Cross Site Experiments
JECAM Annual Science Meeting

Kiev, Ukraine, 11 October 2016

Sven Gilliams, VITO-TAP, Hendrik Boogaard, Alterra
SIGMA Consortium

SIGMA Activities

Land cover & crop land assessment

Agricultural Productivity

Env. Impact Assessment of Land use change

Sites: Ukraine, China, Argentina, Brazil, Belgium, Russia, Ethiopia, …..

Data Management

Stimulating Innovation for Global Monitoring of Agriculture

SIGMA Cross site experiments

- Tools
  - VEGA and AGRO-STAC
- Yield estimation
- Global trends-> hotspots of change
- Future

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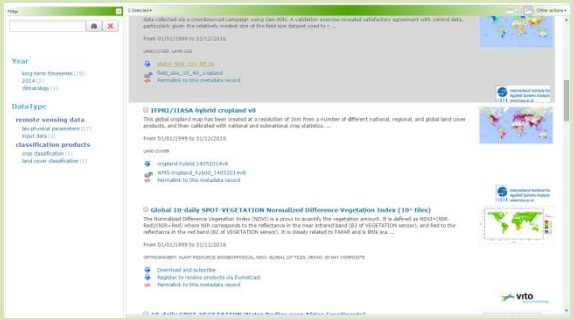
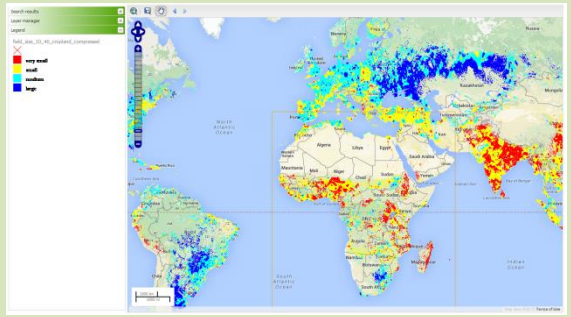
Data Management

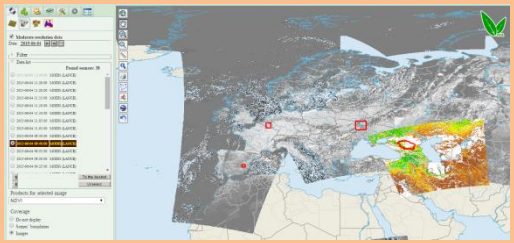


SIGMA Geoportal

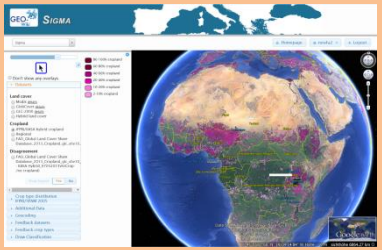
(http://sigma.geoportal.vgt.vito.be/)



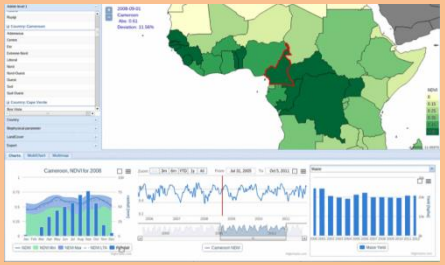
VEGA-GEOGLAM



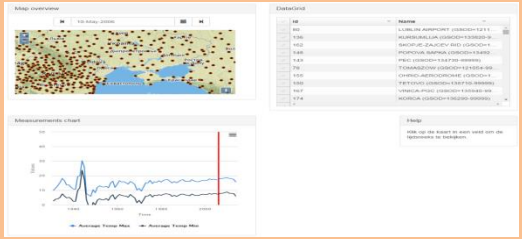
Geo-Wiki & pictures app



Vegetation dashboards



STAC interactive i/f



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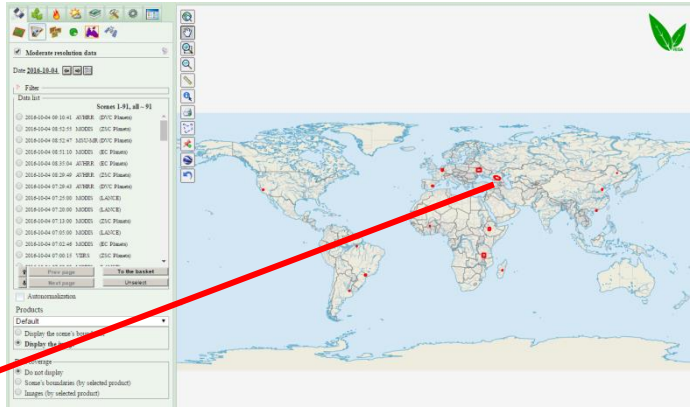
VEGA-GEOGLAM

agricultural monitoring web system

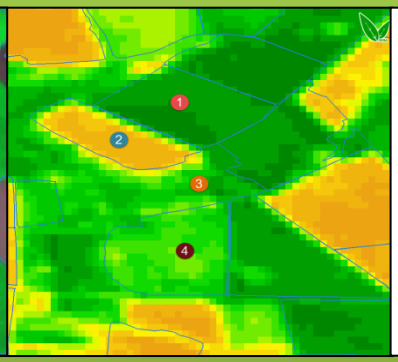
- crop status assessment and online agriculture monitoring



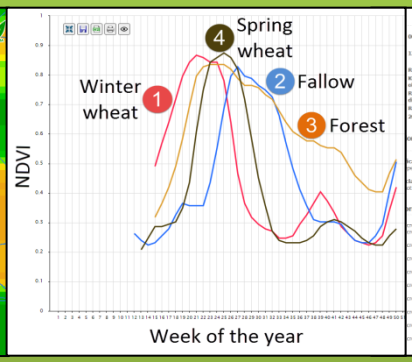
- Combined analysis of Earth Observation and in-situ data over the SIGMA/JECAM test-sites

2015-05-26
Landsat 8
Kursk region, Russia

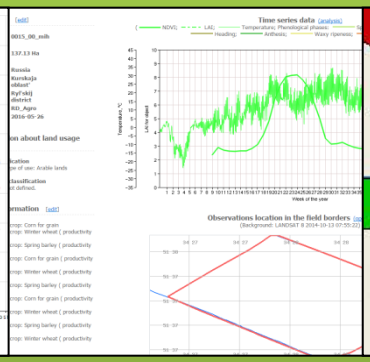
New data included, S1-S2,…



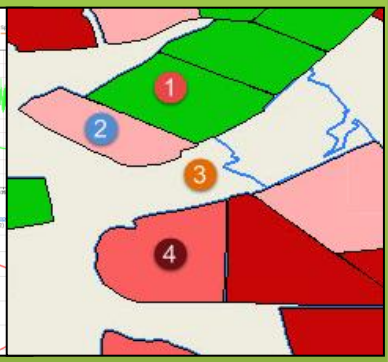
PROBA-V
cloud-free NDVI map



NDVI profiles for the selected objects



In-situ data for the 1st field
crop type, yield, phenological stages



Crop status assessment by comparison with the NDVI norm

vega.geoglam.ru

SIGMA Field Data base

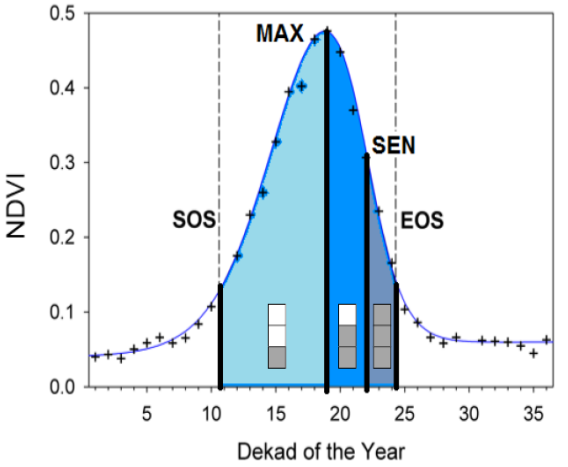
- Need for local crop data

In-situ crop field data needed to improve accuracy and reliability of global and regional studies and monitoring systems through e.g. validation and/or calibration of models and satellite based products

Wall to wall, available, standardized

Local, scattered, heterogeneous

Validate crop map (EU-FP7: SIGMA)



