Development of an anelastic convection model in rotating spherical shells for stars, gas and icy giant planets.

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The problem of convection in rotating spherical shells has been studied vigorously as a fundamental model of global convection presumably emerging in celestial bodies, such as stars, gas and icy giant planets, and terrestrial planetary interiors. Recently, according to development of numerical computational abilities, fundamental aspects and characteristics of convection has been revealed and knowledge about this issue is increased under the assumption of Boussinesq approximation, which ignores compressibility of the fluid. However, compressible convection in rotating spherical shells has not yet understood compared with Boussinesq convection, although some studies performed so far use the anelastic approximation in order to deal with compressibility. Compressibility is an important element for discussing deep convection of stars and gas and icy planets, since thickness of their convection layers is several times larger than the scale height. Not only for these celestial bodies but also for extra-solar gas giant planets, which have been so many discovered with recent sophisticated technologies of astronomical observation, compressibility could not be ignored for considering fluid motion in their interiors. Investigation into effects of compressibility on convection in rotating spherical shells is expected to contribute to the basic knowledge for considering fluid motions in the interiors of these many celestial bodies.

Based on the consideration described above, we are now developing a numerical model of an anelastic fluid in rotating spherical shells in order to assess effects of compressibility on convective motions. On the development of the model, we extended our numerical model of Boussinesq convection in rotating spherical shells accomplished so far to the anelastic system. Instead of velocity field in the case of Boussinesq fluid, we described mass flux with poloidal and toroidal potentials, which was able to extend our Boussinesq model constructed so far to the anelastic case in a natural way.

In the presentation, results of some numerical experiments using our newly developed model will be shown, and future planning is also discussed.