GMN Outreach Project

Tasks, games and competitions

5.2.2024

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The Global Meteor Network

What you will find in this document

In this document, you will find some interesting hands-on tasks, some funny games and some suggestions for competitions. Please note that these activities are optional and here to accompany the learning modules with something that will give students some real output.

Tasks

Identify constellations in the camera's FOV

Author: Radim Stano, radim.stano@outlook.com

In this task, students will learn and explore constellations on the screen and they should be encouraged to have a look at the clear night sky. This task requires a basic knowledge of the CMNbinViewer (part of the RMS software - information and how-to can be found in the module RMS), which will be used to export the images and a free open-source planetarium software (information can be found in the module Astronomy or some youtube videos, e.g. this detailed one: https://www.youtube.com/watch?v=tKyja_iSuNM).

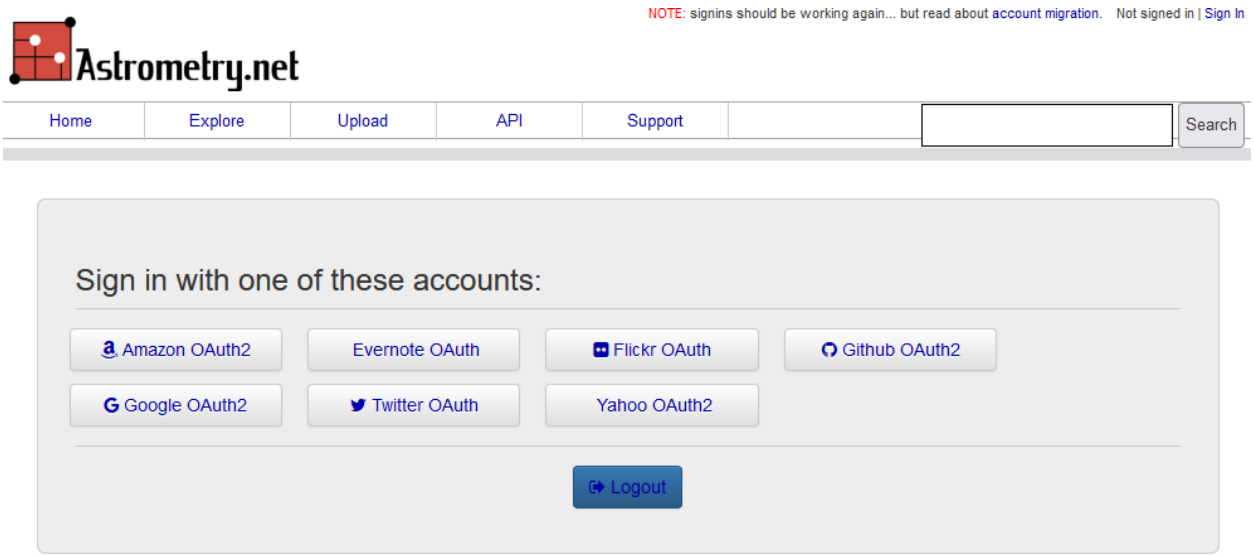
1) From the clear night capture export some images using CMNbinViewer directly on your Raspberry and transfer images to your PC (alternatively just open it on the Raspberry Pi and keep it there)
2) Start Stellarium, set the location to your location, date and time to the date and time of the picture
3) Based on the position of your camera and the direction it looks to the sky, set the roughly same position in the Stellarium
4) Try to identify the bright stars first and check with Stellarium
5) Try to find out what constellations are visible

Alternatively (if the constellations were not identified or just for fun) you can try also astrometric solving also called plate solving via the web astrometry.net at this URL:

https://nova.astrometry.net/

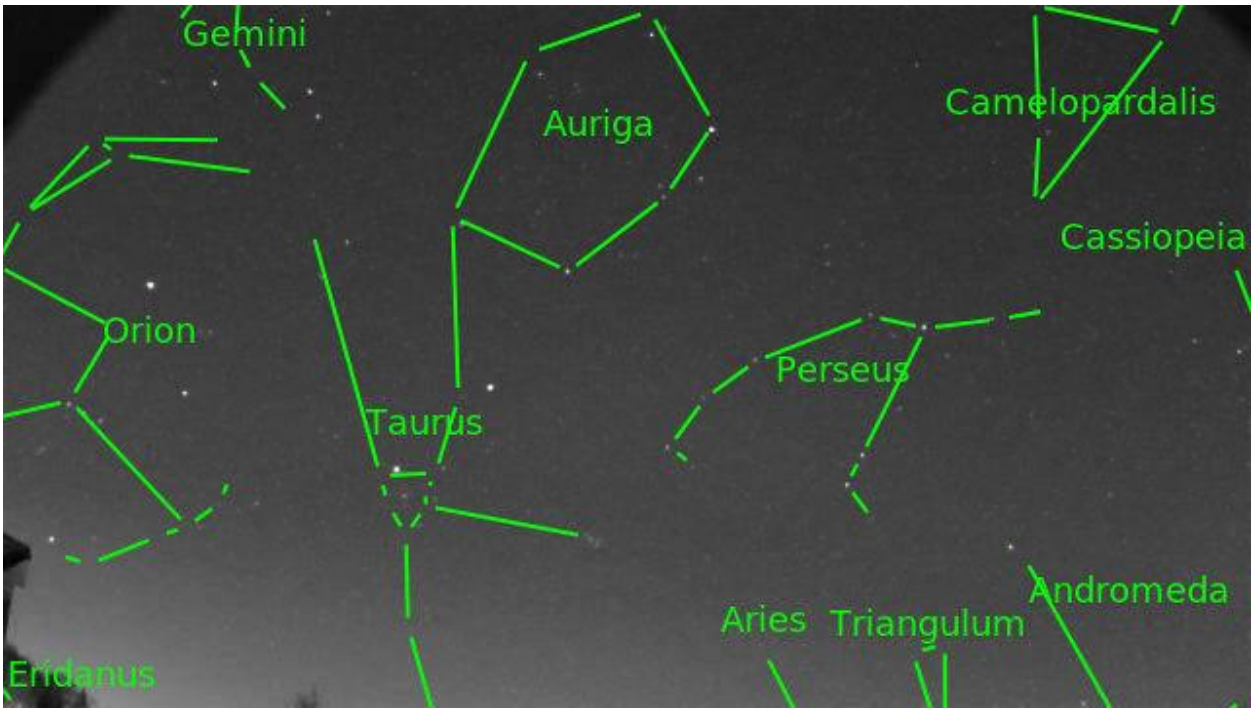
1) Upload the picture of the night sky previously obtained here: https://nova.astrometry.net/upload

2) Wait for it to be solved
3) Compare the solution with your findings and Stellarium
4) Download the picture and share it.
5) Optional: create a school/group account on astrometry.net. However, this is not possible directly, so you will need to create an account on one of these:



Simply create a basic free account on e.g. GitHub and login with this at astrometry.net. Now all your pictures can be saved in albums.

This is how the solved astrometry looks together with the constellation's lines:



Tip: Once you've identified the constellations, if possible, take your students out during the night to find them in the sky.

Tip: In the all-night video observe how the constellations (and stars) are changing positions and discuss it with students, encouraging them to find the cause.

