Modelling the impact of climate change on the yield of European grasslands

Martha Dellar

Kairsty Topp, Guillermo Pardo, Agustin del Prado, Georgios Banos, Eileen Wall

Leading the way in Agriculture and Rural Research, Education and Consulting

Introduction

iSAGE: Innovation for Sustainable Sheep and Goat Production in Europe

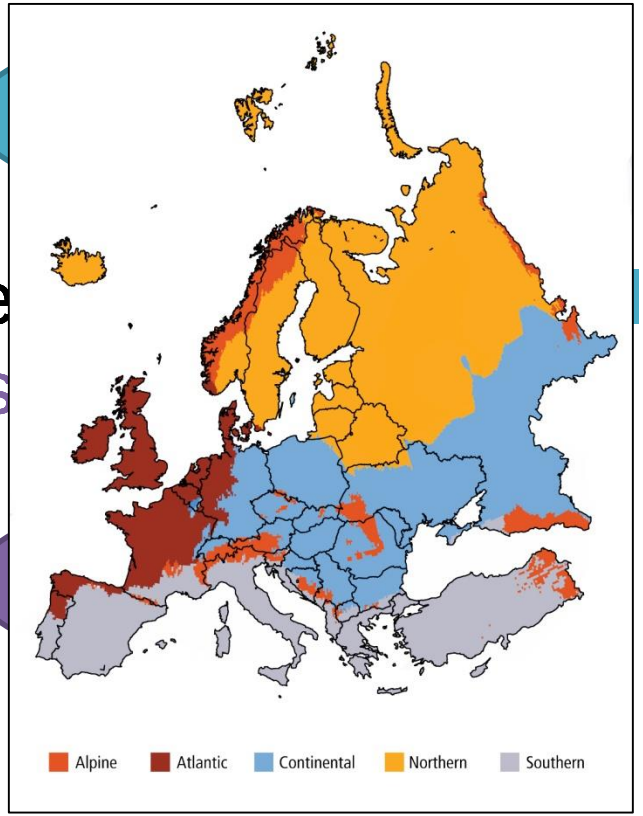
→Impacts of climate change on sheep and goat systems

