# CASI Processing at the NERC
## Airborne Remote Sensing Facility

CASI-SWIR Workshop

2002 Flight Campaign

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MONKS WOOD

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NATURAL ENVIRONMENT RESEARCH COUNCIL

# CASI-SWIR Workshop

- Presentation Outline
  - Airborne Remote Sensing Facility
  - Data Processing Strategy
  - Level 1b Processing
  - Level 3a Processing
  - Case Studies (UK & Belgium)
  - Summary / Conclusions

# Airborne Remote Sensing Facility

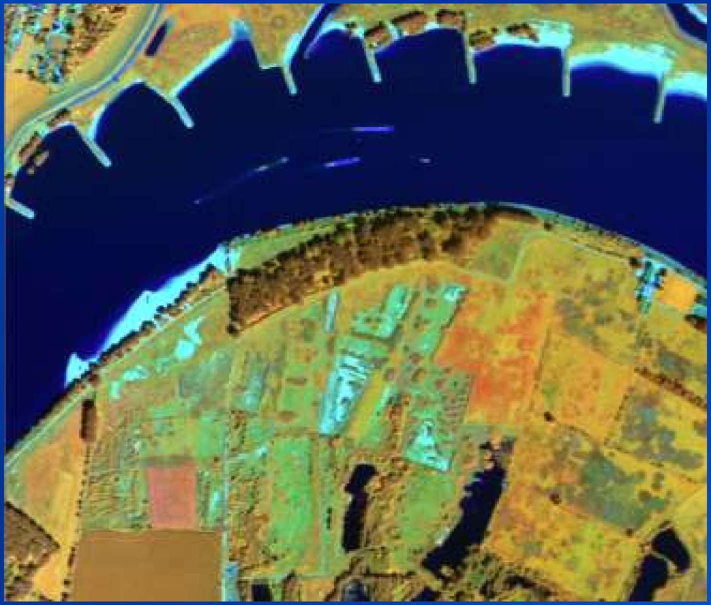
- Aircraft Platform
- Instrument Suite
  - ATM & CASI-2
  - RC-10 camera
  - Terrain mapping LiDAR
- Integrated Data System
  - Navigation
- Data Processing Strategy
  - Data and software

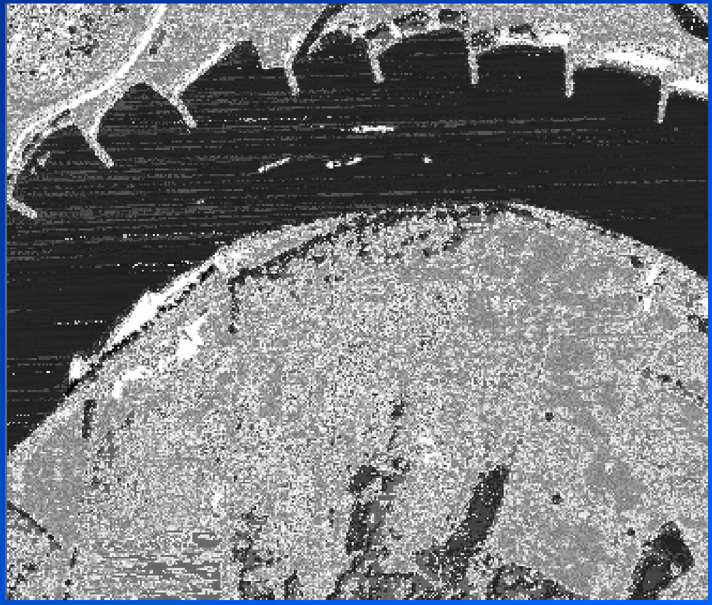
# Airborne Thematic Mapper – Multi-spectral

