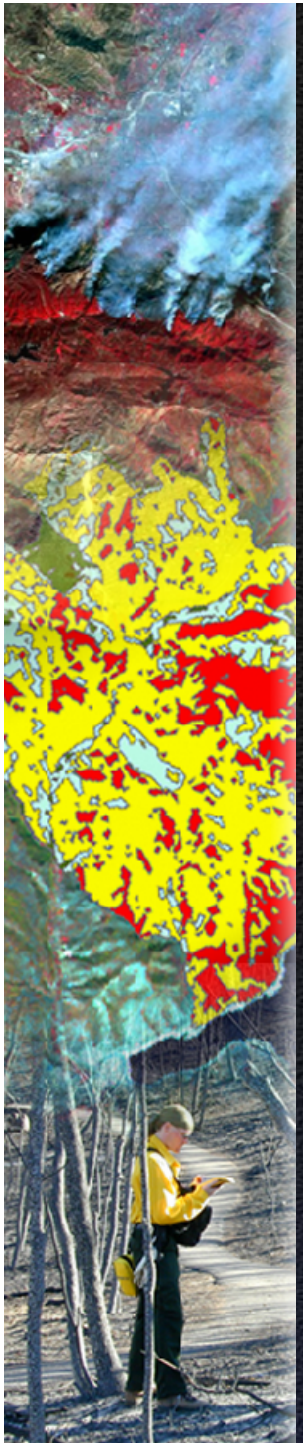


# Digital Remote Sensing

## Part 2: Sensor Properties and Exploiting Spectral Signatures

# Topics

- Important properties of commonly used satellite sensors (for BAER applications)
- Revisit Spectral Signatures
  - Exploiting spectral signature differences with commonly used satellite sensors

# Important Satellite Sensor Properties

- Spatial Properties
  - Spatial resolution
    - *How small of an object can we see?*
  - Spatial extent
    - *How large of an area is covered?*
- Revisit time
    - *How often can we see the same area?*
- Spectral sensitivity
    - *How many "colors" can we see?*
- Other
  - Cost, delivery time, sharing restrictions, etc

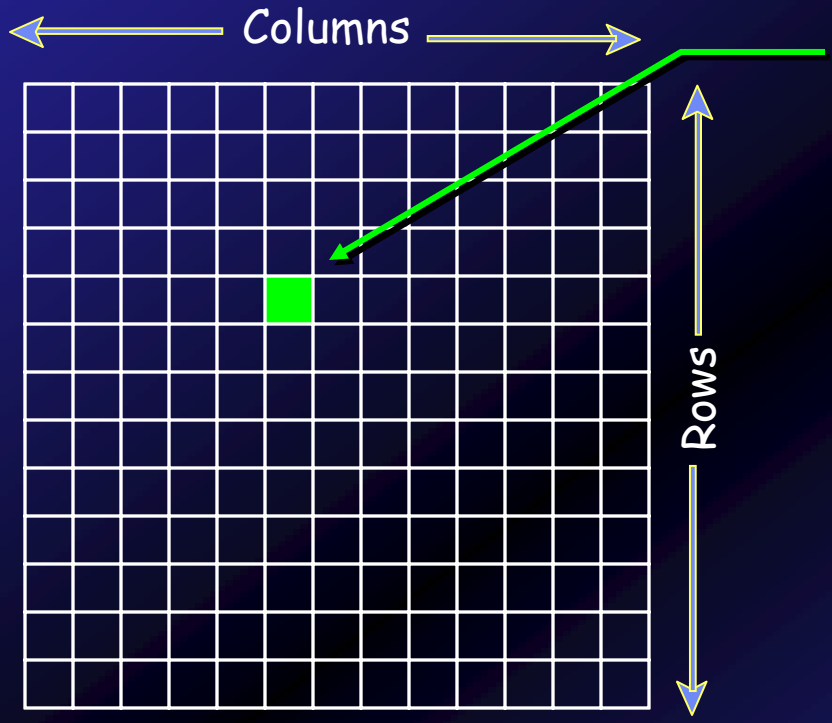
# Sensor Spatial Properties

***Spatial Resolution***

- Measured as the **Ground Sample Distance or more commonly Pixel Size**
  - The distance on the ground covered by the *Instantaneous Field Of View* (IFOV) of the sensor detectors