Validate phenology metrics based on SPOT-VGT time series (EC-MARS)

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Need for AGRO-STAC initiative

- Current agricultural scientific community is fragmented in data management and lack commonly available reference data on (benchmarking of) agricultural production
- SIGMA* needs mechanism to manage and exchange in-situ data from JECAM sites: a minimum data set to test and develop methods & to improve data and tools to serve the crop monitoring community (GEOGLAM)
- AGMIP** acknowledged need for generic data model for exchanging agronomy data within the community

* EU-FP7: SIGMA = Stimulating Innovation for Global Monitoring of Agriculture

** AGMIP: Agricultural Model Improvement and Inter-comparison Project

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AgMIP

Need for AGRO-STAC initiative

- In-situ data is heterogeneous:
  - Different attributes
  - Different locations
  - Different time stamps
  - Different periods
- To facilitate retrieval, exchange and use of data:
  - Data have to be checked, processed, stored and maintained in a consistent, transparent and unambiguous manner

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AGRO-STAC: Data

- Data collection focused on ***crop monitoring*** domain e.g. data on crop type, phenology, LAI, yield, biomass..
- Collected & processed in-situ '**open**' crop data

JECAM in-situ data sets:

- INTA_JECAM
- RADI_JECAM
- CIRAD_AGRHYMET_JECAM

Other data sets

- EU FP7 Mocccasin
- ZALF 1992_271
- CGIAR_AGTRIALS
- EU_FP7_AGRICAB
- UN_IFAD_WFP_WRMF

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AGRO-STAC: Data

- Format conversion
- Unit conversion
- Scientific conversion e.g. phenology into BBCH scale
- Documentated in WIKI
- Loaded and maintained data in AGRO-STAC db

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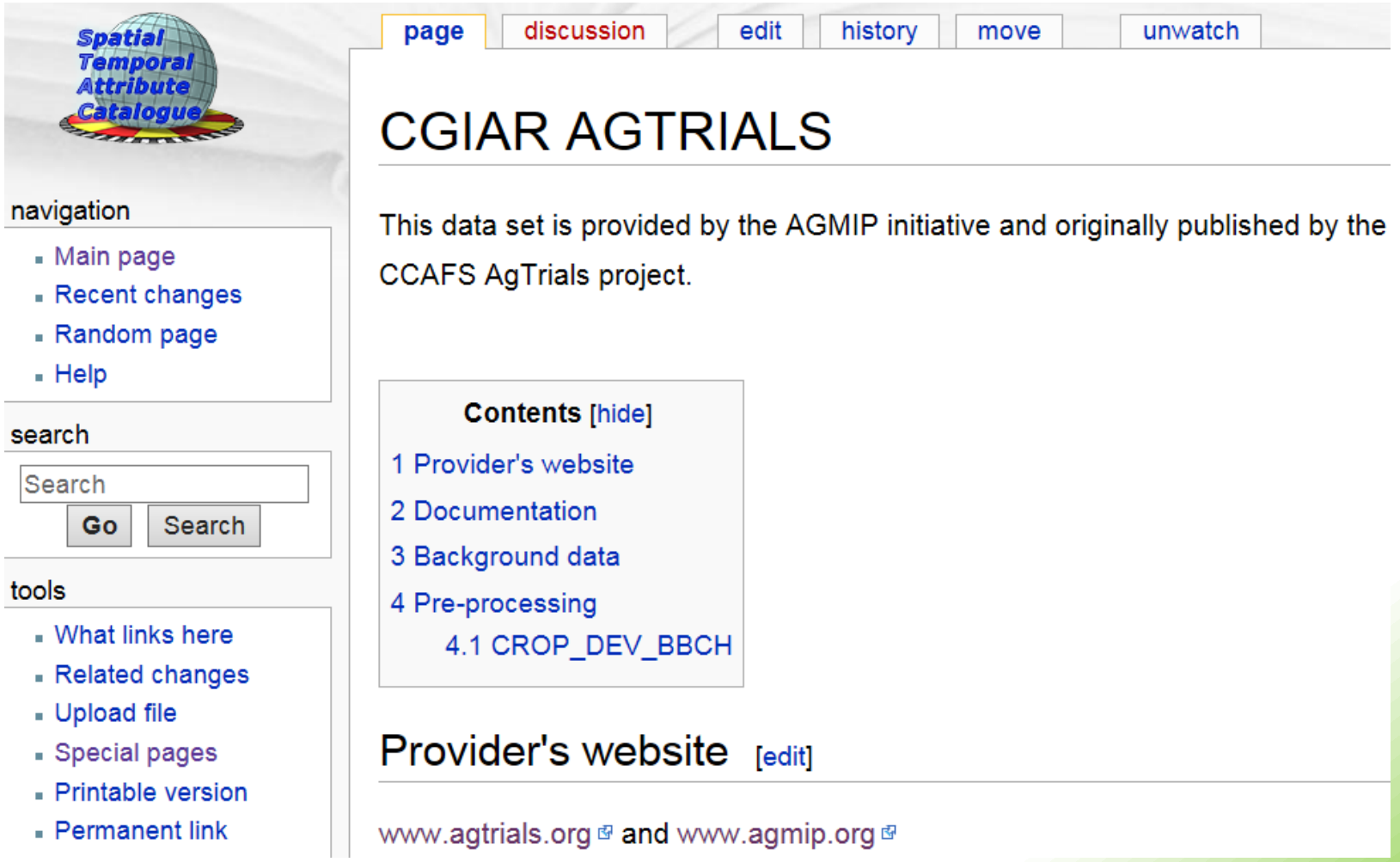
AGRO-STAC: Data



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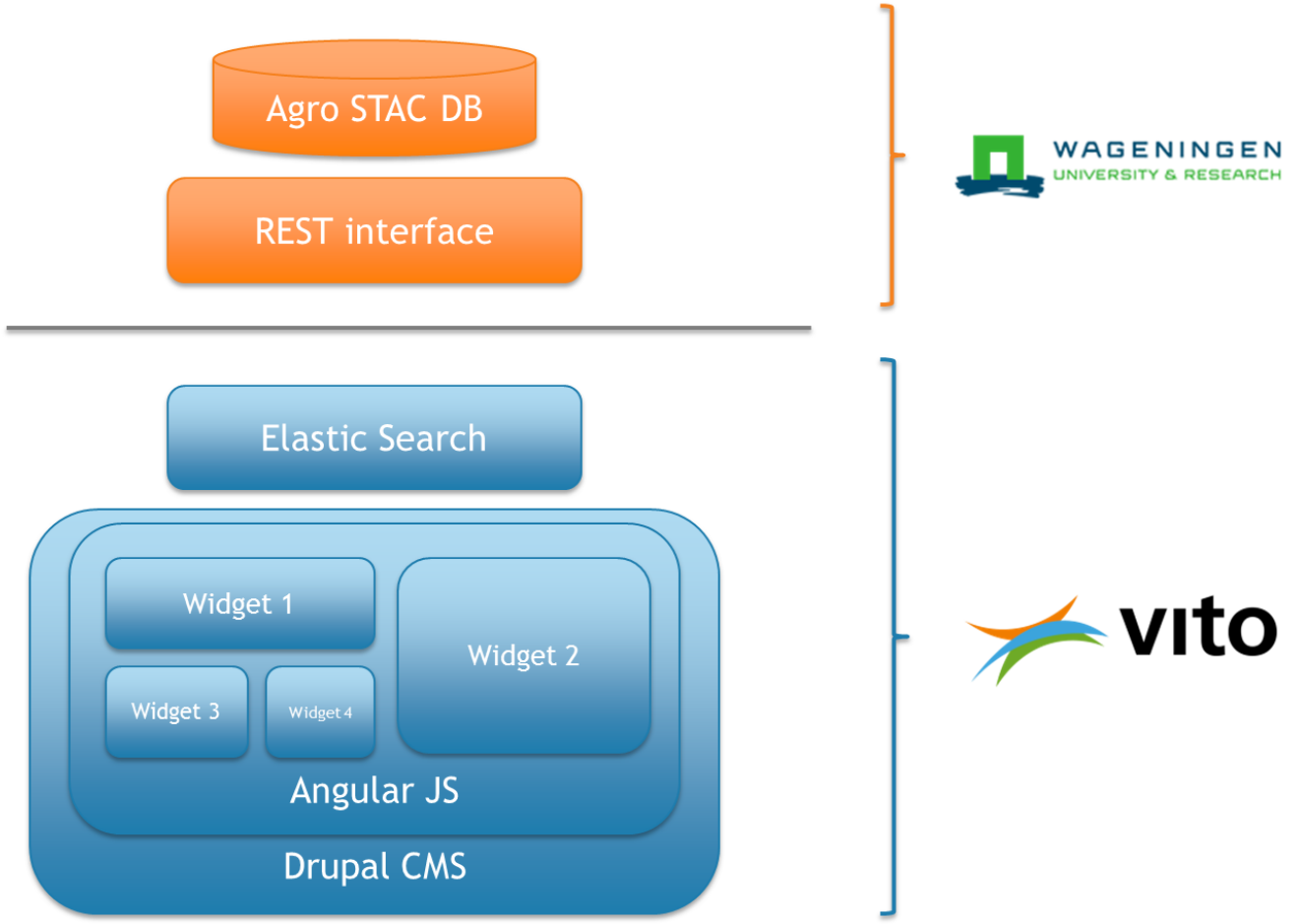
AGRO-STAC: Archictecture



