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Evidence of seasonal modulation of seismic sequences in the Azores

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This work provides an assessment of cyclical variations in seismicity and their relationship with hydrological disturbances in the Azores Triple Junction, looking in particular for seasonal and inter-annual modulations of the earthquake occurrence rate caused by sea-level anomaly and total wave height variations. The work involves the manipulation and the statistical analysis of the Azores seismic catalogue (considering only oceanic events), from 2008 to 2018. We analyzed the seasonal variations of the ocean seismicity by computing the ratio of Winter/Spring (JFMA) events and Summer/Fall (JASO) events, following demonstrated methodologies applied in previous studies in continental areas such as the New Madrid seismic zone and the Himalayan mountains. The seismicity rates in the Azores are higher during Summer/fall (JASO) and lower during Winter/Spring (JFMA), with a ratio JFMA/JASO significantly lower than 1. Different months were also considered for the Winter/Summer ratio (NDJF/MJJA) to observe if the seasonal pattern is still present and statistically significant. The results show that the seasonal variations are better captured when considering the NDJF/MJJA ratio and regions with higher number of events, such as between the Mid-Atlantic Ridge and Faial and Pico islands. Monte Carlo simulations and the Jack-knife approach confirmed that the probability of observing such a seasonality by chance is less than 1% mainly for magnitudes from M3.2 to M5.0, and is not the consequence of extreme deviations. The connection between the seasonal modulation and the hydrological loads was investigated using the Singular Spectrum Analysis. The principal components of the ocean seismicity rate present a strong correlation with the total wave height, and mainly with the sea-level anomaly, which might be possible triggers of the ocean seismicity rate in the Azores region.
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