

Self-Contained Atmospheric Correction and Parameter Retrieval from Imaging Spectroscopy Data

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Outline

1. Introduction

- Why atmospheric correction for imaging spectroscopy

2. Solved problems

- Automatic parameter retrieval for water vapor and aerosols
- Integration of geometric and atmospheric processing
- Correction of pushbroom-type imaging spectroscopy data

3. Results of self-contained correction

- ATCOR-type integrated correction
- Considering the smile influence
- Spectral polishing

4. Conclusions and outlook

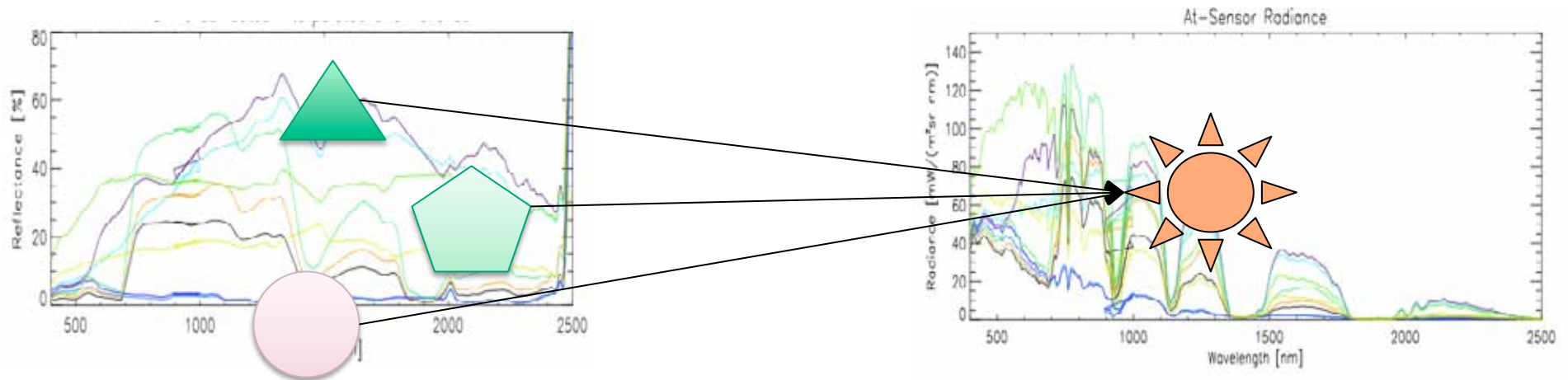
Why Atmospheric Compensation?

Importance for imaging spectroscopy:

- Surface reflectance quantities; ideally spectral albedo are basis for imaging spectroscopy applications.
- Half of all spectral bands are heavily affected by atmospheric scattering and absorption.
- High variability of environmental conditions from aircraft
- Regular monitoring using this evolved technology has become a challenge.

Radiative Transfer Simulation

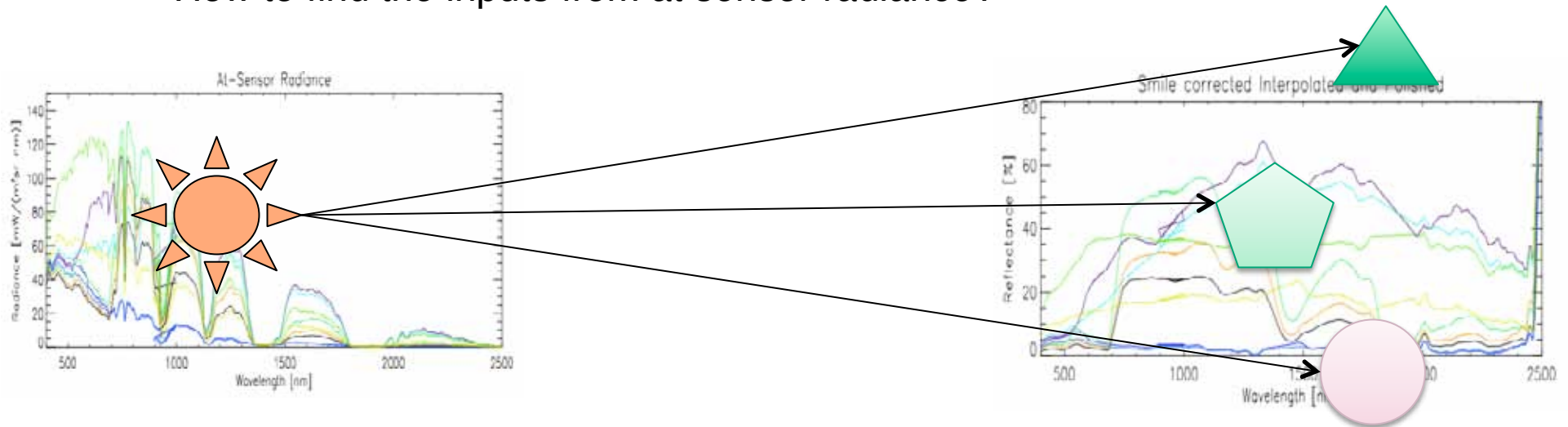
Accurate physical modeling of the radiance as a basis:



(the MOD0 w/ MODTRAN5 software being a helper to ease this part)

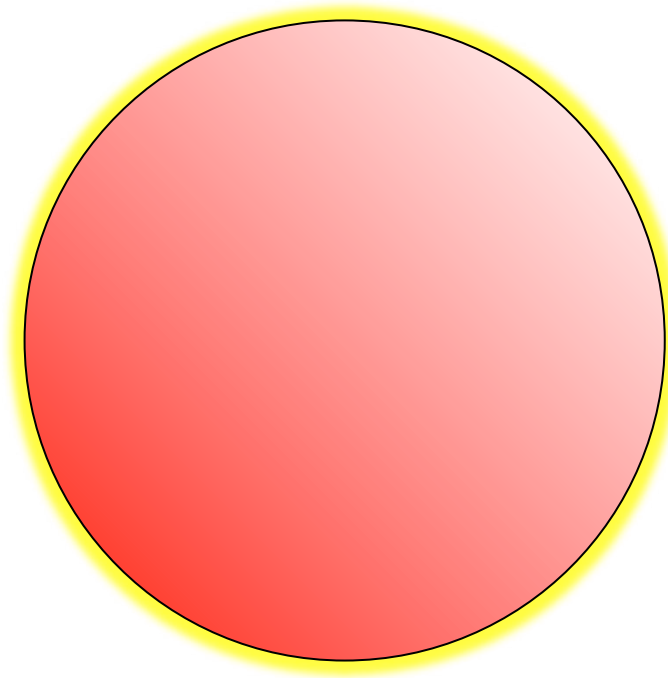
Inversion?

