

# ***FLG-5134 Análise Geoespacial***

## **SENSORIAMENTO REMOTO E PROCESSAMENTO DIGITAL DE IMAGENS**

**Prof. Dr. Reinaldo Paul Pérez Machado**

# O que é Sensoriamento Remoto?

## Palavras-chave

- Radiação eletromagnética
- Reflexão e/ou emissão da energia
- Registro da interação da energia com a matéria utilizando sensores fotográficos e /ou imagedores
- Interpretação de fenômenos geográficos

# O que é Sensoriamento Remoto?

CRÓSTA & SOUZA (1997) definem como o objetivo do sensoriamento remoto a *obtenção e análise de informações* sobre materiais (naturais ou não), objetos ou fenômenos na superfície da Terra *a partir de dispositivos situados à distância dos mesmos.*

# O que é Sensoriamento Remoto?

Arte e ciência da obtenção de informação sobre um objeto *sem contato físico direto* com o objeto. É a tecnologia científica que pode ser usada para medir e monitorar importantes características biofísicas e atividades humanas (JENSEN, 2000).

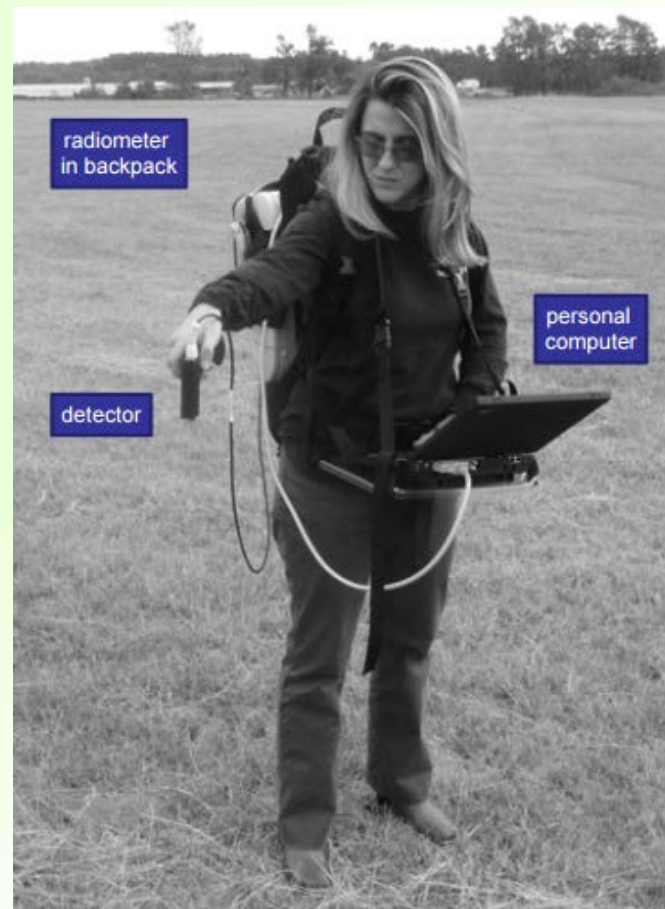
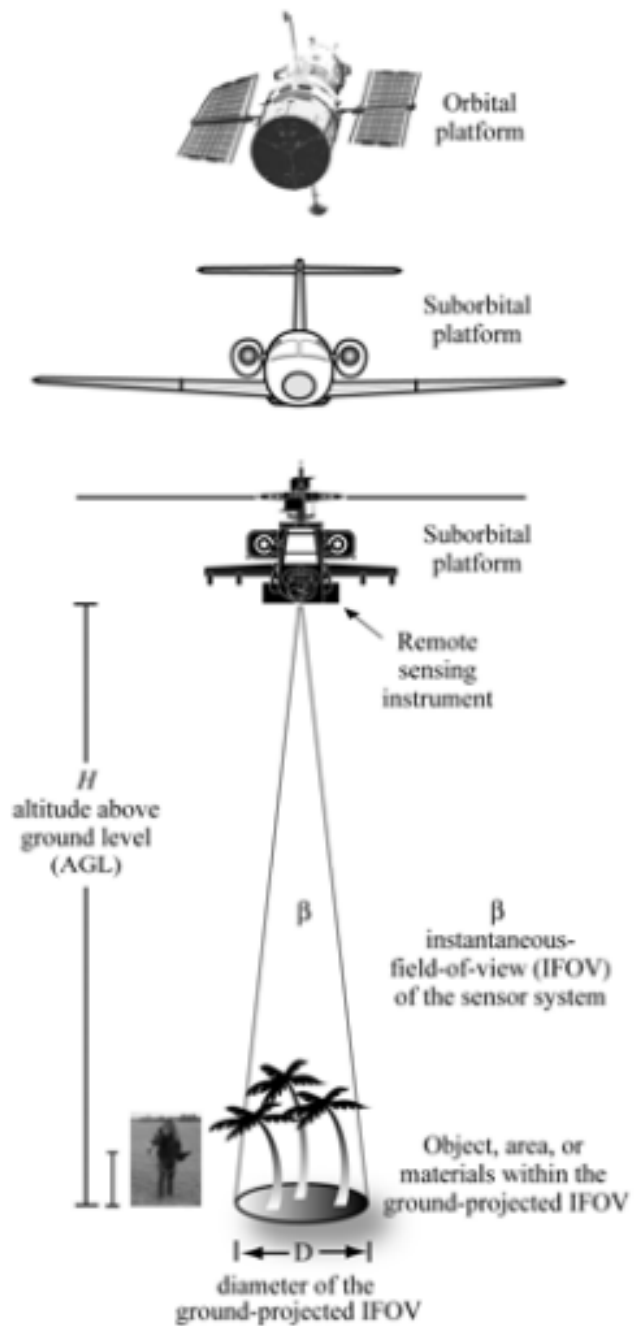
# O que é Sensoriamento Remoto?

Utilização conjunta de modernos equipamentos sensores, equipamento para processamento dos dados, equipamento de transmissão, aeronaves, espaçonaves etc, com o objetivo de estudar o ambiente terrestre através do registro e das interações entre as radiações eletromagnéticas e as substâncias componentes da planeta terra em suas mais diversas manifestações (NOVO, 1993).

# Níveis de Aquisição (principais divisões)

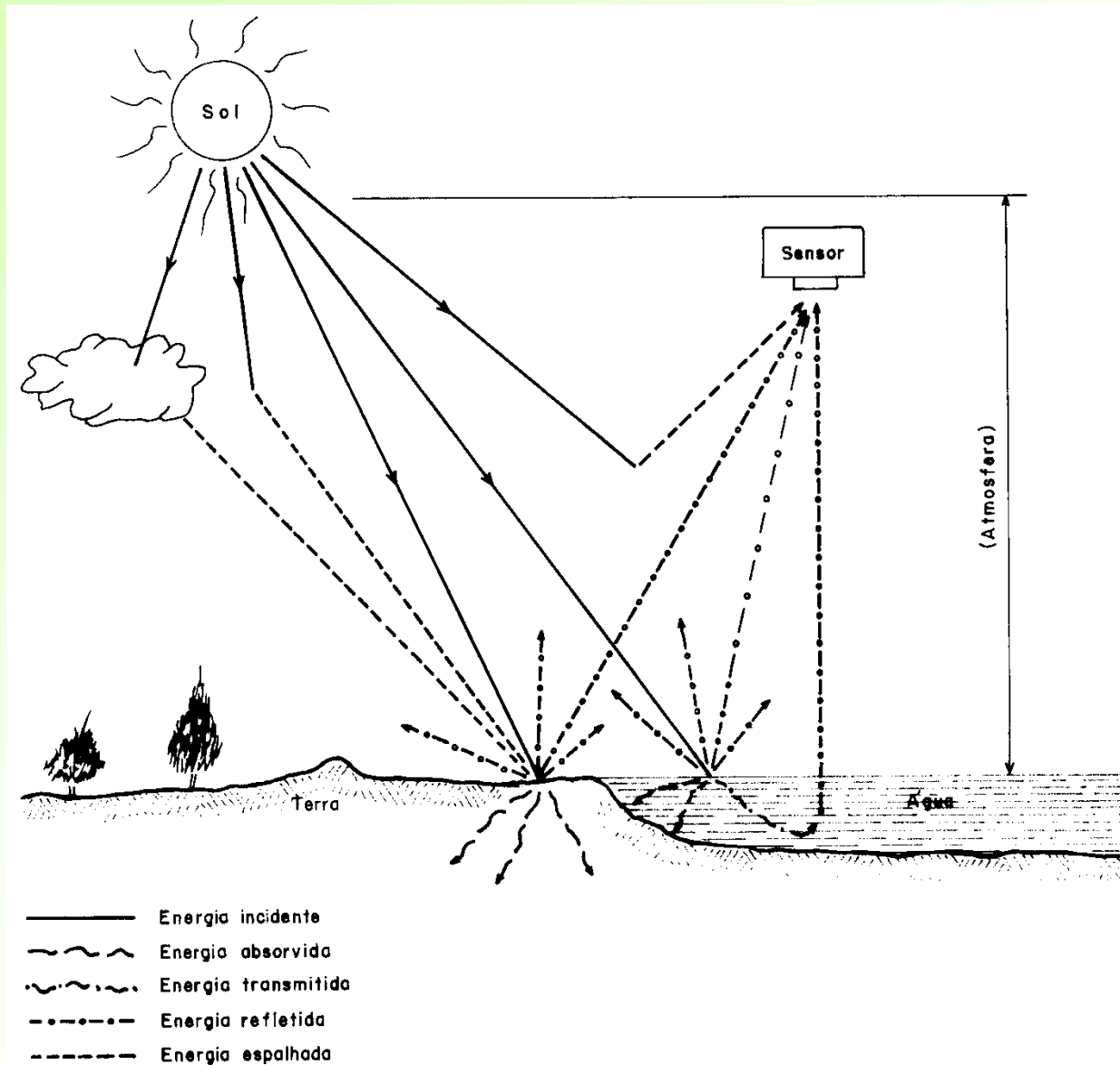
- Sensoriamento Remoto *Orbital* (*Satélites*)
- Sensoriamento Remoto *Aéreo* (*Aviões*)
- Levantamentos em campo

