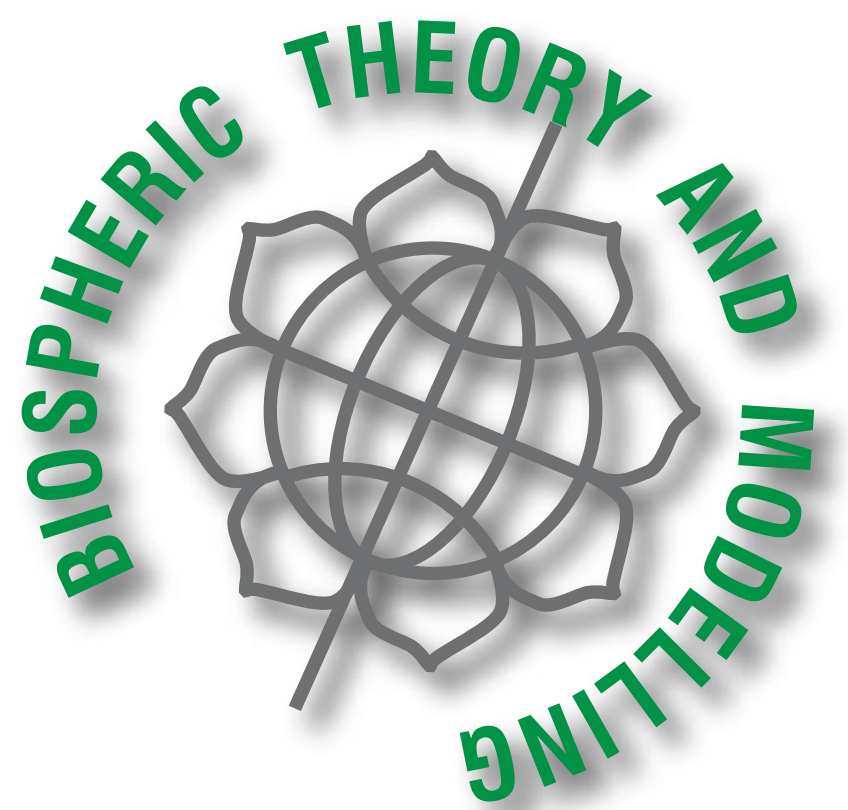


Effects of recent climate and past biogeography on global patterns of phytodiversity - a preliminary report



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There is an ongoing dispute about the effects of recent climate and past biogeography on global patterns of functional phytodiversity. The global gradient in biodiversity (Fig. 1) can still be referred to as the 'major, unexplained pattern of natural history' (Ricklefs in Lewin, R. 1989, p. 527). The most prominent hypotheses dealing with the origin of global diversity gradients can be divided into two major groups. (1) Processes underpinning patterns of biodiversity have been treated as a product of equilibrium states with recent climate, e.g. of an elevated net primary productivity of vegetation. (2) On the other hand they have been attributed to past geographical settings and climates, like long term ecological stability and past speciation, dispersion, persistence and extinction.

In order to approach the role of diversity for biosphere functioning, it is relevant to understand its dynamics on large spatial and temporal scales. Our research addresses the question to what extent climatic conditions and variability shape patterns of functional phytodiversity.

