(SS06) "Into the Icehouse" climate and vegetation change at the end of the Pliocene (a joint ROCEEH and NECLIME symposium)

Date: August 25
Place: Room 5236 (oral), Room 6302 (poster)
Organizers: Torsten Utescher & A. Angela Bruch
Contact email address: utescher@geo.uni-bonn.de
Purpose: The drastic global change from Neogene warm to Quaternary ice house climate took place to a large extent during the Pliocene. Marine records give evidence for a globally severe cooling and/or increasing aridity during Pliocene and towards the Pleistocene. There is evidence from various palaeobotanical records that this change involved a distinct loss in biodiversity, and for the first time, plant associations are recorded that are close to modern ecosystems. However not many details are known yet about the spatial and temporal distinctions in terrestrial climate evolution, influencing the vegetation cover differently in different parts of the continents.
Our symposium aims to discuss the late Pliocene to early Pleistocene terrestrial climate record, its spatial differentiation and influence on vegetation development. Contributions to quantitative vegetation and climate reconstructions based on all kinds of plant fossils, macro remains as well as pollen, and from all parts of the world are welcome to provide an overview of temporal and spatial changes at the Pliocene/Pleistocene transition.

Oral Presentation

Aug. 25 [AM2] Room: 5236

Chair: Torsten Utescher

10:50-11:30 **[Keynote] Late Pliocene vegetation and climate changes from the western Mediterranean area: the Camp dels Ninots maar record** SS06-O01 (220)

Gonzalo Jiménez-Moreno, Francesc Burjachs, Isabel Expósito, Oriol Oms, Angel Carrancho, Juan José Villalaín, Jan van der Made, Jordi Agustí, Gerard Campeny, Bruno Gómez de Soler, Eduardo Barrón

11:30-11:50 **A marine palynological study from off north-western Africa as a tool for land–sea correlation in the Late Pliocene** SS06-O02 (540)

Francesca Vallé, Suzanne A.G. Leroy, Chiori O.C. Agwu, Lydie M. Dupont

11:50-12:10 **Plio-Pleistocene vegetation response on orbitally forced climatic cycles in Southern Europe** SS06-O03 (54)

Angela A. Bruch, Adele Bertini

Aug. 25 [PM2] Room: 5236

Chair: Angela A. Bruch

14:50-15:10 **Early Pleistocene vegetation and climate changes in continental deposits of the Lesser Caucasus of Armenia** SS06-O04 (223)

Sébastien Joannin, Jean-Jacques Cornée,Philippe Münch, Michel Fornari, Iuliana Vasiliev, Wout Krijgsman, Samuel Nahapetyan, Ivan Gabrielyan,Vincent Ollivier, Paul Roiron, Christine Chataigner

15:10-15:30 **Pliocene climate cycles and vegetation variability in NW Germany prior to the onset of**

severe Pleistocene cooling SS06-O05 (538)

Torsten Utescher, Abdul R. Ashraf, Volker Mosbrugger, Andreas Schäfer

15:30-15:50 **Plio-Pleistocene climate, vegetation, and biogeography in southern Australia** SS06-O06 (487)

Kale Sniderman, Greg Jordan, Nick Porch

Aug. 25 [PM3] Room: 5236

Chair: Torsten Utescher

16:20-16:40 **Cenozoic vegetation and climate changes in the subtropical East Asia: a case study from Guangxi, south China** SS06-O07 (293)

Yusheng (Christopher) Liu, Cheng Quan

16:40-17:00 **Late Pliocene vegetation and climate change at Fudong, southwestern China** SS06-O08 (204)

Yong-Jiang Huang, Zhe-Kun Zhou, Frédéric M.B. Jacques, Yu-Sheng (Christopher) Liu, Tao Su, Yaowu Xing

Poster Presentation

Aug. 25 [PM1] Room: 6302

13:30-14:30 **Miocene-Pliocene vegetation changes of west southern Africa (Namibia)** SS06-P01 (192)

