

Applications of multi-spectral satellite data

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Adjusted by E de Coning
South African Weather Service

Content



1. Why should we use RGBs?
2. How do we construct an RGB product?
3. Recommended RGBs
4. Examples
5. Quiz

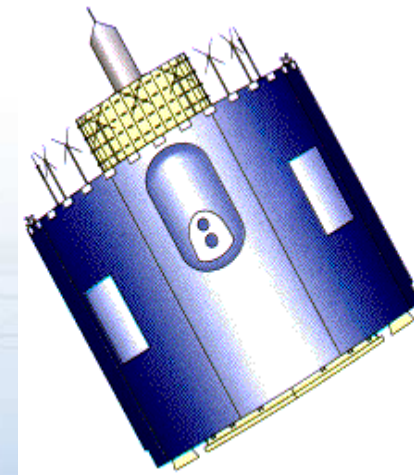
METEOSAT SECOND GENERATION (MSG)



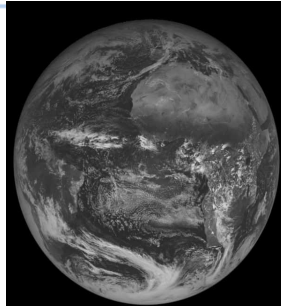
Ariane 513 Vol 155 - ATLANTIC BIRD™ 1 - MSG 1 - 28 août 2002

MSG-1 Launch on 28 Aug 2002

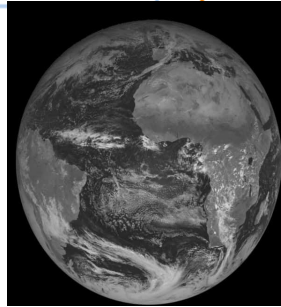
- Spinning Enhanced Vis & IR Imager
- 12 Spectral Channels
- Full Images every 15 Minutes
- Reduced Images every 5 Minutes
- 3 km horizontal 'sampling distance' at Sub-Satellite Point (SSP)
- Hi-Res VIS-Channel 1 km sampling distance (SSP)



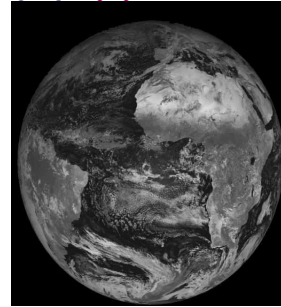
MSG-1 First Image: 28 November 2002



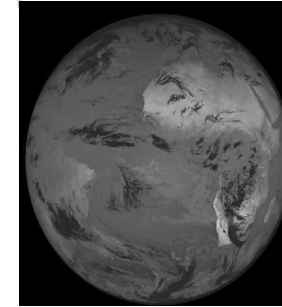
VIS 0.6



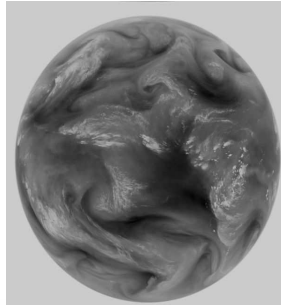
VIS 0.8



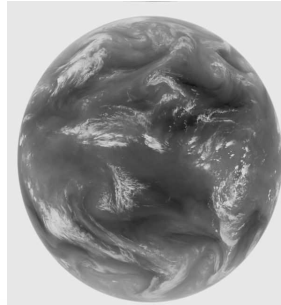
NIR 1.6



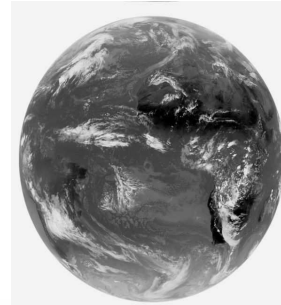
MIR 3.9



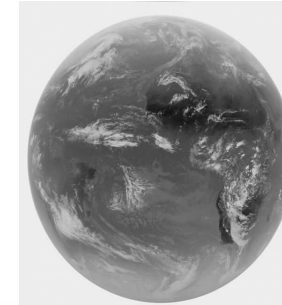
WV 6.2



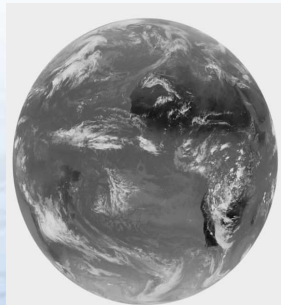
WV 7.3



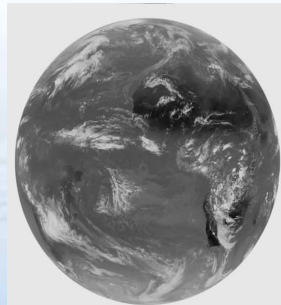
IR 8.7



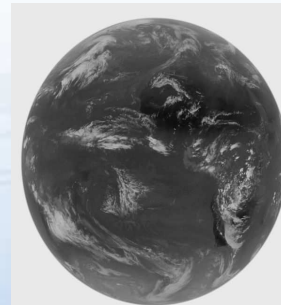
IR 9.7



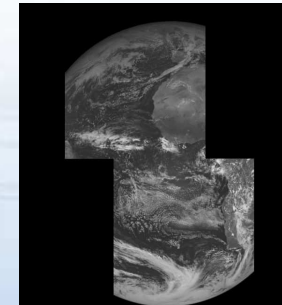
IR 10.8



IR 12.0



IR 13.4

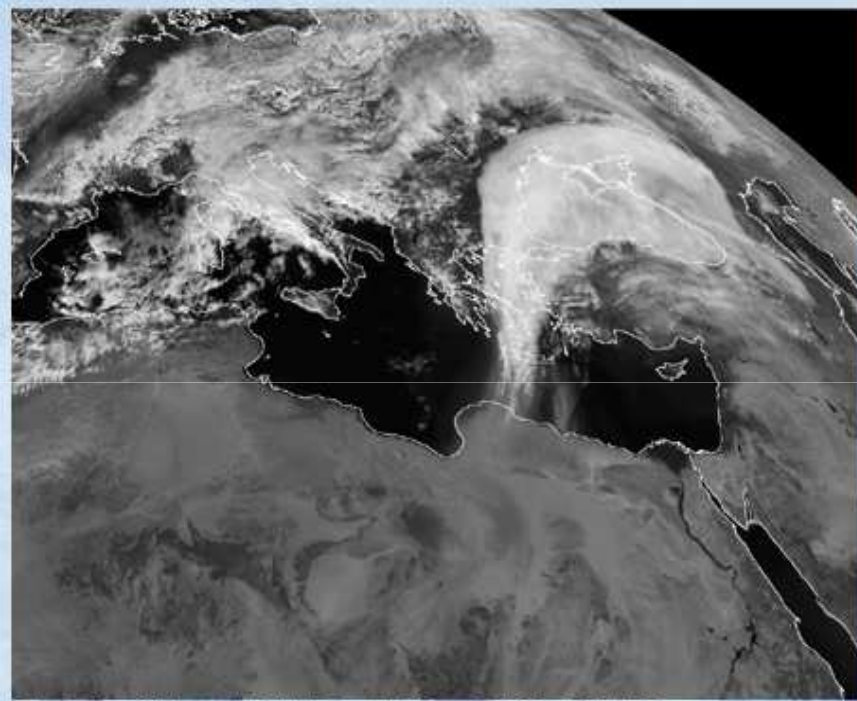


HRV

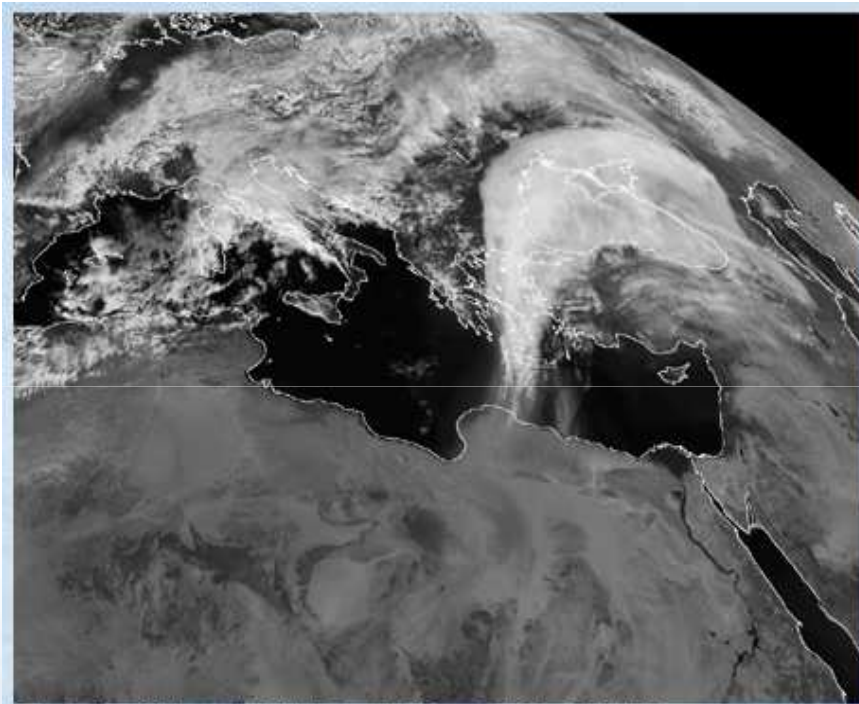
RGB PRODUCTS – A WAY TO APPLY SATELLITE INFORMATION VISUALLY

Ex 1: Where is the dust cloud ?

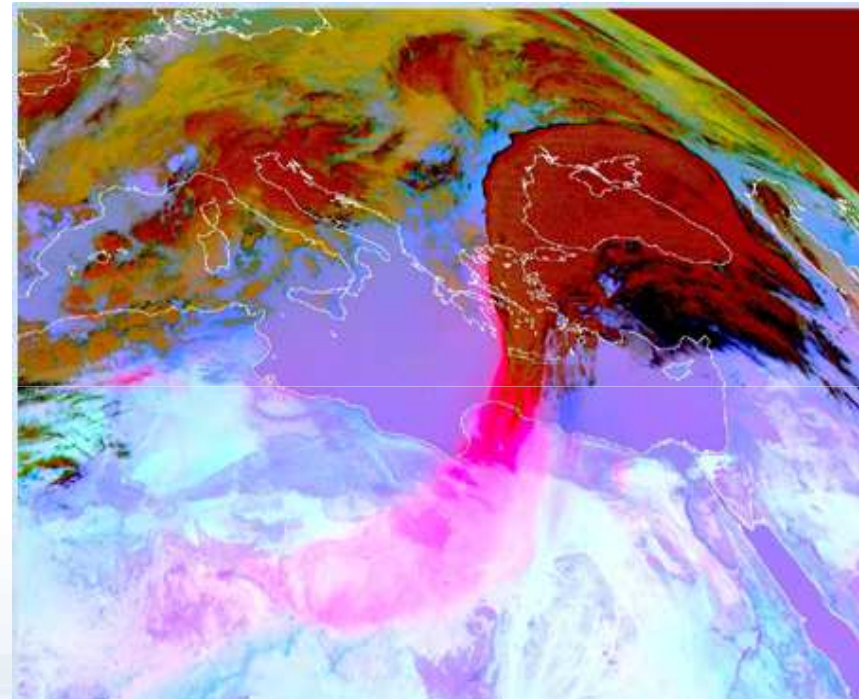
Visible (VIS0.6) image



Visible (VIS0.6) image



Dust RGB Product

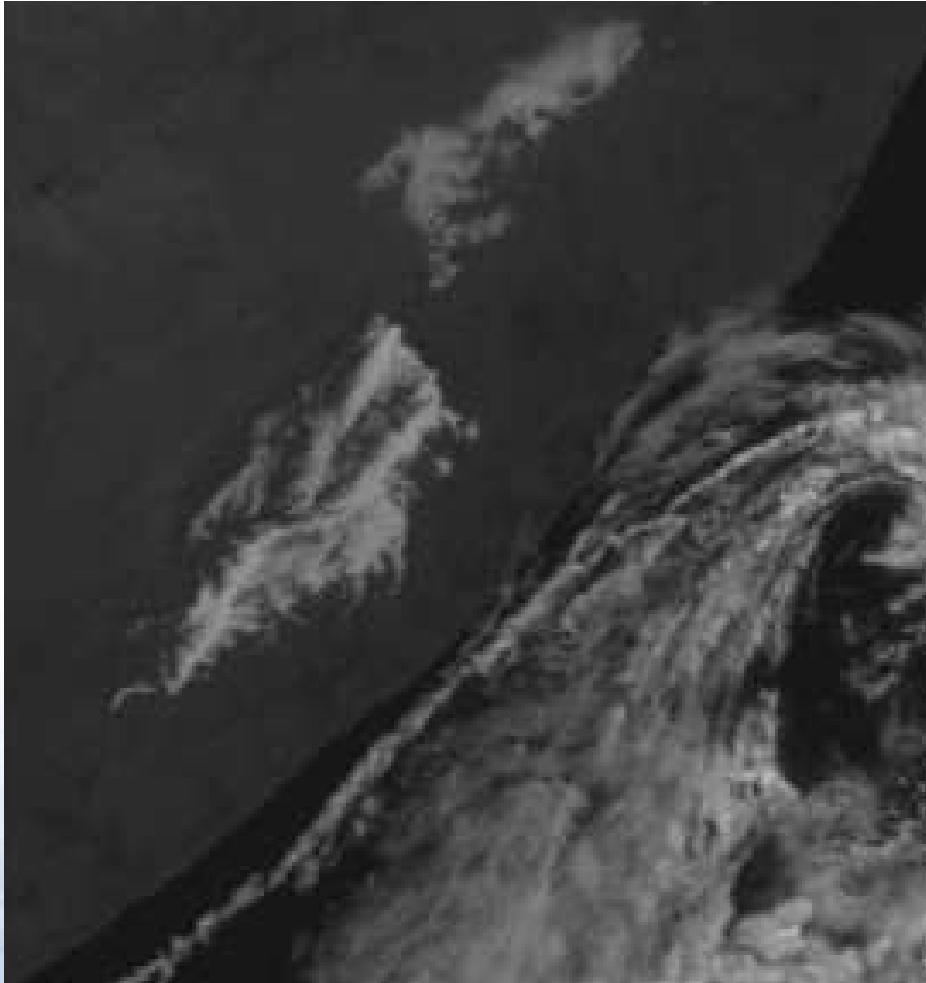


23 March 2008, 12 UTC

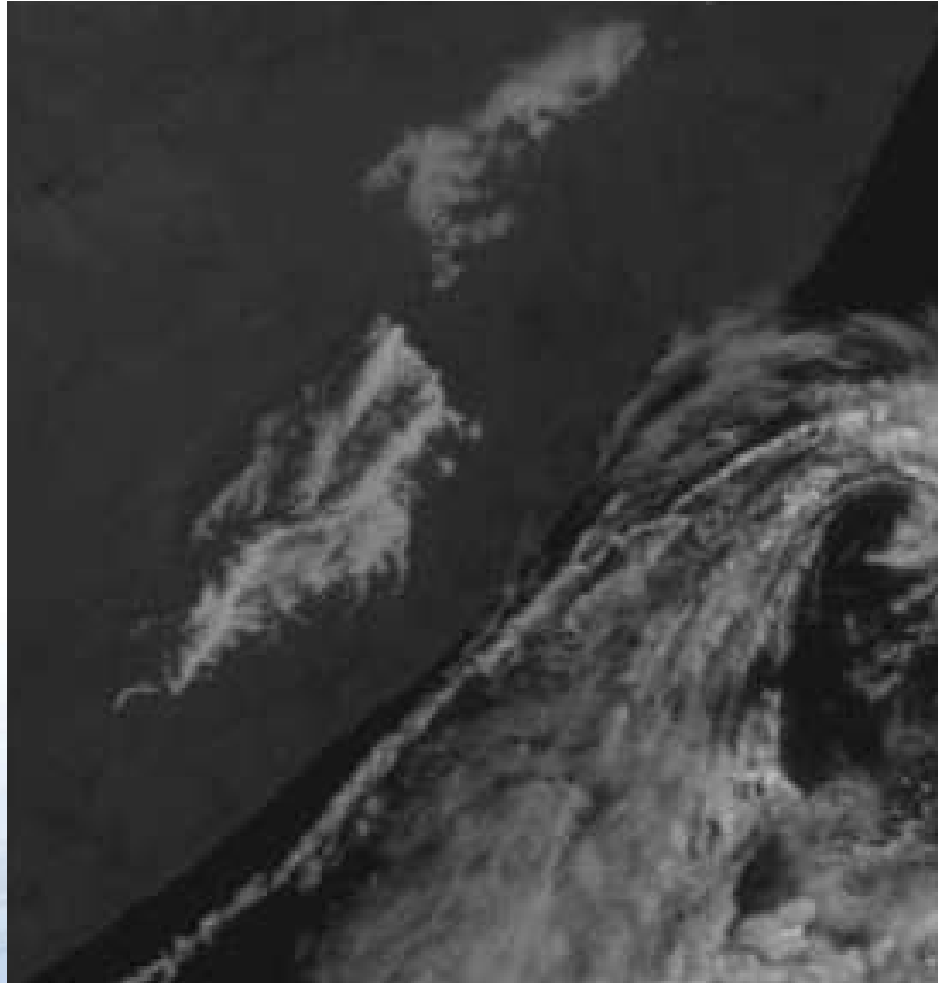
EUMETRAIN Module on RGB images:

http://www.zamg.ac.at/eumetrain/Seiten/CAL_Topic.htm

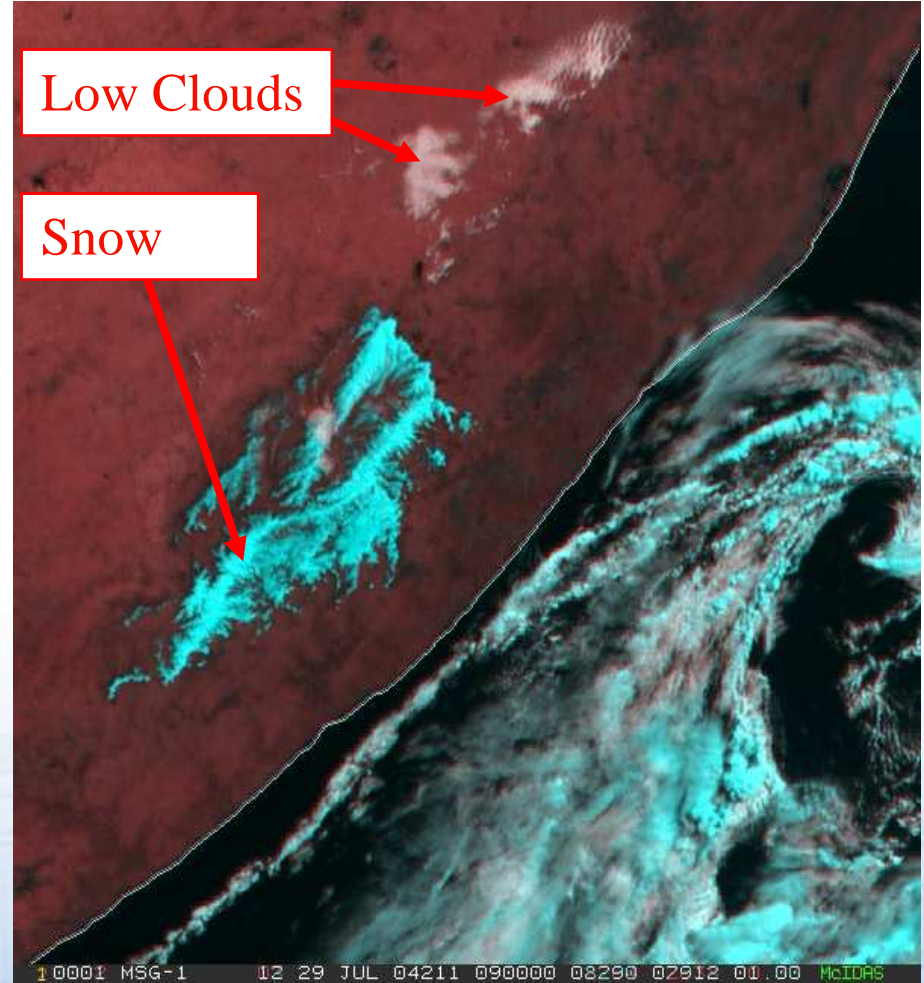
Ex 2: Where is a) snow and b) where are the low clouds ?



MFG VIS Channel



MFG VIS Channel



Low Clouds

Snow

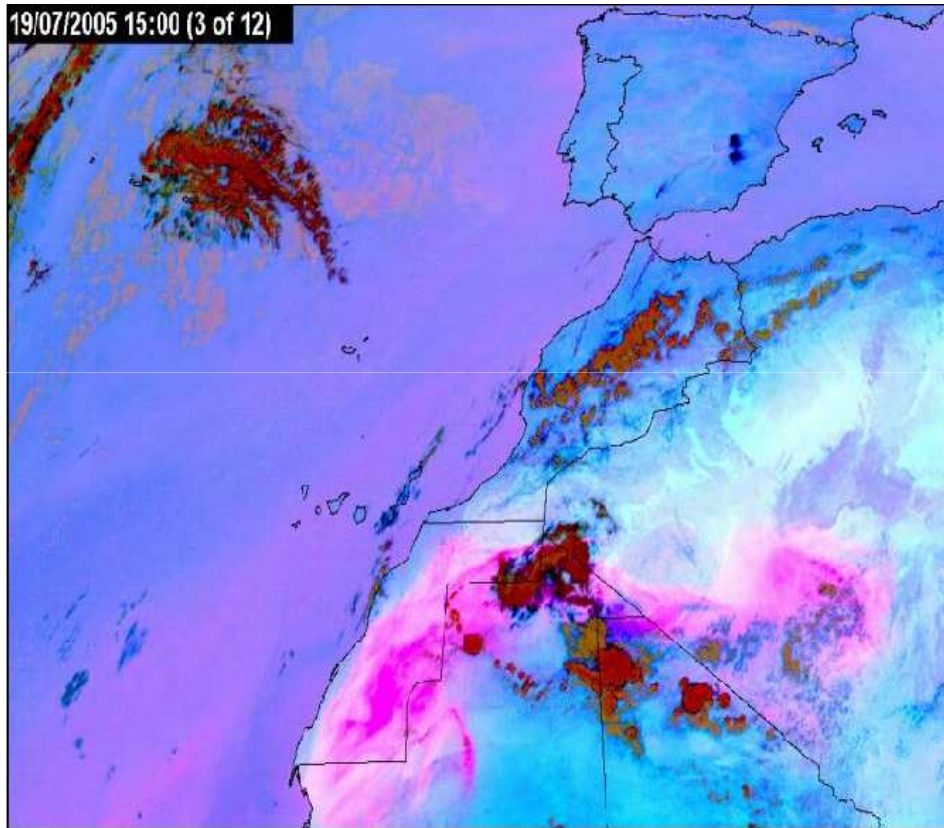
MSG RGB HRV, NIR1.6

29 July 2004, 09 UTC



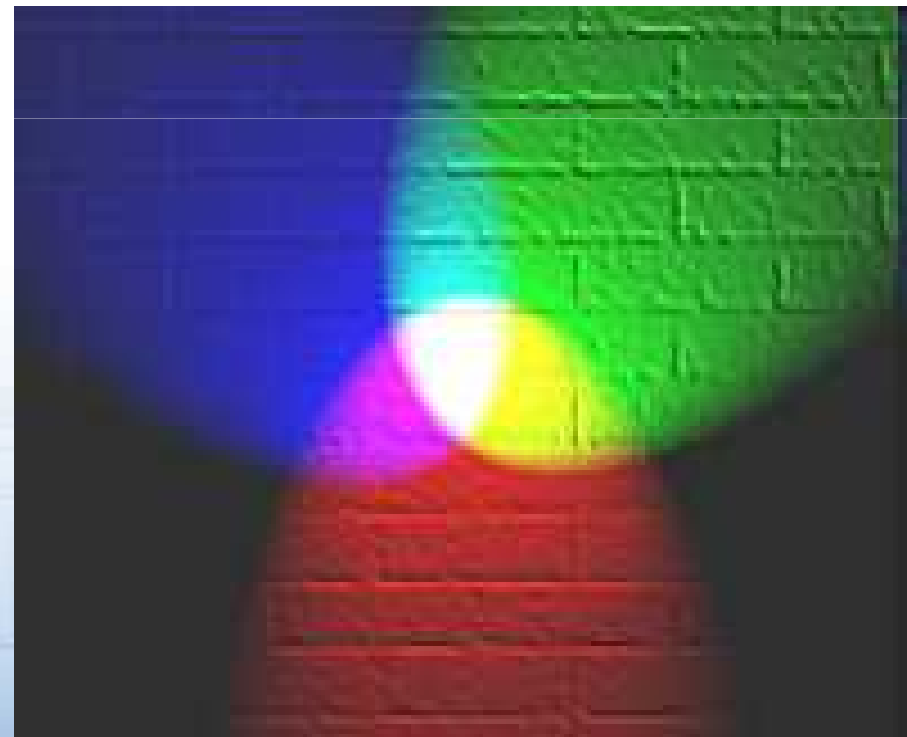
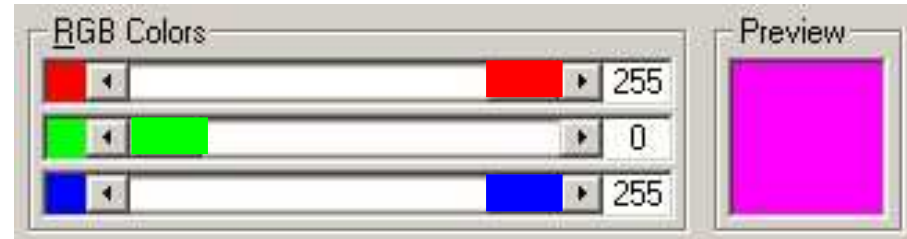
HOW DO WE MAKE RGB PRODUCTS?