# Sensor Spatial Properties

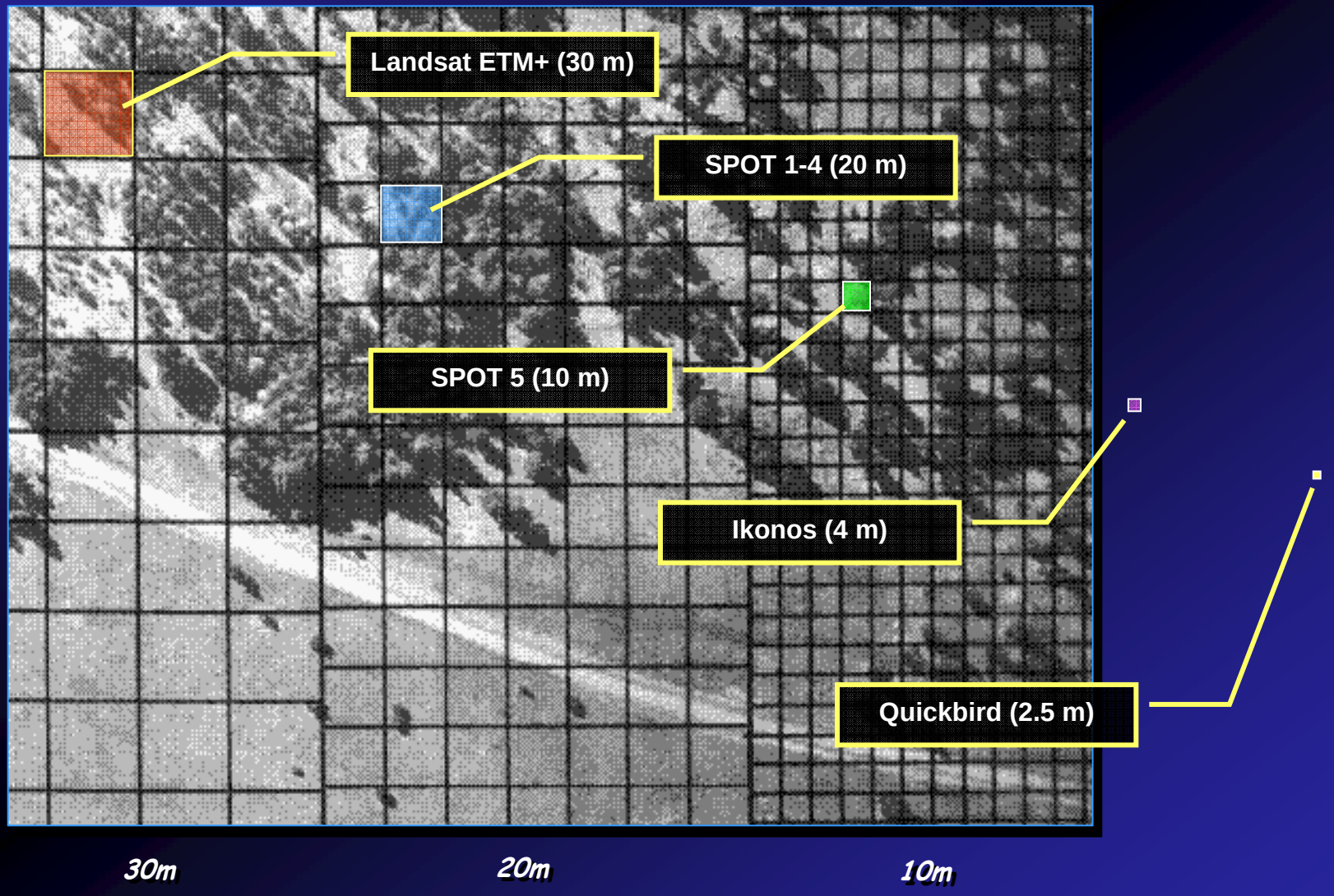
## *Pixels in a Raster Format*




A Pixel (picture element) is an individual cell in a raster image. Each pixel has three dimensions. Length and width are established by the IFOV of the sensor system. The third dimension is represented by a digital number. The value of the digital number relates directly to the average integrated brightness of all the surface objects and material contained within the pixel.

# Sensor Properties—Spatial Resolution

## *Spatial Resolution - Pixel Sizes of selected sensors*



# Sensor Spatial Properties

## *Spatial Extent (Area Covered)*

- Generally, there is a direct relationship between pixel size and image extent
  - Sensors that have a large IFOV and therefore large pixel size, usually produce imagery that covers large areas
  - Sensors that have a small IFOV and therefore small pixel size usually produce imagery that covers small areas

| Sensor | Pixel Size (m) | Extent (sq km) |
|---|---|---|
| Landsat | 30 | 34,225 |
| SPOT 4 | 20 | 3600 |
| SPOT 5 | 10 | 3600 |
| Quickbird | 2.4 | 272 |

# Sensor Properties—Revisit Time

- How often does the sensor gather an image of the same ground area? Depends on:
  - Orbital characteristics
  - Image Swath width
  - Off-nadir viewing capabilities (i.e., pointable optics)
  - Number of satellites in the family

# Sensor Properties—Revisit Time

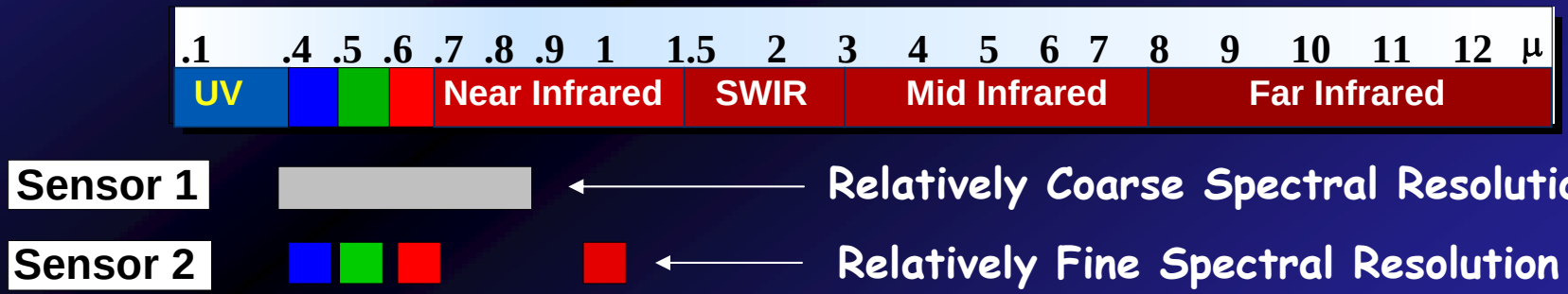
| Sensor: | Landsat/ASTER | SPOT 4,5 | AWiFS | Quickbird/IKONOS |
|---|---|---|---|---|
| Revisit Time | 8 days | 3-4 days | 5 days | 3-4 days |
| Notes: | Landsat 7 and ASTER have a revisit time of 16 days each.<br><br>Landsat 5 images an area 8 days after Landsat 7. | Imagery is typically acquired 48-72 hours after an order is submitted. Clouds and smoke can delay useful acquisition. | Imagery is typically acquired 48-72 hours after an order is submitted. Clouds and smoke can delay useful acquisition. | Areas can be revisited every 2 to 11 days depending on latitude and look angle tolerance. |

Note: delivery time can be significantly different than revisit time.