Sebastian Hoetzel, Francesca Vallé, Lydie Dupont

SS06-O01 (220)

Late Pliocene vegetation and climate changes from the western Mediterranean area: the Camp dels Ninots maar record

Gonzalo Jiménez-Moreno[1], Francesc Burjachs[2,3,4], Isabel Expósito[3,4], Oriol Oms[5], Angel Carrancho[6], Juan José Villalaín[6], Jan van der Made[7], Jordi Agustí[2,3,4], Gerard Campeny[3,4], Bruno Gómez de Soler[3,4], Eduardo Barrón[8]

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The Late Pliocene is a very interesting period as climate deteriorates from a warm optimum at ca. 3.3-3.0 Ma to a progressive climate cooling, an intensification of Northern Hemisphere glaciations. Around that time, the Mediterranean area also witnessed the establishment of the mediterranean-type seasonal precipitation rhythm (summer drought). These important climate changes produced significant vegetation changes such as the extinction of several thermophilous and hygrophilous

plant taxa from the European latitudes. Besides these long-term trends, climate was also characterized by cyclical variability (i.e., orbital changes) that forced vegetation changes (forested vs. open vegetation). In the Mediterranean area, cyclical changes in the vegetation are mostly forced by precession, even if during the 2.8 – 1.0 Ma period obliquity also played an important role on shaping the vegetation. In this study we analyzed pollen from a Late Pliocene maar lake core from NE Spain. An increase in aridity is observed throughout the studied sequence. Cyclical changes in the vegetation are also observed mostly forced by precession but also by obliquity and eccentricity. Precipitation seems to be the main factor controlling these cycles. Climate, paleobiogeographical and age implication are discussed within the context of the late Pliocene Northern Hemisphere glacial intensification.

Keywords: palynology, vegetation, climate variability, Late Pliocene, Mediterranean area.

SS06-O02 (540)

A marine palynological study from off north-western Africa as a tool for land–sea correlation in the Late Pliocene

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The distribution of pollen in marine sediments reflects vegetation changes on the continent. The combined study of pollen and dinoflagellate cysts from marine sediments gives the opportunity to establish land-sea correlations, trying to link climate and vegetation changes to oceanic changes. Here we present the preliminary results of a palynological study of well-dated marine sediments retrieved offshore north-western Africa at ODP Site 659 (18°05'N 21°02'W; 3071 m water depth). ODP Site 659 is located outside the upwelling area and lies directly under the main stream of the Saharan Air Layer, which carries dust, plant waxes, and pollen out of the African continent. The source areas of pollen at this location are mainly the savannah and the dry forest (woodlands) from the Sahel zone and the Sahara desert. We present the pollen and dinocysts records for an interval between ~3.6 and 2.7 Ma. The aridity/humidity cycles occurring during the Quaternary in the South Sahara and Sahel zone are supposed to be driven by the variability of the Atlantic meridional overturning circulation. We want to test this for the Pliocene. Modelling studies suggest that during the mid-Pliocene (3.6 – 3 Ma), the final closure of the Central American Seaway strengthened the Atlantic meridional overturning circulation enhancing heat advection to high northern latitudes and increasing the precipitation in north-western Africa. As a result of more humid conditions, mid-Pliocene woodlands and tropical savannahs extended northwards far into the today's arid regions. Additionally we ran XRF scanning of the sediment cores to compare our pollen record with element ratios (Ti/Ca and Fe/K). These data can be used as indication of terrestrial input and as climatic index.

SS06-O03 (54)

Plio-Pleistocene vegetation response on orbitally forced climatic cycles in Southern Europe

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The pace and causes of the early human colonization, in one or several migratory waves from Africa in new environments of the Eurasian continent during the Early Pleistocene, are still a matter of debate. However, climate change is considered a major driving factor of hominin evolution and dispersal patterns. In fact directly or indirectly by its severe influence on vegetation, physiography of landscape, and animal distribution, climate modulates the availability of resources. Plant fossils usually are rare or even absent at hominin sites. Thus, direct evidence on local vegetation and environment is generally missing. Independent from such localities, pollen profiles from the Mediterranean realm show the response of regional vegetation on global climate changes and cyclicity, with distinct spatial and temporal differences. Furthermore, plant fossils provide proxies for climate quantification that can be compared to the global signal, and add data to understanding the regional differentiation of Mediterranean environments. In this presentation we will discuss various palaeobotanical data from Southern Europe to assess Early Pleistocene climate and vegetation in time and space as part of the environment during the first expansions of early humans out of Africa.

