Lunar perception Project.
Moon's view from different latitudes on earth.

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Abstract

Based on pictures of the moon taken from several observers located at different latitudes, a composition of the crescent moon was made. It shows that the moon looks exactly the same to all observers, as long as the moon is transiting the meridian of any given location. However, northern latitudes and southern latitudes observers will see the moon "flipped" horizontally to each other. On the other hand, the angle of the moon's terminator to any observer will be affected by the latitude of where the observer is located. Moon rise and moon set are the moments where this angle difference is stronger.

Introduction

Is the moon's view the same for all human beings that inhabith on earth? Being our planet almost an sphere, wil it be posible that the moon's view being affected by the observer's latitude?

Those two questions were the ones that trigger this project.

Objective

The objective of this project was to evaluate the output from a 3D model developed to show moon's phases formation[1]. In the 3D model the angle formed by the lunar terminator and the observer's horizon differs for several latitude observations.

Materials and methods

In order to collect data (moon's pictures) for this project several volunteers were recruited from all over the world, from different earth latitudes[2]. The volunteers received precise instructions on how to take the picture, so the way the picture was taken should not vary from observer to observer[3]. It was instructed that the picture should be taken with any regular, digital camera. Due the massive use of this digital cameras, otherwise the project will risk not to have enough volunteers. It was also stablished the date for the pictures. Coud be either March 22nd, 23rd or 24th. Being the perfect date 22nd, day of the crescent moon. A picture of the day before or after will be good enough. The three day window opportunity was set with possible cloudy skies in mind, at the observer's location.

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[1] Appendix: 3D simmulation model for moon phases.
[2] Appendix: List and location of volunteer observers.
[3] Appendix: How to take the picture.

Once data (pictures) collected, the next step is to create the image composition with the gathered data. Moon's pictures will be sorted based on the latitude's observer. The next step will be the analysis of the pictures. Basically, two results are spected: **a)** that the moon's terminator angle will be varying consistently from 90º North to the ecuator, and backwards from ecuator to 90º South. Or **b)** the moon's terminator will be the same to each observer.

Results

According to the previously described procedure, a composite image was obtained[4].

Regrettably, high latitude northern hemisphere observers, 45º and up, had cloudy skies that prevent them to take the picture. However, the project could continue despite this important lack of data.

[4] Appendix: Resulting composite image, bigger.

The image size of the moon varies considerably from observer to obsever, this is due the kind of imaging camera used to take the picture. As explained in Materials and methods, the observers were instructed to take the pictures with regular digital cameras.

Discussion

From the several pictures taken, it is clear that there is neither significant nor consistent variation of the moon's terminator angle to earth, for all observers' location. Although there are some variation in the terminator's angle, but they origin is the way the picture was taken and not due the latitude of the observer location.

The conclusion for this facts is that two or more given observers will see the moon in exactly the same way (and the same moon's terminator inclination) from each other as long as they see the moon when it is transiting or on the observer's meridian[5]. However, should be taken in account that the northern hemisphere observers and southern hemisphere observers will have an interesting discrepancy. The will see the moon flipped horizontally to each other. This is due their latitude observing location. The northern observer watch the moon facing south, and viceversa, the southern observer watch the moon facing north. This is why, both views are compared, they looks flipped horizontally to each other.

This is the composite image, where it show the moon as they see it from their location.

