GINKGO
Palaeovegetation Workshop

June 3-5, 2014, Frankfurt

Organized by

Senckenberg Research Institute and Museum
Biodiversity and Climate Research Centre Frankfurt (BiK-F)
Max Planck Institute for Meteorology
GINKGO network for climate and global ecosystem modelling

www.ginkgo-biosphere.net

Organization

Scope
Terrestrial biosphere and climate affect each other. Plants need sunlight, warmth and rain, the vegetation, in turn, changes radiation and heat fluxes between soil and atmosphere as well as evaporation and water storage in the soil. How does this interaction differ between current interglacial climate, glacial climate and pre-Quaternary climate states? How do plant traits change with time? How have dynamic global vegetation models to be adapted to address palaeo climate and vegetation dynamics? Do we need to equip our models with special palaeo plant functional types?

Format
Presentations and plenary discussions. Every speaker has 30 minutes, including discussion, and should speak between 10 and 20 minutes (speaker's choice).

Venue
Day 1: *Senckenberg Museum for Natural History, Senckenberganlage 25*
25 minutes walk from main station. Or take tube line U4 to Bockenheimer Warte (2 stations), leave tube station via exit Senckenberg (back in the direction from which the tube came) and follow the dinosaurs. Enter the museum through the main entrance and walk straight ahead (please identify yourself as participant of GINKGO workshop, organized by Hickler/Mosbrugger). After descending the stairs into the dinosaur hall turn to your right twice and then enter the 'Meriansaal' through the concealed door to your left. If locked, call Thomas Hickler 0177-7993359.

Day 2 and 3: *Biodiversity and Climate Research Centre (BiK-F), Georg-Voigt-Straße 16*
200 m south-west of Senckenberg museum. Lecture hall Wallace, ground floor, turn left after entering through the main entrance.

Local contact
Judit Berg
Biodiversity and Climate Research Centre (BiK-F), Frankfurt
email: Judit.Berg@senckenberg.de
phone: +49 (0)69 7542 1822
fax: +49 (0)69 7542 1800

Website
www.ginkgo-biosphere.net/Activities.62.0.html

Program

Tuesday, June 3

13:00-13:30: Welcome
Volker Mosbrugger, Senckenberg Research Institute and BiK-F, Frankfurt
Martin Claussen, Max Planck Institute for Meteorology and Universität Hamburg
Thomas Hickler, University Frankfurt and BiK-F

13:30-14:00: Thomas Hickler, University Frankfurt
Adapting DGVMs for modelling vegetation over the last 400 Million years
14:00-14:30: Torsten Utescher, University Bonn
The use of PFTs in palaeovegetation reconstruction
14:30-15:00: Martin Claussen, MPI for Meteorology and Universität Hamburg
PFTs and the stability of atmosphere-vegetation interaction – some conceptual thoughts

15:00-15:30: Coffee

15:30-16:00: Ulrich Salzmann, Northumbria University Newcastle
Challenges in reconstructing and quantifying Pliocene vegetation and climate with data and model
16:00-16:30: Jed Kaplan, University of Lausanne
Modeling global vegetation in the late Quaternary: What progress have we made over the past 20 years and what are the priorities for the future?
16:30-17:00: Thomas Giesecke, University Göttingen
The problem of the laggards

17:00-18:00: Discussion: *Challenges in palaeo-vegetation modelling*

19:00: Dinner (location will be announced)

Wednesday, June 4

QUATERNARY

09:00-09:30: Malte Semmler, University Göttingen
Exploring Holocene vegetation pattern in central Europe
09:30-10:00: Mirjam Pfeiffer, Biodiversity and Climate Research Centre (LOEWE BiK-F)
Vegetation and fire modeling in the late Quaternary: How should we handle anthropogenic fire disturbance?
10:00-10:30: Michael Stärz, Alfred Wegener Institute, Bremerhaven
Dynamic soil feedbacks on the climate of the mid-Holocene and the Last Glacial Maximum

10:30-11:00: Coffee

... continuation day 2

GENERAL PRINCIPLES, HERBIVORES AND PERMIAN

11:00-11:30: Hugo de Boer, University Utrecht
Physical constraints predict scaling of stomatal sizes and densities across species and evolutionary time

