



# Modeling the effects and feedbacks of irrigation on the regional climate in Northern Italy

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# ■ Framework

## HICSS LANDMATE project

- Modelling human **LAND** surface modifications and its feedbacks on local and regional **cliMATE**
- Interaction of land surface and atmosphere (moisture, heat, momentum and mass exchanges)
- Research on direct biophysical effects of **human land surface modifications** on atmospheric processes
- Land management is of major importance for the agriculture in Europe e.g. irrigation
  
- Part of WCRP CORDEX Flagship Pilot Study **LUCAS** (**L**and **U**se **A**cross **S**cales)
  - **RCM ensemble** experiments including land use change
  - **Quantifying biophysical effects** of land use changes on the regional climate in Europe



# ■ Motivation

## Irrigation as human land surface modification

- Example for land management
- Widely used
- Needs to be **parameterized** in climate models
- Effects not studied sufficiently **on high resolution**
- **Complex interactions** with regional climate can be expected on different time and spatial scales

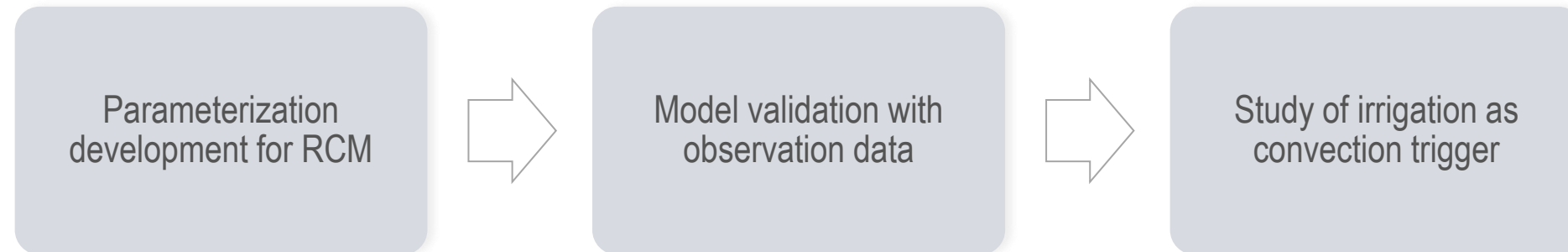


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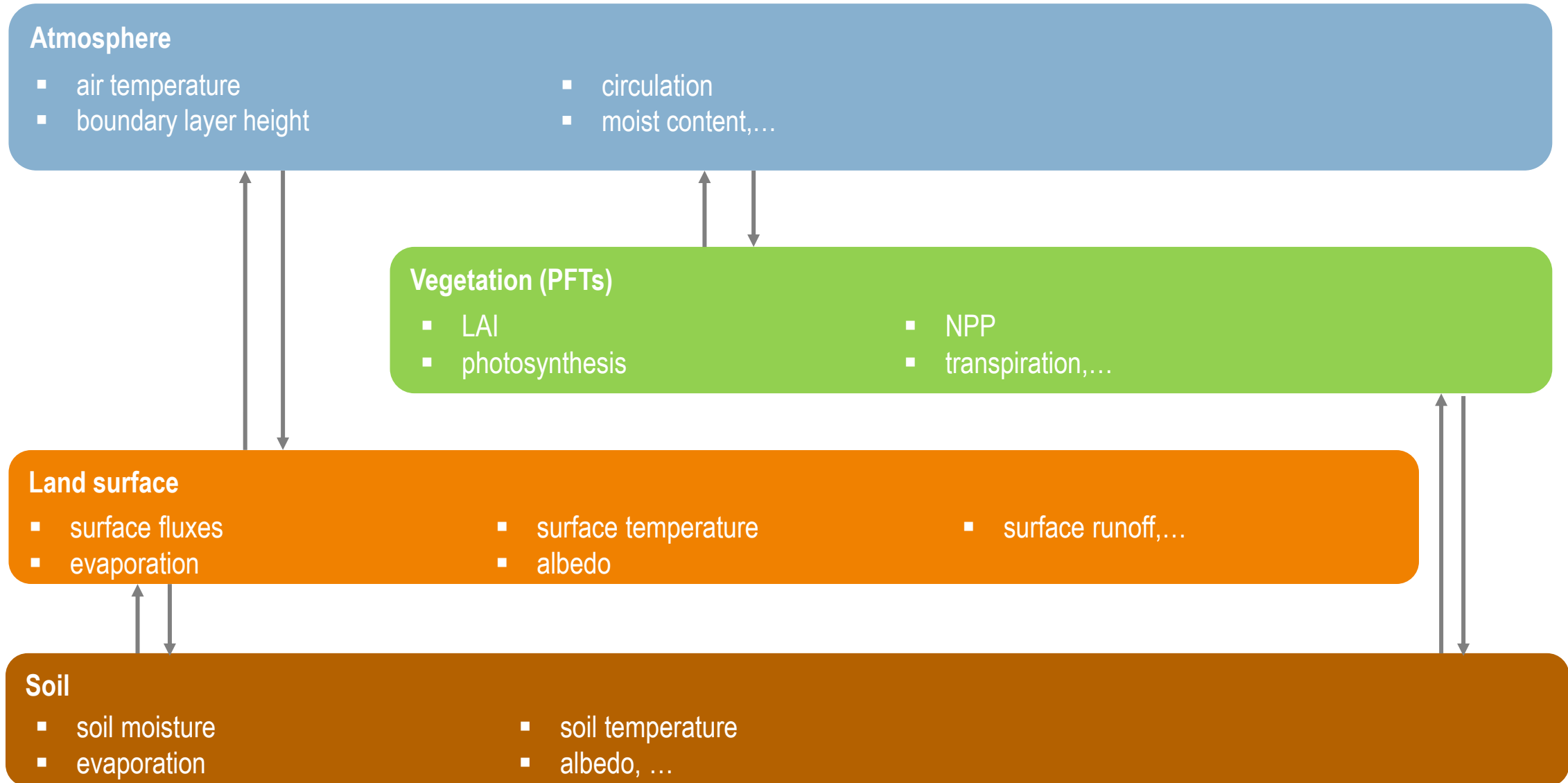
# ■ Objectives