How to find the inputs from at sensor radiance?



(ATCOR atmospheric correction software being one of the solutions for that part...)

Towards Full Operationality



One button-Operation

Pre-Conditions:

- Well-calibrated instrument
- Integrated geometric/atmospheric processing
- Full spectral range:
 - 400-1000 nm for aerosol retrieval
 - 900-1200 nm for water vapor retrieval
- Stable processing methods and software
- Pushbroom instrument post-processing
- Consistent meta-data handling

... is mostly achieved today

Instruments

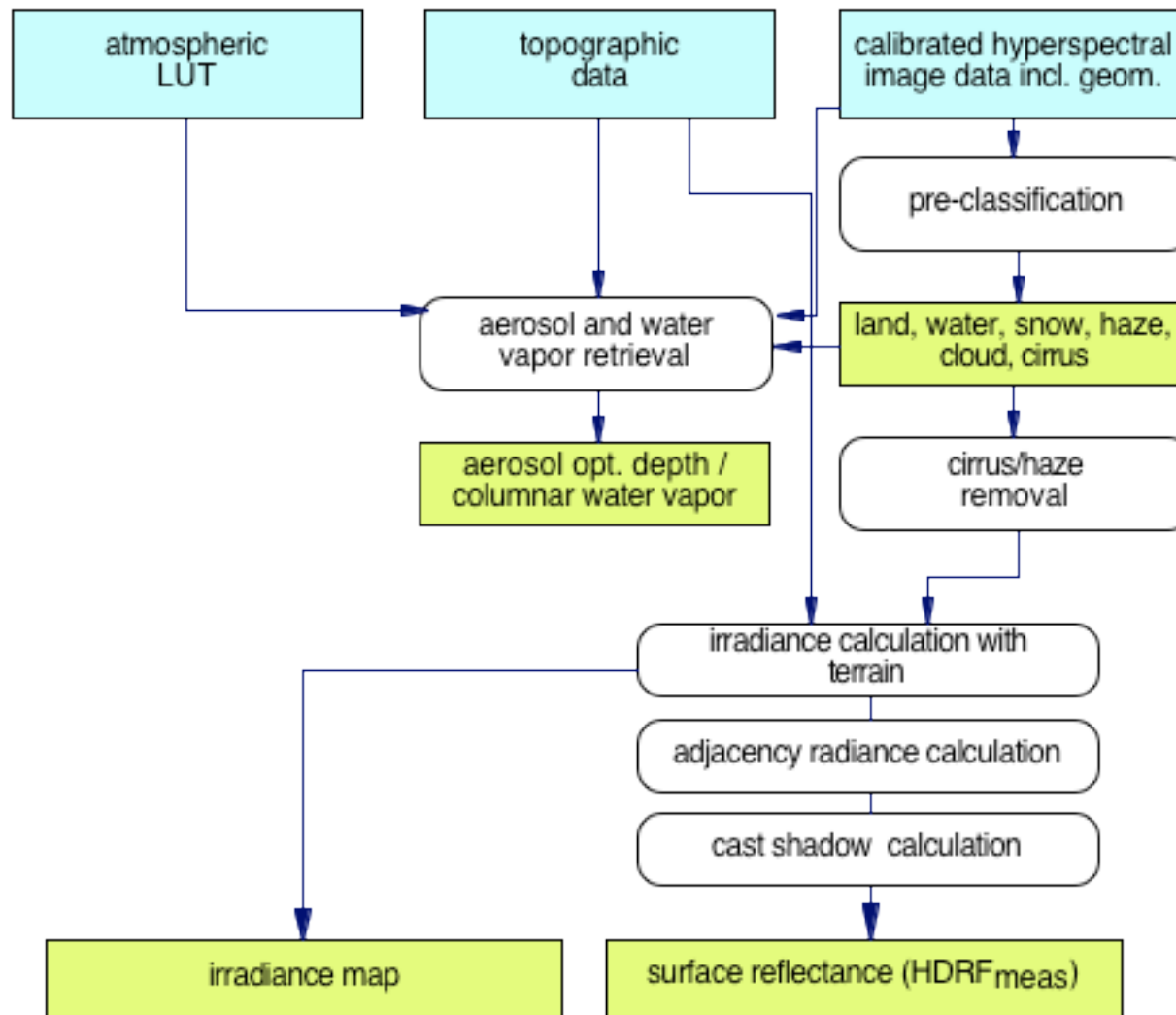
Available airborne imaging spectrometers of sufficient quality for 'red button' (in order of appearance):

- AISA
 - CASI
 - HYSPEX
- ... and more

Space instruments:

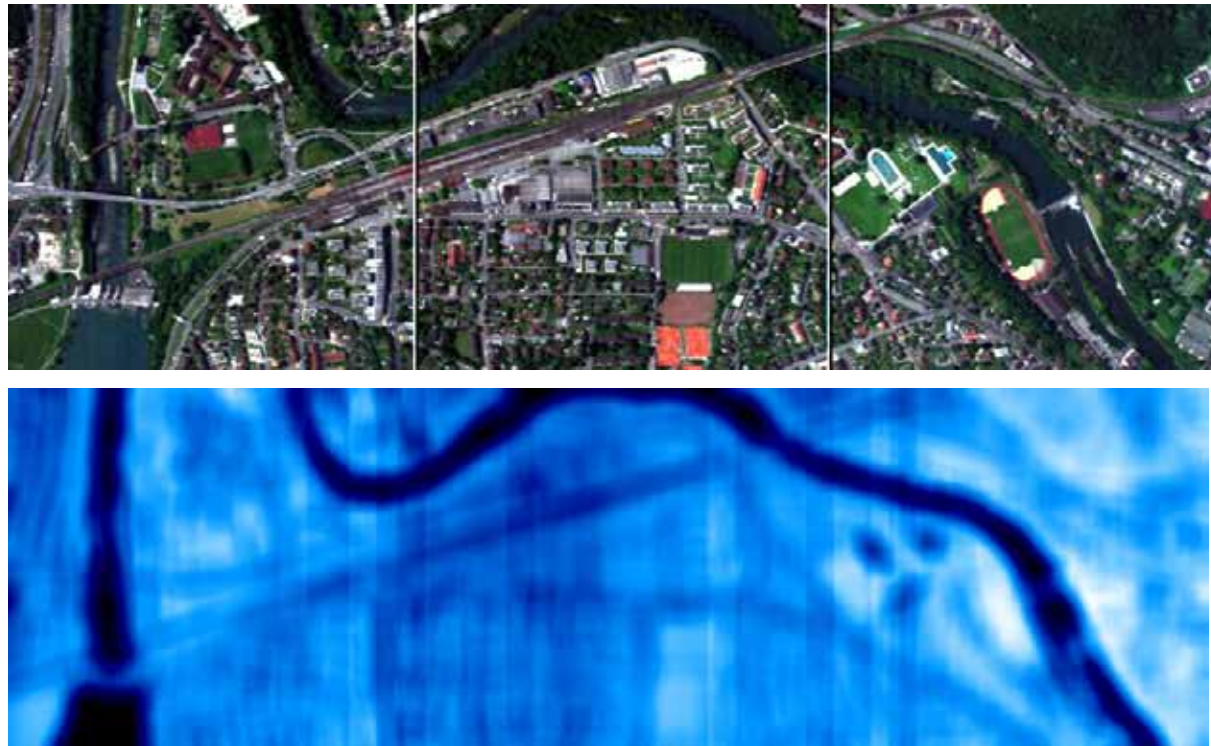
- ENMAP
 - HYSPIRI
- ... that's the future...

