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Hydrophone localization for the newly installed CTBTO station HA04 using noise from the installation vessel

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Comprehensive Nuclear-Test-Ban Treaty Organization

During December 2016, the cabled hydroacoustic station HA04 was installed close to the Crozet Islands, France, in the southern Indian Ocean as part of the Comprehensive Nuclear-Test-Ban Treaty Organization's (CTBTO) International Monitoring System (IMS) designed to detect nuclear explosions worldwide. The HA04 station consists of two triplets of cabled to shore hydrophones deployed north and south of Crozet. Each triplet forms a two kilometre triangular configuration positioned in the Sound Fixing and Ranging channel for optimum performance. The water depth is approximately 1200 m with the hydrophones connected to a riser cable of approximately 700 m in length. The deployment was conducted from a cable vessel utilising high precision global and dynamic positioning system to position the sensors as close as possible to the planned locations.

Although high confidence in the sensor locations was achieved during the vessel operation, the locations were verified by independent means in order to refine sensor locations, optimize station performance, and to ensure that the deployment was within the tolerance of the terms of reference for the deployment. The alternative estimate of the individual sensor locations was formulated as a global optimization problem with 10 unknown parameters, i.e. latitude, longitude and depth for each sensor within a station and an effective sound speed value in water. The objective function was defined as a least-mean-square type error function between modelled and measured arrival times between pairs of hydrophones. The arrival times were obtained by cross-correlating radiated noise from the surface vessel deploying the sensors while performing a dedicated known track for the purpose of the hydrophone localization. Results from the hydrophone localization estimation are presented and compared to the planned positions together with uncertainty estimates caused by independent modelling and measurement errors.