The Impact of Digital Data on Seismic Bulletins

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poster

Internationally funded to publish a definitive global seismicity bulletin, the ISC has avoided changes that might alter the fundamental content of the Bulletin. This conservative approach has been mandated by the need for hypocentres, magnitudes and other earthquake parameters that are as uniform as possible. It is now possible, however, to compute new locations and magnitudes for the ISC's entire Bulletin back to 1964 and to provide data more flexibly, for example giving users residuals with respect to their own choice of location or earth model. Thus, the ISC could now change models or procedures occasionally as required to best serve seismologists, and compute new parameters of past events according to the updated practices. But seismologists are changing their practices to take better advantage of broadband digital data in studying earthquake physics, earth structure, explosion monitoring, seismic hazards and seismotectonics. To serve all these needs, even more fundamental changes in the Bulletin may be required. Within the next few years, the ISC plans to begin experimental measurement and publication of waveform measurements and earthquake parameters that are not now routinely catalogued. Possible measurements include automated later phase picks, surface wave dispersion, and spectral measurements. Possible earthquake paramters include source time function parameters, waveform-based depths, and relative locations from waveform-based relative arrival times. We welcome input from the community on the parameters and algorithms that are most likely to prove useful and reliable.

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Abstract

Broad-band, high dynamic range instruments have changed seismology.

How can bulletins help seismologists get more from new instrumentation?

Part of the answer has been available for twenty years: the Harvard CMT catalogue shows that earthquake parameters other than those from high-freqeuncy onset picks can be usefully catalogued

Part of the answer has been available for many years: the Harvard CMT catalogue shows that earthquake parameters other than those from high-freqeuncy onsets can be usefully cataloged.

Other moment tensors are now computed routinely, *e.g.*, by NEIC using Sipkin's method and by ERI using Kawakatsu's algorithm.

NEIS has added other broad-band measurements to its global bulletin. Choy's energy release, *e.g.*, is now available in sufficient numbers for statistical comparison of different tectonic settings.

Hypocentre Locations

One seismological issue to be addressed is earthquake locations. Continuity is important, but several factors suggest that it is now time to implement changes:

- Well-known inaccuracies in J.-B. tables
- Capability to re-compute *all* locations
- Engdahl *et al.* demonstration
- GSETT-3 outcome

Important considerations in changing location procedures include

- Will scatter be increased from including more marginal locations?
- Will later phase mis-identifications adversely effect solutions?
- Will new, unknown biases be introduced in locations?
- Should ISC use regional models? A 3-dimensional model? Empirical corrections?

Setting Priorities

The Bulletin has been useful to a wide range of seismologists, and efforts are sometimes expended to improve utility for one purpose with little effect on the others. In changes during the next several years, should priority be placed on

- Earthquake physics?
- Earthquake hazard?
- Earth structure?
- Seismotectonics?

Earthquake Physics

Should ISC compute further earthquake parameters? Possibilities include:

- source duration or rupture area
- simplified source time functions
- higher-order moment tensors

Earthquake Hazard

Should the ISC engage in an ongoing effort to carry forward the intentions of GSHAP?

- Continuously improve the global historical seismicity catalogue.
- Conduct ongoing refinement of a set of globally-defined source structures.
- Regularly re-compute hazard based on more complete historical catalogues, refined source regions, and the most recent seismicity.

Earth Structure Studies

Should ISC make waveform measurements specifically for improving earth structure? Such measurements might include

- later phase picks for arrival time tomography
- shear wave splitting for anisotropy
- Jordan's generalised ScS arrivals
- free oscillation spectra
- surface wave dispersion

Earthquake Sequence Procedures

Should ISC carry out special procedures for selected earthquake sequences?

- Cross-correlation based relative arrival times, for relative locations
- Inter-station spectral ratios, for t* and, ultimately, attenuation.

Waveform Measurements

Should ISC make waveform measurements (or encourage station operators to undertake new standardised measurements) that seem potentially useful for many purposes, *e.g.*,

- *Signal-to-noise ratio*: useful as a quality-indicator for other measurements
- *Waveform envelopes*: might effectively combine information about scattering and source duration
- *Amplitude spectra*: either spline fits or by use of physically meaningful parameters
- *Inter-phase spectral ratios*: to help distinguish different types of sources

Conclusion

Seismology is being done in new ways. Some new work requires inversion from waveforms. But even some of the most advanced work can be formulated as a measurement, followed by inversion for source parameters from the measurements.

Advances using measurments can be applied sooner and more widely if new standard measures are adopted and shared by seismologists. That is, fundamental changes in the content of the Bulletin will benefit seismology.

The ISC intends to pursue these advances by seeking

- input from the seismological community, in part through a series of small workshops.
- results from special studies for its database, where authors will allow free distribution.
- funding for trial projects to compute new parameters.

In the real world, the ISC cannot implement everything that it might do all at once. Vote here for your favourite idea of what the ISC should do if it had the use of one extra person for one year:	
A) Integrate readings from PASSCAL experiments and other temporary deployments with ISC data.	–
B) Add aftershock catalogues and other relative location studies into ISC products.	–
C) Integrate historical seismicity catalogues and macroseismic information into a global database.	–
D) Develop a program to retrieve waveform segments for automated picks of later phases.	–

E) Start computing higher-order moment tensors and other experimental source parameters.	–
F) Make a "really cool" web site with virtual-reality for viewing 3-D, time-dependent seismicity.	–