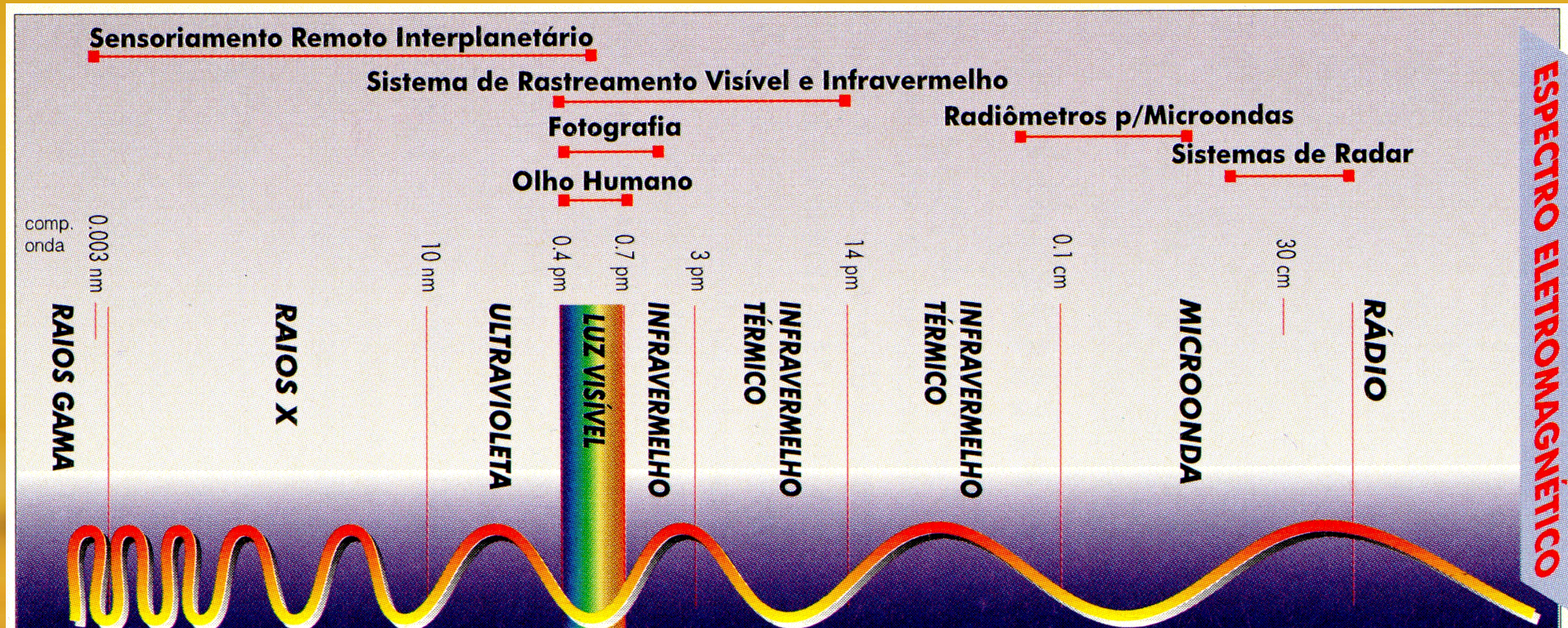


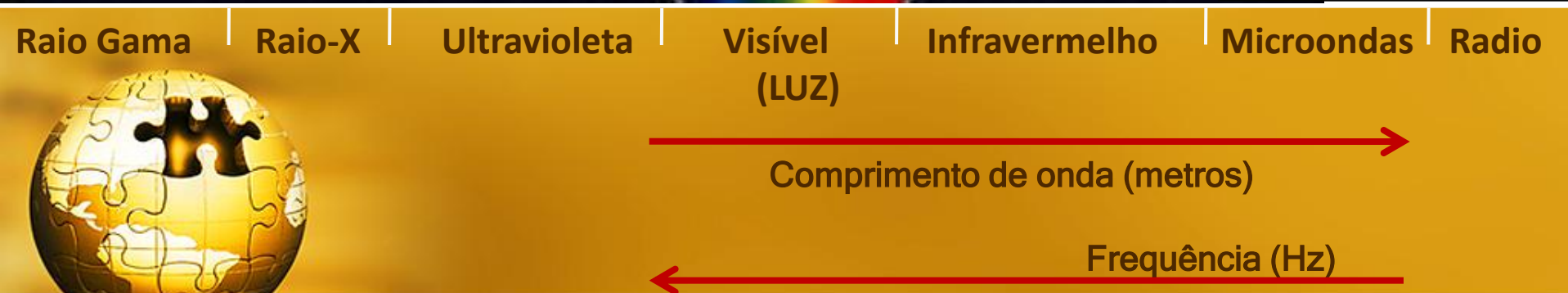
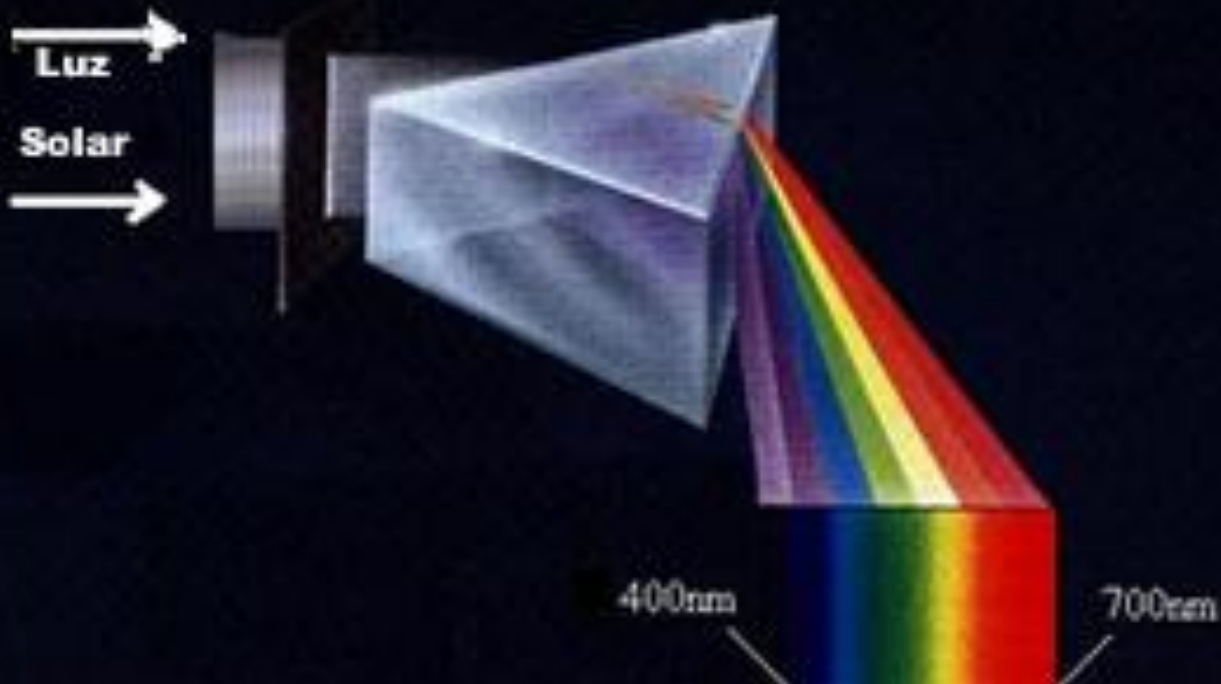
Espectro Eletromagnético

Regiões espectrais de interesse do Sensoriamento Remoto:
Ótico e Microondas



ESPECTRO ELETROMAGNÉTICO

Espectro Eletromagnético



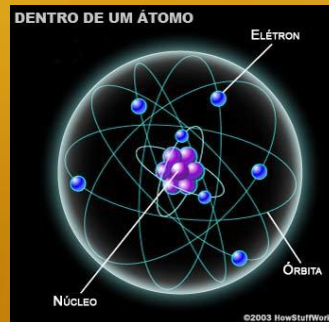
O que é 1 micrometro?

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



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, $1\text{ nanômetro} = 0,000000001\text{ m}$



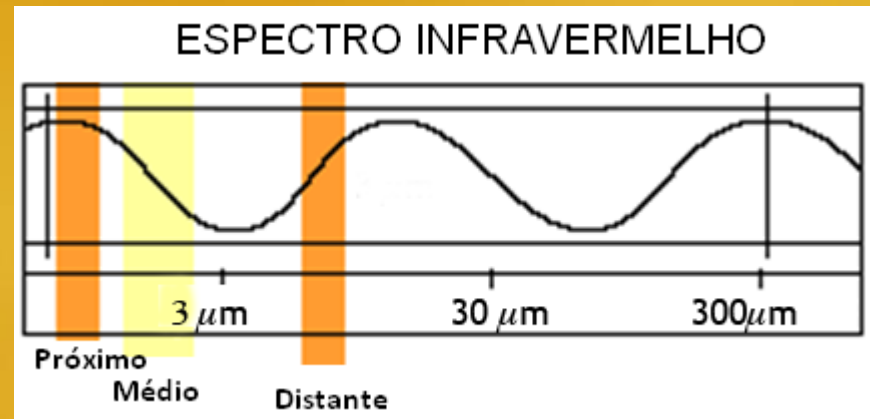
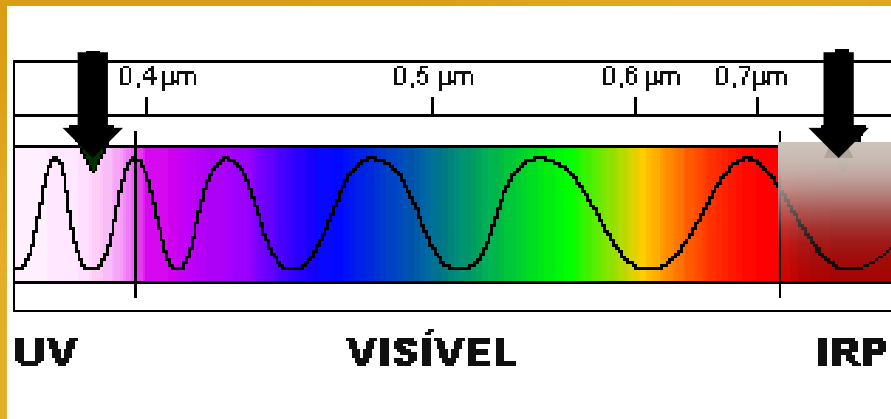
Faixas espectrais importantes para o SR

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

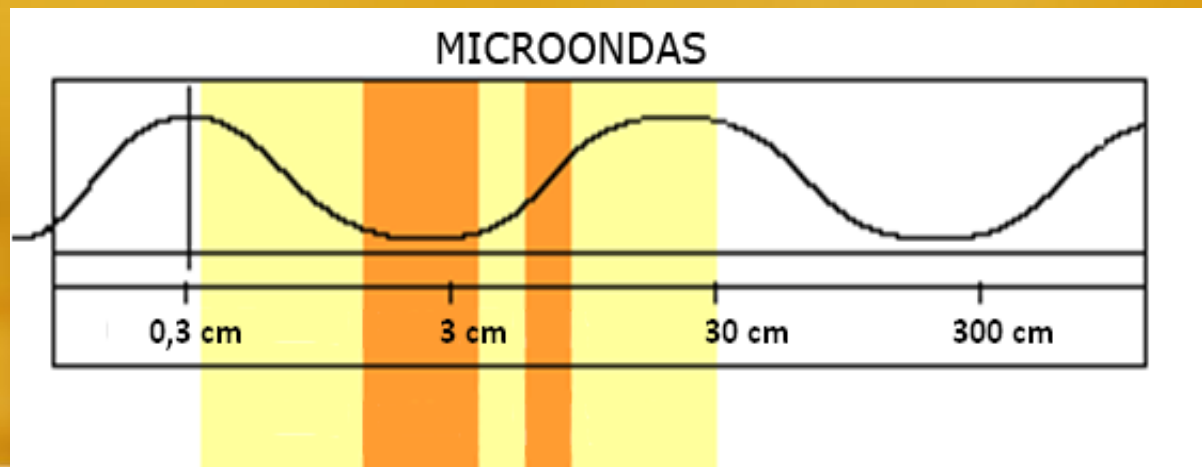


Regiões Espectrais

SENSORIAMENTO REMOTO PASSIVO

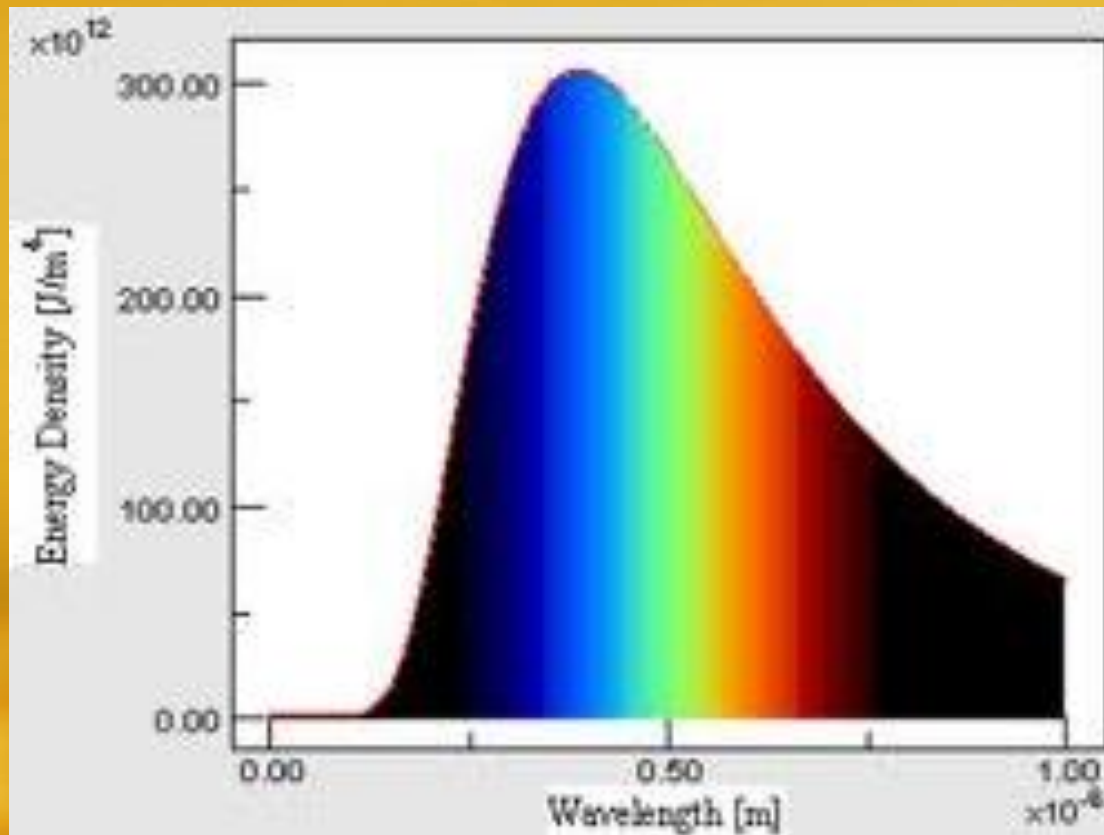


SENSORIAMENTO REMOTO ATIVO



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



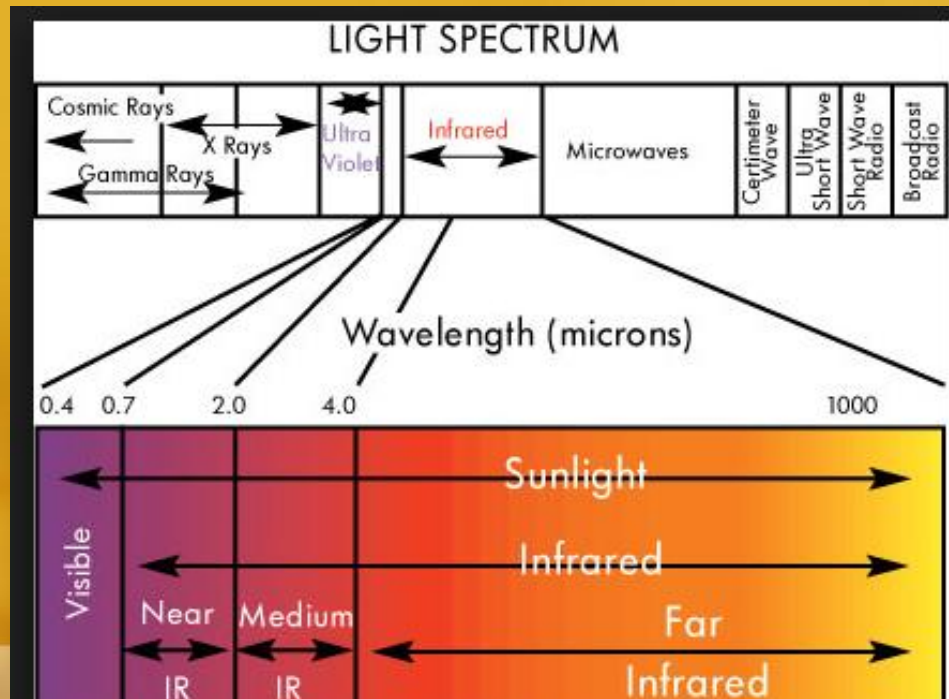
Infravermelho

NIR - “Near Infrared”

