PRESENT-DAY REQUIREMENTS OF ASTRONOMIC NAVIGATION

Lecture delivered by Captain A. STASSINOPOULOS
Hydrographer of the Royal Greek Navy,
at the Vth International Hydrographic Conference.

In spite of the great changes brought about by the large-scale application of radio-navigation, there is no doubt but that the ancient astronomic method will, for a long time to come, be that used by navigators to make the fix when they find themselves far from the coast.

After a century of study, those methods have at last reached a concrete form. That of MARC is now-a-days accepted by all. It satisfies every requirement and its accuracy, which varies up to one mile, is sufficient both for the needs of navigation and for making a landfall.

The most propitious time for MARC's observation is at dawn or at the nautical twilight, by the observation of three stars which immediately gives by the intersection of the three altitude position lines, an accurate fix. At these moments the visibility of stars of first and second magnitude is good and the horizon clear. The inconvenience of this method resides in the fact that the computation of the three altitude position lines requires a considerable time. This is not practical when the modern speed of ships is considered and, generally speaking it is not in accord with the present rhythm of things to have the fix on the chart often only half-an-hour after the observation has been made.

It would be desirable, if possible, to be able to plot the fix on the chart at the exact moment of the observation. This might be accomplished by the use of automatic machines or of tables containing the dead-reckoned altitude; but the use of such aids is not practicable. On the one hand, the machines are bulky, costly and fragile; on the other, the tables, because of the approximation of one mile which is considered necessary especially in the case of making a landfall, would run into several volumes, and clearly no one can be advised to carry on board a whole library for the solution of one problem.

However, such a document might be reduced to 1/150th of its size, i.e. comprised in a pamphlet of a few pages if, instead of showing the hour angle every four seconds as required for the approximation of one mile, we could have it every ten minutes only.

If the "rounded hour angle" method is used, we must calculate in advance the chronometric time corresponding to one rounded hour angle; and carry out the observation at the exact moment computed beforehand: that is, we calculate the angle not at any time but at the definite time fixed by the chronometer. In this way, instead of giving the observation signal to the time recorder, who will give the indication of the hour, it is he who will give the signal at the instant when the seconds' hand reaches the predetermined time which corresponds to the rounded hour angle; and at that instant the observer will measure the sextant altitude of the star.

This certainly presents the inconvenience of making the observation more difficult, but when we recall that in Navigational Schools the efficiency of the observers is tested in this way (i.e. the professor gives the observation signal to the pupil), we may conclude that after a little practice this may be regarded as no longer an inconvenience.

Another and still greater inconvenience is that this method cannot be used in cloudy weather; it would certainly be a great deception if, at the predetermined times of observation and after having worked out all the necessary calculations, the predetermined fixed stars were found to be hidden by cloud. Consequently, this method is not always applicable in foggy weather.

On the other hand, however, it is still of great use in clear weather especially in areas such as those of the southern Atlantic and of the major part of the Pacific Ocean where the sky is for the greater part of the year clear.

The use of this method enables us to plot the position on the chart in minimum time after the observation and to avoid all computation of logarithms, for we can easily draw up tables giving directly the estimated altitude. In that way we fix three hours, preferably at dawn or at nautical twilight but also at any other time whatsoever corresponding to the rounded hour angle of three stars chosen beforehand; we then find on the tables the three estimated altitudes; the three true altitudes are measured with the sextant and in this way the three altitude position lines are plotted on the chart. To apply this method we must naturally know in advance which stars of first and second magnitude are observable at a given time, i.e. that have an altitude greater than 10° and less than 80°. Among these we choose three, the azimuths of which at the given moment intersect at angles greater than 30° and less than 150°.

This can easily be found by means of a star-globe or of the gelatine " Chichester " instrument. However, as it is difficult to use a star-globe in a charthouse and the " Chichester " fabrications are expensive and do not last long, we have conceived 6 diagrams which give us the stars observable at any given time in the following way :

The latitude is read on the abscissae, then following the ordinate vertical line the curve of each fixed star is intersected. We then take up the angle corresponding to each point of intersection on the left scale which we subtract and add to the sideral time of the moment. In this way two time limits are obtained between which, taking into account the right ascension of the star, the latter will be at an altitude greater than 10° (continuous curves) or greater than 80° (broken-line curves).

The use of these diagrams is easier than it seems at first sight. An experienced mariner does not need to add and subtract for each star. The limits between which it must be noted whether the right ascension is included, narrow evenly towards the top, always around the same centre: sideral time. The navigator can thus easily and instantaneously check at a glance, for each star chosen, whether or not its right ascension is included within those limits.

We place these diagrams at the disposal of the International Hydrographic Bureau so that, if deemed advisable, the Bureau may disseminate them among mariners who may not wish to purchase a star-globe or a " Chichester " instrument.

It is also suggested that it might be interesting to encourage the rounded hour angle method in International Navigation and that the question might be given consideration. It is true that it is not easy to impose new methods. Navigational methods are matters of individual training, habit and personal preferences.

However, we are of opinion that if the International Hydrographic Bureau would make appropriate propaganda and publish a volume of tables, not too voluminous, giving the estimated altitudes (such a volume might include the above-mentioned diagrams), there are few mariners who would not appreciate the advantage of obtaining their fix when the sky is clear immediately after the observation without being obliged to resort to logarithms and with the desirable accuracy of one nautical mile.

