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Quantifyinghistorical and future net exchanges of greenhouse gases of CO2, CH4 and N2O between land and the atmosphere in Northern Eurasia

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The largest increase of air temperature and climate extremes have occurred in Northern Eurasia in recent decades, and are projected to continue during this century. The changing climate will affect biogeography, land cover, and carbon sink and source activities, which in turn, will affect how global land use evolves in the future as humans attempt to mitigate and adapt to climate change. Regional land-use changes, however, also depend on pressures imposed by the global economy and environmental changes. Feedbacks from future land-use change will further modify regional and global biogeochemistry and climate. This study uses as suite of linked biogeography, biogeochemical, economic, and climate models to explore how vegetation shifts in Northern Eurasia will influence land-use change, carbon cycling and biomass supply across the globe during the 21st century. We find that, at the global scale, while more land will be allocated towards food and biofuel crops (from current 22 to 37 million km2 at the end of the 21st century) due to increasing population and associated economic development, and changes of land use and vegetation shift in northern Eurasia, under the no-policy scenario. The affected global land-use change and climate result in a global cumulative carbon sink of 52 PgC under the no-policy scenario (where CO_2 equivalent green house gas concentrations reach870 ppmv by the end of 21st century), while under the policy scenario (limits CO_2equivalent greenhouse gas concentrations to 480ppmv by the end of this century), the cumulative carbon is sink of 63Pg C. The global biomass supply will decrease 36 and 14 Pg under the no-policy and policy scenarios, respectively. In the presentation, we will also discuss our analysis on N_2O and CH_4 exchanges between the biosphere and the atmosphere in response to the changes of land cover and climate during this century.

Figure 1. *The linkages between the economic model, the AOGCM, and the TEM are simulated as a loosely coupled system, running EPPA to produce emissions scenarios, then the AOGCM with a reduced form version of TEM to produce climate scenarios, and then the TEM driven by climate and land use scenarios to produce productivity impacts. EPPA is then rerun with these productivity impacts, producing new scenarios of land use change, and TEM is rerun to estimate CO2 and other trace gas impacts of the final land use scenarios.*

Recent Publications

1. Liao, C., & Zhuang, Q. (2017). Quantifying the role of snowmelt in stream discharge in an Alaskan watershed: An analysis using a spatially distributed surface hydrology model. Journal of Geophysical Research: Earth Surface, 122. https://doi.org/10.1002/2017JF004214

2. Tan, Z., Zhuang, Q, Shurpali, N. J, Marushchak, M. E, Biasi, C, Eugster, W, and Anthony, K. W (2017), Modeling CO2 emissions from Arctic lakes: Model development and site-level study, J. Adv. Model. Earth Syst., 9, doi:10.1002/2017MS001028

3. Zhu, P., Q. Zhuang, P. Ciais, L. Welp, W. Li, and Q. Xin (2017), Elevated atmospheric CO2negatively impacts photosynthesis through radiative forcing and physiology-mediated climate feedback, Geophys. Res. Lett.,44, doi:10.1002/2016GL071733

4. Jin, Z., Zhuang, Q., Wang, J., Archontoulis, S. V., Zobel, Z. and Kotamarthi, V. R. (2017), The combined and separate impacts of climate extremes on the current and future US rainfed maize and soybean production under elevated CO2. Glob Change Biol. doi:10.1111/gcb.13617

5. Zhuang, Q., Zhu, X., He, Y., Prigent, C., Melillo, J. M., McGuire, A. D., Prinn, R. G., and Kicklighter, D. W. (2015), Influence of changes in wetland inundation extent on net fluxes of carbon dioxide and methane in northern high latitudes from 1993 to 2004, Environ. Res. Lett. 10 (2015) 095009.

Biography

Qianlai Zhuang's research focuses on the interactions among atmosphere, biosphere, and human dimension in the context of climate change, chemical element cycles, and policy-making. One of his major research activities is on carbon exchanges between terrestrial ecosystems and the atmosphere by investigating how changes of climate, soil physics (e.g., permafrost dynamics, change of soil moisture), atmospheric chemicals (e.g., CO_2 and O_3), land-use and land-cover (e.g., fire disturbances), affect the carbon assimilation and decomposition with both process-based and inversion modeling approaches. My second major research activity is on modeling CH_4 exchanges between the atmosphere and terrestrial ecosystems. My third major research activity is on analyzing consequences of air pollutants for ecosystem services and the economy.

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