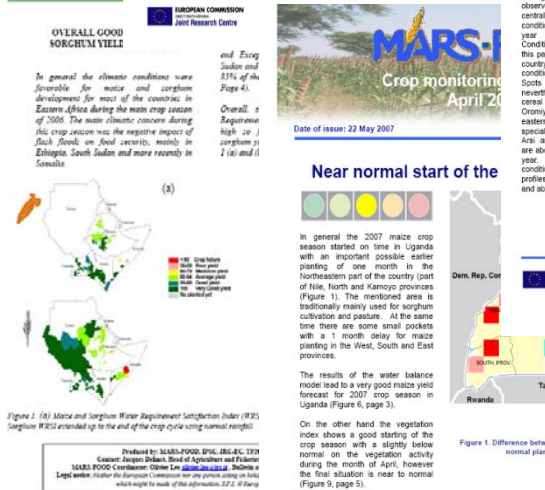
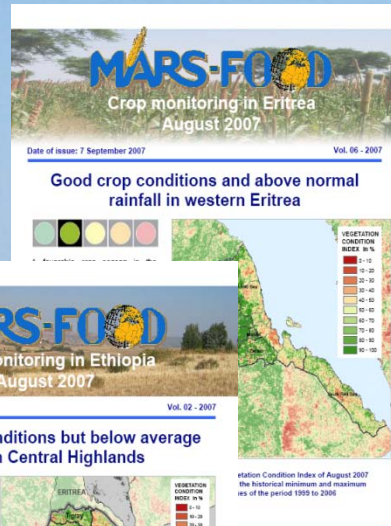
DG AGRI
DG RELEX
DG EUROSTAT
EU Delegations
Member States
National Agencies
Int. Institutions (FAO, ...)

End of campaign evaluation & feed backs

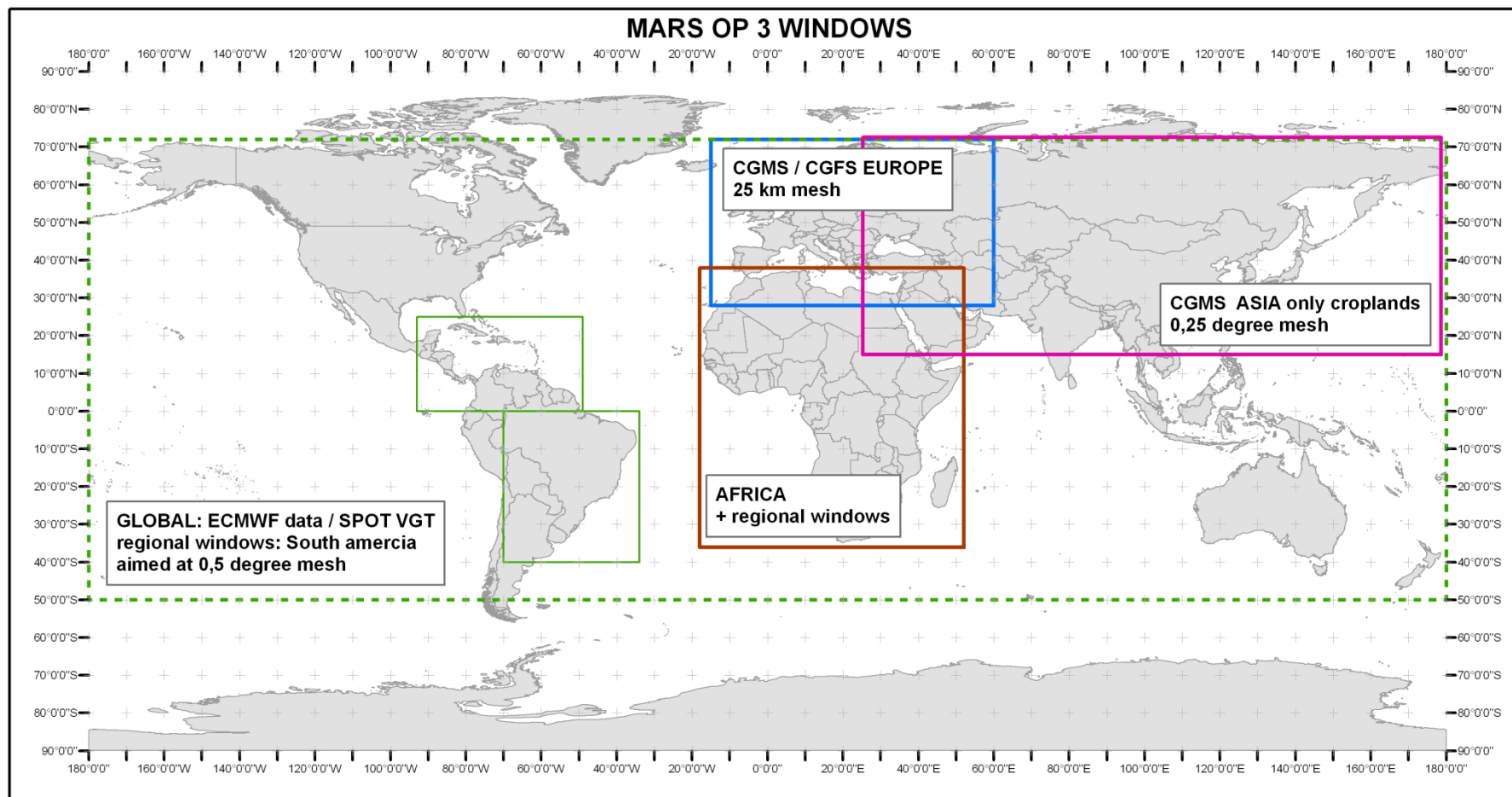
- European Window
- 35 countries covered
- 11 crops of interest
- 30 years of meteo and agrometeo data
- 21 years of low resolution satellite information
- 20 crop's indicators are daily simulated



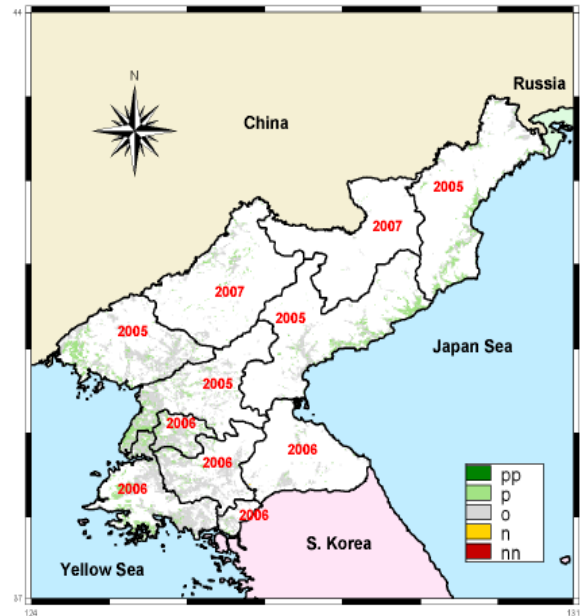
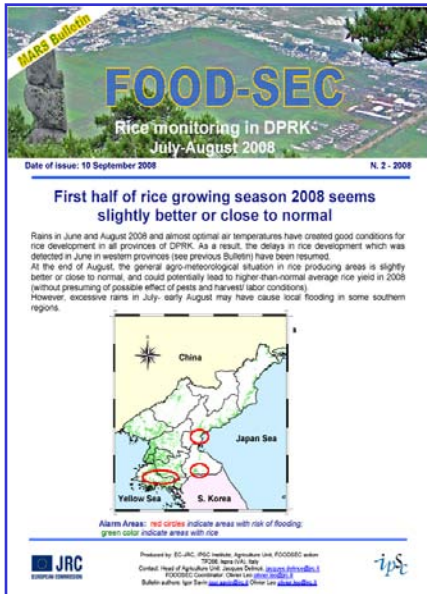
2003 - 2009 Focus on the Horn of AFRICA