→Impacts of climate change on pastures

Introduction

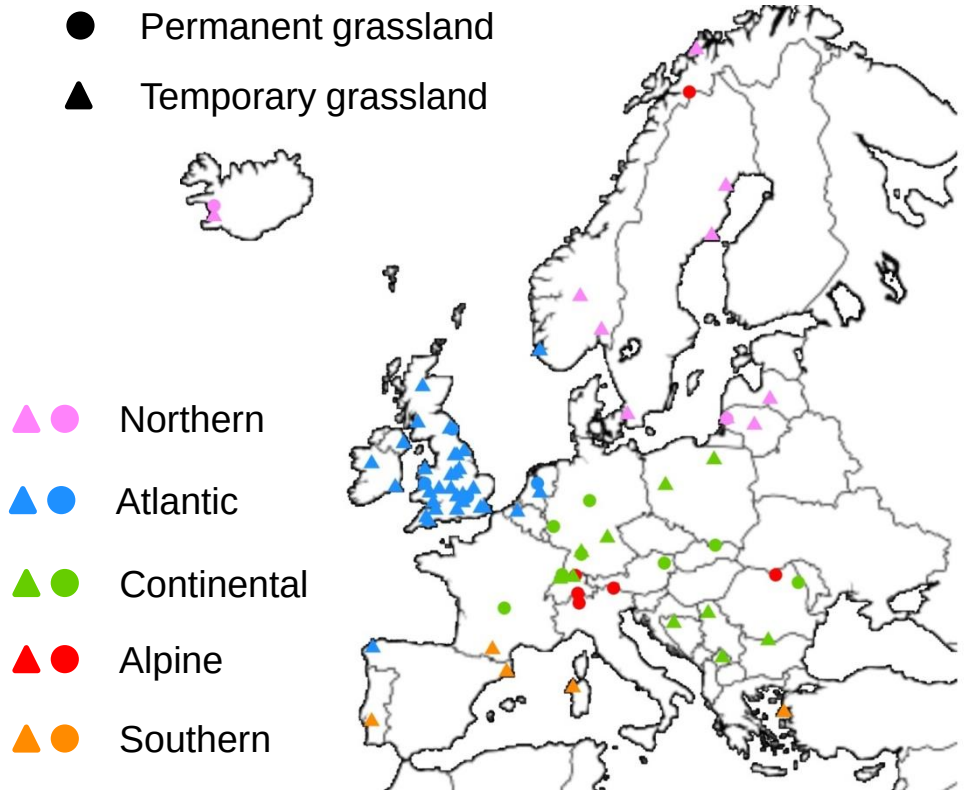
Statistical and dynamic approaches

Modelling the impact of climate ld of European gras

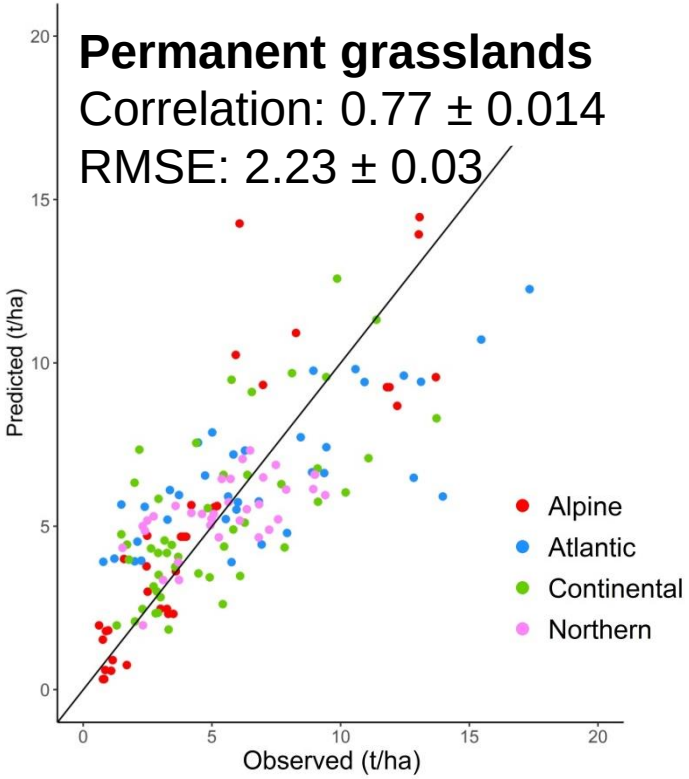


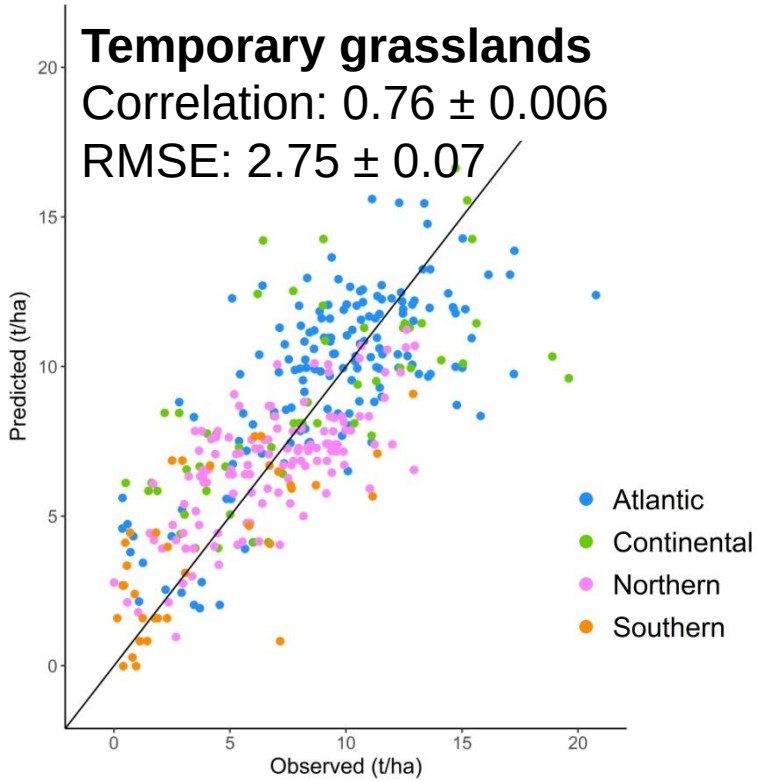
Statistical model

- 29 experiments, 89 sites
- Stepwise regression on:
  - Monthly rainfall
  - Monthly temperature
  - Cuts per year
  - Altitude
  - Nitrogen fertiliser
  - Legume percentage



