TYPOLOGY OF DROUGHT STRESS SCENARIOS AT EUROPEAN LEVEL FOR WHEAT

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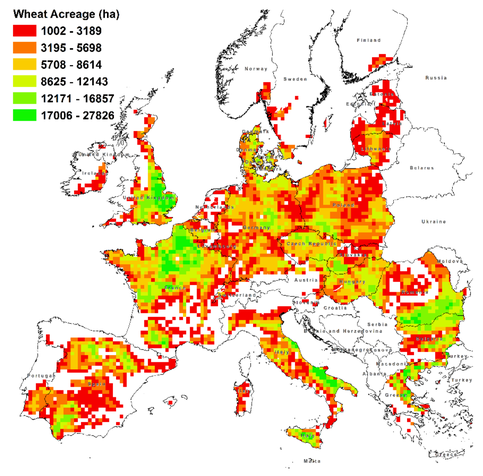
1 Overview

Characterization of the environment as felt by the crop is important to understand genotype by environment interactions and to optimize field trial networks. However, a characterization of drought stress scenarios at the EU level for wheat is still missing. Here we aimed to:

- Characterize the typology of drought stress patterns and identify Environment Types (ETs) across Europe for wheat.
- Analyze the occurrence probabilities and temporal trends of the ETs at the continental and regional levels.

2 Data and Simulation Setup

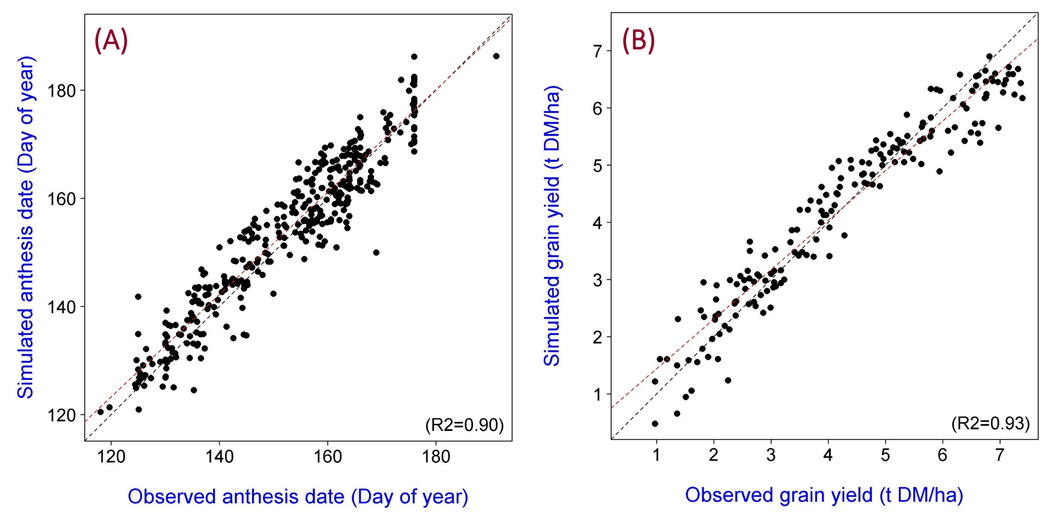
- Daily weather data (1984-2014) from the JRC-Agri4Cast gridded (25x25 km) meteorological database [1], soil data from the Harmonized World Soil Database (1x1 km) [2], N application data from the CAPRI database [3] at the climate zone level [4], and anthesis date from the JRC-Agri4Cast AgroPheno database (25x25 km) were used as inputs. Historical yield data at the NUTS2 level for the period 1985-2010 were extracted from the Eurostat agriculture database [5].
- The wheat crop model *SiriusQuality* [6,7] was used to simulate crop growth and water deficit. Adapted cultivars at each climate zone were selected among 28 previously calibrated cultivars based on anthesis date and yield predictions. JRC grid cells with wheat acreage > 10^3 ha (Fig. 1) and in each grid cell soil components > 30 cm deep were considered, resulting in 25,528 simulation units.



▲ Fig. 1 | Wheat acreage for grid cells (25x25 km) with >10^3 ha of wheat.