# Sensor Properties--Spectral Sensitivity

- Spectral Sensitivity:
  - The size, number, and position of imaging bands.

Example:



# Sensor Properties--Spectral Sensitivity

## *Multispectral Imagery in Ecosystem Management*


Visible Region (Blue, Green, Red): Cultural features, soil versus water, hydrography, vegetation.

Near Infrared (Reflected Infrared): Vegetation discrimination, biomass, soil, snow from clouds

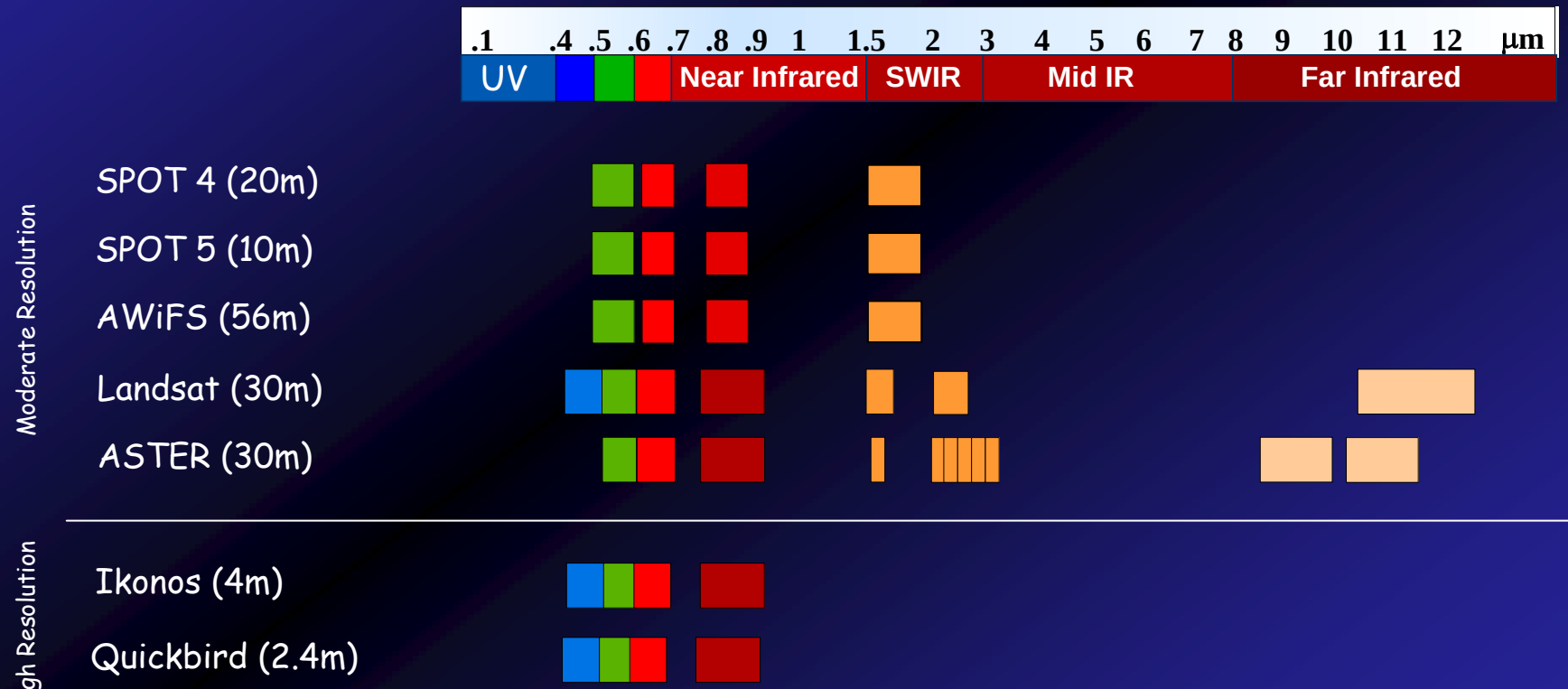
Shortwave-Infrared (Partly reflected-Partly emitted): Moisture absorption, the high temperature thermal window, wildfires, vehicles, exhausts.

Far Infrared: Includes the longwave thermal window, vegetation stress, thermal

Longer (e.g., Radar) wavelengths: Surface Texture, Interferometry, topography, and ???

