Estimation of Ultraviolet A (315–400 nm) and Ultraviolet B (280–315 nm) on region of Biskra

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ABSTRACT. *The dependence of Ultraviolet A and Ultraviolet B on wavelength as well as the fit of the sun height, approximation has been investigated under the location Biskra city of Algeria. The study is based on spectral data acquired with both spectral wavelengths: (280–315 nm) (315–400 nm). Under clear conditions Ultraviolet A and B are the main atmospheric components responsible for direct effects on earth. Measurements of Ultraviolet A and B properties along with simultaneous measurements of global solar irradiances were recorded at an urban site (Biskra, Algeria) to characterize the radiative effect of atmospheric from January to December 2013. This relationship constitutes an alternative tool for estimating Ultraviolet A and B from routine irradiance measurements available from numerous radiometric stations worldwide. The results of the proposed model were compared with the experimental data and there was an excellent correlation between the results obtained. We conclude from this study with a good result between measurement data and prediction which done a perfect approximation with a great convergent.*

RÉSUMÉ. *La dépendance de l'ultraviolet A et de l'ultraviolet B sur la longueur d'onde ainsi que l'ajustement de la hauteur du soleil, dont une approximation a été étudiée à Biskra, ville d'Algérie. L'étude est basée sur des données spectrales acquises avec les deux longueurs d'onde spectrales: (280 à 315 nm) (315 à 400 nm). Dans des conditions bien définies, les ultraviolets A et B sont les principales composantes atmosphériques responsables des effets directs sur la Terre. Des mesures des propriétés ultraviolettes A et B ainsi que des mesures simultanées des irradiances solaires globales ont été enregistrées dans un site urbain (à Biskra, Algérie) afin de caractériser l'effet radiatif de l'atmosphère de janvier à décembre 2013. Cette relation constitue un outil alternatif pour l'estimation de l'ultraviolet A et B à partir de mesures de routine d'irradiance disponibles auprès de nombreuses stations radiométriques dans le monde. Les résultats du modèle proposé ont été comparés aux données expérimentales et il existait une excellente corrélation entre les résultats obtenus. Nous concluons de cette étude avec un bon résultat entre les données de mesure et la prédiction qui a fait une approximation parfaite avec une grande convergence.*

KEYWORDS: *Ultraviolet A, Ultraviolet B, sun height solar radiation.*

MOTS-CLÉS: Ultraviolet A, Ultraviolet B, rayonnement solaire de hauteur du soleil.

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1. Introduction

Ultraviolet (UV) is an electromagnetic radiation with a wavelength from 100 nm to 400 nm, shorter than that of visible light but longer than X-rays. UV radiation is present in sunlight constituting about 10% of the total light output of the Sun. It is also produced by electric arcs and specialized lights, such as mercury-vapor lamps, tanning lamps, and black lights. Although long-wavelength ultraviolet is not considered an ionizing radiation because its photons lack the energy to ionize atoms, it can cause chemical reactions and causes many substances to glow or fluoresce. Consequently, the chemical and biological effects of UV are greater than simple heating effects, and many practical applications of UV radiation derive from its interactions with organic molecules.

The sun radiates energy in a wide range of wavelengths, most of which are invisible to human eyes. The shorter the wavelength, the more energetic the radiation, and the greater the potential for harm, Ultraviolet (UV) radiation that reaches the Earth’s surface is at wavelengths between 290 and 400 nm (nanometers, or billionths of a meter). This is shorter than wavelengths of visible light, which are 400 to 700 nm.

Reports the work was used of action spectra in calculating a biologically effective ultraviolet radiation fluence is reviewed and was presented a new method for the optimum estimation of an action spectrum from data obtained in such experiments (Rundel, 1983). Some work shows a physiological and developmental processes of plants was affected by UV-B radiation, even by the amount of UV-B in present-day sunlight (Caldwell *et al*., 1995). The work was concerned about stratospheric ozone depletion was stimulated interest in the effects of UVB radiation (280–320 nm) on marine phytoplankton (Cullen and Neale, 1994). The reports were found the quality and quantity of UV measurements was increased greatly in the last few years. Enhanced UV levels were clearly associated with the Antarctic springtime ozone reductions (Madronich *et al*., 1995). The some work shows the extreme ultraviolet (EUV) radiation from laser-produced plasma (LPP) was thoroughly studied for application in mass production of next-generation semiconductor devices, was developed an integrated numerical simulation code for the target design (Katsunobu *et al*., 2008).

