Modelling 14 years of remote sensing based net primary productivity for China: patterns, trends and hot spot phenomena

C. Eisfelder, C. Kuenzer

German Aerospace Center (DLR), Earth Observation Center (EOC), German Remote Sensing Data Center (DFD), 82234 Wessling, Germany

Motivation

Net primary productivity (NPP) is a key environmental indicator and provides information about vegetation productivity and carbon sequestration. Monitoring of NPP is of special interest in regions that are quickly changing such as China, a country that shows immense and rapid development. Economic growth and migration trends put pressure on ecological resources. Observation of NPP dynamics helps to understand possible impacts of both meteorological and human impact on the environment.

Methods

NPP time-series with 1 km spatial resolution for entire China for 14 years (1999–2012) were modelled using the Biosphere Energy Transfer Hydrology (BETHY/DLR) model, which is driven by remote sensing based and meteorological data. The usage of remote sensing derived leaf area index (LAI) as one major input parameter allows not only analysis of climate effects but also observation of human induced, local, and temporary effects on vegetation productivity.
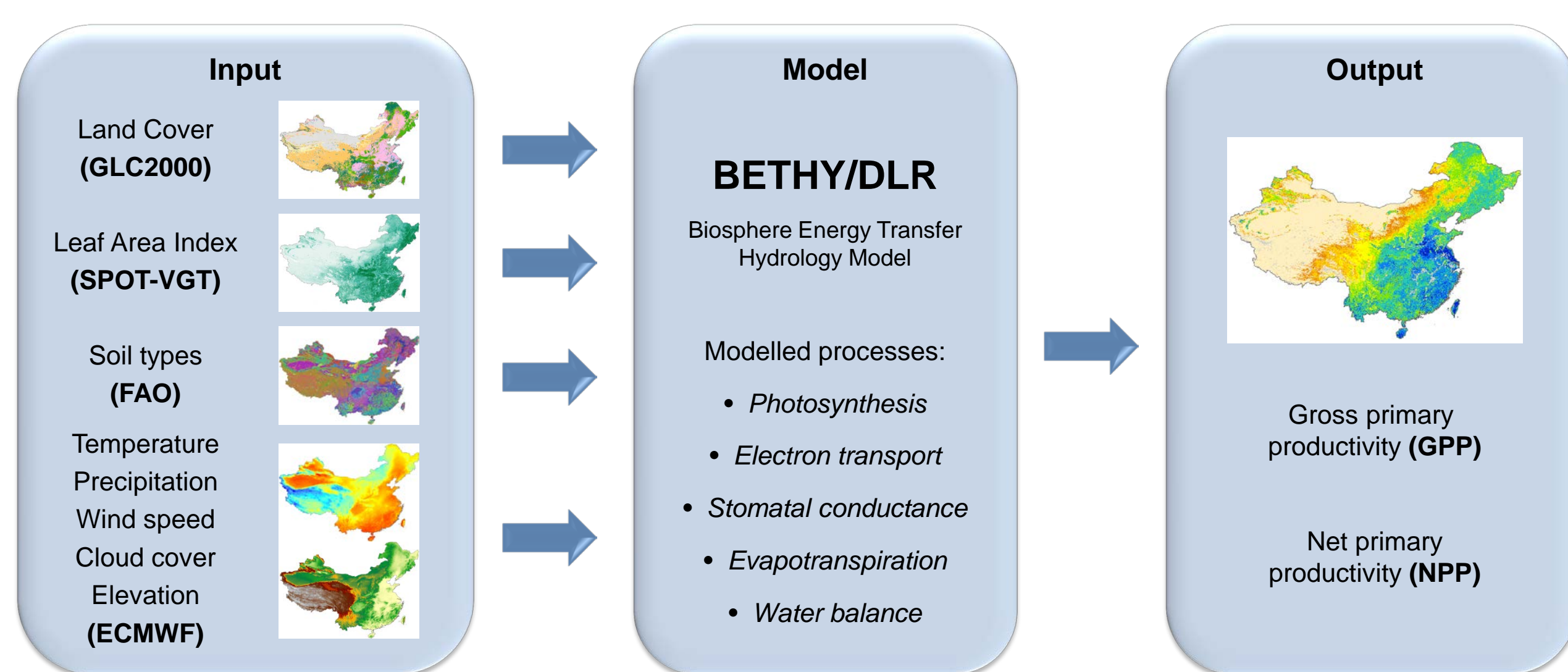

Figure 1. Scheme of BETHY/DLR model.

