

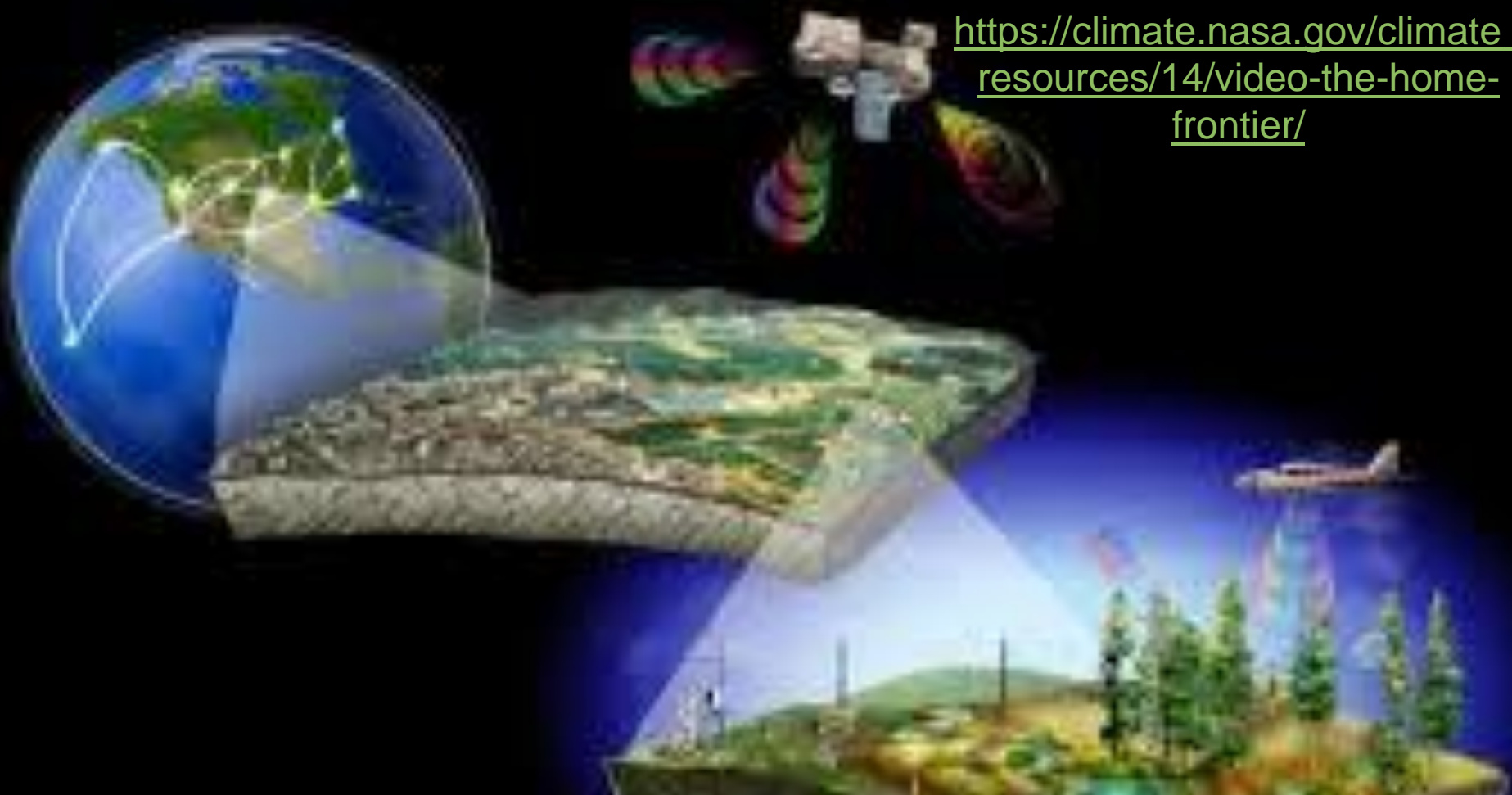
XXII Curso de Uso Escolar de Sensoriamento Remoto no Estudo do Meio Ambiente

Fundamentos de Sensoriamento Remoto e Comportamento Espectral de Alvos

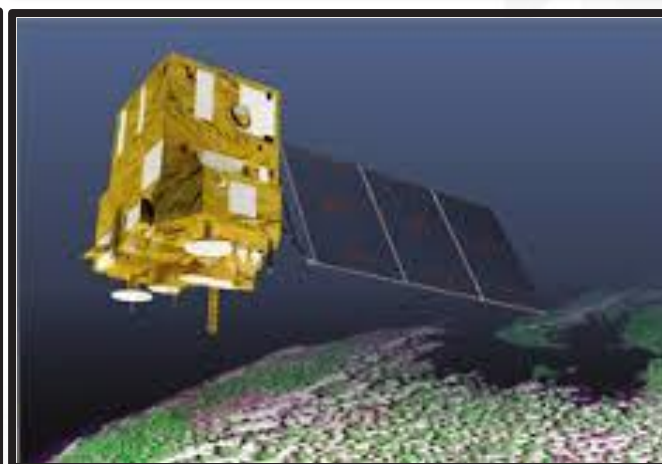
Elisabete Caria Moraes
elisabete.moraes@inpe.br

São José dos Campos - SP
Julho/2021

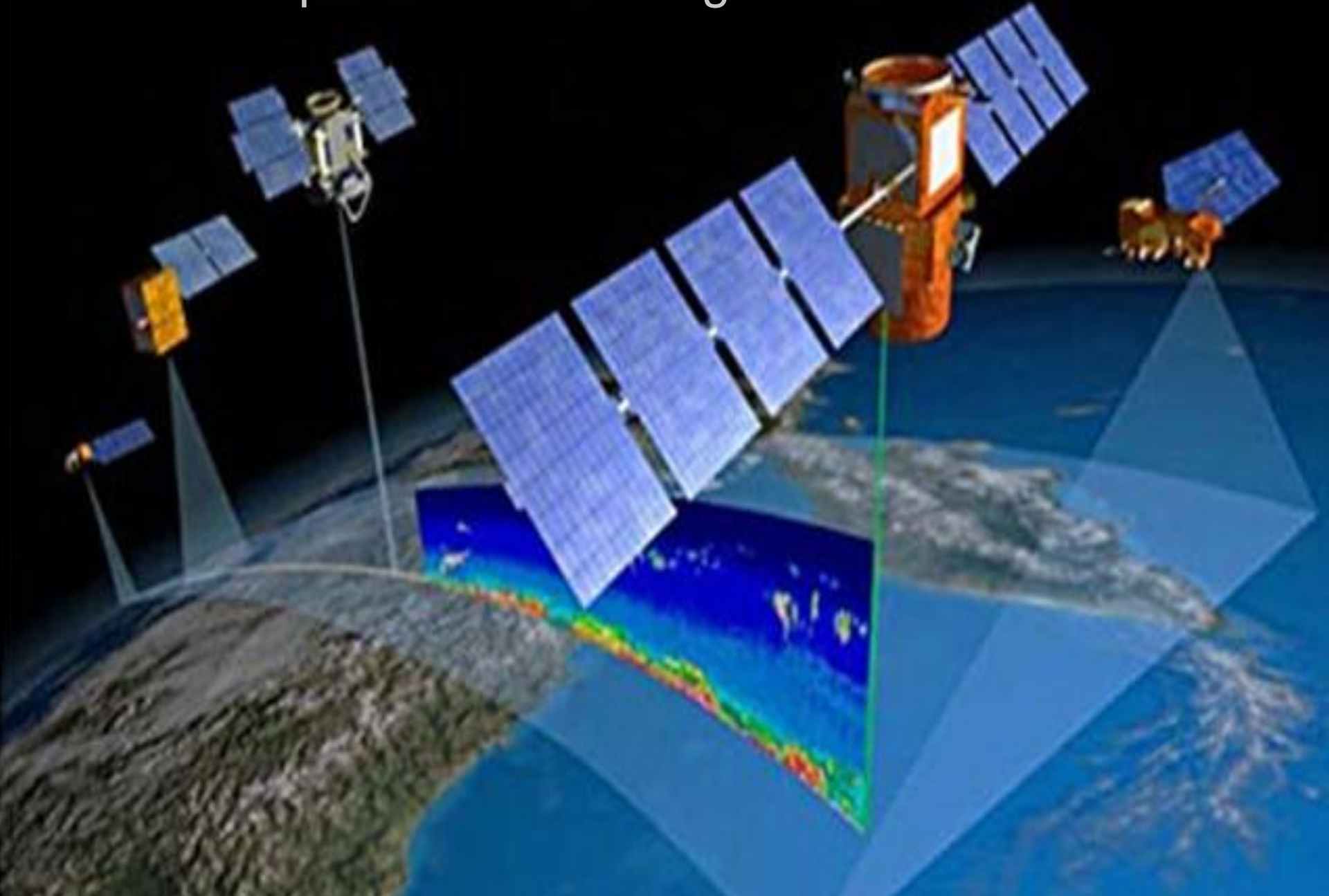
Sensoriamento Remoto



Origem



<https://climate.nasa.gov/earth-now/#/>



Monitoramento da

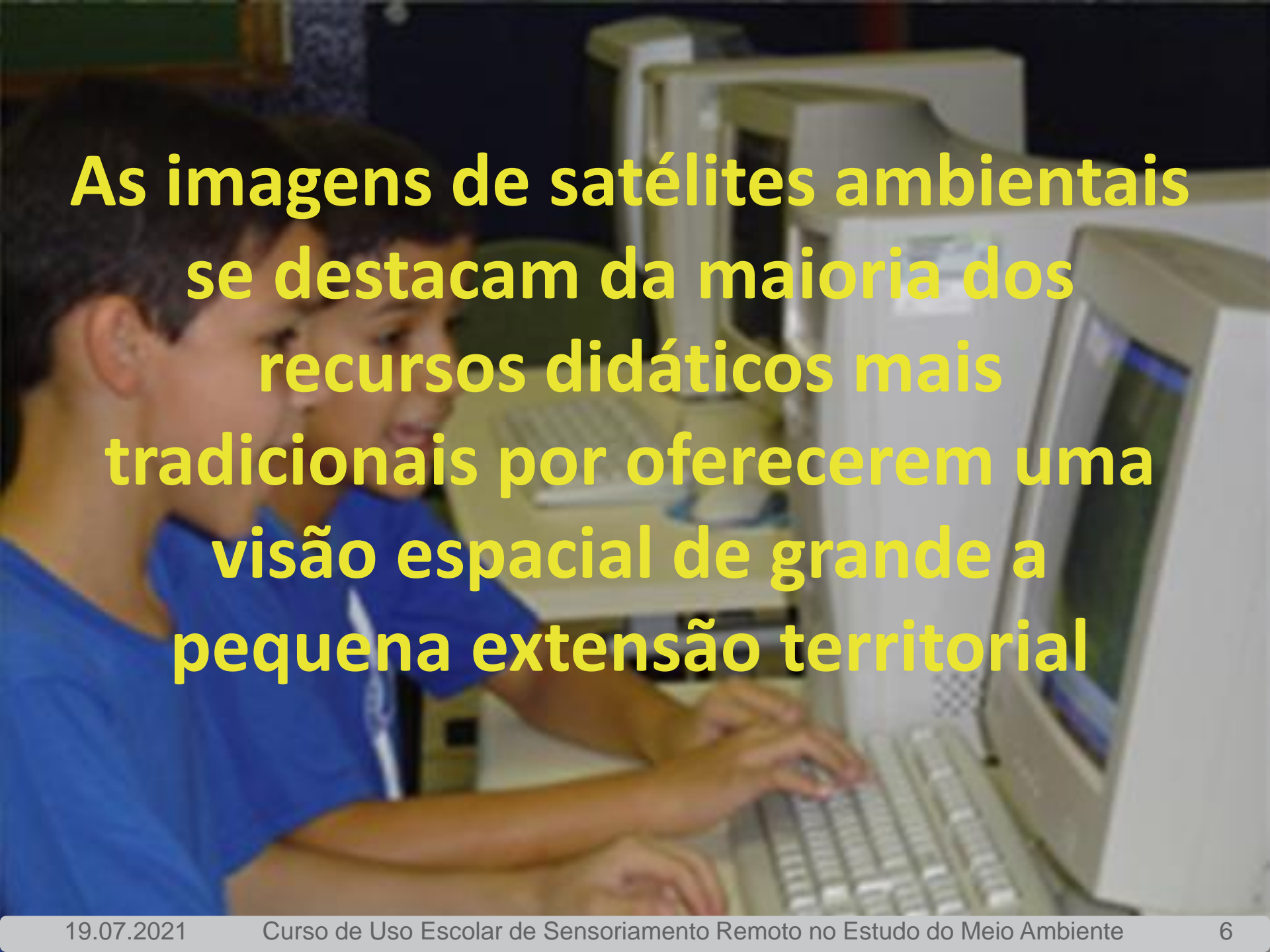
Atmosfera e dos Recursos Terrestres



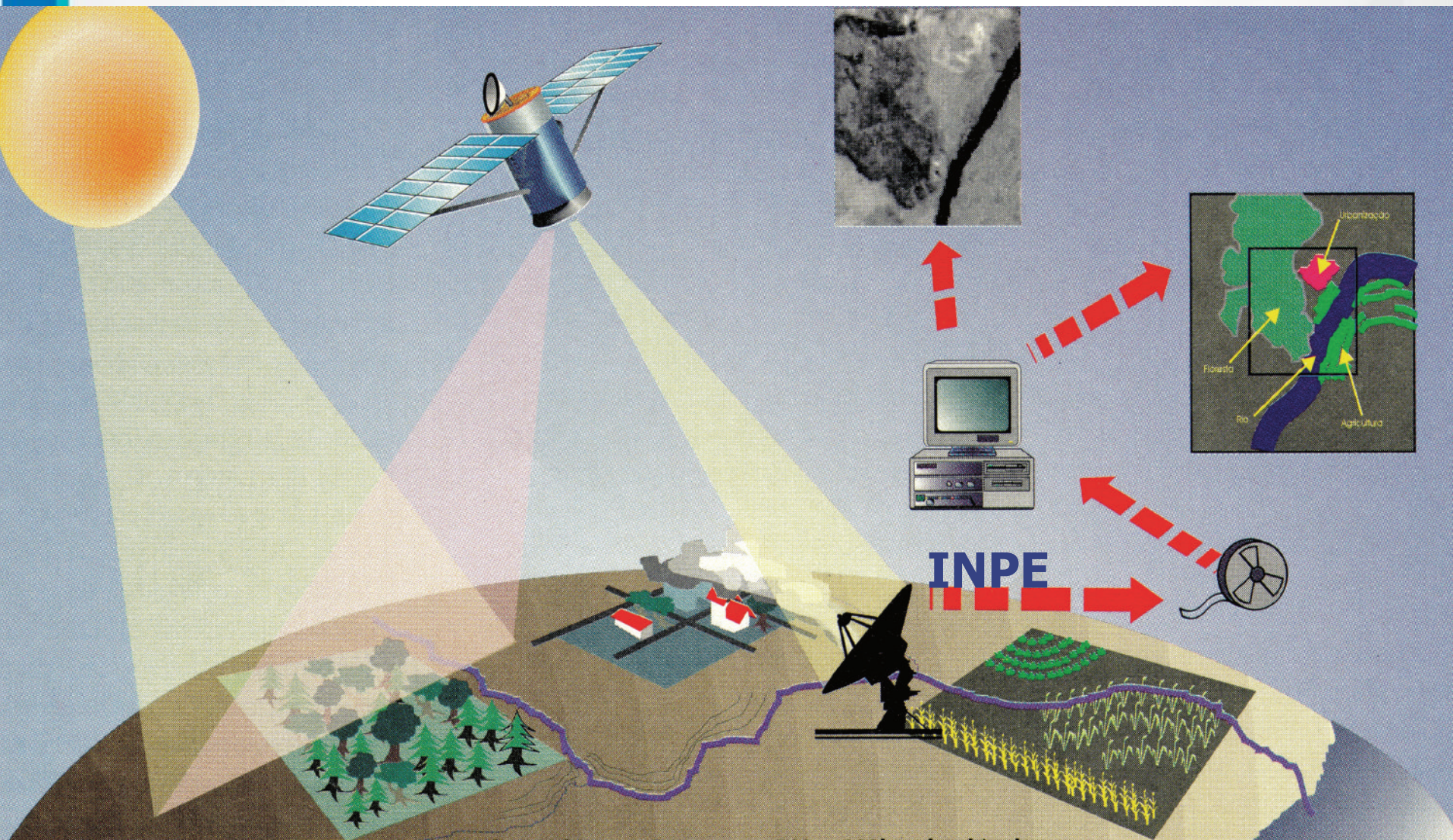
A satellite image of Earth showing the continent of South America in the center, surrounded by the Atlantic Ocean. The image is used as a background for the text.

Recurso didático não tradicional que favorece a obtenção de informações multidisciplinares.

As características extraídas de imagem de satélites ambientais podem ser utilizadas com finalidades múltiplas, servindo a praticamente todas as áreas que estudam a superfície terrestre ou fenômenos atmosféricos.

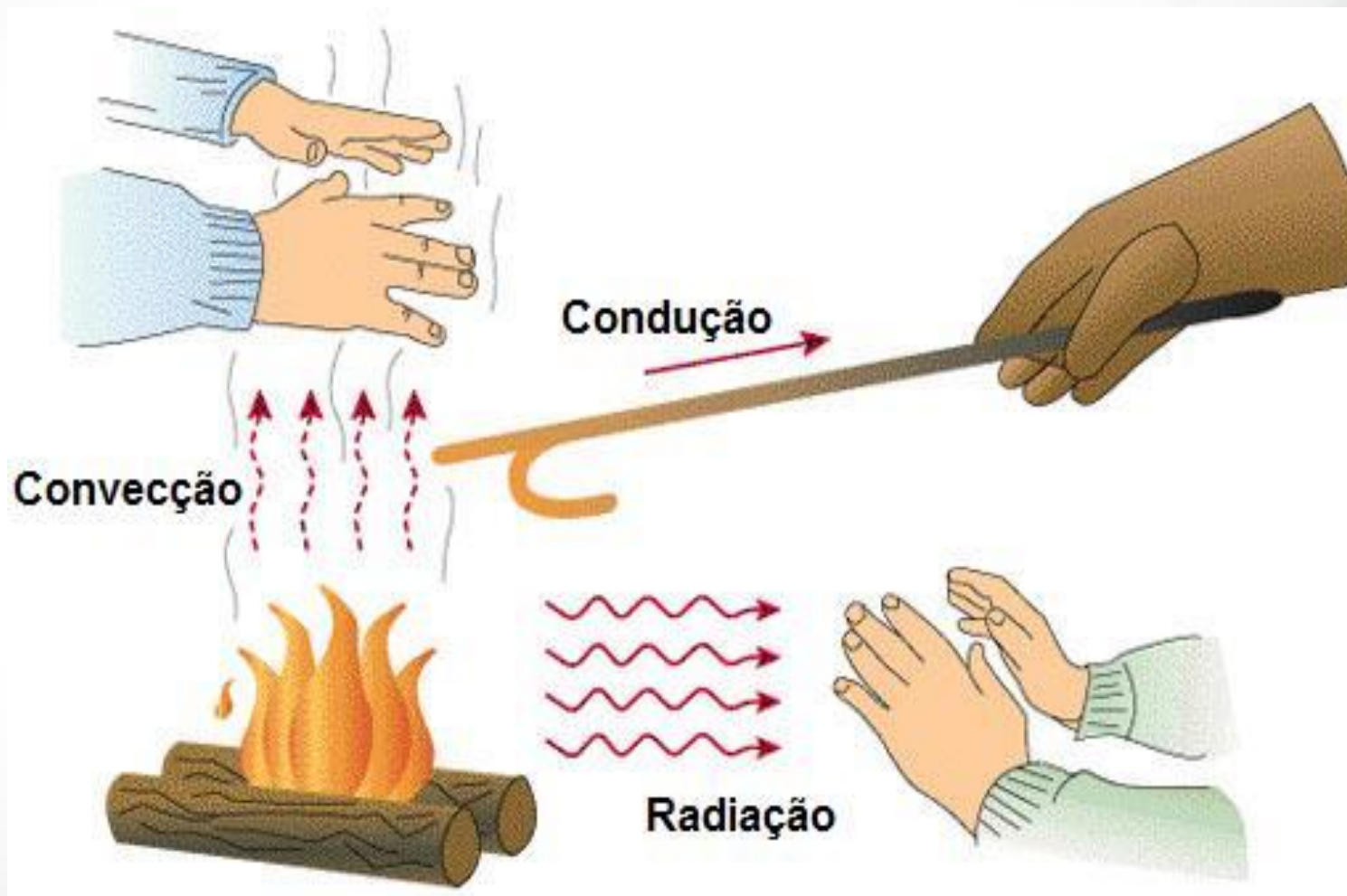
The background image shows two young students, a boy and a girl, both wearing blue t-shirts, sitting at a desk in a computer lab. They are looking at a large CRT monitor. The boy is on the left, and the girl is on the right, with her hands on the keyboard. The text is overlaid in a bright yellow color on top of the image.

