The Coordinated Arctic Acoustic Thermometry Experiment – CAATEX

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Introduction

The central Arctic Ocean under the sea ice is poorly observed and remains largely unknown. The CAATEX project is designed to address four major research questions:

- *What is the spatiotemporal variability of mean ocean temperature in the central Arctic Ocean?*
- *How do local atmosphere-ice-ocean interaction processes vary between seasons and regions?*
- *How well do climate models estimate the heat content of the Arctic Ocean?*
- *How do climate models with the least biases in ocean heat content project the fate of the Arctic sea ice?*

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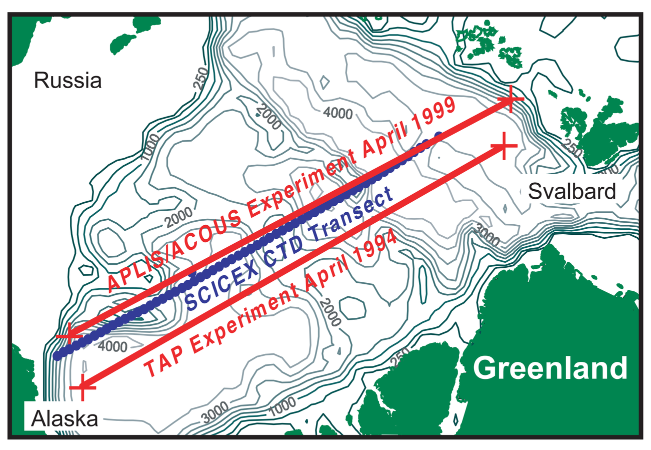
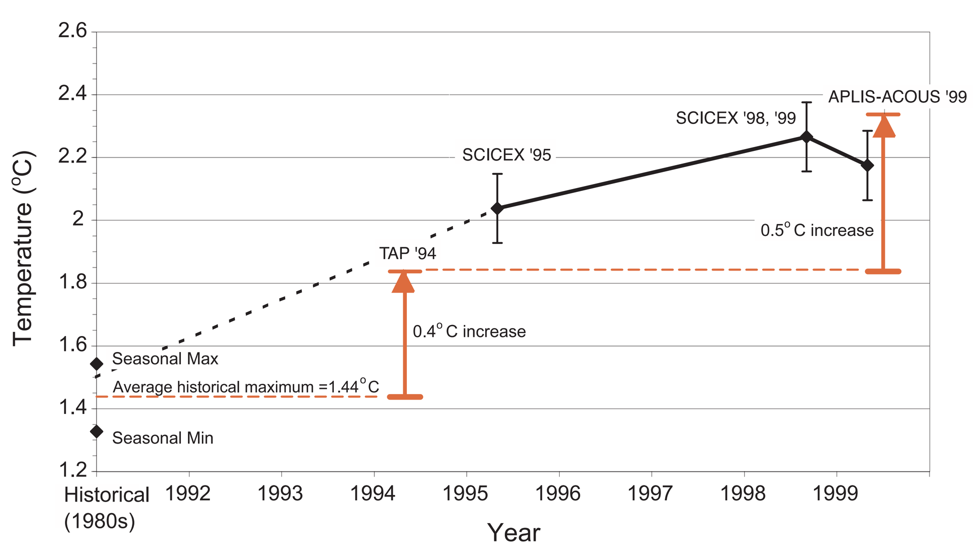
The TAP experiment 1994

