Appendix 8-A

PHOTOSYNTHETIC ACTIVE RADIATION (PAR) WORKSHEETS

Calibration PAR Worksheet

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20050208: This program is from a diskette provided with the following reference;
         S. Lawrence Dingman, Physical Hydrology, University of New Hampshire, Macmillan Publishing Co., NY, 1994.

SOLARRAD.WK1        DAILY GLOBAL RADIATION ON AN INCLINED SURFACE
                    See Appendix E.
             Units: MJ = MJ/m^2 h; W = W/m^2; cal = cal/cm^2 day
Solar Con (Isc) =     4.921  MJ      =     1367  W       =      2821  cal
========= ========= ========= ========= ========= ========= =========== =========
--------> ENTER               LOCATION: Jaffrey NH
--------> ENTER     LATITUDE  (Lambda):   42.800  degrees=>      0.747  radians
--------> ENTER     SLOPE ANG LE(beta):    0.000  degrees=>      0.000  radians
--------> ENTER SLO PE AZIMUT H(alpha):    0.000  degrees=>      0.000  radians
--------> ENTER          YEAR  DAY (J):     217  => Date =     04-Aug
--------> ENTER OPTICAL AIR MASS (Mopt) FROM FIG. E-4:           3.2            QUAL2e: keep at 3.2
--------> ENTER     AIR TEMP:     24.0  C
--------> ENTER     REL HUM:        70  %
Vap Pres=    20.95  mb DewPt=     18.2  C  Precip  Water =         3.4  cm
--------> ENTER     SURFACE   ALBEDO:       0.05                                ALBEDO = Surface Reflectivity (set =~ 0.05 for water)
--------> ENTER     DUST ATTENUATION (gamma-dust):               0.06           Dust Attenuation: Range = 0 - 0.15 per QUAL2E
========= ========= ========= ========= ========= ========= =========== =========
HORIZONTAL          Day Angle (Gamma) =    3.718  radians =   213.041  degrees
             Decli nation    (delta) =    0.300  radians =    17.192  degrees
     Ecce ntricity  ro/r)^2 =             0.971
  Sunrise     Thr =   -7.110  h  Sunset     Ths =    7.110  h
PolarSum      Thr =           h  Sunset     Ths =           h
PolarWin      Thr =           h  Sunset     Ths =           h
      Day Length =  14.220   h          PolarSum            PolarWin
Extraterr    K'ET =   38.163  MJ      =  1.06E+04  W      =     911.557  cal
PolarSum*    K'ET =            MJ      =  0.00E+00  W      =       0.000  cal
                     tau-sa =    0.504      tau =    0.444
Direct      K'dir =   16.949  MJ      =  4.71E+03  W      =     404.852  cal
PolarSum* K'dir =              MJ      =  0.00E+00  W      =       0.000  cal
                      tau-s =    0.646  gamma-s =    0.414
Diffuse     K'dif =    7.909  MJ      =  2.20E+03  W      =     188.911  cal
PolarSum* K'dif =              MJ      =  0.00E+00  W      =       0.000  cal
Global        K'g =   24.858  MJ      =  6.91E+03  W      =     593.763  cal
PolarSum*    K'g =             MJ      =  0.00E+00  W      =       0.000  cal
Backscat     K'bs =    0.258  MJ      =  7.16E+01  W      =       6.153  cal
