

(SS25) Late Cenozoic to modern marine palynology of the circum-Pacific Ocean

Date: August 25

Place: Room 5336 (oral), Room 6309 (poster)

Organizers: Fabienne Marret, Anne de Vernal & André Rochon

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Purpose: Over the last decades, deep-sea sediments from the Pacific have revealed the strong potential of marine palynology to reconstruct past environmental changes on long- and short terms. For instance, the NE side of the Pacific has been relatively well investigated for the recent distribution of dinoflagellate cysts as a tool for past sea-surface reconstructions. Longer records are also available, combining pollen and dinoflagellate cysts, enabling a comprehensive picture of the regional climate dynamics. However, the Pacific Ocean is still understudied compared to the Atlantic Ocean, although it is an important component of the global atmospheric-ocean coupled system. The biological affinity of many palynological taxa from the Pacific still needs to be documented. Moreover, there are modern organic-walled dinoflagellate cysts that are endemic to the Pacific Ocean (for ex., *Dalella chathamense*, *Echinidinium* spp.). Therefore, it is timely to shed some light on the marine palynology of the Pacific realm.

Oral Presentation

Aug. 25 [AM1] Room: 5336

Chair: Vera Pospelova

9:00-9:40 **[Keynote] Late Cenozoic Dinoflagellate cysts and paleoproductivity from the eastern equatorial Pacific** [SS25-O01 \(603\)](#)

Mónica Zegarra, Javier Helenes

9:40-10:00 **Responses of dinoflagellate cyst assemblages to occasional inflows of warm-water current into the Japan Sea during Late Pliocene** [SS25-O02 \(260\)](#)

Hiroshi Kurita, Naotaka Kusamiya

10:00-10:20 **Marine response to warm MIS11, east Tasman Sea, New Zealand** [SS25-O03 \(413\)](#)

Joseph G. Prebble, Lionel Carter, Erica Crouch, Giuseppe Cortese, Helen Neil

Aug. 25 [AM2] Room: 5336

Chair: Kenneth Neil Mertens

10:50-11:10 **Pollen deposition in the northern South China Sea: present and the last glacial maximum** [SS25-O04 \(85\)](#)

Lu Dai, ChengYu Weng, Jun Lu

11:10-11:30 **High-resolution Southern Hemisphere palynological records from interglacial stages 5e and 11 from a marine sediment core adjacent to Westland, New Zealand** [SS25-O05 \(438\)](#)

Matthew Ryan, Rewi Newnham, Gavin Dunbar, Marcus Vandergoes, Helen Neil, Helen Bostock

11:30-11:50 **Interglacial conditions during mid- to late Pleistocene in the NE and SW Pacific Ocean** [SS25-O06 \(314\)](#)

Fabienne Marret, Anne de Vernal

11:50-12:10 **The use of dinoflagellate cyst assemblages for quantitative reconstructions of sea-surface conditions in the North Pacific** [SS25-O07 \(42\)](#)

Sophie Bonnet, Anne de Vernal, Taoufik Radi

Aug. 25 [PM2] Room: 5336

Chair: Kazumi Matsuoka

14:30-15:10 **[Keynote] Sedimentary records of dinoflagellate cysts in eastern Pacific coastal and estuarine waters** [SS25-O08 \(412\)](#)

Vera Pospelova

15:10-15:30 **Reassessment of sea-surface conditions in the Gulf of Alaska during the late Pleistocene-Holocene based on dinocyst assemblages** [SS25-O09 \(92\)](#)

Anne de Vernal, Sophie Bonnet, Taoufik Radi, Fabienne Marret

15:30-15:50 **Sea surface conditions during the last deglaciation in the subarctic Pacific: palynological evidence** [SS25-O10 \(426\)](#)

Taoufik Radi, Anne de Vernal, Eric Galbraith

Aug. 25 [PM3] Room: 5336

Chair: Hiroshi Kurita

16:20-16:40 **Influence of the Pacific Decadal Oscillation in the Beaufort Sea over the last 150 years based on dinoflagellate cyst assemblages** [SS25-O11 \(432\)](#)

André Rochon, Lise Durantou

16:40-17:00 **Process length variation of the cyst of the dinoflagellate *Protoceratium reticulatum* in the North Pacific: a new density proxy and first evidence of pseudo-cryptic speciation** [SS25-O12 \(329\)](#)

Kenneth Neil Mertens, Manuel Bringué, Nicolas Van Nieuwenhove, Yoshihito Takano, Vera Pospelova, André Rochon, Anne de Vernal, Taoufik Radi, Barrie Dale, R. Timothy Patterson, Kaarina Weckström, Elinor Andrés, Stephen Louwye, Kazumi Matsuoka

17:00-17:20 **Polyphyletic round brown spiny dinoflagellate cysts** [SS25-O13 \(320\)](#)

Kazumi Matsuoka, Kenneth Neil Mertens, Hisae Kawami, Yoshihito Takano, Vera Pospelova, Anna Pieńkowski

17:20-17:40 **New findings of the unsolved cyst - motile relationship of the *Protoperidinium oblongum*-complex** [SS25-O14 \(449\)](#)

Chihiro Sarai, Kazumi Matsuoka

Poster Presentation

Aug. 25 [PM1] Room: 6309

13:30-14:30 **Late Miocene - Early Pliocene productivity, temperature and upwelling in the Eastern Equatorial Pacific** [SS25-P01 \(545\)](#)

Tjerk J. T. Veenstra, Stefan Schouten, Gerald R. Dickens, Jan Backman, Appy Sluijs

Cenozoic organic-walled dinoflagellate cysts from the Central Pacific Ocean (IODP Expeditions 320-321; Pacific Equatorial Age Transect; Sites U1331-U1338) [SS25-P02 \(544\)](#)

Tjerk J. T. Veenstra, Francesca Sangiorgi, Appy Sluijs

Organic-walled dinoflagellate cyst production in the Santa Barbara Basin: implications for harmful algal blooms and paleoenvironmental reconstructions [SS25-P03 \(48\)](#)

