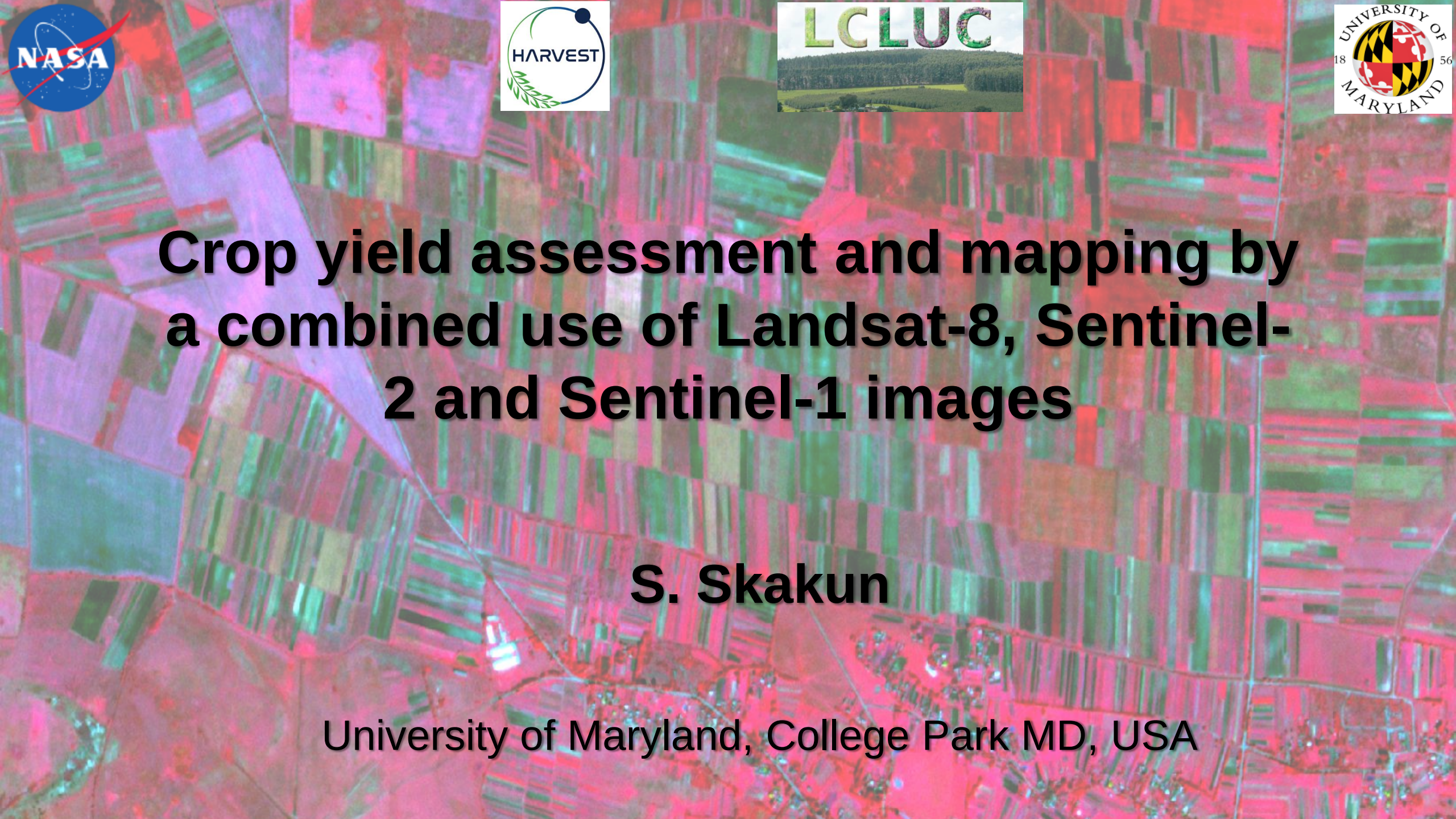


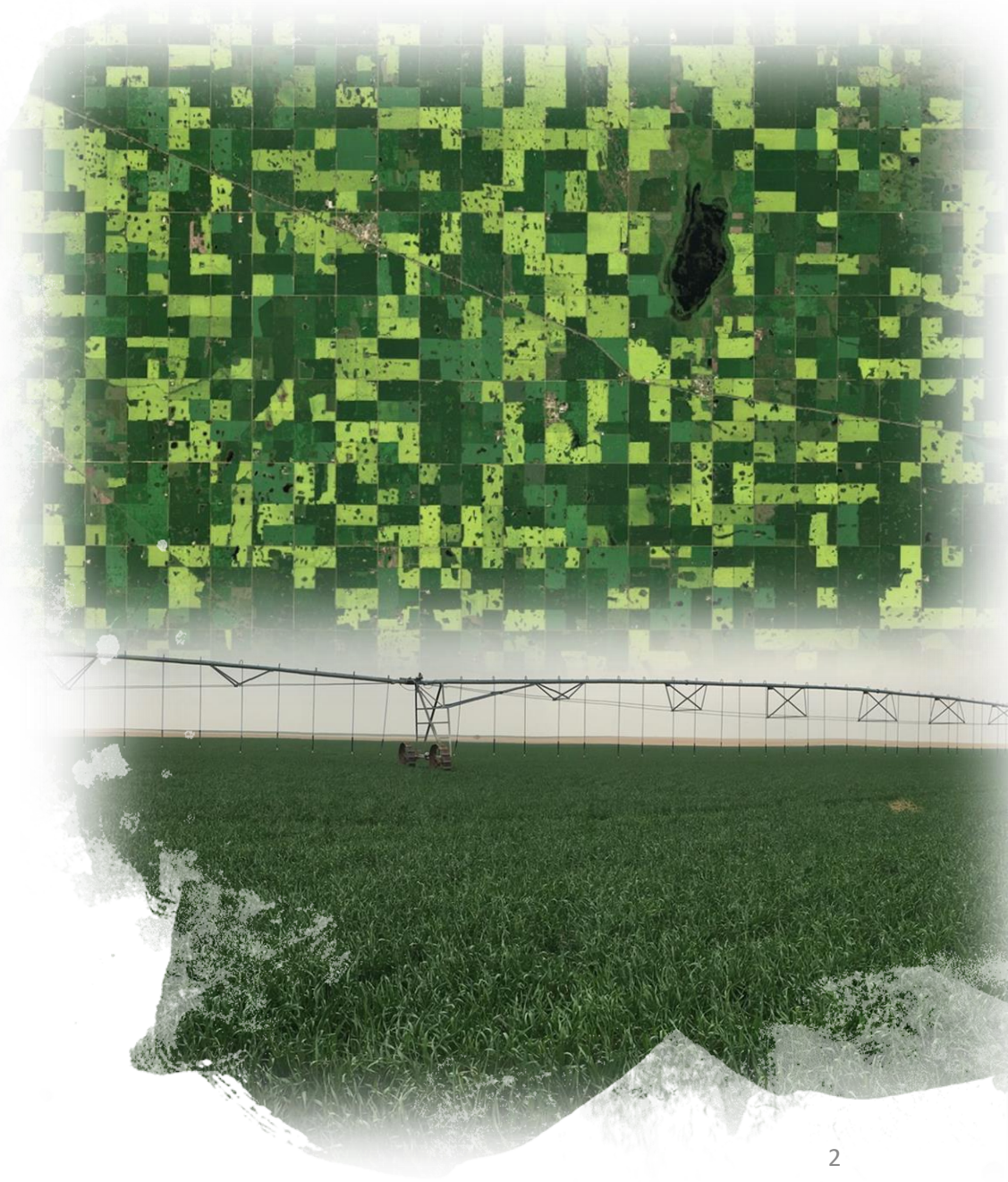
Crop yield assessment and mapping by a combined use of Landsat-8, Sentinel-2 and Sentinel-1 images

S. Skakun

University of Maryland, College Park MD, USA

Content

- Update on winter wheat yield mapping in Ukraine
  - Adding 2019 validation
  - Adding Gaussian processes
  - Combining optical + SAR data
- Maize and soybean yield assessment at field scale in Iowa (2018-2019)
  - Using Planet data
  - Using HLS data



Project overview

- **Crop yield assessment and mapping by a combined use of Landsat-8, Sentinel-2 and Sentinel-1 images**
  - PI: **S. Skakun** (UMD)
  - Co-Is: **J.-C. Roger**, **B. Franch**, **N. Kalecinski** (UMD)
  - PhD student: **A. Santamaria, M.G.L. Brown** (UMD)
  - Collaborators:
    - **D. Johnson** (USDA-NASS)
      N. Kussul (Space Research Institute, Ukraine)
      E. Copati (The Buenos Aires Grain Exchange, Argentina)
      S. Veron, D. de Abelleyra (Instituto Nacional de Tecnologia Agropecuaria, Argentina)
      C. Champagne (Agriculture and Agri-Food Canada)
      + **JECAM**
  - Objective:
    - to develop a new algorithm and products for agriculture monitoring, namely **crop yield assessment** and **mapping**, by combining moderate spatial resolution images acquired by **Landsat-8, Sentinel-2 and Sentinel-1/SAR** remote sensing satellites
  - Crops:

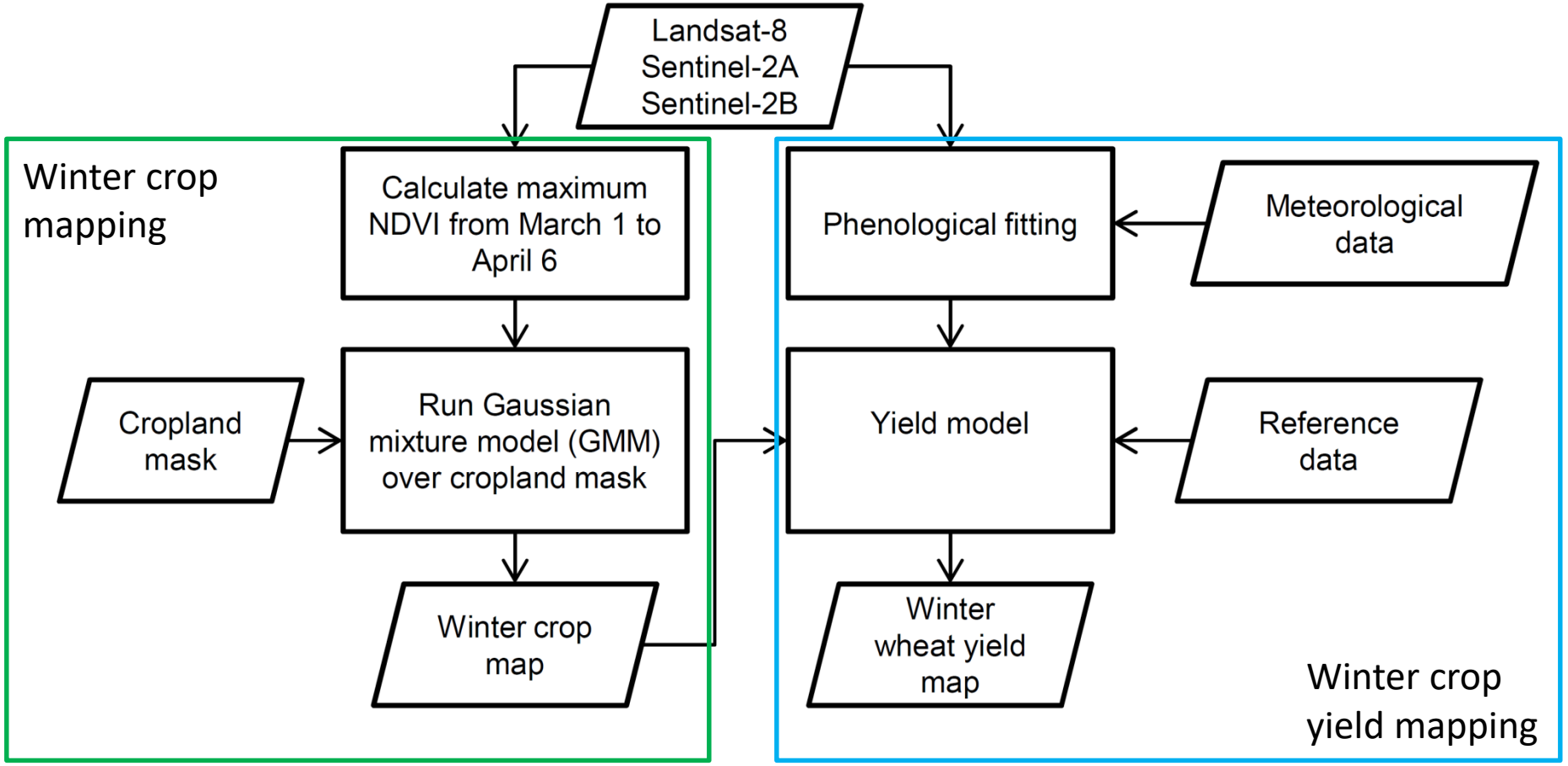

wheat


corn


soybean

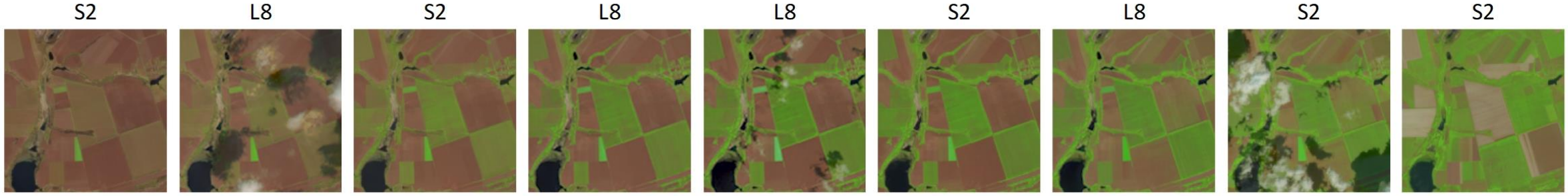
Crop yield assessment methodology

- Methodology (for winter wheat)

