# Contrasting climate change effects on dairy cattle through Machine Learning approach

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Climate is changing!

Projected changes in annual mean temperature (left) and annual precipitation (right)

Changing expected for 2071-2100 period, in comparison with 1971-2000. Source: EEA
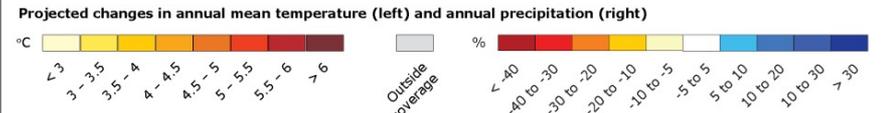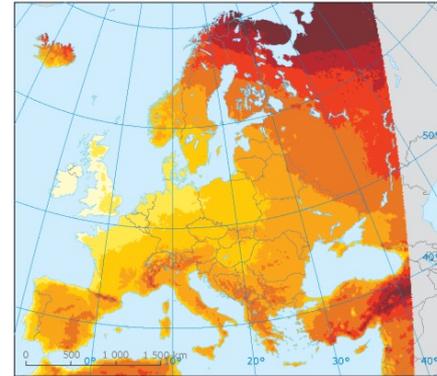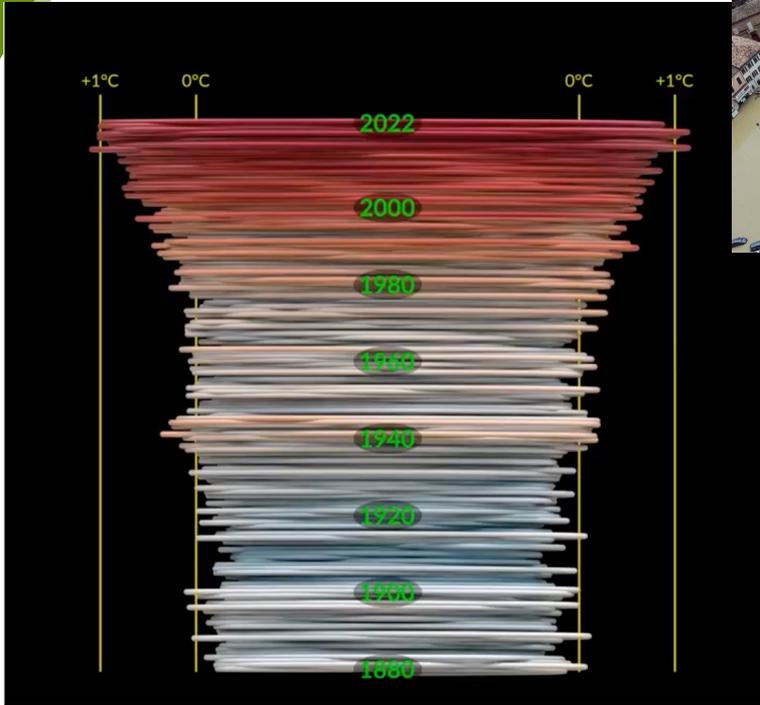
Great Video by NASA - National Aeronautics and Space Administration
showing the increase in global temperatures from 1880 - 2022 in degree Celsius.
Whites and blues indicate cooler temperatures, oranges and reds show warmer
temperatures. What becomes shockingly clear: global temperatures have
increased from mainly human activities as time has passed.

Impacts

Cyanotic tongue.

Inflamation of the muzzle and salivation.

Modelling the impact of climate change

Workflow

Historical data

Workflow

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Historical data

Libro Genealogico
Pezzata Rossa Italiana
A.N.A.P.R.I. - Udine

AI

H$_2$O.ai

$$Y = a + bX$$

Livestock Environment Opendata

Highlander
High performance computing to support smart land services

SEBASTIEN

Spoiler alert!