As imagens de satélites ambientais se destacam da maioria dos recursos didáticos mais tradicionais por oferecerem uma visão espacial de grande a pequena extensão territorial

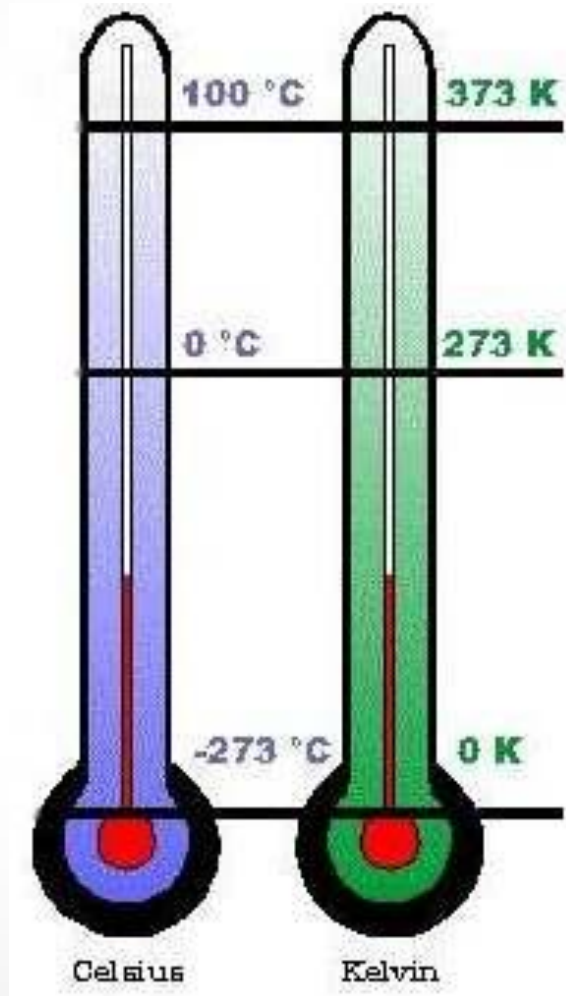


Os satélites orbitam a Terra entre 700 e 830km de altitude

Propagação de Energia



Relação entre as escalas Celsius e Kelvin



$$0 \text{ K} = - 273,16^{\circ}\text{C}$$

$$T_{\text{C}} = T_{\text{K}} - 273,16$$

T_{C} = temperatura Celsius

T_{K} = temperatura Kelvin

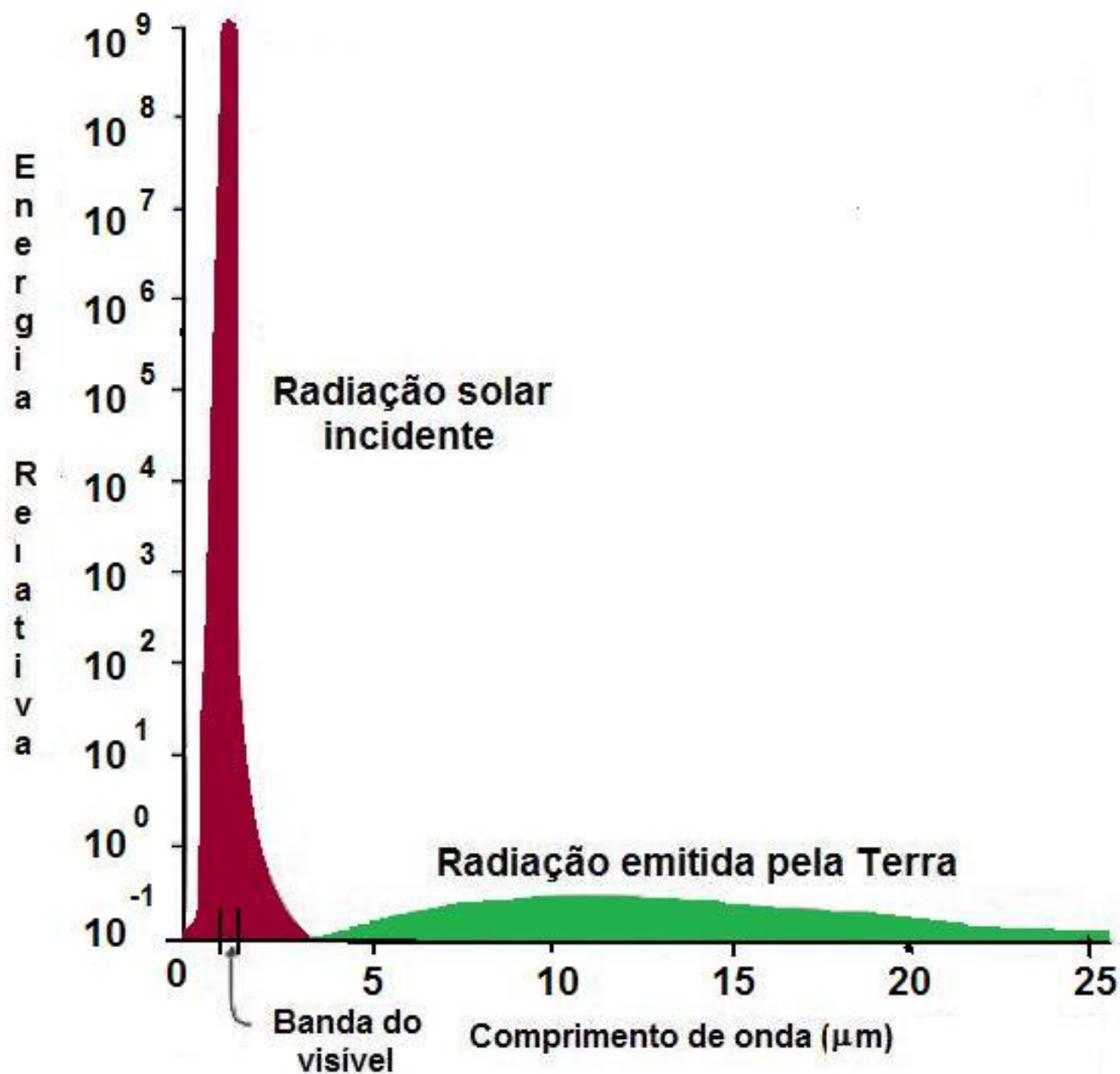
Todo corpo com temperatura acima de zero absoluto (0 K) emite energia eletromagnética

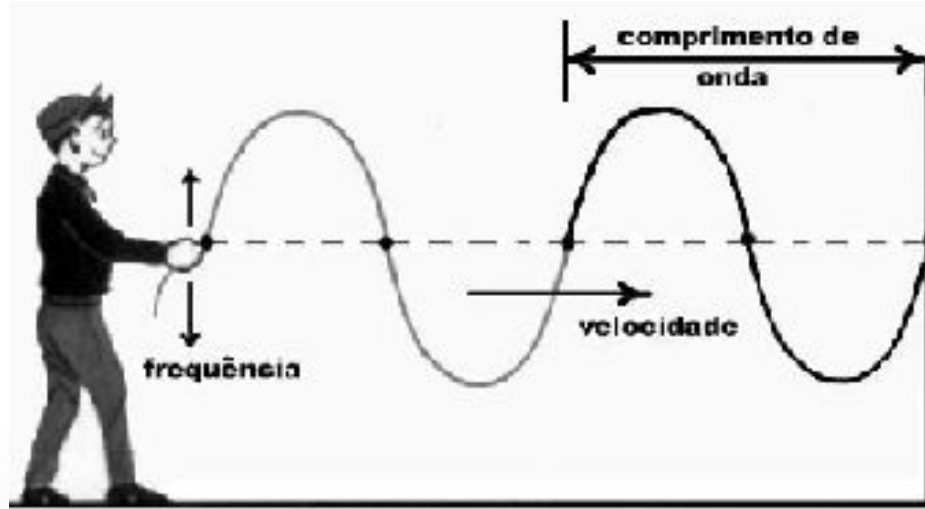
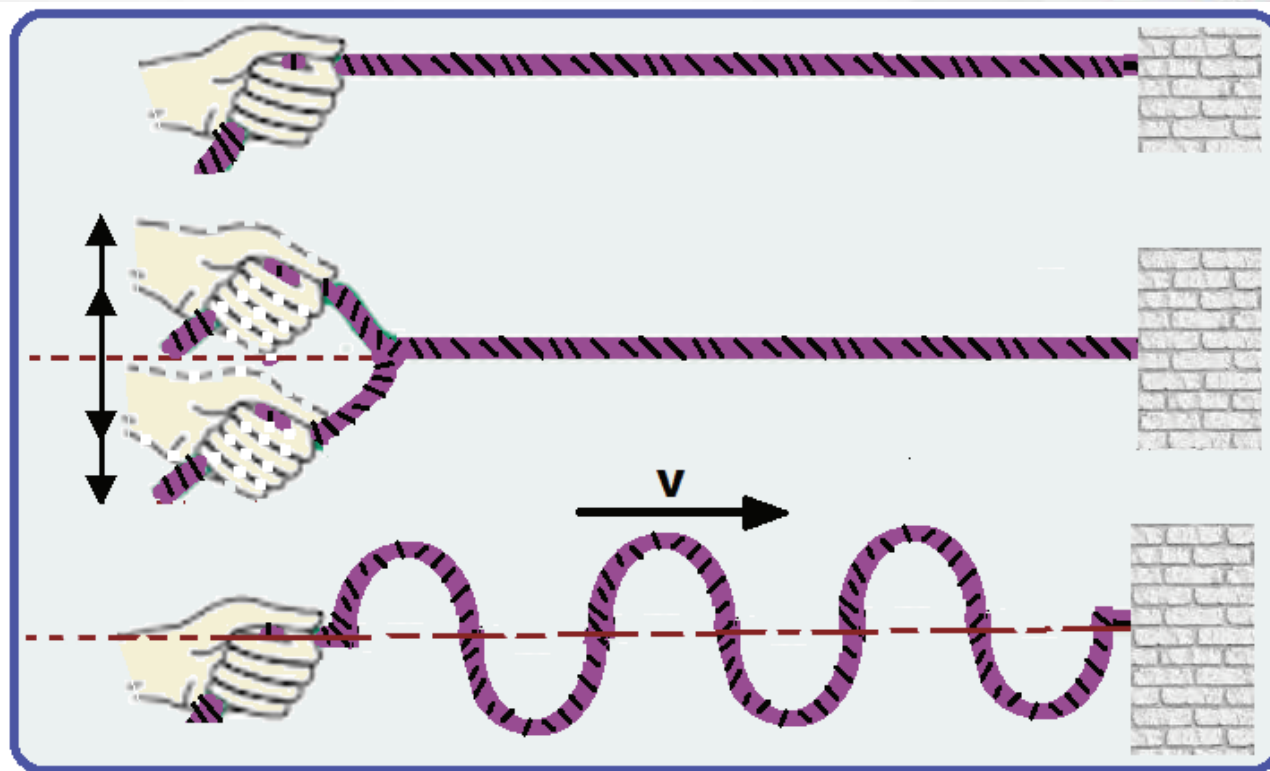


Sol



Terra



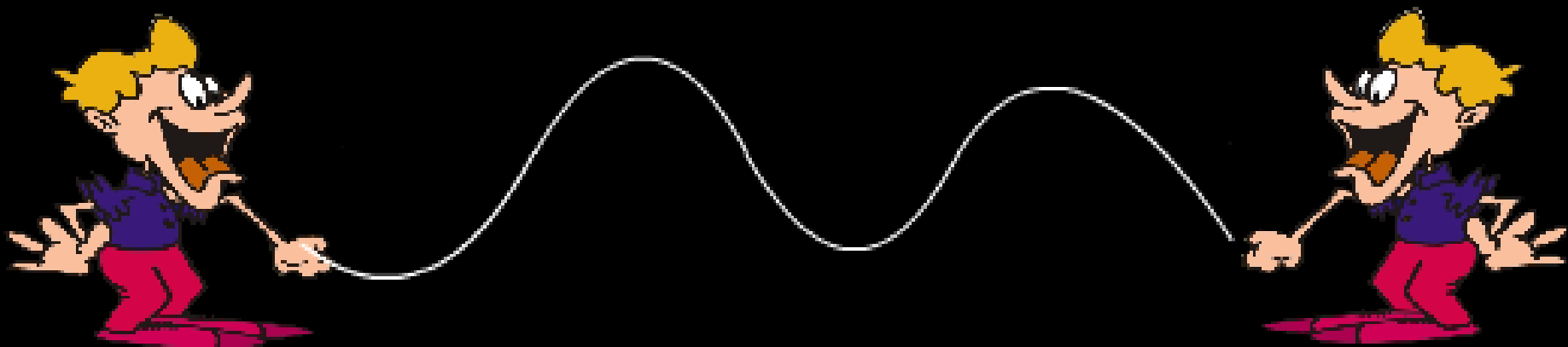


Observe o comprimento de onda



AUMENTANDO A ENERGIA NA CORDA

O QUE SE OBSERVA?



Qual a relação entre energia e frequência (f)?

$$E \propto f$$

Qual a relação entre energia e comprimento de onda (λ) ?

$$E \propto 1/\lambda$$

Qual a relação entre frequência e comprimento de onda (λ)?

$$f = c / \lambda$$

ou

$$c = f \cdot \lambda$$

Energia da Onda Eletromagnética



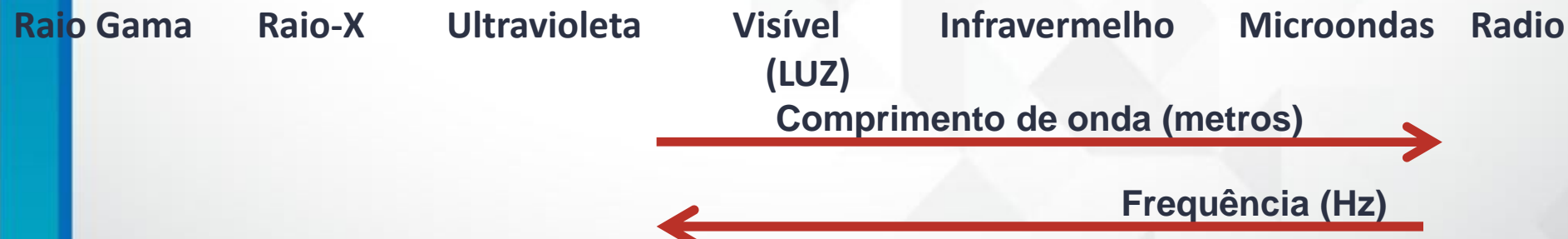
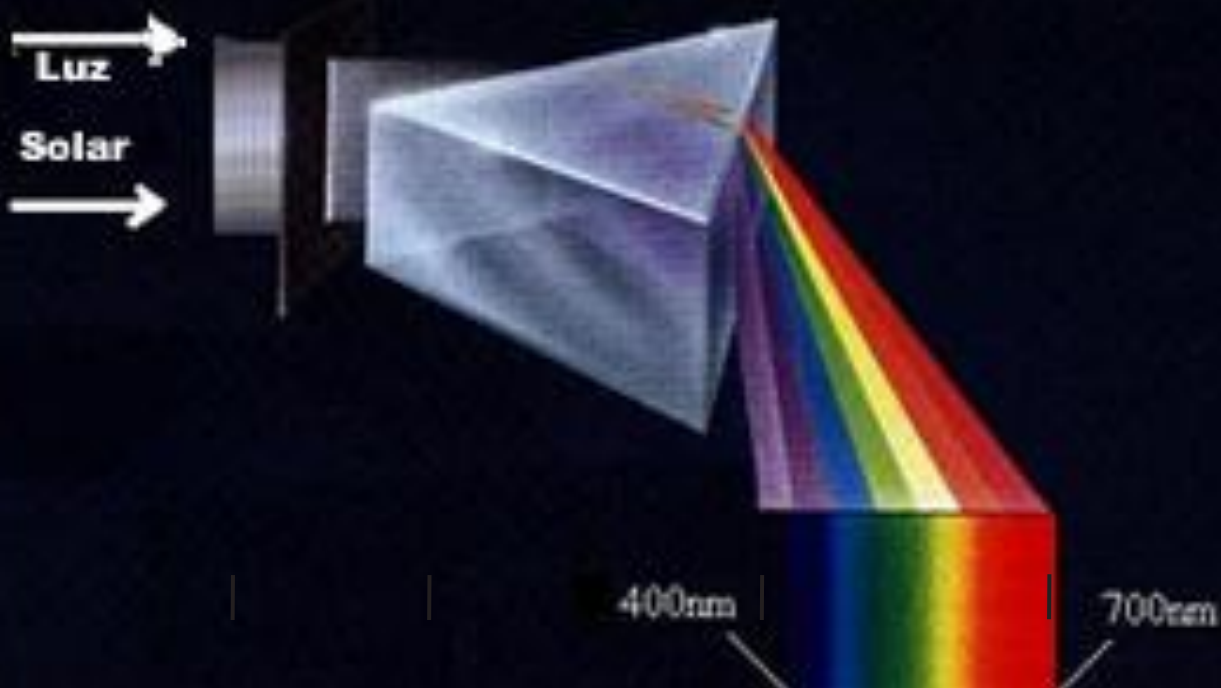
$$E = \text{cte} \cdot f$$

ou

$$E = \text{cte} \cdot c / \lambda$$

medida da capacidade da radiação de realizar trabalho físico, de aquecer um objeto ou causar mudança de estado da matéria

Ordenação contínua da energia eletromagnética em função do comprimento de onda ou da frequência



Espectro Eletromagnético

Raios Gama

Raios X

Ultra-Violeta

Visível

Infravermelho

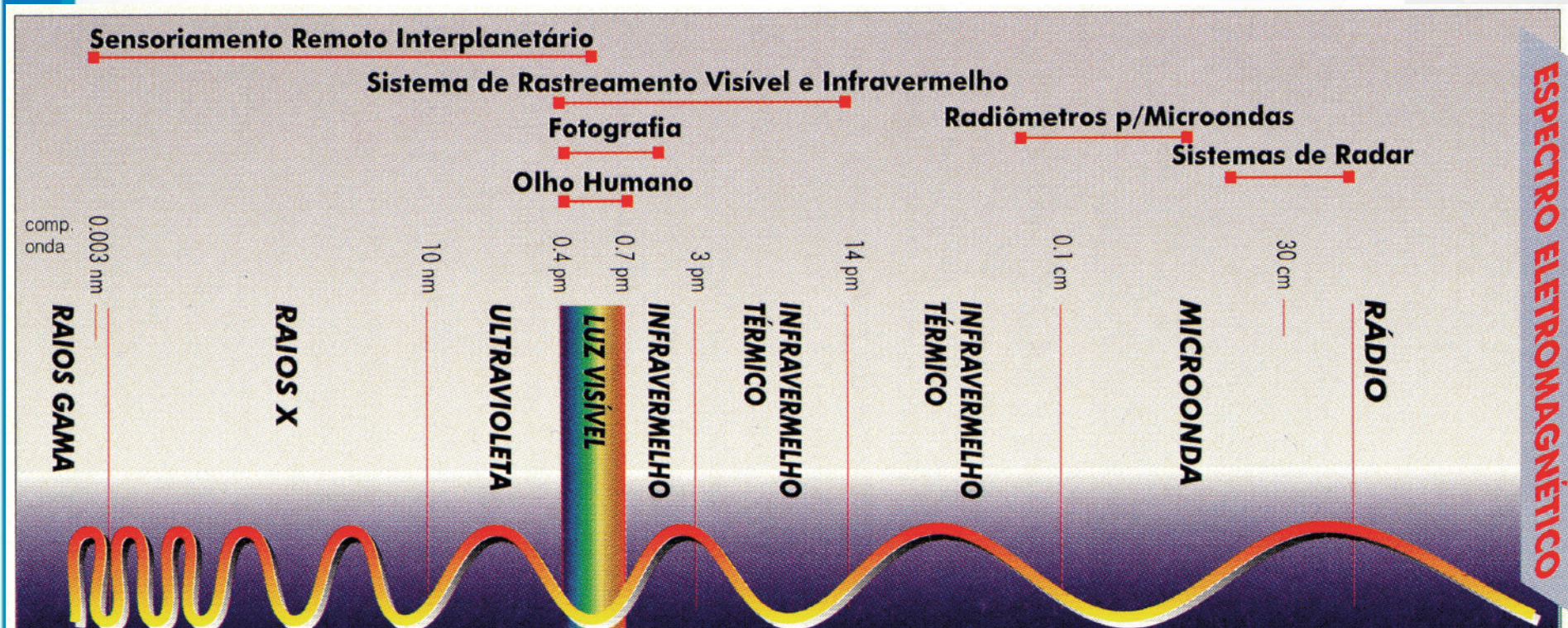
Microondas

Rádio



Espectro Eletromagnético

Regiões espectrais de interesse do Sensoriamento Remoto:
Ótico e Microondas



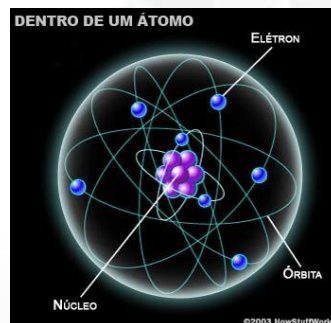
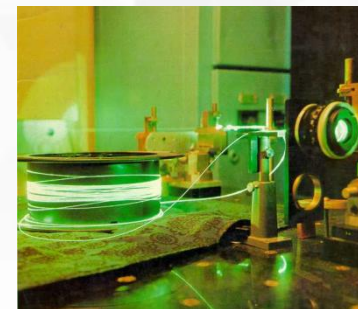
O que é 1 micrometro?

