

Age, lens transmission and the circadian effectiveness of solar and of lamp radiation

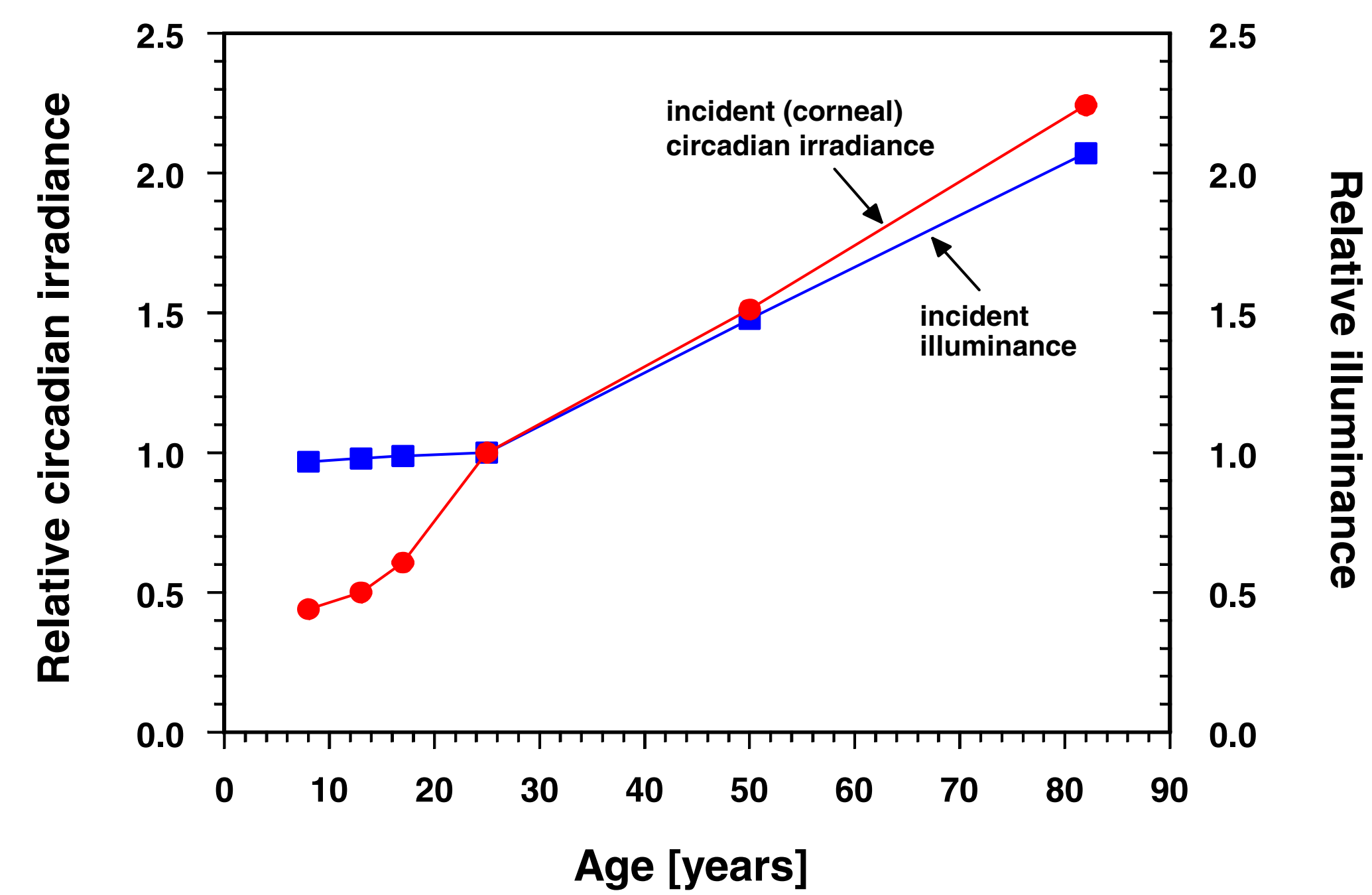