Visible

NIR

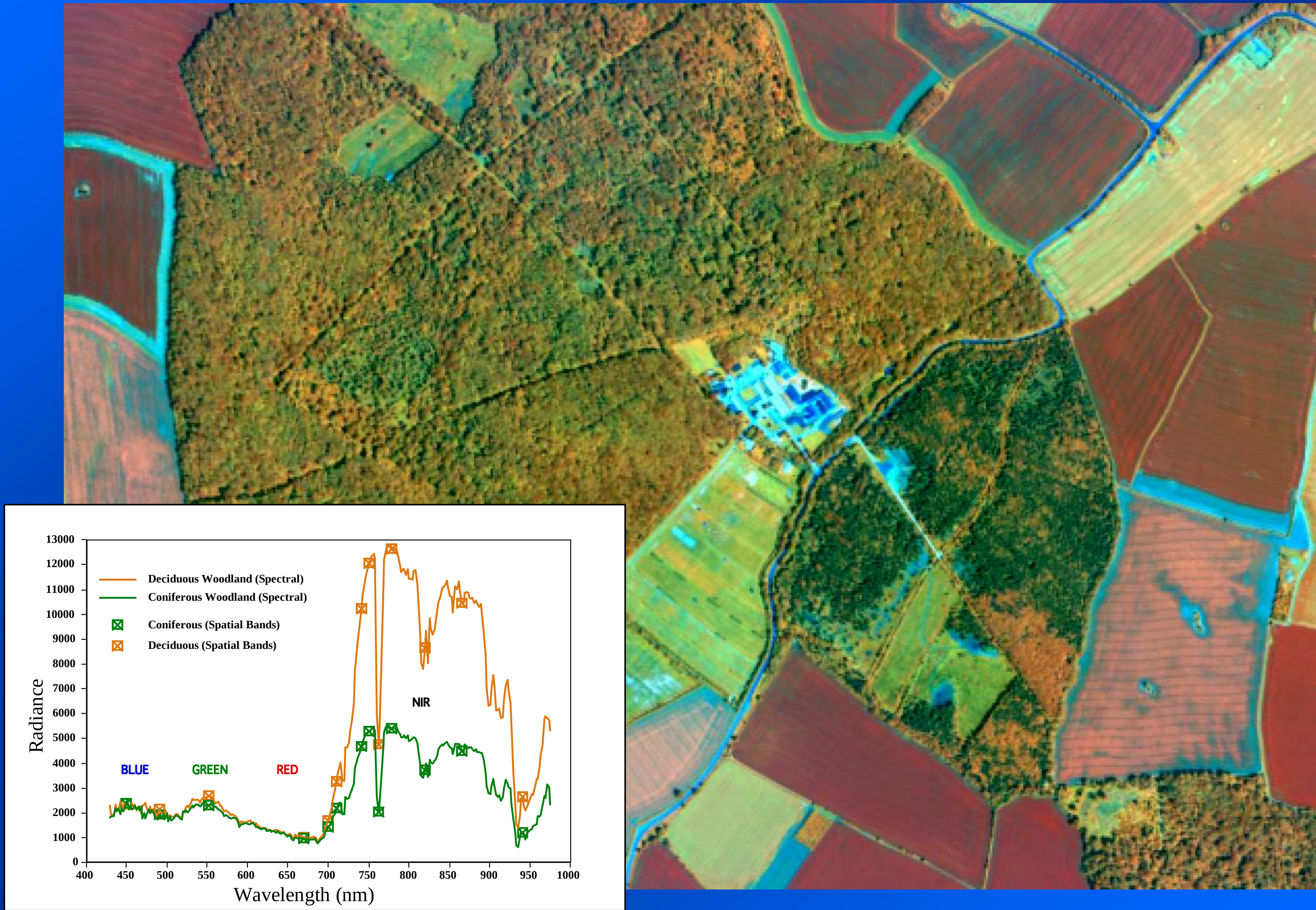
SWIR



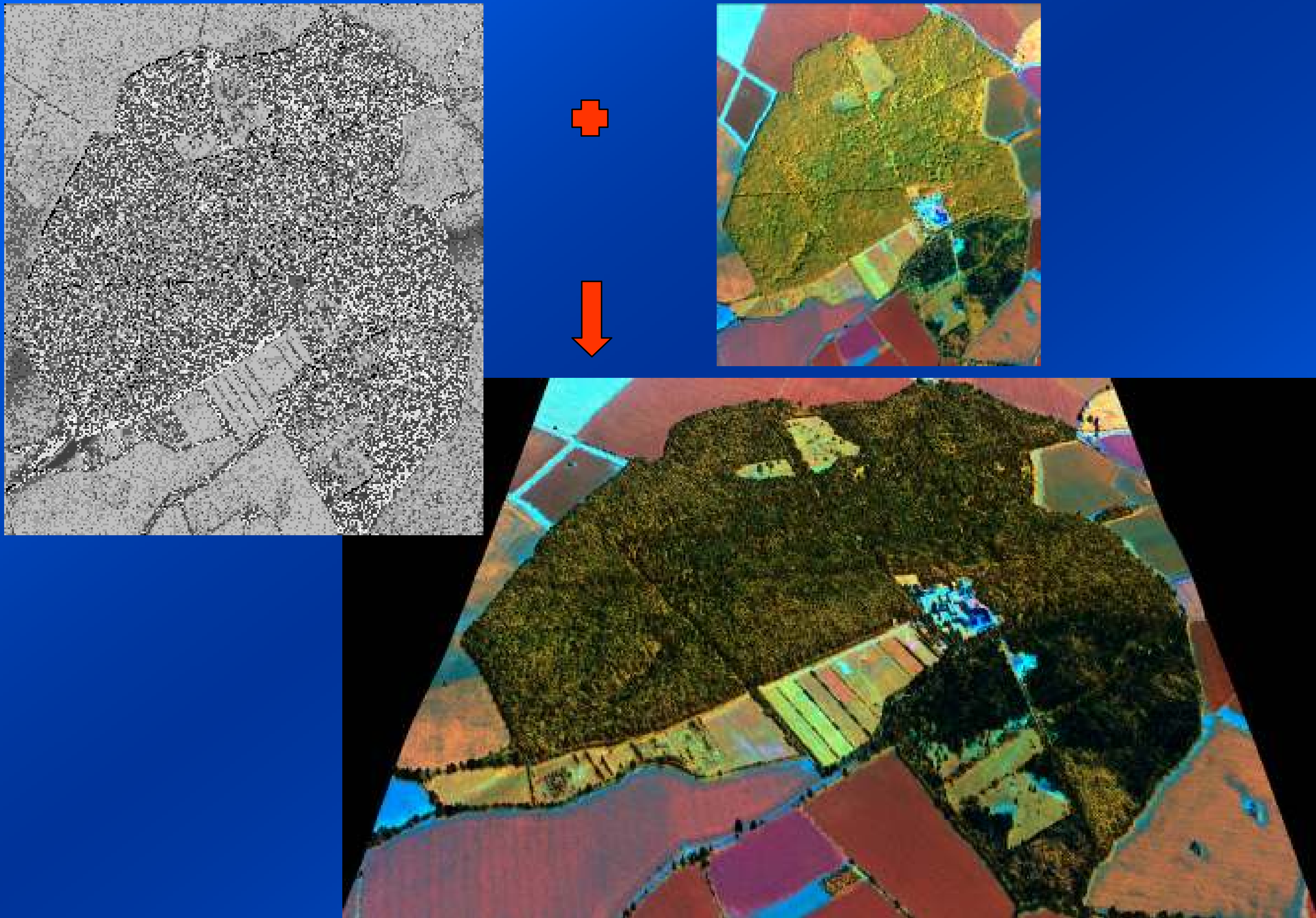


TIR

# Compact Airborne Spectrographic Imager - Hyperspectral



# Terrain Mapping LiDAR - (Unit for Landscape Modelling)



# Integrated Data System

- Sensor time synchronisation
- GPS Position
  - Latitude / Longitude / Height @ 20Hz
- GPS Attitude
  - Roll / Pitch / Heading @ 20Hz
- Inertial Attitude
  - Roll / Pitch / Heading @ 64Hz→200Hz

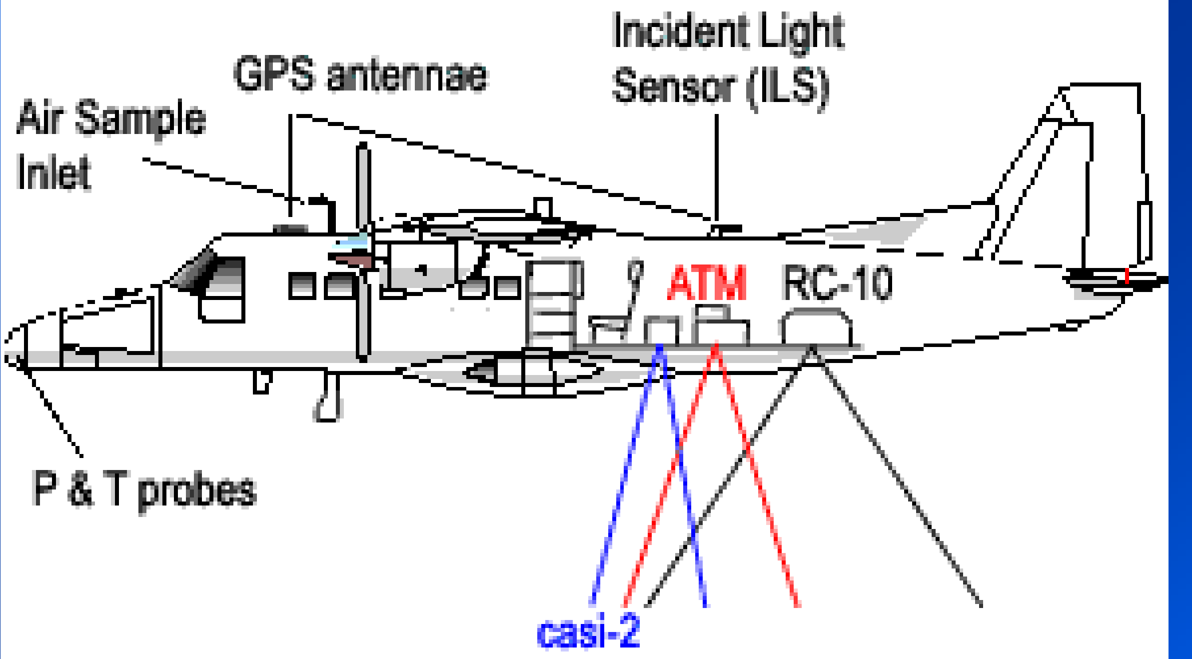
# Data Processing Strategy

- NASA Standard Data Products
  - Level 0 - Raw Sensor Data
  - Level 1b - Calibrated Data + Navigation
  - Level 2 - Geophysical Data
  - Level 3a - Geo-corrected Data
  - Level 4 - Multi-temporal, Multi-sensor Data
- Hierarchical Data Format (HDF)
  - Image data in HDF Scientific Data Sets
  - Metadata in HDF VGroups

# Level 1b Data Processing

- Radiometric Calibration
  - Calibration to ‘at-sensor’ radiance
- Navigation Processing
  - Differential GPS correction of position
  - GPS / Sensor ‘level arm’ offset
  - Sensor boresight misalignment calibration
  - Integration of GPS / inertial attitude
  - Interpolation to ATM / CASI scan sync time

