Assessment of the impact of climate change in temperate zone on grain legume yield and N2 fixation

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

ESA2018
XVe European Society for Agronomy Congress
August 27-31, 2018 - Geneva, Switzerland
www.esa-congress-2018.ch

Impact of climate change on grain legume yield and N_2 fixation in a temperate climate

Gatien Falconnier, Anthony Vermue, Etienne-Pascal Journet,

Laurent Bedoussac, Eric Justes

INRA SCIENCE & IMPACT

cirad

Why grain legumes ?

Objectives

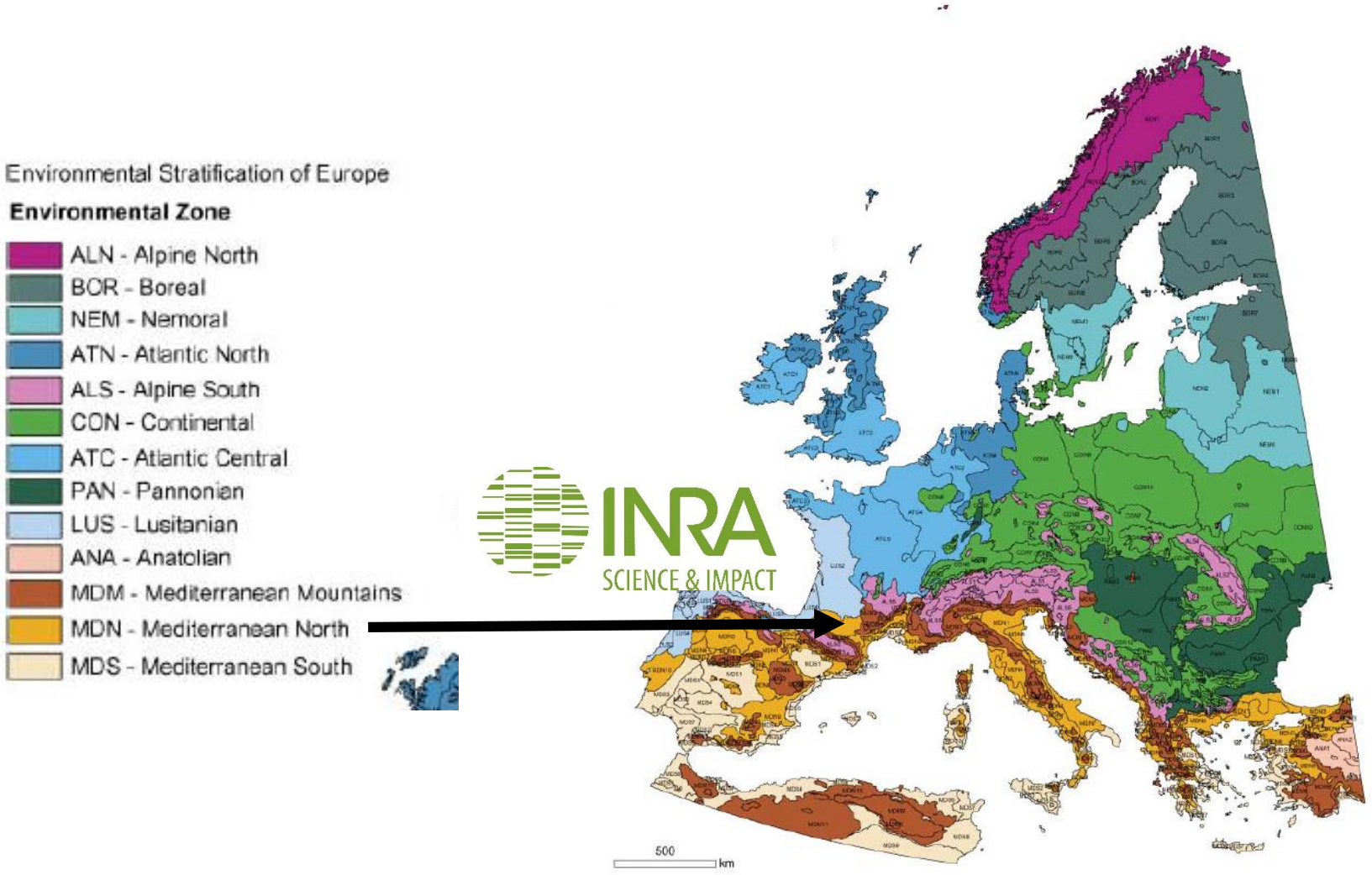
- What will be the potential impact of climate change on legume performance ?

