Deep drilling adjacent to polar ice sheets is important to reveal the dynamic history of ice formation and ice loss, the interaction with the surrounding ocean and atmosphere, and to project the extent of future ice-mass loss and associated sea-level rise.

With respect to the 2050 Science Framework our planned ocean drilling research falls into Flagship Initiative (FI) Ground Truthing Future Climate Change and the Strategic Objective (SO) Earth’s Climate System. Synergies with NASA could be to extend the short, satellite-based record into the past and provide technological drilling solution for harsh environments.

The Weddell Sea’s Filchner-Ronne Ice Shelf is one of the two major Antarctic drainage system, fed by the majority of the surrounding East Antarctic ice streams. The Weddell Sea is also the major source of Antarctic Bottom Water formation, which regulates the extent and intensity of the Atlantic Meridional Overturning Circulation. The study region hence plays a key role in driving Earth’s climate and ice-sheet variability.

Our planned drillings on the continental slope of the Weddell Sea target contourites – sedimentary ridges formed by the deposition of fine-grained mud – that contain a complete and high-resolution, continuous sediment record of at least the past 4 million years of Earth’s polar ice-sheet history. Critical time periods include the initiation of the Northern Hemisphere glaciation, the Mid-Pliocene warm time, the Mid-Pleistocene transition, late Quaternary ice-age cycles and the sedimentary record of glacial terminations and their transition into warm climate periods.

Our goal is to deliver critical data on the past behavior and interaction of the ice-ocean-atmosphere system and the implications for future dynamic ice-mass loss. Drillings will have to be achieved through a mission-specific platform (MSP). Further technological developments and improvements are envisaged to allow for drilling in water depth beyond 2000 m and in ice-invested areas. Critical ground-truthing work specific to this IODP proposal has been accomplished during the past decade by, e.g., [1-7].

We will generate data sets on ice-sheet dynamics (iceberg-rafted debris, provenance studies ($^{40}$Ar/$^{39}$Ar dating, U-Pb and Nd-Sr analysis), grain-size analysis), sea-ice extent (IPSO$_{25}$, diatom assemblages), sea-surface temperatures (TEX86, Mg/Ca) and paleo-CO$_{2}$ (B/Ca and Mg/Ca). Chronology will be ground-truthed by seismo-stratigraphic models, paleomagnetic measurements and bio-stratigraphic investigation. High-resolution age models will rely on carbonate shell isotope and relative paleointensity stratigraphies.

The first drillings in front of one of the world’s largest ice shelves will address fundamental and critical questions on past, present and future (in)stabilities in the Antarctic Ice Sheet. Obtaining such knowledge is crucial to better project future Antarctic ice-mass loss and the associated rise in global mean sea level. The drillings shall also provide crucial information on the interhemispheric relation of ice-sheet and climate events through past tipping points. Finally, the key location at the southern extension of the Atlantic Ocean will allow to study mechanisms of past, and future, bottom-water formation, sea-ice variability and the influence on the global overturning circulation.

References: