DEVELOPMENT OF GLOBAL LAND SURFACE EMISSIVITY MAP AT AMSR-E PASSIVE MICROWAVE FREQUENCIES

Hamidreza Norouzi*, Marouane Temimi, and Reza Khanbilvardi
The City University of New York, City College, NOAA-CREST, 140 street @ convent avenue, New York City, New York, 10031, USA
*Email: hnorouzi@gc.cuny.edu

Microwave emissivity over ocean is relatively well understood by scientists. However, over land because of the existence of different land covers and their various physical properties land surface emissivity retrieval does not seem to be straightforward. Land emissivity plays a key role in Numerical Weather Prediction (NWP) models, since it acts like a crucial boundary condition. The accuracy of prediction of this parameter will mitigate the impact of cloud liquid water in retrieving air temperature, water vapor, and surface temperature. Land emissivity also can be used as an indicator of soil moisture and land use/land cover variation especially in presence of clouds, since microwave emissions can penetrate clouds.

The objective of this study is to develop global land emissivity maps using AMSR-E passive microwave observations at different frequencies along with several ancillary data. The International Satellite Cloud Climatology Project (ISCCP) (Rossow et al, 1999) database has been used to obtain several inputs for the proposed approach such as land surface temperature and cloud mask. These datasets have 3 hourly temporal resolution and about 30 km spatial resolution. Additional ancillary data such as TOVS water vapor amount and atmospheric temperature profile have been also used to assess the atmospheric contribution. In this study, first, simple experimental equations were used to calculate the atmospheric correction parameters at 19 and 37 GHZ (Choudury 1993), and for 10.7 and 6.9 GHz no atmospheric correction was considered. Although it is well known that the correction of the atmospheric effect is solely required at higher frequencies (over 19 GHz), our results have shown that a correction at 10.7 GHz is also necessary. In order to systematically correct for the atmospheric contribution at different frequencies, the Community Radiative Transfer Model (CRTM) (Yong Han et al., 2006) will ultimately be used to estimate upwelling and downwelling atmospheric contributions. CRTM has already been implemented and tested.

The proposed approach in this study is based on three main steps. First, all necessary data have been collected and processed i.e. reprojection to 25 km equal area map and cloud mask application. Second, instantaneous global land emissivities are determined using AMSR-E ascending and descending images and several ancillary data (i.e. land surface temperature, water vapor, air temperature, etc.). Finally, monthly compositing of emissivity maps has been performed to eliminate gaps generated by cloud-covered areas where surface temperature is not available. AMSR- E frequencies at 6.9, 10.7, 18.7, 36.5, and 89.0 GHz have been used to retrieve the instantaneous emissivity. Water vapor information produced by ISCCP (TOVS data) was used to calculate upwelling, downwelling temperatures, and atmospheric transmission. In addition, NCEP atmospheric data (Kalnay et al, 1996) has also been used in the retrieval process for comparison purposes. The frequent determination of the land surface temperature (LST) (8 times a day) in the ISCCP database has allowed for the assessment of the diurnal cycle effect on emissivity retrieval. A difference in magnitude and phase between thermal temperature and microwave brightness temperature has been noticed. Prigent et al (1999) have already addressed this issue over desert areas and attributed it to the difference in penetration depths between thermal and microwave radiation. The proposed methodology for emissivity retrieval expands the investigation of this difference between LST and microwave brightness temperature to a global scale. Moreover, additional factors such as topography, soil wetness and vegetation cover will be examined. The advantage of AMSR-E low frequencies (6.9, 10.7 GHz) is their sensitivity to subsurface physical soil properties because of their relatively high penetration depth.

Preliminary land emissivity maps have been developed at the AMSR-E frequencies for a year (2003). A sample of results has been shown in figure (1). At lower frequencies the RFI issue has been addressed. The differences between daytime and nighttime emissivity as well as differences in retrieved emissivities from different frequencies will be studied.

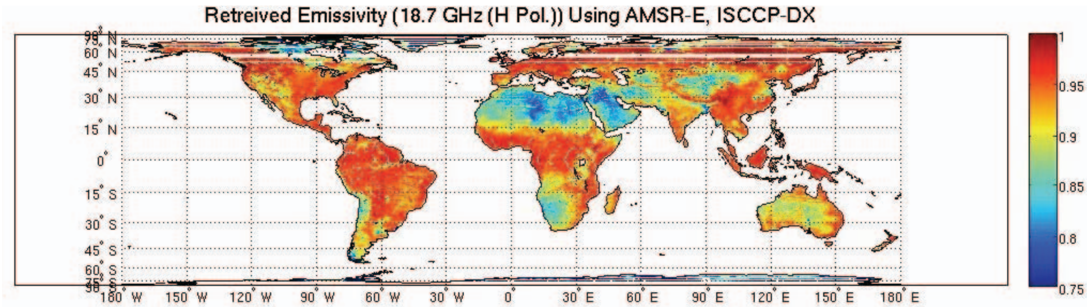

Figure 1: Retrieved emissivity for AMSR-E at 18.7 GHz H polarization using ISCCP-DX data as skin temperature, July 2003.

Additionally, the potential of extrapolating the obtained land emissivity maps to different window and sounding channels is being investigated in this study. At this stage of the project the developed emissivity maps have been validated qualitatively by comparing the developed emissivity maps at the AMSR-E frequencies to the global land use distribution. The reliability of the obtained product will be quantitatively assessed by comparing it to land emissivity data from SSM/I (Prigent et al, 1997 and 2006) and also NOAA/NESIDIS/STAR product, which derived from multiple platforms (SSM/I, AMSU and Windsat) through a data assimilation process.

References

- Choudhury, B.J. (1993). Reflectivities of selected land surface types at 19 and 37 Ghz from SSM/I observations. *Remote Sensing of Environment, 46*, 1

- Kalnay, E., and Coauthors, 1996: The NCEP/NCAR 40-Year Reanalysis Project. Bull. Amer. Meteor. Soc., 77, 437–470.

- Prigent, C., W. B. Rossow, and E. Matthews, 1997: Microwave land surface emissivities estimated from SSM/I observations. J. Geophys. Res., 102, 21 867–21 890.

- Prigent, C., W.B. Rossow, E. Matthews, and B. Marticorena, 1999: Microwave radiometric signatures of different surface types in deserts. J. Geophys. Res., 104, 12147-12158, doi:10.1029/1999JD900153.

- Prigent, C., F. Aires, and W.B. Rossow, 2006: Land surface microwave emissivities over the globe for a decade. *Bull. Amer. Meteorol. Soc.*, **87**, 1573-1584, doi:10.1175/BAMS-87-11-1573.

- Rossow, W. B., and R. A. Schiffer, 1999: Advances in understanding clouds from ISCCP. Bull. Amer. Meteor. Soc., 80, 2261–2287.

- Weng, F., B. Yan, and N. C. Grody, 2001: A microwave land emissivity model. J. Geophys. Res., 106, 20 115–20 123.

- Yong Han, Paul van Delst, Quanhua Liu, Fuzhong Weng, Banghua Yan, Russ Treadon and John Derber, 2006: JCSDA Community Radiative Transfer Model (CRTM) - Version 1, *NOAA Tech Report 122*.