Standard atmospheric and radiometric correction



Parameter Retrieval for Atmospheric Correction (1)

Water vapor: absorption feature analysis at 940/1130 nm leads to columnar water vapor amounts (except for dark objects)

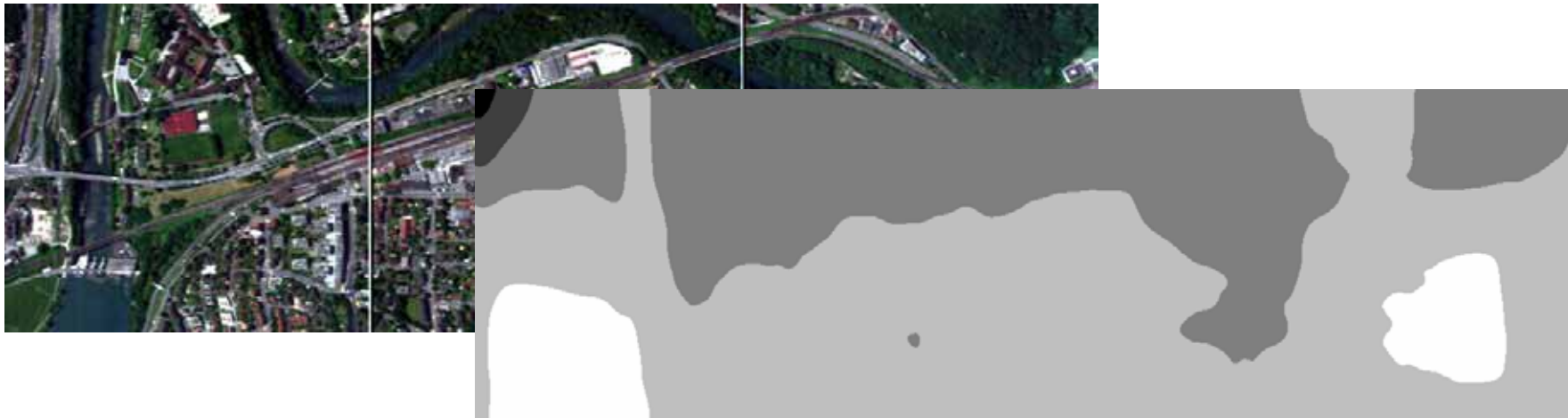


Parameter Retrieval for Atmospheric Correction (2)

Aerosol detection:

aerosol optical depth from dark dense vegetation approach
(Kaufman) and

aerosol standard model by empirical best fit



-> All parameters: sufficient accuracy for unsupervised atmospheric compensation but not for meteorological applications.

Corrected spatial effects (ATCOR example)

Relying on:

- Data calibration
- Accurate LUT generation or reference (MODTRAN...)
- Digital Elevation model

Spatial inhomogeneities:

- Viewing angle dependencies of scattered radiance
- Terrain influences (illumination/height)
- Cloud shadows and Cirrus

