! This program computes TOA solar radiation every hour for any
! location on Earth and any day of year
!
! Input:  lat    [the latitude in degrees]
!         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,qinte
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 (100,180) 'Month', 'Sunlight time', 'Daily flux'
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
   WRITE (100,900) mon(k),hr,mi,sec,fe*delta*cos(h0),t,qinte,qdaily
900 FORMAT (A8,A18,A15,F12.6)
   END DO
WRITE (100,901) """""""""""""""""""""
901 FORMAT (A8)
END
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(A8,18,215,F15.4)
END DO
CLOSE(100)
END PROGRAM Hmwk1_1