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The Variation in Soil Temperature and its Effects on the Movement of Water Vapor in the Surface Zone

Yijian Zeng1, 2**, Li Wan**1**, Zhongbo Su**2**, Kangle Huang**1**, Xusheng Wang**1

1. School of Water Resources and the Environment Science, China University of Geosciences, Beijing 100083, China

2. International Institute for Geo-information Science and Earth Observation, Enschede, The Netherlands

In desert and semi-desert areas, water content in the unsaturated zone comes not only from atmospheric precipitation, but also from condensation of water vapor. Due to limited precipitation, condensation plays an important role in maintaining vegetation and the ecology in such areas. In order to understand the continuous process of vapor transport in top soil layer (between 10cm∼30cm below surface), an experiment with controlled conditions was conducted in an outdoor sand bunker. Micro-meteorological variables (such as wind speed, air humidity and air temperature) in the near-surface air, ground surface temperature, soil temperature, soil water content and matrix suction at different depths in the soil were observed hourly. To reduce uncertainty of the measurement of soil water content, in situ method was employed to monitor soil moisture variation instead of using traditional gravimetric method. A Fourier progression type equation of temperature wave based on the heat transport equation was derived to predict the response of temperature at variable depths to ground surface condition. The comparison of calculated temperature with measured temperature shows that the temperature wave equation reflects the thermal regime of soil very well. Besides, according to the temperature wave equation, the reference depth at which we should measured soil temperature in a filed experiment was determined. Furthermore, through analysis of the correlation between soil temperature and changes of soil moisture, we found that temperature gradient played a dominant role in vapor transport in top soil layer (10cm∼30cm below surface). The observation also revealed consistently that

moisture content in the measurement range soil increased and decreased while temperature gradient was downward and upward, respectively. At last, the analysis of the mechanism of vapor transport in the depth from 5cm to 30cm indicated that the development of condensation water in vadose zone is controlled by diurnal soil temperature variation.