(SS24) Detection and characterisation of millennial-scale climate variability in Quaternary pollen records (INQUA IFG ACER symposium)

Date: August 29
Place: Room 5335 (oral), Room 6309 (poster)
Organizers: William J. Fletcher & Maria Fernanda Sanchez Goñi
Contact email address: will.fletcher@manchester.ac.uk
Purpose: Millennial-scale variability is increasingly recognized as a recurrent feature of Quaternary climates. Following more than a decade of intensive research into Dansgaard-Oeschger cycles and Heinrich events of the last glacial, it is clear that palynology has a vital role to play in understanding biosphere responses to millennial-scale variability and in constraining spatial variability in the impacts of this variability. These insights can lead in turn to better understandings of the underlying mechanisms and drivers of millennial-scale climatic changes. We welcome contributions related to the investigation of millennial-scale climatic variability in palynological records, in particular related to: palynology as part of multiproxy investigations of long terrestrial or marine sediment sequences; constraining the timing and nature of millennial-scale variability during the last or earlier glacial-interglacial cycles; vegetation-climate interactions on millennial timescales. This symposium is part of the activities of the INQUA International Focus Group ACER (Abrupt Climate Changes and Environmental Responses).

Oral Presentation

Aug. 29 [AM2] Room: 5335

Chair: William J. Fletcher

10:50-11:30 **[Keynote] Detection and characterisation of millennial-scale vegetation and climate variability in Quaternary pollen records from East Asia -recent progress and future perspective** SS24-O01 (178)

Ryoma Hayashi, Hikaru Takahara, Yaeko Igarashi, Fujio Kumon, Ping-Mei Liew, Masanobu Yamamoto, Sayuri Kawai, Tadamichi Oba, Tomohisa Irino, Koji Shichi

11:30-11:50 **Vegetation response to abrupt climate changes in the southern Black Sea region during MIS3, glacial Terminations 1 and 2** SS24-O02 (476)

Lyudmila S. Shumilovskikh, Helge W. Arz, Dominik Fleitmann, Hermann Behling

11:50-12:10 **Millennial scale vegetation and climatic variability during past interglacial stages in NW Iberia – A focus on MIS 9 and 11** SS24-O03 (95)

Stéphanie Desprat, Maria Fernanda Sanchez Goni, Bruno Malaizé, Linda Rossignol

Aug. 29 [PM2] Room: 5335

Chair: Stephanie Desprat

14:30-14:50 **Detection of Dansgaard-Oeschger-like climate variability during Marine Isotope Stages 8 and 9 a-c (240 to 310 ka) at Tenaghi Philippon, NE Greece** SS24-O04 (127)

William J. Fletcher, Ulrich C. Müller, Kimon Christanis, Jörg Pross

14:50-15:10 **Climatic dissymmetry and millennial/century pacing in pollen/spores records from Northern South America** SS24-O05 (546)

César A. Velásquez R, Zaire González C

15:10-15:30 **Pollen evidence for a cool, dry Younger Dryas and warm, wet Early Holocene in the Southeastern United States** SS24-O06 (31)

Christopher E. Bernhardt, Debra A. Willard, John Gifford

15:30-15:50 **Postglacial change in the vegetation and climate of western Siberia and mountains of southern Siberia based on palaeopalynological data** SS24-O07 (39)

Tatiana Artemevna Blyakharchuk

Aug. 29 [PM3] Room: 5335

Chair: William J. Fletcher

16:20-16:40 **A 500,000-year-long continental pollen record of Lake Van in eastern Anatolia** SS24-O08 (287)

Thomas Litt, Nadine Pickarski, Georg Heumann, PALEOVAN science team

16:40-17:00 **A new Pleistocene climate record from the Northern Andes** SS24-O09 (527)

Vladimir Torres, Henry Hooghiemstra, Lucas Lourens, Chronis Tzedakis

Poster Presentation

Aug. 29 [PM1] Room: 6310

13:30-14:30 **Vegetation reconstruction in MIS5e and MIS5d based on plant remains from the Mizukiri peat layer, Fukui, western Japan** SS24-P01 (136)

Ryota Fujii, Hikaru Takahara, Ryoma Hayashi, Atsushi Yabe, Kazuo Terada, Arata Momohara, Yasunobu Yoshizawa, Hirofumi Yamamoto, Tomio Nakagawa

Vegetation change during the latter half of MIS 3 in the Abukuma Highland, Southern Tohoku, Japan SS24-P02 (469)

Koji Shichi, Shigeto Ikeda, Takashi Uchiyama

Holocene vegetation and climate change in the southern Okhotsk Sea region based on pollen records from the Lake Abashiri, Hokkaido, northern Japan SS24-P03 (207)

Yaeko Igarashi, Sung Gi Hu, Tatsuhiko Sakamoto, Makoto Okamura, Hiromi Matsuoka, Khoichi Iijima, Tomoyuki Ohyama, Kiyo Yamanobe

History of vegetation and climate of Sakhalin Island in the Late Pleistocene-Holocene SS24-P04 (336)

Yury Mikishin, Irina Gvozdeva

Pollen record of late Pleistocene-Holocene vegetation and climate changes from a paleolake in Yili Valley, central Asia SS24-P05 (609)

Keliang Zhao, Xiaoqiang Li, John Dodson, Xinying Zhou, Pia Atahan

Seasonal cycles of laminated sediments in northern Taiwan inferred by pollen analysis SS24-P06 (286)

Ting-Wei Lin, Ping-Mei Liew

Vegetation and wildfires under climate changes between Marine Isotope Substages

(MIS) 5e and 5b in central Poland SS24-P07 (247)

Piotr Kołaczek, Monika Karpińska-Kołaczek

Environment dynamics at the Eemian/Weichselian transition: palynological data from the central part of the East European Plain SS24-P08 (379)

