CEE 599C

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Assignment 1: Radiation

The net radiation non-closure are calculated in two selected sites, and energy budget non-closure are also calculated using the MTCLIM algorithms.

1. Selection of sites:

We selected two sites from FluxNet sites, Niwot Ridge, Colorado, USA (40.0328, -105.5464) and Kendall Grassland, Arizona, USA (31.7365, -109.9419). These two sites have, relatively, sufficient data we will need. Data are downloaded from:
http://cdiac.esd.ornl.gov/programs/ameriflux/data_system/aamer.html

2. Extraction of variables:

Six years of data are extracted from the website for the following variables:

Downward solar radiation
Downward longwave radiation
Emitted longwave radiation
Reflected solar radiation
Net radiation
Latent heat flux
Ground heat flux
Sensible heat flux
Surface air temperature

Data runs from 2002/01/01 to 2012/12/31 at the time step of half-hourly. Missing data are filled based on data at previous time.

3. Non-closure in the net radiation

Non-closure in the net radiation is calculated as:

$$Rn - (Rg - RgOut + Rgl - RglOut)$$

Where Rn is the observed net radiation, Rg is downward solar radiation, RgOut is emitted solar radiation, Rgl is downward longwave radiation, RglOut is emitted longwave radiation.

Niwot

Figure 1 and Figure 3 show the observed net radiation, solar radiation and longwave radiation by diurnal and seasonal cycle, respectively. Figure 2 and Figure 4 show the net radiation non-closure by diurnal and seasonal cycle, respectively.

From Figure 2, net radiation non-closure is relatively lower during the daytime than that at night; since longwave radiation remains higher at night, it can account for the difference.
From Figure 4, net radiation non-closure is relatively lower at winter and spring than that at summer and autumn; and since longwave radiation remains higher at summer and autumn, it can account for the difference.

