Assessing earthquake detection performance using hydro-acoustic datasets from oceanic gliders

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Abstract

The ocean plays a vital role in stabilizing the climate and sustaining life on Earth. The following years were proclaimed by the United Nations as the Decade of Ocean Science for Sustainable Development (2021-2030), and Seismology faces a significant challenge in effectively monitoring the activities underwater. The seismic energy released by submarine activities generates acoustic energy at the seafloor-water interface. When examining hydro-acoustic waves alongside seismic waves, we observe that these acoustic waves propagate more efficiently in the water column compared to seismic waves through the earth due to little attenuation in the SOFAR (sound fixing and ranging) channel, mainly at low frequencies (1-50 Hz). Underwater, a variety of signals can be detected, e.g., earthquakes, landslides, volcanic eruptions, explosions; and acoustic waves have been felt at distances of several thousand kilometers from both natural and anthropic sources. The development of underwater unmanned observation platforms, such as argo floats and oceanic gliders, has revolutionized oceanographic research and they have been widely used in marine surveys and military defense operations, and with a hydrophone, the instrument offers the capacity to measure the noise level underwater, along with the detection of hydro-acoustic waves. Based on data from 5 year of oceanic glider missions of the Project of Underwater Soundscape Monitoring of Santos Basin (PMPAS-BS), a requirement in the federal environmental licensing process for oil and gas production, we explore potential uses of hydro-acoustic datasets for earthquake detection. During the analysis, we conducted a characterization of sounds recorded by an oceanic glider, and our findings identified diverse signals that exhibited characteristics consistent with earthquakes. An exemplary case is the magnitude 6.1 earthquake of 24 December 2019 16:43:32 (UTC), at Santiago del Estero Province in Argentina, which was recorded after ~3 minutes at approximately 16,5° (~1800 km) away from the epicenter. Additionally, as per our processing, we found signals related to airguns acquisition during the middle of February 2019, presenting a dominant frequency between 7 and 14 Hz. In order to distinguish seismic events and self-noise produced during the glider's dive, the seismic events recorded were predominantly analyzed in time and frequency domain; however, when we faced a lack of conviction, we listened to the audio recorded, which helped to characterize the operating noise of the glider's machinery, e.g., piston, fin, air bladder. These results have significant implications for using oceanic gliders to detect seismic events in a near-real-time, coupled with identifying promising features, key challenges and desirable developments for seismic monitoring.