- $1/1\text{milhão} = 1/1.000.000 = 0,000001$ metros
 - $1\text{ milhão} = 1000 \times 1000 = 1.000.000$
- Logo, **1 micrometro = 0,000001 m**



O que é 1 nanômetro?

- $1/1\text{bilhão} = 1/1.000.000.000 = 0,000000001$ metros
- $1\text{ bilhão} = 1000 \times 1000 \times 1000 = 1.000.000.000$
- Logo, **1 nanômetro = 0,000000001 m**

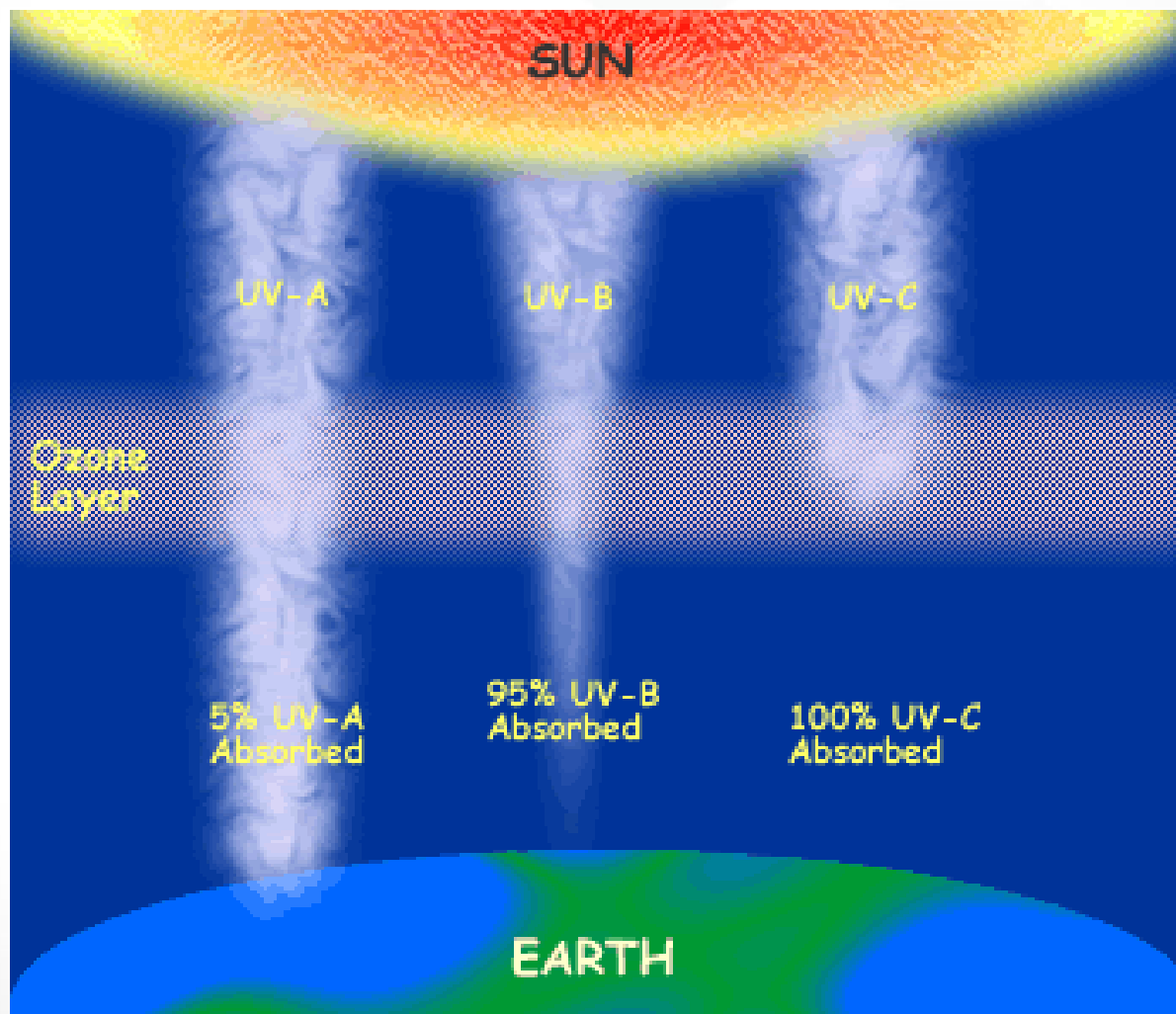


Faixas espectrais importantes para o SR

Denominação	Comprimento de onda (μm)
SR Óptico	0,30 – 14,0
Refletido	0,40 – 4,00
Visível	0,40 – 0,70
Infravermelho próximo	0,70 – 1,10
Infravermelho Médio	1,10 – 4,00
Infravermelho distante (Termal, Emitido)	8,00 – 12,0
Microondas	1 mm a 1m

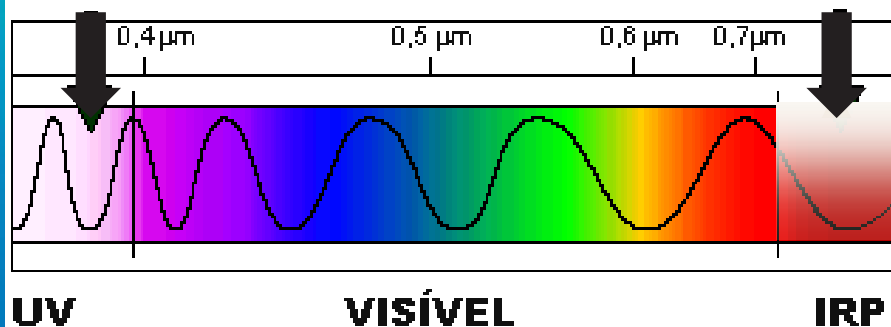
Ultravioleta

Estrelas e outros objetos quentes emitem energia em UV

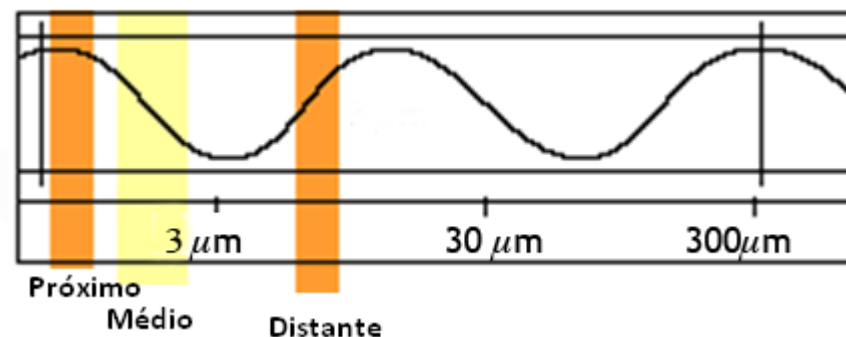


Regiões Espectrais

SENSORIAMENTO REMOTO PASSIVO

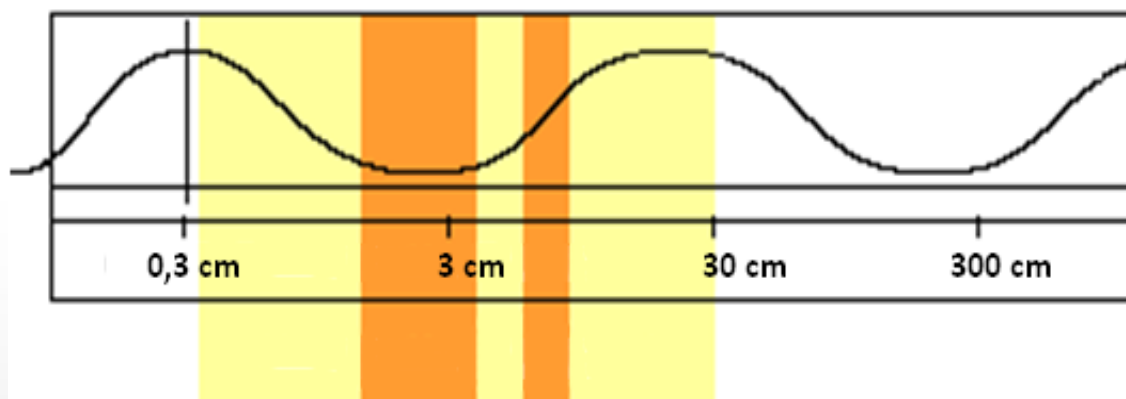


ESPECTRO INFRAVERMELHO



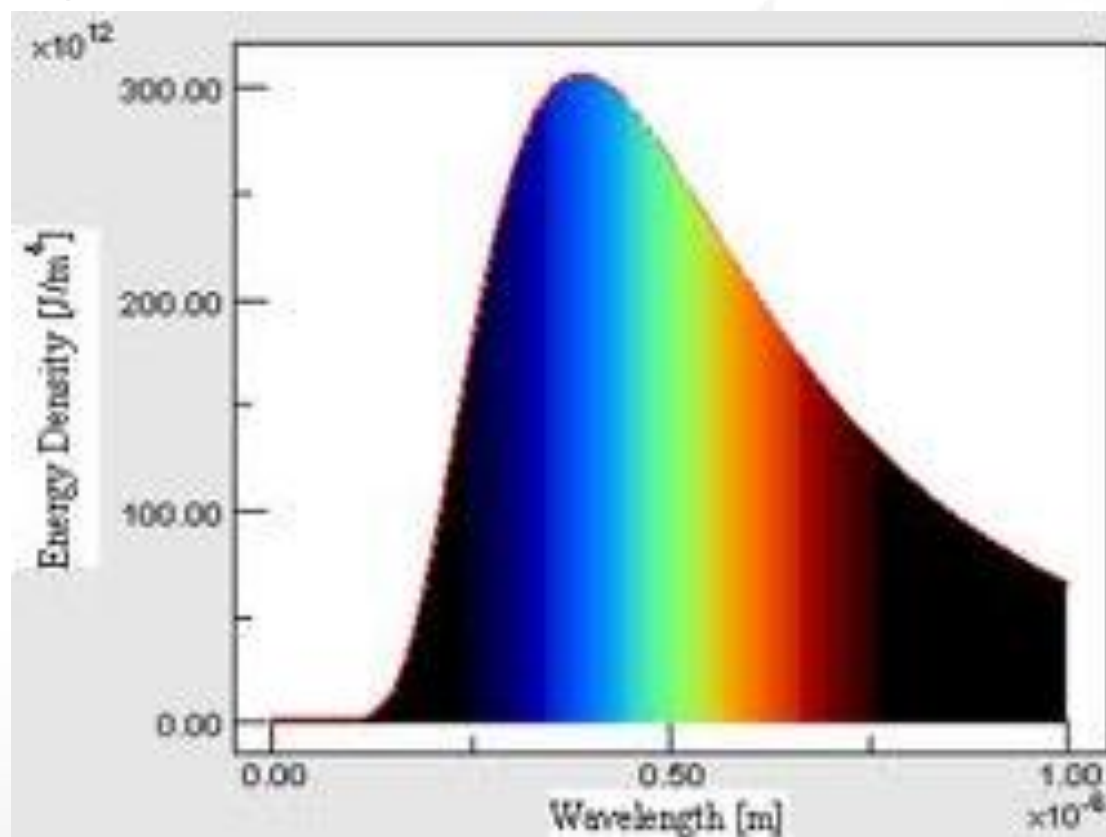
SENSORIAMENTO REMOTO ATIVO

MICROONDAS



Visível

- Energia que sensibiliza o olho humano.
- A radiação visível é emitida por muitas coisas, p. ex. fogo, lâmpadas e estrelas.



Espectro Visível

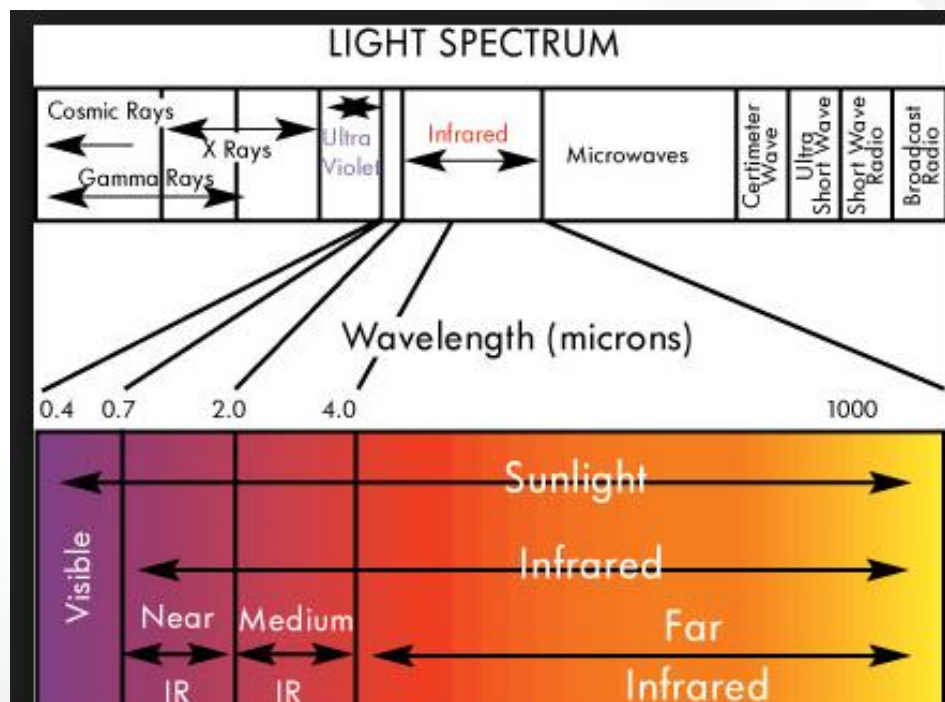
- violeta: 400 a 455 nm
- azul: 455 a 492 nm
- verde: 492 a 577 nm
- amarelo: 577 a 597 nm
- laranja: 597 a 622 nm
- vermelho: 622 a 700 nm

Espectro Visível

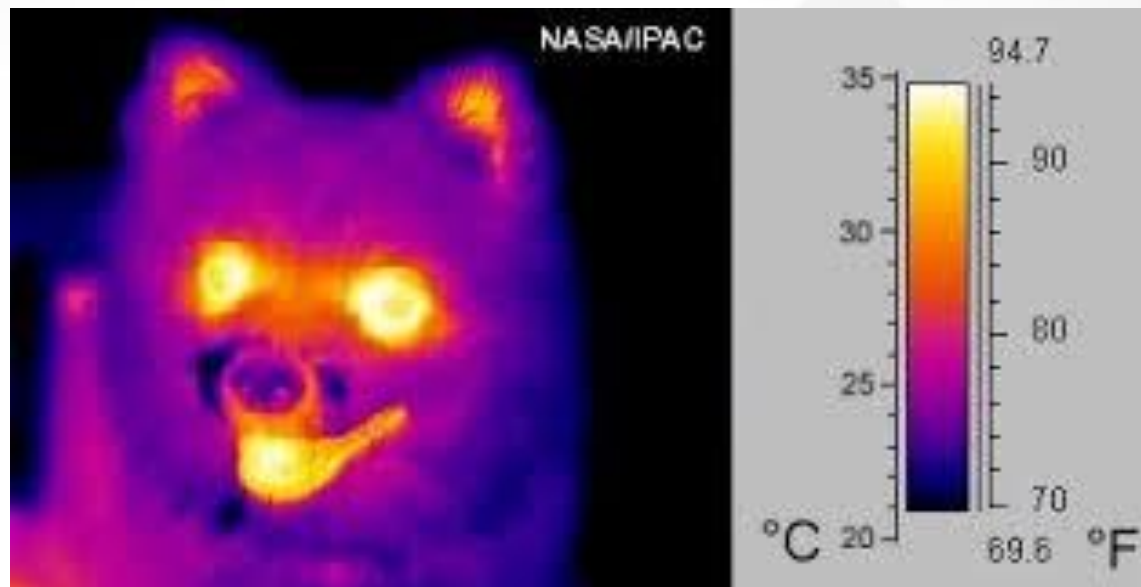


Infravermelho

- NIR** – “Near Infrared”
- SWIR** – “Short Wavelength Infrared”
- MWIR** – “Middle Wavelength Infrared”
- LWIR** – “Long Wavelength Infrared”

