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Unbalanced Exchange Flow and Its Implications for the Night Cooling of Buildings NICHOLAS WISE, GARY HUNT, University of Cambridge — The passive ventilation of buildings at night, when the outside air is cooler, is integral to many natural ventilation schemes, purging the building of heat accumulated during the day. These schemes often use displacement flow, where warmer air exhausts through a high-level opening and cooler air enters through a low-level opening. In order to design a natural ventilation system, it is necessary to be able to predict flow rates and the time to complete a purge. Current models assume that displacement flow is maintained throughout the purge, however we show that this is not possible. Instead, we show that the flow must transition to an unbalanced exchange flow at a critical flow rate, below which there will be both warm outflow and cool inflow simultaneously through the high-level opening, but still cool inflow through the low-level opening. The redistribution of buoyancy this causes in the room changes the predicted flow rates and time to complete a purge. We develop and present a theoretical model that captures this behaviour and predicts the unbalanced exchange flow rates and resulting purge times.

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