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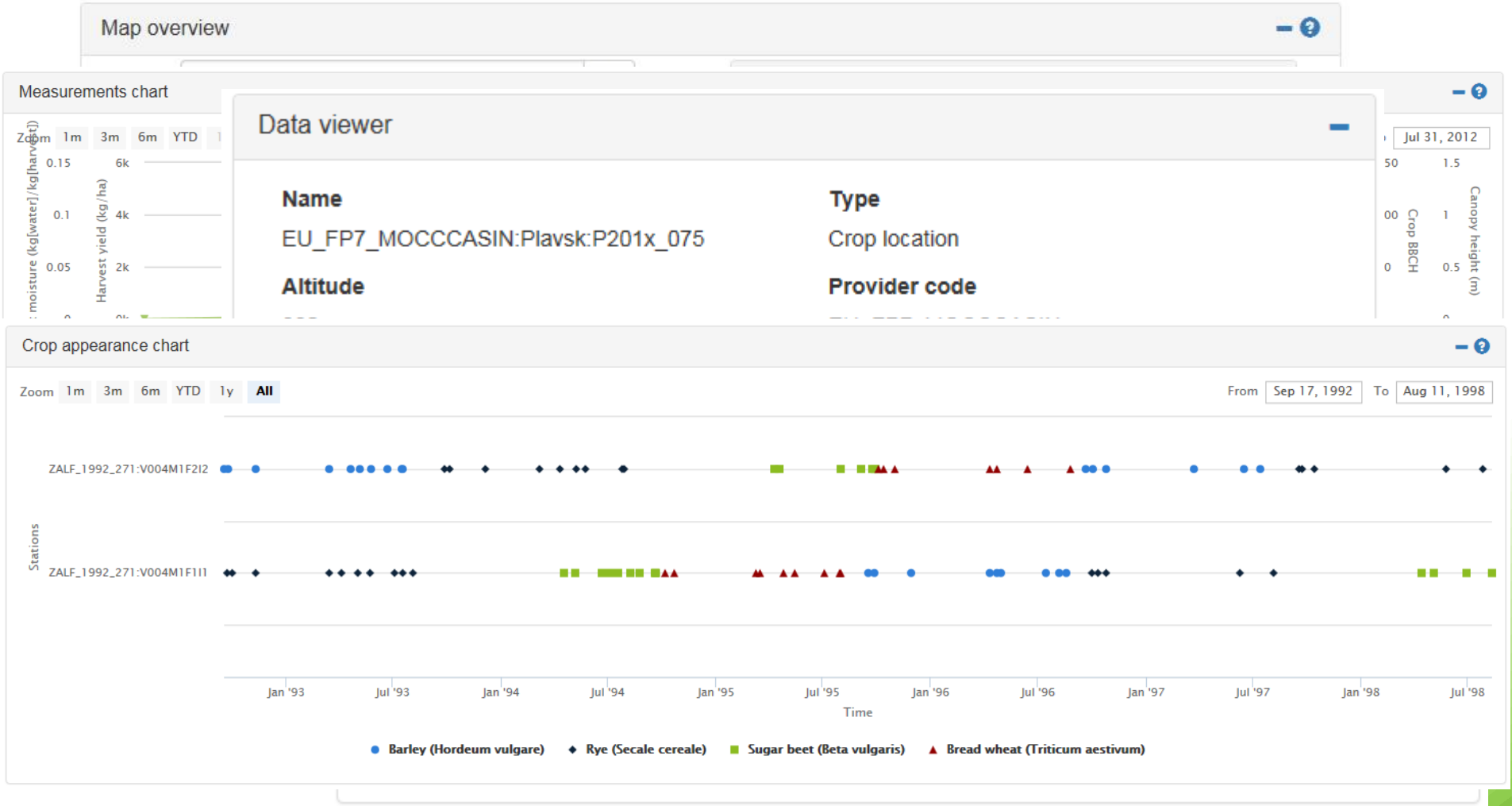
AGRO-STAC: Viewer



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AGRO-STAC: Next steps

- Viewer improvements
  - Selection by quantity
  - Technical improvements
  - Bugs
- Adding more data (align with other initiatives)
- Apps for specific aims
- Extend/enhance use in projects and networks

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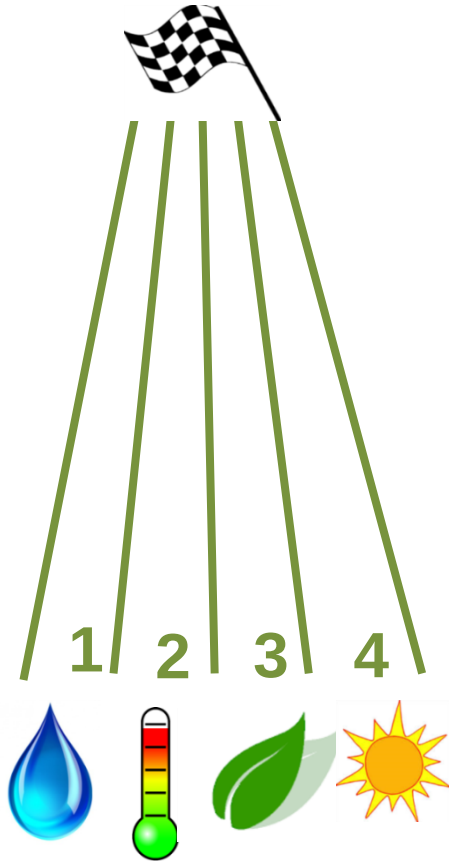
Cross Site Experiment;
Crop Yield Forecasting

- EO indicators in crop yield forecasting



How do (EO based) indicators from **publically** available, **global** data sets perform in crop yield forecasting across different **agro-environmental landscapes** (JECAM sites)?

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Protocol

- Benchmark:
  - Use global commonly available datasets
  - Use same thematic indicators (NDVI, FAPAR, RFE etc.)
  - Use same type of indicators (dekad and cumulated)
  - Select 2 crops, per crop 3 main regions at GAUL level 2 (or 1)
  - Yield statistics 2000-2013 (GAUL level 2 or 1)
  - Cropland to aggregate indicators: GLCshare (class = 2)
- Later: how local data / research can improve forecast?