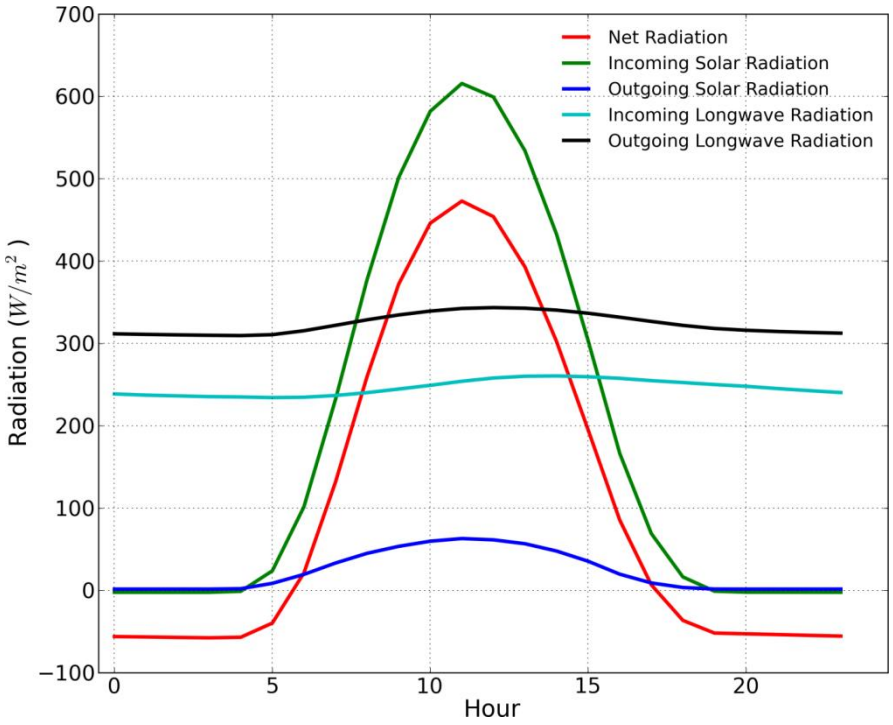

Figure 1 Observed radiation by diurnal cycle at Niwot

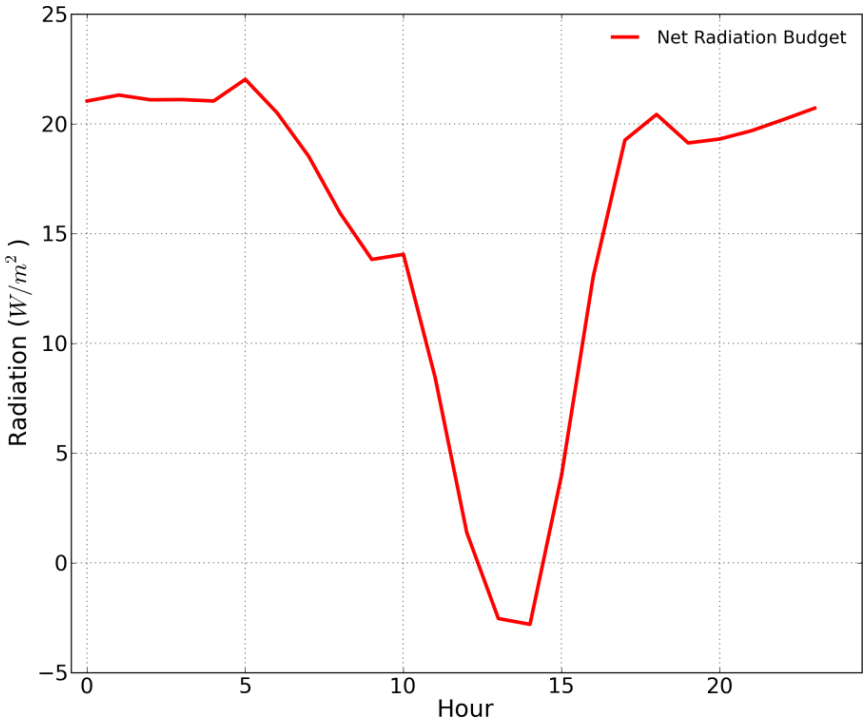

Figure 2 Net radiation non-closure by diurnal cycle at Niwot

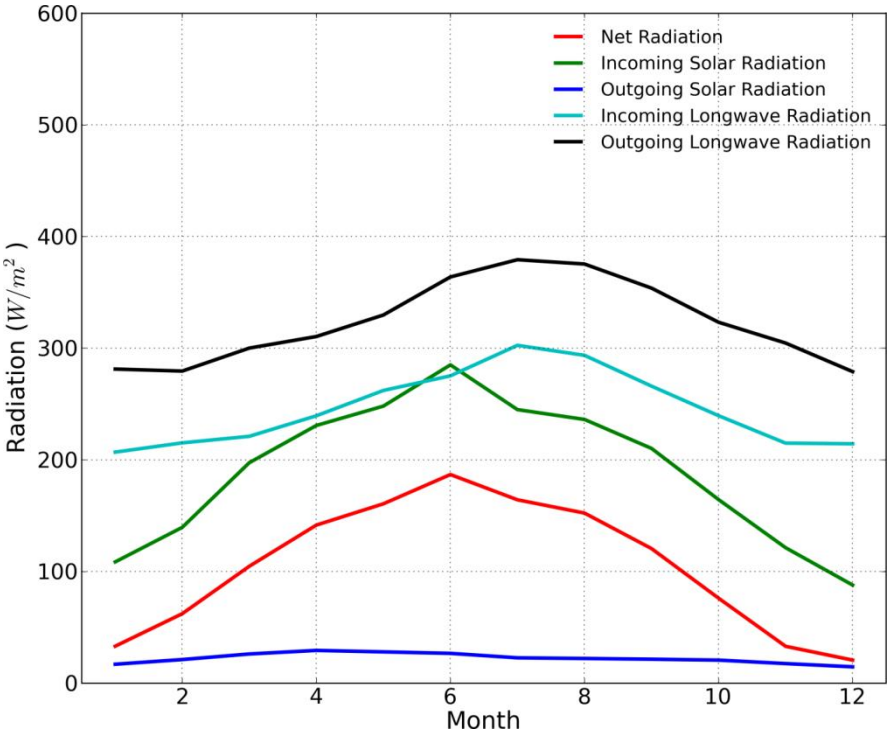

Figure 3 Observed radiation by seasonal cycle at Niwot

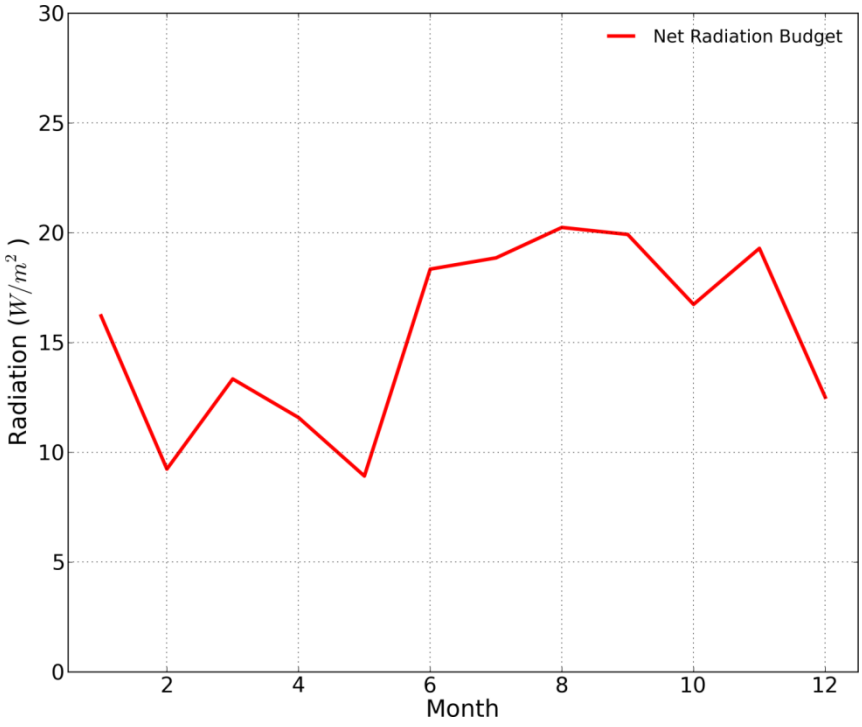

Figure 4 Net radiation non-closure by seasonal cycle at Niwot

Kendall

Figure 5 and Figure 7 show the observed net radiation, solar radiation and longwave radiation by diurnal and seasonal cycle, respectively. Figure 6 and Figure 8 show the net radiation non-closure by diurnal and seasonal cycle, respectively.

Figure 6 and Figure 8 show that the net radiation non-closure is very small both by diurnal and seasonal cycle, and this indicates that some variable of downloaded data have been computed instead of observed.

