Analysis of the main arable crops' phenology by polarimetric descriptors derived from H/A/α decomposition of Sentinel-1 time series data

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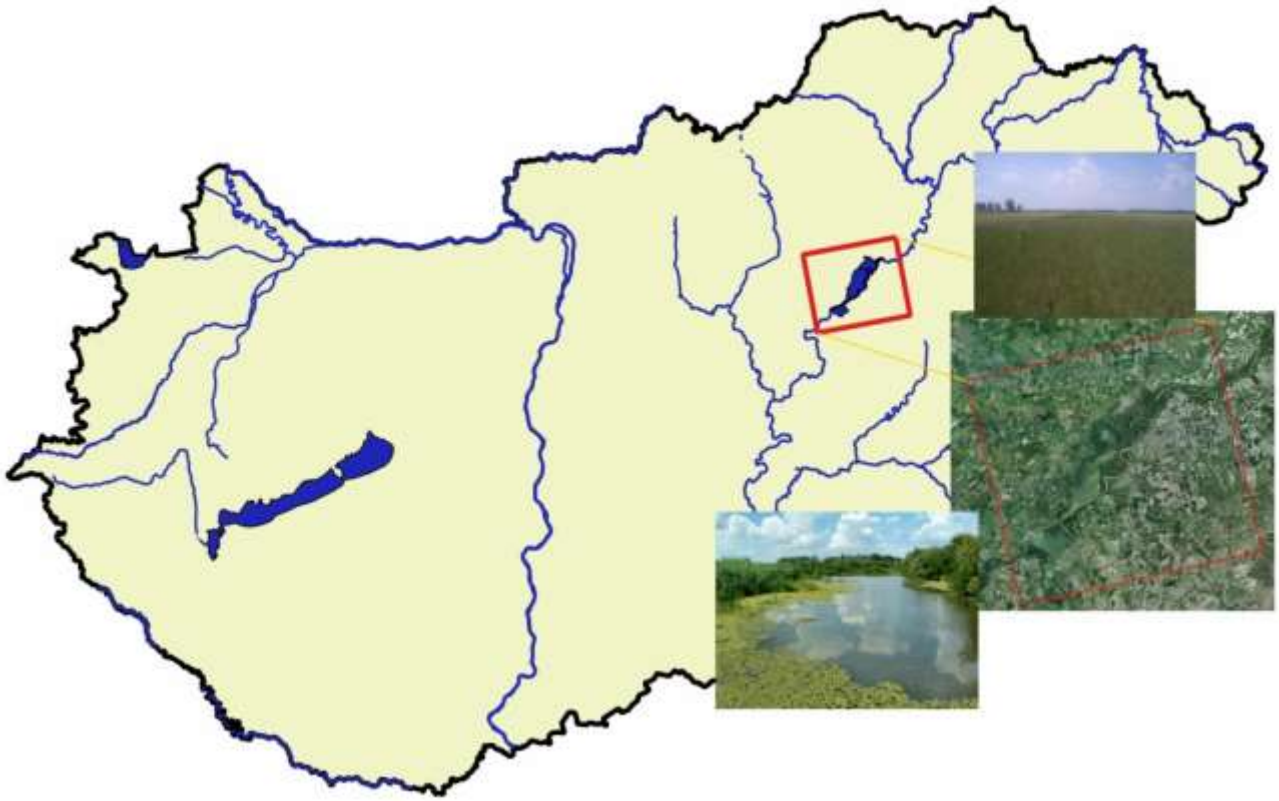
Motivation

- The **continuous monitoring** of crops condition is important in agriculture.
- Time series of optical data cannot give enough information due to cloud coverage.
- Sentinel-1 series give the chance to examine development of crops by time series with no gaps.
- Phenology profiles of typical crops can give valuable information about the crop condition for the agriculture.

Study area – Lake Tisza



Lake Tisza region has a complex characteristics and rich in different type of land cover categories, especially in agricultural areas.

In this area there are many crops like maize, wheat, peas, sunflower, alfalfa, rapeseed etc.

Crops examined

Maize

Features:
- Veg. period: Jun.-Oct.
- Vertical dominance of structure

2015: 11 pieces / 47 ha
2016: 20 pieces / 544 ha

Sunflower

Features:
- Veg. period: May.-Aug.
- Complex structure
- Flowering in July
- Desiccation in Aug.

2015: 16 pieces / 55 ha
2016: 20 pieces / 461 ha

Winter wheat

Features:
- Veg. period: Oct.-Jul.
- Vertical dominance of structure
- Wheat ear in April

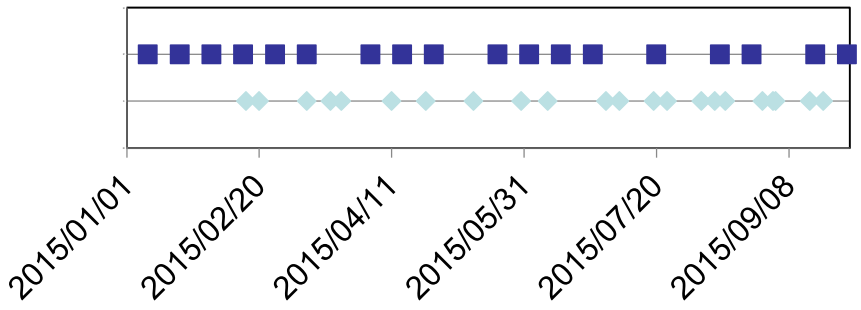
2015: 12 pieces / 55 ha
2016: 20 pieces / 535 ha

Rapeseed

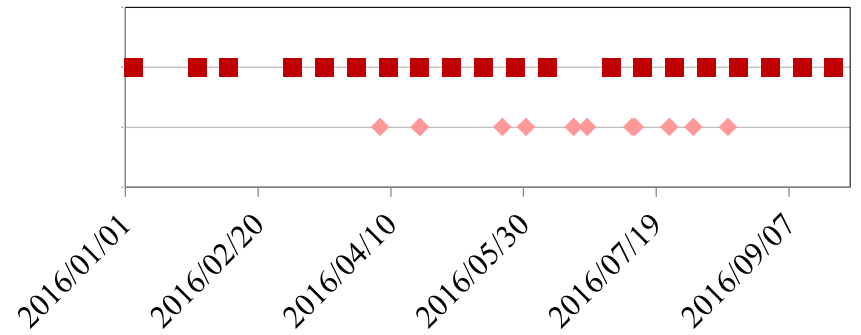
Features:
- Veg. period: Oct.-Jun.
- Complex structure
- Flowering in Apr-May

2015: 7 pieces / 45 ha
2016: 21 pieces / 522 ha

Data



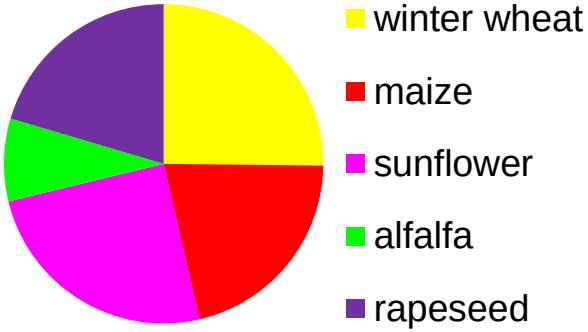
Sentinel-1 (20m)
Proba-V (100m)