# Remote Sensing Measurement



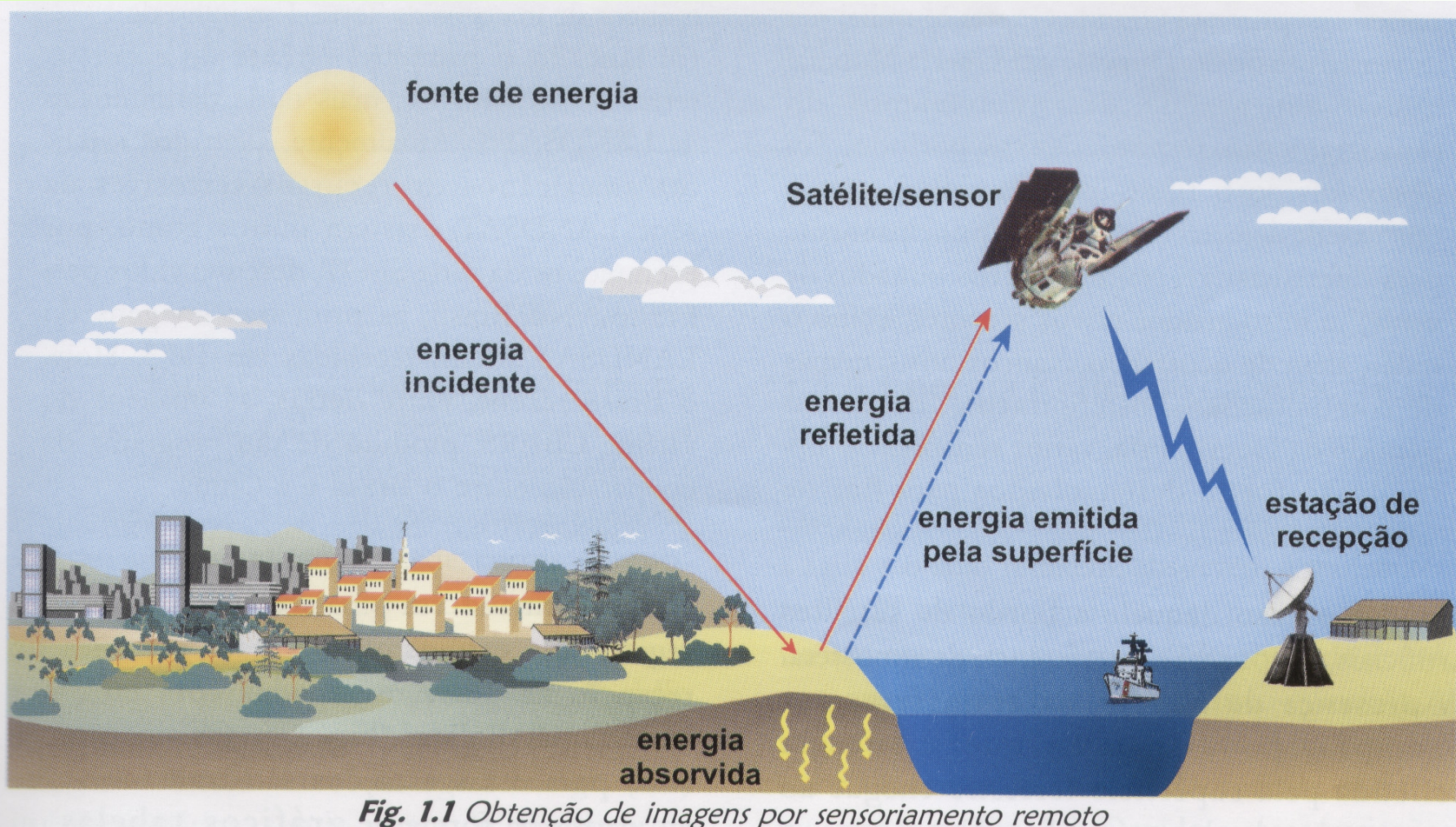
Jensen, 2000

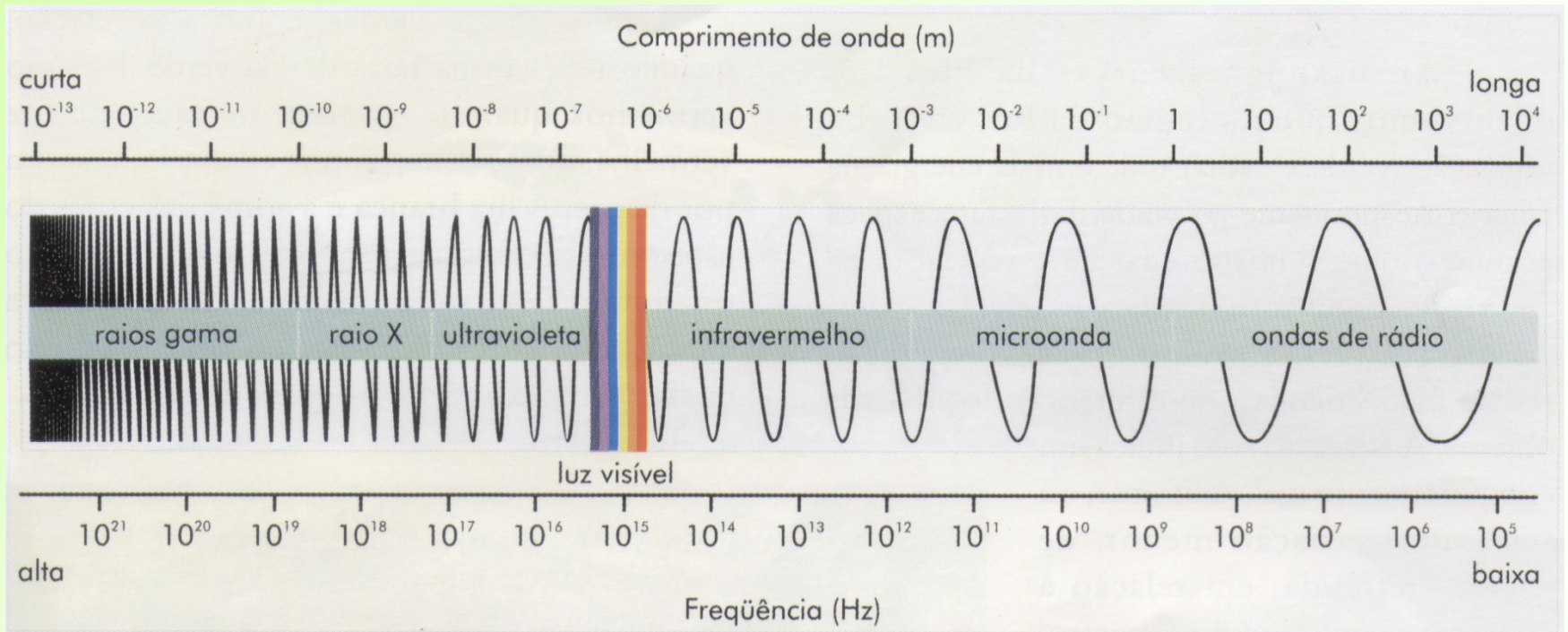
# Interação da radiação eletromagnética



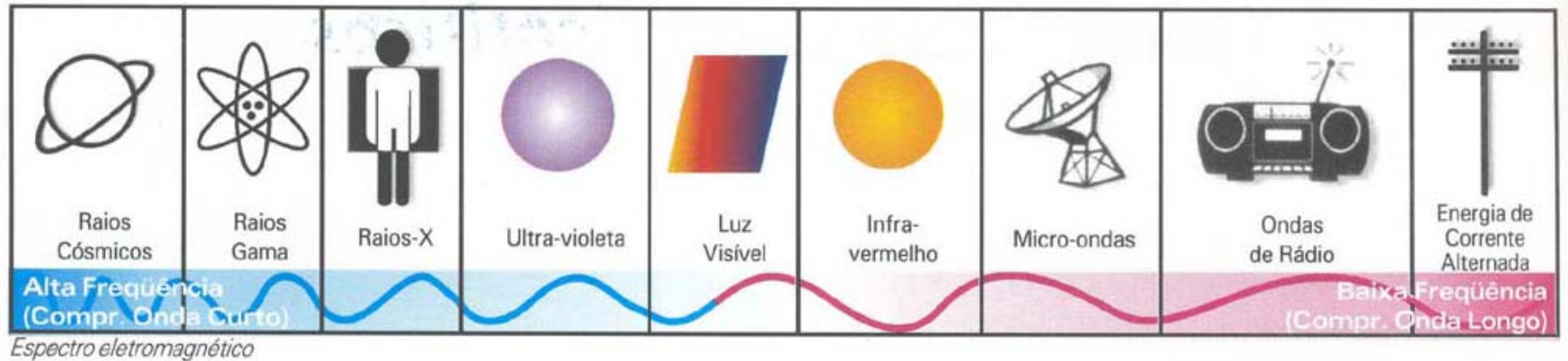


# Aquisição de dados



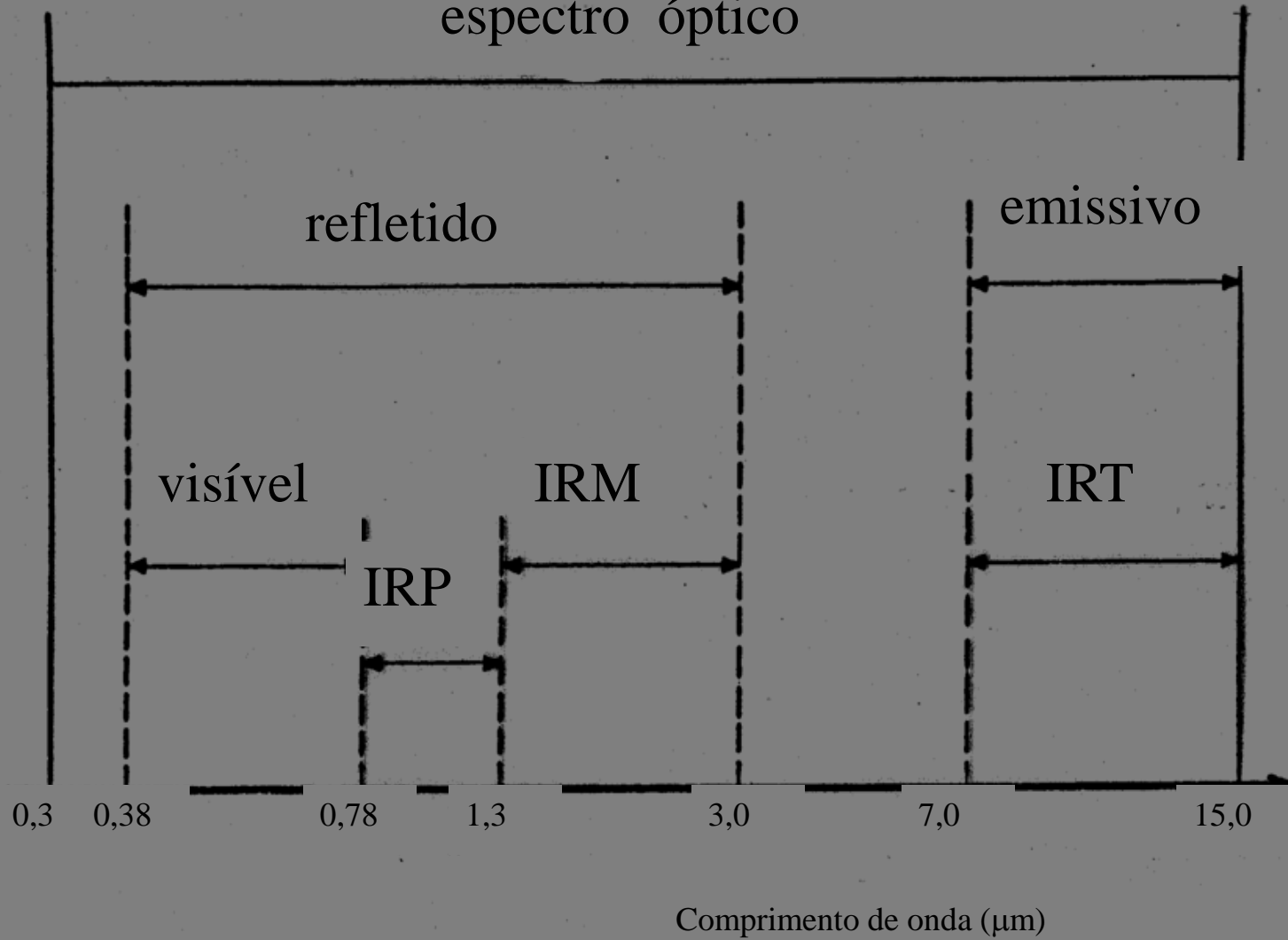


Florenzano (2002)



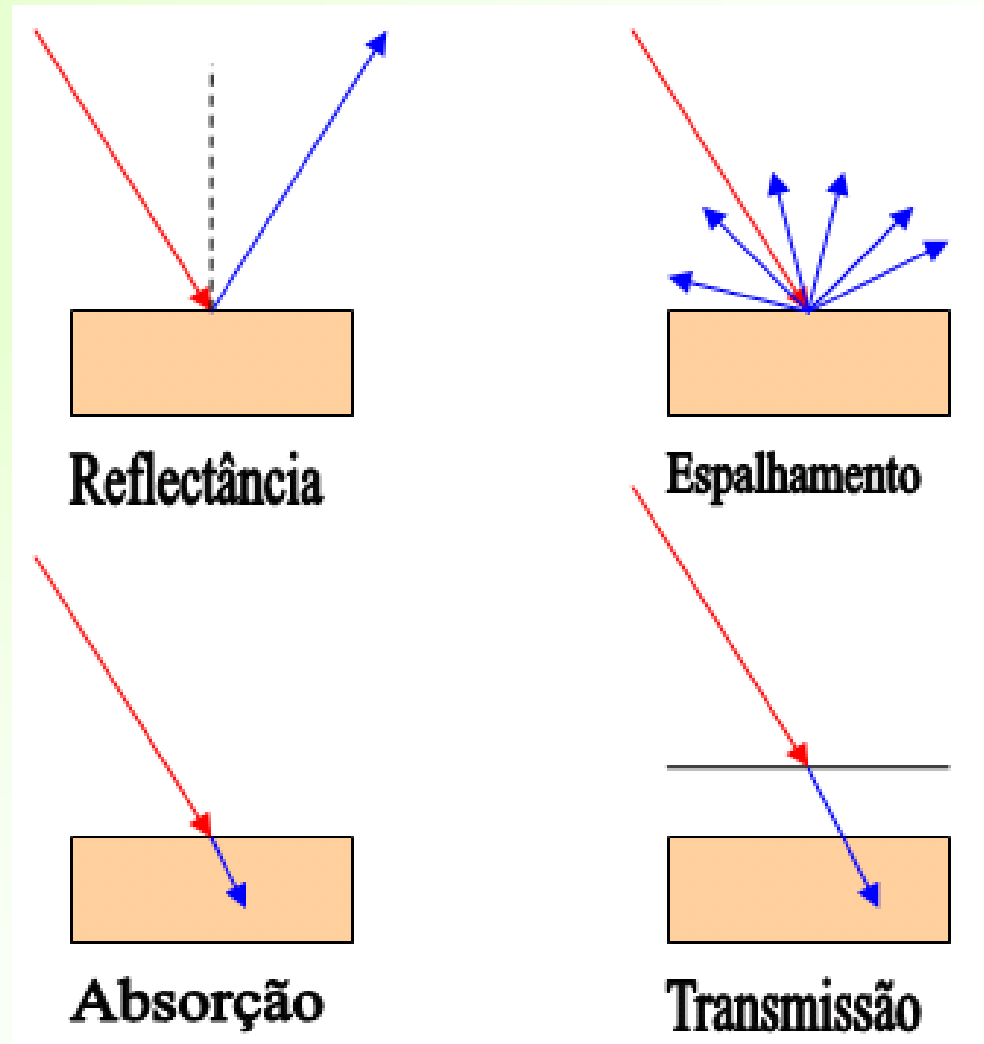
<http://www.cena.usp.br/irradiacao/espectrodeondas.jpg>

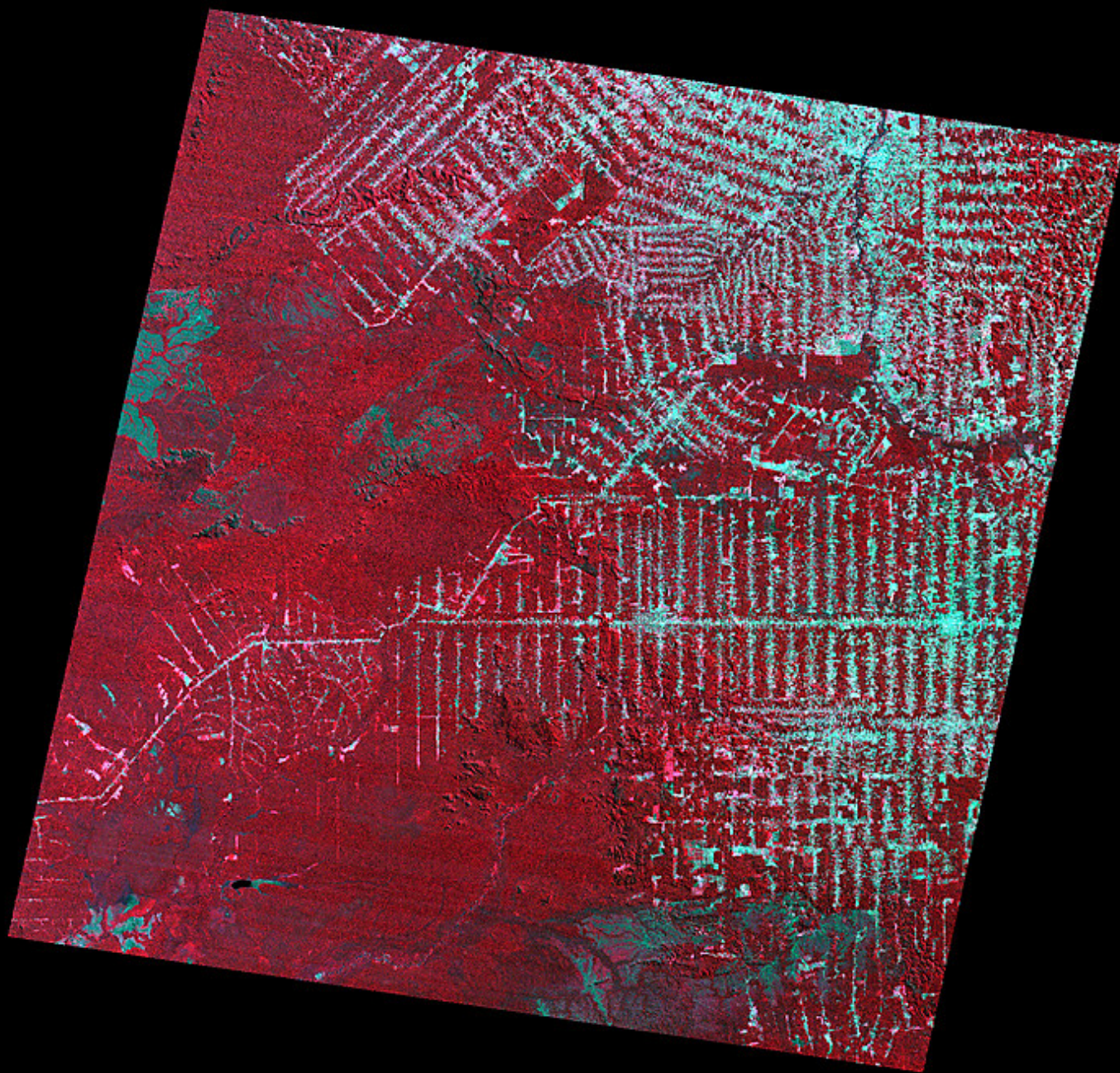
# espectro óptico



# Interação da energia eletromagnética com a atmosfera e com a superfície terrestre

- Energia incidente
- Energia absorvida
- Energia transmitida
- Energia refletida