SHAP Summary plot for "GBM_model_python_1663938203330_33"
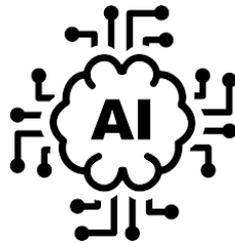
Minimum Temperature -**20**d

Maximum Temperature -**2**d
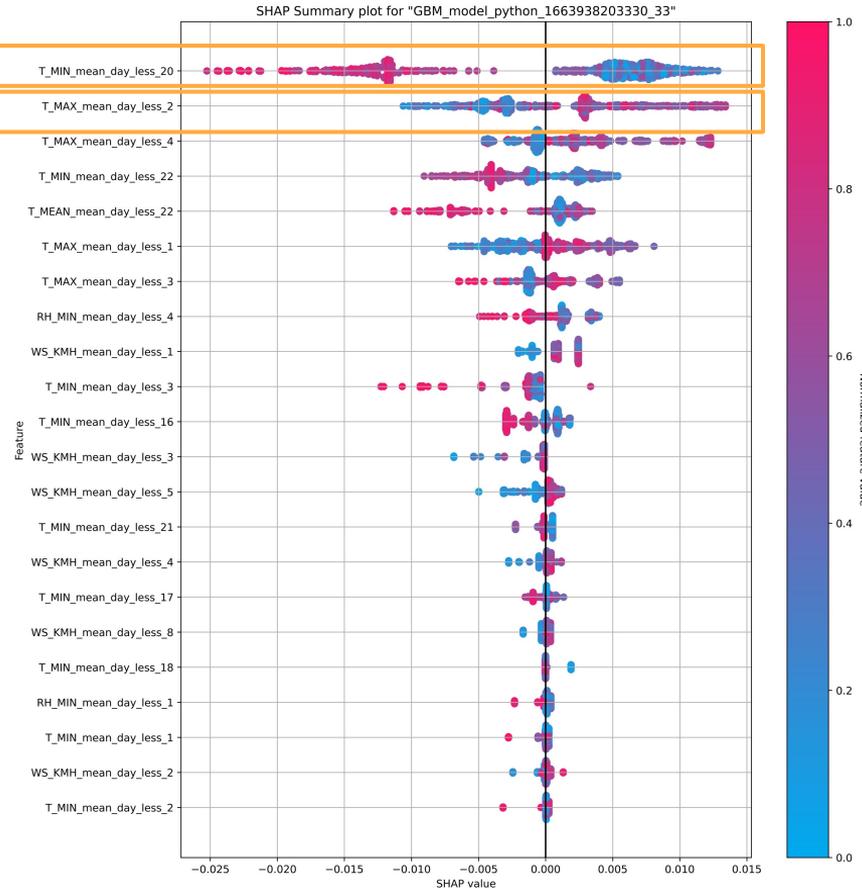
Long and short terms effects!

Spoiler alert!

SHAP Summary plot for "GBM_model_python_1663938203330_33"

Not only temperature or humidity!

