Compilation of RGB Recipes

How to create the EUMETSAT suggested standard RGB images from METEOSAT/SEVIRI and MetOp/AVHRR data?

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Introduction

This document contains description (the so called 'recipes') how to create the EUMETSAT suggested standards RGB types from METEOSAT/SEVIRI and MetOp/AVHRR data. For each RGB type a table contains the needed parameters.

Colour beam	Channel (difference)	Range			Gamma
Red		MIN1	MAX1	K or %	Gamma1
Green		MIN2	MAX2	K or %	Gamma2
Blue		MIN3	MAX3	K or %	Gamma3

The second column shows which channels (or channel differences) should be visualised in the red, green and blue colours beams. Before combining them, these images should be calibrated and enhanced.

- The measured values should be calibrated by calculating reflectivity (R) or brightness temperature (BT) values. In case of solar channels the calibration should include solar zenith angle correction as well: the reflectivity should be divided by the cosine of the solar zenith angle. (The zenith angle should be maximise e.g. at 80 degree.)
- The images should be then linearly stretched within the brightness temperature or reflectivity ranges. (The 3rd and 4th columns contain the lower and upper limit of the corresponding ranges, while the 5th column contains the unit. In some cases the range is 'inverted': the MAX and the MIN values are reversed.)
- A so called gamma correction is performed, if needed. If gamma is equal to 1 then no gamma correction is needed. (The 6th column contains the Gamma parameter.)

The enhancement expand the range (MIN, MAX) of R or BT values to the full range of display values (0-255, BYTE) by a linear stretching and a possibly non linear expansion.

$$\boldsymbol{BYTE = 255 * \left(\frac{X - MIN}{MAX - MIN}\right)^{\frac{1}{Gamma}}}$$

where

X is the input value - the actual calibrated value: reflectivity (R) or brightness temperature (BT),

MIN and MAX are the lower and upper limit of the range of the stretching,

Gamma is the parameter of the gamma correction,

BYTE is the output value – the intensity of the enhanced image (if the full range of display value is 0-255)

METEOSAT/SEVIRI RGB recipes

Airmass RGB

Colour beam	Channel (difference)	Range			Gamma
Red	WV6.2 – WV7.3	-25	0	K	1
Green	IR9.7 – IR10.8	-40	+5	K	1
Blue	WV6.2 inverted	243	208	K	1

The table shows which channels or channel differences are visualised in the red, green and blue colour beams. The measured values should be first calibrated to brightness temperatures. The channels or channel differences should be then enhanced – linearly stretched - within the brightness temperature ranges shown in the table. No gamma correction is applied.

Dust RGB

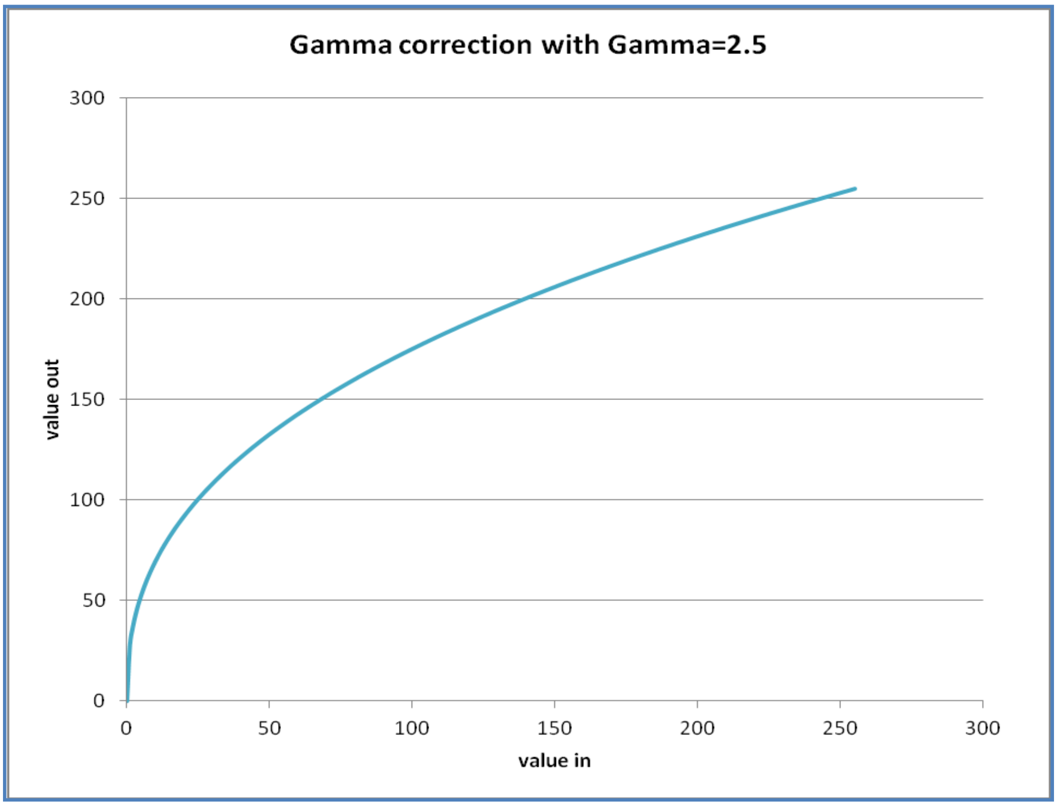
Colour beam	Channel (difference)	Range			Gamma
Red	IR12.0 – IR10.8	-4	+2	K	1.0
Green	IR10.8 – IR8.7	0	+15	K	2.5
Blue	IR10.8	261	289	K	1.0

