Geophysical Research Abstracts
Vol. 13, EGU2011-1515, 2011
EGU General Assembly 2011

Uncertainty of climate and carbon cycle changes in North Eurasia due to uncertainty in values of terrestrial biota governing parameters

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Impact of uncertainty in values of two governing parameters on spread of climate and carbon cycle response to anthropogenic and natural forcing in North Eurasia is studied employing ensemble simulation with the A.M.Obukhov Institute of Atmospheric Physics, Russian Academy of Sciences (IAP RAS) climate model of intermediate complexity. Individual members within this ensemble were constructed by sampling two global parameters conditioning the dynamics of terrestrial carbon cycle. The first parameter is the Michaelis–Menten half saturation point for plant fertilisation by atmospheric CO_2. The second parameter controls soil respiration enhancement due to land use cultivation. The IAP RAS model is forced by reconstructed anthropogenic and natural climate forcings for the 16–20th centuries. For the 21st century, anthropogenic emissions of greenhouse gases (except CO_2 emissions due to land use) and sulphate aerosols are prescribed according to the Special Report on Emission Scenarios (SRES). Uncertainty ranges are calculated by using the Bayesian averaging which allows to suppress impact of non–realistic ensemble members on final statistics. It is obtained that, even for the small number of sampled governing parameters employed in this study, carbon cycle response is statistically indistinguishable between different SRES scenarios. In particular, during the 21st century the model–simulated primary production in Eurasia poleward of $50^o N$ (North Eurasia thereafter) increases from 6.0 ± 0.1 PgC/yr to 10.6 ± 0.5 PgC/yr and vegetation carbon stock in this region increases from 48 ± 1 PgC to 84 ± 4 PgC. Changes of soil carbon stock in North Eurasia are statistically insignificant. Carbon uptake by North Eurasian ecosystems increases from 0.08 ± 0.05 PgC/yr in the late 20th century to 0.6 ± 0.2 PgC/yr in the middle of the 21st century and then decreases reaching 0.4 ± 0.4 PgC/yr in the end of this century. However, drastic difference in anthropogenic emissions between different SRES scenarios leads to statistically significant difference in build up of carbon dioxide in the atmosphere and in rise surface air temperature. In particular, carbon dioxide atmospheric content under SRES scenario A2 (A1B, B1) in year 2100 reaches 773 ± 28 $ppmv$ (662 ± 24 $ppmv$, 534 ± 16 $ppmv$). The corresponding annual warming over the Eurasia poleward of $50^o N$ in the 21st century amounts 8.3 ± 0.3 K (6.7 ± 0.3 K, 5.4 ± 0.3 K). Respectively, precipitation in North Eurasia increases from 535 ± 4 mm/yr to 787 ± 12 mm/yr (741 ± 11 mm/yr, 690 ± 9 mm/yr).