# IMPACT OF TERRAIN TOPOGRAPHY ON RETRIEVAL OF SNOW WATER EQUIVALENCE USING PASSIVE MICROWAVE REMOTE SENSING

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## 1. INTRODUCTION

Passive Microwave remote sensing has ability to obtain the snow information of a certain depth. Therefore it can be used to retrieve Snow Water Equivalent (SWE) on land surface. The mountainous terrain can impact passive microwave brightness temperature by changing the satellite observation geometry and interactive radiation between terrains. Kerr et al. (2003) simulate the influence of different incidence angle using a semi-empirical model. Guo Ying et al. (2009) proposed a terrain correction algorithm of passive microwave remote sensing of soil moisture, considering the variation of local incidence angle, polarization rotation and shadow effect caused by different terrain surface. The linear relationship between brightness temperature difference at 18.7 GHz and 36.5 GHz and snow depth has been commonly used in most of SWE retrieval algorithms. A.B. Tait(1998) thought that complex mountainous terrain might cause a dramatic potential sources of error in the estimation of SWE from passive microwave radiation. So it is necessary to evaluate the influence of the terrain on passive microwave brightness temperature at 36.5GHz and 18.7GHz. Hence we chose the terrain correction method developed by Guo et al, (2009) to evaluate the impact of terrain on AMSR-E baseline SWE retrieval algorithm (Chang et al., 1987). Further, the influence of the terrain on the precision of SWE is investigated in this study.

## 2. METHODS

The desending data on January, 2, 2009 of AMSR-E Level 2A was selected. And Guo Ying 's terrain correction algorithm was used to calculate the brightness temperature of vertical polarization and horizontal channels respectively at 18.7GHz and 36.5GHz.The Guo Ying's terrain correction formulas are as following :

$$T_{Bv}(\theta) = T_{Bvl}(\bar{\theta}_l)\cos^2|\bar{\varphi}| + T_{Bhl}(\bar{\theta}_l)\sin^2|\bar{\varphi}| \quad (1)$$

$$T_{Bh}(\theta) = T_{Bvl}(\bar{\theta}_l)\sin^2|\bar{\varphi}| + T_{Bhl}(\bar{\theta}_l)\cos^2|\bar{\varphi}| \quad (2)$$

$$T_{Bv}(\bar{\theta}_l) = \frac{\cos^2|\bar{\varphi}| \cdot T_{Bv}(\theta) - \sin^2|\bar{\varphi}| \cdot T_{Bh}(\theta)}{\cos^2|\bar{\varphi}| - \sin^2|\bar{\varphi}|} \quad (3)$$

$$T_{Bh}(\bar{\theta}_l) = \frac{\cos^2|\bar{\varphi}| \cdot T_{Bh}(\theta) - \sin^2|\bar{\varphi}| \cdot T_{Bv}(\theta)}{\cos^2|\bar{\varphi}| - \sin^2|\bar{\varphi}|} \quad (4)$$

Where $\bar{\theta}_l$ is the local incidence angle and $|\bar{\varphi}|$ is the absolute value of the average of the polarization rotation angle.

The impact of topography on microwave brightness temperature at the global scale was analyzed. Then, the current SWE algorithm based on Statistical model was used to estimate the influence of the terrain on the precision of SWE via four kinds of the polarization difference of different polarization combinations at 18.7GHz and 36.5GHz .And the polarization combinations, which are more suitable for retrieving SWE in the mountains, were found out.

## 3. RESULTS

The result of the difference before and after terrain correction: Vertical polarization channels are apt to be greater than zero. The maximum difference at 18.7GHz is up to +14K.While horizontal polarization channels to be less than zero. The maximum difference at 36.7 is up to -12K.At the same frequency in different polarization, the impact of topography on the brightness temperature has the opposite pattern. Fig.1, 2, 3 and 4 show the histograms of the difference before and after terrain correction at 18.7GHz and 36.7GHz with different polarizations.