The Dust RGB is composed of the IR8.7, IR10.8 and the IR12.0 channel data. The input values are calibrated brightness temperatures [K].

Before creating the RGB, the images should be enhanced in two steps.

- First a linear stretch is performed within the indicated ranges.
- Then a gamma correction is applied for the green component.

The gamma correction performs a non-linear expansion. It enhances the contrast either in the darker or in the brighter tones (depending on the Gamma parameter). In case of the Dust RGB (where Gamma is equal to 2.5), the contrast of the darker tones are increased, see the figure below.



Effect of the gamma correction if the Gamma parameter is equal to 2.5

24 hour Microphysics RGB

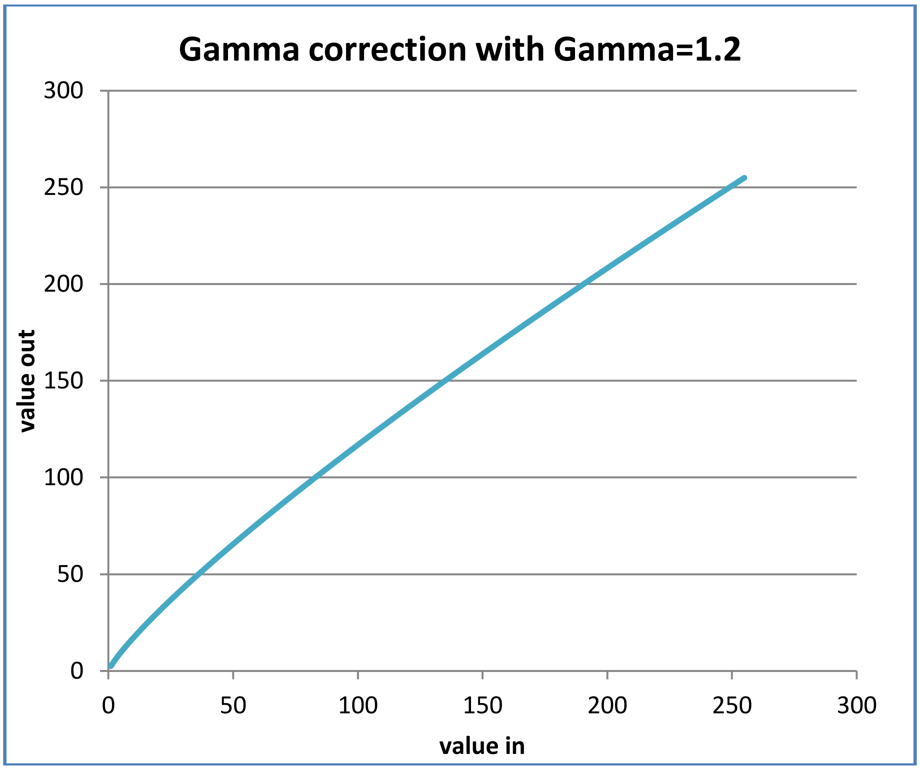
Colour beam	Channel (difference)	Range			Gamma
Red	IR12.0 – IR10.8	-4	+2	K	1.0
Green	IR10.8 – IR8.7	0	+6	K	1.2
Blue	IR10.8	248	303	K	1.0

