INTERNATIONAL SEISMOLOGICAL CENTRE (ISC)

2013

Annual Director's Report

The year 2013 was another productive year for the ISC with as many as 18 members of staff involved in operations and several major development projects. Bulletin data for earthquakes and explosions during recent (2010-2013) and historical (1950-1959) periods were added to the ISC database. Two new major products: the ISC-GEM Catalogue and the ISC Event Bibliography were made publicly available. A link between the computer facilities at CTBTO and the ISC database was further enhanced with assistance on relevant waveform retrieval and web-location tool. The work on the Visual ISC Bulletin Analysis System has begun jointly with the OeRC of Oxford University. The ISC database and the website mirror was operated at the IRIS DMC, ERI and LLNL. The GT list and the Station Registry have been further updated. A large number of scientific articles published by researchers worldwide in 2013 indicate an extensive use of the ISC data.

EXECUTIVE SUMMARY

- Despite continued worldwide economic uncertainty, the ISC finances remained stable thanks to the continued support from 62 Member-Institutions in 47 countries and additional project grants from the CTBTO, US NSF, GEM Foundation, FM Global, UK KTP as well as sponsorship from Reftek.
- 18 staff members plus a member of the OeRC of Oxford University worked at the ISC during the year.
- Parameters of 822 stations, including those from USArray, were registered and modified in the **International Seismograph Station Registry** (IR).
- Within hours, days and weeks after event occurrence, the ISC collected, grouped and distributed preliminary bulletin data from 26 networks and data centres worldwide.
- The main collection of revised bulletins from 115 institutions stood at 12 months behind real time with a few agencies not being able to adhere to this deadline.
- An unprecedented aftershock sequence following the 2011 **Great Tohoku Earthquake** caused up-to four-fold increase in the volume of several monthly bulletins and consequently a temporary delay in production of the reviewed ISC Bulletin.
- As a result, only 9 months of data were added to the **Reviewed ISC Bulletin** in 2013 with as many as 65,000 seismic events which would a typical number for a 12 month period.
- The size of the ISC database increased by ~27% during the year and reached 143Gb.
- The ISC Bulletin is substantially more complete than the bulletins of either the NEIC/USGS or the IDC/CTBTO.
- The **ISC-GEM Global Instrumental Earthquake Catalogue** (1900-2009) was released; it is a major homogeneous record of large earthquakes to be widely used for global and regional seismic hazard and risk assessment.
- The **ISC Event Bibliography** was released; it is a welcome help to researchers, students, supervisors, journal editors in many fields of Geophysical research.
- We continued operating and improving the **CTBTO Link to the ISC database** with a healthy stream of recorded queries from the NDCs and IDC.
- We released the first volume of the printed **Summary of the Bulletin of the ISC** – a major publication summarising current information on the ISC, procedures and standards, network contributions, contents of the ISC Bulletin with two articles on notable earthquakes contributed by staff of USGS and Geological Survey of Canada.
- The ISC database and the website mirror were operated at IRIS DMC in Seattle, ERI in Tokyo and LLNL in Livermore. This improved the speed of access to the ISC data.
- We continued maintaining and distributing the IASPEI Reference (**GT**) Event List, the **EHB** Bulletin and the List of **International Contacts in Seismology**.
- The ISC staff submitted and published several scientific articles, participated in several conferences providing publicity for the ISC throughout the year.
- The large number of published scientific articles indicates a wide-range use of the ISC Bulletin data by many researchers worldwide.

STAFF

As many as 18 members of staff worked at the ISC during 2013, thanks to the regular Member's and sponsor's support and a number of additional projects such as the ISC-GEM Catalogue, CTBTO Link and the Bulletin Rebuild.

Among the staff there are 4 PhD, 8 M.Sc. or equivalent and 4 B.Sc. or equivalent degrees.

Several members of staff took part in professional meetings, travelled to international conferences and participated in professional training programmes.

The ISC staff often organise sessions during major scientific conferences. Several ISC staff are members and often take part in running professional organizations such as IASPEI, AGU, SSA and SECED.

During the year we saw the departure of Sepideh Rastin who returned to New Zealand to complete her PhD degree. New employees included Kostas Lentas from Greece to assist with the download and processing of seismic waveforms under the CTBTO Link project. Rebecca Verney moved from the ISC-GEM team to the Analyst Team to further strengthen the ISC Bulletin review. Elizabeth Ball and Daniela Catanescu joined the ISC-GEM team to assist with data entry from historical seismic station bulletins.

Formally an employee of the Oxford e-Science Research Centre of the University of Oxford, Dr Hui Fang, is now based at the ISC working on a joint three-year project creating the Visual Bulletin Analysis System (VBAS).

In addition, a student from the University of Oxford and two local secondary school students have helped the ISC on a voluntary basis for several weeks.

MANAGEMENT and ADMINISTRATION

Dmitry Storchak, Ph.D.
Director/Seismologist
Russia/UK

Maureen Aspinwall
Administration Officer
UK

DATA and SYSTEMS MANAGEMENT

James Harris
Systems & Database Administrator
UK

John Eve, B.Sc.
Data Collection Officer
UK

Przemek Ozgo
Junior Systems Admininistrator
Poland

DEVELOPMENT

István Bondár, Ph.D.
Senior Seismologist
Hungary

Wayne Richardson, Ph.D.
Senior Seismologist
New Zealand

Konstantinos Lentas, M.Sc.,
Seismologist/Developer
Greece
(joined in November)

Sepideh Rastin, M. Eng.
Developer
Iran
(left in June)

BULLETIN ANALYSIS TEAM

Emily Delahaye, M.Sc.
Seismologist / Lead Analyst
Canada

Blessing Shumba, M.Sc.
Seismologist / Analyst
Zimbabwe

Rosemary Wylie,
M.Phys.Geog., Analyst
UK

Rebecca Verney, B.Sc.,
Trainee Analyst,
UK
(moved from ISC-GEM team in January)

Ivana Jukić, M.Sc.
Seismologist / Trainee Analyst
Croatia

VBAS PROJECT

Hui Fang,
PhD, Computer Science
China
Based at the ISC, formally an employee of the OeRC, Oxford University

ISC-GEM and EVENT BIBLIOGRAPHY OFFICE

Domenico Di Giacomo,
Ph.D.
Seismologist
Italy

Natalia Safronova,
M.Eng.
Data Entry Officer
Russia

Elizabeth Ball,
B.Sc.Geog.,
Data Entry Officer
UK
(joined in November)

Daniela Catanescu,
M.Sc.Admin.,
Data Entry Officer
Romania
(joined in November)

OPERATIONS

INTERNATIONAL SEISMOGRAPH STATION REGISTRY (IR)

Traditionally, the ISC maintains the International Seismograph Station Registry (IR) together with NEIC/USGS. The IR allocates globally unique codes to seismic stations worldwide.

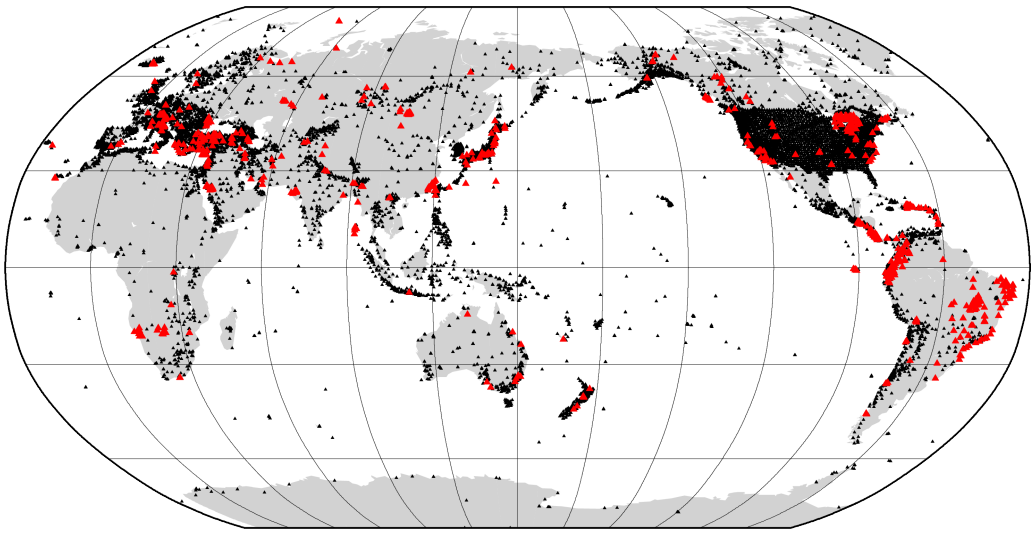


Figure 1. *19,615 stations, open or closed, were fully registered in the IR at the end of 2013(in black); parameters of 822 of those (in red) were either registered or modified during 2013; the USArray is a prominent feature of the Registry in North America; new additions in Central and South America and the Caribbean are the result of improvements in the GT list and ISC active participation in the CTBTO RSTT initiative.*

At the end of 2013, the IR contained information on 19,655 stations with 822 of them registered or updated during the year (Fig.1). In particular, the IR has been substantially extended in Central and South America and the Caribbean as part of the work on improving the IASPEI Reference Event (GT) List and ISC's active participation in CTBTO initiative on building the Regional Seismic Travel Times (RSTT).

Joint work with the NEIC is currently underway to update the IR with the new Agency.Deployment.Station.Location (ADSL) convention in accordance with the IASPEI recommendation. The new registry will feature station codes that are unique within each network deployment as opposed to being globally unique. The new registry will help to give credit to all institutions that perform different parts of the monitoring job: operating seismic stations, performing waveform analysis or reporting parametric data.

The ISC runs a popular web-page giving an account of already registered stations as well as inviting the submission of parameters required to register a new station. Figure 2 demonstrates per country use of the IR related web-searches. US numbers are dominated by the NEIC running regular queries to synchronise their database with the IR.

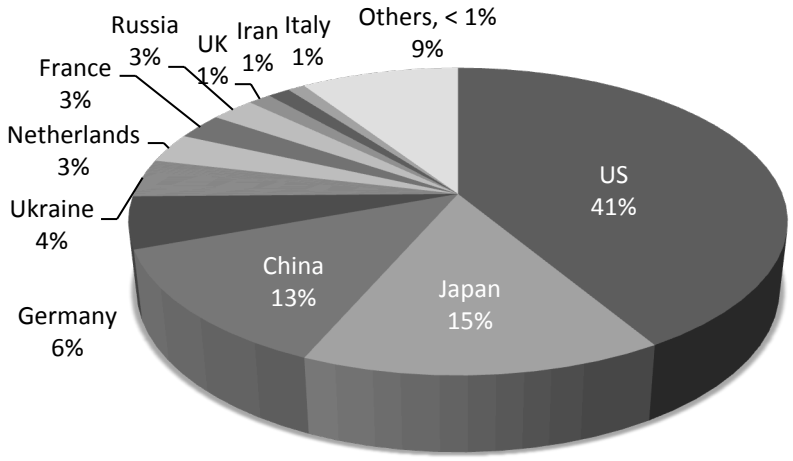


Figure 2. *Per country statistics of the web-searches related to the IR*

The unique IR codes are used by the international waveform data centres such as the IRIS DMC and ORFEUS for an appropriate waveform archival and distribution.

COLLECTING PRELIMINARY NETWORK BULLETINS

The ISC continues to collect preliminary bulletin data from a large number of networks and data centres. These data are expected to undergo at least a minimal review by local analysts. Typically the incoming data include a preliminary hypocentre location, magnitude estimates, moment tensor solution and station arrival data, though variations are large from agency to agency. 26 agencies reported preliminary data to the ISC during year 2013 (Table 1).

In 2013, the National Seismic Monitoring Centre in Georgia began contributing its preliminary bulletins in addition to the final bulletins that had been reported for several years.

Unfortunately, contributions of preliminary solutions from the Council of Geosciences, South Africa were still not resumed, having been previously interrupted for the period of internal review of the data availability policy. In 2013, we also lost preliminary contributions from ETH, Switzerland and National Seismological Centre of Syria.

Table 1*. 26 agencies reported preliminary hypocentre determinations and corresponding arrival time data to the ISC in 2013. New in 2013 are the reports from Georgia.*

Country	**Reporting Agency**
Armenia	National Survey of Seismic Protection
Australia	Geoscience Australia
Canada	National Earthquake Hazards Program
China	China Earthquake Administration
Cyprus	Cyprus Geological Survey Department
Czech Republic	Geophysical Institute, Academy of Sciences of the Czech Republic
Denmark	Geological Survey of Denmark and Greenland
Egypt	National Research Institute of Astronomy and Geophysics
France	European Mediterranean Seismological Centre

Georgia	Seismic Monitoring Centre of Georgia
Germany	Helmholtz Centre Potsdam GFZ German Research Centre Geosciences
Germany	Landeserdbebendienst Baden-Wuerttemberg
Indonesia	Badan Meteorologi dan Geofisika
Iran	International Institute of Earthquake Engineering and Seismology
Israel	Geophysical Institute
Italy	Istituto Nazionale di Geofisica e Vulcanologia
Japan	Japan Meteorological Agency
Kazakhstan	National Nuclear Center
Kyrgyzstan	Institute of Seismology, Academy of Sciences of Kyrgyz Republic
Norway	NORSAR
Russia	Geophysical Survey (GS), Russian Academy of Sciences (RAS)
Russia	Baykal Centre, GS, Siberian Branch, RAS
Russia	Kamchatka Regional Seismic Centre, GS, RAS
Spain	Instituto Geografico Nacional
UK	British Geological Survey
USA	National Earthquake Information Center, USGS

In addition, there are 11 agencies that switched into a speedy mode of data processing, where bulletins are produced soon after event occurrence and the staff never return for event re-analysis unless there is a special need (Table 2). Theses agencies can be considered as reporting both preliminary and final bulletins at the same time.

***Table 2**. Agencies that perform their final earthquake analysis within a month of event occurrence.*

Country	**Reporting Agency**
Brazil	Instituto Astronomico e Geofísico
Chinese Taipei	Institute of Earth Sciences, Academia Sinica
France	Laboratoire de Détection et de Géophysique/CEA
French Polynesia	Laboratoire de Géophysique/CEA
Germany	Alfred Wegener Institute for Polar and Marine Research
Germany	Seismological Observatory Berggießhübel, TU Bergakademie Freiberg
Ireland	Dublin Institute for Advanced Studies
Moldova	Institute of Geophysics and Geology
Namibia	Geological Survey
New Zealand	Institute of Geological and Nuclear Sciences
Puerto Rico, USA	National Seismic Network, University of Puerto Rico

BUILDING PRELIMINARY ISC BULLETIN

Preliminary hypocentre solutions and station arrivals are grouped in the ISC database with corresponding solutions from other agencies and made available through the standard ISC Bulletin search procedure within a few hours of receipt. For each event an output includes several hypocentre solutions reported by various agencies, all reported source mechanisms and magnitude estimates as well as corresponding station arrival data. Earthquake headers include logo images of each reporting agency. By clicking on the logo, Preliminary ISC Bulletin users can get further information from each agency directly.

Almost all events with magnitude 5 and above and many of smaller magnitudes are reported within the first week. Further reports beyond one week add information to already reported large and moderate events and also inform about smaller events.

This process is there to fill the gap between the event occurrence and the time when the final Reviewed ISC Bulletin becomes available. It presents an attempt to consolidate the effort of many data centres and networks to make their data available internationally in good time. At this stage ISC does not compute or publish its own event solutions. This service is not intended for use by the media or civil protection agencies. It is designed to be used by seismologists to receive as much information as possible in one single format from one single place and then to get access to details using provided links to the original data reporters.

No later than one year after each seismic event occurrence, the preliminary data from agencies are substituted with their final, revised versions; this is well before the ISC analysts make their final review of the ISC Bulletin. The ISC hypocentre solutions are still based only on the revised set of bulletin parametric data given by each reporting institution.

COLLECTING REVISED NETWORK BULLETINS

The standard ISC data collection is the collection of revised bulletin data from many agencies (network data centres and single observatories) around the world up to 12 months behind real time. With a few exceptions, this delay gives the data contributors enough time for reviewing and finalising their bulletin data before submission to the ISC. Figure 2 shows 115 agencies that reported final reviewed bulletin data directly to the ISC in 2013. In addition, a few tens of agencies report to the ISC via regional data concentrating centres such as the National Earthquake Information Center (NEIC), the European Mediterranean Seismological Centre (EMSC) and the Central American Seismological centre (CASC). Large events with magnitude 4.5-5.0 and above in Africa and on mid-oceanic ridges are reported by the NEIC, International Data Centre of CTBTO, Geophysical Survey of Russian Academy of Sciences (GS RAS) and China Earthquake Networks Center (CENC).

During 2013 we began receiving bulletin data from:

- Observatoire Volcanologique de Goma, Democratic Republic of Congo
- Geological Survey Department, Malawi
- Research Centre for Astronomy and Geophysics, Mongolia

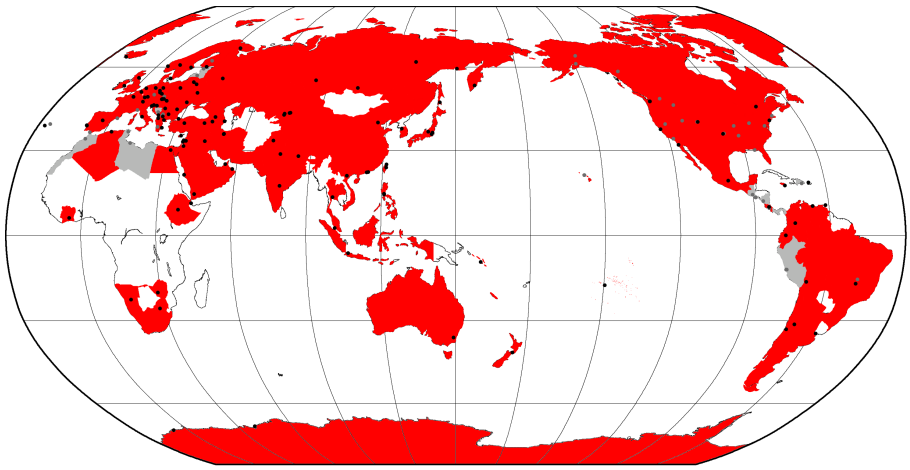


Figure 3. *115 agencies around the world (black dots) report bulletin data directly to the ISC. Dry land territories covered by these reports are in red. Grey areas and grey dots indicate those territories and agencies that are covered indirectly via reports from NEIC, EMSC and CASC. No colour indicates areas that are not covered by local network operator reports.*

The last bullet point is especially noteworthy. For many years, the ISC has been trying to encourage cooperation with the Research Centre of Astronomy and Geophysics (RCAG), Mongolian Academy of Sciences. With the help of the RCAG's Scientific Secretary, Dr Sodnomsambuu Demberel and the Head of Department of Seismology, Dr Munkhuu Ulziibat, we identified a plan for such cooperation that included training one of the RCAG's specialists at the ISC. With financial support from the CTBTO, Mrs Dashdondog Mungusuren (Mungun), the Head of the Data Analysis Laboratory, was able to travel to England and stay at the ISC for two months, gaining experience in all aspects of ISC operations and development. As part of this training, Mungun worked on the registration of Mongolian seismic stations and integration of station bulletins from 1970-1980 into the ISC Bulletin. She was familiarised with the ISC-GEM Catalogue, ISC Event Bibliography, GT dataset and the ISC earthquake Locator. She was also trained to use the CTBTO Link software.

Mongolian bulletins for 2009-2011, provided by Mungun, have already become part of the ISC Bulletin. The analysts, reviewing the data for 2011, reported major improvement in station coverage for events in Mongolia. On her arrival back to Ulan Bator, Mungun was planning to organize monthly submission of Mongolian bulletins to the ISC.

The ISC is grateful to CTBTO for the invaluable support that we received during this training that will help to bring the Mongolian NDC to a high level, contribute invaluable data to the RSTT initiative and strengthen further bulletin data exchange between the RCAG and ISC.

During 2013, the IRIS DMC continued its contribution of station arrival times that were picked and reviewed by the USArray Array Network Facility in the Institute of Geophysics and Planetary Physics (IGPP) of the Scripps Institution of Oceanography, UCSD. The data set represents a considerable increase in station arrival numbers associated to already known

events in the US and moderate to large events worldwide (Fig. 4). Whilst being a major source of highly useful data for tomographic research, this data set presented a major challenge to the ISC in the past because the large concentration of stations generally biased the ISC solutions. This is no longer the case since data year 2009 when the new ISC Locator has taken correlated travel-time error structure into account. Nevertheless, the increased numbers of stations, reporting the same event, continue to create a major workload for the ISC Analysts.

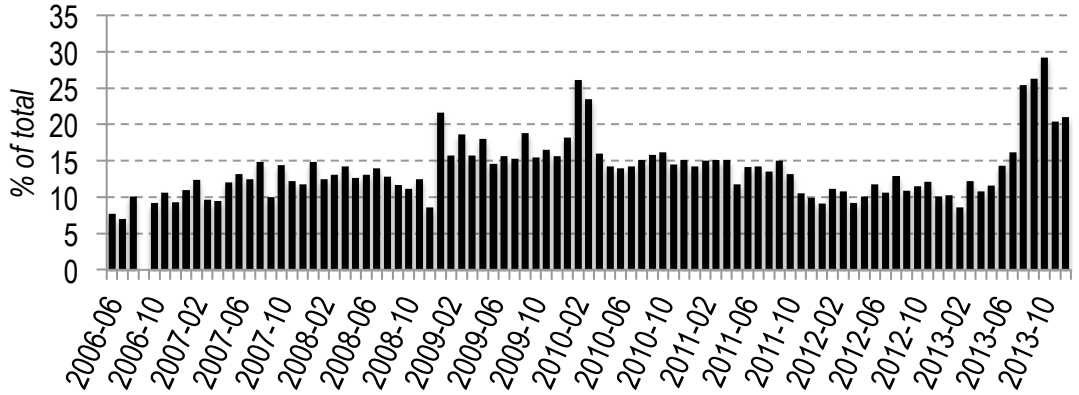


Figure 4. *Fraction of arrival time picks reported by USArray network facility as compared to the total number of arrivals associated to ISC Bulletin events of magnitude over 4.5.*

ISC BULLETIN REVIEW

The ISC Bulletin is progressively updated with each network report coming in. Preliminary network contributions are substituted with final reviews. New events are built, merged or split with every new report coming to the ISC by e-mail and processed either automatically or manually by the ISC Data Entry Officer, who is working remotely from his home office in Scotland.

The ISC seismologists/analysts review approximately one fifth of all events formed in the ISC database by the automatic procedures. This is the review that makes the ISC Bulletin accurate and trustworthy. The accuracy of *ak135*-based ISC solutions and magnitude estimates, proper grouping of reported information between the events in the Bulletin is under constant scrutiny. The ISC analysts also review the correctness of automatic association of reported station arrivals to events, reported arrival's phase identification and travel-time residuals.

When the time comes, one month's worth of data is pulled into a separate database table space and a set of automatic procedures are run to produce the first automatic ISC event locations and magnitude determinations for those events that are large enough to be reviewed by the ISC seismologists. It would be impossible for the ISC to sustain a review of every reported event, so from data year 1999 the data collection thresholds were removed and review thresholds introduced. Following various recent improvements this system continues to serve its purpose by limiting the number of seismic events to be reviewed by ISC analysts.

The threshold criteria are complex yet almost all events of magnitude approximately 3.5 and larger are reviewed.

The team of five analysts (including two trainees) reviewed 9 months of the ISC Bulletin (Dec 2010-Aug 2011) during the calendar year 2013. The Team included:

- Mrs Emily Delahaye (Canada), the Lead Analyst, maternity leave April-Dec 2013
- Mr Blessing Shumba (Zimbabwe), Analyst
- Ms Rosemary Wylie (UK), Analyst
- Ms Rebecca Verney (UK), Trainee Analyst
- Ms Ivana Jukić (Croatia), Trainee Analyst

During Mrs Delahaye's absence her duties were shared by Rosemary Wylie and Blessing Shumba. Scientific assistance was also given by Dr. Wayne Richardson, Senior Seismologist, whose long experience of editing the ISC Bulletin was also useful during the training as well as in solving difficult cases.

