Estimating Cotton Water Consumption Using a Time Series of Sentinel-2 Imagery

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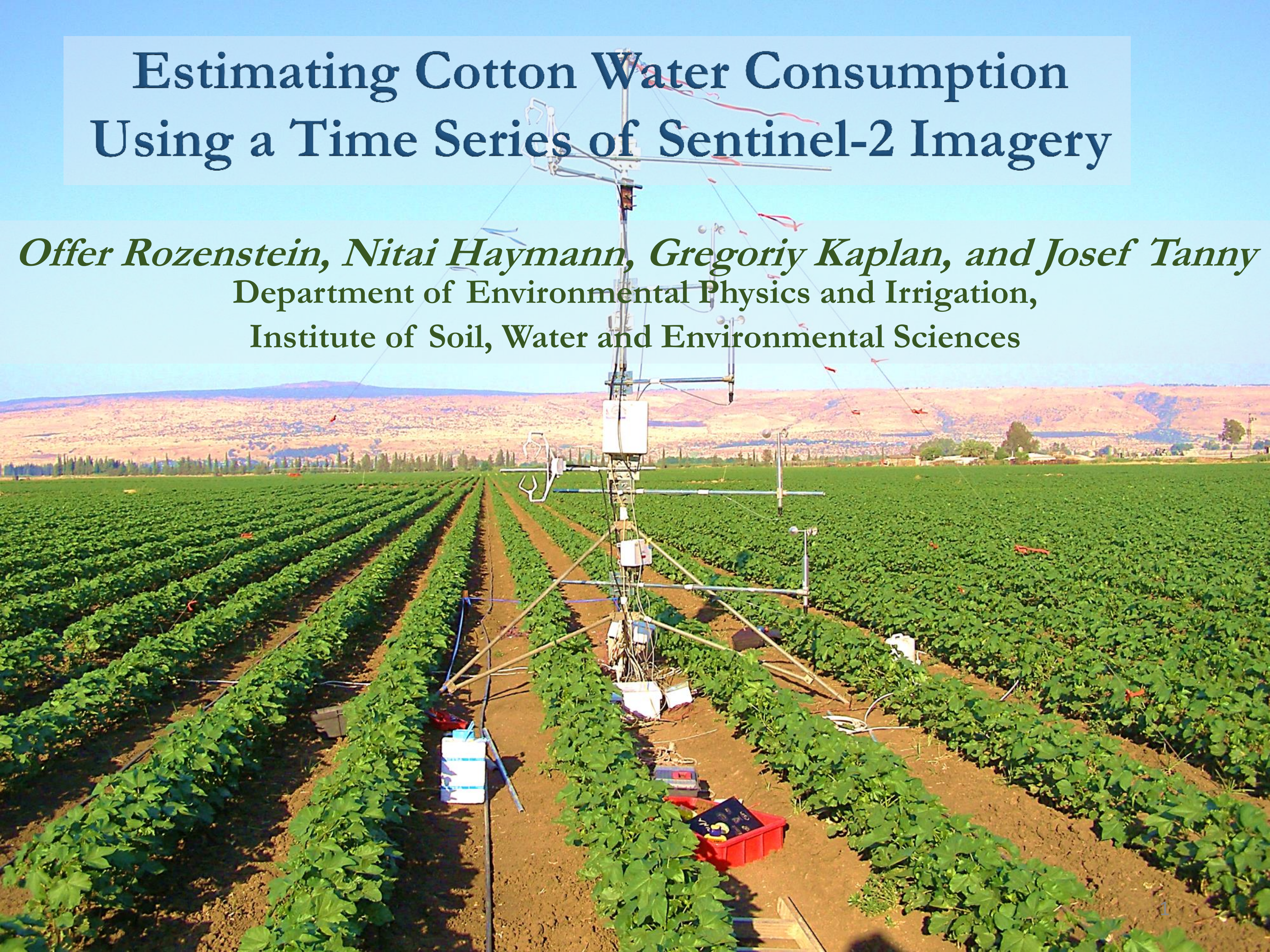


The Motivation

- **Monitoring the changes of soil and crops in agricultural fields throughout the growing season is key to increasing the production efficiency.**

