CATALOGUE OF ENHANCEMENTS FOR WEATHERSATELLITES

The GeoSatSignal and HRPT-reader LUT100/256/361 series

Second and Enlarged Edition
from the
NOAA/NESDIS Goes Enhancements

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INTRODUCTION

Traditional grayscale images don't show a lot of details. But on Infrared channels every pixel does represents a thermal value. Since infrared is based on heat or thermal radiation each gray tone pixel can be connected to a specified to a thermal value. There are 256 gray-tones on each image in a range of +56.8 C to -109.0 C. This results in a 0,6 C step for each gray tone. Whit this knowledge we can improve the images from the satellites, just by replacing the requested gray for any other colour.
The extended LUTs, the LUT361 series, for GeoSatSignal have a range of +60 C to -120 C. The range -120 C to -109 C and 56.8 C to 60 C are not used in the LUT, but they are shown in the graphs and listed in the tables. This to complete the full range of the extended 361 pixel width of the LUT (-120 to +60 C) for GeoSatSignal offered in this package.
White and light gray tones are usual cold temperatures. But differences in the thermal radiations are hard to see if the temperatures are close to each other. The solution to get a higher contrast is to replace some gray tones. By example: If we want to have a better contrast for extremely cold cloud-tops in a range of -60 C to -80 C then we replace the graytones into any other gray or even another colour. Now we can see the differences in thermal radiation in much better contrast and detail.
The NNG enhancementseries are designed for use with the GOES satellites, but can be used for the Meteosat satellites and other satellites (NOAA, Japanese satellites) as well. The LUTs, enhancements and definitions in this distribution are based on the official descriptions from weatherservices and satellite operators, but prepared for use with GeoSatSignal. Several enhancements are available for studying the weather. There are not only enhancements for cyclones, overshooting thunderstorms and supercels, but also for fog, fire detection and seasonal weather.
Each enhancement comes with a brief description for its use and diagram showing the relation of the thermal radiation or brightness pixel and its colour.
Making 3D images from infrared is another enhancement technique with use of LUTs. You can find them on some place on the web. Enhancements of this kind are not included in this overview, because they are not supported by GSS.

CHANNELS

CHANNEL COMPARISON FOR USA, JAPANESE AND EUROPEAN WEATHERSATELLITES

This table shows the relation of the available channels from the US, Japanese and European weathersatellites. GEO is refering to geostationary satellites and LEO to polar orbiters (Low Earth Orbiters). For Goes channel 3 is centered at 6.7 :m. Most LUTs are designed for Goes satellites. But, by example, if in this catalogue a LUT is refering to Goes IR4 than it can also be used for Meteosat 1 to 7 channel 3 or Meteosat 8 and 9 for channel 10. All other IR channels named in the catalogue are refering to the standard IR 10.8 :m channel.

	GEO								LEO			
Channel	**Goes**		**Meteosat**		**GMS**		**MTSat**		**NOAA**		**METOP**	
Vis 0.6	1	x	1	x3	1	x		x	1	x	1	x
Vis 0.8			2	x					2	x	2	x
NIR 1.64			3	x					3A	x	3A	x
IR 3.9	2	x	4	x			4	x	3B	x	3B	x
WV 6.2	3	x	5	x3	4	x	3	x				
WV 7.3			6	x								
IR 8.7			7	x								
IR 9.7			8	x								
IR 10.8	4	x	9	x3	2	x	1	x	4	x	4	x
IR 12.0	5	x1	10	x	3	x	2	x	5	x	5	x
IR 13.4	6	x2	11	x								
HRV			12	x								
x	present											
x1	Goes 8 to 11 only											
x2	Goes 12 onward											
x3	Meteosat 1-7 channels											

DESCRIPTION OF THE AVAILABLE CHANNELS

All the solar reflecting channels VIS, HRV and NIR are counting in gray from 0 to 255. The watervapour channels are also counting in gray shades but are limited from around -90 to around -5 C. But it should be noted that watervapour channels are not set in thermal degrees Celcius. This values are only for corresponding gray on the measurements. The other infrared channels are useual ranging from -109 C to +56.8 C.

VIS 0.6, VIS 0.8 and HRV

This channel shows in gray the tones what the naked eye should see. Features are visible by reflection of the solar radiation. Bright features appear as white and reflect almost all solar radiation and black absorts all solar radiation. Thus they are essential for tracking and detection of clouds at daytime and show many surface details. The visual VIS 0.8 provide better results on land features and the High Resolution Visual offer a better resolution up to 1 km at nadir.

NIR 1.64

The Near Infra Red channel is also a solar reflecting channel and may help to discriminate clouds from snowcover and from water and ice clouds. It provide also information about aerosols.

IR 3.9

Primarily used to detect fog and low clouds at night. But this channel is also useful to detect forest fires and measurements of sea en landsurface temperatures at night.

WV 6.2 and WV 7.3
Watervapour channels are to determinate watervapour in earths atmosphere. Dry conditions appear as black and saturated as white. It shows als winds in the upper atmospheric levels even if there are no drifting clouds available. Meteosat MSG offers two different channels in the watervapour band. The WV 6.2 channel optimized for the 320 hPa level and the WV 7.3 for the 450 hPa level.
Water vapour channels responds to emitted radiation only. Improvements in this channel include slightly greater than a factor of two in spatial resolution and a factor of nearly four in signal-to-noise. These improvements may be seen in comparison imagery that follows. These higher quality data should lead to:

a) better winds in cloud free areas;
b) improved analysis of synoptic-scale features; and
c) the ability to identify mesoscale features embedded within larger scale systems.

It should be noted that the watervapour channels are not calibrated, not for any thermal radiation or grayvalue, and they counts in gray from 1 to 256. Therefore the watervapour images might looking different by using a LUT from this catalogue by use for any satellite if compared whit web images.

IR 8.7
Mainly used to provide information about cirrus and helps support to discriminate water and ice clouds.

IR 9.7
The ozone channel. It provides information about the diurnal ozone variation.

IR 10.8 and IR 12.0
Infrared images are thermal based and can't never be used to determinate clouds only. It is a themal issue that cold thermal values are given as white and warm as black in the frames. Discrimination of land and sea features from low clouds is difficult in infrared. Especially when near surface and other low cloudstop are almost equal to groundlevel thermal values. On the image they look as identical gray tones.
Discrimination of clouds is even more difficult during wintertime. Temperatures below freezinglevel near the surface makes it difficult to decide if the area is overcast with cold clouds or just cloudfree. Freezinglevel is often used as a thresholt for cloudy circumstances, but that doesn’t work in cold continental wintertime with temperatures below 0 C. Therefore take always a look to the visual images or if you live in Europe or Africa take a look on the advanced MSG airmass product. Clouds are well resolved from land and sea because of the combination from different channels available.There is a small difference between IR 10.8 and IR 12.0. The last one is more sensitive for cirrus. Improvements of the infrared channels give much more detail:

a) better cloud drift winds;
b) improved severe storm and heavy rainfall identification and monitoring;
c) improved monitoring of land surface heating and cooling (in dry air) for applications such as frost/freeze forecasting;
d) improved low level moisture identification in combination with the 12.0 um channel;
e) additional synergies with other channels.

IR 13.4
The CO_2 absorption channel can also be used to estimate the atmospheric instability and improve thermal data from the lower troposphere.

ENHANCING OF SATELLITE IMAGES

CLOUDTOPS, PRECIPITATION AND WEATHERRADAR

Frontal systems have often thick clouds with cold tops. Basically this are thick clouds known as Nimbostratus and Cumulonimbus. The last one are showerclouds and are often visible behind coldfronts as well. This kind of clouds are often participated with precipitation, but this doesn't mean that the precipitation reaches always earth's surface. The principle is simple, the change of any precipitations grows with thick clouds and colder cloudtops. Thick clouds with tops from around -15 down to -50 C indicate a possibility of precipitation. Use of LUTs can extract or accentuate these regions. But this technique does not guarantee if precipitation realy exists. Precipitation can be evaporate before it reaches earth surface. It is therefore a good idea to check out the local weatherrader if any precipition occurs in your neighbourhood. But be aware that weatherradar could give false echo's too. Drizzle or light rain can't often be seen, either with weatherradar or with satellite images. Because the rainfal is to light to give echos and drizzle is often comming from low altitude (warm) clouds as stratus and they are to warm to detect with false colour frames from satellites too.

MAKING OF LUTS

It is not possible to give a general description for making of costumized LUTs. Each photo-editor or drawing tool could be a help, but all have different menu-options and it is therefore impossible generalize it in a manual. But some of the tips below might be a help to set up a LUT for own needs.
LUTs to create with help of the LUTmaker are included, this descriptions are only valid for the 100*2, 256*2 and 361*2 LUTs to be used for any infrared of watervapour channel. It is recommended to use the 100*2 LUTs for any kind of cloudmasks, the 256*2 is suitable for watervapour and visual channels. Both can be used for general shading enhancements. Use for all other infrared channels the 361*2 LUTs. It is a good idea to organize your LUTs and maybe this catalogue might give you an idea how the LUTs for GSS are organized.

The first step to create a LUT is making a new empty image with your editor. Depending on your needs this could be:

100 pixels width and 2 pixels depth,
256 pixels width and 2 pixels depth,
361 pixels width and 2 pixels depth.

Choose a white template and create this image. It doesn't care which DPI was choosen, but if there are any problems in use then choose 72 DPI. Now activite the rulers and be sure to set them on pixels. For the 361*2 LUTs each 20 pixels is equal to 10 C and the left side starts at the cold end at -120 C. Enable the rulers grid option and set the horizontal grid to 20 pixels.
The first 11 C are not in use by any thermal channel, so you can leave it white or replace the white by the pixelcolor of -109 C. Select with a mask-tool the requested thermal range you like to enhance and fill this with a colour with use of the fill mask option. Your editor should have options for palleted colours fixed to one colour or you can make shaded and smoothed pallets by use to two colours. Select another thermal range after you have finished the part of your LUT to continue your creation. The pixels beyond 58 C are not in use so can leave them white or replace it with the latest pixelcolour know.
It is difficult to generate LUTs form examples from the web. If you need help to make LUTs from any source not represented in the catalogue then mail to the satsignal usergroup to we shall try to assist you.

Reproducing multispectral products
LUT controled output is one way to enhance satellite imagery. Another way is combining more as one spectral satellite channel. With this technique more als one channels are combined into a new image. Each channel is representing a colour; Red, Green or Blue, but you may also combine a group of satellite channels into a colourband and combine them in a photo-editor. Be sure to invert the images to get a 'negative' format. This is the format as the images are received from the satellite; thus black at cold end and white at the warm end. If your reference tells you that you need an inverted image then use the standard GSS output. In words, think in the opposite way if you wish to combine any channel.
Open in a requested satellite channel and save it in the RGB mode. Save the channels into separate images and join them into a photo editor. Repeat this for other channels needed. Now you will find three sets of images in gray, each representing a colour. Use the 'difference' option to overlay/combine the RGB channels of your choice in your photo-editor to create a new image. You may adjust the brightness, contrast and intensity if you wish to get a better image.
Combine of channels can also be used for other modes as RGB. You have to check out which combinations are possible, but with use of Corel Photopaint you have options for:

HSB Hue Saturation Brightness
LAB Lumination with two chromatic components a and b
RGB Red Green Blue
YIQ Model based on the North American video standard

Another way to combine satellite channels is with the use of RGB filters. They are included in the toolset of Meteo Maarssen. Available are inverted and non inverted RGB filters. Also think again into

the opposite way before to use them. You have to check out which option gives the best results for your needs while making multispectral products.

THE COLOUR LOOKUP TABLE CATALOGUE

ABOUT THE LOOK UP TABLES (LUT)

The original LUTs used by NOAA and some other US weatherservices are made in the NWS Advanced Weather Interactive Processing System (AWIPS). These LUTs are starting at the warm side (left) and the cold side is at the right side. GeoSatSignal and HRPTReader are using a simmular system, but it starts with the cold part at the left side and the warm section ends at the right side. The LUTs in this catalogue can't be converted to other applications, the results are unpredictable in that case.

There two kinds of LUTs available: calibrated and non calibrated. The calibrated LUTs comes with a graph and a setup table for RGB or grayscale settings. Non calibrated LUTs are build up by examples from webimages. Colors are set by comparing the thermal value in GeoSatSignal and the used colors from the images published on the web and carefully tuned for use in GeoSatSignal. There might be always some differences between the LUTs in this catalogue and the offical versions. LUTs from this family comes only with a thermal or brigthness count bar. Therefore the land/sea masks and GeoSatSignal LUTs are also published without calibrated RGB/grayscale table settings.

Please note that there is another kind of calibration. Satellite channels can be calibrated or not. LUTs from the LUT361 family are recommended for use on calibrated channels and the LUT256 family should be used for non calibrated channels. The last are 256 pixels wide and correspondents with the 256 gray shades. Non calibrated satellite channels are using only the gray shades.

LOOK UP TABLES FOR GEOSATSIGNAL/HRPTReader

Currently there are three families of LUTs for GeoSatSignal and HRPTReader available:

LUT100 family

This LUT is 100 pixel wide and two pixel in depth. Is was originally designed to support land sea masks, where the lower part was used for sea features and the upper part for land features. This format is not longer supported in this way in GoeSatSignal 6. The LUT100 family has a become a different rule: It is intended to be used to create a cloudmask. The upper part of this LUT controls the thermal value, while the lower part is used for a brightness fading control for transparency. Herewith speudo visual images from infrared can be made.

The old versions of the LUTs from 100*2 pixelsize are redesigned into the 361*2 family.

LUT100b family

The LUT100b was the first LUT which could be used in GeoSatSignal. This LUT is 100 pixel wide and 255 pixel in depth. Thermal values are on the X-axis in a range from -60 C to +40 C. The brightness of this LUTs are controled on the Y-axis and each pixel represents a value in the RGB or grayscale and have values from 0 (darkest) to 255 (brightest). LUTs from the 100b subfamily are useful for false colour visual images.

All LUTs made with the additional LUTmaker program are member of the LUT100b family. See the section: Making of LUTs in the 256 and 361 range for more details to create LUTs for these families.

LUT256 family

There are 256 shades of gray visible with the nkaed eye and the LUTs with the format of 256*2 pixels are intended to be used for non calibrated data with shades of gray, such as watervapour or the visual channel. This format supports land/sea masks if requested.

LUT361 family

LUTs from this family are 361 pixels wide and 2 in depth. These LUTs are controled by thermal data with steps of 0,5 C from -109 C to +55 C. The full range of this LUTs are -120 C to +60 C, but the sections beyond the thermal limits from the calibrated thermal data are not used. This LUTs supports the land/sea masks available in GeoSatSignal.

CONVENTION OF LUT FILENAMING

LUT[nnn(b)]_[source]-[enhancement]-[info].bmp

nnn	pixelwidth
b	brightness control
source	weatherservice or other source
enhancement	enhancement, channel, or type
info	extra information

nnn	100, 256, 361 pixels

source	ADDS	Aviation Digital Data Service (USA)
	AFWA	US AirForce Weather Agengy
	AWI	AccuWeather Inc (USA)
	BMS	Brunei Meteorological Services
	BOM	Bureau of Meteorology (Australia)
	CFMI	Centro Funzionale Meteo-idrologico Di Protezione Civile Della Regione Liguria (Italy)
	COD	College of DuPage/NexLab (USA)
	CHMI	Czech Hydrometeorological Institute
	DSRS	Dundee Satellite Receiving Station (UK)
	EAL	Earth At Large (Netherlands)
	EUM	Eumetsat
	FSU	Florida State University (USA)
	GPS	Goes Project Science (USA)
	GSS	GeoSatSignal
	IMN	Instituto Nacional Meteorologia (Spain)
	LMD	Laboratoire de Météorologie Dynamique (France)
	MD	Meteorological Department (Oman)
	MDNAA	Meteorologische Dienst Nederlandse Antillen en Aruba (Netherlands Antilles and Aruba)
	MFR	Meteo France
	MI	Meteorologisk Institutt (Norway)
	MM	Meteo Maarssen (Netherlands)
	MMS	Mauritius Meteorological Services
	MOAD	Meteorological Office Abu Dhabi (United Arab Emirates)
	MSC	Meteorological Service of Canada
	NGSS	NOAA Geostationary Satellite Server (USA)
	NLSP	NASA Langley Satellite Page (USA)
	NHC	National Hurricane Center (USA)
	NNG	NOAA/NESDIS-Goes (USA)
	NRL	Naval Research Laboratory (USA)
	NSAB	NOAA Science Advisory Board (USA)
	OSU	Ohio State University (USA)
	PME	Precidency of Meteorology and Evironment (Saudi Arabi)
	PUMA	Preparation of the Use of MSG1 in Africa
	RCR	RAMSDIS-CIRA/RAMMB from Colorado State University (USA)
	SMNA	Service Meteorológica Nacional (Argentina)
	SMNM	Servicio Meteorológica Nacional (Mexico)
	SNMH	Servico Nacional de Meteorlogia e Hidrologia (Bolivia)
	SSEC	Space Science and Engineering Data Center (USA)
	TWC	The Weather Channel (USA)
	UB	University of Berlin (Germany)
	UCAR	University Corporation for Atmospheric Research (USA)
	UKMO	United Kingdom Meteorlogical Office
	WUG	Weatherunderground (USA)

enhancement, channel or type	known enhancement codes	
	CIRA	
	HRIT	
	IR	Standard the 10.8 :m channel, otherwise channelnumber given.
	LRIT	
	Tx	Toolset: x = R (red), G = (green), B = (blue), i = (inverted).
	WV	Is equal to Goes IR3 or Meteosat WV.
	VIS	
info	bw	black/white - grayscale
	cc	colour
	cm	cloud mask
	ct	cloud tops
	fc	false color
	fog	fog
	lsct	land sea cloud tops
	mod	modified
	sst	sea surface temperatures

SETUP
Expand all files to the directory/folder from GeoSatSignal. They should appear on the processing-tap from the jobsetup menu and popup at "LUT".

ACKNOWLEDGEMENTS
Most definitions and descriptions are taken from the original sources and translated if necessary. The LUTs are named in the order as I found them during my survey on the web, this doesn't mean that the LUTs are developed by that agency. Some LUTs are used at several weatherservices and it is hard to find out the source. Not every weather agency does co-orporate with this project. Some are very heplfull, while others won't give any reaction on any request. But special thanks to NOAA, Eumetsat, the Norwegian Institute of Meteorology and the Deutcher Wetterdienst for all their help and descriptions about LUTs and multispectral image manipulation.

PART ONE
SINGLE CHANNEL ENHANCEMENTS

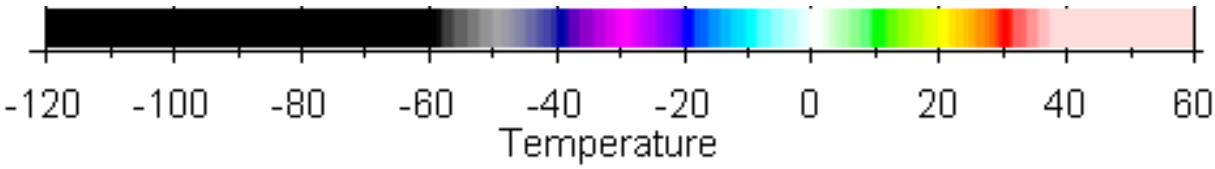
GEOSATSIGNAL DERIVED PRODUCTS AND ENHANCEMENTS

GeoSatSignal standard LUTs in the 100 pixel series are in a range of -60 C to +40 C; but digital data does have a range of -109 C to +55 C. The lowest temperatures in the earth's atmosphere are around -80 C. Therefore the 100 pixel series are not very usefull to study extreme cold cloudtops as overshooting tops on thunderstorms, cyclones and well exposed frontal cloudbands near the vortex.

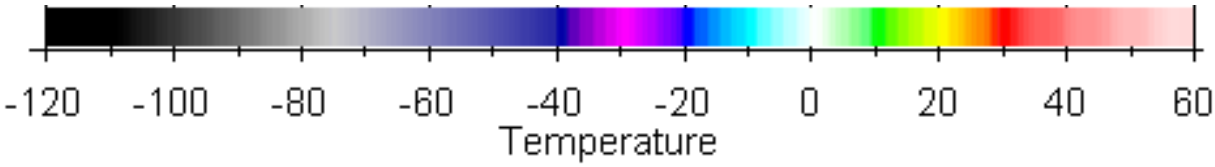
There are two different 100 pixel LUTs available. The LUT100b_GSS-series have a brightness control for visual channels and don't support the land/sea masks. If you wish to use the land/sea masks then you should use the LUT256 or LUT361 series instead. This serial is two pixel high and the lower part represents the thermal sea features. The upper part shows thermal features on land.
The old 100*2 pixel LUTs does not longer support the land/sea masks. The lower part now controls the brightness as a fading option for use in cloudmasks to create speudo visual images out of infrared data.
The LUT100b_GSS-series can be used for visual imagery as well.

INFRARED

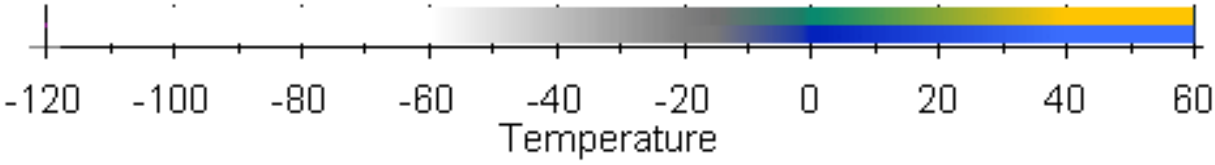
LUT: LUT361_GSS-IR-cc1.bmp (former TempToColourTherm.bmp)



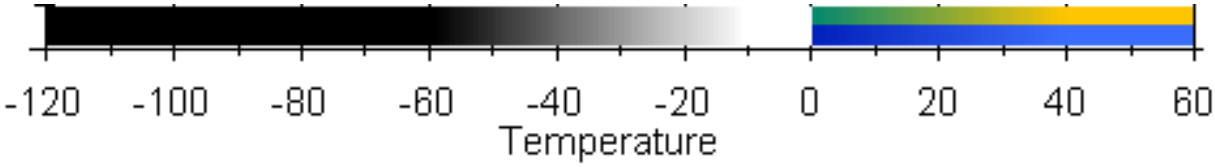
LUT: LUT361_GSS-IR-cc2.bmp



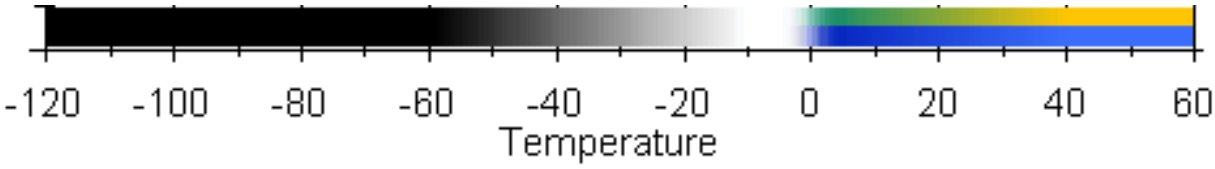
LUT: LUT361_GSS-IR-lsct1.bmp (former: LUTLandSea.bmp)



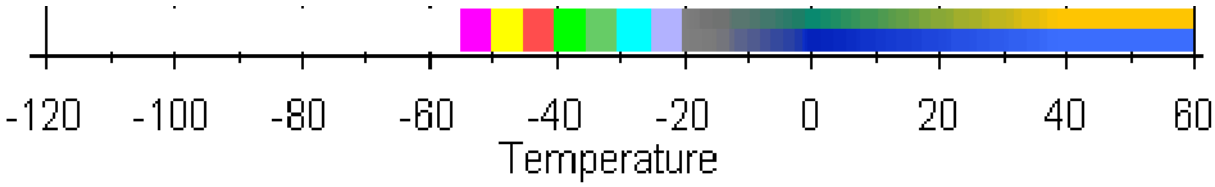
LUT: LUT361_GSS-IR-lsct2a.bmp (former: LUTLandSeaBlackClouds.bmp)



LUT: LUT361_GSS-IR-lsct2b.bmp (former: LUTLandSeaBlackClouds2.bmp)



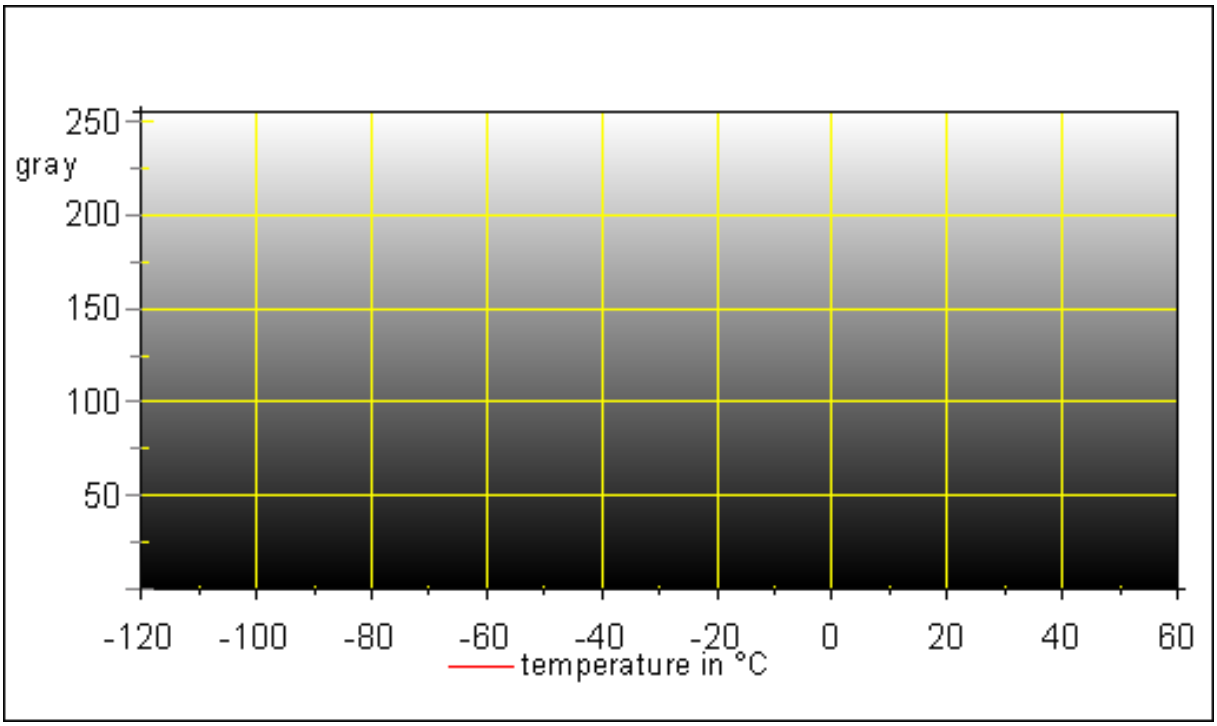
LUT: LUT361_GSS-IR-lsct3.bmp (former: LUTLandSeaCT.bmp)



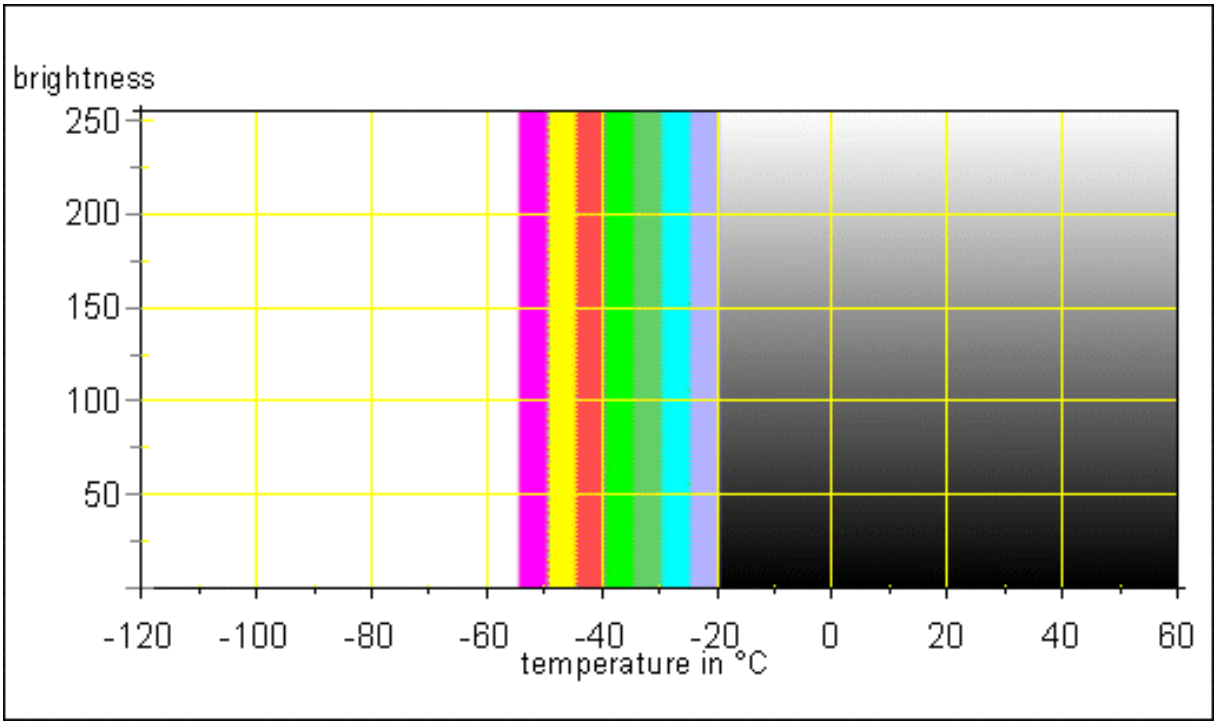
LUT361_GSS-IR-lsct1 meets the LUT used at US Air Force base at Sembach (Germany), but there are some small differences.. The GSS version is using the thermal values from the data for the land and sea features. Sembach is using a kind of a cloudmask from white (cold cloudtops) to dark gray (warm cloudtops) on a static basemap. See fore details about this technique the cloudmask LUTs on page 20 if you wish to use a static basemap.The LUT361_GSS-IR-lsct2a/b are based on the LUT100_GSS-IR-lsct1, but do have black cloudtops instead of white. The 2b version fades around freezing level. And lsct3 is based on lsct1 but has a coloured cloudtop enhancement down to -60 C.

