

## Long-range ocean sound propagation effects related to the search for the Argentine submarine ARA San Juan.

The CTBT IMS hydrophone stations HA10 (Ascension Island in the Atlantic Ocean) and HA04 (Crozet Islands in the southern Indian Ocean) detected an unusual impulse-like event on 15th November 2017, which originated from the vicinity of the last known position of the Argentine submarine ARA San Juan. The location accuracy was confirmed by a depth charge deployed by the Argentine Navy two weeks later, which was detected by the same two hydrophone stations. Both impulse-like signals propagated out to a distance of approximately 7000 kilometres along different geodesic paths from the event origin through different underwater environments. The impact of the ocean waveguide propagation on these signals is analysed. Strong low-pass filtering and time dispersion are observed at the receiving end. Simulations of signal propagation along geodesic paths from the impulse-like event locations to HA10 and HA04 are performed by two-dimensional parabolic equation modelling of full time-series, utilizing spatial and temporal oceanographic database information. The modelling results broadly agree with bandwidth and time-dispersion features observed at HA10 and HA04 for the 15th November 2017 signal. These results suggest that inclusion of long-range propagation effects is beneficial for the detection and classification of distant signals from underwater impulsive events.

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