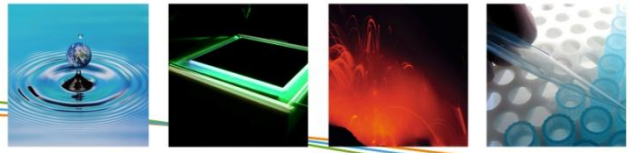
vito
vision on technology



APEX and LiDAR remote sensing supporting fine-scale forest management

Pieter Kempeneers (VITO)
Luc Bertels (VITO)
Flore Devriendt (University Ghent)
Frieke Van Coillie (University Ghent)
Kris Vandekerckhove (INBO)

Objectives

- Hyperspectral data
  - Potential for forestry: tree species mapping
  - Limitations: poor tree delineation, forest structure (tree heights, understorey,…)
- LiDAR data
  - Potential for forestry: tree delineation, forest structure, understorey,…
- Combining hyperspectral and LiDAR: data fusion
  - Improved hyperspectral pre-processing using LiDAR data
  - Improved forest parameter retrieval (tree heights, stem density)
  - Tree species mapping using combined LiDAR and hyperspectral data (todo)

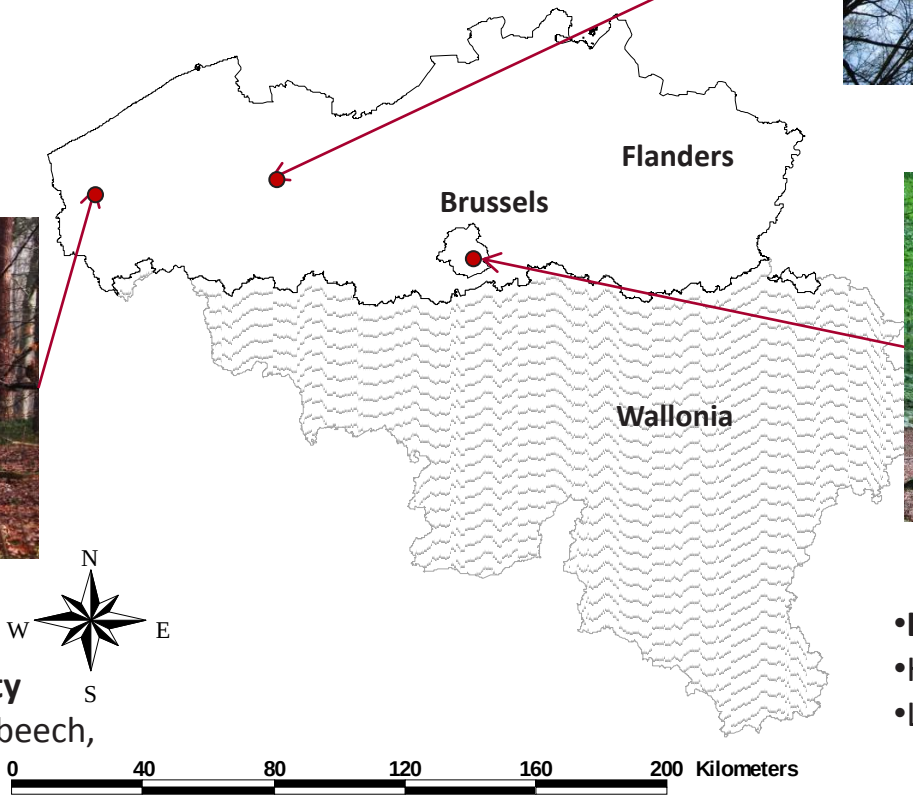
Study area

Aelmoeseneiebos

- **High structural complexity**
- mixed oak, beech, ash and larch stand
- rich understorey

Wijnendalebos

- **Medium structural complexity**
- Mixed oak forest with maple beech, larch, hazel,…



Kersselaerspleyn

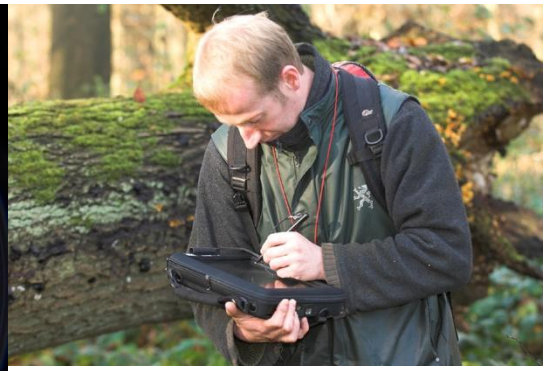
- **Low structural complexity**
- Homogeneous old beech stands
- Limited admixture of oak

Available data

- Field measurements
  - Tree species, heights, stem density,...
- LiDAR
  - Riegl LMS Q560 full waveform
    - Wavelength: 1560 nm
    - point density > 10 points/m^2
- Hyperspectral data

Sensor	Spectral resolution	Spatial resolution
CASI	96 bands (368-1052 nm)	1 m
AHS	63 bands (452-2552 nm)	5 m
APEX	301 bands (375-2500 nm)	1.5 m

Field measurements



Full dendrometric inventories

- tree position;
- species
- DBH all trees > 5 cm diameter;
- tree heights all trees upper canopy