Ms Rebecca Verney, a Berkshire resident with a degree in Psychology, joined the Analysis team in January following the end of her duties for the ISC-GEM Catalogue project, where she learned patterns of seismological reporting by many tens of observatories worldwide. At the beginning of her work as an analyst, she was given additional training in waveform processing of local, regional and teleseismic earthquakes for one week by the staff of Bergen University. We appreciate this help from our long-standing Member-Institution.

The team was also helped by the Director during the final steps in the analysis procedure.

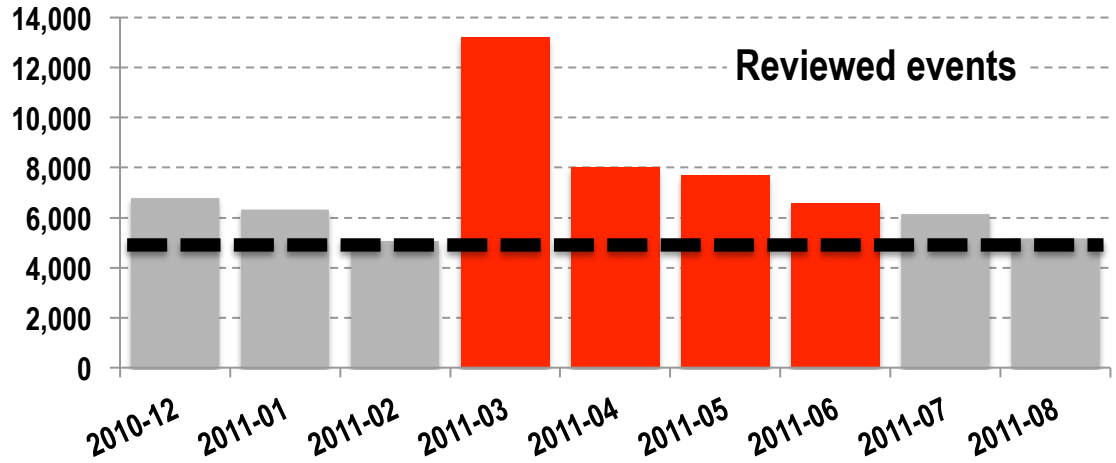


***Figure 5**. Monthly number of seismic events in the Reviewed ISC Bulletin processed during 2013. The three preceding year average is shown with black dashed line. Red bars represent the data months dominated by events of the 2011 Tohoku aftershock sequence.*

In 2013, the Analysis team was working under the extreme pressure for two further reasons. First, constant attention had to be given to the development of the new analysis system (see below). Secondly, processing of the 2011 Great Tohoku earthquake sequence required

working with an unprecedented number of earthquakes. There were more events in the 9 months of reviewed ISC Bulletin (Dec 2010 – Aug 2011) than in a normal 12 month period observed in the past. The month of March 2011 contained 270% of the norm. Three months of March-May 2011 contained almost double of the regular event number (Fig. 5).

The result of the ISC work can be seen when comparing Figures 6 and 7, showing hypocentre locations reported by all data contributing networks and primary hypocentres in the ISC Bulletin. A fuzzy picture of the worldwide seismicity sharpens up, especially in case of the reviewed ISC Bulletin.

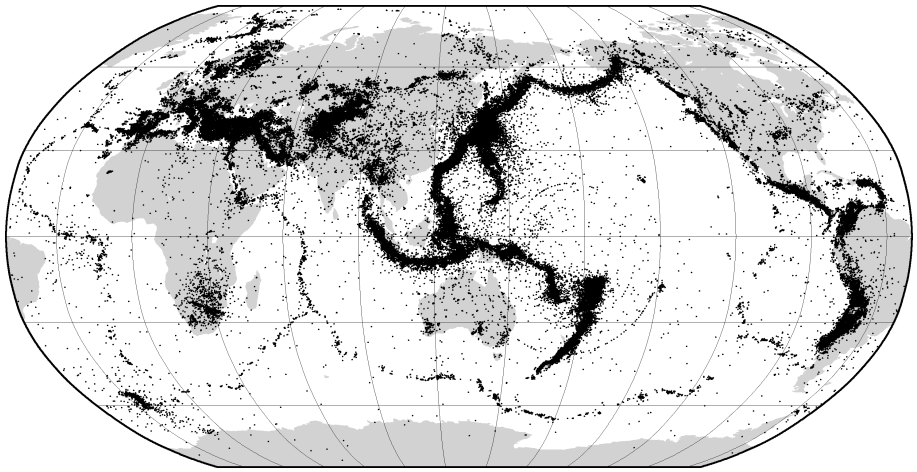


***Figure 6**. All hypocentres reported by individual networks (Dec 2010 – Aug 2011).*

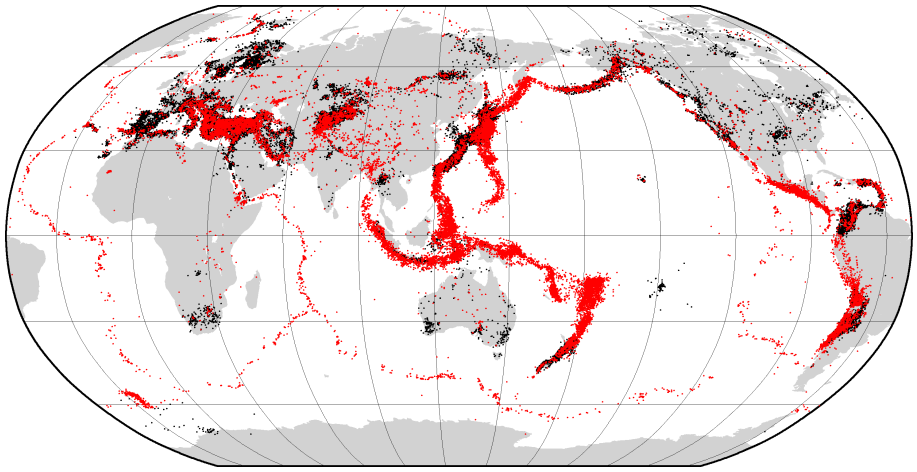


***Figure 7**. Primary hypocentres in the ISC Bulletin (black) in the period (Dec 2010 – Aug 2011); red colour highlights the events reviewed by the ISC analysts.*

Overall, during the calendar year 2013, ~65,000 reviewed events with ~5.6 million of associated phases were added to the reviewed part of the Bulletin by the ISC analysts. Figure 8 demonstrates the diversity of seismic phases identified in the ISC Bulletin.

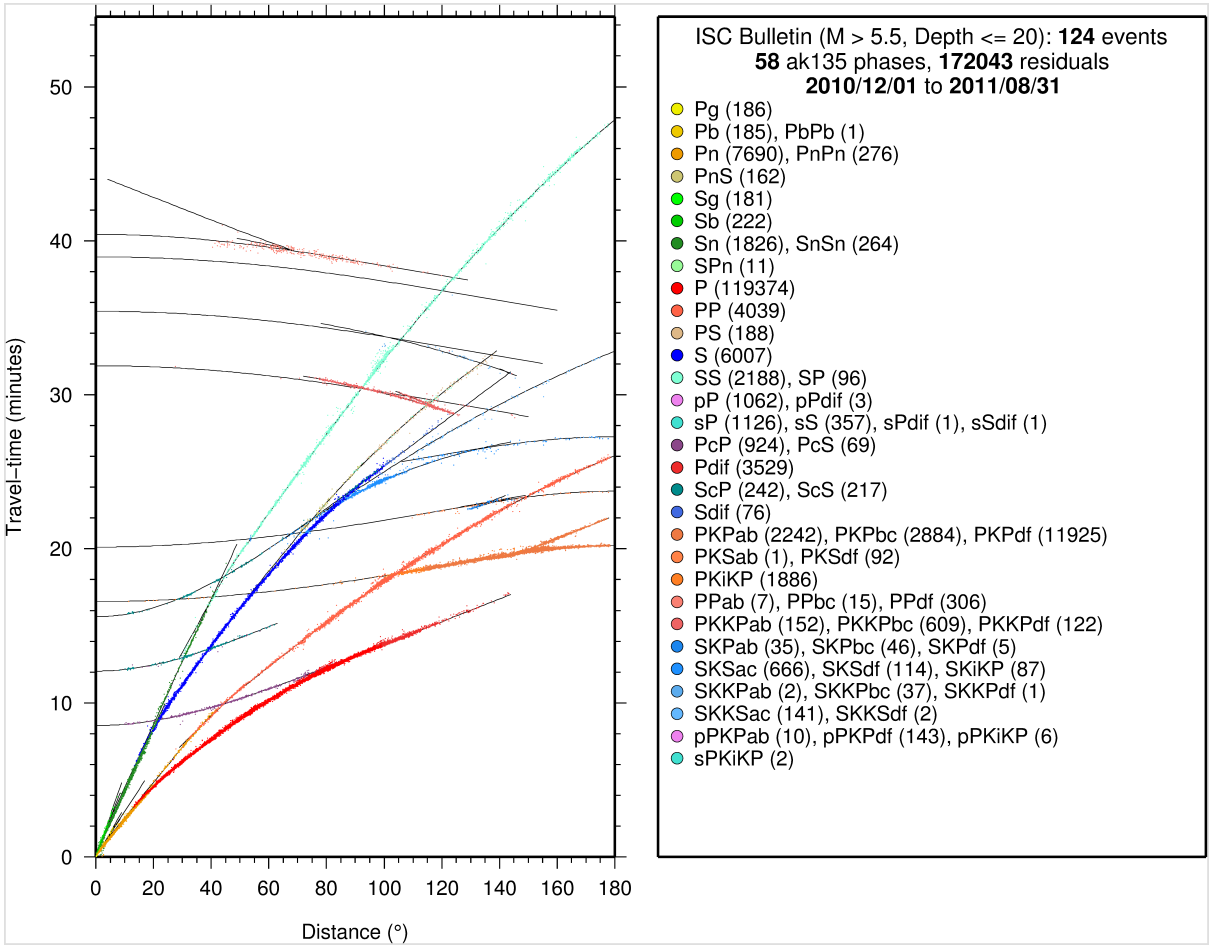


***Figure 8**. Seismic phases from shallow events reviewed by the ISC analysts during 2013.*

DESIGNING A VISUAL BULLETIN ANALYSIS SYSTEM (VBAS)

The issue of the constantly increasing amount of station arrival information available for each event in the Bulletin is pressing. With partial support (66.6%) from the UK Government Knowledge Transfer Programme (KTP) and jointly with the Oxford University e-Research Centre (OeRC) we are now working on the development of the Visual Bulletin Analysis System (VBAS) to replace the existing paper-scanner-screen based batch-type analysis. The new system would allow the ISC analysts to concentrate on the review of graphical information summaries with highlighted outliers instead of reviewing all data in text format.

From July 2013, Dr Hui Fang was formally employed by Oxford University to work as a KTP Associate on this project. He is permanently based at the ISC and shares his office with the ISC Analysts that take keen interest in this development. In his work Hui Fang is supported by Prof. Min Chen and Dr. Simon Walton who specialize in computer visualization at OeRC in Oxford. All three, assisted by the ISC staff, started designing ways of efficient and concise presentation of seismological bulletin information in graphical as opposed to textual way.

GENERAL STATISTICS of the ISC BULLETIN

The ISC Bulletin and the ISC database grow by the day in both seismic event (earthquake or explosion) numbers and reported seismic wave arrival times and amplitudes at stations registered in IR (Fig. 9 a,b).

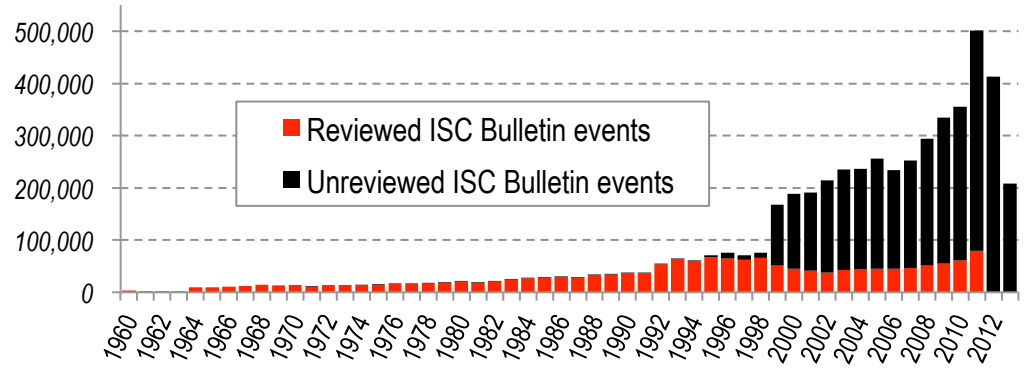


***Figure 9a**. Timeline of the annual number of reviewed and unreviewed (small) events in the ISC Bulletin. The total height of each column represents the annual number of all seismic events in the ISC Bulletin.*

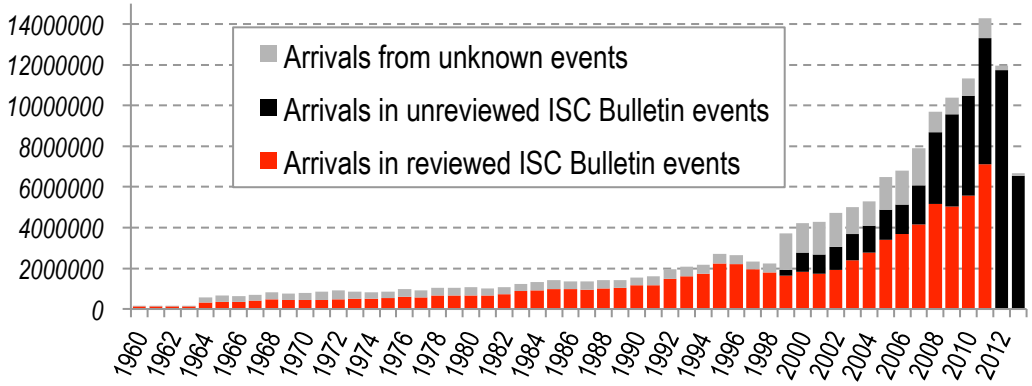


***Figure 9b**. Timeline of the annual number of seismic arrivals associated with both reviewed (red) and unreviewed (black) events in the ISC Bulletin, as well as those arrivals in the ISC database that are not associated to any known events (grey). The total height of each column represents the annual number of all seismic arrivals in the ISC database.*

Figure 10 demonstrates the comparative magnitude completeness of the ISC Bulletin and bulletins of the NEIC/USGS and IDC/CTBTO. The ISC and IDC Bulletins appear to be more complete globally than NEIC by at least half a unit of magnitude. The NEIC has adopted its new global magnitude cut-off threshold of 4.5 which means that the ISC Bulletin will always be more complete by definition. The IDC is unlikely to use many more seismic sites/arrays than they use at present due to exact IMS network station positions written in the Comprehensive Test Ban Treaty. Hence, it is likely that there will be even more seismic

events in the future that will be unique to the ISC Bulletin. The ISC Bulletin, of course, has a vast number of small events not listed in either IDC or NEIC bulletins.

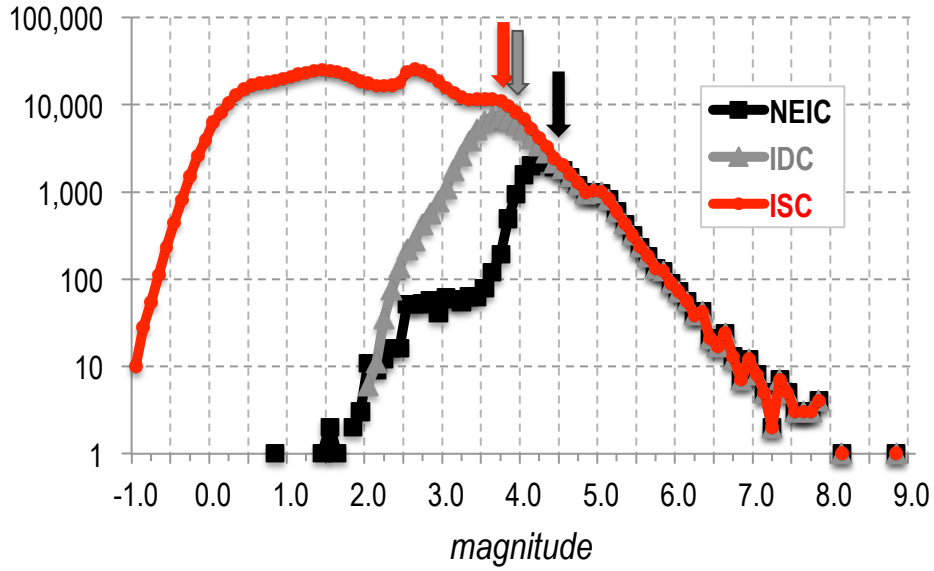


***Figure 10**. Number of seismic events in the ISC, NEIC/USGS and IDC/CTBTO (REB) bulletins during the 2009-2011 period; vertical arrows indicate an approximate magnitude of completeness.*

The ISC Bulletin is used by many researchers worldwide. Figure 11 shows that use of ISC Bulletin from the ISC website has, yet again, more than doubled in 2013 as compared to 2012.

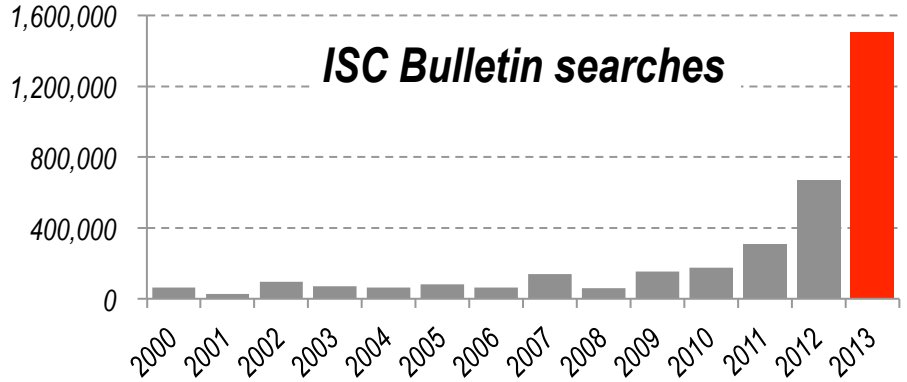


***Figure 11**. Annual number of the ISC Bulletin searches made by website users during 2013.*

Figure 12 shows the multinational character of the ISC Bulletin users with France in the lead during 2013.

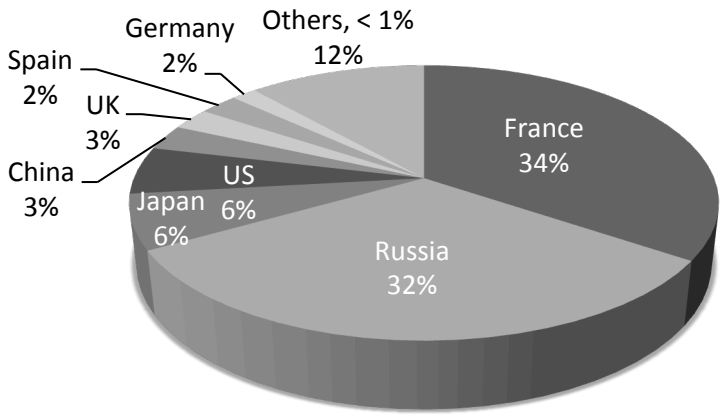


***Figure 12**. Per country distribution of the ISC Bulletin searches made by ISC website users during 2013.*

The above statistics include the use of the website at IRIS DMC, yet it does not include bulletin searches made from mirror-sites at ERI in Tokyo and LLNL in Livermore. Where reliably known, we removed the numbers related to web crawlers.

ISC DATABASE

The ISC holds its entire collection of data in the relational Postgre database on a Linux server with a RAID Array. In 2013, this database grew by ~27% and reached 143Gb, thanks to a steady increase in the number of seismic arrival picks associated to the ever growing number of reported seismic events.

IASPEI GT LIST

The International Seismological Centre maintains the IASPEI database of Reference Events (earthquakes and explosions, including nuclear) for which epicentre information is known with high confidence (to 5km or better, GT5) with seismic signals recorded at regional and/or teleseismic distances (Fig.13a,b). It should be noted that the depth of these events is not known to the same level of accuracy as the epicentre. The global effort of collecting and validating GT events is coordinated by the CoSOI/IASPEI working group on Reference Events for Improved Location chaired by Bob Engdahl and Eric Bergman. This database of 7,802 reference events (1962-2012) and approximately 500,000 station arrivals facilitates better visualization of the Earth structure, better modelling of velocities of seismic waves, more accurate travel time determinations and increased accuracy of event locations. ISC users are able to search this database at the ISC website and receive GT locations and corresponding ISC locations along with station arrival data available for each event. A cross-link to the ISC Bulletin is provided for users to go between ISC and GT databases.

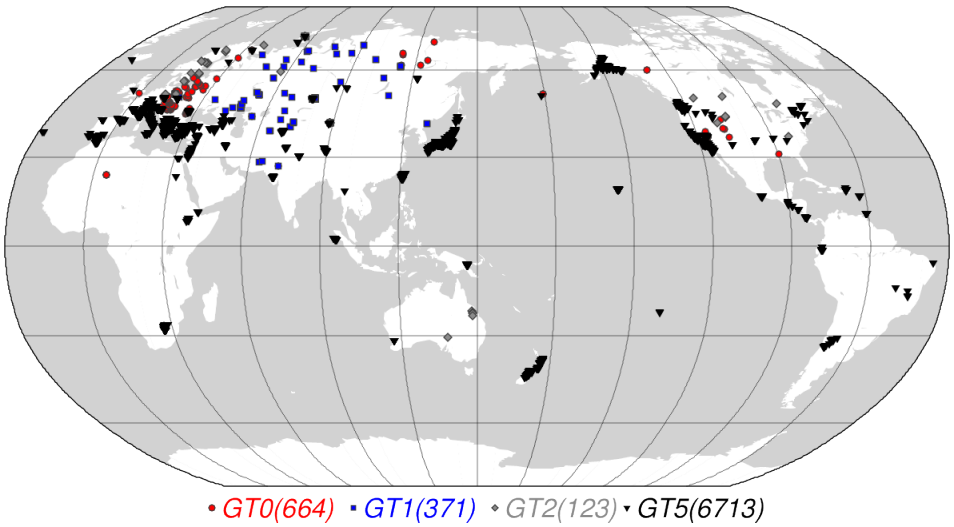


Figure 13a. *The IASPEI List contains seismic events during 1959-2012 for which epicentre information is known with high confidence (to 5km or better (GT5))*

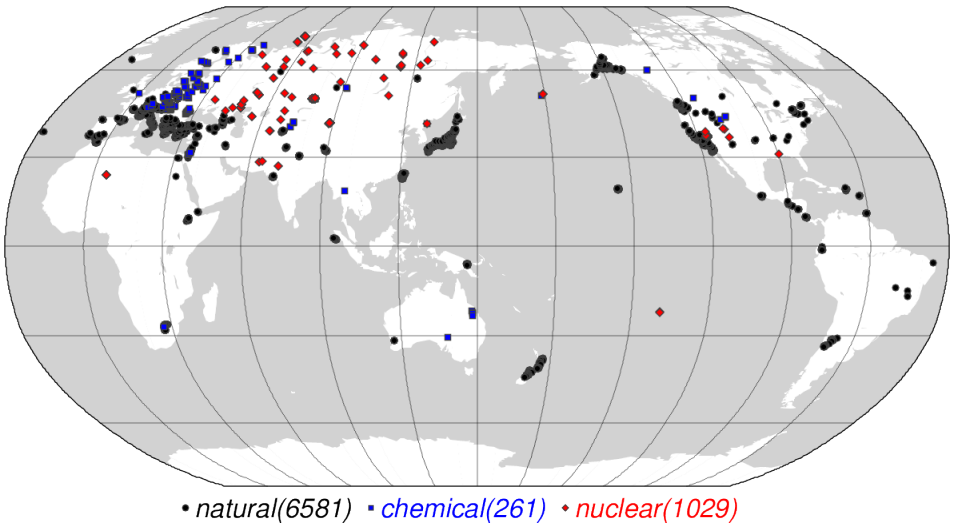


Figure 13b. *The IASPEI List contains natural earthquakes as well as chemical and nuclear explosions.*

At the end of analysis of each ISC Bulletin data year, we add new events to the Reference Event List. During 2013, 162 events have been added or updated (Fig. 14).

