The Relationship Between Cloud Height and the Reflection Position of the Kinmen Bridge.

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Abstract

During our astronomical observations at the school's observatory, we discovered that clouds reflect the light spots from the Kinmen Bridge. We considered whether we could deduce the cloud height from the reflection position. Combining this with weather data, we found that the light spot position changes with cloud height. Based on our observations, most light spots appear closer to the westernhorizon, indicating lower cloud positions.

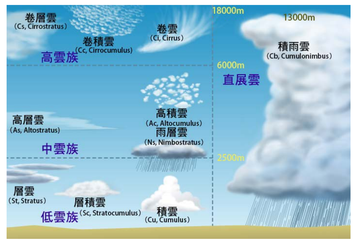
Research Question

Based on the position of clouds reflections, we can roughly estimate cloud types based on altitude. Our cloud observations are often conducted during the day, as effective night observations are frequently hindered. This led us to consider a physical method using the reflection of light from clouds, making nighttime cloud observations feasible. Our school has equipment in collaboration with the Taipei Astronomical Museum: a fisheye camera for all-sky observations. Combined with weather data and landscape photos, we were inspired to explore whether the reflections on the Kinmen Bridge can indicate cloud height, or if there is a correlation between the reflection height and weather conditions.

Introduction

Content Knowledge

In 1803, the classification system of Luke Howard from England was adopted by the World Meteorological Organization (WMO) and was printed in the 'International Cloud Atlas' in 1956, to serve as a standard for cloud observation in countries around the world. According to the WMO 'International Cloud Atlas,' clouds are divided into ten genera (or cloud genera), under which they are further classified into species, varieties, supplementary features and accessory clouds, mother clouds, and others. The ten genera of clouds are: cirrus, cirrocumulus, cirrostratus, altocumulus, altostratus, nimbostratus, stratus, stratocumulus, cumulus, and cumulonimbus (photos of the ten cloud genera are shown on the back cover). Another classification of clouds is based on their general altitude, dividing them into four families: low clouds, middle clouds, high clouds, and vertically developed clouds.



Research Methods

Geographic Location Brief

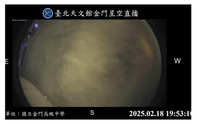
Kinmen, surrounded by the sea on all sides, is located in the Taiwan Strait, adjacent to the southeastern coast of mainland China, and is a county of Taiwan.It is surrounded by the sea on all sides, without high mountains to block it, so the wind is strong. In summer, there are southwest sea breezes, and thick fog often occurs in March and April.

Climatic Characteristics During the Observation Period

Kinmen in February is in winter, and the climate characteristics are as follows:1.Lower temperatures: The average temperature ranges from 10°C to 17°C. 2. Strong winds: The northeast monsoon prevails, with stronger sea winds. 3. Less rainfall: It is drier compared to most areas in Taiwan. 4. Large temperature difference between day and night: The temperature can differ by up to 5°C within a day.

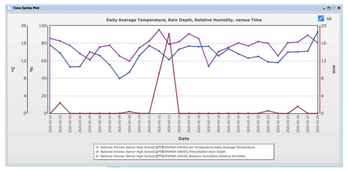
Observation Equipments:

1.Fisheye Camera 2.The automatic weather station on the rooftop (left), the Skyline Surveillance Camera (middle)



Weather Data from Our School's Automatic Weather Station

The following is the average temperature, humidity, and rainfall for Kinmen in February.



Data selection

We selected data from a ten-day period spanning late February to early March. During this time, there are more significant weather changes, and the images captured by the fisheye camera are more diverse. This allows us to showcase different weather conditions, and the reflection positions also vary.

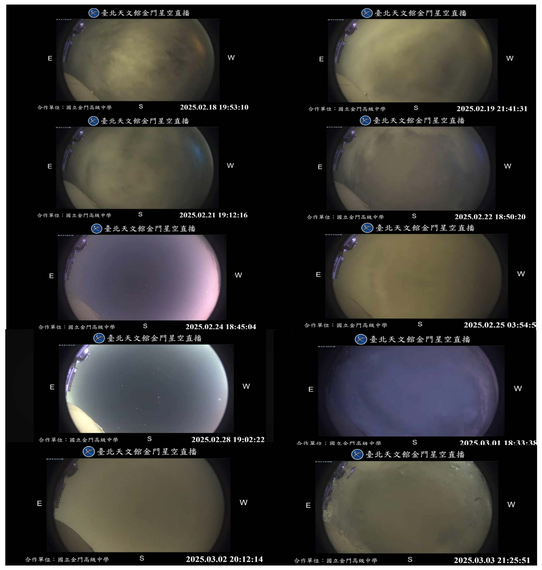
Research Process

During the observation period in late February, we selected screenshots from the fisheye camera when the weather was better and recorded the weather data for that day. We attempted to identify the correlation between the position of cloud reflections and the weather conditions. The reflection positions are roughly divided into three categories based on their distance from the western side: low, medium, and high positions.

Results

Here is a table compiled based on weather data and observed photographs.

	Date	Temperature (°C	Humidity (%)	Reflection Position
2	Feb 18	13.3	72	Medium
3	Feb 19	15.4	77	Low
4	Feb 21	12.8	79	High
5	Feb 22	13.1	82	Medium
6	Feb 24	13.1	59	No clouds
7	Feb 25	14.1	80	No reflection
8	Feb 28	18.8	80	No clouds
9	Mar 1	17.2	75	Low (foggy)
10	Mar 2	17.8	88	No reflection
11	Mar 3	18.2	100	Not visible



From the fisheye camera lens, it can be observed that the closer the light spot is to the western horizon, the lower the cloud layer on that day, and vice versa. However, reflection phenomena are not visible during fog, rain, or when there are no clouds.

Discussion

If the weather is good, the cloud height is related to the position of the reflection. The higher the cloud layer, the further the light spot is from the western horizon. By observing the reflection positions in the fisheye camera images, it is apparent that the reflection is relatively low. Combining this with the weather data, it can be inferred that Kinmen, due to local weather conditions and terrain, typically experiences low-level clouds. However, the reflection from the Kinmen Bridge only provides a rough indication of the cloud height. In the future, if opportunities arise, we hope to find a more accurate method of observation.

When the lower atmosphere is very humid, on rainy or foggy days, the air near the ground contains a large amount of moisture, which makes it easier for stratus clouds (low-level clouds) to form. If the ground temperature drops and the humidity in the air increases, stratus clouds may thicken downward. In more stable atmospheric conditions, low-level clouds can also develop over cold seas. When the cloud base reaches the ground or sea level, it transforms into fog. Conversely, when the ground is heated by sunlight and the humidity in the air decreases, dense fog will thin and rise, forming low-level clouds.

When warm, moist air flows over a cooler surface, the air temperature near the ground drops, and the water vapor becomes saturated, which makes "advection fog" more likely to form. In the northwest part of the Taiwan Strait, during winter, the cold air from the northern Chinese coast lowers the sea temperature. When the weather briefly warms in winter and spring, warm air flows into the cooler northern part of the Taiwan Strait, causing frequent fog in Kinmen. Kinmen enters its fog season in February, and the light is unable to penetrate the cloud layers, which is why no reflection is visible.

Conclusions

From this work, it can be preliminarily concluded that under favorable weather conditions, the position of the reflection can be used to roughly determine the altitude of the clouds.
We hope to find more precise methods for measuring cloud height that can overcome weather-related limitations in the future.

Bibliography

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