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Response to extreme climate event over Europe by terrestrial ecosystem: experiments in repeated 2003 year's climate and in future climate with reduced monthly variability

T. Kato, N. Viovy, P. Ciais, and N. Vuichard
LSCE, CEA-CNRS-UVSQ, Gif-sur-Yvette, France (tomomichi.kato@lsce.ipsl.fr)

The climate change greatly influences on the terrestrial carbon cycle, and the spatial and temporal pattern of those influences would provide us the understanding of the uncertainties in climate-ecosystem interaction. Especially, heat wave in 2003 would have given great impact on European ecosystem production, as Ciais et al. (2005) suggested that primary productivity was largely reduced by climatic change over west Europe in 2003. Here we use the terrestrial carbon cycle model ORCHIDEE (Krinner et al., 1999), which models carbon, water and energy fluxes, soil carbon and soil water pools, to understand how the ecosystem responds to extreme climate event over Europe.

The ERAinterim/WATCH-based climate forcings are used for spin-up and main simulations. In repeated 2003 year's climate experiment (Exp 1), first, we spin-up the ORCHIDEE for 1000 years to get the equilibrium status in ecosystem productions and carbon storages by repeatedly using the 30 year climatology forcings from 1901-1930. Second, we run the ORCHIDEE from 1901 to 1989 under a transient condition, and then under a variety of the conditions from 1990-2010: Control, 3 continuous 2003 climate forcings (2 x 2003 climate forcing, 3 x 2003, 4 x 2003), and 4 periodical 2003 climate forcings (2003 climate forcings were inserted every 2 years, every 3 years, every 4 years, and every 5 years). In amplified future climate (Exp 2), we run the ORCHIDEE from 1901 to 2100 forced by ERAinterim/WATCH combined climate as control, and then run by the climate data with reduced monthly variability. Vegetation dynamics and land use change are not performed. Spatial resolution is 0.5 x 0.5 degree.

In exp 1, preliminary analysis shows that, while GPP grows gradually in control run, GPPs decrease in 2003 climate year largely in all the runs. However, GPPs recover to the same level of Control in normal climate year. It suggests that there is no effect on photosynthesis process by potentially reduced leaf biomass due to heat wave in 2003 climate years, and the litter input into soil layer is kept as same as Control for whole period. Living biomasses decrease in 2003 climate year largely as similar as GPPs, and are kept smaller to the end of 2010 than Control. 4x2003 and every 2 years treatments show lowest living biomasses in 2010 and suggest that continuous or frequent 2003 climate years reduce living biomasses significantly. Finally, Soil+litter Carbon content decreases in central-eastern Europe, and increases in northern Europe in the next year of last 2003 year climate: 2008, 2008, 2006, and 2005 for every 2, 3, 4, 5 years of 2003 climate treatment. 4x2003 treatment shows similar tendency, but 2x2003 and 3x2003 do not. In exp 2, we will present the result about how the extreme condition will alter the ecosystem's behaviour compared to the Control future climate run.