3 Prediction of Phenology and Yield

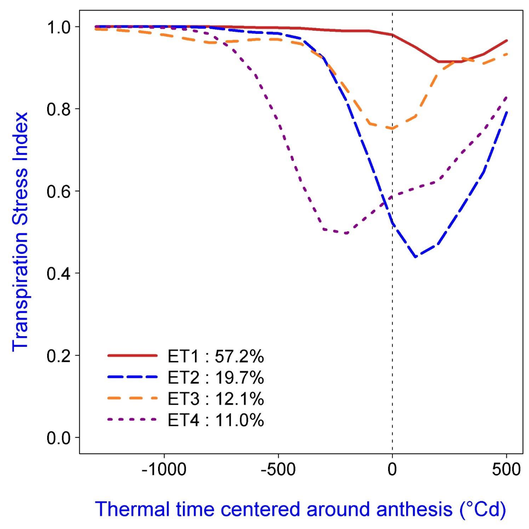
- Anthesis, as the most important growth stage, was used to identify eight adapted cultivars at the climate zone level (Fig. 2A).
- Simulated grain yield of adapted cultivars aggregated at the NUTS2 level compared well with measured grain yield (Fig. 2B).



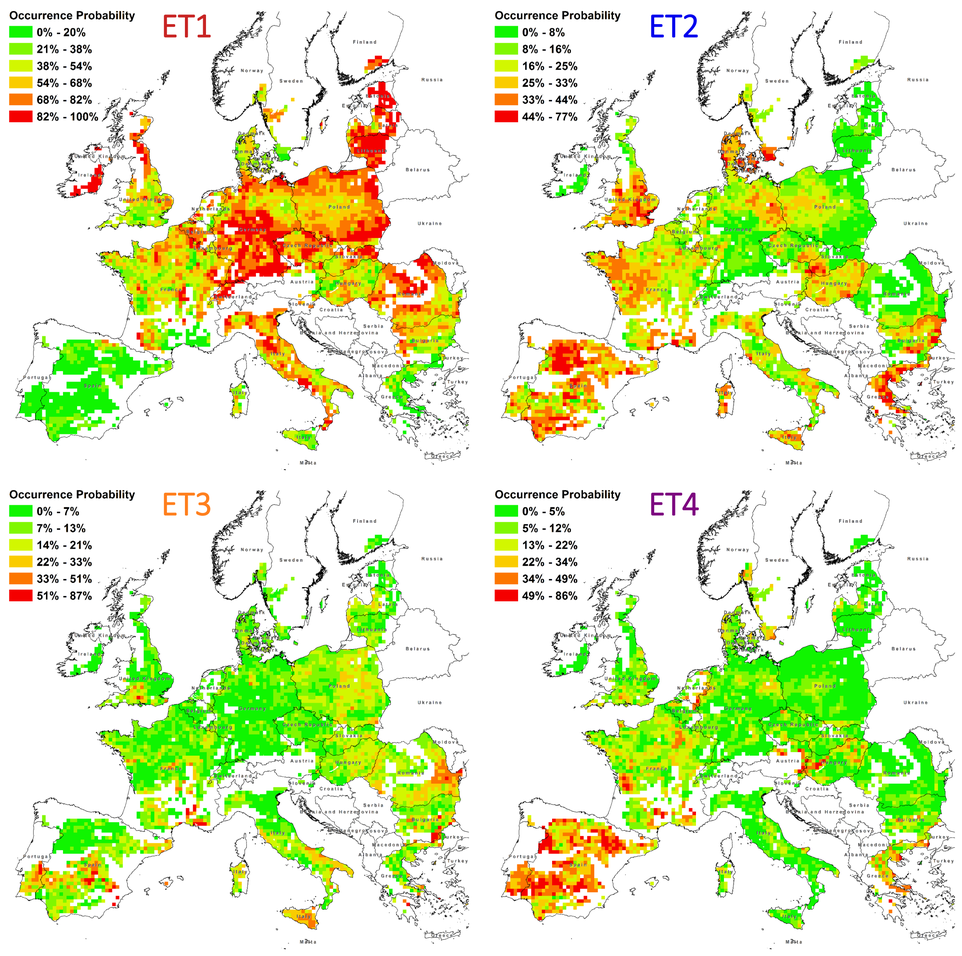
▲ Fig. 2 | Simulated vs observed (A) anthesis date aggregated at the climate zone level (n = 371), and (B) grain yield aggregated at the NUTS2 level (n = 2882).

