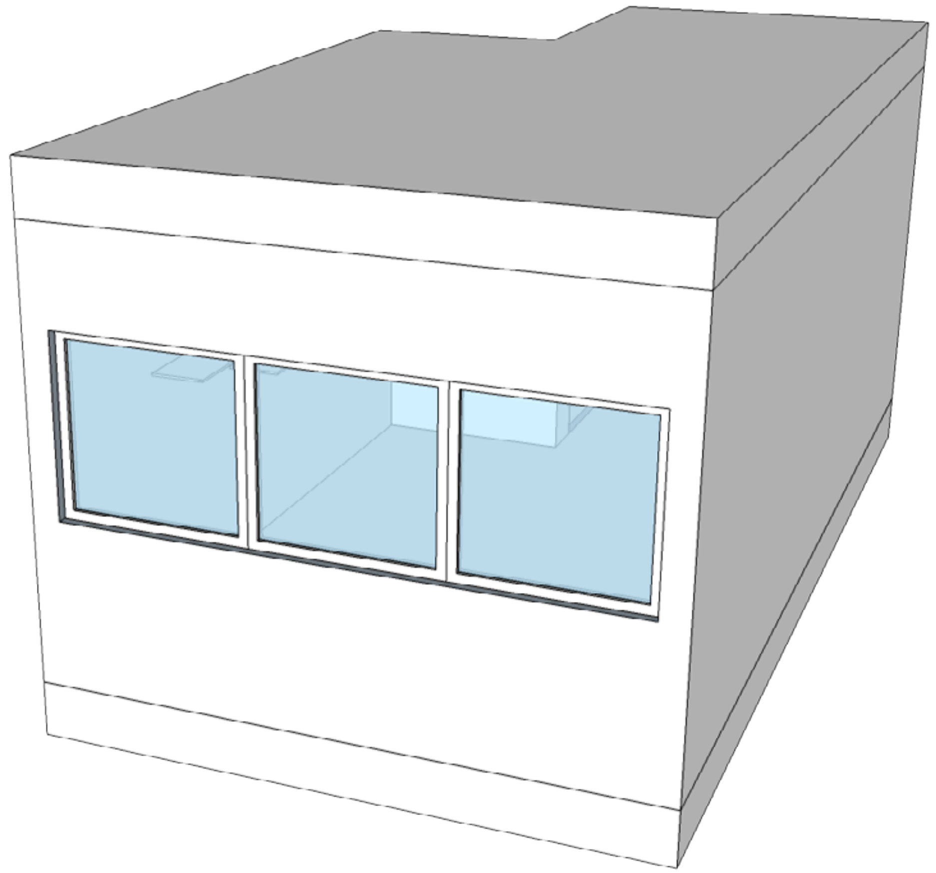
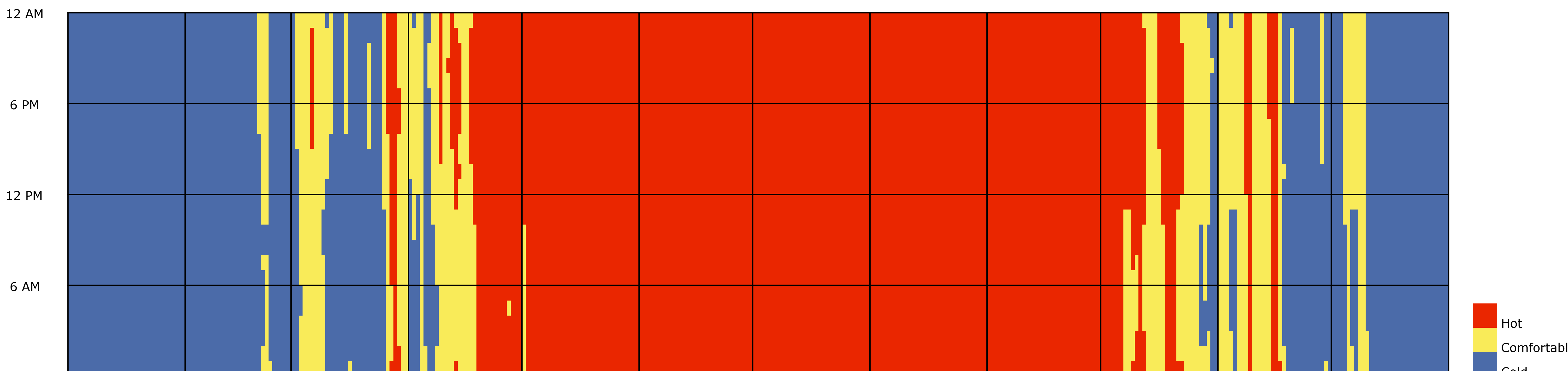


