Geophysical Research Abstracts
Vol. 13, EGU2011-5034, 2011
EGU General Assembly 2011

Retrieving cloud optical depth and ice particle size using thermal infrared radiometry: Application to the monitoring of thin ice clouds in an arctic environment

Yann Blanchard, Alain Royer, and Norm O'Neill
CARTEL, Université de Sherbrooke, Sherbrooke, Canada (yann.blanchard@usherbrooke.ca)

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 impact as cloud condensation nuclei). The cloud optical depth (COD) and effective particle diameter (Deff) of ice clouds are two key parameters whose variations could strongly influence radiative effects and climate in the Arctic environment. The presence, for example, of polluted sulfuric-acid bearing aerosols (like during Arctic Haze) can significantly change ice-particle size formation leading to the cooling of the low troposphere during the Polar-winter, while non-polluted ice clouds lead to increase the greenhouse effects. Two types of thin ice clouds (TIC) can thus be distinguished: TIC1 characterized by a low concentration of acidic aerosols and small crystals (Deff < 30 μm) with slow sedimentation; TIC2: high sulfate aerosols, large ice crystals (Deff > 30 μm, up to 300 μm), with fast sedimentation.

Our objective is to assess the potential of using multi-band thermal radiance measurements of zenith sky radiance for retrieving COD and Deff of TIC in the Arctic. We show that a retrieval algorithm using a look-up table approach based on sky radiance simulations in six thermal bands (between 8 and 14 μm) enables to distinguish TIC1 from TIC2 if COD < 3, knowing cloud height, atmospheric profiles and water vapor content. We present results of our methodology using ground-based thermal infrared radiance measurements in six bands extracted from band integrated P-AERI spectra (provided by NOAA). Retrievals were applied at the high-Arctic Polar Environment Atmospheric Research Laboratory (PEARL) in Eureka, Nunavut, Canada (80°N, 86°W) and validated using LIDAR (AHSRL) and RADAR (MMCR) data. The results of the retrieval method were used to separate TICs into TIC1 and TIC2, according to their Deff. Inversions were performed across two polar winters.

Results show the proposed approach can retrieve COD with relatively good accuracy (RMSE = 0.22, R2=0.91) and classify TIC1 / TIC2 clouds with moderate classification accuracy, with an overall accuracy of 80% (100 cases analyzed). We also investigate the correlation between our retrievals and key auxiliary measurements such as the sulfate concentrations made using the Aerosol Mass Spectrometer (AMS). Retrievals over two winters demonstrate the capability of a light and simple automatic six band thermal radiometer to monitor TIC in the Arctic during winter.