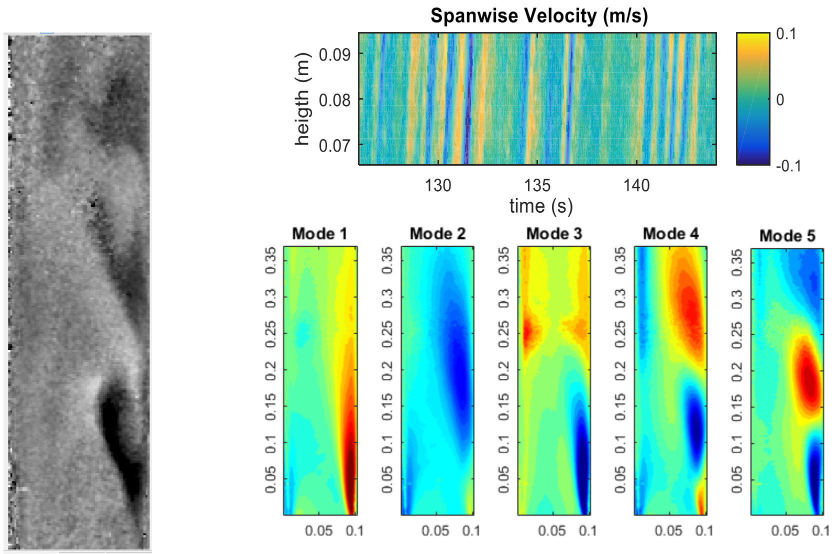
PHD thesis

Impact of radiation on convective instabilities in open cavity

This work focuses on the development of natural convection flows and the control of heat and mass transfers in semi-confined cavities. The geometrical configuration is a vertical channel (open domain at the bottom and the top) with homogeneous or inhomogeneous Neumann boundary conditions at the walls.

The intended application benefits relate to building integration and passive control of ventilated envelope components producing electricity and heat. Predicting the behavior and the impact of these components respectively on the building and on the close external environment (urban micro-climate), developing control strategies and optimized management of these envelopes with evolutive functions, require working at the scale of phenomena and in particular on the physical mechanisms driving the laminar / turbulent transition of the flow.
Physics of this problem in open geometry is complex since behaviour of the flow associated to heat /mass transfers are are on the one hand very sensitive to external environmental conditions and on the other hand are the seat of several coupled phenomena (convection, conduction, radiation). The experimental and numerical research developed within the CETHIL laboratory to date have been carried out under the assumption of transparent fluid medium.

The objective of the research work pursued within the framework of this phd thesis relies on the determination of the thresholds of appearance, nature, origin (kinematic, thermal) and intrinsic mechanisms of instabilities controlling the transition of the flow. In particular, the radiation / convection coupling will be implemented in the analysis tools by considering a participative fluid medium. The difficulties inherent to this type of analysis lies on the flow, heat/mass transfer models and the associate choice of base profiles according to the 1D / 2D / 3D instability modes studied. To deal these first steps, different experimental (Fig. 1) and numerical (DNS 2D, LES 3D) results produced in the field of a collaboration with LOCIE (USMB, France), UNSW (Australia) and the University of Sydney (Australia) will be considered.



(a) (b)

Fig 1 : Natural convection flow in a vertical channel. (a) Inlet instability. PIV Measurement. (b) Traveling waves and modal decomposition under acoustic forcing (f=0.44Hz) – Channel inlet.

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Modelling, CFD, stability of fluid flow, heat transfer, radiation

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