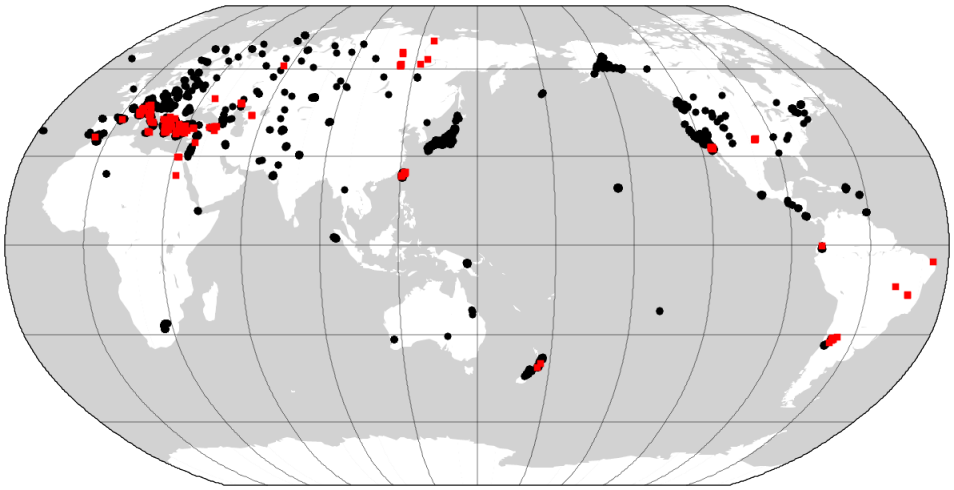


Figure 14. *During 2013, 162 events (red) have been either updated or added to the IASPEI list of Reference earthquakes and explosions*

EHB Bulletin

The EHB (Groomed ISC Bulletin) (Engdahl *et al*., 1998) contains a set of most accurate seismic event locations regularly used in academic research, especially in seismic tomography. The EHB algorithm has been used to significantly improve routine hypocentre determinations of well-recorded events made by the ISS, ISC and NEIC/PDE.

The EHB algorithm uses:

- the *ak135* 1D global travel-time model with ellipticity and elevation corrections;
- iterative relocation with dynamic phase identification (Kennett *et al*., 1995);
- first arriving P, S and PKP phases and teleseismic depth phases pP, pwP and sP;
- empirical teleseismic patch corrections (for 5x5 degree patches);
- weighting by distance-dependent phase variance;
- selection criteria for EHB events having 10 or more teleseismic ($\Delta > 28^{o}$) observations with a teleseismic secondary azimuthal gap < 180º.

Following the agreement with Bob Engdahl, the EHB is hosted on the ISC website and currently contains 141,478 events between 1960 and 2008 accompanied by ~25 million arrival data. The EHB can be browsed, searched or downloaded from the ISC web-site. Corresponding events of the ISC and EHB Bulletins are cross-referenced for the convenience of the ISC users.

With the new ISC Location algorithm (Bondar and Storchak, 2011) in the ISC routine operations and planned relocation and enrichment of the entire ISC Bulletin with the new and missing bulletin data already taking place, it is understood that further production of the EHB bulletin in its current form, that made such a great contribution towards the global tomographic studies, is discontinued.

SEISMOLOGICAL CONTACTS

The objective of this project is to update and maintain up-to-date information on the network of scientific institutions, seismologists and geophysicists in each country willing to serve as scientific points of contact to:

- Seismologists and Geophysicists in other countries;
- Governments;
- Charitable, Response and Relief organizations;
- Media.

Particular care is given to establishing and maintaining contacts in developing countries.

The service benefitted from support in terms of staff time from the Institute of Geophysics and the China Earthquake Networks Center of China Earthquake Administration.

The registry in its current form is readily available for scientific & research institutions, governmental bodies, charitable and relief organizations and media at:

www.isc.ac.uk/projects/seismocontacts (Fig.15).

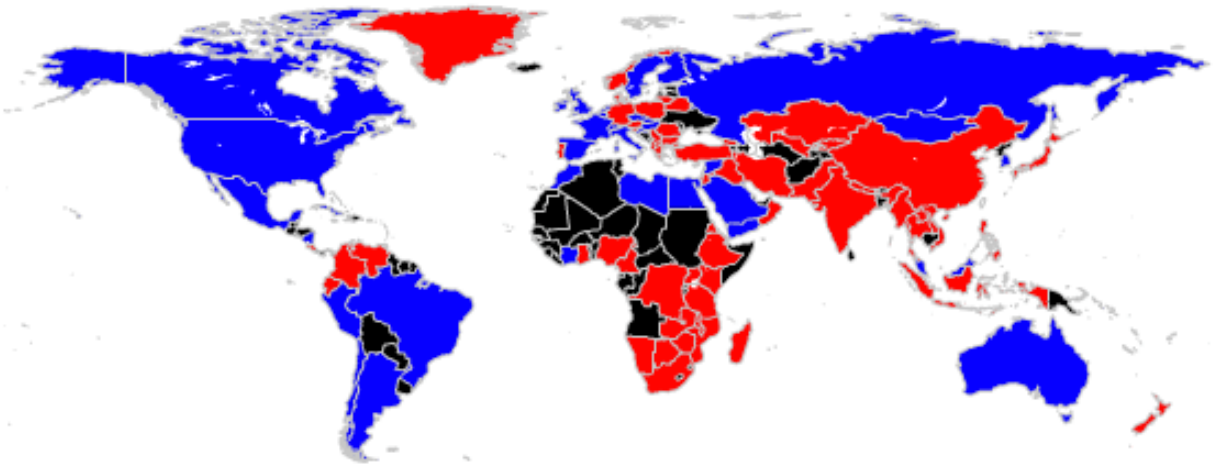


Figure 15. *Seismological Contacts webpage; in **red** are countries in which institutes and individual staff members are willing to share information and serve as a local point of contact; in **blue** are countries for which we have information about operating geophysical organisation(s); in **black** are countries for which we do not hold any information.*

ISC WEB and FTP SERVICES

The ISC web-site as a whole and the ISC Bulletin search in particular continued to grow in popularity during 2013 (Fig.16). The number of hits reached ~7.5 million, having increased by almost 60% compared with 2012. Procedures for crawler identification have been, once again, improved this year, hence there is a discrepancy with corresponding numbers in the 2012 Director's Report. The website hits include access to various pages, including the products, standards, general information, documents and history notes.

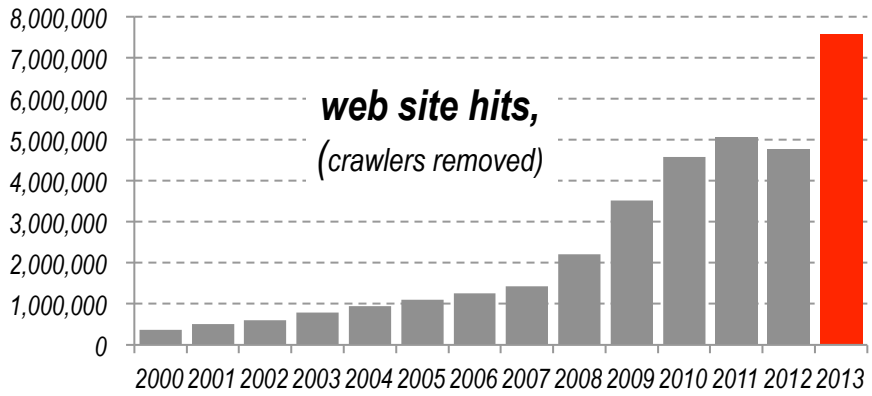


Figure 16. *Annual numbers of the ISC website hits.*

The ISC ftp site is used for downloading the pdf copies of the printed ISC Bulletins and Regional Catalogues, the ISC Bulletin in FFB and ISF formats, the EHB bulletins and the text version of the IR station list.

Per country usage of the ISC web and ftp services (Fig. 17) demonstrates worldwide interest to the ISC data.

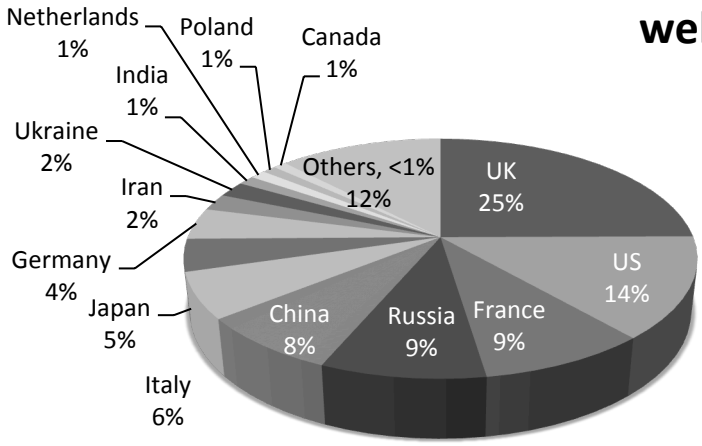


Figure 17 (a). *Per country statistics of the ISC web site hits*

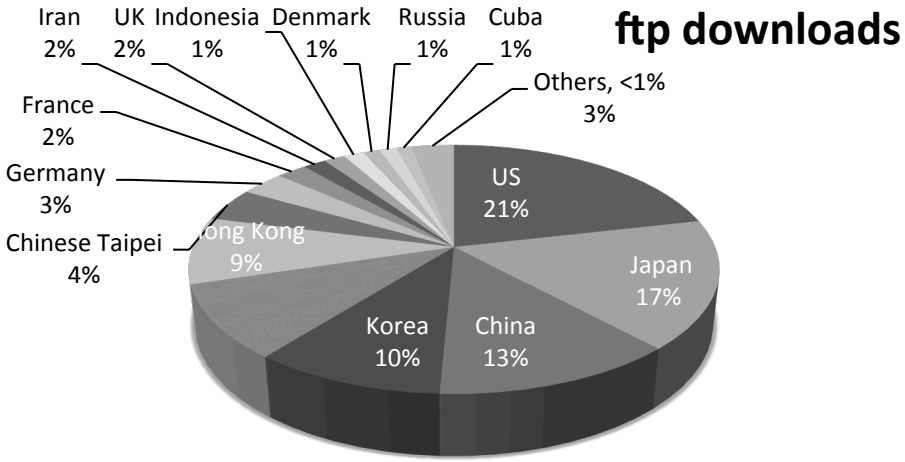


Figure 17 (b)*. Per country statistics of the ISC ftp site use*

ISC DATABASE and WEBSITE MIRRORING and BACKUP

Based on the NSF funding, the ISC continued maintaining one of it's servers at the IRIS DMC in Seattle, US in order to hold a mirror of the ISC database and the ISC website. This was done with the kind assistance from the DMC in order to achieve a general ISC data back-up, fall over facility in case of a breakdown of services at the ISC itself as well as to spread the load on the ISC Internet line and give ISC users faster access to data.

In addition, the IRIS DMC is able to use the database on a daily basis to serve the DMC archive users with event based selection of waveform data.

The mirror has been operational since September 2011. The database in Seattle is updated with 1 hour time lag. The ISC continues to promote the mirror on the website, in regular

newsletters and email notifications. The mirror at IRIS currently serves 10% of the bulletin searches.

Other mirrors of the ISC database are maintained by the Earthquake Research Institution (ERI) of University of Tokyo to serve the research community in Japanese universities and by the Lawrence Livermore National Laboratory (LLNL) to serve users from monitoring laboratories in the US.

DEVELOPMENT PROJECTS

The ISC-GEM CATALOGUE

The ISC-GEM Global Instrumental Earthquake Catalogue (1900-2009) is the result of a special effort to adapt and substantially extend and improve existing ISC data to serve the requirements of the specific user group who assess and model seismic hazard and risk on a regional and global scales. The Catalogue will also have a multidisciplinary use in a wide range of other areas such as studies of global seismicity, inner structure of the Earth, tectonics, nuclear monitoring research, rapid determination of hazard etc. The catalogue will also serve as a reference by those compiling regional seismicity catalogues.

The project was funded by the **GEM Foundation** as part of the five Global Hazard Components. The ISC led the project performed by the Team of International Experts that included several members of the ISC staff as well as Bob Engdahl (University of Colorado Boulder), Antonio Villaseñor (IES Jaume Almera, Spain), Peter Bormann (GFZ, emeritus), Willie Lee (USGS, emeritus) and Graziano Ferrari (INGV/SISMOS). The effort was monitored by IASPEI observers: Roger Musson (BGS), Johannes Schweitzer (NORSAR), Göran Ekström (Columbia Uni) and Nobuo Hamada (JMA).

The project included a large data collection and digitizing effort summarised on Fig. 18.

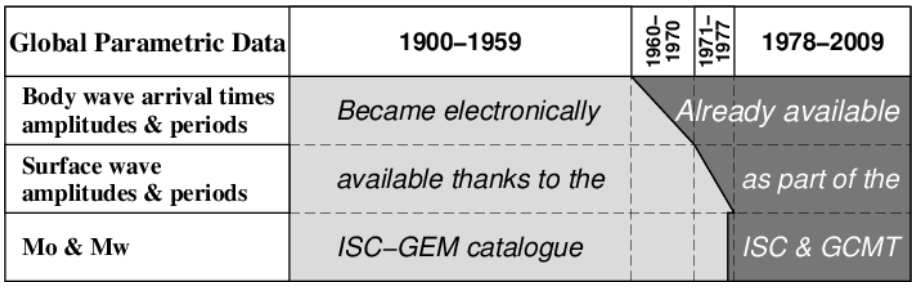


***Figure 18**. Summary of parametric data that became available in electronic form as a result of the ISC-GEM project.*

The following magnitude cut-off thresholds applied:

- 1900-1917: $M_S \geq 7.5$ worldwide + smaller shallow events in stable continental areas
- 1918-1959: $M_S \geq 6.25$
- 1960-2009: $M_S \geq 5.5$

The project deliverables included:

- 110 years of relocated earthquake hypocentres, using the same technique combining the EHB depth analysis and the ISC new Location procedures (Fig. 19);
- recomputed M_S (or other) magnitude values for relocated events;
- M_W values (with uncertainty) based on seismic moments from GCMT (Dziewinski et al., 1981, Ekström et al., 2012) and individual credible earthquake studies where possible and M_W proxy values in other cases using appropriate empirical relationships between M_S/mb and M_W (Fig. 20).

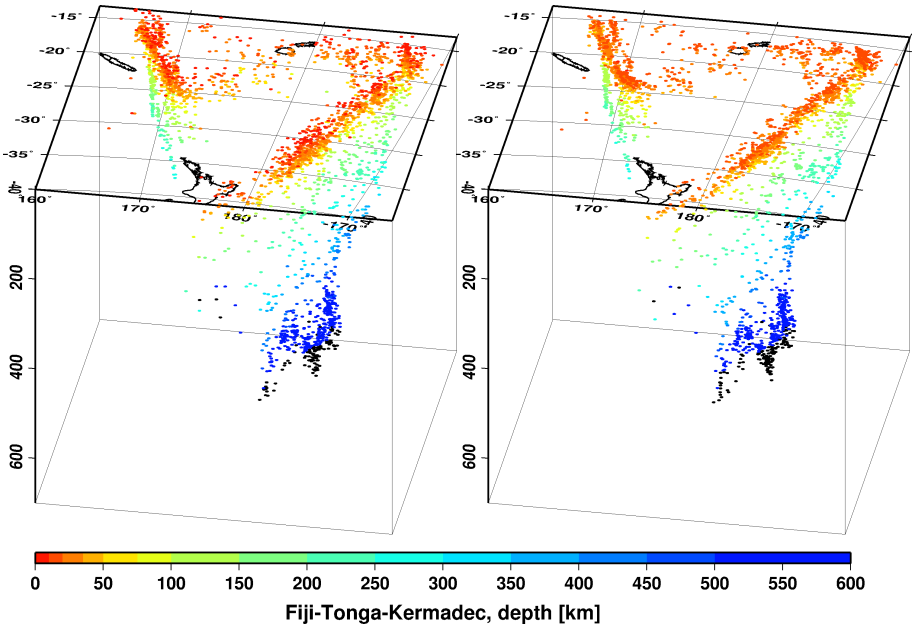


***Figure 19**. Example of improvement in earthquake location in the region of Fiji-Tonga-Kermadec; **on the left** are the best previously known locations; **on the right** – the same earthquakes in the ISC-GEM Catalogue.*

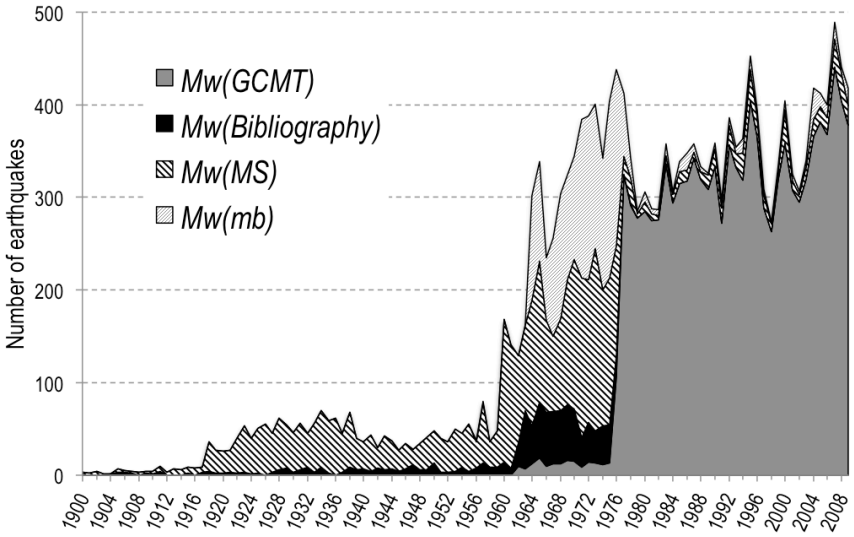


***Figure 20**. Sources of magnitude information used in the ISC-GEM Catalogue.*

Figure 21 shows the magnitude distribution of earthquakes in the ISC-GEM Catalogue which demonstrates the difference in the periods before and after 1960.

Figure 22 shows our plans for extending the ISC-GEM Catalogue in the early instrumental period. On Nov 1, 2013, based on the initial funding committed by the GEM Foundation and FM Global, we started extending the ISC-GEM Catalogue in the periods 1950-1959 and 2010-2011. Most of the effort is to align the magnitude cut-off thresholds in the first 60 years of the 20th century with the cut-off thresholds that applied after 1960. Provided our fundraising campaign is successful, we shall complete the work in the next 4 years.

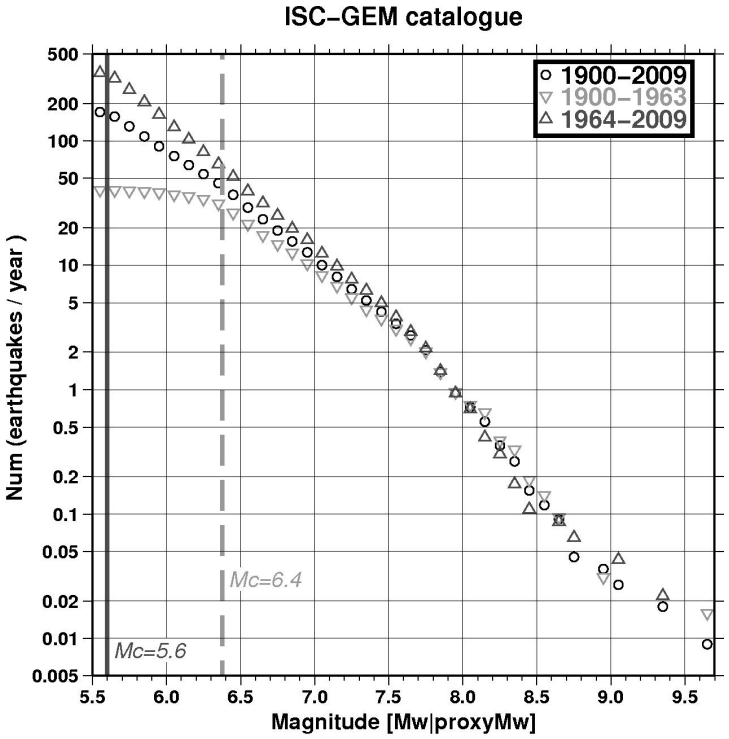


Figure 21. *Magnitude frequency distribution of earthquakes in the ISC-GEM Catalogue within different periods of time*

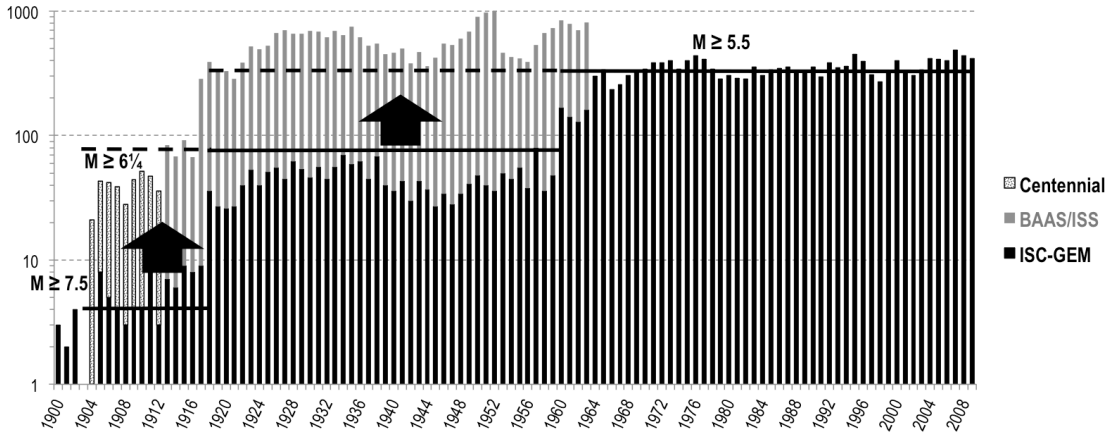


Figure 22. *Comparison of the annual number of earthquakes during the early instrumental period in the current version of the ISC-GEM Catalogue, the BAAS/ISS bulletins (1913-1960) and the Centennial Catalog (1904-1912) (Engdahl and Villaseñor, 2002). The horizontal bars indicate the expected average annual number of earthquakes above the current magnitude cut-off thresholds, based on earthquake numbers in modern instrumental period. The black arrows signify our current effort to extend the ISC-GEM catalogue by complementing it with earthquakes of smaller magnitudes before 1960.*

The ISC-GEM Catalogue was released for the first time In January 2013 through the dedicated suite of webpages on the ISC website. Following further work and user comments, four version were released during 2013 with the log of changes updated each time. Since its release, **2229** downloads have been made from over a **thousand** different IP-addresses. Figure 23 shows the use of the catalogue by different countries.

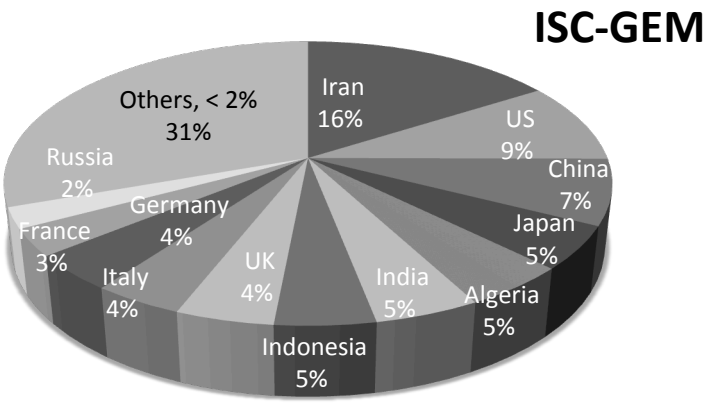


***Figure 23**. Per country use of the ISC-GEM Catalogue in 2013*

During 2013, we also submitted six scientific articles to the *Seismological Research Letters* and *Physics of the Earth and Planetary Interior*. These articles describe the project, history of global seismological observations, massive data collection effort, procedures and general analysis of the ISC-GEM Catalogue.

