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# Automatic cloud type classification based on the combined used of a sky camera and a ceilometer

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In spite of its scientific relevance, the detection and classification of clouds still presents open challenges. In last years the use of whole sky cameras for these purposes has experienced a considerable development, fostered in part by the usefulness of these instruments in the solar energy applications. In most cases, the main application is the automatic measurement of the total cloud cover, but algorithms for automatic cloud type classification have also been proposed. These algorithms rely on statistical procedures that evaluate the characteristics of the camera image channels. Although they perform well, they still show some weaknesses: 1) only discriminate between certain types of clouds and 2) performance is poor for multi-cloud images. In this work we present a new methodology for automatic cloud classification based on the synergetic use of a sky camera and a ceilometer. The procedure was trained and evaluated based on a set of 717 images collected in the radiometric stations of the Univ. of Jaén (Spain). 10 different types of clouds have been considered (clear sky, cumulus, stratocumulus, nimbostratus, altocumulus, altostratus, cirrocumulus, cirrostratus and cirrus plus an additional category (multi-cloud) that represents images with different types of clouds. The classification models have been trained using state of the art methods: random forest for group classification and extreme gradient boosting trees for specific classification. Firstly, only information from the three camera channels was used. Secondly, ceilometer information (number of cloud layers, height and width of the different layers) was included. Finally, also the measured GHI was also used. Models were evaluated with 10-fold crossvalidation in all cases. Results show that knowing cloud height, along with GHI boosts classification accuracy greatly. Overall, the best model is able to classify the 10 types of cloud/sky conditions with 75% accuracy, but performance varies greatly depending on the cloud type.