INTERNATIONAL SEISMOLOGICAL CENTRE

2008

Annual Director's Report

The year 2008 has been a year of the active search for further support, new members of staff and directions of further developments. The Centre received a lot of good publicity. New data, products and services were offered to users. It was a challenging yet successful year.

CONTENTS:

EXECUTIVE SUMMARY

2008 has been a challenging yet a very successful year for the ISC. Through the increased support from existing and new members and also additional grant secured from the UK Foreign and Commonwealth Office, the ISC's finances have been substantially improved from last year with 68% of funding now arriving at the ISC bank account in UK sterling - the currency in which most of the ISC expenditure occurs.

As a result, two new members of staff were hired to develop existing and new services that the ISC provides to seismologists and geophysicists worldwide. The ISC building and computer facilities have been improved.

IASPEI Reference Event List (GT) is now accommodated within the ISC Bulletin and also distributed by the ISC along with station arrivals.

The total period of the ISC collection of station arrivals has been increased by further four years by inclusion of the ISS data covering the period 1960-1963.

1652 USArray current and planned sites are included in the International Registry and the USArray reviewed station picks are now part of the ISC Bulletin. Several other new data sets were acquired through the year. Current final bulletin collection from networks now stands at 13.4 months behind real time.

In addition, to fill the time gap between seismic event occurrence and corresponding bulletin publication, the ISC runs the collection of reviewed provisional data from approximately 20 data centres around the world. This information arrives within hours/days/weeks after event occurrence and being grouped and distributed the next day after submission as part of the automatic ISC Bulletin.

The delay in the production of the reviewed ISC Bulletin has been eliminated by completing review of 14.5 months worth of the Bulletin during this year.

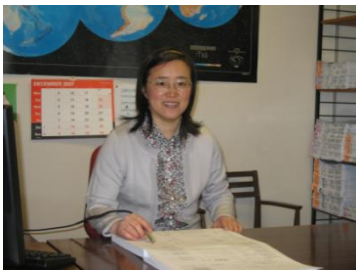
Further funds have been raised or committed by new and existing members to allow the ISC to hire further essential personnel in the coming year to develop the desperately required interactive bulletin analysis tool and boost a new bulletin data search.

STAFF

OPERATIONS:

James Harris, *United Kingdom*, System & Database Administrator

Beatriz Vera, *Colombia*, Seismologist / **Lead** Analyst



Baokun Li, *China*, Seismologist / Analyst

Przemas Kowalski, *Poland*, Seismologist / Analyst, **left in Dec**

Peter Dawson, *United Kingdom*, Data Collection Manager, **retired in July**

John Eve, *United Kingdom*, Data Collection Officer, **joined in April**

DEVELOPMENT

István Bondár, *Hungary*, **Senior** Seismologist / Developer, **joined in July**

Oriol Gaspà Rebull, *Spain*, Seismologist / Developer

Juan Benjumea Cadavid, *Colombia*, Seismologist / Developer, **joined in June**

MANAGEMENT&ADMIN

Dmitry Storchak, *Russia/United Kingdom*, Director, **appointed from Jan 1**

Maureen Aspinwall, *United Kingdom*, Administration Officer

OPERATIONS

INTERNATIONAL STATION REGISTRY

Traditionally the ISC maintains the International Seismographic Station Registry (IR) together with the World Data Center for Seismology, Denver (NEIC). The Registry allocates globally unique codes to seismic stations and currently has over 16.5 thousand stations documented. Those stations that have reported to the ISC are indicated on figure 1. The ISC runs a popular web-page allowing review of already registered stations as well as submission of parameters required to register a new station. The most recent large task was registration of 1652 stations of USArray. Valuable assistance has been received from IRIS during this process. Over six hundred already operational USArray sites have been fully registered. Station codes for projected sites of the Transportable Array have been reserved for future use without specifying exact coordinates. It is likely that during the actual installation process some sites may be shifted some distance in search for better local geological and noise conditions. Once re-measured these coordinates will then be fully registered in the IR.

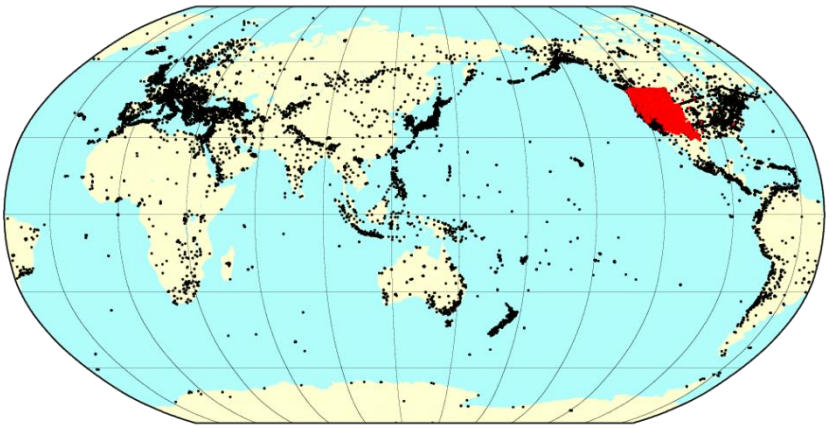


Figure 1. *Approximately 16,500 seismic stations are currently registered in the International Seismographic Station Registry (IR) (black dots). This year 1652 USArray stations have been fully registered (red dots) or reserved.*

STANDARD BULLETIN DATA COLLECTION

The standard ISC data collection is the collection of final reviewed bulletin data from approximately 120 different agencies around the world. We continued to reduce the delay in collection by 2.5 days per month on average. At the end of 2008 it stood at 13.4 months behind real time with almost all agencies being able to cope with the data delivery schedule. We plan to stop accelerating the data collection once the schedule reaches the mark of 12 months behind real time.

Half-way through the year the Data Collection Manager has retired. In the expectation of his retirement, 3 months in advance, the new Data Collection Officer was hired and trained. As compared to the previous arrangement, the new officer is not involved in programming. All changes to existing agency-specific parsers and writing parsers for new data has become a responsibility of existing development staff. The new Data Collection Officer now works four days a week and proved to be able to cope with the data collection rather well.

Figure 2 shows approximately 120 agencies that routinely report final reviewed bulletin data to the ISC. Red colour on this figure indicates the dry land territories that are covered by these reports. It is clear that further work on improving the ISC data collection in Africa, South America and parts of Eastern Europe and Asia is urgently required. Some territories in Eastern Europe, although appear white, in fact are already covered through contributions of the European-Mediterranean Seismological Centre (EMSC). Large events with magnitude 4.5-5.0 and above in Africa and South America are of course reported by the National Earthquake Information Center (NEIC), International Data Centre (IDC) and other agencies.