Keywords: Southern Europe, Early Pleistocene, climate cycles, vegetation cycles.

SS06-O04 (223)

Early Pleistocene vegetation and climate changes in continental deposits of the Lesser Caucasus of Armenia

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The Lesser Caucasus is an active volcanic and tectonic belt which resulted from the collision of the Arabian and the Eurasian plates since Neogene times. During the Quaternary, the Lesser Caucasus was uplifted and large lakes developed in graben structures. In this active background, and, in the context of evolving climate states (i.e. climate cycles) during Pleistocene time, the Lesser Caucasus can provide crucial insight into exploring direct environment (i.e. vegetation landscape and climate) of first hominids in Eurasia. Thus, in this poorly investigated region, one must question whether the vegetation recorded the particular climate scheme of humid glacials and arid interglacials as suggested in Kazakhstan. In Southern Armenia, the diatomitic sequences of the Shamb paleo-lake offer a rare opportunity to give new insights of Western Asia vegetation-inferred paleo-climate. We investigate pollen-based climate changes of the most complete Shamb section (Joannin et al., 2010). $^{40}Ar/^{39}Ar$ dating of two volcaniclastic layers provided ages of 1.24 ± 0.03 and 1.16 ± 0.02 Ma (2σ).

Magnetostratigraphic data show that the entire Shamb section is of reversed polarity which correlates with part of the Matuyama period (1.785-1.070 Ma). Pollen- and macroremains-based glacial and interglacial phases are compared with climate changes inferred from the global (LR04) oxygen isotope record. The Shamb section ranges from approximately 1.30 to 1.08 Ma (marine isotopic stages 40 to 31). The vegetation of the Lesser Caucasus developed in a mosaic pattern in a Pleistocene continental, mostly arid climate, similar to the present-day. The vegetation changes record a dominant climate response to the obliquity orbital parameter and the influence of precession could not be established. Pollen and macroflora both indicate that glacial periods were cold and dry and that interglacials were warm with local humidity. The early Pleistocene Western Asia climatic model is thus similar to Mediterranean climatic model.

SS06-O05 (538)

Pliocene climate cycles and vegetation variability in NW Germany prior to the onset of severe Pleistocene cooling

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The application of quantitative techniques such as Coexistence Approach and interpretation of diversity of plant functional types (pfts) on the palaeobotanical record allows for detailed reconstructions of continental climate and its variability. For the NW European Cenozoic, recent studies based on macro- and microflora reveal a close correlation of continental temperature evolution and global signals known from marine archives. Prior to the Pleistocene comparatively warm climate conditions with MAT around 12.5 °C and CMT above freezing prevailed in NW Germany, significant cooling set on during the Gelasian. For the first time in the Neogene regional climate history, cooling strongly affected even summer temperature. In contrast to numerous other European continental areas, where drying is reported, the inferred Pliocene mean annual precipitation rates in NW Germany at first dropped below 1,000 mm at the beginning of the Zanclean, but then increased again along the later Pliocene. Presently two Zanclean to Piacencian palynomorph records from the Lower Rhine Basin comprising a total of 350 samples are analyzed in detail to study climate and vegetation change. Withal, restrictions caused by erosional surfaces and gaps in the record, the palynomorph spectra obtained from the the paludal to lacustrine sequences reveal orbital scale cyclicity of climate and vegetation change, suggesting a distinct coupling of the continental climate evolution with the marine environmental system. Phases of eustatic sea-level lowstand connected to glaciation events are mirrored in the continental curves and reflected by vegetation change. It is shown that climate variability is characterized by non-proportional changes of climate parameters. As was assumed from the general record variability primarily effects the cold season in the earlier part of the Pliocene, from the Piacencian on, summer temperatures show a high variability as well. Unlike the climate dynamics previously characteristic for the area cool phases tend to have higher rainfall in the Pliocene pattern. The climate cycles are also reflected in vegetational patterns, e.g. diversity proportions of broadleaved evergreen woody angiosperms vs. needleleaved cool temperate components. [Grant: DFG MI 926 / 8-1]