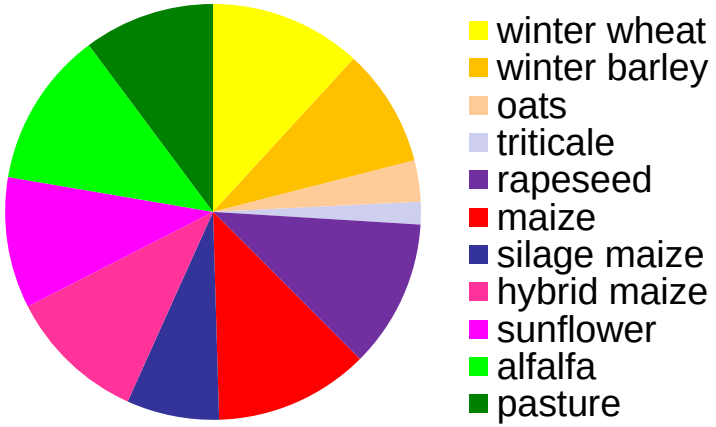
Sentinel-1 (20m)
Proba-V (100m)

pass	ascending
incident angle (^{0})	36.87-40.40
wavelength (cm)	C (5.6)
beam	IW3
polarisation	dual (VV+VH)
spatial resolution (m)	20
derived bands	α, α1, α2, anisotropy, entropy, SE, Sei, Sep, L1, L2, $б_0^{VH}$, $б_0^{VV}$, $б_0^{VH}/б_0^{VV}$