Manuel Bringué, Vera Pospelova, Dorothy Pak

Early Miocene biostratigraphy of dinoflagellate cysts of northern Japan [SS25-P04 \(261\)](#)

Hiroshi Kurita, Akiko Obuse

Dinoflagellate cysts as indicators of millennial scale climatic and oceanographic variability in Guaymas Basin, Gulf of California (Mexico) during the Late Quaternary [SS25-P05 \(415\)](#)

Andrea M. Price, Kenneth N. Mertens, Vera Pospelova, Thomas F. Pedersen, Raja S. Ganeshram

A comparative study of the modern dinocyst assemblages from the Pacific coast of Mexico (15° N to 25°N) and the Gulf of Mexico (17° N to 29°N) [SS25-P06 \(285\)](#)

Audrey Limoges, Anne de Vernal

Modern pollen distribution in marine sediments from the northern part of the South China Sea and its environmental significance [SS25-P07 \(301\)](#)

Chuanxiu Luo, Muhong Chen, Rong Xiang, Jianguo Liu, Lanlan Zhang, Jun Lu, Mingxi Yang

SS25-O01 (603)

Late Cenozoic Dinoflagellate cysts and paleoproductivity from the eastern equatorial Pacific

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Productivity of dinoflagellate cyst assemblages in the equatorial Pacific (ODP Site 1039), show changes related to early Miocene (~18 Ma) to Holocene paleoceanographic and tectonic events during its travel from near the Equator to its actual location offshore Costa Rica. The assemblages are abundant, diverse, and dominated by photosynthetic gonyaulacoid forms. Variations in composition and concentration of the taxa observed characterize five intervals, these are: 1) early-middle Miocene (18.2-11.75 Ma), dominated by abundant *Batiacasphaera* and *Impagidinium*, represents stable oceanic environments, away from the continent, before the beginning of the Panama closure; 2) earliest late Miocene (11.75-8.7 Ma), distinguished by scarce *Batiacasphaera* and *Impagidinium*, represents a severe decrease in productivity, also reported regionally as the Carbonate Crash event; 3) late Miocene to early Pliocene (8.7-4.5 Ma), characterized by abundant *Impagidinium* and *Nematosphaeropsis*, represents a marked recovery in productivity, and coincides

partially with the Global Biogenic Bloom. The assemblage is dominated first by *Impagidinium*, and then by *Nematosphaeropsis*, and *Batiacasphaera* almost disappears; 4) late Pliocene (4.5-2.5 Ma), characterized by scarce *Impagidinium* and *Nematosphaeropsis*. This decrease in recovery is probably related to “El Niño-like” conditions, when a deep thermocline diminished oceanic primary productivity in the entire eastern Pacific. This interval does not contain *Batiacasphaera*, and there is a significant increase of continental palynomorphs, and finally 5) late Pliocene to Holocene (2.5-0.05 Ma), with moderate abundance and richness of dinoflagellates, and dominated by *Spiniferites* and *Selenopemphix* forms, which can be explained by the proximity of the Costa Rica Dome. The continental proximity is also shown by a high influx of continental palynomorphs, particularly baccate pollen, probably associated to the onset of the Northern Hemisphere Glaciations.

Keywords: dinoflagellate cyst, eastern Pacific, paleoproductivity, Neogene, Site 1039.

SS25-O02 (260)

Responses of dinoflagellate cyst assemblages to occasional inflows of warm-water current into the Japan Sea during Late Pliocene

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The present-day Japan Sea has only limited connections with oceanic waters through a few shallow straits. Following the relatively open status in the Miocene, this isolation became prominent in the Pliocene, when inflow of warm-water currents into the sea occurred during each eustatic highstand period corresponding to a warming event. The present study aims to discuss responses of dinoflagellate cyst assemblages to such occasional changes of surface waters. For the studied section of the Upper Pliocene Kuwa'e Formation in the northern part of the Niigata Basin, dated as 3.5 Ma – 2.8 Ma, detailed investigations of diatoms, radiolaria, foraminifera and paleomagnetism are available from previous studies. We examined 75 samples which provide an average chronological resolution of ca. 14 ka. The assemblages are dominated generally by species of *Achomosphaera*, *Spiniferites* and *Operculodinium*. Also included are such thermophilic species as *Lingulodinium machaerophorum*, *Melitasphaeridium choanophorum* and *Tuberculodinium vancampoae* of which occurrences are concentrated at three stratigraphic levels within the total section. This means that the thermophilic species should have responded to a 230 ka climatic cycle. In addition, occurrences of globorotalid foraminifera which is also a warm-water indicator were reported from slightly higher levels than those of the thermophilic species of dinoflagellates and diatoms. This apparent time lag may be attributed to differences between primary producers and predators.

SS25-O03 (413)

Marine response to warm MIS11, east Tasman Sea, New Zealand

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Marine Isotope Stage (MIS) 11 (434 – 341ka) with an orbital configuration, bathymetry and biota similar to the Holocene, but with warmer sea surface temperatures (SST) than now is a potential analogue to gauge ocean responses under projected warmer conditions. Dinoflagellate cyst (dinocyst) assemblages in four giant piston cores [MD06-2987, -2988, -2989, -2991] recovered from levees of the Hokitika Canyon/Channel system off the western South Island, New Zealand, were used to evaluate upper ocean conditions during MIS11. Presently, the mean annual SST is 15°C. Productivity is moderate to high under the influence of near shore upwelling, and seasonal mixing of nutrients off shore. Dinoflagellate cyst-based transfer function models for SST have been constructed for the Southwest Pacific, based on previously published sea floor assemblages, and new observations of assemblages from the Tasman Sea. Transfer function models for MIS11 using dinocysts and planktonic foraminifera show SSTs were at least 1-4°C warmer than the present. This elevated warmth was accompanied by dinocyst assemblages and foraminifera that are today found in low productivity oceanic settings. Such inferred low productivity during MIS11 may reflect: a relaxation of coastal upwelling, decreased winter mixing, less stable waters during spring and summer growing seasons, or nutrient limitation from reduced airborne dust input. Stable isotopes from two species of depth dependent foraminifera point to enhanced stratification and reduced mixing during this time.