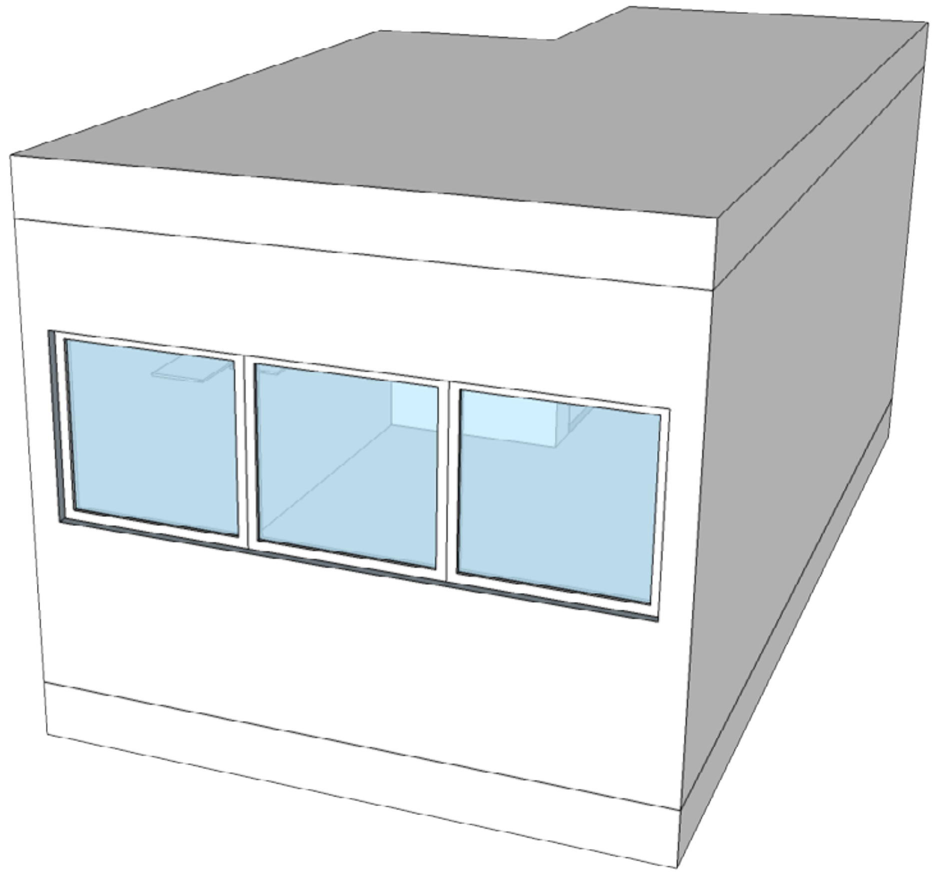
Base Case

The base case model contains one exterior wall with three windows and the rest are interior walls, floor, and ceiling that are adiabatic. The program of the room is residential, and hence a mid-rise apartment program will be used to simulate the internal loads of the building. Due to the adiabatic nature of the room, it can be estimated that the room will have trouble cooling off during the summer season.

