# Modeling land cover changes with the regional model REMO-iMOVE for Europe

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# Acknowledgements


Ralf Podzun, Kevin Sieck, Joni-Pekka Pietikäinen, Diana Rechid,

Susanne Pfeifer, Christopher Moseley, Alberto Elizalde, Daniela Jacob

and the **whole REMO group**

Stefan Hagemann, Christian Reick, Thomas Raddatz, Reiner Schnur,

Veronika Gayler, Monika Esch

**For explanations, technical hints and fruitful discussions about REMO, JSBACH and ECHAM 3, 4, 5 and 6**

# Outline

- Aims
- REMO-iMOVE technical basics & features
- The AR5 harmonized land use change scenario and its implementation
- Experiment setup and results
- Conclusions

# Aims



1. couple REMO to an vegetation scheme which is able to account for land use changes

2. Model land use changes in a physically consistent manner

3. Check if 50 years of land use changes have an effect on the regional scale

# REMO-iMOVE technical basics & features



REMO[1] + JSBACH[2] (in parts) = **REMO-iMOVE**

REMO with **i**nteractive $\underbrace{\textbf{MO}\text{saicbased}}$ **VE**getation

No flux differentiation
between different plant
covers

# REMO-iMOVE technical basics & features



→ **plant functional type approach** for representation of vegetation on biome scale (16 PFTs)

→ **explicitly modeled** key processes of vegetation:

**radiation absorption in the plant canopy** (LAI) [3,4]

**photosynthesis** (radiation & soil water & $CO_2$) [3,5,6]

**stomatal conductance** (radiation & $CO_2$) [3]

**phenology** (model time, soil water, heat sum)[2]

→ **online at model timestep basis**

# REMO-iMOVE technical basics & features

**Interactive changes** in vegetation have the need that the model knows about **all relevant parameters (distribution, albedo, roughness) at run time**

**The information needed could be introduced by the use of new datasets & measurements:**

**GLOBCOVER 2000 (1x1 km²)** (7)

**Harmonized World Soil Database (1x1 km²)** (8)

**Tsvetsinskaya et al. 2002 (albedo of soils)**

# The AR5 harmonized land use change sc

Harmonized land use change information for AR5 **globally on 0.5°** resolution

Ranging from **1700 to 2100** in different szenarios

**5 land use classes:** primary | secondary | pasture | urban | crop

**Additional information:** harvested from forest | shrubland

**This information needs to be translated into the models' representation of geographical vegetation distribution**

# The AR5 harmonized land use change sc

Information used for Europe

pr. / sec. to cropland

harvested from mature and young pr. / sec. forest

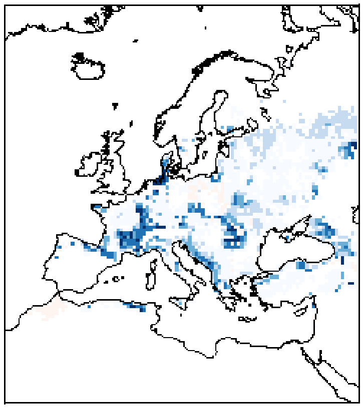
harvested from shrubs

| | | FROM | | | |
|---|---|---|---|---|---|
| | | forest | shrub | grass | crop |
| TO | forest | | | X | X |
| | shrub | | | X | X |
| | grass | X | X | | X |

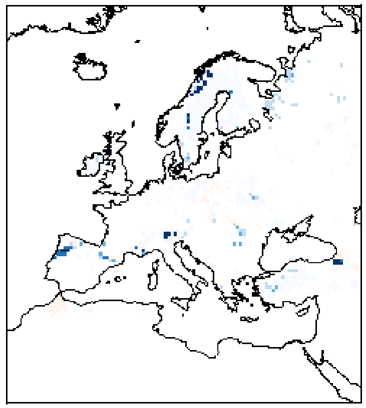
**changes use the dominant type approach**