RGB Image Composites – How?



How do we get a picture like this?

Exercise - Which of these colours do you need to make magenta ?



Color Selector

Edit Options Help

RGB Colors

Red: 255
 Green: 0
 Blue: 254

Darker: [Slider] Lighter

Format Converter

HTML [Dropdown] [Input] Convert

Color Dialog
 Palette Tool
 Copy Swatch

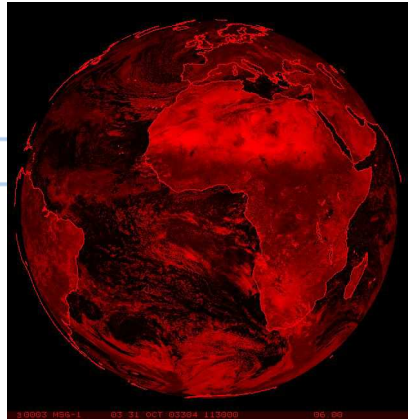
Preview: [Magenta Square]

Picker: [Crosshair Icon]
 Click & Drag
 X:
 Y:

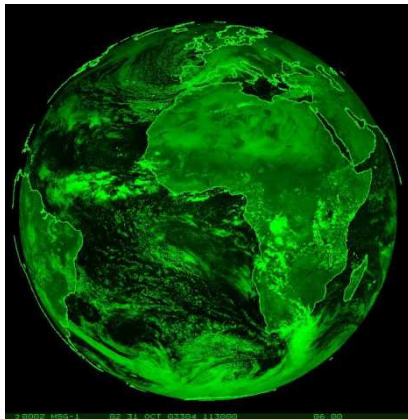
H <u>I</u> ML	R <u>G</u> B	H <u>S</u> L	C <u>M</u> Y
#FF00FE	255,0,254	300,255,128	0,255,1
Hexadecimal	D <u>e</u> cimal	O <u>c</u> tal	
FE00FF	16646399	77400377	

Principle of RGB

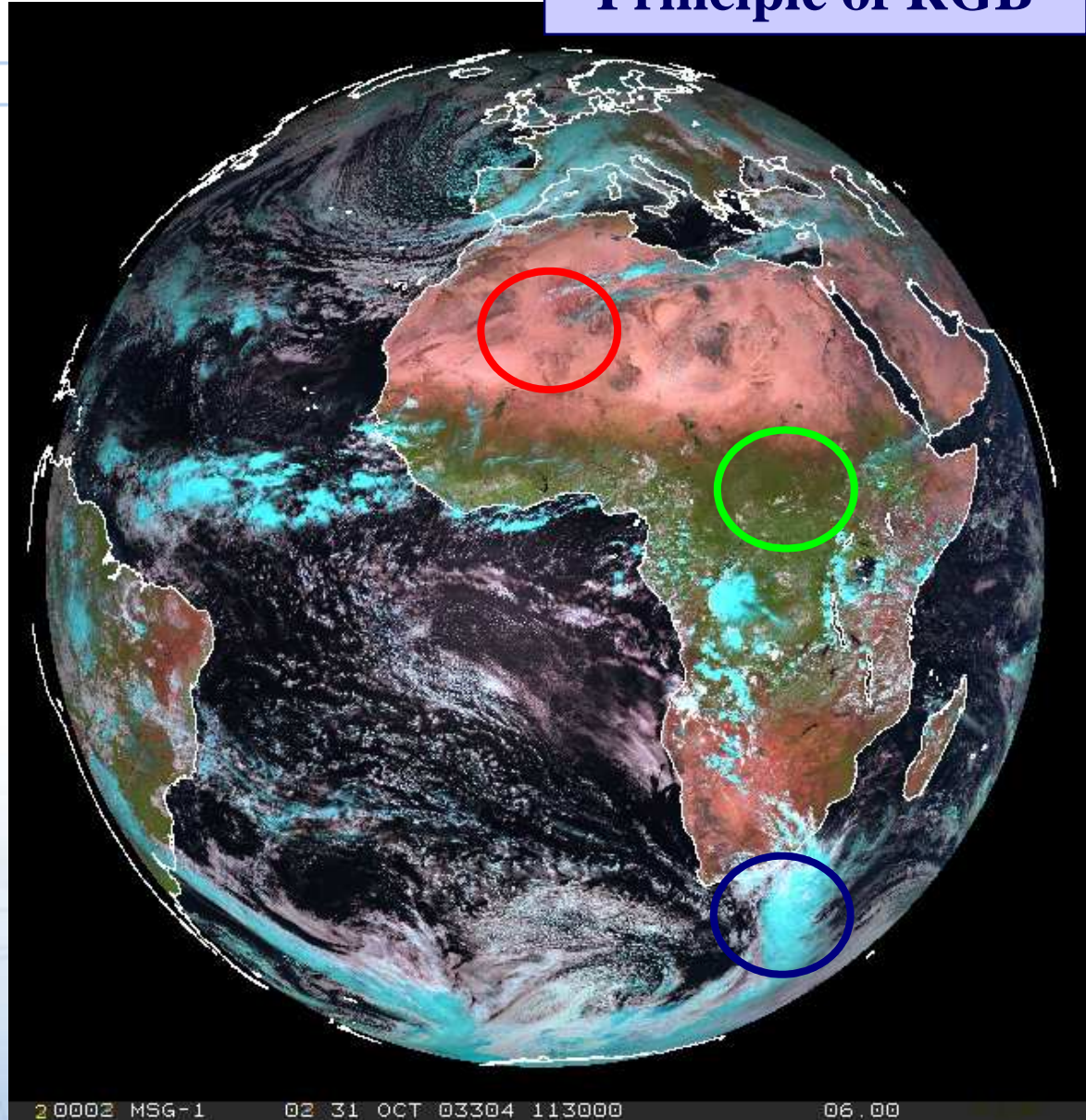
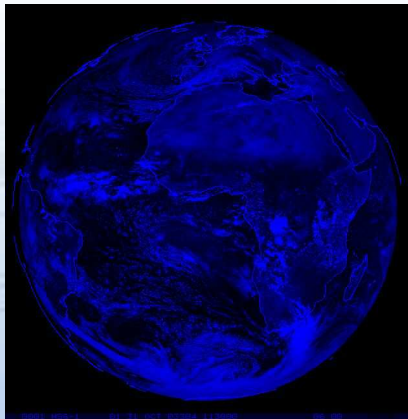
NIR1.6



VIS0.8



VIS0.6



20002 MSG-1 02 31 OCT 03304 113000 06.00


Principle of RGB


Color Selector

Edit Options Help

RGB Colors

Red: 218
Green: 140
Blue: 134

Preview: 

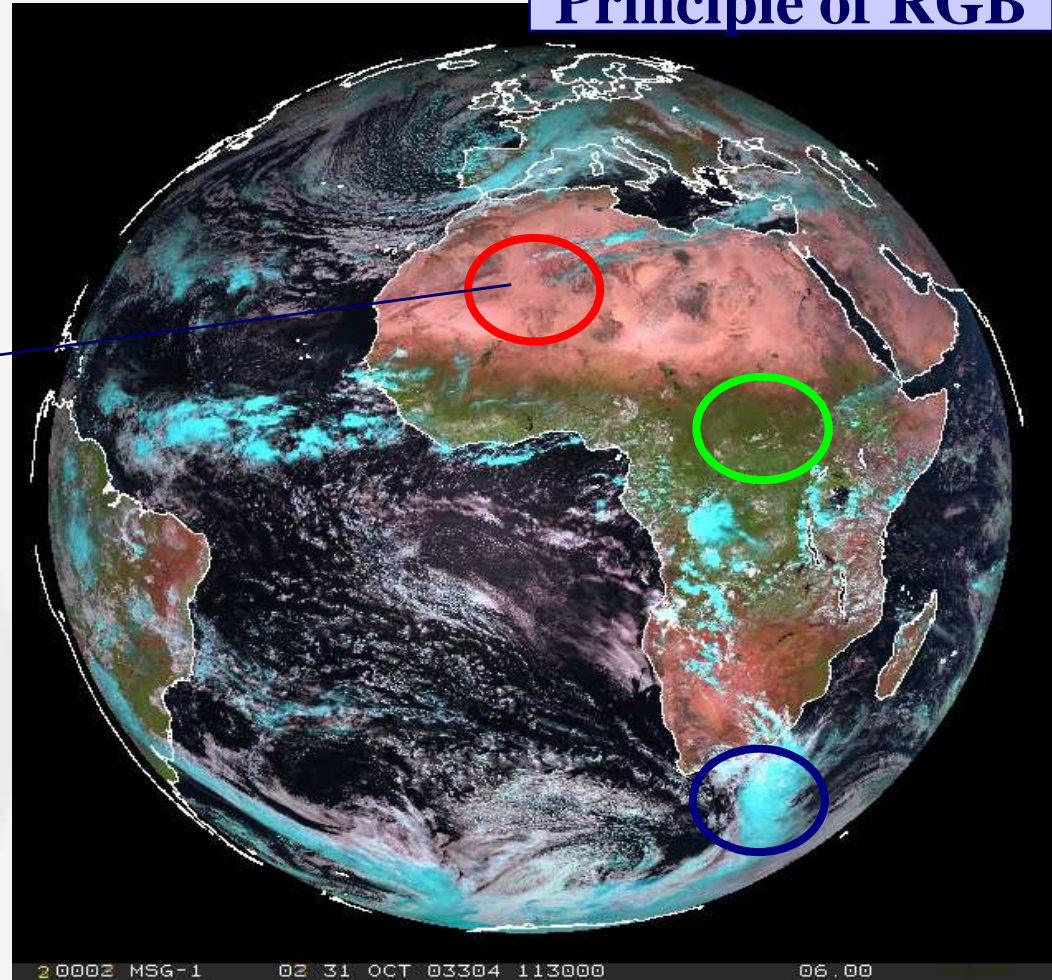
Picker: 
Click & Drag
X: 1118
Y: 500

Format Converter

HTML: Convert

Color Dialog
Palette Tool
Copy Swatch

HTML	RGB	HSL	CMY
#DA8C86	218,140,134	4,136,176	37,115,121
Hexadecimal	Decimal	Octal	
868CDA	8817882	41506332	



Earth Surface

Channel 03 (NIR1.6)

Clouds

High reflectance

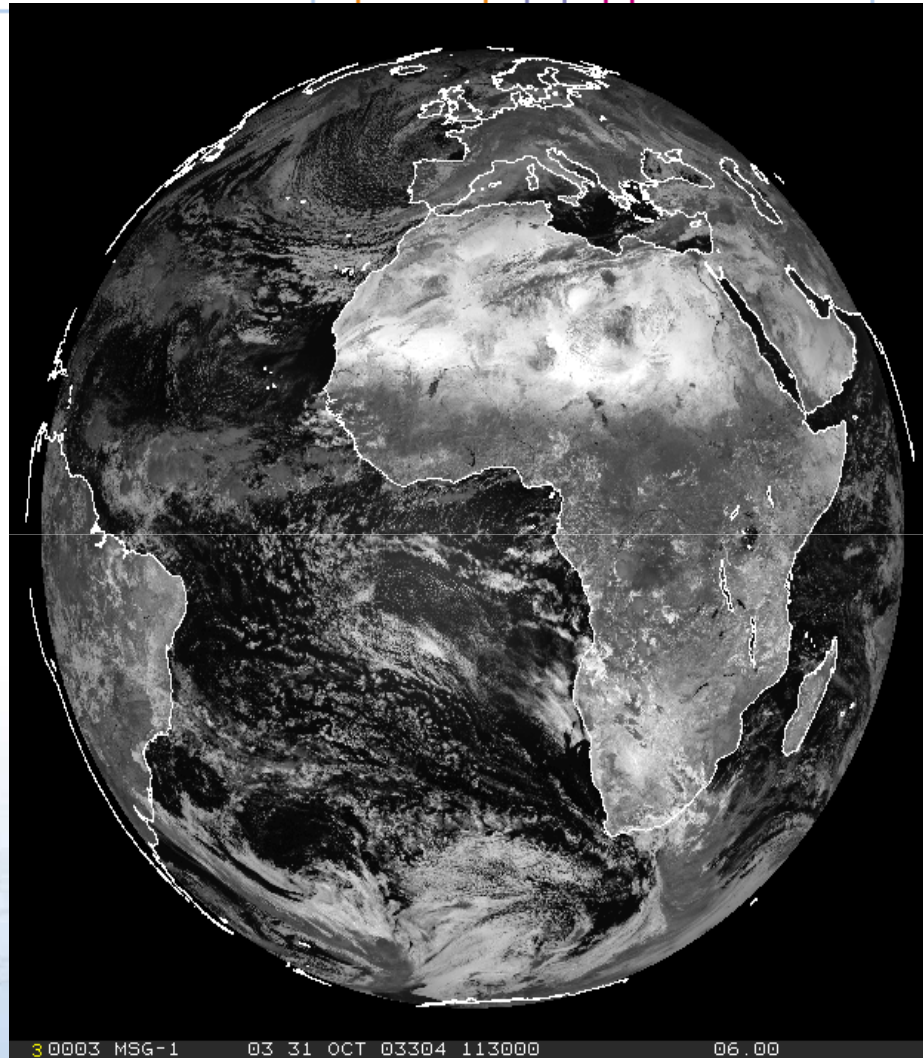
Sun Glint
Sand Desert

Gras, Rice fields

Forest

Bare Soil

Snow
Ocean, Sea



Water clouds with small droplets

Water clouds with large droplets

Ice clouds with small particles

Ice clouds with large particles

31 October 2003, 11:30 UTC

Earth Surface

Channel 02 (VIS0.8)

Clouds

Sun Glint
Snow

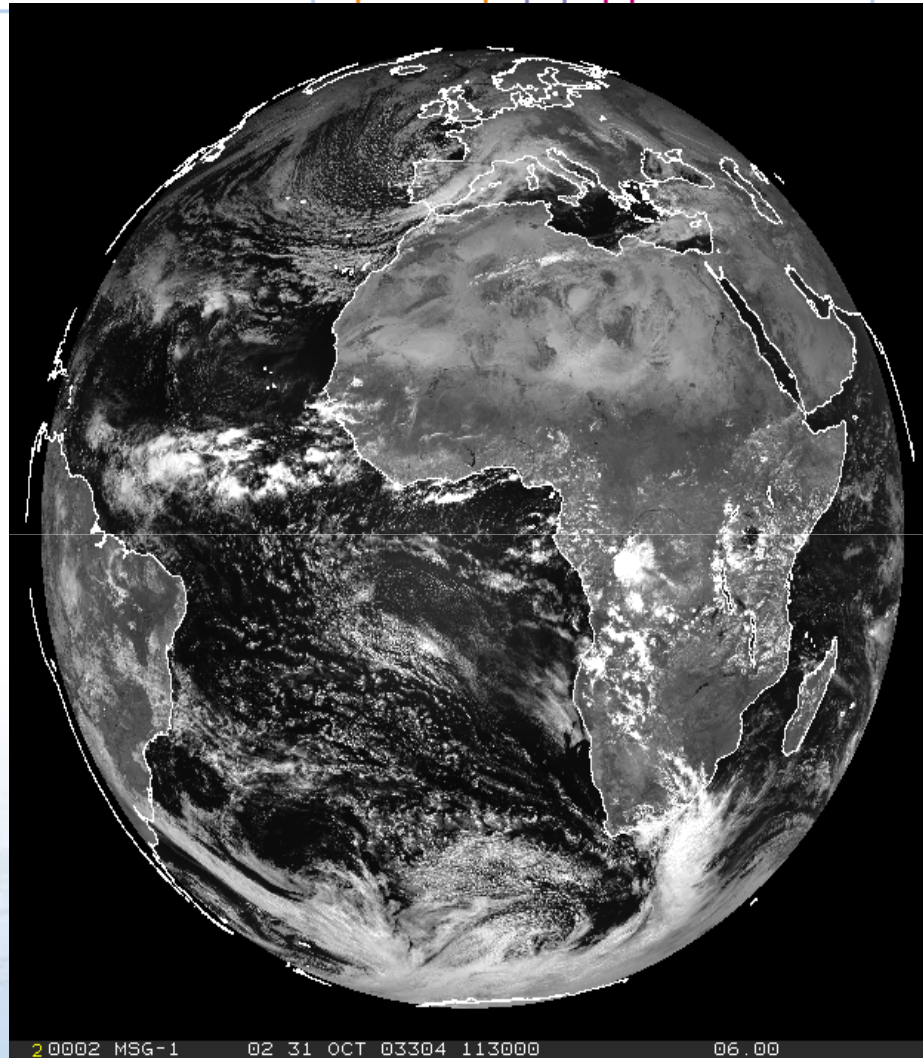
Desert

Gras, Rice fields

Forest

Bare Soil

Ocean, Sea



High reflectance

Very thick
clouds

Very thin clouds
over land

Very thin clouds
over ocean

31 October 2003, 11:30 UTC

Earth Surface

Channel 01 (VIS0.6)

Clouds

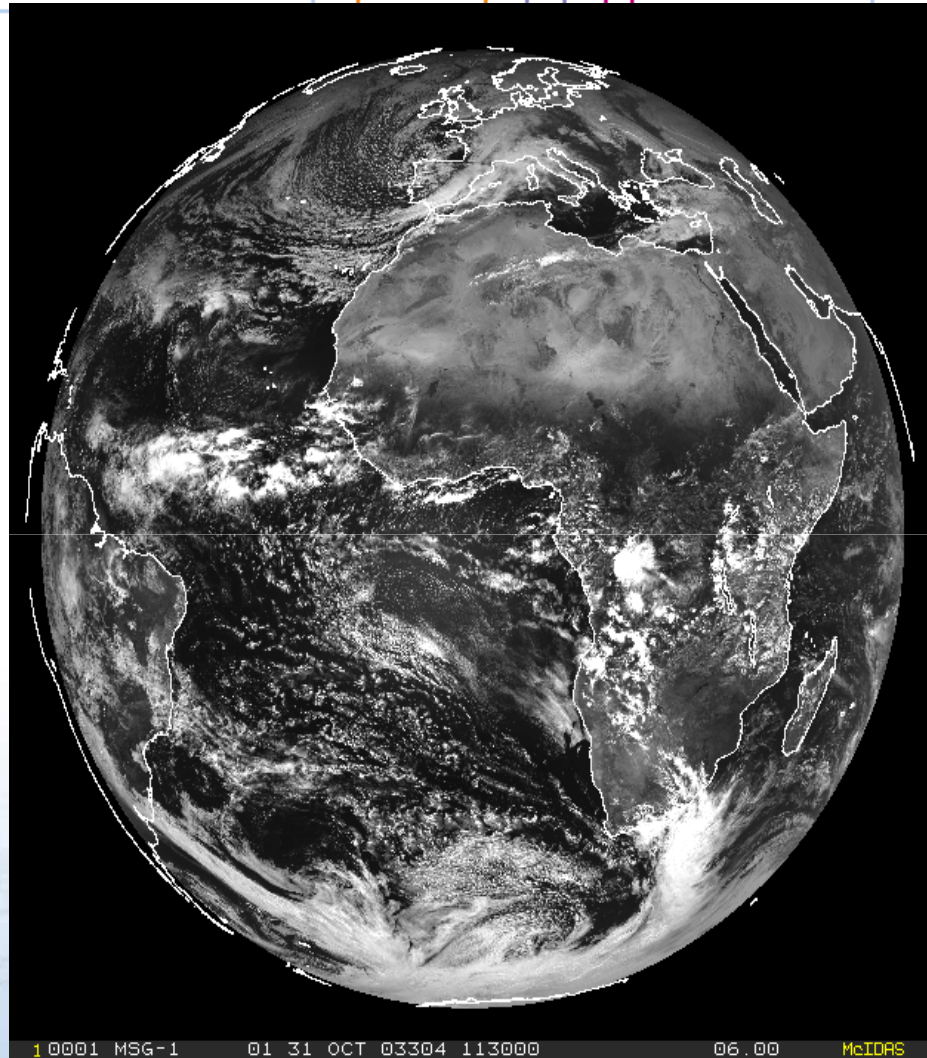
Sun Glint
Snow

Desert

Bare Soil

Forest

Ocean, Sea



High reflectance

Very thick
clouds

Very thin clouds
over land

Very thin clouds
over ocean

31 October 2003, 11:30 UTC

Principle of RGB

Color Selector
Edit Options Help

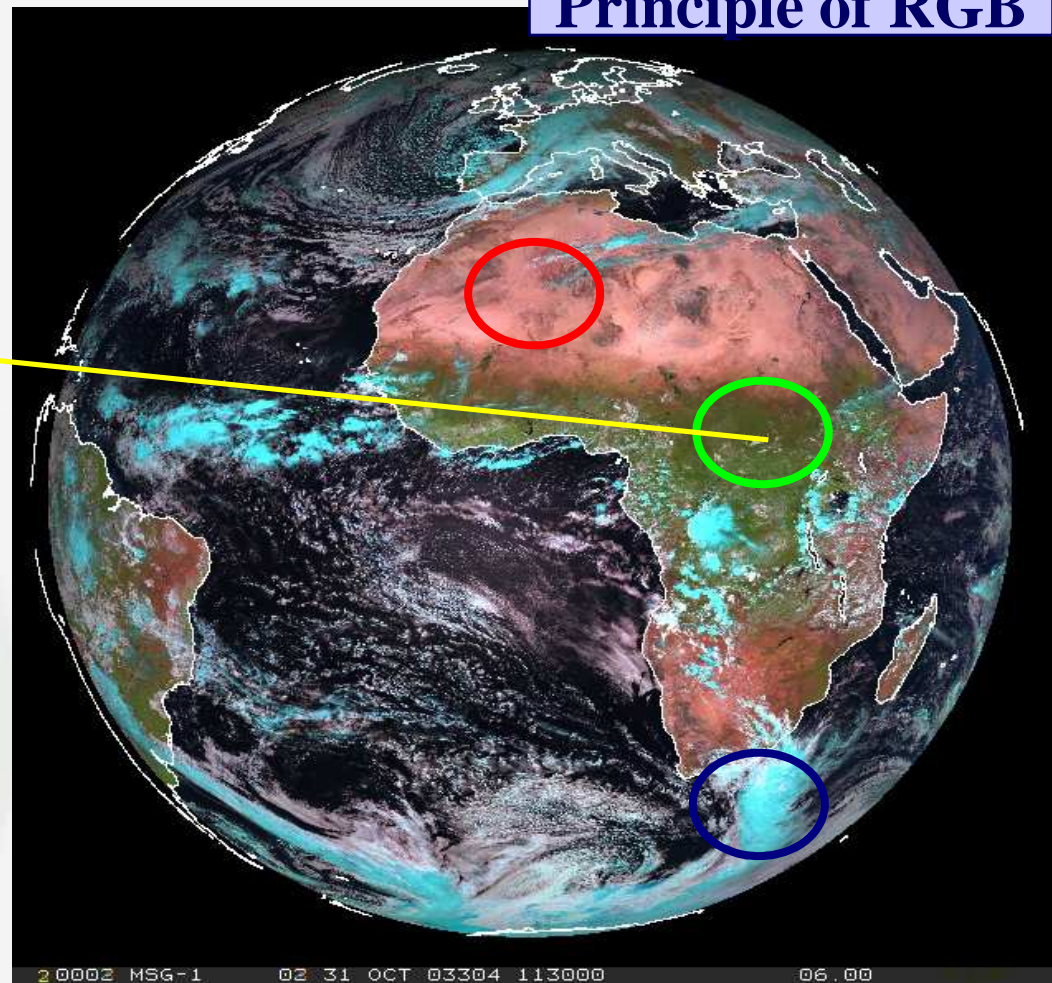
RGB Colors
Red: 72
Green: 75
Blue: 31

Preview: [Dark Green Swatch] ←

Picker: Click & Drag
X: 1152
Y: 509

Format Converter
HTML: [Dropdown] Convert

HTML	RGB	HSL	CMY
#484B1F	72,75,31	64,106,53	183,180,224
Hexadecimal	Decimal	Octal	
1F4B48	2050888	7645510	



