Seen from the ground, clouds come in a wide variety of shapes and sizes; faces, animals, plants – the only limit is the observer's imagination. However, climatologists only distinguish ten generic types, divided into four levels: high-, mid- and low-level, plus an extra level for clouds found at more than one level. It is very important for us to know about the different types of clouds and how frequently they appear over a given location on Earth because they determine the amount of solar energy that reaches our planet's surface. For example, sunlight can pass through cirrus clouds, even if they cover the entire sky. On the other hand, thick storm clouds can make it dark in the middle of the day, while the sun shines as usual.

Solar energy is the prime source of power for nearly all processes on Earth. Climatologists are therefore very interested in charting the spatial distribution of clouds, as they affect the amount of radiation that reaches us. However, there is more than one problem. Not only do we need to know which part of the Earth clouds are covering, we also need to know their height. If you think that all we need to do is take a look at the sky, classify the clouds, and assign them to levels, you would be very wrong! Imagine there are low-level clouds that cover the whole sky. How are you going to observe any other mid- or high-level clouds? Climatologists have the same problem: when the sky is covered with low-level clouds, they cannot detect higher-level clouds and their observations are unreliable.

However, we have another tool: weather satellites, which can look at clouds from above. Unfortunately, they face the same problem as surface-based observers – the information they gather is "flat", the third (height) dimension is missing. These satellites can easily detect large amounts of high- and mid-level clouds, but it is sometimes impossible for them to detect low-level clouds. To make things worse, different satellites rely on different observation and detection approaches, which means that the data they gather is different. For example, estimates of the frequency of high-level clouds range between 12% and 65%. A large discrepancy! Clearly, multi-level clouds are a substantial challenge even for meteorological satellites.

But help is at hand, in the form of scientific satellites that use experimental methods not found in operational meteorology. In 2006, two of these spacecraft were launched: CloudSat and CALIPSO. CloudSat is a cloud radar, while CALIPSO is a laser radar (lidar). Both emit pulses towards the Earth, and wait for the "echo". The echo is produced when a pulse hits a cloud droplet or an ice crystal. The two instruments complement each other. The lidar can detect thin clouds, which are invisible to the cloud radar. The cloud radar, in turn, can pass through thick clouds (e.g. storm clouds), unlike the lidar. When these two instruments are used together, the results are astonishing – it is as if the clouds have been cut with a lidar–radar knife. The data they provide is perfectly suited for determining the vertical profile of clouds in the Earth's atmosphere.

The Project will – for the very first time – investigate the cloud profiles that have been collected over the past five years by the CloudSat and CALIPSO spacecraft. Sophisticated statistical tests will establish the reliability of these satellite-based measurements, which will help us to know how much uncertainty there is in climate models. We will pay particular attention to cirrus clouds as they are the most difficult to accurately detect. This will also improve the reliability of surface-based observations. Thanks to our work, climatologists will have an unprecedented insight into the properties of cloud cover, and eventually be able to accurately calculate how much of the Sun's energy has managed to reach us – after fighting its way through the clouds!