Tip: Use astrometry.net to label pictures from different parts of the night (start of the night, then middle and lastly before dawn)

Observe the change of constellations during the year

Author: Radim Stano, radim.stano@outlook.com

This task will guide students through a long-term project of observing the changes in the night sky during the year.

1) Similarly to the "Identify constellations in the camera's FOV" task, export the image via CMNbinViewer directly on your Raspberry and transfer images to your PC (choose either the beginning or the middle of the month, same time - e.g. midnight)
2) Use the astrometry.net method in the "Identify constellations in the camera's FOV" task to solve the plate for you and label your constellations

3) Save images in a dedicated folder on a PC
4) Collect all the images throughout the year
5) Observe changes in the constellations and confirm and check in Stellarium
6) Discuss the reasons behind the constellation change. Which constellations do you see in the summer, and which ones in the winter?

Note: You need to do point 1) as soon as possible after it was recorded as the records are being deleted after some time (normally there are up to 7 days of raw data available on the 256 GB of storage). Also if the weather does not permit the exact hour and day in the month, just take the closest possible day and/or hour.

Tip: You may work with more than 1 picture per month.

Tip: You can try to create a year-through video if you have enough pictures

Observe the change in the duration of the night

Author: Radim Stano, radim.stano@outlook.com

In this task, students will observe the changes in the night and day length for your location. This task can be done via the GMN Weblog archive of your station (https://globalmeteornetwork.org/weblog/) or directly on your Raspberry Pi.

1) Have a look at your station's data on your Raspberry Pi in particular to this directory via the icon RMS_DATA on the desktop /home/pi/Desktop/RMS_data/ArchivedFiles/. Choose your desired directory. Directories are named like this:

   SK0002_20211224_153524_078340 where the orange is the year of the archive, dark red is the month and green is the day. Then look for a file with the name like this

   SK0002_20211224_153524_078340_CAPTURED_thumbs.jpg where the important part of the name is in orange. Open this file directly on your Raspberry Pi or download it to some PC.

2) Each frame in the *CAPTURED_thumbs.jpg has its timestamp. Find the first time and date looking dark enough and write down the time. Do the same for the end of the night.
3) Optional: Instead of looking at the data on your Raspberry Pi, you can have a look at your "Captured thumbs" at https://globalmeteornetwork.org/weblog/, select your

country, and your station and look at the latest data or Select archive - Captured. There are “Captured thumbs” from at least one year.

Tip: write down data in an Excel sheet and create a graph out of this data

Identify the brightest stars and/or planet(s)

Author: Radim Stano, radim.stano@outlook.com

In this task, students will try to identify the brightest stars and/or planets (if they are in the field of view). This task can be done via the GMN Weblog archive of your station (https://globalmeteornetwork.org/weblog/) or directly on your Raspberry Pi.

1) Similarly, to the “Identify constellations in the camera’s FOV” task, export the image via CMNbinViewer directly on your Raspberry and transfer images to your PC
2) Use the astrometry.net method in the “Identify constellations in the camera’s FOV” task to solve the plate for you and label your constellations
3) Save images in a dedicated folder on a PC
4) Collect such images in the course of a month or two to be able to observe the changes
5) Identify the brightest stars and create a table in Excel with the magnitude of the stars
6) Observe the changes of the brightest stars as they change in the course of time, and do the same for planets. Are the changes the same for stars, constellations and planets?
7) Compare with the simulation in Stellarium and try to scratch the star’s movement and planet(s) movement

Create a video/gif of the bright meteor or fireball

Author: Radim Stano, radim.stano@outlook.com

In this task, students will create gifs and mp4 videos of fireballs or meteors and they can share them afterwards on social media, YouTube or the school webpage. RMS module and Computer science module, in particular familiarity with basic Linux commands and the command line, is necessary to create these.

RMS creates the following files during data capture. These are put into a dated folder in ~/RMS_data/CapturedFiles

-FF*.fits - these are the FourFrame FITs files containing the blocks of 256 frames. The FF format is lossy.

-FR*.bin - when a fireball is detected, a lossless H.264 video block is saved.

-FS*.bin - these are fieldsum files - basically measuring the brightness of the image.

Creating time lapse

This will convert 1 FITS image into 1 jpeg image -> timelapse of the whole night is around 2:30 min. so it means you need 25 FF files to generate 1 second. THIS IS NOT useful for a meteor or fireball video/gif, but it is useful for longer videos

Script itself is here: /home/pi/source/RMS/Utils/GenerateTimelapse.py

Command to run from ~/source/RMS directory and files are in the /home/pi/temp/4/ (you can have it also elsewhere, then just change the path) :

python -m Utils.GenerateTimelapse -x -f 25 /home/pi/temp/4/

Create a gif of fireball (must have FR file)

copy FF and FR files (from the captured directory with the timestamp equal to FR file(s) - YOU NEED both FF and FR files which must have identical timestamps) into some directory.

(vRMS) pi@raspberrypi:~/source/RMS $ ll ~/temp/1|grep -e FF -e FR|grep -v png

-rw-r--r-- 1 pi pi 3700800 Dec 7 17:29 FF_SK0002_20211207_172851_859_0176384.fits

-rw-r--r-- 1 pi pi 3700800 Dec 7 17:29 FF_SK0002_20211207_172902_084_0176640.fits

-rw-r--r-- 1 pi pi 410664 Dec 7 17:29 FR_SK0002_20211207_172851_859_0176384.bin

-rw-r--r-- 1 pi pi 510636 Dec 7 17:29 FR_SK0002_20211207_172902_084_0176640.bin

(vRMS) pi@raspberrypi:~/source/RMS $

Go to ~/source/RMS and from there run this command for extraction of files

python -m Utils.FRbinViewer /home/pi/temp/1/ -e ## this will extract the png files from FR files

Then go to the directory where the PNG files are created and create a gif file:

cd /home/pi/temp/1/

convert -delay 4 *.png -loop 0 -fuzz 2% +dither -layers Optimize +map animation_23032023_0109.gif

Generate mp4 video (clean/raw without the rectangle around it) from the FF files and FTPdetect.info file (detection file of events - everything that was recognized as a possible meteor):

copy 1 FF file before the event, 1 event FF file and 1 FF file after the event and the FTPdetectinfo_*.txt from the same night (example of the file name: FTPdetectinfo_SK0002_20230215_164218_557511.txt) to some directory e.g. /home/pi/temp/4

python -m Utils.GenerateMP4s /home/pi/temp/4

Create a gif from any FF file -> use CMN_binViewer from your Raspberry (shortcut is on your Desktop on your Raspberry Pi)