    - Faba bean (*Vicia Faba*) (winter cultivar)
    - Field Pea (*Pisum sativum*) (spring – winter cultivars)

    = The two most widely grown legumes in Europe

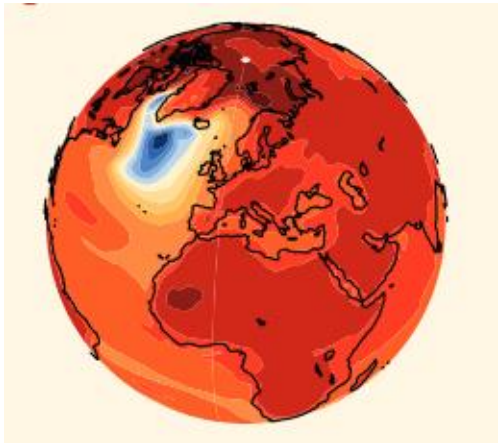
- What are the factors responsible for changes in legume performance ?

Auzeville – Southwestern France



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

Climate scenarii

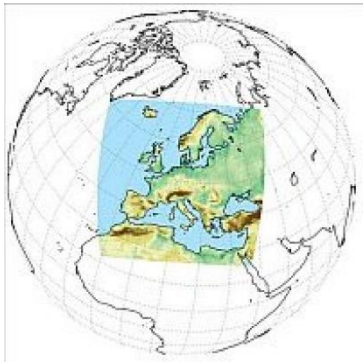


- Baseline : Meteorological record a t Auzeville station (1995-2015)

- 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/)

