vito
vision on technology

29/04/2015

BELAIR 2015 airborne flight campaigns output

BELAIR 2015 kick-off, BelSPO, Brussels, March 20th 2015

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BELAIR

Data processing

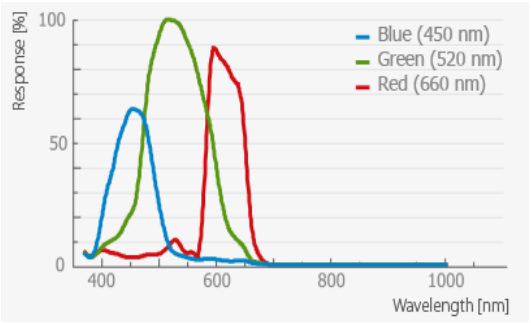
Multi-spectral (UAV): Sony NEX-6 RGB, Canon IXUS RGB/S110 RE, Multispec 4C

spatial resolution:	3 to 10 cm
spectral range:	RGB, GB+Red Edge, GB+Red Edge+NIR
spectral resolution:	coarse

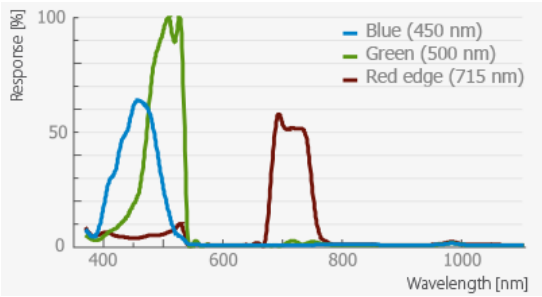
Hyper-spectral (airborne): APEX

spatial resolution:	2 to 5 m
spectral range:	380 nm – 2500 nm
spectral resolution:	5 nm (VNIR), 10 nm (SWIR)