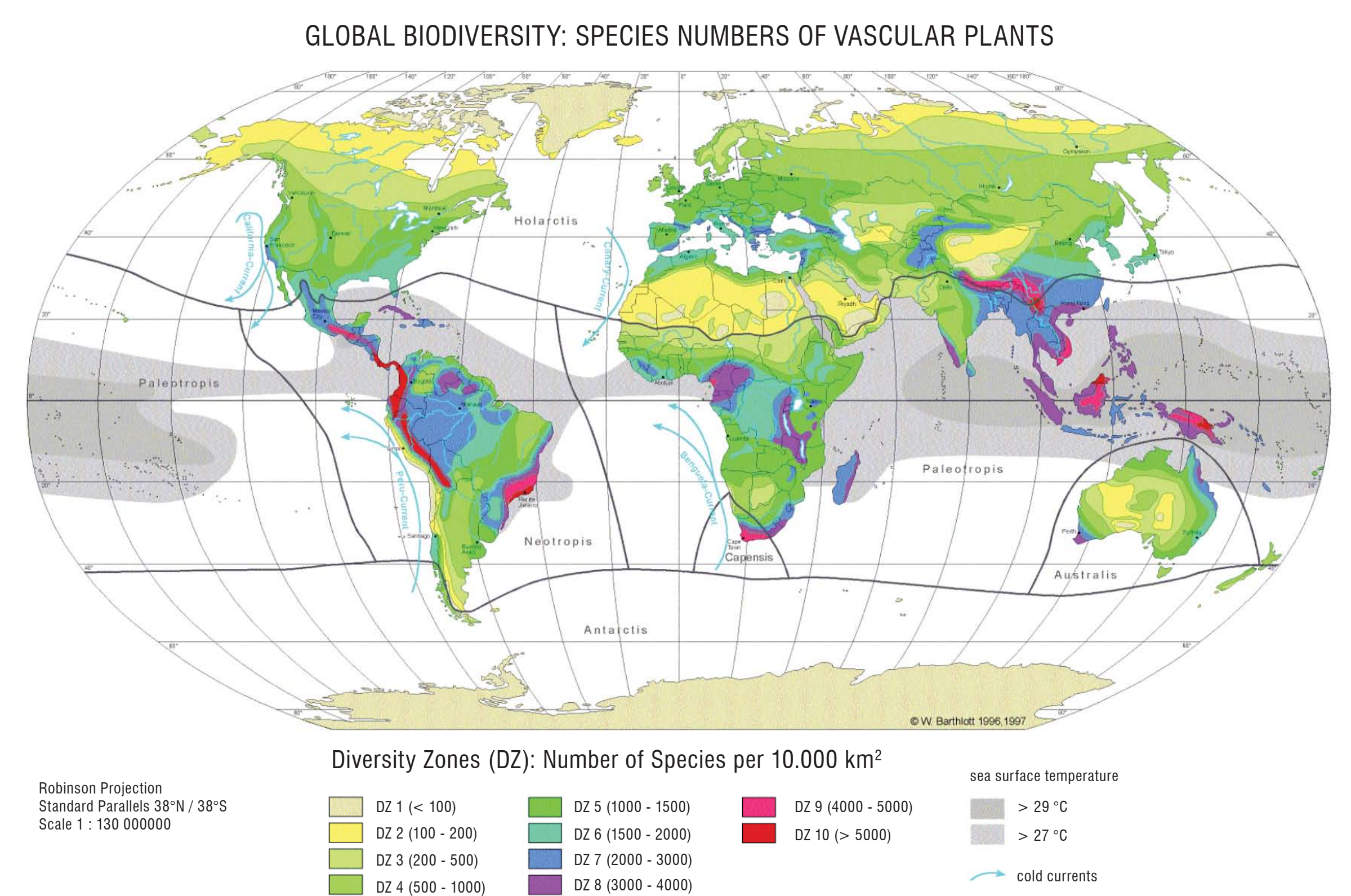


Fig. 1 Map of global biodiversity of vascular plants based on observational data. Published by Bathlott *et al.* (1999), available at the world wide web: <http://www.botanik.uni-bonn.de/system/biomaps.htm>.