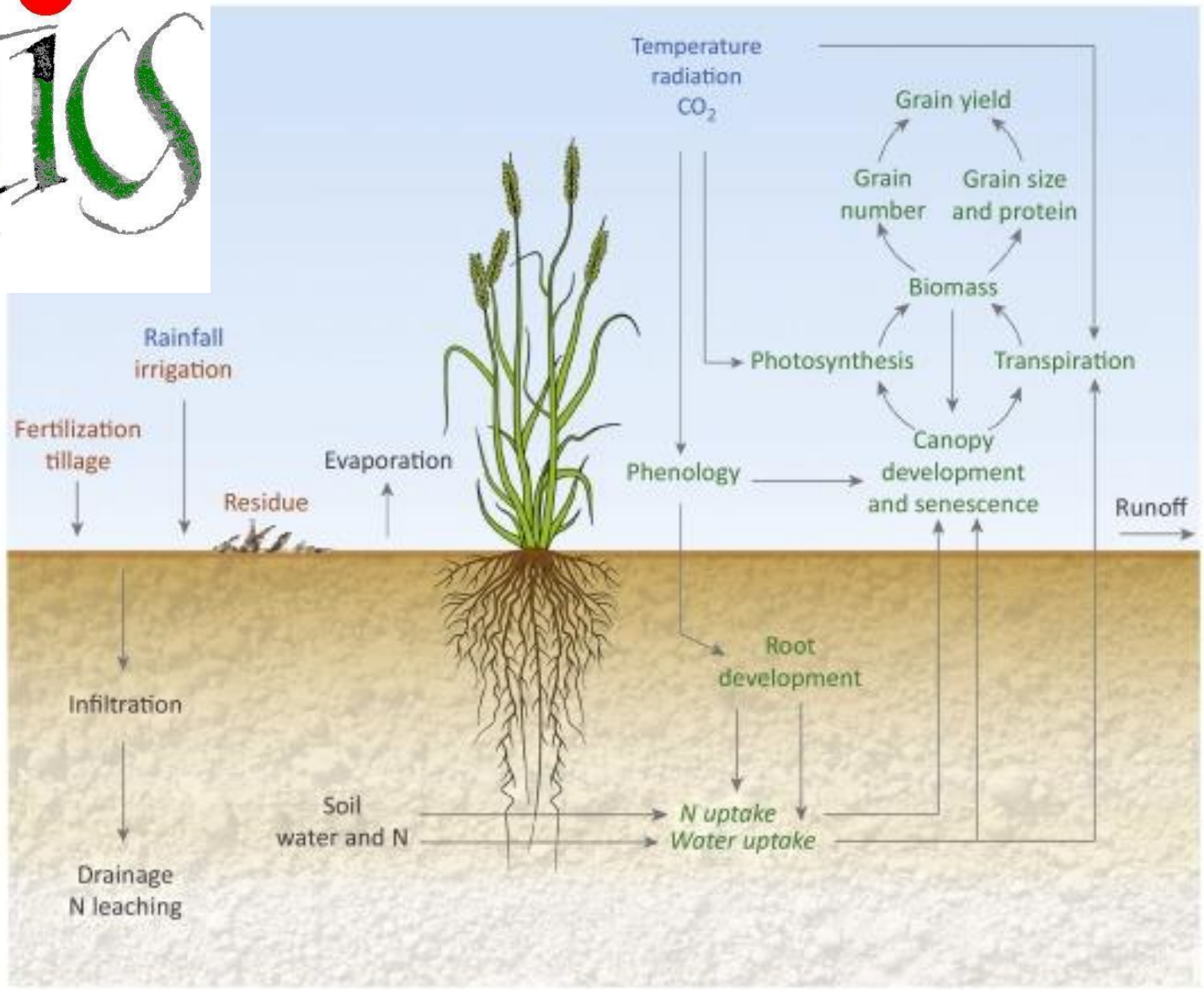


Changes in Temperature and Rainfall

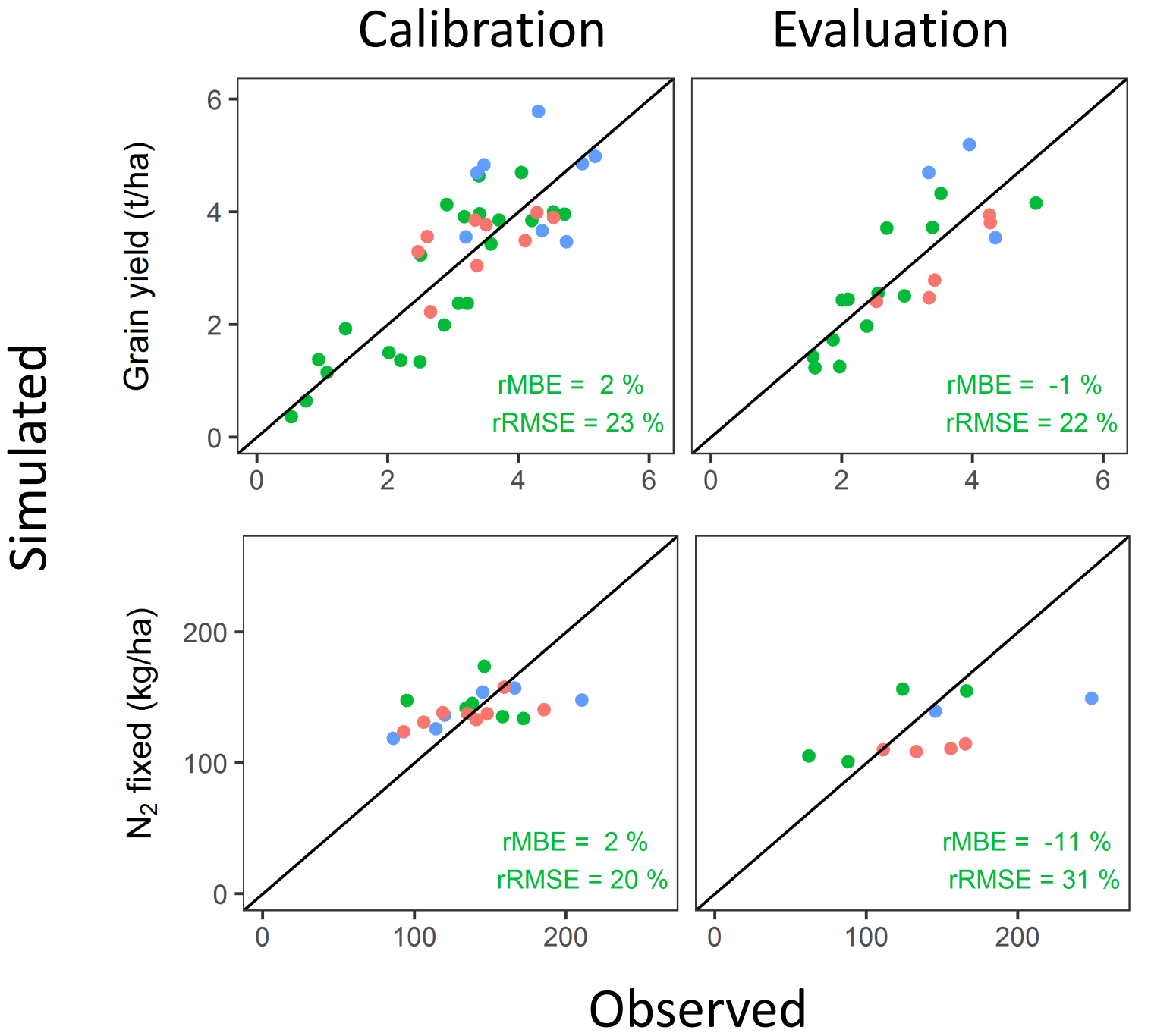
- Daily average temperature (averaged across the growing season)
  - Medium emission scenario (RCP 4.5): +1°C to +2.6 °C
  - High emission scenario (RCP 8.5) : +2.4°C to +4.1 °C