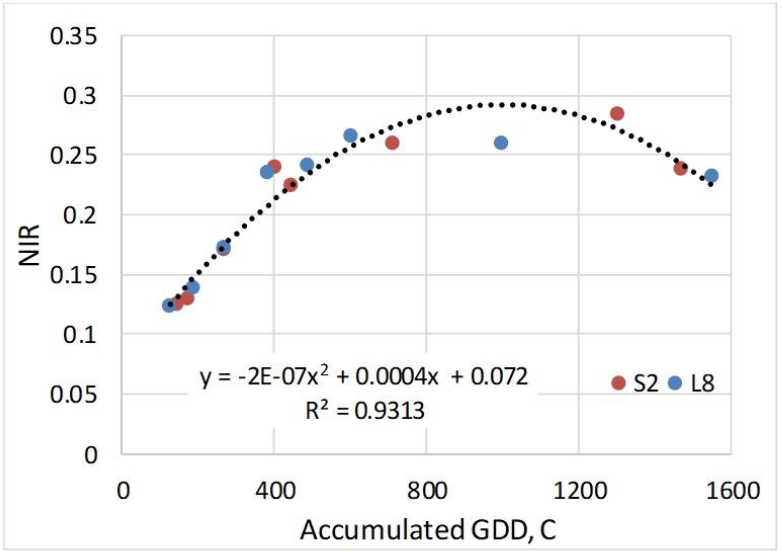


Crop yield assessment at **regional** scale

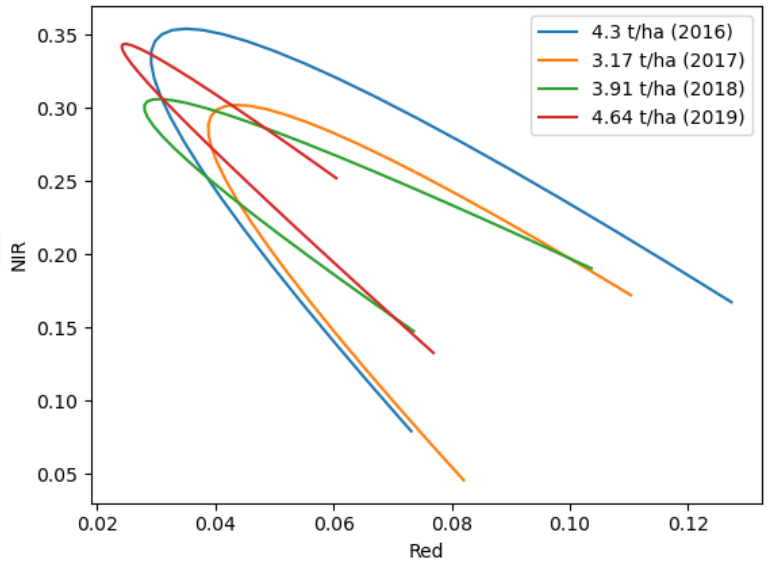
Multi-source image time series



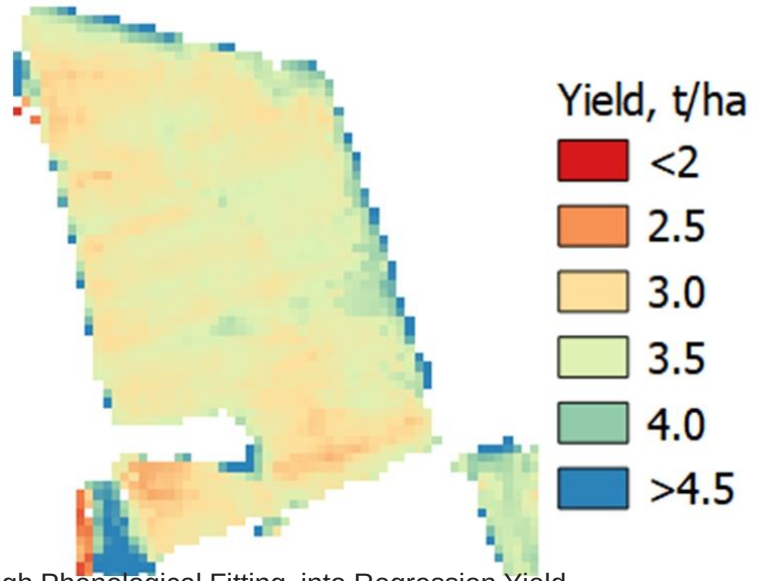
Phenological fitting



Model calibration/validation



Winter wheat yield mapping



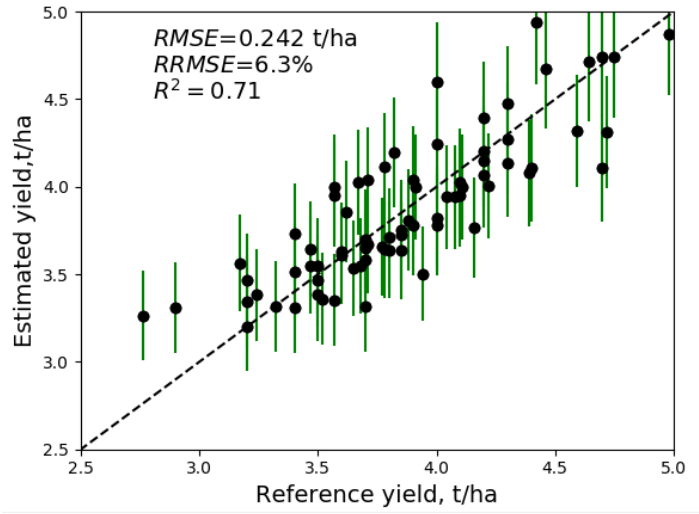
Skakun, S., et al. (2019). Winter Wheat Yield Assessment from Landsat 8 and Sentinel-2 Data: Incorporating Surface Reflectance, Through Phenological Fitting, into Regression Yield Models. ***Remote Sensing***, *11*(15), 1768.

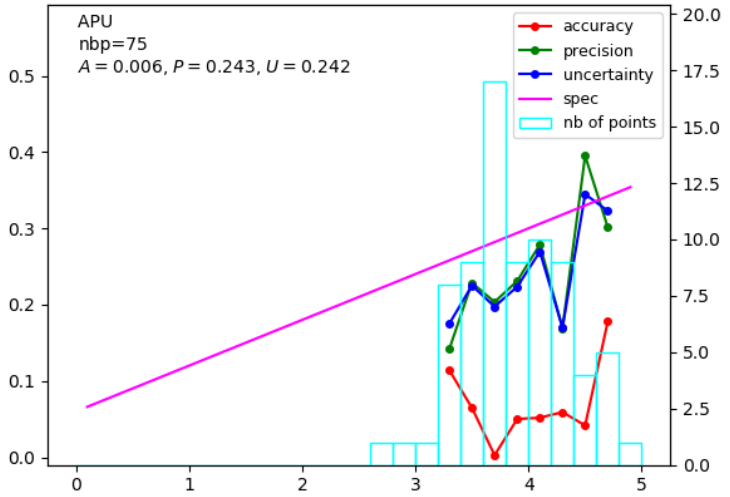
Cross-validation

- 2016-2019
- Regional scale
- Two models:
  - **Linear with L2 regularization**, and
  - **Gaussian Process** (GP)
    - Kernel ~ Const * RBF + WhiteNoise

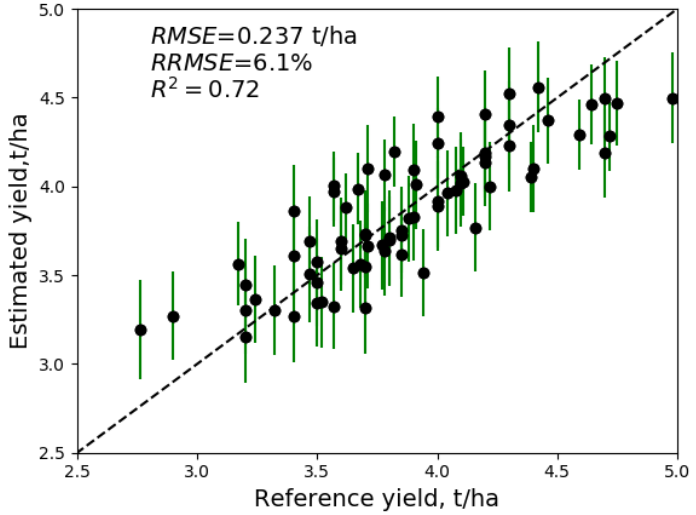
- Defined a specification for wheat yields:
  - **spec = 0.06 + 0.06 * yield [t/ha]**
    - E.g. 4.0 ± 0.3 [t/ha]

