Upscaling of spectroradiometer data for stress detection in orchards with remote sensing

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Overview

- Background and previous research
- Objectives
- Upscaling
  - Leaf to TOC: ACRM
  - TOC to TOA: MODTRAN4
- Stress Detection
  - Simulated spectra
  - Airborne spectra
- Conclusions

Background

- Stress conditions in vegetation
  - Drought, Mildew, Nutrient shortage,…
  - Change of reflectance spectrum
  - Detection via remote sensing (Hyperspectral sensor)
- Previous research
  - Stress detection in leaves (nutrient shortage and mildew in apple trees)
  - Wavelet based hyperspectral classification

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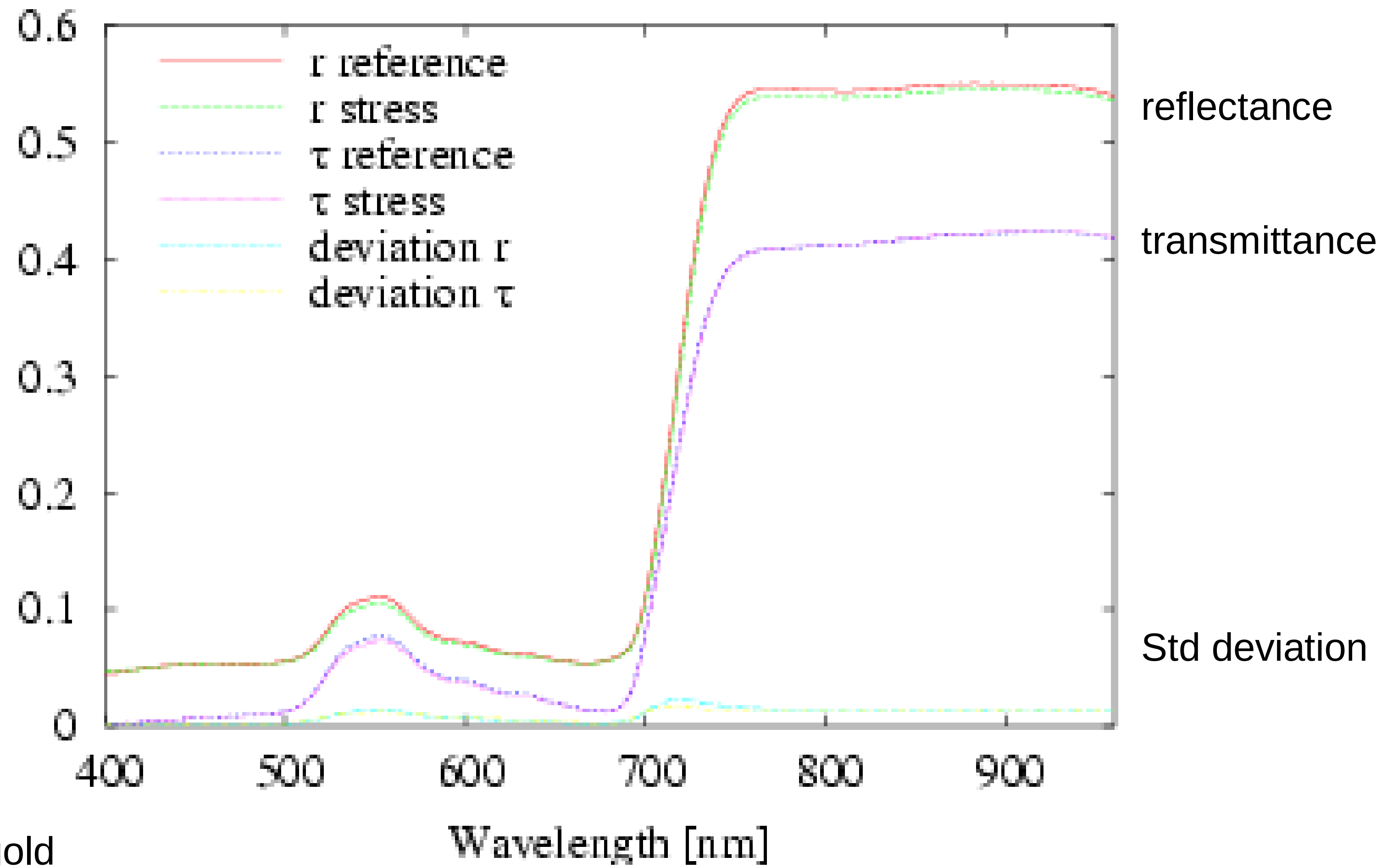
Experiments

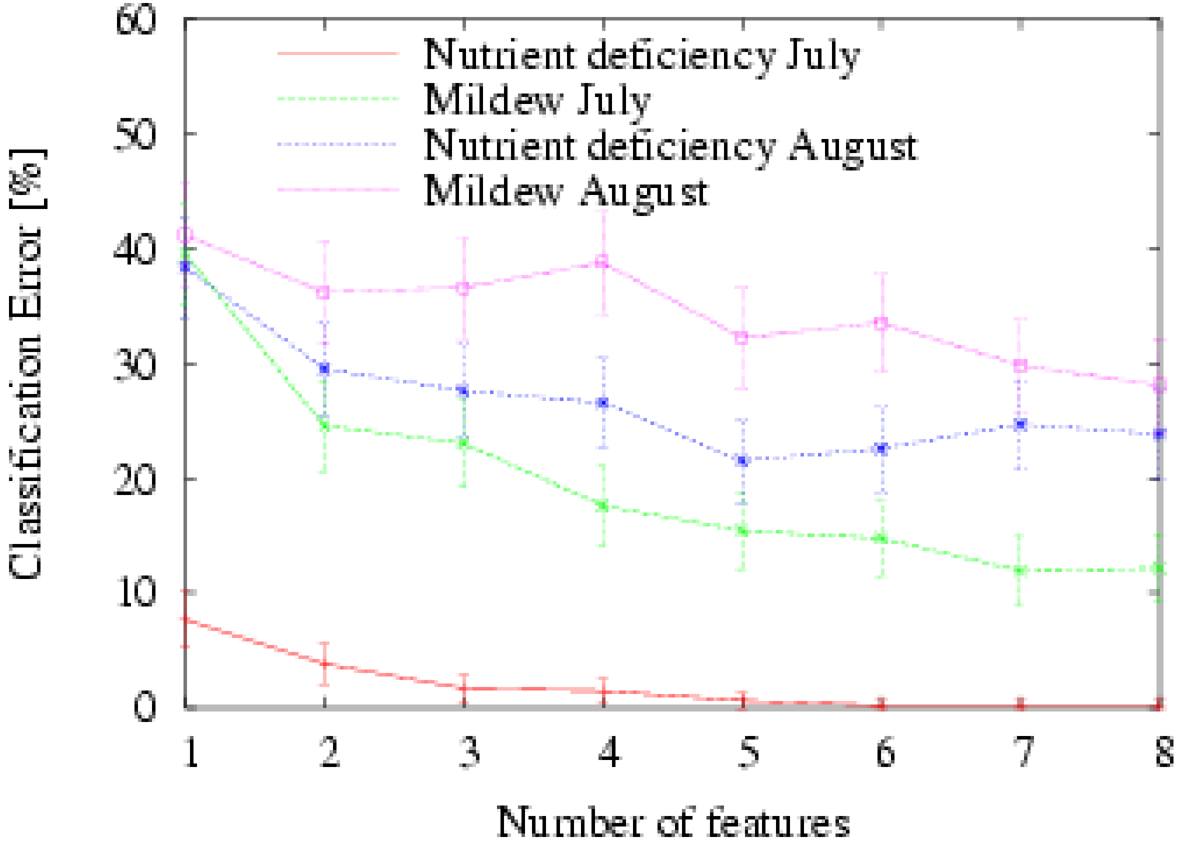
- Experimental test plot: Royal Research Station of Gorsem, St-Truiden (B)
- Apple trees
  - Jonagold and Golden
- Stress-Reference
  - Nitrogen
  - Mildew & Scab

