



European  
Commission



# Requirements from agriculture applications

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On behalf  
Andrea Toreti &  
MARS colleagues



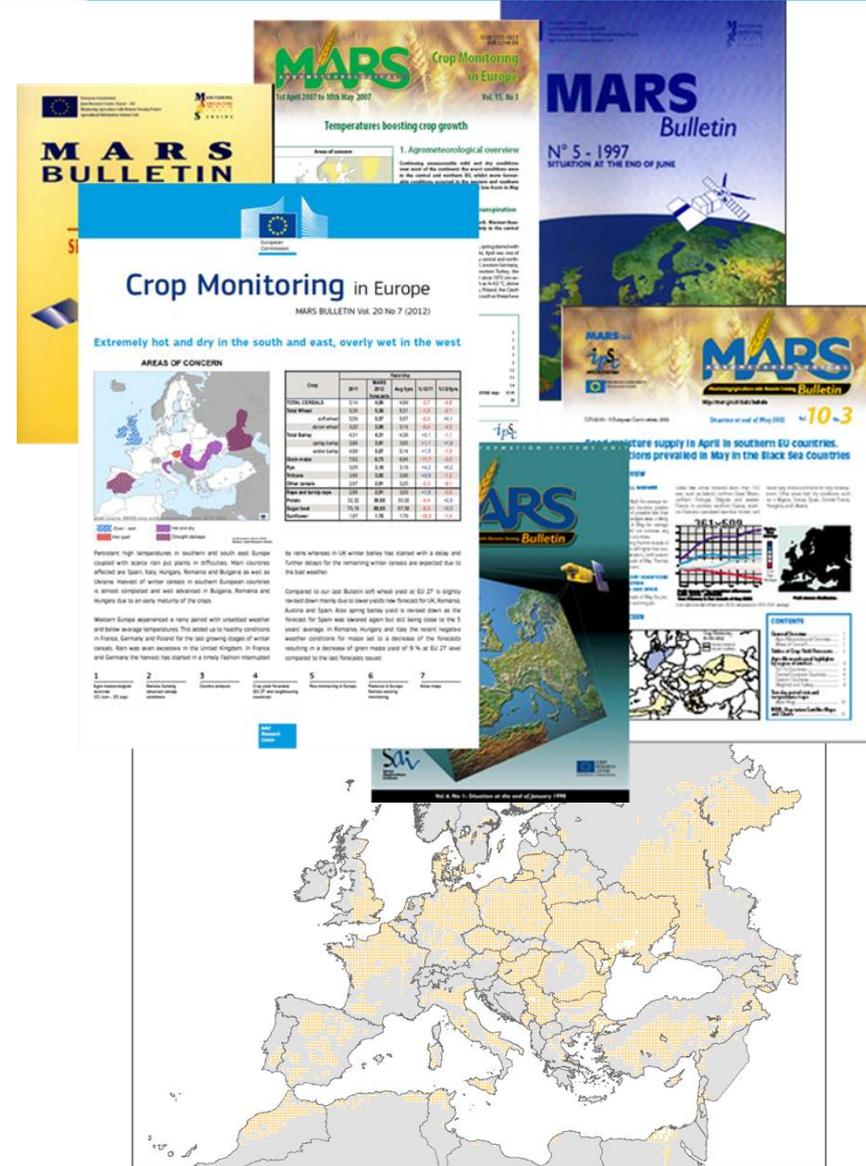
**Joint Research Centre**

the European Commission's  
in-house science service