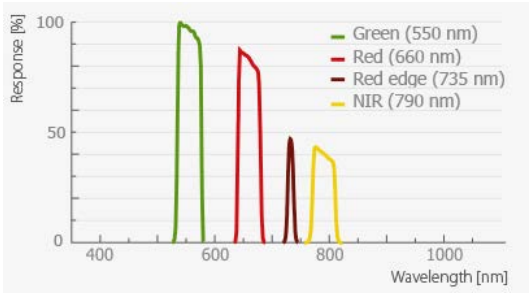
Multi-spectral data processing



Sony NEX-6 / Canon IXUS RGB



Canon S110 RE

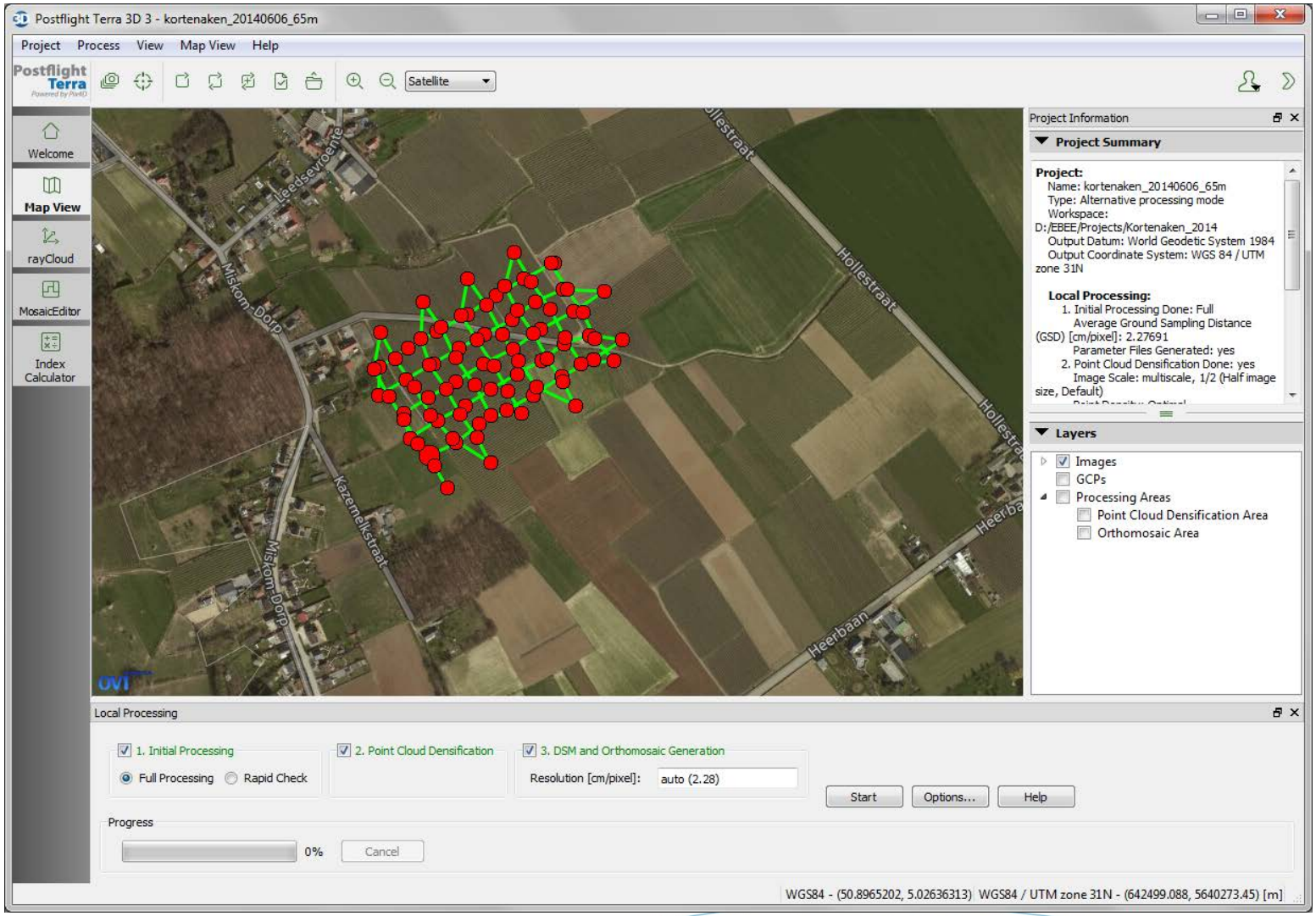


Multispec 4C

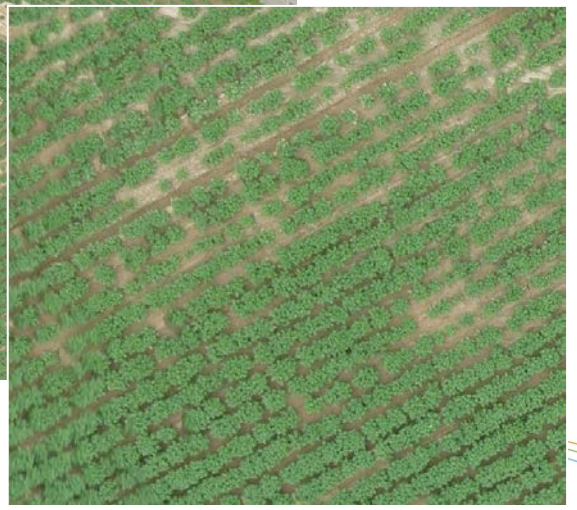
Multi-spectral data processing

- (COTS) Software:
  - Photoscan (Agisoft)
  - Postflight Terra 3D (Pix4D)
- Input
  - Raw image data
  - Raw position and orientation data
- Output
  - georeferenced orthomosaic
  - georeferenced Digital Surface Model
  - Processing Quality Report