# The AR5 harmonized land use change sc

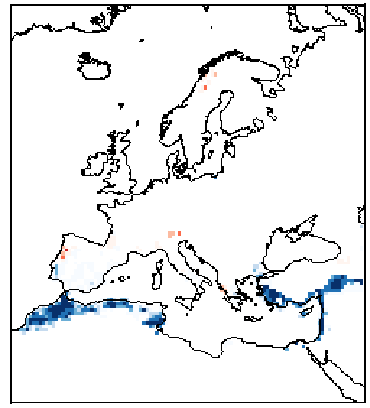
broadleaf deciduous forest



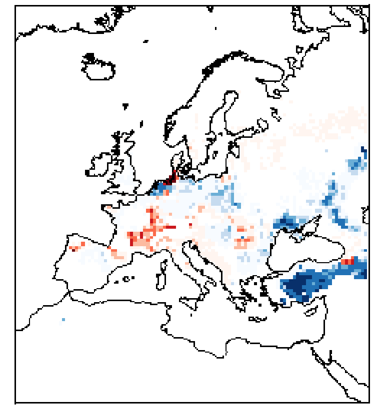
needleleaf evergreen forest



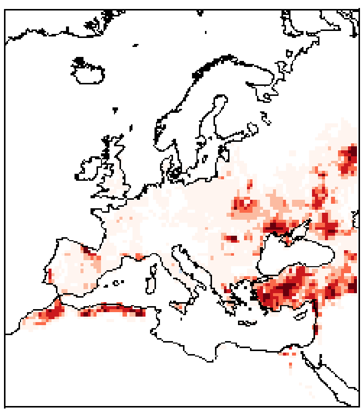
raingreen shrubs



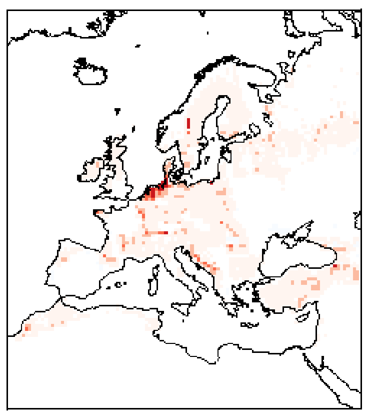
shrubs



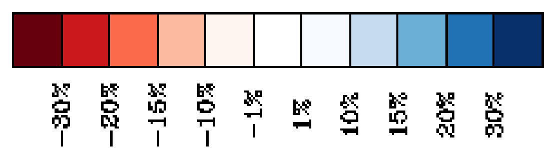
cropland



C3 grass

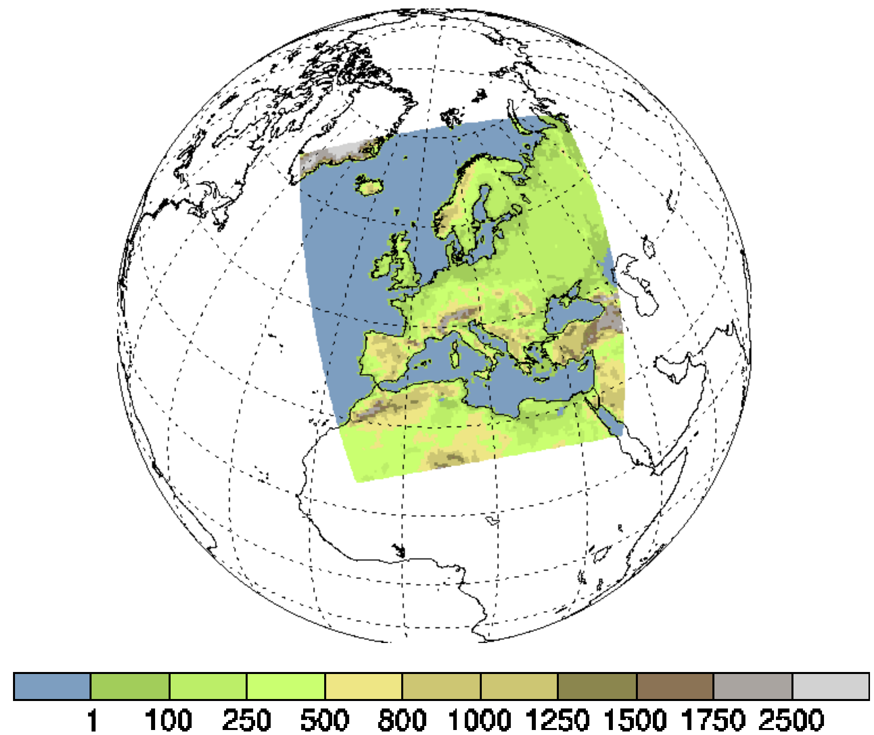


Change in % cover fraction
1950 - 1995



# Experiment setup and results

## ERA INTERIM FORCED RUNS




Model: REMO-iMOVE
Domain: Europe 0.44
Period: 1995-1999
(3 years spin-up)