- Development of **new irrigation parameterizations**
- **Quantifying effects** of irrigation on the local to regional climate
- Analysis of **moist convection** triggered or suppressed by irrigation

Reach them by...



# Selected relevant parameters to be investigated



# Regional climate model simulations

## REMO-iMOVE

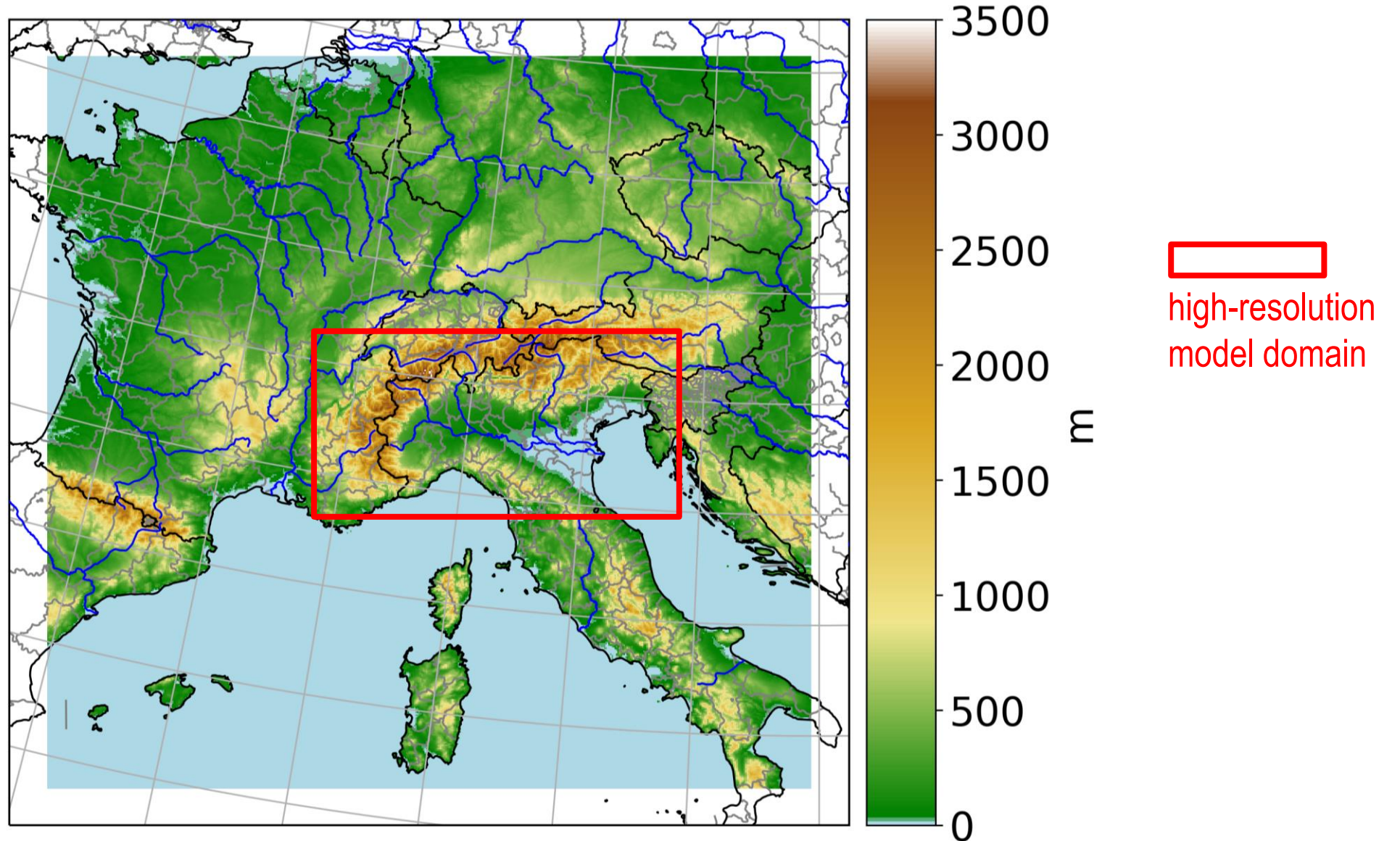
- RCM with interactive **MO**osaic **VE**getation, including some routines from JSBACH<sup>1</sup>
- Vegetation represented as **plant functional types** (PFTs)
- Dynamic representation of vegetational processes
- Representation of land surface heterogeneity using fractional PFTs per grid cell