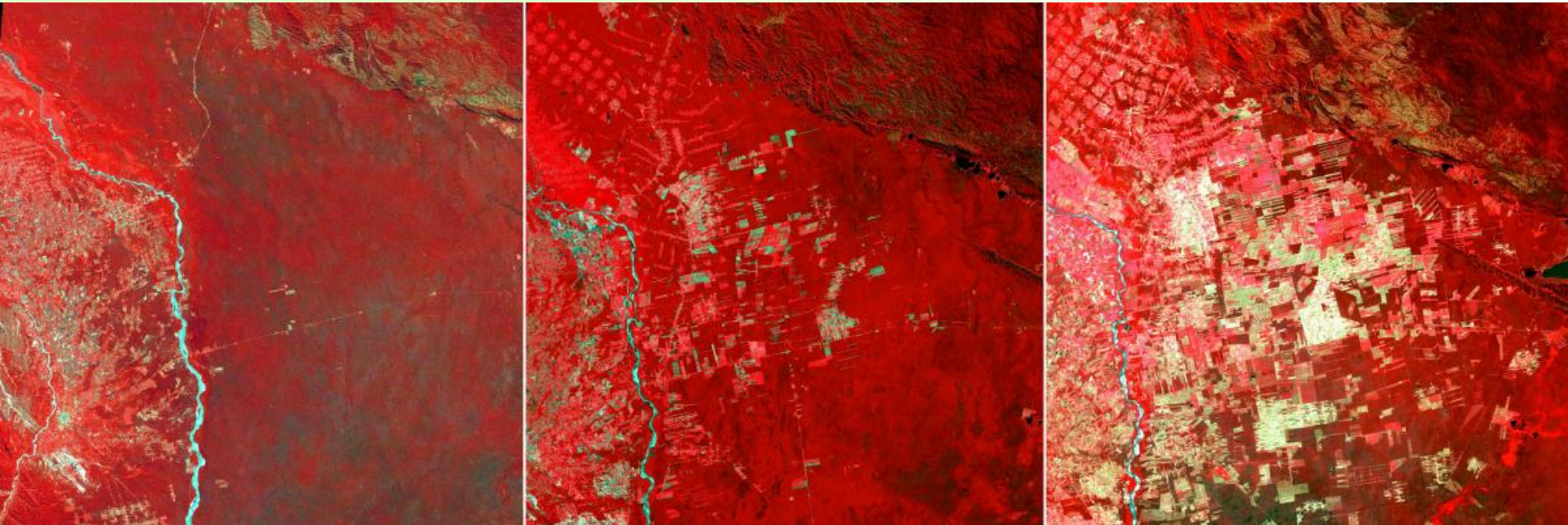


Landsat  
TM 4

imagem CBERS 2 CCD da região de Manaus - AM  
composição colorida 4 (R), 3 (G), 2 (B) - órbita 173/103 data 17/08/04

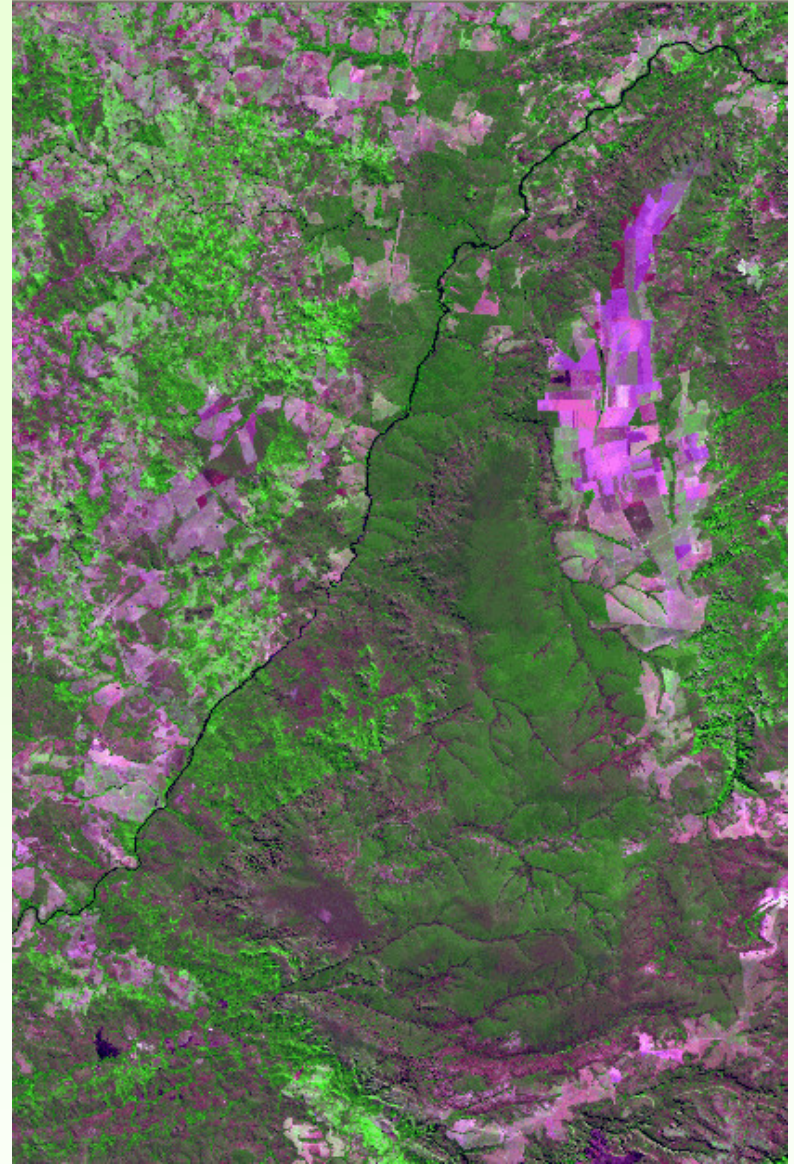
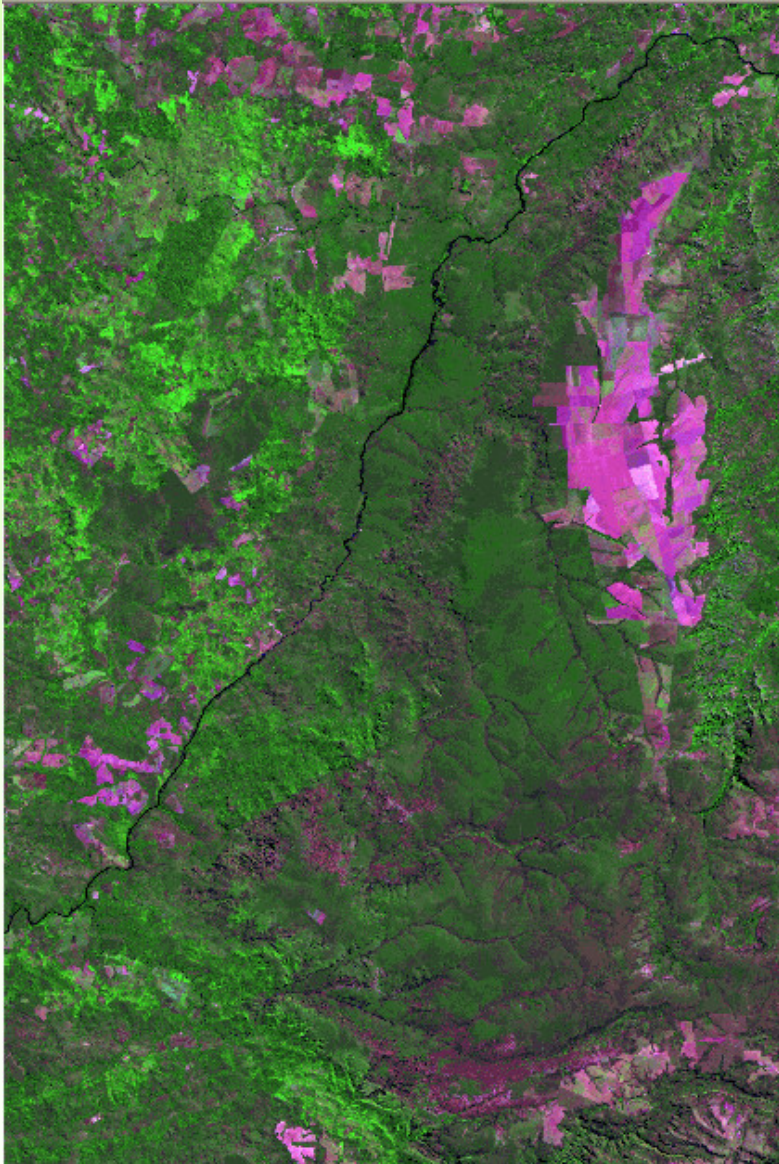


# Desmatamento na Amazônia Boliviana



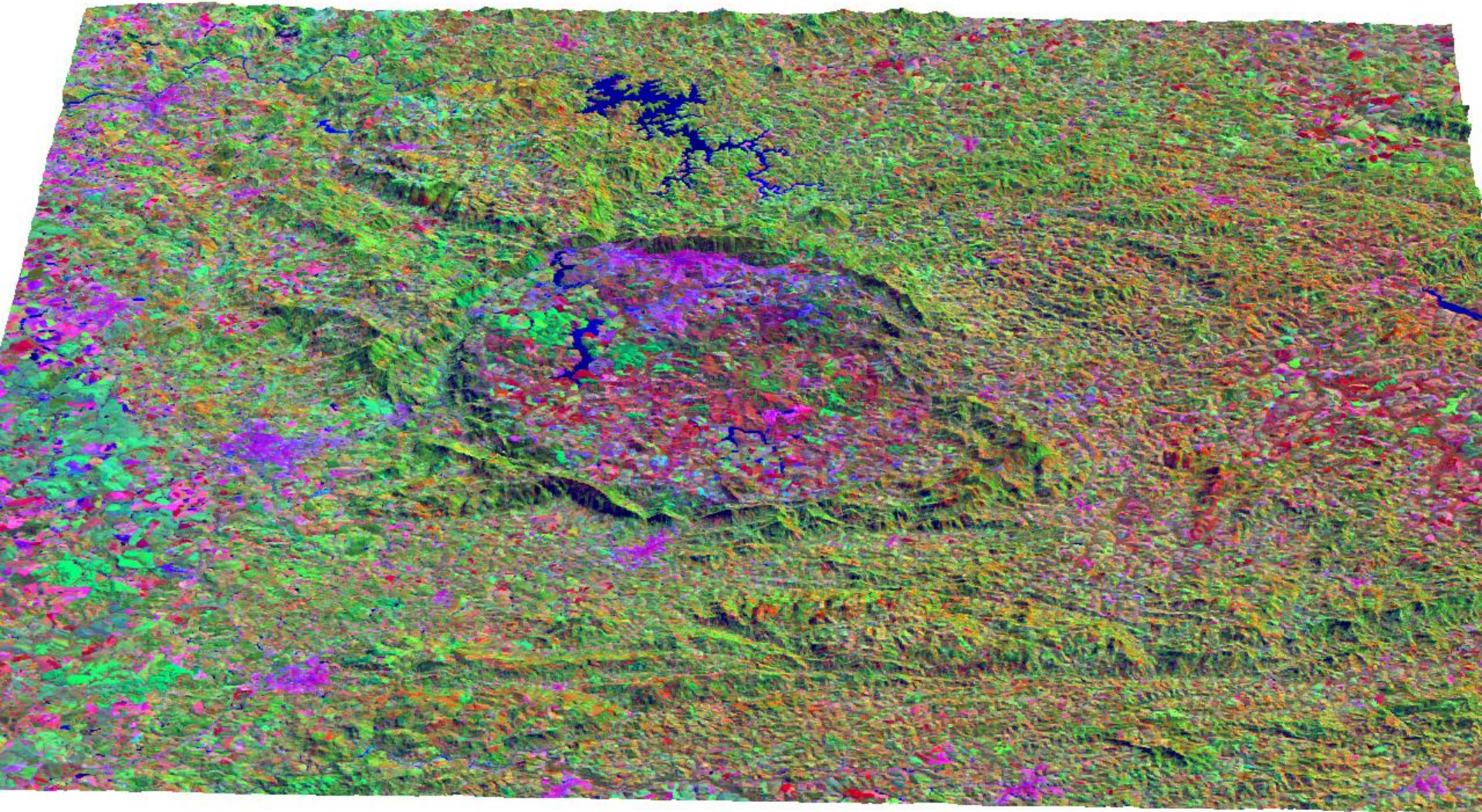
Landsat  
TM 5

# Terra Indígena São Marcos / MT – 1993 - 2000



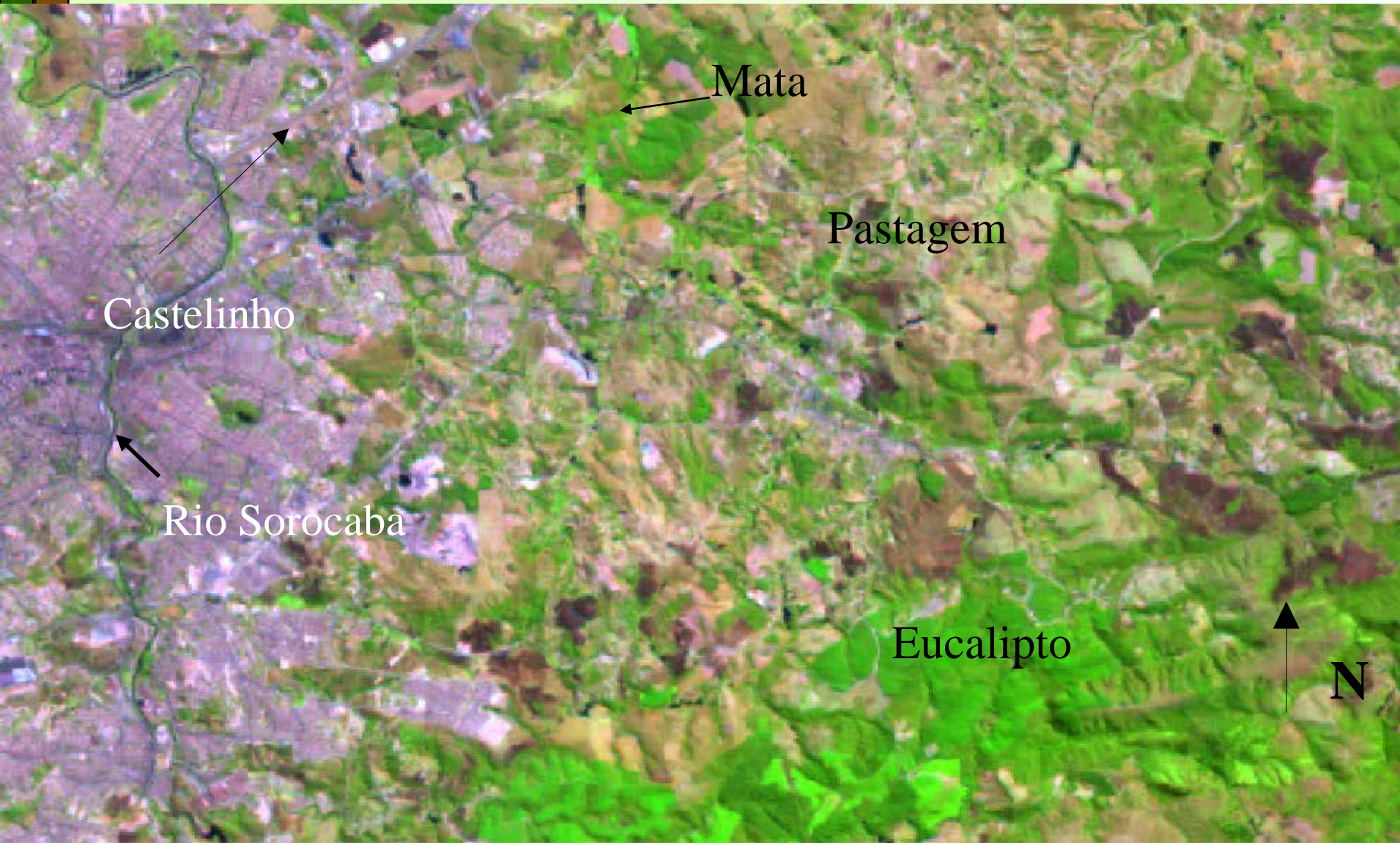
Landsat TM 5





Landsat TM +

# Landsat7 ETM+ de 1999 de Sorocaba



# Imagens de Satélite x Fotografias Aéreas?

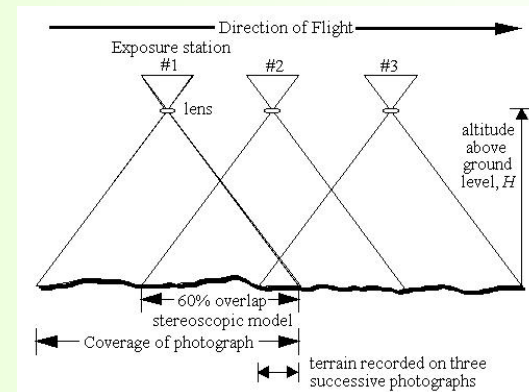
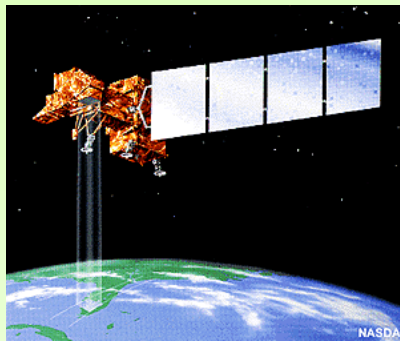


