

Aerosol optical depth measurements in the
UV, visible and near infrared at Thule Air Base,
Greenland (76.5° N), during 1999



Solar Radiometers at Thule Air Base (76.5° N, 68.8° W)

Frank Charleson Bason

Ph.D. Thesis
Institute of Physics and Astronomy, Aarhus University
and the Danish Meteorological Institute, 1999

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Foreword

Background

This work was undertaken from 1996-1999 in cooperation with Aarhus University and the Danish Meteorological Institute (DMI) and motivated by a long-term personal interest in the measurement of solar radiation and the design of measuring instruments. Funding for equipment was in part available due to a parallel project, *Performance of photovoltaic panels under difficult climatic conditions* (ENS project 51181/97-066), undertaken for the Danish Ministry of Environment and Energy. A sabbatical year from Silkeborg Amtsgymnasium for preparing instrumentation and performing measurements at Thule Air Base was possible due to flexible, part-time employment and gracious assistance from the Danish company A/S Søren Frederiksen, one of the largest manufacturers of science equipment in Scandinavia.

Acknowledgements

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The presentation

A brief remark is perhaps in order regarding the presentation. Rather than produce a document which would be readable only by expert specialists in atmospheric physics, I have attempted to make it accessible to colleagues in neighboring disciplines who have expressed a continuing interest in the subject and to Danish students who may choose to study atmospheric physics. Danish institutions have made increasingly significant contributions to atmospheric science and geophysics in recent years, and it is important to recruit more young people to the field. For these reasons I have, when in doubt, chosen clarity over conciseness.

A scientific paper describing the results has been submitted to the ISES (International Solar Energy Society) journal **Solar Energy**, and a paper will be presented at the ISES Conference in Copenhagen in June, 2000, for publication in the proceedings of that meeting.

Dansk Resumé

Afhandlingens formål er beskrivelsen af målinger af atmosfæriske aerosoler i arktiske omgivelser og perspektivering af disse målinger inden for den atmosfæriske fysik. For at opnå dette mål præsenteres en kortfattet oversigt over forskning i atmosfæriske aerosoler samt de analytiske værktøjer, der skal benyttes til databehandling. Udformningen, fremstillingen og kalibreringen af smalbandsradiometre, et bredbåndspyreheliometer samt et CCD fiberoptisk spektrometer beskrives. Data blev optaget primært ved Thule Air Base (Pituffik) i Grønland ved $76,5^\circ$ N ca. 810 sømil (1500 km) fra Nordpolen. De arktiske aerosoldata rækker over perioden fra midt i maj gennem tidlig oktober 1999. CCD instrumentet blev testet og anvendt i Silkeborg i Danmark ($56,1^\circ$ N) til indsamling af solspektra med henblik på eventuel fremtidig anvendelse f.eks. på Thule Air Base.

Den højnede bevidsthed i de senere år om såvel menneskeskabte som naturlige påvirkninger af jordens atmosfære har givet anledning til øget opmærksomhed om atmosfæriske aerosolers indvirkning på jordens strålingsbalance. GCM'ere (General Circulation Models), der kan give troværdige forudsigelser af temperaturændringer i atmosfærens grænselag, kræver kendskab til den rumlige fordeling, beskaffenheden, koncentrationen og størrelsesfordelingen af troposfæriske aerosolpartikler. Denne afhandling beskriver optiske metoder til fremskaffelse af disse informationer samt instrumentering, der er blevet fremstillet til dette formål. De arktiske forsøg i Pituffik blev gennemført på DMI's (Danmarks Meteorologiske Instituts) laboratorium nær Thule Air Base ($76,5^\circ$ N, $68,6^\circ$ W).

Jordens strålingsbalance påvirkes af atmosfæriske aerosoler, små partikler typisk med diametre mellem $0,01 \mu\text{m}$ og $20 \mu\text{m}$. Aerosol påvirkninger kan være *direkte* på grund af spredning og absorption af indkommende solstråling og reflekteret stråling fra jorden, eller *indirekte* på grund af den vigtige rolle, som aerosoler spiller i forbindelse med skydannelse. Den totale solindstråling midlet over hele jordoverfladen er ca. 344 W/m^2 . Den totale klimapåvirkning (eng. *climate forcing*) på grund af aerosoler og andre faktorer beskrives bekvemt i netop disse enheder.

Rapporten fra IPCC (Intergovernmental Panel on Climate Change) Working Group i 1995 konkluderer, at aerosoler kan være ansvarlig for en negativ klimapåvirkning på 1 eller 2 watt per kvadratmeter og således til en vis grad kompensere for den globale opvarmning, der menes at stamme fra de såkaldte drivhuseffekter ($+2,4 \pm 0,4 \text{ W/m}^2$). Der findes mange metoder til observation af den rumlige og tidsmæssige fordeling samt størrelsesfordelingen af atmosfæriske aerosoler. Disse metoder indbefatter observationer fra satellitter, fra luftfartøjer og fra ballonbårne instrumenter såvel som jordbaserede optiske iagttagelser af solstrålingens ekstinktion. Det er denne sidstnævnte metode, der er det primære tema for denne afhandling.

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