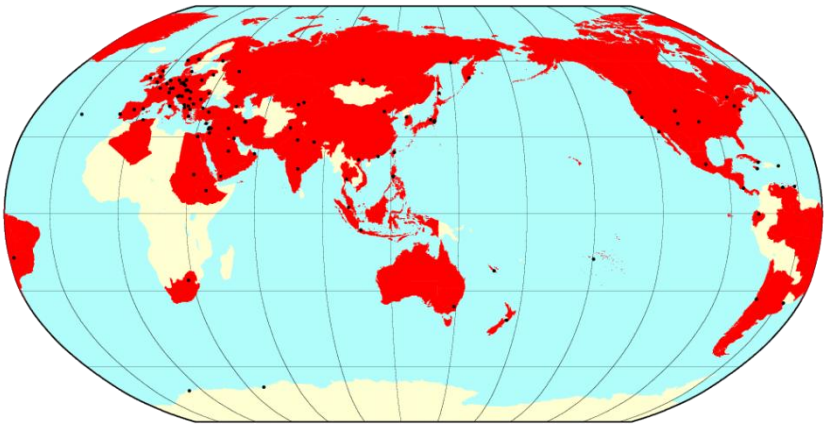


Figure 2. *Approximately 120 agencies around the world (black dots) report bulletin data to the ISC. Dry land territories covered are in red.*

Starting with data month of July 2006 IRIS DMC began contributing station arrival times that were picked and reviewed by USArray Array Network Facility in San Diego. 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. Whilst being a major source of data for tomographic research, this data set presents a major challenge to the ISC:

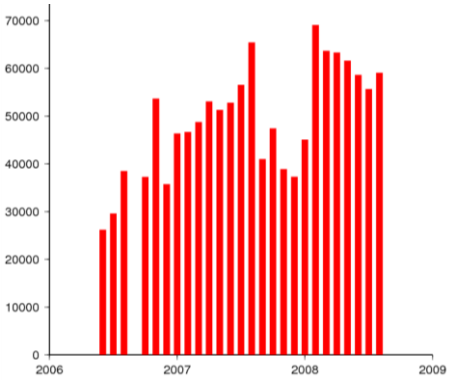


Figure 3. *Number of arrival picks reported by USArray stations for events in the ISC Bulletin per month.*

- Current ISC location algorithm is not designed to cope with the bias caused by large concentrations of seismic stations in specific azimuthal directions
- Current ISC Bulletin review procedures are designed for analysts to review each station arrival. The increased numbers of stations reporting the same events present a challenge for the editing team.

Also new bulletin data sets were received from the following institutions:

- Geophysical Observatory, Addis Ababa University, Ethiopia;
- Institute of Geophysics and Geology, Chisinau, Moldova;
- Geophysical Survey, Siberian Branch of Russian Academy of Sciences, Novosibirsk, Russia

- Centre of Geophysical Monitoring, National Academy of Science, Minsk, Belarus

An important advance has been made by the China Earthquake Networks Center of China Earthquake Administration (CENC/CEA). In the past earthquake hypocentres and station arrival data from 24 registered stations were reported separately from each other. As a result of the joint efforts of colleagues at CENC and the Chinese speaking member of the ISC staff, CENC is now reporting its data in the ISF format, where hypocentre solutions are followed by station arrivals. All cases where USGS solutions are adopted for association of Chinese station arrivals are clearly indicated. Another new advance is the reporting of the un-associated station readings (out of 24 registered stations) that CENC staff haven't used for their bulletin production, yet these data are useful if associated to other events in the ISC Bulletin.

During the Director's visit to CEA in October a request to increase the number of reporting stations was made. We are hoping for a positive outcome to this request.

The ISC data collection mostly runs smoothly, but in a few cases the data collection has been subject of long and difficult communication with hours, days and weeks spent trying to bring data that in other times would have arrived effortlessly.

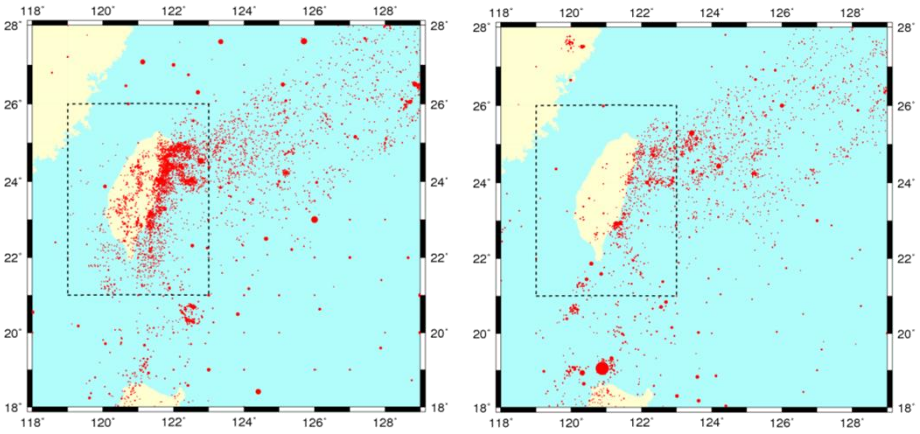


Figure 4. *Events in the ISC Bulletin before and after 1 July 2005 in the vicinity of the island of Taiwan.*

The data from the CWB (Chinese Taipei) have been available to ISS/ISC since 1930. As a result of several upgrades the CWB network of seismometers and accelerometers remains one of the densest in the world. Following an unfortunate dispute on the agency name, the CWB data are now missing from the ISC Bulletin from July 1, 2005 (see figure 4). Long and slow-moving negotiations are continuing, helped by the Institute of Earth Sciences of Academia Sinica (IES AS) and China Earthquake Administration. The ISC Director, with the financial support from IES AS was able to visit CWB on a side trip from 14 WCEE in Beijing and present the ISC's point of view and suggestions to relevant officials at CWB. The ISC is hoping for eventual resolution to this crisis. In the mean time events in the region are reported by the JMA (Japan), PHIVOLCS (Philippines), IES AS (Chinese Taipei),

CENC/CEA (China), NEIC/USGS, IDC/CTBTO and other agencies. The completeness of the ISC Bulletin in the area has, of course, suffered enormously.

No data for data year 2006 have been received from Saudi Arabia. This was caused by operational disruptions following the transfer of responsibilities for running the National Seismic Network of Saudi Arabia from King Abdulaziz City for Science and Technology in Riyadh to Saudi Geological Survey in Jeddah.

The ISC also experienced rather sporadic data submission from National Seismic Network of Kuwait.

Following the Great Sumatra earthquake, network operations of Badan Meteorologi dan Geofisica, Indonesia were disrupted, archives lost and normal data contribution stopped. To compensate for the loss, the ISC now receives automatic alert messages and picks from stations installed by the GFZ Potsdam for the Indian Ocean Alert System. We also receive teleseismic picks, rather sporadically, from a network installed with the help from LDG a number of years ago. Search for new data from the region from networks installed by several institutions from Japan and China continues.