Average **Wind Speed** -1d
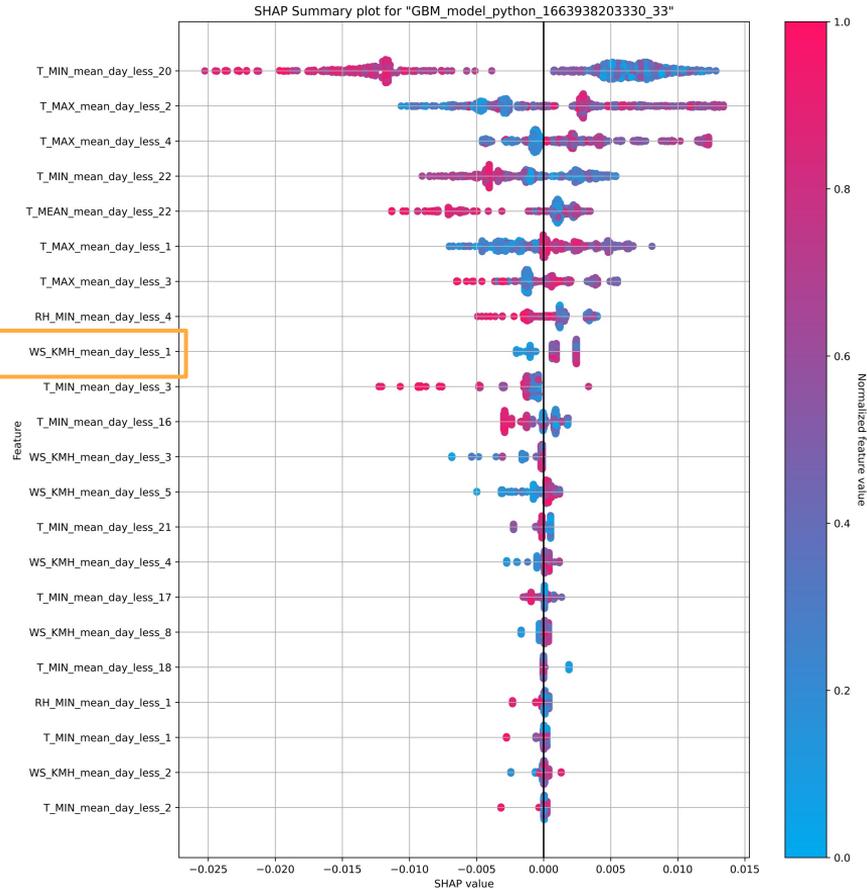
Application of prediction model

Material and methods
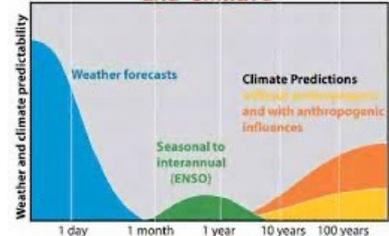
Weather forecasting

- Short term prediction
- Few days in the future

COSMO-2I
COSMO-2I: COSMO at 2.2km - Italy area

Sub-seasonal forecast

- Prediction from 15 to 30 days in the future

EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS

Long term projection

- Until 2050
- Dynamically downscaled under RCP8.5 scenario at 2.2 km over Italy

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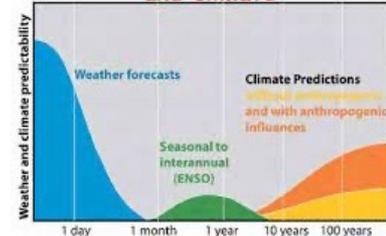
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MISTRAL
Meteo Italian Supercomputing Portal

COSMO-2I
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Sub-seasonal forecast

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-

ECMWF
EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS

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cmcc
Centro Euro-Mediterraneo
sui Cambiamenti Climatici

Past (1989-2018) VS future (2021-2050)
Warm (April-May) VS hot (July-August)

Material and methods

- Single climatic variables
  - Temperature (min, max, mean)
  - Relative humidity (min, max, mean)
  - Wind
  - Precipitation (total)
  - Cloud cover (total)

- Discomfort Index (DI)
  - Equivalent of THI
 - Daily minimum, maximum and average
  - Cumulate

DI (maximum per day)

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  - Cumulate

DI (maximum per day)

