

Astronomy in the city

**Rosa M. Ros, Juan A. Belmonte, Jarita Holbrook,
Noorali T. Jiwaji, Dismas Simiyu**

*International Astronomical Union
Polytechnical University of Catalonia, Spain,
Institute Astrophysics Canarias, Spain,
University of the Western Cape, South Africa,
Open University of Tanzania, Tanzania
Meru University of Science and Technology, Kenya*



ORIENTATION OF THE PYRAMIDS

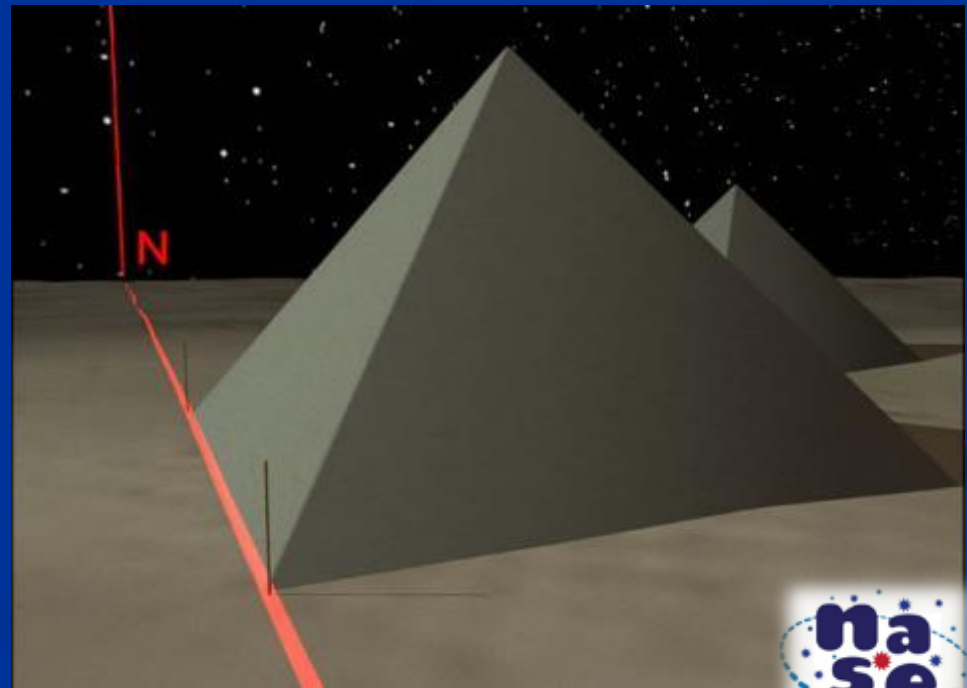
Giza, Egypt, Africa
2500 BC



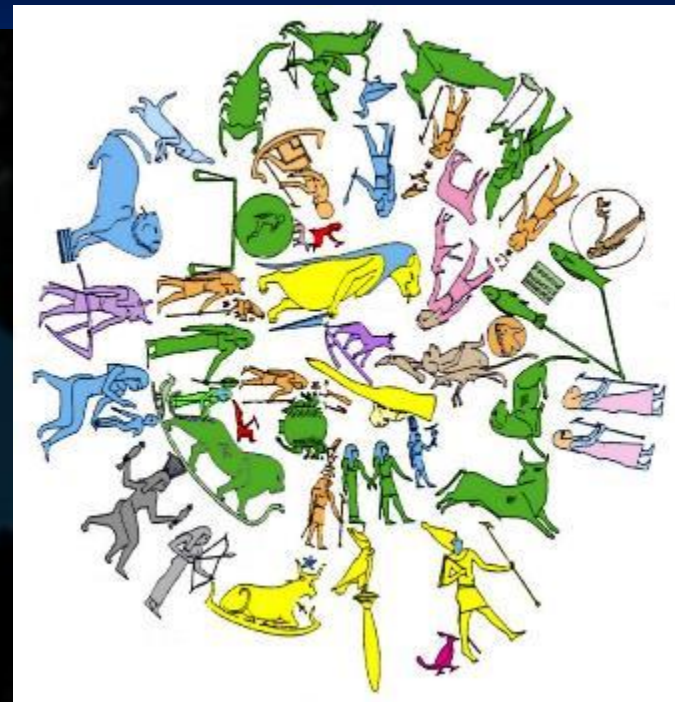
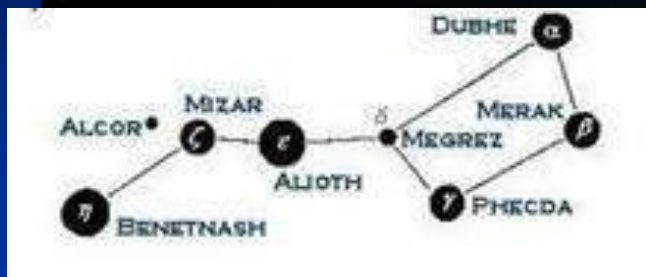
Not all of Egypt's pyramids are correctly oriented; in fact, only a few of the more than sixty well known have a precise orientation.

The pyramids of the pharaohs of dynasty IV in Dahshur and Giza are the best oriented, with errors of 15' or less.

Astronomical alignment of the pyramid of Kefren (around 2545 BC) towards the meridian transit of Megrez and Phecda of the constellation Meskhetyu (The Leg of the Bull), equivalent to Ursa Major partially



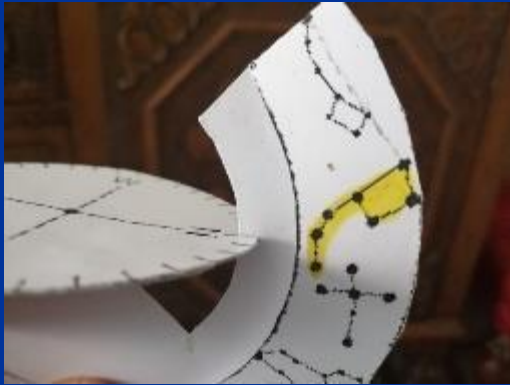
"Imperishable" constellation of the **Bull's Leg**



Currently Merak and Dubhe indicate the position of the polar at 2° from the pole. Formerly Megrez and Phecda determined the situation of Thuban that in 2787 B.C. which was only $2'$ from the pole



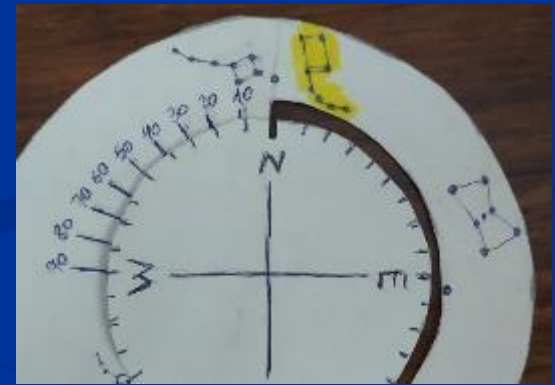
The placement of the pyramids responds to religious motivations. The Egyptians believed that the stars disappeared and reappeared, allowed to transcend death. **"The ducts of the pyramids face north because there were the stars that never disappeared from the sky, the circumpolar stars, which never died"**



Now 2000



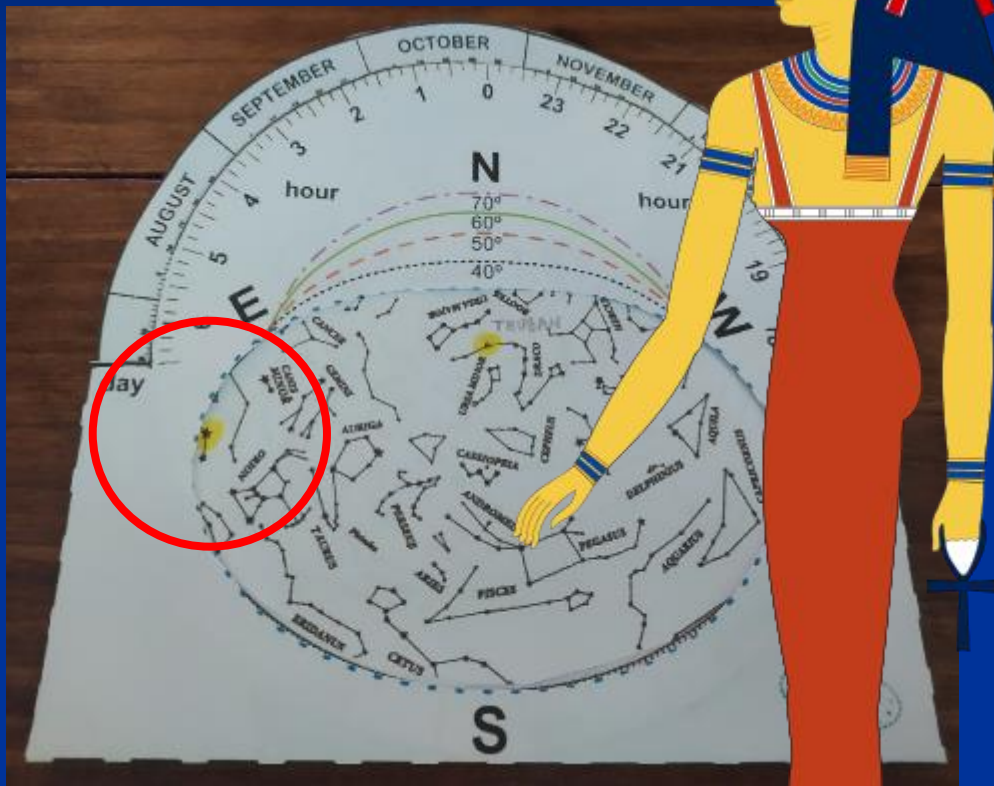
Before 2500 BC



Cairo latitude 30°N

The access corridors were built with a slope such that this would facilitate the king's ascension to the northern skies, domain of the "undying stars".

