

**CTBTO Contribution** to the  
**Global Earthquake Data Collection:**  
a view from the  
**International Seismological Centre (ISC)**

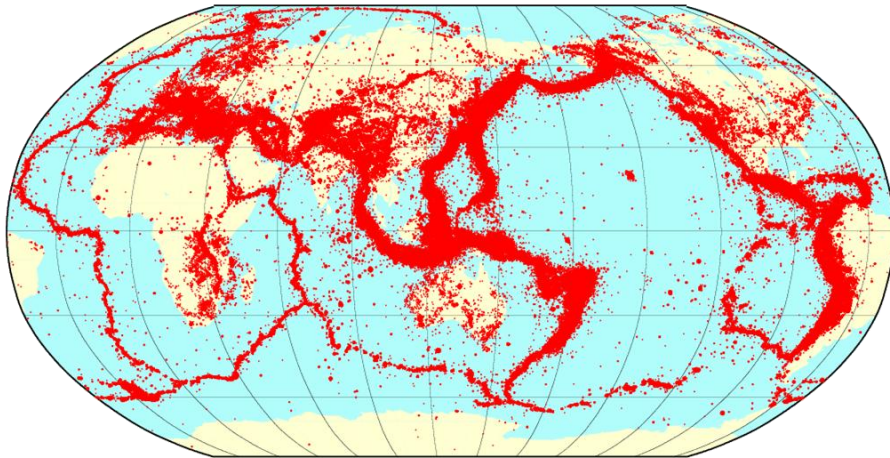
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***[www.isc.ac.uk](http://www.isc.ac.uk)***

# ISC Mission

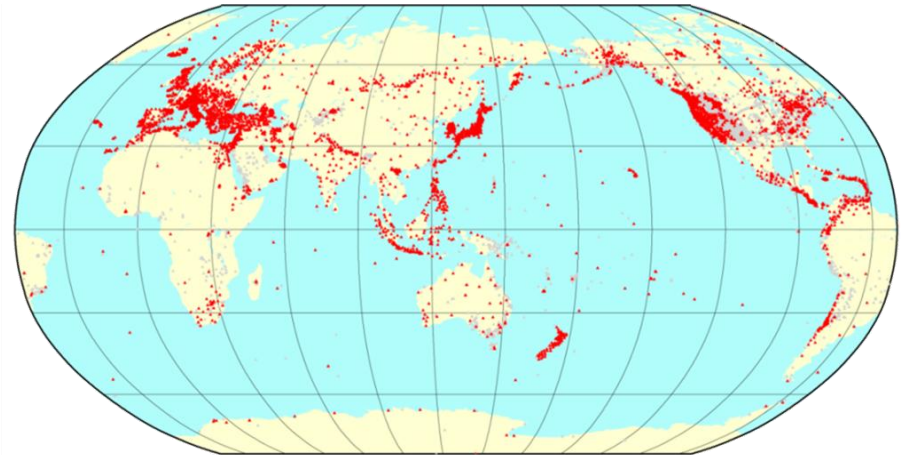
1. **ISC Bulletin** - the definitive summary of the world seismicity, the longest continuous & uniform set of bulletin data



1960-2009

2. **International Seismic Station Registry**

(with WDC for Seismology, Denver, USGS)



**16,583** stations,  
incl. ~1,600 US Array stations.

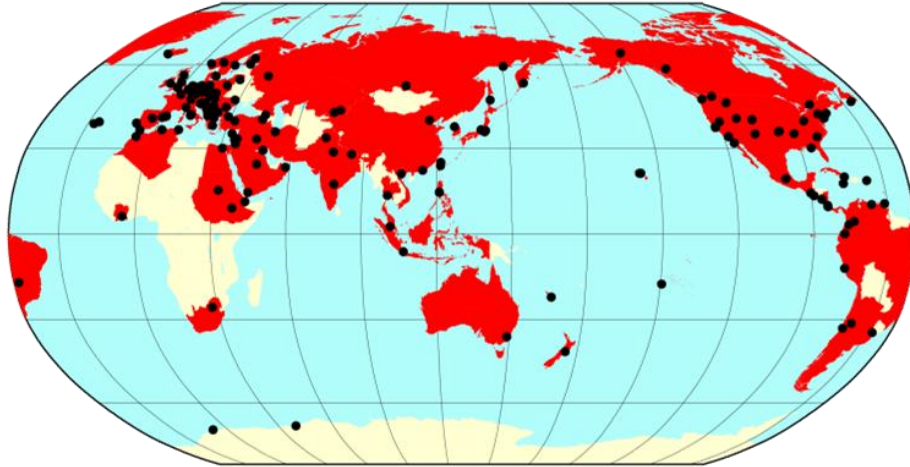
3. **Reference event collection (GT0-5)**

(with IASPEI)

