SESSION: (B1) Mechanisms of S2D predictability

(B1-15)

Multi-scale enhancement of climate prediction over land by increasing the model sensitivity to vegetation variability

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The effective sub-grid vegetation fractional coverage varies seasonally and at interannual time-scales in response to leaf-canopy growth, phenology and senescence. Therefore it affects biophysical parameters such as the surface resistance to evapotranspiration, albedo, roughness length, and water from soil field capacity exploitable by vegetation. To adequately represent this effect in the EC-Earth ESM, we included an exponential dependence of the vegetation cover on the Leaf Area Index according to the Lambert Beer law of extinction of light under vegetation canopy.

By comparing two sets of simulations performed with and without the new variable fractional-coverage parameterization, spanning from centennial (20th Century) simulations and retrospective predictions to the decadal (5-years), seasonal (2-4 months) and weather (4 days) time-scales, we show for the first time a significant enhancement in climate simulation and prediction over land that is consistently obtained at the multiple time-scales considered. Particularly large effects at multiple time scales are shown over boreal winter middle-to-high latitudes over Canada, West US, Eastern Europe, Russia and eastern Siberia due to the implemented time-varying shadowing effect by tree-vegetation on snow surfaces. Over Northern Hemisphere boreal forest regions the improved representation of vegetation-cover consistently correct the winter warm biases, significantly improves the climate change sensitivity, the decadal potential predictability as well as the skill of forecasts at seasonal and weather time-scales. Significant improvements of the prediction of 2m temperature and precipitation are also shown over transitional land surface hot spots. Both the potential predictability at decadal time-scale and seasonal-forecasts skill are enhanced over Sahel, North American Great Plains, Nordeste Brazil and South East Asia, mainly related to improved performance in the surface evapotranspiration.

This work demonstrates, for the first time, that the implementation of a realistic representation of vegetation in Earth System Models (ESMs) can significantly improve climate prediction across multiple time-scales, and the details of the results are discussed in a peer-review paper just published on Climate Dynamics (Alessandri et al., 2017; doi:10.1007/s00382-017-3766-y).