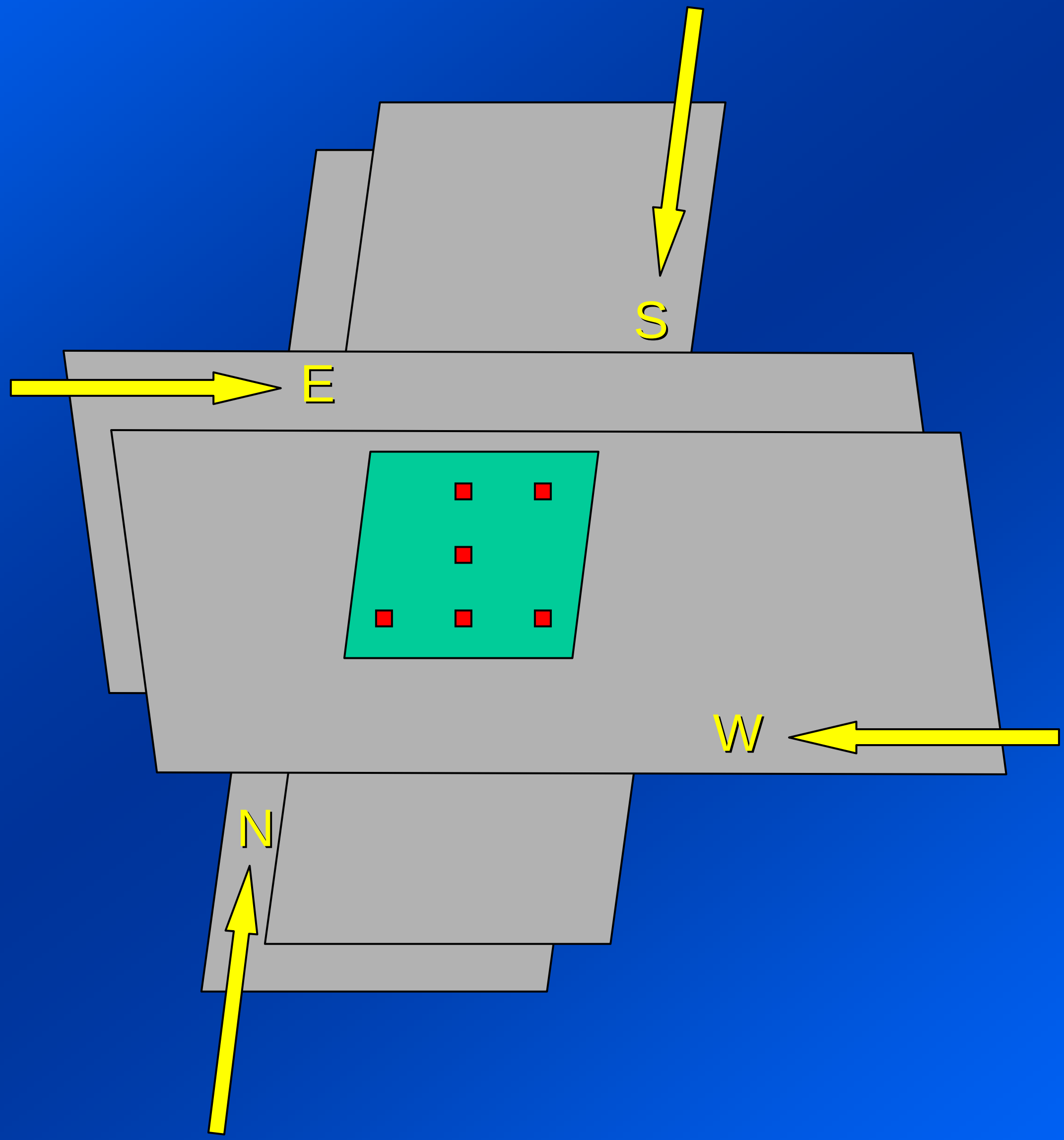
# GPS / Sensor 'level-arm' offset




NERC ARSF Dornier 228 instruments set up

# Geometric Targets for Boresight Misalignment Calibration

# Geometric Targets for Boresight Misalignment Calibration



# GPS/INS Attitude Integration

| | Advantages | Disadvantages |
|---|---|---|
| GPS | • Absolute attitude for each epoch<br>• Independent measurement for each epoch | • Low sampling frequency<br>• Measures airframe motion<br>• Moderate accuracy |
| INS | • High sampling frequency<br>• Measures sensor motion<br>• High relative accuracy | • Drift problems, random walk<br>• Dependency between epochs |