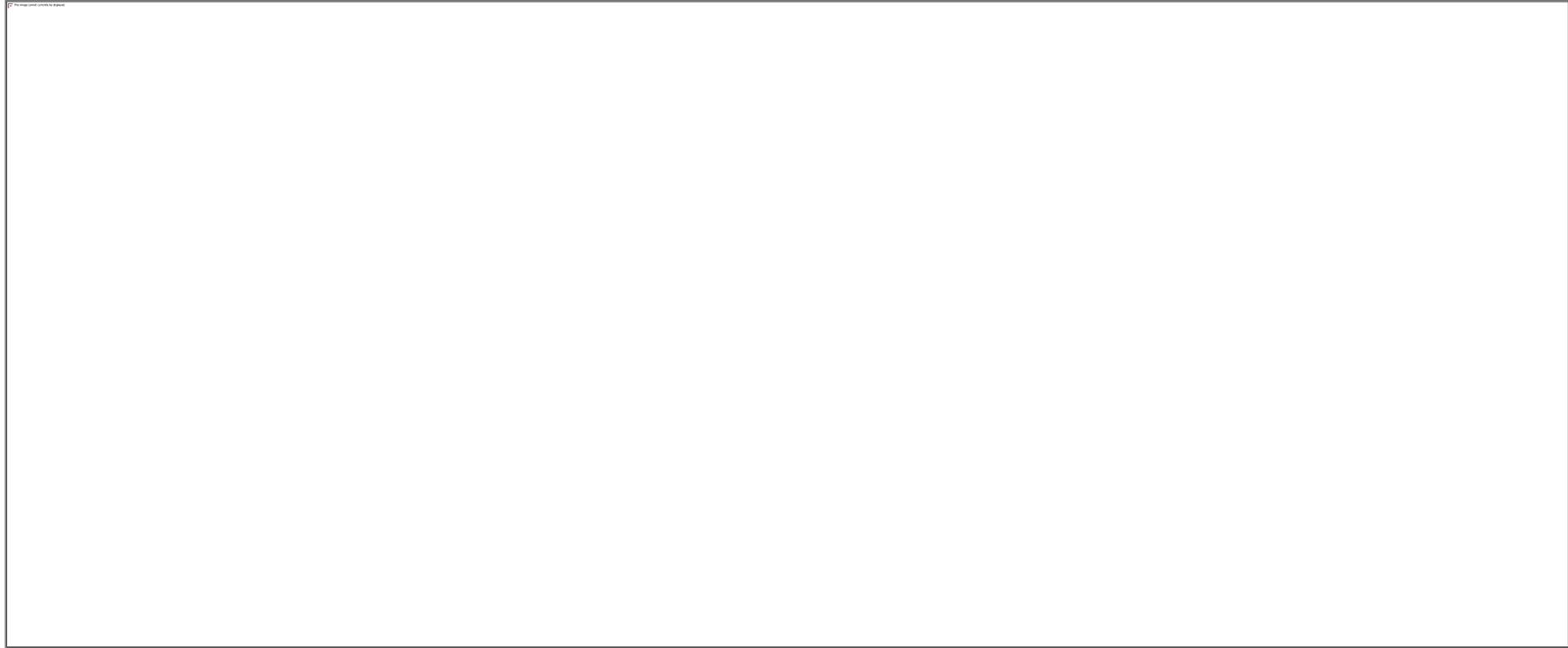
# MAIN ACTIVITIES

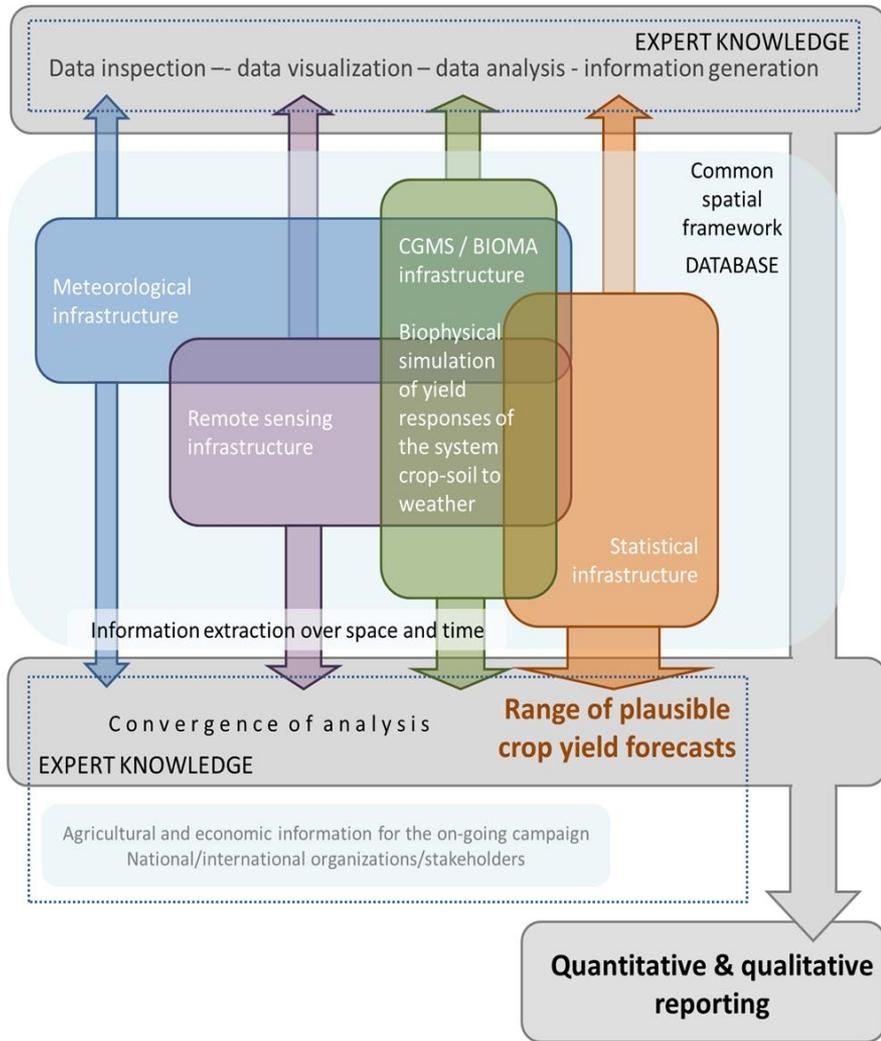
- Crop monitoring and yield forecasting in EU and neighbouring countries since 1992
- Crop monitoring and yield forecasting in other regions of the world since 2015
- Climate, climate change and agriculture
- Crop Modelling



