

Main optical sensors for the observation of land surface

	NOAA AVHRR	SPOT VEGETATION	MERIS	MODIS	LANDSAT MR SID	ASTER	SPOT	IKONOS
Swath Coverage	2400 km	1600 km	1200 km	1200 km	185 km	60 km	60 km	11 km
Résolution spatiale	1km 4 km 16 km	1 km	300 m 1.2 km	250 m 500 m 1 km	30 m 15 m	15 m (Vis) 30 m (SWIR) 90 m (IRT)	10 m 5 m 2.5 m	5 m 1 m
Temporal revisit	week	2 days	3 days	3 days	16 jours	8 min/orbite	25 jours	
Bands	5 R-IR-IRT	4 VIS-PIR	15 VIS-PIR	36 VIS-IR-IRT	7 + Pan VIS-IR-IRT	14 VIS-IR-IRT	4+Pan VIS+IR	
Cost	~ 0	~ 0			600 \$	~ 0	1000 € 100 €	3000 \$

Main optical sensors for the observation of land surface

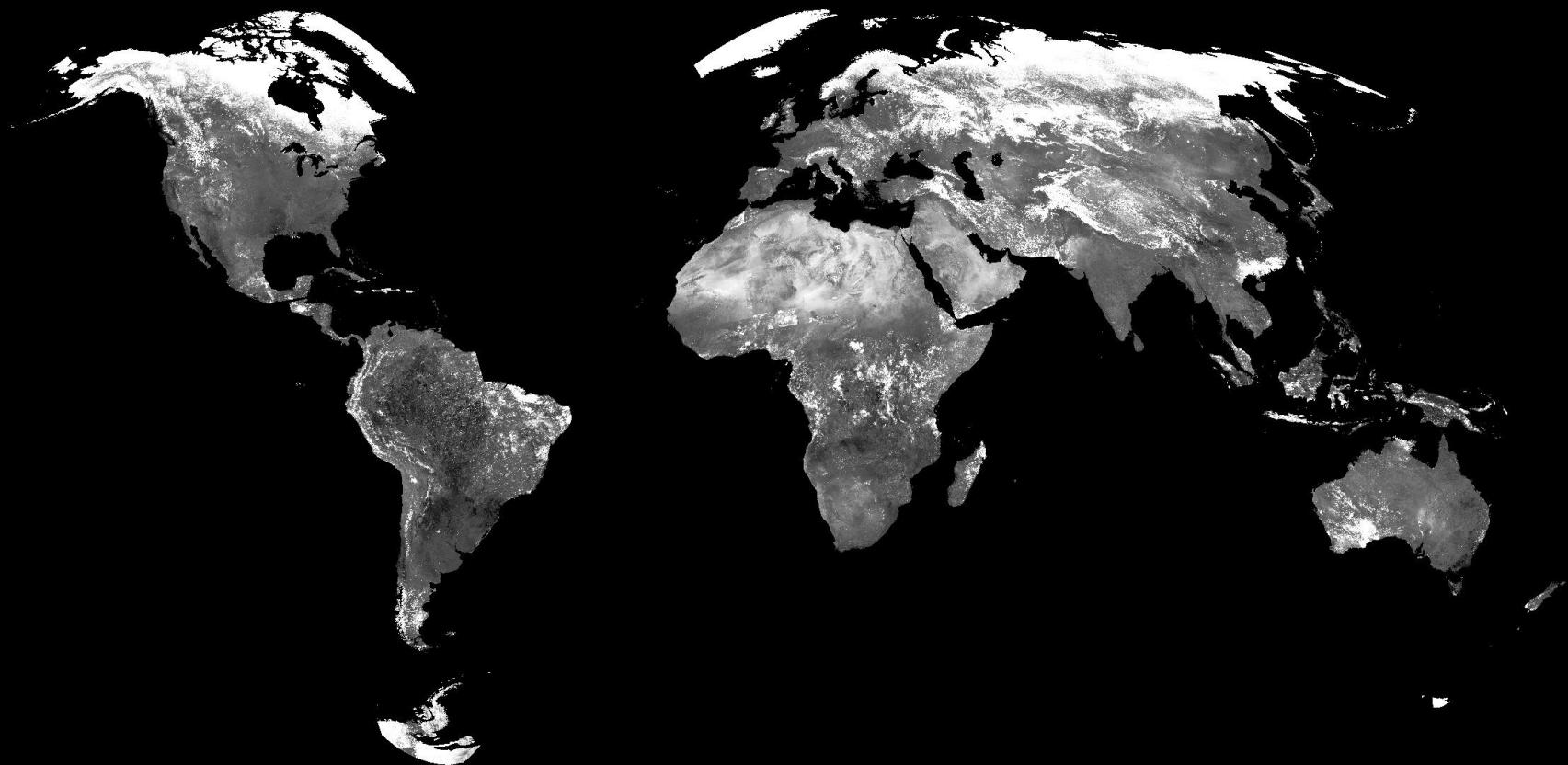
	SPOT	IKONOS	...	PLEIADES		SENTINEL2	
				1A	1B	2A	2B
Période mission	Fév. 1986 -	Sept. 99		Déc. 2011-	Déc. 2012	Juin 2015	2016
Swath coverage	60 km	11 km		20 km		300 km	
Résolution spatiale	10 m 5 m 2.5 m	5 m 1 m		2m 0.5 m		60 m 20 m 10 m	
Répétitivité	25 jours					10 days	
Bandes	4+Pan VIS+IR			4 + Pan VIS + PIR		13 bands VIS + PIR	
Coût	1000 € 100 €	3000 \$		Même ordre		GRATUIT	

Introduction

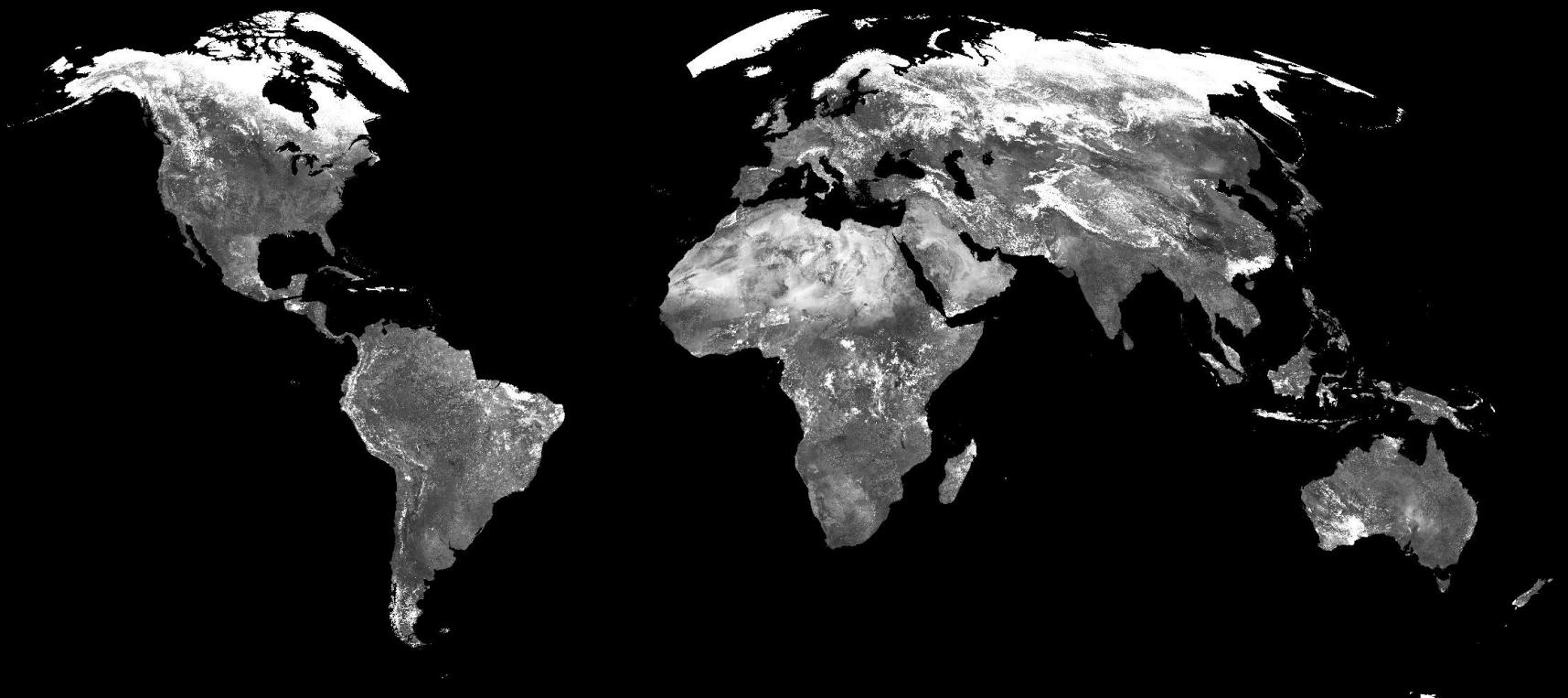
Optical sensors for forestry

<i>Name</i>	<i>Acquisition period</i>	<i>Acquisition type</i>	<i>Bandes</i>	<i>Spatial resolution (m)</i>	<i>Revisit time (days)</i>	<i>Scene cover or width (km)</i>	<i>Average Cost km² (€)</i>
Landsat	1972 - today	Permanent	Near 8	30	16	185x185km	0
Aster	2000 – today	Permanent ?	15	15 - 90	16	60x60km	Low cost?
Spot	1986 - today	Order	3 to 4	2.5 to 20m	26	60x60km	0.2 to 1.5
Spot 6/7	Sept 2012 - today	Order	4	1.5m to 6m	1	NA	4 to 10
Pleiade	2012 - today	Order	4	0.7 to 2.8	1	100x100 max	10 to 20
RapidEye	2008 - today	Order	5	6.5	5?	77km	1?
QuickBird	2001 - today	Order	4	0.6 to 2.4	1 to 3	15x15km	16 to 40
CBERS	1999 – today ?	Permanent	5?	20	14	120km	0?
AVNIR2	2006 to 2011	Permanent	4	10	15?	70km	
Sentinel 2	2015	Permanent	13	10 to 60m	5	290km	0

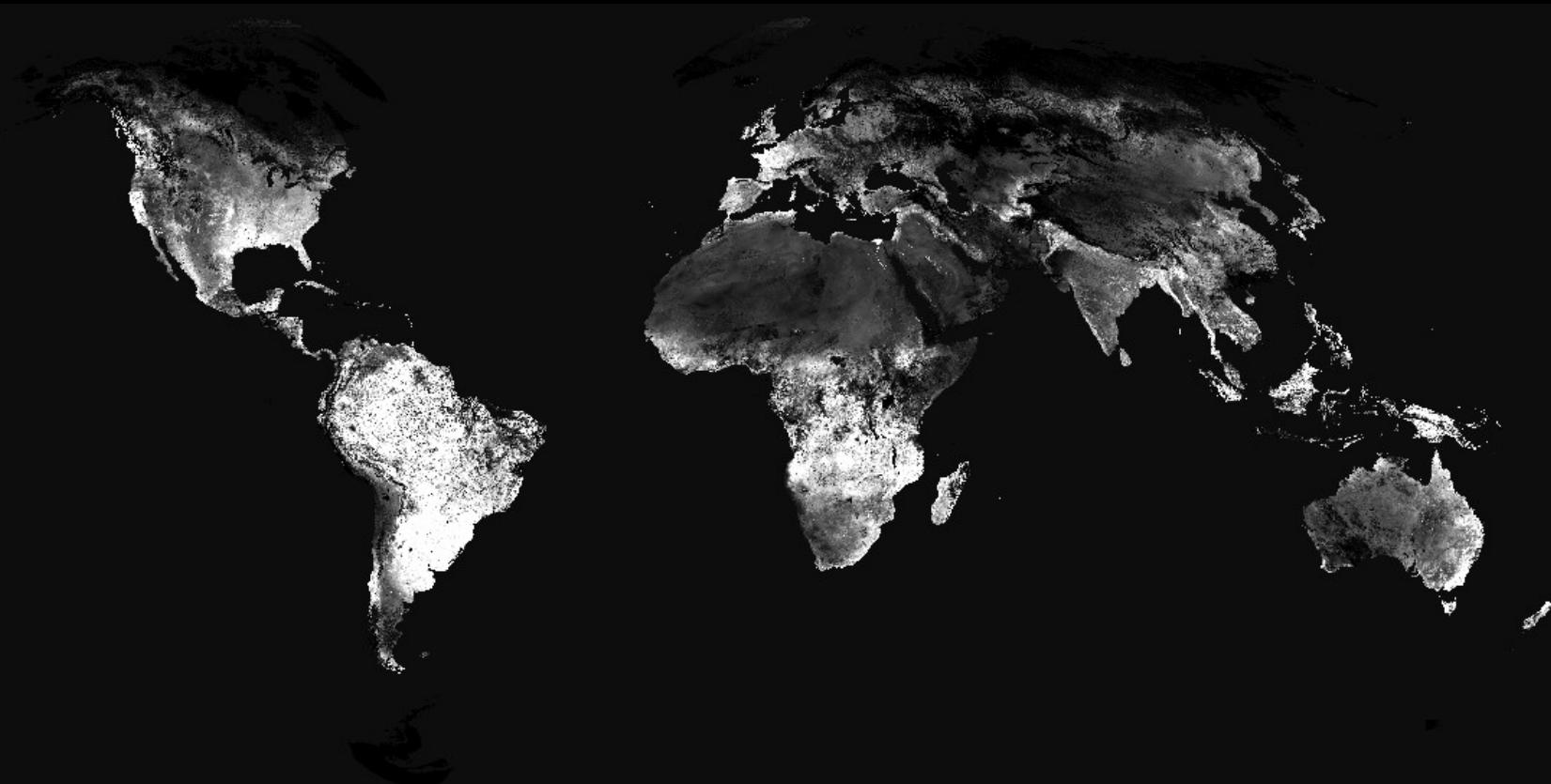
Global image NOAA-AVHRR
Red Channel
1-10 april 1992



