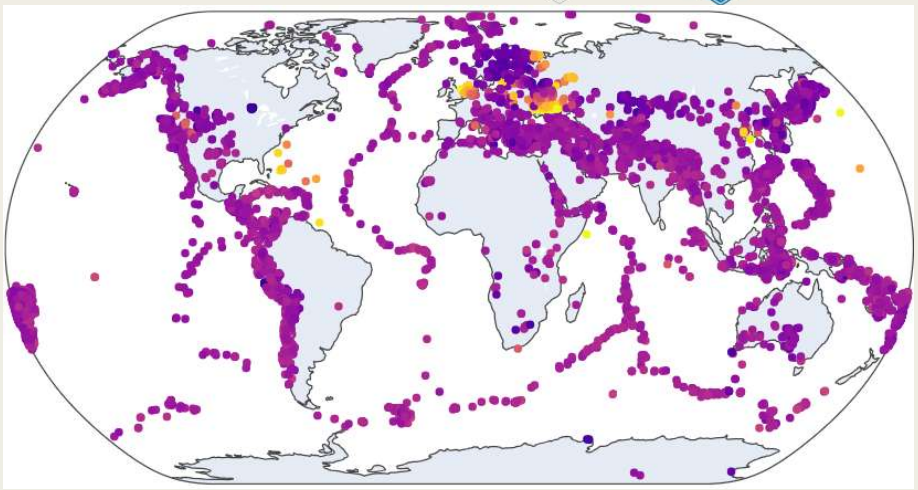
Analysis of Global Seismicity in 2024 and the Occurrence of Tsunamigenic Events Using the SSEB from the IDC of the CTBTO

Pedro M. Paulino / Jottin M. Leonel

Centro Nacional de Sismología (CNS) / Universidad Autónoma de Santo Domingo (UASD)



The Standard Screened Event Bulletin (SSEB) has proven to be a powerful and realistic tool for understanding global seismicity. Unlike raw seismic catalogs, the SSEB provides screened and validated data, offering greater reliability by minimizing false detections. In the context of this study, it has allowed us to observe clear seismic patterns, identify tsunamigenic candidates with greater confidence, and analyze tectonic behavior with precision. Its consistency and global coverage make it an essential reference for evaluating seismic hazards and supporting risk mitigation strategies.

As part of a comprehensive approach, we present data from other international seismic networks to complement and cross-check the findings based on the SSEB.

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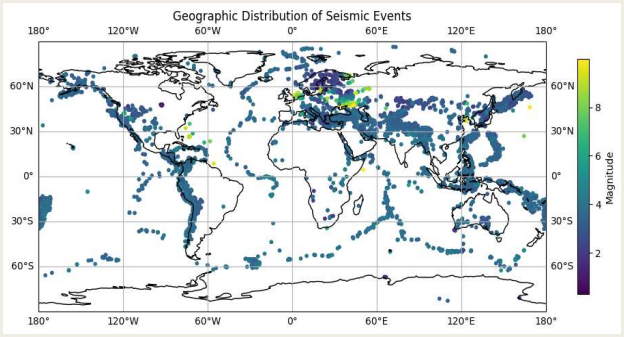
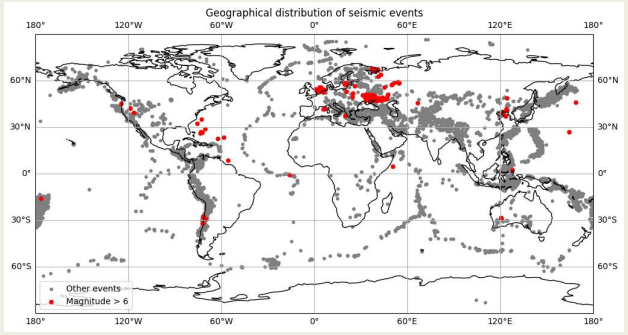
P5.1-255

Global seismology



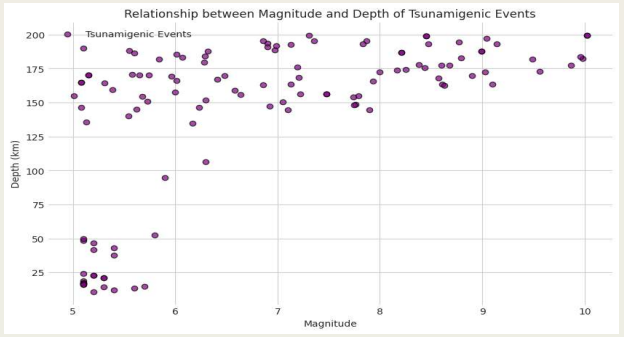
Here we show where earthquakes occurred during 2024. Every dot is a real event, placed by location and colored by how strong it was. You can clearly see how earthquakes align with major tectonic regions, especially around the Pacific, the Indian Ocean, and southern Europe. This map reminds us that seismic activity is not random—it follows the hidden architecture of the planet.