ISC EVENT BIBLIOGRAPHY

In April 2013, the ISC released its new product - the ISC Event Bibliography. The ISC Event Bibliography facilitates an interactive web search for references to scientific publications linked to both natural and anthropogenic events that have occurred in the geographical region of their interest based on earthquake (location, time, magnitude, etc.) and/or publication parameters (author name, journal, year of publication, etc.). The output is presented in a format accepted by major scientific journals. For most recent publications the results include the DOI that allows direct access to scientific articles from corresponding journal websites.

References were collected and linked to events in the ISC database based on the titles and abstracts of scientific publications that could be found in the ISC Bibliography of Seismology, electronic indexes provided by scientific journals as well as references collected during the work on the ISC-GEM Catalogue.

References to publications are not limited to Seismology. They cover a broad range of disciplines including, but not limited to earthquake engineering, tectonics, structural geology, geodesy, remote sensing, nuclear test monitoring, tsunami, landslides, environmental studies, coastal science, natural disasters, hydrology, geochemistry, atmospheric sciences and geomagnetism. This feature makes the Event Bibliography an attractive tool for multidisciplinary studies and useful for researchers and students from different fields.

The Event Bibliography includes ~16,000 articles, ~14,000 seismic events and ~500 journal titles (Di Giacomo et al., 2014). Seismic events cover the period from 1904 till present; publications cover the period from 1950 till present (Fig. 24).

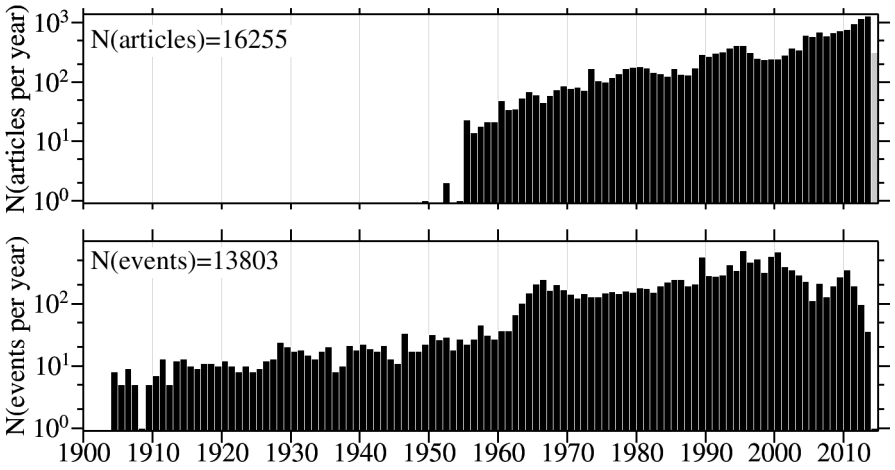


***Figure 24**. Annual numbers of seismic events and related scientific articles in the ISC Event Bibliography*

During the first 8 months since the ISC Event Bibliography became available, users from a number of countries made 5307 searches (Fig.25).

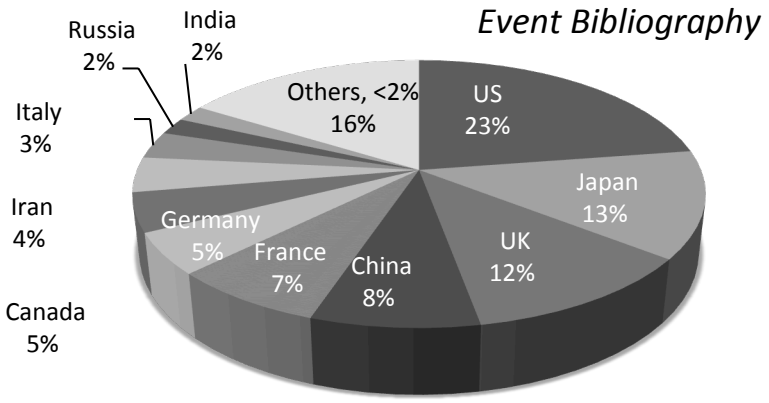


***Figure 25**. Per country use of the ISC Event Bibliography in 2013*

CTBTO LINK to the ISC DATABASE

Back in 2008, the UK Foreign and Commonwealth Office (FCO) awarded the ISC with a three year grant to set up a dedicated and secure link to the ISC database for the CTBTO PTS and National Data Centres. The UK FCO provided 90% of the total funding with GEUS (Denmark), NORSAR (Norway), FOI (Sweden) and University of Helsinki (Finland) complementing it with 2.5% each. From April 2011, the funding of the project was taken over by the CTBTO with an intention to continue for three years until March 2015.

During 2013 we maintained a dedicated server at the ISC that holds a mirror version of the ISC database. The dedicated web-based software package designed and maintained by the ISC for this service allowed users from PTS and National Data Centres for CTBTO to query the ISC database in ways specific to the explosion monitoring community. The software

package includes four types of bulletin searches: an area based, an REB event based, GT event based and an IMS station based search through the wealth of the parametric information in the ISC database.

The objective of the project is to provide the capacity for NDCs to perform various types of analysis such as:

- assessing the historical seismicity in a specific region;
- putting an event of interest into context with the seismicity of the surrounding region;
- examination of observations reported by non-IMS stations;
- comparison of hypocentre solutions provided by various agencies;
- relocating an REB event based on the user selected arrival times available for this event in the ISC database;
- investigation of station histories and residual patterns of IMS or IMS surrogate stations.

We also developed an interface for selecting waveforms of non-IMS stations for REB events from the IRIS DMC archive. For each recent REB and GT event, this interface:

- allows selection of stations by distance / azimuth to the REB epicentre;
- shows the number of stations, for which waveforms are available at IRIS DMC;
- exhibits pre-prepared images of selected waveforms, filtered and un-filtered with theoretical first arrivals indicated on top of the waveform images;
- offers a form to request part of waveform, based on absolute or relative theoretical arrival times of required seismic phases or on group velocity of surface waves;
- triggers a request to IRIS DMC; as a result, users receive required waveforms by e-mail in the SEED format.

Figure 26 shows user activity on the Link by both PTS/CTBTO and NDCs.

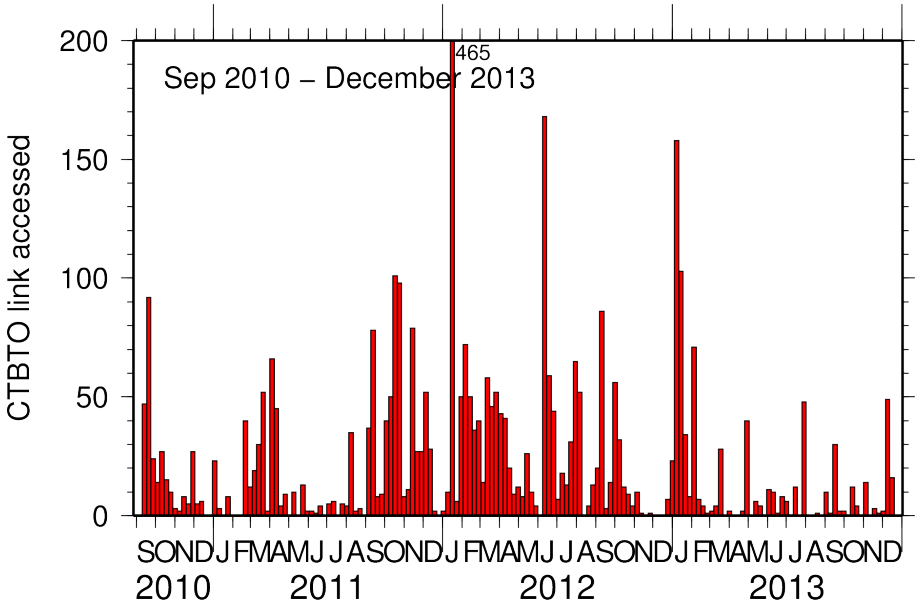


***Figure 26**. The Link to the ISC database mirror is provided to the NDCs through the IDC secure website. The figure shows the healthy stream of user activity.*

It may first appear that this project benefits only CTBTO. This isn't true as the ISC, its Member-Institutions and the ISC Bulletin and other product users gain a great deal from the developments on this project:

- The ISC development staff acquired important skills and experience during this project. The advances made under this project are gradually implemented to improve the traditional open ISC web services.
- In particular, experience of downloading, checking quality and processing waveforms on the industrial scale will help the ISC's mid-term plans of making its own automatic waveform measurements to further improve the quality of the ISC Bulletin.
- The ISC and its Bulletin users gained much speedier access to the REB Bulletin which is now available within 20-50 days after event occurrence as opposed to half a year to a year in the past (Fig. 27).
- Many National Data Centres for CTBTO are run by institutions that are either Members of the ISC or reporters of data to the ISC.
- Several NDC's either became ISC Members or increased their financial contributions, based on the added value of the ISC service.

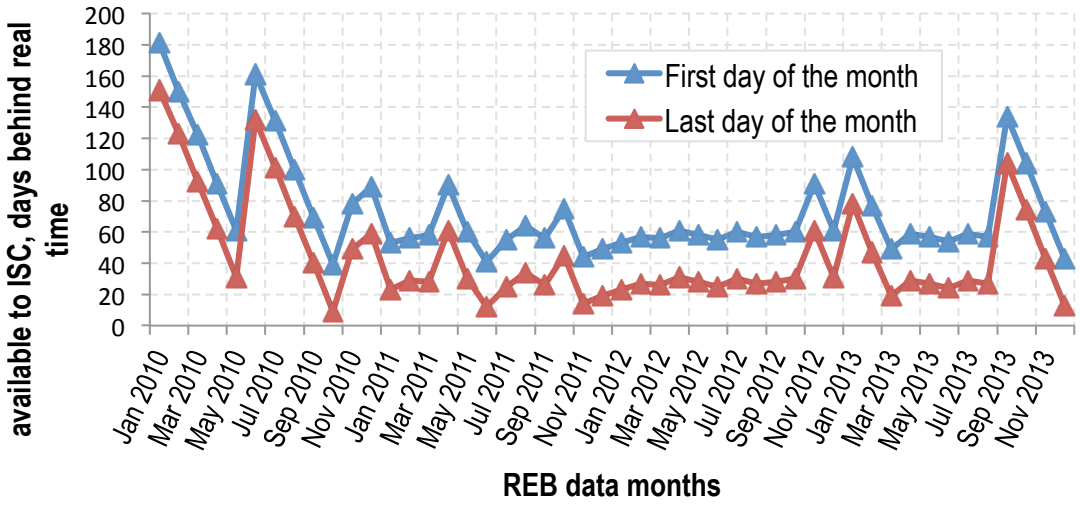


Figure 27*. The availability of the IDC REB data to general ISC Bulletin users (days behind real time) has considerably improved with the routine operation of the CTBTO Link.*

It also has to be noted that although the software created under this project is open only to the monitoring community, the actual data used by them are exactly the same as used by all ISC users: the ISC Bulletin, GT List, EHB and International Seismograph Station Registry.

ISC BULLETIN REBUILD

The value of the ISC Bulletin is dependent upon following uniform procedures over a long period of time. Nevertheless, essential changes in the ISC procedures have occurred:

- The *ak135* velocity model has been used since 2006 whilst *JB* travel times were used in the past.
- A new event Locator based on different approach was introduced from data year 2009.
- Throughout the ISC history different sets of seismic phases were used for location: P & (from 2001) S with other *ak135* phases from 2009.
- Latitude & longitude error estimates were computed before Oct 2002, followed by full error ellipses later on.
- Procedures that determine what reported events require relocation by the ISC were also changed in 1999, 2005 and 2006.

Thus, the ISC Bulletin will benefit from being rebuilt using uniform procedures to guarantee homogeneity through its entire period: 1960-2009. The US NSF provided substantial funding for this project to complement the funds already made available by Japan, India and China for further general development at the ISC.

As part of this project we are:

- Re-computing all ISC hypocentres with uncertainties;
- Re-computing all ISC event magnitudes with uncertainties;
- Soliciting, obtaining and integrating essential additional datasets that have not been available at the time of original ISC Bulletin production (Fig.28);
- Performing essential integrity and consistency checks, quality control and correction.

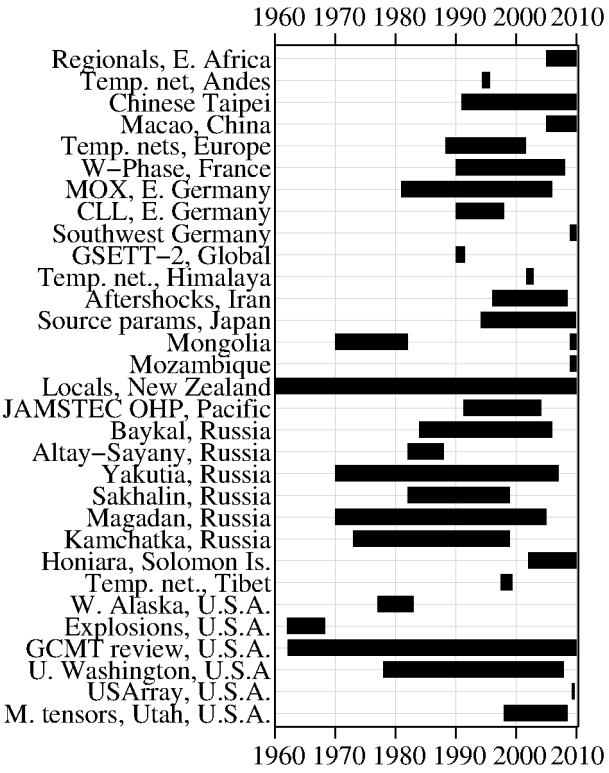


***Figure 28**. Previously unavailable data to become part of the Re-built ISC Bulletin.*

During 2013 we continued with a thorough review and clean-up of the contents of the ISC Bulletin in the areas of seismic arrival phase identifications, channel information, first motion information and suspiciously large magnitude estimates.

Due to an unfortunate cut in the fourth year of the NSF funding, the release of the rebuilt ISC Bulletin had to be delayed until the beginning of year 2015.

PRINTED SUMMARY of the BULLETIN of the ISC

The ISC has ceased publication of the printed ISC Bulletin with the last data of year 2009. From data year 2010 it was decided to replace this publication with the printed Summary of the ISC Bulletin which covers six months of the Bulletin data enclosed on a DVD. The old Bulletin was a listing of individual event hypocentres and magnitudes. The new publication features articles on the following topics:

- The ISC (Mandate, History, Evolution of the Bulletin, Member Institutions, Sponsors, Data Contributors, Staff)
- Operational Procedures (data collection, grouping, association, thresholds, event location, magnitude determination, review, history of operational changes)
- Availability of the ISC Bulletin
- Citing the ISC
- IASPEI Standards
- Summary of Seismicity (6 months)
- Notable Events
- Statistics of Collected Data
- Overview of the ISC Bulletin
- Leading Data Contributors
- Glossary
- Acknowledgements
- References

As many as seven members of the ISC staff worked on the project to prepare the first Summary. As a book publisher, the ISC receives a refund of the Value Added Tax on all goods and services that it buys from other suppliers.

SCANNING HISTORICAL STATION BULLETINS

Digital scanning of the most important part of the historical station bulletin collection has been completed by the SISMOS project at the INGV in Italy. A considerable fraction of station bulletins used for preparation of the ISC-GEM Catalogue has been transported to Rome, scanned and returned to the ISC warehouse in the Autumn of 2013. Digital images bearing the ISC and INGV logos will eventually become available to users from the ISC and SISMOS websites.

This project was made possible thanks to original funding from the GEM Foundation.

FINANCE

The detailed financial statements of the ISC for 2013 were audited by Griffins, Chartered Accountants (Newbury, UK) and approved by Prof. John Woodhouse of ISC Executive Committee. These statements present the state of ISC's financial affairs as at 31/12/2013.

INCOME

In 2013, ISC had a total income of £717,588 from national contributions and grants for special projects. The grants are listed as Other Income and amount to 18% of the total income. The providers of these funds are itemised on page 7 of the accounts. Interest on ISC bank accounts plus the income from selling ISC publications is also included. The NSF funds and also other grants where work is yet to continue have been split between 2013 and 2014.

Unfortunately, the IGN, long-term national Member for Spain has informed us of their withdrawal for years 2013-2014 due to large scale cuts in science budgets imposed by the Spanish Government. The last year of 2012/2013 support from NSF was cut by 6%. JAMSTEC also had to temporarily reduce their contribution by 13%.

On the other hand, Geoscience Australia has doubled its support of the ISC operations and intends to continue at the new level.

The exchange rate between the UK £ and USA $ veered between the opening rate of £1=$1.62 at the start of the year, down to £1=$1.5 and then finishing the year at £1=$1.65 at the end of December. The UK £ to Euro exchange rate began the year at £1=€1.22, went to £1=€1.15 and ended the year at £1=€1.20. These variations affected several membership contributions and project grants.

At the year-end £74,300 had yet to be paid by members but at the time of writing this report some £57,000 has been received.

EXPENDITURE

About 83% of ISC expenditure in 2013 was committed to personnel costs, £19,350 less than the amount spent in 2012. The salary costs include salaries, pension contributions, and recruitment and repatriation of new and departing staff. The ISC salaries follow the UK academic salaries scales.

Building expenses were just below the previous years' costs and computing costs fell by £10,650. The total travel costs for the staff and the Executive Committee were on a par with the previous year. The annual Executive Committee meeting was held in Sweden. Staff travelled to several countries to attend professional meetings to seek new data and future funding as well as to increase the profile of the ISC. Staff also took part in meetings related to current projects performed by the ISC.

RESERVES

The gain in income over expenditure for 2013 was £64,933. ISC total reserves, comprising the cash in the bank, building and land, the money owed to ISC (debtors) minus the money ISC owes (creditors) increased during 2013 to £739,549, this includes money earmarked for on-going projects. The Contingency Fund stands at £30,000 in accordance with the wishes of the ISC Governing Council. The ISC General Reserve of £709,549 is equivalent to around 12 months future operation of the ISC. This is well within British guidelines for charitable organizations.

CASH FLOW

The cash flow in Figure 29 shows receipts and outlays using dates when transactions were recorded at the bank and the bank balances where US Dollars and Euros are converted to Sterling using the exchange rate as of the end of each month.

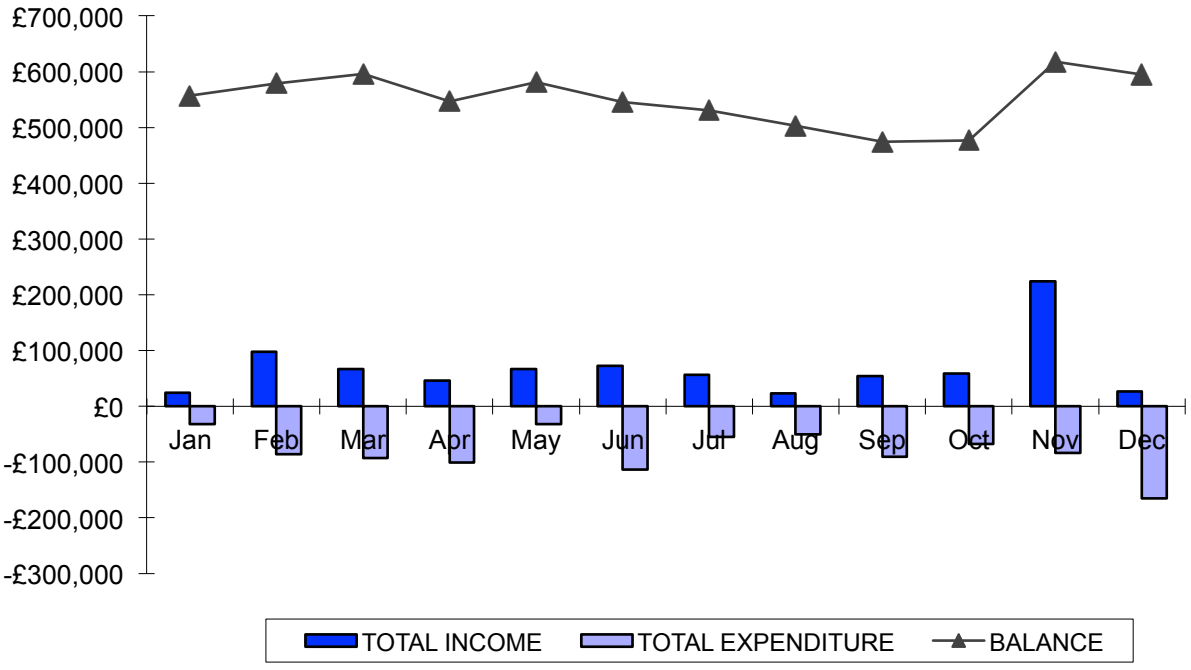


Figure 29. Income/expenditure cash flow and cash balance in 2013.

SCIENTIFIC LIAISONS

VISITORS to the ISC

The following geophysicists visited ISC premises in Thatcham during the year:

- Remy Bossu, EMSC, Bruyeres-le-Chatel, *France*
- Stephanie Godey, EMSC, Bruyeres-le-Chatel, *France*
- Jean Letort, CEA and Grenoble University, *France*
- Mungunsuren Dashdondog, RCAG of MAS, *Mongolia*
- Bufelo Lushetile, Geological Survey, Windhoek, *Namibia*
- Emily Ford, Thatcham and Exeter University, *UK*
- Rebecca Morgan, Oxford University, *UK*
- Min Chen, OeRC, Oxford University, *UK*
- Simon Walton, OeRC, Oxford University, *UK*
- Paul Earle, NEIC/USGS, Golden, *USA*

CONFERENCES, MEETINGS, WORKSHOPS

Members of the ISC staff gave talks or presented posters at the following conferences, meetings and workshops:

- Mediterranean Earthquakes, CRAAG, Algiers, *Algeria*
- CTBTO Training and RSTT workshop, San Juan, *Argentina*
- S&T conference, CTBTO, Vienna, *Austria*
- EPOS meeting, Erice, *Italy*
- GEM Reveal meeting, Pavia, *Italy*
- Symposium on Polar Science, NIPR, Tachikawa, *Japan*
- AGU Meeting of Americas, Cancun, *Mexico*
- International Workshop on Regional Cooperation in Seismology and Earthquake Engineering in South and Central Asia, Kathmandu, *Nepal*
- Nordic Seismology Seminar, Bergen, *Norway*
- Gulf Seismic Forum, Muscat, *Oman*
- Geophysical School, Perm, *Russia*
- International Seismology School, Gelendzhik, *Russia*
- Africa Array meeting, Johannesburg, *South Africa*
- IASPEI Assembly, Gothenburg, *Sweden*
- Insurance Modelling and Data Expose (IMDE), London, *UK*
- KTP workshop, London, *UK*
- NEIC-ISC-EMSC Coordination Meeting, Thatcham, *UK*
- SSA Meeting, Salt Lake City, *USA*

ISC STAFF VISITING OTHER INSTITUTIONS

Often with the help of the hosting institution, the members of the ISC staff visited and, where appropriate, gave a presentation to members of staff of:

- CRAAG, Algiers, *Algeria*
- INPRES, San Juan, *Argentina*
- IDC CTBTO, Vienna, *Austria*
- IMS CTBTO, Vienna, *Austria*
- LDG/CEA, Bruyeres-le-Chatel, *France*
- GEM Secretariat, Pavia, *Italy*
- RISSC, Naples, *Italy*
- NIPR, Tachikawa, *Japan*
- JAMSTEC, Yokohama, *Japan*
- ERI, Tokyo, *Japan*
- JMA, Tokyo, *Japan*
- Department of Mines and Geology, Kathmandu, *Nepal*
- Earth Science Department, Bergen University, *Norway*
- Sultan Qaboos University, Muscat, *Oman*
- Mining Institute, Perm, *Russia*
- Royal Society, London, *UK*
- SECED, London, *UK*
- Utah Geological Survey, Salt Lake City, *USA*

ISC STAFF TRAINING

The ISC Trainee Analyst, Rebecca Verney, spent a week at the Earth Science Department of Bergen University in Norway, where she learned the methods of waveform processing of local and teleseismic events.