# Sensor Properties--Spectral Sensitivity

## *Spectral Sensitivity of Common Sensor Systems*

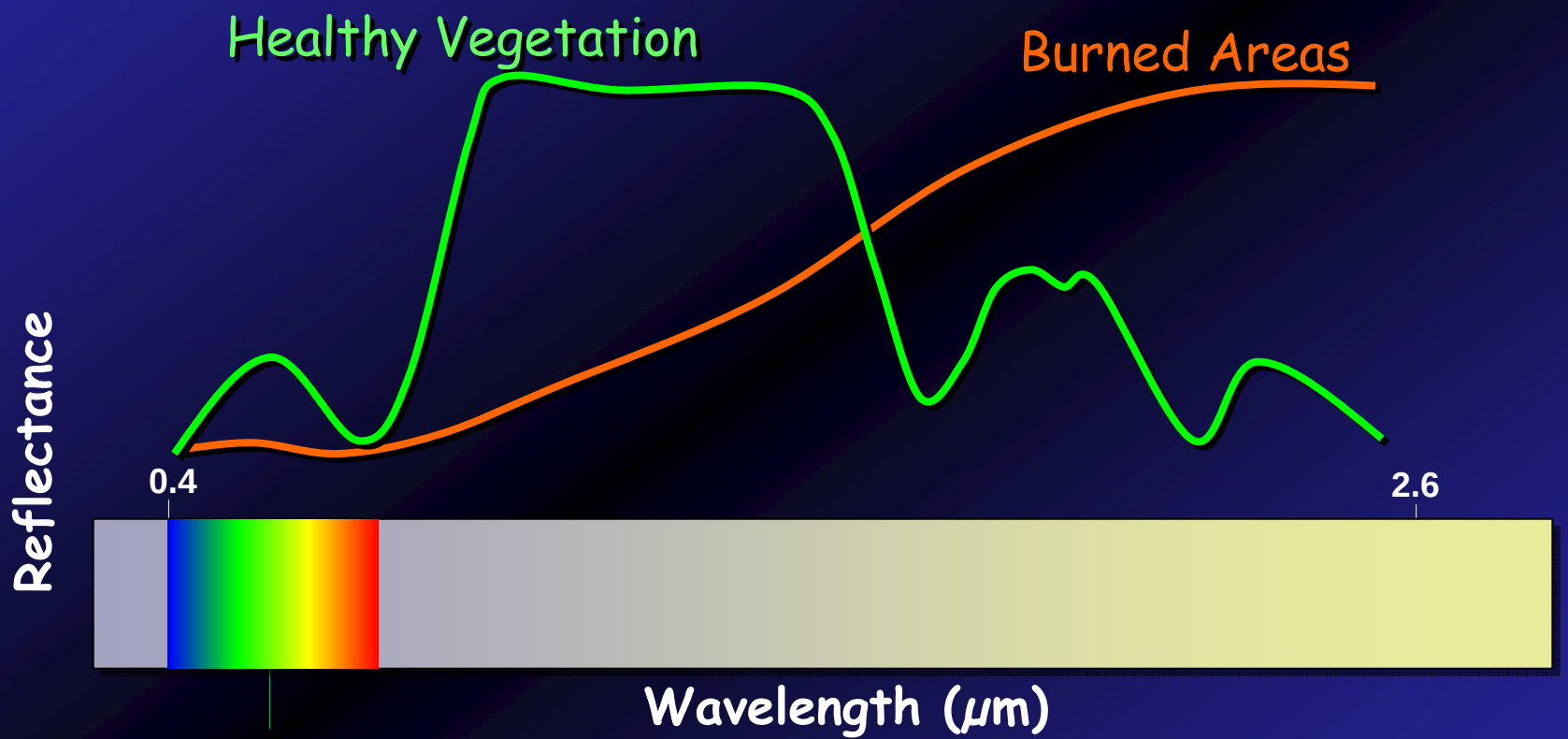


# Other Sensor Properties

| Sensor: | Landsat | SPOT 4 and 5 | AWiFS | IKONOS / Quickbird |
|---|---|---|---|---|
| Cost/Scene | ~$500 | $2500 to $10,000 | $1,000 | Varies (high--typically > $10K) |
| Delivery Time (after acquisition) | 24 hrs | 6 hrs | 24 - 48 hrs | 48 hours |
| Sharing Restrictions | None | Federal Space | Federal Space | Variable (depending on pricing) |

# Revisiting Spectral Signatures

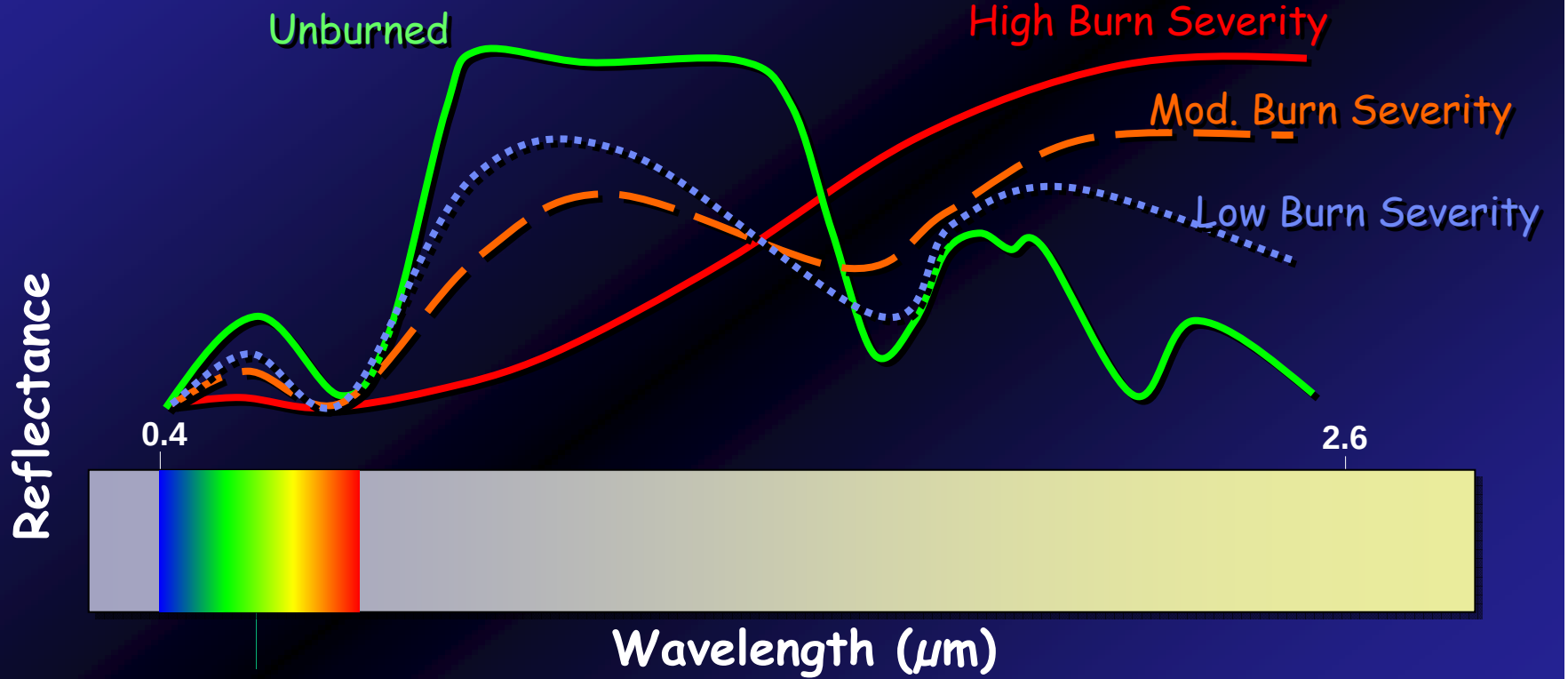
## *Exploiting Spectral Response Curves*