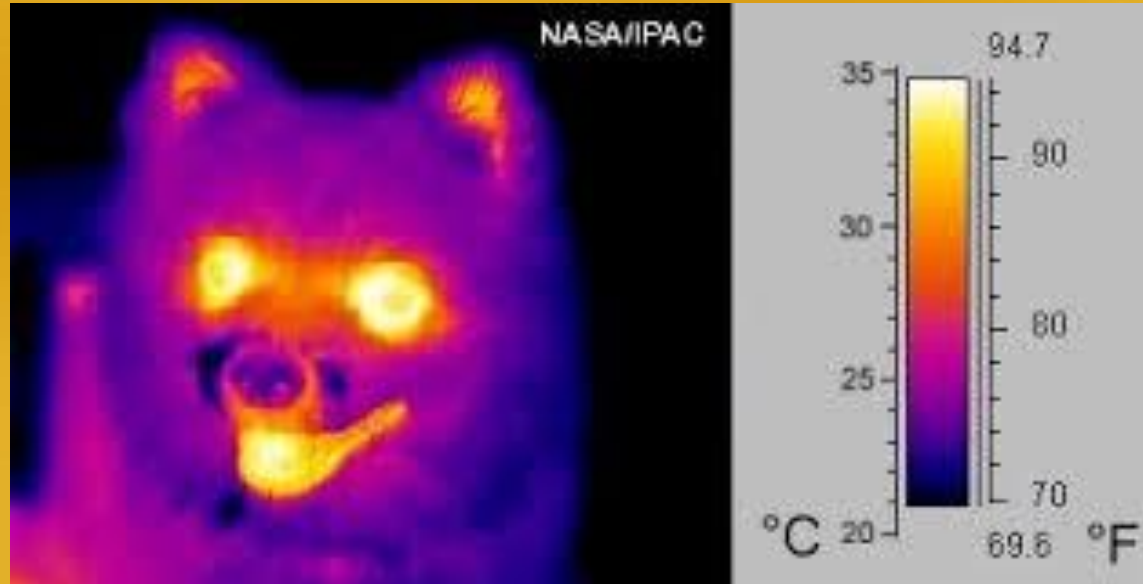
SWIR - “Short Wavelength Infrared”

MWIR - “Middle Wavelength Infrared”

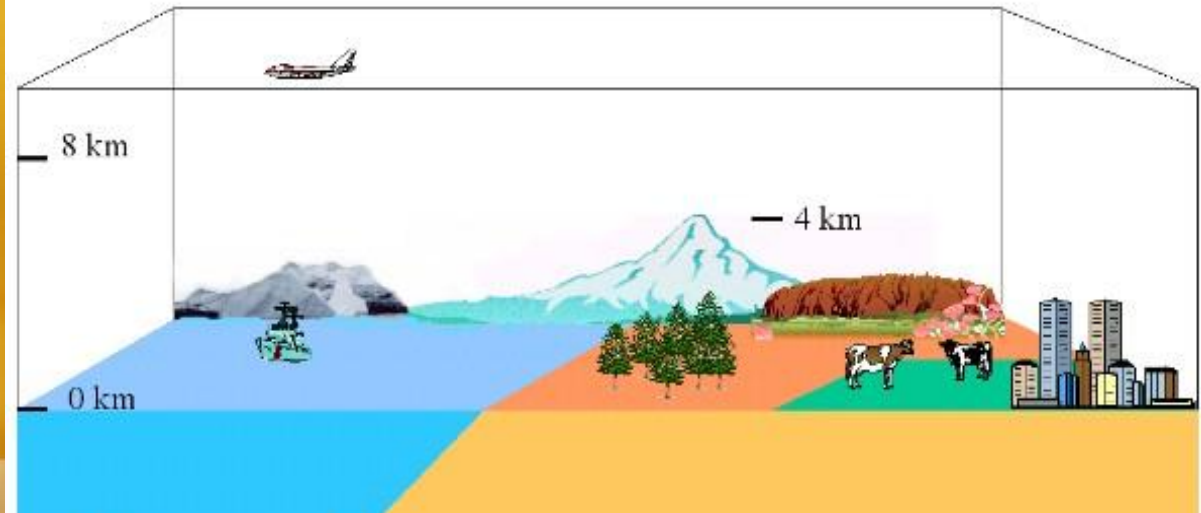
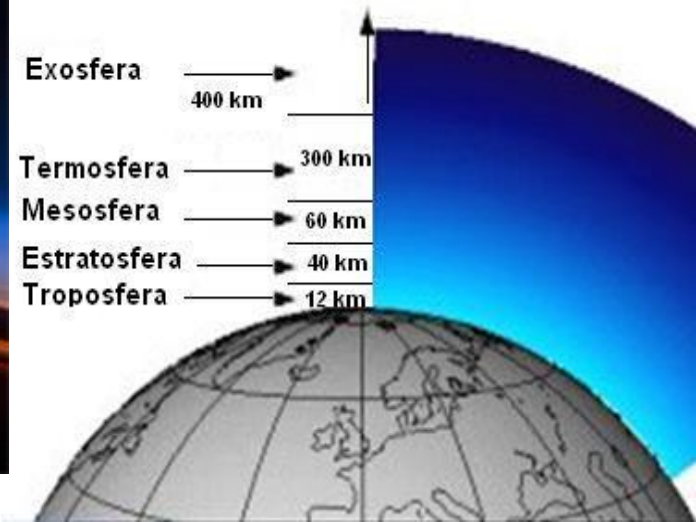
LWIR - “Long Wavelength Infrared”



Infravermelho distante



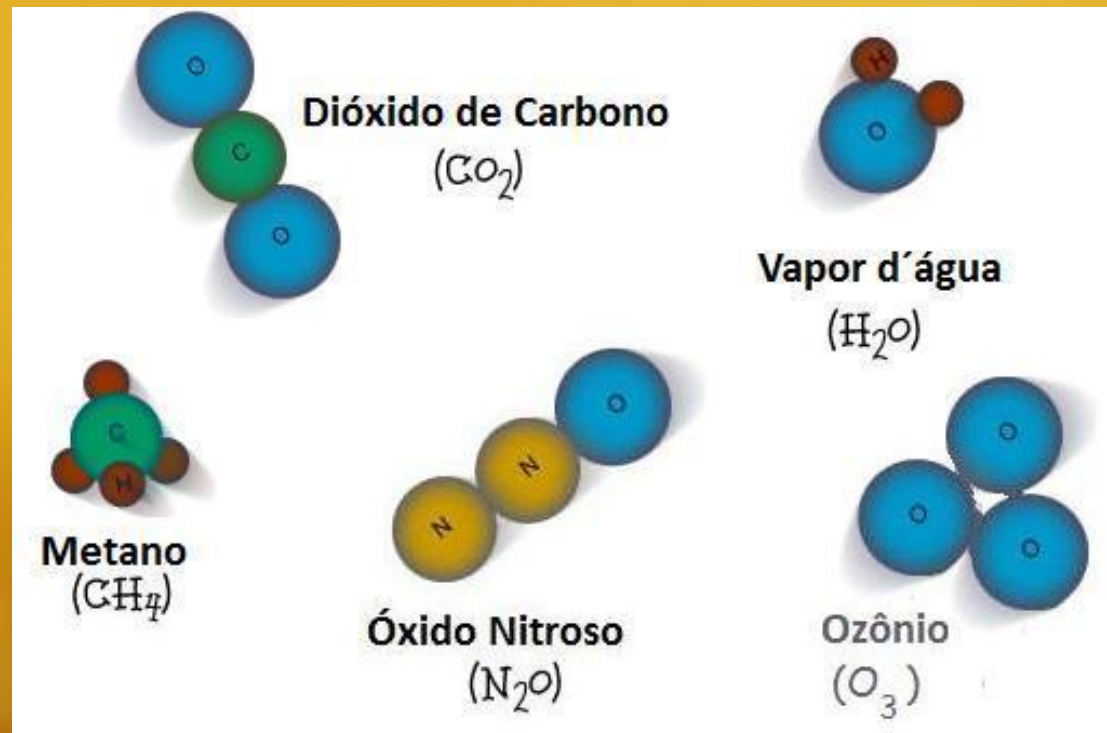
Espaço Profundo



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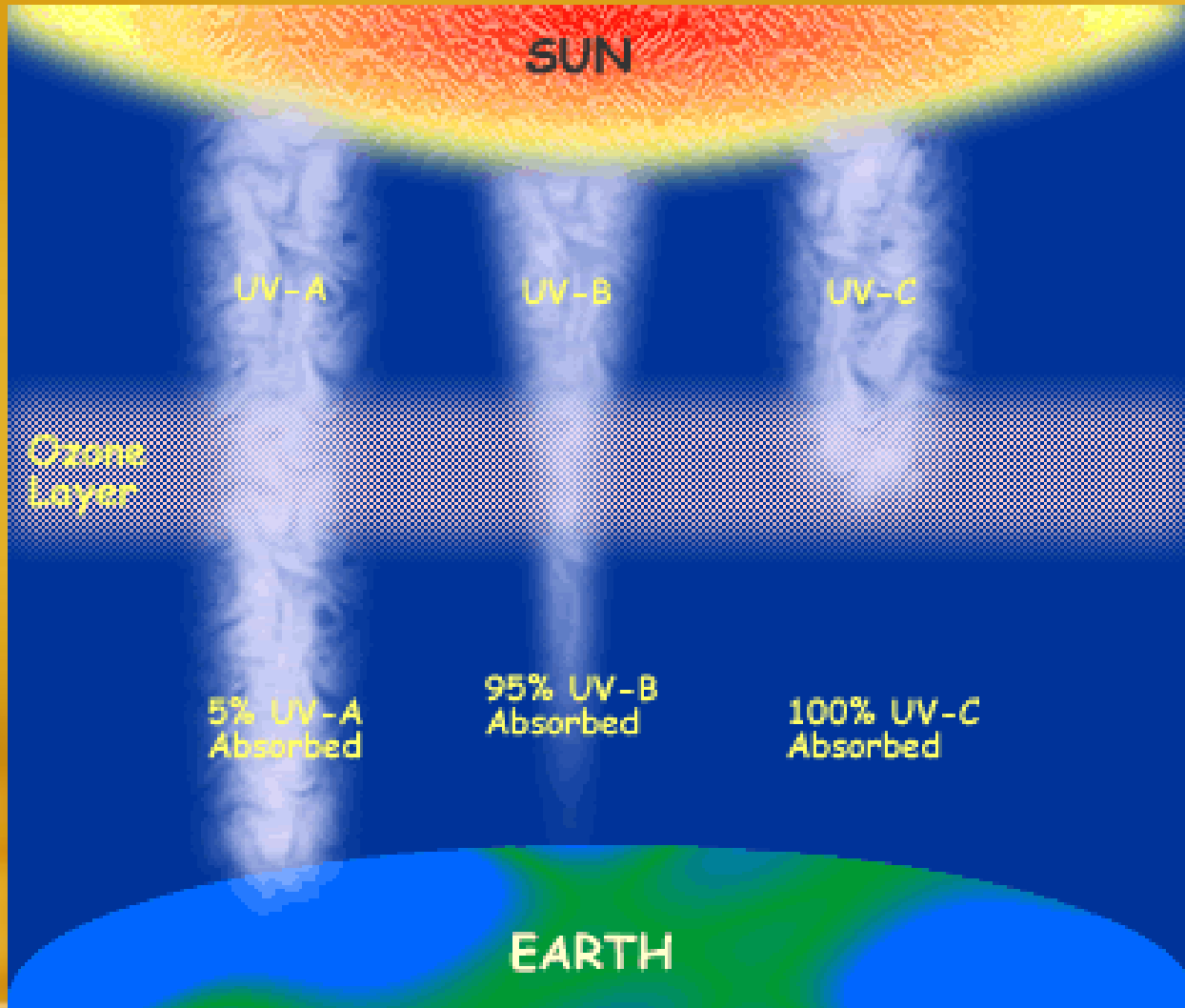
Interação da Radiação Solar com a Atmosfera

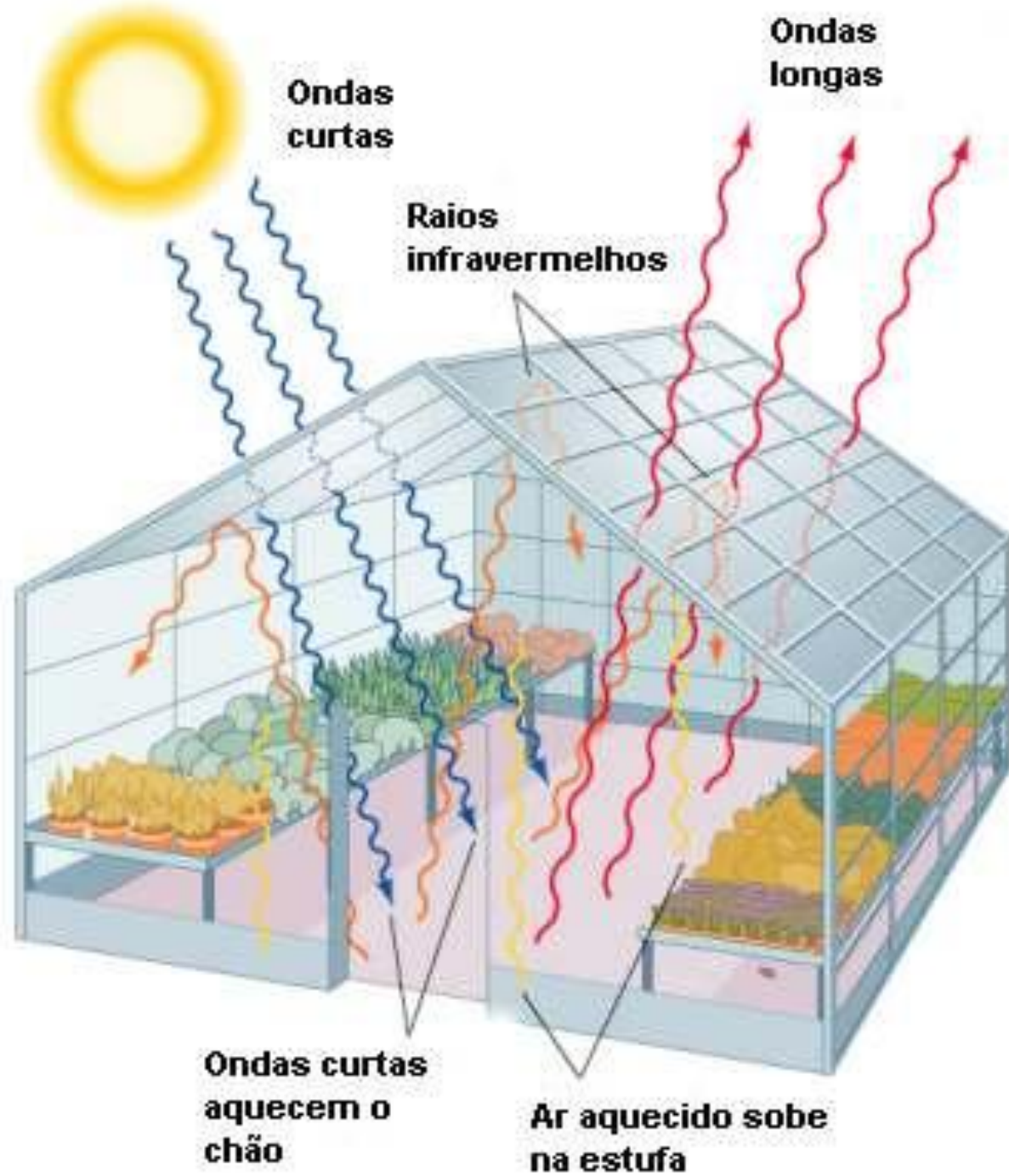
- A energia eletromagnética ao atravessar a atmosfera é absorvida, refletida e espalhada pelos gases nela presentes

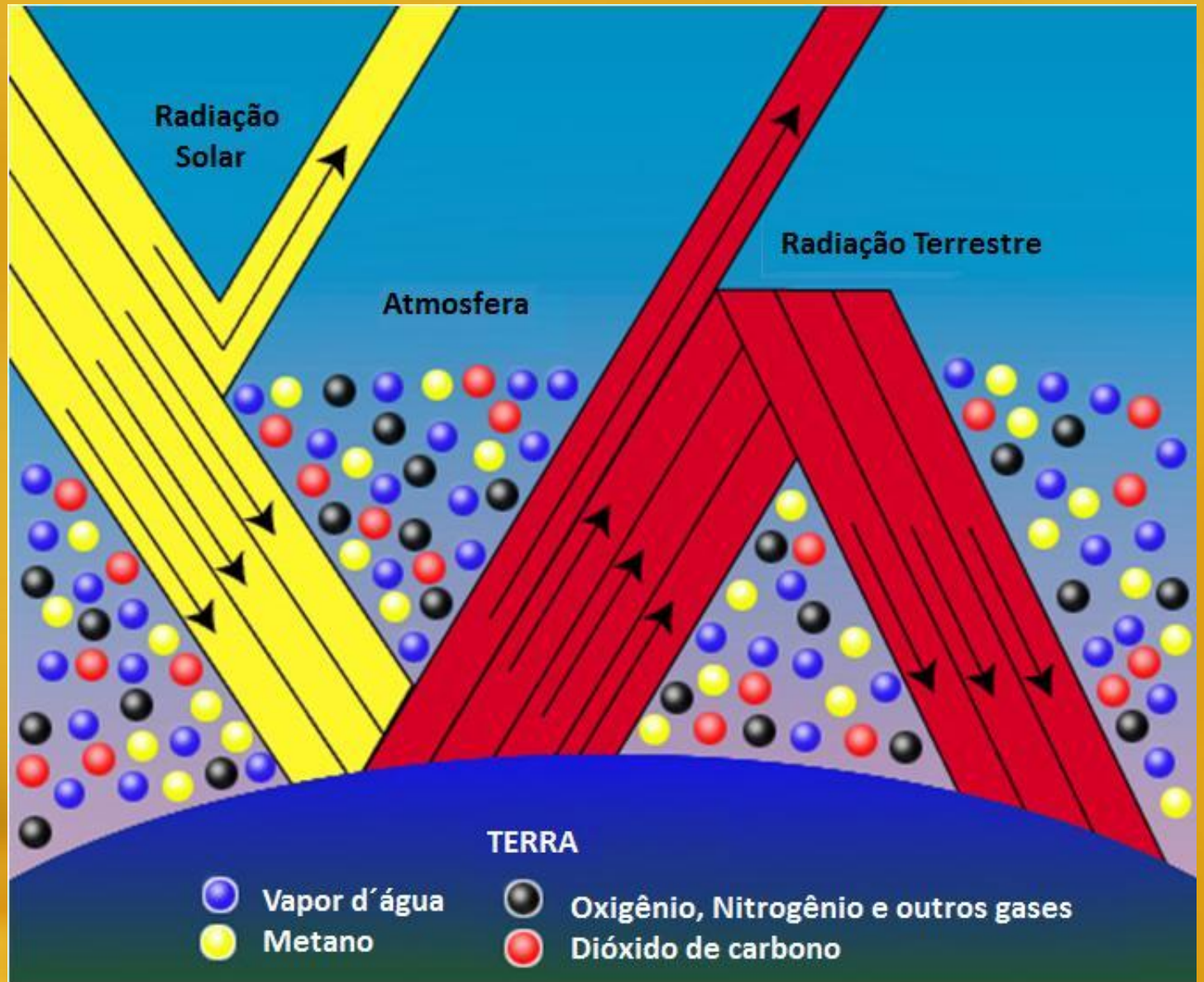


Ultravioleta

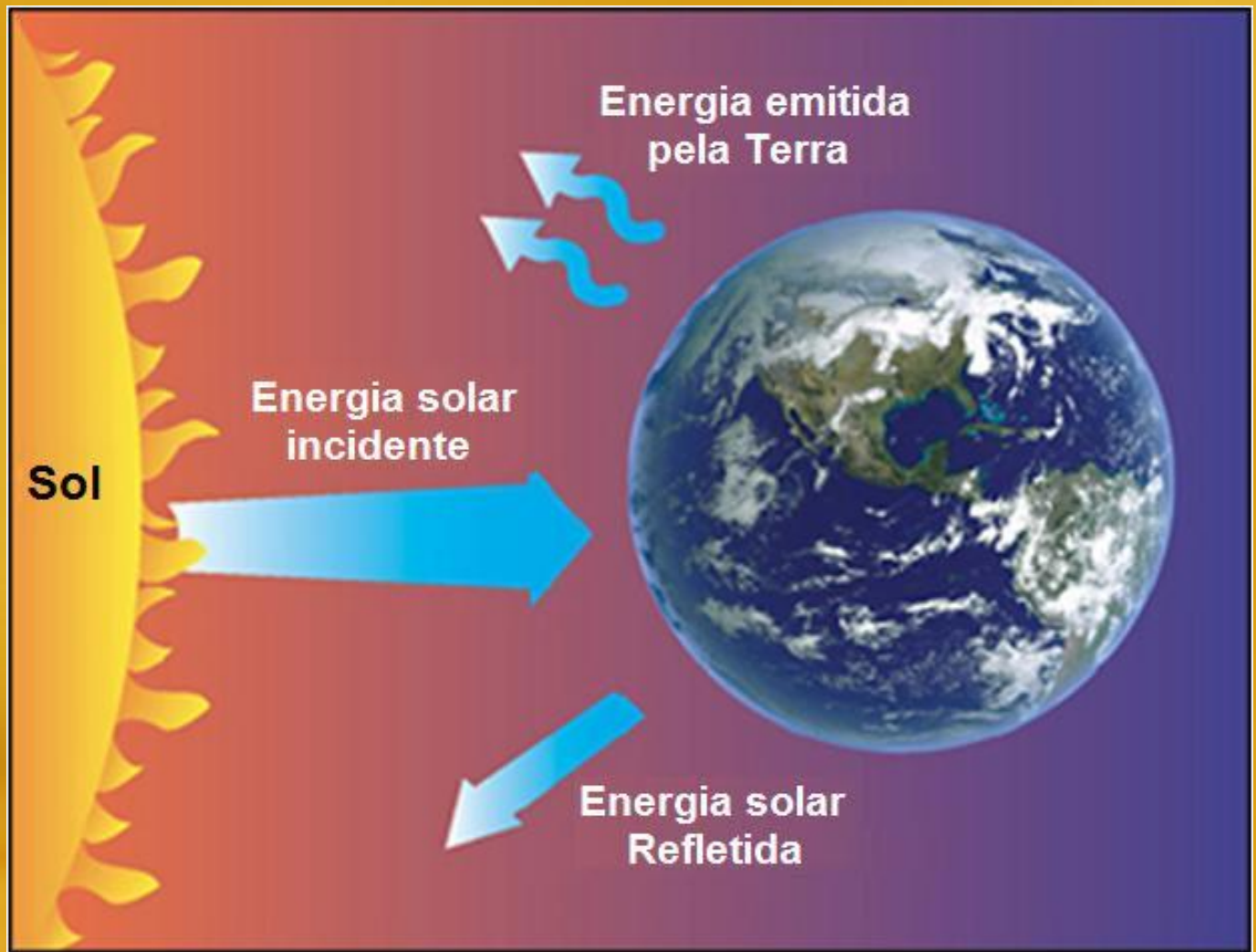
Estrelas e outros objetos quentes emitem energia em UV



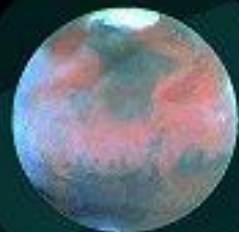




Balanço de Radiação



Mars
Thin atmosphere
(Almost all CO₂ in ground)



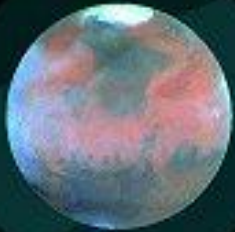
Earth
0,03% of CO₂ in the atmosphere



Venus
Thick atmosphere
containing 96% of CO₂



Mars
Thin atmosphere
(Almost all CO₂ in ground)
Average temperature : - 50°C



Earth
0,03% of CO₂ in the atmosphere
Average temperature : + 15°C

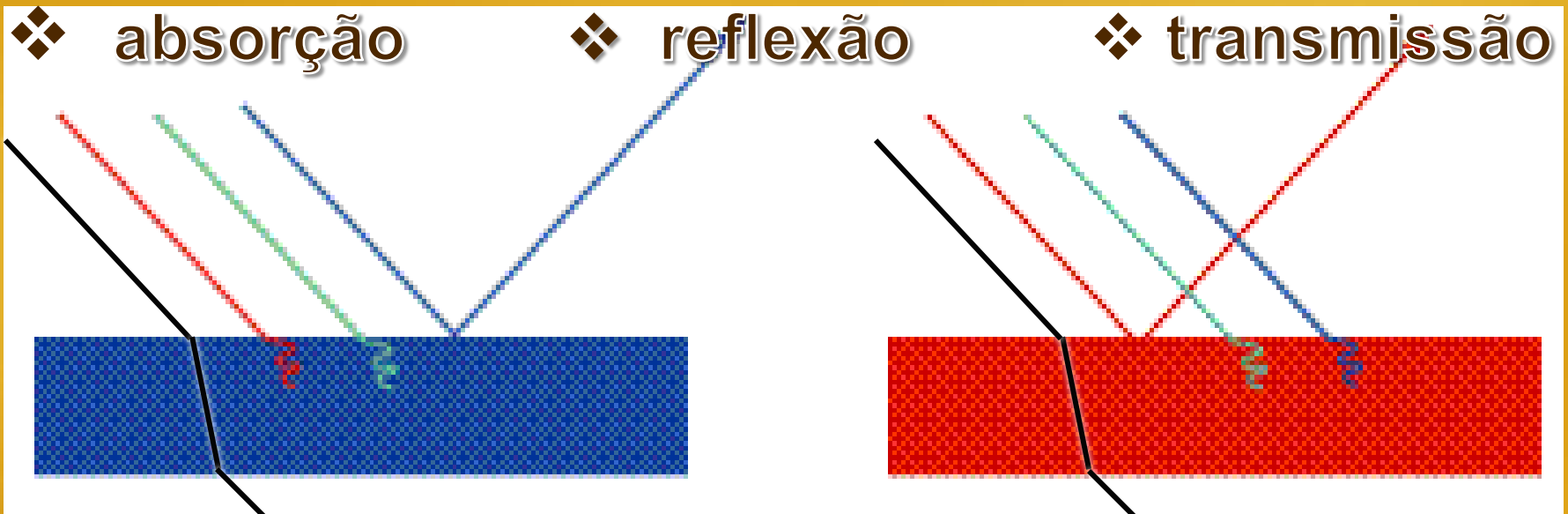


Venus
Thick atmosphere
containing 96% of CO₂
Average temperature : + 420°C



**Pressão atmosférica 90 vezes maior
que a da Terra, T chegando a 482°C**

Interação Energia Eletromagnética x Objeto



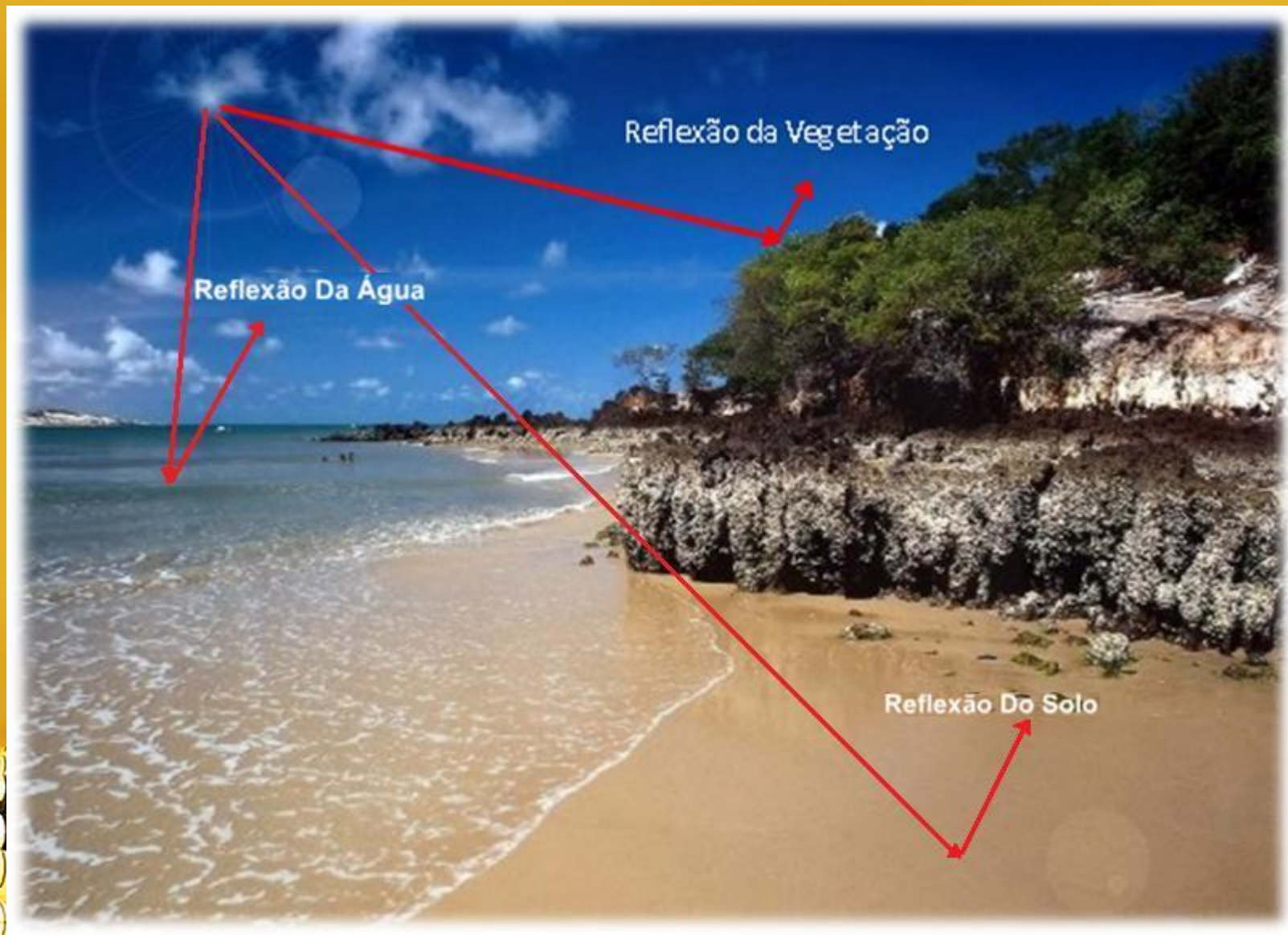


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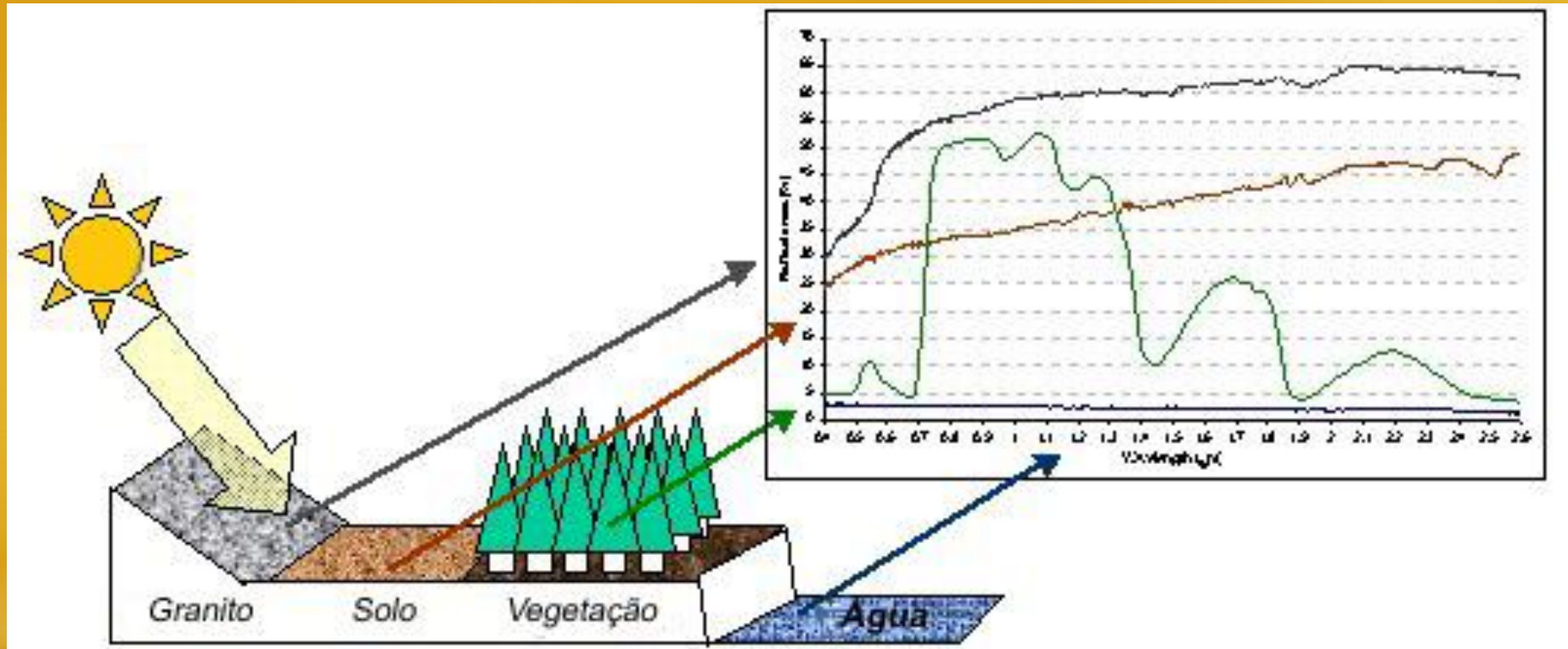