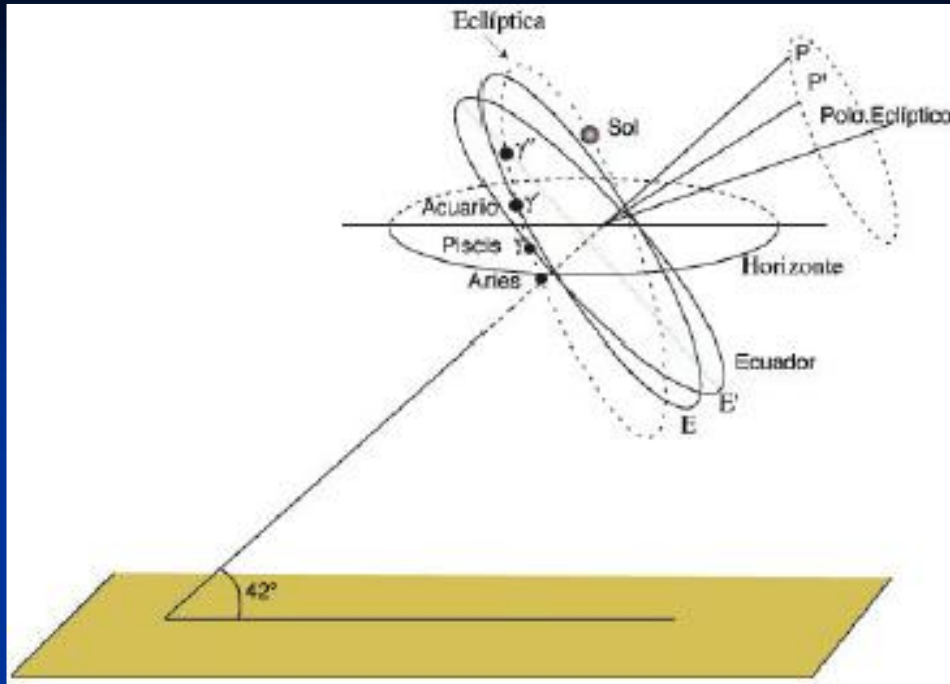
The Sirius star, called Sopdet by the Egyptians, gives rise to one of these singular events: its first annual appearance at dawn, the so-called heliacal rising (the first day it becomes visible to the west at dawn just before sunrise about July 25th) and this moment announced the arrival of the flood of the Nile, of great importance in Egypt.



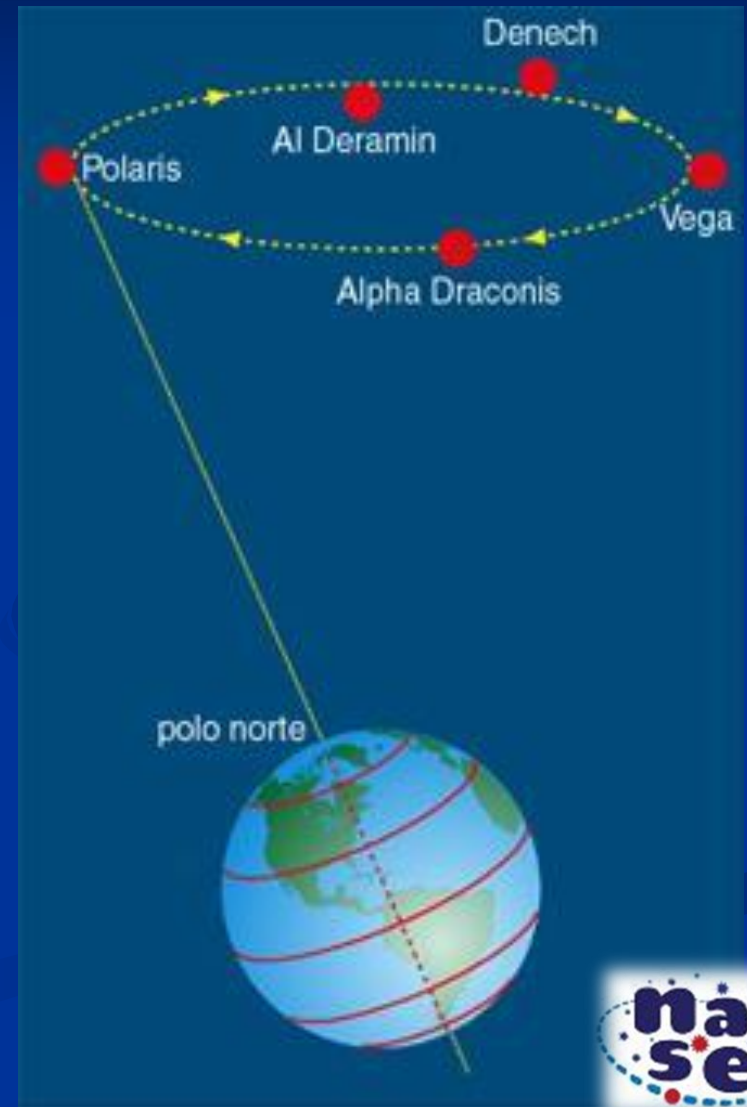
The star Sirius remained invisible for 70 days, the same time as in the mummification process, the bodies were immersed in natron salts to dehydrate them for 70 days and the body was subsequently removed.



Precession of the Equinoxes

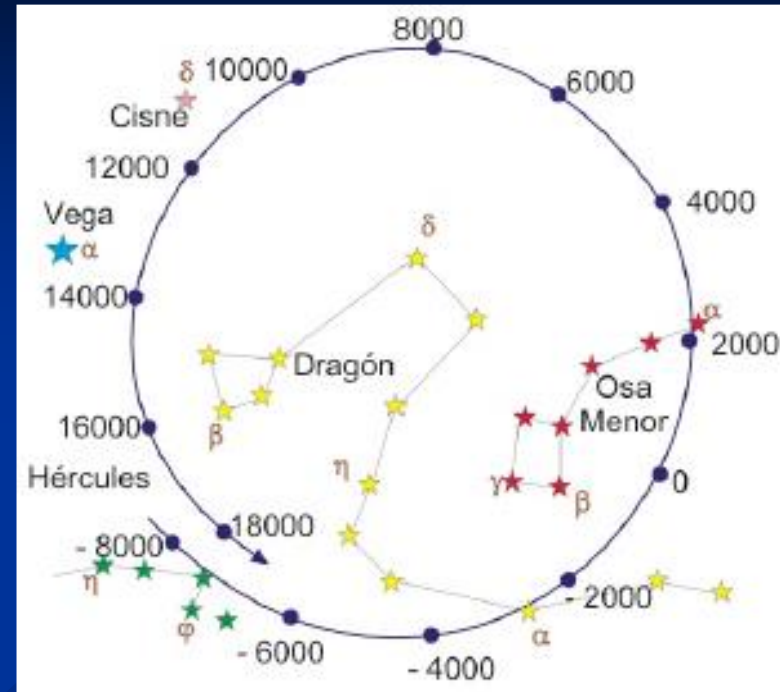


Due to the Precession of the Equinoxes, the point of intersection between the equator and the ecliptic, called the Aries point (because it was in this constellation) has moved to the constellation of Pisces.



Precession of Equinoxes

Precession is the motion of change of direction of the Earth's axis of rotation describing in 25776 years a circumference (or $50.29''/\text{year}$) like a spinning top. The celestial equator also wobbles and its intersection with the ecliptic varies.