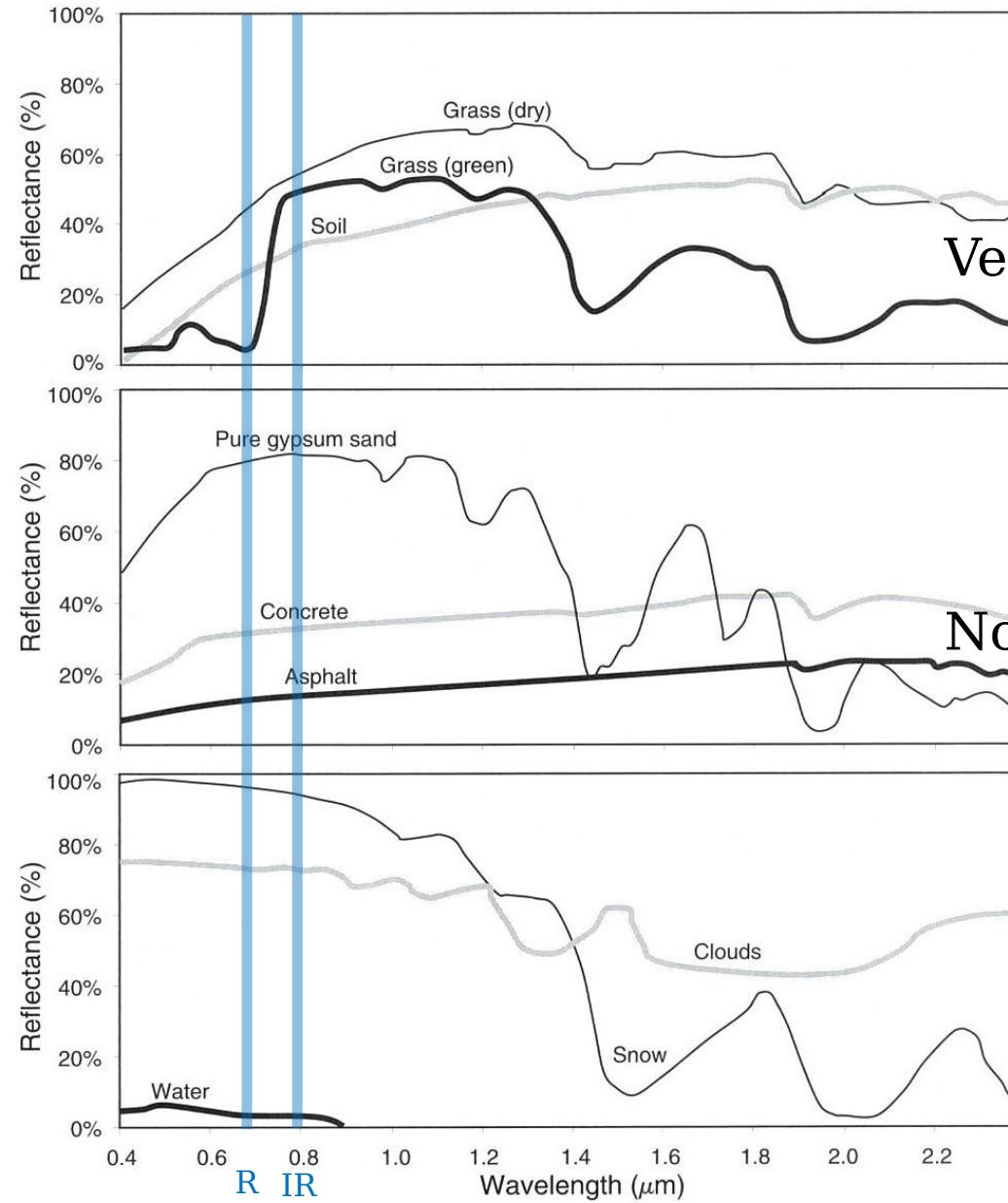
Global image NOAA-AVHRR
Channel Near Infrared
1-10 april 1992



Global image NOAA-AVHRR
NDVI
1-10 april 1992



Spectral signatures of different types of surfaces



Vegetation Index

Ratio: $\frac{\rho_{IR}}{\rho_R}$

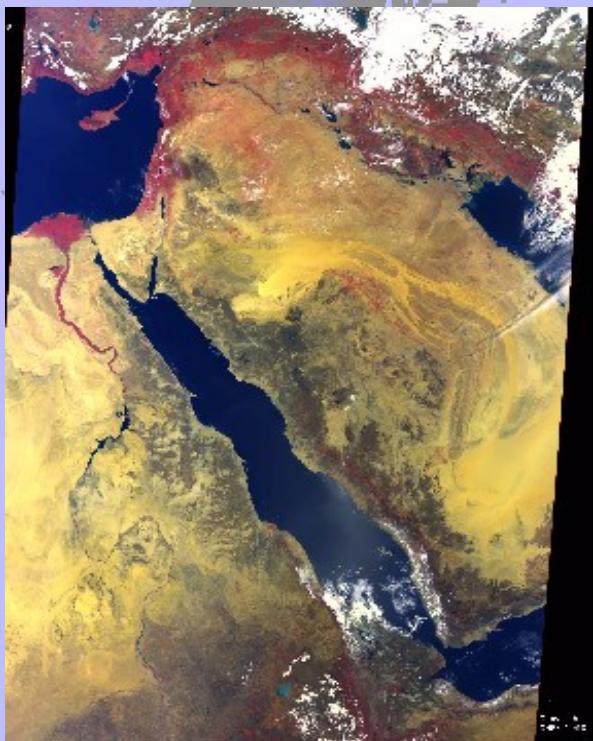
Difference: $\rho_{IR} - \rho_R$

Normalized Diff. Vegetation Index:

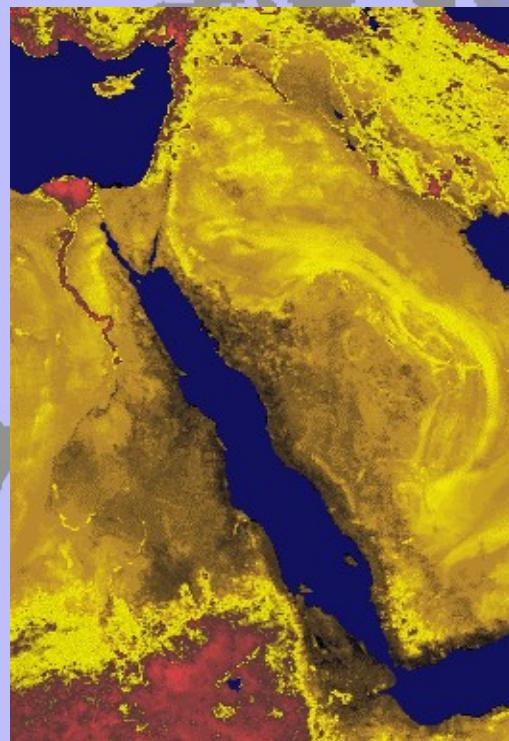
$$NDVI = \frac{\rho_{IR} - \rho_R}{\rho_{IR} + \rho_R}$$

