Exposure of wheat to heat across Australia

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I am a crop physiologist and crop simulation modeller. I love maths and stats and the quantitative side of biology and genetics. Attending Data School gave me the opportunity to upgrade my skills and interact with people who are more proficient, opening doors to collaboration.

My Synthesis Project

Wheat crops around the country are increasingly exposed to failure, yield and quality losses adjudicated to higher temperatures, environmental demand and climate variability. This study aims to gather, compile and analyse information on when these changes in environmental variables are occurring in relation to different stages of crop development, with what pattern and frequency.

To do this, environmental variables or derived indices were based on gridded soil and weather information across the country (5x5km) (www.bom.gov.au) and used to quantify trends from 1957 to 2017. The crop simulation model APSIM NextGen (Holzworth et al., 2018) was used to simulate the phenology of 60 cultivars in 10 sowing dates and the start and end date of ten different crop phases. Only a cultivar of of intermediate maturity sown at recommended sowing date is presented here.

My Digital Toolbox

GitHub for version control, HPC and R for processing and visualising data.

My time went …

Tidying, processing, and inspecting the data dispersion with different statistical techniques absorbed most of my time. The scripts were run from the command line, using SLURM to iterate through the folders picking different cultivar × sowing date combinations for each crop stage. Special thanks to my mentor for teaching me how to do that.

Next steps

This project will continue with more data analysis and association studies. I would like to learn more data visualisation to create meaningful graphs for this type of data set, improving on available formats.

Main findings applying Data School skills

Different to the changes in the date of last frost, the first day of heat (T>32°C, 20th percentile) occurred consistently earlier, up to more than half a day earlier (-0.65 d/year) (Figure 1). This reduces the 'safe flowering' window.

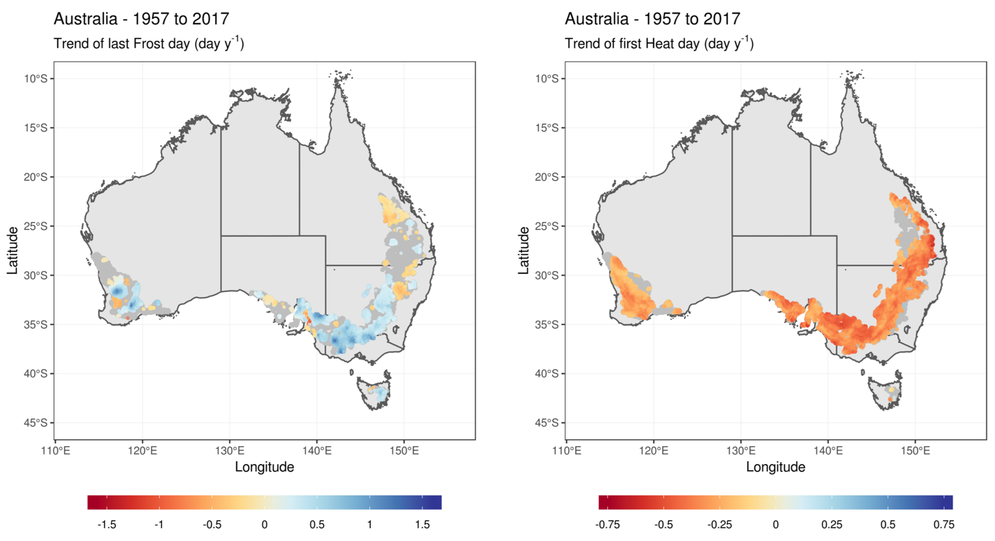

Figure 1: Trends in last frost and first heat day between 1957 and 2017. Coloured cells where the trend was significantly different from 0, grey cells indicate no change.

The early reproductive period and the grain filling period were analysed per growing region (Figure 2).