Leaf level: spectra



Fruit: Jonagold
Stress type: mildew & scab

Leaf level: classification results



Full resolution and bandwidth (ASD: 3nm/10nm, 350nm-2500nm)
Data collected with contact probe (~ 480 samples)

Objectives

1. Separability of classes in airborne spectra
   - Upscaling leaf reflectances to TOA radiances
2. Classification of real airborne hyperspectral imagery, using upscaled (simulated) spectra as training
   - Test site: research station at Gorsem (B)
   - Small scale (12 trees induced with stress): few pixels (statistical relevance!)

TOA: Top Of Atmosphere

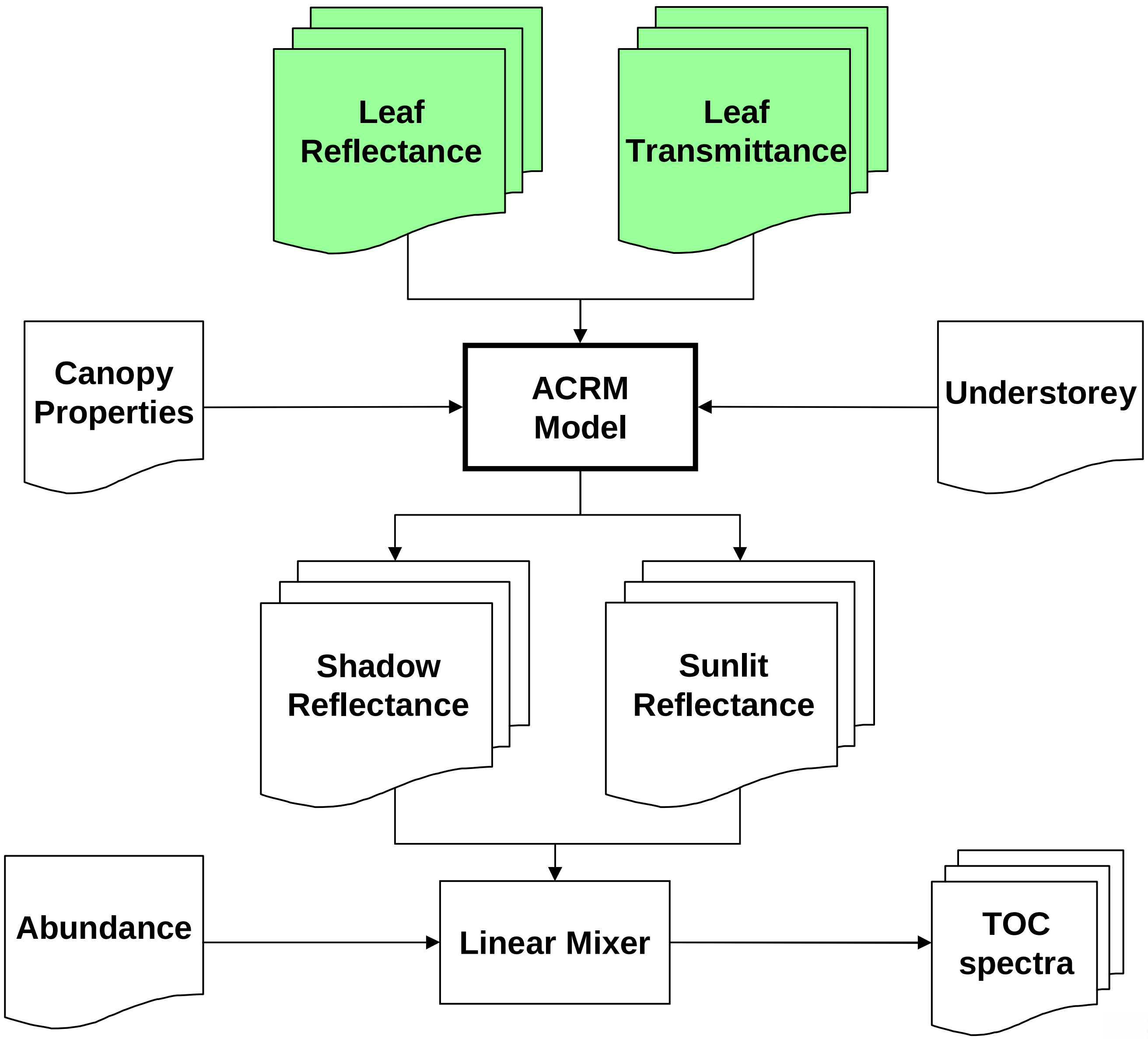
Upscaling: Leaf to TOC

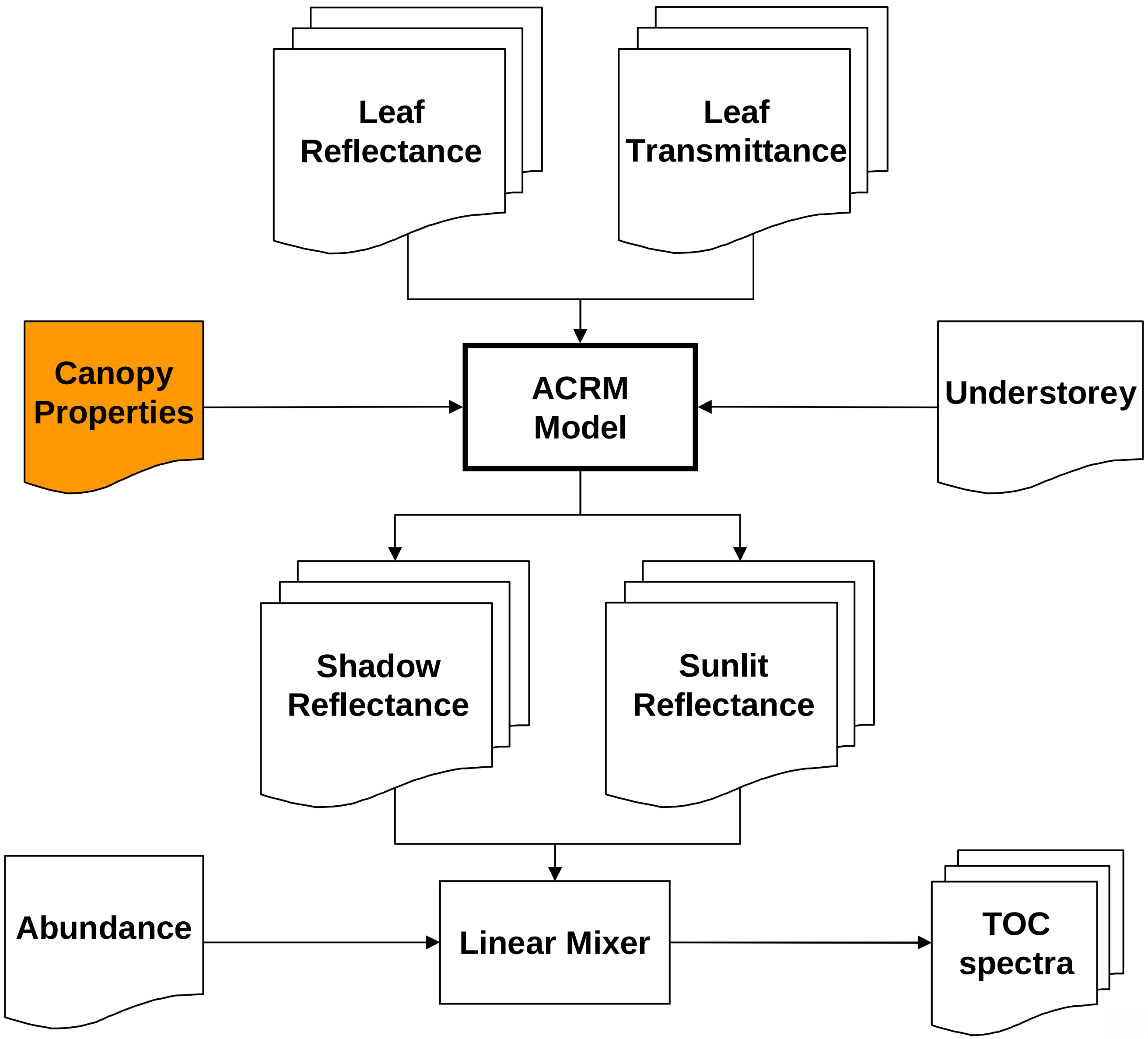
Canopy Reflectance model: ACRM

Jonagold, mildew & scab

→ **ACRM Model** →

TOC: Top Of Canopy


Leaf Reflectance
Leaf Transmittance
Canopy Properties
ACRM Model
Understorey
Shadow Reflectance
Sunlit Reflectance
Abundance
Linear Mixer