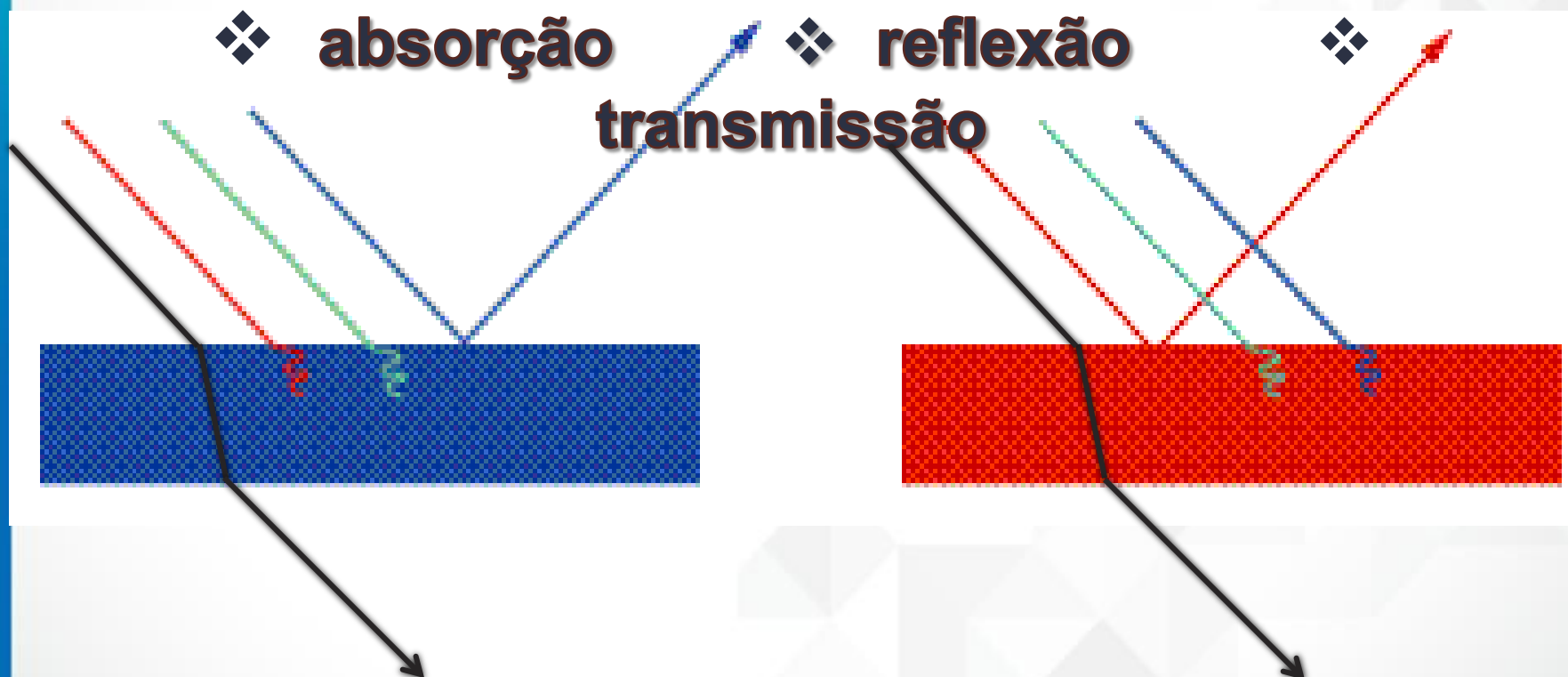


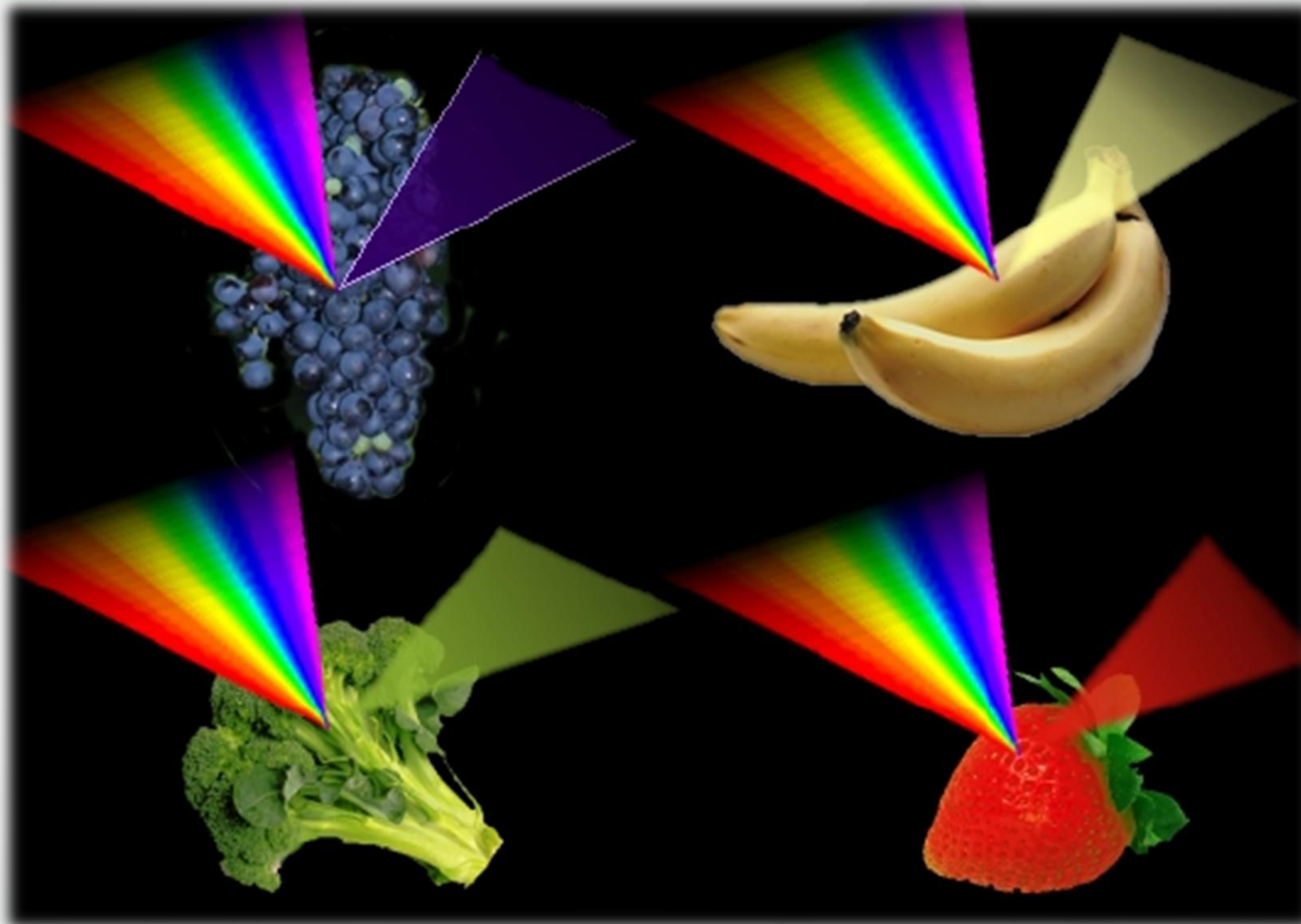
Infravermelho distante



Interação

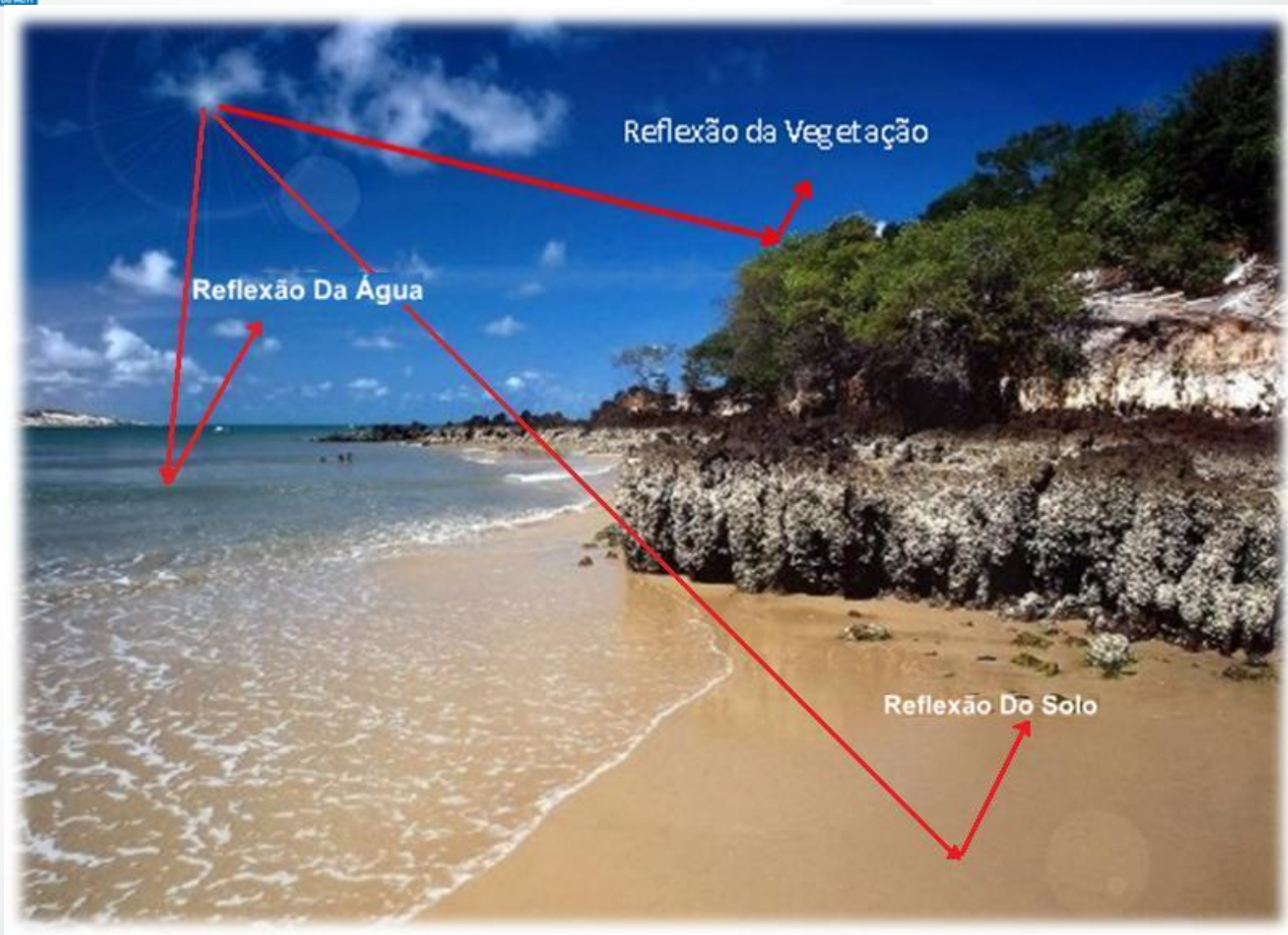
Energia Eletromagnética x Objeto



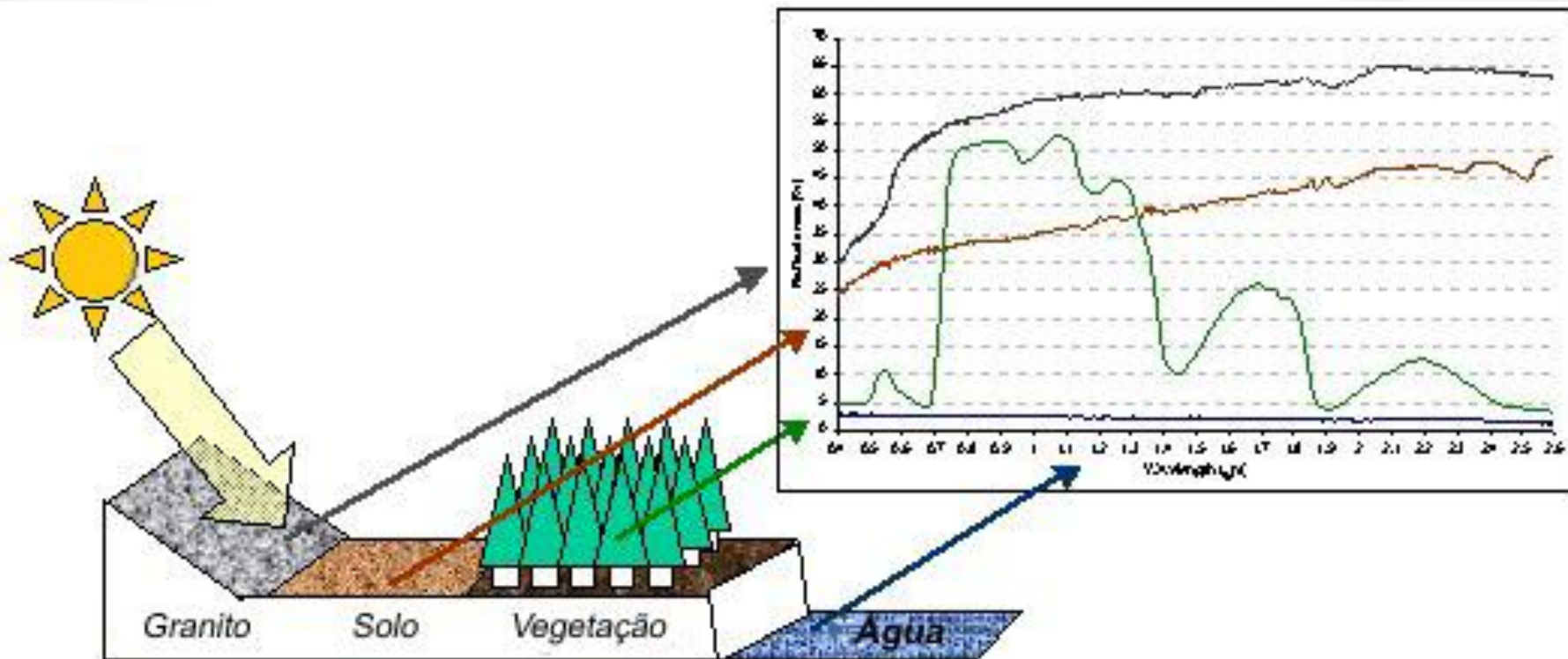






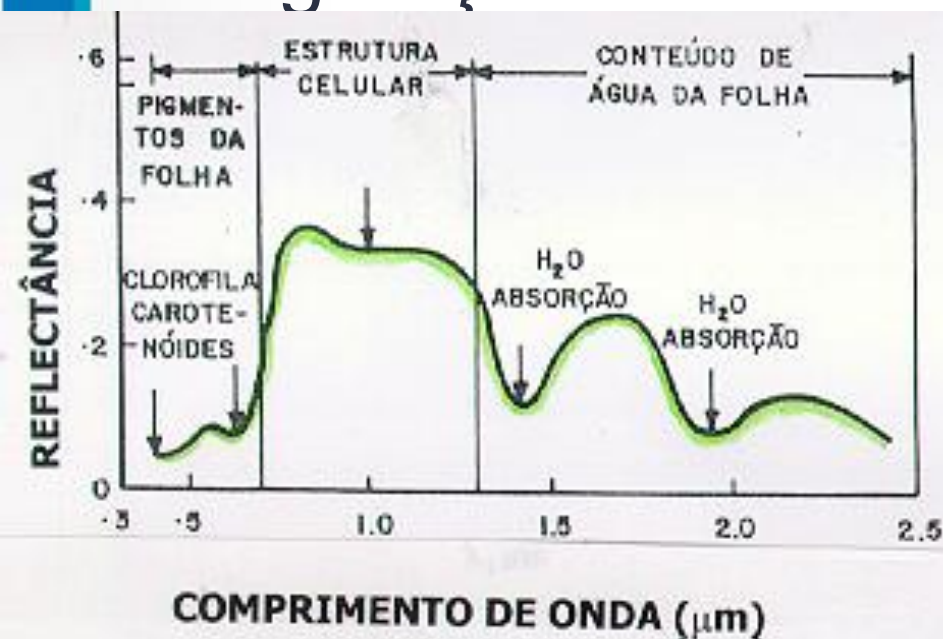


Comportamento Espectral

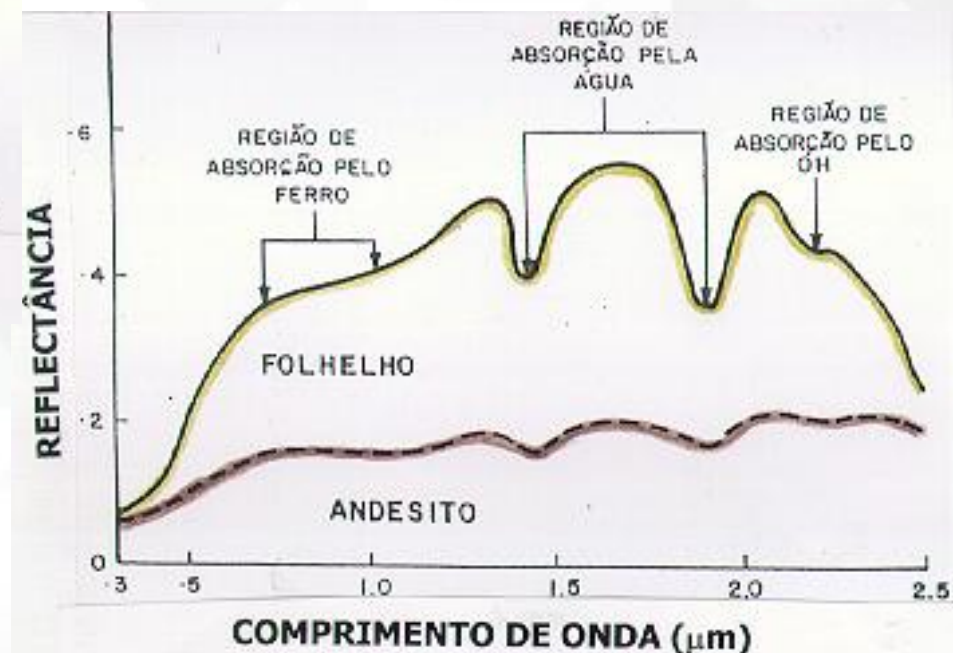


Comportamento Espectral

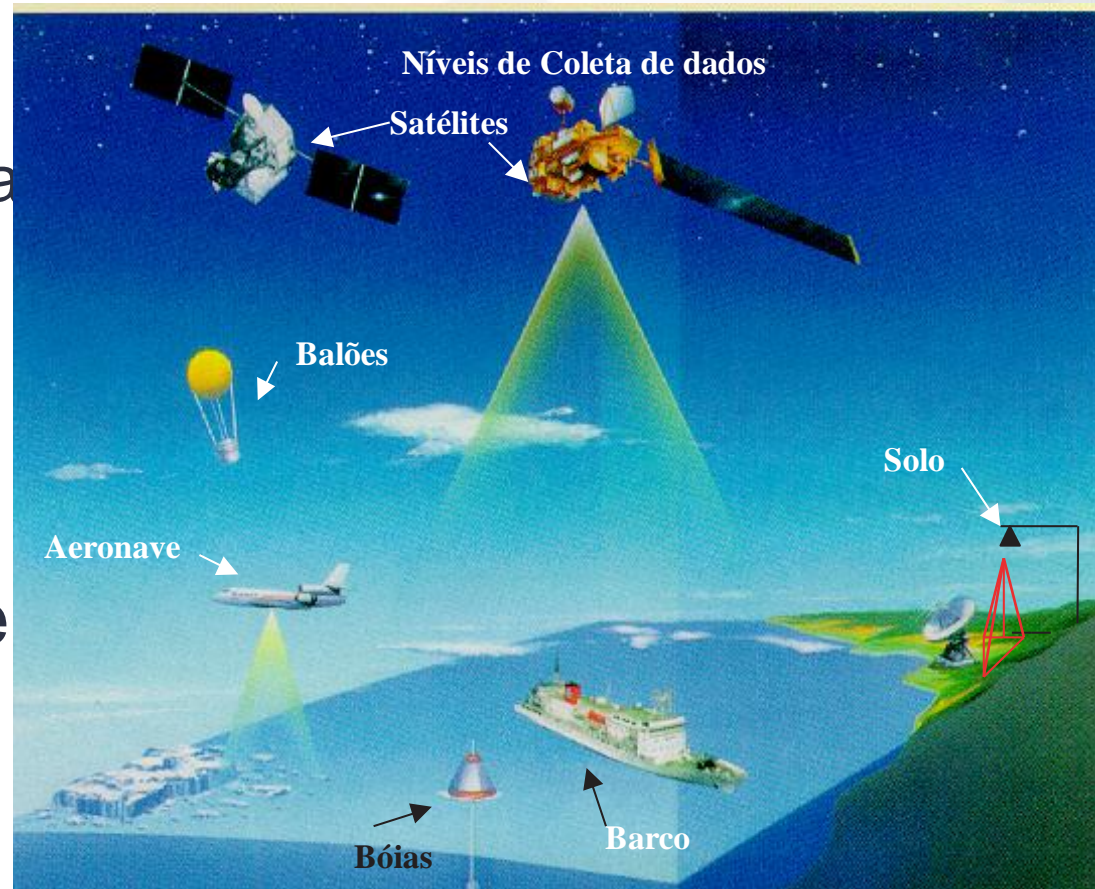
Vegetação sadia



Rochas



Níveis de Coleta de Dados



- Nível orbital ou plataforma espacial

- Nível suborbital

 - ❖ plataforma aérea

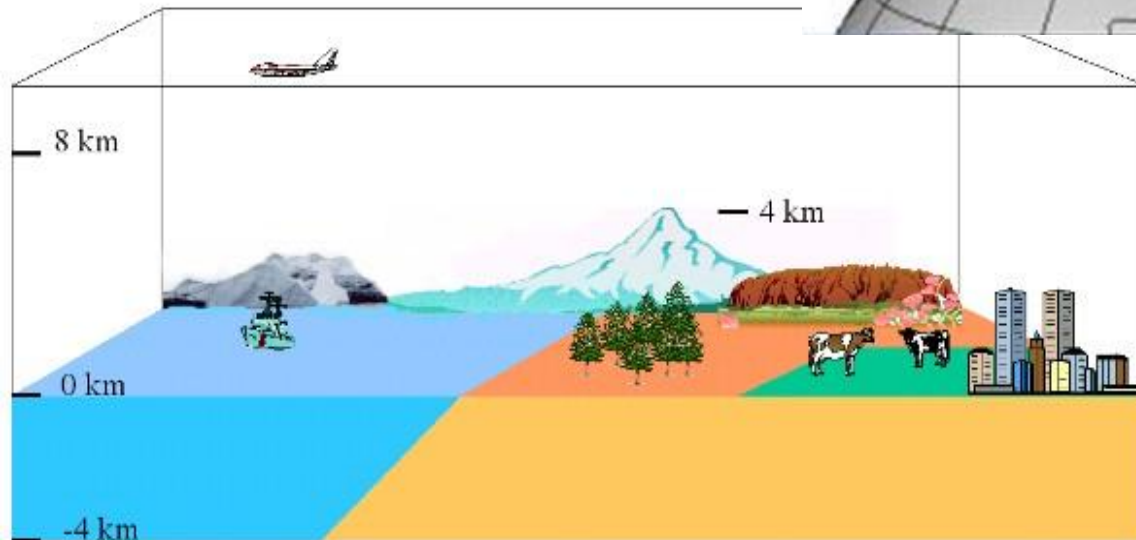
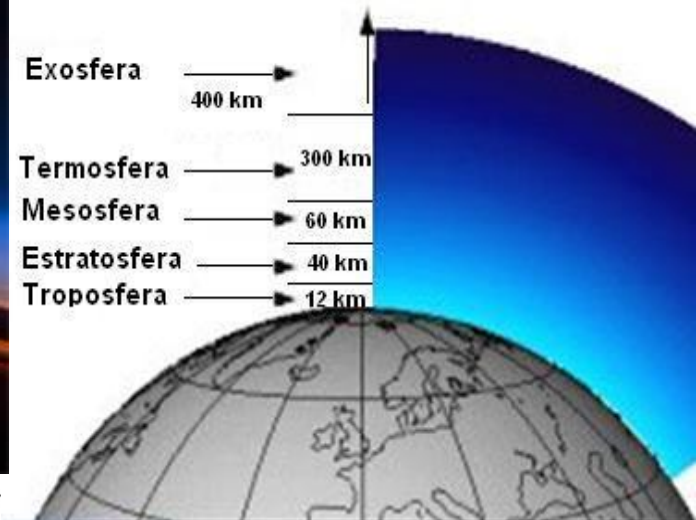
 - ❖ plataforma terrestre

