Modelling the effects of regional environmental change on key ecosystem services in Sweden – *Projected changes in potential natural vegetation distribution, NPP and carbon Storage*

Deniz Koca[1], Ben Smith[1], Martin Sykes[1]

[1] Center for Geoiosphere Studies, Dept. of Physical Geography & Ecosystems Analysis, Lund University, Sölvegatan 12, Lund Sweden

Background

Projected climate change constitutes an additional pressure to most of the natural ecosystems, which have already been faced to many other human caused threats such as increased population and pollution, unsustainable resource use and management practices, and loss of native biodiversity etc.

Terrestrial ecosystems, particularly forests, provide a variety of crucial products and services to humankind. They supply our demand for timber, fuel, food etc.; play a crucial role in carbon and nutrient cycling, soil and water quality, and conservation of biodiversity; and provide opportunities for recreational and cultural activities. Possible alterations in forest ecosystems due to climate change are likely to affect such goods and services, for instance, their crucial role in global carbon cycle and climate system. Projected changes in temperature and precipitation combined with higher levels of CO_2 have the tendency to alter the net primary productivity (NPP) of these ecosystems (through changes in plant physiological processes and in vegetation composition and structure), which may in turn change their capacity to sequester carbon and ultimately the global carbon budget. Thus, it is essential to study the possible impacts of climate change on forest ecosystems and the goods/services they provide, if we want to develop adaptive strategies to handle with the potential negative outcomes of the changing climate.

LPJ-GUESS Ecosystem Modelling Framework

The generic ecosystem-modelling framework LPJ-GUESS (Smith *et al.*, 2001) incorporates two well-established and broadly validated ecosystem models, LPJ-DGVM (Sitch *et al.,* 2003) and GUESS (Figure 1). Both models incorporate state-of-the-art mechanistic representations of plant physiology, canopy-atmosphere exchange of CO_2 and H_2O, soil hydrology, soil organic matter decomposition and population dynamics. The main difference between LPJ-DGVM ("population") mode and GUESS ("cohort") mode is in the degree of abstraction of vegetation dynamic processes, i.e. establishment, mortality and competition for light and water between plant functional types (PFTs) or species. Population mode is computationally efficient and well-suited to spatially-extensive analyses using generically-defined PFTs (e.g. boreal needleleaved evergreen; temperate summergreen), whereas cohort mode, though slower to run, can be applied at finer spatial scales and can distinguish more closely-defined PFTs or individual species (e.g. different species of trees in mixed forests). The existence of alternative vegetation modes is a unique feature that makes LPJ-GUESS an ideal tool for studies focusing on a range of ecosystem properties at various levels of spatial, temporal and biological detail.

