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! ____________________________________________________________
! This program computes TOA solar radiation every hour for any
! location on Earth and any day of year
!
! 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 length of daylight
! 2) improve accuracy to second
! Xavier 9/13/2010
!____________________________________________________________
PROGRAM Hmwk1_1
IMPLICIT NONE
CHARACTER(15),PARAMETER                 ::    city = "Houston"
REAL,PARAMETER                          ::    lat = 29.76
INTEGER                                 ::    i,j,k,sec1,sec2,stat1,stat2
INTEGER,DIMENSION(1:12)                 ::    doy,dlight,hr,mi,sec
DOUBLE PRECISION,DIMENSION(1:12)        ::    qmean
CHARACTER(3),DIMENSION(1:12 )           ::    mon
DOUBLE PRECISION                        ::    t,qdaily,phi,fe,delta,h,czen,q,h00,h0,qin
te
DOUBLE PRECISION, PARAMETER             ::    pi = 3.1415926
REAL, PARAMETER                         ::    s0 = 1367. !Wm^-2
phi = lat*pi / 180.0                            ! convert to radians.
doy = (/1,32,60,91,121,152,182,213,244,274,305,335/)
mon = (/"Jan","Feb","Mar","Apr","May","Jun","Jul","Aug","Sep","Oct","Nov","Dec"/)
OPEN (100, FILE='hmwk1-2.dat')
WRITE(100,*) "Length of Sunlight During the Day for the First Day of Every Month"
WRITE(100,680) " for the City of ",city," with the latitude at ",lat," degree."
680 FORMAT(A,A12,A,F6.2,A)
WRITE(100,*)
WRITE(100,180) 'Month', 'Sunlight time', 'Daily flux'
WRITE(100,180) '', 'Hour Min Sec', 'W/m2'
180 FORMAT(A8,A18,A15)
DO k=1,12
    j = doy(k)
    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
    stat1 = 0
    stat2 = 0
    DO i=1,86400
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        t = (i - 1/2.0)/3600.                !the hour of day
        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(stat1.EQ.0 .AND. q.GT.0) THEN
            sec1 = i
            stat1 = 1
            stat2 = 1
        END IF
        IF(stat2.EQ.1 .AND. q.LT.0) THEN
            sec2 = i
            stat2 = 0
        END IF
        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
    dlight(k) = sec2 - sec1
    hr(k) = INT(dlight(k)/3600)
    mi(k) = dlight(k)-hr(k)*3600
    mi(k) = INT(mi(k)/60)
    sec(k) = dlight(k) - hr(k)*3600  - mi(k)*60
    qmean(k) = qdaily/(86400.)
    WRITE(100,280) mon(k),hr(k),mi(k),sec(k),qmean(k)
    280 FORMAT(A8,I8,2I5,F15.4)
END DO
CLOSE(100)
END PROGRAM Hmwk1_1
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