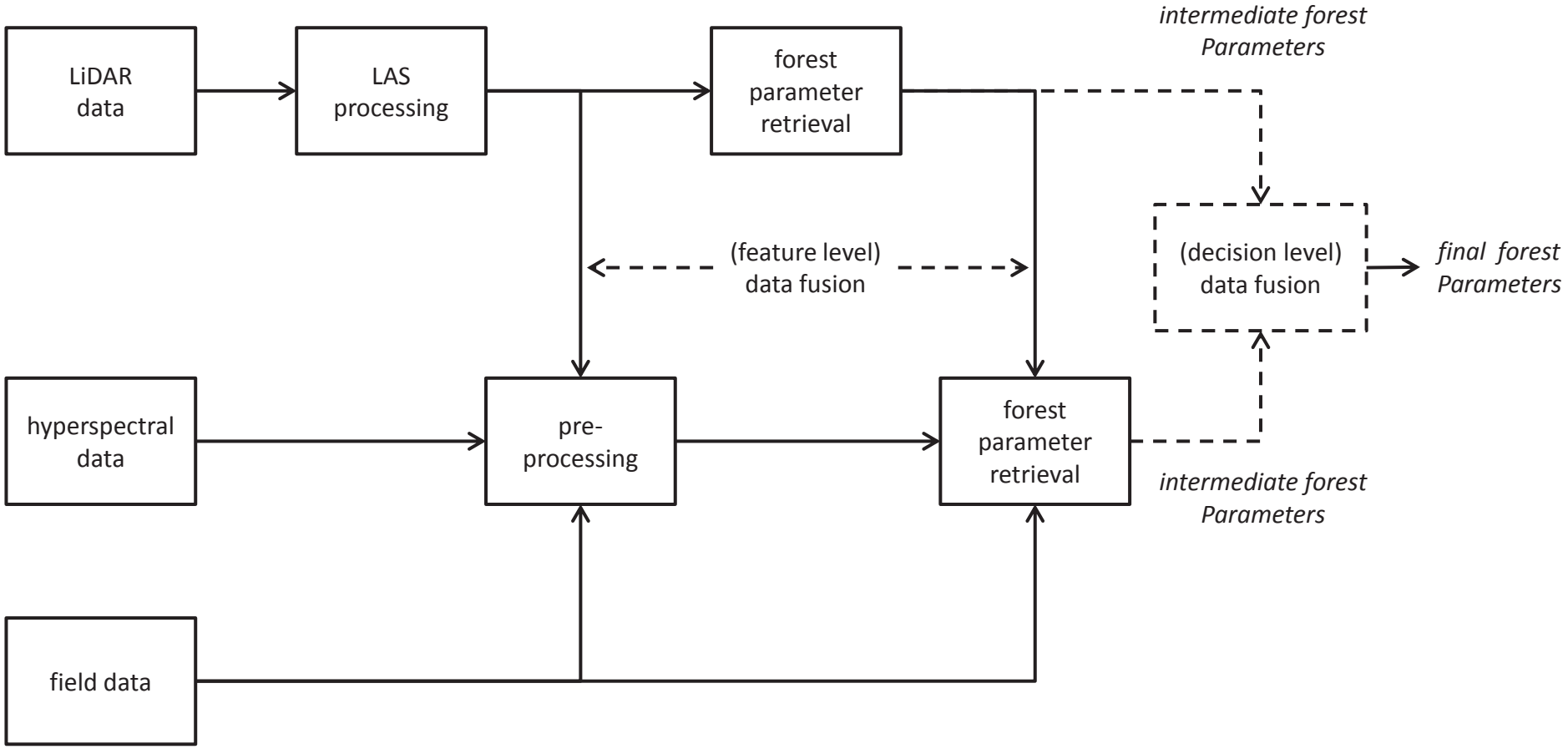
Canopy gaps

- hemispheric photos

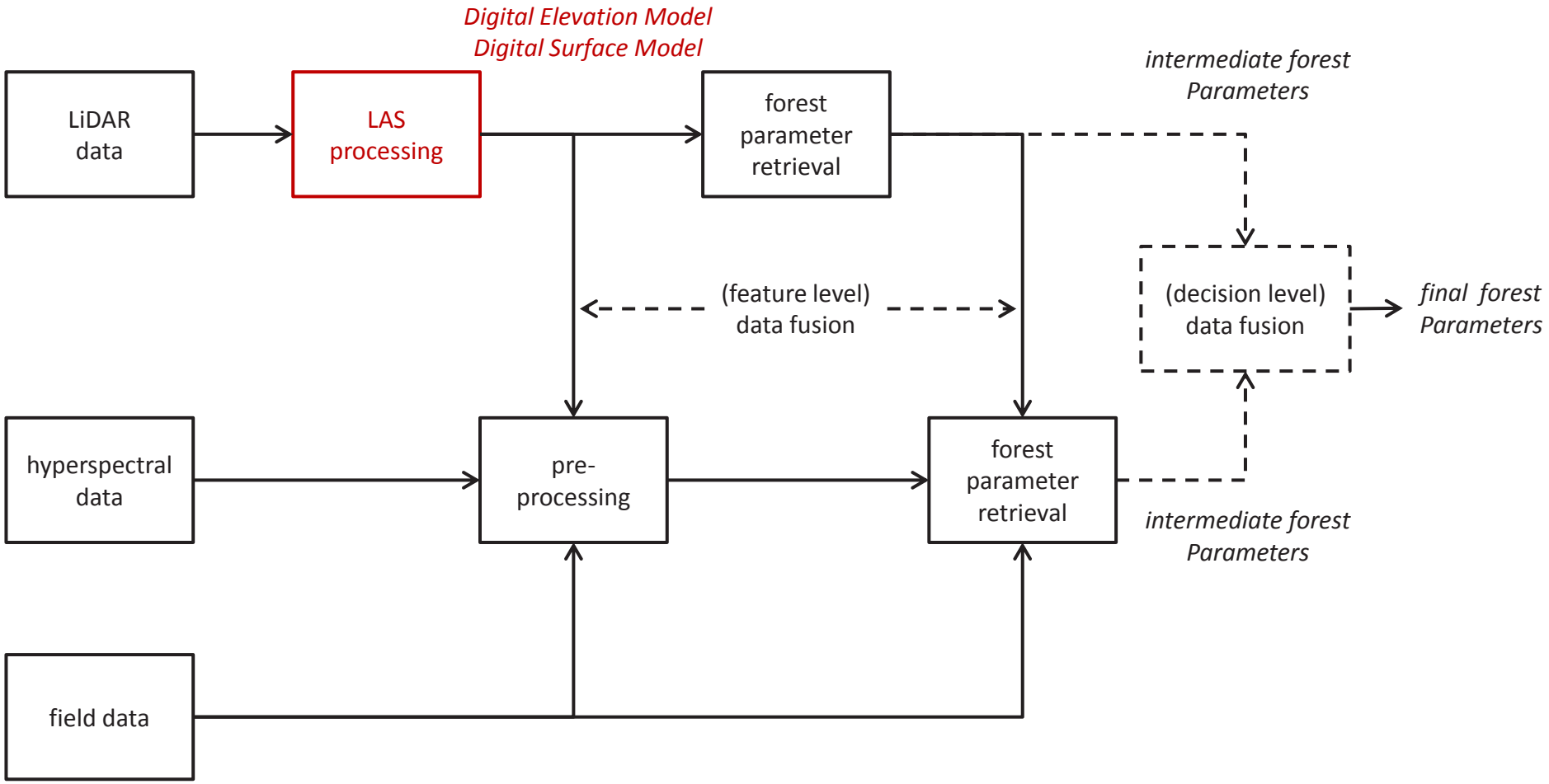
Tree vitality

- On a selection of trees : evaluation of discoloration and leaf loss (international methodology for level I forest vitality evaluation).

Methods



LAS processing



