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The relationship between M_w and other magnitude scales for earthquakes of the North Caucasus

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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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