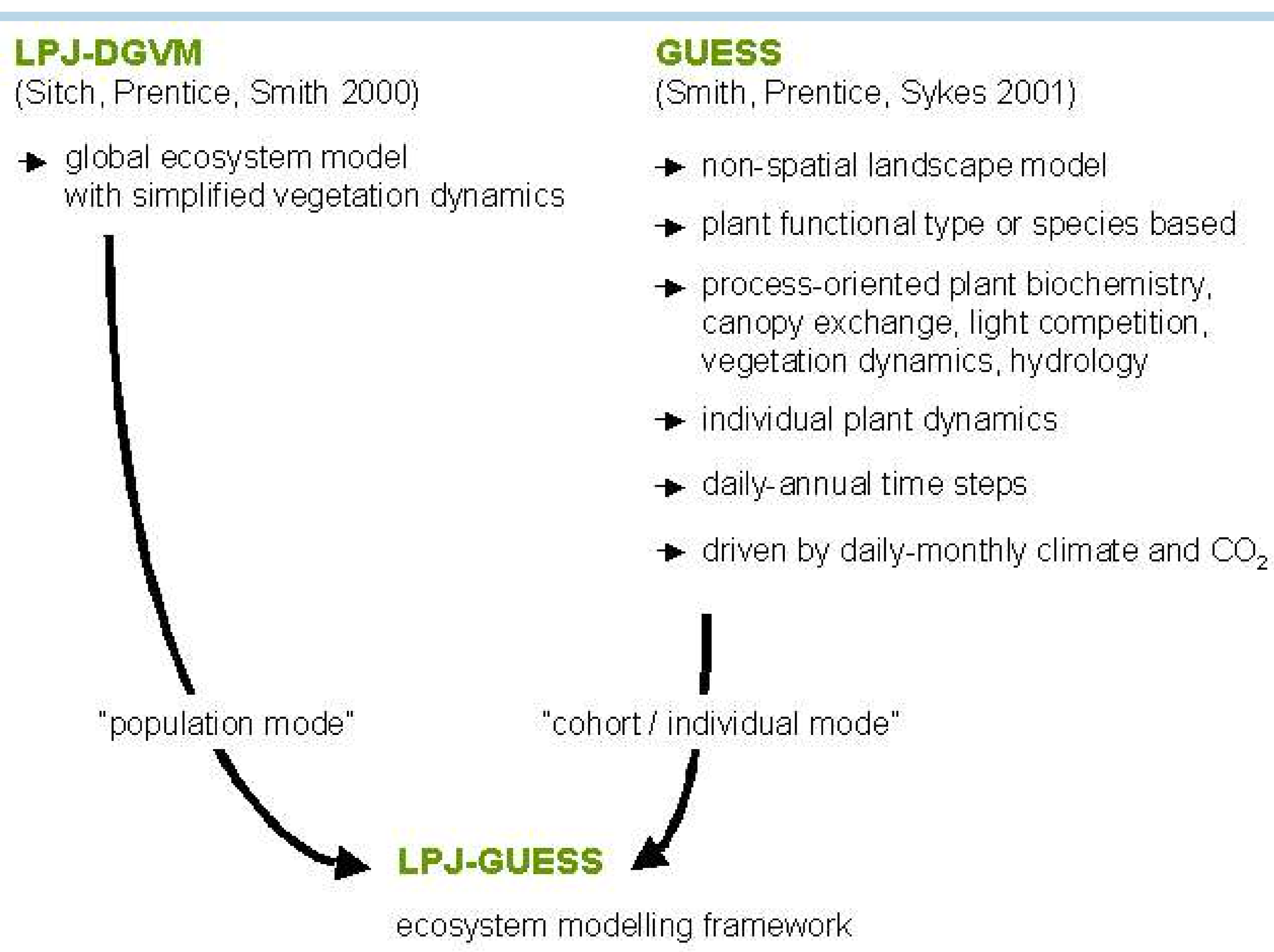

Figure 1 LPJ-GUESS generic ecosystem-modelling framework

Preliminary Results – Projected changes in potential natural vegetation distribution, NPP and carbon storage

Simulations performed with LPJ-GUESS together with SWECLIM RCM outputs suggest that possible shifts in climatic zones under different scenarios may change regional patterns of potential natural vegetation distribution on species level (Figure 2). Moreover, in relation to changing vegetation distribution, levels of net primary production (Figure 3) and carbon fluxes (Figure 4) of Swedish forest ecosystems are simulated and compared for the late 21st century with the present day.