Elevated solar UV-B radiation was associated with stratospheric ozone reduction may exert effects on terrestrial ecosystems through actions on plants, microbes, and perhaps on some animals, and were found the actions of elevated carbon dioxide and UV-B appear to be largely independent, but interactions occur between changes in UV-B and other factors (Caldwe *et al*., 1998). the authors were found a new function which gives a good results for all solar zenith angles between 0◦ and 90◦ and a wide range of total ozone values, this function was derived by fitting the measurements of total ozone and the UV-index was obtained from two instruments, one in the mid-latitudes and one in the tropics.

2. Materials and methods

2.1. Prediction of ultraviolet A and B

In this study, we enter into the site of the SoDa Service for take essential data corresponding to our study. The SoDa Service is a broker for a list of services and web services, i.e. it offers a one-stop access to a large set of information relating to solar radiation and its use.

The variation of aerosol optical depth corresponding to the urban of Biskra is taken according to Ultraviolet A and B for all month of the year and then trying to fit the irradiation the Ultraviolet on the horizontal area as a function of height solar angle.

2.2. Theoretical study

According to measurement data of the radiation of Ultraviolet A and B about one year of 2016 trying to research a mathematical model which calculated the Ultraviolet A and B as a function to heigh solar angle h.

The mathematical model chooses written with the equation:

$$(UVA, UVB) = \frac{\delta}{1 + \exp\left(-\eta \times (h - \tau)\right)} \tag{1}$$

The constants δ, η and τ relate to the number of the months see the table 1.

The table 1 shows the constants of the radiation of the Ultraviolet A and B as a function to month it is taking with a good residual R^2.

We can be written the constants with equation as a function in a number of months see (eqs.2, 3, 4, 5, 6 and 7)

About the radiation Ultraviolet A:

$$\delta_{UA} = \left(136.59 - 107.15 N_m + 43.31 N_m^2 - 7.45 N_m^3 + 0.5776 N_m^4 - 0.0168 N_m^5\right) \tag{2}$$
$$R^2 = 0.8775$$

$$\tau_{UA} = \begin{pmatrix} 777.17 - 1916.3 N_m 1953.96 N_m^2 - 1043.09 N_m^3 + 324.29 N_m^4 \\ - 61.72 N_m^5 + 7.29 N_m^6 - 0.521 N_m^7 + 0.021 N_m^8 - 3.472.10^{-4} N_m^9 \end{pmatrix} \tag{3}$$
$$R^2 = 0.993$$

$$\eta_{UA} = \begin{pmatrix} 0.392 - 0.688\,N_m + 0.59\,N_m^2 - 0.246\,N_m^3 + 0.057\,N_m^4 \\ -0.0076\,N_m^5 + 5.926.10^{-4}\,N_m^6 - 2.503.10^{-5}\,N_m^7 + 4.428.10^{-7}\,N_m^8 \end{pmatrix} \quad (4)$$

$R^2 = 0.977$

Table 1. The constants of the radiation of the Ultraviolet A and B as a function to months of the year

Ultraviolet A (315–400 nm)						
N	1	2	3	4	5	6
R²	0,953	0,967	0,994	0,996	0,995	0,996
δ	67,84	38,78	49,36	58,50	62,65	56,47
τ	41,09	34,23	22,14	13,61	28,12	37,20
η	0,097	0,104	0,114	0,095	0,075	0,078
N	7	8	9	10	11	12
R²	0,981	0,993	0,933	0,990	0,990	0,935
δ	55,41	56,80	102,3	45,68	34,41	18,84
τ	28,26	19,68	36,35	36,03	51,52	38,87
η	0,079	0,087	0,073	0,093	0,107	0,141
Ultraviolet B (280–315 nm)						
N	1	2	3	4	5	6
R²	0,960	0,968	0,994	0,995	0,995	0,995
δ	1,419	0,905	1,145	1,34	1,462	1,311
τ	38,72	33,69	21,74	13,06	28,08	36,57
η	0,099	0,104	0,113	0,094	0,074	0,077
N	7	8	9	10	11	12
R²	0,982	0,993	0,938	0,991	0,991	0,934
δ	1,29	1,322	1,857	1,044	0,792	0,496
τ	27,95	19,43	30,11	35,04	50,37	39,72
η	0,078	0,086	0,077	0,094	0,109	0,121