 - campo

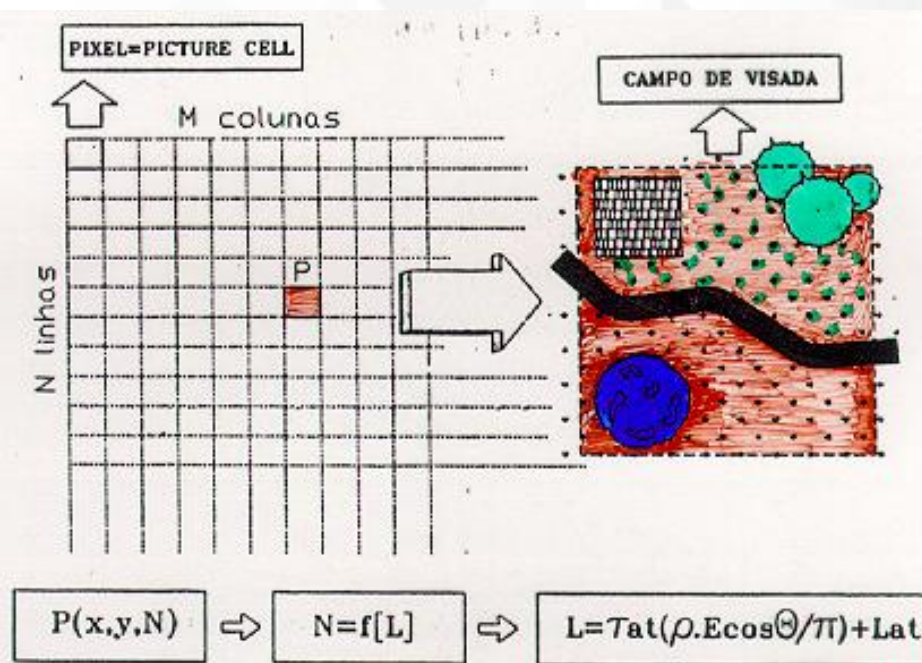
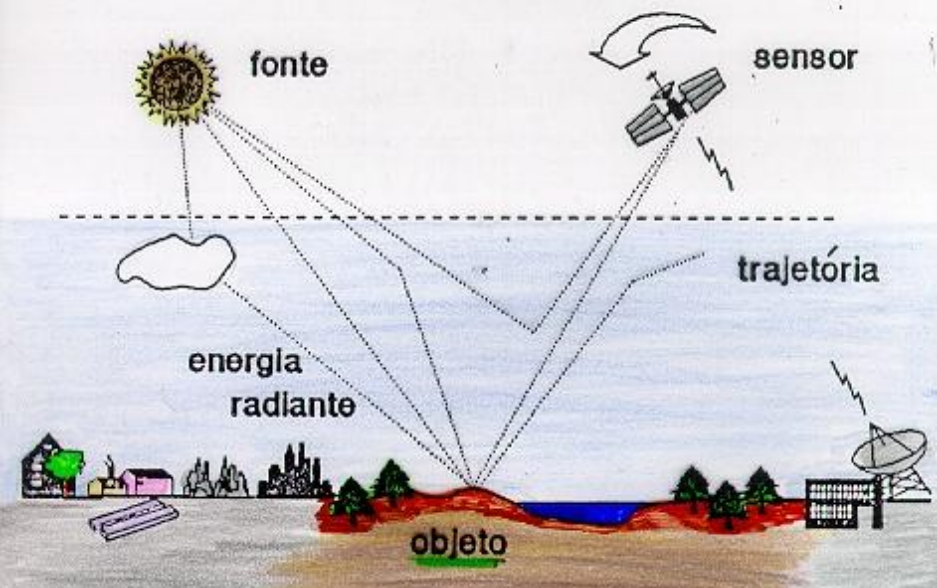
 - Laboratório

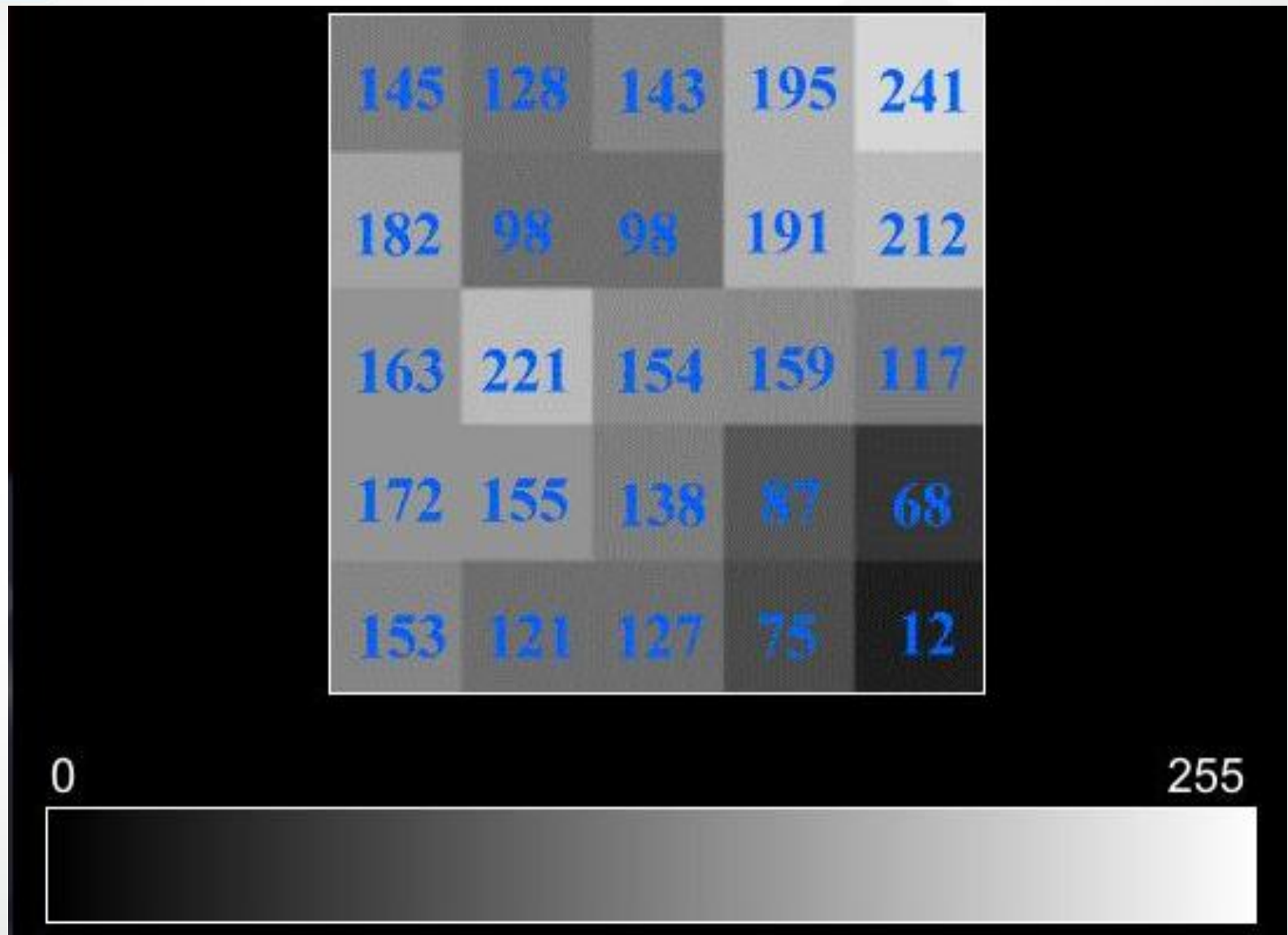
Importância da plataforma terrestre

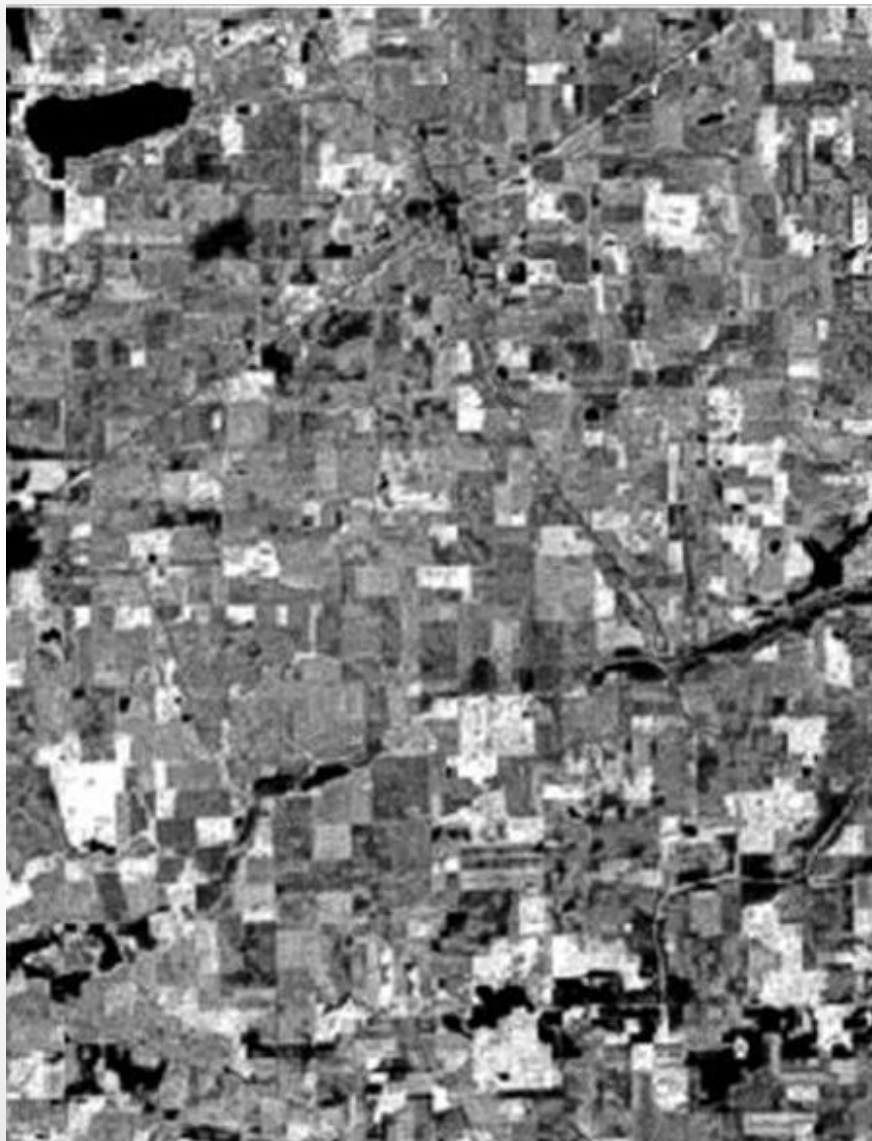
- ➔ Valor de referência para as outras plataformas
- ➔ eliminação da atmosfera terrestre



fase de aquisição



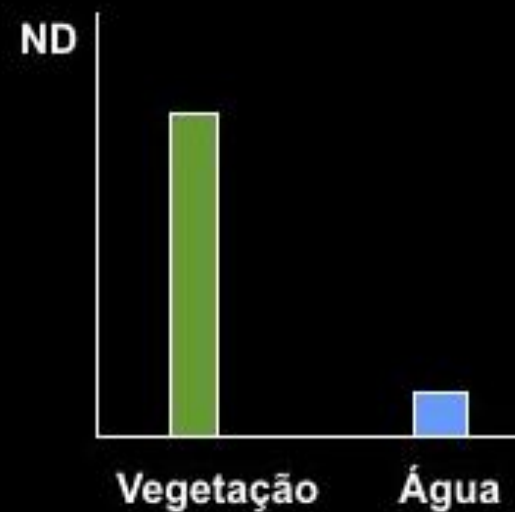




Reflexão no Infravermelho Próximo

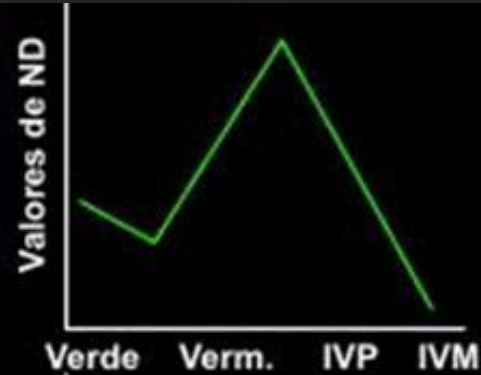
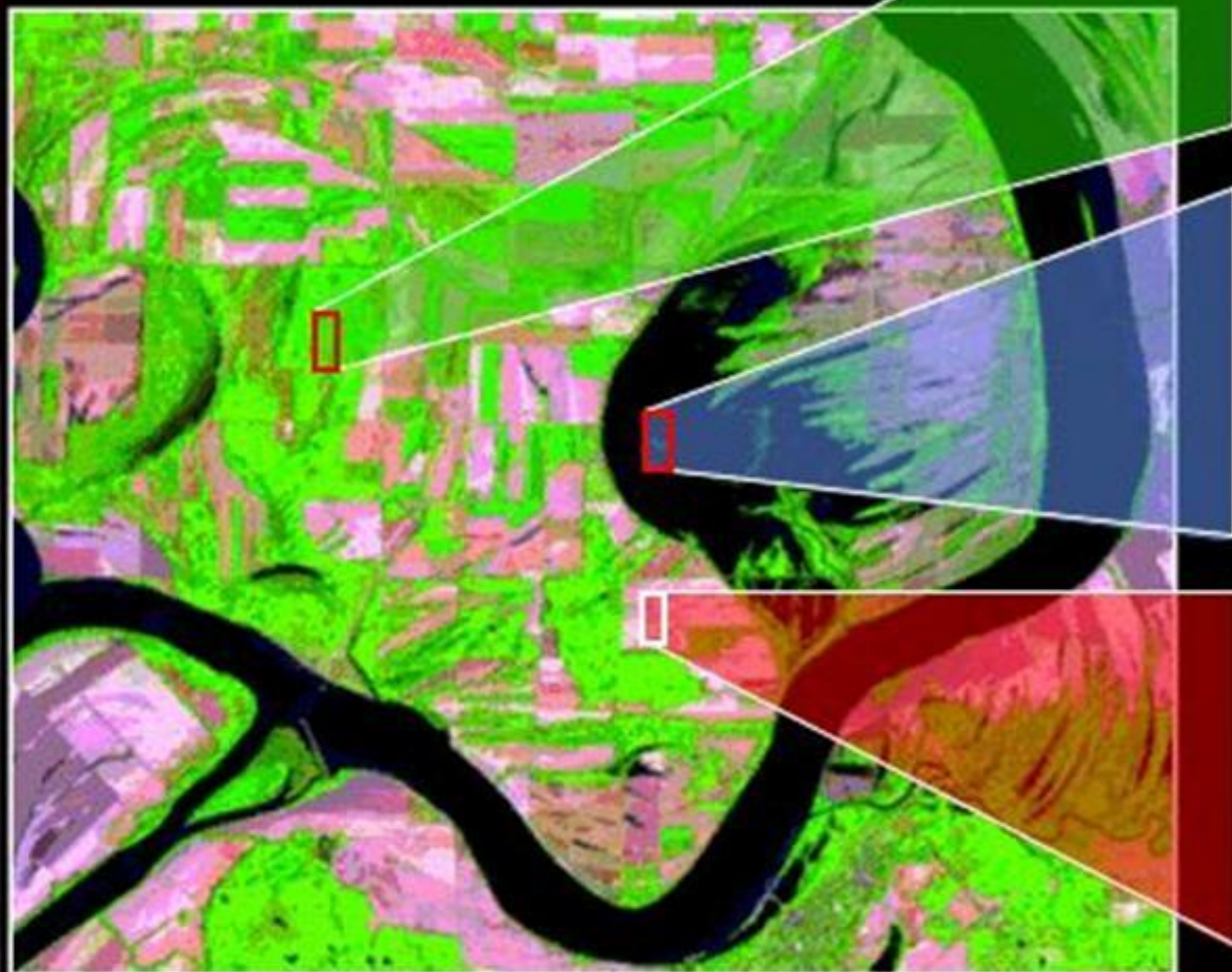


Reflexão no Infravermelho Próximo

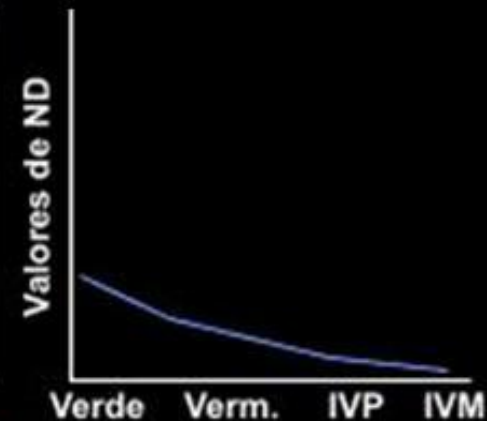
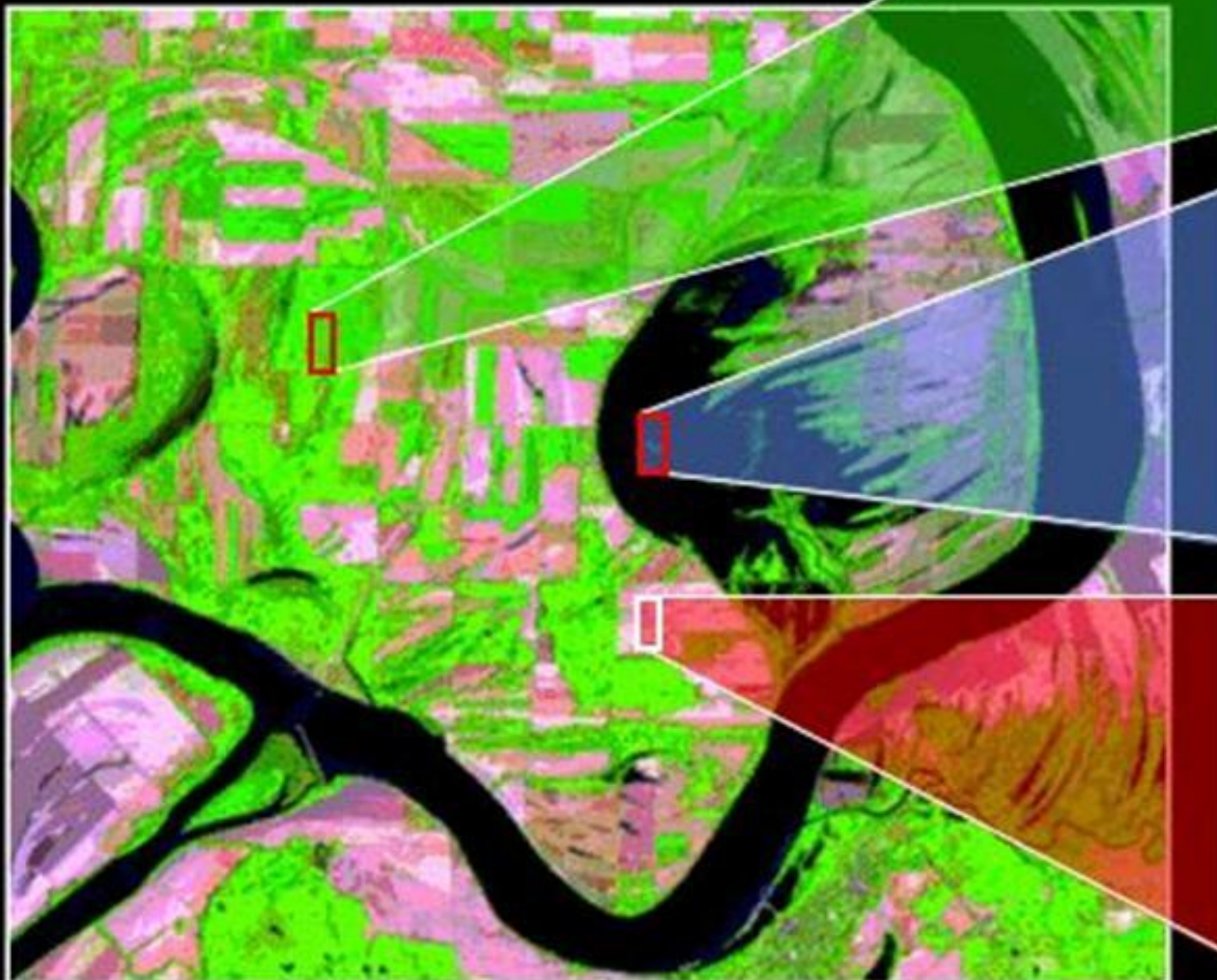




