

# **LATITUDE PAR LA POLAIRE & VARIATION DU COMPAS**

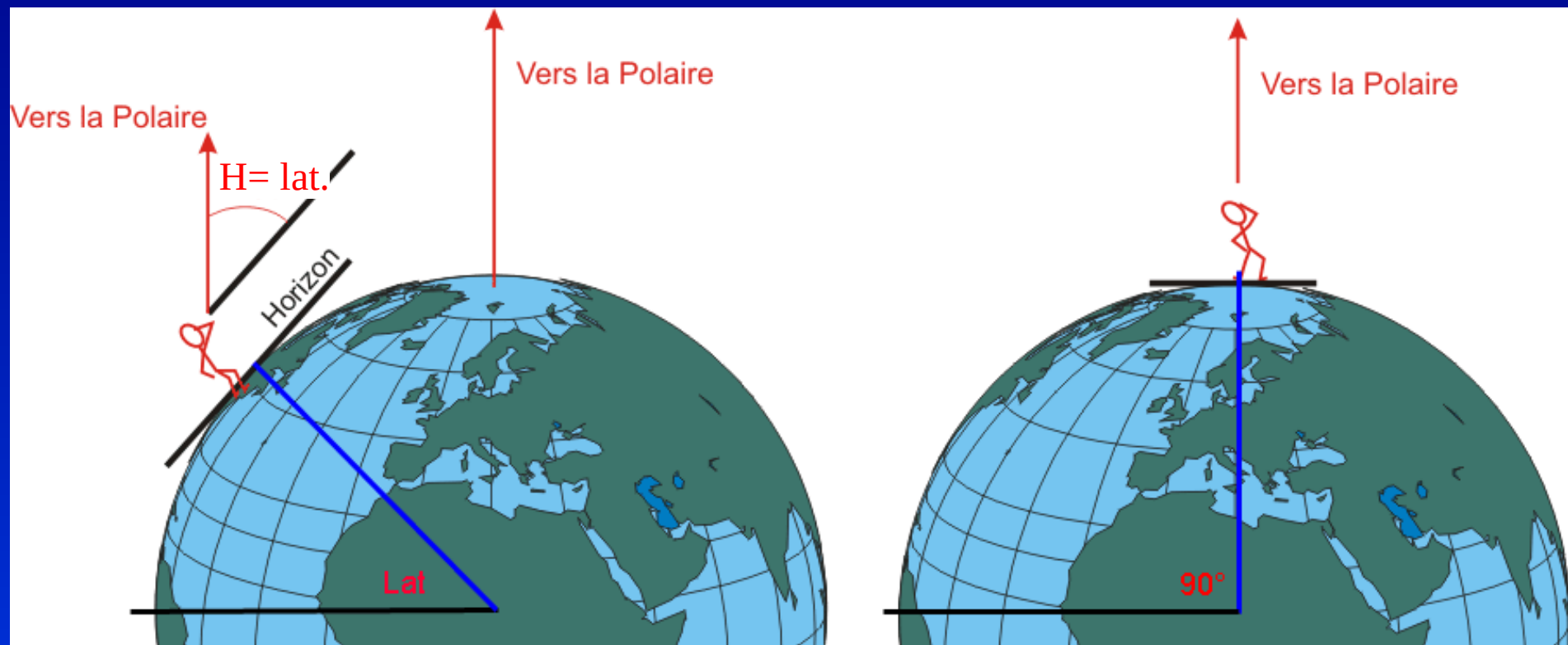
1- Latitude et variation par la polaire

2- Variation du compas

- 1-  
***LATITUDE & VARIATION  
PAR LA POLAIRE***

# 1- Latitude & variation à la polaire

## Le principe



$$\phi \simeq H [\text{corrections}]$$

$$\phi = Ha + a_0 + a_1 + a_2 - 1^\circ$$

$Ha$  = apparent altitude

$a_i$  = correction lues dans le Nautical almanac en fonction de :