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Regions

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Data

	single dekad	cumulated
NDVI based on SPOT-VGT	x	x
fAPAR based on SPOT-VGT	x	x
Rainfall based on CHIRPS	x	x
Rainfall based on ECMWF ERA-Interim	x	x
Minimum temperature based on ECMWF ERA-Interim	x	
Maximum temperature based on ECMWF ERA-Interim	x	
Average temperature based on ECMWF ERA-Interim	x	x

	winter wheat	grain maize	soy beans	millet	sorghum	sunflower
Argentina (Buenos Aires province)	x		x			
Burkina Faso				x	x	
Niger				x	x	
France	x	x				
Ukraine	x	x				
Russia (Stavropol oblast)	x					x
China (Shandong province)	x	x				

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Method

- Multiple regression models statistically tested in CST tool
- Find best multi-indicator model for set of region, crop and dekad (max of 3 indicators per model)
- Test single-indicator models for set of region, crop and dekad
- Compare by “Root mean squared error for prediction”
- Accept both positive and negative correlated indicators
- The following models are excluded in advance:
  - Models with too high variance inflation factor
  - Models with indicators with non-significant t-values

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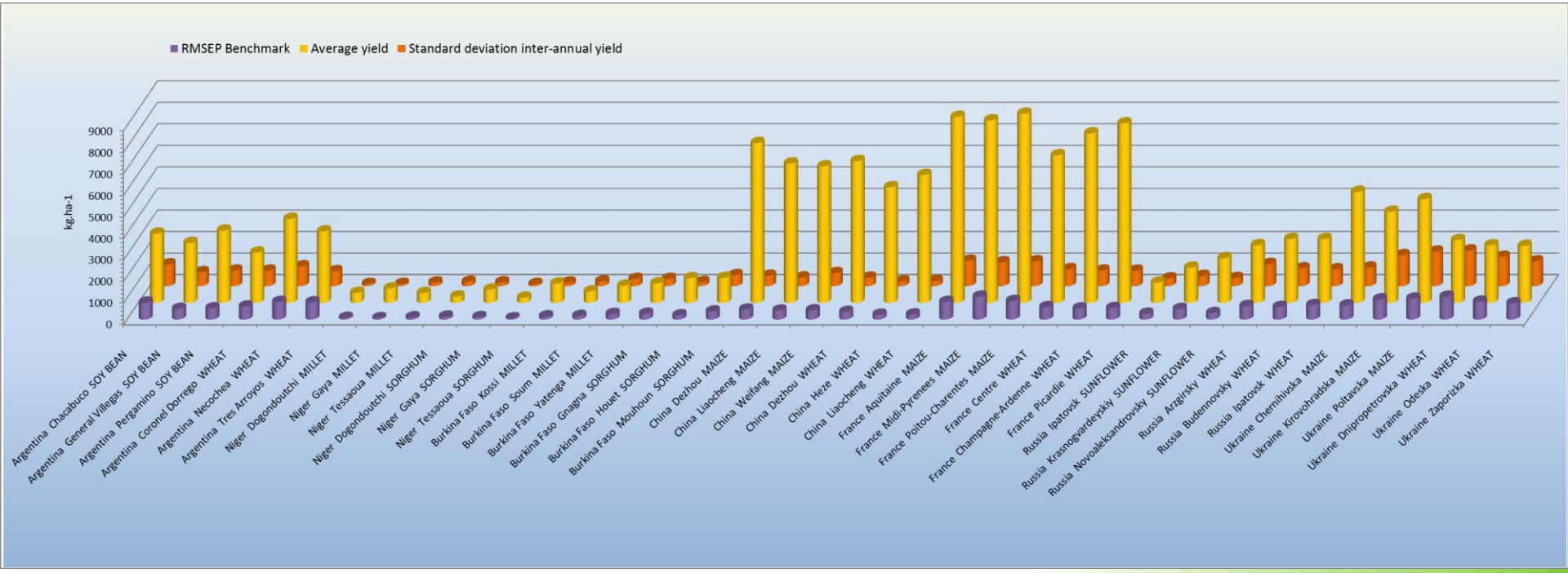
Results

Average yield

Standard deviation of annual yield increment

Root mean squared error for prediction of benchmark model



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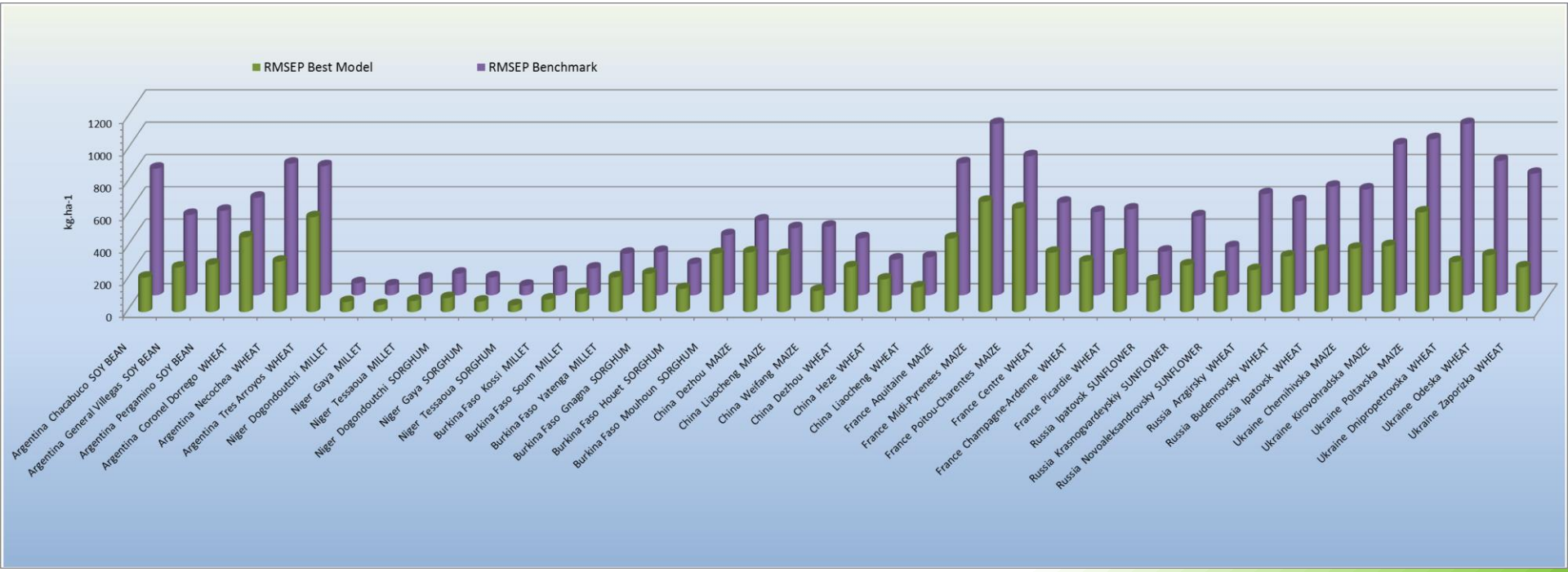
Results

Root mean squared error for prediction of benchmark model

Root mean squared error for prediction of best model



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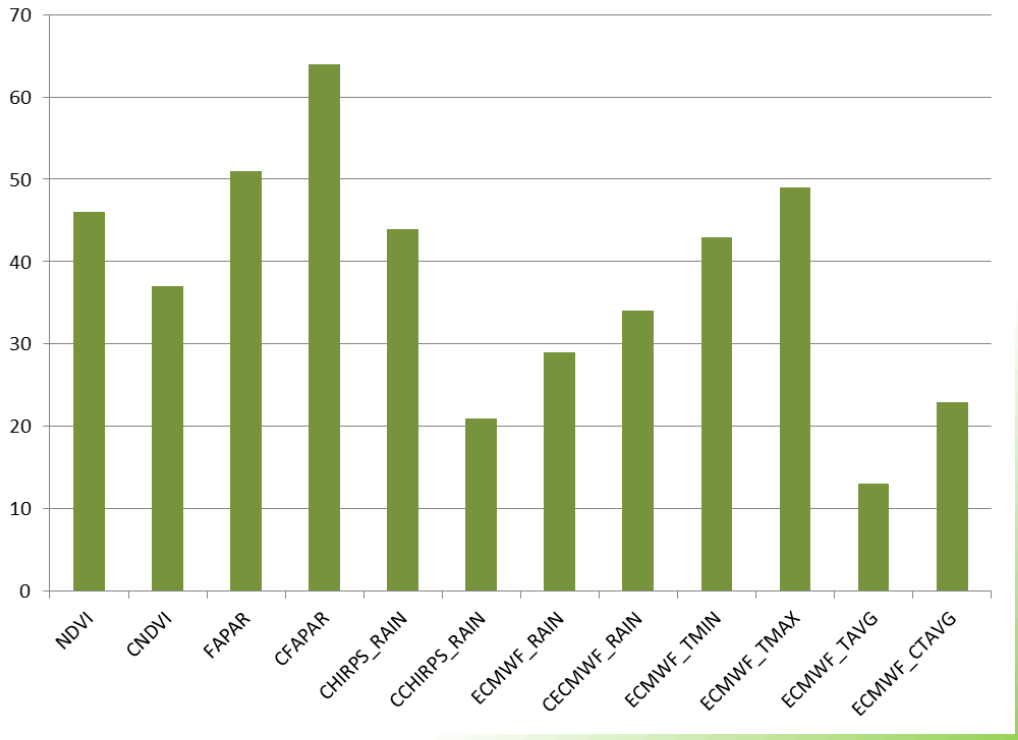
Results

