Remote Sensing & Photogrammetry
W4

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Image processing

1. Visual interpretation of single spectral band
   - Readout of DN and coordinates: x,y
2. Image enhancement
   - Histogram calculation
   - Linear histogram streatching
   - Image comparison before and after *stretching*
   - Different parameters of linear *stretching*
   - Histogram saturation and equalization
3. Visualization of multispectral bands
   - RGB
   - FCC

Image processing

4. Multi bands operation
    - Ratio – Vegetation Index (VI)
    - Normalized ratio – Normalized Vegetation Index (NDVI)
    - Multi chanel statistics
    - Principal Componemt Analysis (PCA)
    - Map algebra
    - Image fusion
5. Image classification
    - Density slicing
    - piece-wise linear stretchning
    - Mulispectral image classification
        - Sampling
        - Different algorithms
        - Classification accuracy assessement
        - Post classification operation

Map algebra - radiance

- Radiance (luminance) calculation:

$$L_{\lambda} = gain \cdot DN + offset = ((L_{\max} - L_{\min})/255) \cdot DN + L_{\min}$$

- L_{λ} – spectral radinace recorded by sensor
- L_{min} – minimal radiance of detectors in PAN: – 5.00
- L_{max} – maximal radiance of detectors in PAN: 244.00
- DN – of channel 8, PAN

Map algebra - albedo

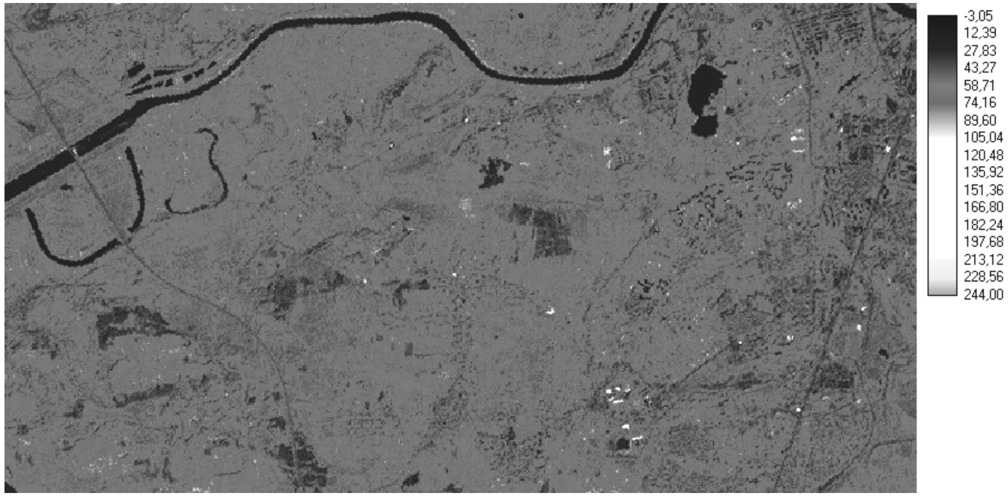
Albedo

$$\rho = \frac{\pi \cdot L_{\lambda} \cdot d^{2}}{ESUN_{\lambda} \cdot \cos\theta_{S}}$$

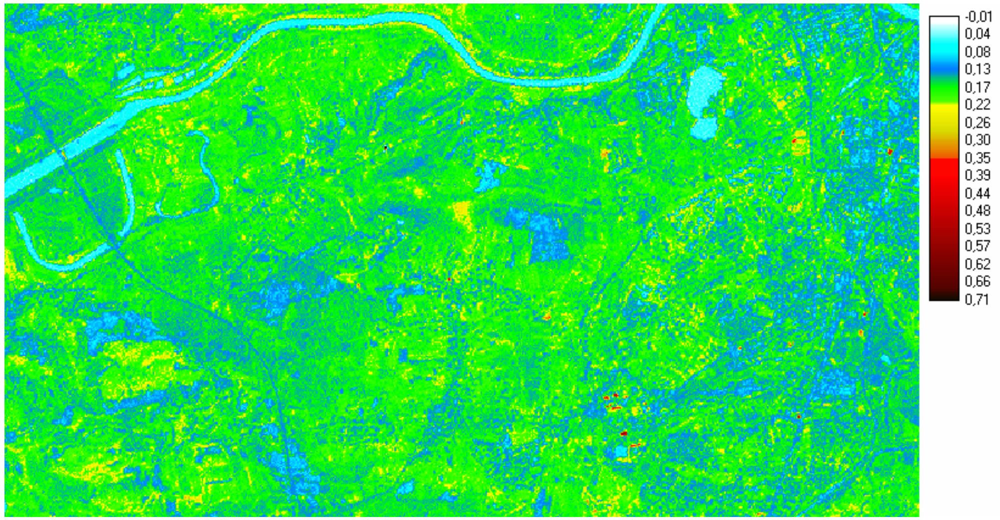
where:
ρ– albedo
L_{λ} – spectral radiance recorded by sensor
d – distance between Earth and Sun in astronomical units for given day of the year
$ESUN_{\lambda}$ – mean irradinace = 1368.00
θ_{S} – Sun zenith angle