- **LHA** (à calculer)
- le mois (donné)
- $\phi_e$

# 1- Latitude & variation à la polaire

## Polaris Table

| 274             | POLARIS (POLE STAR) TABLES,<br>FOR DETERMINING LATITUDE FROM SEXTANT ALTITUDE AND FOR AZIMUTH |             |             |             |             |             |             |             |             |             |               |               |
|-----------------|-----------------------------------------------------------------------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|---------------|---------------|
| L.H.A.<br>ARIES | 0°-<br>9°                                                                                     | 10°-<br>19° | 20°-<br>29° | 30°-<br>39° | 40°-<br>49° | 50°-<br>59° | 60°-<br>69° | 70°-<br>79° | 80°-<br>89° | 90°-<br>99° | 100°-<br>109° | 110°-<br>119° |
| $a_2$           | $a_2$                                                                                         | $a_2$       | $a_2$       | $a_2$       | $a_2$       | $a_2$       | $a_2$       | $a_2$       | $a_2$       | $a_2$       | $a_2$         | $a_2$         |
| 0               | 17.8                                                                                          | 13.7        | 10.9        | 09.7        | 09.9        | 11.7        | 14.9        | 19.5        | 25.3        | 32.1        | 39.7          | 47.9          |
| 1               | 17.3                                                                                          | 13.3        | 10.7        | 09.6        | 10.1        | 12.0        | 15.3        | 20.0        | 25.9        | 32.8        | 40.5          | 48.7          |
| 2               | 16.9                                                                                          | 13.0        | 10.6        | 09.6        | 10.2        | 12.2        | 15.7        | 20.6        | 26.6        | 33.5        | 41.3          | 49.6          |
| 3               | 16.4                                                                                          | 12.7        | 10.4        | 09.6        | 10.3        | 12.5        | 16.2        | 21.1        | 27.2        | 34.3        | 42.1          | 50.4          |
| 4               | 16.0                                                                                          | 12.4        | 10.3        | 09.6        | 10.5        | 12.8        | 16.6        | 21.7        | 27.9        | 35.0        | 42.9          | 51.3          |
| 5               | 15.6                                                                                          | 12.1        | 10.1        | 09.6        | 10.6        | 13.1        | 17.1        | 22.3        | 28.6        | 35.8        | 43.7          | 52.1          |
| 6               | 15.2                                                                                          | 11.9        | 10.0        | 09.7        | 10.8        | 13.5        | 17.5        | 22.8        | 29.3        | 36.6        | 44.6          | 53.0          |
| 7               | 14.8                                                                                          | 11.6        | 09.9        | 09.7        | 11.0        | 13.8        | 18.0        | 23.4        | 29.9        | 37.3        | 45.4          | 53.8          |
| 8               | 14.4                                                                                          | 11.4        | 09.8        | 09.8        | 11.2        | 14.2        | 18.5        | 24.0        | 30.6        | 38.1        | 46.2          | 54.7          |
| 9               | 14.0                                                                                          | 11.2        | 09.7        | 09.8        | 11.5        | 14.5        | 19.0        | 24.7        | 31.4        | 38.9        | 47.0          | 55.5          |
| 10              | 13.7                                                                                          | 10.9        | 09.7        | 09.9        | 11.7        | 14.9        | 19.5        | 25.3        | 32.1        | 39.7        | 47.9          | 56.4          |
| Lat.            | $a_1$                                                                                         | $a_1$       | $a_1$       | $a_1$       | $a_1$       | $a_1$       | $a_1$       | $a_1$       | $a_1$       | $a_1$       | $a_1$         | $a_1$         |
| 0               | 0.5                                                                                           | 0.6         | 0.6         | 0.6         | 0.6         | 0.5         | 0.5         | 0.4         | 0.3         | 0.3         | 0.2           | 0.2           |
| 10              | .5                                                                                            | .6          | .6          | .6          | .6          | .5          | .5          | .4          | .3          | .3          | .3            | .2            |
| 20              | .5                                                                                            | .6          | .6          | .6          | .6          | .5          | .5          | .4          | .3          | .3          | .3            | .2            |
| 30              | .6                                                                                            | .6          | .6          | .6          | .6          | .5          | .5          | .4          | .3          | .3          | .3            | .2            |
| 40              | .6                                                                                            | .6          | .6          | .6          | .6          | .6          | .6          | .5          | .5          | .5          | .5            | .5            |
| 45              | .6                                                                                            | .6          | .6          | .6          | .6          | .6          | .6          | .6          | .6          | .5          | .5            | .5            |
| 50              | .6                                                                                            | .6          | .6          | .6          | .6          | .6          | .6          | .6          | .6          | .6          | .6            | .6            |
| 55              | .6                                                                                            | .6          | .6          | .6          | .6          | .6          | .6          | .6          | .7          | .7          | .7            | .7            |
| 60              | .6                                                                                            | .6          | .6          | .6          | .6          | .6          | .7          | .7          | .7          | .7          | .8            | .8            |
| 62              | .7                                                                                            | .6          | .6          | .6          | .6          | .6          | .7          | .7          | .7          | .8          | .8            | .8            |
| 64              | .7                                                                                            | .6          | .6          | .6          | .6          | .6          | .7          | .7          | .8          | .8          | .9            | .9            |
| 66              | .7                                                                                            | .6          | .6          | .6          | .6          | .7          | .7          | .8          | .8          | .9          | .9            | 1.0           |
| 68              | .7                                                                                            | .6          | .6          | .6          | .6          | .7          | .7          | .8          | .9          | 1.0         | 1.0           | 1.0           |
| Month           | $a_3$                                                                                         | $a_3$       | $a_3$       | $a_3$       | $a_3$       | $a_3$       | $a_3$       | $a_3$       | $a_3$       | $a_3$       | $a_3$         | $a_3$         |
| Jan.            | 0.7                                                                                           | 0.7         | 0.7         | 0.7         | 0.7         | 0.7         | 0.7         | 0.7         | 0.7         | 0.6         | 0.6           | 0.6           |
| Feb.            | .6                                                                                            | .6          | .7          | .7          | .7          | .7          | .8          | .8          | .8          | .8          | .8            | .8            |
| Mar.            | .5                                                                                            | .5          | .6          | .6          | .7          | .7          | .8          | .8          | .8          | .9          | .9            | .9            |
| Apr.            | 0.3                                                                                           | 0.4         | 0.4         | 0.5         | 0.5         | 0.6         | 0.7         | 0.7         | 0.8         | 0.8         | 0.9           | 0.9           |
| May             | .2                                                                                            | .2          | .3          | .3          | .4          | .5          | .5          | .6          | .7          | .7          | .8            | .9            |
| June            | .2                                                                                            | .2          | .2          | .2          | .3          | .3          | .4          | .5          | .5          | .6          | .7            | .7            |
| July            | 0.2                                                                                           | 0.2         | 0.2         | 0.2         | 0.2         | 0.2         | 0.3         | 0.3         | 0.4         | 0.4         | 0.5           | 0.6           |
| Aug.            | .3                                                                                            | .3          | .3          | .2          | .2          | .2          | .2          | .3          | .3          | .3          | .4            | .4            |
| Sept.           | .5                                                                                            | .5          | .4          | .4          | .3          | .3          | .3          | .3          | .3          | .3          | .3            | .3            |
| Oct.            | 0.7                                                                                           | 0.6         | 0.6         | 0.5         | 0.5         | 0.4         | 0.4         | 0.3         | 0.3         | 0.3         | 0.3           | 0.3           |
| Nov.            | 0.9                                                                                           | 0.8         | .8          | .7          | .6          | .6          | .5          | .5          | .4          | .3          | .3            | .3            |
| Dec.            | 1.0                                                                                           | 1.0         | 0.9         | 0.9         | 0.8         | 0.8         | 0.7         | 0.6         | 0.6         | 0.5         | 0.4           | 0.4           |
| Lat.            | AZIMUTH                                                                                       |             |             |             |             |             |             |             |             |             |               |               |
| 0               | 0.4                                                                                           | 0.3         | 0.1         | 0.0         | 359.8       | 359.7       | 359.6       | 359.5       | 359.4       | 359.3       | 359.2         | 359.2         |
| 20              | 0.4                                                                                           | 0.3         | 0.1         | 0.0         | 359.8       | 359.7       | 359.5       | 359.4       | 359.3       | 359.2       | 359.2         | 359.1         |
| 40              | 0.5                                                                                           | 0.3         | 0.2         | 0.0         | 359.8       | 359.6       | 359.4       | 359.3       | 359.2       | 359.1       | 359.0         | 358.9         |
| 50              | 0.6                                                                                           | 0.4         | 0.2         | 0.0         | 359.7       | 359.5       | 359.3       | 359.1       | 359.0       | 358.9       | 358.8         | 358.7         |
| 55              | 0.7                                                                                           | 0.5         | 0.2         | 0.0         | 359.7       | 359.5       | 359.2       | 359.0       | 358.9       | 358.7       | 358.6         | 358.6         |
| 60              | 0.8                                                                                           | 0.5         | 0.2         | 0.0         | 359.7       | 359.4       | 359.1       | 358.9       | 358.7       | 358.5       | 358.4         | 358.4         |
| 65              | 0.9                                                                                           | 0.6         | 0.3         | 359.9       | 359.6       | 359.3       | 359.0       | 358.7       | 358.4       | 358.3       | 358.1         | 358.1         |

Latitude = Apparent altitude (corrected for refraction) -  $1^\circ + a_2 + a_1 + a_3$

The table is entered with: L.H.A. Aries to determine the column to be used; each column refers to a range of  $10^\circ$ .  $a_2$  is taken, with mental interpolation, from the upper table with the units of L.H.A. Aries in degrees as argument;  $a_1$ ,  $a_3$  are taken, without interpolation, from the second and third tables with arguments latitude and month respectively.  $a_2$ ,  $a_1$ ,  $a_3$  are always positive. The final table gives the azimuth of *Polaris*.