Appearance of indicators in crop yield forecast models



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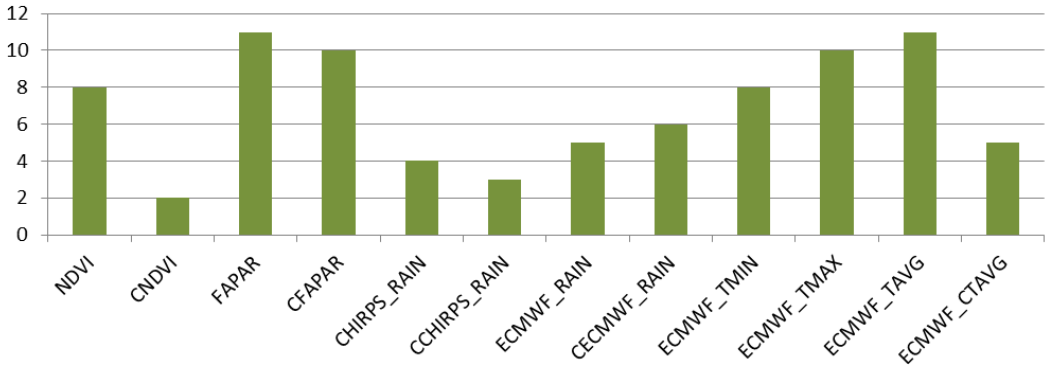
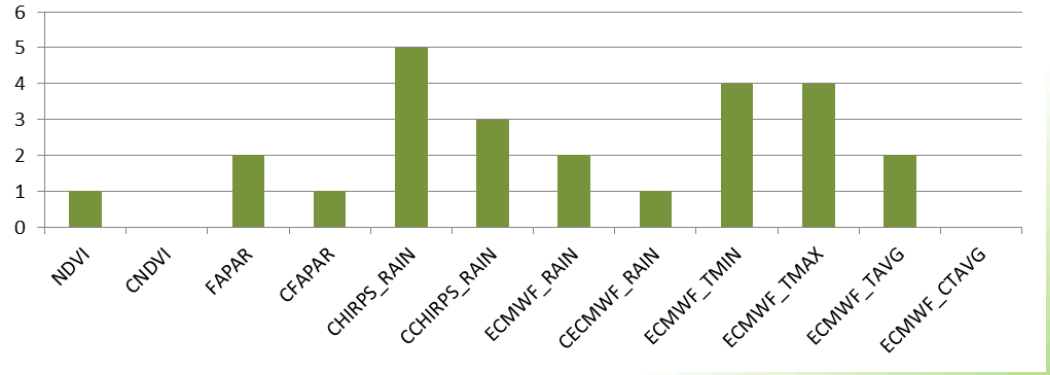
Results

Appearance of indicators in crop yield forecast models

Argentina, Buenos Aires



China, Shandong



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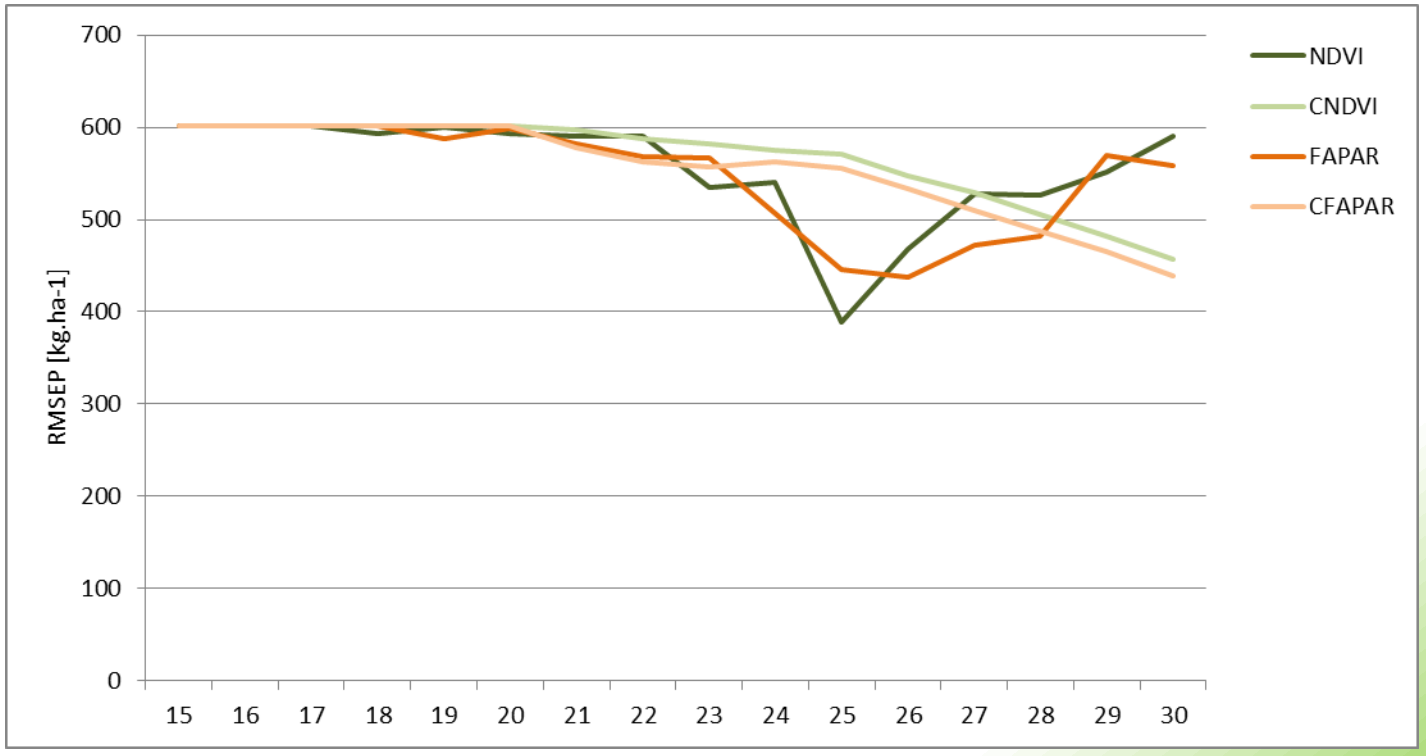
Results

Indicator specific performance (soy beans, Argentina, EO-vegetation)



