WP8 - SCIENTIFIC AND TECHNICAL VALIDATION OF PRODUCT AND SERVICES

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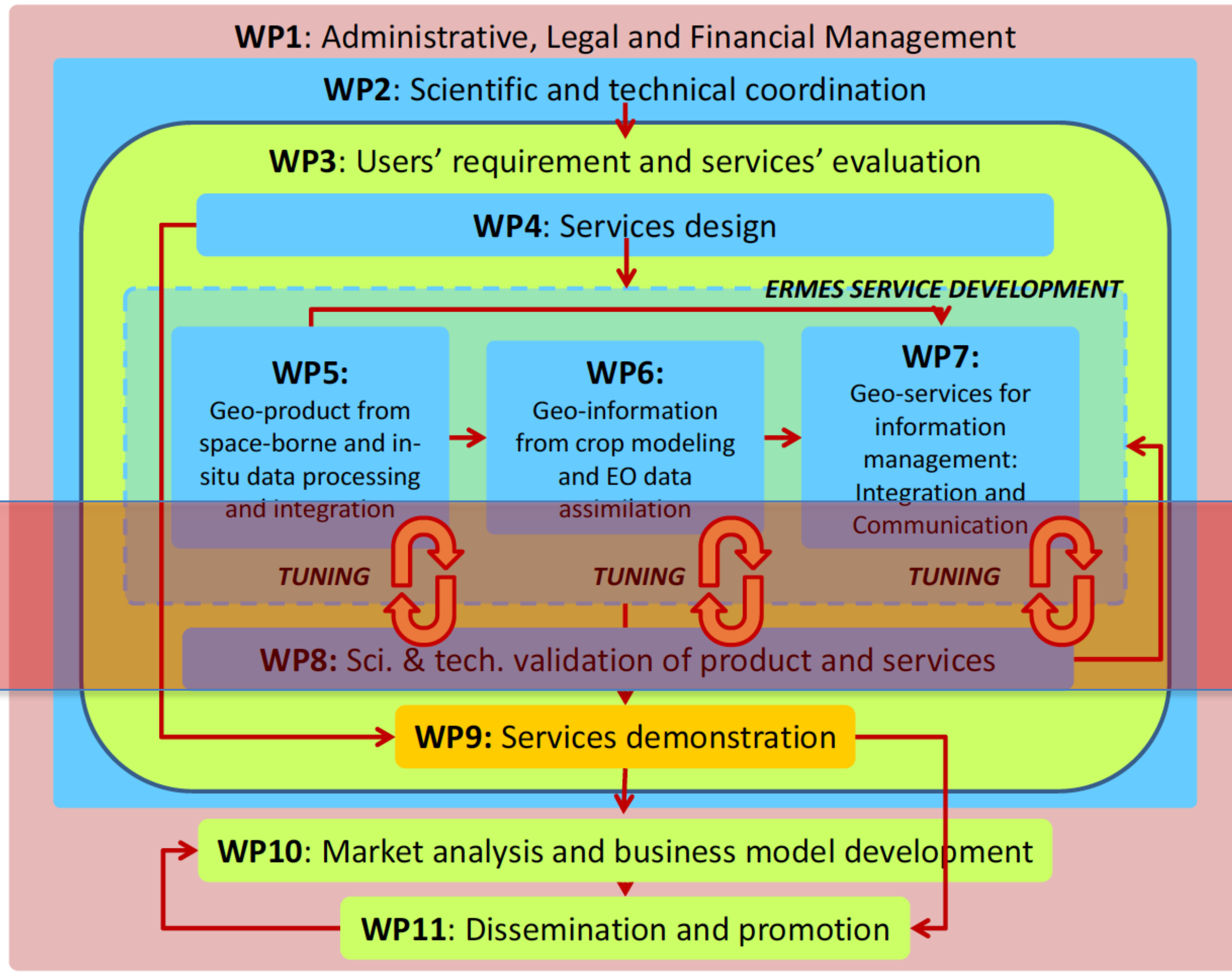
- ✓ **Introduction: WP Objectives and workplan**
- ✓ Activities
- ✓ Results
- ✓ Final Remarks

Main Objectives of the WP8

Assess **products** and **services** quality:

- ✓ EO products
- ✓ crop model information
- ✓ the overall service functionalities

feedbacks



➡ scientific soundness

➡ operational needs (users)

Work Plan for Months 18-34

	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17
Deliv	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32	M33	M34	M35	M36
D8.1	ERMES local products technical and scientific validation: first year v0																	
D8.2								ERMES local products technical and scientific validation: second year v1										
D8.3	ERMES regional products technical and scientific validation: first year v0																	
D8.4								ERMES regional products technical and scientific validation: second year v1										
D8.5	ERMES service technical and scientific validation: first year v0																	
D8.6								ERMES service technical and scientific validation: second year v1										

Workplan of WP8 in months 18-34 with reference to expected deliverables

ERMES Validation: in a nutshell

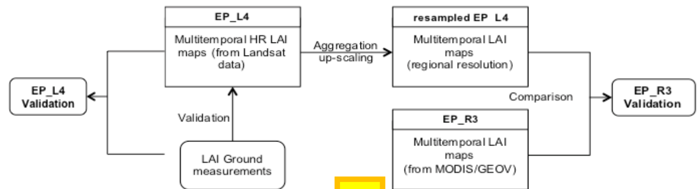
ERMES
AN EARTH OBSERVATION MODEL BASED RICE INFORMATION SERVICE

Products, Info and tools

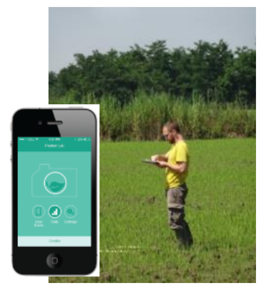
- **Rice maps ; Flooding Maps** (EP_R1) — *WP5*
- **Phenology maps** (EP_R2) — *WP5*
- **Regional Blast Risk alert** (EI_R2) — *WP6*
- **Meteo data** (EP_R5) — *WP5*
- **LAI maps** (EP_R4 – EP_L4) — *WP5*
- **Yield forecast/estimation** (EI_R2) — *WP5*
- **Constant patterns** (EP_L2) — *WP5*
- **Seasonal patterns** (EP_L3) — *WP5*
- **Local Biotic risks; Development stage** (EI_Lx) — *WP6*
- ***AgriNotebook* smart app** — *WP7*
- ***Regional and Local geoportals*** — *WP7*

