Summary of the 2008* Reviewed ISC Bulletin

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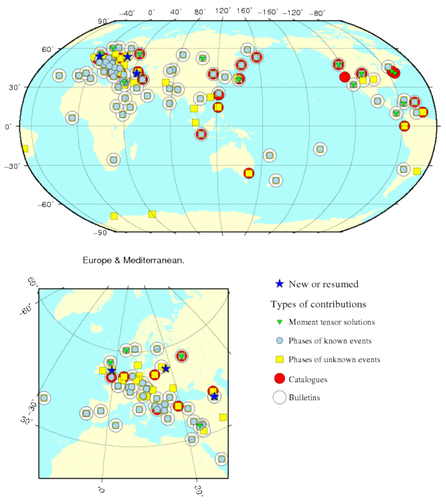
ABSTRACT

The ISC Bulletin Editors are currently processing the Reviewed ISC Bulletin for the year 2008, which is expected to be published by the end of 2010. The Preliminary Bulletins (unreviewed) have been available from the ISC website since events occurred. Here we provide an overview of the data in the 2008* Bulletin. The major sources of contributed data are described, and the ISC dataset is compared to those of other global data centres. The importance of re-analysis of events for which hypocentres and phase readings (including unassociated phase readings) are reported by more than one contributing agency is discussed. The overall completeness of the Bulletin as well as the completeness in oceanic and continental areas is discussed, and the differences in location and magnitude computed by the ISC and other global data centres are shown and explained. A summary of "new" events located by the ISC from previously unassociated phase readings is given, and other events of special interest including felt and damaging earthquakes and events caused by human activities (explosions and rockbursts) that were reported to the ISC are shown. The thresholds used for manual review of the ISC Bulletin are discussed.

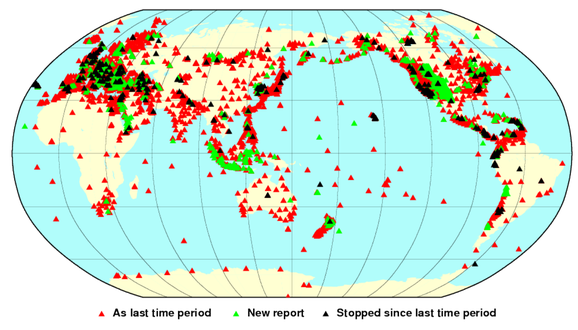
*** This poster covers the latest twelve months of the reviewed bulletin, which is August 2007 – July 2008.**

DATA CONTRIBUTORS



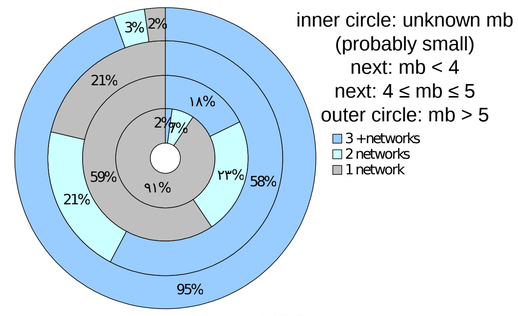
123 agencies contributed to the ISC Bulletin for August 2007 – July 2008. The ISC generally accepts seismic data in the form of a bulletin (a collection of hypocentres and associated station readings), a catalogue of hypocentres, unassociated station readings, station readings associated to already known hypocentres and moment tensor solutions. Where possible the ISC prefers a "bulletin" as opposed to "catalogue plus unassociated readings". This allows us to produce the ISC Bulletin more efficiently and also guarantees the accuracy of associations. The maps show a considerable number of blue circles on white circles, which indicate room for improvement. There were no agencies that sent us data for August 2006 – July 2007 that did not send us data for August 2007 – July 2008. Two new or previously interrupted contributions are indicated by blue stars.

SEISMIC STATIONS REPORTING TO THE ISC



The value of the ISC Bulletin is totally dependent on the network of stations around the world reporting their data to the ISC in time for analysis. The above map represents the stations which contributed at least one seismic phase reading, which was associated to an event in the ISC Bulletin. The total number of stations, including USArray stations, has been growing over the years and reached 5166 by July 2008. This is up 7% as compared to August 2006 – July 2007. Red triangles indicate those stations which reported in both August 2007 – July 2008 and August 2006 – July 2007. The turnover of the reporting stations is high. 15% of the total number did not report during the previous year (green triangles). 9% of the stations that reported in the previous year have not reported in August 2007 – July 2008 (black triangles). This is due to various reasons. Some stations were closed or moved far enough to warrant another station code. In other cases the contact with a network was lost and the data was not contributed.

