Exercise #1 SP.769 PV Solar Energy Systems
Fall 2004

In the handout on the geometry of the solar resource, we deduced that the total radiation impinging upon a "horizontal" surface in space, i.e., outside the earth's atmosphere at a latitude = λ is given by

$$H_{ext} = \frac{24}{\pi}\phi_{ext}\cos\delta\cos\lambda[\sin\omega_{ss} - \omega_{ss}\cos\omega_{ss}]$$

where d is the declination at any day of the year, *n*

$$\delta = 23.45 \cdot \sin\left(360 \cdot \frac{284 + n}{365}\right)$$

and ω_{ss} is the hour angle at sunrise/sunset (in radians), measured from solar noon, positive to the west.

$$\omega_{sunrise/sunset} = \omega_{ss} = \arccos[-\tan\delta\tan\lambda]$$

A "clearness index" K_T, was also defined in the handout: It is defined as the ratio of monthly average, daily total horizontal insolation on the earth's surface $\overline{H}$, as measured with an instrument, to the monthly average, daily total horizontal insolation outside the atmosphere, in outer space, $\overline{H}_{ext}$, computed in accord with the equation above - setting the day number, *n*, to a day in the middle of the month.

$$K_T = \overline{H} / \overline{H}_{ext}$$

The *Solar Radiation Data Manual for Flat-Plate and Concentrating Collectors* (link to web site found on our Stellar site) gives the monthly average, daily total horizontal insolation, H, for many cities in the US. (This is Column C, the one labeled "Flat-plate Collector, Facing South, at Fixed Tilt = 0". Does the "Facing South" mean anything in this case?)

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Your task is to pick a city near your home town (or any city if your home town is not in the US) and compute monthly values for the clearness index. Note that for any month there are many years worth of data so construct an average (of an average!) in estimating K_T using at least some of the years and give some idea of the "spread" of the data.

You are encouraged to use a spread sheet but that's is not necessary. If you need help in doing so (or anything) stop by Monday or Tuesday or Wednesday (email me before).

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