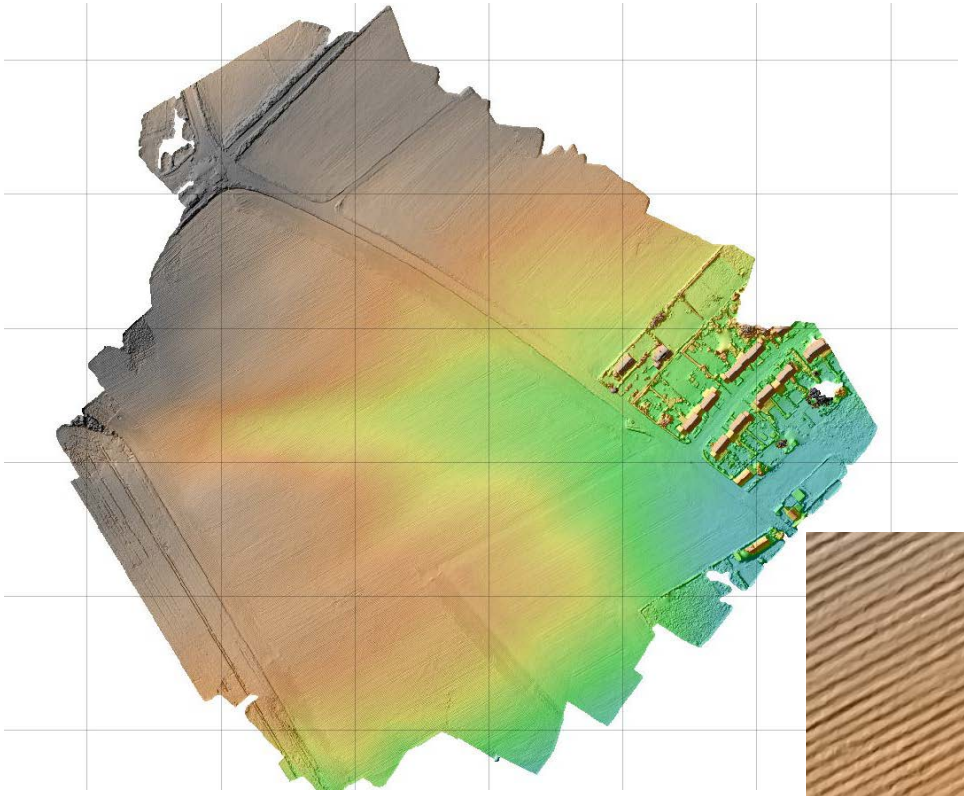
Multi-spectral data processing

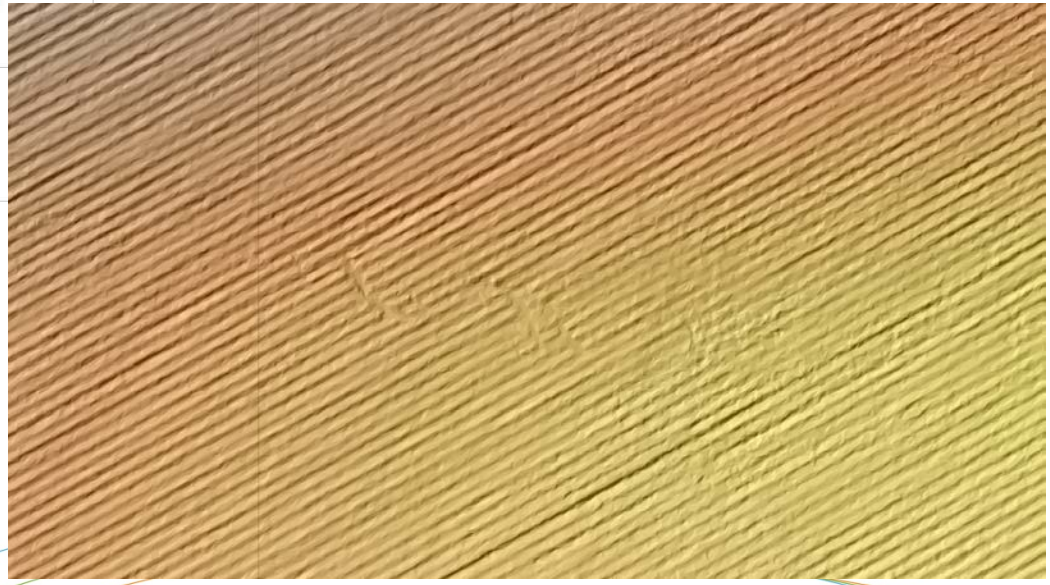


Multi-spectral data processing: ortho



Multi-spectral data processing: DSM





Multi-spectral data processing

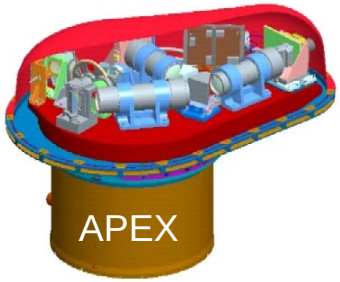
Recommendations for post-processing of UAV-data by the users

