Abstract: A possibility of measuring water vapor column from diffuse irradiance and the extension of optical retrieval in cloudy days was investigated. The data consist of measurements on the diffuse spectroradiometer (RSS), deployed on the North Slope of Alaska (NSA) site during the winter deployment. The Spectral analysis from 320 to 4000 nm with spectral resolution of 6 nm and 0.01 nm was made every 0.1 degree of solar zenith angle for the entire cycle by the signal of unblocked measurement that must be kept below the detector saturation point. We computed the transmittance at absorption wavelength 760-nm may contain some information about the type of the cloud coverage. In an additional effort to compensate for the effects of varying pathlength with different atmospheric conditions we used the MWR to derive the non-absorbing wavelength of 781-nm to distinguish between degree of overcast.

Discussion: The correlation of 0.97 and 0.95 between MWR and diffuse RSS retrievals using 780nm and 940nm transmittances, respectively, can be considered very good. We speculated that the retrievals with 940nm are slightly better because of the fact that the 940nm photon mean travel a more similar path in the atmosphere than the 780nm photon because of a lower water vapor content in the atmosphere.

The transmittance is partially dependent on solar zenith angles [17, 37, and 56.79° for Fig. 2]. This is because the backscattering of diffuse RSS is performed on non-linear dispersion that is determined at the beginning of the cycle by the model of atmospheric backscattering and must be kept below the detector saturation point. In the reported results the retrieved water vapor column from diffuse irradiance produces a resultant that correlates with water vapor column from the MWR measurement. In other words, one can imagine that parameters of the retrieval method from the diffuse irradiance will be determined by the atmospheric condition, as well as the transmittance measurement at the different wavelengths. Furthermore, we want to emphasize that all the possible improvements suggested in the previous paragraphs would not yield information beyond the RSS-RSS cross correlation.

Figure 1

Figure 2

Figure 3

Figure 4

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Figure 8

Figure 9

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References

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Figure 1. Microwave and RSS direct irradiance retrievals

Figure 2. Diffuse spectrum

Methodology: We try to find a function of diffuse irradiance that predicts the water vapor column retrieved by the MWR. More precisely, we consider only two special elements of the diffuse irradiance at 760-nm to derive the absorption band of 940-nm and 780-nm and the seasonal or geographic effects on the ozone absorption band. The transmittance at absorption wavelength is greatly desensitized to aerosols and radiometric calibration uncertainties. This method of retrieving water vapor column at 760-nm we hope to compensate for the effects of varying pathlength with different atmospheric conditions.

The transmittance at absorption wavelength is given by

\[ T_{\lambda} = \frac{1}{g} \left( \frac{\lambda}{\lambda_{\text{abs}}} \right)^{\frac{1}{a}} \]

where \( T_{\lambda} \) is the transmittance at absorption wavelength. This equation is derived from the Beer-Lambert law and the Beer’s law. The transmittance at absorption wavelength is given by

\[ g(x) = \frac{1}{a} \left( \frac{x}{x+b} \right) \]

where \( x \) is the water vapor column [mm], and \( a \) and \( b \) are the model parameters. The method is particularly useful in cases where the signal-to-noise ratio is low, such as during clear sky days. This error can be reduced by averaging data points or by implementing a change in model function. The sensitivity of the retrieval method from the diffuse irradiance will be determined by the atmospheric condition, as well as the transmittance measurement at the different wavelengths. Furthermore, we want to emphasize that all the possible improvements suggested in the previous paragraphs would not yield information beyond the RSS-RSS cross correlation.