Imagem Landsat ETM+ 5R4G3B  
órbita 219/77 de 1999



Fotografia aérea BASE SA (2000),  
escala aprox. 1: 30 000



Área central do município de Embu/SP  
1962-1973-1994



## Jardim Santo Eduardo/Embu/SP: 1962 - 1994



# Aquisição de dados

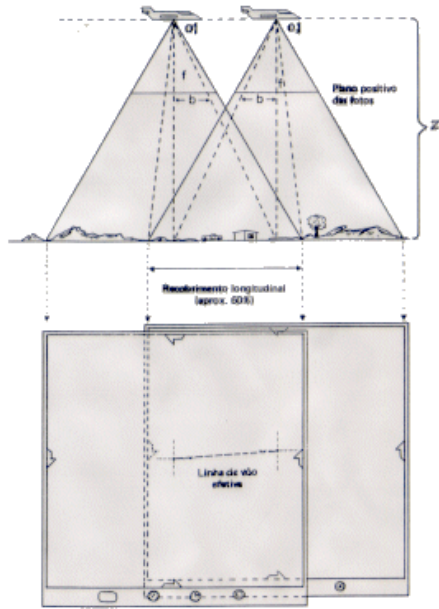
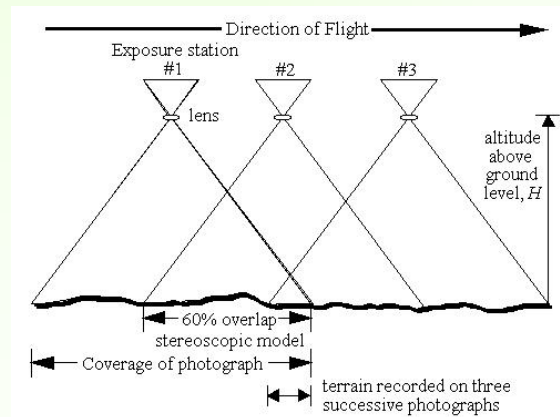
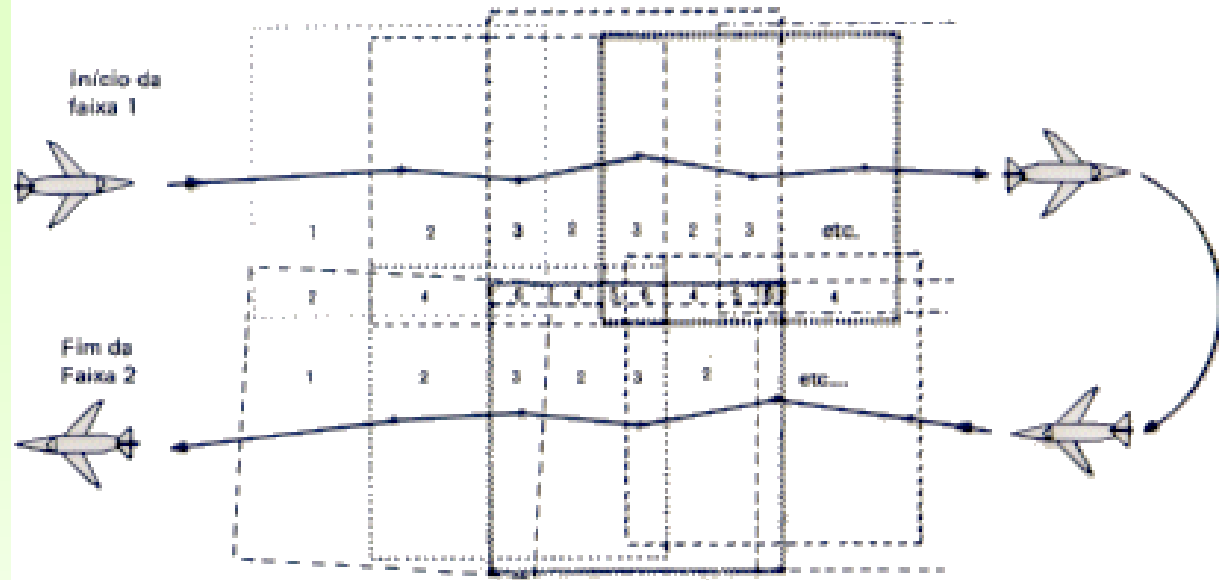
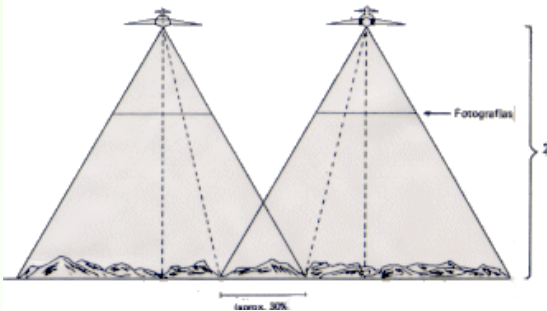










fig. 4.3 - Recobrimento longitudinal

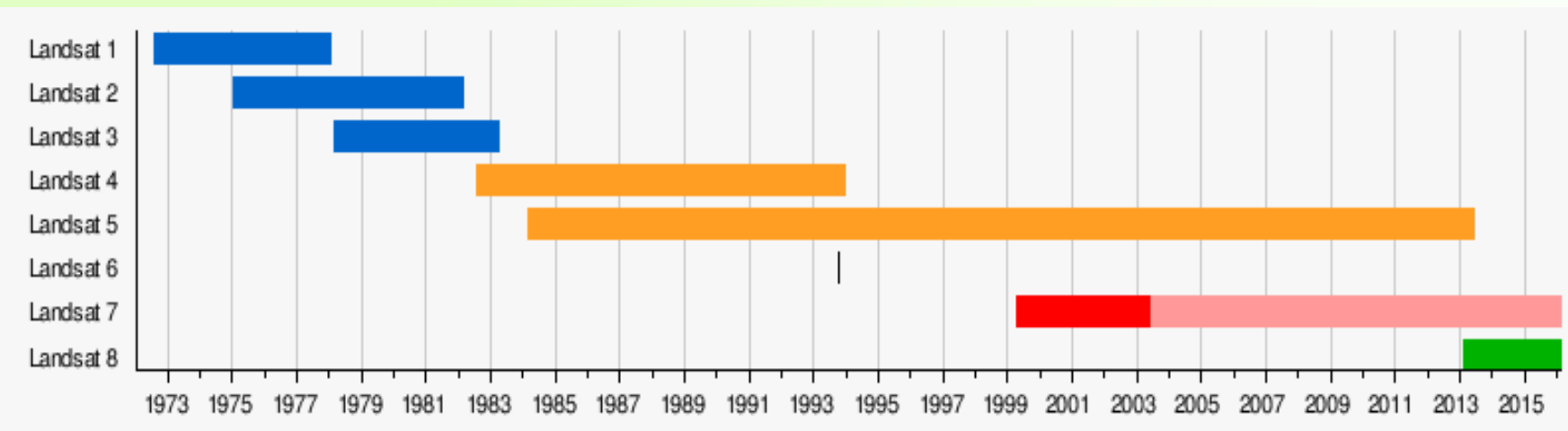


# Programa Landsat

Instrument	Picture	Launched	Terminated	Duration	Notes
<a href="#">Landsat 1</a>		July 23, 1972	January 6, 1978	2 years, 11 months and 15 days	Originally named Earth Resources Technology Satellite 1.
<a href="#">Landsat 2</a>		January 22, 1975	February 25, 1982	2 years, 10 months and 17 days	Nearly identical copy of Landsat 1
<a href="#">Landsat 3</a>		March 5, 1978	March 31, 1983	5 years and 26 days	Nearly identical copy of Landsat 1 and Landsat 2
<a href="#">Landsat 4</a>		July 16, 1982	December 14, 1993	11 years, 4 months and 28 days	First of the TM sensors with 30 m spatial resolution.
<a href="#">Landsat 5</a>		March 1, 1984	June 5, 2013 <sup>[7]</sup>	29 years, 3 months and 4 days	Nearly identical copy of Landsat 4. Longest Earth-observing satellite mission in history.
<a href="#">Landsat 6</a>		October 5, 1993	October 5, 1993	0 days	Failed to reach orbit.
<a href="#">Landsat 7</a>		April 15, 1999	Still active	16 years, 11 months and 27 days	Operating with scan line corrector disabled since May 2003. <sup>[8]</sup>
<a href="#">Landsat 8</a>		February 11, 2013	Still active	3 years and 2 months	Originally named Landsat Data Continuity Mission from launch until May 30, 2013.

# Programa Landsat

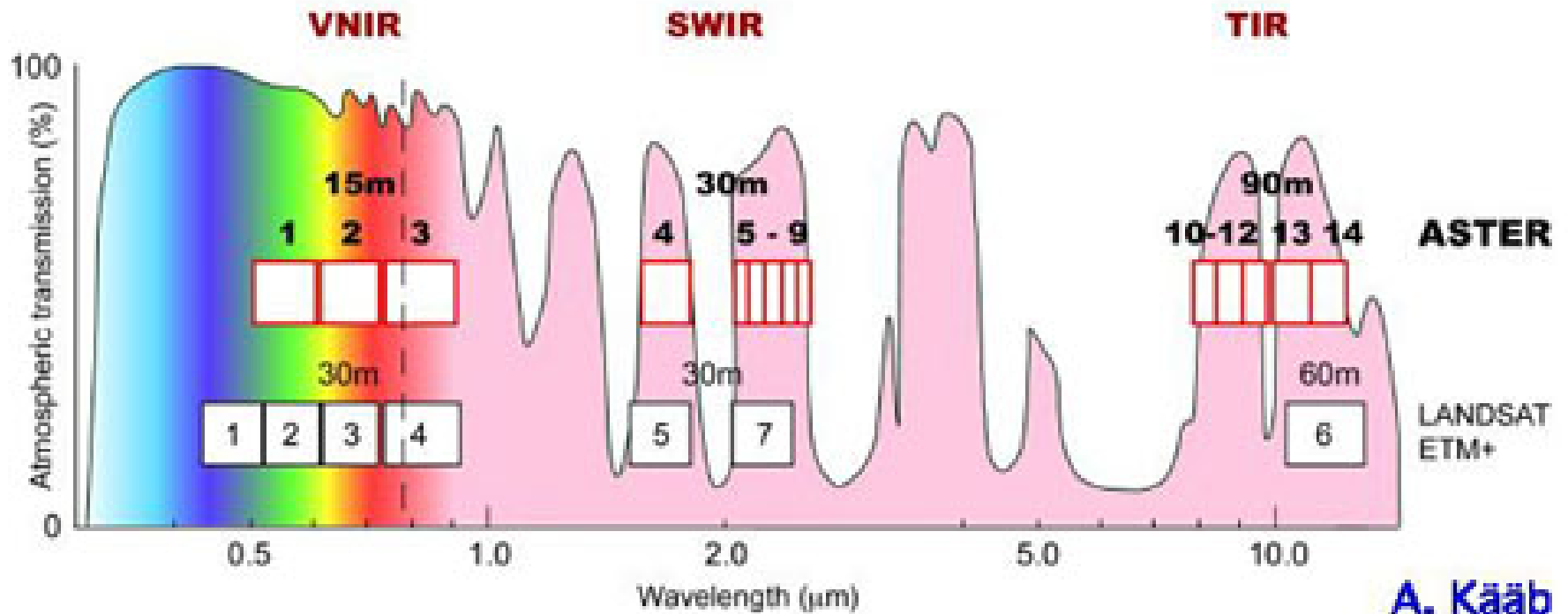
## Chronological Launch and Retirement History



Fonte: Wikipédia, 2016



## Bandas do Landsat-7 ETM+ e ASTER

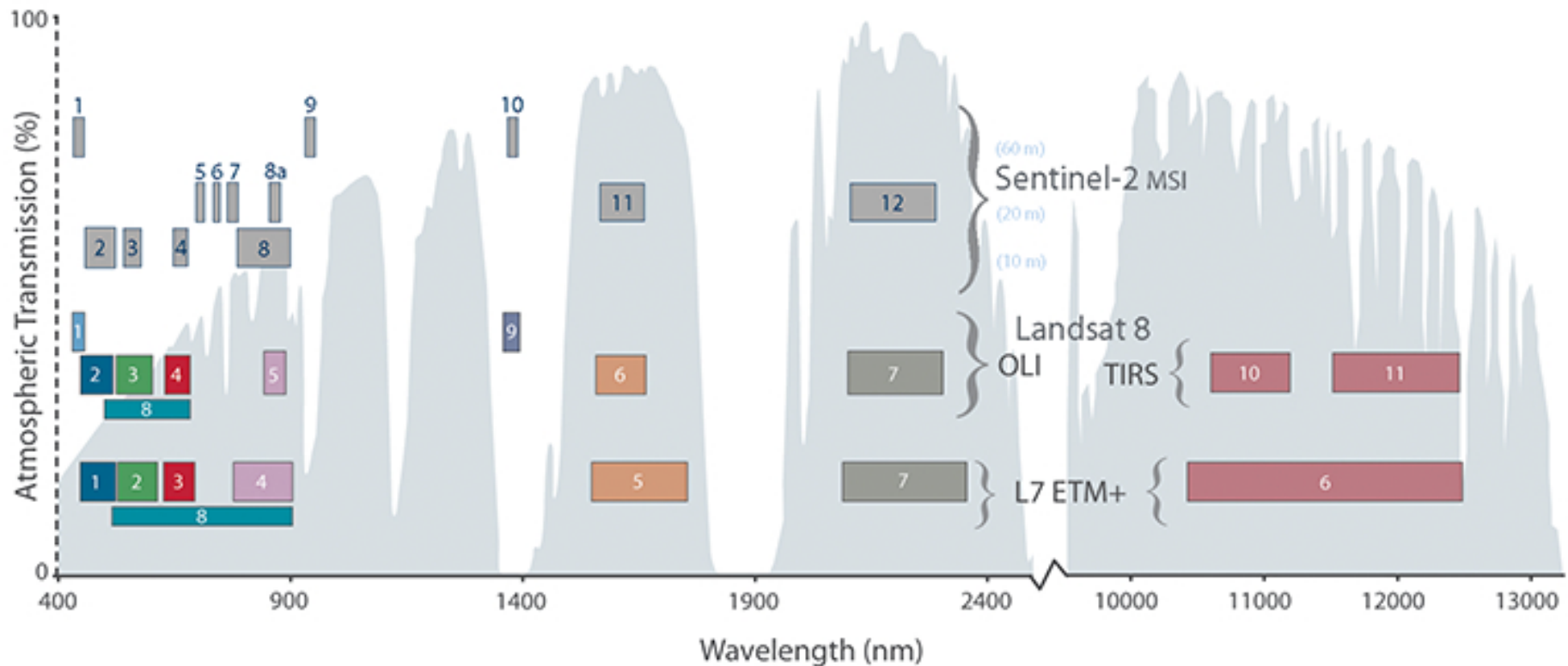


*GLIMS: Global Land Ice Measurements from Space  
Monitoring the World's Changing Glaciers*