INFRARED AND VISUAL - BRIGHTNESS CONTRELED

LUT: LUT100b_GSS-VIS-bw.bmp (former: LUTgrayscale.bmp)



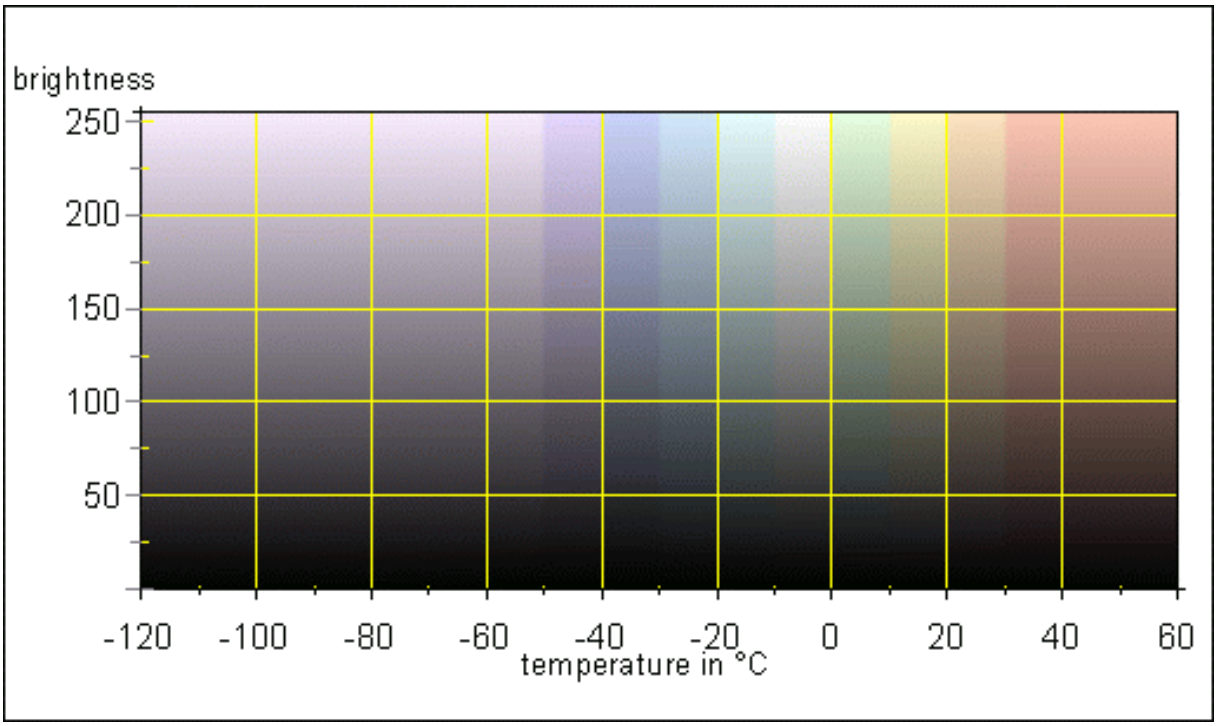
LUT: LUT100b_GSS-VIS-ct.bmp (former: LUTCloud-top.bmp)



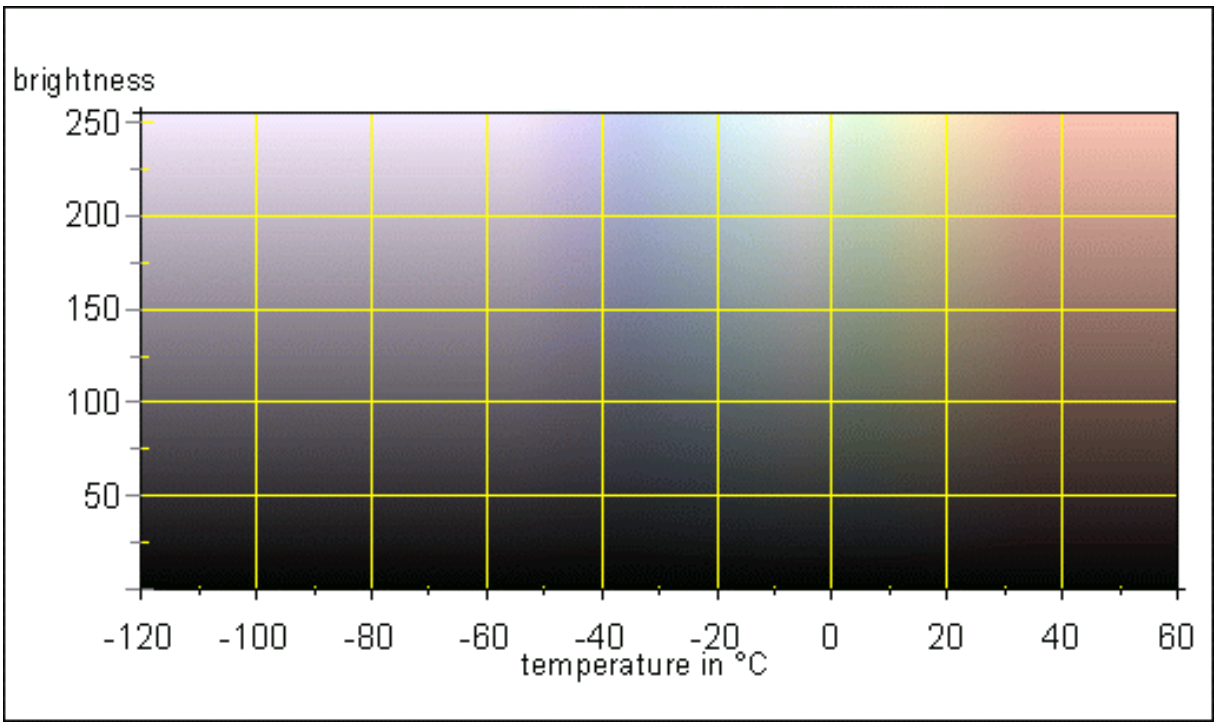
A different technique is used for the LUT100b_GSS-series. They have a brightness control for the visual channels. It is advised to use the NOAA ZA or ZB enhancement (LUT361_NNG-ZA-bw and LUT361_NNG-ZB-bw) for a full overview in IR gray.

VISUAL - FALSE COLOUR

LUT: LUT100b_GSS-VIS-fc1.bmp (former TempToColourHSV)



LUT: LUT100b_GSS-fc2.bmp



False colour visual LUTs from GSS are controled by the infrared channel for the thermal value of the cloudtops or surface features. The brightness of the gray pixel on the visual channel correspondents with the equal pixel on the brightness axis (Y-axis). The LUT100b series have a 256 pixel depth and

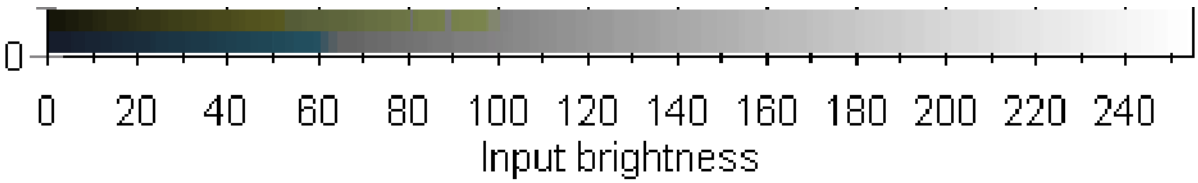
each gray value from the visual channel can be compared with a colour on the LUT, long as it correspondents with the thermal value for that pixel on IR.

Early program releases did only offer the brigtness LUTs and several LUTs are developed for this. A problem was to split surface features as water and land. Since this problem was solved with the inroduction of land sea masks. Most of this LUTs became outdated and are not refered in this overview. Just two of them are left, but they are the most important LUTs.

LUT100b_GSS-VIS-fc2 is quite simmular to the version build in into the main program, exept for one point. The program is internal using a version fading to white on top. But LUT100b_GSS-VIS-fc2 doesn't have such a white section. The result is more colour depth for clouds and a much less overexposered look during high summer when the clouds are reflecting much more solar radiation as during the winterseason.

LUT version fc1 is stepped and thermal controled by stable contourbars, version fc2 is smoothed.

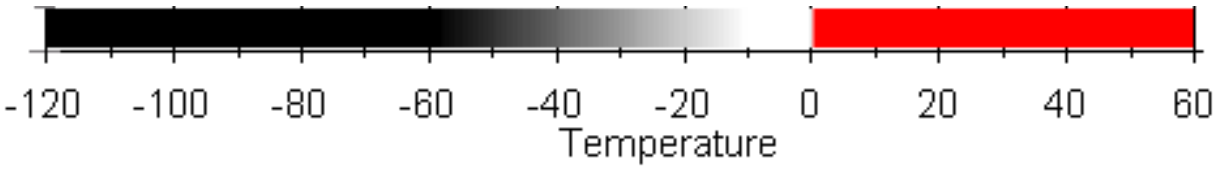
LUT: LUT100_GSS-VIS-fc3.bmp (former LUTLandSea-WEFAX-visible.bmp)



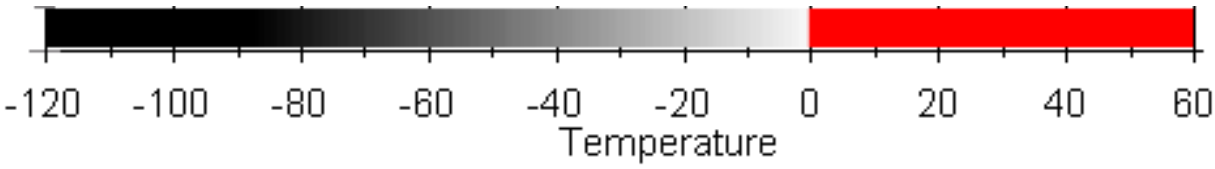
There only a few LUTs for enhancing the visual channel without help of a second (IR) channel. NOAA offers a couple. But the GSS version is the only one with support for the Landsea masks. NOAA's LUTs are more scientific but if if wish to use only to have a discrimation of land and sea with cloud, then the former WEFAX LUT would be good choice. It can be used for kind of visual channels from all satellites, and not for the WEFAX quality only.

INFRARED - CLOUDMASKS

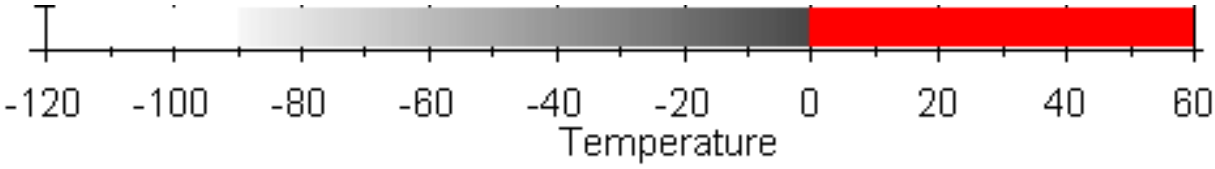
LUT: LUT100_GSS-IR-cm1.bmp (former LUTLandSeaBackground.bmp)



LUT: LUT361_GSS-IR-cm2.bmp



LUT: LUT361_GSS-IR-cm3.bmp



The cloudmaks LUTs are intended to be used to extract clouds from IR imagery. The threshold for the cloudmask is set at 0 C. There are two versions available. The original 100 pixel version has a limited thermal range from -60 C to +40 C. But the extended 361 pixel version is using full thermal range and provide more details on extreme cold cloudtops. Output can be used in MapToGeo. This software package is using a color which would be displayed as a transparant layer. It is using the red section in the LUT.

Remember for cases of low surface temperatures that are allways circumstances of uncovered (=cloudfree) area's, while IR suggests a cloudy overcast. Soon as the surface temperatures drops below 0 C, then it looks as cloudy. But this happens under clear skies.

USAF Sembach in Germany is using a simmular technique. Althougth we don't have their basemap used, we can use their cloudmask technique to get a reasonable look alike image for the cloudcover. Such a look alike cloudmask LUT is available as LUT361_GSS-IR-cm3.bmp and it is using the full thermal range.
Several other weather offices are using this technique to create speudo visual images from IR with a topographic background. Bassically the used technique is the same and this LUTs are not included in this overview.

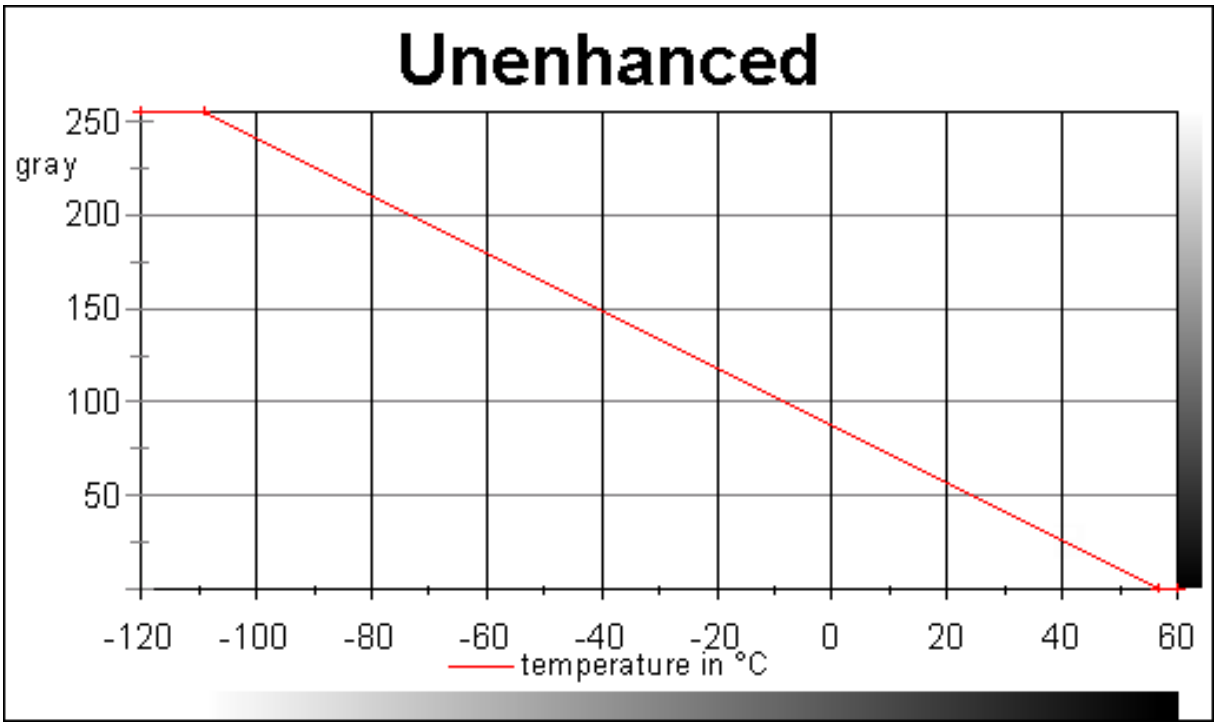
Another technique with fading clouds is recently developed by Ferdinand Valk form Earth At Large. More details about Ferdinand's cloudmask technique with use of a background map is descripted on page 69.

NOAA/NESDIS ENHANCEMENTS

Enhancement lookup tables are used to improve the quality of GOES digital infrared (IR) imagery, and to help the user easily identify specific cloud top temperature ranges. The tables are used to alter the output image brightness (or color) value for various input brightness temperature ranges. The original tables were developed in the 1970's for "GOES-tap" images, and thus displayed images in shades of gray.

Each enhancement comes with a description for its use and how it is build up. The graphs shows us the relation between the gray shade and the correponding temperature. Below each graph is the LookUp Table (LUT) shown. The known colored improved versions are also shown in the LUT-bar.

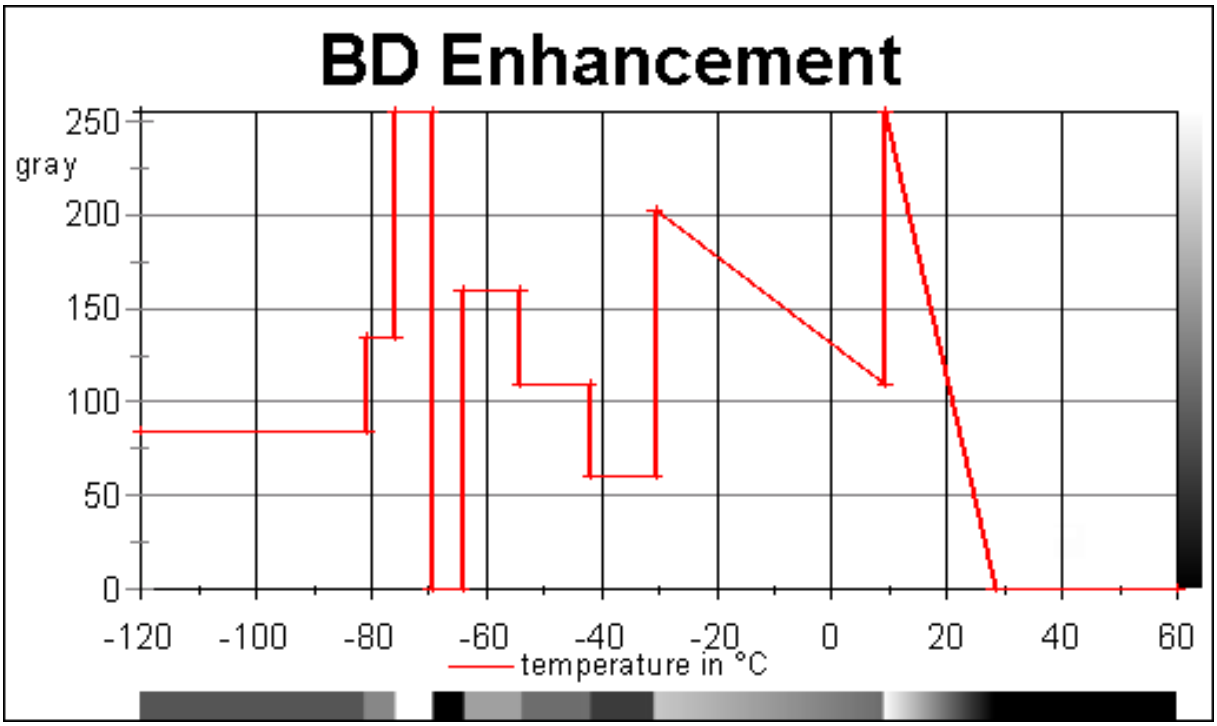
Not included are the *standard visual* and *visual low light* enancements. Identical enhancement effects can be reached with the use of the LUT100b_GSS-VIS-bw in conjunction the internal brightness adjust settings in the jobsetup.



The IR sensors on board the weather satellites measure the amounts of infrared energie emitted by the earth and the atmosphere because the amount of energy emitted depends on the temperatures of the surfaces. IR imagery is essentially a picture of the surface and cloudtops temperatures potrayed in black, white and gray tones. Warm appear as black and cold as white.
On most display systems the gray scale of an IR omage is composed of 256 gray shades, ranging from white (coldest) to black (warmest). The data correlates temperature with gray shade in a simple relationship, shown in the upper graph. This simple gray-scale can be improved to show better some details. The enhancements can used to show up this details, as cold cloudtops, just by replacing the original shades of gray. And this what the enhancements intend to do: Show details for some particular weather phenonema.

The gray-scale starts with black (RGB 000-000-000) and ends with white (255-255-255).

LUT: -

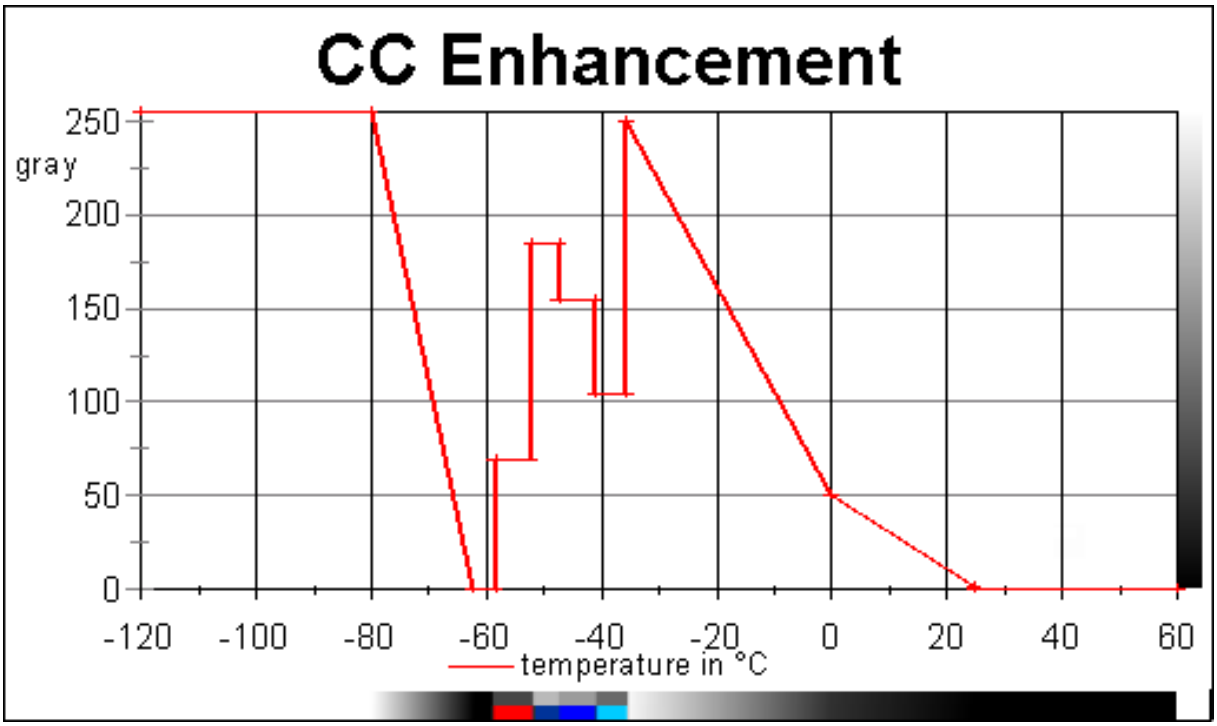


The BD enhancement curve for thermal IR imagery is the most complicated of all the main black and white enhancement curves. The complication is the result of the recurring series of grey level steps as the brightness temperature decreases. This curve is usually displayed to measure the intensity of tropical cyclones that contain eyes. This curve highlights certain temperatures in the eye and eye wall of the storm system known to be related to the intensity of a hurrcane. Dvorak (1984) developed a technique for measuring the intensity of these tropical cyclones by comparing the warmest spot within the eye and the warmest cloud top temperature within the cold cloud ring surrounding the eye. The greater that difference, the more intense the tropical cyclone. This curve facilitates those estimating tropical cyclone intensity by highlighting the differences between the eye temperature and that of the cold cloud ring by performing severe contrast stretches in both warm and cold portions of the enhancement curve.

Compare the structure of the tropical cyclone eye with the BD enhancement to that with no enhancement. Notice that the eye does not show up as well with the BD as with the MB enhancement. This does not matter since how well the eye is defined (and thus intensity estimates) can only be measured by viewing changes using the same enhancement.

LUT: LUT361_NNG-BD-bw.bmp

Seg no	Gray	Temp	Comments
1	000-000	60.0 to 28.3	Little or no information
2	000-255	28.3 to 9.4	Low clouds
3	109-202	9.2 to -30.5	Cirrus outflow pattern
4	060-060	-30.7 to -41.9	Dark gray
5	110-110	-42.2 to -54.0	Medium gray
6	160-160	-54.4 to -64.0	Light gray
7	000-000	-64.4 to -69.5	Black
8	255-255	-69.9 to -75.7	White
9	135-135	-76.2 to -80.6	Top medium
10	085-085	-81.2 to -120.0	Top dark

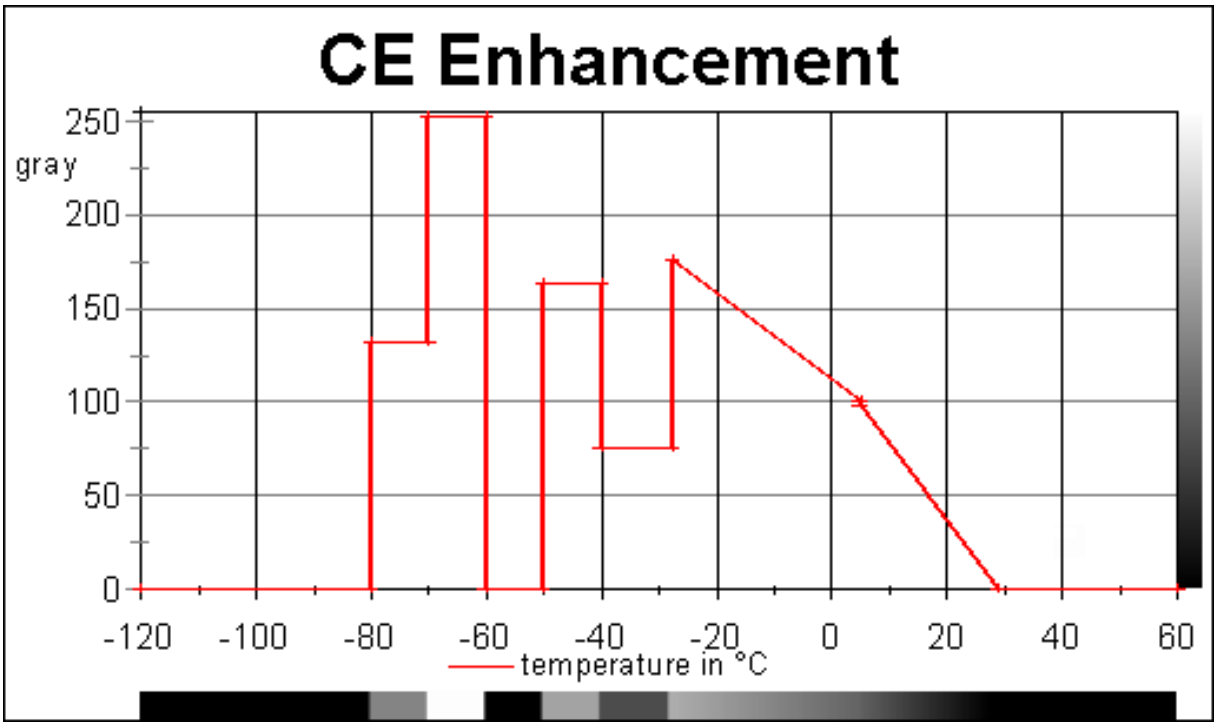


The CC enhancement curve is similar to the MB curve, but is modified for use over colder northern latitudes in winter.

Description of colour version: *The first 5 enhancement levels are: -36 to -42 C (light blue), -42 to -47 C (thistle), -48 to -52 C (dark blue), and -53 to -58 C (red).*

LUT: LUT361_NNG-CC-bw.bmp
LUT: LUT361_NNG-CC-cc.bmp

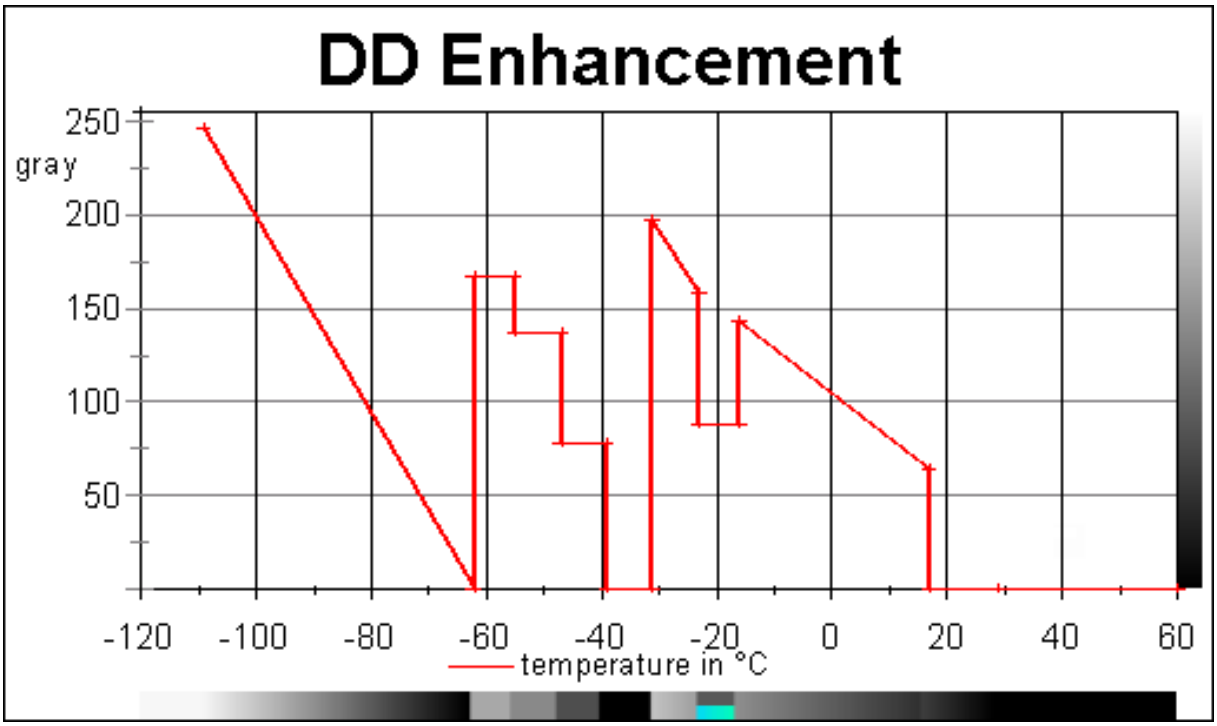
Seg no	Gray	Temp	Comments
1	000-000	60.0 to 24.8	Little or no information
2	001-050	24.7 to -0.1	Low level features
3	050-250	-0.2 to -35.2	Mid level enhancement
4	105-105	-35.2 to -41.1	Cirrus/thunderstorms
5	155-155	-41.4 to -47.4	Cirrus/thunderstorms
6	185-185	-47.6 to -52.1	Cirrus/thunderstorms (light gray)
7	070-070	-52.5 to -58.4	Cirrus/thunderstorms (dark gray)
8	000-000	-58.8 to -62.1	Cirrus/thunderstorms (black)
9	000-255	-62.5 to -80.0	Overshooting tops (repeat gray)
10	255-255	-80.6 to -120.0	White



This LUT shows the high-latitude surface features delineated (land, water, low clouds). Gray region near -30° C highlights lightning occurence in summer and precipitation in winter.

LUT: LUT361_NNG-CE-bw.bmp

Seg no	Gray	Temp	Comments
1	000-000	60.0 to 29,0	Little or no information
2	000-098	29,0 to 5,0	Low level features
3	101-176	5,0 to -27,5	Mid level features
4	076-076	-27.5 to -40.0	Occurence of lightning in summer)*
5	163-163	-40.0 to -50.0	Cold cloudtops
6	000-000	-50.0 to -60.0	Cold cloudtops
7	253-253	-60.0 to -70.0	Cold cloudtops
8	132-132	-70.0 to -80.0	Overshooting cloudtops
9	000-000	-80.0 to -120.0	Extreme cold cloudtops
			)* preciptation in winter

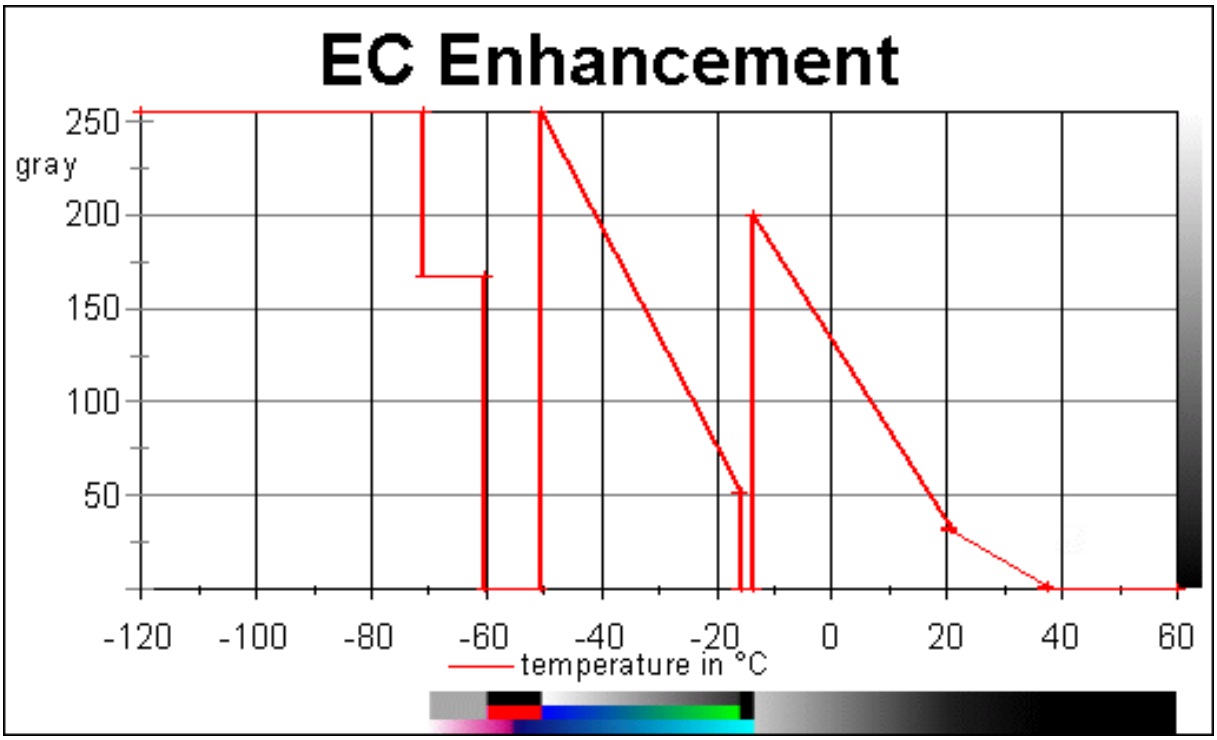


This LUT is used for finding heavy snow regions in extratropical cyclones. Heavy snow band starts 1 degree of latitude north of the southern edge of the cold enhancement. The Snow Production Zone is centered on -20° C.