Validation / Verification

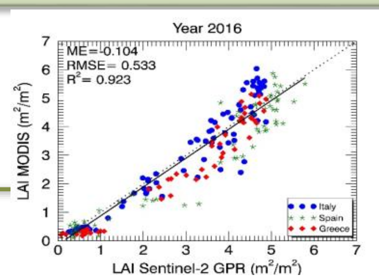
Protocols



Reference data /user feedbacks



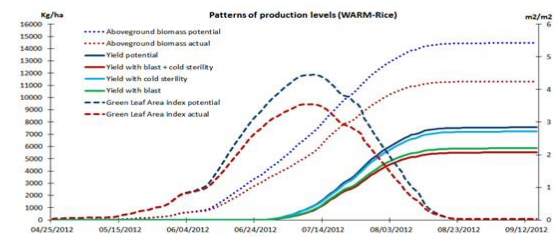
Validation results



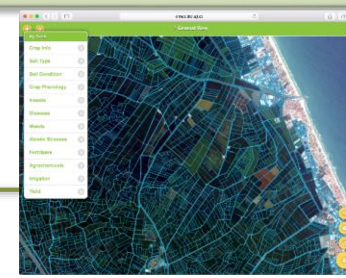
Tuning / Wrap-up

Processing chains

Modelling solutions



Tools



- ✓ Introduction: WP Objectives and workplan
- ✓ **Activities**
- ✓ Results
- ✓ Final Remarks

Activities months 18 - 34

First demonstration year

- finalize accuracy/quality assessment (single products/tools and of the overall services) for 2015

- analyse the lessons learnt after 2015 and propose tuning and improvements as regards processing chains, solutions and tools for the second year of demonstration

Second demonstration year

- accuracy/quality assessment for 2016

- analyse and recap the level of quality achieved by the products, tools and services at the end of the demonstration phase

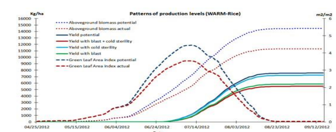
Monitoring product quality throughout workflows and among countries

- ✓ Introduction: WP Objectives and workplan
- ✓ Activities
- ✓ **Results**
  - ✓ Lesson learned after first year of demonstration (2015 crop season)
  - ✓ Validation after second year of demonstration (2016 crop season)
- ✓ Final Remarks

from 2015 to 2016

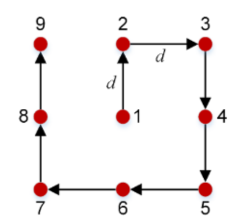
Lesson learned 2015 → Activities for/before 2016

- EP_R1: Rice mapping
- EP_R2: Phenology
- EP_R5 – EP_L5: Meteo data → recalibrate variables → new version validated before 2016
- EI_R2-4, EI_L1: Yield forecast/estimation
- EI_R3- EI_L2: Risk alert → new regional solution



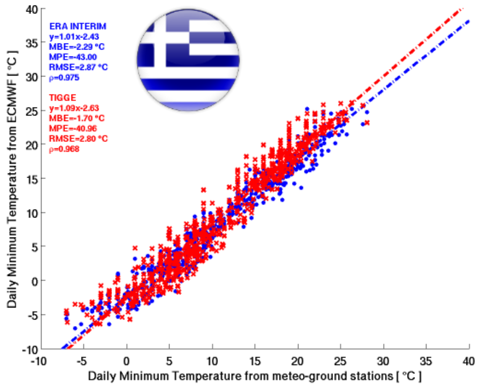
- EP_R4-EP_L4: Bio parameter
- EP_L2: Constant pattern
- EP_L3: Seasonal pattern

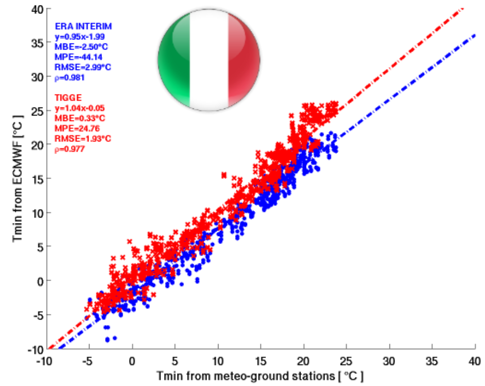
→ To improve LAI in situ data collection → LAI working group → improved data set 2016

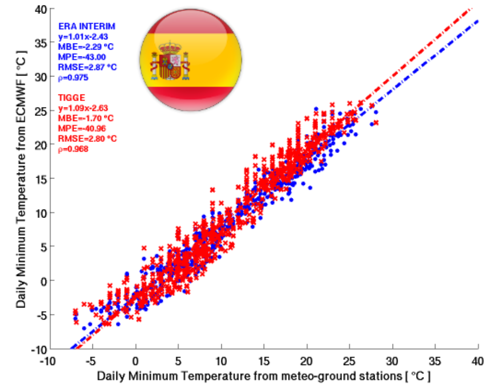


- EI_R1 & EP_L6 → Tools: Geoportal & smart app

meteo data re-processing







Recognised bias in V0

AREA	Statistical scores for TMax				Statistical scores for TMin			
	ρ	MPE [%]	MBE [°C]	RMSE [°C]	ρ	MPE [%]	MBE [°C]	RMSE [°C]
GR (no cal.)	0.98	14.64	-2.42	3.13	0.98	36.98	-3.48	3.81
GR (cal.)	**0.98**	**1.08**	**-0.21**	**1.84**	**0.98**	**19.14**	**-1.86**	**2.39**
IT (no cal.)	0.96	9.79	-2.22	3.46	0.96	34.31	-2.23	3.12
IT (cal.)	**0.97**	**5.75**	**-0.07**	**2.30**	**0.96**	**7.45**	**0.16**	**2.15**
ES (no cal.)	0.94	15.93	-3.34	4.02	0.95	23.421	-2.71	3.36
ES (cal.)	**0.95**	**0.93**	**-0.18**	**2.03**	**0.96**	**6.14**	**-0.84**	**1.97**

MPE [%]
36.98
19.14
34.31
7.45
23.421
6.14

intercalibration with MARS data sets (for archive and NRT) Improved performance in V1

Example → Archive (2003 – 2014)

- ✓ Introduction: WP Objectives and workplan
- ✓ Activities
- ✓ **Results**
  - ✓ lesson learned after first year of demonstration (2015 crop season)
  - ✓ **Validation after second year of demonstration (2016 crop season)**
    - A. EO product (EP_*)
      1. against reference data
      2. Indicators of internal consistency
      3. comparison with related variables
      4. intercomparison among products
      5. against expert knowledge and other ancillary data (judgement)
    - B. Modelling information (EI_*)
- ✓ Final Remarks

EO product (EP_*)

1) Comparison against reference data

Rice crop maps (EP_R1)