Create a coverage map of the region

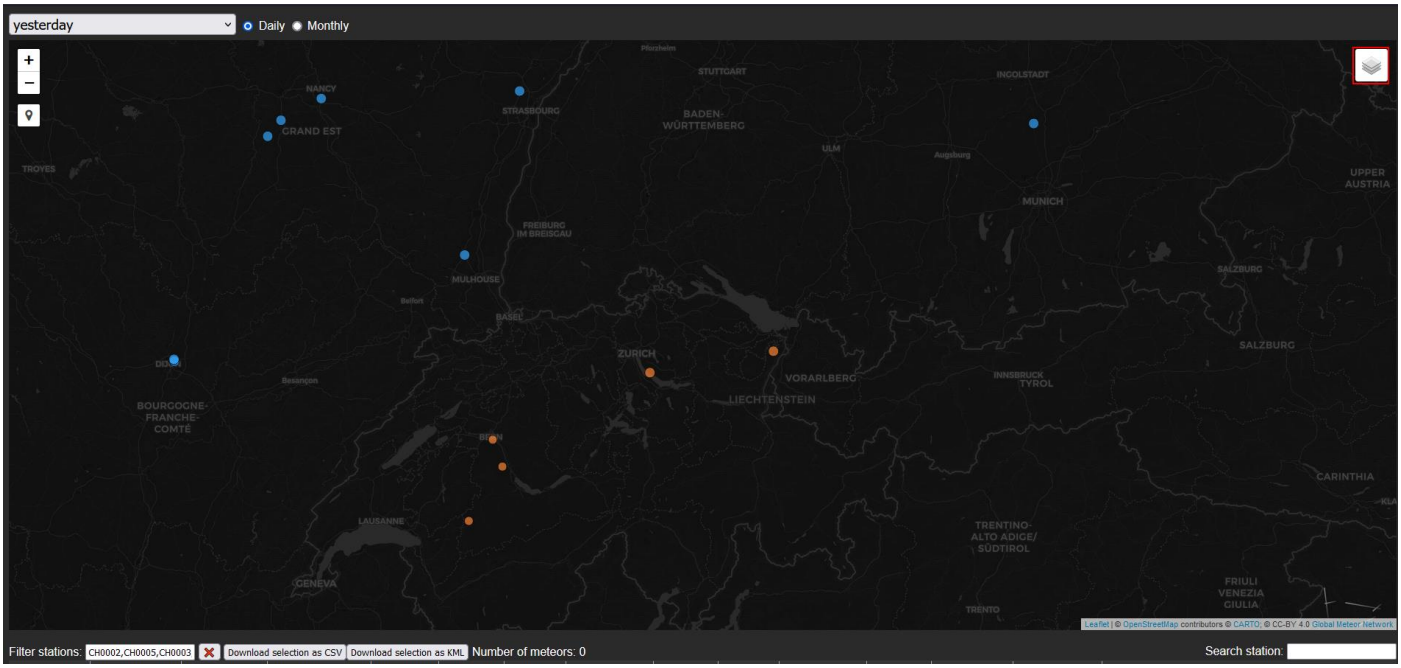
Author: Radim Stano, radim.stano@outlook.com

In this task, students will create a coverage map of the region they live in. It can be shared or used for an article in local newspapers. It can be used to help others point their cameras or to attract building cameras of not covered parts of the area.

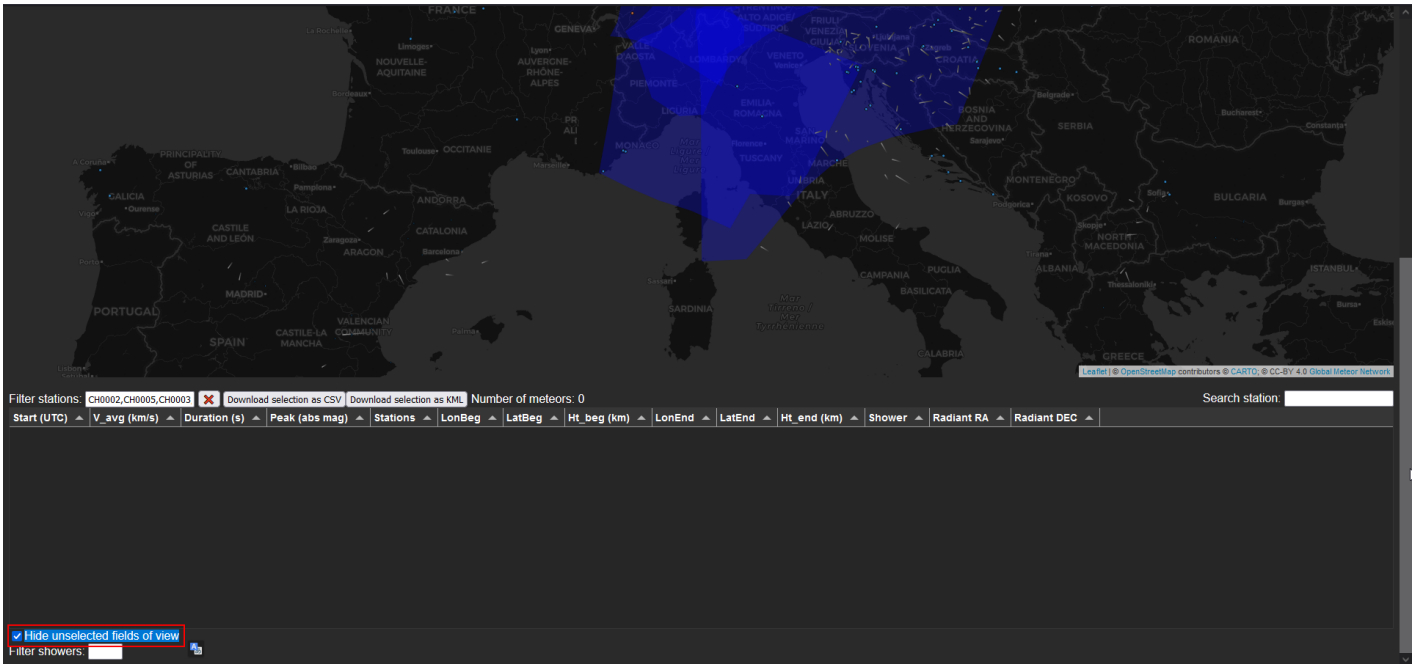
Method 1:

1) Visit https://tammojan.github.io/meteormap/, wait for the data to be loaded and then a minute or so, so the coverage data are loaded as well.
2) Find the area of interest on the map and zoom in a bit