Curso de Uso Escolar de Sensoriamento Remoto - Inpe

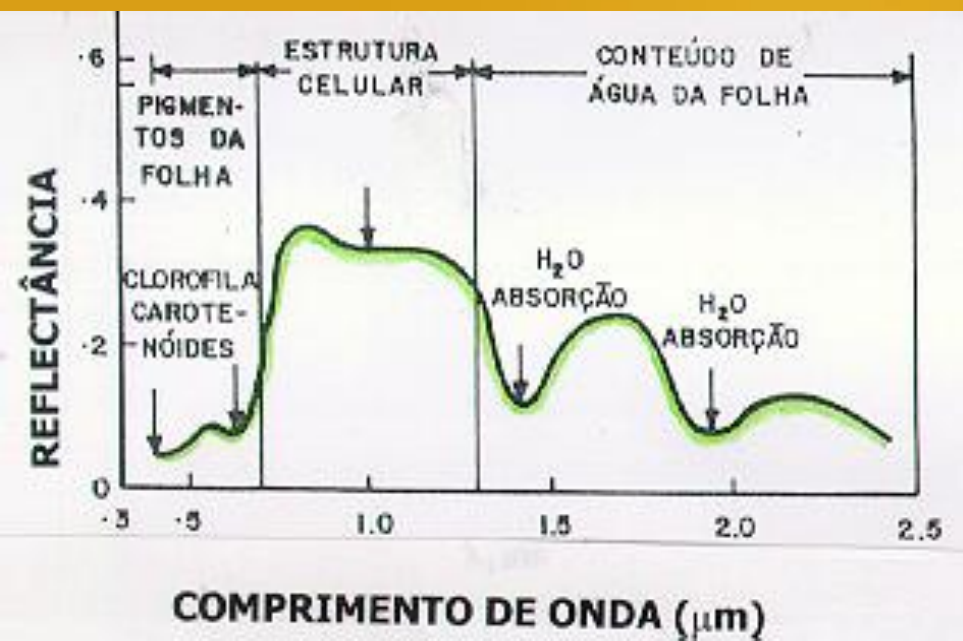


Comportamento Espectral

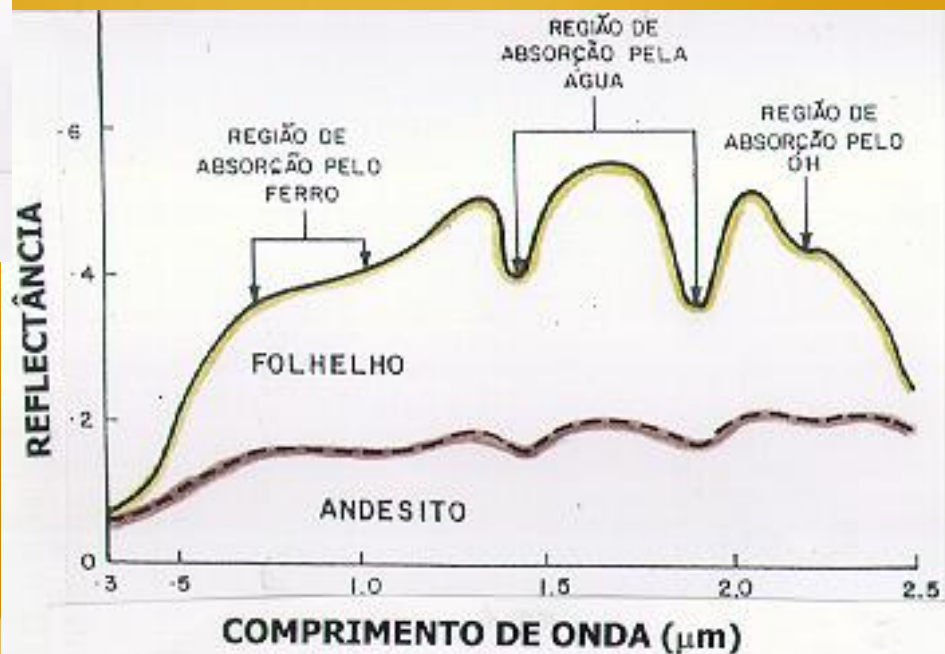


Comportamento Espectral

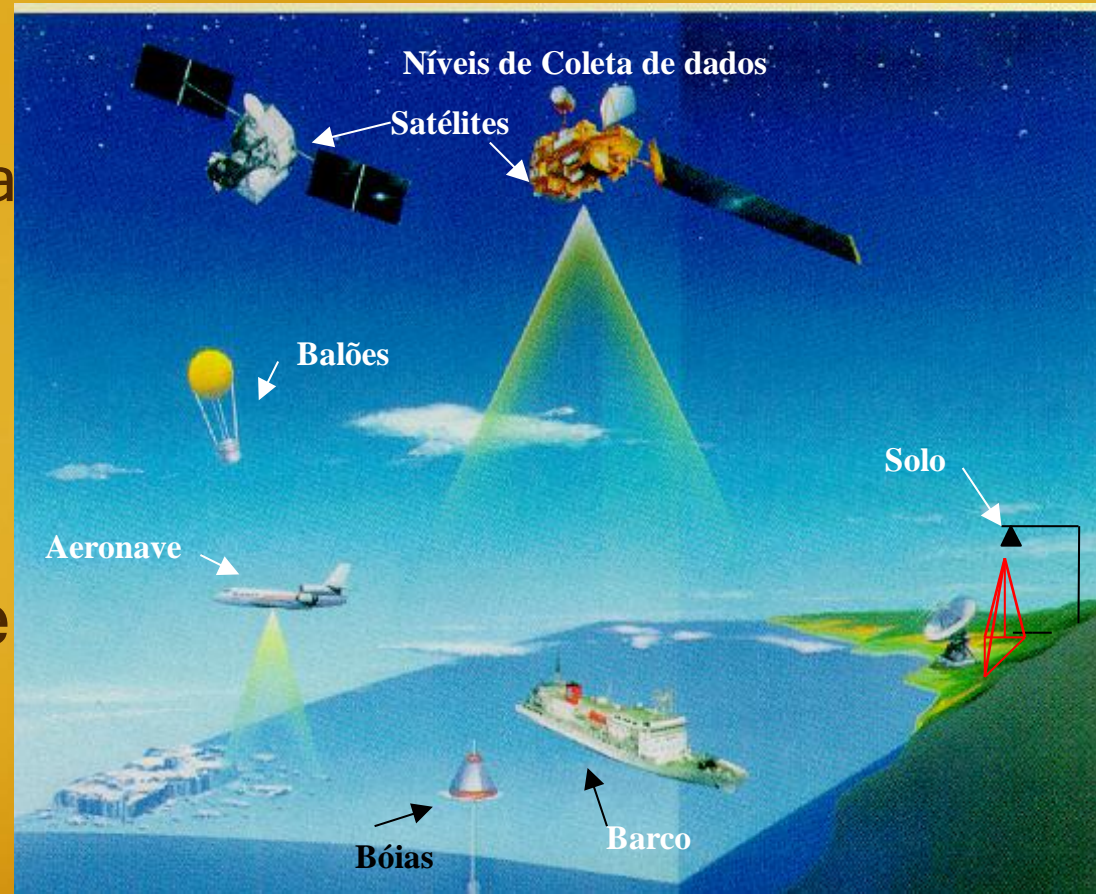
Vegetação sadia



Rochas



Níveis de Coleta de Dados



- **Nível orbital ou plataforma espacial**

- **Nível suborbital**

- ❖ **plataforma aérea**

- ❖ **plataforma terrestre**

- **campo**

- **Laboratório**

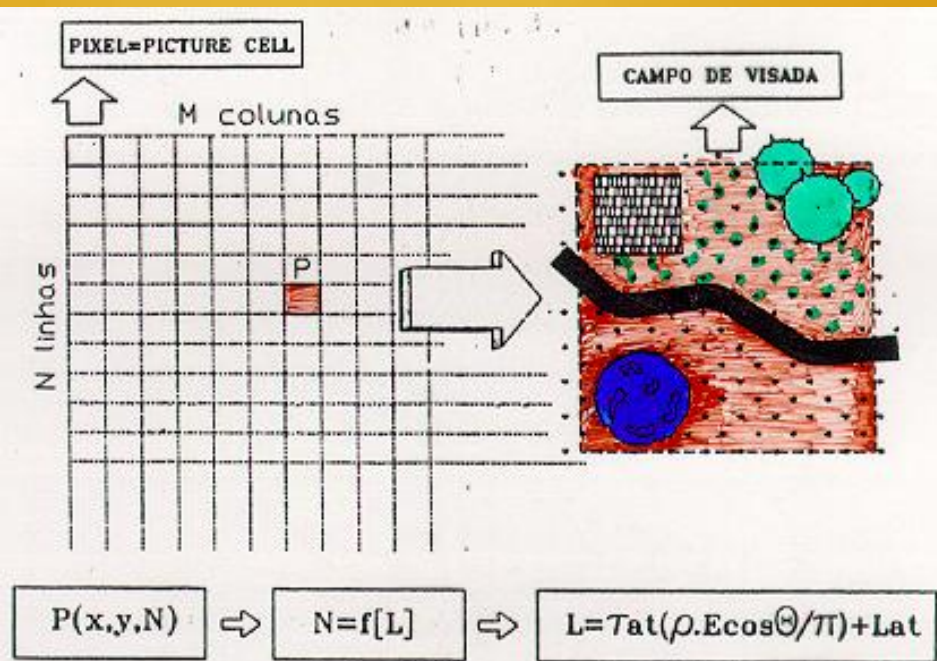
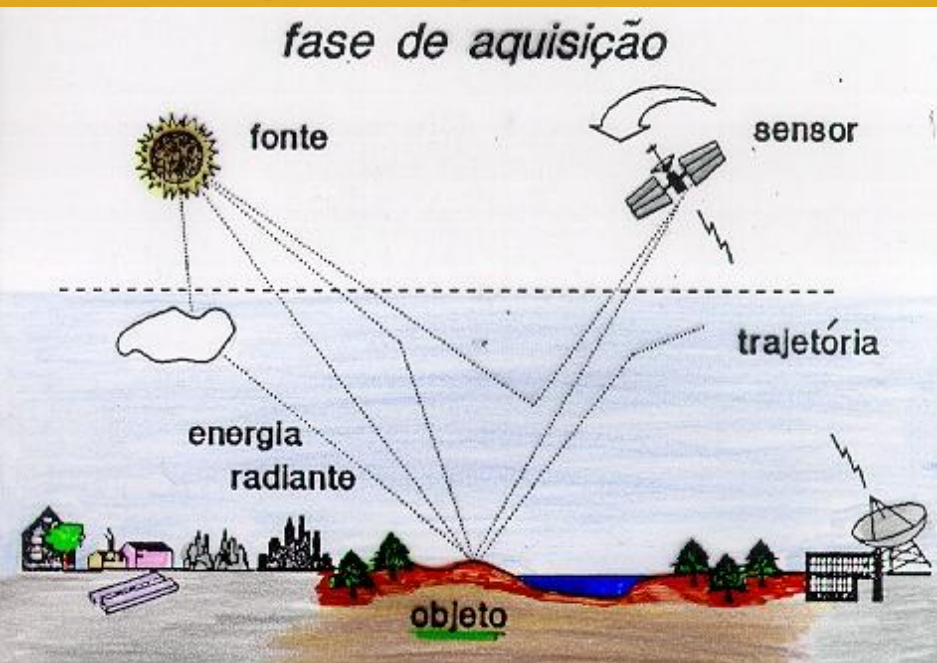


Importância da plataforma terrestre

→ verdade terrestre para as outras plataformas

→ eliminação da atmosfera terrestre

Aquisição das imagens



145	128	143	195	241
182	98	98	191	212
163	221	154	159	117
172	155	138	87	68
153	121	127	75	12