LAS processing

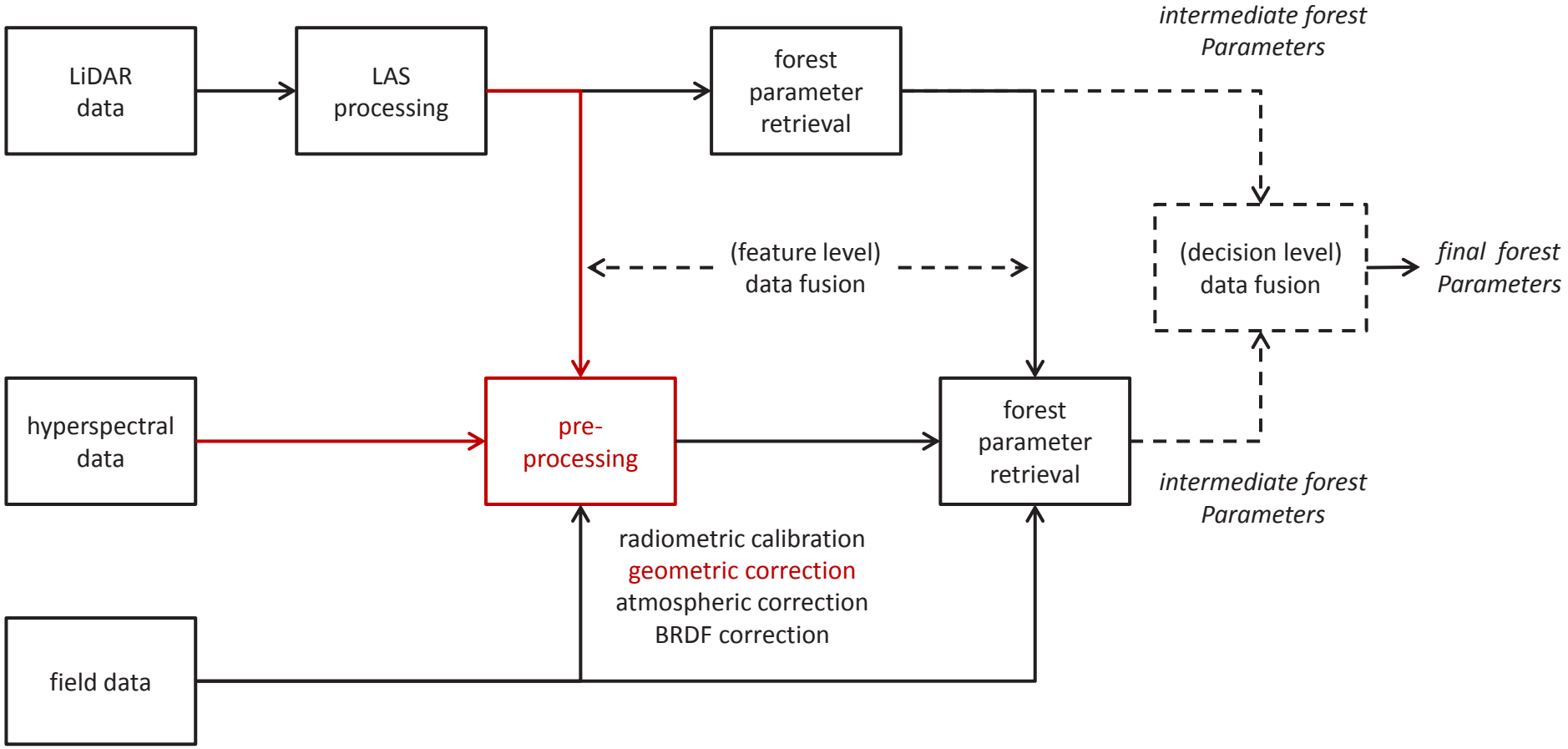
- Producing:
  - Digital terrain model
    - according to Zhang, C. 2003[1]
    - fill holes (weighting proportional to inverse distance)
  - Digital surface model
    - Based on maxima in LAS file
    - Morphological closing filter (3x3)