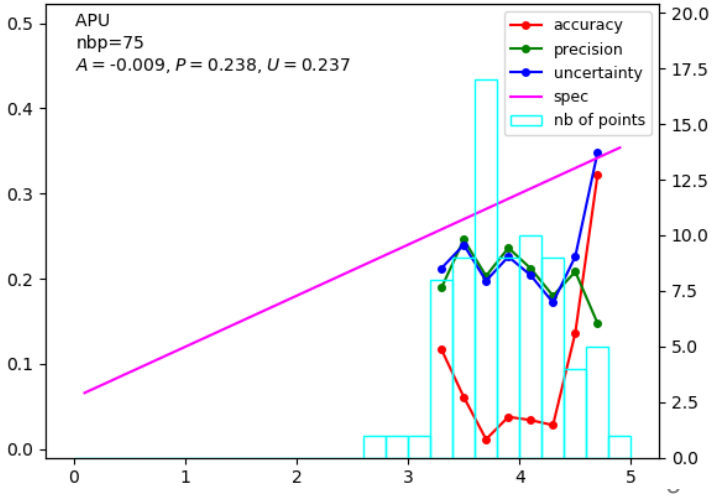
Linear model



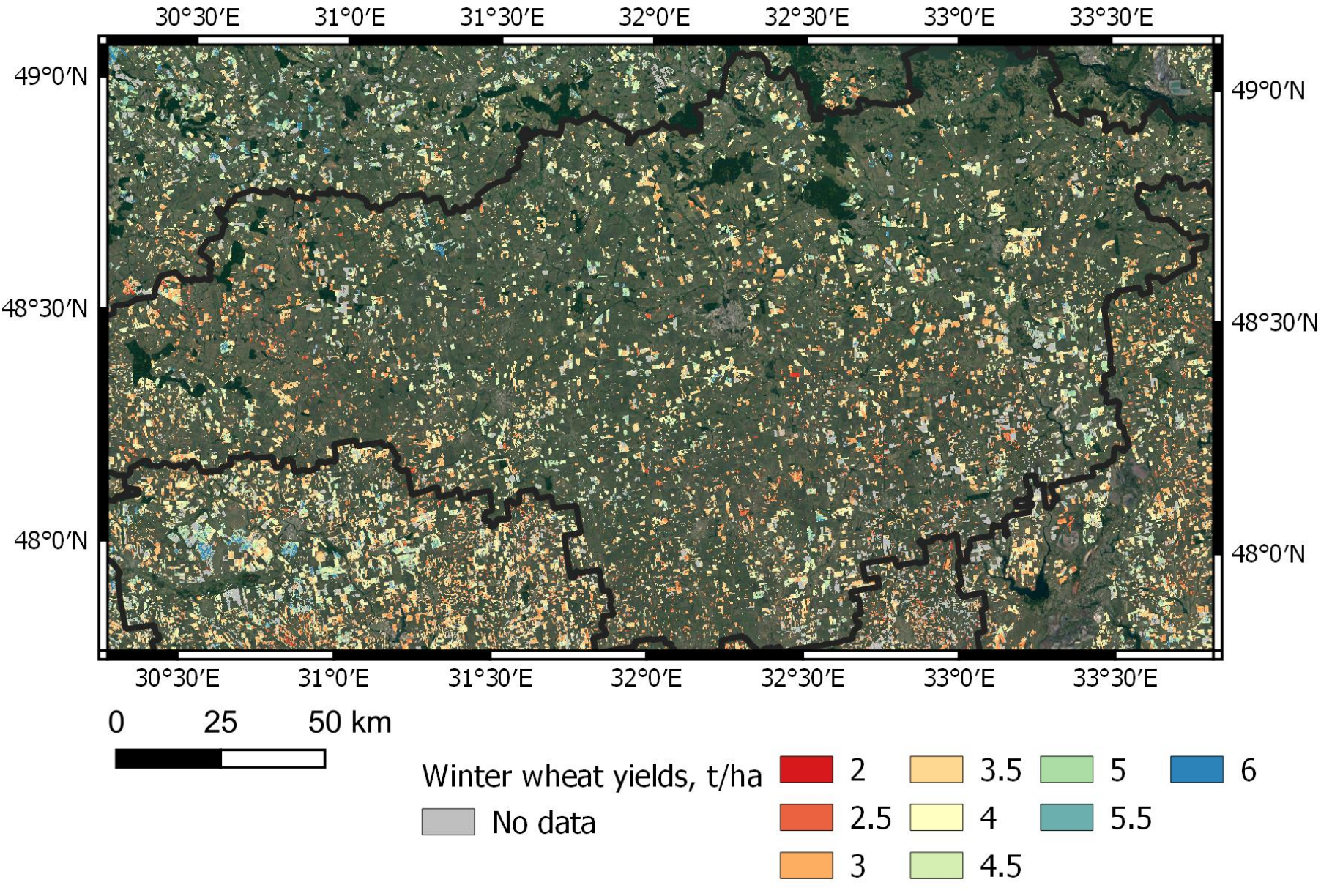


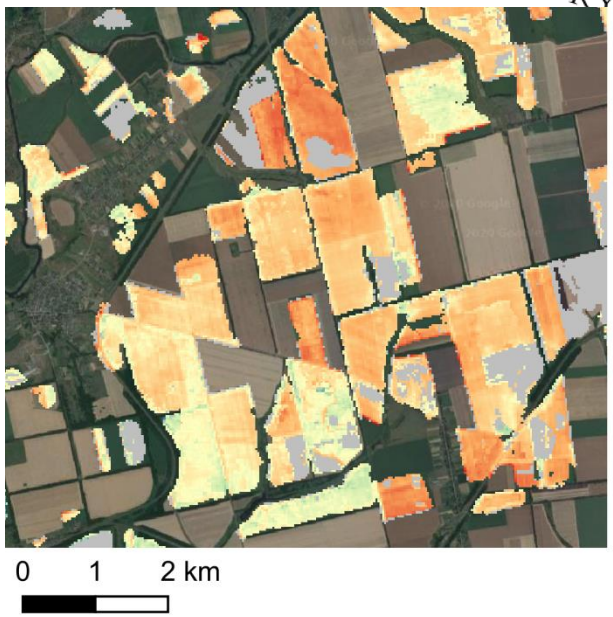
GP model

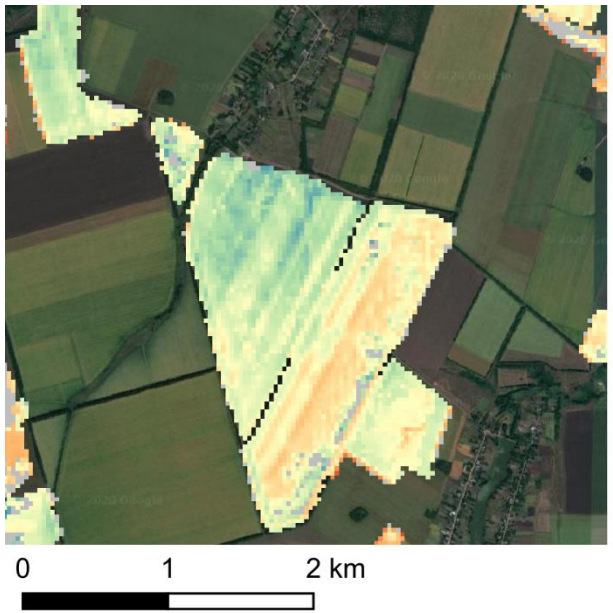




Example of yield map for 2018

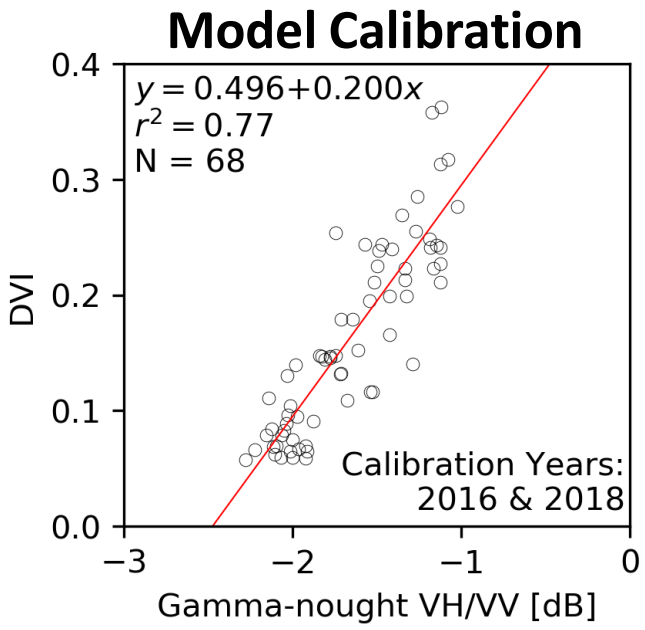


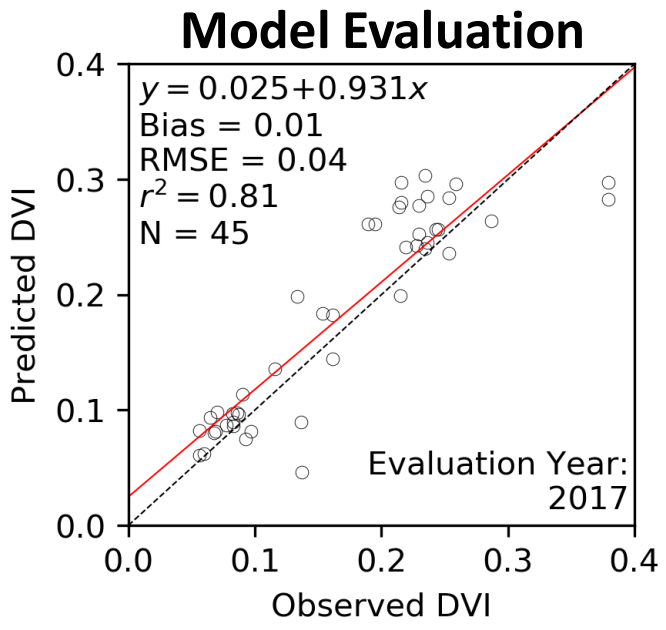


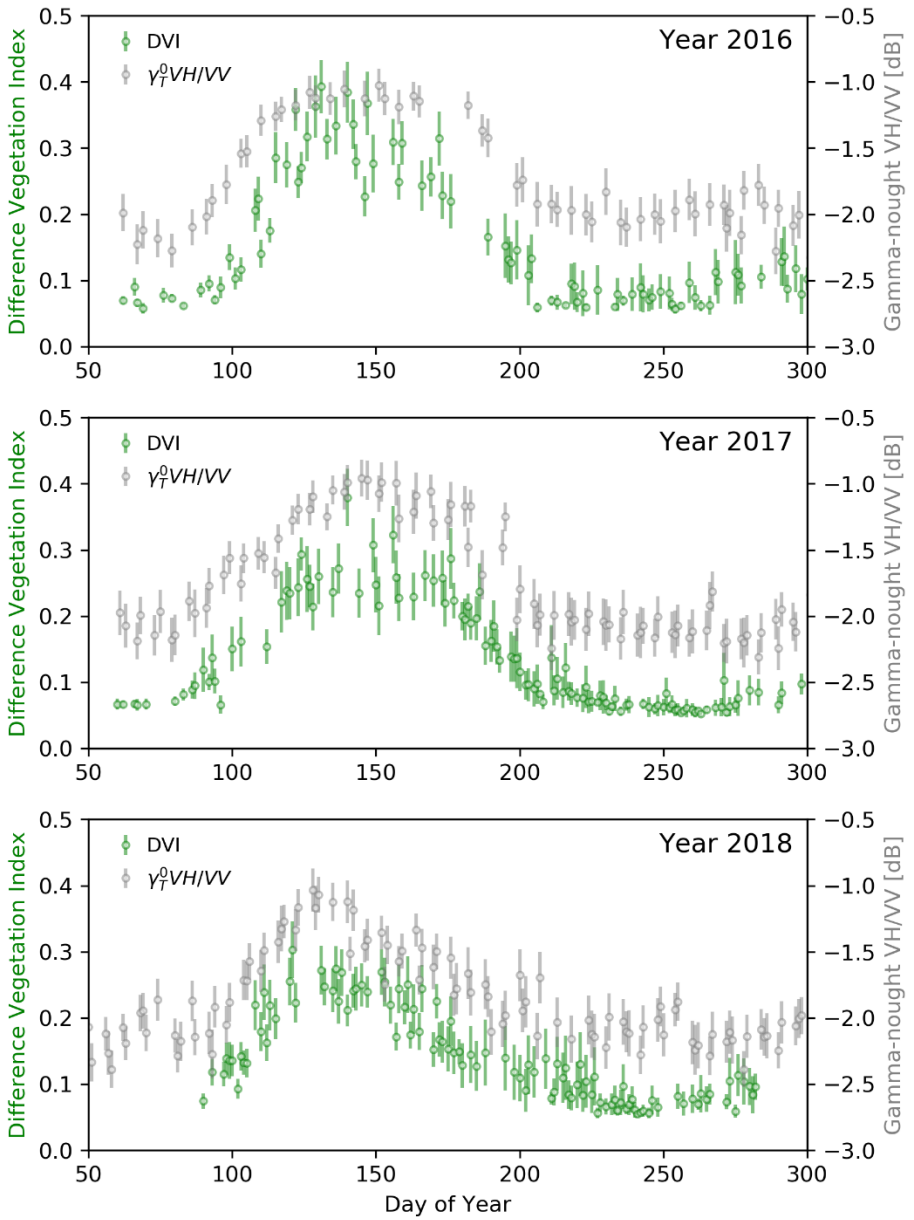


Combining optical + SAR

- Optical and SAR indices show similar temporal behavior on the growing season.
  - Optical: Difference Vegetation Index (DVI) from HLS