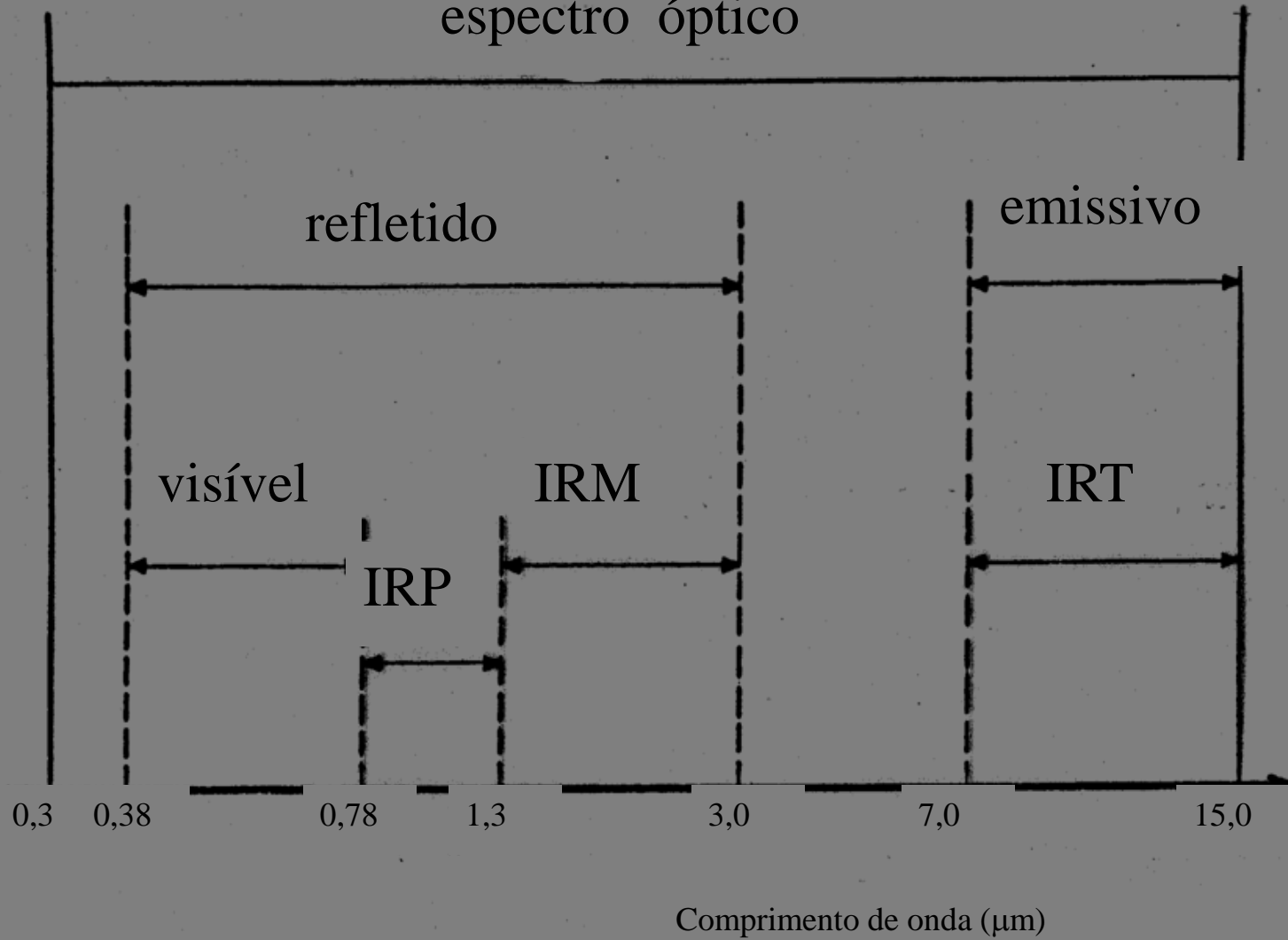
<http://www.glims.org/>

# Landsat 8 e Sentinel 2 (2017)

Comparison of Landsat 7 and 8 bands with Sentinel-2

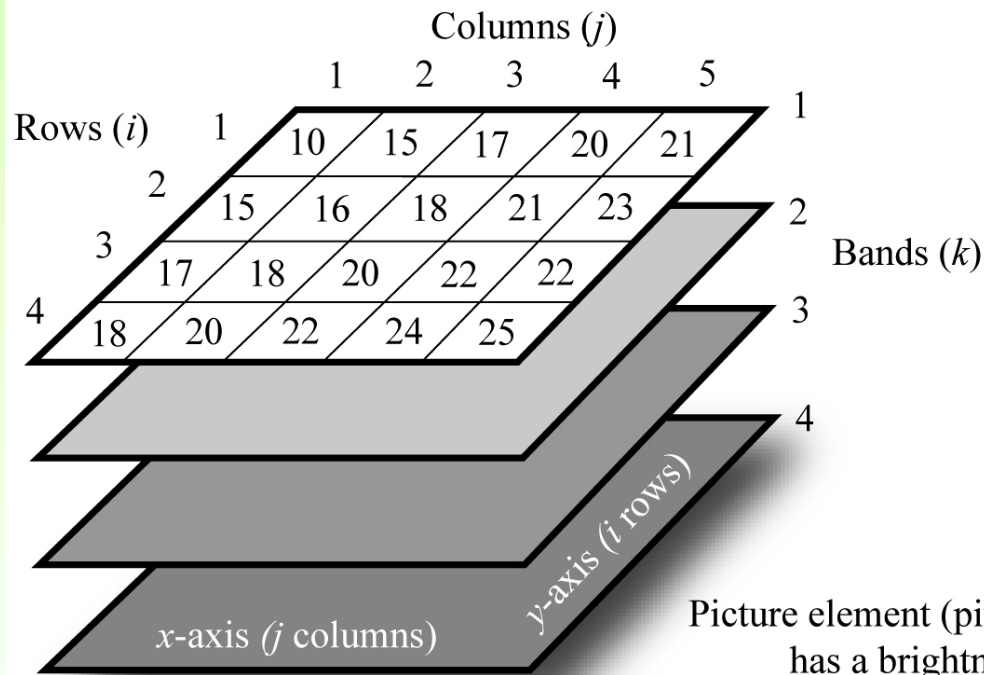


# espectro óptico



# Estrutura de uma imagem digital

## Digital Image Terminology



Brightness value  
range (often 8-bit)

255 — white

127 — gray

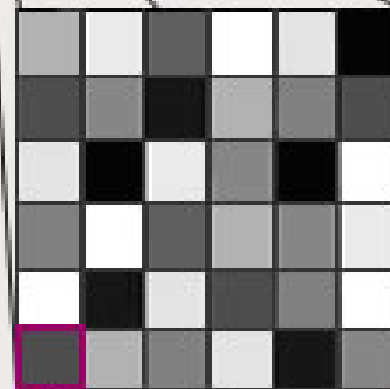
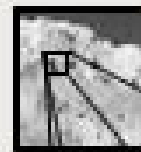
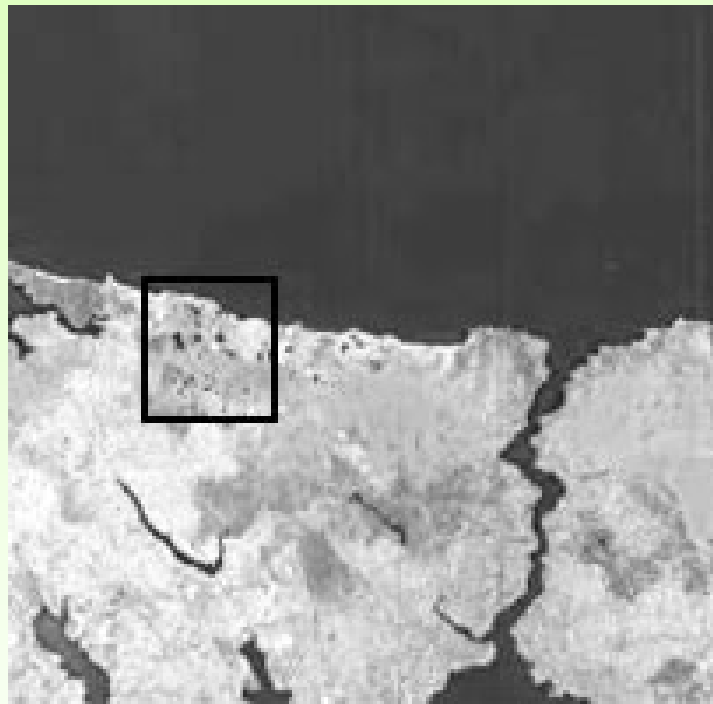
0 — black

Associated  
grayscale



Picture element (pixel) at location row 4, column 4, band 1  
has a brightness value of 24, i.e.,  $BV_{4,4,1} = 24$

# Estrutura de uma imagem digital



→ Pixel

165	242	85	254	220	0
70	140	21	168	123	74
232	0	243	142	0	255
122	255	85	171	134	236
236	15	220	71	110	255
85	174	114	223	14	140

→ Digital Number (DN)

# Processamento digital de imagens: Funções

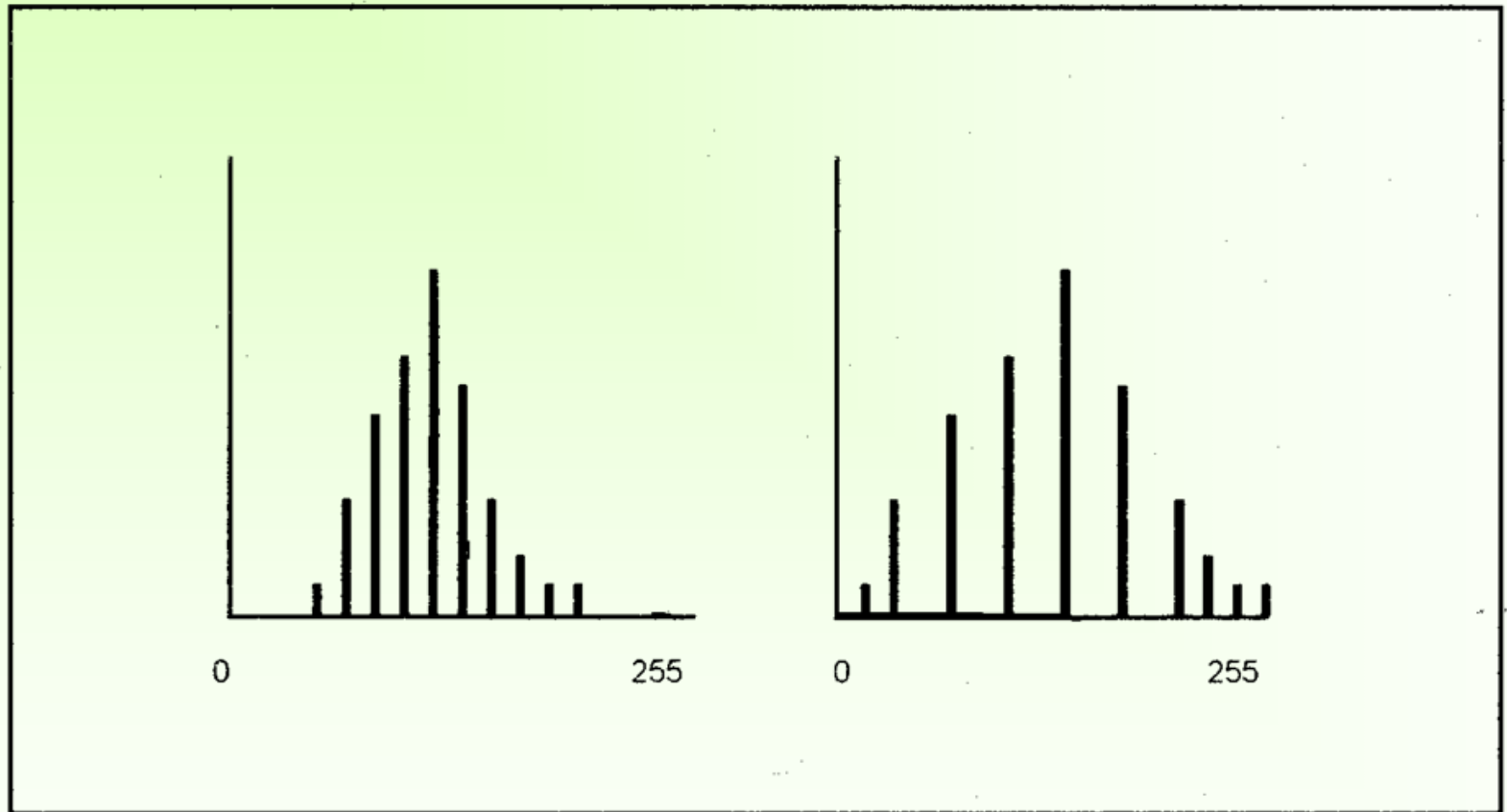
- Facilitar a identificação e extração da informação contida nas imagens para posterior interpretação.
- Remover ou amenizar degradações e distorções que limitam a capacidade visual humana.
- Processar grande quantidade de dados.

# Processamento digital de imagens

O processamento digital de imagens de sensoriamento Remoto é dividido em:

- Pré-processamento: correção radiométrica e geométrica das imagens;
- Realce: aplicar contrastes nas imagens;
- Classificação: realizar o mapeamento utilizando algoritmos de agrupamento de padrões.

# Aumento linear de contraste

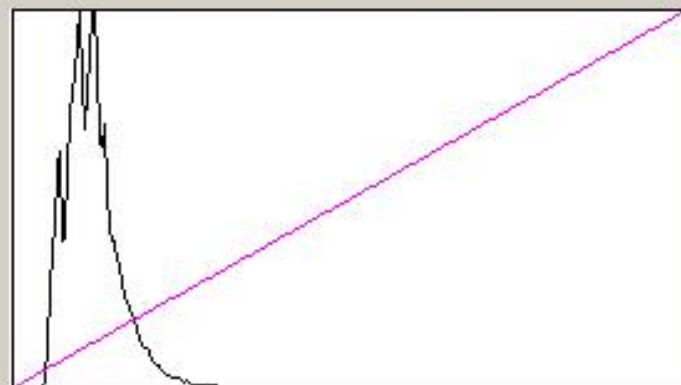






### Contraste

Operação Canal Exibir Executar Ajuda



Nível de Entrada:

LUT/População

Entrada:   Nova:

Média

M:  G:  B:

Edição(saída)

Valores

Mín:  CR Máx:  CR

Fatias

CR

Salvar Imagem

Nome:   Banda



### Contraste

Operação Canal Exibir Executar Ajuda

Nível de Entrada:

LUT/População

Entrada:   Nova:

Média

M:  G:  B:

Edição(saída)