About the radiation Ultraviolet B:

$$\delta_{UB} = \arcsin\begin{pmatrix} 1.421 - 0.6978\,N_m + 0.293\,N_m^2 - 0.052\,N_m^3 + 0.00414\,N_m^4 \\ -1.254.10^{-4}\,N_m^5 \end{pmatrix} \quad (5)$$

$R^2 = 0.9195$

$$\tau_{UB} = \begin{pmatrix} 859.18 - 2144.57\,N_m + 2195.32\,N_m^2 - 1175.75\,N_m^3 + 366.96\,N_m^4 \\ -70.17\,N_m^5 + 8.33\,N_m^6 - 0.598\,N_m^7 + 0.024\,N_m^8 - 4.033.10^{-4}\,N_m^9 \end{pmatrix} \quad (6)$$

$R^2 = 0.972$

$$\eta_{UB} = \begin{pmatrix} 0.49 - 0.909\,N_m + 0.78\,N_m^2 - 0.33\,N_m^3 + 0.077\,N_m^4 - 0.0105\,N_m^5 \\ +8.383.10^{-4}\,N_m^6 - 3.584.10^{-5}\,N_m^7 + 6.379.10^{8}\,N_m^8 \end{pmatrix} \quad (7)$$

$R^2 = 0.9184$

3. Results and discussion

The Figure 1, show the variation of irradiation in Ultraviolet A according the database about the wavelength between (315–400 nm) as function to time of the day corresponding to six months from January to June of year 2016. We can be seen the minimum variation in the month of January when the ultraviolet A go to 28.54 Wh/m² in the middle sun and the median variation, it's selecting to March attend 45.16 Wh/m² and the maximum evolution in May when ultraviolet A equal 58.93 Wh/m².

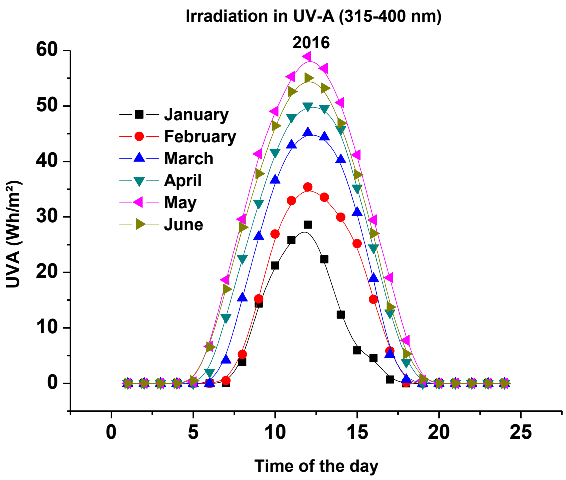

Figure 1. Evolution of irradiation in Ultraviolet A according to database 2016 of January to June

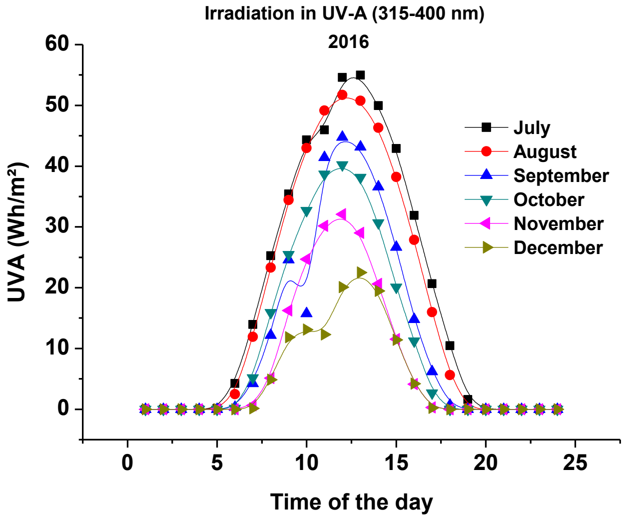

Figure 2. evolution of irradiation in Ultraviolet A according to database 2016 of July to December