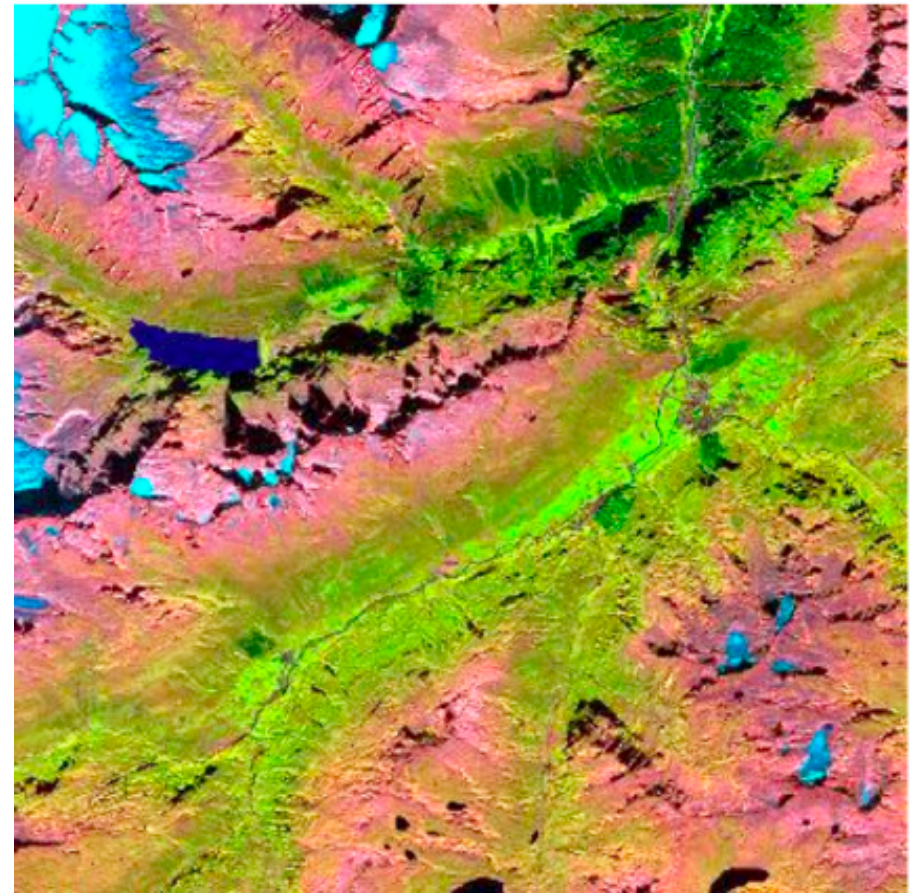
Haze and Cirrus Correction



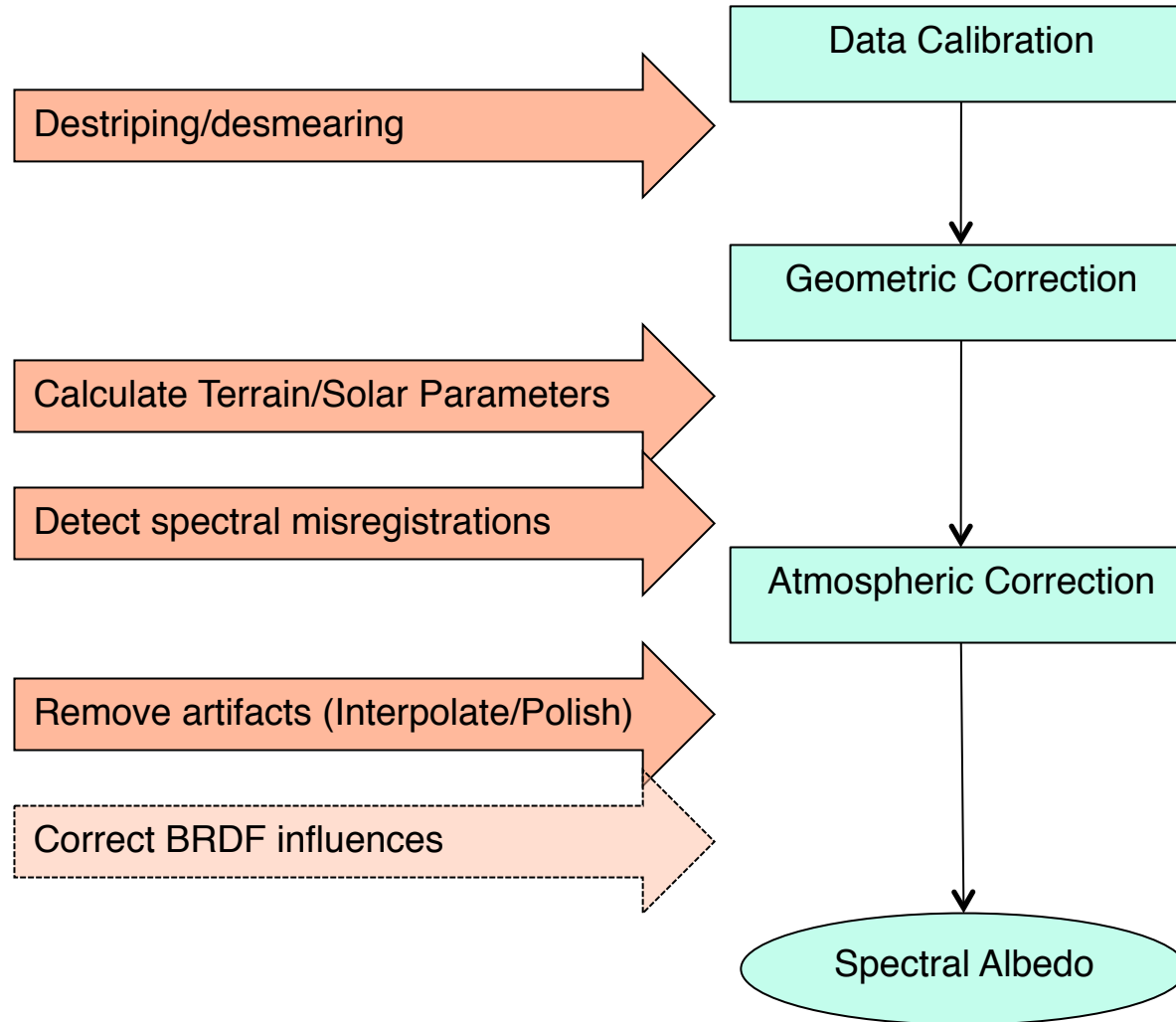
Topographic Shadow (ADS-40 data)