*The goal of remote sensing is to take advantage of differences in spectral response curves to distinguish one thing from another.*

# Healthy Vegetation vs Burned Areas

## *Exploiting Spectral Response Curves*

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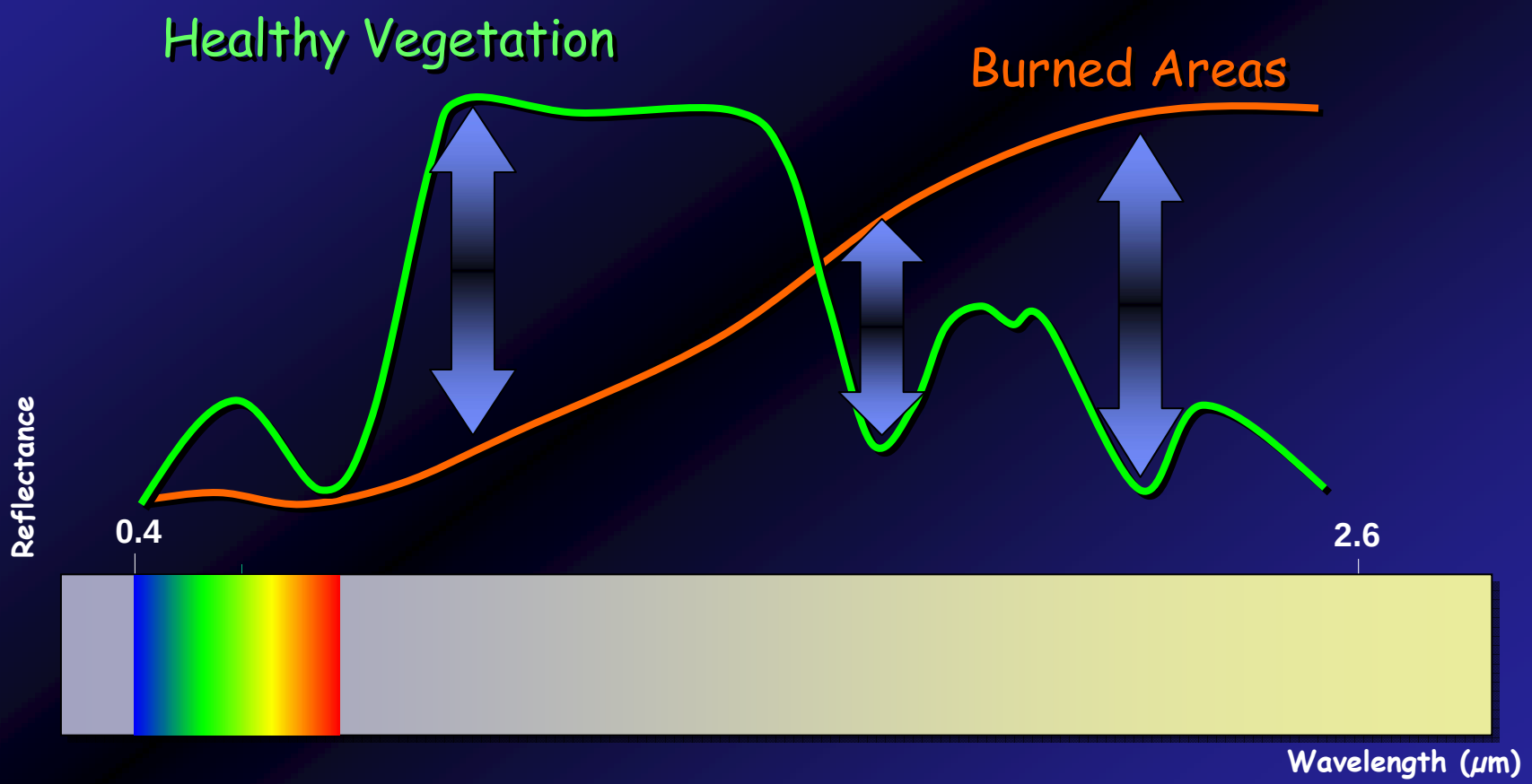
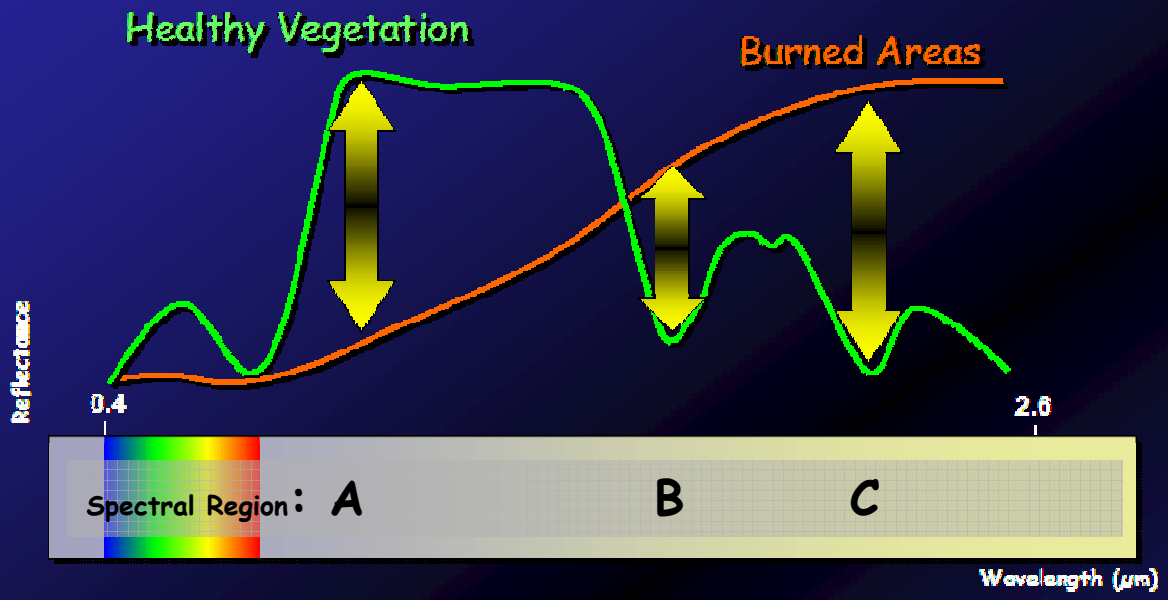
## *Exploiting Spectral Response Curves*




