Decadal observations of deep ocean temperature change passively probed with acoustic waves

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INTRODUCTION AND MAIN RESULTS

Hydrophone arrays in the SOFAR channel continuously detected coherent sound waves from ambient noise and deterministic sources

Changes in deep ocean temperature are passively retrieved from the very small acoustic travel time differences through cross correlation

A decrease of -0.002 s/yr is derived, corresponding to a 0.007 ^{o}C/yr increase at 900m water depth over nearly two decades at IMS station H10 near Ascension Island

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IMS hydro-acoustic station H10

IMS hydro-acoustic station H10 has been operational since 2005. It consists of two hydrophone triplets to the North and South of Ascension Island in the Atlantic Ocean.
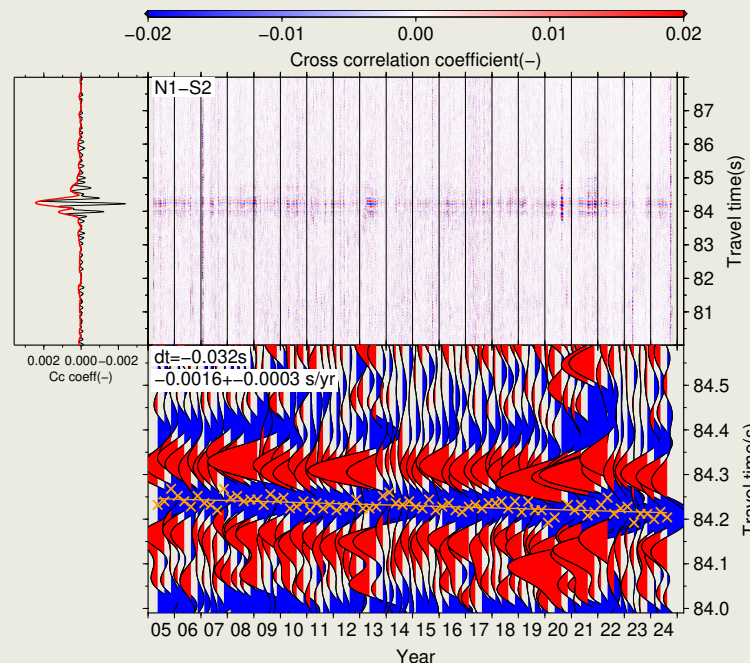
Variations in the deep ocean sound speed strongly depend on temperature. These variations can be assessed by determining the travel time differences between the northern and southern triplet.

Traditionally, such research has been conducted with ambient noise. A technique know as interferometry also applied in e.g. seismology. Here, deterministic transient signals will be used to accurately measure the travel time differences and hence the change in deep ocean temperature.
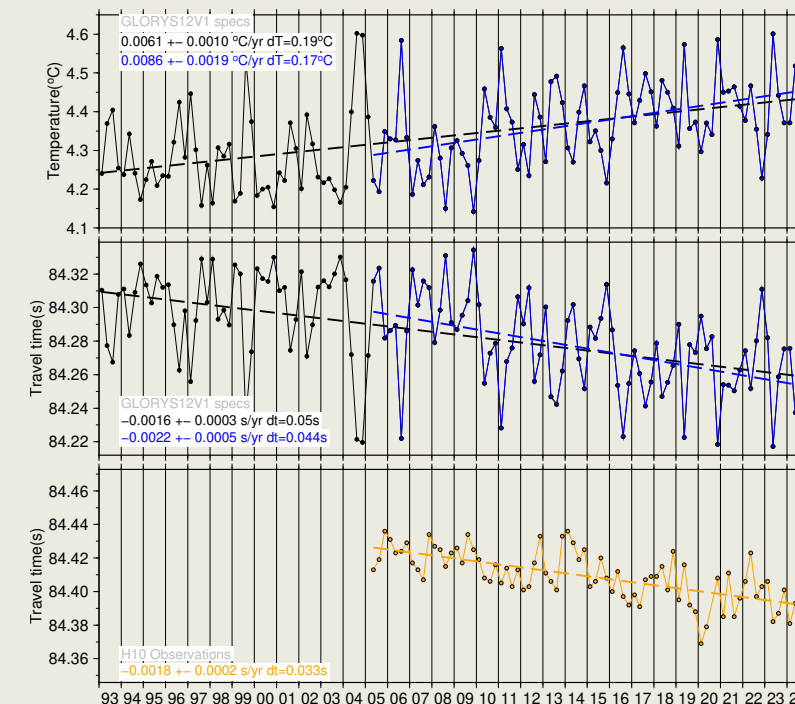
Cross Correlation Functions

Deterministic transient signals from a common source are extracted from the IDC detection database. A stationary phase+ is retrieved from transients appearing from a southerly direction (endfire).

Cross Correlation Functions (CCFs) for each hydrophone pair between H10N and H10S are calculated. Long-term trends are found of on average -0.0018 +- 0.0002 s/yr from all CCFs and all hydrophone pairs.

Deep ocean Warming

GLORYS12V1 specs
0.0061 +- 0.0010 °C/yr dT=0.19°C
0.0086 +- 0.0019 °C/yr dT=0.17°C

GLORYS12V1 specs
−0.0016 +- 0.0003 s/yr dt=0.05s
−0.0022 +- 0.0005 s/yr dt=0.044s

H10 Observations
−0.0018 +- 0.0002 s/yr dt=0.033s

Travel time differences are also modeled on the basis of Copernicus Marine Service Information: GLORYS12V1 temperature and salinity specifications (*https://doi.org/10.48670/moi-00021*). Comparing models and observations implies: a reduction in travel time of -0.002 s/yr corresponding to a temperature increase of 0.007 °C/yr over 20 year at 900m water depth.

The IMS senses climate variability