CROSS-COMPARISON AND VALIDATION OF MODIS AQUA CLOUD MASK BY USING CLOUDSAT AND CALIPSO DATASETS

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1. Introduction

In the context of Nowcasting project financed by the Puglia region (Southern Italy), a cloud mask algorithm has been developed based on MODIS images [1]. The aim of the algorithm has been to give support to the meteorological satellite to detect cloud coverage, especially considering the spectral channels which mainly characterize the MODIS sensor with respect to the meteorological ones such as METEOSAT.
The knowledge of the cloud distribution is fundamental as it exerts an enormous influence on our weather and climate. Some examples illustrate the importance of cloud profile and cover information. Clouds are a fundamental stage of the cycle of water in the atmosphere, condensing water vapor and forming precipitation. Clouds also dominate the energy budget of the planet as they tend to cool the earth by reflecting sunlight back to space while simultaneously warming the earth by absorbing and reemitting thermal radiation. [2].
Furthermore, clouds influence climate variability and change by affecting the efficiency at which the hydrological cycle operates.

One of the main issue of the cloud mask algorithm is the validation which may be achieved by considering ground measurements such as the lidar and ground radar measurements. However, direct measurements of the vertical structure of clouds have, until now, been limited to a few ground-based radar sites. A new satellite-based cloud experiment, called the CloudSat mission (http://cloudsat.atmos.colostate.edu/home), aims at providing with observations necessary to advance the understanding of cloud distributions .
Cross-sensor inter-comparison is important to assess calibration quality and consistency and ensure continuity of observational datasets. This paper presents a cross-comparison of the data acquired by the MODIS, CLOUDSAT and CALIPSO sensors in order to understand the limit of the developed cloud-mask algorithm and to provide a quantitative validation assessment by using exclusively remotely sensed data.

2. Data and methodology

Available data sets from both satellites have been browsed and selected from the NASA's GSFC web site MODIS Atmosphere, Level-1B Granule Images (http://modis-atmos.gsfc.nasa.gov/IMAGES/). The corresponding CLOUDSAT and CALIPSO granules were also selected and downloaded (http://cloudsat.atmos.colostate.edu/data). The initial analysis has been carried out on six images acquired partly in 2006 and 2008 but covering almost all the seasonal periods.
The technique for the cloud detection has been developed using the MODIS cloud-mask algorithm heritage. However, the threshold tests have been executed without comparing solar reflectances and thermal brightness temperatures with thresholds determined in advance, but with thresholds obtained from classification methods [1]. The main advantage of this technique is that the thresholds are obtained directly from the images, 75% of the spectral signatures, called end members, derived from the winter images and 80% from summer images can be considered as being well discriminated in the detection of the various cloud types. This technique aims at adapting a global algorithm like the one developed by the MODIS team to the regional level.

The cloud mask algorithm has been applied to the MODIS AQUA images and the results have been compared to the tracks simultaneously acquired by the CLOUDSAT and CALIPSO sensors. The comparison is carried out on the level of horizontal lines for the MODIS AQUA images and vertical profiles for the other two sensors.

3. Results

The comparison has been carried out by considering both the cloud mask and the intermediate levels such as the brightness temperatures and the reflectances for different channels from which the cloud mask is derived. The preliminary analysis indicates a general good agreement among the different sources. A main underestimation of cloud cover is present on the sea and especially for high thin clouds. First results indicate that in order to increase the cloud cover accuracy the threshold for the intermediate levels (brightness temperature and reflectances) may be changed by taking into account also the cloud vertical profiles.

References

[1] G. Cappelluti, A. Morea, C. Notarnicola, F. Posa, "Automatic detection of local cloud systems from MODIS data", *Journal of Applied Meteorology and Climatology*, vol. 45, no.8, p. 1056-1072, August 2006.

[2] Wielicki, B. A., R. D. Cess, M. D. King, D. A. Randall, and E. F. Harrison, 1995: Mission to planet Earth: Role of clouds and radiation in climate. *Bull. Amer. Meteor. Soc.,* 76, 2125–2153.