Earth Surface

Channel 03 (NIR1.6)

Clouds

High reflectance

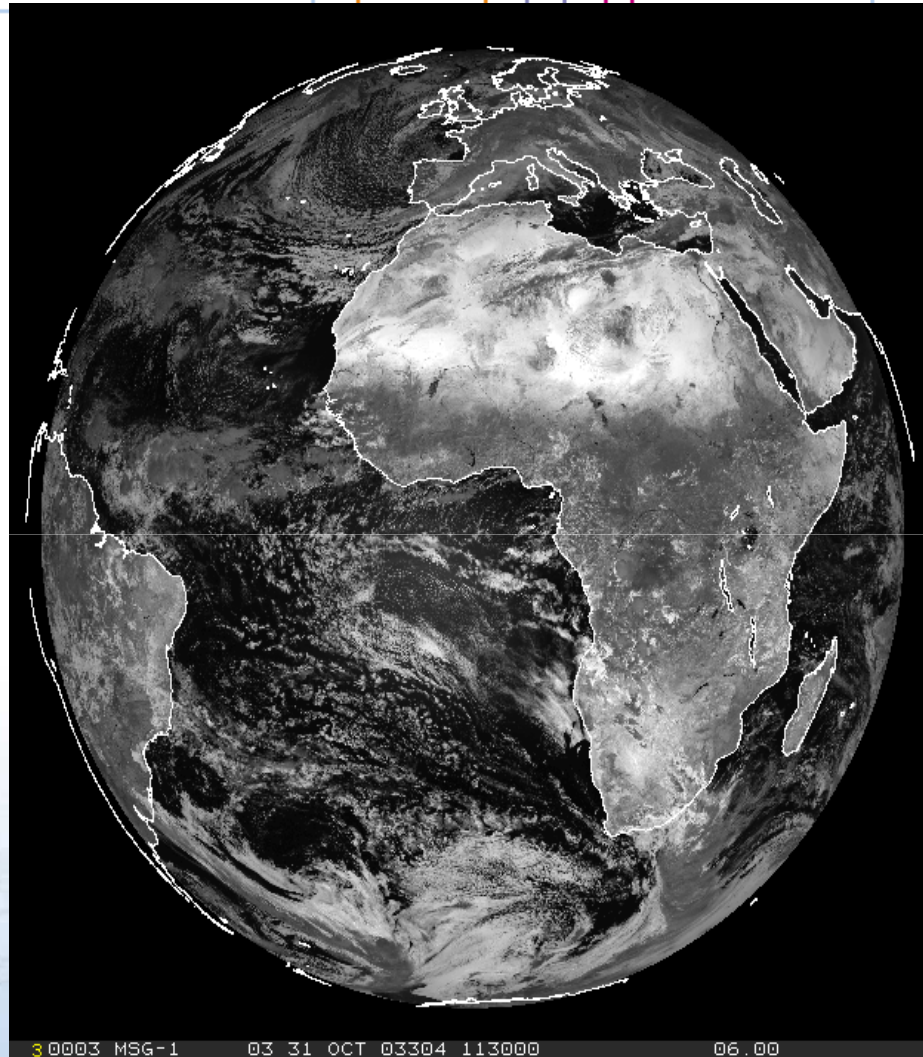
Sun Glint
Sand Desert

Gras, Rice fields

Forest

Bare Soil

Snow
Ocean, Sea



Water clouds
with small
droplets

Water clouds
with large
droplets

Ice clouds with
small particles

Ice clouds with
large particles

31 October 2003, 11:30 UTC

Earth Surface

Channel 02 (VIS0.8)

Clouds

Sun Glint
Snow

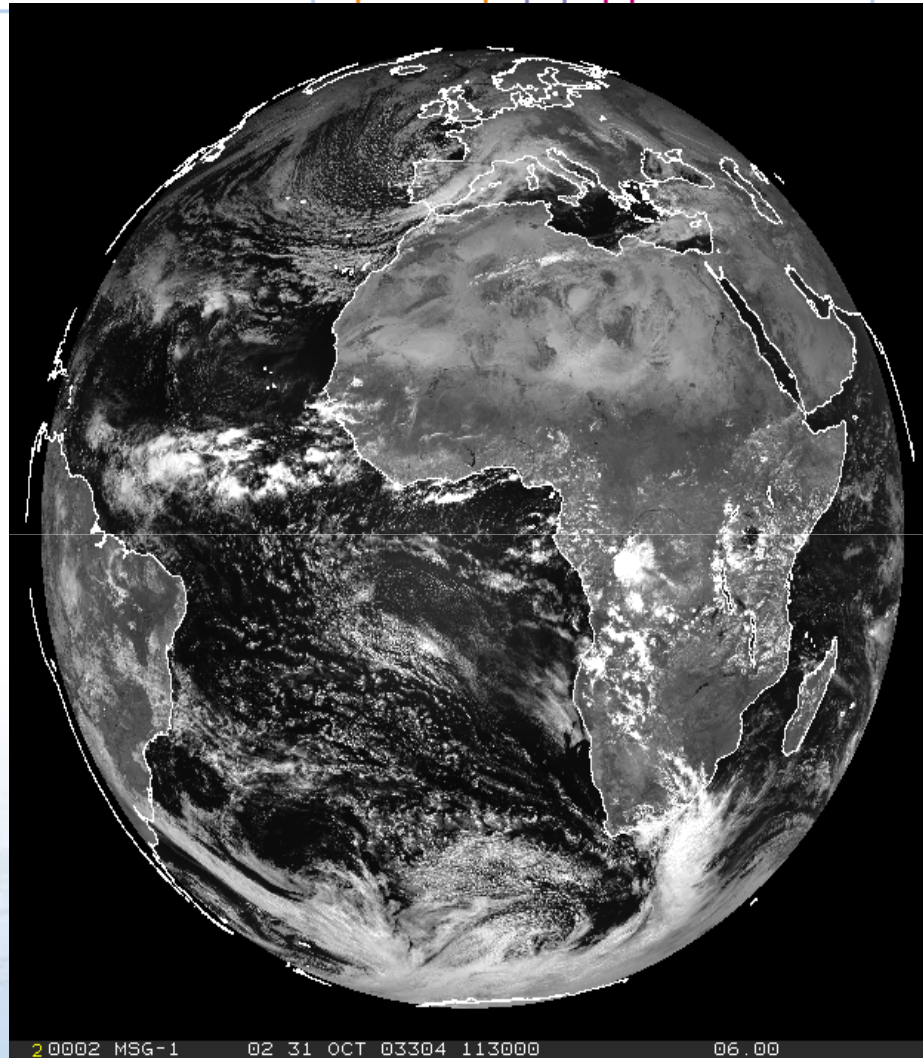
Desert

Gras, Rice fields

Forest

Bare Soil

Ocean, Sea



High reflectance

Very thick
clouds

Very thin clouds
over land

Very thin clouds
over ocean

20002 MSG-1 02 31 OCT 03304 113000 06.00

31 October 2003, 11:30 UTC

Earth Surface

Channel 01 (VIS0.6)

Clouds

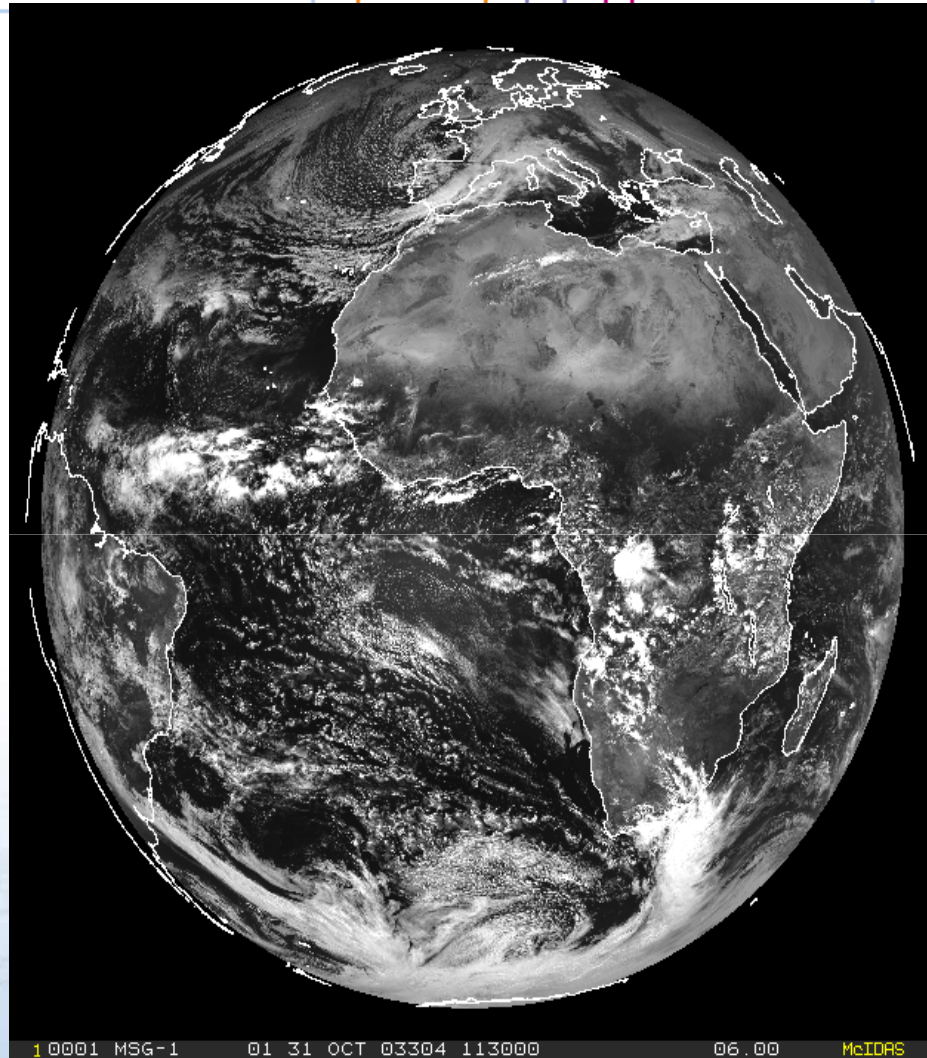
Sun Glint
Snow

Desert

Bare Soil

Forest

Ocean, Sea



High reflectance

**Very thick
clouds**

**Very thin clouds
over land**

**Very thin clouds
over ocean**

31 October 2003, 11:30 UTC


Principle of RGB


Color Selector



Edit Options Help

RGB Colors

Red: 83
Green: 224
Blue: 238

Preview: 

Picker: 
Click & Drag
X: 1153
Y: 674

Darken:  Lighten: 

Color Dialog

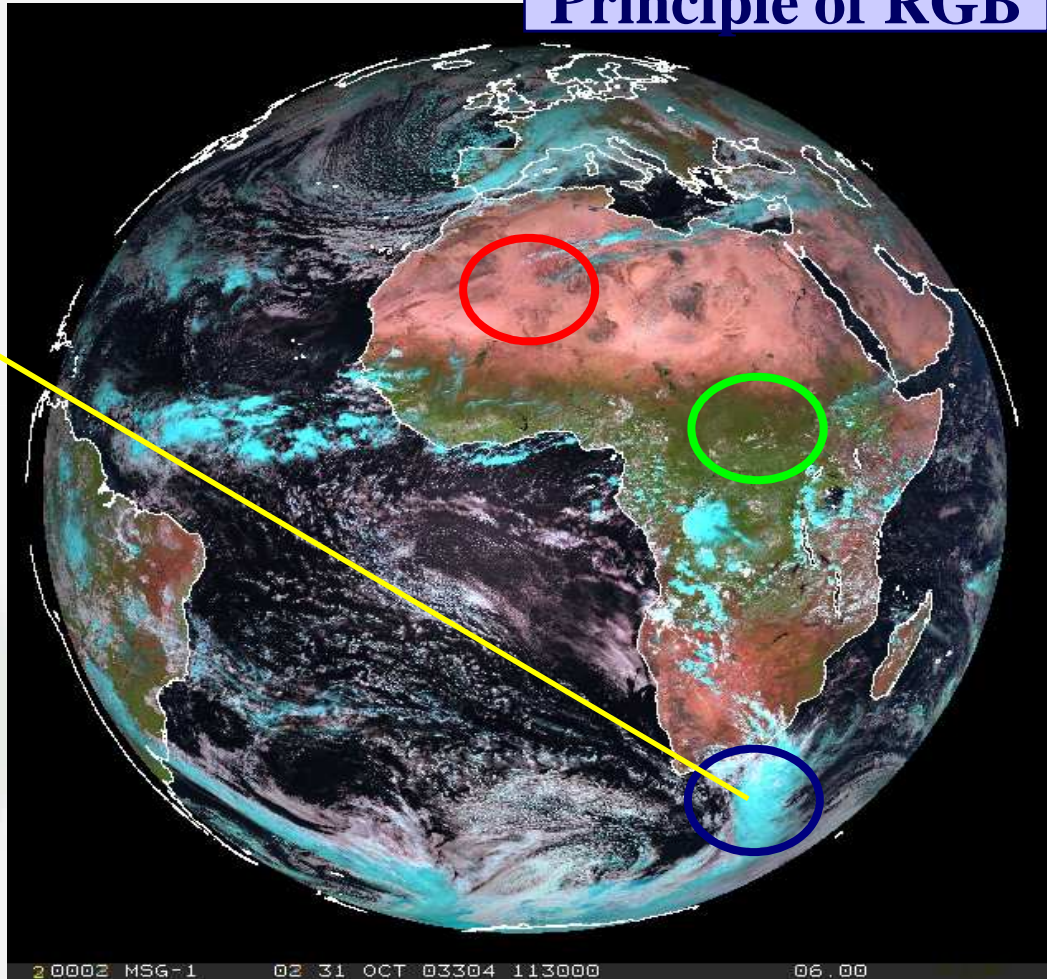
Format Converter

HTML: Convert

Palette Tool

Copy Swatch

HTML	RGB	HSL	CMY
#53E0EE	83,224,238	185,209,160	172,31,17
Hexadecimal	Decimal	Decimal	Octal
EEE053	15654995		73560123



Earth Surface

Channel 03 (NIR1.6)

Clouds

High reflectance

Sun Glint
Sand Desert

Water clouds with small droplets

Gras, Rice fields

Water clouds with large droplets

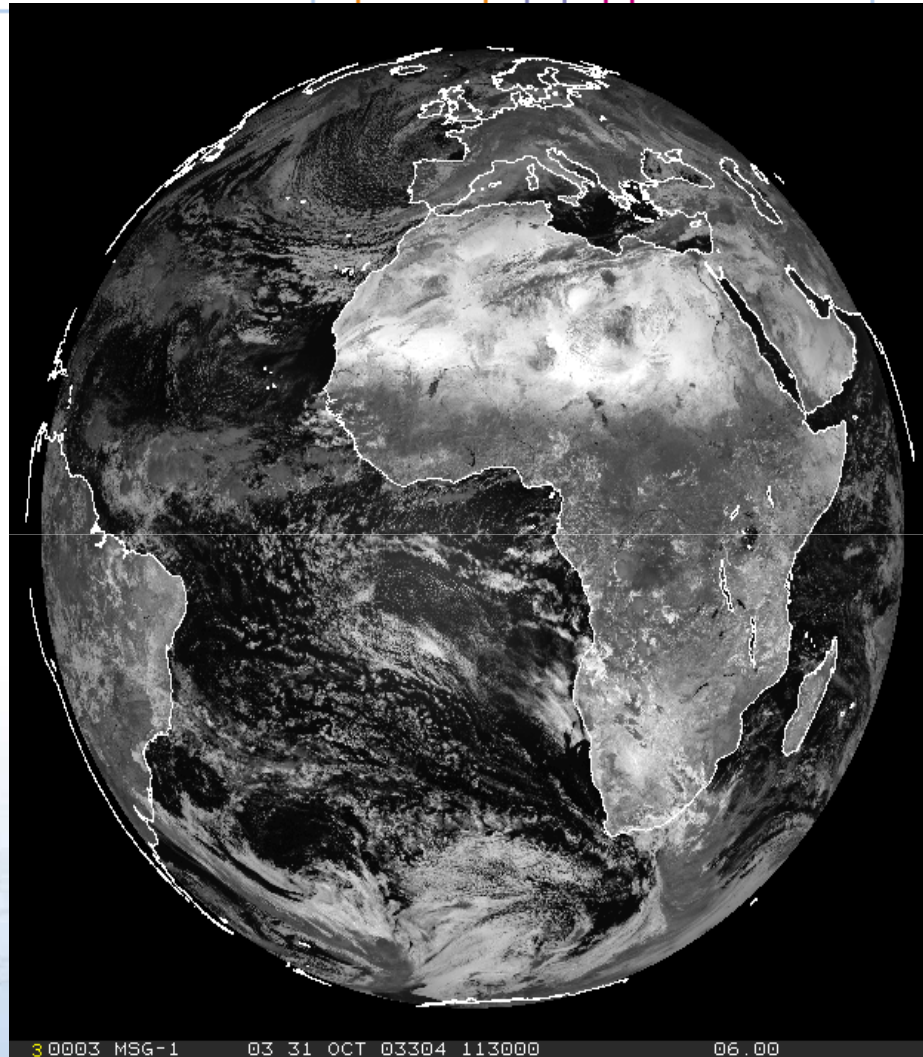
Forest

Ice clouds with small particles

Bare Soil

Snow
Ocean, Sea

Ice clouds with large particles



31 October 2003, 11:30 UTC

Earth Surface

Channel 02 (VIS0.8)

Clouds

Sun Glint
Snow

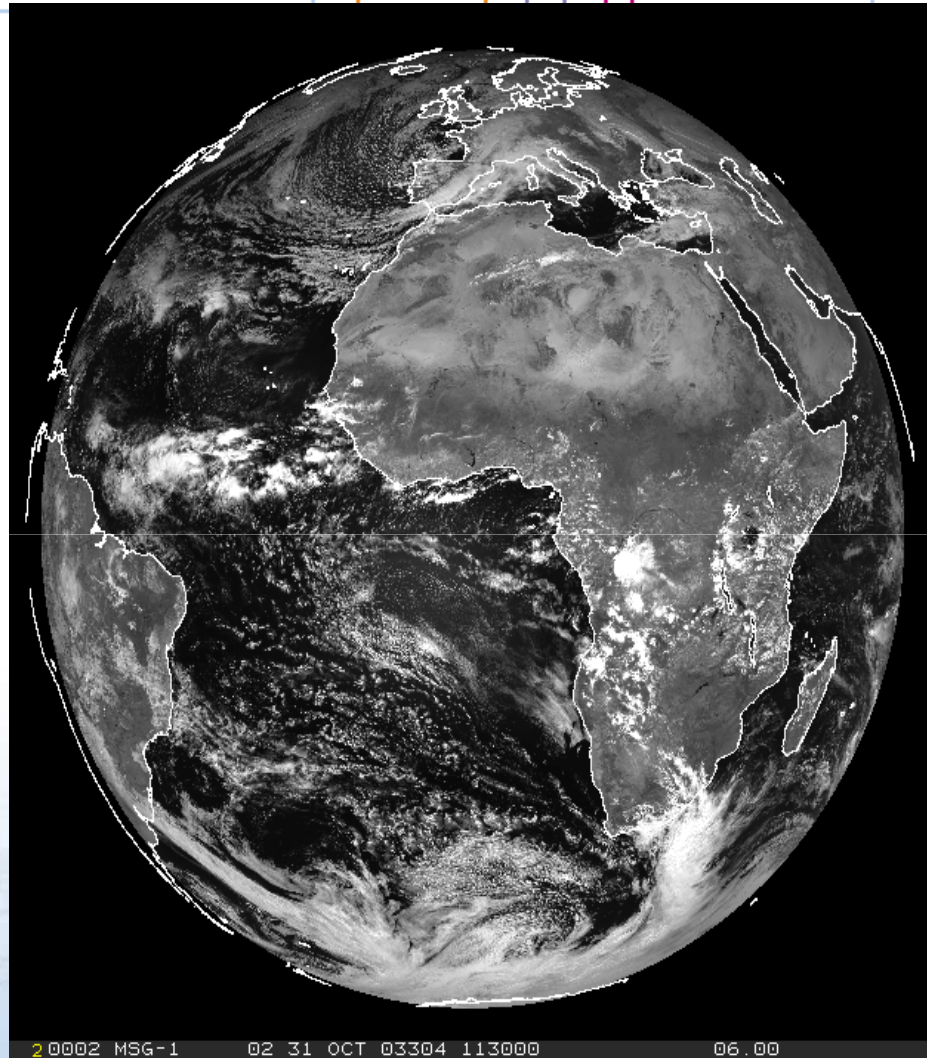
Desert

Gras, Rice fields

Forest

Bare Soil

Ocean, Sea



High reflectance

**Very thick
clouds**

**Very thin clouds
over land**

**Very thin clouds
over ocean**

Low reflectance

31 October 2003, 11:30 UTC



Earth Surface

Channel 01 (VIS0.6)