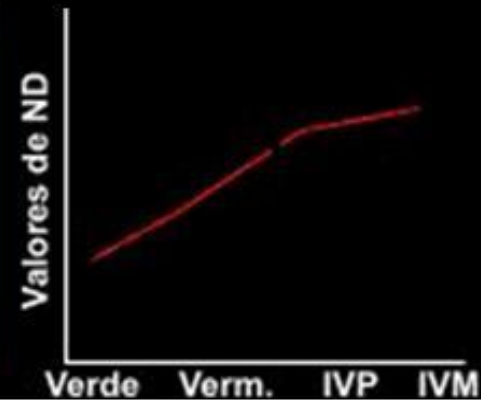
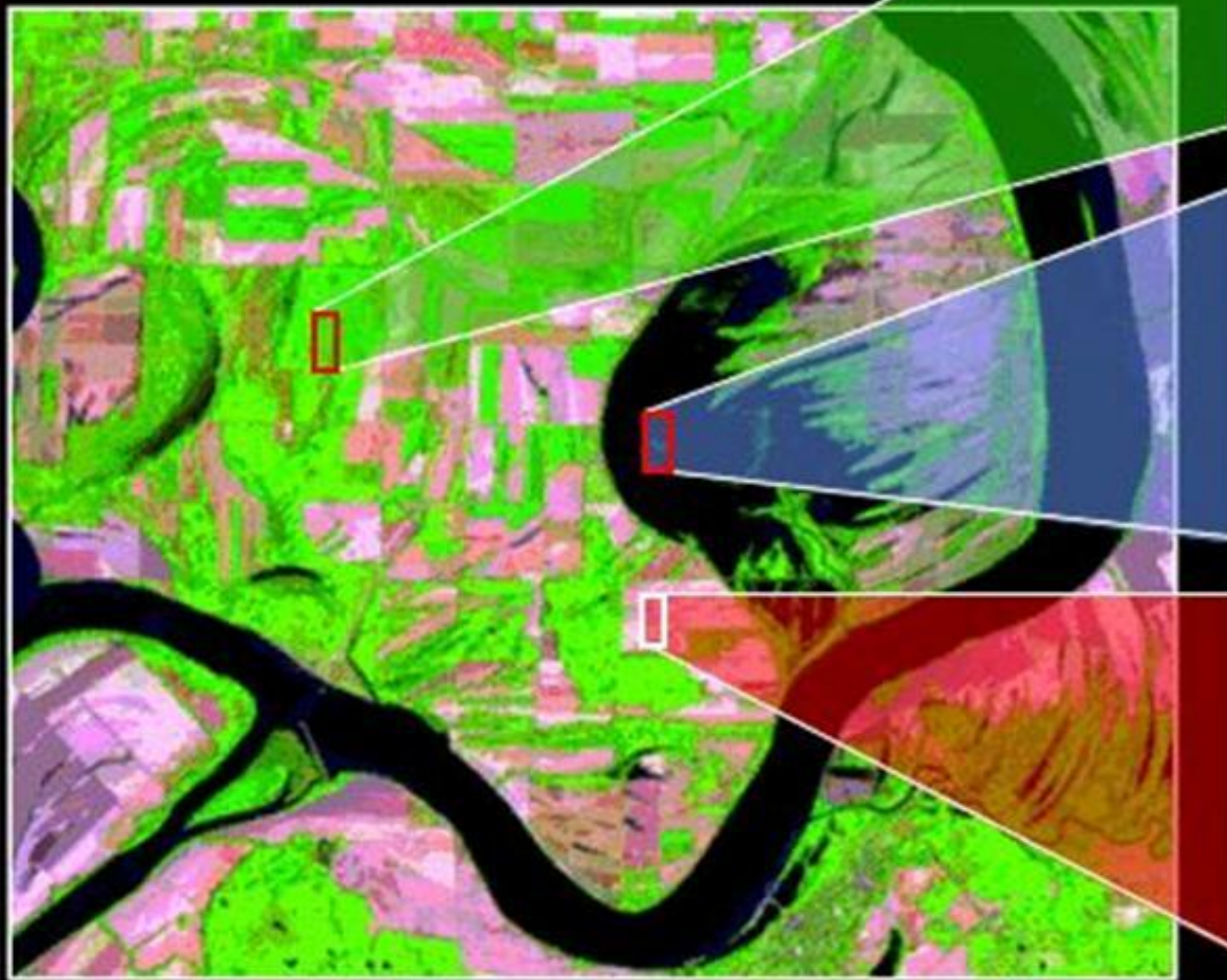
Respostas Espectrais



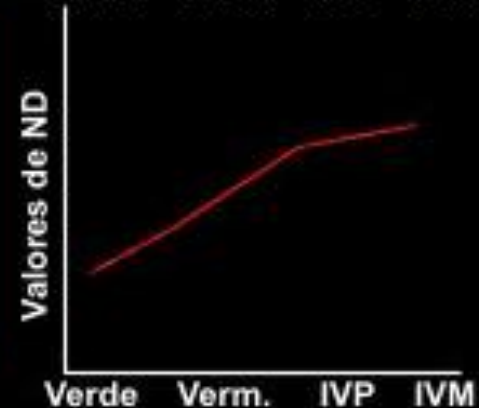
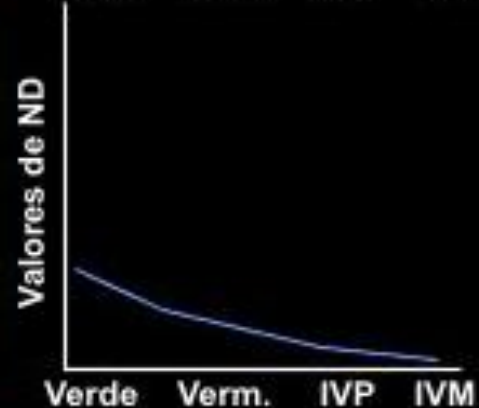
Respostas Espectrais



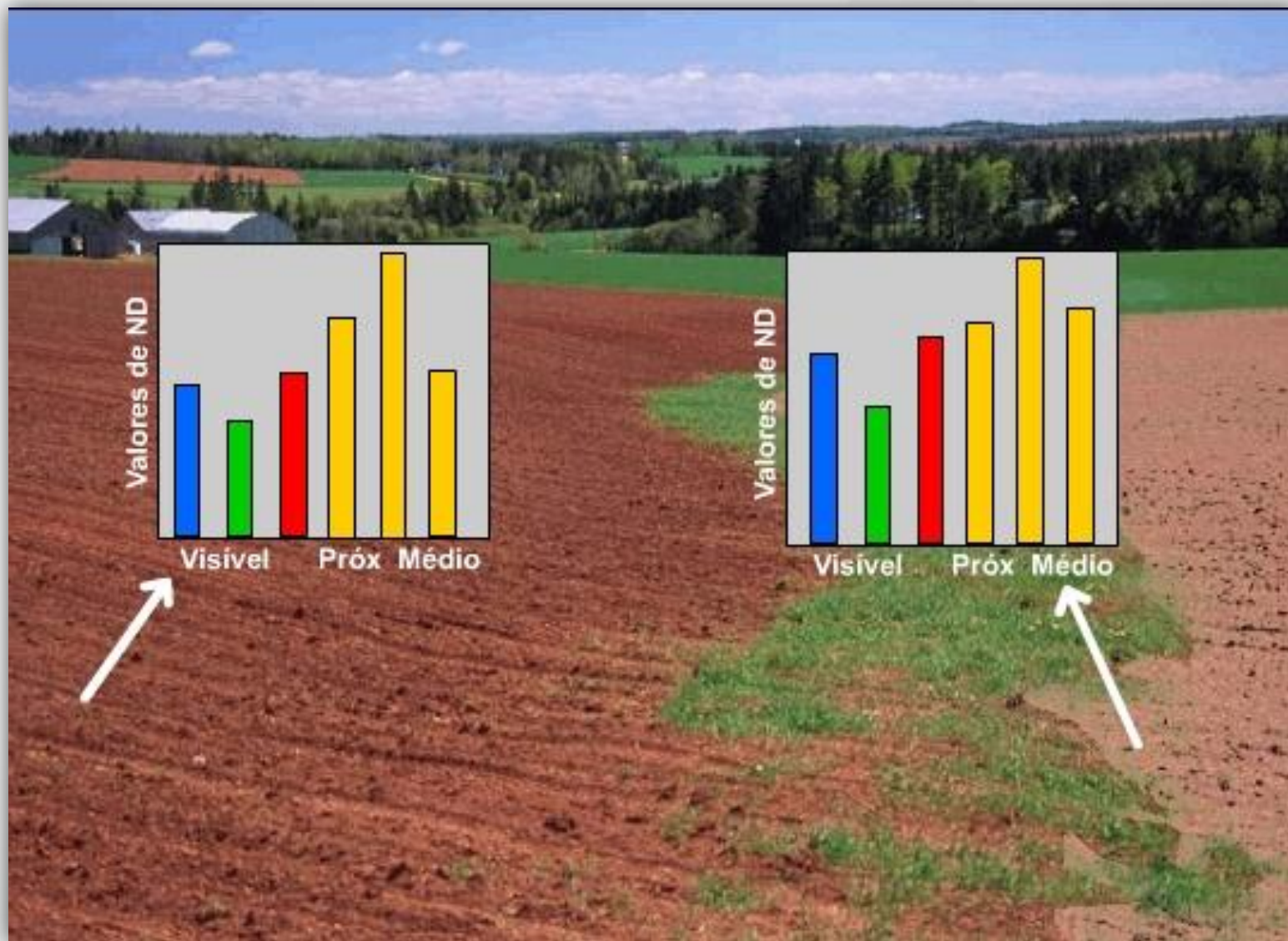
Respostas Espectrais

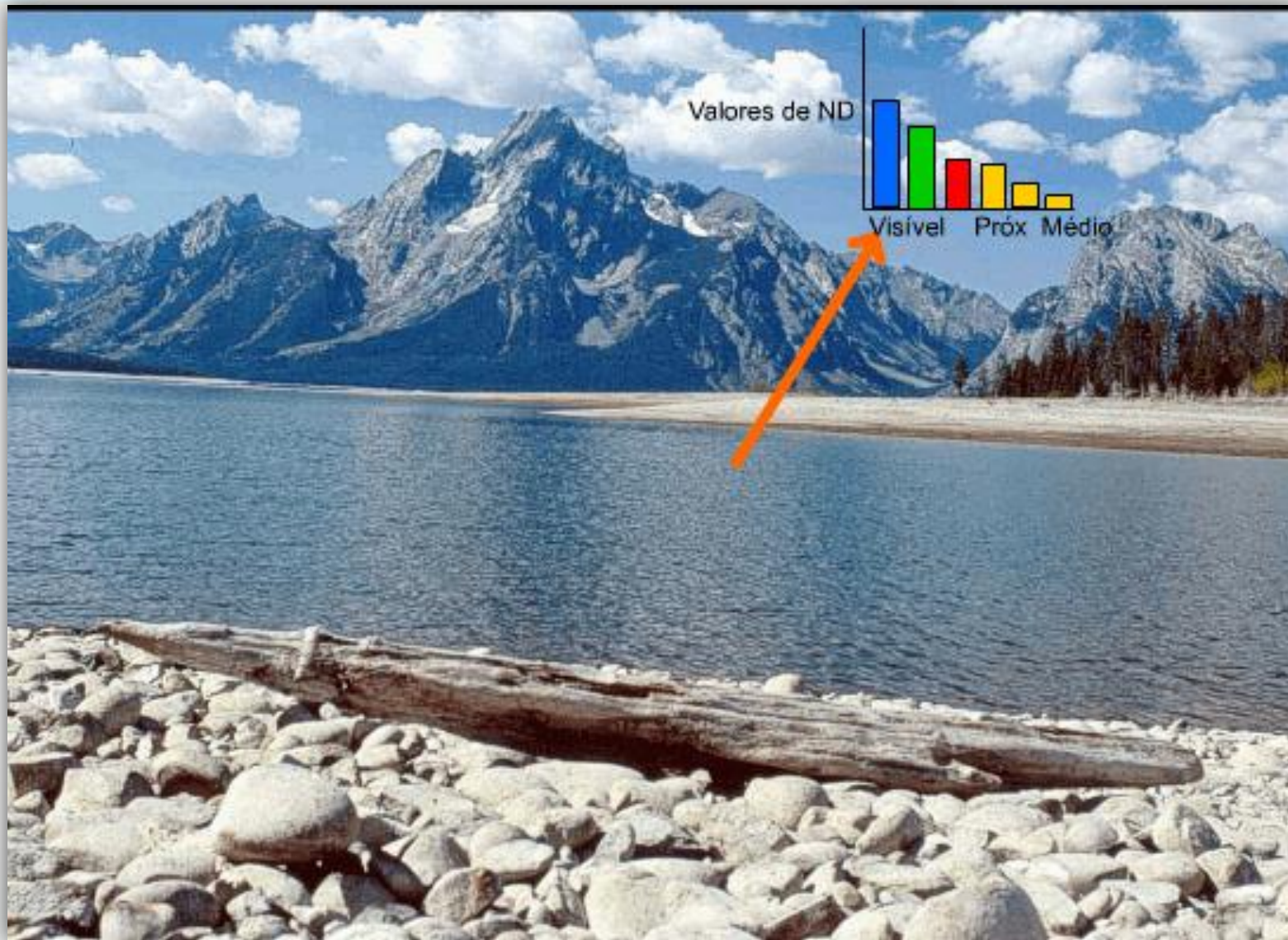


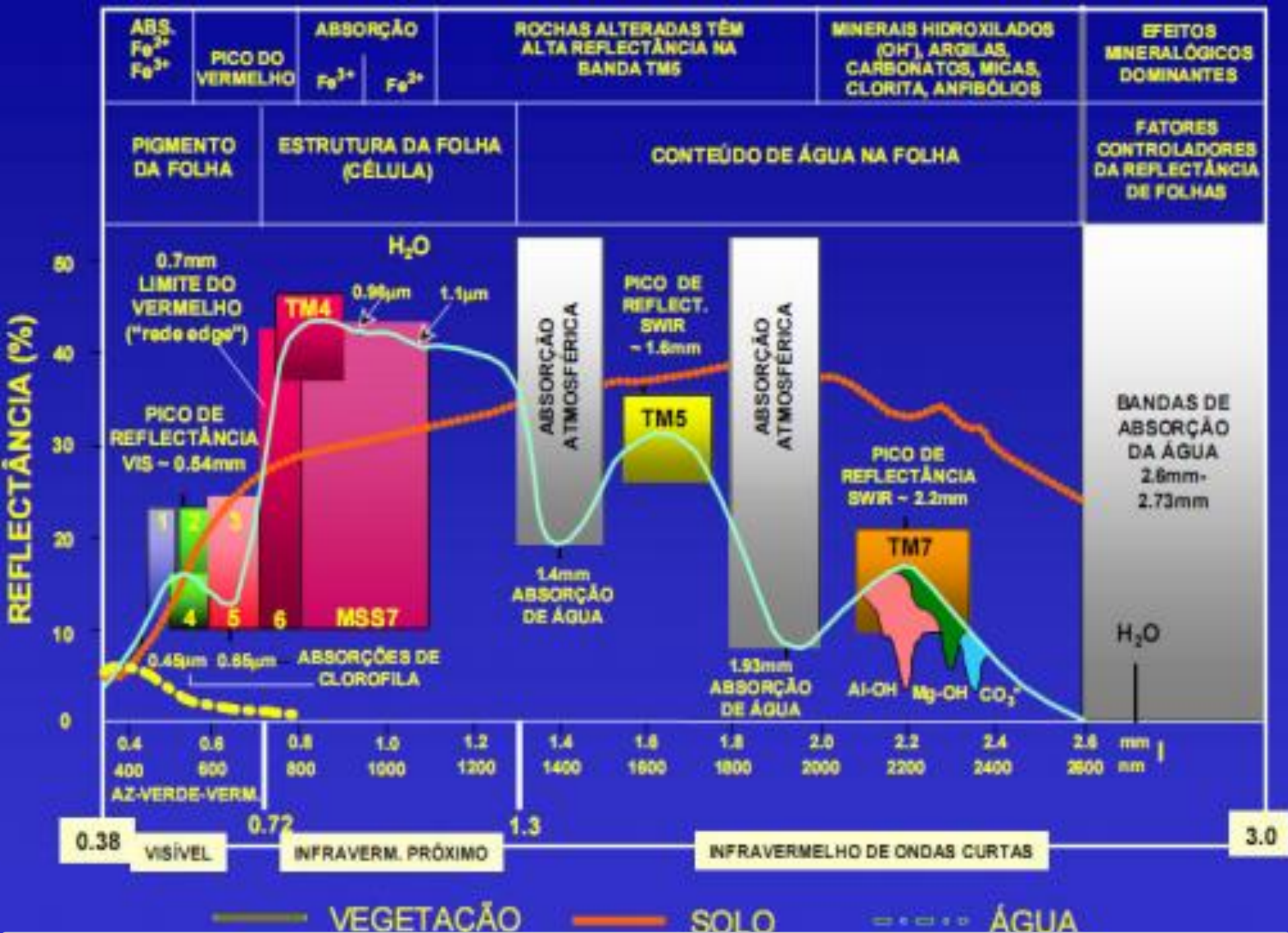
Respostas Espectrais



Fonte: Teresa G. Florenzano





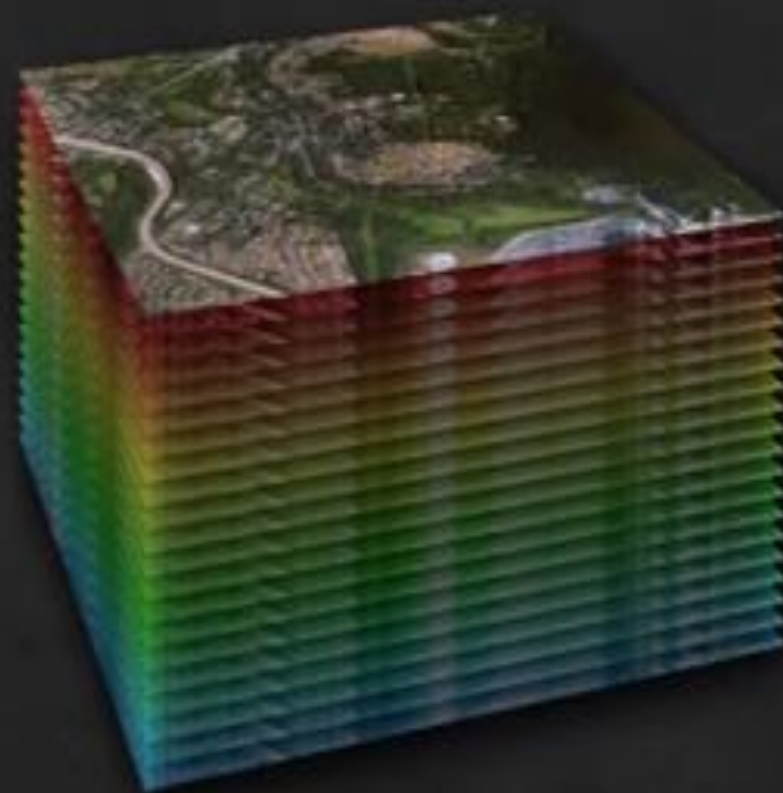
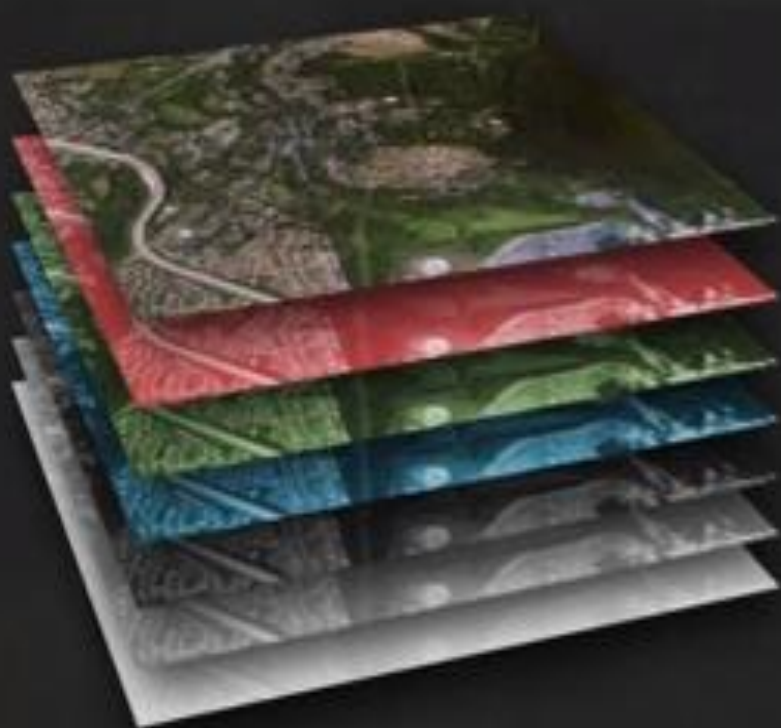


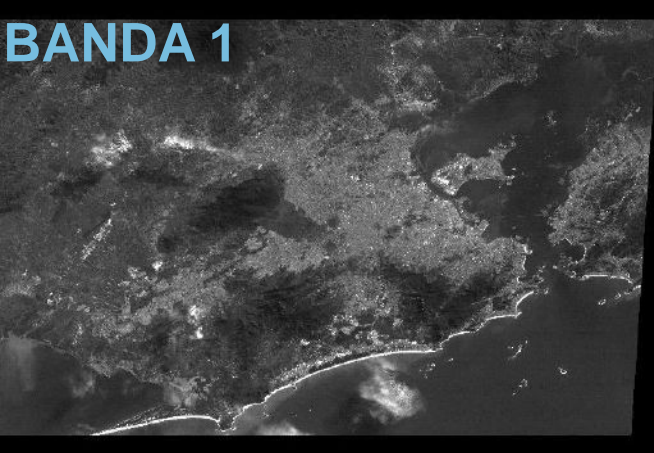
Multiespectral

- Algumas bandas (ex: 36)