Elena Yu. Novenko

Spatial and temporal patterns of dissimilarity between past and present vegetation in Europe in relation to climate changes and human activities SS24-P09 (46)

Simon Brewer, Walter Finsinger, Thomas Giesecke, Basil Davis

SS24-O01 (178)

Detection and characterisation of millennial-scale vegetation and climate variability in Quaternary pollen records from East Asia -recent progress and future perspective

Ryoma Hayashi[1], Hikaru Takahara[2], Yaeko Igarashi[3], Fujio Kumon[4], Ping-Mei Liew[5], Masanobu Yamamoto[6], Sayuri Kawai[4], Tadamichi Oba[6], Tomohisa Irino[6], Koji Shichi[7]

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Regional climate in East Asia is highly sensitive to changes in global climate forcing because the westerly jet path and the oceanic subarctic boundary occur in the region. This sensitivity suggests that East Asia should be ideal for investigation of the vegetation and climatic response of the northern hemisphere to the Dansgaard-Oeschger (D-O) cycles. Millennial-scale variability has been reported from several lithological, geochemical or isotopic records in the region. In this talk, recent progress of millennial-scale vegetation and climate variability and its characteristics in pollen records during the last glacial from East Asia are summarized mainly based on Takahara et al. (2010) and several new pollen records. High-resolution pollen records from Taiwan, Japan and Sakhalin, the coastal area of East Asia, show biome shifts during the period from D-O 19 to GS 18/19, from temperate conifer forest to cold/cool conifer forest in Japan and from subtropical forest to temperate deciduous/conifer forest in Taiwan. Vegetation changes associated with D-O 17, including development of cool mixed forest in central Japan, temperate deciduous broadleaf forest in western Japan and subtropical forest in Taiwan, also reflect biome shifts from MIS 4 to MIS 3. The registration of D-O warming events in MIS 3, although reflected by shifts in the abundance of key species such as *Cryptomeria japonica* in western Japan, is not sufficient to produce changes in biomes. Development of cold deciduous forest in Heinrich event 1 in Sakhalin, Hokkaido and central Japan was conspicuous, while vegetation response in YD was small scale and within the same biome in the East Asian Islands. In addition, the pollen record from Lake Baikal, the high-latitude continental area, shows fluctuations in broad-leaved and coniferous forest in response to the D-O cycles. Although herb vegetation dominated during the cool phases, distribution areas of broad-leaved vegetation and of coniferous forests expanded during the warm phases. In particular, *Picea* forest rapidly expanded in D-O 12. However, no expansion of coniferous forests was recognized in D-O 8 around Lake Baikal. In contrast, temperate conifer forests increased not only in D-O 12 but also in D-O 8 around western Japan. European pollen records show similar contrast

between above and below 40°N, marked forest development occurred during all D-O 16-17, 14, 12, and 8 at southernmost latitudes, while forest development was stronger during D-O 14 and 12 than either D-O 16-17 and 8 at above 40°N (Fletcher et al. 2010).

Keywords: Dansgaard-Oeschger (D-O) cycles, Heinrich events, last glacial, East Asian Islands, Lake Baikal.

SS24-O02 (476)

Vegetation response to abrupt climate changes in the southern Black Sea region during MIS3, glacial Terminations 1 and 2

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Palaeoenvironmental studies in the southern Black Sea region were mainly contributed to the last 25 kyr and reveal a high sensitivity of the area to climatic changes. Suggested glacial refugia in the Caucasus and Pontic Mountains as well as lack of regional high-resolution studies create a special interest to vegetation reactions on abrupt changes during the glacial time and glacial-interglacial transitions. Here we present new pollen records from the cores 22-GC3/8 and 25-GC1 with special emphasis on land-sea correlation, provided by comparison to oxygen isotope and dinoflagellate cyst records from the same cores. The age-control of the time series is based on shell oxygen isotopes (ostracods, bivalve) correlated to the isotope records of Uranium series dated stalagmites from Solufar Cave, NW Anatolia. The close link between oxygen isotope records from Black Sea sediment cores and Anatolian speleothemes has been demonstrated earlier. During glacial periods, the pollen spectra are dominated by *Artemisia*, Chenopodiaceae and Poaceae, indicating steppe vegetation in Northern Anatolia. Relatively low arboreal pollen percentages reveal arid conditions during this time, whilst stable occurrence of *Fagus, Carpinus betulus, Ostrya*-type, *Tilia, Corylus* etc. indicate the existence of small euxinian forest refugia on the adjacent land. The first vegetation reactions to the warming and increase of humidity during Terminations 1, 2 and DO-events are indicated first by an increase of *Pinus diploxylon*-type and later by this of *Quercus robur*-type. Interestingly, pollen of euxinian vegetation do not increase during the glacial warming periods, what is likely explained by too cold and dry conditions and/or too short time for spreading of euxinian vegetation. Pines and oaks forest developments during warming periods show good correlations with increase in dinoflagellate cyst concentrations, indicating higher primary productivity as a response on the increased sea-surface temperatures. In general, pollen and dinoflagellate cyst records reveal a clear response of vegetation development to climate changes in Northern hemisphere.

Keywords: pollen, sea-surface conditions, glacial-interglacial transition, DO-events, Northern Anatolia.