4 Environment Types

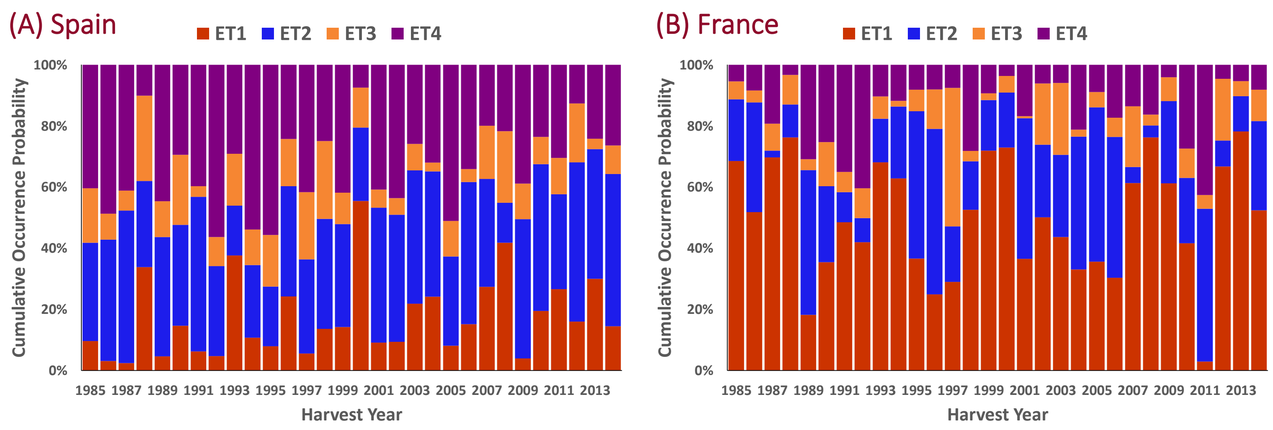
- Cluster analysis identified four main ETs based on transpiration stress index defined as the ratio of actual to potential plant transpiration (Fig. 3).
- The occurrence probability of each ET was determined at the grid level (Fig. 4). South-western and south-eastern Europe were the regions which were most impacted by drought stress over the last 30 years.



◀ Fig. 3 | Patterns of transpiration stress index in the four main Environment Types (ETs) identified across Europe. Inset illustrates the occurrence probabilities at the continental level. ET1 and ET3 represent no and mild stress patterns, respectively. ET2 and ET4 represent sever drought stress during the stem extension period and around anthesis and early grain filling, respectively.



▲ Fig. 4 | Spatial variability of the occurrence probabilities of the four main Environment Types (ETs) identified across Europe.



▲ Fig. 5 | Occurrence probabilities of the four main Environment Types (ETs) over time for Spain (A) and France (B)

- The occurrence probabilities of the ETs over the period 1984-2014 do not show any significant temporal trend across the entire Europe (data not shown).
- In some countries stress patterns show significant trends, like ET1 (increasing) and ET4 (decreasing) in Spain (Fig. 5A), while in others no significant trend was detected (e.g. in France, Fig. 5B).

5 Conclusion & Perspective

- A distributed gridded simulation framework was developed and a clustering approach was used to analyze the typology and occurrence probability of drought stress patterns across Europe. Regions with high frequency of severe drought stress were located. Preliminary trend analysis at the continental level shows no significant trend in the occurrence probability of the identified Environment Types, but in some countries significant trends were detected.
- A similar approach is currently undertaken for other drought-related indices as well as temperature and N stress indices under past and future climate scenarios. An integrated stress index is to be developed to investigate the interaction of co-factors of different natures.

6 References

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