PROVISIONAL BULLETIN DATA COLLECTION

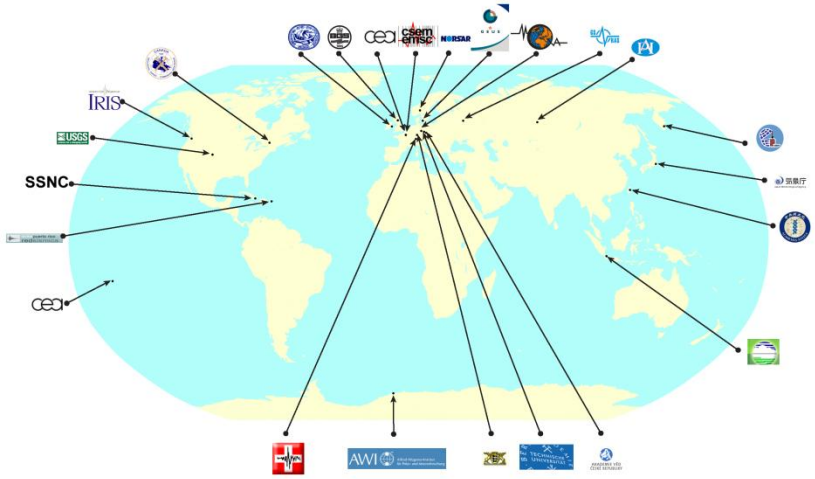


Figure 5. *Approximately 20 networks and data centres report provisional reviewed bulletin data to the ISC.*

In 2008 the ISC stepped up its collection of provisional bulletin data from various networks and data centres. These data are expected to undergo at least a minimal review by local analysts. Typically these data include a provisional hypocentre location, magnitude estimate, moment tensor solution and station arrival data, though variations are large from agency to agency. Approximately 20 agencies reported provisional data to the ISC at the year end (see figure 5).

Provisional hypocentre solutions are being grouped in the ISC database within a day after receipt and made available through the standard ISC Bulletin search procedure (see figure 6). For each event an output includes several hypocentre solutions reported by various agencies, all reported magnitude estimates and station arrival data.

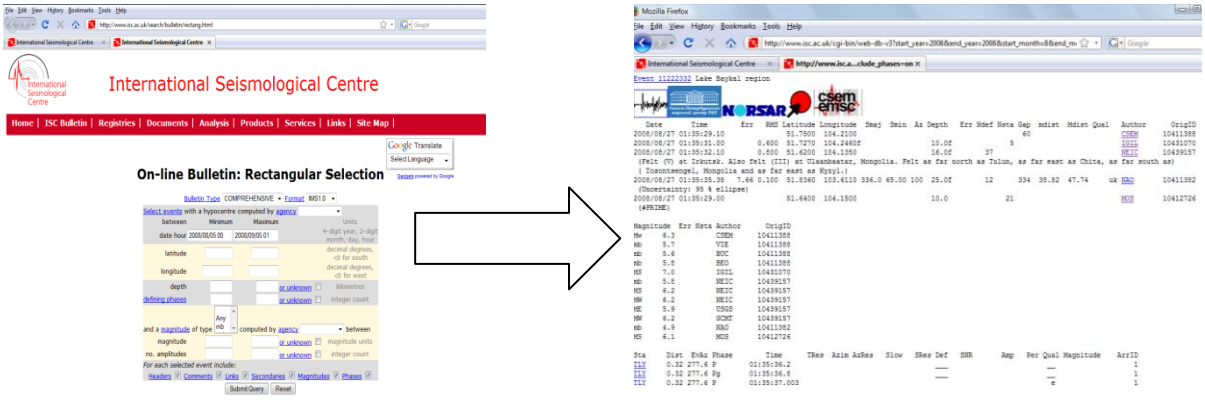


Figure 6. *Provisional hypocentre solutions and made available through the standard ISC Bulletin search procedure.*

By clicking a logo provided for each reporter, the user is re-directed to a corresponding recent event notification web-page of an agency that provided the original bulletin data (see figure 7). This is an additional service that the ISC provides by giving further publicity to national networks and data centres involved in the dissemination of information about recent seismic events locally and on a regional or even global basis.

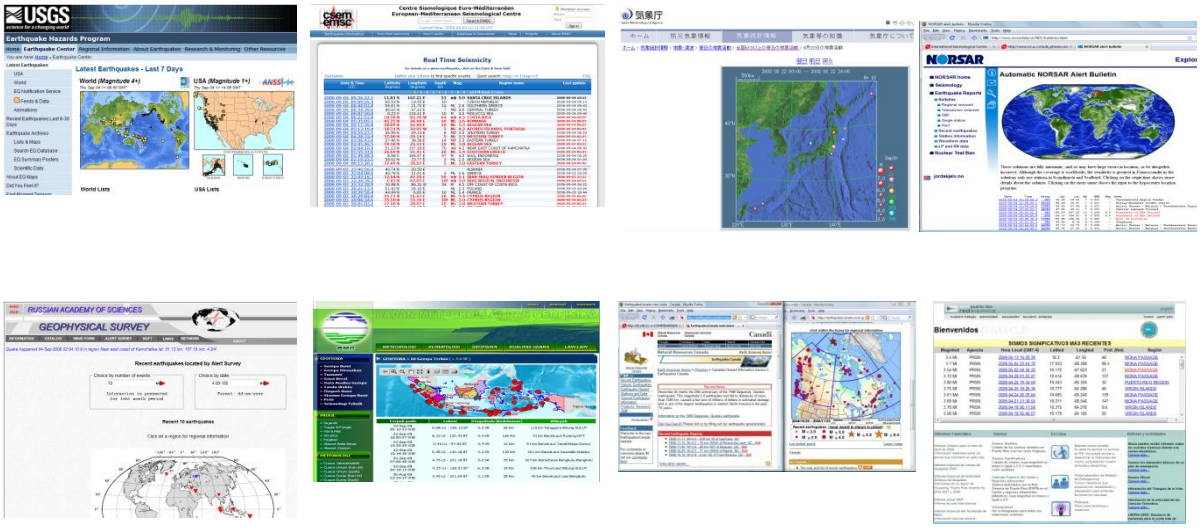


Figure 7. *By clicking logos on the ISC Bulletin page users are re-directed to the original recent event notification pages of the corresponding reporting agencies.*

Figure 8 shows the magnitude distribution of events reported to the ISC within 3 days, 7 days, 1 month and 4 months after event occurrence. It appears from the graph that all events with magnitude 4.5 and above are reported within a first week. Further reports beyond one week add information to already reported large and moderate events plus inform about further smaller events.

This additional initial data collection is intended 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. Currently the ISC observes a delay of at least one day before making these data available. At this stage ISC does not compute or publish its own event solutions. This service is not intended to be used by media or civil protection agencies. It is indeed designed to be used by seismologists.