Hipparchus observed it between 147 and 127 BC, (about 2000 years ago). Then this point named Aries point (because it was in that constellation) has moved to the constellation of Pisces and the north pole has changed.

$$50.29'' \times 2000 = 100580'' = \text{approx } 28^\circ \text{ a zodiac sign}$$

For example, now the North Pole is on the Polaris of Ursa Minor and 2000 years ago it was Thuban in the Draco.



ROMAN CITIES

Barcelona, Spain, Europe
10 BC



Barcelona was founded by the Roman Empire in the 1st century BC. (it was called Iulia Augusta Faventia Paterna Barcino) on a small hill called "Mons Taber".

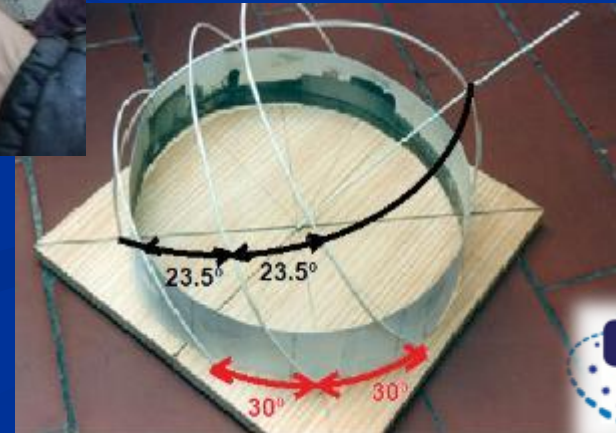
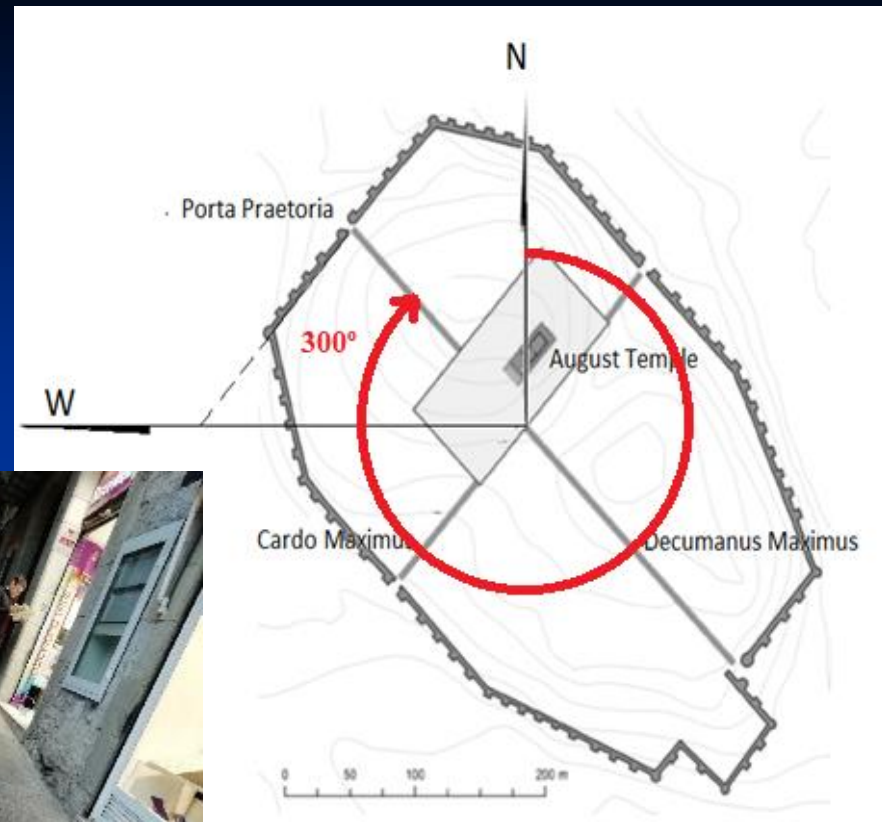
The Temple of Augustus was located at the highest point of Mons Taber



Barcino was crossed by the Decumanus Maximus (main street with approximate orientation from east to west), and the Cardo Maximus (from north to south) which crossed the city.



The Decumanus Maximus (East-West) is easy to find in present-day Barcelona and it is not difficult to calculate its angle to the West $300^\circ - 270^\circ = 30^\circ$ and compare the result obtained with the results of professional archaeoastronomers.

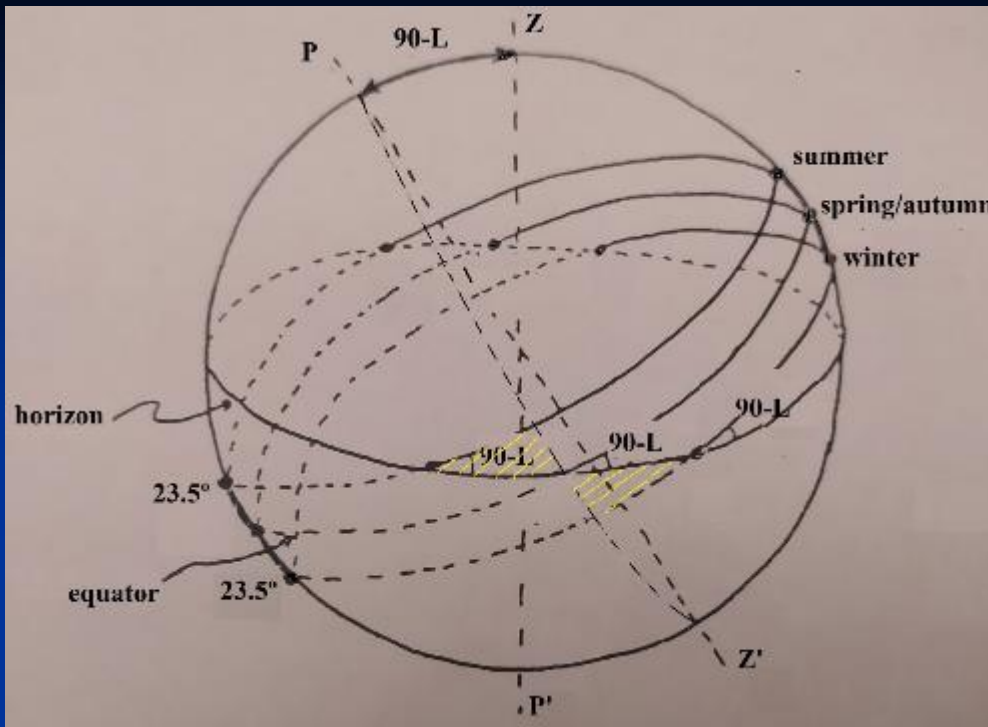


For example, the table summarizes the result of a study carried out by J. A. Belmonte on 270 urban structures and military settlements measured

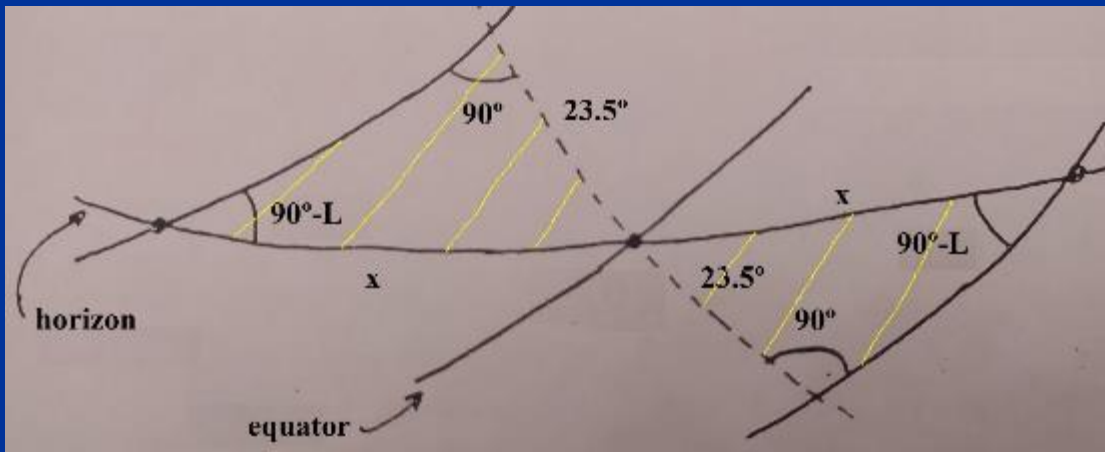
Declination	Festivity	Zone
+23,5°	Sunset, Summer solstice June, 21st <i>Sol invictus, Appolus</i>	Cartago Nova Mediterranean Zone Galia and Germania
+7 °	Sunrise and Sunset March, 1st <i>Mars Festivity</i>	Britania, Limes Arabicus Limes Germanicus
0°	Equinox March, 21st September, 21st	Iberic origin North of Africa and nest to the East Berberes Group
-23,5°	Sunset, Winter solstice December, 21st <i>Saturnalias</i>	East and West of Rome