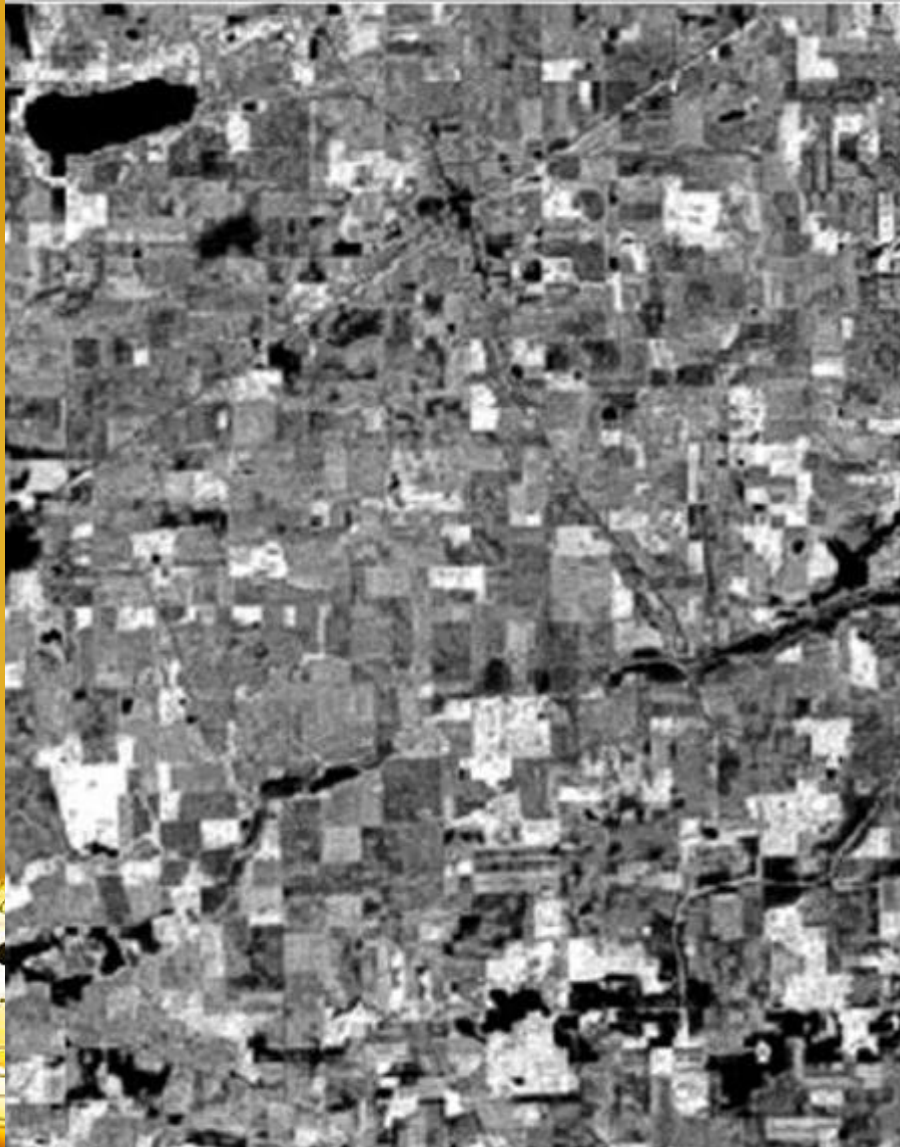


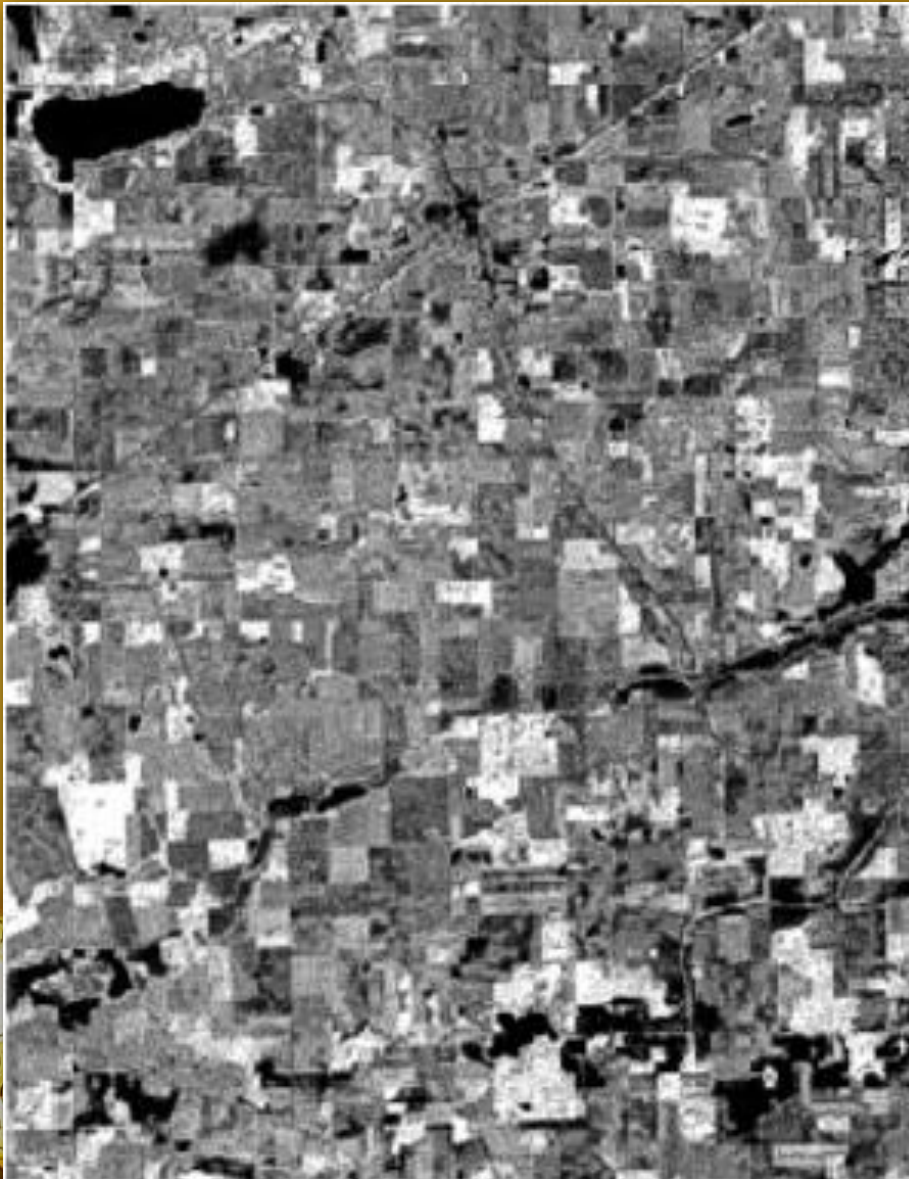
0

255



Reflexão
no
Infravermelho
Próximo



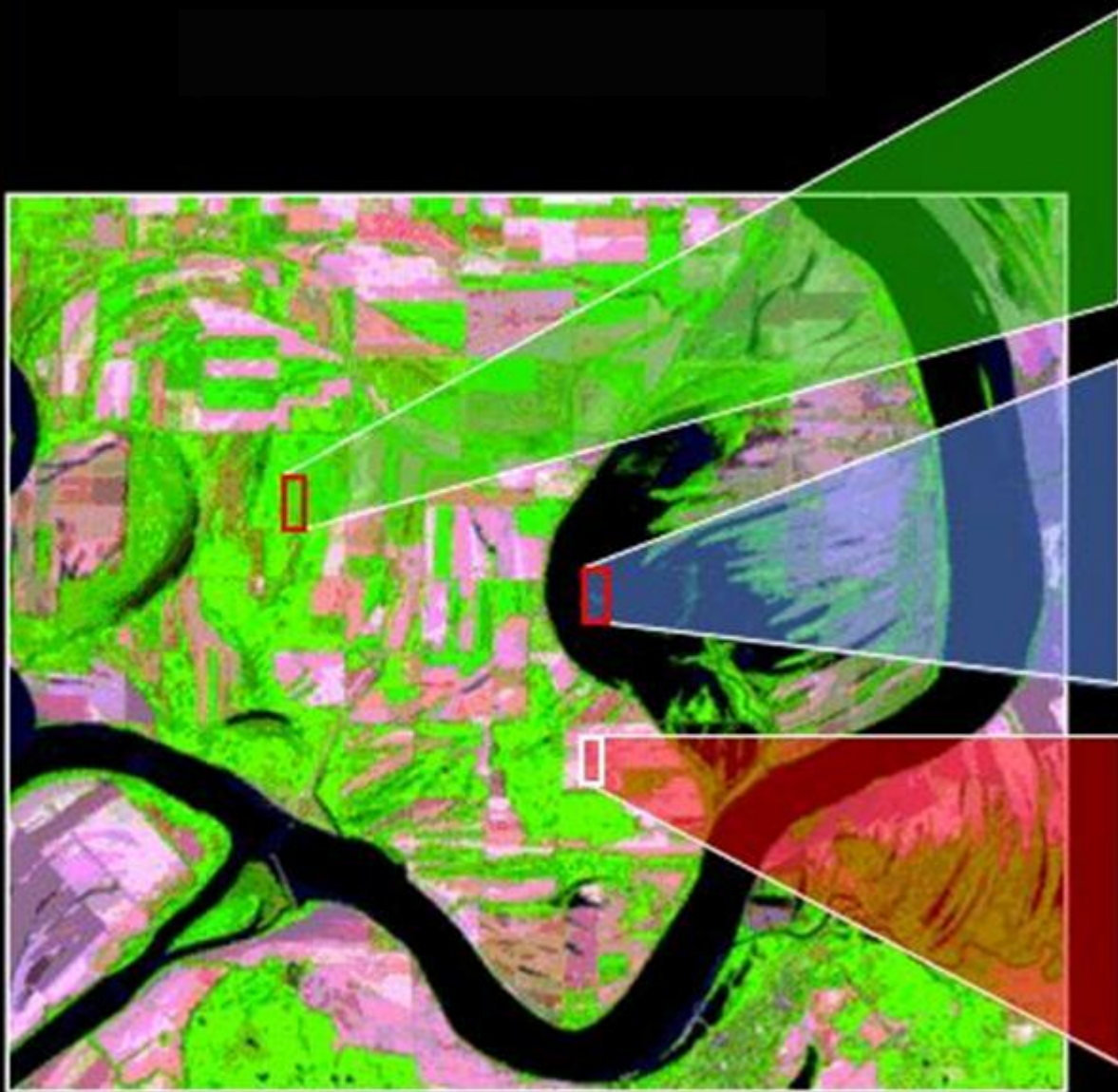


Reflexão no Infravermelho

Próximo



Respostas espectrais nas bandas do verde, vermelho, IRP e IRM



Respostas Espectrais



Valores de ND

Verde Verm. IVP IVM



Respostas Espectrais



Valores de ND

Verde Verm. IVP IVM

Respostas Espectrais



Valores de ND

Verde Verm. IVP IVM

Respostas Espectrais



Valores de ND



Verde Verm. IVP IVM

Valores de ND

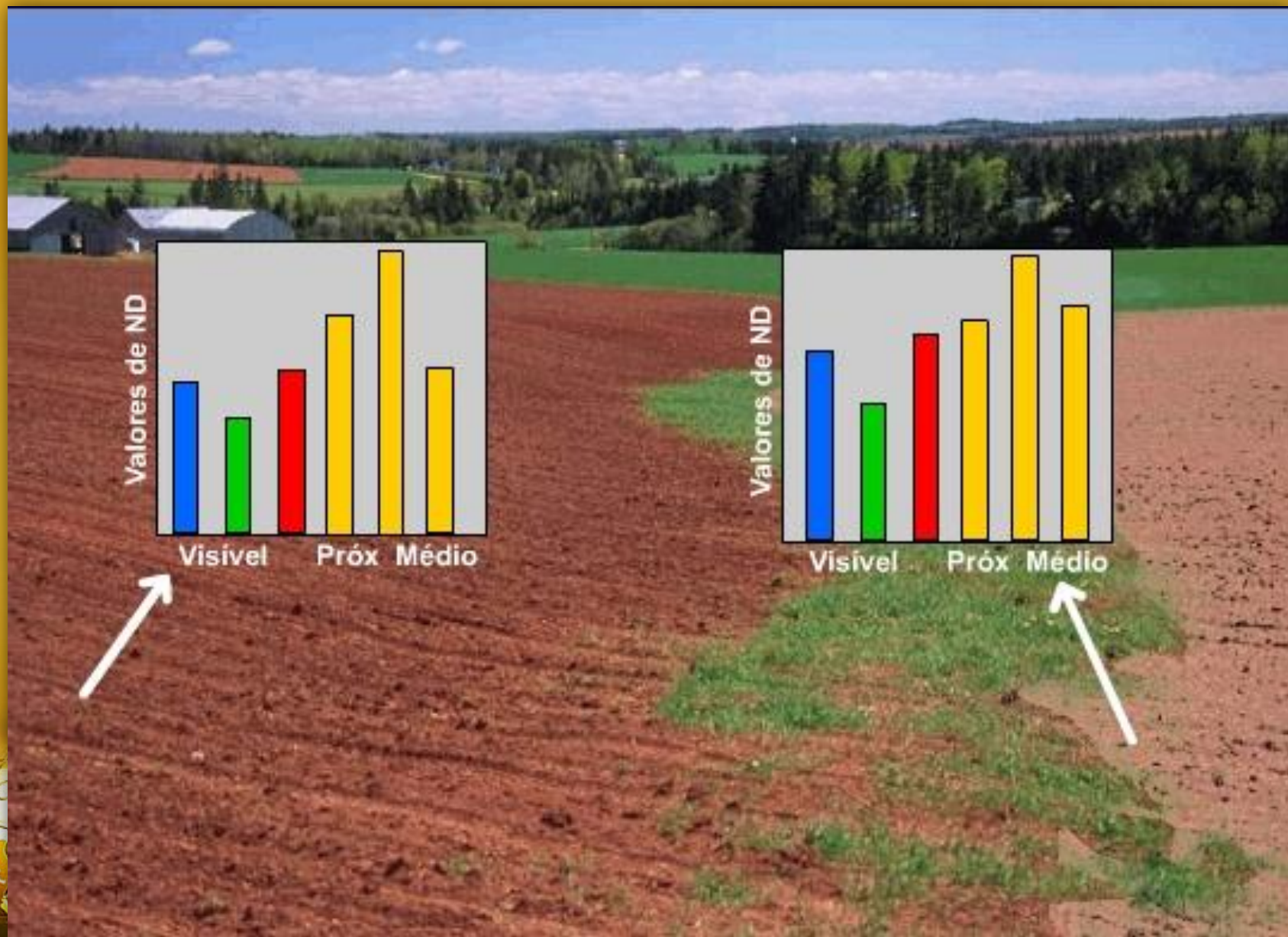


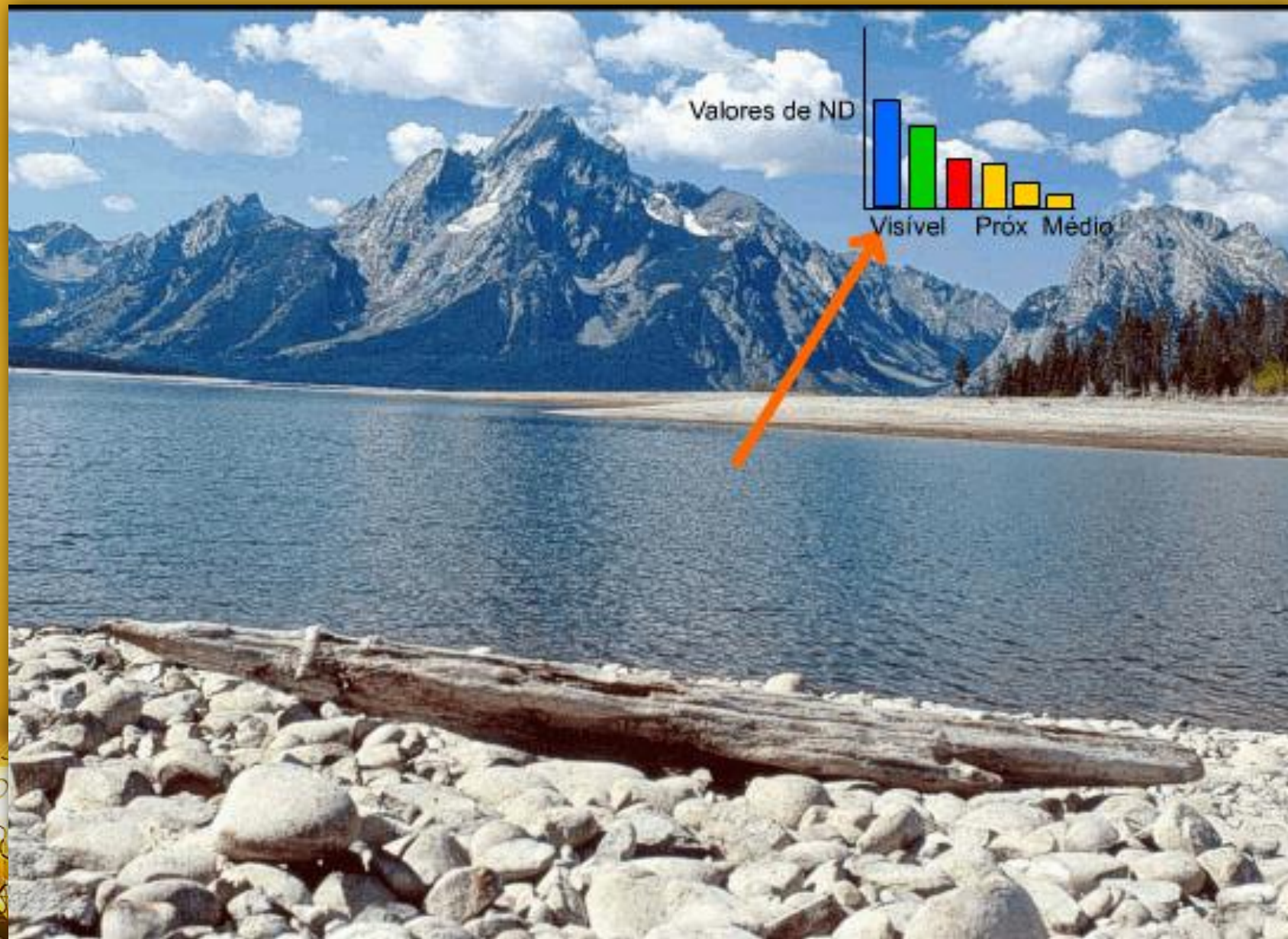
Verde Verm. IVP IVM

Valores de ND



Verde Verm. IVP IVM

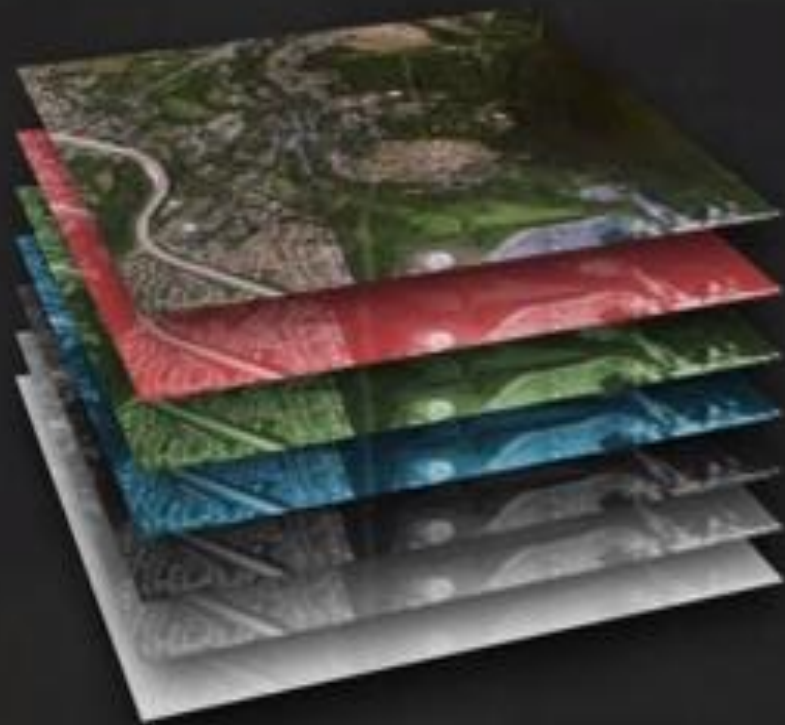




Imageamento

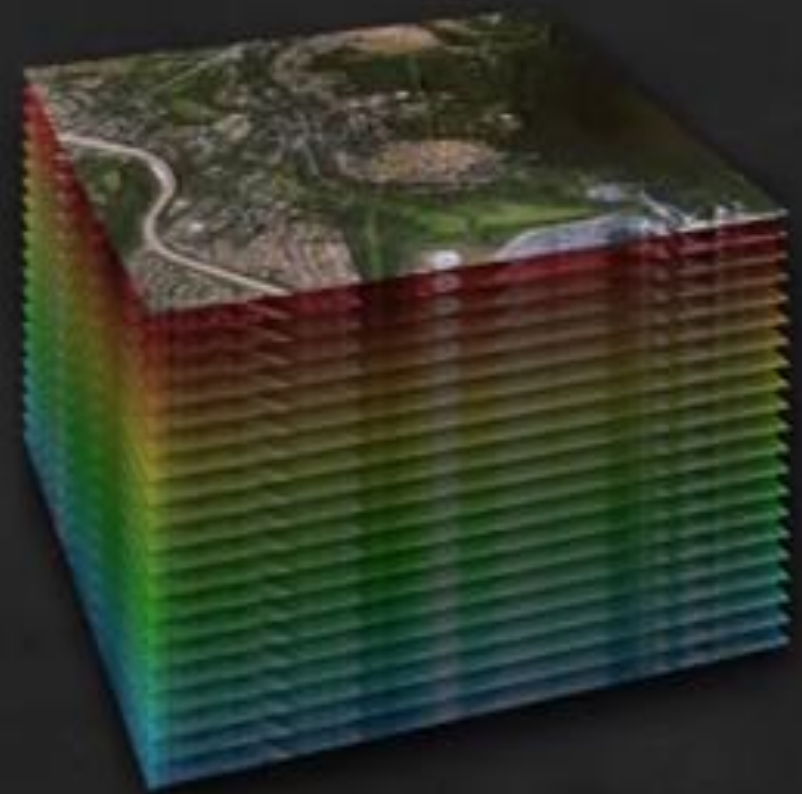
Multiespectral

- Algumas bandas (ex: 36)



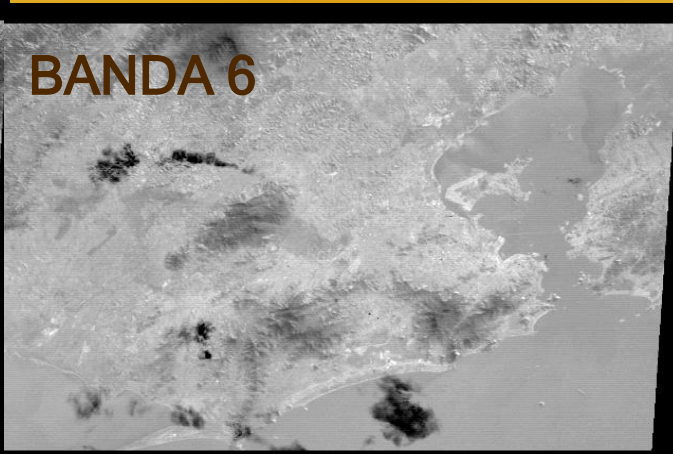
Hiperespectral

- Acima de 100 bandas

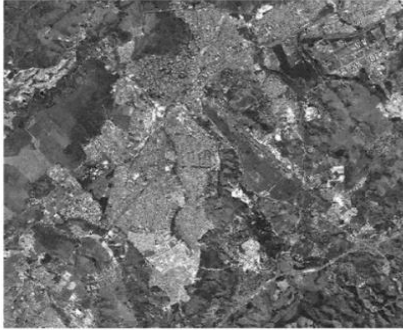




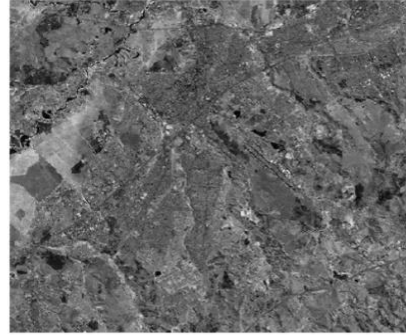
RIO DE JANEIRO



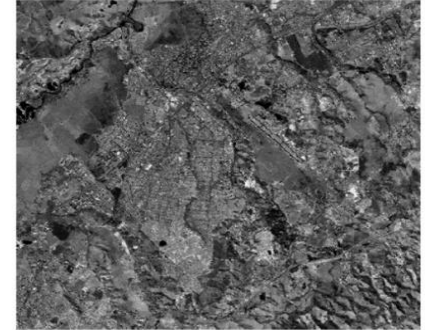
Banda 3
Visível



Banda 4
Infravermelho



Banda 5
Infravermelho



Filtro Azul



Filtro Verde



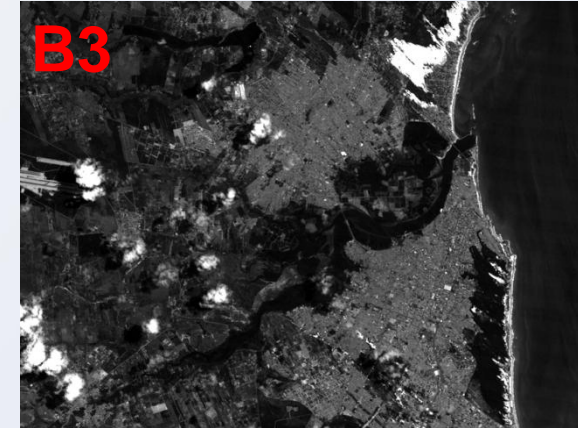
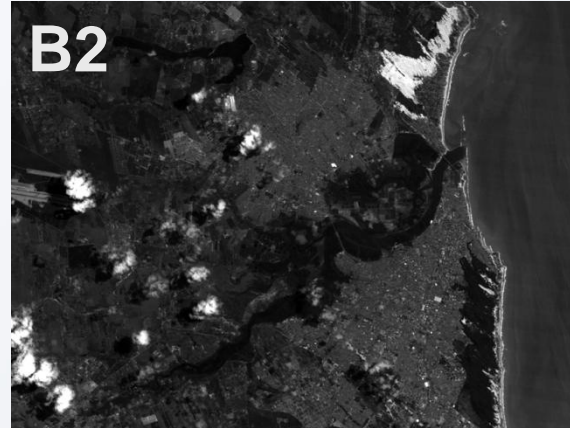
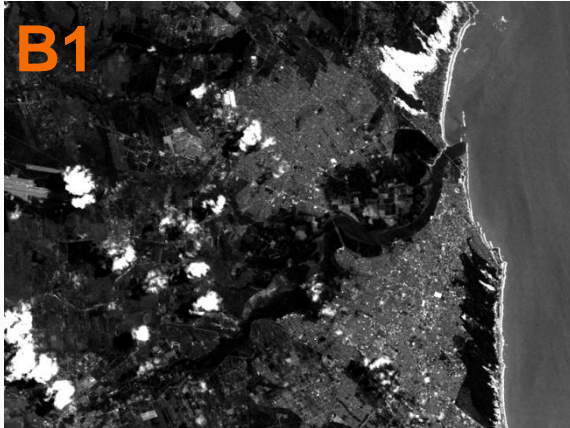
Filtro Vermelho