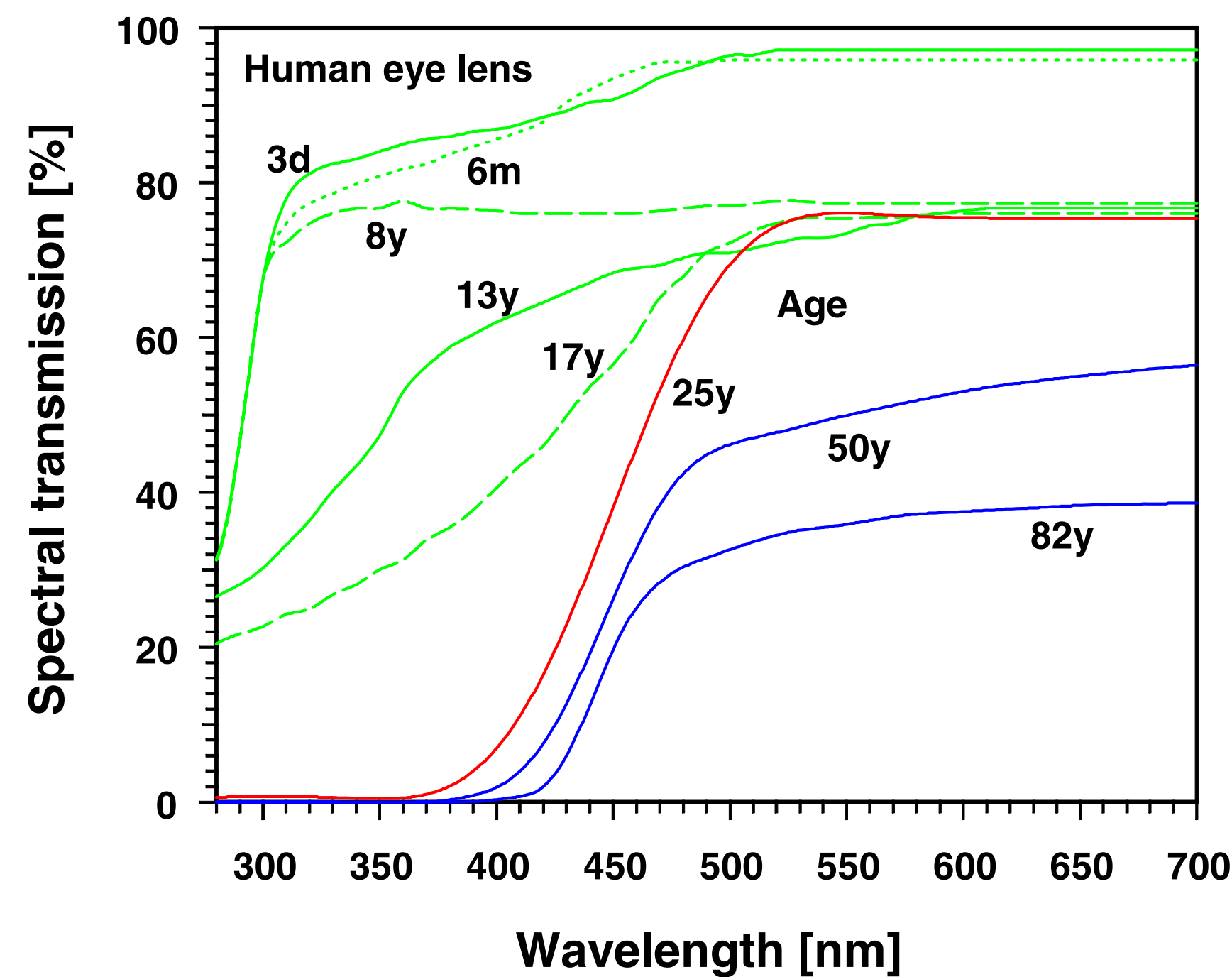
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Introduction