[1] Zhang, C. (2003). A progressive morphological filter for removing nonground measurements from airborne LiDAR data. IEEE Transactions on Geoscience and Remote Sensing, 41(4), 872-882

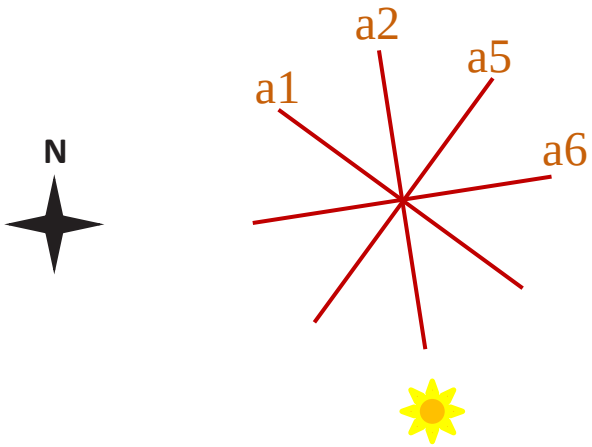
Results LAS processing: digital terrain model

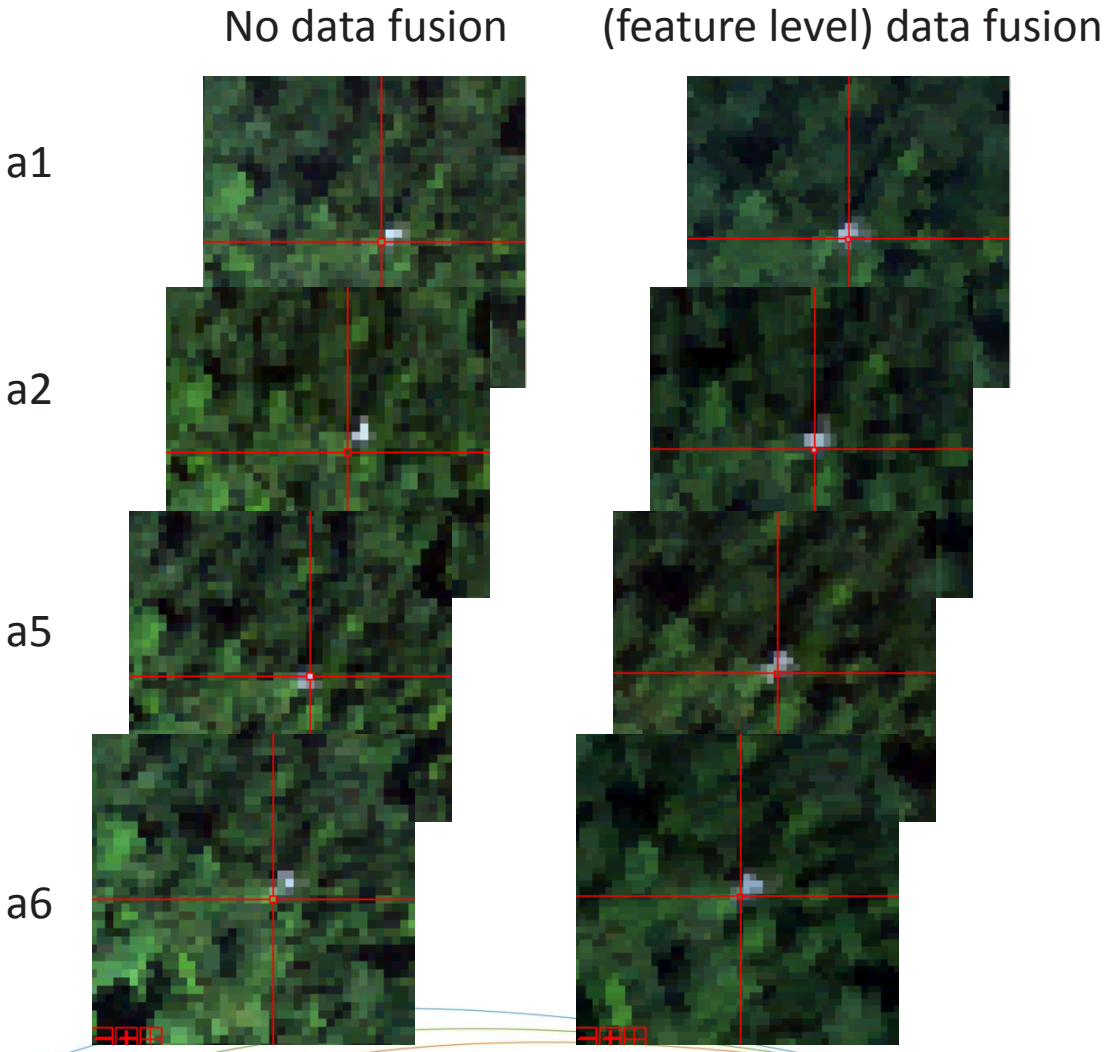
Results LAS processing: digital surface model

