EVALUATION OF THE ATMOSPHERE INFLUENCE TO *AMSR-E* MEASUREMENTS OVER SNOW-COVERED AREA USING BELOW-ATMOSPHERE REFERENCE MEASUREMENTS AND IN-SITU DATA IN SODANKYLÄ, FINLAND

Yubao Qiu[1,6], *Jiancheng Shi*[2], *Juha Lemmetyinen*[3], *Anna Kontu*[3], *Jouni Pulliainen*[3], *James R. Wang*[4], *Lingmei Jiang*[5], *Martti Hallikainen*[6], *Li Zhang*[1] *and Huadong Guo* [1]

[1)] Center for Earth Observation and Digital Earth, Chinese Academy of Sciences, Beijing 100190, China (e-mail ybqiu@irsa.ac.cn)

[2)] Institute for Computational Earth System Science, University of California, Santa Barbara, CA 93106-3060, USA

[3)] Finnish Meteorological Institute (FMI), Arctic Research Centre, Tähteläntie 62, FI-99600 Sodänkylä, Finland

[4)] School of Geography, Beijing Normal University, Beijing 100875, China

[5)] NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA

[6)] Department of Radio Science and Engineering, Helsinki University of Technology, FIN-02015 TKK, Finland

Global satellite microwave observation, ongoing for decades, provides spatial distribution of quantities like evapotranspiration, soil moisture, snow water equivalent (SWE), and precipitation (snow/rain) on scales applicable to weather forecast, hydrological and climatic models. With the global warming trend, passive microwave measurement plays a significant role in the global environment and climate research work.

Usually, considering earth microwave remote sensing of snow parameters, the effect of the atmospheric influence is generally considered small on the microwave band, especially in the current AMSR-E frequencies configuration of 6.9-, 10.7-, 18.7-, 23.8-, 36.5- and 89.0GHz. However, the sky brightness temperature is a function of frequency sensitive to parameters such as water vapor content, liquid water (cloud and precipitation), oxygen, hydrometeors and atmospheric temperature. With the increasing frequency, the atmospheric contribution becomes more important.

In the past years, many studies also have paid attention to the atmosphere influence in snow parameters retrievals, such as Pulliainen, J. and Hallikainen (1993, 2001), and Wang, J.R. (2003). These all considered the atmosphere as an attenuation or emission source that could influence the retrieval accuracy quantitatively or qualitatively. Wang, J.R. (2006, 2007) studied the atmosphere influence on the *SWE* retrieval using the *in-situ* atmosphere profiles quantitatively in two American experiment sites. J.R. Wang's result shows that the atmospheric influence in the retrieval of SWE is significant even during clear-sky conditions. Qiu and Shi's work (2007) indicated a disagreement between the satellite soil moisture and precipitation estimations. Correcting the operational retrieval algorithm based on this study is a subject of further study.

In this paper, we investigate the atmosphere influence to the AMSR-E radiometers quantitatively over the snow covered area in winter time, and also validate the HUT Snow Emission model in different atmosphere conditions. A 13-day experimental measurement with the HUTRAD (Helsinki University of Technology Radiometer) radiometer has been done in Sodankylä, Finland, where snow depth is typically more than 50 cm. An extensive in-situ dataset, including atmosphere balloon radio sonde data, were collected during the campaign.

Firstly, using snow emissivity simulation of the HUT model, the simulated atmosphere influence with different six clear-sky atmosphere models with different integrated water contents (2.5~6.5g/cm^2) shows that the atmosphere influence at 6.9- and 10.7- GHz could be ignored at any snow depth (the simulated SD<120cm), while the atmosphere is a non-negligible absorber and emitter of microwave radiation at frequencies higher than 18.7 GHz. Different cloud condition simulations show that the linear correlation between SWE and the difference between 18.7GHz and 36.5GHz is totally distorted by atmospheric influence.

Secondly, a comparison between the HUT Snow Emission model and semi-empirical parameters from actual balloon sounding data calculations show some discrepancy. The HUT Snow Emission model's parameterization of atmosphere contribution is more than that calculated from PUT balloon data. Especially in the high frequencies, for example 36.0GHz, the HUT models's atmosphere contribution is up to 90K, while using the standard atmosphere models (six atmosphere models: sub-summer, sub-winter, mid-summer, mid winter and tropic, and US62 atmosphere model), it is no more than 32K～39K. It could be explained by the calculation comparison that the transmissivity in HUT Snow Emission model is lower than that of the actual atmosphere data calculation with the updated model, which will be the main point that should be deeply studied. The time series atmosphere contributions between the experimental time 03/03/2008 and 13/03/2008 are variational.

This study drives the updating of the HUT model with the updated atmosphere model and the parameterization work of the atmospheric correction when dealing with the different time and space over 20 cm snow depth.

This work is also related to the validation of the HUT Snow Emission model in Sodankylä experiment and Finland sub-arc airborne experiments in winters of 2005 and 2006.

References:

[1] Pulliainen, J., Grandell, J., Hallikainen, M., “HUT snow emission model and its applicability to snow water equivalent retrieval”. IEEE Transactions on Geoscience and Remote Sensing, vol. 37, no. 3, pp. 1378-1390, 1999.

[2] Wang, J.R., and M. Tedesco，“Identification of atmospheric influences on the estimation of snow water equivalent from AMSR-E measurements”, Remote Sens. Environ., 111, 398-408, 2007

[3] Hallikainen, M., “Retrieval of snow water equivalent from Nimbus-7 SMMR data: Effect of land-cover categories and weather conditions”. IEEE Journal of Oceanic Engineering, vol. OE-9, no. 5, pp. 372-376, December 1984.

[4] Yubao Qiu, Jiancheng Shi, Lingmei Jiang, Kebiao Mao, “Study of Atmospheric effects on AMSR-E microwave brightness temperature over Tibetan Plateau”, Geoscience and Remote Sensing Symposium, 2007. IGARSS 2007. 1873-1876, 2007