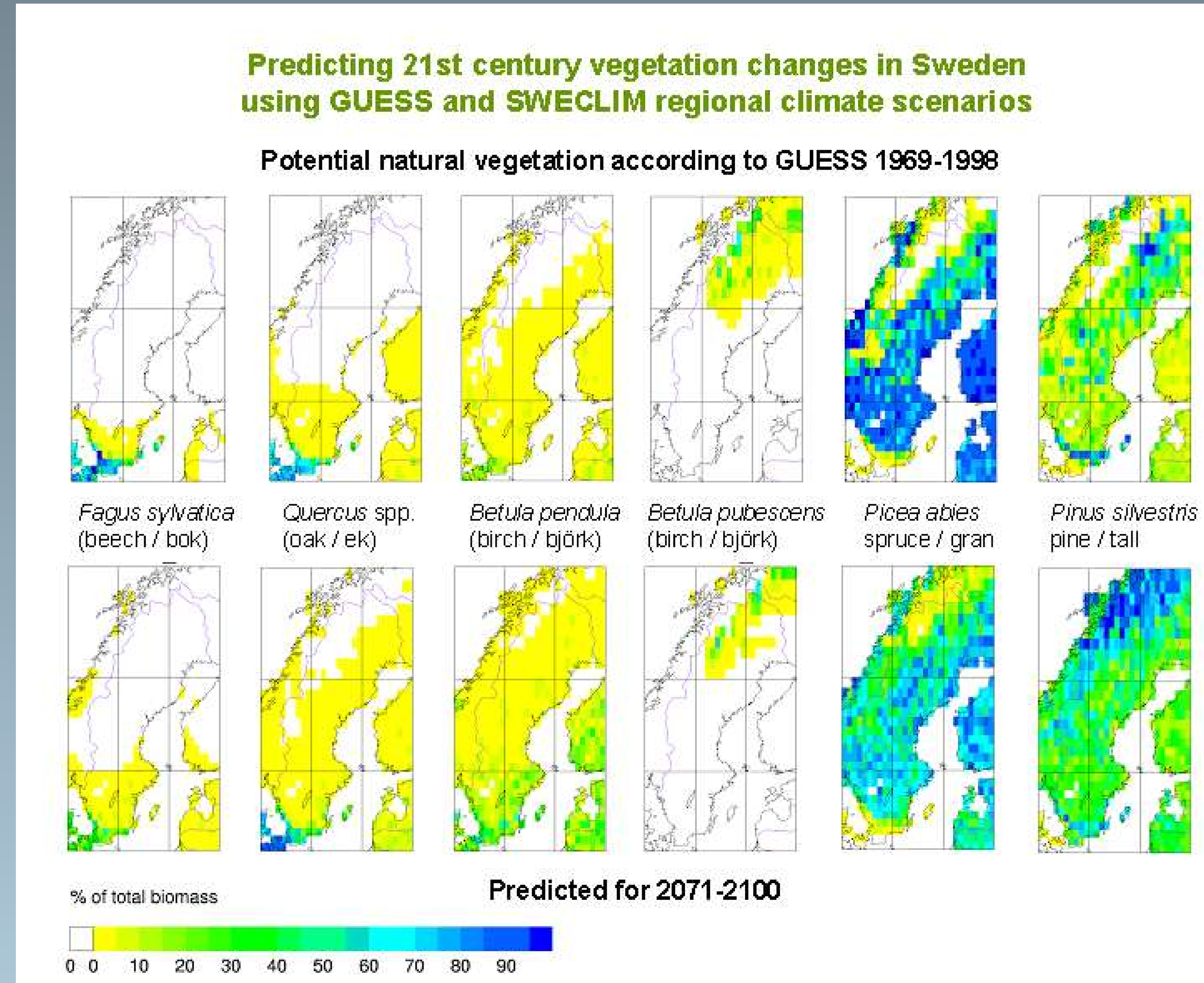

Figure 2 Possible changes under SWECLIM's regional climate scenario built on SRES A2 scenario of IPCC and based on HadCM3/AM3.