Model fit – statistical model





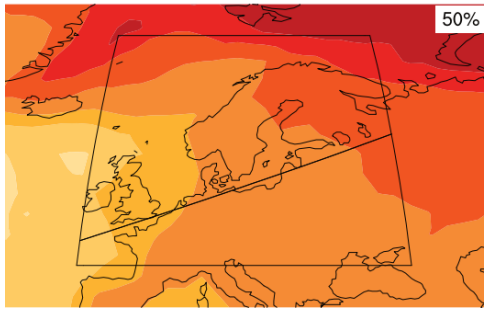
Climate change in Europe

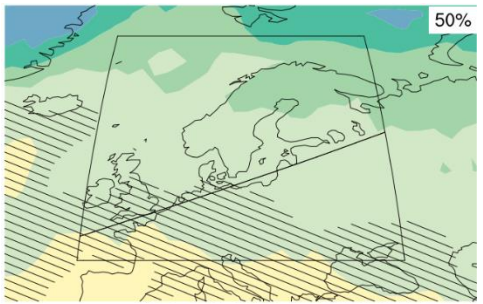
Average annual predictions for 2081 - 2100, relative to 1986 - 2005

Temperature

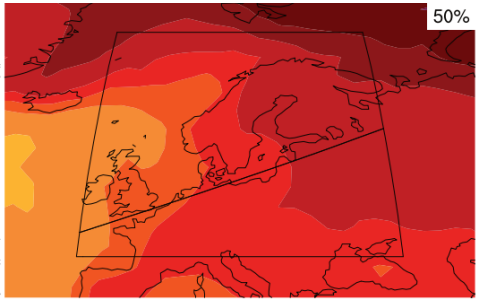
Precipitation

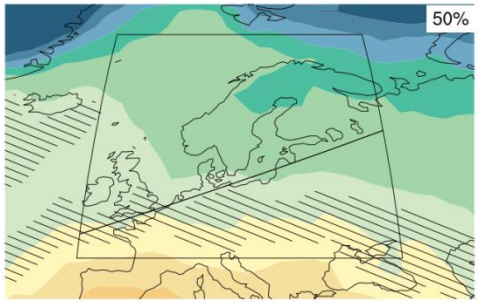
Midrange scenario (RCP4.5)

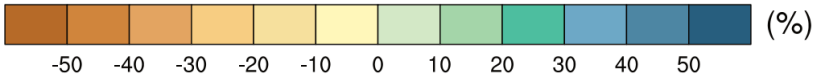




Extreme scenario (RCP8.5)



