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## Assessment of the impact of climate change in temperate zone on grain legume yield and N<sub>2</sub> fixation

Gatien Falconnier, Anthony Vermue, Etienne-Pascal Journet, Laurent Bedoussac, Eric Justes

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**ESA2018**

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August 27-31, 2018 - Geneva, Switzerland

[www.esa-congress-2018.ch](http://www.esa-congress-2018.ch)

# Impact of climate change on grain legume yield and N<sub>2</sub> fixation in a temperate climate

Gatien Falconnier, Anthony Vermue, Etienne-Pascal Journet,

Laurent Bedoussac, Eric Justes





# Why grain legumes?



# Objectives













- What will be the potential impact of climate change on legume performance ?
  - Faba bean (*Vicia Faba*) (winter cultivar)
  - Field Pea (*Pisum sativum*) (spring – winter cultivars)

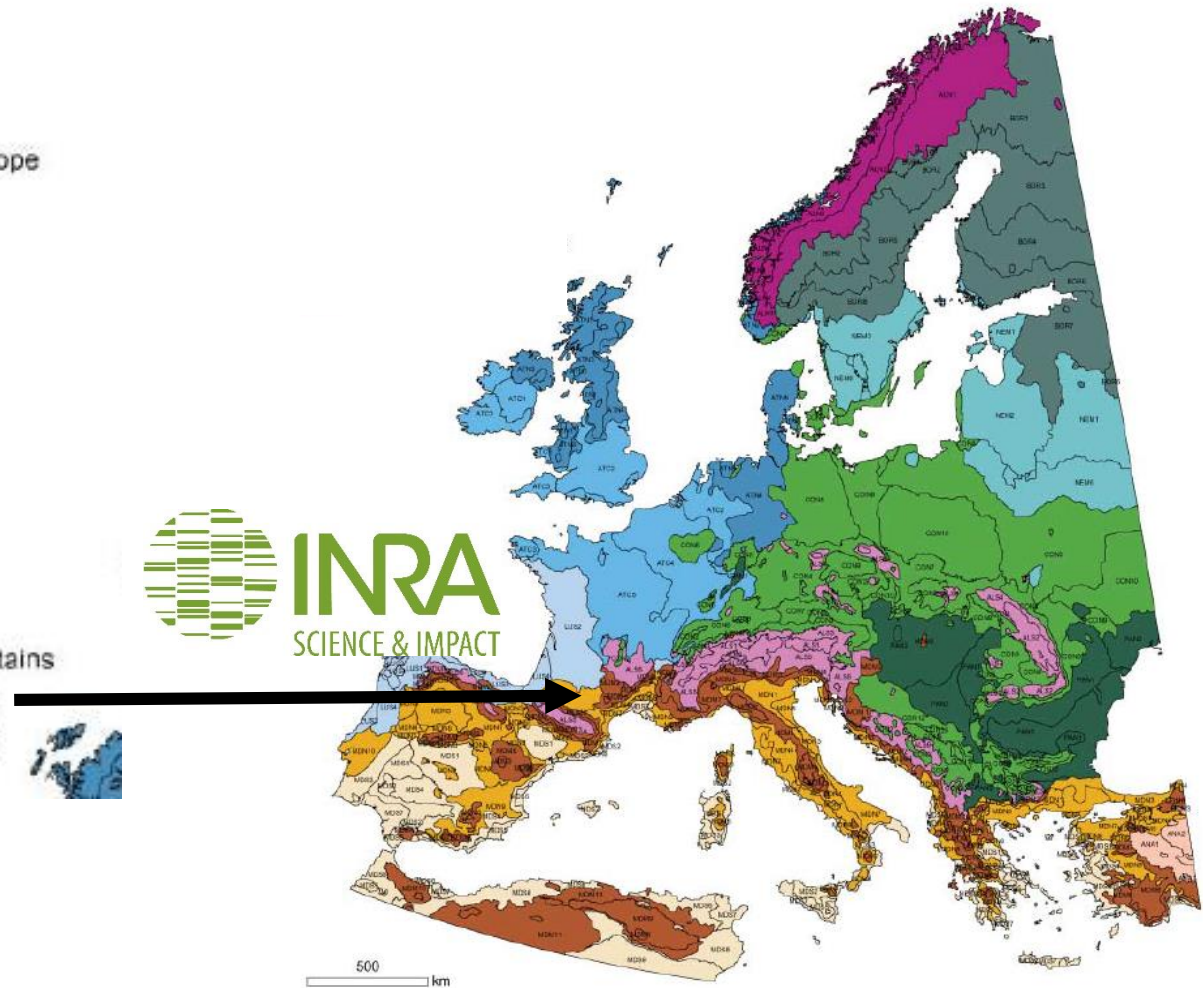
= The two most widely grown legumes in Europe
- What are the factors responsible for changes in legume performance ?