11:30-12:00: Thomas Kleinen, MPI for Meteorology, Hamburg
Modelling vegetation during the Permian

12:00-12:30: Mikael Fortelius
Dental ecometrics, palaeodiet and palaeoclimate: more questions than answers

12:30-13:30: Lunch

MIOCENE I

13:30-14:00: Jussi Eronen, Biodiversity and Climate Research Centre (LOEWE BiK-F)
Modeling Late Miocene (11-7 Ma) vegetation with LPJ-GUESS and comparison with proxy data

14:00-14:30: Simon Scheiter, University Frankfurt
Fire and fire-adapted vegetation promote C4 expansion in the late Miocene

14:30-15:00: Felix Portmann, LOEWE BiK-F & Goethe-University Working Group Hydrology
Comparing palaeovegetation proxy records with model results for the Late Miocene: Methods and possible conclusions on the Gulf Stream intensity

15:00-15:30: Coffee

MIOCENE II and EOCENE

15:30-16:00: Louis Francois, Université de Liège
Middle Miocene vegetation reconstructions with the CARAIB dynamic vegetation model and validation using the NECLIME database

16:00-16:30: Ulrike Port, MPI for Meteorology, Hamburg
Vegetation-climate interactions during the Early Eocene

16:30-17:00: Johan Liakka, Biodiversity and Climate Research Centre (LOEWE BiK-F), Frankfurt
The impact of climate-vegetation interactions on the onset of the Antarctic ice sheet

17:00-18:00: General Discussion and planning of next day

19:00: Dinner (location will be announced)

Thursday, June 5

09:00-12:00: Open program depending on participants
+ major challenges in palaeo-modelling
+ possible cooperations
+ workshop summary

Abstracts

Physical constraints predict scaling of stomatal sizes and densities across species and evolutionary time

H.J. de Boer[1,2], C. A. Price[2], F. Wagner-Cremer[1], S.C. Dekker[1], P. J. Franks[3], E. J. Veneklaas[2]
[1]Utrecht University, Faculty of Geosciences, the Netherlands
[2]University of Western Australia, School of Plant Biology, Australia
[3]The University of Sydney, Department of Environmental Sciences, Australia

Stomata on plant leaves consist of a minute diffusion pore and two guard cells that regulate the exchange of CO_2 and water vapour between the leaf interior and the atmosphere. This basic stomatal morphology evolved approximately 400 million years ago and remains common to nearly all land plants today. Despite this common morphology, stomatal sizes and densities (*e.g.* the number of stomata per unit leaf area) range over three orders of magnitude across extant species and evolutionary time. A correct representation of stomatal sizes and densities is imperative to accurately model leaf gas exchange in palaeovegetation, however, this feat is complicated owing to the large variability in these traits. We derive a model describing allometric tradeoffs between stomatal densities, the dimensions of the guard cells and the stomatal pores based on a global compilation of 862 extant species. Our results show a consistent allocation of diffusive area in leaves across extant species and evolutionary time. We propose that this consistent allocation of diffusive area reflects evolutionary pressure to maximize the diffusive conductance of the leaf surface within physical constraints on stomatal spacing. The emergence of common scaling relations between stomatal traits may facilitate the development of models describing leaf gas exchange across evolutionary time.

Dental ecometrics, palaeodiet and palaeoclimate: more questions than answers

Mikael Fortelius, University of Helsinki

Recent advances in understanding the causes of tooth wear are forcing a re-interpretation of how dental proxies for diet and climate should be interpreted. After decades of theoretical complacency and ad hoc interpretation of observational data it is becoming clear that progress will require more experimental work and more theoretical rigour than has been customary. I present an outline of a Theory of All Tooth Wear and discuss pilot results of field studies and laboratory experiments bearing on the relationship between tooth wear, diet and eolian particles. I also present early result on the geographic distribution of areas where estimates based on dental ecometrics are much too high or low and invite discussion on the implications of these findings.

