Presentation of the Project 7.ACP.RPR.532

Strengthening Remote Sensing for Early Warning, Food Security and Environmental Monitoring in the IGAD Countries

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Contents

- The IGAD countries
- Justification of the project
- Objectives
- The partners
- Beneficiaries
- Implementation
- Example of RFE generated from CPC/US GS method
- Example of RFE generated from TAMSAT method
- Examples of other products
- Conclusion

The IGAD countries

Djibouti

Eritrea

Kenya

Sudan

Uganda

Somalia

Ethiopia

Justification of the project (1)

- Need of improved Food Security systems
  - Due to repeated and prolonged droughts, there is a need for more efficient Food Security systems and Environmental Monitoring in Eastern Africa
- Need of up to date and reliable information
  - The existing source of information at the national and sub-regional levels, in Eastern Africa, are not sufficient to provide accurate, reliable and timely data to early warning and environmental information systems

Justification of the project (2)

- Need of new Remote Sensing equipment and activities
  - The sub-region needs a strengthening of the Remote Sensing & GIS equipment and activities, to provide up to date and reliable information to Food Security and Environmental Information sectors

Main objectives

- To improve the Early Warning component of the national and regional information systems for Food Security and Environmental Monitoring and to ensure their sustainability at national and sub-regional levels within the IGAD sub-region

Specific objectives

- Reinforcing RS&GIS component of EWS
  - Reception & use of satellite data (low resolution, e.g. Noaa/AVHRR, Spot4-5/Végétation, Terra/Modis…)
  - Development of local and regional data networks
- Implementing EMS
  - Setting up environmental information systems
  - Monitoring of environmental parameters
- Building national capacities
  - Tools and equipment
  - Training / workshops

The partners

- IGAD : Contracting authority
- EU : Donor
- KMD : Hosting institution
- SCOT : Technical assistance
- IGAD Member States :
  - Meteorological services (NMS)
  - EWS and Agricultural agencies
  - Environmental agencies
  - Universities

Beneficiaries

- Decision makers in IGAD countries (Early Warning and Environmental Monitoring teams)
- The poor and the food insecure groups whose livelihoods are natural-resource dependant
- Resource managers, analysts and scientists in departments and institutions charged with management of natural resources
- Donors - validation of relief requests

Implementation (1)

- EWS strengthening :
  - Assessment of needs and priorities, specification of equipment to set up
  - Setting up of ground stations for acquisition, processing, and archiving satellite data : Meteosat and NOAA/AVHRR
  - Acquisition of Spot4-5/Végétation data
  - Processing of derived products
    - Using the best processing data techniques and methodologies
    - Tools harmonization
    - Utilization of improved products (NDVI and RFE)

Implementation (2)

- EMS strengthening :
  - Assessment of environmental monitoring needs and priorities
  - Specification and implementation of environmental information systems at national and sub-regional level
  - Monitoring of environmental parameters
  - Regional database development

Implementation (3)

- Both EWS and EMS strengthening :
  – Improvement of network communication facilities
  – Reinforcing EWS and EMS units with training on products and equipment
  – Developing standard software and methodologies for use in IGAD countries

Regional Implementation

- Provide an intranet network in all the countries of the region with access to a regional hub. Advantages :
  - Backup and reference solution
  - Facility to maintain and upgrade the software and to get new satellite data
  - Easy access for member countries to a reliable data and archiving services
  - Sustainability of the solution

National Implementation

- Development of national data banks and communications facilities
- Reinforcement of EWS and EMS : upgrading existing facilities
  - Specifications
  - Consolidation
  - Replacement of old equipment
  - Adding new processing systems and archiving systems

NOAA-CPC TECHNIQUE

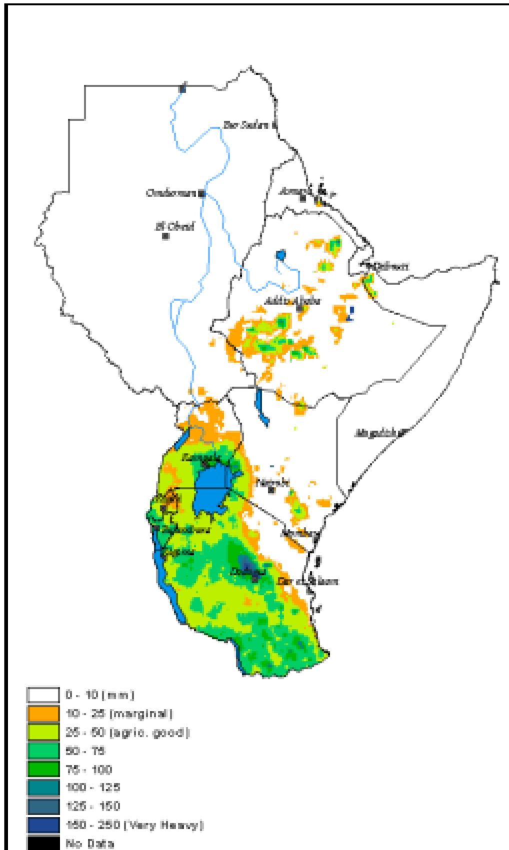
- Most of the rainfall in the tropics comes mainly from convective clouds
- Effect of topography in rain formation
  - Warmer clouds also produce rainfall
- The CTH can be computed from satellite IR images (METEOSAT)
- The total amount of rainfall is the sum of convective and stratiform rains

Inputs

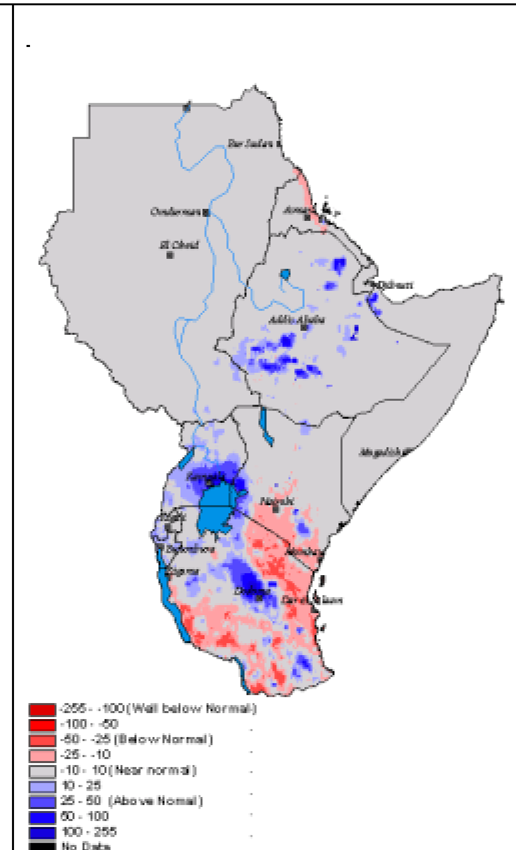
- Satellite rainfall estimates from:
  - METEOSAT-IR observations
  - AMSU microwave observations
  - SSM/I observations
- Global Telecommunications System (GTS) gauge reports of daily rainfall
- NOAA/NCEP/GDAS numerical model rainfall fields

Example of RFE generated from CPC / USGS method

RFE image Dekad 1, January 2002



Difference RFE image between Dekad 1, January 2002, and Long Term mean for the same period