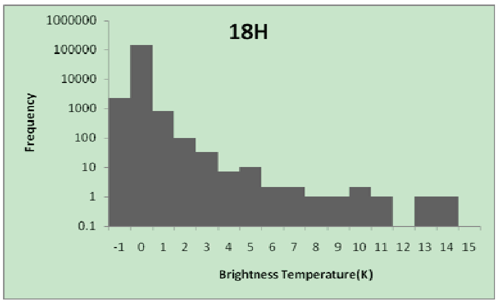


Fig.1 18.7GHz H polarization histogram

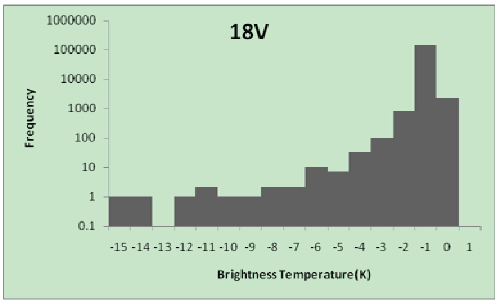


Fig.2 18.7GHz V polarization histogram

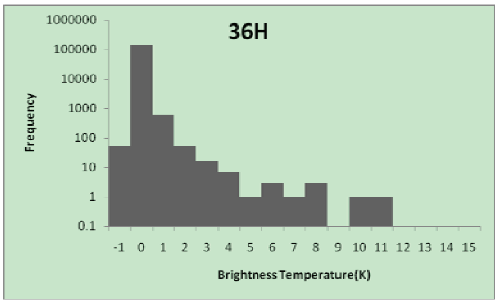


Fig.3 36.5GHz H polarization histogram

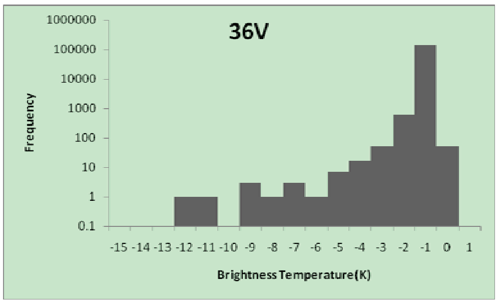


Fig.4 36.5GHz V polarization histogram

At 18.7GHz and 36.5GHz, according to different polarization combinations, the high-frequency subtract from low-frequency. The results are as the following.

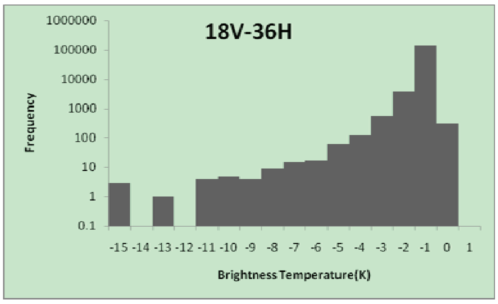


Fig.5 18V-36H histogram

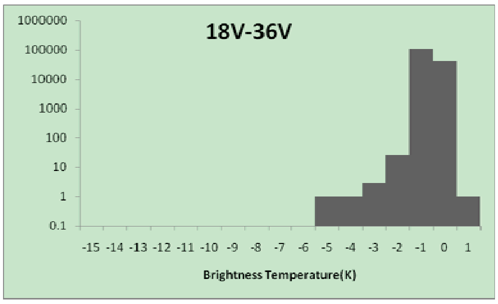


Fig.6 18V-36V histogram

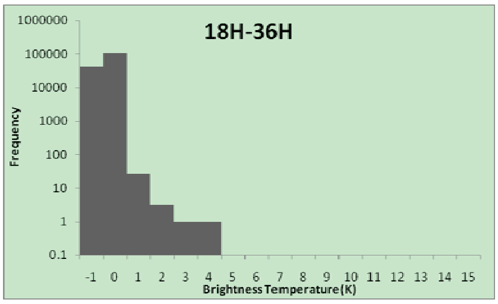


Fig.7 18H-36H histogram

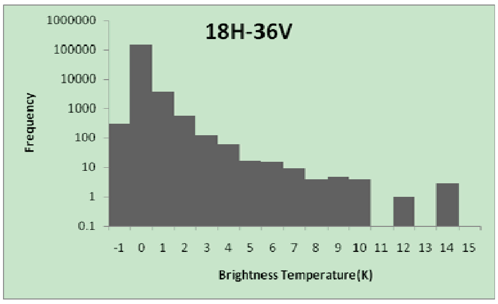


Fig.8 18H-36V histogram

- The result of the difference of the same polarization is that the Brightness Temperature value obviously narrow down, as is shown in Fig.6 and Fig.7. So the same polarization difference reduce the impact of the terrain factor when retrieving SWE.
- The result of the difference of the different polarization is that the Brightness Temperature value increase, as is shown in Fig.5 and Fig.8.So the different polarization differences enhance the impact of the terrain factor when retrieving SWE.

## 4. CONCLUSIONS AND DISCUSSIONS

From a global perspective, the influence of the terrain on the Passive Microwave Brightness Temperature is similar at 18.7 GHz and 36.5GHz.The vertical polarization channels are apt to be greater than zero while the horizontal ones to be less than zero.

Considering the impact of terrain and retrieving SWE at 36.5 GHz channel and 18.7GHz channel, the difference of the same polarization can offset the impact of the terrain partly, while the difference of the different polarization can enlarge the influence of the terrain. So, the polarization differences of the same polarizations are better frequency combination comparing to the polarization differences of the different polarizations.

Nevertheless, the value of most of the brightness temperature is less than 2K. So according to the result of Guo Ying ‘s terrain correction algorithm, the impact of the terrain on the retrieval of SWE is almost ignorable using current SWE retrieval algorithms. But several measurements express that the terrain have important influence on the error of the estimation of SWE. And the reasons may as following: scale effect in over coarse resolution; to describe the influence of the terrain, it may be insufficient of just taking account of local incidence angle, polarization rotation and shadow effect, so it is necessary to do some further study on the influence of the terrain.

## 5. REFERENCES

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