Schlussbericht/Jahresbericht 15. Dezember 2011

IEA SHC TASK 36: SOLAR RESOURCE KNOWLEDGE MANAGEMENT

GLOBAL RADIATION SHORT TERM FORECAST AND TRENDS /
AEROSOL CLIMATOLOGY

Für den Inhalt und die Schlussfolgerungen ist ausschliesslich der Autor dieses Berichts verantwortlich.

Abstract

In the framework of IEA Solar Heating and Cooling (SHC) task 36 Meteotest investigates the possibilities and quality of global radiation forecast, the trend of recent global radiation data and distribution of atmospheric aerosols.

In the 6th and final year 2011 of task 36 the work within the tasks has been finished and the final report has been started to write. The follow on task 46 has started in July 2011.

METEOTEST wrote two chapters in the final report, which will be published in 2012. One is dealing about aerosol climatologies and one about long term trends of global radiation.

To conclude the work of the last 6 years three contribution of *METEOTEST* are highlighted: 1. the new aerosol optical depth map, 2. the trend analysis of global radiation and 3. the benchmark of radiation forecast models.

Introduction

In the framework of IEA Solar Heating and Cooling (SHC) task 36 "Solar Resource Knowledge Management" [1] Meteotest investigates mainly the possibilities and quality of global radiation forecast. The task 36 is divided into 3 main subtasks:

A) Standard qualification for solar resource products (includes benchmarking of different radiation estimation models based on satellite measurements).

B) Common structure for archiving and accessing solar resource products (includes proto-type of online tool for accessing data).

C) Improved techniques for solar resource characterization and forecast; improve satellite retrieval methods for solar radiation products; conduct climatological analysis of solar re-sources.

The aim in the radiation forecast subtask is to define the quality of the existing models and to enhance the quality.

Work done and results

The year 2011 was used to finalize the task and report about the work done. No additional work parts have been started.

Final subtask deliverables as well as inputs for the Handbook on Solar Radiation of all three parts are in preparation or nearly finished. The delays are not due to Swiss contributors, but to the subtask leaders.

Final report

METEOTEST wrote two chapters of the final reports, which will be published in 2012. One is dealing with aerosol climatologies and another with long term trends of global radiation (see BFE Jahresbericht 2009 of IEA SHC Task 36).

To conclude the work of the last 6 years three contribution of *METEOTEST* are highlighted:

1. New aerosol optical depth map: Figure 1 shows the average aerosol optical depth map

2. Trend analysis of global radiation: Table 1 gives an overview of the global radiation trends

3. Benchmark of radiation forecast models: Table 2 shows the accuracy of the forecast-ed global radiation (hourly values, Switzerland).
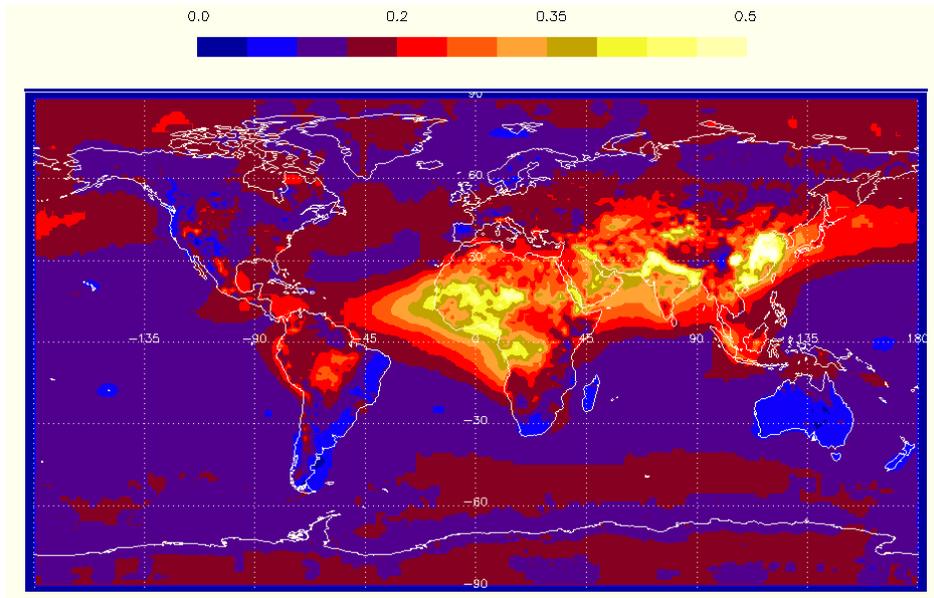

Figure 1: Yearly mean of aerosol optical depth at 550 nm 2001-2008, based on Aeronet [2] and satellite data of NASA. These values are used within Meteonorm Version 6.1 and 7. Aerosol optical depth has a big influence on the amount of clear sky radiation reaching the ground.