PolarSum*   K'bs =             MJ      =  0.00E+00  W      =       0.000  cal
CLEAR SK    K'cs =   25.116  MJ      =  6.98E+03  W      =     599.915  cal <===
POLARSUM*                      MJ      =  0.00E+00  W      =       0.000  cal <===
========= ========= ========= ========= ========= ========= =========== =========
SLOPE:        Delta   Omega =    0.000  radians =    0.000  degrees
Equivalent Latitude       =    0.747  radians =   42.800  degrees
             Noon =    0.000  h            0.000  radians =      0.000  degrees
 Sunrise    (Tsr) =   -7.110  h           -1.861  radians =   -106.648  degrees
  Sunset    (Tss) =    7.110  h            1.861  radians =    106.648  degrees
      Day  Length =   14.220  h
Extraterr    K ET =   27.752  MJ      =  7.71E+03  W      =     662.892  cal
Polar Sum* K ET =     23.032  MJ      =  6.40E+03  W      =     550.142  cal
CLEAR SKY     Kcs =   20.492  MJ      =  5.69E+03  W      =     489.475  cal <===
POLARSUM*             10.229  MJ      =  2.84E+03  W      =     244.336  cal <===
SlopeFactor (f sd) Direct =     0.727      Polar   Sum* =    #DIV/0!
SlopeFactor (f sl)  Total =     0.816      Polar   Sum* =    #DIV/0!
========= ========= ========= ========= ========= ========= =========== =========
        * Ignore "Polar Summer" results unless other values = ERR
        * If all values = ERR, clear-sky radiation = 0.
```

BTU/ft2	Fraction available for photosynthesis	Fraction Cloud Cover	Forest Canopy Density	QUAL2e Total Daily Solar Radiation (Input for Option 2 Light Ave Method) = Total Daily PAR
2211.888	0.440	0.010	0.010	962.304
Range	.43-.45	0-1.0	0-1.0	

Verification PAR Worksheet

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20050208: This program is from a diskette provided with the following reference;
         S. Lawrence Dingman, Physical Hydrology, University of New Hampshire, Macmillan Publishing Co., NY, 1994.

SOLARRAD.WK1        DAILY GLOBAL RADIATION ON AN INCLINED SURFACE
                    See Appendix E.
             Units: MJ = MJ/m^2 h; W = W/m^2; cal = cal/cm^2 day
Solar Con (Isc) =     4.921  MJ      =     1367  W       =      2821  cal
========= ========= ========= ========= ========= ========= =========== =========
--------> ENTER               LOCATION: Jaffrey NH
--------> ENTER     LATITUDE  (Lambda):  42.800  degrees=>      0.747  radians
--------> ENTER     SLOPE ANG LE(beta):   0.000  degrees=>      0.000  radians
--------> ENTER SLO PE AZIMUT H(alpha):   0.000  degrees=>      0.000  radians
--------> ENTER          YEAR  DAY (J):     224  => Date =     11-Aug
--------> ENTER OPTICAL AIR MASS (Mopt) FROM FIG. E-4:           3.2           QUAL2e: keep at 3.2
--------> ENTER     AIR TEMP:     24.0  C
--------> ENTER     REL HUM:        70  %
Vap Pres=    20.95  mb DewPt=     18.2  C  Precip  Water =        3.4  cm
--------> ENTER     SURFACE   ALBEDO:       0.05                             ALBEDO = Surface Reflectivity (set =~ 0.05 for water)
