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Applications of high-resolution schemes based on normalized variable formulation for 3D indoor airflow simulations

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SUMMARY
Computational fluid dynamics (CFD) has been used in a routine manner for the design of indoor environments. The quality of these CFD studies varies from poor to excellent, and only in year 2003 Sørensen and Nielsen recommend a detailed guideline on imposing quality control in the CFD-related works for indoor airflow simulations. One of these recommendations is to use monotone high-resolution (HR) schemes that apply flux limiters to ensure solution boundedness while preserving the high-order accuracy of the differencing schemes. In this paper, based on the _-formulations derived from the normalized variable formulation, four recently developed HR schemes, GAMMA, CUBISTA, AVLSMART and HOAB, are applied to several indoor airflow problems such as (1) Smith–Hutton problem (dead-end channel); (2) forced convection problem (horizontal/oblique inflow) in a parallelepiped room; (3) mixing ventilation problem focusing on the prediction of local mean age of air; (4) flow in a two-room chamber with internal partition and (5) displacement ventilation in a mockup office. Based on the flow results, the aspects
of accuracy and robustness of these HR schemes are addressed for appropriate selection of an 'ideal' differencing scheme to improve the quality of 3D indoor CFD calculations

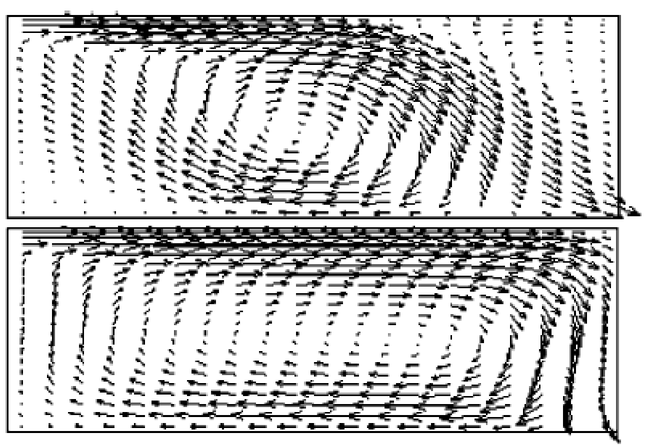

Figure 7. Comparison of the airflow patterns for the horizontal inflow forced convection problem using GAMMA scheme on M2. Top: zero-equation turbulence model and bottom: RNG k–ε turbulence model.

Figure 7 (top) shows the flow pattern predicted by the zero-equation turbulence model using the GAMMA scheme on M2 mesh. As seen, there are two recirculating regions being represented in the upper-right and lower-left corners of the room. As expected, the upper-right recirculation region is visually larger than that predicted by Chen and Xu using the UD scheme. By employing the RNG *k*–epsilon turbulence model (see Figure 7 bottom), however, both the secondary recirculations are not seen. This is consistent with the conclusion deduced from Chen and Xu in their calculation using the standard *k*–epsilon turbulence model.