Banda 3,4 e 5

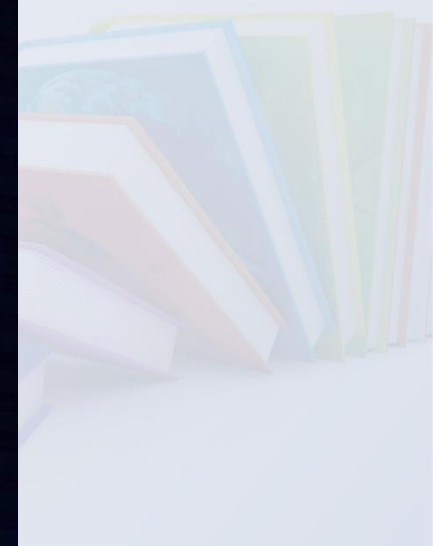
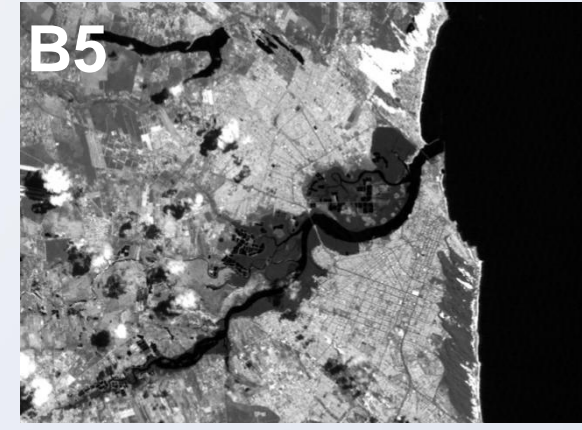
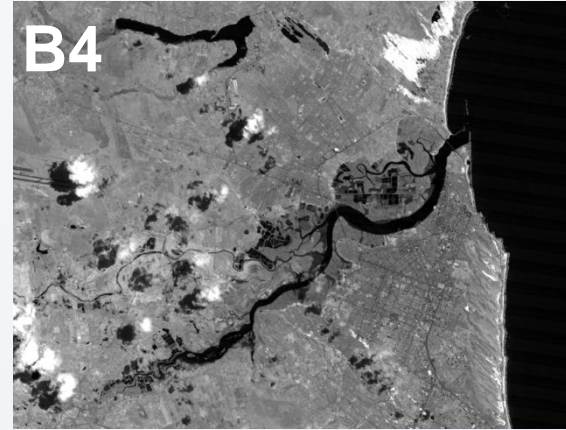
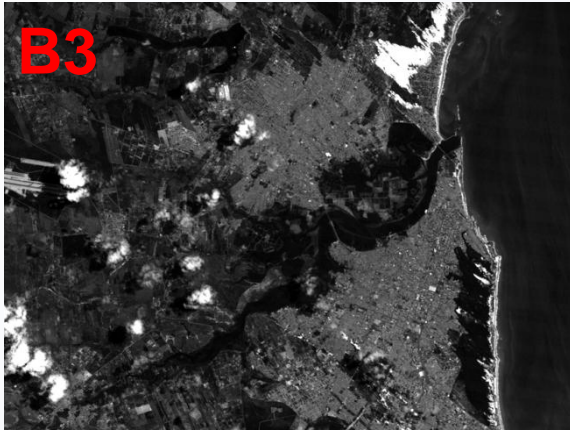


Colorida

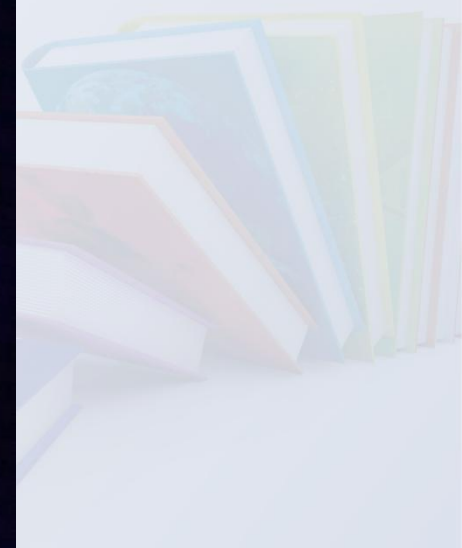
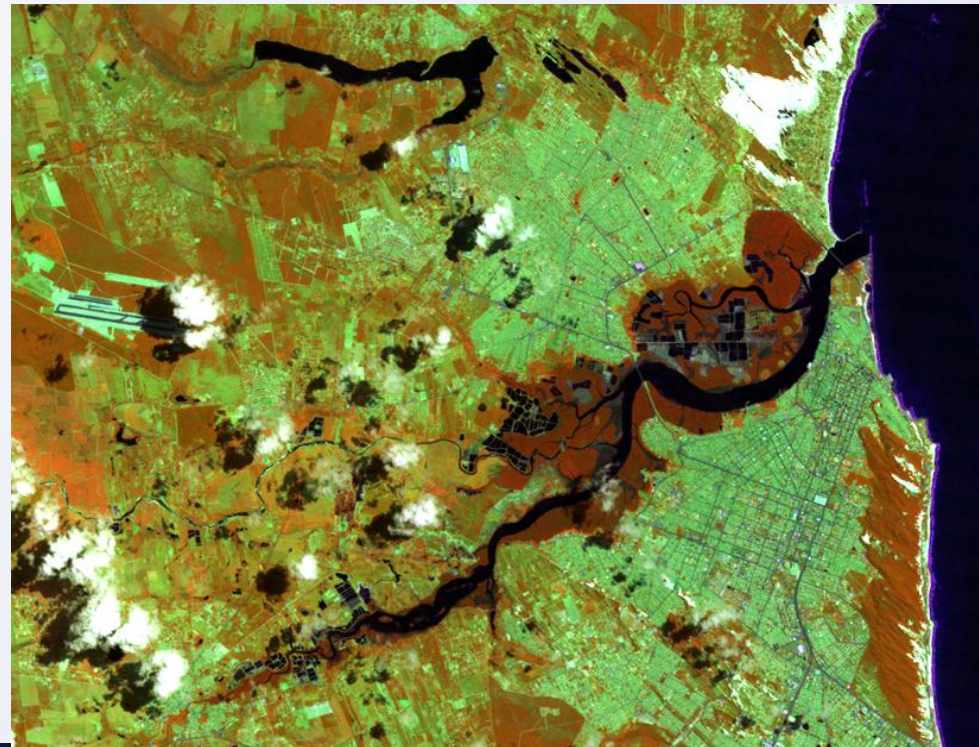
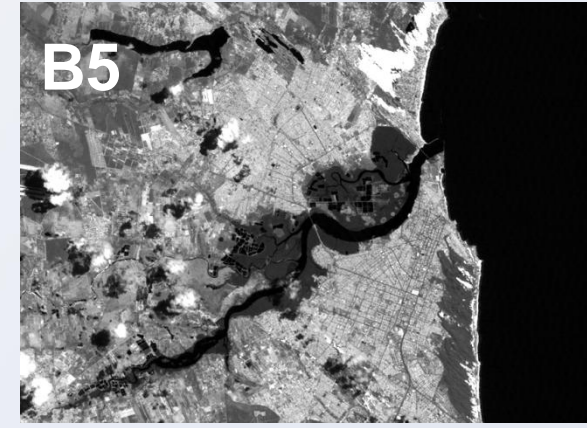
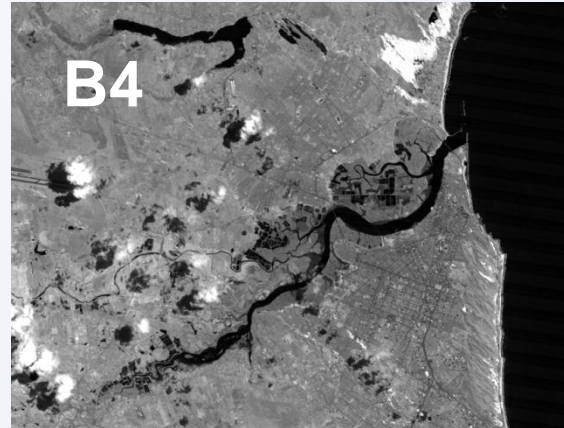
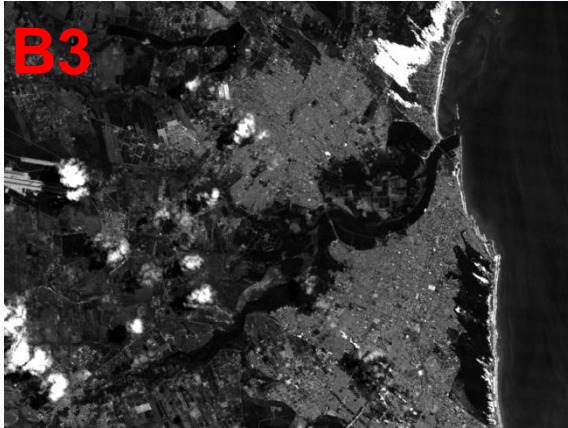
Composição Colorida



Composição Colorida



Composição Colorida





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**)



Fort Collins, Colorado, USA

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)



Fort Collins, Colorado, USA

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

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Landsat 8

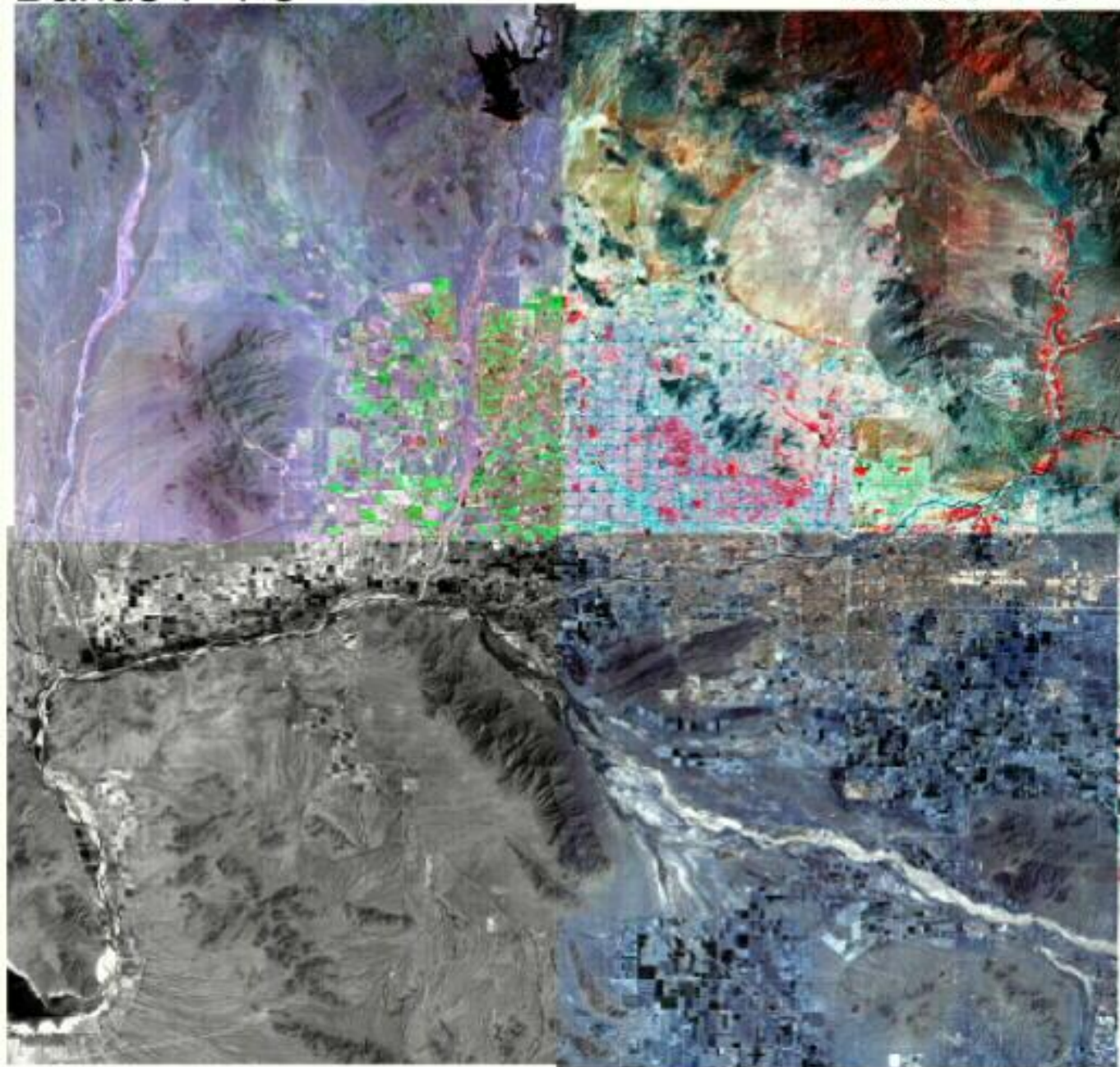
OLI



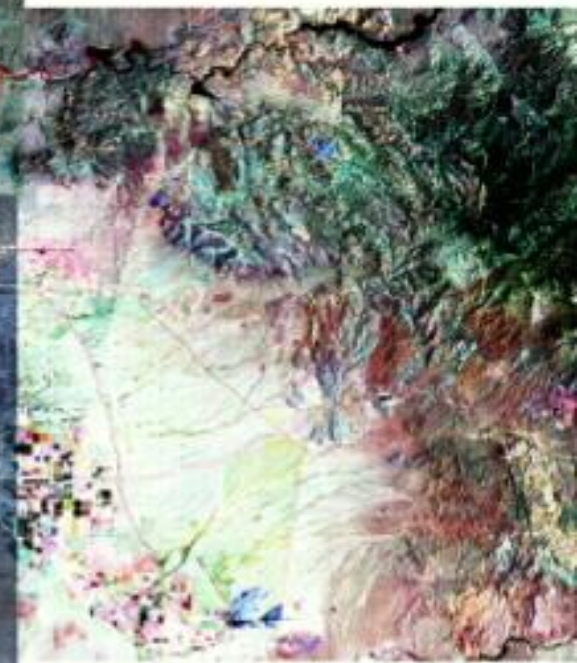
Aplicações	Bandas B G R
Cor Verdadeira	4 3 2
Falsa Cor (urbano)	7 6 4
Cor Infravermelha (vegetação)	5 4 3
Agricultura	6 5 2
Penetração Atmosférica	7 6 5
Vegetação Saudável	5 6 2
Solo/água	5 6 4
Natural com Remoção Atmosférica	7 5 3
Infravermelho Solar	7 5 4
Análise da Vegetação	6 5 4