Clouds

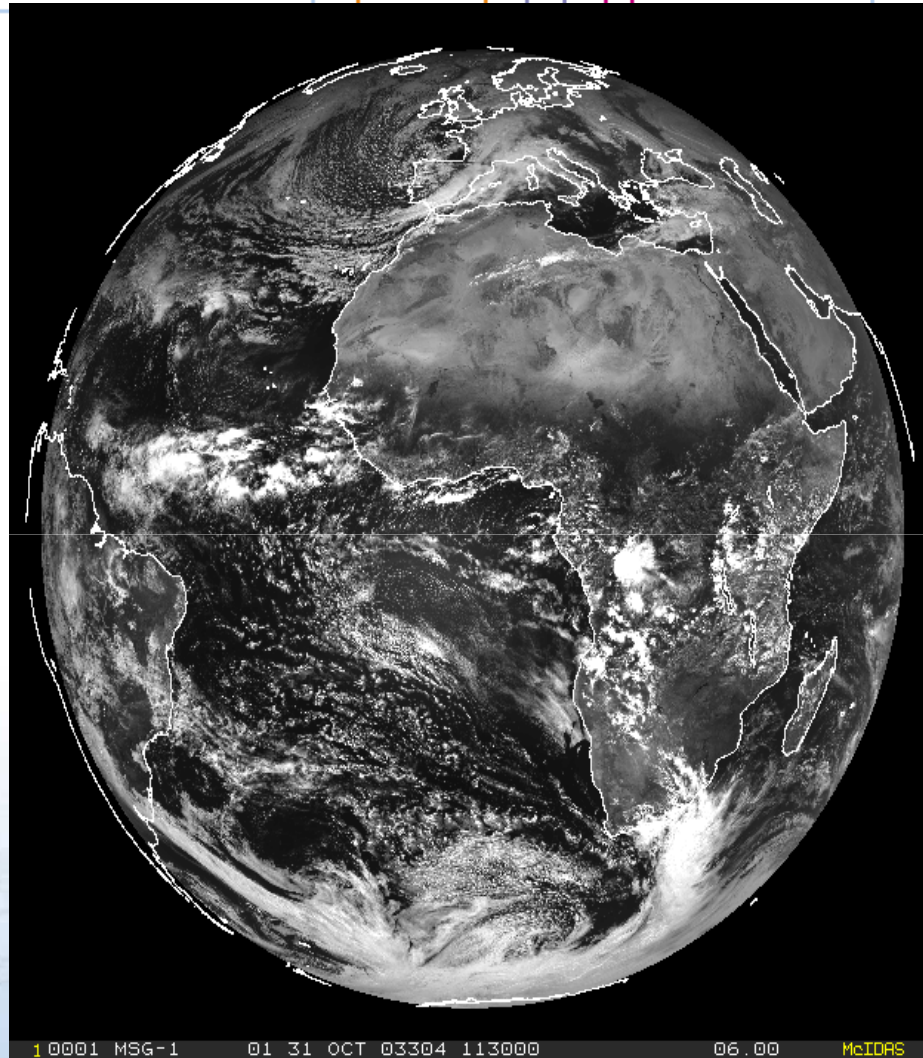
Sun Glint
Snow

Desert

Bare Soil

Forest

Ocean, Sea



High reflectance

**Very thick
clouds**

**Very thin clouds
over land**

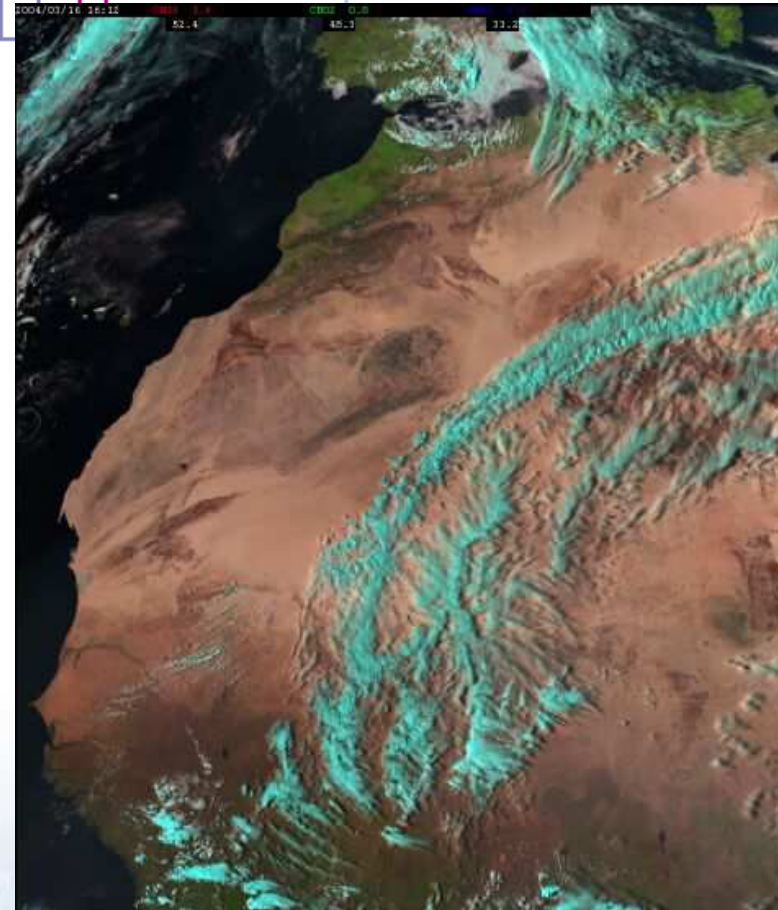
**Very thin clouds
over ocean**

31 October 2003, 11:30 UTC



RGB 01-02-03

gives bluish surface colours







RGB 03-02-01

gives more "natural colours"



MSG-1, 16 March 2004, 16:00 UTC

RGB Image Composites – Pros & Cons

Advantages:

-  Millions of colours: high information content;
-  Easily implemented;
-  Preserves “natural look” of images by retaining original textures (in particular for clouds);
-  Preserves temporal continuity allowing for smooth animation of RGB image sequences.

Drawbacks:

-  Millions of colours compared to discrete classes used in quantitative image products → interpretation more difficult;
-  Cannot be handled by colour-blind.

Rules for Creating “Good” RGB Products

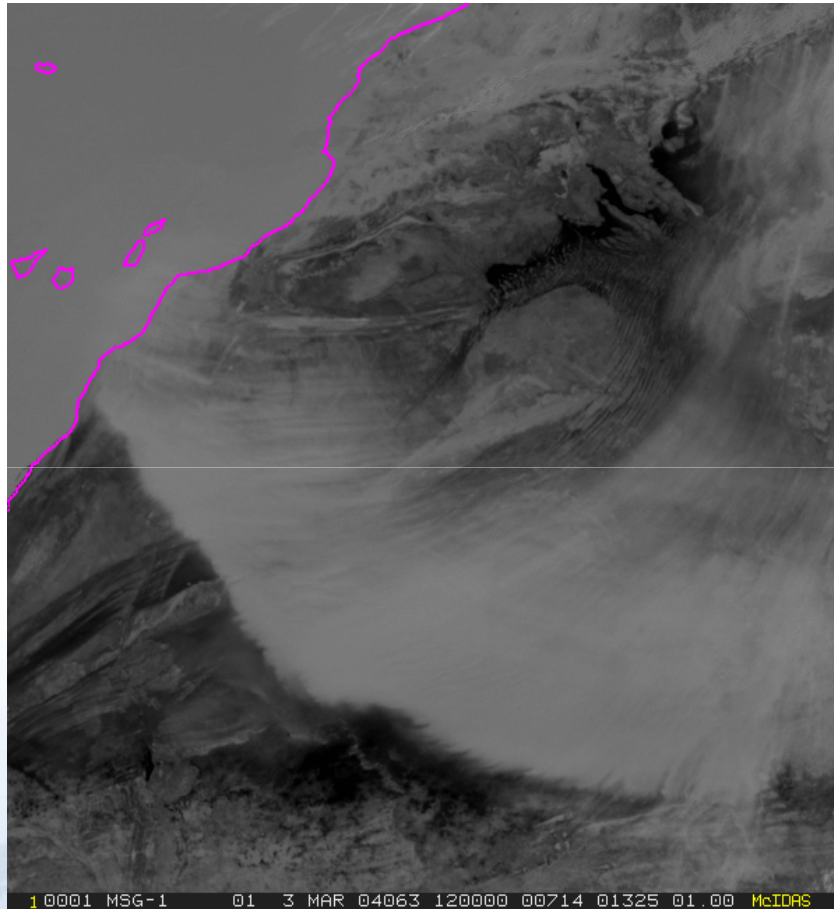
🌸 Selection of the three inputs

- Select three channels or channel differences that represent three different but relevant physical properties !!!

🌸 Proper enhancement of the three inputs:

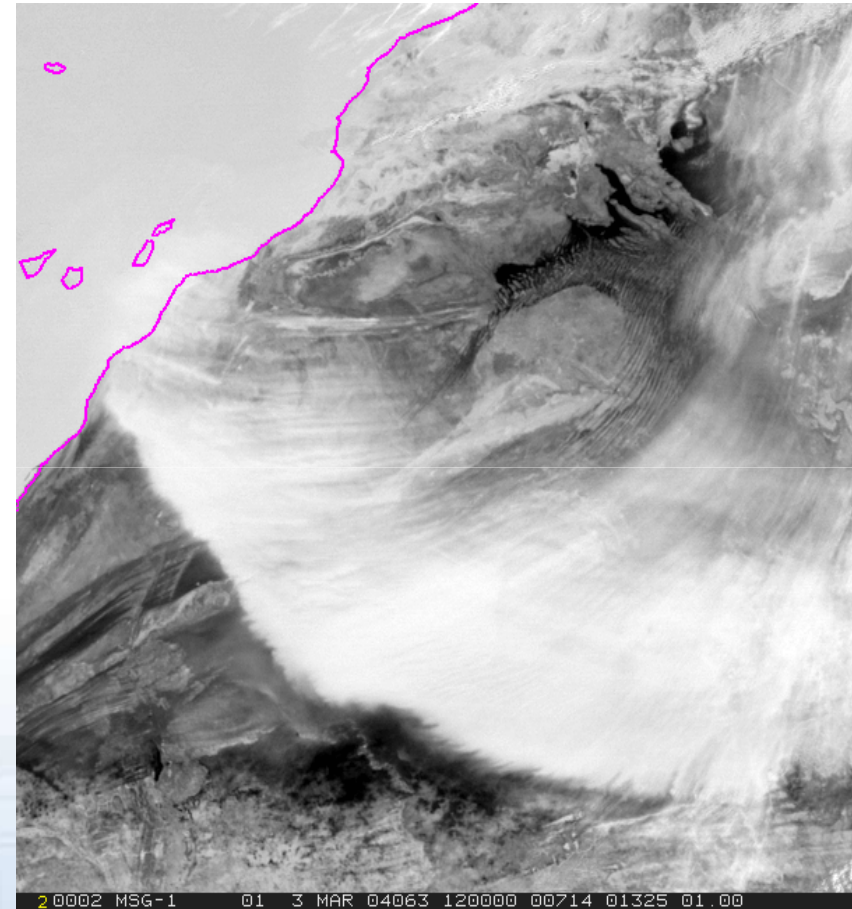
- Convert from radiances to brightness temperatures (IR) or reflectances (VIS);
- **Reduce the range** [BTmin, BTmax] for optimal contrast;
- **Gamma** correction, if needed

Stretching of Intensity Range: Example



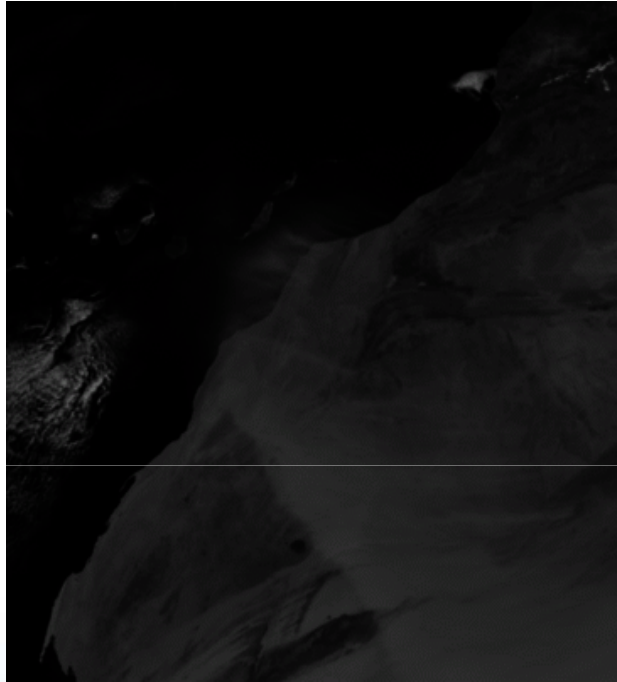
Range = -15 K / +15 K, $\Gamma=1.0$

MSG-1, 3 March 2004, 12:00 UTC, **Diff. IR8.7 - IR10.8**



Range = -15 K / 0 K, $\Gamma=1.0$

Gamma Correction: Example



Range = 0 - 100%, $\Gamma=0.5$

Range = 0 - 100%, $\Gamma=1.0$

Range = 0 - 100%, $\Gamma=2.0$

MSG-1, 3 March 2004, 12:00 UTC, Channel 01 (VIS0.6)

RECOMMENDED SCHEMES FOR
RGB IMAGE COMPOSITES
WITH MSG SEVIRI

RGBs for Operational Forecasting

- ✿ At WMO level: agree on a strict minimum of harmonised RGB composites
- ✿ 24-7 capability → IR channels only
- ✿ Two RGB composites which complement each other:
 - ✿ 24-h Microphysics
 - ✿ Airmass
- ✿ Five application specific RGBs

MSG RGB Tutorial (MSG Interpretation Guide)



	RGB Composite	Applications	Time
1.	RGB 10-09,09-07,09 (24-h Ash microphysics):	Dust, <u>Clouds</u> (thickness, phase), Contrails Fog, Ash, SO ₂ , Low-level Humidity	Day & Night
2.	RGB 05-06,08-09,05	<u>Severe Cyclones</u> , Jets, PV Analysis	Day & Night
3a.	RGB 10-09,09-04,09 (Night microphysics):	Clouds, <u>Fog</u> , Contrails, Fires	Night
3b.	RGB 02,04r,09 (Day Microphysics):	<u>Clouds</u> , Convection, Snow, Fog, Fires	Day
4.	RGB 05-06,04-09,03-01:	<u>Severe Convection</u>	Day
5.	RGB 02,03,04r:	<u>Snow</u> , Fog	Day
6.	RGB 03,02,01:	<u>Vegetation</u> , Snow, Smoke, Dust, Fog	Day

EUMETSAT training in RGBs

- ✿ EUMETSAT involved in several training events
- ✿ MSG interpretation guide on EUMETSAT website
- ✿ Case studies for different features in different countries on EUMETSAT website
- ✿ For each RGB:
 - ✿ The recommended ranges
 - ✿ The recommended gamma corrections
 - ✿ The colour interpretations (charts)
 - ✿ Several examples for the different features

Examples of some of these RGBs

1. Day Natural RGB (3-2-1)
2. Day Microphysics (2,4r,9)
3. 24 hour night microphysics (10-9,9-4,9)

1. RGB 03, 02, 01

("Day Natural Colours")

R = Channel 03 (NIR1.6)

G = Channel 02 (VIS0.8)

B = Channel 01 (VIS0.6)

Applications:	Vegetation, Dust, Smoke, Fog, Snow
Area:	Full MSG Viewing Area
Time:	Day-Time

RGB 03, 02, 01: Interpretation of Colours



High-level ice clouds



Low-level water clouds



Ocean

Veg. Land

Desert

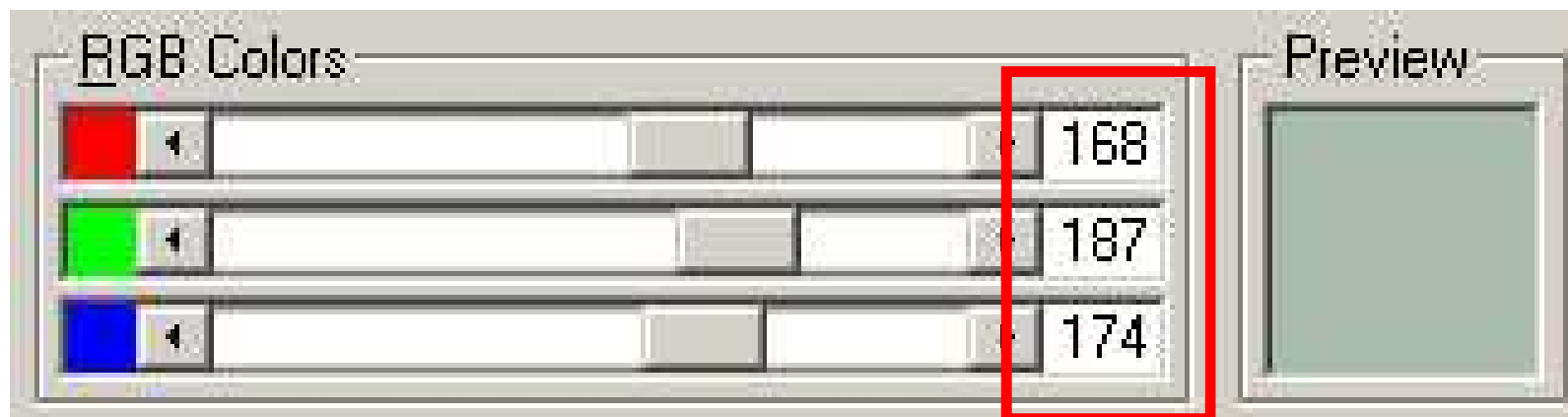
Snow

RGB 03, 02, 01 Example: Low-level Water Clouds (St, Sc)

NIR1.6

VIS0.8

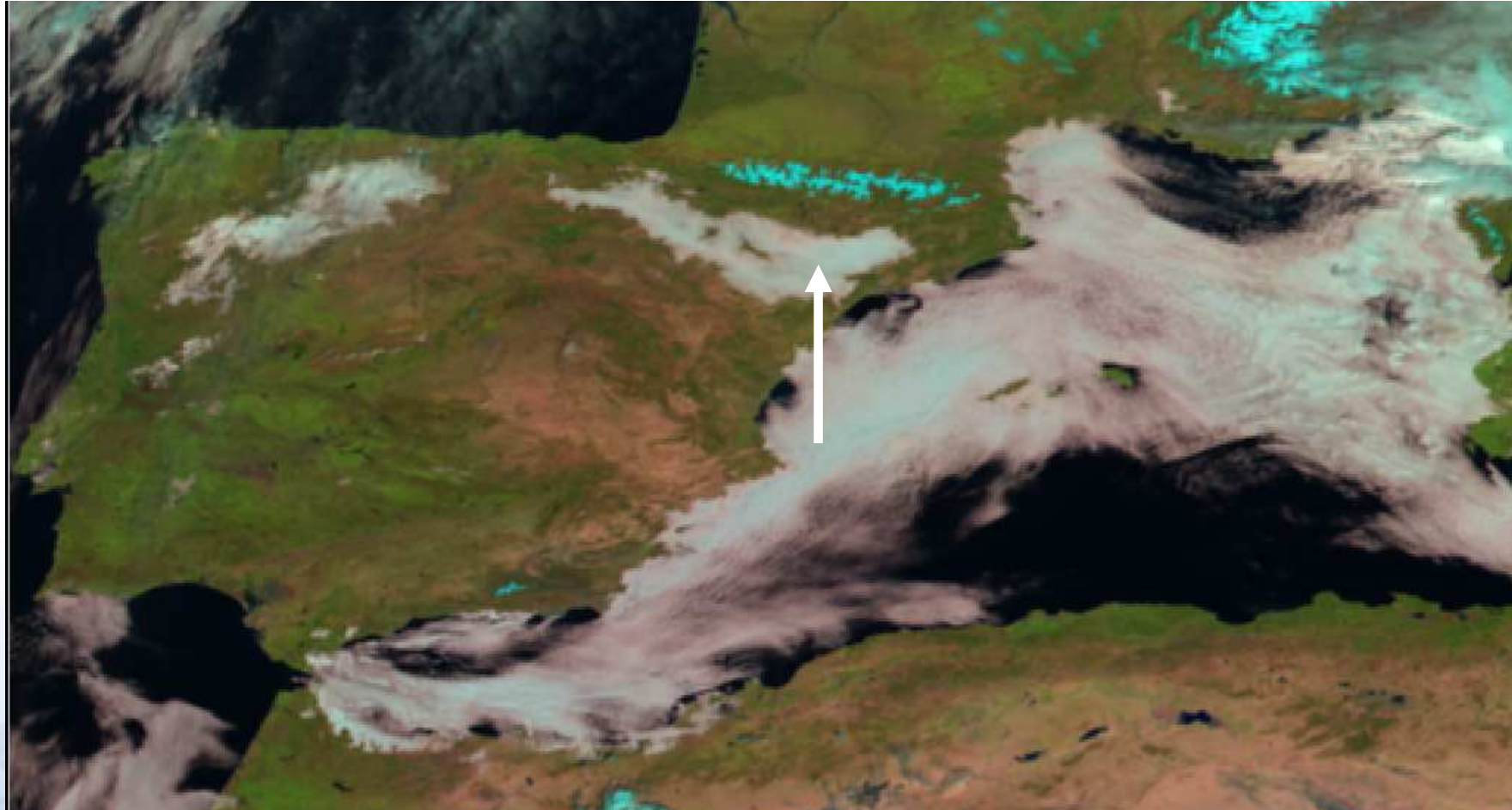
VIS0.6



In RGB 03,02,01 images, low water clouds with small droplets appear in whitish-blue/pinkish colours !