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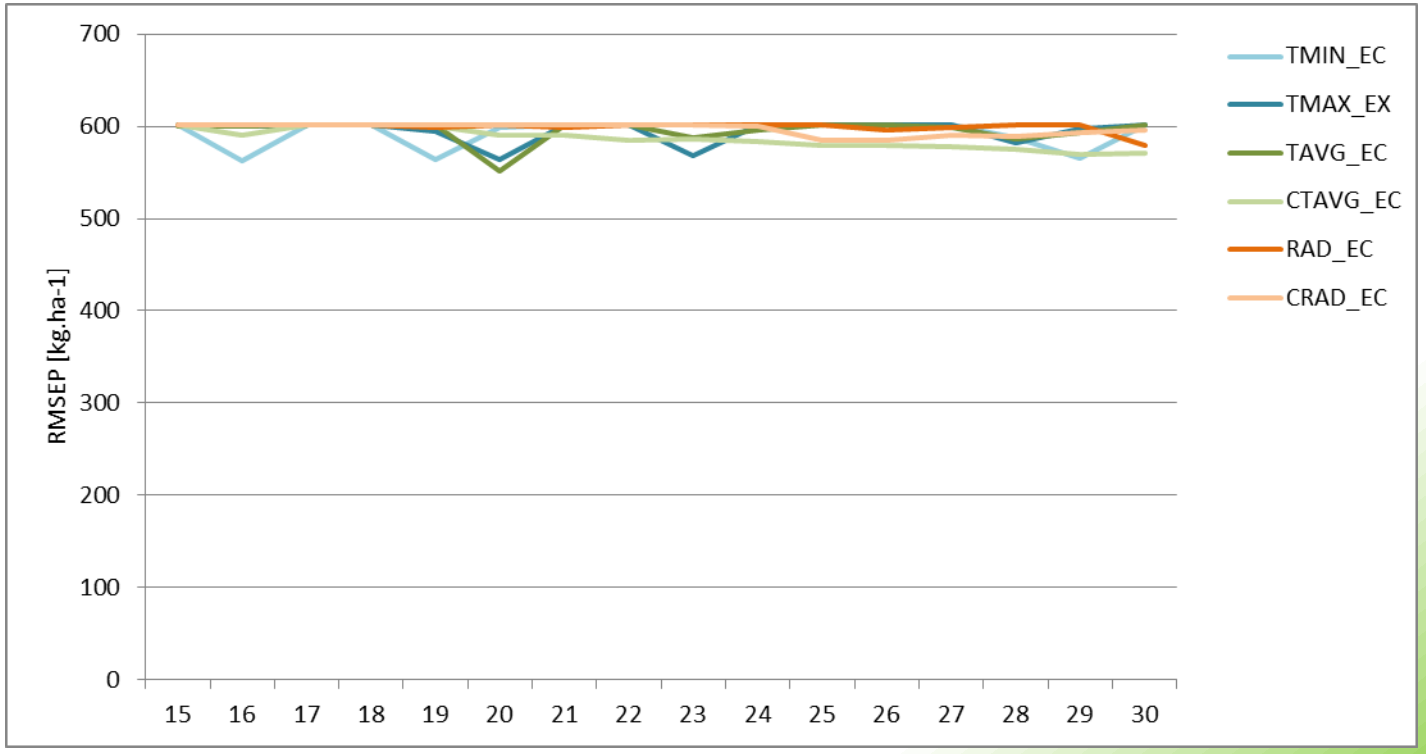
Results

Indicator specific performance (soy beans, Argentina, temperature / radiation)



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Cross Site Experiment; Hotspots of changes

- Part of the trend analysis work

Yearly and seasonal phenology and productivity

- Trends of NDVI phenology and productivity parameters
- Trends of aggregated soil moisture, temperature and rainfall

Global hotspot analysis and identification of significant areas

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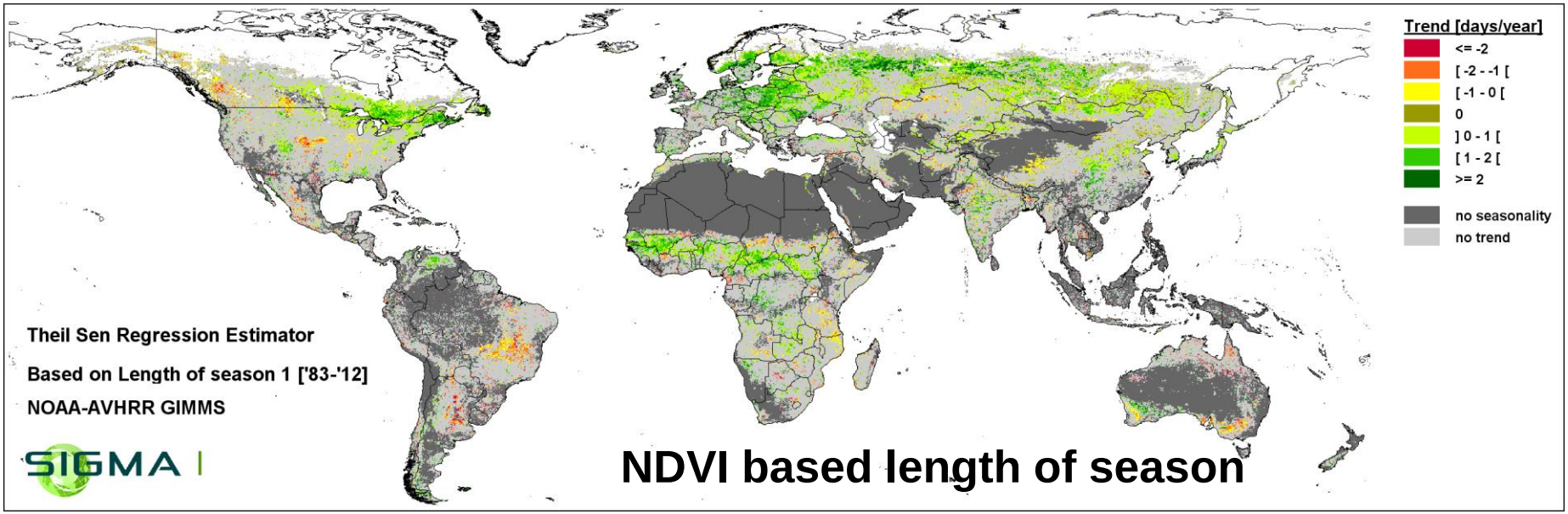
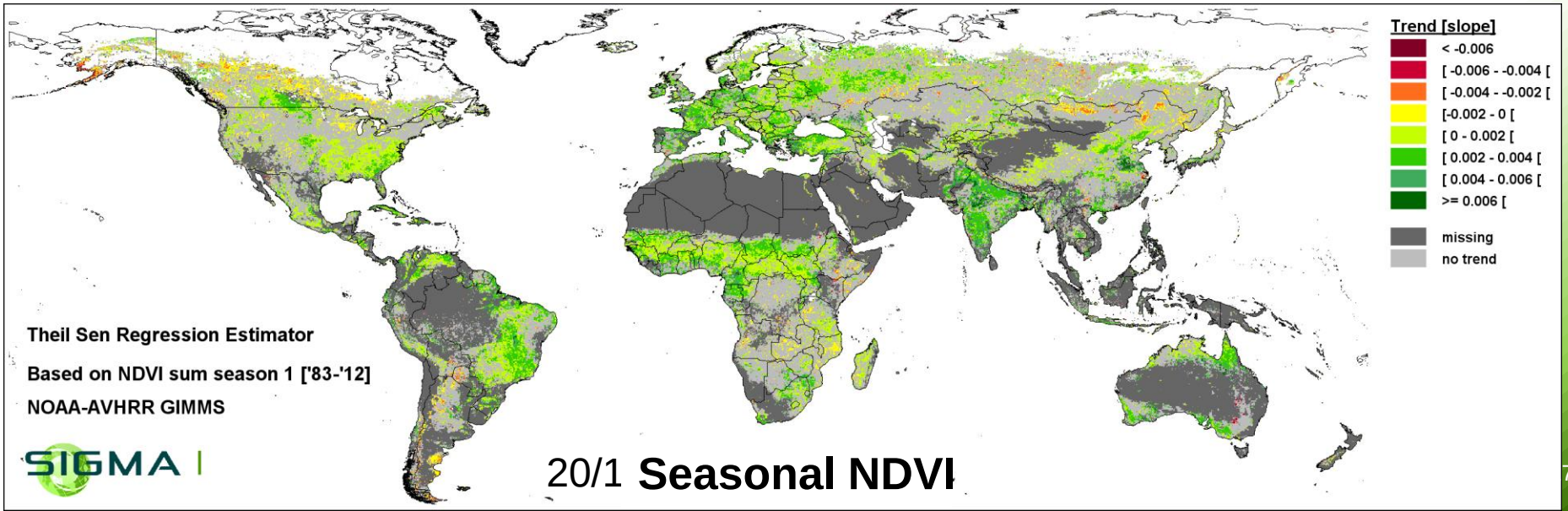
What do we observe at global scale?