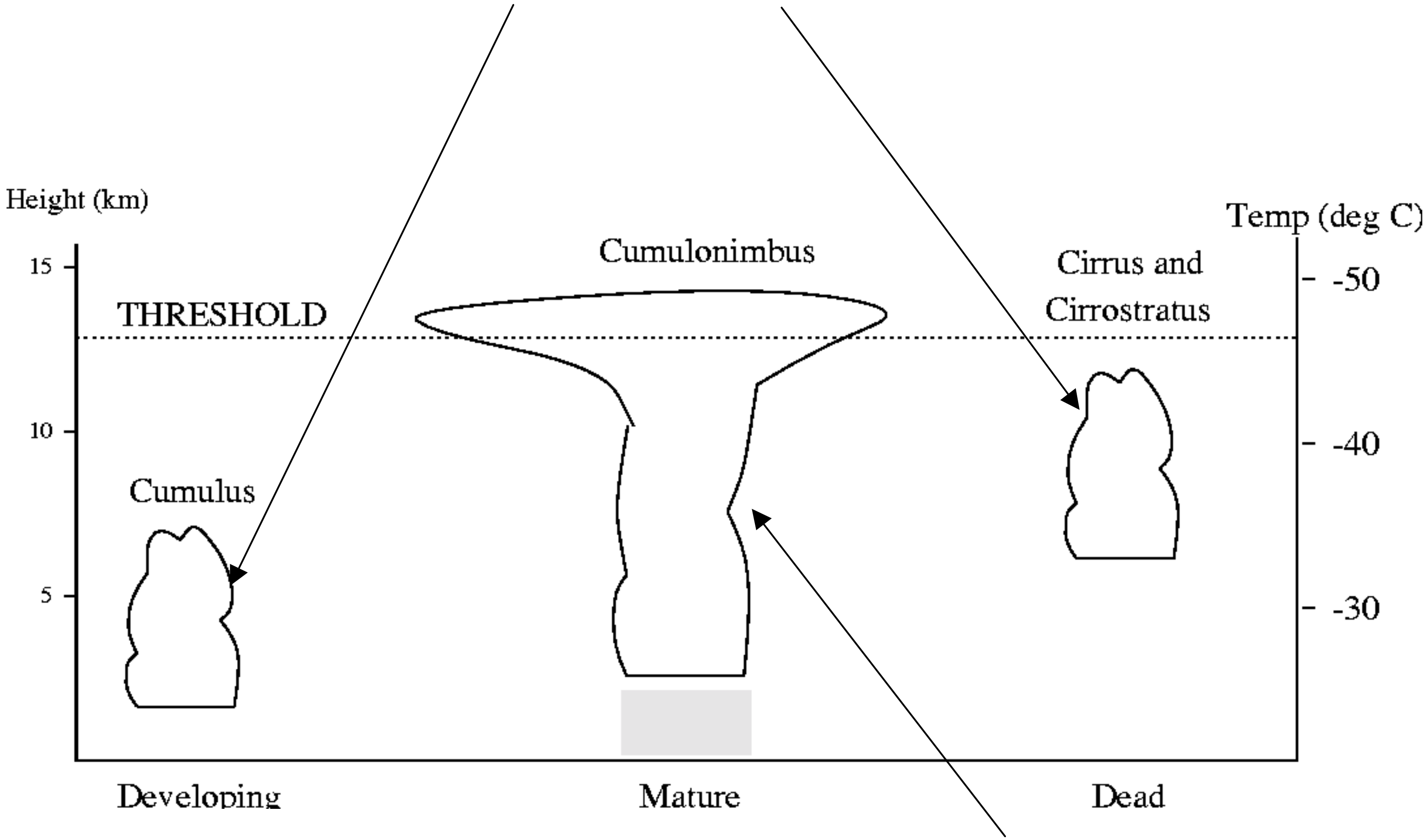


Data used from Meteosat geostationary satellite

RFE Generated by TAMSAT Technique

- Rainfall in the tropics is mainly from convective clouds
- These clouds precipitate only when their tops have reached a certain optimal temperature or height
- The cloud top heights/temps can be uniquely isolated in METEOSAT IR images

Non-raining clouds

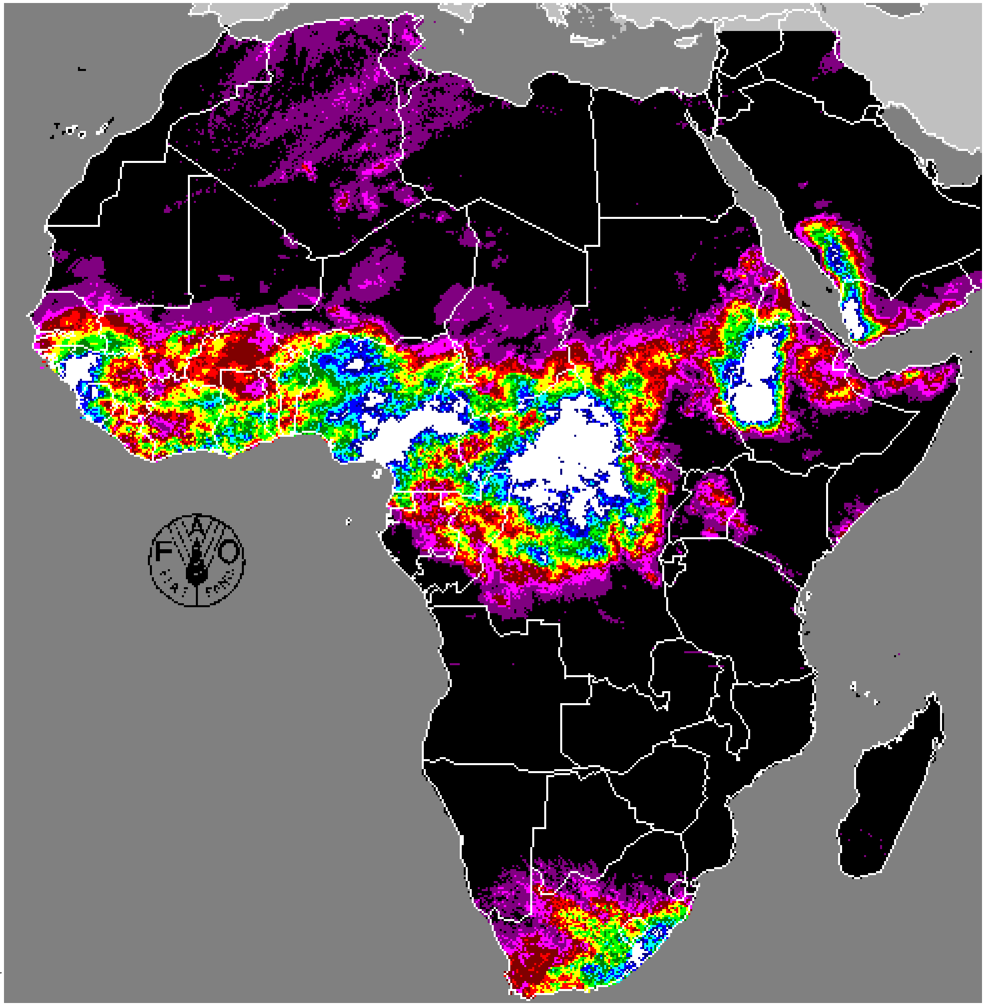


Raining cloud

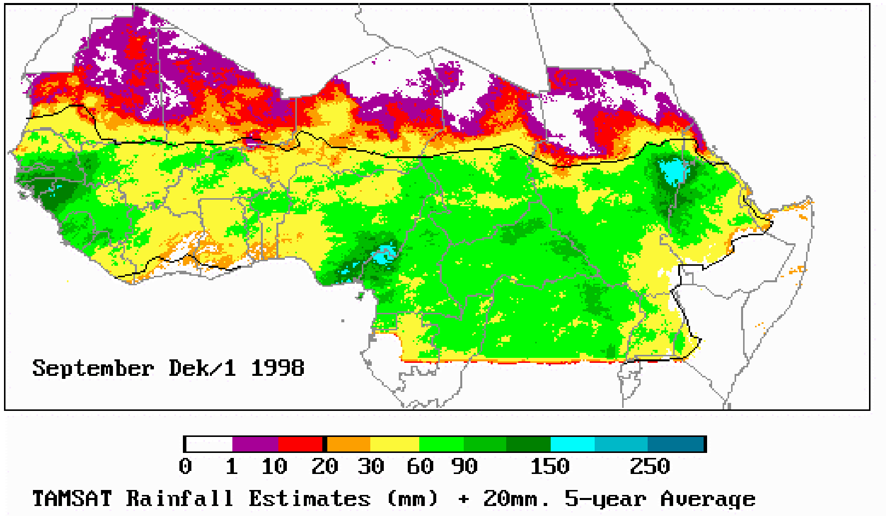
Input Data

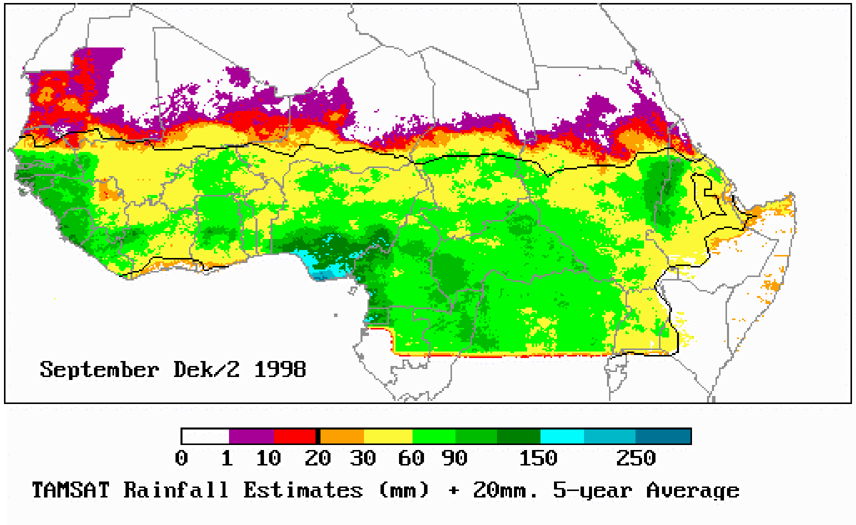
- Half-hourly or hourly thermal - infrared (T-IR) images – to create CCD images
- Rain gauge data
- Climate information for creating the calibration zones