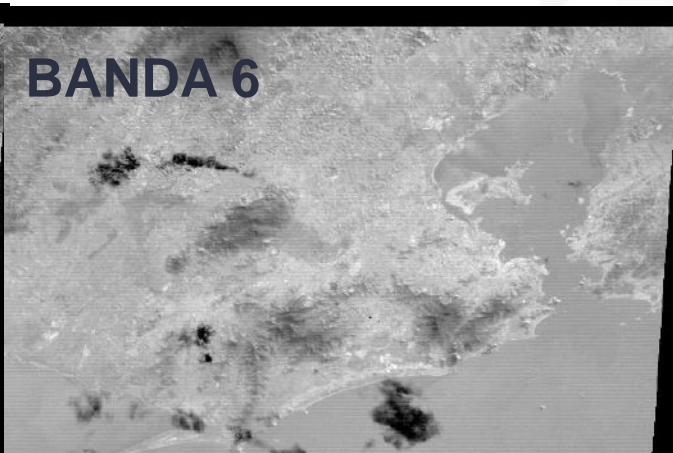
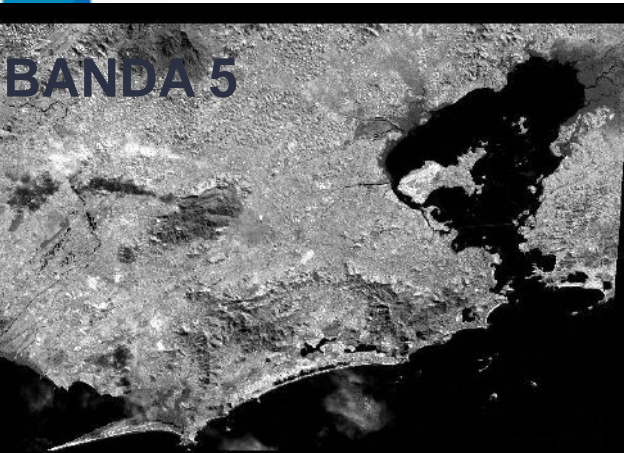
Hiperespectral

- Acima de 100 bandas

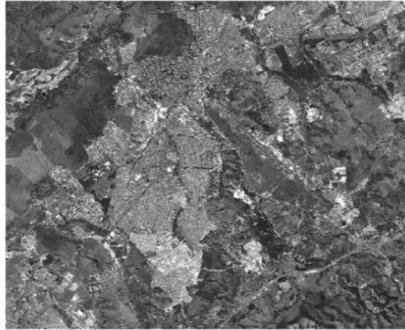




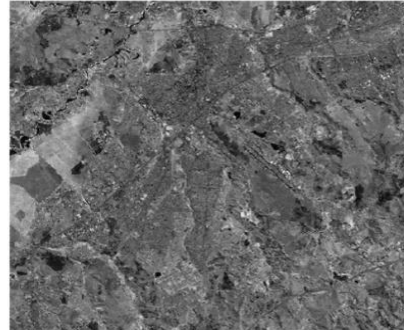
RIO DE JANEIRO



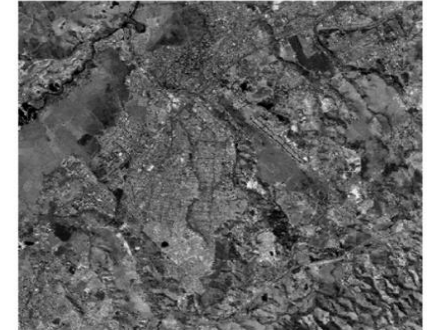
Banda 3
Visível



Banda 4
Infravermelho



Banda 5
Infravermelho



Filtro Azul



Filtro Verde



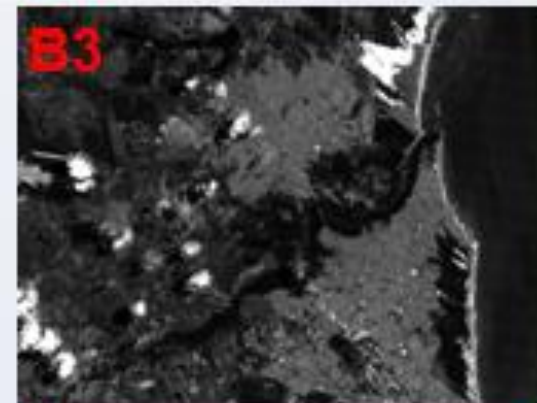
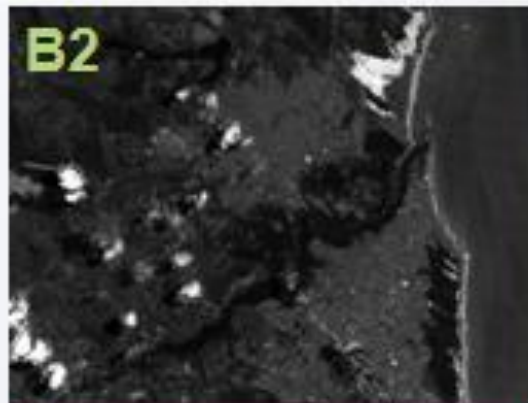
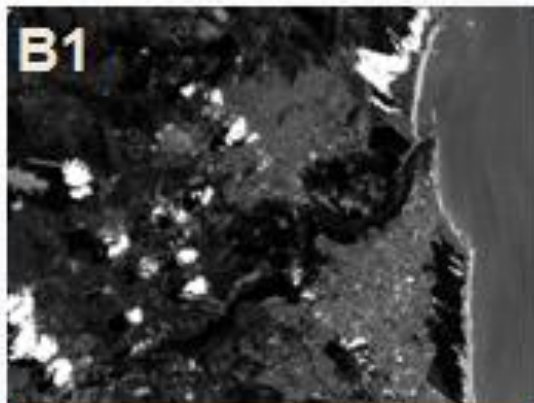
Filtro Vermelho

Banda 3,4 e 5

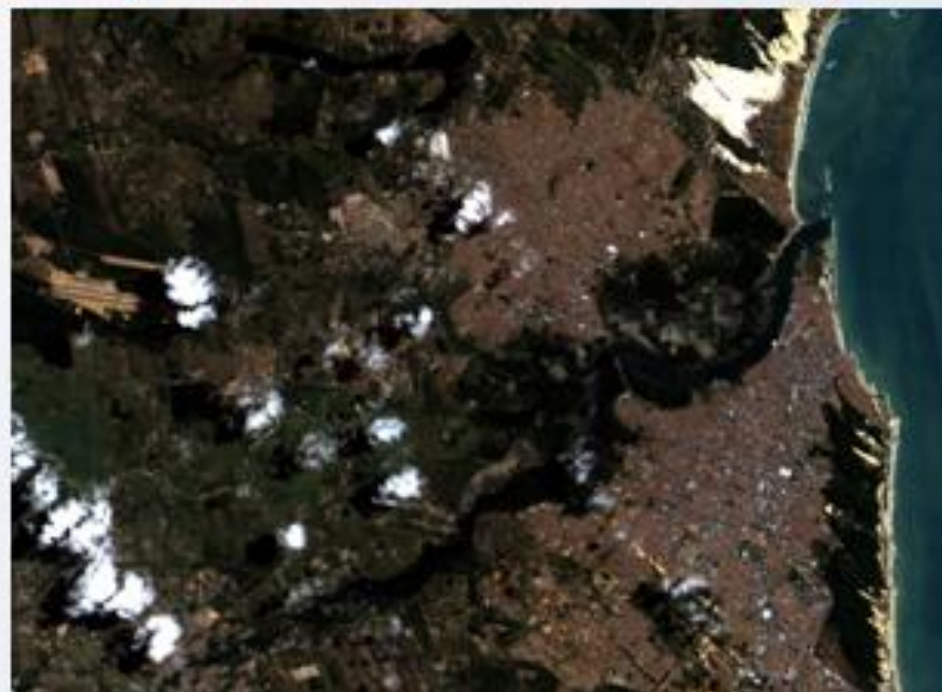


Colorida

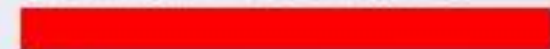
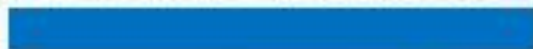
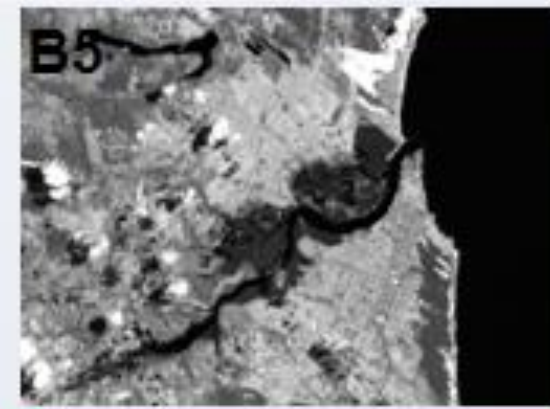
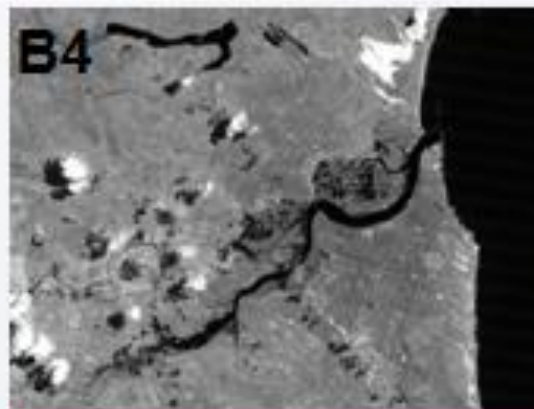
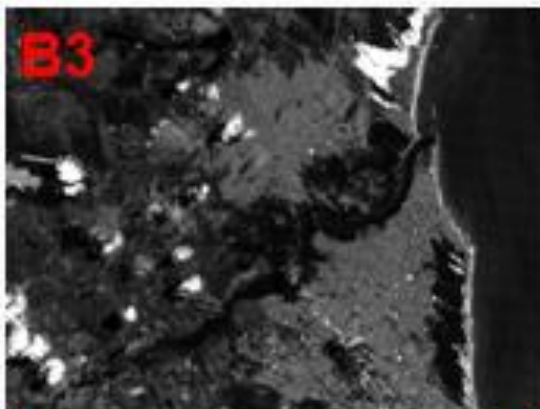
Composição Colorida



**Cor
Verdadeira**



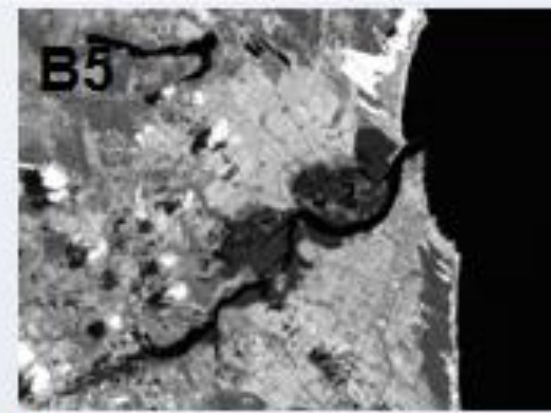
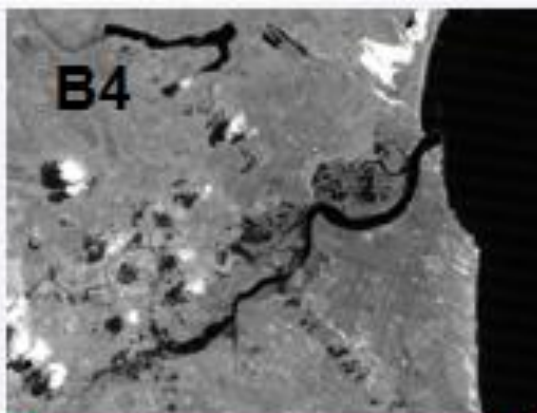
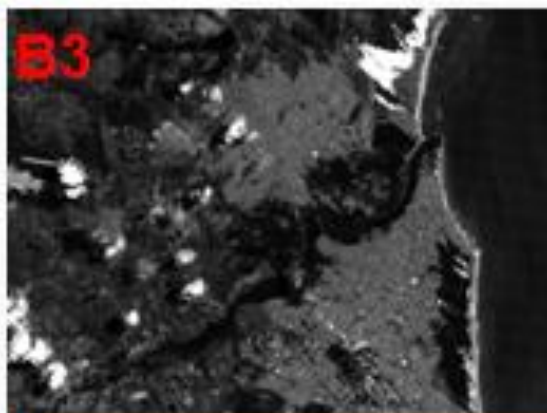
Composição Colorida



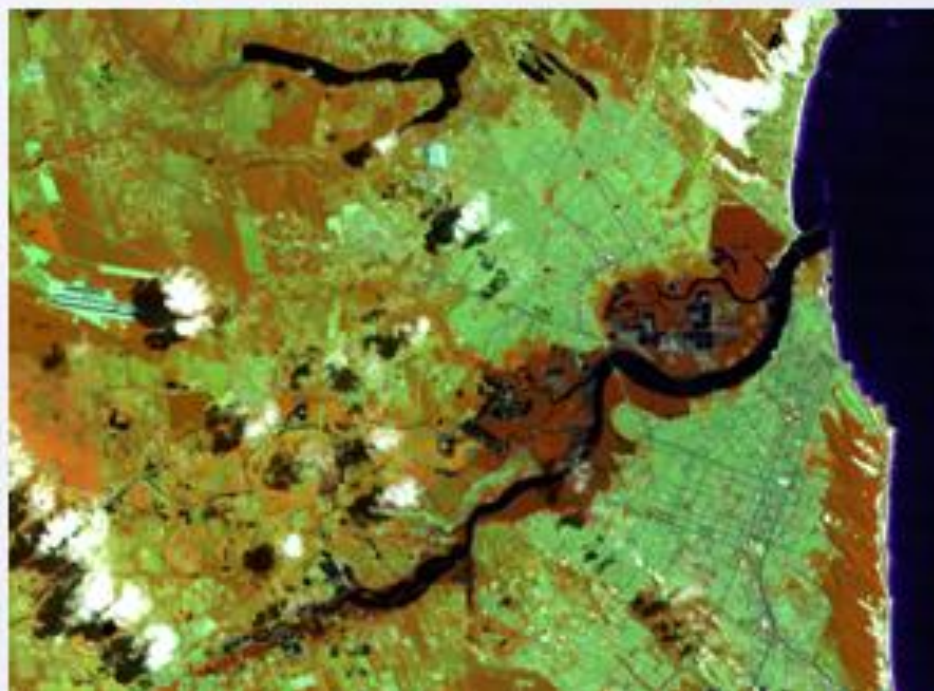
**Cor
Falsa**



Composição Colorida

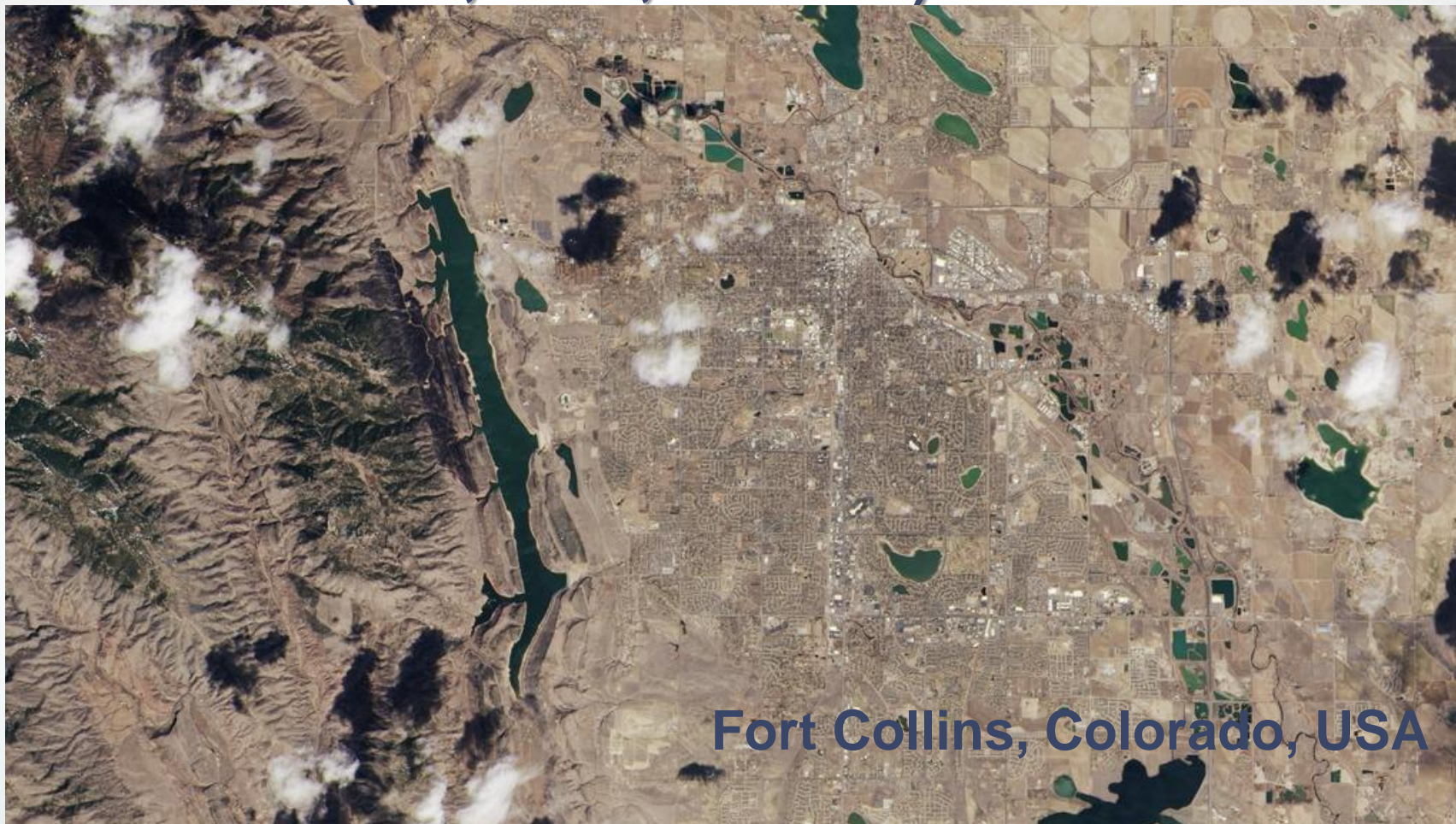


**Cor
Falsa**



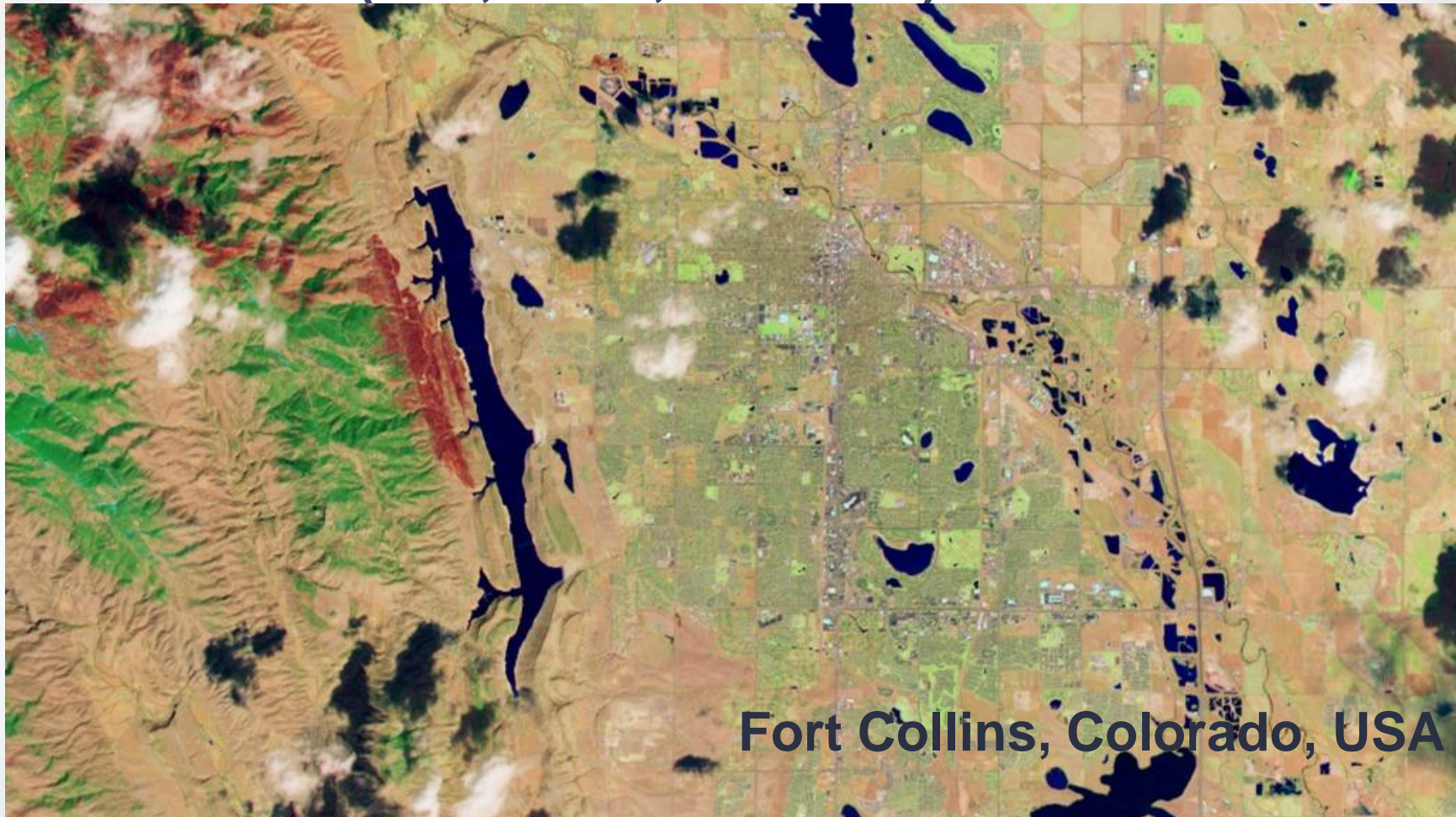
	Bandas Landsat-8	Comprimento de onda (micrometros)	Resolução (metros)
OLI	Banda 1 – Aerossol Costeiro	0,43 – 0,45	30
	Banda 2 – Azul	0,45 – 0,51	30
	Banda 3 – Verde	0,53 – 0,59	30
	Banda 4 – Vermelha	0,64 – 0,67	30
	Banda 5 – Infravermelho Próximo (NIR)	0,85 – 0,88	30
	Banda 6 – SWIR ₁	1,57 – 1,65	30
	Banda 7 – SWIR ₂	2,11 – 2,29	30
	Banda 8 – Pancromático	0,50 – 0,68	15
	Banda 9 – Cirrus	1,36 – 1,38	30
TIRS	Banda 10 – Infravermelho Termal (TIRS) ₁	10,60 – 11,19	100
	Banda 11 - Infravermelho Termal (TIRS) ₂	11,50 – 12,51	100

