Geophysical Research Abstracts
Vol. 21, EGU2019-16186, 2019
EGU General Assembly 2019
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Using a thermal-infrared camera to retrieve cloud base height from the ground

Guillaume Roussel, Olivier Liandrat, Louis-Etienne Boudreault, Sylvain Cros, and Frederik Kurzrock
Reuniwatt, France (guillaume.roussel@reuniwatt.com)

Observing cloud covers and their evolution in the sky from the ground is useful for various applications such as small-scale weather-modelling processes, short-term solar energy forecast, air-traffic management and long-term records of local atmospheric processes for climate change studies.

Several solutions to observe cloud properties exist: human observations, radiometers and active instruments (radar and lidar). Each of these techniques have their own advantages but none of them are able to provide a continuous vision of the entire sky vault at a reasonable price. Observation with all-sky imagers (ASI) is a solution to observe and forecast cloud cover in the next 30 minutes. Many ASI are available on the market, producing sky images in the visible spectra which are mainly used for solar energy purposes. However, visible-range spectra limits the observation to daytime and images are often affected by sun glare while cloud types can only be roughly estimated with image-processing techniques.

The Sky Insight designed by Reuniwatt is an ASI observing in the long-wave infrared band (8-14 μm) using a camera mounted with an uncooled array of microbolometers. It permits to obtain a continuous observation of the sky (night and day) without sunglare with a constant observation quality by day and night. Observed cloud emittance can be analysed to retrieve cloud-base temperature (CBT), cloud-base height (CBH) and cloud-optical depth (COD).

In this work, we present a CBH retrieval method from the Sky Insight using a machine learning approach with collocated ceilometer measurements. For the moment, we focus on a unique CBH measurement in the same direction pointed by the ceilometer. Using a nearby atmospheric profile, the CBH derived from ceilometer observation is converted into CBT. Then, a multilayer perceptron artificial neural network (MLP-ANN) is trained with : the Sky InSight™ numerical count, the collocated numerical count simulated under clear sky condition , air temperature measured at surface level on the Sky InSight as input parameters and CBT derived from lidar as training samples. Then, the trained ANN is used to convert a set of input data into CBT. This CBT is converted into CBH using the current nearby radiosounding.

About 6 months of these CBHs are compared to those from a ceilometer located in Palaiseau near Paris (France). Both observations are temporally integrated on a 10-minutes basis. Standard deviation error between ceilometer measurements and Sky InSight retrieval is about 600 meters when ceilometers indicates a CBH below 3000m, about 1 km for altitudes between 3000 and 6000 m. Further works are ongoing to validate CBH at other viewing zenith angles of the sky vault.