  - SAR: Gamma-nought VH/VV (γT0) from Sentinel-1

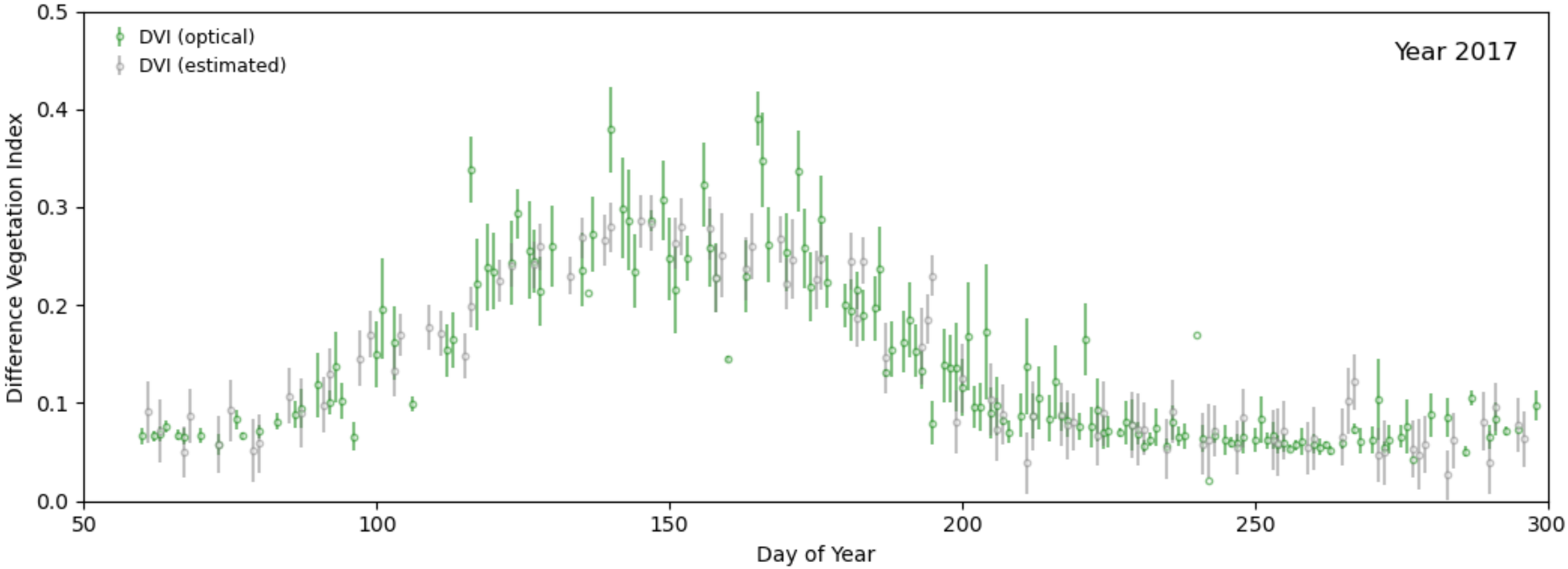




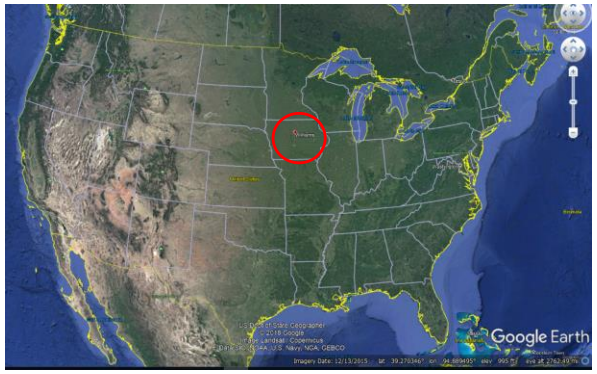


Combining optical + SAR

- Temporal profiles of DVI from HLS and SAR-derived



Ground data: crop yields at **field** scale



Field scale yields for corn and soybean (Hamilton County, IA, USA). Provided by Iowa State University

Soybean

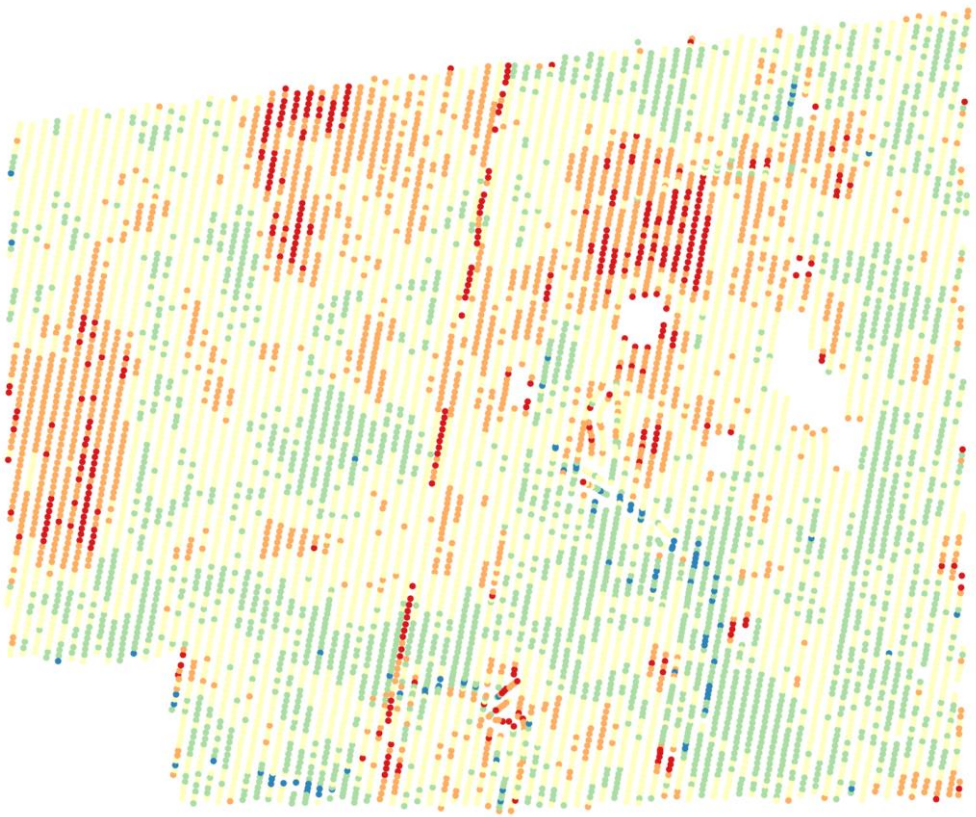
Yield, bu/ac

20 50 80

Field scale yield:

52 ± 9 bu/ac (16%)

(3.5 t/ha)



