

## **Sun Position Calculations**

Sun on the move allows calculations of the sun during flight or stationary. The program allows readouts for sunrise, sunset, start and end of twilight (calculation of imsak, Muslim prayer time), sun position (Azimuth and angle relative to the horizon). The calculations are based on either the center or the top rim of the sun (selectable). All calculations are corrected for refraction and altitude, but the horizon (and thus the sunrise / sunset calculation) does not account for mountains or clouds. Also calculated and displayed are the distance in NM (nautical miles), the ground speed in Kts (NM / hour) and the bearing in deg. (initial true track of the great circle between the two waypoints).

### **Entry formats:**

**Waypoint:** DDMM.M or DDDMM.MN

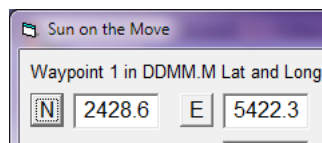
Latitude accepts 2 digits for degrees, 2 digits for minutes and 1 digit after the decimal point. Range: 0 – 9000.0

Longitude accepts 3 digits for degrees, 2 digits for minutes and 1 digit after the decimal point. Range: 0 – 18000.0

Leading '0' can be omitted, decimal point can be omitted.

Example: 24° 28' 35" / E 054° 22' 18"

enter as:



Caution: Minutes can not be omitted, e.g. 54°N / 30°W has to be entered as N 5400 W 3000.

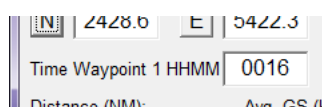
**Time:** HHMM, all entries and readouts are in UTC (GMT).

Time accepts 2 digits for hours and 2 digits for minutes.

Range: 0 – 2359

Example: 00:16am

Enter as:

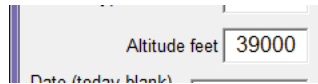


## Sun on the Move

**Altitude:** Observation altitude, all entries are in feet. Range 0 – 60000 ft.  
If altitude is left empty, 0 ft is used as default

Example: Flight Level 390 (39'000 feet)

Enter as:

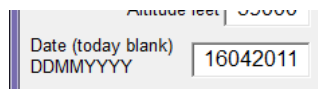
A screenshot of a software interface showing a field labeled 'Altitude feet' with the value '39000' entered. Below it, a partially visible field is labeled 'Date (today blank)'.

Caution: If you observe at 5000 ft, but you are on ground, enter 0 ft (or leave Altitude field empty), because calculations are based on the theoretical horizon of 0°.

**Date:** DDMMYYYY, enter date of observation or leave empty. If left empty, the current date is entered automatically.  
Range: any valid date.

Example: April 16<sup>th</sup>. 2011

Enter as:

A screenshot of a software interface showing a field labeled 'Date (today blank) DDMMYYYY' with the value '16042011' entered.

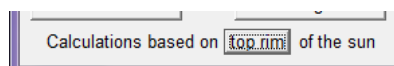
Caution: Dates before 1950 and beyond 2050 will not have the same accuracy, because of Almanac tables used.

**Top Rim:** If Top Rim is selected, calculations are based on the top rim of the sun. Otherwise (center selected) calculations are based on the center of the sun.

Note: The solar azimuth and angle displayed to the right of the waypoints are always referenced to the center of the sun, irrespective of the top rim / center button selection.

Example: Calculation based on the top rim of the sun.

Enter as:

A screenshot of a software interface showing a button labeled 'Calculations based on top rim of the sun'. The 'top rim' part is highlighted with a red box.

Caution: When changing between center and top rim a new calculation of the sunrise / sunset or twilight has to be started with the respective button.

## Between waypoints in flight:

**Example 1:** For calculations in flight, the path between the 2 waypoints is calculated along the great circle. The distance in nautical miles (NM), the average ground speed in knots (Kts or NM per hour) and the bearing (initial true track) between the two waypoints in degrees (deg) are calculated and displayed.

Time Waypoint 1 HHMM 0300

Distance (NM): 256.844 Avg. GS (Kts): 453.255 Bearing (deg): 298.9

Waypoint 2 in DDMM.M Lat and Long

Enter the values as below. Date can be omitted, if the current date is desired for calculation. If altitude is omitted 0 ft is assumed. For this example top rim reference is selected.

Sun on the Move

Waypoint 1 in DDMM.M Lat and Long

N 4457.2 E 2510.2

Time Waypoint 1 HHMM 0300

Center of the sun is at:  
Azimuth: 68.851  
Angle: -3.08336993021579

Distance (NM): 256.844 Avg. GS (Kts): 453.255 Bearing (deg): 298.9

Waypoint 2 in DDMM.M Lat and Long

N 4653.7 E 1941

Time Waypoint 2 HHMM 0334

Center of the sun is at:  
Azimuth: 70.911  
Angle: -0.149080928991043

Altitude feet 40000

Sunrise at position Time  
N4649.6/E01953.9 0333

Date (today blank)  
DDMMYYYY 16042011

Calculations based on top rim of the sun amcos ag oberönz

If a sunrise or sunset takes place between the two waypoints and time, the result is displayed in the corresponding fields. The same applies for twilight calculations.