Capacity Building and transfer to National FS Teams



	GLOBAL window + regional RS windows data: ECMWF SPOT VGT model: GWSI, CGMS level 1		EUROPEAN window data: meteo station data ECMWF NOAA - AVHRR, MODIS, MSG, SPOT VGT model: CGMS CGFS		ASIAN window + regional RS window data: ECMWF SPOT-VGT model: CGMS		AFRICAN window + regional windows data: meteo station ECMWF MODIS, MSG SPOT VGT
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Deviation of NDVI of 2nd dekade of August 2008 from long-term average (SPOT-VGT)
pp – higher than average, p – slightly higher than average, o – close to average, n – slightly lower than average, nn – lower than average; Red figures indicate for each province, the most similar past year in term of NDVI time profile

DPRK Close to average Rice crop performance (2nd dekade August 2008) in nearly all rice zones

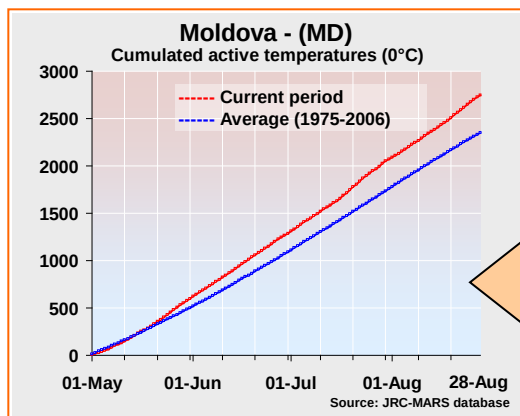
MOLDOVA:

- 2007 Specific report / assessment Drought and Heat stress
- 2009 Drought _ Report and yield forecast provided to FAO GIEWS

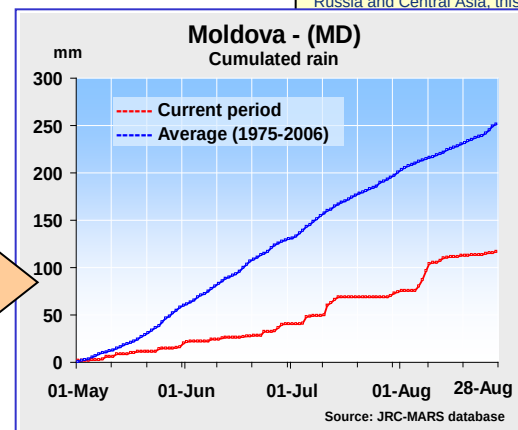
A request from AIDCO –A (6/08/07)

From: GIORGI Sergio (AIDCO)
[mailto:Sergio.GIORGI@ec.europa.eu]
Sent: 06 August 2007 16:52
To: GENOVESE Giampiero (JRC)
Subject: FW: Agro-meteorological Bulletin for Russia and Central Asian Countries (2007-3)

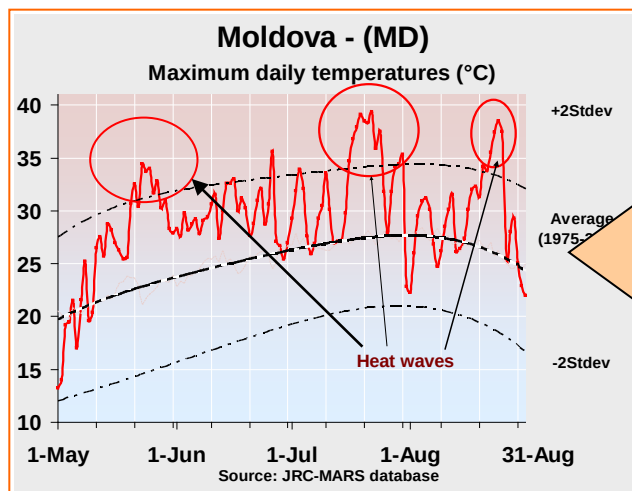
Dear Mr Genovese,
being somewhat familiar with the JRC bulletins produced for Russia and Central Asia, this is to kindly request your assistance in providing information concerning the agro-meteorological situation (such as this year's situation) in the ENP countries and Yemen for the period 2007-3 (AIDCO) for coordination & supervision for