Documanus maximum is 30° from the West which in Barcelona (latitude 41°) corresponds to the summer solstice 23.5°





$$\sin x = \sin 23.5^\circ / \cos L$$



Latitude L	X°
0°	23,5°
10°	24°
20°	25°
30°	27°
40°	32°
50°	40°
60°	53°

$$\sin x / \sin 90^\circ = \sin 23.5^\circ / \sin (90^\circ - L)$$



LALIBELA MONASTIC CITY

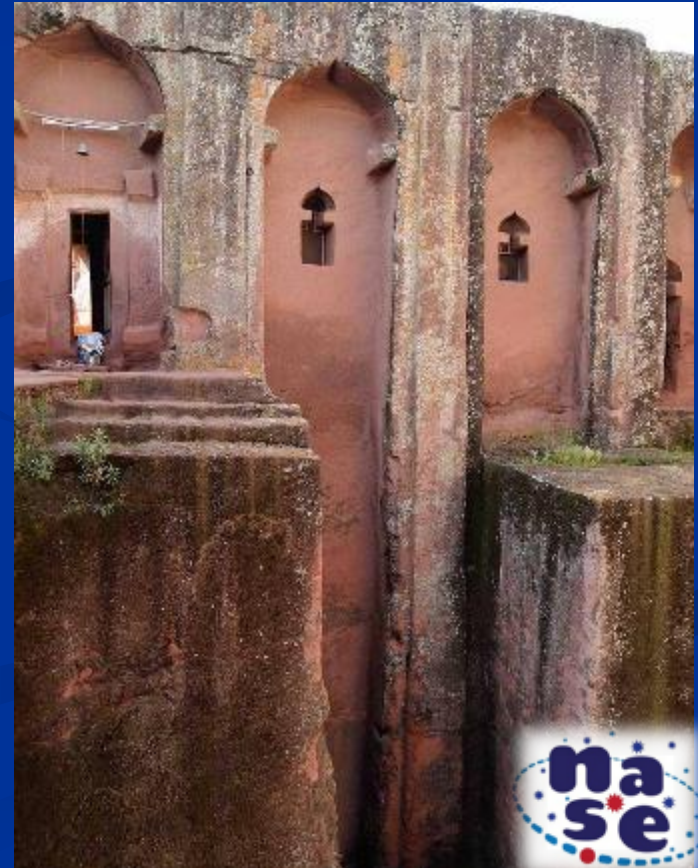
Lalibela, Ethiopia, Africa

1200



According to tradition, the king of Ethiopia, Lalibela (1133-1173) traveled to Jerusalem. After this city fell into Muslim hands, Lalibela decided to create a new Jerusalem in Ethiopia, giving his own name to this city of churches.

The churches of Lalibela were built between the 7th and 13th centuries. They are carved in single blocks of red basalt rock, without bricks or mortar.

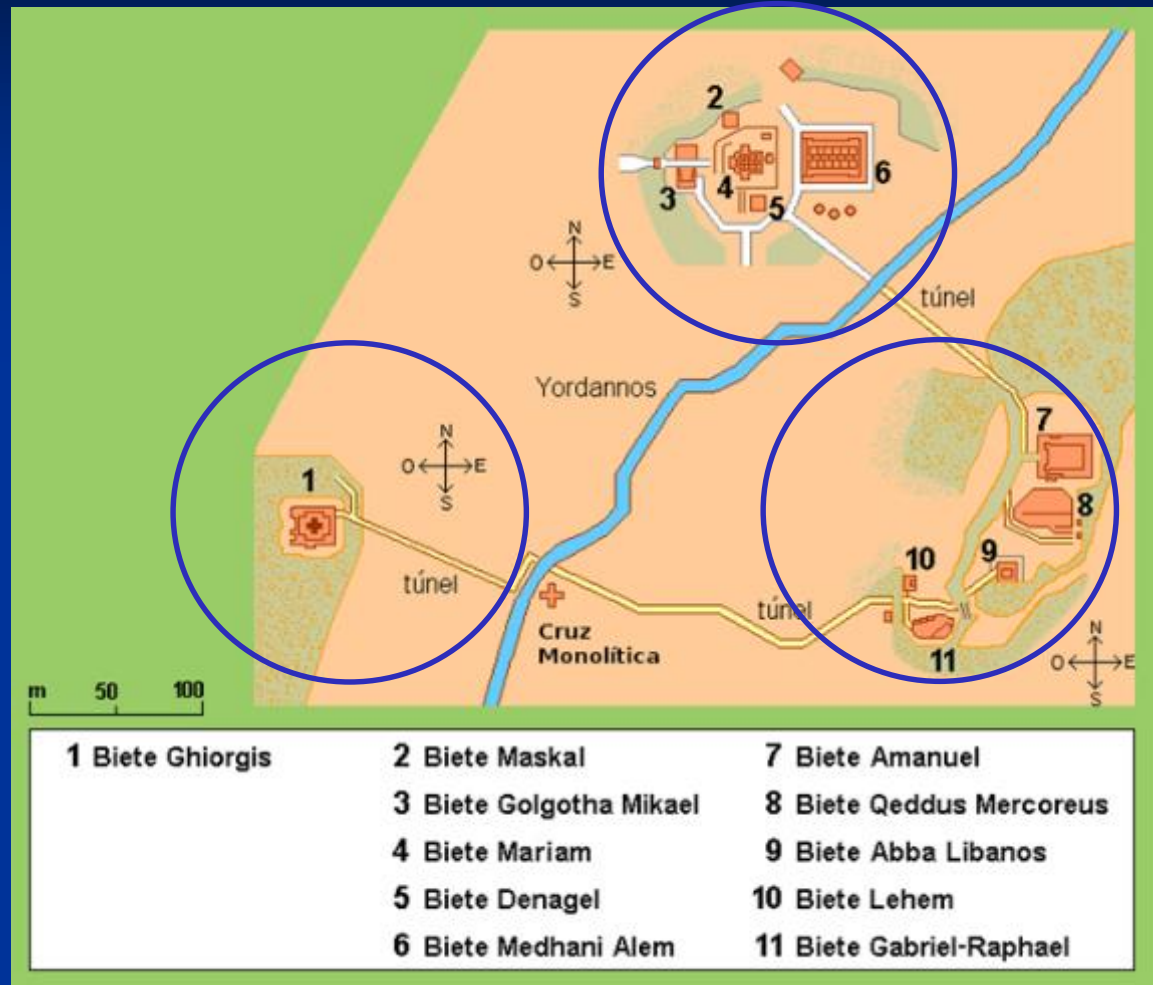


The Lalibela churches are divided into two groups, separated by the Jordan River (a river carved out of the rock).

The Northwest group consists of “new” churches (built in 12th century), well oriented with decorations from the Empire of Axum

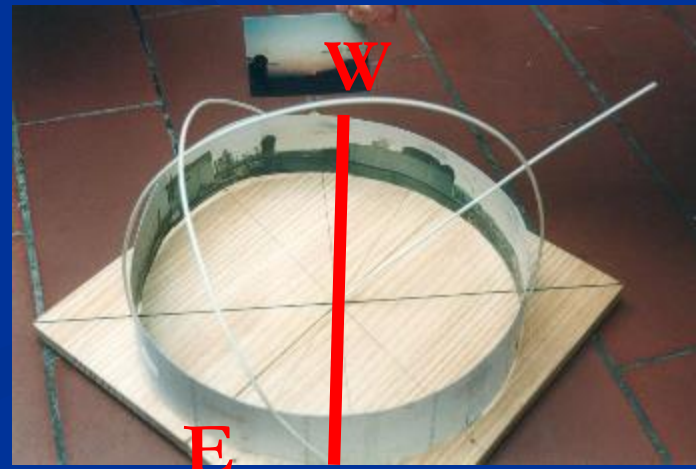
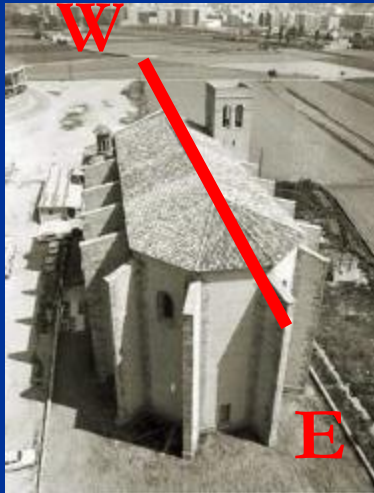
The Southeast group is composed of adapted churches and old palaces belonging to the end of the Axum kingdom (from the 7th to the 10th century) and are not oriented.

