Satellite solar meteorology: operational use of the Meteosat system to compute solar irradiance

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SATELLITE SOLAR METEOROLOGY :

OPERATIONNAL USE OF THE METEOSAT SYSTEM TO COMPUTE SOLAR IRRADIANCE.

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THE NEEDS IN SOLAR METEOROLOGY.

In a wide range of human activities going from agrometeorology and water resources to the design of optimal solar system or photovoltaic energy producing units a better knowledge of the solar radiation field is required. On the other hand the monitoring of the cloud field is also of great importance to measure the impact of anthropogenic activities like deforestation or the release of greenhouse gases in the earth-atmosphere system. Therefore since the last past years the scientific as well as the engineer communities show a large interest in new methods of estimation of the global radiation field. In fact traditionnal methods lying on the production of radiation maps by interpolating between the points of the ground pyranometer network are too inaccurate to represent the climatic variations on scales ranging from ten to a few hundred of kilometers and the situation is even worse in a large number of regions where pyranometer networks simply do not exist. Satellite methods then provide the very useful tool for these studies. This paper summarizes the experience acquired by CTAMN in this domain.

THE METHOD.

Since 1980 an original method of estimation of global solar radiation based on the Meteosat system is studied and developped by CTAMN and since January 1983 this method is operationnaly used to produce hourly and daily maps of solar irradiance. Only a brief description of the fundamentals of the method is done since extensive description and comparison with other methods can be found elsewhere. Basically it lies on the preliminary construction by a least square technique of a reference albedo map wich is reactualized every three days in order to take account of the seasonnal variations of albedo. Then this albedo map is used to discriminate the cloudy situations from the clear ones and to construct maps of continuous cloud indexes which are a measure of the relative cloudiness of the pixels. Assuming that a linear relationship between cloud indexes and ground solar irradiance holds measurements from the ground pyranometers are used to compute regression coefficients and to translate cloud indexes into radiation measurements.

RESULTS.

After a preliminary stage devoted to the calibration and first comparisons with the ground measurements in order to study the accuracy of the method which is indeed very satisfactory (namely around 30 Joules per square centimeter for hourly values and 200 joules per square centimeters for daily values) the method was operationnaly used over Europa since January 1983 to the present days and since February 1984 to the present days over west-Africa. Eight images per day are acquired from a SDUS station coupled with the CTAMN processing facilities. The images are then processed and stored on magnetic tapes providing a very useful data collection on solar radiation. Monthly means are published and available in form of radiation atlases for each months since the beginning of the operationnal exercise. Comparisons of these atlases with the ones published by the CEC from traditionnal methods show excellent agreement and the capability of the method to capture local micro-climate which cannot be obtained by other methods. Some examples will illustrate these points. Finally a discussion is made on the limitations of the method and on the comparison with similar ones.

CONCLUSION.

The capability of a method of estimation of global solar irradiance based on the utilisation of the Meteosat system is demonstrated on the basis of an operationnal use and show the potential usefulness of satellite use in solar meteorology. Emphasis is made on the fact that the Meteosat system is part of the world meteorological geostationnary satellite system and that the Meteosat system will be supported in the 1990's. This fact provide a unique opportunity to derive long time series of observations which can be very reliable for climatological purposes.