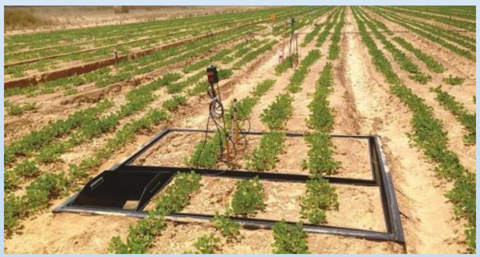
- **In particular, information about the crop evapotranspiration (ET_c), which represents the combined water loss due to evaporation from the soil surface and transpiration from the crop surface, can facilitate better irrigation planning, and ultimately, water use efficiency.**

The Crop Coefficient (K_c) Approach

$$ET_c = K_c \, ET_0$$

Crop ET

Reference ET



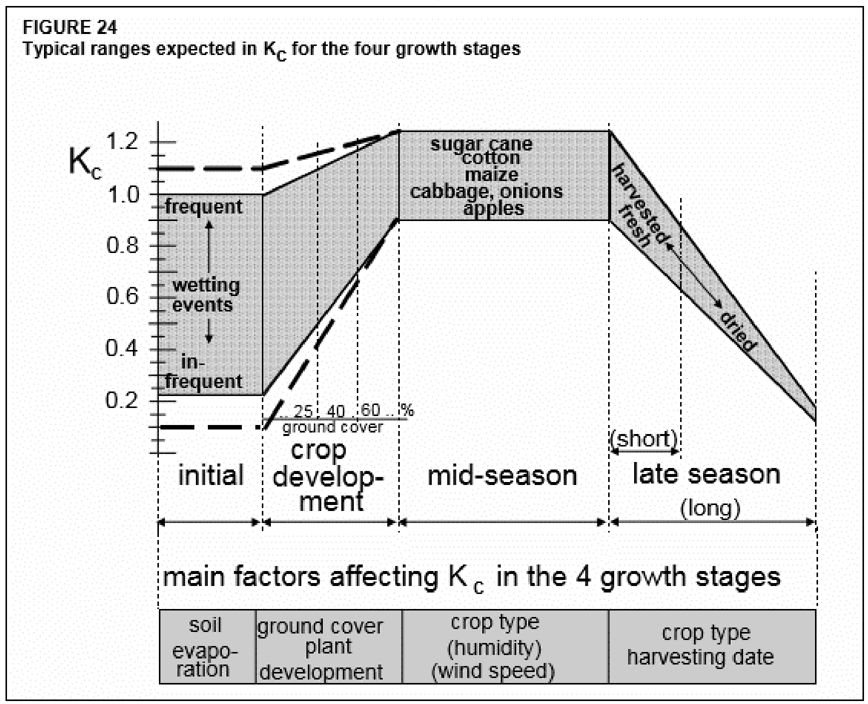


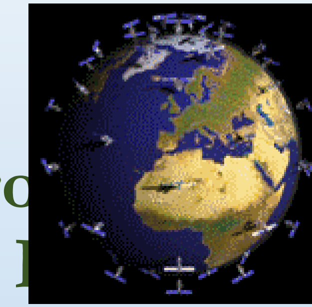
FIGURE 24
Typical ranges expected in K_c for the four growth stages

(Allen et al., 1998)