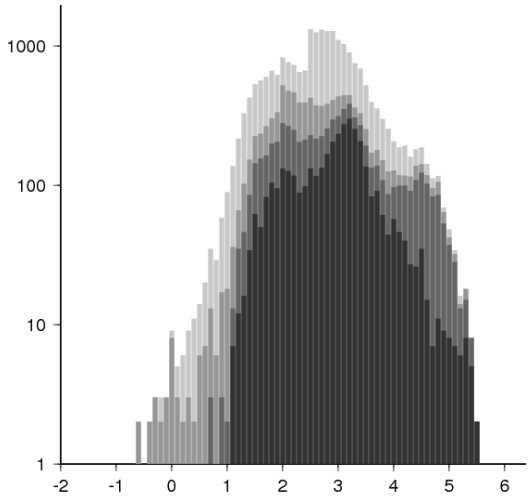


Figure 8. *Magnitude distribution of recent events reported to the ISC within 3 days, 7 days, 1month and 4 months after event occurrence shown in shades of grey, the sooner - the darker.*

Obviously provisional data from agencies are later substituted with their final bulletin data, well before the ISC analysts make a final review of the ISC Bulletin. The ISC hypocentre solutions are still based on the final set of bulletin data given by each reporter.

ISC BULLETIN REVIEW

The team of three ISC analysts reviewed 14.5 months worth of the bulletin data in 2008. The team was helped by the Director during the last steps in the analysis procedure.

Following the ISC Governing Council decision, the ISC has used AK135 velocity model to compute ISC solutions from data year 2006. These solutions are reviewed by the ISC analysts. In order to provide consistency with the previous years, an additional set of automatic ISC locations based on Jeffreys-Bullen travel time tables (coded as ISCJB) is produced for those events with AK135 solution available. The only ISCJB solutions that are reviewed are those that show considerable departures from standard ISC locations based on AK135. Producing two sets of ISC solutions will continue until such a point when the entire ISC dataset is recomputed with AK135 using currently developed location procedure.

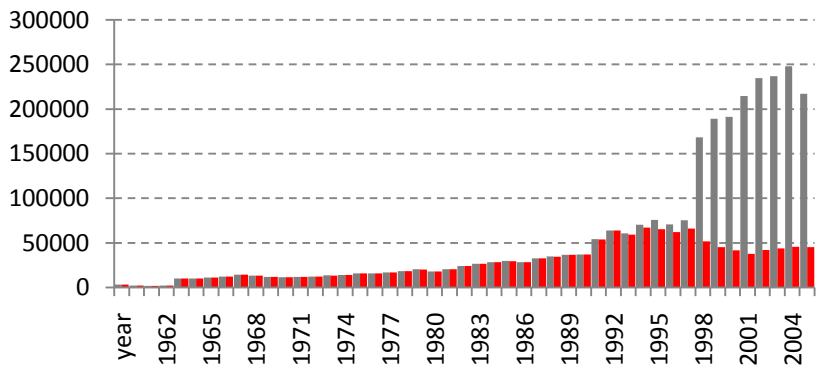


Figure 9. *The total number of events in the ISC Bulletin (grey) and the number of events reviewed by the ISC analysts (red) per year.*

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 restricting the number of seismic events to be reviewed by ISC analysts. Figure 9 shows annual numbers of all seismic events versus the number of events reviewed by the ISC analysts. The ISC analysts normally review approximately 20% of all events in the ISC Bulletin. Although most of the Bulletin preparation is done automatically, it is the analyst's review that makes the 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.

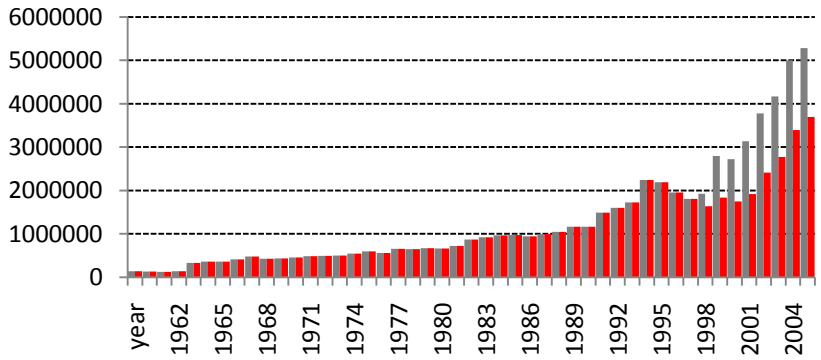


Figure 10. *The total number of station arrivals in the ISC Bulletin (grey) and the number of station arrivals reviewed by the ISC analysts (red) per year.*

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. As the number of events stays the same on average, the number of associated arrivals gradually grows out of control as can be seen on figure 10. The introduction of new data sets, although beneficial for bulletin users, put an extra strain on the ISC analyst resources. The introduction of large data sets, especially the USArray have indeed slowed down the review process.

Thus a new approach to the Bulletin review process is required. One of the answers is the introduction of an interactive editing system in place of the paper-based batch-type analysis. Also the ISC needs to concentrate on the review of outliers instead of reviewing all data. The system required will take a long time to design, develop and test in operations. Nevertheless, it has become so urgent that no expense should be spared. Any delay in the development and implementation of new software will only worsen the situation with the analyst team gradually requiring more and more staff to be able to cope with the load and the schedule.

ISC WEB and FTP SERVICES

The ISC web-site as a whole and the Bulletin search in particular continued to grow in popularity over 2008 (see figure 11). The number of hits (excluding web crawlers) reached 2.2 millions, having increased 55% compared to year 2007. Although the number of Bulletin searches compared to 2007 went down 50%, the actual amount of Bulletin data taken has actually doubled to 20 Gb.