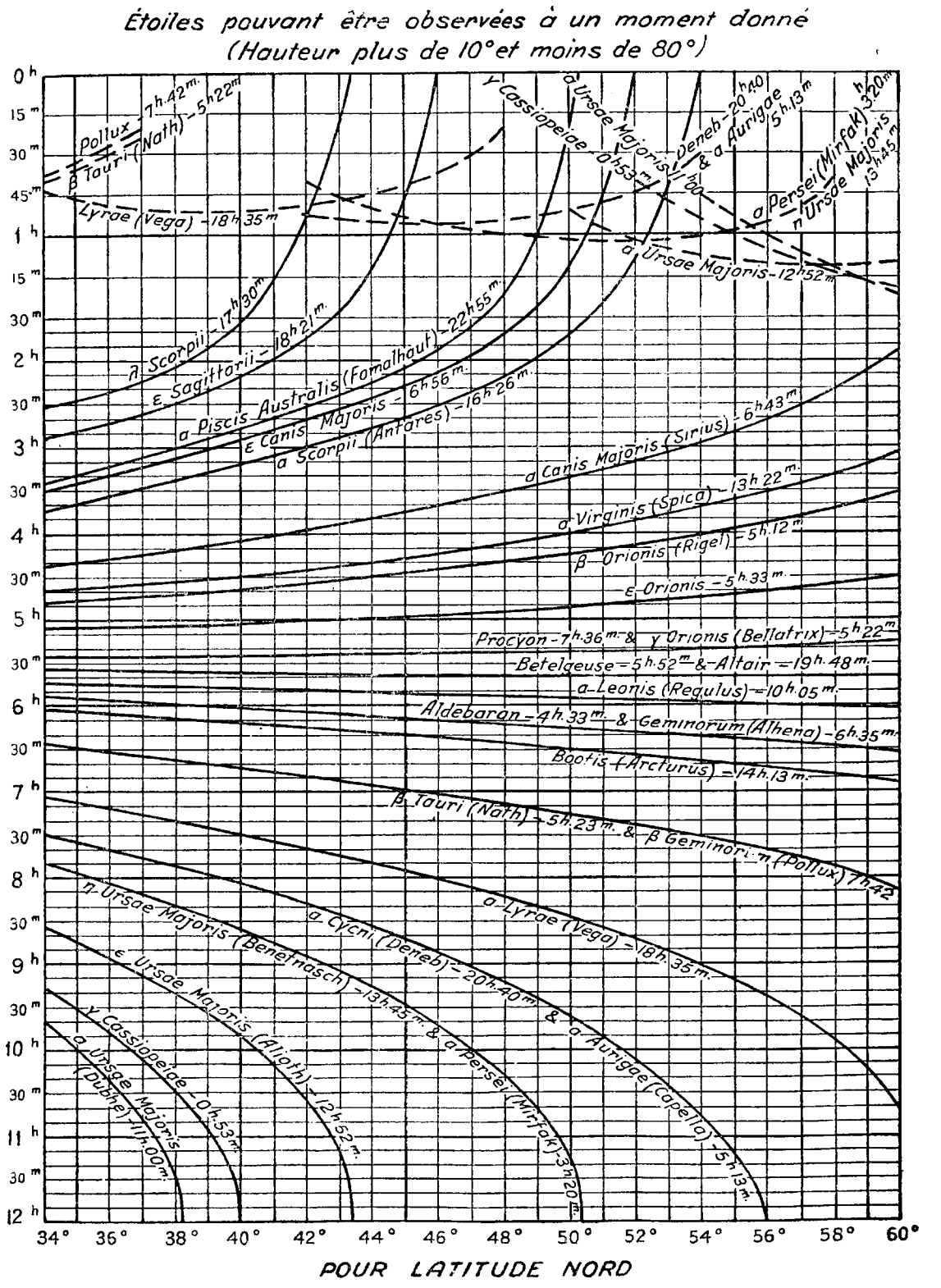
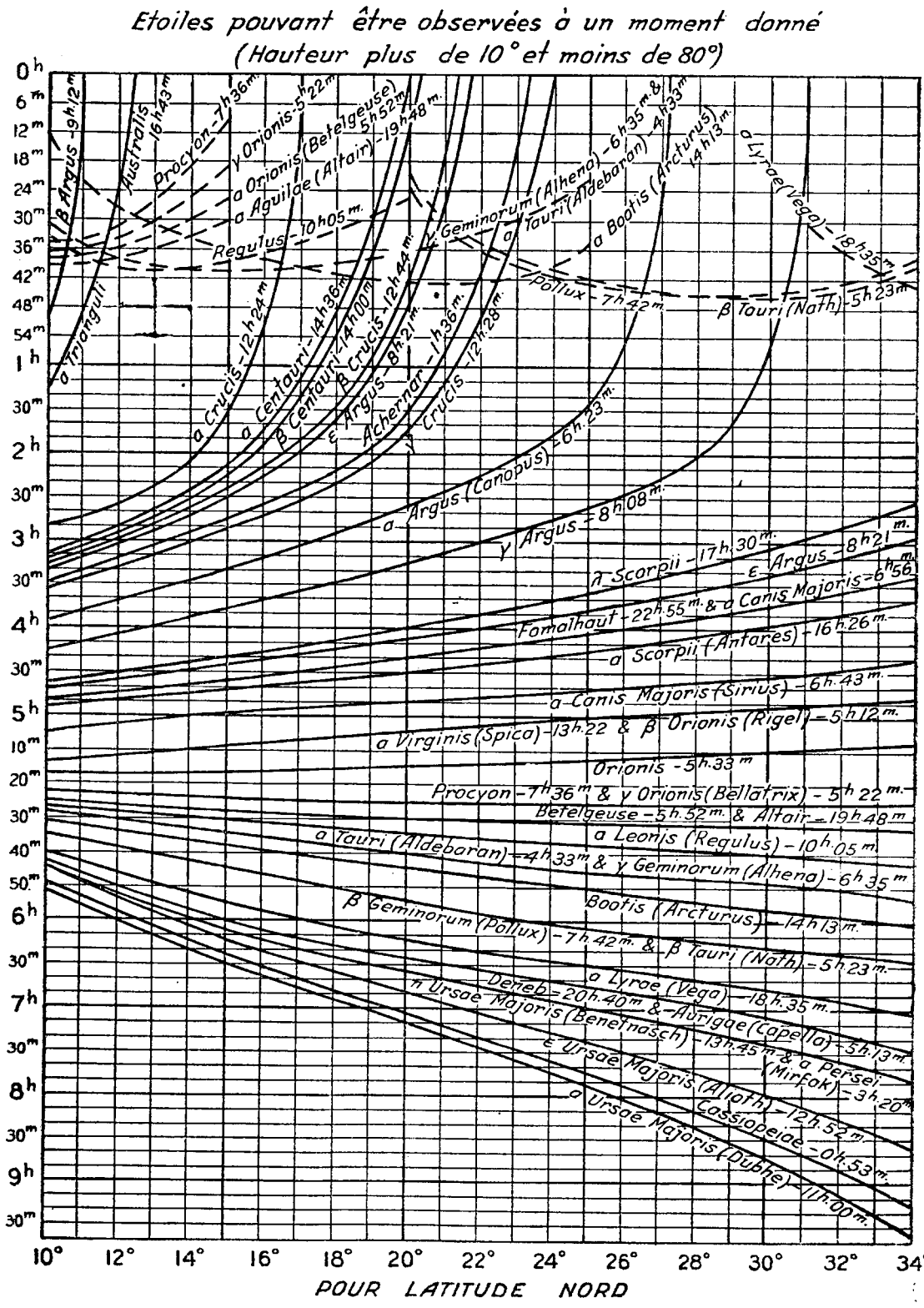