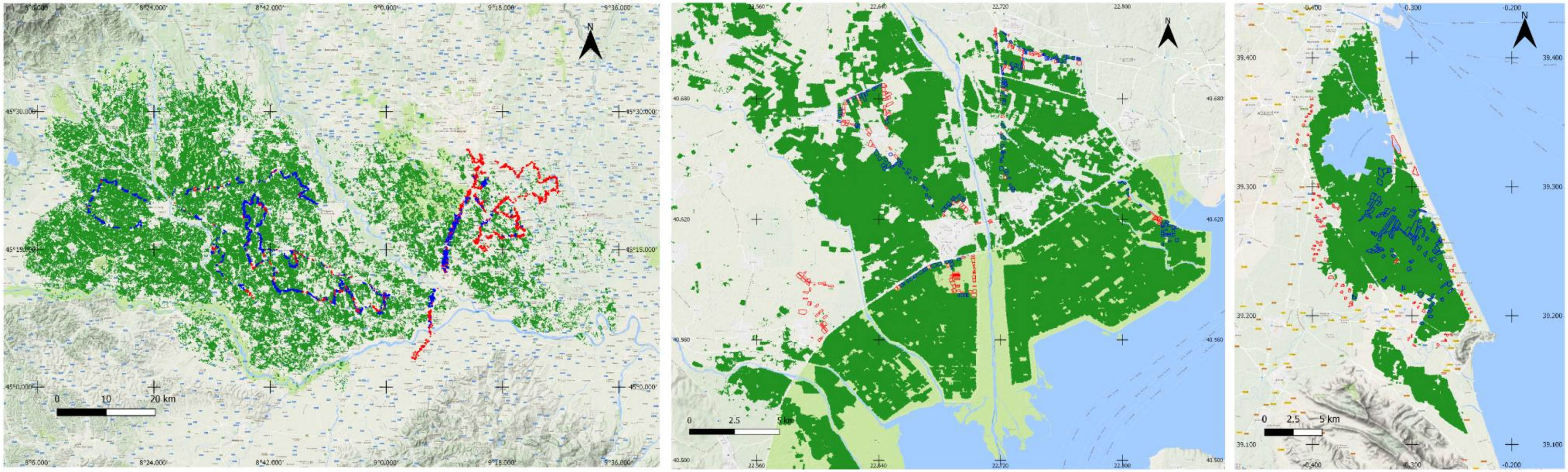


Table S2. Confusion matrices related to rice crop maps.

Italy

	Classification RICE	Classification NOT RICE	Producer's Accuracy
Reference RICE	1639	194	89.4
Reference NOT RICE	157	1237	88.7
User's accuracy	91.3	86.4	

Greece

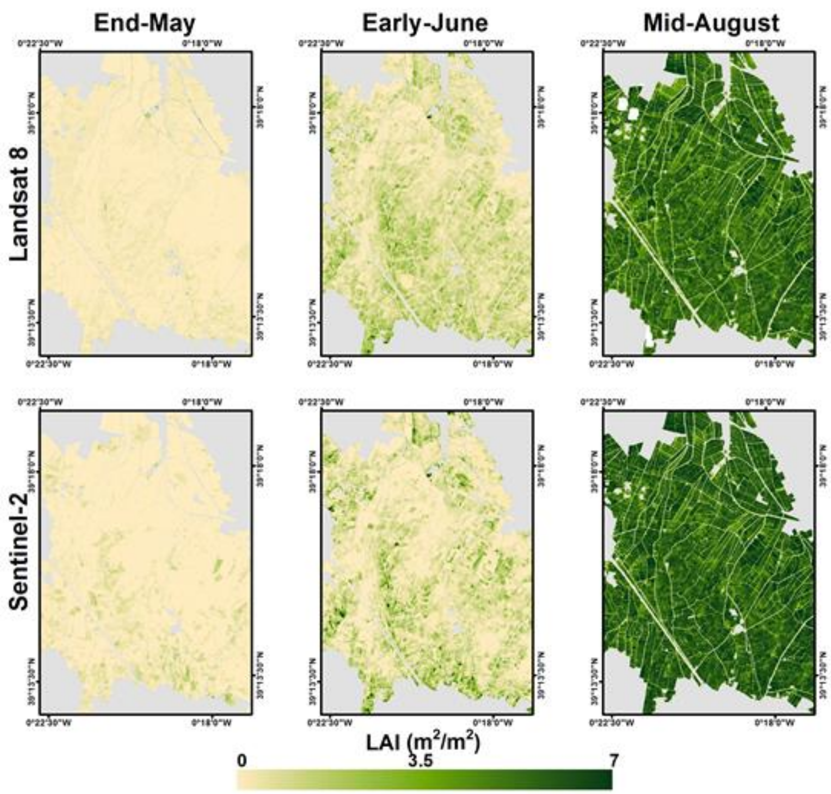
	Classification RICE	Classification NOT RICE	Producer's Accuracy
Reference RICE	7812	369	95.5
Reference NOT RICE	143	7364	98.1
User's accuracy	98.2	95.2	

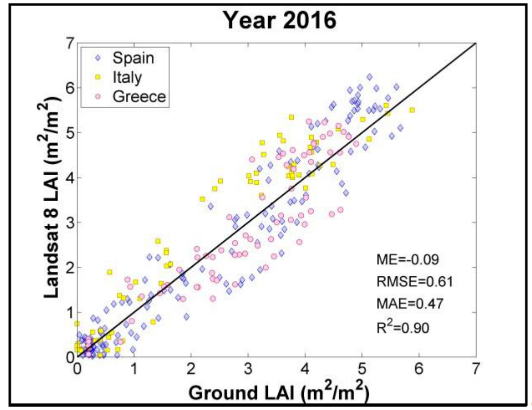
Spain

	Classification RICE	Classification NOT RICE	Producer's Accuracy
Reference RICE	21606	186	99.1
Reference NOT RICE	9	7367	99.9
User's accuracy	100.0	97.5	

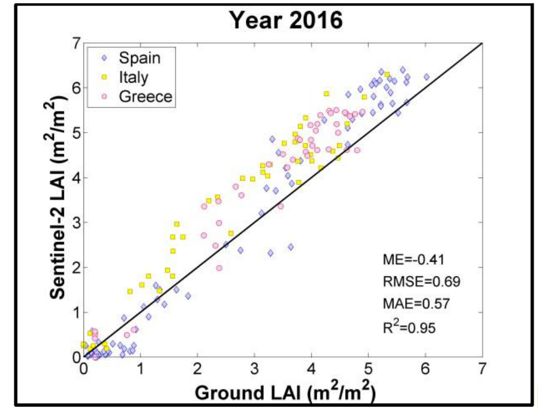
1) Comparison against reference data

High Resolution LAI maps vs field data (EP_L4)