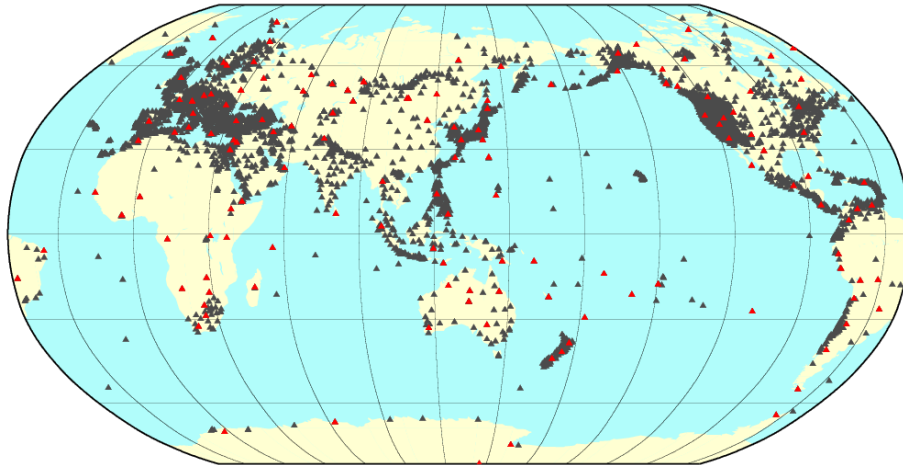


**7,334** GT0-5 seismic events  
with station arrivals

# REB - critical part of global bulletin collection



*120 seismic networks report to the ISC*



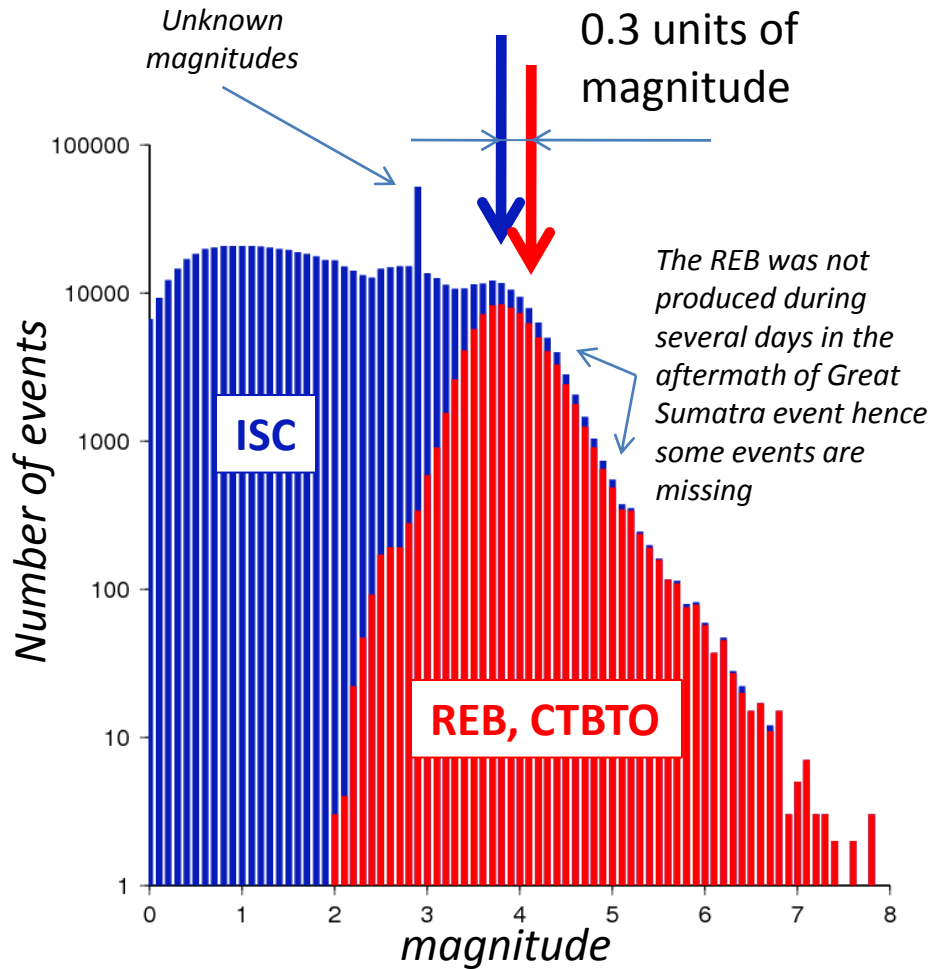
***CTBTO seismic arrays and stations**  
Arrays and stations of other networks*

- ❑ 120 seismic networks report seismic bulletin data to the ISC.
- ❑ The Reviewed Event Bulletin (REB) of IDC/CTBTO is an integral part of this data collection.
- ❑ The REB is indeed a critical component of this collection.

