Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Analysis of vortical structures in turbulent natural convection SANGRO PARK, CHANGHOON LEE, Yonsei University — Natural convection of fluid within two parallel walls, Rayleigh-Bénard convection, is studied by direct numerical simulation using a spectral method. The flow is in soft turbulence regime with Rayleigh number 10^6, 10^7, 10^8, Prandtl number 0.7 and aspect ratio 4. We investigate the relations between thermal plumes and vortical structures through manipulating the evolution equations of vorticity and velocity gradient tensor. According to simulation results, horizontal vorticity occurs near the wall and changes into vertical vorticity by vertical stretching of fluid element which is caused by vertical movement of the thermal plume. Additionally, eigenvalues, eigenvectors and invariants of velocity gradient tensor show the topologies of vortical structures, including how vortical structures are tilted or stretched. Difference of velocity gradient tensor between inside thermal plumes and background region is also investigated, and the result indicates that thermal plumes play an important role in changing the distribution of vortical structures. The results of this study are consistent with other researches which suggest that vertical vorticity is stronger in high Rayleigh number flows. Details will be presented in the meeting.

Sangro Park
Yonsei University

Date submitted: 31 Jul 2014 Electronic form version 1.4