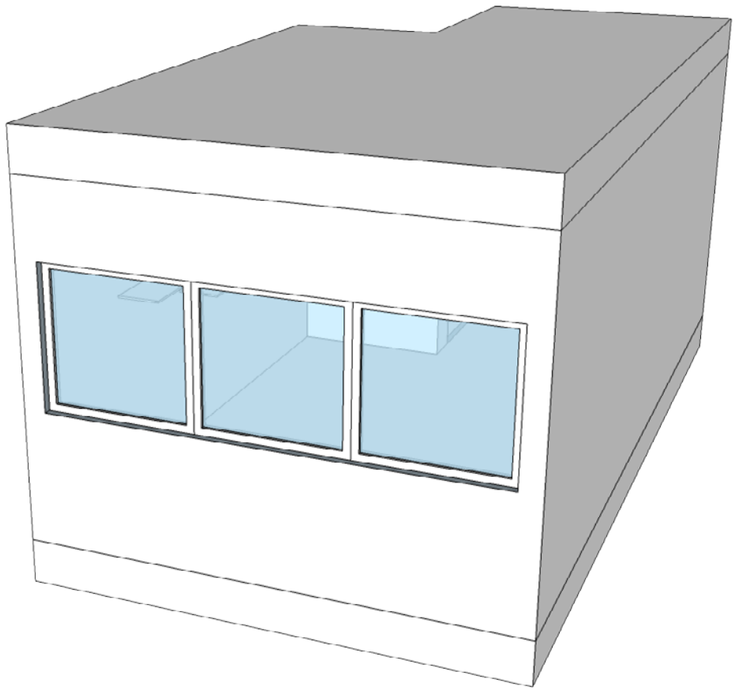
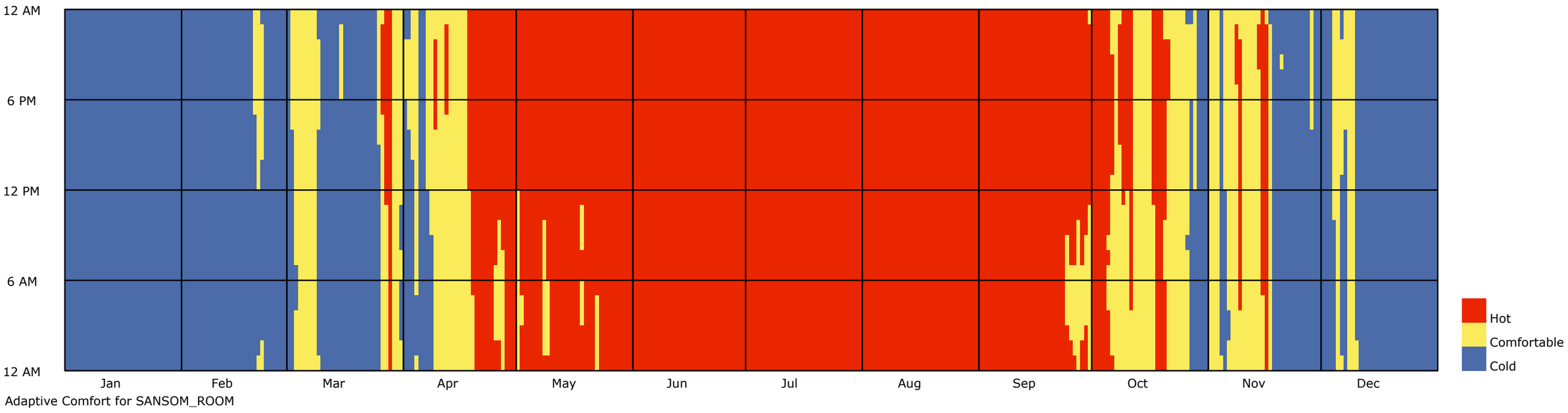