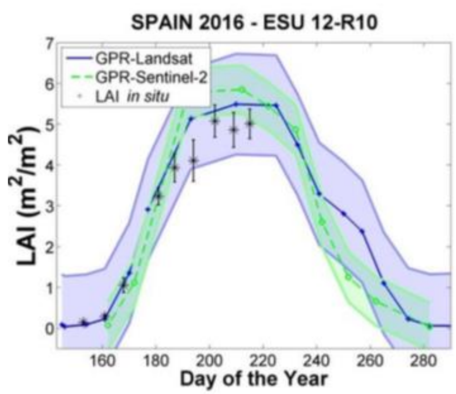


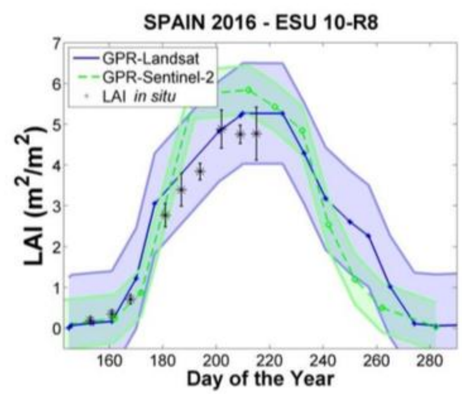


a)



b)

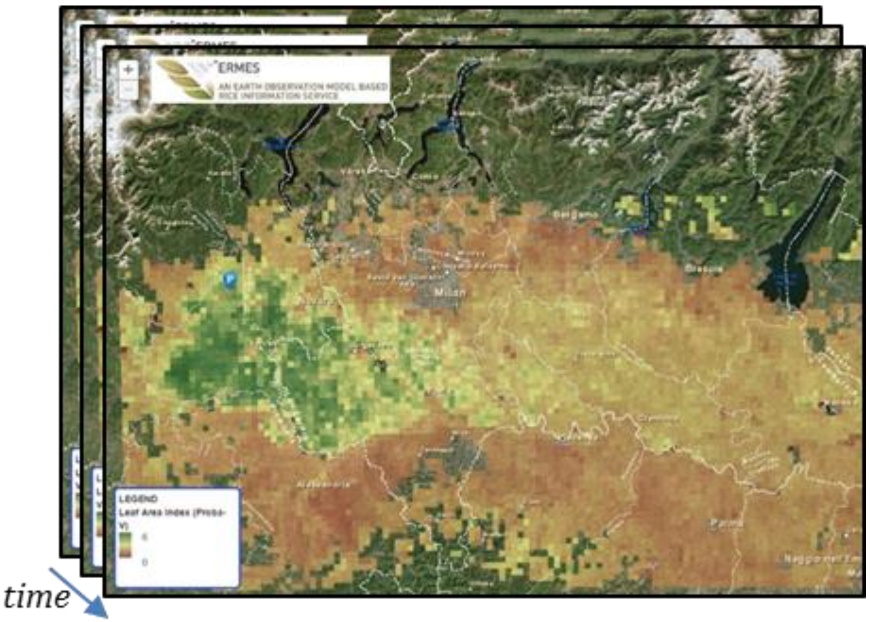


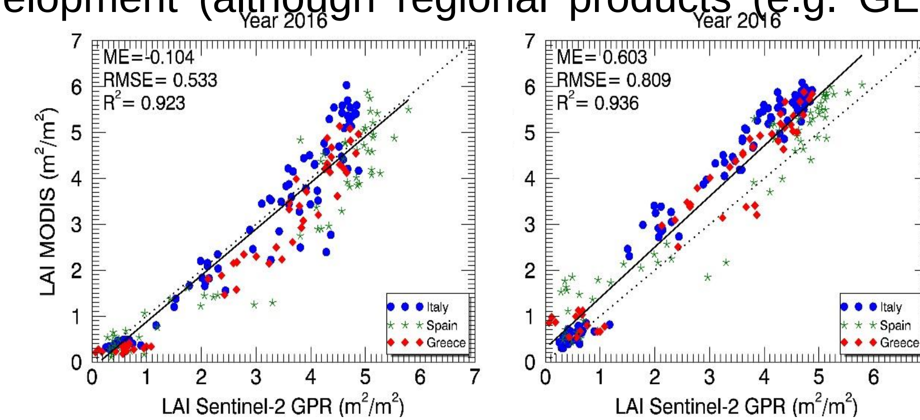


1) Comparison against reference data

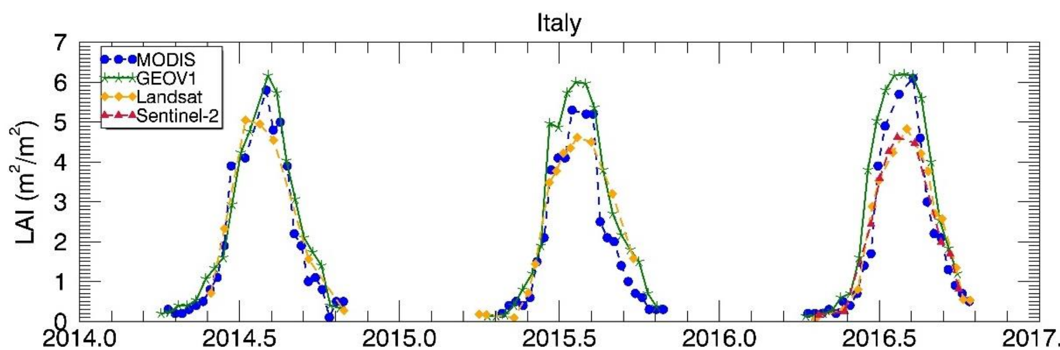
Copernicus (EP_R3) vs HR LAI maps (EP_L4)

- ✓ A good consistency (high correlation, low bias) between the regional and local aggregated LAI maps
- ✓ similar dynamics from sowing up to rice development (although regional products (e.g. GEOV1) present higher values during the peak season)





Comparison regional and aggregated local LAI for the 3 ERMES study area during year 2016



Temporal evolutions in the 2014, 2015 and 2016 rice seasons for a representative rice pixel in Italy.

2) Internal validation by validity measures

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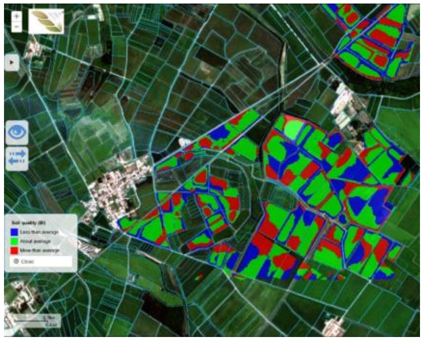
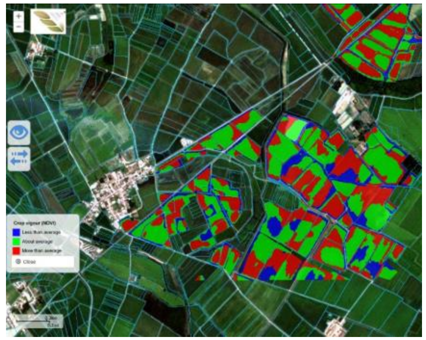
Computation of “silhouette index” (cluster optimality): constant patenrs (EP_L2)