The circadian action spectrum and the effective threshold irradiance for sufficient melatonin suppression of about $E_{cm} \approx 0.2 - 0.3 \text{ W m}^{-2}$ were measured for young adults (1, 2). However, the spectral transmission of the human eye-lenses shows typical age dependent decreases and shifts to longer wavelengths (3). Thus, the ratio $k_{cv} = E_c/E_v$ between the circadian effective irradiance E_c and the illuminance E_v on the retina depends on both the spectral distribution of incident (corneal) irradiance and on the age. Both the incident circadian effective irradiance and the illuminance have to be increased in dependence of age to generate equivalent stimuli on the retina.

Spectral transmission of human eye-lenses and age. Increase of corneal irradiance with age to get equivalent retinal irradiance.

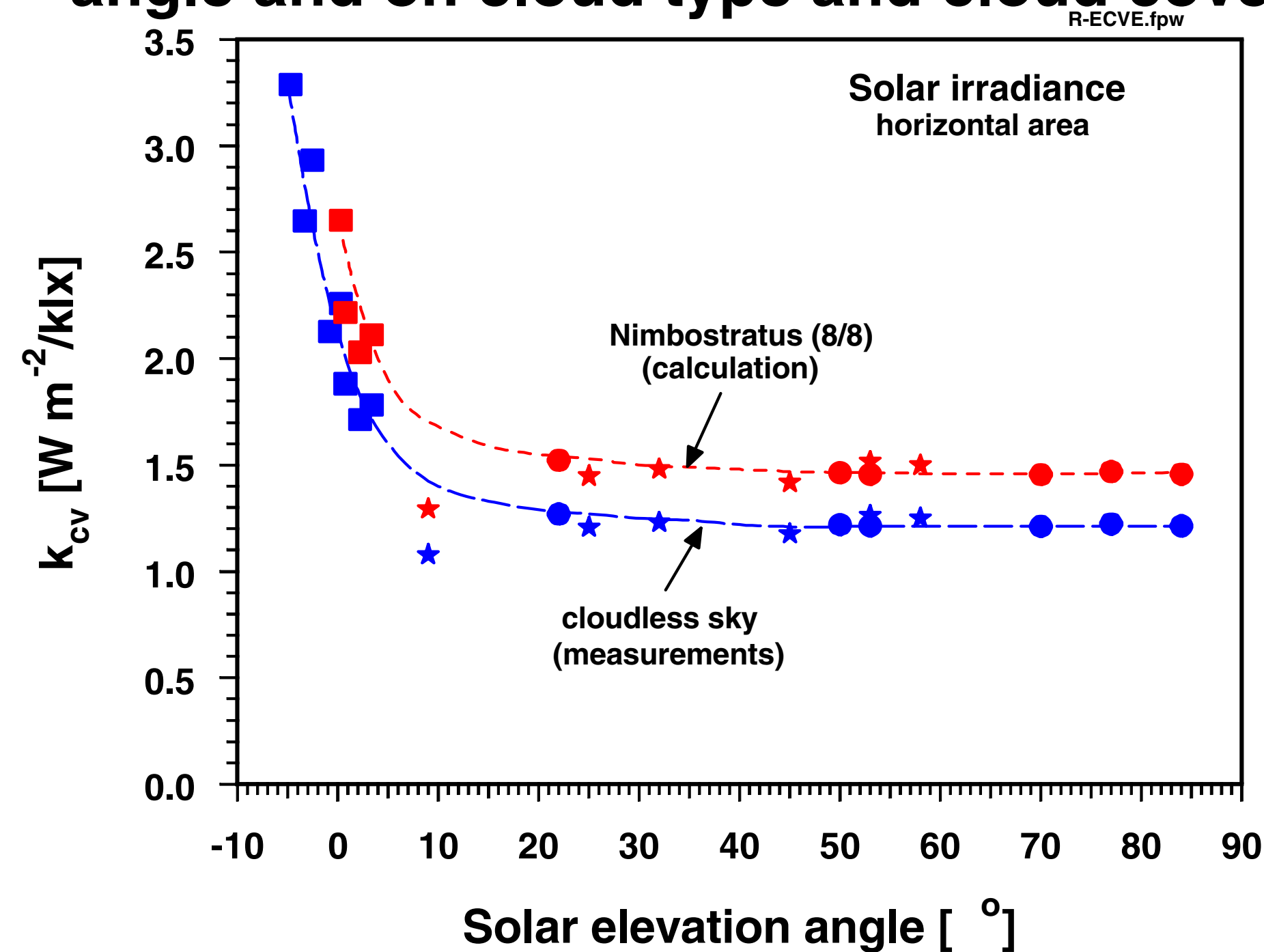


Results

of extrapolations to evaluate the circadian effectiveness depending on age

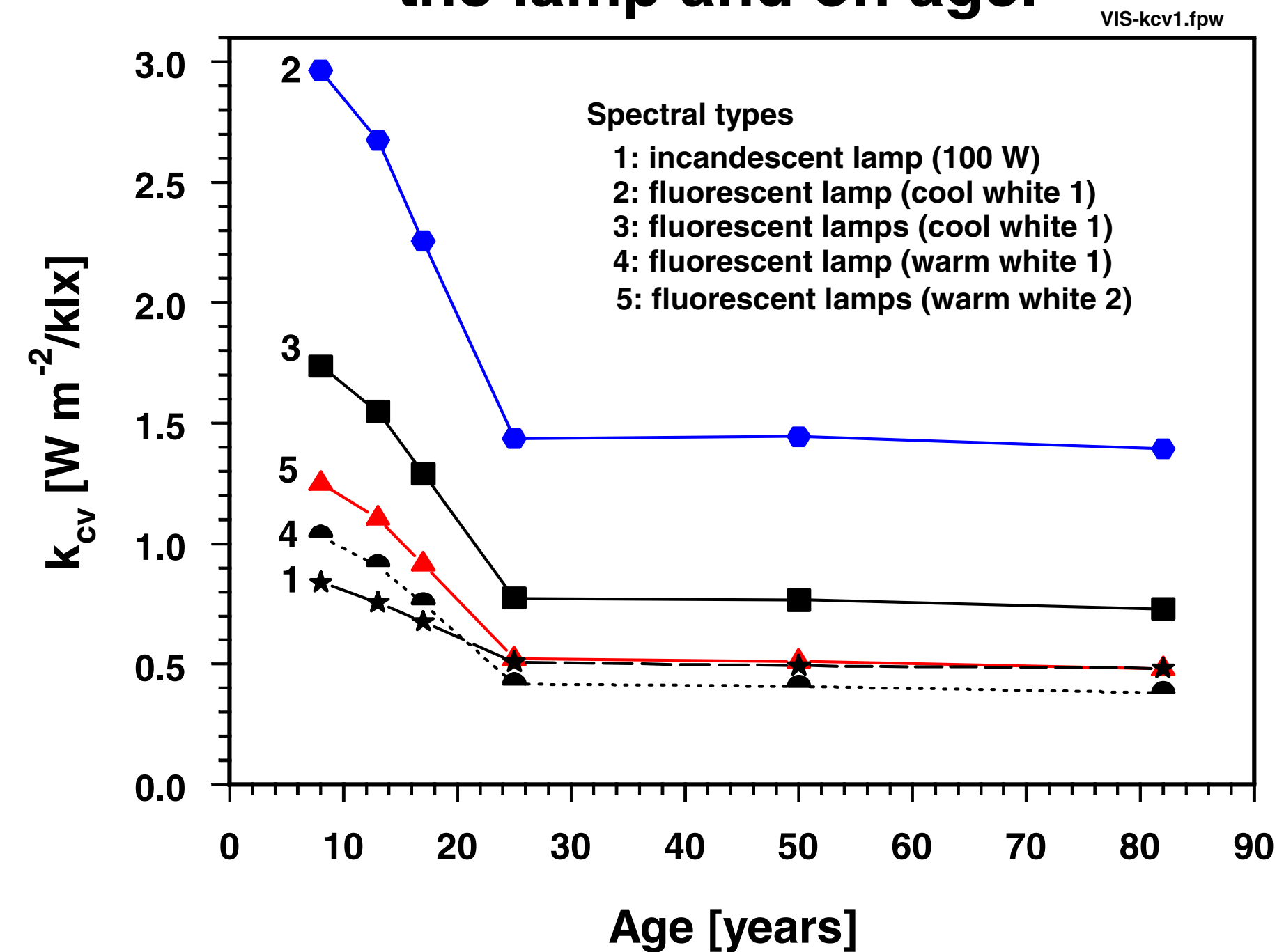
Solar irradiance

The ratio k_{cv} depends on the solar elevation angle and on cloud type and cloud cover.