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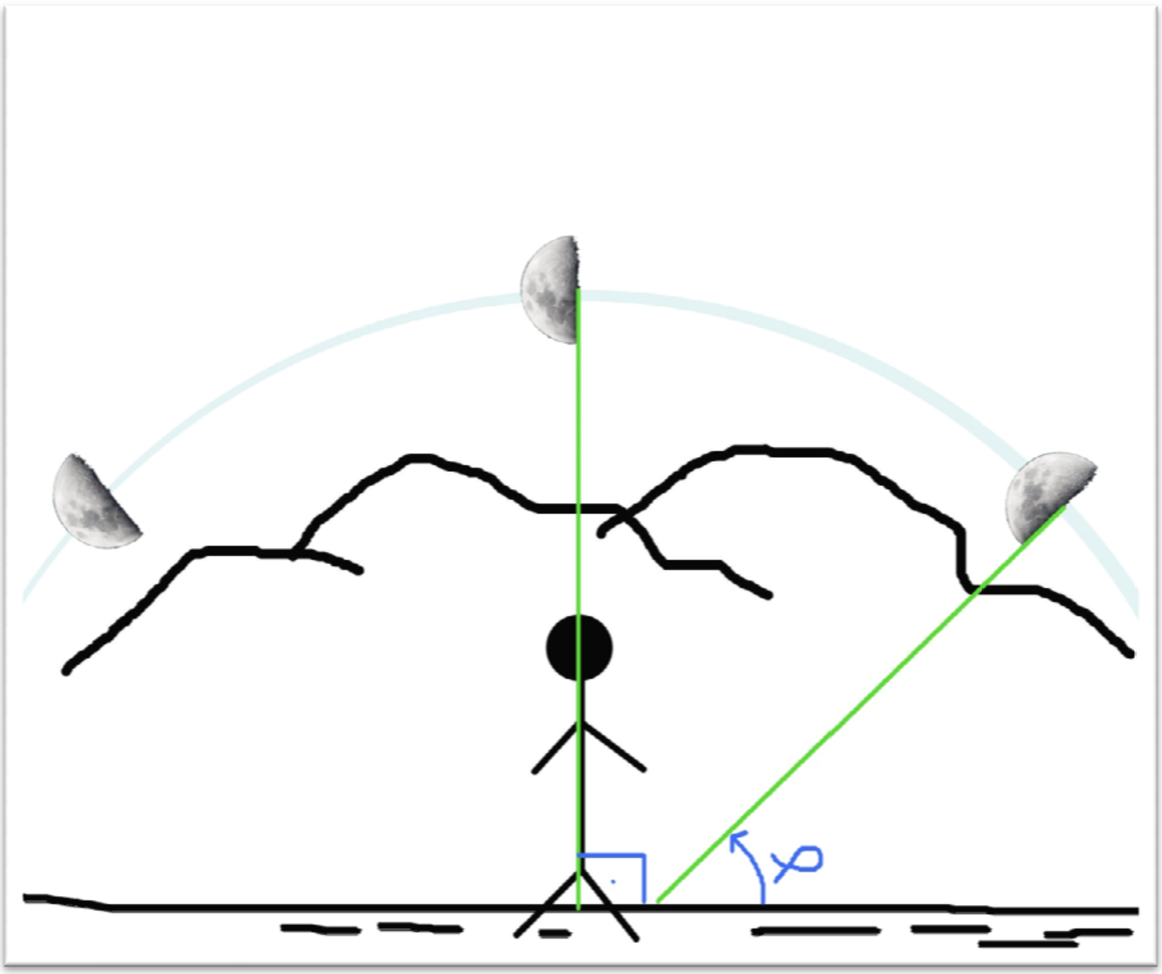
[5] Appendix: Meridian's definition.