$$\phi = Ho + a_0 + a_1 + a_2 - 1^\circ$$

$a_0$  = fonction de LHA<sub>y</sub>

$a_1$  = fonction de  $\phi_e$

$a_2$  = fonction du mois

Azimuth = fonction de  $\phi$

# 1- Latitude & variation à la polaire

## Méthodologie

274 POLARIS (POLE STAR) TABLES,  
FOR DETERMINING LATITUDE FROM SEXTANT ALTITUDE AND FOR AZIMUTH

| L.H.A.<br>ARIES | 0°-<br>9° | 10°-<br>19° | 20°-<br>29° | 30°-<br>39° | 40°-<br>49° | 50°-<br>59° | 60°-<br>69° | 70°-<br>79° | 80°-<br>89° | 90°-<br>99° | 100°-<br>109° | 110°-<br>119° |
|-----------------|-----------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|---------------|---------------|
| $a_2$           | $a_2$     | $a_2$       | $a_2$       | $a_2$       | $a_2$       | $a_2$       | $a_2$       | $a_2$       | $a_2$       | $a_2$       | $a_2$         | $a_2$         |
| 0               | 17.8      | 13.7        | 10.9        | 09.7        | 09.9        | 11.7        | 14.9        | 19.5        | 25.3        | 32.1        | 39.7          | 47.9          |
| 1               | 17.3      | 13.3        | 10.7        | 09.6        | 10.1        | 12.0        | 15.3        | 20.0        | 25.9        | 32.8        | 40.5          | 48.7          |
| 2               | 16.9      | 13.0        | 10.6        | 09.6        | 10.2        | 12.2        | 15.7        | 20.6        | 26.6        | 33.5        | 41.3          | 49.6          |
| 3               | 16.4      | 12.7        | 10.4        | 09.6        | 10.3        | 12.5        | 16.2        | 21.1        | 27.2        | 34.3        | 42.1          | 50.4          |
| 4               | 16.0      | 12.4        | 10.3        | 09.6        | 10.5        | 12.8        | 16.6        | 21.7        | 27.9        | 35.0        | 42.9          | 51.3          |
| 5               | 15.6      | 12.1        | 10.1        | 09.6        | 10.6        | 13.1        | 17.1        | 22.3        | 28.6        | 35.8        | 43.7          | 52.1          |
| 6               | 15.2      | 11.9        | 10.0        | 09.7        | 10.8        | 13.5        | 17.5        | 22.8        | 29.3        | 36.6        | 44.6          | 53.0          |
| 7               | 14.8      | 11.6        | 09.9        | 09.7        | 11.0        | 13.8        | 18.0        | 23.4        | 29.9        | 37.3        | 45.4          | 53.8          |
| 8               | 14.4      | 11.4        | 09.8        | 09.8        | 11.2        | 14.2        | 18.5        | 24.0        | 30.6        | 38.1        | 46.2          | 54.7          |
| 9               | 14.0      | 11.2        | 09.7        | 09.8        | 11.5        | 14.5        | 19.0        | 24.7        | 31.4        | 38.9        | 47.0          | 55.5          |
| 10              | 13.7      | 10.9        | 09.7        | 09.9        | 11.7        | 14.9        | 19.5        | 25.3        | 32.1        | 39.7        | 47.9          | 56.4          |
| Lat.            | $a_1$     | $a_1$       | $a_1$       | $a_1$       | $a_1$       | $a_1$       | $a_1$       | $a_1$       | $a_1$       | $a_1$       | $a_1$         | $a_1$         |
| 0               | 0.5       | 0.6         | 0.6         | 0.6         | 0.6         | 0.5         | 0.5         | 0.4         | 0.3         | 0.3         | 0.2           | 0.2           |
| 10              | .5        | .6          | .6          | .6          | .6          | .6          | .5          | .4          | .4          | .3          | .3            | .2            |
| 20              | .5        | .6          | .6          | .6          | .6          | .6          | .5          | .5          | .4          | .4          | .3            | .3            |
| 30              | .6        | .6          | .6          | .6          | .6          | .6          | .5          | .5          | .5          | .4          | .4            | .4            |
| 40              | .6        | .6          | .6          | .6          | .6          | .6          | .6          | .5          | .5          | .5          | .5            | .5            |
| 45              | .6        | .6          | .6          | .6          | .6          | .6          | .6          | .6          | .5          | .5          | .5            | .5            |
| 50              | .6        | .6          | .6          | .6          | .6          | .6          | .6          | .6          | .6          | .6          | .6            | .6            |
| 55              | .6        | .6          | .6          | .6          | .6          | .6          | .6          | .7          | .7          | .7          | .7            | .7            |
| 60              | .6        | .6          | .6          | .6          | .6          | .6          | .7          | .7          | .7          | .7          | .8            | .8            |
| 62              | .7        | .6          | .6          | .6          | .6          | .6          | .7          | .7          | .7          | .8          | .8            | .8            |
| 64              | .7        | .6          | .6          | .6          | .6          | .6          | .7          | .7          | .8          | .8          | .9            | .9            |
| 66              | .7        | .6          | .6          | .6          | .6          | .7          | .7          | .8          | .8          | .9          | .9            | 1.0           |
| 68              | .7        | .6          | .6          | .6          | .6          | .7          | .7          | .8          | .9          | 1.0         | 1.0           | 1.0           |
| Month           | $a_3$     | $a_3$       | $a_3$       | $a_3$       | $a_3$       | $a_3$       | $a_3$       | $a_3$       | $a_3$       | $a_3$       | $a_3$         | $a_3$         |
| Jan.            | .7        | .7          | .7          | .7          | .7          | .7          | .7          | .7          | .7          | .6          | .6            | .6            |
| Feb.            | .6        | .6          | .7          | .7          | .7          | .7          | .8          | .8          | .8          | .8          | .8            | .8            |
| Mar.            | .5        | .5          | .6          | .6          | .7          | .7          | .8          | .8          | .8          | .9          | .9            | .9            |
| Apr.            | .3        | .4          | .4          | .5          | .5          | .6          | .7          | .7          | .8          | .8          | .9            | .9            |
| May             | .2        | .2          | .3          | .3          | .4          | .5          | .5          | .6          | .7          | .7          | .8            | .9            |
| June            | .2        | .2          | .2          | .2          | .3          | .3          | .4          | .5          | .5          | .6          | .7            | .7            |
| July            | .2        | .2          | .2          | .2          | .2          | .2          | .3          | .3          | .4          | .4          | .5            | .6            |
| Aug.            | .3        | .3          | .3          | .2          | .2          | .2          | .2          | .3          | .3          | .3          | .4            | .4            |
| Sept.           | .5        | .5          | .4          | .4          | .3          | .3          | .3          | .3          | .3          | .3          | .3            | .3            |
| Oct.            | .7        | .6          | .6          | .5          | .5          | .4          | .4          | .3          | .3          | .3          | .3            | .3            |
| Nov.            | .9        | .8          | .8          | .7          | .6          | .6          | .5          | .5          | .4          | .3          | .3            | .3            |
| Dec.            | 1.0       | 1.0         | .9          | .9          | .8          | .8          | .7          | .6          | .6          | .5          | .4            | .4            |
| Lat.            | AZIMUTH   |             |             |             |             |             |             |             |             |             |               |               |
| 0               | 0.4       | 0.3         | 0.1         | 0.0         | 359.8       | 359.7       | 359.6       | 359.5       | 359.4       | 359.3       | 359.2         | 359.2         |
| 10              | 0.4       | 0.3         | 0.1         | 0.0         | 359.8       | 359.7       | 359.5       | 359.4       | 359.3       | 359.2       | 359.2         | 359.1         |
| 20              | 0.4       | 0.3         | 0.1         | 0.0         | 359.8       | 359.7       | 359.5       | 359.4       | 359.3       | 359.2       | 359.2         | 359.1         |
| 30              | 0.5       | 0.3         | 0.2         | 0.0         | 359.8       | 359.6       | 359.4       | 359.3       | 359.2       | 359.1       | 359.0         | 358.9         |
| 40              | 0.6       | 0.4         | 0.2         | 0.0         | 359.7       | 359.5       | 359.3       | 359.1       | 359.0       | 358.9       | 358.8         | 358.7         |
| 50              | 0.7       | 0.5         | 0.2         | 0.0         | 359.7       | 359.5       | 359.2       | 359.0       | 358.9       | 358.7       | 358.6         | 358.6         |
| 55              | 0.8       | 0.5         | 0.2         | 0.0         | 359.7       | 359.4       | 359.1       | 358.9       | 358.7       | 358.5       | 358.4         | 358.4         |
| 60              | 0.8       | 0.5         | 0.2         | 0.0         | 359.7       | 359.4       | 359.1       | 358.9       | 358.7       | 358.5       | 358.4         | 358.4         |
| 65              | 0.9       | 0.6         | 0.3         | 359.9       | 359.6       | 359.3       | 359.0       | 358.7       | 358.4       | 358.3       | 358.1         | 358.1         |