- 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

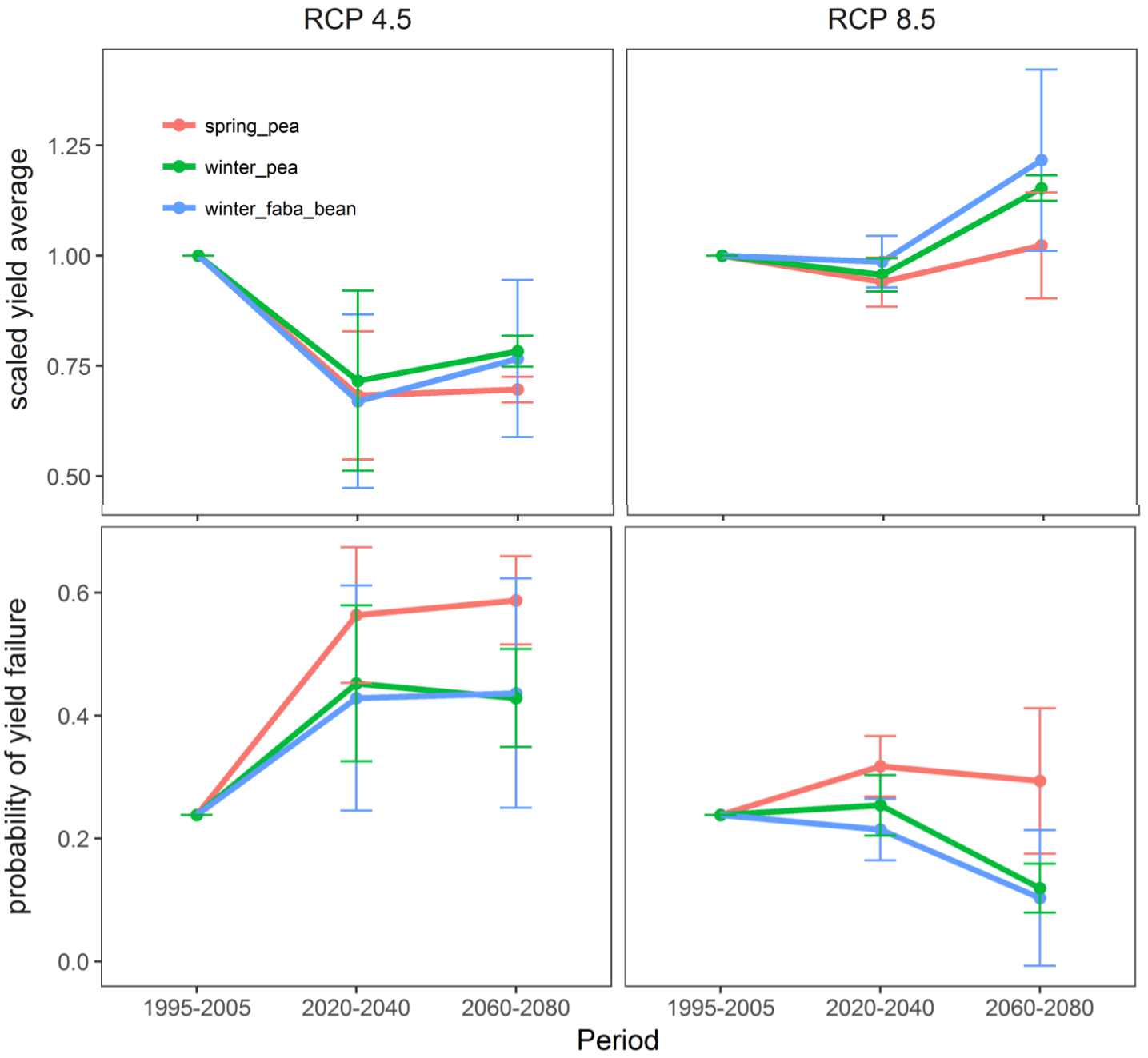


Source: Chenu et al. (2017*) Contribution of Crop Models to Adaptation in Wheat.* Trends in Plant Science 22, 472–490.