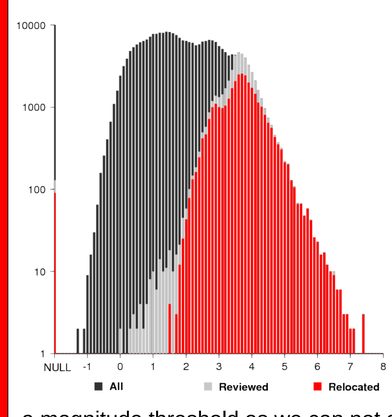
EVENT MAGNITUDE AND NUMBER OF CONTRIBUTING NETWORKS



This figure shows a distribution of ISC events with magnitude and the number of distinct networks that reported each event. Grey segments represent events reported by only one network. The ISC does not usually calculate hypocentres for these events, as they will almost always be less accurate than those calculated by the local network using appropriate local travel times rather than the global AK135 travel times used by the ISC. These events make up 91% of events with unknown mb magnitude (likely to be small local events), decreasing to only 2% of events with magnitudes greater than mb 5.

Aqua and blue segments represent events recorded by more agencies. The ISC will often be able to produce the best solution for these events, by using data from multiple agencies and sometimes improving the azimuthal coverage. Only 9% of events with unknown mb magnitude were recorded by two or more networks, and 95% of events with mb > 5 were recorded by three or more networks.

THRESHOLDS FOR MANUAL REVIEW

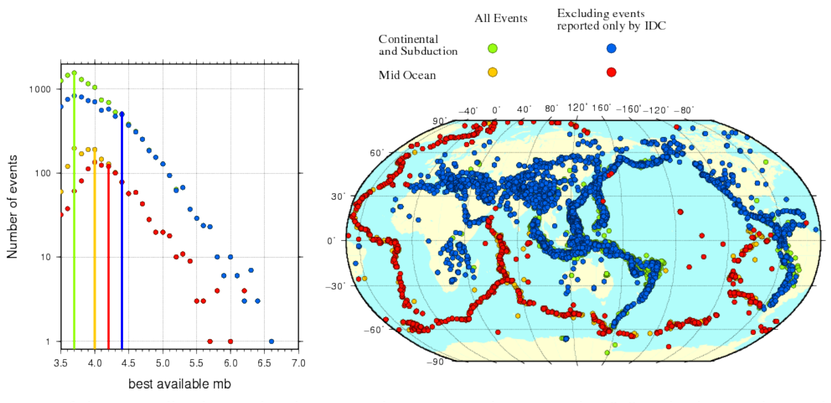


The ISC has not applied a collection threshold since 1999. All reported events, regardless of how small they were, have been parsed to the ISC database, processed automatically and made available to the ISC users.

For manual review of the automatic bulletin, the ISC had to apply a magnitude threshold as we can not afford to review every event. We concentrated on events with magnitude 3.5 and greater. We also reviewed events with station readings reported at distances of more than 10 degrees and events reported by at least two different networks.

The ISC only attempts to relocate events from the reviewed part of the bulletin. 34% of the total number of reviewed events could not be relocated by the ISC due to the lack of required number of station reports of P- and/or S-arrivals or poor azimuthal coverage of those reports. One major problem is that some agencies still report hypocentres but not the station readings on which those hypocentres were based.

BULLETIN COMPLETENESS IN CONTINENTAL AND OCEANIC REGIONS

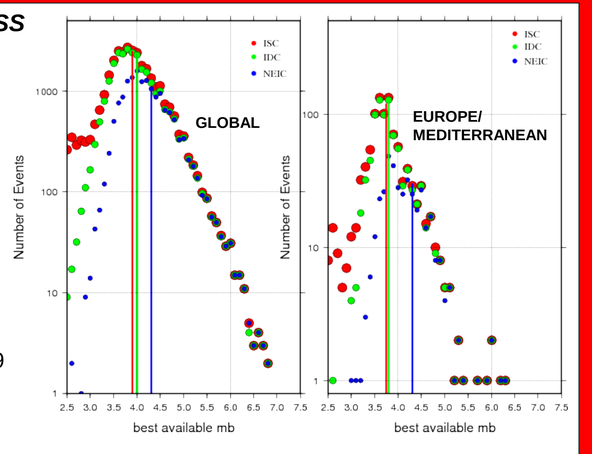


As many of the contributing seismic networks have predominantly continental positions there is a difference of about 0.3 units of mb in completeness of the ISC bulletin in continental and mid-oceanic regions.