# Auzeville – Southwestern France

Environmental Stratification of Europe


**Environmental Zone**

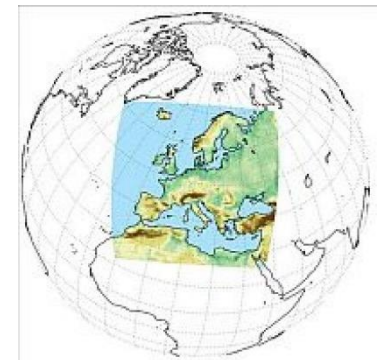
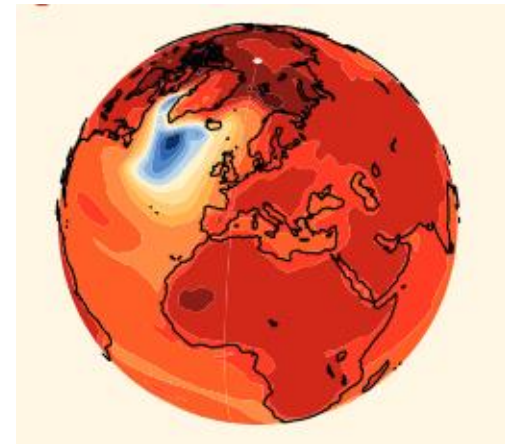
-  ALN - Alpine North
-  BCR - Boreal
-  NEM - Nemoral
-  ATN - Atlantic North
-  ALS - Alpine South
-  CON - Continental
-  ATC - Atlantic Central
-  PAN - Pannonian
-  LUS - Lusitanian
-  ANA - Anatolian
-  MDM - Mediterranean Mountains
-  MDN - Mediterranean North
-  MDS - Mediterranean South



Metzger, et al (2005) *A climatic stratification of the environment of Europe*. *Global Ecology and Biogeography* 14, 549–563.

# Climate scenarii

- Baseline : Meteorological record a t Auzeville station (1995-2015) 
- Mid-term (2020-2040) and long-term (2060-2080) periods
  - Two emission scenarios
    - Medium stabilization scenario « RCP 4.5 »
    - High emission scenario « RCP 8.5 »
  - 3 climate models = GCM/RCM combinations (Euro-CORDEX, <http://www.euro-cordex.net/>)