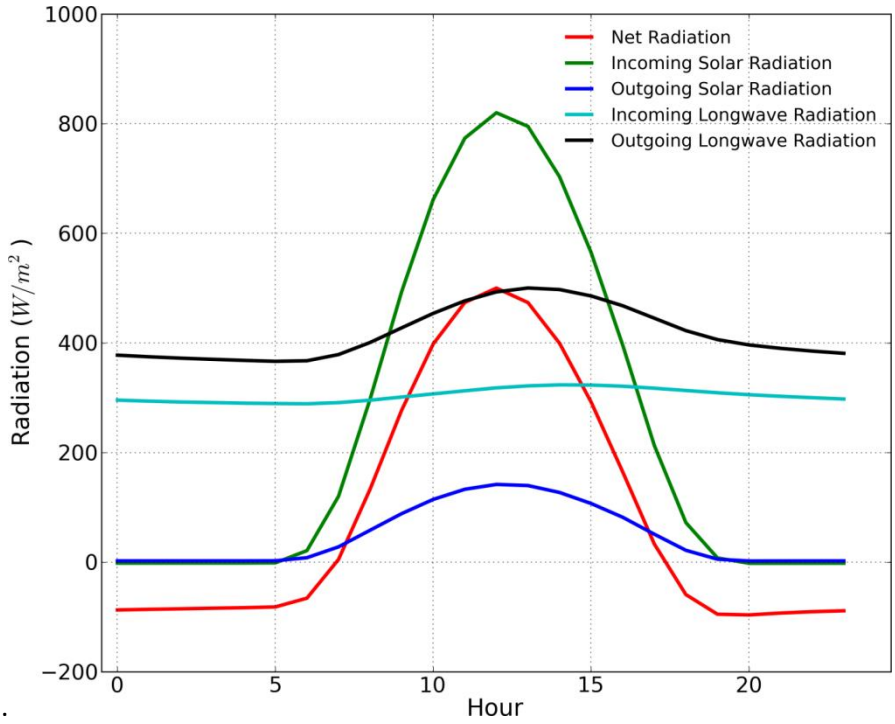

Figure 5 Observed radiation by diurnal cycle at Kendall

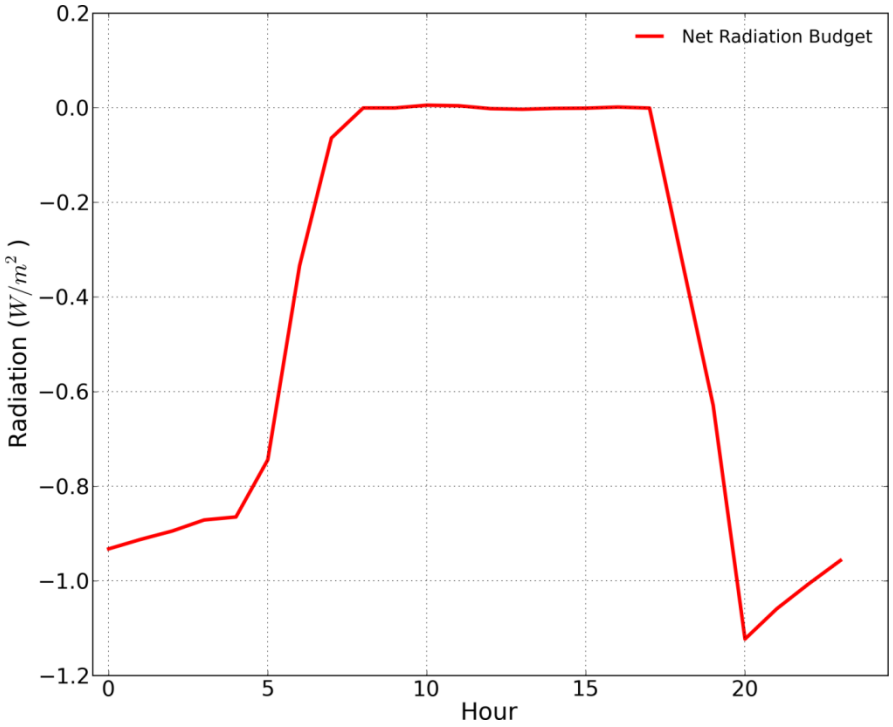

Figure 6 Net radiation Budget by diurnal cycle at Kendall

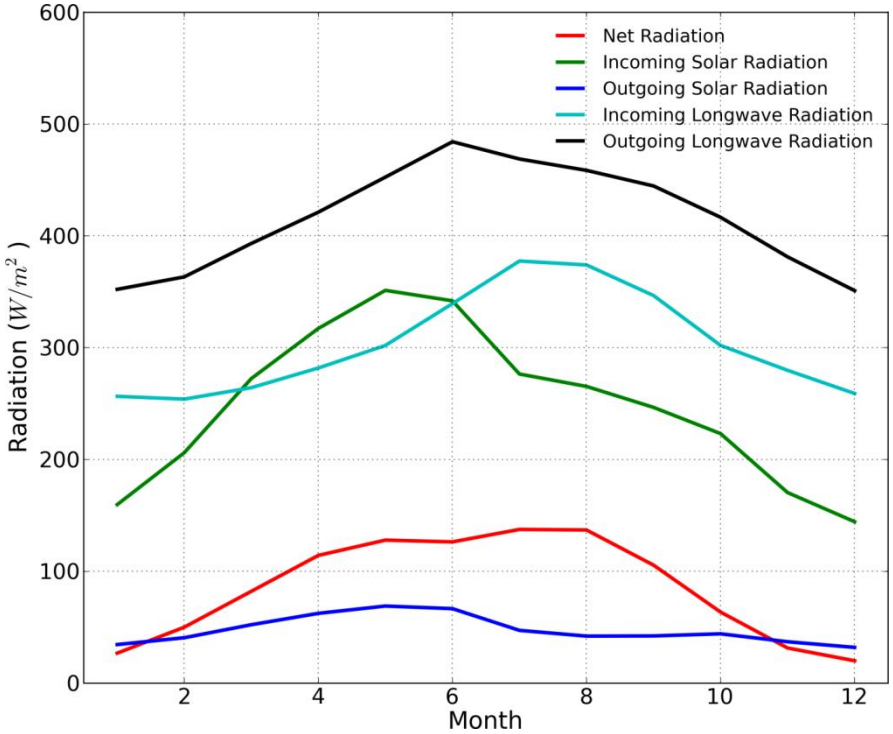

Figure 7 Observed radiation by seasonal cycle at Kendall

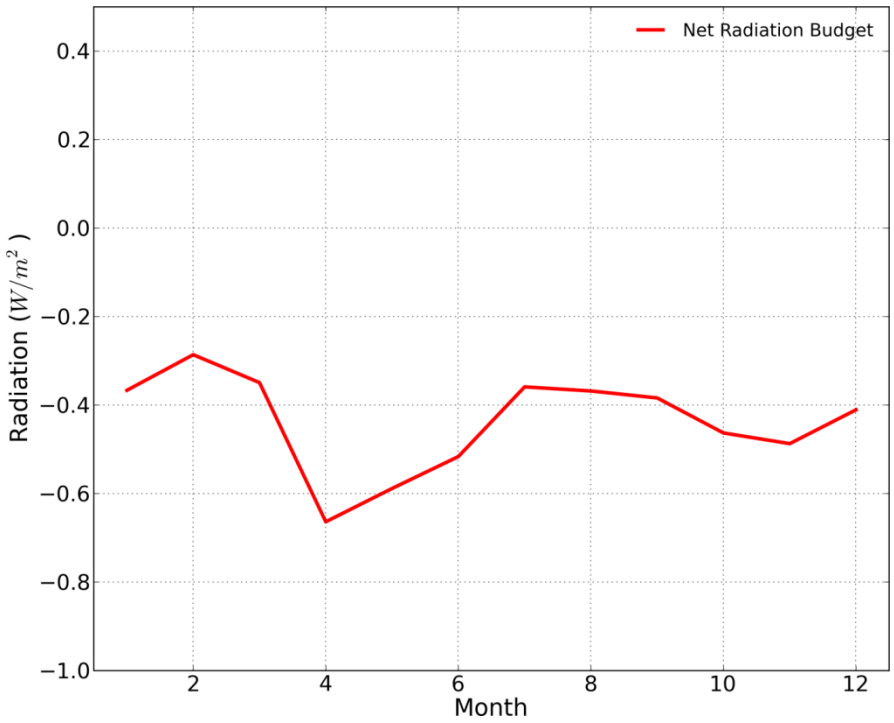

Figure 8 Net radiation Budget by seasonal cycle at Kendall

4. Energy budget non-closure

Energy budget non-closure is computed as

$$Rn - H - LE - FG$$

Where Rn is observed net radiation, H is sensible heat flux, LE is latent heat flux, FG is ground heat flux.

Niwot

Figure 9 and Figure 10 show the energy budget non-closure by diurnal and seasonal cycle at Niwot.

The diurnal cycle shows the energy budget peaks at about 100 W/m^2 at noon, when net radiation, latent heat flux and sensible heat flux all peak. The ground heat flux remains close to zero during the whole day, which could due to lack of data or difficulty of measurement.

The seasonal cycle shows the energy budget peaks in May, and is generally higher in summer than in other seasons. And still, the ground heat flux can account for the energy budget errors.