- Experience gained from DroneSed and iPot project to relate UAV imagery to physical properties of plants/water
- Pitfalls identified, processing procedures being refined:
  - Synchronization between sensor and pos system
  - Accuracy of position and orientation data
  - Effect of lens distortions
  - Radiometric calibration/normalisation of the imagery

- **ASD measurements:**
  use calibrated reference panels (white and/or grey)

- **GPS measurements:**
  Ground Control Points

Hyper-spectral data processing- overview



L0/L1 processing
Destriping

APEX PAF (RSL)

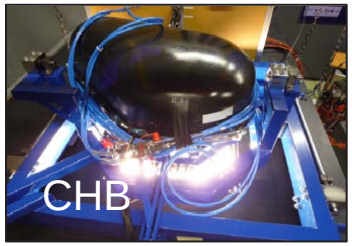
Destriped calibrated cubes
+
corresponding metadata

SBET processing

APPLANIX POSPAC

SBET

HDF5 files



APEX sensor model
APEX spectral characteristics

CDPC airborne
imagery database

CDPC L2 processing chain:
Geomodelling
Atmospheric correction
Spectral resampling
Projection

***Colibri*: spectral smoothing**

Hyper-spectral data processing

POS data processing

APEX data processing

- Raw data extraction
- Radiometric calibration
- Destriping
- Boresight calibration
- Spectral shift detection
- Data “archiving”

→ APEX L0/L1 processing

- Geometric correction
- Atmospheric correction
- Vicarious calibration
- Spectral resampling
- Spectral smoothing

→ APEX L2 processing

POS data processing

- Applanix Pospac SW
- Input =
  - raw GPS position data (X,Y,Z),
  - raw IMU orientation data (roll, pitch, yaw=true heading)
  - gimbal data from stabilized mount
  - GPS base station data for the time frame of the flight
  - Installation parameters, i.e. lever arms and mounting angles
- Output =
  - SBET-file, i.e. Smoothed Best Estimated Trajectory

⟹ ***providing position (X,Y,Z) and orientation (R,P,Y) parameters for every scanline in the APEX images***

- Boresight calibration:
  correct for misalignment angles between sensor and IMU coordinate system

⟹ ***providing boresight angles $\triangle R$, $\triangle P$ and $\triangle Y$***

Hyper-spectral data processing

POS data processing

APEX data processing:

- Raw data extraction
- Radiometric calibration
- Destriping
- Boresight calibration
- Spectral shift detection
- Data “archiving”

