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1. Introduction

This document describes the UV Index calculation based on the UVS_Data values measured by ZOPT Digital UV-Energy sensors. The calculation method is only valid for the solar UV radiation. Other UV sources will require a different UV Index calculation which depends on their spectral radiation properties.

2. UV Index Calculation (Preliminary)

The UV Index (UVI) measurements have to be executed in the horizontal plane. The reference for UVI calculation as shown in the document is gain mode 18 and 20 bit output resolution. If necessary, the UVS data register values need to be transformed by means of Equation (1) into corresponding UV counts.

$$(1) \quad UV = \frac{18}{\text{GAIN}} \cdot 2^{(20 - \text{RESOLUTION})} \cdot \text{UVS\_DATA}$$

For solar UV radiation measurements the UVI is calculated according to Equation (2)

$$(2) \quad UVI = \text{uvi\_coeff} \cdot \frac{UV}{\text{uvi\_cor}}$$

with the preliminary coefficient $\text{uvi\_coeff} = \frac{1}{5500} \quad \left[\frac{UVI}{count}\right]$

The correction term uvi_cor (default value 1) can be used in order to get more accurate results depending on the actual solar elevation angle as shown in C_0 = 3.1543

C_1 = -0.6204E-01

C_2 = 0.2186E-03

C_3 = 3.5516E-06

Figure 1. A polynomial approximation is given in Equation (3) with preliminary coefficients and the solar elevation angle in degree.

$$(3) \quad \text{uvi\_cor} = \sum_{i=0}^{3} C_i \cdot elevation^{\,i}$$

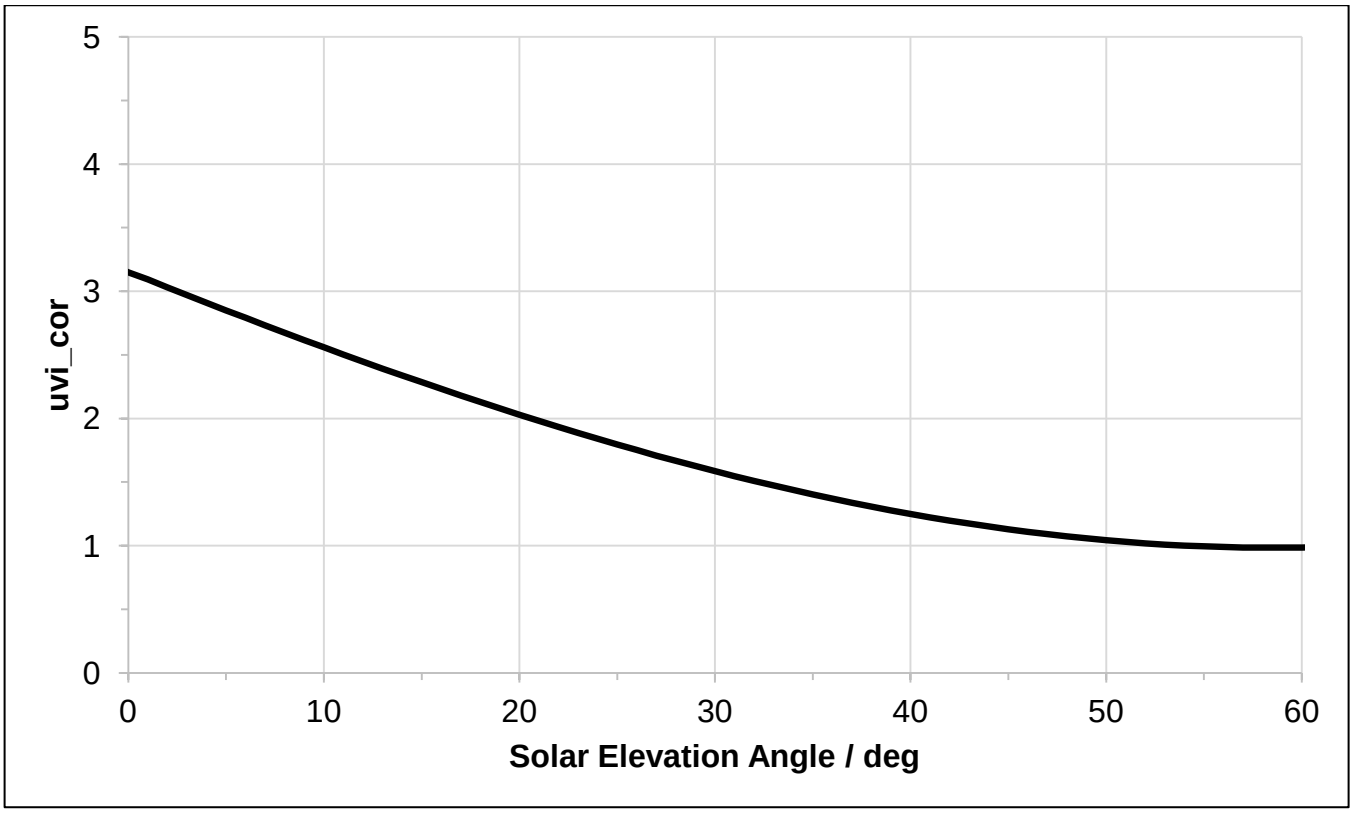
C_0 = 3.1543

C_1 = -0.6204E-01

C_2 = 0.2186E-03

C_3 = 3.5516E-06

Figure 1 UVI Correction versus solar elevation angle



3. Solar Elevation Angle Calculation

The solar elevation angle is defined for any location on the surface of the earth as a function of the geographic coordinates, date and time. A relatively precise approximation is given below, simplified calculation methods may also be sufficient. For further information see http://en.wikipedia.org/wiki/Position_of_the_Sun.

Input Parameter	Description
lat	latitude (in deg, N with positive sign, S with negative sign)
$long$	(in deg, E with positive sign, W with negative sign)
d	day of the year (beginning with Jan 01 = 1)
h	hour (UTC)
m	minute
$k = \frac{\pi}{180}$	constant

Fractional year (in rad)

$$(4) \quad n = \frac{2\pi}{365} \times \left(d - 1 + \frac{\left(h + 1 + \frac{m}{60}\right) - 12}{24}\right)$$

Declination angle (in rad)

$$(5) \quad declin = 0.006918 - 0.399912\cos(n) + 0.070257\sin(n) - 0.006758\cos(n) + 0.000907\sin(n) - 0.002697\cos\left(\frac{3}{2}n\right) + 0.00148\sin\left(\frac{3}{2}n\right)$$

Equation of time

$$(6) \quad t = 229.18(0.000075 + 0.001868\cos(n) - 0.032077\sin(n) - 0.014615\cos(2n) - 0.040849\sin(2n))$$

Hour angle (in deg)

$$(7) \quad a = 15\left(h + 1 + \frac{m}{60} - \frac{15 - long}{15} - 12 + \frac{t}{60}\right)$$

Sine of elevation angle

$$(8) \quad x = \sin(k\,lat)\sin(declin) + \cos(k \times lat)\cos(declin)\cos(k \times a)$$

Elevation angle (in deg)

$$(9) \quad elevation = \frac{1}{k}\arcsin(x)$$

4. Revision History

Revision Date	Description of Change
March 26, 2015	Initial version (preliminary)
August 18, 2016	Changed to IDT branding.

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