Mild

DI
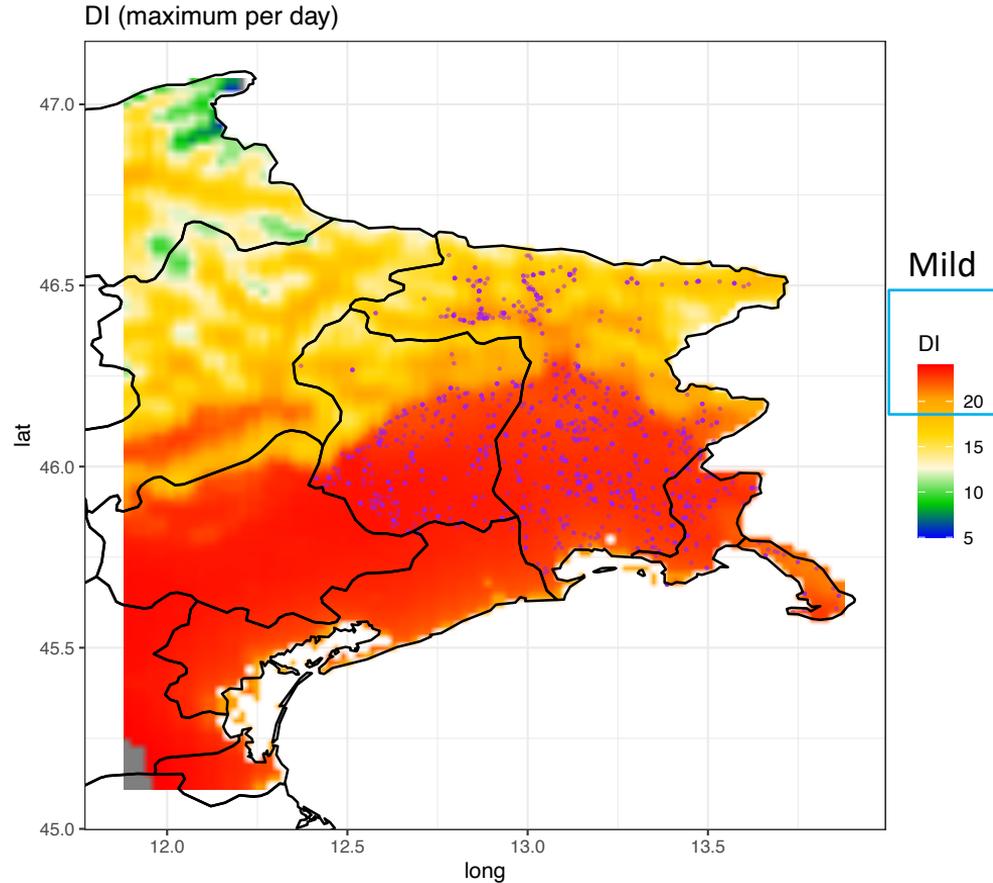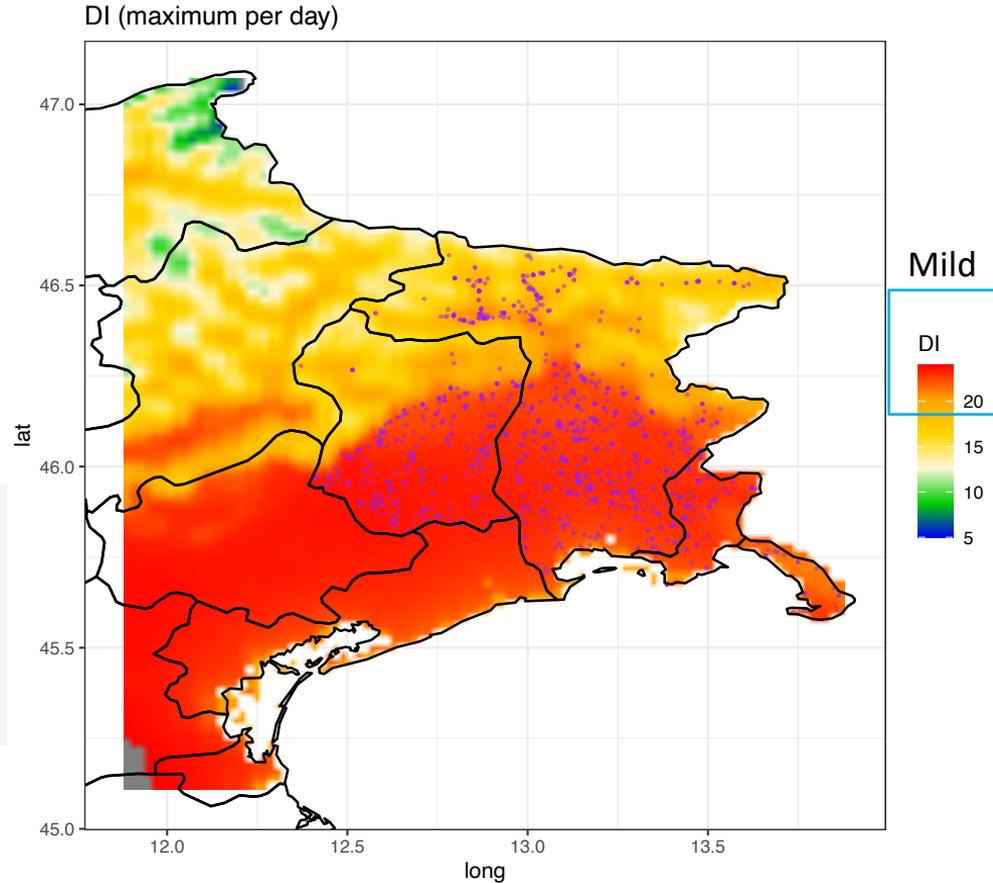
Milk yield