Keywords: Pliocene, Northwest Germany, palaeoclimate, vegetation, diversity.

SS06-O06 (487)

Plio-Pleistocene climate, vegetation, and biogeography in southern Australia

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The nature and timing of the shift from warmer Neogene climates to Quaternary ice house climates is poorly known in Australasia. However, we present evidence from Early Pleistocene fossil pollen, plant macrofossils, and beetles that in southern Australia the major transition from warm, moist, summer-wet Neogene climates into cooler, summer-dry climates did not coincide closely with the Pliocene-Pleistocene boundary near ~2.6 Ma, but occurred later, some time after ~1.5 Ma. We present data showing that mesic rainforest communities, dominated by conifers and angiosperms now extinct in Australia, coexisted alongside hyperdiverse, micro-sclerophyll plant communities, for which the closest analogues are the extraordinarily species rich sclerophyll shrublands of southwest Australia. It has previously been widely assumed, largely based on fossil pollen records only, that the Neogene-Quaternary transition heavily impacted rainforest biomes while promoting the radiation of the Australian sclerophyll flora. However, our data suggest that the novel development of a winter-dominated rainfall regime, or perhaps more generally of higher-amplitude climate variability in the Pleistocene, caused mass extinctions in both Australian vegetation types. Southeast Australian Early Pleistocene plant and insect taxa which are still extant in Australia tend now to be confined to refugia either to the south (Tasmania), to the east (montane New South Wales and Queensland) or in the far southwest (Southwest Australian Floristic Region). These regions may have functioned as refugia because of varying combinations of relictual climates and of low orbital-scale species range dynamics (ORD, of Jansson & Dynesius 2002, *Ann. Rev. Ecol. Syst.* 33:741) (perhaps, in southwest Australia).

Keywords: palynology, palaeobotany, sclerophyll, rainforest, beetle.

SS06-O07 (293)

Cenozoic vegetation and climate changes in the subtropical East Asia: a case study from Guangxi, south China

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A quantitative paleoclimate study was applied to a macroflora from the Changsheling Formation in Guangxi of SW China. The age of the flora with cuticle-preserved leaves is still on debate, but it is accepted that it cannot be older than the Pliocene. This is a rare late Neogene or early Pleistocene macroflora in the southern subtropical-northern tropical China. The dominant fossil plant families include Lauraceae, Anonaceae, and Fagaceae, which seems not to be much change in terms of vegetation type to the modern. Both the Coexistent Approach and Leaf Margin Analysis were employed to test the paleoclimate condition of this flora may represent. The reconstructed temperatures of MAT, CMMT, and WMMT appear to be close to those of the modern; while precipitations show some contrasting differences although the estimated MAP appears overlapped

with the modern. Both the ancient precipitations in wettest and driest months appear quite low, e.g. 160-370 mm (estimated) vs 580-600 mm (modern) for the wettest month and 7-64 mm (estimated) vs 58-66 mm (modern). In addition, the precipitation in warmest month appears almost twice wetter for the fossil flora than that of the modern. In other words, our work suggests that in the late Neogene or early Pleistocene of tropical southern China the temperature seems not to be changed much, but the precipitations in wettest and driest months were much drier than those of today, while that in the warmest month was much wetter in the past than today.

Keywords: paleoclimate, late Cenozoic, southern China, subtropical-tropical regions.

