

The FastRT UV simulation tool: recent updates, spin-offs and applications

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Abstract:

FastRT is a popular, fast, yet accurate UV simulation tool that computes downward surface UV doses, UV indices, and irradiances in the spectral range 290 to 400 nm with a resolution as small as 0.05 nm. Here we show new, computationally demanding, example results generated by the FastRT model for studies of the effect of UV radiation on vitamin D synthesis.

FastRT online interface and freely available source code:

<http://nadir.nilu.no/~olaeng/fastrt/fastrt.html>

Brief FastRT description:

Look-up tables of transmittances produced from libRadtran.

Computes full UV spectra and arbitrary UV biologically effective doserates within a few milliseconds on a standard PC.

At least 160 times faster than libRadtran.

More information in Engelsen and Kylling [2005].

The vitamin D winter

Vitamin D synthesis in human skin occurs only when incident UV radiation exceeds a certain threshold [Webb et al, 1988]. From simulations of UV irradiances worldwide and throughout the year, we have studied the dependency of the extent and duration of dermal vitamin D synthesis in terms of latitude, time, total ozone, clouds, aerosols, surface reflectivity and altitude [Engelsen et al., 2005]. A web page allowing the computation of the duration of cutaneous vitamin D production worldwide throughout the year, for various atmospheric and surface conditions, is available on the Internet at <http://zardoz.nilu.no/~olaeng/fastrt/VitD.html> and <http://zardoz.nilu.no/~olaeng/fastrt/VitD-ez.html>.

Figure 1 shows sample results for standard global conditions. The effective vitamin D winter as observed on humans is likely to last longer than in figure 1 due to UVR attenuation from skin and clothes.

References:

Engelsen, O. and A. Kylling (2005) Fast simulation tool for ultraviolet radiation at the earth's surface. *Optical Engineering*, 44(4), 041012-1-7.

Engelsen O., M. Brustad, L. Aksnes and E. Lund (2005) Daily Duration of Vitamin D Synthesis in Human Skin with Relation to Latitude, Total Ozone, Altitude, Ground Cover, Aerosols and Cloud Thickness, *Photochemistry and Photobiology*, 81(6), 1287-1290.

Webb, A.R. and O. Engelsen (2006) Calculated Ultraviolet Exposure Levels for a Healthy Vitamin D Status. *Photochemistry and Photobiology*, 82(6), 1697-1703.

Webb, A. R., L. Kline and M. F. Holick (1988) Influence of season and latitude on the cutaneous synthesis of vitamin D3: Exposure to winter sunlight in Boston and Edmonton will not promote vitamin D3 synthesis in human skin. *J. Clin. Endocrinol. Metab.* 67, 373-378.

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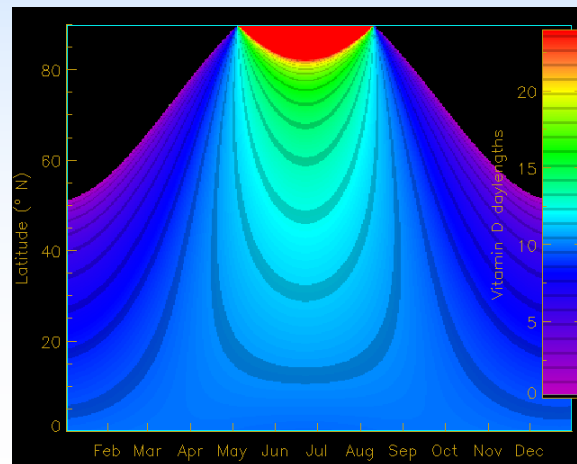


Figure 1: Daily period (in hours) of vitamin D production in terms of time and latitude for a clear atmosphere and no surface reflection and for a typical level of total ozone (300 DU). Black areas constitute the vitamin D winter. Based on the method of Engelsen et al. [2005].

Calculations of vitamin D synthesis

To compute the recommended UV exposure times for different conditions, including various levels of ozone, cloud, aerosol, surface albedo and surface elevation, skin exposure, desired vitamin D doses, etc. visit the web pages

http://nadir.nilu.no/~olaeng/fastrt/VitD_quartMED.html and

http://nadir.nilu.no/~olaeng/fastrt/VitD-ez_quartMED.html where user selected inputs can be applied to the calculations. For example, we show the required exposure to obtain a dose recently recommended to gain the optimal health benefits (1000 IU, figure 2) with face, arms and hands exposed. The method is described in Webb and Engelsen [2006] and is based on former experiments on human subjects in walk-in UV chambers. They showed that one full body minimum erythemal UV dose (1 MED) corresponds to a dietary intake of 10000-25000 IU.

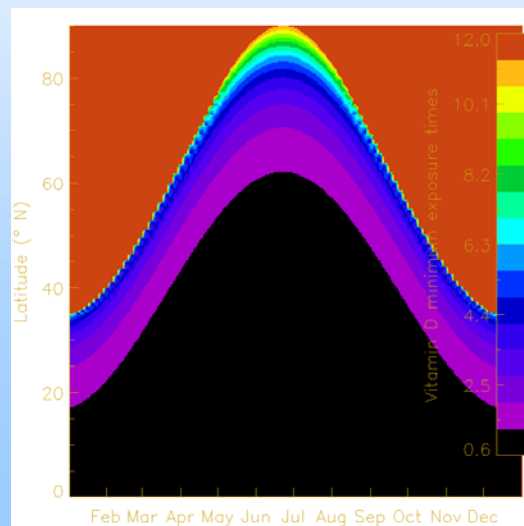


Figure 2. UV exposure times (hours) around noon for a cloudless sky and 350 DU total ozone with respect to latitude and day of year in order to obtain the equivalent of 4000 IU for skin type 2 (MED 250 J m⁻²), i.e., 949.2 J m⁻² vitamin D effective UV dose. We assume 11.5% of the body is exposed. The red areas illustrate when and where the 4000 IU equivalent is not achievable. In the black area the desired dose is obtained in less than an hour.