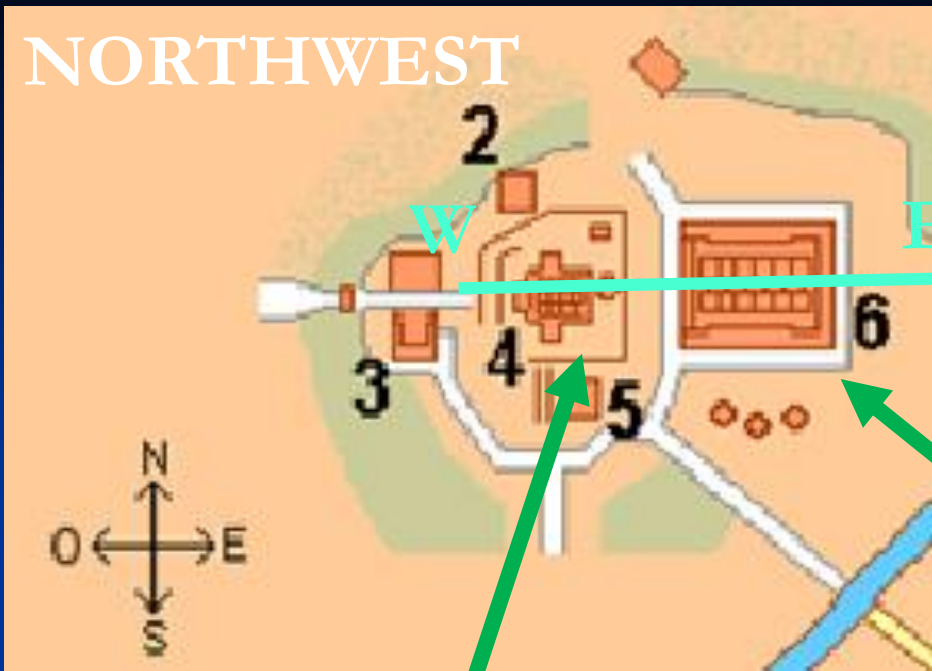
Separated is the Bete Giyorgis church from the 12th and oriented



At the Council of Nicaea (325) it was determined that the apse of a church was to the East and the gateway to the West so that the priest would be facing East during the services.

The churches, according to the orthodox custom of orienting their temples to the East, to pray towards where the sun rises (Christ represents the light), placed three doors: one to the North (where men entered), another to the South (destined to the women) and a third to the West (for the clergy).



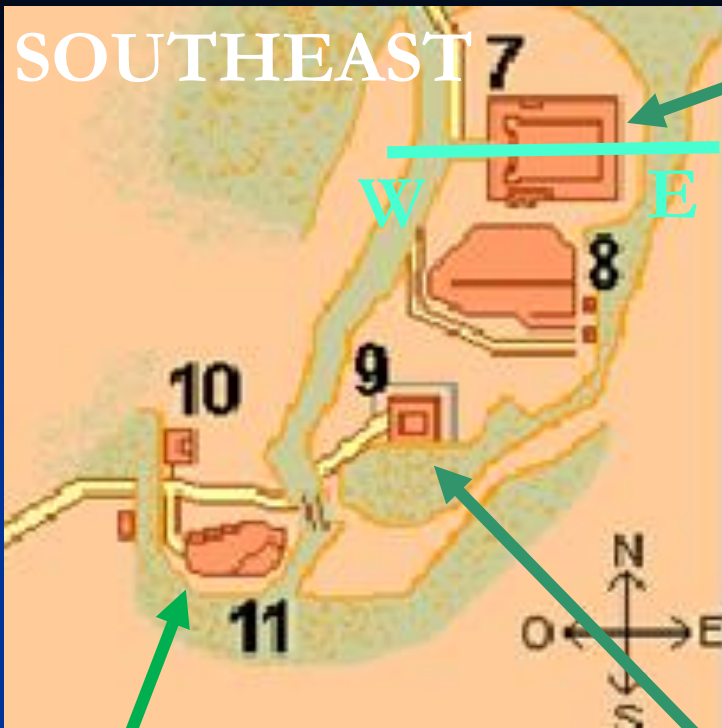


The Church of **Bete Medhani Alem** (Savior of the World) is the largest excavated monolithic church in the world. It is oriented E-W. It has three entrances, one to the South, another to the West and the main one to the North.



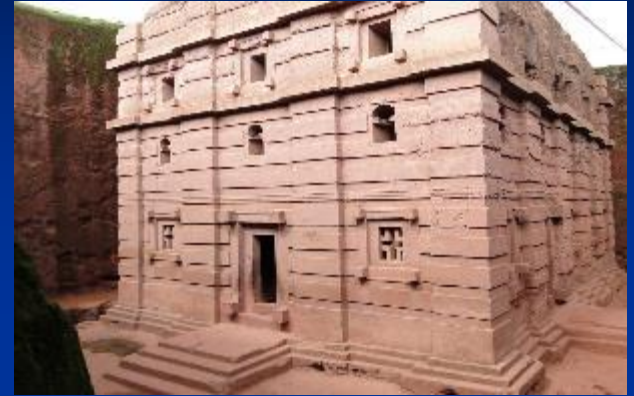
The Church **Bete Maryam** (Mary) is well oriented. Its three doors are framed with porches that have been restored.





Biet Amanuel (Emmanuel)

It was originally the chapel of the royal palace. It is oriented



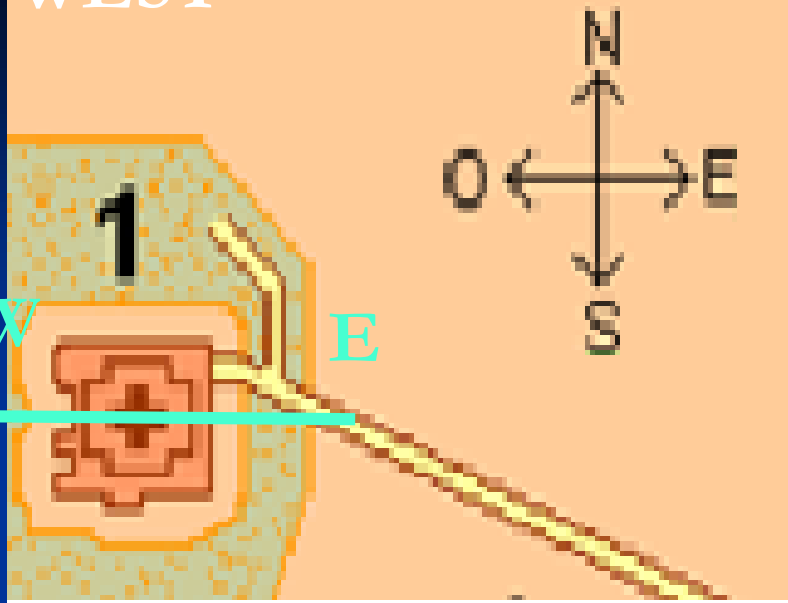
Bete Abba Libanos side walls carved but the roof without separating from the rock. It is not oriented.



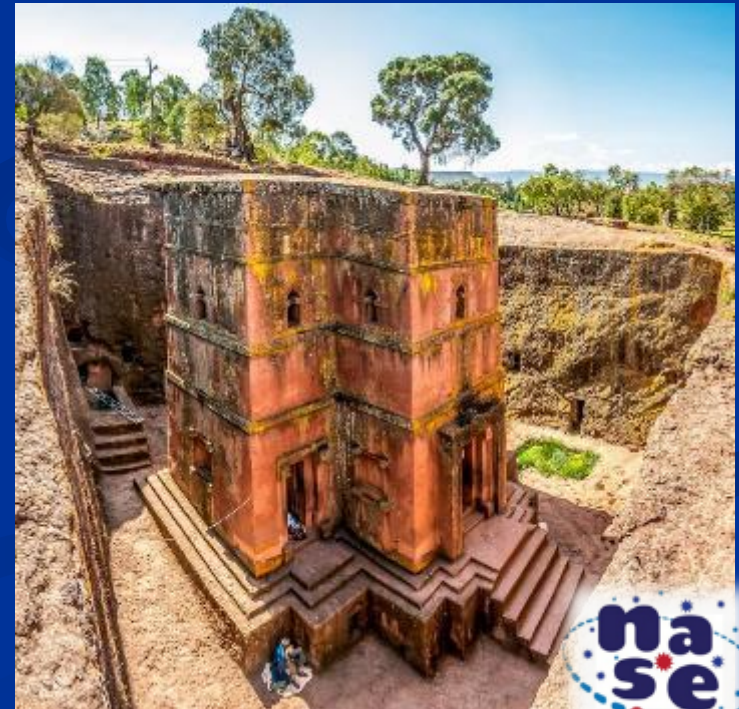
Bete Gabriel-Rafael (Gabriel and Rafael)

with the appearance of an imposing fortress. Excavated as a fortified palace complex in the 7th and 8th centuries. It is not oriented

WEST



Bete Giyorgis (Saint George)
It is isolated. Excavated below ground level in the shape of a Greek cross. It has a triple cross carved on the roof. It has three doors on the west side. The last one was built. It is well oriented.