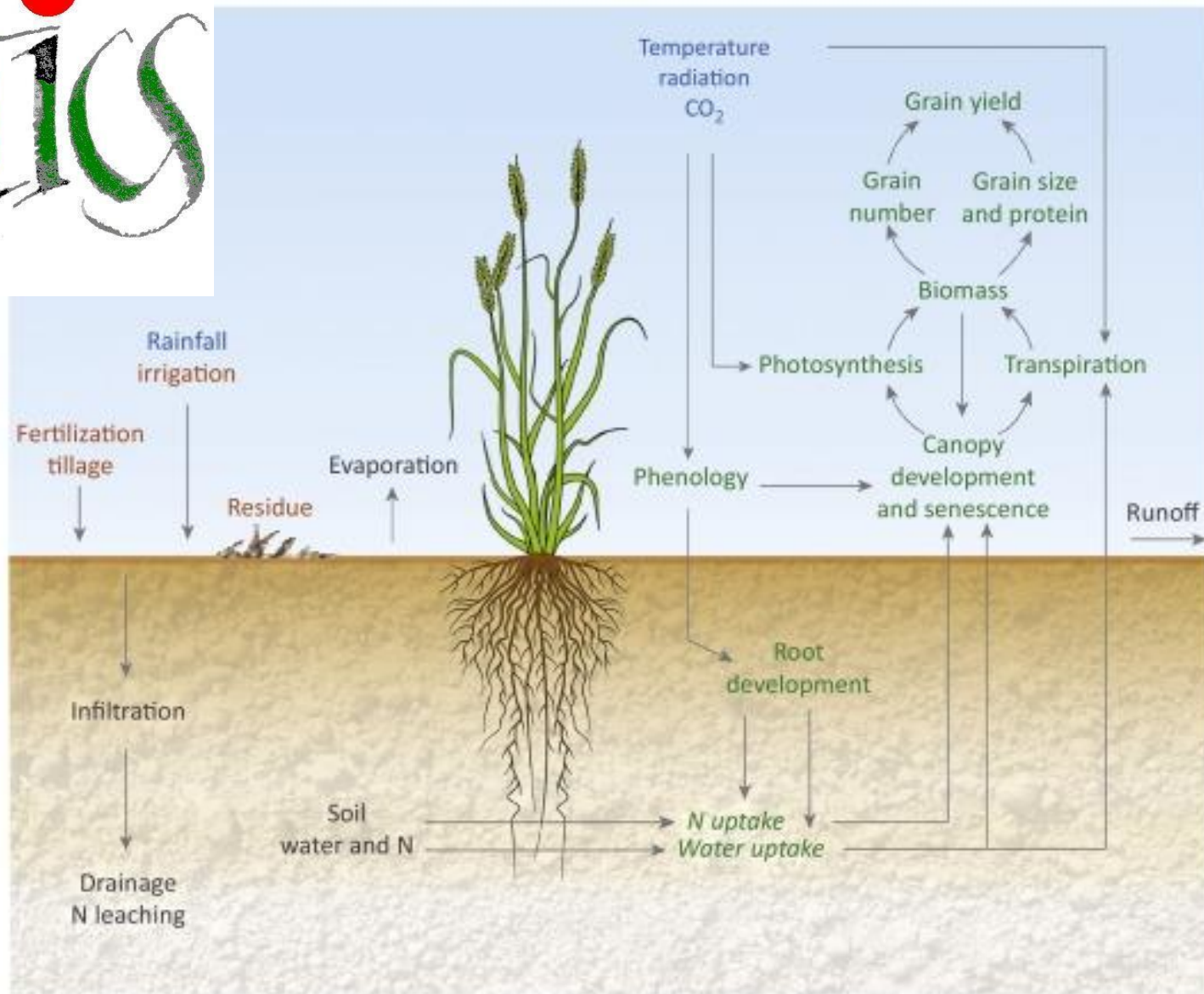
# Changes in Temperature and Rainfall

- Daily average temperature (averaged across the growing season)
  - Medium emission scenario (RCP 4.5): +1°C to +2.6 °C
  - High emission scenario (RCP 8.5) : +2.4°C to +4.1 °C
- Total growing season rainfall :
  - Medium emission scenario (RCP 4.5): -4% to +5%
  - High emission scenario (RCP 8.5) : -4% to +3%

# Cropping system experiments





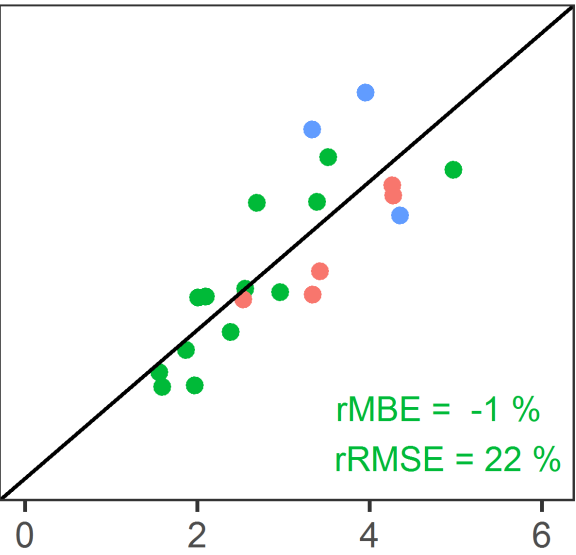
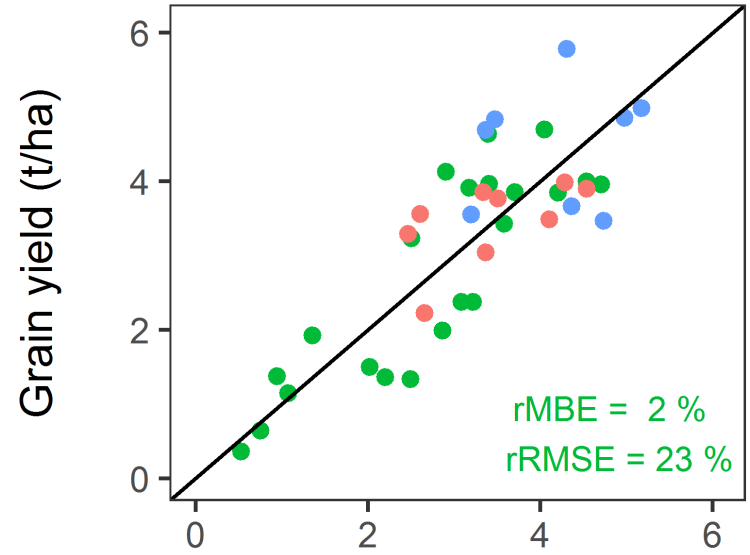