Map algebra - albedo

DN
PAN
Band 8
Landsat ETM+

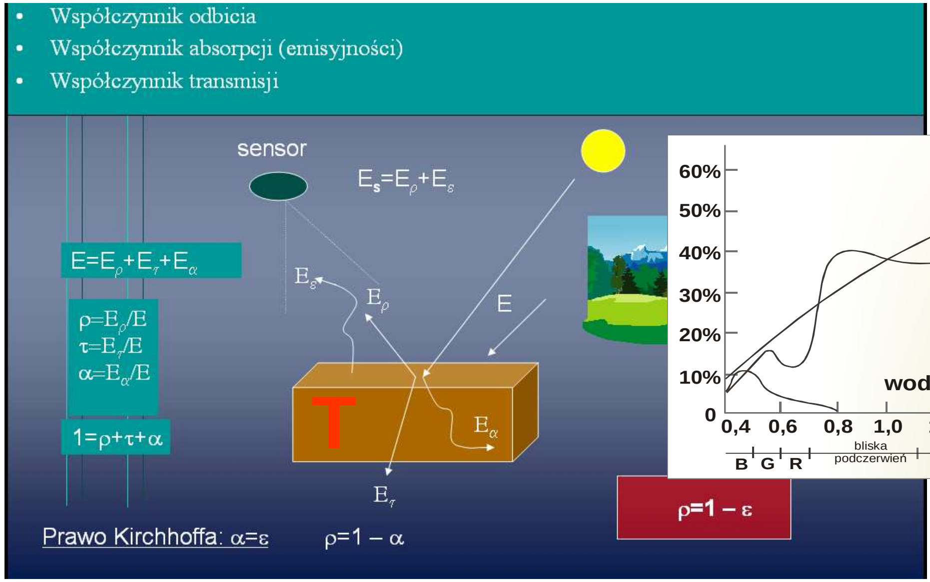


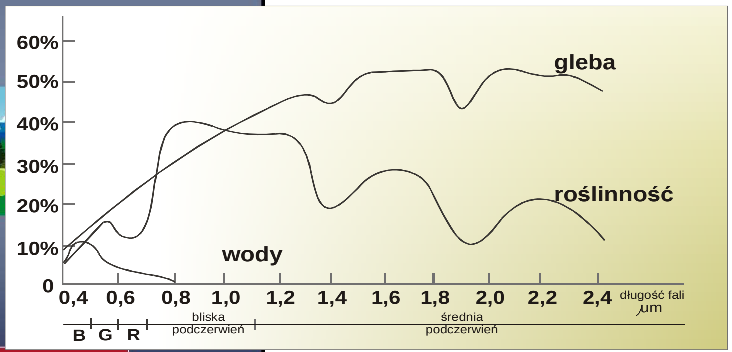
Albedo
(0.52 –0.90 μm)