→ APEX L0/L1 processing

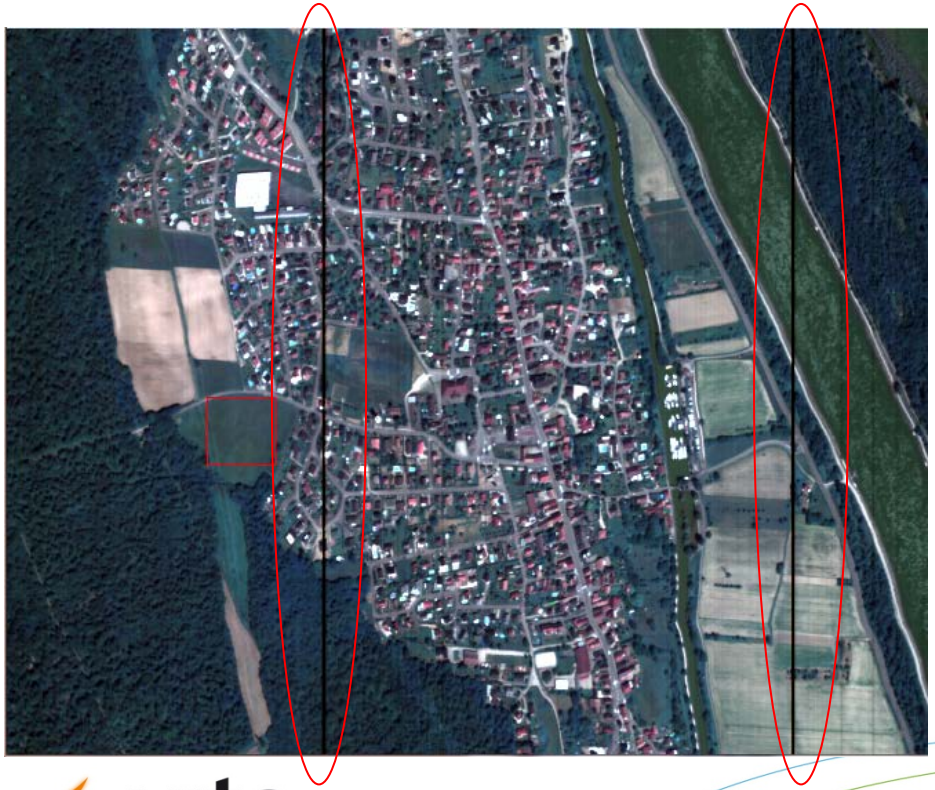
- Geometric correction
- Atmospheric correction
- Vicarious calibration
- Spectral resampling
- Spectral smoothing

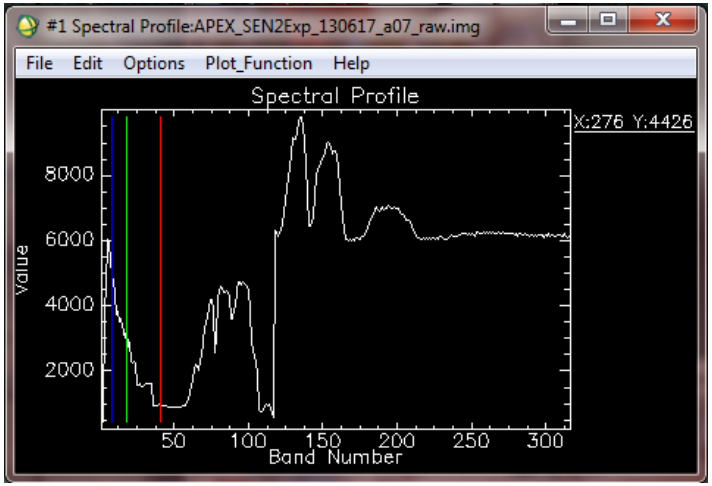
→ APEX L2 processing

APEX – L0 processing

Mission *.tar → **APEX PAF:** Level 0 →

Raw image cubes (DNs)
Raw quicklooks (black wires)
Housekeeping data (UTC of each scanline)
Dark Current data





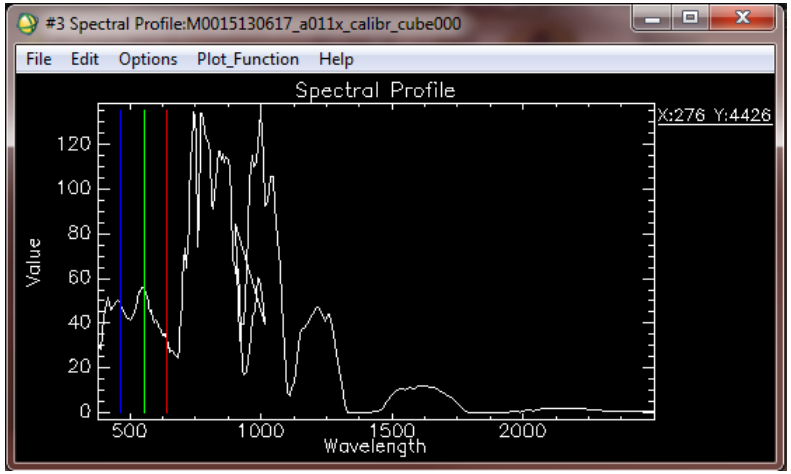
APEX – L1 processing

Radiometric calibration, incl wire pixel replacement

Raw image data (DNs)
Dark Current data
+
Calibration cubes (yearly CHB campaign)