Keywords: dinoflagellate, transfer function, productivity, sea surface temperature.

SS25-O04 (85)

Pollen deposition in the northern South China Sea: present and the last glacial maximum

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Palynological evidence from deep marine sediments provides excellent chances for reconstructing coastal environment changes and for comparing the histories between the marine and terrestrial systems. In this research, we try to understand the vegetation and environmental conditions in the northern South China Sea (SCS) during the Last glacial maximum (LGM) based on modern surveys of pollen transportation. Forty five surface sediment samples, distributed in the near shore, continental shelf, slope and basin around the SCS were analyzed. After comparing the continental vegetation with the pollen assemblages, we know that abundant fern plants were well represented in the marine sediments by a few major spore types. *Pinus massoniana* forest patches were widely distributed in the inner regions, and were well reflected by its pollen in the marine sediments, because they were well transported by rivers. Subtropical and tropical broadleaved forests were dominated by evergreen *Quercus* and *Castanopsis* pollen. Pollen of most shrubs was absent, and temperate components were well represented, but herbal pollen, especially Poaceae and Cyperaceae was abundant. A palynological record from a marine sediment core (MD2906) shows that the pollen assemblages during the LGM were much different. The core is from the northern SCS, near Dongsha Island. The pollen data show that during the LGM, pollen assemblages were characterized by abundant *Artemisia* pollen (40-50%), little *Pinus* pollen and few spores. Temperate pollen percentage was relative high (5-10%), as well as tropical and subtropical components (5-10%). During the last glacial termination and Holocene intervals, percentage of *Pinus* pollen strongly increased, and temperate, tropical and subtropical forest components slightly increased, while abundance of herbal pollen decreased, and spores slowly increased. According to modern pollen

distribution and transportation ways, abundant *Artemisia* pollen, rare *Pinus* pollen and spores indicated colder and drier climate than today during the LGM, because *Artemisia* mainly distributed in the arid north and northwest China, *Pinus massoniana* belongs to warm pine, and ferns mainly live in moist environments. Fern spores were mainly transported by water flows. However, good presence of deciduous and evergreen broadleaved tree pollen showed limited temperature drop.

SS25-O05 (438)

High-resolution Southern Hemisphere palynological records from interglacial stages 5e and 11 from a marine sediment core adjacent to Westland, New Zealand

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Beyond the Last Glacial Maximum, little is known about how mid-latitude Southern Hemisphere (MLSH) terrestrial vegetation responded to climatic forcing over the last one million years (Ma). Previous terrestrial palynological records of MLSH interglacial periods are often fragmentary and poorly dated. These problems can be circumvented by extracting terrestrial palynomorphs from marine sediments. Here, we present palynological data at <2 ka resolution through Marine Isotope Stages (MIS) 5 and 11 from a giant piston core (MD06-2991) collected from the eastern Tasman Sea (42°21.06'S, 169°59.59'E, 886 mbsl). This core location lies ~100 km west of New Zealand's South Island on the north levee bank of the submarine Hokitika canyon where sediment is accumulating at 7 cm/kyr. Chronological control is provided by matching a benthic foraminifera $\delta^{18}\text{O}$ record from this core with the global stack of LR04 (Lisiecki and Raymo, 2005), enabling the relative timing of terrestrial pollen events to be compared with the history of sea surface temperature (SST), global ice volume and insolation. At the time of writing this abstract preliminary results suggest that MIS 5e may contain a greater relative abundance in podocarp-hardwood taxa, in particular the warm lowland forest taxon *Dacrydium cupressinum*, when compared to the MIS 11 interglacial assemblages. In contrast, SST estimates from assemblages of planktonic foraminifera from the same submarine canyon setting show both MIS 11 and MIS 5e were interglacials of similar warmth (Hayward et al., 2012). As forest growth in this highly humid region is unlikely to be precipitation-limited, these findings suggest that these distinctions between interglacials in the proportion of podocarp-hardwood pollen in this particular maritime climate setting may be influenced by factors other than temperature, such as seasonality, frost, ice cover or competition from other tall tree taxa.

Keywords: palynology, Southern Hemisphere, submarine setting.

SS25-O06 (314)

Interglacial conditions during mid- to late Pleistocene in the NE and SW Pacific Ocean

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Long and continuous DSDP and ODP sediment sequences have enabled worldwide investigation of past environmental conditions. Amongst the microfossils studied in these sequences, pollen and dinoflagellate cysts (=dinocysts) have proven to be useful tracers of climatic and oceanographical conditions. Over the last 25 years, a database of recent dinocyst assemblages from the Northern Hemisphere has been developed for quantitative estimations of past sea-surface conditions through collaborative work. From an initial number of 371 sites (in the 1990s) mainly located in the North Atlantic, the database now comprises around 1500 sites, including the North Pacific and adjacent seas. Equally, a database of recent dinocyst assemblages was developed in the Southern Ocean and presently encompasses 169 sites. Both databases are not merged as endemic species from the Southern Ocean were discovered (*Selenopemphix antarctica*, *Impagidinium variaseptum*). Two long sequences, ODP Hole 887 (Gulf of Alaska, NE Pacific) and DSDP Hole 594 (Chatham Rise, SW Pacific) were studied for their dinocyst content. ODP887 covers the last ~400 kyr, whereas only the last 140 kyr were studied in DSDP594. In ODP887, dinocyst assemblages are characterized by moderately high species diversity, with important changes in assemblages in relation with glacial to interglacial transitions. Gonyaulacacean taxa, in particular *Operculodinium centrocarpum*, accompanied by *Nematosphaeropsis labyrinthus* and *Spiniferites elongatus*, dominated during interglacial episodes whereas glacial periods are characterized by the dominance of the heterotrophic taxon *Brigantedinium* spp., accompanied with *Impagidinium pallidum*. The dinocyst assemblages in the DSDP594 sequence is dominated by *S. antarctica*, accompanied with *Brigantedinium* spp., *N. labyrinthus* and *Spiniferites* species. The modern analogue technique was used for reconstructing winter and summer sea-surface temperatures and salinities, as well as sea-ice cover duration. We present here new estimations (based on the updated northern and southern databases) of the conditions for the last few interglacial stages in the Pacific Ocean. Overall, Marine Isotope Stage (MIS) 5e was warmer than present-day conditions in the SW by about 4°C but cooler in the NE (by about 2°C), whereas MIS 11 was the warmest interglacial in the NE Pacific (by about 3°C) for the last 400,000 years.