Corn

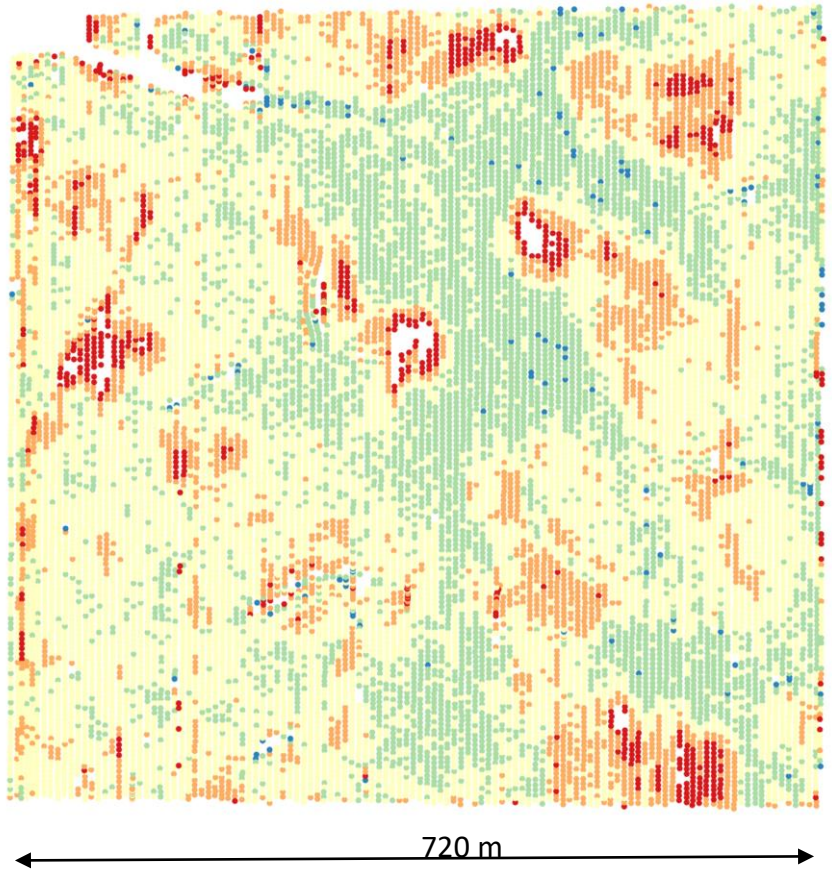
Yield, bu/ac

90 180 270

Field scale yield:

186 ± 24 bu/ac (13%)

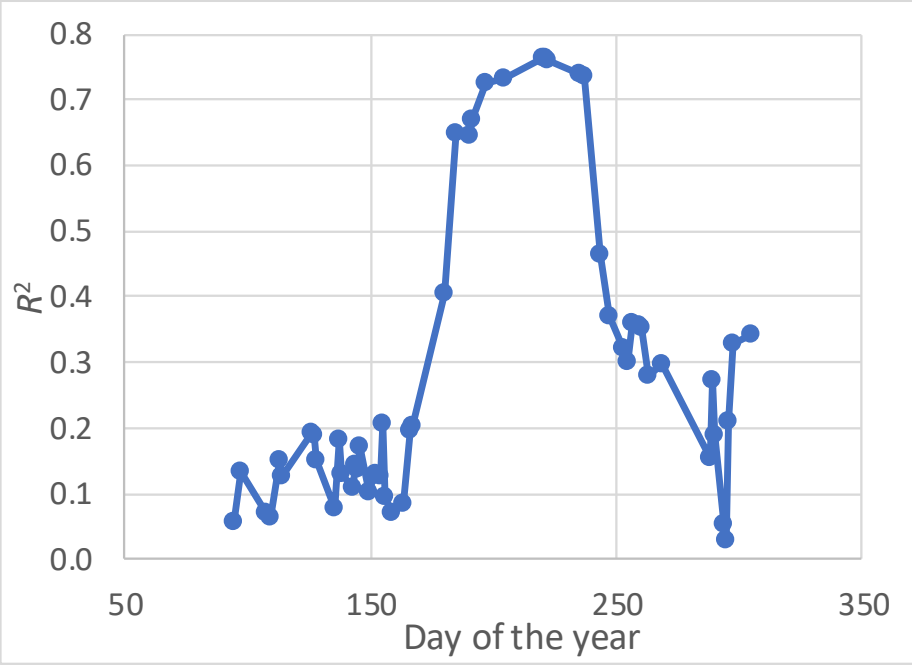
(11.7 t/ha)

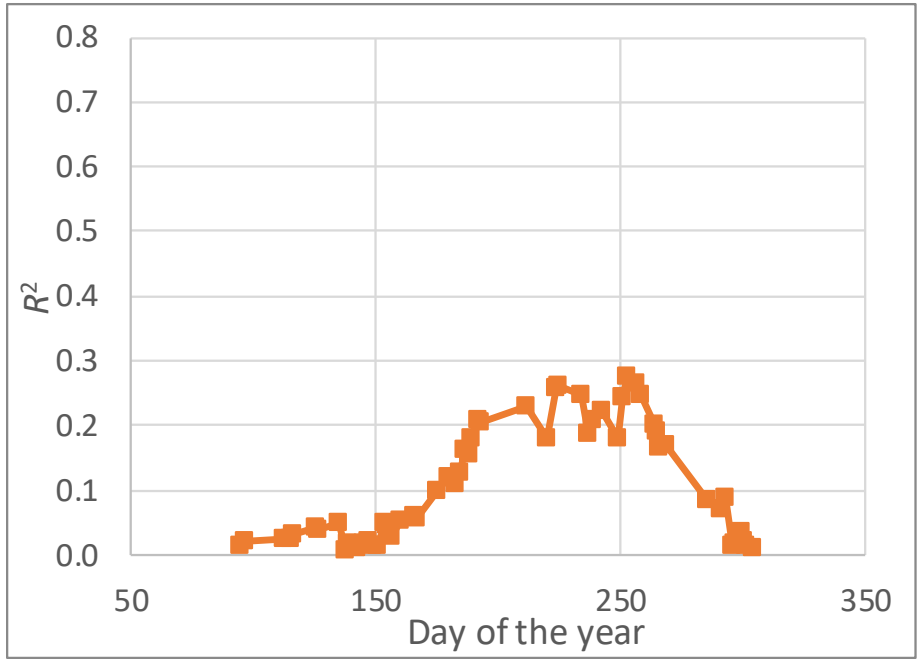


Results: PlanetScope

- The coefficient of determination (R^2) between yields and Planet-derived surface reflectance's varied among fields from **0.1 to 0.75** (average among 15 fields was **0.34±0.17**)

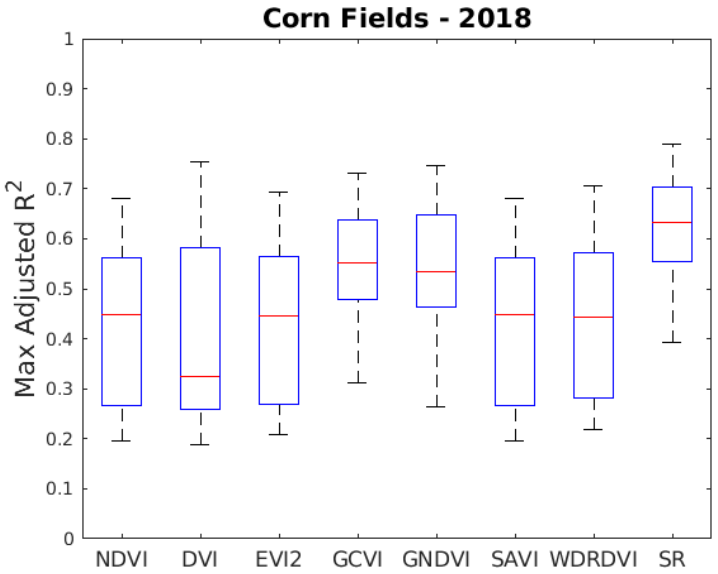
- Temporal variations of R^2 for single-date linear relationships between yields and Planet-derived surface reflectance for **two different fields of soybean**: one field featuring a high coefficient of determination (**0.76**) and another field poor correspondence (**0.28**)