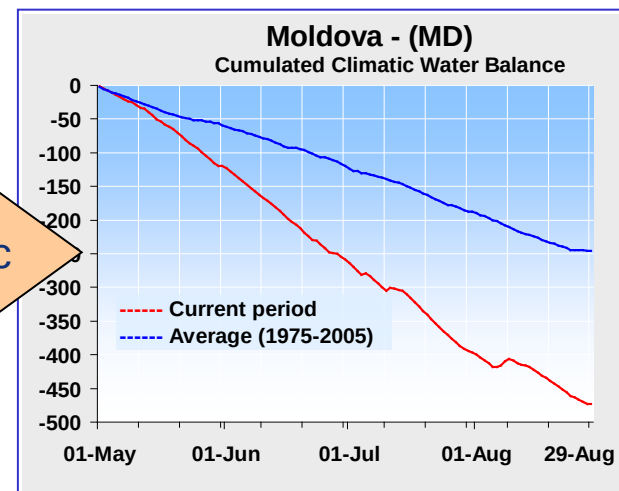
Quick analysis



A rapid analysis of the meteo data confirms the gravity of situation

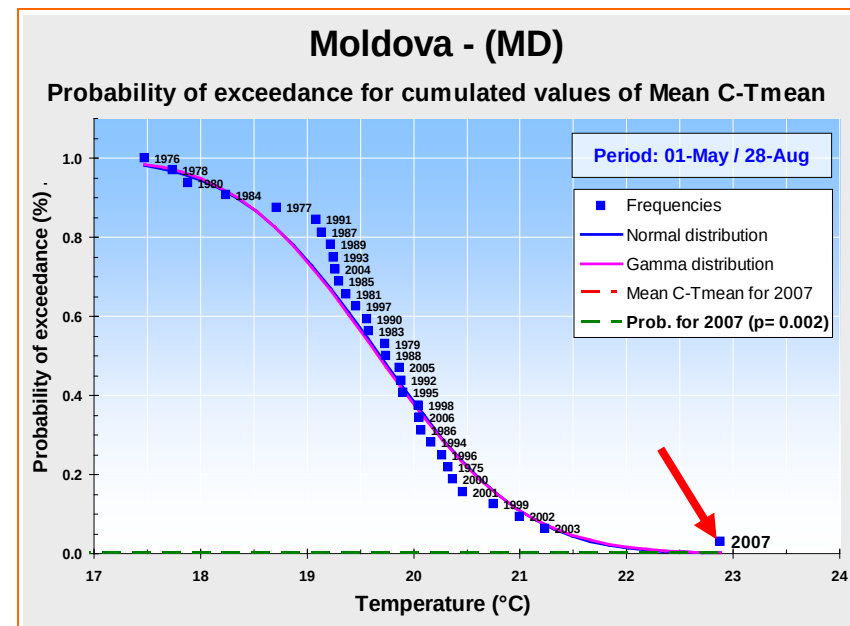
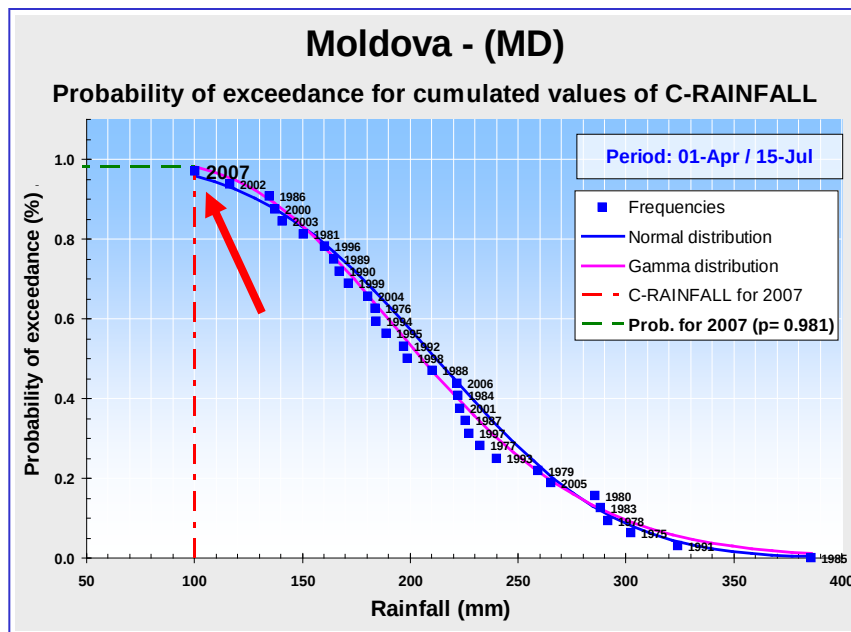


Agro climatic



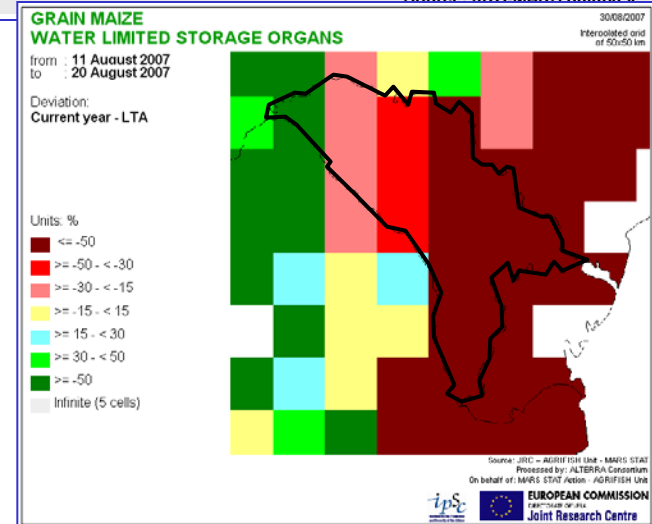
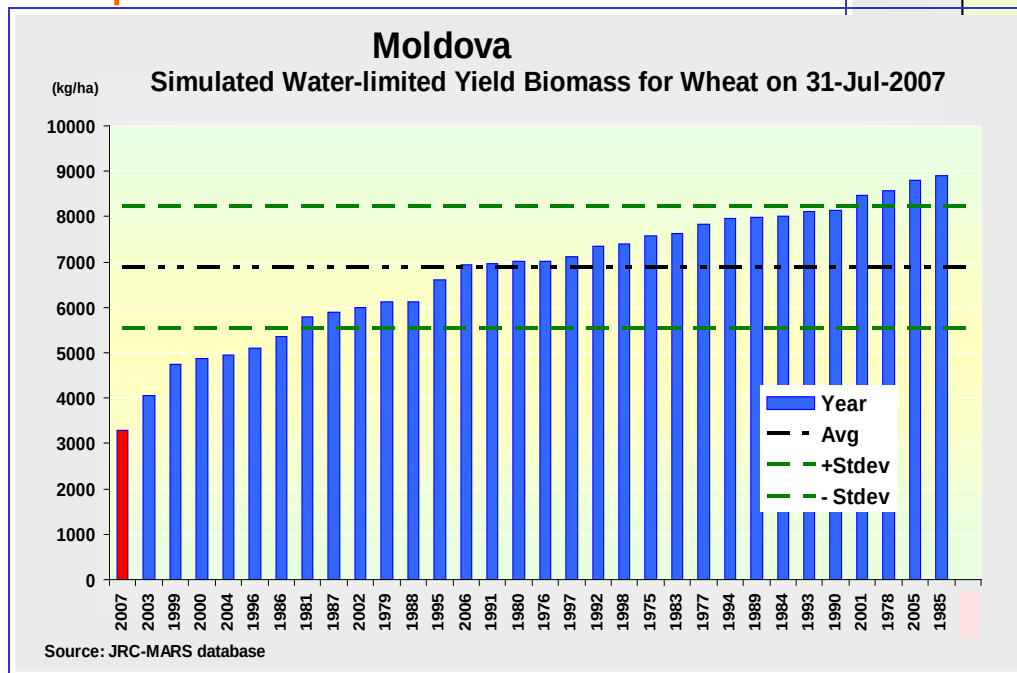
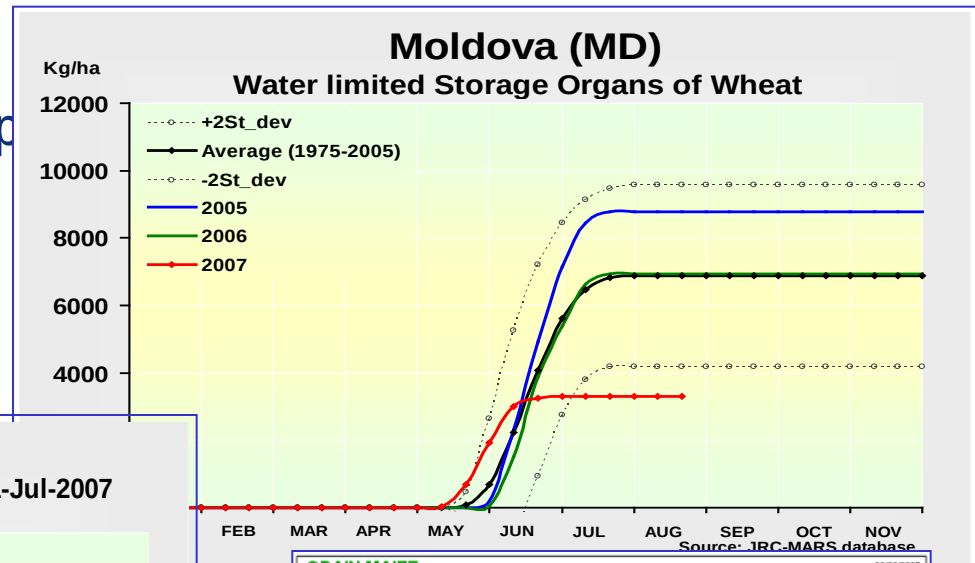
2007 Drought and heat-stress in Moldova

