# 1 equation_of_time

## 1.1 Introduction to equation_of_time

`equation_of_time` returns the difference between the standard mean day and the actual. This is the difference in minutes between the Sun's standard meridian and the actual transit. For example, a standard clock will indicate the passage from AM to PM at noon, while the actual maybe at 12:45 pm. This difference, 45 minutes, is the equation of time. There are two main causes – first is that the Earth's orbital speed varies throughout the year, and second that the Earth rotational axis is inclined to the orbital plane. The equation of time can also be used to display the observed position of the Sun in the sky during the day with respect to seasonal variation.

## 1.2 Definitions for equation_of_time

`equation_of_time_full(T, UT)` [Function]
Returns declination *dec*, equation of time *E* and ecliptic longitude *lambda*.

`equation_of_time(T, UT)` [Function]
Returns declination *dec* and equation of time *E*.

`analemma(day,month,year,tzi,ds)` [Function]
Returns declination *dec* and equation of time *E*.

`greenwich_hour_angle(UT, E)` [Function]
Returns the Greenwich hour angle (degrees).

`sun_hour_angle(phi, h, dec)` [Function]
Returns the sun hour angle (degrees).

`calculate_rise_time(T, lat, lon, sgn, h)` [Function]
Returns sunrise (if *sgn* = +1) or sunset (if *sgn* = -1) universal times in hours.

`julian_dow(dow,week,month,year)` [Function]
Returns the Julian day of nth *dow*. For example, for year 2016, 1st Sunday in November julian_dow(1,1,11,2016) and 2nd Sunday of March julian_dow(1,2,3,2016).

`day_of_year(day,month,year)` [Function]
Returns the day number of the year.

`DST(jd,ds)` [Function]
Returns standard Daylight savings correction.

`UT_to_local_time(UT,jd,tz,ds)` [Function]
Returns local time given universal time.

`local_to_UT_time(LT,jd,tz,ds)` [Function]
Returns universal time given local time.

`day_duration(T, jd, lat, lon, h)` [Function]
Returns the length of the day, from sunrise to sunset.

`observer_coord(`*`hour_angle, dec`*`, lat)` [Function]
Returns the observed azimuth and altitude given *hour_angle*, *dec* at observer latitude *lat*

`observer_coord_gha(`*`gha, dec`*`, lat, lon)` [Function]
Returns the observed azimuth and altitude given *gha*, *dec* at observer latitude *lat* longitude *lon*

`sun_alt_az(`*`jd,tz,ds,lat, lon, h`*`)` [Function]
Returns lists of azimuth and altitude, and labels.

`day` [Variable]
Day of month.

`dec` [Variable]
declination in degrees.

`dow` [Variable]
Day of week.

`ds` [Variable]
Daylight savings offset in hour.

`E` [Variable]
Equation of time in minutes.

`gha` [Variable]
Greenwich hour angle in degrees.

`h` [Variable]
Observer altitude above ground level in meters.

`hour_angle` [Variable]
Hour angle in degrees.

`jd` [Variable]
Julian day number.

`lambda` [Variable]
Ecliptic longitude in degrees.

`lat` [Variable]
Observer latitude in degrees.

`lon` [Variable]
Observer longitude in degrees.

`LT` [Variable]
Local time, e.g. time in Observer frame.

`month` [Variable]
Month of year.

`phi` [Variable]

Observer latitude in degrees.

`sgn` [Variable]

Setting. +1 for rise. -1 for set.

`T` [Variable]

Julian days in centuries from J2000.

`tz` [Variable]

Timezone offset in hours.

`tzi` [Variable]

Timeone offset in hours

`UT` [Variable]

Universal time in hours.

`week` [Variable]

Week of month.

`year` [Variable]

Conventional year number.

# Appendix A Function and variable index