Keywords: dinocysts, Eemian, MIS 11.

SS25-O07 (42)

The use of dinoflagellate cyst assemblages for quantitative reconstructions of sea-surface conditions in the North Pacific

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The oceanographic history of the North Pacific Ocean is still poorly documented, compared to that of the North Atlantic Ocean. The establishment of an adequate dinocyst database would help to develop transfer functions and reconstruct past sea-surface conditions such as temperature, salinity primary productivity and sea-ice cover. Here we report on palynological results from 53 surface sediment samples from the North Pacific Ocean, including the Bering and Okhotsk Seas (37-64°N, 144°E-148°W), in order to i) provide an overview of dinocyst taxonomic diversity and ii) document the relationships between dinocyst distribution, sea-surface conditions, and North Pacific surface water masses and/or currents. Five assemblage zones can be distinguished: 1) the Okhotsk Sea zone, which is associated to temperate and eutrophic conditions, seasonal upwelling, and Amur River discharges. It is characterized by the dominance of *Operculodinium centrocarpum*, *Brigantedinium* spp., and *Islandinium minutum*; 2) the Western Subarctic Gyre zone with subpolar and mesotrophic conditions, under the influence of the Kamchatka Current and Alaska Stream inflows. The

assemblages are dominated by *Nematosphaeropsis labyrinthus*, *Pyxidiniopsis reticulata* and *Brigantedinium* spp.; 3) the Bering Sea zone, depicting a subpolar environment, influenced by seasonal upwellings and inputs from the Anadyr and Yukon Rivers. It is characterized by the dominance of *I. minutum* and *Brigantedinium* spp.; 4) the Alaska Gyre zone with temperate conditions and nutrient-enriched surface waters, which is dominated by *N. labyrinthus* and *Brigantedinium* spp.; and 5) the Kuroshio extension-North Pacific-Subarctic Current zone characterized by a subtropical and oligotrophic environment, which is dominated by *O. centrocarpum*, *N. labyrinthus* and warm taxa of the genus *Impagidinium*. The analyses have shown the endemism of some taxa in the North Pacific. This is the case of *Impagidinium japonicum*, *Impagidinium velorum*, the new *Pyxidiniopsis reticulata* morphotype, *Dalella chathamensis* and most *Echinidinium* species. It can be hypothesized that dissimilarities in dinocyst assemblages from the North Pacific and North Atlantic-Arctic may be related to differential speciation on both sides of the Bering Strait, which acted as a natural physiographical barrier during the recent geological past. Dinocyst data from the northern North Pacific were incorporated into the Northern Hemispheric database (n=1419 sites) to develop transfer functions based on the modern analogue technique. Validation tests on both the North Pacific Ocean dataset (= 359 sites) and the n=1419 database demonstrate that the updated Northern Hemisphere database is suitable for further reconstructions of sea-surface parameters.

Keywords: Bering Sea, Okhotsk Sea, transfer functions, modern analogue technique, marine palynology.

SS25-O08 (412)

Sedimentary records of dinoflagellate cysts in eastern Pacific coastal and estuarine waters

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This presentation highlights recent progress in studies of dinoflagellate cysts from the eastern Pacific Ocean. Our work has started from determining diversity and abundance of dinoflagellate cysts in this relatively unexplored ocean, and sets the stage for future taxonomic work required for making progress in studying this complex environment. I report some initial steps in that direction, and suggest subsequent perspectives for future work. Results of the ongoing extensive collaborative investigation of the diversity and seasonality of dinoflagellate production in coastal and estuarine waters of western Canada, United States and Mexico will be presented. Studies of sediment trap samples from British Columbia (Canada) and Santa Barbara Basin (California, USA) have allowed us to identify seasonal and inter-annual variability of dinoflagellate cyst production. The composition, diversity, abundance and seasonal succession of dinoflagellate cyst taxa have been documented and examined in relation to changes in freshwater input, sea surface temperature, salinity, and biogenic silica on a high-resolution temporal scale. This research can be viewed as part of concerted efforts by a number of research collaborations aimed at analysis of dinoflagellate cyst assemblages from hundreds of surface sediment samples collected in eastern Pacific coastal waters. Statistical analyses of cyst assemblages combined with known environmental parameters have shown significant correlations with marine primary productivity, sea-surface temperature, and salinity. Such studies expand the knowledge of dinoflagellate cyst ecology and provide further justification in favor of using dinoflagellate cysts for accurate reconstructions of past environmental conditions along the Pacific coast of North America. Several examples of such reconstructions from high sedimentation rate areas in the eastern North Pacific are provided.

Keywords: dinoflagellate cysts, sediment traps, sediments, coastal northeastern Pacific Ocean,

climate.

