Geophysical Research Abstracts
Vol. 13, EGU2011-297, 2011
EGU General Assembly 2011

Using satellite data to assess vegetation properties and recent changes in the African forest-savanna transition

Edward Mitchard (1), Patrick Meir (1), Sassan Saatchi (2), France Gerard (3), Iain Woodhouse (1), Simon Lewis (4), Ted Feldpausch (4), and Jon Lloyd (5)

(1) University of Edinburgh, School of GeoSciences, Edinburgh, United Kingdom, (2) NASA Jet Propulsion Laboratory, 4800 Oak Ridge Drive, CA, USA, (3) Centre for Ecology and Hydrology, Wallingford, UK, (4) Earth and Biosphere Institute, University of Leeds, Leeds, UK, (5) Faculty of Science, University of Queensland, Brisbane, Queensland, Australia

We present results showing that optical, radar and LiDAR data are sensitive to changes in woody cover and woody biomass in the west and central Africa's forest-savanna transition. Combining these different results, validated by extensive field data, we show that there has been significant woody expansion in this region across the past three decades, as well as some areas of deforestation.

The wide forest-savanna transition zone of Africa is currently poorly modelled by global vegetation models, and the carbon stocks and emissions of Africa are also very poorly constrained. This leads to great uncertainty about both the contribution of Africa to climate change, and the effects climate change will have on the continent. It is known that Africa is highly vulnerable to changes in precipitation and temperature, so decreasing this uncertainty is very important both for its human population, and to help efforts to preserve its ecological capital.

Using field inventory data collected during the TROBIT campaigns in 2007 in Cameroon, Mali, Ghana and Burkina Faso, in addition to 77 ha of field data collected in Gabon in 2009, we have been able to use remote sensing to map woody cover and woody biomass across West Africa. This has been done with a combination of L-band radar data (ALOS PALSAR), optical data (Landsat, ASTER, MODIS), and spaceborne LiDAR data (ICESat GLAS).

We have shown that cross-polarised L-band radar has a strong and consistent relationship with aboveground biomass (AGB) up to a saturation point around 150 Mg ha^{-1}. This can be used to create AGB maps of savanna and woodlands, and as the data is available from 2007 to present can be used to track dynamics, with us detecting significant deforestation and afforestation from 2007-2009 in a 40 000 km^2 area of Cameroon. From the same area, but over a longer timescale (1986-2006) using high resolution (30 m) optical data we have been able to track changes in woody cover, finding significant woody encroachment in the savanna regions. This has relied on using dry-season imagery, when the grass layer is dead but there are still leaves on the trees.

We have extended this analysis to a coarser resolution (500 m) using 16-day composites of MODIS data, and have shown that biomass and vegetation structure can be differentiated using phenological signals, elucidated by Fourier Transforms of the time-series; however these relationships vary markedly in space. Using coarser resolution AVHRR data (8 km) some of the resulting maps can be backdated to the early 1980's, however at this resolution, and given the calibration difficulties with AVHRR data, the results have high uncertainties. In general though they show a general expansion in the forest area across West Africa, though with some regions of obvious deforestation.

We have also found a strong relationship between a spaceborne LiDAR-derived measurement of basal-area weighted height and AGB on the ground. Though the LiDAR footprints from the GLAS instrument on the IceSAT satellite are widely spaced, covering less than 0.01 % of the land surface, they are evenly distributed, therefore both greatly expanding our 'ground-truth' dataset. We have developed a method whereby this can be used to map woody biomass well beyond the saturation limit of radar and optical data.

In conclusion, we have found that three different remote sensing systems (radar, optical and LiDAR data) can all be used to ascertain properties of the forest-savanna transition in Africa.