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On the Structured Convection

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Natural convection driven by heating patterns is known as structured convection. It gives rise to fascinating new physics. It has been determined so far that it can reduce pressure losses in conduits, intensify mixing, be used to extract energy from the flow (energy harvesting), give rise to thermal drift and nonlinear thermal streaming, can be used for propulsion, used for horizontal pumping (horizontal chimney effect), can be used to create streaks and rolls in shear layers, and can dominate local contamination transport. Patterns of thermal waves offer further exciting applications, from pumping in conduits to wind generation. Combining heating and topography patterns activates the pattern interaction effect, whose strength changes significantly with minor changes in both patterns' relative positions, similar to initial conditions in a chaotic system. The spatial parametric resonance drives such flows' stability, which can give rise to many flow structures, including solitons. Heating patterns frequently occur in nature, e.g., the surface topography (building pattern) and thermally relevant features of this topography, like color variations (color patterns of roofs, streets, and parks) in the urban environment (heat island effect). Similar conditions are encountered in rural environments where local circulation can be driven by different heating rates of forests and lakes and can be modified by terrain topography. Recent progress in the analysis of structured convection will be discussed.