*Key spectral differences to exploit. What is the best way to take advantage of these differences ? --i.e., is there a way to accentuate the differences?*

# Exploiting Spectral Response Curves with Band Ratios




| Band Ratio | Unburned | Burned | Effectiveness |
|---|---|---|---|
| A/red | Very High | ~1 | Okay |
| **A/B** | **Very High** | **Very Low** | **Very Good** |
| **A/C** | **Very High** | **Very Low** | **Best** |
| B/C | ~1 | ~1 | Least |

# Exploiting Spectral Response Curves with Band Ratios

***Constrained by the sensor…***

| Band Ratio | Unburned | Burned | Effectiveness |
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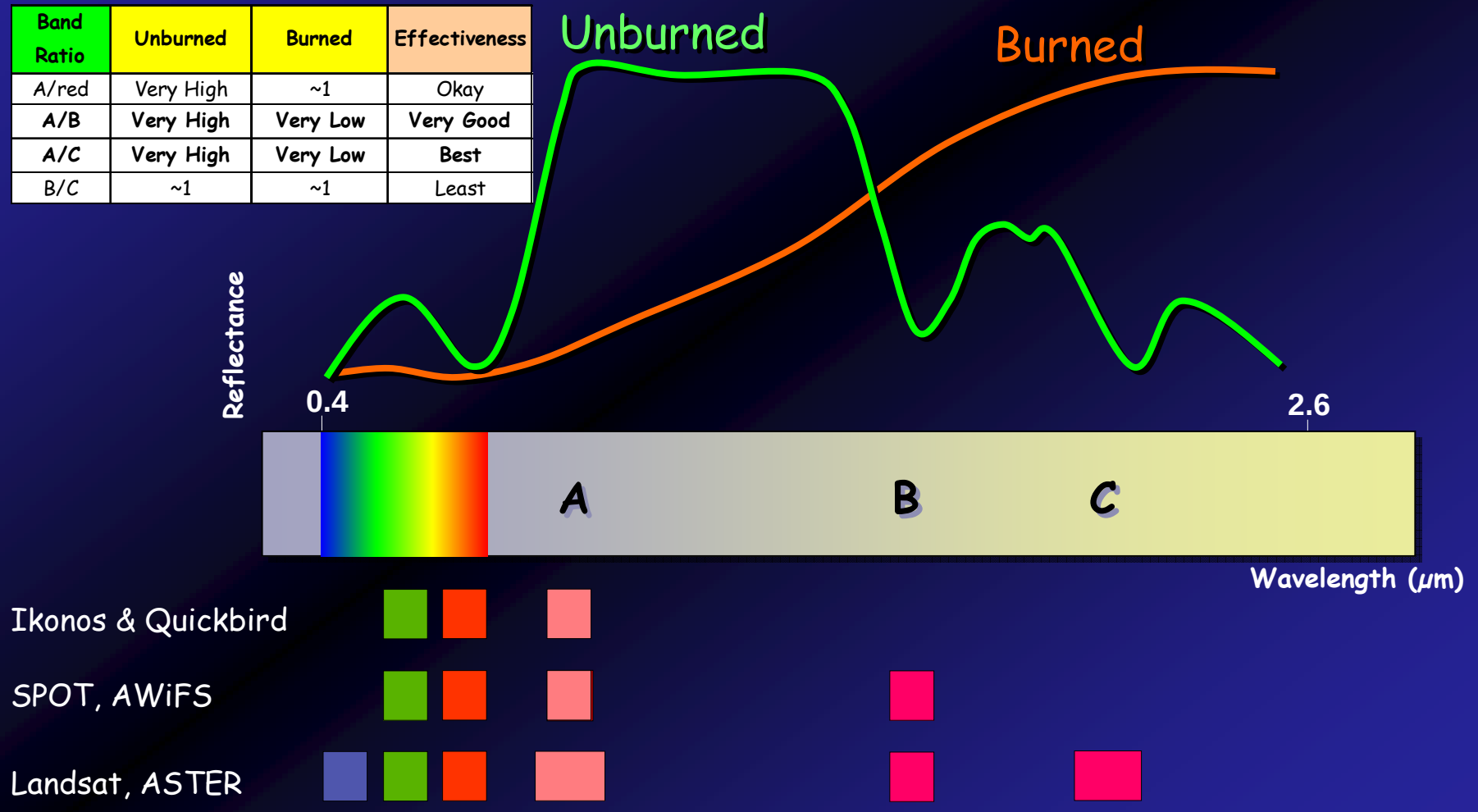