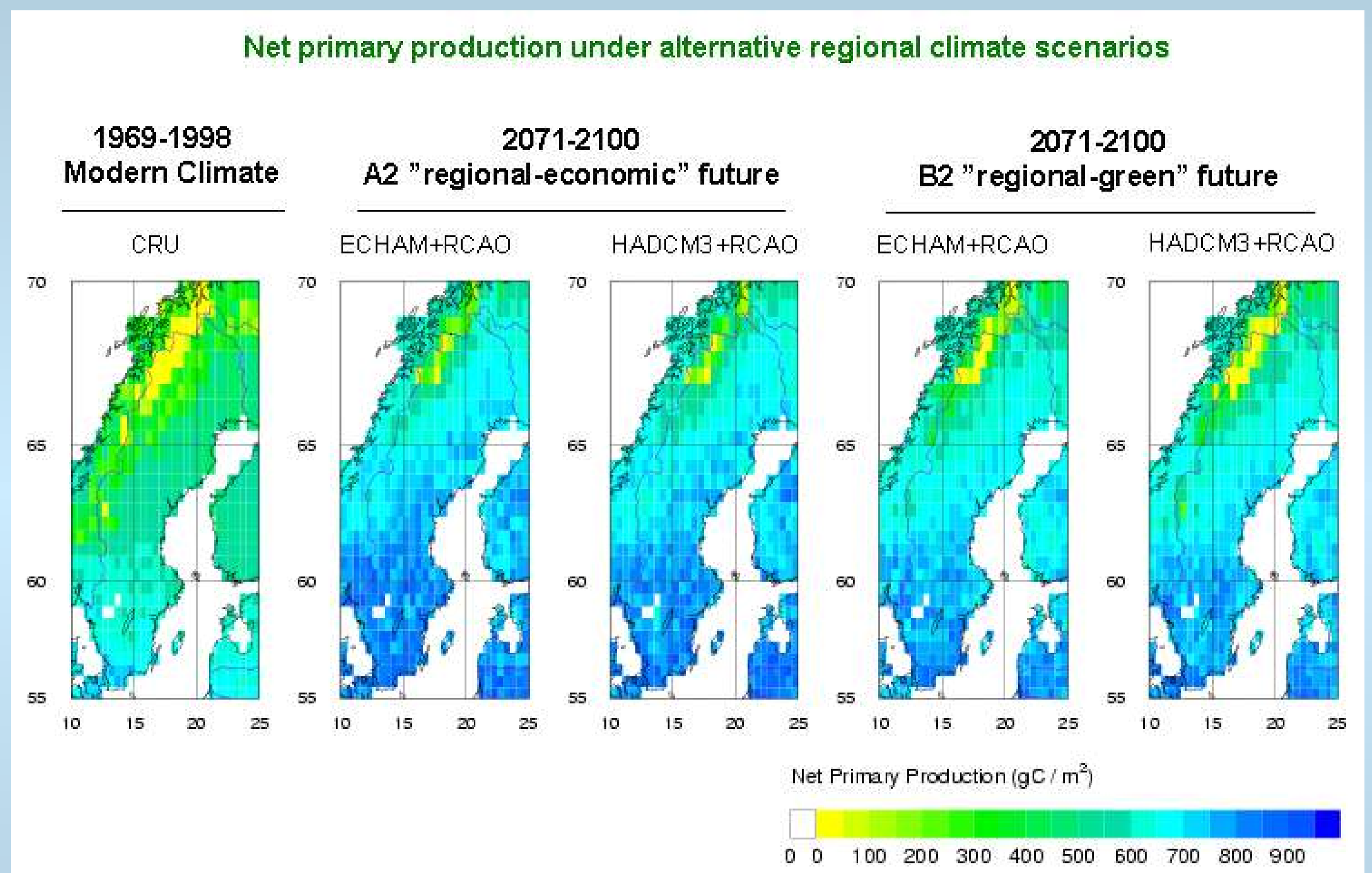

Figure 3 First map from left shows the present situation according to GUESS and CRU historical climate data. Following next four maps illustrates the possible changes under SWECLIM's two different regional climate scenarios built on SRES A2 and B2 scenarios of IPCC and based on HadCM3/AM3 and ECHAM4/OPYC3.