The 24 hour Microphysics RGB is composed of the IR8.7, IR10.8 and the IR12.0 channel data. The input values are calibrated brightness temperatures [K].

Before creating the RGB, the images should be enhanced in two steps.

- First a linear stretch is performed within the indicated ranges.
- Then a gamma correction is applied for the green component.

The gamma correction performs non-linear expansion. It enhances the contrast either in the darker or in the brighter tones (depending on the Gamma parameter). In case of the 24 hour Microphysics RGB (where Gamma is equal to 1.2), the contrast of the darker tones are slightly increased, see the figure below.



Effect of the gamma correction if the Gamma parameter is equal to 1.2

Ash RGB

Colour beam	Channel (difference)	Range			Gamma
Red	IR12.0 - IR10.8	-4	+2	K	1
Green	IR10.8 – IR8.7	-4	+5	K	1
Blue	IR10.8	243	303	K	1

The table shows which channels or channel differences are visualised in the red, green and blue colour beams. The measured values should be first calibrated to brightness temperatures. The channels or channel differences should be then enhanced – linearly stretched - within the brightness temperature ranges shown in the table.

Day Microphysics RGB

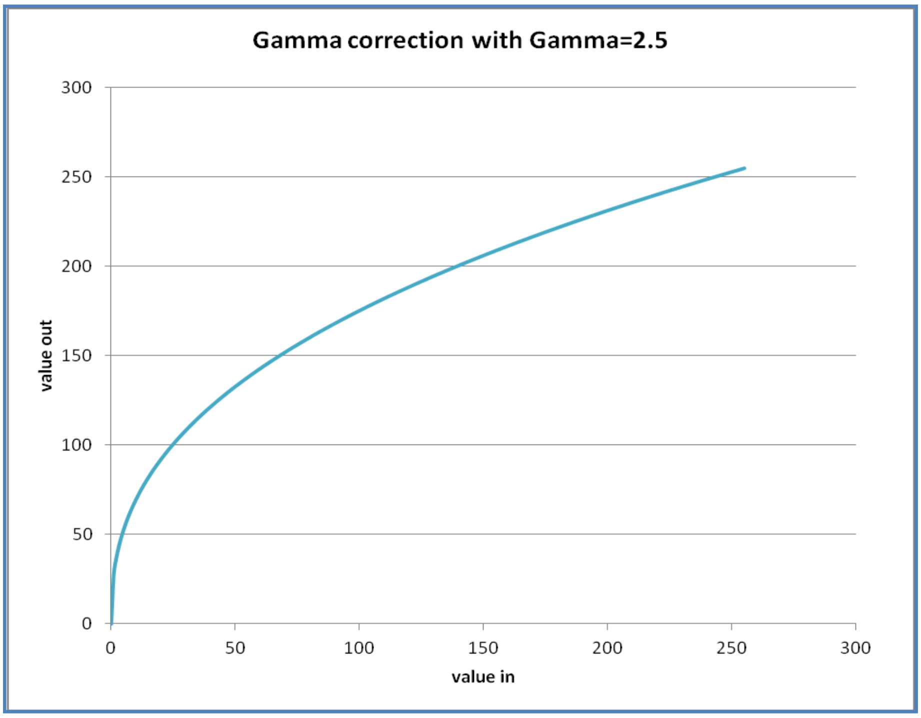
Colour beam	Channel	Range			Gamma
Red	VIS0.8	0	100	%	1.0
Green	IR3.9refl	0	60	%	2.5
Blue	IR10.8	203	323	K	1.0

The Day Microphysics RGB is composed of the VIS0.8, IR3.9 and the IR10.8 channel data. The measured values should be calibrated to calculate reflectivity (including also solar zenith angle correction) from the solar channels and brightness temperature from the thermal channel. During daytime the IR3.9 radiance includes reflected (shortwave) solar contribution as well as emitted thermal radiation. In the Day Microphysics RGB we are only interested in the solar component. To create the Day Microphysics RGB one has to calculate the solar component of the measured IR3.9 signal. The abbreviation IR3.9refl indicates the reflectivity computed from the solar component of the measured IR3.9 radiation.