Results: geometric correction

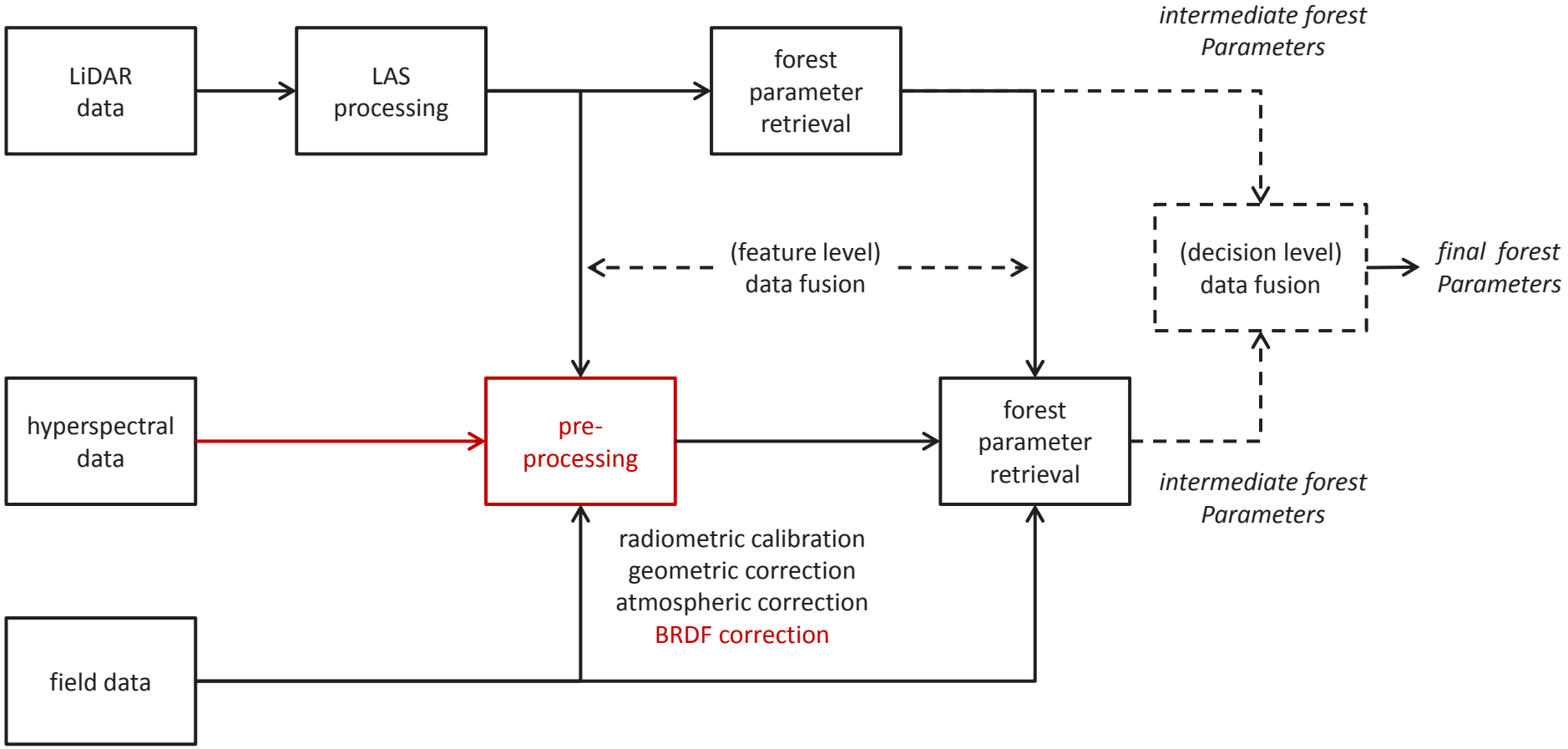


Results: geometric correction





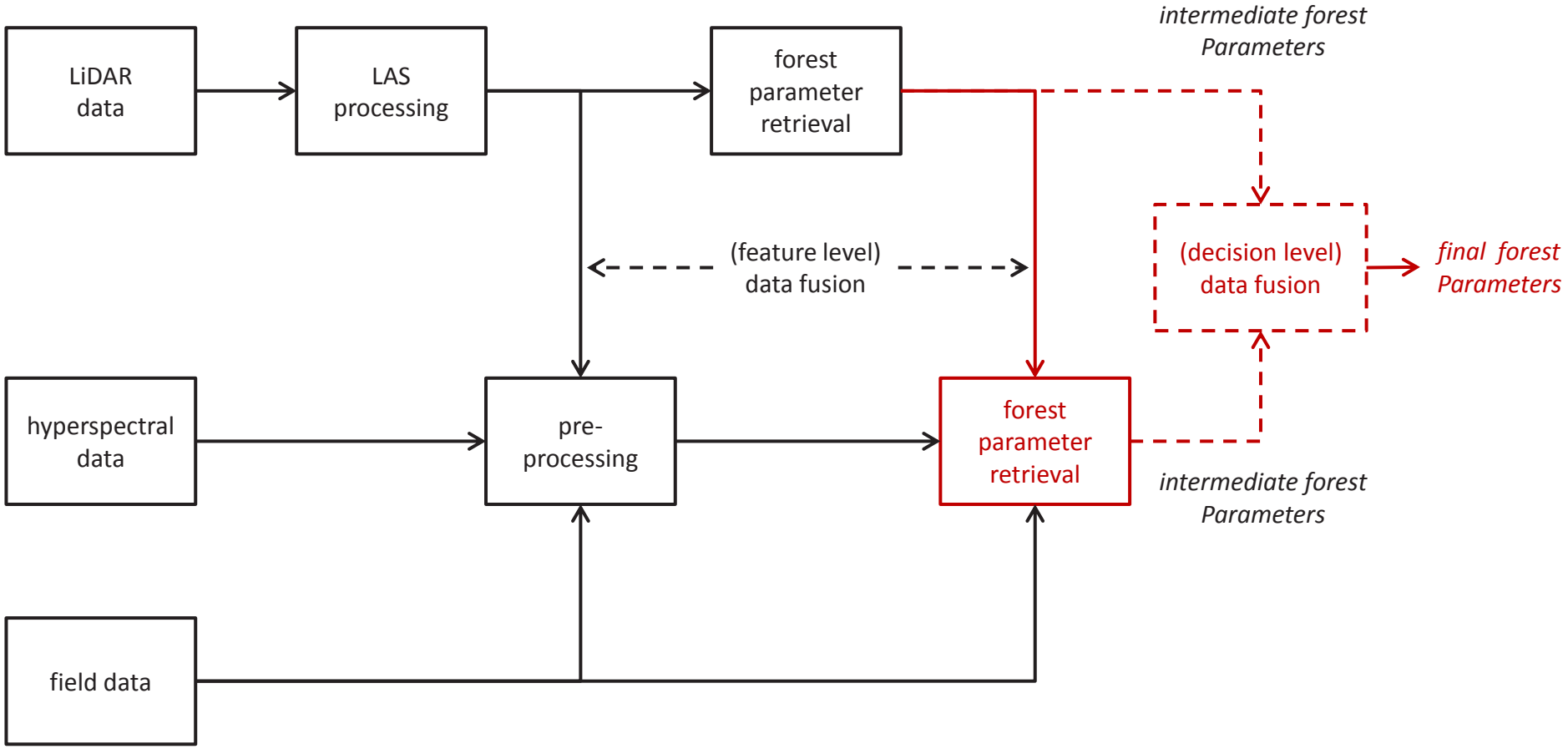