Source: Lillesand *et al.*, 2004

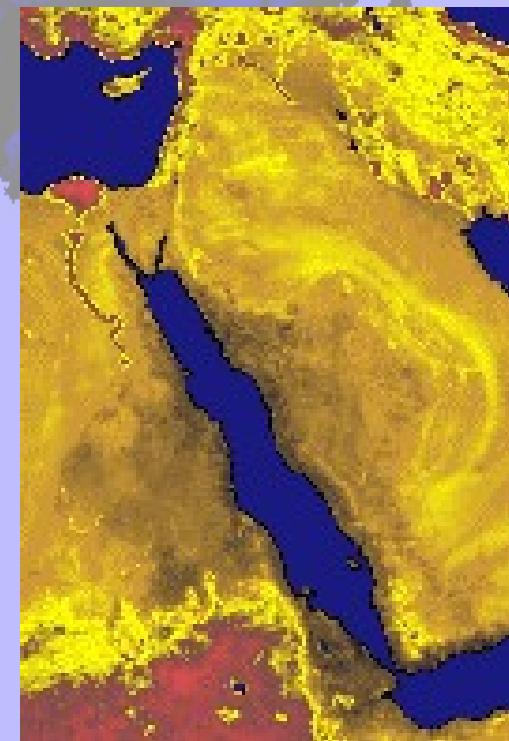
SPOT-VEGETATION



NOAA-AVHRR



NOAA-AVHRR



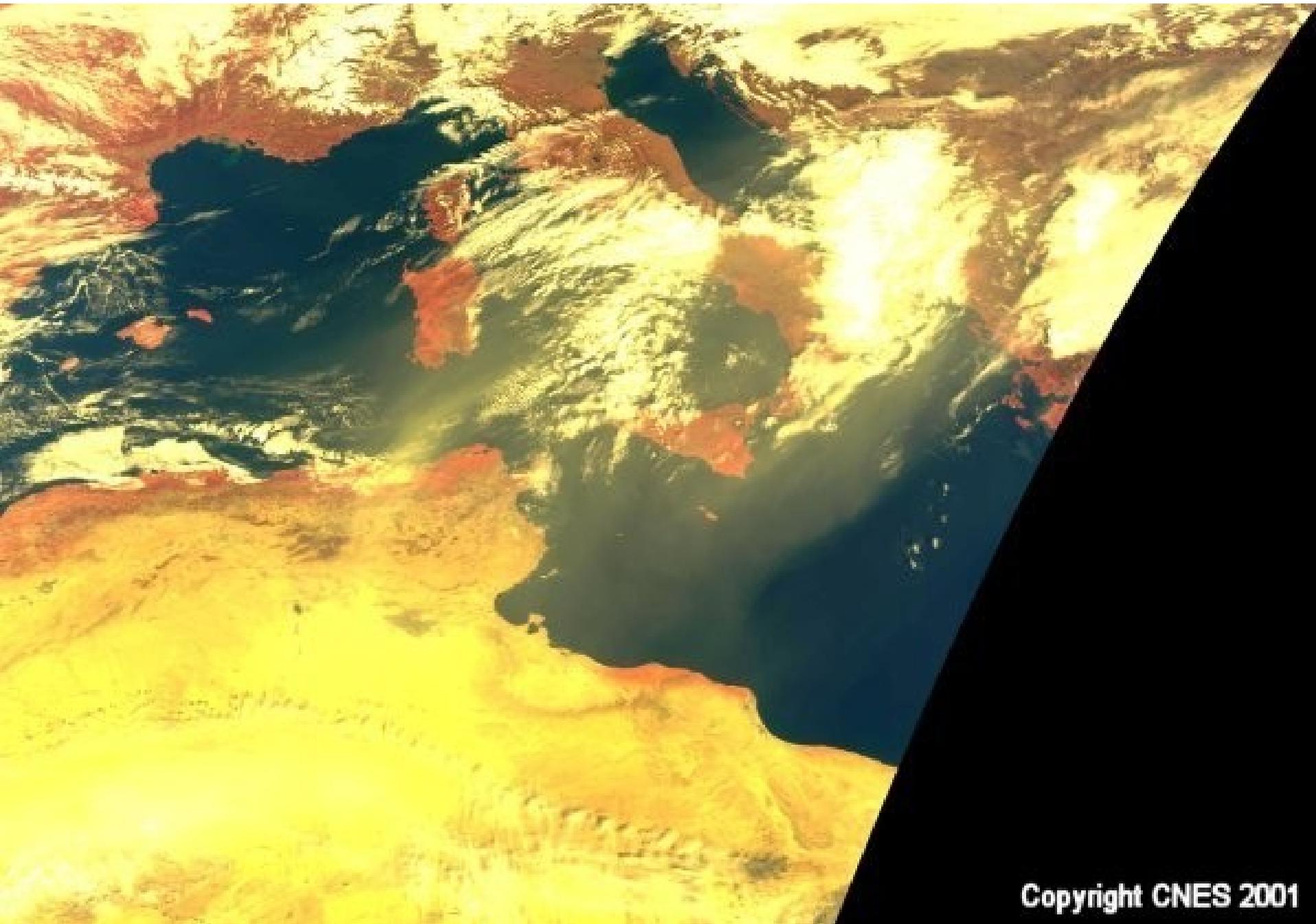
Pixel Size: 1 x 1 km²

Pixel Size: 8 x 8 km²

Pixel Size: 16 x 16 km²

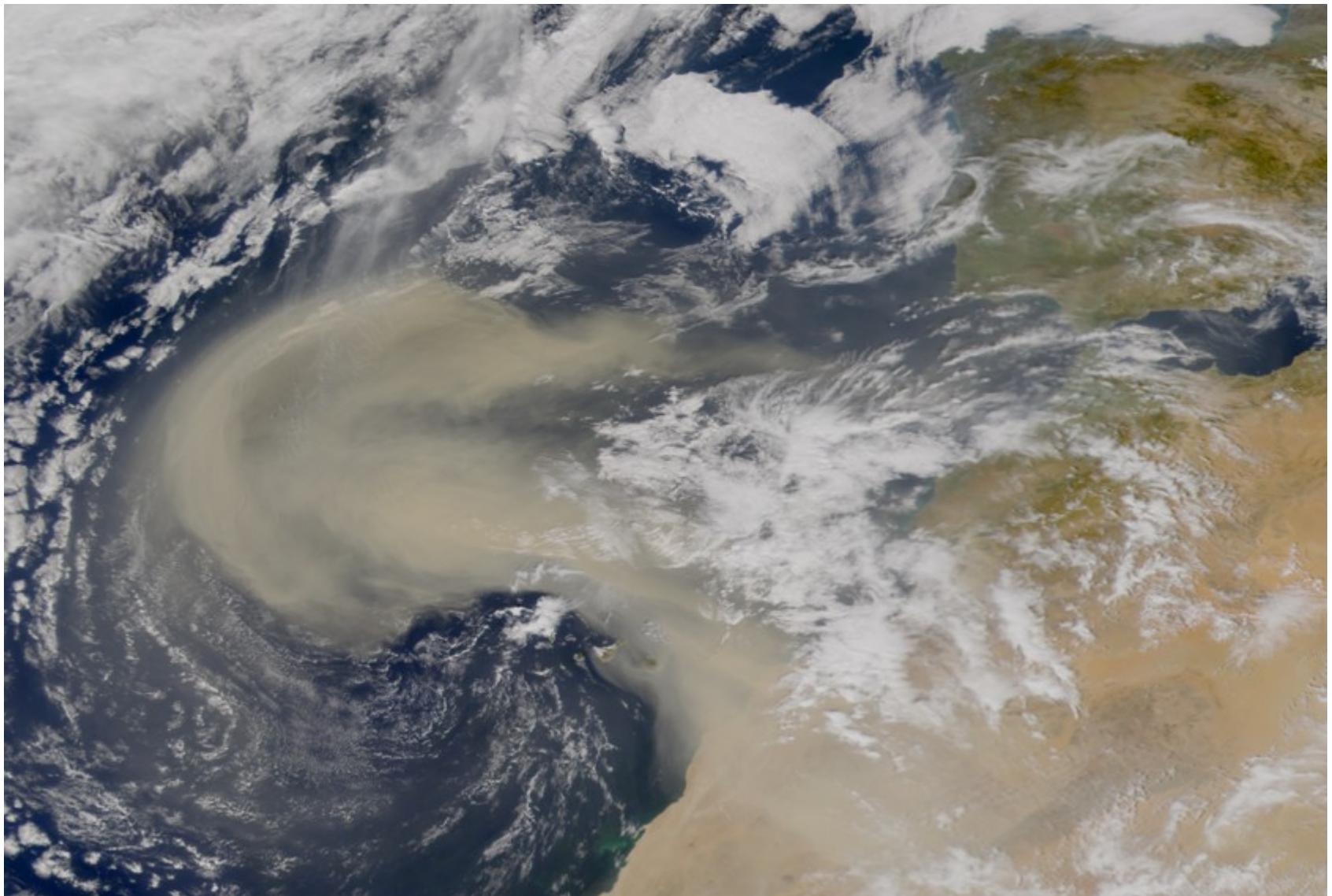


Copyright CNES 1998

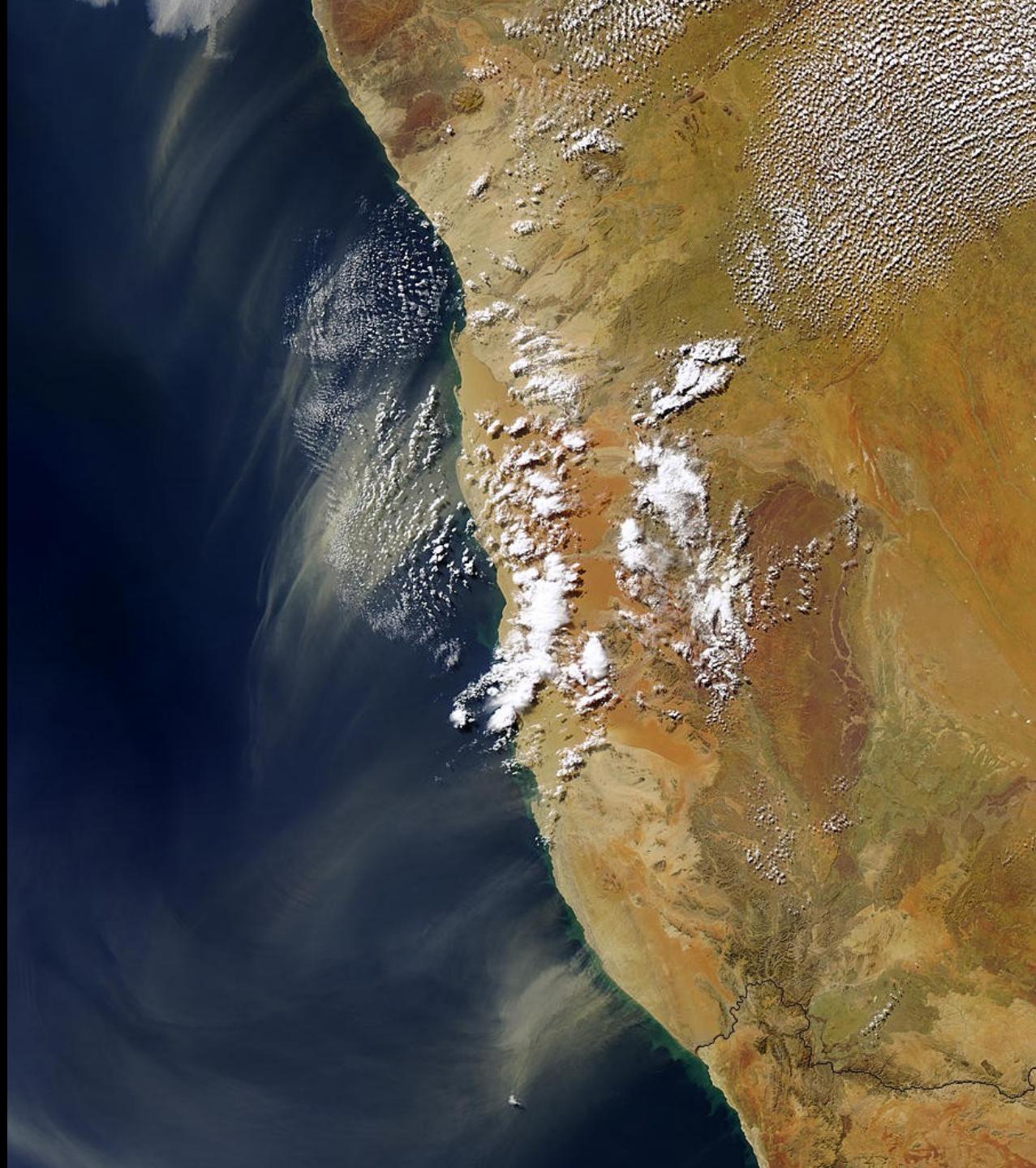


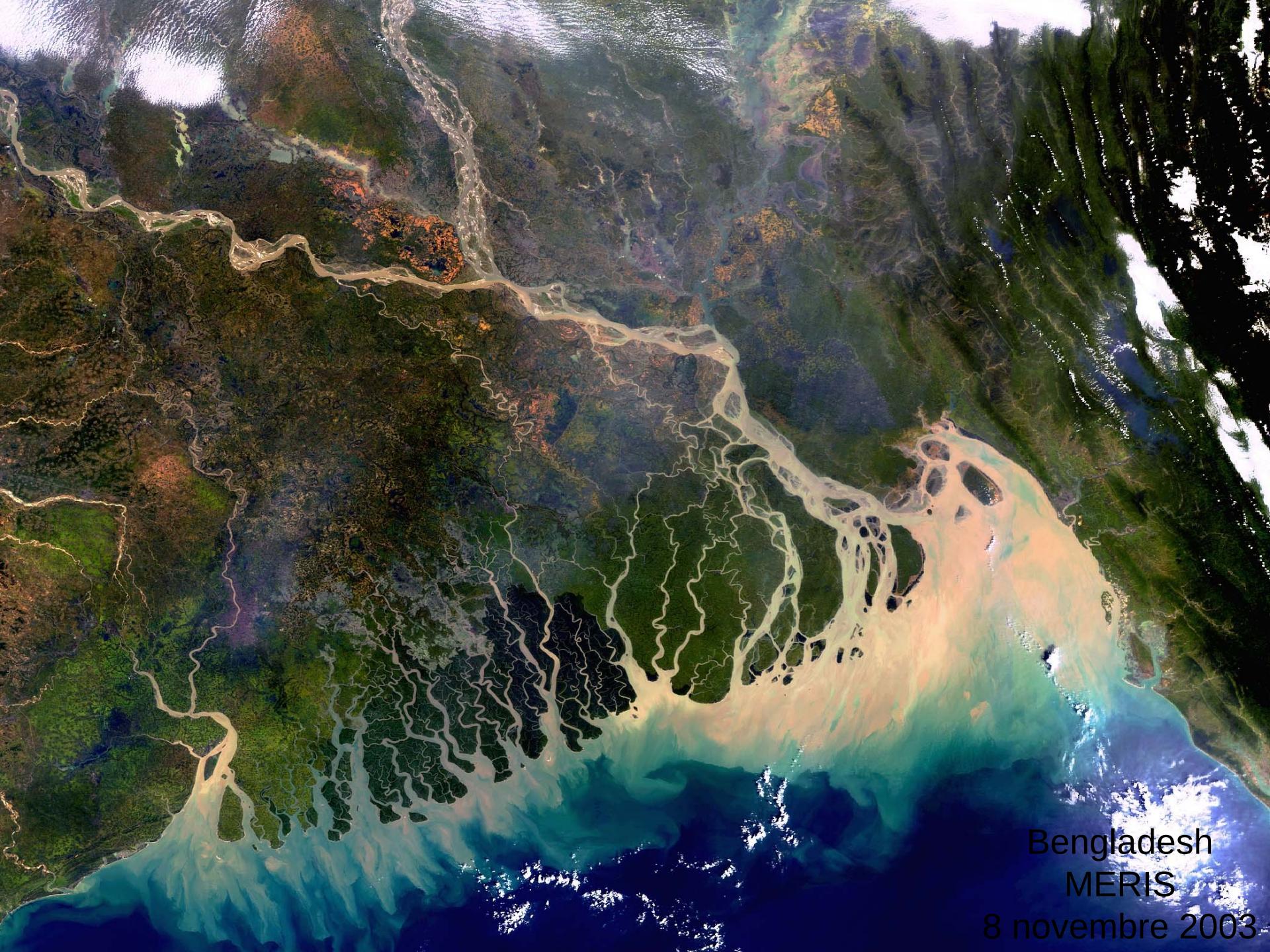
Copyright CNES 2001

SeaWIFS - 26.02.00
dust from West Africa
4 km spat. Res.



Désert de Namibie
MODIS
8 juillet 2004



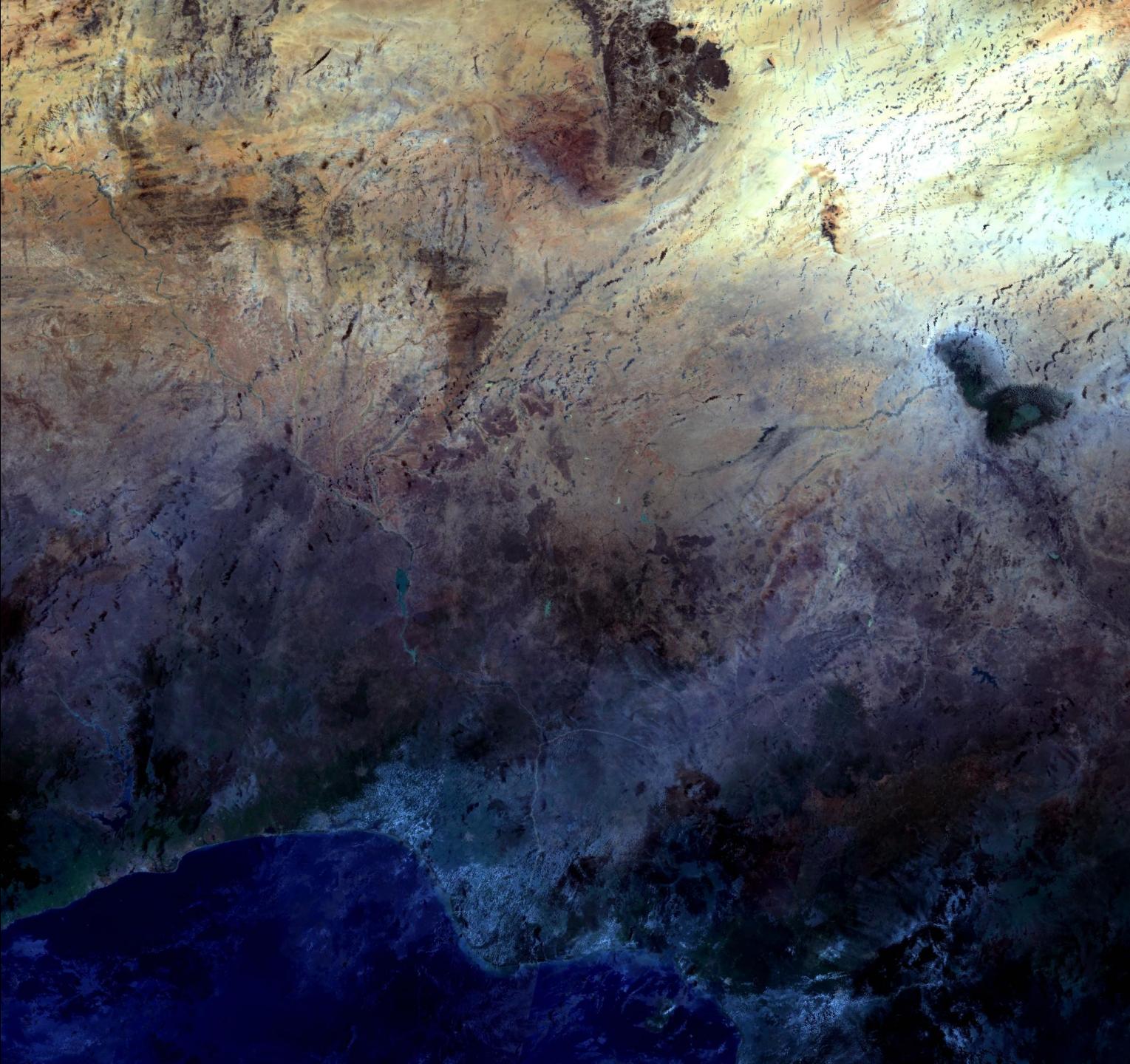


Bangladesh
MERIS
8 novembre 2003



Mer Caspienne
MÉRIS
22 septembre 2003

MERIS
300 m - 1200 m



MERIS
300 m - 1200 m





A satellite image showing the coastline of Senegal. The image is dominated by a light brown and tan color, representing dry land. A dark blue line, representing the coastline, runs along the top right and then turns inland. A large body of water, colored dark blue, is visible on the right side. The terrain shows some greenish-brown patches, likely vegetation or wetlands. The overall texture is somewhat mottled and lacks fine detail.

Sénégal
MERIS
15 avril 2003

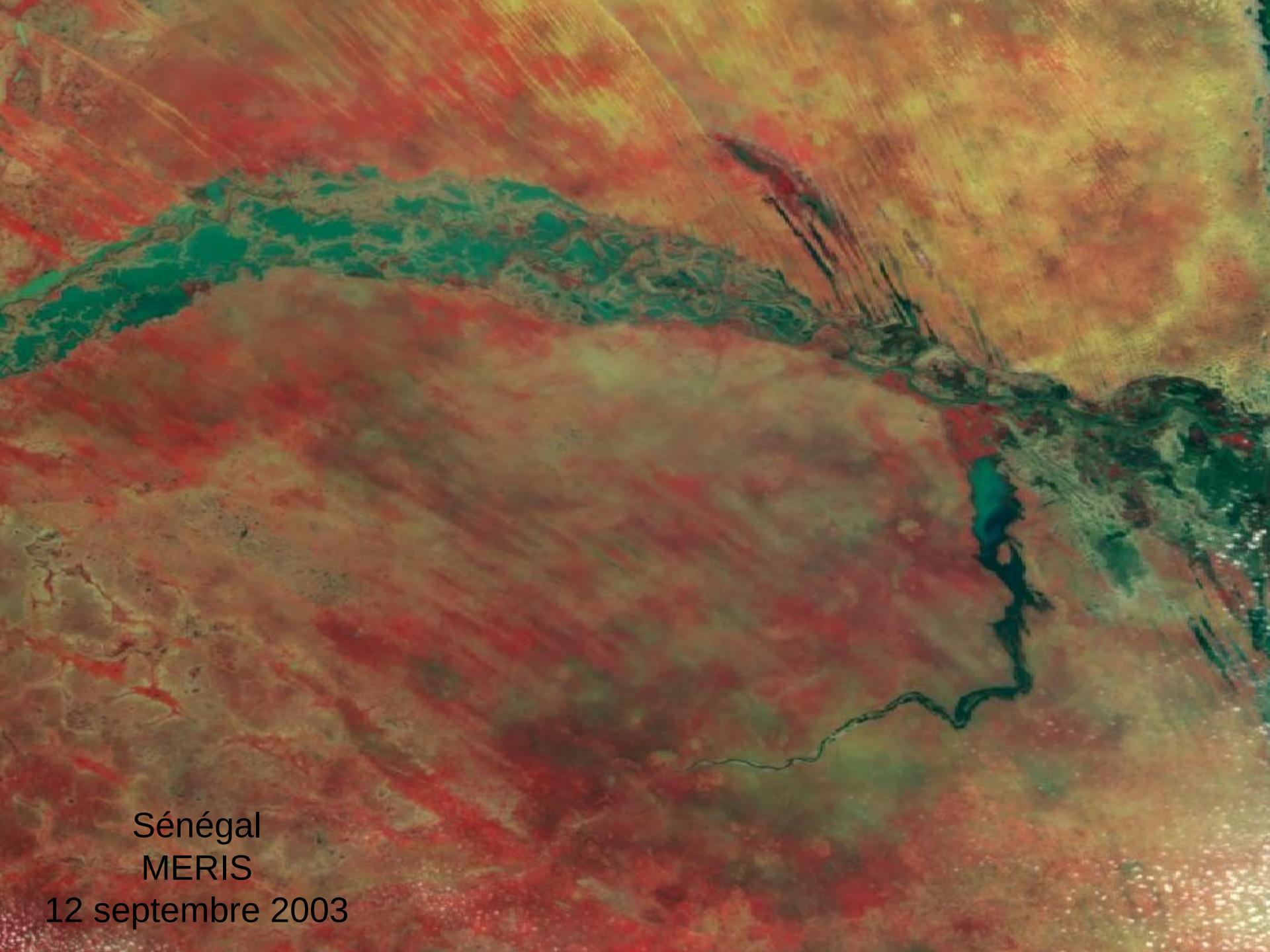


Sénégal
MERIS
30 mai 2003



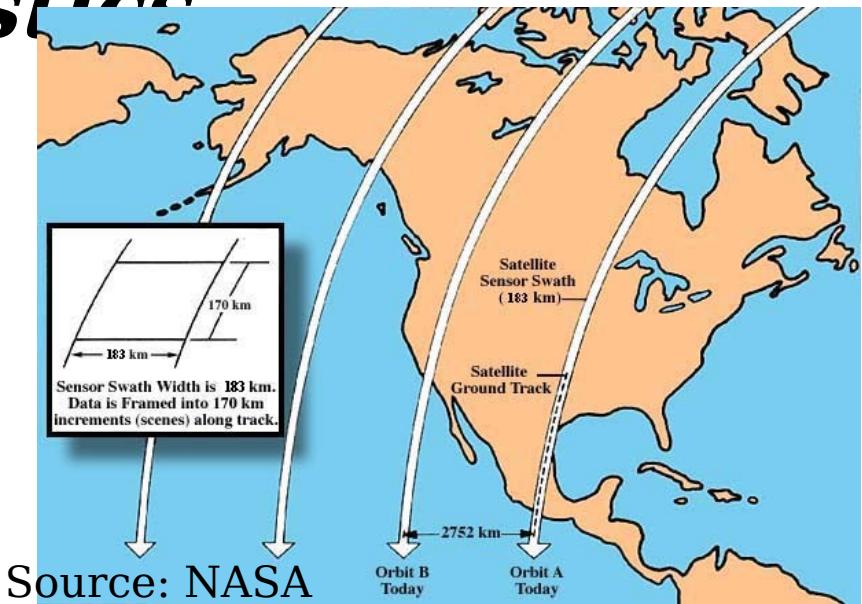
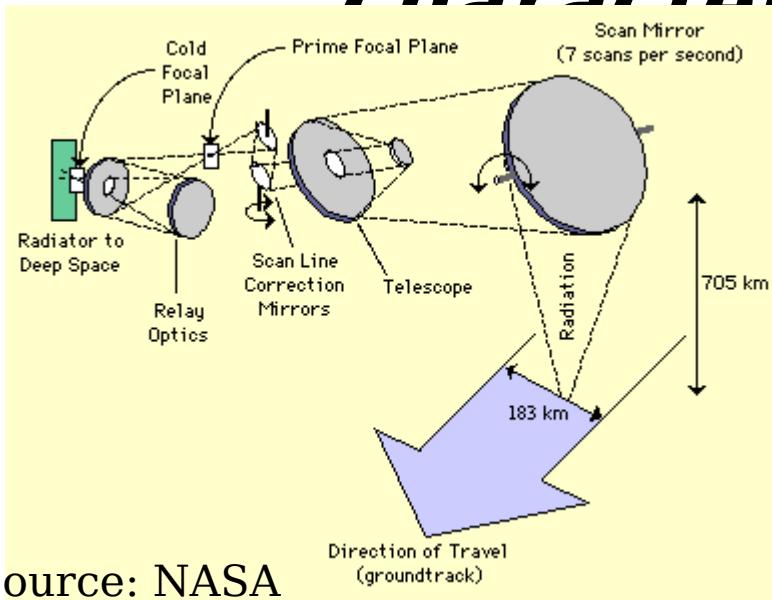
A high-resolution aerial satellite image showing the coastal region of Senegal. The image captures a long, narrow strip of land extending from the bottom right towards the top left. The coastal area is characterized by a dark, irregular line representing the shoreline, which is heavily marked with red and black. A significant concentration of red and black markings is visible near the southern tip of the landmass. The surrounding water is a light beige or tan color, indicating shallow coastal waters. The terrain appears dry and sandy, with some darker, possibly vegetated or rocky, areas further inland.