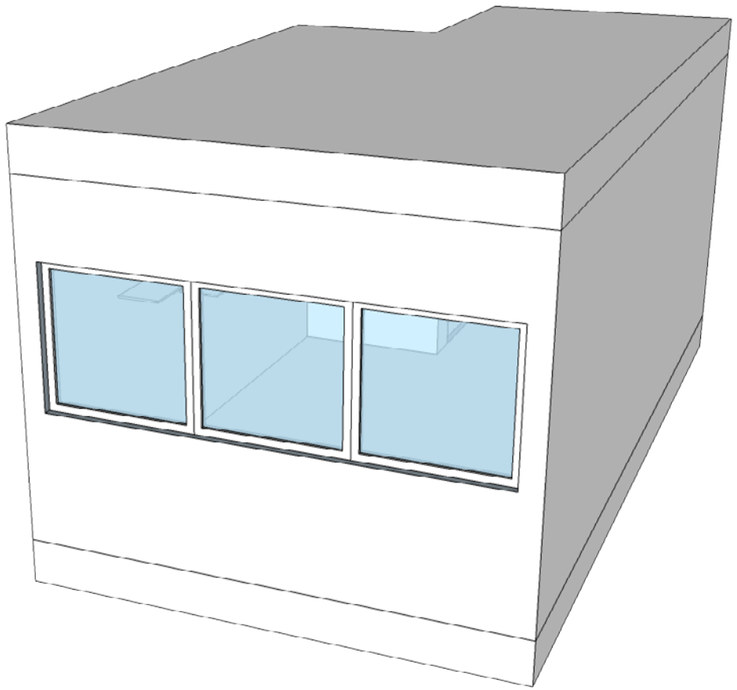
Base Case

This base case model is continued from last week's energy model. It contains one exterior wall with three windows and the rest are interior walls, floor, and ceiling that are adiabatic. All elements are pre-1980 constructions. 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. One thing that has changed since the last energy model is that now customized zone loads and infiltration rate have been inputted in Energy Plus, with slight changes to the results of the simulation.

The energy simulation of the base case (without conditioning or natural ventilation) shows that the room has a hot stress issue between mid-April to the beginning of October throughout entire days. There are patches of comfortable days in the months of March, April, September, October, November, and December, but otherwise the room is too cold between mid-November to March. The base case room is comfortable for 17% of the time, with 48.4% of the time being too hot, and 34.6% of the time being too cold.



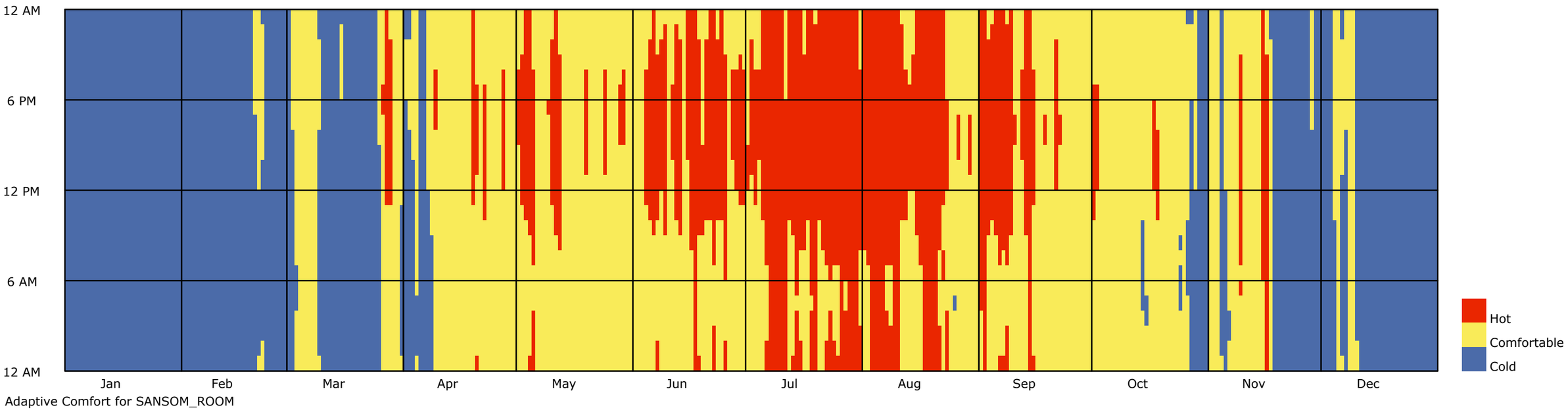
Adaptive Comfort for SANSOM_ROOM



Natural Ventilation

Considering the base case simulation results, it can be inferred that the room is too hot for most of the time (nearly 50%) and natural ventilation is needed to help cool off the internal loads of the room. Rationally speaking, natural ventilation should be utilized when the indoor environment is too hot, and outdoor temperatures are cooler or comfortable and lower than the indoor temperatures. Therefore, when indoor temperatures get above about 24 degrees, while outdoor temperature is anywhere between 16 to 28 degrees, natural ventilation can be used. With that in mind, the natural ventilation setting of this simulation is set to turn on when indoor temperature is between 24-35 while outdoor temperature is between 16-28 degrees.

With the customized zone loads and the natural ventilation setting inputted, the indoor comfort of the room improved significantly. The room is now comfortable for 44.7% of the time, with 20.4% of the time being too hot, and 34.9% of the time being too cold. Notice that the percent of time the room is cold did not change much from the base case, but the amount of time the room is hot decreased by a staggering 28%. This is the benefit of simply adding natural ventilation to the room.