Étoiles pouvant être observées à un moment donné
(Hauteur plus de 10° et moins de 80°)
Pollux - 7h.42m.
β Tauri (Nath) - 5h.22m.
Lyrae (Vega) - 18h.35m.
γ Cassiopeiae - 0h.53m.
α Ursae Majoris (Dubhe) - 11h.00m.
Deneb - 20h.40
α Aurigae 5h.13m
η Ursae Majoris 13h.45m
α Persei (Mirfak) 3h.20m
α Ursae Majoris - 12h.52m
η Scorpii - 17h.30m.
ε Sagittarii - 18h.21m.
α Piscis Australis (Fomalhaut) - 22h.55m.
ε Canis Majoris - 6h.56m.
α Scorpii (Antares) - 16h.26m.
α Canis Majoris (Sirius) - 6h.43m
α Virginis (Spica) - 13h.22m.
β Orionis (Rigel) - 5h.12m
ε Orionis - 5h.33m.
Procyon - 7h.36m. & γ Orionis (Bellatrix) - 5h.22m
Betelgeuse - 5h.52m & Altair - 19h.48m.
α Leonis (Regulus) - 10h.05m.
Aldebaran - 4h.33m. & Geminorum (Alhena) - 6h.35m.
Bootis (Arcturus) - 14h.13m.
β Tauri (Nath) - 5h.23m. & β Geminorum (Pollux) 7h.42
α Lyrae (Vega) - 18h.35m.
η Ursae Majoris (Benetnasch) - 13h.45m. & α Persei (Mirfak) - 3h.20m.
α Cygni (Deneb) - 20h.40m. & α Aurigae (Capella) - 5h.13m.
ε Ursae Majoris (Alioth) - 12h.52m.
γ Cassiopeiae - 0h.53m.
α Ursae Majoris (Dubhe) 11h.00m.
0h 15m 30m 45m 1h 15m 30m 2h 30m 3h 30m 4h 30m 5h 30m 6h 30m 7h 30m 8h 30m 9h 30m 10h 30m 11h 30m 12h
34° 36° 38° 40° 42° 44° 46° 48° 50° 52° 54° 56° 58° 60°
POUR LATITUDE NORD

