Project: **1337**

Project title: **Land Management, climate and financial markets**

Principal investigator: **Leonore Jungandreas**

Report period: **2025-11-01 to 2026-10-31**

During this allocation period, I focused on two main projects. Firstly, I investigated the biogeophysical land–atmosphere feedbacks, specifically the effects on heat extremes caused by cover crops. Secondly, I prepared and started testing nested storm-resolving simulations to investigate the impact of resolution on biogeochemical (carbon allocation) and biogeophysical (water and energy fluxes) processes over agricultural land.

The computing time allocated for the first quarter remained largely unused. During this period, my work focused on other obligations, mainly teaching, writing a perspective paper, and reviewed analysis for the cover crop paper (see Project 1). The perspective paper is currently being revised for resubmission.

Project 1: Land-atmosphere feedbacks of cover crops

We (me and my co-authors) investigate cover crops based on simulations with the ICON-ESM model version 2024.10. We select specific regions to better disentangle the land-atmosphere feedbacks that drive changes in mean and extreme temperatures in Europe. The publication will focus on the effect of cover crops on extreme temperatures.

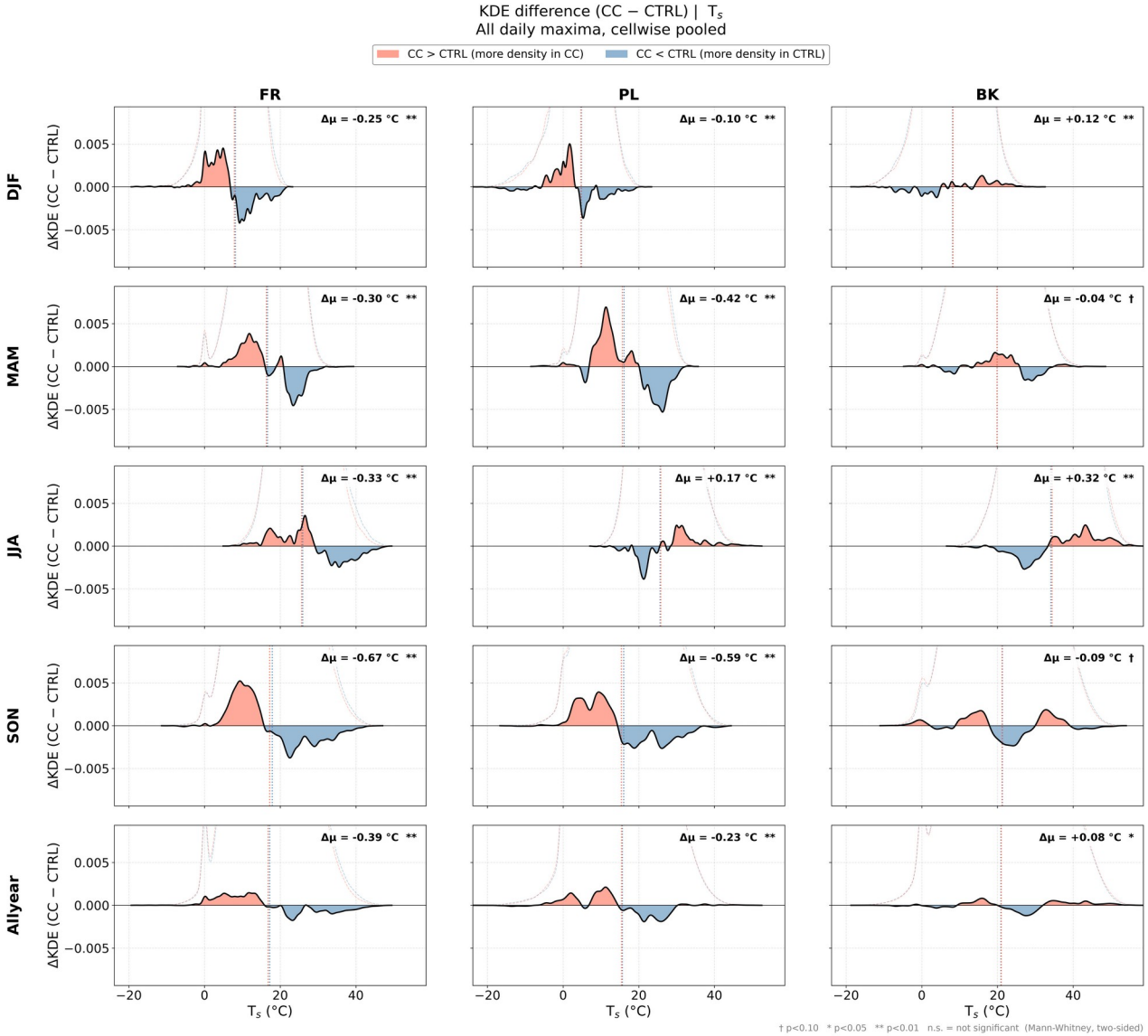


Fig 1: Change in the KDE-density function for daily maximum temperatures between CC (Cover