Before creating the RGB, the images should be enhanced in two steps.

- First a linear stretch is performed within the indicated ranges.
- Then a gamma correction is applied for the green channel.

In case of the Day Microphysics RGB (where Gamma is equal to 2.5), the contrast of the darker tones are increased, see the figure below.



Effect of the gamma correction if the Gamma parameter is equal to 2.5

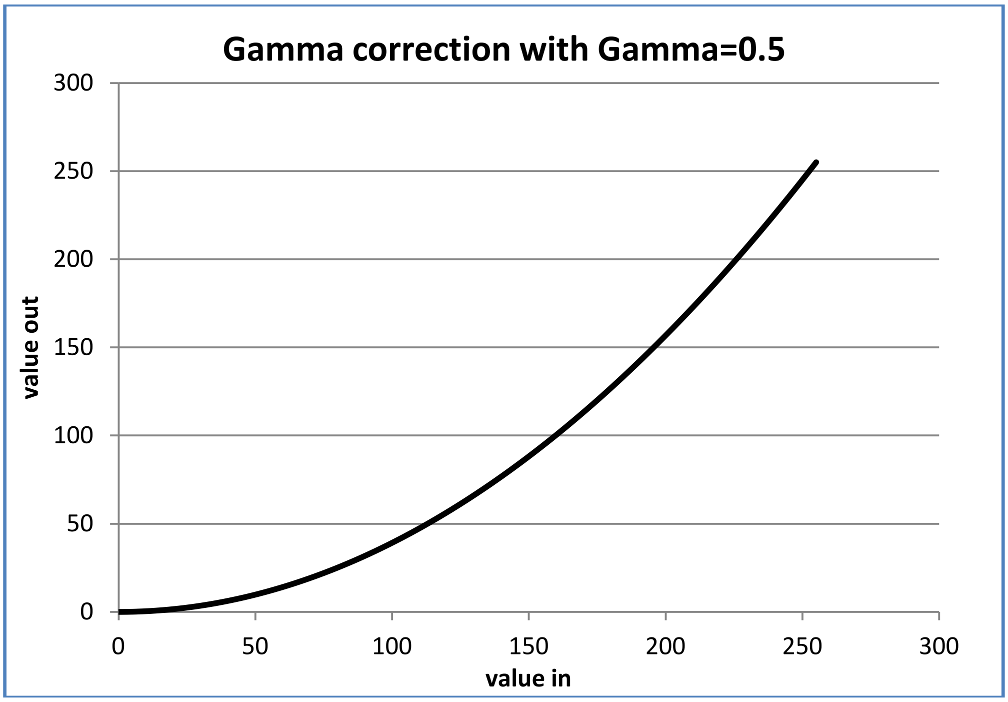
Severe Storms RGB

Colour beam	Channel difference	Range			Gamma
Red	WV6.2 – WV7.3	-35	+5	K	1
Green	IR3.9 – IR10.8	-5	+60	K	0.5
Blue	NIR1.6 – VIS0.6	-75	+25	%	1

The Table shows which channel differences are visualised in the red, green and blue colour beams. Before combining them, these images should be calibrated and enhanced in one or two steps.

- First a linear stretch is performed within the brightness temperature or reflectivity ranges.
- Then a so called gamma correction is performed for the green component.

The gamma correction enhances the contrast in the darker or in the brighter tones (depending on the Gamma parameter). In case of the green component of the Severe Storms RGB (Gamma is equal to 0.5), the contrast of the brighter tones are increased, see the figure below.