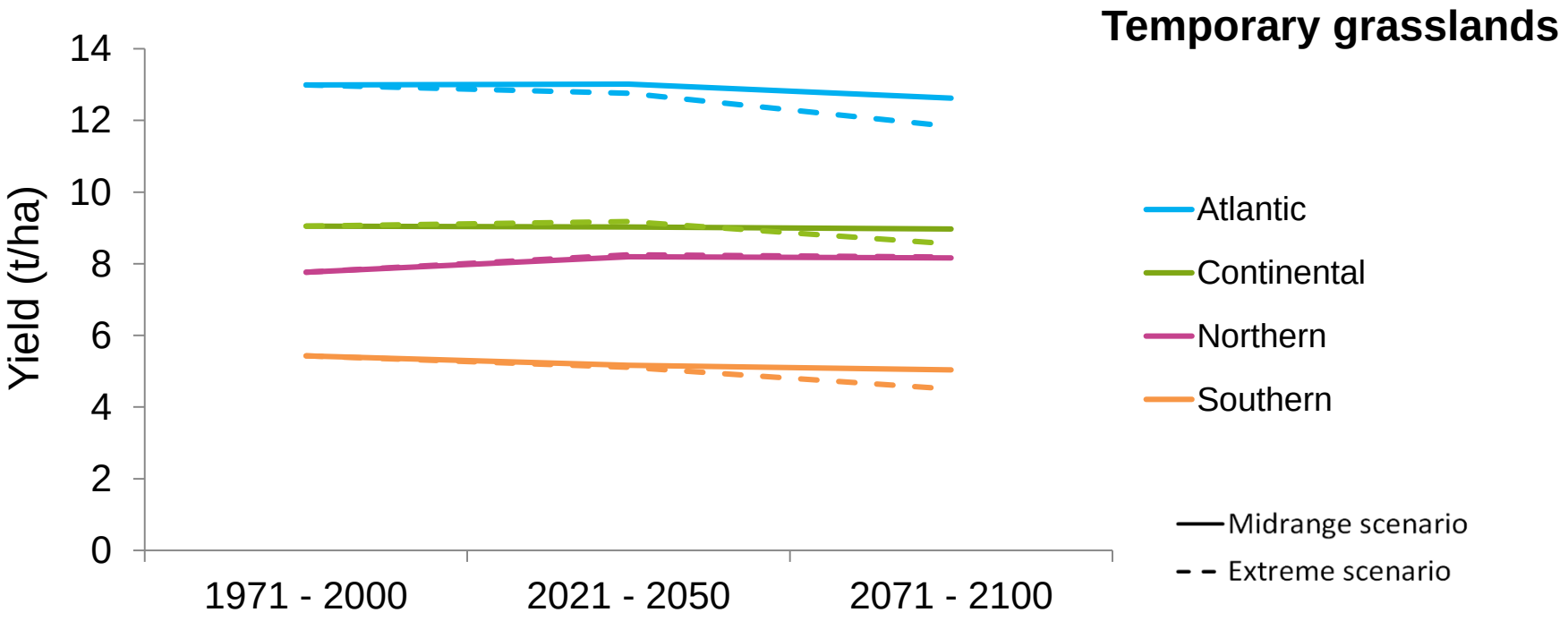




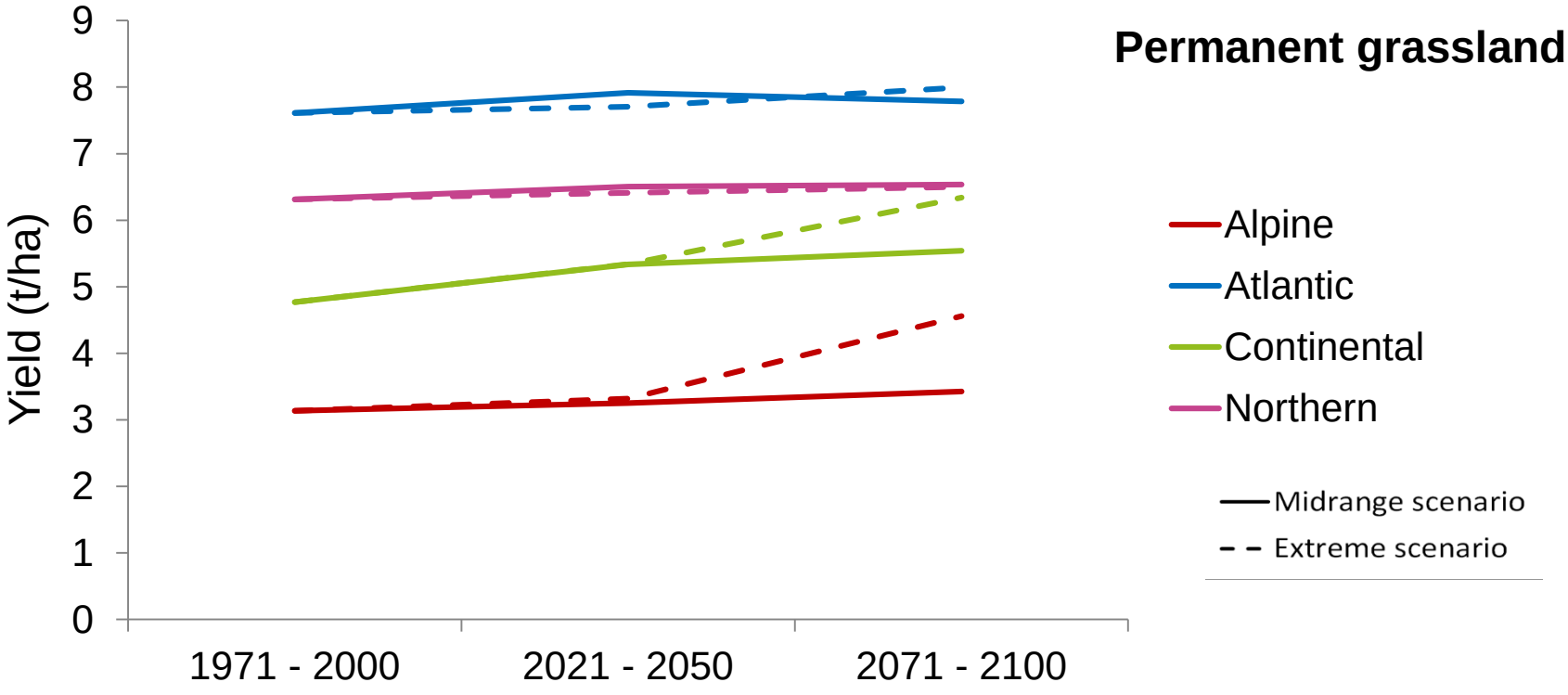
Statistical model: Climate change

- Can’t go beyond bounds of input data when making predictions
  - Adjusted predicted temp/rainfall to min/max of input data
- For each region used average fertiliser, legume content, mowing frequency, etc.