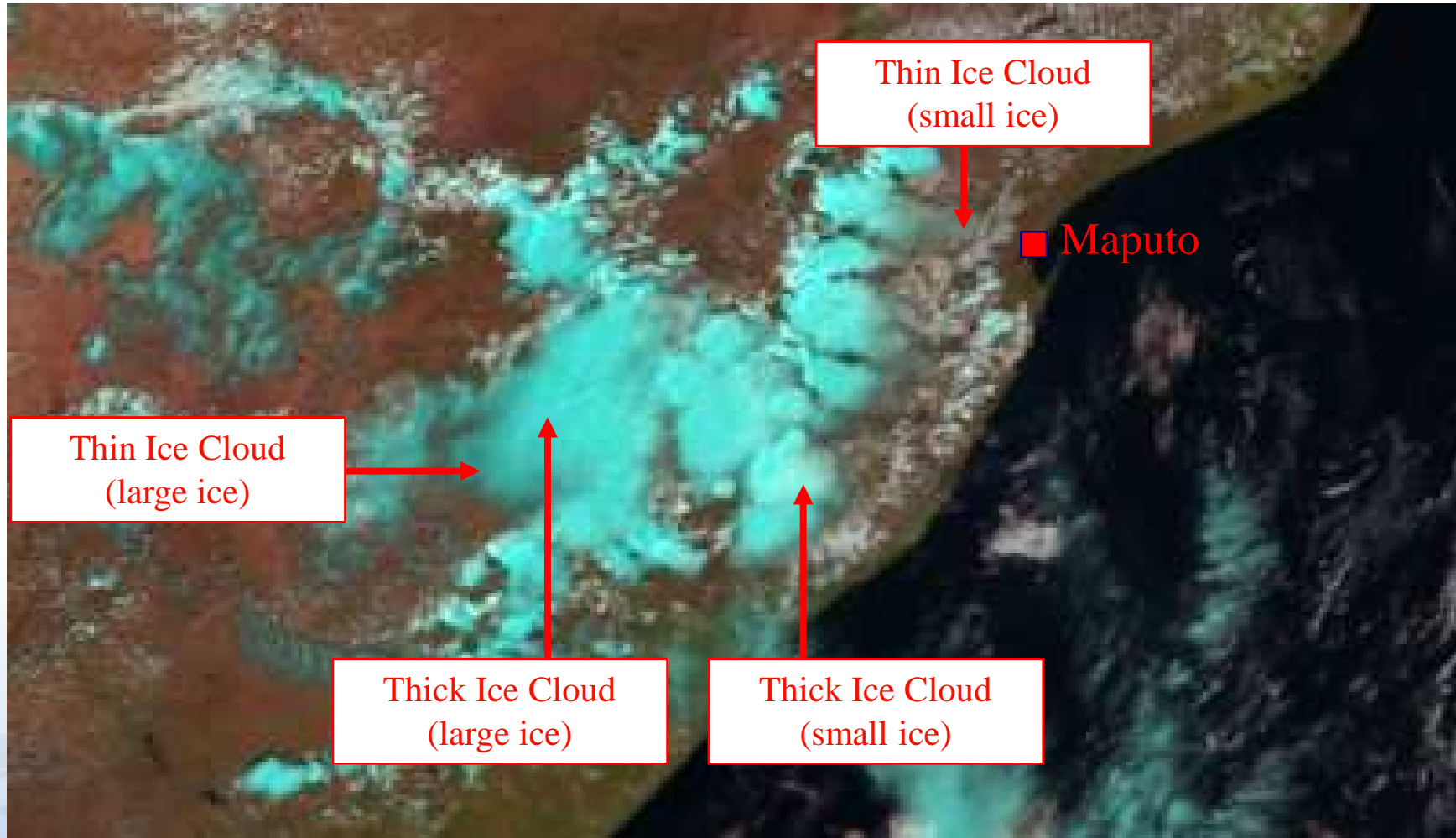
The values shown above (in the red box) correspond to the location (shown by an arrow) on the next slide !

RGB 03, 02, 01 Example: Low-level Water Clouds (St, Sc)



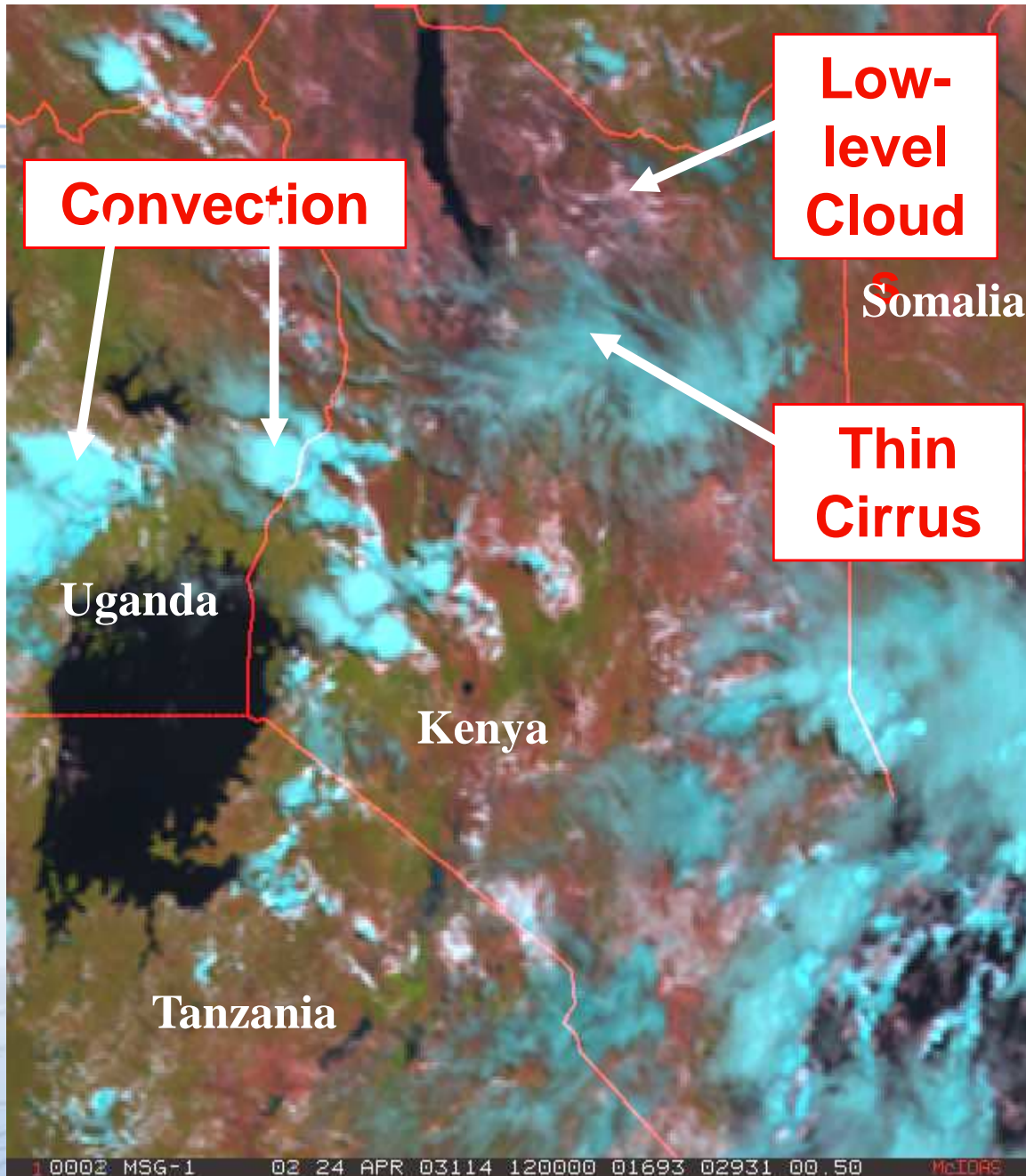
MSG-1, 03 February 2004, 11:30 UTC

RGB 03, 02, 01: Not the best for convection but still useful!



MSG-1, 6 November 2004, 12:00 UTC, RGB 03, 02, 01

Convection Kenya/Uganda



Meteosat-8, 24 April 2003
12:00 UTC

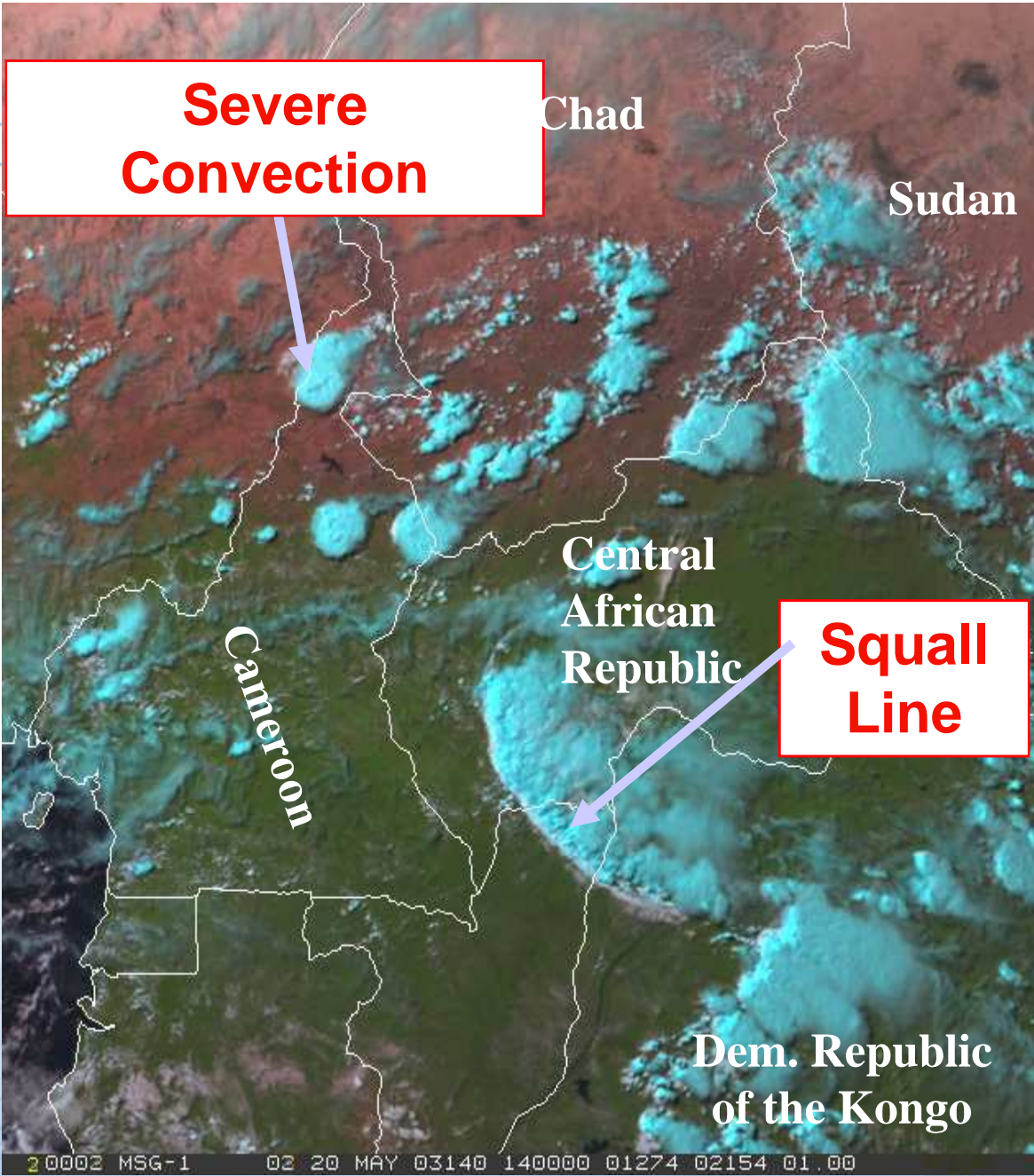
RGB Composite

R = NIR1.6

G = VIS0.8

B = VIS0.6





Convection Day & Night

Convection N. Cameroon

Meteosat-8, 20 May 2003
14:00 UTC

RGB Composite
R = NIR1.6
G = VIS0.8
B = VIS0.6



2. RGB 02, 04r, 09
("Day Microphysics")

devised by: D. Rosenfeld

R = Channel 02 (VIS0.8)

G = Channel 04r (IR3.9, solar component)

B = Channel 09 (IR10.8)

Applications:	Cloud Analysis, Convection, Fog, Snow, Fires
Area:	Full MSG Viewing Area
Time:	Day-Time
Users:	Hungary, Israel, South Africa



RGB 02, 04r, 09 ("Day Microphysics")

devised by: D. Rosenfeld

Recommended Range and Enhancement:

Beam	Channel	Range	Gamma
Red	02 (VIS0.8)	0 ...+100 %	1.0
Green	04r (IR3.9r)	0 ... +60 %	2.5
Blue	09 (IR10.8)	+203 ... +323 K	1.0



Physical Interpretation (for dust/ash/water/ice clouds)

R = Difference VIS0.8

Optical Thickness, Viewing Geometry

G = Difference IR3.9r

**Optical Thickness, Phase, Particle Size, Viewing
Geometry**

B = Channel IR10.8

Top Temperature

Interpretation of Colours for High-level Clouds



Deep precipitating cloud
(precip. not necessarily
reaching the ground)

- bright, thick
- large ice particles
- cold cloud

Deep precipitating cloud
(Cb cloud with strong
updrafts and severe
weather)*

- bright, thick
- small ice particles
- cold cloud

*or thick, high-level lee
cloudiness with small ice
particles

Thin Cirrus cloud
(large ice particles)

Thin Cirrus cloud
(small ice particles)