Soil Quality

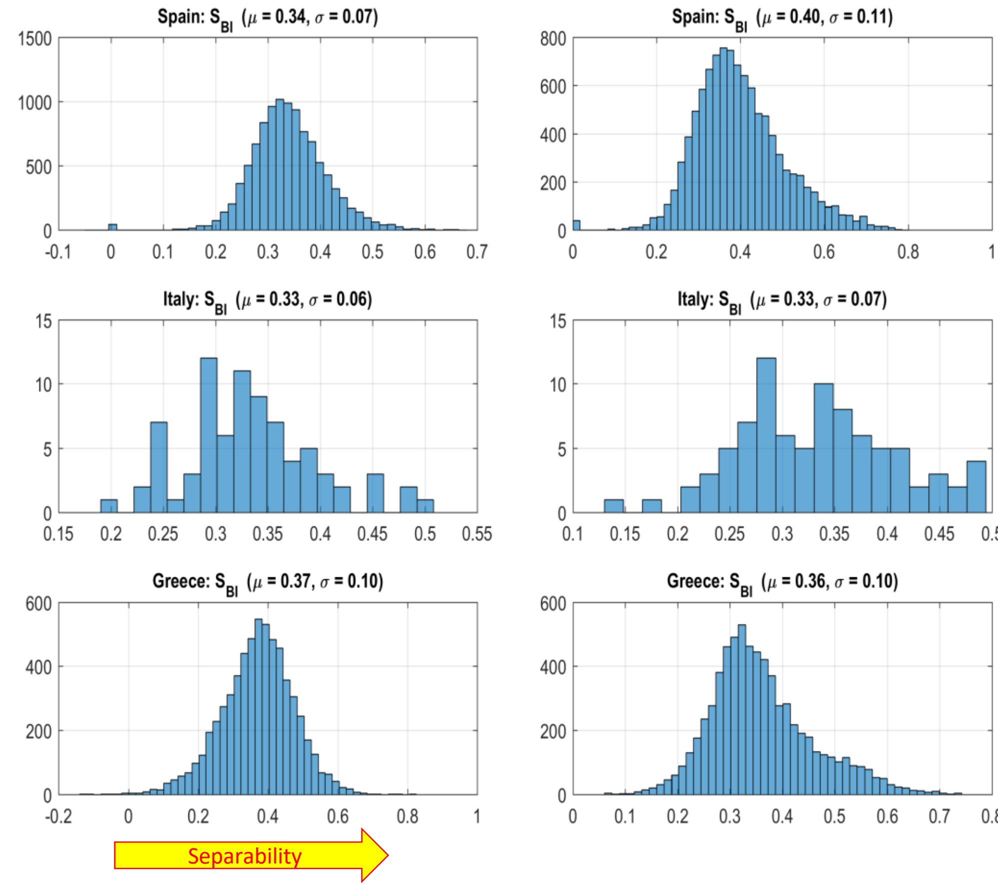


Crop Vigour



Intersection

Good separability of clusters



$$s_j = \frac{b_{pj} - a_{pj}}{\max\{a_{pj}, b_{pj}\}}$$

Euclidean distances of object (pixel) $\boldsymbol{x}_j$ from the nearest and second nearest prototype (cluster centre).

3) Comparison with related parameters:

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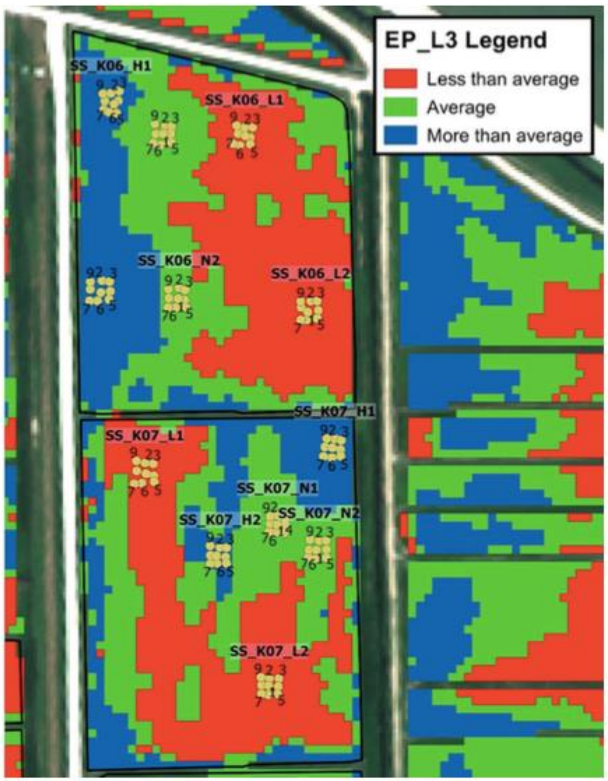
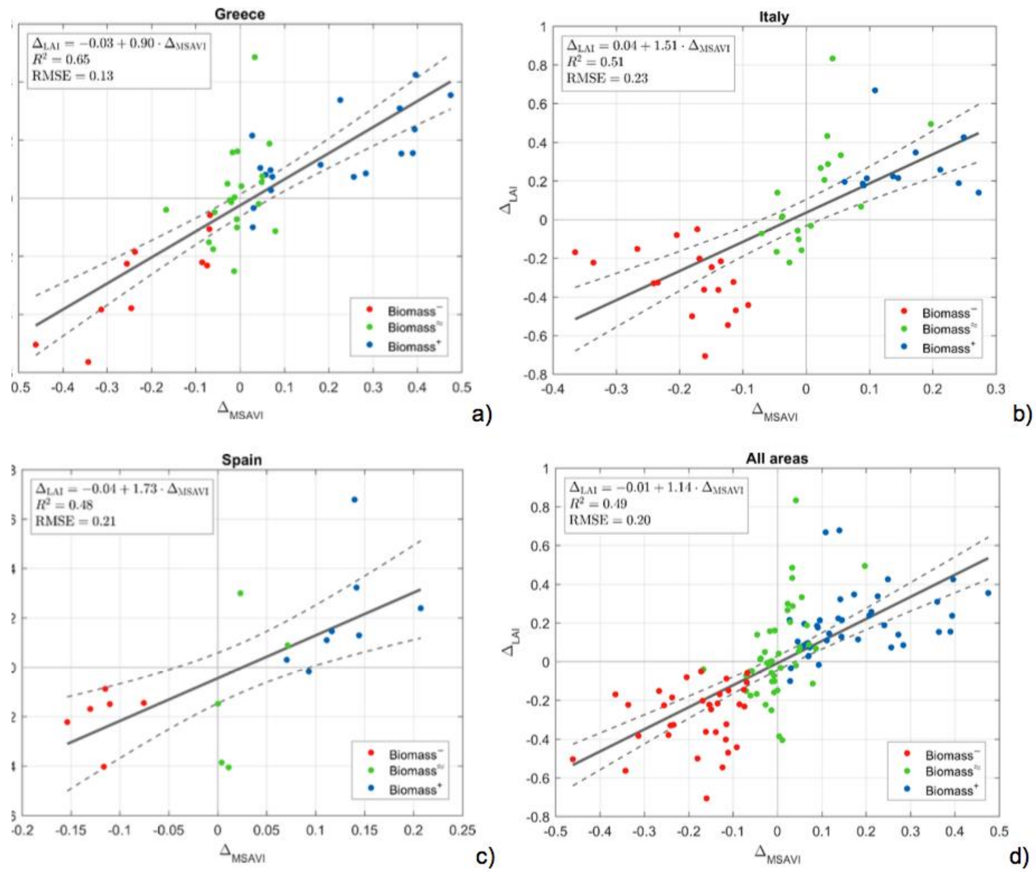
Coherence of MSAVI patterns with infield LAI anomalies