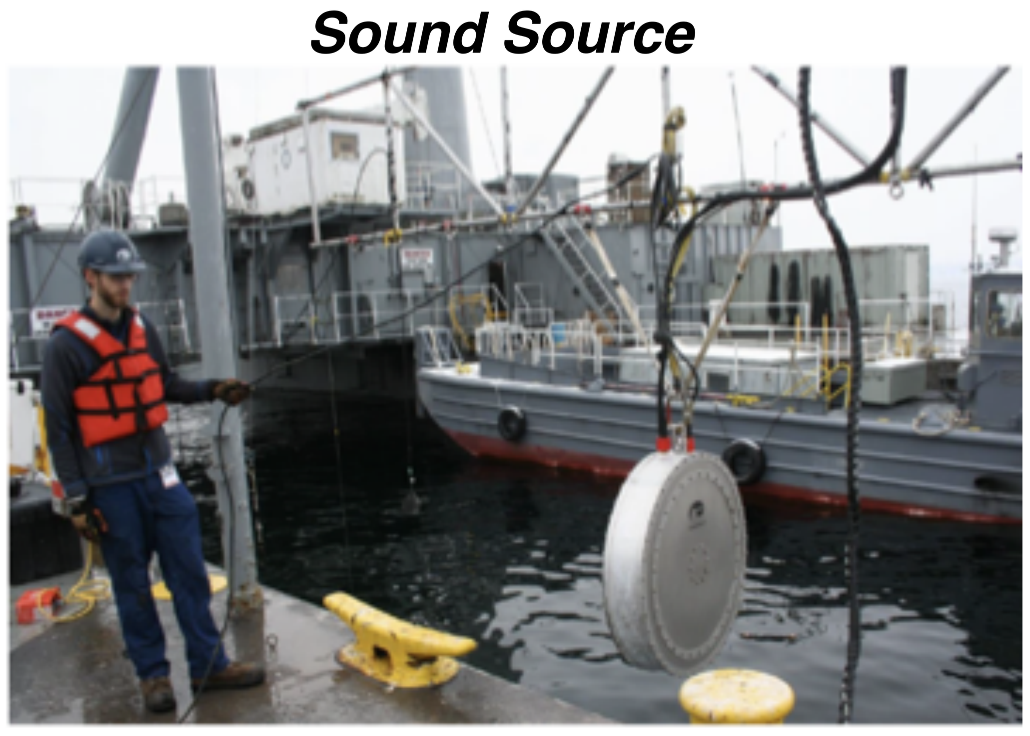




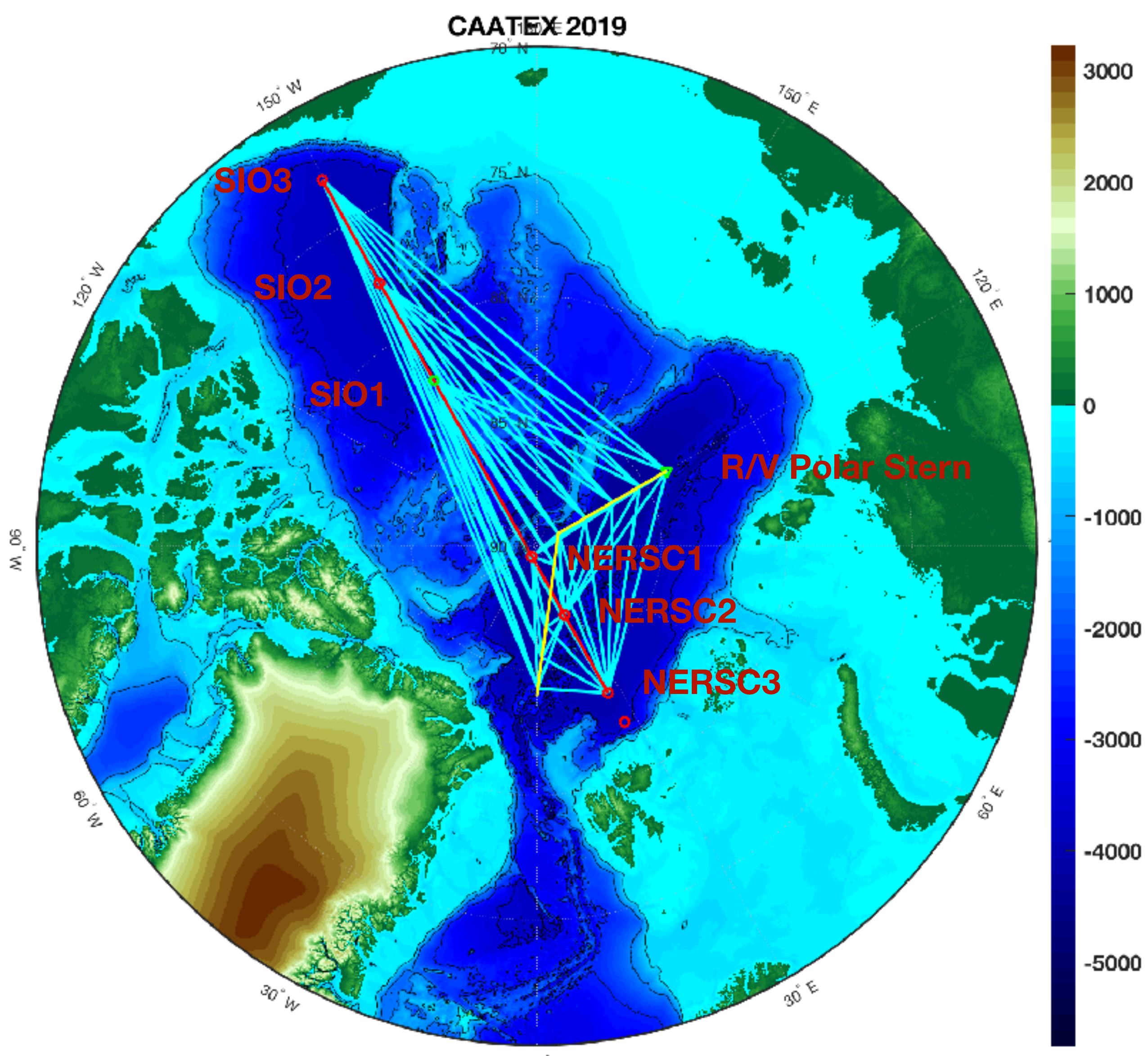
The red lines on the upper panel show the paths of acoustic transmissions in 1994 and 1999, and the blue lines show the tracks of submarine oceanographic surveys. The lower panel shows heat content along those paths, which is one of the key points of comparison to the proposed CAATEX measurements.

Fom Dushaw et al., "Observing the Ocean in the 2000s: A Strategy for the Role of Acoustic Tomography in Ocean Climate Observation," Observing the Oceans in the 21st Century, C.J. Koblinsky and N.R. Smith (Eds), GODAE Project Office and Bureau of Meteorology, Melbourne.. 2001.