Modern land use scenario:
land use from 1995 to 1999

Past land use scenario:
land use of 1950

# modern LU vs. past LU

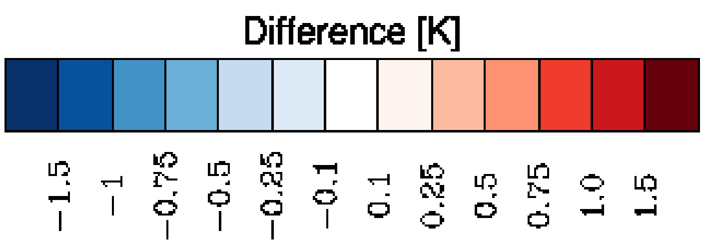
**Surface temperature differences**

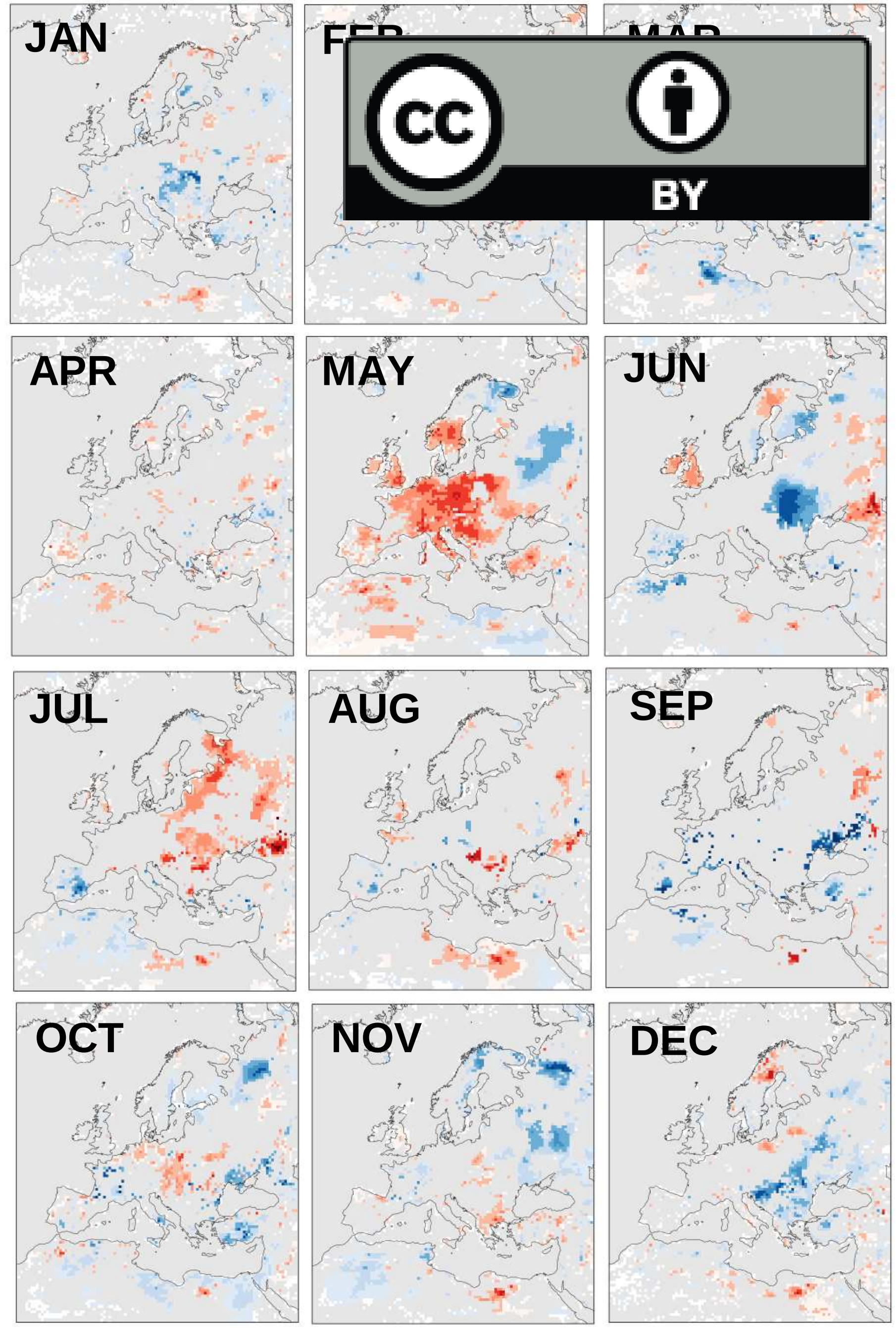
- T-test: significant changes in monthly mean values at 90% level

- changes up to +/- 1.5 K

- if projected to the climate change signal:

  → **substantial altering or enhancement**



# Experiment setup and results

## Climate change signals from observations:

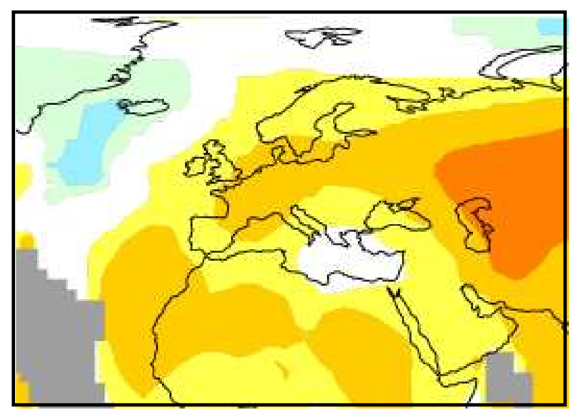
Germany: C.D. Schönwiese 2010 [10]