It is essential to underline the importance of the IDC (CTBTO) contribution. Green and yellow circles on the graph and map show all shallow ISC events with mb estimates available. Blue and red circles exclude those events reported to the ISC only by IDC. The IDC contribution improves the ISC mb completeness by 0.2 units in continental regions, and by 0.7 units in oceanic regions. Note that the accuracy of additional event locations provided by the IDC is sometimes poor due to a small number of contributing array/station readings. Some of these events appear on the map as green and yellow circles that stand out from normal seismic areas. At times the ISC is able to improve the accuracy of such events by using additional readings reported by non-IMS stations.

OVERALL mb COMPLETENESS

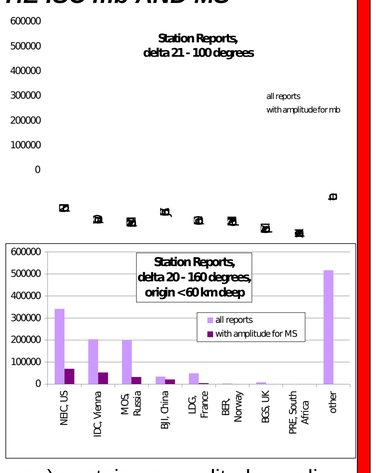
We tried to establish an overall mb completeness of the three most comprehensive global bulletins: IDC, NEIC and ISC. Completeness thresholds are shown for all events globally (with available mb estimates) and for events in the Europe/Mediterranean region. The ISC bulletin is the most complete, with a magnitude threshold of approximately mb 3.9 (~mb 3.7 in the Europe/Mediterranean region), and includes nearly all events from the NEIC and IDC bulletins. The IDC bulletin is nearly as complete as the ISC bulletin, with a magnitude threshold of mb 4.0 (~mb 3.8 in the Europe/Mediterranean region). The NEIC bulletin is less complete with a magnitude threshold of approximately 4.3 mb (~4.3 mb in the Europe/ Mediterranean region). The difference is likely to be because the IDC forms events using fewer stations and amplitude readings, with resulting lower quality solutions for some events.



Here we only use events with an available mb estimate. One has to remember that if magnitudes of smaller events were taken into consideration, the ISC bulletin would then appear as a profoundly more comprehensive source of data than either IDC or NEIC.

One should expect large regional variations of completeness due to predominant continental position of seismic networks.

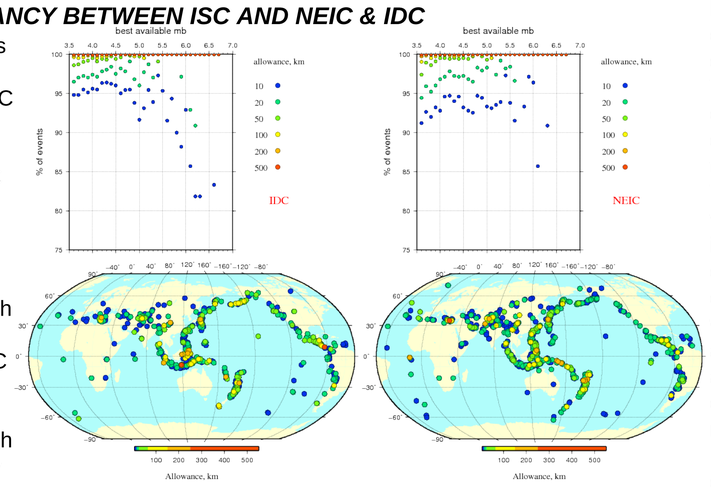
CONTRIBUTORS TO THE ISC mb AND MS



The majority of station reports eligible for ISC mb, and with amplitude readings for mb, come from only a few sources. By far the largest are NEIC (31%), IDC (CTBTO, 26%), and MOS (Russia, 19%). Over 75% of eligible station reports from IDC, BJI (China) and DMN (Nepal) come with an amplitude for mb. Over half of eligible reports from LDG (France), MOS, NEIC, AUST (Australia) and CSEM (Europe) contain an amplitude reading for mb.