Ocean

Veg. Land

Fires / Desert

Snow

Interpretation of Colours for Mid-level Clouds



Supercooled, thick water cloud

- bright, thick
- large droplets

Ocean



Supercooled, thick water cloud

- bright, thick
- small droplets

Veg. Land



Supercooled thin water cloud with large droplets

Fires / Desert

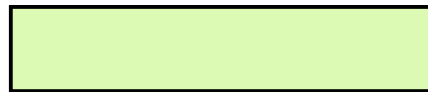


Supercooled, thin water cloud with small droplets *

* or, in rare occasions, thin Ci cloud with small ice particles

Snow

Interpretation of Colours for Low-level Clouds



Thick water cloud
(warm rain cloud)
- bright, thick
- large droplets

Thick water cloud
(no precipitation)
- bright, thick
- small droplets

Thin water cloud with
large droplets

Thin water cloud
with small droplets

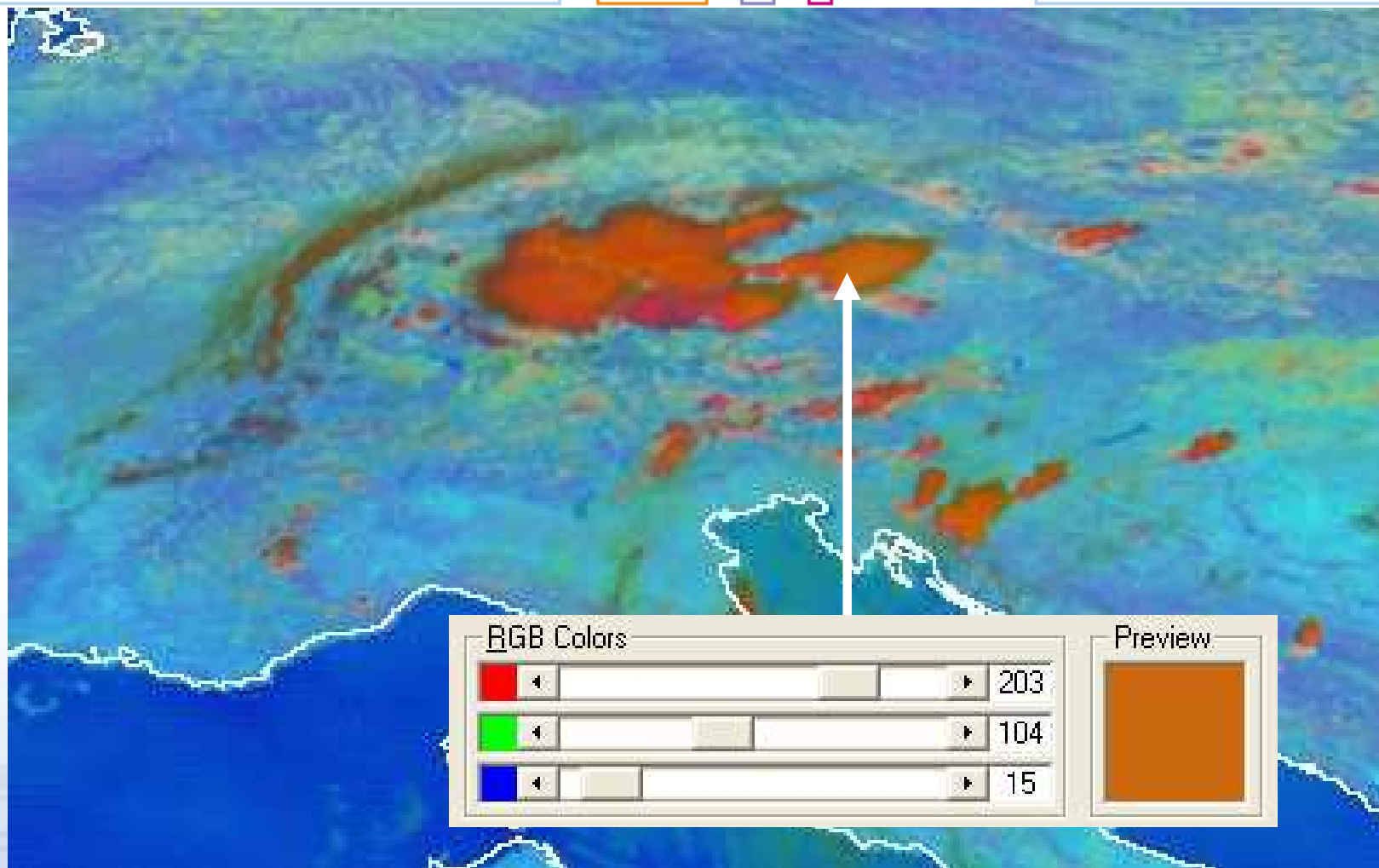
Ocean

Veg. Land

Fires / Desert

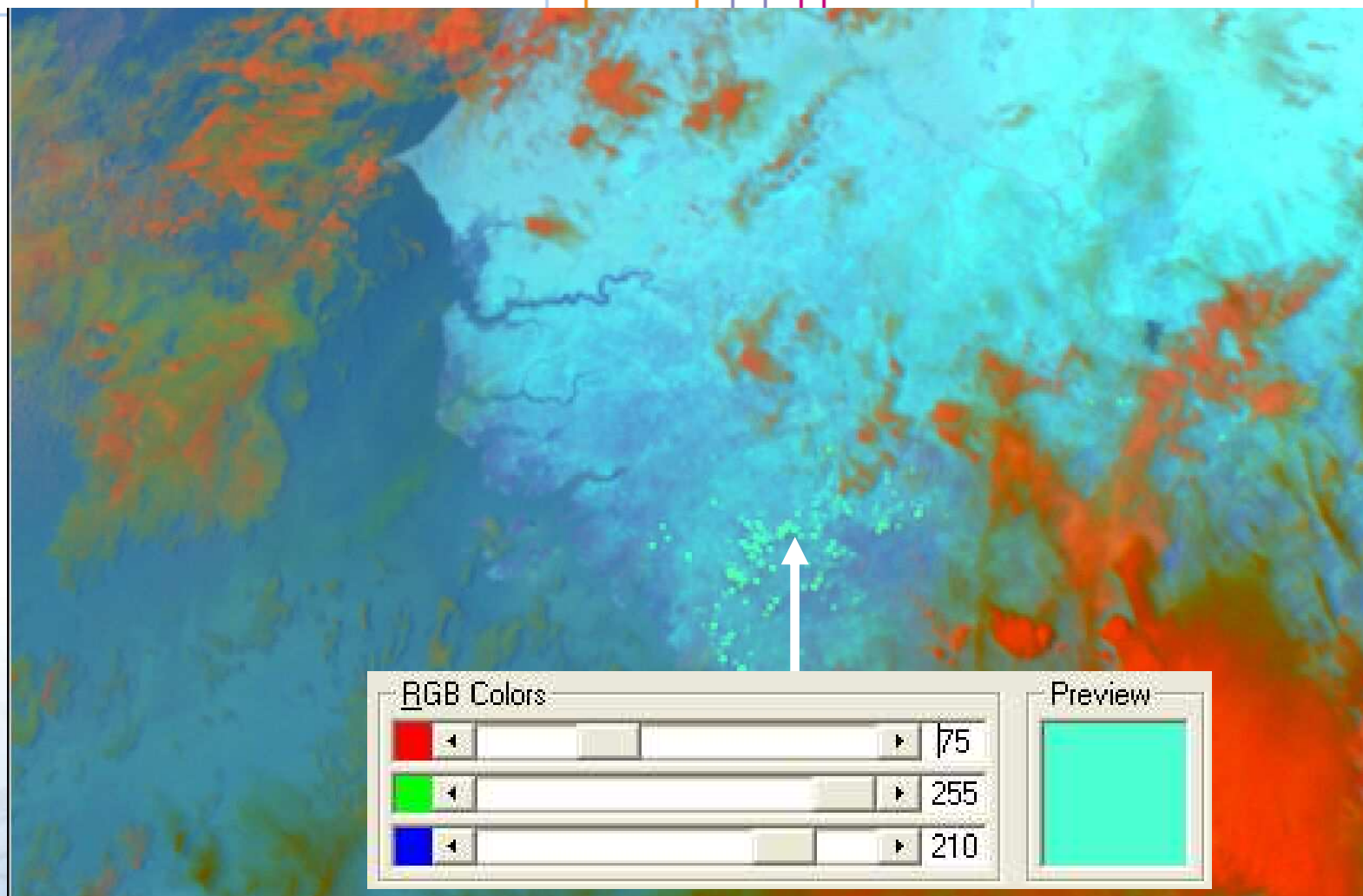
Snow

Example 1: Severe Convection



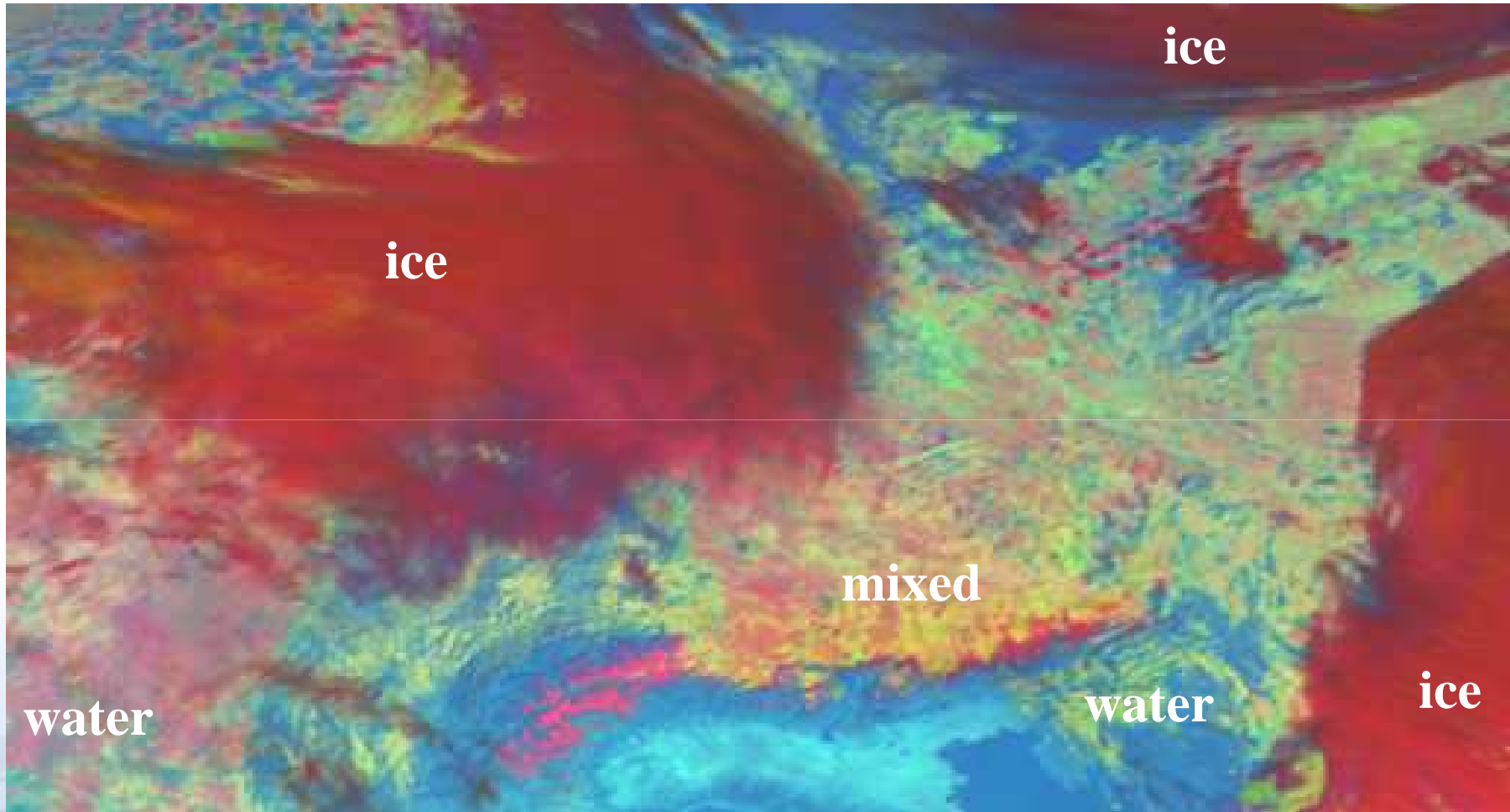
MSG-1, 13 June 2003, 12:00 UTC

Example 3: Fires



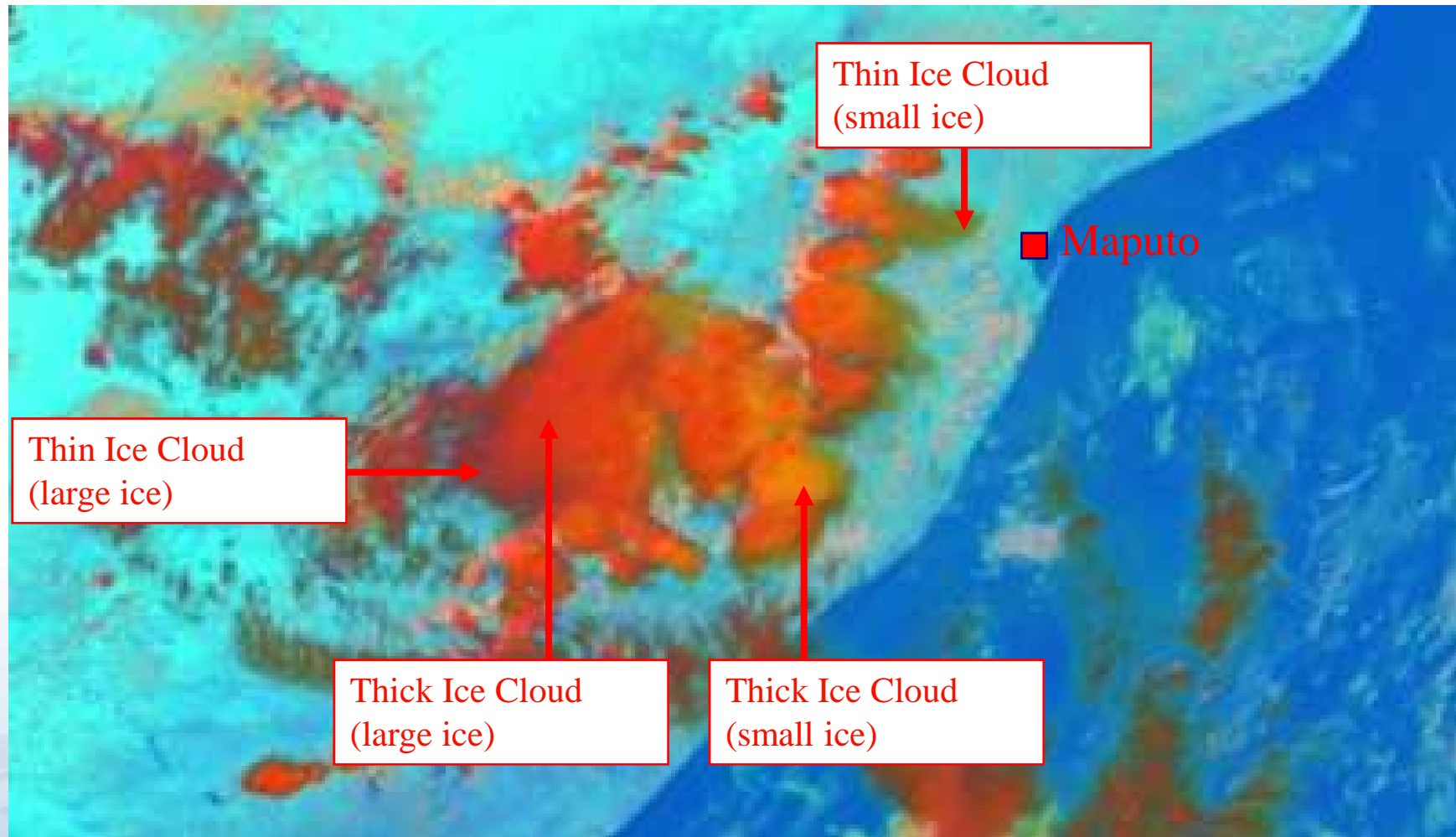
MSG-1, 27 April 2004, 14:15 UTC

Example 4: Ice vs Water Clouds



MSG-1, 8 October 2003, 12:00 UTC

Small vs Large Ice Particles



MSG-1, 6 November 2004, 12:00 UTC



WHAT ABOUT NIGHT TIME?

3. RGB 10-09, 09-04, 09
("Night Microphysics")

devised by: D. Rosenfeld

R = Difference IR12.0 - IR10.8

G = Difference IR10.8 - IR3.9

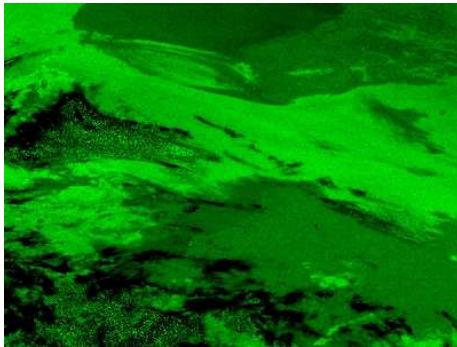
B = Channel IR10.8

Applications:	Cloud Analysis, Fog, Contrails, (Snow)
Area:	Full MSG Viewing Area
Time:	Night-Time
Users:	most European & African NMSs, Middle East

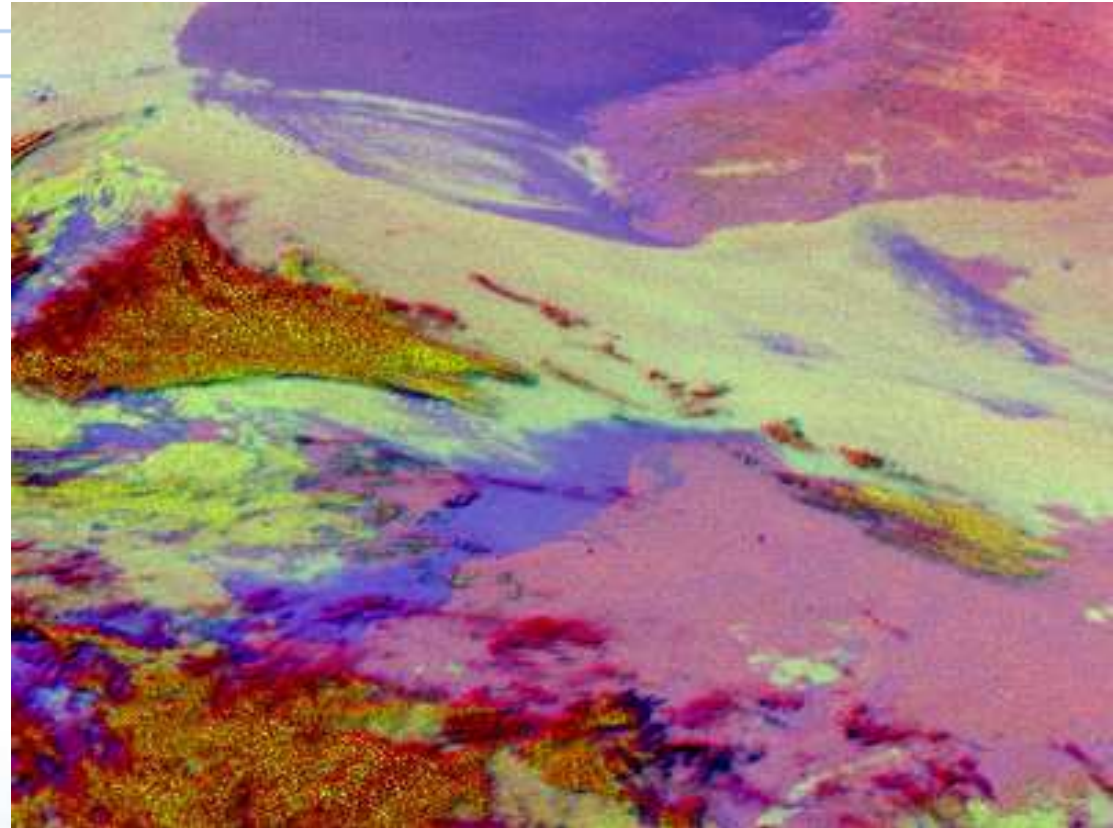
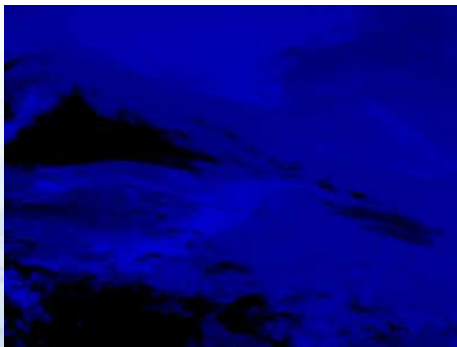
**Ch.10
-Ch.09**



**Ch.09
-Ch.04**



Ch.09



MSG-1, 9 November 2003, 02:45 UTC
RGB Composite 10-09, 09-04, 09



RGB 10-09, 09-04, 09 ("Night Microphysics")

devised by: D. Rosenfeld

Recommended Range and Enhancement:

Beam	Channel	Range	Gamma
Red	IR12.0 - IR10.8	-4 ... +2 K	1.0
Green	IR10.8 - IR3.9	0 ... +10 K	1.0
Blue	IR10.8	+243 ... +293 K	1.0

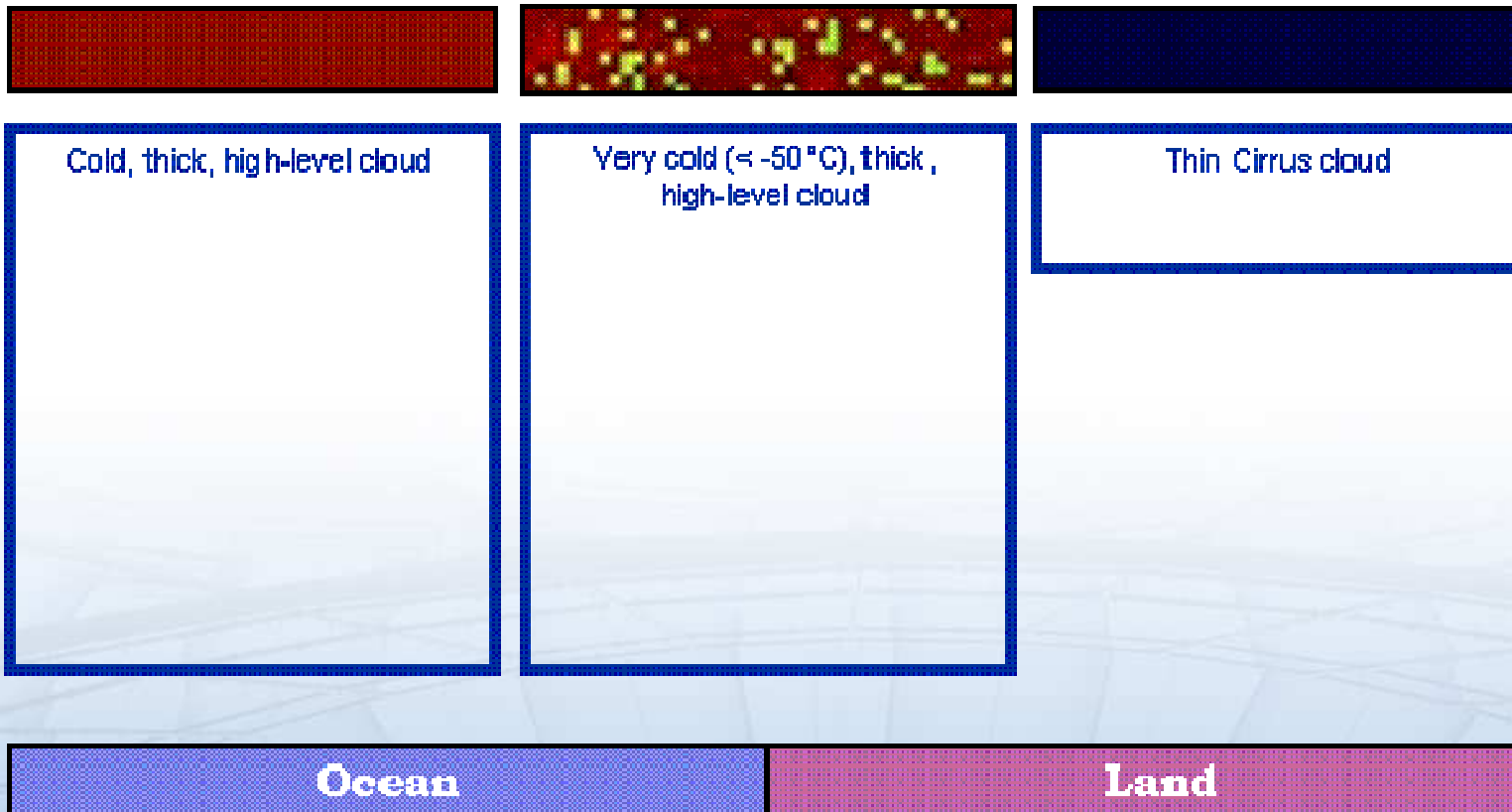
**Physical Interpretation
(for dust/ash/water/ice clouds)**

**R = Difference IR12.0 - IR10.8
Optical Thickness, Tsurf-Tcloud**

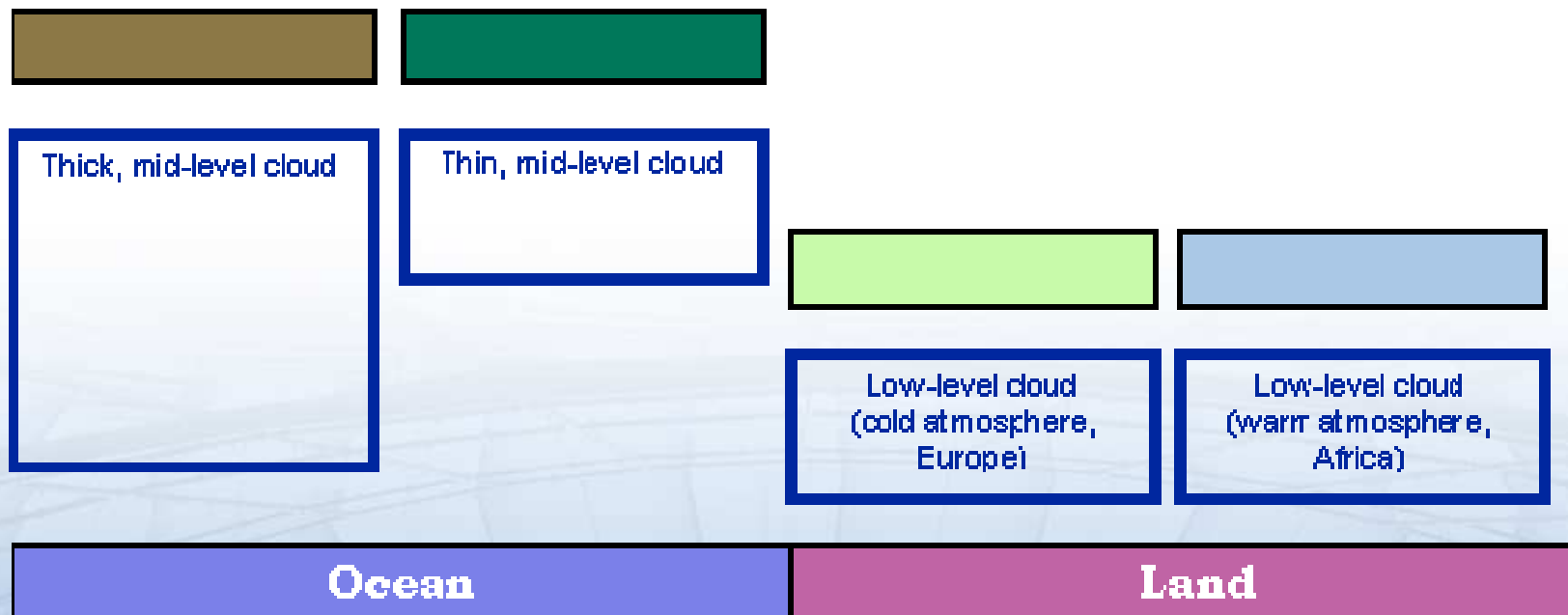
**G = Difference IR10.8 – IR3.9
Optical Thickness, Tsurf-Tcloud, Phase, Particle Size**

**B = Channel IR10.8
Top Temperature**

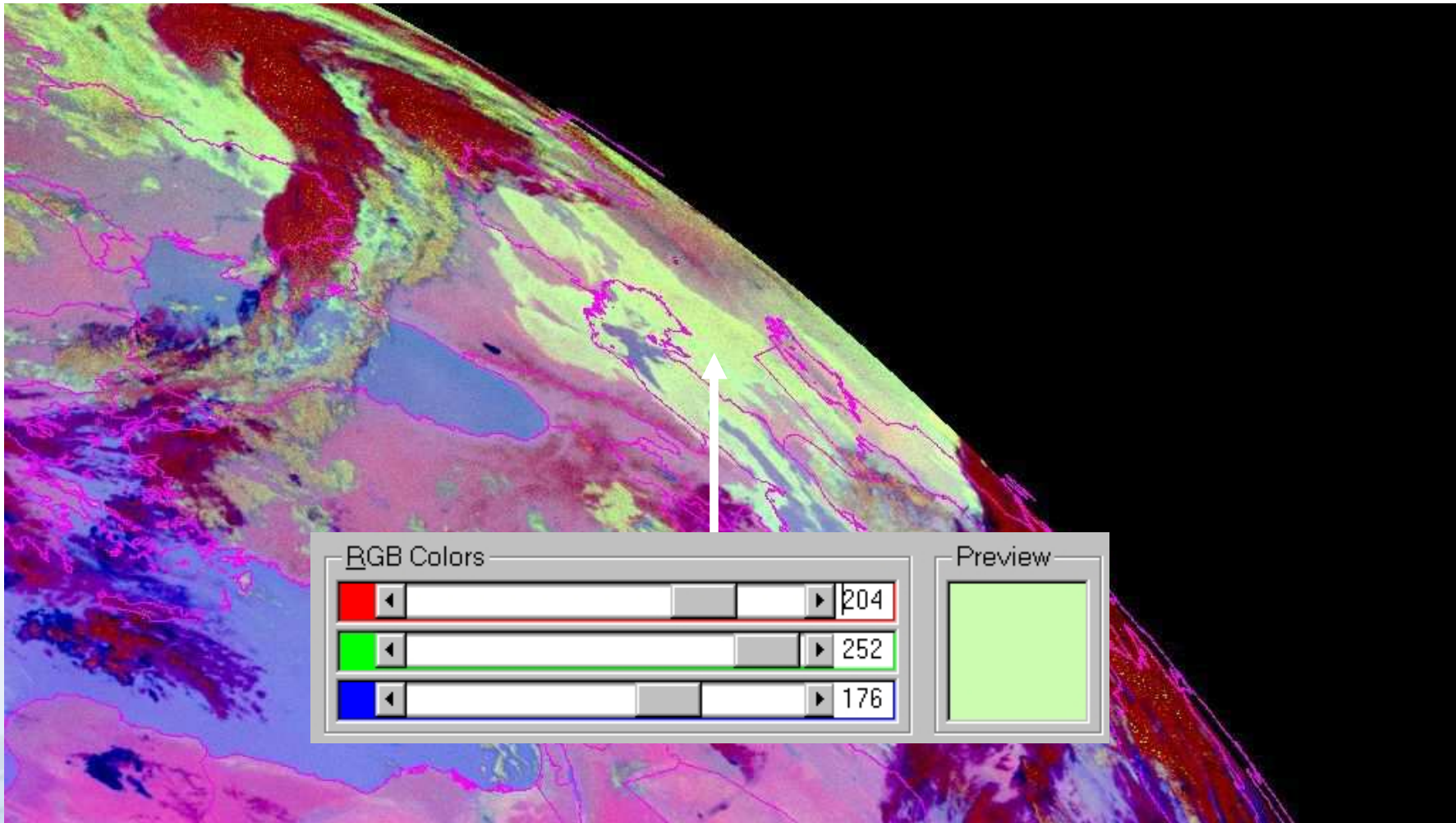
RGB 10-09, 09-04, 09:



RGB 10-09, 09-04, 09: Interpretation of Colours for Mid/Low-level Clouds

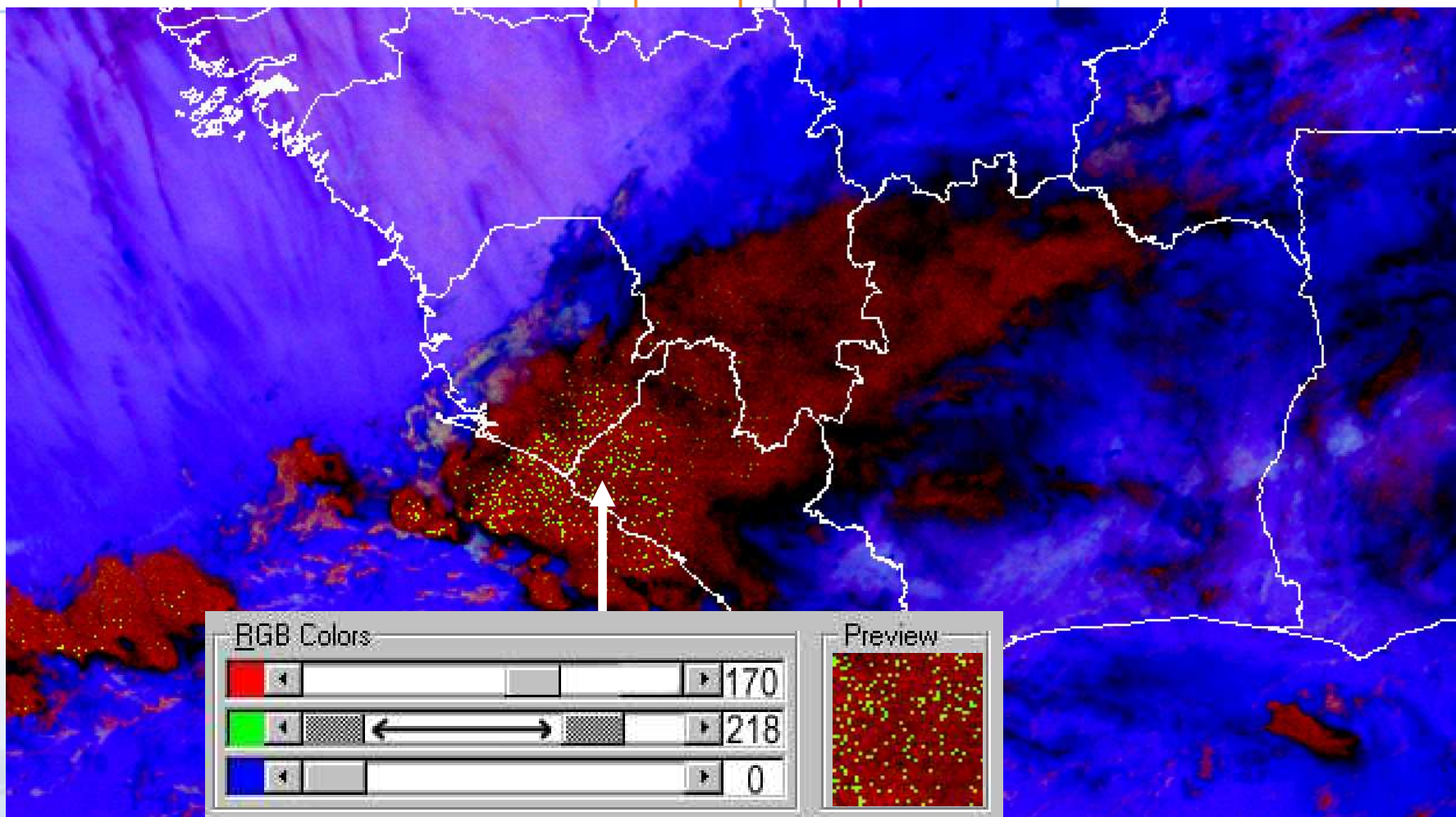


Example: Fog



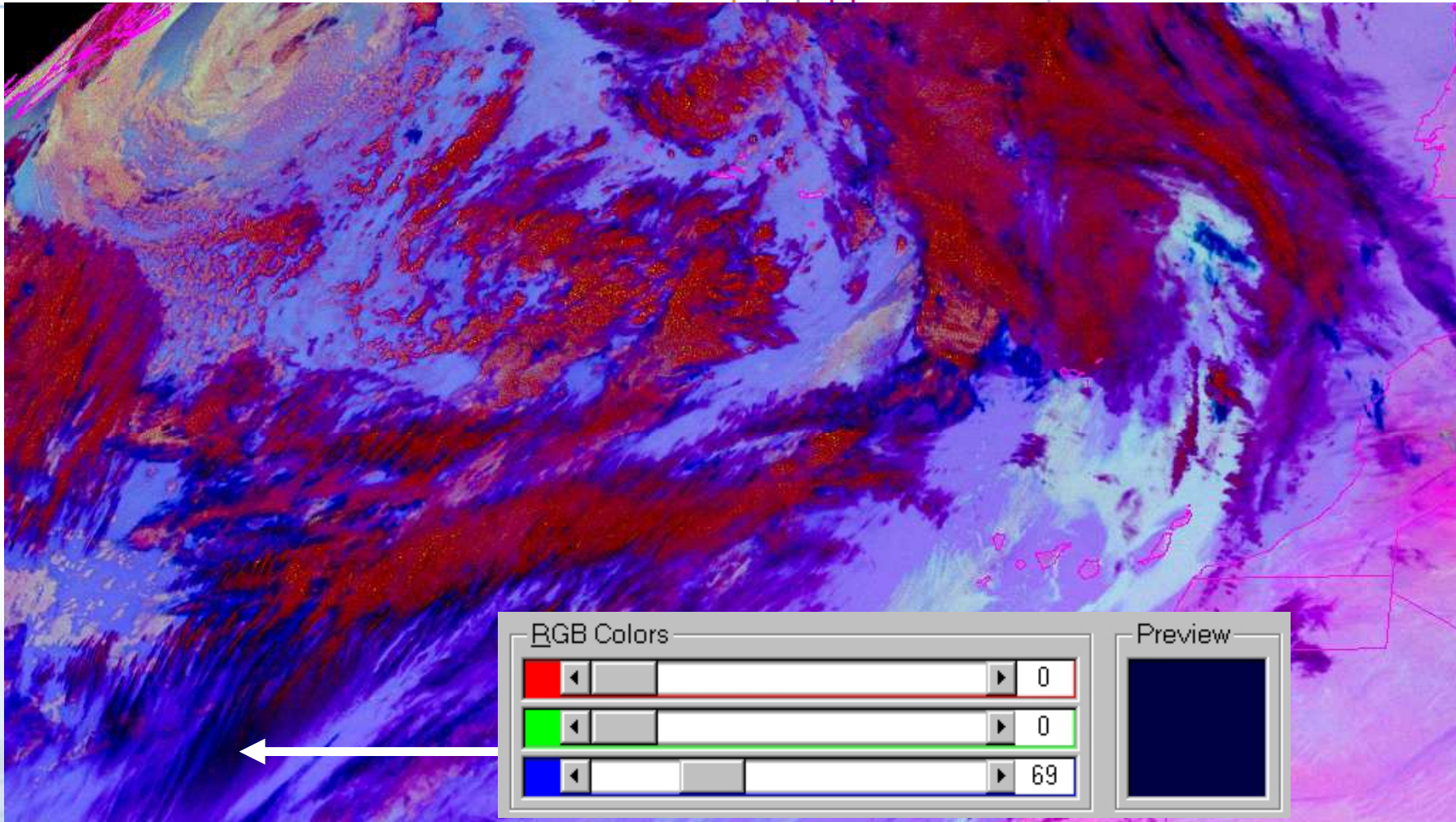
MSG-1, 14 March 2005, 00:00 UTC

Example: Cb



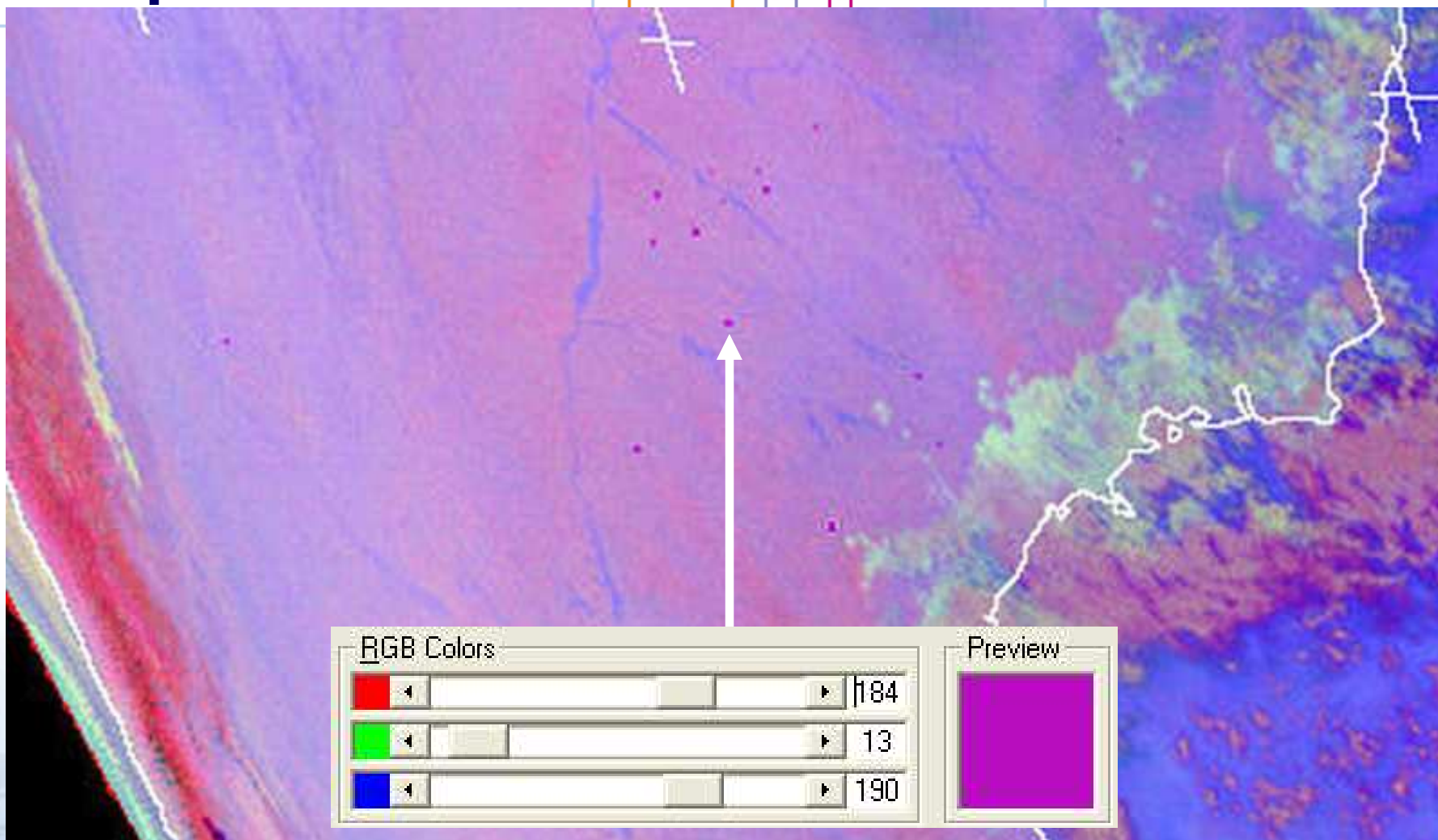
MSG-1, 19 April 2005, 03:15 UTC

Example: Cirrus



MSG-1, 18 March 2005, 00:00 UTC

Example: Fire



MSG-1, 16 May 2006, 00:00 UTC

Summary

- 🌸 Red-Green-Blue combinations are useful to accentuate different features in satellite imagery for different applications such as convection, fires, fog etc...
- 🌸 Using the Colour Selector tool it is easy to see the role played by each channel (or channel difference)
- 🌸 Altering the range and gamma settings is useful for specific purposes
- 🌸 Using the WMO standard for RGB products is essential

Quiz

DAY NATURAL (3-2-1)

Where are water clouds and where thicker Cu/Cb?



SOUTH AFRICA

2 December 2005, 12 UTC

EUMETSAT

RGB 03, 02, 01: Interpretation of Colours



Ocean

Veg. Land

Desert

Snow

Where are water clouds and where thicker Cu/Cb?



SOUTH AFRICA

2 December 2005, 12 UTC

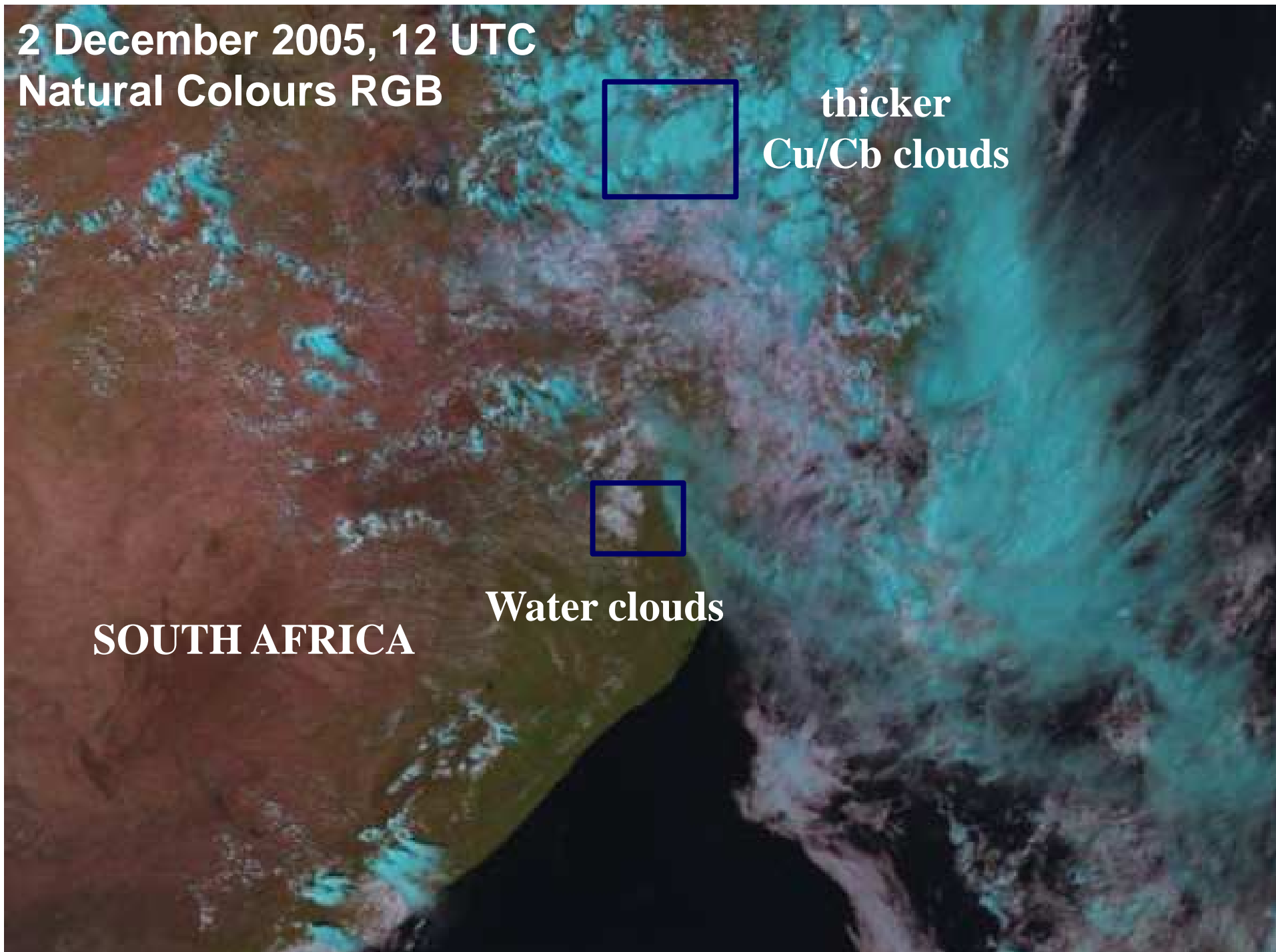
EUMETSAT

2 December 2005, 12 UTC
Natural Colours RGB

thicker
Cu/Cb clouds

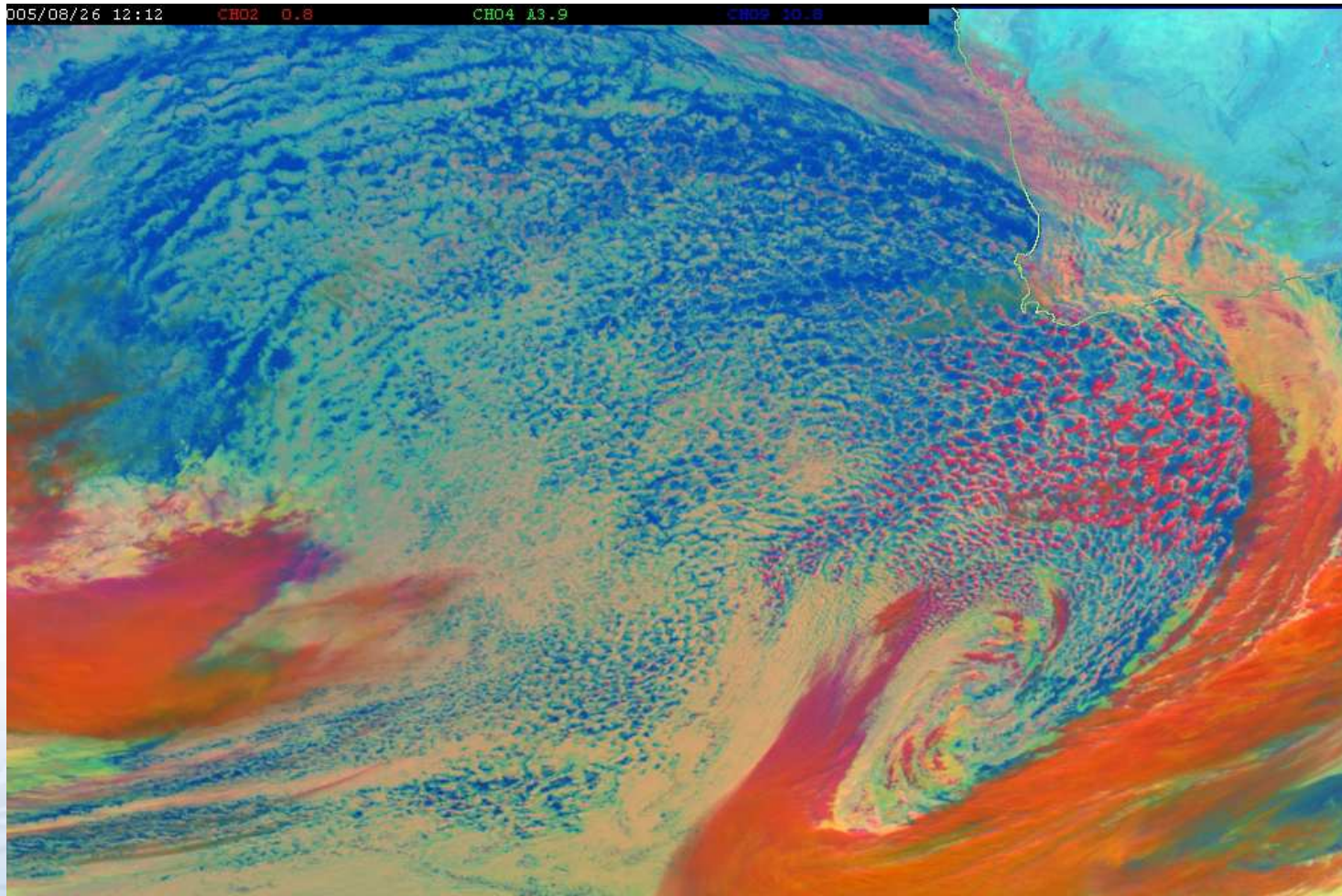
Water clouds

SOUTH AFRICA



DAY MICROPHYSICAL (2,4R,9)

Where are ice clouds and where water clouds?



MSG-1, 26 August 2005, 12:00 UTC

Interpretation of Colours for High-level Clouds



Deep precipitating cloud
(precip. not necessarily
reaching the ground)

- bright, thick
- large ice particles
- cold cloud

Deep precipitating cloud
(Cb cloud with strong
updrafts and severe
weather)*

- bright, thick
- small ice particles
- cold cloud

*or thick, high-level lee
cloudiness with small ice
particles

Thin Cirrus cloud
(large ice particles)

Thin Cirrus cloud
(small ice particles)

