Slope Correction for Albedo on Inclining Terrain

Thermopile Pyranometers Net Radiometer microCache

Introduction:

Albedo is an important concept in climate studies for maintaining a ground radiation balance and water and heat exchanges within the land–atmosphere system. Albedo is measured parallel to the ground, but this presents a problem when one is trying to measure sloping or rough terrain. In this study, the researchers presented a theory that one can accurately measure albedo on a mountain or hill by applying a slope-correcting calculation.

Set Up:

This study occurred at Jellhaug, a burial mound located on the Vik plain in Norway, in August and September 2022. The researchers selected four locations on the mound in north, east, west, and south-facing areas. Each area had a slope of 15°, 17.5°, 12°, and 16°, for the northern, eastern, southern, and western slope, respectively.

Horizontal and slope-parallel albedo were taken in clear, overcast, and cloudy conditions. Horizontally measured albedo was provided by Apogee's upward-looking (SP-510-SS) and downward-looking (SP-610-SS) thermophile pyranometers, which were connected to microCache Bluetooth data loggers (AT-100). Slope-parallel albedo was measured by an Apogee net radiometer (SN-500-SS).

Results:

In this study they found that the slope correction formula improved the linear correlation coefficient between the slope-parallel and horizontally measured albedo by 0.60, 0.51 and 0.24 for clear, partly overcast, and cloudy conditions. When it was clear, slope-parallel and slope-corrected albedo deviated by 5% in terms of mean absolute error, while the slope correction reduced the deviation between the horizontally measured and slope-parallel albedo by 70%. Daytime trends revealed a large discrepancy with smaller/larger horizontally measured albedo than slope-parallel albedo for the western/eastern slope during morning (opposite during afternoon). For the southern/northern slope, the horizontal orientation of the radiation sensors both overestimated and underestimated the albedo for all atmospheric clearness conditions. The horizontally measured reflected radiation had on average a difference of 3 Wm^{-2} from the slope-parallel reflected radiation, corresponding to a deviation of 3%.

Conclusion:

The findings show that slope correction improves the reliability of the horizontally measured albedo in sloping terrain when slope-parallel measurements are not possible. However, during partly overcast conditions, the simple slope correction suffers and should not be applied when avoidable.

Application Summary

Summary:

Using Apogee thermopile pyranometers, microCache logger, and a net radiometer, researchers applied a corrective factor to albedo measurements taken on sloping terrain.

Apogee Sensor Used:

- AT-100: microCache Bluetooth Micro Logger
- SP-510-SS: Upward Thermopile Pyranometer
- SP-610-SS: Downward Thermopile Pyranometer
- SN-500-SS: Net Radiometer

Organization

Faculty of Environmental Sciences and Natural Resource Management, Norwegian University of Life Sciences

Location

Jellhaug, a burial mound located on the Vik plain in south-eastern Norway

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Reference Article:

A simple slope correction of horizontally measured albedo in sloping terrain