USING A LAND SURFACE MODEL TO SIMULATE NET PRIMARY PRODUCTIVITY IN CHINA COMPARING WITH THE PROCESS MODEL DERIVED BY REMOTE SENSING

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Abstract: In this study, we analyze Net Primary Productivity from 51-year (1950-2000) offline simulations using an Australian land-surface model CABLE (CSIRO Atmosphere Biosphere Land Exchange). The analysis of the land surface model performance in China has highlighted the potential to simulate carbon cycle in an integrated framework.

CABLE is the terrestrial model which belongs to the Australian Community Climate and Earth System Simulator (ACCESS). The model's carbon-cycle component, adapted from the simple carbon pool model developed by Dickinson et al. (1998), simulates terrestrial carbon processes. The model-simulated annual plant net primary productivity (NPP), which is determined from the annual carbon assimilation corrected for respiratory losses, is further partitioned into leaves, roots and wood.

The NCC data developed by Ngo-Duc et al. (2005) was used as the forcing data in the study. NCEP/NCAR reanalysis was combined and interpolated with observed precipitation, temperature and surface radiation datasets, referring to it as NCC forcing data. In this offline experiment, we used 1949 forcing data for a 10-year spin-up and then ran the model continuously for 51 years from 1950 to 2000.

The model annual NPP climatology with the estimated 2001 annual NPP from Feng et al. (2007) what was derived from a process model driven by remote sensing in deriving China NPP at 1-km resolution. The CABLE results are highly comparable with those, with annual NPP decreasing from southeast to northwest. Southern China has high annual NPP of more than 1,200 gC m−2 year−1, while the Tibetan Plateau, north and northwest regions show very low annual NPP. The low NPP was contributed in the Tibetan Plateau to low temperature and the short plant growing season, and the low NPP in the northwest region to the small amount of annual precipitation (Xiao et al. 2006; Cao et al. 2003). Such fundamental features have been well captured in the CABLE simulations.

The model-simulated NPP variability was also compared with a number of published results in China. CABLE is skillful in reproducing NPP interannual variability in the region as shown in Yang et al. (2005), who used an improved biosphere model with remote sensing data, studied NPP variations over northeast China, with similar year-to-year fluctuations for the period of 1982 to 2000 and a sharp reduction in late nineties in both datasets. Nevertheless, the satellite-based approach showed that NPP had an upward trend in northeast China for the period of 1981 to 2000, but the model shows a significant downward trend starting around early nineties. This discrepancy can be caused by a number of reasons. The atmospheric CO2 concentration is fixed at 350 ppm in the CABLE offline experiment but observed CO2 concentration shows a significant upward trend. Using a prefixed CO2 concentration in the model experiment appears to be the chief reason for it failing to simulate an upward NPP trend. We have further analyzed the model-simulated autotrophic and heterotrophic respirations and their connections to changes in climate forcing. The analysis shows high correlations between model-simulated autotrophic respiration and surface air temperature in the forcing data. Thus, largely due to the surface warming, autotrophic respiration is significantly increased in the 51-year model period. Moreover, the rainfall declining in the late nineties leads to a reduction in soil heterotrophic respiration. But the net carbon respiration from canopy and soil is increased, due to the fact that the increase in autotrophic respiration significantly exceeds the decreases in soil heterotrophic respiration. Such an increase in surface respiration is another importance factor in understanding why the model failed to simulate the upward NPP trend.

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