Valores

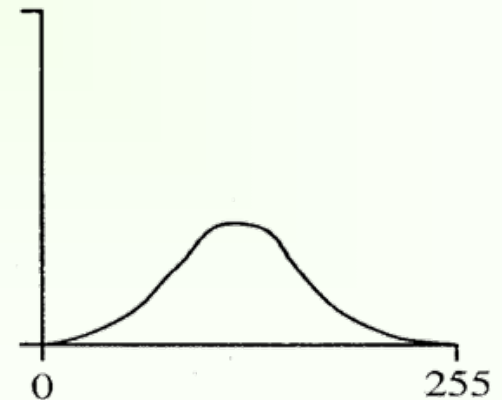
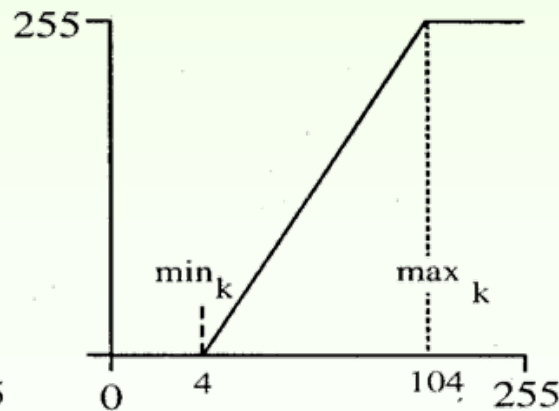
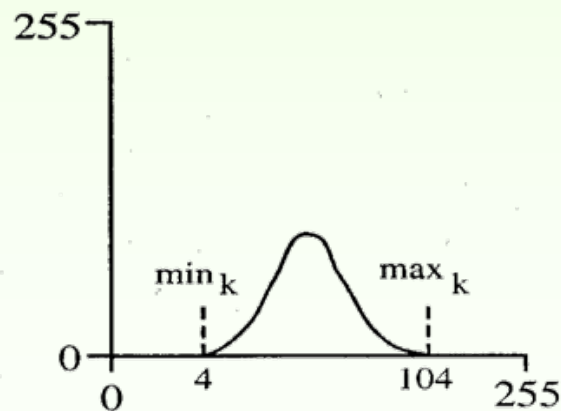
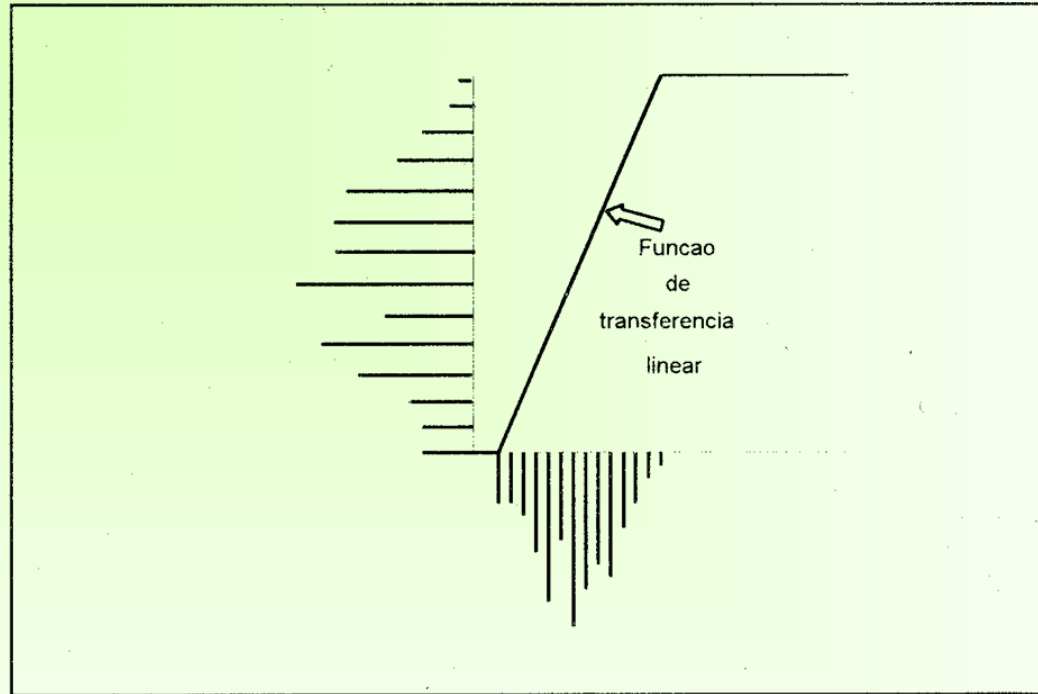
Mín:   Máx:

Fatias

Salvar Imagem

Nome:   Banda

# Função de transferência Linear



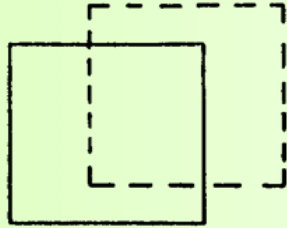
# Correção geométrica

O objetivo é gerar uma imagem que tenha a integridade geométrica de um mapa, sem as distorções causadas pelo processo de aquisição da imagem e devidas aos seguintes fatores:

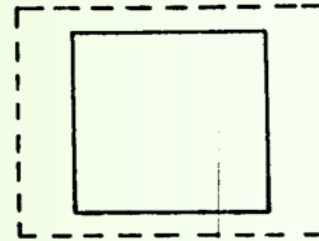
- ✓ Variações na altitude, atitude e velocidade do satélite
- ✓ Distorção panorâmica
- ✓ Curvatura da Terra
- ✓ Rotação da Terra (skew)
- ✓ Refração atmosférica
- ✓ Deslocamento de relevo
- ✓ Variações na velocidade de varredura do sensor

# Distorções

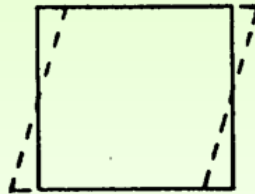
**Translação**



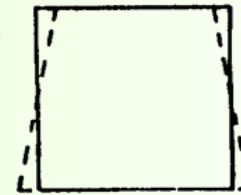
**Altitude**



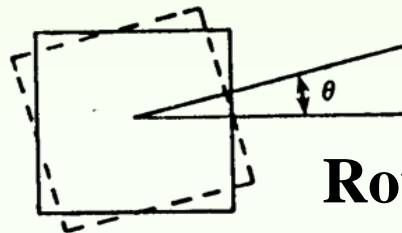
**Inclinação**



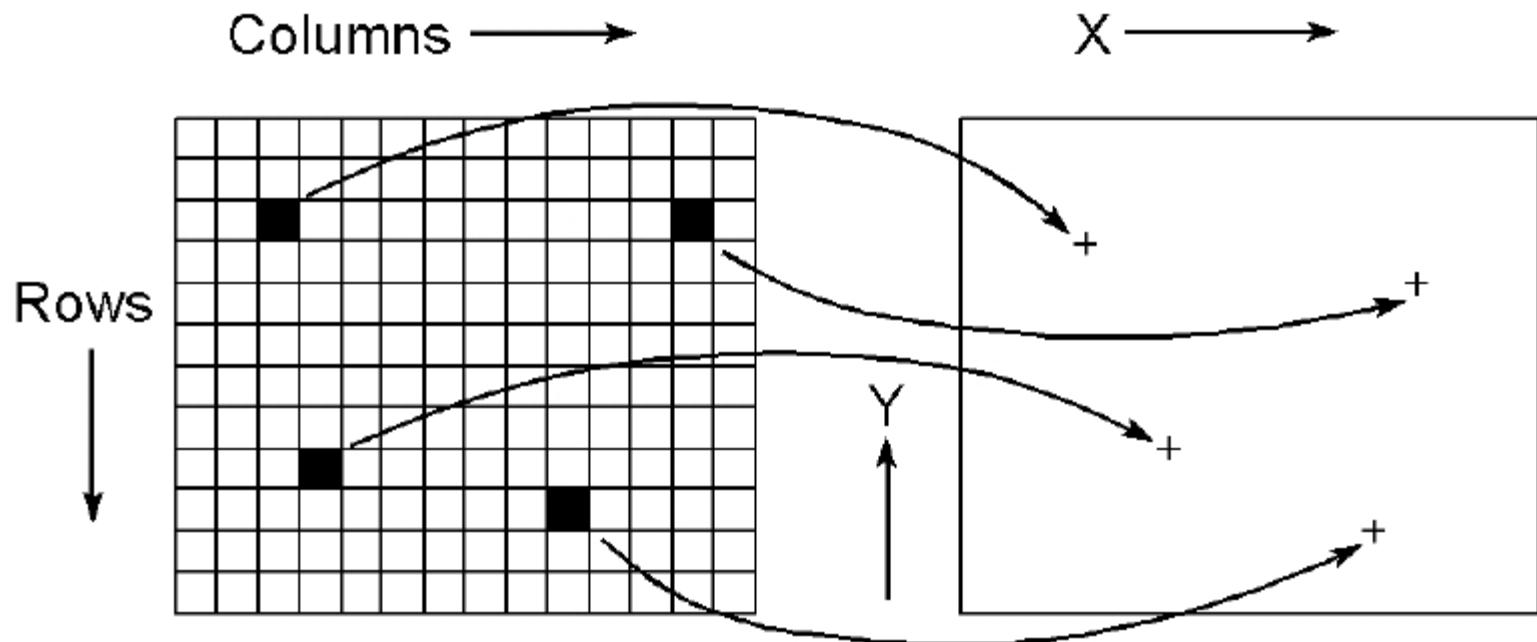
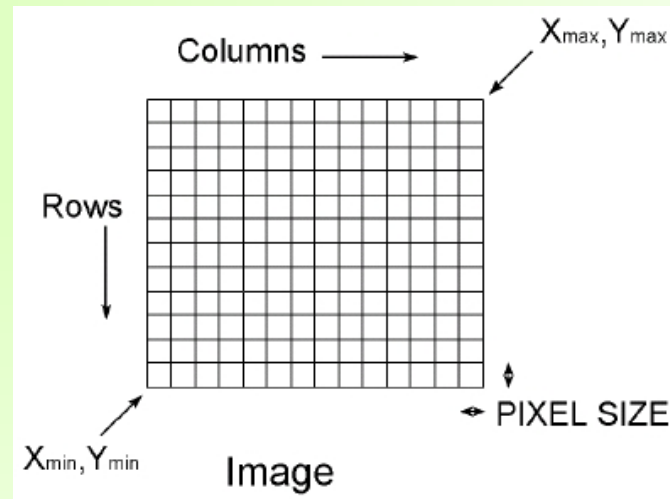
**Perspectiva**



**Rotação**



# Georeferenciamento

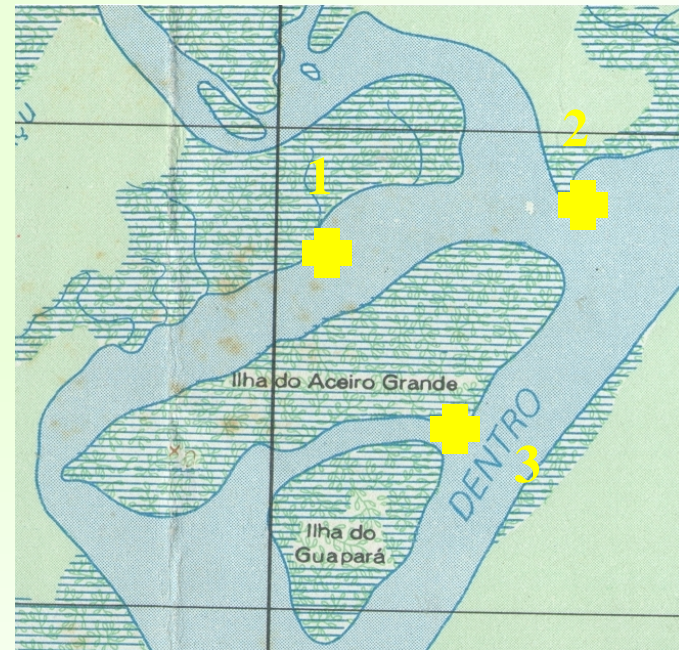
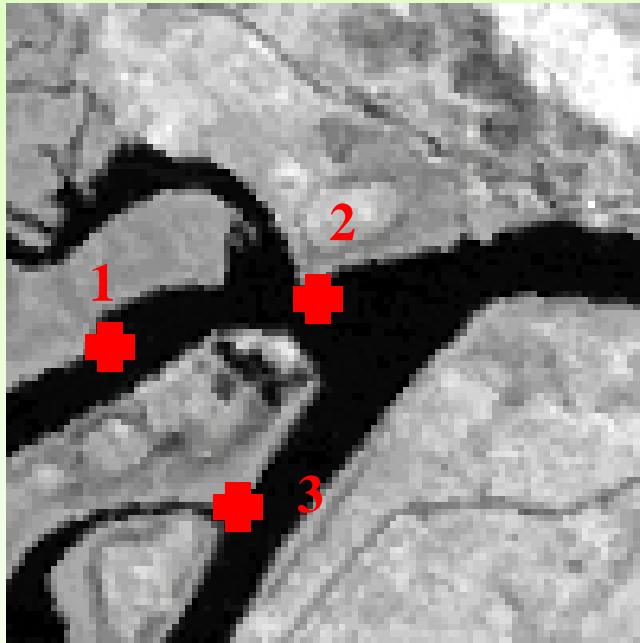