Spatial and temporal NPP patterns

Annual and monthly NPP patterns allow for analysing spatio-temporal NPP distributions. Monthly data provide information about temporal patterns of vegetation productivity for different regions and different vegetation types. Analyses of interannual NPP variability revealed considerable differences in the development of annual vegetation productivity within the analysed time period for different provinces.
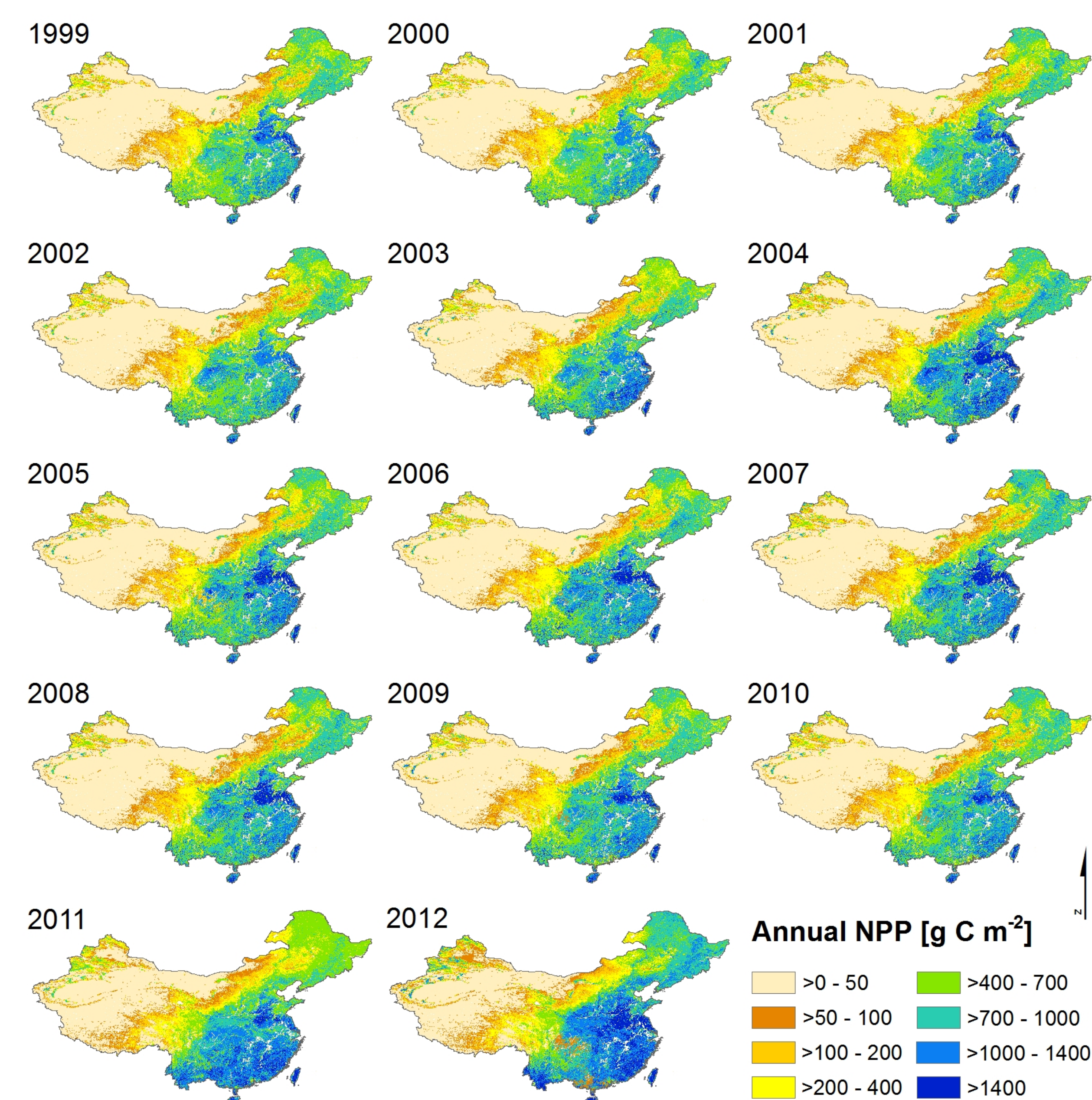