Middle Miocene vegetation reconstructions with the CARAIB dynamic vegetation model and validation using the NECLIME database

L. François[1], A. Henrot[1,2], T. Utescher[3], N. Hamon[4], B. Erdei[5], M. Dury[1], M. Krapp[6], N. Herold[7], A. Goldner[7]
[1] Unité de Modélisation du Climat et des Cycles Biogéochimiques, Université de Liège, Louis.Francois@ulg.ac.be
[2]Forschungszentrum Jülich, D-52425 Jülich (Germany)
[3]Geologisches Institut, University of Bonn, Nussallee 8, D-53115 Bonn; Senckenberg Research Institute / Biodiversity and Climate Research Centre (BiK-F), Frankfurt M (Germany)
[4]Laboratoire des Sciences du Climat et de l'Environnement, CNRS-CEA-UVSQ, F-91191 Gif-sur-Yvette (France)
[5]Botanical Department, Hungarian Natural History Museum, P.O. Box 222, H-1476, Budapest (Hungary)
[6]Potsdam Institute for Climate Impact Research (PIK), P.O. Box 60 12 03, D-14412 Potsdam (Germany)
[7]Department of Earth, Atmospheric, and Planetary Sciences, Purdue University, West Lafayette, IN 47907 (USA)

The vegetation of the Middle Miocene has been reconstructed with the CARAIB dynamic vegetation model, using as inputs several published Middle Miocene climate simulations conducted with General Circulation Models of different complexity: (a) Planet Simulator, (b) FOAM-LMDZ4, (c) MPI-ESM, (d) CCSM3.0 and (e) CESM1.0. The version of the CARAIB model used is based on a classification of plants into 26 plant functional types (PFTs). The spatial distribution, net primary productivities and biomasses of these PFTs under the various modelled climate configurations of the

Middle Miocene are compared. The degree of openness of the vegetation is also analysed along several climatic gradients under these palaeoclimate reconstructions and is compared to the present-day reference simulation of the vegetation model, to evaluate possible change in vegetation openness between the Middle Miocene and the Present.
Then, we apply the method developed by François et al. (Palaeogeography, Palaeoclimatology, Palaeoecology, 304, 359–378, 2011) to compare the simulated spatial distribution of PFTs with NECLIME palaeoflora data from 161 localities distributed worldwide, translated in terms of the presence/absence of these PFTs. This comparison is undertaken globally and in selected regions of the world, using all available localities. The level of agreement varies among models, among PFTs and among regions.

The problem of the laggards
Thomas Giesecke
Department of Palynology and Climate Dynamics, Albrecht-von-Haller Institute for Plant Sciences, Georg-August-University at Göttingen, Germany
Analysing the Holocene vegetation history of Europe highlights three widespread tree species to reach their maximum distribution and abundance only during the second half of the Holocene. These trees are Picea abies, Fagus sylvatica and Carpinus betulus, often characterised as shade tolerant and referred to as late successional species. Also Abies alba may be put into this group reaching its maximum abundance and distribution in the mid Holocene. In particular Picea and Fagus have changed the forest systems they invaded affecting ecosystem services through their dense canopy and acidic litter. The spread of Picea in Scandinavia has pushed deciduous trees south and thus shifted the limit between predominantly nemoral and boreal species. The late arrival of both species has often been attributed to migrational lag, however, this hypothesis cannot explain all of the palaeoecological evidence. Picea was present on the Scandinavian Peninsula throughout the Holocene and only became abundant during the last 3000 years. Fagus survived the last Glacial Maximum in many locations around the Mediterranean and also only expanded here during the second half of the Holocene. In the case of Fagus, but not Picea, human land-use may have triggered or facilitated the late expansion in some regions. Simulations of the Holocene vegetation development often include all of these late-coming species to be present from the early Holocene onward contradicting the fossil evidence. In order to study the effect of their late expansion in simulations these late-coming species have to be restricted in the model for the early Holocene. Consequently scenarios of their future climate driven abundance in Europe are highly uncertain as we cannot yet explain their past dynamics with any degree of certainty. An explanation for their late expansion involving climate change is intriguing, although the character of this change and its effect on the vegetation is little explored.