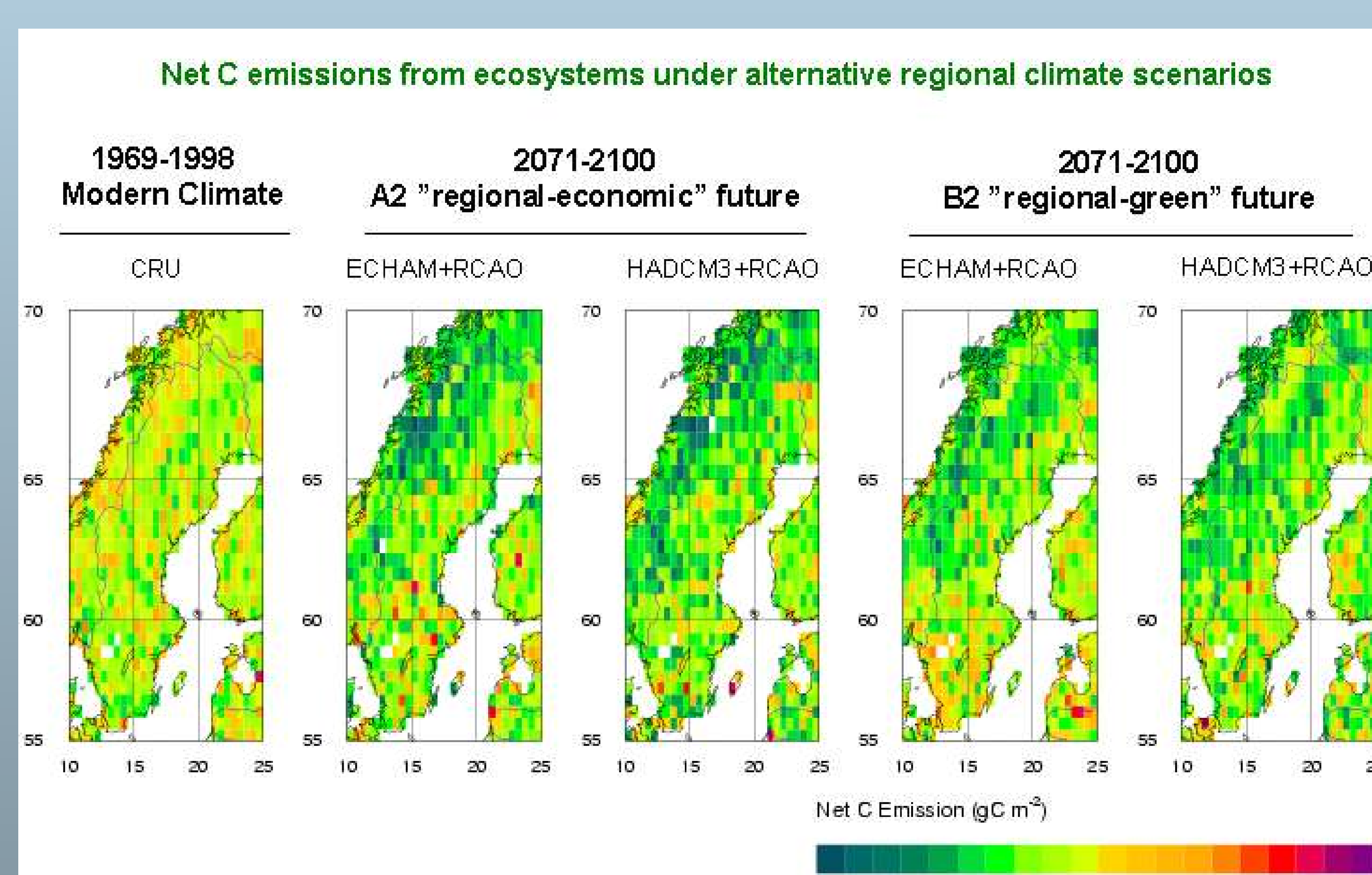

Figure 4 First map from left shows the present situation according to GUESS and CRU historical climate data. Following next four maps illustrates the possible changes under SWECLIM's two different regional climate scenarios built on SRES A2 and B2 scenarios of IPCC and based on HadCM3/AM3 and ECHAM4/OPYC3.

References

Sitch S, Smith B, Prentice IC, *et al.* (2003) Evaluation of ecosystem dynamics, plant geography and terrestrial carbon cycling in the LPJ Dynamic Global Vegetation Model. *Global Change Biology,* **9,** 161-185.

Smith B, Prentice C, Sykes M (2001) Representation of vegetation dynamics in the modelling of terrestrial ecosystems: comparing two contrasting approaches within European climate space. *Global Ecology & Biogeography,* **10,** 621-637.