Sound Source



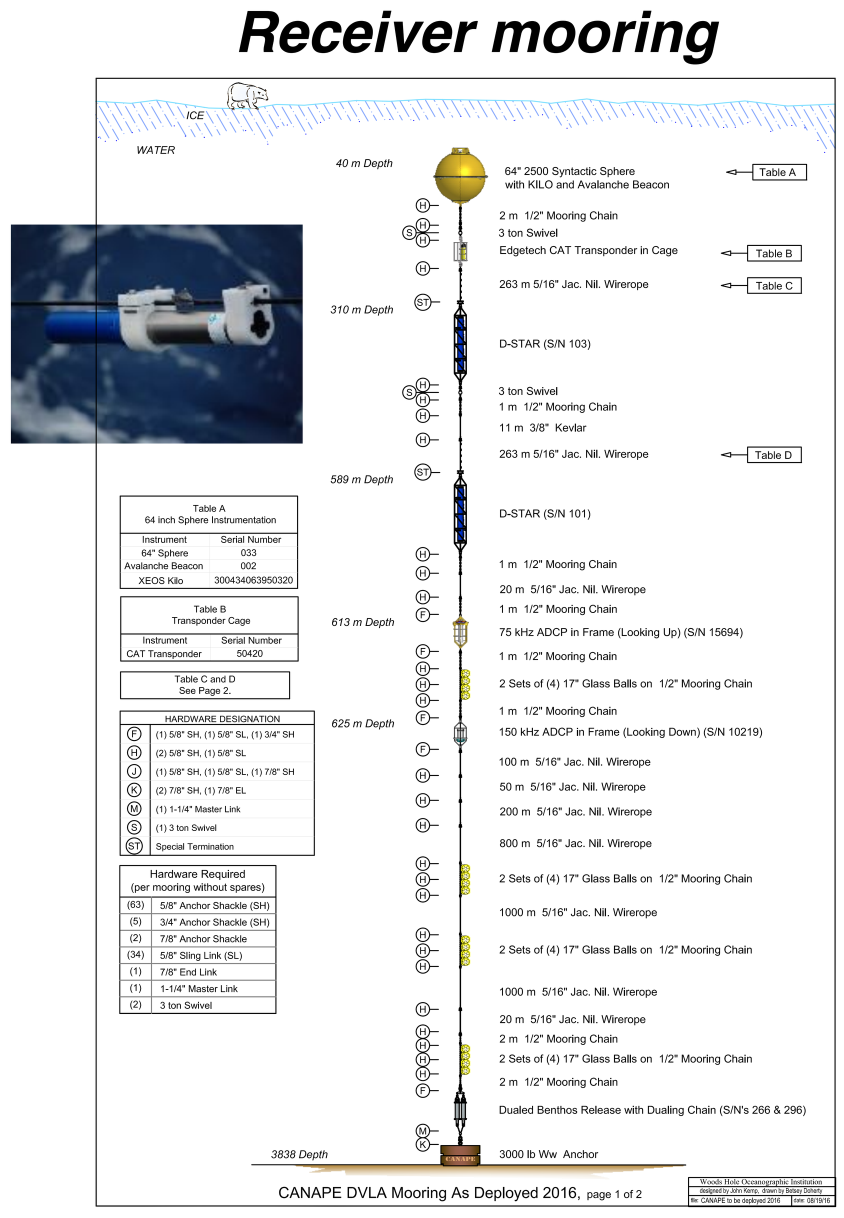
The GTI low-frequency sound source under test at the Seneca Lake Facility.



The anticipated drift of the R/V Polarstern (yellow), the moorings proposed by the U.S. partners (SIO1, SIO2, and SIO3) and by the Norwegian partners (NERSC1, NERSC2, and NERSC3), and examples of the acoustic paths between the drifting source and the moorings (cyan). The fixed path between the source at SIO1 and the other moorings are shown in red.

The GTI low-frequency sound source will be deployed and operated from a hovercraft. The sound-source will be deployed through an ice-hole next to the hovercraft.