PLANCHE I


Etoiles pouvant être observées à un moment donné
(Hauteur plus de 10° et moins de 80°)
0h
6m
12m
18m
24m
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42m
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2h
30m
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30m
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30m
5h
10m
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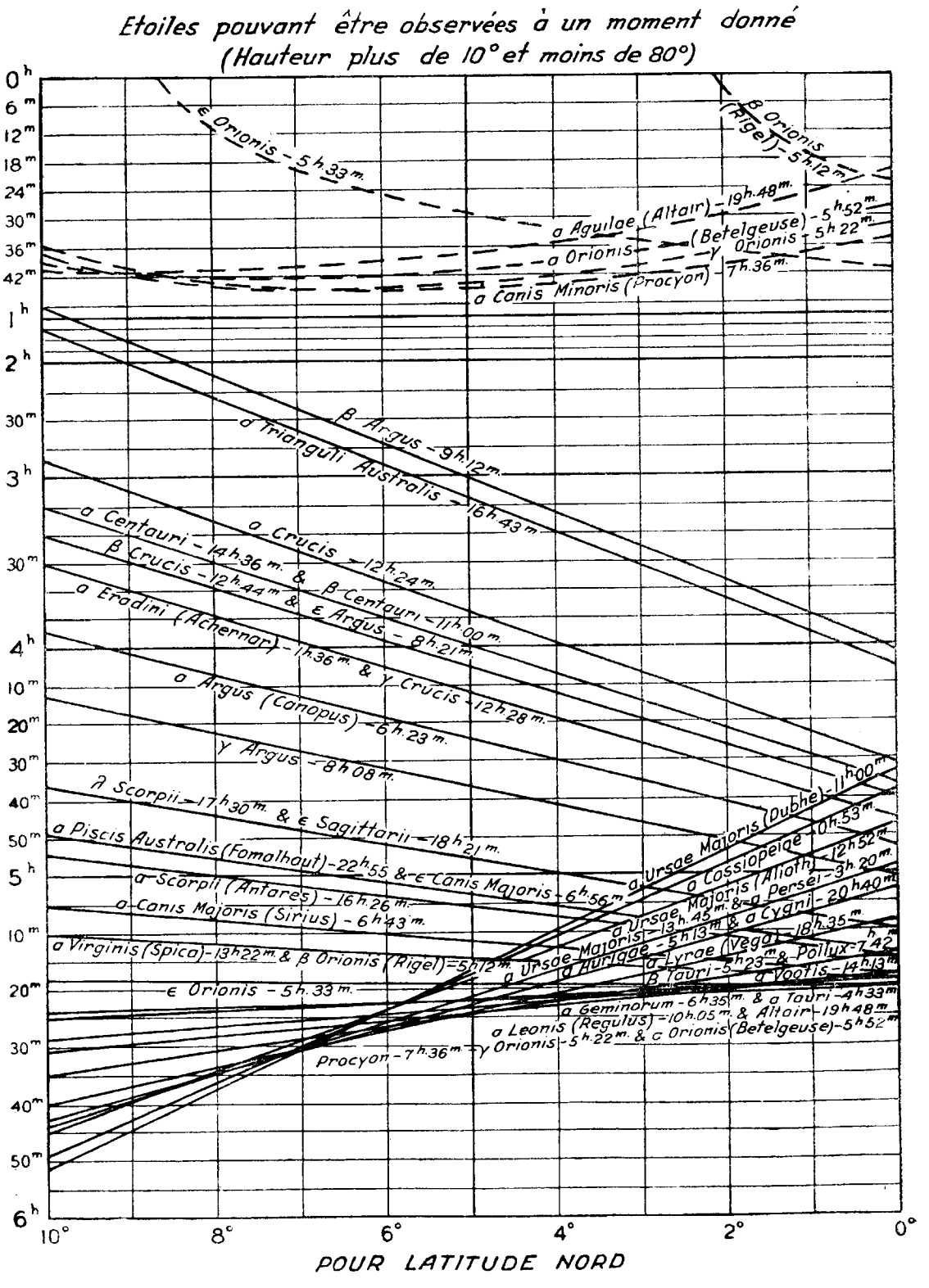
30m
40m
50m
6h
30m
7h
30m
8h
30m
9h
30m
β Argus - 9h12m
Australis - 16h43m
Procyon - 7h36m
γ Orionis - 5h22m
α Orionis (Betelgeuse) 5h52m
α Aguilae (Altair) - 19h48m
Regulus - 10h05m.
α Trianguli
α Crucis - 12h24m
α Centauri - 14h36m
β Centauri - 14h00m
β Crucis - 12h44m.
ε Argus - 8h21m.
Achernar - 1h36m.
γ Crucis - 12h28m.
γ Geminorum (Alhena) - 6h35m. &
α Tauri (Aldebaran) - 4h33m.
α Boötis (Arcturus) 14h13m.
α Lyrae (Vega) - 18h35m.
Pollux - 7h42m.
β Tauri (Nath) - 5h23m.
α Argus (Canopus) - 6h23m.
γ Argus - 8h08m.
λ Scorpii - 17h30m.
ε Argus - 8h21m.
Fomalhaut - 22h55m. & α Canis Majoris - 6h56m.
α Scorpii (Antares) - 16h26m.
α Canis Majoris (Sirius) - 6h43m.
α Virginis (Spica) - 13h22 & β Orionis (Rigel) - 5h12m.
Orionis - 5h33m
Procyon - 7h36m & γ Orionis (Bellatrix) - 5h22m.
Betelgeuse - 5h52m. & Altair - 19h48m
α Leonis (Regulus) - 10h05m.
α Tauri (Aldebaran) - 4h33m & γ Geminorum (Alhena) - 6h35m
Boötis (Arcturus) - 14h13m.
β Geminorum (Pollux) - 7h42m. & β Tauri (Nath) - 5h23m.
α Lyrae (Vega) - 18h35m.
Deneb - 20h40m. & Aurigae (Capella) - 5h13m.
η Ursae Majoris (Benetnasch) - 13h45m & α Persei (Mirfak) - 3h20m
ε Ursae Majoris (Alioth) - 12h52m.
α Ursae Majoris (Dubhe) - 11h00m.
Cassiopeiae - 0h53m.
10° 12° 14° 16° 18° 20° 22° 24° 26° 28° 30° 32° 34°
POUR LATITUDE NORD

PLANCHE II


Etoiles pouvant être observées à un moment donné
(Hauteur plus de 10° et moins de 80°)
0h
6m
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18m
24m
30m
36m
42m
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4h
10m
20m
30m
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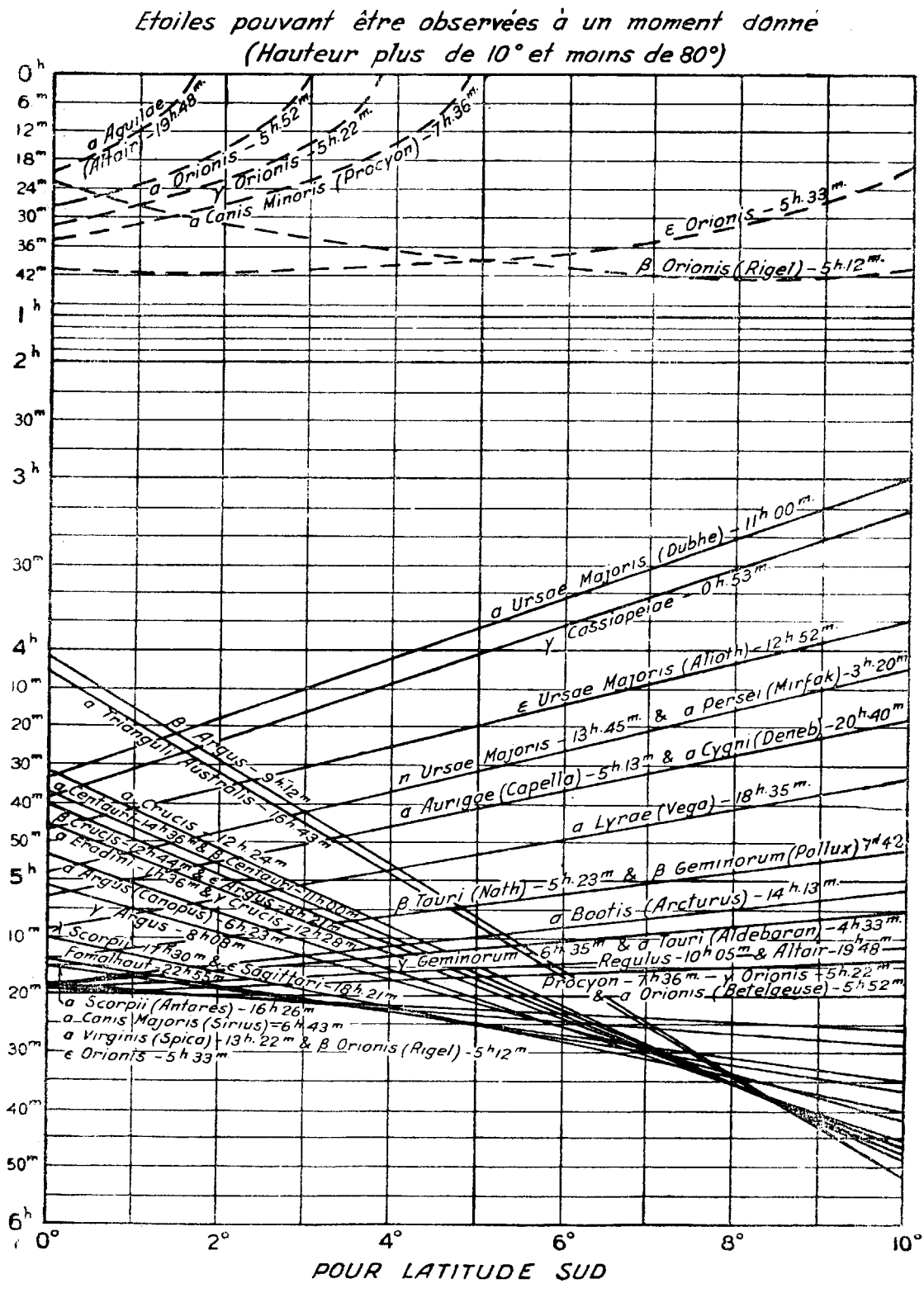
50m
5h
10m
20m
30m
40m
50m
6h
ε Orionis - 5h.33m.
β Orionis (Rigel) - 5h.12m.
α Aguilae (Altair) - 19h.48m.
α Orionis (Betelgeuse) - 5h.52m.
γ Orionis - 5h.22m.
α Canis Minoris (Procyon) - 7h.36m.
β Argus - 9h.12m.
α Trianguli Australis - 16h.43m.
α Centauri - 14h.36m. & β Centauri - 11h.00m.
α Crucis - 12h.24m.
β Crucis - 12h.44m. & ε Argus - 8h.21m.
α Eradini (Achernar) - 1h.36m. & γ Crucis - 12h.28m.
α Argus (Canopus) - 6h.23m.
γ Argus - 8h.08m.
η Scorpii - 17h.30m. & ε Sagittarii - 18h.21m.
α Piscis Australis (Fomalhaut) - 22h.55 & ε Canis Majoris - 6h.56m.
α Scorpii (Antares) - 16h.26m.
α Canis Majoris (Sirius) - 6h.43m.
α Virginis (Spica) - 13h.22m. & β Orionis (Rigel) - 5h.12m.
ε Orionis - 5h.33m.
α Ursae Majoris (Dubhe) - 11h.00m.
α Cassiopeiae - 10h.53m.
α Ursae Majoris (Alioth) - 12h.52m.
α Ursae Majoris - 13h.45m. & α Persei - 3h.20m.
α Ursae Majoris - 5h.13m. & α Cygni - 20h.40m.
α Aurigae - 5h.13m. & α Lyrae (Vega) - 18h.35m.
α Lyrae (Vega) - 18h.35m.
β Tauri - 5h.23m. & Pollux - 7h.42m.
α Geminorum - 6h.35m. & α Tauri - 4h.33m.
α Leonis (Regulus) - 10h.05m. & Altair - 19h.48m.
α Orionis (Betelgeuse) - 5h.52m.
γ Orionis - 5h.22m.
Procyon - 7h.36m.
10°
8°
6°
4°
2°
0°
POUR LATITUDE NORD