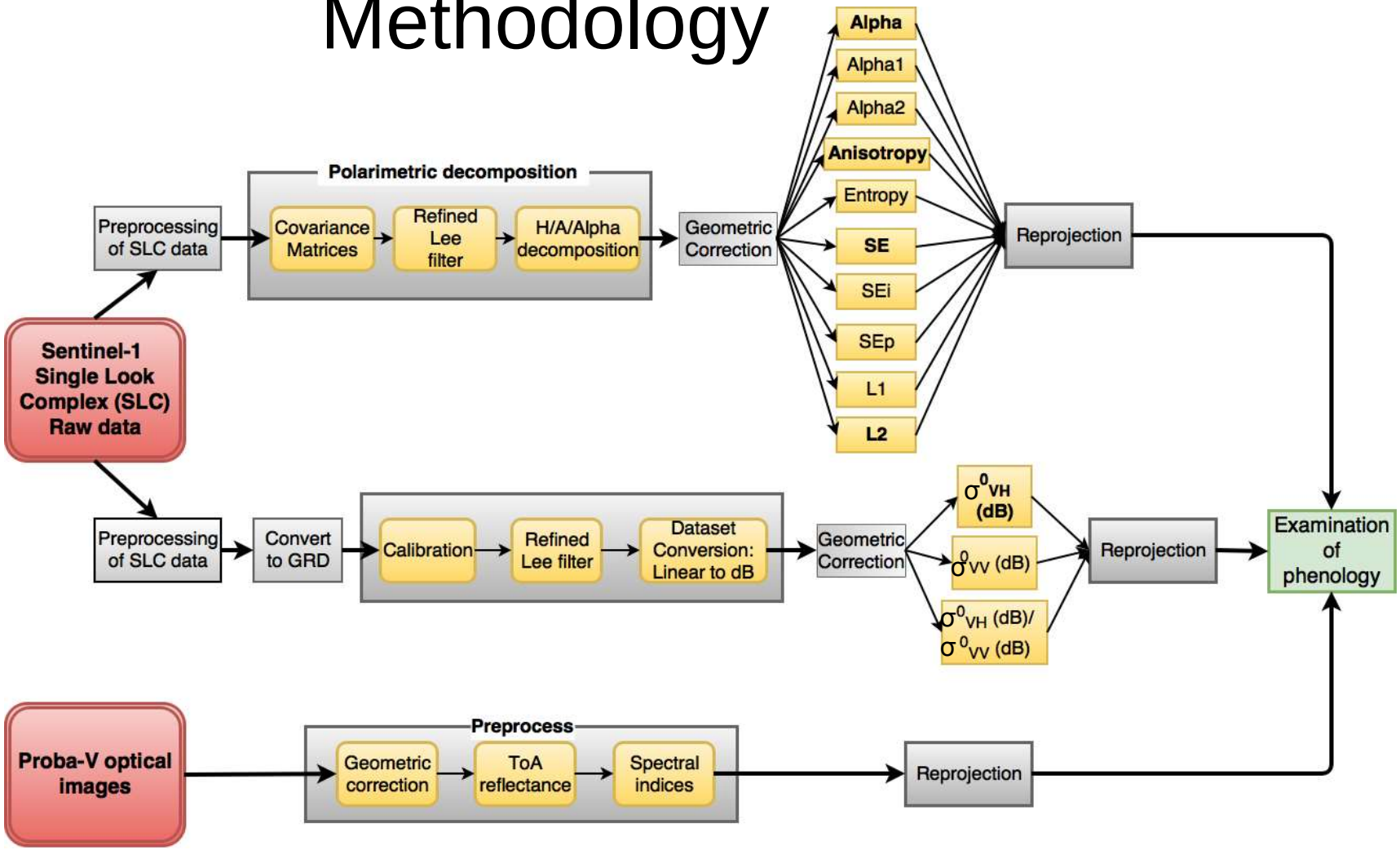
Distribution of training area in 2015



Distribution of training area in 2016

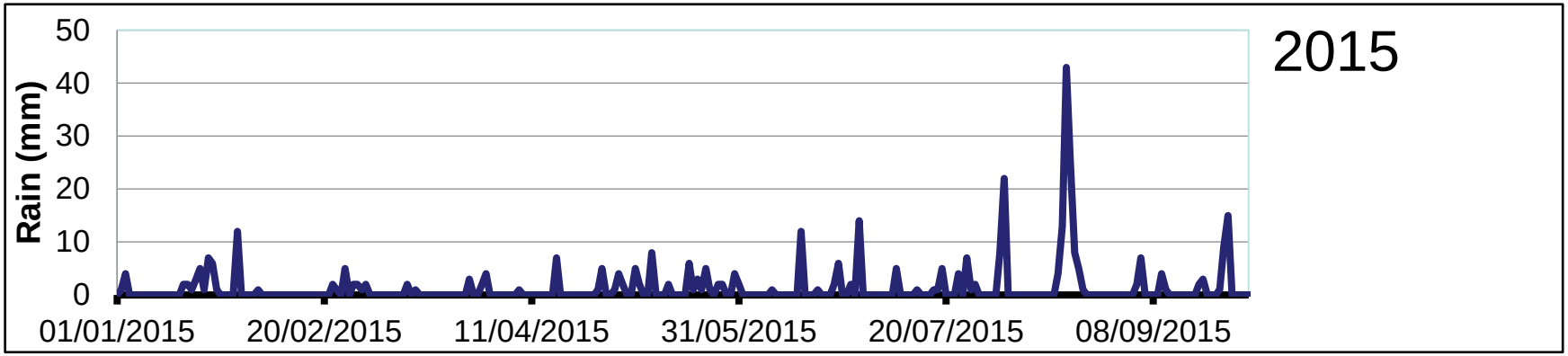


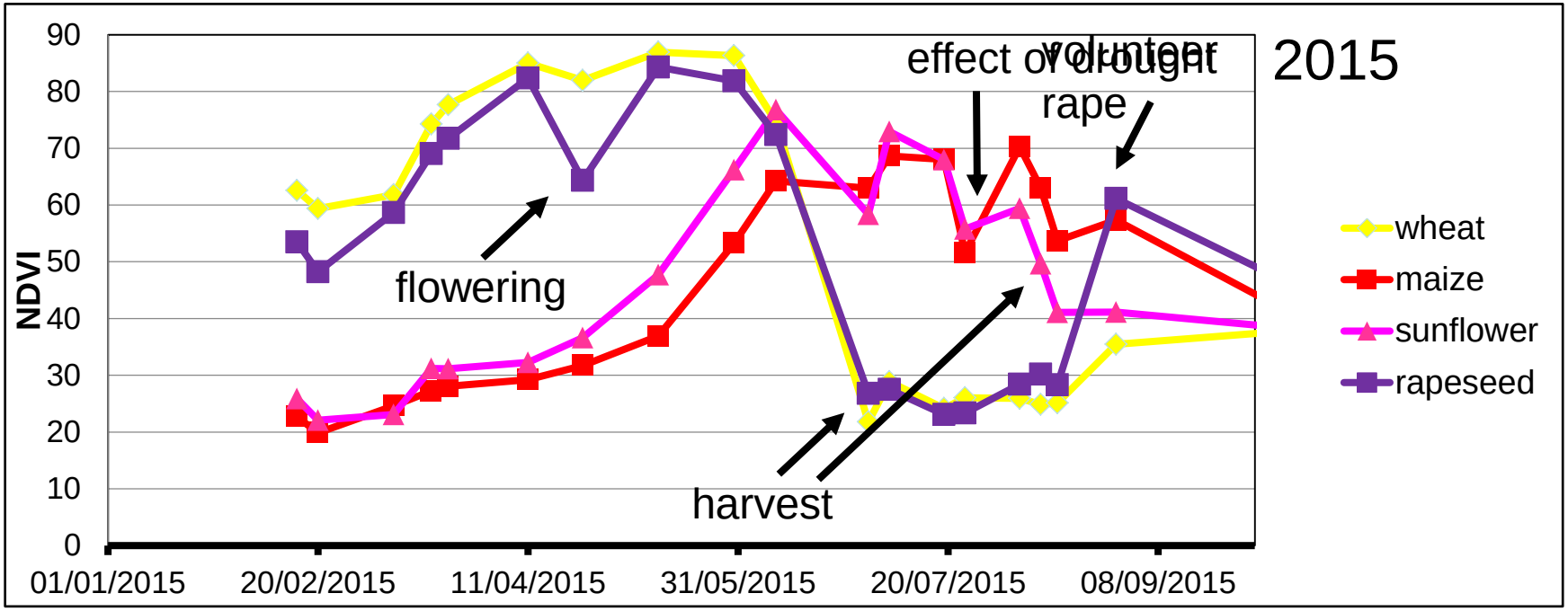
Methodology



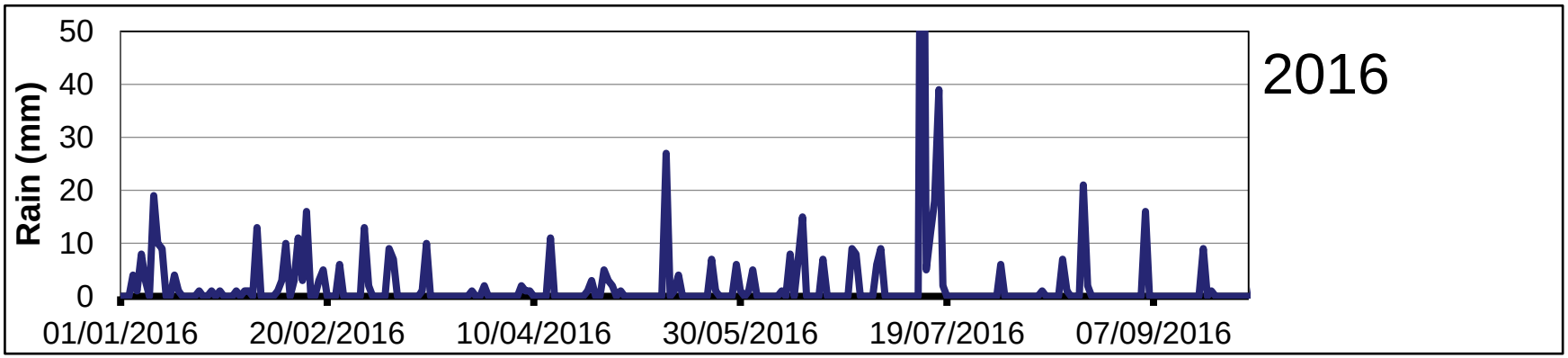
Surek et al. (2015): **Comparison off efficiency of optical and radar data for land cover classification**. *ESA PolinSAR 2015. ISBN 978-92-9092-293-3.*