Latitude = Apparent altitude (corrected for refraction) -  $1^\circ + a_2 + a_1 + a_3$

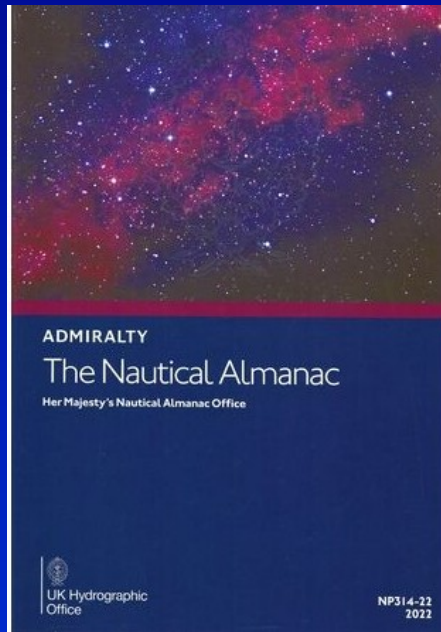
The table is entered with: L.H.A. Aries to determine the column to be used; each column refers to a range of  $10^\circ$ .  $a_2$  is taken, with mental interpolation, from the upper table with the units of L.H.A. Aries in degrees as argument;  $a_1$ ,  $a_3$  are taken, without interpolation, from the second and third tables with arguments latitude and month respectively.  $a_2$ ,  $a_1$ ,  $a_3$  are always positive. The final table gives the azimuth of *Polaris*.

- 1- Déterminer  $GH_{Ay}$ , puis  $LH_{Ay}$
- 2- Déterminer  $Ho$  à partir de  $Hs$
- 3- Déterminer  $a_0$ ,  $a_1$  et  $a_2$  avec la table de la polaire  
pour  $a_0$ , il est nécessaire d'interpoler  
Pour  $a_1$  et  $a_2$  ne pas interpoler
- 4- Appliquer la formule :

$$\phi = Ha + a_0 + a_1 + a_2 - 1^\circ$$

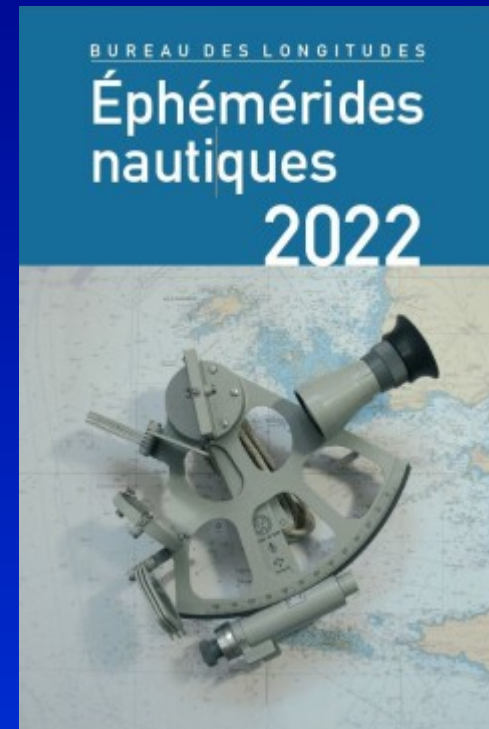
# 1- Latitude & variation à la polaire

## Nautical almanac versus éphémérides nautiques



$$\phi = Ha + a_0 + a_1 + a_2 - 1^\circ$$

Ha= apparent altitude



$$\phi = Hv + A + B + C$$

Hv= Hauteur vraie

# 1- Latitude & variation à la polaire

## Application

On 15th April 1981 at 08h 58min UT, DR position was  $46^{\circ} 30' \text{N}$ ,  $046^{\circ} 15' \text{W}$   
Polaris was bearing  $002^{\circ}$  with sextant altitude  $46^{\circ} 30,4'$ .  
The index error is  $2,0'$  on the arc, the height of eye 15m.  
Find latitude of observer and compass error



# 1- Latitude & variation à la polaire

## Application

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APRIL 13, 14, 15 (MON., TUES., WED.)