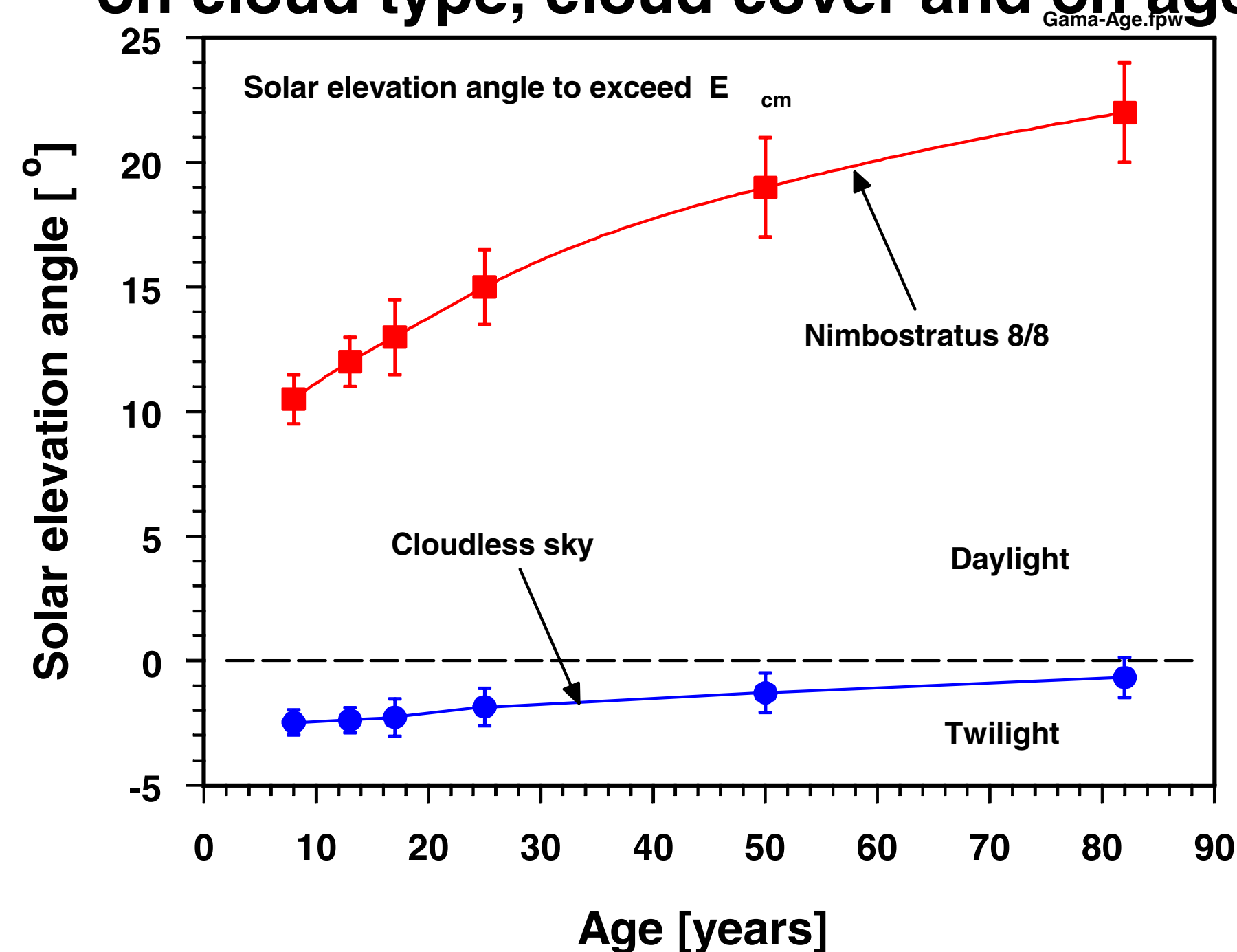


Irradiance of lamps

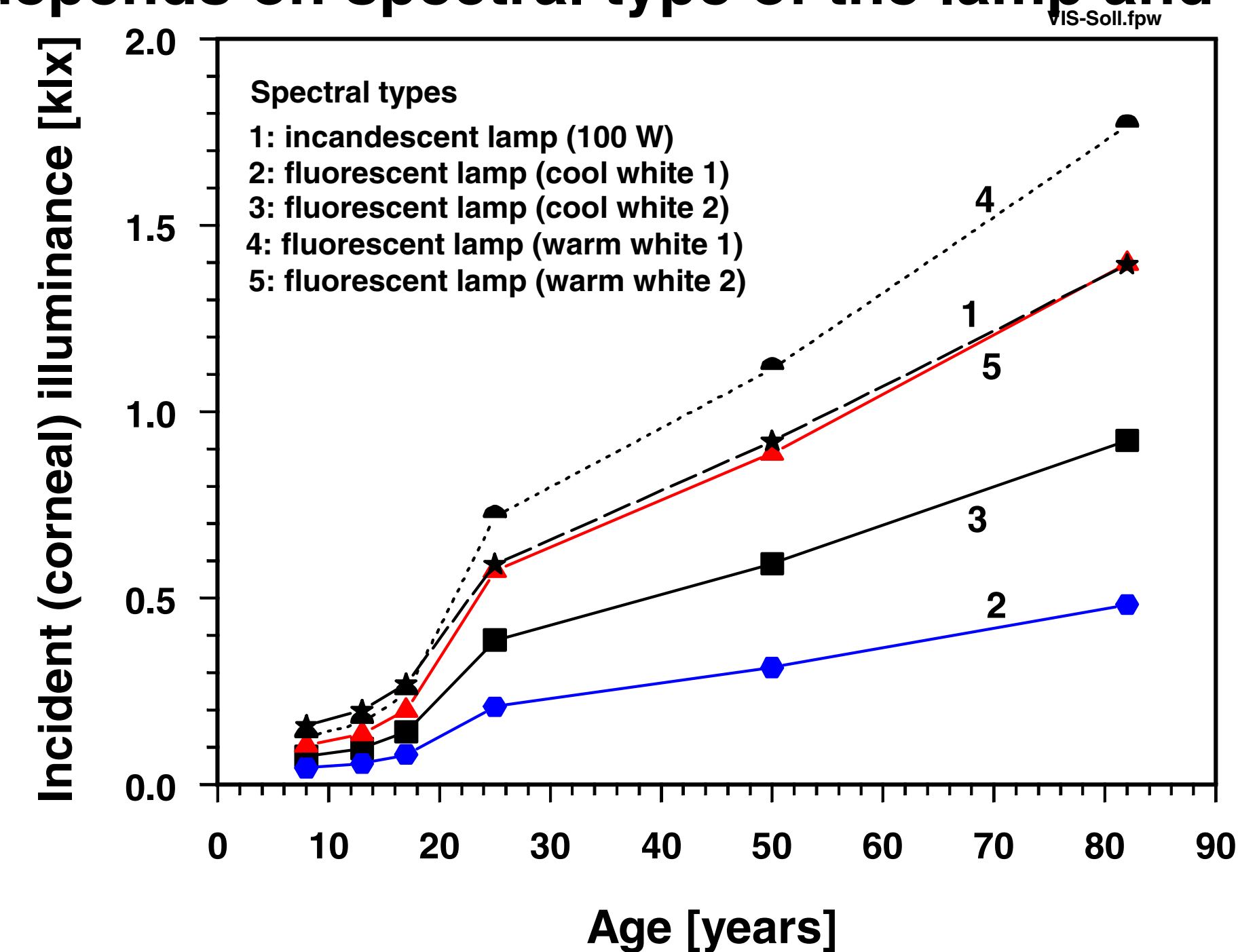
The ratio k_{cv} depends on spectral type of the lamp and on age.



The solar elevation angle to exceed E_{cm} depends on cloud type, cloud cover and on age.



The incident (corneal) illuminance to exceed E_{cm} depends on spectral type of the lamp and on age.



Conclusions

- No limitation of melatonin suppression between sunrise and sunset for cloudless sky.
- Limited daily periods of time suitable to stimulate melatonin suppression by outdoor exposures depending on latitude, season and age in the case of sky covered by dark clouds.

- Need to consider aging effects of the eyes into the characterisation of the circadian effectiveness of lamps as well as to optimise lighting in order to stimulate or to prevent melatonin suppression.
- The ratio k_{cv} defines the *relative circadian effectiveness* of lighting. It is proposed to use k_{cv} determined in different steps of age in order to classify lamps.

References

(1) Brainard, GC et al., *J. Neurosci.* 2001, 21(16) 6405-12; (2) Thapan, K et al., *J. Physiol* 535.1 (2001) 261-7; (3) Lerman, S, *J. Gerontol.* 38(1983) 293-301.