TOC spectra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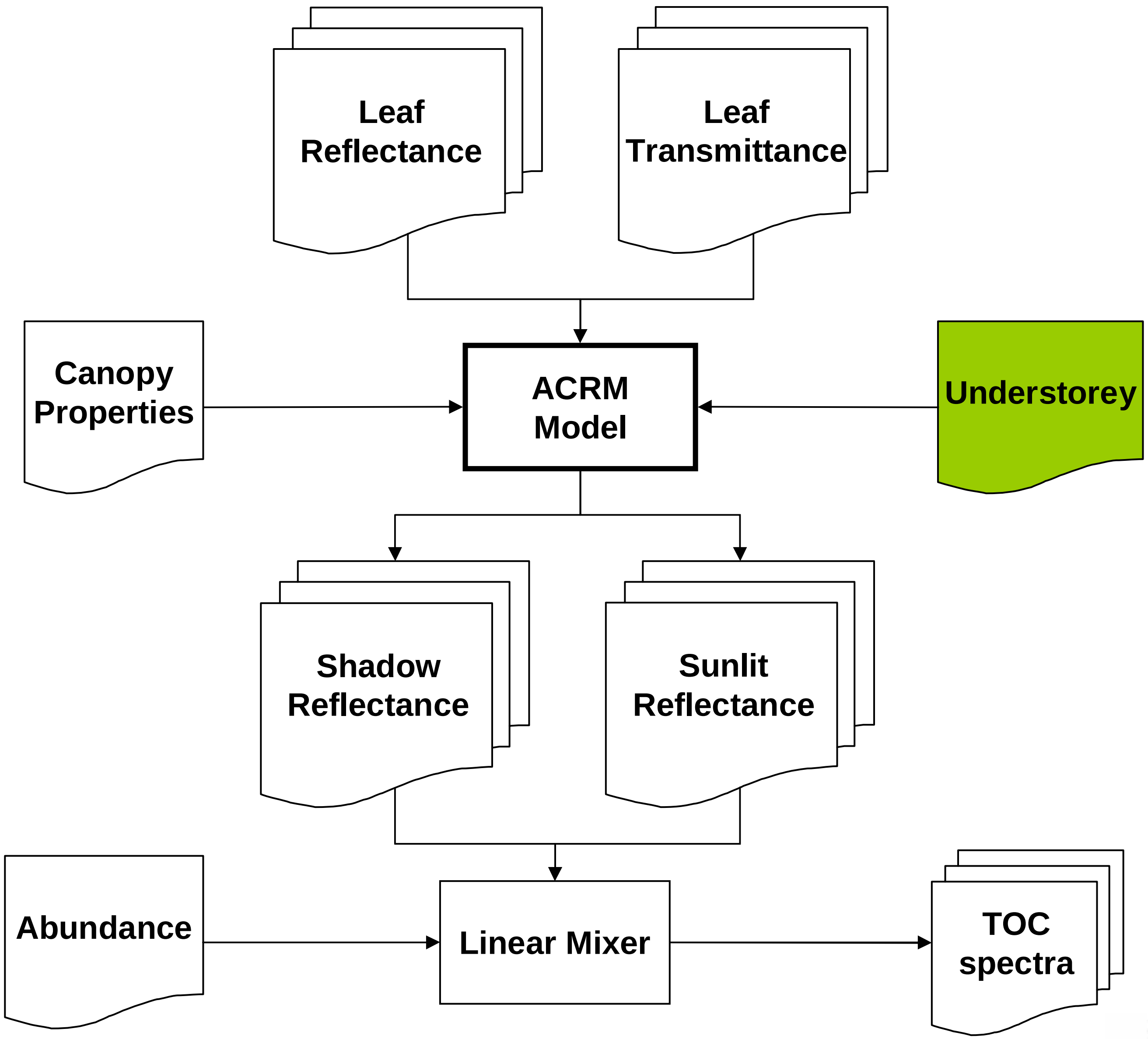
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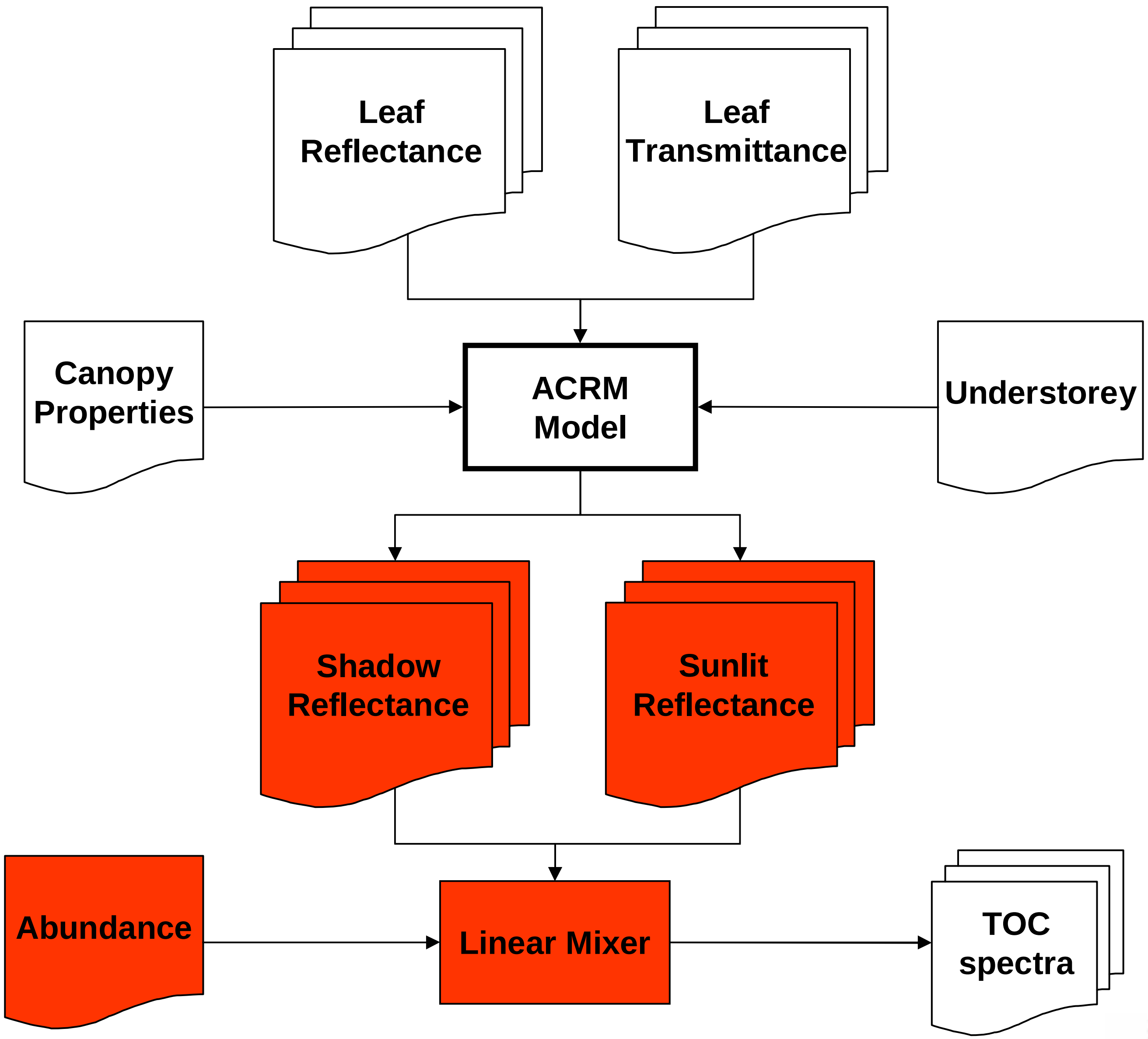
Leaf
Reflectance
Leaf
Transmittance
Canopy
Properties
ACRM
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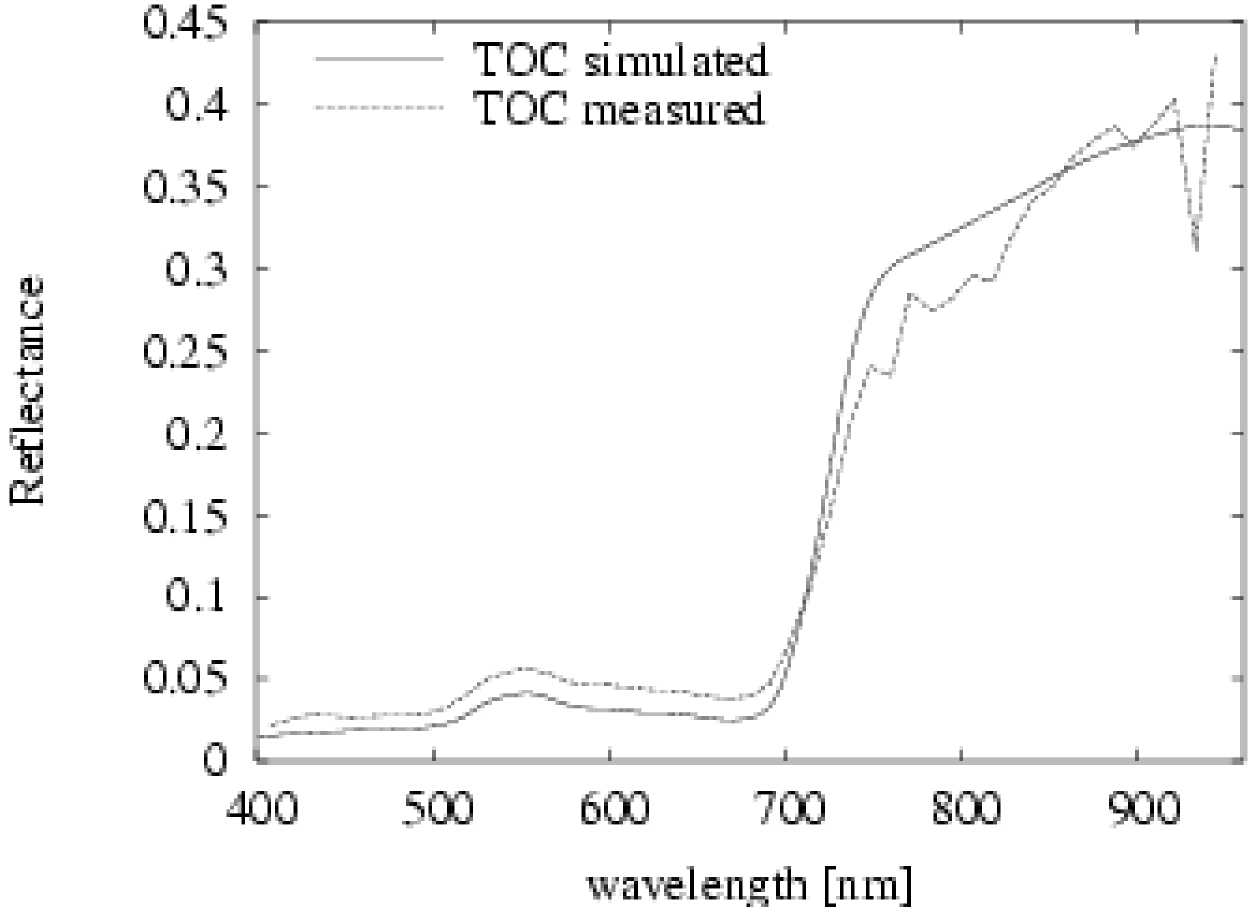
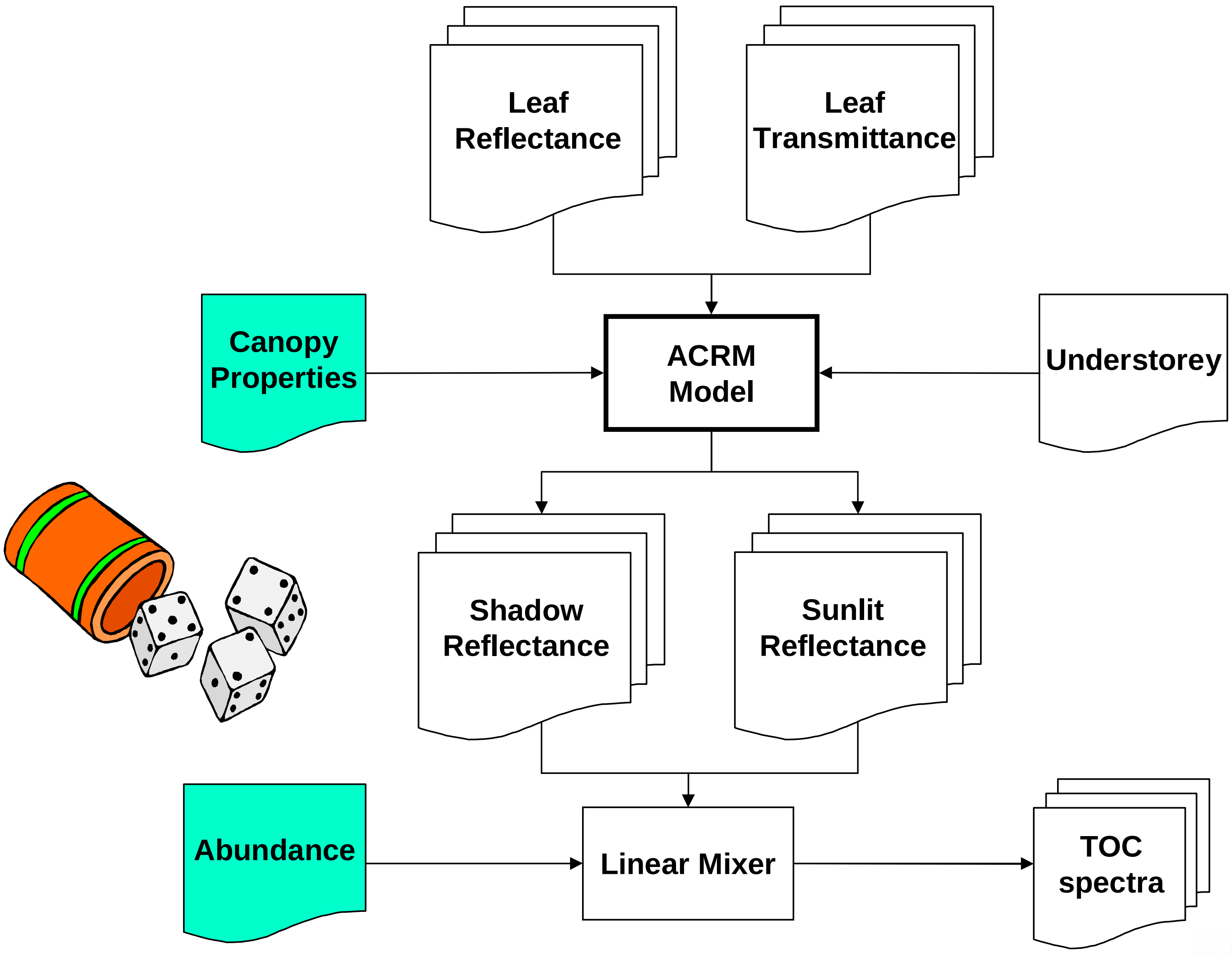
Shadow
Reflectance
Sunlit
Reflectance
Abundance
Linear Mixer
TOC
spectra