SS24-O03 (95)

Millennial scale vegetation and climatic variability during past interglacial stages in NW Iberia – A focus on MIS 9 and 11

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An increasing number of records show that millennial scale changes appear as an inherent pattern of the Earth's climate superimposed to the glacial-interglacial variability. However, the origin and controlling factors modulating these climatic instabilities remain unclear. To improve our understanding, it is necessary to investigate the millennial scale variability under a wide panel of baseline climate states. So far, few studies have focused on instabilities of Marine Isotope Stages (MIS) 9 and 11 even though they appear of particular interest. Interglacial periods of both stages have been identified as close analog of the current interglacial (Ruddiman et al., 2007; Loutre & Berger et al., 2000). Sporadic information shows that rapid climatic changes occurred during the MIS 11 and 9 interglacial periods, for instance in Antarctica, Germany or SW Iberia (Pol et al., 2011; Koutsodendris et al., 2010; Tzedakis et al., 2004). In addition, in the Vostok deuterium record, suborbital variability within the MIS 9 interval between 310–290 ka and MIS3 appears of similar pacing and amplitude despite a different astronomical forcing but a similar range of sea level (Siddall et al., 2007). We present a high-resolution marine pollen record from the NW Iberian margin covering the interval from 425,000 to 270,000 years ago which includes MIS9 and 11 (Desprat et al., 2009, 2005 and new data). This study enables to document vegetation changes in the NW Iberian Peninsula directly on a marine stratigraphy and therefore to examine the marine-terrestrial linkages under different baseline climate states. Suborbital vegetation changes in NW Iberia in response to cool/cold events are detected throughout the studied stages even during MIS 9e and 11c ice volume minimum. However, instabilities appear more frequent and of higher amplitude during intervals of an intermediate to high ice volume and mainly periods of ice growth. Each suborbital cold event detected in NW Iberia has a counterpart in the sea surface temperature records. High to moderate amplitude cold episodes detected on land and in the ocean appear to be related to changes in deep water circulation and probably to iceberg discharges. This work provides therefore additional evidence of pervasive millennial-scale climatic variability in the North Atlantic borderlands throughout past climatic cycles of the Late Pleistocene regardless of glacial state. However, ice volume might have an indirect influence on the amplitude of the millennial climatic changes in Southern Europe.

Keywords: marine palynology, palaeoclimatology, NW Iberian margin, southwestern European vegetation, Marine Isotope Stages 9 and 11.

SS24-O04 (127)

Detection of Dansgaard-Oeschger-like climate variability during Marine Isotope Stages 8 and 9 a-c (240 to 310 ka) at Tenaghi Philippon, NE Greece

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A new, centennial-scale-resolution record from Tenaghi Philippon (NE Greece) documents vegetation changes in the NE Mediterranean region during the interval 240-312 ka (corresponding to

Marine Isotope Stage [MIS] 8-9c). Superimposed on orbital-scale shifts between predominantly forested and open landscapes are multiple episodes of abrupt forest expansion (termed Abrupt Mediterranean Forest Expansions, or AMFEs), which reflect abrupt increases in warmth and moisture availability. The occurrence of AMFEs enables the characterisation of Dansgaard-Oeschger-like events for the antepenultimate glacial (MIS 8), and confirms threshold behaviour of millennial-scale variability with respect to global ice-volume during this interval, with high amplitude changes prevalent during intermediate ice volume and climate states corresponding to sea-level lowering of approximately 50 – 90 m below present. A peak-for-peak match between AMFEs and Antarctic temperature maxima suggests interhemispheric coupling of millennial events via global oceanic circulation changes and synergistic variability in atmospheric circulation. The severity of stadial conditions in the NE Mediterranean region furthermore provides a robust predictor for the amplitude of Antarctic warming, strongly supporting interhemispheric climatic anti-phasing related to the dynamics of the bipolar see-saw. The findings underline the important role of long palynological records such as TP in the robust detection of millennial-scale events beyond the last glacial period, and the potential for future work beyond the current limits of ice core records.

Keywords: Mediterranean region, abrupt climate change, interhemispheric climate coupling.

SS24-O05 (546)

Climatic dissymmetry and millennial/century pacing in pollen/spores records from Northern South America

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High resolution pollen/spores records (Velásquez, C., 2005; Velásquez C. and H. Hooghiemstra, in preparation) from Páramo de Frontino (6º29N, 76º6´W) and pollen/diatoms records from Lake La Cocha (01º 08´N, 77º 09´ W) in Colombia (Carranza, Z., *et al*, The Holocene, in review); spanning 17300 and 14000 cal yr BP respectively, are compared with Frontino and Cariaco Basin (offshore Venezuela) titanium records and a Cariaco sea surface temperatures record (Gorin, G., *et al*, in preparation; Haug, *et al*., 2001; Lea D., *et al.*, 2003; respectively); with reference to detected vegetation and climate cycles. In the Late Holocene, most of the high frequency cycles registered in Frontino (42, 52, 77, 90, 200 years) coincided with $\delta^{14}C$ signal cycles. Low frequency cycles of 1500-2500 yr are present along the records, suggesting that the North Atlantic Bond Cycles are also registered in northwestern South American terrestrial records. The most remarkable events occurred at 11600, 10300, 8100, 7000, 5200, 2700, 1400 and 400 cal yr BP according to Frontino record. Some of these changes were dry while others wet, showing that both patterns "Cold poles, dry tropics" and "Cold poles, wet tropics" can be expressed depending of the position and strength of the Intertropical Convergence Zone and the High pressure Bermudas System. From our records is evident a close relation between the Northern Hemisphere Total Solar Irradiance variations and vegetation changes. Solar forcing could explain the vegetation changes and the detected pacing. We also found that the estimated temperatures from Páramo de Frontino (pollen based) and sea surface temperatures in Cariaco followed a similar trend during the last 14.000 yr cal BP. In the case of moisture, the Titanium record (indicative of rainfall) from the Cariaco Basin and the aquatic vegetation pollen and titanium records from Páramo de Frontino, show a clear antiphase behavior during the Lateglacial, Early and Middle Holocene and a in phase behavior during the last 4000 cal yr BP. Some dissymmetry is also detected in a latitudinal gradient between Frontino pollen and Lake La Cocha diatoms records. Position and shape of Intertropical Convergence Zone is postulated as responsible for this variation.