| M.T.                                            | ARIES         |                   | VENUS -3.5        |                   | MARS +1.4         |               | JUPITER -2.0      |                                           | SATURN +0.8   |               | STARS         |               |               |                                 |                   |
|-------------------------------------------------|---------------|-------------------|-------------------|-------------------|-------------------|---------------|-------------------|-------------------------------------------|---------------|---------------|---------------|---------------|---------------|---------------------------------|-------------------|
|                                                 | G.H.A.        | Dec.              | G.H.A.            | Dec.              | G.H.A.            | Dec.          | G.H.A.            | Dec.                                      | G.H.A.        | Dec.          | Name          | S.H.A.        | Dec.          |                                 |                   |
| 13<br>M<br>O<br>N<br>D<br>A<br>Y                | 00 201 05.6   | 178 04.1 N 8 27.0 | 181 45.7 N 7 34.7 | 17 27.7 N 0 08.9  | 15 18.7 N 0 23.1  | Acomar        | 315 37.4 S40 23.0 | A<br>l<br>i<br>o<br>h                     | 01 216 08.0   | 193 03.7 28.2 | 196 46.4 35.4 | 32 30.4 09.0  | 30 21.4 23.2  | Achernar                        | 395 45.6 S57 20.1 |
|                                                 | 02 231 10.5   | 208 03.3 29.4     | 211 47.1 36.1     | 47 33.1 09.1      | 45 24.0 23.2      | Acruz         | 173 36.1 S62 58.9 |                                           | 03 246 13.0   | 223 02.8 30.6 | 226 47.8 36.9 | 62 35.9 09.2  | 60 26.6 23.3  | Adhara                          | 255 31.9 S28 57.1 |
|                                                 | 04 261 15.4   | 238 02.4 31.8     | 241 48.5 37.6     | 77 38.6 09.4      | 75 29.2 23.4      | Aldebaran     | 291 17.8 N16 28.2 |                                           | 05 276 17.9   | 253 02.0 33.0 | 256 49.2 38.3 | 92 41.3 09.5  | 90 31.9 23.4  | A<br>l<br>i<br>o<br>h           | 166 41.6 N56 03.8 |
|                                                 | 06 291 20.4   | 268 01.6 N 8 34.1 | 271 49.9 N 7 39.1 | 107 44.1 N 0 09.6 | 105 34.5 N 0 23.5 | 07 306 22.8   | 283 01.1 35.3     |                                           | 286 50.6 39.8 | 122 46.8 09.7 | 120 37.1 23.6 |               |               |                                 |                   |
|                                                 | 08 321 25.3   | 298 00.7 36.5     | 301 51.3 40.5     | 137 49.5 09.8     | 135 39.8 23.6     | 09 336 27.8   | 313 00.3 37.7     |                                           | 316 52.0 41.3 | 152 52.3 09.9 | 150 42.4 23.7 |               |               |                                 |                   |
|                                                 | 10 351 30.2   | 327 59.9 38.9     | 331 52.7 42.0     | 167 55.0 10.0     | 165 45.0 23.8     | 11 366 32.7   | 342 59.4 40.1     |                                           | 346 53.4 42.7 | 182 57.7 10.1 | 180 47.7 23.8 |               |               |                                 |                   |
|                                                 | 12 381 35.2   | 357 59.0 N 8 41.3 | 1 54.1 N 7 43.5   | 198 00.4 N 0 10.2 | 195 50.3 N 0 23.9 | 13 396 37.6   | 12 58.6 42.5      |                                           | 16 54.8 44.2  | 213 03.2 10.3 | 210 52.9 24.0 |               |               |                                 |                   |
|                                                 | 14 411 40.1   | 27 58.1 43.7      | 31 55.5 44.9      | 228 05.9 10.5     | 225 55.5 24.1     | 15 426 42.5   | 42 57.7 44.9      |                                           | 46 56.2 45.7  | 243 08.6 10.6 | 240 58.2 24.1 |               |               |                                 |                   |
|                                                 | 16 81 45.0    | 57 57.3 46.0      | 61 56.9 46.4      | 258 11.4 10.7     | 256 00.8 24.2     | 17 456 47.5   | 72 56.9 47.2      |                                           | 76 57.6 47.1  | 273 14.1 10.8 | 271 03.4 24.3 |               |               |                                 |                   |
|                                                 | 18 111 49.9   | 87 56.4 N 8 48.4  | 91 58.2 N 7 47.9  | 288 16.8 N 0 10.9 | 286 06.1 N 0 24.3 | 19 486 52.4   | 102 56.0 48.6     |                                           | 106 58.9 48.6 | 303 19.5 11.0 | 301 08.7 24.4 |               |               |                                 |                   |
|                                                 | 19 126 52.4   | 102 56.0 49.6     | 106 58.9 48.6     | 303 19.5 11.0     | 301 08.7 24.4     | 20 141 54.9   | 117 55.6 50.8     |                                           | 121 59.6 49.3 | 318 22.3 11.1 | 316 11.3 24.5 |               |               |                                 |                   |
|                                                 | 20 141 54.9   | 117 55.6 50.8     | 121 59.6 49.3     | 318 22.3 11.1     | 316 11.3 24.5     | 21 156 57.3   | 132 55.2 52.0     |                                           | 137 00.3 50.8 | 333 25.0 11.2 | 331 14.0 24.5 |               |               |                                 |                   |
| 22 171 59.8                                     | 147 54.7 53.2 | 152 01.0 50.1     | 348 27.7 11.3     | 346 16.6 24.6     | 23 187 02.3       | 162 54.3 54.3 | 167 01.7 51.5     | 3 30.4 11.4                               | 1 19.2 24.7   |               |               |               |               |                                 |                   |
| 14<br>T<br>U<br>E<br>S<br>D<br>A<br>Y           | 00 202 04.7   | 177 53.9 N 8 55.5 | 182 02.4 N 7 52.3 | 18 33.2 N 0 11.6  | 16 21.8 N 0 24.7  | Canopus       | 264 07.2 S52 41.5 | T<br>U<br>E<br>S<br>D<br>A<br>Y           | 01 217 07.2   | 192 53.4 56.7 | 197 03.1 53.0 | 33 35.9 11.7  | 31 24.5 24.8  | C<br>a<br>p<br>e<br>l<br>l<br>a | 281 11.0 N45 58.8 |
|                                                 | 02 232 09.7   | 207 53.0 57.9     | 212 03.8 53.7     | 48 38.6 11.8      | 46 27.1 24.9      | Deneb         | 49 48.3 N45 12.5  |                                           | 03 247 12.1   | 222 52.6 58.9 | 227 04.5 54.5 | 63 41.4 11.9  | 61 29.7 24.9  |                                 |                   |
|                                                 | 04 262 14.6   | 237 52.1 60.0     | 242 05.2 55.2     | 78 44.1 12.0      | 76 32.4 25.0      | Denebola      | 182 58.4 N14 04.0 |                                           | 05 277 17.0   | 252 51.7 61.4 | 257 05.9 55.9 | 93 46.8 12.1  | 91 35.0 25.1  |                                 |                   |
|                                                 | 06 292 19.5   | 267 51.3 N 9 02.6 | 272 06.6 N 7 56.7 | 108 49.5 N 0 12.2 | 106 37.6 N 0 25.1 | Dubhe         | 194 21.2 N61 51.3 |                                           | 07 307 22.0   | 282 50.8 63.8 | 287 07.3 57.4 | 123 52.3 12.3 | 121 40.3 25.2 |                                 |                   |