The ISC Developer, Sepideh Rastin, took part in 3rd Earth "Skience" School in Munich, Germany, obtaining skills in using the ObsPy python library for waveform processing.

WORK EXPERIENCE at the ISC

Charis Horn, an Earth Sciences student at Oxford University, Tom Malthouse (Downs School, Compton) and Aleksey Storchak (Pangbourne College) volunteered for work placement at the ISC helping to digitise the historical global seismic bulletins of the British Association for the Advancement of Science (BAAS) dating back to the beginning of the 20th Century. Their work substantially contributed towards the improvement of the ISC-GEM Catalogue.

IASPEI MEDAL

In July, the ISC Honorary Seismologist Dr Robin D. Adams was announced to be the first recipient of the newly established IASPEI Medal.

ISC PRIZE for OXFORD UNIVERSITY STUDENTS

A few years ago the ISC established a small annual Prize in Mathematics and Geophysics (£200 and the annual ISC DVD-ROM) for a best first year student at the Earth Science Department of its home institution – the University of Oxford. In 2013, the prize was given to Mr Guy Paxman, the student with the best exam results in geophysics and mathematics. By awarding this prize the ISC hopes to attract Oxford University students to take note of the ISC services right from their first year, support the ISC in the future and perhaps even help the ISC in fulfilling its mission.

STATION BULLETIN ARCHIVE OF PROF. AMBRASEYS

The ISC's work on the ISC-GEM Catalogue has been assisted by the materials received from the late Prof Nicolas Ambraseys collection of historical seismic station bulletins. With permission and kind help of Mrs Xeni Ambraseys, we brought a full car-load of bulletins from Prof Ambraseys's London flat to the ISC. The collection was stamped, added to the ISC warehouse and extensively used for extension of the ISC-GEM Catalogue.

SCIENTIFIC PAPERS PUBLISHED by the ISC STAFF

Several scientific articles describing the work on the ISC-GEM Catalogue have been prepared for submission during 2013:

Storchak, D.A., D. Di Giacomo, I. Bondár, E. R. Engdahl, J. Harris, W.H.K. Lee, A. Villaseñor and P. Bormann, 2013. Public Release of the ISC-GEM Global Instrumental Earthquake Catalogue (1900-2009). *Seism. Res. Lett.*, 84, 5, 810-815.

Di Giacomo, D., Storchak, D.A., Safronova, N., Ozgo, P., Harris, J., Verney, R. and Bondár, I., 2014. A New ISC Service: The Bibliography of Seismic Events, *Seismol. Res. Lett.*, 85, 2, 354-360, doi: 10.1785/0220130143

Storchak, D.A., D. Di Giacomo, I.Bondár, W.H.K. Lee, P.Bormann and E.R. Engdahl. ISC-GEM: Global Instrumental Earthquake Catalogue (1900-2009): **Introduction.** Submitted to *PEPI*.

Di Giacomo, D., J. Harris, A. Villaseñor , D.A. Storchak, E.R. Engdahl, W.H.K. Lee and the Data Entry Team. ISC-GEM: Global Instrumental Earthquake Catalogue (1900-2009): I. **Data collection** from early instrumental seismological bulletins. Submitted to *PEPI*.

Bondár, I., E.R. Engdahl, A. Villaseñor , J. Harris and D.A. Storchak. ISC-GEM: Global Instrumental Earthquake Catalogue (1900-2009): II. **Location** and seismicity patterns. Submitted to *PEPI*.

Di Giacomo, D., I. Bondár, D.A. Storchak, E.R. Engdahl, P. Bormann and J. Harris. ISC-GEM: Global Instrumental Earthquake Catalogue (1900-2009): III. Re-computed Ms and mb, proxy Mw, final **magnitude composition** and completeness assessment. Submitted to *PEPI*.

Lee, W.H.K. and D.A. Storchak. ISC-GEM: Global Instrumental Earthquake Catalogue (1900-2009): IV. Bibliographical search for reliable **seismic moments** of large earthquakes during 1900-1979. Submitted to *PEPI*.

OTHER REFERENCES USED IN THIS REPORT

BAAS, 1900-1912. British Association for the Advancement of Science, Ciculars 1-27 issued by the Seismological Committee of the British Association for the Advancement of Science (*Shide Circulars*).

BAAS, 1913-1917. British Association for the Advancement of Science, Seismological Committee, monthly bulletins.

Bondár, I., and D. Storchak, Improved location procedures at the International Seismological Centre, 2011. *Geophys. J. Int*., 186, 1220-1244.

Dziewonski, A.M., Chou, T.A. and Woodhouse, J.H., 1981. Determination of earthquake source parameters from waveform data for studies of global and regional seismicity, *J. Geophys. Res.*, 86, B4, 2825-2852.

Ekström, G., Nettles, M., and Dziewonski, A.M., 2012. The global CMT project 2004–2010: Centroid-moment tensors for 13,017 earthquakes, *Phys. Earth Planet. Int*., 200-201, 1-9.

Engdahl, E.R., van der Hilst, R. and Buland, R., 1998. Global teleseismic earthquake relocation with improved travel times and procedures for depth determination, *Bull. Seism. Soc. Am.*, 88, 722-743.

Engdahl, E.R., and A. Villaseñor, 2002. Global seismicity: 1900-1999. In *International Handbook of Earthquake and Engineering Seismology*. Part A, edited by W.H.K. Lee, H. Kanamori, P.C. Jennings and C. Kisslinger. Academic Press, 665-690.

ISS, 1918-1963. International Seismological Summary, annual volumes.

Kennett, B. L. N., Engdahl, E. R., and Buland, R., 1995. Constraints on seismic velocities in the Earth from traveltimes, *Geophys. J. Int*., 122, 108-124.

SCIENTIFIC PAPERS PUBLISHED in 2013 that USED the ISC DATA

This list is a result of a special effort to put together a collection of scientific papers that used ISC or EHB data and published in 2013. The list is by no means complete. The ISC has become such a household name that many researchers unfortunately fail to reference the ISC when using the ISC data.

We have searched Google Scholar for scientific papers that refer to the ISC data. We used the exact phrases "International Seismological Centre", and "International Seismological Center" and "EHB"+ "seismic" for papers appearing in 2013. No doubt many more references can be found by using different search phrases.

Uppermost mantle seismic velocity and anisotropy in the Euro-Mediterranean region from Pn and Sn tomography J Díaz, A Gil, J Gallart - Geophysical Journal **International**, 2013 - gji.oxfordjournals.org **...** as high velocity slabs within the upper mantle in global and regional **...** arrivals reported at the **International Seismological Center** (ISC) catalogue (**International Seismological Centre** 2010) during **...** Therefore, the observed low-seismic velocities are probably related to the presence **...**

New constraints on the 3D shear wave velocity structure of the upper mantle underneath Southern Scandinavia revealed from non-linear tomography B Wawerzinek, JRR Ritter, C Roy - Tectonophysics, 2013 – Elsevier **...** For global context of the study area see Fig. **...** 2) with signal-to-noise ratios larger than 2 were suitable for the shear wave tomography, because seismic phases of these **...** Hypocentral parameters are taken from the **International Seismological Centre** and the US Geological Survey. **...**

Public Release of the ISC–GEM **Global** Instrumental Earthquake Catalogue (1900–2009) DA Storchak, D Di Giacomo, I Bondár… - **Seismological** …, 2013 - 171.66.125.217 **...** several hundred research and operational institutions around the world for providing **...** Global teleseismic earthquake relocation with improved travel times and procedures for **...** relocation of early instrumental seismicity: Earthquakes in the **International Seismological** Summary for **...**

Location and magnitudes of earthquakes in Central Asia from **seismic** intensity data: model calibration and validation D Bindi, AAG Capera, S Parolai… - … **International**, 2013 - gji.oxfordjournals.org **...** in Tables 1 and 2 are the locations and magnitudes from the ISC bulletin (**International Seismological Centre**, http://www.isc.ac.uk/) and from the Global Centroid Moment **...** occurrence of such large earthquakes makes Central Asia one of the areas of the world most prone to **...**

Plate reconstructions in the Arctic region based on joint analysis of gravity, magnetic, and seismicanomalies IY Koulakov, C Gaina, NL Dobretsov… - Russian Geology and …, 2013 – Elsevier **...** This model is based on using travel time data from the global catalogues of **International Seismological Center** (ISC, 2001) for the time 862 I.Yu. Koulakov et al. / Russian Geology and Geophysics 54 (2013)

Iranian earthquakes, a uniform catalog with moment magnitudes S Karimiparidari, M Zaré, H Memarian, A Kijko - Journal of **seismology**, 2013 – Springer **...** website; The Iranian Seismological Centre 2010) and provides data online from 2006 up to the present. **...** Global agencies: 1. ISC, **International Seismological Centre** UK: This center collects and recalculates earthquake locations from national and local agencies. The Fig. **...**

Fluid ascent and magma storage beneath Gunung Merapi revealed by multi-scale **seismic** imaging BG Luehr, I Koulakov, W Rabbel, J Zschau… - Journal of Volcanology …, 2013 – Elsevier **...** sources. Therefore, special efforts have been made to reprocess the ISC catalogue and as a result many specialists use a relocation method developed by **Engdahl**, van der Hilst, and Buland (the **EHB** method, **Engdahl** et al., 1998). **...**

How rigid is a rigid plate? Geodetic constraint from the TrigNet CGPS network, South Africa R Malservisi, U Hugentobler… Journal **International**, 2013 - gji.oxfordjournals.org **...** Seismicity from **International Seismological Centre** (2010). **...** Focal Mechanism for the Machaze earthquake from the Global CMT catalog. **...** 2007) using orbit products from the CODE (Center for Orbit Determination in Europe) Analysis center of the International GNSS Service (IGS **...**

Fractional dynamics and MDS visualization of earthquake phenomena AM Lopes, JA Tenreiro Machado, CMA Pinto… - … & Mathematics with …, 2013 – Elsevier **...** earthquake's amplitudes follow a Beta distribution both at the regional and global levels **...** In this study the Bulletin of the **International Seismological Centre** (ISC), available online at http://www **...**

A unified seismic catalog for the Iranian plateau (1900–2011) MP Shahvar, M Zare, S Castellaro - Seismological Research …, 2013 - 171.66.125.217 **...** EMMA), Global Seismic Hazard Assessment Program (GSHAP), KAR, Global Centroid Moment Tensor (GCMT),EuropeanMediterranean Seismological Centre (EM

SC**), International Seismological Centre** (ISC), National ... as one of the most reliable catalogs ...

Crustal structure of the rifted volcanic margins and uplifted plateau of Western Yemen from receiver function analysis A Ahmed, C Tiberi, S Leroy, GW Stuart… - … **International**, 2013 - gji.oxfordjournals.org **...** 6 National Oceanography Centre Southampton, University of Southampton, Southampton, UK;7 Yemen **...** The seismic data are extracted from ISC seismic catalogue for the period January 1970–February 2012 and M ≥ 5.0 (**International Seismological Centre** 2012). **...**

A Nonlinear Method to Estimate Source Parameters, Amplitude, and Travel Times of Teleseismic Body Waves RF Garcia, L Schardong, S Chevrot - Bulletin of the **Seismological** …, 2013 - bssaonline.org **...** **...** Improvements in relocation algorithms applied to travel-time picks collected by the **International Seismological Center** (ISC) (Engdahl et al., 1998) have recently been implemented at the ISC (Bondár and McLaughlin, 2009; Bondár and Storchak, 2011), but the location errors **...**

Improving the Mediterranean seismicity picture thanksto international collaborations S Godey, R Bossu, J Guilbert - Physics and Chemistry of the Earth, Parts A/ …, 2013 - Elsevier**...** to the **International Seismological Center** (ISC) to be integrated in their global bulletin of ... in coordination with international data centres like the ISC and the World Data Center for ... proposed by the international data centres in association with the FDSN (International Federation of ...

Underwater acoustic records from the March 2009 eruption of Hunga Ha'apai-Hunga Tonga volcano in the Kingdom of Tonga DWR Bohnenstiehl, RP Dziak, H Matsumoto… - Journal of Volcanology …, 2013 – Elsevier **...** and videos obtained by amateur photographers spurred both regional and global media attention. **...** The **International Seismological Centre** (2010) reported 90% error ellipse (dashed with line) is shown **...** This is equivalent to the Real-time Seismic Amplitude Measurement (RSAM **...**

Quantitative Archaeoseismological Study of a Roman Mausoleum in Pınara (Turkey)—testing seismogenic and rockfall damage scenarios KG Hinzen, H Kehmeier, S Schreiber - Bulletin of the **Seismological** …, 2013 - bssaonline.org **...** **...** Epicenters of historical earthquakes from 2100 BCE to 1959 CE are from Tan et al. (2008) and those from 1960–2008 are from the **International Seismological Center** online bulletin (see Data and Resources). Major historic earthquakes are labeled with their year of occurrence. **...**

P-wave anisotropic tomography in Southeast Tibet: new insight into the lower crustal flow and seismotectonics W Wei, D Zhao, J Xu - Physics of the Earth and Planetary Interiors, 2013 – Elsevier **...** . The data used in this study were recorded by three kinds of seismic networks in Southeast Tibet and adjacent regions: (1) national and provincial stations of the Chinese Seismograph Network;(2) stations compiled by the **International Seismological Center** (ISC);

Global monitoring: the challenges of access to data R Harris, R Browning - 2013 - books.google.com **...** database of geophysical data derived from marine seismic surveys

Coastal…Panel on Climate Change Intellectual Property Rights **International Seismological Centre** International Standards Organization…xxiiGlobal Monitoring MSG MSS MTP NARA NASA NASDA NDSC NERC…

Thermal structure and megathrust seismogenic potential of the Makran subduction zone GL Smith, LC McNeill, K Wang, J He… - Geophysical …, 2013 - Wiley Online Library

... We use the ISC (**International Seismological Centre**) location (placing it offshore), but it should be noted **...** side is defined by a continental geotherm to generate the global average back **...** [9] Thesubducting plate geometry is constructed from combined 2-D seismic reflection lines **...**

2.5-Dimensional tomography of uppermost mantle beneath Sichuan–Yunnan and surrounding regions Y Lü, Z Zhang, S Pei, E Sandvol, T Xu, X Liang - Tectonophysics, 2013 – Elsevier **...** These travel time data are from three sources, the **International Seismological Centre** (1960–2007), the China Earthquake Data Center (1990–2009 **...** The average Vp/Vs ratio of our study area is less than the global average for the …

Assessment Of Seismic Hazard With Local Site Effects: Deterministic And Probabilistic Approaches KS Vipin - 2013 - etd.ncsi.iisc.ernet.in **...** The first step in the seismic hazard analysis is to compile the earthquake catalogue. **...** Centre for Atomic Research (IGCAR) Kalpakkam etc.) and international agencies (Incorporated Research Institutions for Seismology (IRIS), **International Seismological Centre** (ISC), United **...**

The 2010 Mw 6.5 Rigan, Iran, Earthquake Aftershock Sequence M Rezapour, A Mohsenpur - Bulletin of the **Seismological** Society of …, 2013 - bssaonline.org **...** In addition, the reported Global CMT solution for the second shock is similar to **...** The **International Seismological Centre** catalog was also searched for instrumental earthquakes using http://www.isc **...** of Tehran for providing waveform data recorded by the temporary seismic network **..**

Bayesian inference of Earth's radial seismic structure from body-wave traveltimes using neural networks RWL de Wit, AP Valentine… - … Journal **International**, 2013 - gji.oxfordjournals.org **...** 1995), for instance, is used in the location algorithm of the **International Seismological Centre** (ISC). **...** and receivers are globally distributed, that is, within the typical limitations of seismological data coverage. **...** 5). This could indicate that there are no global low-velocity zones in the **...**

2012 Haida Gwaii Quake: Insight Into Cascadia's Subduction Extent W Szeliga - Eos, Transactions American Geophysical

Union, 2013 - Wiley Online Library **...** need to earthquake were contributed by USGS and the National Earthquake Information Center in Golden **..** Earthquake locations were contributed by the **International Seismological Centre**. **...**

Delamination in the Betic Range: Deep structure, seismicity, and GPS motion F de Lis Mancilla, D Stich, M Berrocoso, R Martín… - …, 2013 - geology.gsapubs.org **...** of Betic range and foreland (GB—Guadalquivir basin; GC—Gulf of Cadiz), seismic broadband stations and permanent global positioning system **...** Iberia (black arrows) and localizations of intermediate deep earthquakes from **International Seismological Centre** (http://www **...**

Analysis of Italian Earthquake catalogs in the context of intermediate-term prediction problem L Romashkova, A Peresan - Acta Geophysica, 2013 – Springer **...** Since 1986 it is updated using the NEIC Global Hypocenters' Database System (GHDB 1989). **...** CSEP-Italy and NEIC datasets is present- ed in Sections 3-4.
The **International Seismological Centre** compiles the **...** The ISC Bulletin contains world-wide data from 1904 to present day. **..**

Mariana Forearc Crust CORK Pressure Data: Observations and Implications KA Vinas - 2013 - scholarlyrepository.miami.edu
... **International Seismological Centre** (ISC) Database which contains a searchable catalog of earthquake data from seismic networks and data centers worldwide.

Current stress and strain-rate fields across the Dead Sea Fault System: Constraints from seismological data and GPS observations M Palano, P Imprescia, S Gresta - Earth and Planetary Science Letters, 2013 – Elsevier **...** including all available data reported in literature and in the World Stress Map **...** From the **International Seismological Centre** (http://www.isc.ac.uk) on-line catalogue,

A new evaluation of seismic hazard for the northwestern part of Saudi Arabia NS Al-Arifi, RE Fat-Helbary, AR Khalil, AA Lashin - Natural hazards, 2013 – Springer

of seismological catalogues and bulletins including those of he **International Seismological Centre** (ISC), the **...** of the present study are compared with those of the Global Seismic Hazard Assessment **...**In: Proceedings of the 4th world conference on earthquake engineering, vol 1 **...**

Strong ground motion simulation of the 2003 Bam, Iran, earthquake using the empirical Green's function method H Sadeghi, H Miyake, A Riahi - Journal of **seismology**, 2013 – Springer **...** this earthquake one of the deadliest and most damaging earthquakes in the world that year **...** the polarity of the P-wave first motions, reported by ISC (**International Seismological Centre** 2012 **...** 2005) in the direction of the rupture propagation, where the strong seismic energy arrives **...**

Electrical conductivity of the Pampean shallow subduction region of Argentina near 33 S: Evidence for a slab window Al Burd, JR Booker, R Mackie… - Geochemistry, …, 2013 - Wiley Online Library **...** not appear to have any Wadati-Benioff zone earthquakes deeper than 195 km [**International Seismological Centre**, EHB Bulletin

Introduction to the Special Issue on the 2011 Tohoku Earthquake and Tsunami

T Lay, Y Fujii, E Geist, K Koketsu… - 2013 - bssaonline.org
... As one of a number of recent great earthquakes to strike around the world (since 2004 the rate of global shallow earthquakes with M w ≥8.0 is **...** van der Elst et al. (2013) examine the **International Seismological Centre** (ISC), USGS Preliminary Determination of Epicenters **...**

Vp structure of the outermost core derived from analysing large-scale array data of SmKS waves S Kaneshima, G Helffrich - Geophysical Journal **International**, 2013 gji.oxfordjournals.org **...** There are differences among global earth models in detailed V p structure at the **...** 4, 5 and 6) waves which are observed at large-scale broad-band seismic networks. **...** for the events, whose epicentres agree with those reported by the **International Seismological Centre**

Earthquake occurrence reveals magma ascent beneath volcanoes and seamounts in the Banda region A Špičák, V Kuna, J Vaněk - Bulletin of Volcanology, 2013 - Springer

... For our seismotectonic analysis, the **EHB** (**Engdahl**, van der Hilst, Buland) database of hypocenter determinations, a groomed version of the **International Seismological Centre** (ISC) bulletin, has been utilised, covering the time period of 1960–2008. **...**

Two-year survey of earthquakes and injection/production wells in the Eagle Ford Shale, Texas, prior to the MW4. 8 20 October 2011 earthquake C Frohlich, M Brunt - Earth and Planetary Science Letters, 2013 – Elsevier **...** While earthquake seismologists have long recognized that fluid injection into the subsurface sometimes **...** Since 1982 the **International Seismological Centre** (ISC) has reported 15 earthquakes within the area **...**

Fluid pressure and temperature transients detected at the Nankai Trough Megasplay Fault: Results from the SmartPlug borehole observatory S Hammerschmidt, EE Davis, A Kopf - Tectonophysics, 2013 – Elsevier **...** possible, and these were compared to online earthquake catalogues of the **International Seismological Centre** (ISC) and **...** This allowed a clear distinction of the type of seismic waves

A non-stationary epidemic type aftershock sequence model for seismicity prior to the December 26, 2004 M 9.1 Sumatra-Andaman Islands mega-earthquake AR Bansal, Y Ogata - Journal of Geophysical Research: Solid …, 2013 - Wiley Online Library **...** [9] Here we compared the NEIC magnitude (m b) with the ISC (**International Seismological Centre**) magnitude (M **...** in the year 1996 is due to the use of IDC (International Data Centre ... for quantifying the activation and quiescence in the different regions of the world [Kumazawa et ...

