PWV

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ABSTRACT

Keywords: PWV: Precipitable water vapor

1. INTRODUCTION

For millimeter-wavelength observation, atmospheric transparency is limited by a lot of influences. The water vapor is one of the main reasons influencing the observation, which includes the pressure broadening and turbulence from water vapor. The orbitals of an atom can be perturbed in a collision with a neutral atom or by a close encounter involving the electric field of an ion, and the statistical effects of the electric fields of large numbers of closely passing ions are termed pressure broadening.[1] The water molecules in the atmosphere can make absorption radiation attenuate the signal and emission add inherent noise.[2] Water vapor turbulence will increase the effects of time delay on the interferometer. The water vapor will change the index of refraction of air, which leads to the arrival time of the light from the same source being different.

The precipitable water vapor (PWV) is a common way of measuring the water vapor in the atmosphere. The standard definition of PWV is the value of the integrated amount of water vapor that is contained in a vertical column of air extending from the Earth's surface to the top of the atmosphere, typically expressed as the height of the liquid water equivalent.[3] We used the brightness temperature to better represent the PWV influence on the atmosphere transparency. The brightness temperature is another way to specify power per unit solid angle per unit bandwidth in terms of the Rayleigh–Jeans approximation.[4] We used the model from PyRTlib[5] to see all the frequency Brightness Temperature. In practice, we measure the brightness temperature between 170-190 GHz to fit the model and then determine the PWV(use am to show in the future). After that, we can have the overall figure between brightness temperature and all frequencies (1-200 GHz), see Fig. 1.

My work is to calculate the PWV for our model in PyRTlib. The model data is only related to each height layer with the pressure and the molecular densities of water vapor. Using the definition of PWV, I approximate the integral by the trapezoidal rule. Then, taking the integral result over the product of the mass density of liquid water and the acceleration of gravity, we will have the PWV for our data,see Fig. 2.

2. COMPARE PYRTLIB AND AM

PyRTlib is a new independent Python package for non-scattering line-by-line microwave radiative transfer simulations.[5] The advantages of PyRTlib include:

- provides user-friendly Python interfaces
- allows convenient comparison between different models
- gives the T_B results with uncertainty

The limitations include that the code is slow when dealing lot of data, and accuracy of the code is related to the user.

The am package is a tool for optical depth, radiative transfer, and refraction computations involving propagation through the atmosphere and other media at microwave through submillimeter wavelengths.[6]

- Advantages: fast, accurate, open, tested, flexible, and well-documented.
- Limitations: interface is IO based and non-trivial to script. Tied to a detailed configuration format for the model specification.

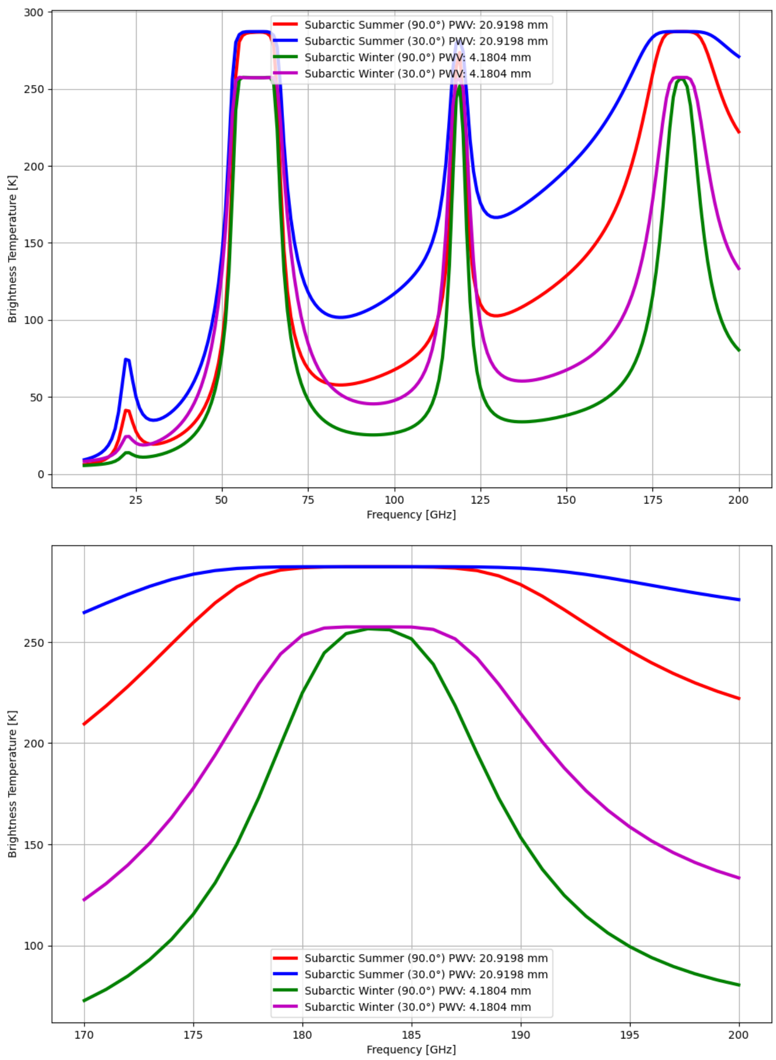

Figure 1. up: 1-200 GHz model, bottom: focus on 170-200 GHz model, which we used for measure the PWV.