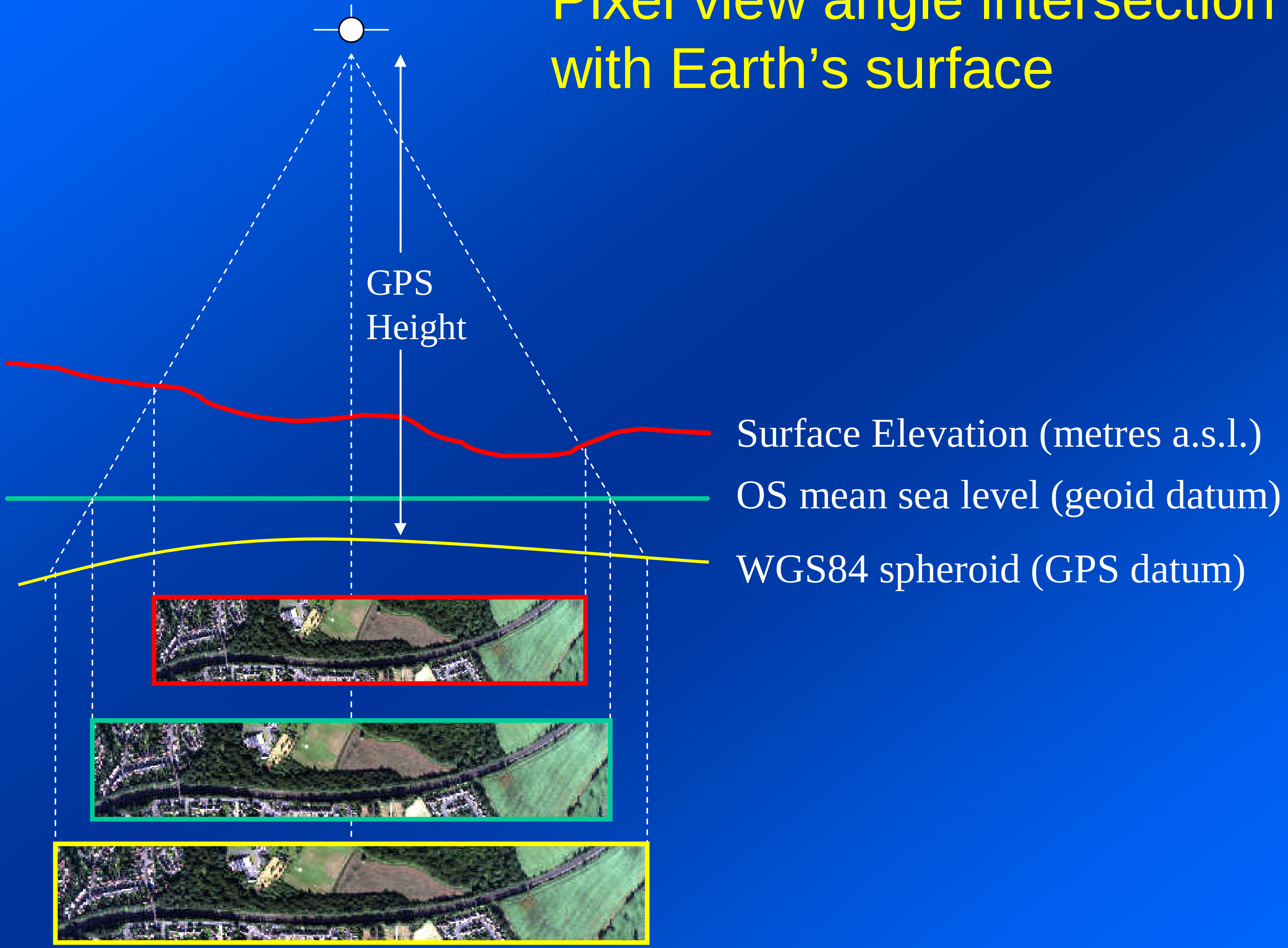
# GPS/INS Attitude Integration

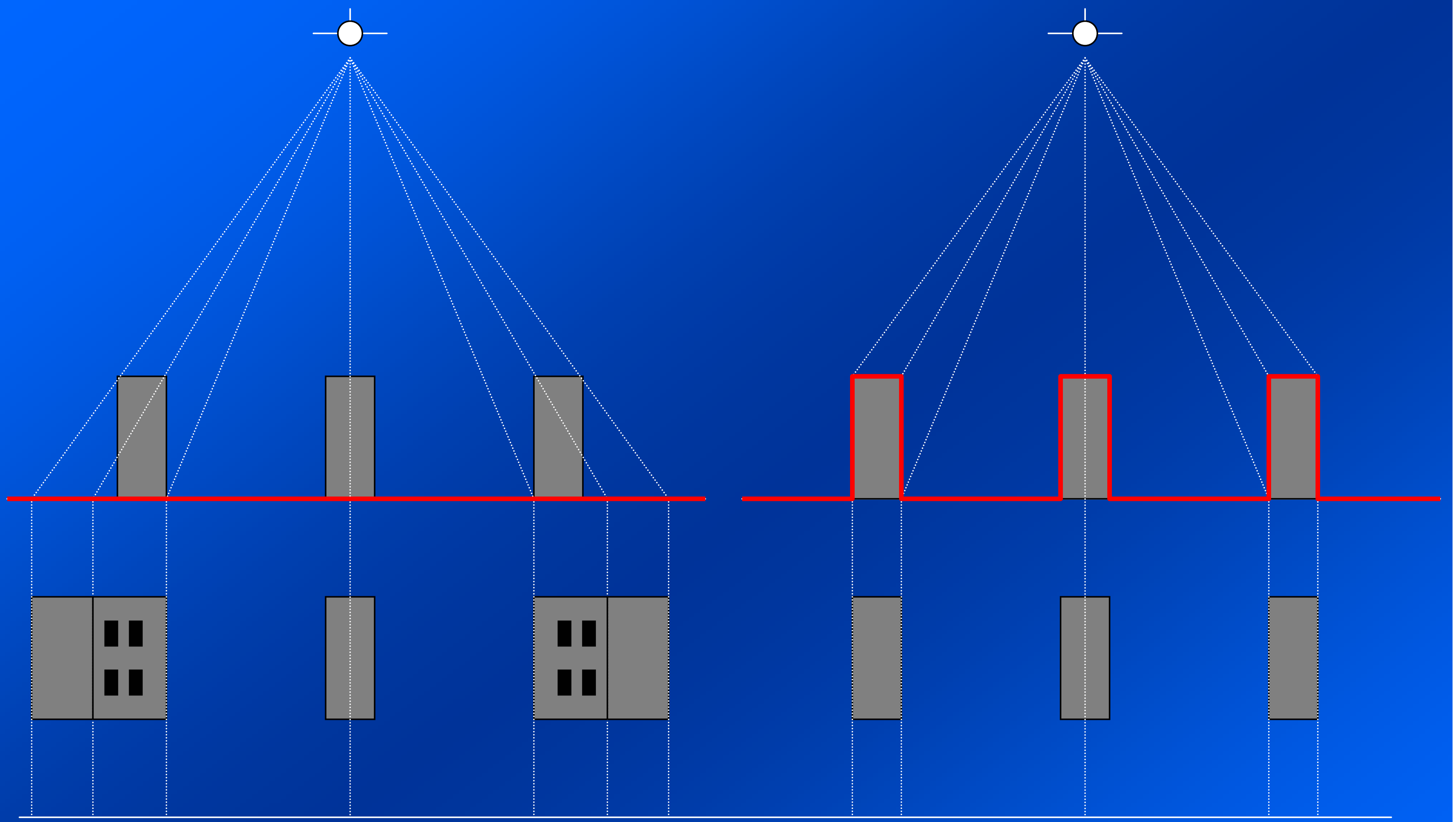
- Options for GPS / INS attitude integration
  - Simple linear or polynomial regression
  - Kalman filtering
- Smoothing of GPS only attitude
- Interpolation of attitude & position to scan time

# Level 3a Data Processing

- L1b sensor position → L3a pixel location
  - Sensor position and attitude
  - Sensor geometric model
  - WGS84 spheroid → Earth geoid transformation
  - Pixel view angle intersection with Earth's surface

# Pixel view angle intersection with Earth's surface





a) Flat terrain model

Digital Elevation Model (DEM)

b) Terrain model with building heights

Digital Surface Model (DSM)

# Level 3a Data Processing

- Resampling of output pixel value
  - Resampling algorithm(s)
  - Output pixel spatial resolution
  - Output product control

- ‘azgcorr’ software provided to NERC funded users

- Future implementation of Level 2 & 4 algorithms
- Future generic sensor processing

# Case Studies – UK

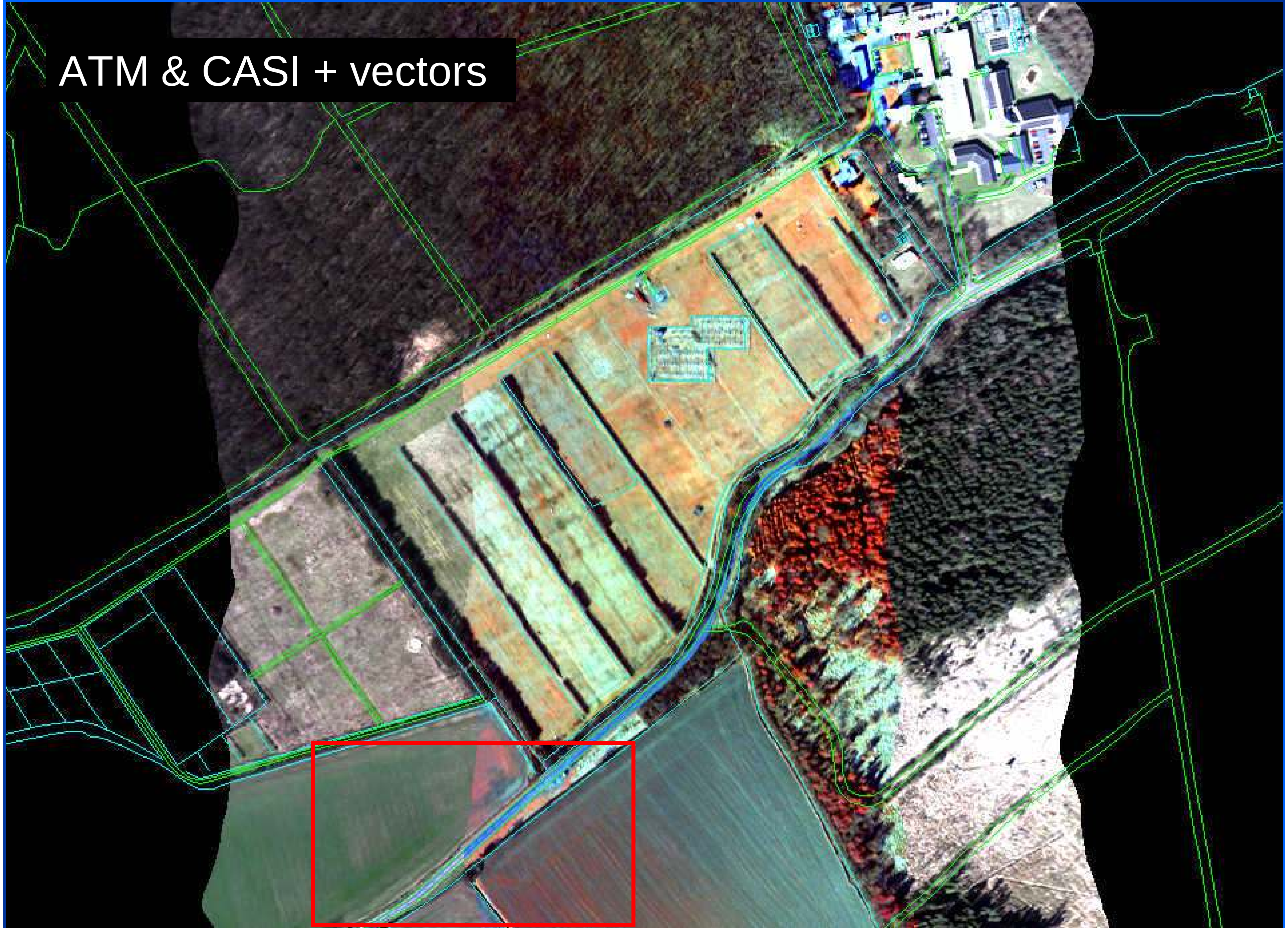
- ATM and CASI-2 Data (2003)
  - CEH Monks Wood
  - Processed with ARSF IDS and azgcorr
  - 1.0 metre spatial resolution
  - Bicubic spline resampling
  - UK British National Grid
  - Radiance data