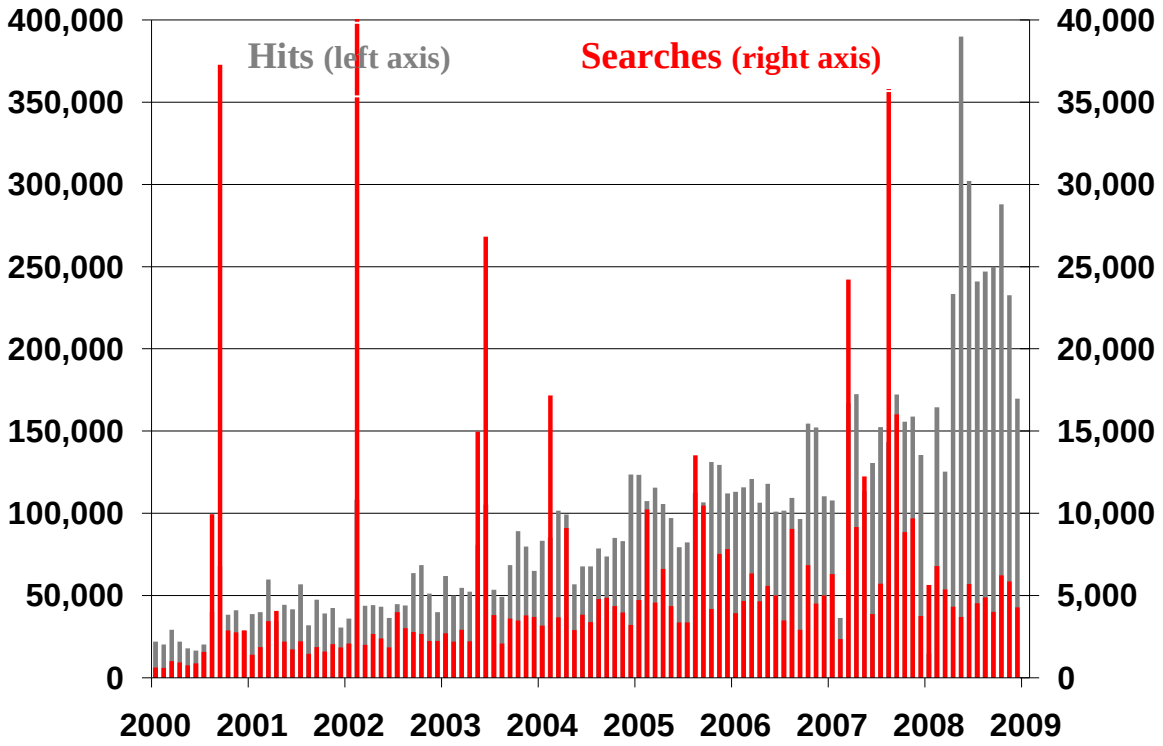


Figure 11. *Number of ISC website hits (grey, left axis) and number of ISC Bulletin searches (red, right axis) per month.*

The most popular services were (in the order of presentation):

- International Station Registry (up ten times compared to 2007);
- Bulletin search;
- Bibliography search (up two times compared to 2007);
- Maps using the bulletin search data;
- Links to agencies providing real time data;
- Search of original contributed to the ISC data;
- SKS splitting data.

The statistics of the ISC web-site use per country is shown on figure 12. Although net, gov, edu and com are the domains mostly registered in the US, they are shown separately. In any case the US is by far the main user of our services followed by the UK, China, Japan, Greece, Italy, Russia, France and Germany.

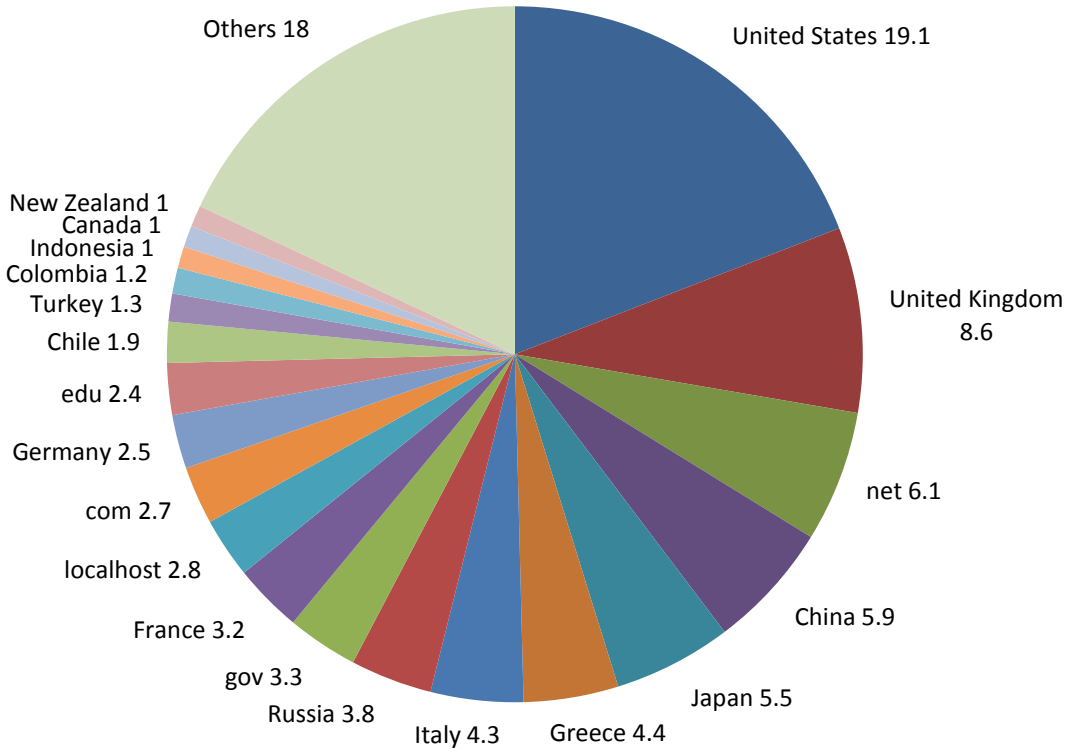


***Figure 12**. ISC website use per country, percents. Category "Others" includes all users with a share of less than one percent.*

DEVELOPMENTS

ISS DATA (1960-1963)

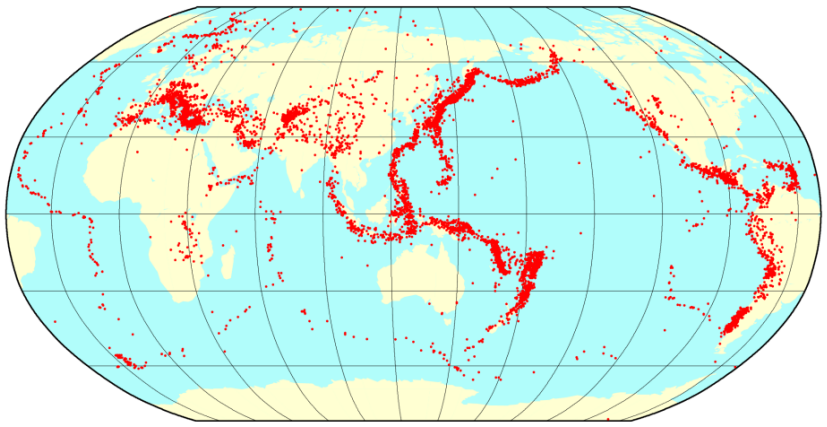


***Figure 13.** Epicentres of seismic events in the International Seismological Summaries (ISS) for 1960-1963.*

The ISC data collection has always included the hypocentre solutions of events in the first part of the 20th century that were mostly based on the data of the ISC's predecessor – the International Seismological Summary (ISS). Yet the ISC data users were never able to acquire the station arrival data that were available in a somewhat unusual

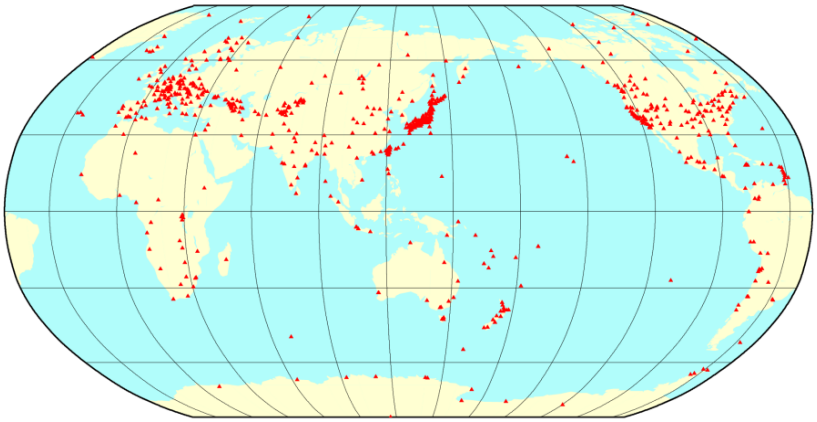


Figure 14. *Positions of seismic stations that contributed arrival data to the International Seismological Summaries (ISS) in 1960-1963.*

form in the paperback copies of the ISS, covering a total period from 1918 till 1963.