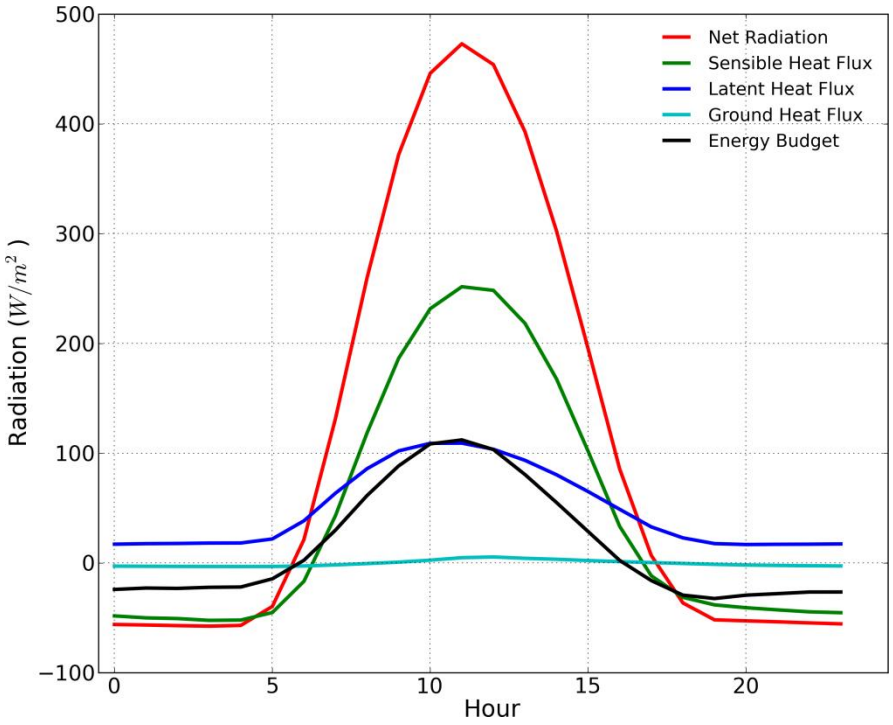

Figure 9 Energy budget non-closure by diurnal cycle at Niwot

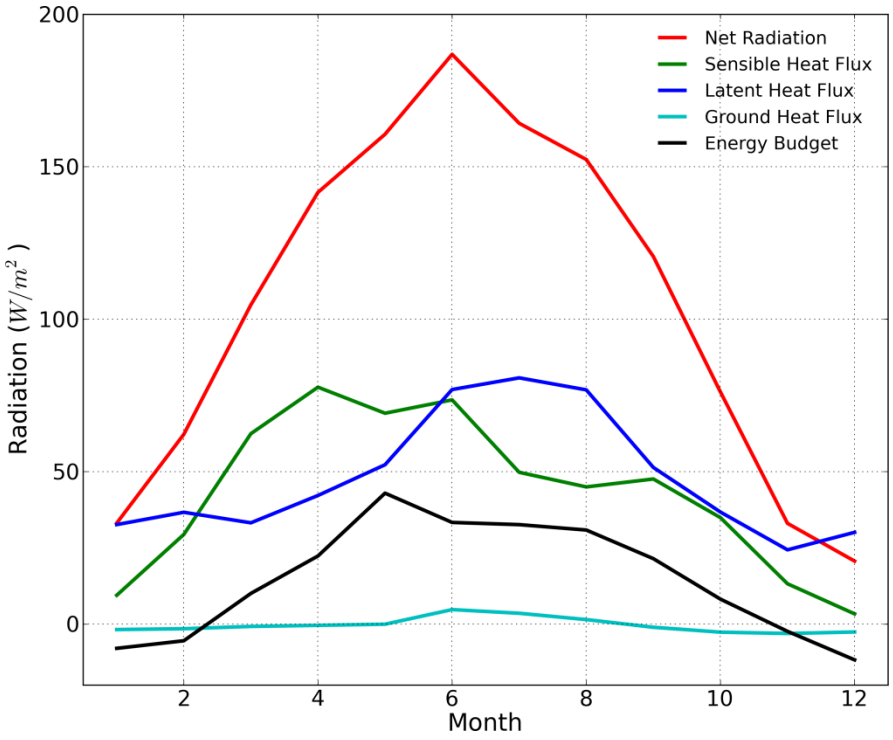

Figure 10 Energy budget non-closure by seasonal cycle at Niwot

Kendall

Figure 11 and Figure 12 show the energy budget non-closure by diurnal and seasonal cycle at Kendall.

The diurnal cycle shows the energy budget peaks at about 100 W/m^2 at 10 in the morning. The latent heat flux remains low for almost whole day, which I think could explain the energy budget errors.

