TOWARDS MULTI-INCIDENCE ANGLE PASSIVE MICROWAVE RETRIEVAL OF SOIL MOISTURE

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1. INTRODUCTION

The first dedicated satellite for soil moisture measurement, known as the Soil Moisture and Ocean Salinity (SMOS) Earth Explorer mission, was launched by the European Space Agency in November 2009. One novel aspect of this innovative spaceborne sensor is utilization of the multi-incidence angle observations for soil moisture retrieval [2]. Previous studies have shown that there are significant incidence angle dependencies of land surface variables on the measured brightness temperature [1, 4-8]. These relationships can be utilized to estimate some of the soil moisture retrieval parameters such as vegetation index and surface roughness parameter and thus, resulting in a more accurate retrieval. However, due to the absence of comparable spaceborne products, multi-incidence angle retrieval algorithms such as L-MEB (L-band Microwave Emission of the Biosphere; [9]) have been basically developed from synthetic simulations and high-resolution data from towers, with the modelling of incidence angle relationships based on only a subset of the possible land surface conditions. Consequently, the derived relationships and model interactions between land surface variables and observed brightness temperature response need to be verified at larger spatial scales and extended for a wider range of land surface conditions.

2. METHODOLOGY

This paper investigates the relationship between soil moisture and observed passive microwave emission at multiple incidence angles, using L-band airborne data from recent field experiments in Australia, conducted under the scope of the NAFE campaign (National Airborne Field Experiment) in 2005 [3]. A forward radiobrightness model is used to predict the brightness temperature response for a range of incidence angles, given inputs of ground measured soil moisture, soil temperature and vegetation characteristics. The simulations are made across a range of locations with wheat cover and multiple dates, representing significant variability in ground conditions. Subsequently, the forward-simulated response is compared with the airborne L-band brightness temperature observations using i) default sets

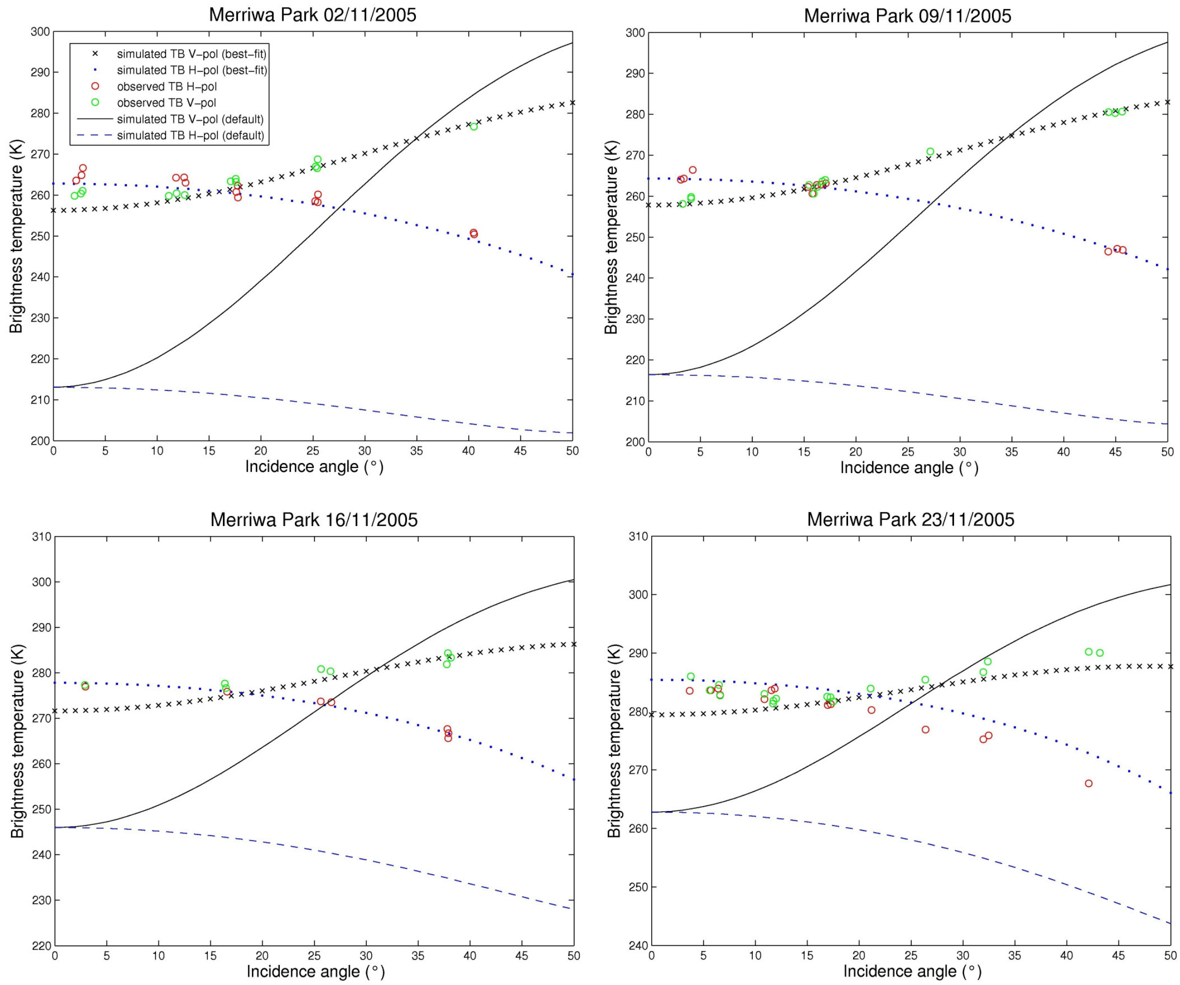

Figure 1: Comparison of forward model results against observed airborne brightness temperature measurements (circles) for different soil moisture conditions at Merriwa Park. The model outputs were derived from i) ground measured data with default parameters (solid/dashed line) and ii) ground measured data with calibrated model parameters on observed data from the 9th of November (stars/dotted line).

of L-MEB parameters given by Wigneron et al. [9] and ii) on-site calibrated retrieval parameters using airborne observed data from the 9th of November. Based on the derived model results, the utility of multi incidence angle soil moisture retrieval is assessed.

3. RESULTS AND DISCUSSION

The forward model results are derived from the default L-MEB parameters and ground measured data including soil moisture, soil temperature, soil texture and vegetation water content. The angular dependency modelled with the parameters for wheat cover found by Wigneron et al. [9] differs significantly from the observed brightness temperature signal in airborne data. The simulated radiobrightness is much lower than the actual measured values and does not seem to capture the angular related polarization mixing effect between the vertically and the horizontally polarized microwave response. Especially, within the range of low incidence angles (less than 10 degrees) both polarization curves show a temperature difference of up to 50K compared to the measured signal. While this difference decreases significantly with increasing incidence angle for the vertically polarized microwave response, the predicted horizontally polarized microwave trend still underestimates the measured signal by at least 30K when using default parameters. The overall model performance is improved by calibrating parameters on vegetation spectral properties and the roughness components to the observed data. Calibrated model parameters from the 9th of Novermber 2005 are subsequently tested on different soil moisture conditions and locations in order to test their robustness.

4. REFERENCES

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