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UAS LiDAR Height, Density, and Intensity Parameters and Multispectral Reflectance in Artificial Neural Networks (ANN) for Winter Wheat Biomass Estimations Over a Growing Season

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Introduction

- Use of UAS multispectral sensors when estimating biomass or other agricultural metrics, although good at indicating plant health, are victim to saturation effects providing less insight on the spatial variability.
- LiDAR provides information on the plant structure throughout the vertical extent of the canopy and is not impacted by issues of omission from shadowing.
- This study looks into combining different products from these sensors to find the best estimation of biomass for winter wheat throughout a growing season.

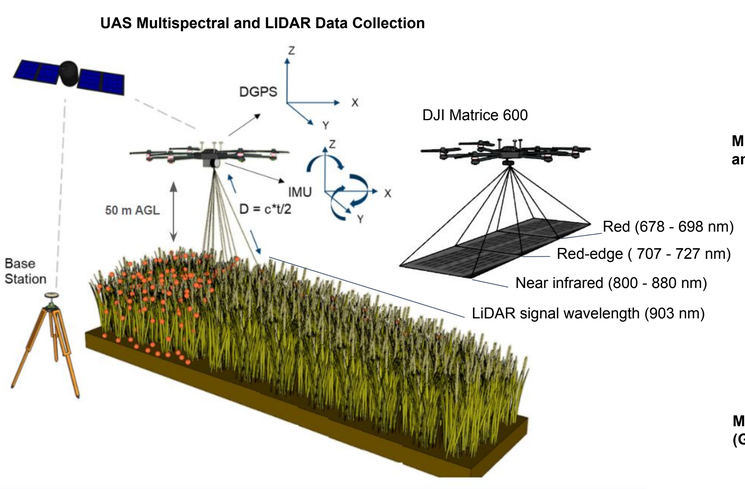
Study Area & Experimental Design

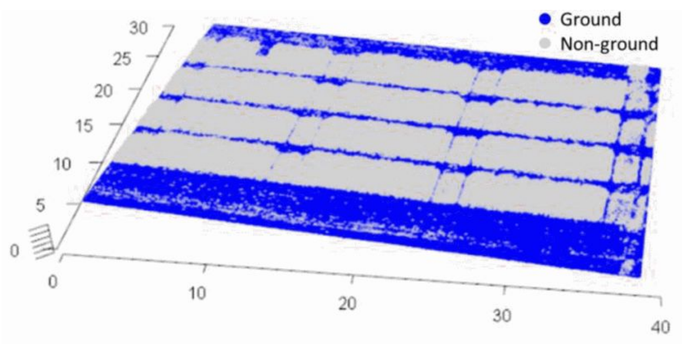
- Winter wheat experiment (CKA PhenoRob central experiment site, Germany) consisting of 12 plots and 72 subplots.
- Destructive measurements taken from 10 different subplots each flight campaign