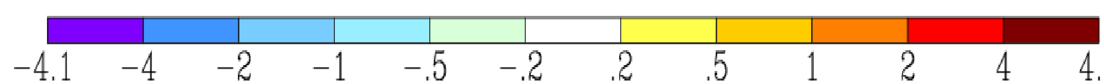
| Temperature | MAM | JJA | SON | DJF | YEAR |
|---|---|---|---|---|---|
| 1901-2000 | +0.8 | +1.0 | +1.1 | +0.8 | +1.0 |
| 1950-2000 | +1.4 | +0.9 | +0.2 | +1.6 | +1.0 |

Europe:

Annual temperature anomalies
1930-1960 vs. 1980-2010

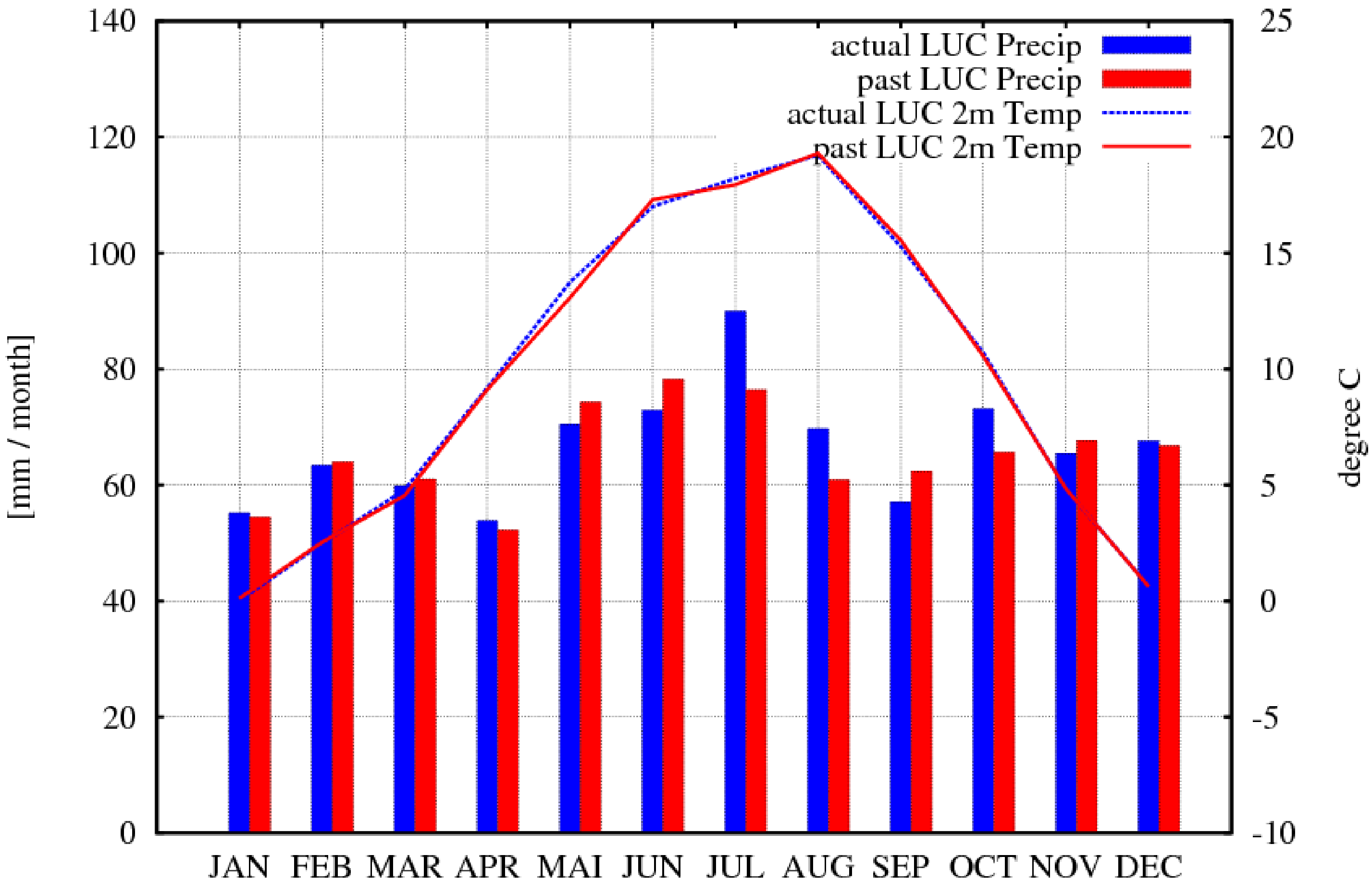
Hansen et al. 2010 [11]
(http://data.giss.nasa.gov/gistemp/maps/)