Modeling global vegetation in the late Quaternary: What progress have we made over the past 20 years and what are the priorities for the future?
Jed O. Kaplan (jed.kaplan@unil.ch)
Institute of Earth Surface Dynamics, University of Lausanne, Géopolis, 1015 Lausanne, Switzerland
More than two decades ago, the development of the first global biogeography models led to an interest in simulating global land cover at in the past. These models promised the possibility of creating a coherent picture of the Earth's vegetation that went beyond qualitative extrapolation of sitebased observations, e.g., from paleoecological archives, and was not limited to areas with a high density of sites. Then as now, the goal of much work simulating past vegetation was to explore and understand the role of biogeophysical and biogeochemical feedbacks between the Earth's land surface and the climate system. Paleovegetation modeling for the late Quaternary has also influenced debates on the character of natural vegetation, the conservation and ecological restoration goals, and the coevolution of modern humans, civilization, and the landscapes in which they live.
The first simulations of global land cover in the past used equilibrium vegetation models, e.g., BIOME1, BIOME3, and BIOME4, and focused on well-known timeslices of interest in paleoclimate

research, including the Last Glacial Maximum (LGM, 21,000 BP) and the mid-Holocene (6,000 BP). The questions addressed included: quantification of the importance of terrestrial vegetation in the glacial carbon cycle, the role of changing vegetation cover on glacial inception, and the influence of biogeophsyical feedbacks on the amplitude and spatial pattern of the mid-Holocene African Monsoon. In the intervening years, as both vegetation and climate models evolved and improved, the spatial resolution, number of time periods studied, and the type of research questions address expanded greatly. Studies covered the dynamics of Arctic vegetation, wetland area, wetland methane emissions, and paleo-atmospheric chemistry, dust emissions and effects on paleoclimate, among others.

A major recent advance in paleovegetation modeling during the late Quaternary has come with the development of Dynamic Global Vegetation Models (DGVMs) that are capable of simulating changing vegetation cover over time, continuously. Several DGVMs have been directly incorporated into the land surface scheme of modern Earth System Models (ESMs), further allowing the exploration of land-atmosphere feedbacks, e.g., during abrupt climate change events, such as those that occurred during the last deglaciation. Recent increases in computer power have also allowed offline simulations, i.e., not directly coupled to an ESM, with DGVMs to simulate vegetation change over long time periods, e.g., continuously for the entire Holocene. Realizing that climate change alone was not the only driver of land cover change over the late Quaternary, the most recent developments in paleovegetation modeling for this time period have incorporated human agency as an influence on vegetation. Incorporation of scenarios of Anthropogenic Land Cover Change (ALCC) into DGVMs has allowed a quantitative contribution to the ongoing, lively debate regarding the role of humans in influencing Holocene atmospheric greenhouse gas concentrations.

With the further advances in ESMs and the availability of very long climate change scenarios, e.g., TraCE-21ka, improvements to DGVMs such as the explicit representation of age structure and plant traits, and the increasing awareness of the importance of human-environment interactions, the future of paleovegetation modeling for the late Quaternary presents a variety of opportunities. One important focus for future modeling should be on simulating the dynamics of ecotones, e.g., forest-grassland boundaries, over time, particularly during abrupt transient climate change events. Accurate simulation of ecotone boundaries is traditionally a weakness in DGVMs, yet these environments are highly valued by humans for their ecosystem services both at present and in the past, paleoecological evidence suggests that ecotone boundaries were very sensitive to past climate change, and they are critical locations where land-atmosphere feedbacks could have amplified or attenuated ongoing, externally-forced climate change. Lessons drawn from paleovegetation simulations may shed new light on the behavior of the earth system that will be valuable for understanding the future.

