

**The relationship between  $M_w$  and other magnitude scales for earthquakes of the North Caucasus****Anastasia S. Zvereva<sup>1</sup>**, Anna A. Skorkina<sup>2</sup><sup>1</sup> Geophysical Service of the Russian Academy of Sciences<sup>2</sup> Institute of Earthquake Prediction Theory and Mathematical Geophysics, Russian Academy of Sciences[zvereva.as59@gmail.com](mailto:zvereva.as59@gmail.com)

The study of earthquake source spectra helps to better understand the physics of an earthquake source, and important for different engineering seismology problems. Particularly, using source spectrum one can determine seismic moment and moment magnitude which are crucial parameters for seismic hazard studies. The source spectra of 127 earthquakes in the North Caucasus for the period 2008–2021, with  $h=1-85$  km, were calculated, using the Brune source model [1]. Data processing was realized in the SEISAN program [2]. The processing procedure involves calculating the S-wave displacements spectrum, correction for attenuation in the crust and upper mantle and geometric spreading. The seismic moment  $M_0$  was determined from records of earthquakes from hypocentral distances of 50–250 km and with SNR more than 2. The data of individual estimates of different type of magnitude accumulated by present time allowed for a detailed study of intermagnitude relationships in the North Caucasus region. We compared the magnitude  $M$ , obtained by recalculation from Rautian energy class KP, with other magnitude scales  $M^*$ : mbISC – teleseismic magnitudes based on body P-wave, calculated at the International Seismological Center [3],  $M_w^{SS}$  – spectral moment magnitude and local magnitude  $M_L$ . Assuming a linear relationship between magnitudes, regression analysis was performed, using linear and orthogonal regressions. For the relationship between  $M$  and  $M_w$  is obtained the minimum RMS for all analyzed events, and a linear dependence with a slope close to one (0.88 and 0.95 were obtained by linear and orthogonal regression, respectively). The relationship between  $M$  and the regional scale of local magnitudes  $M_L$ , as well as  $M_w$ , show smaller RMS values and also represents a linear trend with a slope close to 1. The difference in estimates of individual seismic station estimates of local and moment magnitudes shows that  $M_w$  estimates are more stable than  $M_L$ . On the other hand,  $M_L$  estimates is easier to obtain, especially for small earthquakes ( $M_L=1.5$  and  $M_L=0.5-1.0$  for some areas), while the  $M_w$  for the North Caucasus for a given seismic network configuration can now be determined as  $M=2.9$ . Also, for moderate and small earthquakes of the North Caucasus, relationships between  $M_w$  and  $M_L$  magnitudes have been established as  $M_w=M_L+0.02$  in the magnitude range  $M_w=3.0-4.5$ . We also got a comparable general linear relationship between  $M_w$  and mbISC. However, the RMS for the resulting relationship is noticeably higher than for  $M_L$  and  $M_w$ , therefore, individual mbISC estimates should be used carefully. The scaling of focal spectra of 44 earthquakes in the North Caucasus has been studied, which is an important practical result, since it allows us to estimate the probabilistic range of strong ground motions for the study area, which is one of the basic characteristics are using to seismic hazard assessment. Based on the above, in the magnitude range of 1.5–4, we can recommend the local magnitude  $M_L$  as a “quasi  $M_w$ ” magnitude for earthquakes in the North Caucasus, which correlate with  $M_w$  as  $M_L=M_w-0.02$  in the magnitude range  $M_w=3.0-4.5$ .

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**References**

1. Brune J. N. Tectonic stress and the spectra of seismic shear waves from earthquakes. Journal of geophysical research, (1970). 75(26), 4997–5009. DOI: 10.1029/JB075i026p04997
2. Havskov J., Voss P., Ottemoller L. Seismological observatory software: 30 Yr of SEISAN // Seismological Research Letters. (2020). Vol. 91(3). No. 1. pp. 846–1852.

3. International Seismological Centre. On-line Bulletin. <https://doi.org/10.31905/D808B830>