IODP Proposal Cover Sheet

☐ New ☐ Revised ☐ Addendum

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Title:	Arctic Ocean Paleoceanography: Towards a Continuous Cenozoic Record from a Greenhouse to an Icehouse World (ArcOP)		
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Permission to post abstract on IODP-MI Web site: ☐ Yes

Abstract: (*400 words or less*)

Prior to 2004, geological sampling in the Arctic Ocean was mainly restricted to near-surface Quaternary sediments. Thus, the long-term Pre-Quaternary geological history is still poorly known. With the successful completion of the Arctic Coring Expedition - ACEX (IODP Expedition 302) in 2004, a new era in Arctic research has begun. Employing a novel multi-vessel approach, the first Mission Specific Platform (MSP) expedition of IODP has proven that drilling in permanently ice-covered regions is possible. During ACEX, 428 meters of Quaternary, Neogene, Paleogene and Campanian sediment on Lomonosov Ridge were penetrated, providing new unique insights into the Cenozoic Arctic paleo-oceanographic and climatic history. While highly successful, ACEX also has three important limitations. The ACEX sequence possibly contains a large hiatus spanning the time interval from late Eocene to middle Miocene (based on the original biostratigraphic age model) or an interval of strongly reduced sedimentation rates (new Os-Re-isotope-based age model). This is a critical time interval, as it spans the time when prominent changes in global climate took place during the transition from the early Cenozoic Greenhouse world to the late Cenozoic Icehouse world.

Furthermore, generally poor recovery during ACEX prevented detailed and continuous reconstruction of Cenozoic climate history. Finally, a higher-resolution reconstruction of Arctic rapid climate change during Neogene to Pleistocene times, could not be reached during ACEX. We believe, this justifies a return to the Lomonosov Ridge for a second MSP - type drilling campaign within IODP to fill these major gaps in our knowledge on Arctic Ocean paleoenvironmental history through Cenozoic times and its relationship to the global climate history.

Overall goal of the proposed drilling campaign is the recovery of a complete stratigraphic sedimentary record on southern Lomonosov Ridge to meet our highest priority paleoceanographic objective, the continuous long-term Cenozoic climate history of the central Arctic Ocean. Furthermore, sedimentation rates two to four times higher than those of ACEX permit higher-resolution studies of Arctic climate change. As demonstrated in the proposal, this goal can be achieved by careful site selection, appropriate drilling technology, and applying multi-proxy approaches to paleoceanographic, paleoclimatic, and age-model reconstructions. We propose one primary deep drill site (LR-11B) with three APC/XCB/RCB holes, supplemented by a short APC drill site (LR-10B), to recover multiple sections of the sediment sequence to ensure complete recovery for construction of a composite section.

ArcOP objectives are key elements in the IODP New Science Plan, Theme 1 *Climate and Ocean Change*, especially Challenges 1 and 2.

Scientific Objectives: (*250 words or less*)

A complete stratigraphic sedimentary sequence representing the continuous Cenozoic climate history of the central Arctic Ocean will be studied to answer the following key questions:

- Did the Arctic Ocean climate follow the global climate evolution during its course from early Cenozoic Greenhouse to late Cenozoic Icehouse conditions?
- Are the Early Eocene Climate Optimum (poor recovery in the ACEX record) and the Oligocene and Mid-Miocene warmings also reflected in Arctic Ocean records?
- Did extensive glaciations (e.g., the OI-1 and Mi-1 glaciations) develop synchronously in both the Northern and Southern Hemispheres?
- What is the timing of repeated major (Plio-)Pleistocene Arctic glaciations as postulated from sediment echosounding and multi-channel seismic reflection profiling?
- What was the variability of sea-ice in terms of frequency, extent and magnitude?
- When and how did the change from a warm, fresh-water-influenced, biosilica-rich and poorly ventilated Eocene ocean to a cold, fossil-poor, and oxygenated Neogene ocean occur?
- How critical is the exchange of water masses between the Arctic Ocean and the Atlantic and Pacific for the long-term climate evolution as well as rapid climate change?
- What is the history of Siberian river discharge and how critical is it for sea-ice formation, water mass circulation and climate change?
- How did the Arctic Ocean evolve during the Pliocene warm period and succeeding cooling?
- How do the new ArcOP record correlate with the terrestrial record from the Siberian Lake El'gygytgyn?
- What is the cause of the major hiatus recovered in the ACEX record? Does this hiatus in fact exist?