Time Waypoint 2 HHMM 0334

Altitude feet 40000

Date (today blank)

Angle: -0.149080928991043

Sunrise at position Time  
N4649.6/E01953.9 0333

Note that the above calculation was made with the top rim selection enabled. A sunrise does occur, but only the top part of the sun rises above the horizon (see next example).

Calculations based on top rim of the sun amcos ag oberönz

## Sun on the Move

**Example 2:** The same entries for calculation as the previous example but with calculations based on the center of the sun, would not show a sunrise, because the center of the sun does not raise above the horizon between the 2 waypoints at the given time and altitude.

Sun on the Move

Waypoint 1 in DDMM.M Lat and Long  
N 4457.2 E 2510.2  
Time Waypoint 1 HHMM 0300  
Distance (NM): 256.844 Avg. GS (Kts): 453.255 Bearing (deg): 298.9  
Center of the sun is at:  
Azimuth: 68.851  
Angle: -3.08336993021579

Waypoint 2 in DDMM.M Lat and Long  
N 4653.7 E 1941  
Time Waypoint 2 HHMM 0334  
Altitude feet 40000  
Date (today blank) DDMMYYYY 16042011  
Center of the sun is at:  
Azimuth: 70.911  
Angle: -0.149080928991043

Sun is below horizon between time at Waypoint 1 and time at Waypoint 2!

Sunrise / Sunset Twilight Clear  
Calculations based on center of the sun amcos ag oberönz

Note: The position of the center of the sun is always displayed beside the waypoints, irrespective of the center / top rim button selection.

**Example 3:** When waypoints far apart are selected, sunset and sunrise might occur twice.

Sun on the Move

Waypoint 1 in DDMM.M Lat and Long  
N 4158.9 W 8754.4  
Time Waypoint 1 HHMM 0207  
Distance (NM): 6306.626 Avg. GS (Kts): 472.406 Bearing (deg): 34.9  
Center of the sun is at:  
Azimuth: 301.20  
Angle: -13.733020782779

Waypoint 2 in DDMM.M Lat and Long  
N 2426.5 E 5440.2  
Time Waypoint 2 HHMM 1528  
Altitude feet 35000  
Date (today blank) DDMMYYYY 16042011  
Center of the sun is at:  
Azimuth: 286.40  
Angle: -7.41198918754937

Accurate along great circle only.  
Select closer waypoints if desired!

Sunrise at position Time  
N6352.2/W03915.9 0635  
Sunset at position Time  
N2705.1/E05305.6 1505

Sunrise / Sunset Twilight Clear  
Calculations based on center of the sun amcos ag oberönz

Note: The occurrences are calculated along the great circle (shortest distance) between the two waypoints. If the waypoints are chosen far apart (>1000 NM) an accuracy warning is displayed.

## Calculate sunrise / sunset at any location:

**Example:** To calculate sunrise / sunset or twilight at any location, just enter the geographical position in latitude and longitude of waypoint 1. If all other fields are left blank, the sunrise and sunset or twilight start end times are calculated for the current date and displayed. The date field can be changed as well as the altitude and the top rim or center of the sun reference.

The screenshot shows a software window titled "Sun on the Move". It contains the following fields and controls:

- Waypoint 1 in DDMM.M Lat and Long:** Latitude is set to "N 2428.6", and Longitude is set to "E 5422.3".
- At Waypoint 1:** Displays "Sunrise is at 0201" and "Sunset is at 1444".
- Time Waypoint 1 HHMM:** An empty text box.
- Distance (NM):** An empty text box.
- Avg. GS (Kts):** An empty text box.
- Bearing (deg):** An empty text box.
- Waypoint 2 in DDMM.M Lat and Long:** Latitude is set to "N" and Longitude is set to "E", both followed by empty text boxes.
- Time Waypoint 2 HHMM:** An empty text box.
- Altitude feet:** An empty text box.
- Date (today blank) DDMMYYYY:** Set to "16042011".
- Buttons:** "Sunrise / Sunset" (highlighted), "Twilight", and "Clear".
- Footer:** "Calculations based on center of the sun" and "amcos ag oberönz".

## **Calculate position and angle of the sun at any location:**

**Example:** To calculate the sun position (Azimuth and angle) at any location, just enter the geographical position in latitude and longitude of waypoint 1 and the desired time in UTC (GMT). If all other fields are left blank, the position of the center of the sun is calculated for the current date and displayed. The date field can be changed as well as the altitude.

Sun on the Move

Waypoint 1 in DDMM.M Lat and Long

N 2428.6 E 5422.3

Time Waypoint 1 HHMM 1200

Distance (NM): Avg. GS (Kts): Bearing (deg):

Waypoint 2 in DDMM.M Lat and Long

N E

Time Waypoint 2 HHMM

Altitude feet

Date (today blank) DDMMYYYY 16042011

Center of the sun is at:  
Azimuth: 264.44  
Angle: 36.4993017802306

Sunrise / Sunset Twilight Clear

Calculations based on center of the sun amcos ag oberönz

Note: The “center”/”top rim” button has no influence on the calculation. The “Sunrise / Sunset” and the “Twilight” buttons both calculate the same result.

## **Comments and questions:**

Please forward questions or report errors to [montich@swissonline.ch](mailto:montich@swissonline.ch)