PLANCHE III


Etoiles pouvant être observées à un moment donné
(Hauteur plus de 10° et moins de 80°)
0h
6m
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18m
24m
30m
36m
42m
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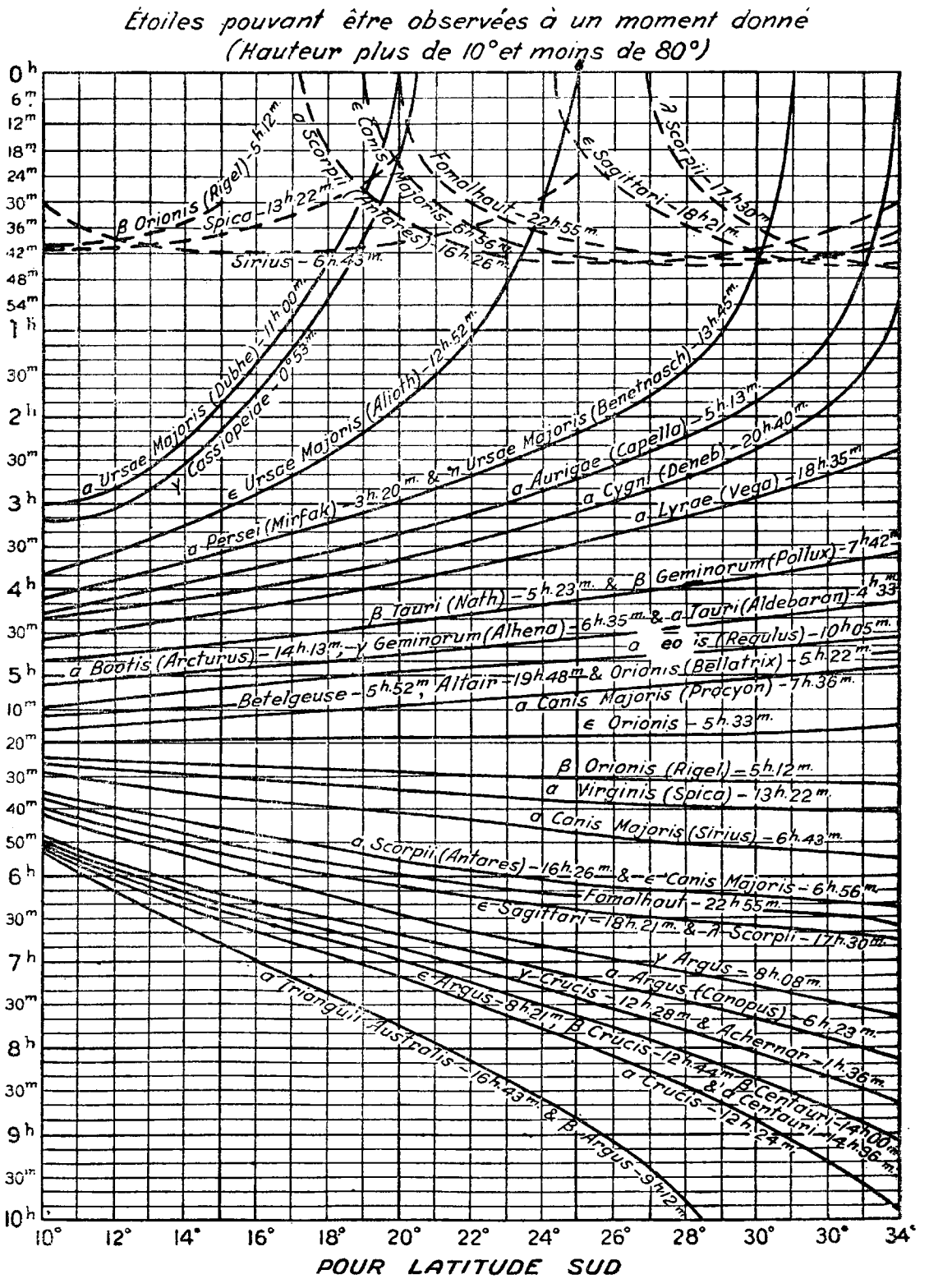
2h
30m
3h
30m
4h
10m
20m
30m
40m
50m
5h
10m
20m
30m
40m
50m
6h
α Aquilae (Altair) - 19h.48m.
α Orionis - 5h.52m.
γ Orionis - 5h.22m.
α Canis Minoris (Procyon) - 7h.36m.
ε Orionis - 5h.33m.
β Orionis (Rigel) - 5h.12m.
α Ursae Majoris (Dubhe) - 11h 00m.
γ Cassiopeiae - 0h.53m.
ε Ursae Majoris (Alioth) - 12h.52m.
η Ursae Majoris - 13h.45m. & α Persei (Mirfak) - 3h.20m.
α Aurigae (Capella) - 5h.13m & α Cygni (Deneb) - 20h.40m.
α Lyrae (Vega) - 18h.35m.
β Geminorum (Pollux) 7d 42
α Bootis (Arcturus) - 14h.13m.
α Tauri (Aldebaran) - 4h.33m.
Regulus - 10h 05m & Altair - 19h 48m
Procyon - 7h.36m. - γ Orionis - 5h.22m
& α Orionis (Betelgeuse) - 5h.52m.
β Tauri (Nath) - 5h.23m & β Geminorum
γ Geminorum - 6h.35m & α Tauri
α Triangul. Australis - 16h.43m
β Argus - 9h.12m
α Centauri - 14h.36m & β Centauri - 11h.00m
α Crucis - 12h.24m
β Crucis - 12h.44m & ε Argus - 25h.21m
α Eridani - 1h.36m & γ Crucis - 12h.28m
α Argus (Canopus) - 6h.23m
γ Argus - 8h.08m
λ Scorpii - 17h.30m & ε Sagittari - 18h.21m
Fomalhaut - 22h.55m
α Scorpii (Antares) - 16h.26m
α Canis Majoris (Sirius) - 6h.43m
α Virginis (Spica) - 13h.22m & β Orionis (Rigel) - 5h.12m
ε Orionis - 5h.33m
0°
2°
4°
6°
8°
10°
POUR LATITUDE SUD