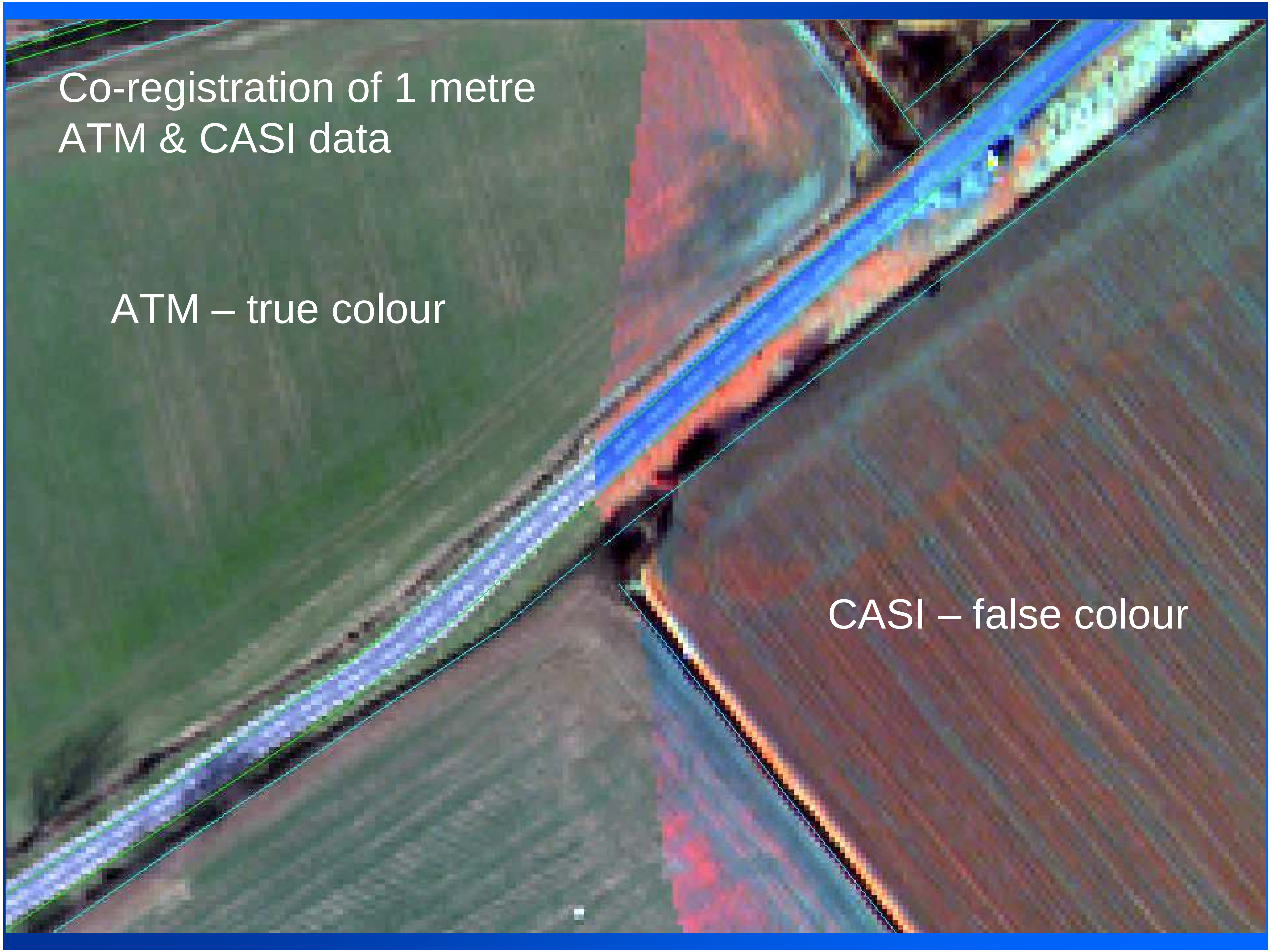
# ATM & CASI-2

# ATM & CASI + vectors

# ATM & CASI + vectors

## ATM & CASI + vectors

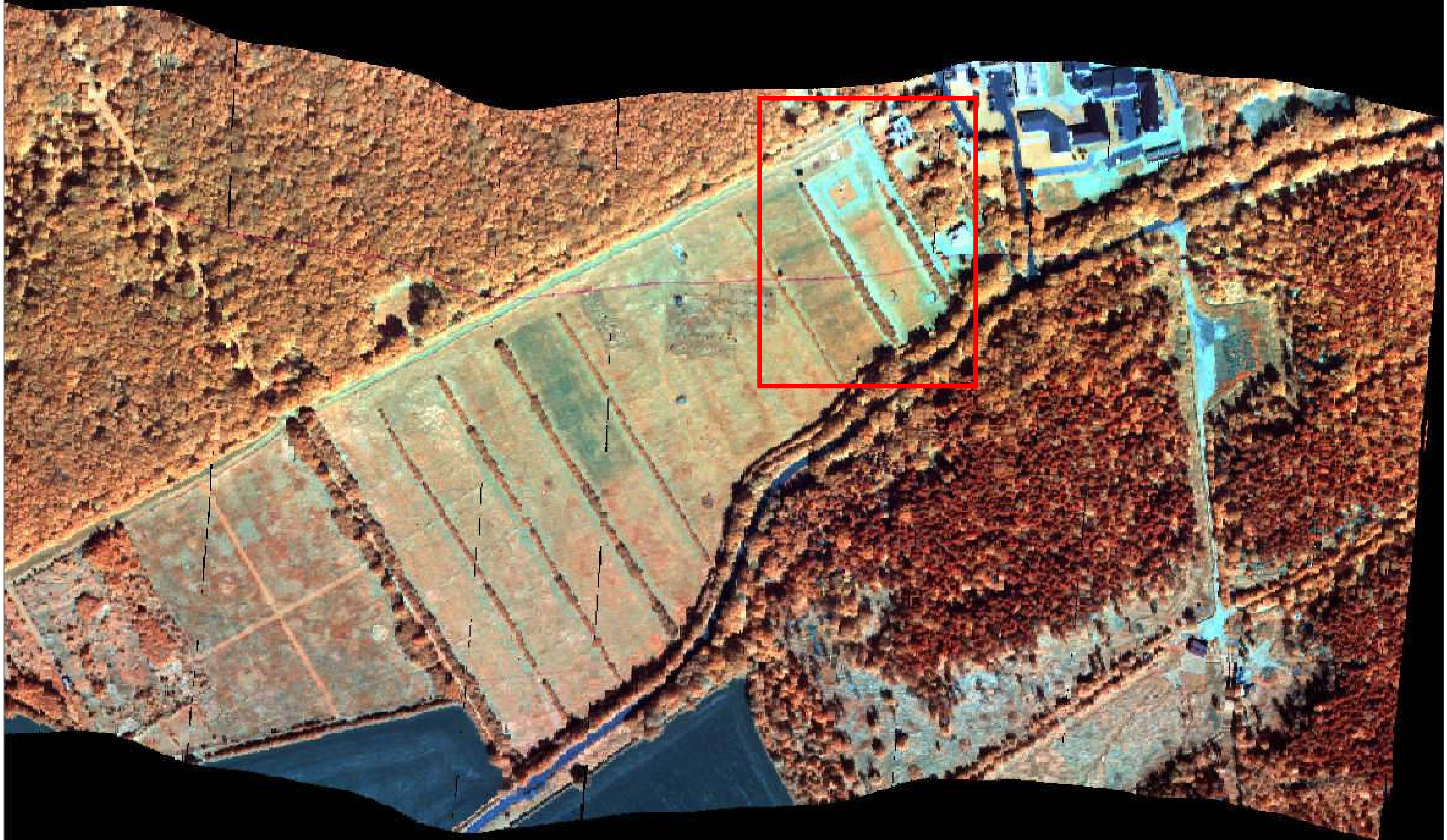



Co-registration of 1 metre
ATM & CASI data
ATM – true colour
CASI – false colour

# Case Studies – UK

- CASI – SWIR (SASI) (2002)
  - CEH Monks Wood
  - Processed by ITRES software
  - 0.7 metre spatial resolution
  - Nearest Neighbour (NN) resampling
  - UTM projection
  - Radiance and Reflectance data