## Features of the CTBTO input:

- High quality certified instruments;
- Globally distributed;
- Data are 100% reviewed;
- Consistency in procedures over long period of time;
- On average, high accuracy arrival picking & phase identification thanks to array processing;
- Complements an alternative set of picks from co-located with CTBTO stations;
- **Reasonably well documented procedures.**

# Overall completeness

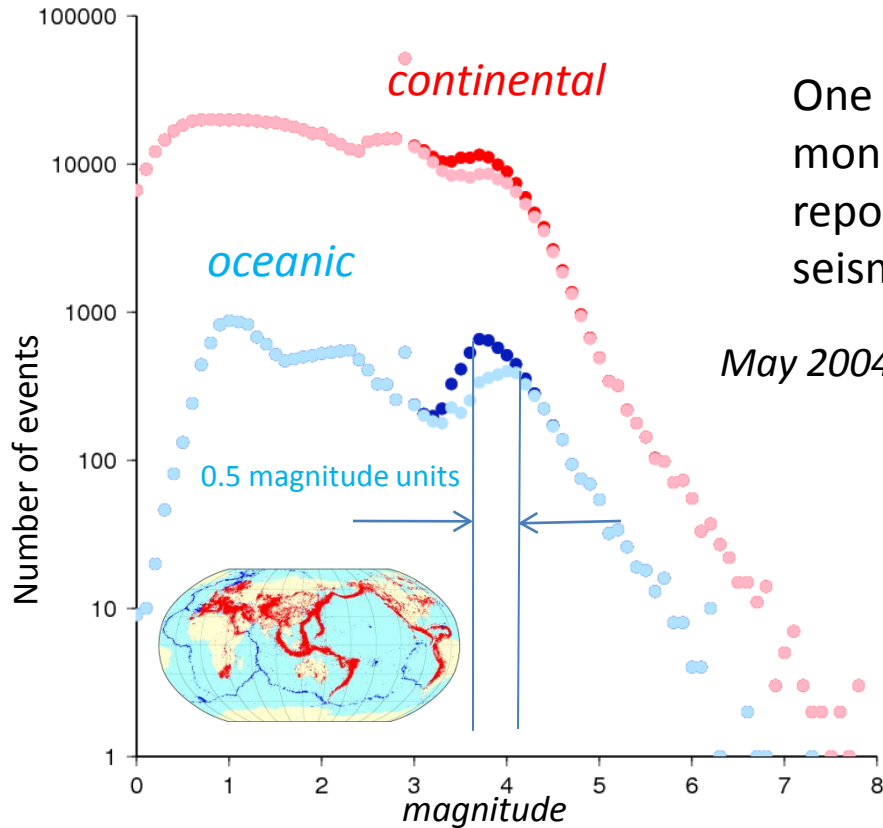


The difference in completeness of the ISC Bulletin and the CTBTO REB is minimal.

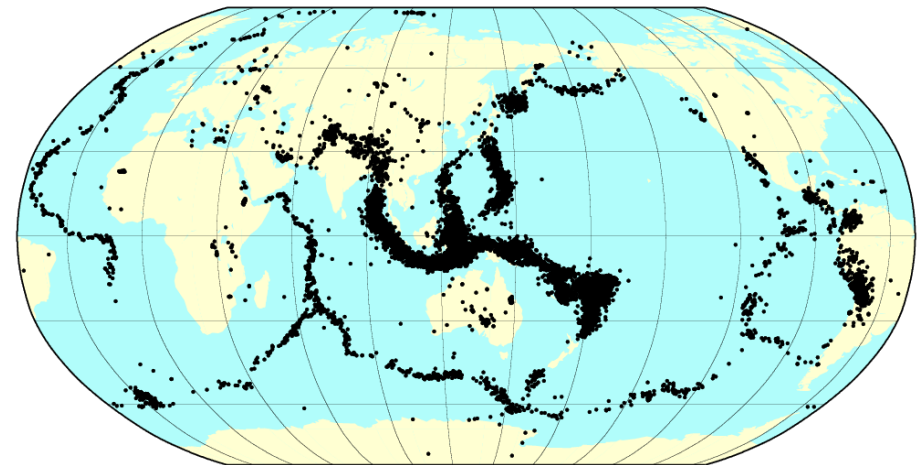
Using a network of only a few tens of seismic installations around the world CTBTO is capable of detecting all events with magnitude above 4.