Annual NPP [g C m^{-2}]

>0 - 50 | >400 - 700
>50 - 100 | >700 - 1000
>100 - 200 | >1000 - 1400
>200 - 400 | >1400

Figure 2. Annual NPP for China for the years 1999–2012 calculated with BETHY/DLR.
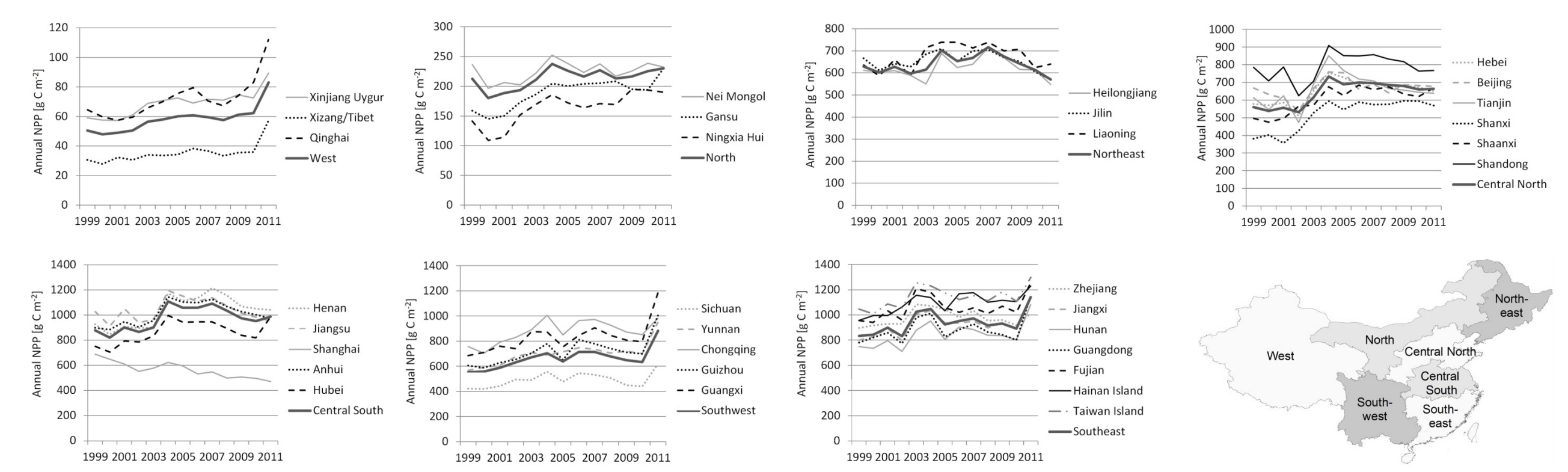

Figure 3. Interannual NPP variation for various regions in China. The thick solid lines show mean annual NPP for each region. The other lines show mean annual NPP for individual provinces. The figure in the lower right shows the location of the regions within China.
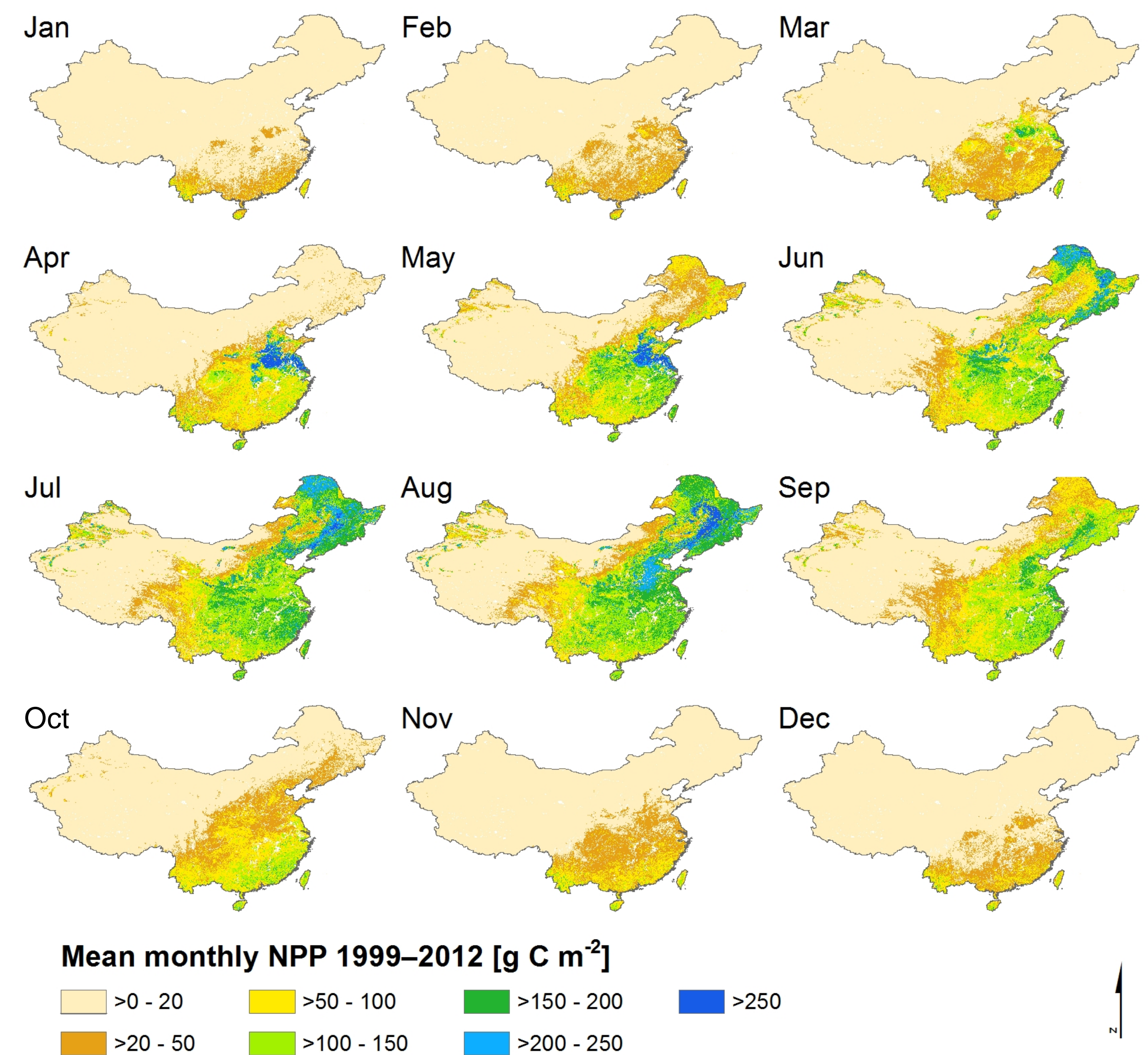

Mean monthly NPP 1999–2012 [g C m^{-2}]

>0 - 20 | >50 - 100 | >150 - 200 | >250
>20 - 50 | >100 - 150 | >200 - 250

Figure 4. Mean monthly NPP for China for the time period 1999–2012.