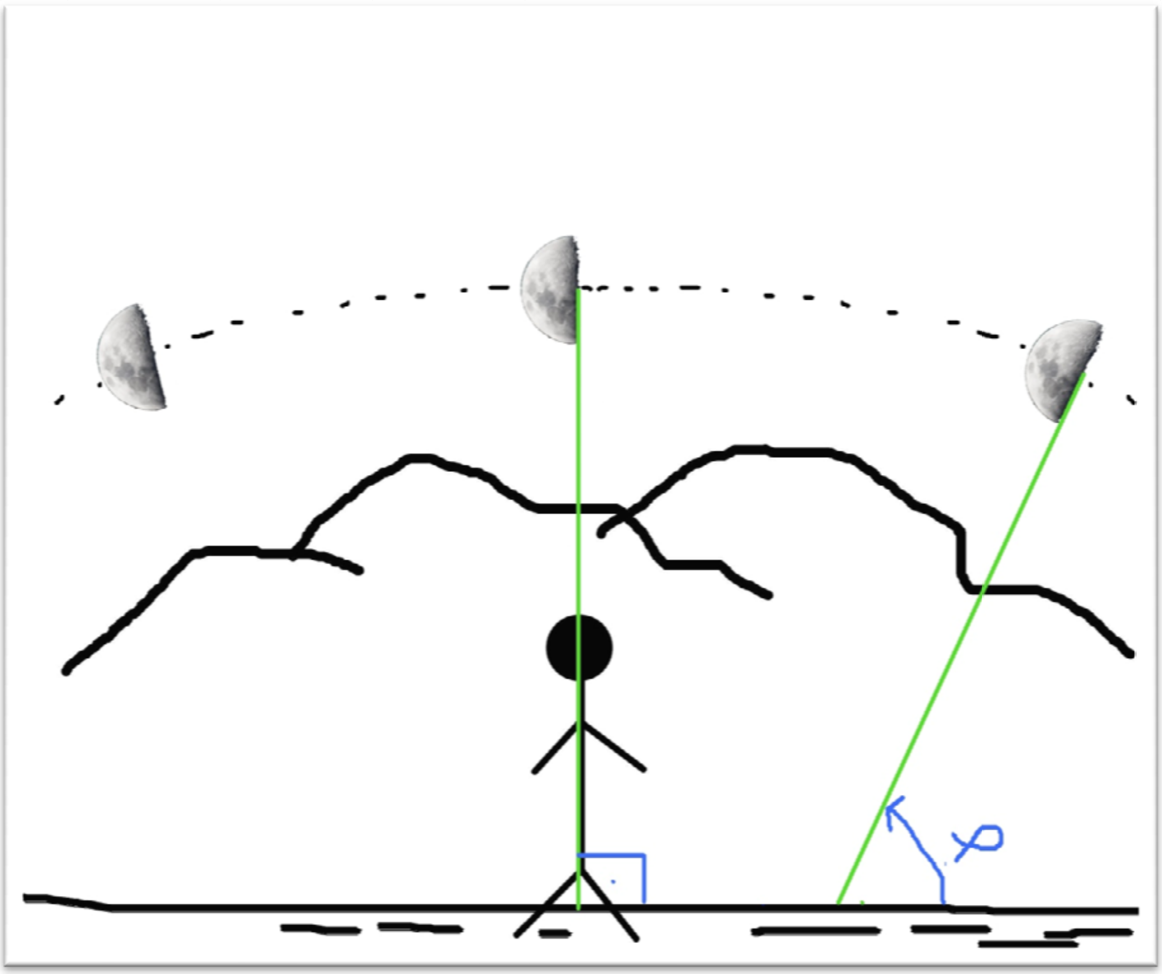
Now that is clear that all the observers see the moon the same way (as was explained before), Is that true always? The answer is not. The moon's terminator angle it is different at different latitudes, as long the moon it's not over the observers' meridian. The path in the sky that the moon transits while over the horizon its given by the observer's latitude. The highest the observer's latitude, the greater the curve of the moon's path across the sky. Also, the greater the moon's terminator angle. This is better explained in the following illustrations:

Moon observed at high latitudes



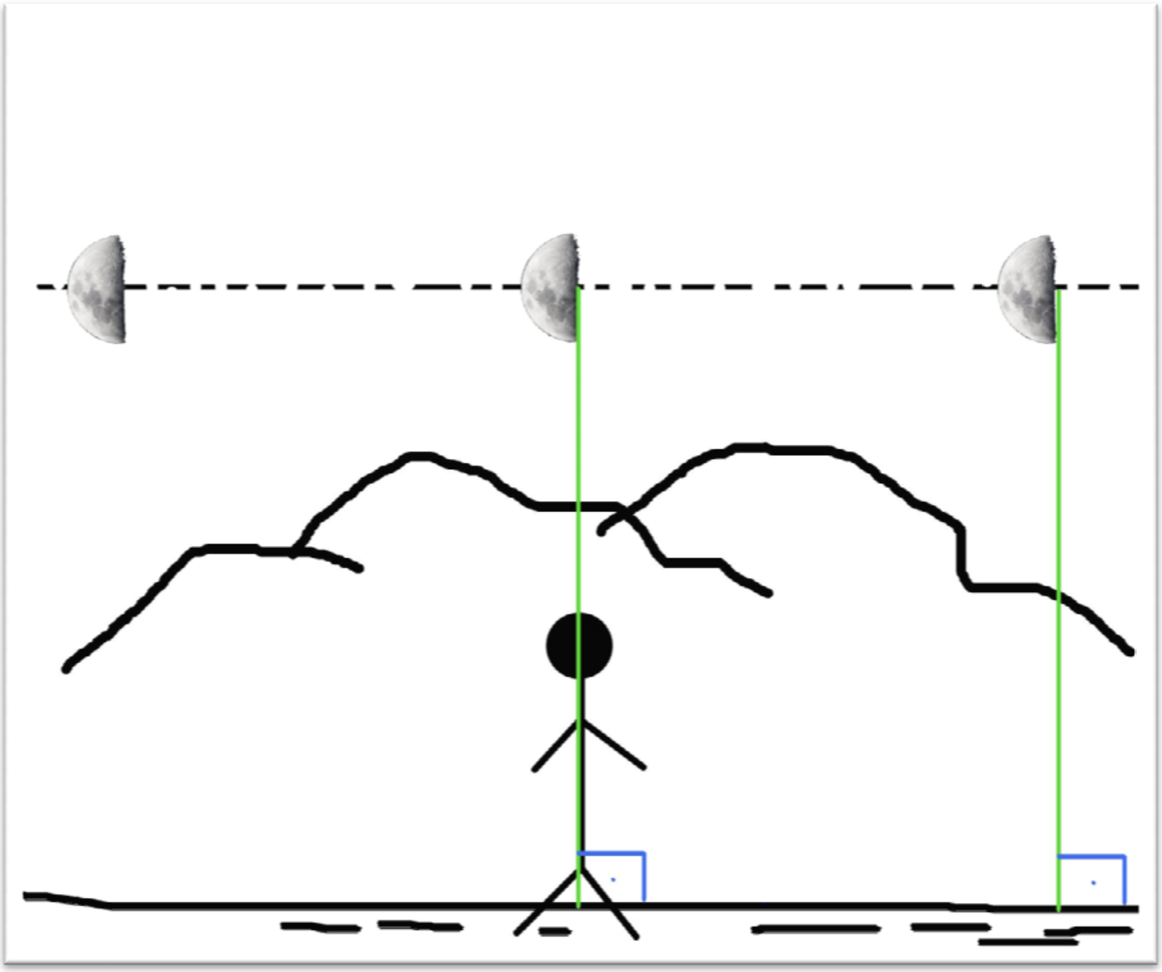
As seen in the illustration, the moon raises over the horizon with a very low angle's terminator (α). Slowly, as moon moves up in the sky, the terminator's angle moves to 90º. This is when the moon its over the observer's meridian.

Moon observed at mid latitudes



In this case, when the moon rises over the horizon it’s terminator make an angle (α) greater than as the previous case. Still, α will be steadly increasing until it reach 90º, at the observer´s meridian. The moon’s path in the sky it’s an arc, not as curved as it occurs at high latitudes.

Moon observed at low altitudes, o close to over the Equator.



Observing the moon close, or over the equator, the moon will rise up over the horizon with its terminator's angle very close to, or at, 90º. When the moon reaches the observer's meridian, will be 90º, as the stated cases before.