→ **APEX PAF:** Level 1 →

At-sensor Radiance cubes (mW/m2/nm/sr)

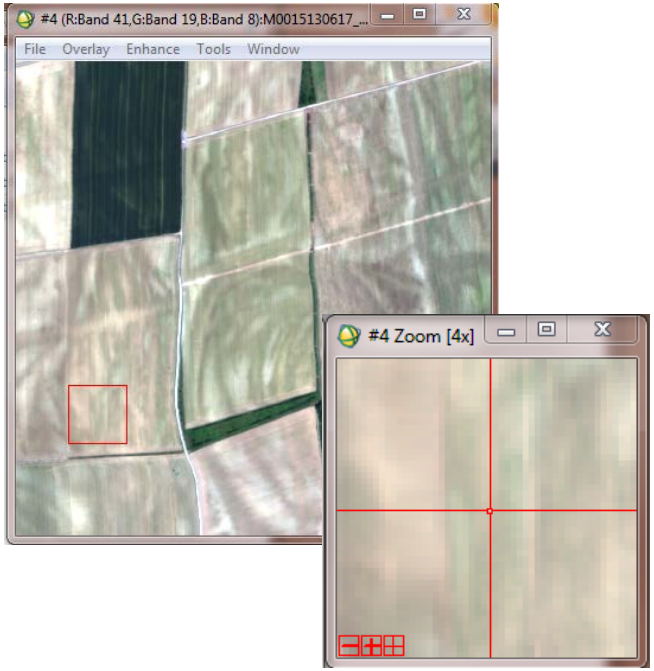


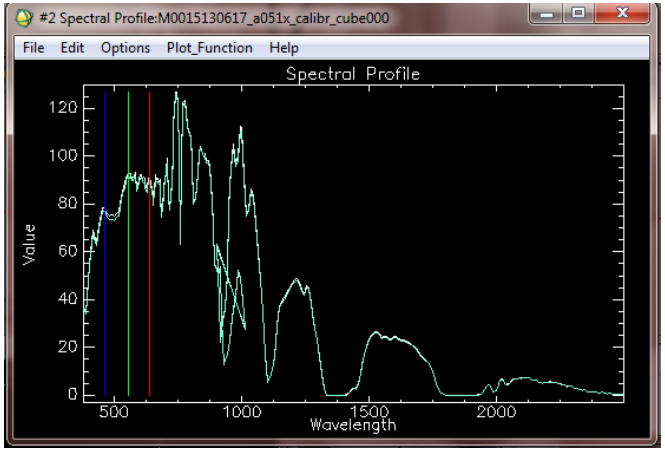
APEX – Destriping

At-sensor Radiance cubes
(mW/m2/nm/sr)

APEX PAF:
Destripe

Destriped
at-sensor Radiance cubes
(mW/m2/nm/sr)