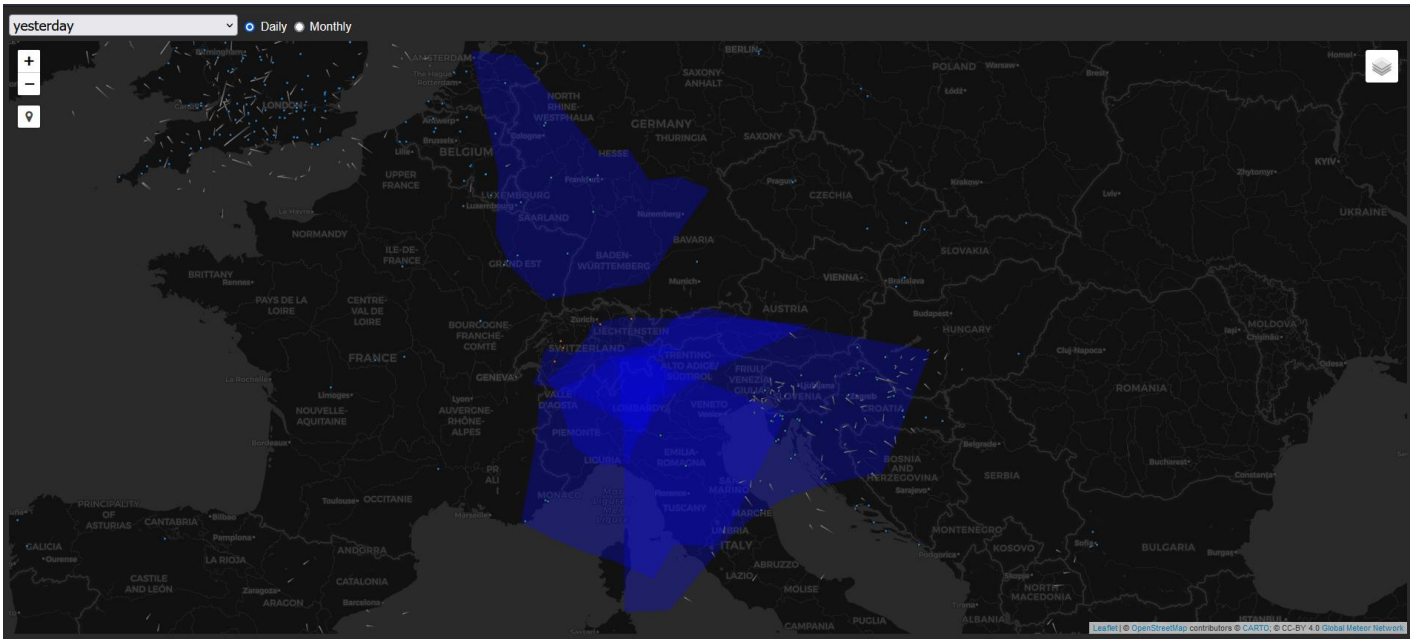
3) Select the cameras in the region by right-clicking on the first and right-clicking and pressing CTRL on the keyboard for the others
4) Select layers in the upper right corner of the map and choose the layer of your choice - either 25 km, 75 km or 100 km. This will bring you the field of view and coverage at the selected altitude. :



5) Tick “Hide unselected fields of view” under the map and meteor list:



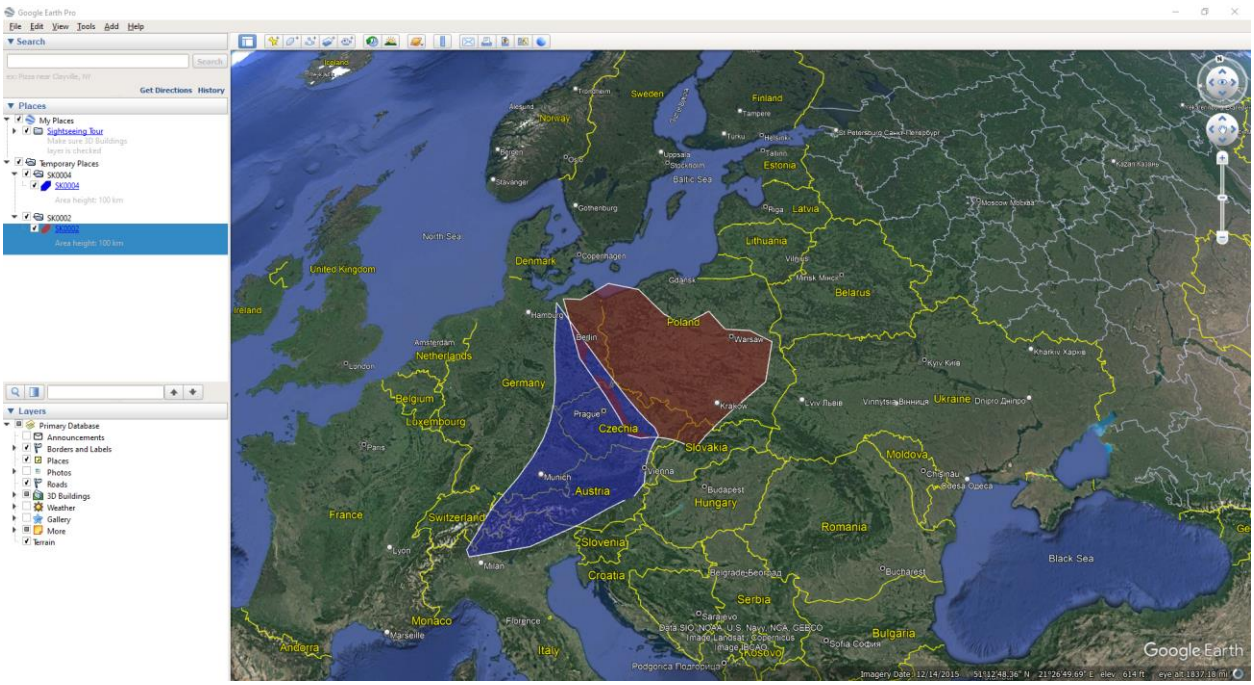
6) Adjust the zoom and take screenshots for all the altitudes in the layer selection (25 km, 70 km and 100 km).
7) This is an example of all cameras in Switzerland and their field of view for altitude 100 km:



Note: the recommended screenshotting tool is Greenshot which can be found at https://getgreenshot.org/. Feel free to use any of your choices.

Method 2:

1) Download Google Earth Pro from https://www.google.com/earth/about/versions/
2) Note the name of stations you would like to create coverage for
3) Download their kml files from the GMN server here https://globalmeteornetwork.org/data/kml_fov/
4) Save all the kml files you are interested in one directory
5) Open Google Earth Pro and in Explorer open all the files you wish, they will be loaded
6) Experiment with different heights and colours + opacity of the coverage area
7) This is what it looks like for cameras SK0002 and SK0004 at a height of 100 km:



Find out the light pollution in the region

Author: Radim Stano, radim.stano@outlook.com

In this task, students will have a look at the light pollution area of the region they live in and discuss what it is caused by, what kinds of street lights are being used in their area, how to help decrease the light pollution and if there are any laws/recommendation of the federal/local government and plans from the city council.

1) Visit https://www.lightpollutionmap.info/ or find any other light pollution map web pages and check their relevance/accuracy
2) Observe in the night your area from the garden/apartment
3) Discuss the causes and how to fight it
4) Discuss what causes the light pollution, what effects on people and animals/nature it has
5) Discuss what you can do to fight it
6) Check if there are any federal/local laws or city council plans to address this issue.

Calculate the trajectory of a meteor

Author: Radim Stano, radim.stano@outlook.com

In this task, students will use a professional tool to calculate the trajectory of a meteor from at least two stations. This is the very same tool GMN uses to calculate trajectories and possible drops of meteorites. It is called SkyFit2.