|                                                 | 08 322 24.4   | 297 50.4 65.0     | 302 08.0 58.1     | 138 55.0 12.4     | 136 42.9 25.3     | Elathin       | 90 57.3 N51 35.2  |                                           | 09 332 29.4   | 312 50.0 66.2 | 317 08.7 58.5 | 153 57.7 12.5 | 151 45.5 25.4 |                                 |                   |
|                                                 | 10 352 29.4   | 327 49.5 67.4     | 332 09.4 75.6     | 169 00.4 12.6     | 166 48.1 25.4     | Enif          | 34 11.4 N 9 47.1  |                                           | 11 362 31.8   | 342 49.1 68.5 | 347 10.1 80.3 | 184 03.2 12.7 | 181 50.8 25.5 |                                 |                   |
|                                                 | 12 382 34.3   | 357 48.7 N 9 09.7 | 2 10.8 N 8 01.1   | 199 05.9 N 0 12.9 | 196 53.4 N 0 25.6 | Gacrux        | 172 27.8 S57 00.6 |                                           | 13 397 36.8   | 12 48.2 10.9  | 17 11.5 01.8  | 214 08.6 13.0 | 211 56.0 25.6 |                                 |                   |
|                                                 | 14 412 39.2   | 27 47.8 12.1      | 32 12.1 02.5      | 229 11.3 13.1     | 226 58.7 25.7     | Hadar         | 149 22.2 S60 16.9 |                                           | 15 427 41.7   | 42 47.4 13.3  | 47 12.8 03.3  | 244 14.1 13.2 | 242 01.3 25.8 |                                 |                   |
|                                                 | 16 82 44.1    | 57 46.9 14.4      | 62 13.5 04.0      | 259 16.8 13.3     | 257 03.9 25.8     | Hamal         | 328 28.8 N23 22.5 |                                           | 17 457 46.6   | 72 46.5 15.6  | 77 14.2 04.7  | 274 19.5 13.4 | 272 06.5 25.9 |                                 |                   |
|                                                 | 18 112 49.1   | 87 46.1 N 9 16.8  | 92 14.9 N 8 05.4  | 289 22.2 N 0 13.5 | 287 09.2 N 0 26.0 | Kochab        | 137 17.9 N74 13.9 |                                           | 19 487 51.5   | 102 45.6 18.0 | 107 15.6 06.2 | 304 20.5 13.6 | 302 11.8 26.0 |                                 |                   |
| 15<br>W<br>E<br>D<br>N<br>E<br>S<br>D<br>A<br>Y | 00 203 03.9   | 177 43.5 N 9 23.9 | 182 01.9 N 8 09.8 | 19 38.6 N 0 14.1  | 17 24.9 N 0 26.4  | Mirfak        | 309 16.0 N49 47.6 | W<br>E<br>D<br>N<br>E<br>S<br>D<br>A<br>Y | 01 218 06.3   | 192 43.0 25.0 | 197 19.8 10.5 | 34 41.3 14.3  | 32 27.6 26.4  | M<br>i<br>r<br>f<br>a<br>k      | 76 28.6 S26 19.2  |
|                                                 | 02 233 08.8   | 207 42.6 26.2     | 212 20.5 11.3     | 49 44.0 14.4      | 47 30.2 26.5      | Peacock       | 53 57.9 S56 47.6  |                                           | 03 248 11.3   | 222 42.1 27.4 | 227 21.2 12.0 | 64 46.8 14.5  | 62 32.8 26.6  |                                 |                   |
|                                                 | 04 263 13.7   | 237 41.7 28.6     | 242 21.9 12.7     | 79 49.5 14.6      | 77 35.4 26.6      | Pollux        | 243 57.7 N28 04.3 |                                           | 05 278 16.2   | 252 41.3 29.7 | 257 22.6 13.5 | 94 52.2 14.7  | 92 38.1 26.7  |                                 |                   |
|                                                 | 06 293 18.6   | 267 40.8 N 9 30.9 | 272 23.3 N 8 14.2 | 109 54.9 N 0 14.8 | 107 40.7 N 0 26.8 | Rasalhague    | 96 29.1 N12 34.3  |                                           | 07 308 21.1   | 282 40.4 32.1 | 287 24.0 14.9 | 124 57.4 14.9 | 122 43.3 26.8 |                                 |                   |
|                                                 | 08 323 23.6   | 297 39.9 33.3     | 302 24.6 15.6     | 140 00.4 15.0     | 137 46.0 26.9     | Rigel         | 208 09.4 N12 03.5 |                                           | 09 333 28.5   | 312 39.5 34.4 | 317 25.3 16.4 | 155 03.1 15.1 | 152 48.6 27.0 |                                 |                   |
|                                                 | 10 353 28.5   | 327 39.1 35.6     | 332 26.0 17.1     | 170 05.8 15.2     | 167 51.2 27.0     | Rigil Kent.   | 140 24.7 S60 45.1 |                                           | 11 363 31.0   | 342 38.6 36.8 | 347 26.7 17.8 | 185 08.5 15.3 | 182 53.8 27.1 |                                 |                   |
|                                                 | 12 383 35.4   | 357 38.2 N 9 37.9 | 2 27.4 N 8 18.6   | 200 11.3 N 0 15.4 | 197 56.5 N 0 27.2 | Schedar       | 350 09.1 N56 25.8 |                                           | 13 398 35.9   | 12 37.7 39.1  | 17 28.1 19.3  | 215 14.0 15.5 | 212 59.1 27.2 |                                 |                   |
|                                                 | 14 413 38.9   | 27 37.3 40.3      | 32 28.8 20.0      | 230 16.7 15.6     | 228 01.7 27.3     | Sirius        | 258 55.5 S16 41.7 |                                           | 15 428 41.7   | 42 36.9 41.5  | 47 29.5 20.7  | 245 19.4 15.7 | 243 04.3 27.4 |                                 |                   |
|                                                 | 16 83 43.3    | 57 36.4 42.6      | 62 30.2 21.5      | 260 22.1 15.9     | 258 07.0 27.4     | Spica         | 158 56.8 S11 03.8 |                                           | 17 458 45.8   | 72 36.0 43.8  | 77 30.9 22.2  | 275 24.9 16.0 | 273 09.6 27.5 |                                 |                   |
|                                                 | 18 113 48.7   | 87 35.5 N 9 45.0  | 92 31.6 N 8 22.9  | 290 27.6 N 0 16.1 | 288 12.2 N 0 27.6 | Vega          | 80 55.5 N38 45.7  |                                           | 19 488 50.7   | 102 35.1 46.1 | 107 32.3 23.6 | 305 30.3 16.2 | 303 14.9 27.6 |                                 |                   |
| 16<br>T<br>H<br>U<br>R<br>S<br>D<br>A<br>Y      | 00 204 03.1   | 177 33.1 23.0     | 182 01.1 8 23.0   | 20 11.3 N 0 16.1  | 17 24.9 N 0 27.6  | Zuben'ubi     | 137 32.3 S15 57.8 | T<br>H<br>U<br>R<br>S<br>D<br>A<br>Y      | 01 219 06.3   | 192 32.6 23.0 | 197 18.9 10.5 | 34 31.3 14.3  | 32 27.6 26.4  | V<br>e<br>n<br>u<br>s           | 80 55.5 N38 45.7  |
|                                                 | 02 234 08.1   | 207 42.6 26.2     | 212 20.5 11.3     | 49 44.0 14.4      | 47 30.2 26.5      | Peacock       | 53 57.9 S56 47.6  |                                           | 03 250 11.3   | 222 42.1 27.4 | 227 21.2 12.0 | 64 46.8 14.5  | 62 32.8 26.6  |                                 |                   |
|                                                 | 04 264 13.7   | 237 41.7 28.6     | 242 21.9 12.7     | 79 49.5 14.6      | 77 35.4 26.6      | Pollux        | 243 57.7 N28 04.3 |                                           | 05 280 16.2   | 252 41.3 29.7 | 257 22.6 13.5 | 94 52.2 14.7  | 92 38.1 26.7  |                                 |                   |
