Sufficient Condition for Realization of the Lorenz Chaos in Natural Convection Experiment

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Since the deterministic chaos was discovered by Lorenz (1963), the concept that the system continue to make transition around multiple unstable steady states spontaneously became a new perception pattern in various ground. It is very profitable to discover a simplified deterministic model where underlies apparently complicated phenomena. There are many signs that such a viewpoint gives understanding of various non-periodic oscillations in geophysical fluid. However, the simplified deterministic model is not always profitable as a approximation for actuality. There are artificial non-linear dynamical systems where are too simplified. The Lorenz Chaos as a model of the Benard Convection is just such a example. The root of the Lorenz's 3 dimensional model was a approximation of dynamics of one roll cell in the Benard Convection. In spite of that, the Lorenz Chaos has no appearance in real Benard Convection experiment, because one roll cell has no appearance from the beginning of real experiment. In order to make the Chaos view point profitable truly, it is necessary to find out sufficient condition that realize a low dimensional sub-system in infinite dimensional system, at least approximately.

In this study, as a laboratory experiment, the condition for which realizes the Lorenz Chaos is investigated. Purpose of this study is to find the sufficient condition where the simplified model becomes profitable for understanding of real thermal convection, comparing with theoretical consideration and numerical simulation. One of inevitable conditions is that this natural convection is closed through a whole loop. As the other important condition, it was found that the flow field becomes turbulent flow. Since the planetary scale geophysical fluid motion also a closed natural convection between two concentric spherical shells, knowledge from this laboratory experiment may link to understanding of global scale geophysical fluid.