Description of colour version: *The SPZ is replaced by a shading color from (R/G/B) 4/253/182 to 3/218/247 (range -16.0 to -23.0 C).*

LUT: LUT361_NNG-DD-bw.bmp
LUT: LUT361_NNG-DD-cc.bmp

Seg no	Gray	Temp	Comments
1	000-000	60.0 to 29,0	Little or no information
2	000-064	29,0 to 17,0	Land and water
3	049-144	17,0 to -16.0	Low and mid level features
4	088-088	-16.0 to -23.0	Snow Production Zone
5	159-198	-23.0 to -31.0	Cold cloudtops
6	000-000	-31.0 to -39.0	Cold cloudtops
7	078-078	-39.0 to -47.0	Cold cloudtops
8	137-137	-48.0 to -55.0	Cold cloudtops
9	168-168	-55.0 to -62.0	Cold cloudtops
10	000-247	-62.0 to -109.0	Extreme cold cloudtops

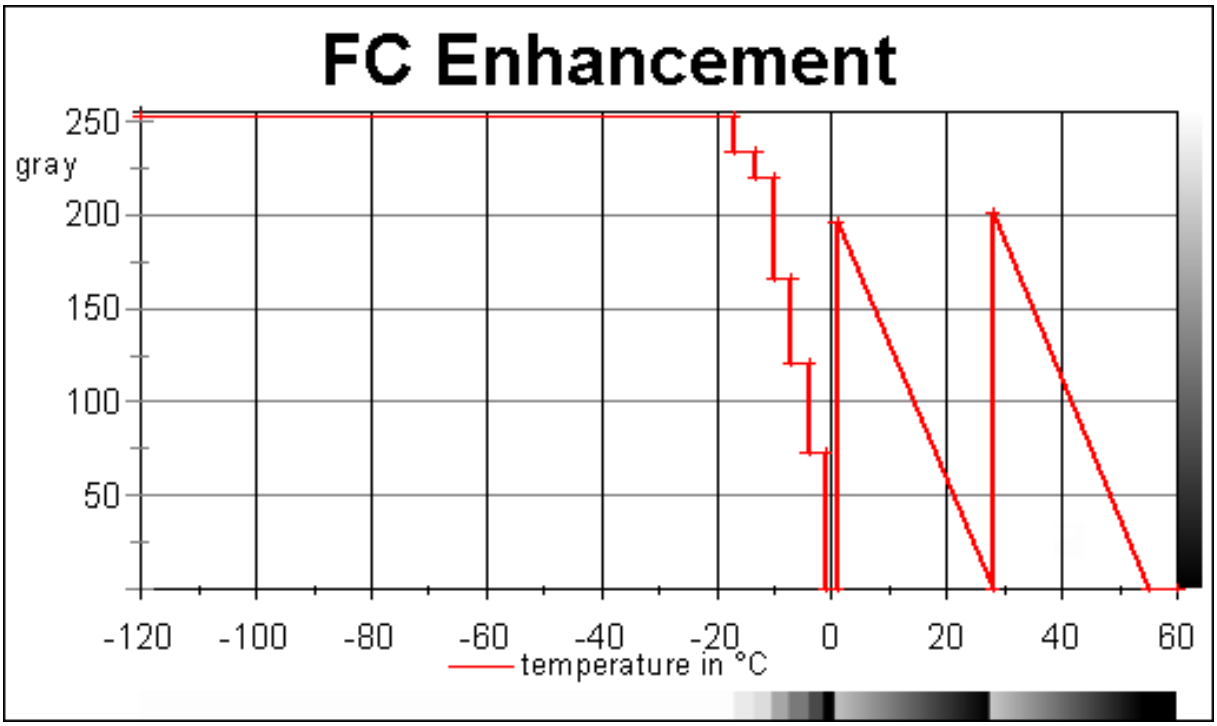


The EC enhancement curve is designed for general purpose use during the cool season.

Description of colour versions:
cc: *Center of the bar: The green and blue regions highlight the cloud top temperature range normally associated with cool season precipitation (-15 to -50 C); the red and gray enhancements represent -51 to -6 C and -62 to -70 C convective cloud tops, respectively.*
mod: *Bottom of the bar.*
Exact RGB settings not known at this moment.

LUT: LUT361_NNG-EC-bw.bmp
LUT: LUT361_NNG-EC-cc.bmp
LUT: LUT361_NNG-EC-mod.bmp

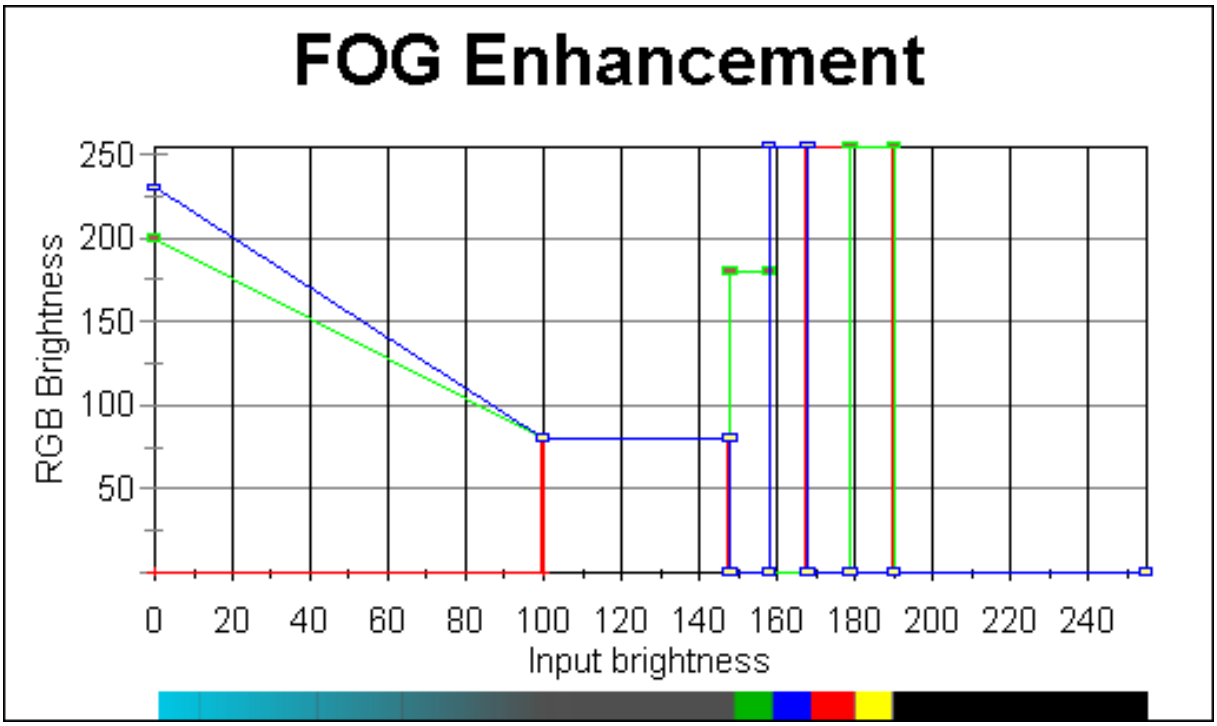
Seg no	Gray	Temp	Comments
1	000-000	60.0 to 37.3	Little or no information
2	001-032	37.2 to 20.8	Land and water features
3	033-200	20.6 to -13.3	Water and low clouds
4	000-000	-13.5 to 15.8	Low/middle cloud benchmark
5	052-255	-15.9 to -50.3	Mid/high clouds)*
6	000-000	-50.6 to -60.2	Convective cloudtops
7	168-168	-60.6 to -70.4	Convective cloudtops
8	255-255	-70.8 to -120.0	Coldest cloudtops
			)* Cool season precipitation



The FG enhancement is designed for hydrologic circumstances on the surface. Steps are created to show the temperature distribution in the snowfield. Snow melt can detected with near sufrace freezinglevel. Also useful to detect soil mosture and grondtemperatures. Be sure to check if the requested region has clear skies/uncovered with clouds.

LUT: LUT361_NNG-FC-bw.bmp

Seg no	Gray	Temp	Comments
1	000-000	60.0 to 55.0	Little or no information
2	000-201	55.0 to 28.0	Land and water features
3	000-196	28.0 to 1.0	Land and water features
4	000-000	1.0 to -1.0	Snowcover at freezing level
5	073-073	-1.0 to -4.0	Snowcover
6	121-121	-4.0 to -7.0	Snowcover
7	166-166	-7.0 to -10.0	Snowcover
8	220-220	-10.0 to -13.0	Snowcover
9	234-234	-13.0 to -17.0	Snowcover
10	253-253	-17.0 to -120.0	Little or no information

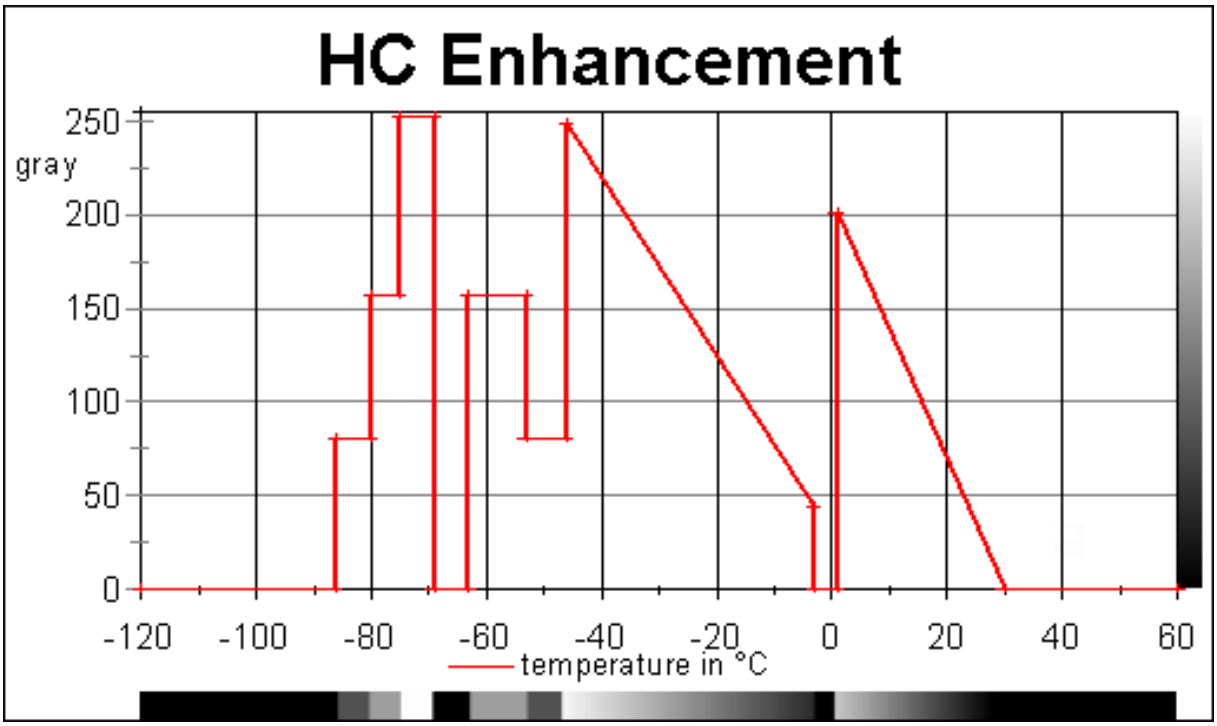


A special fog depth color enhancement based on the temperature difference between GOES IR Band 2 (3.9 :m) and Band 4 (10.7 :m) shows approximate depth of low level clouds and fog. The colour steps show increasing cloud depth, from green (0 - 200 m) to black (> 500 m). The cloud depths obtained from this product are valid only for single cloud layers.
The difference in brightness temperature (or brightness) can be enhanced by simply contrast stretching the resulting image (use a factor of 10). The temperature difference threshold (3.9 :m- 10.7 :m) is -2 C or colder for fog/stratus (closer to 0 C for very cold conditions). Values between -2 and +2 are normally cloud-free. Large postive values would represent cirrus clouds.
The Meteosat 8 IR channels (9 = 10.8 :m; 3 = 3.9 :m) can be used in the same way as GOES for nighttime detection of fog. See on page 86 for more details for the MSG fog product.

LUT: LUT256_NNG-IR-fog.bmp

Seg no	Input	T (9-3)	Red	Green	Blue	Feature
1	000-100	-13 to -3	000	200-080	230-080	Cirrus
2	101-148	-3 to +2	080	080	080	No Clouds
3	149-158	2 to 3	000	180	000	Low cloud <200 m
4	159-168	3 to 4	000	000	255	Low cloud 200-300 m
5	169-179	4 to 5	255	000	000	Low cloud 300-400 m
6	180-190	5 to 6	255	255	000	Low cloud 400-500 m
7	191-255	>6	000	000	000	Low cloud >500 m

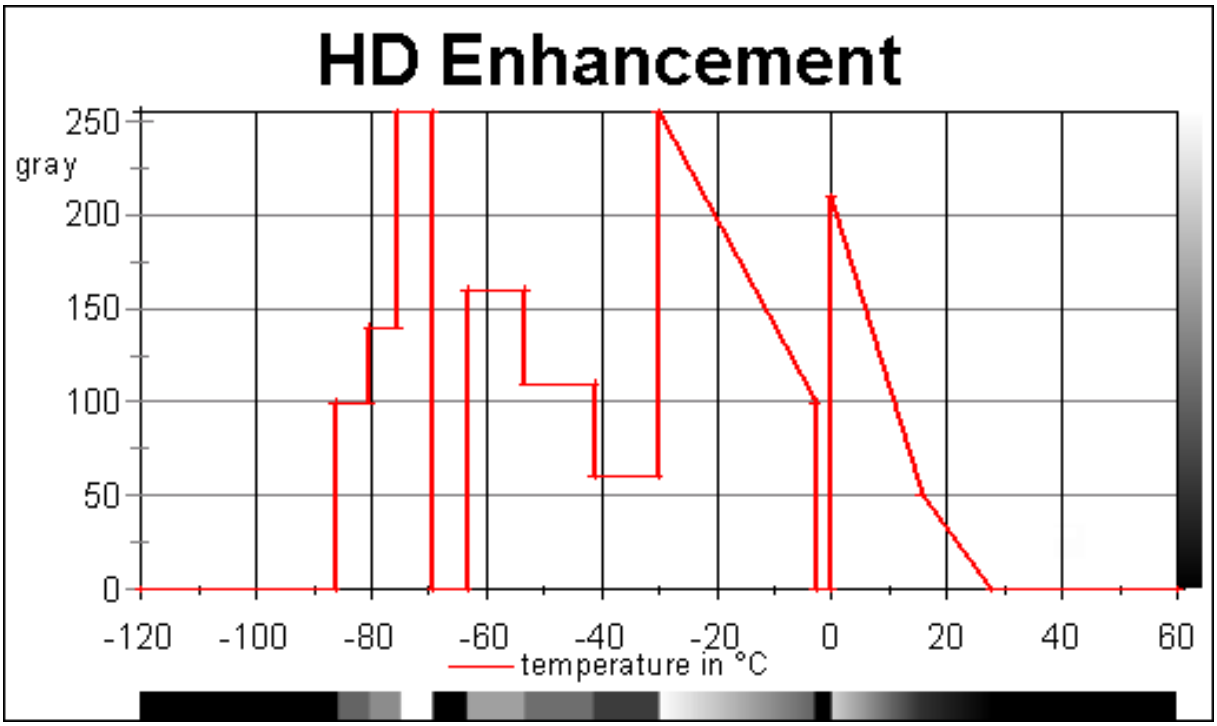
Note: *This CLUT is not supported in GeoSatSignal.*



Enhancement to use in tropical hurricane season. Mid-latitude stratus, tropical cumulustops are shown with the seasurface temperatures at the warm end. Mid-tropospheric ramp to show frontal band cloudiness. Hurricane intensity pattern recognition.

LUT: LUT361_NNG-HC-bw.bmp

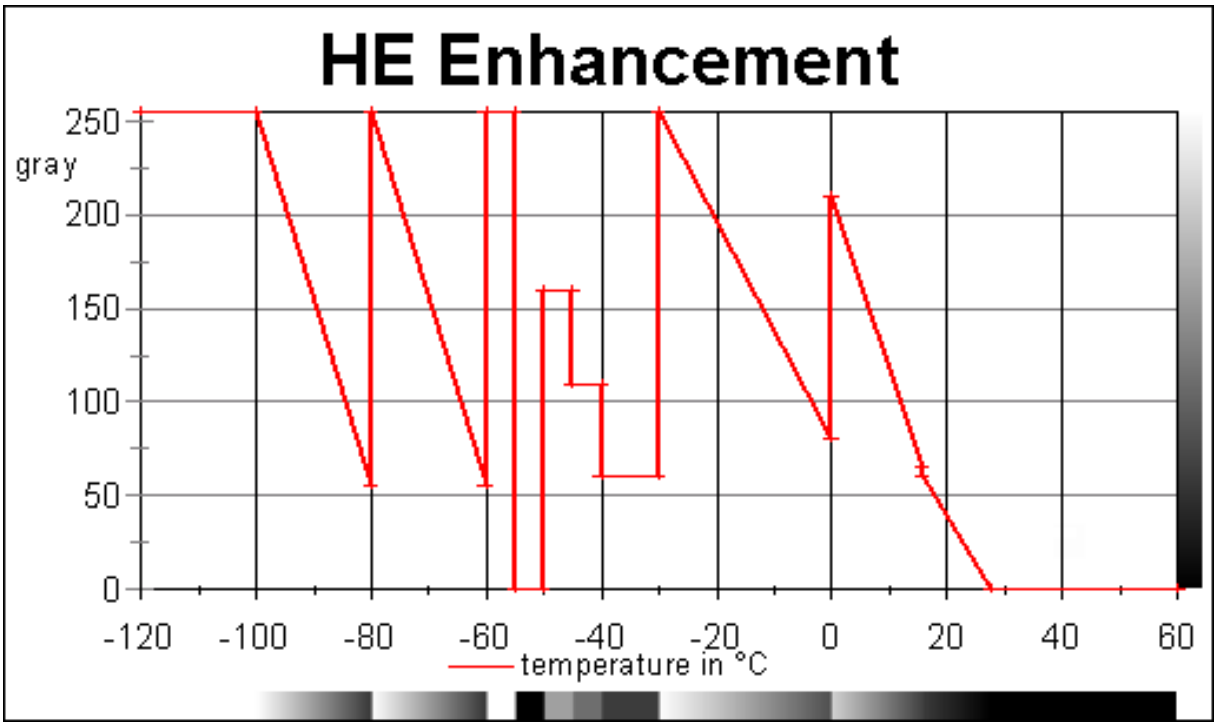
Seg no	Gray	Temp	Comments
1	000-000	60.0 to 30.0	Little or no information
2	000-201	30.0 to 1.0	Seawater features and low clouds
3	000-000	1.0 to -3.0	Freezing level
4	044-249	-3.0 to -46.0	Mid-tropospheric fronts
5	081-081	-47.0 to -53.0	Cloudtops
6	157-157	-53.0 to -63.0	Cloudtops
7	000-000	-63.0 to -69.0	Cloudtops
8	253-253	-69.0 to -75.0	Cloudtops
9	157-157	-75.0 to -80.0	Cloudtops
10	081-081	-80.0 to -86.0	Cloudtops
11	000-000	-86.0 to -120.0	Cloudtops



The HD curve is a modification of the HC curve to provide low cloud information, the freezing level, mid-tropospheric fronal systems, and tropical storm classification data. The portion of the curve for temperatures colder than -30.7 C is nearly identical to the BD tropical storm curve.

LUT: LUT361_NNG-HD-bw.bmp

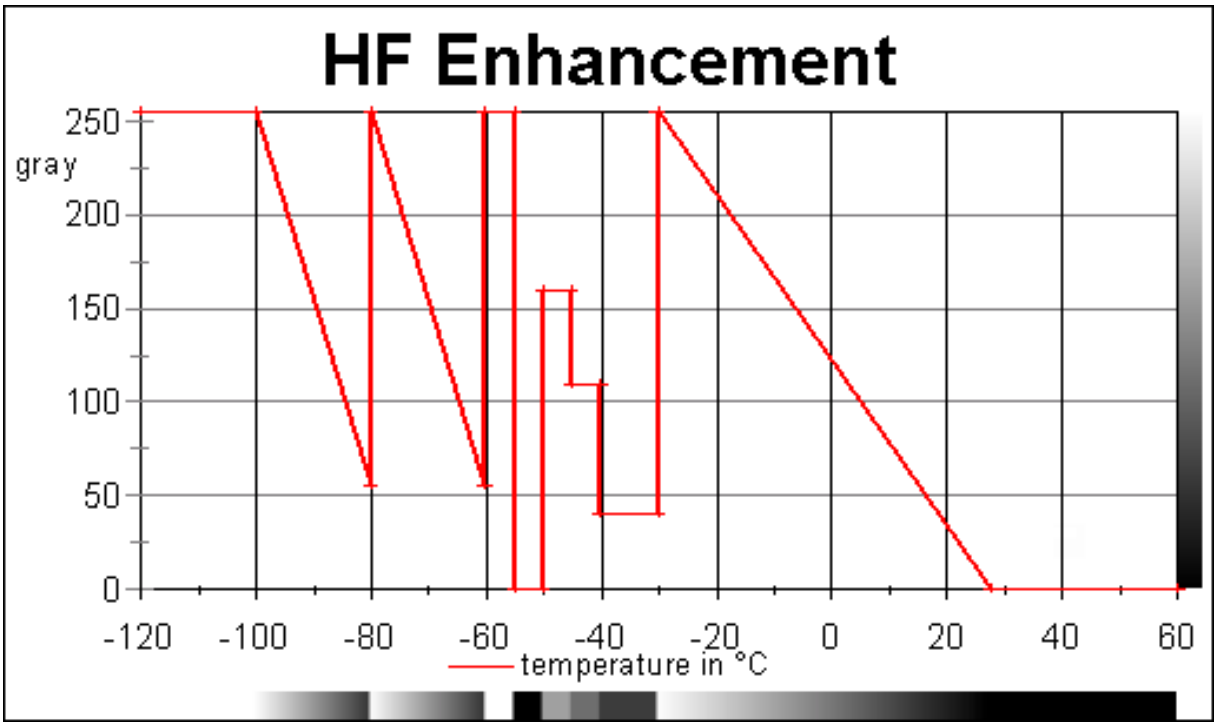
Seg no	Gray	Temp	Comments
1	000-000	60.0 to 27.8	Little or no information
2	000-050	29.7 to 15,8	Land and water
3	050-210	15.3 to 0.3	Water and low clouds
4	000-000	-0.2 to -2.7	Freezing zone
5	100-255	-3.2 to -30.2	Mid-tropospheric fronts
6	060-060	-30.7 to -41.2	Cloudtops
7	110-110	-42.2 to -53.2	Cloudtops
8	160-160	-54.2 to -63.2	Cloudtops
9	000-000	-64.2 to -69.2	Cloudtops
10	255-255	-70.2 to -75.2	Cloudtops
11	140-140	-76.2 to -80.2	Cloudtops
12	100-100	-81.2 to -86.2	Cloudtops
13	000-000	-87.2 to -120.0	Cloudtops



The HE curve is used principally by weather offices in the western United States. It provides good enhancement of a wide variety of cloud types, but is somewhat complex, and may be difficult to use at first. It enhances low and middle level clouds common along the Pacific Coast of North America in two separate gray shade ranges. The freezing level is easily determined, an advantage for aviation users concerned with icing. Step wedge regions display very cold infrared cloud top temperatures associated with thunderstorms and frontal systems in 5 degree increments down to -60 C. Two additional "repeat grey" segments define cloud top temperatures colder than -60 C.

LUT: LUT361_NNG-HE-bw.bmp

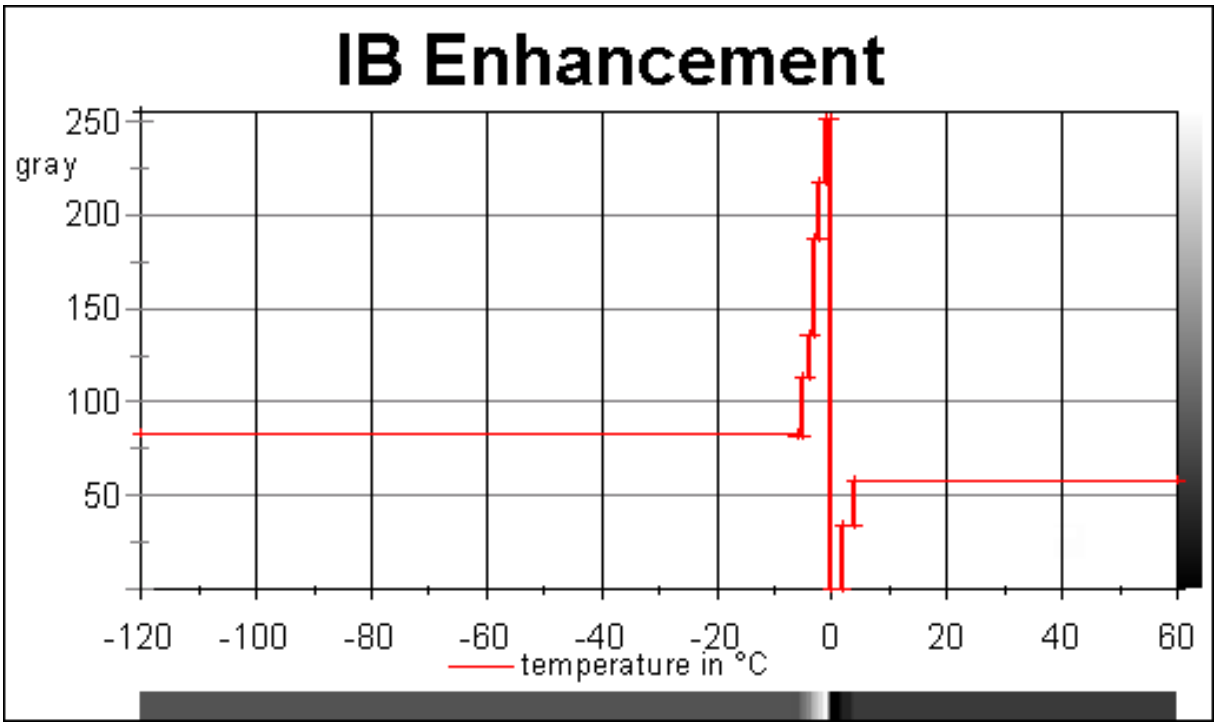
Seg no	Gray	Temp	Comments
1	000-000	60.0 to 27.8	Little or no information
2	001-060	27.7 to 15.9	Land and water
3	065-210	15.7 to 0.1	Water and low clouds
4	080-255	-0.1 to -29.8	Mid tropospheric fronts
5	060-060	-30.1 to -39.8	Cloudtops
6	110-110	-40.1 to -44.8	Cloudtops
7	160-160	-45.1 to -49.7	Cloudtops
8	000-000	-50.0 to -54.7	Cloudtops
9	255-255	-55.0 to -59.9	Cloudtops
10	055-255	-60.2 to -79.5	Cloudtops
11	055-255	-80.0 to -99.4	Cloudtops
12	255-255	-100.4 to -120.0	No information



The HF curve is the most current of the "H" series of curves, and is used principally by weather offices in the western United States. It provides good enhancement of low and middle level clouds common along the Pacific Coast of North America. Step wedge regions display very cold infrared cloud top temperatures associated with thunderstorms and frontal systems in 5 degree increments down to -60 C. Two additional "repeat gray" segments define cloud top temperatures colder than -60 C.

LUT: LUT361_NNG-HF-bw.bmp

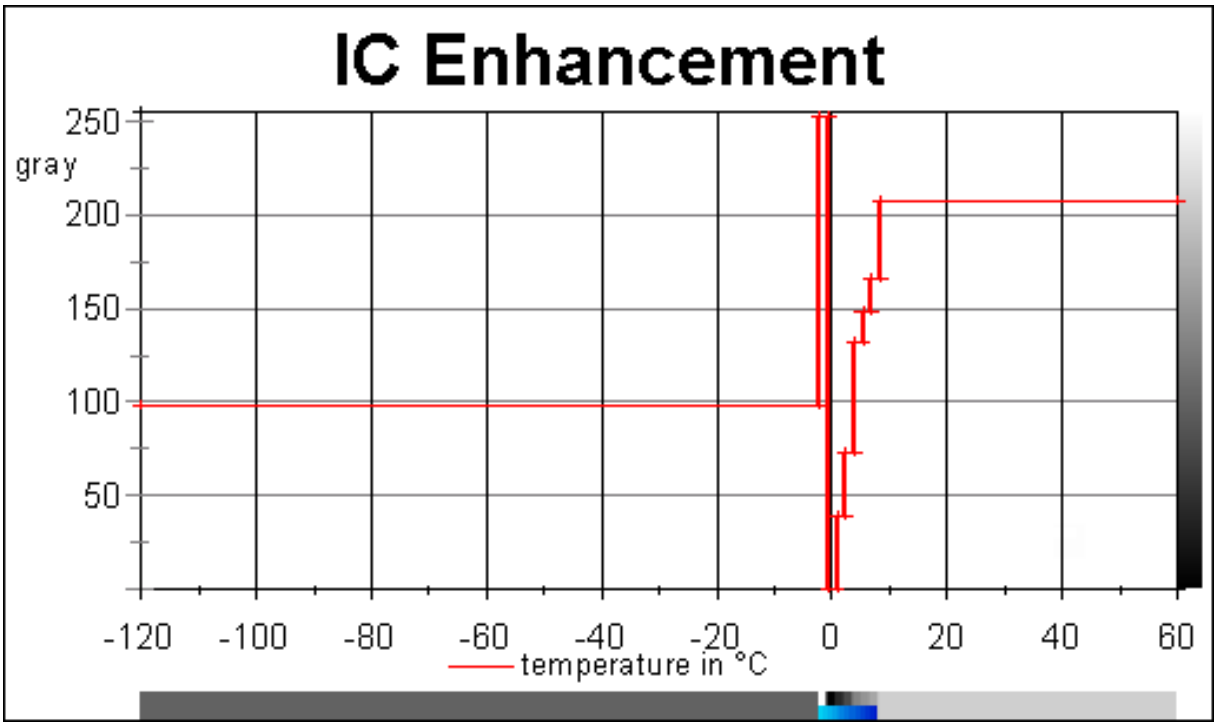
Seg no	Gray	Temp	Comments
1	000-000	60.0 to 27.8	Little or no information
2	000-255	27.7 to -29.8	Low and middle clouds
3	040-040	-30.1 to -39.8	Dark gray
4	110-110	-40.1 to -44.8	Medium gray
5	160-160	-45.1 to -49.7	Light gray
6	000-000	-50.0 to -54.7	White
7	255-255	-55.0 to -59.9	Black
8	055-255	-60.2 to -79.5	Repeat gray
9	055-255	-80.0 to -99.4	Repeat gray
10	255-255	-100.4 to -120.0	No information



An enhancement to get a better delineation of near and below freezing surface temperatures. Is is used for the minimum temperature forecasts in southeast US. Surface temperatures of +4 to -6°C are emphasized.

LUT: LUT361_NNG-IB-bw.bmp

Seg no	Gray	Temp	Comments
1	058-058	60.0 to 4.0	No information
2	034-034	4.0 to 2.0	Radiation frost/rime possible
3	000-000	2.0 to 0.0	Radiation frost/rime possible
4	251-251	0.0 to -1.0	Freezing zone
5	217-217	-1.0 to -2.0	Freezing
6	187-187	-2.0 to -3.0	Freezing
7	136-136	-3.0 to -4.0	Freezing
8	113-113	-4.0 to -5.0	Freezing
9	082-082	-5.0 to -6.0	Freezing
10	083-083	-6.0 to -120.0	No information

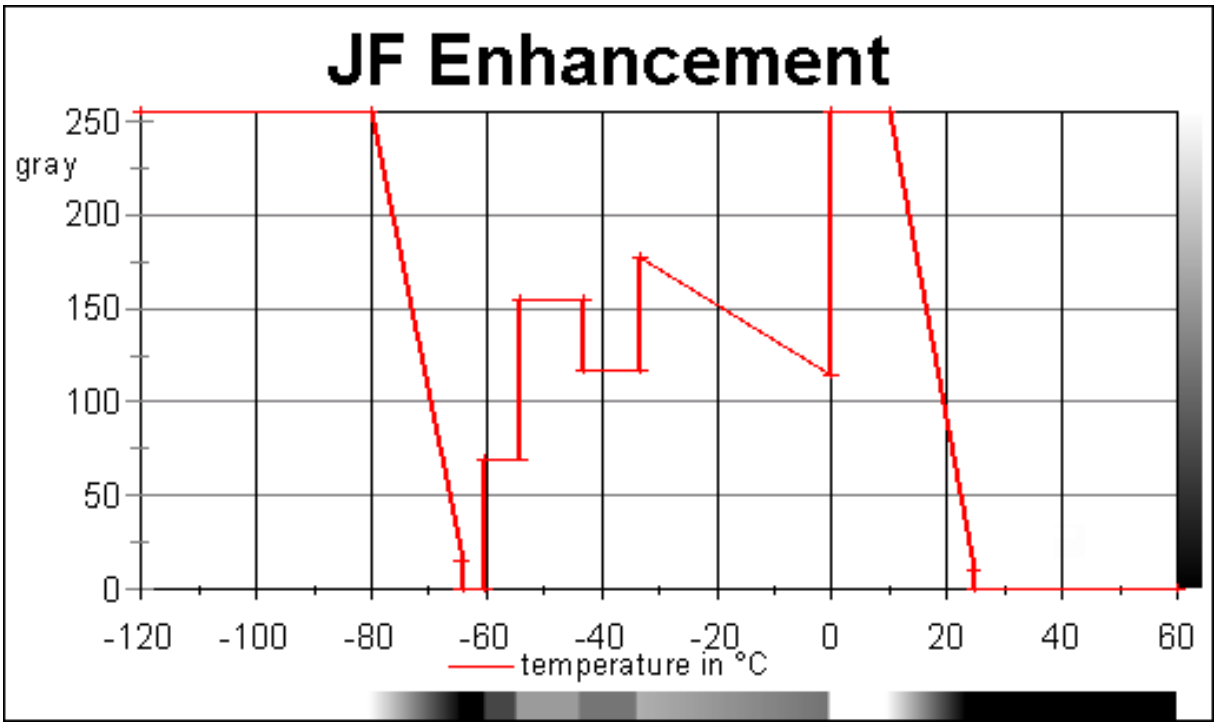


The IC enhancement is used to improve the delineation of seasonal frost/freeze onset thermal zone. It is targeted at minimum surface temperatures in southeast US. Surface temperatures of 8,5 to -2,0°C are emphasized.