Effect of the gamma correction if the Gamma parameter is equal to 0.5

Snow RGB

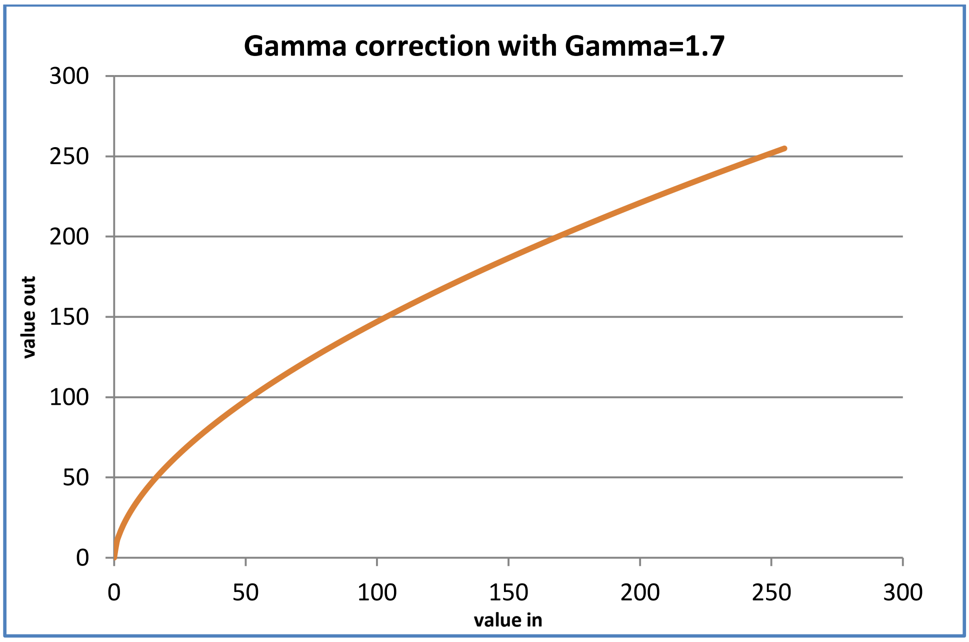
Colour beam	Channel	Range			Gamma
Red	VIS0.8	0	100	%	1.7
Green	NIR1.6	0	70	%	1.7
Blue	IR3.9refl	0	30	%	1.7

The Snow RGB is composed of the VIS0.8, NIR1.6 and the IR3.9 channel data.
The measured values should be calibrated to calculate reflectivity (including also solar zenith angle correction). During daytime the IR3.9 radiance includes reflected solar contribution as well as emitted thermal radiation. In the Snow RGB we are interested only in the solar component. To create the snow RGB one has to calculate the solar component of the measured IR3.9 signal. The abbreviation IR3.9refl indicates the reflectivity computed from the solar component of the measured IR3.9 radiation.

Before creating the RGB, the images should be enhanced in two steps.

- First a linear stretch is performed within the indicated reflectivity ranges.
- Then the gamma correction is performed.

The gamma correction performs non-linear expansion. It enhances the contrast either in the darker or in the brighter tones (depending on the Gamma parameter). In case of the Snow RGB (where Gamma is equal to 1.7), the contrast of the darker tones are increased, see the figure below.



Effect of the gamma correction if the Gamma parameter is equal to 1.7

Natural Colours RGB

Colour beam	Channel	Range			Gamma
Red	NIR1.6	0	100	%	1
Green	VIS0.8	0	100	%	1
Blue	VIS0.6	0	100	%	1

The Natural Colours RGB is composed of the VIS0.6, VIS0.8 and the NIR1.6 channel data. The measured values should be calibrated to calculate reflectivity (including also solar zenith angle correction). The images should then be then enhanced – linearly stretched - within the reflectivity ranges shown in the table.

HRV Clouds RGB

Colour beam	Channel	Range			Gamma
Red	HRV	0	100	%	1
Green	HRV	0	100	%	1
Blue	IR10.8 inverted	323	203	K	1

The HRV Cloud RGB is composed of the HRV and the IR10.8 channel data. The measured values should be calibrated to calculate reflectivity (including also solar zenith angle correction) from the solar channel and brightness temperature from the thermal channel.
The channels should then be enhanced – linearly stretched - within the brightness temperature and reflectivity ranges shown in the table. No gamma correction is applied.