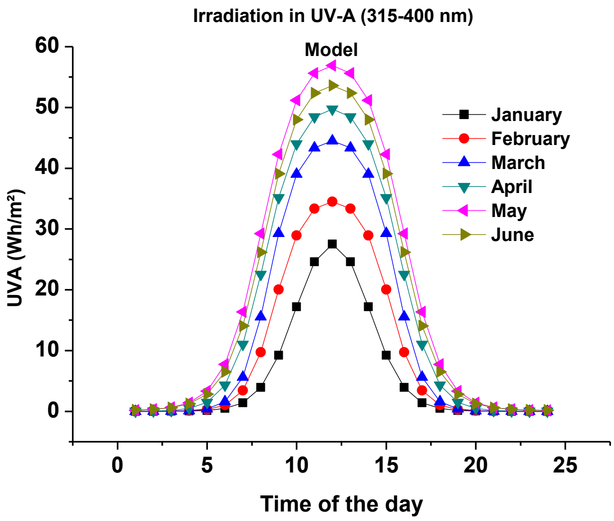

Figure 3. Evolution of irradiation in Ultraviolet A according to model (January – June)

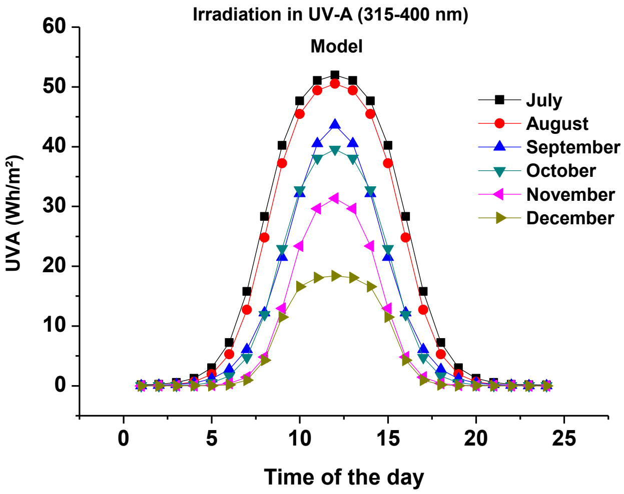

Figure 4. Variation of irradiation in Ultraviolet A according to model (July–December)

The Figure 2 shows the variation of the Ultraviolet A corresponding in the months of July to December as a function of time of the day. We can be seen that the radiation of the Ultraviolet A take a maximum various in the month of July and a minimum in December when the ambient temperature is low versus to July.

The Figure 3 and 4 shows the variation of irradiation in Ultraviolet A according the model proposed about wavelength (315 – 400 nm) as a function of time of the day corresponding to 12 months from January to December of year 2016. The results, it's suitable with the database which show in the Figure 1 and 2.

The Figures 5 and 6 shows the variation of irradiation in Ultraviolet B according to the database as a function of time of the day corresponding to the months from January to December. We can be found that the maximum values selected of approximately to 1.38 Wh/m² in the month of May and 1.29 in the July and a minimum environ of 0.5 to 0.6 in the months of December and January corresponding to the season of the winter, when the radiation of the Ultraviolet to be decreased.

The Figures 7 and 8 shows the variation of irradiation in Ultraviolet B according to the model proposed as a function of time of the day corresponding to the months from January to December. We can be found that the maximum values selected by approximately it's comparable to the Figures 5 and 6, where the variations become a good prediction.

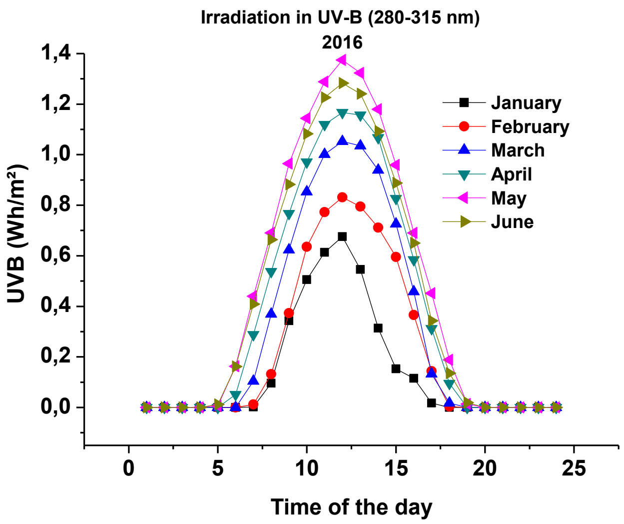

Figure 5. Variation of irradiation in Ultraviolet B according to database (January – June)