Of all station reports eligible for ISC MS; only 13% contain amplitude readings. This is largely due to a limited frequency band of majority of seismic stations. 96% of all amplitude reports eligible for ISC MS come from just four sources: NEIC, IDC, MOS (Russia) and BJI (China). 60% of eligible reports from BJI contain amplitudes for MS; but of the other agencies none have more than 40% of their eligible reports with amplitudes for MS.

LOCATION DISCREPANCY BETWEEN ISC AND NEIC & IDC



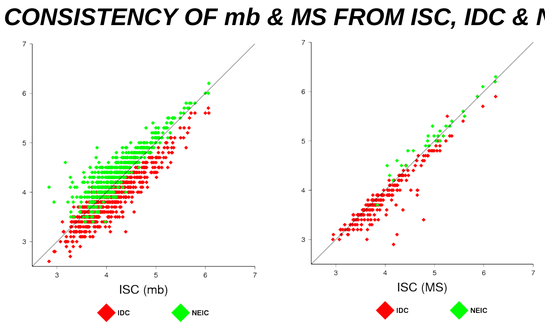
The IDC and NEIC bulletins are integral and most important subsets of the ISC bulletin. Here we tried to estimate the differences in final locations between ISC and IDC/NEIC. We considered a magnitude distribution of a number of common events with mb estimate available, for which the location discrepancy between ISC and IDC/NEIC is in excess of a certain amount. Due to the short time period considered, high magnitudes were artificially misrepresented.

Over 90% of events with magnitudes ≤ mb 5.5 have IDC & ISC locations ≤ 10 km apart, and more than 85% for events with magnitudes of ≤ mb 6.0. Nearly all events have ISC & IDC locations ≤100km apart. Over 85% of events have NEIC & ISC locations ≤ 10 km apart, and over 90% of events with magnitudes ≤ mb 5.5. Nearly all events with magnitudes > mb 4.0 have NEIC & ISC locations ≤ 100km apart. Due to the small number of large events per year, it is less likely that a high percentage of events will match, as a single problematic location causes the overall percentage to drop dramatically.

The maps show the events with position discrepancies higher than the allowance shown. They show that as the value of the allowance increases, the "event-outliers" gradually concentrate to the areas with sparse networks and areas where ISC has an advantage of using comprehensive local reports.

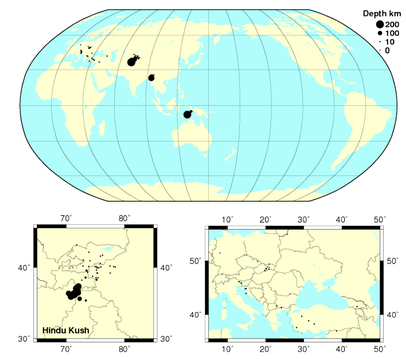
In computation of location discrepancy we have used an event position and its error ellipse. The ISC mb completeness threshold of the ISC bulletin for August 2007 – July 2008 was ~ 3.9. Overall 76% of ISC & NEIC error ellipses for mb>3.9 events overlap, and 84% for ISC & IDC. The difference in percentage can be attributed to the different set of events in each case as well as to incompleteness of the IDC network, which leads to large uncertainties in IDC locations. Therefore despite several degrees of distance between some ISC and IDC epicentres, the formal error ellipses still overlap.

CONSISTENCY OF mb & MS FROM ISC, IDC & NEIC



Values of the ISC mb & MS are heavily dominated by IDC & NEIC amplitudes. It is important to know how consistent the ISC mb & MS values are with those of IDC & NEIC. We only considered events common to ISC & IDC/NEIC, where both ISC & IDC/NEIC mb & MS estimates are available. It is evident that the IDC mb & MS values are generally smaller than those of the ISC. This discrepancy is likely to be caused by non-standard procedures at a number of agencies including the IDC. In particular: non-standard filtering of waveforms prior to taking measurements, non-standard measurement procedures, constant use of arrays, and predominantly low noise station siting. ISC mb & MS are generally more consistent with those of the NEIC than they are with those from IDC, but NEIC values are generally larger than those from the ISC. This could be caused by the influence of the lower values from IDC on the ISC values.