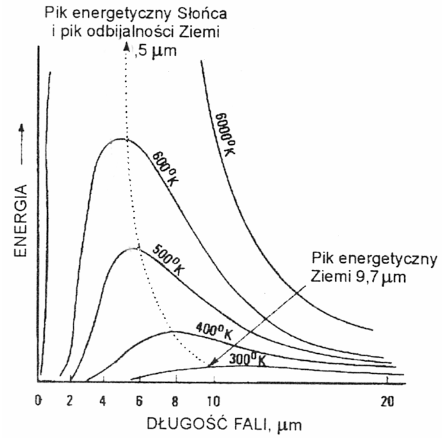


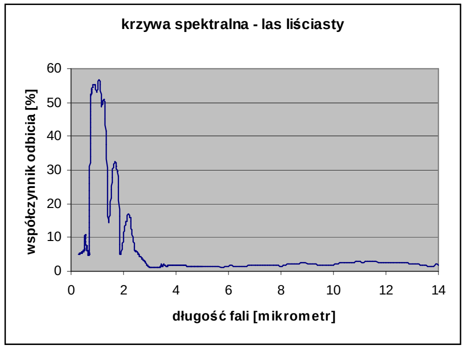
VIR, SWIR, TIR

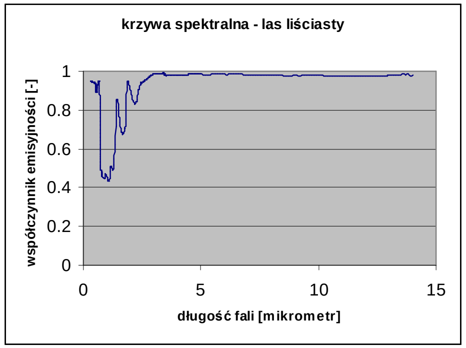
Spectral curves

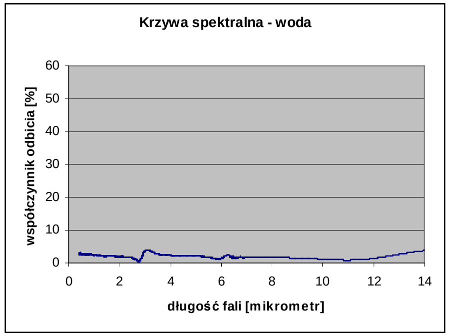


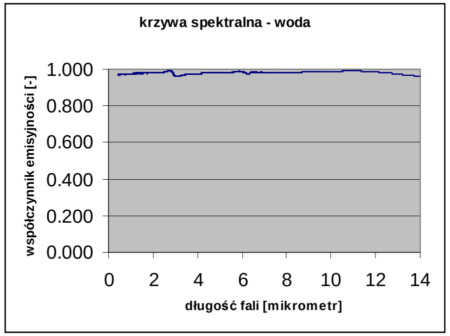








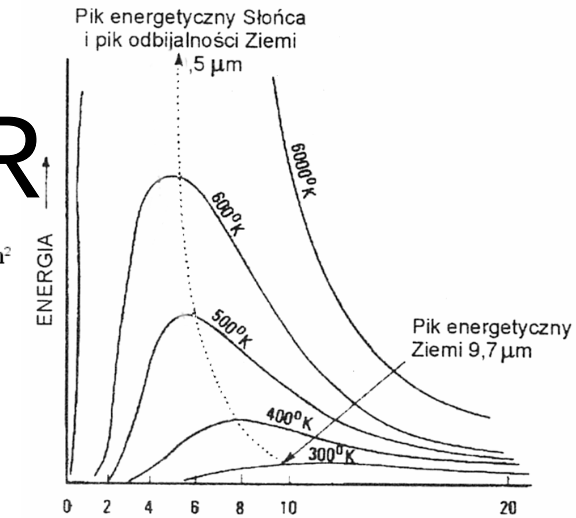




$$E_\rho(\lambda) = \rho(\lambda)\, E(\lambda)$$

$$E_s(\lambda) = \varepsilon(\lambda)\, B(\lambda, T_s) + (1-\varepsilon(\lambda))\, E(\lambda)$$