|                                                 | 06 294 18.6   | 267 40.8 N 9 30.9 | 272 23.3 N 8 14.2 | 109 54.9 N 0 14.8 | 107 40.7 N 0 26.8 | Rasalhague    | 96 29.1 N12 34.3  |                                           | 07 310 21.1   | 282 40.4 32.1 | 287 24.0 14.9 | 124 57.4 14.9 | 122 43.3 26.8 |                                 |                   |
|                                                 | 08 324 23.6   | 297 39.9 33.3     | 302 24.6 15.6     | 140 00.4 15.0     | 137 46.0 26.9     | Rigel         | 208 09.4 N12 03.5 |                                           | 09 335 28.5   | 312 39.5 34.4 | 317 25.3 16.4 | 155 03.1 15.1 | 152 48.6 27.0 |                                 |                   |
|                                                 | 10 354 28.5   | 327 39.1 35.6     | 332 26.0 17.1     | 170 05.8 15.2     | 167 51.2 27.0     | Rigil Kent.   | 140 24.7 S60 45.1 |                                           | 11 364 31.0   | 342 38.6 36.8 | 347 26.7 17.8 | 185 08.5 15.3 | 182 53.8 27.1 |                                 |                   |
| 17<br>F<br>R<br>I<br>D<br>A<br>Y                | 00 205 03.1   | 177 33.1 23.0     | 182 01.1 8 23.0   | 20 11.3 N 0 16.1  | 17 24.9 N 0 27.6  | Zuben'ubi     | 137 32.3 S15 57.8 | F<br>R<br>I<br>D<br>A<br>Y                | 01 220 06.3   | 192 32.6 23.0 | 197 18.9 10.5 | 34 31.3 14.3  | 32 27.6 26.4  | V<br>e<br>n<br>u<br>s           | 80 55.5 N38 45.7  |
|                                                 | 02 235 08.1   | 207 42.6 26.2     | 212 20.5 11.3     | 49 44.0 14.4      | 47 30.2 26.5      | Peacock       | 53 57.9 S56 47.6  |                                           | 03 251 11.3   | 222 42.1 27.4 | 227 21.2 12.0 | 64 46.8 14.5  | 62 32.8 26.6  |                                 |                   |
|                                                 | 04 265 13.7   | 237 41.7 28.6     | 242 21.9 12.7     | 79 49.5 14.6      | 77 35.4 26.6      | Pollux        | 243 57.7 N28 04.3 |                                           | 05 281 16.2   | 252 41.3 29.7 | 257 22.6 13.5 | 94 52.2 14.7  | 92 38.1 26.7  |                                 |                   |
|                                                 | 06 295 18.6   | 267 40.8 N 9 30.9 | 272 23.3 N 8 14.2 | 109 54.9 N 0 14.8 | 107 40.7 N 0 26.8 | Rasalhague    | 96 29.1 N12 34.3  |                                           | 07 311 21.1   | 282 40.4 32.1 | 287 24.0 14.9 | 124 57.4 14.9 | 122 43.3 26.8 |                                 |                   |
|                                                 | 08 325 23.6   | 297 39.9 33.3     | 302 24.6 15.6     | 140 00.4 15.0     | 137 46.0 26.9     | Rigel         | 208 09.4 N12 03.5 |                                           | 09 336 28.5   | 312 39.5 34.4 | 317 25.3 16.4 | 155 03.1 15.1 | 152 48.6 27.0 |                                 |                   |
|                                                 | 10 355 28.5   | 327 39.1 35.6     | 332 26.0 17.1     | 170 05.8 15.2     | 167 51.2 27.0     | Rigil Kent.   | 140 24.7 S60 45.1 |                                           | 11 365 31.0   | 342 38.6 36.8 | 347 26.7 17.8 | 185 08.5 15.3 | 182 53.8 27.1 |                                 |                   |
| 18<br>S<br>A<br>T<br>U<br>R<br>D<br>A<br>Y      | 00 206 03.1   | 177 33.1 23.0     | 182 01.1 8 23.0   | 20 11.3 N 0 16.1  | 17 24.9 N 0 27.6  | Zuben'ubi     | 137 32.3 S15 57.8 | S<br>A<br>T<br>U<br>R<br>D<br>A<br>Y      | 01 221 06.3   | 192 32.6 23.0 | 197 18.9 10.5 | 34 31.3 14.3  | 32 27.6 26.4  | J<br>u<br>p<br>i<br>t<br>e<br>r | 80 55.5 N38 45.7  |
|                                                 | 02 236 08.1   | 207 42.6 26.2     | 212 20.5 11.3     | 49 44.0 14.4      | 47 30.2 26.5      | Peacock       | 53 57.9 S56 47.6  |                                           | 03 252 11.3   | 222 42.1 27.4 | 227 21.2 12.0 | 64 46.8 14.5  | 62 32.8 26.6  |                                 |                   |
|                                                 | 04 266 13.7   | 237 41.7 28.6     | 242 21.9 12.7     | 79 49.5 14.6      | 77 35.4 26.6      | Pollux        | 243 57.7 N28 04.3 |                                           | 05 282 16.2   | 252 41.3 29.7 | 257 22.6 13.5 | 94 52.2 14.7  | 92 38.1 26.7  |                                 |                   |
|                                                 | 06 296 18.6   | 267 40.8 N 9 30.9 | 272 23.3 N 8 14.2 | 109 54.9 N 0 14.8 | 107 40.7 N 0 26.8 | Rasalhague    | 96 29.1 N12 34.3  |                                           | 07 312 21.1   | 282 40.4 32.1 | 287 24.0 14.9 | 124 57.4 14.9 | 122 43.3 26.8 |                                 |                   |
|                                                 | 08 326 23.6   | 297 39.9 33.3     | 302 24.6 15.6     | 140 00.4 15.0     | 137 46.0 26.9     | Rigel         | 208 09.4 N12 03.5 |                                           | 09 337 28.5   | 312 39.5 34.4 | 317 25.3 16.4 | 155 03.1 15.1 | 152 48.6 27.0 |                                 |                   |
|                                                 | 10 356 28.5   | 327 39.1 35.6     | 332 26.0 17.1     | 170 05.8 15.2     | 167 51.2 27.0     | Rigil Kent.   | 140 24.7 S60 45.1 |                                           | 11 366 31.0   | 342 38.6 36.8 | 347 26.7 17.8 | 185 08.5 15.3 | 182 53.8 27.1 |                                 |                   |
| 19<br>S<br>U<br>N<br>D<br>A<br>Y                | 00 207 03.1   | 177 33.1 23.0     | 182 01.1 8 23.0   | 20 11.3 N 0 16.1  | 17 24.9 N 0 27.6  | Zuben'ubi     | 137 32.3 S15 57.8 | S<br>U<br>N<br>D<br>A<br>Y                | 01 222 06.3   | 192 32.6 23.0 | 197 18.9 10.5 | 34 31.3 14.3  | 32 27.6 26.4  | M<br>a<br>r<br>s                | 80 55.5 N38 45.7  |
|                                                 | 02 237 08.1   | 207 42.6 26.2     | 212 20.5 11.3     | 49 44.0 14.4      | 47 30.2 26.5      | Peacock       | 53 57.9 S56 47.6  |                                           | 03 253 11.3   | 222 42.1 27.4 | 227 21.2 12.0 | 64 46.8 14.5  | 62 32.8 26.6  |                                 |                   |
|                                                 | 04 267 13.7   | 237 41.7 28.6     | 242 21.9 12.7     | 79 49.5 14.6      | 77 35.4 26.6      | Pollux        | 243 57.7 N28 04.3 |                                           | 05 283 16.2   | 252 41.3 29.7 | 257 22.6 13.5 | 94 52.2 14.7  | 92 38.1 26.7  |                                 |                   |
|                                                 | 06 297 18.6   | 267 40.8 N 9 30.9 | 272 23.3 N 8 14.2 | 109 54.9 N 0 14.8 | 107 40.7 N 0 26.8 | Rasalhague    | 96 29.1 N12 34.3  |                                           | 07 313 21.1   | 282 40.4 32.1 | 287 24.0 14.9 | 124 57.4 14.9 | 122 43.3 26.8 |                                 |                   |
|                                                 | 08 327 23.6   | 297 39.9 33.3     | 302 24.6 15.6     | 140 00.4 15.0     | 137 46.0 26.9     | Rigel         | 208 09.4 N12 03.5 |                                           | 09 338 28.5   | 312 39.5 34.4 | 317           |               |               |                                 |                   |