Frequency analysis on 32 years confirms a series of extreme events of Drought and Heat wave occurring at key development stages for both winter and summer crops

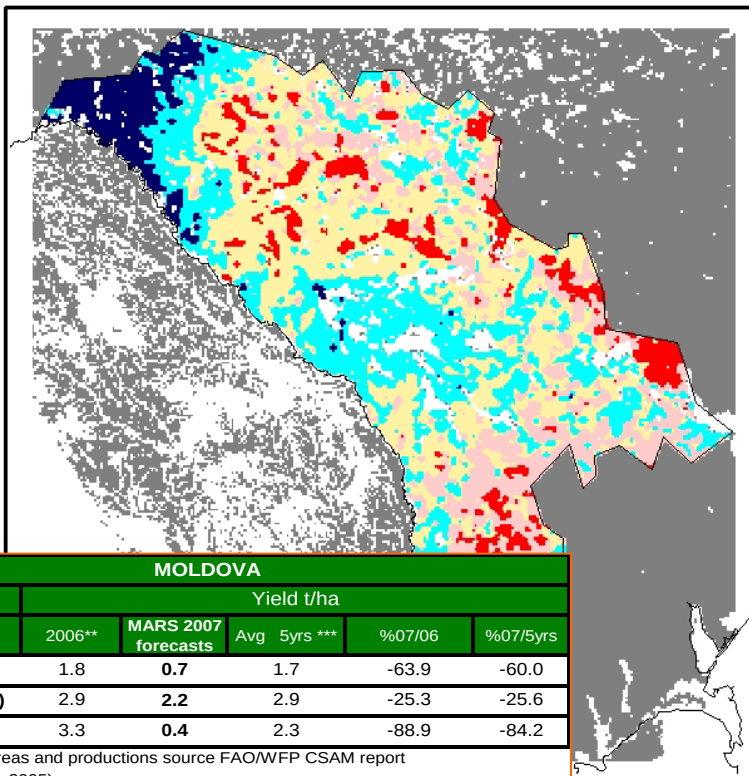


2007 Drought and heat-stress in Moldova

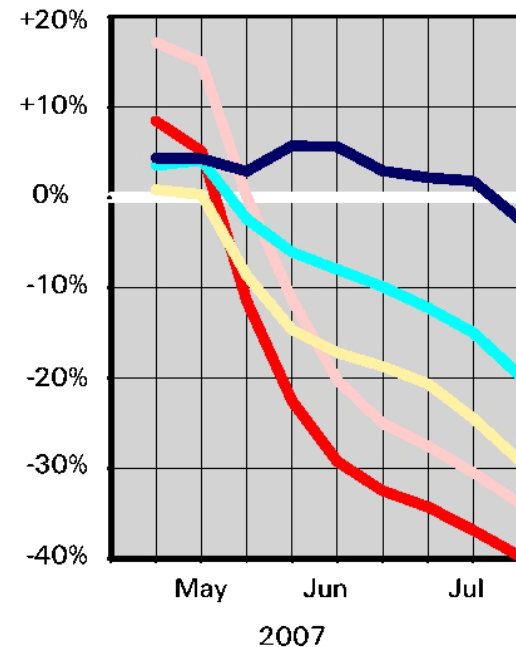
Crop Simulations (Wheat, rapeseed, sp Barley, Sunflower) by WOFOST model (CGMS) indicated an **exceptional damage to both winter and summer crops.**



TEN DAY NDVI CLUSTER ANALYSIS OF SPOT VEGETATION DATA FOR ARABLE LAND - DIFFERENCE BETWEEN CURRENT YEAR (2007) AND LONG TERM AVERAGE (1999 - 2006)



TEN DAY NDVI DIFFERENCES in Percent



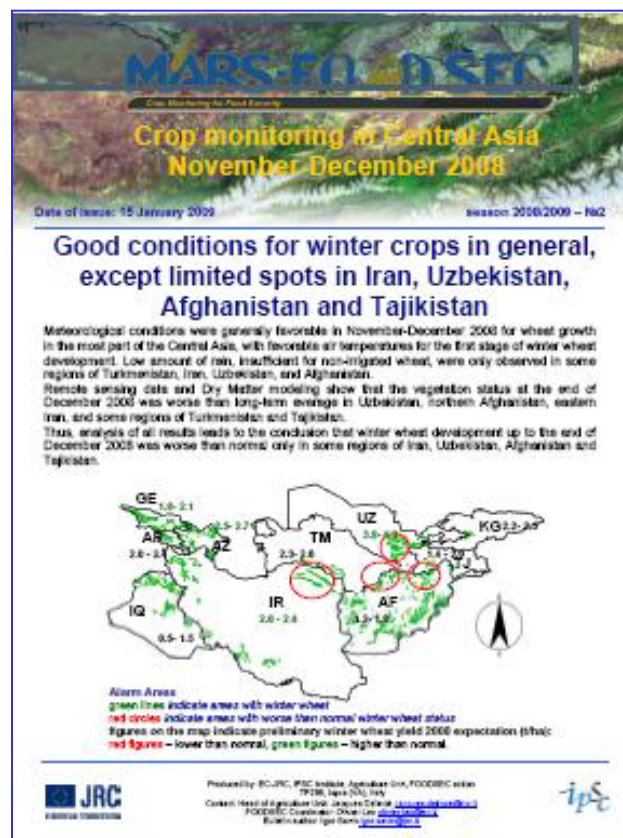
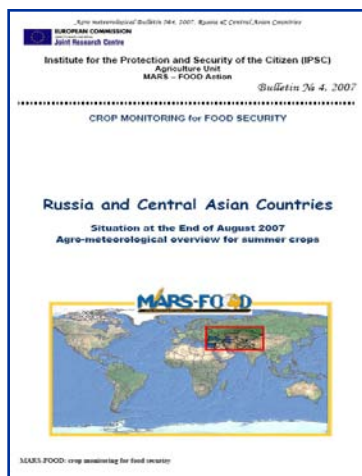
MOLDOVA					
	Yield t/ha				
	2006**	MARS 2007 forecasts	Avg 5yrs ***	%07/06	%07/5yrs
barley	1.8	0.7	1.7	-63.9	-60.0
grain maize (SI)	2.9	2.2	2.9	-25.3	-25.6
wheat	3.3	0.4	2.3	-88.9	-84.2