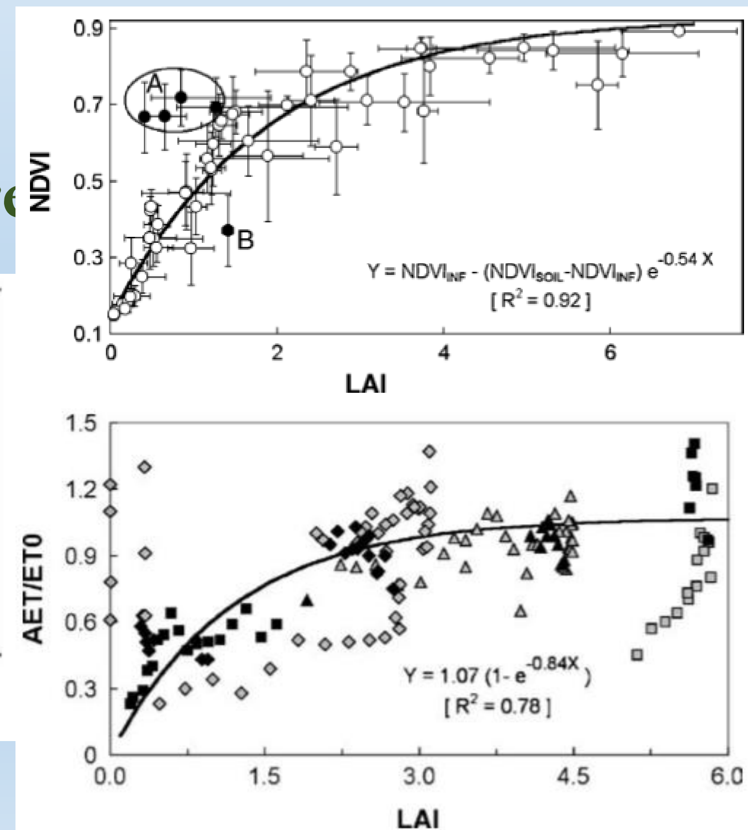
Disadvantages of standard K_c recommendations

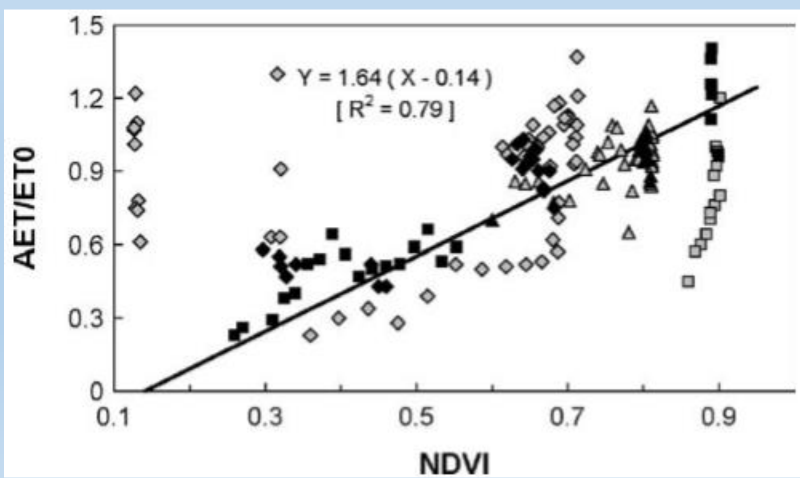
- K_c has been shown to vary between sites and between seasons.
- Weather anomalies + standard K_c = ET_c Error
- Deviations from standard conditions due to specific fertilization, variations in crop planting density, and stress factors such as pests.
- Spatial heterogeneity in soil characteristics such as water holding capacity and nutrients availability is not reflected in standa