This year, thanks to continuing work of Antonio Villaseñor of the Institute of Earth Sciences "Jaume Almera" and Bob Engdahl of Colorado University, the ISC was able to introduce to its database station arrival picks for ISS events in 1960-1963. Various errors in epicentre information and some missing events were also corrected. Figures 13 and 14 show the geographical distribution of events for this period of time as well as positions of those stations that contributed station arrival picks for this events.

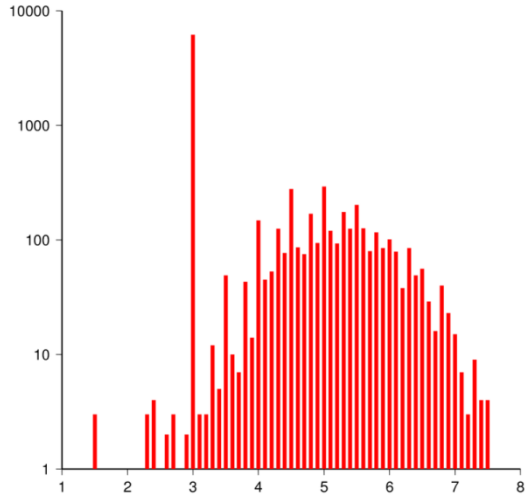


Figure 15. *Magnitude distribution of events in the International Seismological Summaries (ISS) in 1960-1963. The large peak at magnitude 3 indicates events with no magnitude estimate available.*

The magnitude distribution graph (figure 15) gives a rough idea of the overall completeness of the bulletin during this period of time. The odd high pick at M=3 merely reflects the number of events where no magnitude estimate is available. One of the known deficiencies of the ISS data is that there were no magnitude estimates published, so that these had to be taken from several other sources of global and regional data.

As a result of this development the ISC bulletin data collection grown "backwards" as opposed to normal growth as years go by. It now contains station data covering a total period from 1960 till 2008. It is expected that further ISS data covering the first part of 20th century will be made available to the ISC Bulletin users in due course.

IASPEI GT LIST

The International Seismological Centre now maintains the IASPEI database of Reference Events (earthquakes and explosions) for which epicentre information is known with high confidence (to 10km or better (GT10)) with seismic signals recorded at regional and/or teleseismic distances. 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 was coordinated by the CoSOI/IASPEI working group on Reference Events for Improved Location chaired by Bob Engdahl and Paul Richards. This database of a significantly large number of reference events (over 7,000) 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 using a web application and receive GT locations, 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. A graph on the left shows comparative numbers of nuclear explosions, chemical explosions and natural seismic events in each GT category.

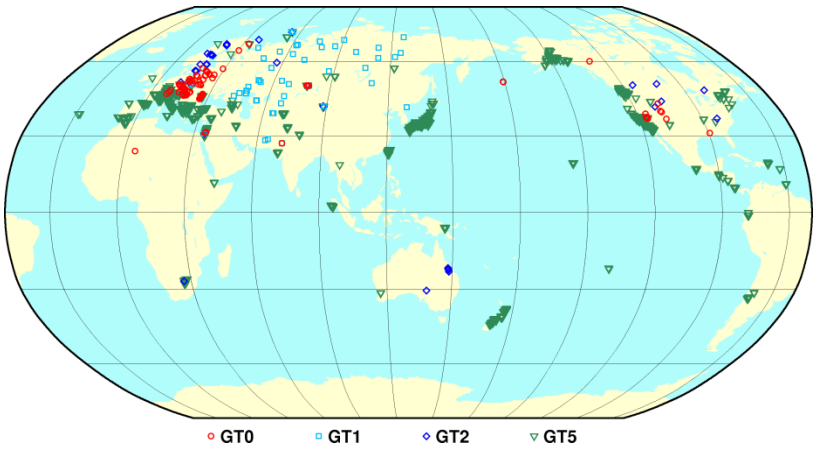


Figure 16. *Events in the IASPEI list of Reference earthquakes and explosions. Colours indicate the GT accuracy to which the position of epicentre of each event is known.*

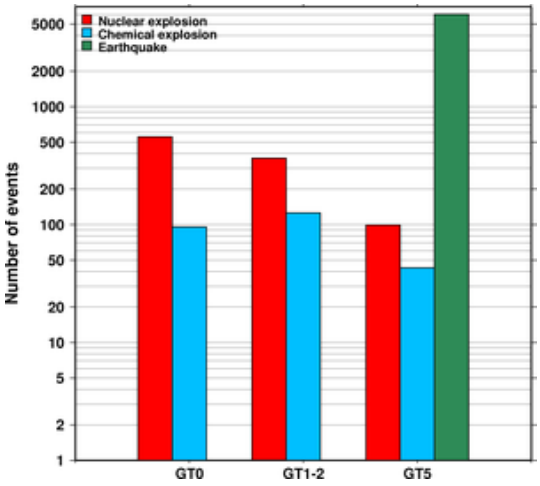


Figure 17. *Number of nuclear explosions, chemical explosions and natural earthquakes in each GT category.*

ISC LOCATION PROCEDURES

As described above, the first step in the process of modernizing the ISC location procedures was the adoption of the AK135 velocity model for computing ISC hypocentres whilst still

producing locations based on Jeffreys-Bullen travel time tables. At this point there are approximately 26 thousand events in the ISC Bulletin with both AK135 and JB based ISC solutions. The mean difference is 5.4km with 90% of the locations within 15 km. A 1.4 s origin time difference reflects the JB P baseline shift.

The ISC senior seismologist/developer has been working on further modernization of the ISC location procedures. Several computer bugs have been identified and eliminated. The station elevation and ellipticity corrections have been reviewed and rectified where necessary. Our next plans include:

- Using phases made available by AK135 such as PKP, core phases and further depth-sensitive phases including pwP;
- Improving relative weighting scheme between phases;
- Introducing probabilistic phase identification methods;
- Obtaining starting location via Nearest Neighbour Algorithm;
- Accounting for correlated model error structure;
- Characterizing reading errors by non-Gaussian, skewed and heavy-tailed probability distributions;
- Using measured azimuth and slowness;
- Improving magnitude determination procedures.

The following contributions of computer code were received to assist this development:

- pwP corrections from E.R. Engdahl;
- Nearest Neighbour Algorithm from B.L.N. Kennett and M.S. Sambridge;
- Depth phases for improved depth determination from J.R. Murphy and B.W. Barker.

Once the algorithms have been coded, tested, approved by the ISC Governing Council and put into operation, there is a plan to re-compute the entire ISC data collection from 1960 till present, using the newly adopted procedures and the AK135 velocity model.