** based on 2006 areas and productions source FAOWFP CSAM report
*** FAOSTAT (2001-2005)
(SI) only surviving and/or irrigated fields

At least a quarter of the total crop areas are seriously affected (crop failure)

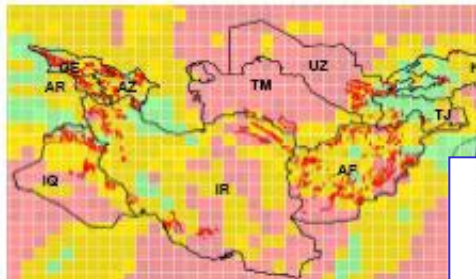
• Transition period between redefinition of windows // Bulletins

- 2007 Russia and Central Asia
- 2008 Russia and Ukraine covered in “European Window” + Specific Central Asia Bulletin , Disrupted early 2009
- in 2010 Kazakhstan and Central Asia. in a large CGMS ASIA Window (incl. India, China)

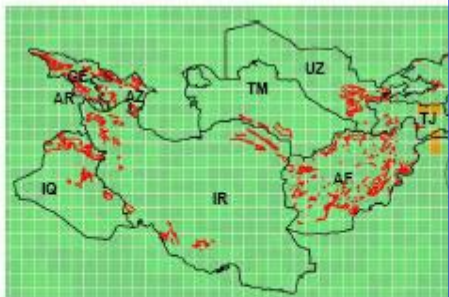




Meteo conditions

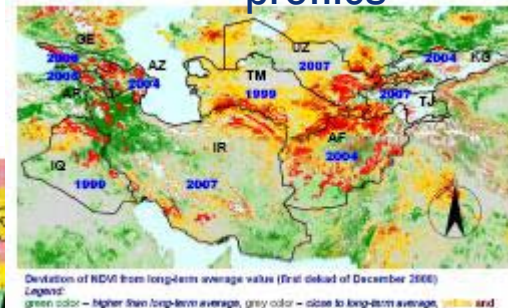


Precipitation during November-December 2008 as a limiting factor of winter wheat
Legend:
Amount of precipitation for wheat growth: o – optimal; m – sufficient; n – insufficient; upwards gray hatchings – less precipitation than normal; downwards gray hatchings – precipitation more than normal
red lines indicate areas with winter wheat

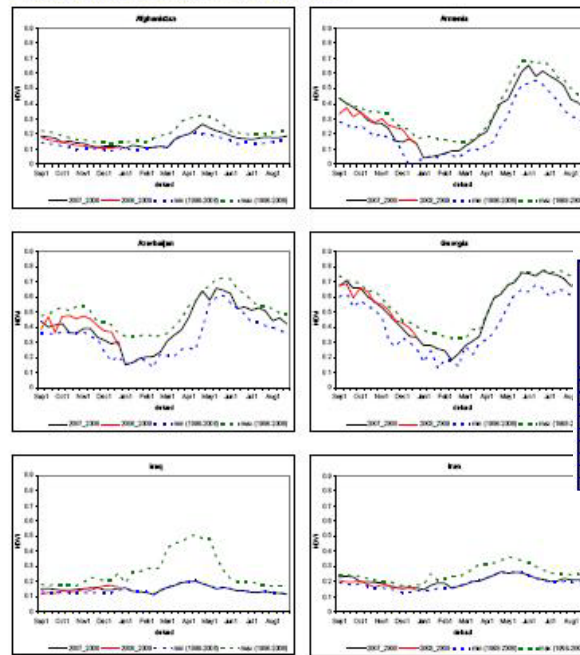


Temperature conditions during November-December 2008 as a limiting factor of winter wheat
Legend:
green color – favorable temperature conditions, and yellow color – extreme temperature; upwards gray hatchings – lower than normal temperature; downwards gray hatchings – normal temperature;
red lines indicate areas with winter wheat