## Experimental setup

- High-resolution simulations on **convection-permitting** scale (3 km)
- Non-hydrostatic version of REMO
- Using implemented parameterizations
- Summer season
- Pilot region: **Northern Italy**

<sup>1</sup> Wilhelm, C. et al., 2014. Interactive coupling of regional atmosphere with biosphere in the new generation regional climate system model REMO-iMOVE. Geoscientific Model Development, 7, 1093-1114. doi:10.5194/gmd-7-1093-2014.

# Pilot region: Northern Italy



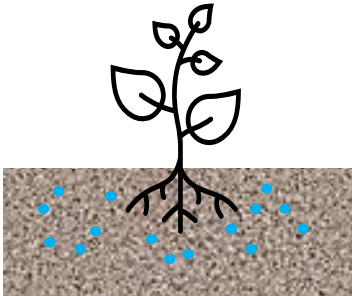
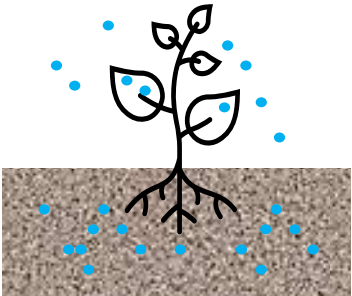
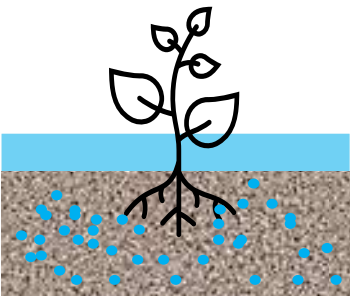
# Planned parameterizations I

## Requirements

- Irrigation during growing season
- Different irrigation methods require different parameterizations
- Most used irrigation methods in northern Italy<sup>2</sup>:

## Implementation

- Split PFTs in irrigated and rainfed PFTs
- Amount of irrigation water needs to be subtracted from available water reservoirs

	Channel irrigation	Sprinkler irrigation	Flooding
Planned model representation	Direct increase of soil moisture	Addition to rain rate	Land surface properties similar to a shallow lake
			

<sup>2</sup> Inea et al., 2014. Atlas of Italian Irrigation systems.



# Planned parameterizations II

## Activation of irrigation

- Soil moisture limitation

## Amount

$$w_{irr} = w_{S_{target}} - w_{S_{actual}}$$

$w_{irr}$ : irrigation water

$w_s$ : soil water content

## Application

- Check for irrigation requirement in the morning each day
  - Growing season
  - Activation trigger
- Evenly applied irrigation water for a specific time period (hours)

# ■ Challenges & Outlook

## Challenges

- Development of parameterizations, which can be applied to different regions
- Desirable would be parameterizations, which can be easily adapted to other (regional) climate models

## Outlook

- Quantify potential of irrigation effects as climate adaptation and mitigation measures
- Study as part of the multi-model ensemble of LUCAS
- Define important findings for the implementation of irrigation parameterizations for other RCMs

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