Sénégal
MERIS
27 juin 2003



Sénégal
MERIS
12 septembre 2003

Landsat-TM7 characteristics



focale: $f = 2.4 \text{ m}$

ouv. diaphragme: $d = 40 \text{ cm}$

déTECT. élém.: 0.1 mm

$$\Rightarrow \text{IFOV} = 10^{-4} / 2.4 = 41.7 \cdot 10^{-6} \text{ rad}$$

$$\Rightarrow \delta x = \text{IFOV} H = \mathbf{30 \text{ m}}$$

Bande 1 : $0.45 - 0.52 \mu\text{m}$

Bande 2 : $0.52 - 0.6 \mu\text{m}$

Bande 3 : $0.63 - 0.69 \mu\text{m}$

Bande 4 : $0.76 - 0.90 \mu\text{m (NIR)}$

Bande 5 : $1.55 - 1.75 \mu\text{m (SWIR)}$

Bande 7 : $2.08 - 2.35 \mu\text{m (SWIR)}$

Bande 6 : $10.4 - 12.5 \mu\text{m (IRT)} \quad (\mathbf{60m})$

PAN : $0.5 - 0.9 \mu\text{m} \quad (\mathbf{15 m})$

The LANDSAT mission

Satellite	Sensor	Swath	Bits	VNIR				SWIR			TIR			
L8	OLI	185km	12	30m	30m	30m	30m	30m			30m			
	TIRS			30m	30m	15m					100m			
Landsat 7	ETM+	185km	8	30m	30m	30m	30m	15m	30m		30m		60m	
Landsat 4 & 5	MSS	185km	8	82m				82m	82m	82m	82m			
	TM	185km	8	30m	30m	30m	30m	30m	30m	30m	30m	120m		
Landsat 1-2	RBV	183km		80m	80m	80m	80m							
Landsat 3	RBV	183km		40m										
Landsat 1-3	MSS	183km	8	79m	79m	79m	79m	79m					240m (L3 Only)	

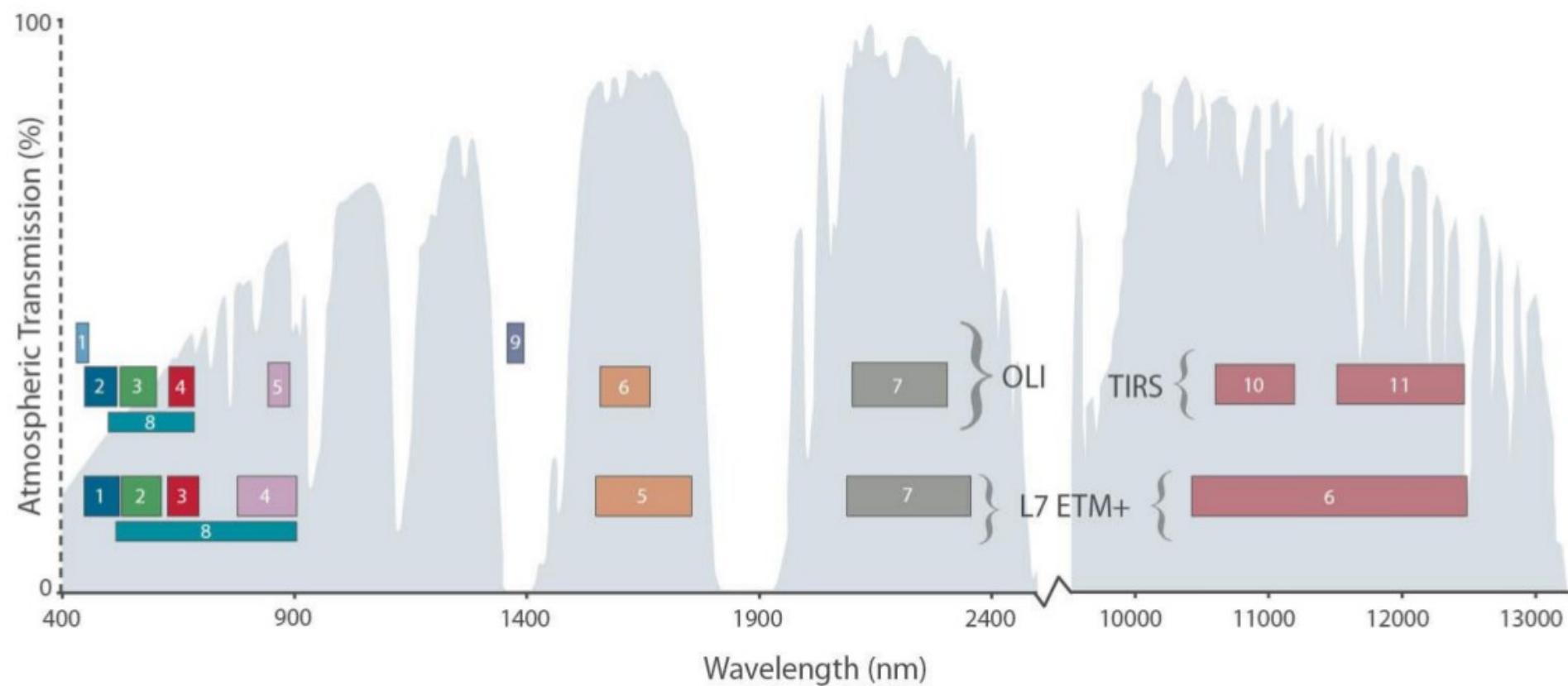
USGS, Landsat 8 Data Users Handbook

LANDSAT characteristics

OLI and TIRS Spectral Bands vs ETM+ Spectral Bands

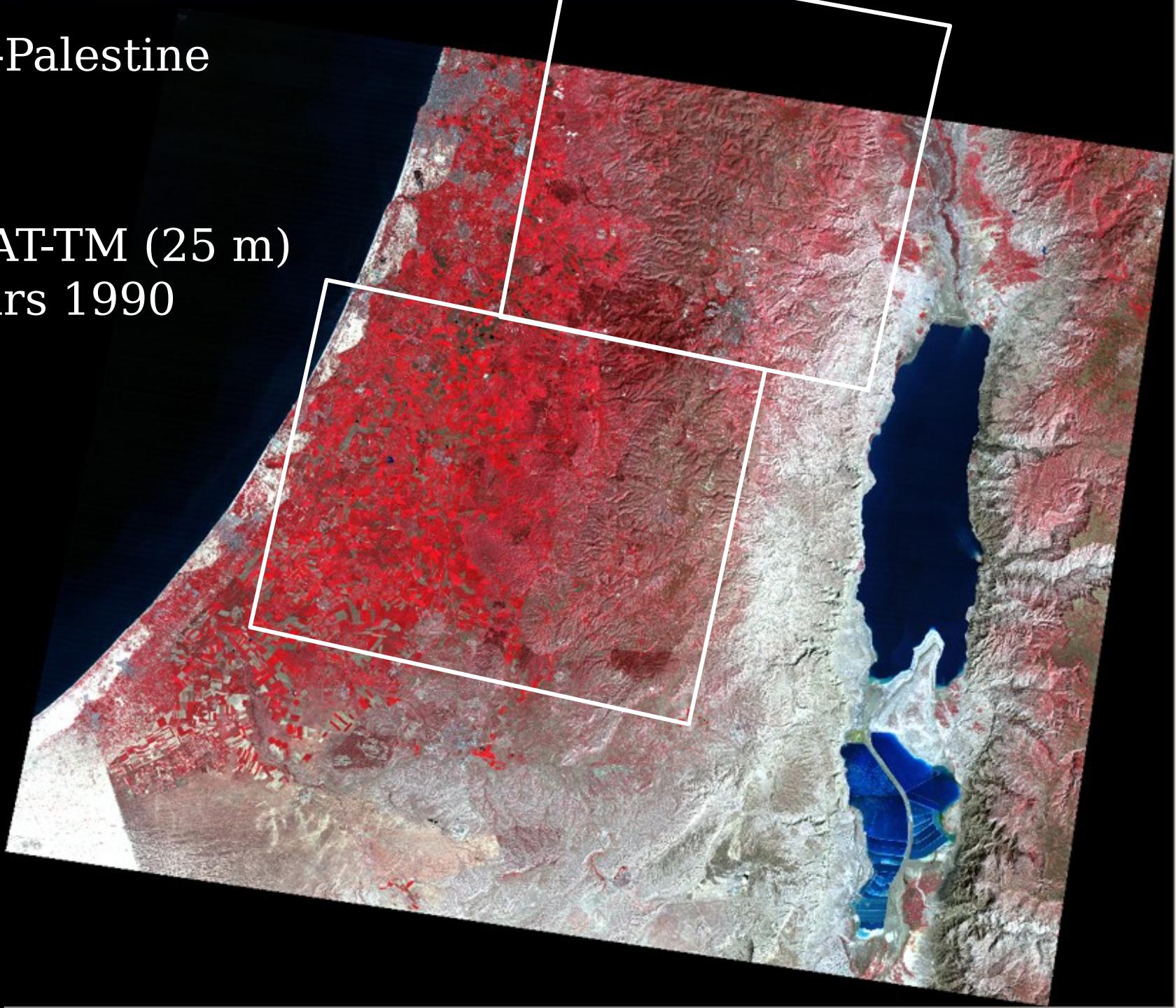
Landsat-7 ETM+ Bands (μm)			Landsat-8 OLI and <i>TIRS</i> Bands (μm)		
			30 m Coastal/Aerosol	0.435 - 0.451	Band 1
Band 1	30 m Blue	0.441 - 0.514	30 m Blue	0.452 - 0.512	Band 2
Band 2	30 m Green	0.519 - 0.601	30 m Green	0.533 - 0.590	Band 3
Band 3	30 m Red	0.631 - 0.692	30 m Red	0.636 - 0.673	Band 4
Band 4	30 m NIR	0.772 - 0.898	30 m NIR	0.851 - 0.879	Band 5
Band 5	30 m SWIR-1	1.547 - 1.749	30 m SWIR-1	1.566 - 1.651	Band 6
Band 6	60 m TIR	10.31 - 12.36	<i>100 m TIR-1</i>	<i>10.60 – 11.19</i>	Band 10
			<i>100 m TIR-2</i>	<i>11.50 – 12.51</i>	Band 11
Band 7	30 m SWIR-2	2.064 - 2.345	30 m SWIR-2	2.107 - 2.294	Band 7
Band 8	15 m Pan	0.515 - 0.896	15 m Pan	0.503 - 0.676	Band 8
			30 m Cirrus	1.363 - 1.384	Band 9

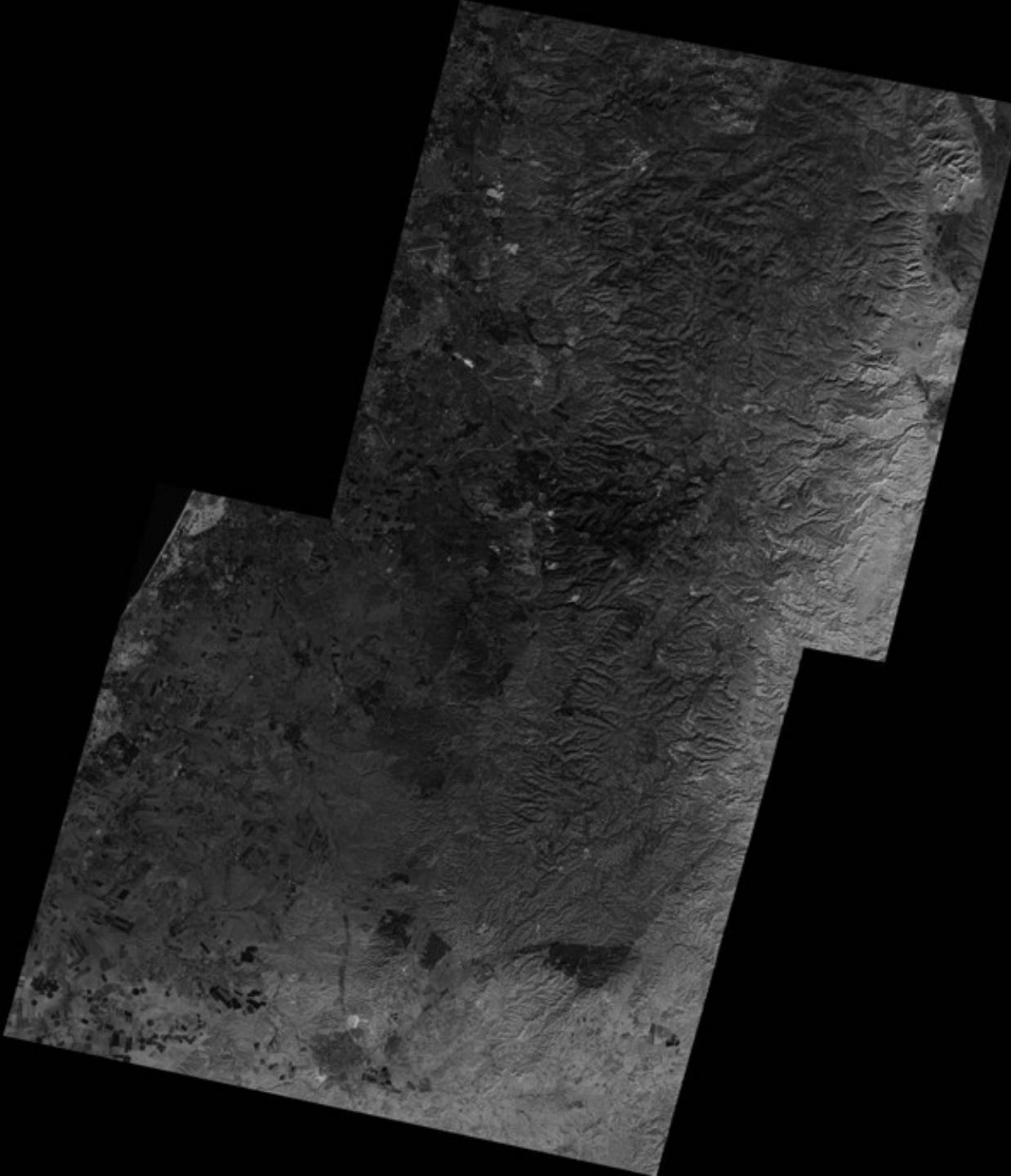
Landsat 8 vs Landsat 7 ETM+ Spectral Bands



Israël-Palestine

LANDSAT-TM (25 m)
mars 1990



A grayscale satellite image showing a coastal region with a mix of urban and rural landscapes. The image is oriented diagonally and is set against a black background.

