IMPROVED SNOW DEPTH RETRIEVAL ALGORITHM IN CHINA AREA USING PASSIVE MICROWAVE REMOTE SENSING DATA

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1. INTRODUCTION

Information on the snow cover is very needed in hydrological, numerical weather prediction, climate models and in a large number of other environmental applications. Snow depth (SD) is important input parameter for snow cover hydrologic model and climate model. There are many methods [1][2][3][4]of estimating snow depth, which are mostly based on the relationship between snow depth and difference of 18 GHz and 36 GHz horizontally polarized brightness temperature, for example, the popular algorithm of AMSR-E snow cover product is based on the above relationship. But in china area, by compared the retrieval SWE using algorithm of AMSR-E product with the measurements by meteorological stations [5], we found the AMSR-E products overestimated the snow volume in western china, and the estimated retrieval error was great. So we need to improve the snow depth or snow water equivalent retrieval accuracy in order to meet the demand of national and provincial water resource and agricultural agencies, hydropower companies, and meteorological forecast offices, to support their operational activities.

2. DATA

In the paper, we used the data sets: (1) the passive microwave passive brightness temperatures (Tb) [6] from 2002 to 2008 used in this study were measured by The Advanced Microwave Scanning Radiometer Earth Observing System (AMSR-E), which has a better performance in configuration than the former microwave radiometers like SMMR or SSM/I. And MYD10C2 8 Day snow cover data were used, MYD10C2 products were selected for this study since the products is less effected by cloud. (2) Snow depth measurements and land surface temperature in each station were acquired by meteorological station in china snow area. (3) Ancillary data sets which include IGBP classification map [7], MOD12Q1 V004 vegetation coverage and MODIS NDVI products MYD13A2 were required. Ancillary data was used to observe the forest cover and eliminate the disturbing factor like surface water body in the study area.

3. RETRIEVAL METHOD

There are two aspects to successful snow cover retrieval from space using passive microwave radiometers. First, the snowpack must be detected and second it must be quantified in terms of its snow depth. When viewed using passive microwave radiometers from above the snowpack, the scattering of upwelling radiation depresses the brightness temperature of the snow at increasingly high frequencies. This scattering behavior of snow can be exploited to detect the presence of snow on the ground. So we need find the better relations between the snow depth and Tb, in china snow area, we found that the land cover is sensitive to SD retrieval algorithm and the snow cover fraction(f_{snow}) can improve the retrieval precision. Most empirical algorithms use a spectral difference between the 19GHz and 36GHz to estimate SD, in the paper we added the

89GHz to new algorithm because the 89GHz is sensitive to shallow snow，considering distributing massive shallow snow in china area.

So we can express the new empirical algorithms, per-grid cell SD estimates value was produced as the sum of the SD values obtained from each land cover algorithm weighted by the percentage land cover type (f) within each grid cell:

$$SD = f_{forest} * SD(forest) + f_{shrub} * SD(shrub) + f_{grass} * SD(grass) + f_{barren} * SD(barren) \quad (SD>=5cm)$$

$$SD(forest) = 1.381 + 1.107 * f_{snow} * (t18h - t36h) + 2.807 * (t89v - t89h)$$
$$SD(shrub) = 3.696 + 0.173 * f_{snow} * (t36v - t36h) + 0.014 * (t89v - t89h)$$
$$SD(grass) = 6.495 + 0.531 * f_{snow} * (t18h - t36h) + 0.116 * (t89v - t89h)$$
$$SD(barren) = 2.990 + 0.417 * f_{snow} * (t18v - t36v) + 0.364 * (t89v - t89h)$$

Where f_{forest} represents forest cover fractions, f_{shrub} for shrub cover fractions, f_{grass} for grass cover fractions and f_{barren} for barren cover fractions in per-gird cell by determined form the International Geosphere-Biosphere Programme (IGBP)1 km global land cover classification; and f_{snow} for the snow cover fractions. The new algorithm was developed in snow depth of meteorological station with larger than 5cm, because the shallow snow can not be detected by the passive microwave radiometers [8].

4. RESULTS AND DISCUSSION

Compared records of snow depth by the meteorological station in 2003 with measure data and estimation value by the new algorithm and AMSR-E algorithm, we worked out that the RMSE of snow depth retrieved by the new algorithm is 5.1cm, which less than RMSE of snow depth got by the AMSR-E products (the snow depth is calculated by the AMSR-E snow products (snow water equivalent) and snow density) with 17.8cm. The results suggest that the retrieval accuracy was improved, and the new algorithm can retrieve the snow depth of china area accurately, but there was the larger error in Tibetan plateau, which is probably caused by the topography, patched snow, the frozen soil and so on. So we need to study further to improve the SD retrieval accuracy of Tibetan plateau, and whether the new algorithm is suit for other countries, which is also in need of researching in the future.

5. REFERENCES

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