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Possible land cover change feedbacks to surface albedo and net radiation over Siberia in a warming climate

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Our goal was to simulate vegetation cover and hot spots of vegetation change in the changing climate of Siberia by the end of the 21st century and to insight regarding vegetation change feedbacks on the alteration of surface albedo and energy. We applied the Siberian BioClimatic Model (SiBCliM) to the HadCM3 A2 (with the highest temperature increase) and B1 (with the lowest temperature increase) scenarios of the Hadley Centre (IPCC, 2007) to highlight possible vegetation change. SiBCliM predicts a biome (a zonal vegetation class) from three climatic indices (growing degree-days, negative degree-days, and an annual moisture index) and permafrost. Large changes in land cover are predicted from the A2 scenario: coverage by northern vegetation types (tundra, forest-tundra, and taiga) would decrease from 70 to some 30% enabling southern habitats (forest-steppe, steppe and semidesert) to expand coverage from 30 to 70%. Altered land cover would feedback to the climate system resulting in a potential non-linear response to changes in climate. We investigated the effects of land cover change on surface reflectivity (albedo) resulting in net radiation alterations. We calculated annual albedo as the mean of summer albedo during months with no snow cover and winter albedo during months with snow cover. Snow cover appearance and dissappearance were related to surface temperature thresholds 0, 3 and 5 Celsius degrees. Albedo change by 2080 was calculated as the differences between albedo ascribed to each pixel (between 60oE - 140oE and 50oN -75oN) according to a vegetation type and snow cover presence/absence in the current and the 2080 climates. In a warmed climate, by 2080, albedo would increase in the southern and middle latitudes in Siberia due to the forest retreat. In the northern latitudes and highlands, tundra would be replaced by the forest with decreased albedo. The total would result in about a 1% albedo increase over the entire area. Under the predicted warmer climate, these calculations suggest that the annual shortwave and consequently net radiation would decrease in 2/3 of the area in the south and would increase in 1/3 of the area in the north resulting in an even greater warming than currently predicted in the high latitudes. Thus, the regional effects of land cover change on climate would be non-linear. This land change projection suggests that the interactive biosphere should be included in global and regional circulation models to get more reliable projections.

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