



# Sunrise project

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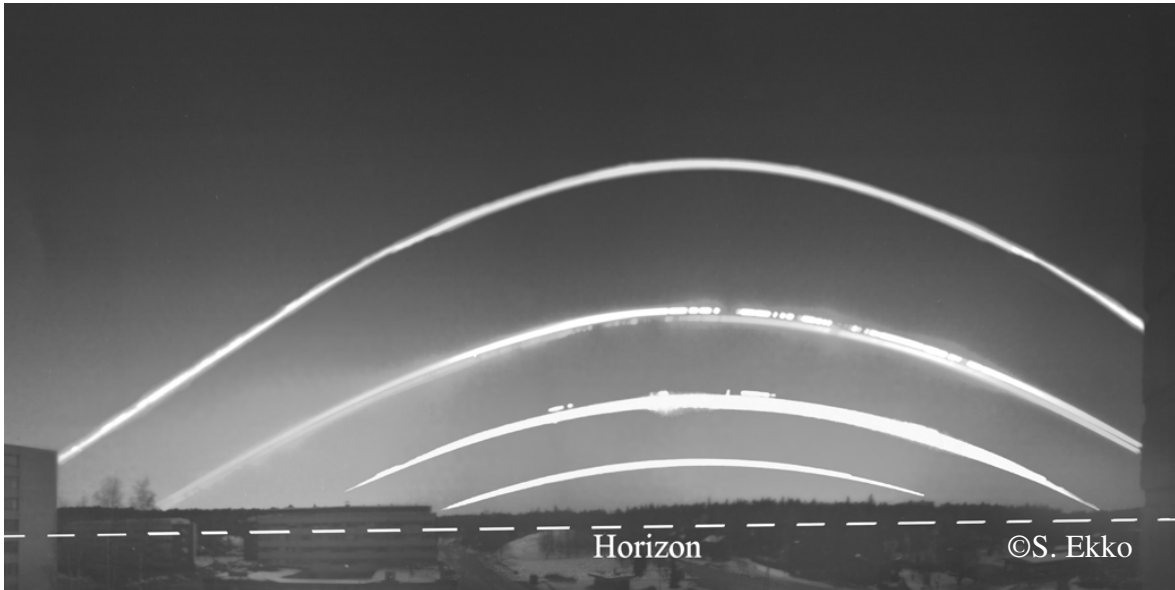


Figure 1: Sun paths in Turku, Finland in January (lowest arch) – April (highest arc). Photographed with two curved-back pinhole cameras around the 20<sup>th</sup> of every month. In this project, we will photograph only the left hand (sunrise) part of the March (vernal Equinox) curve.

## Introduction

Sun path is different every day and depends on the latitude of the location .

For instance:

- During the summer the Sun path is higher than in winter.
- The Sun path slope in the sunrise area (or in the sunset area) is the co-latitude of the location.
- The Sun does not rise in the East cardinal point everyday.
- At equinoxes, the Sun rises due east and sets due west all over the world.

All these aspects can be observed by means of the following project. Students can build themselves a simple devise (pinhole camera) in order to catch the paths of the rising or setting Sun.



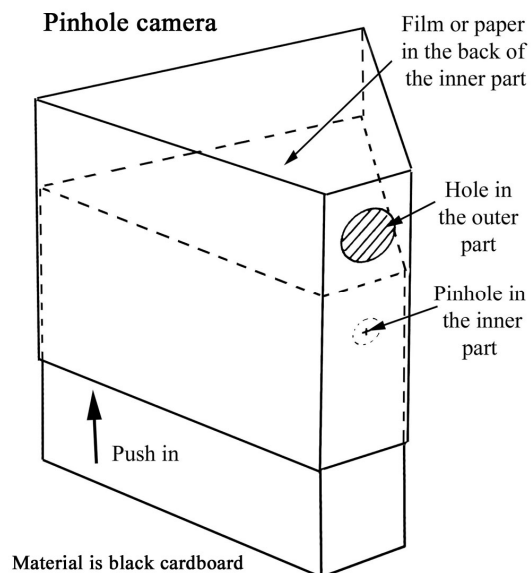
## Summary

The idea of the Sunrise Project is that the students use simple self-built cardboard pinhole cameras to make very long-exposure (several days) photographs of the sunrise or sunset around vernal equinox (15.3.2011 – 25.3.2011) at different latitudes. During the long exposure, the bright Sun will leave a trail on the light-sensitive material (Fig. 5), and we can see the path of the rising Sun. We will share the photos taken at different latitudes by e-mail. By measuring the rising angle and comparing it with the photographs taken in other locations students can find the connection between latitude and the rising angle.

This leads to discussions on the geometry of Earth-Sun system, climate and seasons. In higher grades, a more mathematical treatment is possible too.

## Procedure

The students will build the cameras (Fig. 2) by themselves of matt-black cardboard and other simple materials. The work is comparatively easy, but care is needed in building the camera and making the exposure.



