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Evaluation and probabilistic assessment of vegetation contribution to seasonal climate prediction in EC-Earth

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The EC-Earth earth system model has been recently developed to include the dynamics of vegetation. In its original formulation, vegetation variability is operated by the Leaf Area Index (LAI), which affects climate by changing the vegetation physiological resistance to evapotranspiration. This coupling has been found to have only a weak effect on the surface climate modeled by EC-Earth. To adequately represent the effects of vegetation variability on biophysical parameters such as the surface roughness, albedo and soil field capacity, we modified the land-surface model of EC-Earth to introduce an exponential dependence of the vegetation covers on the LAI.

The modified model is used to perform a retrospective seasonal hindcast experiment with LAI prescribed from a dataset based on the third generation GIMMS and MODIS satellite observations. The hindcast setup is: 7 months forecast length, 1st May and 1st November start dates, 10 members for each start date, spanning 1982–2009 period. The probabilistic performance of the model with improved sensitivity to vegetation variability is evaluated with respect to a control experiment where LAI does not vary. A comprehensive set of probabilistic skill measures is analyzed for both the sensitivity and the control experiment. Results demonstrate that a realistic representation of vegetation variability significantly improves the seasonal forecasts of surface temperature and precipitation. The sensitivity is particularly large for temperature during boreal winter over central North America and Central Asia. This may be attributed in particular to the effect of the high vegetation component on the snow cover. Summer forecasts are improved in particular for precipitation over Europe, Sahel, North America, West Russia and Nordeste. Prediction of extremes is significantly improved in the sensitivity experiment. In particular, improvements are shown for the prediction of 2003 European summer heat wave.