Session: "Cross scale systems" subtopic 6.1 Digital tools for site specific and diversified field arrangements to increase ecosystem services and biodiversity.

Title: Using agroecosystem models to optimize spatial and temporal crop diversification in new field arrangements in heterogeneous landscapes.

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Abstract: Germany has a strong agricultural sector, with more than four million hectares dedicated to the production of major cereals. Despite the high productivity of these intensified systems, the practice has also led to a series of environmental concerns due to the pollution of water bodies resulting from nutrient leaching, increased N_2O greenhouse gas emissions to the atmosphere and loss of biodiversity, raising the need to switch to multifunctional agricultural systems that better contribute to the provision and regulation of ecosystem services and additionally improve cropping systems resilience to the changing climate. Crop diversification offers multiple benefits to the agroecosystem on improving resource use efficiency, yield/yield stability, reducing pest incidence, and reduction of yield risk. Additionally, with the development of smaller agricultural robots in the future, it may be possible to redefine large field arrangements in the agricultural landscape with smaller field sizes (e.g. patches) adapted by considering physical and chemical spatial soil heterogeneities. Combining spatial and temporal crop diversification with new field arrangements considering field heterogeneities can be an alternative to improve resource use efficiency and the provision and regulation of ecosystem services. Agroecosystem models are a meaningful tool to explore crop and ecosystem dynamics, with the flexibility to explore a wide range of environments and management practices and they can be used as a complementary tool to experimentation of diversified field arrangements. Our aim is to apply and further develop dynamic agro-ecosystem models to explore how different spatial crop arrangements adapted to spatial soil heterogeneities affect the multifunctional response of agroecosystems and how they can contribute to a more sustainable and resilient agriculture. By applying agroecosystem models, we are aiming to explore the following questions: i) Can we improve resource use efficiency and ecosystem services within heterogeneous landscapes through new spatial arrangements of crops (spatio-temporal crop diversification)? ii) Can we use remote sensing or other sensing technologies, for model calibration, validation and improvement? iii) What are the possible implications of upscaling this practice from the landscape to regional scale? Here we present the results for the first stage of model application on exploring the impacts of spatial and temporal diversification on crop yields and resource use efficiency and their interaction with patch sizes. The expected outcomes of this research is to gain mechanistic insights into scale-dependent effects of crop diversification on agroecosystem performance and to demonstrate and evaluate the possibilities of new digital technologies combined with crop modelling to implement and manage diversified new field arrangements in a sustainable manner.