Main agricultural areas across Europe

# *Where*





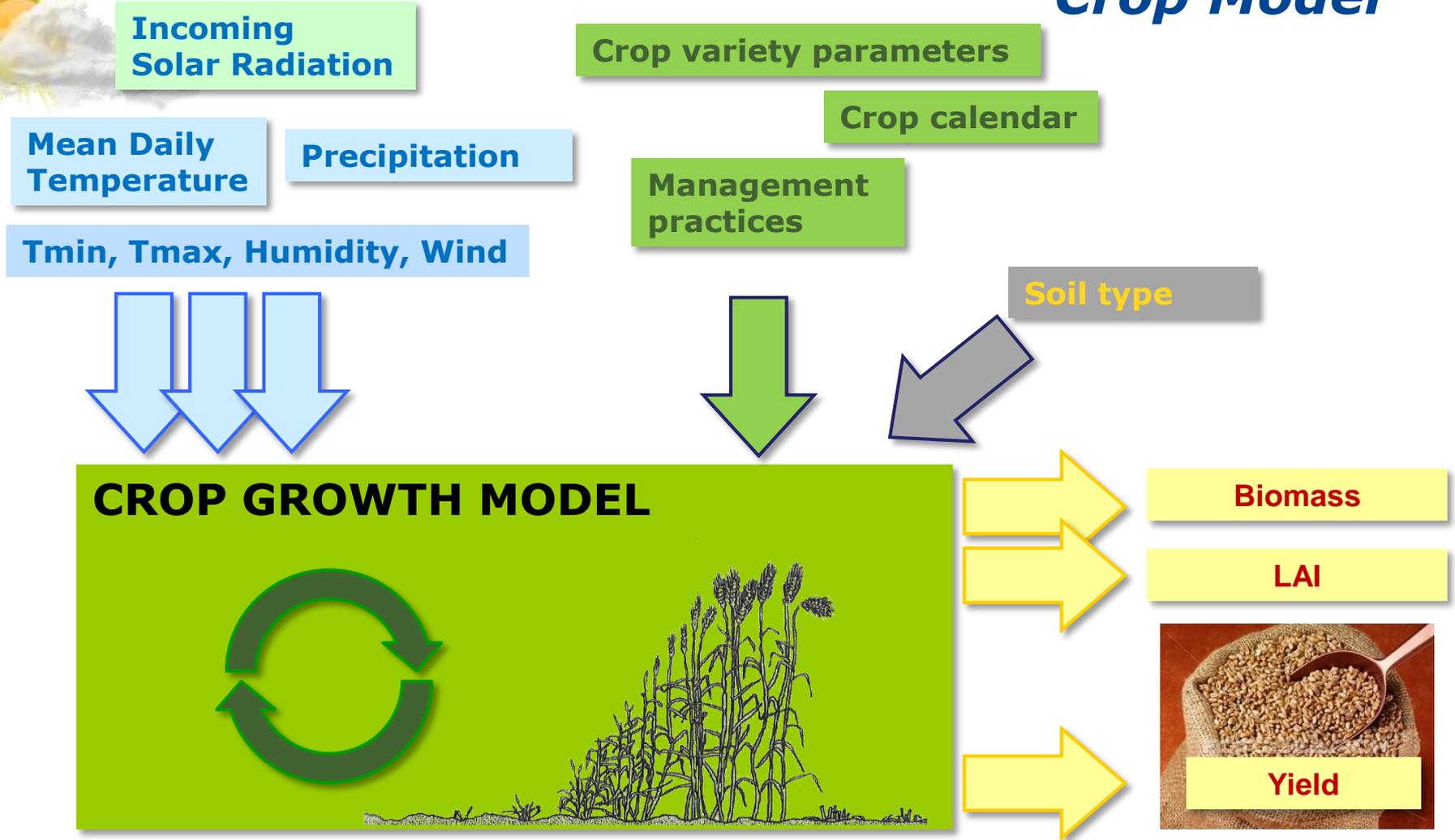
*How*

**MARS** Crop Yield Forecasting System

Biophysical model  
application  
platform



# Crop Model



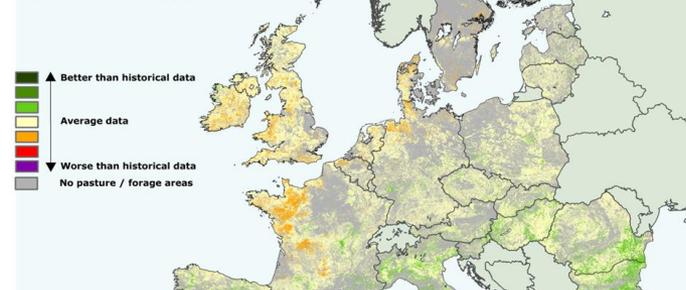
## MSG since 2005 :

**Downwelling radiation,**  
*Evapotranspiration (R&D)*  
**Snow cover (masking)**  
*Land Surface Temperature (R&D)*

## Data Remote sensing

### Seasonal cumulated NDVI

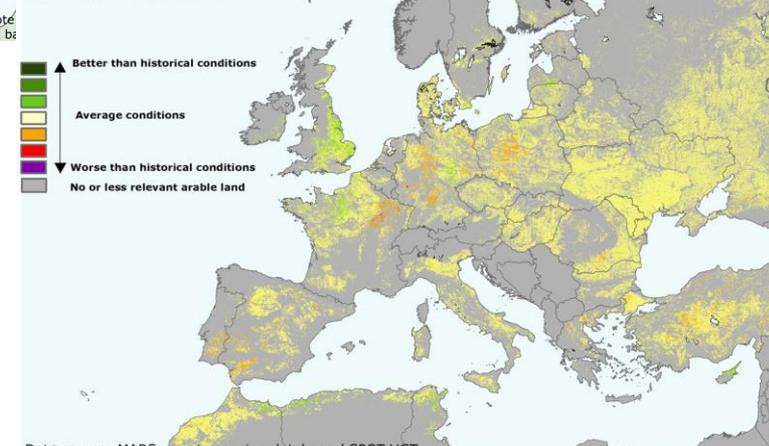
Current season data vs historical data  
Current season data: 1st Oct 2009 - 30 Sep 2010  
Historical data: 1 Oct - 30 Sep



Data source: MARS remote  
Pasture and forage\_mask b

### Potential fAPAR evolution for the growing season

Average scenario vs historical conditions  
Average scenario given by sum of:  
Current season data: 1st March 2012 - 30 April 2012  
Long term average data: 1 May - 30 September



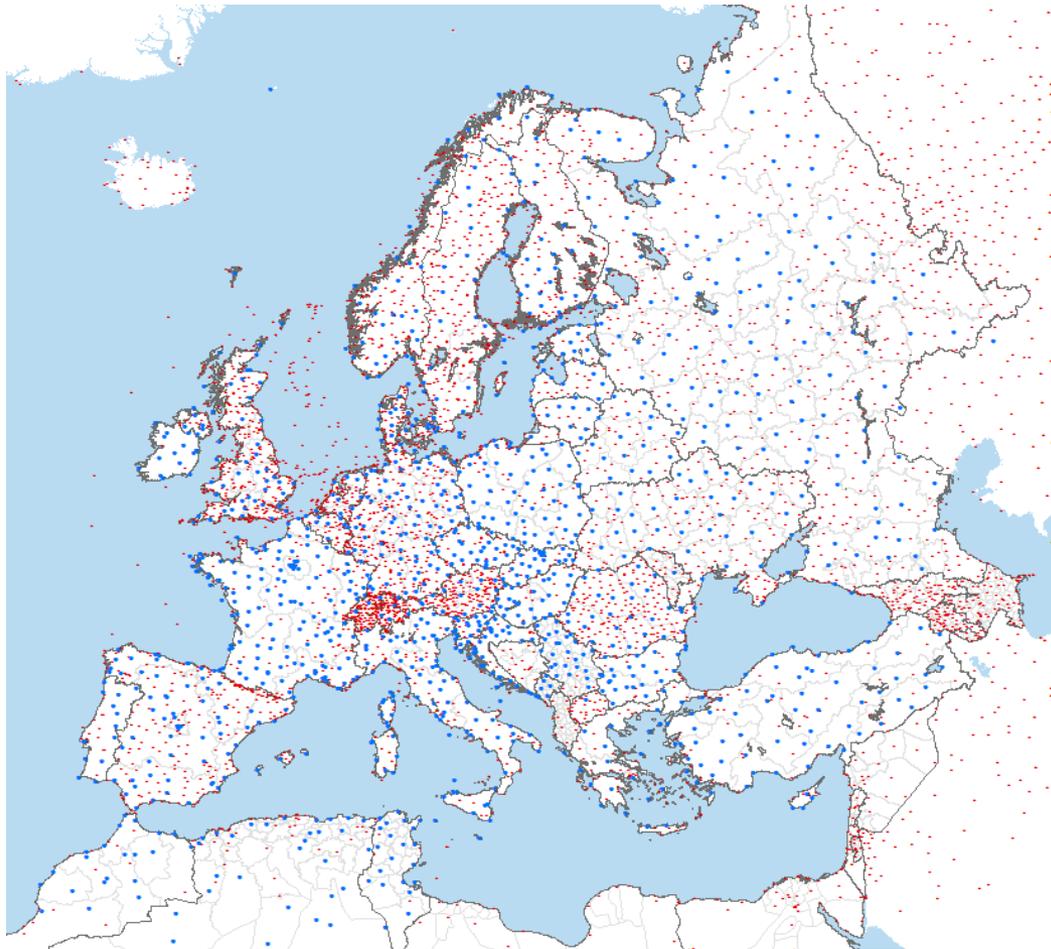
Data source: MARS remote sensing database / SPOT-VGT  
Arable land\_mask of non irrigated arable land based on CLC 2000