*May 2004 – Apr 2007;  
incl. aftershock sequence of Great Sumatra Earthquake*

# Monitoring continental & oceanic seismicity



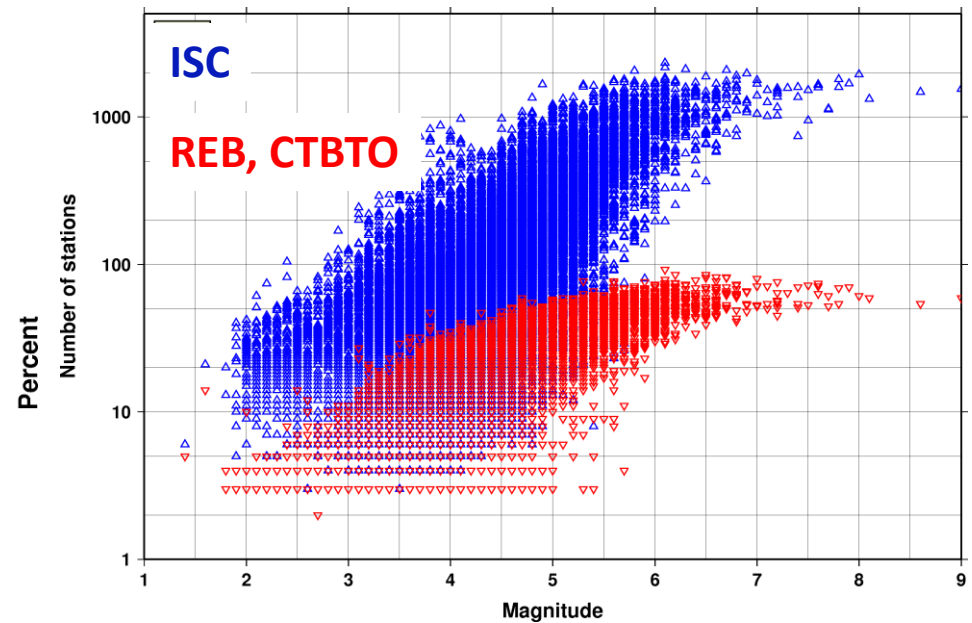
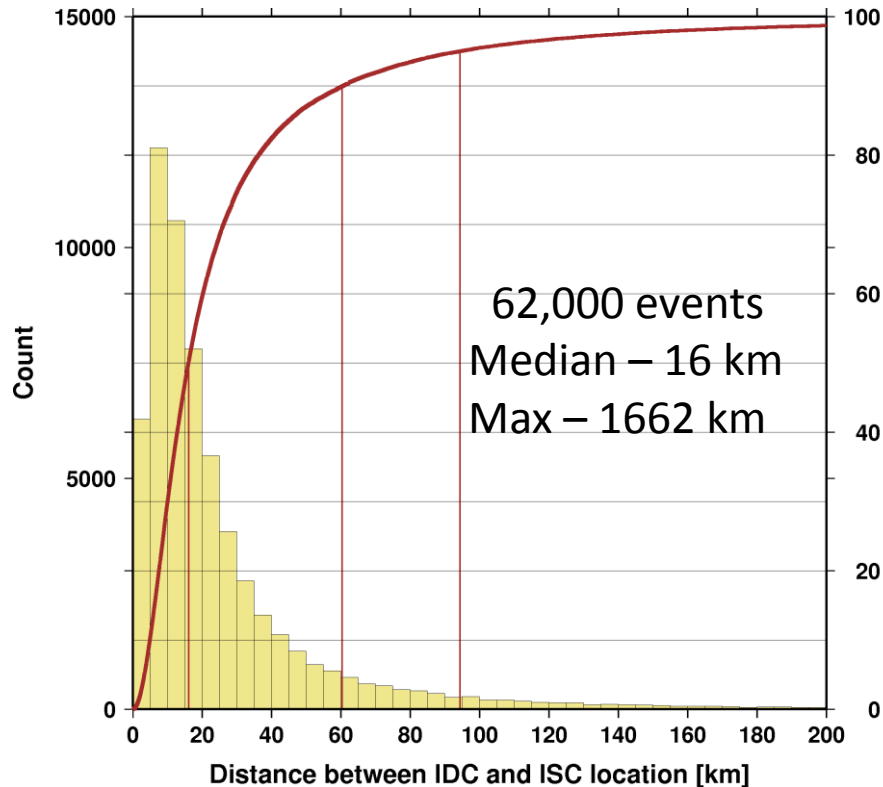
One of the most important CTBTO contributions to monitoring the world seismicity is the systematic reporting of seismic events in oceanic areas where seismic networks are sparse or non-existent.



**Bright red & blue** colours indicate the CTBTO contribution in completeness of the ISC Bulletin in **continental** and **oceanic** areas.

