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Interactive comment on "Integrated radar and lidar analysis reveals extensive loss of remaining intact forest on Sumatra 2007–2010" *by* M. B.Collins and E. T. A. Mitchard

Anonymous Referee #2

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The research depicted in the discussion paper uses a combination of ground data and L-band SAR and LiDAR spaceborne imagery to assess deforestation over intact swamp forest in Sumatra (Indonesia) between 2007 and 2010. The methodology relies on producing an above ground biomass (AGB) map and a Lorey's height map for 2007, Lorey's height maps for 2008, 2009 and 2010, and assessing annual deforestation in the 2007-2010 period using a threshold of 10 m reduction in Lorey's height. Therefore, with this methodology it was possible not only to estimate the AGB C stocks in 2007 but also C fluxes due to deforestation (assuming all AGB was oxidised as a consequence of deforestation).

The methodology presented in this discussion paper has the potential to be used op-

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erationally by developing countries in their activities to prepare for REDD+ and other forest conservations programmes. However, one of the limitations in this methodology is access to LiDAR data required to calibrate the model between Lorey's height and L-band HV backscatter intensity. As mentioned by the authors currently there's no spaceborne sensor acquiring LiDAR data, so other alternatives must be sought to generate spatially explicit and extensive estimates of Lorey's height. Other limitations and shortcomings of the methodology that need to be addressed are:

1) The authors need at least to discuss the impact of using relatively small plots (0.25 ha) to estimate AGB in high heterogeneous tropical forests with regard to a recent paper: Rejou-Mechain, M. et al. (2014). Local spatial structure of forest biomass and its consequences for remote sensing of carbon stocks. Biogeosciences, 11, 6827-6840.

2) The impact of compressing ∼11,000 ICESat GLAS shots into 25 Lorey's height classes to establish the relationship between Lorey's height and ALOS PALSAR HV backscatter intensity.

3) The research aims at assessing the impact of deforestation over intact swamp forest; however, data collected from 6 plots in secondary peat swamp forest were also included in the equation relating AGB as a function of Lorey's height.

4) Provide a more detailed description about the methodology used to calibrate the ALOS PALSAR HV backscatter intensity between 2007 and 2008-2010. This is a critical step in the methodology and the paper would benefit if the authors could include some plots showing the HV backscatter intensity in the period 2007-2010 over unchanged forest areas before and after the calibration procedure.

5) The uncertainty analysis should also consider the following sources of error: i) model relating AGB to Lorey's height from the 42 plots, ii) model used to carry out the intercalibration of ALOS PALSAR HV backscatter intensity.

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Find below some specific comments:

Page 8574, lines 17-20. This might be true but as a consequence of combination of L-band SAR data and LiDAR shots.

Page 8574, lines 22-24. This sentence is implying that D&D in tropical regions occurs as a consequence of lack of market valuation for ecosystem services, which is misleading. Far more important direct (and indirect) drivers should be mentioned.

Page 8574, line 24. It would be useful to properly define what is deforestation and forest degradation in the context of this paper.

Page 8575, lines 19-23. An important initiative is missing, the UN-REDD programme.

Page 8575, lines 24-25. REDD+ "will" require the quantification of forest AGB.

Page 8576, lines 8-10. Remote sensing data from P-band SAR and LiDAR don't suffer (at least that much) from this saturation problem. In fact, that was the main reason for ESA selecting the BIOMASS mission.

Page 8577, lines 25-26. The expected launch date is 2020. Also, please include the following reference for the BIOMASS mission: Le Toan, T., Quegan, S., Davidson, M. W. J., Balzter, H., Paillou, P., Papathanassiou, K., et al. (2011). The BIOMASS mission: Mapping global forest biomass to better understand the terrestrial carbon cycle. Remote Sensing of Environment, 115(11), 2850–2860.

Page 8580, lines 15-16. The proposed method will be able to estimate deforestation but not degradation.

Page 8582, lines 9-11. Please include the date of the field data measurement.

Page 8582, lines 18-19. Please include the units of those three variables.

Page 8584, lines 6-7. The ALOS PALSAR mosaics (25-m spatial resolution) have already been multilooked (16-looks), so the mean over a 4x4 pixel window is not an initial

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multilooking procedure. Please see: Shimada, M., Itoh, T., Motooka, T., Watanabe, M., Tomohiro, S., Thapa, R., and Lucas, R. (2014). New Global Forest/Non-forest Maps from ALOS PALSAR Data (2007-2010). Remote Sensing of Environment, 155, 13-31.

Page 8584, lines 11-24. What procedure was put in place to guarantee that the ICESat GLAS shots in the 2003-2007 period correspond to the same (or approximate the same) vegetation structure that was imaged by the ALOS PALSAR sensor? E.g., an ICESat GLAS shot in 2003 over mature swamp forest, which was subsequently deforested in 2006, thus appearing in the 2007 ALOS PALSAR mosaic as being deforested.

Page 8585, line 17. Reference to Fig. 3 appears before reference to Fig. 2.

Page 8585, line 19. Equation 5 doesn't have any parameters.

Page 8589, lines 1-6. This approach might detect the few first rows of flooded forest close to the rivers (where the double bounce from the HH will cause higher backscatter values). But flooded forests are often not only in the close vicinity of rivers and might extent further inland, where that double bounce effect would not be visible.

Page 8591, lines 16-18. Can't these points with lower AGB and Lorey's height be early secondary forest? Also, on page 8585 (lines 10-11) it is mentioned that 25 bins were used (1, 2, . . ., 25). However, Figure 3 (and Table 1) is showing 26 points.

Page 8592, lines 6-7. This sentence is a bit confusing.

Figure 4. Please re-arrange the various components of this figure. The north arrow is far too big. There's no indication about the location of (d) and (e) in relation to (c).

Page 8594, lines 7-9. Approximately 11,000 ICESat GLAS shots were compressed into 26 (or 25?) Lorey's height bins, so a heavy average process was carried out and it's not so unexpected that model fit was good. It would be informative if the 95% confidence interval around the mean HV backscatter for each Lorey's height bin could be included in Fig. 3.

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Page 8594, lines 27-28. This reference is for Africa (Cameroon). Is it applicable to Indonesia? Does it estimate the combined uncertainty related to species identification, and height and AGB estimation?

Page 8595, lines 10-13. Usually the RMSE (%) is defined against the mean value.

Page 8597, Lines 12-16. This sentence is also a bit confusing. Figure 2 only shows 42 plots, as 14 plots were measured in swamp bush areas.

Interactive comment on Biogeosciences Discuss., 12, 8573, 2015.