Source: Chenu et al. (2017) *Contribution of Crop Models to Adaptation in Wheat*. Trends in Plant Science 22, 472–490.

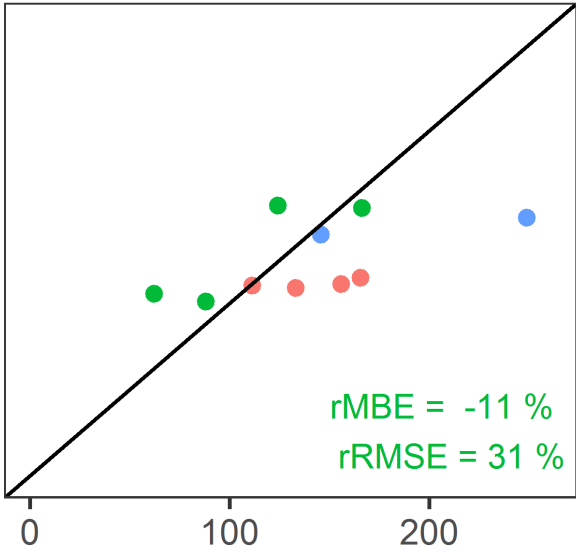
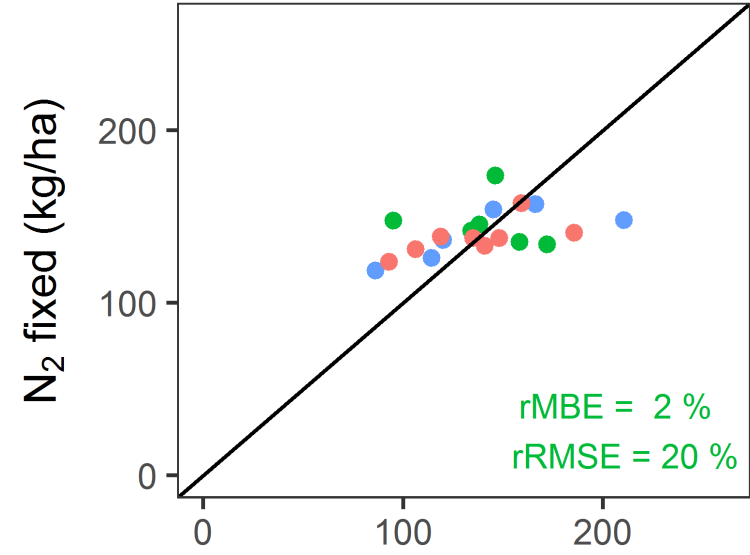
Simulated

