Temperature and velocity fields in natural convection by PIV and LIF

Natural convection in a cubical cavity (L = 250 mm) filled with water is created by heating a square plate (0.5 L) centred in the bottom wall and by cooling the sidewalls, while the remaining walls are insulated. The Rayleigh number based on cavity side length and temperature difference between plate and cooled walls is $1.4 \times 10^{10}$. The flow is turbulent and is similar to some indoor room flows. Combined Particle Image Velocimetry (PIV) and Planar Light Induced Fluorescence (LIF) are used to measure local velocities and temperatures. Data measured in a symmetry plane parallel to a sidewall are presented in terms of mean velocities and temperature and in terms turbulent quantities including Reynolds fluxes. The flow consists a plume rising above the heated plate into an almost stagnant fluid with a weakly stratified temperature field, as well as thin buoyancy driven boundary layers down the sidewalls. The measured Reynolds fluxes show that the dominating heat transport is in the plume in vertical direction. This transport relates to hot parcels of fluid rising due to buoyancy. A considerable heat transport in horizontal direction from the plume to the surrounding, stagnant fluid maintains the stratified temperature field.

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