Top Of Canopy level: spectra

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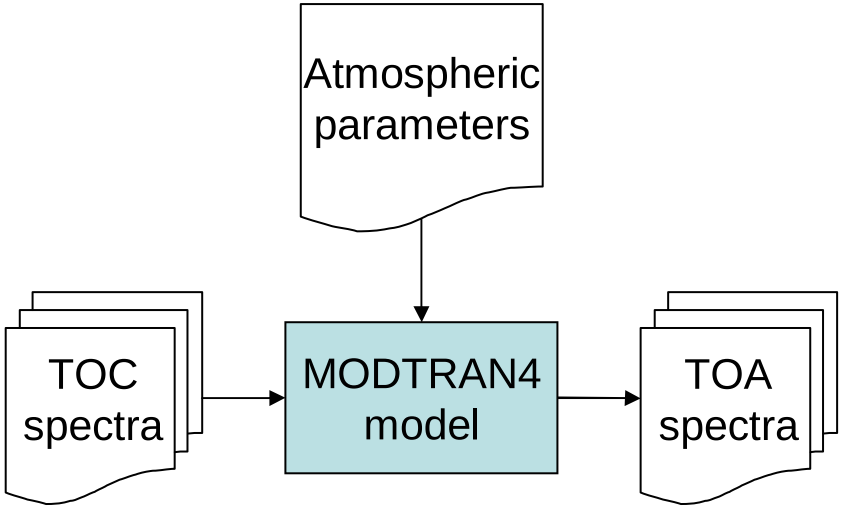
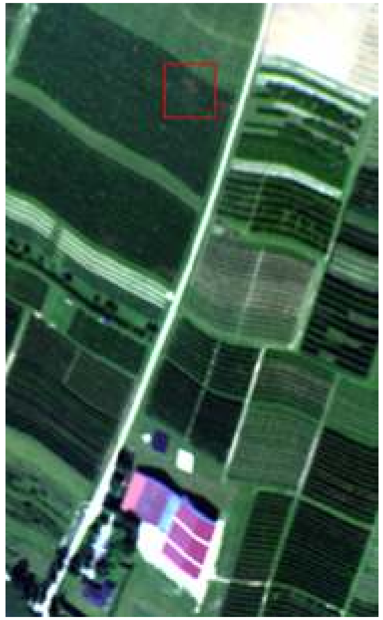
TOC spectra

