Research on retrieving the profile of slant paths refractivity by Ground-Based Microwave Radiometer

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Abstract

Based on the measurement data by MP 3000A （Ground-Based Microwave Radiometer ）from January 2014 to February 2014 in the QingDao(36.04 °N, 103.8 °N)，China, the azimuth change of bright temperature has been examined. The refractivety profiles are obtained by using the neural network inversion technique. The precision of the inversion technique is much batter. At a fixed elevation it is shown an asymmetry in the variation of bright temperature, so that based on the asymmetry in the variation of bright temperature the inversion refractivity profile existing in the contour line. The value is varied in contour line of refractivity at a fixed elevation with the different azimuth angles. It is shown the asymmetry characteristic of troposphere atmosphere in this experiment.

1. Introduction

Ground-based Microwave radiometer can continuously monitor the atmosphere in real-time in all-weather. It is widely applied in passive remote sensing. Retrievals of atmosphere profiles using neural networks have been reported by Chumside et al. Their neural network inversion of microwave radiometer data is nearly as good as an optimized statistical retrieval in terms of overall RMS error. After that, many algorithms related with ANN (Artificial Neural Network) have been developed [1, 2, 3]. Based upon relevance vector machine (RVM), the technique of retrieving atmospheric profiles including vapor, temperature, and refractivity by ground-based radiometer is developed by Lin et al [4].

The asymmetry characteristic of refractivity is shown in this paper. In this paper, we give the observation of azimuth change based on the bright temperature data from January 2014 to February 2014 observed by MP 3000A Ground-based Microwave radiometer in Qingdao, China.

2. MP 3000A radiometer and measurement data

MP-3000A Profiling Radiometers produce vertical profiles from the surface to 10 km. The MP-3000A produces high-resolution temperature, relative humidity and water vapor profiles, and low-resolution liquid profiles. The MP-3000A of the temperature profiling subsystem utilizes sky brightness temperature observations at selected frequencies between 51 and 59 GHz. The water vapor profiling subsystem utilizes sky brightness temperature observations at selected frequencies between 22 and 30 GHz. The calibrated brightness temperature accuracy is 0.2K [5].

Figure 1 shows an azimuth change in the different frequencies' brightness temperature (MP-3000A measurement data) when the elevation is 15°. The blue line from left to right stand for the MP-3000A Radiometers value of frequencies: 22GHz, 22.234 GHz, 22.5 GHz, 23.000 GHz, 23.034 GHz, 23.500 GHz, 23.834 GHz, 24 GHz,24.5GHz,25 GHz, 25.5 GHz, 26.000 GHz, 26.234 GHz, 26.500 GHz, 27.000 GHz, 27.5 GHz, 28 GHz, 28.5 GHz, 29 GHz, 29.5 GHz, 30 GHz, 51.248 GHz, 51.76 GHz, 52.28 GHz, 52.804 GHz, 53.336 GHz, 53.848 GHz, 54.4 GHz, 54.94 GHz, 55.5 GHz, 56.02 GHz, 56.66 GHz, 57.288 GHz, 57.964 GHz, 58.8 GHz in turn. It shows the brightness temperature has an azimuth change in the allowable of measurement accuracy. The brightness temperature has a sudden big change from 22 to 30 GHz when the azimuth from 100 °

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to 150 ^{o}, and has a sudden diminish from 51.248 to 52.804 GHz when the azimuth from 50 ^{o} to 200 ^{o}. There is cloud in the azimuth from 100 ^{o} to 150 ^{o}, so that it has a sudden big change from 22 to 30 GHz.

