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Convection, thermal stratification and the energy penalty of localised heating with and without thermal mass ANDREA KUESTERS, ANDREW W. WOODS, BP Institute, University of Cambridge — When a large enclosed space is heated from a point source, the space becomes vertically stratified in temperature. We develop a model for this stratification in the case of constant mixing ventilation, in which there is high level supply and extract of air, testing our model predictions with some new laboratory experiments. We demonstrate that with large ventilation flow or a small heat flux a strong two layer stratification develops in the space, whereas with low ventilation flux or large heat supply the stratification is weak. We explore how thermal mass affects this stratification and generalise the results to allow for a combination of a space with a distributed and a point source of heating. One important consequence of the stratification is that in order to achieve comfortable temperatures in the occupied zone near the floor of the space, temperatures become elevated higher in the space; with mixing ventilation this increases the heat loss associated with the ventilation in comparison to that in a well-mixed space, in which the temperature is maintained at the comfort temperature throughout. Using our model, we compare the cost of such stratification in terms of elevated heating load, accounting for the role of the thermal mass in controlling the strength of the stratification.

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