The High Resolution Visible (HRV) channel is used in two colour beams not to lose the high resolution appearance.

HRV Fog RGB

Colour beam	Channel	Range			Gamma
Red	NIR1.6	0	70	%	1
Green	HRV	0	100	%	1
Blue	HRV	0	100	%	1

The Table shows which channels are visualised in the red, green and blue colour beams. The measured values should be calibrated to calculate reflectivity (including also solar zenith angle correction). The images should be then enhanced – linearly stretched - within the reflectivity ranges shown in the table.

The High Resolution Visible (HRV) channel is used in two colour beams not to lose the high resolution appearance.

Night Microphysics RGB

Colour beam	Channel (difference)	Range			Gamma
Red	IR12.0 – IR10.8	-4	+2	K	1
Green	IR10.8 – IR3.9	0	+10	K	1
Blue	IR10.8	243	293	K	1

The Night Microphysics RGB is composed of the IR3.9, IR10.8 and the IR12.0 channel data. The input values are calibrated brightness temperatures [K].

The channels should then be enhanced – linearly stretched - within the brightness temperature ranges shown in the table. No gamma correction is applied.

MetOp/AVHRR RGB recipes

The AVHRR instrument onboard of the MetOp satellite has fewer channels than the METEOSAT/SEVIRI instrument. It measures in 6 channels, two of them are alternatives: the IR3.74 channel works only during night, while the NIR1.6 channel works only during day.

The table below lists the names and the central wavelengths of the channels of the MetOp/AVHRR instrument and the central wavelength of the closest SEVIRI channels.

METOP/AVHRR channels		Closest METEOSAT/SEVIRI channel	
Name	Central wavelength	channel	Central wavelength
1	0.63	VIS0.6	0.64
2	0.87	VIS0.8	0.81
3a (daytime)	1.61	NIR1.6	1.64
3b (nighttime)	3.74	IR3.9	3.90
4	10.80	IR10.8	10.80
5	12.00	IR12.0	12.00

Day Microphysics RGB

Colour beam	Channel	Range			Gamma
Red	Channel 2	0	100	%	1
Green	Channel 3a	0	70	%	1
Blue	Channel 4	203	323	K	1

The table shows which channels are visualised in the red, green and blue colour beams. The measured values should be calibrated to calculate reflectivity (including also solar zenith angle correction) from the solar channels and brightness temperature from the thermal channel. The channels should then be enhanced – linearly stretched - within the brightness temperature and reflectivity ranges shown in the table. No gamma correction is applied.

Clouds RGB

Colour beam	Channel	Range			Gamma
Red	Channel 1	0	100	%	1
Green	Channel 2	0	100	%	1
Blue	Channel 4 inverted	323	203	K	1

The table shows which channels are visualised in the red, green and blue colour beams. The measured values should be calibrated to calculate reflectivity (including also solar zenith angle correction) from the solar channels and brightness temperature from the thermal channel. The channels should then be enhanced – linearly stretched - within the brightness temperature and reflectivity ranges shown in the table. No gamma correction is applied.

Natural Colours RGB

Colour beam	Channel	Range			Gamma
Red	Channel 3a	0	100	%	1
Green	Channel 2	0	100	%	1
Blue	Channel 1	0	100	%	1

The table shows which channels are visualised in the red, green and blue colour beams. The measured values should be calibrated to calculate reflectivity values (including also solar zenith angle correction). The images should be then enhanced – linearly stretched - within the reflectivity ranges shown in the table. No gamma correction is applied.

Night Microphysics RGB

Colour beam	Channel (difference)	Range			Gamma
Red	Channel 5 - Channel4	-4	+2	K	1
Green	Channel 4 - Channel 3b	-4	+6	K	1
Blue	Channel 4	243	293	K	1

The table shows which channels (or channel differences) are visualised in the red, green and blue colour beams. Before combining them the measured values should be calibrated to calculate brightness temperatures. The channels (or channel differences) should be then enhanced – linearly stretched - within the brightness temperature ranges shown in the table. No gamma correction is applied.