Keywords: palinology, Intertropical Convergence Zone, titanium, Colombia, climatic and vegetation changes.

SS24-O06 (31)

Pollen evidence for a cool, dry Younger Dryas and warm, wet Early Holocene in the Southeastern United States

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Well-dated, high-resolution pollen records from the Florida peninsula shows a rapid vegetation response to temperature and precipitation change associated with the last deglaciation 16-8 ka. A Tampa Bay pollen record shows assemblages indicating the YD was cold and dry (low *Pinus* pollen abundance and high Amaranthaceae), but another record from Lake Tulane, Florida, show the YD as warm and wet (high pine, low oak (*Quercus*) and ragweed (*Ambrosia*)). Here, we present a high-resolution, 7000-year pollen record of vegetation change from an 8.2 m sediment core from Little Salt Spring (LSS), FL, an hourglass-shaped karst sinkhole lake (water depth = 72 m) that spans the Younger Dryas and Early Holocene. Previous paleohydrological reconstructions based on carbon and oxygen isotopes indicate that LSS is sensitive to deglacial climate and sea-level changes. Distinct changes in pollen assemblages correspond to well-documented climatic events. Rapid increases in hickory (*Carya*) and oak pollen indicate abrupt cooling and drying during the YD. These rapid changes in climate regimes resulted from meltwater floods into the Gulf of Mexico (GOM), southward shifts in the Intertropical Convergence Zone (ITCZ), and migration of the Bermuda High (BH). A second peak in cool, dry taxa around 10.6ka corresponds to timing of Meltwater Flood 5 (MWF-5). Comparing the LSS record to Cariaco and Tampa Bay records, we find that regionally the YD was cooler and drier than the early Holocene. In addition to understanding the nature of abrupt climate changed in the southeastern United States, precisely establishing the timing and nature of abrupt climate events like the YD is also important in understanding early Native American settlement patterns near and around sink holes in Florida because occupation near these features has been related to regional drought.

Keywords: palynology, Florida, climate variability, Native Americans.

SS24-O07 (39)

Postglacial change in the vegetation and climate of western Siberia and mountains of southern Siberia based on palaeopalynological data

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Using 97 published pollen diagrams, supplied by radiocarbon dates (including 22 diagrams of author) a spatial variations in areas with the main tree species of Siberia (and the genus Artemisia) for each 1000-year time slice were reconstructed. A total of 99 maps were produced for thirteen

1000-year time slices from the Late Glacial to the present. In addition, pollen records along the central and eastern longitudinal transects in western Siberia were compared. This revealed 5 relatively stable vegetation-climate periods during last 13,000 years and showed that the first closed forest, of *Pinus sibirica* and *Abies sibirica*, formed in the mountains of southern Siberia 1200 years earlier than closed forests of *Betula pendula* and *Pinus sylvestris* developed on the plains of western Siberia. Only later in the middle Holocene did *Pinus sibirica* and *Abies sibirica* spread onto the western Siberian plains. It was found that during Holocene optimums at 9 and at 6 thousands yr. BP in western Siberia increased role of dark-coniferous tree species (*Picea obovata* and *Abies sibirica*) and northern boundary of forests shifted to the north. Reconstructed spatial-temporal dynamic of areas of main tree species in western Siberian and in the mountains of southern Siberia showed that synchronous change in vegetation in the northern and southern boundaries of forest zone were triggered, most possibly, by global change of climate. Using known ecological tolerances of the main tree species of Siberia, variations in areas allowed vegetation and climatic changes to be documented in details at 1000-year intervals from termination of the last Glacial period. Spatial peculiarities of these changes in western Siberia were documented for Late Glacial time, for the two Holocene optimums and for the deterioration of climate in the late Holocene. The resulting maps of spatial variations in vegetation in Siberia over time can be used to create paleoclimatic models, including numerical models for future global environmental and climatic changes.

Keywords: pollen diagram, vegetation, change of climate, Siberia.

SS24-O08 (287)

A 500,000-year-long continental pollen record of Lake Van in eastern Anatolia

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Lake Van, a large terminal lake in eastern Anatolia (Turkey), holds a key position within a sensitive climate region between the Black Sea, Caspian Sea and Mediterranean Sea. Lake Van extends over 130 kilometers on a high plateau; lake level at present is 1665 meters above sea level. The lake water, up to 450 meters deep, is alkaline (pH ~9.8) and saline (~21.4‰). Its long and partly annually laminated sedimentary record provides an excellent paleoclimate archive because it yields a long and continuous continental sequence that covers several glacial-interglacial cycles. Lake Van is therefore a key site to reconstruct Quaternary climate evolution in the near east. Because the lake is the deepest lake in Anatolia, which, in contrast to other more shallow lakes, likely never dried out in its history, it was identified as the most promising candidate to contain a long and continuous sediment archive. The drilling campaign, supported by the International Continental Scientific Drilling Program (ICDP), operated by the U.S.-based company Drilling, Observation and Sampling of the Earths Continental Crust (DOSECC), was carried on in July and August 2010. DOSECC developed and assembled a new Deep Lake Drilling System (DLDS) that was specifically designed for coring sediments from deep lakes and that was first operated in Lake Van. The DLDS worked at water depths of up to 360 meters. Cores from 140 meters (Northern Basin site) and 220 meters (AhlatRridge site) below the lake bed depth were retrieved. To obtain a complete sedimentary section, the two sites were cored multiple times. The cores are stored at an Integrated Ocean Drilling Program's core repository located at the University of Bremen's Center for Marine Environmental Sciences (MARUM) in Germany. Preliminary oxygen isotope data, XRF scanning results, as well as pollen analyses, suggest that the Ahlat Ridge record encompasses ca 500,000 years of paleoenvironmental history. In addition to the current interglacial stage (marine isotope stage 1), three to four interglacial stages can be identified on the basis of annually laminated lithologies and higher amounts of pollen from trees such as deciduous oak, which favor warmer environments.