### Calibration

### Evaluation



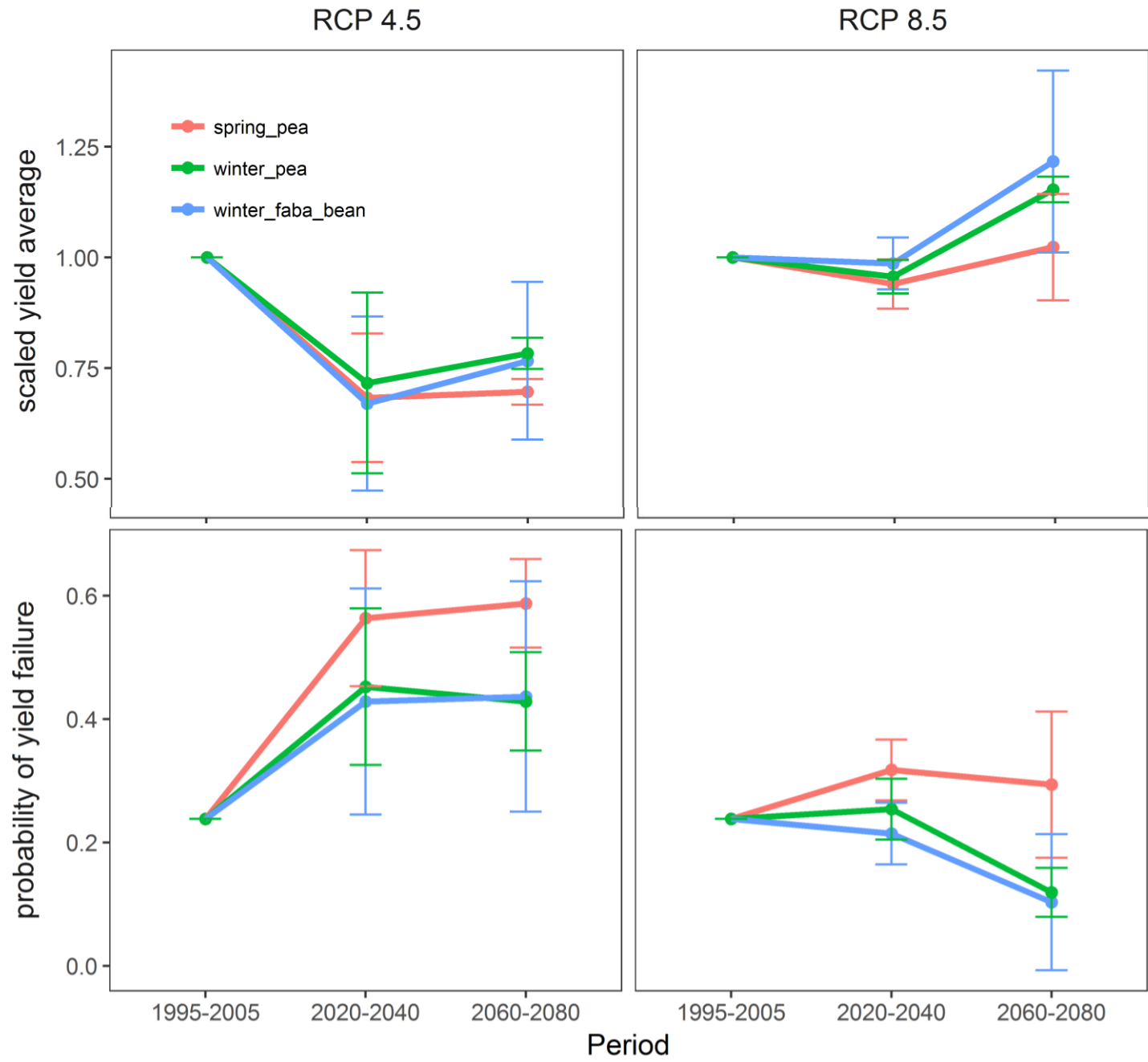
- spring pea
- winter fb
- winter pea



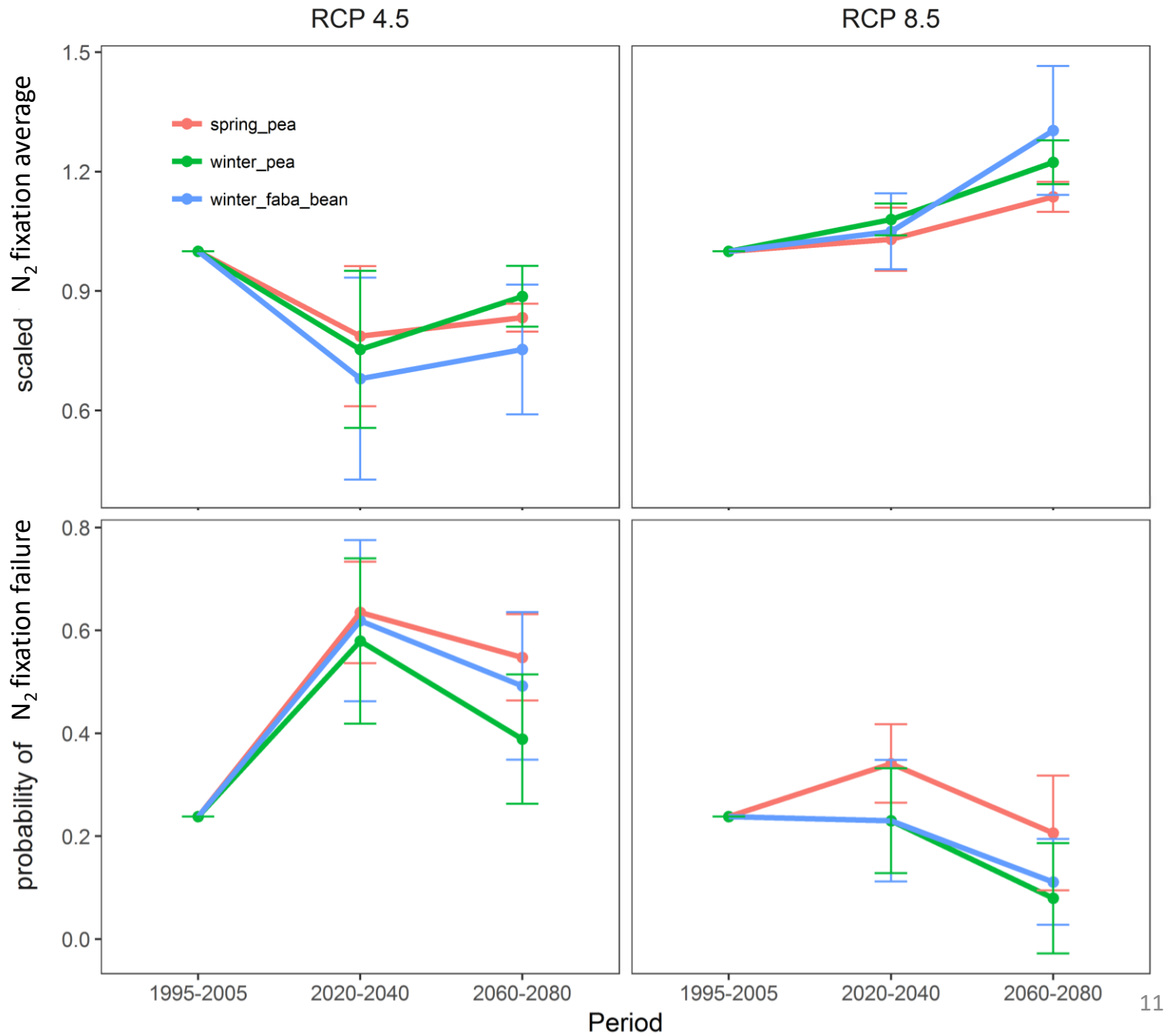
Observed

Falconnier et al.  
*Calibration and evaluation of the STICS soil-crop model for faba bean to explain variability in yield and N<sub>2</sub> fixation.* Submitted to European Journal of Agronomy