Bands 7-4-5

Bands 4-3-2



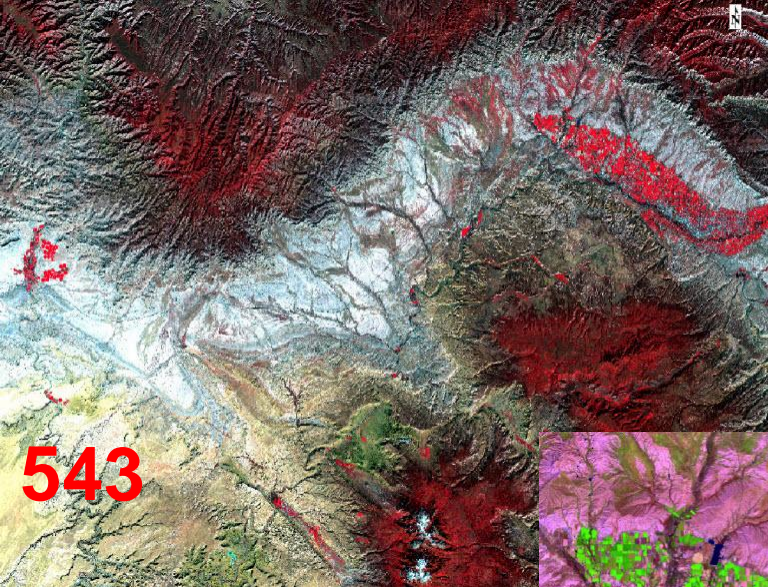
Landsat 8 Sensor OLI



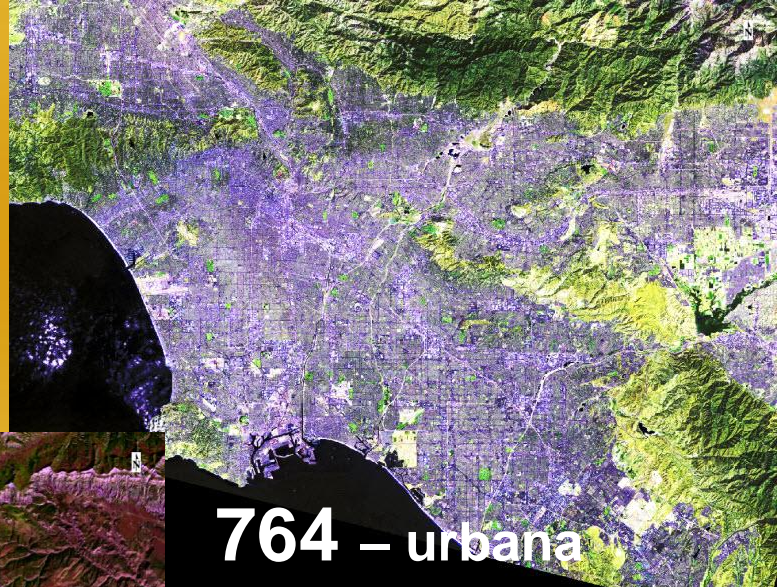
Bands 7-5-3

Landsat Band 1

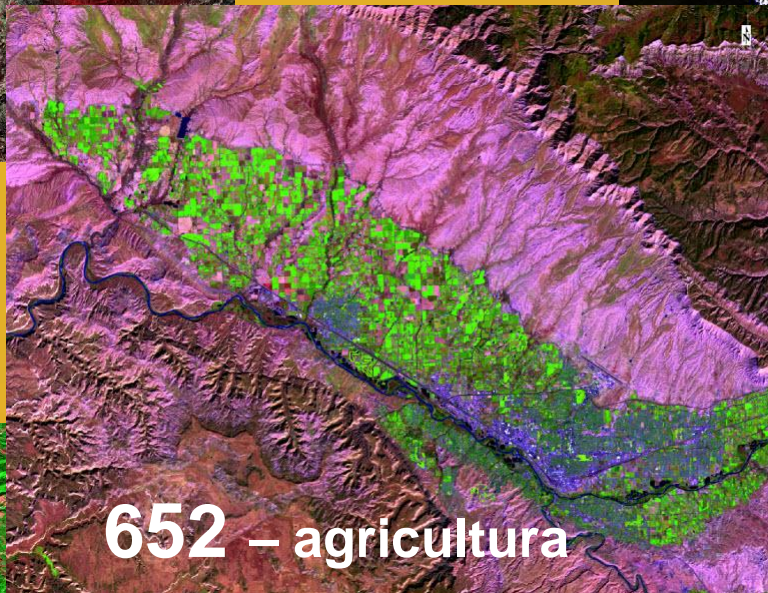
Bands 3-2-1



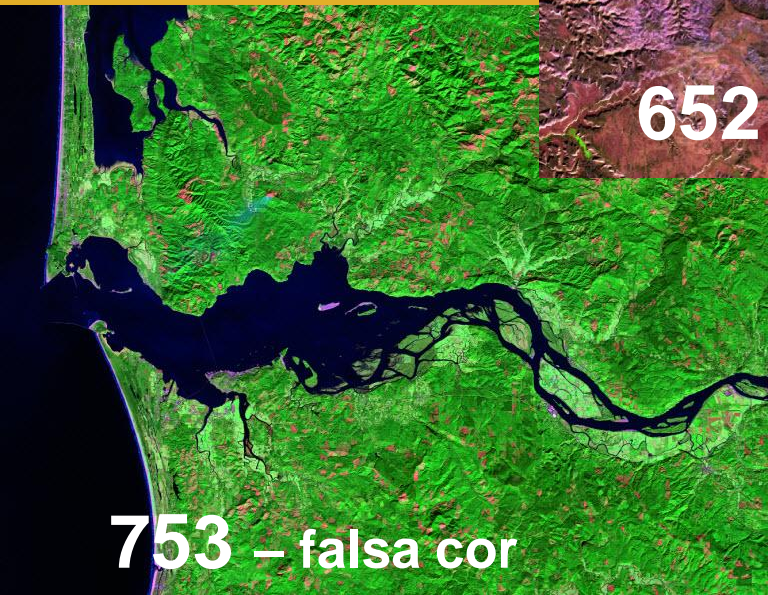
543



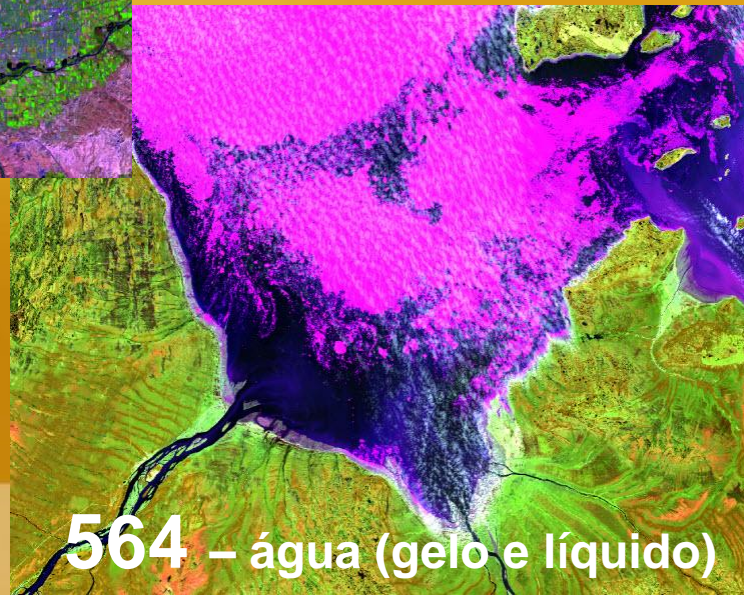
764 – urbana



652 – agricultura

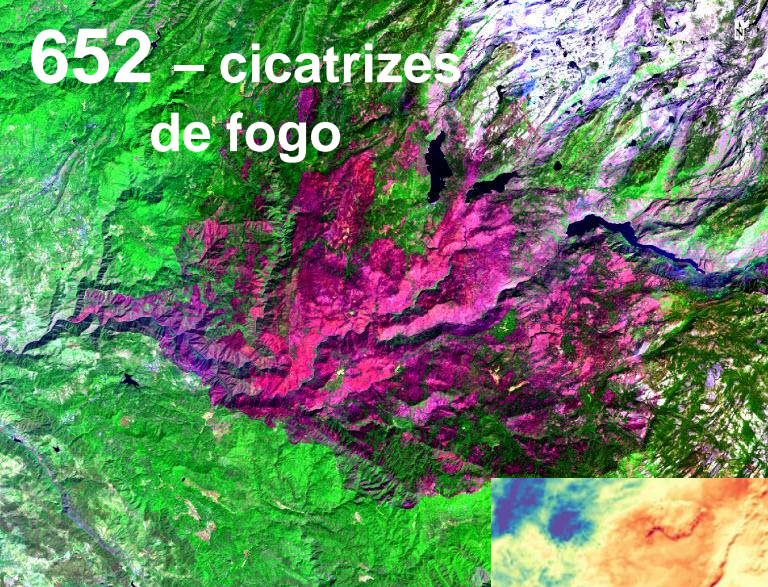


753 – falsa cor



564 – água (gelo e líquido)

652 – cicatrizes
de fogo



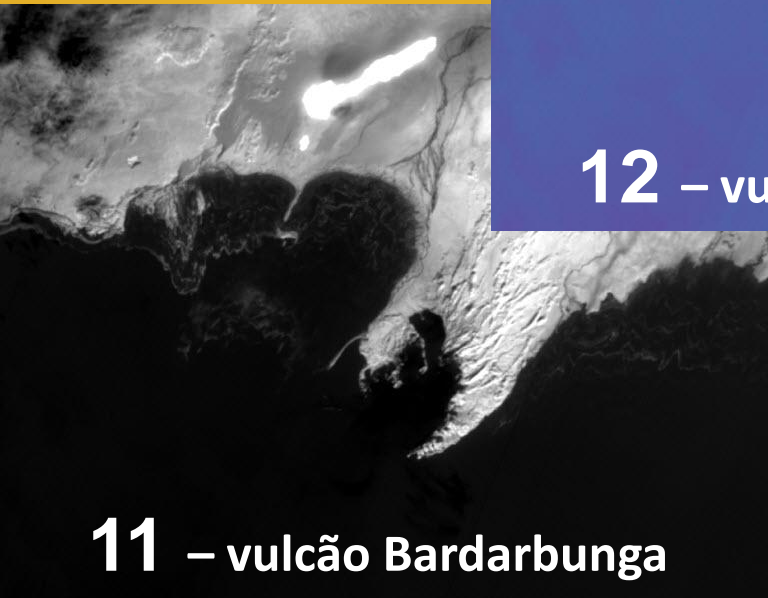
571 – qualidade de água e
aerossóis



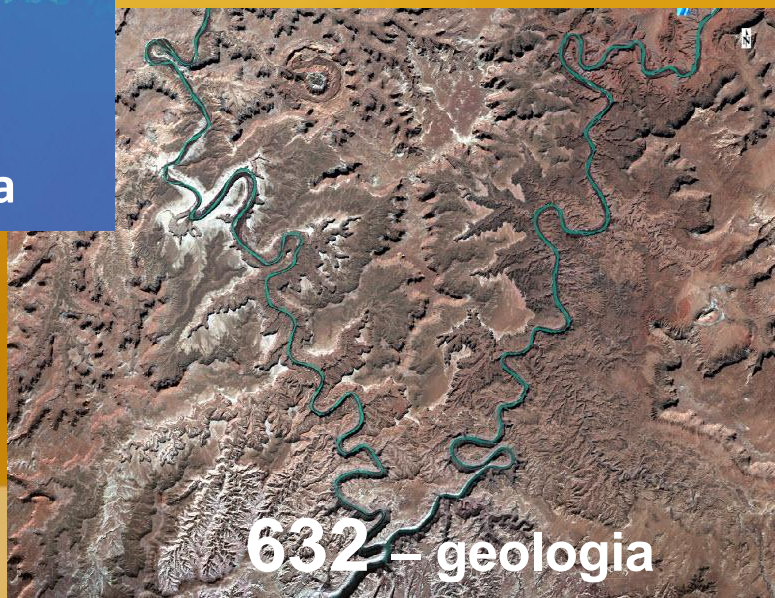
12 – vulcão Bardarbunga



11 – vulcão Bardarbunga



632 – geologia



Sugestões de sites

https://www.youtube.com/watch?v=Ftbx4_kYRUg

https://youtu.be/Ftbx4_kYRUg

<https://www.youtube.com/watch?v=eGIDxp4TNWk>



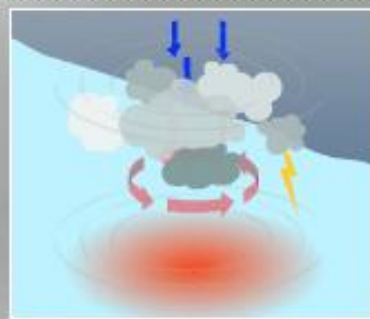
ESPECIAL ON-LINE desastres naturais

veja.com

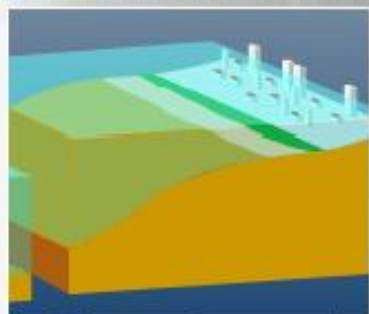
Terremotos



Furacões



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

Cronologia (1900 - 2008)

MORTOS	ANO
8 mil	1900 Galveston (EUA), furacão
38 mil	1902 Martinica, vulcão Pelée
3 mil	1906 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 Yokohama (Japão), terremoto
200 mil	1927 Nanshan (China), terremoto
1,8 mil	1928 Flórida (EUA), furacão

SAIBA MAIS

SAIBA MAIS

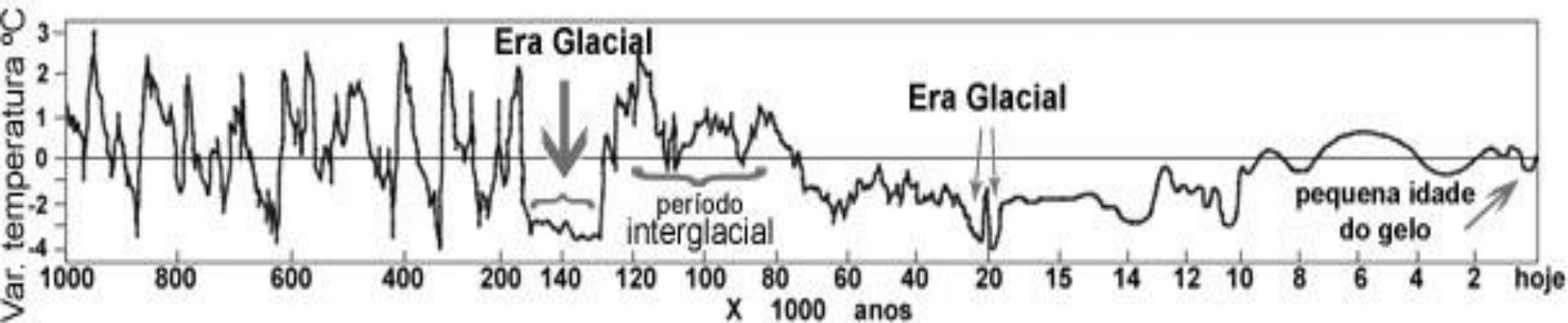
Outras tragédias (1500 - 1900)

[clique aqui](#)