Upscaling TOC to TOA

Radiative transfer model: MODTRAN4



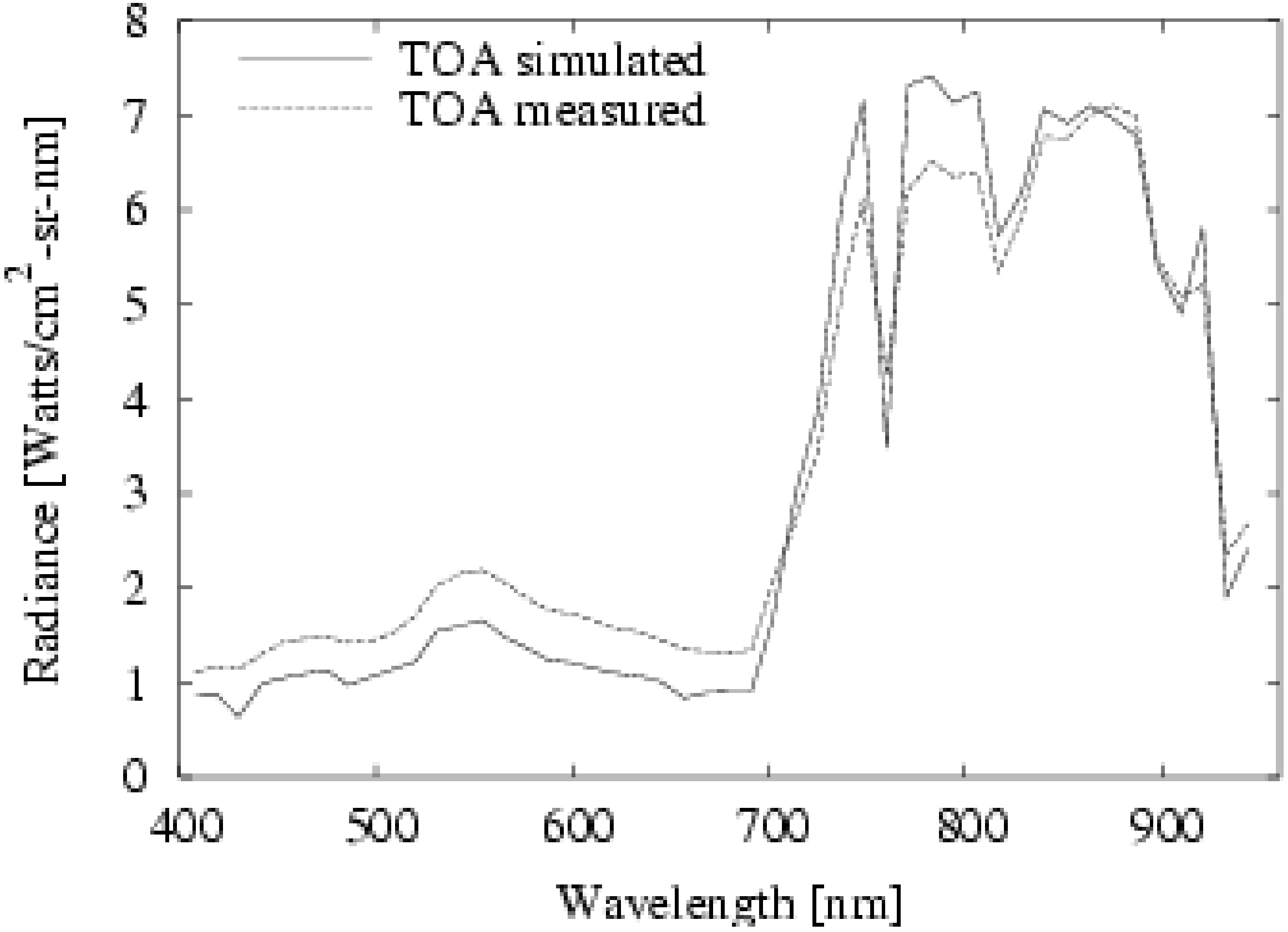


CASI sensor:

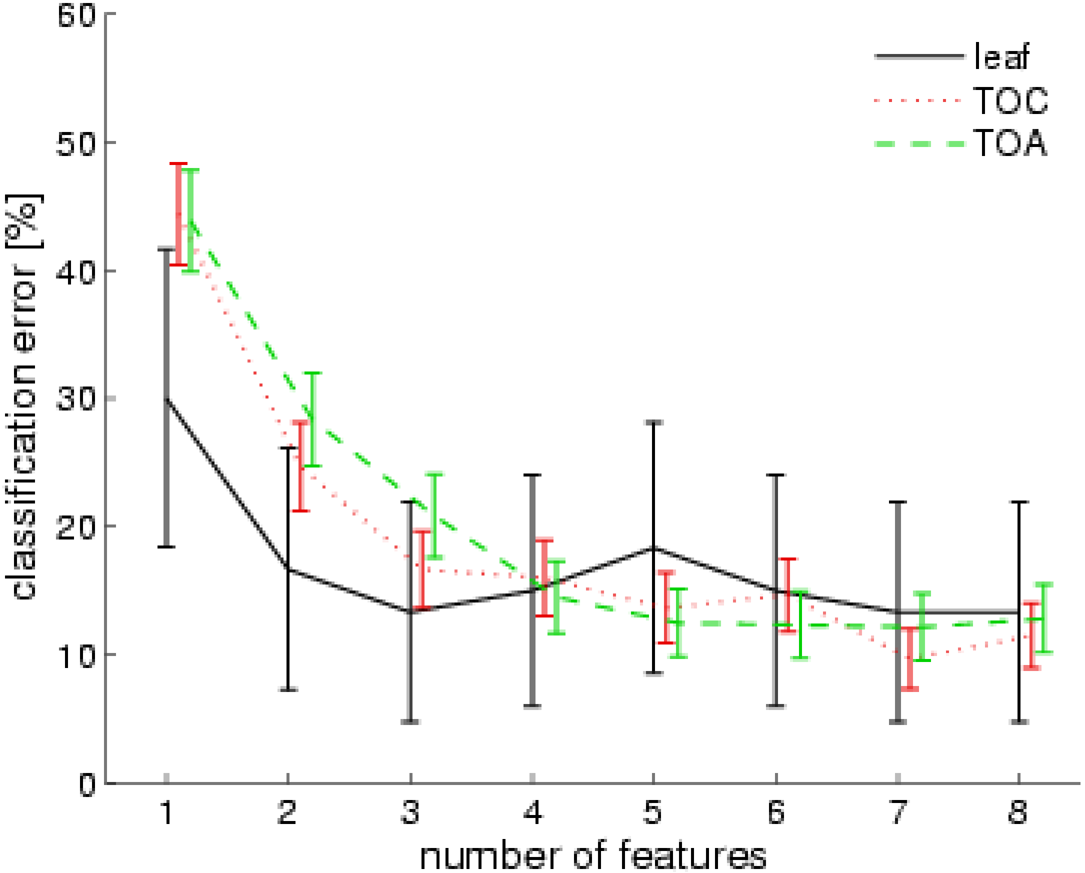
48 bands, 1 m x 1.3m

TOC: Top Of Canopy
TOA: Top Of Atmosphere

Top Of Atmosphere level: spectra

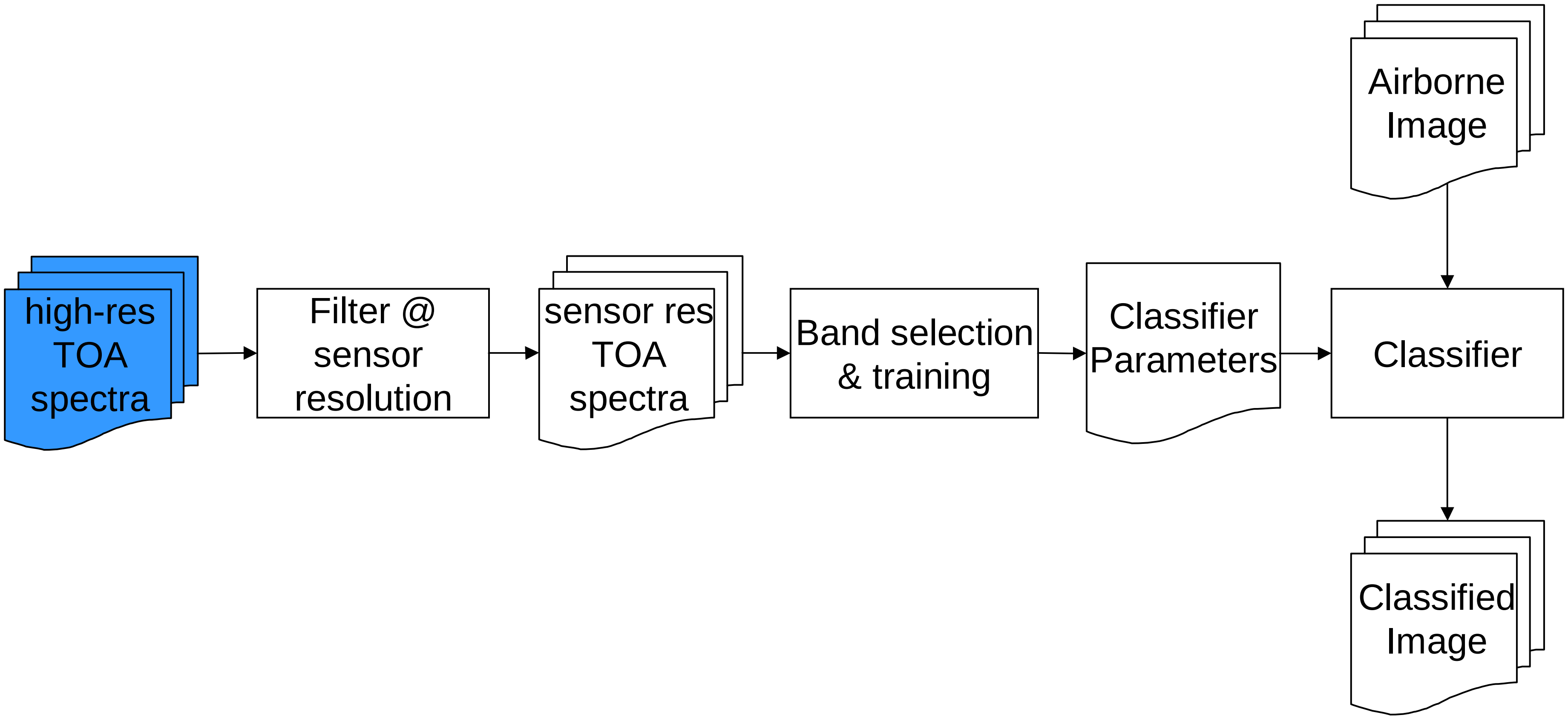


Classifying simulated spectra

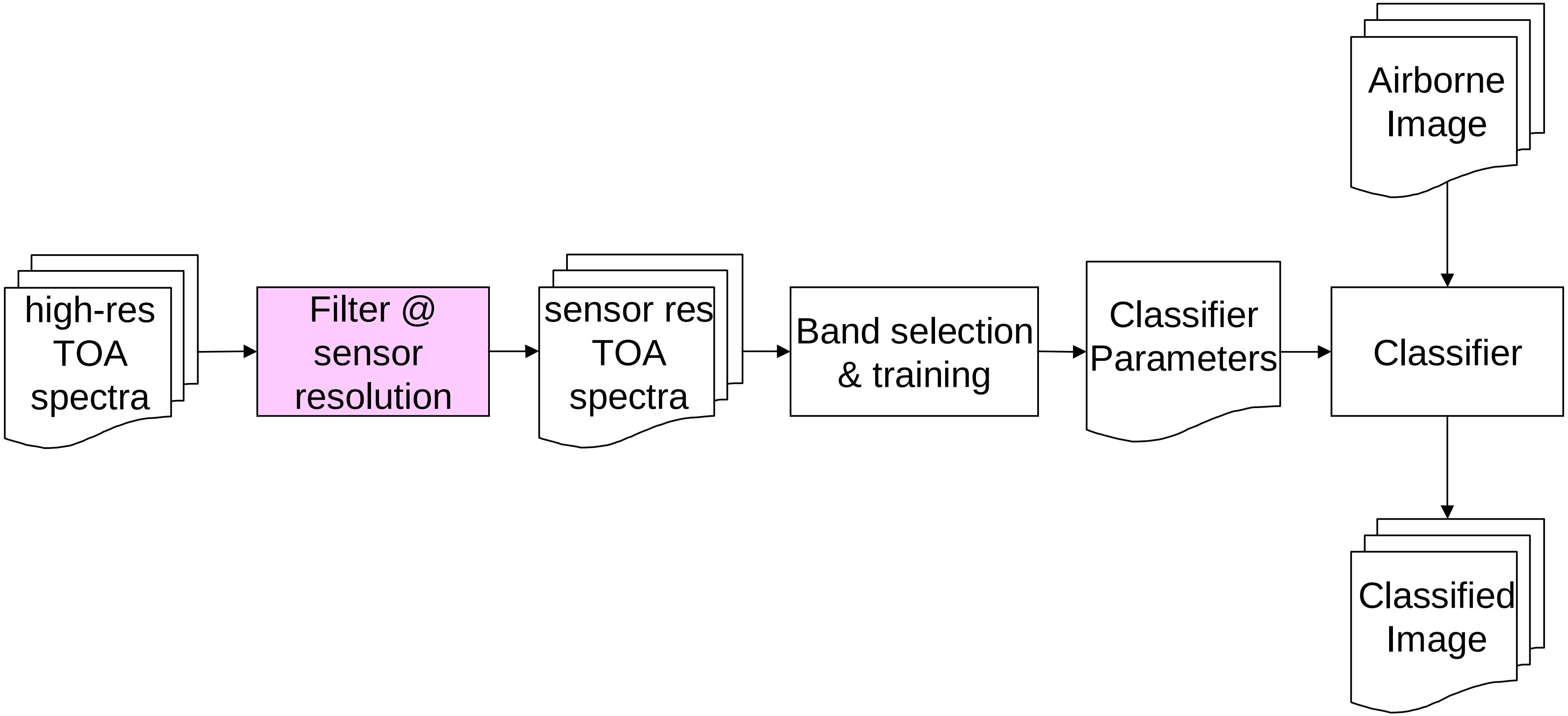


Reduced spectral resolution and bandwidth (CASI: ~12nm, 408nm-944nm)
600 Simulated spectra