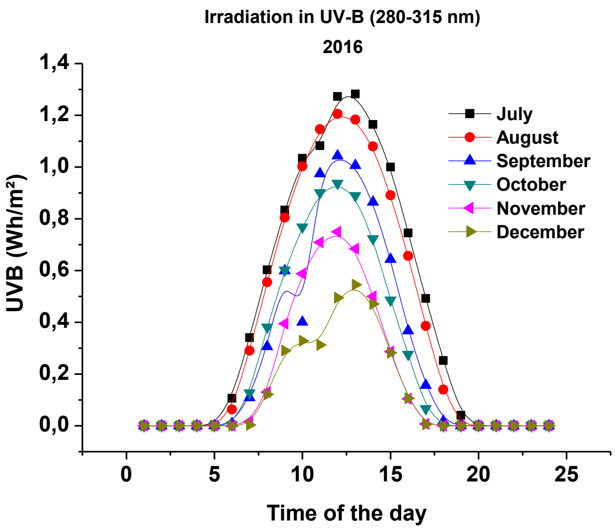

Figure 6. Variation of irradiation in Ultraviolet B according to database (July– December)

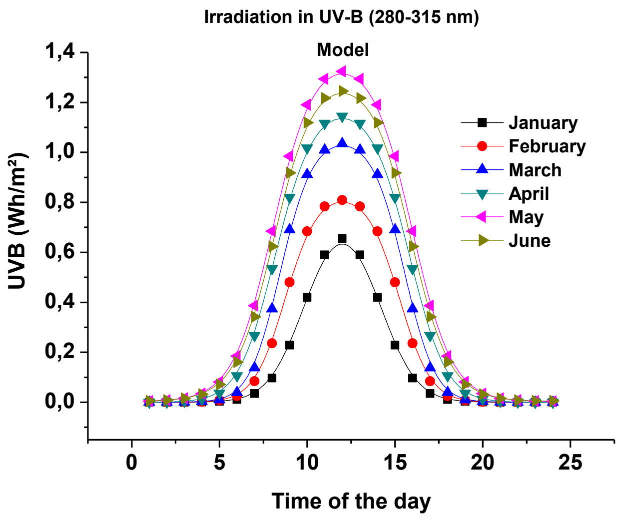

Figure 7. Variation of irradiation in Ultraviolet B according to model (January – June)

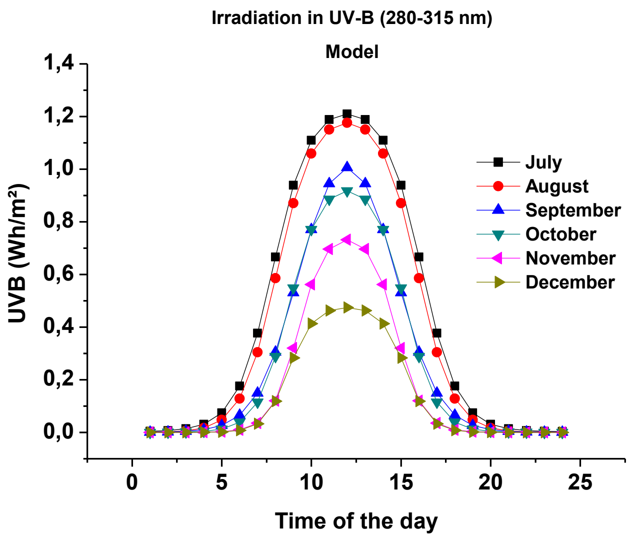

Figure 8. Variation of irradiation in Ultraviolet A according to the model (July – December)