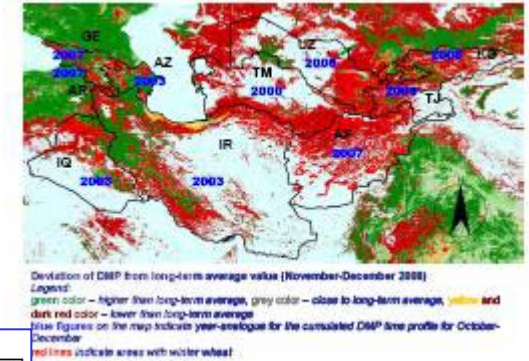
NDVI conditions & profiles



Annex 3. NDVI time series for winter wheat zones



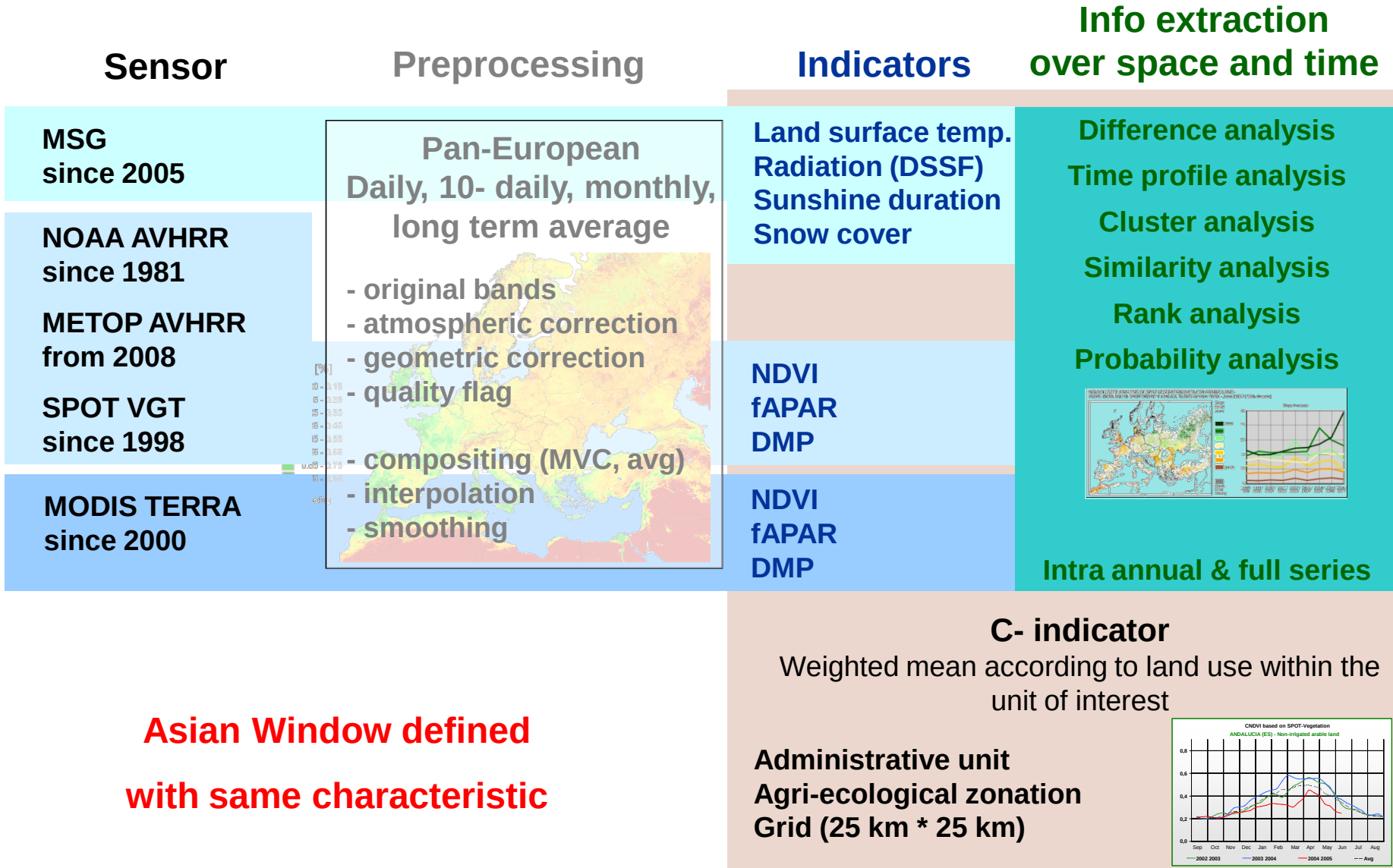
DMP



Deviation of DMP from long-term average value (November-December 2008)
Legend:
green color – higher than long-term average, grey color – close to long-term average, yellow and dark red color – lower than long-term average
Blue figures on the map indicate year-analogues for the calculated DMP time profile for October-December
red lines indicate areas with winter wheat

country code	crop growth indicator & winter wheat yield expectation (t/ha)									Winter wheat yield expectation for 2009 (t/ha)
	precipitation sum for the period from October to June (based on regression analysis, and year-analogue definition)			NDVI curve (based on regression analysis, and year-analogue definition)			DMP curve (based on regression analysis, and year-analogue definition)			
	yield	R ²	yield for year-analogue	yield	R ²	yield for year-analogue	yield	R ²	yield for year-analogue	
AF	-	-	1.6	-	-	1.3	-	-	1.9	1.3-1.8
AR	-	-	2.3	-	-	2.1	-	-	1.3	2.0-2.4
AZ	-	-	2.8	-	-	2.6	-	-	2.8	2.6-2.7
GE	-	-	1.9	-	-	2.0	-	-	1.6	1.8-2.1
IR	-	-	2.1	-	-	2.3	-	-	2.1	2.0-2.4
IQ	-	-	0.5	-	-	0.5	-	-	1.4	0.5-1.5
KG	-	-	2.3	-	-	2.4	-	-	-	2.2-2.6
TJ	-	-	1.6	-	-	1.6	-	-	-	1.4-2.0
TM	-	-	-	-	-	2.5	-	-	2.4	2.3-2.8
UZ	-	-	3.9	-	-	4.2	-	-	-	3.8-4.5

Preliminary Forecasts

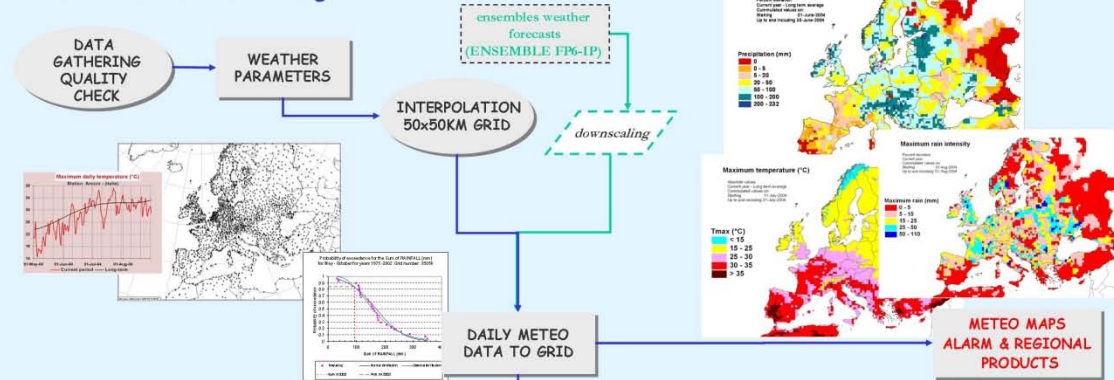


Complement station network

Enhance, fill gaps, increased density, cross-checking

Parameter: LST, radiation, snow cover

Level1: Weather Monitoring



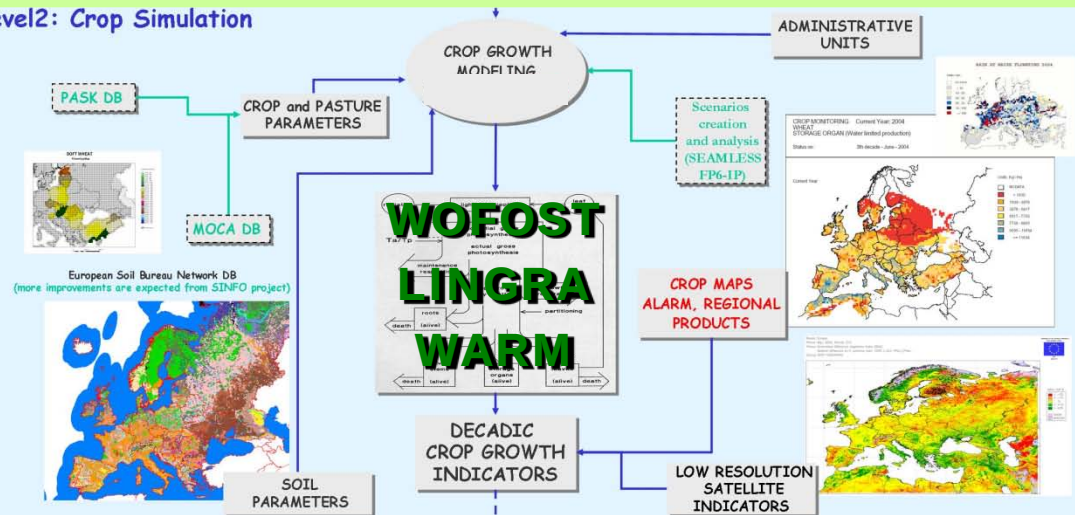
Alternative source for CGMS data as direct input for crop models