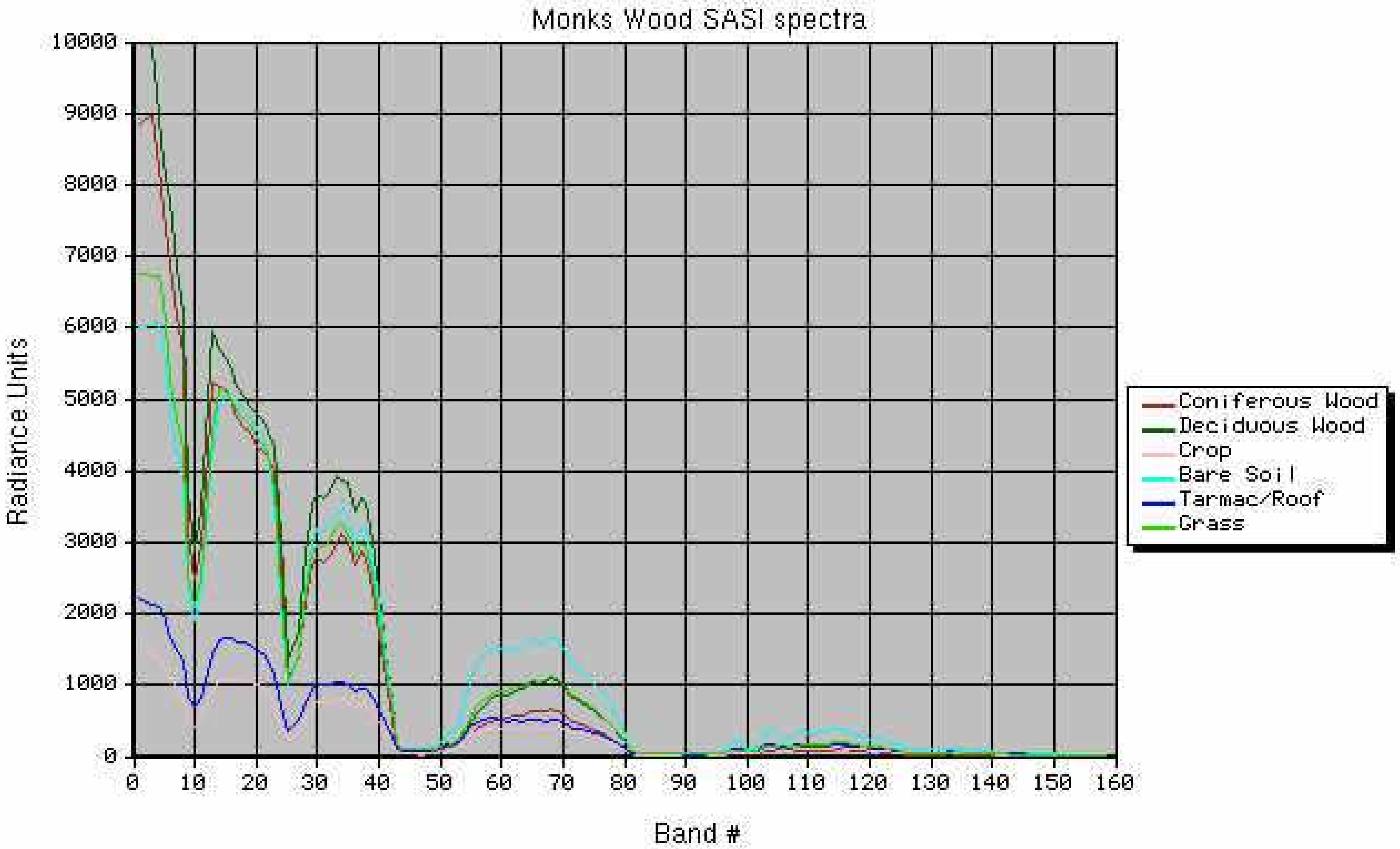
# SASI – Channels 2, 68, 123 (RGB)



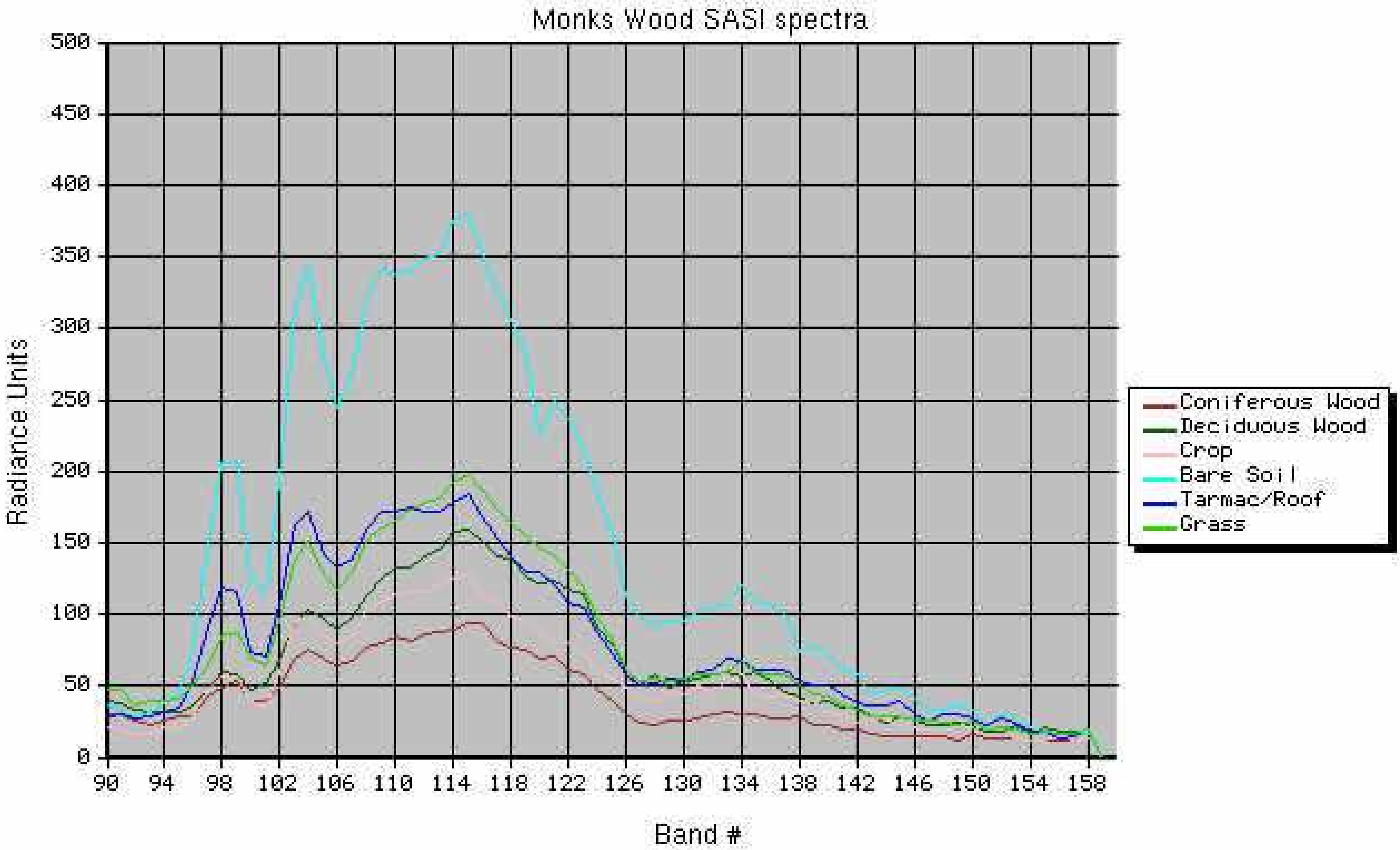
ATM 1.0 metre (bicubic spline)

SASI 0.7 metre (NN)