SS25-O09 (92)

Reassessment of sea-surface conditions in the Gulf of Alaska during the late Pleistocene-Holocene based on dinocyst assemblages

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Reconstructions of the variations of sea-surface conditions in the Gulf of Alaska during the late Pleistocene and Holocene have been proposed more than ten years ago on the basis on dinocyst data (de Vernal and Pedersen, *Paleoceanography* 1997; Marret et al., *Can. J. Earth sciences* 2001). These reconstructions were made by using a database that included no more than 371 sites located in North Atlantic and Arctic-subarctic. Since then, the standardized “modern” dinocyst database has been significantly enlarged with data from the North Pacific and the Bering Sea (cf. Radi and de Vernal, *Marine Micropaleontology* 2008; Bonnet et al., *Marine Micropaleontology* 2012; Geotop website), which makes it more suitable for paleoceanographic reconstructions in the North Pacific. The Northern Hemisphere dinocyst database now includes close to 1500 sites with about 350 sites from the Pacific. Hence, it seems relevant to revisit the paleoceanography of the Gulf of Alaska based on the last 23 000 years dinocyst record from core PAR-87A10 (~44°22'N, 148°28'W). The dinocyst assemblages are characterized by concentrations of the order of 10³ cysts cm⁻³ and the occurrence of *Operculodinium centrocarpum*, *Nematosphaeropsis labyrinthus*, *Spiniferites elongatus* s.l., *Pyxidinospis reticulata*, *Impagidinium pallidum*, *Pentapharsodinium dalei*, and *Brigantedinium* spp. The samples from the last glacial interval, which contain dominant *I. pallidum* and *Brigantedinium* spp., have modern analogues in the Arctic and subarctic seas adjacent to the North Atlantic. The samples from the postglacial interval are characterized by dominant *Operculodinium centrocarpum*, *Nematosphaeropsis labyrinthus*, and *Spiniferites elongatus* s.l.; they have good modern analogues in the northeast North Pacific. The reconstructions of sea-surface conditions based on the updated database show similar trends and fluctuations than those published in 1997. The salinity variations, ranging from 29 to 34 psu in summer with minimum values during the last glacial maximum, are almost identical. However, the amplitude of temperature changes is much larger, with warmer conditions than those previously reconstructed during Bølling-Allerød (up to 16°C instead of 7°C) and the early Holocene (up to 15°C instead of 10°C). The new database thus permits reconstructions that evidence particularly high sea-surface temperatures at time of maximum summer insolation at high northern latitudes and extremely high sensitivity of the subpolar North Pacific with respect to climate changes from glacial to interglacial.

SS25-O10 (426)

Sea surface conditions during the last deglaciation in the subarctic Pacific: palynological evidence

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In order to document sea surface condition variations in the subarctic Pacific during the last deglaciation, palynological analyses have been carried out on well dated sedimentary cores from ODP Site 887, located in the Gulf of Alaska (54.37° N, 148.45° W, 3647 m), site MD01-2416 (51.27° N, 167.73° E, 2317 m) and ODP Site 882 (50.35° N, 167.58° E, 3244 m) located in the western subarctic Pacific. At ODP Site 887 (Gulf of Alaska), dinocyst assemblages show a remarkable change 14.6 kys ago. This transition is characterized by an abrupt increase in the percentage of dinocysts associated with autotrophic activity relative to a decrease in cysts produced by heterotrophic dinoflagellates, notably *Isandinium minutuum*, *Brigantedinium* spp., and the Arctic morphotype of *Polykrikos*. Transfer functions using dinocyst assemblages suggest that the transition corresponded to the increase of sea surface temperature, from 5 to 15°C in summer, disappearance of sea ice, and increase in primary productivity from < 100 to ~ 200 gC m⁻² year⁻¹. At the western subarctic sites (MD01-2416 and ODP Site 882), the transition from the last glacial maximum (LGM) to the Holocene seems to be more gradual. The change towards higher relative abundances of autotrophic taxa started at ~17 ka. At both sites, summer sea surface temperature gradually increased, from 4°C during the LGM to about 12°C during the Holocene. Similarly, productivity increased from < 100 to 200-250 gC m⁻² year⁻¹. These observations are in agreement with the hypothesis that weak primary productivity was associated to weak ventilation and high stratification in subarctic Pacific during glacial periods. Inversely, the more intense ventilation of the North Pacific during interglacial stages might have resulted in increase of primary productivity in the North Pacific. Finally, our results suggest that during the deglaciation the western North Pacific experienced more gradual changes than eastern North Pacific.

Keywords: North Pacific, deglaciation, primary productivity, sea surface temperature, dinoflagellate cysts.

SS25-O11 (432)

Influence of the Pacific Decadal Oscillation in the Beaufort Sea over the last 150 years based on dinoflagellate cyst assemblages

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Dinoflagellate cyst assemblages were analyzed in a 36 cm-long sediment core collected in 2009 in the Mackenzie Trough (Canadian Beaufort Sea) to document the evolution of sea surface conditions and primary productivity since the onset of the industrial age. The average sediment accumulation rate of 2.6 mm/year, calculated from ²¹⁰Pb measurements, allows for a sub-decadal resolution over the ~150 years encompassed by the sedimentary sequence (AD 1855-2009). Transfer functions based on the modern analogue technique were used to document the evolution of sea surface parameters (temperature, salinity, duration of sea ice cover) using dinoflagellate cyst assemblages as proxy indicators. Reconstructed sea surface parameters were then compared with the Pacific Decadal Oscillation (PDO) and Arctic Oscillation (AO) indexes to determine their potential influence on the variability of oceanic conditions in the area. Positive phases of the PDO are marked by relatively high temperature and salinity conditions and reduced sea ice cover, which are accompanied by peaks of high dinoflagellate cyst influxes. We associate these conditions with upwelling events that bring nutrient-rich Pacific waters in the upper part of the water column, enhancing primary productivity. Such upwelling events occur on a regular basis along the Mackenzie Trough and slope areas in modern times. Conversely, negative phases of the PDO are marked by relatively cool, low salinity conditions and low primary productivity, as suggested by the low dinocyst influx values. The AO does not seem to correlate with any of the reconstructed parameters or dinocyst influxes. However, positive phases of the AO are associated with high influx values of freshwater palynomorphs, which

we use as indicators of the Mackenzie River discharge. This suggests that positive phases of the AO may be linked with increased precipitations within the Mackenzie River watershed. These results indicate that the PDO may be the dominant atmospheric and oceanic circulation mode in the western Canadian Arctic at multi-decadal timescales, while the AO has limited influence.