4) Intercomparison among products 1/2

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Coherence of information provided by local spatial variability products (pairwise)

Products compared	Objective	Method	Results	Comment
EP_L2 & EP_L3	constant patterns (EP_L2) tend to affect the current growing season's within-parcel variability (EP_L3) ?	one-way ANOVA and Tukey's HSD test EP_L3 variability maps vs EP_L2 for the second part of the season	significant differences in mean Δ_{MSAVI} values for all EP_L2 classes	a substantial number of parcel presented seasonal variabilities during the 2016 growing season that were also identified in previous years
EP_L3 & EP_L4	within-parcel biomass variability (EP_L3) explains the variability in LAI (EP_L4) during the growing season?	Correlation analysis EP_L3 variability maps (Δ_{MSAVI}) and a corresponding LAI variability measure Δ_{LAI} from the EP_L4 LAI maps	it confirms the correlation between the EP_L3 variability maps and the within-parcel variability of LAI	this confirms the suitability of the EP_L3 for supporting VRT surface fertilisation activities
EP_L3 & EP_L7	biomass variability (EP_L3) and crop homogeneity (EP_L7) at different stages of the development cycle do correspond?	one-way ANOVA and Tukey's HSD test EP_L3 variability maps (Δ_{MSAVI}) against the EP_L7 single-date classifications (before and after the booting stage)	significant differences between the Δ_{MSAVI} mean values for each EP_L7 class	distributions with high degree of overlap, some complementarity of products

Outcomes:

- Coherence → constant/seasonal patterns; seasonal patterns/LAI maps
- Complementarity → EP_L7 shows variabilities that are not detected by other products

4) Intercomparison among products 2/2

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Example: intercomparison between products: EP_L3 vs EP_L7

Coherent as development is favourable or faster, opposite something is affecting the biomass

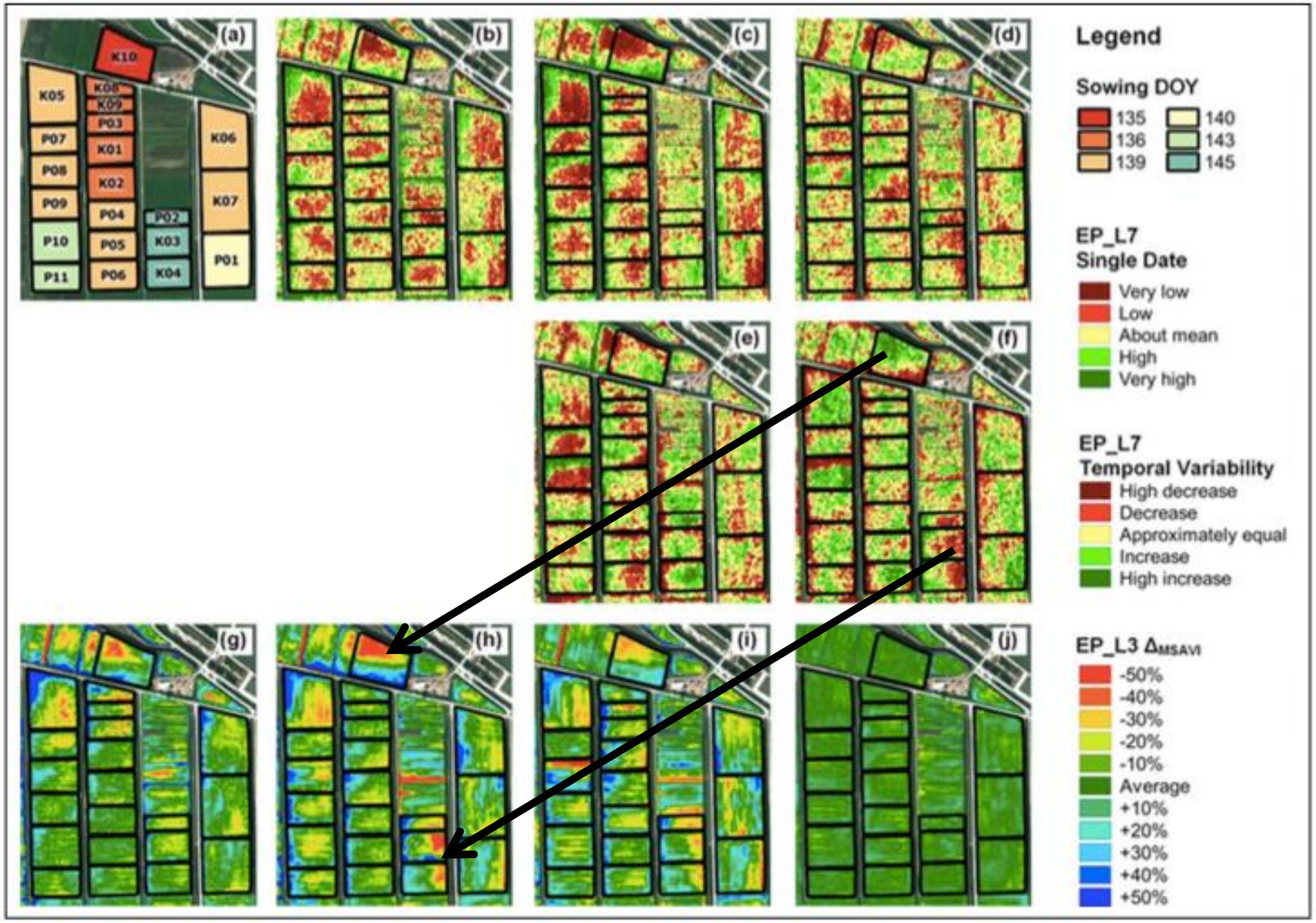
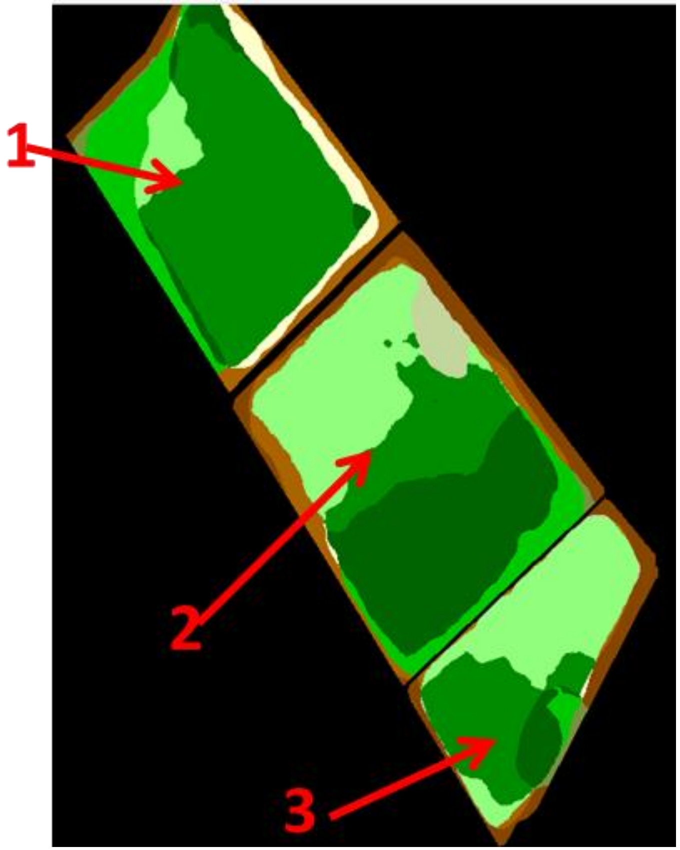


