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Effect of Thermal Boundary Modulation in a Restricted Fluid Domain of a 3D Vertical Bridgman Apparatus

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Fluids heated from below provide non linear behaviour very rich and interesting in many scientific fields. The classic Rayleigh–Bénard problem offers a first approach to this complexity of flow evoluting from a conductive to convective regime and a first predictive way of coupling with solid/liquid transition. Stable dynamic solutions are of interest in practice because of their impact on the constitution control. For example, in electronic applications, growth involves convection dominating dopant segregation and influencing interface shape. 2D models are used for predictive investigation of directional solidification configurations based on thermal or solutal control, under full or low gravity conditions. Heating conditions varying with time interacts with flow characteristics and the unsteadiness thresholds, such situations are encountered for example for electronic component energized inducing unsteady generation of heat. The heat and mass transfer regarding the amplitude and the frequency of a given oscillation imposed to the hot wall exhibits a particular behaviour when compared to the configuration without modulation. Starting with the steady regime for a given low Rayleigh number, modulation can activate a resonant state for which it is possible to predict the next oscillatory state that the system can reach without modulation but only with increasing the intensity of the convection (higher Ra). In this paper we will investigated the effect of wall temperature modulation, for the 3D case, on the flow and heat transfer.

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