Topographic Correction

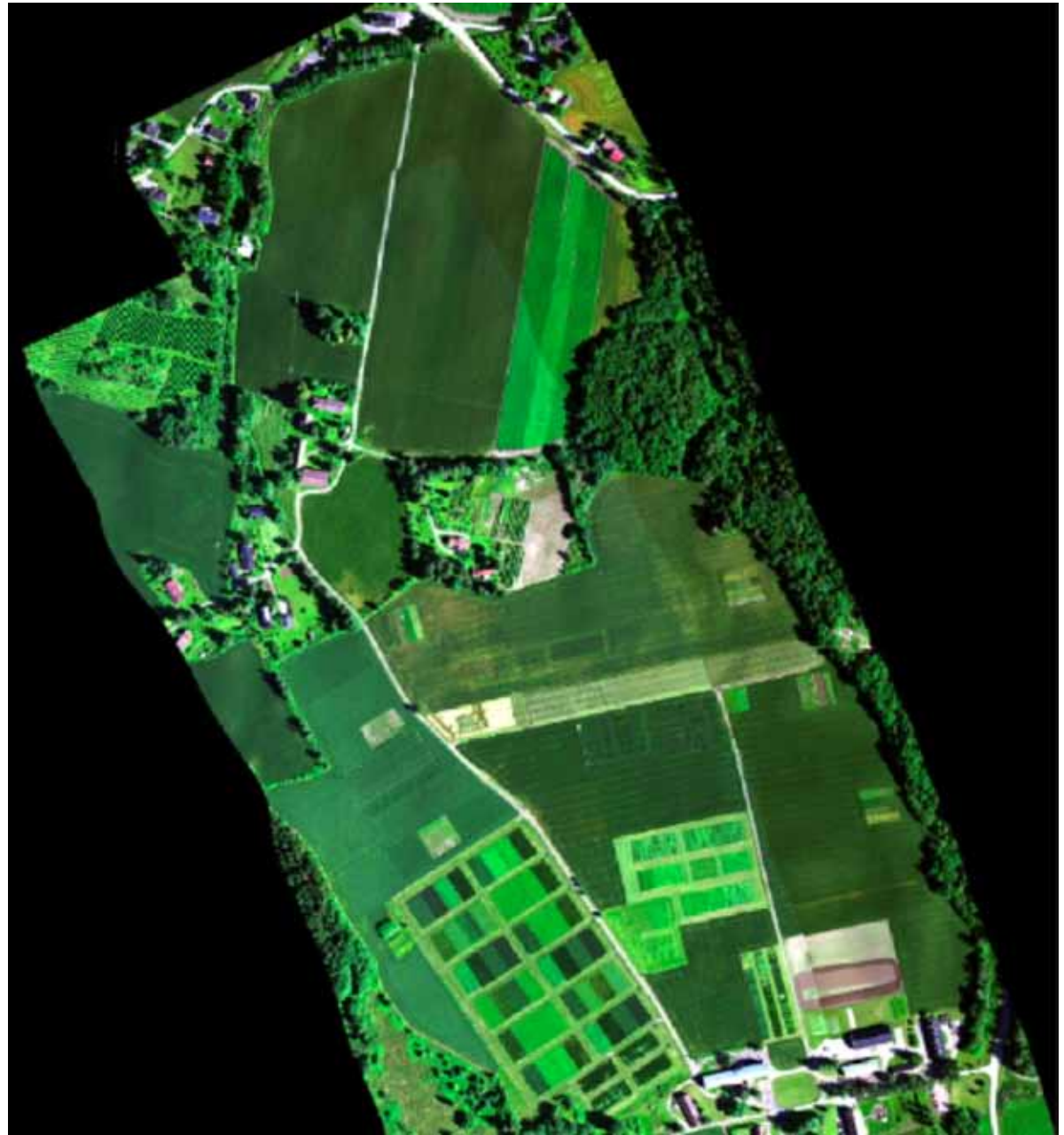


Completing the Chain



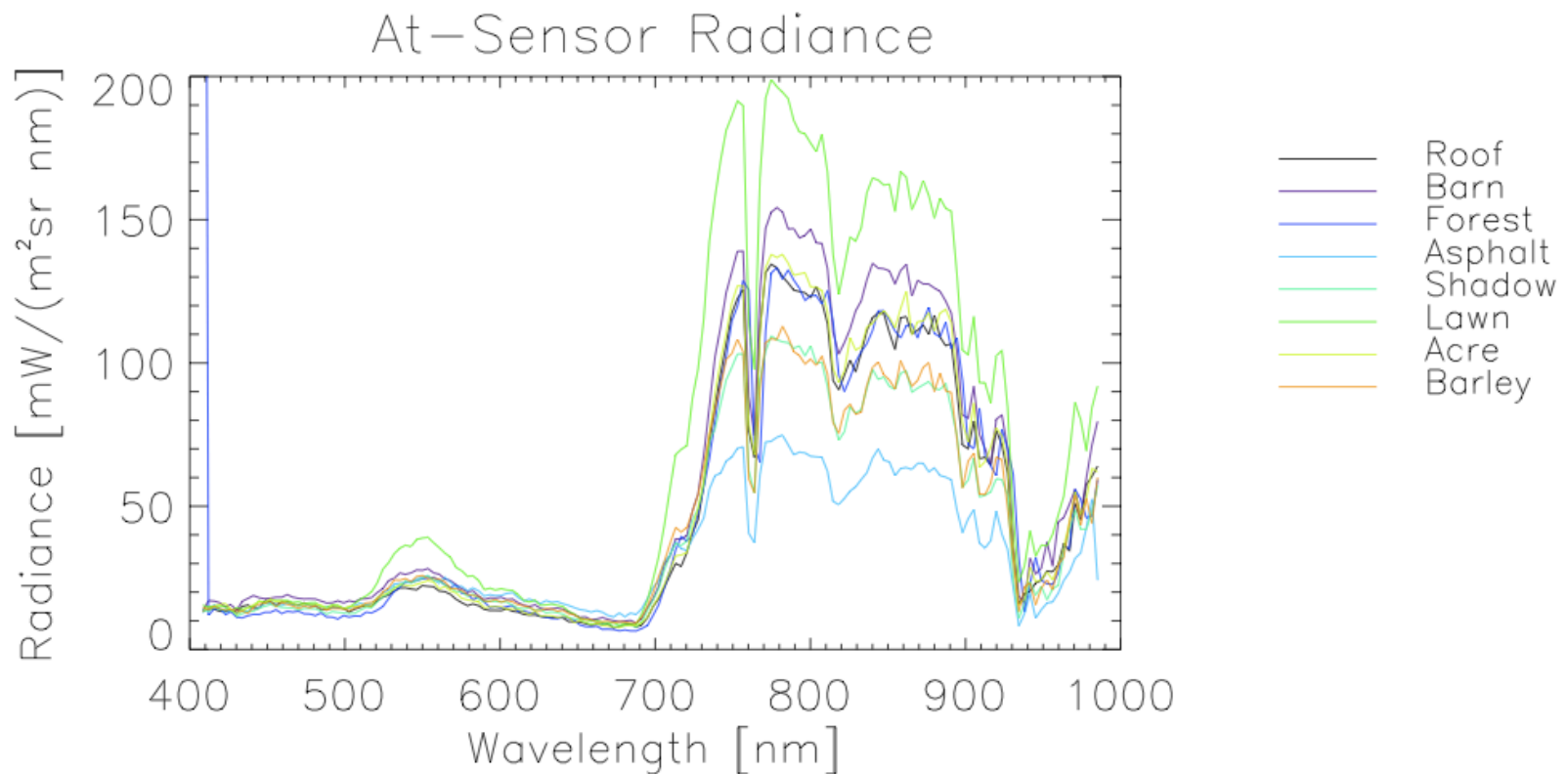
Calibrated, orthorectified imagery

Hypspec Imagery Example
(Norsk Electro Optics)