# Georeferenciamento



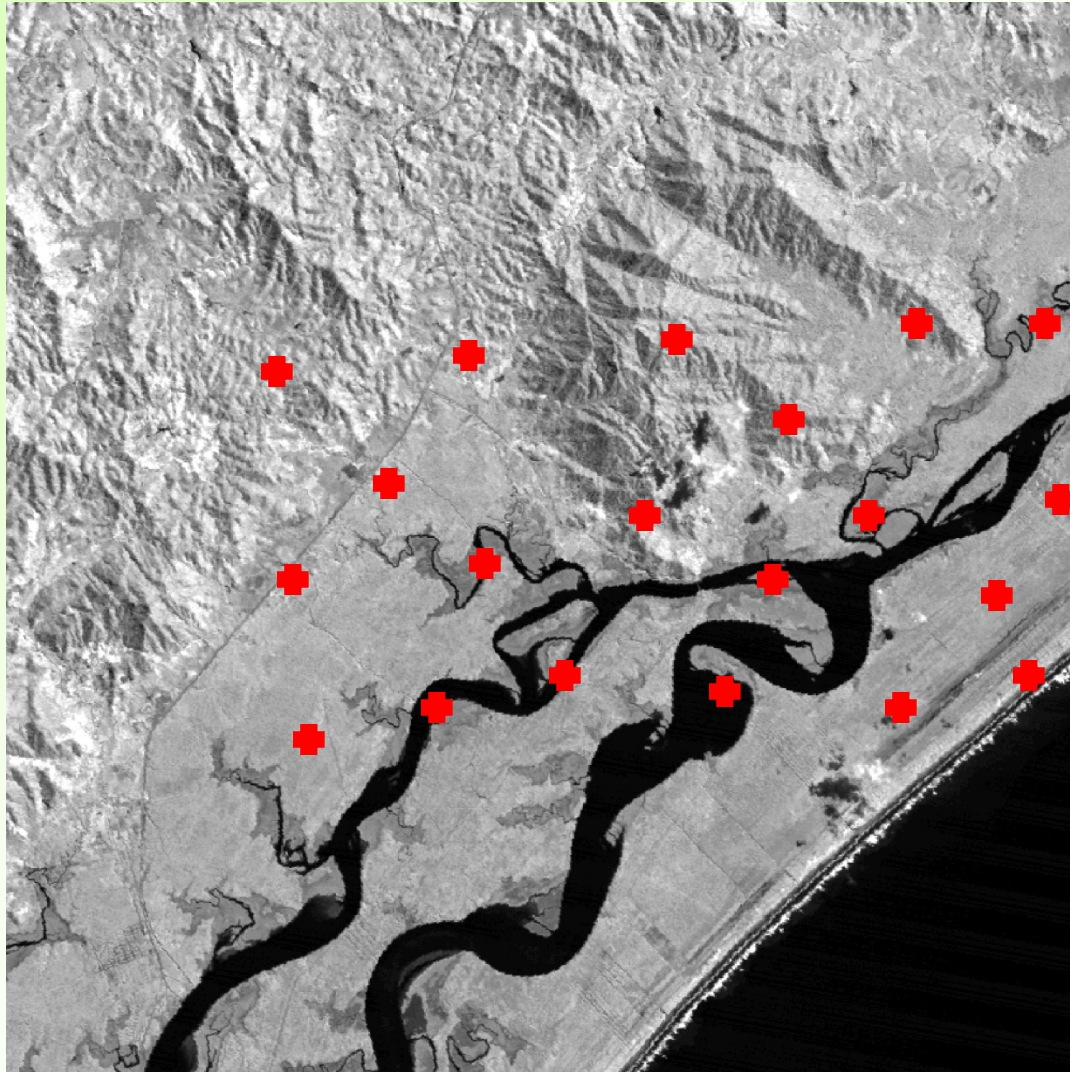
# Georeferenciamento

Seleção de pontos comuns

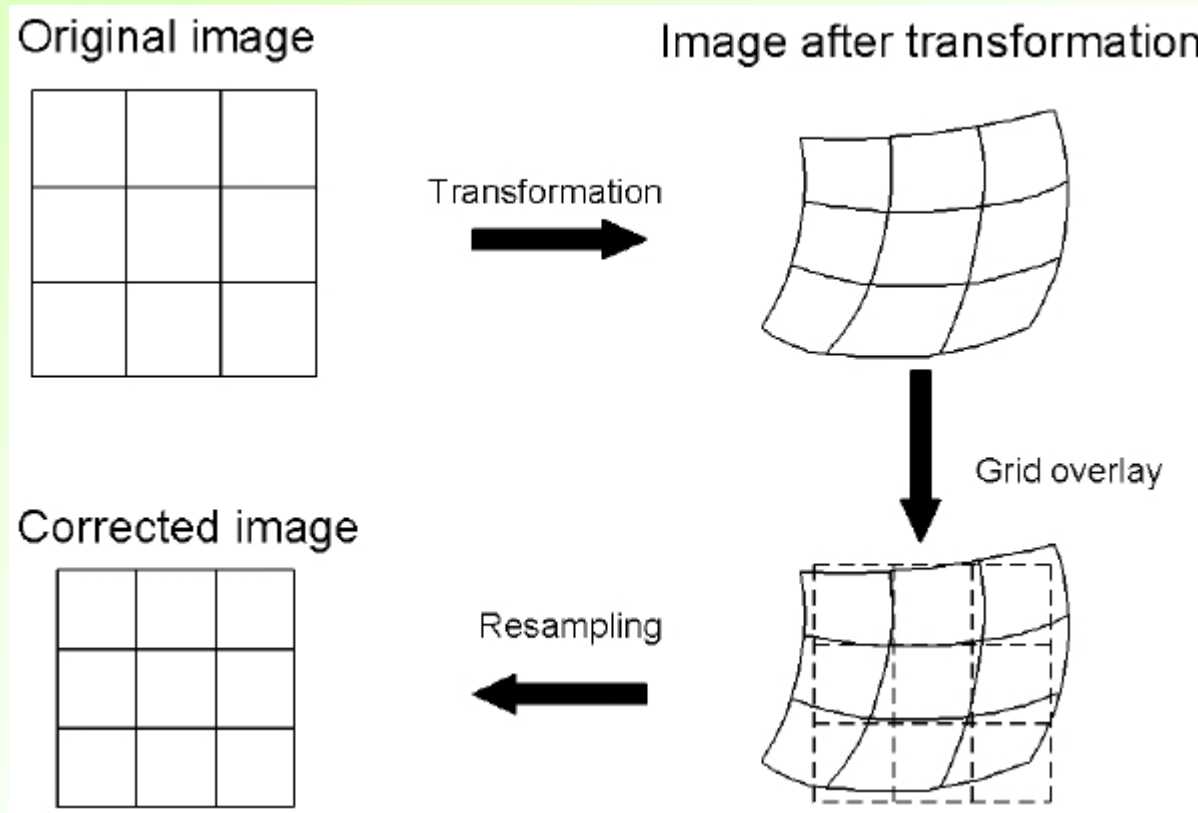




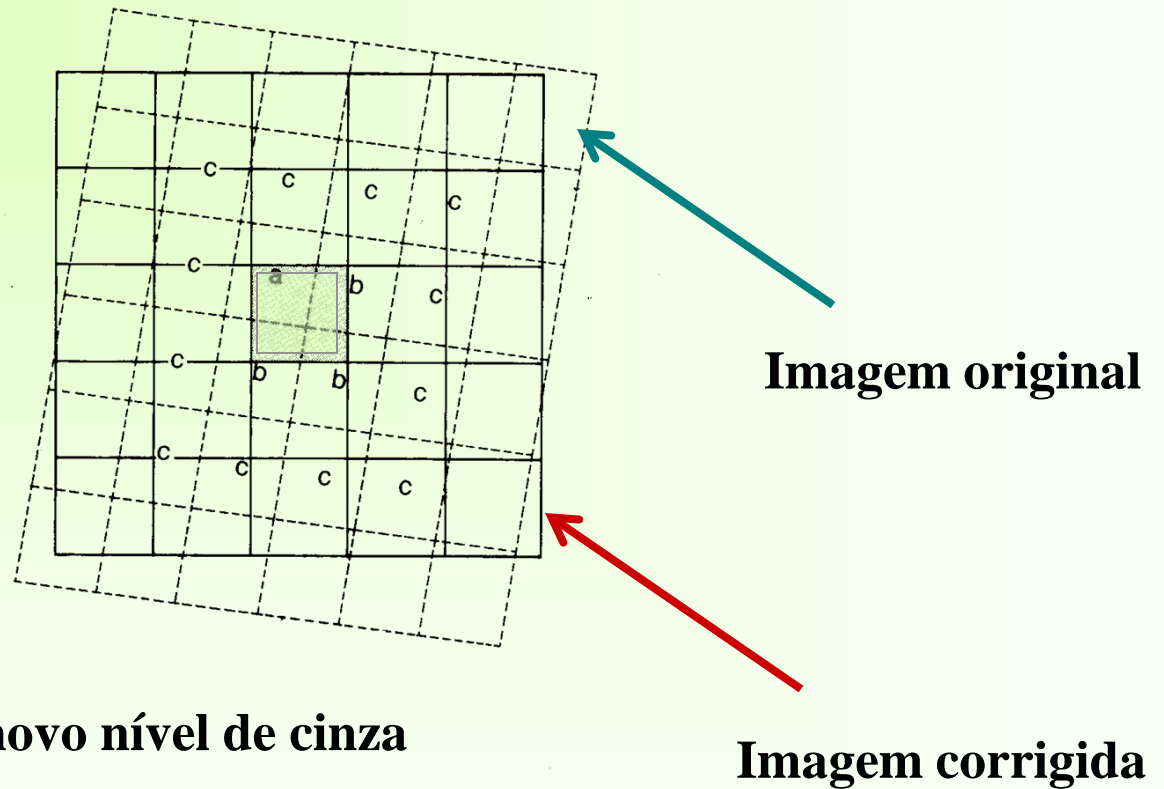
# Georeferenciamento



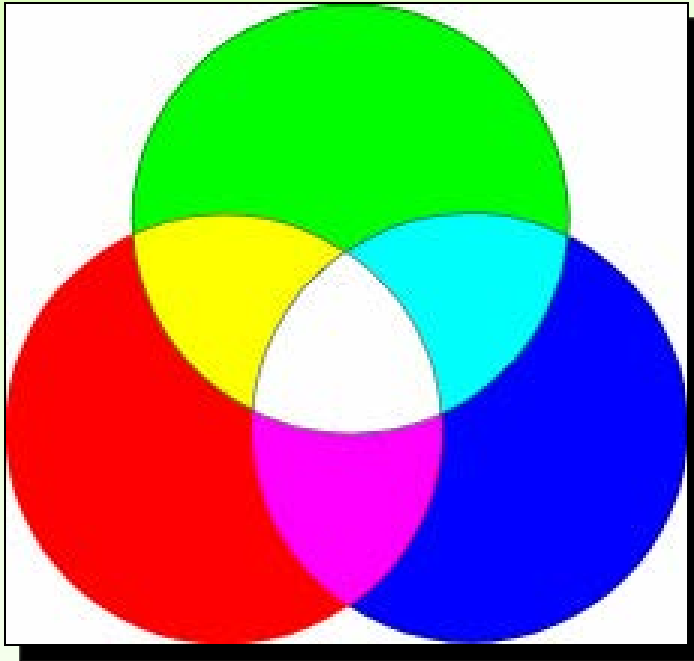
# Reamostragem



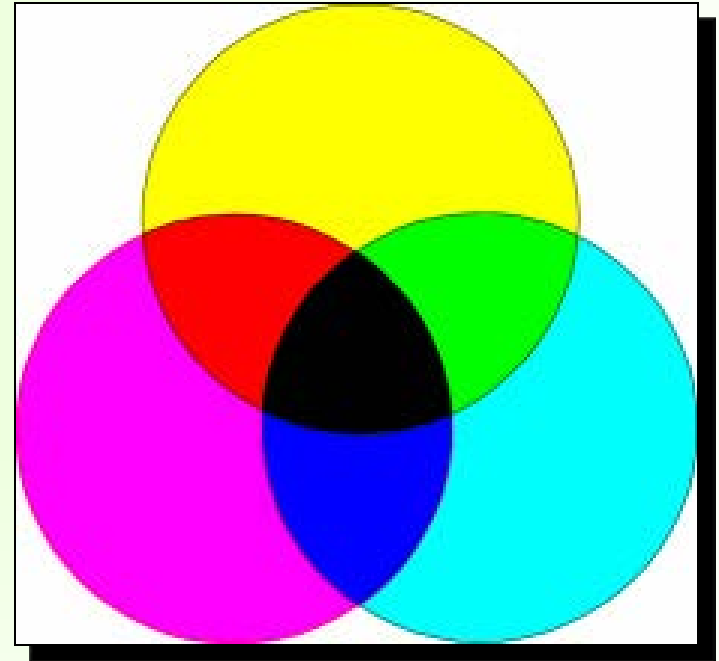
# Reamostragem



# Composições coloridas RGB

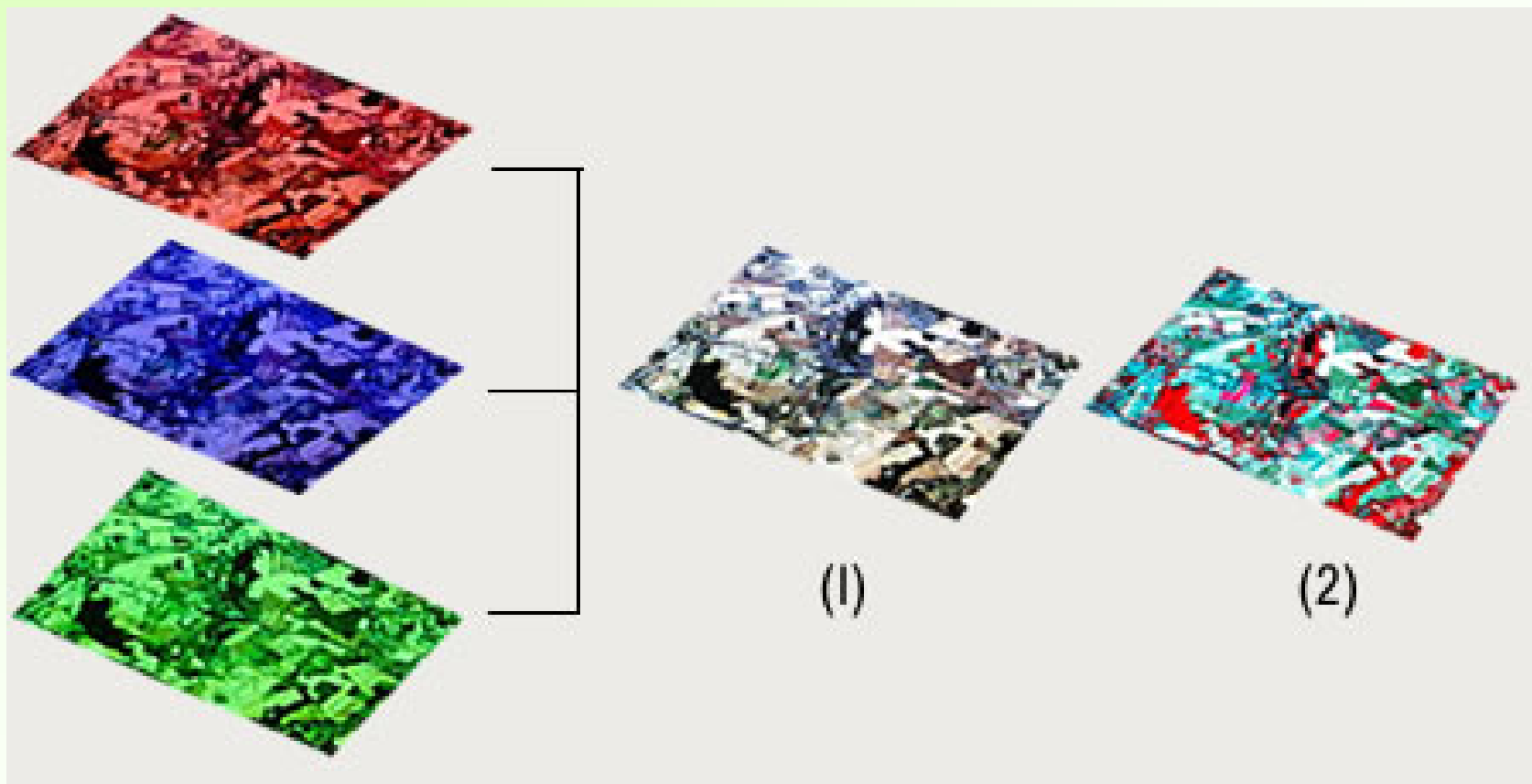


Aditivas



Subtrativas

# Composições coloridas RGB



# Composições coloridas RGB

Imagem Landsat 7 ETM+ da região de Santos - SP  
Composição colorida 5 (R), 4 (G), 3 (B) - órbita 219/77 data 07/08/01



Banda 3



Banda 4



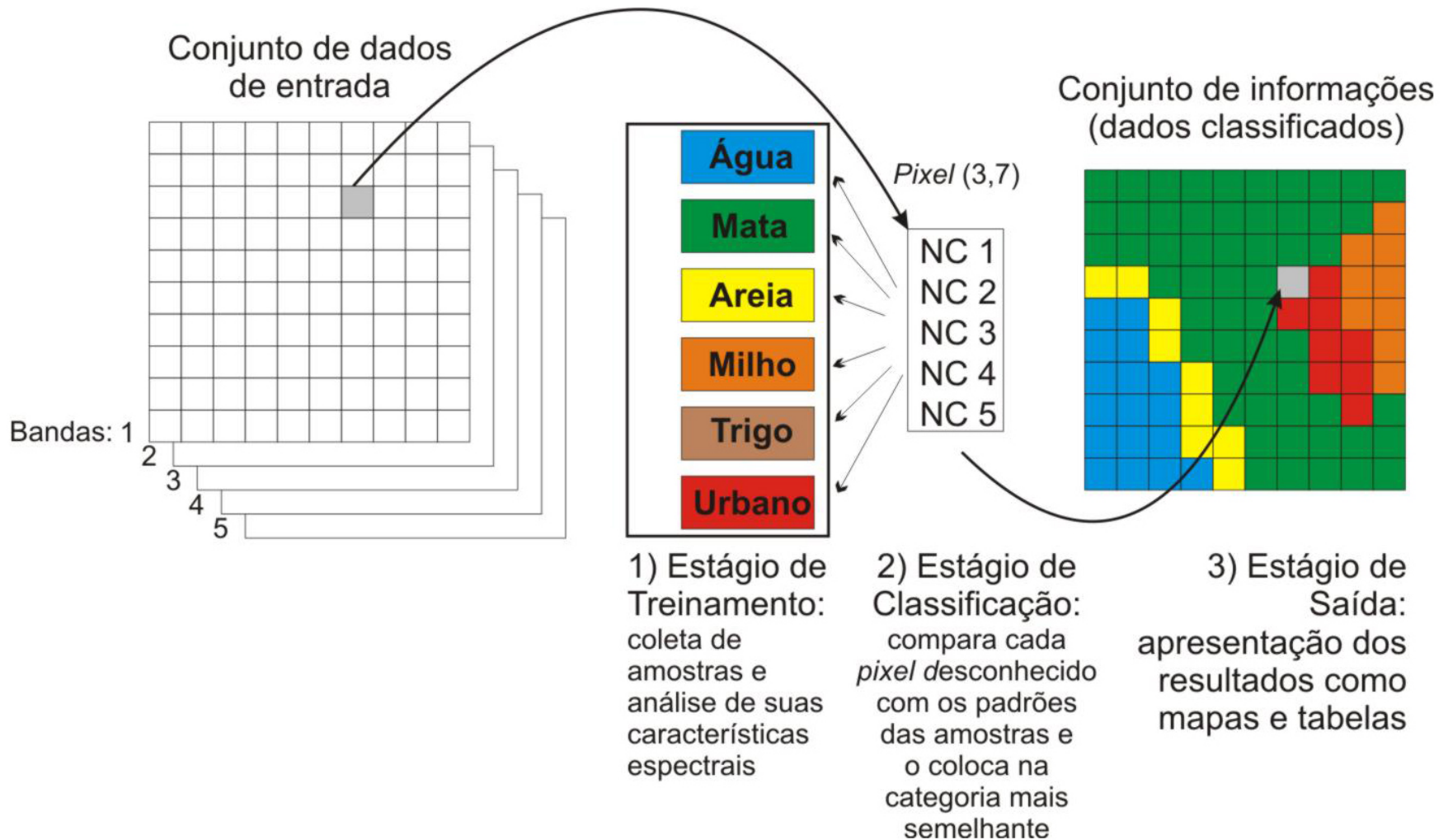
Banda 5

# Composições coloridas RGB

imagem CBERS 2 CCD da região de Manaus - AM  
composição colorida 4 (R), 3 (G), 2 (B) - órbita 173/103 data 17/08/04