**NOAA AVHRR**  
since 1981

**METOP AVHRR**  
from 2008

**SPOT VGT**  
since 1998

**PROBA-V**  
since 2014



## **Data Ground Observations (Europe)**

**Daily data from approx. 4000 weather stations ('reliable', 'less reliable')**

**Quality Controls** (*i.e. consistencies: range value, comparison with neighbours's station etc ...*)

**Daily interpolation on a 25 km grid**

**End-of-year re-processing** (due to delayed access of some stations)

**Daily gridded archive (1975-last complete year) is available.**

<http://agri4cast.jrc.ec.europa.eu/DataPortal/>

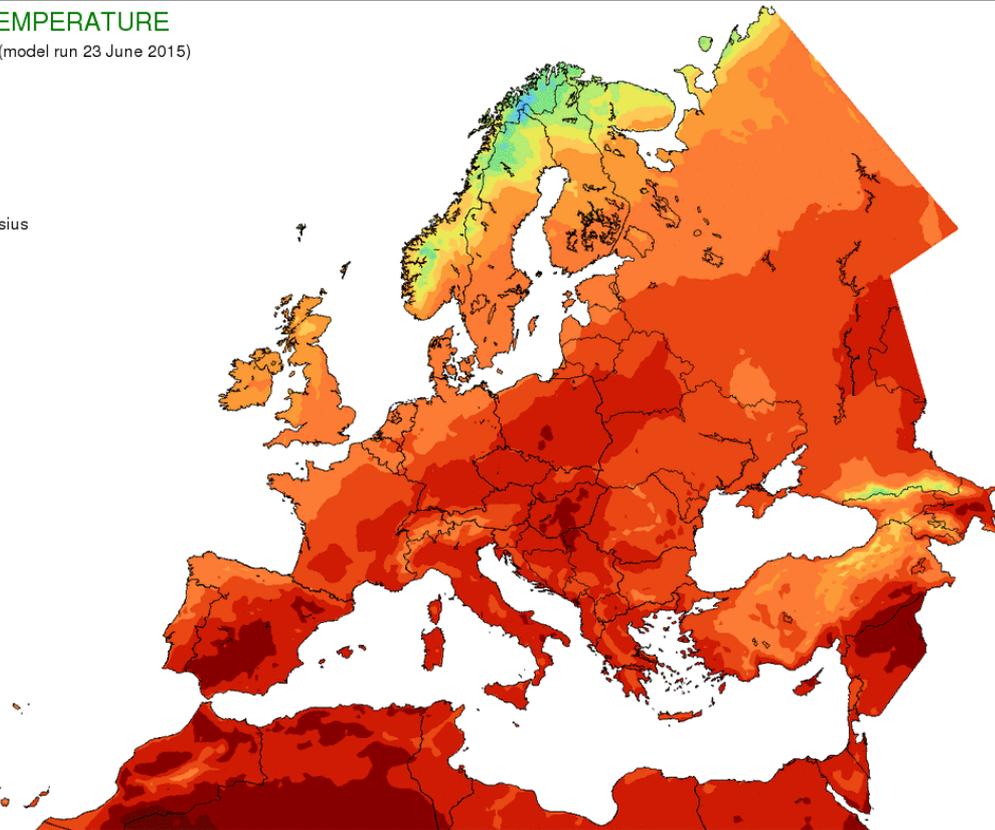
## ERA-40 & ERA-Interim (*qualitative check*)

- **Medium range forecast (16 km, 15 days)**
  - **Extended range forecast (1 month)**
  - **Long range forecast**
  - **Deterministic forecast (HRES - 10 days)**  
**(quantitative for crop yields forecast)**
- **Downscale at 25 km**

### MEAN 2M TEMPERATURE

Operational model (model run 23 June 2015)  
valid: 02 July 2015

Units: Degrees Celsius



(c) European Union 2015, source: Joint Research Centre

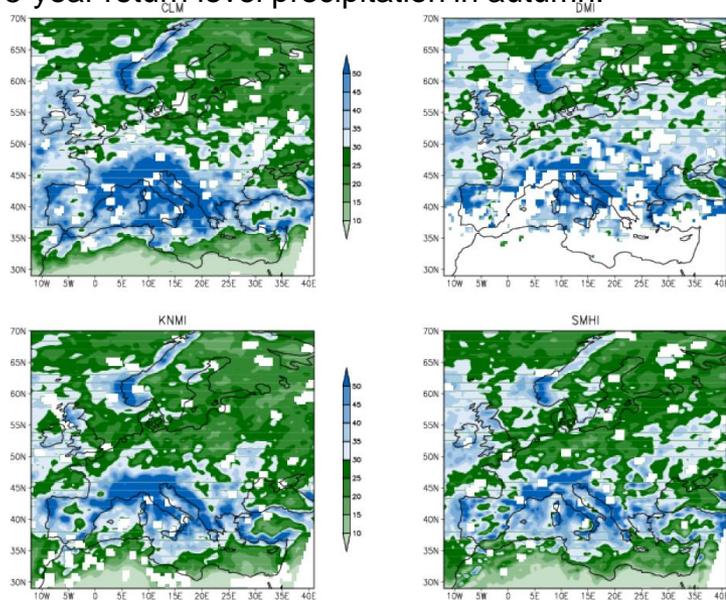
The geographical borders are purely a geographical presentation and are only intended to be indicative. These borders do not necessarily reflect the EC position.