Satellite Remote Sensing



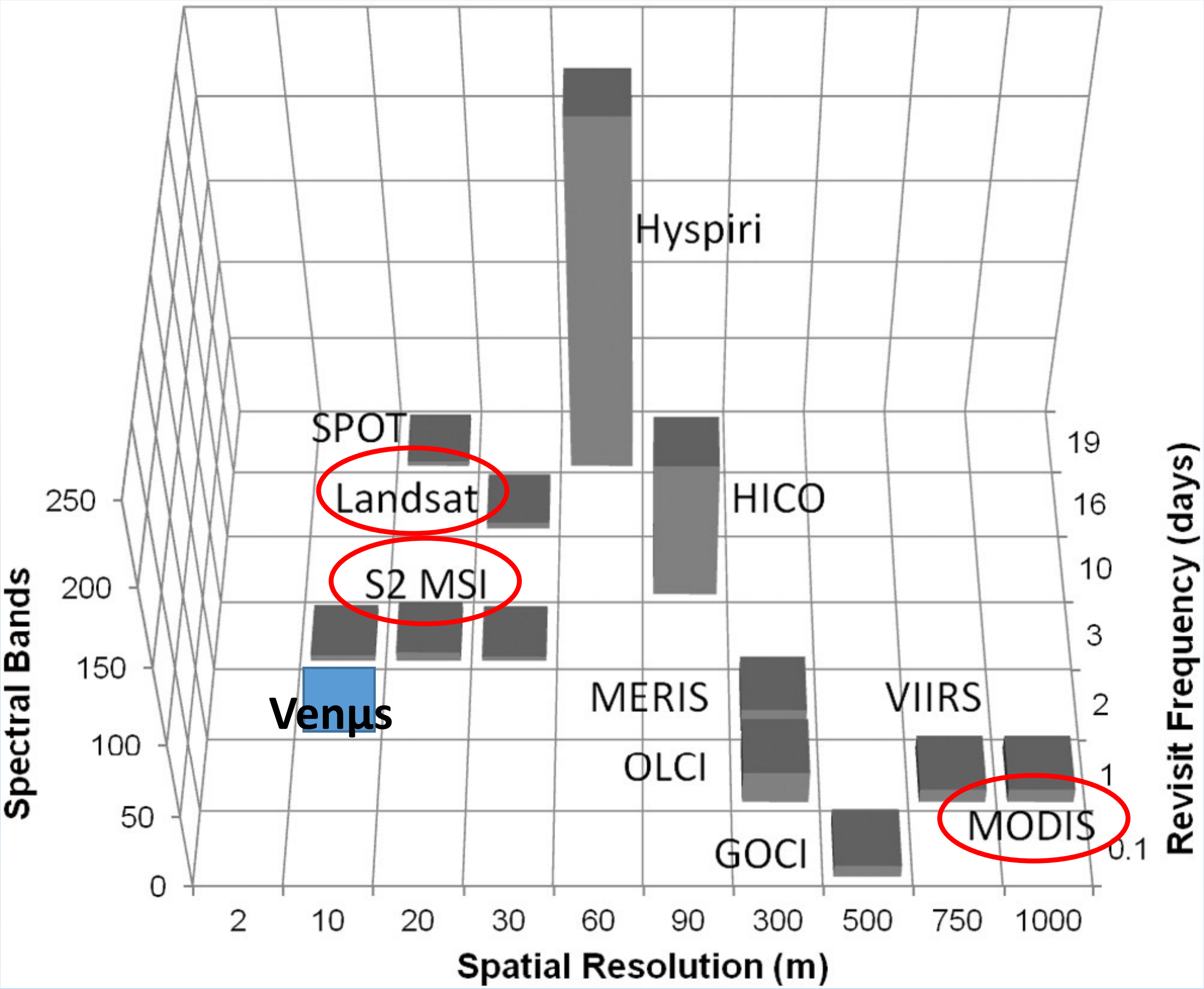
- Synoptic coverage at fixed time intervals.
- Spectral vegetation indices correlated with cro characteristics including biomass, Leaf Area I (LAI), plant height, and yield.
- Spectral vegetation indices corre