The impact of climate-vegetation interactions on the onset of the Antarctic ice sheet

Johan Liakka[1,2], Florence Colleoni[3], Bodo Ahrens[4], Thomas Hickler[1,2,5]
[1]Biodiversity and Climate Research Centre (LOEWE BiK-F), Frankfurt am Main, Germany
[2]Senckenberg Gesellschaft für Naturforschung, Frankfurt am Main, Germany
[3]Centro Euro-Mediterraneo per i Cambiamenti Climatici, Bologna, Italy
[4]Institute for Atmospheric and Environmental Sciences, Goethe University, Frankfurt am Main, Germany
[5]Institute of Physical Geography, Goethe-University, Frankfurt am Main, Germany

A global coupled atmosphere/vegetation model and a dynamic ice-sheet model were employed to study the impact of climate-vegetation interactions on the onset of the Antarctic ice sheet during the Eocene-Oligocene transition. We found that the CO2 threshold for Antarctic glaciation is highly sensitive to the prevailing vegetation. In our experiments, the CO2 threshold is less than 280 ppm if the Antarctic vegetation is dominated by forests, and between 560 and 1120 ppm for tundra and bare ground conditions. The large impact of vegetation on inception is attributed to the ability of canopies to shade the snow-covered ground, which leads to a weaker snow-albedo feedback and higher summer temperatures. However, the overall effect of canopy shading on the Antarctic climate also depends on features like local cloudiness and atmospheric meridional heat transport. Our results suggest that vegetation feedbacks on climate are crucial for the timing of the Antarctic glaciation.

Vegetation and fire modeling in the late Quaternary: How should we handle anthropogenic fire disturbance?

Mirjam Pfeiffer (mirjam.pfeiffer@senckenberg.de)
LOEWE Biodiversität und Klima Forschungszentrum (BiK-F), Senckenberganlage 25, D-60325 Frankfurt am Main

In many natural ecosystems, fire acts as an important disturbance agent. Aside from altering vegetation structure and composition, it affects carbon storage and biogeochemical cycling and results in the release of climatically relevant trace gases including CO2, CO, CH4, NOx, and aerosols. While contemporary process-based fire models have explicit routines to simulate fire occurrence, behavior, and the effects of fire on vegetation, these models lack the possibility to account for anthropogenically-caused burning prior to the industrial period. However, humans have used fire since the Paleolithic as a tool for managing landscapes, optimizing hunting and gathering opportunities, cooking, hunting and defense, and communication. Although the relationship of humans and fire has changed over time, the extensive industrial fire suppression following the widespread mechanization of agriculture in the 20th century has been unprecedented in human history. While the natural occurrence of fire is largely controlled by climatic conditions, humans can directly alter fire regimes by increasing the number of ignitions and shifting their timing, and indirectly by altering fuel structure and availability. Depending on the saturation of environments with respect to natural ignitions, the importance of human-caused ignitions may vary, with effects being specifically important in naturally ignition-limited environments. Based on the knowledge that fire has been an indispensable part of human life for probably more than 30.000-80.000 years and that humans frequently used fires in constructive ways to manage ecosystems prior to the existence of modern day technology, we argue that the role of anthropogenic burning should not be omitted when modeling vegetation dynamics during the late Quaternary. In an attempt to incorporate human burning into the process-based modeling of fire and vegetation dynamics, we developed a representation of anthropogenic biomass burning under preindustrial conditions that distinguishes different relationships between humans and fire based on varying subsistence strategies. Using LPJ in combination with this new process-based module of natural and anthropogenic burning, we investigated the role of natural and anthropogenic fire in creating Europe's steppe-type vegetation during the Last Glacial Maximum (LGM). We argue that including both natural and anthropogenic fire as disturbance factor into DGVMs may be essential to simulate vegetation patterns that are in better agreement with the high degree of landscape openness indicated by environmental proxy data for Europe during the LGM. Our simulation results suggest that already relatively small total increases in average annual burning due to ignitions caused by Paleolithic hunter-gatherers result in a considerable reduction in simulated tree cover, leading to a simulated vegetation cover that more closely agrees with pollen-based vegetation reconstructions.

Comparing palaeovegetation proxy records with model results for the Late Miocene: Methods and possible conclusions on the Gulf Stream intensity

Felix T. Portmann, Torsten Utescher, Johan Liakka, Thomas Hickler*
* Biodiversity and Climate Research Centre LOEWE BiK-F, Senckenberg Research Institute und Natural History Museum, Senckenberganlage 25, D-60325 Frankfurt am Main, Germany, Phone: +49 - 69 - 75 42 – 1859, Fax: +49 - 69 - 75 42 – 1800, E-Mail: felix.portmann@senckenberg.de

