Project Title: Impact of Tropospheric Aerosols on the Past Surface Radiation Income: Calibration with ARM Site Data

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FINAL REPORT

SUMMARY

The travel grant has been used to study the effect of tropospheric aerosols on past surface irradiance data. G. Kukla and B. Liepert visited the ARM CART cite in Oklahoma. After discussions with members of the ARM science team we decided to use the National Solar Radiation Data Base of the United States to address this question. The impact of aerosols on surface radiation in the past time interval from 1960 to 1990 in the US has been studied. We focused on the indirect effect of aerosols on climate and established cooperation with U. Lohmann from Dalhousie University, Halifax. Two trips one to Halifax, Canada and one to Palisades, New York - were made during this cooperation. Finally B. Liepert and U. Lohmann wrote a manuscript to summarize the results of this investigation, which is accepted for publication in J. Climate. This DOE grant has been acknowledged accordingly.

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WORK REPORT

Visit to Southern Great Plains ARM Site:

G. Kukla and B. Liepert visited the Southern Great Plains ARM site during the fall IOP from October 1 to 5, 1997. The permanent CART's site radiation instrumentation was inspected and calibration problems were discussed with other ARM science team members who participated in the IOP. We were also interested in more detailed information about the BSRN (baseline surface radiation network) shortwave instruments from the WMO.

ARM Science Team Meeting in Tuscon, AZ, from March 23 to 27, 1998

B. Liepert participated in the ARM Science Team Meeting in Tuscon, AZ in March 23 to 27, 1998 and presented the latest scientific results in the poster session.

Visit of Dalhousie University in Halifax, Canada from July 10 to 14, 1998

We established cooperation with Prof. U. Lohmann from the Department of Physics of Dalhousie University in Halifax, Canada. The goal of this meeting was to cooperate in a study that investigates the indirect effect of aerosols on the surface shortwave radiation budget and assess the impact on global climate. We developed a strategy in which we compare a global climate model experiment provided by U. Lohmann with surface shortwave irradiance measurements from the historic archive of the National Solar Radiation Data Base NSRDB.

Visit of U. Lohmann from Dalhousie University Halifax to Lamont-Doherty Earth Observatory Palisades, NY from October 1 to 4, 1998.

U. Lohmann visited LDEO on October 1 to 4, 1998 to discuss preliminary results. U. Lohmann also gave a talk in the LDEO seminar series.

SCIENTIFIC RESULTS

SUMMARY

Surface climatologies of solar irradiance, fractional cloud coverage and precipitation rates for the US are used to evaluate the aerosol-cloud-interactions in the GCM experiment. However, it was not possible to fully confirm the existence of indirect aerosol effect. This is mainly due to deficiencies in the modeled hydrological cycle.

The model (the ECHAM4 GCM) correctly predicts the annual mean total cloud coverage in the US, whereas global solar radiation is underestimated by 13W/m^2 . This deficiency stems from cloudy conditions. Clouds are either optically too thick or the vertical distribution of clouds is erroneous. This is confirmed by the modeled overcast solar irradiance, which is 27W/m^2 lower than observed. The clear sky modeled radiation and the observations agree. Precipitation rates are underestimated by 42% in the United States. The modeled cloud cover is too low over the Central United States in July and August and consequently the solar irradiance exceeds the observations during these months. The opposite occurs in winter when the model overestimates the cloud cover and thus underestimates solar irradiance. The non-seasonality of vegetation and soil parameters seems the causes for these deficiencies. This is a problem in all GCMs and needs to be addressed. The convective precipitation formation might also contribute to these discrepancies. On the other hand, this drying out effect of the inner continent is not as pronounced in coastal regions and in particular, the comparisons for the German grid-box provide indications for the validity of the indirect aerosol effect. The modeled annual cloud cover and solar radiation cycles for the present day aerosol load are in better agreement with observations. Furthermore, the model shows an interesting shift from low cloud reduction to cirrus formation in spring as a consequence of the indirect aerosol effect, a result, which is confirmed by observational data.

REFERENCE

Liepert, B.G. and U. Lohmann, 2001: A comparison of surface observations and ECHAM4-GCM experiments and its relevance to the indirect aerosol effect. J. Climate, in print.