Results: BRDF correction



Results: BRDF correction

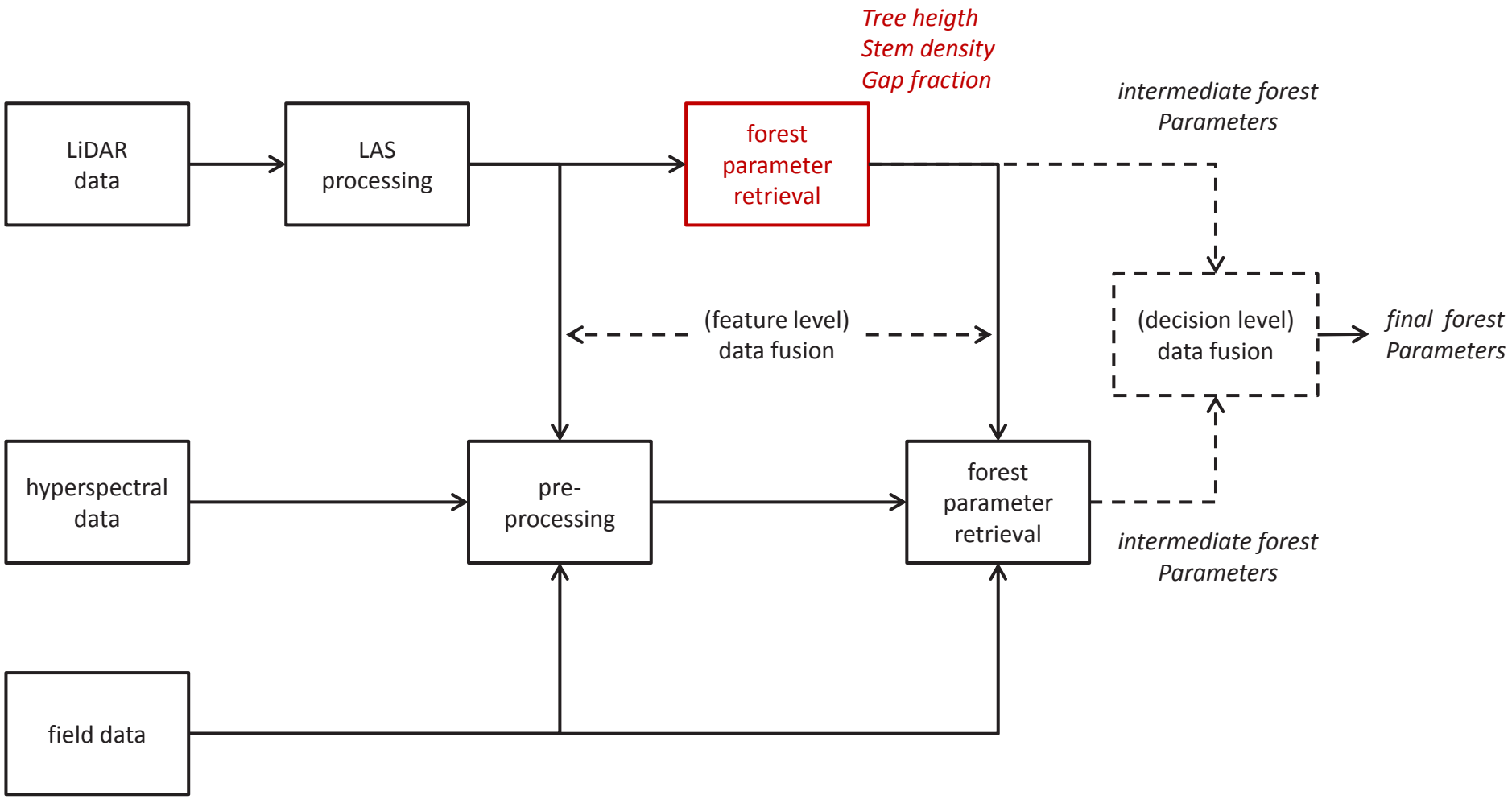
test image (not APEX)