The seasonal cycle shows the energy budget is higher in summer than in other seasons. Figure 12 shows the sensible heat flux drops in summer, which I think could have largely led to the positive energy budget errors in summer

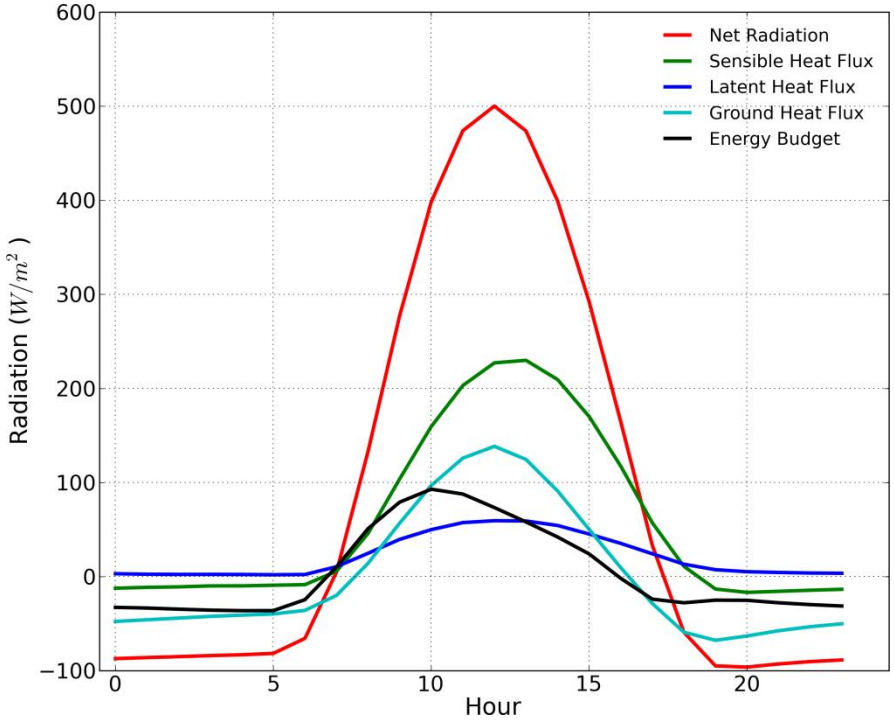

Figure 11 Energy budget non-closure by diurnal cycle at Kendall

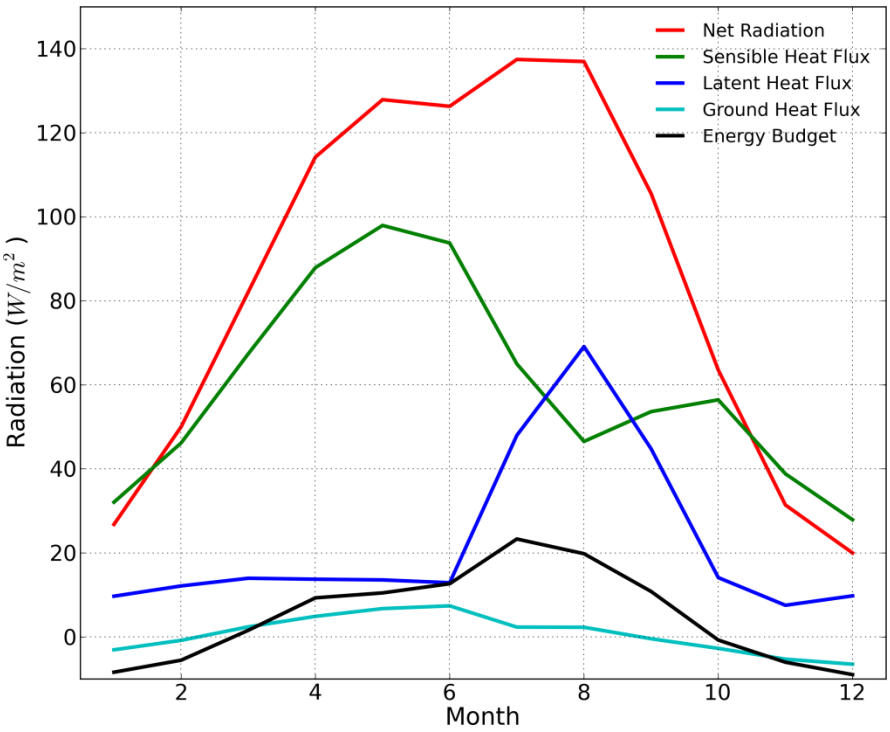

Figure 12 Energy budget non-closure by seasonal cycle at Kendall