Complex deep seismic anisotropy below the Scandinavian Mountains C Roy, JRR Ritter - Journal of **seismology**, 2013 – Springer **...** In this study, we combine seismological

measurements at several networks in the **...** Global mantle tomography models contain a transition from low seismic velocity underneath **...** Mw is the moment magnitude; event details are taken from the **International Seismological Centre ...**

International Collaboration to Improve The Regional Seismic Travel Time (RSTT) Model SC Myers, ML Begnaud, S Ballard… - AGU Fall Meeting …, 2013 - adsabs.harvard.edu

... available computers is key to the usefulness of the method by seismic centers that **...** the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) and the **International Seismological Centre** (ISC). **...** to the ak135 model (Kennett et al., 1995), which is the global standard **...**

Analysis of precursory seismicity patterns in Zagros (Iran) by CN algorithm M Maybodian, M Zare, H Hamzehloo… - Turkish Journal of …, 2013 - journals.tubitak.gov.tr

... the **International Seismological Centre** [ISC]) plus regional data sets (those of the International Institute of **...** Between the global catalogs (ISC and NEIC), the completeness and therefore the quality of the …

Body-Wave Magnitude mb Is a Good Proxy of Moment Magnitude Mw for Small Earthquakes (mb< 4.5–5.0) P Gasperini, B Lolli, G Vannucci - **Seismological** Research Letters, 2013 - 171.66.125.217 **...** Body-wave magnitudes m b are taken from the **International Seismological Centre (ISC) Bulletin** from 1964 to **...** (2012) as 0.07 units for Global CMT, NEIC **...** New Manual of Seismological Observatory Practice (NMSOP-2), IASPEI, GFZ

Source and Aftershock Analysis of a Large Deep Earthquake in the Tonga Flat Slab

C Cai, DA Wiens, LM Warren - AGU Fall Meeting Abstracts, 2013 - adsabs.harvard.edu **...** Earthquake source observations, Seismicity and tectonics, 7240 Subduction zones. **...** Arrival times picked from the local seismic stations together with teleseismic arrival times from the **International Seismological Centre** (ISC) are used for **...**

Dynamic analysis of earthquake phenomena by means of pseudo phase plane

AM Lopes, JAT Machado - Nonlinear Dynamics, 2013 – Springer **...** Data compiled by the **International Seismological Centre** (ISC), available online at http://www.isc.ac.uk

Along-axis variations of the seismicity of ultraslow spreading ridges V Schlindwein, A Demuth - 2013 - epic.awi.de **...** Epicentres located within 30–35 km of the rift axis were extracted from the catalogue of the **International Seismological Centre** for a time period of 35 **...** Here, volcanic centres often have an increased seismicity rate relative to the background rather than appearing as seismic gap **...**

How Complete is the ISC-GEM Global Earthquake Catalog? AJ Michael - AGU Fall Meeting Abstracts, 2013 - adsabs.harvard.edu **...** Keywords: Earthquake interaction, forecasting, and prediction,**...** In January, 2013, the **International Seismological Centre** (ISC), in collaboration with the Global Earthquake Model **...**

Seismic drift demand on multi-storey buildings in Sri Lanka due to long-distant earthquakes P Gamage, S Venkatesan, R Dissanayake - 2013 - dl.lib.mrt.ac.lk

The global awareness on earthquake hazards has increased dramatically with recent devastating earthquakes, eg **... International Seismological Centre**, United Kingdom: http://www.isc.ac.uk/search/bulletin/

Seismotectonic structures in the offshore of Northeast Taiwan from OBS data Y Su, J Lin - AGU Fall Meeting Abstracts, 2013 - adsabs.harvard.edu **...** events were detected manually with the Antelope software and the global velocity model **...** Except the first cluster, which was well determined by the **International Seismological Centre** (ISC) catalogue

The South Aegean seismological network–HSNC G Hloupis, I Papadopoulos, JP Makris… - Advances in …, 2013 - adv-geosci.net **...** RODP, KOSK, THT2) are registered to **International Seismological Centre** (ISC) and the network is listed by International Federation of **...** A specific Global System Table **...** The establishment and operation of a modern, dense seismological network in a region characterized by high **...**

International Workshop on Regional Cooperation in Seismology and Earthquake Engineering in South and Central Asia, September 16-19, 2013 in Kathmandu …

AK Shukla - nset.org.np **...** the world, the other five being Mexico, Taiwan, California, Japan and Turkey. This part of India **...** configured to include about 100 global stations of IRIS (a consortium of Incorporated Research **...**Seismological Bulletins of IMD are shared regularly with **International Seismological Centre...**

Body-wave magnitudes of underground nuclear explosions at major test sites derived by the maximum-likelihood method S Peacock, A Douglas, D Bowers… - EGU General Assembly …, 2013 - adsabs.harvard.edu **...** Abstract. Body-wave magnitudes (mb) of ~600 underground nuclear tests have been derived from station amplitudes collected by the **International Seismological Centre** (ISC), by a joint inversion for mb and station-specific magnitude corrections (Lilwall 1986). **...**

ISC-GEM Global Instrumental Earthquake Catalogue (1900-2009)-An Improved View of the Seismicity of the Earth I Bondar, ER Engdahl, D Di Giacomo… - AGU Spring Meeting …, 2013 - adsabs.harvard.edu Title: ISC-GEM Global Instrumental Earthquake Catalogue (1900-2009) - An Improved View of the **...** Spain;), AE(862 Richardson Court, Palo Alto, CA, USA;),

AF(**International Seismological Centre**, Thatcham, United Kingdom

Seismic monitoring in Namaqualand/Bushmanland region H Malephane, RJ Durrheim… - 13th SAGA Biennial …, 2013 - earthdoc.org **...** Square Kilometer Array (SKA) project, destined to be the world's largest and **...** networks, the South African National Seismological Network, and the **International Seismological Centre** has been **...** changes seem to coincide with periods of increased global seismic moment release. **...**

Ancient subduction zone in Sakhalin Island AG Rodnikov, NA Sergeyeva, LP Zabarinskaya - Tectonophysics, 2013 – Elsevier **...** E, with the hypocenter determined to be at a depth of 18 km (**International Seismological Centre**, 1997). **...** by subduction processes in the Late Cretaceous–Paleogene and the subsequent **seismic** movements in **...** Closing the gap between regional and global travel time tomography. **...**

SEISMIC RISK IN COLOMBO–PROBABILISTIC APPROACH SB Uduweriya, KK Wijesundara, PBR Dissanayake - saitm.edu.lk **...** Disaster Management Authority, New Delhi, India (2011) and Internationally recognized earthquake **...** as the National Earthquake Information Centre (NEIC), the **International Seismological Centre** (ISC)

Contributions of GPS Permanent Station and Seismological Observatory to Geophysical Studies at Maitri, Antarctica During XXIV Indian Antarctic … AN Rao, SVR Rao, GB Navinchander, A Akilan… - 2013 - 14.139.119.23 **...** The Global network of GPS stations included Maitri (MAIT), Casey (CAS1) and Davis Fig. ... Subsequently, it was upgraded with a Broad Band Digital System in January, 2001. The Broad Band Seismic data were contributed to **International Seismological Center** (ISC), UK **...**

A study of Pn anisotropy beneath continent in East Asia G Song, T Kang - AGU Fall Meeting Abstracts, 2013 - adsabs.harvard.edu We use Pn waves propagating within the mantle lid to constrain seismic anisotropy in the uppermost part of **...** in epicentral distance in and around East Asia from 1960 to 2011 from the Bulletin of the **International Seismological Centre**. **...**

The ISC Contribution to the RSTT Development and Validation Effort

I Bondár, D Storchak - ctbto.org **...** István Bondár and Dmitry Storchak **International Seismological Centre**, Abstract Recently the CTBTO has launched a global initiative to facilitate the development of the Regional Seismic Travel Time (RSTT) velocity model on a global scale by forming **...**

Regional Variation of the w-Upper Bound Magnitude of GIII Distribution in the Different Regions of Western Anatolia Y Bayrak, E Bayrak - 7th Congress of the Balkan Geophysical Society, 2013 - earthdoc.org **...** is divided into 15 seismic regions based on their seismotectonic regime. The database used in this work was taken from different sources and catalogues such as TURKNET, **International Seismological Centre** (ISC), Incorporated Research Institutions for Seismology (IRIS) and **...**

Probabilistic seismic hazard analysis in Nepal TD Ram, G Wang - Earthquake Engineering and Engineering Vibration, 2013 – Springer **... seismic** belt and is one of the most earthquake-prone countries in the world. **...** Thapa and Wang, 2010) as well as data from the **International Seismological Centre** (ISC), the **...** 1994, when local earthquake data became available from the National Seismological Center (NSC) of **...**

Regional, Local, and In-mine Moment Tensors for the 2013 Rudna Mine collapse KM Whidden, L Rudzinski, G Lizurek… - AGU Fall Meeting …, 2013 - adsabs.harvard.edu

... Seismic monitoring and test-ban treaty verification, Earthquake source ... 2) velocity models derived from the POLONAISE'97 seismic refraction experiment **...** tensor estimates from two different agencies (see **International Seismological Centre** event 7443851

Analysis and Visualization of Seismic Data Using Mutual Information JAT Machado, AM Lopes - Entropy, 2013 - mdpi.com **...** 3. Analysis Global Seismic Data The Bulletin of the **International Seismological Centre** (ISC) [28] is adopted in what follows. **...** events are divided into the fifty groups corresponding to the Flinn-Engdahl (FE) regions of Earth [58,59], which correspond to seismic zones usually used **...**

Updated seismic hazard assessment of Tunisia A Ksentini, NB Romdhane - Bulletin of Earthquake Engineering, 2013 – Springer **...** hazard and seismotectonic contexts in the framework of the Global Seismic Hazard Assessment **...**in Tunis City was conducted by the World Bank (World Bank/Egis **...** or more agencies (mainly: United States Geological Survey: USGS, **International Seismological Centre**: ISC, Euro **...**

An Earthquake Catalogue for El Salvador and Neighboring Central American Countries (1528-2009) and Its Implication in the Seismic Hazard Assessment

W Salazar, L Brown, W Hernández, J Guerra - davidpublishing.com **...** 13] W White and Harlow (1993) [14] S Molnar and Sykes (1969) [15] World standard catalogues (1900-2009) I ISC (**International Seismological Centre**), 2010,

Waveform cross correlation applied to earthquakes in the Atlantic Ocean D Bobrov, I Kitov, M Rozhkov - arXiv preprint arXiv:1307.0520, 2013 - arxiv.org **...** of the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) is a global network. By design, the IMS includes 50 primary and 120 auxiliary seismic stations. ... the seismological community as a bulletin distributed by the **International Seismological Centre**. **...**

The deep seismic structure of the Ethiopia/Afar hotspot and the African superplume SE Hansen, AA Nyblade - Geophysical Journal **International**, 2013 - gji.oxfordjournals.org **...** The largest source of travel-time residuals used is the reprocessed **International Seismological**

Centre database (Engdahl et al **...** the MER may better resolve the shallow LVZ caused by decompression melting, while global models may

"The Only Danish Seismologist" Objective I Lehmann - Journal of the Royal Astronomical Society - physicist.org .. In the early 1960s a critical discussion emerged on upgrading the ISS, at that time many years in arrears and underfunded. She was active in the establishment of its successor, the **International Seismological Centre** (I.S.C.)

Seismic swarms, fluid flow and hydraulic conductivity in the forearc offshore North Costa Rica and Nicaragua M Thorwart, Y Dzierma, W Rabbel… - **International** Journal of …, 2013 – Springer **...** Along the world's convergent margins, fluids are continually recycled from the ocean floor ..(2011) On-line Bulletin, http://www.isc.ac. uk, **International Seismological Centre**, Thatcham.

Multifractality in seismic sequences of NW Himalaya A Chamoli, RBS Yadav - Natural Hazards – Springer ... This is one of the most active regions of the world, where recently an ... from NEIC of USGS (http://neic.usgs.gov/neis/epic/epic-global.htm) to ... from different seismological sources such as International Seismological Summary **International Seismological Centre** (ISC),

Combined Rayleigh-and Love-Wave Magnitudes for Seismic Event Discrimination and Screening Analysis JK MacCarthy, DN Anderson 2013 - bssaonline.org

... The discriminant is calibrated using a global data set of 124 earthquakes and 26 ... in numerous studies and has been adopted by the International Data Center seismic protocols for **...** of 20 s, and mb values are obtained from the **International Seismological Centre** and United **...**

Tectonic Structures Across the Eastern African Rift Likely to Pose the Greatest Earthquake Hazard in Kenya JK Mulwa, F Kimata - geothermal-energy.org

... International Seismological centre, EHB Bulletin, www.isc.ac.uk, 2009 **...** Kennett, BL, and Engdahl,ER: Travel times for global earthquake location and phase identification ..

Statistical Analysis of Earthquakes in Iran-Yazd Province in the years 2006 to 2009 SA Almodarresi, KY Nasab, EA Mirkhalili - sciencepub.net **...** [36] About three million earthquakes occur in the world each year, or roughly eight **...** The surface wave magnitude scale 7.4, waves to the inner 6.4 is recorded by the **International Seismological Centre** - UK (ISC).

Deterministic and probabilistic seismic hazard analysis for Gwadar City, Pakistan

SU Rehman, M Khalid, A Ali, AEKA El - Arabian Journal of Geosciences, 2013 - Springer**...** different return periods. For this purpose, seismic data were collected from the Pakistan Meteorological Department and **International Seismological Center** (2010) databases for development of a comprehensive data catalog.

Spatial variation of probabilistic seismic hazard for Mumbai and surrounding region SS Desai, D Choudhury - Natural Hazards – Springer **...** largest known case of reservoir-induced seismicity (RIS) in the world and has **...** Geological Survey of India (GSI), United States Geological Survey (USGS), **International Seismological Centre** (ISC) UK **...**

Understanding Extension within a Convergent Orogen: Lithospheric Structure of the Pannonian Basin GA Houseman, GW Stuart - gef.nerc.ac.uk **...** Hypocentral information is from the Bulletin of the **International Seismological Centre**. **...**

DETERMINISTIC SEISMIC HAZARD ASSESSMENT OF DEHRADUN CITY M Kumar, HR Wason, R Das - igs.org.in ... is among most seismically active regions in the world, and has **...** data from the period 1809 to 1999 was considered from ISC **(International Seismological Centre)** UK **...** search/Bulletin), National Earthquake Information Centre (NEIC) and GCMT

K-means cluster analysis and seismicity partitioning for Pakistan K Rehman, PW Burton, GA Weatherill - Journal of **Seismology**, 2013 - Springer**...** 1) the British Geological Survey (BGS) dataset (The BGS World Seismicity Database 2004 **...** make use of the International Seismological Summary (ISS)/**International Seismological Centre** (ISC), ENGD **...** 1998), Global Seismic Hazard Assessment Programme (GSHAP; Zhang et al. **...**

Probabilistic Seismic Hazard Assessment for Jamaica W Salazar, L Brown, G Mannette - davidpublishing.com **...** [14]; (b) ISC (**International Seismological Centre**); (3) US **...** For the cases of events with magnitude ML and MD, relations from another part of the world have been…

Seafloor structure near the epicenter of the great 25 March 1998 Antarctic Plate earthquake Y Nogi - Journal of Geophysical Research: Solid Earth, 2013 - Wiley Online Library**...** The study area and the ship's tracks during the KH-01-3 Leg 2 cruise are shown in Figure 1. The main shock epicenter from the National Earthquake Information Center (NEIC) and the locations of epicenters from the **International Seismological Center** (ISC) for

Earthquake clustering in the tectonic pattern and volcanism of the Andaman Sea region A Špičák, J Vaněk - Tectonophysics, 2013 – Elsevier **...** We have used the EHB (Engdahl, van der Hilst, Buland) database (http://www.isc.ac.uk/ehbbulletin/) of earthquake parameters derived from hypocentral determinations published by the **International Seismological Center** (ISC — http://www.isc.ac.uk/). **...**

Effects of 17 August Earthquake (Mw= 7.4) and 12 November Earthquake (Mw;= 7.2) to the Sapanca Lake M Saygi, N Hoskan, OB Tan - 7th Congress of the Balkan Geophysical …, 2013 - earthdoc.org **...** The average depth ranges from 31- 33 m and the deepest place is 61 m. North Anatolian Fault (NAF) is one of the most seismically active faults in the world. **...** Bulletin of **International Seismological Centre**, UK, (1904-2000)

Focal-Depth Estimation Using Pn-Coda Phases Including pP, sP, and PmP ES Husebye, T Matveeva… - 2013 - bssaonline.org **...** Pn arrival times (Z-components) as listed in the **International Seismological Centre** (ISC) and **...**

Corner flow in the Isthmus of Tehuantepec, Mexico inferred from anisotropy measurements using local intraslab earthquakes GL Soto, RW Valenzuela - Geophysical Journal **International**, 2013 - gji.oxfordjournals.org **...** Therefore, for most of these earthquakes the **International Seismological Centre** reports the location determined

The Spatial and Genetic Relation between Seismicity and Tectonic Trends, the Bitter Lakes Area, North-East Egypt AM Hegazi, TA Seleem, HA Aboulela - … & Geostatistics: An Overview, 2013 - scitechnol.com **...** the **International Seismological Centre (ISC)**… Seismological approaches such as earthquake focal mechanisms play an important role in **...** 7. Morgan P (1990) Egypt in the framework of global tectonics **...**

Mantle Anisotropy Beneath the Earth's Mid-Ocean Ridges A Nowacki - Plate Deformation from Cradle to Grave, 2013 – Springer **...** aim to measure the seismic anisotropy beneath MORs around the world using the **...** the best-fitting double-couple solutions as given by the Global CMT project. **...** to the USGS National Earthquake Information Center (NEIC) and **International Seismological Centre** (ISC) catalogues. **...**

Seismic hazard across Bulgaria and neighbouring areas: regional and site-specific maximum credible magnitudes and earthquake perceptibility TJ Bayliss, PW Burton - Natural hazards, 2013 – Springer **...** key in developing a robust and suitable tool for seismic hazard assessment. **...** 1963); data from the comprehensive earthquake database of the **International Seismological Centre** (ISC)

Long-term earthquake prediction in the Marmara region based on the regional time-and magnitude-predictable model N Sayil - Acta Geophysica, 2013 – Springer**...** Mf is the magnitude of the following mainshock, Tt is the interevent time measured in years, Mp is the magnitude of the preceding mainshock, and M0 is the yearly seismic moment rate in the region. **...**

Microseismicity of the Mid-Atlantic Ridge at 7° S–8° 15′ S and at the Logatchev Massif oceanic core complex at 14° 40′ N–14° 50′ N I Grevemeyer, TJ Reston… - Geochemistry, Geophysics, , 2013 - Wiley Online Library .. four earthquakes that were also detected by global seismic stations and reported by the **International Seismological Centre** (ISC)

Spectral Analysis of Seismic Waves in the Northern Indian Ocean Region S Venkatesan, P Gamage - Bulletin of the **Seismological** Society of …, 2013 - bssaonline.org **...** were properly recorded in international archival databases such as the **International Seismological Centre** (ISC)

Upper-mantle structure beneath the southern Bohemian Massif and its surroundings imaged by high-resolution tomography H Karousová, J Plomerová

…Journal **International**, 2013 - gji.oxfordjournals.org **...** them for the effect of instrument response to simulate WWSSN-SP (World Wide Standardized **...**9) in global, or, large-scale regional tomography (eg Piromallo & Morelli 2003 **...** 2009), based on data reported to the **International Seismological Centre** (ISC) from relatively sparsely **...**

The Use of Stochastic Optimization in Ground Motion Prediction M Segou, N Voulgaris - Earthquake Spectra, 2013 - earthquakespectra.org **...** seismic parameters (Moss 2009), provided by the web site of the **International Seismological Centre** (http://www.isc.ac.uk)

Active accommodation of plate convergence in Southern Iran: Earthquake locations, triggered aseismic slip, and regional strain rates WD Barnhart, RB Lohman… - Journal of Geophysical …, 2013 - Wiley Online Library **...** 03 May 2005 (Table 1, ID 10) with a combination of seismic data, spatial **...** the vicinity of several earthquakes that are cataloged by the **International Seismological Centre** (ISC)

Observed and predicted North American teleseismic delay times X Lou, S van der Lee - Earth and Planetary Science Letters, 2013 – Elsevier **...** in the preference order of EHB (Engdahl et al., 1998), ISC (**International Seismological Centre**, 2010), and **...** Teleseismic body wave delay time variations are caused by seismic velocity..

Temporal variations of seismicity parameters in the Central Alborz, Iran M Agh-Atabai, MS Mirabedini - Acta Geophysica – Springer **...** ISC (2011), **International Seismological Centre**, Thatcham, United Kingdom, on-line bulletin, http://www.isc.ac.uk.

IRIS Demonstration–Hungary 2011 B Theilen-Willige, H Wenzel, L Weisz, A Papp… - researchgate.net**...** data downloaded from, **International Seismological Centre**, ISC, USGS **...**

Automated Recovery of the 2012 Sumatera Aftershock Sequence Using Waveform Cross Correlation D Bobrov, U Khukhuudei, I Kitov… - Journal of Earth …, 2013 - davidpublishing.com **...** aseismic areas, the REB is a key contributor to the ISC (**International Seismological Centre**) bulletin, which **...** component in the formulation and testing of a potentially prolific seismological idea —the **...** use of historical data for precise location and characterization of global seismicity **...**

Detection of a tall ridge at the core–mantle boundary from scattered PKP energy

DA Frost, S Rost, ND Selby… - … Journal **International**, 2013 - gji.oxfordjournals.org **...** on the order of thousands of kilometres) variations in global seismic velocities (eg **...** We select 153 events from the **International Seismological Centre** (ISC) catalogues and Comprehensive Nuclear..

Seismic microzonation of a nuclear power plant site with detailed geotechnical, geophysical and site effect studies N James, TG Sitharam, G Padmanabhan, CS Pillai - Natural Hazards – Springer **...** (IGCAR) at Kalpakkam, United States

Geological Survey (USGS), **International Seismological Centre** (ISC), UK **...** study area is a part of intraplate region where the seismic activity is **...**

Delineation of seismic source zones based on seismicity parameters and probabilistic evaluation ofseismic hazard using logic tree approach KS Vipin, TG Sitharam - Journal of Earth System Science, 2013 – Springer **...** were collected from sources like India Meteorological Department (IMD), **International Seismological Centre** (ISC),

Rates of Quaternary deformation in the Ouarzazate Basin (Southern Atlas Front, Morocco) ÀP Castilla, A Teixell, ML Arboleya - Annals of Geophysics, 2013 - annalsofgeophysics.eu **...** Basin, indicating seismic events Mv >3 since 1964 (extracted from **International Seismological Centre** database).

Fractal Geometry of Faulting DD Jackson, YY Kagan, F Schoenberg - moho.ess.ucla.edu **...** The ISC worldwide catalog (**International Seismological Centre**, 1995, and references therein) starts at 1964/1 **..**

The hazard potential of the western segment of the Makran subduction zone, northern Arabian Sea CP Rajendran, K Rajendran, M Shah-Hosseini… - Natural hazards, 2013 - Springer); data from:…Bulletin of the **International Seismological Centre** (1964–1972 ...

