BNL-81755-2008-AB

# *OBSERVING THE INDIRECT EFFECT AT NORTH SLOPE OF ALASKA: SPECTROSCOPIC LESSONS FOR FUTURE SATELLITE MISSIONS*

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*For presentation at the*
American Geophysical Union Fall Meeting
San Francisco, CA
December 15-17, 2008

**Environmental Sciences Department/Atmospheric Sciences Division**
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P.O. Box, Upton, NY
www.bnl.gov

**ABSTRACT**

The high Arctic is perhaps the best natural laboratory for studying the aerosol first indirect effect (IDE), as its meteorology involves (1) low-level stratiform cloud cover as the predominant sky condition, (2) pervasive anthropogenic aerosol burden (Arctic haze) throughout winter and spring, and (3) a contrasting clean-air scenario during autumn. Several ground-based observational and multi-phase cloud modeling studies have demonstrated the existence of the Arctic IDE, particularly in its longwave manifestation. Detection and monitoring of the Arctic IDE from existing spacecraft instruments remains challenging, however, because of the high albedo surface that prevails through most of the spring season. During the U.S. Department of Energy Atmospheric Radiation Monitoring (ARM) program's Indirect and Semi-Direct Aerosol Campaign (ISDAC), we deployed a shortwave visible and near-IR spectroradiometer at Barrow, Alaska, during April-May 2008. This instrument measured downwelling spectral irradiance, over the wavelength range 350-2200 nm, in one-minute intervals continuously throughout the field program. ISDAC also involved numerous coordinated overflights of Barrow by NASA and Environment Canada research aircraft making in situ measurements of cloud and aerosol properties. We show how spectral measurements of the radiation field in the 1.6 and 2.2 $\mu$m windows can be used to retrieve cloud thermodynamic phase, optical depth, and effective particle size, and how such retrievals can be used to detect and quantify the Arctic IDE. These results provide suggestions for (1) methods to detect the IDE in the Arctic from sensors such as MODIS, and (2) how future satellite missions might be configured for improved IDE studies, in particular, through enhanced spectral resolution at wavelengths longer than 1 $\mu$m.