# SASI radiance spectra

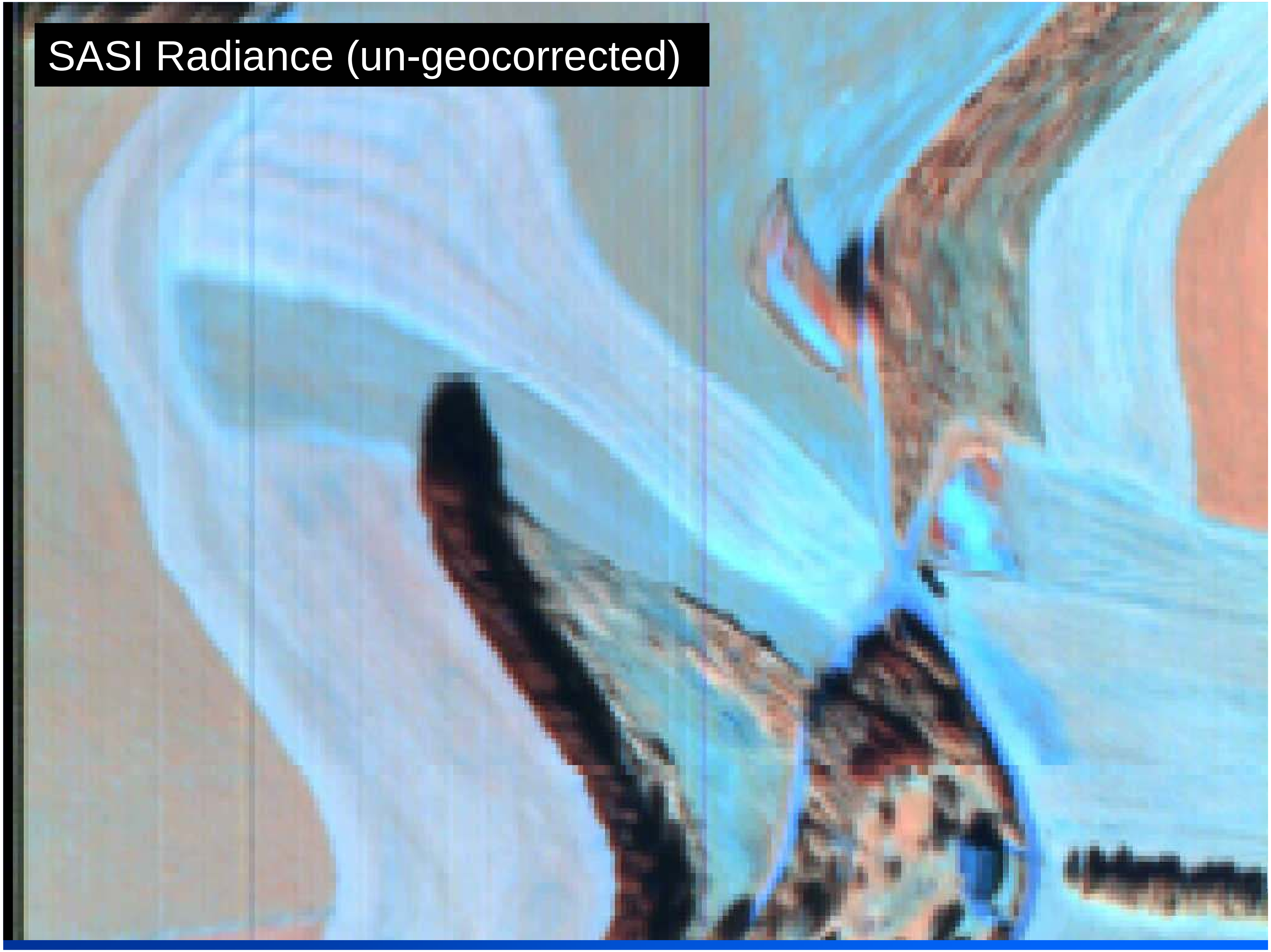


# SASI radiance spectra



# Case Studies - Belgium

- CASI – SWIR (SASI) (2002)
  - Rural scene
  - Processed by ITRES software
  - Radiance data (geometrically uncorrected)
  - Reflectance data (geometrically corrected)


SASI Radiance (un-geocorrected)