Israël-Palestine

SPOT - Panchro (10m)
janvier 2000

SPOT - XS
Brest, France - 20 m rés. spatiale





SPOT - Panchro
rés. spatiale: 10 m

Brest, France

SPOT 5
rés. spatiale: 10 m



Banda Aceh, Indonésie
17 juillet 2003

SPOT 5
rés. spatiale: 10 m



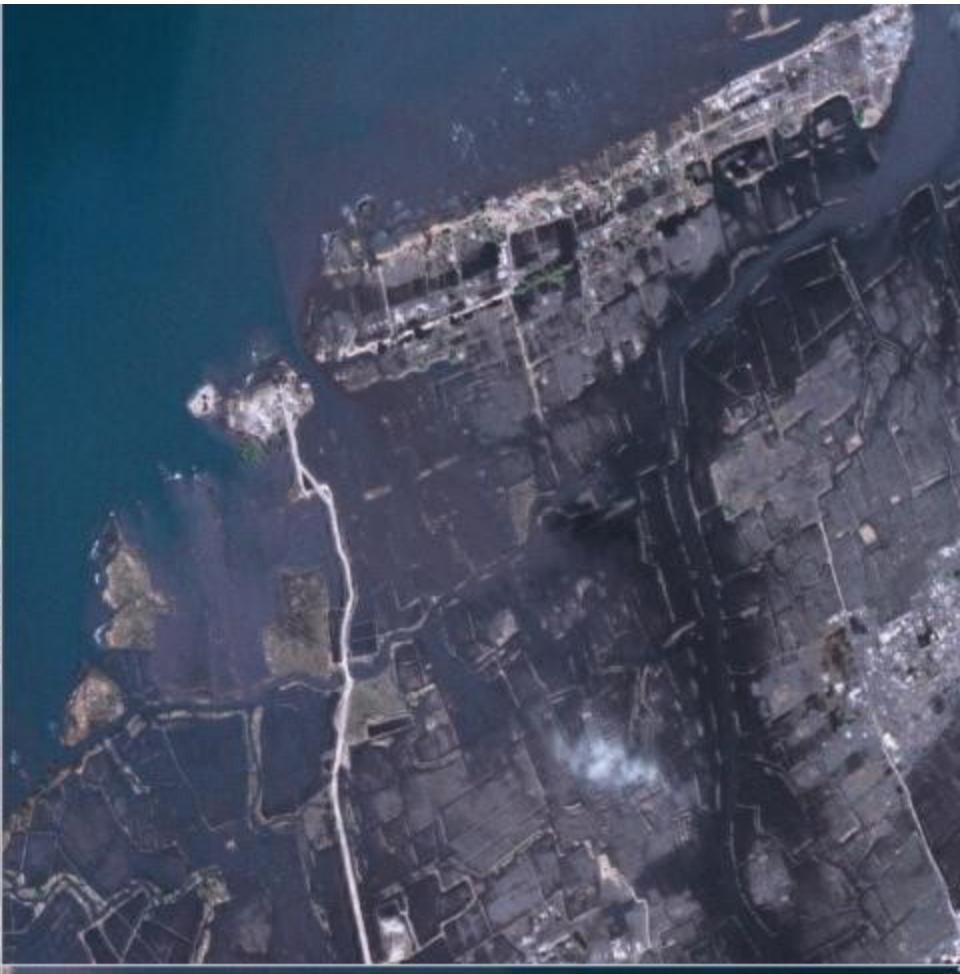
Banda Aceh, Indonésie
17 juillet 2003

SPOT 5
rés. spatiale: 10 m
Banda Aceh, Indonésie

17 juillet 2003



30 décembre 2004



SPOT 5
rés. spatiale: 10 m
Banda Aceh, Indonésie

17 juillet 2003



30 décembre 2004

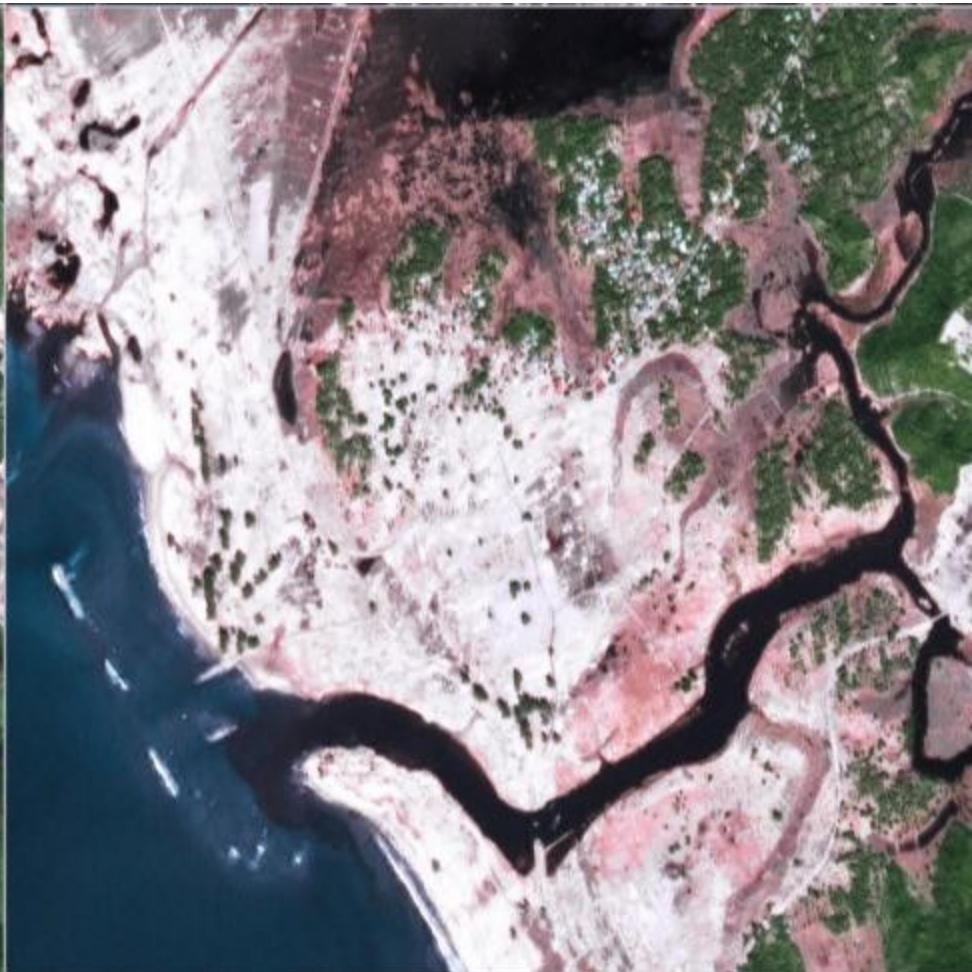


SPOT 5
rés. spatiale: 10 m
Banda Aceh, Indonésie

17 juillet 2003

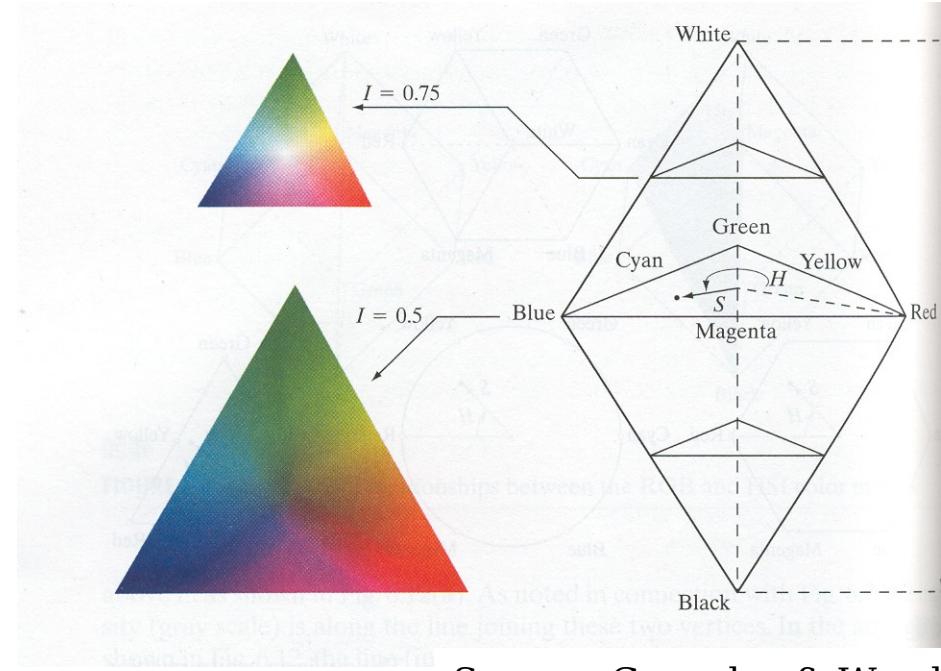
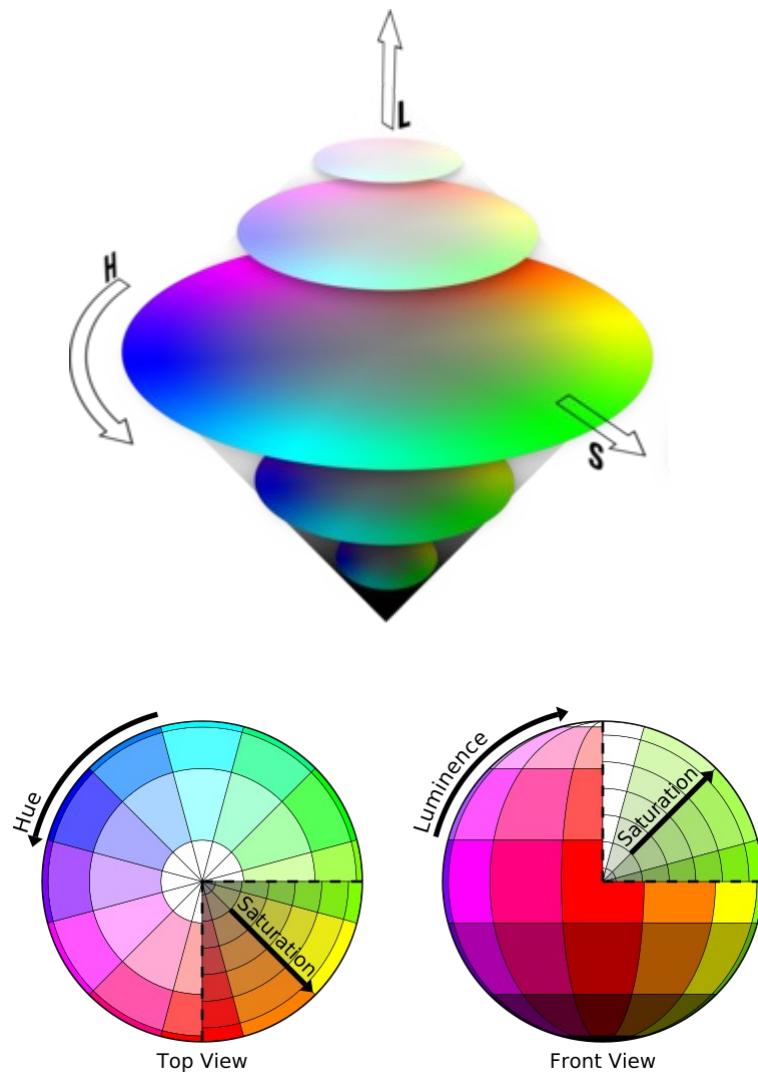


30 décembre 2004



Modèle TSL (HSL)

TSI (HSI)



Source: Gonzales & Wood

image originale



canal rouge



canal vert



canal bleu



canal teinte



canal saturation



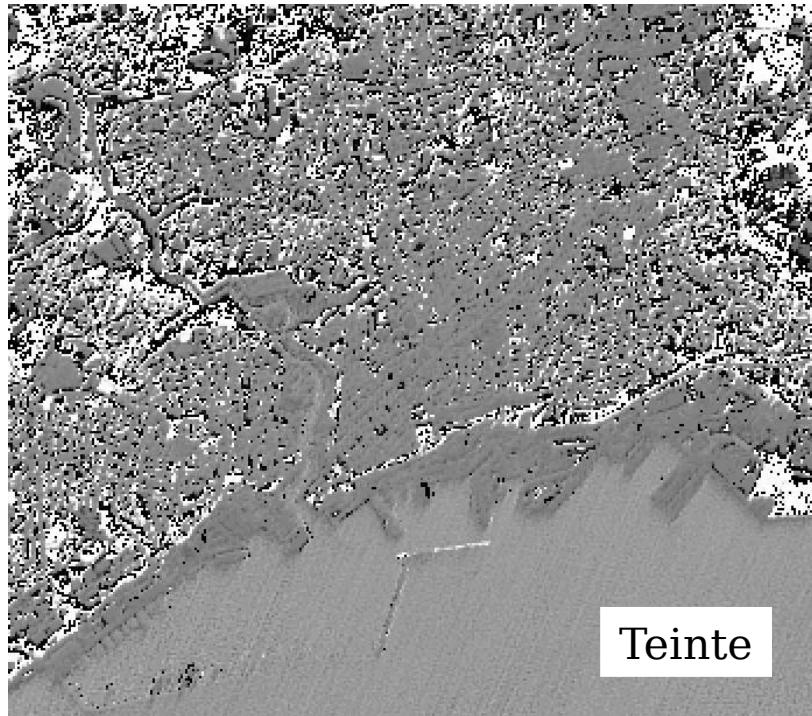
canal intensité



SPOT - XS
Brest, France - 20 m rés. spatiale



SPOT - XS
20 m rés. spatiale: rééchantillonage x 2



RGB □ HSI



Teinte

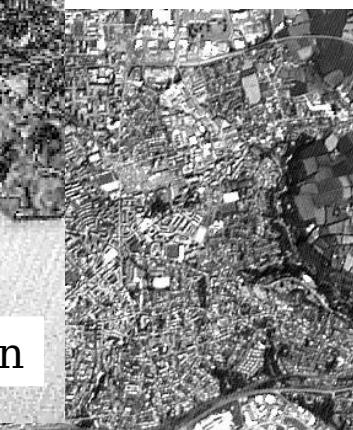
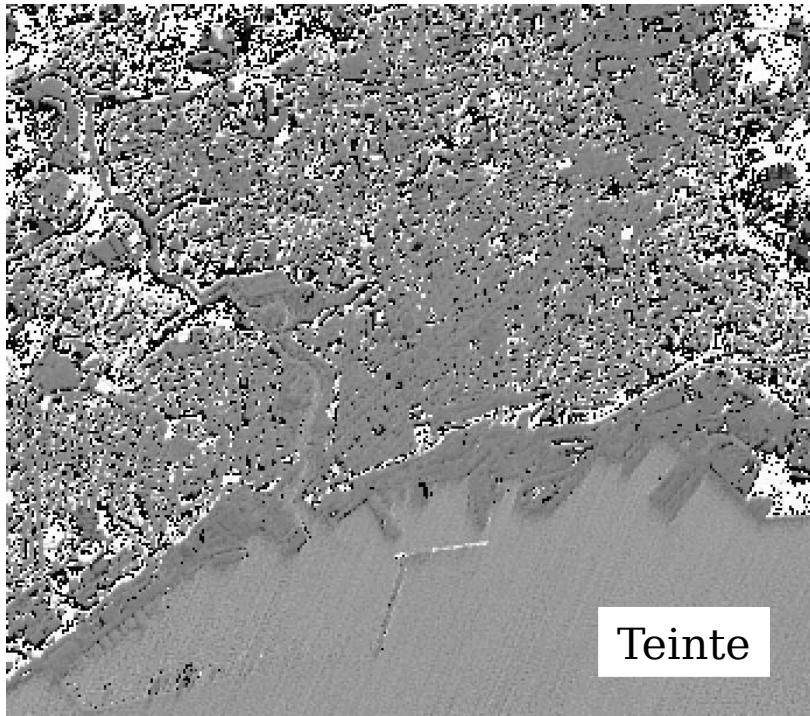


Saturation



Intensité

SPOT - XS
20 m rés. spatiale: rééchantillonage x 2



HSI ☐ RGB.....