Description of colour version:
The range of -1,5 C to 8,5 C is replaced by shaded blue, RGB 3/213/244 at the cold end and 0/19/202 at the warm end.

LUT: LUT361_NNG-IC-bw.bmp

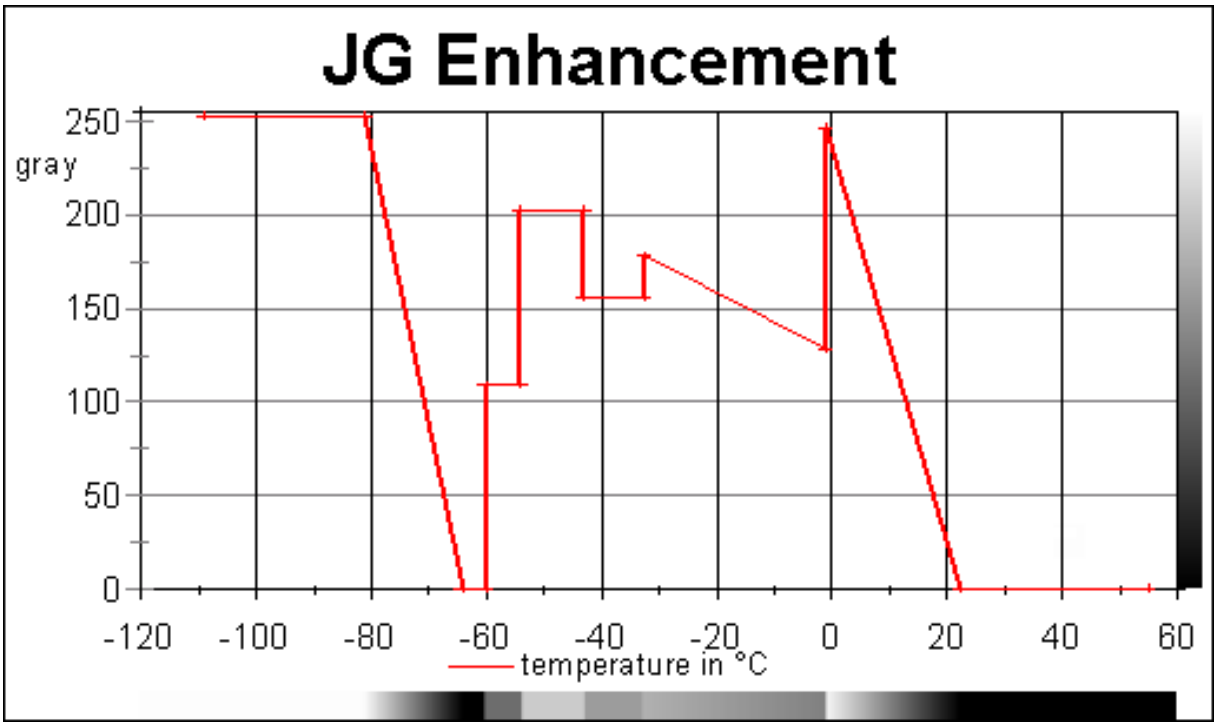
Seg no	Gray	Temp	Comments
1	000-000	60 to 8.5	No information
2	000-050	8.5 to 7.0	Surface temperature
3	050-210	5.5 to 4.0	Surface temperature
4	000-000	4.0 to 2.5	Radiation frost/rime possible
5	100-255	2.5 to 1.0	Radiation frost/rime possible
6	060-060	1.0 to -0.5	Radiation frost/rime possible
7	110-110	-0.5 to -2.0	Freezing
8	160-160	-2.0 to -120.0	No information



The JF curve is a hybrid enhancement scheme used to highlight both sea surface temperatures, and cold cloud tops associated with thunderstorms and other weather systems. It is somewhat simpler to interpret than the later JJ curve. The coldest portion of the curve (less than -33 C) is nearly identical to the general-use MB curve. Maximum enhancement is provided at the warm end (25 to 10 C) to depict sea surface temperatures and warm low clouds in tropical and sub-tropical areas.

LUT: LUT361_NNG-JF-bw.bmp

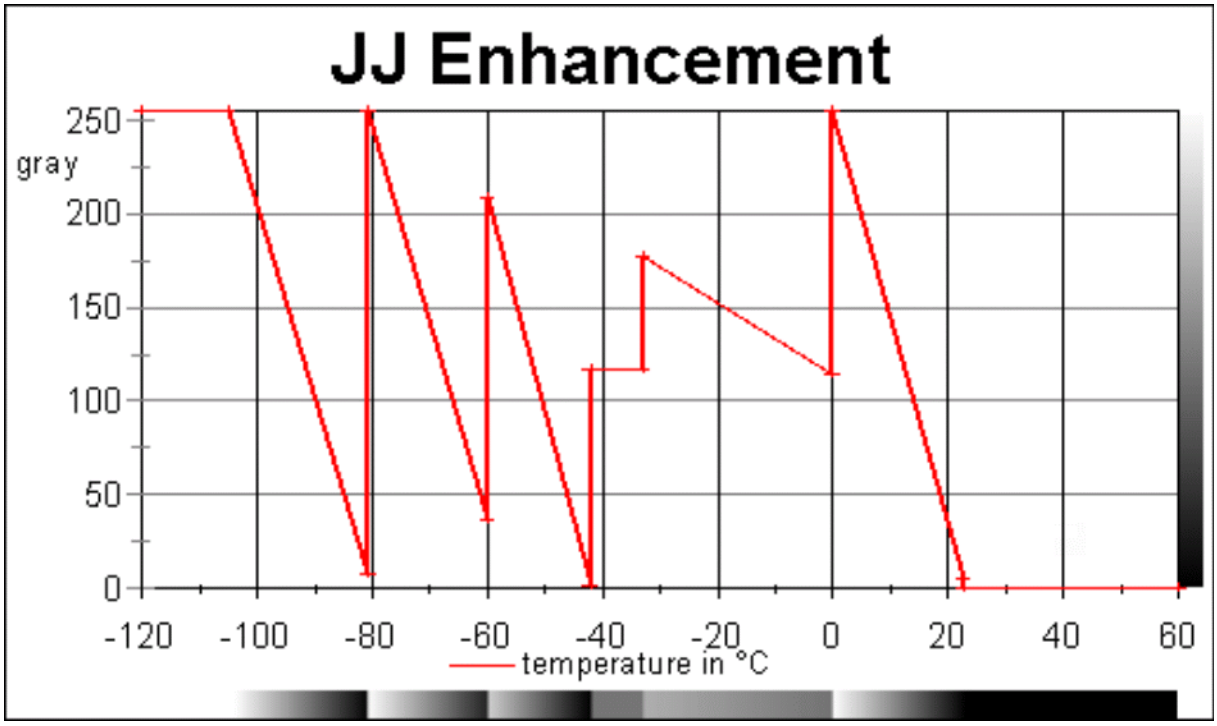
Seg no	Gray	Temp	Comments
1	000-000	60.0 to 24.8	Warm water and land
2	010-255	24.7 to 10.2	Water temperature gradient
3	255-255	10.0 to 0.1	Buffer zone
4	115-177	-0.1 to -32.9	Middle clouds/freezing level
5	117-117	-33.2 to -42.7	First level contour
6	155-155	-43.0 to -53.7	Thunderstorm
7	070-070	-54.0 to -59.9	Thunderstorm
8	000-000	-60.2 to -63.6	Thunderstorm
9	015-255	-64.0 to -80.0	Overshooting tops
10	255-255	-80.4 to -120.0	Very cold cloudtops or white



A curve used during the winter season to detect SST gradients, stratus and costal fog. It can be used also to discrimninate convective and stratiform cloudtops.

LUT: LUT361_NNG-JG-bw.bmp

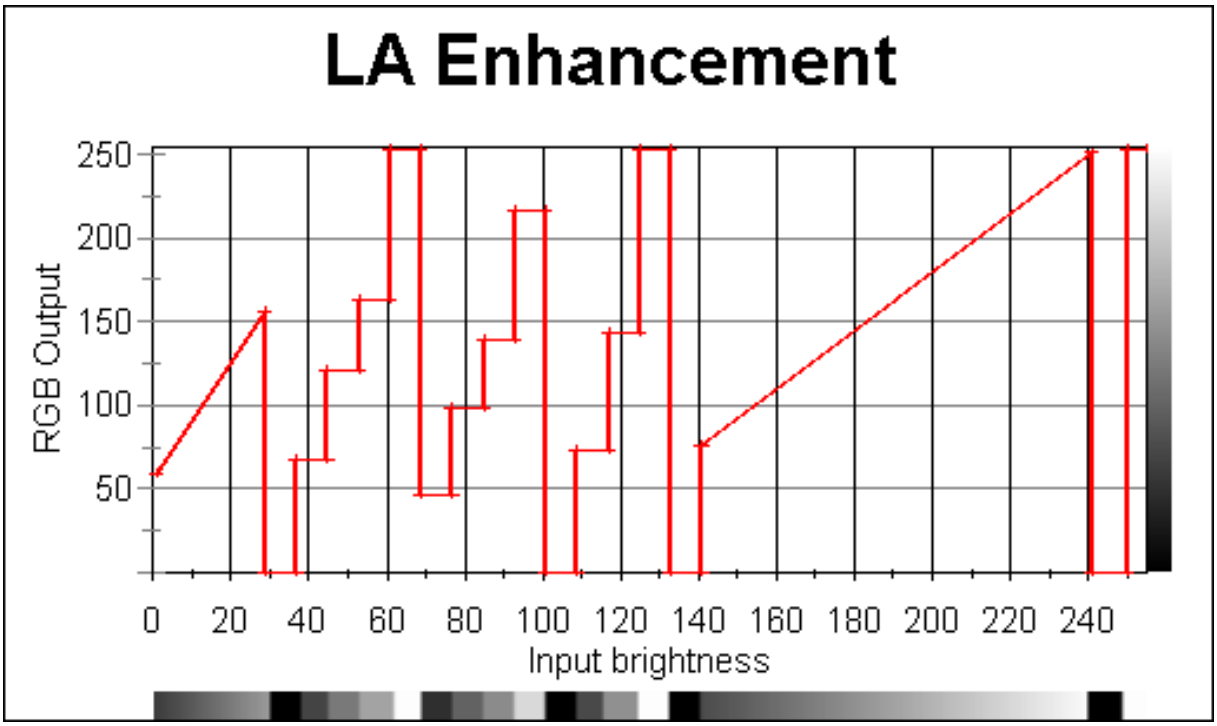
Seg no	Gray	Temp	Comments
1	000-000	60.0 to 22.5	Little or no information
2	010-255	22.5 to -1.0	Water temperature gradient)*
3	255-255	-1.0 to -32.5	Cloudtops
4	115-177	-43.0 tp -54.0	Cloudtops
5	117-117	-54.0 to -60.0	Cloudtops
6	155-155	-60.0 to -64.0	Thunderstorms
7	070-070	-64.0 to -81.0	Overshooting cloudtops
8	000-000	-81.0 to -109.0	Little or no information
			)* Fog and stratus



The JJ curve is used to highlight both sea surface temperatures, and cold cloud tops associated with thunderstorms and other weather systems. Maximum enhancement is provided at the warm end (23 to 0 C) to depict sea surface temperatures and low clouds. The presence of a freezing level break point is important for aviation users interested in icing conditions. Multiple, steep, ramp enhancement ranges provide considerable detail within cold cloud tops such as thunderstorms, but it is difficult to determine the actual temperatures with any accuracy.

LUT: LUT361_NNG-JJ-bw.bmp

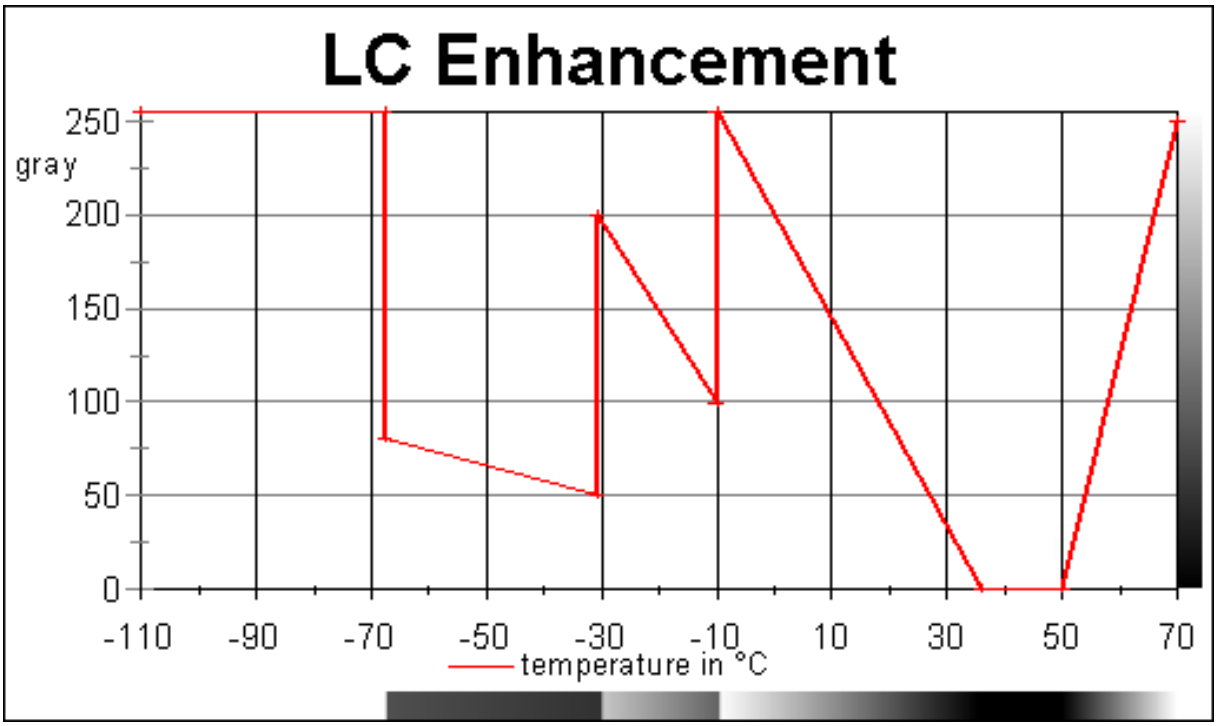
Seg no	Gray	Temp	Comments
1	000-000	60.0 to 22.8	Warm water and land
2	005-255	22.7 to 0.1	Water temperature gradient
3	115-177	-0.1 to -32.9	Middle clouds/freezing level
4	117-117	-33.2 to -42.0	First level contour
5	001-209	-42.2 to -59.8	Cirrus/convection
6	036-255	-60.2 to -80.6	Thunderstorm
7	008-255	-81.2 to -104.9	Tropical convection
8	255-255	-106.9 to -120.0	No information



This LUT is designed for the visual channel. It is used to discriminate early morning fog. Fog is clearly visible with use of this enhancement. Compare the enhanced image with the visual image processed with the default VIS enhancement. The LA fog dissipation cruve for visual images can be used on images within up around 1 ½ hour after sunrise.
Input brightness from 29 to 140 is set as noise. Early mornig fog counts from 0 to 28 as fading gray

LUT: LUT256_NNG-LA-bw.bmp

Seg no	Input	Gray	Seg no	Input	Gray
1	000-028	059-156	10	093-100	217-217
2	029-036	000-000	11	101-108	000-000
3	037-044	068-068	12	109-116	073-073
4	045-052	121-121	13	117-124	144-144
5	053-060	163-163	14	125-132	253-253
6	061-068	253-253	15	133-140	000-000
7	069-076	047-047	16	141-240	076-251
8	077-084	098-098	17	241-249	000-000
9	085-092	139-139	18	250-255	253-253

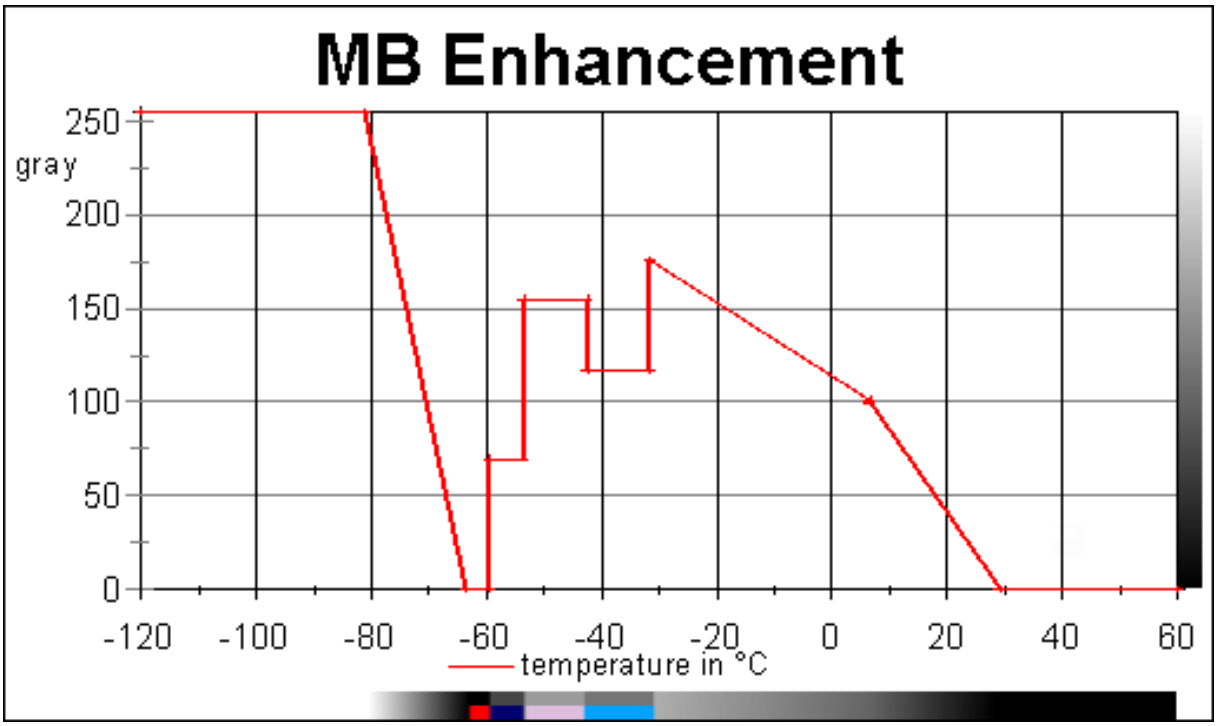


The LC curve is used on images from the 3.9 micron shortwave infrared channel (CH2) of GOES and channel 3 of Meteosat. It provides maximum enhancement in the temperature range where fog and low clouds typically occur (36 to -9 C). Another enhanced thermal range is from -10 to -29 C, the region of precipitation generation in mid-latitude weather systems. Since CH2 is sensitive to "hot spots," a steep, reverse ramp is found at the warm end (68 to 50 C) to show any observable fires as white. There is no enhancement at the very cold end (-30 to -67 C), due to the instrument noise normally present at these temperatures.

LUT: LUT361_NNG-LC-bw.bmp

Seg no	Gray	Temp	Comments
1	250-000	70.0 to 50.2	Fires
2	000-000	50.1 to 36.1	Little or no information
3	000-255	36.0 to -9.4	Fog/low clouds/surface features
4	100-200	-9.9 to -29.4	Middle clouds/cirrus
5	050-080	-30.7 to -67.4	Cold clouds/no enhancement
6	255-255	-67.4 to -110.0	No information

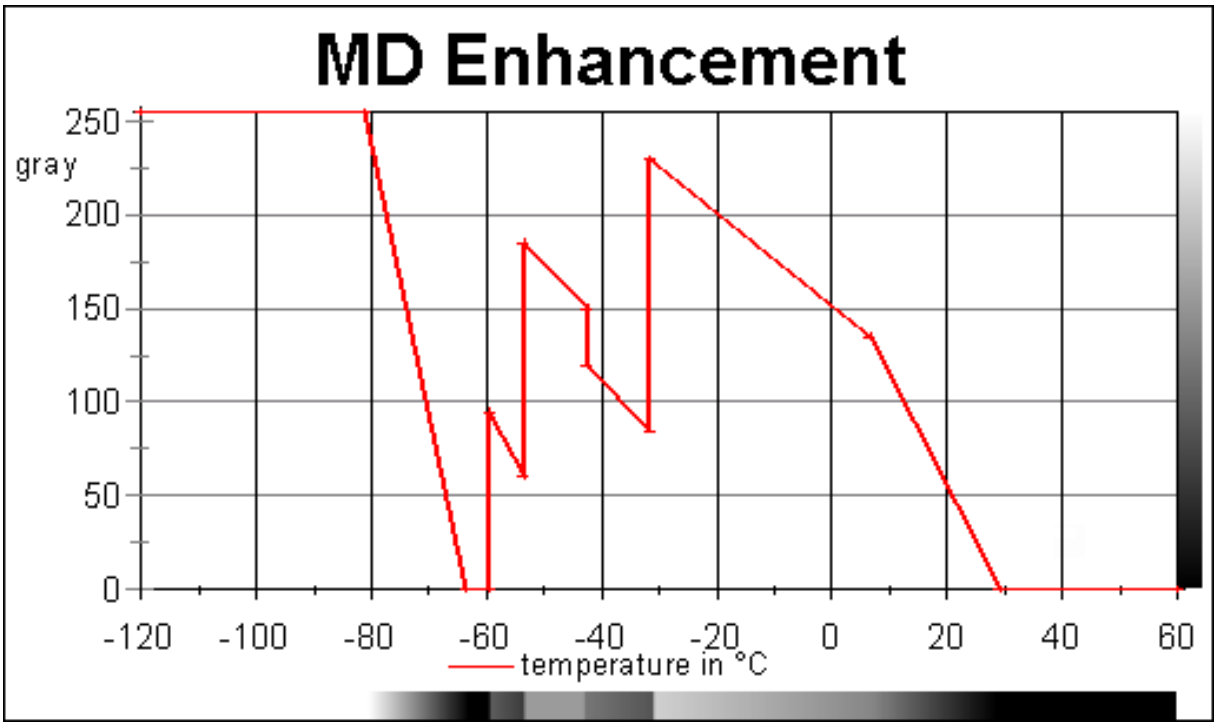
Note: *This CLUT is not supported in GeoSatSignal, as it was designed for Goes 1 to 7. The other IR2 enhancement curves can be used instead.*



The MB enhancement curve for thermal IR imagery artificially defines brightness values for temperatures of less than -35 C. This curve is the most widely used in the meteorological community because of the way cold cloud tops are highlighted. In this curve the grey scale is altered to make the very cold, high, overshooting cumulonimbus or thunderstorm cloud tops stand out. The effect is a contoured pattern in the cloud top that highlights areas of intense and/or potentially severe weather. For temperatures above -35 C the MB enhancement is similar to the ZA enhancement. However, for the temperature range of -35 to -60 C, there is a general decerease in assigned output brightness values with decreasing temperature. Note that for temperatures below about -60 C, the curve is severely stretched across all brightness values. Details of storm top structure for cloud tops that reach these very cold temperature levels can be easily emphasized with the MB curve.
Compare the structure of the tropical cyclone cloud tops with the MB enhancement to that with no enhancement.

LUT: LUT361_NNG-MB-bw.bmp
LUT: LUT361_NNG-MB-cc.bmp

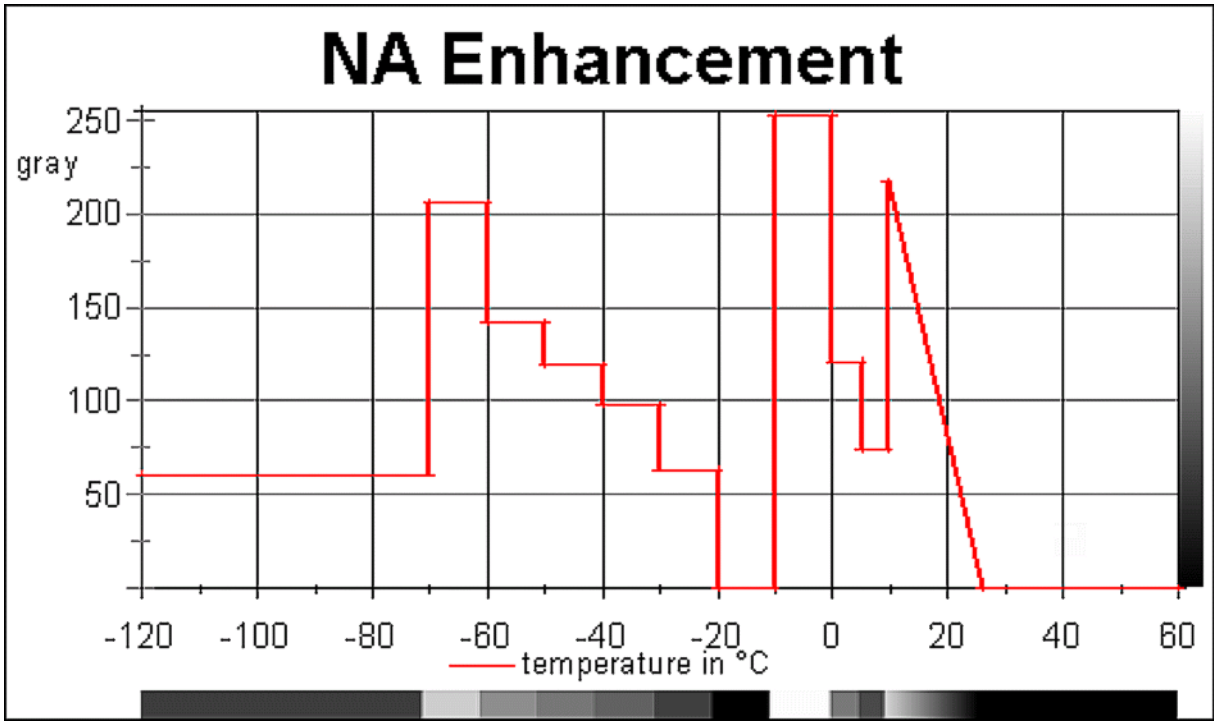
Seg no	Gray	Temp	Comments
1	000-000	60.0 to 29.3	Warm water and land
2	000-100	29.2 to 6.8	Surface features/warm clouds
3	101-176	6.7 to -31.2	Middle clouds
4	117-117	-31.6 to -42.3	Middle clouds/freezing level
5	155-155	-42.5 to -53.3	Cirrus/thunderstorm
6	070-070	-53.6 to -59.4	Cirrus/thunderstorm
7	000-000	-59.7 to -63.1	Cirrus/thunderstorm
8	000-255	-63.5 to -80.5	Overshooting cloudtops
9	255-255	-80.1 to -120.0	Very cold cloudtops or space



The MD curve is a modification of the popular, general use MB enhancement scheme. It is intended for warm season use, and provides improved enhancement within the gray "step wedges" that depict "warm top" convection (Segment number 4, 5, 6). An additional improvement is better delineation of warm low clouds (30 to 7 C). The middle cloud range is somewhat broader than the MB, and enhancement of details is minimized. Otherwise, it is the same as the MB curve.

LUT: LUT361_NNG-MD-bw.bmp

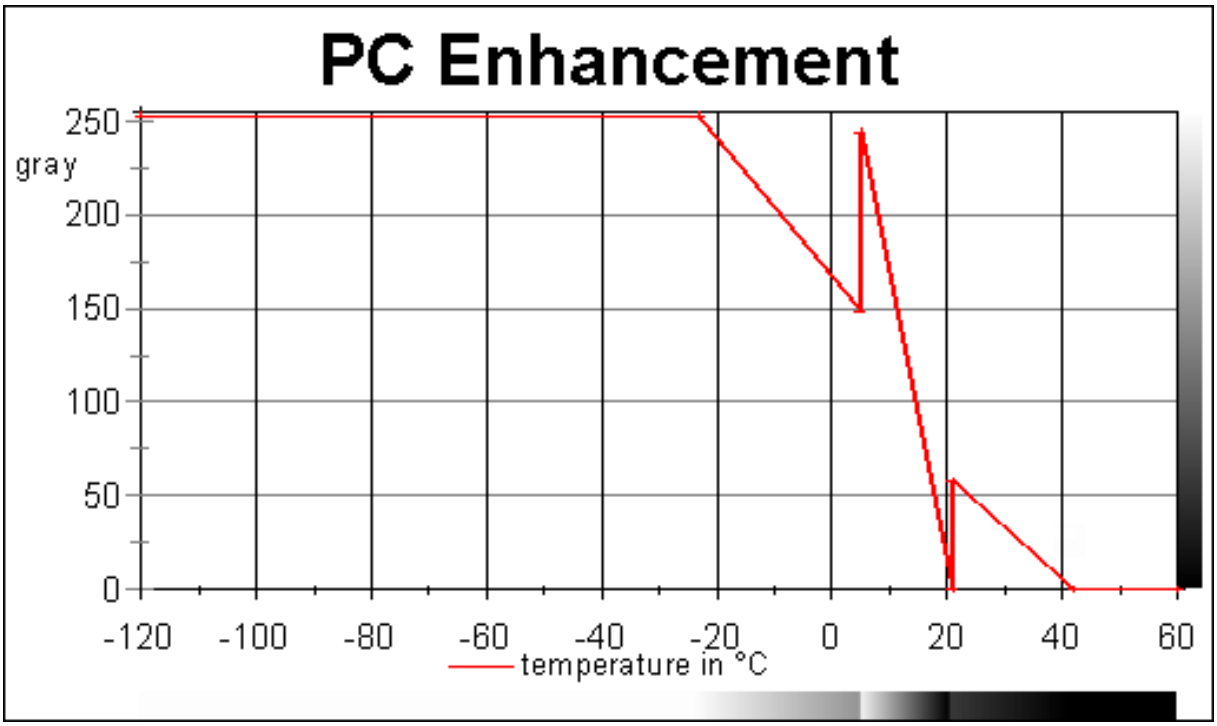
Seg no	Gray	Temp	Comments
1	000-000	60.0 to 29.3	Warm water and land
2	000-135	29.2 to 6.8	Surface features/warm clouds
3	135-210	6.7 to -31.2	Middle clouds
4	085-120	-31.6 to -42.3	Middle clouds/freezing level
5	150-185	-42.5 to -53.3	Cirrus/thunderstorm
6	060-095	-53.6 to -59.4	Cirrus/thunderstorm
7	000-000	-59.7 to -63.1	Cirrus/thunderstorm
8	000-255	-63.5 to -80.5	Overshooting cloudtops
9	255-255	-80.1 to -120.0	Very cold cloudtops or space



The SST/Land IR-curve is used to display seasurface temperatures and land/sea bounderies in smoothed gray. Further is it designed to view the freezing zone and it shows the higher cloudtops in steps of 10 C.