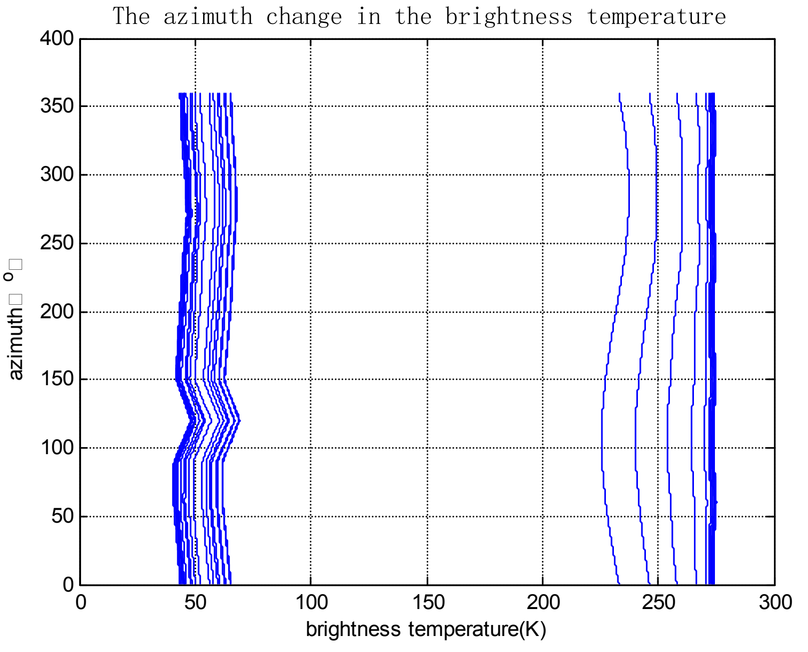

Fig 1 Azimuth change in the different frequencies' brightness temperature

Based on MP-3000A Radiometers measurement data from January 2014 to February 2014 at QingDao，China, At a fixed elevation it is shown an azimuth change in the bright temperature, so that the refractivity profiles are obtained by using the neural network inversion technique and the azimuth change in the bright temperature value. So the inversion refractivity profile existing in the contour line based on the asymmetry in the variation of bright temperature.

3. Results

It used the neural network inversion technique for retrieving the profile of slant paths refractivity by Ground-Based Microwave Radiometer. From figure 2 could obtained the neural network inversion technique precision. Figure 2 calculates the profile of zenith refractivity RMS: the layers average RMS is 1.7781N, the test days Average RMS is 1.8954N. Figure 2 displays the zenith refractivity inversion accuracy less than 2N using the neural network inversion technique. So the precision of the neural network technique is much batter in the allowable of measurement accuracy.

Table 1 the average RMS of elevation at 15^{o}

Azimuth angle	1^{o}	10^{o}	30^{o}	60^{o}	90^{o}	120^{o}	150^{o}	180^{o}
The layers Average RMS	2.2678	1.8728	2.3580	4.2195	5.4525	5.5431	4.2637	2.4424
The test days Average RMS	2.3o98	1.9640	2.3580	4.2195	5.7850	5.8805	4.5083	2.5518

Table 1 gives the value of the sample radio refractivity RMS when azimuth angle is varied and the elevation is 15^{o}. It is shown that the RMS value is bigger when the azimuth angle from1^{o} to 180^{o} than zenith refractivity RMS, and the value varied with parabola.

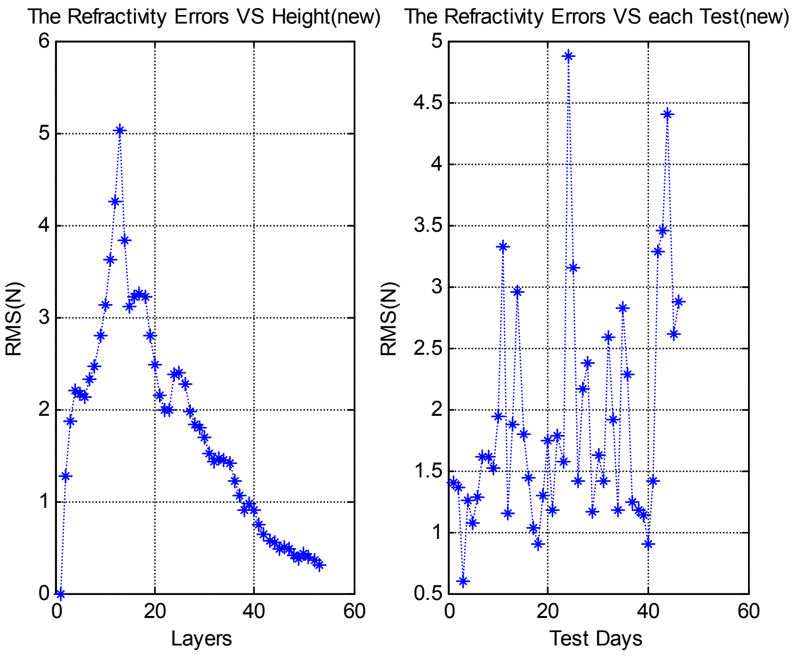

Fig 2 The change of the zenith refractivity profile RMS

The results can prove the asymmetry characteristic of troposphere atmosphere in this experiment. At a fixed elevation it is shown an asymmetry in the variation of brightness temperature existing in the month, so as to the inversion refractivity profile has an asymmetry. Using this can acquire the profile of slant paths refractivity.