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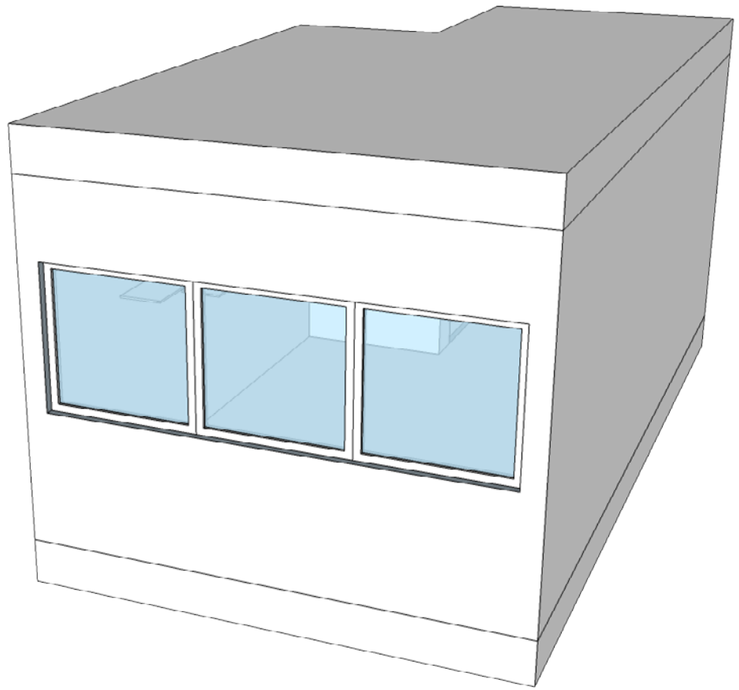
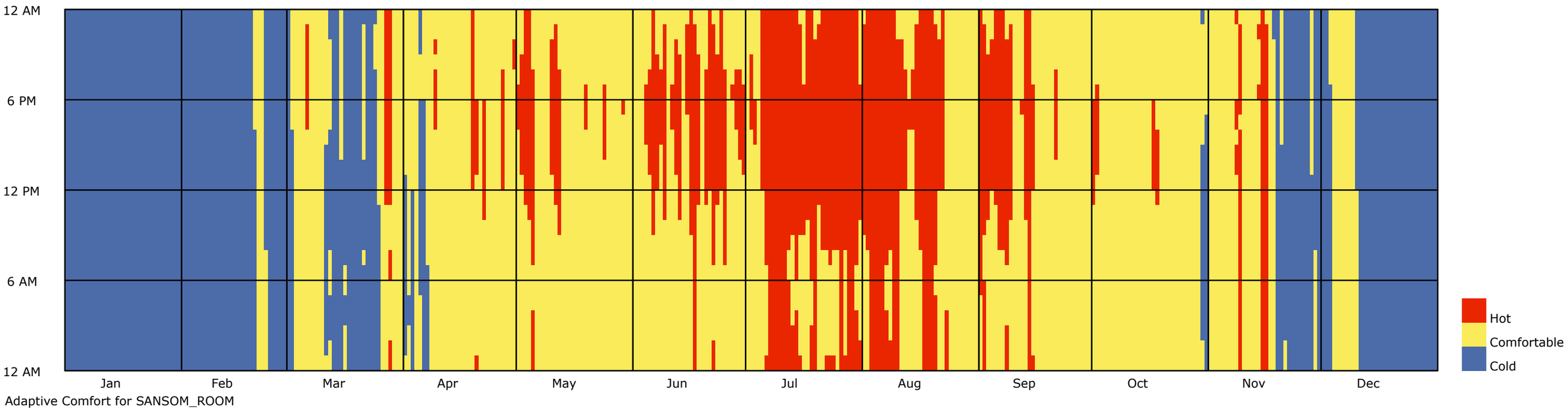


Natural Ventilation and changed R-values

Next, to make the room even more comfortable, I can look into decreasing the cold stress of the room. In order to do that, the R-values of the exterior wall and windows construction need to be increased. For this energy simulation, the EP construction types for the exterior wall and windows were updated from their pre-1980 construction types in the base case to ASHRAE 90.1-2010 construction types. This has the effect of doubling the R-value of both the exterior wall and the windows.

The resulting simulation indicates that, with natural ventilation and doubled R-values, the room is comfortable for 51.9% of the time, with 18.1% of the time being too hot, and 30% of the time being too cold. Thus, by just changing the R-value of the construction types, the amount of time comfortable was increased by 7%, while the amount of time it is too cold decreased by nearly 5%.