These submillimeter-scale annual laminations reflect strong seasonal fluctuations in particle supply resulting in alternations of aquatic biomass, authigenic carbonates, and detrital constituents. These warm phases probably coincide with marine isotope stages 5, 7, 9, and 11 or 13. Cold stages are characterized by non-laminated, banded lithologies and predominance of pollen types related to steppe plants.

SS24-O09 (527)
A new Pleistocene climate record from the Northern Andes

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We present a new pollen-based climate record from the paleolake Bogotá located at 2550 m altitude in the Northern Andes. The vegetation history and inferred record of climate change from this site at near equatorial latitude (4°N) spans without significant interruptions the period from 1.7 Ma to 0.027 Ma according to the most recent astronomical tuning of the record. The new composite pollen record FunzaC combines the previously published 357 m long Funza1 record with the new 586 m long Funza2 record. The resulting time series was analyzed in the depth domain, data were detrended and the arboreal pollen signal was spectrally analyzed using the RETFIT software. For tuning purposes we matched maxima of the Alnus signal with the LR04 benthic $\delta^{18}O$ record. The proliferous pollen producer Alnus is used as an indicator of events past temperatures crossed the ~9.5°C level, characterizing the mean annual temperature at the upper forest line. Alnus never occurs above this ecotone. The visual match with the tuned marine record yielded 15 tie points for the upper part of the record. The spectral analysis showed significant peaks at 7.6 m and 9.5 m; we interpreted these cycles as the precession component in the record. Further wavelet analysis shows the consistency of the FunzaC tuning. This new composite record has a strong impact on the understanding of vegetation evolution in relation to climate change. The evolution of páramo vegetation and montane forest biomes show five distinct stages throughout the Pleistocene. Although most of the pollen record reflects non-analogue vegetation associations we could still apply present-day plant distributions and modern climatological constrains to reconstruct vegetation dynamics and Pleistocene climate change in the tropical mountains during the last 1.7 Ma. The new information from record FunzaC improved understanding of the basin history, lake level fluctuations, and biome evolution due to tectonic adjustments and climate change.

Keywords: pollen record, Colombia, precession, astronomical tuning, spectral analysis.

SS24-P01 (136)
Vegetation reconstruction in MIS5e and MIS5d based on plant remains from the Mizukiri peat layer, Fukui, western Japan

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A 3m-thick peat layer with abundant plant macroscopic remains, embedded in marine terrace sediment was found at Mizukiri site, Fukui Prefecture in the coastal area of the Sea of Japan. The volcanic ash layers such as DKP (62 ka) and SK(110-115 ka) tephra were recognized in the white-gray deposit and the brown soil deposit overlain the peat layer, respectively. Preliminary pollen data of the peat layer was reported by Hayashi *et al*. (2011). In our study, we carried out pollen analysis of the peat layer in high resolution (5 cm interval, ＜100 years) to make correlation to abrupt climate changes such as the D-O event. Three local pollen zones were recognized based on fluctuations of tree pollen. *Cryptomeria* pollen shows high percentages in all levels of the peat layer. In the lower part of the peat sediment, *Quercus* subgenus *Cyclobalanopsis* (evergreen oak) pollen and *Lagerstroemia* pollen are recognized continuously in low percentages, associated with deciduous broadleaved tree pollen and aquatic herbs. Cupressaceae-type and *Picea* pollen increase in the middle part of the peat layer. In the upper part, *Picea* pollen decrease and deciduous broadleaved tree pollen increase again. According to the pollen records from Lake Biwa (Hayashi *et al.*2010a, b) and Kurota Lowland (Takahara and Takeoka, 2000), western Japan, continuous appearance of *Quercus* subgenus *Cyclobalanopsis* pollen with *Lagerstroemia* pollen are recognized only in the last interglacial period (MIS5e). Comparison with these pollen records, suggests that the peat layer in the Mizukiri site represents the vegetation change during the end of the last interglacial to the earliest stage of the last glacial (MIS 5e to 5d). Macroscopic plant remains of *Picea* cf. *shirasawae, Abies firma, Chamaecyparis pisifera* and *Cryptomeria japonica* were recognized in middle and upper parts of the peat layer (Yabe et al, 2011). It suggests that spruce, which is a cold/cool temperate conifer, coexisted with temperate conifers, such as *Chamaecyparis* and *Cryptomeria* on the coastal area of the Sea of Japan in the early last glacial period (MIS 5d). Also, we will refer the possibility of vegetation changes related to the D-O events in MIS 5d based on the high resolution pollen data.

Keywords: Last interglacial-glacial transition, high resolution pollen analysis, macroscopic plant remains, D-O event, Sea of Japan.

SS24-P02 (469)

Vegetation change during the latter half of MIS 3 in the Abukuma Highland, Southern Tohoku, Japan

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Several palynological studies in Southern Tohoku during the last glacial period have been performed so far (e.g., Yoshida et al., 1981; Soma 1984). However, because of poor age controls and low resolution data, it is difficult to discuss the minute relationship between vegetation and climate change during this period. We reconstructed vegetation changes during the latter half of MIS 3 by

using a sediment core (TA) from tamano-tameike in Fukushima Prefecture, located in the northern part of the Abukuma Highland. The collected 285-cm-long TA core consists of peaty clay and a clay layer. Three calibrated radiocarbon dates were used to build an age model by linear interpolation. From the pollen analysis of the TA core, pinaceous coniferous taxa, such as *Pinus* subg. *Haploxylon*, *Picea*, *Tsuga* and *Abies* dominate in zone TA-1: 43–35 cal ka BP. Next, deciduous *Quercus* increases and *Picea* and *Abies* decrease in zone TA-2: 35–32 cal ka BP. *Betula* then rapidly increases and pinaceous conifers decrease in zone TA-3: 32–31 cal ka BP. This vegetation change with alteration from coniferous taxa to *Betula* is similar to other pollen records from Southern Tohoku. Temporal increases in *Betula* occurred at 39 and 31 cal ka BP and these may relate to Heinrich events 4 and 3. In addition, increases in pinaceous conifers and decreases in *Betula* corresponding to Dansgaard-Oeschger (D-O) event 8 were remarkable around 38 cal ka BP, although the responses to other D-O events were not clear. We show that vegetation change in the Abukuma Highland during the latter half of MIS 3 was partly in response to abrupt North Atlantic climate events.