Sample CCD Image - ARTEMIS



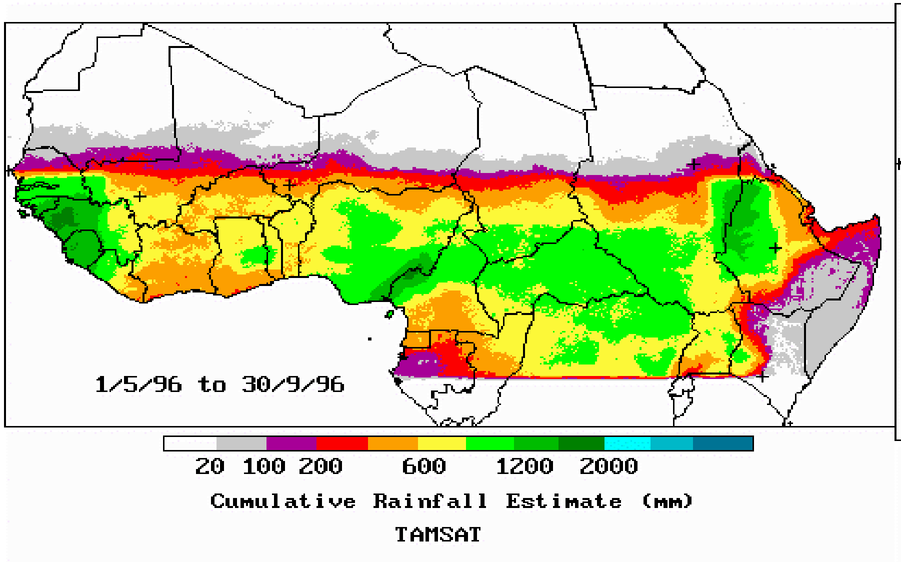
Example of RFE generated from TAMSAT method

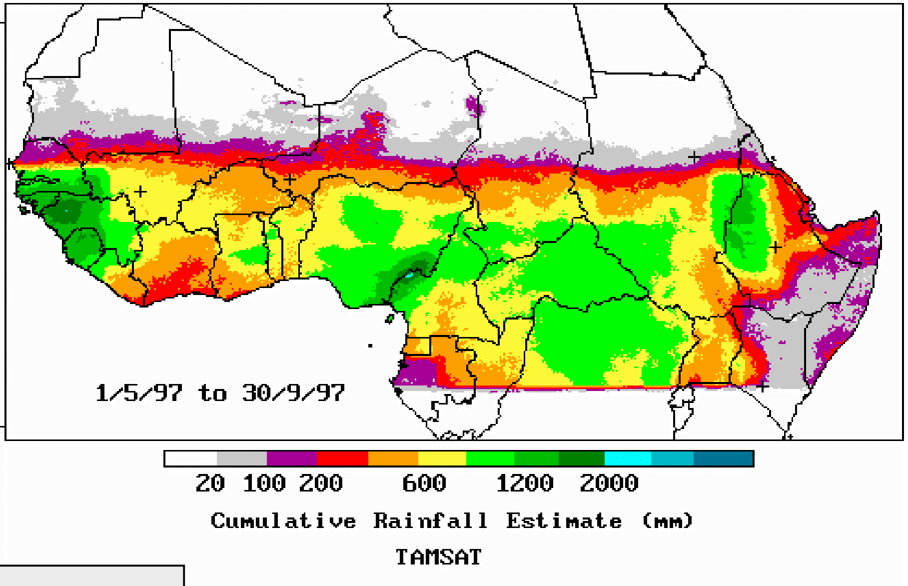




Data used from Meteosat geostationary satellite

Example of seasonal cumulative RFE for 1996 and 1997 generated from TAMSAT method





Data used from Meteosat geostationary satellite

Low Resolution Polar Instruments & Satellites, Operational and Foreseen

Past and present civilian Low & Medium Resolution optical satellite systems		
Country	**Sensor / Mission**	**Operational activity period**
USA	**AVHRR 1 / NOAA 6, 8, 10, 12**	Jun 1979 to Dec 1994
USA	**AVHRR 2 / NOAA 7, 9, 11, 14**	Jun1981 to now
Europe	ATRS / ERS 1 & 2	Aug 1991 to now
Russia	MSU-SK / RESURS 01-3	Nov 1994 to now
USA	SEAWIFS / ORBVIEW 2	Oct 1997 to now
India	WIFS / IRS 1C, P3, 1D	Jan 1996 to now
India	MOS / IRS P3	May 1996 to now
France	**VEGETATION / SPOT 4 & 5**	May 1998 to now
USA	**AVHRR 3 / NOAA 15, 16, 17**	Jun 1998 to now
Russia	MSU-SK / RESURS 01-4	Aug 1998 to now
China	MVISR / FENG-YUNG 1C	Jul 1999 to now
China/Brazil	WFI / CBERS 1	Dec 1999 to now
USA	**MODIS / TERRA & AQUA**	Feb 2000 to now
Europe	**AATRS / ENVISAT**	Mar 2002 to now
Europe	MERIS / ENVISAT	Mar 2002 to now

Future civilian Low & Medium Resolution optical satellite systems		
Country	**Sensor / Mission**	**Operational activity period**
Japan	GLI / ADEOS 2	Foreseen Sept 2002
USA	**AVHRR 3 / NOAA N**	Foreseen Jun 2003
USA	**MODIS / AURA**	Foreseen 2004
India	OCM / IRS P4	Foreseen 2003
Russia	MSU-SK / ALMAZ 1B	Foreseen 2005
USA/Europe	**AVHRR 3 / METOP 1 & 2**	Foreseen Dec 2005 & 2010
China/Brazil	WFI / CBERS 2	Launch date: not communicated

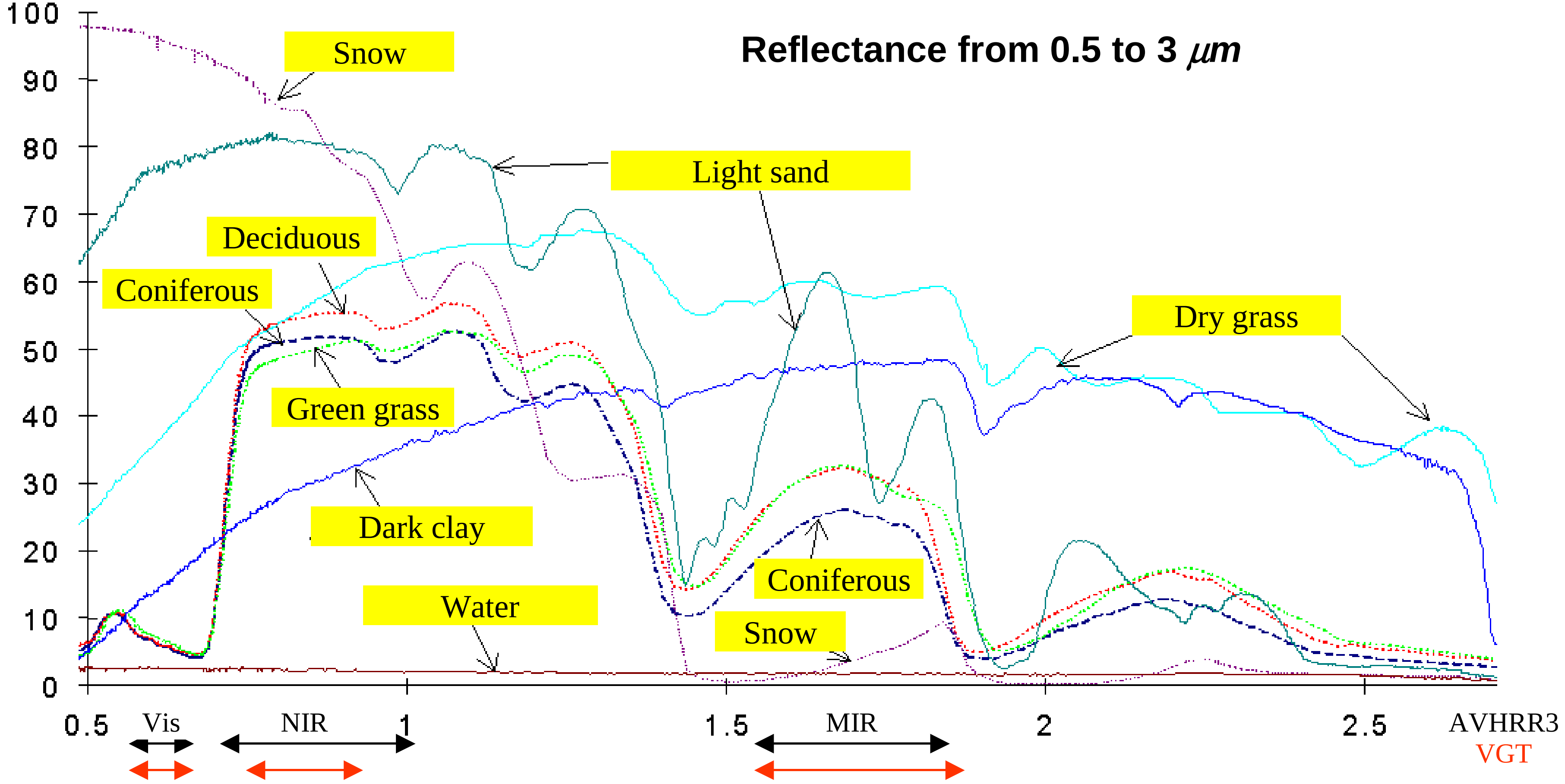
More and more LR polar satellites, more and more data

