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Strategies for the ISC development

2009-2011

Introduction

This document is setting the strategies for further ISC Development. It has been considered and supported by the ISC Executive Committee during its meeting in Thatcham on June 8-9, 2008. It has been endorsed in principle by the ISC Governing Council at the meeting on January 11, 2009 in Cape Town. Corrections/amendments from the Council members, supplied within one month of this meeting, have been taken into account.

The current financial situation at the ISC is stable. The budget is on the recovery path with introduction of the membership fees in GBP from the beginning of year 2008 and the great additional support received from new and existing Members. The general world economic outlook at the end of year 2008 is not bright though. It is common that in similar times governmental and research funding agencies concentrate on the funding of core projects, trying to prioritise their spending and save on services that are not in high demand. It is especially important in this situation to step up the development of the Centre to make sure that the ISC services and products remain an important requirement for geophysical research.

Summary

In view of the above the ISC development shall be focused on the following major tasks:

1. Bringing **manual review** of the ISC Bulletin to **12-15 months** after an event occurrence.
2. Collecting reviewed provisional bulletin data soon after events occur to keep the ISC database updated with most accurate data available at any time.
3. **Perfecting and enlarging** incoming reviewed bulletin **data**.
4. Revising and **modernizing** the ISC analysis **procedures**.
5. Establishing **automatic** procedures to build a consistent set of specific **waveform measurements** to improve the accuracy of the ISC Bulletin.
6. Producing **user-focused ISC on-line Bulletin** and **printed ISC Bulletin Summary**.
7. Re-establishing the **unique role** of the ISC among seismic networks and data centres by becoming a readily available source of useful information and timely feedback.

1. Manual review of the ISC Bulletin 12-15 months after event occurrence

Traditionally the ISC deliberately delayed its Bulletin review for as long as two years to allow all final reviewed network bulletins to be delivered to the ISC. The deadline of 2 years was set when printed materials and magnetic tapes were sent to the ISC for analysis.

Communication technologies have changed dramatically with e-mail messages now being the predominant way of reporting to the ISC. There is never a time when all final reviewed network bulletins are available. It does not make sense to delay production of the ISC Reviewed Bulletin once 95% of the incoming network bulletins are available. Based on this, 12-15 months after event occurrence appears a suitable goal for the production of Reviewed ISC Bulletin. We hope that agencies responsible for the remaining 5% of data will adjust their deadline policies once they realise that their data fail to appear in the Reviewed ISC Bulletin that is truly and widely considered as final depository of seismic bulletin data. In the worst case the data arriving after the deadline can still be added to the ISC Bulletin available on-line.

Bringing manual review of the ISC bulletin to 12-15 months after event occurrence is a costly endeavour. This is because an additional member of the editing team needs to be employed and trained to a sufficiently high level. Yet it is important to achieve this goal for a number of reasons.

- This reinforces the perception of the ISC being modern and up-to-date whilst still allowing collection of the majority of final network bulletins prepared worldwide.
- This would allow much more efficient communication between ISC seismologists and data contributors during collection and review processes. At present the ISC often has problems recovering technical information about station parameters and events that happened a long time ago in the minds of the colleagues running networks.
- Based on the outcome of much earlier Bulletin review, the ISC would be in a position to provide timely and useful automatic structured feedback to data contributors.

The ISC editors are still using paper listings to review approximately 4,000 events per month in a batch mode. The bar coding system introduced several years ago helped to reduce the unnecessary routine elements from editors work and reduced a possibility of typing errors. With recent 10 fold increase in the speed of ISC database queries it became possible to assist the editor's decision making process with on-screen graphical information once an event bar code was scanned directly off the paper listing. Despite all these recent advances the ultimate goal should be the design, coding and implementation of the fully interactive editing system. This system would include an automatic measure of confidence of each event processing results. Only events showing a low measure of confidence should be reviewed by the ISC analysts. This way the ISC would be able to cope with the enormous increase in the number of seismic stations reporting its data to the ISC.

2. Collecting reviewed provisional bulletin data to keep the ISC database updated with most accurate data available at any time.

A large number of agencies worldwide have moved towards issuing seismic event solutions based on automatic picking of first arrivals followed by seismologist's review. In addition a number of other networks report seismic arrivals for already reported events. There is no global international agency that takes the effort to combine this kind of information and offer the best available solutions at any point in time for seismic events worldwide. This role clearly fits the ISC mandate. The ISC needs to step up efforts in filling its database with provisional reviewed seismic bulletins as soon as these

become available, grouping them together on event basis, identifying the likely best solution and providing a link to the original sources of information. The members of the ISC Governing Council should be asked to convey this development to their home institutions in order to increase the number of participating organizations and the geographical coverage.