Hot Spot phenomena

In Shanghai province, we observe a decrease in NPP, which shows the strong influence of one of Asia's fastest growing megacities on the environment. For a region affected by forest disturbances in Northeast China, results show that NPP time-series are suitable for identification and monitoring of forest disturbance and regrowth.
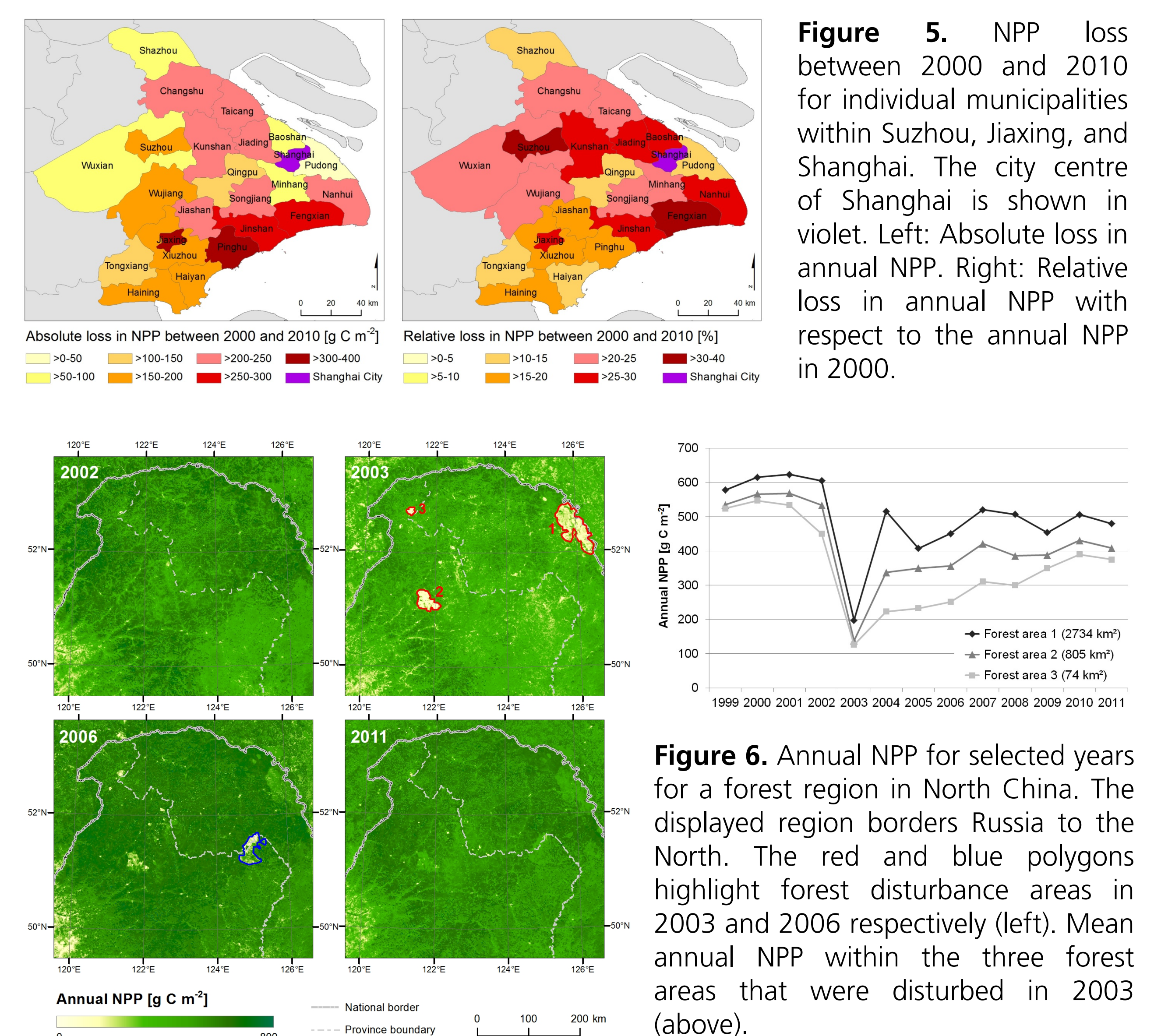

Figure 5. NPP loss between 2000 and 2010 for individual municipalities within Suzhou, Jiaxing, and Shanghai. The city centre of Shanghai is shown in violet. Left: Absolute loss in annual NPP. Right: Relative loss in annual NPP with respect to the annual NPP in 2000.

Figure 6. Annual NPP for selected years for a forest region in North China. The displayed region borders Russia to the North. The red and blue polygons highlight forest disturbance areas in 2003 and 2006 respectively (left). Mean annual NPP within the three forest areas that were disturbed in 2003 (above).

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