Low Resolution Polar Instruments Spectral Bands

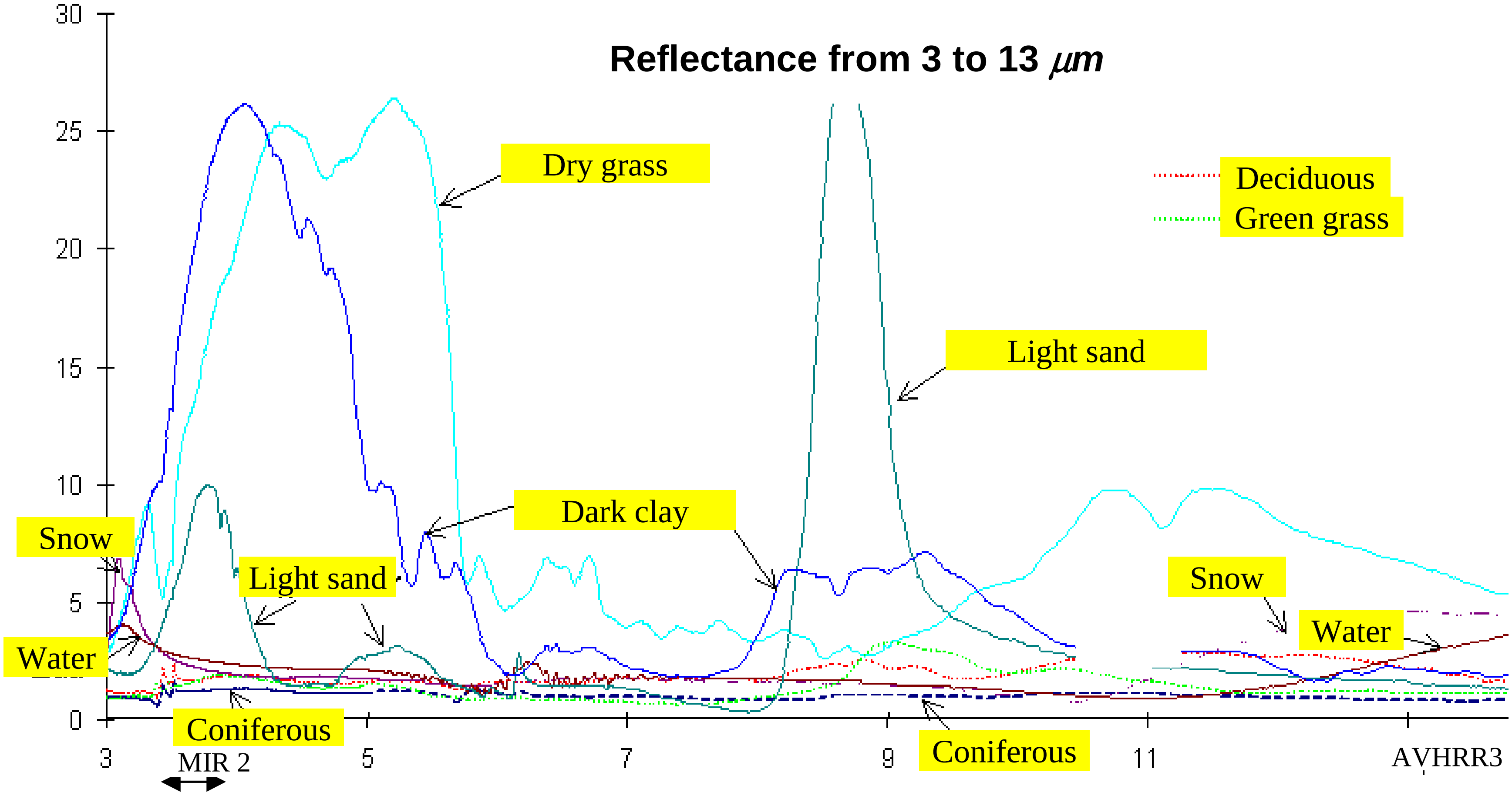
Low & Medium Resolution sensors	Spectral bands in microns and main applications						Resolution in m (nadir)	Optimal mapping scale at full resolution	Revisit capa-city in day	Swath in km
	Blue	Green	Red	NIR	SWIR	TIR				
	Ocean color, phytoplancton, cloud properties		Vegetation, land cover, cloud properties		Atmospherical properties, surface temperature					
AVHRR 1			0.58-0.68	0.72-1.1	3.44-3.93	10.5-11.3 10.5-11.3	1100	1 : 500,000 1 :10,000,000	0.5	3000
AVHRR 2			0.58-0.68	0.72-1.1	3.55-3.92	10.3-11.3 11.5-12.5	1100	1 : 500,000 1 :10,000,000	0.5	3000
AVHRR 3			0.58-0.68	0.72-1.1	1.58-1.64 3.65-3.93	10.3-11.3 11.5-12.5	1100	1 : 500,000 1 :10,000,000	0.5	3000
ATSR					1.58-1.64 3.55-3.93	10.4-11.3 11.5-12.5	1000	1 : 500,000 1 :10,000,000	16-35	500
SEAWIFS	0.40-0.42 0.43-0.45	0.48-0.50 0.50-0.52 0.54-0.56	0.66-0.68 0.74-0.78	0.84-0.88			1000	1 : 500,000 1 :10,000,000	1-2	1500- 2800
WIFS			0.62-0.68	0.77-0.86			188	1 : 200,000 1 : 500,000	5-24	774
VEGETATION	0.43-0.47		0.61-0.68	0.79-0.89	1.58-1.75		1000	1 : 500,000 1 :10,000,000	1	2200
WFI			0.63-0.69	0.76-0.90			260	1 : 200,000 1 : 500,000	3-5	900
MSU-SK R01-3 ***MSU-SK R01-4***		0.54-0.60	0.60-0.72 0.72-0.82	0.81-1.0		10.3-11.7	185 (IRT : 650) 170 (IRT : 600)	1 : 200,000 1 : 500,000	2-4	600 710
MVISR	0.43-0.48	0.48-0.53 0.53-0.58	0.58-0.68	0.84-0.89 0.90-0.96	1.58-1.64 3.55-3.93	10.3-11.3 11.5-12.5	1080	1 : 500,000 1 :10,000,000	…?	2860
MODIS	B8: 0.40-0.42 B9: 0.43-0.44 B3: 0.45-0.47	B10: 0.48-0.49 B11: 0.52-0.53 B12: 0.54-0.55 B4: 0.54-0.56	B1: 0.62-0.67 B13: 0.66-0.67 B14: 0.67-0.68 B15: 0.74-0.75	B2: 0.84-0.87 B16: 0.86-0.87 B17: 0.89-0.92 B18: 0.93-0.94 B19: 0.91-0.96	B5 to B7 & B20 to B26: from 1.23 to 4.54	B27 to B36: from 6.53 to 14.38	250 (B1 to 2) 500 (B 3 to 7) 1000 (B8 to 36)	1 : 250,000 1 : 10,000,000	2	2330
MERIS *reprogrammable in flight*	B1 : 0.41 B2 : 0.44 (bandw. = 0.01)	B3 : 0.49 B4 : 051 B5 : 0.56	B6 : 0.62, B7 : 0.66 B8 : 0.68, B9 : 0.70 B10 : 0.75, B11 : 0.76 B12 : 0.77	B13 : 0.86 B14 : 0.89 B15 : 0.90			300-1200	1 : 250,000 1 : 10,000,000	3	300 575 1150
AATSR			0.55 0.67	0.87	1.6 3.7	10.8 12	1000	1 : 500,000 1 :10,000,000	3	512
GLI	B1: 0.38, B2: 0.40 B3: 0.41, B4: 0.44 B5: 0.46, B20: 0.46	B6: 0.49, B7: 0.52 B8: 0.54, B9: 0.56 B21: 0.54	B10: 0.62, B11: 0.66 B12: 0.68, B13: 0.67 B14&15: 0.71, B16: 0.74 B17: 0.76, B22: 0.66	B18&19: 0.86 B23: 0.82	B24: 1.0, B25: 1.11 B26: 1.24, B27: 1.38 B28: 1.64, B29: 2.21	B30: 3.71, B31: 6.70 B32: 7.30, B33: 7.50 B34:8.60, B35: 10.80 B36:12.00	250 (B 20 to 23 & 28 to 29) 1000 (B 1 to 19, 24 to 27, & 30 to 36)	1 : 250,000 1 : 10,000,000	4	1600
OCM	[0.40…			…0.88]			360	1 : 250,000	…?	1420