EM laws TIR

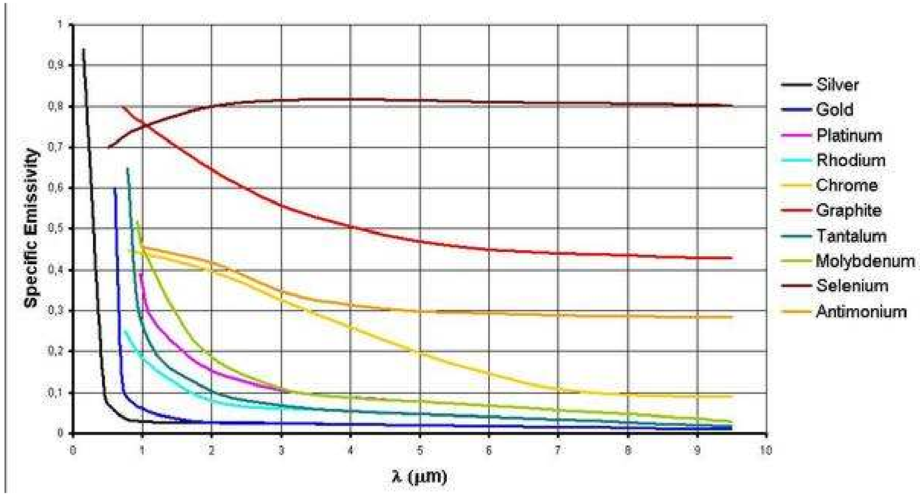


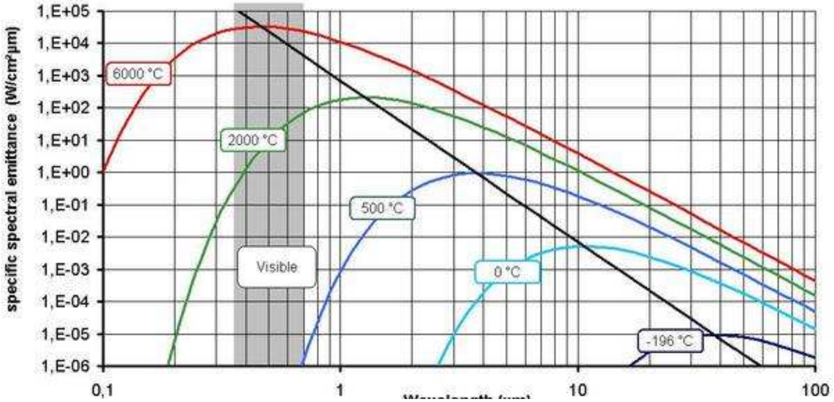
$$M_\lambda = \frac{c_1}{\lambda^5 * [\exp(c_2/\lambda T) - 1]}$$