3. Perfecting and enlarging incoming reviewed bulletin data

The ISC data collection remains one of the most comprehensive collections of seismic reviewed parametric data. Yet this collection needs to be improved in many areas.

- The ISC needs to encourage data contributors to provide uncertainties for all types of submitted information.
- The completeness of the ISC data collection varies dramatically throughout the globe. Certain efforts should be made to improve collection in South America, Africa, South East Asia and oceanic areas, where new networks, including ocean-bottom, are being installed. An assistance of UNESCO and UK DFID may be used.
- Close attention needs to be given to networks with artificially limited data reporting.
- The ISC needs to search for additional types of parametric data to be collected. Examples might include: finite source rupture models, information on the quality of onset time picking etc. The ISC will need to take part in a collaborative worldwide effort to define how this information is to be determined and reported.
- Jointly with IASPEI, the ISC needs to continue searching for suitable reference events to improve seismic event location.
- The ISC needs to increase the time span of its data collection by including the ISS station arrival data for 1918-1963 as these become available.
- The ISC should advertise itself as a depository of historical data sets. Datasets from SEIS-UK and PASSCAL deployments need to be included in the ISC database.

4. Revising and modernizing the ISC analysis procedures

ISC is a world renowned data centre. Its parametric data collection covers a considerable period of time and is the best source of global seismic bulletin data for a number of applications. It is the right balance between consistency of procedures over a long period of time and the ability to adapt to ongoing changes in the needs of contemporary seismology that has so far kept the Centre and its data in demand. It has become apparent though, that the Centre's current location procedures have gradually fallen behind the progress in global earthquake location and are in need of substantial revision.

The ISC has been able to call and successfully run two Location workshops at IASPEI meetings in Santiago (2005) and Perugia (2007). This workshops and consequent publications show the directions for advancing ISC location:

- ✓ Using a more modern 1-D Earth model that better describes observed primary and secondary seismic arrivals;
- ✓ Accounting for correlated model error structure;
- ✓ Describing reading errors by non-Gaussian, skewed and heavy-tailed probability distributions;
- ✓ Using core phases and further depth-sensitive phases (core and surface reflections);
- ✓ Applying probabilistic phase identification methods;

- ✓ Minimizing Lp norm with iterative reweighted least squares or non-linear optimization algorithms;
- ✓ Using SNR, back azimuth and slowness measurements
- ✓ Applying a meaningful set of default depths;

As soon as new procedures are developed, thoroughly tested and results evaluated it would become possible to re-compute the complete dataset going back to 1964.

It became also apparent that ISC needs to put efforts in re-evaluating its procedures of reporting network magnitudes and computing its own ISC magnitudes:

- introduce a system of selecting a preferred magnitude estimate among those reported by other agencies and computed by the ISC;
- encourage data reporters to use those magnitude types recommended by the COSOI/IASPEI working group on magnitude issue;
- investigate the possibility of computing magnitudes based on ISC's own amplitude measurements (see next).

5. Automatic procedures to build a consistent set of specific waveform measurements to improve the accuracy of the ISC Bulletin

The availability of continuous on-line seismic waveforms is improving day by day. It becomes apparent that to address specific well known problems the ISC could use this enormous free source to make consistent automatic sets of measurements to be used in operations in addition to reported data. Such problems include:

- absence of reliable depth constraints and magnitude estimates for a large fraction of bulletin events,
- persistent incoherence of amplitude measurement techniques used by various networks,
- inconsistency in onset time of surface reflections reported by different networks.

In fact the precedent is already made by some reporters scanning waveforms available on-line and reporting automatically-made parameters to the ISC. ISC should investigate possibilities of:

- amplitude measurements in line with new recommendations of IASPEI/COSOI working group;
- picking arrival times of surface reflections at a number of stations simultaneously to assist depth determination of those events where close station readings are unavailable;
- picking first arrivals at stations that show high likelihood of detection for a combination of event position and magnitude;
- resurrecting the successful pilot project of making automated shear wave splitting measurements that may be put into operations under the agreement with one of the interested scientific groups outside ISC.

These procedures, new to the ISC, could be built on the experience gained by leading research groups in the US, UK, Germany, France and elsewhere.

A complete and standardised set of amplitude measurements and onset times of specific common phases would be a very useful service to the seismological community that would never be offered by

a national agency. It is an example of how the ISC can use its international position to provide real benefit to its users.

Manual waveform measurements independently taken off the waveforms by analysts from different institutions and collected by the ISC will for a long time remain a powerful benchmark for quality assessment of newly compiled sets of automatic readings. Yet it is important to start breaking stereotypes linked to the ISC and gradually try using waveform measurements where appropriate to improve the accuracy of the ISC Bulletin.

