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Sensitivity of isoprene emissions estimated using MEGAN to the time resolution of input climate data - Supplementary material

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1 Diurnal cycles

In order to generate hourly data values for temperature and radiation from single daily or monthly average values we have imposed diurnal cycles in the form of sinusoidal functions. The equations used for these cycles are shown below:

Temperature: When deriving the daily (or monthly) average temperatures we also calculate the diurnal temperature range. We assume that the range is symmetrical about the mean and that the minimum temperature occurs at 06:00 LT and the maximum at 14:00 LT everywhere. The profile is then calculated from:

$$\theta = (\theta_m + \Delta\theta) \times \sin^2\theta_T + (\theta_m - \Delta\theta) \times \cos^2\theta_T \tag{1}$$

where θ_m is the daily (or monthly) mean temperature, $\Delta\theta$ is the amplitude of the profile (taken to be half of the daily temperature range) and θ_T is the temperature variation angle, given by:

$$\theta_T = \frac{\phi_T}{8} \times \frac{\pi}{2} \tag{2}$$

for times between 06:00 and 14:00, and:

$$\theta_T = \frac{\phi_T + 8}{16} \times \frac{\pi}{2} \tag{3}$$

for times between 14:00 and 06:00, where ϕ_T is the time elapsed since 06:00.

Radiation: We use the daily (or monthly) average radiation and determine the local times of dawn and dusk for each grid cell. The radiation is set to zero for times between dusk and dawn; during daylight hours the radiation is calculated from:

$$R = (R_m \sin R_T) \times \frac{12\pi}{\Delta T} \tag{4}$$

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where R_m is the daily (or monthly) mean radiation, ΔT is the length of time between dawn and dusk, and R_T is the radiation variation angle, given by:

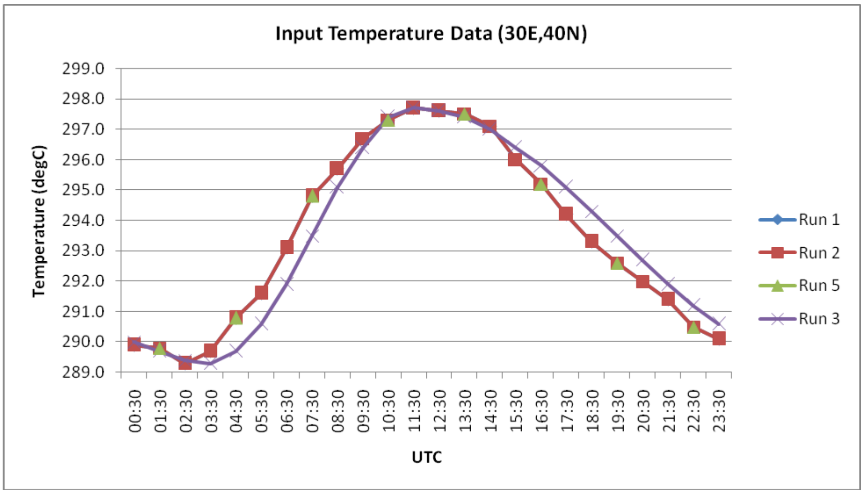
$$R_T = \phi_R \times \frac{\pi}{\Delta T} \tag{5}$$

where ϕ_R is the time elapsed since dawn (LT).

We have analysed the profiles generated from our diurnal cycles for temperature and radiation to investigate why the consistent decrease in emissions occurs when average climate input data were used. Although the temperature and/or radiation values are not always a precise match, there is no evidence of a systematic bias in the profiles. Rather, the discrepancies appear to arise as a result of the presence of clouds, as shown in Figures 1 and 2 below.

Figure 1 shows typical temperature and radiation profiles generated by the algorithms described above, against the original hourly or 3 hourly data. The plots show good agreement between the timing and magnitude of the maximum and minimum temperature radiation values from the different data sets.

Figure 2 illustrates the effect of clouds on the profiles (at the same location as above). In this instance, in January, a front moved through causing both temperature and radiation to fall sharply in a way not predicted by the simple diurnal cycle. The temperature in the second air mass is notably higher, a feature that is not captured by our profile. The drop in radiation resulted in a low average value for the day which led to a significant underestimation in radiation values in the morning and early afternoon from our diurnal cycle. Cloud effects cannot easily be included in a simple diurnal model of temperature and radiation and we are satisfied that for the most part our algorithms generate data that fits closely with the original hourly data.