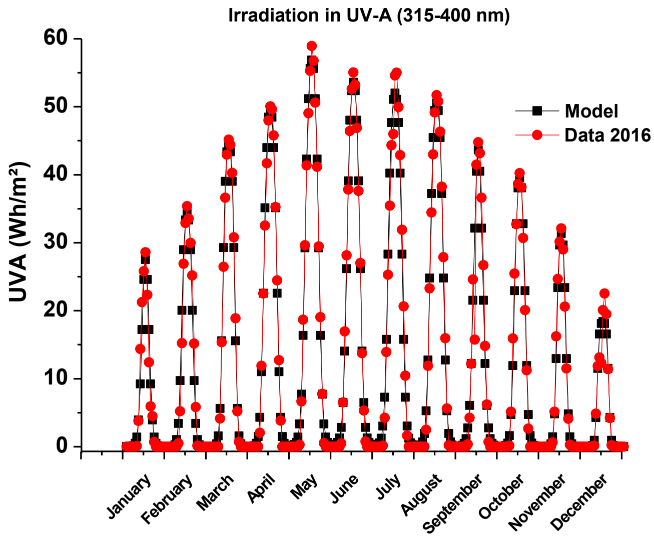

Figure 9. comparison of irradiation in Ultraviolet A according to the database and the model (July – December)

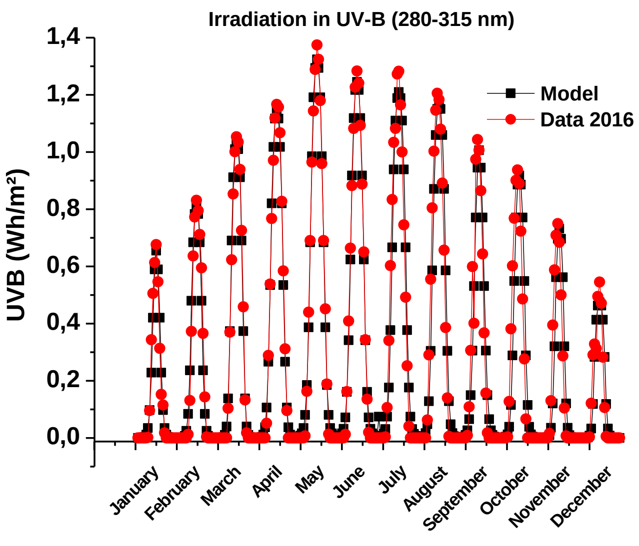

Figure 10. comparison of irradiation in Ultraviolet B according to the database and the model (July – December)

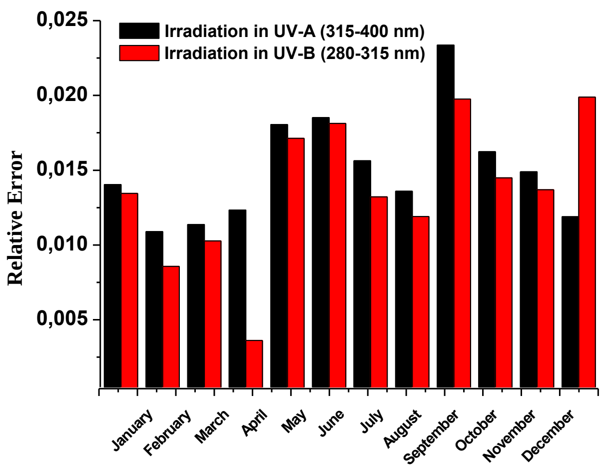

Figure 11. Relative error of irradiation in Ultraviolet A and B (July – December)

In this time we illustrate the radiation of Ultraviolet A and B as a function of the months of the year see Figure 9 and 10, we can be seen that the variation of each peak shows the evolution, such as Gaussian curves which beginning with low value and maximize in high value in the months of the May, June and July. The approximation together between the database and the model proposed, which it shows a good prediction.

The relative error show that the prediction form gives good approximations which varying between 0.5 to 2.5 %. We can be selected a maximum relative error in the month of September and a minimum in the month of April but by low relative error.

5. Conclusion

The result gives during the year of 2016 about all months, we are trying to give a theoretical form of prediction this variation of the radiation of ultraviolet A and B. The aims this study is how are we function this prediction in the computer for simulation something need the values of Ultraviolet. The study shows a good approximation between the database and the prediction form of Ultraviolet A and B by relative error arrive to 2.5 %.

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although they may not agree with all of the interpretations/conclusions of this paper.

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