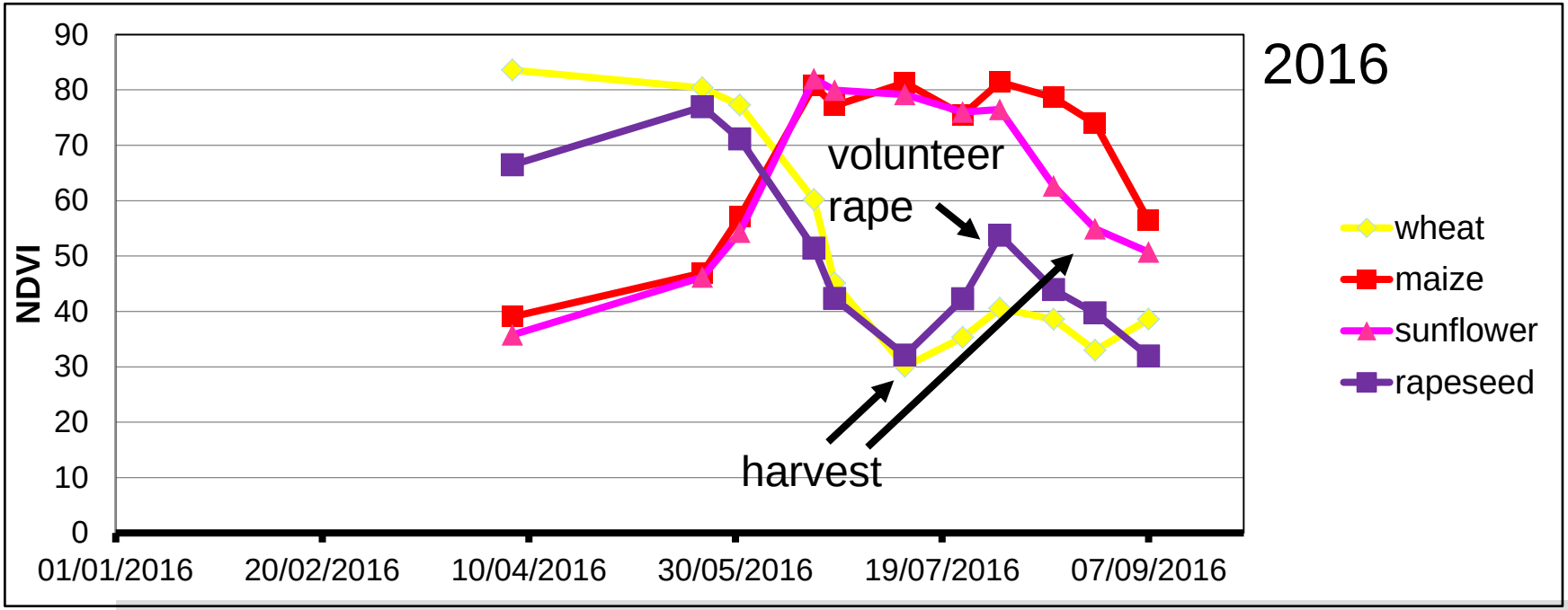
Phenology profiles: NDVI



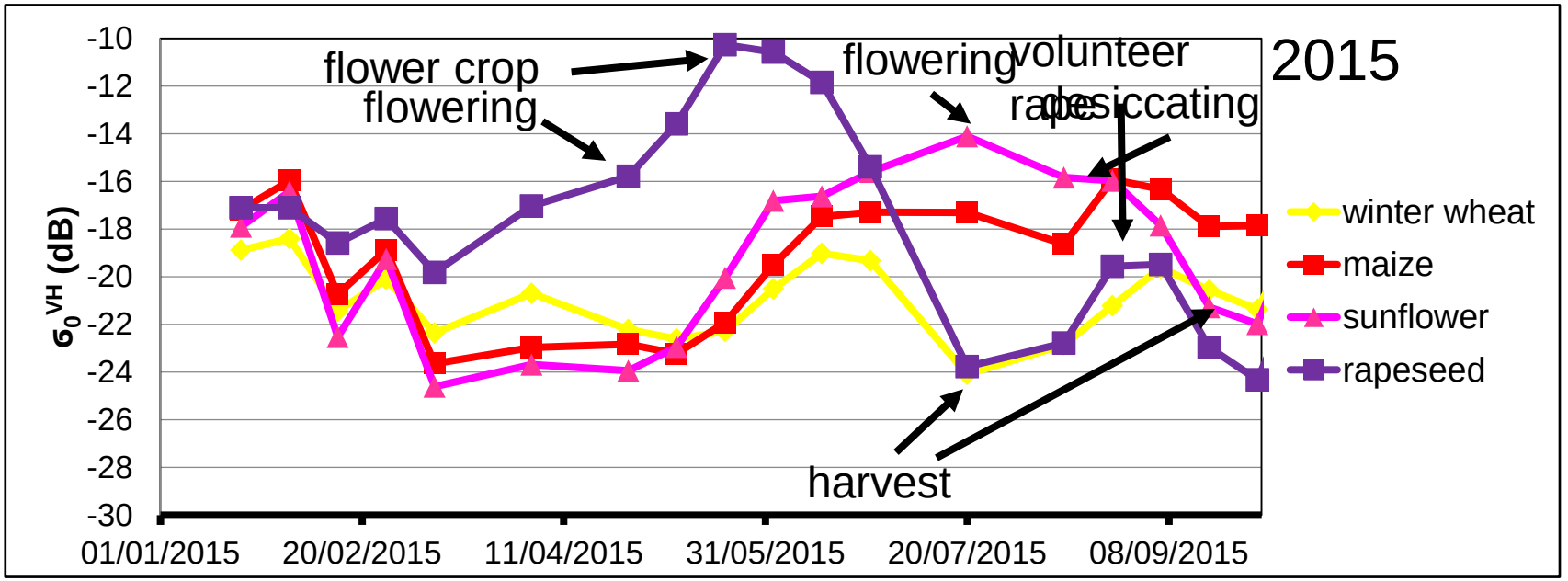


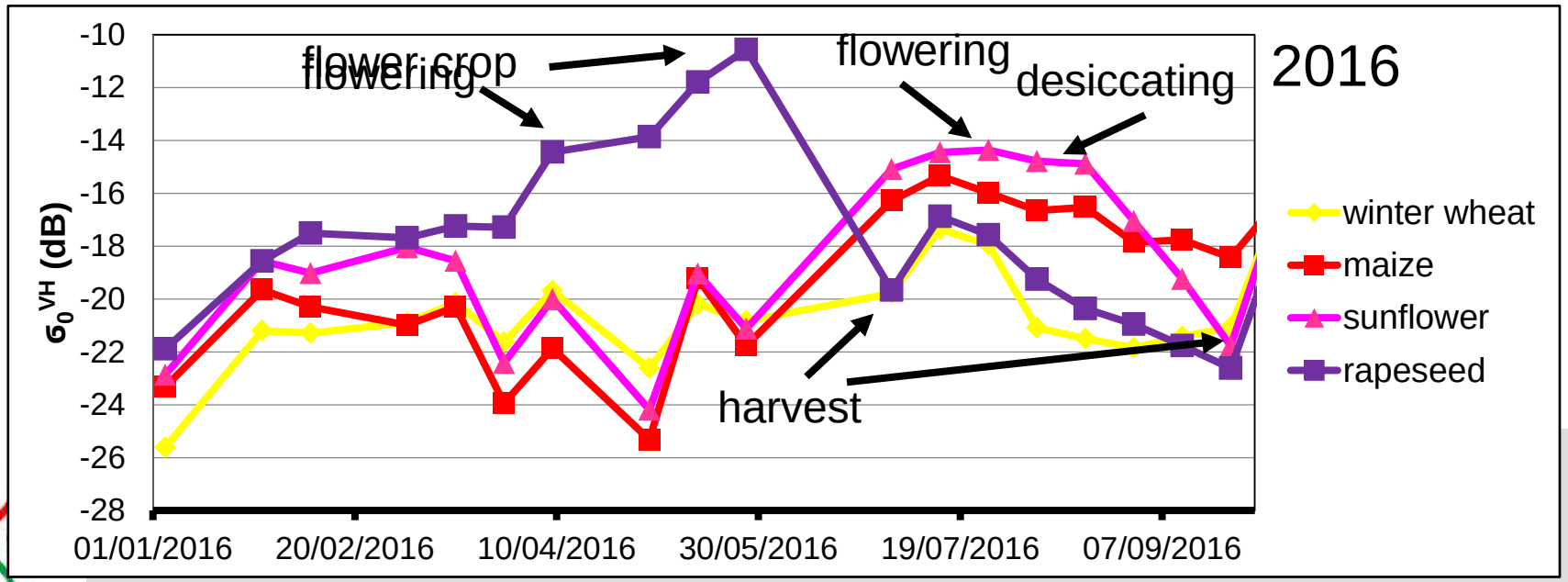
Phenology profiles: NDVI





Phenology profiles – σ_0^{VH}