LUT: LUT361_GSS-NA-bw.bmp

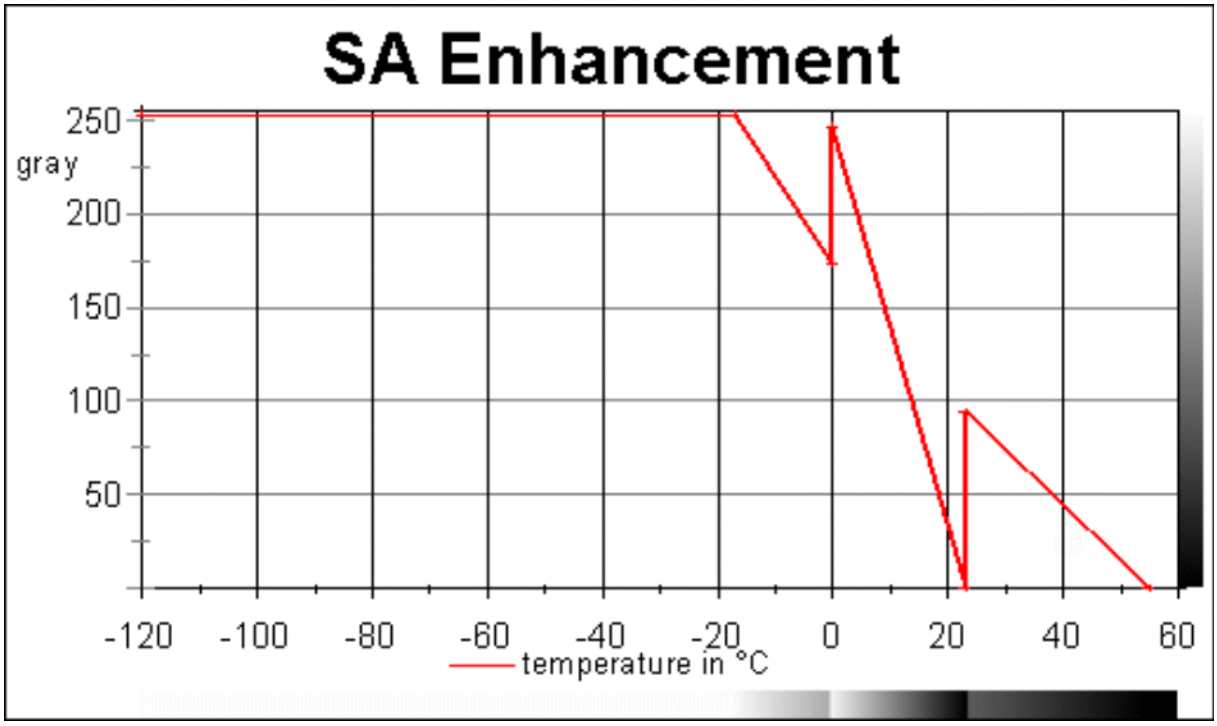
Seg no	Gray	Temp	Comments
1	000-000	60.0 to 26.0	Little or no information
2	000-217	26.0 to 9.5	Surface features
3	074-074	9.5 to 5.0	Surface features/low clouds
4	121-121	5.0 to 0.0	Surface features/low clouds
5	253-253	0.0 to -10.0	Freezing level/mid cloudtops
6	000-000	-10.0 to -20.0	Cloudtops
7	063-063	-20.0 to -30.0	Cloudtops
8	098-098	-30.0 to -40.0	Cloudtops
9	119-119	-40.0 to -50.0	Cloudtops
10	142-142	-50.0 to -60.0	Cloudtops
11	206-206	-60.0 to -70.0	Cloudtops
12	061-061	-70.0 to -120.0	Little or no information



An curve to show sea surface temperatures and it shows upwelling particularly well. The enhancement is used during late spring and fall on the US west coast to detect cold water surfaces in the Great Lakes and the US Northeast regions. There are no enhancements below the -23.0 C.

LUT: LUT361_NNG-PC-bw.bmp

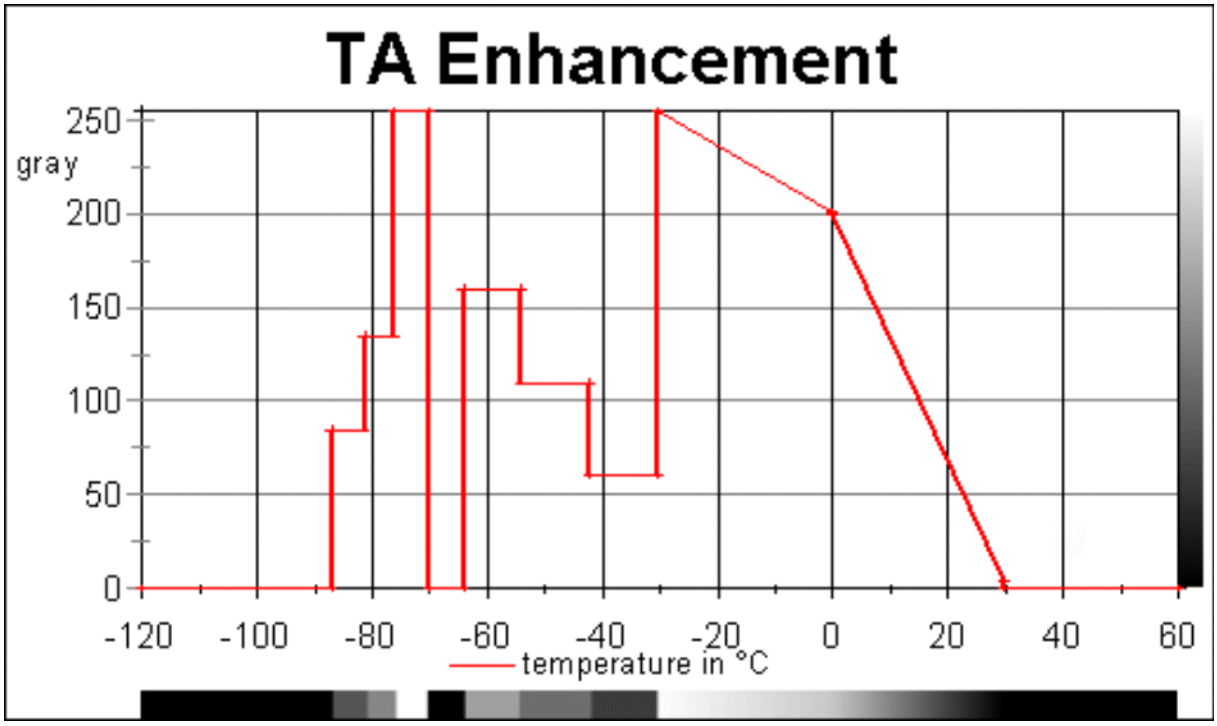
Seg no	Gray	Temp	Comments
1	000-000	60.0 to 42.0	Little or no information
2	000-058	42.0 to 21.0	Surface features
3	000-244	21.0 to 5.0	Land/water features
4	149-253	4.5 to -23.0	Mid. Clouds
5	253-253	-23.0 to -120.0	Little or no information



Curve to be used for wintertime SST and land/ocean contrast.

LUT: LUT361_NNG-SA-bw.bmp

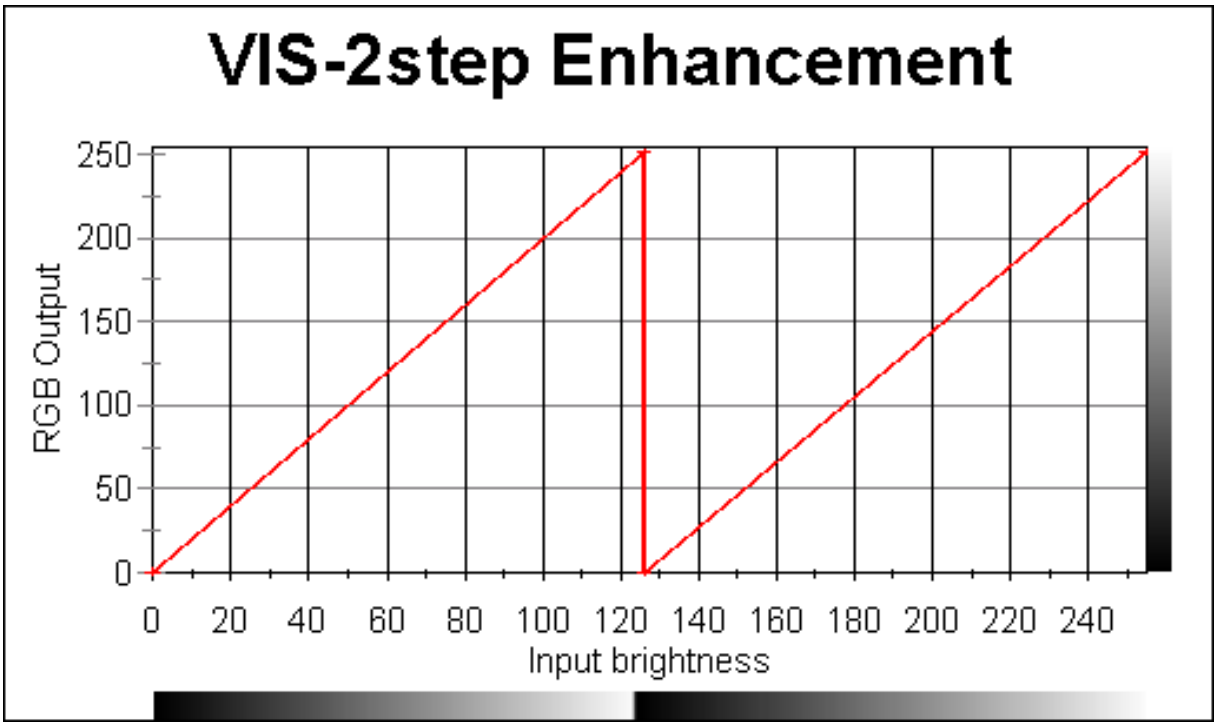
Seg no	Gray	Temp	Comments
1	000-094	55.0 to 23.0	Land features
2	000-247	23.0 to 0.0	Land/water features
3	173-253	0.0 to -17.0	Clouds
4	253-253	-17.0 to -109.0	Clouds



The TA curve is a combination of the CA curve (warm portion) (not included) and the HD curve (colder portion). The linear part of the curve is to improve land/water/low cloud contrast. The coldest part of the curve is in the same temperature ranges that are used for precipitation estimates and tropical storm classifications.

LUT: LUT361_NNG-TA-bw.bmp

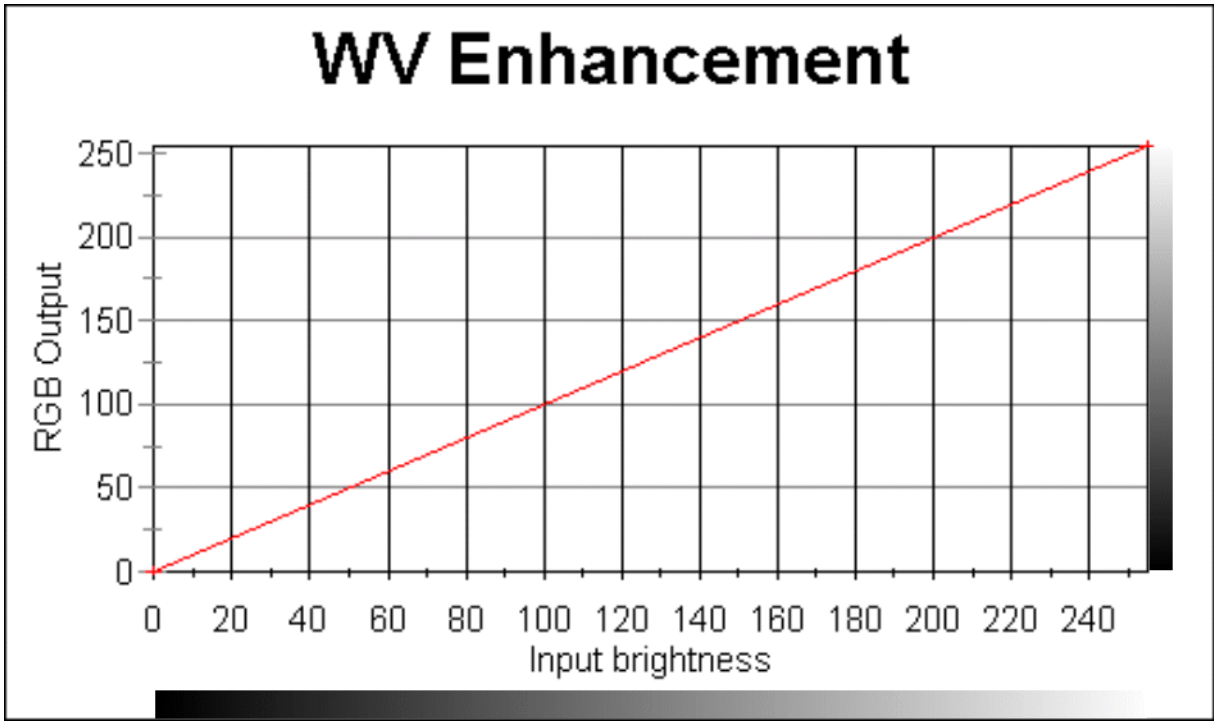
Seg no	Gray	Temp	Comments
1	000-000	60.0 to 29.8	Little or no information
2	004-200	29.7 to 0.1	Water and low clouds
3	201-201	-0.1 to -30.1	Mid tropospheric fronts
4	060-060	-30.3 to -41.9	Cloudtops
5	110-110	-42.2 to -53.7	Cloudtops
6	160-160	-54.0 to -63.6	Cloudtops
7	000-000	-64.0 to -69.9	Cloudtops
8	255-255	-70.4 to -75.7	Cloudtops
9	135-135	-76.2 to -80.6	Cloudtops
10	085-085	-81.2 to -86.3	Cloudtops
11	000-000	-87.0 to -120.0	Maximum cold



A curve for the visual channel to emphasizes the lower and upper clouds. Cloudtop features:
- vershooting tops
- waves
- cirrus plumes
- shadows

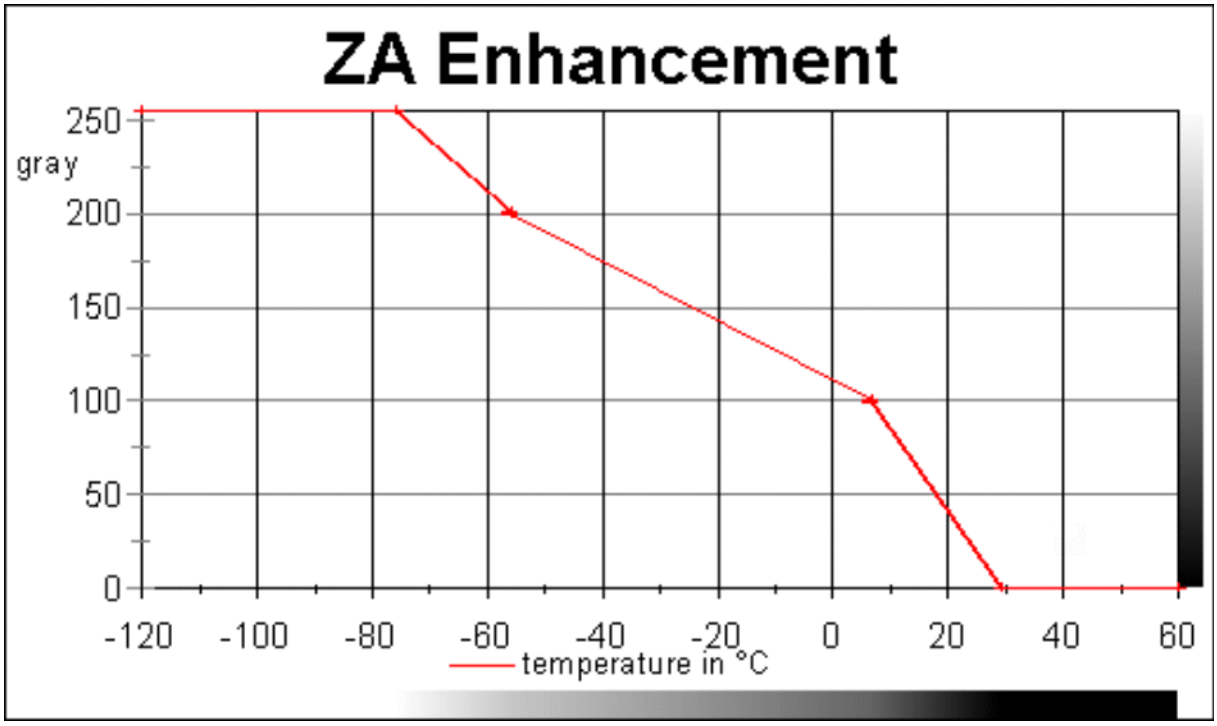
LUT: LUT256_NNG-VIS2step-bw.bmp

Seg no	Input	Gray
1	000-126	000-251
2	127-255	000-251



The actual converted range as counted by thermal pixels for watervapour is from -90 C to -5 C. But watervapourdata can't be set as any thermal value. Pixelcounts beyond these limits are lost. Therefore a traditional grayscale can be used to improve the waterchannel for the full grayscale range between the limits from RGB 000/000/000 to 255/255/255.

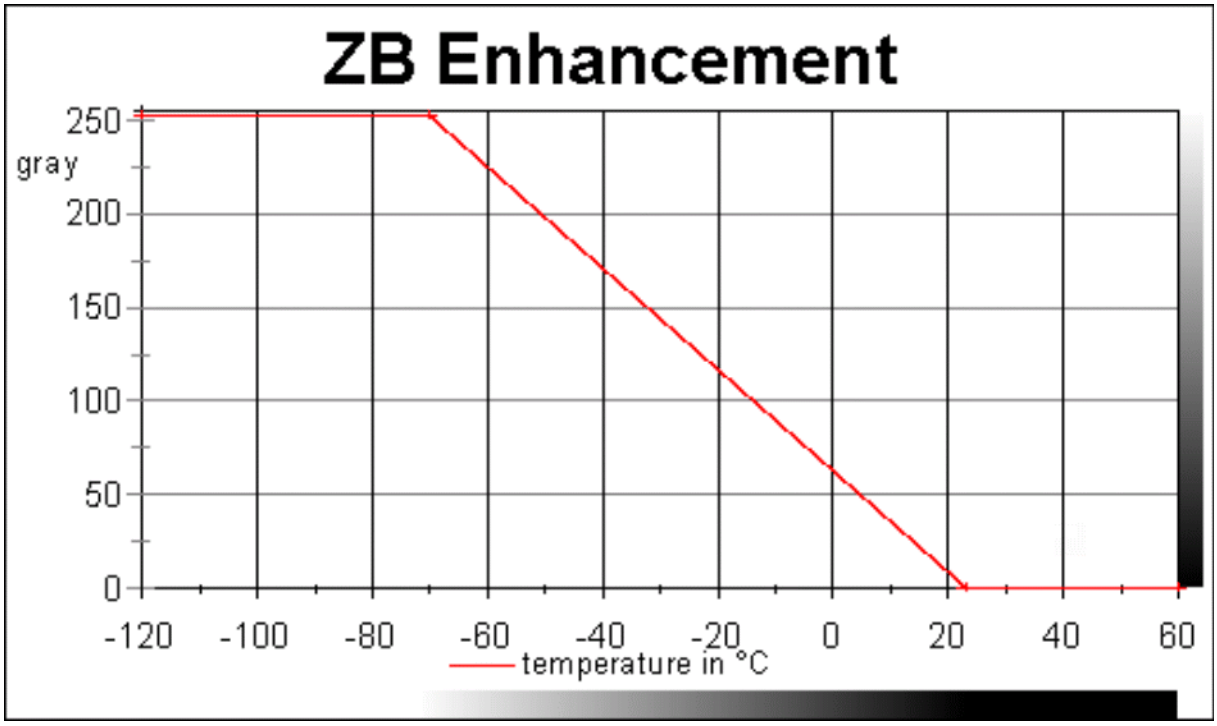
LUT: LUT265_NNG-WV-bw.bmp



A general smoothed enhancement for general-purpose infrared enhancement technique. Adviced for the warm season.

LUT: LUT361_NNG-ZA-bw.bmp

Seg no	Gray	Temp	Comments
1	000-000	60.0 to 29.3	Little or no information
2	000-100	29.2 to 6.8	Surface features/low clouds
3	101-200	6.7 to -55.7	Mid/upper level clouds
4	201-255	-55.7 to -75.2	Cold clouds/thunderstorm
5	255-255	-75.7 to -120.0	Little or no information



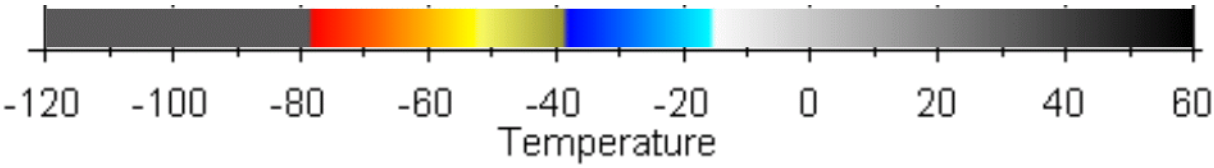
A general smoothed enhancement for general-purpose infrared enhancement technique. Adviced for the cold season.

LUT: LUT361_NNG-ZB-bw.bmp

Seg no	Gray	Temp	Comments
1	000-000	60.0 to 23.0	Little or no information
2	000-253	23.0 to -70.0	General enhancements
3	253-253	-70.0 to -120.0	Little or no information

INFRARED - AVN

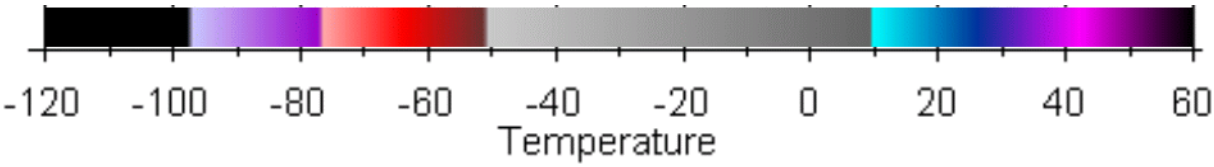
LUT: LUT361_NNG-AVN-cc.bmp



Aviation color enhancement.

INFRARED -JSL

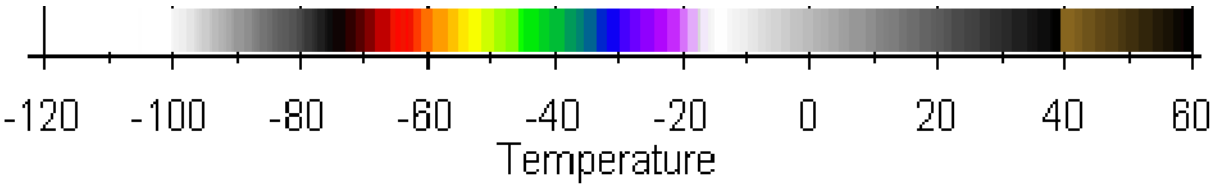
LUT: LUT361_NNG-JSL-cc.bmp



An curve used for tropic features as cyclones.

INFRARED - RAINBOW

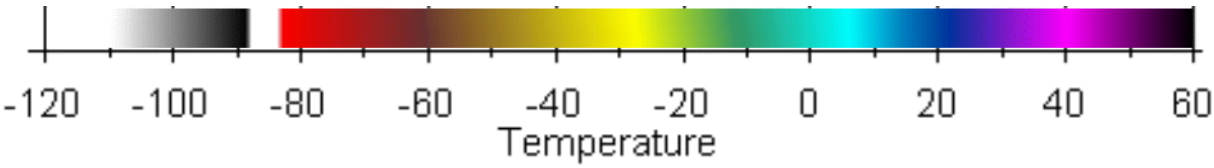
LUT: LUT361_NNG-IR-cc1.bmp



This rainbow LUT offers a rainbow pallete from -70 C to -15 C. Extreme cold cloudtops are in a grayscale with white on top. There is an extra extention on the warm side. Temperatures above the +40 C starts with brown and is fading into black on the end of the thermal scale. With this extention extreme hot spots in deserts can be easely determinated.
There some LUTs with slight variations on this theme. This LUT is also known als CIMSS convention form the SSEC (Space Science and Engineering Data Center)

INFRARED - RAINBOW

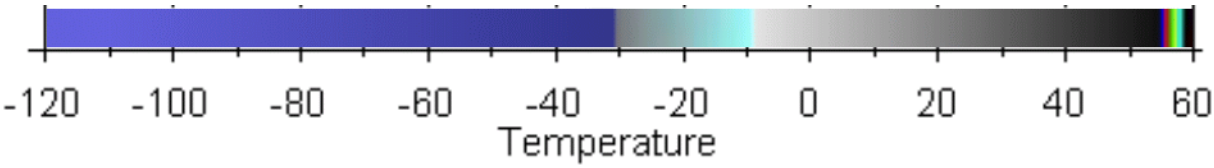
LUT: LUT361_NNG-IR-cc2.bmp



Compare this LUT with the partional rainbow LUT361-NGSS-IR-cc3.bmp.

IR2

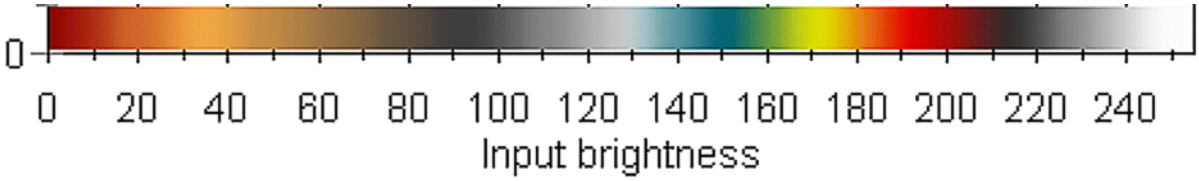
LUT: LUT361_NNG-IR2-cc.bmp



Images at this wavelength consist not only of radiation emitted by the earth atmosphere system, but also reflected solar radiation. Useful for fog and other liquid water cloud identification, cloud phase changes, distinction of cloud cover over snow fields, and fire detection. It can be used as replacement for the LC enhancement. The IR2 refers to Goes channel 2, but can also be used for other geostationairy weathersatellites.

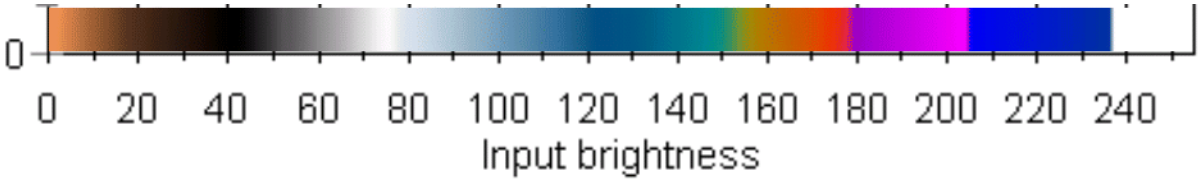
WATER VAPOUR - RAINBOW

LUT: LUT256_NNG-WV-cc1.bmp

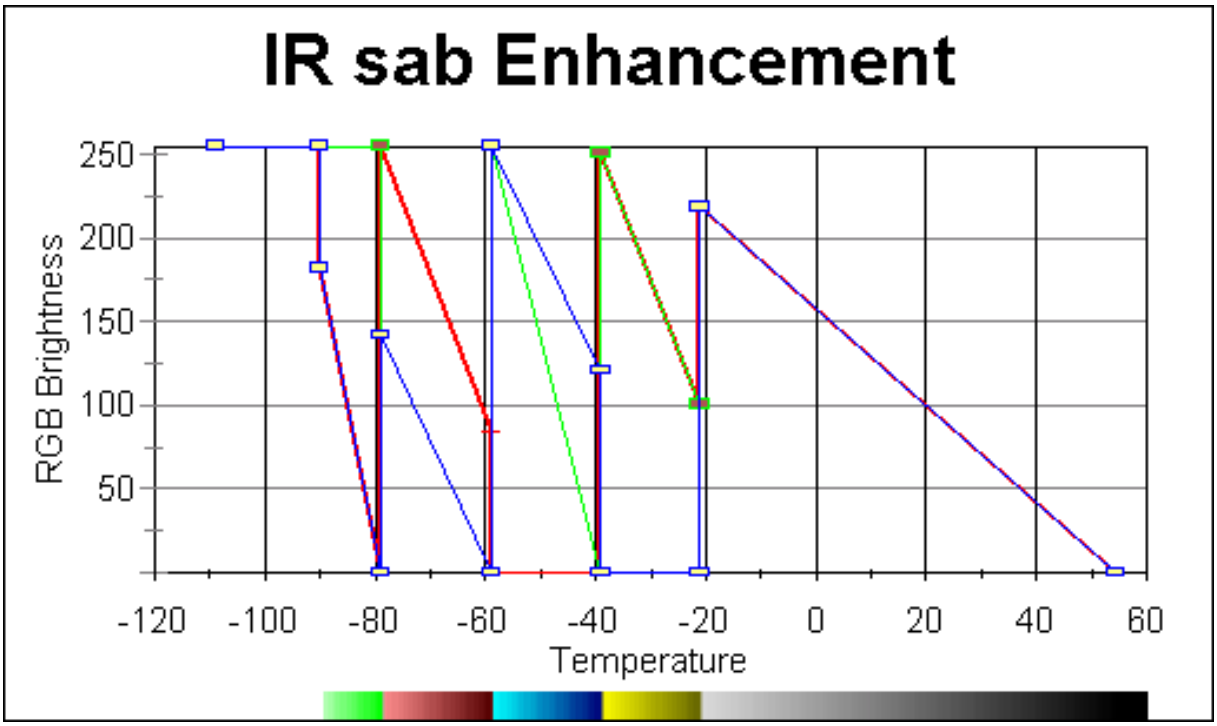


WATER VAPOUR - RAINBOW

LUT: LUT256_NNG-WV-cc2.bmp



NOAA SCIENCE ADVISORY BOARD ENHANCEMENT



The IR sab curve is an alternate IR curve for the IR-CIRA or IR4winter enhancement. It offers emphasizes cold cloud tops with sharp breakpoints at -21 C, -39 C, -59 C and -79 C. The IR sab curve is also known as FT (FunkTop) enhancement.

LUT: LUT361_NSAB-IR-cc.bmp

Seg no	Temp	Red	Green	Blue	Feature
1	54.5 to -21.0	000-219	000-219	000-219	Land and sea features)*
2	-21.0 to -39.0	101-251	101-251	000-000	Cloudtops
3	-39.0 to -59.0	000-000	000-255	121-255	Cloudtops
4	-59.0 to -79.0	085-255	000-142	000-142	Cloudtops
5	-79.0 to -90.0	000-182	255-255	000-182	Cloudtops
6	-90.0 to -109.0	255-255	255-255	255-255	No information
					)* Low and mid. level cloudtops

NOAA GEOSTATIONARY SATELLITE SERVER ENHANCEMENTS

NOAA's Geostationary Satellite Server is offering infrared enhancements with colours set to pixel brightness. The pixel brightness are set to corresponding thermal values with the next formulea:

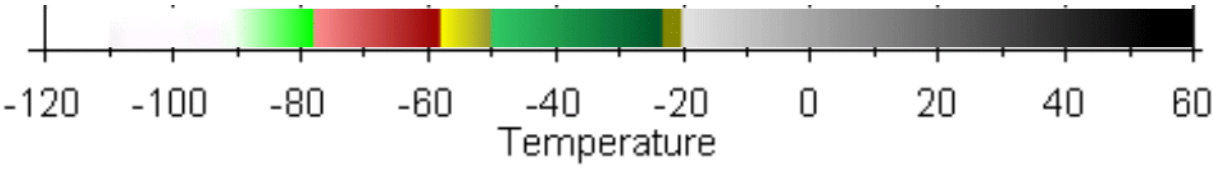
For $B > 176$
$T = 418 - B$
or when $B <= 176$
$T = 330 - (B/2)$

B = Brightness; T = Temperature in Kelvin.

Pixel values are not set for the watervapour channel.

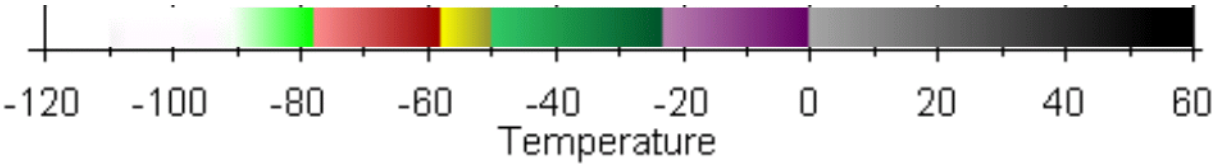
INFRARED

LUT: LUT361_NGSS-IR-cc1.bmp



INFRARED

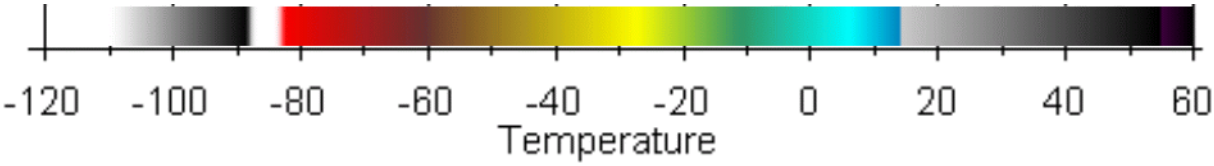
LUT: LUT361_NGSS-IR-cc2.bmp



Two near identical LUTs. The LUT361_NGGS-IR-cc2 has an extra enhancement for the freezing zone.

