Development of Spectral Based Methods for Analyzing Sunlight Effects on Indoor Thermal Comfort

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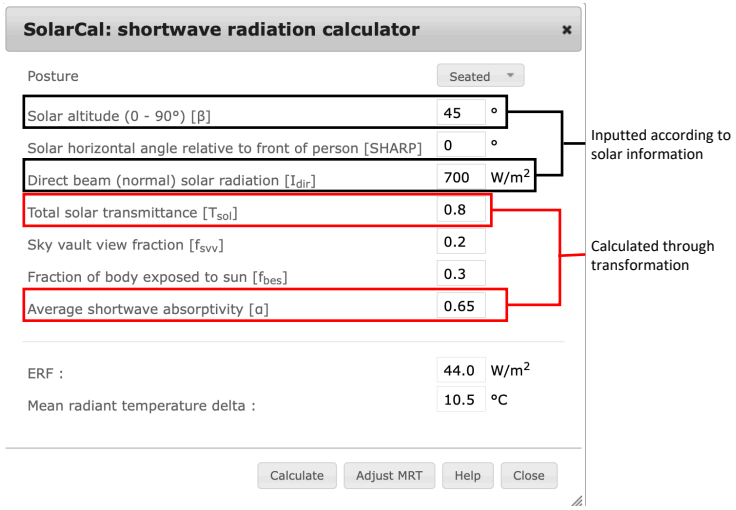
Background

- Main radiant temperature in PMV model
- Shortwave radiation by main radiant temperature delta
- SolarCal software
- Spectral specifications instead of constant parameters

Spectral based model



$$T_{sol\_s} = \frac{\sum_{290}^{1650} S \cdot T_{sol\_spe} d\lambda}{\sum_{290}^{1650} S d\lambda}$$

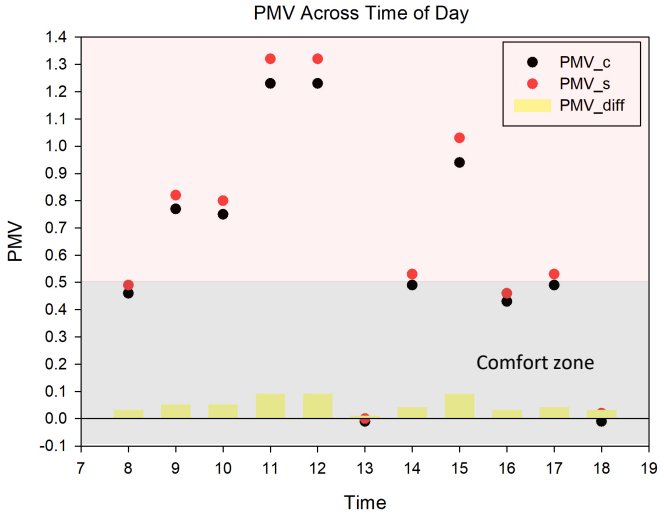
$$\alpha_s = \frac{\sum_{290}^{1650} S \cdot T_{sol\_spe} \cdot \alpha_{spe} d\lambda}{\sum_{290}^{1650} S \cdot T_{sol\_spe} d\lambda}$$

Verification Results

Verification for the effect of using spectral-based methods to calculate mean radiant temperature delta by computing and comparing one-day sunlight data in Denver, Colorado.

Time	I_{dir}	β	T_{sol_c}	T_{sol_s}	α_c	α_s	$M\Delta_c$	$M\Delta_s$
08:00	468	14.4		0.5786		0.5746	3.8	4.0
09:00	669	25.6		0.5792		0.5777	5.6	5.9
10:00	622	37.1		0.5820		0.5798	5.5	5.8
11:00	914	48.5		0.5798		0.5787	8.3	8.8
12:00	922	59.4		0.5798		0.5774	8.3	8.8
13:00	115	68.5	0.554	0.5900	0.57	0.5731	1.0	1.1
14:00	448	72.4		0.5819		0.5757	4.0	4.2
15:00	745	68.0		0.5816		0.5785	6.6	7.1
16:00	399	58.7		0.5838		0.5783	3.6	3.8
17:00	435	47.7		0.5831		0.5760	4.0	4.2
18:00	116	36.3		0.6069		0.5934	1.0	1.2

- 0.1 magnitude differences of MRTΔ
- Depends on spectral variations
- Intensity matters



- 0.01 magnitude differences of PMV values
- Even minor difference matters

Conclusion

- Decimal magnitude differences between constant parameters and spectral based parameters of
  - total solar transmittance (0.01)
  - average shortwave skin absorptivity (0.001)
  - and then mean radiant temperature (0.1)
  - PMV values (0.01)
- Even minor differences in PMV values may cause significant differences of thermal comfort levels