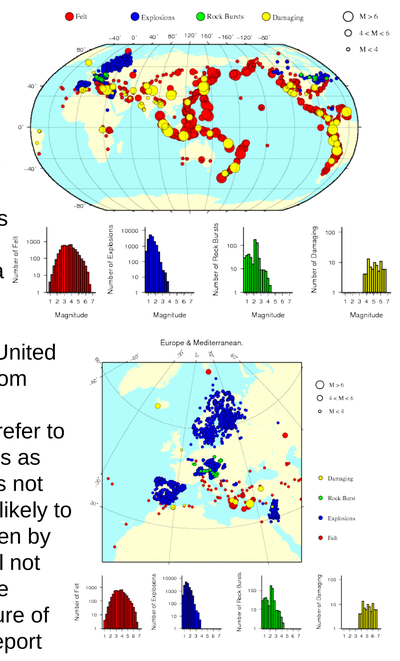
ISC EVENTS FROM UNASSOCIATED STATION REPORTS



Since 1974 we have searched unassociated phase readings to find events not reported by other agencies, so called "search events". These were either moderate events in remote areas and border regions or events of small magnitude elsewhere. In the past local reports of hypocentral solutions of small events were often initially ignored by the ISC data collection to help reduce the load on the ISC data management and analysis system. However the station arrival times for these events often filtered through into the data collection.

The ISC has entirely removed all data collection thresholds starting with data year 1999, and the number of search events has dropped as a result. This is because comprehensive local reports already contained many of those events. Now we believe that in a majority of cases the ISC search events are genuinely new. The areas usually include border regions in the Balkan Peninsula (often explosions or rockbursts), Eastern Turkey, Hindu Kush, Burma, Indonesia and the Pacific Rim. Magnitudes can sometimes be assigned to search events, if at least one amplitude reading was reported to the ISC within a distance range of 21 to 100 degrees. However no magnitudes were able to be calculated for search events in the period August 2007 – July 2008. These are probably all very small events.

EVENTS OF SPECIAL INTEREST



Events which were either caused by human activities (green/blue) or felt by people (red) or caused damage (yellow) are shown. The distribution of the felt and damaging events generally matches the areas where both the level of seismicity and population are high. The distribution of explosions and rockbursts generally matches the areas of industrial activities. One could, for instance, observe a large number of explosions/rockbursts in Scandinavia, North West Russia, Germany, Poland, Slovenia, France, Canada and the United States. Unfortunately there are no reports from other areas with comparatively high level of industrial activities. In fact some agencies prefer to exclude artificial events from their catalogues as opposed to marking them as artificial. This is not always the best approach. Such events are likely to be reported by neighbouring agencies or even by international data centres, who generally will not have precise information on the nature of the event. Having appreciated the sensitive nature of this issue; the ISC asks where possible to report artificial events along with natural ones.

FINAL REMARKS

- The ISC Bulletin for August 2007 – July 2008 is the most comprehensive global source of seismic parametric data.
- The overall mb completeness threshold of the ISC Bulletin for August 2007 – July 2008 is ~ mb 3.9. This is subject to a large regional variation.
- The ISC bulletin would be at least 0.2 units of mb less complete without the IDC contribution.
- Over 78% of the ISC events with mb magnitudes above the mb completeness threshold are located based on station readings from at least three different networks.
- The ISC mb values are dominated by the body wave amplitudes from NEIC (31%), IDC (26%) and MOS (Russia, 19%). 96% of all surface wave amplitudes for ISC MS are contributed by just four sources: NEIC, IDC, MOS and BJI (China). The ISC bulletin would benefit from more agencies contributing amplitudes.
- The ISC and NEIC mb and MS values are generally consistent. The IDC values of mb and MS are generally smaller than those from the ISC.
- 76% of the ISC and NEIC, and 84% of the ISC and IDC, error ellipses for common events with mb magnitudes greater than the mb completeness threshold overlap.
- A small number of new events were discovered by the ISC using unassociated station reports, which are missing from the original IDC and NEIC bulletins.
- The ISC bulletin would benefit from station reports contributed as associated to known hypocentres.