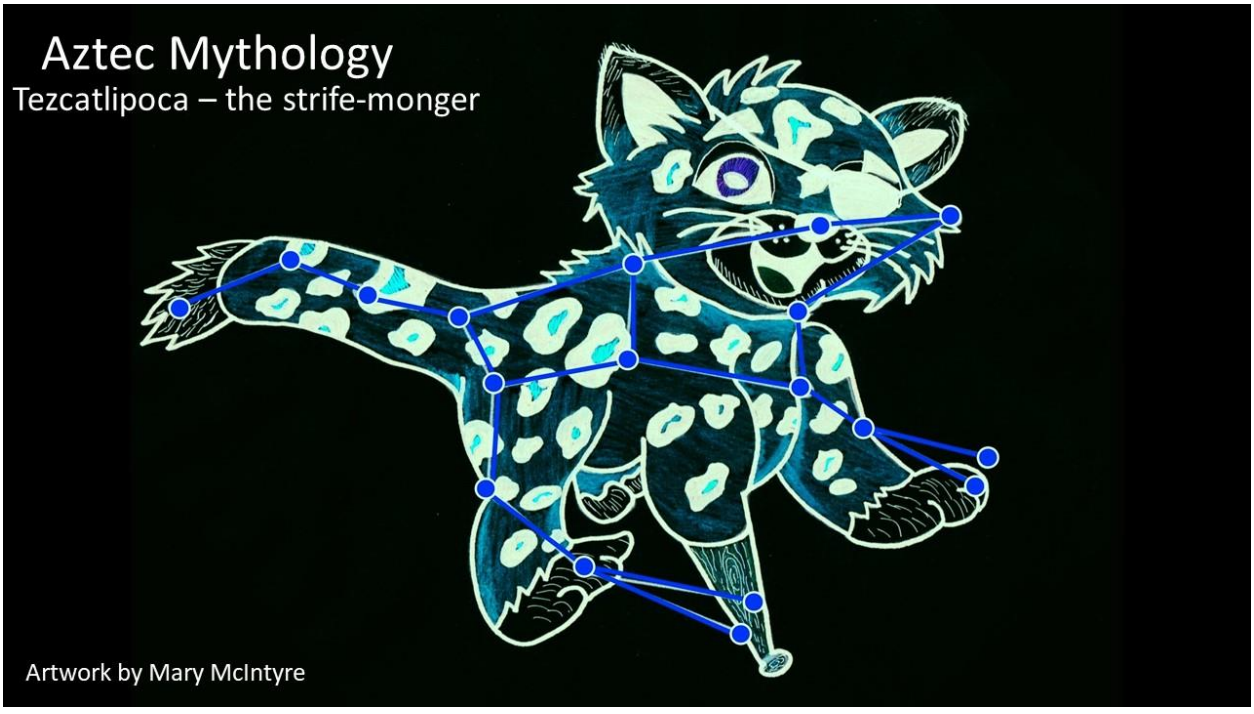
This is the most advanced task and it requires some prerequisites. You can perform this locally on your Raspberry Pi where all the tools are preinstalled, but we recommend doing it on a Windows PC (Linux PC, Mac Computer will do too) as this task can take several hours and you can divide and save your work as you go.

0) If you are going to perform the task on a Windows PC, please follow this guide to set the environment - https://globalmeteornetwork.org/wiki/index.php?title=Windows_Installation, the guide is available for a Linux PC - https://globalmeteornetwork.org/wiki/index.php?title=Installation_for_Linux and also Apple Computer - https://globalmeteornetwork.org/wiki/index.php?title=MacOS_Install
1) Gather data, save your own data and let Radim Stano know from which station you need the data, use Meteor map to check which other stations captured the meteor/fireball you are interested in https://tammojan.github.io/meteormap/ or if it was not captured by the RMS software search for it manually among your neighboring stations in the weblog https://globalmeteornetwork.org/weblog/. This is the most important step and should be done as soon as possible to prevent the data from being deleted as it might happen that the fireball detector will not catch the fireball and the data has to be manually collected. All the other steps once the data (the **FF file, the FR file, the .config file and the platepar_cmn2010 file**) are saved can be conducted later on.
2) This task's explanation needs a complex showcase it is better to use video in this case. Please follow the steps in this video – https://youtu.be/ao3J9Jf0iLQ?t=4617
3) You can find more about SkyFit2 on this page - https://globalmeteornetwork.org/wiki/index.php?title=SkyFit2

Art - Create your own constellations

Author: Mary McIntyre spiceyspiney@gmail.com (graphics and idea), Radim Stano, radim.stano@outlook.com (text)

In this task, students can have a look at the night sky, using captures from a meteor camera or have a look at Stellarium and use their imagination to create a set of their own constellations with their own stories – sketches, paintings, overlays or any other style. Also, redesigning the current constellations to something new is possible! For this task, you can include students from the whole school. For this task we do not include any specific instructions, just let your students' imagination work. You can send us your students' creation and we gladly publish it on our website. Also, you can use them for school magazines or similar. We are including some of Mary's work as inspiration.




McIntyre Mythology: Lyra – The Atat!


Estonian Mythology – Lindu the Bride
Milky Way image by Mary McIntyre

Art - Create a Lunar Crater Sketch

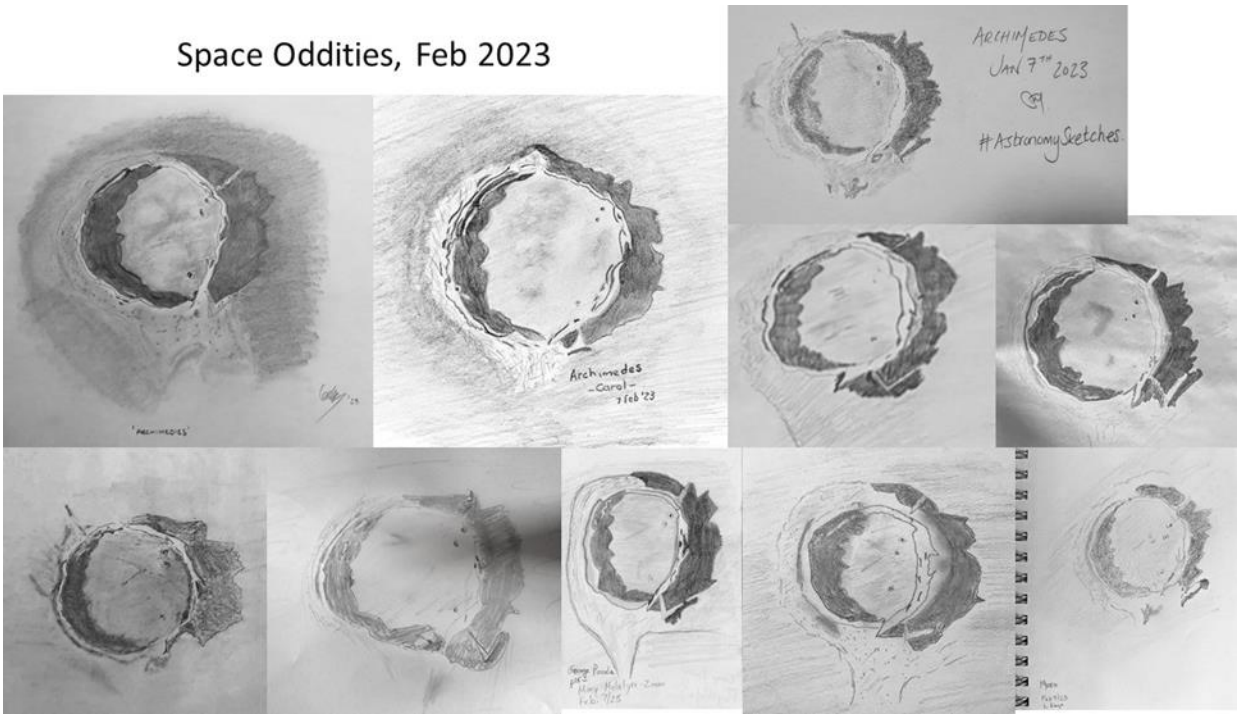
Author: Mary McIntyre spiceyspiney@gmail.com

Thanks to advances in modern technology, basic astrophotography is something that is now available to everybody. Most of us can take really fantastic photos of the Moon through a telescope using nothing more than the mobile phone we carry around in our pocket. However, this ability often comes at the expense of proper visual observing.