Please describe below any non-standard measurements technology needed to achieve the proposed scientific objectives.

The sites are located in the seasonally ice-covered central Arctic Ocean (southern Lomonosov Ridge), and will need mission specific vessels to perform the drilling in the pack ice (marginal ice zone). A well organized ice-management strategy and support by an icebreaker (e.g., *Oden*) are needed.

Proposed Sites:

Site Name	Position	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
LR-01A (Alternate site for LR-11B)	80.9502 °N 142.9717 °E	1402	1225		1225	Recovery of a complete stratigraphic sedimentary record on the southern Lomonosov Ridge to meet our highest-priority paleoceanographic objective, the continuous long-term Cenozoic climate history of the central Arctic Ocean (Alternate Site)
LR-02A (Alternate site for LR-11B)	80.9650 °N 142.4717 °E	1458	1300		1300	Recovery of a complete stratigraphic sedimentary record on the southern Lomonosov Ridge to meet our highest-priority paleoceanographic objective, the continuous long-term Cenozoic climate history of the central Arctic Ocean (Alternate Site)
LORI-5B (Alternate site for LR-11B)	83.8005 °N 146.4750 5E	1333	1250		1250	Recovery of a complete stratigraphic sedimentary record on the southern Lomonosov Ridge to meet our highest-priority paleoceanographic objective, the continuous long-term Cenozoic climate history of the central Arctic Ocean (Alternate Site)

LR-03A (Alternate site for LR-11B)	81.1825°N 142.0918°E	1013	1185		1185	Recovery of a complete stratigraphic sedimentary record on the southern Lomonosov Ridge to meet our highest-priority paleoceanographic objective, the continous long-term Cenozoic climate history of the central Arctic Ocean (Alternate Site)
LR-04C (Alternate site for LR-11B)	81.3531°N 141.2484° E	875	930		930	Recovery of a complete stratigraphic sedimentary record on the southern Lomonosov Ridge to meet our highest-priority paleoceanographic objective, the continuous long-term Cenozoic climate history of the central Arctic Ocean, and to recover the HARS in a shallow depth (Alternate Site)

LR-05B (Alternate site for LR-11B)	81.3256°N 141.4248°E	906	1050		1050	Recovery of a complete stratigraphic sedimentary record on the southern Lomonosov Ridge to meet our highest-priority paleoceanographic objective, the continous long-term Cenozoic climate history of the central Arctic Ocean, and to recover the HARS in a shallow depth (Alternate Site)
LR-06A (Alternate site for LR-11B)	81.4568°N 140.7299°E	779	800		800	Recovery of a complete stratigraphic sedimentary record on the southern Lomonosov Ridge to meet our highest-priority paleoceanographic objective, the continous long-term Cenozoic climate history of the central Arctic Ocean, and to recover the HARS in a shallow depth (Alternate Site)

LR-11B **(Primary site)**	81.4365°N 140.8405 °E	794	900		900	Recovery of a complete stratigraphic sedimentary record on the southern Lomonosov Ridge to meet our highest-priority paleoceanographic objective, the continous long-term Cenozoic climate history of the central Arctic Ocean, and to recover the HARS in a shallow depth (**Primary Deep Site**)
LR-10B **(Primary supplementary site, located 6.5 km NNW of Site LR-11B)**	81.4836 °N 140.5855 °E	890	50		50	Recovery of the undisturbed uppermost (Quaternary) sedimentary section **(Primary Shallow Site)**
LR-07A (Alternate site for LR-11B)	81.6851°N 142.3074°E	764	740		740	Recovery of a complete stratigraphic sedimentary record on the southern Lomonosov Ridge to meet our highest-priority paleoceanographic objective, the continous long-term Cenozoic climate history of the central Arctic Ocean, and to recover the HARS in a shallow depth (Alternate Site)

LR-08A (Alternate site for LR-11B)	82.4215°N 142.1678°E	1450	865		865	Recovery of a complete stratigraphic sedimentary record on the Lomonosov Ridge to meet our highest-priority paleoceanographic objective, the continuous long-term Cenozoic climate history of the central Arctic Ocean (Alternate Site)
LR-09A (Alternate site for LR-11B)	82.8274°N 142.4677°E	1251	750		750	Recovery of a complete stratigraphic sedimentary record on the southern Lomonosov Ridge to meet our highest-priority paleoceanographic objective, the continous long-term Cenozoic climate history of the central Arctic Ocean, and to recover the HARS in a shallow depth (Alternate Site)