- Historical & projection in the hot period
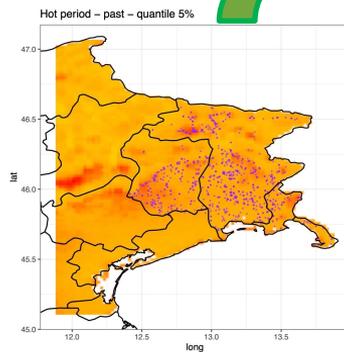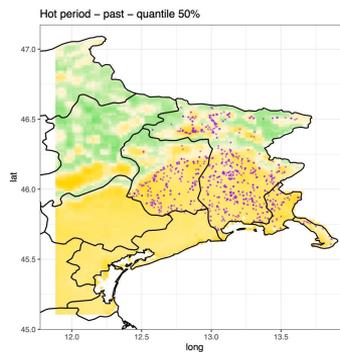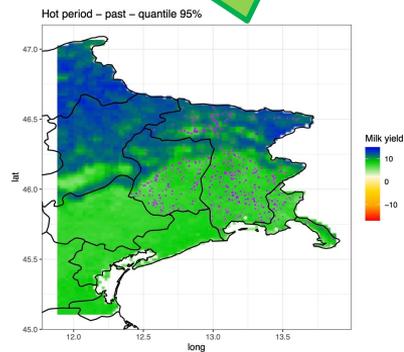
+18.98
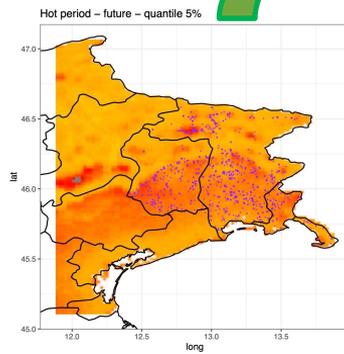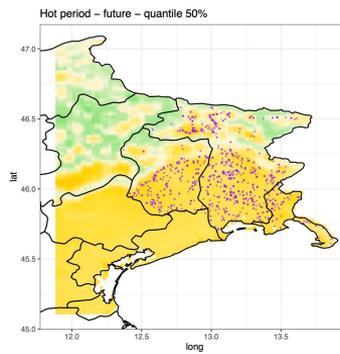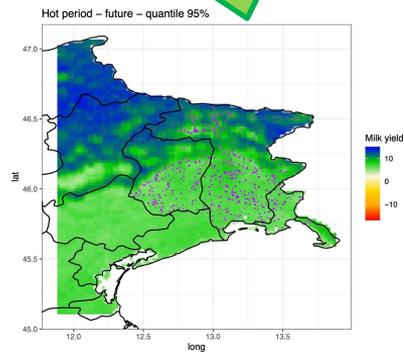
5° percentile · 50° percentile · 95° percentile