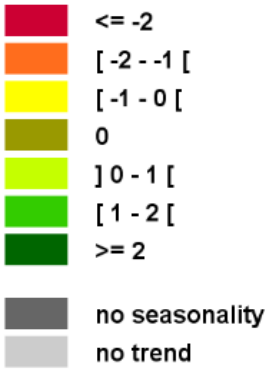
Based on 30 year of GIMMS data 1983-2012



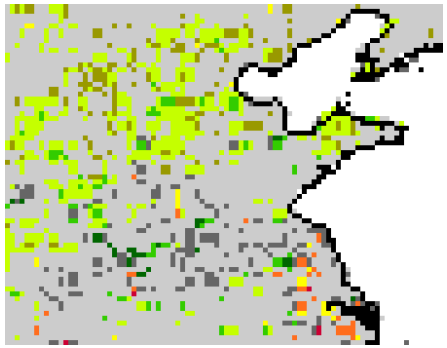


Hotspots of a changing environment

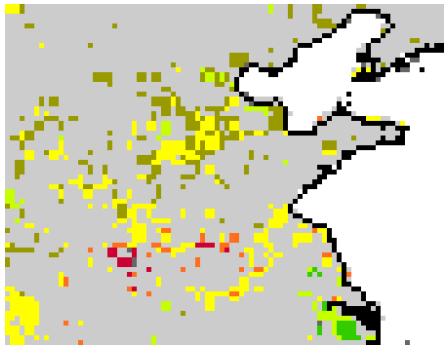
- GIMMS NDVI 3g (1983-2012)



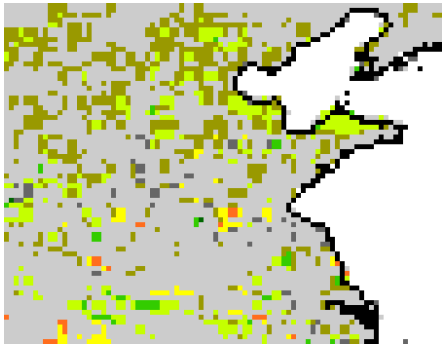
Length of season

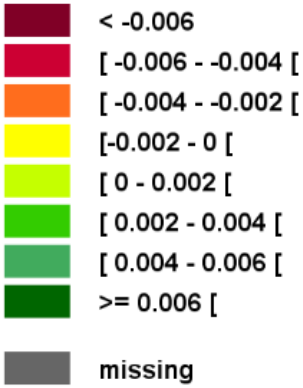


Start of season

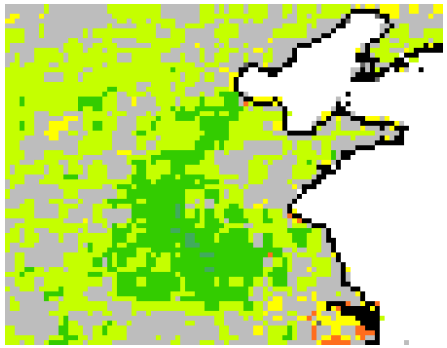


End of season

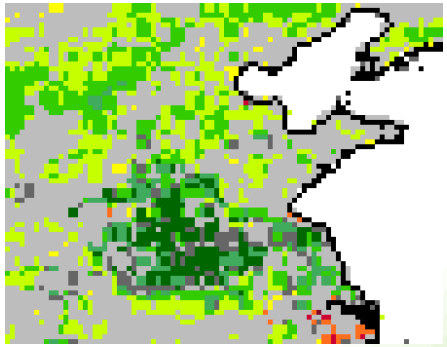




Yearly NDVI



Seasonal NDVI



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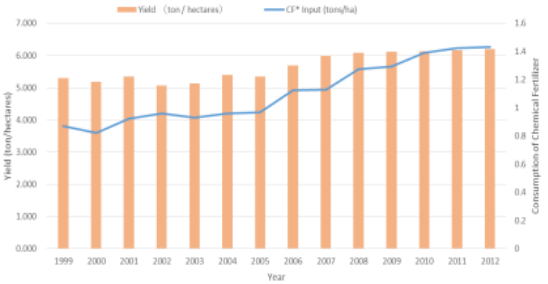
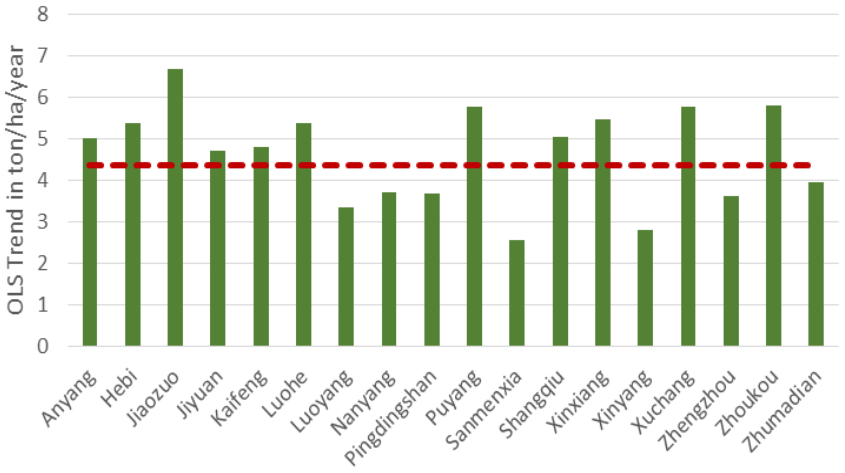
Trends and changes in natural & man-made vegetation dynamics

- Irrigated croplands of the Northern China Plains
  - Significant increase of the consumption of chemical fertilizer

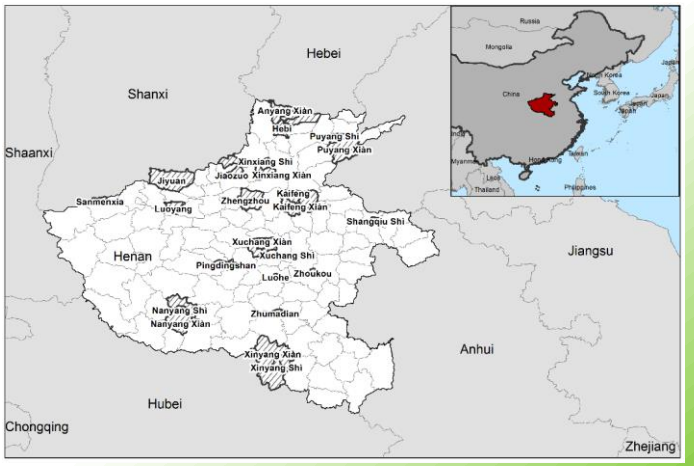
→ **Increase of crop production**



Relationship between yield (ton/ha) and artificial fertilizer used (ton)



OLS yield trends for the reference period 1999 to 2012. Data is given in tons/ha per year. The red dotted line represents the average across all 18 communities.



Overview of 18 communities located in the Northern China Plains.

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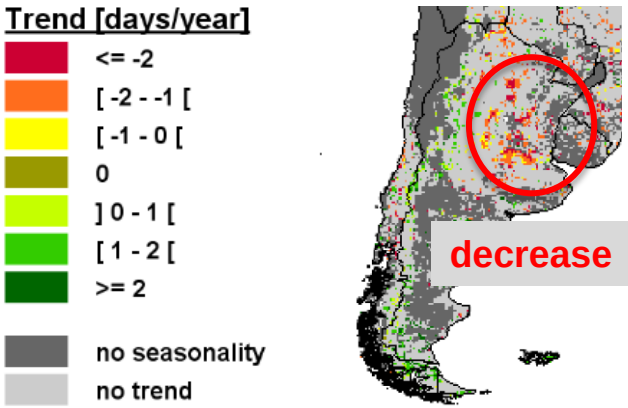
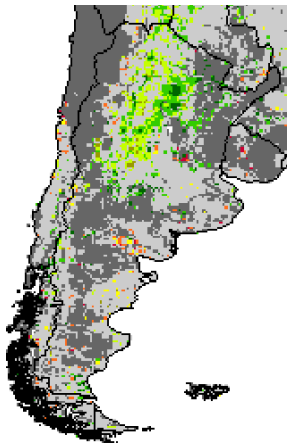
Hotspots of a changing environment

- GIMMS NDVI 3g (1983-2012)