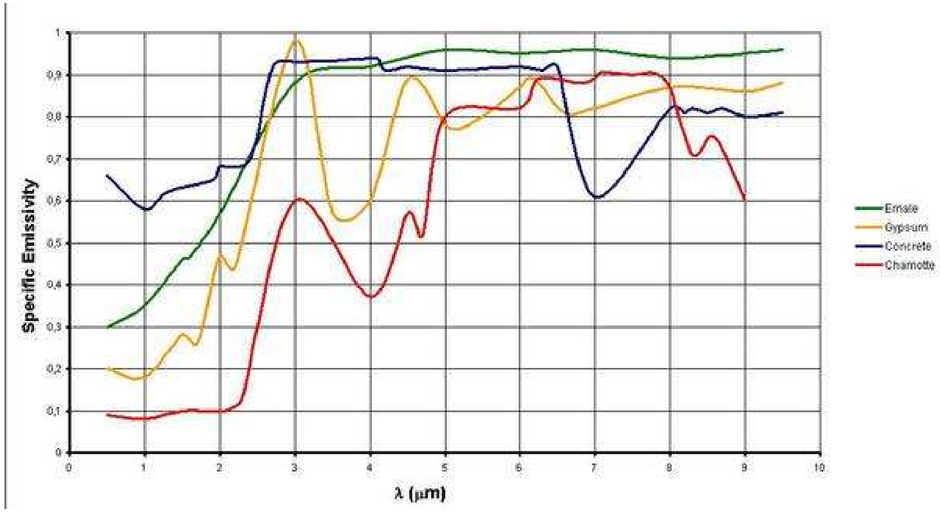
$c_1 = 3{,}74 * 10^{-16}\ W*m^2$

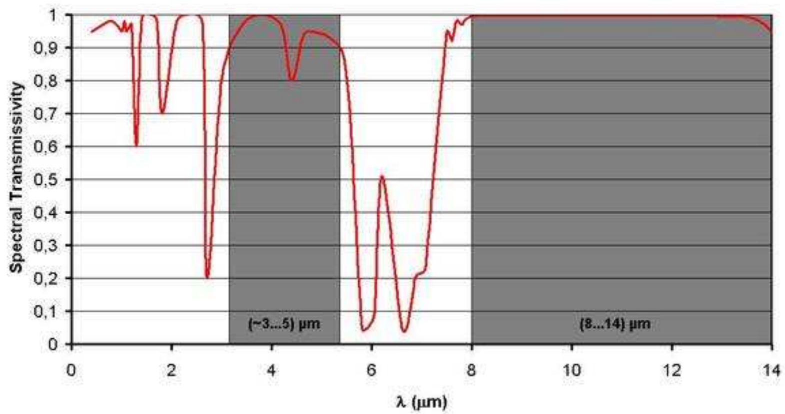
$c_2 = 1{,}44 * 10^{-2}\ K*m$

$$\lambda_{max} * T = 2896\ \mu m*K$$







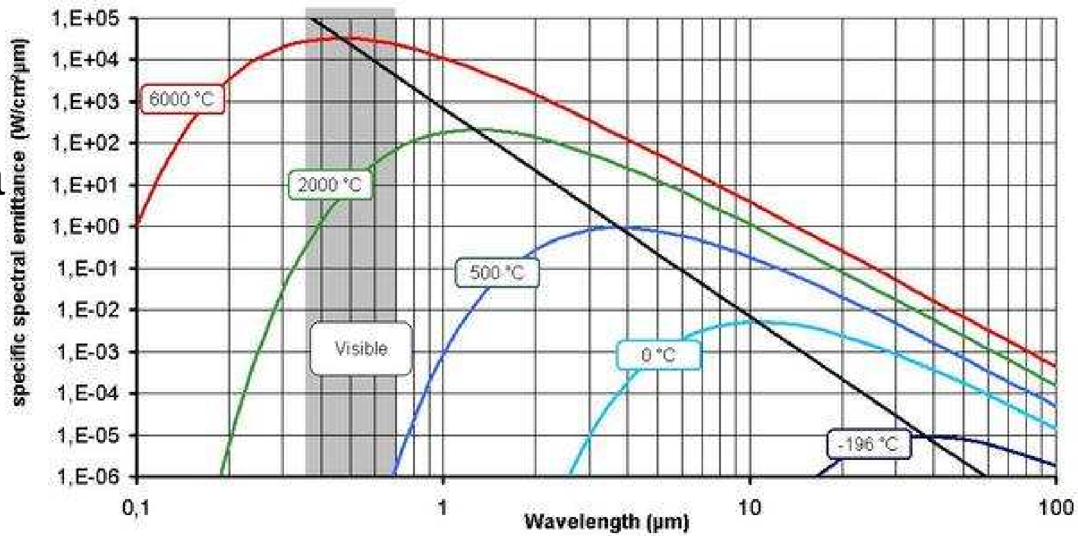


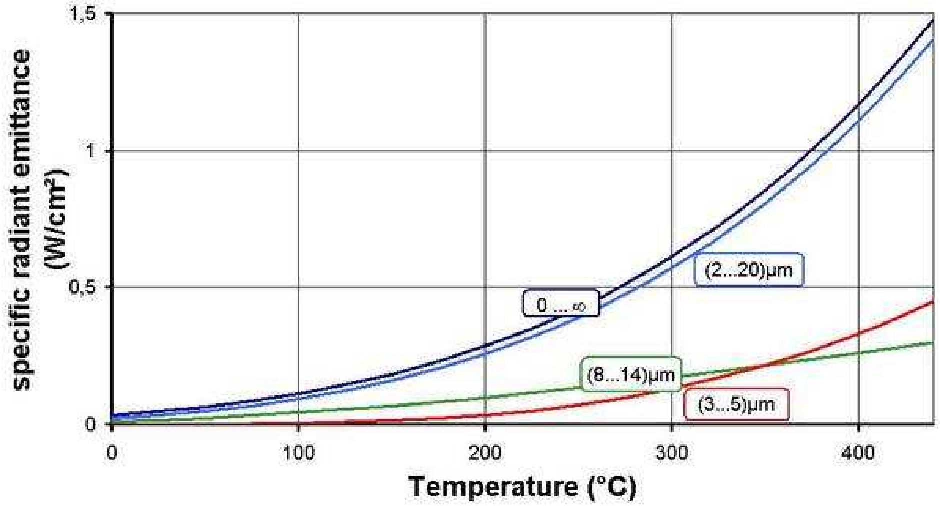
EM laws TIR

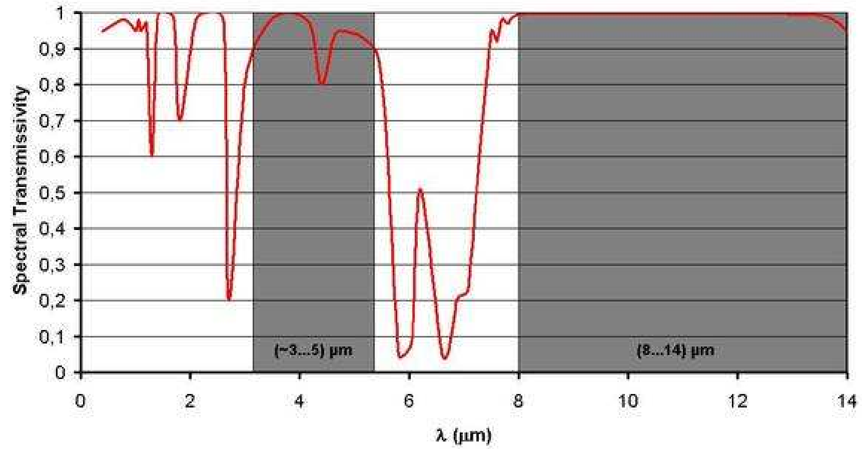
$E = \varepsilon \sigma T^4$

σ - Stefan-Boltzmann consta

$5{,}67 \cdot 10^{-8} W/(m^2 \cdot K)$





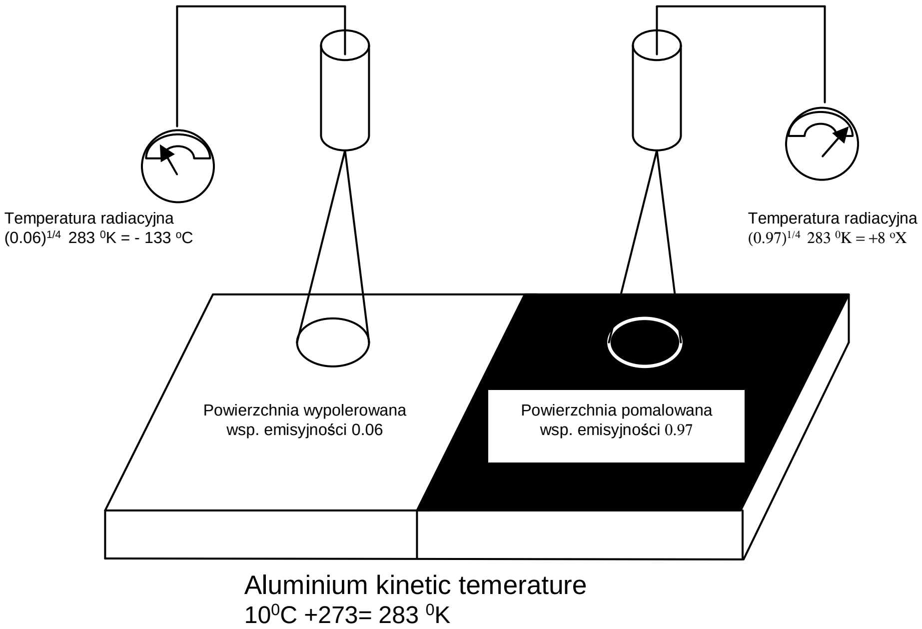


Map algebra - temperature

Radiant temperature

$$T = \sqrt[4]{\varepsilon} \cdot T_{rzecz}$$

$$E = \sigma T^4 = \sigma[(\varepsilon)^{1/4} T_{rzecz}]^4 = \sigma \varepsilon T^4_{rzecz}$$



Map algebra - temperature

Temperature

$$L_\lambda = gain \cdot DN + offset = \left(\left(L_{\max} - L_{\min}\right)/255\right) \cdot DN + L_{\min}$$

$$\left(W \cdot m^{-2} \cdot sr^{-1} \cdot \mu m^{-1}\right)$$

- where:
- L_λ – spectral radiance of the sensor,