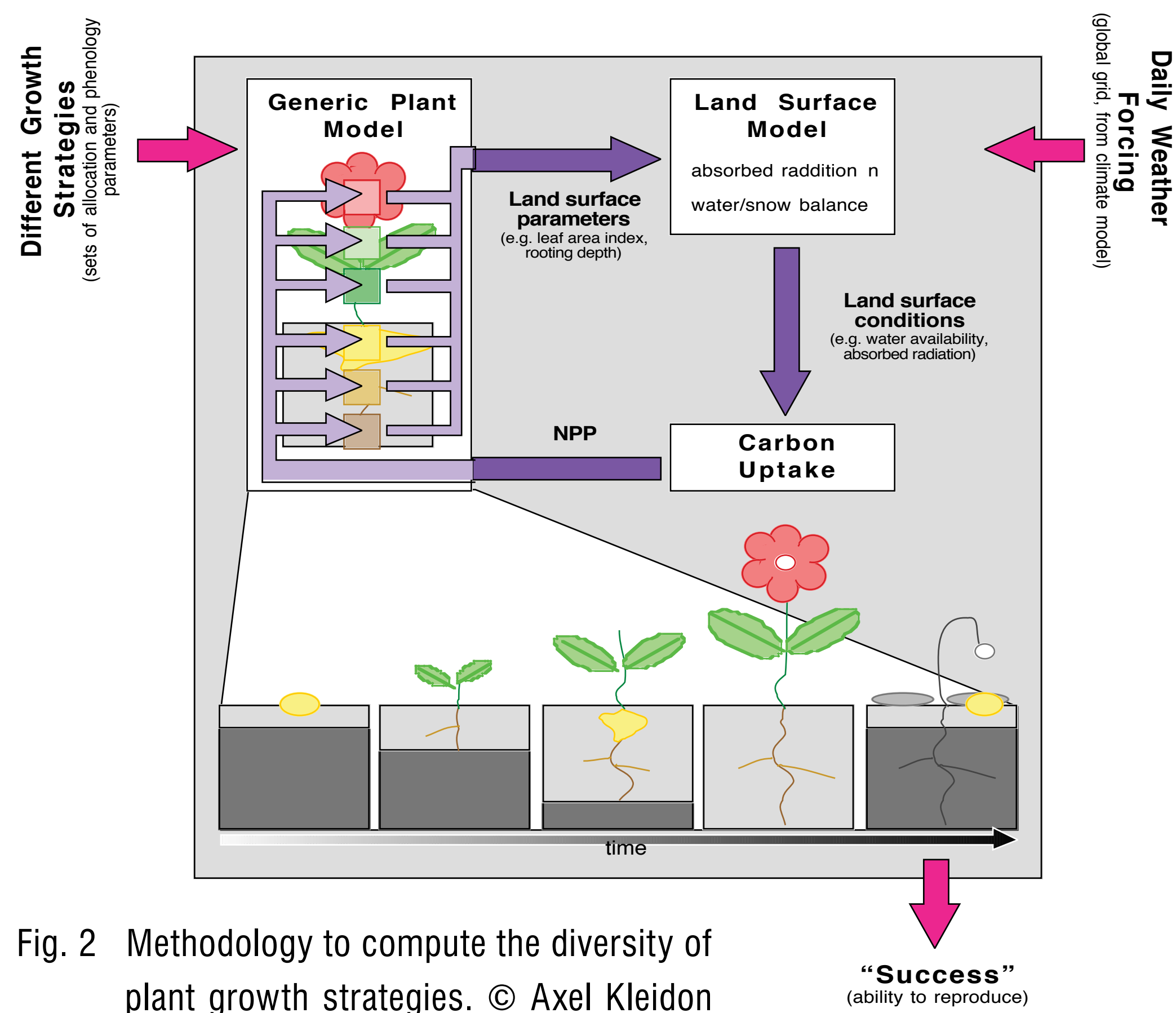


Fig. 2 Methodology to compute the diversity of plant growth strategies. © Axel Kleidon

METHOD

Kleidon & Mooney (2000) applied a mechanistic model to global biodiversity for recent climate conditions: Different plant growth strategies are represented by different sets of model parameters related to allocation and phenology (Fig. 2). The success of each plant growth strategy is determined by its reproductive success that is the capability to reproduce itself during its lifetime under given atmospheric forcing (derived from a climate model). In order to obtain a global map of plant trait diversity, a Monte Carlo simulation was conducted on a global grid in which a wide range of different plant growth strategies was tested for success. In that way major patterns of diversity are captured well such as the majority of biodiversity hotspots as well as the latitudinal diversity gradient. Similar results are obtained using data from the ECMWF era40 Reanalysis (Fig. 3) that will be used to validate the model with available observational data (Fig. 1).