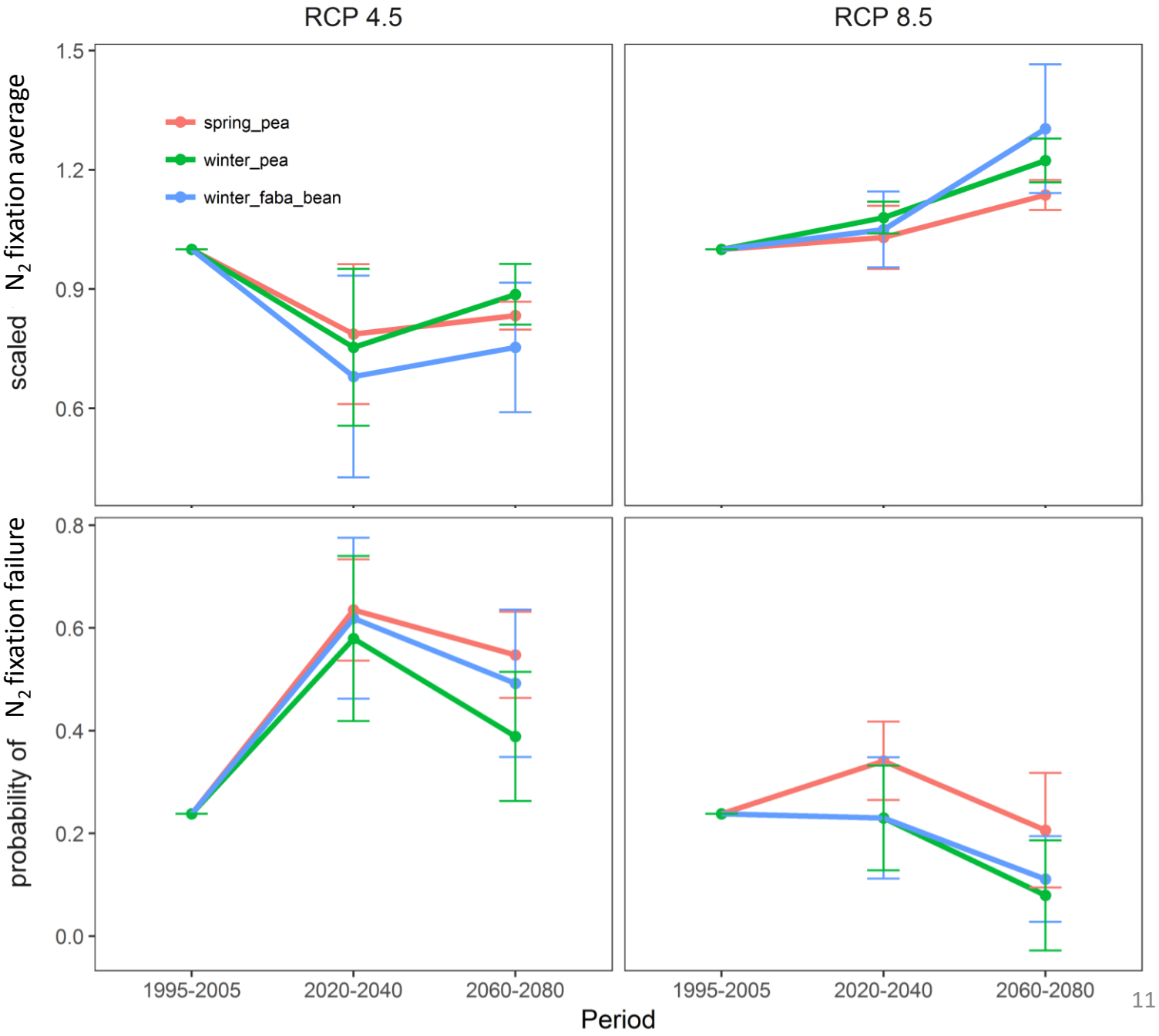


Falconnier et al. *Calibration and evaluation of the STICS soil-crop model for faba bean to explain variability in yield and N_2 fixation*. Submitted to European Journal of Agronomy