6. User-focused ISC on-line Bulletin and printed ISC Bulletin Summary

The on-line ISC Bulletin became available almost 10 years ago. Since that time the Printed ISC Bulletin has experienced a gradual decline serving rather as a visible landmark on the shelves of seismologists, a kind of a souvenir or a company brochure. Its existence has been partly warranted by the quarterly CD attached to its back cover. Yet the time has come to re-evaluate the purpose and requirements to both On-line and Published ISC bulletins.

The On-line ISC Bulletin should be re-focused to answer demands of various distinct groups of ISC data users and remain the most up-to-date comprehensive source of ISC data. The Printed ISC Bulletin will be an asset for the Centre if converted into a summary of the enclosed CD enhanced with some useful information about the ISC and its operations.

6.1 On-line ISC Bulletin

In its present form and format the ISC Bulletin is often too complex for some of its users and not informative enough for others. It is too difficult to satisfy all bulletin users with the same product. With this in mind it appears beneficial to set up several bulletin designs that all would be based on the contents of the ISC database. These bulletins would serve different user communities by being tailored to their needs:

- *Bulletin of event origins* that is primarily oriented to those interested in seismic hazard studies, prediction, seismotectonics. This bulletin should have emphasis placed on:
    - reporting parameters of seismic events
    - reliable estimates of uncertainties based on configuration of reporting network and types of available data
    - summary of recording network
    - simple event quality flag
    - magnitude estimate summary with assessment of quality
    - seismic moment, moment tensor solution
    - felt and damage information
    - available finite source rupture models
- *Bulletin of station arrivals* that is primarily oriented to those interested in Earth structure studies as well as those looking for initial assessment of data available. This bulletin should concentrate on full representation of seismic arrival data, exhibiting in addition to standard parameters:
    - picking accuracy
    - operator and ISC phase interpretation
    - type of instrument
    - channel
    - author and reporter

    - availability of on-line waveform data
- *Bulletin of events studied in scientific literature*. Perhaps to start with, scientific journal publishers can be asked to include a link in their on-line versions of the papers to the ISC Bulletin or events in each paper.
- *Bulletin for general public*, and/or schools that includes less data but more graphic material explaining uncertainties of values reported in seismic bulletins.

6.2 Printed ISC Bulletin Summary

In its present form the ISC Printed Bulletin is only useful to serve as a visual reminder of the vast ISC data collection. It is hardly ever used for research. Instead it could be converted to a very useful summary of the data stored on a CD attached to its back cover. This ISC Bulletin Summary may include the following graphs, statistics and information:

- ISC status and purpose
- history page
- supporters and logos
- data contributors
- ISC staff and Executive Committee
- overview of the ISC procedures
- typical examples of information in the bulletin
- regional seismicity maps with indication of location uncertainty
- station maps
- regional magnitude frequency graphs with estimates of completeness
- summary of seismic phases reported
- summary of magnitude estimates
- previously unreported events and events of special interest
- brief comparisons with the products of other major data centres

This product would be useful to both seismologists wishing to see the changing contents of the enclosed CD as well as to the ISC staff as a brochure to be used in search for new members. It is expected that the cost of production and posting of the Bulletin Summary will be smaller compared to the current expense of printing the ISC Bulletin.

7. Re-establishing the unique role of the ISC among seismic networks and data centres by becoming a readily available source of useful information and timely feedback

It is important for the ISC to reassert its unique central position with respect to seismic networks around the world. We need to promote an image of the ISC as being a contemporary data centre close to the front line, using modern analysis procedures and delivering accurate data timely and efficiently. With this in mind the ISC could offer its services in cooperation with other international institutions:

- Preparing and updating a structured web-based **book of seismic networks** and temporary deployments, where each network would be in a position to maintain its visibility and report essential information on the current and former state of the network, analysis procedures, staff, temporary problems, development plans.
- Re-designing the ISC **station book** to include maps and summary of parametric data availability in the ISC database. Analysis of parameter data reported by each station can be made.

- Establishing under CoSOI/IASPEI and running jointly with NEIC a new **International Seismic Network and Station Registry**. This Registry should allow the ISC to credit network owners and operators as well as parametric data authors and reporters. It will also allow the ISC to deal efficiently with widespread cases where duplicating parametric data based on the same freely available waveforms reported to the ISC by various data providers.
- Setting, jointly with COSOI/IASPEI, a web-based **help desk** that gives access to all necessary documentation that guides through processing and reporting of parametric seismic data. In particular, hosting the Manual of Seismological Observatory Practice (**MSOP**) would allow the ISC to contribute towards educational programmes in seismology.
- Offering selections from the ISC Bulletin to well-established agencies for review.
- Offering a timely feedback to data contributors on the area of their interest.