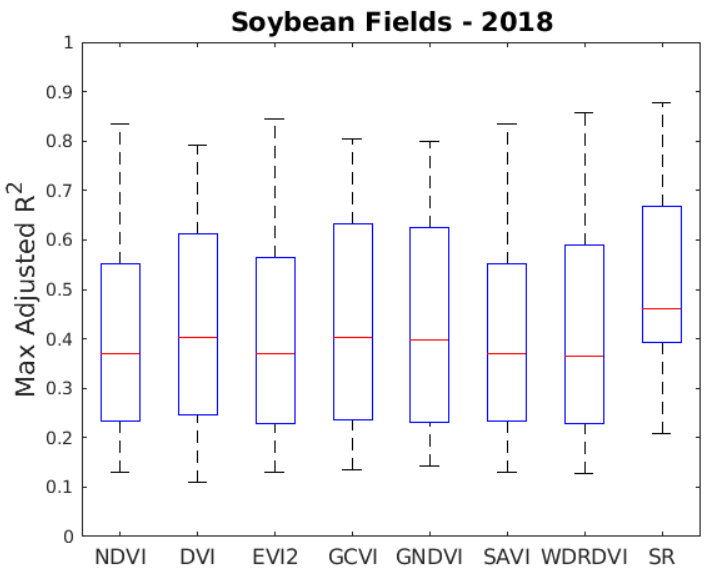


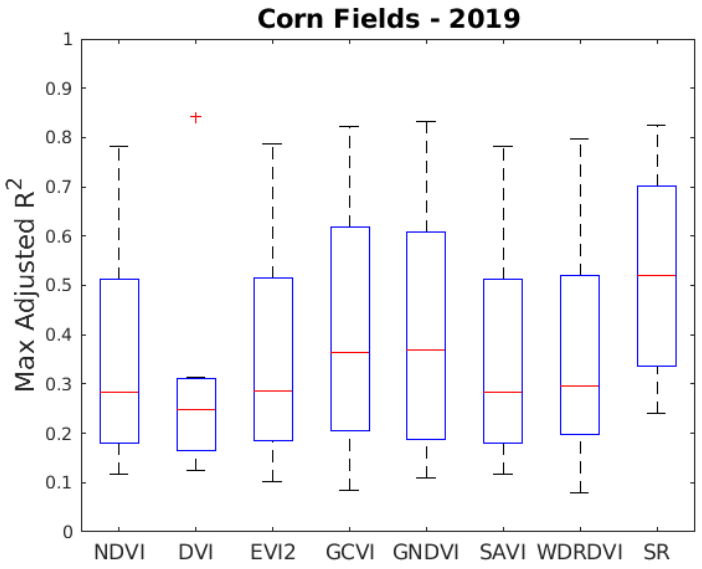


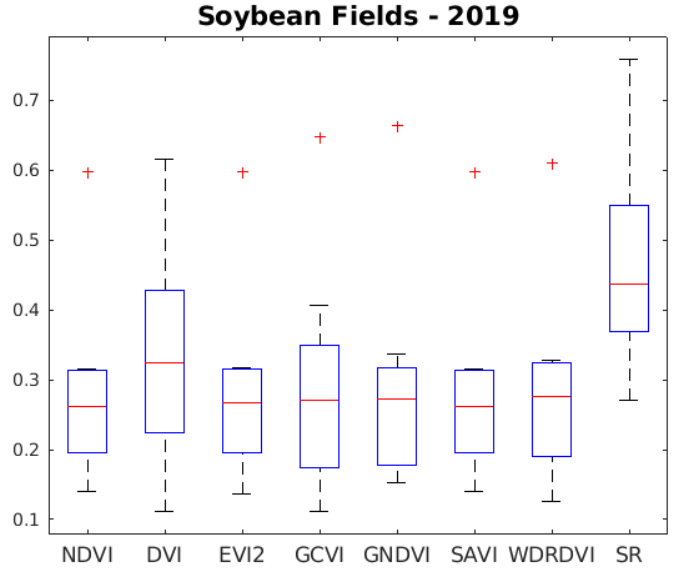
Correlating in-field yields with HLS data

- Maximum per-field Rsq between yields and linear models based on various features



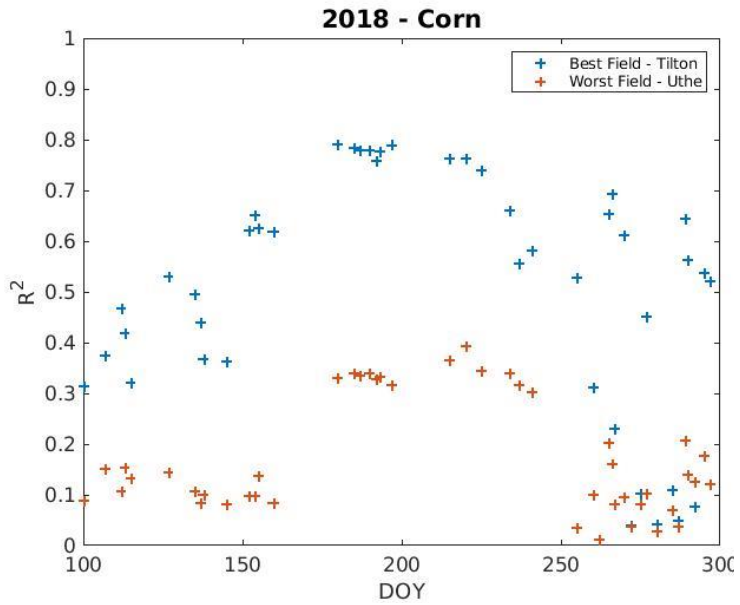


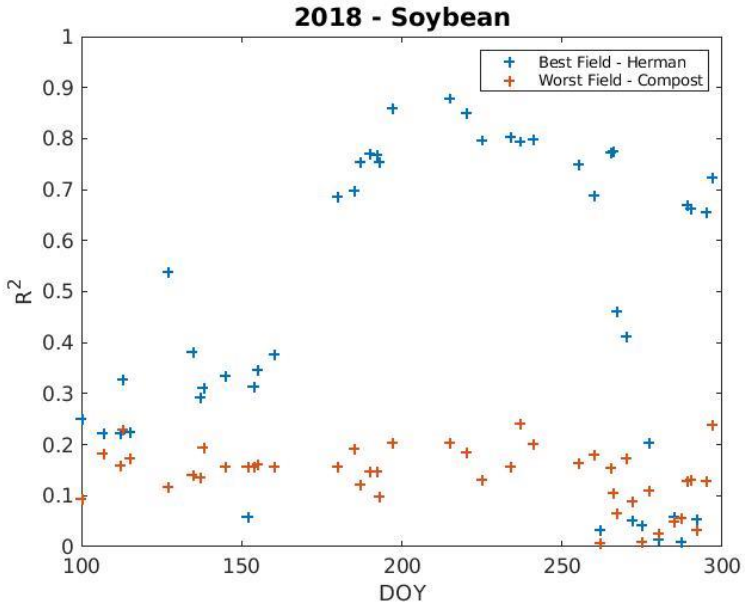


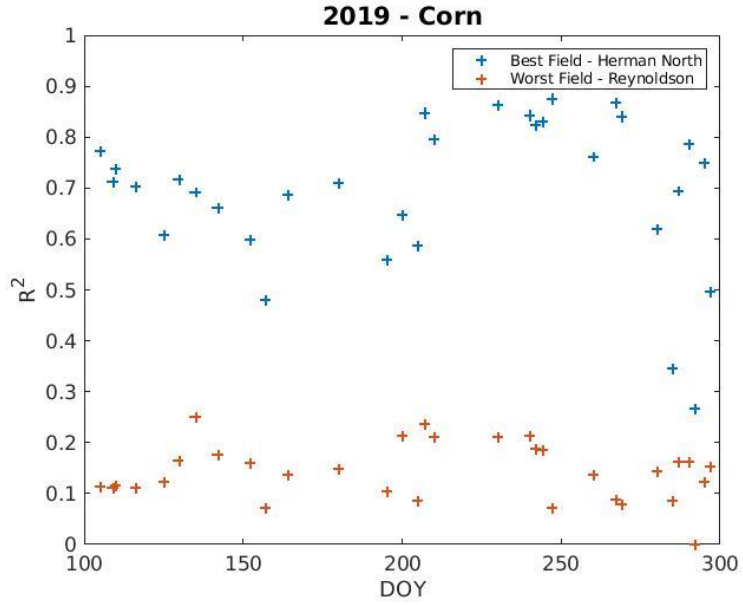


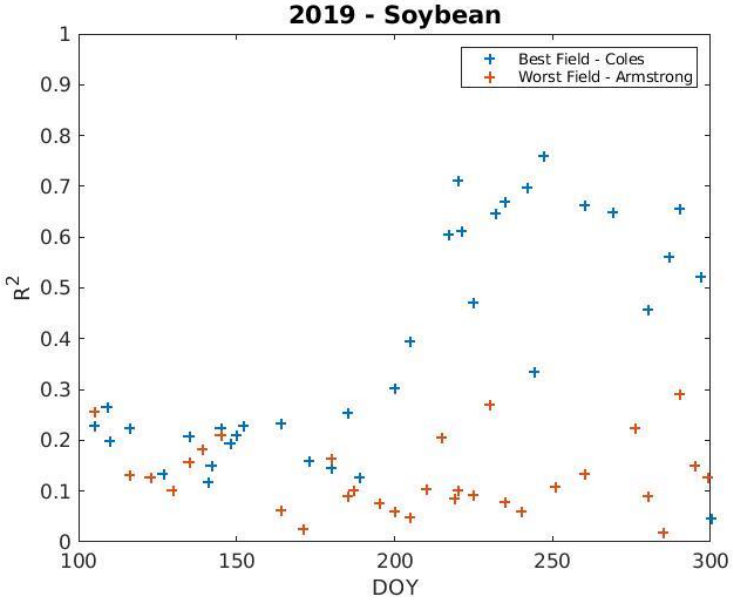
Correlating in-field yields with HLS data