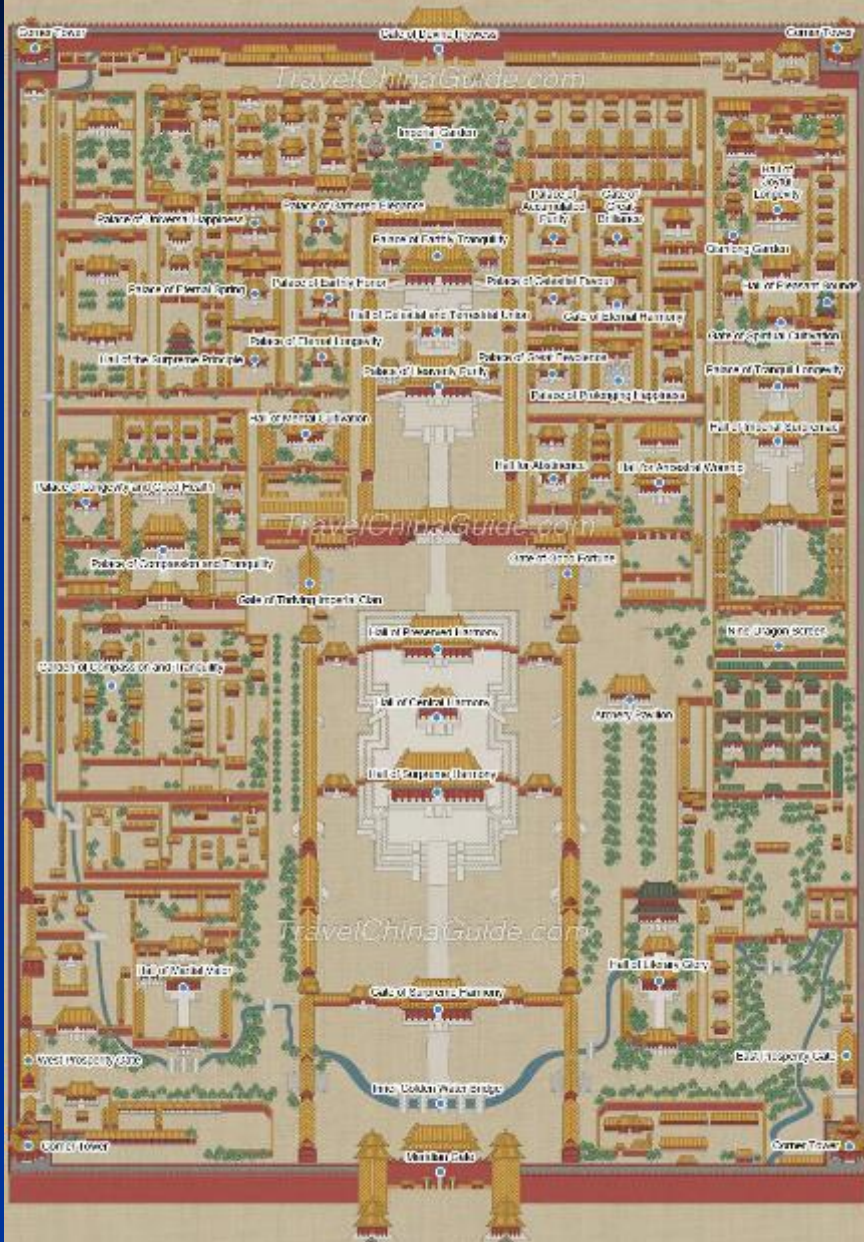
FORBIDDEN CITY

Beijing, China, Asia

1420



A Full Map of the Forbidden City

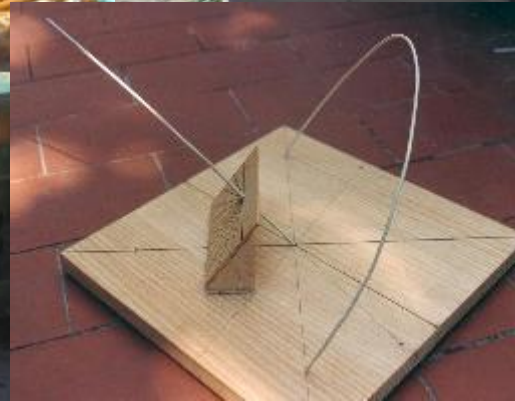


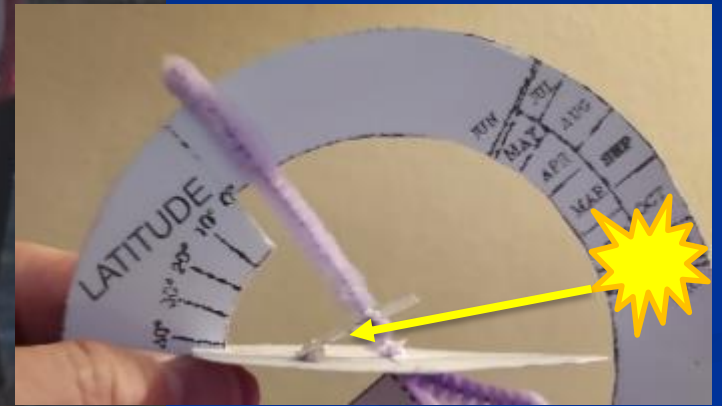
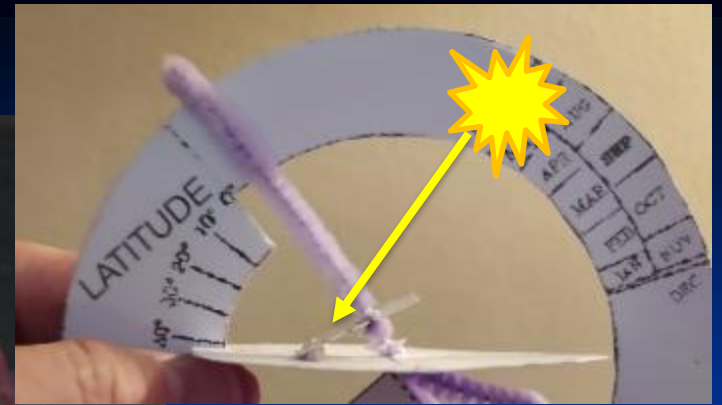
The full map is oriented
North-South
according the local meridian.

Location Map of Forbidden City and Tiananmen Square



There is a collection of equatorial sundials aligned with the local meridian





The plane of sundial is parallel to the equator and the gnomon is according the terrestrial rotation axis.