PLANCHE IV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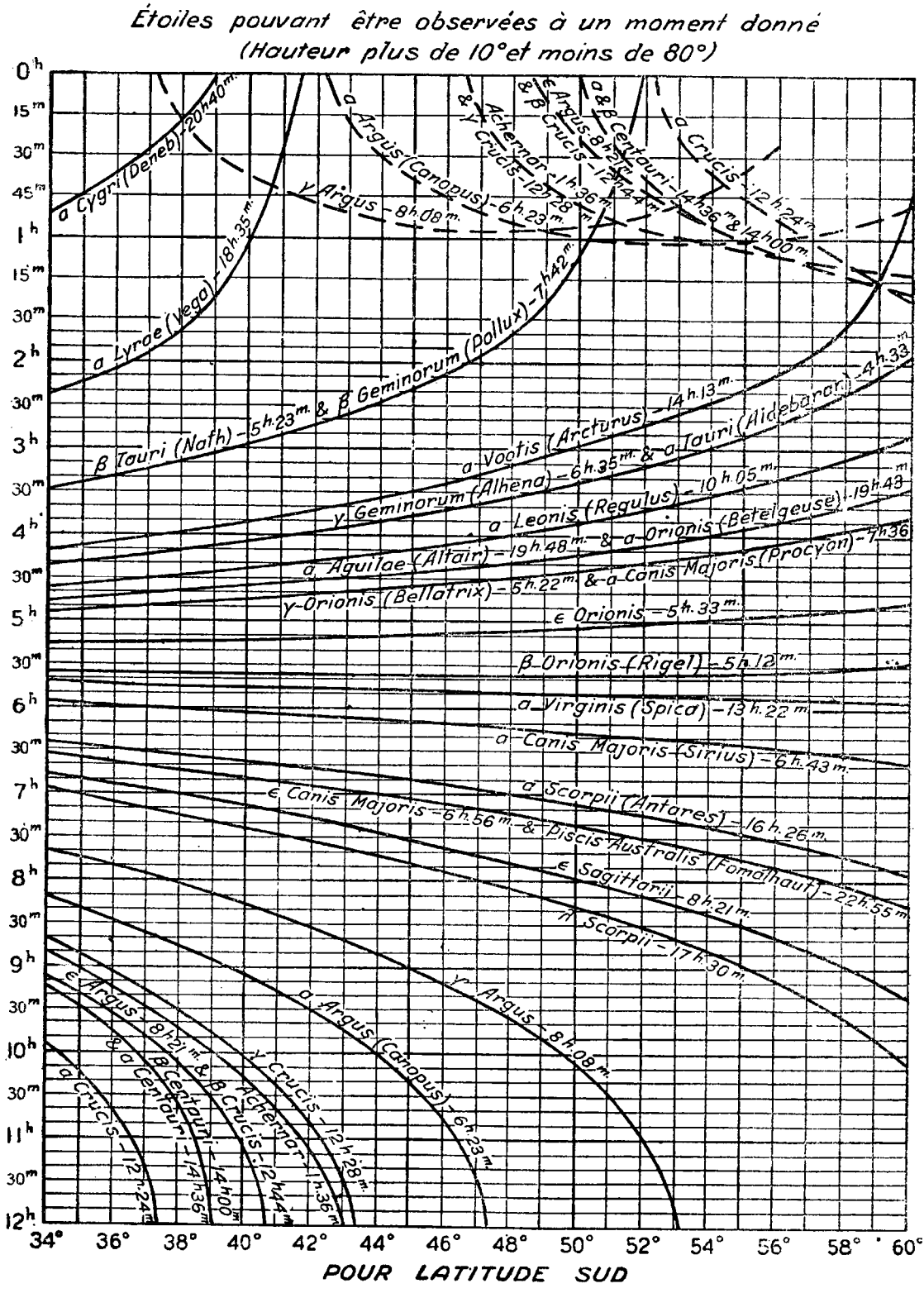
β Orionis (Rigel) - 5h.12m.
Spica - 13h.22m.
Sirius - 6h.43m.
α Scorpii (Antares) - 16h.26m.
Fomalhaut - 22h.55m.
ε Sagittarii - 18h.21m.
π Scorpii - 17h.30m.
α Ursae Majoris (Dubhe) - 11h.00m.
γ Cassiopeiae - 0h.55m.
ε Ursae Majoris (Alioth) - 12h.52m.
α Persei (Mirfak) - 3h.20m. & η Ursae Majoris (Benetnasch) - 13h.45m.
α Aurigae (Capella) - 5h.13m.
α Cygni (Deneb) - 20h.40m.
α Lyrae (Vega) - 18h.35m.
β Tauri (Nath) - 5h.23m. & β Geminorum (Pollux) - 7h.42m.
α Bootis (Arcturus) - 14h.13m. - γ Geminorum (Alhena) - 6h.35m. & α Tauri (Aldebaran) - 4h.33m.
α Leonis (Regulus) - 10h.05m.
Betelgeuse - 5h.52m. Altair - 19h.48m. & Orionis (Bellatrix) - 5h.22m.
α Canis Majoris (Procyon) - 7h.36m.
ε Orionis - 5h.33m.
β Orionis (Rigel) - 5h.12m.
α Virginis (Spica) - 13h.22m.
α Canis Majoris (Sirius) - 6h.43m.
α Scorpii (Antares) - 16h.26m. & ε Canis Majoris - 6h.56m.
Fomalhaut - 22h.55m.
ε Sagittarii - 18h.21m. & π Scorpii - 17h.30m.
γ Argus - 8h.08m.
γ Crucis - 12h.28m. & Achernar - 1h.36m.
α Argus (Canopus) - 6h.23m.
ε Argus - 8h.21m. β Crucis - 12h.44m. β Centauri - 14h.00m.
α Trianguli Australis - 16h.43m. & β Argus - 9h.12m.
α Crucis - 12h.24m. & α Centauri - 14h.36m.
10° 12° 14° 16° 18° 20° 22° 24° 26° 28° 30° 30° 34°
POUR LATITUDE SUD