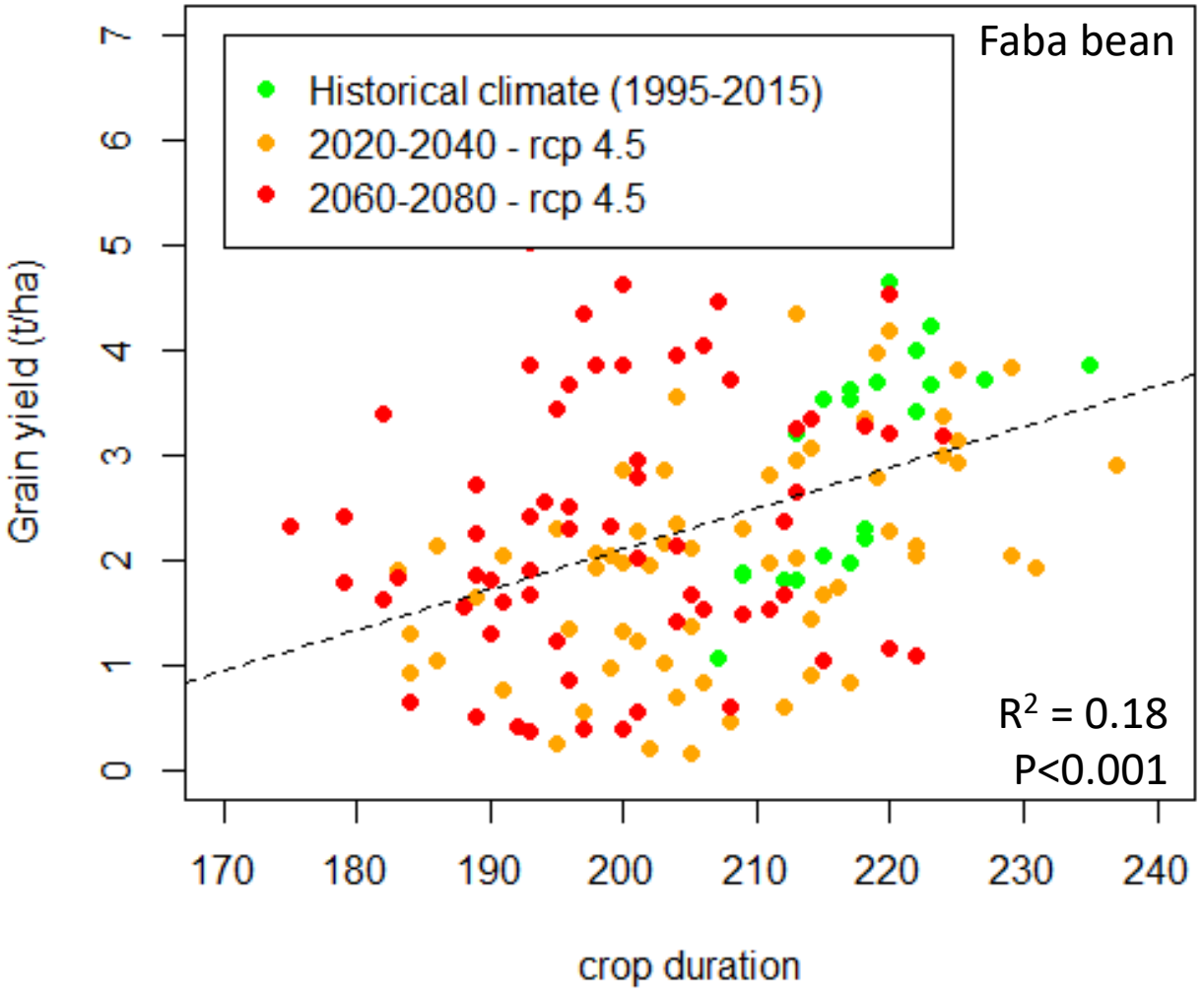
Grain Yield


RCP 4.5
RCP 8.5
spring_pea
winter_pea
winter_faba_bean
scaled yield average
1.25
1.00
0.75
0.50
probability of yield failure
0.6
0.4
0.2
0.0
1995-2005
2020-2040
2060-2080
Period