INFRARED

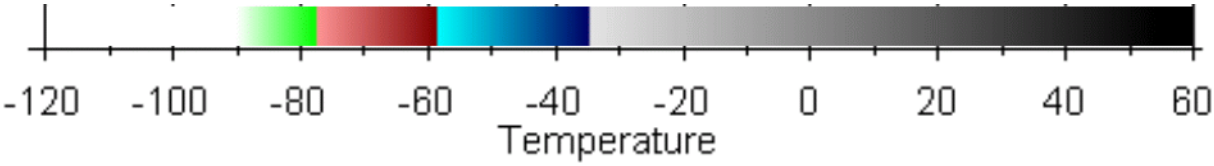
LUT:LUT361_NGSS-IR-cc3.bmp



From around 14 C and lower temperatures identical to the rainbow LUT361_NNG-RB-cc2.

INFRARED

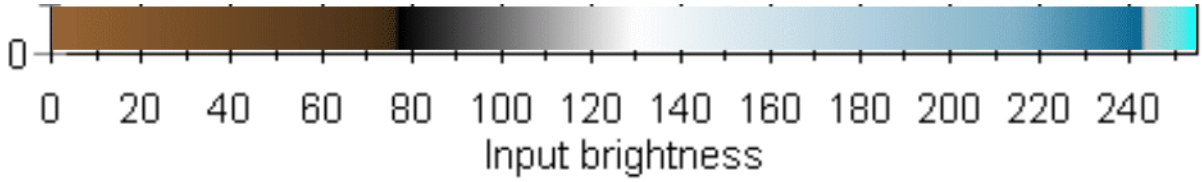
LUT: LUT361_NGSS-IR-cc4.bmp



This LUT is enhanced for cold cloudstop and useful for (severe) thunderstorm and cyclones.

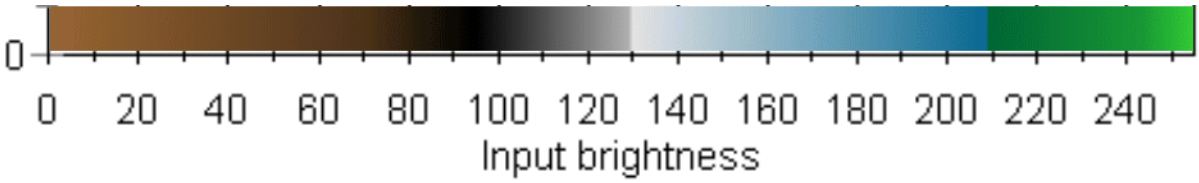
WATER VAPOUR

LUT: LUT256_NGSS-WV-cc1.bmp



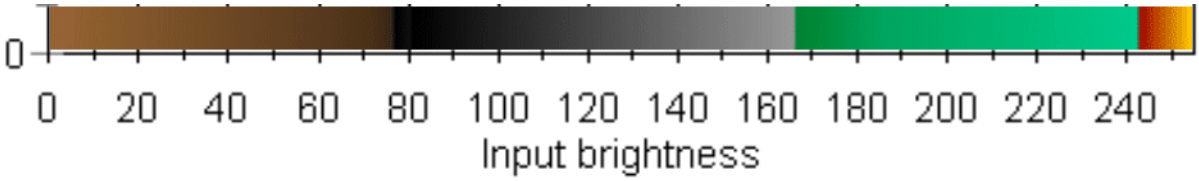
WATER VAPOUR

LUT: LUT256_NGSS-WV-cc2.bmp



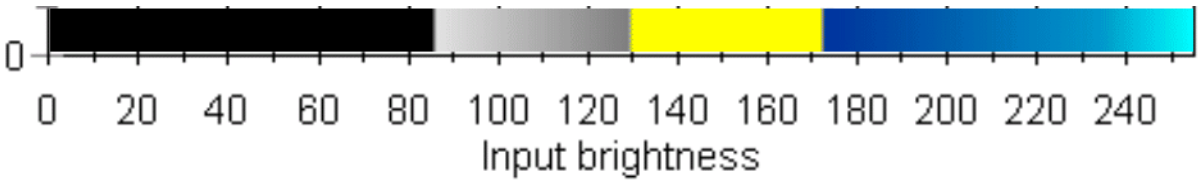
WATER VAPOUR

LUT: LUT256_NGSS-WV-cc3.bmp

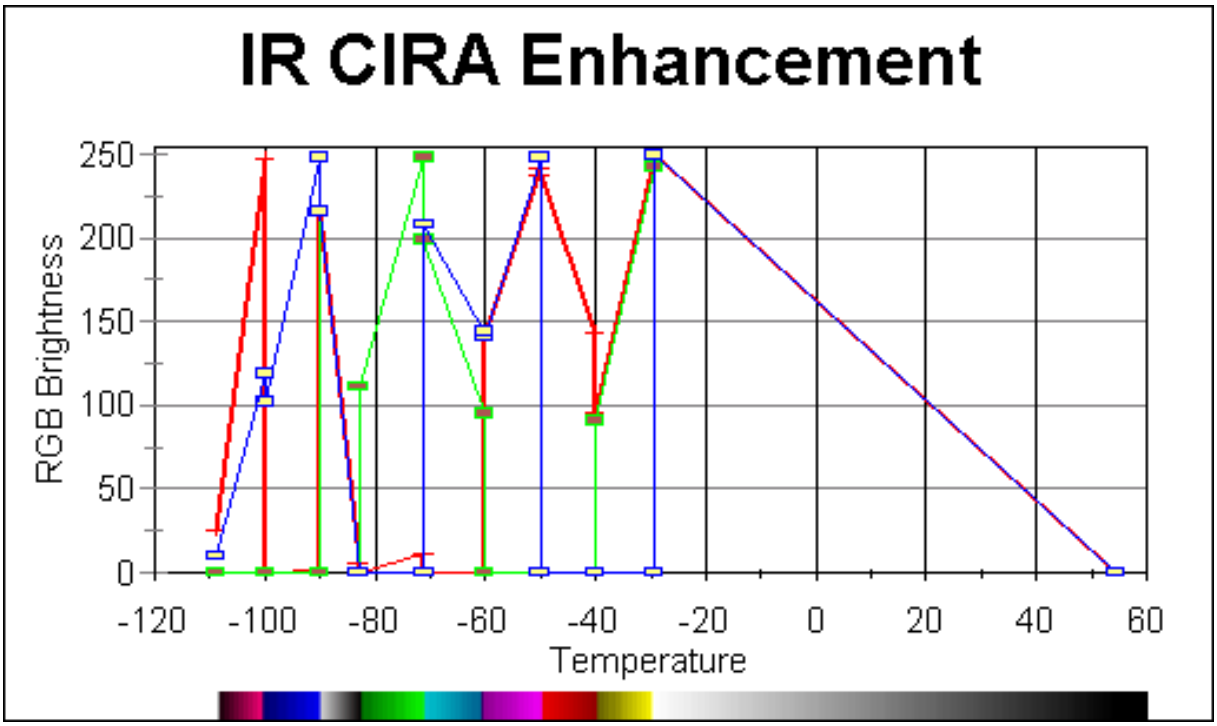


WATER VAPOUR

LUT: LUT256_NGSS-WV-cc4.bmp



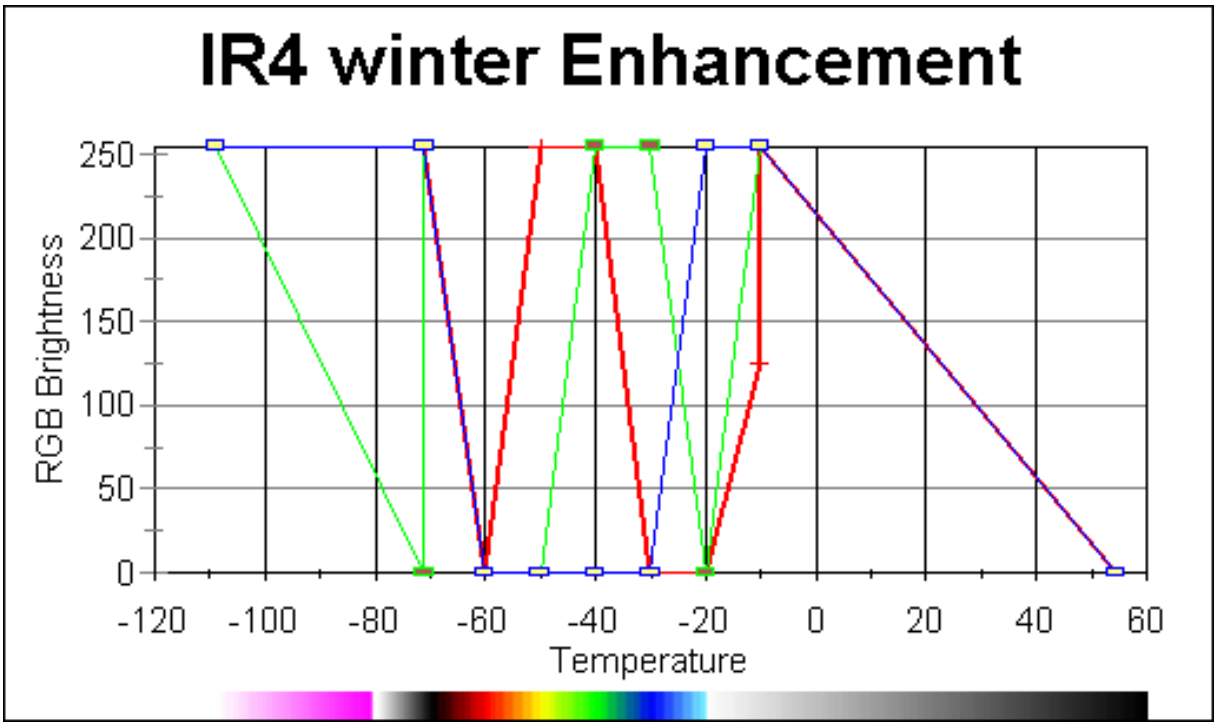
RAMSDIS-CIRA/RAMMB ENHANCEMENTS



This IR enhancement has significant color gradations within the -50 C to -70 C (equilibrium level / tropopause level) temperature range. Then it is helpful in detecting the Enhanced-V signature from thunderstorms, but this enhancements is also be tailored to account for seasonal and regional variations of this important cloud top temperature range.

LUT: LUT361_RCR-CIRA-cc.bmp

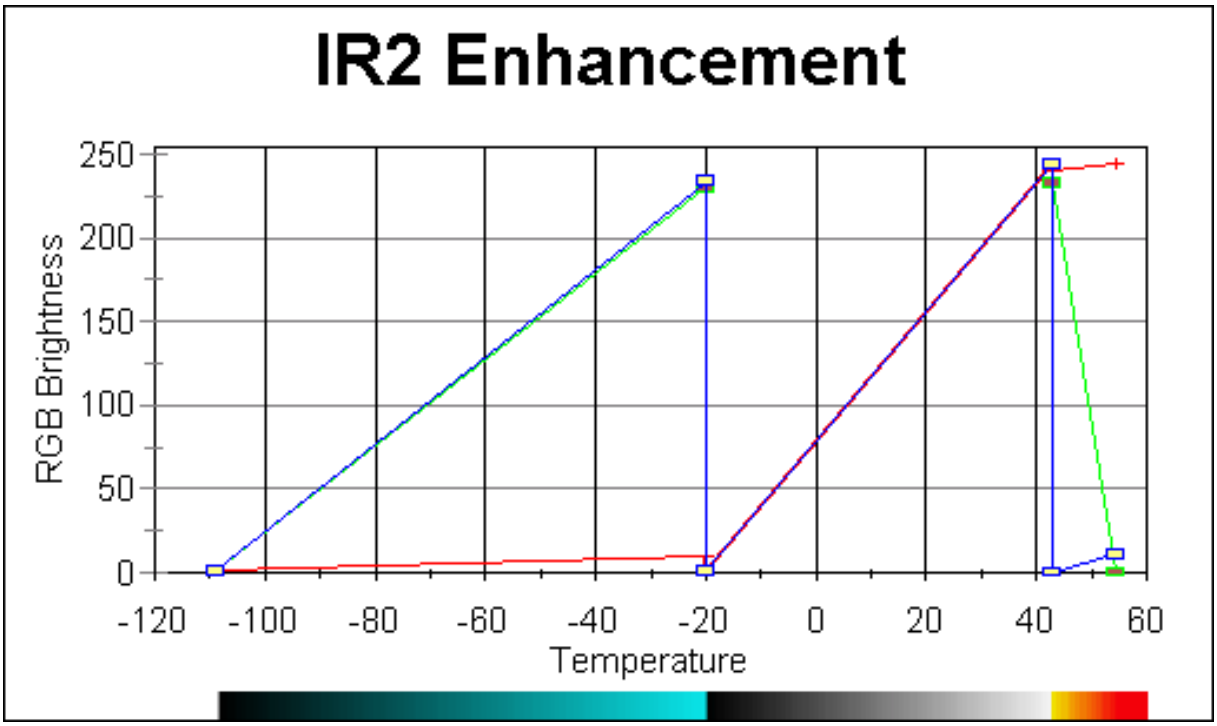
Seg no	Temp	Red	Green	Blue	Feature
1	54,5 to -29,5	000-250	000-250	000-250	Low Clouds
2	-30,0 to -40,0	248-095	242-091	000-000	Cloudtops
3	-41,0 to -50,0	144-237	000-000	000-000	Cloudtops
4	-51,0 to -60,0	242-140	000-000	248-141	Tropopause/thunderstorm
5	-61,0 to -71,0	000-000	095-199	144-208	Tropopause/thunderstorm
6	-72,0 to -82,0	012-000	248-111	000-000	Overshooting cloudtops
7	-83,0 to -90,0	006-216	000-216	000-216	Overshooting cloudtops
8	-91,0 to -100,0	001-000	000-000	248-102	Extreme cold cloudtops
9	-101,0 to -109,0	248-025	000-000	119-010	Extreme cold cloudtops



The alternate "IR4_winter" enhancement has a few more color gradations within the critical -50 C to -70 C range (red to black to white) than the default "CIRA (IR default)" enhancement (violets to lighter blues), which could possibly aid in the initial detection of more subtle equilibrium level / tropopause level features.
IR4 is refering to the Goes IR channel 4, but can be used for other geostationary weathersatelites as well.

LUT: LUT361_RCR-IR4winter-cc.bmp

Seg no	Temp	Red	Green	Blue	Feature
1	54,5 to -10,0	000-250	000-250	000-250	Low Clouds
2	-20,0 to -30,0	248-095	242-091	000-000	Cloudtops
3	-30,0 to -40,0	144-237	000-000	000-000	Cloudtops
4	-40,0 to -50,0	242-140	000-000	248-141	Cloudtops/thunderstorm
5	-50,0 to -60,0	000-000	095-199	144-208	Tropopause
6	-60,0 to -71,0	012-000	248-111	000-000	Tropopause
7	-71,0 to -109,0	006-216	000-216	000-216	Overshooting cloudtops



See notes on page 40.

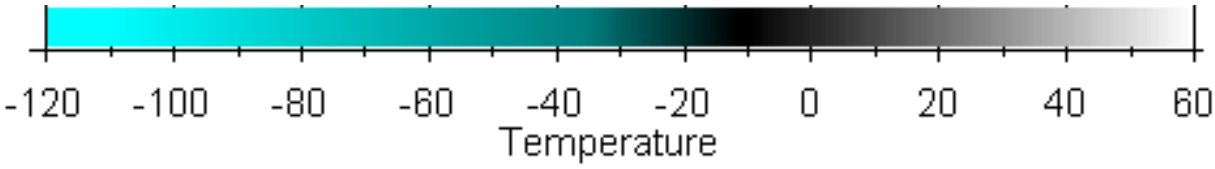
LUT: LUT361_RCR_IR2-cc1.bmp

Seg no	Temp	Red	Green	Blue	Feature
1	54.5 to 43.0	244-240	000-233	011-000	Fire
2	43.0 to -20.0	244-001	244-001	244-001	Surface and low cloud features
3	-20.0 to -109.0	010-001	230-001	234-001	Water/ice cloud discrimination

IR2

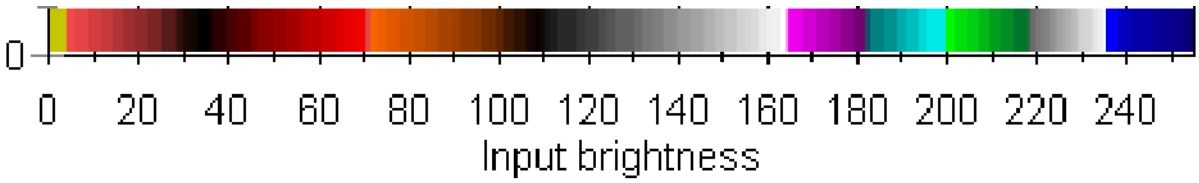
LUT:LUT361_RCR-IR2-cc2.bmp

An alternate IR channel 2 curve.



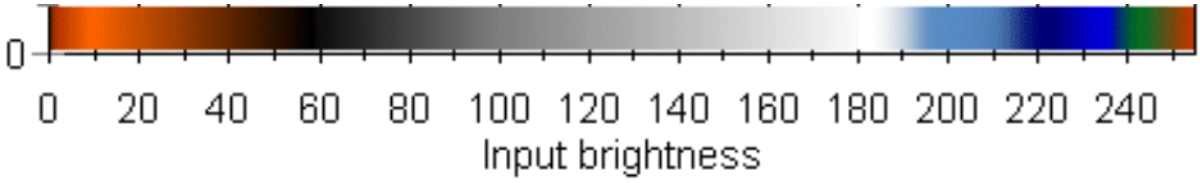
WATER VAPOUR

LUT: LUT265_RCR-WV-cc1.bmp

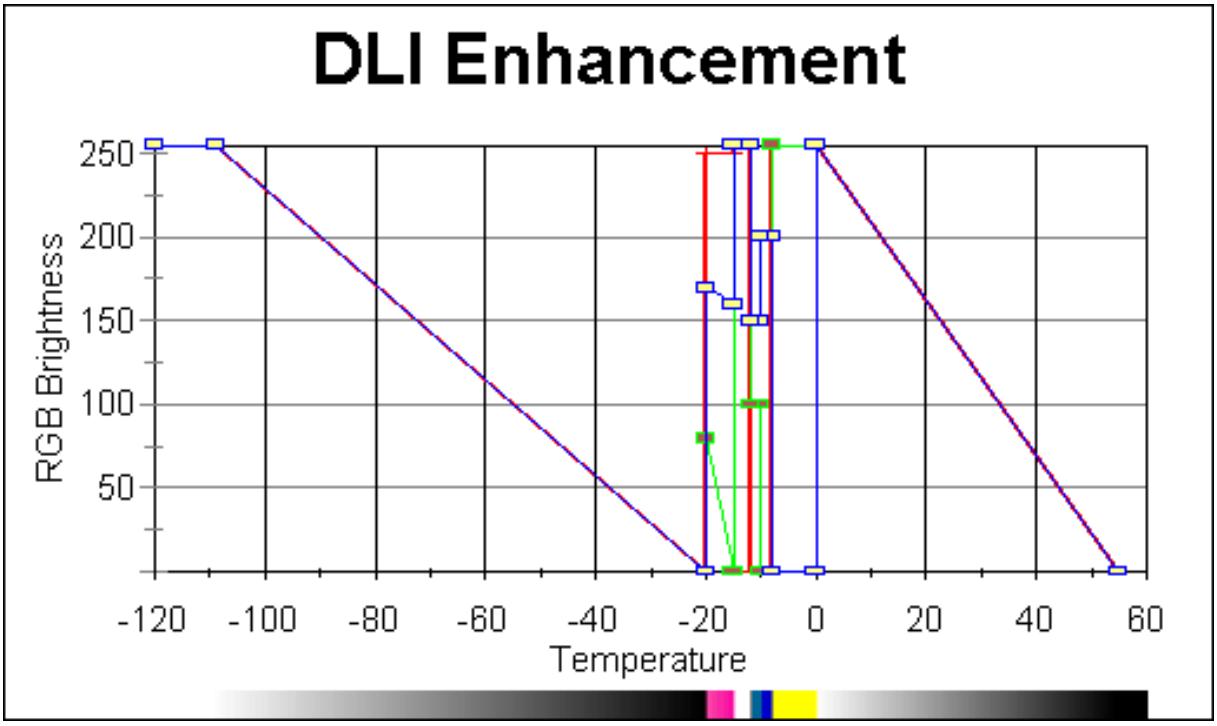


WATER VAPOUR

LUT: LUT265_RCR-WV-cc2.bmp



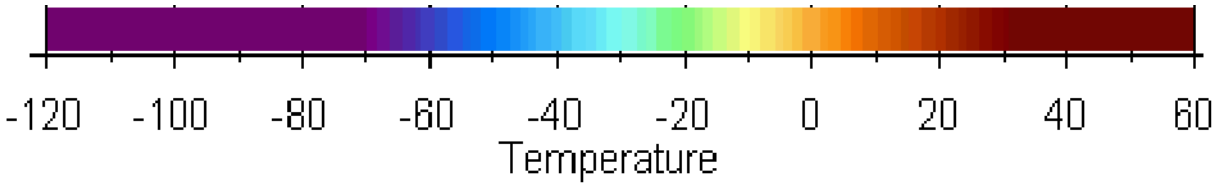
UCAR ENHANCEMENTS



The Detection of Liquid or Icing enhancement is based on cloud top temperature, and using a color enhancement as detailed in the accompanying table, the potential presence of ice in cloud tops can be determined through the use of 10.7-µm IR imagery. The presence of liquid at cloud top generally indicates that the entire cloud is predominantly liquid. This is particularly helpful for analyzing freezing drizzle environments with low stratus, which may have areas of more vertical development.

Seg no	Temp	Red	Green	Blue	Feature
1	55.0 to 0.0	000-255	000-255	000-255	Liquid cloudtops
2	0.0 to -8.0	255-255	255-255	000-000	Liquid cloudtops
3	-8.0 to -10.0	000-000	000-000	200-200	Likely lquid cloudtops
4	-10.0 to -12.0	000-000	100-100	150-150	60% change on icing
5	-12.0 to -15.0	255-255	255-255	255-255	70% change on icing
6	-15.0 to -20.0	250-250	000-080	160-170	90% change on icing
7	-20.0 to -109.0	000-255	000-255	000-255	Icing present

INFRARED
LUT: LUT361_UCAR-IR-cc.bmp



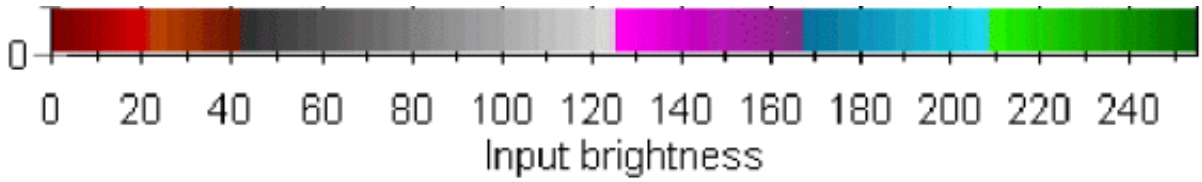
A rainbowcurve starting with red at the warm side. Used in avaition for all geostationairy weathersatellites. Also used by ADDS.

MISCELLANEOUS ENHANCEMENTS FROM WORLDWIDE NATIONAL, REGIONAL AND OTHER WEATHER AGENCIES

Enhancements in this section are based on webimages from various weather agencies; national, regional or commercial. Almost al of the enhancements are used for IR 10.8 imagery. Most of them are reconstructed and there might be some slight differences with the original. Some are serious and interesting, while others provide poor details. This overview intends to be complete as possible complete for an overview of all the LUTs used in the world. It will give the user an idea how several agencies are playing with colours to get the best, or even completely destroy the image.
Several national weather offices are using a technique as descripted section GeoSatSignal derived prodects and enhancements/Infrared cloudmasks op page 20. These kind of LUTs are not included in this overview.
The LUTs in this section do meet the colors used by agencies on their web pages.

ADDS (AVIATION DIGITAL DATA SERVICE) - USA

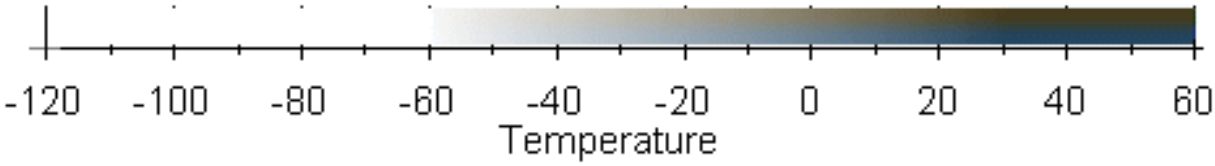
WATER VAPOUR
LUT: LUT256_ADDS-WV-cc.bmp



Used in avaition for all geostationairy weathersatellites.

AFWA (AIRFORCE WEATHER AGENCY) - USA

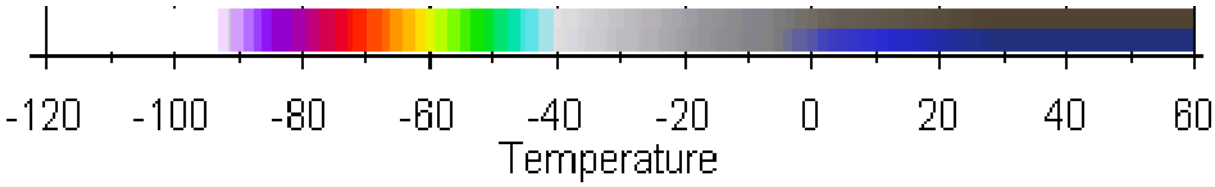
INFRARED
LUT: LUT361_AFWA-IR-cc.bmp



Modelcurve used for the webimagery of AFWA.

AWI (ACCU WEATHER INC) - USA

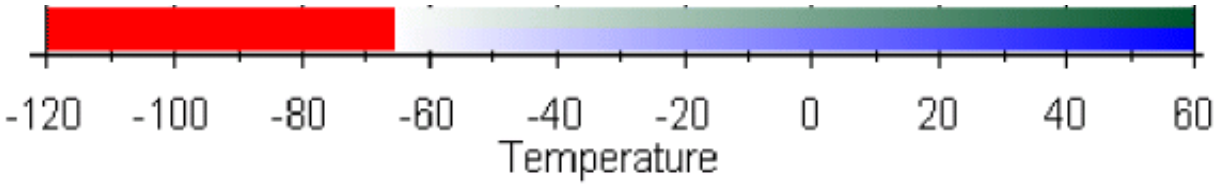
INFRARED
LUT: LUT361_AWI-IR-cc.bmp



Modelcurve used for the webimagery of AW.

BMS (BRUNEI METEOLOROGICAL SERVICES)

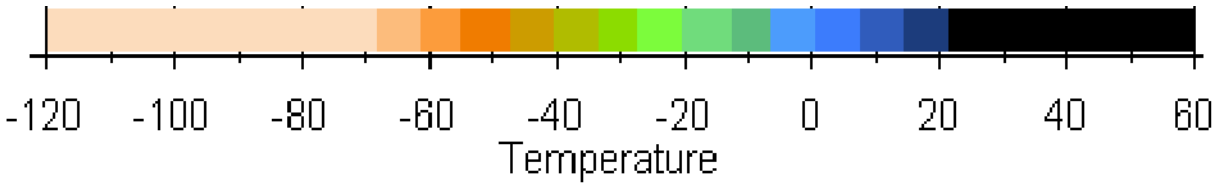
INFRARED
LUT: LUT361_BMS-IR-cc.bmp



A simple curce to detect cold cloudtops from severe weather events on the tropics. Used on the webimagery of the BMS.

BOM (BUREAU OF METEOROLOGY) - AUSTRALIA

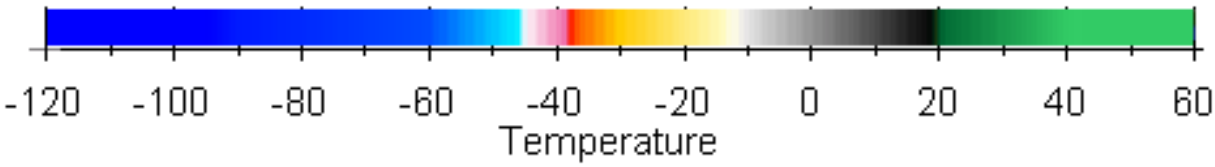
INFRARED
LUT: LUT361_BOM-IR-cc.bmp



A stepped LUT used to enhance webimages from BOM.

CFMI (CENTRO FUNZIONALE METEO-IDROLOGICO DI PROTEZIONE CIVILE DELLA REGIONE LIGURIA) - ITALY

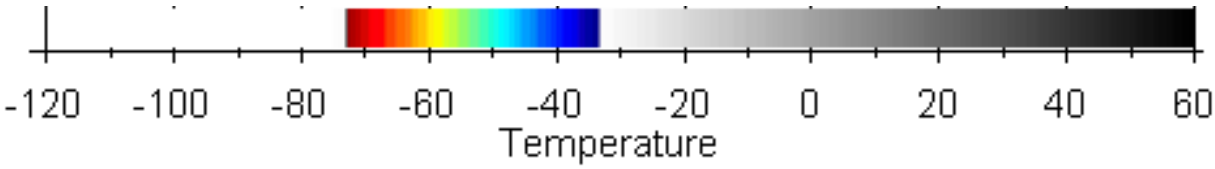
INFRARED
LUT: LUT361_CFMI-IR-cc.bmp



It is a nice LUT for high, middle and low clouds. But extremely low clouds, as overshooting cloudtops in thunderstorms or hurricanes/cyclones, are not well exposed. A fair weather zone is exposed at 20 C.

CHMI (CZECH HYDROMETEOROLOGICAL INSTITUTE)

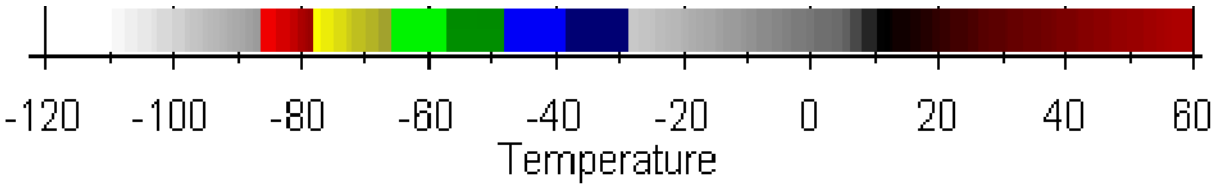
INFRARED
LUT: LUT361_CHMI-IR-cc.bmp



This LUT is primeraly used to enhance NOAA imagery for cold cloudtops. Rainbow from -73 to -33 C.

COD (COLLEGE OF DUPAGE/NEXLAB) - USA

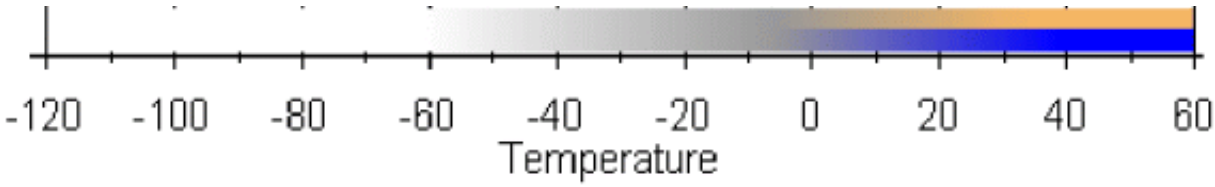
INFRARED
LUT: LUT361_COD-IR-cc.bmp



Modelcurve used for the webimagery of COD.

DSRS (DUNDEE SATELLITE RECEIVING STATION) - UK

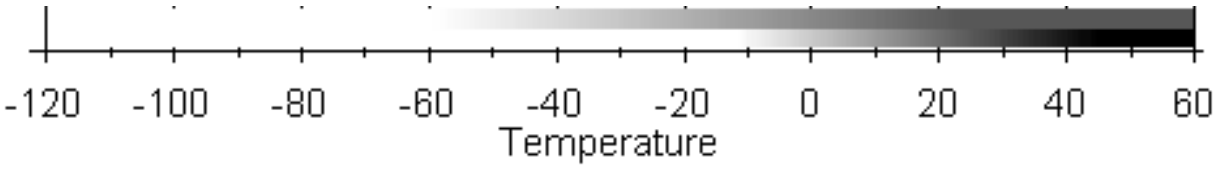
INFRARED
LUT: LUT361_DSRS-IR-cc.bmp



Modelcurve used for the webimagery DSRS.

