Analysis of the dynamical feature of diurnal cycle horizontal convection using linear theory

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The atmosphere of the earth is stably density-stratified fluid. Due to the difference in the thermal responses between the land and the sea, the differential heating causes horizontal convection across the coast line. The earth has diurnal and annual cycle horizontal convections in the atmosphere corresponding to the rotation and yearly round of the earth. From analysis of observational data, we found that the dynamical impedance of the annual cycle horizontal convection over the Japanese Islands is larger than that of annual cycle horizontal convection. Stommel and Veronis 1957 indicate that the annual convection is closer to static phenomenon than the diurnal convection.

The motion caused by inertia generally has higher dynamical impedance when the forcing with higher frequency is given. The results of this study, however, show that the diurnal convection, which is caused by higher frequency forcing, has lower dynamical impedance than that of the diurnal convection. This lower dynamical impedance of the diurnal convection can be understood by considering with resonance between the forcing and the adjustment process. The atmosphere of the earth has an inertial oscillation as a normal mode. For the area of the Japanese islands (about 35 degrees north latitude) the time cycle of the inertial oscillation is about 1 day. Because the time cycle of the forcing (solar radiation) is close to the time cycle of the adjustment process (inertial oscillation), the forcing resonates with the adjustment process and the dynamical impedance becomes low.

To examine the idea we calculate the dynamical impedance of horizontal convection using linear theory. This calculation shows that the dynamical impedance in diurnal cycle is lower than that of annual cycle.