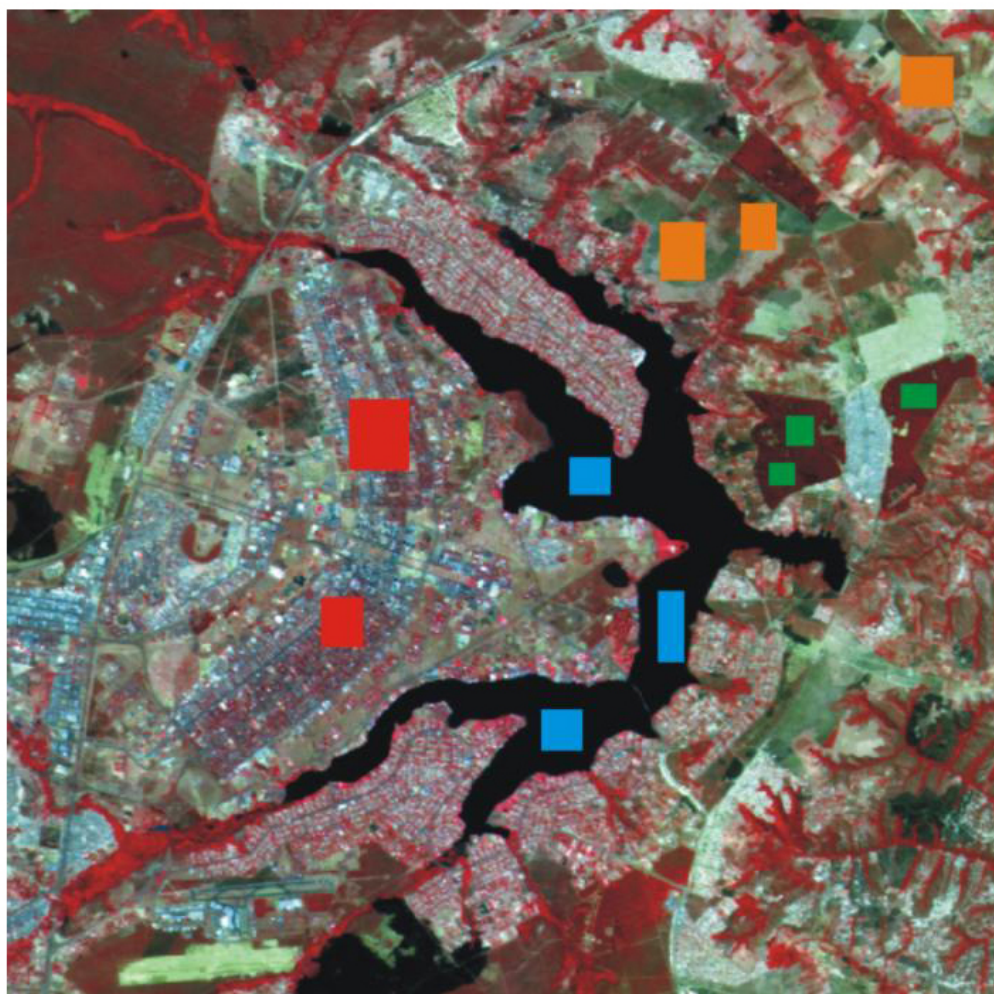


# Classificação de padrões





# Seleção de amostras



## LEGENDA

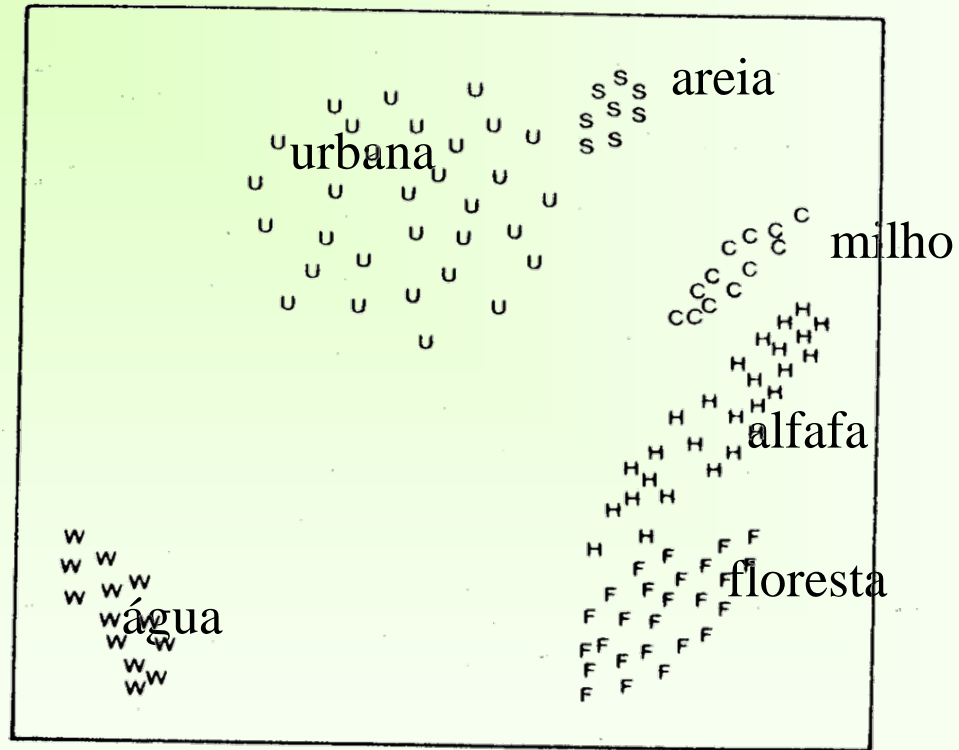
-  Urbano
-  Água
-  Reflorestamento
-  Agrícola

# Escolha de um classificador



# Espaço de atributos

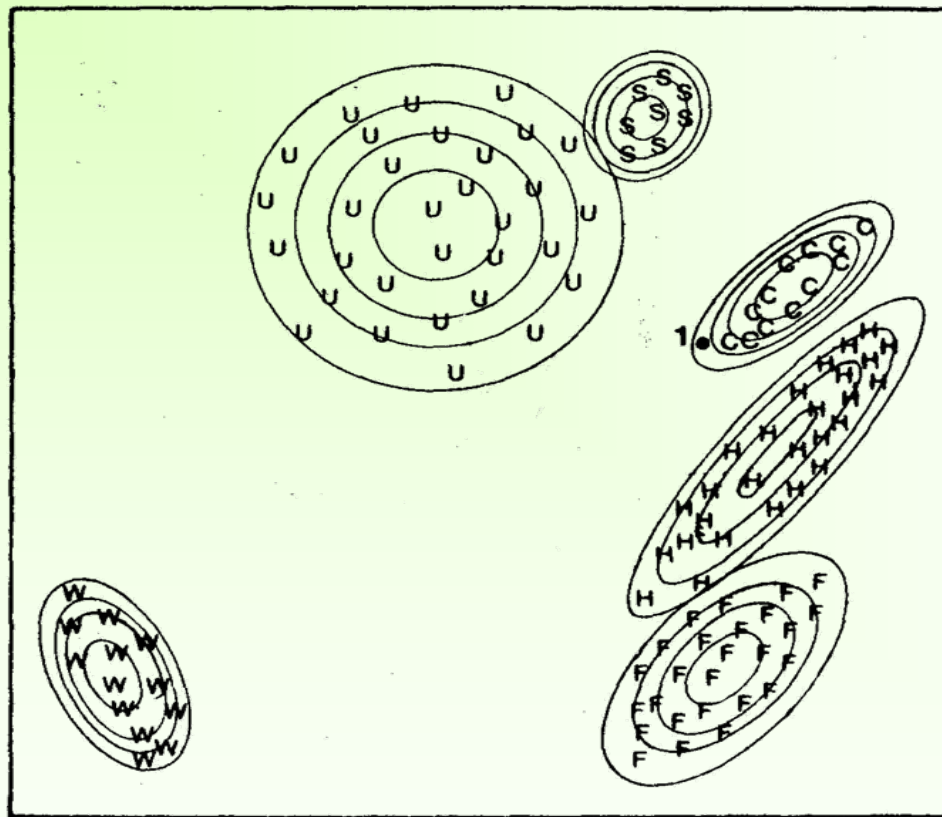
Banda 2



Banda 1

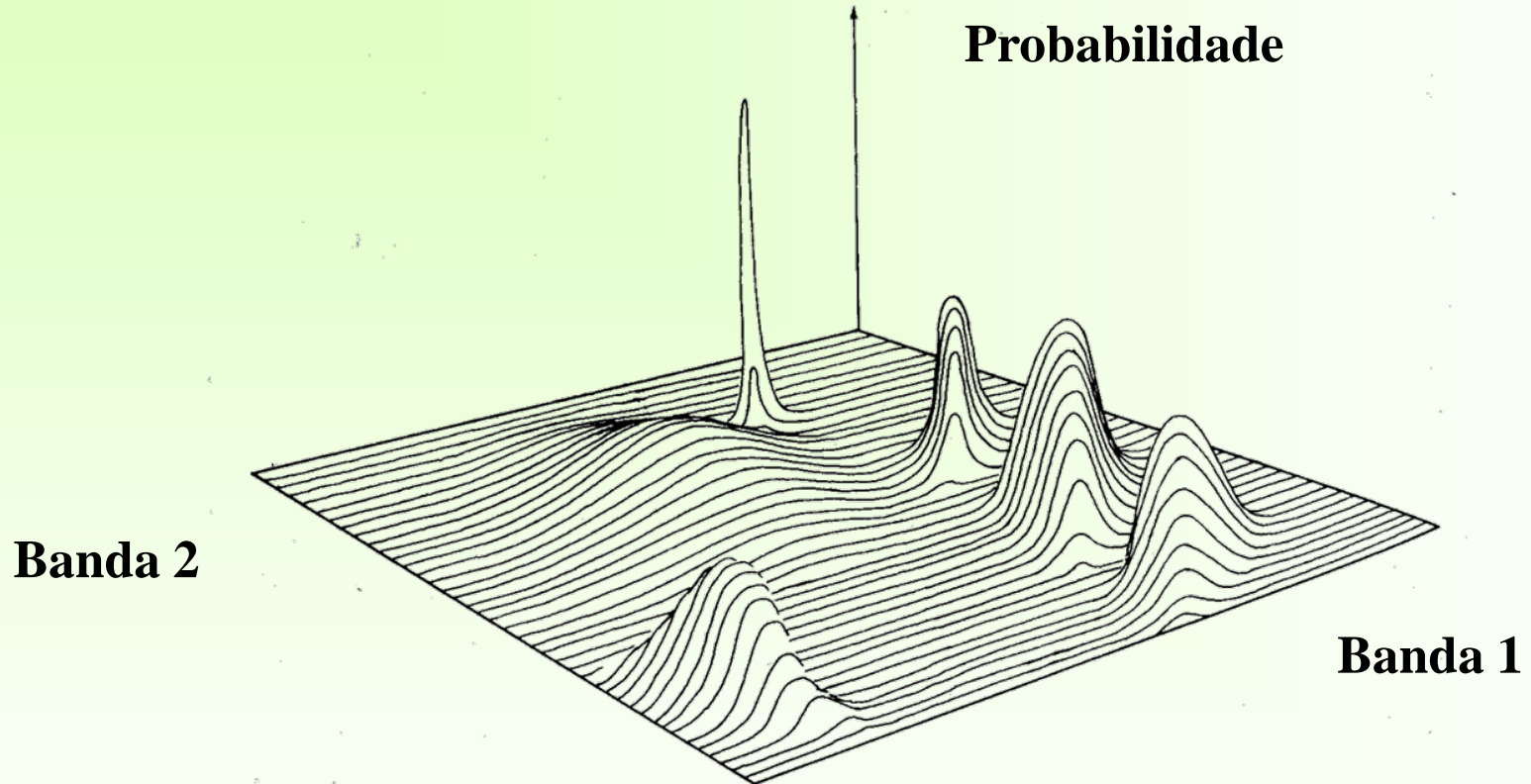
# Máxima Verossimilhança

Banda 2



Banda 1

# Função de Probabilidade



# PARA BAIXAR ILWIS

<http://www.itc.nl/ilwis/downloads/ilwis33.asp>

# PARA BAIXAR ILWIS

ILWIS 3.3 Download page - Mozilla Firefox

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ILWIS 3.3 Download page X +

www.itc.nl/ilwis/downloads/ilwis33.asp

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# ILWIS

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## ILWIS 3.3 Download page

### ILWIS 3.31 Update


ILWIS 3.31 is a service pack on ILWIS 3.3. Some new functionality has been added to the Hydrologic Flow Operations and the Spatial Multiple Criteria Evaluation (SMCE); some bugs were fixed.

- ILWIS 3.31 update (for ILWIS 3.3 only!)

### ILWIS 3.3 Installation


#### Single file download and installation

Download the ILWIS 3.3 self-extracting executable `ILWIS3.3Academic.exe` listed below. When the file has been downloaded, start the executable by double-clicking it. The installation files will be unpacked, then the ILWIS 3.3 installation is automatically started. To install under Windows NT/2000/XP, administrator rights are required.

 [ILWIS3.3Academic.exe](#) (19.3 MB)

#### Multiple part download and installation

In case you have an unstable internet connection, download the fifteen (15) files listed below into one folder. When all files have been downloaded, start the executable by double-clicking it. The installation files will be unpacked, then the ILWIS 3.3 installation is automatically started. To install under Windows NT/2000/XP, administrator rights are required.

-  [data1and2.exe](#) (1.07 MB)
  - [data3.cab](#) (1.44 MB)
  - [data4.cab](#) (1.44 MB)
  - [data5.cab](#) (1.44 MB)
  - [data6.cab](#) (1.44 MB)
  - [data7.cab](#) (1.44 MB)
  - [data8.cab](#) (1.44 MB)
  - [data9.cab](#) (1.44 MB)
  - [data10.cab](#) (1.44 MB)
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  - [data13.cab](#) (1.44 MB)
  - [data14.cab](#) (1.44 MB)
  - [data15.cab](#) (0.98 MB)
  - [data16.cab](#) (1.44 MB)