Receiver mooring



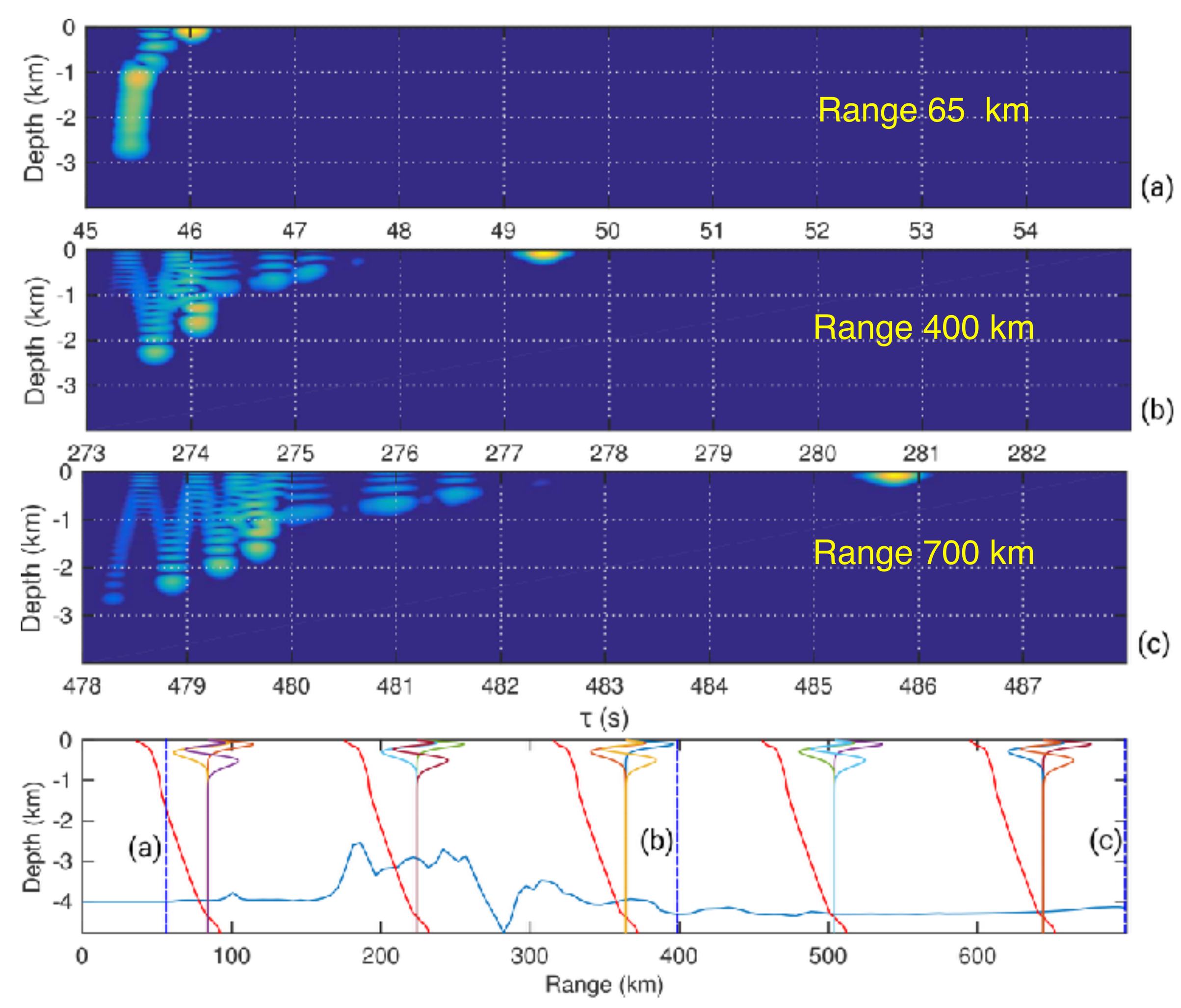
A typical receiver mooring with a vertical line array of hydrophones. A hydrophone (inset picture) is coupled inductively to the mooring wire allowing it to be synchronized by a central controller.

Our approach *is to use basin-wide acoustic thermometry and local ice-ocean observations in combination with an eddy-resolving ice-ocean model to produce improved ocean state estimates. This can be used to estimate the Arctic Ocean heat content and to benchmark global climate models.*

The observing system consists of a low-frequency source hanging under the ice close to the hovercraft, which will drift as part of the MOSAIC cluster. Fixed moorings with acoustic transceivers will receive signals from the source. This concept is called Drifting Acoustic Thermometry, and it will provide a scan of mean ocean temperature using sections along each line connecting the drifting source with the moorings. Additionally the measurements between moorings will provide yearlong time series of mean ocean temperature.

Each mooring will also provide oceanographic point measurements (CTD, current meters, upward looking sonars). In this way, CAATEX will provide data covering a much larger area than only the MOSAIC area.

Prior to deployment in 2019 a careful design study will be carried out to optimise the configuration of the moorings with its instruments.



Timefronts calculated with KRAKEN for a 34 Hz source at 160 m depth, at 65 km (a), 400 km (b), and 700 km (c) from a source at NERSC-3 The lower panel shows the bathymetry (blue solid), sound speed profiles (red solid), mode functions (solid, coloured), and the ranges where the time fronts are calculated (blue dashed).

With funding from The Research Council of Norway
European Commission