- Examples of fields with the highest and lowest correlations between SR and yields

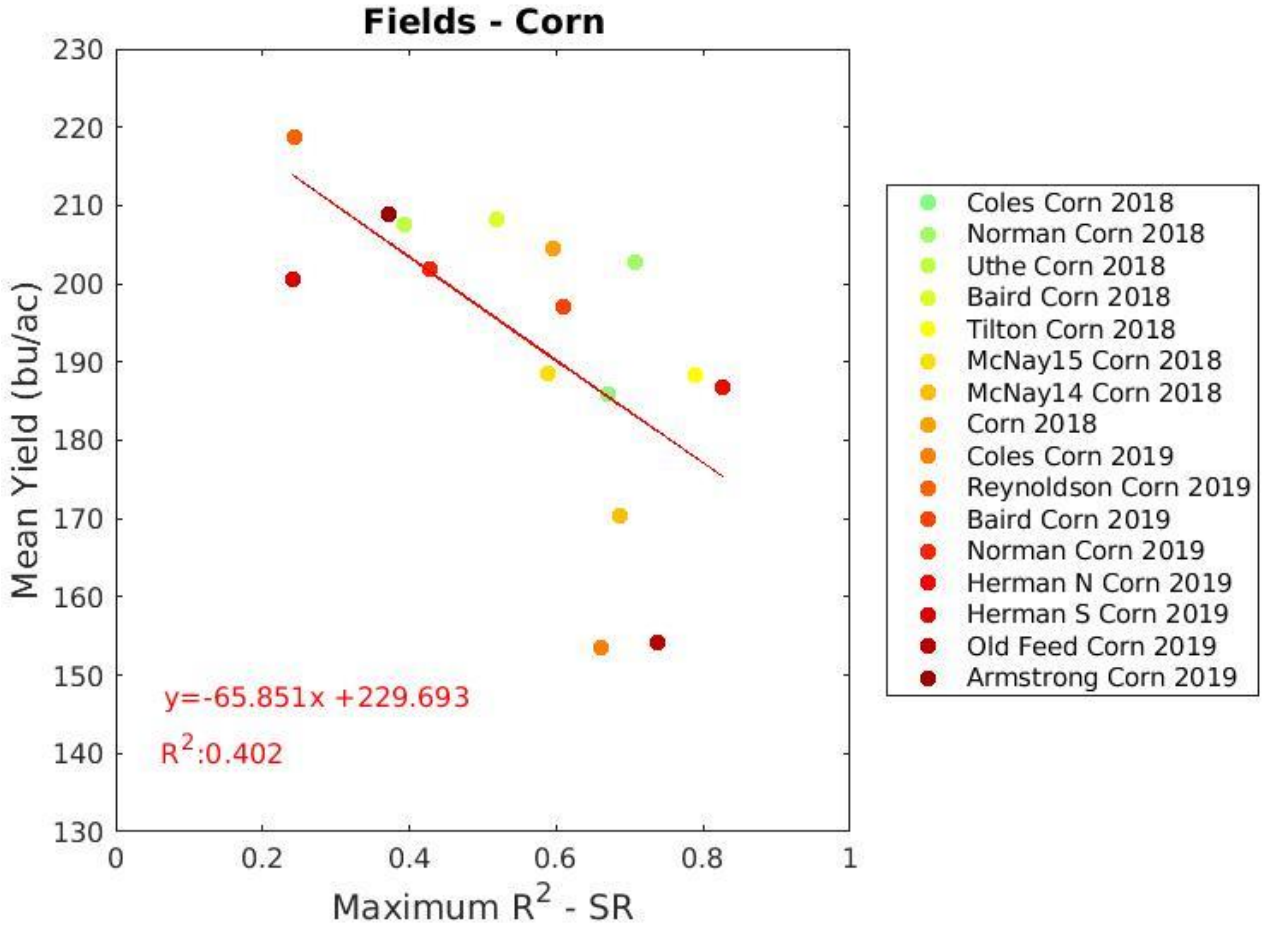


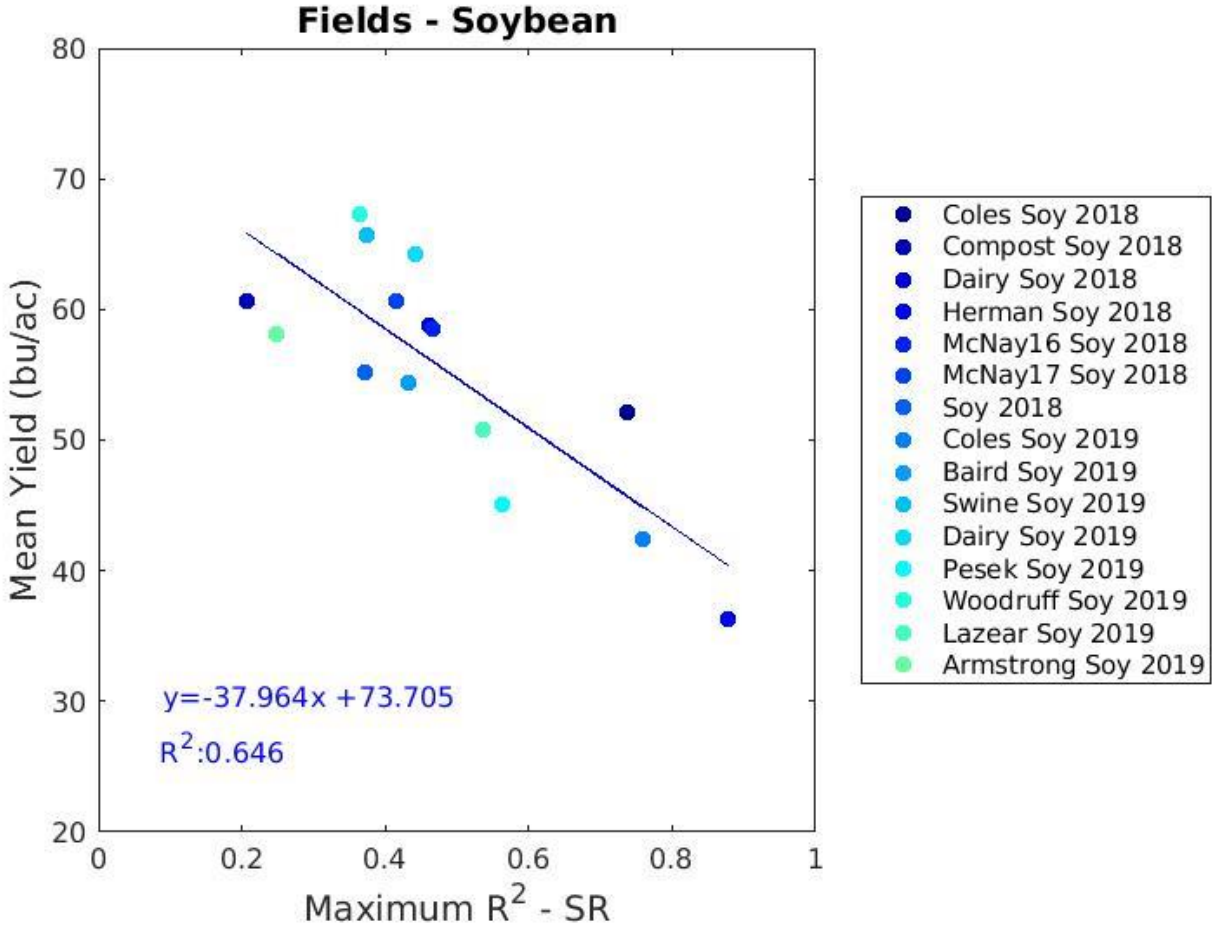






Correlating in-field yields with HLS data





Conclusions

- Regional (for Ukraine) winter wheat yield prototype product is available
  - Plans to extend to major wheat producing regions in Ukraine and Kansas
- Potential for improvements fin yield assessment by combining optical + SAR data
- Corn/soybean, Iowa
  - 4 PlanetScope's spectral bands at 3 m explained from 10% to 75% of in-field corn/soybean yield variability
  - Similar results for HLS at 30 m resolution
  - Rsq generally decreases as yields increases

Thank You!