During the Late Miocene (Tortonian) the poleward heat transport by the North Atlantic Ocean circulation was possibly reduced by a partial opening of the Central American Isthmus. Potentially, these changes had a substantial effect on the European climate at this time. Different palaeo-proxy data are often used to compile boundary conditions for climate models. In our study we compare climate data, derived from palaeobotanical proxies using the Coexistence Approach, with results of climate model experiments which were designed to mimic possible Gulf Stream intensities during the Tortonian. Different palaeoclimatological measures of temperature (CMT, MAT, WMT) and precipitation (MAP) were compared using various measures for finding the optimal fit to sensitivity experiment results. Results were found to be contrasting for temperature and precipitation. Application of proxy-derived temperature anomalies on Clausius-Clapeyron derived precipitation – evaporation difference lead to improved consistency. The findings suggest that changes of North Atlantic storm track variability was less important for the European precipitation during the Late Miocene than previously found. Furthermore, consistent with numerous earlier studies, our results highlight the difficulties of current models to satisfactorily simulate the spatial variability of past climates.

Grant: German Research Foundation (DFG) MI 926/8-1 (Arne Micheels/Thomas Hickler, Volker Mosbrugger, Madelaine Böhme).

Vegetation-climate interactions during the Early Eocene

Ulrike Port
Max Planck Institute for Meteorology, Hamburg

The Early Eocene climate was much warmer and more humid than present-day climate. We test if vegetation played a different role in this unique climate than today.

First, we focus on the impact of vegetation on the Early Eocene climate and on the present-day climate. Using the earth system model MPI ESM, we simulate a tree and a desert world for both time slices. The comparison of the tree world with the desert world reflects the idealised impact of vegetation. We consider the impact of vegetation on climate on global scale by assessing the radiative forcing and feedbacks due to vegetation. The radiative forcing by trees is similar in the Early Eocene and in the present-day climate. However, the feedbacks induced by vegetation are differently strong in the two climate states. The sea-ice albedo feedback is weak in the Early Eocene, because permanent sea ice is absent. In present-day climate, the sea-ice albedo feedback is well pronounced. The lapse/water vapour feedback is stronger in the Early Eocene than in the present-day climate. These results emphasise the sensitivity of feedbacks to the climate state.

Second, we focus on vegetation-climate interactions in the two climates. We continue the simulations of the tree world and the desert world and allow with dynamic vegetation. The question which arises is: Does the vegetation approach the same state when it starts from a tree world as if it starts from a desert world? In the Early Eocene climate, a desert evolves in Central Asia. This desert is smaller when the simulation starts from a tree world instead of a desert world. In the tree world, precipitation is stronger in the Asian desert than in the desert world. Starting from the humid tree world, vegetation survives in Central Asia. Starting from the dry desert world, vegetation fails to establish. In present-day climate, vegetation started from a tree world and from a desert world approach the same state. In the Sahara, precipitation is similar in the tree world and in the desert world due to the large scale atmospheric circulation over the Sahara. Air subsides over the Sahara. The subsidence suppresses convection and even with a dense tree cover precipitation is weak. The specific continent distribution and the vegetation cover in the two time slices make vegetation differently sensitive to the initial vegetation cover.

Fire and fire-adapted vegetation promote C4 expansion in the late Miocene

Simon Scheiter
University Frankfurt

Large proportions of the Earth's land surface are covered by biomes dominated by C4 grasses. These C4 dominated biomes originated during the late Miocene, 3-8 Myr ago, but there is evidence that C4 grasses evolved some 20 Ma earlier during the early Miocene/Oligocene. Explanations for this lag between evolution and expansion invoke changes in atmospheric CO2 and seasonality of climate and fire. However, there is still no consensus about which of these factors triggered C4 grassland expansion. We use a vegetation model, the aDGVM, to test how CO2, temperature, precipitation, fire and the tolerance of vegetation to fire influence C4 grassland expansion. Simulations are forced with late Miocene climate generated with the Hadley Centre coupled ocean-atmosphere-vegetation GCM. We show that physiological differences between the C3 and the C4 photosynthetic pathway cannot explain C4 grass invasion into forests, but that fire is a crucial driver. Fire-promoting plant traits serve to expand the climate space where C4 dominated biomes can persist. We propose that three mechanisms were involved in C4 expansion: (1) C4 grasses invade C3 grasses in open, seasonal environments; (2) fire allows grasses to invade forests; and (3) evolution of fire-resistant savanna trees expands the climate space occupied by savannas.