Data from **ECMWF**  
Processed by **MeteoGroup**

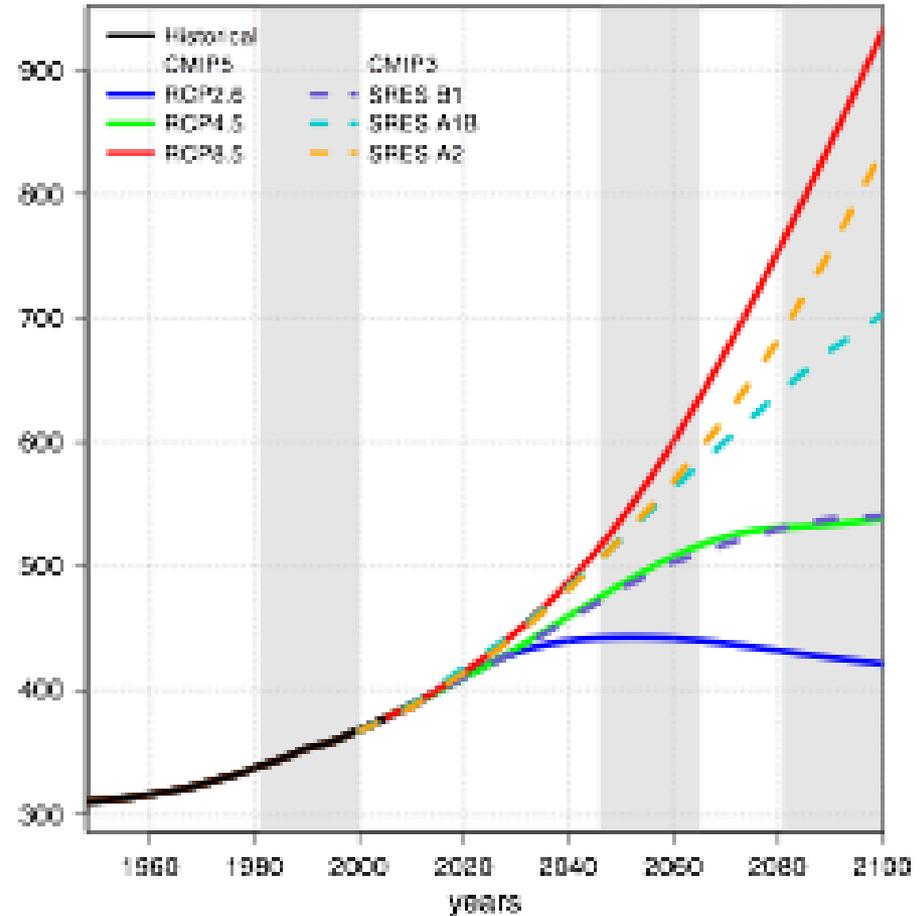
# Data: Climate projections

- ENSEMBLES
- CMIP5 (**RCP8.5**, **RCP4.5**) - Global
- CORDEX (EUR11, EUR44, **RCP8.5** (high emission), **RCP4.5** (mid-range mitigation) – Regional

Evaluations of EUR-11 Cordex Regional Climate models:  
5-year return level precipitation in autumn.



CO2 concentrations [ ppm ]



## Data: Climate projections

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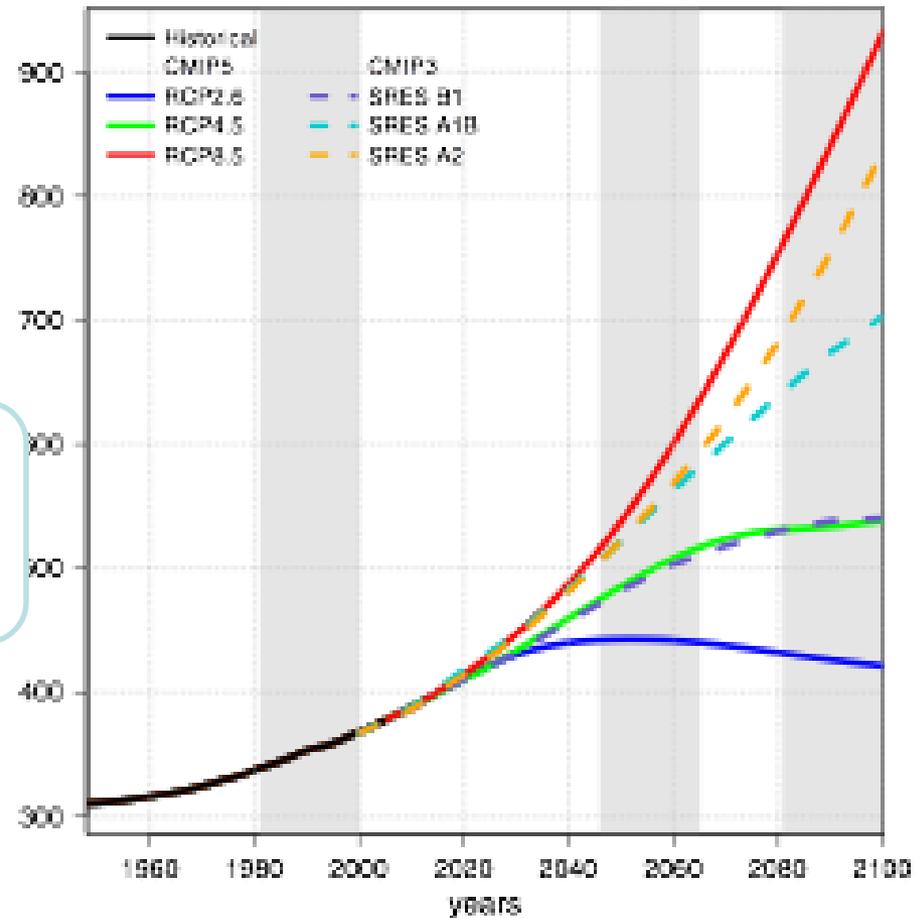
Potential