PLANCHE V


Étoiles pouvant être observées à un moment donné
(Hauteur plus de 10° et moins de 80°)
0h
15m
30m
45m
1h
15m
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30m
4h
30m
5h
30m
6h
30m
7h
30m
8h
30m
9h
30m
10h
30m
11h
30m
12h
34° 36° 38° 40° 42° 44° 46° 48° 50° 52° 54° 56° 58° 60°
POUR LATITUDE SUD
α Cygni (Deneb) - 20h 40m.
α Lyrae (Vega) - 18h 35m.
α Argus (Canopus) - 6h 23m.
γ Argus - 8h 08m.
α & γ Crucis - 12h 28m.
ε Argus - 8h 21m. & β Crucis - 12h 44m.
α & β Centauri - 14h 36m. & 14h 00m.
α Crucis - 12h 24m.
α Lyrae (Vega) - 7h 42m.
β Tauri (Nath) - 5h 23m. & β Geminorum (Pollux) - 7h 42m.
α Bootis (Arcturus) - 14h 13m.
α Tauri (Aldebaran) - 4h 33m.
γ Geminorum (Alhena) - 6h 35m. & α Tauri (Aldebaran) - 4h 33m.
α Leonis (Regulus) - 10h 05m.
α Aquilae (Altair) - 19h 48m. & α Orionis (Betelgeuse) - 19h 43m.
γ Orionis (Bellatrix) - 5h 22m. & α Canis Majoris (Procyon) - 7h 36m.
ε Orionis - 5h 33m.
β Orionis (Rigel) - 5h 12m.
α Virginis (Spica) - 13h 22m.
α Canis Majoris (Sirius) - 6h 43m.
α Scorpii (Antares) - 16h 26m.
ε Canis Majoris - 6h 56m. & Piscis Australis (Fomalhaut) - 22h 55m.
ε Sagittarii - 8h 21m.
π Scorpii - 17h 30m.
γ Argus - 8h 08m.
α Argus (Canopus) - 6h 23m.
γ Crucis - 12h 28m.
Achernar - 1h 36m.
ε Argus - 8h 21m. & β Crucis - 12h 44m.
β Centauri - 14h 00m.
α Centauri - 14h 36m.
α Crucis - 12h 24m.

PLANCHE VI