NEXT STEPS

Up to now the model of Kleidon & Mooney (2000) does not consider the effect of past climate and biogeography on recent diversity patterns - a task our future research will address. In order to allow for simulations under climatic changes the model should be extended to account for plant migration. Thus, the next steps will focus on the following questions:

- Is the modelling approach of Kleidon and Mooney (2000) capable to reproduce past biogeographical settings, such as Eocene (56 - 34 Ma) biodiversity patterns (Fig. 4)?
- Can the model be used to reproduce vegetation types resulting from climates outside the present and observed envelope, e.g. non-analog vegetation types of the mid-Holocene (Williams *et al.* 2001)?
- Does the consideration of plant dispersal allow for dynamic simulations, e.g. the development of scenarios under future and rapid climate change?

Literature:

- Barthlott, W., Biedinger, N., Braun, G., Feig, F., Kier, G., & Mutke, J. (1999) *Acta Botanica Fennica* 162: 103-110.
- Kleidon, A. & Mooney, H.A. (2000) *Global Change Biology* 6: 507-523.
- Lewin, R. (1989) *Science* 244: 527-528.
- Utescher, T. & Mosbrugger, V. (2007) *Palaeogeography, Palaeoclimatology, Palaeoecology* 247: 243-271.
- Williams, J.W., Shuman, B.N., & Webb, T. (2001) *Ecology* 82: 3346-3362.