Keywords: pollen analysis, pinaceous conifer, *Betula*, Heinrich event, Dansgaard-Oeschger event.

SS24-P03 (207)

Holocene vegetation and climate change in the southern Okhotsk Sea region based on pollen records from the Lake Abashiri, Hokkaido, northern Japan

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Hokkaido, the northernmost island of Japan, is surrounded by the Pacific Ocean, Japan Sea, and Okhotsk Sea, and is situated in the cool-temperate to subarctic zone with both tropical and arctic influences. The vegetation on Hokkaido has floristic features intermediate between the temperate and the subarctic regions. The sea current has an effect on the terrestrial climate. The Tsushima Warm Current (TWC) began to flow into the Japan Sea at its present volume 8 kyrs BP (Oba et al., 1991). Four pulses of the TWC have been identified based on rhythmic fluctuations in diatom temperature (Koizumi, 1987). In the Okhotsk Sea, one of the tributaries of the TWC flows southeastward along the coast of Hokkaido. Studies of the warm-water mollusk assemblages distributed along the Okhotsk Sea coast have revealed four warm stages in the Holocene, indicating activation of the TWC (Matsushima, 2010). On the other hand, studies of the warm-water diatom species from marine core HO76 P1, about 70 km from the shores of Lake Abashiri, have revealed eight peaks over 7 kyrs (Shimada et al., 2000). To clarify the influence of the TWC on coastal vegetation and climate, the bottom sediment of Lake Abashiri was palynologically investigated. Lake Abashiri is a brackish lake located on the coast of the southern Okhotsk Sea. It is 32.87 km^2 in size and 16 m in maximum depth. Holocene sediment from the lake bottom consists of basal gravel and 30 m of thick silt, which has a varve-like banding structure (Hu Sung Gi et al., 2012). Pollen analysis has been performed on core 9803 obtained from the southwest corner of the lake located near the mouth of the Abashiri River (43°56′38″N, 144°08′09″E). A 28-m-thick sediment sequence deposited 9.6 ^{14}Ckyrs BP has revealed fluctuations in vegetation. The warm period, which was characterized by forests dominated by *Quercus* trees, lasted from ca. 8.4 ka to ca. 1.2 ka. During this time, eight *Quercus* peaks were recognized at ca. 8.4, 7.1, 5.6, 4.6, 4, 3.2, 2, and 1.6 ka. The trends in the fluctuation of *Quercus* are similar to the warm diatom peaks from core HO76 P1. The millennial-scale variability in *Quercus* might indicate the occurrence of TWC pulses along the coast

of the southern Okhotsk Sea.

Keywords: palynology, millennial-scale variability of vegetation and climate in Holocene, southern Okhotsk Sea region, Lake Abashiri, pulse of the Tsushima Warm Current.

SS24-P04 (336)

History of vegetation and climate of Sakhalin Island in the Late Pleistocene-Holocene

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Late Pleistocene-Holocene vegetation and climate of Sakhalin Island were reconstructed through studies of peat-bogs. The period of 14000–15000 Cal. yr BP is characterized by forest-tundra vegetation and cold conditions. During the Allerod warming 12900–14000 Cal. yr BP appeared spruce. The wood vegetation was presented by larch-birch forests. The phase of birch/walnut and spruce/fir forests is fixed a warming in the middle of Boreal Period of Holocene (8900–10100 Cal. yr BP). The oak forests was forming at the Early-Middle Atlantic Period (7900–8200 and 7300–7700 Cal. yr BP), in warm climatic conditions. Short cooling in this episode (7700–7900 Cal. yr BP) it was noted by a birch/alder and spruce/fir forests. The phase of birch/alder reflected the onset of cooler and dry climatic conditions of the latter half of Middle Atlantic Period. A significant climate warming in the Late Atlantic Period 5350–6500 Cal. yr BP resulted in spread of broad-leaved forests and in a decreasing role of dark-needle trees. The phase of alder/dwarf-birch/birch and fir/spruce forests has most likely reflected the stage of an Early Subboreal cooling (4900–5200 Cal. yr BP). A Middle Subboreal warming and relative aridness of the climate 4250–4400 Cal. yr BP resulted in a growing role of oak forests. The maximum spread of fir/spruce forests growing in a cooler and more humid climate than in the preceding phase has been fixed by pollen assemblages with largest quantity of dark-needle tree pollen. The phase of small-leaved and fir/spruce forests with broad-leaved species presence was developing in a drier and warm climate of the Late Subboreal Period 3100–3500 Cal. yr BP. The phase of small-leaved and broad-leaved forests with oak dominance as well as of fir/spruce forests reflected a significant climate warming 2800–3000 Cal. yr BP. The phase of fir/spruce and small-leaved forests was developing in a cooler and humid climate of the Early Subatlantic Period 2200–2500 Cal. yr BP. An intensive climate warming in the latter half of the Early Subatlantic resulted in spread of broad-leaved forests. A climate cooling in the first half of the Middle Subatlantic Period resulted in disappearance of broad-leaved forests, increasing role of spruce/fir and small-leaved forests 1700–1800 Cal. yr BP. The phase of fir/spruce and broad-leaved forests has most likely fixed a climate warming in the latter half of the Middle Subatlantic Period.