Methods

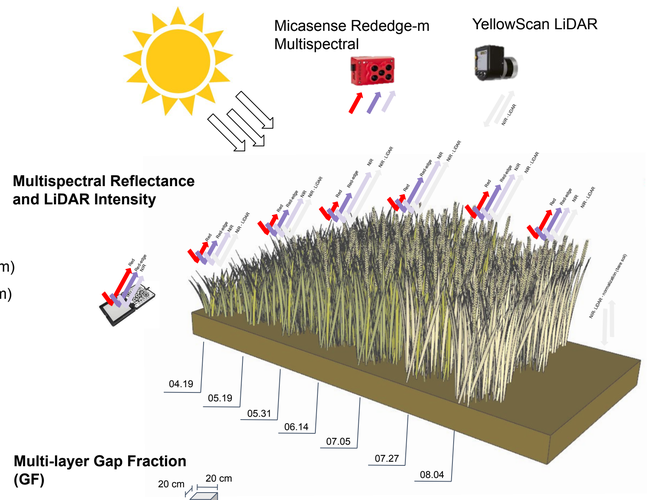
TSEB-PT Model

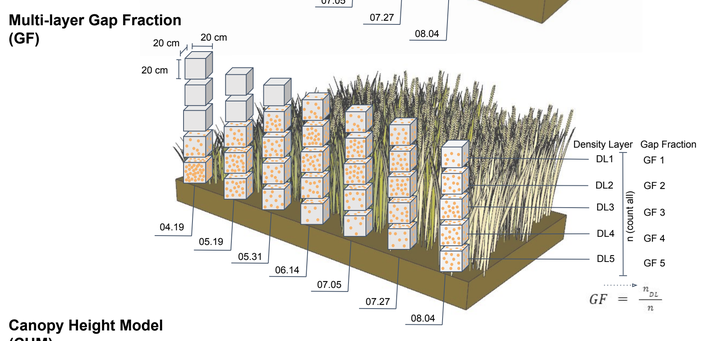
UAS Data Collection

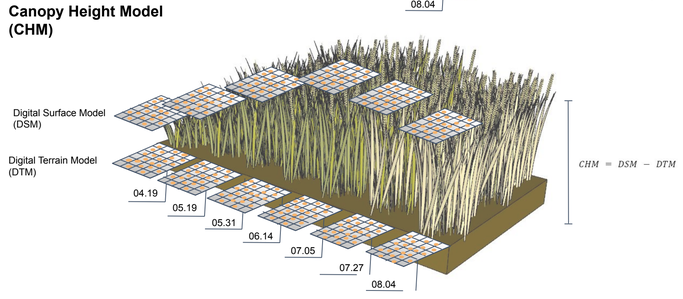


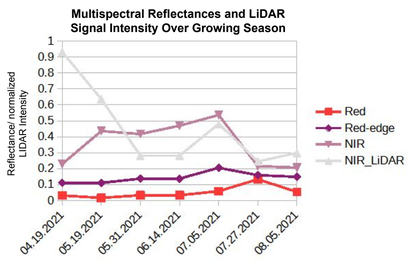


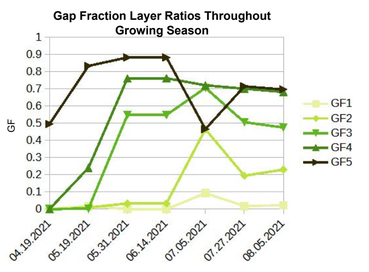
Derived UAS Data Products

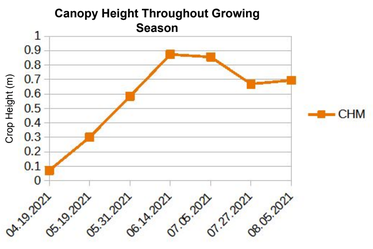




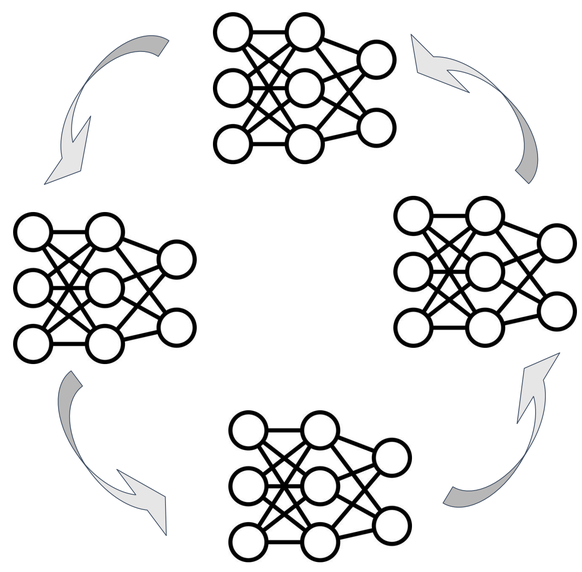






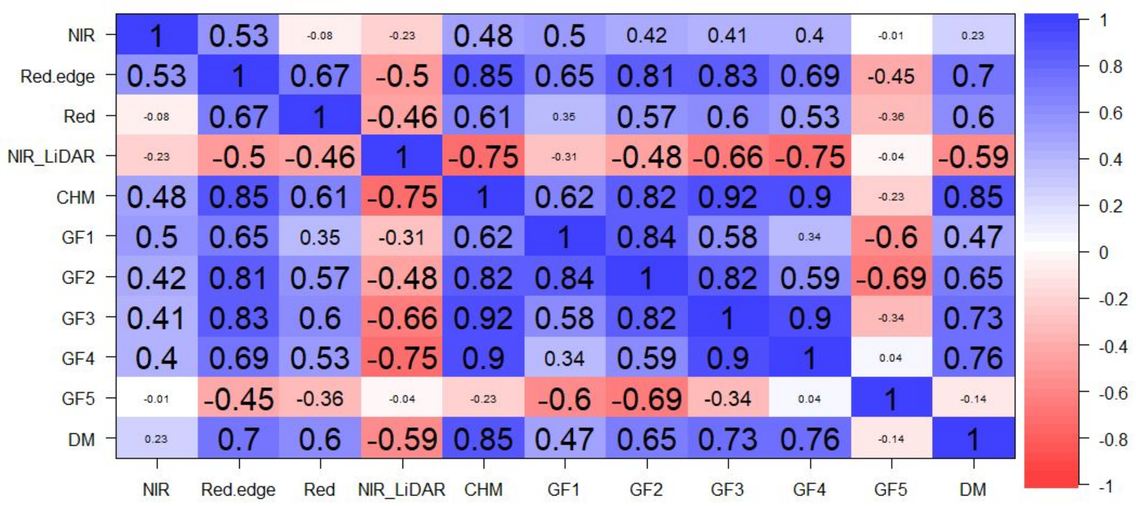


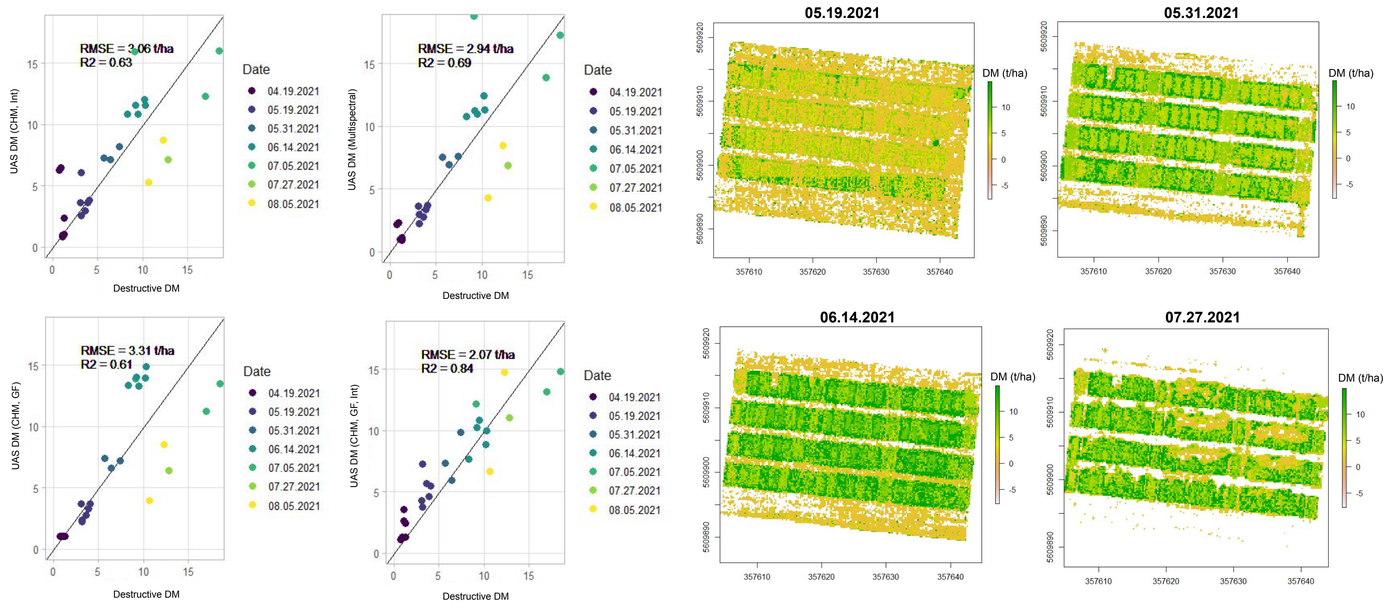
Artificial Neural Network



- All derived UAS sensor products in different combinations plugged into artificial neural networks for best predictors of biomass.
- LiDAR:
  - canopy height model (CHM)
  - Signal Intensity
  - Multi-layer gap fraction (5 x 20cm layers)
- Multispectral bands:
  - red
  - red-edge
  - near infrared (NIR)

Results





Related Work

(1) Bates, J. S., Montzka, C., Schmidt, M., & Jonard, F. (2021). **Estimating Canopy Density Parameters TimeSeries for Winter Wheat Using UAS Mounted LiDAR**. Remote Sensing, 13(4), 710.

(2) Bates, J., Jonard, F., Bajracharya, R., Vereecken, H., and Montzka, C.: **Machine Learning with UAS LiDAR for Winter Wheat Biomass Estimations**, AGILE GIScience Ser., 3, 23.

(3) Montzka, C.; Donat, M.; Raj, R.; Welter, P.; Bates, J.S. **Sensitivity of LiDAR Parameters to Aboveground Biomass in Winter Spelt**. Drones 2023, 7, 121.

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