- L_{min} – minimum spectral radiance , in thermal band 0.00,
- L_{max} – maximum spectral radiance , in thermal band 17.04
- DN – of thermal band

Map algebra - temperature

$$M_\lambda = \frac{c_1}{\lambda^5 * [\exp(c_2/\lambda T) - 1]}$$

$$c_1 = 3{,}74 * 10^{-16}\ W*m^2$$

$$c_2 = 1{,}44 * 10^{-2}\ K*m$$

$$T = \frac{K_2}{\ln\left(\frac{K_1}{L_\lambda}+1\right)}$$

gdzie:

L_λ – luminancja spektralna zarejestrowana przez radiometr satelity $\left(W \cdot m^{-2} \cdot sr^{-1} \cdot \mu m^{-1}\right)$

K_1, K_2 - stałe kalibracyjne

$$K_1 = \frac{2 \cdot \pi \cdot c^2 \cdot h}{\lambda^5} = 666.09 \left(\frac{W}{m^2 \cdot sr \cdot \mu m}\right)$$

$$K_2 = \frac{h \cdot c}{k \cdot \lambda} = 1282.71\ (K)$$

k – stała Boltzmanna $1{,}380 \cdot 10^{-23} \left(\frac{J}{K}\right)$

h – stała Planka $6{,}626 \cdot 10^{-34}\ (J \cdot s)$

c – prędkość światła $2{,}998 \cdot 10^{8} \left(\frac{m}{s}\right)$

λ – długość fali (m)