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! _____________________________________________________________
! This program computes the length of sunlight of each month by
! averaging from the first and last day of that month
!
! Input:  lat    [the latitude in degress]
!         j      [the Julian day number or day of year]
! Output: q      [the solar flux per unit surface area in W/m2
!         qdaily [daily mean value of q]
!         h00    [the hour angle at sunrise or sunset in radians
!                 based on discrete time intervals of one hour
!         h0     [the hour angle at sunrise or sunset in radians]
!                 based on analytical form]
!         qinte  [daily mean value of q, from analytical form]
!
! Author: Liang Yang 1/31/2002
!
! Modifications:
! 1) output zenith angle
! 2) add several other terms
! Liang Yang 10/12/2005
!
! Modifications:
! 1) calculate the lenght of daylight first day and last of each
!    month and then average them as monthly mean value
! 2) improve accuracy to second
! Xavier 9/13/2010
!_____________________________________________________________
PROGRAM Hmwk1_3
IMPLICIT NONE
INTEGER,DIMENSION(37)                   ::    lats
INTEGER                                 ::    i,j,k,u,dlight
INTEGER,DIMENSION(4)                    ::    doy,hrs,mis,secs
DOUBLE PRECISION                        ::    t,qdaily,phi,fe,delta,h,czen,q,h00,h0,qin
te,qmean
DOUBLE PRECISION, PARAMETER             ::    pi = 3.1415926
REAL, PARAMETER                         ::    s0 = 1367. !Wm^-2
OPEN (100, FILE='hmwk1-3.dat')
WRITE(100,*) "Length of Sunlight During the Day for the First Day of Each Season"
WRITE(100,*)
WRITE(100,'(A10,A41)') ' Latitude', 'Sunlight time'
WRITE(100,'(A10,4A15)') ' (degree)', 'Mar 20 ','Jun 21 ','Sep 22',' Dec 21'
WRITE(100,180) '', 'Hour Min Sec', 'Hour Min Sec', 'Hour Min Sec', 'Hour Min Sec'
180 FORMAT(A10,4A16)
DO i=1,37
    lats(i) = 90 - (i-1)*5
END DO
doy = (/79,172,265,355/)
DO i=1,37
    DO k=1,4
        j = doy(k)
        phi = lats(i)*pi / 180.0              ! convert to radians.
        fe = 1 + 0.033*cos(2.*pi*j/365.)      !the eccentricity factor
                                              ! or the relative distance between Earth
and Sun
        delta = 0.4093*sin(2*pi*j/365.0 - 1.405) !the solar declination
                                                 !in radians
        h0 = acos(-tan(phi)*tan(delta))       !the hour angle at sunrise
                                              !or sunset
        qinte = (s0*fe/pi)*(h0*sin(phi)*sin(delta)+cos(phi)*cos(delta)*sin(h0))
                                              !daily mean in analytical form
        qdaily = 0.0
        dlight = 0
        DO u=1,86400
            t = (u - 0.5)/3600.               !the hour of day
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            h = pi*(t-12.)/12.               !the hour angle in radians
            czen = sin(phi)*sin(delta)+cos(phi)*cos(delta)*cos(h)
            q = s0*fe*czen
            IF(q.GT.0) dlight = dlight + 1
            IF (q.LT.0.) q = 0.              !negative means Sun is
                                             !below horizon, set to zero
            IF (q.GT.0.) h00 = h             !hour angle at sunset
            qdaily = qdaily + q              !get daily cumulative
         END DO
         hrs(k) = INT(dlight/3600)
         mis(k) = dlight-hrs(k)*3600
         mis(k) = INT(mis(k)/60)
         secs(k) = dlight - hrs(k)*3600  - mis(k)*60
         qmean = qdaily/(86400.)
      END DO
      WRITE(100,280) lats(i),hrs(1),mis(1),secs(1),hrs(2),mis(2),secs(2),hrs(3),mis(3),s
ecs(3),hrs(4),mis(4),secs(4)
END DO
280 FORMAT(I9,4(I8,2I4))
CLOSE(100)
END PROGRAM Hmwk1_3
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