Cloud Radiative Effect in dependence on Cloud Type

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Motivation and Objective

- Radiative transfer of energy in the atmosphere and the influence of clouds on the radiation budget remain the greatest sources of uncertainty in the simulation of climate change (IPCC, 2013).
- Depending on the cloud cover and the shape, altitude, and the type of cloud, the influence on the shortwave (0.3 - 3 μm) and longwave (3 – 100 μm) radiation is different.
- Further parameters (e.g., temperature and integrated water vapor (IWV)) also have an influence on the development of the clouds and thus on the radiative budget of the Earth.
- The objective of this study is to calculate the Cloud Radiative Effect (CRE) depending on cloud cover and cloud type.

Results

- Correlation between cloud cover and longwave cloud effect (LCE); blue: single events with cumulus clouds in PAY; red: linear fit.
- Correlation between cloud cover and shortwave cloud effect (SCE); blue: single events and sun covered by cumulus clouds in PAY; red: single events and sun visible.

Discussion

- The study has been performed for cases with only one cloud type.
- Case studies help to understand the large spread in the CRE when the same fractional cloud cover is present.
- The main effect on SCE spread is whether the sun is covered by a cloud or not.
- Several possible sources of uncertainty: model, instrument, cloud cover detection and cloud type algorithms.

Conclusions and Outlook

- First approach to calculate the longwave and shortwave cloud effect dependent on cloud cover and cloud type for two different sites in Switzerland.
- To get more significant results the data set has to be increased.
- To use parameters which may have an influence on the cloud radiative effect have to be analysed.
- The study will also be performed in Davis, Switzerland (1’560 m a.s.l).
- A thermal infrared camera system is in development in order to perform the study also at night.

Cloud Radiative Effect (CRE)

CRE = Measurement – clear sky model
- Shortwave (SW): CRE_SW = SWm – SWcs
- Longwave (LW): CRE_LW = LWm – LWcs

Cloud types

- Cirrus-Cirrostratus
- Cirrocumulus-Altocumulus
- Stratocumulus
- Cumulus
- Stratocumulus-Altocumulus
- Cirrostratus
- Cumulonimbus-Nimbostratus
- Fog

Methods

Cloud cover calculation
- Based on spectral information of the all-sky camera data.
- Automatic detection and calculation.

Cloud type determination
- Based on a set of statistical features describing the color (spectral features) and the texture of an image (textural features) (Wacker et al., 2015).
- Automatic detection.

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