Keywords: dinoflagellate cyst, Beaufort Sea, Pacific Decadal Oscillation, transfer functions, paleoproductivity.

SS25-O12 (329)

Process length variation of the cyst of the dinoflagellate *Protoceratium reticulatum* in the North Pacific: a new density proxy and first evidence of pseudo-cryptic speciation

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The process length variation of cysts of the dinoflagellate *Protoceratium reticulatum* (Claparède et Lachmann) Bütschli in surface sediments from the North Pacific was investigated. The average process length showed a significant inverse relation to annual seawater density: $\sigma_{t \text{ annual}} = -0.8674 \times \text{average process length} + 1029.3$ ($R^2=0.84$), with a standard error of 0.78 kg m^{-3} . A sediment trap study from Effingham Inlet in British Columbia shows the same relation of average process length to local seawater density variations. When compared to the Baltic-Skagerrak region, where the average process length variation is significantly related to annual seawater density with the following calibration: $\sigma_{t \text{ annual}} = 3.5457 \times \text{average process length} - 993.28$ ($R^2=0.86$, standard error 3.09 kg m^{-3}), we find these calibrations cannot be reconciled. This accentuates the regional character of the calibrations, which can be related to variations in molecular data (SSU, LSU and ITS sequences) showing the presence of several genotypes and the occurrence of pseudo-cryptic speciation within this species.

Keywords: density proxy, dinoflagellate cysts, *Protoceratium reticulatum*, Operculodinium centrocarpum.

SS25-O13 (320)

Polyphyletic round brown spiny dinoflagellate cysts

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Many spiny round brown dinoflagellate cysts have been collected from surface sediments in low to high latitudes. In a paleontological sense, these cysts consist of several different morphologies such as *Islandinium* and *Echinidinium* and classified into the Subfamily Protoperidinioideae and/or Subfamily Diplopsalioideae mainly based on their archeopyle types. However, due to difficulty of establishing cultures of such heterotrophic species for cyst incubation experiments and observation of the archeopyle, the corresponding thecate stages of most these cysts are still unknown. Recent progress in single-cell molecular rDNA analysis of these thecate forms and cysts revealed that round brown spiny cysts are polyphyletic, which confirms morphological evidence, i.e. *Oblea acanthocysta* belonging to the Diplopsalioideae and *Protoperidinium tricingulatum* and *Protoperidinium minutum* to the Protoperidinioideae. In addition to this, molecular analysis for a single cyst of *Islandinium minutum* without a cyst incubation experiment supports that this cyst belongs to Protoperidinioideae. Except for *O. acanthocysta*, other species forming round brown spiny cysts including *I. minutum* make a well-established clade; Monovela Group in the Family Protoperidiniaceae, which is clearly separated from the genus *Protoperidinium* sensu stricto as well as *Protoperidinium oblongum* and *P. claudicans*.

Keywords: diplopsalid, *Protoperidinium*, Monovela Group, round brown spiny cyst, *Islandinium*.

SS25-O14 (449)

New findings of the unsolved cyst - motile relationship of the *Protoperidinium oblongum*-complex

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Protoperidinium oblongum is a member of the marine heterotrophic thecate dinoflagellates. This species was first described by Aurivillius in 1881 and thereafter several varieties were recognized by Dangeard in 1927. Three varieties characterized by different cell shape, number of anterior intercalary plates and their shapes were described as *P. oblongum* var. *latidorsale*, *P. oblongum* var. *inaequale* and *P. oblongum* var. *symmetricum* respectively and now are called as *P. oblongum* complex by Yamaguchi in 2007. So far, based on the cyst germination experiment, three morphologically different cyst types have been known to produce plankton cells identical to *P. oblongum*, temporally called as cordate, rhombic, and horned types. However, these relationships of the cyst and plankton cells have been yet uncertain, because careful and precise observation of the morphology of germinated plankton cells were not sufficiently carried out until now. For clarifying these uncertain relationships, three morphologically different cyst types collected from sediments of Omura Bay in West Japan were provided for germination experiments. Observation of external morphology of germinated thecate cells, in particular the shape of antapical horns, number of anterior intercalary plates, their shapes and molecular phylogenetic analysis using a part of the LSU rDNA demonstrate the following relationships; cordate type cyst is identical to *P. oblongum* var. *latidorsale*, angular cordate type cyst to *P. oblongum* var. *inaequale* and rhombic type cyst to *P. oblongum* var. *symmetricum*. Consequently these two varieties are independent and therefore should be re-described as *Protoperidinium latidorsale* and *Protoperidinium inaequale*. In addition to these results, the molecular phylogenetic analysis

suggests that *P. oblongum* var. *latidorsale* and *P. oblongum* var. *inaequale* formed a different clade from the clade including the type species of the genus *Protoperidinium*.

Keywords: *Protoperidinium oblongum* complex, dinoflagellate cyst, var. *latidorsale*, var. *inaequale*, cyst-theca relationship.

SS25-P01 (545)

Late Miocene - Early Pliocene productivity, temperature and upwelling in the Eastern Equatorial Pacific

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The modern Eastern Equatorial Pacific (EEP) is characterized by strong zonal and meridional gradients in sea surface temperature (SST), thermocline depth and biological productivity. In general, these gradients relate to wind-driven upwelling in the far east and along the Equator. Recent paleotemperature studies have suggested that, during the late Miocene and early Pliocene, the EEP had reduced SST gradients and increased stratification relative to present-day, a so-called 'Permanent El Niño' state. However, during about 8 and 4 million years ago (Ma), sites within the EEP also had much higher sedimentation of biogenic components, which seems more consistent with enhanced upwelling rather than stratification. In the spring of 2009, Integrated Ocean Drilling Program (IODP) Expeditions 320 and 321 drilled a series of sites that comprise the Pacific Equatorial Age Transect (PEAT). The late Miocene-early Pliocene time interval was recovered as Sites U1337 and U1338 near the Equator. As documented at previous sites in the region, the sedimentary records at both sites exhibit elevated accumulation of biogenic material between about 8 and 4 Ma. Importantly, though, the sediment cores at U1337 and U1338 are remarkably well preserved because of recent advances in drilling technology. In this study, we apply a combination of techniques to understand two short time intervals at Site U1338 within the broader late Miocene-early Pliocene time span. The intervals were chosen to maximize deviations in physical properties and long-term sediment accumulation. The techniques included dinocysts counts, paleothermometry (TEX₈₆ and U^K₃₇) and bulk carbon and oxygen isotopes. Our results suggest a highly variable record of SST, sea surface salinity and carbon isotope composition of planktonic organisms, each coupled to sediment composition and dinocyst occurrences. We interpret these changes as representing variations in upwelling intensity, with a direct link between surface conditions and the sedimentary record. A 'permanent El Niño' may not have been as permanent as previously suggested.