LR polar data become more and more diverse, complex and adapted to specific purposes

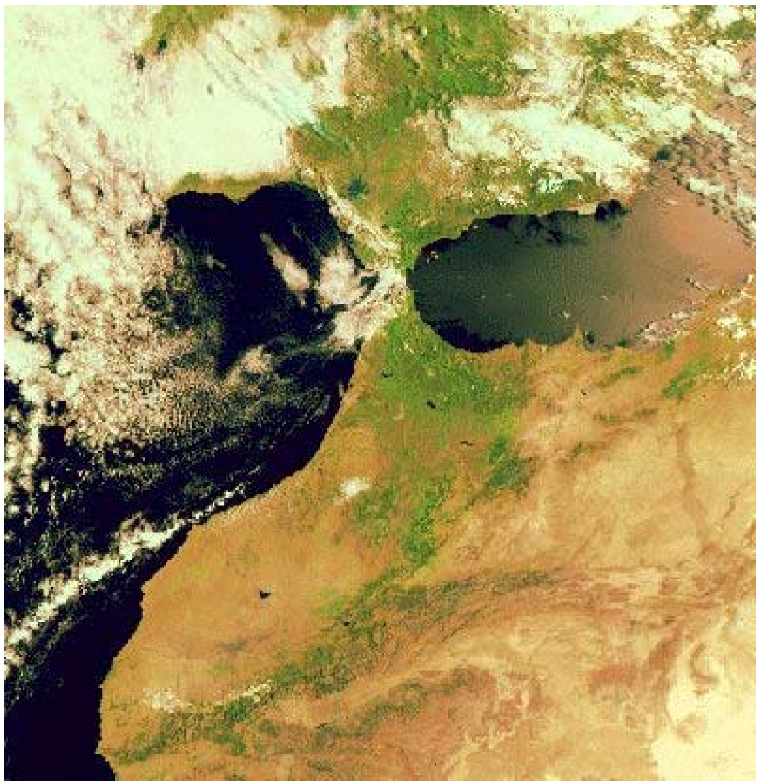
Main spectral signatures (1)



Main spectral signatures (2)



Noaa/AVHRR 2-3 sensor main applications : meteorology and vegetation monitoring



NOAA 15 : Northern Africa (Morocco and Spain)

Platforms : satellites of the Noaa series
Fisrt lauch of operational satellite : Noaa-6 in 1979

Heliosynchronous orbit (altitude 833-870 Km)

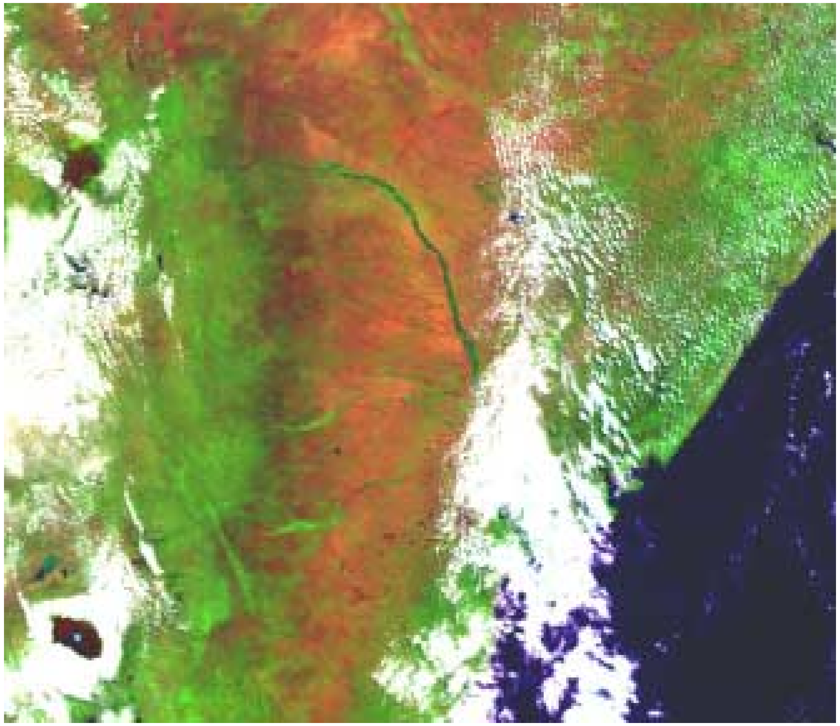
Wide Field : width (Swath) = 2 700 / 2 894 Km

Low Resolution = 1.1 Km (at nadir)
not constant throughout the field

5/6 Optical Spectral Bands
- *Red : 0.58-0.68 µm*
- *Near Infra Red : 0.72-1.05 µm*
- *Short Wave Infra Red :*
  - *- AVHRR2 : 3.55-3.92 µm*
  - *- AVHRR3 : 3.65-3.93 & 1.58-1.64 µm*
- *Thermal : 10.3-11.3 & 11.5-12.5 µm*

Revisit capability : 6 images per day thanks to 3 satellites on perpendicular orbits

Spot 4-5 / Végétation sensor main applications : vegetation and ocean monitoring



Spot4/Vegetation : Eastern Kenya

Platforms : satellites of the Spot4 serie
Fisrt lauch of operational satellite : Spot4 in March 98

Heliosynchronous orbit (altitude 830 Km)

Wide Field : width (Swath) = 2 250 Km

Low Resolution = 1.1 Km (at nadir)
constant throughout the field

4 Optical Spectral Bands
Blue : 0.43-0.47 µm
Red : 0.61-0.68 µm
Near Infra Red : 0.79-0.89 µm
Short Wave Infra Red : 1.58-1.75 µm

Revisit capability : 2*2 images per day

Terra-Aqua / Modis sensor main applications : vegetation, atmosphere and ocean monitoring

Terra/Modis : Tanzania & Lake Victoria (bands 1, 4, 3)

Platforms : satellites of the EOS serie
Fisrt lauch of operational satellite : EOS AM1, December 99

Heliosynchronous orbit (altitude 705 Km)

Wide Field : width (Swath) = 2 330 Km

Medium & Low Resolution = 250m, 500m, 1000 m (at nadir) not constant throughout the field

36 Optical Spectral Bands

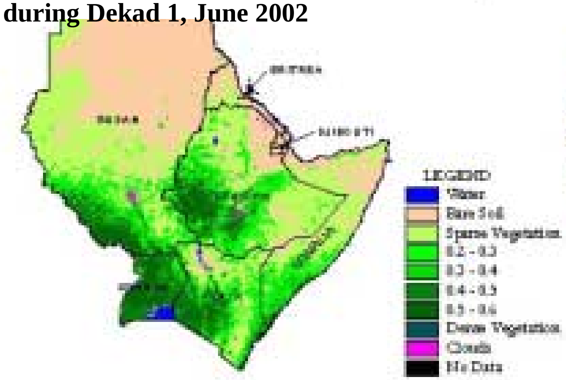
Blue : 3 bands from to 0.43-0.47 µm
Green : 4 bands 0.48 to 0.56 µm
Red : 4 bands 0.62 to 0.75 µm
Near Infra Red : 5 bands 0.84 to 1.96 µm
SW Infra Red : 10 bands 1.23 to 4.54 µm
Thermal Infra Red : 10 bands 6.53 to 14.38 µm