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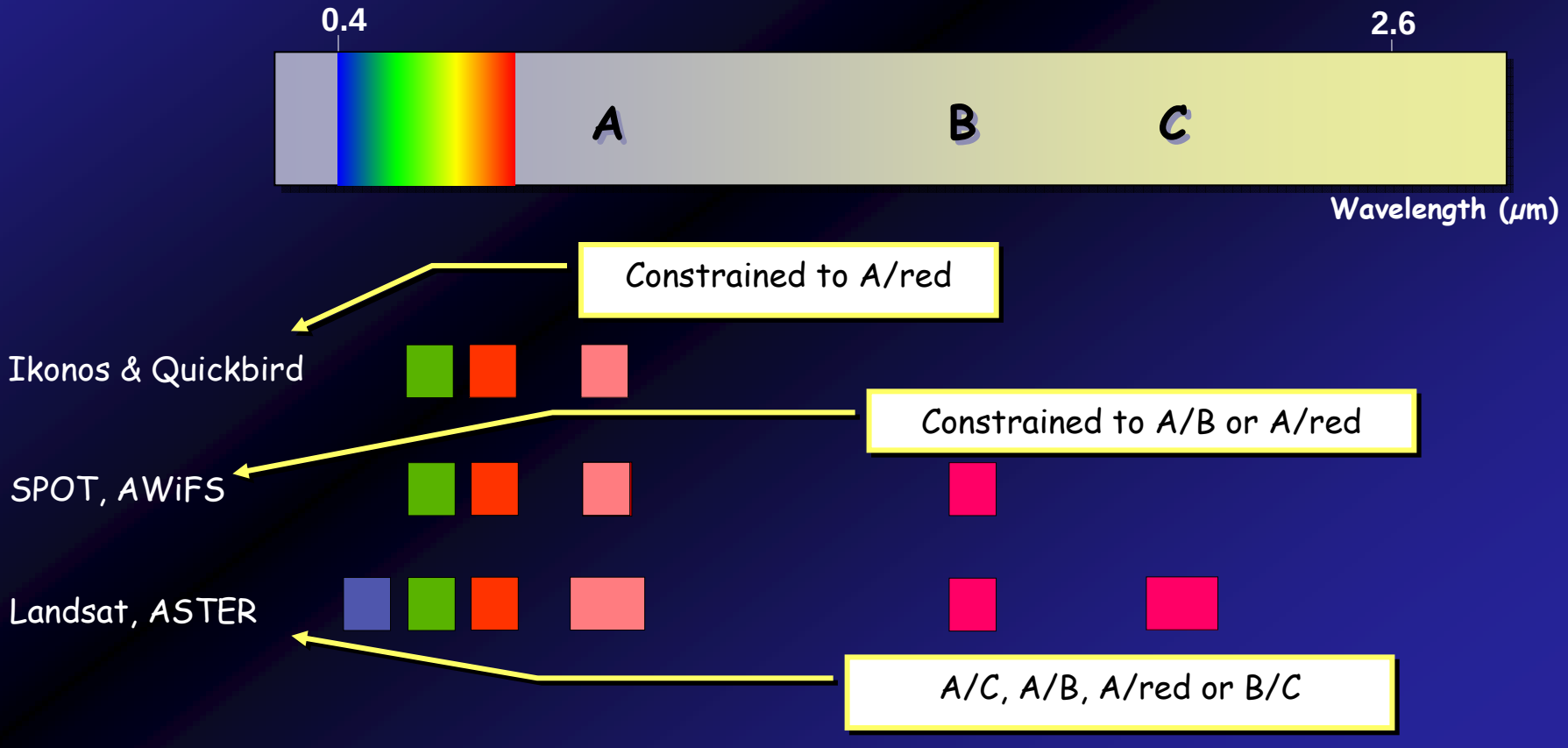
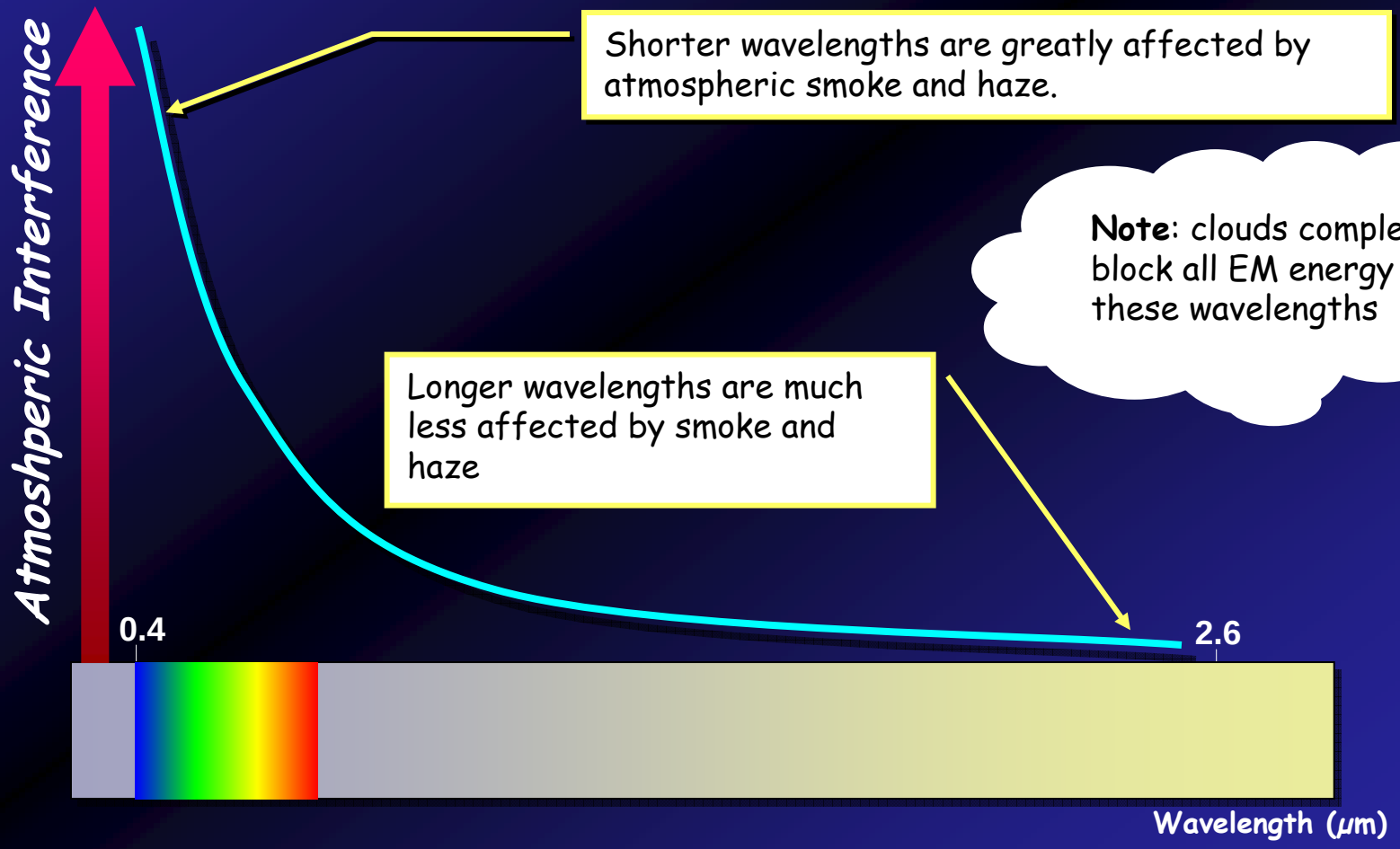