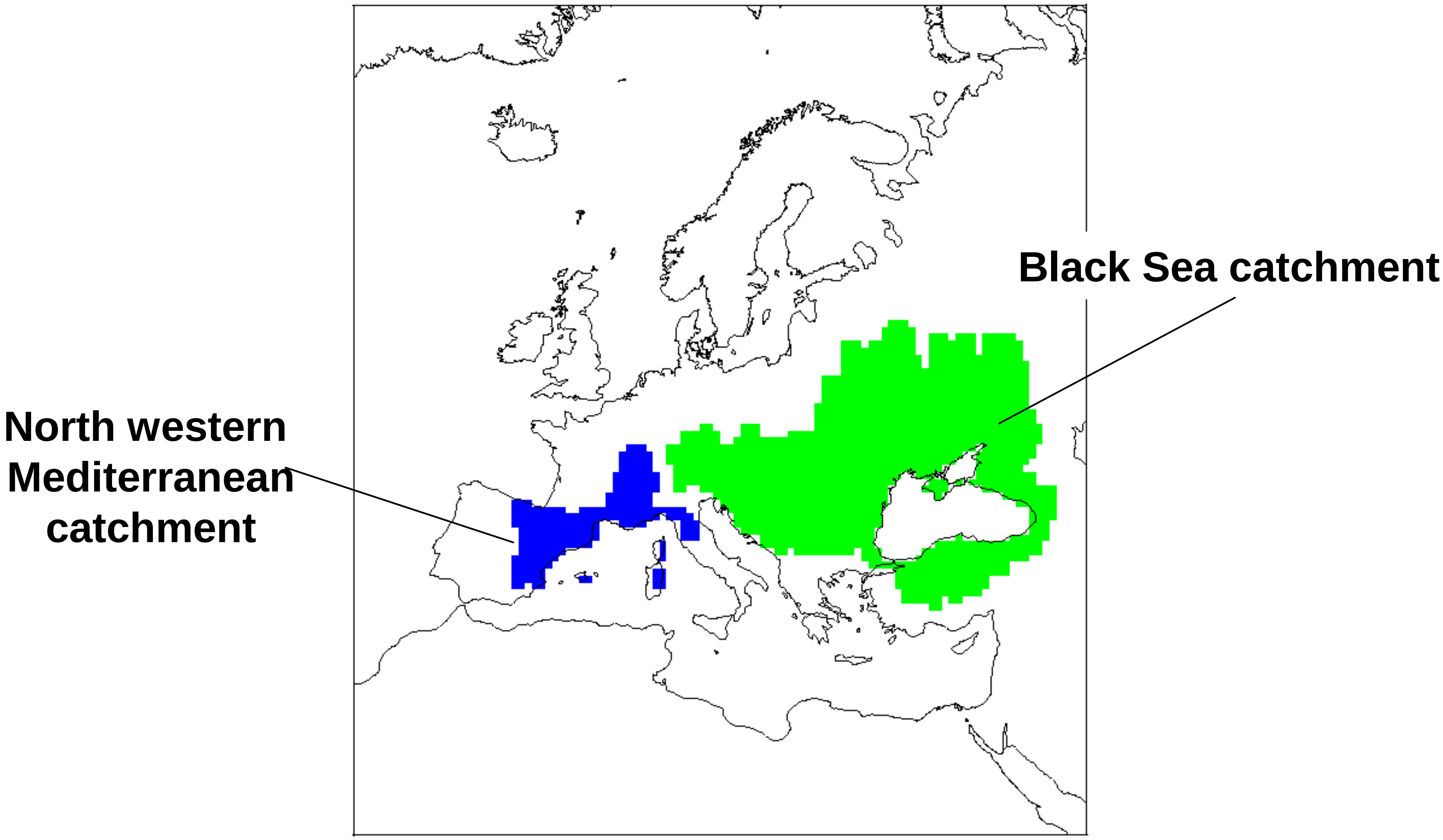
# Experiment setup and results

## Climate characteristics in Germany