Meteo: radiation, sunshine duration, snow cover

Vegetation state: NDVI, fAPAR, DMP to derive phenology or biomass

Input/calibration/update of CGMS

Level2: Crop Simulation

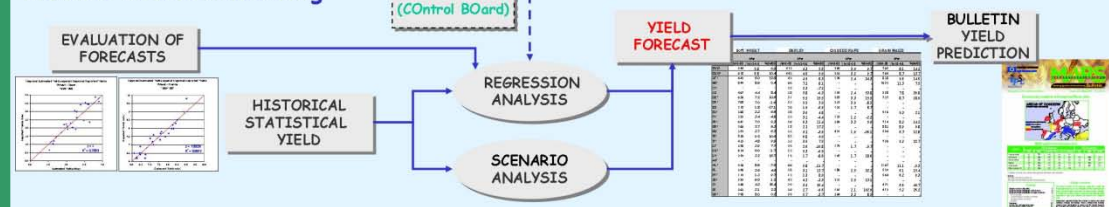


Regression indicator & scenario

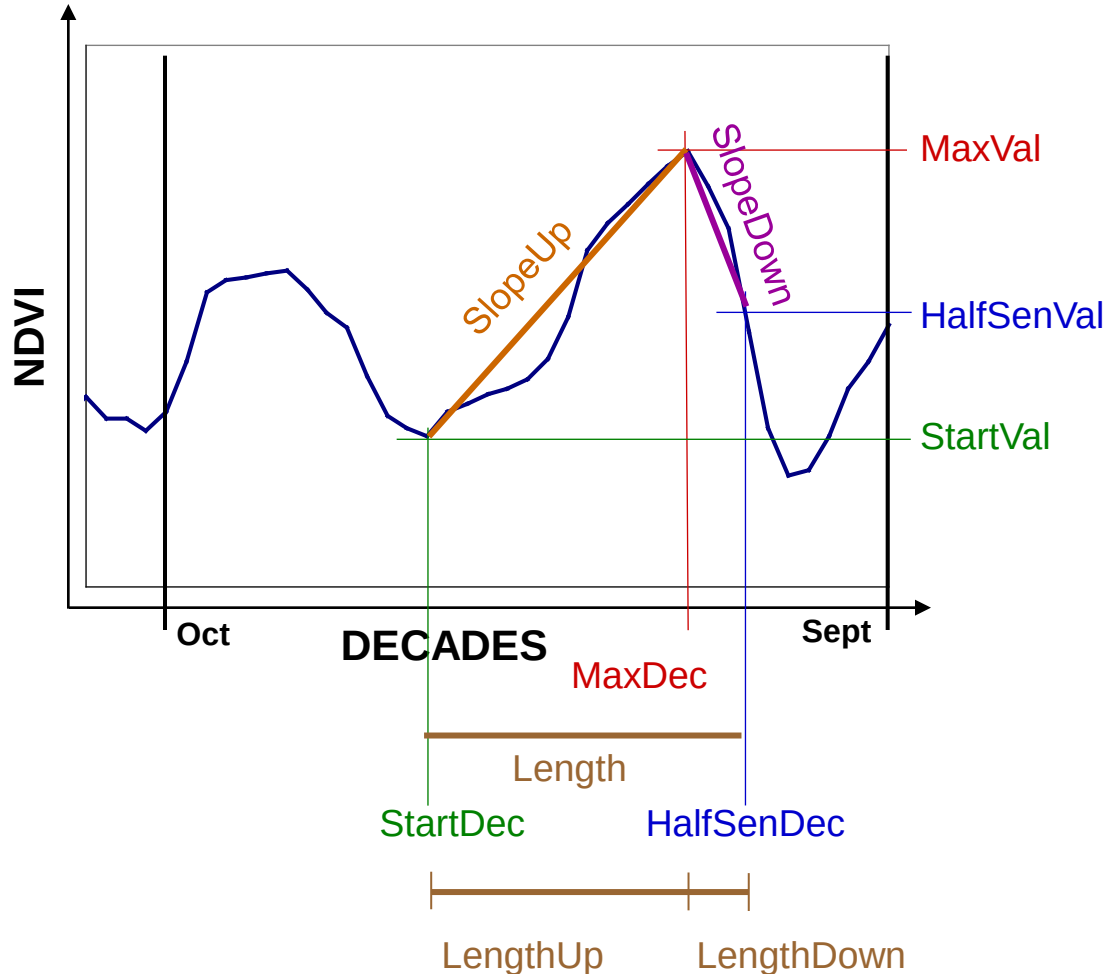
Chronos indicators derived from NDVI, fAPAR

Similarity analysis

Level3: Yield Forecasting



- Radiation most promising parameter for direct ingestion by crop development model level I
- RS vegetation state parameters very efficient in semi arid but CGMS 10 daily crop growth parameters are better predictors in non water limited situations
- **Vegetation state parameters – link between Chronos** indicators and crop phenology further to be established
 - Collection of observed phenol data is crucial (agro-phenological network)
- Good crop masks for the extraction are needed, as regional / local statistics (weighting)



Chronos phasing indicators:

StartDec

MaxDec

HalfSenDec

Chronos intensity indicators:

StartVal

MaxVal

HalfSenVal

Chronos duration indicators:

Length

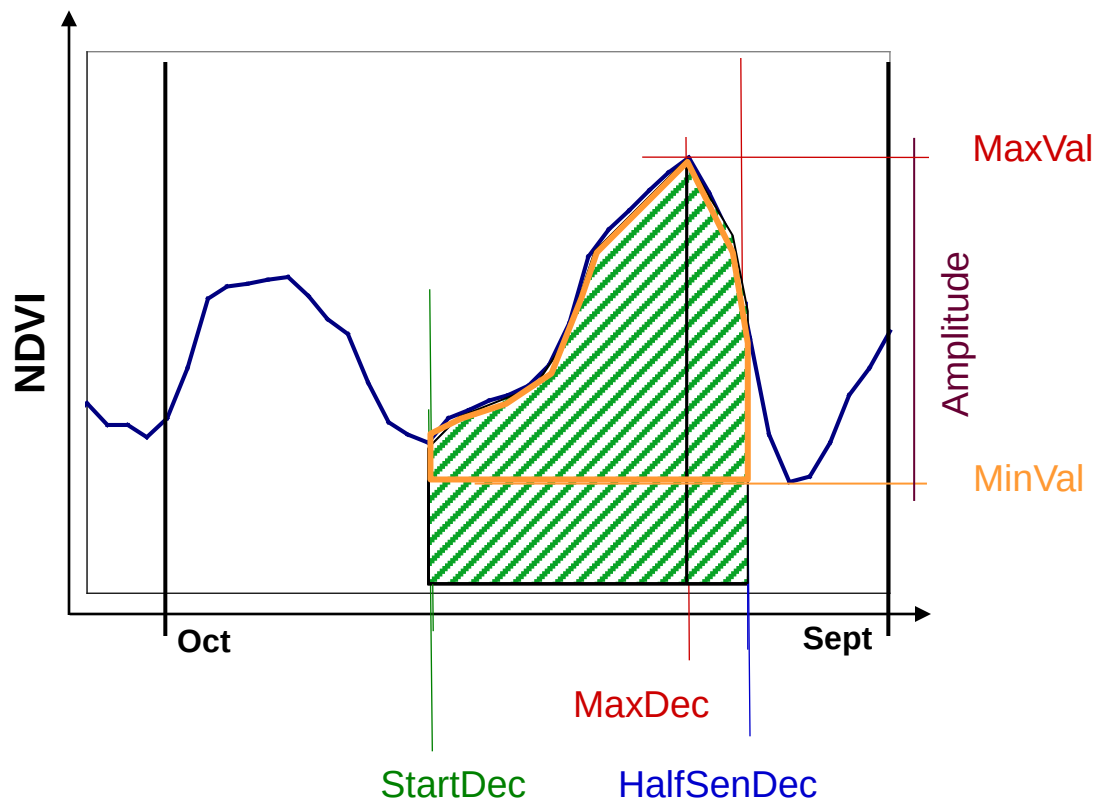
LengthUp

LengthDown

Chronos cumulative indicators I:

SlopeUp

SlopeDown



Chronos cumulative indicators II:

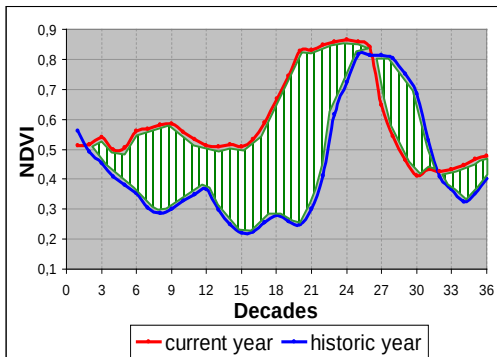
-  Cum_StartMax
-  Cum_MaxHalf
-  Cum_StartHalf
-  Cum_StartHalf_min
- Amplitude

Potential Use of Most Similar Year of the Time Series to Current Year

DISTANCE



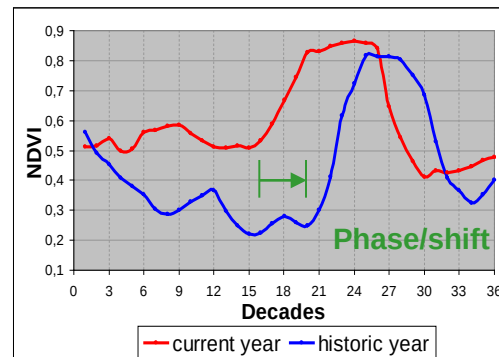
Overall similarity
dependent from
phase and intensity



CORRELATION



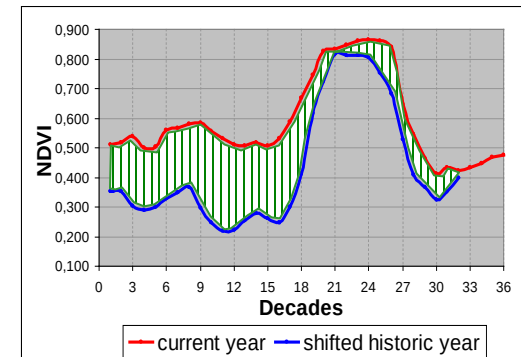
Shift in crop cycle
independent from
intensity



CORRELATION + DISTANCE



Cycle similarity
independent from
the date



$$ABSdiff_k = \sum_{i=1}^n ABS(NDVI_{current,i} - NDVI_{k,i})$$

$$simyear = MIN(ABSdiff_k)$$

k = year, i = decades

$$corr_coeff1_k = \frac{\sum_{i=1}^n (NDVI_{current,i} - \overline{NDVI}_{current}) \cdot (NDVI_{k,i} - \overline{NDVI}_k)}{\sqrt{\sum_{i=1}^n (NDVI_{current,i} - \overline{NDVI}_{current})^2 \cdot \sum_{i=1}^n (NDVI_{k,i} - \overline{NDVI}_k)^2}}$$

$$simyear = MAX(corr_coeff1_k)$$

$$ABSdiff_k = \sum_{i=1}^n ABS(NDVI_{current,i} - NDVI_{k,i})$$

$$simyear = MIN(ABSdiff_k)$$

Crop monitoring focusing on Yield

- Areas estimates provided by survey or trend analysis

Mapping information crucial for crop masks

- Extraction of cleaner low resolution indicators (agric / crop specific)
- In Europe use of Corine Land cover (1:200 000, 5 years Updating)
- Low - medium resolution classification 1-5 years updating.

Area Estimates with Remote sensing ?

Area Estimates ?

MARS Regional Inventories in EU 1988- 1995

- AFS Field Surveys (Regular grid, square segments - 500 m 1km)
- Regression estimates with 1 date (wall to wall) High Resolution images
 - Small or very small parcel in most of old Europe
 - poor cost-efficiency

New contexts and drivers:

- Decoupled policies, Development of biofuels
- Low cost wide Swath Satellites with high or Medium resolution
- Important to test new approaches in Europe and “emerging” countries

But

- Target accuracy very high: << expected inter-annual variation Pixel counting doesn't provide an unbiased statistical estimates

➤ *necessity of robust validation protocols*

Pilot activities foreseen in Central Asia

Ukraine:

AREA ESTIMATES

Region: 1- 2 oblasts 40 ~ 60,000 km² + 1Mio ha of cereals (Wheat)

Images: 2 types of tests: Multi-date classification using AWIFS and MODIS

Ground data: >1000 points by AFS or randomly collected “along the road”

Special attention to the validation protocols

On going call for proposal → Campaign 2010

YIELD FORECASTING: Collaboration agreement with the “Leonid Pogorilyy Ukrainian Scientific Research Institute”

Kazakhstan:

Collaboration Agreement being signed with NCRST

- Crop Monitoring and Yield forecast systems
- Similar pilots on Area Estimates to be defined and carried out in 2010 - 2011 (GEOLAND2 Project)

MARS data infrastructures, Statistical tools + crop development models are open and ready to share with nat. or reg. organizations

- Implement operational monitoring system
- Carry out specific development or research in similar fields (ex desertification, drought...)
- Simulate Climate change impact and adaptation strategies...

We are interested in integrating user's feed backs, calibration / validation... geo-localized ground data (phenology, yields, pests)

Contact us or participate to a CGMS workshop and training course (ISPRA 2010) !

Thanks for your attention !

Olivier Léo - Bettina Baruth