Future work



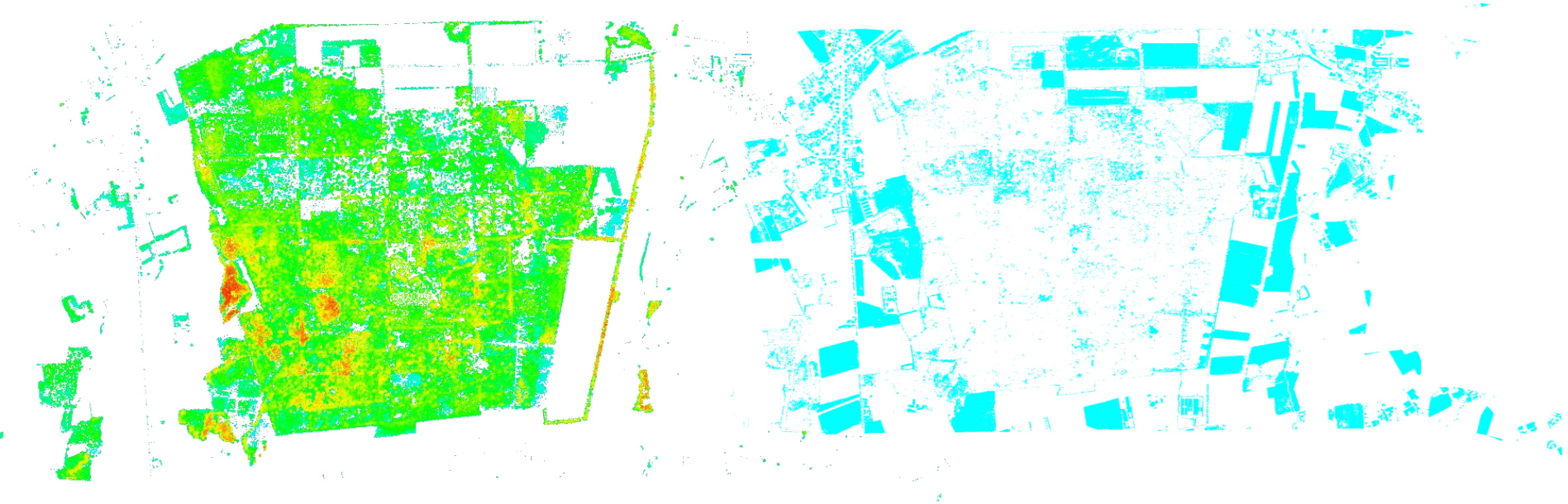
Forest parameter retrieval from LiDAR

(BEO - day presentation)