N_2 fixation

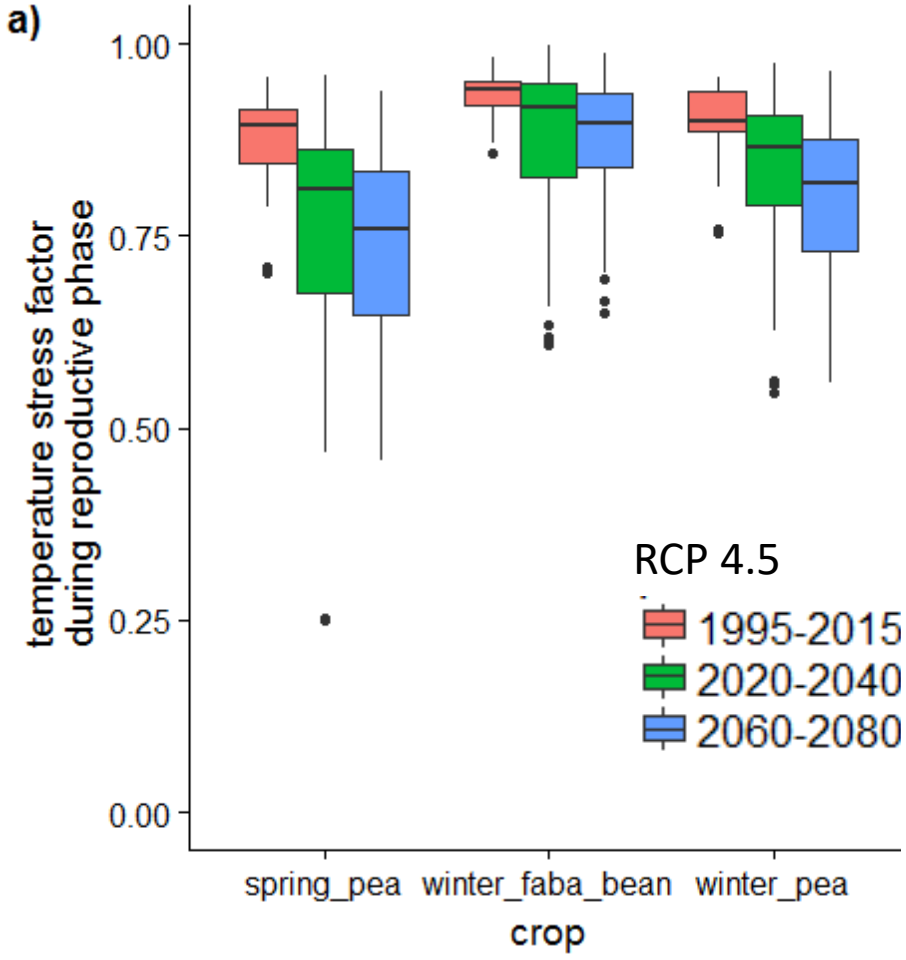

RCP 4.5
RCP 8.5
spring_pea
winter_pea
winter_faba_bean
scaled N_2 fixation average
probability of N_2 fixation failure
1.5
1.2
0.9
0.6
0.8
0.6
0.4
0.2
0.0
1995-2005
2020-2040
2060-2080
Period

Higher temperatures reduce crop duration



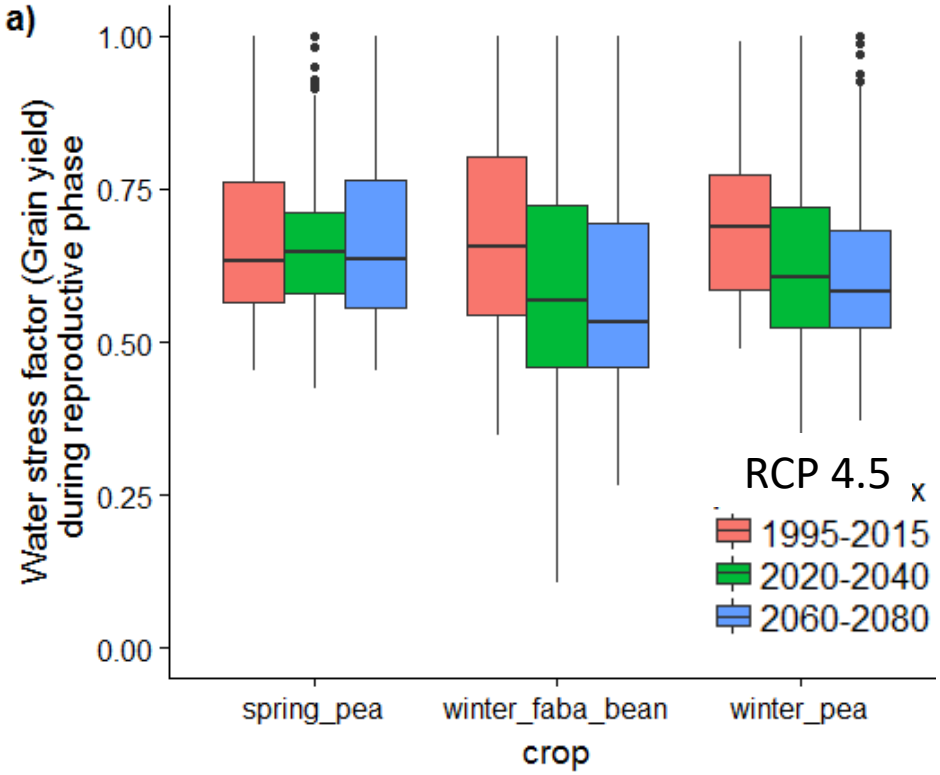
Higher temperatures reduce radiation use efficiency- interrupt grain filling

Reduction of radiation use efficiency



Water stress

Actual:maximal plant transpiration



Conclusion

- Potential impact of climate change on legume perfomance ?

  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

  CO2 fertilisation compensates for these stresses, but only under high emission scenario.

Thank you !