One way that you improve your astronomy observation skills is to create a sketch. You can practice this by using photos as a reference to begin with, then once you've figured out a sketching method that works for your style of drawing, you can use it to create sketches of constellations, the Moon, galaxies, etc., as seen with the naked eye or through a telescope eye piece.

When you make a sketch of something, you have to look at it really carefully and you will begin to see subtle features that would have evaded your attention otherwise. Because there is no atmosphere on the Moon, the shadows are dark and sharp and can create some really dramatic landscapes that are pleasing to draw, so that's a great place to start. Even if you only attempt to create a sketch a couple of times, it will genuinely make you a better observer in the future.

It may feel overwhelming when you first start, but absolutely everybody can create a useful and unique sketch just by following some simple steps. For science, it is important that we draw accurately, but when you first start learning how to draw the Moon don't worry about that; better accuracy will come with practice. Also don't compare your results with other people's work; just as we all have unique handwriting, we also have a unique drawing style and it's fine to let that show through. As long as the shapes and shadows are in the correct place, a regular lunar observer will recognise the crater you have drawn. Below is a photo collage of sketches created during Mary McIntyre's online astronomy sketching workshop for the Space Oddities You Tube show. Everybody produced a sketch of lunar crater Archimedes and when you look at this collage every sketch looks completely different, yet it's immediately obvious that they are all the same crater. Yours will look different than all of these and that's exactly as it should be.



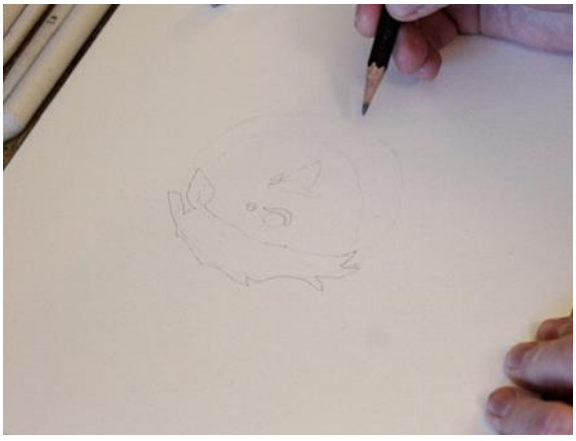
Materials needed:

- A clear reference photo of a lunar crater. Photos taken during a low Sun angle are best because they have well defined shadows and highlights and the terrain relief is clearer
- A sheet of white paper
- A pencil. 2B pencils are easier to blend but an HB pencil also works fine
- A pencil eraser that has clean, sharp edges – trim the end with a craft knife if necessary
- A cotton bud (Q-tip) or blending stump for blending

To create this sketch we used this reference photo of crater Arzachel taken by *Craig Howman*

Step 1:

Sketch the general outline of the crater then begin to outline the areas that are brightest along the illuminated edge of the main crater, the small craters on the floor of Arzachel and the top of the central peak – these are the areas of the page we need to keep clean. Then outline the shadows on the crater floor. It can help to think of everything as a series of abstract shapes that come together to create a landscape.



Step 2:

Mark out the other areas that contain deep shadows, including the central peak shadow, then colour in all of the shadow areas and lightly blend over the pencil, making sure to keep the shadow edges sharp. Don't try to erase all of your pencil strokes; if you look at Galileo's sketches you can see his pencil lines!

Step 3:

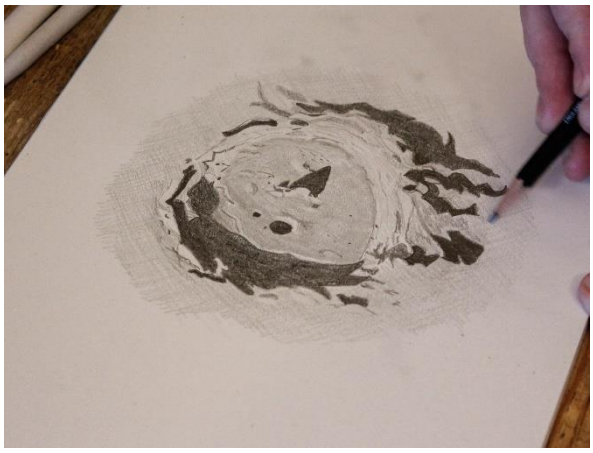
Once the highlight and shadow regions are mapped out, start to add the tones and textures seen around the crater rim. This could be bands of shadow along the slump terraces or hummocky regions around the edge, but remember any shadows here will not be as dark as the shadows being cast by the crater wall and central peak. You can actually use your dirty blending tool as a drawing tool here because it creates a subtle, blended band of shadow. You don't need to agonise over every single thing being perfect here; just use your pencil and blending tool to create a texture that mimics what your eye sees; you can use dots and dashes, cross-hatching, scribbles, etc.

Step 4:

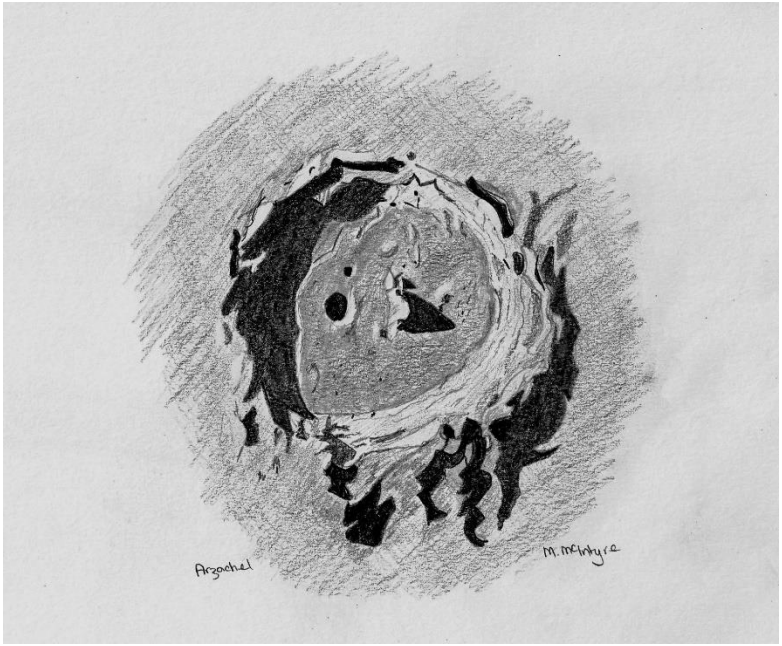
Using your pencil on its side, lightly shade in the crater floor. Whilst doing this, check how light the crater floor looks compared to the area outside of the crater and try to mimic that tone. It's far easier to do a second layer to deepen it if necessary, so go lightly to begin with. Gently blend over it to smooth it out, again being careful not to disrupt the sharp shadow edges.