MONUMENT
“Mitad del Mundo”
Quito, Ecuador, América
1992

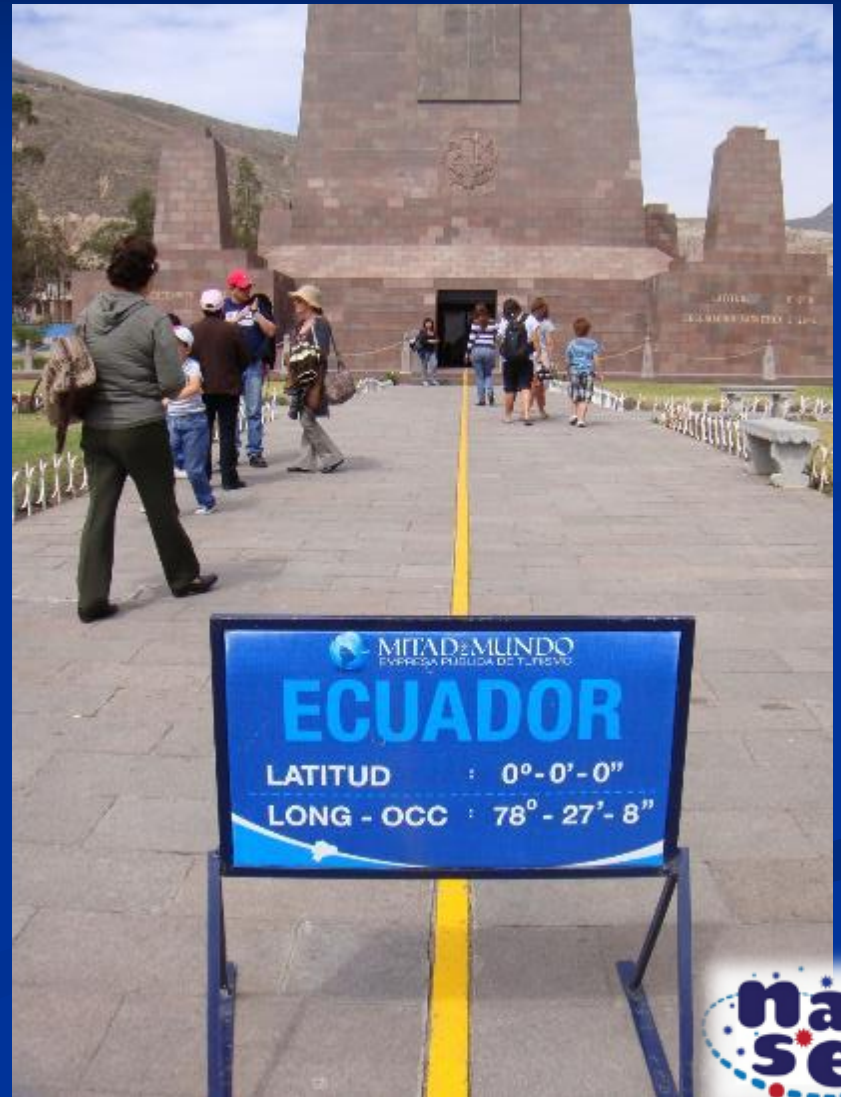


Equator Monument in the Equator line



Parallel Earth, with the Equator line on the top

The Equator line



Parallel Earth? a few weeks after equinox



There is a mistake
with the position!!!

BUSHMEN

Kalahari Desert, Africa

2014



Kalahari Desert

Botswana
Zimbabwe
Namibia
South Africa



The Milky Way was created by a girl who wanted a little light so that people could see back home. The girl collected a handful of wood ashes from the fire, threw them into the sky, and created a bright path. Later he created some of the brightest stars by taking root in the sky. According to legend, the white stars are ready to eat, but the red ones are old roots that are no longer edible.



The reddish Antares in Scorpio is called "The star that ends the fire". Not only does it have a reddish color, but (at certain times of the year) it gets very late, when the campfires have gone out.

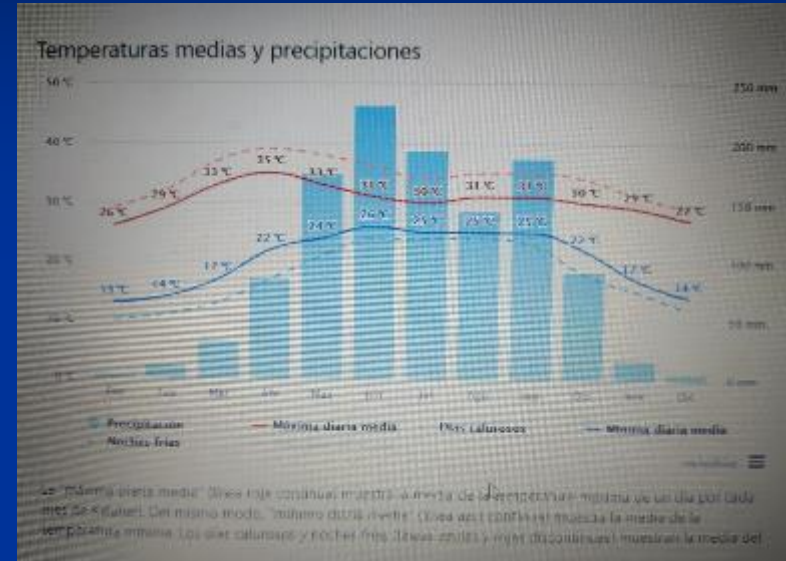
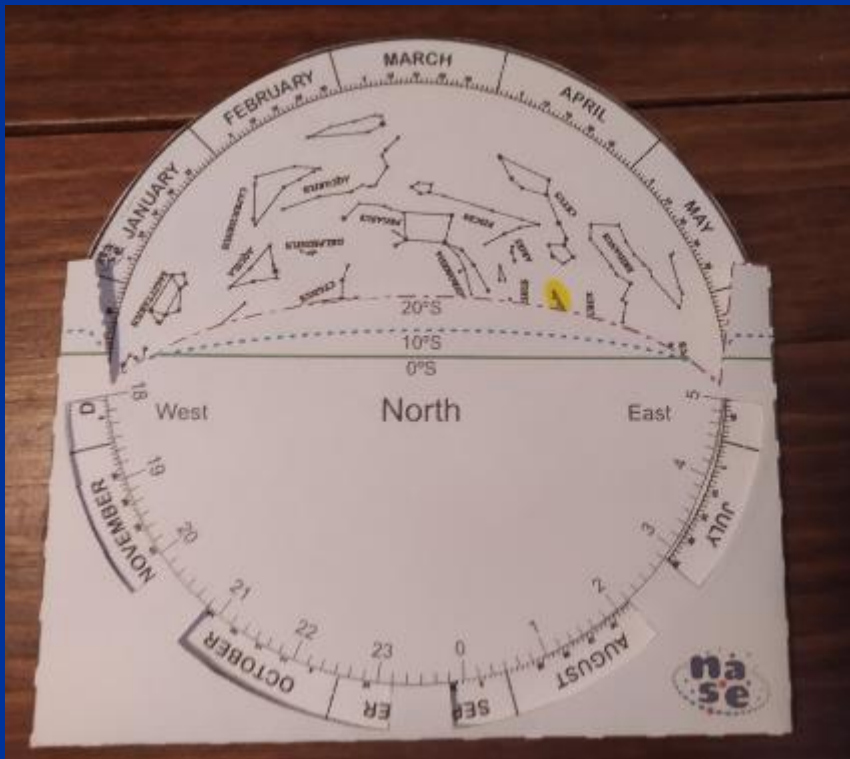


The Bushmen see turtles in Orion, depending on the tribe:

- a) Orion Belt stars as "3 male turtles (hanging from a pole)", and the Sword of Orion as "3 turtles females (hanging from a pole)".
- b) The stars of the feet and knees of Orion (perhaps because they seem to move through the sky slower than stars of the head and shoulders of Orion).



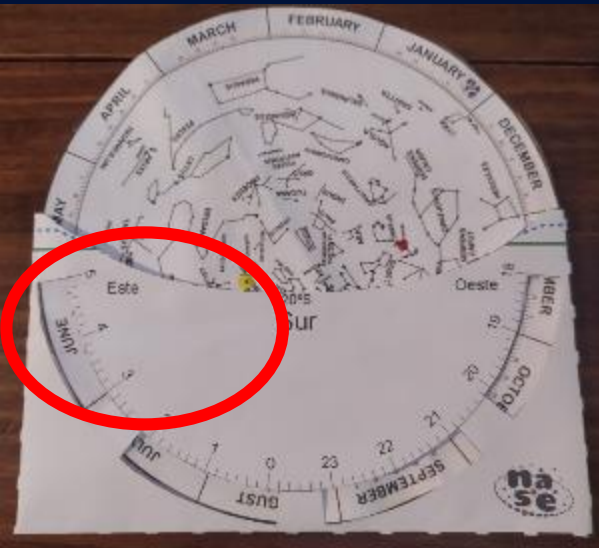
The first visibility of the Pleiades in the morning twilight heralds the beginning of the rainy season (at the end of June)



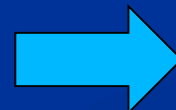
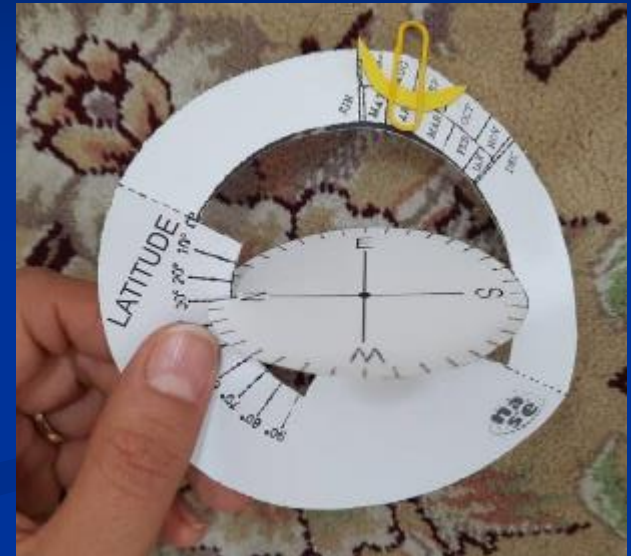
"Sirius is Canopus's grandmother", because Sirius comes out after Canopus, and the old men tend to follow behind the more agile youngsters.