The energy simulation of the base case (without conditioning) shows that the room indeed has a hot stress issue between mid-April to mid-October throughout entire days. There are patches of comfortable days in the months of March, April, October, November, and December, but otherwise the room is too cold between mid-November to March. The results indicate that the base case room is comfortable for 15.7% of the time, with 51.8% of the time being too hot, and 32.5% of the time being too cold.



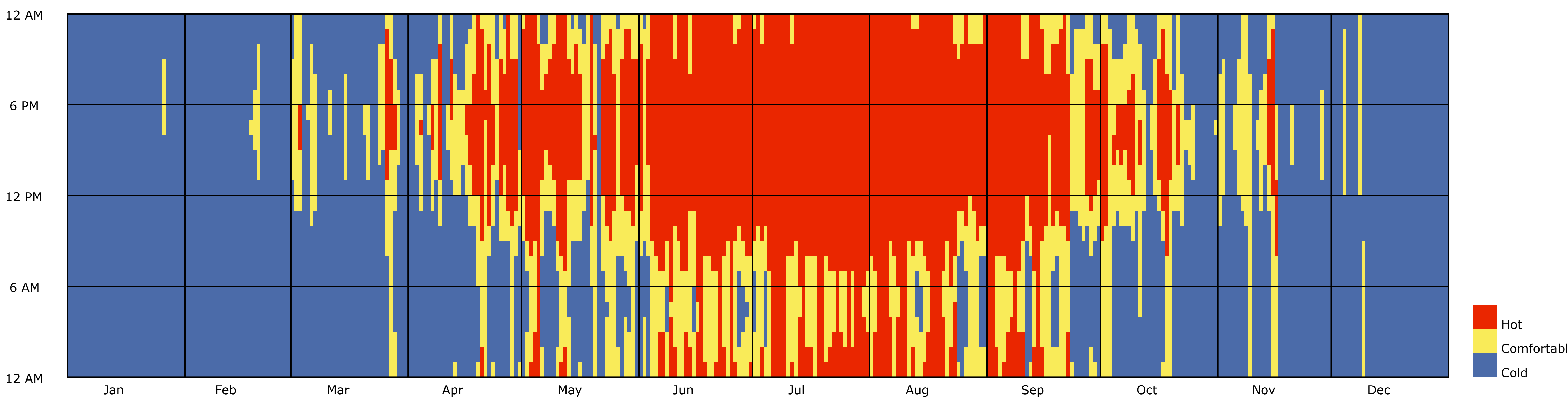
Adaptive Comfort for SANSOM_ROOM



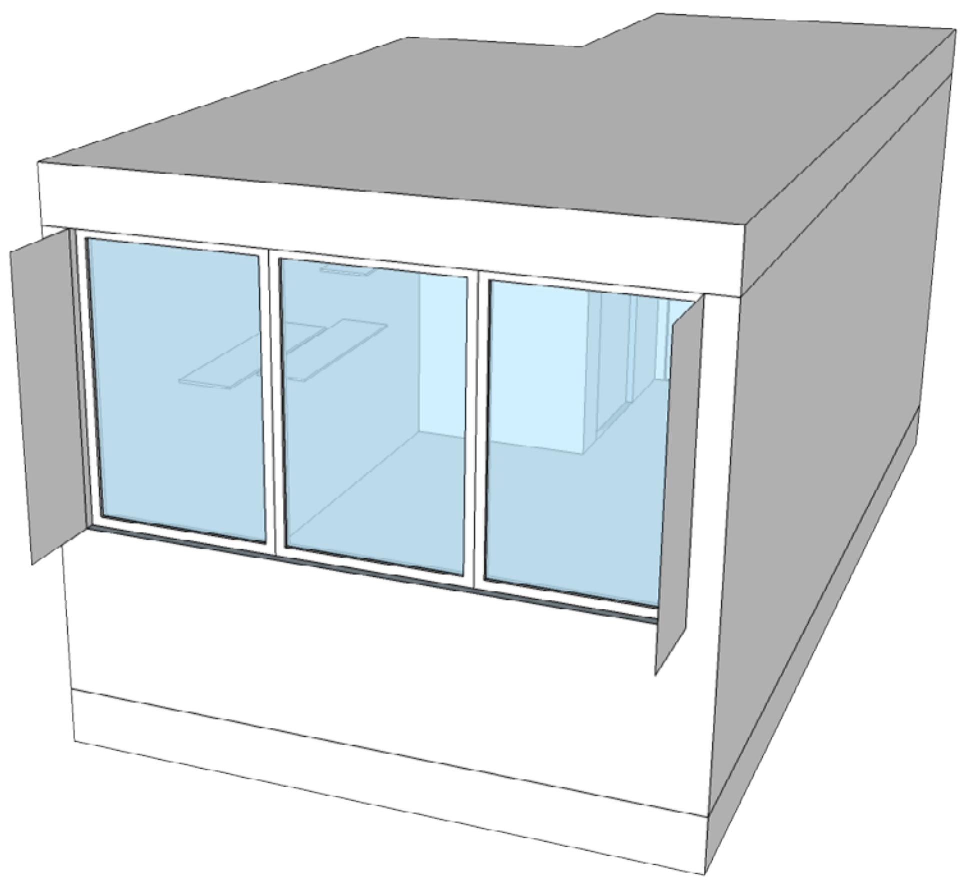
Base Case - no adiabatic

Considering that the main issue of over 50% hot stress is coming from the fact that the room has mostly adiabatic walls, with no way for the internal heat gain to leave the room, a simulation is performed on the base case without adiabatic walls to see how the room performs without adiabatic walls. This ignores the context of the room being in a dormitory building.

As seen in the adaptive comfort simulation results, if the room is located completely externally without adiabatic walls, its internal comfort environment would resemble that of the outdoors of Philadelphia. There would be heat stress mostly in the afternoon and evening between mid-April to mid-October. There are comfortable hours scattered before and after these hot hours in those months. For the rest of the time the room will be too cold. For this room without adiabatic walls, the time the room is comfortable has increased to 19%, with 29.8% of the time being too hot, and 51.2% of the time being too cold.