Figure 6.2: Various ERMES products produced during the 2016 growing season for some parcels inside DEMETER's stations in the Greek local study area. a) Sowing DOYs and names the parcels mentioned in the main text; the single-date EP_L7 product at DOY: b) 159, c) 167 and d) 175; the temporal variability EP_L7 product at DOYs: e) 159–167 and f) 167–175; the EP_L3 Δ_{MSAVI} products at DOY: g) 162, h) 174, i) 184 and j) 211.

5) Against expert knowledge and other ancillary data 1/2

Validation against expert knowledge: constant pattern (EP_L2)

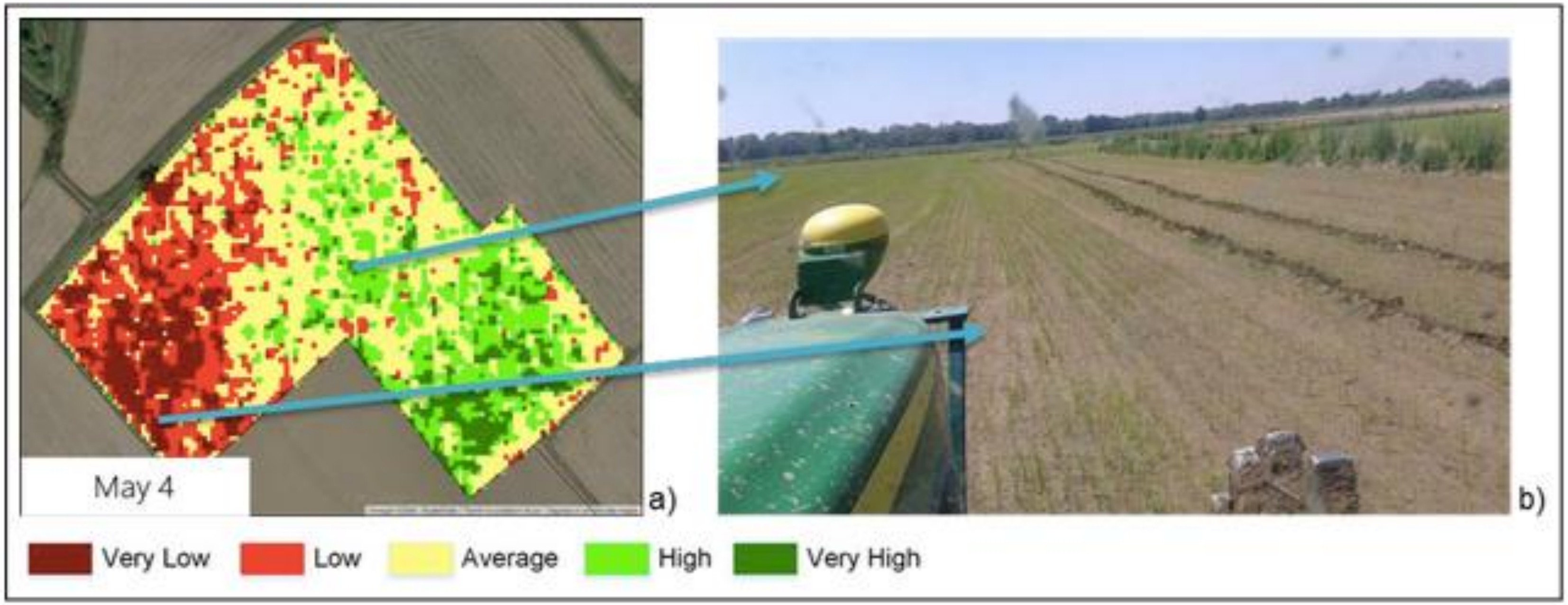


The constant patterns retrieved by EP_L2 map is explained by farmer knowledge:

- Zone 1 is to be ascribed to the water provision from this upper left area (red arrow).
- Zone 2 crop vigour differences in the map are related to a different soil texture.
- Zone 3 is almost due to the fact that this zone is interested by a overlapping by fertilizer spreader.

5) Against expert knowledge and other ancillary data 2/2

Validation against expert knowledge: early stages homogeneity maps (EP_L7)



Anomaly in SAR product (provided in NRT) reveals a strong correspondence to poor emergence in the field

Modelling information (EI_*)

Regional Modelling solution (EI_R*)

