Meteorologische Zeitschrift, Vol. 15, No. 1, 65-72 (February 2006)

Article

Characterization of low clouds with satellite and ground-based remote sensing systems

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(Manuscript received June 30, 2005; in revised form September 27, 2005; accepted October 25, 2005)

Abstract

Satellite and ground-based retrievals of a number of (low) cloud characteristics are compared in this paper in order to assess the performance of the techniques and identify potential synergies. Centred on the COST720 International Comparison Campaign for Temperature, hUmidity and Cloud profiling (TUC), four cases with different meteorological situations are analysed in detail. Parameter agreement (for cloud presence, liquid water path, cloud geometrical thickness and cloud top temperature) is good in general. It is shown that satellite retrievals of liquid water path and cloud thickness could be improved using liquid water content derived from ground-based measurements, while ground-based retrievals can profit from the spatial component in satellite data. Taken together, the combination of instruments and techniques presented in this paper allows for a detailed assessment of complex cloudy atmospheres.

Zusammenfassung

Dieser Artikel vergleicht satellitengestützt und auf Basis von Bodenmessungen ermittelte Eigenschaften von niedrigen Wolken mit den Zielen, die Methoden auszuwerten und potenzielle Synergien zu indentifizieren. Rund um die TUC-Vergleichskampagne (International Comparison Campaign for Temperature, hUmidity and Cloud profiling) der COST-Aktion 720 werden vier Fallstudien mit verschiedenen meteorologischen Lagen detailliert untersucht. Wie gezeigt werden kann, stimmen die erfassten Parameter (Wolkenbedeckung, Flüssigwasserpfad, Wolkendicke, Wolkentemperatur) generell gut überein. Es zeigt sich allerdings, dass Satellitenretrievals des Flüssigwasserpfades und der Wolkendicke durch Heranziehung von Flüssigwassergehaltsinformationen aus Bodenmessungen verbessert werden könnten. Bodenbasierte Methoden wiederum finden in der räumlichen Komponente der Satellitendaten eine sinnvolle Ergänzung. Zusammengenommen ist auf Basis der hier präsentierten Kombination von Instrumenten und Techniken eine detaillierte Erfassung komplexer atmosphärischer Wolkensituationen möglich.

1 Introduction

Clouds and their interactions with radiation have been identified in the Third Assessment Report of the Intergovernmental Panel on Climate Change as "probably [the source of] the greatest uncertainty in future projections of climate" (IPCC, 2001). The physics of cloud and radiation interaction is known to be incompletely described in models. For instance, significant discrepancies have been reported between observations of shortwave radiation absorption in clouds and matching 3D model simulations (O'HIROK and GAUTIER, 2003). In addition, changes especially in low cloud coverage and type are expected due to temperature change and aerosol indirect effect, but these changes are also not understood well enough for precise predictions to be made. A comprehensive review of known uncertainties is given by STEPHENS (2005).

Improving the knowledge of cloud and radiation interaction requires the analysis of simultaneously observed radiation and cloud characteristics. While observation of radiation by both satellite and ground-based systems is relatively satisfactory, determination of cloud properties is incomplete, and still suffers from large uncertainties. Intercomparison campaigns where many systems are used in parallel for determining cloud properties offer the opportunity to identify shortcomings in cloud observing systems, determine synergies between such systems and propose solutions for improving cloud characterization. The present paper intends to accomplish such objectives by comparing satellite and ground-based remote sensing systems. The paper lays no claim to completeness, but rather aims at considering a set of

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0941-2948/2006/0100 $ 3.60
DOI: 10.1127/0941-2948/2006/0100