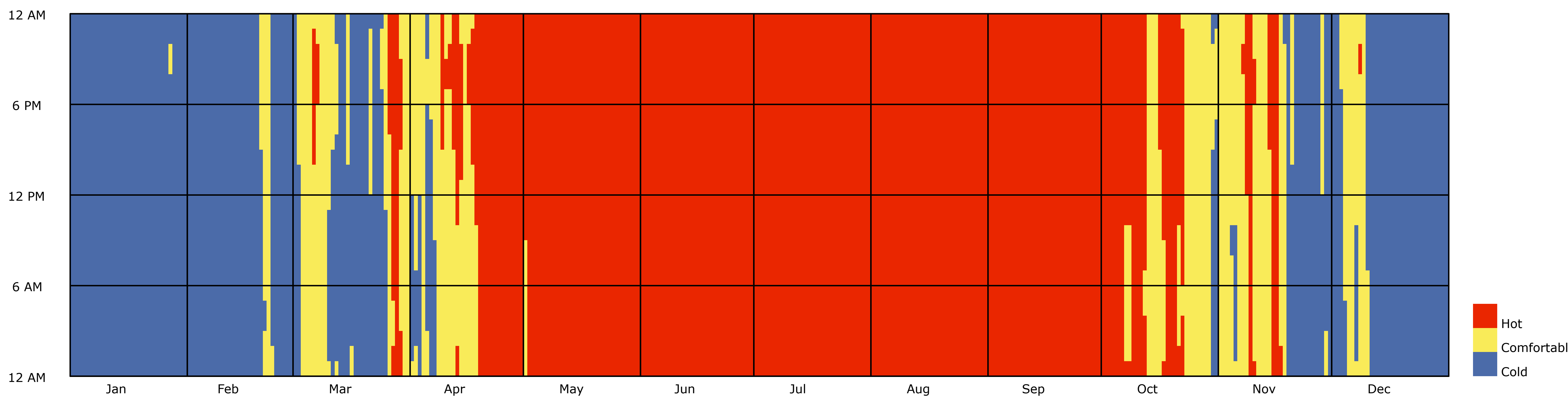
Adaptive Comfort for SANSOM_ROOM



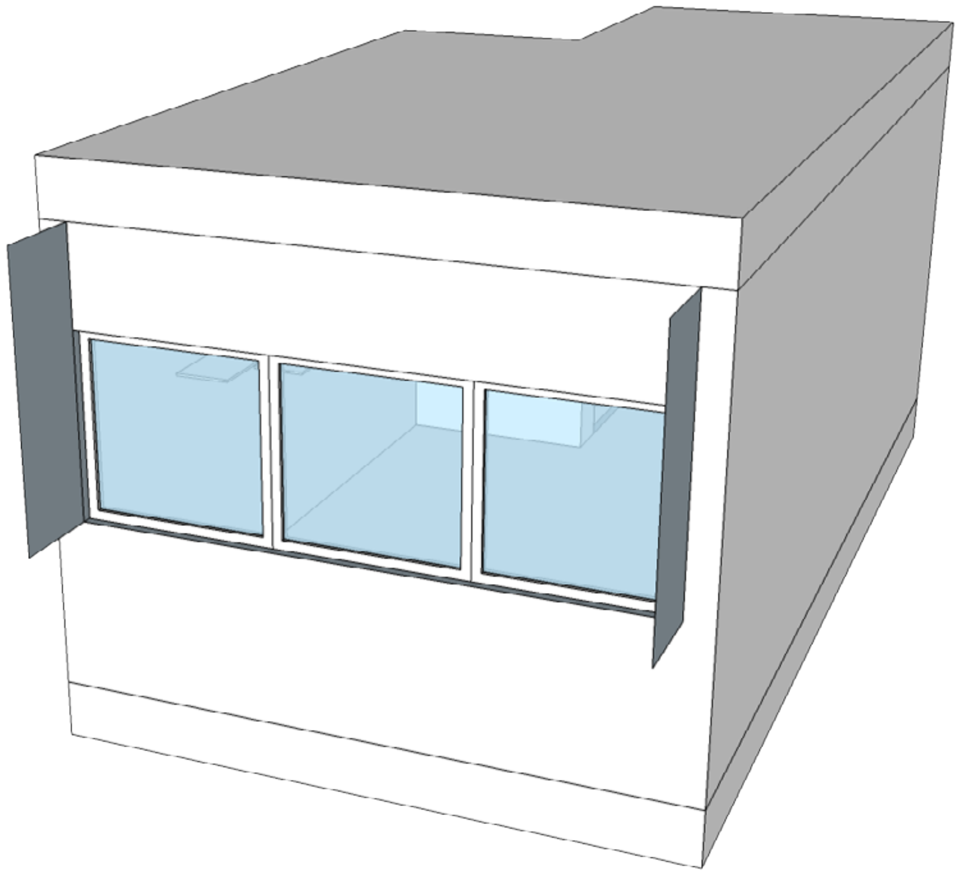
Improved design - increased glazing, shading, and changed wall construction

To evaluate an improved design, the model was returned to being adiabatic with consideration of the context of the room. Given that the base case had a problem of having too much heat stress for over 50% of the time, an improved design should allow for more heat to leave the room and block any heat gain being received from the sun. Another factor that is also affecting the indoor comfort of the room is the construction of the walls which determines how well the room will be insulated against the outside weather. In order to do that, the glazing was increased to reach the ceiling in this design while shading devices were added to the east and west edges of the glazing to block any low northeast and northwest sun from the long days in the summer from entering the room. The construction of the exterior wall and windows were also changed from a pre-1980 construction (the building was built in 1970) to an ASHRAE 90.1-2010 construction. This had the essential effect of increasing the R-values of the wall and glazing.