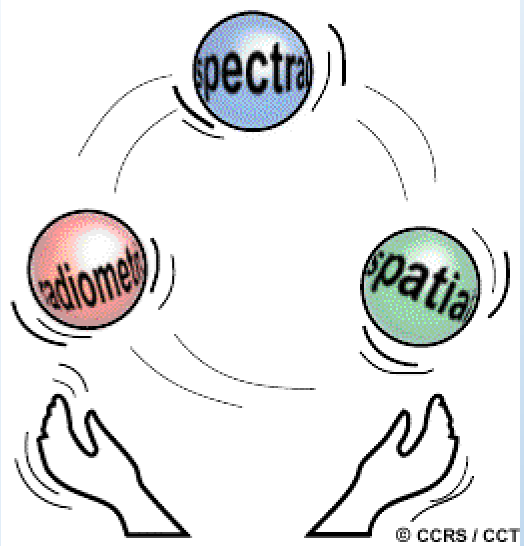




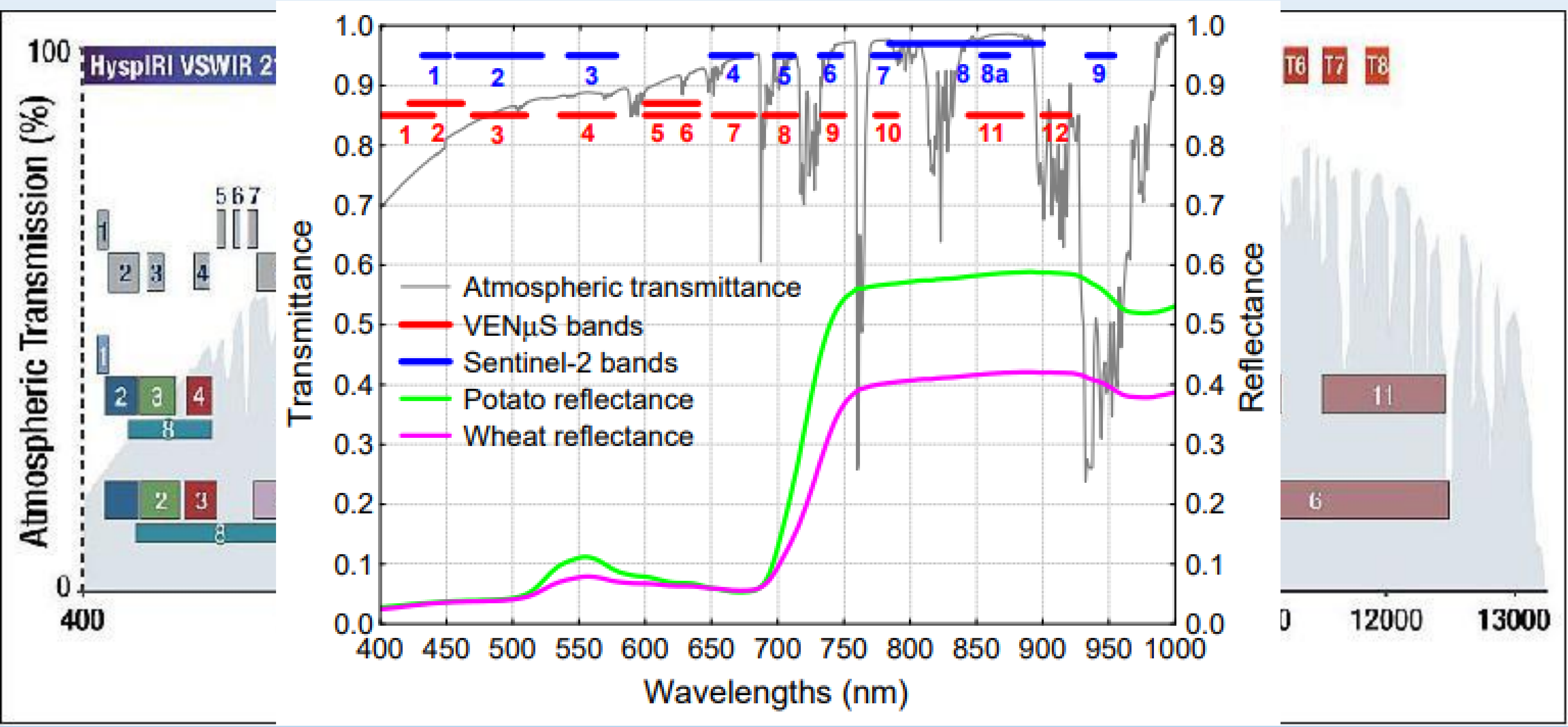
(Duchemin et al., 2006)

Plar Orbiting Satellites: The Tradeoff Between Spatial, Spectral and Temporal Resolutions



