## Project: **1337** Project title: Land Management, climate and financial markets Principal investigator: Leonore Jungandreas Report period: **2022-11-01 to 2023-10-31**

The main goal of the project is to simulate the biogeophysical impacts of cover crops on extreme weather events, especially drought, heat, and extreme precipitation over Europe. For this purpose, I use the coupled ICON-JSBACH model framework. The following steps are necessary for the successful completion of the project:

1. developing and implementing a cover crops (CC) scheme into the land component JSBACH

2. test the CC scheme

3. perform the AMIP experiments for which computation time was requested

In the past ten months, I successfully developed and implemented the CC scheme into JSBACH (task 1) and performed JSBACH standalone simulations to test the CC scheme for physical sensibility (task 2). I further ran a 36-year (1979-2015) control (CTRL) experiment with the CC scheme switched off (where the first 15 years are considered as spinup time for the model) and, starting from a restart file (year 1994) of the CTRL simulation a 21-year CC experiment. The CTRL and CC experiment simulations are done with a global AMIP setup on a horizontal resolution of R2B4. For testing the CC scheme (JSBACH standalone simulations) and the two AMIP simulations, about 5000 CPU node hours (October) and about 26Tb of storage on Levante are used.



Fig 1: Difference in Leaf area index (LAI), Maximum daily temperature (Txx) and Consecutive dry dys (CDD) between the CC and the CTRL experiment over Europe. Analysis has been performed for the period 1994 to 2015.

Figure 1 shows the first analysis of the two global AMIP experiments focusing on Europe. However, cover crops are enabled to grow in the subtropics all over the globe. The left panel indicates an increase in the mean leaf area index when cover crops are enabled. This increase results in a substantial increase in maximum daily temperature (TXx) over northern Europe and a decrease over southern Europe up to about 47°N (middle panel). Moreover, over large parts of Europe, the number of consecutive dry days (CDD) decreases except in south-east Europe (right panel).

Preliminary analysis indicates that these changes in TXx and CDD do not result from changes in latent and sensible heat flux or albedo over Europe (not shown). Because cover crops in our simulations are allowed to grow in the subtropics (north and south of 30°) all over the globe, we consider larger-scale circulation changes as a possible cause for the changes in CDD and TXx. This, however, needs further investigation.

These results have been presented as a poster at the WCRP conference (October 23rd - 27th, 2023).

## Reasons for expired resources and deviations from the project plan

However, I have to report that I could only use some requested resources (several expired), and I had to modify my simulation plan. Due to the following reasons, I had to cancel or postpone the spinup simulations with a higher spatial resolution of 40km or the nesting experiments from 20 down to 2.5 km horizontal resolution:

1. the new version of ICON-MPIM is still firmly under development. It took several months until an AMIP setup was available, which I could use to perform the first global simulations. Moreover, the setup was only available in an R2B4 setup. The input data for 40km horizontal resolution or higher are even, until now, not available. I have the information that Thomas Raddatz and Veronika Gayler (and others) are working on the seamless version of ICON, including the necessary high-resolution input data for the simulations. However, no final information could be given, on when this setup will be available.

The implementation of the CC scheme took much longer than expected and needed several rounds of revision and testing with the JSBACH standalone version until it was finalized (about six months in total). In between, I needed to evaluate the changes in LAI due to the growth of CC based on observation datasets and implemented the learnings in the CC scheme.
Another reason for using fewer requested resources is the parallel work on an interdisciplinary publication part related to this project. This publication needed to be prioritized due to its relevance for the application and meetings for the "Breathing Nature" excellence cluster of the University Leipzig (in collaboration with the UFZ, MPI-BGC Jena, iDiv, and some others). My co-authors and I intensively worked on a perspective paper on interactions between land management, climate, and financial markets. We aim to submit it between December and January.

In my application last year I planned to perform simulations only over the European domain. However, currently, there is no AMIP setup for regional simulations available and ready to use. Preparing the boundary data and the modified regional AMIP setup myself would have consumed another considerable amount of time, which likely led to the expiration of more resources. That is why I decided to start with the available global R2B4 setup.

The computation resource application for 2024 is based on this year's progress. I will build upon the two available experiments and push forward the high-resolution simulations in the upcoming year.