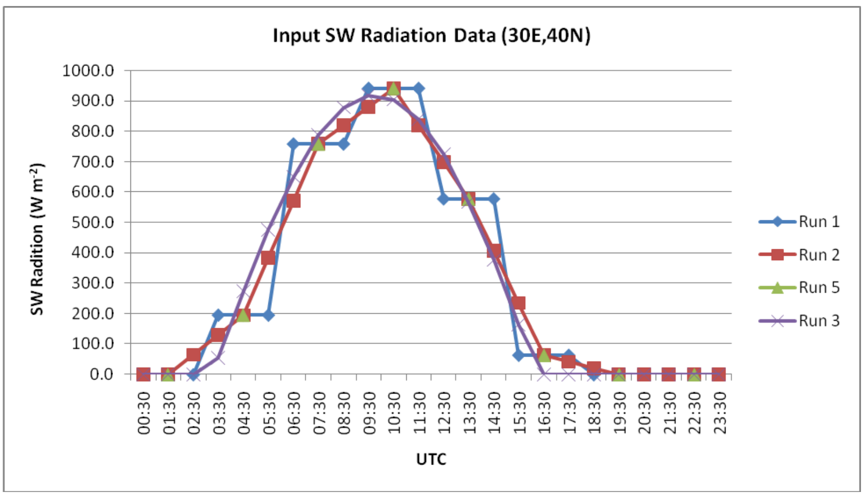
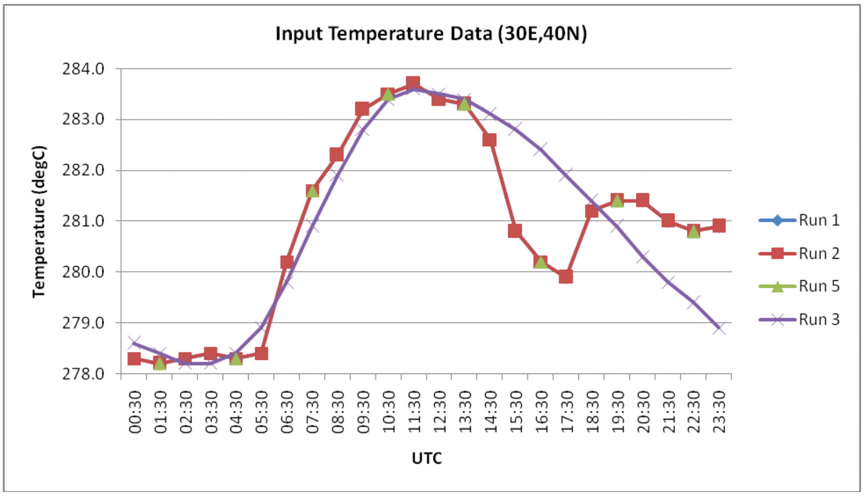


Fig. 1. Typical temperature (top) and radiation (bottom) values for the original hourly or 3 hourly data as used in Runs 1, 2 and 5 together with the profiles generated from daily average temperature and radiation data using the diurnal profile described above



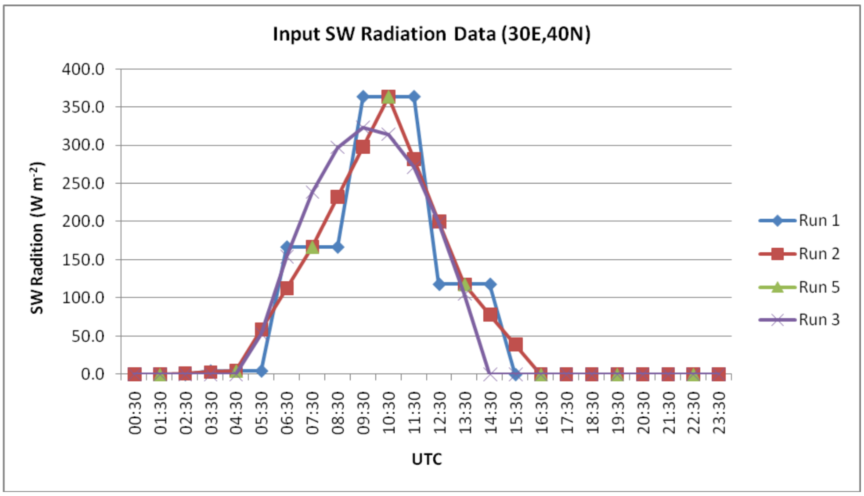


Fig. 2. Temperature (top) and radiation (bottom) profiles as described in Figure 1 above for a day in January that demonstrates the problems associated with clouds