Water Limited

- CO<sub>2</sub>
- Temperature, radiation, precipitation

**Crop Yield Projections**

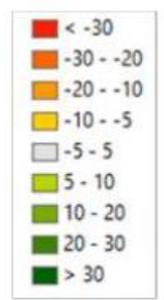
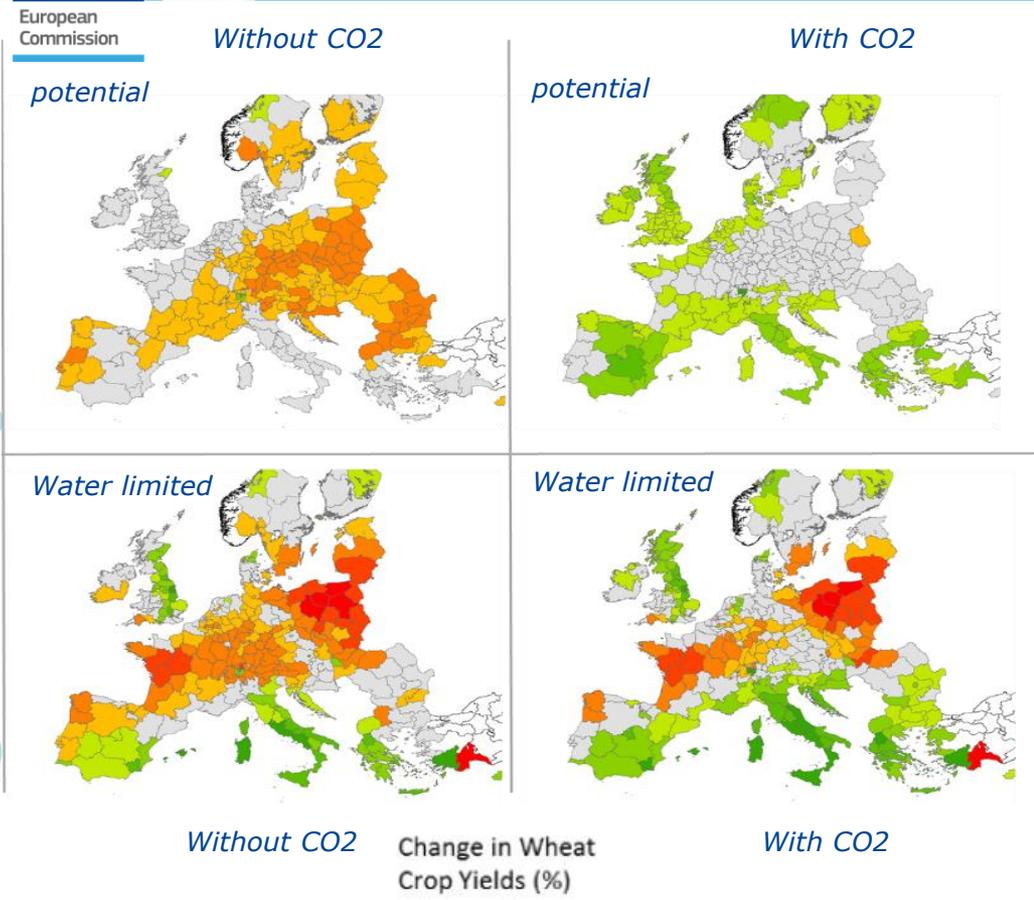
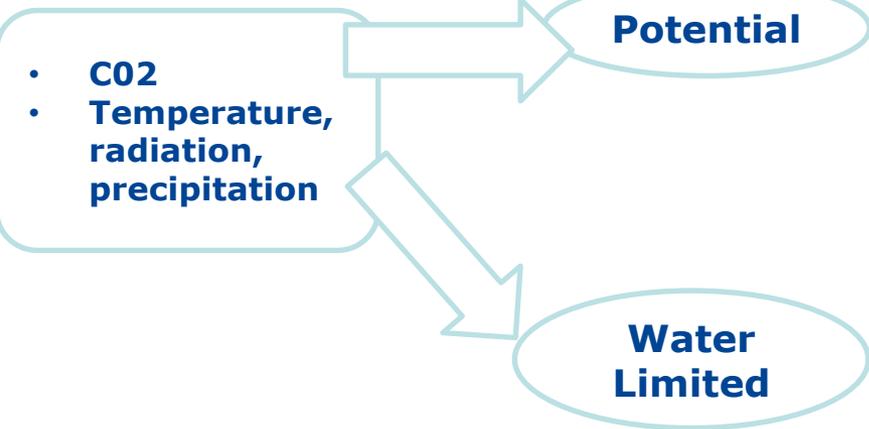
CO<sub>2</sub> concentrations [ ppm ]





# Data: Climate projections

Climate: bias corrected  
ENSEMBLES HadCM3 GCM-RCM

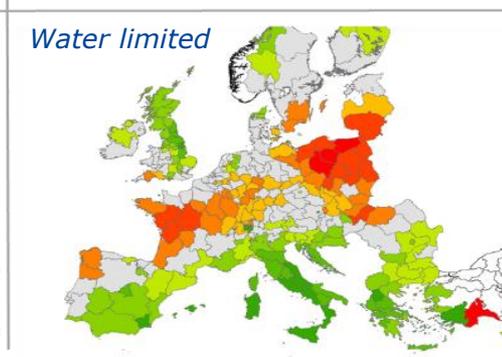
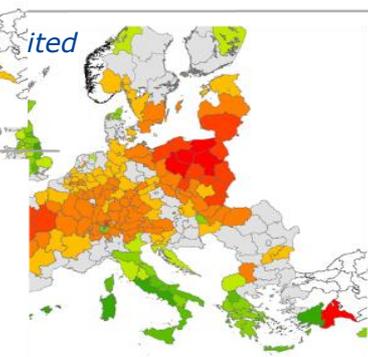
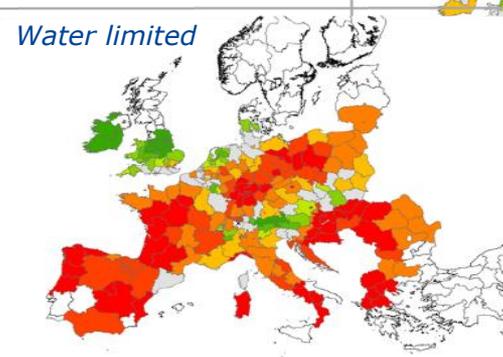
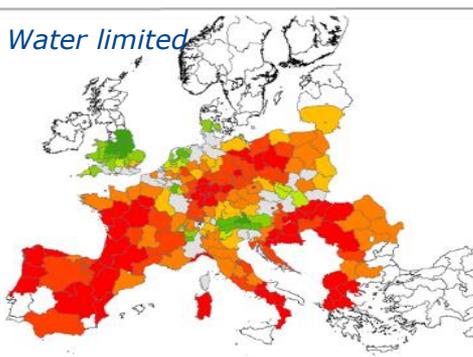
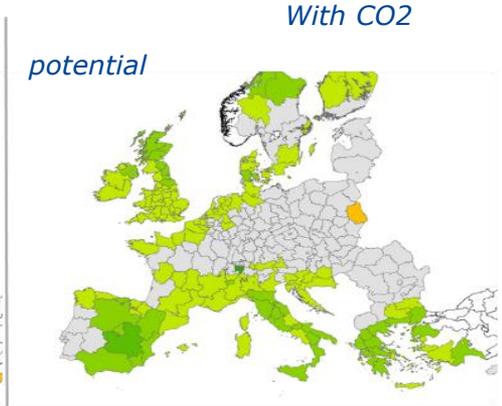
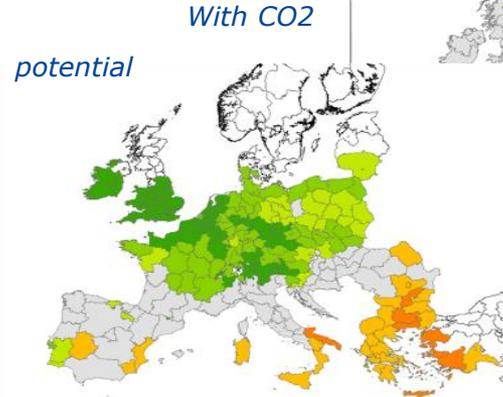
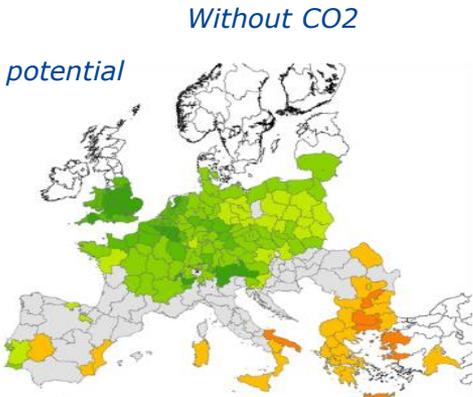


