Impacts of Climatic and Atmospheric Changes on the Terrestrial Carbon Cycle

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In this presentation, we report some key findings of the completed project entitled "Investigation on the mechanisms controlling the terrestrial carbon cycle and its optimized calculation" funded under the Key Global Change Program of the Chinese Ministry of Science and Technology. For the purpose of evaluating the impacts of climate change, CO_2 fertilization and nitrogen deposition on the carbon cycle of different regions of the world, we processed historical satellite data from the Advanced Very High Resolution Radiometer (AVHRR) and the Moderate Resolution Imaging Spectrometer (MODIS) to generate a global leaf area index (LAI) time series from 1981 to 2012 at 8 km resolution. This LAI series is used as input to an ecosystem model named Boreal Ecosystem Productivity Simulator (BEPS) to estimate the gross primary productivity (GPP) and net ecosystem productivity (NEP) with additional inputs of historical climate, nitrogen deposition and CO_2 data. Modelled annual NEP compares well with the "residual land sink" estimates (excluding disturbance effects) from 1981 to 2012 by the Global Carbon Budget Office (r^2=0.44, $p<0.01$, RMSE<0.4 Pg C/y). Through model experiments, we found that climate change had a negative effect on global GPP and NEP, while CO_2 fertilization was the major driver for the terrestrial carbon sink during the simulation period. The LAI series shows a general increasing trend from 1981 to 2000 and then a decreasing trend after 2000, and the overall LAI change had a small but positive accumulated effect on the land sink. The effect of nitrogen deposition was positive but small. The sensitivity of the global GPP is found to be about 19% per 100 ppm increase in CO_2, which is slightly smaller than the average of CMIP5 models but considerably larger than the average of the results from free air CO_2 enrichment experiments (FACE). The regional differences in the effects of climatic change and nitrogen deposition are large and will be discussed in the presentation.

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Kenji Satake is a professor of Earthquake Research Institute, the University of Tokyo. His research interest is giant earthquakes and tsunamis in the world, for which he uses geophysical, geological or historical approaches. For the geophysical approach, he developed a tsunami waveform inversion method which combines instrumentally recorded tsunami waveforms and computer simulation to estimate the tsunami generation and propagation processes. For the geological and historical approaches, he uses sand deposit brought by past tsunamis or historical literature describing damage to infer the earthquakes and tsunamis in the past, such as the 869 Jogan earthquake, a predecessor of the 2011 Tohoku earthquake. He was elected as a fellow of American Geophysical Union in 2010. He served as a chair of IUGG (International Union of Geodesy and Geophysics) Tsunami Commission, a bureau member of IUGG, and president of AOGS from 2012 to 2014. Currently, he is a vice president of IASPEI (International Association of Seismology and Physics of the Earth's Interior) and Editor-in-Chief of Geoscience Research Letters, the official journal of AOGS. He is also a vice president of Japanese Society for Active Fault Studies, and chair of governmental committee of long-term forecast under the Earthquake Research Committee.