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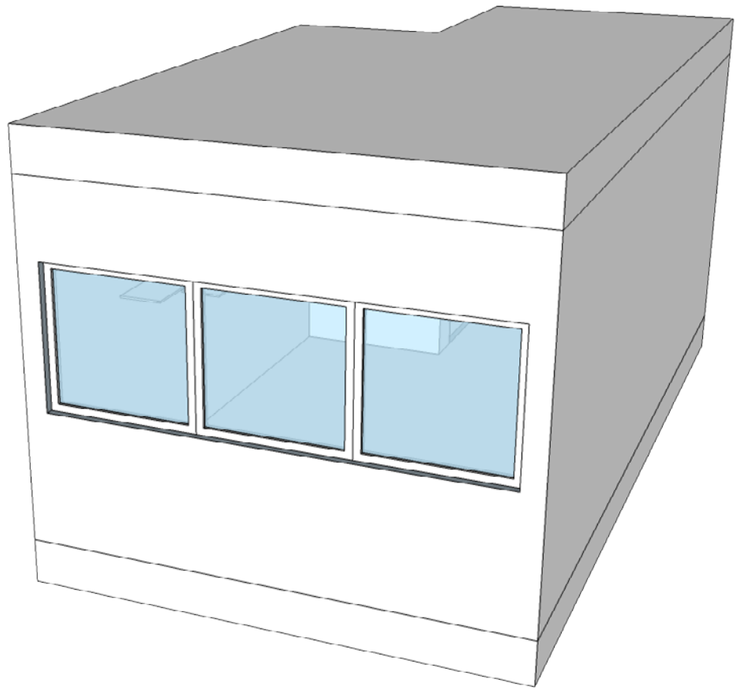
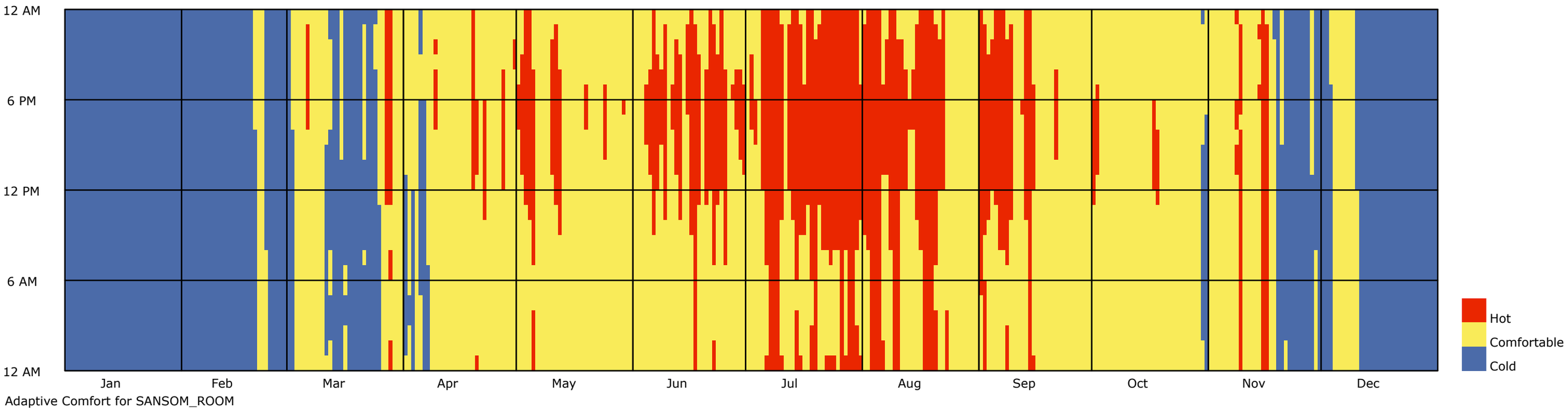


Maximum natural ventilation

Re-examining an earlier decision, it can be said that the decision to set the upper limit of the indoor temperature for natural ventilation to 35 degrees was quite arbitrary. It is illogical to turn off natural ventilation if the indoor temperature reaches higher than 35 degrees, when it is clear that any temperature higher than that would still be extremely uncomfortable. Rather, the logical decision should have been that natural ventilation is needed for all indoor temperatures higher than 24 degrees. That means it is necessary to find out the highest indoor temperature the room can reach in the entire year (the "worst case scenario"). For this room, this is found to be 43 degrees by graphing the air temperatures simulated using the base case room with customized zone loads.

With this new information, the natural ventilation setting for the energy simulation is changed to maximize natural ventilation for any indoor temperatures between 24 and 43 degrees, if outdoor temperatures are in the range of 16 to 28 degrees. This helped captured the last of the extremely hot hours, and the results are that the room is comfortable for 52.8% of the time, with 17.1% of the time being too hot, and 30% of the time being too cold. Ultimately, with maximized natural ventilation and doubled R-values, the months of April, May, and October became mostly comfortable, while the months of June, July, August, and September have hot afternoons and moderately comfortable mornings.



Adaptive Comfort for SANSOM_ROOM