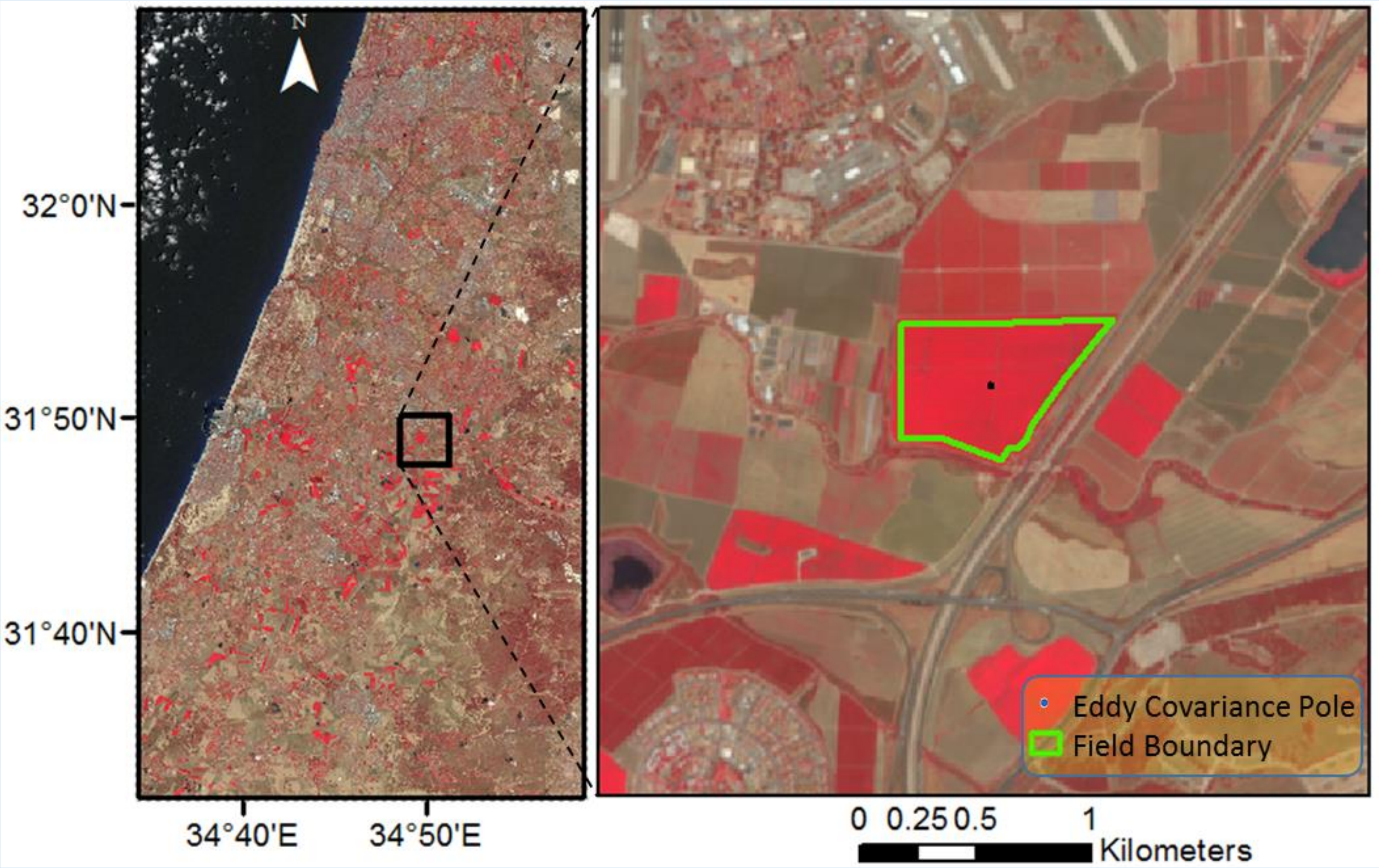


Improvement in Specteral Vegetation Monitoring

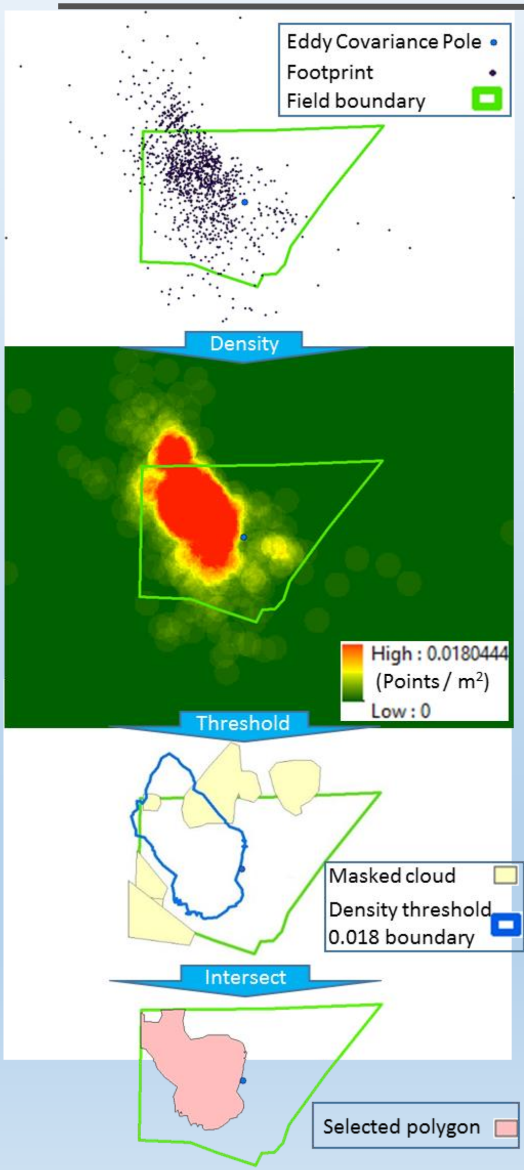


Herrmann et al. (2011)

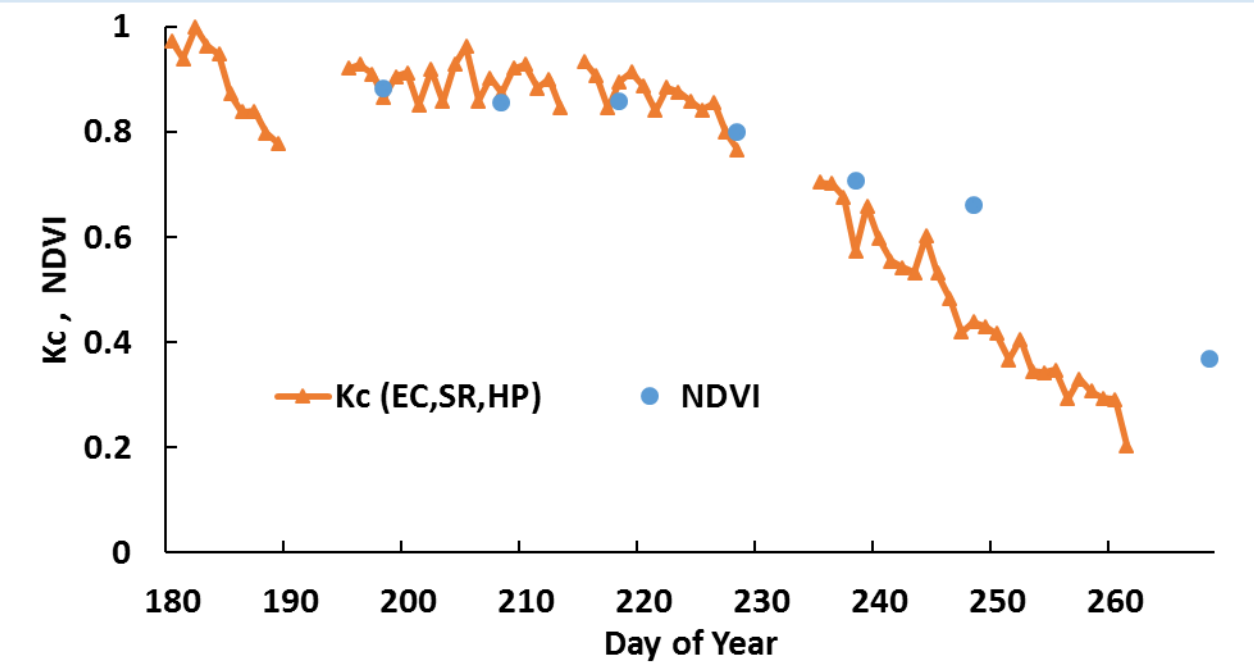
Study Area


N
32°0'N
31°50'N
31°40'N
34°40'E
34°50'E
Eddy Covariance Pole
Field Boundary
0 0.25 0.5 1
Kilometers

Results



Eddy Covariance Pole
Footprint
Field boundary
Density
High : 0.0180444
(Points / m²)
Low : 0
Threshold
Masked cloud
Density threshold
0.018 boundary
Intersect
Selected polygon