The resulting design had an improved comfort rate of 16.7%, up from the 15.7% of the base case. However, contrary to expectations, the overall heat stress throughout the year actually increased to 52.6% of the time, likely due to the higher insulation value of the walls, which made it harder for the internal heat of the room to escape. This had the added benefit in the cold seasons, decreasing the amount of time the room has cold stress down to 30.8% from the 32.5% of the base case.



Adaptive Comfort for SANSOM_ROOM

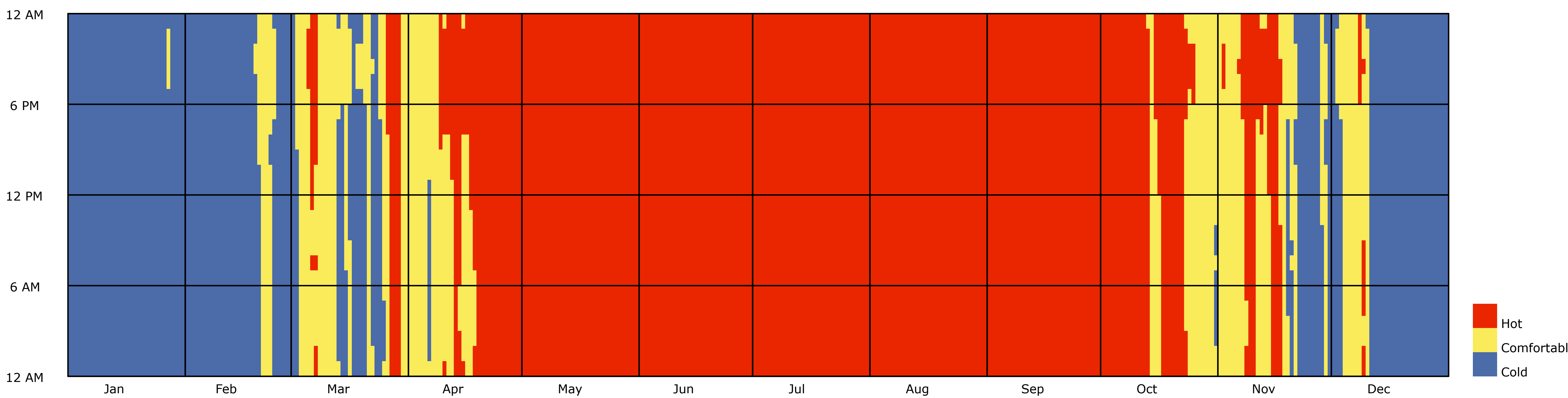


Improved design - original glazing, added shading, and changed wall construction

The results of the last improved design reveal that more so than increasing heat loss through increased glazing area, the comfort environment of the room is affected by the construction of the walls through which heat loss is occuring. The more insulation the room has, the less time it would have cold stress in the winter as the internal heat gain of the building will be insulated and help heat up the room.

Using that logic, the next improvement to the design is to return the glazing back to the original size of the base case, but change the wall and glazing construction to use the newer ASHRAE 90.1-2010 standard so that they have higher R-values. The shading is kept in place to prevent the low suns in the summer from entering the room. The results are that the time the room is comfortable increased to 17.4%. Now that there is more wall area with high insulating R-value, the heat stress of the room increases to 55.7% of the time. However, as expected, the cold stress in the winter decreases to 26.9% of the time, down from 32.5% of the base case.

What these simulations are revealing is that, without natural ventilation, it would be hard to cool the room or decrease its heat stress. However, with increased insulation, it is possible to improve the cold stress of the room by insulating the internal heat gain from loss.



Adaptive Comfort for SANSOM_ROOM