Most dangerous events



Out of more than 15,000 seismic events recorded by the SSEB in 2024, this graphic highlights those with tsunamigenic characteristics: magnitude greater than 6, depth shallower than 100 km, and near the coast (not always). This selection offers a realistic glimpse into where these dangerous events occur — and which parts of our world are most at risk.

Depth magnitude relationships



In this magnitude-vs-depth plot (depth ≤ 1000 km), red dots represent the few earthquakes that meet our tsunamigenic criteria: Mw ≥ 7.0 and depth < 100 km. These events are potentially capable of generating tsunamis, especially when they occur in subduction zones where vertical seabed displacement can move large volumes of water.

Out of 15,341 seismic events recorded in 2024, most were minor (12,859 with M < 4), while 2,037 events reached between M4 and M6, and 445 exceeded magnitude 6. On average, that's 1,534 earthquakes per month, and the seismic activity occurred at an average depth of about 101.7 km.

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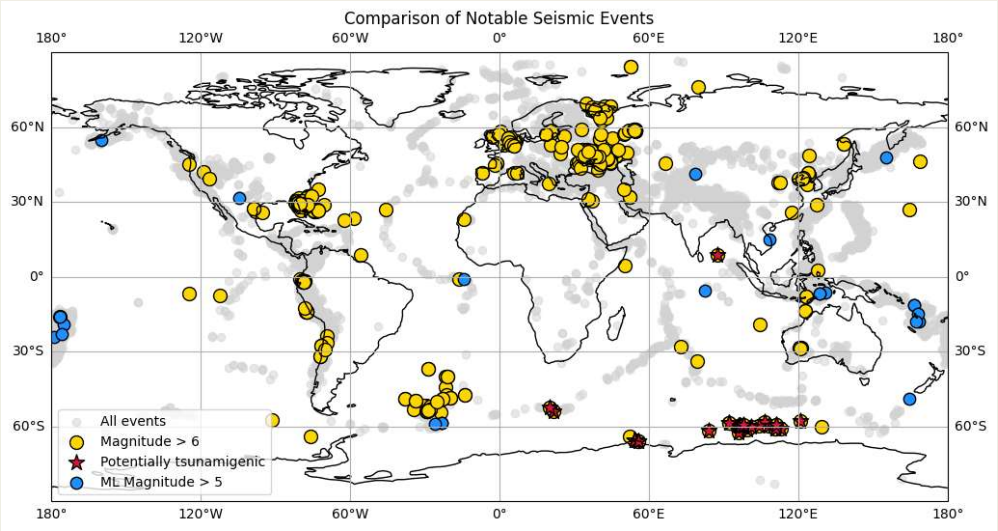

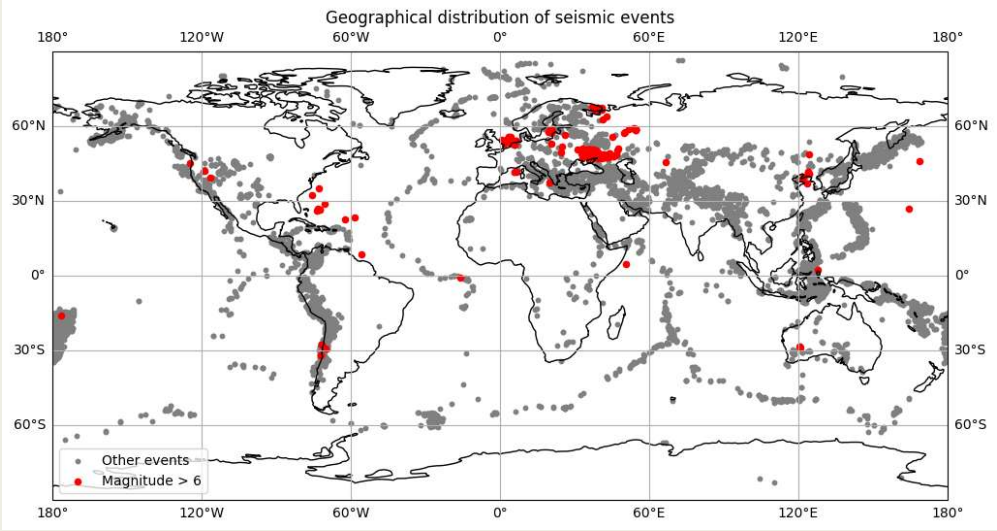

Our world map built from the **full 2024 SSEB data** clearly shows that seismic activity is not random—it outlines the tectonic plates with precision. The highest concentrations appear around the Pacific Ring of Fire, and when we zoom into specific hotspots like Japan, Indonesia, or the South American coast, we see stronger and more frequent events. These aren't just active zones—they're mostly subduction areas, where one plate dives beneath another, which is exactly what can generate tsunamis. This makes the map more than just a distribution of earthquakes; it's a direct and visual connection between plate tectonics and the global tsunamigenic threat.