Revisit capability : according to the band

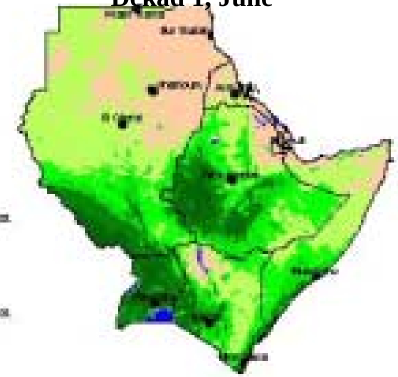
Problems with the data web server : not yet fully operationnal

Example of NDVI products from NOAA/AVHRR GAC database

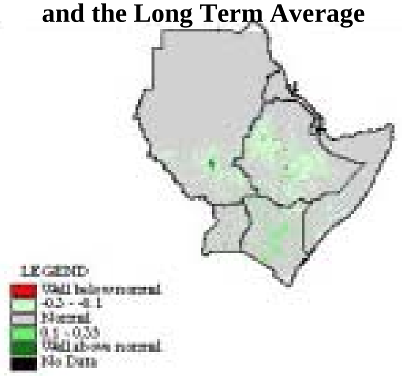
Vegetation Conditions in IGAD Region during Dekad 1, June 2002



Lond Term Average Vegetation Conditions for Dekad 1, June



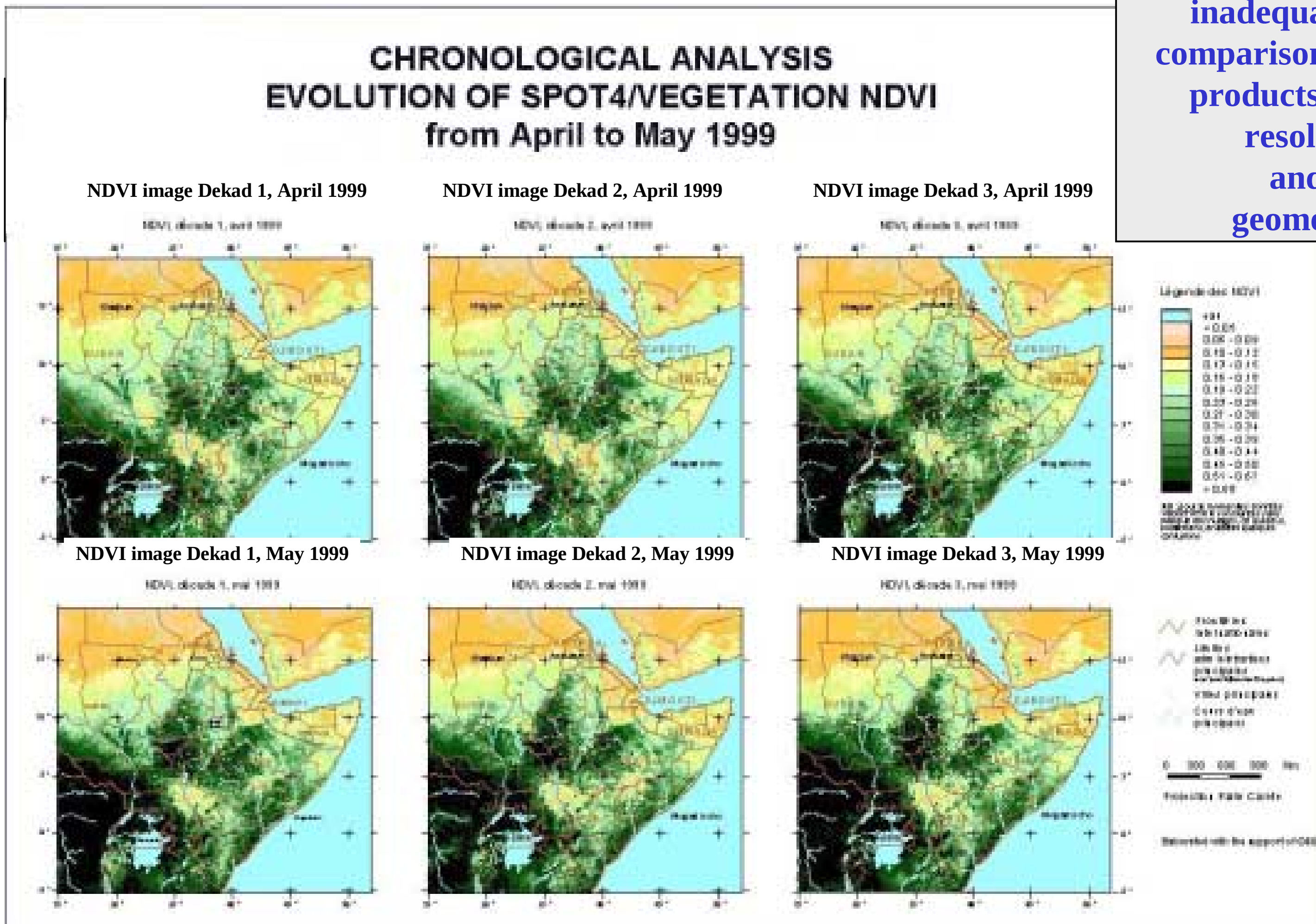
Difference betwwen Dekad 1, June 2002 conditions and the Long Term Average



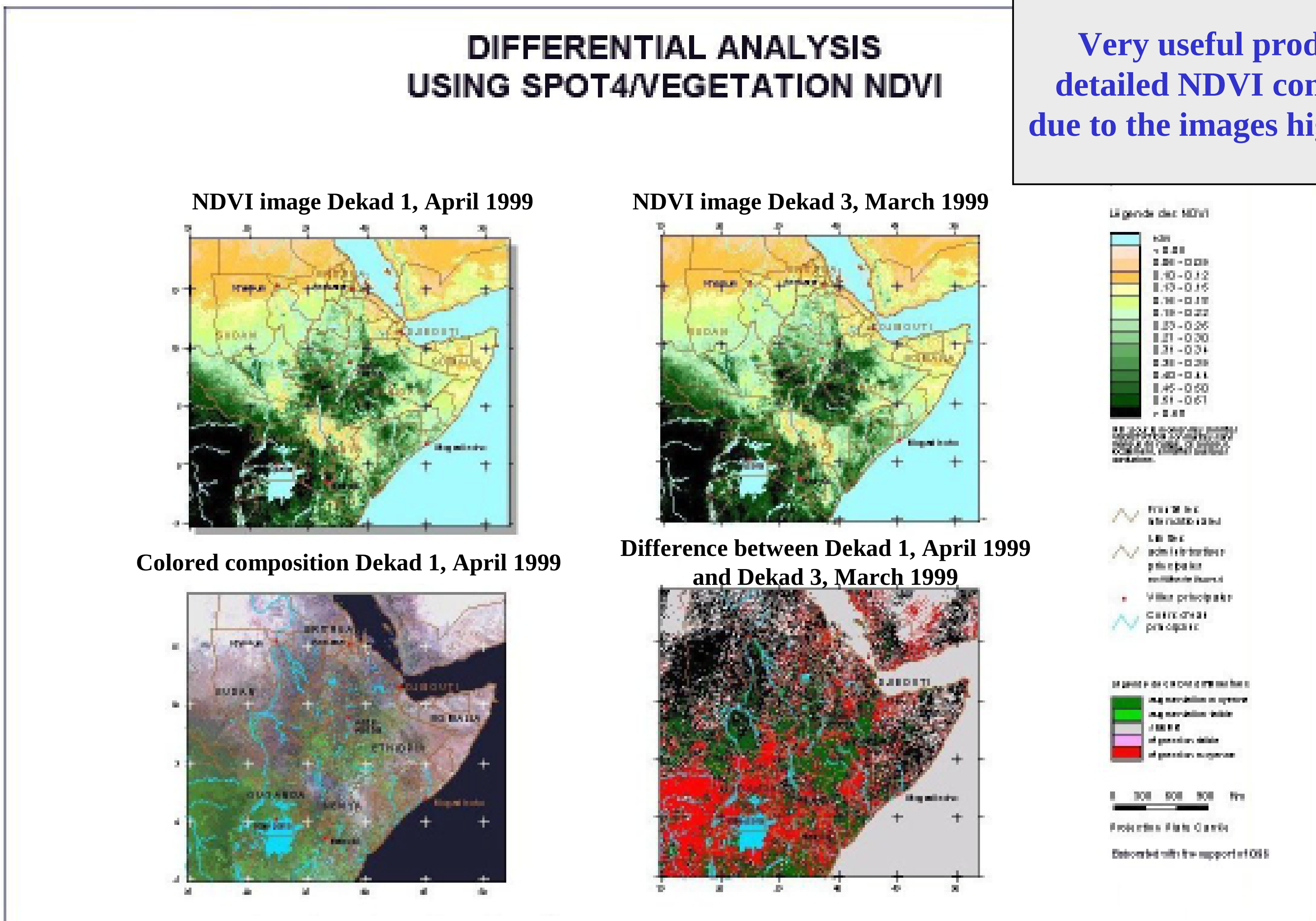
Long time archive (since 1979) adequate for long time comparisons but imprecise product due to coarse resolution (+/- 4 km) and poor geometric accuracy