When **Canopus is seen in the morning sky in winter**, (the Sun is paler) and they associate it with a rich food and its name is "**The star of the ant egg.**"

Similarly, with the appearance of Sirius in the heat of the morning sun, **women go out early in search of Bushman rice (termite eggs).**



Certain groups of Bushmen believe that when the crescent Moon tilts downward, it is said to be looking towards a grave and this is a sign that many people will die soon. A crescent pointing upward is a favorable sign. The round full Moon is a sign of satisfaction and that people will find food in abundance.



Seeing the Moon as a U or an n corresponds to a latitude in the equatorial zone between +20° and -20°

Namibia or Boswana



EQUADOR LINE
Uganda, Africa
2018



Equator line in the Victoria Lake in Uganda.



The Equator line in the middle of the road from Mbarara to Kampala.



SOLAR PANELS

Ulaanbaatar, Mongolia, Asia

2019



With solar panels ... with different orientations?



In Ulaanbaatar **ALWAYS** the same orientation according the solar path!!





Direction N-S with the inclination = site latitude



Best sits in the Bus

From Ulaanbaatar to Tsetserleg

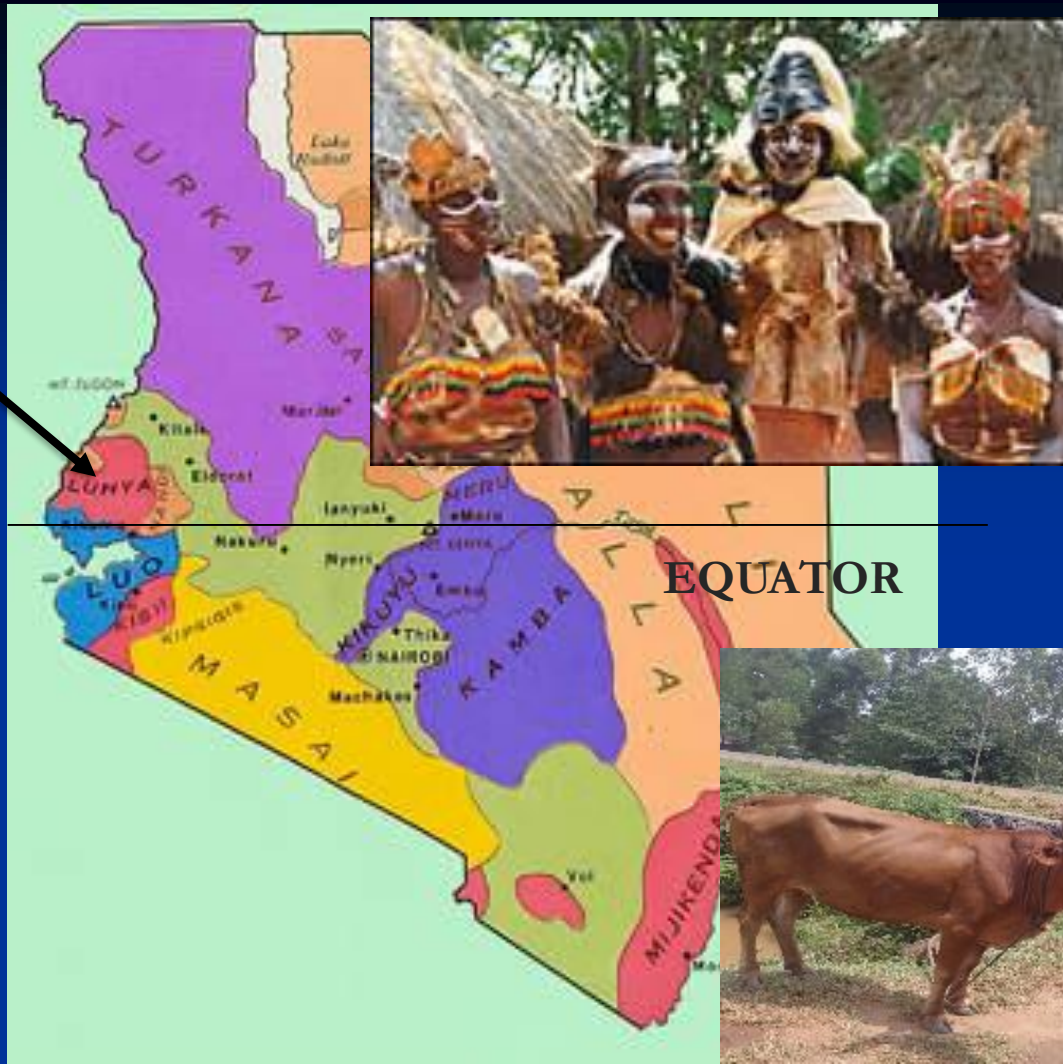


Sunny place on the South side of the buss (on the left), that is to say



LUHYA TRIBE
Kenya, Africa
2019





The 14% of Kenya population are in Luhya tribe in the occidental province of Kenya.



A father said to his son: “you have to move the animals to drink in the river when your shadow will be in the middle of your feet”.



Throughout the day the shadows change direction and length. This tribe is in Ecuador, at noon the shadows are the shortest and remain between the feet (more or less) throughout the year.



When the shadow is in the middle of his feet, the Sun is in the local meridian, then, it is approximately at midday



TUBU AND SANDAWE TRIBES

Tanzania, África

2020



The Turu of
Tanzania are at
a latitude of
5°S in the
Singida region

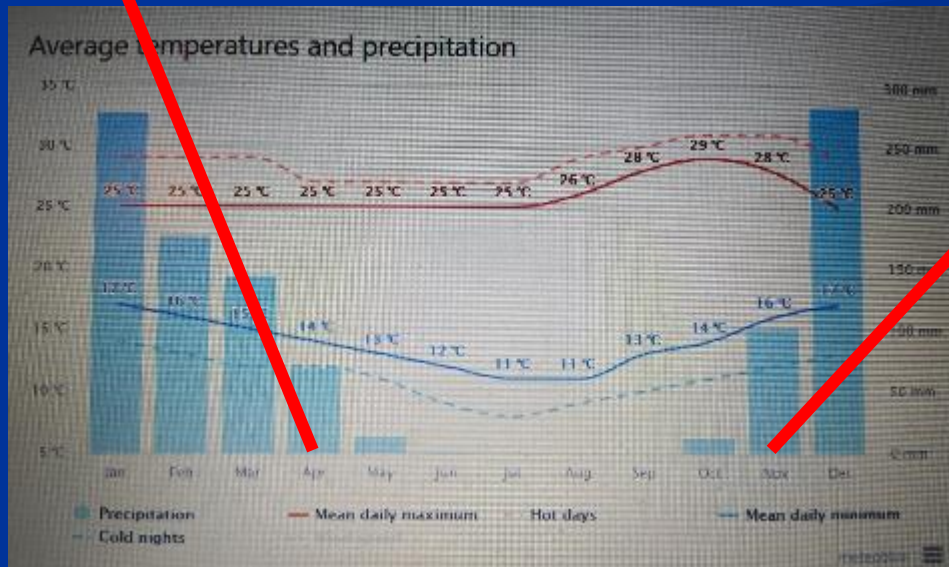


The Turu consider the Moon as a woman because its phases are similar to the weight gain and loss associated with pregnancy

During the full Moon, when it appears to be “pregnant with all living things,” important annual ceremonies are held



The Turu called the Pleiades "Kilimia" and think of it as wife and mother, marking the end of the dry season with her return in November. They marked the ideals of women, such as caring for people and offering water to those in need.



SINGIDA: CLIMATIC TABLE AND WEATHER PER YEAR



The Turu regard Small Magellanic Cloud as female while the Large Magellanic Cloud is male. During the rainy season, the Magellanic Clouds are thought to aid the Pleiades in bringing the heaviest rains when they appear beside each other (in December).



The Sandawe of Tanzania are in a latitude of 6°S in the area of in the region of Dodoma, capital of Tanzania





The Sandawe of Tanzania consider the Sun less masculine when it is lower in the sky and less harsh, and it becomes more masculine as it reaches its zenith. The Sandawe are in the equatorial area and the Sun in the zenith is stronger and it is stronger than in another latitude

**Many Thanks
for your attention !**