AUTOMATIC WAVEFORM MEASUREMENTS

We also plan to improve the accuracy of the ISC Bulletin by gaining necessary limited information from the waveforms widely available on-line. A dedicated member of the development staff has been preparing to carry out experiments on a limited set of stations in order to:

- Measure body-wave amplitudes in accordance with the recommendations of the IASPEI WG on Magnitude Measurement; based on reported parametric data we often do not know how amplitudes are measured; consistent amplitude measurements will improve magnitude determination;
- Pick teleseismic depth phases; this will improve our capability to determine accurate event depths;

- Estimate signal-to-noise ratio; this will facilitate the SNR-based weighting schemes.

It is believed that taking this information consistently using the same technique has a chance to contribute to the Bulletin in the positive way, even when measurements will be taken automatically with station-to-station consistency observed.

DEVELOPMENT STRATEGIES (2009-2011)

A separate document has been prepared by the Director to outline further development strategies for the next three years. This document has been subject to discussion at the ISC Executive Committee and the ISC Governing Council. An updated version is available from the ISC web-site.

PROJECTS

CTBTO-LINK

Following a long and difficult application process, the UK Foreign and Commonwealth Office (FCO) has 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 agreed to provide 90% of the total required funding (£89,524) on the condition that four other relevant institutions from Nordic countries were to contribute remaining 10%.

Under this project the ISC will install a dedicated server to hold a mirror version of the ISC database and create web-based software to query the ISC database in ways specific to the monitoring community. It is expected that in three years time PTS will consider the feasibility of supporting maintenance of this system beyond this project.

Effectively the project started only in late Nov 2008 when the first quarterly FCO payment was received. The server has been purchased, configured and installed. The ISC Director and Systems and Database Administrator travelled to the IDC to meet colleagues at PTS and discuss the system configuration and software design. The work on the database mirroring and software design continues.

It is essential that achievements in almost all aspects of this project will advance the ISC services to researchers from existing member-institutions.

FINANCES

The detailed financial statements of the ISC for 2008 were audited by Griffins, Chartered Accountants (Newbury, UK) and approved by Prof. John Woodhouse of the ISC Executive Committee. These statements present the state of ISC's financial affairs as at 31 December 2008.

INCOME

In 2008, the ISC had a total income of £ 503,613 from national contributions, UK FCO grant, sponsorship from Munich Re, the income from selling ISC publications plus interest from the ISC bank accounts. This amounted to almost 16% more than was budgeted and approved by the ISC Governing Council. In comparison with 2007, this was a 26% increase in total income.

In accordance with the decision of the Governing Council, in 2008 the ISC sent invoices to their members in GBP for the first time. This proved largely successful with the funds being readily available to spend in the currency our expenses occur giving the ISC greater long-term stability. Figure 18 shows the dramatic change to parts of the income in 2007 and 2008 denominated in USD, GBP and Euro.

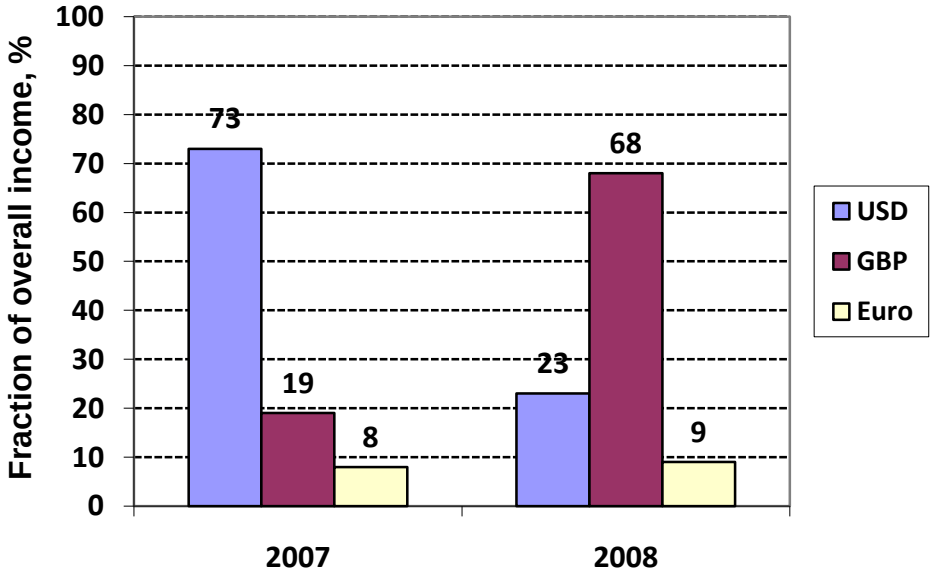


Figure 18. *The change in fraction of the overall income paid in US dollars, British pounds and Euros between 2007 and 2008.*

The exchange rate between GBP and USD fluctuated between £1=$1.99 at the start of the year, to £1=$2 in the middle of the year, and finishing at the end of December at £1=$1.46. The exchange rate between GBP and Euro fluctuated between £1=1.36€ at the start of the year, to £1=1.26€ in the middle of the year, and finishing at the end of December at £1=1.03€. The benefit of invoicing member organizations in British pounds was to reduce where possible the dependency of the ISC resources from these fluctuations. As a result only 32% of the ISC income in 2008 was subject to these fluctuations compared to 81% in 2007.

During 2008, three more members, each with one unit, joined the ISC Governing Council:

- AWE Blacknest, UK

- Meteorological Organization and Seismology, Ministry of Transport, Iraq
- Seismic Research Unit, UWI, Trinidad & Tobago.

Following our request to support new developments at the ISC, eight more units were raised by existing members generously increasing their contributions:

- INGV, Italy increased from 5 units to 9,
- NORSAR, Norway - from 1 to 3 units,
- Uppsala University, Sweden - from 1 to 2 units.
- GFZ, Germany - from 1 to 2 units,

IFREE/JAMSTEC also joined in support of the ISC development with the 2008 membership payment (5 units) received in January 2009.

First payment of £10,108 from the FCO grant was received to develop a dedicated link to the ISC database for PTS CTBTO and National Data Centres.

Sponsorship of $5,000 for year 2008 from Munich Re is also expected.

At year-end, after 3 consecutive years the membership fees from the KISR, Kuwait were unpaid and were written off and 2007 year subscription from KMA, Korea was also written off.

EXPENDITURE

More than 78% of the ISC expenditure in 2008 was on personnel costs, some £14,780 less than 2007. During 2008 Dr Dmitry Storchak began his term as Director and Dr Peter Dawson retired from his position of Data Collection Manager and Developer to be replaced by Mr John Eve, Data Collection Officer. Mr Juan Benjumea and Dr István Bondár joined the ISC as Seismologist/ Developer and Senior Seismologist/Developer, respectively. At the end of the year one of the ISC Bulletin analysts, Mr Przemas Kowalski left the ISC to return to Poland. The salary costs include: salaries, pension contributions, recruitment and repatriation of a new and departing staff. The ISC salaries follow the UK academic salary scales.