Ocean

Veg. Land

Fires / Desert

Snow

Interpretation of Colours for Mid-level Clouds



Supercooled, thick water cloud

- bright, thick
- large droplets

Ocean



Supercooled, thick water cloud

- bright, thick
- small droplets

Veg. Land



Supercooled thin water cloud with large droplets

Fires / Desert

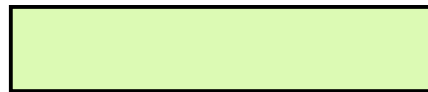


Supercooled, thin water cloud with small droplets *

* or, in rare occasions, thin Ci cloud with small ice particles

Snow

Interpretation of Colours for Low-level Clouds



Thick water cloud
(warm rain cloud)
- bright, thick
- large droplets

Thick water cloud
(no precipitation)
- bright, thick
- small droplets

Thin water cloud with
large droplets

Thin water cloud
with small droplets

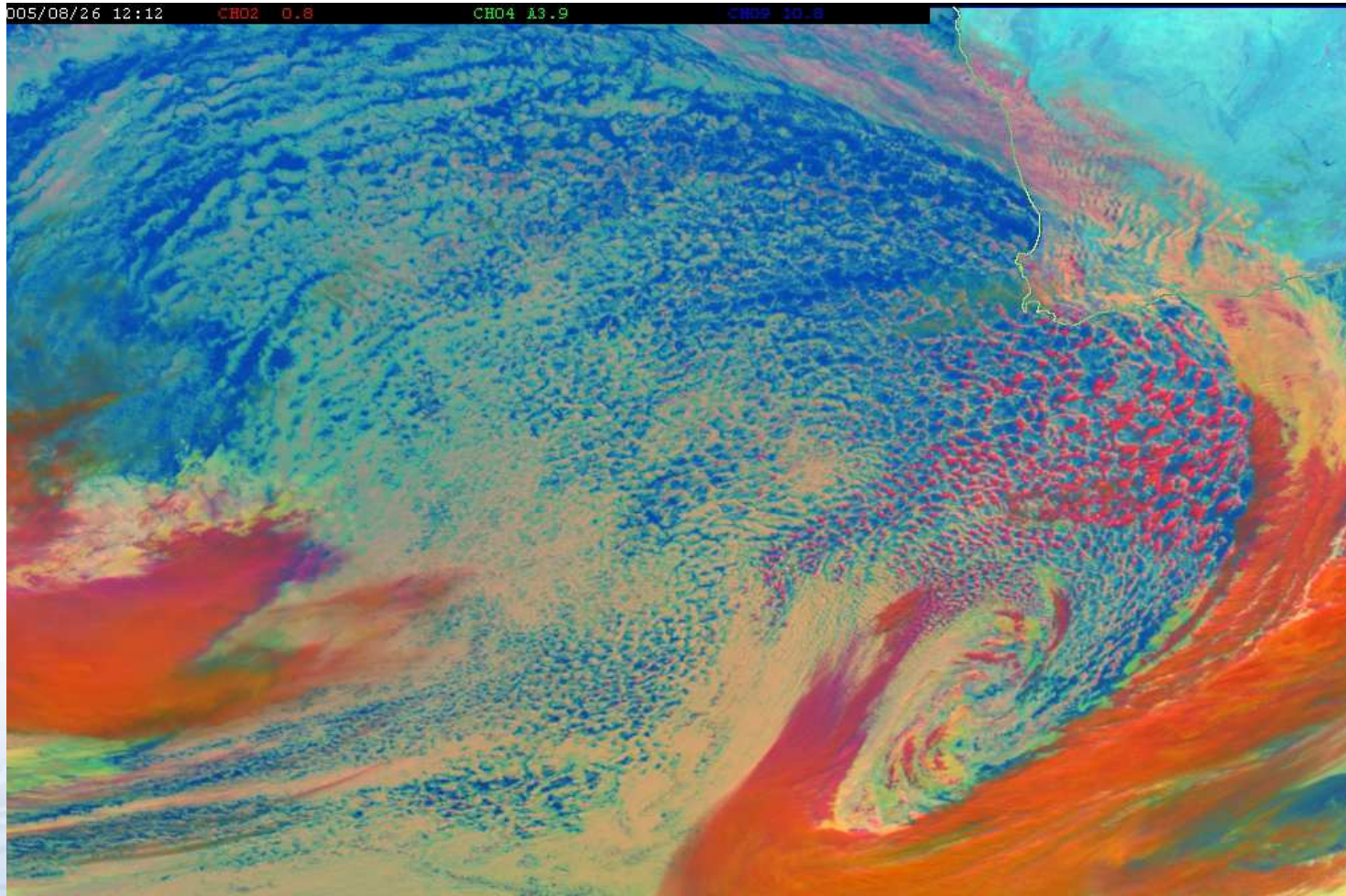
Ocean

Veg. Land

Fires / Desert

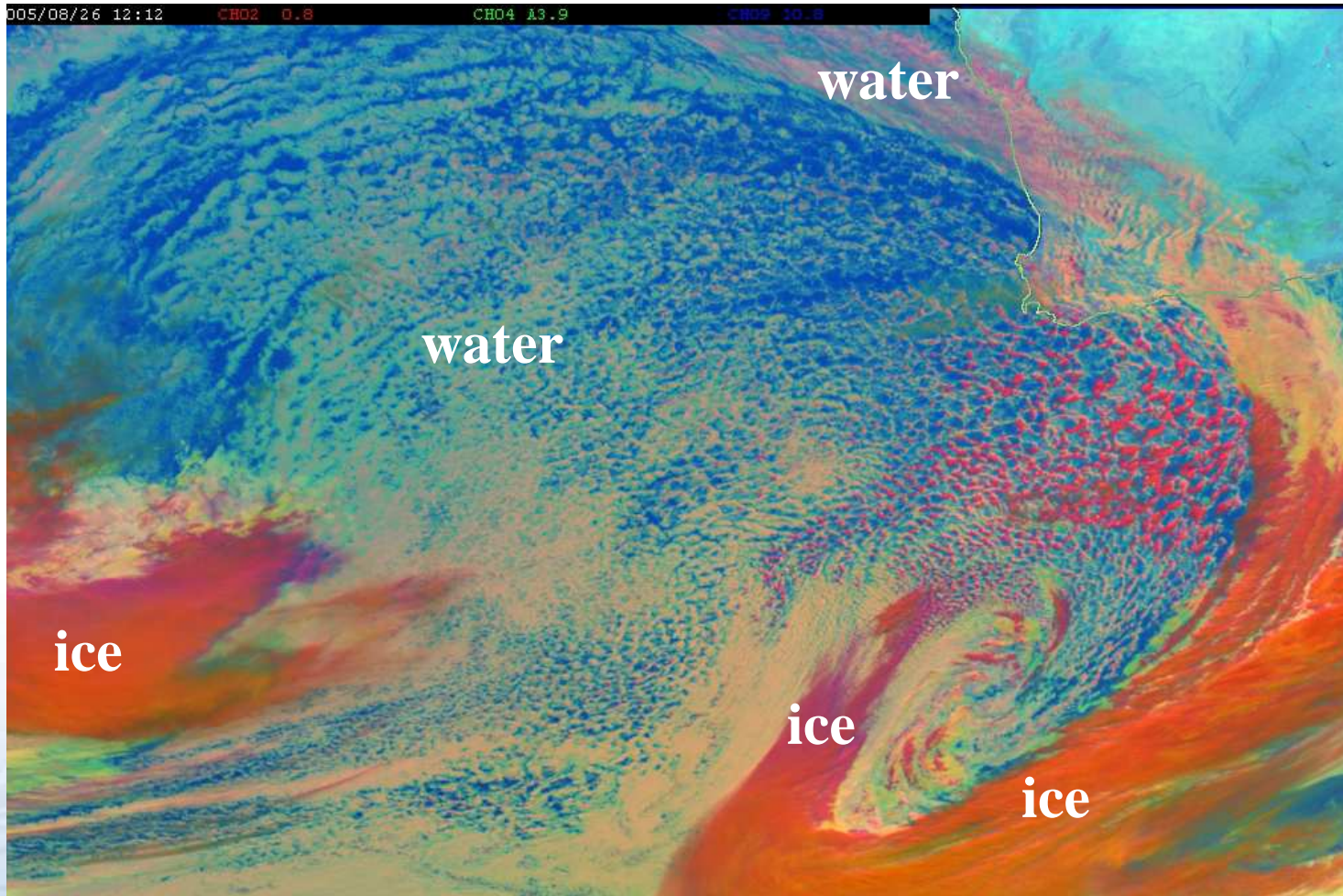
Snow

Where are ice clouds and where water clouds?



MSG-1, 26 August 2005, 12:00 UTC

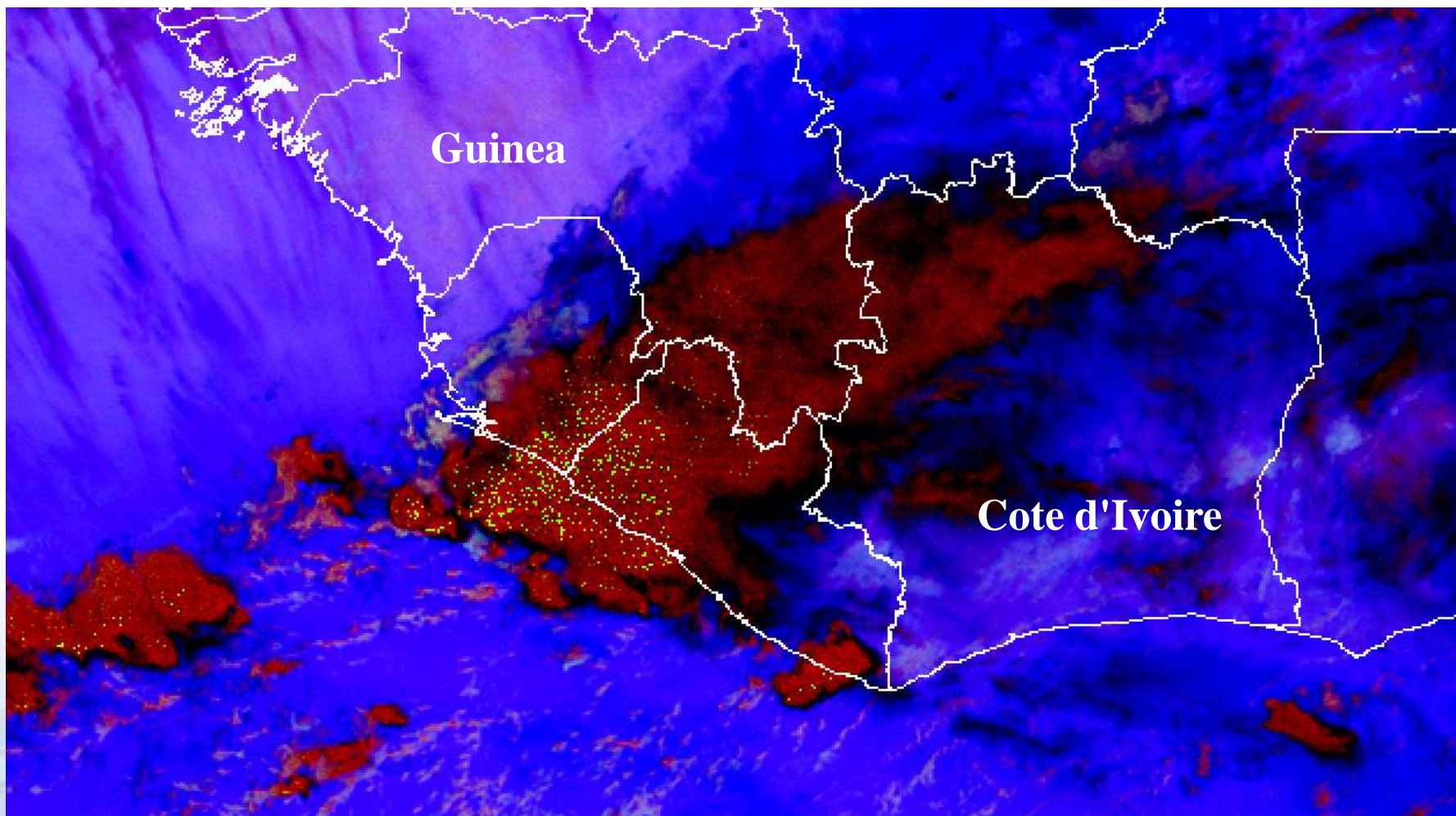
Ice vs Water Clouds



MSG-1, 26 August 2005, 12:00 UTC

NIGHT MICROPHYSICAL (10-9,9-4,9)

Where are the convective clouds (Cb)?

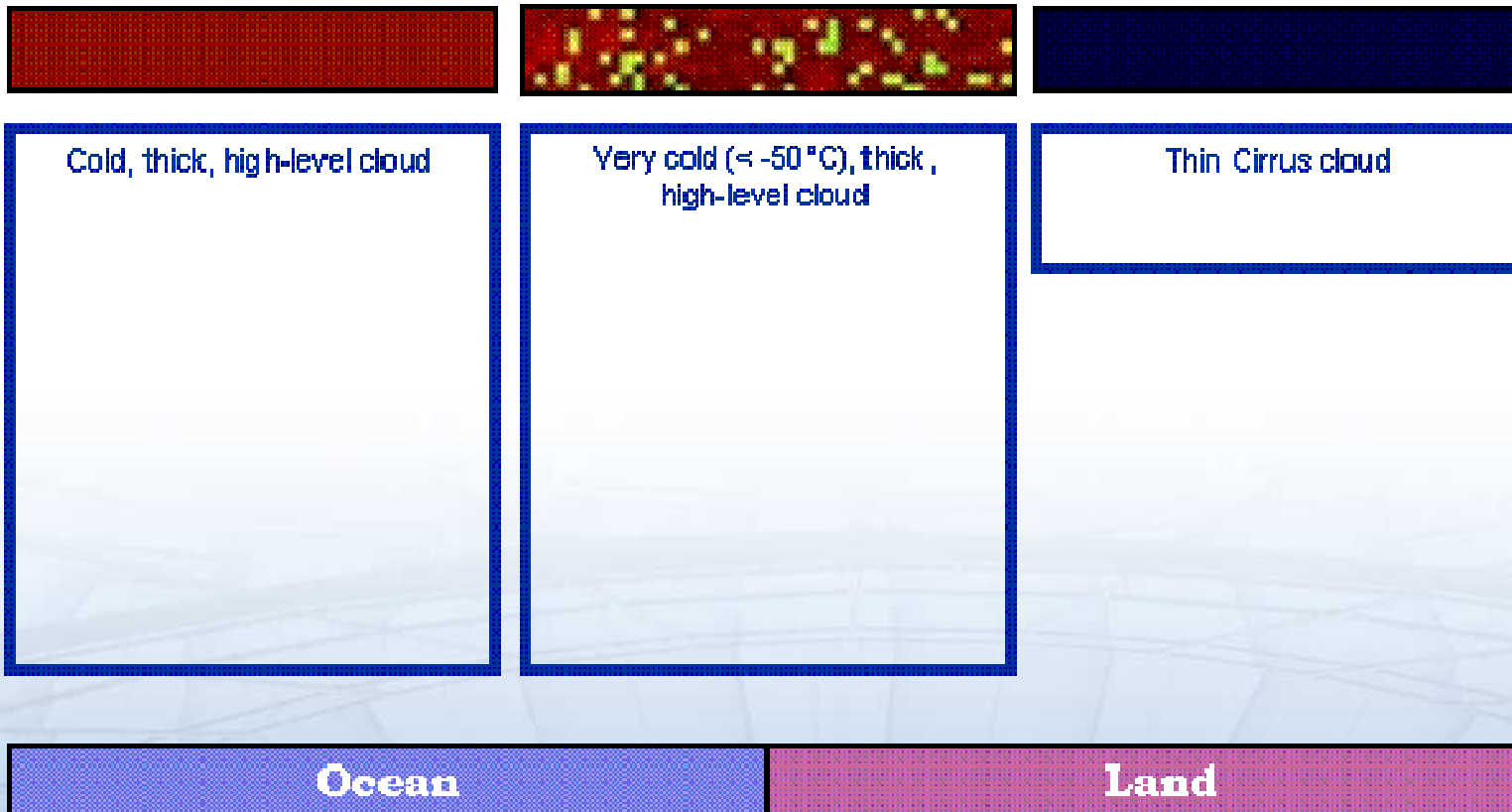


MSG-1, 19 April 2005, 03:15 UTC

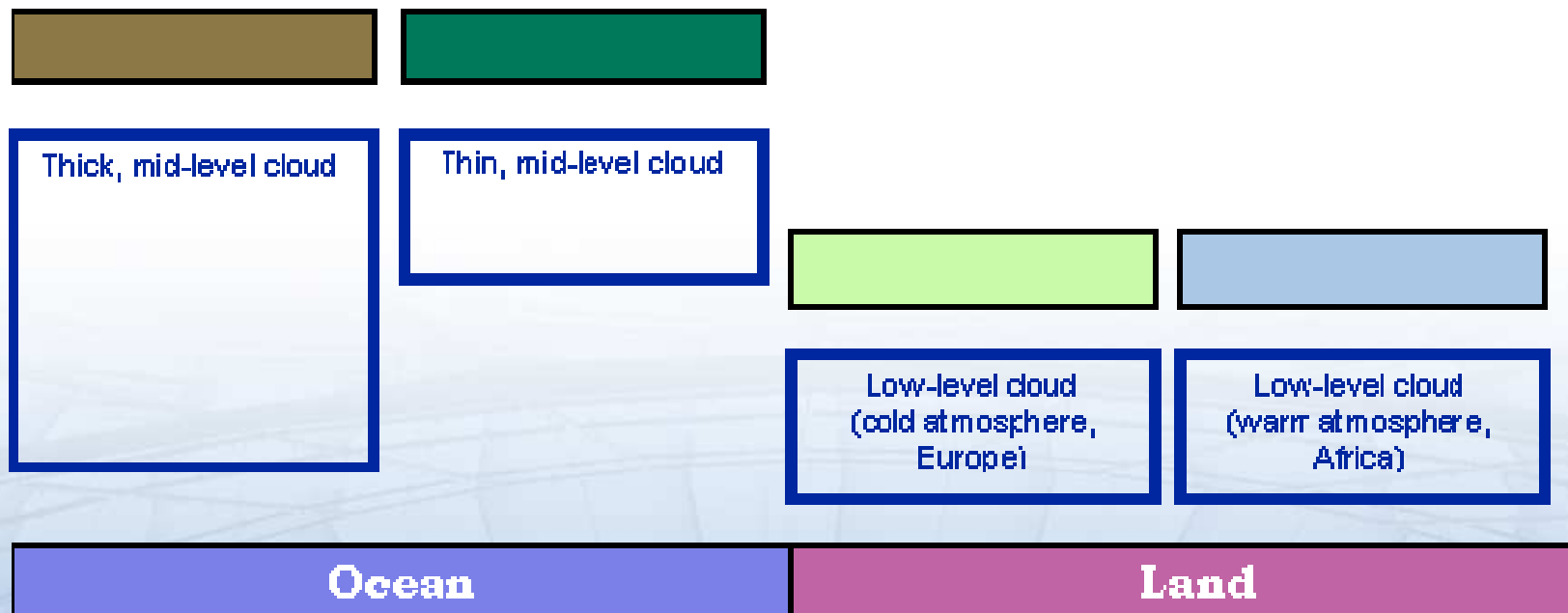
> [IMAGE GALLERY](#), Derived Products, Fog



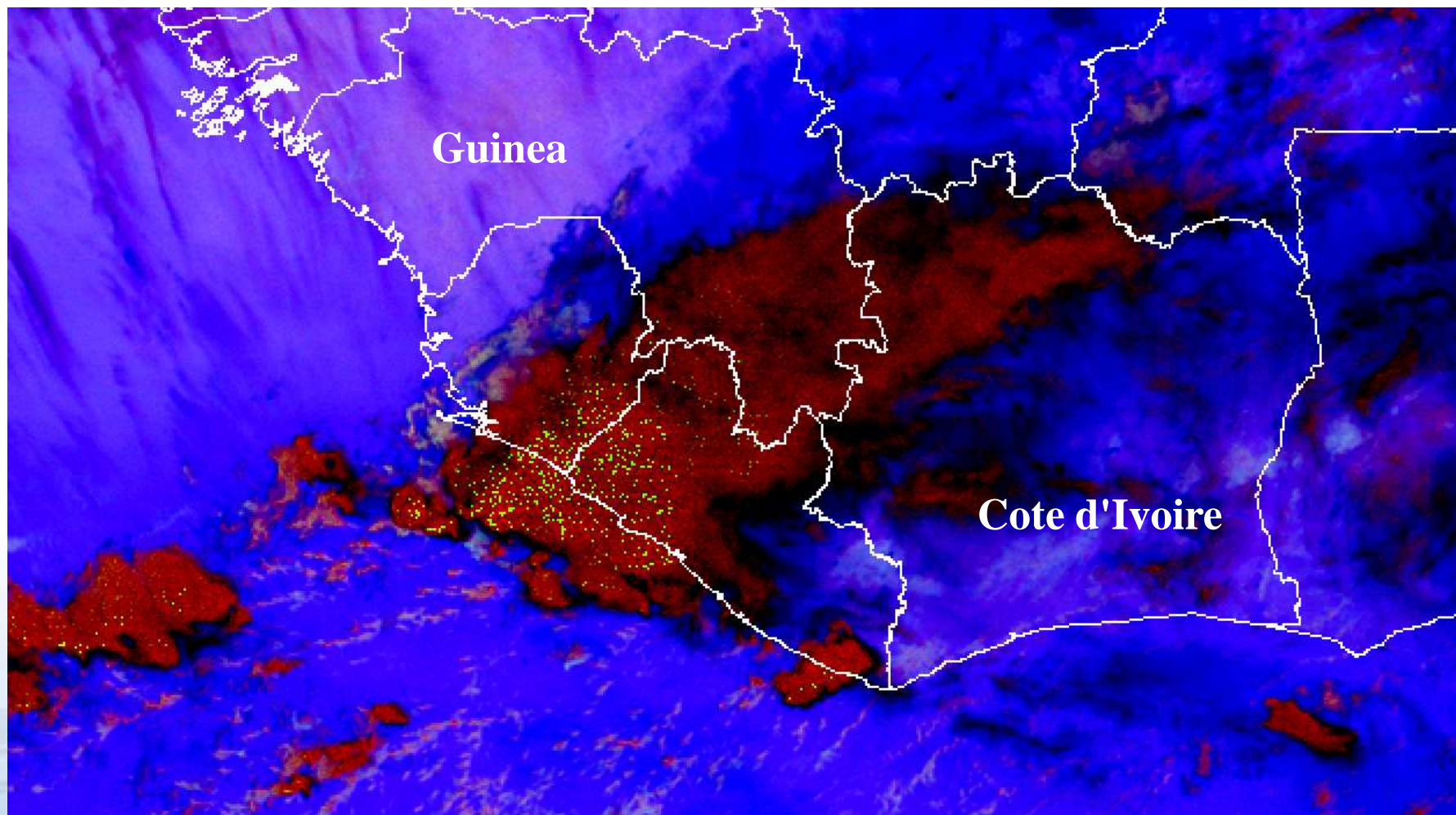
RGB 10-09, 09-04, 09:



RGB 10-09, 09-04, 09: Interpretation of Colours for Mid/Low-level Clouds



Where are the convective clouds (Cb)?

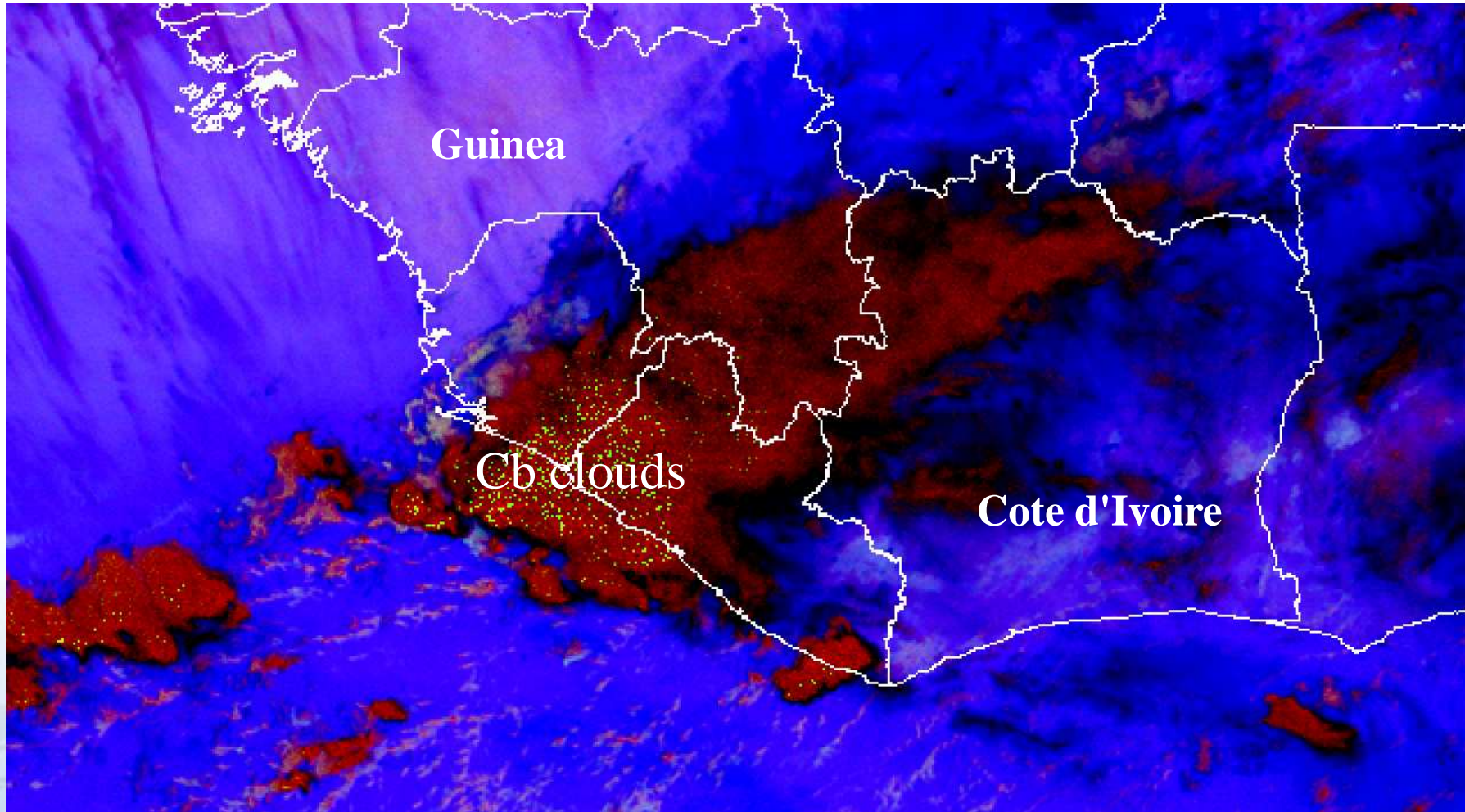


MSG-1, 19 April 2005, 03:15 UTC

> [IMAGE GALLERY](#), Derived Products, Fog



Where are the convective clouds (Cb)?



MSG-1, 19 April 2005, 03:15 UTC

Thank you!

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