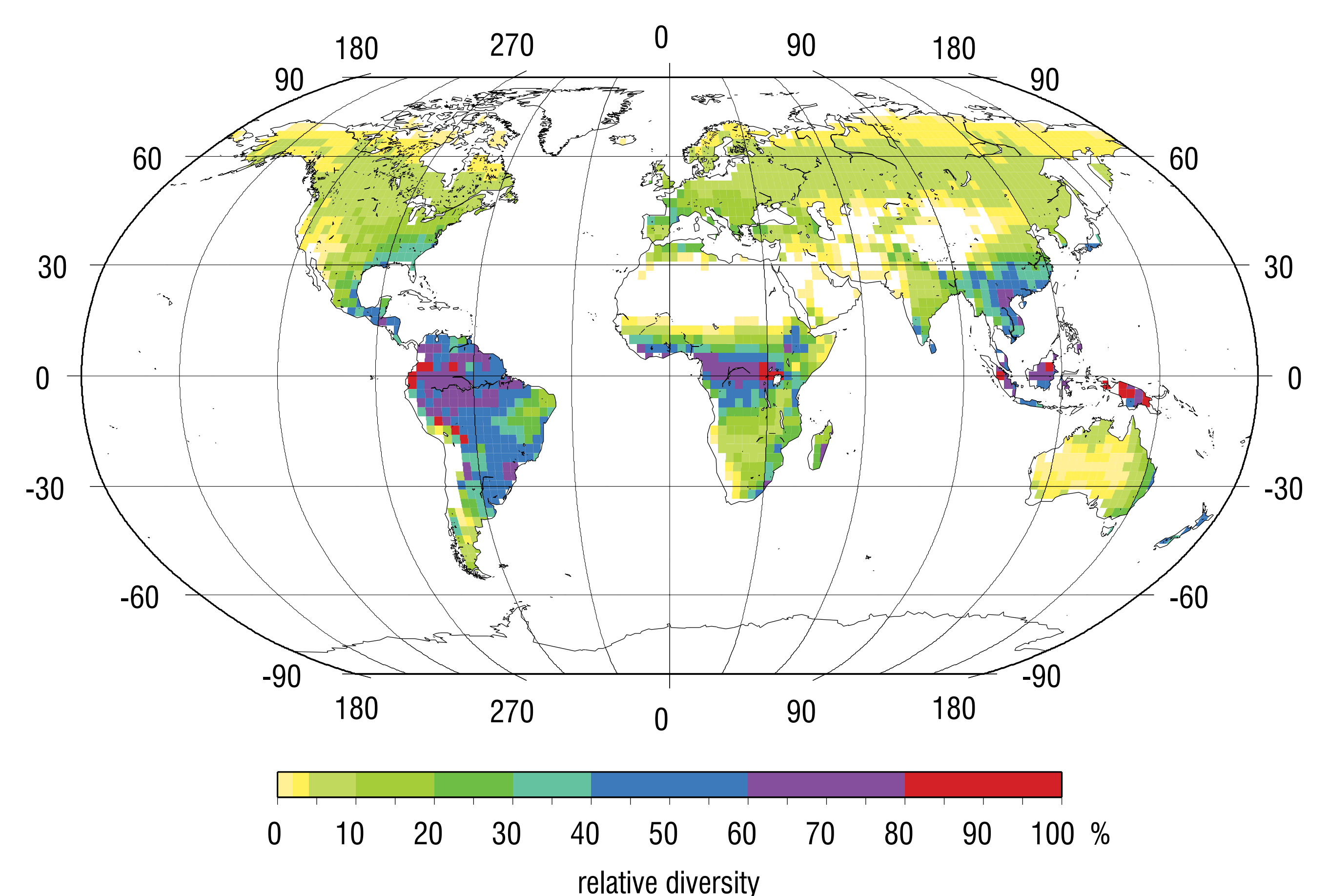


Fig. 3 Model results obtained using data from the ECMWF era40 Reanalysis (http://data.ecmwf.int/data/d/era40_daily). The map shows the simulated distribution of species diversity. The value of 'relative diversity' is the percentage of the maximum diversity values simulated.

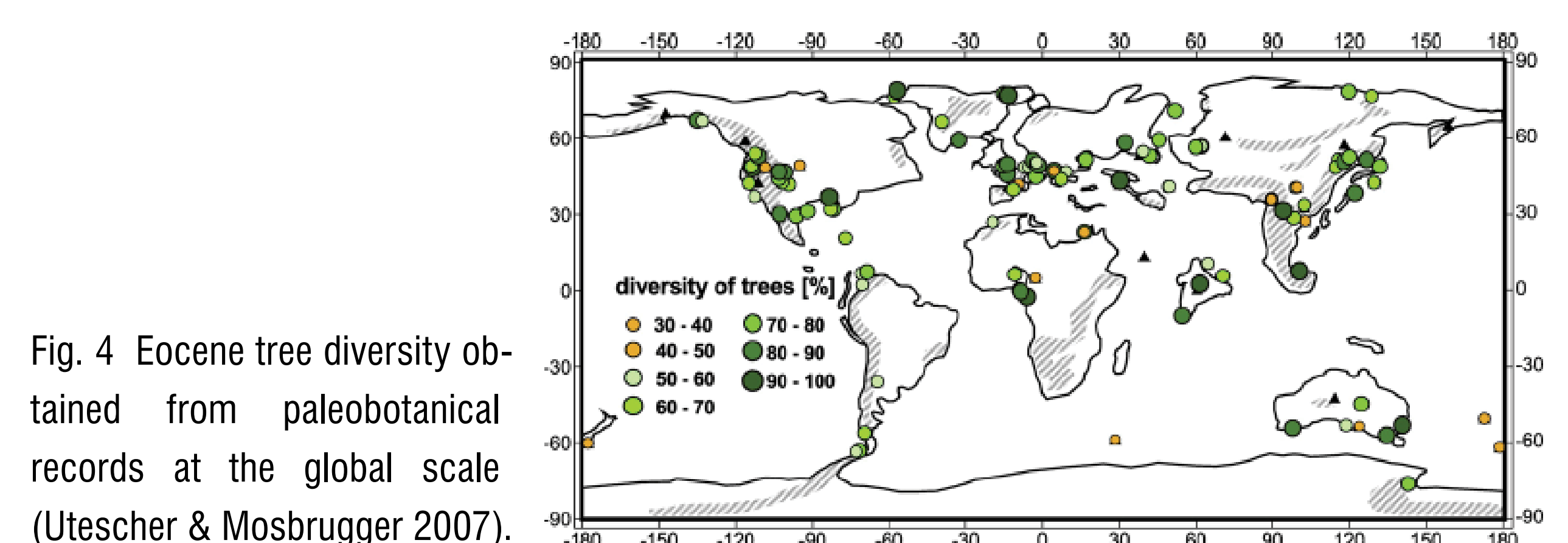


Fig. 4 Eocene tree diversity obtained from paleobotanical records at the global scale (Utescher & Mosbrugger 2007).