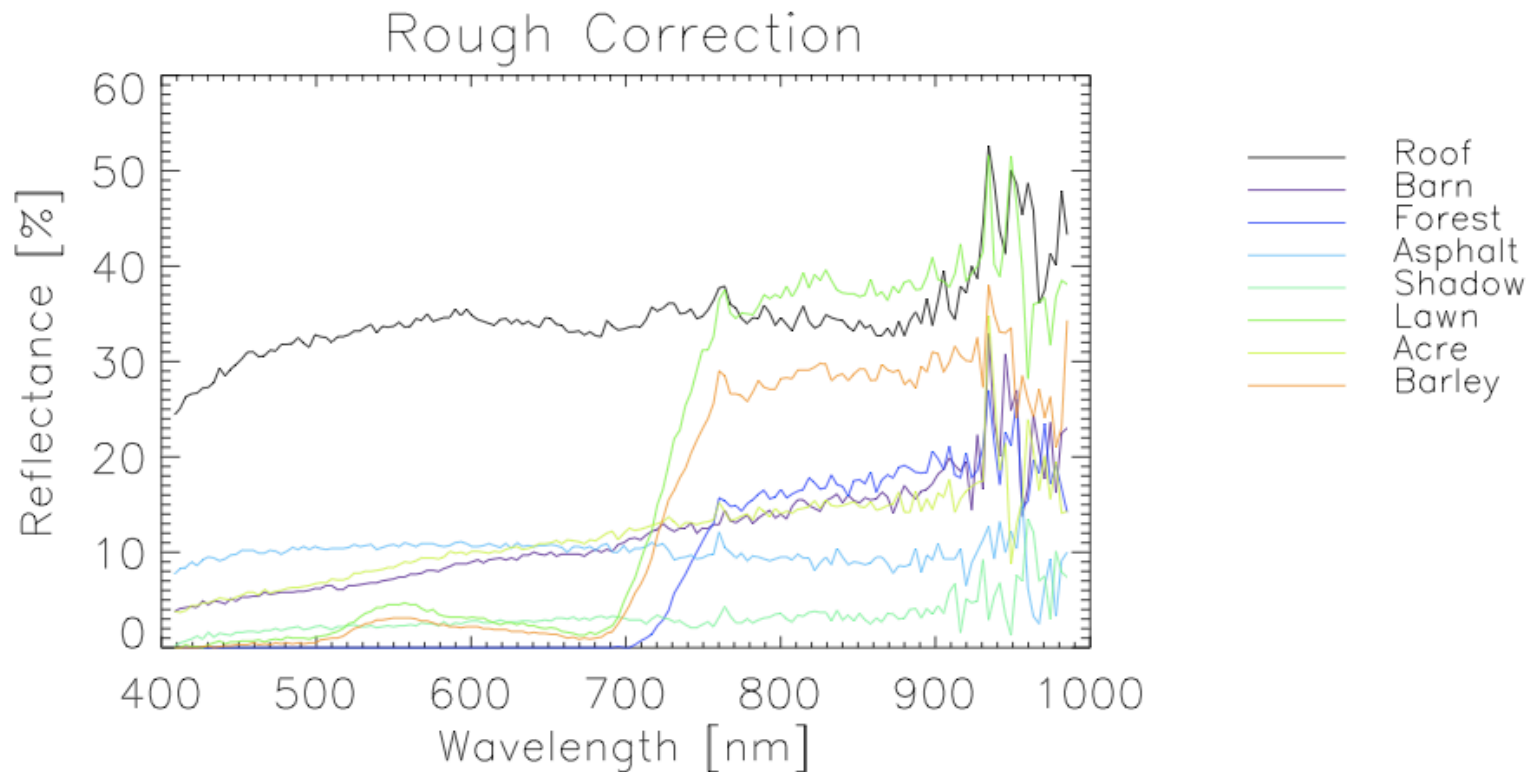
Calibrated At-Sensor Radiance

Starting point...



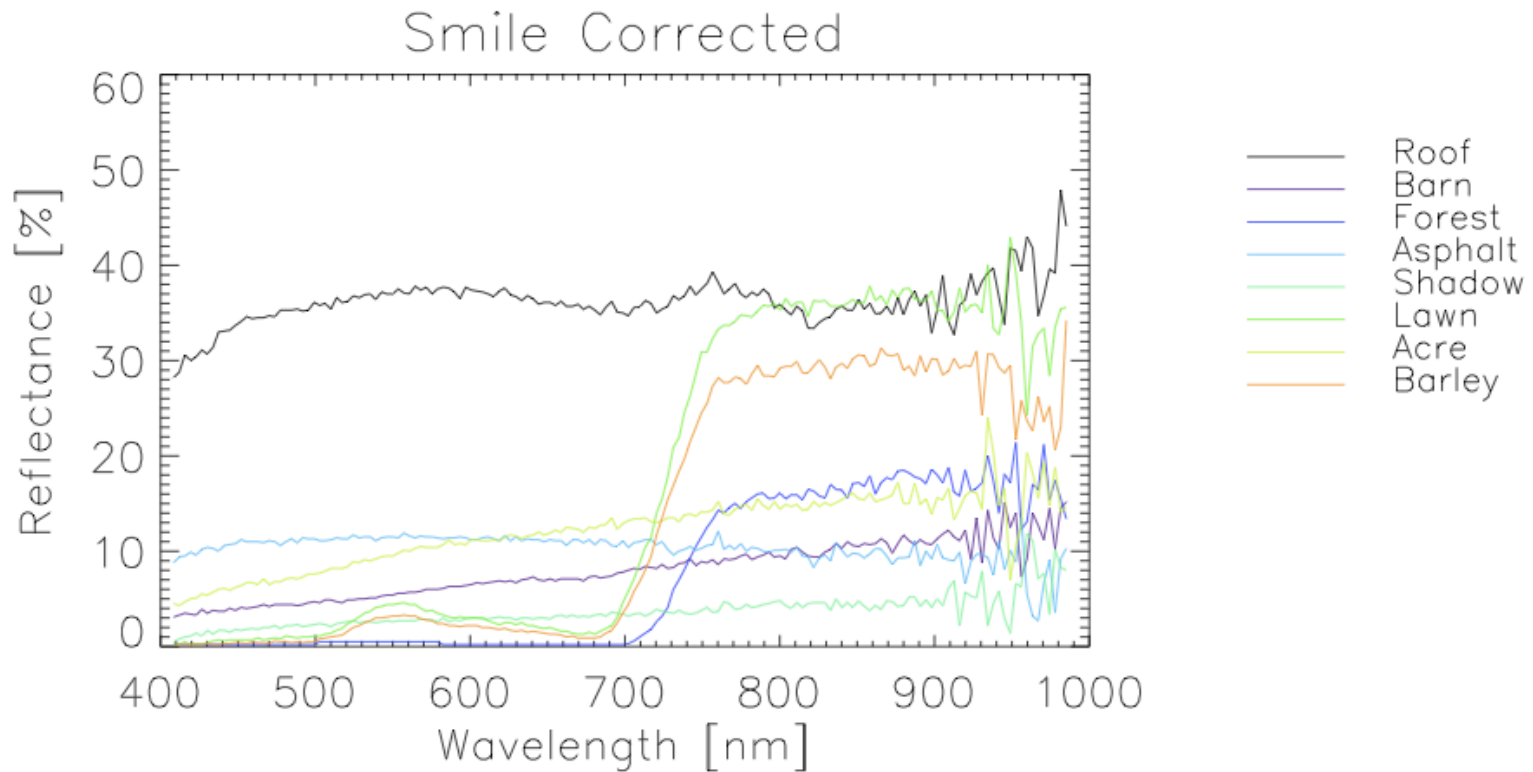
Atmospheric Compensation of Spectra (1)