REFERENCES

[1] Carroll, B. W. and Ostlie, D. A., [*An Introduction to Modern Astrophysics:*], Cambridge University Press, 2 ed.

[2] Radford, S. J. and Holdaway, M. A., "Atmospheric conditions at a site for submillimeter-wavelength astronomy," **3357**, 486–494. ADS Bibcode: 1998SPIE.3357..486R.

[3] Kelsey, V., Riley, S., and Minschwaner, K., "Atmospheric precipitable water vapor and its correlation with clear-sky infrared temperature observations," **15**(5), 1563–1576. Publisher: Copernicus GmbH.

[4] Condon, J. J. and Ransom, S. M., [*Essential Radio Astronomy*]. Publication Title: Essential Radio Astronomy ADS Bibcode: 2016era..book.....C.

[5] Larosa, S., Cimini, D., Gallucci, D., Nilo, S. T., and Romano, F., "PyRTlib: an educational python-based library for non-scattering atmospheric microwave radiative transfer computations," **17**(5), 2053–2076. Publisher: Copernicus GmbH.

[6] Paine, S., "The am atmospheric model."

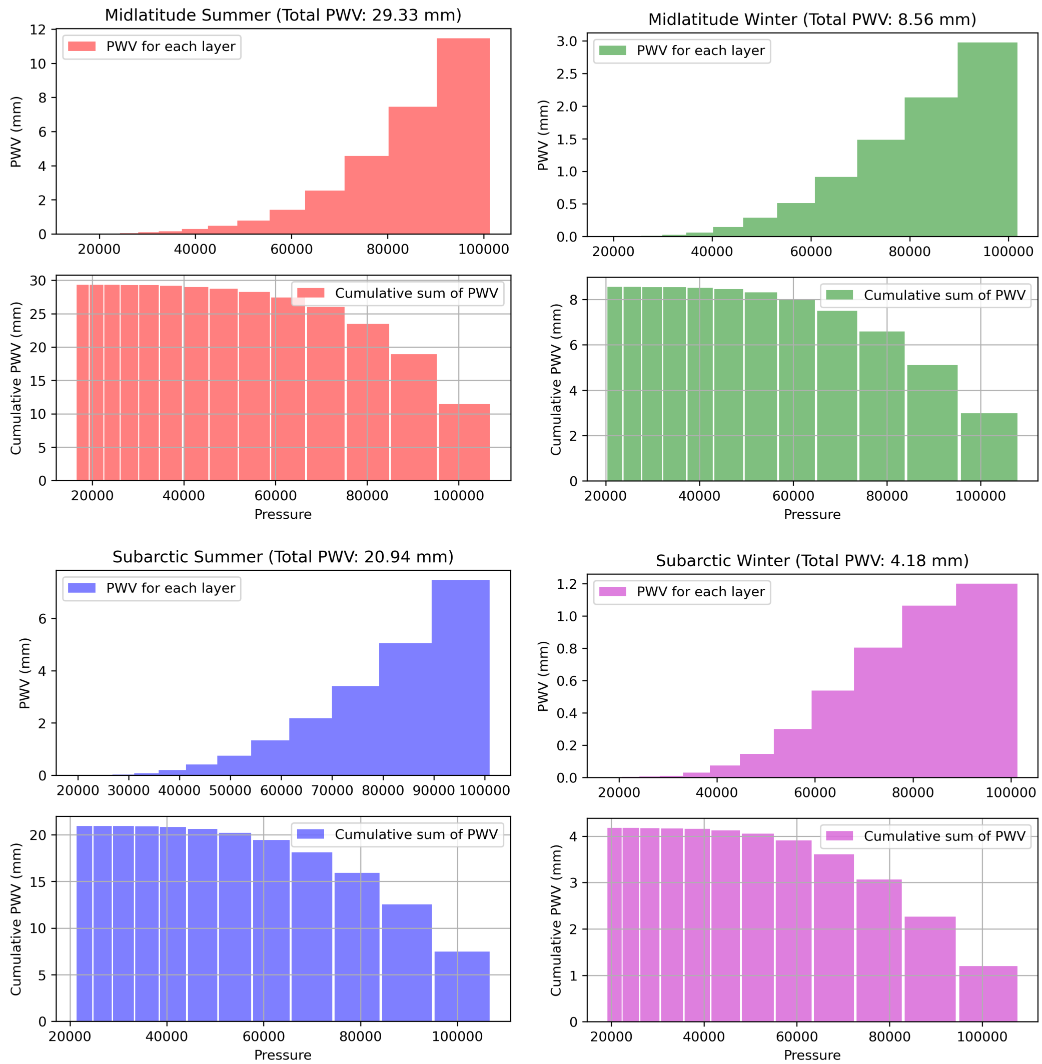

Figure 2. PWV for different model, left up is midlatitude summer, right up is midlatitude winter, left bottom is subarctic summer, right bottom is subarctic winter.