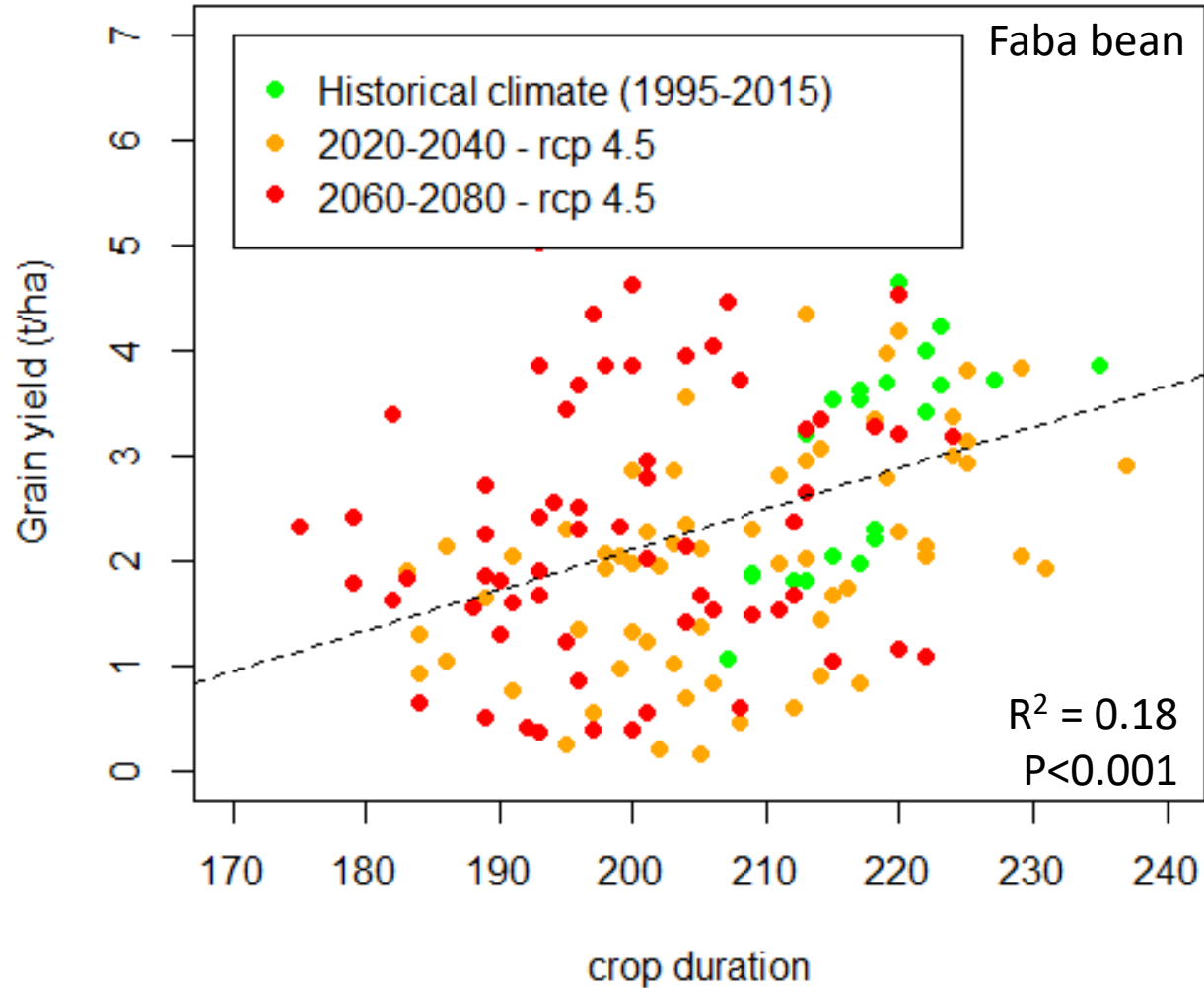
# Grain Yield



# N<sub>2</sub> fixation

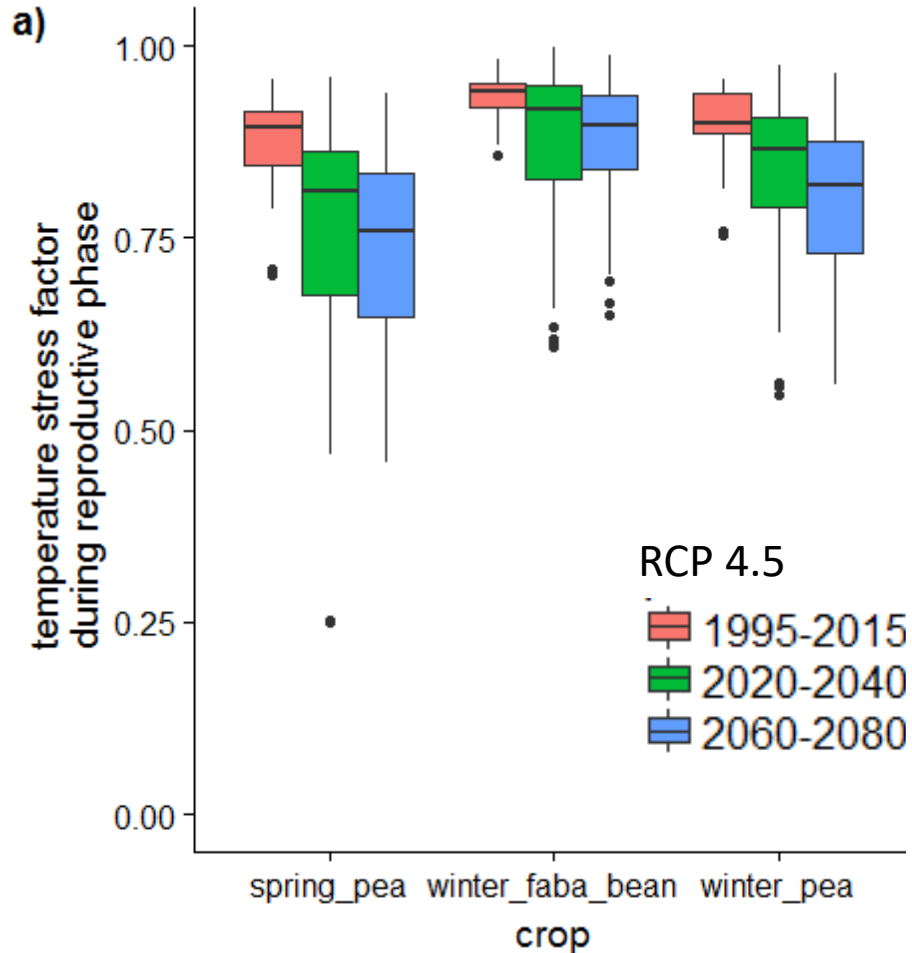


# Higher temperatures reduce crop duration



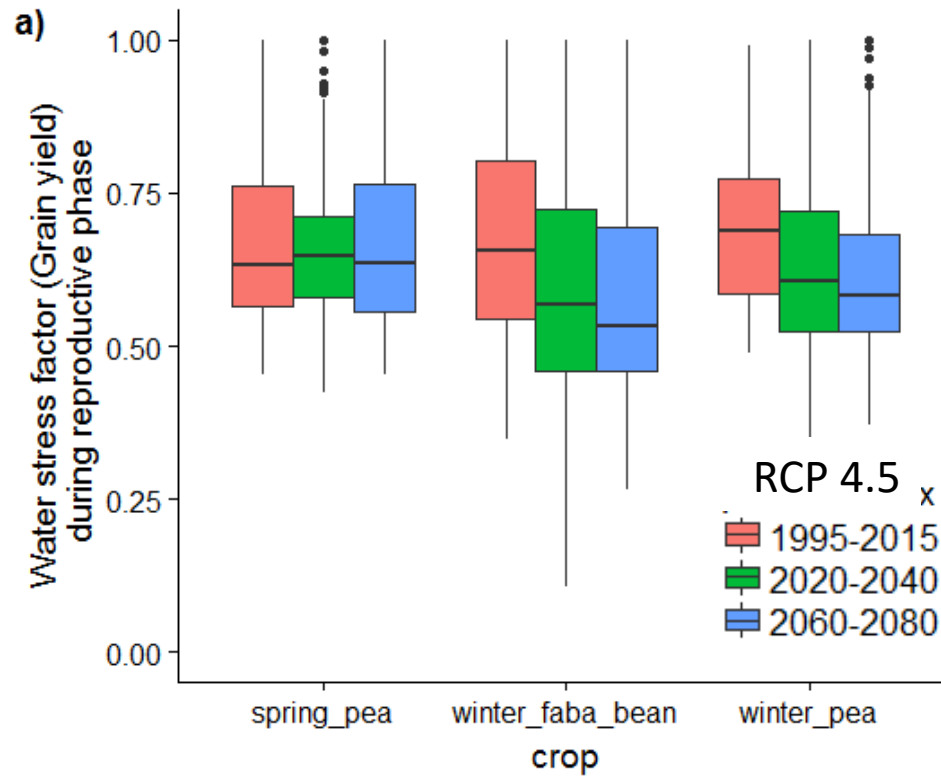
# Higher temperatures reduce radiation use efficiency- interrupt grain filling

*Reduction of radiation use efficiency*



# Water stress

*Actual: maximal plant transpiration*



# Conclusion

- Potential impact of climate change on legume performance ?

Depend on the emission scenario

e.g faba bean a 25% decrease in  $N_2$  fixation = 30 kg of Nitrogen loss for cropping systems.

- Main driving abiotic stresses ?

Higher temperatures : decrease in crop duration, RUE, stop grain filling

Water stress: reduces biomass accumulation and more severely nitrogen fixation

CO<sub>2</sub> fertilisation compensates for these stresses, but only under high emission scenario.



Thank you !