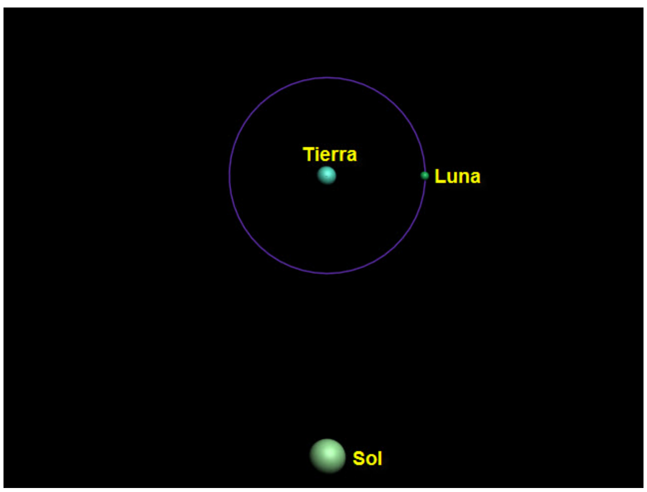
Conclusions

As seen in the three cases, the moon's terminator angle forms 90º at reaching the meridian at the observers' location. That is what this project has demonstrated. This position is the same to all latitudes. However, the moon terminator's angle will vary for different latitudes at the moon rise and moon set.

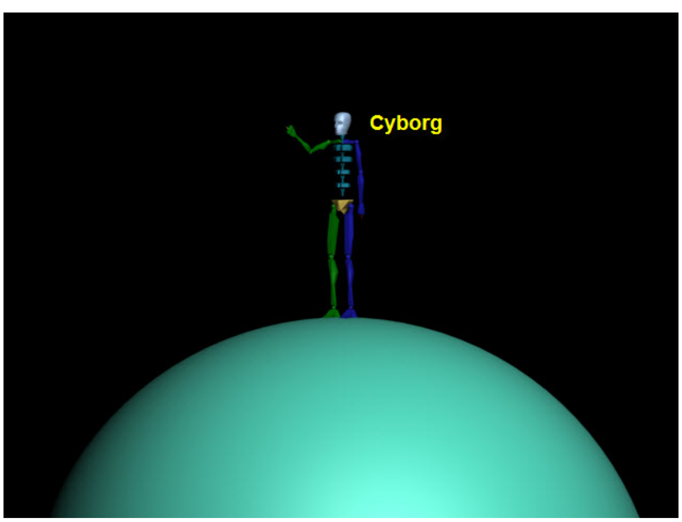
Appendix 1: Simmulation model for lunar phases (spanish)

"Trataré de explicar este fenómeno utilizando imágenes de tres dimensiones. Representando de esta manera al sol (fuente de luz), y la tierra y la luna como esferas. Esto se llama hacer un modelo. Es decir, es una representación simplificada de algún fenómeno complejo. Que se simplifica para poder tener una mejor comprensión del mismo. También pondré un observador sobre la tierra. Este observador es un cyborg (Cyborg: ser compuesto por una parte cibernética y una parte orgánica. Es decir, un ser parte maquina y parte humano) y quiere entender como ocurren las fases de la luna. Este cyborg es un muñequito extraordinariamente grande para la "tierra", y está hecho así con fines didácticos. Recuerden que el modelo o imágenes que estoy usando en este blog no están ni a escala, ni se considera los movimientos de rotación de la tierra ni de la luna. Solo la luna tendrá un movimiento de traslación.

Esta es la disposición de las esferas en el modelo de nuestro sistema modelado:



Y este es un detalle del cyborg:



Nuevamente por fines didácticos, nuestro cyborg está parado sobre la esfera “Tierra”. Durante la mayor parte de este texto estará en el punto superior de la esfera (tierra), es decir sobre el Polo Norte. Se debe tener en cuenta esta ubicación para entender la orientación de las fases. Ya al final del documento, moveré a cyborg hacia unas latitudes un poco más bajas, para ver las fases lunares desde esta perspectiva.

Nuestro cyborg tiene el brazo derecho levantado apuntando en dirección al sol. Convengamos que **siempre** este brazo apuntará al sol, de modo que podamos saber de dónde proviene la luz (lo que ayuda a entender las fases lunares). Otra convención es que la cara siempre estará apuntando a la luna, esto por la misma razón anterior. A no ser que se indique otra cosa, siempre se enfocará al cyborg desde el sol. Y por lo general la imagen que tendremos de este cyborg siempre será visa desde la espalda del muñeco.”