Approximately 8,000 events a year are reported to the ISC only by the CTBTO

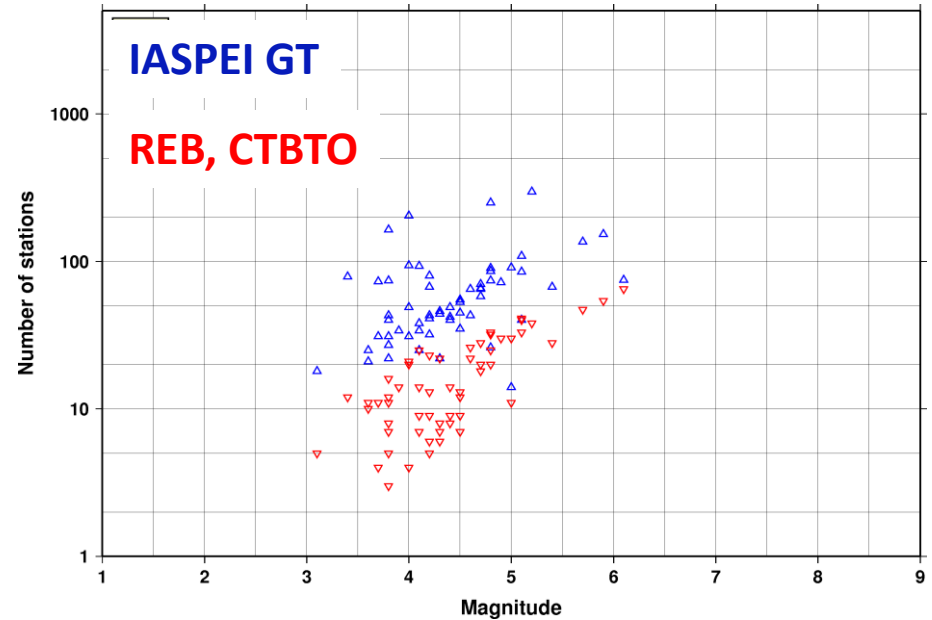
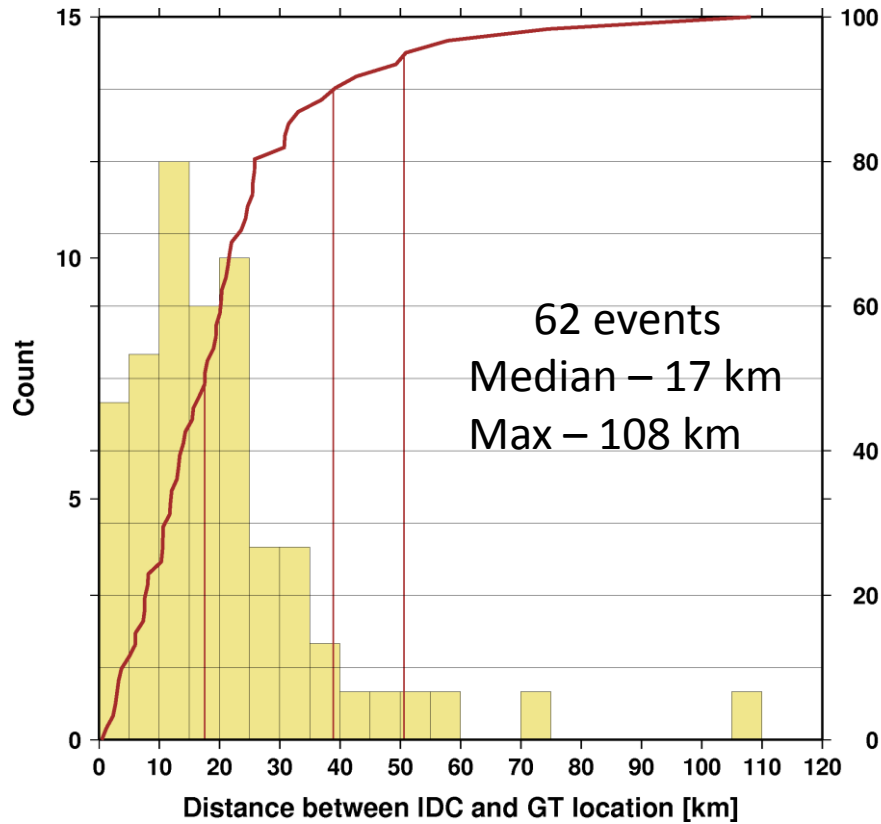
# Event location: CTBTO versus ISC



*May 2004 – Apr 2007*

Technically, ISC locations can not be considered as “ground truth” as these are biased by uneven configuration of network, location procedures and velocity model used. Yet the sheer volume of stations used by the ISC, including those very close to events, compared to CTBTO, in general should provide reasonably high degree of accuracy. In this respect the fact that as many as 50% of IDC locations are within 16 km of corresponding ISC locations and as many as 90% are within 60 km is indicative of a good CTBTO performance.

