Exploring climate-biodiversity interactions in observational data and models

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Climate change and biodiversity loss are increasingly considered jointly, particularly to find optimal solutions for both crises and to avoid negative side-effects and feedbacks. Much research has been devoted to predicting the effects of climatic changes on the distribution of species, but the consequences of biodiversity changes for the climate system are less understood. For instance, what are the main aspects (species richness, functional diversity, land cover patchiness) and mechanisms through which biodiversity interacts with the climate? Do landscapes with different levels of diversity contribute differently to climate regulation or feedbacks? How do human choices such as nature conservation or natural resources production affect the climate? To address these questions, we combine observational and modelling approaches in a collaborative effort of ecologists and climate scientists.

First, we present how ecosystem diversity affects forests’ climate response (indicated by interannual variability in summer NDVI) and climate effect (indicated by interannual variability in summer LST), using 20 years (2003-2022) of remote sensing data at 1 km resolution over Europe. We consider different diversity levels (taxonomic, functional, structural) together with various ecosystem, topography, soil, and climate predictors in a multiple linear regression with Ridge regularisation. This approach allows isolating the effects of specific biodiversity aspects (e.g. tree species richness, forest edge density), functional properties (e.g. leaf type, leaf traits), and structure (e.g. canopy height, tree cover density), and determining the sign and magnitude of their contribution. We show which aspects and scales of biodiversity are relevant for ecosystem stability and climate regulation, respectively, and classify forests into response and effect types that could be considered in coupled biosphere-atmosphere models.

Second, we discuss how biodiversity aspects can be integrated into the coupled biosphere-atmosphere regional climate model COSMO-CLM² to quantify their effects on land-atmosphere interactions and feedbacks over Europe. We demonstrate one approach, utilising future land cover scenarios derived from the Nature Futures Framework that represent different value perspectives on nature (intrinsic, instrumental, and relational), habitat types from EUNIS (European Nature Information System), and species abundances from EVA (European Vegetation Archive). Our results show temperature differences of up to several degrees locally, with enhanced temperature
sensitivities under hot and dry conditions. Such findings can help identify synergies between biodiversity conservation, climate change mitigation, and adaptation, and support the development of effective policy solutions.

Finally, this presentation will provide perspectives for research at the interface of biodiversity and climate change.

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