Keywords: pollen assemblage, forest-tundra, dark-needle forest, small-leaved forest, broad-leaved forest.

SS24-P05 (609)

Pollen record of late Pleistocene-Holocene vegetation and climate changes from a paleolake in Yili Valley, central Asia

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High resolution pollen record with precise AMS^{14}C dating from paleolake sediments in Yili Valley, central Asia, provide an opportunity to reconstruct the vegetation and climate changes over the past 15,000 cal yr BP. *Betula-Picea* mixed forest occured at 14.7 cal kyr BP and corresponds to the onset of the warm Bølling period in the North Atlantic. A long dry period was detected from 14.5 to 13.6 cal kyr BP on the basis of the occurrence of Chenopodiaceae desert. A subalpine meadow community dominated by *Geranium* covered the area during 13.6-13.4 cal kyr BP, suggesting lower temperatures at this time. This may coincide with the Older Dryas (OD). The most humid period in the record occurred between 13.4 and 12.9 cal kyr BP, which coincides with the warm Allerød period. Dry conditions prevailed from ~12.9 to 11.7 cal kyr BP in the area, coinciding with the Younger Dryas (YD) in the North Atlantic. Within this period a three-phase climate fluctuation was detected, which can be summarized as follows: a dry early YD (12.9-12.6 cal kyr BP), a slightly moister mid-YD (12.6-12.0 cal kyr BP) and a very dry late YD (12.0-11.7 cal kyr BP). These millennial to century-scale climatic events in Yili Valley probably originate from the same mechanisms as shown in other palaeoclimate records in North Hemisphere. The early Holocene (10.6-7.6 cal kyr BP) was the wettest time with a developed temperate steppe. A dry climate with desert vegetation arose in the early mid-Holocene (7.6-6.5 cal kyr BP), spanning 1100 years. A second humid phase emerged between 6.5 and 5.2 cal kyr BP, whose vegetation community was represented by temperate steppe. Moisture was reduced again and the climate became drier between 5.2 and 3.3 cal kyr BP when vegetation was dominated by desert steppe in the Yili Valley. Regional comparisons indicate that the moisture changes in Yili Valley were mainly influenced by the North Atlantic Ocean SSTs through the westerlies. The mean position of the Siberian High Pressure cell probably made a great contribution to the drought between 7.6 and 6.5 cal kyr BP. The climate changes were generally consistent between the Westerly-dominant central Asia and Asian monsoon regions since the last deglaciation, possibly forced by summer insolation conditions in the Northern Hemisphere.

Keywords: last deglaciation, Bølling-Allerød warm period, Younger Dryas, the westerlies, moisture changes.

SS24-P06 (286)
Seasonal cycles of laminated sediments in northern Taiwan inferred by pollen analysis

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Laminated lake sediments are investigated for their potential to record annual change in paleoclimatic study. Here we show laminated sediments with seasonal cycles from lake deposits inferred from pollen study in Taipei Basin and Hualien, Taiwan. The former is in the lower part of Taipei Basin deposits -depth 228 m to 251.7 m of Hsinchuan Core which most likely belongs to the antepenultimate glaciation corresponding to the upper part of MIS 8. The latter is the YD deposits in between depths 53 m and 67 m of Peipu Core, Hualien. Both couplets of cores show that grain size is slightly coarser and thicknesses is thicker and variable in the light halves than the dark halves. In couplets of Taipei Basin, the major components in light grey layer are quartz (>70%) associated with clay mineral like illite etc. while clay increases in the dark grey layer. Pollen fossil shows the regularity that the light grey layer contains more warmer elements such as *Cyclobalanopsis* and *Castanopsis* while the dark grey layer is characterized by significant amounts of Poaceae and less

warm elements like Pinaceae (*Pinus*, *Picea*, *Tsuga*) and *Alnus*. Compared with the present pollen calendar of Taipei area, of which the *Pinus* and Gramineae appear in winter-spring while the *Cyclobalanopsis* and *Castanopsis* in early summer, they are very possible varve deposits due to stronger seasonality during glaciation. Constrained by radiocarbon dating, the laminated sediments in Peipu Core, Hualian, are deposits during Younger Dryas. The sedimentation rate of 0.97 cm/yr by counting 207 couplets between depths 61-63 m coincides with that of 0.98 cm/yr obtained from the C14 dates. Pollen assemblages in dark and light layer-couplets show seasonal cycles with reference to the pollen calendar from modern Hualian. The summer- autumn blooming taxon like *Alnus* and Lagerstroemia are with higher percentage in light layers. The winter-spring blooming taxon like *Pinus* and *Tsuga* are with higher percentage in dark layers. Based on seasonal characteristics of couplets, we then study the thickness change of the light halves of couplets which is considered as a proxy for change of annual summer precipitation. Presently the summer precipitation change in NE Taiwan is related with the ENSO activity. Spectrum analysis for lamination thickness of light grey layers (summer layer), shows a prominent 3-4 and 6-7 year peaks. This may indicate that ENSO occur during antepenultimate glaciation and YD even with higher activity.

Keywords: lamination, Younger Dryas, ENSO.