# Event location: CTBTO versus IASPEI GT

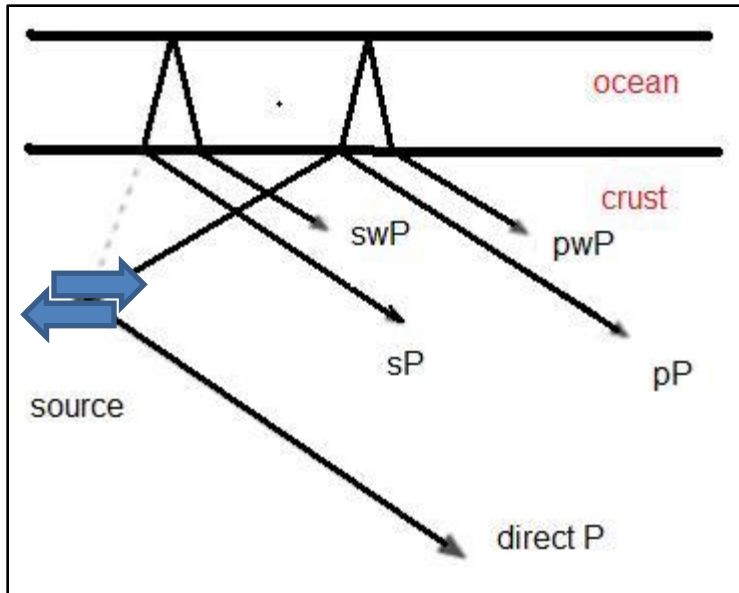


*May 2004 – Apr 2007*

ISC maintains the IASPEI collection of Ground Truth events. Between May 2004 and Apr 2007 these are just 62 moderate to large and very well constrained earthquake locations (up-to GT5).

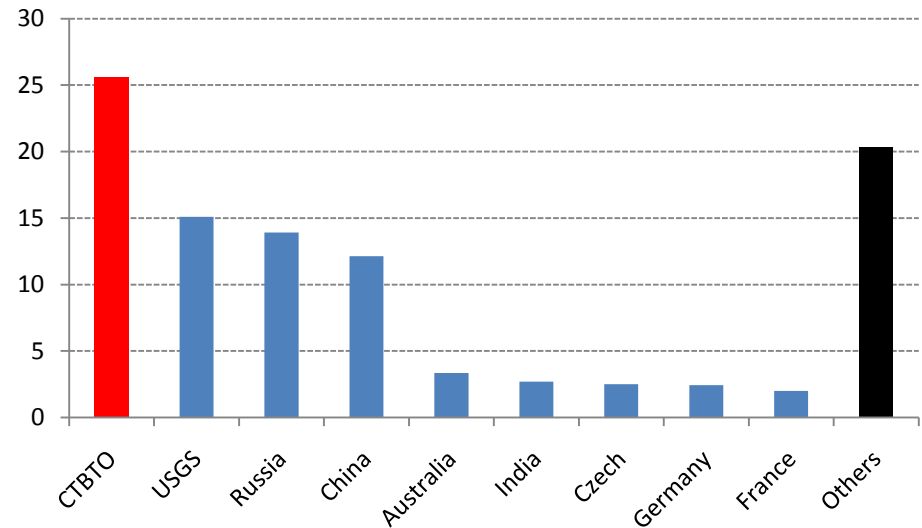
As many as 50% of REB events are within 17 km of the GT locations and as many as 90% within 40 km of GT.

# Constraining event depth



*In the absence of very close seismic stations it helps to constrain the depth of seismic events using differential times of arrival of direct P wave and waves reflected from free crust or ocean surfaces.*

Fraction of pP reports to the ISC, %

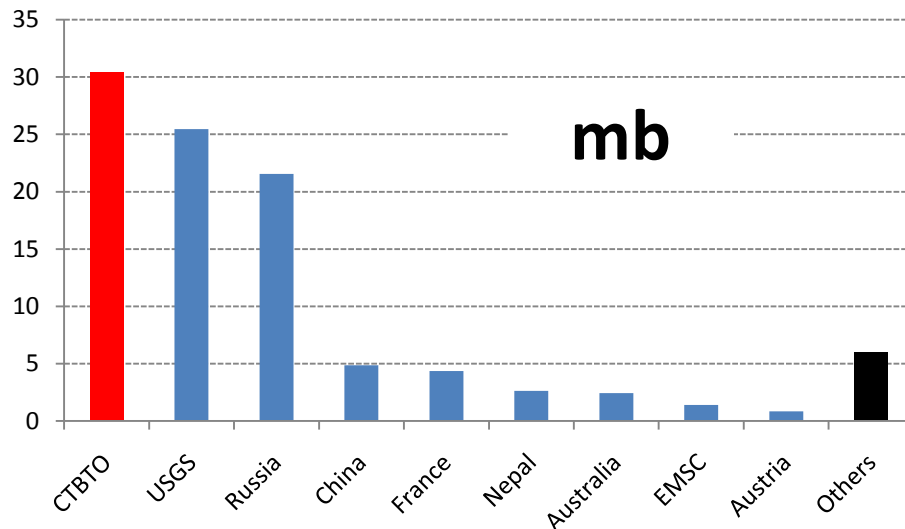


- ❑ CTBTO contributes as much as a quarter of all pP reports to the ISC
- ❑ Due to well known difficulty in picking these arrivals on waveforms, it is important that similar data of other networks are complimented by data of CTBTO