Seismic hazard across Bulgaria and neighbouring areas: extreme magnitude recurrence and strong ground shaking PW Burton, TJ Bayliss - Natural hazards, 2013 – Springer **...** and 42nd of the 50 most seismically active countries in the **world**—Bulgaria has also contributed significant amounts to global and European **...** recording (1900–1963); data from the comprehensive earthquake database of the **International Seismological Centre** (ISC) were **...**

Studying deep sources of volcanism using multiscale seismic tomography I Koulakov - Journal of Volcanology and Geothermal Research, 2013 – Elsevier **...** results of several studies related to different volcanic complexes of the world, published or **...** down to approximately 1000 km, we use data from global seismological databases, which are mostly available in the catalogue of the **International Seismological Center** (ISC, 2001 **...**

Predicting ground motion from induced earthquakes in geothermal areas J Douglas, B Edwards, V Convertito… - … of the **Seismological** …, 2013 - bssaonline.org by **international** agencies, such as the **International Seismological Centre** (ISC), using **...**

Mass movement deposits in the 3.6 Ma sediment record of Lake El'gygytgyn, Far East Russian Arctic. MA Sauerbrey, O Juschus, AC Gebhardt… - Climate of the …, 2013 - search.ebscohost.com **...** at dis tances to the lake of 99 and 66 km, respectively (**International Seismological Centre**, 2011). **...**

2012 Haida Gwaii Quake: Insight Into Cascadia's Subduction Extent US Former - Eos, Transactions, American Geophysical Union, 2013 - Wiley Online Library **...** the scientific community may also need to reassess the implications for ***seismic*** hazard not only **...** Earthquake locations were contributed by the **International Seismological Centre**

Back-arc extension in the Andaman Sea: Tectonic and magmatic processes imaged by high-precision teleseismic double-difference earthquake relocation T Diehl, F Waldhauser, JR Cochran… - Journal of …, 2013 - Wiley Online Library **...** Bulletin locations such as provided by the ISC (**International Seismological Centre**) or EDR (Earthquake **...**

On the foreshocks of strong earthquakes in the light of catastrophe theory AV Guglielmi, AL Sobisevich, LE Sobisevich… - arXiv preprint arXiv: …, 2013 - arxiv.org **...** catastrophe model, and in the Section 5 we are analyzing the round-the-world seismic echo as a possible trigger of the mainshock. Initial data for the study were taken from the earthquake catalog of the International Seismological Centre (ISC, http://www.isc.ac.uk). **...**

Seismicity of Gujarat BK Rastogi, S Kumar, SK Aggrawal - Natural hazards, 2013 – Springer **...** BK Rastogi Á S. Kumar (&) Á SK Aggrawal Institute of Seismological Research, Gandhinagar **...** is seismically one of the most active intraplate regions of the World. **...** Department (IMD), Geological Survey of India (GSI), NEIC USGS, **International Seismological Centre** (ISC), Gujarat **...**

Semi-Periodic Sequences and Extraneous Events in Earthquake Forecasting. II: Application, Forecasts for Japan and Venezuela CBQ Cartaya, FAN Pichardo, E Glowacka… - Pure and Applied … - Springer plus information from other international centers, such as the South American Regional Seismological Center (CERESIS), the **International Seismological Centre** (ISC), and **...**

Estimation of design basis earthquake using region-specific< i> M</i>< sub> max</sub>, for the NPP site at Kalpakkam, Tamil Nadu, India P Anbazhagan, CV Smitha, A Kumar… - Nuclear Engineering and …, 2013 – Elsevier International agencies include the **International Seismological Centre** (ISC) data **...**

Possible causes of a harbour porpoise mass stranding in Danish waters in 2005 AJ Wright, M Maar, C Mohn, J Nabe-Nielsen, U Siebert… - PloS one, 2013 - dx.plos.org **...** Institute at the Technical University of Denmark – DTU, but held at the World Data Centre **...** of the specific local situation of the strandings site; (2) the global or distant **...** the contiguous Danish and Norwegian North Sea in the data held at **International Seismological Centre** [46] over **...**

VARIATION STRENGTH ANALYSIS OF CONCRETE BRIDGE STRUCTURE REINFORCED WITH STEEL BARS AND SHAPE MEMORY ALLOY WIRES SO Odeyemi, AA Adedeji - researchgate.net **...** Nigeria is not situated where major **seismic** activities are observed in the world; but the **...** In the same vein, an earthquake with body wave magnitude of 4.4 had occurred in Nigeria in 2000 and was

recorded by some agencies like the **International Seismological Centre** (ISC). **...**

Reactivation and mantle dynamics of North China Craton: insight from P-wave anisotropy tomography Y Tian, D Zhao - Geophysical Journal **International**, 2013 - gji.oxfordjournals.org **...** (3) Each teleseismic event was recorded by at least seven seismic stations in our study region. **...** 1994, 2013). Hypocentre parameters of the teleseismic events were obtained from the reprocessed Bulletin of
the **International Seismological Centre** (Engdahl 2006). **...**

A New Zealand-Specific Pseudospectral Acceleration Ground-Motion Prediction Equation for Active Shallow Crustal Earthquakes Based on Foreign Models

BA Bradley - Bulletin of the **Seismological** Society of America, 2013 - bssaonline.org **...** In summary, a large proportion of events (all active shallow crustal and subduction interface events,
and some subduction slab events) in the final database have locations obtained from either the
International Seismological Center (ISC; Engdahl et al., 1998) or a relocated NZ **...**

Intensity distribution of M 4.9 Haryana–Delhi border earthquake AK Gupta, S Chopra, SK Prajapati, AK Sutar… - Natural hazards, 2013 – Springer **...** The epicenters are based on **International Seismological Centre** (ISC) catalog (1964–2012) and
Seismotectonic Atlas **...**

Defining the relationship between seismicity and deformation at regional and local scales NNA Williams - 2013 - thesis.library.caltech.edu **...** earthquakes, which can be recorded by global networks, are widely studied, and any **...** used long period teleseismic data acquired by the World Wide Standardized Seismograph **...** inversions were performed using locations obtained from
the **International Seismological Centre** (ISC **...**

Origin of hotspots in the South Pacific: Recent advances in seismological and geochemical models D Suetsugu, T Hanyu - Geochemical Journal, 2013 - svr4.terrapub.co.jp **...** travel-time inversion on global P-wave arrival time data from the **International Seismological Centre** (ISC)

Active faulting on the Ninetyeast Ridge and its relation to deformation of the Indo-Australian plate WW Sager, JM Bull, KS Krishna - Journal of Geophysical …, 2013 - Wiley Online Library **...** School of Ocean and Earth Science, National Oceanography Centre Southampton, University of Southampton, Southampton, UK. **...** The greatest seismic activity occurs in a band stretching NE-SW from the Java Trench, across **...** Data Source: **International Seismological Centre** (2013 ...

Determination of the Permeability of the South Chamorro Seamount in Mariana Forearc Crust Using Pressure Response to Tidal Loading Method PN Akmal - 2013 - scholarlyrepository.miami.edu **...** forearc (Fryer, 2012). From multi-channel seismic data, the downgoing slab lies at around 20 km below the seamount (Oakley, 2007). **...** 16:6:13.9 GMT was at 168 km away from 1200C with 7.0 Mw (Data
from **International Seismological Centre**, 2011, …

Relative Motion Between the Rivera and North American Plates Determined from the Slip Directions of Earthquakes G Suárez, SH Jaramillo, WL Bandy - Pure and Applied Geophysics, 2013 – Springer **...** 2; Table 1). The epicentral locations of the earthquakes are those reported by
the **International Seismological Centre**. **...** (1987

Finite frequency whole mantle P wave tomography: Improvement of subducted slab images M Obayashi, J Yoshimitsu, G Nolet… - Geophysical …, 2013 - Wiley Online Library **...** The first group consists of ~11.3 million arrival times reported to the **International Seismological Centre** (ISC) in the period of

Spatial patterns of geomorphic surface features and fault morphology based on diffusion equation modeling of the Kumroch Fault Kamchatka Peninsula, Russia SN Cervera Heinlein - Journal of Volcanology and Geothermal Research, 2013 – Elsevier **...** Seismic data is from
the **International Seismological Centre**. **...** It is one of the most seismically active tectonic margins in
the world (Gorbatov et al **...**

Multiscale mapping of completeness magnitude of earthquake catalogsI Vorobieva, C Narteau, P Shebalin… - … of the **Seismological** …, 2013 - bssaonline.org **...** approach is efficient for determining the M c -value worldwide for the Global (formerly Harvard) Centroid Moment Tensor and
the **International Seismological Centre** (M>4 **...** As with other volcanic island arcs around the world,
complex seismic patterns may be observed in **...**

PEPI manuscript KC002-04, PEPI 4179; Journal# 5357. Printed: January 6, 2003 ACCURACY OF MODERN GLOBAL EARTHQUAKE CATALOGS YY Kagan - moho.ess.ucla.edu **...** the earthquake distributions for the ISC worldwide catalog (**Inter-national Seismological Centre**, 1995, and **...** We study the earthquake distributions for the global catalog of moment tensor inver **...**from the PDE or ISC catalogs, the CMT catalog includes seismic moment centroid **...**

Segmentation of the Izu-Bonin and Mariana slabs based on the analysis of the Benioff seismicity distribution and regional tomography results. K Jaxybulatov, I Koulakov, NL Dobretsov - Solid Earth, 2013 - search.ebscohost.com **...** we use the travel times of P and S waves from
the **International Seismological Centre** (ISC) for the **...** of the Earth and variable crustal thick- ness according to
the global model CRUST2 **...**

Intensity-based source inversion of the destructive earthquake of 1694 in the southern Apennines, Italy L Sirovich, F Pettenati, F Cavallini - Journal of Geophysical …, 2013 - Wiley Online Library
... from **International Seismological Centre**d, fixed, 15.33 ± 0.011, 40.86 ± 0.014. **...**

A double seismic zone in the subducting Juan Fernandez Ridge of the Nazca Plate (32° S), central Chile M Marot, T Monfret, M Pardo… - Journal of Geophysical …, 2013 - Wiley Online Library**...** M l values remain close to the M w values available from the **International Seismological Centre** (ISC) catalog **...**

Himalayan hazard study on the basis of stress and strain state of 1991 Uttarkashi earthquake using Coulomb stress transfer model DK Gupta, D Bhowmick, PNS Roy - Geomatics, Natural Hazards …, 2013 - Taylor & Francis **...** According to the online bulletin of **International Seismological Centre** (ISC), the Uttarkashi main shock was accompanied …

Is it possible to detect earlier ionospheric precursors before large earthquakes using principal component analysis (PCA)? JW Lin - Arabian Journal of Geosciences, 2013 – Springer The VAN Group examined seismic electric signals (SES) in an attempt to… Source **International Seismological Centre ...**

Global observation of vertical-CLVD earthquakes at active volcanoes A Shuler, M Nettles, G Ekström - Journal of Geophysical …, 2013 - Wiley Online Library

... by global seismicity catalogs, such as the bulletins of the **International Seismological Centre** (ISC) and the **...**

Tectonic implications of spatial variation of b-values and heat flow in the Aegean region UY Kalyoncuoglu, Ö Elitok, MN Dolmaz - Marine Geophysical Research, 2013 - Springer

... with the magnitudes of Mb ≥ 3.5 and Ms ≥ 3.0, from the **International Seismological Centre** (ISC) catalogue.

Seismic hazard analysis and seismic slope stability evaluation using discrete faults in northwestern Pakistan B Kim - 2013 - ideals.illinois.edu**...** earthquakes (Mw ≥ 4) obtained chiefly from the **International Seismological Centre** (ISC) and **...**

Slow slip and aseismic deformation episodes associated with the subducting Pacific plate offshore Japan, revealed by changes in seismicity D Marsan, T Reverso, A Helmstetter… - Journal of Geophysical …, 2013 - Wiley Online Library **...** of Epicenters (PDE) catalog of the National Earthquake Information Center, the **International Seismological Centre** (ISC) catalog, and the Global Centroïd Moment **...**

Seismic hazard estimates for the area of Pylos and surrounding region (SW Peloponnese) for **seismic** and tsunami risk assessment D Slejko, M Santulin, J Garcia - 2013 - ogs.trieste.it **...** and ML for the outer and the inner part of the Hellenic Arc, using the data of **International Seismological Centre**. **...**

Recent evolution and challenges in the Seismic Hazard Analysis of the Po Plain region, Northern Italy E Faccioli - Bulletin of Earthquake Engineering, 2013 – Springer **...** shades of green depict the depth to the base of Pliocene, reaching in the deepest part (centre right of **...** enclosed within I5 and I5.5 isoseismals (from DBMI11)a Pettenati and Sirovich (2012) .b **International Seismological Centre** (http://www. **...**

Imaging topographic growth by long-lived postseismic afterslip at Sefidabeh, east Iran, Tectonics, 33, doi: 10.1002/2013TC003462 A Copley, K Reynolds - 2013 - bullard.esc.cam.ac.uk **...** et al., 2006], in agreement with the centroid depths estimated using body wave seismology [Berberian et al **...** the only to be present in the area in the **International Seismological Centre** (ISC) catalog **...**

Thermal-mechanical modeling of salt-based mountain belts with pre-existing basement faults: Application to the Zagros fold and thrust belt, southwest Iran F Nilfouroushan, R Pysklywec, A Cruden, H Koyi - Tectonics, 2013 - Wiley Online Library **...** The inset shows the shaded relief map of Iran with overlaid earthquake distribution from the **International Seismological Centre** catalog (magnitude > 4, during 1973 **...**

Fault weakening across the frictional-viscous transition zone, Karakoram Fault Zone, NW Himalaya D Wallis, RJ Phillips, GE Lloyd - Tectonics, 2013 - Wiley Online Library **...** The Karakoram Fault Zone (KFZ) with Harvard Centroid Moment Tensor (CMT) solutions, **International Seismological Centre** and National **...**

Seismicity and seismotectonics of Libya: as an example of intraplate environment EA Al-Heety - Arabian Journal of Geosciences, 2013 – Springer **...** Sykes 1996); (c) the centennial catalog (Engdahl and Villaseore 2002); (d) the updated global earthquake catalog for stable continental regions (Schulte and Mooney 2005); (e) **International Seismological Center** 2011; and (f) the Preliminary Determination of Earthquakes **...**

Station Travel-Time Calibration Method Improves Location Accuracy on a Global Scale A Giuntini, V Materni, S Chiappini… - Seismological …, 2013 - 171.66.125.217 **...** DATA AND ANALYSIS. P-wave arrival times at a selected set of 39 seismic regional or teleseismic stations from 50 earthquakes located in northern Honshu, Japan, were obtained from the online Bulletin of the **International Seismological Center** (ISC, http://www.isc.ac.uk). **...**

Continuous-cyclic variations in the b-value of the earthquake frequency-magnitude distribution ZH El-Isa - Earthquake Science, 2013 – Springer **...** The seismicity of the whole Earth, its two hemispheres and four quadrants that occurred during the period January 1990 to December 2011 is utilized in this study as compiled from the catalogues of three major sources, namely the **International Seismological Center** (ISC

General orthogonal regression relations between body-wave and moment magnitudes R Das, HR Wason, ML Sharma - Seismological Research Letters, 2013 - 171.66.125.217 **...** regions during the period 1976–2007. The body-wave magnitudes have been collected from the **International Seismological Center**, United Kingdom

(http://www.isc.ac.uk/search/Bulletin). Body-wave magnitudes of 1566 events **...**

Improvement of seismicity parameters in the Arabian Shield and Platform using earthquake location and magnitude calibration AM Al-Amri, AJ Rodgers - ... Dynamics and Sedimentary Basins: The Arabian ..., 2013 – Springer **...** The KACST station locations were compared with those reported by: the Provisional Technical Secretariat (PTS) of the Comprehensive Test Ban Treaty Organization (CTBTO) Reviewed Event Bulletin (REB); **International Seismological Center** (ISC) and the United States **...**

Uppermost mantle velocity from Pn tomography in the Gulf of Aden J Corbeau, F Rolandone, S Leroy... - EGU General ..., 2013 - adsabs.harvard.edu **...** Previous tomographic studies covered the eastern Gulf of Aden and were thus incomplete or at a large scale with a too low resolution to see the lithospheric structures. From 1990 to 2010 49206 Pn arrivals were selected from the **International Seismological Center** catalogue. **...**

Tomographic Inversion of Pn Waves beneath Southern Scandinavia A Latif - 75th EAGE Conference & Exhibition incorporating SPE ..., 2013 - earthdoc.org **...** Data selection and Pre-Processing Dataset for this study comprises of travel times of Pn phase (compressional wave generated by earthquakes/mining explosions and is refracted from Moho) that are listed in the bulletins of **International seismological center** from 1971 to 2011. **...**

A complete and homogeneous magnitude earthquake catalogue of Iraq EAMS Al-Heety - Arabian Journal of Geosciences, 2013 – Springer **...** Events were considered duplicates if they had a time difference of 10 s or less and space origin difference of 0.5° or less. In a given set of duplicate events, an event, which had a magnitude and **International Seismological Center** source, was retained as the record of the event. **...**

Contributions of GPS Permanent Station and Seismological Observatory to Geophysical Studies at Maitri, Antarctica During XXIV Indian Antarctic ...

AN Rao, SVR Rao, GB Navinchander, A Akilan... - 2013 - 14.139.119.23 **...** The Broad Band Seismic data were contributed to **International Seismological Center** (ISC), UK The Processing of the data up to 2005 has been completed and the seismological Bulletin of Maitri Station for 2005 has been published. **...**

Systematic Global Multiple-Event Relocation: A Case Study of Alaska Earthquakes from 1900-present H Benz, SC Myers, PS Earle... - AGU Fall Meeting ..., 2013 - adsabs.harvard.edu **...** Alaska (~130W) to the western-most Aleutian arc (~175E), using a combination of local, regional and teleseismically derived location and phase information from Alaska Earthquake Information Center (AEIC), NEIC and **International Seismological Center** (ISC) catalogs. **...**

Analysis of Quetta-Ziarat earthquake of 29 October 2008 in Pakistan Z Rafi, N Ahmed, S Ur-Rehman, T Azeem et al.. - researchgate.net **...** The focal mechanism of the foreshock and mainshock was obtained. For this purpose, data were also obtained from the **International Seismological Center (ISC)** alongside PMD. Amalgamation of focal mechanism and aftershocks indicated the nature of the fault. **...**

Seismicity and seismotectonics of the Jeddah area, Saudi Arabia MS Fnais, K Abdelrahman, S E-Hady... - Earthquake Resistant ..., 2013 - books.google.com **...** These data are merged, precisely reviewed, re-analyzed and refined from duplicated events through the **International Seismological Center** (ISC); United States Geological Survey (USGS); and the European Mediterranean Seismological Center (EMSC). **...**

Probabilistic Seismic Hazard Analysis of East Java Region, Indonesia. A Susilo, Z Adnan - International Journal of Computer & ..., 2013 - search.ebscohost.com **...** the area of 5oSL – 12oSL and 105oWL - 116oWL taken from MCGA, USGS which consists of NEIC-USGS, NOAA, the PDQ and the combined catalog of the Advanced National Seismic System (ANSS), as well as the catalog of the **International Seismological Center** (ISC) and **...**

A Homogeneous Earthquake Catalog for Western Turkey and Magnitude of Completeness Determination KM Leptokaropoulos, VG Karakostas... - Bulletin of the ..., 2013 - bssaonline.org **...** achieving homogeneity for magnitudes. Data are obtained from the **International Seismological Center** (ISC), where earthquake magnitudes are reported in different scales and come from a variety of sources.

TRAVEL-TIME SOURCE SPECIFIC STATION CORRECTION IMPROVES LOCATION ACCURACY G Alessandra, M Valerio, C Stefano... - ... and Technology 2013 ..., 2013 - earth-prints.org Page 1. P-wave arrival times at 59 seismic regional or teleseismic stations from 16 earthquakes located in central Italy, were obtained from the online Bulletin of **International Seismological Center** (ISC, http://www.isc.ac.uk).

History, Aim and Scope of the 1 st and 2 nd Edition of the IASPEI New Manual of Seismological Observatory Practice P Bormann - gfzpublic.gfz-potsdam.de **...** been measured by many stations after the installation of the US World-Wide Standard Seismograph Network (WWSSN) in the 1960s and after the National Earthquake Information Center (NEIC) of the US Geological Survey and the **International Seismological Center** (ISC) **...**

Apply of Explicit Finite Element in Seismic Ground Motion Computation Y Bai, X Xu - Journal of Applied Mathematics and Physics, 2013 - scirp.org **...** On 28 July 1976, a destructive earthquake struck the city of Tangshan, in mainland China, 160 km east of Beijing. The focal depth of the MS = 7.8 Tangshan earthquake was 10 km [Bulletin of the **International Seismological Center** (ISC)]. **...**

Ground Truth Determinations of Detonation Sites of Peaceful Nuclear Explosions in the Sakha Republic (Yakutia), Russia K Fujita, KG Mackey, HE Hartse - Bulletin of the

Seismological …, 2013 - bssaonline.org **...** second that they state were obtained from "automated recordings of the detonation times"; for the other four (Sheksna, Horizon-4, Neva 2-2, and Neva 2-3), they give seismic estimates purportedly derived by adding 2.5 s to the **International Seismological Center** (ISC) origin **...**

SEISMIC HAZARD ANALYSIS WITH PROBABILISTIC AND STATISTICAL METHODS OF SINOP PROVINCE, TURKEY RF Kartal, G Beyhan, A Keskinsezer - ias.ac.in **...** TABLE 1 The Creation of Earthquake Catalog Republic of Turkey Prime Ministry Disaster and Emergency Management Precidency (RTPMDEMP, 2009) earthquake database and **International Seismological Center** (2009) records were used for earthquake catalogs. **...**

On magnetic precursors of earthquakes OD Zotov, AV Guglielmi, AL Sobisevich - Izvestiya, Physics of the Solid …, 2013 – Springer **...** using the data from the Mikhnevo observatory. In our study, we used the catalogue of the **International Seismological Center** (ISC catalogue), which, to a certain extent, represents global seismicity. In the future, it is planned to **...**

Kamchatka subduction zone, May 2013: the Mw 8.3 deep earthquake, preceding shallow swarm and numerous deep aftershocks A Špičák, J Vaněk - Studia Geophysica et Geodaetica, 2013 – Springer **...** 7.5 640.6 Philippines 2010 7 23 6.776 123.259 Page 4. A. Špičák and J. Vaněk iv Stud. Geophys. Geod., 58 (2014) determinations published by the **International Seismological Center** (ISC - http://www.isc.ac.uk/) by the procedure of Engdahl et al. (1998). **...**

Seismic response to recent tectonic processes in the Banda Arc region A Špičák, R Matějková, J Vaněk - Journal of Asian Earth Sciences, 2013 – Elsevier **...** Relocated hypocentral determinations of the **International Seismological Center** (EHB data) and fault plane solutions of the Global Centroid Moment Tensor Project have been used together with previously published information on regional geology and dynamics. **...**

Changbai intraplate volcanism and deep earthquakes in East Asia: a possible link? D Zhao, Y Tian - Geophysical Journal International, 2013 - gji.oxfordjournals.org **...** Distribution of earthquakes (M ≥ 4.0) in the East Asian region compiled by the **International Seismological Center** (ISC) during 1964–2006 and by the National Earthquake Information Center, US Geological Survey (USGS) during 2007–2009. **...**

Seismicity and seismotectonics of the Gulf of Aqaba region H Zuhair - Arabian Journal of Geosciences, 2013 – Springer **...** Arab J Geosci Page 3. (UNJ), the Jordan Seismological Observatory (JSO), the **International Seismological Center** (ISC), the National Earthquake Information Center (NEIC) of the USGS, and the American Incorporated research Institutions for Seismology (IRIS). **...**

Pattern Recognition on Seismic Data for Earthquake Prediction Purpose A Moatti, MR Amin-Nasseri, H Zafarani - europment.org **...** However there are no major fault trace in Qeshm island, it has experience high seismic activities[11], Fig. 2. III. DATA CATALOG In this study, the seismic data from the **International Seismological Center** (ISC) catalog has been used. **...**

Crust–mantle coupling at the northern edge of the Tibetan plateau: Evidence from focal mechanisms and observations of seismic anisotropy V Levin, GD Huang, S Roecker - Tectonophysics, 2013 – Elsevier **...** compare the inversion results. We use catalogs of CEA, PDE/USGS, the **International Seismological Center** (ISC), EHB (Engdahl et al., 1998), and the global CMT (Dziewonski et al., 1981; http://www.globalcmt.org). For those rCMTs **...**

A spatial statistical analysis of the occurrence of earthquakes along the Red Sea floor spreading: clusters of seismicity K Al-Ahmadi, A Al-Amri, L See - Arabian Journal of Geosciences, 2013 – Springer **...** Historical data have been collected from Ambraseys et al. (1995). International data centers have been searched for additional data such as the I**nternational Seismological Center** for the period from 1964 to 1998, and the National Earthquake Information Center as well. **.**

Remote triggering not evident near epicenters of impending great earthquakes NJ van der Elst, EE Brodsky, T Lay - Bulletin of the Seismological …, 2013 - bssaonline.org **...** of the M≥8 earthquakes identified in the Prompt Assessment of Global Earthquakes for Response (PAGER) catalog since 1998, using two global earthquake location catalogs, Preliminary Determination of Epicenters (PDE) and the **International Seismological Center** (ISC), and **...**

Shallow-focus seismicity and tectonic structure of the Sea of Japan IN Tikhonov, VL Lomtev - Russian Journal of Pacific Geology, 2013 – Springer **...** seismicity in the Sea of Japan is registered by several national seismological surveys (the Russia, the Japanese, and the Democratic People's Republic of Korea) and is also summarized in the bulletins of the NEIC/USGS and the **International Seismological Center** (ISC) world **...**

Teleseismic tomography of the southern Puna plateau in Argentina and adjacent regions M Bianchi, B Heit, A Jakovlev, X Yuan, SM Kay… - Tectonophysics, 2013 – Elsevier **...** area. Based on the **International Seismological Center** (ISC) earthquake catalog, we performed a global P teleseismic wave tomography focusing on South America to resolve a 3-D structure of the subducted oceanic slab.

The Mechanisms of Earthquakes and Faulting in the Southern Gulf of California DF Sumy, JB Gaherty, WY Kim, T Diehl… - Bulletin of the …, 2013 - bssaonline.org **...** Earthquakes reported in the **International Seismological Center** (black dots) and Global Centroid Moment Tensor (white dots; mechanisms labeled with date and magnitude) global catalogs for the period from October 2005 to October 2006 are**...**

Crustal structure of the Northwestern part of the Arabian Shield in Saudi Arabia deduced from gravity data MS Fnais, HM El-Araby, AR Kamal… - Scientific Research …, 2013 - academicjournals.org **...** Page 10. Fnais et al. 475 Figure 10. 2D gravity modeling profiles. provided by the National Earthquake Information Centre (NEIC); (iii) the

International Seismological Centre (ISC) online bulletin; (iv) Regional catalogues of Poirier and Taher (1980) and Ambraseys et al. (1994). **...**

ANALYSIS OF TWO EARTHQUAKE SEQUENCES OCCURRED IN 2012 IN THE TIMISOARA AREA, ROMANIA E Oros - ROMANIAN JOURNAL OF PHYSICS, 2013 - nipne.ro **...** digital data. http://www.iaspei.org/ commissions/ CSOI.html, 2005. 9. International Seismological Centre, On-line Bulletin, http://www.isc.ac.uk, **International Seismological Center**, Thatcham, United Kingdom, 2010...