1- Latitude et variation par la polaire

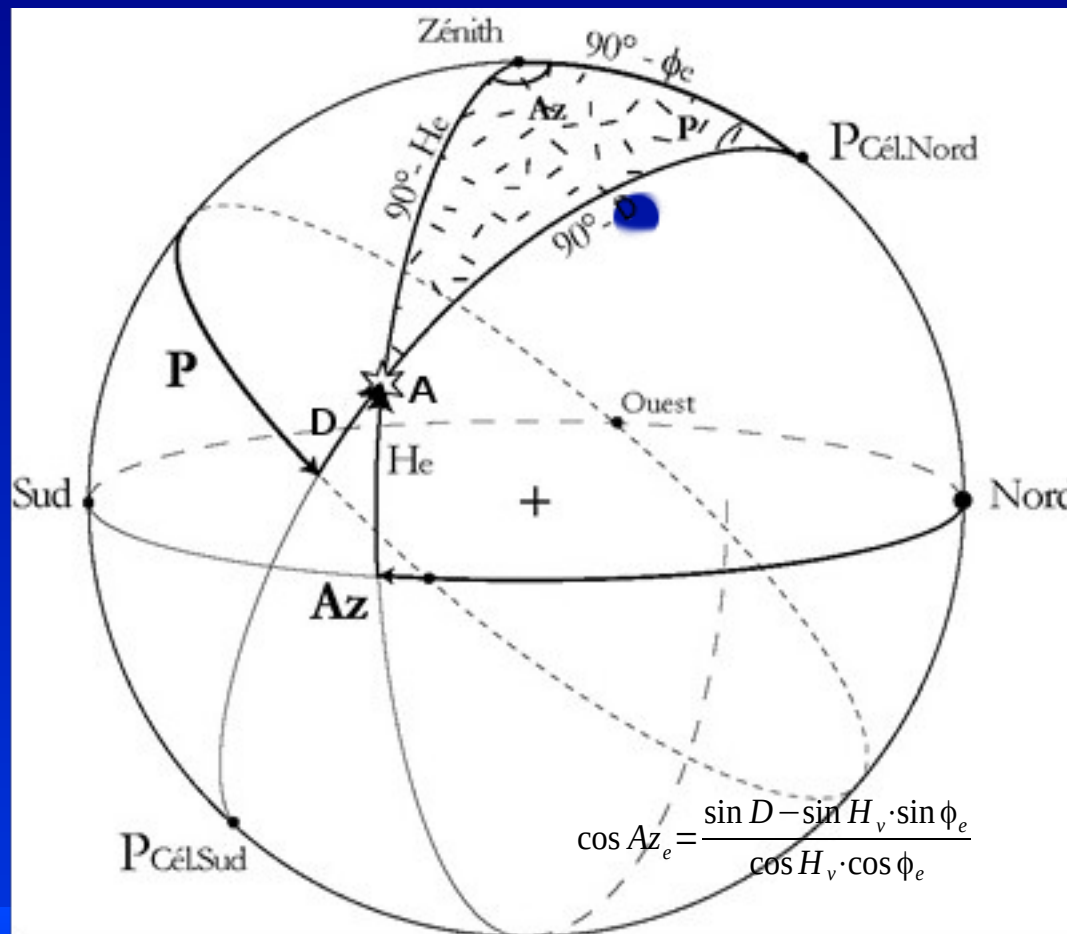
2- Variation du compas

- 2-

# ***VARIATION DU COMPAS au lever & coucher du Soleil***

# 2- Variation du compas

## Formule



$$\cos Az_e = \frac{\sin D - \sin H_v \cdot \sin \phi_e}{\cos H_v \cdot \cos \phi_e}$$

D et φ<sub>e</sub> sont :  
 positifs si Nord  
**négatifs si Sud**

Lien entre Z<sub>e</sub> et Az<sub>e</sub>  
 Z<sub>e</sub> = Az<sub>e</sub> si l'astre est 'Est'  
 Z<sub>e</sub> = **360 - Az<sub>e</sub>** si l'astre est W

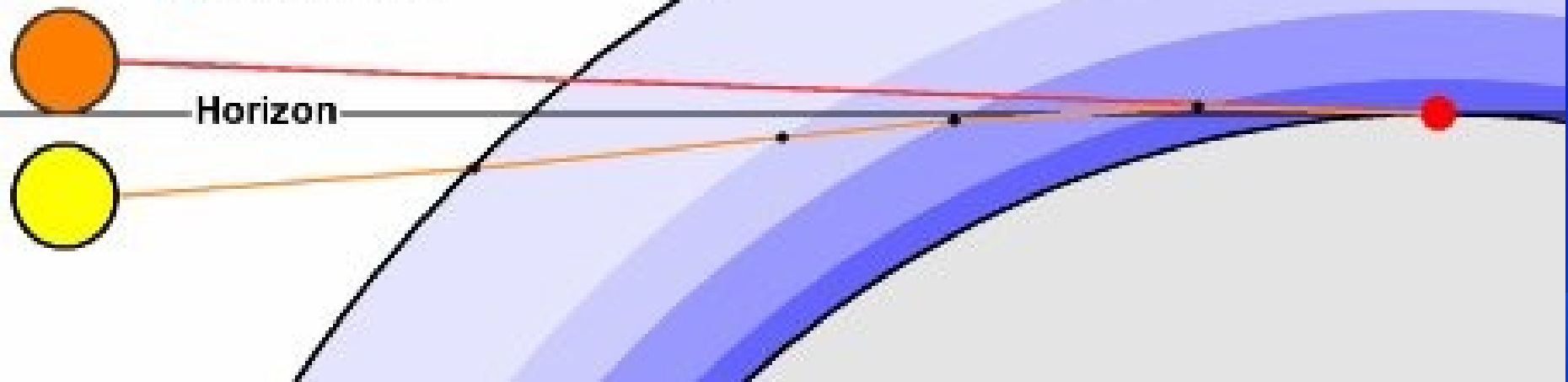
## 2- Variation du compas

### Refraction

- light enters layer of different density

● actual sun

● apparent sun



# 2- Variation du compas

## Méthodologie

Au lever /coucher **vrai** du Soleil

$\Leftrightarrow$

le bord inférieur du Soleil est au 2/3 de son diamètre au dessus de l'horizon.

(on détermine le diamètre du jour dans le NA)



$$\cos Az_e = \frac{\sin D}{\cos \phi_e} \quad \text{Par simplification}$$

Au lever /coucher **apparent** du bord inférieur du Soleil

$$H_v \approx -0,5^\circ$$

Au lever /coucher **apparent** du bord supérieur du Soleil



$$\cos Az_e = \frac{\sin D - \sin H_v \cdot \sin \phi_e}{\cos H_v \cdot \cos \phi_e}$$

$$Z_v \approx Az_e \text{ (au lever /astre à l' Est)}$$

$$Z_v \approx 360 - Az_e \text{ (au coucher /astre à l' ouest)}$$

## 2- Variation du compas

### Application

On 31 July 1981, at 0604 ZT, in DR position LAT  $16^{\circ} 42.3' \text{ S}$ , LONG  $28^{\circ} 19.3' \text{ W}$ , you observed an amplitude of the Sun.

The lower limb was a little above the horizon, and the Sun was bearing  $069.8^{\circ} \text{ pgc}$ . At the time of the observation, the helmsman reported that he was heading  $143^{\circ} \text{ pgc}$  and  $167$  per magnetic compass. The variation in the area was  $23^{\circ} \text{ W}$ . What were the gyro error and deviation for that heading?