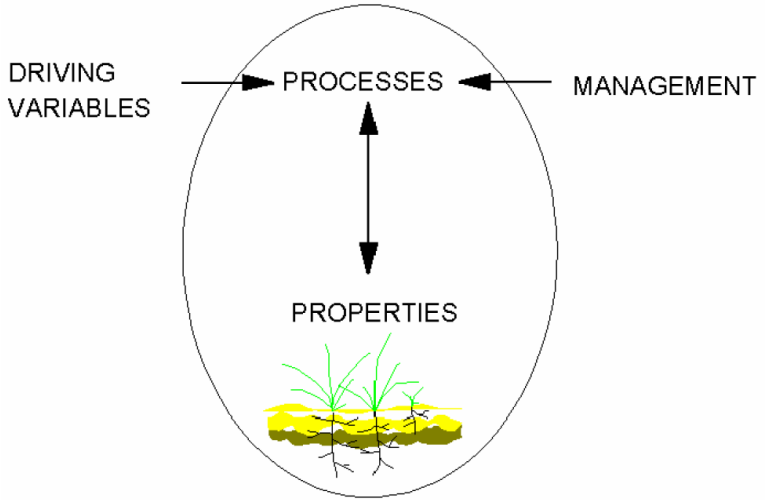
Predicting future yields



Predicting future yields



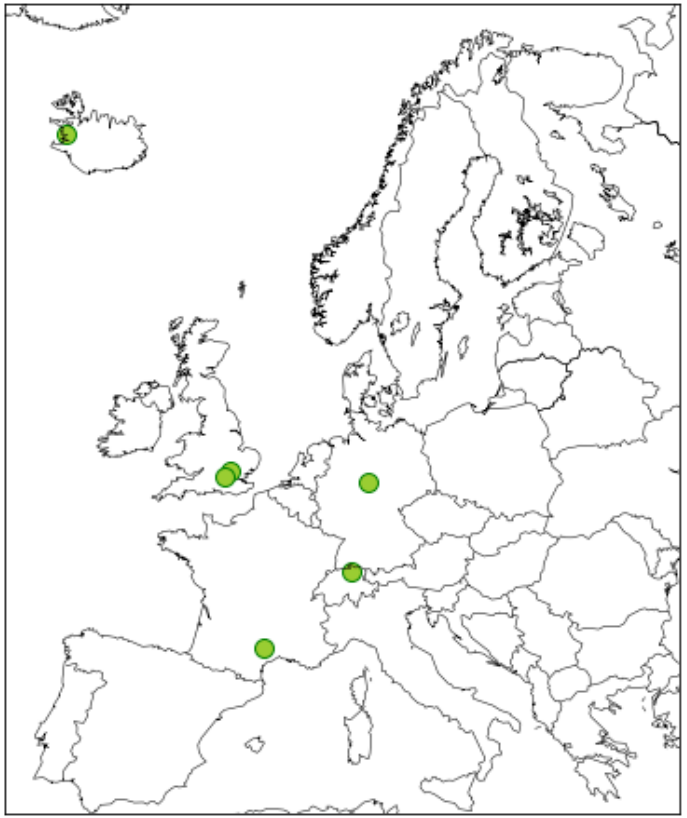
Dynamic model: Century



- Ecosystem analysis tool
- Models C and N fluxes throughout plant-soil system
- Monthly time-step
- Site specific
- Large number of inputs
- Main inputs: monthly temperature and precipitation, soil properties, plant properties, CO_2 change, management, site history

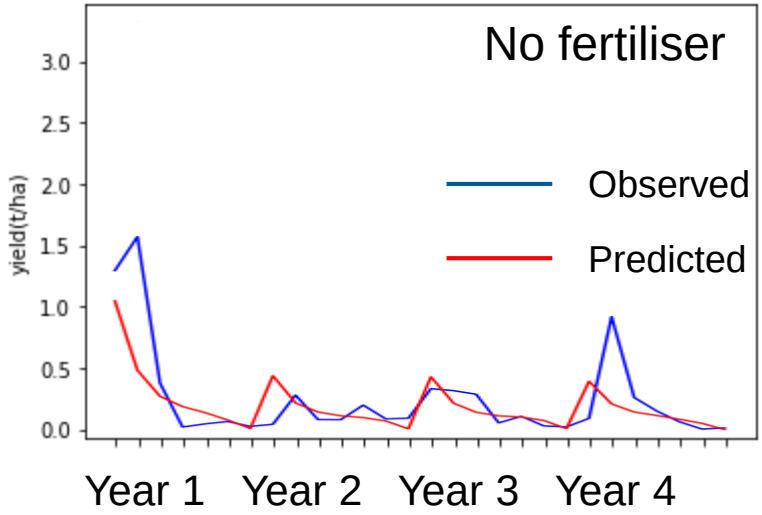
Dynamic model: Sites

- One site per region (two for Atlantic region)
- All permanent grasslands (except one Atlantic site)
- MCMC simulations to parameterise model inputs