Step 5:

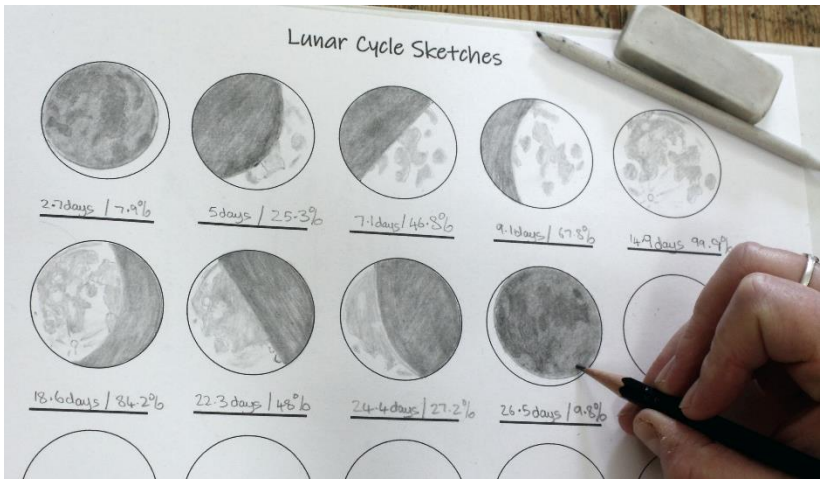
Now shade the area around the outside of the crater, again using the pencil on its side and once again being mindful of whether the surrounding area is lighter or darker than the crater floor. Getting these subtle tonal differences correct will really help to add dimension.



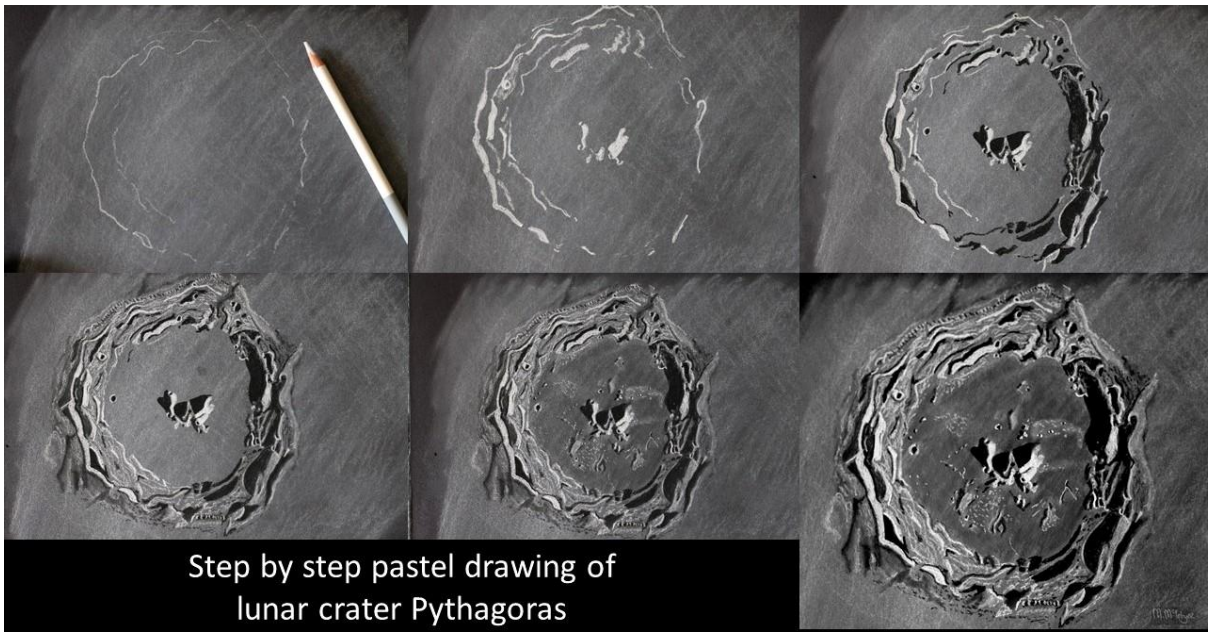
Step 6:
If any pencil has blended over the highlighted areas, use the corner of your eraser to brighten them up again. Take one last look around and add in any features you may have missed. Once you're happy, always make sure you sign your finished sketch.



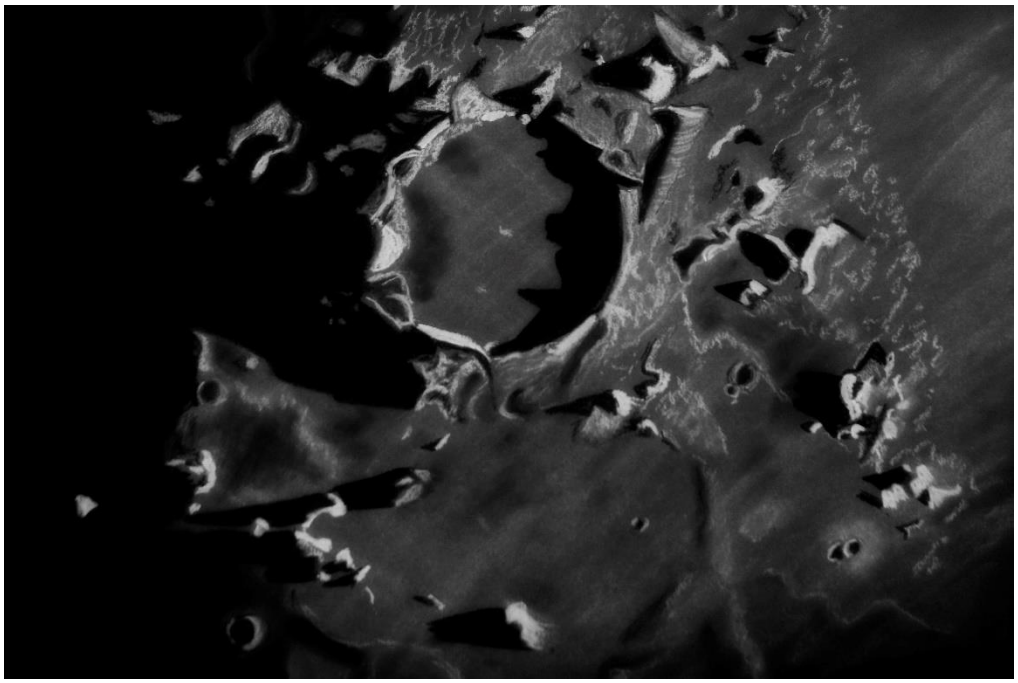
You can follow the same steps to create sketches of the whole Moon, either naked eye or through a telescope. Another fun project is to create a sketch of the Moon at regular intervals during an entire lunar phase cycle. This will help you to learn the phases and see how the Moon's appearance changes.



If you have access to black paper and chalk pastels, you can create really dramatic lunar crater drawing because the white chalk pastels stand out so brightly on the black paper. The steps are essentially the same; outline, add the highlights, add the shadows then all the details in between. The collage below shows you step by step how a pastel drawing of lunar crater Pythagoras was created on black paper.