Table 1: Result of linear trend analysis for the period 1985-2006 based on GEBA database [3]. Cursive values are not significant (on a 95% level). Trends in Europe and Japan are clearly positive (effect is also known as "global brightening") and in China and India mostly negative [4, 5].

Region	Trend [W/m^2 10y]
all	1.82
Europe	4.13
Northern Europe	2.94
Germany / Austria	4.64
Switzerland	3.07
United Kingdom	*1.52*
Asia	*1.43*
Japan	5.25
India	-5.44
Canada	*-0.21*

Table 2: Root mean squared error (rmse), mean absolute error (mbe) and bias for the four forecasting approaches and persistence, first forecast day, complete Swiss data set [6]. The uncertainty (rmse) ranges between 40 and 45% and is clearly lower than persistence.

approach (forecast model, operator)	rmse in W/m^2	mae in W/m^2	bias in W/m^2
ECWMF, Univ. Oldenburg Germany	107 (39.6%)	70 (25.8%)	-1 (-0.3%)
BLUESKY Wetter, Austria	109 (40.5%)	73 (27.0%)	-9 (-3.3%)
MOS, Meteomedia, Germany	122 (45.0%)	85 (31.5%)	-18 (-6.6%)
WRF (GFS based), Meteotest, Switzerland	119 (44.2%)	76 (28.0%)	4 (1.3%)
Persistence (constant clearness index)	158 (58.4%)	104 (38.7%)	-17 (-6.3%)

New task

The kick off meeting of task 46 was held in Kassel in September 2011 (in combination with ISES SWC 2011). It will include the following four subtasks:

Subtask A: Solar Resource Applications for High Penetration of Solar Technologies

This subtask will develop the necessary data sets to allow system planners and utility operators to understand short-term resource variability characteristics, in particular up and down ramp rates, to better manage large penetrations of solar technologies in the grid system. Although this work is primarily focused toward PV systems, which react almost instantaneously to cloud passages over individual panels, the information is also useful for solar thermal and CSP systems where intermittence resources can impact their ability to meet load demands.

- A-1: Solar variability, and specifically ramp rates, for particular systems
- A-2: Integration of solar with other RE technologies
- A-3: Spatial and temporal balancing studies of the solar and wind energy resource

Subtask B: Standardization and Integration Procedures for Data Bankability

- B-1: Measurement best practices
- B-2: Gap-Filling, Quality control, flagging, data formatting
- B-3: Integration of different (short and long) data sources
- B-4: Evaluation of the use of TMY data
- B-5: Data uncertainties over various time frames

Subtask C: Solar Irradiance Forecasting

- C-1: Short term forecasting (1 – 7 days ahead)
- C-2: Integration of solar forecasts into operations

Subtask D: Advanced Resource Modelling

- D-1: Improvements to existing solar radiation retrieval methods

- D-2: Development of global solar resource data sets for integrated assessment of global and regional RE scenarios modelling, with a special focus on CSP and solar heating technologies

- D-3: Long term analysis and forecasting of solar resource trends and variability

National / international cooperation

The work was done in the framework of IEA Solar Heating and Cooling task 36. From Switzerland there is also University of Geneva part of the task team.

Outlook

The task will be finished next year. The follow on task 46 has been approved in November 2010. The new task started in July 2011 and will end in June 2016.

References

[1] Homepage of IEA Solar Heating and Cooling task 36: http://www.iea-shc.org/task36/

[2] http://aeronet.gsfc.nasa.gov/

[3] https://protos.ethz.ch/geba

[4] J. Remund, 2010: Zeitliche Entwicklung der Globalstrahlung von 1950 bis 2099, 25. SYMPOSIUM "PHOTOVOLTAISCHE SOLARENERGIE", Bad Staffelstein, Germany, 3. – 5. März 2010.

[5] J. Remund and S.C. Müller, 2010: Trends in global radiation between 1950 and 2100, EuroSun Conference, Graz, Austria, Sep. 29th to Oct 1st 2010

[6] Lorenz et al. 2009, Benchmarking of different approaches to forecast solar irradiance, 24th European Photovoltaic Solar Energy Conference (EUPVSEC), Hamburg, Germany, Sep. 21st to 25th 2009.