Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 125 (2017) 221–229

Energy Procedia

www.elsevier.com/locate/procedia

European Geosciences Union General Assembly 2017, EGU
Division Energy, Resources & Environment, ERE

Quality assessment of high-resolution climate records of satellite derived solar irradiance

Marieke Dirksen[a,*], Jan Fokke Meirink[a], Raymond Sluiter[a]

[a]*KNMI, P.O. Box 201, De Bilt 3730AE, The Netherlands*

Abstract

Measurements from geostationary satellites allow the retrieval of surface solar irradiance homogeneously over large areas, thereby providing essential information for the solar energy sector. Here, the SICCS solar irradiance data record derived from 12 years of MSG satellite measurements is analysed with a focus on the Netherlands. Daily SICCS data is validated with pyranometer observations, indicating a bias of approximately 3W/m^2. Next, the data record is optimized using surface observations and kriging interpolation with satellite observations as trend. Long term averages, seasonal variations and inter-annual variability of solar irradiance show regional patterns related to the surface type.

Peer-review under responsibility of the scientific committee of the European Geosciences Union (EGU) General Assembly 2017 – Division Energy, Resources and the Environment (ERE).

Keywords: Solar Irradiance; Satellite measurements; pyranometer; kriging; climatology; MSG

1. Introduction

There is a need to understand climate variability at local scale. Local and global problems are linked, therefore an improved understanding of the local climate potentially leads to a deeper understanding of global climate [1]. High resolution solar irradiance is important in many fields such as meteorology (e.g. [2]) and climatology (e.g. [3], [4]). Previous studies used a satellite-based irradiance product to derive long term averages and climatologies [5].

If we interpolate the average solar irradiation for the Netherlands based on 32 observation stations [6], it results in a smooth pattern for the Netherlands (Fig. 1b). However, local spatial patterns are lacking. Enhanced spatial detail can be provided by satellite observations (e.g. [7], [8]).

Previously, ground-based measurements have been interpolated with a satellite product (CM-SAF, [9]), using a dataset of two years over Belgium [7]. From the different interpolation techniques kriging with external drift showed the best performance. Spatially patterns were improved and station errors were lower. Compared with [7] this re-

* Corresponding author. Tel.: +0316-152-400-99
E-mail address: dirksen@knmi.nl

1876-6102
Peer-review under responsibility of the scientific committee of the European Geosciences Union (EGU) General Assembly 2017 – Division Energy, Resources and the Environment (ERE).
10.1016/j.egypro.2017.08.197

search uses a time series from 2004/01/19 until 2016/01/19 with daily data of the Meteosat Second Generation (MSG) product Surface Insolation under Clear and Cloudy Skies (SICCS) [10] and 32 ground based observations over the Netherlands. First, an assessment of the quality of the satellite observations is made using the ground-based observations. Secondly, ground-based measurements are integrated with the satellite product SICCS to create an optimized high resolution solar irradiance dataset. Finally, climatologies are calculated from the new dataset.

2. Methods

Ground based observations have a limited spatial coverage with high accuracy while SICCS provides continuous spatial information with lower accuracy. In this chapter we describe the differences between both datasets and the algorithm to combine the datasets. Data with a daily time resolution is used to analyze differences and perform a Kriging with External Drift (KED) analysis.

2.1. Ground-based Observations

The ground based solar irradiance observations originate from Automatic Weather Stations (AWS), with a time resolution of 10 minutes. Currently a total of 32 stations measure radiation (Fig. 1a) using a pyranometer. The 12 second measurements are averaged over 1 minute as well as 10 minutes. The instruments can have a calibration uncertainty up to 10 W/m^2 [11]. For the daily measurements an error of 3% is expected [12].

2.2. Satellite Observations

The Spinning Enhanced Visible and Infrared Imager (SEVIRI) on-board MSG measures reflected and emitted radiation from the earth in 12 spectral channels with a sub-satellite spatial resolution of 3x3 km^2 and a repeat frequency of 15 minutes [13]. The SICCS algorithm [10] to derive surface solar irradiance for every SEVIRI pixel works in three

a b

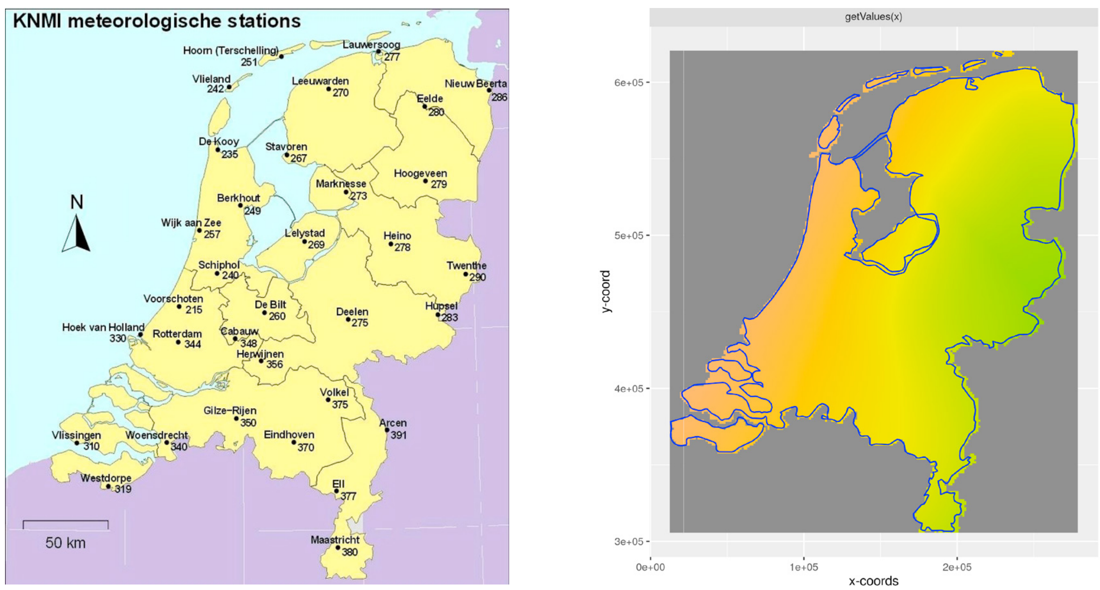

Fig. 1: (a) Overview of the KNMI stations. At all locations except Vlieland pyranometers measure the solar irradiance. (b) Kriging interpolation using the 32 ground-based observations and with distance to the sea as trend for the time period 2004 until 2016.