--------> ENTER     DUST ATTENUATION (gamma-dust):              0.06         Dust Attenuation: Range = 0 - 0.15 per QUAL2E
========= ========= ========= ========= ========= ========= =========== =========
HORIZONTAL          Day Angle (Gamma) =    3.839  radians =    219.945  degrees
              Decli nation    (delta) =    0.265  radians =     15.211  degrees
     Ecce ntricity (ro/r)^2 =             0.973
  Sunrise     Thr =   -6.972  h  Sunset     Ths =    6.972  h
PolarSum      Thr =           h  Sunset     Ths =           h
PolarWin      Thr =           h  Sunset     Ths =           h
      Day Length =  13.944   h          PolarSum            PolarWin
Extraterr    K'ET =   36.976  MJ     =  1.03E+04  W      =     883.221  cal
PolarSum*   K'ET =            MJ     =  0.00E+00  W      =       0.000  cal
                     tau-sa =    0.504      tau =    0.444
Direct      K'dir =   16.422  MJ     =  4.56E+03  W      =     392.266  cal
PolarSum* K'dir =             MJ     =  0.00E+00  W      =       0.000  cal
                      tau-s =    0.646  gamma-s =    0.414
Diffuse    K'dif =     7.663  MJ     =  2.13E+03  W      =     183.039  cal
PolarSum* K'dif =             MJ     =  0.00E+00  W      =       0.000  cal
Global        K'g =   24.085  MJ     =  6.69E+03  W      =     575.305  cal
PolarSum*   K'g =             MJ     =  0.00E+00  W      =       0.000  cal

Backscat     K'bs =    0.250  MJ     =  6.93E+01  W      =       5.961  cal

PolarSum*  K'bs =             MJ     =  0.00E+00  W      =       0.000  cal
CLEAR SK   K'cs =   24.335  MJ     =  6.76E+03  W      =     581.267  cal <===
POLARSUM*                     MJ     =  0.00E+00  W      =       0.000  cal <===
========= ========= ========= ========= ========= ========= =========== =========
SLOPE:        Delta   Omega =    0.000  radians =    0.000  degrees
Equivalent Latitude       =    0.747  radians =   42.800  degrees
              Noon =    0.000  h            0.000  radians =      0.000  degrees
 Sunrise    (Tsr) =   -6.972  h           -1.825  radians =   -104.583  degrees
  Sunset    (Tss) =    6.972  h            1.825  radians =    104.583  degrees
      Day  Length =   13.944  h
Extraterr    K ET =   28.264  MJ     =  7.85E+03  W      =     675.125  cal
Polar Sum* K ET =     20.491  MJ     =  5.69E+03  W      =     489.457  cal
CLEAR SKY     Kcs =   20.466  MJ     =  5.69E+03  W      =     488.845  cal <===
POLARSUM*              9.101  MJ     =  2.53E+03  W      =     217.384  cal <===
SlopeFactor (f sd) Direct =     0.764      Polar   Sum* =    #DIV/0!
SlopeFactor (f sl)  Total =     0.841      Polar   Sum* =    #DIV/0!
========= ========= ========= ========= ========= ========= =========== =========
        * Ignore "Polar Summer" results unless other values = ERR
        * If all values = ERR, clear-sky radiation = 0.
```

