Geophysical Research Abstracts
Vol. 19, EGU2017-19307, 2017
EGU General Assembly 2017

Benchmarking sensitivity of biophysical processes to leaf area changes in land surface models

Giovanni Forzieri (1), Gregory Duveiller (1), Goran Georgievski (2), Wei Li (3), Eddy Robestson (4), Markus Kautz (5), Peter Lawrence (6), Philippe Ciais (3), Julia Pongratz (2), Stephen Sitch (7), Andy Wiltshire (4), Almut Arneth (5), and Alessandro Cescatti (1)

(1) JRC Ispra Italy, (2) MPI Hamburg Germany, (3) LSCE IPSL France, (4) UK Metoffice, Exeter, United Kindgom, (5) KIT, Germany, (6) NCAR, Boulder, Colorado, (7) University of Exeter, United Kingdom

Land surface models (LSM) are widely applied as supporting tools for policy-relevant assessment of climate change and its impact on terrestrial ecosystems, yet knowledge of their performance skills in representing the sensitivity of biophysical processes to changes in vegetation density is still limited. This is particularly relevant in light of the substantial impacts on regional climate associated with the changes in leaf area index (LAI) following the observed global greening. Benchmarking LSMs on the sensitivity of the simulated processes to vegetation density is essential to reduce their uncertainty and improve the representation of these effects.

Here we present a novel benchmark system to assess model capacity in reproducing land surface–atmosphere energy exchanges modulated by vegetation density. Through a collaborative effort of different modeling groups, a consistent set of land surface energy fluxes and LAI dynamics has been generated from multiple LSMs, including JSBACH, JULES, ORCHIDEE, CLM4.5 and LPJ-GUESS. Relationships of interannual variations of modeled surface fluxes to LAI changes have been analyzed at global scale across different climatological gradients and compared with satellite-based products. A set of scoring metrics has been used to assess the overall model performances and a detailed analysis in the climate space has been provided to diagnose possible model errors associated to background conditions.

Results have enabled us to identify model-specific strengths and deficiencies. An overall best performing model does not emerge from the analyses. However, the comparison with other models that work better under certain metrics and conditions indicates that improvements are expected to be potentially achievable. A general amplification of the biophysical processes mediated by vegetation is found across the different land surface schemes. Grasslands are characterized by an underestimated year-to-year variability of LAI in cold climates, ultimately affecting the amount of absorbed radiation. In addition patterns of simulated turbulent fluxes appear opposite to observations. Such systematic errors shed light on the current partial understanding of some of the mechanisms controlling the surface energy balance. In contrast forests appear reasonably well represented with respect to the interactions between LAI and turbulent fluxes across most climatological gradients, while for net radiation this is only true for warm climates. These proven strengths increase the confidence on how certain processes are simulated in LSMs. The model capacity to mimic the vegetation-biophysics interplay has been tested over the real scenario of greening that occurred in the last 30 years. We found that the modeled trends in surface heat fluxes associated with the long-term changes in leaf area could vary largely from those observed, with different discrepancies across models and climate zones.

Our findings help to identify knowledge gaps and improve model representation of the sensitivity of biophysical processes to changes in leaf area density. In particular, comparing models and observations over a wide range of climate and vegetation conditions, as analyzed here, allowed capturing non-linearity of system responses that may emerge more frequently in future climate scenarios.