Combinação de bandas 2, 3, 4 cor verdadeira (azul, verde, vermelho)



Realça informações sobre: Corpos de água (regiões de águas rasas; turbidez; correntes; e sedimentos em suspensão), Áreas Urbanas e Vegetação

Combinação de bandas 3(verde), 5(NIR), 7(SWIR) (azul, verde, vermelho)



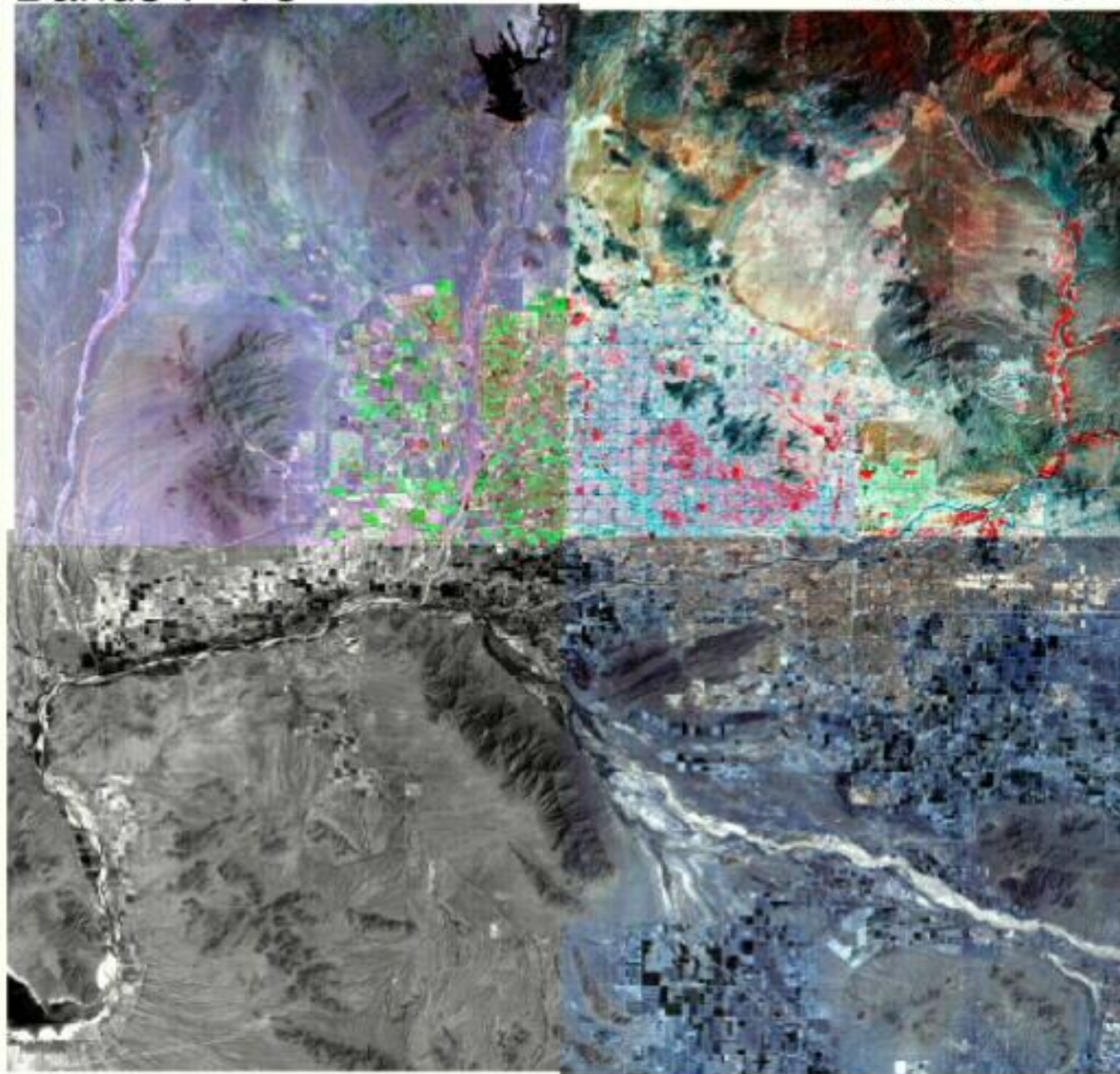
Combinação de duas bandas no IR possibilita a maior diferenciação entre solo e água; Tipos e condições de vegetações; Áreas urbanas e Solos expostos.

Aplicações	Bandas B G R
Cor Verdadeira	4 3 2
Falsa Cor (urbano)	7 6 4
Cor Infravermelha (vegetação)	5 4 3
Agricultura	6 5 2
Penetração Atmosférica	7 6 5
Vegetação Saudável	5 6 2
Solo/água	5 6 4
Natural com Remoção Atmosférica	7 5 3
Infravermelho Solar	7 5 4
Análise da Vegetação	6 5 4

Bands 7-4-5

Bands 4-3-2

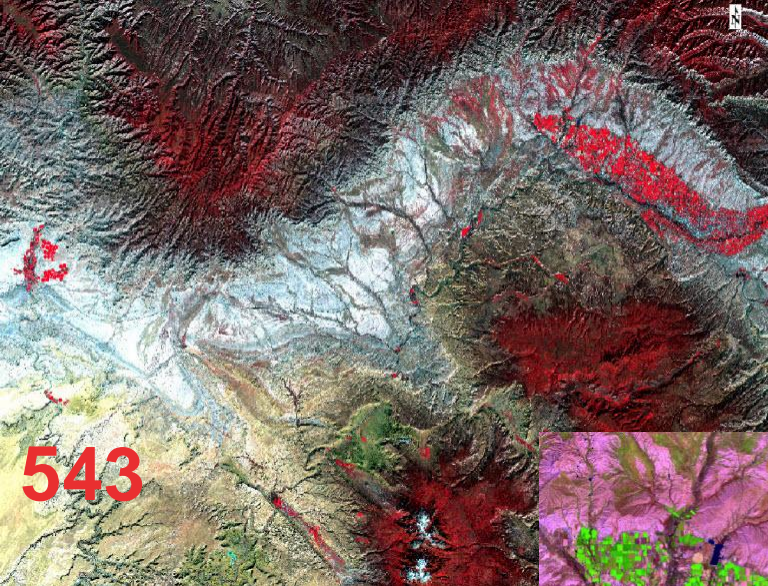
Landsat 8 Sensor OLI



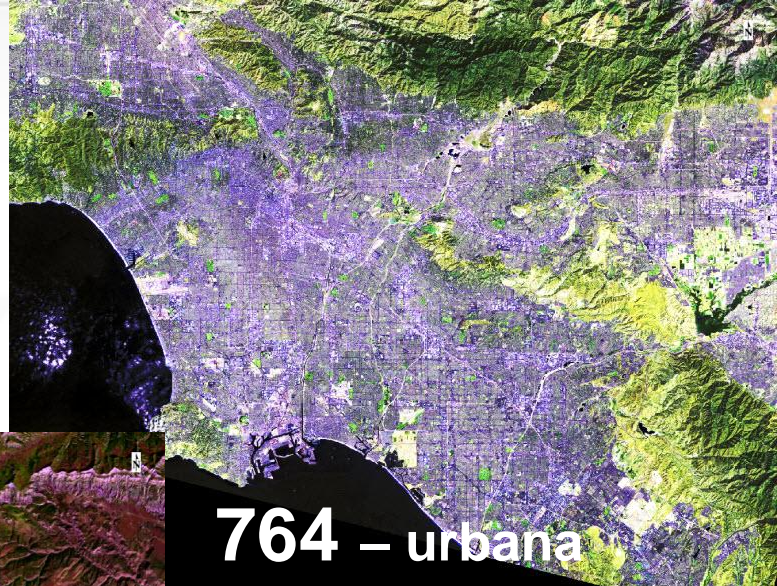
Bands 7-5-3

Landsat Band 1

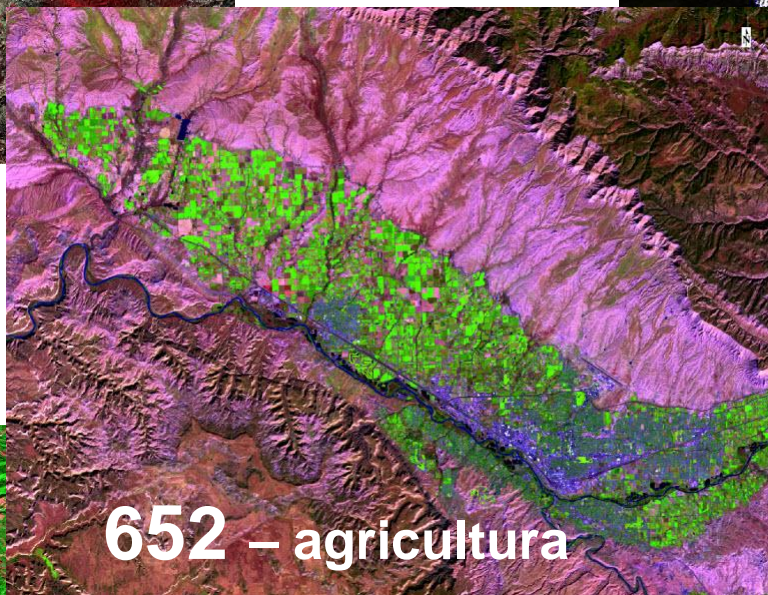
Bands 3-2-1



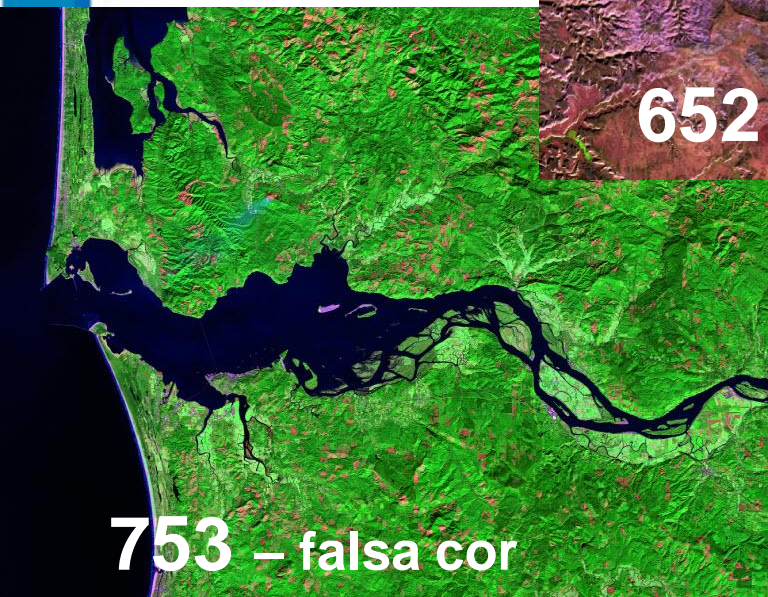
543



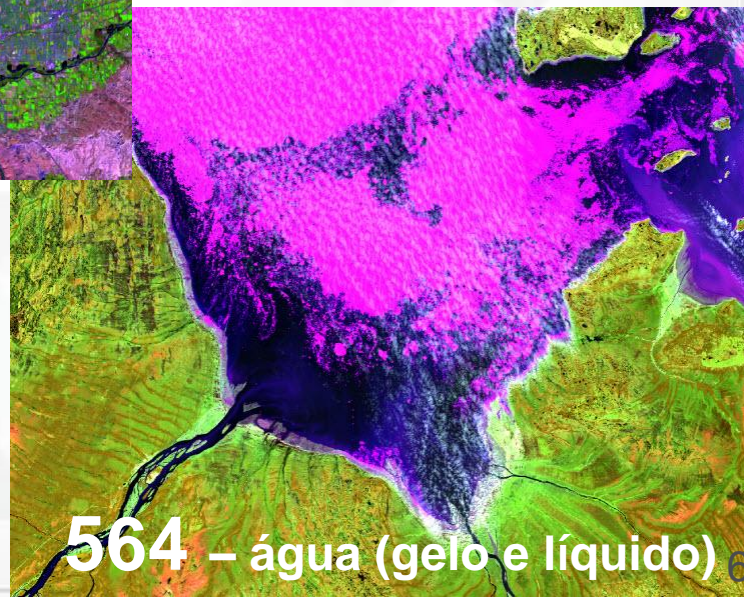
764 – urbana



652 – agricultura

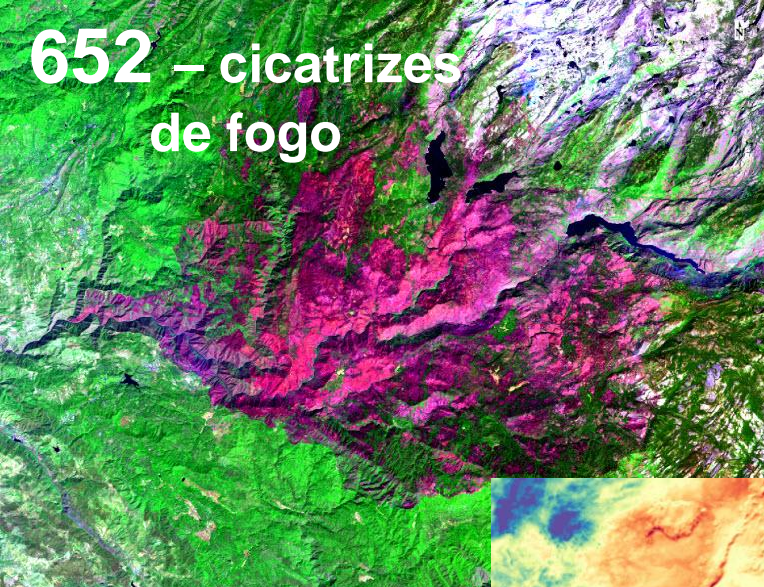


753 – falsa cor



564 – água (gelo e líquido)

652 – cicatrizes
de fogo



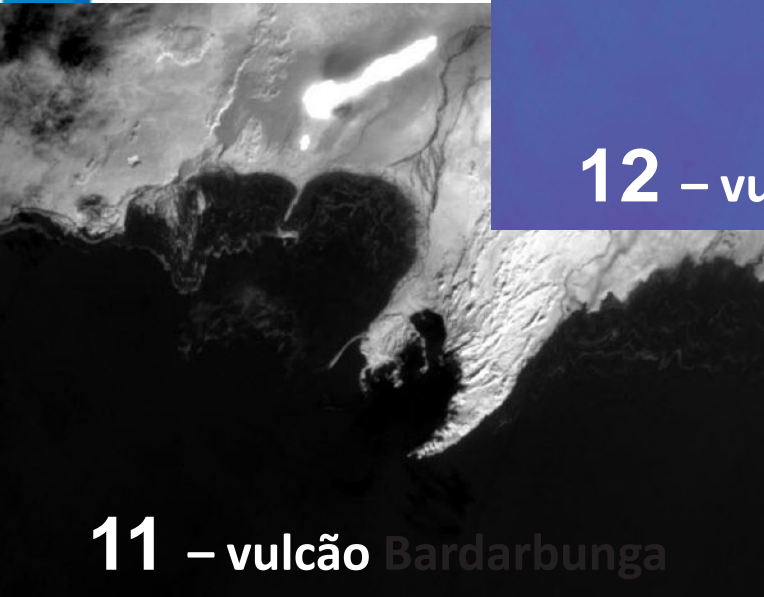
571 – qualidade de água e
aerossóis



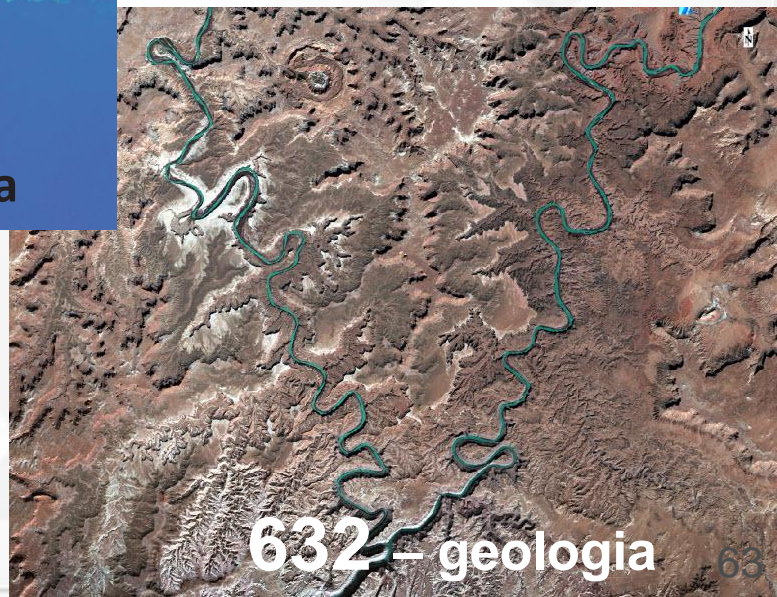
12 – vulcão Bardarbunga



11 – vulcão Bardarbunga



632 – geologia



Sugestões de sites

Desmatamento: Atividades realizada na Amazônia

https://www.youtube.com/watch?v=kg9Yb8_nAlc

Cartilhas didáticas

http://www.inpe.br/ensino_documentacao/difusao_conhecimento/cartilhas_didaticas.php

Vídeos Educacionais

<http://videoseducacionais.cptec.inpe.br/>

<http://www.inpe.br/noticias/videos.php>

<https://www.youtube.com/watch?v=oOjFJhM2YJM&t=104s>

A Terra em 100 Anos e o Simulador Terrestre

https://youtu.be/Ftbx4_kYRUg

ESPECIAL ON-LINE

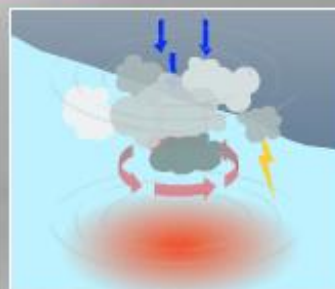
desastres naturais



Terremotos



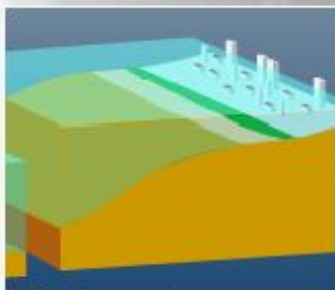
Furacões



Cronologia (1900 - 2008)

MORTOS	ANO
8 mil	1900 Galveston (EUA), furacão
38 mil	1902 Martinica, vulcão Pelée
3 mil	1906 SAIBA MAIS San Francisco (EUA), terremoto com incêndios
20 mil	1906 Chile, terremoto
70 mil	1908 Messina (Itália), terremoto
200 mil	1920 Gansu (China), terremoto
143 mil	1923 SAIBA MAIS Yokohama (Japão), terremoto
200 mil	1927 Nanshan (China), terremoto
1,8 mil	1928 Flórida (EUA), furacão

Tsunamis



Outros fenômenos



▪ Vulcões, enchentes, secas e ondas de calor, nevascas e avalanches

Contexto



▪ Homem x natureza: as tragédias na história e como elas mudam tudo

Outras tragédias (1500 - 1900)

[clique aqui](#)

http://veja.abril.com.br/especiais_online/desastres_naturais/
Atualmente só disponibilizado só para assinantes