SnT 2025 8 SEPTEMBER ONLINE DAY 9 TO 12 SEPTEMBER AT HOFBURG PALACE, VIENNA & ONLINE
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

Reviewing Ground Truth Event Selection

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INTRODUCTION AND MAIN RESULTS

The IASPEI Reference Events List (referred to as the GT List) contains seismic event locations constrained to 5 km or better. The latest criteria for identifying these events was proposed by Bondár and McLaughlin (2009) and uses the azimuthal distribution of stations within 150 km as a criteria.

We propose an updated version of this criteria using a new measure of azimuthal station coverage, defined as the Cyclic Polygon Quotient (CPQ). We show that using this new criteria we can improve the geographic distribution and increase the number of events in the GT List from approximately 10,000 to greater than 70,000.

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IASPEI Reference Events List (GT List)

The GT list is a database of 12,278 earthquakes and explosions from 1959 to 2020, with hypocentres known to a high confidence (10 km or better) (Fig. 1). Events are coded from GT0 – GT5 where GT(X) is known to within X km, with a 95% confidence level.

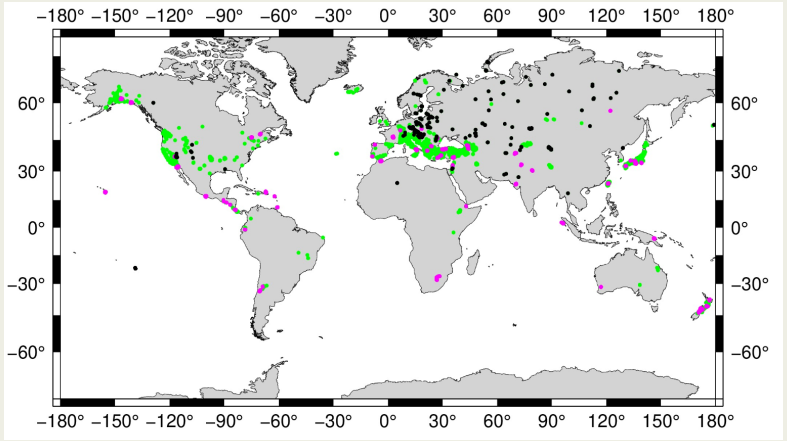


Figure 1: Circles are the locations of GT events, green are GT5 earthquakes, black are GT0,1,2 explosions and purple are GT from multi event methods.

The criteria used to identify GT events are taken from Bondár and McLaughlin (2009) and are applied before and after relocation (Table 1).

Table 1: Purple criteria are applied before and after relocation, green criteria are applied after relocation.

- **Magnitude < 6.1**
- **Phases within 150 km**
- **At least one station within 10 km**
- **Secondary azimuthal gap < 160°**
- **Balanced station distribution, ΔU < 0.36**
- **Semi-major axis of error ellipse <= 5 km**
- **Earthquake depth not fixed to a set value**

Cyclic Polygon Quotient

The balanced station distribution criteria (ΔU) measures the azimuthal distribution of stations. Adding stations to an event can cause this criteria to worsen with the result on longer meeting GT criteria (Fig. 2).

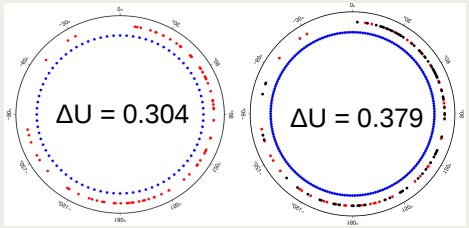


Figure 2: Red Circles are event station azimuths of reported stations for an event in New Zealand. Blue circles are the same number of stations evenly distributed in azimuth. Black circles are added unreported stations for the same event.

We propose a new measure of station distribution, Cyclic Polygon Quotient (CPQ) to replace ΔU (Fig. 3). CPQ is a ratio of the unitary circle area and the area created by connecting event to station azimuths (Figure 3).

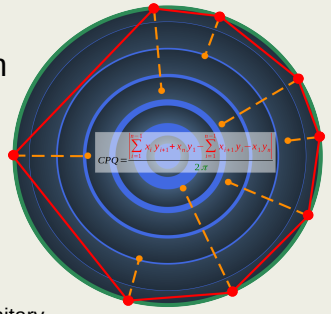
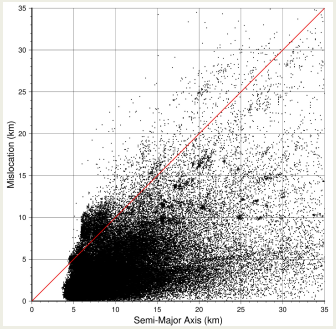


Figure 3: Orange circles are station locations, Red circles are station event azimuths projected to a unitary circle.



To test event location accuracy for we compare event mislocation to the size of the semi-major axis of the error ellipse (Figure 4). 93 % of events have a semi-major axis greater than the mislocation allowing semi-major axis to be used as the main criteria.

Figure 4: Black dots are randomly sampled station distributions for GT0 events.

New GT List

We propose amended criteria for the GT list (Table 2).

Table 2: New criteria are in white.

- **Magnitude < 6.1**
- **Phases within 150 km**
- **At least one station within 10 km or 5 or more stations reporting both P and S phases**
- **CPQ >= 0.4 & Secondary Azimuthal Gap <= 210°**
- **Recorded at distances >= 2°**
- **Semi-major axis of error ellipse <= 5 km**
- **Earthquake depth not fixed to a set value**

The depth criteria were added by evaluating the ability of the ISC location algorithm (ISCloc) to solve for depth.

This new set of criteria results in the the GT list increasing from 12,278 events to 80,730 events (Figure 5). Additionally the geographic coverage of the GT events has also been improved. This work is published in Seismica: ***https://doi.org/10.26443/seismica.v4i1.1536***

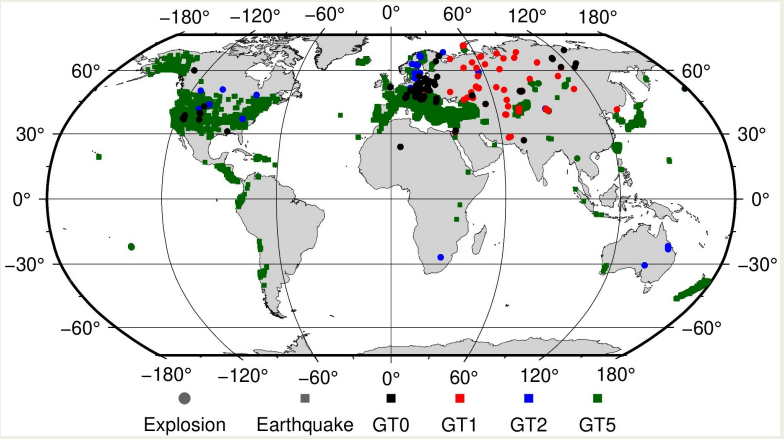


Figure 5: New GT List without GT from multi event methods.

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