Distributed Systems and Remote Sensing

Towards in-situ Sensor Network assisted Remote Sensing of Crop Parameters

— Precision Farming —

UNIVERSITÄT OSNABRÜCK

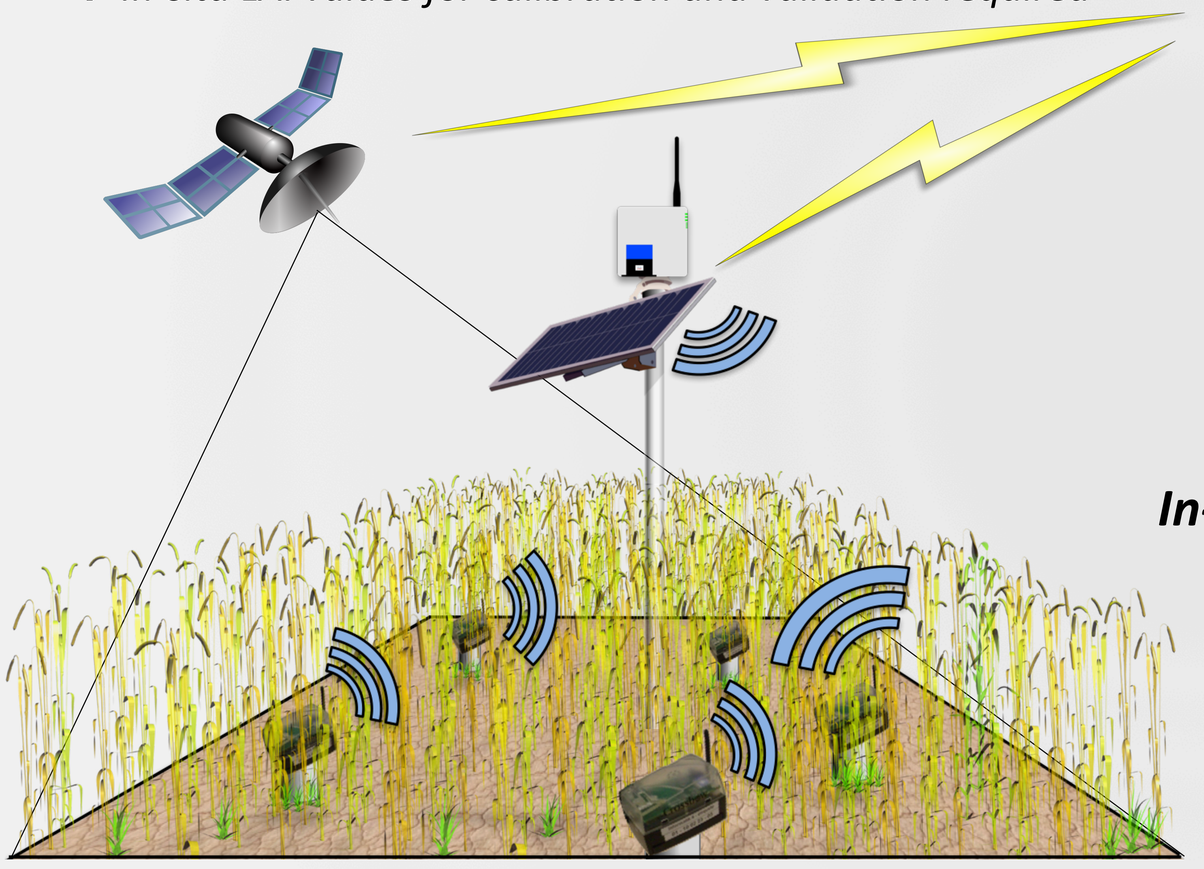
Jan Bauer, Bastian Siegmann, Thomas Jarmer, Nils Aschenbruck

Motivation

Remote Sensing data acquired from satellites are a vital information source for precision agriculture to assess current crop conditions allowing to increase the efficiency of agricultural management and the accuracy of yield models.
In this context, the Leaf Area Index (LAI) is one of the most important plant parameters and serves as a valuable indicator for the photosynthetical performance of vegetation. LAI estimates can be derived by air- and spaceborne multi- and hyperspectral imagery using different approaches and models. For the calibration and validation of these models, a ground-based in-situ LAI assessment is highly demanded. However, traditional LAI measurements are very cost and labor intensive and have limited temporal availability.

LAI Assessment via Remote Sensing

- *Radiative transfer models (e.g., PROSAIL)*
- *Empirical-statistical regression models*
  → In-situ LAI values for calibration and validation required



Joint LAI Assessment

Linking Remote Sensing with in-situ Measurements

Parameter Maps

- *Site-specific agricultural management (e.g., fertilization, irrigation, plant protection)*
- *Yield modeling*

In-situ LAI Assessment using Wireless Sensor Networks

- *Plurality of low-cost, low-power, wireless, and small devices*
  → WSNs tailored for monitoring applications
- *Limited sensing accuracy is compensated by large number of collaborating devices*
- *Enabling high spatio-temporal resolution*
- *Synchronized measurements*
- *Reducing time and acquisition costs*

Our WSN approach [1]

Monsi-Seaki model:
radiation interception by canopy

$$L = -\omega \cdot ln\left(\frac{\overline{B}}{\overline{A}}\right)$$

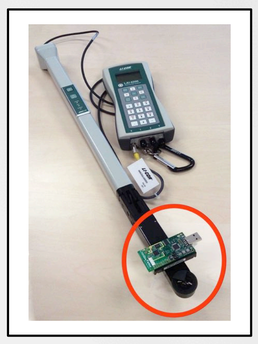
- *LAI estimation based on transmittance measurements*
- *Distributed PAR sensors: above (A) and below (B) canopy*

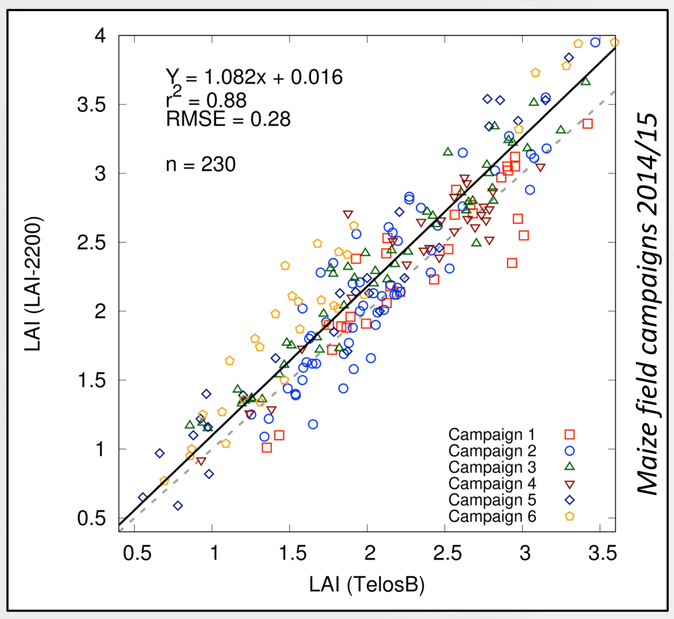
Work in progress...

Wheat field deployment 2016

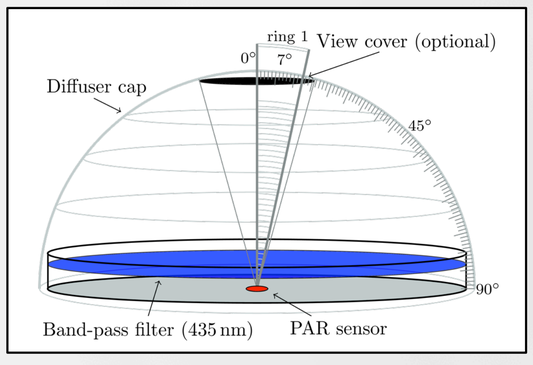
WSN vs. LI-COR LAI-2200

- *Accurate LAI estimates derived by low-cost WSN technology* [2]

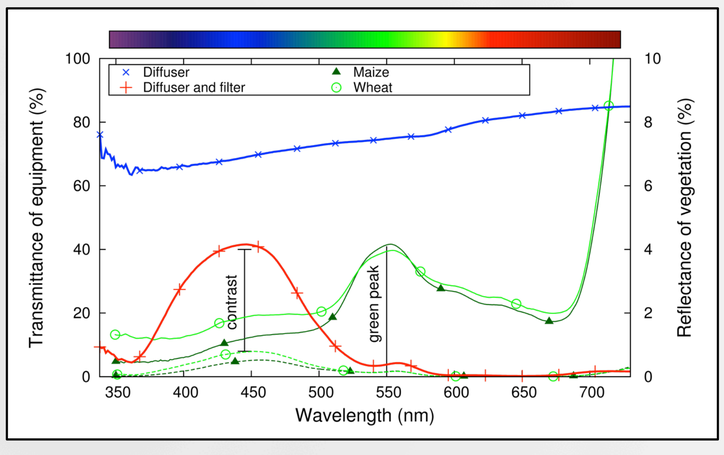




Sensor Enhancement [2]



- *Spectral restriction of PAR using a blue band-pass filter (435 nm)*



- *Spectral analysis shows an increased contrast between plant and sky*
  → improves LAI estimation

References

[1] J. Bauer, B. Siegmann, T. Jarmer, N. Aschenbruck. **"On the Potential of Wireless Sensor Networks for the In-Field Assessment of Bio-Physical Crop Parameters"** Proc. of the Int. Workshop on Practical Issues In Building Sensor Network Applications (SenseApp), Canada, 2014.

[2] J. Bauer, B. Siegmann, T. Jarmer, N. Aschenbruck. **"On the Potential of Wireless Sensor Networks for the In-Situ Assessment of Crop Leaf Area Index".** In Revision for the Int. Journal of Computers and Electronics in Agriculture.

http://sys.cs.uos.de

http://www.igf.uos.de