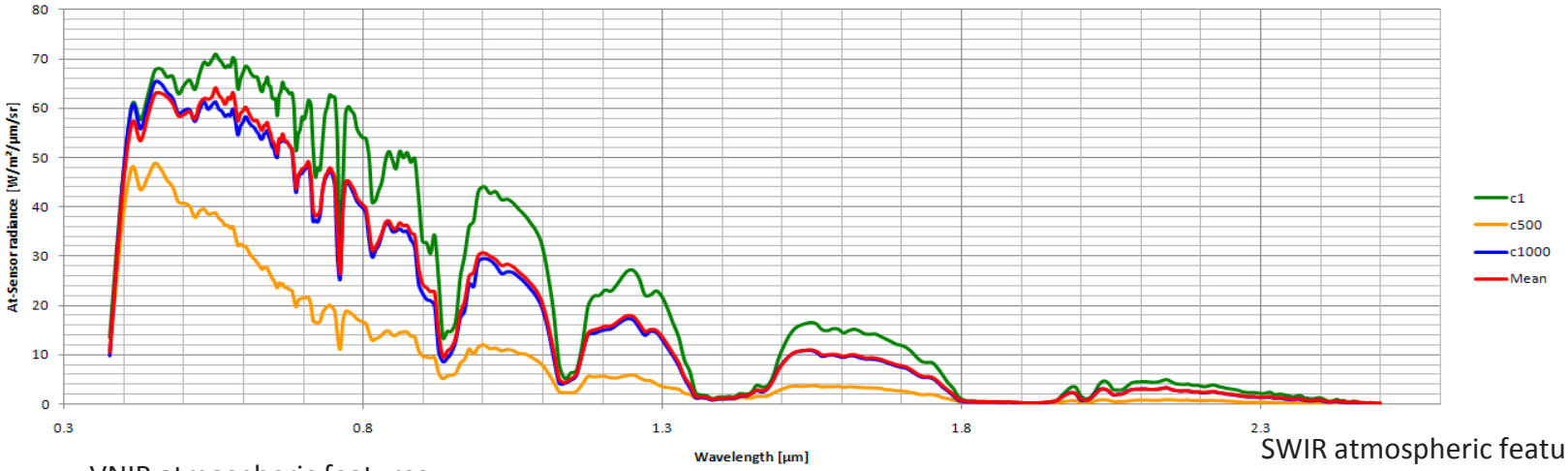


APEX – spectral shift detection

APEX suffering from spectral shifts during flight, shifts depend on flying height/pressure/temperature

During the archiving process, an automatic spectral shift detection is performed, which is:

- radiance-based (Gao *et al.,* 2004), i.e. a spectrum-matching technique applied on the at-sensor radiance
- using a set of atmospheric absorption features



VNIR atmospheric features

- NO2 at 430 nm
- O2 at 687 nm
- O2 at 762 nm
- H2O at 815 nm
- H2O at 935 nm

SWIR atmospheric features

- H2O at 935 nm
- H2O at 1137 nm
- CO2 at 2007 nm
- CO2 at 2060 nm
- CH4 at 2210 nm
- CH4 at 2415 nm

APEX - data archiving

- Create HDF5 file, containing:
  - At-sensor radiance data
  - Sensor metadata:
    - Sensor spectral characteristics (incl shift parameters)
    - Sensor geometry
    - Sensor exterior orientation (POSdata for each scanline)
    - Additional (quality) information
- Register HDF5 file in the Central Database, so it becomes available for further processing in VITO's Central Data Processing Center (CDPC)

Note that:

- Flight lines are cut in image parts of 3000 scan lines to ease file handling
- Overlap of 200 scanlines for adjacent image parts

Hyper-spectral data processing

POS data processing

APEX data processing:

- Raw data extraction
- Radiometric calibration
- Destriping
- Boresight calibration
- Spectral shift detection
- Data “archiving”

→ L0/L1 processing

- Geometric correction
- Atmospheric correction
- Vicarious calibration
- Spectral resampling
- Spectral smoothing

→ L2 processing

APEX – Geometric correction

- Performed automatically in CDPC, using custom VITO software
- Direct Georeferencing, ortho production through forward projection using X,Y,Z,R,P,Y values originating from the SBET files, boresight angles, sensor model and DTM/DSM
- Resampling to a user-specified output projection system:
  - geographic coordinate system
  - UTM
  - Lambert72
  - …
- Digital Elevation Models:
  - Flanders: AGIV LIDAR DTM @ 5m resolution
  - Europe: ASTER DTM @ 30m resolution
SRTM DTM @ 90m resolution
  - **User DTM/DSM** **@ higher resolution**

APEX – Atmospheric correction

- Performed automatically in CDPC, using custom VITO software (MODTRAN based, fully configurable)
- 'Smile aware' atmospheric correction, using different wavelengths for the across track pixels