You can also add additional features seen in the area around the lunar crater. Every additional feature you add that is displaying shadows and highlights will help to give that illusion of a three dimensional drawing. The sketch below is of Plato and the surrounding area by Mary McIntyre. At a glance it looks very detailed but if you look closely, nothing in this sketch is actually that detailed. It's just a series of abstract shapes that contain light and shade, and they all come together to produce what looks like a dramatic moonscape.

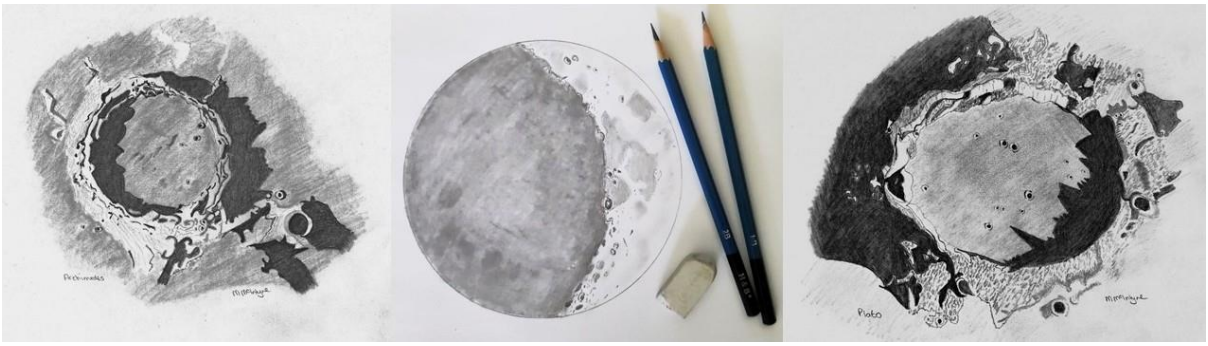


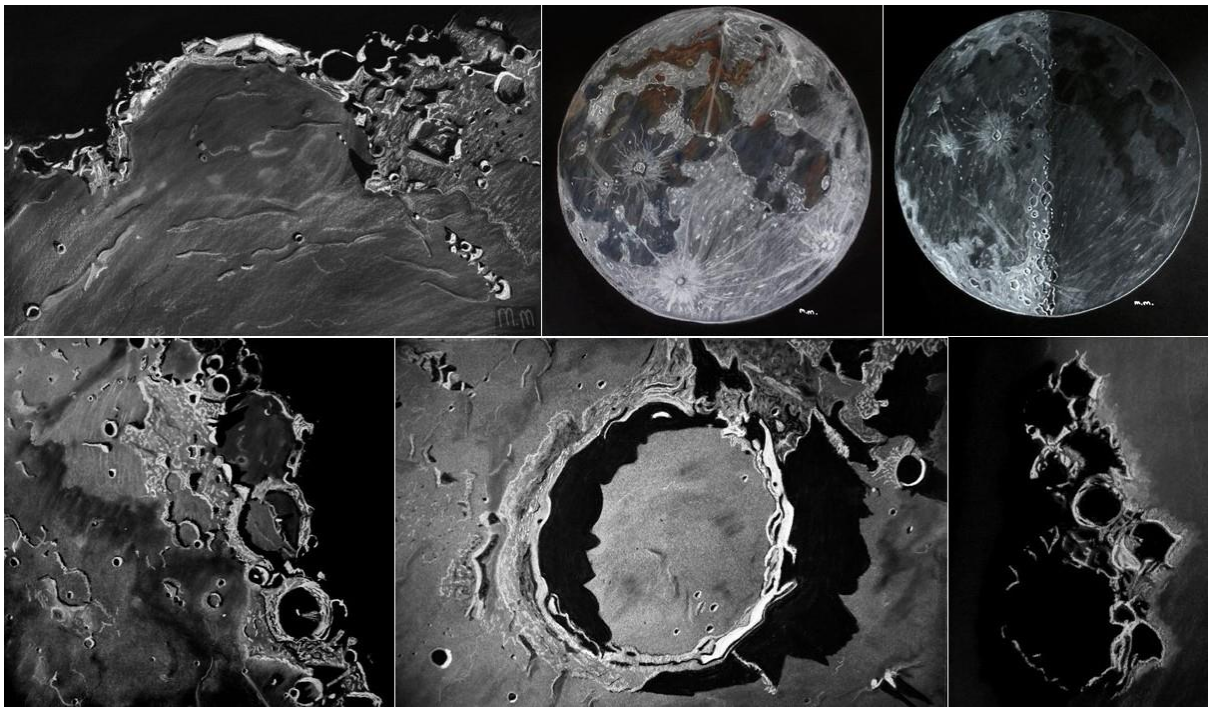
Some Final Top tips:

If you're feeling unhappy with how your drawing is looking, prop it up somewhere a view it from further way, or take a photo of it with your phone and see how it looks on screen. You'll be amazed at how three dimensional it looks compared to seeing up close and from above.

The steps above are just one way to approach pencil sketching. You may find you work better doing things in a light different order, so experiment and stick with what works for you.

Never throw away your old sketches because they will help you to track your own progression as an astronomy sketcher and will help you to record your progress as you find your own drawing style. Every artist sees the flaws in their own work but other people will not, so be proud of what you've created.





Games

Game 1

Explore the possibility of using these free games (crediting the authors) available as PDFs in Portuguese and English:

https://divulgacao.iastro.pt/en/et-a-solar-system-adventure-game/

https://divulgacao.iastro.pt/pt/et-download/

https://drive.google.com/file/d/1cIhOylWCwS-uUff8sjjKUR-ZFS-P2Y9M/view

https://drive.google.com/file/d/1B1kKZJbszBE-4G5X4nyTX-yyeqgbabm1/view

Competitions

Art - Picture with meteor, meteorite, comet and/or universe thematic competition - local or global

It is important to gain support for science from as many people as possible as this explains to them why science is important and can justify the expenses of any kind of science. Apart from this even NASA uses artists to bring abstract and remote concepts closer to the general public.

To involve students with more artistic interests in the universe rather than technical you can run an all-school competition where the task will be to paint, draw, sketch or artistically express the meteor, meteorite, comet and/or universe theme.

Please get in touch with us in case you are doing or planning such a competition to discuss the possibility of sponsoring prices for students. We gladly publish the work of your students on the Project's website.

Art - Short story with meteor, meteorite, comet and/or universe thematic competition - local or global

Science fiction had a great impact on many to-be scientists and it allows us to think about the future and imagine what if or also to bring serious themes set into the future. It is also a very favorite part of the literature and many books were filmed or turned into series. There are immortal names like Isaac Asimov, Arthur C. Clark, Frank Herbert, Robert A. Heinlein H.G. Wells and we can continue and continue.

To involve students with writing interests rather than technical you can run an all-school competition where the task will be to write a short story about meteor, meteorite, comet and/or universe. There are no limits in art. Then you can publish it in your school's magazine. This task can be done in English or your local language, but in case we run during the next rounds the competitions we will most likely accept only English stories due to the international nature of our team.

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