Keywords: marine palynology, organic-walled dinoflagellate cysts, ENSO, permanent El Niño, paleothermometry.

SS25-P02 (544)

Cenozoic organic-walled dinoflagellate cysts from the Central Pacific Ocean (IODP Expeditions 320-321; Pacific Equatorial Age Transect; Sites U1331-U1338)

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Organic-walled dinoflagellate cysts are a valuable tool for the reconstruction of marine paleoenvironments. Much information is available on organic-walled dinocysts in shelf regions through geological history, but very little is known from deep ocean settings. During the Integrated Ocean Drilling Program (IODP) Expeditions 320 and 321 (Pacific Equatorial Age Transect; PEAT; spring 2009) eight sites (U1331-U1338) have been recovered in the Eastern Equatorial Pacific. Together they compile a continuous record since the middle Eocene. In this study we present a qualitative analysis of organic-walled dinocysts in the Eastern Equatorial Pacific from the Eocene to the present as a framework for future research.

Keywords: marine palynology, biostratigraphy, deep ocean.

SS25-P03 (48)

Organic-walled dinoflagellate cyst production in the Santa Barbara Basin: implications for harmful algal blooms and paleoenvironmental reconstructions

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A fortnightly sediment trap record spanning from May 1995 to March 1997 provides insights on the production of organic-walled dinoflagellate cysts in the highly productive waters of the Santa Barbara Basin (SBB), offshore Southern California. The trap was deployed at 538 m depth, in the oxygen-depleted bottom waters. Marine productivity in the SBB is greatly influenced by wind-driven coastal upwelling, particularly intense from spring to early summer. During periods of active upwelling, dinoflagellate cyst export to the bottom waters are higher (up to ~ 240,000 cysts m⁻² day⁻¹) compared to conditions of highly stratified surface waters (~ 60,000 cysts m⁻² day⁻¹). The assemblages are dominated by cysts of heterotrophic dinoflagellates *Brigantedinium* spp. (overall relative abundance of 62.4 %) and *Echinidinium* spp. (13.7 %). In total, 41 dinoflagellate cyst taxa are identified. Palynological and multivariate analyses show that *Brigantedinium* spp. is associated with active upwelling conditions, whereas *Lingulodinium machaerophorum* indicates post-("relaxed") upwelling conditions. Potentially toxic dinoflagellate species have been recovered in both thecal (e.g., *Prorocentrum micans*, *Lingulodinium polyedrum*) and encysted forms (*Lingulodinium machaerophorum*). The latter accounts for 5.0 % of the total assemblage. *Prorocentrum micans* fluxes exceed 80,000 thecae m⁻² day⁻¹, typically in association with highly stratified, nutrient-depleted waters. These results have important implications for reconstructing past harmful algal bloom occurrences and climate history of the SBB from the underlying laminated sediments.

Keywords: sediment trap, dinoflagellate cysts, *Lingulodinium machaerophorum*, upwelling, eastern North Pacific.

SS25-P04 (261)

Early Miocene biostratigraphy of dinoflagellate cysts of northern Japan

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Cenozoic dinoflagellate cyst biostratigraphy of Japan has been relatively well-documented for the Paleogene and for the Middle Miocene and younger strata (Matsuoka, 1983; Matsuoka et al., 1987; Kurita, 2004), although the Early Miocene interval has been scarcely discussed. The present study aims to establish a biostratigraphic scheme particularly for the lower Lower Miocene interval of northern Japan. Our discussion uses data from the Yubari, Haboro and Shiranuka areas, Hokkaido. The assemblages are quite similar through the three different localities, which confirms the broad geographical extent of the *Operculodinium* sp. B Taxon-Range Zone established in the Shiranuka area by Kurita (2004). The assemblages are characterized by relatively low diversity and by common occurrences of *Operculodinium* sp. B of Kurita (2004), and include *Achomosphaera ramulifera*, *Brigantedinium* spp., *Filisphaera filifera*, *Lejeunecysta* spp., *Reticulosphaera actinocoronata*, *Spiniferites* spp. and an acritarch species *Paralecaneia indentata*. Minor occurrences of the following species were also recorded; *Heteraulacacysta campanula*, *Impagidinium paradoxum* and *Tuberculodinium rossignoliae*. The age of the zone is provided by the *Thalassiosira praeprae* Zone (diatom, 20.3 – 24.0 Ma; Yanagisawa and Akiba, 1998) as well as by the fission track ages of 20.6 – 23.8 Ma. On the other hand, the *Operculodinium* sp. B Zone is covered with regional unconformity by the Lower – Middle Miocene *Diphyes latiusculum* Zone of Matsuoka et al. (1987). The oldest known age of the *D. latiusculum* Zone is given in the Joban area, Fukushima, northeast Japan, where the *D. latiusculum* Zone extends down as old as 18.2 Ma (Yanagisawa, 2011). As a consequence, the *Operculodinium* sp. B Zone can be well established below the *D. latiusculum* Zone at least within Hokkaido, and dated as 20 – 24 Ma. Slight modification of the definition of the zone may be required. In addition, a marked increase of species diversity at the base of the *D. latiusculum* Zone, being coincident with the Miocene warming, is the most prominent floral change of dinoflagellate cysts in the Late Oligocene - Miocene in northern Japan.