Example of NDVI products from Spot4-5/Végétation (1)

Short time archive (since 1998) inadequate for long time comparisons but very precise products due to constant resolution (1 km) and very high geometric accuracy

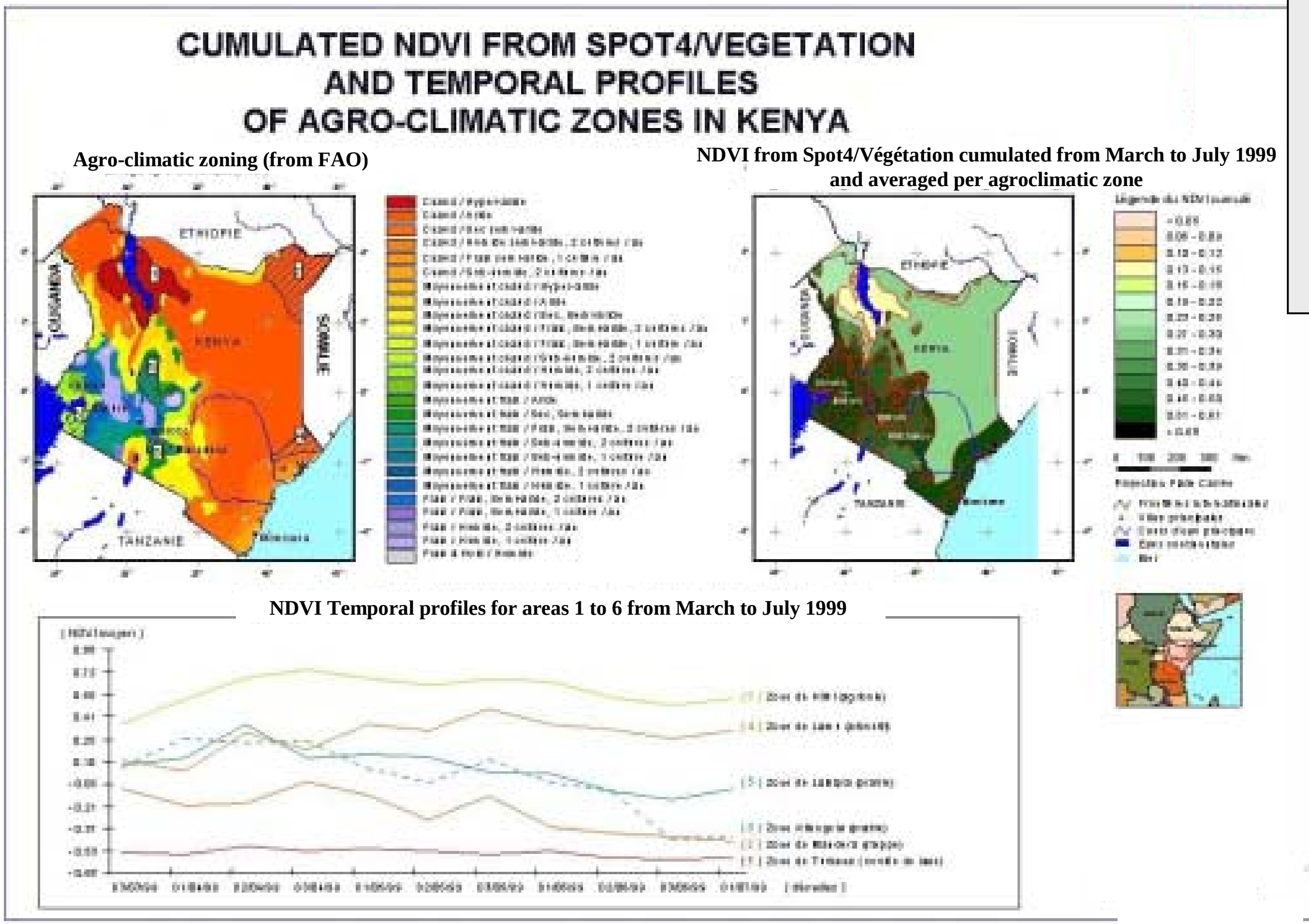


Example of NDVI products from Spot4-5 / Végétation (2)



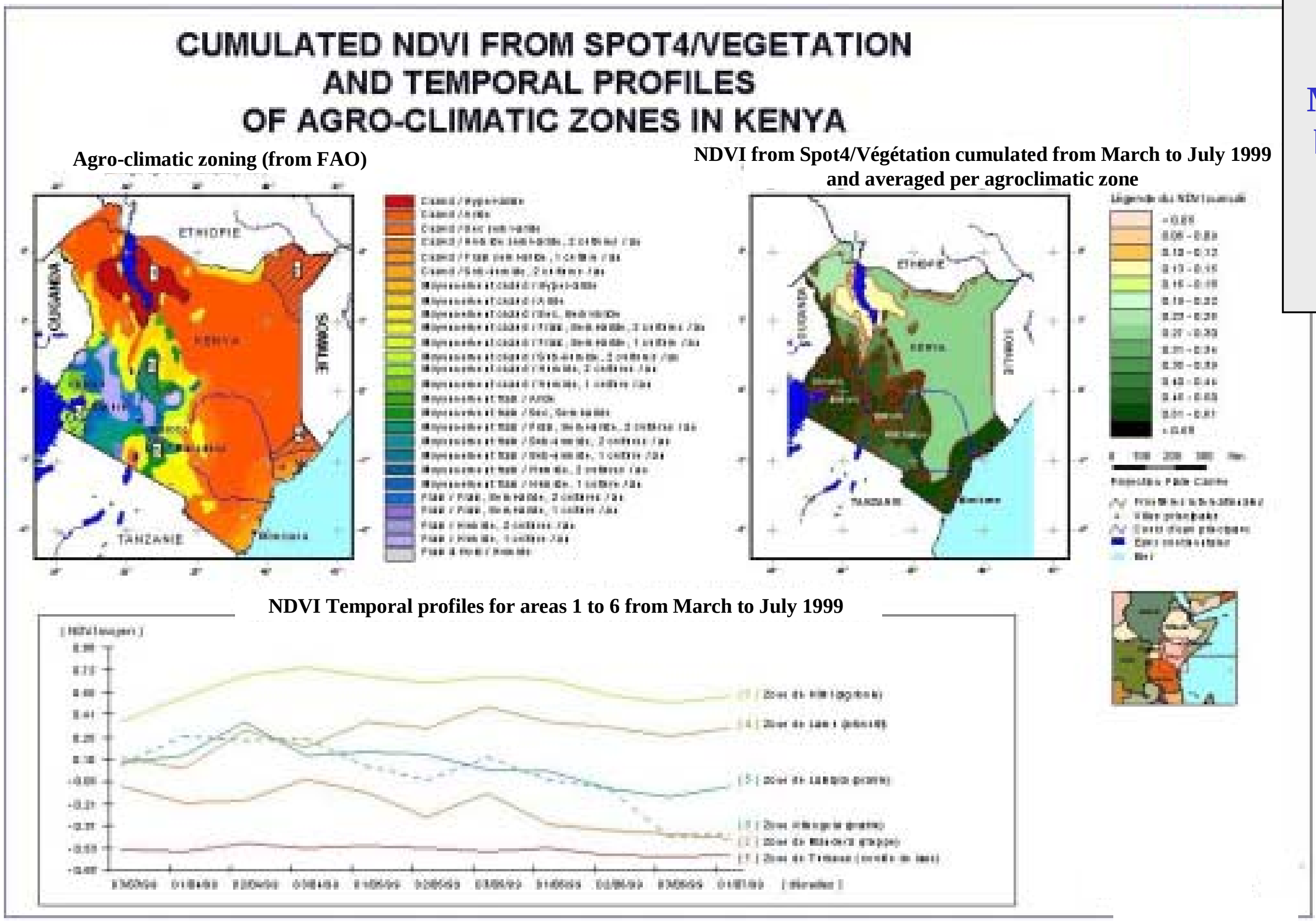
Very useful products for detailed NDVI comparisons due to the images high precision