2030s changes (% w.r.t. 2000s)  
in **wheat** yield under the A1B scenario

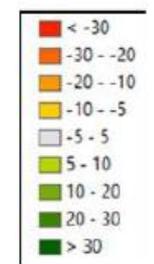
Source: Ramos et al., 2015

# 2030s changes (% w.r.t. 2000s) in **wheat** yield under the A1B scenario

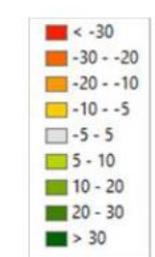
## 2030s changes (% w.r.t. 2000s) In **maize** yield under the A1B scenario



Change in Maize  
Crop Yields (%)

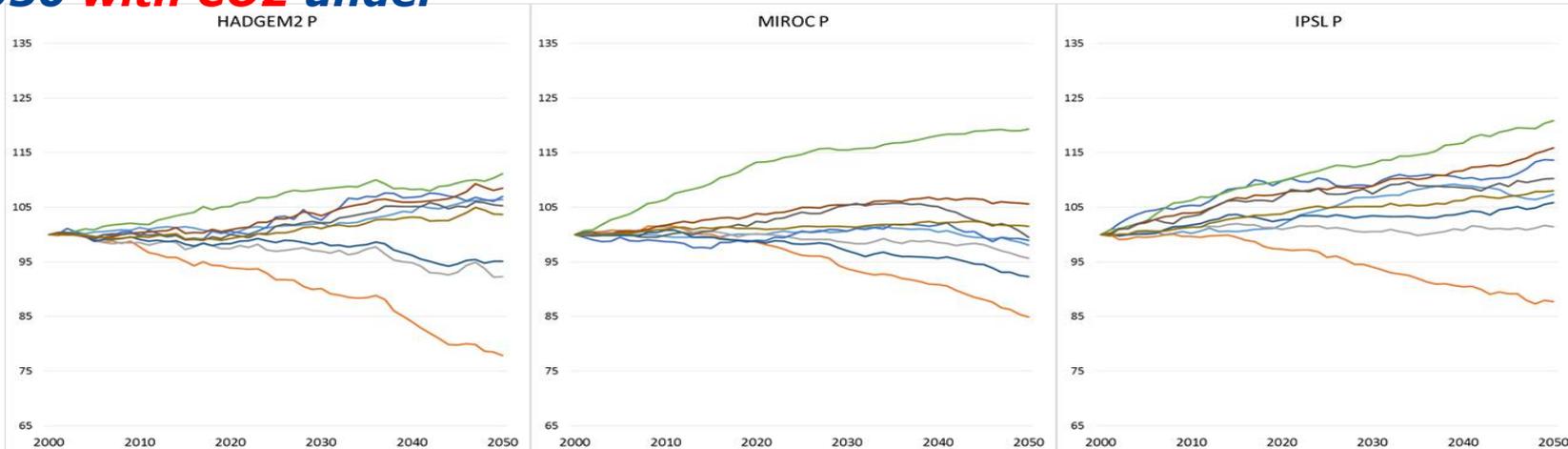


Change in Wheat  
Crop Yields (%)