SS24-P07 (247)

Vegetation and wildfires under climate changes between Marine Isotope Substages (MIS) 5e and 5b in central Poland

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This paper presents a fresh examination of a pollen profile from Ustków (central Poland, Central Europe) collected from a buried kettle-hole lake/mire. Palynological research showed slightly different patterns of vegetation in comparison to other sites located in Central Europe. Among them were: an early *Ulmus* maximum simultaneous with *Betula* optimum in the Early Eemian, a relatively late optimum of *Taxus baccata* during the decline of the Middle Eemian and a distinct division of the older part of the Late Eemian into phases of *Abies-Picea* and *Picea-Pinus* forest domination. The Herning stadial (MIS 5d) is characteristic of its bipartition demonstrated by heathland domination during the older part of the stadial, whereas during the younger part *Juniperus* thickets and *Artemisia*-Poaceae steppe prevailed, which makes this succession similar to those described from northern Germany. The pollen spectra reflecting the Brørup interstadial (MIS 5c) distinctly revealed an intra- Brørup cold oscillation visible in a drastic fall in arboreal pollen concentration and a simultaneous peak of *Artemisia*. Moreover, the youngest part of the interstadial reflected the period of *Larix* domination in local forests (percentages, higher than 15% of the total pollen sum, are unique in the sequences from Central Europe). Local pollen taxa, non-pollen palynomorphs (NPPs) and lithology of deposits revealed that a water body existed in the kettle-hole from the Late Saalian-Early Eemian transition to the phase of *Carpinus* domination during the Middle Eemian, from the Herning stadial (MIS 5d) to the early Brørup interstadial (MIS 5c), and in the Rederstall stadial (MIS 5b), while between those time-intervals a poor and/or rich fen and/or bog functioned. Concentration and percentages of charcoal combined with the presence of *Gelasinospora* (HdV-1; fungus related with fires) and *Pteridium aquilinum* (a heliophilous fern) point to the greater influence of wildfires on the environment during the Early and Middle Eemian (phases of *Betula-Ulmus*, *Quercus-Fraxinus* forests and *Corylus* forests/thickets domination), the Late Eemian (especially the phase of *Pinus* woodlands) and the Brørup interstadial (mostly in the phase of *Larix*

domination). A fall in fire intensity during the younger part of the *Carpinus* phase in the Middle Eemian (MIS 5e) probably triggered the expansion of *Taxus baccata* – a taxon sensitive to wildfires. The higher concentration of charcoal in the Herning and Rederstall stadials might have been the result of the downwash of older material.

Keywords: Eemian, Weichselian, pollen, non-pollen palynomorphs (NPPs), Central Europe.

SS24-P08 (379)

Environment dynamics at the Eemian/Weichselian transition: palynological data from the central part of the East European Plain

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Vegetation and climate dynamics during the transitional period from Eemian Interglacial to Early Weichselian Glacial epoch in the central part of the East European Plain have been studied using detail pollen data of two profiles. The first section is 8 m in depth borehole situated in the Central Forest State Natural Biosphere Reserve (CFSNBR) in the south of the Valdai Hills (Tver' region). The second one, the profile Ples is an outcrop (6.2 m thickness) in a deep ravine on the right bank of the Volga river valley (Ivanovskoe region). Both profiles are characterized by high degree of similarities as in lithological composition as in pollen and macrofossil records that allowed us to correlate these materials. The pollen and macrofossil data on the lower layers of these sequences recorded a typical succession of forest communities during the Eemien Interglacial. The end of the Interglacial (biosone E7) was characterized by unstable environments. A number of short-term phases of pine-birch forests with spruce alternating with birch woodlands were identified. According to data from two considered profiles, the first post-Eemian cooling was divided into two stages by a short climatic amelioration. In this phase, birch open woodlands spread over the area, while the proportion of grassland was slightly reduced. There are certain data indicating existence of similar small-scale warming inside the Herning cooling all over Europe. Probably, the climate of the initial part of the glacial epoch was characterized by inner instability resulting in the sequence of second-, and even third-order climatic oscillations expressed against the background of the overall trend towards cooling. The first Early Weichselian cold stage was followed by a warming. Changes in pollen assemblages at this stage reflect a rapid afforestation of the central regions of the East European Plain. Birch woodlands with participation of spruce became widespread during the first half of the interval. Larch, pine and spruce forests with Siberian pine, similar to the contemporary middle taiga in West Siberia, were predominant during its second half. By the composition of pollen spectra and flora, these warm intervals in the sections of the CFSNBR and Ples are similar to the Brörup phase in West Europe. According to OSL dating of the section Ples, the age of this interstade is about 90 kyr BP (Boettger et al., 2007). A comparison of pollen data of profiles CFSNBR and Ples with the oxygen isotope curves derived from deep ice core from northern Greenland (NorthGRIP Members, 2004) reveals a close resembles between characters of fluctuations. The main early-glacial warming in both sediment sequences can be correlated with the warm Dansgaard-Oeshger (DO) events 24 and 23. In this case, the cold Greenland stage 26 corresponds to some cooling at the end of the Eemian warm stage.

Keywords: Eemian Interglacial, Early Weichselian Glacial, DO events, the East European Plain (Russia).

SS24-P09 (46)

Spatial and temporal patterns of dissimilarity between past and present vegetation in Europe in relation to climate changes and human activities

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The analysis of large collections of fossil records (e.g. pollen databases) indicates that terrestrial ecosystems are neither stable in time nor stable in space. The dissimilarity between modern and past pollen assemblages can shed light on the antiquity of modern ecosystems, their environmental thresholds, and their resilience in a changing environment. With these aims in mind, we explored dissimilarities between modern and past pollen assemblages over the past ~15,000 years in Europe. These dissimilarities are based on approximately 850 pollen records from the European Pollen Database (EPD), recently improved with the construction of robust calendar-age chronologies for each record rather than the somewhat distorted radiocarbon timescale. We present here some first analyses based on this dataset, with special attention to identifying regions where, and periods during which, ecosystems were mostly different from present ones. Human activities (such as farming and deforestation) and past climatic changes will be evaluated as drivers for the emergence and disappearance of ecosystems across Europe.

Keywords: antiquity, non-analogue vegetation, pollen, database.