SPOT - XS
Brest, France - 20 m rés. spatiale





SPOT - Panchro
rés. spatiale: 10 m

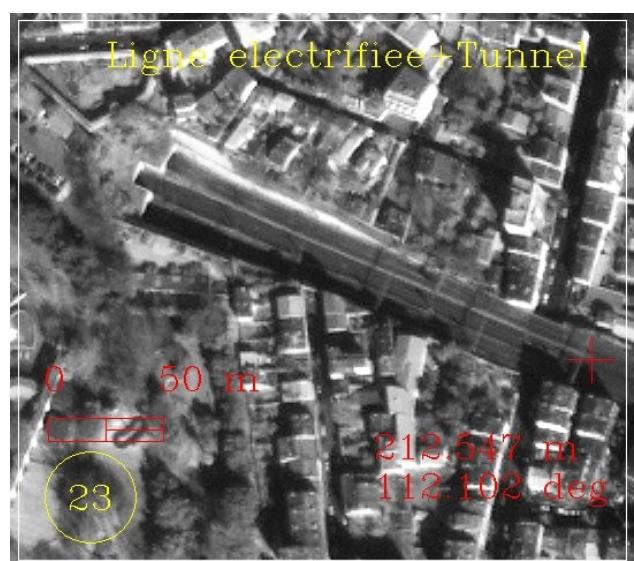
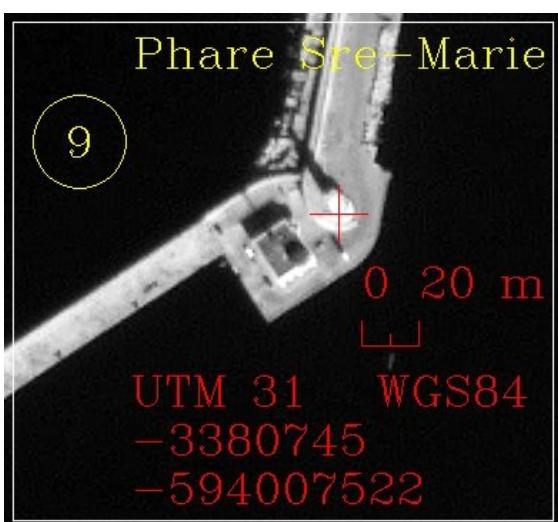
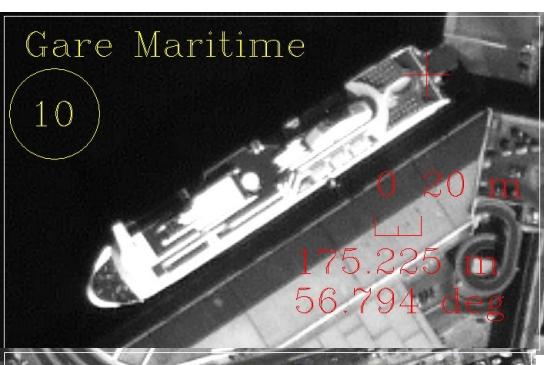
Brest, France



FUSION
XS - PANCHRO

3 canaux - 10 m

Brest, France



IKONOS

1 x 1 m²



Donnée QUICK BIRD, Paris, 27 mars 2002

PLEIADES



PLEIADES



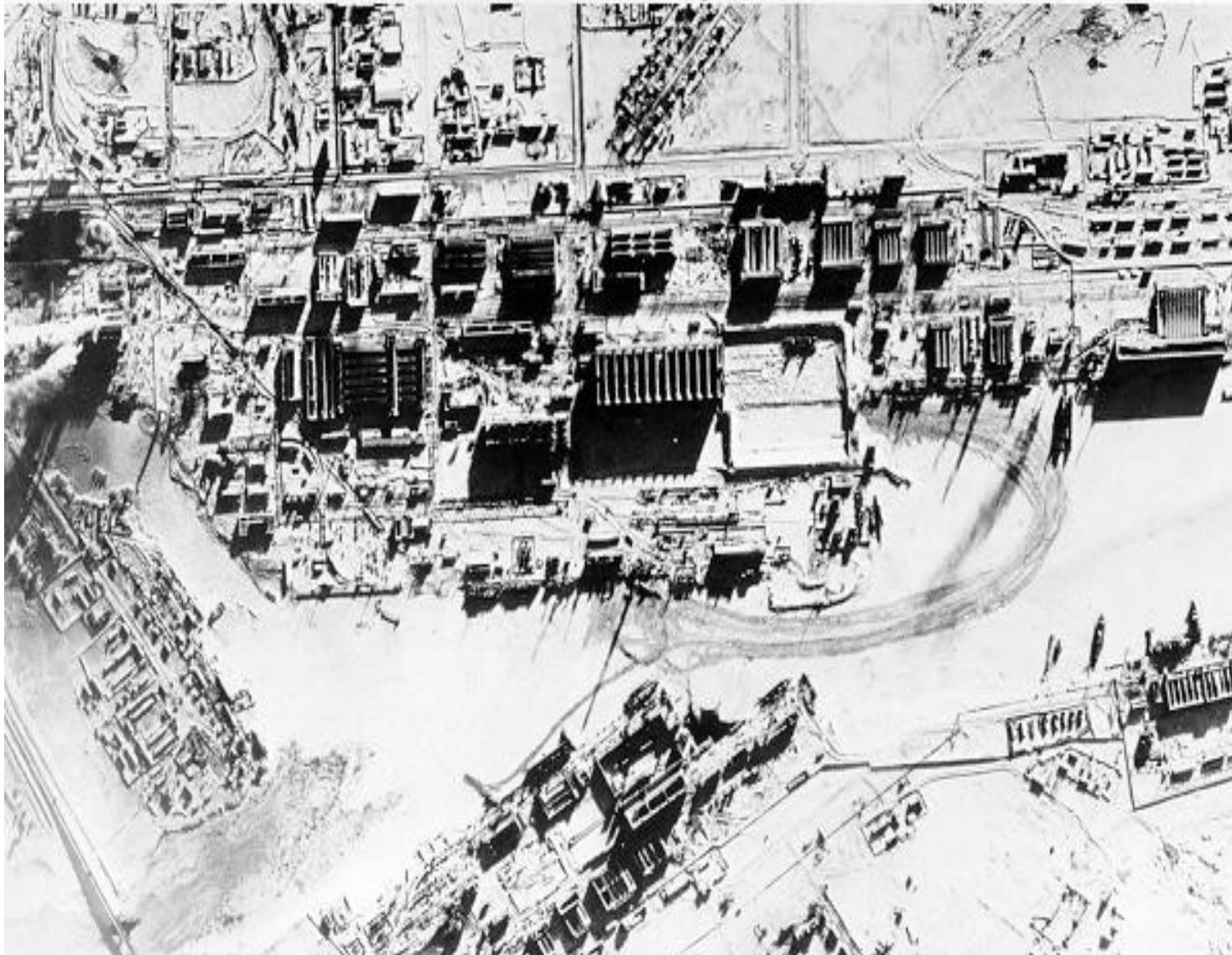
Renseignement stratégique



▲ REBUILDING TERROR? The al-Sharqat chemical plant in northwest Iraq; intelligence sources say Saddam is creating new facilities there

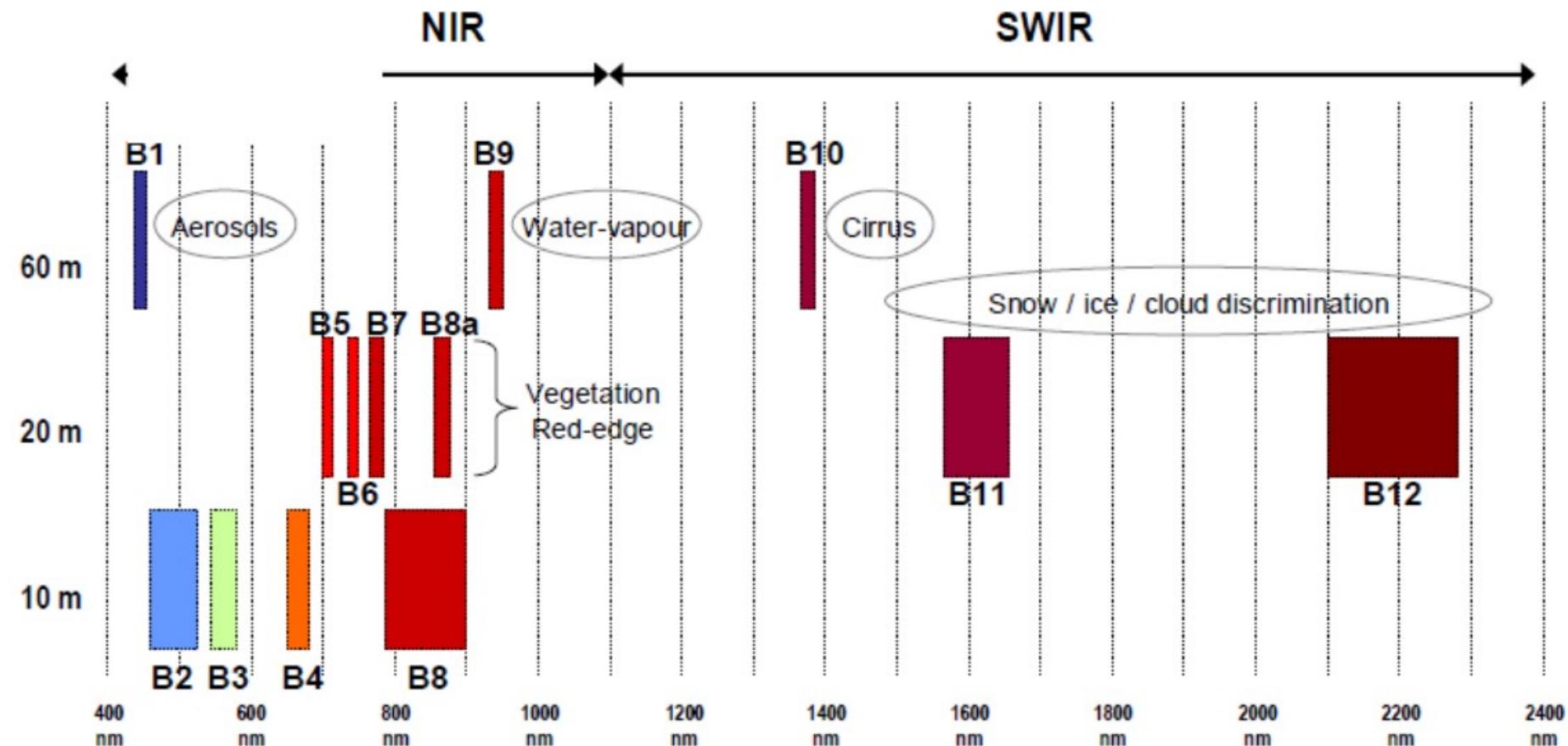
Renseignement stratégique

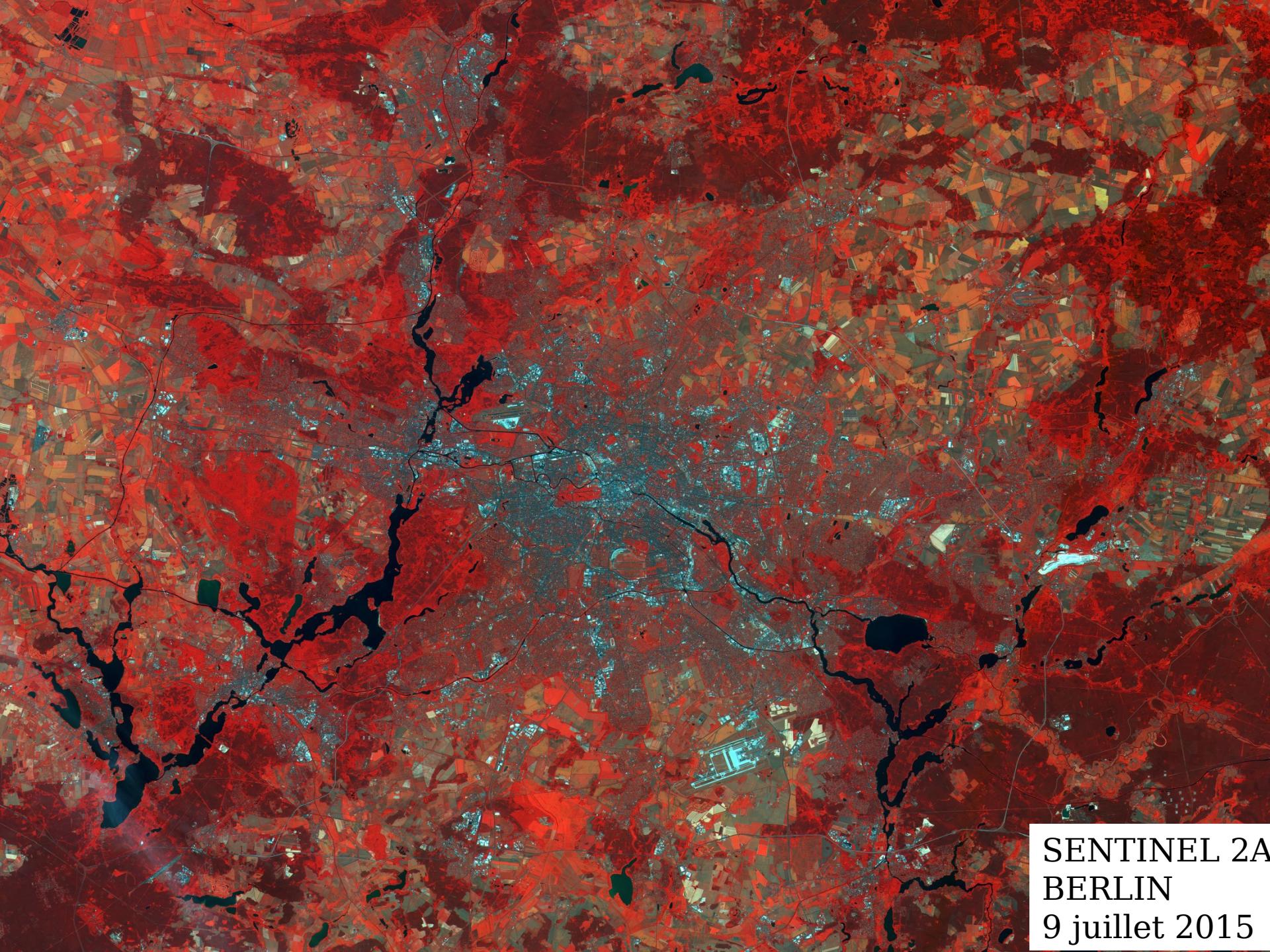
Severodvinsk Shipyard, USSR, 10 February 1969



