Dear Pat,

Below is the final report on the aforementioned grants sponsored by your office.


During the grant period, we have developed a new solar radiation model with a high spectral resolution similar to line-by-line calculations in the thermal IR, hereafter referred to as the line-by-line equivalent (LBLE) solar model. The spectral resolution has two options: 1 cm⁻¹ with 10 g's and 50 cm⁻¹ with 30 g's. The correlated κ-coefficients for these spectral intervals for H₂O from 2,000 to 21,000 cm⁻¹ (0.5-5 μm) are determined from the updated 1966 HITRAN data based on the method developed by Fu and Lieu [1992] for three temperatures and 11 pressures covering the earth's atmospheric conditions. The correlated κ-coefficients for the 2.0 and 2.7 μm CO₂ bands are also derived, in which overlaps between H₂O and CO₂ lines are accounted for by means of the multiplication rule. Absorption due to O₃ and O₂ bands and Rayleigh scattering contributions are accounted for based on the conventional method. More recently, other trace gases have also been included in the program. We have also compiled the single-scattering properties of six typical aerosol types provided in d'Almeida et al. [1991] in connection with the LBLE solar model. The optical properties for various types of water clouds follow the methodology described in Fu and Lieu [1993]. The single-scattering properties of ice crystals for radiative transfer calculations are computed from a unified theory for light scattering by ice crystals developed by Lieu and Takano [1994], Takano and Lieu [1995], and Yang and Lieu [1996a,b].

The "exact" adding/doubling radiative transfer program including full Stokes parameters developed by Takano and Lieu [1989] is used to calculate the transfer of monochromatic solar radiation in vertically inhomogeneous atmospheres. For wavelengths between 3.7 to 5 μm, thermal emission contributions to the solar flux transfer are accounted for by adding the thermal emission part. The thermal part, although small, has not been accounted for in broadband solar flux calculations and could be a not insignificant energy source in the upper part of the atmosphere; a subject for future exploration. The spectral solar radiative transfer program also includes the options of using the detailed solar irradiance data such as that given by Anderson et al. [MODTRAN, 1995] averaged over appropriate spectral resolutions. The LBLE solar model including emission contribution was used to interpret and understand the UAV flux measurements that were carried out on November 31, 1991 (Edwards Air Force Base) and April 19 and 20, 1994 (Oklahoma). Results have been submitted to your office via interim reports.

2. Light Scattering and Radiative Transfer in Cirrus Clouds

Physically-based light scattering and absorption programs have been developed for nonspherical ice crystals for applications to remote sensing and radiation/climate modeling. We have used the Monte Carlo/geometric-ray-tracing approach to determine the scattering, absorption,
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Summary of Work Performed:

1. 5/5: The Unalaska Public Works Department shipped the monitoring tower and equipment bought for the canceled project there to Nome, so that it could be erected for wind monitoring on Anvil Mountain.

2. 5/10: Steve Blazek (NEPA Compliance Officer) provided a copy of the draft Environmental Assessment to David Lockard (Project Manager) for review. Lockard provided comments by e-mail on 5/18.

3. 5/25: Lockard signed a Purchase Request for consulting services with WecTec Inc. to oversee the installation of two monitoring towers and equipment on Anvil Mountain.

4. 5/31: John Handeland (Director of the Nome Joint Utility System) obtained a permit from the Sitnasuak Native Corporation for temporary installation of the monitoring towers on Anvil Mountain. The utility paid the $3,000 fee for the permit.

5. 6/19-21: Lockard and consultant Ed McCarthy erected two monitoring towers on Anvil Mountain with assistance from utility linesmen. Jim Dory, Assistant City Engineer, agreed to change the data cards on a monthly basis and mail them to Lockard for processing. Several utility workers expressed an interest in the project and received training on collecting data. The Anvil City Science Academy, a local charter school, expressed an interest in using the wind monitoring data for a science project. Lockard attended a Nome Joint Utility Board meeting where he gave a short presentation and answered questions on the proposed project.

6. 7/5: Lockard received 10 days of wind data from the two sites on Anvil Mountain. The 10m anemometer at site #1 showed a 12.7 mph average windspeed for the period, with a S/SW prevailing wind direction. The diurnal windspeed for the period followed the expected utility load profile quite well, with a peak at 2PM and a minimum at midnight.

7. 7/17: Blazek provided an updated draft EA to Lockard for review. Lockard provided review comments on 7/19.