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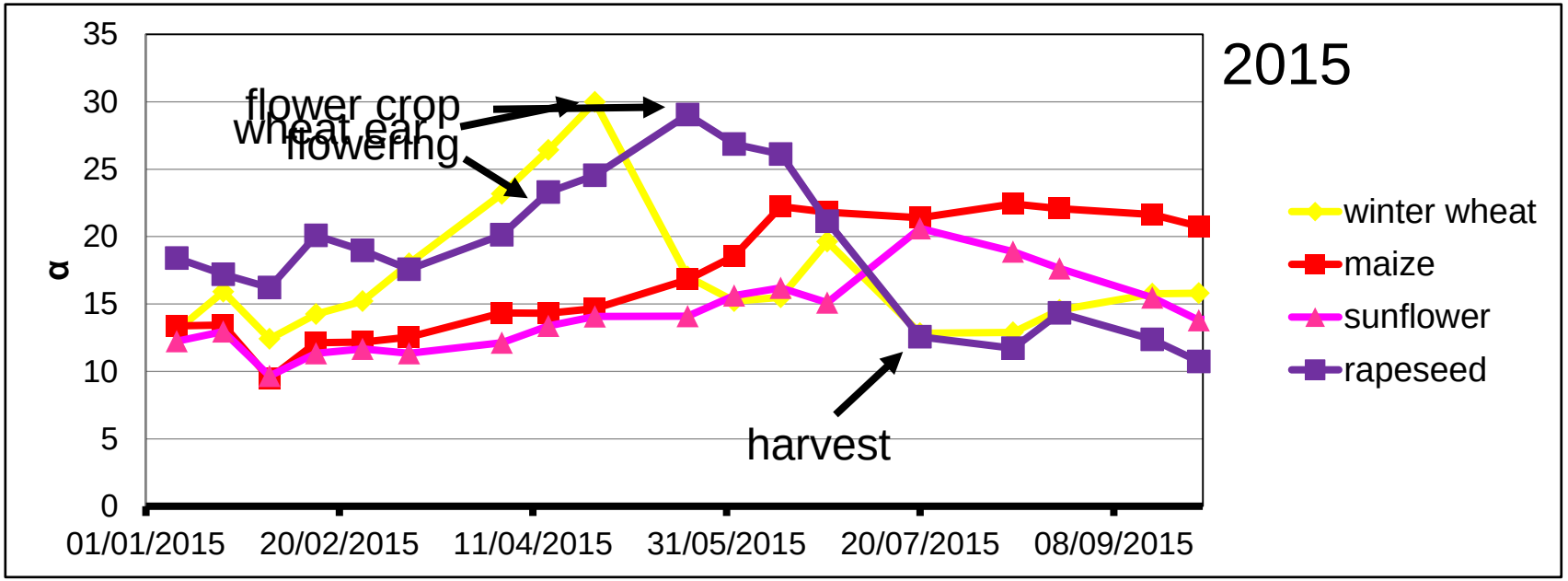
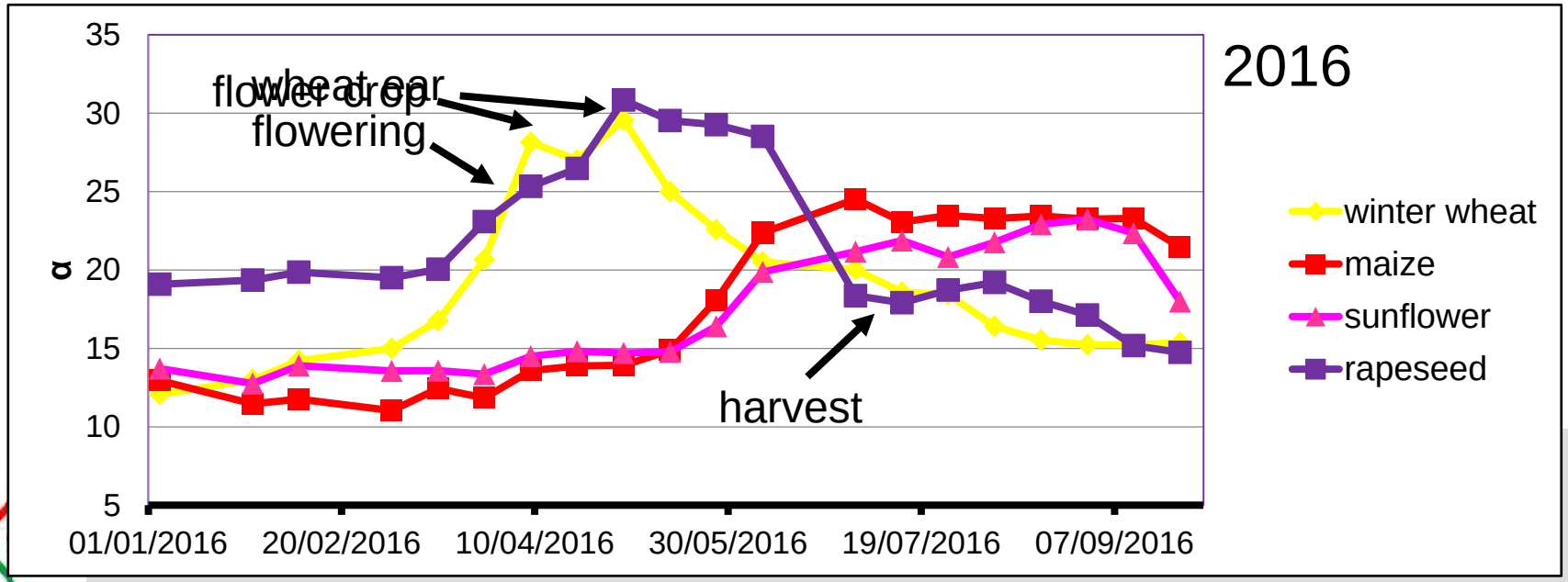
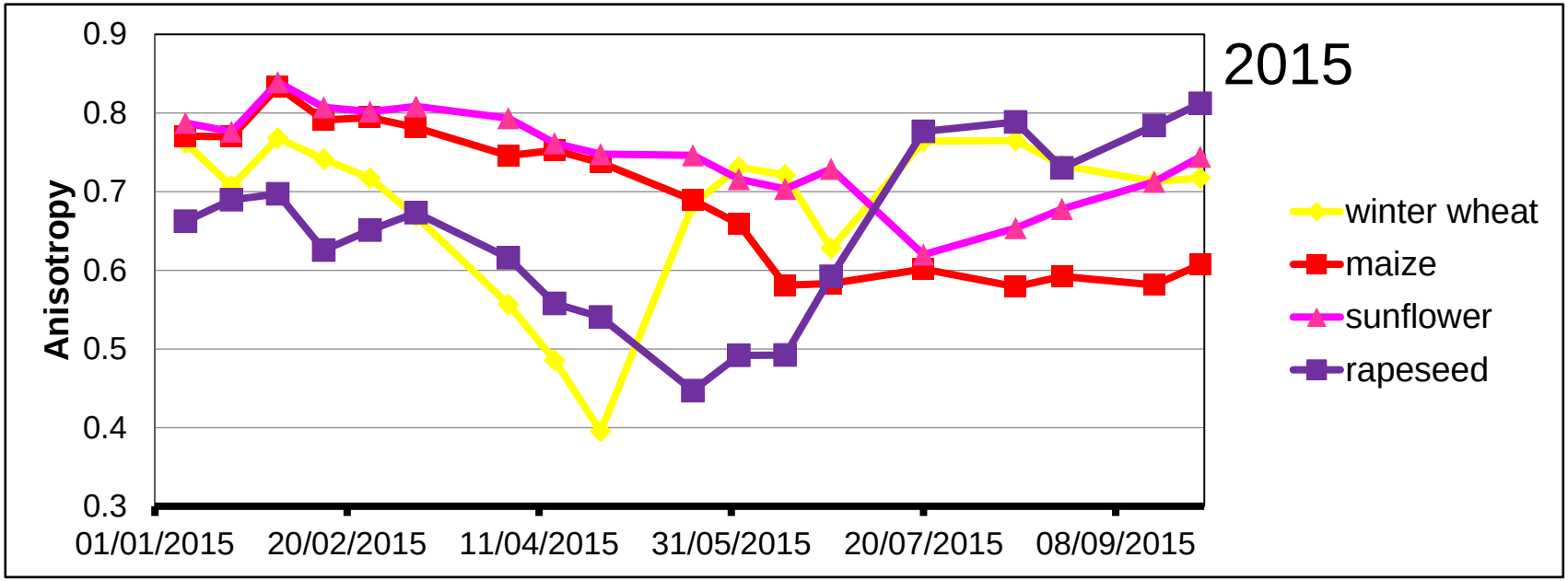
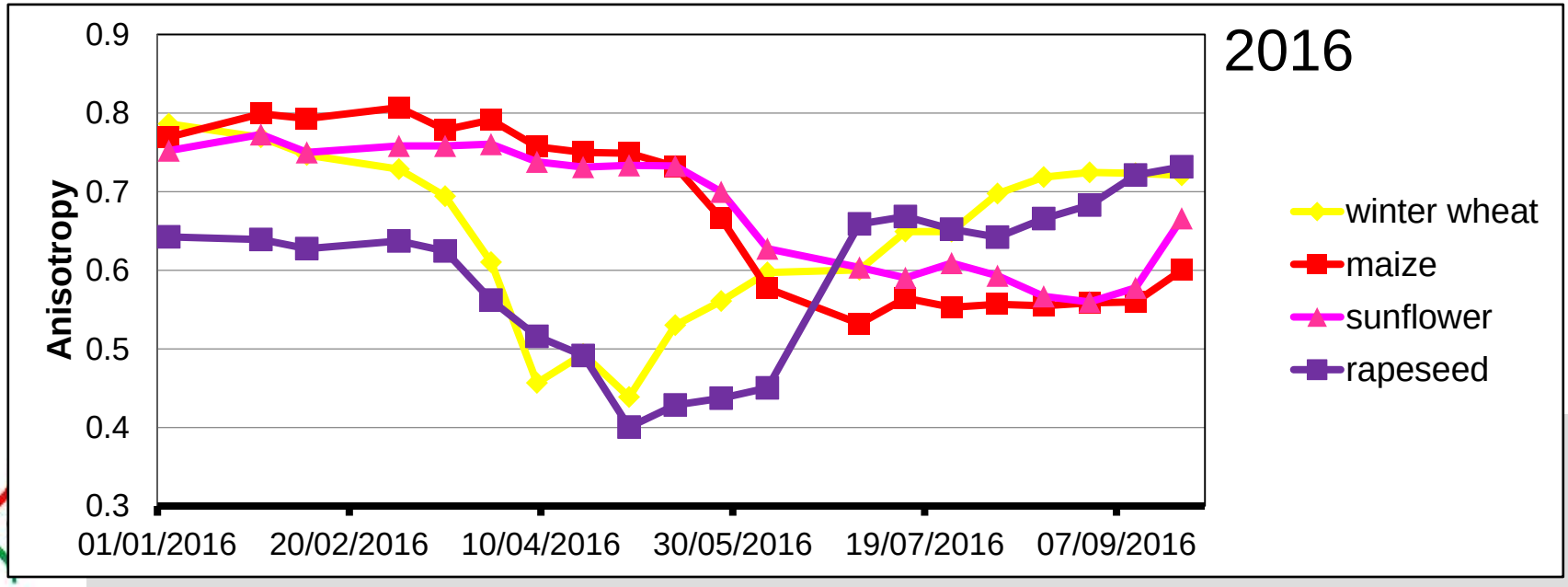
Phenology profiles – α



