

Because of the refractive interface at the surface of blue-ice fields in Antarctica, the authors expect a “subsurface enhancement in both the downwelling and upwelling fluxes relative to the incidence irradiance.” This subsurface enhancement is a consequence of total internal reflection for angles of upward radiation greater than about 50 degrees. The authors have exaggerated this enhancement in two ways.

(1) The irradiance is the integral of radiance over the 2π solid angle of a hemisphere, with weighting by $\cos\theta$, where θ is the angle of incidence. As a consequence, the reflectance \bar{R} for

diffuse incidence is $\bar{R} = \frac{\int R(\theta) \cos \theta d\omega}{\int \cos \theta d\omega} = \frac{\int R(\theta) \cos \theta \sin \theta d\theta}{\int \cos \theta \sin \theta d\theta}$. The weighing factor

$\cos\theta$ appears to be missing from the authors’ calculation. On page 8 line 30, for a refractive index $m=1.306$ and diffuse incidence, the authors get a transmittance $T=0.832$, implying a reflectance $R = 1-T = 0.17$. The correct value of reflectance for diffuse incidence, computed using the above equation, is $R=0.06$ (which by the way is confirmed experimentally as the albedo of a flat water surface under diffuse incidence), but the erroneous value $R=0.17$ could be obtained if the cosine-weighting was missing from the calculation. Also, on line 31, for the radiation incident on the ice/air interface from below (refractive index $m = 1/1.306 = 0.776$), the authors get $R=0.668$. The correct value is $R=0.48$, but the erroneous value $R=0.668$ could be obtained if the cosine-weighting was missing. This error must be corrected before resubmission.

(2) Secondly, the authors have exaggerated the enhancement by assuming the ice surface is planar. Glacier-ice surfaces of the Antarctic blue-ice fields are rough; it’s a bumpy ride in a snowmobile. As a result, few photons coming from below will be incident on surface facets at local angles experiencing total internal reflection. Since the authors are using a Monte Carlo model, they can incorporate surface roughness. Perhaps there are some measurements of surface roughness that could guide the authors. If such measurements are not available, I suggest assuming a distribution of slope angles with a standard deviation of 20 degrees.

Minor comments:

Page 2 lines 12-13. “there is a tendency to treat the shortwave radiative flux as a single broadband parameter”. For snow, the errors caused by the broadband approximation were shown by Brandt and Warren 1993 (*J. Glaciol.*, 39, 99-110).

Page 4 line 14. The location given for Frontier Mountain (73 S, 160 W) is far out in the ocean. Probably the authors instead mean 160 E.

Page 4 line 22. Equation (1) is wrong. The denominator, N_{bub} , should instead be in the numerator, to give the correct units (m^{-1}) for k_{sca} .

Page 4 line 23. Equation (2) should be scaled by $(1 - \text{porosity})$.