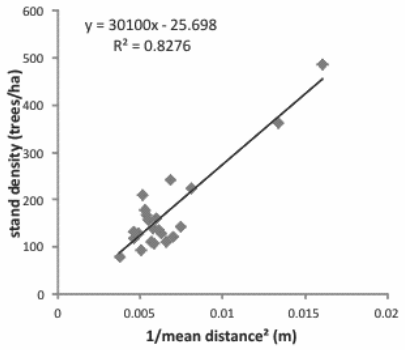
Tree height

Gap fraction

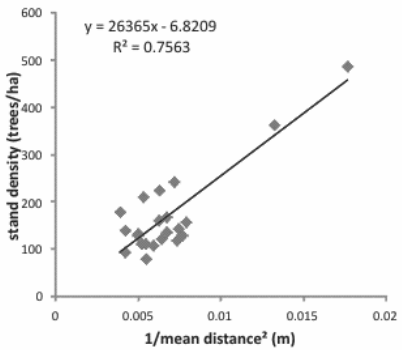


Stem density

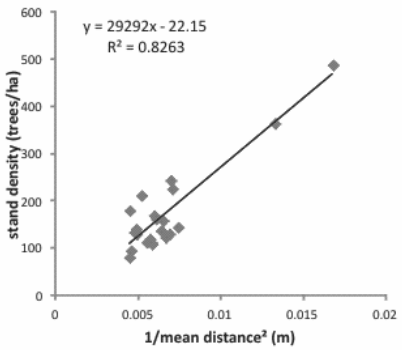
DLF parallel



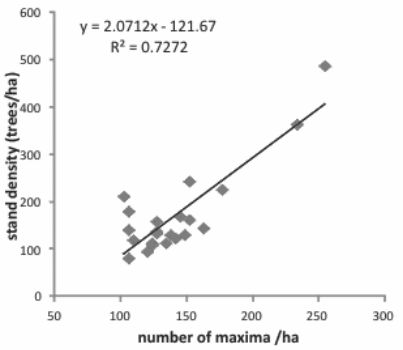
DLF perpendicular



DLF parallel +perpendicular



LMF

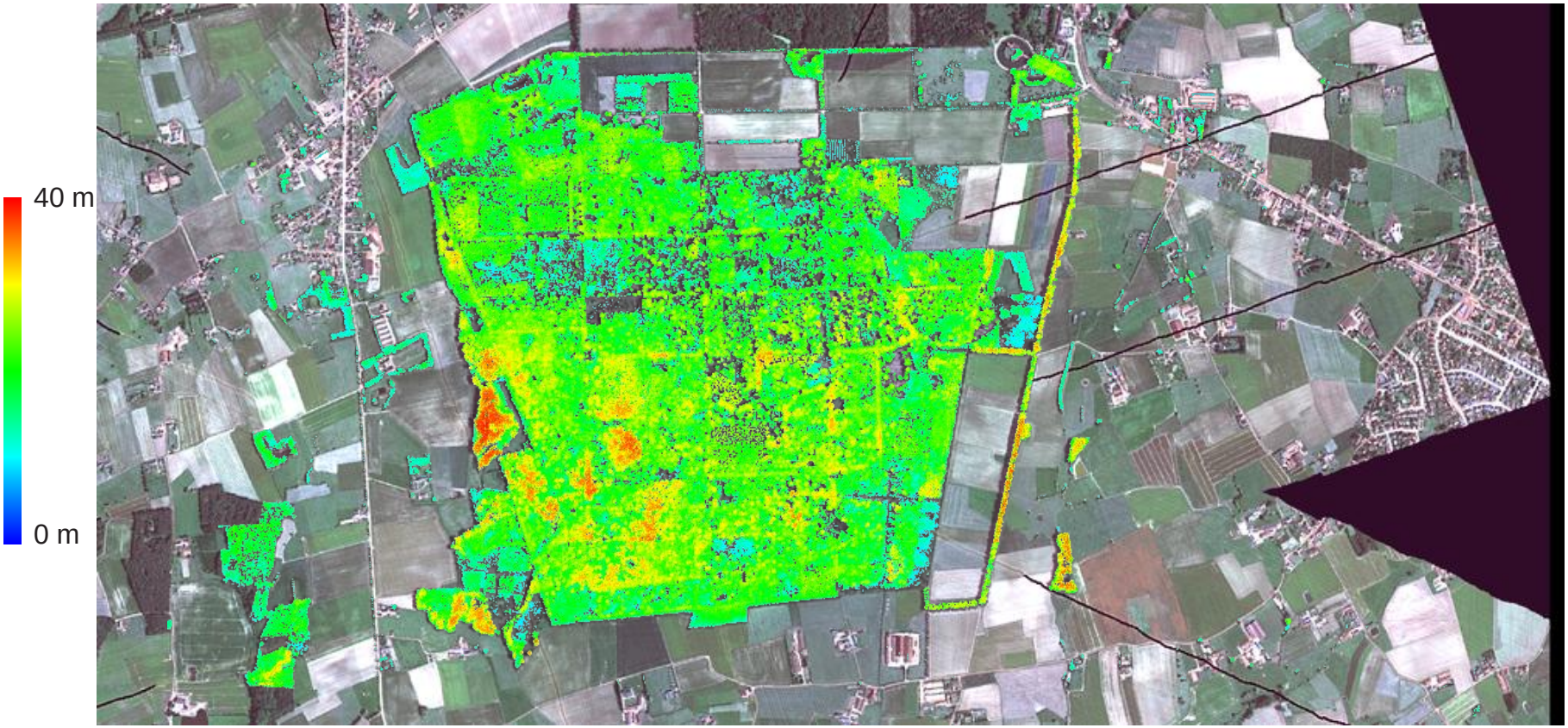


vito
vision on technology

Results: hyperspectral

RGB: True colour APEX image

Results: hyperspectral + LiDAR



Vegetation height model

RGB: True colour APEX image

vito
vision on technology

Conclusions

- Preliminary results show potential of data fusion
  - Improved hyperspectral pre-processing using LiDAR data
  - Potential of LiDAR data for forest parameter retrieval
    - Tree heights, stem density (Beoday)
- Next steps: tree species mapping using combined LiDAR and hyperspectral data

pieter.kempeneers@vito.be