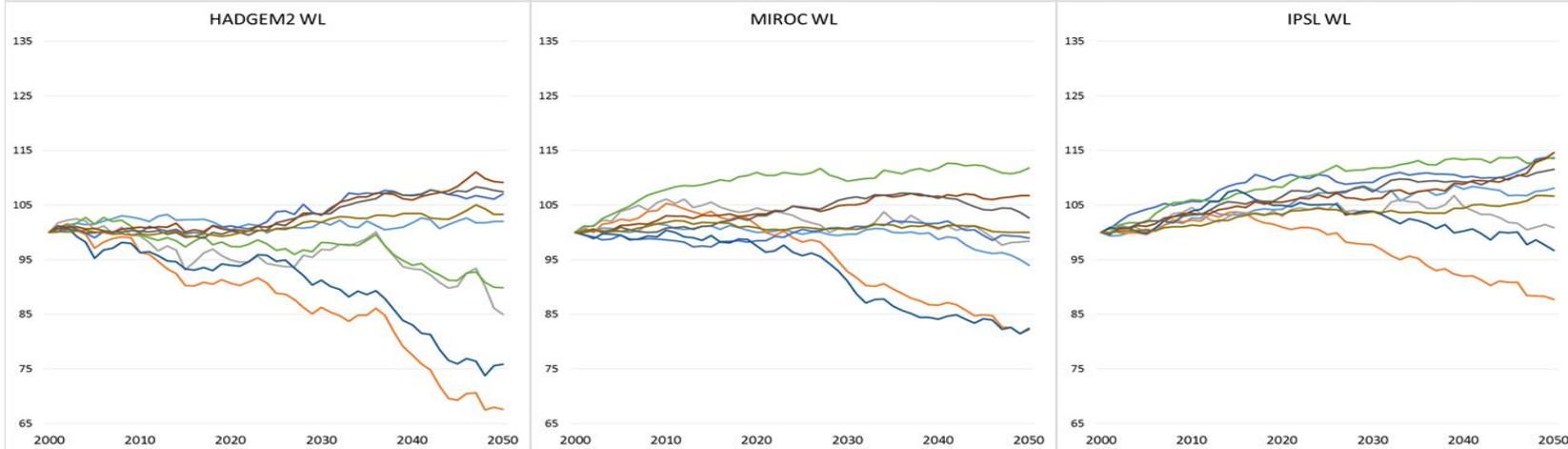


# Changes in crop yields from 2000 to 2050 with CO<sub>2</sub> under RCP8.5

Potential



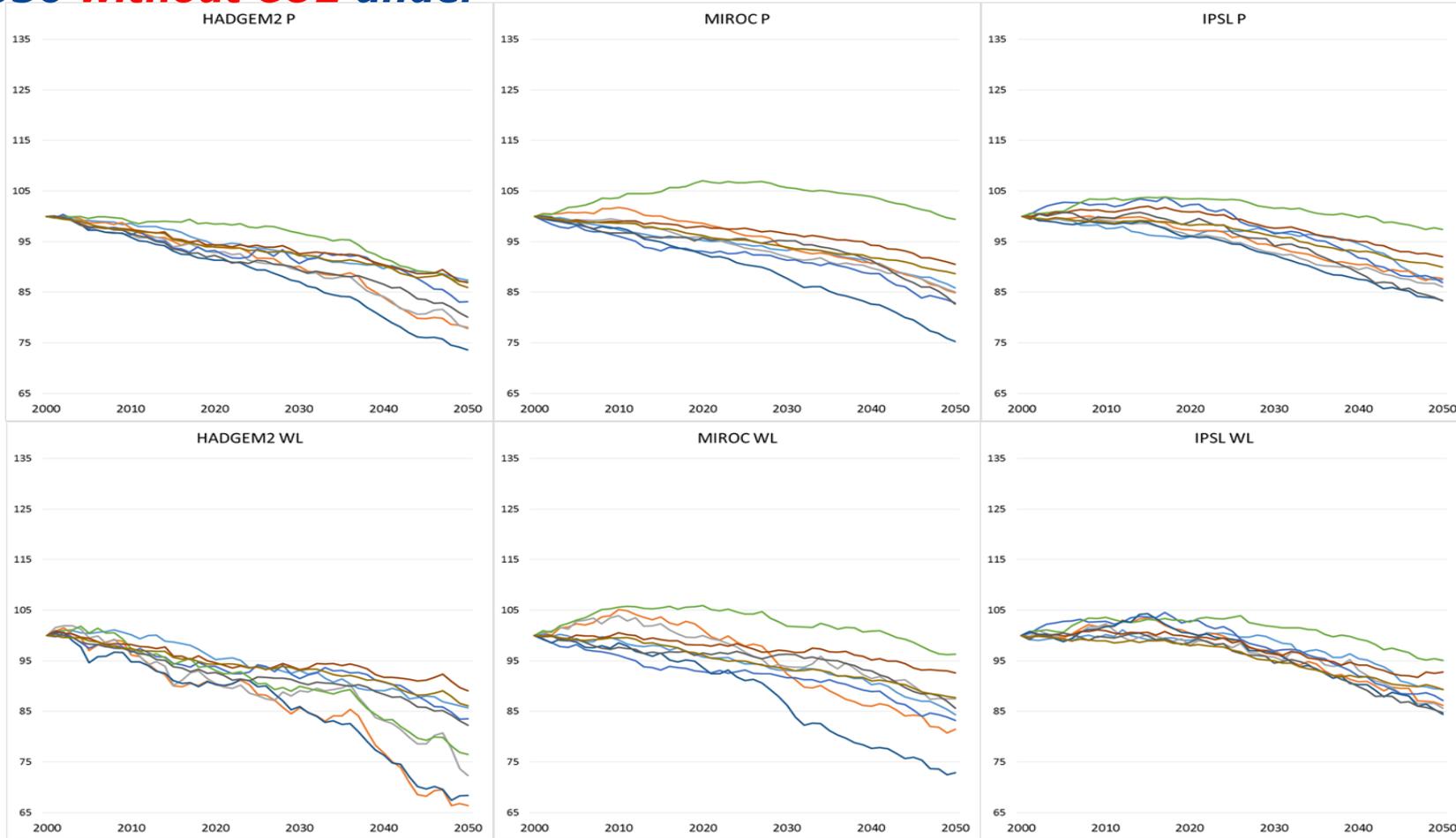
Water limited



Field Beans    Maize    Potato    Rye    Sugar Beet  
Sunflower    Wheat    Rapeseed    Barley

# Changes in crop yields from 2000 to 2050 **without CO2** under RCP8.5

Potential



Field Beans    Maize    Potato    Rye    Sugar Beet  
Sunflower    Wheat    Rapeseed    Barley

## How C3S could help reducing such predictions results differences ?

Regional Climate Model actually perform at  $\sim 10$  km

'Past and actual' Gridded Observation at  $\sim 25$  km (European level)

→ **There is a need to validate and benchmark these RCM models**

This task therefore requires gridded observation at 10 km

Modeling Corner:

EUR-11 resolution gridded observational dataset with a better representation of extremes

Better bias-correction procedures (crops are 'so' sensitive...)

Complete EUR-Cordex Global Climate Model – Regional Climate Model matrix for uncertainties evaluation

More Cordex runs over some other regions in the world (e.g., South America)

Include crop model in Earth System Model?

Support for Cloud Resolving Model?

## **Requirements for Earth Observation**

- 1. Creation of a long term record archive, with GCOS target accuracies, including:**
  - **Downwelling surface radiation (daily, 25 km), snow cover (daily, 1 km), land surface temperature (daily, 1 km)**
  - **Leaf Area Index/FAPAR/Fractional cover at 10 m-30 m (e.g. Sentinel-2)**
    - **These vegetation products are needed to get crops specific information.**

## ***Requirements for observation***

- 1. Availability of more ground observations (especially for precipitation, radiation)**

## ***Requirements for forecast and reanalysis***

- 1. High spatial resolution reanalysis, ideally **updated every day** and with an annual re-processing to include more info**

→ **Target for Europe: 5 km**

- 2. Improvement of the seasonal forecast as it is used as 'observations' in crop yields**