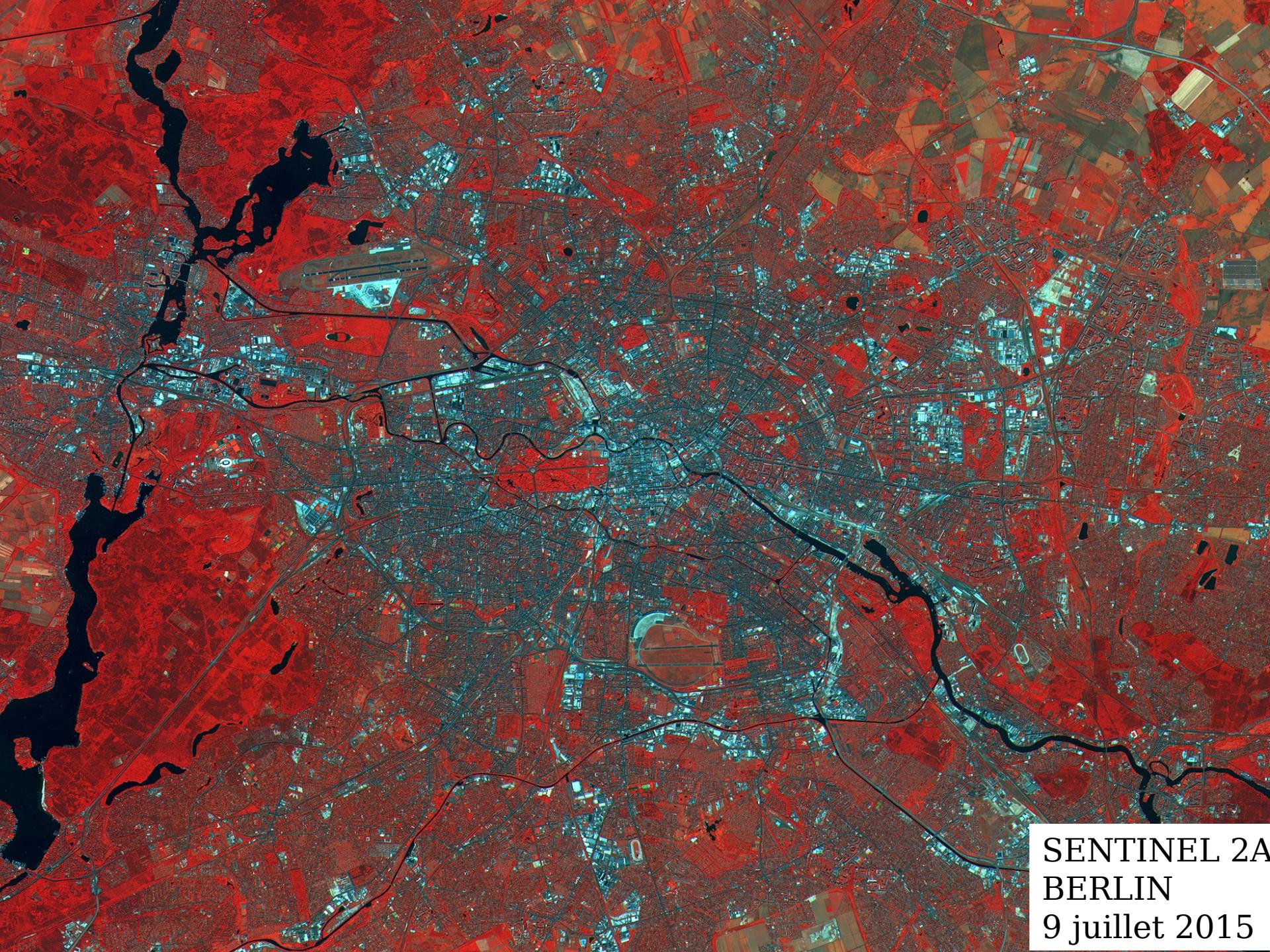
SENTINEL-2 MSI

Spatial resolution vs Spectral bands





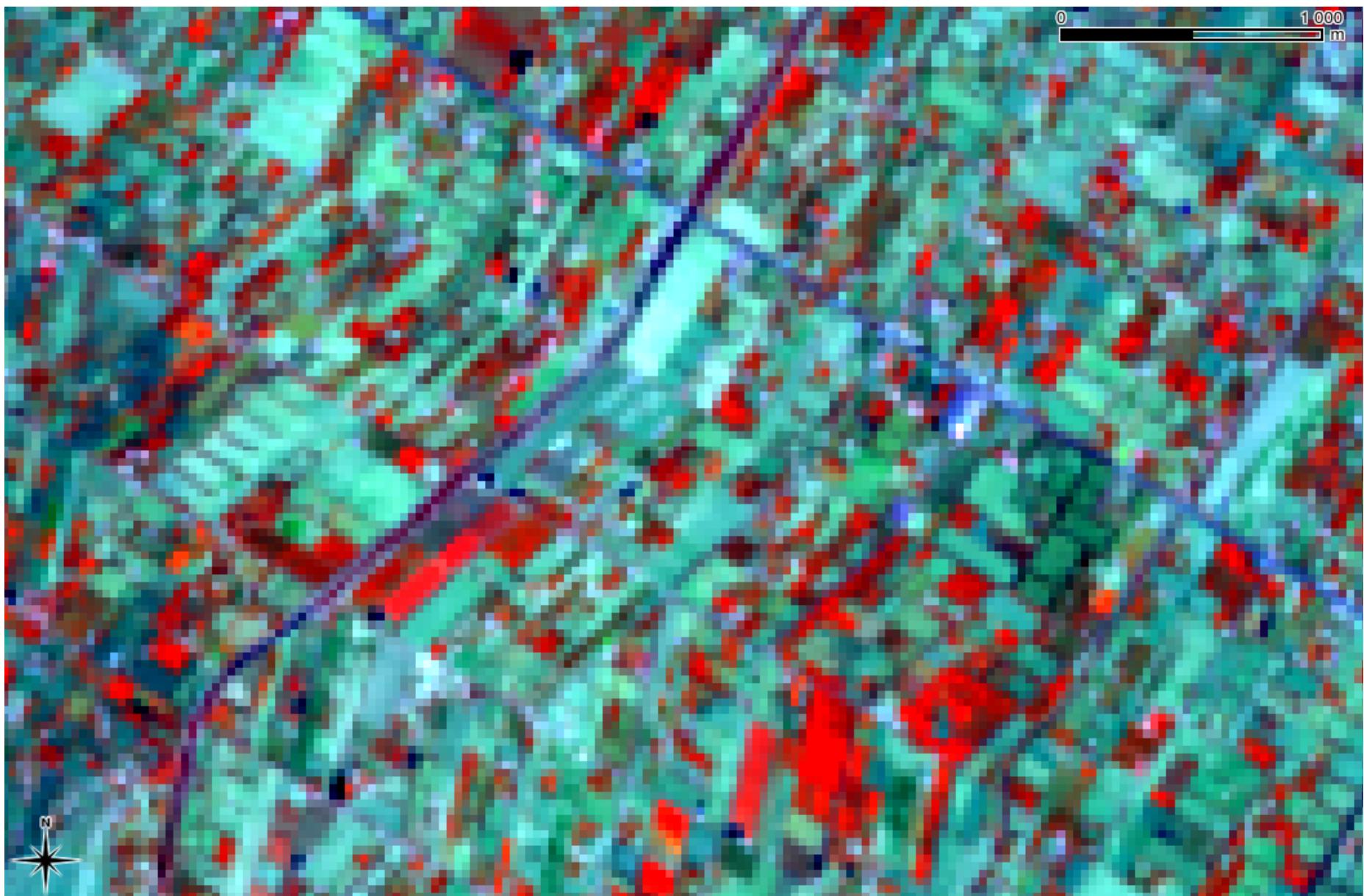
SENTINEL 2A
BERLIN
9 juillet 2015



SENTINEL 2A
BERLIN
9 juillet 2015

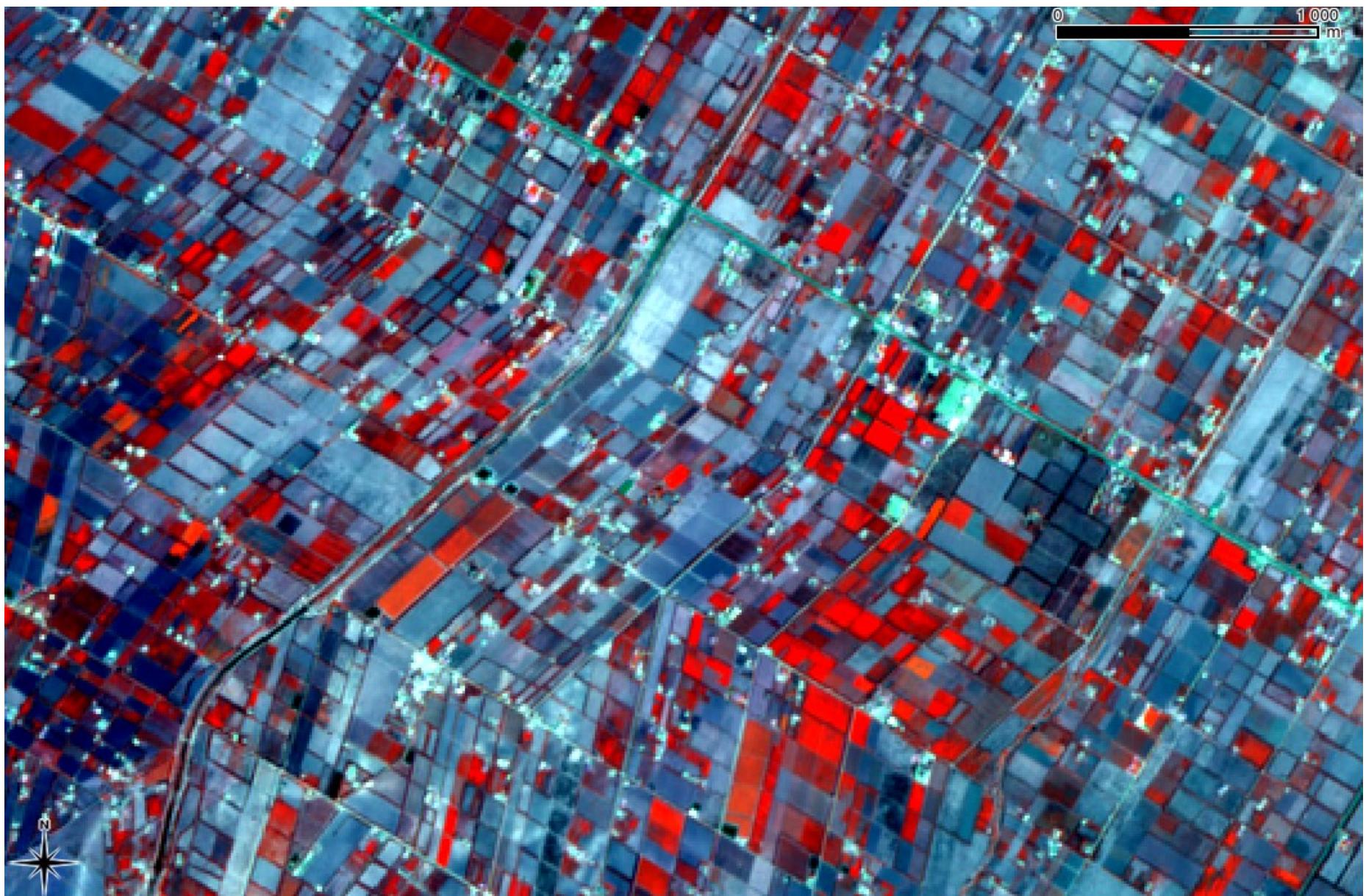
Nador Region, Marocco

LANDSAT 8 (spat. res. 30 m)



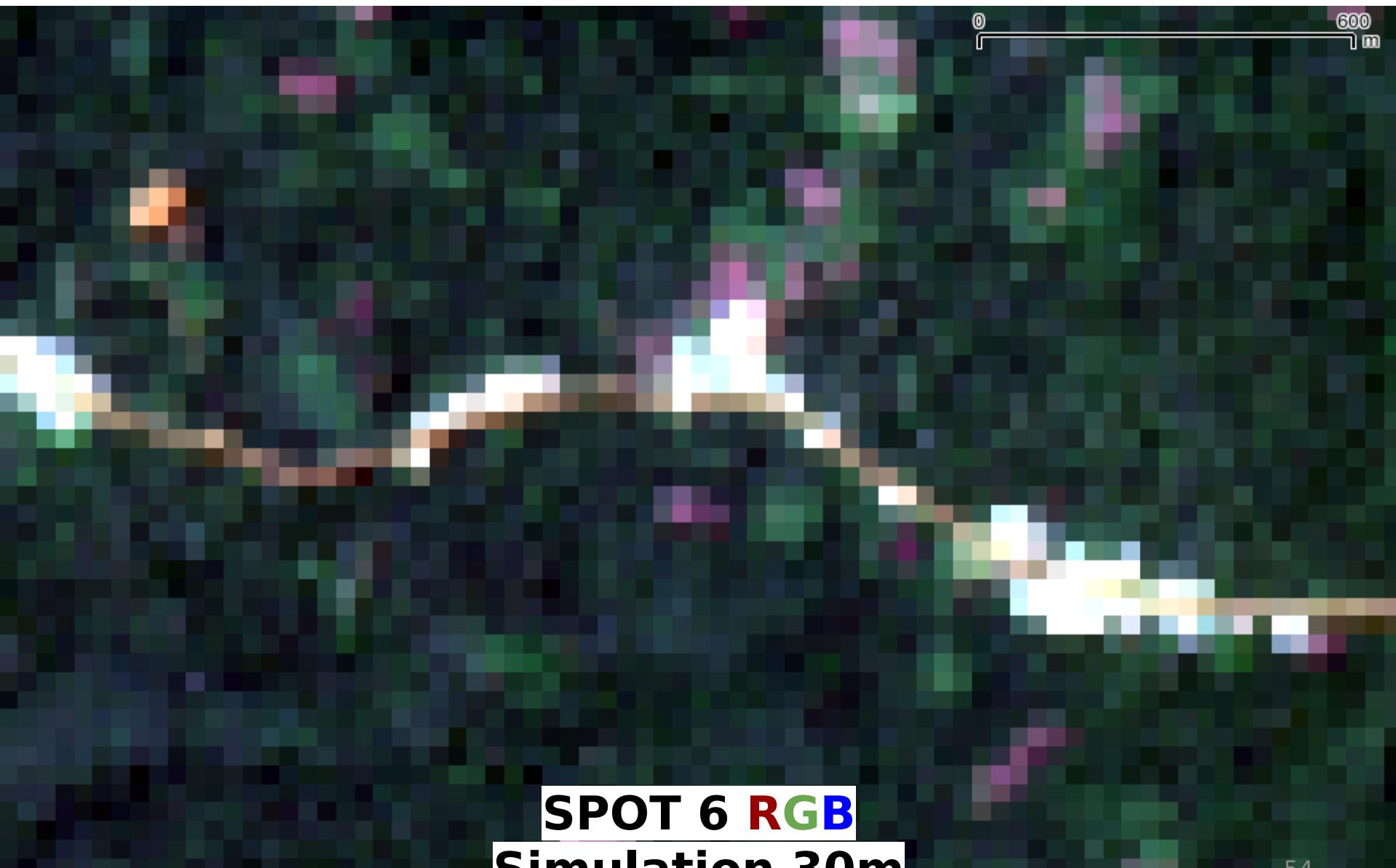
Nador Region, Marocco

Sentinel-2 (spat. res. 10 m)