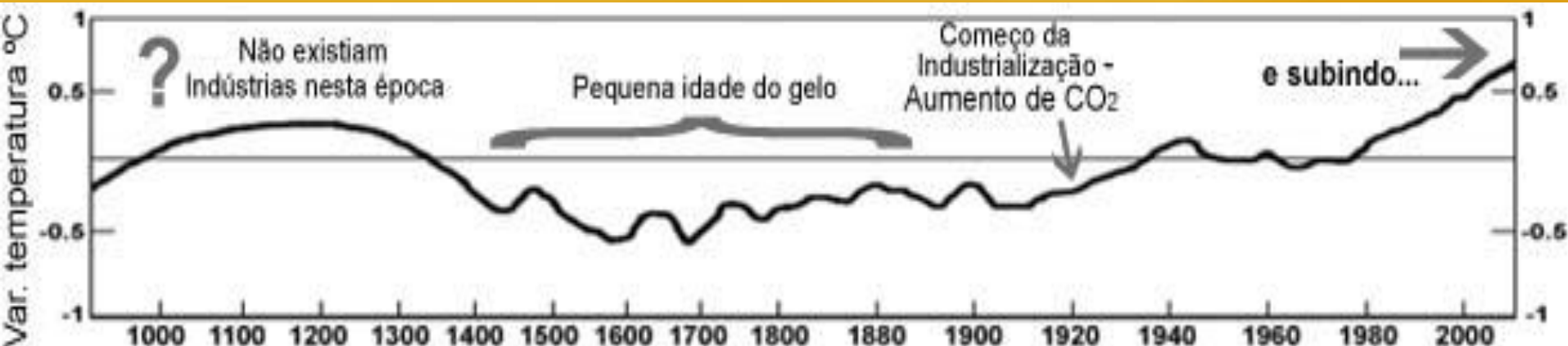


Variação da Temperatura

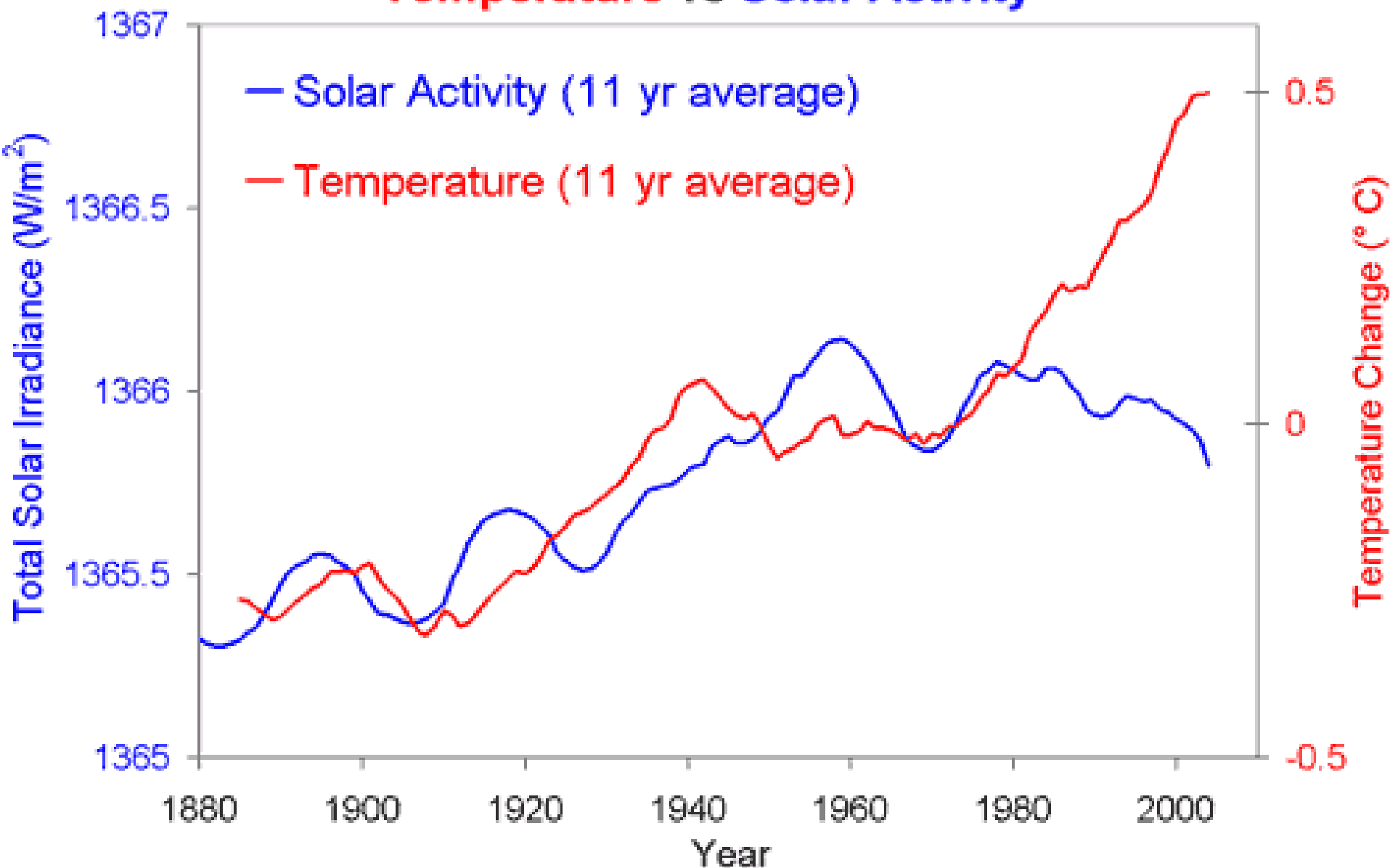
- Últimos Milhão de anos

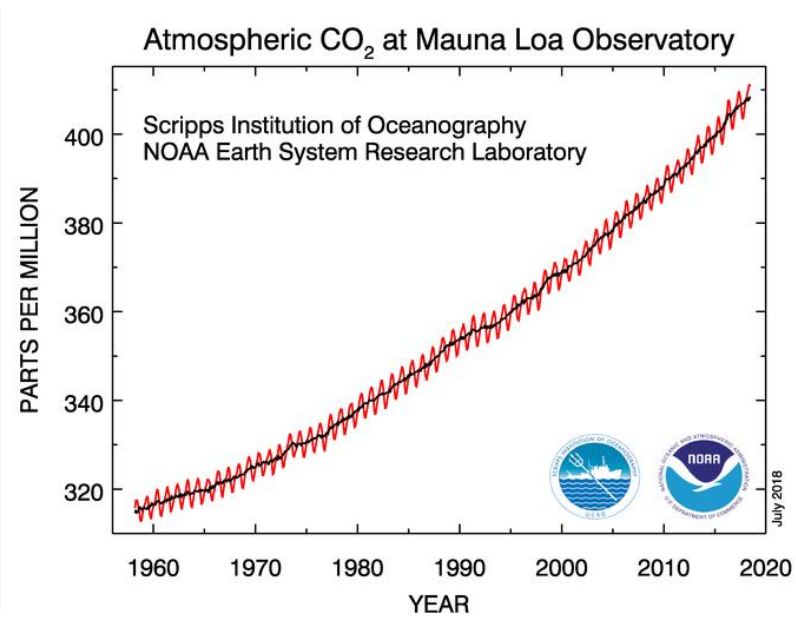
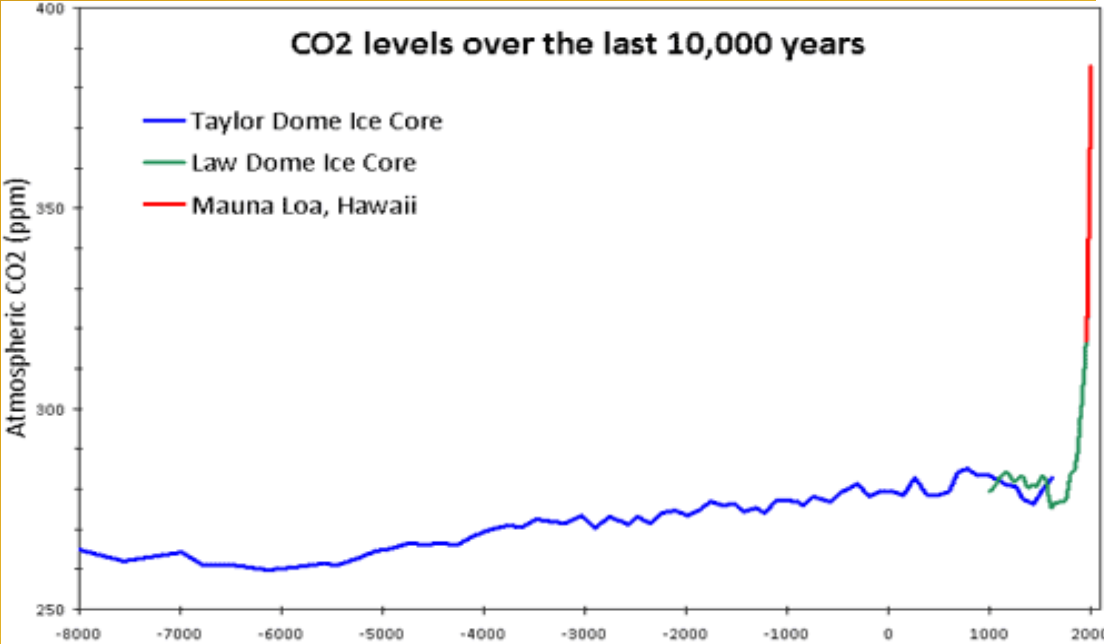


- Últimos mil anos



Temperature vs Solar Activity





Material educativo

https://globalchange.umich.edu/globalchange1/current/lectures/king/carbon_cycle/carbon_cycle.html

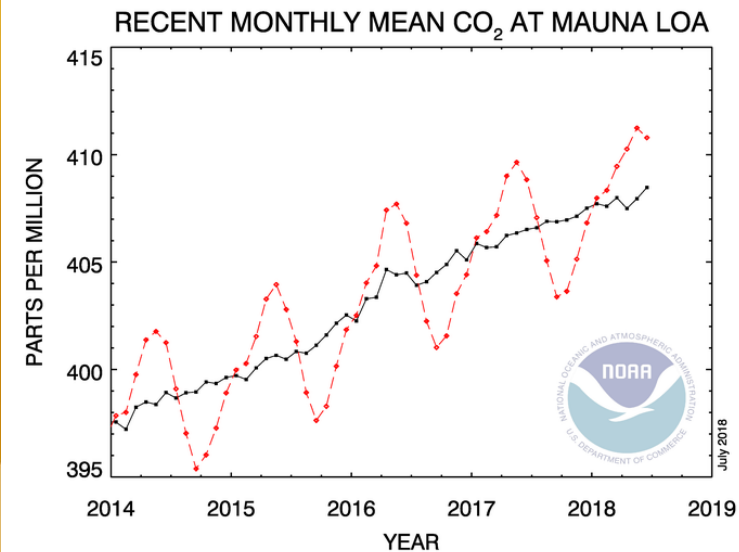
<https://www.co2.earth/daily-co2>

<https://www.esrl.noaa.gov/gmd/ccgg/trends/index.htm>



Junho 2017 - 408,84 ppmv

Junho 2018 - 410,79 ppmv



Emissão Territorial (MtCO₂)

Territorial (MtCO₂)

Rank	Country	MtCO ₂
1	China	9680
2	United States of America	5561
3	India	2597
4	Russian Federation	1595
5	Japan	1232
6	Germany	789
7	Indonesia	641
8	Iran	616
9	Saudi Arabia	602
10	South Korea	599
11	Canada	558
12	Brazil	507
13	South Africa	457
14	Mexico	457
15	United Kingdom	428
16	Australia	428
17	Turkey	382
18	Thailand	373
19	France	331
20	Italy	327
21	Poland	310
22	Taiwan	260
23	Malaysia	252

Territorial (MtCO₂)

Rank	Country	MtCO ₂
1	United States of America	5561
2	Canada	558
3	Brazil	507
4	Mexico	457
5	Venezuela	207
6	Argentina	202
7	Chile	82
8	Colombia	81
9	Peru	59
10	Trinidad and Tobago	47
11	Ecuador	41
12	Cuba	37
13	Dominican Republic	23
14	Bolivia	18
15	Guatemala	11
16	Panama	9.8
17	Honduras	8.5
18	Costa Rica	7.8
19	Uruguay	7.8
20	Jamaica	7.8
21	Netherlands Antilles	7.0
22	El Salvador	6.7
23	Paraguay	5.3

FONTE: <http://www.statista.com/>



PORTAGE GLACIER AK, 1914 • NOAA



PORTAGE GLACIER AK
© 2004 GARY BRAASCH
(AERIAL ESTIMATION OF 1914)



1928



2004

Vista do Glaciar Upsala,
Argentina



2002



2009



Payachatas na Bolívia

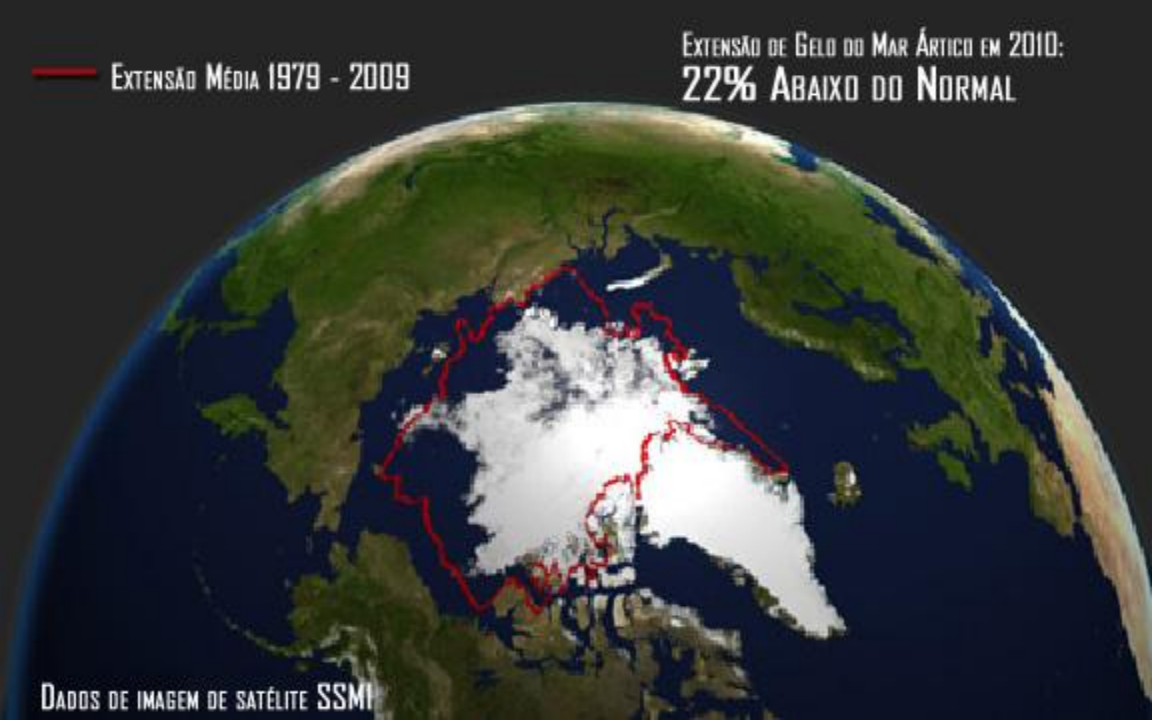
2014



Ártico e a região do Permafrost

Permafrost começou a descongelar

- 850 bilhões de toneladas de carbono armazenado no solo congelado do Ártico poderia ser liberado na atmosfera



- *Uma grande reserva de metano, gás estufa 30 vezes mais potente que o dióxido de carbono está se abrindo.*

Aquecimento Global

O avanço do aquecimento global pode liberar para a atmosfera um enorme volume de CH_4 e CO_2 retido no permafrost, o solo perenemente congelado do Ártico. O processo já começou e tem potencial de acelerar ainda mais a elevação das temperaturas no planeta.



Grandes blocos de permafrost no litoral do Alasca se partem e caem ao mar.

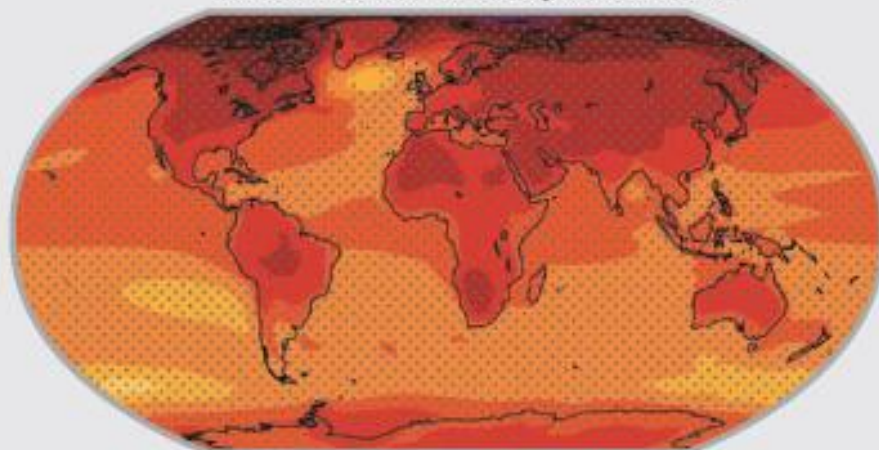


Varição da média da temperatura à superfície 1986-2005 a 2081-2100

Melhor dos cenários
Referentes à libertação de CO₂



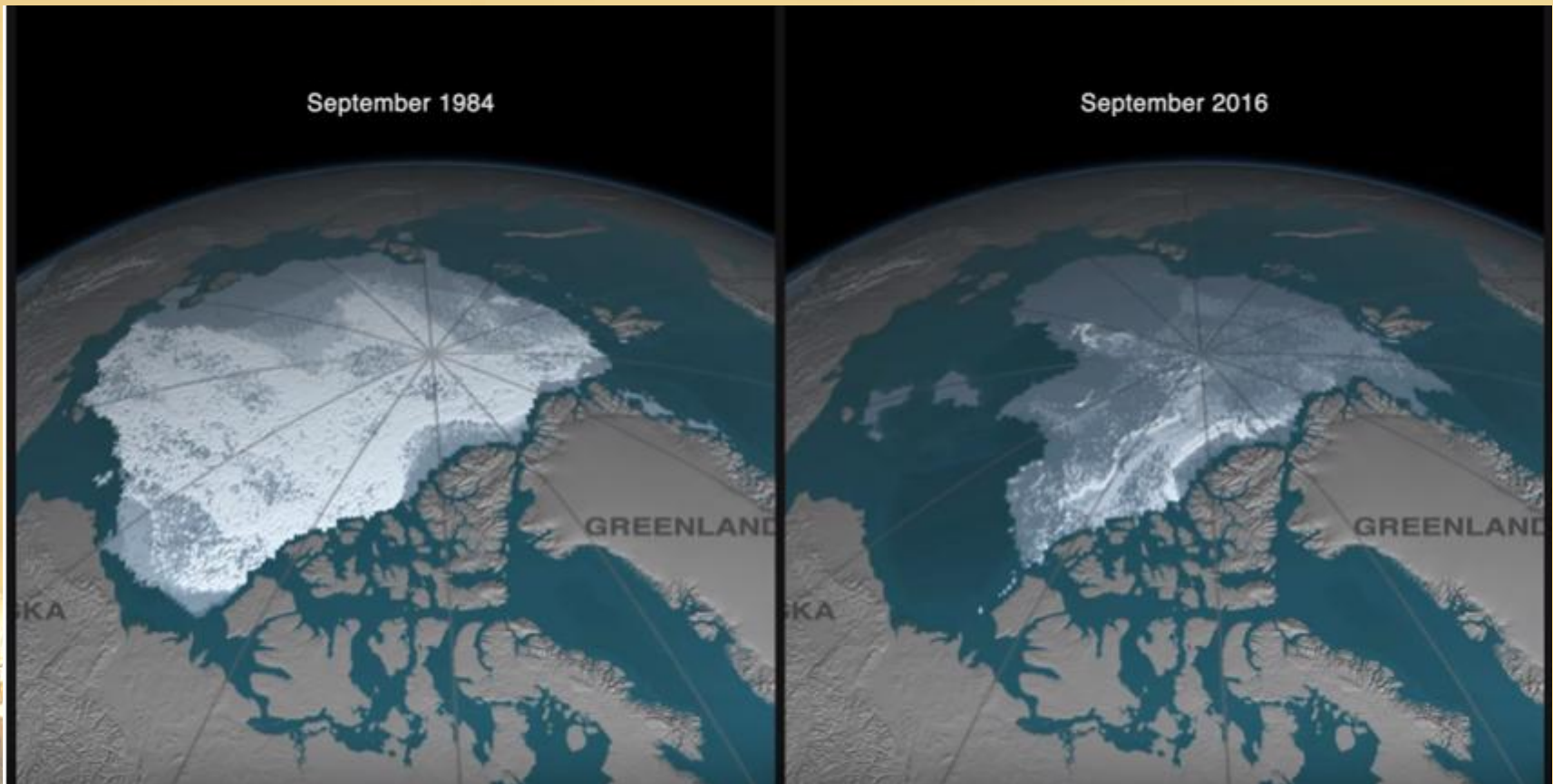
Pior dos cenários
Referentes à libertação de CO₂



(°C)



https://climate.nasa.gov/climate_resources/184/earth-360-video-the-call-of-science/



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