+19.36

Milk yield

- Temperate & hot in the future
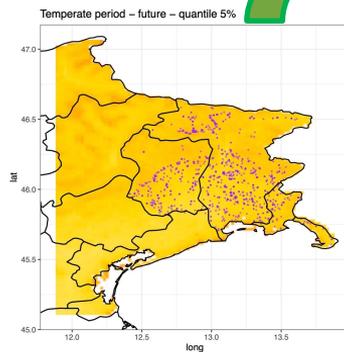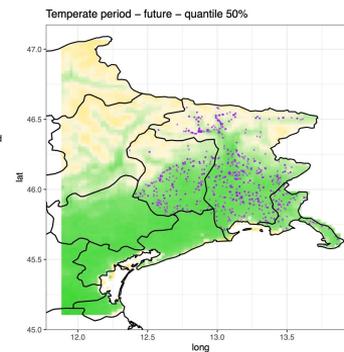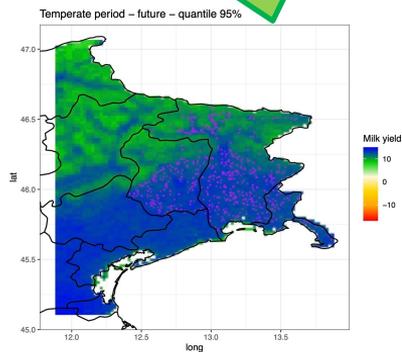
+16.68
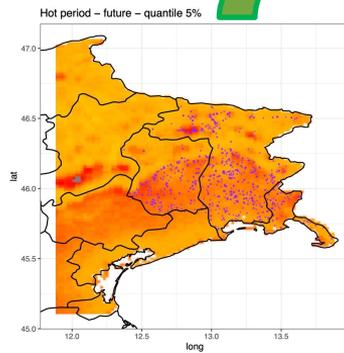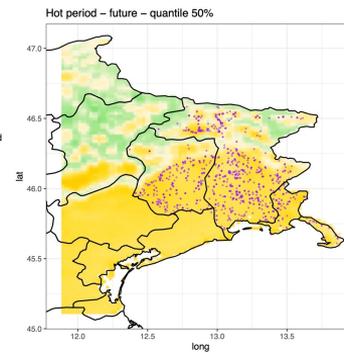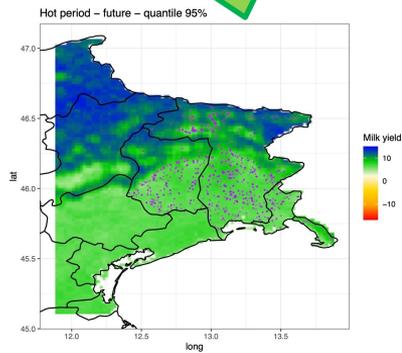
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Milk yield