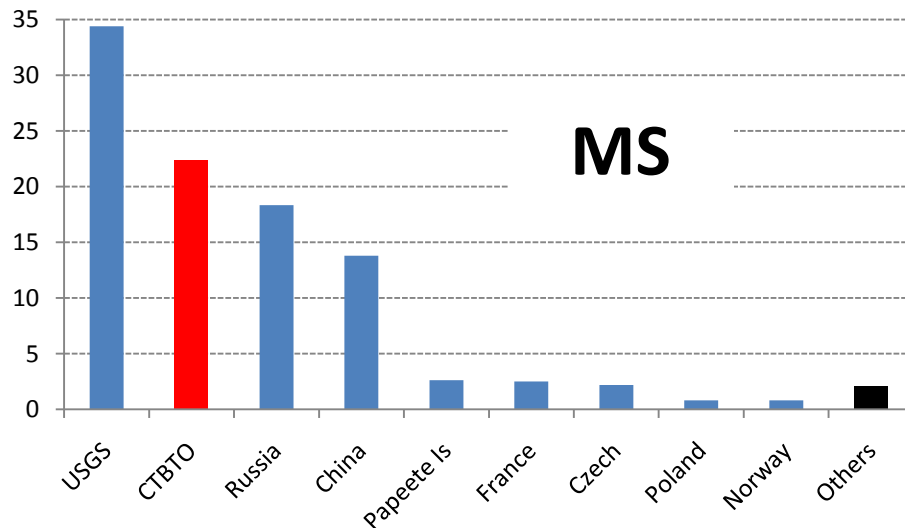
# Contribution to magnitudes

Fraction of amplitudes reported to the ISC, %



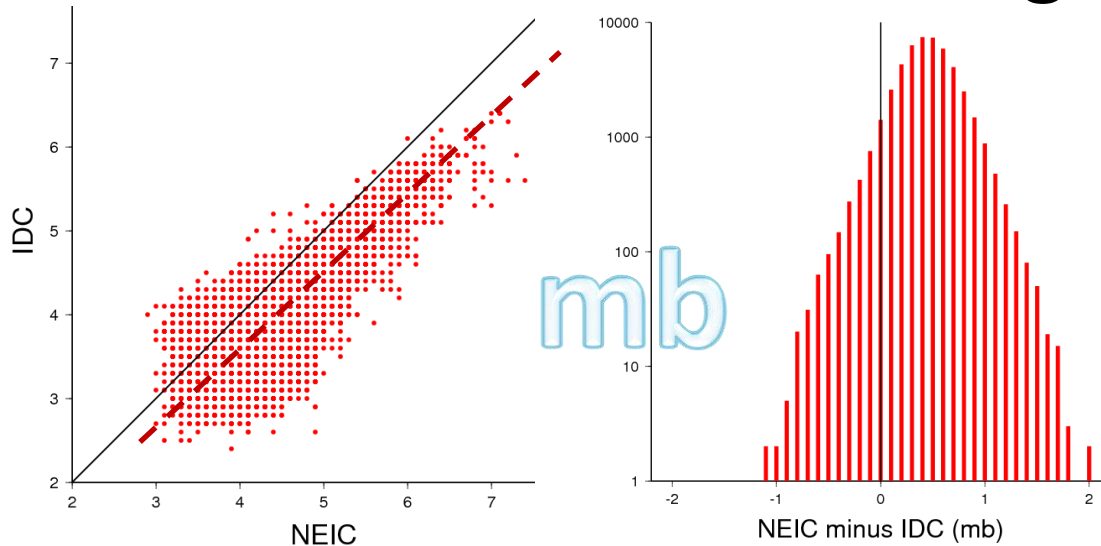
Body (mb) and surface (MS) wave magnitudes are important parameters of seismic events used in many fields, especially seismic hazard assessment and nuclear test monitoring.

Contribution of the CTBTO is enormous but has its positive and negative sides.

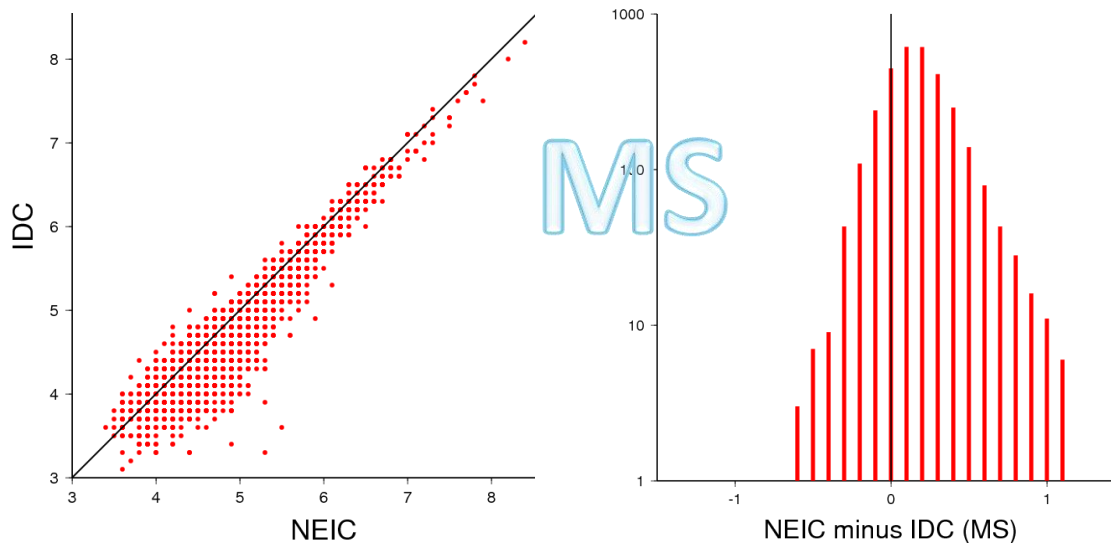


Many events, especially in oceanic areas, would have no magnitude estimate at all had the wave amplitudes not been measured and reported by the CTBTO.