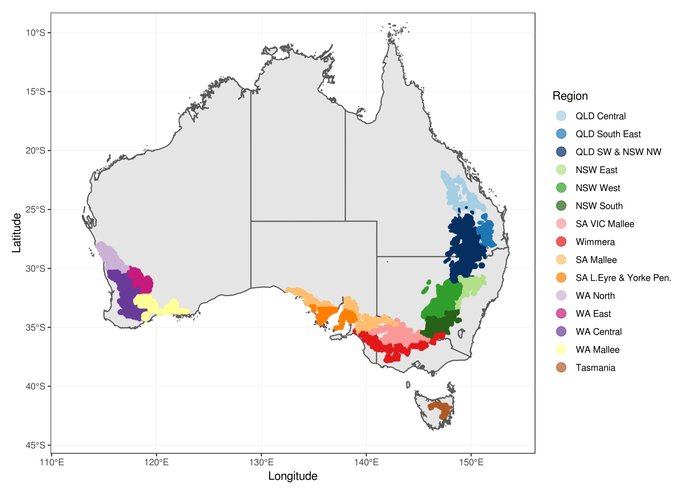

Figure 2: Australian cropping belt and regions.

Maximum temperature increased significantly in both phases (Figure 3), resulting in significant shortening of the grain filling period, while minimum temperature exhibited little change.

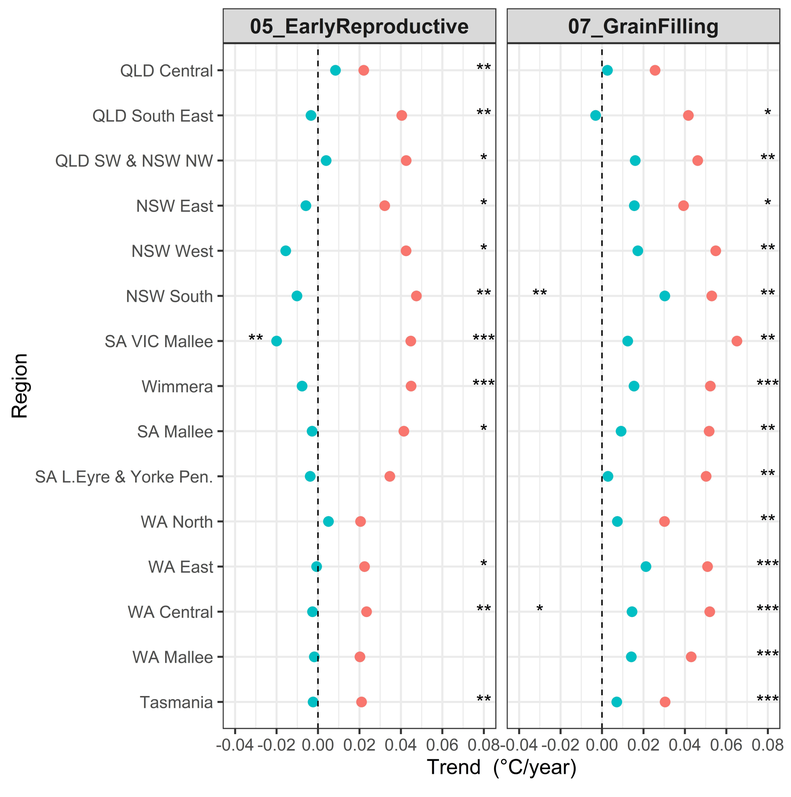

Figure 3: Trends in maximum and minimum temperature (1970 to 2017) across Australian regions for the Early Reproductive and the Grain Filling period. Asterisk indicate significant differences at P<0.001 (***), P<0.01 (**) and P<0.05(*). Left asterisks are significance for Tmin and right for Tmax.

Conclusions

Analysis of weather variables during the cropping season and per crop phase can define targets for research and development. The increase in maximum temperature before flowering and during grain filling negatively impacts phase duration, spike fertility and grain growth.

This study would not have been possible without the learnings and tools offered in Data School.

MY DATA SCHOOL EXPERIENCE

I am based in Toowoomba, QLD, and was not able to attend many classes in person. Distance education has its challenges! However, thanks to the good predisposition of the teachers and a fabulous student cohort, I did not feel left out. I hope my experience and feedback can help future DS content around the country. I now feel more able to help point others in the right direction for training.

More personally, I am excited about how much more time I will have to think about problems, hypotheses and solutions (once I really get good at this!) rather than processing data and be creative working with others with the new tools I have at hand.