Introduction à la télédétection

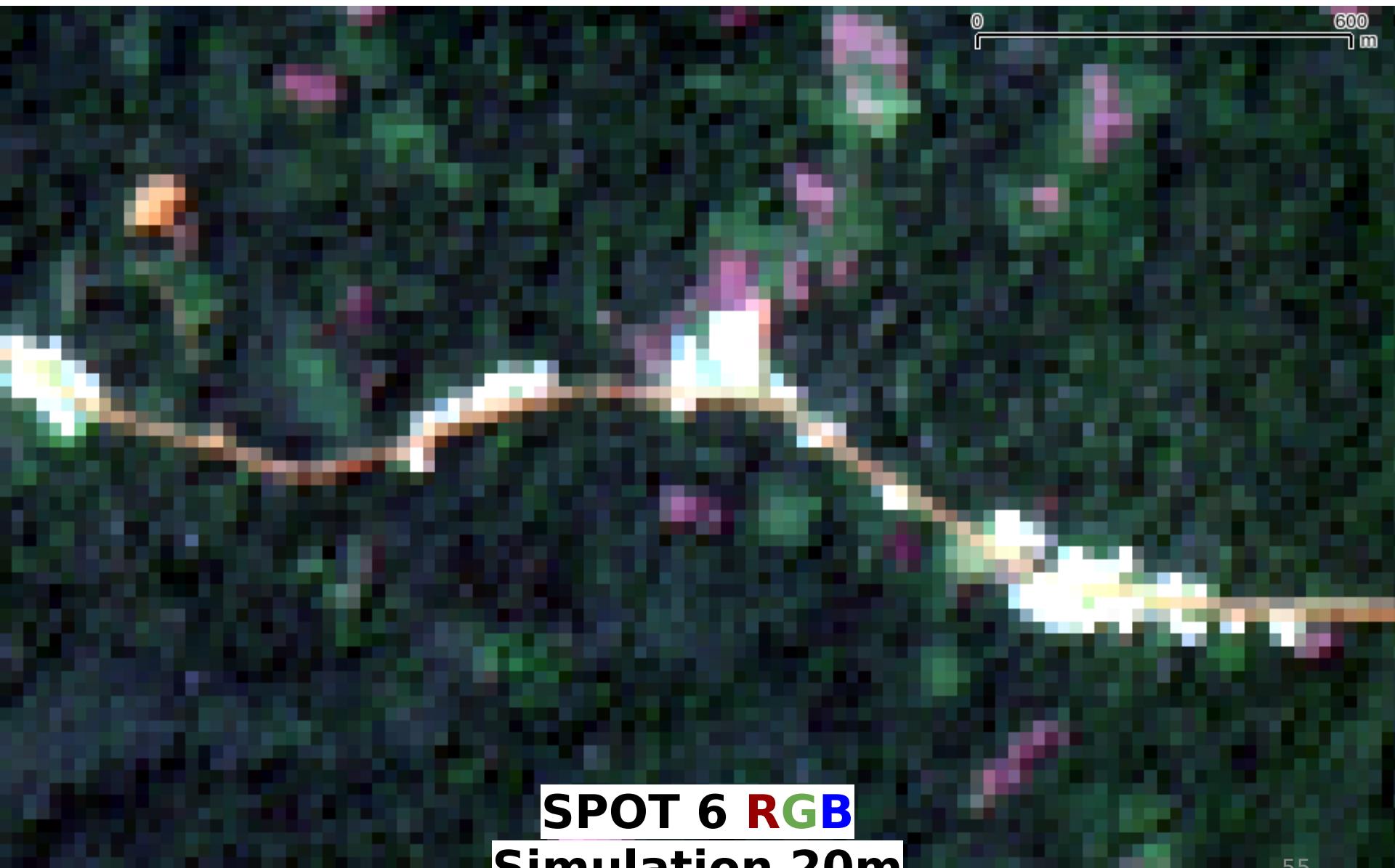
Résolution spatiale



SPOT 6 RGB
Simulation 30m

Introduction à la télédétection

Résolution spatiale



Introduction à la télédétection

Résolution spatiale



SPOT 6 RGB
Simulation 10m

Introduction à la télédétection

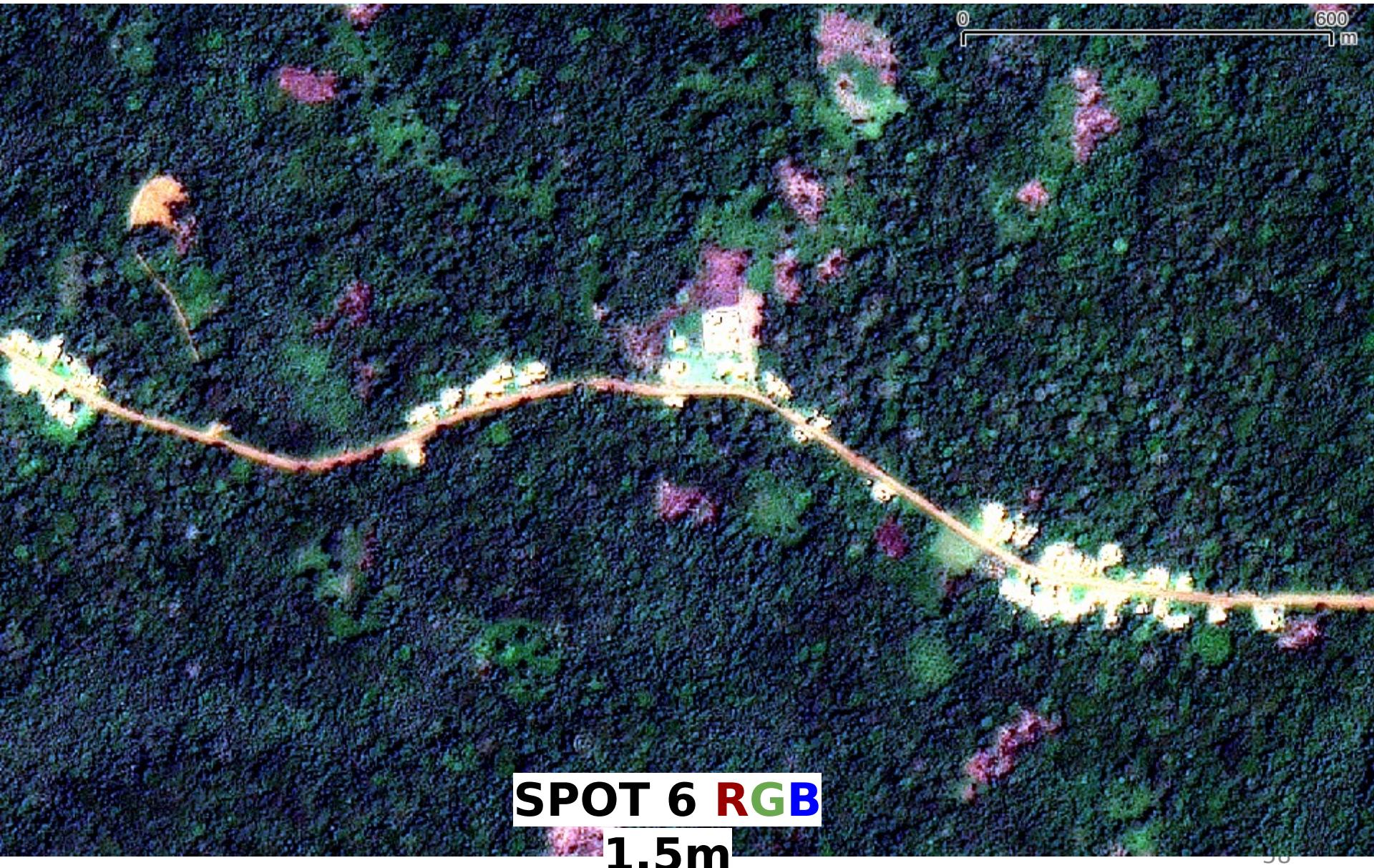
Résolution spatiale



SPOT 6 RGB
Simulation 5m

Introduction à la télédétection

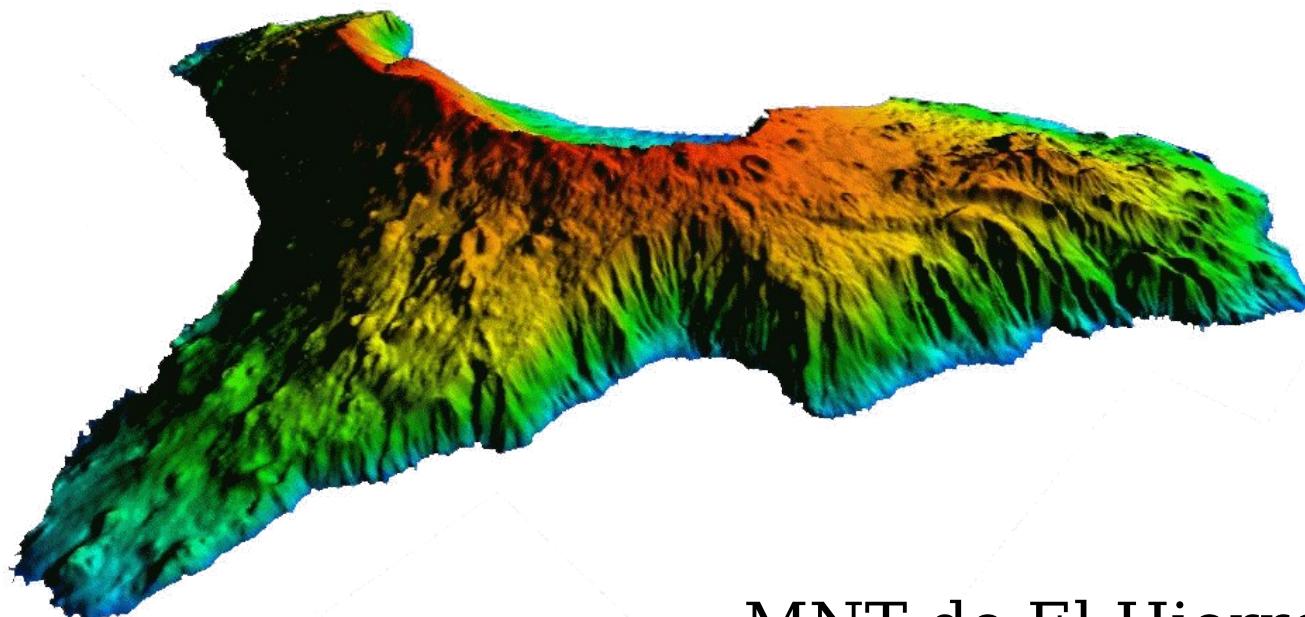
Résolution spatiale



Documentation optical data (Sentinel-2) processing

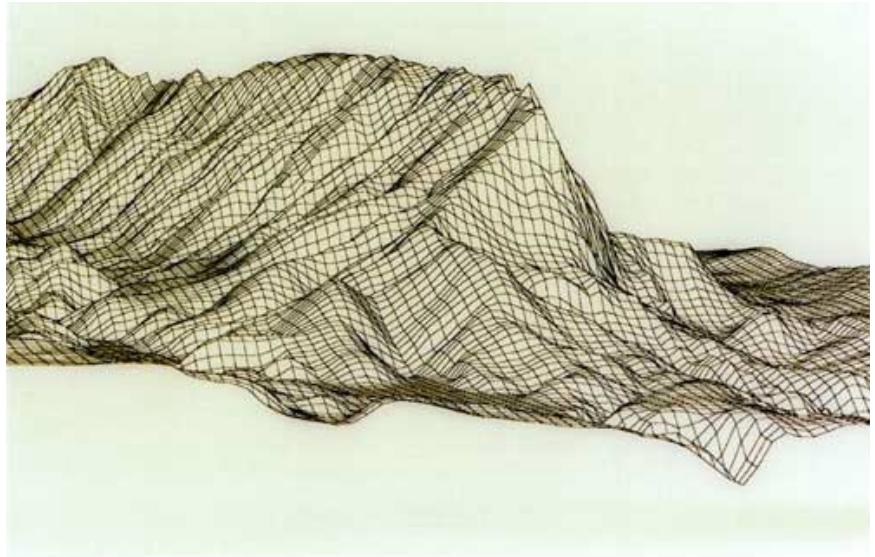
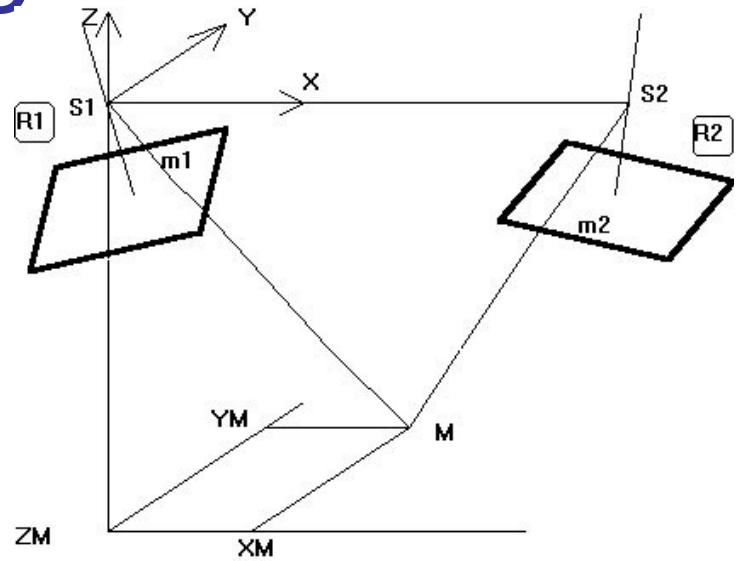
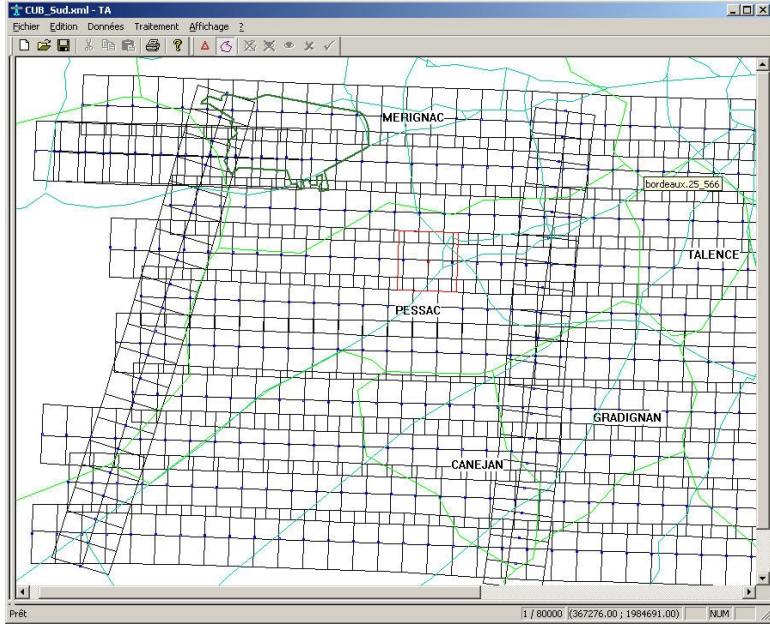
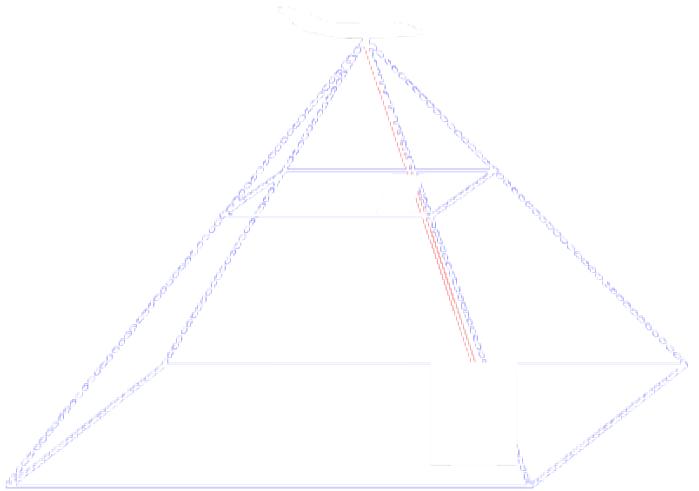
<http://www.onfinternational.com/data/technical/tutorials/Sentinel-2-Optical-Data-Processing>

STÉRÉOSCOPIE: Accès au relief



MNT de El Hierro, Canari
IGN Espagn

Photogrammétrie



BRIGE