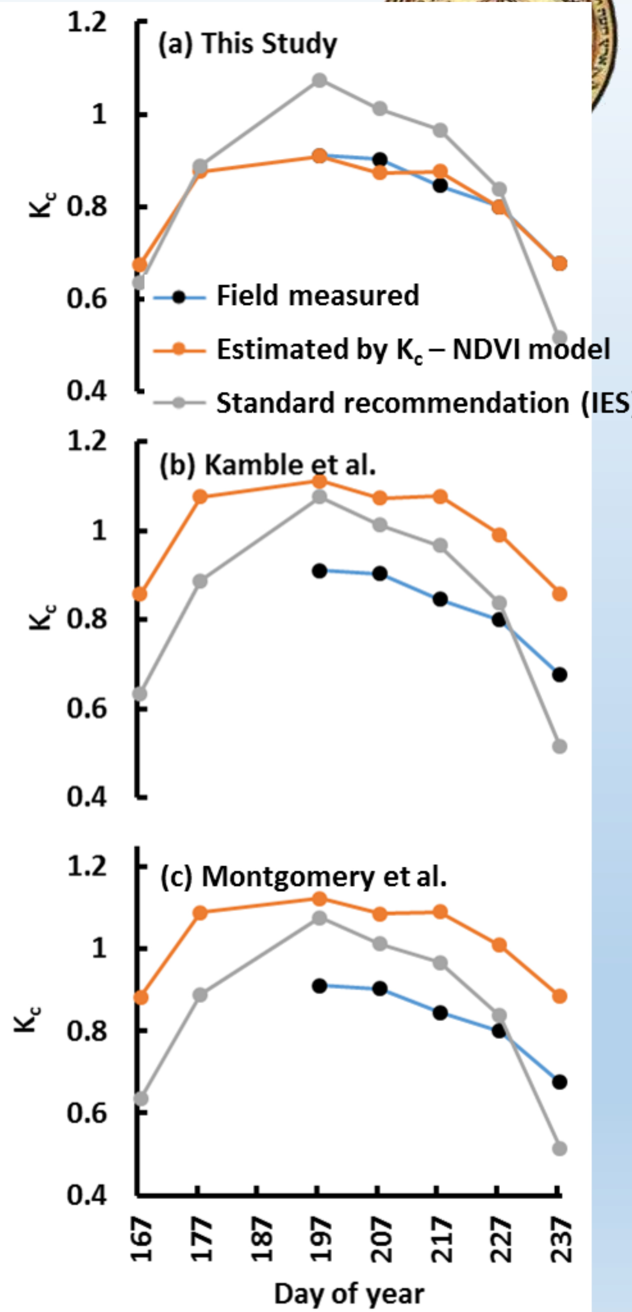


Kc , NDVI
0
0.2
0.4
0.6
0.8
1
180
190
200
210
220
230
240
250
260
Day of Year
Kc (EC,SR,HP)
NDVI

Results

Table 2: Linear K_c – Vegetation Index regression models, ranked according to RMSE.

Index	Equation	R^2	RMSE
MTCI	y = 0.2033x+0.0696	0.9915	0.0079
REIP	y = 0.1127x-80.455	0.9942	0.0125
S2REP	y = 0.1288x-92.37	0.9942	0.0134
ARVI	y = 1.2752x-0.2182	0.9582	0.0175
SAVI	y = 1.6666x-0.2639	0.9576	0.0176
MSAVI2	y = 1.1929x-0.6057	0.952	0.0188
IPVI	y = 2.6679x-1.6013	0.9493	0.0193
MSAVI	y = 1.4789x-0.12	0.9492	0.0193
NDVI	y = 1.3334x-0.2669	0.9491	0.0193
TNDVI	y = 3.0269x-2.6499	0.949	0.0193
GNDVI	y = 1.6906x-0.413	0.9484	0.0194
IRECI	y = 0.2492x+0.4425	0.9408	0.0208
GEMI	y = 2.5699x-1.6329	0.9372	0.0214
EVI	y = 1.8851x-0.6947	0.9206	0.0241



Conclusions

- Sentinel-2 is superior to older generations of public domain satellite data in terms of spatial, temporal and spectral resolutions.

- This allows, for the first time, to estimate K_c, an important parameter for irrigation management, at a high frequency that can support irrigation decisions, at a fine spatial resolution of 10 m that well captures within field variability, and at higher accuracy than before, owing to the sensor's unique spectral bands that cover the red-edge region.

- Venµs offers an even better revisit time than Sentinel-2, thus improving the estimation of K_c.

Thanks for listening!