Trace Gas Retrievals Using the Polar Atmospheric Emitted Radiance Interferometer (P-AERI)

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ABSTRACT

The Arctic and Antarctic are expected to experience the most drastic changes in their environments due to climate change. The main increase in the global temperature is attributed to carbon dioxide; however, recent research has shown that the combined effect of trace gases will be to that of CO2.1 It is therefore important to develop a greater understanding of the effects of trace gases and to develop a model to change and to have a well-developed record of trace gas amounts to observe changes. The objective of this research project is to retrieve the amount of trace gases over a three-year period (March 2008 to April 2011) where the Polar Atmospheric Emitted Radiance Interferometer (P-AERI) was at the OPAL facility in Alaska. Namely, for clear sky times only. The P-AERI has a spectrometer range of 350-1,800 cm\(^{-1}\). The instrument will observe the trace gases: CH4, CO2, HCN, NO, NO2, HNO3, and CO. The findings of this project may allow for a better understanding of the pattern changes in the trace gas columns amounts over the time period.

INSTRUMENT

The Polar Atmospheric Emitted Radiance Interferometer (P-AERI), shown in figure 1, is an atmospheric emission radiance interferometer (AERI) that is modified for use in the polar regions. The AERI is a ground-based Fourier-transform infrared (FTIR) spectrometer that passively measures atmospheric emission and was developed by the Space Science and Engineering Center (SSEC) at the University of Wisconsin.2 The P-AERI is modified such that it is able to view the atmosphere and surface at any angle from 0 to 180 degrees. The interferometer, Model MB-100, is manufactured by ABX Bremen Corporation. It has two spectral channels: 1) measure frequencies from 500-1800 cm\(^{-1}\) and channel 2) measure frequencies from 1750-4000 cm\(^{-1}\). The work presented focuses on data from channel 1. The instrument was stationed at the Zero-altitude PEARL Auxiliary Laboratory (ZPAL), as seen in figure 3, in Eureka, Nunavut, Canada (80°N 86°W) from March 2008 to June 2009. Measurements were taken every seven minutes with a resolution of 0.5 cm\(^{-1}\); every minute, even during the polar night.3

METHOD: filtering data

The main focus of this work is the retrieval of trace gas column amounts during clear sky times. The presence of clouds makes the retrieval of trace gas difficult since water vapor results in strong absorption of radiation throughout the spectrum of interest. Clear sky times were determined using the mixed-phase cloud retrieval model MDR-CERA3 output created by Christ Cox which retrieves clear optical depth and water vapor depth through the use of a 0.25 to determine if the instrument was viewing cloud at the time of the spectrum. If the clear sky times the simulated radiance were calculated using the line-by-line radiative transfer model (LBLRTM). Time series are created showing the measured and simulated radiation in microwindows between strong lines, 990 cm\(^{-1}\), 991 cm\(^{-1}\), and 1005 cm\(^{-1}\). Times when the measured radiance was larger than the simulated radiance by 0.8 W/m\(^2\) sr\(^{-1}\) cm\(^{-1}\) or greater, were removed. This criteria was not met at most three atmospheric windows analyzed. Measured radiances much larger than the simulated radiance is the result of large amounts of water in the atmosphere, probably cloud, which should be avoided when possible.

Future work

Future work includes the retrieval of the total column amounts of each of the trace gases listed using both channel one and channel two over the entire time period. Water vapor selected for each trace gas will be refined. Moreover, the results will be compared to those obtained by the PEARL facility in Eureka from October 2008 to April 2009.

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REFERENCES