Example of cumulated and averaged NDVI products from Spot4-5/Végétation (3)



Very useful products for Food Security and Environment Monitoring analysis but need a reliable agro-ecosystemic or land use zoning and GIS database

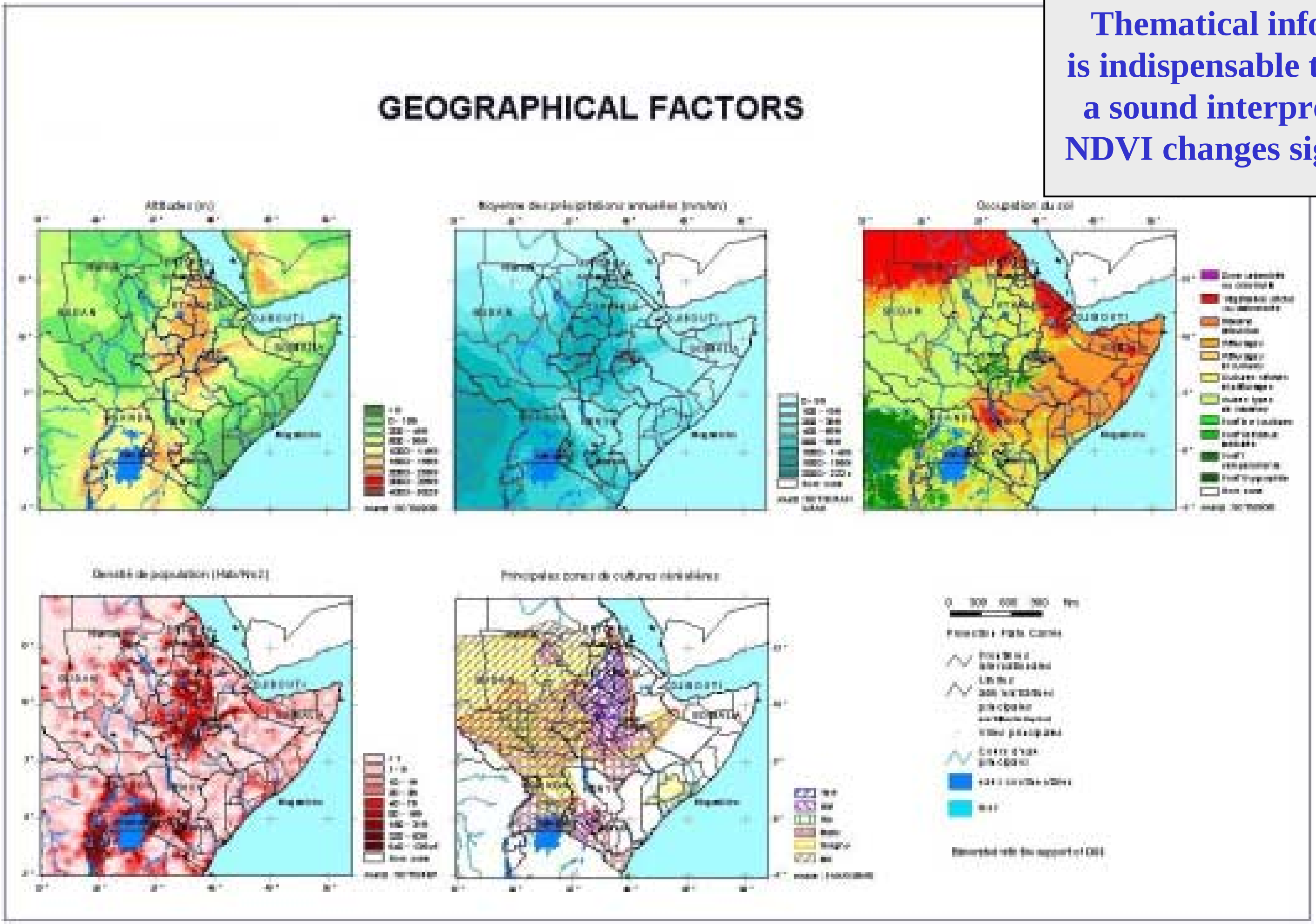
Example of cumulated and averaged NDVI products from Spot4-5/Végétation (3)



Very useful products for Food Security and Environment Monitoring analysis but need a reliable agro-ecosystemic or land use zoning and GIS database

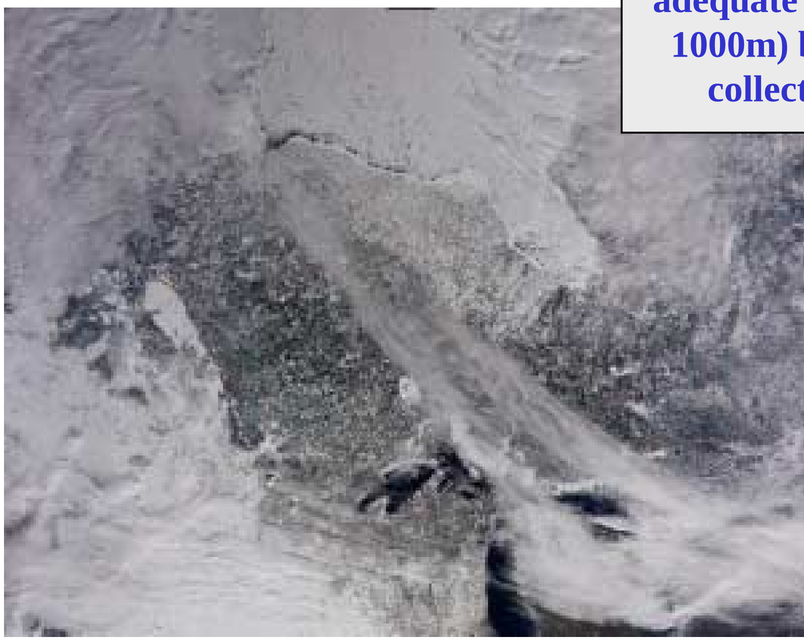
Example of ancillary thematical data for NDVI products interpretation

Thematical information is indispensable to provide a sound interpretation of NDVI changes signification

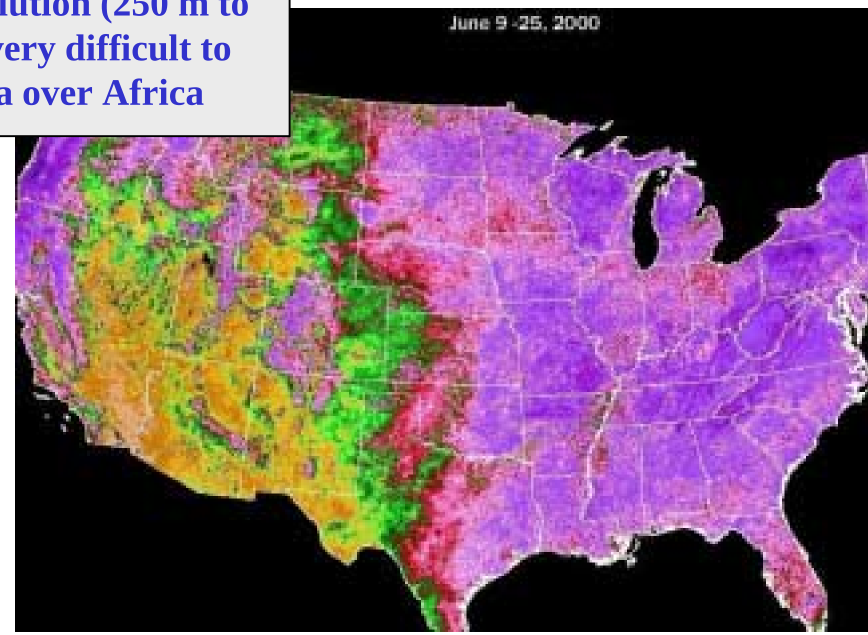


Example of 250m images and composited NDVI from Terra/Modis

Very interesting products due to adequate resolution (250 m to 1000m) but very difficult to collect data over Africa



Direct broadcast 250 m MODIS image over GSFC (Greenbelt, MD), March, 1, 2001 bands 1, 4, 3



NDVI 16 days composited 250 m MODIS image June 9-25, 2000

And now, a brief conclusion :

- Remote Sensing and GIS techniques are very useful to ensure Food Security if :
  - the right equipment is installed and operational
  - the right products are elaborated using the RS & GIS software
  - sound methods are available for vegetation, environment and social monitoring
  - the EW and EM staffs are correctly trained
  - sound pilot projects have been carried out to link theoretical and practical aspects