Geophysical Research Abstracts, Vol. 7, 04858, 2005
SRef-ID: 1607-7962/gra/EGU05-A-04858

Relations between different kinds of magnitude measurements

P. Bormann (1), **D. Kaiser** (2), R. Gutdeutsch (3), Liu Ruifeng (4)

(1) formerly GeoForschungsZentrum Potsdam, Kleinmachnow, Germany, (2) Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover, Germany, (3) Institute of Meteorology and Geophysics, University of Vienna, Austria, (4) Institute of Geophysics, China Earthquake Administration, Beijing, China. (d.kaiser@bgr.de)

IASPEI established in 2001 an international WG in charge of proposing standards for magnitude measurements based on digital data and procedures that are in tune with original definitions of body and surface wave magnitudes, thus ensuring long-term continuity and compatibility of magnitude data in international catalogues. As part of this endeavour the authors have analysed tens of thousands of magnitude data determined by the Data Center of the National China Seismic Network in Beijing based on standardised procedures applied by well-trained personnel. All amplitude and period measurements for magnitude calculations are based on recordings of standard classes of instruments as proposed by Willmore (1979) in the Manual of Seismological Observatory Practice: class A4 for short-period 1-Hz seismometer recordings (which are more broadband towards higher frequencies than the WWSSN-SP); class C for medium-period recordings (flat displacement response between about 10 Hz and 10 s; corresponding to original Kirnos instruments) and class B1, corresponding to WWSSN long-period instruments. Before 2002, the readings have been made on analogue recordings and since January 1, 2002 on digital broadband data filtered according to these classical standard responses. Notable is that body-wave magnitudes are routinely calculated at the Beijing Data Center both from short-period recordings within 5 seconds after the P-wave onset and from medium-period BB recordings measuring the amplitude maximum within the whole P-wave train. Only this is in accordance with Gutenberg´s original definition for body-wave magnitudes mB, not, however, the later introduced practices at the WWSSN/NEIC and the CTBTO/IDC for short-period body-wave magnitudes mb.

We present and discuss the relationships between the various Chinese magnitudes (mb, mB, Ml, Ms and Ms7) first. Then we investigate their correlation with the standard magnitudes mb and Ms as determined at NEIC. In order to compare the relationship between different sets of magnitude data pairs, both being afflicted with errors, we use the orthogonal regression instead of the usually applied simple regression which is based on the assumption that only the dependent (ordinate) variable is afflicted with errors. The difference is illustrated by presenting for each data set both the respective single parameter and the orthogonal regressions. Yet, the latter is based on the assumption that both variables are afflicted with quantitatively the same errors. This assumption is reasonable when comparing magnitude data of the same kind, however, short-period magnitudes usually have larger scatter than long-period ones. In these cases the use of the χ^2 regression should be preferred, although the required exact quantification of errors of both variables is difficult. We show, however, that the χ^2 and orthogonal regression yield the same linear regression parameters, if the errors of the two variables are constant and the same. In the case of large correlation coefficients (> 0.85) the deviations between the two types of regression lines can be neglected ($<$ 0.1 magnitude units in the whole magnitude range), even under the extreme assumption that the errors of the two variables differ by a factor of two.

Main conclusions are:

- While Ms-mb relations show strong saturation for mb > 6 the relationship Ms-mB is practically linear up to magnitudes around 8 (orthogonal regression equation: 0.816 mB – 0.578 Ms = 1.486). Therefore, reintroduction of broadband mB into international routine practice is strongly recommended.
- Ms determinations have the least scatter and regional network Ms (such as China Ms7) agrees in the average excellent with global (NEIC) Ms (orthogonal regression equation: 0.682 Ms(NEIC) – 0.732 Ms7 = – 0.280).
- While linear regressions are suitable when comparing magnitude data of the same kind or those determined within the same frequency range, non-linear regressions are required when comparing short-period and long-period magnitude data (saturation effect).
- Orthogonal regression is well suited for comparing most kinds of different magnitude data. If, however, reliable quantitative error estimates of magnitude data are available and reveal significant differences ($>$50%), χ^2 regression is preferable.
- In the case of magnitude saturation (which is common when comparing short-period with long-period magnitude data) non-linear regression is required. It is

suitable, however, only for estimating the saturating magnitude from the non-saturating one while the latter can not be estimated properly in the saturation range of the other.