# Experiment setup and results

## Catchment scale

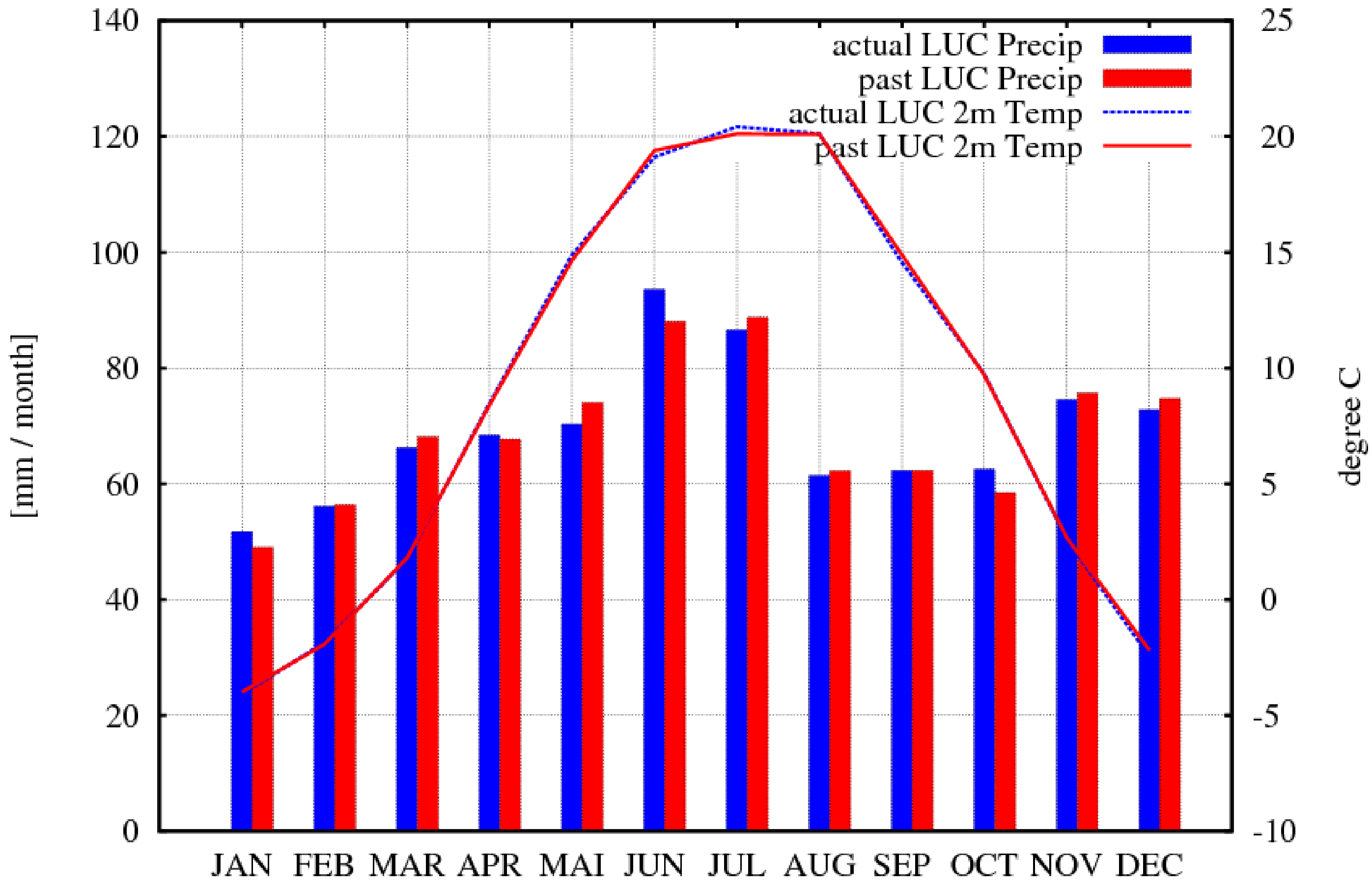



Catchment data: (9)

