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'Impacts of large-scale bioenergy expansion on global land use change and climate over the 21st century'

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Two of the greatest challenges facing humanity this century are climate change and the need for enough energy production to meet the demands of a rapidly growing and developing global population. Bioenergy is expected to be a significant contributor to both issues; as a feedstock for energy security, and as an option for climate mitigation, through replacement of fossil fuels, thus reducing greenhouse gas (GHG) emissions from energy production. However, there are large uncertainties with regards to deployment levels of bioenergy and the impacts it could have on the land system. Bioenergy deployment could potentially reach around 324 EJ/year by 2100 which could correspond to an increase of up to 550 million ha of cropland used for second generation energy crops, corresponding to 35% of current total cropland.
The transformations in land use that would occur could alter the Earth's climate system by increasing GHGs from land use changes (LUC) and through changes in reflectivity and energy exchange characteristics of the land. Using earth system climate models (ESMs), the biogeophysical and biogeochemical impacts of future mitigation scenarios that include and exclude bioenergy can be assessed.
Spatial representations of LUC for bioenergy cropland in future scenarios have only been recently accessible. This study provides an analysis of such scenarios, exploring the differences is land use change at a regional and global level. The scenarios have been inputted into climate models of intermediate complexity, such as the University of Victoria's UVic 2.9 model, to determine the spatial distribution of the different climatic effects and their impact on surface temperature across the globe.

Purpose of the work:
To determine whether the inclusion of second-generation bioenergy as a primary energy source in future mitigation scenarios is a sustainable solution in terms of the impacts it could have on the land system and climate system on a regionally and global scale.

Scientific innovation:
An expansive and comparative analysis of LUC scenarios with a focus on second generation bioenergy cropland has yet to be performed. By carrying out this analysis, it will be seen which land use changes are expected for different countries across the globe if large-scale second generation bioenergy were to be implemented over the 21st century, and how this compares to the present day land use system. Further, in order to represent the scenarios in climate models accurately, the model's infrastructure will be changed to create inputs for non-energy cropland, energy cropland and forestland represented in the scenarios. The newly-modified model could then be used in future studies of scenarios that include second-generation bioenergy policies.