Hydrology and Earth System Sciences Discussions

Interactive comment on "Improved spatial mapping of leaf area index using hyperspectral remote sensing for hydrological applications with a particular focus on canopy interception" *by* H. H. Bulcock and G. P. W. Jewitt

H. H. Bulcock and G. P. W. Jewitt

204501831@ukzn.ac.za

Referee 1 (M. Gerrits)

Remove "Improved" from the title. (i.e. Spatial mapping of leaf area index using hyperspectral remote sensing for hydrological applications with a particular focus on canopy interception).

P5784 L1-2: The first sentence in the abstract "The use of remote sensing. . ." has

been moved to P5784 L7. The abstract now starts with "The establishment of. . ." as suggested by the referee.

P5785 L12-13: We agree with this suggestion. It certainly is more consistent with the rest of the document and has been corrected.

P5785 L14: Additional references have been added. These include the ACRU model (Schulze, 1995), the 3PG model (Landsberg and Waring, 1997) and SIMPLE model (Hörmann, 2007).

P5786 L5: We disagree with changing "providing" to "provide".

P5786 L11: Thank you. This is a good point. The sentence has been changed to: "Current tools to assess water use by commercial afforestation tend to focus on total evaporation and are limited in their consideration of interception from forest canopies as a separate process."

P5787 L4: The spelling error has been corrected (Savenjie => Savenije)

P5879 Eq1: The unit for "S" has been added (mm)

P5787 L21: The sentence has been corrected as recommended. i.e. . . .a measure which is determined by the LAI. . .

P5788 L4: "co-efficient" has been changed to "coefficient".

P5788 Eq3: there isn't an equation for LAI<2.7. The reason the equation was included in the paper is to illustrate that LAI is an important parameter in enhanced wet canopy evaporation and therefore canopy interception.

P5788 L16: the unit for evaporation is mm.day-1.

P5788 L22: Although I agree that rainfall pattern is important in interception, the statement is intended to highlight that these are parameters that are all dependant on LAI, whereas rainfall pattern is not. This statement has been amended to be more clear.

P5788 Eq4: You are correct in saying that the equation does imply that even when there is no rain, there is interception. When using this equation, it would have to be programmed so that when there is no rainfall, there is no interception.

P5789 L5-6: The reason for specifically mentioning the ACRU model, is because it is the only hydrological model that we know of that uses the Von Hoyningen-Huene equation to estimate canopy interception.

P5789 L12: the comma has been removed from 800,mm to 800 mm.

P5790 L10: remote mode..."respectively" changed to ...simultaneously. We are not sure what is unclear about this paragraph, but further explanation is given below and this has been included in the document:

The remote mode uses two controls as apposed to one. Each reading needs an above canopy (or reading outside of the canopy) and a reading below the canopy. Because many sets were being taken, it is more convenient to have a control taking the readings outside the canopy while the readings beneath the canopy are being taken. Once all the readings have been take, the LI-COR software takes the above and below canopy readings and calculates the LAI for each set.

P5792 Eq5. The meaning of "R" has been added i.e. red. It is also mentioned on P5791 L28...Near infrared/red (NIR/R)....

P5792 Eq6: Yes, something did go wrong with the editing of the equation. The 3 should be superscript.

P5793 Eq3: should be λ (wavelength)

P5794 Eq11: removed "j"

P5795 L17: "...could be estimated i if the daily..." has been corrected to "...could be estimated if the daily..."

P5796 L26: the meaning of detrimental in this case is to have a negative effect/impact

on the outcome of the study.

P5797 L1-13: Xiao et al., (1998) found that modelling canopy interception was most sensitive to storage capacity and LAI as the storage capacity is directly related to the LAI. Similarly, Limousin et al., (2008) found that a 25% reduction in storage capacity reduces interception loss by 8.6%. This comment has been added to the text.

P5801 T1: The measurements were taken at 4:30 pm. The weather conditions were clear and sunny. This comment has been added to the text.

P5804 F2-4: There are the same number of data points for all tree species (i.e. 10 per specie). In the figure, some points are on top of each other making it look as though there are less for some.

Referee 2 (Anonymous)

With respect to comment (1) on the number of LAI plots measured and field data collection: "At each of the four study sites (i.e. 12 year old pine, 15 year old pine, 4 year old wattle and 10 year old eucalyptus) ten sets of four reading were taken at each plot for model development and then repeated for model validation. Each of the points were taken at random beneath the canopy." This has now been clarified in the text.

With respect to comment (2) on how the models were created: The models were developed by overlaying the points where the LAI readings were taken on the images that had been corrected with each of the three vegetation indices (i.e. NDVI, SAVI and Vogelmann 1). The pixel values for each point were then extracted and related to its corresponding LAI value. A linear regression model was then fitted to the data using Microsoft® Excel 2003. This has now been added to the text.

With respect to comment (3): Different points were used in the model development and verification and has been clarified in the reply to comment 1.

With respect to comment (4): There are a growing number of studies that are using

hyperspectral remote sensing to estimate the LAI of forest and crop canopies such as those by Delegido et al., (2008), Haboudane et al., (2004) and Zhang et al., (2005). This statement has been added to the text.

With respect to comment (5): The results section has been lengthened as per the referees request by addressing comment (6). The VOG1 index performed better than the NDVI and SAVI because it is a narrowband index as apposed to a broadband index. NDVI and SAVI are susceptible to saturating in dense vegetation. This saturation occurs when the vegetation index no longer increases significantly with an increase in biomass or LAI. This can be seen when using the SAVI for wattle 4yr and eucalyptus 10yr where the slope of the of the data points increases steeper than the trendline. The narrowband VOG 1 index penetrates deeper through the canopy and allows for better estimations of biomass or LAI in denser vegetation. This has been amended in the text.

With respect to the comment on how repeatable this study is elsewhere: The methodology used is repeatable elsewhere, but the models developed are site and image specific. This is because the reflectance values would vary in different images depending on which satellite was used to acquire the image and how the image was corrected.

P5786 L22: The word "underrated" has been changed to "neglected".

P5790 L4: "was" changed to "were"

The reference for the statement on P5791 L22-23 is: Gates, D.M.: Biophysical Ecology, Springer-Verlag, New York, pp. 611. 1980

The reference for the statement on P5791 L20-21 is: Dye, P., Megown, R., Jacobs, S., Drew, D., Megown, K., Dicks, M., Mthembu, S., and Pretorius, C.: Determining the water use and growth of forest plantations through the GIS-based integration of remote sensing and field data in the 3- PG model. Water Research Commission, Report No. 1194/1/02. Pretoria, 2002.

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