Impact of zoning strategies for building performance simulation

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Abstract. Building performance simulation (BPS) can provide detailed information on the thermal behaviour of buildings. Zoning is a key step in input data preparation for BPS. A simulation zone is typically composed of one or more rooms. Large spaces, such as open office spaces, may have multiple zones. Simulation zoning can be distinguished from HVAC zoning, which is a property of the HVAC system. An appropriate simulation zoning may depend on the simulation problem, and results from a trade-off between accuracy and simplicity. In current simulation practice, zoning is usually carried out based on the user's experience. This does not ensure consistency across modelled buildings and practitioners. This paper demonstrates how systematic bottom-up strategies can be applied to aggregate rooms into simulation zones. The impact of such strategies is investigated by applying them to several floors of residential buildings. Building performance simulation is carried out with either conceptual or detailed HVAC modeling. In the second case, variations in both simulation zoning and HVAC zoning are investigated. Simulation results are compared to those obtained with detailed one-zone-per-room models, to assess the deviations due to simulation zoning. A coarser simulation zoning is shown to cause significant deviations in certain cases. A fine simulation zoning may allow control inefficiencies due to coarse HVAC zoning to be quantified.

1. Introduction

Building performance simulation (BPS) can provide quantitative information on the processes that determine the energy consumption of buildings, notably in terms of heating, ventilation and air-conditioning (HVAC). The zone is a core concept in current BPS tools, and a central entity in their input models. Simulation zones determine the spatial discretization of the building model. Heat and mass balance is calculated for each zone. It is assumed that the air in a zone is perfectly mixed. As a consequence, heat transfer and storage surfaces, internal gains and air exchange rates are defined at the zone level (US DOE 2010). Outputs of simulated internal conditions also refer to zones. Geometrically, a zone is enclosed by a set of flat polygonal surfaces. One-dimensional heat conduction is calculated between the zone-facing side and the other side of these surfaces (Crawley et al. 2001). This other side may correspond to another zone, outdoor or ground conditions. Alternatively, it is sometimes assumed that there is no heat transfer across a boundary (adiabatic boundary), which allows the model to be simplified.

This papers deals with the impact of zoning strategies on BPS with either conceptual or detailed HVAC modeling. Zones, like rooms, are special cases of spaces. A space can be defined as a materially or theoretically bounded volume accommodating certain functions (Ekholm & Fridqvist, 2000). A room is a space which is typically enclosed by walls, floors, and ceilings. In the thermal domain, a zone is an aggregation of rooms related to a given purpose. We distinguish zones used in simulation from the zones defined in the context of HVAC systems. In the following, we refer to the former as simulation zones and to the latter as HVAC zones.

An HVAC zone, like a simulation zone, usually corresponds to a room or collection of rooms with common thermal characteristics, but it is defined in the context of HVAC design and operation, independently from simulation. ASHRAE (2013) defines an HVAC zone as a "space