BTU/ft2	Fraction available for photosynthesis	Fraction Cloud Cover	Forest Canopy Density	QUAL2e Total Daily Solar Radiation (Input for Option 2 Light Ave Method) = Total Daily PAR
2143.130	0.440	0.500	0.010	630.239
Range	.43-.45	0-1.0	0-1.0	

7Q10 PAR Worksheet

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20050208: This program is from a diskette provided with the following reference;
         S. Lawrence Dingman, Physical Hydrology, University of New Hampshire, Macmillan Publishing Co., NY, 1994.

SOLARRAD.WK1        DAILY GLOBAL RADIATION ON AN INCLINED SURFACE
                    See Appendix E.
             Units: MJ = MJ/m^2 h; W = W/m^2; cal = cal/cm^2 day
Solar Con (Isc) =     4.921  MJ      =     1367  W       =      2821  cal
========= ========= ========= ========= ========= ========= =========== =========
--------> ENTER               LOCATION: Jaffrey NH
--------> ENTER     LATITUDE  (Lambda):   42.800  degrees=>     0.747  radians
--------> ENTER     SLOPE ANG LE(beta):    0.000  degrees=>     0.000  radians
--------> ENTER SLO PE AZIMUT H(alpha):    0.000  degrees=>     0.000  radians
--------> ENTER          YEAR  DAY (J):     183  => Date =    01-Jul
--------> ENTER OPTICAL AIR MASS (Mopt) FROM FIG. E-4:          3.2          QUAL2e: keep at 3.2
--------> ENTER     AIR TEMP:     27.0  C
--------> ENTER     REL HUM:        70  %
Vap Pres=    25.04  mb DewPt=     21.1  C  Precip  Water =        4.1  cm
--------> ENTER     SURFACE   ALBEDO:      0.05                          ALBEDO = Surface Reflectivity (set =~ 0.05 for water)
--------> ENTER     DUST ATTENUATION (gamma-dust):              0.06     Dust Attenuation: Range = 0 - 0.15 per QUAL2E
========= ========= ========= ========= ========= ========= =========== =========
HORIZONTAL          Day Angle (Gamma) =    3.133  radians =   179.507  degrees
              Decli nation    (delta) =    0.403  radians =    23.112  degrees
     Ecce ntricity  ro/r)^2 =             0.967
  Sunrise     Thr =   -7.552  h  Sunset    Ths =    7.552  h
PolarSum      Thr =           h  Sunset    Ths =           h
PolarWin      Thr =           h  Sunset    Ths =           h
     Day Length =  15.104  h        PolarSum           PolarWin
Extraterr    K'ET =   41.688  MJ     =  1.16E+04  W      =    995.749  cal
PolarSum*    K'ET =            MJ     =  0.00E+00  W      =      0.000  cal
                     tau-sa =    0.472      tau =    0.412
Direct      K'dir =   17.173  MJ     =  4.77E+03  W      =    410.188  cal
PolarSum* K'dir =             MJ     =  0.00E+00  W      =      0.000  cal
                      tau-s =    0.619  gamma-s =    0.441
Diffuse    K'dif =     9.193  MJ     =  2.55E+03  W      =    219.593  cal
PolarSum* K'dif =             MJ     =  0.00E+00  W      =      0.000  cal
Global        K'g =   26.366  MJ     =  7.32E+03  W      =    629.781  cal
PolarSum*    K'g =            MJ     =  0.00E+00  W      =      0.000  cal
```

BTU/ft2	Fraction available for photosynthesis	Fraction Cloud Cover	Forest Canopy Density	QUAL2e Total Daily Solar Radiation (Input for Option 2 Light Ave Method) = Total Daily PAR
2347.607	0.440	0.050	0.010	994.332
Range	.43-.45	0-1.0	0-1.0	

```
Backscat     K'bs =    0.291  MJ     =  8.08E+01  W      =      6.944  cal

PolarSum*  K'bs =             MJ     =  0.00E+00  W      =      0.000  cal
CLEAR SK   K'cs =    26.657  MJ     =  7.41E+03  W      =    636.726  cal <===
POLARSUM*                     MJ     =  0.00E+00  W      =      0.000  cal <===
========= ========= ========= ========= ========= ========= =========== =========
SLOPE:        Delta   Omega =    0.000  radians =    0.000  degrees
Equivalent Latitude       =    0.747  radians =   42.800  degrees
             Noon =    0.000  h            0.000  radians =      0.000  degrees
 Sunrise    (Tsr) =   -7.552  h           -1.977  radians =   -113.279  degrees
  Sunset    (Tss) =    7.552  h            1.977  radians =    113.279  degrees
      Day  Length =   15.104  h
Extraterr    K ET =   24.362  MJ     =  6.77E+03  W      =    581.916  cal
Polar Sum* K ET =     30.447  MJ     =  8.46E+03  W      =    727.259  cal
CLEAR SKY     Kcs =   19.520  MJ     =  5.42E+03  W      =    466.251  cal <===
POLARSUM*             12.542  MJ     =  3.48E+03  W      =    299.587  cal <===
SlopeFactor (f sd) Direct =     0.584      Polar   Sum* =    #DIV/0!
SlopeFactor (f sl)  Total =     0.732      Polar   Sum* =    #DIV/0!
========= ========= ========= ========= ========= ========= =========== =========
        * Ignore "Polar Summer" results unless other values = ERR
        * If all values = ERR, clear-sky radiation = 0.
```