SS06-O08 (204)
Late Pliocene vegetation and climate change at Fudong, southwestern China

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The late Pliocene Fudong Flora from northwestern Yunnan, southwestern China, bears abundant fossil leaves, seeds and fruits. The leaves are recovered from the lower claystone and fine sandstone while the seeds and fruits are from the upper red claystone of the deposits of Sanying Formation. Leaf fossil taxa include *Pinus*, *Picea*, *Berberis*, *Populus*, *Salix*, *Acer*, *Cyclobalanopsis*, *Lithocarpus*, *Quercus* and *Desmodium*, etc., of which, *Quercus* sect. *Heterobalanus* is evidently the dominant element, suggesting evergreen broad-leaved forest vegetation. Seed and fruit fossil taxa include *Ranuculus*, *Chenopodium*, *Antenoron*, *Cucubalus*, *Salix*, *Rubus*, *Aralia*, *Verbena*, *Sambucus*, *Cyperus*, *Scirpus* and *Carex*, etc., of which *Chenopodium* is clearly the dominant component, suggesting grassland, mingled with shrubs such as *Rubus* and *Aralia*. Vegetation type might have been shifted from evergreen broad-leaved forest at the lower stage to grassland at the upper stage of the late Pliocene at Fudong. MAT and MAP based on leaf assemblage yield 12.6-17.4ºC and 529-1151 mm, respectively; MAT and MAP based on seed and fruit assemblage yield 12.2-16.8ºC and 617-1361 mm, respectively. This suggests the climate was getting a little cooler and wetter during the late Pliocene at this locality. Interestingly, the CMMT of the seed and fruit assemblage yields -1.4-6.1ºC, which is significantly lower than that of the leaf assemblage (4.3-8.3ºC). This climatic change might be largely because of the coming glacial period at the end of the late Pliocene.

Keywords: late Pliocene, vegetation, palaeoclimate, Fudong, Yunnan.

SS06-P01 (192)
Miocene-Pliocene vegetation changes of west southern Africa (Namibia)

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The Miocene-Pliocene is the period of the major savanna grassland expansion in Africa and is

followed or accompanied by the expansion of the so-called C_4 plants, which are adapted to dry warm conditions. The driving forces for this expansion are still unknown. Increased climatic seasonality, increasing general aridification, cloud cover, intense herbivory, and fire abundance are discussed to play important roles. It is mostly believed that strong upwelling attended with decreasing sea-surface temperatures played a major role in the desiccation and hydrology changes on the African continent. However, direct evidences for this link have been rarely reported so far and it is still poorly known how the tropical vegetation changed in southern Africa and, especially, how the tropical savannas developed. The main scientific objective of this study is to gain insights in the variability of the tropical vegetation with emphasis on the expansion of the grasslands and its driving forces. Therefore, the current study focuses on the continuous tropical marine sediment sequence of ODP Site 1081, offshore Namibia (19°37'S, 11°19'E, 794 m water depth). The period from 9.2 to 2.8 Ma has been studied for its pollen, spores, and charcoal content. The results suggest relative humid conditions with a rather strong signal of woodlands and mountain vegetation between 9.2 and 8.3 Ma. From 8.3 Ma on, there is a gradual change to drier conditions recorded by a strong increase of grass pollen indicating that savanna grasslands replaced woodlands. This increase represents the major savanna grassland expansion in west southern Africa during the studied period. At 7.2 Ma large amounts of charred particles indicate stronger fire activity. This increased fire activity is probably related to the establishment of the savanna grasslands providing large amounts of fuel for bushfires. At 5.1 Ma the sedimentation pattern indicates higher fluvial input represented by higher pollen influx rates and the presence of swamp and lake indicators, such as *Typha* and Nympheaceae pollen. This might be related to a change in the course of the Cunene River, which fed the Lake Cunene during Late Miocene and Pliocene times (today visible as Etosha pan). The Cunene River discharge to the Atlantic Ocean probably began during late Pliocene times when the inland Lake Cunene started to dry out.

Keywords: Savanna expansion, palaeoclimate, palaeofires, Cunene Lake.