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# Modal excess attenuation of radial modes caused by the non-sphericity of the Earth's radial free oscillation

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The radial free oscillation of the Earth for a spherically symmetric Earth model has pure radial motion with the same amount of radial displacement at the surface. Rosat et al. 2006 first detected the non-sphericity of the gravest radial mode 0S0 from the analysis of superconducting gravimeters and concluded that the non-sphericity can be used to further constrain the laterally heterogeneous structure of the deep Earth. Non-sphericity is also supported through the detection of the horizontal components of the radial mode after the 2004 great Sumatra earthquake recorded by global broadband seismic networks. The non-sphercity of the 0S0 mode is originated by the non-spherical nature of the Earth including its elliptic figure and rotation and lateral heterogeneity inside. The modified or perturbed 0S0 eigenmode has a slight shifted eigenfrequency and non-spherical symmetric eigenfunction. The modified eigenfunction and eigenfrequency are computed correctly if the non-sphericity is given. By adopting a 3D mantle shear velocity heterogeneity model SH12WM13 and scaled density and P wave velocity anomalies, the 0S0 eigenfunction is expressed as a weighted sum of eigenfunctions of a spherically symmetric Earth. The modified 0S0 mode is composed of 73% of 0S0 and 13% of 0S5, 8% of 1S2, 4% of 1S3 of a spherical Earth model. The mode 0S0 of a spherical Earth model is nearly insensitive to the shear attenuation and only sensitive to the bulk attenuation. The modified 0S0 mode becomes sensitive to the shear attenuation through its non spherical motion, therefore the theoretical decay rate of the modified 0S0 modal amplitude increases by introducing non-sphericity of the Earth. Because the 0S0 mode has an extremely large Q, this change of the decay rate of 0S0 mode might be larger than the error of Q observation and the current Q estimates of 0S0 mode might be biased.