- Comparison between
  - Historical & projection
  - Temperate & hot
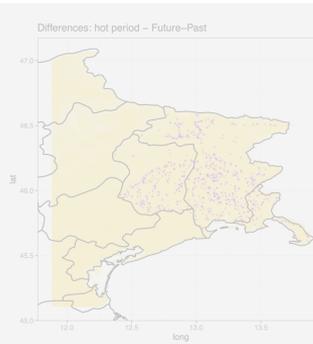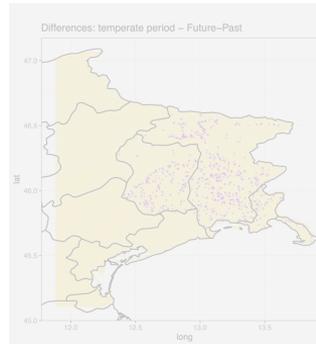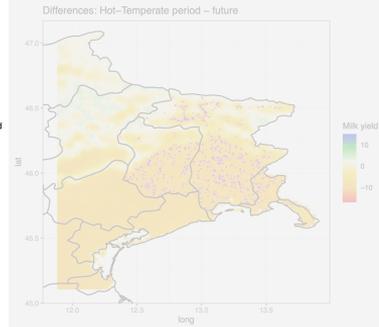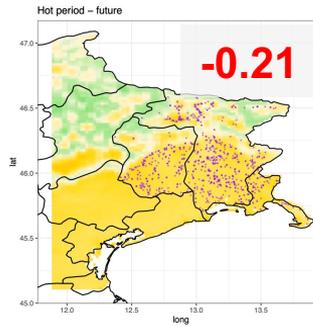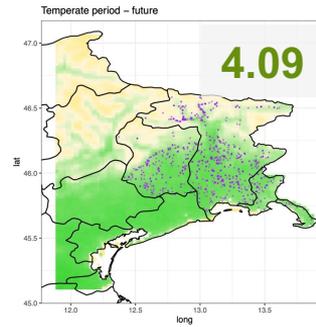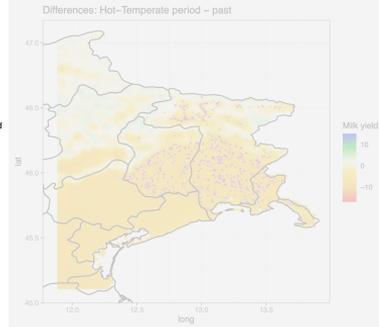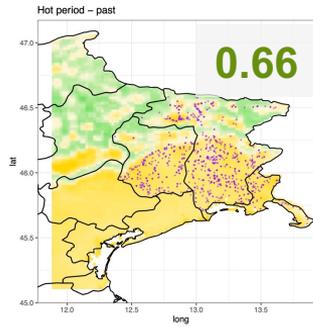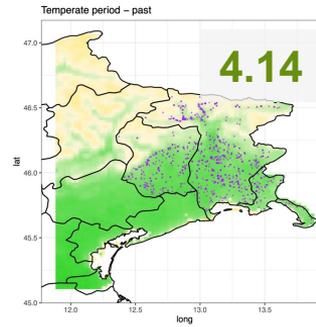
Milk yield