El documento completo se encuentra en:

http://astroimagenes.blogspot.com/2010/02/como-ocurren-las-fases-de-la-luna.html

Appendix 2: Volunteers, and their latitude location.

	Voluntario	Pais	ciudad/lugar	Latitud	
1	Fredrik Broms	Noruega	Kvaløysletta	68	N
2	Leilany garron	Canada	Halifax	44	N
3	Umbriel	España	Gijón	43	N
4	José Angel Sanchez Garcia	España	Cabreros del rio	42	N
5	jipifeliz	España	Xátiva	38	N
6	Lira y Villanus	España	Orihuela	38	N
7	Amir Taheri	Iran	Teheran	35	N
8	Pablo Reynoso	Mexico	Guadalajara	20	N
9	Hardpaella	Colombia	Medellin	6	N
10	Juan Carlos Fajardo Cuellar	Colombia	Guadalupe	2	N
11	Ernesto ribera	Ecuador	Quito	0	
14	Trunks Brief	Chile	Temuco	38	S
16	Victor Gabriel Vibé	Argentina	Ushuaia	54	S

Special thanks to Jaime Escobar Morales, for his cheer up voice for this Project.

(http://astronomos.net23.net/)

Appendix 3: How to take the picture

The perfect date is March 23rd, but 22nd and 24th are ok.

The moon's shot must be taken at "high noon", at the highest point on the sky. Local time is irrelevant. Remember that you do not need to use a telescope or other device. A regular digital camera will do the job perfectly. The procedure to take the picture is as follows:

1.- Locate the geographic north. And stand facing north.

2.- Once you are facing north, take the camera and aim the horizon. Your arm, straight, must be parallel to the floor. Do not shoot yet. The camera should show the horizon in it.

3.- With the camera aligned to the north, and keeping the horizon in the cameras' screen, move up the camera. This will make the camera describe an arc. Move up the camera until the moon show up in the camera screen.