Interplate coupling along the Nankai Trough, southwest Japan, inferred from inversion analyses of GPS data: Effects of subducting plate geometry and spacing of hypothetical ocean-bottom GPS stations S Yoshioka, Y Matsuoka - Tectonophysics, 2013 – Elsevier **...** Various geometric models of the plate have been proposed, including the Crustal Activity Modeling Program (CAMP) standard model determined from **International Seismological Center** (ISC) hypocenter data (Hashimoto et al., 2004), a model obtained from seismic tomography **...**

Variability of megathrust earthquakes in the world revealed by the 2011 Tohoku-oki Earthquake J Koyama, K Yoshizawa, K Yomogida… - Earth, Planets and …, 2013 - 133.87.26.249 **...** Although the plot in Fig. 1b uses a limited data set from 1950 to 2010, the general pattern of the seismicity is identical to the classical plots by Utsu (2001) who used the data sets of **International Seismological Center** and Japan Meteorological Agency.

SEISMIC STABILITY EVALUATION OF KLONG SADAO DAM T Indhanu, T Chalermyanont, T Chub-uppakarn… - nadrec.psu.ac.th **...** 3.SEISMICITYANDEARTHQUAKE The seismicity of Klong Sadao dam was determined based on the seismic data recorded by the **International Seismological Center**, UK and Thai Meteorological Department, covered all of the earthquakes with epicenters located within 500 **...**

A view on processes beneath volcanoes through the prism of seismic tomography IY Koulakov - Herald of the Russian Academy of Sciences, 2013 – Springer **...** Global data for regional modeling.Global seismolog ical data, in this case the **International Seismological Centre** (ISC) Earthquake Catalog, are used in large scale (thousands of kilometers laterally and 1000 km deep) surveys. **...**

Seismicity in the western coast of the South Caspian Basin and the Talesh Mountains AA Zanjani, A Ghods, F Sobouti… - Geophysical …, 2013 - gji.oxfordjournals.org **...** More detailed explanations about these networks can be found in Ghods & Sobouti (2005)and Ghods et al. (2012). We also used arrival time data from the **International Seismological Center** (ISC) and the EHB catalogue for Iran (Engdahl et ...

Use of remote sensing techniques and aeromagnetic data to study episodic oil seep discharges along the Gulf of Suez in Egypt MF Kaiser, AM Aziz, BM Ghieth - Marine pollution bulletin, 2013 – Elsevier **...** A homogeneous catalogue for the recent seismic activity on the area of study for the period from the 1904 to 2010 was compiled for the study period from the National Earthquake Information Center (NEIC), and the **International Seismological Center** (ISC). **...**

Long-term earthquake prediction in western Anatolia with the time-and magnitude-predictable model N Sayıl - Natural hazards, 2013 – Springer **...** been taken from data center as British Association for the Advancement of Science (BAS, working period, 1913–1917), International Seismological Summary (ISS, 1918–1963), Bureau Central International (BCI, 1953–1963) **International Seismological Center** (ISC, continue **...**

Assessment of the statistical earthquake hazard parameters for NW Turkey B Akol, T Bekler - Natural hazards, 2013 – Springer **...** The earthquake catalog information is compiled from Boğaziçi University Kandilli Observatory and Earthquake Research Institute (Kalafat et al. 2007), **International Seismological Center** (ISC) and USA Advance National Seismic System composite catalogs. **...**

Seismic hazard analysis of Mersin Province, Turkey using probabilistic and statistical methods RF Kartal, G Beyhan, A Keskinsezer… - Arabian Journal of …, 2013 – Springer **...** (1975) catalog for 01 Jan 1916 to 31 Dec 1964, **International Seismological Center** (ISC) catalog for 01 Jan 1965 to 31 Dec 2005, and Republic of Turkey Prime Ministry Disaster and Emergency Management Precidency (RTPMDEMP 2009) catalog for 01 Jan 2006 to 31 Dec **...**

Probabilistic seismic hazard analysis for Kakrapar atomic power station, Gujarat, India WK Mohanty, AK Verma - Natural hazards, 2013 – Springer **...** 3) area from study site, with magnitude M ≥ 3 for a period from 1842 to 2010, from different sources such as United States Geological Survey (USGS), **International Seismological Center** (ISC), Incorporated Research Institutions for Seismology (IRIS), Indian Metrolo

Reference database for seismic ground-motion in Europe (RESORCE) S Akkar, MA Sandıkkaya, M Şenyurt, AA Sisi… - Bulletin of Earthquake …, 2013 – Springer **...** In the absence of such earthquake-specific studies, the earthquake metadata (eg, epicentral location, focal depth as well as magnitude estimations other than local magnitude, ML) were mostly taken from the Bulletin of the **International Seismological Center** (www. isc.ac.uk). **...**

Velocity structure of the uppermost mantle beneath East Asia from Pn tomography and its dynamic implications S Wang, F Niu, G Zhang - Journal of Geophysical Research: …, 2013 - Wiley Online Library **...** [5] The Pn data used in this study are taken from the Annual Bulletin of Chinese Earthquakes (ABCE) between 1986 and 2011, the Bulletin of the **International Seismological Center** (ISC) from 1964 to 2011, and the EHB Bulletin between 1960 and 1998 [Engdahl et al., 1998]. **...**

The Constantine (Algeria) seismic sequence of 27 October 1985: a new rupture model from aftershock relocation, focal mechanisms, and stress tensors F Ousadou, L Dorbath, C Dorbath, MA Bounif… - Journal of …, 2013 – Springer **...** 1900. The Ms 5.9 Constantine earthquake occurred on

October 27, 1985 at 16 h 34 min 56 s (UTC time). It has been recorded by 474 seismological stations worldwide as reported by **International Seismological Center** (ISC).

Seismicity of the Baikal rift system from regional network observations NA Radziminovich, NA Gileva, VI Melnikova… - Journal of Asian Earth …, 2013 – Elsevier **...** The references for magnitude values and focal solutions are the following: H – (Harvard) Global CMT Project (www.globalcmt.org), D – Delouis et al., 2002, Db – Doser, 1991b, I – **International Seismological Center** ISC (www.isc.ac.uk), NC – Kondorskaya and Shebalin, 1982 **...**

Probabilistic assessment of tsunami recurrence in the Indian Ocean RBS Yadav, JN Tripathi, TS Kumar - Pure and Applied Geophysics, 2013 – Springer **...** Expert Tsunami Database (ETDB) Project. Earthquake data for the 1964–2010 period taken from the **International Seismological Center** (ISC) are also shown as gray circles in the background.

Seismotectonics and seismogenic source zones of the Arabian Platform AM Al-Amri - Lithosphere Dynamics and Sedimentary Basins: The …, 2013 – Springer **...** The source catalogues from which the utilized seismic data are taken were the United States Geological Survey (USGS) PDE/EDR: 1963–2010; the **International Seismological Center** (ISC) 1963–2010: Ambraseys 1988 from 112–1963 AD; the European Mediterranean **...**

Ground-Motion Prediction Equations of Intermediate-Depth Earthquakes in the Hellenic Arc, Southern Aegean Subduction Area AA Skarlatoudis, CB Papazachos… - Bulletin of the …, 2013 - bssaonline.org **...** moment magnitudes were available only for a few earthquakes, additional checks were performed before adopting the final moment magnitudes listed in Table 1. For this reason m b and M L magnitude estimates reported from the **International Seismological Center** (ISC),

Strike-slip intraplate earthquakes in the Western Philippine Sea Plate JY Lin, YF Chen, CS Lee, SK Hsu, CW Liang, YC Lin… - Tectonophysics, 2013 – Elsevier **...** No event was reported by the global CMT catalog (http://www.globalcmt.org/) and only 8 earthquakes have been recorded by the **International Seismological Center** catalog (ISC, http://colossus.iris.washington.edu/) in our study area during the recording period, indicating **...**

Probabilistic seismic hazard analysis and spectral accelerations for United Arab Emirates Z Khan, M El-Emam, M Irfan, J Abdalla - Natural hazards, 2013 – Springer **...** The earthquake database from National Geoscience uses various references such as National Earthquake Information Center (NEIC), **International Seismological Center** (ISC), Ambraseys and Melville (1982), Nowroozi (1987), National Oceanic and Atmospheric Administration **...**

Global mantle heterogeneity and its influence on teleseismic regional tomography D Zhao, Y Yamamoto, T Yanada - Gondwana Research, 2013 – Elsevier **...** Our previous global tomography model (Zhao, 2004) was determined by using a grid parameterization method to invert arrival-time data from the reprocessed ISC (**International Seismological Center**) data set (Engdahl et al., 1998 and Engdahl, 2006). **...**

Gas injection may have triggered earthquakes in the Cogdell oil field, Texas W Gan, C Frohlich - … of the National Academy of Sciences, 2013 - National Acad Sciences **...** Between 2009 and 2011 the EarthScope USArray temporary seismic stations were deployed in Texas; during this period we found 105 epicenters in the Cogdell area in the catalogs from the NEIC, the **International Seismological Center** (ISC), and the Array Network Facility (ANF **...**

Physical mechanisms for vertical-CLVD earthquakes at active volcanoes A Shuler, G Ekström, M Nettles - Journal of Geophysical …, 2013 - Wiley Online Library **...** Category 1 earthquakes have surface-wave magnitudes, M SW [Ekström, 2006], that are at least one magnitude unit larger than the body-wave magnitudes, m b , reported in the **International Seismological Center** (ISC) Bulletin. **...**

Along-strike variability of rupture duration in subduction zone earthquakes …, SL Bilek, HR DeShon, ER **Engdahl**… - Journal of …, 2013 - Wiley Online Library **...** [2010] to identify depth phases (pP, pwP, sP) and improve phase onset times. The additional depth phases are incorporated with existing phase catalogs and relocated using the **Engdahl**, van der Hilst, and Buland (**EHB**) teleseismic location approach [**Engdahl** et al., 1998]. **...**

A new P wave velocity model beneath East Asia: insights on the relationship between intraplate volcanism and Pacific subduction T Huang, F Niu, M Obayashi - AGU Fall Meeting Abstracts, 2013 - adsabs.harvard.edu **...** Here we combine P-wave traveltime data from the **EHB** (**Engdahl**, van der Hilst, and Buland 1998) catalog of 1964-2007, and manually picks from the regional networks of the China Earthquake Administration (CEArray) consisting of more than one thousand stations from 2007 **...**

Seismic reflection imaging of ultradeep roots beneath the eastern Aleutian island arc

AJ Calvert, SE McGeary - Geology, 2013 - geology.gsapubs.org **...** B: Line A2 after migration and conversion to depth with superimposed earthquake hypocenters within 15 km of line (filled black circles from the Alaska Earthquake Information Center [AEIC, http://www.aeic.alaska.edu]; filled gray circles from **EHB** catalogue [**Engdahl** et al., 1998 **...**

Repeating aftershocks of the great 2004 Sumatra and 2005 Nias earthquakes W Yu, TRA Song, PG Silver - Journal of Asian Earth Sciences, 2013 – Elsevier **...** 2005 great events, respectively. Background seismicity is represented by the events with mb ⩾ 4.3 selected from the **EHB** (**Engdahl**–Hilst–Buland) event catalog (**Engdahl** et al., 1998 and **Engdahl** et al., 2007). S and N denote **...**

Slab buckling and its effect on the distributions and focal mechanisms of deep-focus earthquakes R Myhill -

Geophysical Journal International, 2013 - gji.oxfordjournals.org **...** I use well-constrained earthquake locations from the **EHB** catalogue between 1960 January and 2007 October (**Engdahl** et al. **...** (a) High quality earthquake locations are selected from the **EHB** catalogue (**Engdahl** et al. 1998) and converted into cartesian coordinates. **...**

The plate contact geometry investigation based on earthquake source parameters at the Burma arc subduction zone LP Zhang, ZG Shao, HS Ma, XZ Wang, ZH Li - Science China Earth …, 2013 – Springer **...** Different focal depths are labeled by different colors. The circles denote the **EHB** and **Engdahl** catalogs [66, 67] (http://www.isc.ac.uk/ **EHB**/). The diamonds denote the Global Centroid Moment Tensor catalog (http://www.globalcmt.org/CMTsearch.html). **...**

Seismotectonic framework of the 2010 February 27 Mw 8.8 Maule, Chile earthquake sequence GP Hayes, E Bergman, KL Johnson… - Geophysical …, 2013 - gji.oxfordjournals.org **...** (a) Pre 2010 February 27 seismicity in the centennial (**Engdahl** & Villeseñor 2002; plotted 1900-1973), **EHB** (**Engdahl** et al. 1998; plotted 1964–present) and USGS PDE (plotted 1973–present, for those events without **EHB** locations) catalogues. **...**

Precise relative earthquake location using surface waves K Michael Cleveland, CJ Ammon - Journal of Geophysical …, 2013 - Wiley Online Library **...** of Epicenters (PDE) catalog. We investigated using the **Engdahl**, van der Hilst, and Buland (**EHB**) catalog [**Engdahl** et al., 1998], but not all of the most recent or the older events are included in the **EHB** catalog. Also, while the **...**

3-D Empirical Travel Times: Construction and Applications T Nicholson, M Sambridge, O Gudmundsson - arda.eos.ubc.ca **...** However, this introduces more systematic errors because the locations of small events are more vulnerable to systematic bias (Billings et al. 1994). We choose to concentrate on teleseismic travel times, and use the large database of **Engdahl** et al. (1998) (**EHB**). **...**

Estimation of Source Parameters of M w 6.9 Sikkim Earthquake and Modeling of Ground Motions to Determine Causative Fault S Chopra, J Sharma, A Sutar, BK Bansal - Pure and Applied Geophysics, 2013 – Springer **...** respectively. Some 80 earthquakes M w > 4.0 have been reported in the International Seismological Centre (ISC)/**Engdahl**, Hillst and Buland (**EHB**) relocated catalog for Sikkim and the surrounding area. A microearthquake **...**

Seismicity patterns along the Ecuadorian subduction zone: new constraints from earthquake location in a 3-D a priori velocity model Y Font, M Segovia, S Vaca… - Geophysical Journal …, 2013 - gji.oxfordjournals.org **...** 1996; Guillier et al. 2001) and reduces to about 25° in northern Peru (Tavera et al. 2006). In the 3-DVM, the slab geometry is extrapolated from both local (RENSIG) and teleseismic catalogues [**EHB** catalogue from **Engdahl** et al. (1998)

Intense interface seismicity triggered by a shallow slow slip event in the Central Ecuador subduction zone M Vallée, JM Nocquet, J Battaglia… - Journal of …, 2013 - Wiley Online Library **...** 0.09°. The intense seismic activity, offshore the Manta Peninsula and close to La Plata Island, appears even more clearly than in the **EHB** (**Engdahl**, van der Hilst, and Buland) catalog [**Engdahl** et al., 1998]

Amount of Asian lithospheric mantle subducted during the India/Asia collision A Replumaz, S Guillot, A Villaseñor, AM Negredo - Gondwana Research, 2013 – Elsevier **...** al., 2003). In total, more than 14 million arrival times from 300,000 earthquakes, nearly 4 times the amount used in Bijwaard et al. (1998), were reprocessed using the **EHB** methodology (**Engdahl** et al., 1998).

Temporal Velocity Changes in the Crust Associated with the Great Sumatra Earthquakes W Yu, TRA Song, PG Silver - Bulletin of the Seismological Society of …, 2013 - bssaonline.org **...** events, respectively. Background seismicity is represented by the events with body-wave magnitude (m b) ≥4.3 selected from the **Engdahl**–Hilst–Buland (**EHB**) event catalog (**Engdahl** et al., 1998; **Engdahl** et al., 2007

New constraints on the geometry of the subducting African plate and the overriding Aegean plate obtained from P receiver functions and seismicity F Sodoudi, A Bruestle, T Meier, R Kind… - Solid Earth …, 2013 - solid-earth-discuss.net **...** Seismicity of the western Hellenic subduction zone (lat< 25 ◦ , profiles 1– 10 4 in Fig. 1) was taken from the relocated **EHB**-ISC catalogue 1960–2007 (**Engdahl** et al., 1998). Seismicity of the eastern Hellenic subduction zone (lat>25 ◦ , profiles 4– 8 in Fig. **...**

Estimating earthquake source depths by combining surface wave amplitude spectra and teleseismic depth phase observations R Heyburn, ND Selby, B Fox - Geophysical Journal …, 2013 - gji.oxfordjournals.org **...** Table 3. A comparison between depths estimated in this study and those published in the REB, and by **Engdahl** et al. (1998) (**EHB**). f denotes an artificially fixed depth. **...**

Subducted slabs stagnant above, penetrating through, and trapped below the 660 km discontinuity Y Fukao, M Obayashi - Journal of Geophysical Research: Solid …, 2013 - Wiley Online Library **...** Earthquake hypocenters within a band measuring 50 km wide on both sides of the section plane are also shown, based on the **EHB** (**Engdahl**-Hilst-Buland) Bulletins published from the ISC (http://www.isc.ac.uk/ehbbulletin) [**Engdahl** et al., 1998]. **...**

GPS constraints on active deformation in the Isparta Angle region of SW Turkey

İ Tiryakioğlu, M Floyd, S Erdoğan… - Geophysical …, 2013 - gji.oxfordjournals.org **...** (2006) in SW Turkey and SE Greece used for this study (red: New or updated velocities reported here; purple: Reilinger et al. 2006; blue: Aktuğ et al. 2010). Earthquakes from the **EHB** catalogue (**Engdahl** et al. 1998 and updates thereof), with depth scale shown in inset. **...**

Seismic hazard assessment of Kashmir and Kangra valley region, Western Himalaya, India B Mukhopadhyay, S

Dasgupta - Geomatics, Natural Hazards and …, 2013 - Taylor & Francis **...** incorporated in the present catalogue. The Centennial Catalogue and **EHB** event data [ER **Engdahl** (personal communication)] is also consulted for cross checking of earthquake parameters. Earthquake magnitudes given by different **...**

An Earthquake Catalog for Seismic Hazard Assessment in Ecuador C Beauval, H Yepes, P Palacios, M Segovia… - Bulletin of the …, 2013 - bssaonline.org **...** The second catalog is the **EHB**-ISC catalog (2009), a refined version of the ISC catalog. From 1960 until 2009, **Engdahl** et al.'s (1998) algorithm has been used to significantly improve routine hypocenter determinations made by the ISS, ISC, and PDE. **.**

Effects of errors and biases on the scaling of earthquake spatial pattern: application to the 2004 Sumatra–Andaman sequence S Padhy, OP Mishra, N Subhadra, VP Dimri, OP Singh… - Natural Hazards – Springer **...** region. Recently, Roy et al. (2010) studied the relocated **EHB** events (**Engdahl** et al. 2007) that occurred in the Andaman–Sumatra subduction zone to map the b and D 2 values of the seismogenic structures in the region.

The 2010–2011 South Rigan (Baluchestan) earthquake sequence and its implications for distributed deformation and earthquake hazard in southeast Iran RT Walker, EA Bergman, JR Elliott… - Geophysical …, 2013 - gji.oxfordjournals.org **...** The calibrated locations of all 93 events are presented in Table 1. Many of the events in the cluster were extracted from a database of earthquake locations in the Iran region, located with the **EHB** single-event location algorithm of **Engdahl** et al. (1998). **...**

Co-seismic, geomorphic, and geologic fold growth associated with the 1978 Tabas-e-Golshan earthquake fault in eastern Iran RT Walker, MM Khatib, A Bahroudi, A Rodés… - Geomorphology, 2013 – Elsevier **...** Many of the events in the cluster were extracted from a database of earthquake locations in the Iran region, located with the **EHB** single-event location algorithm of **Engdahl** et al. (1998). The HDC method is not well suited to resolving event depths directly. **...**

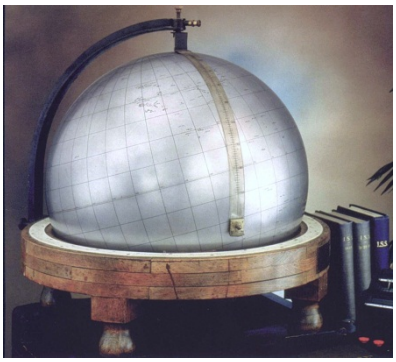
Global heterogeneity of the lithosphere and underlying mantle: A seismological appraisal based on multimode surface-wave dispersion analysis, shear-velocity … AJ Schaeffer, S Lebedev - homepages.dias.ie **...** the profiles to clarify the orientation. Seismicity within 40 km perpendicularly of the cross-section is extracted from the **EHB** catalogue (Eng- dahl et al., 1998) and plotted with white circles. Figure 5 shows "normal" cross sections **...**

P and SH velocity structure in the upper mantle beneath Northeast China: Evidence for a stagnant slab in hydrous mantle transition zone J Li, X Wang, X Wang, DA Yuen - Earth and Planetary Science Letters, 2013 - Elsevier**...** For a good calibration and comparison, we downloaded seismic waveforms from IRIS and epicentral information from **EHB** catalog for another three moderate deep earthquakes which occurred near the same region, and handpicked their arrival times (Fig. 1). Fig. **...**

Historical earthquakes in the Northern Territory K McCue - Newsletter, 2013 - aees.org.au **...** The 1972 event has been reviewed by **EHB** and their location is rather different from the ISC, NEIS and ADE (Stewart and Denham, 1974) ones shown in the table below (from the ISC Bulletin, all four decimal places!). **...** 02:18:56.07 -24.9930 136.3220 13.1 **EHB ...**

The 27 August 2010 Mw 5.7 Kuh-Zar earthquake (Iran): field investigation and strong-motion evidence MP Shahvar, M Zaré - Natural hazards, 2013 – Springer **...** Fig. 1 Instrumentally recorded earthquakes in the north-central Iran region in the period 1939–2010 (circles), using the catalog of ISC, IRSC, and IIEES, and **Engdahl** et al. (2006). **...** 2/16/1990 35.946 54.471 5 ISC 2/16/1990 35.905 54.559 4.6 **EHB** 7/3/2000 35.943 54.79 3.8 **...**

SUMMARY OF ACHIEVEMENTS



- Through the support from 62 Member-Institutions and grants from US NSF, GEM Foundation and CTBTO, the ISC finances stayed healthy, as many as 18 staff members worked during the year and essential improvements to the ISC products and services have been made.
- Parameters of 822 stations have been registered and modified in the International Station Registry.
- Preliminary bulletin data are collected from 37 networks and data centres worldwide.
- Revised bulletins are collected from ~130 networks worldwide.
- The reviewed ISC Bulletin were produced 30 months behind real time.
- During 2013, ~65,000 events with 5.6 million of associated phases have been added to the reviewed ISC Bulletin; this included the 2011 Great Tohoku aftershock sequence.
- The ISC Bulletin is more complete than the bulletins of either the NEIC/USGS or the IDC/CTBTO.
- The ISC database size has increased by ~27% in just one calendar year and reached 143Gb in total.
- The ISC development projects included:
    - The ISC-GEM Global Instrumental Earthquake Catalogue (1900-2009);
    - The ISC Event Bibliography;
    - The CTBTO Link to the ISC database;
    - Printed Summary of the ISC Bulletin;
    - The ISC Bulletin Rebuild (1960-2009);
- The ISC database and the website mirror were operated at IRIS DMC in Seattle, ERI in Tokyo and LLNL in Livermore. This improved the speed of access to the ISC data users.
- We continued maintaining the IASPEI Reference (GT) Event List , the EHB Bulletin and the List of International Contacts in Seismology.
- The ISC staff participated in a large number of conferences and received good publicity throughout the year.
- Several scientific articles describing new ISC products were submitted for publication during 2013.
- The large number of scientific articles published in 2013 indicates a wide-range use of the ISC Bulletin data by many researchers worldwide.

Signed, June 6, 2013

Dr. Dmitry A. Storchak
The Director