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Significant contribution of realistic vegetation representation to improved simulation and prediction of climate anomalies over land

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The EC-Earth earth system model has been recently developed to include the dynamics of vegetation through the coupling with the LPJ-Guess model. In its original formulation, the coupling between atmosphere and vegetation variability is simply operated by the vegetation Leaf Area Index (LAI), which affects climate by only changing the vegetation physiological resistance to evapotranspiration. This coupling with no implied change of the vegetation fractional coverage has been reported to have a weak effect on the surface climate modeled by EC-Earth (e.g.: also Weiss et al. 2012).
The effective sub-grid vegetation fractional coverage can vary seasonally and at interannual time-scales as a function of leaf-canopy growth, phenology and senescence, and therefore affect biophysical parameters such as the surface roughness, albedo and soil field capacity. To adequately represent this effect in EC-Earth, we included an exponential dependence of the vegetation densitiy to the LAI, based on a Lambert-Beer formulation.
By comparing historical 20th century simulations and retrospective forecasts performed applying the new effective fractional-coverage parameterization with the respective reference simulations using the original constant vegetation-fraction, we showed an increased effect of vegetation on the EC-Earth surface climate. The analysis shows considerable sensitivity of EC-Earth surface climate at seasonal to interannual time-scales due to the variability of vegetation effective fractional coverage. Particularly large effects are shown over boreal winter middle-to-high latitudes, where the cooling effect of the new parameterization corrects the warm biases of the control simulations over land. For boreal winter, the realistic representation of vegetation variability leads to a significant improvement of the skill in predicting surface climate over land at seasonal time-scales.
A potential predictability experiment extended to longer time-scales also indicates the potential for the realistic vegetation representation to contribute to predictability of climate over land at the decadal time scales.