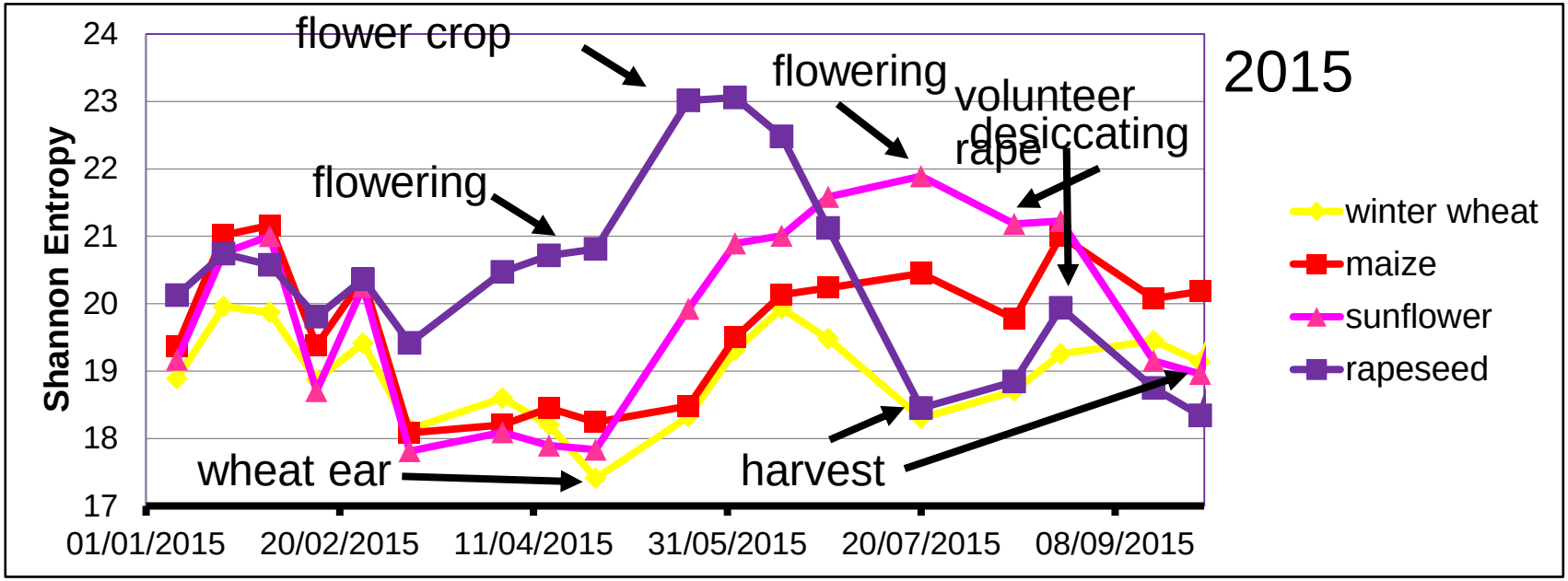


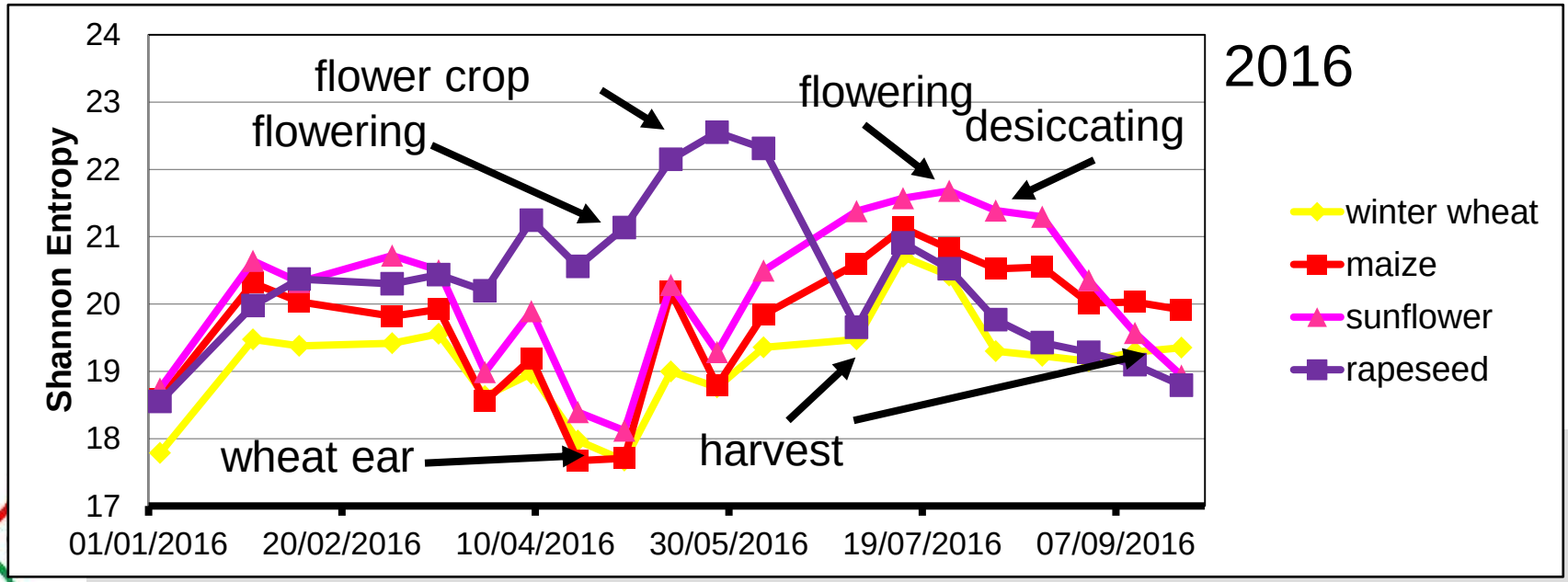
Phenology profiles – Anisotropy



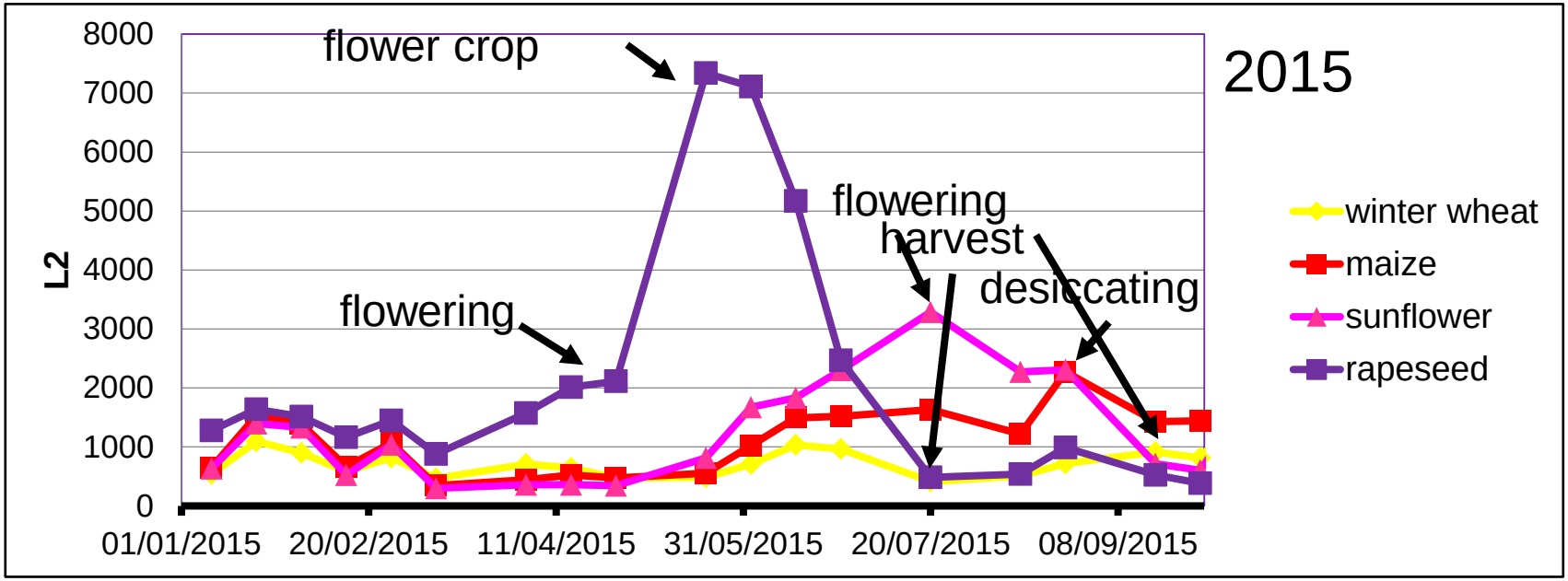


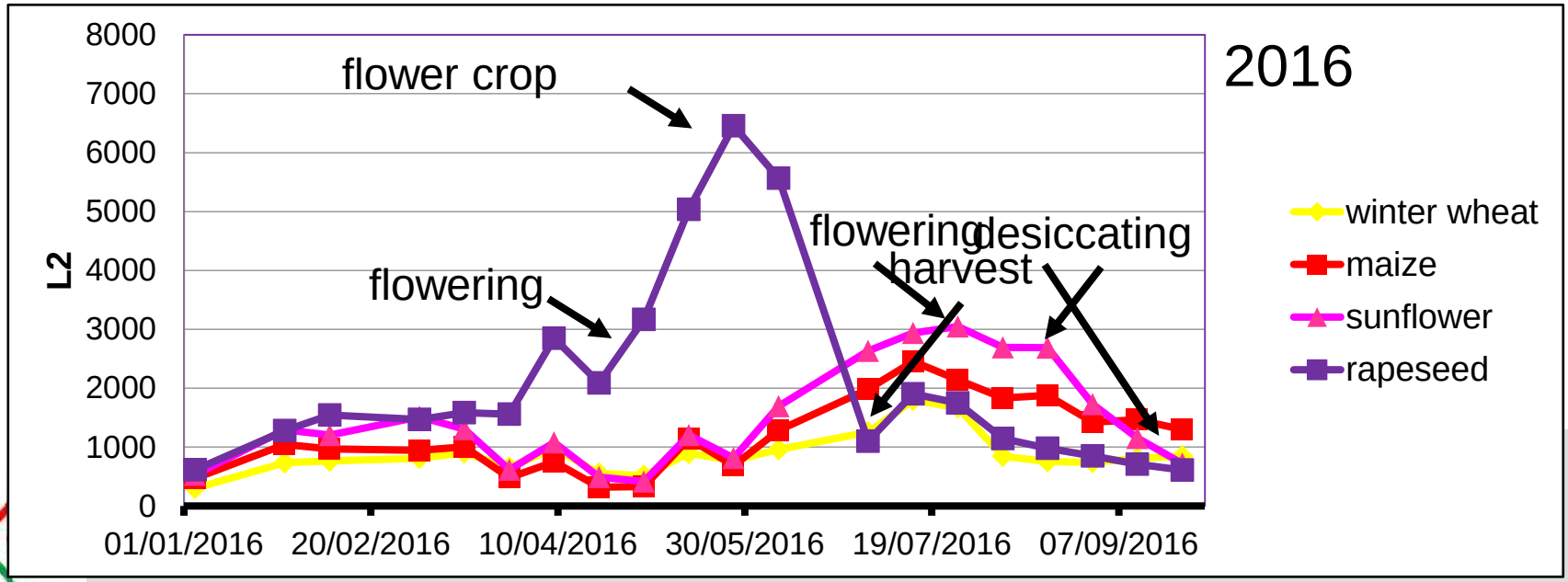
Phenology profiles – Shannon Entropy





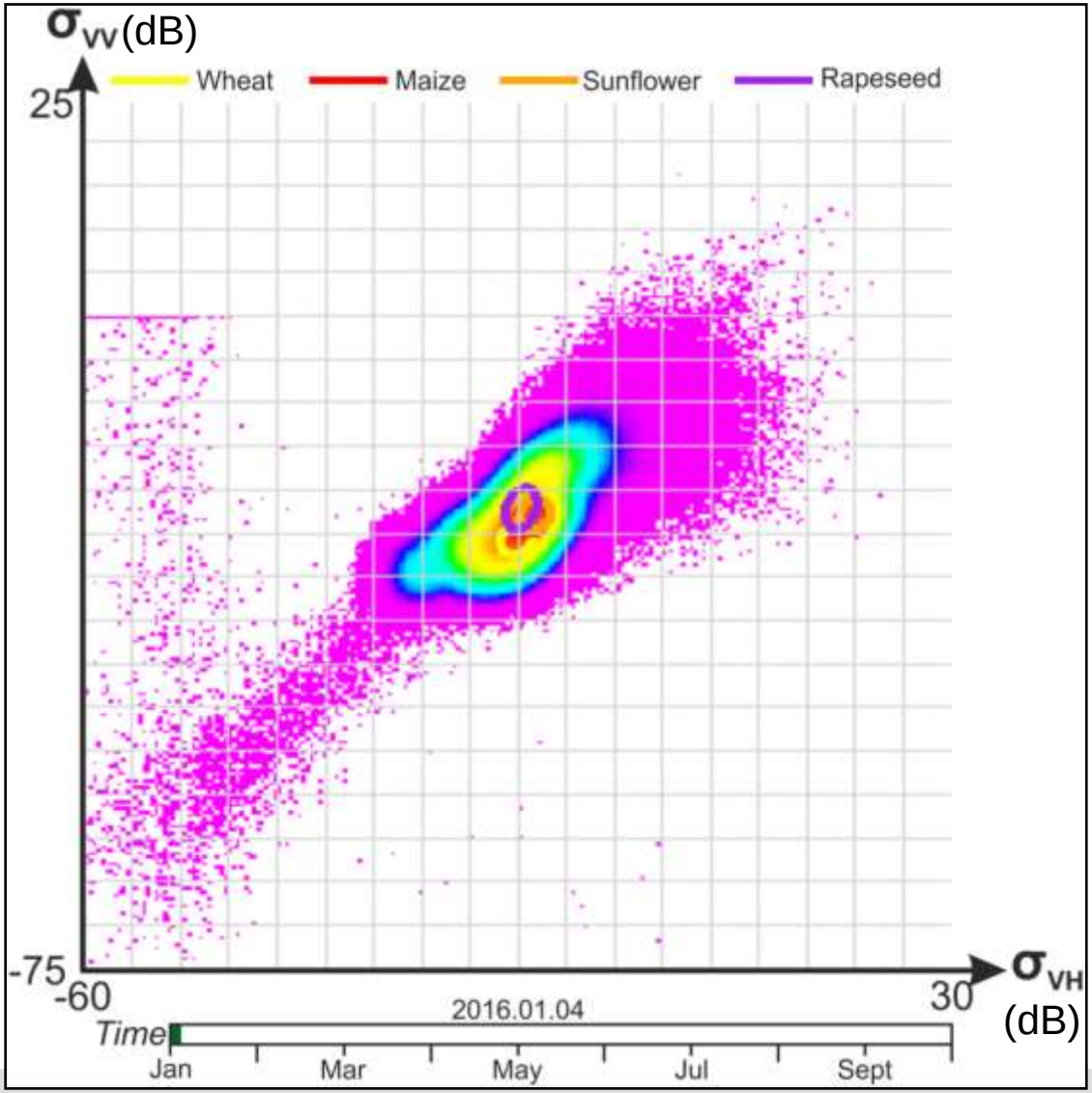
Phenology profiles – Second eigenvalue





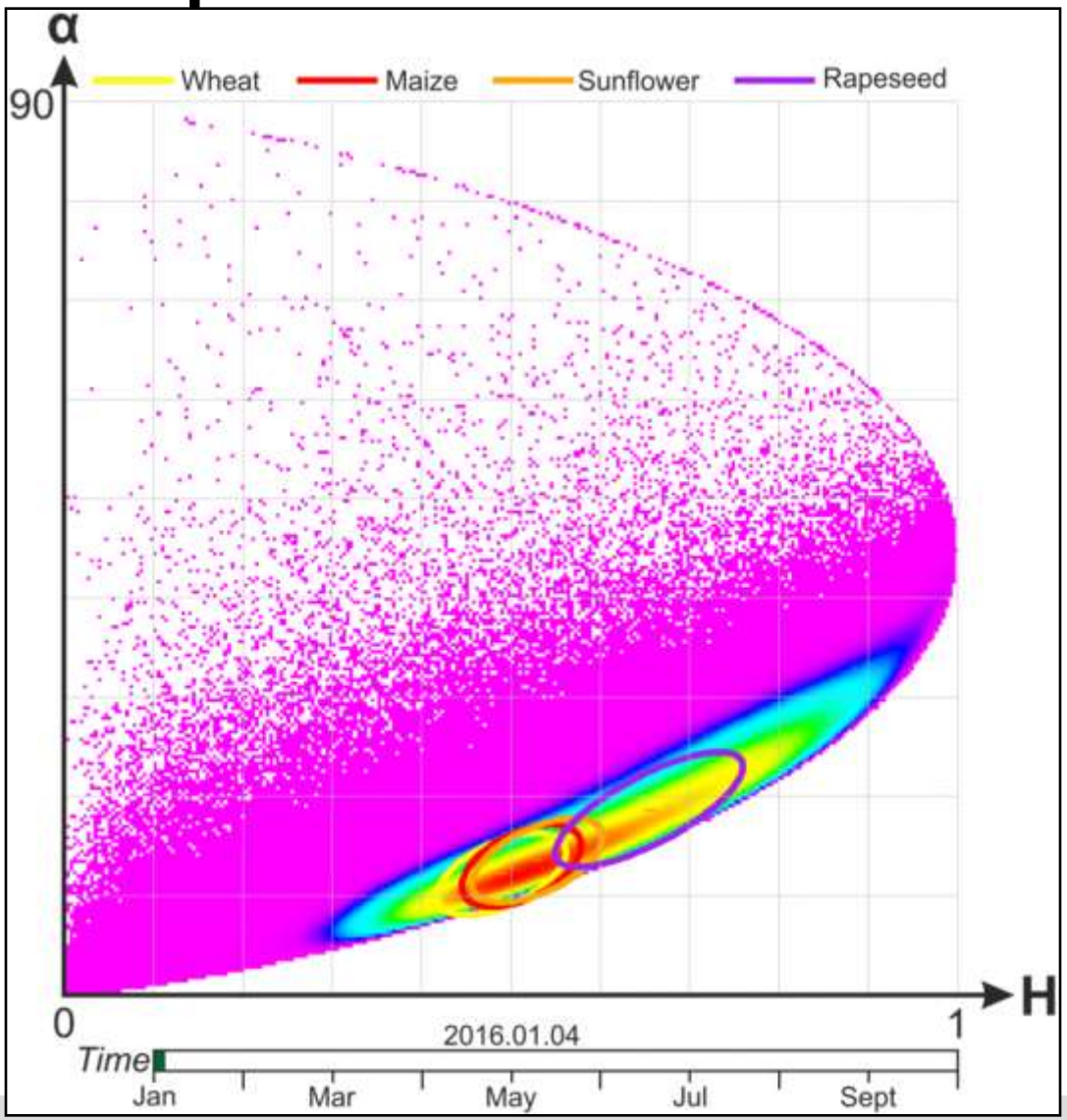
Sigma nought Space 2016

- Separation of maize, sunflower and winter wheat **is not quite good**.
- Rapeseed was separeted well, especially in flowering period.
- The values of both of 6^0 was increased in the flowering period of rapeseed.



H-Alpha Space 2016

- The winter crops and summer crops are **separeted well**.
- There is a short mixing period when summer crops are growing and winter crops is harvested.
- The rapeseed has a charasteristic separation in different short period.
- Maize and sunflower have a similar features in H-α space



Summary

Local max. Local min.

Derived bands / crop type	Alpha	Aniso-tropy	SE	L2	σ^0 (dB) VH	σ^0 (dB) VV
winter wheat	end of April	-	end of April		-	beginning of May
maize	July-Sept.	-	-	-	-	-
sunflower	-	-	middle of July - middle of Aug.	June-Aug.	-	June-Aug.
rapeseed	May-June	May-June	end of May	middle of May-Middle June	middle of May-Middle June	middle of May-Middle June

Conclusion

- In examination of 2 years crop developments have a **recurrent, recognizable phenology profiles** in different radar signitures.
- It was presented that radar features – especially decomposition parameters - can give added information to describe crops' condition.
- Sigma noughts are **not enough** for the agricultural analysis.
- Even though radar features have high potential to give valuable information about the crop status, the **real potential is in the fusion of radar and optical data**.

Thank you for your attention!

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