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Teaching Mathematical Modelling for Earth Sciences via Case Studies

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Mathematical modelling is becoming crucially important for earth sciences because the modelling of complex systems such as geological, geophysical and environmental processes requires mathematical analysis, numerical methods and computer programming. However, a substantial fraction of earth science undergraduates and graduates may not have sufficient skills in mathematical modelling, which is due to either limited mathematical training or lack of appropriate mathematical textbooks for self-study. In this paper, we described a detailed case-study-based approach for teaching mathematical modelling. We illustrate how essential mathematical skills can be developed for students with limited training in secondary mathematics so that they are confident in dealing with real-world mathematical modelling at university level. We have chosen various topics such as Airy isostasy, greenhouse effect, sedimentation and Stokes' flow,free-air and Bouguer gravity, Brownian motion, rain-drop dynamics, impact cratering, heat conduction and cooling of the lithosphere as case studies; and we use these step-by-step case studies to teach exponentials, logarithms, spherical geometry, basic calculus, complex numbers, Fourier transforms, ordinary differential equations, vectors and matrix algebra, partial differential equations, geostatistics and basic numeric methods. Implications for teaching university mathematics for earth scientists for tomorrow's classroom will also be discussed.

Refereces

1) D. L. Turcotte and G. Schubert, Geodynamics, 2nd Edition, Cambridge University Press, (2002).
2) X. S. Yang, Introductory Mathematics for Earth Scientists, Dunedin Academic Press, (2009).