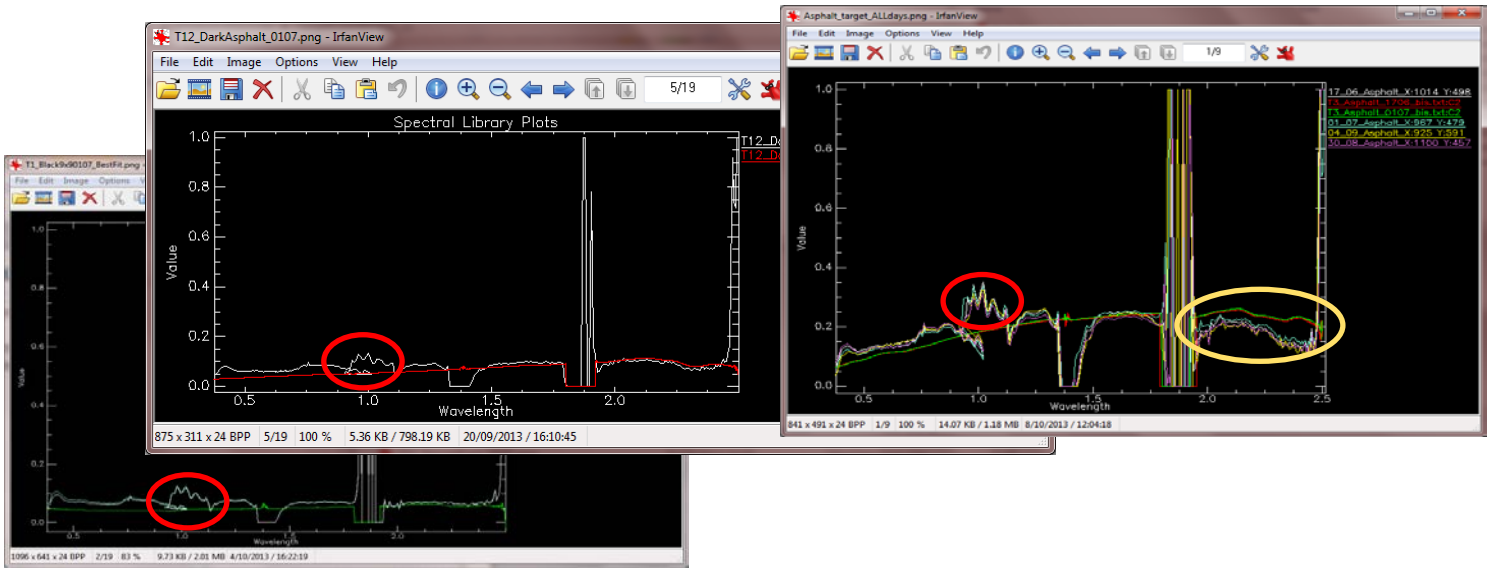
- **Sun photometer measurements**
  provide initial values for the correction parameters (Water Vapor, Visibility, aerosol type)

- **ASD measurements**
  provide reference target spectra for validation:
  - **homogeneous targets**
  - **size at least 5x5 pixels**
  - **lambertian**
  - **bright & dark**

APEX – Vicarious calibration

BelAir 2013 campaign:

- vicarious calibration applied on the APEX data, based on ASD measurements



BelAir 2015 campaign:

- APEX radiometric calibration software extensively reworked/enhanced (RSL)
- need for vicarious calibration to be evaluated, **not applied anymore by default**

APEX - Spectral resampling/smoothing

Atmospheric correction = smile-aware, i.e. resulting reflectance cubes all have slightly different wavelenghts for the bands

- Spectral resampling to the wavelength of the central pixel, as measured during the sensor spectral calibration on the Calibration Home Base (CHB)

After atmospheric correction some noise and spikes remain, in particular around the absorption regions of the atmospheric features

- Wavelength dependent spectral smoothing is performed to remove them

Ground teams: data to be collected

- Sunphoto-meter data
  - Atmospheric correction configuration (APEX)
- ASD data
  - Atmospheric correction validation (APEX)
  - Radiometric calibration/normalisation of imagery (UAV)
- GPS/GCP data
  - Improve geolocation accuracy (UAV)

Thanks for your attention!