The use of Meteosat Second Generation satellite data within a new type of solar irradiance calculation scheme

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1 Introduction

In the context of a safe and environmental friendly energy supply renewable energy systems will be the energy source of the future. Wind energy has become an important energy source in Europe (e.g. 15 % in Denmark) still increasing impressively. The usage of solar energy will increase enormesly in the next 10 years as well. For an optimal and efficient usage of solar energy and for the integration into the electricity grid accurate solar irradiance data in a high spatial and temporal resolution is necessary. Solar irradiance schemes can be used to provide these data using weather satellites such as Meteosat (and in future MSG). Within this poster a brief overview of the HELIOSAT-3 project and the new type of solar irradiance scheme developed within this project is provided.

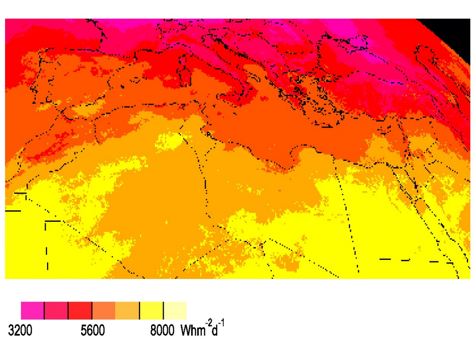
2 Objectives of the project

A successful integration of solar energy technologies into the existing energy structure highly depends on a detailed knowledge of the solar resource. HELIOSAT-3 will supply high quality solar radiation data gained from the exploitation of existing Earth observation technologies and will take advantage of the enhanced capabilities of the new Meteosat Second Generation (MSG) meteorological satellites (see table 1). The expected quality represents a substantial improvement with respect to the available methods and will better match the needs of the users of the resulting products.
In particular, HELIOSAT-3 will provide

- solar irradiance data with high accuracy and spacetime resolution necessary for solar energy applications, plus a large geographical coverage
- additional solar energy specific data (direct and spectral irradiance, angular distribution of diffuse irradiance, spatial structure of irradiance) according to the needs of end-users
- information on HELIOSAT-3 products, its sustain-ability as a service and its potential benefits to end-users.

The objectives of the HELIOSAT-3 project will be achieved by the development and establishment of a new type of solar irradiance calculation schemes. A brief overview of this scheme is provided in the next section.

Fig. 1: Example - solar irradiance map



Example of solar a irradiance map for South-Europe and North-Africa in $\frac{Wh}{m^2 d}$, calculated with the current Heliosat method, Monthly mean April 1995.

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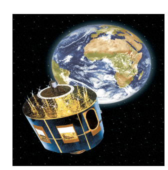
3 The solar irradiance scheme

Geostationary weather satellites like the current Meteosat provide cloud information with a high spatial and temporal resolution. Such satellites are therefore not only useful for weather forecasting, but also for the estimation of solar irradiance since the knowledge of the light reflected by clouds is the basis for the calculation of the transmitted light. Additionally an appropriate knowledge of atmospheric parameters involved in scattering and absorption of the sunlight is necessary for an accurate calculation of the solar irradiance.
Currently, most of the operational calculation schemes for solar irradiance are semi-empirical, based on statistical methods for the calculation of solar irradiance. They use cloud information from the current Meteosat satellite and climatologies of atmospheric parameters e.g. turbidity (aerosols and water vapor) for the calculation of the clear-sky irradiance.
The Meteosat Second Generation satellites (MSG, to be launched in 2002) will provide not only a higher spatial and temporal resolution, but also the potential for the retrieval of atmospheric parameters such as ozone, water vapour and with restrictions aerosols (see poster ST082). With this more detailed knowledge about atmospheric parameters it is evident to set up a new calculation scheme based on radiative transfer models using the retrieved atmospheric parameters as input.
This new scheme will be based on the integrated use of a radiative transfer model (RTM), whereas the information of the atmospheric parameters retrieved from the MSG satellite (clouds, ozone, water vapour) and e.g. from the GOME/ATSR-2 satellites (aerosols) will be used as input for the RTM, see figure 2.

Fig 2: Brief diagram of the calculation scheme



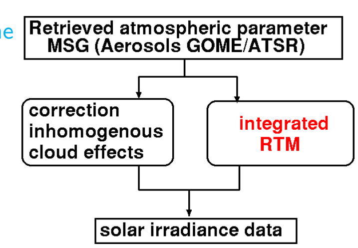


Table 1: Enhanced capabilities of MSG (launch Aug.2002)

parameter	Meteosat	MSG
spatial resolution	2.5 km	1 km
temporal resolution	30 min	15 min
spectral channels	3	12

The integration of RTM into the calculation scheme, instead of using just pre-calculated look-up tables, is only possible if the necessary computing time can be decreased enormously (e.g for Europe 3000000 pixels has to processed every 15 minutes). For this purpose a tricky parametrisation of the diurnal variation of the solar irradiance is applied. Thus makes an integrated (operational) use of RTM within the calculation scheme possible. The integration of the RTM into the calculation scheme is associated with a high flexibility with respect to changes of atmospheric modelling and the different user requirements on the solar irradiance data. More over the usage of water vapour and aerosol information instead of using just turbidity leads to a better estimation of the relation between direct and diffuse light.
Since a detailed description of the new type of solar irradiance scheme is not possible within a poster, interesting people are referred to the HELIOSAT-3 web page (www.heliosat3.de). For a description of the current Heliosat method, see documents at (www.satellight.com/ref/refind/indrsk87.htm)