Convection at the Indoor Side of Complex Fenestration Systems: The ASHWAT Model Revisited (TBPS-2018-0048)

Response to Reviews

We would like to thank the respected reviewers for their thorough review of our work and their thoughtful comments which have helped improve the manuscript. The changes have been highlighted in the revised submission. Below are brief responses to each comment.

Reviewer 1

Comment: Section 1.3 states the presence of indoor mounted CFS has very small influence on U-value. I would say that this is sometimes, but not always true. As an extreme example, there are shades on the market with outdoor facing coated low-e and side tracks, essentially constructing an additional sealed glazing gap. These products significantly impact U-value. Less extreme examples are shown in other papers published by this journal such as Hart, et al. "Experimental validation and model development for thermal transmittances of porous window screens and horizontal louvred blind systems" DOI: 10.1080/19401493.2017.1323010

> Response: The respected Reviewer is right. There are cases where the indoor-mounted attachment can have a large influence on the U-value. Nevertheless, in most *typical* configurations, the U-value is mostly unaffected by the presence of the attachment. The respective sentence in the text was reworded to reflect the point.

Comment: Section 4.1 states that Cij is approximately equal to Cji for RB. The error, percentage wise, for Cgs and Csg is actually quite large though. You should state the criteria used to determine that they are approximately equal.

> Response: The discussion of Table 1 was expanded to clarify the measure of approximate of C_{ij} and $C_{ji.}$ In short, it is the absolute difference between each pair that is important.

Comment: Section 4.2 states slat width is 2.54mm. I believe this is meant to be 25.4mm. If not, this is not representative of VB.

> Response: Corrected; w=25.4 mm

Comment: Section 4.2 (including Figure 8) uses both b and L interchangeably for the distance between glass and VB. According to variable the definitions in the paper, only L should be used.

> Response: The respected Reviewer is right. It is sufficient to specify either b or L. However, since L represents the physical distance between the venetian blind and the glazing while b is mostly a mathematical construct, we find it helpful to include both. For instance,

comparison with measurements (Fig 5) based on L is clearer, while the evaluation of the ASHWAT estimates (Eq. 5) is based on b is simpler.

Comment: Figure 7 states H=11 and L=1.65m. No units are given for H, but either way these values seem much too large to be correct.

Response: Figure caption corrected; H=11L=1.65m

Comment: Table 3 is unclear that the "Res net" column is based on equation 15. This should be made clearer.

Response: Table headings were revised and footnotes were added to clarify.

Comment: All convection and radiation coefficients are sensitive to the openness of the RB and VB to air flow. It's never stated in the paper what openness is used why those particular values are used. Perhaps the briefly mentioned hc value from section 1.2 is meant to account for that, but it is never explained. Additionally the thickness of the slats is not indicated.

Response: The Reviewer is right. Neither in the original ASHWAT model nor in the present work is the effect of openness on the convection coefficients considered. As suggested by the respected Reviewer, the user-specified value, h_c, can reflect those effects. Moreover, if desired and deemed computationally sensible, the CFD model can be refined to include such details as openness; the corresponding values of C_{ij} obtained by dQdT will then reflect that level of detail.

Regarding the thickness of the slats: as stated in Section 3.1.2, in the CFD model, the slats were assumed to be infinitesimally thin. In the revised version, this point is reiterated in Section 4.2.

Reviewer 2

Comment: The explanation of Figure 1 is unclear. Perhaps I should first read some previous papers. I would suggest, however, to clarify the meaning of hin, hout. Does the solar flux Si reaches every layer of the glazing system at Ti?

Response: In general, a portion of the solar flux *may* reach the layer at T_i. In Figure 1, this is shown by S_i. Explanation was added to clarify this point.

Comment: Figure 2 assumes the radiant exchange takes place between the temperature Tg and indoor air temperature Ta.

Response: Please note that Figure 2 corresponds to *convection* at the indoor side. The radiant exchange network would entail a temperature node at T_m (the indoors mean radiant temperature). A sentence was added at the end of Section 1.1 to clarify this point.

Comment: Page 4, line 44: explain the meaning of Ag = As/2 related to Figure 3. If Ag is given, then why the attachment has As = 2 Ag?

Response: $A_s=2A_g$ represents the fact the attachment has two sides, one facing the glazing, and the other facing the indoors. Each side has a surface area of A_s. The text was reworded to clarify this point.

Comment: Explain the physical meaning of Equation 3.

Response: As mentioned in the paragraph following Eq 3, the equation is based on the assumption that the indoor-facing side of the attachment has a heat transfer coefficient of h_c, unaffected by the glazing layer.

Comment: Page 5, line 36: "No difficulty has been reported regarding the delta network..." Unclear. What kind of difficulty?

Response: The text was reworded to clarify.

Comment: Page 15: explain the physical meaning of Cij ≠ Cji and also the physical meaning of proposed equation 14.

Response: Please see the last paragraph of Section 2.3 as well as the discussion of Fig 7 for physical meaning/interpretation of $C_{ij}\neq C_{ji}$

Response: As stated in the text, Eq. 14 is merely a modeling "decision" – a crude engineering maneuver – to come up with *some* representative values to be used in the resistor-network calculations for a case where $C_{ij}\neq C_{ji}$, i.e. the resistor-network model does not strictly apply. It was fortunate that the results based on Eqs. 14 and 15 turned out to be in such remarkable agreement with the CFD results (Table 3).