EAL (EARTH AT LARGE) - NETHERLANDS

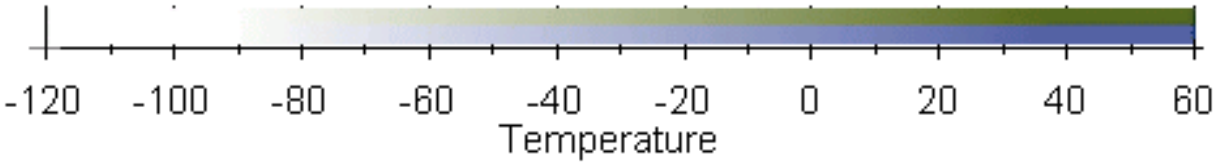
INFRARED - CLOUDMASK
LUT100_EAL-IR-cm.bmp



Ferdinand Valk (Earth At Large) has developed a new method to create speudo visual out of infrared data. This LUT is based on the 256*2 pixel series, but the two lines do have a different meaning. The upper line shows the colour for the clouds and the lower line refers to a fading option. Full black is transparant with use of a background image in GeoSatSignal.

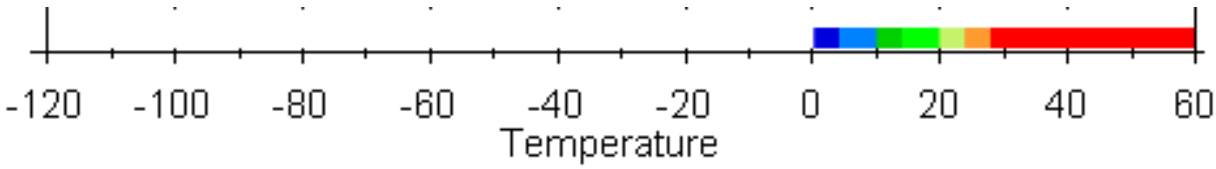
EUMETSAT - (EUROPE)

INFRARED
LUT: LUT361_EUM-IR-cc.bmp



This LUT does meet the colors used by Eumetsat on their webpages, but there might be some slight differences.

INFRARED - SEA SURFACE TEMPERATURES
LUT: LUT361_EUM-IR-sst.bmp



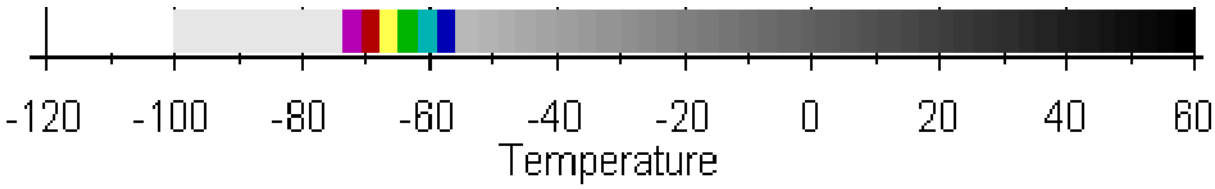
This LUT is used for sea surface temperatures (SST) for Meteosat 5 to 7, but can be used for the MSG family as well by using the IR channel. At Eumetsat the product is generated twice a day at 00 and 12 UTC. For each slot an accumulation of data from last the 12 hours is used.

The LUT shows only features over sea, all other data is removed and is shown as white.

Reproducing a SST product
Users from GeoSatSignal can reproduce this SST products with help of GeoSatSignal and a photo-editor. First you will need a cloudmask product to discriminate the clouds from the surface. They are also available from the Eumetsat archives if you don't have a copy of them. The cloudmasks refered on page 20 won't work for this.
Make a serie of images for the requested region as a first step to recreate such a SST product. Then add in a photo-editor the cloudmask on the image and save them. Be sure to have all the images on an equal scale. For the last step accumulate all the images in a photo-editor and make the white background transparant for each image.

FSU (FLORIDA STATE UNIVERSITY) - USA

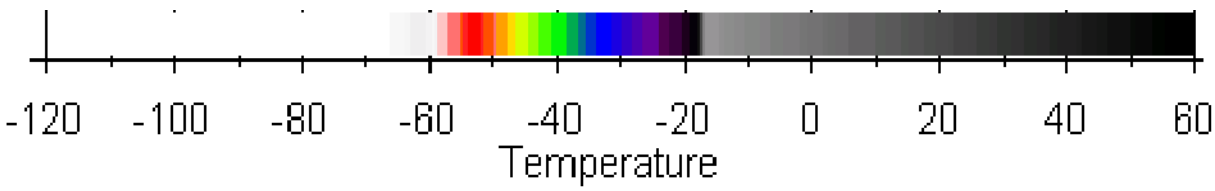
INFRARED
LUT: LUT361_FSU-IR-cc,bmp



A stepped rainbow curve to detect cold cloudtops for Caribean severe weather (thunderstorms and hurricans). Also used at the San Fransico State University.

GPS (GOES PROJECT SCIENCE) - USA

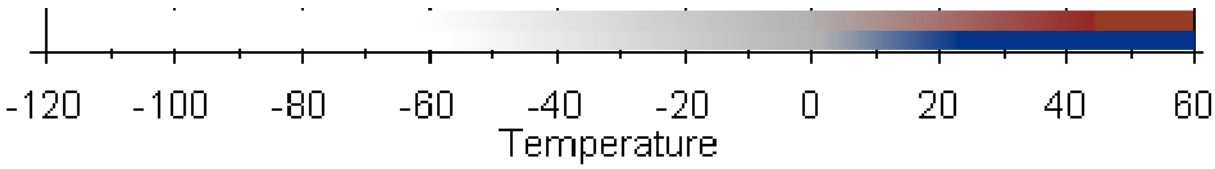
INFRARED
LUT: LUT361_GPS-IR-cc.bmp



A rainbow curve for general use. No enhencements beyond the -70 C limits.

IMN (INSTITUTO NACIONAL METEOROLOGICA) - SPAIN

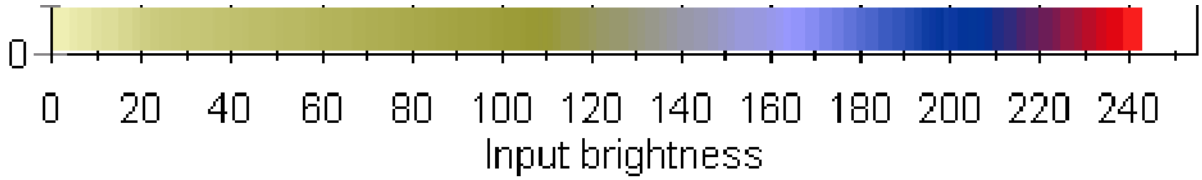
INFRARED
LUT: LUT361_INM-IR-cc.bmp



Modelcurve used for the webimagery of IMN.

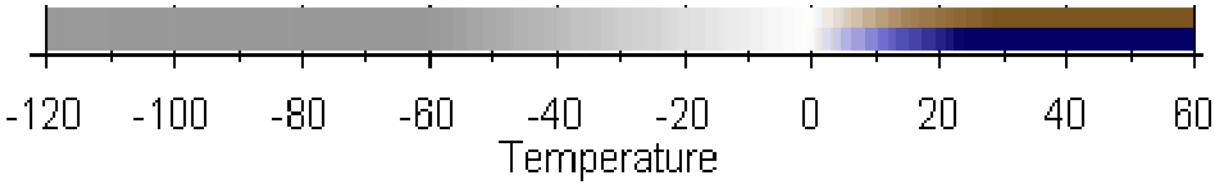
LMD (LABORATOIRE DE MÉTÉOROLOGIE DYNAMIQUE) - FRANCE

WATER VAPOUR
LUT: LUT256_LMD-WV-cc.bmp



MD (METEOROLOGICAL DEPARTMENT) - OMAN

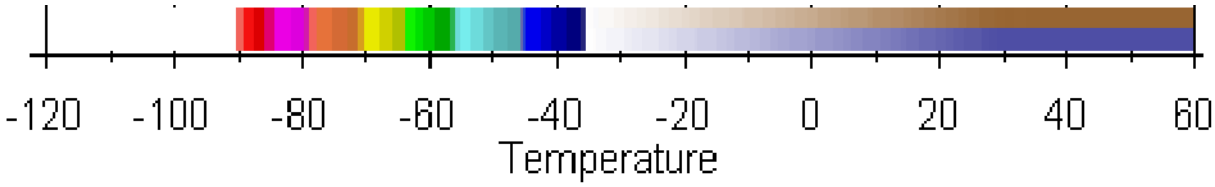
INFRARED
LUT: LUT361_MD-IR-cc.bmp



Modelcurve used for the webimagery of MD.

MDNAA (METEOROLOGISCHE DIENST NEDERLANDSE ANTILLEN & ARUBA) - NETHERLANDS ANTILLES

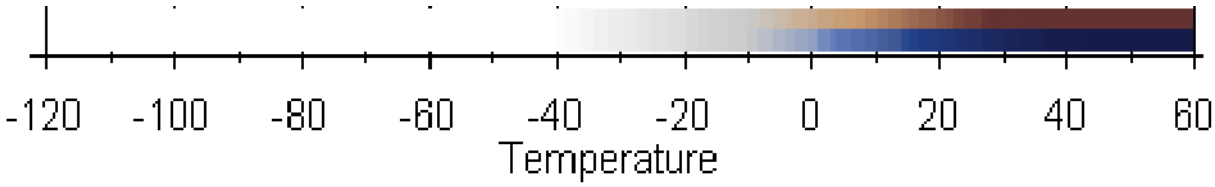
INFRARED
LUT: LUT361_MDNAA-IR-cc.bmp



A curve to enhance cold cloudtops from thunderstorms and hurricans in the Caribean.

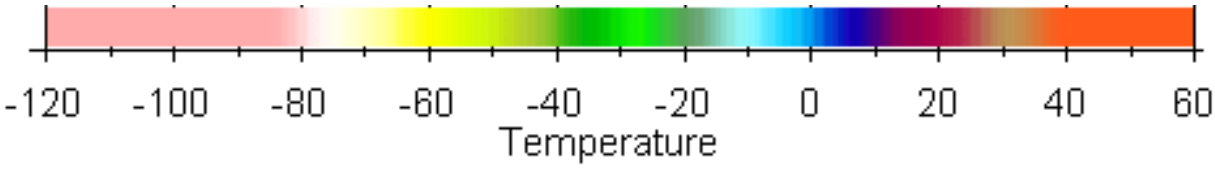
MFR (METEO FRANCE)

INFRARED
LUT: LUT361_MFR-IR-cc1.bmp



Modelcurve used for the webimagery of Meteo France and some territories. Poor enhanced at the cold side.

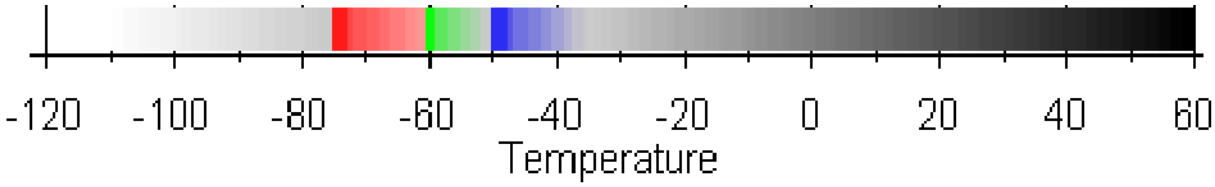
INFRARED
LUT: LUT361_MFR-IR-cc2.bmp



Modelcurve used by Meteo France on their webpages to enhance Meteosat imagery.

MMS (MAURITIUS METEOROLOGICAL SERVICES)

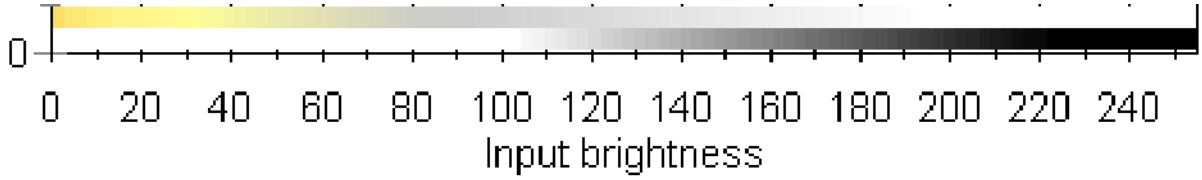
INFRARED
LUT: LUT361_MMS-IR-cc.bmp



This LUT is used to detect cold cloudtops from severe weather events over the Indean Ocean.

MOAD (METEOROLOGICAL OFFICE ABU DHABI) - UNITED ARAB EMIRATES

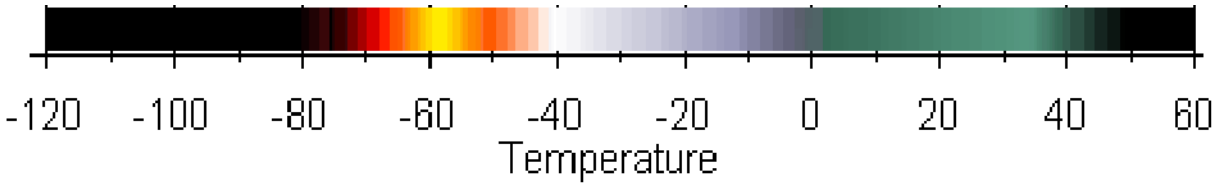
INFRARED - CLOUDMASK
LUT100_MOAB-IR-cm.bmp



Another example of a cloudmask LUT. I found during the LUT survey only one who was different from the EAL standard cloudmask. The MOAB LUT has yellow cold cloudtops.

MSC (METEOROLOGICAL SERVICE OF CANADA)

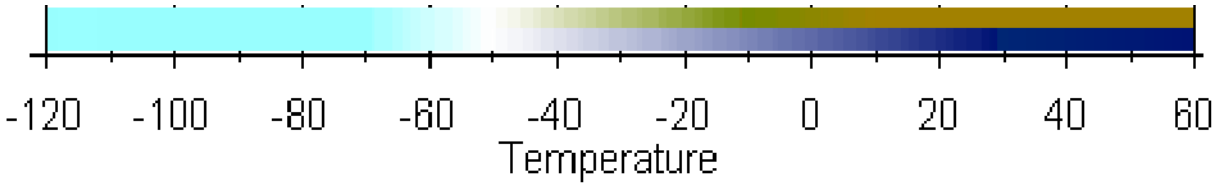
INFRARED
LUT: LUT361_MSC-IR-cc.bmp



Modelcurve used for the webimagery of MSC.

METEOROLOGISK INSTITUTT - NORWAY

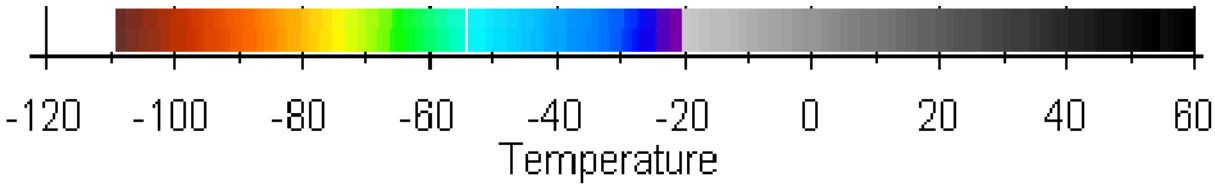
INFRARED
LUT: LUT361_MI-IR-cc.bmp



Modelcurve used for the webimagery of MI.

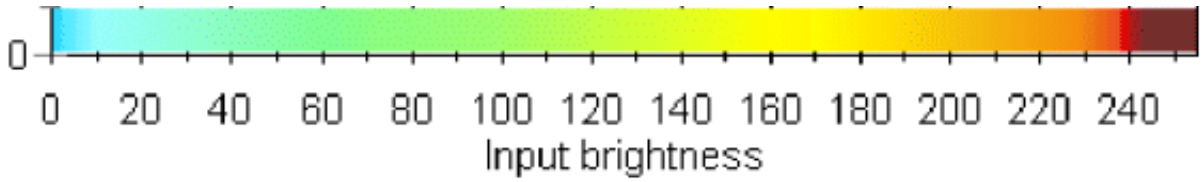
NRL (NAVAL RESEARCH LABORATORY) - USA

INFRARED
LUT: LUT361_NRL-IR-cc.bmp



NLR is using a LUT for cloudtops in Kft, derived from the Goes sounder. The thermal LUT presented therefore doesn't match the NLR images on the web. This is the best compromize. It is better to use LUT361_NNG-IR-cc1.bmp instead, that LUT is based of thermal measurements.

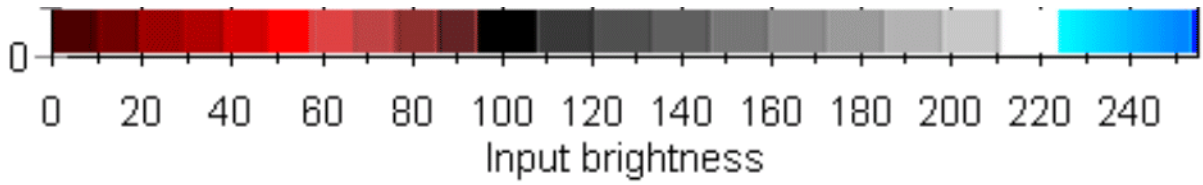
WATER VAPOUR
LUT: LUT256_NRL-WV-cc.bmp



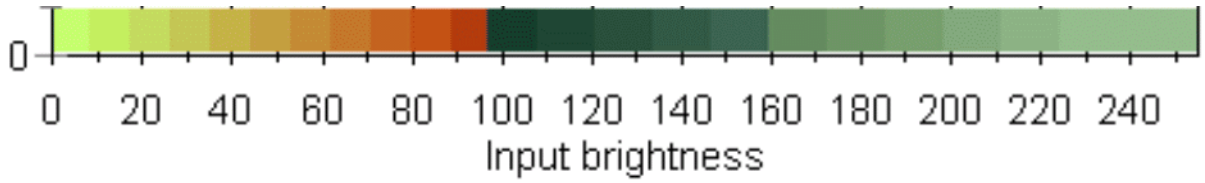
Modelcurve used for the webimagery of NRL

OHIO STATE UNIVERSITY - USA

WATER VAPOUR
LUT: LUT256_OSU-tpc-cc.bmp

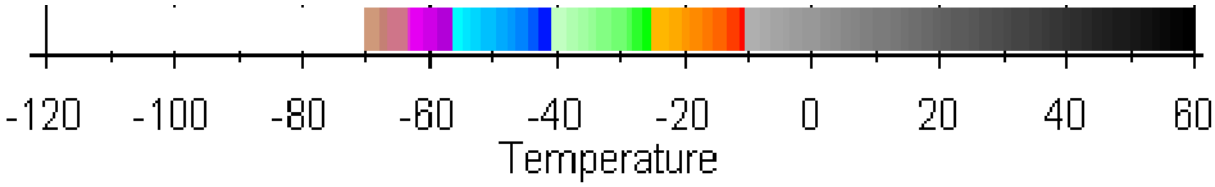


WATER VAPOUR
LUT: LUT256_OSU-gree-cc.bmp



PME (PRESIDENCY OF METEOROLOGY AND ENVIRONMENT) - SAUDI ARABI

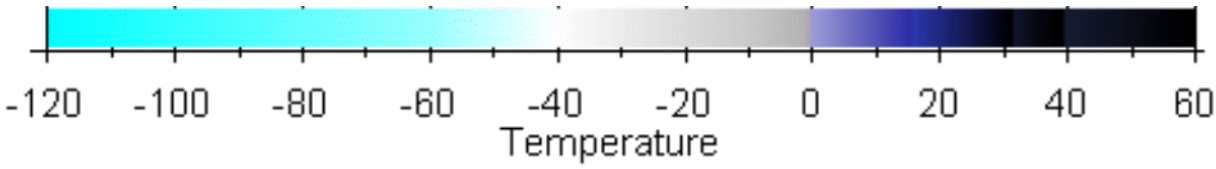
INFRARED
LUT: LUT361_PME-IR-cc.bmp



Modelcurve used for the webimagery of PME.

PUMA (PREPARATION OF THE USE OF MSG1 IN AFRICA)

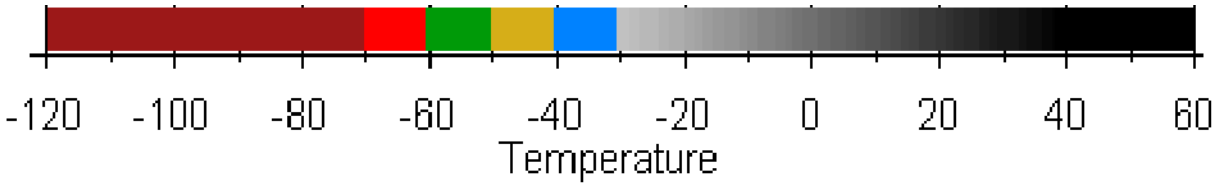
INFRARED
LUT: LUT361_PUMA-IR-cc.bmp



Standard curve for the PUMA project, supported by Eumetsat.

SMNA (SERVICE METEOROLÓGICA NACIONAL) - ARGENTINA

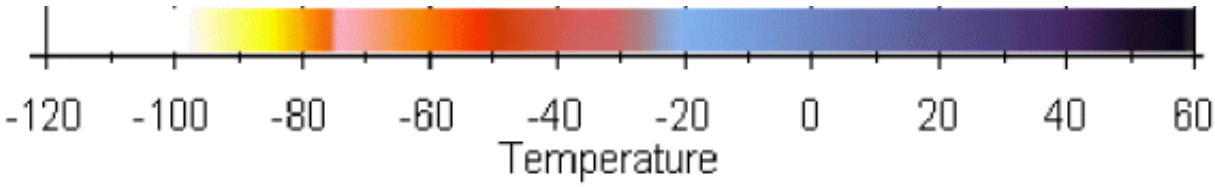
INFRARED
LUT: LUT361_SMNA-IR-cc.bmp



This curve is used by some countries of South America. It provides a good enhacement for thunderstorms over primaeval forests.

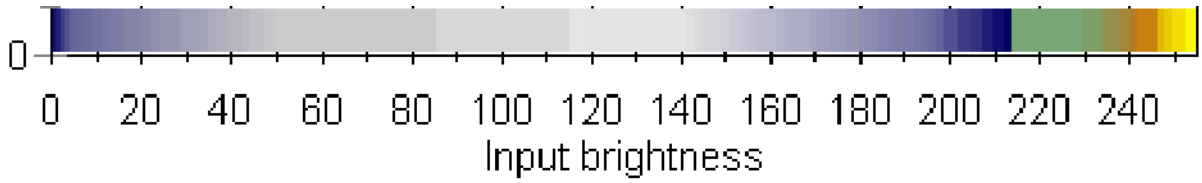
SMNM (SERVICIO METEOROLÓGICA NACIONAL) - MEXICO

INFRARED
LUT: LUT361_SMNM-IR-cc.bmp



An enhancement for cold cloudtops on tropic severe waether events.

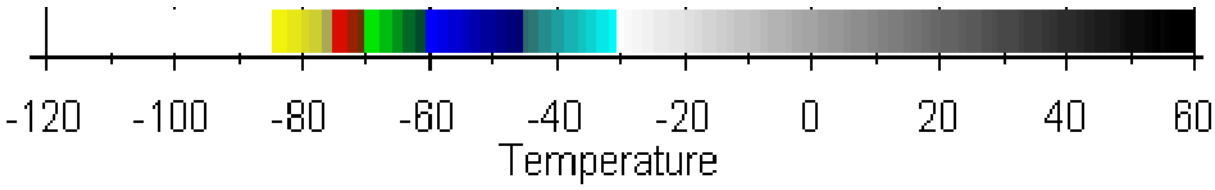
WATER VAPOUR
LUT: LUT256_SMNM-VW-cc.nmp



Modelcurve used for the webimagery of SMNM.

SSEC (SPACE SCIENCE AND ENGINEERING DATA CENTER) - USA

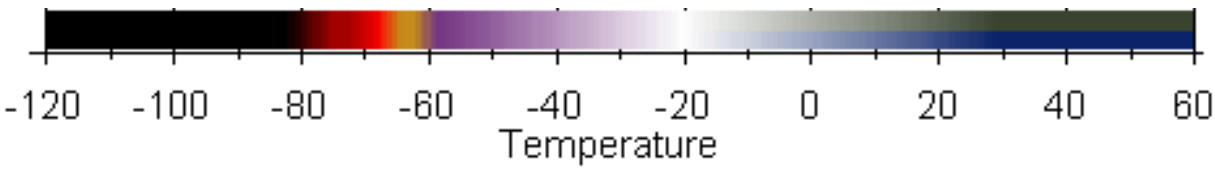
INFRARED
LUT: LUT361_SSEC-IR-cc.bmp



LUT to be used to study tropical weather events.

TWC (THE WEATHER CHANNEL) - USA

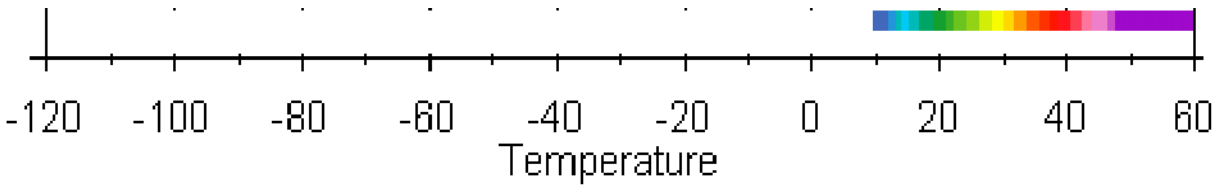
INFRARED
LUT: LUT361_TWC-IR-cc.bmp



Modelcurve used for the webimagery of TWC.

UB (UNIVERSITY OF BERLIN) - GERMANY

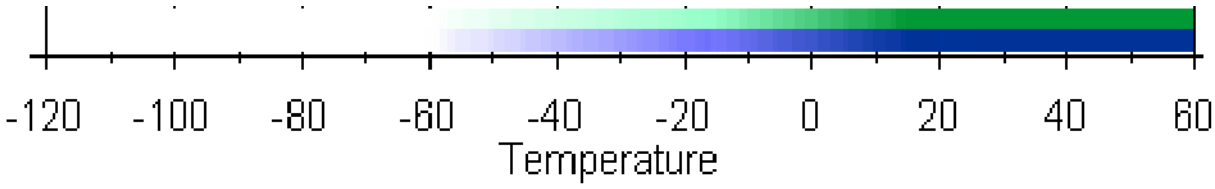
INFRARED
LUT: LUT361_UB-IR-cc.bmp



A warm season LUT to enhance landmass temperatures.

UKMO (UK METEOROLOGICAL OFFICE)

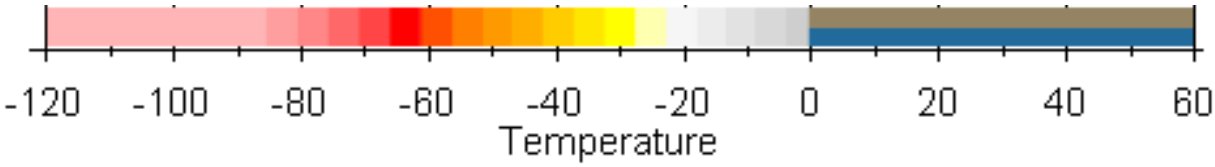
INFRARED
LUT: LUT361_UKMO-IR-cc.bmp



Used as background for public weatherchart overlay.

WUG (WEATHERUNDERGROUND) - USA

INFRARED
LUT: LUT361_WUG-IR-cc.bmp



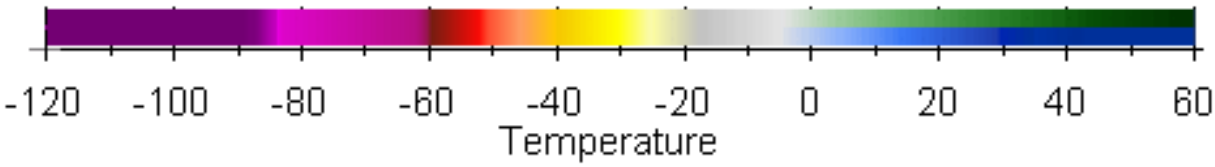
Weatherunderground is using a different technique: Formaly the cloudtops are based on the Goes sounder data. The threshold in the LUT is at 0 C, but results are different with their webimages.

METEO MAARSSEN ENHANCEMENTS

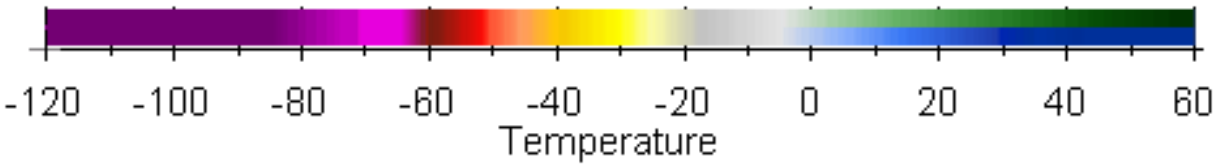
The rainbow version in this section are offering the full thermal range. This gives users the oppertunity to view also the very cold cloudtops. Actually these LUTs have a range of -120 C to +60 C. Pink and purple are used for the extended temperatures from -60 C to -120 C. Also the color dept has been improved. The rainbow versions can be used for IR and WV channel and supports the GSS-landsea masks.

INFRARED

LUT: LUT361_MM-LRIT-cc.bmp



LUT: LUT361_MM-HRIT-cc.bmp

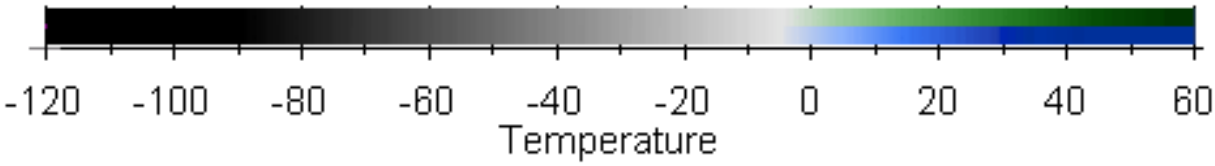


Both enhancements are designed for use with IR channels. LRIT data is slightly degreeded and the LRIT-lut version gives a better smoother result. The LRIT version can be used for the HRIT and/or PDUS data too, but the HRIT version do give more details on cold cloudtops.

These CLUTs can be used to determinate could cloudtops and features on land and sea. Land/seafeatures and near surface cloudmasses are coloured in greenshades for land and blue shades for watersurfaces.

INFRARED - GRAY

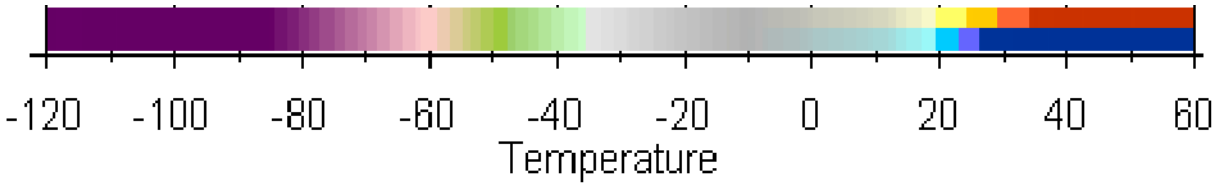
LUT: LUT361_MM-LRIT-bw.bmp



This enhancement can be used for any basemap for use of coloured overlays as radar imagery available from Meteo Maarssen. Cold cloudtops are represented in black, low clouds in gray. Land and sea features as on the rainbow versions.

INFRARED - SEVERE WEATHER

LUT: LUT361_MM-SW-cc.bmp

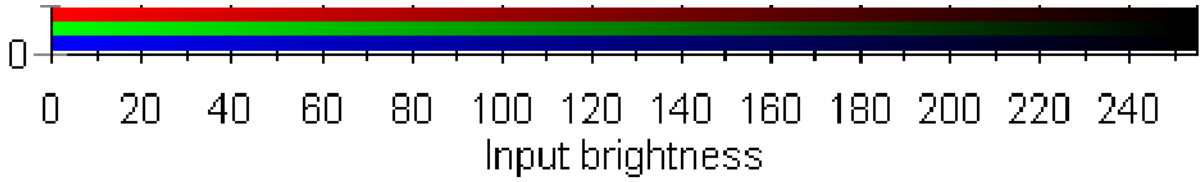


This enhancement is developed for use during the warm season and has some powerfull features to determinate regions of fair summer weather and regions of severe weather. The thermal scale for temperaures >20 C are stepped and devided into steps of 5 C for surface land temperatures and 3.5 C for seasurface temperatures. See the table for details. Cold anvil cloudtops in combination with warm water can be an indication of developing thunder or cyclones during the cyclone season. Over land it could be an indication of severe thunderstorms.

