ISC-GEM: Global Instrumental Earthquake Catalogue (1900-2009)
I. Location and Seismicity Patterns

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Objectives
One of the global components of the Global Earthquake Model Foundation (GEM) effort is to compile a
Reference Global Instrumental Seismic Catalogue (1900-2009) to be used by GEM for the characterization of
different spatial distribution of seismicity, the magnitude-frequency relation and the maximum magnitudes;
• Collect and digitize arrival and amplitude data from various data sources for the period 1900-1960;
• Relocate instrumentally recorded moderate to large earthquakes spanning 110 years of seismicity;
• Calculate body and surface wave magnitudes from original amplitude-period observations;
• Provide direct/indirect Mw estimates based on either seismic moment measurements, or empirical Ms-Mw or
ms-Mw relations;
• Provide uncertainties for each estimated parameter.

Data used for relocation

Event selection
• 1900-1917: Ms ≥ 5.5 and some smaller shallow events in stable continental areas;
• 1918-1959: Ms ≥ 6.0;
• 1960-2009: Ms ≥ 5.5

Phase arrival time data
• Manually added ~675,000 arrival picks to the ISC database;
• 1904-1970: Original station bulletins from the ISC archive (~270,000 picks);
• 1904-1957: Gutenberg noretaps and ISS bulletin (~1,000 picks);
• 1913-1917: BAAS, predecessor of ISS (~5,800 picks);
• 1918-1959: ISS bulletin, predecessor of ISC (400,000 picks);
• Digitally available;
• 1918-1942: Shannon tapes, partially digitized ISS bulletin (~230,000 picks);
• 1923-1970: JMA historical bulletin (~270,000 picks);
• 1960-2009: ISS and ISC bulletin (330,000 + 11,000 picks from the ISC database)

The distribution of the distances between the hypocenters estimated by the EHB and ISC methodologies show remarkable
consistency. The median distance between the EHB and ISC solutions is 9 km, and
90% of the locations are within 20 km of each other. The deviations between EHB and ISC locations show no bias.

 ISC-GEM Catalogue
Global map of preferred solutions (a mixture of hypocenters from the ISC, ISS, Centennial catalogues) before and
after (right) the ISC-GEM relocations. Owing to the substantial increase in the volume of observational data used in the
calculations, the ISC-GEM catalogue offers an improved view of the seismicity of the Earth with significantly better depth estimates and considerably reduced scatter in
location estimates.

Map view and cross-sectional view, and after the ISC-GEM relocation of the area. Note that the apparent deep outlier in
the Tonga cross section is an event from 1986 with well-determined depth confirmed by long-period depth phases.

Summary
• The ISC-GEM main catalogue consists of 18,872 events with ~13 million associated phases.
• All events (except for 10 events between 1900-1901) are relocated.
• ms-Mw magnitudes are calculated from original amplitude-period measurements
• Each event is characterized by a direct/indirect estimate of Mw
• The ISC-GEM catalogue consists of 900 events with ~260,000 associated phases
• Events with less reliable hypocenters
• Events for which no Mw or proxy Mw can be accurately calculated due to lack of data