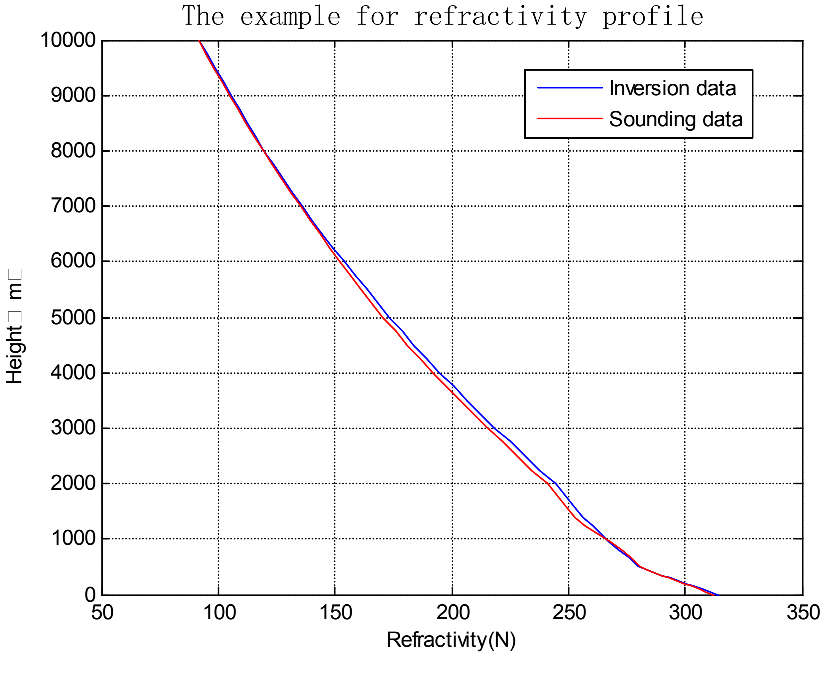

Fig 3 Example of radio refractivity profile when the azimuth angle is 180 ^{o} and the elevation is 15^{o}

Figure 3 displays one example of radio refractivity profile when the azimuth angle is 180^{o} and the elevation is 15^{o}. It is shown that the inversion refractivity profile is similar to the sounding refractivity profile. Figure 4 displays one example of radio refractivity contour map when the azimuth angle is 0^{o}--360^{o} and the elevation is 15^{o}. Which shown that all the refractivity value's variety when the azimuth angle 360^{o} range form up to down scans .

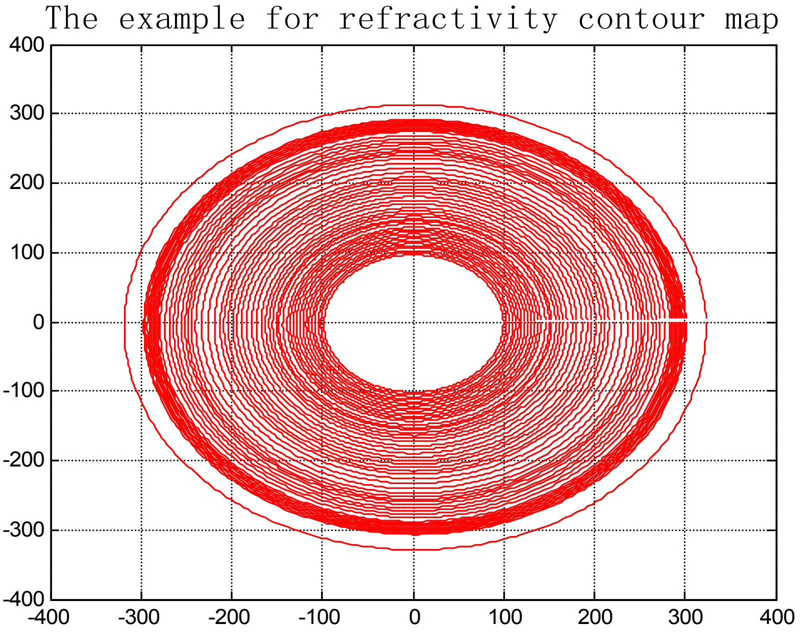

Fig 4 Example of radio refractivity contour map when the azimuth angle is 0^{o}--360^{o} and the elevation is 15^{o}

4. Conclusion

In this paper, based on MP-3000A Microwave radiometer data from January 2014 to February 2014 at the QingDao China, the azimuth change of brightness temperature in the QingDao of China has been examined. It is shown the asymmetry characteristic of troposphere atmosphere in this experiment. At a fixed elevation it is shown an asymmetry in the variation of refractivity existing in the contour line. The value is varied in contour line of refractivity at a fixed elevation because of the dissimilarity azimuth angles. Using this can acquire the profile of slant paths refractivity.

5. Acknowledgments

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