# SASI Reflectance (geocorrected)

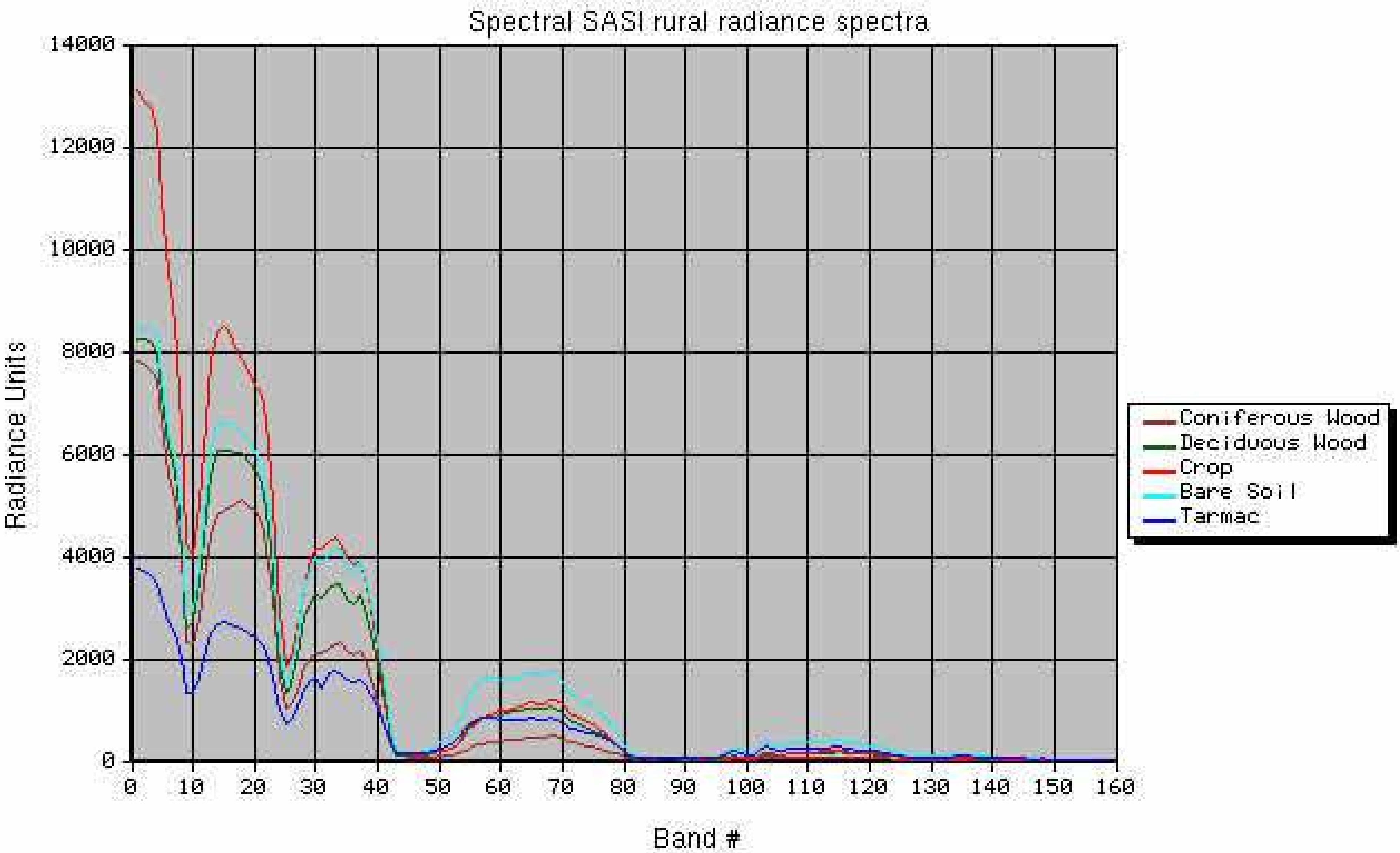
SASI

R 2

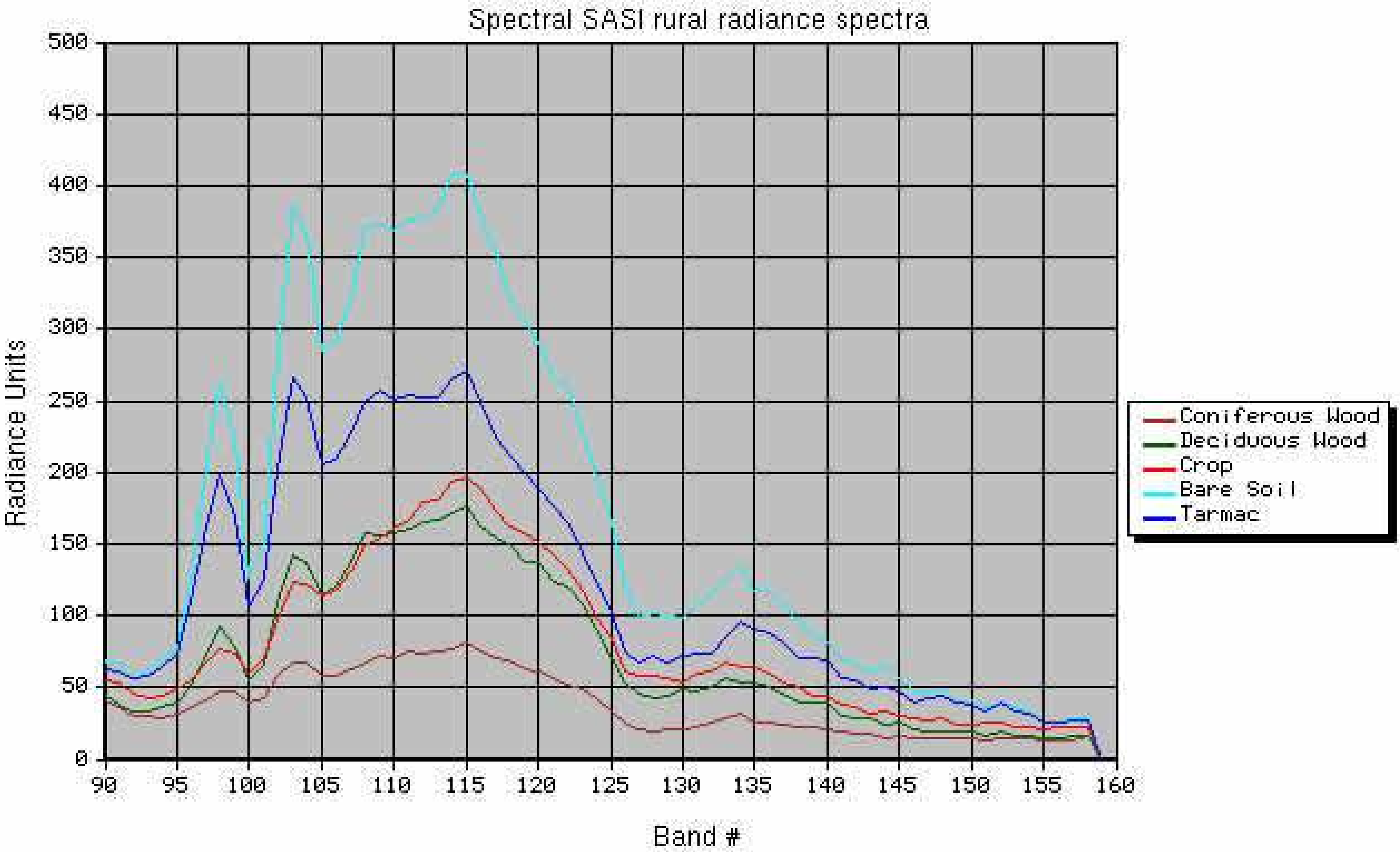
G 68

B 123

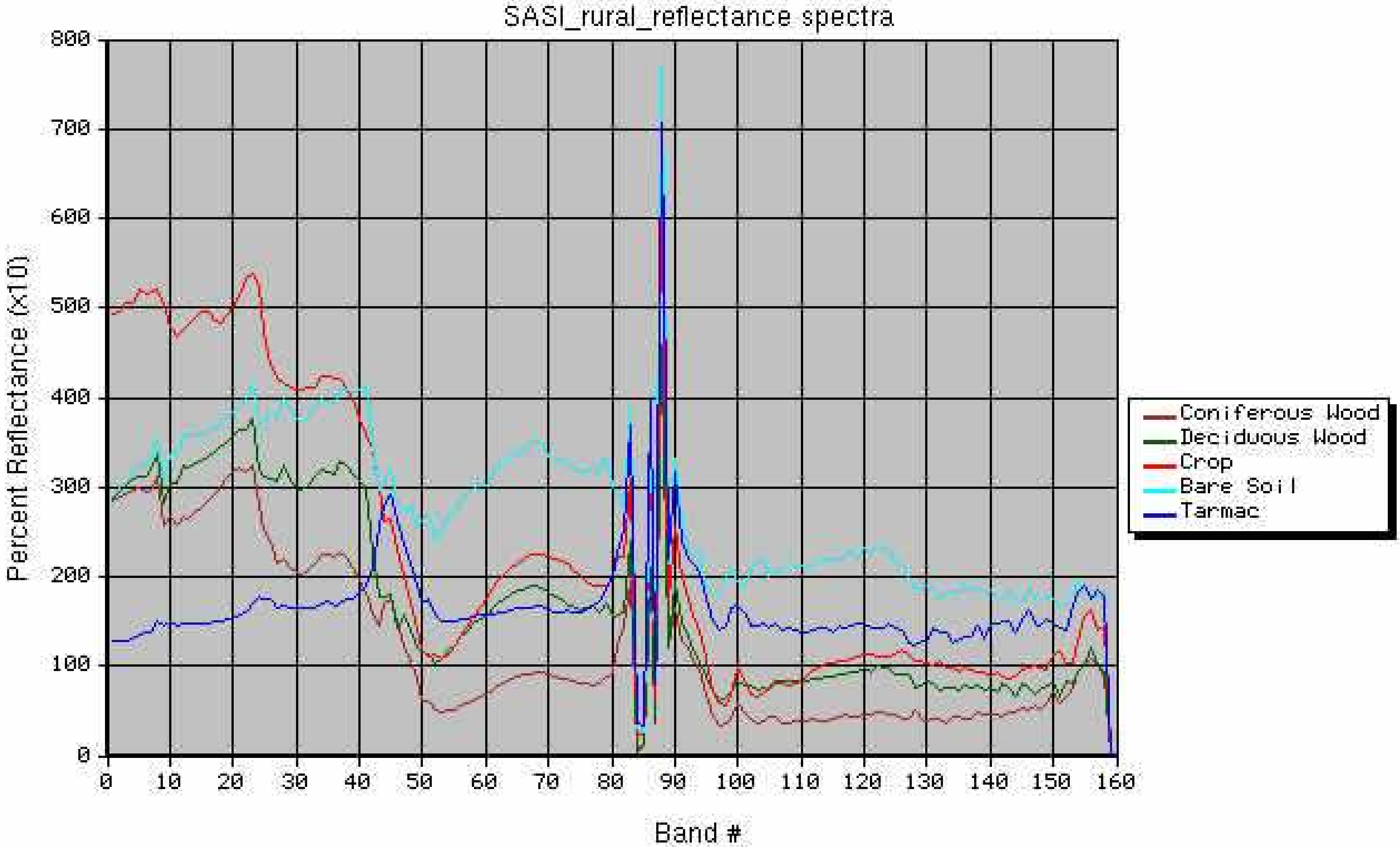
# SASI radiance spectra



# SASI radiance spectra



# SASI reflectance spectra



# Summary / Conclusions

- Potential of imaging spectroscopy (SWIR)
  - Biosphere
  - Geosphere
  - Cryosphere
  - Atmosphere

# Summary / Conclusions

- Potential of imaging spectroscopy (SWIR)
- Availability of hyperspectral sensors (SWIR)
  - Hymap, CASI-SWIR, AISA Hawk

# Summary / Conclusions

- Potential of imaging spectroscopy (SWIR)
- Availability of hyperspectral sensors (SWIR)
- Attention to calibration and pre-processing
  - Spectral and Radiometric calibration
  - Atmospheric and Geometric correction

# Summary / Conclusions

- Potential of imaging spectroscopy (SWIR)
- Availability of hyperspectral sensors (SWIR)
- Attention to calibration and pre-processing
- Retrieval of bio-, geo-physical parameters
  - Underlying physical principles
  - Robust algorithms

# Summary / Conclusions

- Potential of imaging spectroscopy (SWIR)
- Availability of hyperspectral sensors (SWIR)
- Attention to calibration and pre-processing
- Retrieval of bio-, geo-physical parameters
- Development of appropriate techniques
    - Absorption feature extraction
    - Spectral unmixing
    - Spectral matching

# Summary / Conclusions

- Potential of imaging spectroscopy (SWIR)
- Availability of hyperspectral sensors (SWIR)
- Attention to calibration and pre-processing
- Retrieval of bio-, geo-physical parameters
- Development of appropriate techniques

# End of Presentation

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