Removing aerosol and water vapor effects



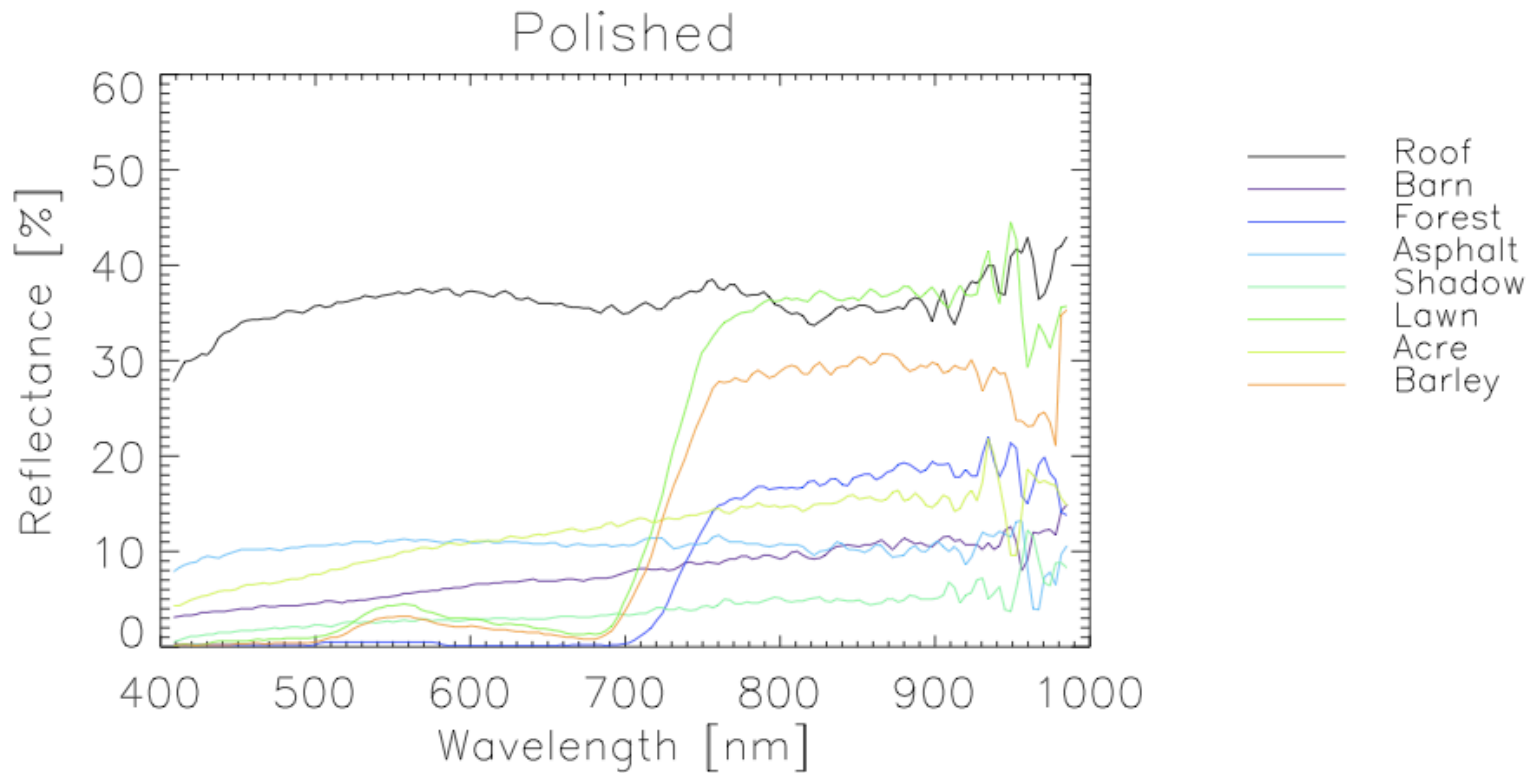
Atmospheric Compensation of Spectra (2)

Removing spectral miscalibrations



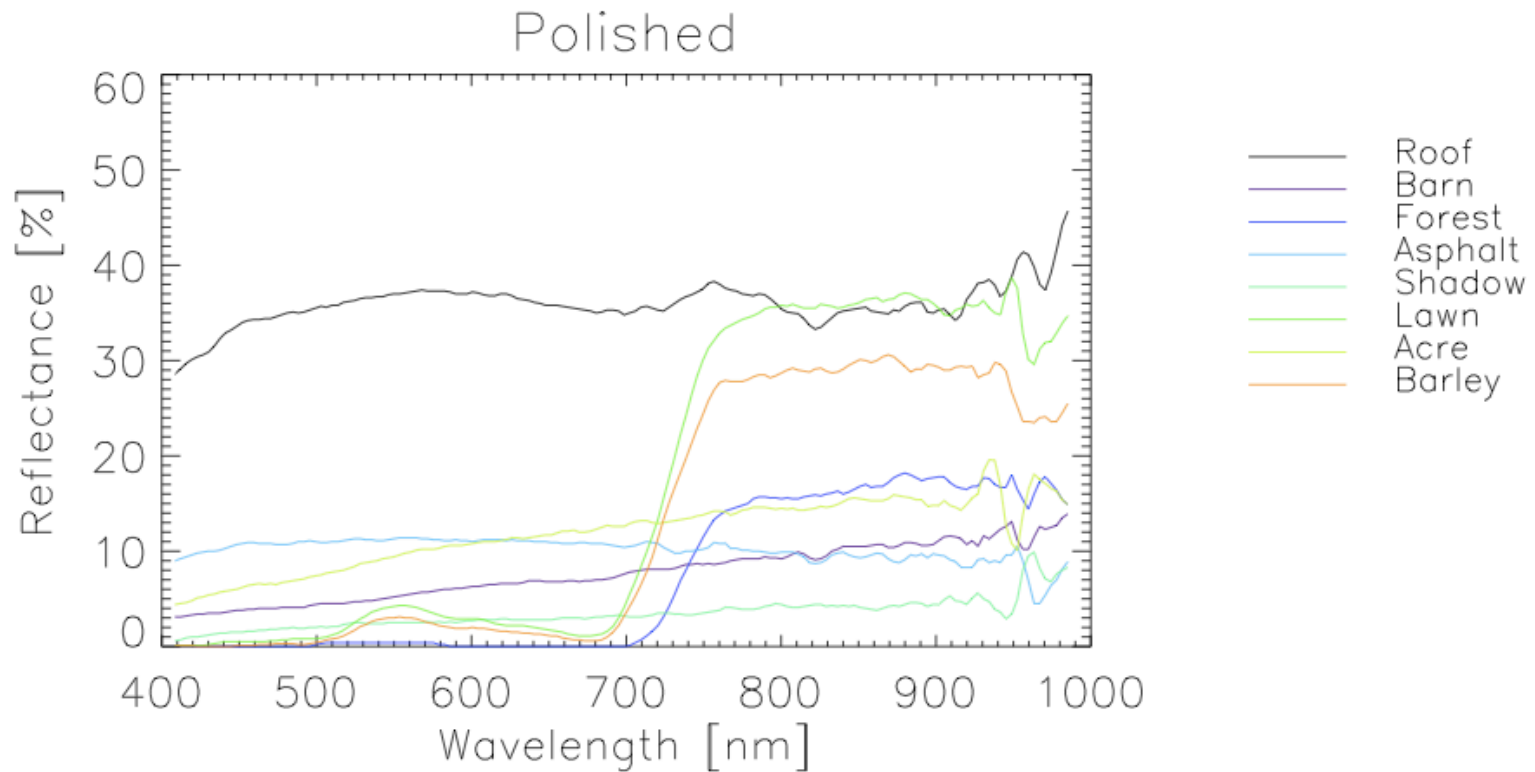
Atmospheric Compensation of Spectra (3)