- Comparison between
 - Historical & projection
 - Temperate & hot
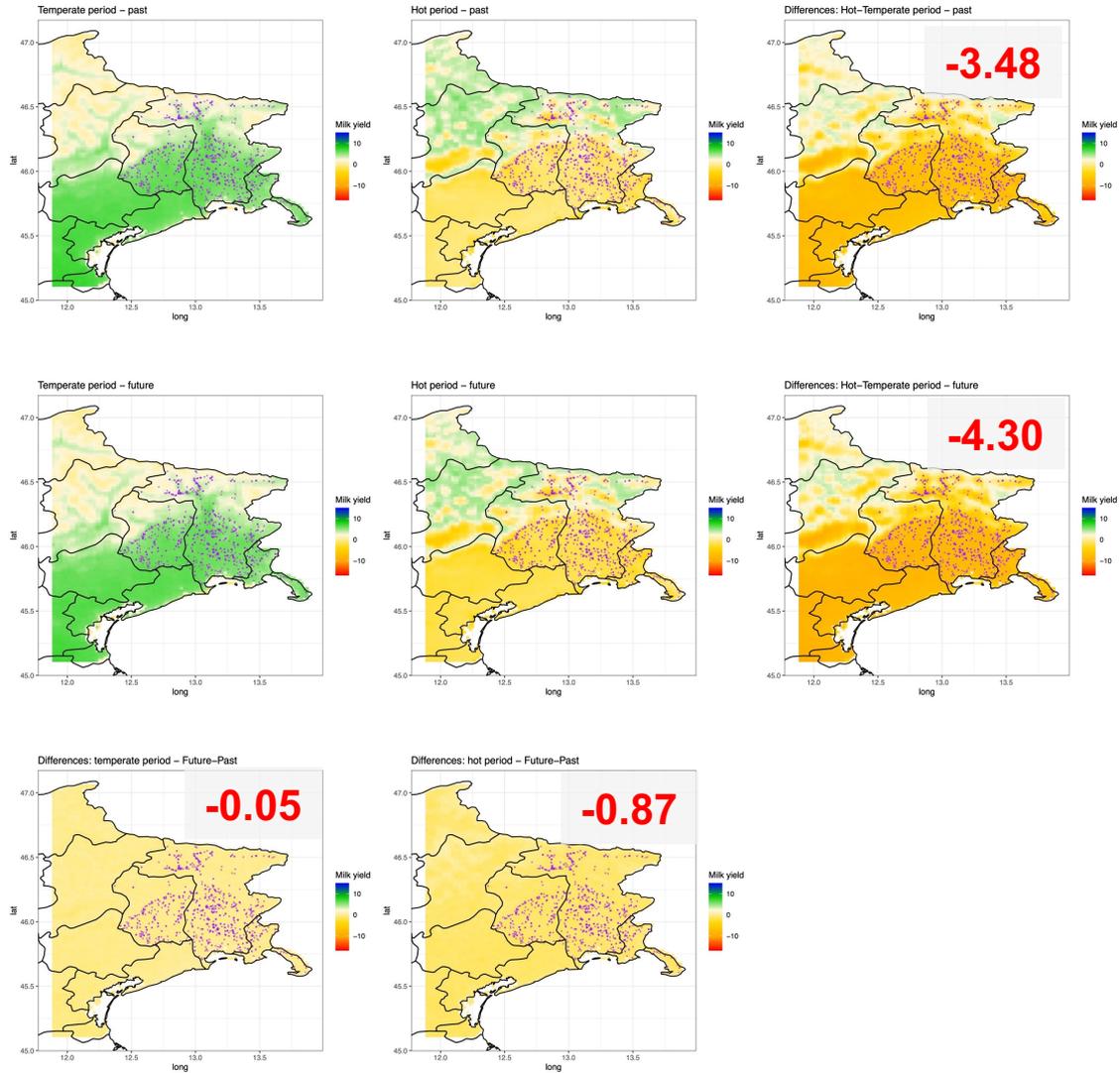
Next steps

# Decision Supporting System

IoT system and edge computing

Main device

• **SIM7020**: allows to communicate the data of the buttons to a server using NB-IoT technology (**LoRa** module is the alternative);

• **GNSS module**: provides the position of the animal.

• **Accelerometer**: registers the movement of the animal's neck

• **Air temperature and humidity**

Skin temperature
Air temperature and humidity

They can provide a measurement of the animal's core temperature if the data are properly related.

Accelerometer
Powered by a button cell and located on the leg or the ankle of the animal. It can provide information about the movements of the animal that are related to its behaviour and wellbeing.

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HPC

docker

SENSOR

SENSOR

SENSOR

PYTHON WEB APPLICATION
BASIC DATA ANALYSIS

FROST SERVER
OGC SENSORTHING API
PostgreSQL DATABASE

GRAFANA
DASHBOARD

MQTT BROKER

USER

USER

USER

REAL TIME
USER
APPLICATION

REAL TIME
USER
APPLICATION

REAL TIME
USER
APPLICATION

Severe

Mild
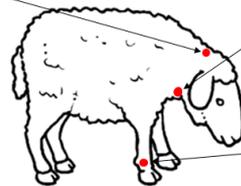
Conclusions

- Machine Learning pipeline to evaluate climate change short and long term effect on livestock production

- System to support farmers management and also breeder associations and policy makers, in particular for long term decisions

- Creating the bases for real-time warnings (DSS)

Acknowledgment

Thank you
for your attention

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