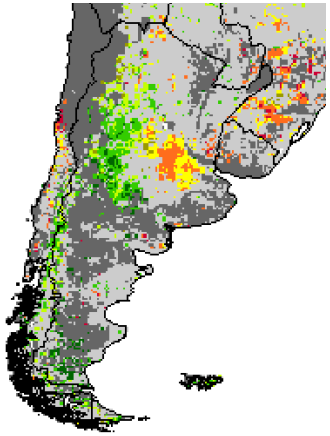
Length of season



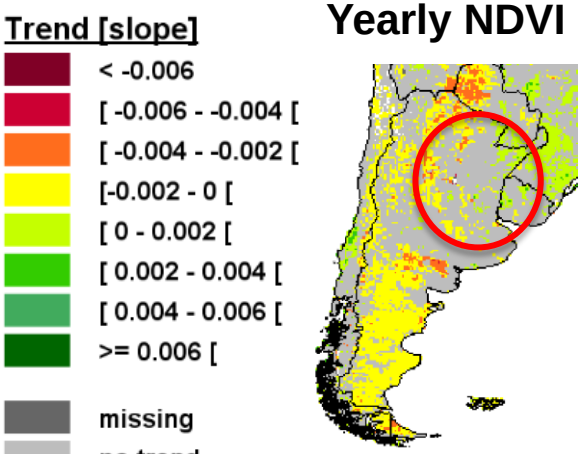
Start of season



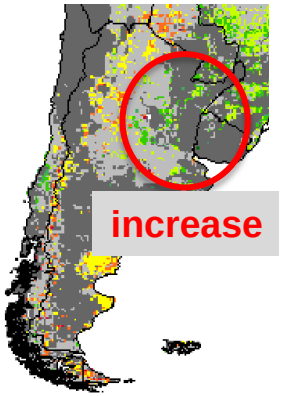
End of season



Yearly NDVI



Seasonal NDVI



Chaco region

Shorter growing season & more productive seasons

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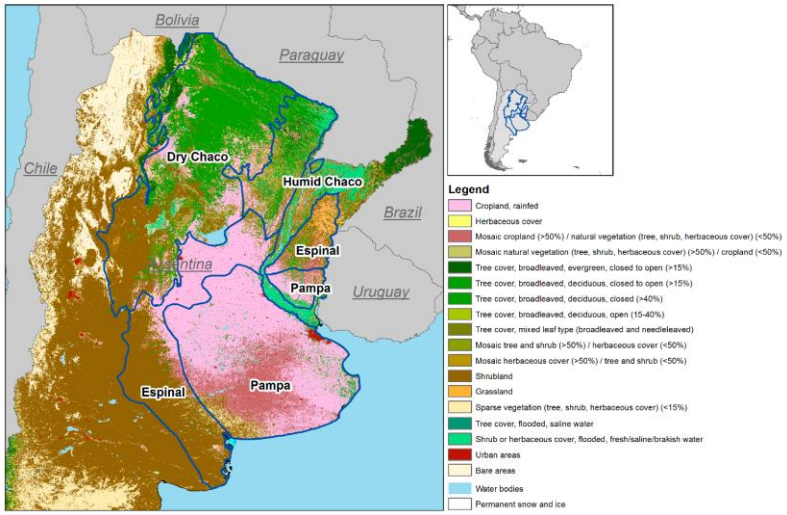
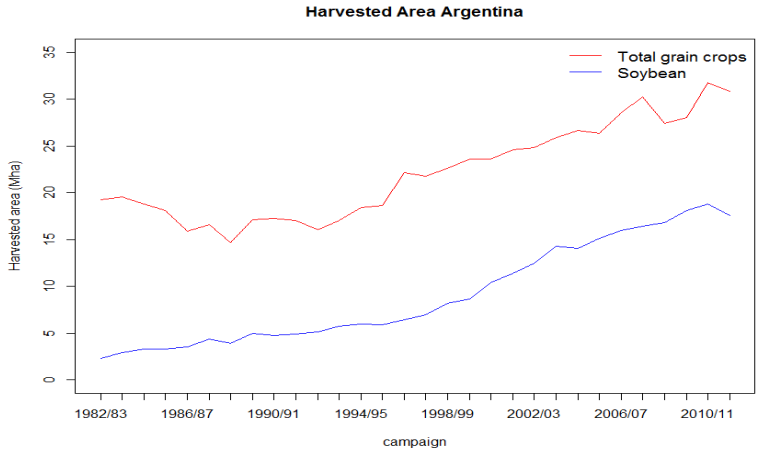
Hotspots of a changing environment

- Cropland and pastoral areas of Argentina



ESA CCI Landover (v1.6.1) in the Dry Chaco, humid Chaco, Pampa and Espinal (blue outline, (Burkart, Bárbaro, Sánchez, & Gómez, 1999)) of Argentina for the year 2010.

- Transformation of natural dry forests into agricultural or rangeland systems
- Large scale land use changes between 1982 – 2012, mostly soybean production
- Agricultural expansion and intensification



Total harvested area of grain crops (red) and soybean (red) in Argentina during the period 1982-2012. Source: Argentine National Ministry of Agroindustry.

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Future Cross Site Experiment

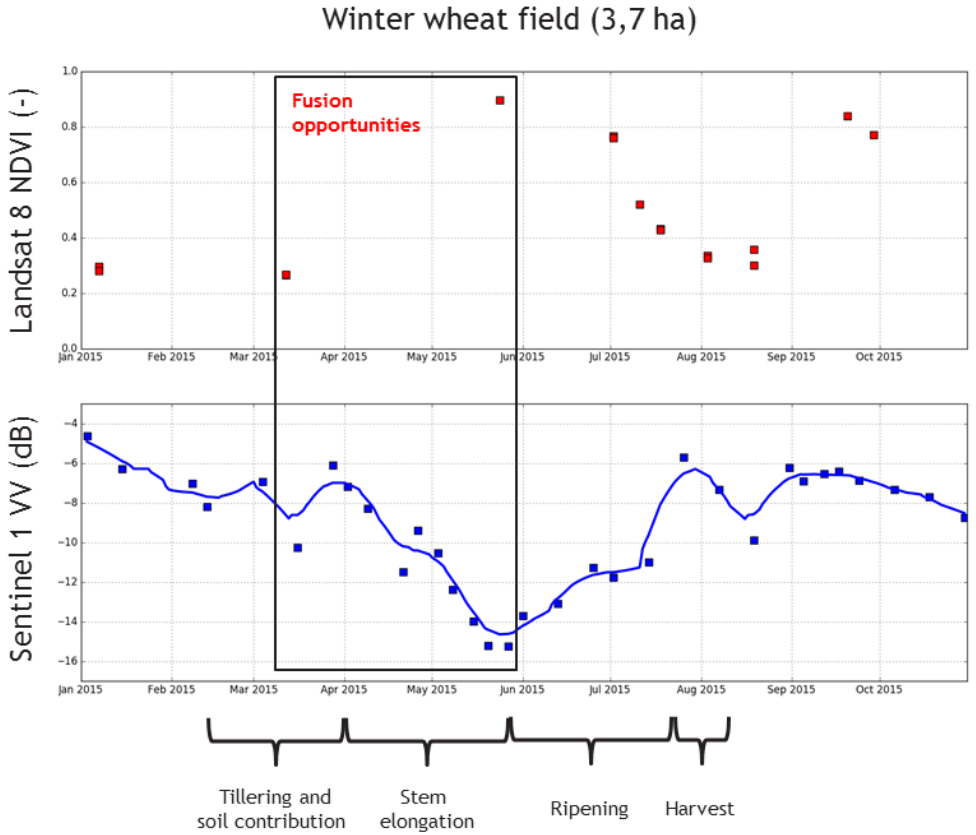
Fusion of optical data and SAR

- Optical: sensitive to *biophysical processes*, **cloud issues**
- SAR: sensitive to *vegetation structure,* **all-weather**

→ Opportunities to use both in **complementary** way to better monitor crops

- Very diverse factors influence SAR backscatter
- Opportunities for using machine learning to combine SAR and optical
- Case study of BE/FR JECAM site, based on Landsat 8 and Sentinel 1, using

Google Earth Engine



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Thank you!

VITO, CIRAD, JRC, IIASA, Alterra, RADI, NMSC, DEIMOS, GeoSAS, RCMRD, Aghrymet, RCMRD, Sarvision, Sarmap, INTA, Geoville , UCL, EFTAS, FAO, ITC, GISAT, IKI, SRI