# Experiment setup and results

## Climate characteristics on catchment scale

### BLACK SEA catchment 1995-1999

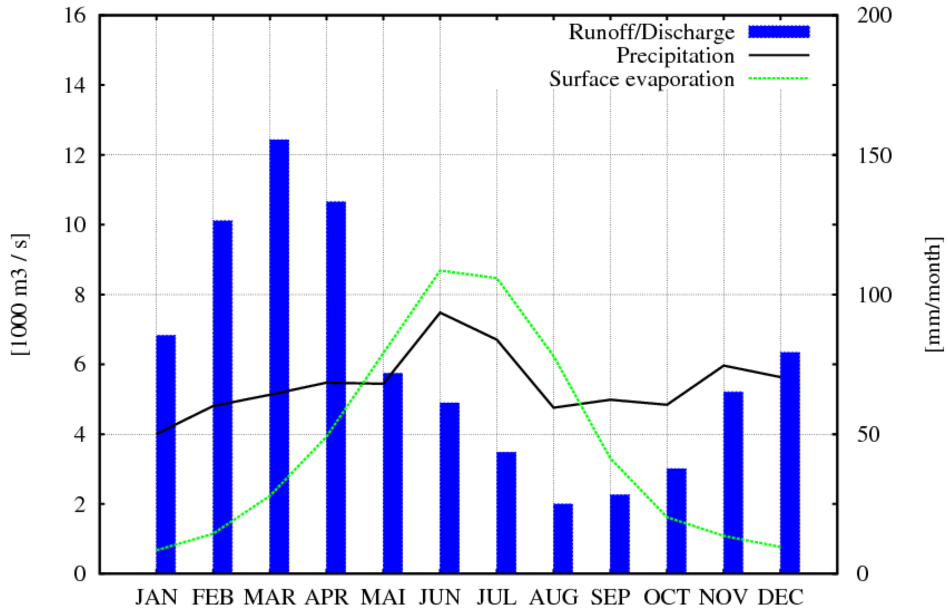


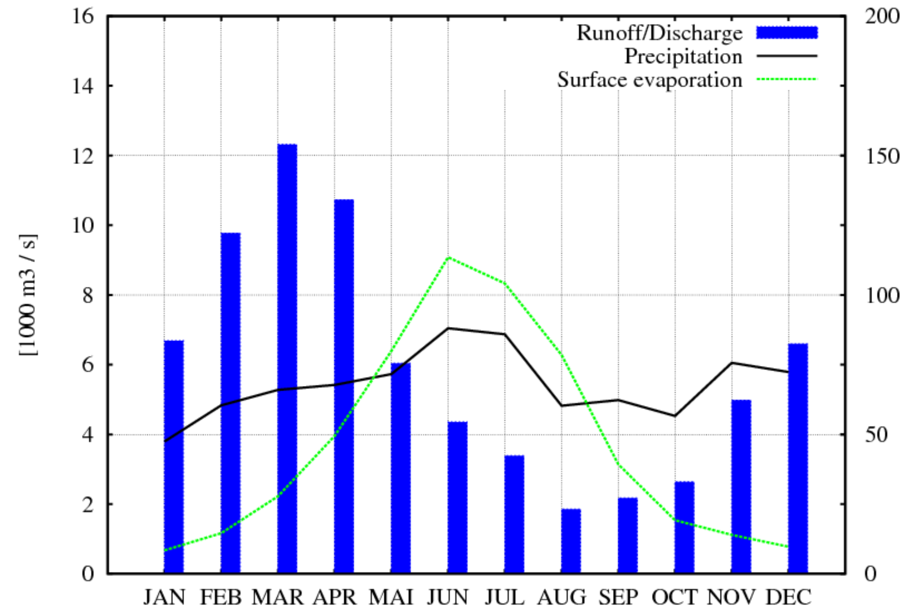
# Experiment setup and results

## Hydrological characteristics on catchment scale

### BLACK SEA catchment 1995-1999

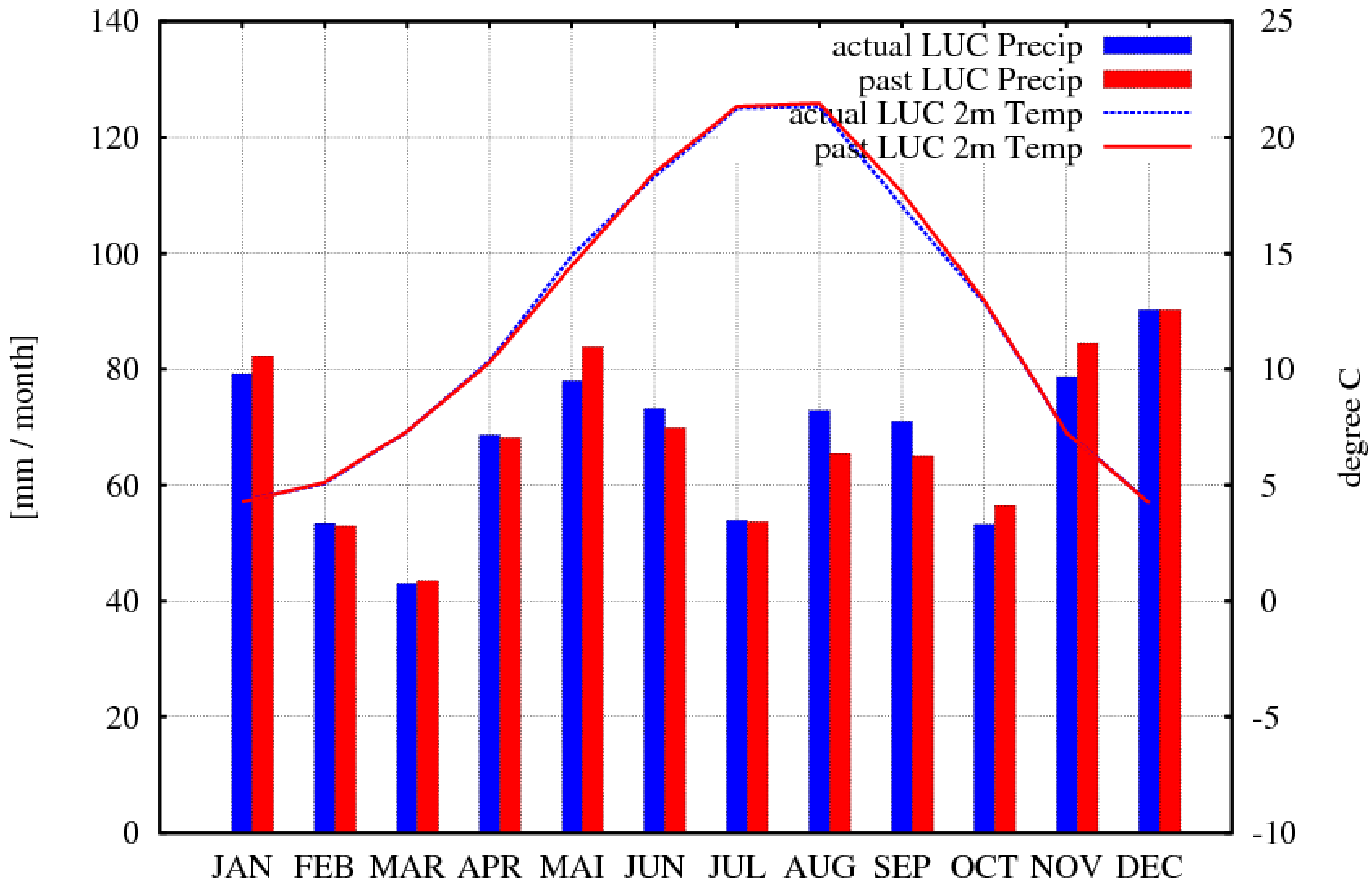
**modern LU** **past LU**



## Climate characteristics on catchment scale

### North western Mediterranean catchment 1995-1999

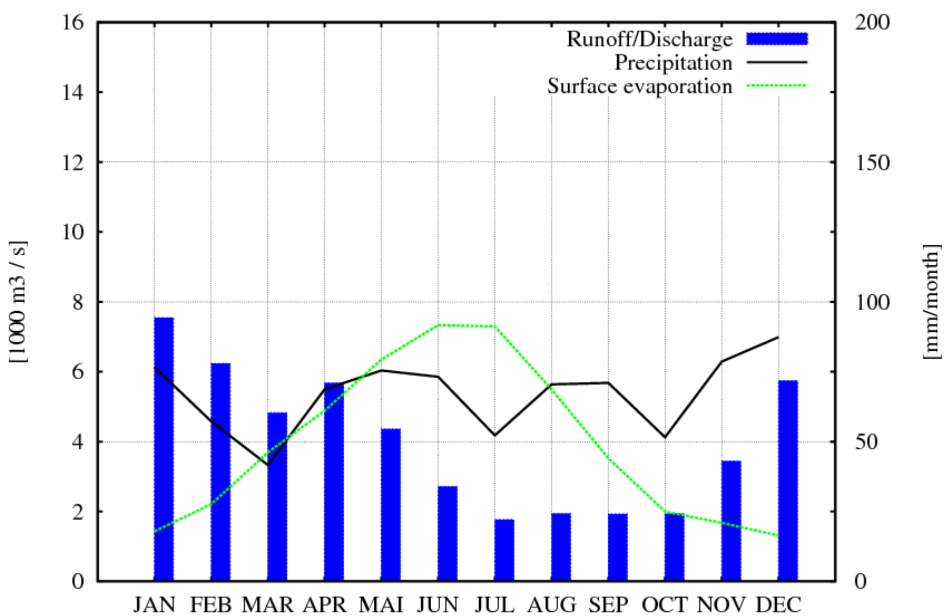


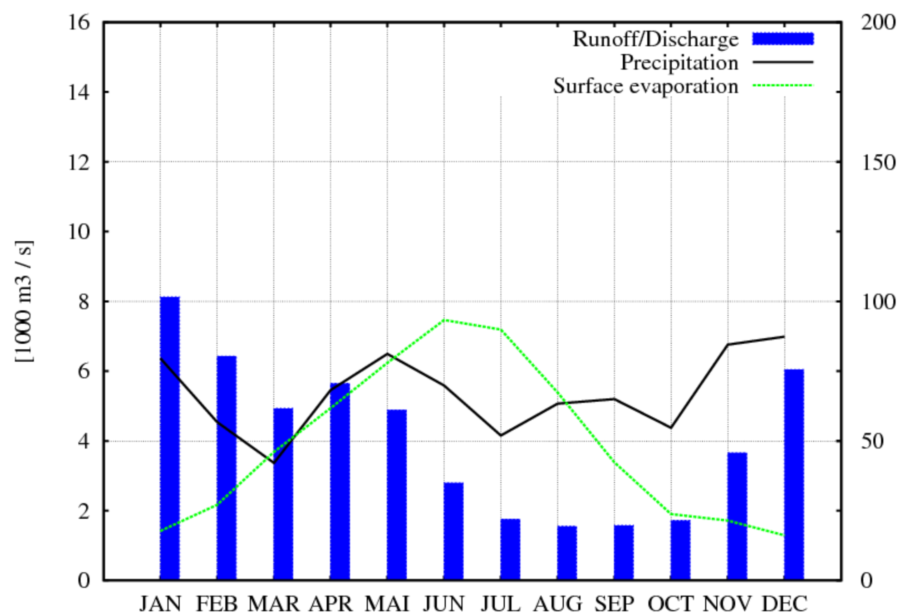
# Experiment setup and results

## Hydrological characteristics on catchment scale

### North western Mediterranean catchment 1995-1999

**modern LU** | **past LU**



# Conclusions

1. The new model version **REMO-iMOVE** is able to react **physically consistent** to geographic vegetation distribution changes

2. Although changes in geographical vegetation distribution are small, the model reacts with changes in **surface energy budget** and **water cycle**

3. Including land use changes into transient **regional climate change scenario** runs may alter or enhance the modeled climate change signal

→ **running also regional climate models with changing land use is recommended**

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**THANK YOU FOR YOUR ATTENTION !**

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