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Accelerating the understanding of plant response to drought stress

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Climate extremes like droughts and heatwaves impact how water, energy, and carbon move through ecosystems. Soil-water-plant-energy interactions can be represented by SCOPE (vegetation photosynthesis model) and STEMMUS (soil water and heat model). SCOPE simulates the radiative transfer of incident light and thermal and fluorescence radiation emitted by soil and plants, temperatures of leaves and soil in the sun and shade, photosynthesis and turbulent heat exchange whereas STEMMUS traces soil moisture and soil heat dynamics and root water uptake.

The integrated model, "STEMMUS-SCOPE", thus links vegetation dynamics to soil moisture and soil temperature variability. This helps to simulate evaporation, transpiration and carbon fluxes better, especially under water stress conditions. With STEMMUS-SCOPE, we can model variables like moisture levels in deeper soil (root-zone-soil moisture) and the amount of carbon that is stored underground (carbon sequestration) at a global scale.

However, applying STEMMUS-SCOPE across ecosystems at a global scale faces numerical problems and computational challenges, such as numerical convergency of the model, optimization issues in calibration, and expensive computational cost. To overcome the challenges, we are developing tools for efficient computing and data handling within the context of EcoExtreML project. The project aims to improve the coupling of STEMMUS and SCOPE models, approximate the integrated model by a machine learning approach, and estimate uncertain model states and parameters using data assimilation techniques. The results of STEMMUS-SCOPE are currently prepared for 170 flux tower sites representing 1040 site-years of data with a half-hour time step across most of the world's climate zones and representative biomes.

In this talk, we will give you an overview of STEMMUS-SCOPE, show how the model can be used, and introduce EcoExtreML project.

References:

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STEMMUS: https://doi.org/10.1007/978-3-642-34073-4, https://github.com/yijianzeng/STEMMUS

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