*crop experiment runs) and CTRL (control run) for the three analysis regions over France (FR), Poland (PL) and the Balkan (BK) (columns) for all four seasons (DJF, MAM, JJA, SON) and All-year. Red indicates increase of probability in the CC compared to the CTRL experiment, blue vice versa. The vertical dotted line and Δμ annotation in the upper right corner of each panel give the shift in the mean of the distribution. Significance was assessed with a two-sided Mann-Whitney test († p<0.10, * p<0.05, ** p<0.01, n.s. = not significant).*

In our simulations, cover crops grow in the France (FR) and the Poland (PL) region and induce a cooling of annual mean temperatures (not shown) and daily maximum temperatures in DJF, MAM and SON (Fig.1). While in the FR domain, cooling of maximum daily temperatures also occurs in JJA (during the growth of the main crop), the PL domain shows warming (Fig. 1, JJA). This regional difference is caused by a soil moisture induced temperature feedback. In the FR domain precipitation replenishes soil moisture and overcompensates transpiration by plants. In contrast, the more continental climate of the PL domain receives too little precipitation to compensate the increase in transpiration by cover crops.
In the Balkan region, no cover crops are growing, likely because conditions are too dry in the model. However, we see small but significant changes in this region, which we attribute to remote effects.These remote impacts have not yet been analyzed in this study.

After a mistake in the analysis was noticed, the project needed major revisions. No additional simulations (HPC resources) were needed, but post-processing and analysis of the results need to be revised. Writing and submitting the manuscript has therefore (and due to other duties) been delayed, but it now on track to be submitted December 2026/January 2027.

Project 2: Nested storm-resolving simulations

In the second project, I aim to perform a nested simulation from a global R2B4 domain to a regional R2B9 (or R2B10) domain covering Europe. The goal is to investigate the impact of resolution on land-atmosphere interactions over agriculture areas. I successfully created all necessary input fields, ran the global carbon spinup. and a one-year nested simulation with the R2B4, R2B5 and R2B6 domain.
Fig. 2 shows the seasonal cycle of leave area index (LAI) over a small test domain over Europe. It hints toward a strong impact of model resolution on the representation of the land surface and vegetation state. Therefore, I hypothesize a associated effect on biogeophysical and biogeochemical feedbacks, which need to be studied in detail.
Following, I test the nested setup down to the R2B9 resolution. Currently, I can run a five-domain-setup from R2B4 to R2B8. Unfortunately, the step to the R2B9 setting is causing major problems and consumed most of the allocated computation resources from the ongoing allocation period. I am currently working on a solution, supported from the DKRZ staff.

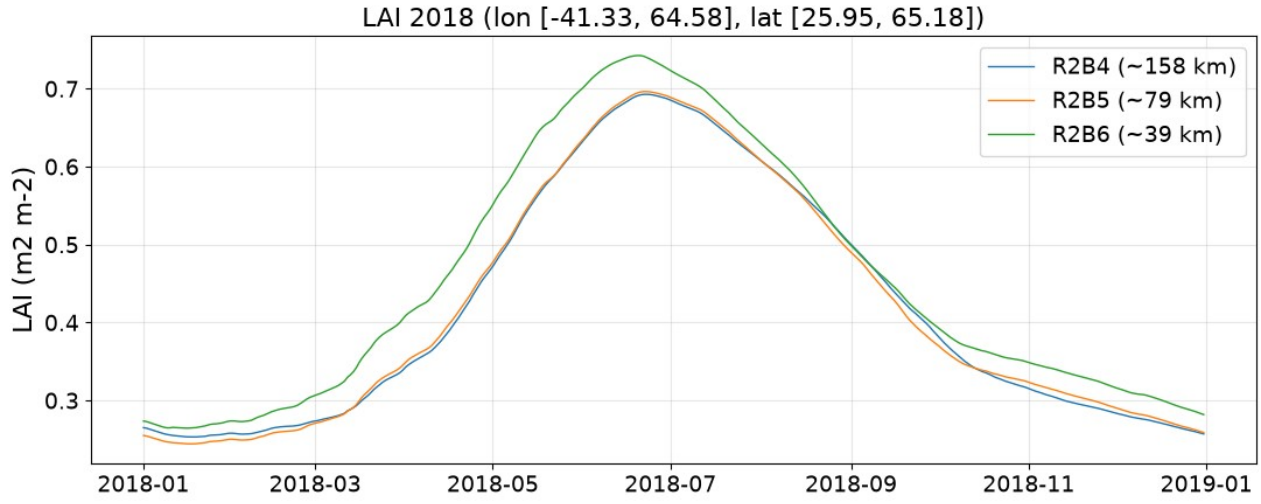


Fig. 2: Mean seasonal leaf area index averaged over a small test domain spanning from 41.33°E to 64.58°W and from 25.95°N to 65.18°N. The colored lines show three different horizontal model resolutions from R2B4 (~160km) in blue, R2B5 (~80km) in orange and R2B6 (~40km) in green.