# Exploiting Spectral Response Curves with Band Ratios

***Constrained by the sensor and atmosphere…***



# Exploiting Spectral Response Curves with Band Ratios

***Constrained by the sensor and the atmosphere…***

| Band Ratio | Unburned | Burned | Effectiveness |
|---|---|---|---|
| A/red | Very High | ~1 | Okay |
| **A/B** | **Very High** | **Very Low** | **Very Good** |
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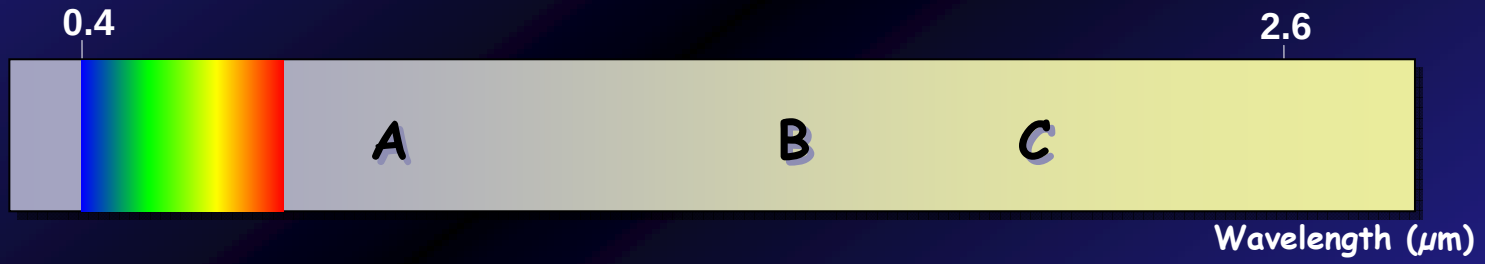


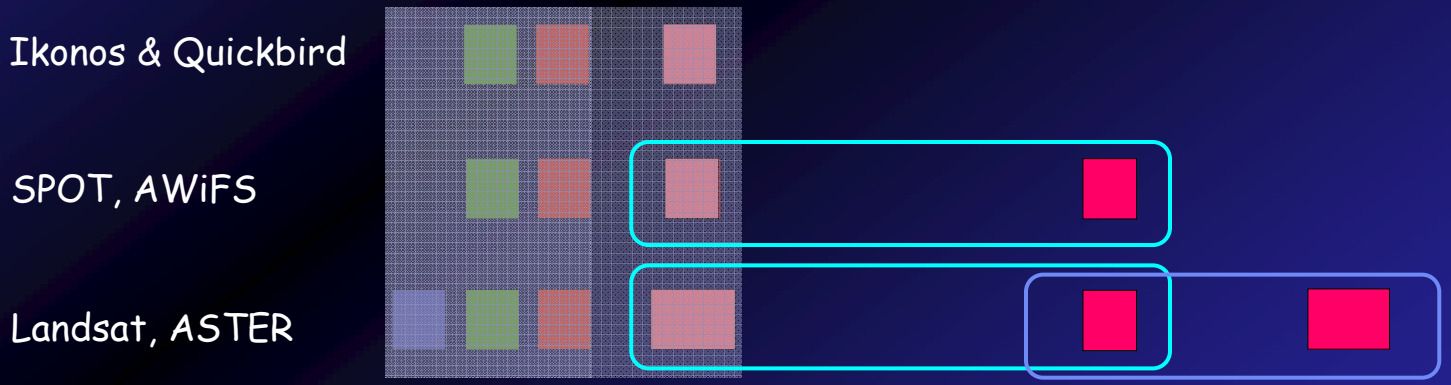

# Summary

- There are a number of satellite sensors available and suitable for BAER
- They have varying spatial properties, spectral sensitivities, revisit times, delivery times, costs and sharing restrictions
- The spectral limitations of the sensor can restrict the exploitation of differing spectral signatures
- Atmospheric conditions can also restrict the exploitation of differing spectral signatures as well as potentially restricting image acquisition

# The End