# mb & MS: deviating standards



*There is, on average, almost 0.5 unit difference between CTBTO and traditional mb. This difference is dependent on mb.*



Unlike the ISC, the National Earthquake Information Center (NEIC) of USGS does not include CTBTO amplitude reports in computation of its magnitudes. Instead the NEIC follows the procedures described in the standard Manual of Seismological Observatory Practice (Willmore, 1979).

There is a considerable **deviation** between the CTBTO and NEIC estimates, most noticeably in **mb**.

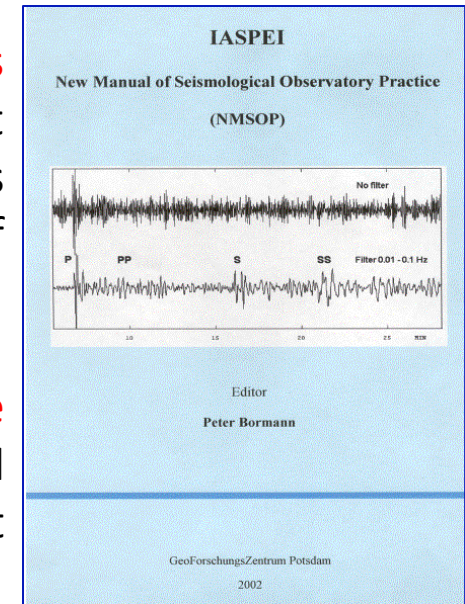
# How can the CTBTO help further?

CTBTO standards to measure amplitudes (filtering & time window) of seismic waves to estimate the mb and MS have been set to fulfil the prime CTBTO mission – to verify and monitor compliance with the Treaty.

We propose that **without changing the existing procedures** CTBTO could **also adopt** the magnitude **standards** laid out by the International Association of Seismology and Physics of the Earth Interior (**IASPEI**) to produce an additional set of amplitudes and magnitudes.

This **alternative data set would not harm the CTBTO prime operations** yet allow the CTBTO data to be even more useful in civil applications, primarily in seismic hazard assessment and earthquake and tsunami alert and response systems.

**The cost to CTBTO would be minimal yet the benefits are enormous.** The work would be confined to introduction of the IASPEI procedures into the operational software. No routine analyst work would be required.



# Conclusions

- ❑ The REB CTBTO is globally complete to approximately magnitude 4
- ❑ Within considered 3 year period 90% of CTBTO event locations were within 60 km of the ISC (62,000 events, median discrepancy 16 km) and 90% - within 40 km of the IASPEI GT (62 events, median discrepancy 17 km).
- ❑ REB is a **critical integral part** of international global seismicity monitoring operations. **CTBTO input to global earthquake data collection is invaluable** because of:
  - Event reports in oceanic and some other remote areas;
  - Reports of depth phases to constrain event depth;
  - Reports of amplitude measurements for MS and mb;
  - Use of globally distributed high quality certified instruments;
  - Data being 100% reviewed;
  - Consistency in procedures over long period of time;
  - On average, high accuracy of arrival picking due to array processing;
  - Provision of alternative set of picks from IMS stations co-located with non-IMS research or operational stations;
  - Well documented procedures;
- ❑ **We are asking the CTBTO** to provide additional high profile service by producing an additional set of amplitude measurements to be used in critical civil applications.

# Appendix: CTBTO link to the ISC database



The **United Kingdom Foreign and Commonwealth Office** along with partners from several Nordic countries are currently funding the project to make the ISC database of seismic events securely linked with computer facilities of Preparatory Technical Secretariat and National Data Centers.



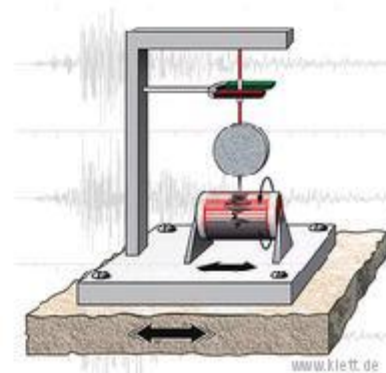
The ISC Bulletin data will soon be made available to PTS and NDCs through dedicated software designed to offer the ISC data in a way convenient to monitoring and verification community.



Area based Search



REB event based Search



Station Based Search