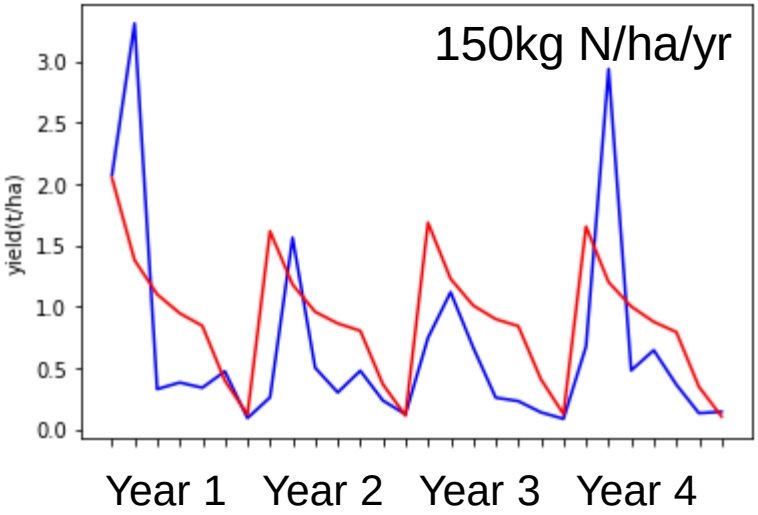


Model fit – dynamic model

Atlantic temporary grassland

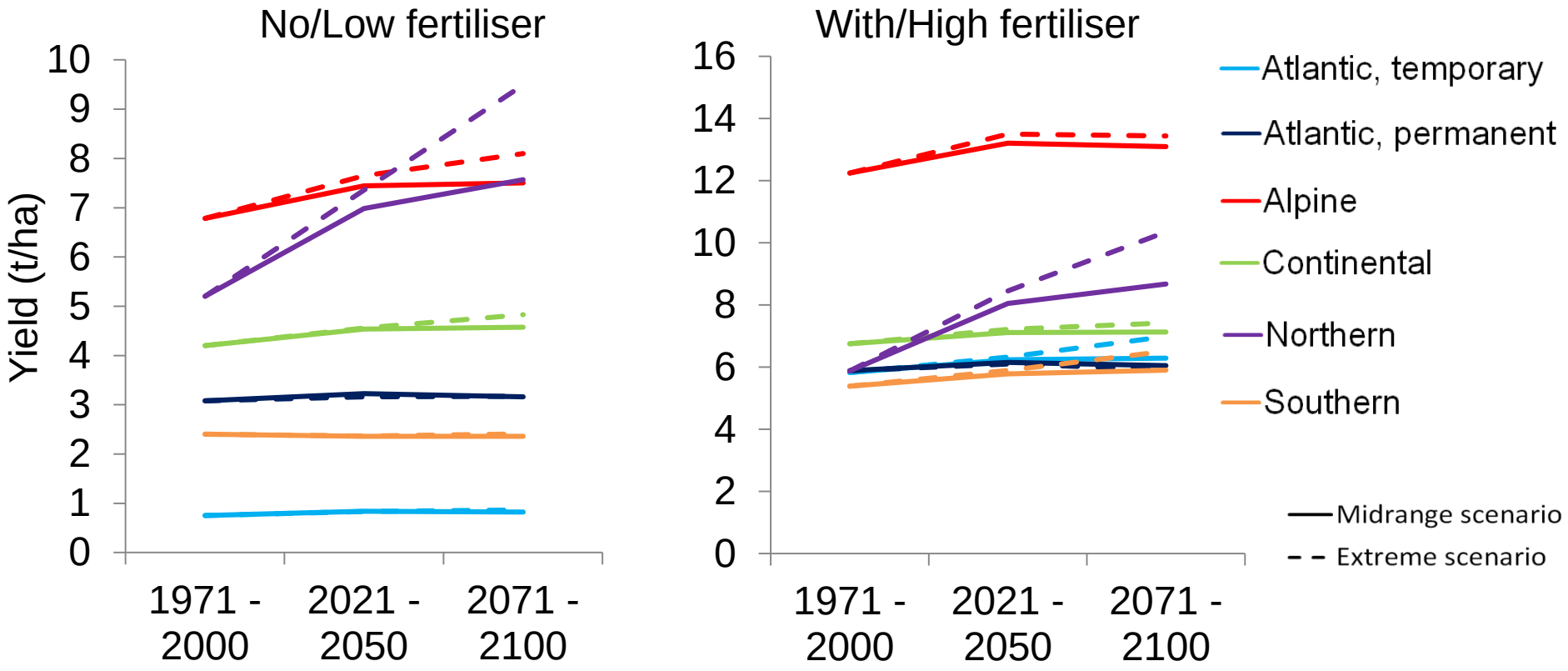


Correlation: 0.74
RMSE: 13.8% of annual mean



Correlation: 0.57
RMSE: 14.8% of annual mean

Climate change – dynamic model



Conclusions

- Both models are reasonably good at predicting pasture yields
- Statistical model:
  - Temporary: Very little change
  - Permanent: Increasing yields for Continental and Alpine regions under extreme scenario, otherwise little change
- Dynamic model:
  - No change or small increases, except for large increases in northern region

Conclusions

- Often little difference between the two climate change scenarios
- Management has more effect than climate change
- Results are good or neutral for grazing livestock
- Also to be considered
  - Extreme weather events
  - Changes in growing seasons
  - Changes in plant species

Acknowledgements

The Scottish Government
Riaghaltas na h-Alba

iSAGE

The University of Edinburgh

European Commission
HORIZON 2020

bc3 BASQUE CENTRE FOR CLIMATE CHANGE
Klima Aldaketa Ikergai