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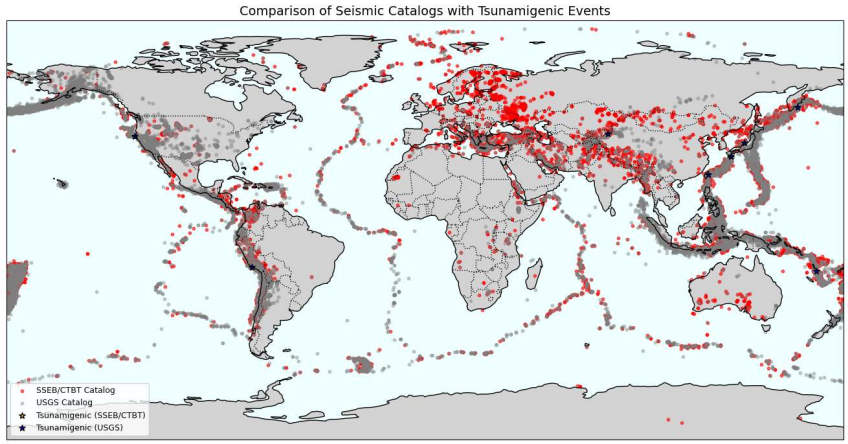
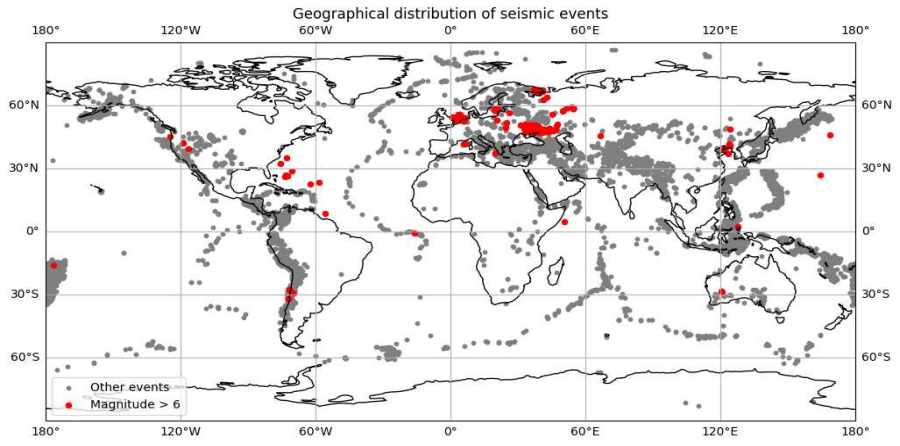
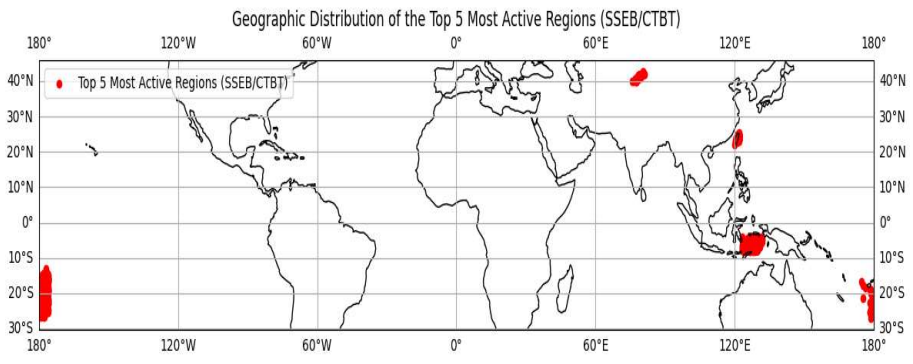
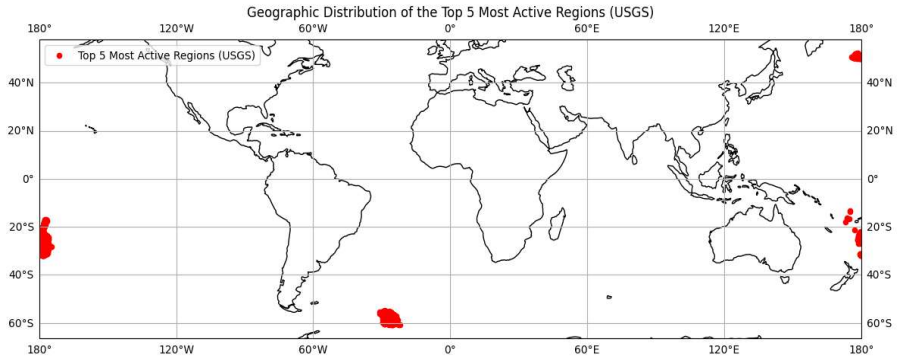
Different catalogs