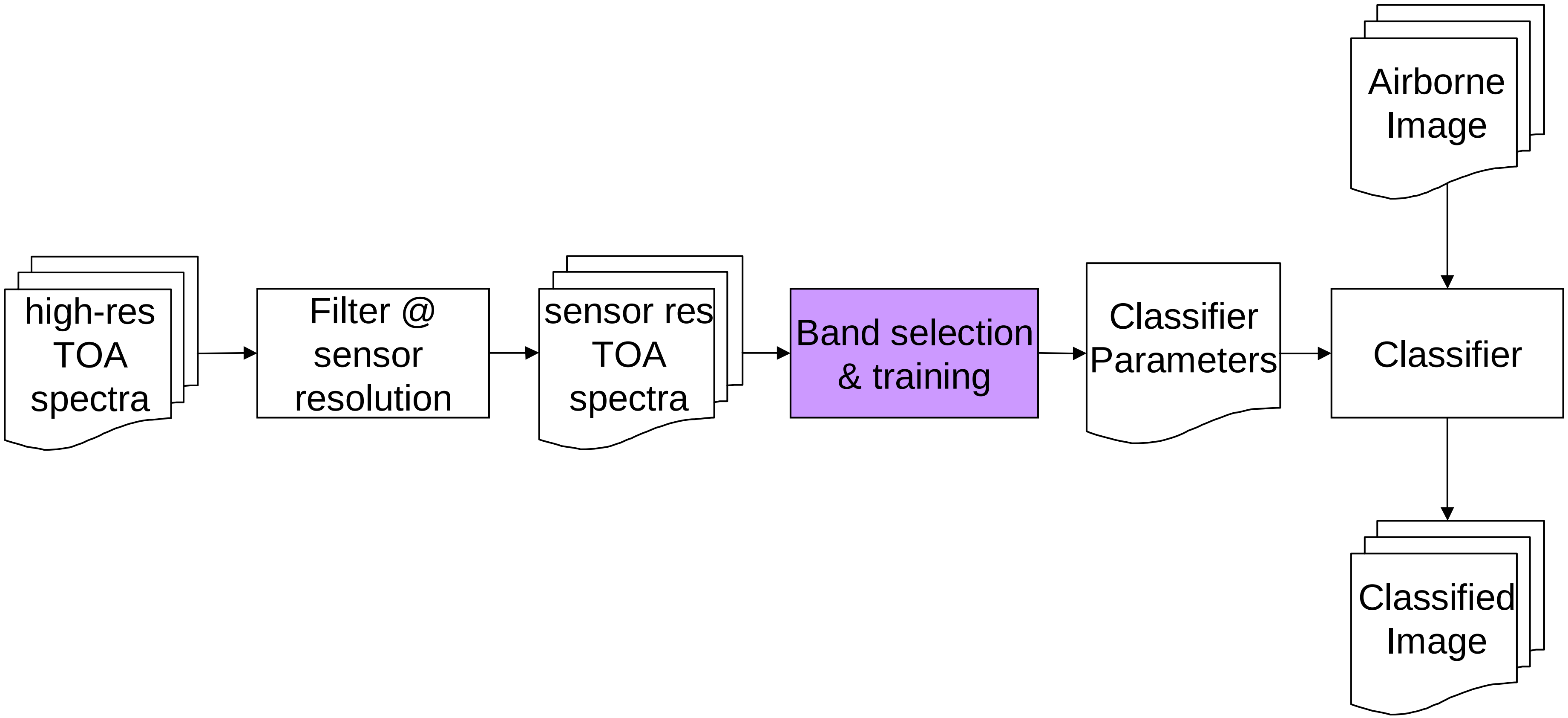
Classifying airborne spectra



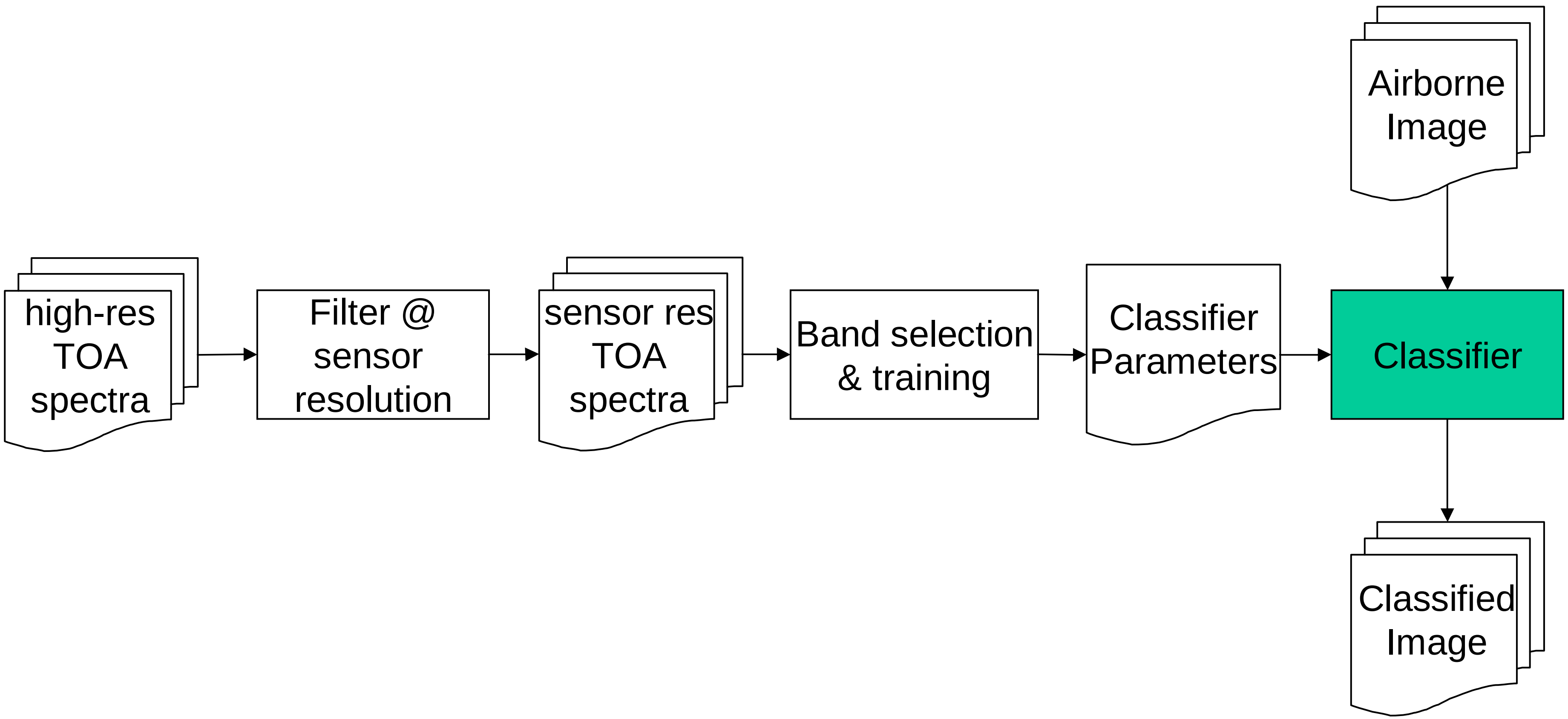
Classifying airborne spectra



Classifying airborne spectra

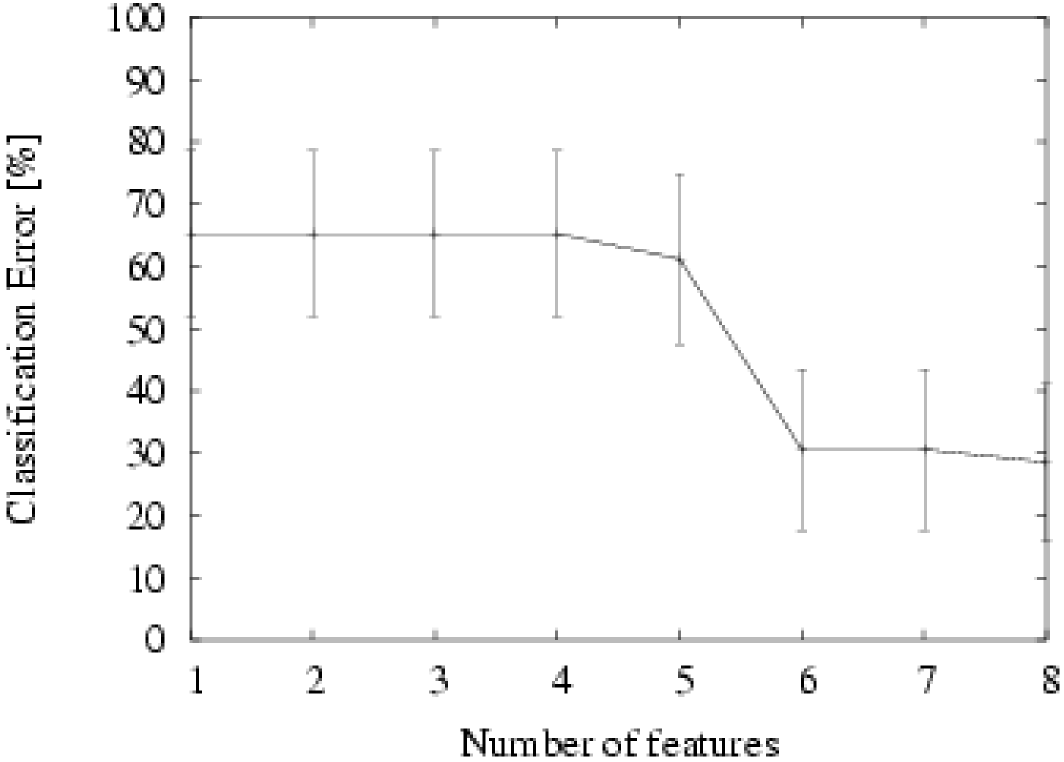


Classifying airborne spectra



Classifying airborne spectra

Jonagold mildew & scab, training with simulated spectra



Confusion Matrix (7 features)

	predicted	
Actual	Reference	Stress
Reference	26.5%	8.2%
Stress	22.4%	42.9%

Conclusions

- Stress can still be detected from simulated airborne hyperspectral spectra
- We are able to detect stress in real airborne hyperspectral spectra with an accuracy of 70 percent when training with upscaled spectra.