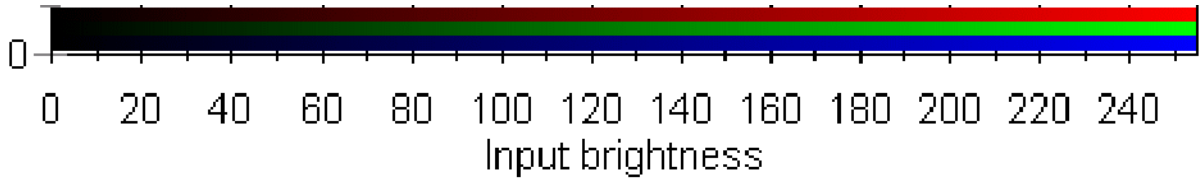
Land		Sea	
T in °C	**Comments**	**T in °C**	**Comments**
<20	Cool	<19.9	Cool
20-25	Fair	20.0-22.4	Temperate
25-30	Warm	23.5-26.9	Fair
30-35	Tropical	>27.0	Warm
>35	Hot		

TOOLSET

LUT: LUT100_MM-Tred1.bmp
LUT: LUT100_MM-Tgreen1.bmp
LUT: LUT100_MM-Tblue1.bmp



LUT: LUT100_MM-Tred2.bmp
LUT: LUT100_MM-Tgreen2.bmp
LUT: LUT100_MM-Tblue2.bmp



A set of six LUTs to process images from any channel in single coloured RGB. The RGB LUTs can be used to combine any channel using a thrid party program. The results are coloured filtered RGB images from any satellite channel. The 1-series have black on the warm end and are coloured on the cold end. The 2-series are inverted in the way GSS reads the satellite datafiles. It should be noted that this is the original way to arange composites from multispectral channels.
The RGB LUTs are set as colour to cold and black to warm. You may histogram equalizing the final product to get a better result for your needs. If you're not familair with combining channels RGB in any photo-editor (see page 9) then these LUTs may be an alternative. Just overlay all the GSS output images in you photo-editor and combine them with the difference option in the object overlay menu (refer your photo-editor).
Be warned that the final results may vary with the GSS RGB output options. This option is a different ways to process data. With use of GSS each satellite channel can be splitted into three grayscale RGB channels. It gives you the option to select a single requested RGB-channel from a satellite channels and make composites in RGB coloured images per RGB-channel.

PART TWO
MULTISPECTRAL MSG PRODUCTS

EUMETSAT DERIVED MSG PRODUCTS

The derived MSG products in this section are direct available from the Eumetsat homepage. Use Autoget to download the images to rectify or remap them in GeoSatSignal.

Please note that not all available products from Eumetsat are represented at this moment. This section will completed in a later release of this catalogue.

For all information about the derided products in this section: copyright Eumetsat 2006.

AIRMASS

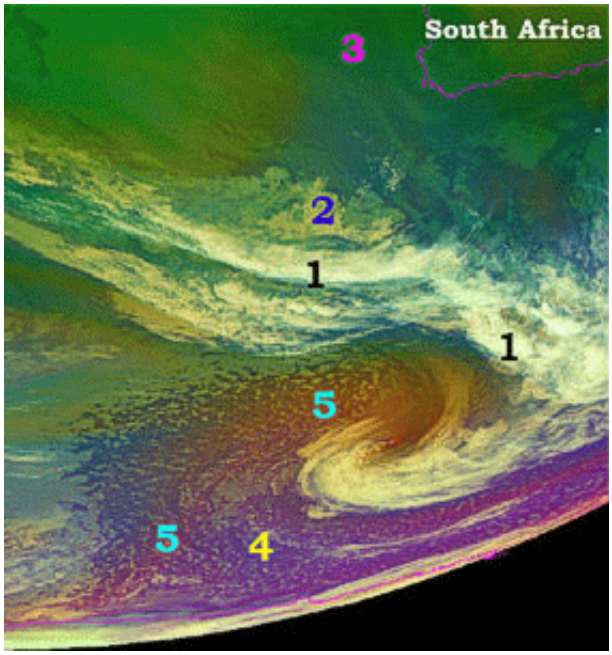
The Airmass product is an RGB composite based upon data from infrared and water vapour channels from Meteosat Second Generation. It is designed and tuned to monitor the evolution of cyclones, in particular rapid cyclogenesis, jet streaks and PV (potential vorticity) anomalies. Due to the incorporation of the water vapour and ozone channels, its usage at high satellite viewing angles is limited.

This colour composite has been designed and tuned using the results of a case study of rapid cyclogenesis (storm Gudrun over the North Atlantic and Baltic Sea on 7-9 January 2005). It combines the following three MSG features for the early detection of rapid cyclogenesis: the WV6.2 - WV7.3 Brightness Temperature Difference (BTD, on red), the IR9.7 - IR10.8 BTD (on green) and the WV6.2 channel (on blue) . All three features are strongly related to airmass characteristics in cloud-free areas and to the height of the cloud in cloudy areas. The WV6.2 channel shows the horizontal distribution of Upper Tropospheric Humidity (UTH). Typical features seen on the WV6.2 images include dry intrusions, deformation zones and jet streaks. The WV6.2 - WV7.3 BTD, which depends on the temperature and humidity profile, shows the distribution of moisture in the troposphere. Finally, the IR9.7 - IR10.8 BTD is related to the total ozone concentration and thus to the height of the tropopause. This particular feature is influenced by the satellite viewing angle (the BTD assumes large values for viewing angles above 80 degrees), which in turn affects the colours of the airmass RGB on the outer edges of the MSG image. In addition, in cloud-free areas the IR9.7 channel gets a strong signal from the earth surface, which leads to large BTDs over hot surfaces (e.g. the desert regions) during daytime. The above variants should be taken into account when interpreting the colours of the airmass RGB.
Combined in a RGB, the result is an image where high clouds appear in white colour, mid-level clouds in light ochre colour and cloud-frees areas in dark green colour (warm air mass with high tropopause) or blue colour (cold air mass with low tropopause). A particular feature of this RGB is that dry descending stratospheric air is marked by a reddish colour.

Composition:

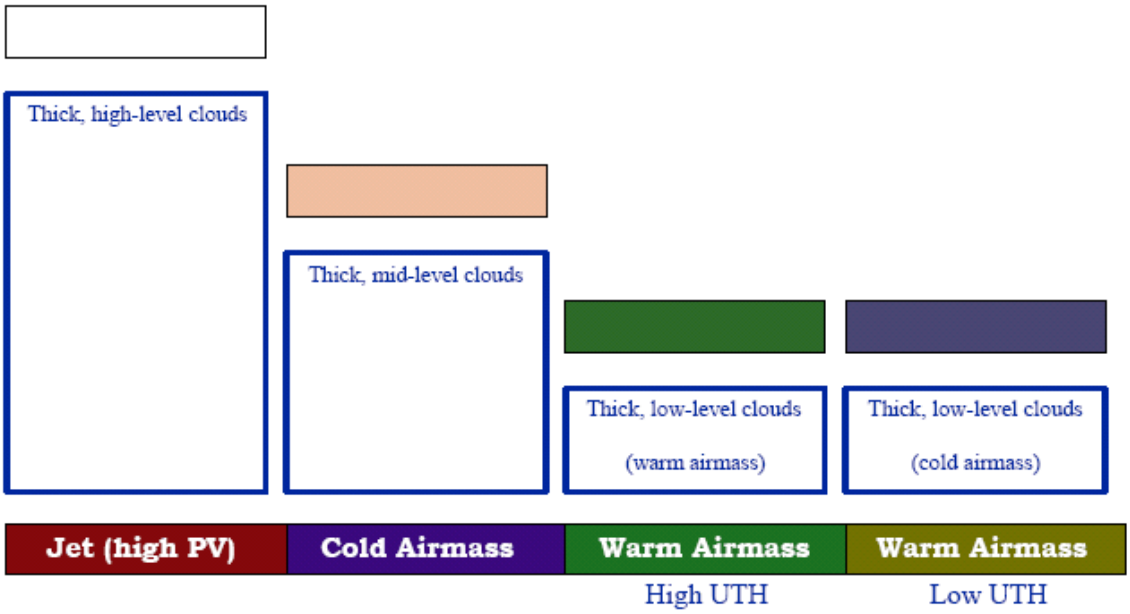
Red	difference WV 6.2 -WV 7.3
Green	difference IR 9.7 - IR 10.8
Blue	WV 6.2 inverted

Application:
Rapid cyclogenesis, jetstream, vorticity, airmasses



Example from 22 March 2005 05:00 UTC
1 High clouds
2 Mid level clouds
3 Warm airmass, high tropopause
4 Cold airmass, low tropopause
5 Dry descending stratospheric air indicating jetstream en vortex.

Interpretation of colours



DUST

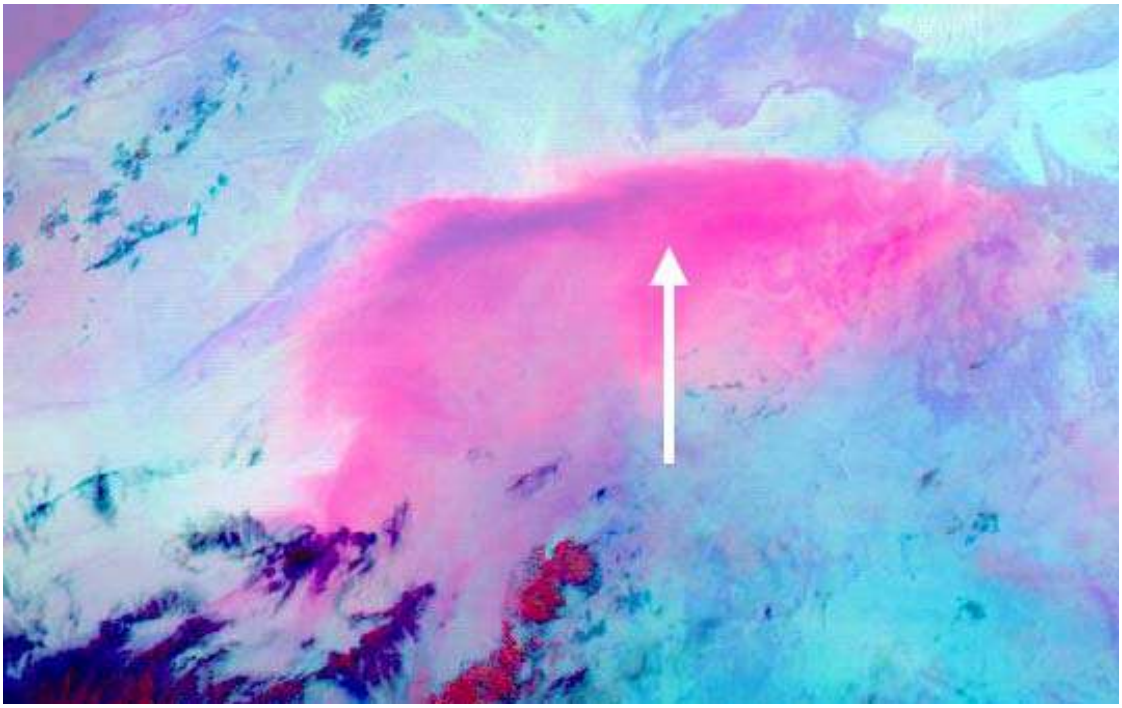
The Dust product is an RGB composite based upon infrared channel data from the Meteosat Second Generation satellite. It is designed to monitor the evolution of dust storms over deserts during both day and night.

This colour composite has been designed to monitor the evolution of dust storms over deserts. The combination does allow however the further (24 hour) tracking of dust clouds as they spread over the sea. In practice, during the daytime the use of visible channels (in particular the HRV channel) is preferable for the tracking of dust over the sea.
Dust appears pink or magenta in this RGB combination. Dry land looks pale blue (daytime) to pale green (nighttime). Thick, high-level clouds have red-brown tones and thin high-level clouds appear very dark (nearly black). For more information, please refer to the following document:
The RGB combination exploits the difference in emissivity of dust and desert surfaces seen in the IR channels listed below. In addition, and during daytime, it exploits the temperature difference between the hot desert surface and the cooler dust cloud.

Composition:

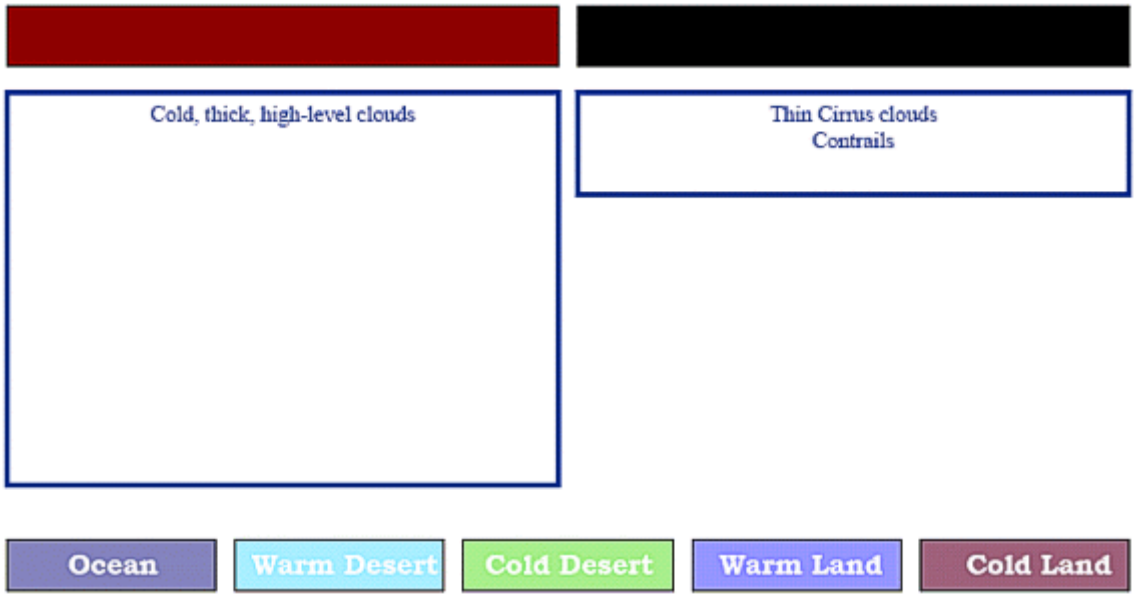
Red	difference IR12.0 - IR10.8
Green	difference IR10.8 - IR 8.7
Blue	IR10.8

Application:
Dust, contrails, thin clouds

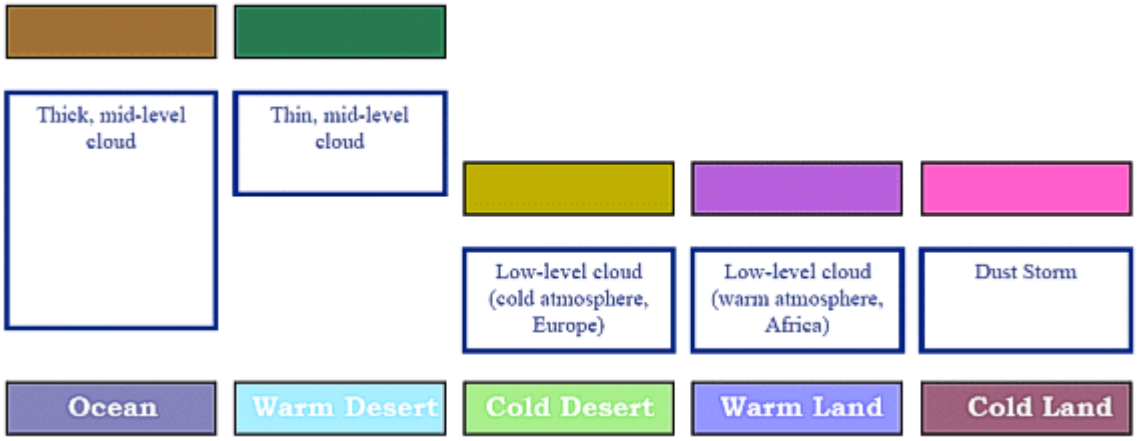


Example of duststorm over the Sahara on 14 july 2003 10:00 UTC

Interpretation of colours for high level clouds



Interpretation of colours for low/mid level clouds



FOG

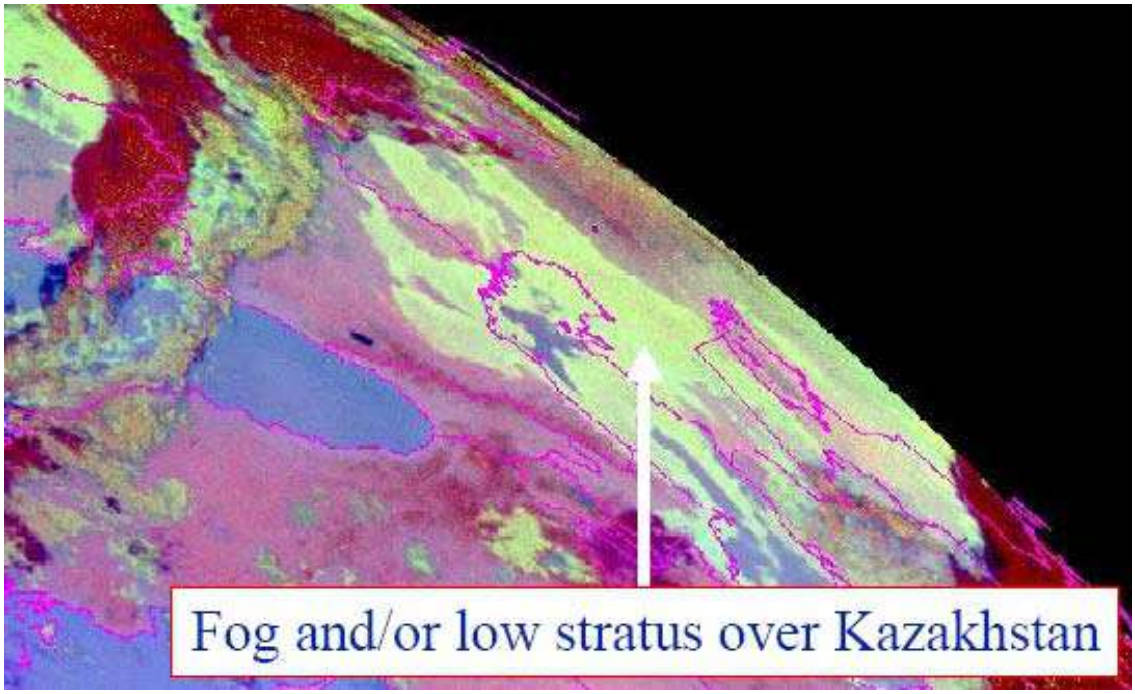
The Fog / Low Clouds product is an RGB composite based upon infrared channel data from the Meteosat Second Generation satellite. It is designed and tuned to monitor the evolution of night-time fog / low stratus. Other (secondary) applications are the detection of fires, low-level moisture boundaries and cloud classification in general. It should be noted that as the product is tuned for night-time conditions, its use during day-time is very limited.

This colour composite has been designed and tuned (by Prof. Daniel Rosenfeld from the Hebrew University of Jerusalem) to monitor the evolution of night-time fog / low stratus, which is usually difficult to detect in the MSG infra-red channels. When animation is applied to this RGB product, the formation of fog, for example, in river valleys can be monitored very closely. Other possible applications are the detection of fires, low-level moisture boundaries, thin Cirrus clouds and general cloud classification. It should be noted that this product is tuned for night-time conditions and is, therefore, not recommended for use during day-time.
At night, fog / low stratus appears light green in this RGB combination: the smaller the droplets the stronger the input from green. In contrast, the cloud-free land appears a pinkish colour, the thick high-level clouds have red tones or appear with a red-yellow speckled colour (indicating very cold clouds) and the thin high-level clouds appear very dark (dark blue).

Composition:

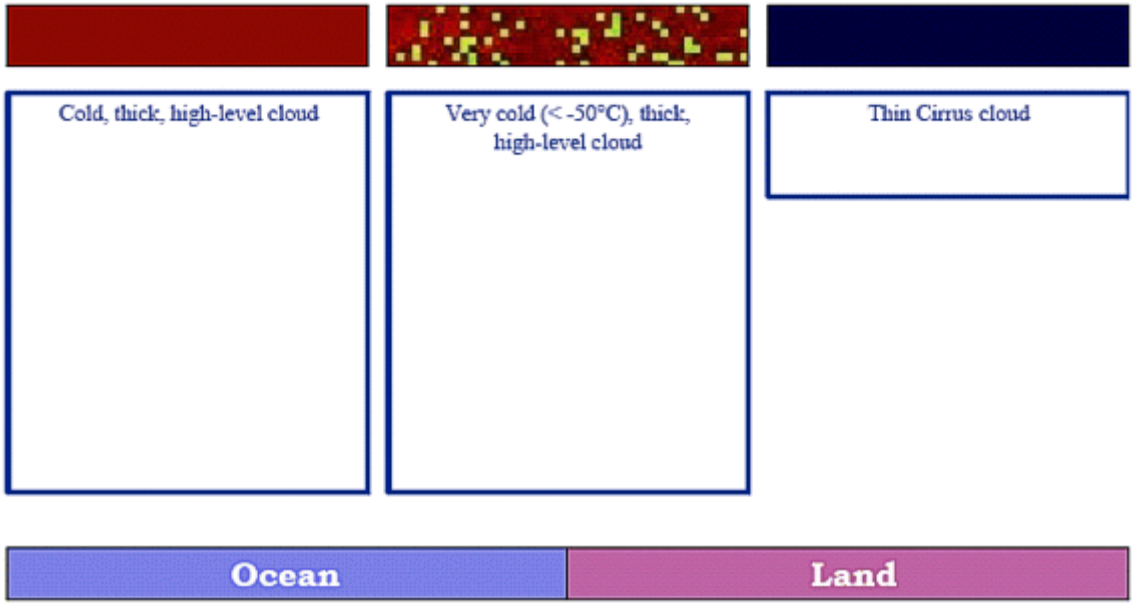
Red	difference IR12.0 - IR10.8
Green	difference IR10.8 - IR 3.9
Blue	IR10.8

Application:
Fog, cloud analyses, contrai

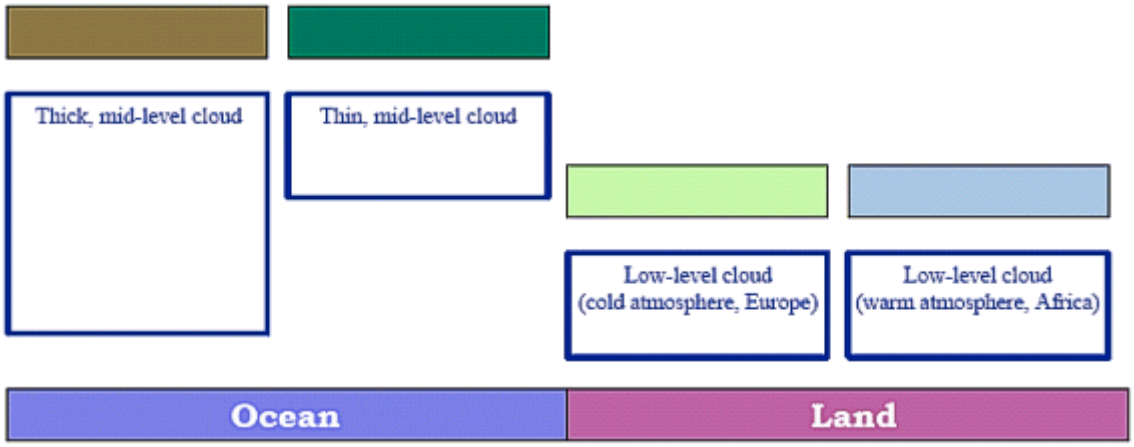


Example from 14 March 2005 00:00 UTC

Interpretation of colours for high level clouds



Interpretation of colours for low/mid level clouds

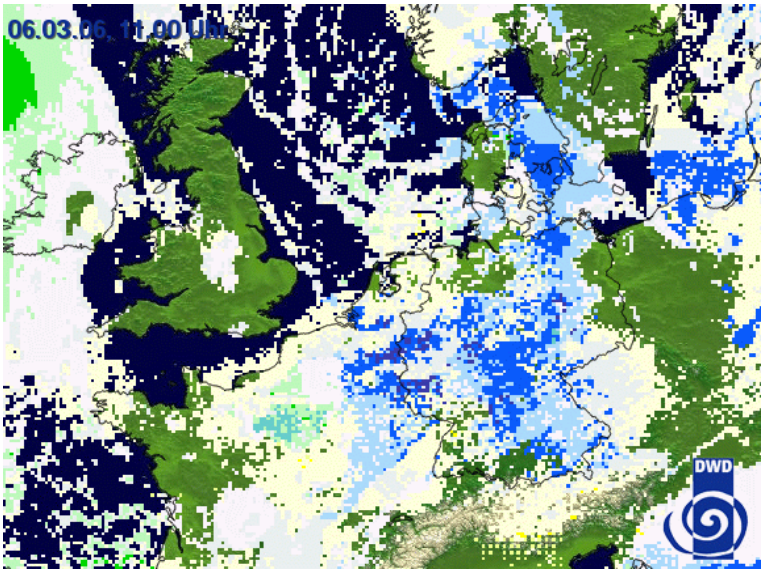


DERIVED MSG PRODUCTS FROM OTHER AGENCIES

DEUTSCHE WETTERDIENST - GERMANY

SATELLITE WEATHER

The satellite weather product in developed at the DWD and combines measurements from traditional surface weatherstations with satellite imagery. Satellite data, synoptic reports and data from other sources are therefore translated into nummerical fields.
Reports from significant weather and cloudreports are translated into classes of weather elements and then compared with Meteosat images with the same resolution in polar stereographic projection with 327680 image points in a 10 km resolution.
First, there are made around 20 clusterfields made by image interpretation of the IR and VIS channels from Meteosat images. A special algorithm is used to calcutate one nummerical value for each field from the channels to get a matrix. Each value should represent an identical weather event. Then the reports are added to the satellite matrix data and the each reported significant weather event should match a matrix dot which gives the key for the weather on the satellite image. Only the eight nearest synoptic reports and five nearest soundingstations are used for calculations. Model analyses are used for regions not covered by weatherstations.
Station reports are used for several hours back in time and they can also be used if there are not reports available for a given time. Winddata and movements of clouds are also derived from satellite images and can be used for area's with less stationdata.



Alternative method for users of GeoSatSignal
This product can't be made at this moment for users of GSS, but there is an alternative way with use of models instead of observations. Although we can't reproduce this prodect exactly, we can try to come close as possible.
Each forecastrun from any model starts with an initialisation of the current state of the atmosphere based on observations from groundbased stations and observations of satellites. First we have to make some basemaps with the use of GrADS, a free third party program. Herewith we can make maps for parameters needed and overlay the results an a satellite image, based on the methode of the DWD, but with use of a cloudmask instead of a visual image.
We are currently working on this alternative and the results will be published in the next release of this overview.

Online examples of this product from the DWD are available at:
http://www.dwd.de/de/WundK/W_aktuell/Satellitenbilder/index.htm

	Red	Green	Blue	Count %	WW	Significant weather
	255	000	000		17	lightning
	200	000	180	5	92,94,96,99	thunder (severe)
	255	000	255	30	91,93,95,97,98,29	thunder (light)
	000	000	255	40	72-75, 86,88,90,27	severe snow, snowshower, hail
	000	255	255	40	70,71,85,87,89,22,23,26,16	snow, snowshower, hail (light) - 16 with frost
	180	255	255	10	70,71,85,87,89,22,23,26,16	snow, snowshower, hail (light) - 16 with frost
	180	255	255	40	76-79	ice and snow pallets
	000	185	185	40	68,69,83,84,26	snow with rain
	000	180	000	40	62-67,81,82	rainshower (severe)
	090	255	090	40	58-61,80,25,16	rain, rainshower (light) - 16 without frost
	180	255	180	10	58-61,80,25,16	rain, rainshower (light) - 16 without frost
	180	255	180	40	50-55	drizzle
	255	255	000	40	40-49	fog
	255	255	200	40	10	haze
		Gray				
		000-240				overcast

Table with RGB settings for satellite weather from de DWD. Count % is number available observations in %.

METEOROLOGISK INSTITUTT - NORWAY

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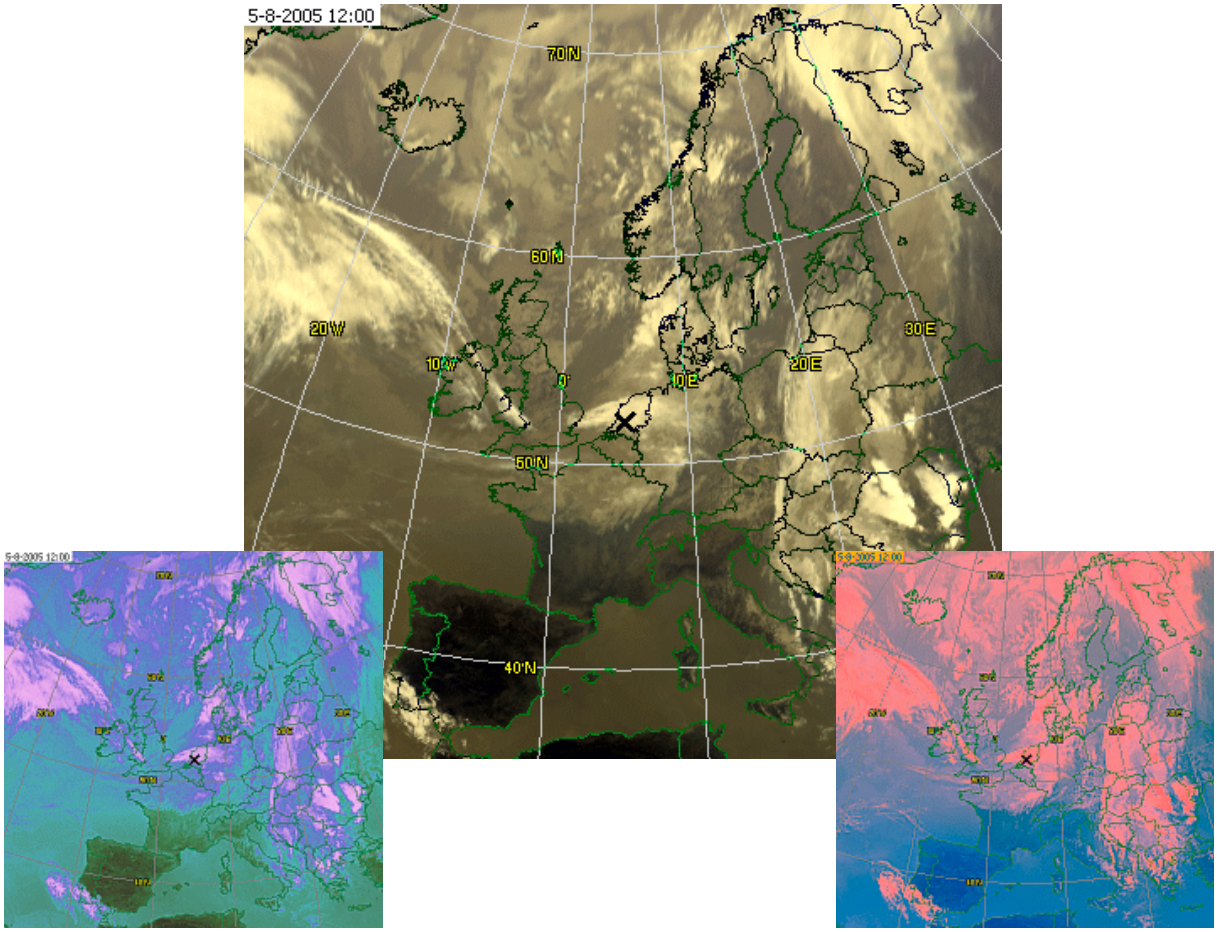
The channel 9-10-11 image the MI website is composed of channel 9 for red, channel 10 for green and channel 11 blue from Meteosat 8. All these channels are IR channels and inverted. Finaly they are also histogram equlized on each channel to increase the contrast. The benifit of this product is to get a better contrast and discimination of clouds and cold surfaces.
This combination is not recommended by Eumetsat. Eumetsat recommend to compose RGB images of channel describing different properties.

Composition:

Red	IR 9.7
Green	IR 10.8
Blue	IR 12.0



Middle: Histogram equalised RGB combined version of ch09-10-11 (Brightness 5, Contrast 25, Intensity 50).
Left: RGB combine using HSB (Hue, Saturation, Brightness),
Right: LAB combination.

SOURCES

http://www.orbit.nesdis.noaa.gov/smcd/opdb/enh/enh.html
http://oiswww.eumetsat.int/~idds/html/product_description.html
http://rammb.cira.colostate.edu/visit/istpds/awips/lookup.html

General source to national weather agencies around the world:
http:www.wmo.ch