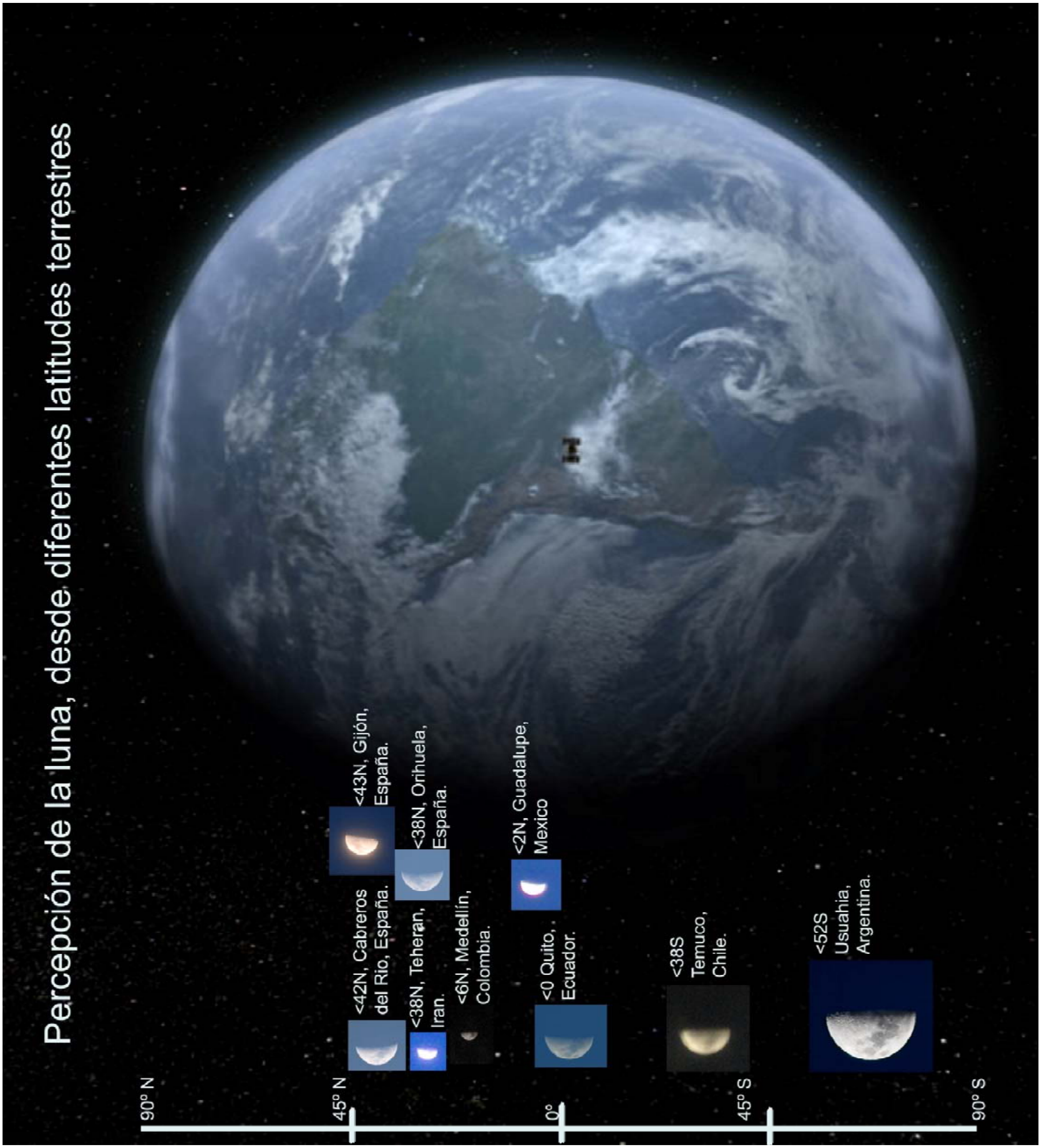
4.-With the moon on the screen, now you can shoot. Remember that is not important a great image resolution, or a great detail of the moons' surface. We are interested in the angle that solar light hits the moon, and the way we see them on earth.

Again, quick instructions: Check the dates, shoot the moon when it is at "high noon", make the shoot with the camera aligned to the north, and perpendicular to the horizon.

The full text is at:

http://astroimagenes.blogspot.com/2010/03/earths-lunar-perception-small-astronomy.html

Anexo 4: Resulting composite image, bigger.



Anexo 5: Meridian's definition

According to wikipedia.org:

Meridian (geography)

From Wikipedia, the free encyclopedia

A **meridian** (or **line of longitude**) is an imaginary arc on the Earth's surface from the North Pole to the South Pole that connects all locations running along it with a given longitude. The position of a point on the meridian is given by the latitude. Each meridian is perpendicular to all circles of latitude at the intersection points. Each is also the same size, being half of a great circle on the Earth's surface and therefore measuring 20,003.93 km.

Since the meridian that passes through Greenwich, England, establishes the meaning of zero degrees of longitude, or the Prime Meridian, any other meridian is identified by the angle, referenced to the center of the earth as vertex, between where it and the prime meridian cross the equator. As there are 360 degrees in a circle, the meridian on the opposite side of the earth from Greenwich (which forms the other half of a circle with the one through Greenwich) is 180° longitude, and the others lie between 0° and 180° of West longitude in the Western Hemisphere (west of Greenwich) and between 0° and 180° of East longitude in the Eastern Hemisphere (east of Greenwich). Most maps show the lines of longitude.

The term "meridian" comes from the Latin *meridies*, meaning "midday"; the sun crosses a given meridian midway between the times of sunrise and sunset on that meridian. The same Latin stem gives rise to the terms a.m. (ante meridiem) and p.m. (post meridiem) used to disambiguate hours of the day when using the 12-hour clock.

Fuente:

http://en.wikipedia.org/wiki/Meridian_(geography)