**Fig 2.** The camera is built from cardboard and aluminium foil, the light-sensitive material is a sheet of enlarging paper. After the exposure, the enlarging paper is scanned. No chemical development is needed. The small aperture (pinhole) of the camera and the low sensitivity of the enlarging paper make possible (and necessary) a very long exposure, even over a week. The bright Sun exposes its path on the paper while moving in the sky.



### You will need

- The drawings
- Two A4 (or one A3) sheets of matt black cardboard
- Clear and black tape
- A piece of matt or semi-matt b&w enlarging paper
- A pinhole
- Scissors or Hobby knife (optional)
- Add a pencil, ruler and some dexterity – and soon your camera is finished.

Note: Sakari will send the participants a pinhole, two sheets of enlarging paper, drawings and instructions. Other materials are easy to obtain in situ.

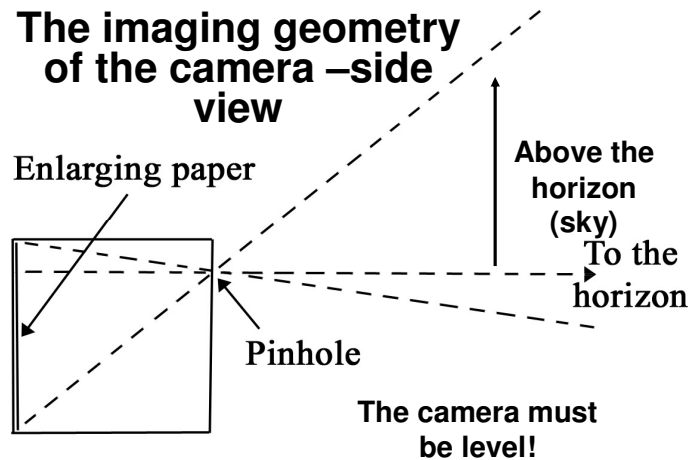


Fig. 3a. The imaging geometry of the pinhole camera.



## View from above

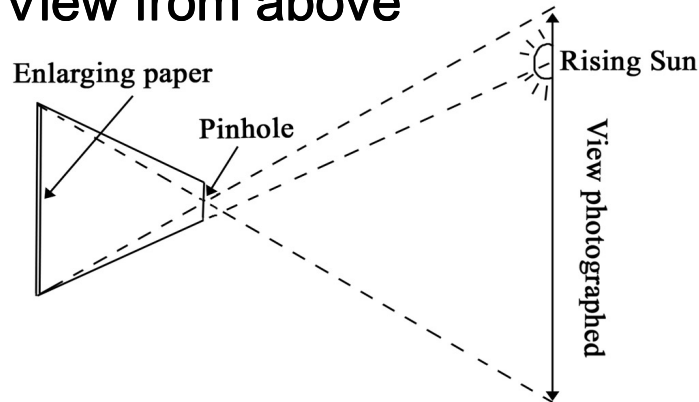


Fig. 3b. The imaging geometry of the pinhole camera.

### Making the exposure:

- You need a window with free view to east (or west for sunset), preferably with clear horizon line.
- Find the sunrise/sunset point in the horizon. At equinox, Sun rises due east and sets due west.
- Turn the camera so, that the line along the right edge points in the direction of the sunrise (Fig. 3 and 4). In the southern hemisphere, the left edge must point in the direction of the sunrise
- For sunset, the left edge of the camera must point to the direction of the sunset.
- Level the camera with the help of a water level
- Expose for some days. At least one cloudless morning is needed.



Fig. 4. Aiming the camera for sunrise. See also fig. 3.



Fig. 5. If the camera is level and the paper and the pinhole are aligned, you can find the horizon in the image.

### Complementary information



- The Sun seems to draw a sinusoidal curve during the day.
- The amplitude of the curve depends on latitude. The nearer the pole you are, the smaller is the amplitude. This image is made around midsummer at 68.5 degrees N, in Finnish Lapland. Exposed 11 days with four curved-back pinhole cameras for a 360 degree view
- Normally, at lower latitudes, only the upper part of the curve is seen.
- The visible part of the curve depends on the date, too; in winter the Sun is lower in the sky, and we see less of the curve.
- See also fig. 1.



### How can you use the images?

- you can compare them to find the differences at different latitudes
- you can measure the rising angle to find how it is related to the latitude
- if the images are taken at equinox, as we will do, you can find the latitude from the rising angle
- you can use spherical trigonometry to calculate the path of the Sun and compare the calculated curves with the images
- and sure you will find many more uses

The students will develop their skills in astronomy, geography, geometry, instrument building and international cooperation: You can have more information on the document provided in "[Sunrise Photos in Lessons](#)"

After the exposure, scan the image, process it and send to Alexandre Costa, e-mail [alexandrejcosta@gmail.com](mailto:alexandrejcosta@gmail.com). Instructions for scanning and processing you will find in the pdf Practical Procedure and Drawings