Yield estimation against official statistics

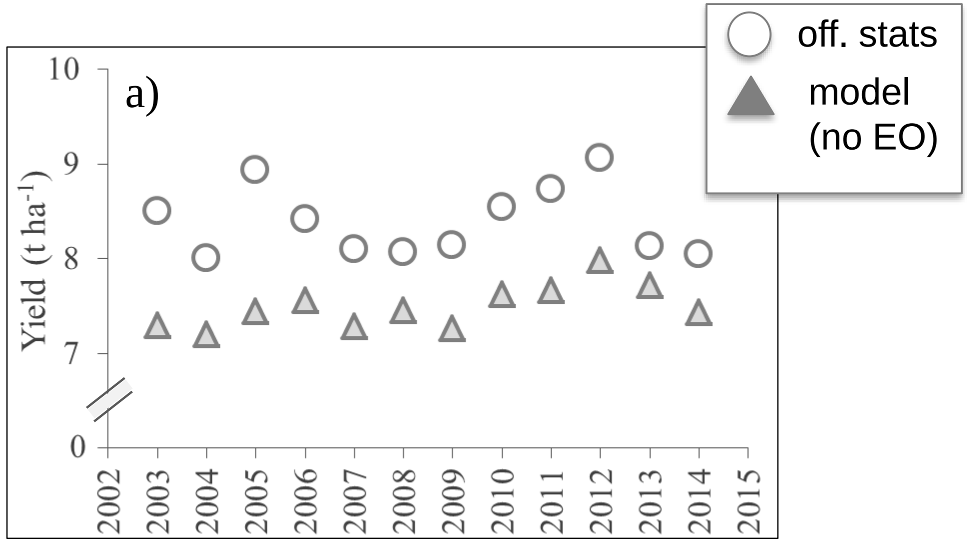
Comparison between official and yields forecasted for Japonica cultivars in Valencia using

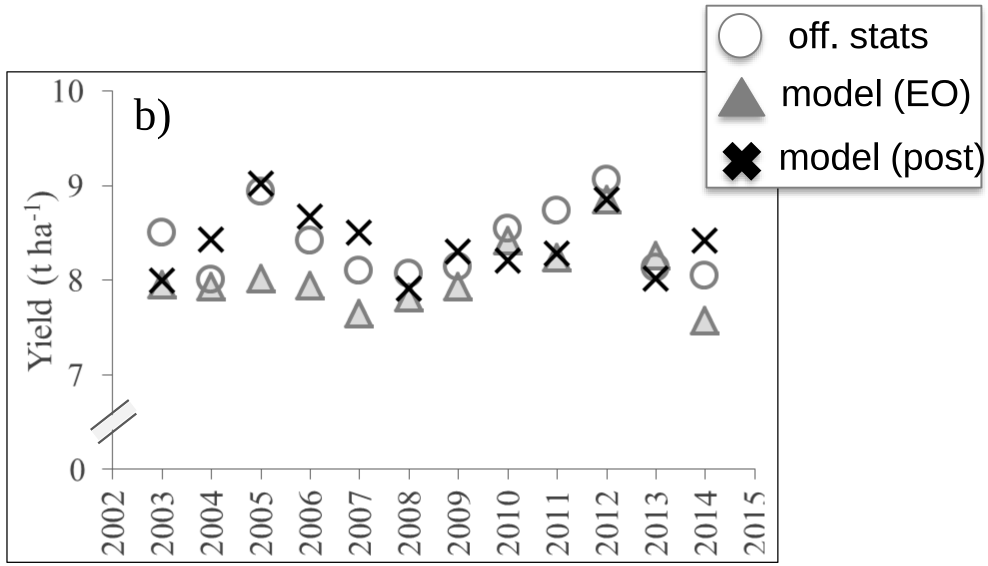
a) no EO products

- only the crop model

b) with EO products assimilation

- Only <u>assimilation</u> of remote sensing LAI
- statistical <u>post-processing</u> of simulated results (including LAI assimilation).





Local Modelling solution (EI_L*)

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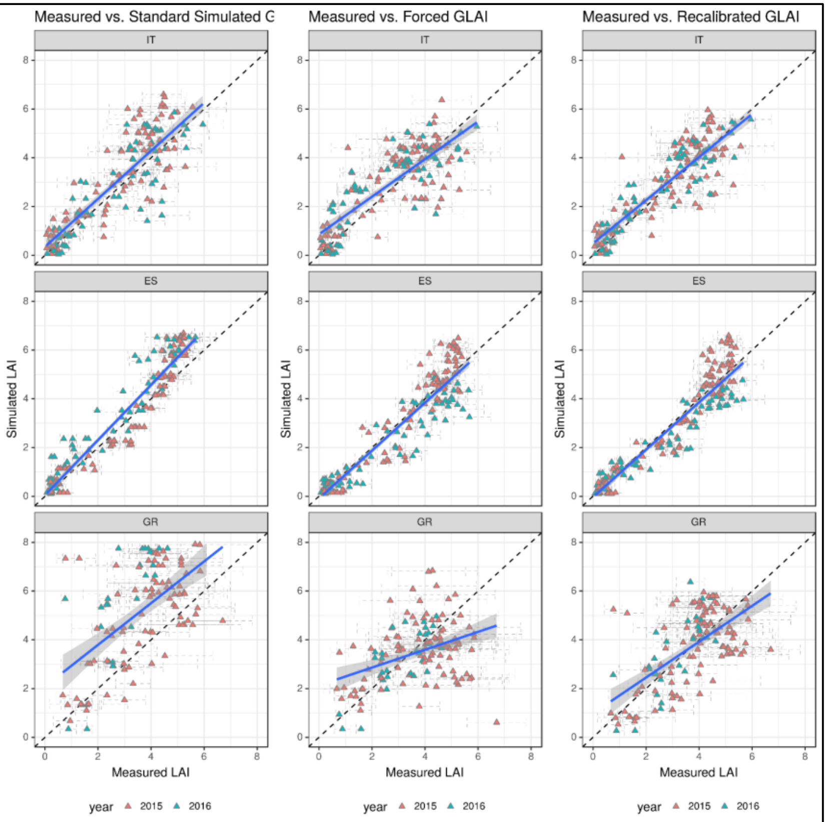
Simulated LAI against in situ data (assimilation of EO data)



Country	Model	2016						
		N	Slope	Int.	MAE	RMSE	EF	R^2
Italy	Default	105	0.95	0.25	0.68	0.77	0.79	0.76*
	Recalibrated		**0.93**	**0.34**	**0.51**	**0.56**	**0.89**	**0.86***
Spain	Default	167	1.13	0.36	0.75	0.62	0.89	0.93*
	Recalibrated		**0.77**	**0.19**	**0.58**	**0.47**	**0.93**	**0.92***
Greece	Default	33	1.64	0.71	2.82	2.97	-6.93	0.59*
	Recalibrated		**1.12**	**-0.01**	**0.85**	**0.99**	**0.11**	**0.58***

Yield estimations at parcel level

- original model exhibited a generally satisfactory accuracy (average absolute errors of 1.69 t/ha and 0.77 t/ha obtained in the 2016 datasets for Greece and Italy, respectively).
- incorporation of EO information increased the model's accuracy (improvement of approximately 23-30%)

WP8 – FINAL REMARKS

- ✓ Big effort in
  - ✓ collecting in situ data (using homogeneous protocol) and maximize their usefulness
  - ✓ interacting with users (single product and service levels)

In situ data

- ✓ quality of EO products @different scales proved to be adequate

Satellite data

- ✓ importance of EO data assimilation into modelling solutions

WARM model

- ✓ suitability of tools for providing value added information as usable and in time

Geoportal

Smart app.

Question Time