Meteorologische Zeitschrift, Vol. **17**, No. 2, 181-186 (April 2008)


**Article**

# Detection of cloud-free skies based on sunshine duration and on the variation of global solar irradiance

CHRISTIAN RUCKSTUHL*[1] and ROLF PHILIPONA[2]

[1]Institute for Atmospheric and Climate Science, ETH Zurich, Switzerland
[2]Physikalisch-Meteorologisches Observatorium, Davos, Switzerland

(Manuscript received August 23, 2007; in revised form January 21, 2008; accepted February 2, 2008)

**Abstract**

Automatic detection of cloud-free skies became more and more important in recent years to evaluate and interpret surface radiation measurements in the context of the greatly debated solar dimming and brightening and to investigate possible changes of the greenhouse effect using longwave downward radiation measurements. To automatically separate cloud-free from cloudy sky situations within the MeteoSwiss automatic meteorological network (ANETZ) a new method based on sunshine duration and hourly global solar irradiance measurements, referred to as sunshine duration method (SSD-M), is presented. Results obtained with this new method are evaluated with the approved automatic partial cloud amount detection algorithm (APCADA). SSD-M identifies at the six investigated radiation sites between 88 and 98 % of cloud-free cases detected by APCADA. The probability of false detection of SSD-M does not exceed 7 % at any of the sites. The new method presents the advantage to use standard solar radiation parameters that are usually measured at advanced meteorological stations. The use of solar measurements restricts the method to detect daytime cloud-free situations only.

**Zusammenfassung**

Die automatische Bestimmung von wolkenfreien Situationen wurde in den letzten Jahren immer wichtiger. Sie ist unerlässlich zur Evaluation und Interpretation von Strahlungsmessungen an der Erdoberfläche im Rahmen des zurzeit stark diskutierten "solar dimming" und "solar brightening" und zur Untersuchung von Veränderungen des Treibhauseffekts mit langwelligen Strahlungsmessungen. Zur automatischen Trennung von wolkenfreien und bewölkten Situationen mit verfügbaren Daten vom automatischen meteorologischen Messnetz (ANETZ) der MeteoSchweiz, stellen wir eine neue Methode vor, welche alleine auf Sonnenscheindauer- und Globalstrahlungsmessungen beruht. Die vorgestellte Methode wird nachstehend als Sonnenscheindauer-Methode (SSD-M) bezeichnet. Wolkenfreie Momente, welche mit SSD-M bestimmt wurden, werden mit dem etablierten automatic partial cloud amount detection algorithm (APCADA) verglichen. SSD-M findet an den sechs untersuchten Stationen zwischen 88 und 98 % von den von APCADA bestimmten wolkenfreien Situationen. Die Wahrscheinlichkeit eines fehlerhaft bestimmten wolkenfreien Himmels liegt bei allen Stationen bei maximal 7 %. Die neue Methode hat den Vorteil, dass Standardgrößen verwendet werden, welche normalerweise an den modernen meteorologischen Stationen gemessen werden. Da zur Bestimmung der wolkenfreien Momente solare Größen verwendet werden, kann SSD-M nur tagsüber angewendet werden.

## 1 Introduction

Automatic cloud-free sky detection is getting more and more important for climate change investigations. For analyses of decadal changes in global solar radiation, known as solar brightening and dimming (e.g. WILD et al., 2005, OHMURA, 2006), it is essential to consider all-sky fluxes as well as cloud-free sky fluxes. By separating all-sky and cloud-free fluxes it is possible to attribute the observed changes either to changes in cloudiness or to changes in the atmospheric transmittance mainly due to changes of the aerosol optical depth. Similarly on analyzing changes on the longwave radiation budget, it is essential to remove the dominant cloud effect in order to investigate changing longwave radiation of the cloud-free atmosphere, which finally allows separating the water vapor and the anthropogenic greenhouse effect (PHILIPONA et al., 2005). Several methods to detect cloud-free skies or to estimate cloud cover have been developed during the last years, and are summarized here. A method to detect cloud-free situations based on high time resolution longwave downward radiation measurements was introduced by MARTY and PHILIPONA (2000) and further developed to detect cloud amount by DÜRR and PHILIPONA (2004), known as automatic partial cloud amount detection algorithm (APCADA). For autonomous cloud amount detection with APCADA an instrument package has been developed (RUCKSTUHL and PHILIPONA, 2005). LONG and ACKERMANN (2000) presented a method based on shortwave diffuse irradiance measurement. The method of DUTTON et al. (2004) is based on

*Corresponding author: Christian Ruckstuhl, Institute for Atmospheric and Climate Science, ETH Zurich, Universitätsstr. 16, 8092 Zurich, Switzerland, e-mail: christian.ruckstuhl@env.ethz.ch

0941-2948/2008/0271 $ 2.70

DOI: 10.1127/0941-2948/2008/0271