Some of the computing expenditure for new machines was paid for from the Computer Replacement Fund. Travel expenditure in 2008 was £3700 greater than the previous year but it should be noted that almost all of this travel resulted in either additional data or additional funding and often both, as well as promotion of the ISC to new audiences.

RESERVES

The gain in income over expenditure for 2008 was £46,673, compared to a loss of £67,869 in 2007. The ISC total reserves, comprising the cash in the bank, building and land, the money owed to ISC (debtors) minus the money ISC owes (creditors and remaining mortgage on the

building) increased during 2008 to £414,294. The ISC computer replacement fund has decreased during 2008 by £6,584 representing purchases made. The ISC has a general reserve of £362,506, including the cost of the building. This is equivalent to just below 10 month's operation of the ISC, which is well within British guidelines for charitable organizations.

CASH FLOW

Figure 19 shows receipts and outlays using dates when transactions were recorded at the bank and the bank balances with US Dollars and Euros converted to Sterling using the exchange rate as of the end of each month.

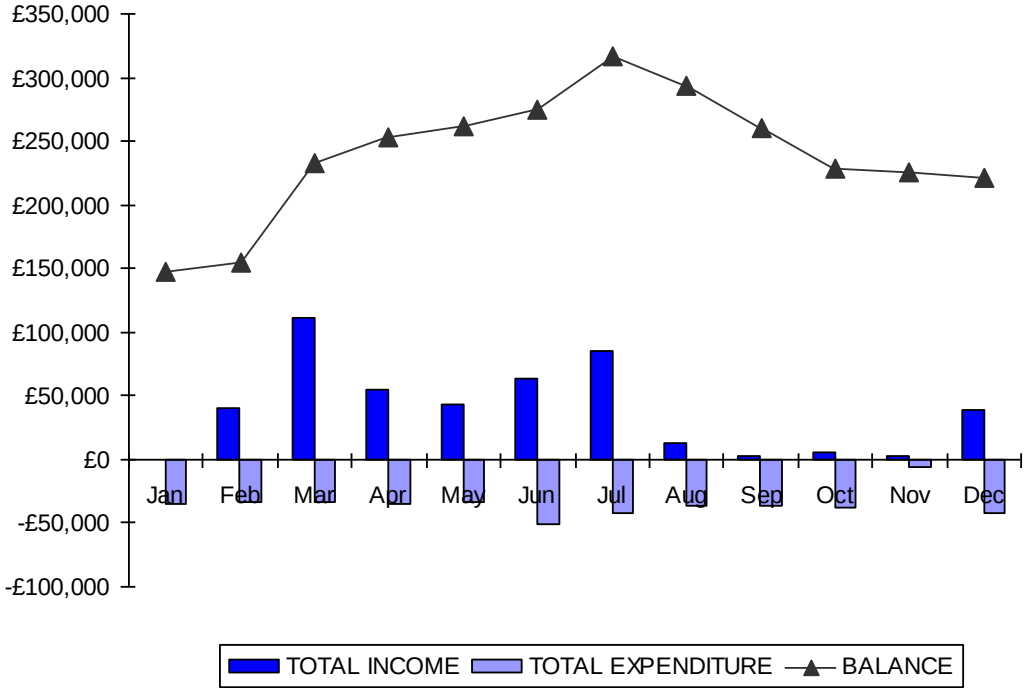


***Figure 19**. Cash flow.*

The ISC has cancelled its £20,000 overdraft facility, as advised by the business manager at the bank in the knowledge that a new overdraft could be arranged for emergency use if contributions are delayed.

SCIENTIFIC LIAISONS

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

- John Woodhouse – University of Oxford, UK
- David Jepsen – Geoscience Australia
- Matthew Purss – Geoscience Australia

- Steven Taylor – Rocky Mountain Geophysics, US
- Dale Anderson – Los Alamos National Laboratory, US
- Debbie Fagan – Pacific Northwest National Laboratory, US
- Brian Kennett – Austrialia National University
- Alan Douglas – AWE, Blacknest, UK
- Roy Lilwall – AWE, Blacknest, UK
- Guy Masters – Scripps Institution *of* Oceanography, UCSD La Jolla, US
- Gary Gibson – Seismic Research Centre, Australia
- Jaroslava Plomerová – Czech Academy of Sciences
- Oleg Starovoit – Russian Academy of Sciences
- John Adams – Geological Survey of Canada
- Anthony Hughes – Former Director of the ISC, UK
- Richard Benyon – Member of Parliament for Newbury, UK

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:

- Geophysical Survey, Russian Academy of Sciences (GS RAS), Obninsk, Russia
- Laboratory of Geophysics and Seismology, Technological Educational Institute of Crete, Chania, Greece
- European-Mediterranean Seismological Centre (EMSC), Bruyères le Châtel, France
- International Data Centre, CTBTO, Vienna, Austria
- Laboratoire de Detection et de Geophysique (LDG), CEA, Bruyères le Châtel, France
- China Earthquake Administration (CEA), Beijing, China
- Institute of Geophysics, CEA, Beijing, China
- China Earthquake Networks Center (CENC), CEA, Beijing, China
- Hong Kong Observatory (HKO), Hong Kong, China
- Institute of Earth Sciences, Academia Sinica, Chinese Taipei
- CWB, Chinese Taipei
- Japan Meteorological Agency (JMA), Tokyo, Japan
- National Research Institute for Earth Science and Disaster Prevention (NIED), Tsukuba, Japan
- Earthquake Research Institute, University of Tokyo, Japan

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

- Nordic Seismology Seminar, Oslo, Norway

- Seismicity of Northern Eurasia, Obninsk, Russia
- IRIS/NSF Workshop on Long-Range Science Plan for Seismology, Denver, USA
- European Seismological Commission, Hersonissos, Greece
- Royal Society Meeting of UK Learned Society representatives, London, UK
- NEIC-ISC-EMSC Coordination Meeting
- World Conference on Earthquake Engineering, Beijing, China
- NEREIS Data Portal for Seismology, brainstorming meeting, Edinburgh, UK
- Asian Seismological Commission, Tsukuba, Japan

CITATIONS OF THE ISC DATA in 2008

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SUMMARY OF ACHIEVEMENTS

- The delay in production of the Reviewed ISC Bulletin has been eliminated.
- 1,650 USArray current and planned sites are included in the International Registry.
- USArray reviewed picks are accommodated within the ISC Bulletin.
- ISC hypocentre and station arrival data collection is increased by further 4 years by including the 1960-1963 ISS data.
- IASPEI Reference Event List (GT) is now accommodated within the ISC Bulletin and also distributed by the ISC along with station arrivals.
- Provisional bulletin data are now collected from approximately 20 data centres around the world within hours/days after event occurrence, grouped and distributed next day after submission as part of the automatic ISC Bulletin.
- Considerable additional Member's support secured for further development.
- Two new members of development staff have been hired;
- Finances substantially improved from last year with further funds raised for the development of the interactive editing tool and new data search.
- ISC building facilities and computer facilities have been improved;

Signed, May 15, 2009

Dr Dmitry A Storchak
Director