SS25-P05 (415)

Dinoflagellate cysts as indicators of millennial scale climatic and oceanographic variability in Guaymas Basin, Gulf of California (Mexico) during the Late Quaternary

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A high-resolution record of organic-walled dinoflagellate cyst production in Guaymas Basin, Gulf of California (Mexico) reveals a complex paleoceanographic history over the last ~40 ka. Guaymas Basin is an excellent location to perform high resolution studies of changes in Late Quaternary climate and paleo-productivity because it is characterized by high primary productivity, high sedimentation rates, and low oxygen bottom waters. These factors contribute to the deposition and preservation of laminated sediments throughout large portions of core MD02-2515. This is one of the first studies in the Northeast Pacific to document dinoflagellate cyst production at a centennial to millennial scale throughout the Late Quaternary. Based on the cyst assemblages two major dinoflagellate cyst zones were established, with eight subzones. The most dominant dinoflagellate cyst taxa found throughout the core were *Brigantedinium* spp. and *Operculodinium centrocarpum*.

Dansgaard-Oeschger events 5-8 are observed in the dinoflagellate cyst records, and are characterized by increases in warm *Spiniferites* taxa such as *Spiniferites pachydermus*. Preceding and during the Last Glacial Maximum *Polykrikos* cf. *kofoidii* increase, responding to oceanographic changes in the Gulf of California perhaps caused by a regression in sea-level. Other intervals of interest are the Younger Dryas where cooler sea-surface conditions are not recorded, and the Holocene which is characterized by the consistent presence of warm water species *Stelladinium reidii*, *Tuberculodinium vancampoae*, *Bitectatodinium spongium* and an increase in *Quinquecuspis concreta*. Changes in cyst assemblages, concentrations and species diversity, along with geochemical data reflect major millennial scale climatic and oceanographic changes.

Keywords: Gulf of California, marine palynology, primary productivity, Dansgaard-Oeschger events, climate change.

SS25-P06 (285)

A comparative study of the modern dinocyst assemblages from the Pacific coast of Mexico (15° N to 25°N) and the Gulf of Mexico (17° N to 29°N)

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Palynological analyses of surface sediment samples from about hundred sites of the southwest Mexican coast were undertaken in order to characterize the relationship between dinocyst assemblages and sea-surface parameters (temperature, salinity, productivity, depth, distance to the coast). The assemblages are characterized by a high diversity of species with more than 30 taxa belonging to Peridinales, Gonyaulacales and Gymnodiniales. The dinocyst counts allowed the recognition of distinct assemblage zones, and correspondence analyses indicate the strong influence of the upwelling intensity and the productivity. Dinocyst assemblages from upwelling areas were dominated by heterotrophic taxa belonging to *Brigantedinium* spp., *Echinidinium* spp., *Polykrikos kofoidii* and *Selenopemphix quanta*. Other characteristic species include *Bitectatodinium spongium* and *Polysphaeridium zoharyi*. At similar latitudes in the Gulf of Mexico, the dinocyst assemblages yield totally different species compositions. Assemblages from recent sediment of the Texas-Louisiana slope, the western Florida coast and the inner shelf of the Mexican state of Veracruz show the dominance of the phototrophic taxa *Spiniferites* spp., *Polysphaeridium zoharyi*, *Operculodinium* spp. and *Impagidinium* spp. along with the cosmopolitan *Brigantedinium* spp., which seems to relate to salinity variations. Moreover, important morphological variations were observed within the different species. The comparison of the assemblages from the western Mexican coast and the Gulf of Mexico illustrates the determinant influence of productivity and hydrographic conditions, respectively.

Keywords: low latitudes, open-ocean, basin, diversity, statistical analyses.

SS25-P07 (301)

Modern pollen distribution in marine sediments from the northern part of the South China Sea and its environmental significance

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We analyzed the pollen and spore distributions in sediments from the northern South China Sea to support reconstruction of the region's palaeoenvironment. The maximum total pollen concentration was >3500 grains/g on the continental shelf and the continental slope of southeastern Hainan Island, the continental shelf near Guangdong, in basins near the Zhongsha Islands, and south of 15°N. The spore concentration reached 2000 spores/g, with high concentrations of trilete spores mainly on the continental shelf near Guangdong and southeastern Hainan Island and high concentrations of monolete spores mainly on the continental shelf near Guangdong and southeastern Hainan Island, and in basins. Tree pollen was abundant on the continental shelves near Guangdong and southeastern Hainan Island, the middle of the study area, and deep basins in the south. Herbaceous pollen was less abundant, with pollen from the Poaceae, Chenopodiaceae, Brassicaceae, and *Artemisia* scattered among the northern and southern regions, with the highest levels near Guangdong and a distribution that followed the northeastern monsoon or surface sea circulation. Chenopodiaceae and Cyperaceae pollen concentrations were high in the north. Poaceae pollen was most abundant along the Guangdong and Vietnam coasts due to the proximity to tropical and subtropical grassland and crops. Monolete spores and Cyperaceae pollen were most abundant near the Pearl River Estuary, southern Hainan Island, and southwestern Taiwan, probably originating from fluvial river discharge. *Pinus* pollen was abundant, with the highest levels on the continental shelf near Guangdong and sea areas south of 15°N; the distribution suggests long-distance transport. Pollen from tropical and subtropical broad-leaved trees (e.g., *Castanopsis*, *Quercus*) had low abundance. *Castanopsis* pollen appeared to originate near Hainan Island, Guangdong, and the Indochina peninsula. Trilete spores (mostly *Dicranopteris*) were most abundant on the continental shelf of southeastern Hainan Island and the continental slope far from Guangdong. High concentrations of trilete spores were mainly on the continental shelf of Guangdong and southeastern Hainan Island, and probably resulted from human disturbance.

Keywords: South China Sea, sediments, pollen, spores, environmental significance.