Conservative derivative polishing



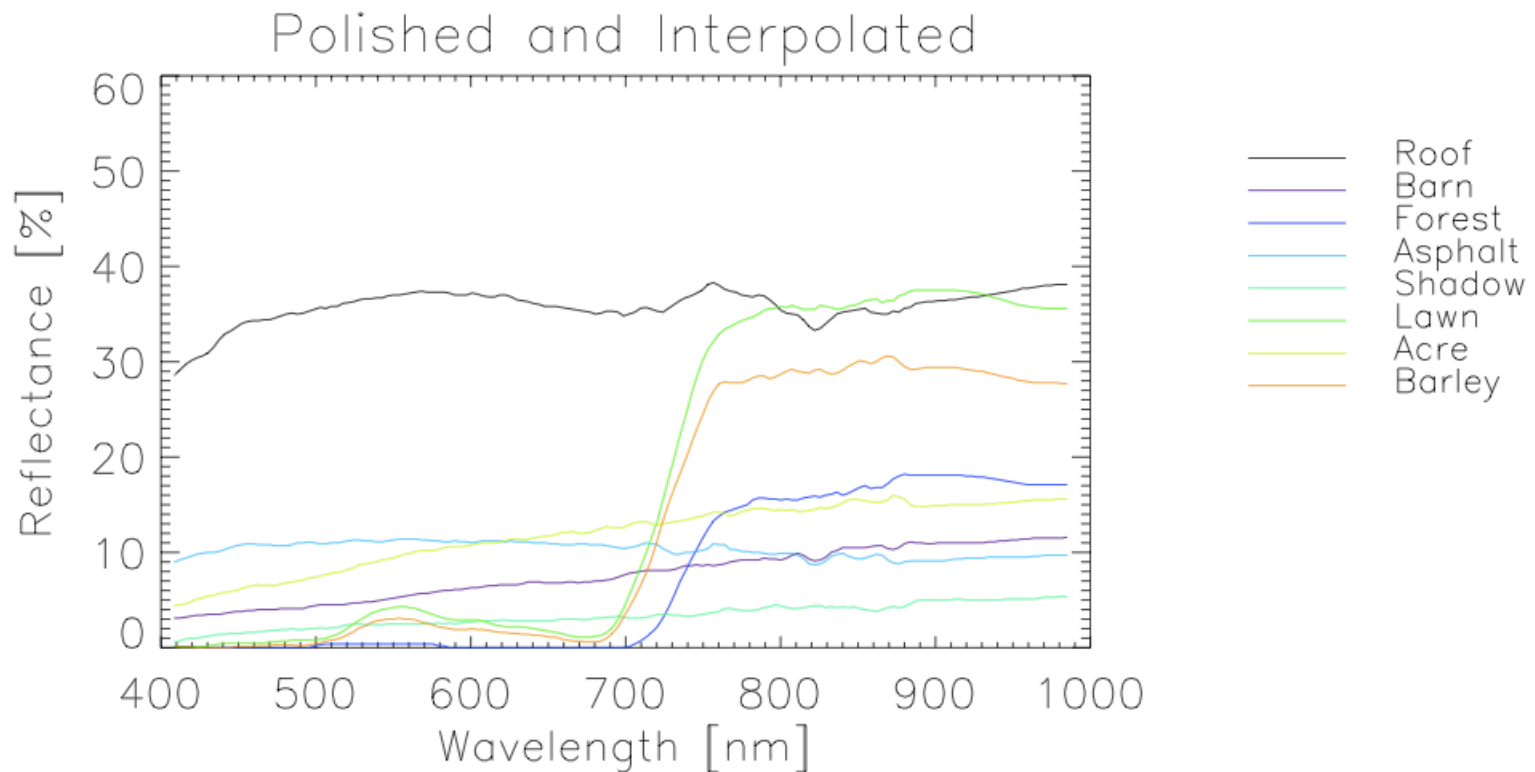
Atmospheric Compensation of Spectra (4)

Stronger Polishing (derivative filter and slight smoothing)



Atmospheric Compensation of Spectra (4)

Water vapor bands interpolation:



Implementations

Systems are evolving, some European examples of processing and archiving systems (PAFs) are (in order of appearance):

- AISA processing chain (SpecIm)
- AHS processing system (INTA SPAIN)
- HYSPEX processing chain (NEO)
- APEX processing chain (VITO/RSL)
- ENMAP processing system (DLR)

Comments:

- Systems are at various levels of operationality
- Standards are about to be established in terms of data formats and quality descriptors (EUFAR!)

Conclusions

Achievements

- The self-contained unsupervised atmospheric compensation is feasible
- Each sensor system needs initial configuration work
- Pushbroom sensor systems take advantage of new developments for the correction of spectral misregistration
- Complete surface spectra may be obtained by appropriate interpolation and filtering

Outlook

Open Challenges

- Functionality of automatic processing needs to be proven in a fully unsupervised environment.
- Increased accuracy of atmospheric parameter retrieval for meteorological applications (satellites!)
- Additional atmospheric parameters (NO_x, CH₄) to be included.
- Standard data formats and processing chains to be established.
- Correction of BRDF effects 'last' missing piece in the puzzle.

Thanks!

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