Abstract: Retrieving cloud optical depth and ice particle size using Thermal and Far IR radiometry in an Arctic environment

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An important goal, within the context of improving climate change modelling, is to enhance our understanding of aerosols and their radiative effects (notably their indirect impacts as cloud condensation nuclei). Ice-crystal size and cloud optical depth (COD) are two key modelling parameters whose variation strongly influences radiative effects in the Arctic environment. The presence, for example, of sulfuric-acid bearing aerosols can significantly change ice-particle size formation leading to significant cooling (relative to ice-particle generation by more pristine aerosols) during the Polar-winter (the dehydration greenhouse feedback or DGF effect proposed by J. P. Blanchet's group at the Université du Québec à Montréal). The presence or absence of diamond dust particles ("clear sky precipitation") in the winter can lead to significant changes in surface heating (as proposed by Lesins et al. of Dalhousie University). It is therefore crucial that ice-crystal size and COD be well characterized in order that such radiative effects be properly modelled.

The general objective of the project is to employ passive, six bands (from 8.3 to 13µm), zenith pointing, thermal IR radiometry as a means of inferring the effective ice-crystal size and COD. This will be accomplished using a split-window (combination of band differences) approach along with MODTRAN 4 radiative transfer simulations to parameterize the behavior of the downwelling zenith radiance as a function of the key optical parameters (including the intensive parameter of effective particle size and extensive parameter of optical depth). Knowledge of other extensive and intensive optical and microphysical parameters derived from radiosonde data, lidar and radar will serve as both auxiliary input data to the model retrieval procedure as well as data for the validation process. Specific input auxiliary data include integrated water vapour content from radiosonde data and effective layer height from lidar backscatter data. Specific validation elements include effective ice-particle radius profiles which can be extracted from the combination of lidar and millimeter cloud radar (MMCR) backscatter coefficients (as per the technique developed by Ed Eloranta at the University of

Wisconsin) as well as indicators of particle shape and phase which can be extracted from lidar depolarization profiles. COD will be compared with measurements from sun and star-photometers and estimation of optical depth from integrated lidar backscatter profiles.

We will also present an extension of the methodology using data in the Far IR window (between 17-25µm) to help us to discriminate different kind of Thin Ice Clouds in Arctic.

The observation site will be the Polar Environment Atmospheric Research Laboratory (PEARL) at Eureka, Nunavut (80°N, 86°W) which is part of the CANDAC network (Canadian Network for the Detection of Atmospheric Change). Results derived from CIMEL thermal IR radiometer measurements at Eureka during October-November 2008 campaign and the spectral integration of P-AERI (Polar Atmospheric Emitted Radiance Interferometer being developed by the University of Idaho) zenith-pointing radiance spectra are analysed. These results are compared with a combination of lidar and millimeter cloud radar (MMCR) backscatter coefficients for the retrieval of crystal size and with lidar and sun and star-photometers for COD. The effects of vertical profiles of crystals and of particle shapes on results are also discussed.