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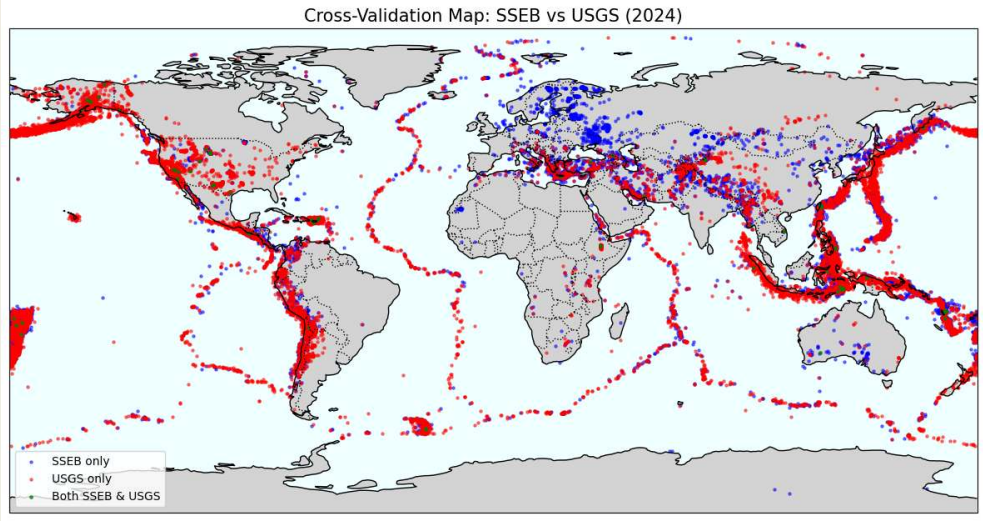
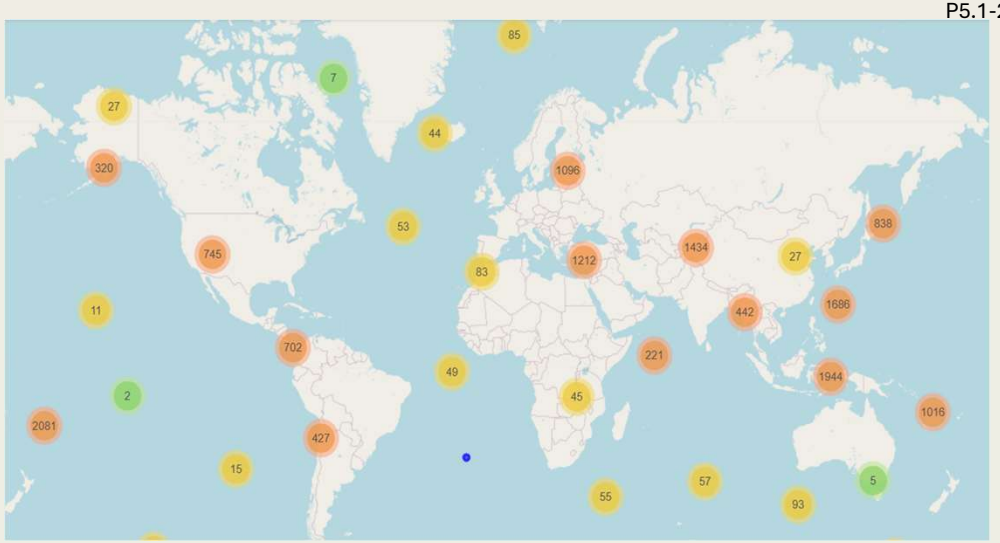


These two maps provide a complementary view of global seismicity in 2024. On the left, the cross-validation map shows a direct comparison between the SSEB from the CTBTO and the USGS catalog, revealing not only strong agreement across major tectonic boundaries but also the added value of each dataset. Notably, the SSEB contributes many unique detections—especially in subduction zones—demonstrating its refined screening capabilities and its global reliability.



This map highlights us the regions with the highest seismic density, reinforcing how the CTBTO's monitoring infrastructure delivers an unparalleled global snapshot of seismic activity.

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The Standard Screened Event Bulletin has proven to be a powerful a nd realistic tool with robust quality. Its high-confidence, expertly screened data are essential not only for tectonic and tsunami-related studies, but also for shaping global disaster prevention policies—helping to prevent major catastrophes when some of these events occur.

Thanks to the CTBT's strategic data pipeline via the IDC, this information provides a powerful foundation to raise awareness, analyze seismic patterns, and help shape public policies that specifically address tsunamigenic risks.

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