Exploring Holocene vegetation pattern in central Europe

Malte Semmler[1], Simon Brewer[2], Thomas Giesecke[1]
[1]*Department of Palynology and Climate Dynamics, Albrecht-von-Haller Institute for Plant Sciences, Georg-August-University at Göttingen, Germany, Malte.Semmler@biologie.uni-goettingen.de*
[2]*Department of Geography, University of Utah, Salt Lake City, UT, 84112 USA*

Pollen diagrams represent the most widely available proxy for past plant cover. Numerical values for many of these datasets are stored in databases, which for Europe is mainly the European Pollen Database (EPD). Analysing past spatial vegetation pattern from pollen diagrams is hampered by their uneven distribution in space, requiring spatial interpolations. For this purpose, maps of pollen abundances of major European species were constructed in 500-year steps for central Europe where site density is high.

In addition to data from the EPD and the Czech pollen database (PALYNCZ) we collected further pollen diagrams through personal contact to other scientist. We also digitized diagrams from publications where the original data could not be accessed. The results show changes in distribution and abundance of major species across central Europe based on 428 pollen diagrams.

To take account of elevation as an important determining factor for species distribution and abundance we used a tricubic interpolation method to interpolate between the uneven distributed data points. The resulting maps are used to explore shifts in the distribution and abundance of species and compared to climate gradients. These analyses indicate that some spatial gradients in abundance are stabile through time and can be linked to climate gradients such as continentality (distance to the sea). The gradient of continentality versus the distribution of Pinus and Quercus indicates positive and negative affinities, respectively. However, around 8,000 cal. B.P Quercus dislocates Pinus through inter species interaction in northern Germany. Overall, the results provide insights into determining factors for past distribution and abundance gradients and a reference for data model comparisons.

The use of PFTs in palaeovegetation reconstruction

T. Utescher[1,2], B. Erdei[3], L. François[4], A. Henrot[4,5], V. Mosbrugger[1]
[1]Senckenberg Research Institute / Biodiversity and Climate Research Centre (BiK-F), Frankfurt M, Germany
[2]Steinmann Institute, University of Bonn, Germany; utescher@geo.uni-bonn.de
[3]Botanical Department, Hungarian Natural History Museum, Budapest, Hungary
[4]Unité de Modélisation du Climat et des Cycles Biogéochimiques, Université de Liège, Belgium
[5]Forschungszentrum Jülich, Germany

Palaeovegetation reconstruction at the level of Plant Functional Types (PFTs) represents a useful tool in palaeobotanical research. Unlike classical techniques, the method provides quantitative data allowing for comparison of records from different times and regions, and hence for studying vegetation gradients in time and space. The approach used in our work group regards diversity of plant functional types encountered in a fossil flora and therefore is comparatively robust towards biasing factors related to taphonomy. Moreover, the technique is applicable on all types of fossil plant organs. Prerequisite for the application of the PFT approach is the classification of the plant fossil record in terms of PFTs represented by each of the taxa while the PFTs considered in each case determine global or regional applicability. Recent applications of the method successfully used a system with 13 arboreal classes and two herbaceous types, and a more detailed classification comprising 26 types including shrub PFTs, respectively. Studies using a comprehensive system with 40 types are in progress. The PFTs are in each case defined by physiognomic traits as well as bioclimatic tolerances of the Nearest Living Relatives of the fossil taxa, all the classification schemes are applicable in a global context. The classification systems using 15 PFTs and 26 types respectively, are both implemented in the CARAIB dynamic vegetation model and thus allow for direct comparison of proxy-based patterns with PFT distribution simulated in palaeo-biome modelling. Application on the fossil record amongst others comprise the reconstruction of global Eocene vegetation patterns, arboreal diversity in Miocene forests of western Eurasia, and changing patterns in the Siberian vegetation along the Cenozoic Cooling.

www.ginkgo-biosphere.net